Riv. It. Paleont. Strat.	v. 89	n. 1	pp. 31–46	tav. 2	Ottobre 1983

OCCURRENCE OF LIASSIC FAUNAS AT WAANEY (UANEI) PROVINCE OF BAY, SOUTH–WESTERN SOMALIA

PAOLO CANUTI (*), MILVIO FAZZUOLI (*), GIOVANNI FICCARELLI (**) & FEDERICO VENTURI (***)

Key–words: Somalia, Stratigraphy, Liassic, Ammonites, *Protogrammoceratinae*.

Riassunto. La successione affiorante a Waaney (Somalia sud–occidentale) è costituita, dal basso verso l'alto, dai seguenti livelli: A) Calcari marnosi nerastri, spessore 20 m; B) Marne ed argilliti grigie e verdastre, spessore 10 m; C) Calcare vacuolare grigio–giallastro, spessore 6 m; D) e F) Calçare bioclastico grigio scuro in strati spessi fino ad un metro, spessore 54 m; E) e G) Calcari bruno–giallastri o rosati a struttura nodulare o brecciata, con due livelli ricchi in Ammoniti, spessore oltre 45 m.

I caratteri sedimentologici indicano che l'ambiente di sedimentazione è passato da una laguna ristretta con apporti clastici fini e probabili episodi evaporitici ad un ambiente francamente marino, relativamente poco profondo e con condizioni di energia variabile, ed infine ad un ambiente di mare più profondo ma parzialmente ristretto, con presenza di fauna oligotipica.

Il materiale paleontologico raccolto nei livelli E) e G) è costituito da circa 40 esemplari di Ammoniti, di taglia variabile da 6 a 15 cm, fossilizzati in calcare grigio–giallastro. Gli Ammoniti del livello E) sono riferibili, con riserva, al genere *Protogrammoceras* e alla specie *Protogrammoceras madagascariense*; quelli del livello G) a *Protogrammoceras madagascariense* ed al genere *Hildaites*. Considerazioni biostratigrafiche sulla Provincia etiopico–indo–malgascia e su aree esterne a detta Provincia, fanno ritenere che l'associazione ad Ammoniti del livello E) sia da attribuire al Toarciano basale e l'associazione del livello G) al Toarciano inferiore.

I dati paleontologici e sedimentologici sono in accordo con i precedenti ritrovamenti di faune liassiche in Arabia, nella Somalia Settentrionale e nel Kenya Nord–orientale.

Summary. The sequence exposed at Waaney (South–western Somalia) consists, from bottom to top, of the following horizons: A) Blackish marly limestones, thickness 20 m; B) Grey and greenish marls and shales, thickness 10 m; C) Vacuolar yellowish–grey limestone, thickness 6 m; D) and F) Bioclastic, dark grey limestones in beds up to 1 m thick, thickness 54 m; E) and G) Yellowish–brown or pink limestones with nodular or brecciated structure, with two levels rich in Ammonites, thickness over 45 m.

Sedimentological features give evidences that the environment evolved from restricted lagoon with fine terrigenous supply and probable evaporitic episodes to shallow sea with varying energy conditions and eventually to deeper but partially restricted sea with oligotypic fauna.

Fossils collected in the E) and G) levels include about 40 specimens of Ammonites of size varying from 6 to 15 cm, fossilized in a yellow–grey limestone. The Ammonites of the E) level may be referred to the genus *Protogrammoceras* (?) and to the species *Protogrammoceras madagascariense*; the Ammonites of the G) level to the *Protogrammoceras madagascariense* and to the genus *Hildaites*. The Ammonite association of the E) level seems to indicate a Lowermost Toarcian age; the association of the G) level an Early Toarcian age, on the ground of biostratigraphic investigations in the Ethiopian–Indo–Malagasy region and in areas outside this Province.

The palaeontological and sedimentological data agree with previous findings of Liassic faunas in Arabia, in Northern Somalia and in North–eastern Kenya.

(*) Istituto di Geologia e Paleontologia dell'Università, via G. La Pira 4, 50122 Firenze.
(**) Istituto di Geologia dell'Università, via E. Betti, 62032 Camerino.
(***) Istituto di Geologia dell'Università, Piazza Università, 06100 Perugia.

