AMMONITE BIOSTRATIGRAPHY OF THE JURASSIC OF TANZANIA

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The present paper summarizes the previous biostratigraphical researches and incorporates the recent research findings on the Jurassic rocks in the coastal basin of Tanzania. The ammonites used for the biostratigraphical classification are from two sub-basins along the coastal belt of Tanzania: Mandawa (south) and Ruvu- Tanga (north). The oldest known ammonites from these basins are of Aalenian age. The biostratigraphical classification of the Jurassic sequence, on the basis of the vertical and horizontal distributions of the ammonite assemblages, permits the erection of eight sub stages of Jurassic: Upper Aalenian (Concavum-Zone), Bajocian (Humphrieasianum-Zone), Middle Callovian (Coronatum-Jason Zone), Upper Callovian (Lamberti-Athleta Zone), Lower Oxfordian (Cordatum-Mariae Zone), Middle Oxfordian (Transversarium-Zone), Lower Kimmeridgian (Tenuilobatus-PlatinotaZone)and Upper Kimmeridgian-Tithonian (Beckeri-Zone). This fauna assemblage forms an intergral part of the Indo-Madagascar Province and the Trans-Erythraean-Trough.

INTRODUCTION

The Jurassic rocks in Tanzania crop out along the coast belt in two basins, namely: the Ruvu-Tanga in the north, along which the NNE-SSW Tanga Fault Pattern is predominant and the Mandawa Basin in the south, which is characterized by the NNW-SSE Lindi Fault Pattern (Fig.1). The oldest sedimentary rocks in the two basins comprise continental Karoo sediments and occasionally evaporites of the Lower Jurassic to Triassic age. The geological investigations in the coastal basins of Tanzania began as early as 19th century. By 1894, Futterer had already initiated palaeontological investigations in the hinterland of Bagamoyo, where he described Oxfordian ammonites and correlated them with the contemporaneous fossil assemblage of India from the Dhosa Oolites. Following the excavations of the German Expedition between 1909 and 1913, many geological and palaeontological sites became well known including the famous locality Tendaguru where there is excellent assemblage of Late Jurassic dinosaur (Sauropods). During the construction of the central Railway between Dar es Salaam and Kigoma, first detailed Jurassic profile between Kidugalo and Ngerengere was taken by Henning (1914). Aitken (1961) published extensive work on the stratigraphy and palaeontology of the Mesozoic in the Mandawa Basin. Kent *et al.* (1971) Later extended these early researches among others. Zeiss (1979), Kapilima (1984), Groescke and Kapilima (1995) and Kapilima (2003) have published the more recent palaeontological investigations on the Jurassic ammonites Most of ammonites described from the Mandawa sub-basin were recovered from the Mandawa-Mahokonde anticline in the hinterland of Kilwa,.extending southerly to the Tendaguru hill in the hinterland of Lindi.The Jurassic sediments in this basin are sub-divided into three main lithostratigraphical units: Pindiro-Shale (Lower to Middle Jurassic), Mandawa-Mahokonde Beds (Bajocian to Kimmeridgian) and Tendaguru Beds

(Kimmeridgian to Lower Cretaceous).The Pindiro Shale consists of marls and shales rich in evaporitic deposits particularly gypsum. The Mandawa-Mahokonde Beds are largely represented by the intercalations of oolitic limestones and calcareous sandstones at the base of the section. The ammonites described by various authors from the Mandawa sub-basin have been encountered from the upper part of the the Mandawa- Mahokonde Beds comprising fossil-rich septarian marls and nodules.

In the Ruvu-Tanga sub-basin four major lithostratigraphic units are recognized: Ngerengere Formation (Lower to Middle Jurassic), Kidugalo-Formation (Aalenian), Lugoba-Formation (Bajocian) and Malivundo-Formation (Upper Callovian-Middle Oxfordian). The Ngerengere Beds are made up of continental arkosic sandstones and conglomerates of the Karoo facies. While the lower part of the Kidugalo Formation comprises silty calcareous sandstones and oolitic limestone void of significant fossils, the upper part is represented by ammonite-rich marl/ shale sequence at the vicinity of the Kidugalo railway station. The Lugoba Formation is characterized by occurrence of the coralliferous limestones forming scattered ridges from Msata to Lugoba. Recently, ammonites of the Bajocian age have been described from Msata (Kapilima 2003). The Malivundo Formation is very rich in septarian nodules from which well-preserved ammonites of the Callovian to Oxfordian age have been described (Kapilima 1984).
In view of the above mentioned scattered occurrences of these ammonites, one of the objectives of this paper is to provide a brief review of the previous research work on the ammonoid assemblages in the light of more recent fieldwork illuminating litho-and biostratigraphical sequence of the Jurassic rocks in Tanzania. Another aim is to present and discuss recent results obtained from the Jurassic palaeontological investigations carried out by the author from 1995 until now.