Introduction.

The present work illustrates the geological and palaeontological results of collections made by P. Canuti and M. Fazzuoli in August 1980 in the area of Waaney (South–western Somalia, Province of Bay), as part of a research program promoted by the C.N.R. of Italy in East Africa.

A substantial support to these investigations was provided by the Faculty of Geology of the National University of Somalia. The authors wish to express their thanks to the Dean, Prof. Ibrahim Hersi, and to the President of the Technical Committee, Prof. Giuliano Piccoli. Particular gratitude is expressed to Dr. Maxamuud Cabdi Caarush, whose friendly solecitude determined the success of our mission.

Geological setting.

In South–western Somalia, the base of the Jurassic sedimentary sequence, unconformably resting on the crystalline basement, is represented by the Iscia Baidoa Fm. (Dominco, 1966), exposed near the town of Iscia Baidoa, on the northern border of the Bur District. The Iscia Baidoa Fm. (Hamanlei Fm. p.p., Azzaroli & Canuti, 1979) has been subdivided into four members: a) a thin basal clastic level (Deleb Mb.), overlain and probably laterally substituted by: b) a marly–calcareous level (Uanei Mb.), underlying two calcareous levels: c) Baidoa Mb. and d) Goloda Mb. (Dominco, 1966).

The Baidoa Mb. forms a prominent cuesta, raised some tens of meter on the crystalline basement and extended laterally for about 100 km; the structure consists of a gently tilted ($< 5°$) monoclyne, dipping NNE.

The type section of the Uanei Mb. is exposed some 15 km NE of Iscia Baidoa, in the locality Waaney (Uanei) (Dominco, 1966). This locality derives its name from a watering place, near the contact between the sedimentary and the crystalline, the latter forming the base level along which the water emerges.

The lithology of the Uanei Mb. was described by Dominco (1966) as an alternating succession of shales, marls and limestones with a thickness of about 120 m; the age was tentatively determined as early Callovian, on evidences provided by Ammonites.

Detailed observations, made in the locality Waaney by Canuti and Fazzuoli, showed that the actual contact between the crystalline basement and the sedimentary is covered by alluvium and travertine deposits; that the basal clastic level is covered by eluvium and that the type–section of the Uanei Mb. is exposed in two scarps separated by and culminating into flat areas, covered by caliche (Fig. 1). Presumably, the lithotype corresponding to the flat areas is made by shales and/or marls, which outcrop for a small thickness in the lower scarp.