METHODS AND MATERIALS

Methods of investigations had involved re-examination and reviews of various previous researches on the Jurassic ammonoid assemblages in the Coastal Basin of Tanzania, aiming at updating the biostratigraphical classifications in accordance with the Jurassic International Stratigraphic Guide (Hedberg 1976). Where biostratigraphical gaps existed, based on more recent field observations and findings, the gaps were filled up through the erection of new ammonite-zonations.The biostratigraphical interpretations were based on comparative studies with ammonite zonations in EUROPE (Dietl 1977 & 1981),Madagascar (Arkell 1956, Collignon 1962) and Kenya (Westermann 1975).

RESULTS

So far there is no evidence of the occurrence of ammonites older than Middle Jurassic. The oldest known ammonites from the coastal basin of Tanzania are of the Middle Jurassic age (Aalenian). The biostratigraphical correlation of the Jurassic in Tanzania is shown in Table. 1.

Middle Jurassic (Aalenian)
Arkell (1956) gave for the first time the evidence of the occurrence ammonite species from the shale borehole samples at the vicinity of Kidugalo. From the shales, Arkell identified *Harpoceras (cf. Leioceras) acutum var. costatum* HORN. Kapilima (1984) who described ammonite species *Planammatoceras cf. klimakomphalum* (VACEK) from the marls at the Kidugalo railway station later confirmed the Aalenian age. The appearance of this form is an indicative of the *Concavum*-Zone.

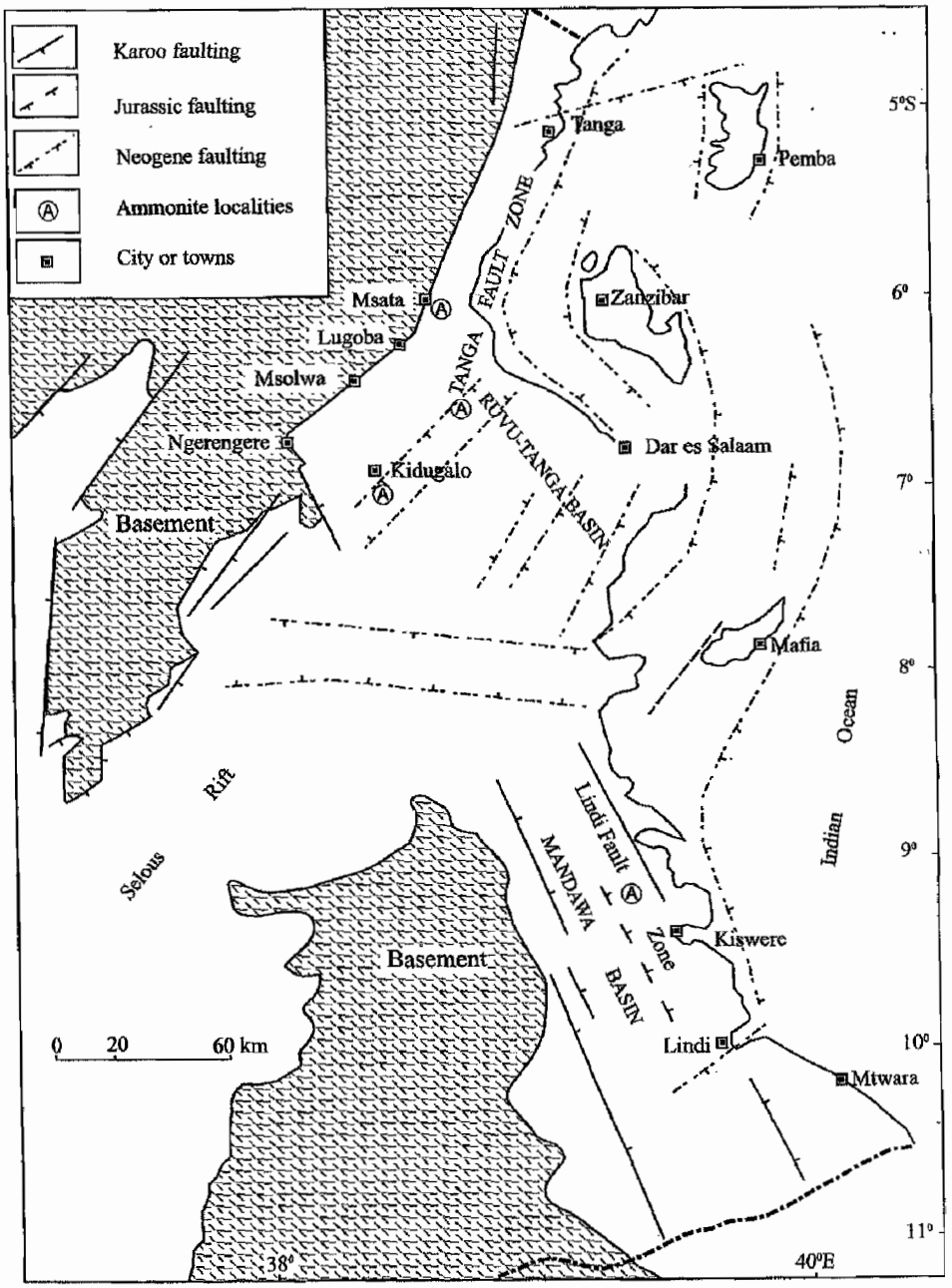

Fig. 1: Coastal Tanzania major structural features controlling the locations of the Mandawa and Ruvu-Tanga sub-basins

Table. 1 Biostratigraphical Correlation of the Jurassic in Tanzania

AMMONITE-BIOZONES OF THE MIDDLE & UPPER JURASIIC IN NW-EUROPE (Arkel 1957, Zeiss 1971, Schmidt Kaler & Zeiss 1973, Dietl 1981 etc)			RUVU-TANGA BASI (HINTERLAND OF DAR ES SALAAM & TANGA) NORTHERN TANZANIA	MANDAWA BASIN (HINTERLAND OF KILWA & LINDI) SOUTHERN TANZANIA
KIMMERIDGIAN	U	*beckeri*		*Sutneria casimiriana* *S. aff. harrina*
	M	*Eudoxus acathicum*		*Pachysphinctes africogermanus* *P. mahokondobeyrichi* *P. mullery* *Iodoceras richthofeni*
	L	*Tunulobatus platynota*		
OXFORRDIAN	U	*Planula bimammatum*		
	M	*Bifurcates transversarium plicatilis*	*Mayites cf. Maya,* *Epimayaites axonoides,* *Euaspidoceras douvellei*	*Mayaites spp., Arisphinctes cotovui* *Euaspidoceeras depresum*
	L	*Cordatum-mariae*	*Parawadekindia arduennensis* *Peltoceratoides cf. semirugous*	
CALLOVIAN	U	*Lamberti-athketa*	*Peltoceras trifidum* *Putealiceras intermedium* *Lunuloceras Pseudopunctatum*	
	M	*Coronatum-jason*		
	L	*Calloviense-macrocephalus*	*Macrocephalites (?)*	
BATHONIAN				
BAJOCIAN	U			
	L	*humpriesianum-sauzei*	*Dorsentensia romani* *Oecotaustes f. angustus*	
AALENIAN	U	*concavum*	*Planammatoceras cf. klimakomphalum*	
	M	*murchisonae*	*Harpoceras cf. Leioceras acutum*	
	L	*Opalinum*		

Middle Jurassic (Bajocian)

Two ammonite species of the Lower Bajocian age have been recently described by the author from the Msata hill in the hinterland of Dar es Salaam (see Kapilima 2003). The two forms, which include *Dorsetensia, cf. D. romani* (OPPEL) *and Oecostrausters (Paroecotraustes) cf. angustus* DOUVILLE *are good indicators of the Humpriesianum- Sauzei Biozones.*

Middle Jurassic (Bathonian-Lower Callovian)

Apart from the described ammonites from the hinterland of Dar es Salaam in the Ruvu-Tanga sub-basin of Aalenian and Bajocian ages, so far there is no record of the occurrence of the Bathonian-Lower Callovian ammonites in both sub-basins. However, from the hinterland of Tanga, it had been reported the occurrence of the ammonite species *Macrocephalites*

macrocephalus from the marls overlying the Bajocian-Bathonian Amboni Limestone (Arkell 1956). On the basis of modern palaeontologicsl classification, his identification is rather doubtful, as his form might as well belong to the *Oxfordian Mayaitids*.

Middle Jurassic (Middle – Upper Callovian)

Arkell(1956) has described the Middle Callovian ammonites, from the Mandawa sub-basin in the hinterland of Kilwa. The most stratigraphically important species included *Indosphinctes cf. indicus* (SIEMIRADZKI), *I. pseudopatina* (PARONA&BONARELI), *Choffatia aff. difficilis* (BUCKMAN) *and Grossouvria* spp. From the Ruvu-Tanga sub-basin, in the septarian nodules at Malivundo, Upper Callovian ammonite species were encountered: *Hecticoceras (Putealiceras) intermedium SPATH, H. (Lunuloceras) pseudopunctatum pseudopunctatum* (LAHUSEN), *Peltoceras trifidium* QUENSTEDT.These forms are part of the *Lamberti- Athleta* Zone.