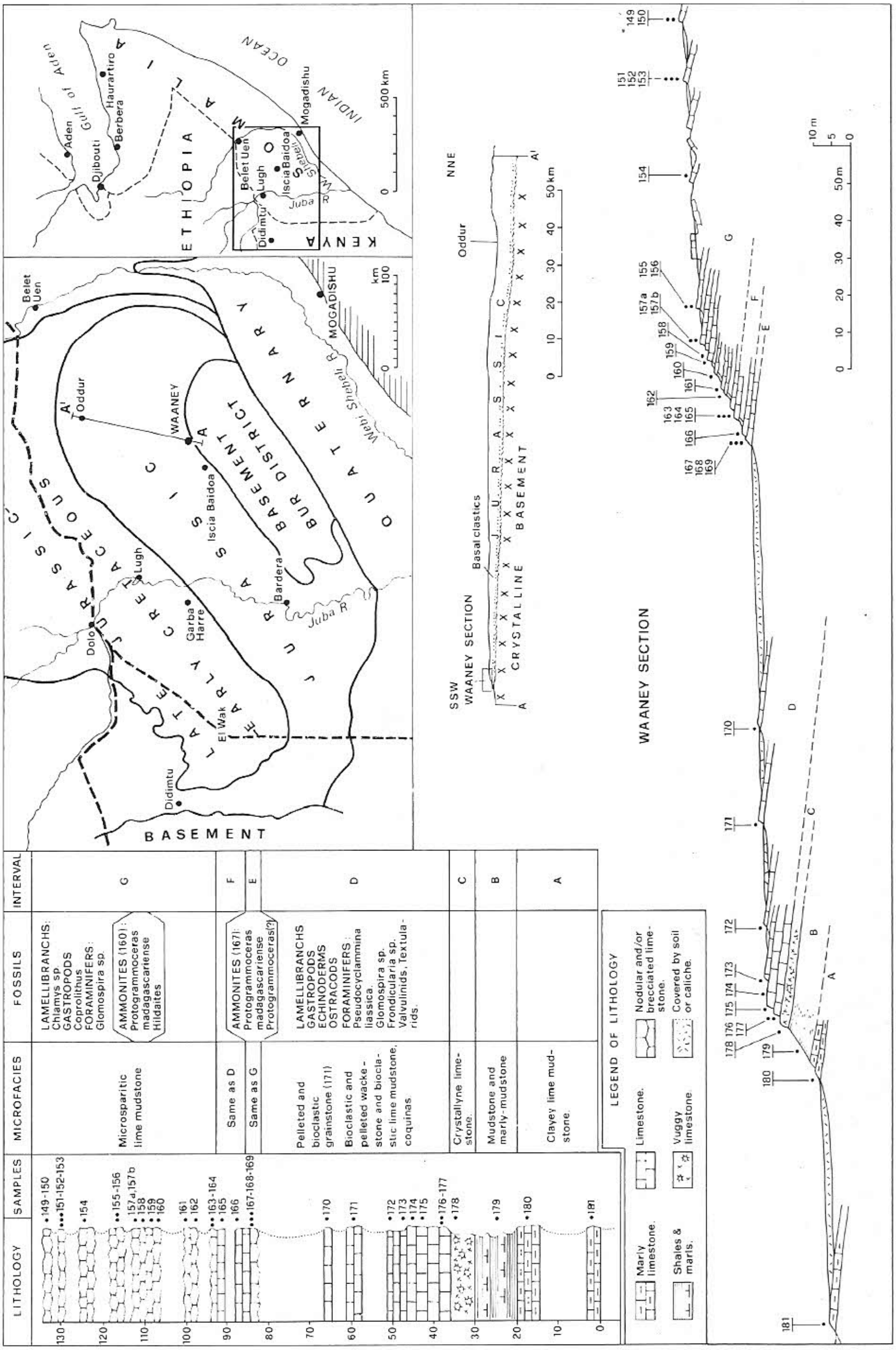

Fig. 1 – Geological cross section and lithostratigraphic column of the outcrop of Waaney.

The section results 134 m thick, but the thickness is indicative, as the topographic profile was reconstructed on the basis of reconnaissance field measurements; it differs little, however, from the thickness quoted above (Dominco, 1966).

Lithology, microfacies, fossils.

Seven levels with clearly distinct litho– and microfacies were recognized in the section (Fig. 1):

Interval A (0 – 20 m) forms the lower flat area, largely covered by caliche. Blackish marly limestones in beds 10–30 cm thick are exposed. These consist of lime mudstones impure for a large content in clay, with detrital quartz of the size of silt. No fossils were observed.

Interval B (20 – 30 m) forms the lower and the middle portion of the lower scarp. It is made of incompetent greenish marls and greenish–grey shales, with slaty or acicular cleavage, barren of fossils.

Interval C (30 – 36 m) forms the upper part of the lower scarp and is made of vacuolar and powdery, yellowish–grey, crystalline limestone. No fossils were found.

Intervals D and F (36 – 82 m; 85 – 92 m). The interval D forms the topmost part of the lower scarp and the intermediate flat area, where a thick caliche crust is developed and outcrops are scanty; the interval F forms the lower part of the higher scarp. In both intervals the lithology consists of dark–grey limestones in beds from 30 cm to 1 m thick. These are bioclastic and pelleted wackestones, occasionally forming true coquinas, and alternate with more or less bioclastic lime mudstones. In the upper part of the interval D, foraminiferal and pelleted grainstones were observed. Identified fossils are Lamellibranchs, Gastropods, Echinoderms, Ostracods and Foraminifera. Among the latter are: *Pseudocyclammina liassica, Glomospira* sp., *Frondicularia* sp., Valvulinids, Textulariids.

Intervals E and G (82 – 85 m; 92 – 134 m). The interval E is present at the base of the higher scarp; the interval G forms the middle and the upper part of the higher scarp and the terminal flat area. Beds may reach thickness of 60–70 cm and are generally well exposed; occasionally, they are more or less displaced along the slope. The lithology is varied and consists mainly of limestones with more or less brecciated and nodular structure; these lithotypes frequently repeat. Some marly limestone levels are present. The colour of the limestones and of the marly limestones is yellowish–brown, occasionally pinkish. The limestone beds consist of microsparitic lime mudstone rich in iron oxides. Megafossils are abundant at least in two distinct levels (Samples S.80.167 and S.80.160) and are represented by Ammonites, Lamellibranchs and Gastropods. Recognized microfossils are: *Glomospira* sp., *Coprolithus* (?).

In the lower level (S.80.167) the macrofauna is represented by:
Protogrammoceras madagascariense (Thévenin)
Protogrammoceras sp.
Chlamys sp.

In the upper level (S.80.160) the following taxa are represented:
Hildaites sp. ind.
Protogrammoceras madagascariense (Thévenin).

Sedimentological features.

Sedimentological features observed in the lower intervals give evidence for a marine, low turbolence environment, with rich, very fine–grained terrigenous supply. Evaporitic episodes may probably be inferred. In the intermediate part of the section, a shallow–water marine environment with higher, even though intermittent, turbolence, can be identified.

In the higher interval the nodularity, the reddish stain due to the presence of iron oxides and the intensive recrystallization would suggest an environment of greater depth than the base levels of waves, of relatively low energy and with reducing conditions and intensive activity of bioturbating organisms. Considering the relatively low depth of deposition, the nodularity may be due to differential compaction of non bioturbated sediments as compared to bioturbated portions (Eller, 1981).

In conclusion, the sedimentary sequence seems to indicate initially a low–energy, restricted lagoon environment with fine–grained terrigenous supply and probable evaporitic episodes. A frankly marine environment of relatively low depth with muddy and sandy carbonate banks and shoals followed and progressively deepened, without reaching the stage of a true open sea, as evidenced by oligotypic Ammonite fauna.

Biostratigraphy.

The microfauna of the Waaney sequence does not provide evidence for datings of great detail because the stratigraphic range of the taxa identified spans a rather wide time. The megafauna, which is almost entirely represented by Ammonites, turned out to be much more significant for the definition of the time interval during which the Waaney sequence was formed. These Ammonites are well represented in number of specimens, but are poorly preserved and unsuitable for identifications at species level, but their determination at genus level provides significant information on the chronology. Some specimens display rather peculiar morphologies which make their generic attribution questionable, and no doubt require closer investigation.

Two associations have been recognized:

2) *Protogrammoceras madagascariense – Hildaites* level, of Early Toarcian age;

1) *Protogrammoceras madagascariense – Protogrammoceras* (?) level, of probably lowermost part of Early Toarcian age.

The most recent and complete studies on the Ethiopian–Indo–Malagasy province were carried out on faunas from Madagascar by Blaison (1967), who recognized this succession, from top to bottom:

7)	Level with	*Nejdia pseudogruneri*		
6)	" "	*Parahildaites sanderi*		
5)	" "	*Hildoceras* sp.		
4)	" "	*Hildoceras madagascariense*	I–K	(K)
3)	" "	*Protogrammoceras madagascariense*	F–K_2	(J)
2)	" "	*Bouleiceras nitescens*	G–K_1	(H_{2-1})
1)	" "	*Paltarpites termieri*		(E–F)

Comparison between our associations and the successions proposed by Blaison reveals interesting differences. Of all the taxa recorded by Blaison, only *Protogrammoceras madagascariense* occurs at Waaney and this may be evidence of unusual environmental conditions, such as probably a restricted basin. The peculiar feature of the Waaney Ammonite fauna makes the correlation with Blaison's zones rather conjectural. Keeping in mind the stratigraphic distribution of the taxa studied here in the Mediterranean and in the Ethiopian–Indo–Malagasy areas, the *Protogrammoceras madagascariense – Hildaites* level of Waaney may reasonably be correlated with Blaison's *Bouleiceras nitescens* or *Protogrammoceras madagascariense* level, and the *Protogrammoceras madagascariense – Protogrammoceras* (?) level with the same level or with the *Paltarpites termieri* level.