Upper Jurassic (Oxfordian)

On the basis of the occurrence of the ammonite species *Parawedikindia arduenensis* (D'ORBIGNY) and *Peltoceratoides cf. semirugosus* (WAAGEN) in the septarian marls at Malivundo, the Malivundo Formation in the hinterland of Dar es Salaam is ascribed to the Lower Oxfordian age (*Cordatum-Mariae* Zone). The ammonite assemblage of the Middle Oxfordian (*Transversarium* Zone) is significant in both sub-basins. Futterer (1894), for the first time described the Oxfordian ammonites from the hinterland of Tanga.They included Mayaitids, Perisphintids and Euaspidoceras (see Arkell 1956). From the Wami river at the village of Mkoko and Malivundo areas in the hinterland of Dar es Salaam, the following Middle Oxfordian forms are common: *Mayaites cf. maya* (SOWERBY), *M. mahabobokensis* BASSE & PERRODON, *M. panganensis* (TORNQUIST), *Perisphinctes (Arisphinctes) cotovui* SIMIONESCU, *Epimayaites axonoides rigida* COLLIGNON *and Dhosaites otoitoides* SPATH.

Upper Jurassic (Kimmeridgian-Tithonian)

From the uppermost part of the Mandawa-Mahokonde Beds at the vicinity of the Nchia village, Groescke & Kapilima (1995) described ammonites of the Lower Kimmeridgian age *(Tenuilobatus-Platynota-Zone)* from the septarian marls: *Pachysphinctes africogermanus* DIETRICH, *P. mahokondobeyrichi* (DIETRICH), *P. mulleri* (BUCKHARDT), *P. recki* DIETRICH, *Idoceras mahokondobalderum* DIETRICH and *Aspidoceras richthofeni* MUELLER

The Tithonian ammonites described by Arkell (1956) from the Tendaguru Beds were re-examined and revised by Zeiss (1979). Zeiss assigned the Tendaguru Beds into Upper Kimmeridgian-Lower Tithonian on the basis of the following forms: *Sutneria aff. hararina* (VENZO), *S. casimiriana* (FONTANNES), *Micracanthoceras sp. and Taramelliceras.*

DISCUSSION

The oldest known Jurassic ammonites in the Trans-Erythraen Trough Realm including Saudi Arabia, Kenya and Madagascar are of the Lower Toarcian age belonging to the genus *Bouleiceras*. The term Trans-Erythraean Trough was conceived as an illustration of an elongate epeiric sea stretching from Saudi-Arabia southward through parts of Ethiopia, Somalia and Kenya to reach the shores of the Indian Ocean. The occurrence of this ammonite form in this realm and other parts of the world such as North Africa, Portugal, Spain and Pakistan, is a clear indication of the existence of the marine migration route between the East African Coast and the western part of the Middle Sea during

Toarcian times. This marine connection is related to the early stages of the fragmentation of the Eastern Gondwana. Besides the occurrence of this form in the Trans-Erythraean Trough, it is also known to occur in Chile and Argentina (v. Hillebrandt. 1973) suggesting the existence of marine connection between the western coast of South America and the East African Coast. The migration route might have occurred through the southern tip of Africa to the East African Coast and extended to Tethys sea. However, this route is doubtful since marine fauna of this age is not known to occur south of Madagascar as well as in Tanzania. In the light of existing palaeontological data, it is reasonable to accept that the exchange route of the marine organisms between the East African Coast and South America was via the Mediterranean and Central America Realms and not through the southern tip of Africa.

Most of ammonite species identified in Tanzania from the Aalenian to the Lower Tithonian sediments form an intergral part of the Indo-Madagascar Palaeobiogeographic Province, reflecting the opening of the Indian Ocean (neritic environment) in the East African coast. The Aalenian ammonites of the *Concavum* Zone at Kidugalo show many affinities with the contemporaneous forms from Europe, Australia and South-America (Westermann and Riccardi 1982). Similarly, the Bajocian forms observed at Msata closely resemble the Bajocian assemblage of Kenya and Madagascar. The Callovian collection in Tanzania is comparable with other forms in Europe and the Indo-Madagascar Province. The Upper Callovian *Hecticoceras* s.l., *Peltoceratoides* in Tanzania is a clear indication of the marine connections with Europe. However the Oxfordian ammonite assemblages including Mayaitid forms are rather endemic forms in the Indo-Madagascar Province.

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