Concluding remarks.

In a regional setting, the Waaney sequence, of Lowermost Toarcian – Early Toarcian age, seems to be slightly older than the lowest calcareous levels above the basal sandstones at Haurartiro, Northern Somalia (S.O.E.C., 1954) and in the Didimtu Beds of NE Kenya (Thompson & Dodson, 1960) (Fig. 2), characterized by the occurrence of *Bouleiceras.*

Moreover the attribution of a Liassic age to the Uanei Mb. rectifies a recent opinion by Canuti and Merla (1979, schematic cross–sections 2 and 3) according to which the base of the Hamanlei limestones resting on the basement is of Callovian age near Iscia Baidoa, on the ground of a former unpublished classification of the Ammonites of the Uanei Mb. by Dominco (1966). Now we know that the sea transgressed the crystalline basement contemporaneously both sides of the Mandera – Lugh Basin.

Besides East Africa, the presence of *Bouleiceras* and *Protogrammoceras* (Howarth, 1973) characterizes the Early Toarcian transgression also in Central Arabia (Jebel Tuwaiq) (Arkell, 1952; Powers et al., 1966), in Pakistan (Fatmi, 1972 in Hallam, 1978), and in NW Madagascar (Thévenin, 1908). All these areas, which are included in the so called «Ethiopian Province» (Hallam, 1975) bounded the shallow marine gulf which, as a southerly directed arm of the Tethys, started to form during the Lias. It is questionable to infer the length and the width of this gulf since there is a considerable uncertainty about the Jurassic position of the Madagascar and India with respect to Africa (for a review of the different hypotheses, see Powell et al., 1980). But whatever that position may have been, it is reasonable to presume that the gulf was bounded on his western side by Arabia and East Africa and on his eastern side by Pakistan–NW India and NW Madagascar (Fig. 2).

As to the western side of the gulf, where frankly marine facies (mainly with Ammonites) of Lower Toarcian age are present (Fig. 2), it is possible to distinguish an «Arabian Bay» to the north and a «Somali Bay» to the south (cf. Arkell, 1952), both open to the east.

The «Arabian Bay» was bounded to the south by the areas of Yemen and Aden–Hadramaut, where older marine fossils are of Callovian (Beydoun, 1966) or Upper Bathonian age (Hallam, 1975).

In the «Somali Bay», Liassic faunas have been found at Haurartiro (western side of the Ahl Madò) (S.O.E.C., 1954), at Waaney, on the eastern side of the «Mandera–Lugh Basin» and at Didimtu, on the western side of it (Thompson & Dodson, 1960). Moreover, microfossils indicative of Liassic age have been found in oil wells of the «Somali Embayment» and of the «Somali coastal basin» (Barnes, 1976; Kamen–Kaye & Barnes, 1979; Angelucci et al., 1980). Levels with probable «*Lithiotis*» facies, of Liassic age in the Tethyan region (Broglio Loriga & Neri, 1976), occur at Matagoi (SW Somalia) (Stefanini, 1931–36).

During the Lias, all these areas were part of the same peneplained region which was invaded from E–NE by the sea (1). Later on, these areas had different tectonic and sedimentary evolution (fig. 9 in Kamen–Kaye & Barnes, 1979).

(1) The Dainelli's assumption of a morphological cause for the lack of the basal Jurassic sediments at several places of Somalia and Ethiopia, that is, of remnants of ancient mountains on the crystalline peneplain (Dainelli, 1943, v. 2, p. 591, figs. 41–44) is certainly untenable (Merla, 1979, ∮15), but Dainelli was justified, at least in the case of the so called Danakil Alps, by the Vinassa de Regny's cross sections at Subucle (Dainelli, 1943, v. 2, p. 412, fig. 29). This cross–section, even if without altitude indications, inevitably suggests that the Jurassic limestones, that form one slope of a valley, abut against the basement rocks outcropping on the opposite slope.

What Vinassa, and consequently Dainelli ignored, was the existence of faults separating the opposite slopes of the valley.

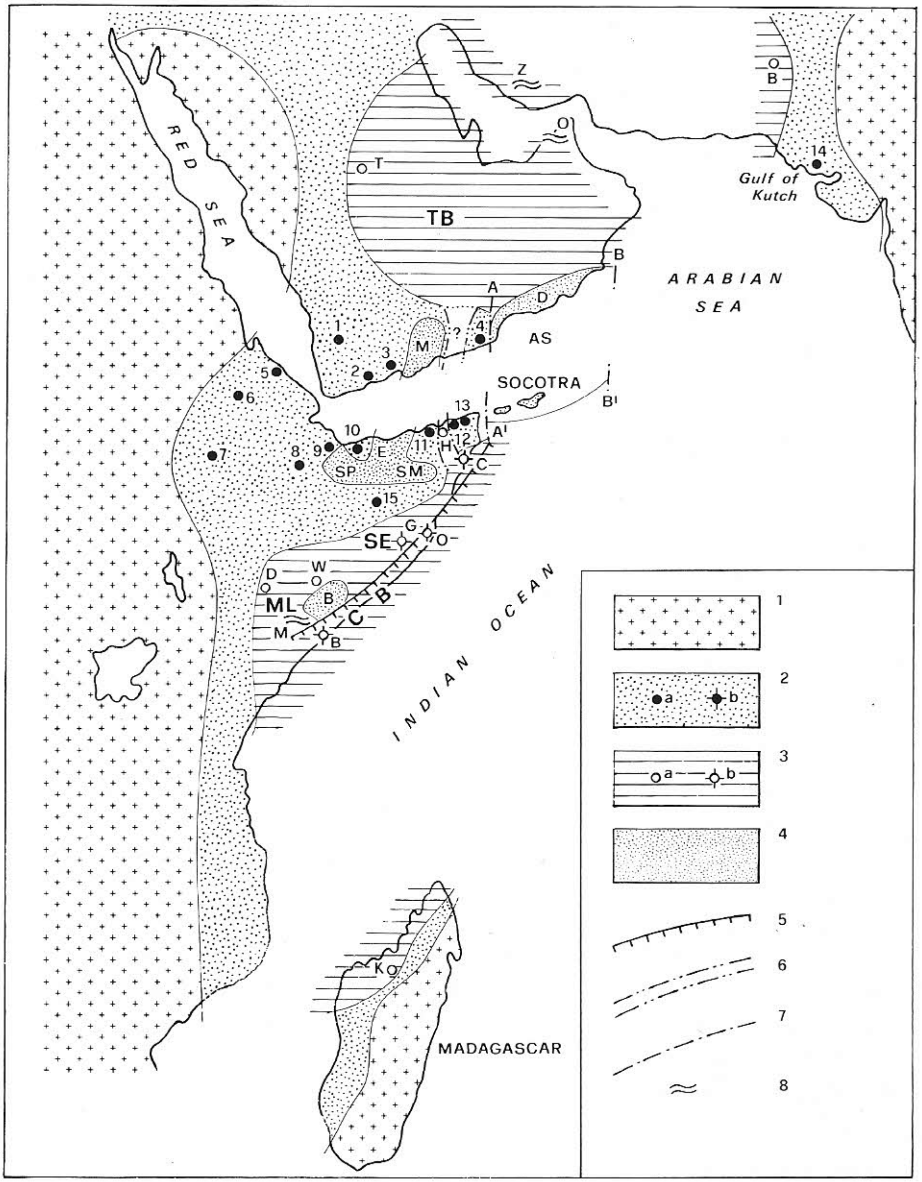

Fig. 2 – Tentative palaeogeographic sketch–map of Arabia – East Africa – Madagascar – NW India in the Lower Toarcian. Present land and sea distribution, small islands excluded. (Sources of data: Arkell, 1952; Azzaroli & Fois, 1964; Barnes, 1976; Beydoun, 1966; Broglio Loriga & Neri, 1976; Bruni & Fazzuoli, 1980; Goldberg & Friedman, 1974; James & Wynd, 1965; Hallam, 1975; Hallam, 1978; Howarth, 1973; Kamen–Kaye, 1978; Kamen–Kaye & Barnes, 1979; Ricateau & Riche, 1980; Swarts & Arden, 1960).

1) Probable land areas.

Both in Arabia and in Somalia–Kenya, the frankly marine sedimentation area was bounded to the west by belts of continental and/or littoral clastic sedimentation (Kohlan Ss., Adigrat Ss., Mansa Guda Ss.) with possible evaporitic episodes, along the crystalline basement of the Nubian shield.

During the Upper Bathonian eustatic rise, the coastline was displaced remarkably toward the west and most of these areas (Fig. 2) acquired the features of a neritic environment, characterized by the occurrence of the so–called «*Eligmus* fauna» (Arkell, 1952; Kamen–Kaye, 1978).

It is not clear how the «Arabian Bay» and the «Somali Bay» were connected during the Lias. The occurrence of Liassic faunas could indicate a narrow connection in the Haurartiro region; but at Ras Sharwayn, on the corresponding Arabian side (Beydoun, 1970), Liassic faunas are missing and the older fauna is Callovian in age (Beydoun, 1966). Moreover, east of Haurartiro, at Majaian (Ahl Madò) and at Ras Hantara, the lowest fossiliferous level contains marine Lamellibranchs and Brachiopods indicating a rather Early Callovian (Bruni & Fazzuoli, 1980), or Upper Bathonian. Therefore, if a connection existed between the «Arabian Bay» and the «Somali Bay» at Haurartiro, this had to be a narrow sea–channel, bounded by emerged highs (Erigavo–Mukallah High (?) (Bruni & Fazzuoli, 1980), and/or by submerged shallow banks. It could be also likely that the Haurartiro region was a small gulf into the northern side of the «Somali Bay».

As to the main connection between the «Arabian Bay» and the «Somali

---

2) Areas, where pre–Bathonian sediments consist of continental–littoral clastics and evaporites: a) Outcrops (1, Amran; 2, Shuqrah; 3, Madbi; 4, Ras Sharwayn; 5, Danakil Horst; 6, Mekele; 7, Blue Nile (Abbai); 8, Harar – Dire Dawa; 9, Borama; 10, Bihendula; 11, Hedigale; 12, Ahl Madò – Majaiàn; 13, Ras Hantara; 14, Kutch); b) Oil wells (15, Sinclair XEF 1 Galadi).

3) Areas with frankly marine liassic sediments: a) Outcrops (B, Baluchistan; D, Didimtu; H, Haurartiro; K, Kandraho; T, Jebel Tuwaiq; W, Waaney); b) Oil wells (B, Sinclair 1 Brava; C, Agip 1 Cotton; G, Sinclair 1 Gira; O, Sinclair 1 Obbia); Sedimentary basins (TB, Tuwaiq Bay; ML, Mandera–Lug Basin; CB, Somalia Coastal Basin; SE, Somalia Embayment).

4) Areas with Cretaceous on the basement, possibly corresponding to hypothetical Jurassic structural highs and/or at regions upwarped during lower Cretaceous (EM, Erigavo–Mukallah High; AS, Arabo–Somali Massif; SM, Sileh Madu Range; SP, Somali Plateau; B, Bur Region).

5) Somalia coastal fault system.

6) Hypothetical narrow seaway connecting the Tuwaiq Bay and the Somali Embayment through Haurartiro (or Haurartiro Gulf).

7) Hypothetical western connection between the Tuwaiq Bay and the Somali Bay: A–A', west of Dhufar High; B–B', east of Dhufar High.

8) Occurrence of «*Lithiotis*» facies (M, Matagoi; O, Oman; Z, Zagros Mt.).

Bay», i. e. as to the eastern extension of an hypothetical «Arabo–somali peninsula», two alternatives can be put forward: a) the coastline was placed between the present Cape Guardafui and the «Dhufar High» (Beydoun, 1966) (Line A–A' in Fig. 2) and b) the coastline was placed east of the «Dhufar High» (Line B–B' in Fig. 2).

As to the case a), there are no evidences of Liassic frankly marine deposits in Dhufar and Socotra. On the contrary, the occurrence in the Dhufar area, between the basement and the overlying sediments of Aptian–Albian age, of scattered patches of continental sandstones with spore and pollens indicating a Liassic age (Beydoun, 1966), clearly correlable with the Adigrat Ss., led to hypothesize a Jurassic history of Dhufar (and probably of Socotra) similar to that of western areas. In this case, the area including Dhufar and Socotra («Arabo –Somali Massif» in Arkell, 1952) of continental environment during the Lias, probably underwent a marine transgression during Upper Bathonian and, in analogy with the Somali Plateau (Bruni & Fazzuoli, 1980), a tectonic upwarping during terminal Jurassic (Beydoun, 1970) or Lower Cretaceous (Kamen–Kaye, 1978), that led to the almost complete erosion of the Jurassic sediments.

Acknowledgements.

The Authors are very grateful to Prof. G. Merla, to Prof. E. Abbate and to Prof. A. Azzaroli for critical reading of the manuscript.

This work was made possible through the financial aid of the National Research Council of Italy (C.N.R.) – Ricerche interdisciplinari in Africa Orientale.

REFERENCES

Angelucci A., Barbieri F., Cabdulqaadir Maxamuud Maxamed, Maxamuud Cabdi Caarush & Piccoli G. (1980) - Preliminary Report on the Jurassic sequence in the Gedo and Bay Regions (South–western Somalia). *Quaderni Geologia Somalia*, v. 4, pp. 115–154, Mogadiscio.

Arkell W. J. (1952) - Jurassic Ammonites from Jebel Tuwaiq, Central Arabia. *Phil. Trans. R. Soc. London*, s. B., v. 236, pp. 241–313, London.

Azzaroli A. & Canuti P. (1979) - The Mesozoic of Somalia. In: Merla G., Abbate E., Azzaroli A., Bruni P., Canuti P., Fazzuoli M., Sagri M. & Tacconi P. - A Geological Map of Ethiopia and Somalia (1973), 1:2.000.000 and Comment with a Map of Major Landforms, pp. 33–37, Firenze.

Azzaroli A. & Fois V. (1964) - Geological outlines of the Northern End of the Horn of Africa. *Proc. 22nd Int. Geol. Congr.*, New Dehli, v. 4, pp. 293–314, New Delhi.

Barnes S. U. (1976) - Geology and Oil Prospects of Somalia, East Africa. *Am. Ass. Petr. Geol. Bull.*, v. 60, pp. 389–413, Tulsa.

Beltrandi M. P. & Pyre A. (1973) - Geological evolution of Southwest Somalia. In: Bassins sédimentaires du littoral Africain. Sedimentary basins of the African Coast. Pt. 2nd. *Ass. Serv. Geol. Afr.* pp. 159–178, Johannesburg.

Beydoun Z. R. (1966) - Geology of the Arabian Peninsula – Eastern Aden Protectorate and Part of Dhufar. *U. S. Geol. Surv. Prof. Paper*, v. 560 H, 49 pp., Washington.

Beydoun Z. R. (1970) - Southern Arabia and Northern Somalia: comparative Geology. *Phil. Trans. R. Soc. London*, v. 267, pp. 267–292, London.

Blaison J. (1967) - Etudes biométriques et révision de l'espèce *Protogrammoceras madagascariense* (Thévenin) 1908. *Ann. Sc. Univ. Besançon*, 3e s., Géologie, v. 3, pp. 59–105, Besançon.

Broglio Loriga C. & Neri C. (1976) - Aspetti paleobiologici e paleogeografici della facies a «*Lithiotis*» (Giurese inf.). *Riv. It. Paleont. Strat.*, v. 82, pp. 651–706, Milano.

Bruni P. & Fazzuoli M. (1980) - Mesozoic structural evolution of the Somali coast of the Gulf of Aden. In: Geodynamic evolution of the Afro–Arabian Rift System. *Acc. Naz. Lincei*, Consiglio Naz. Ricerche, pp. 193–207, Roma.

Canuti P. & Merla G. (1979) - Tectonics. In: Merla G., Abbate E., Azzaroli A., Bruni P., Canuti P., Fazzuoli M., Sagri M. & Tacconi P.- A Geological Map of Ethiopia and Somalia (1973), 1:2.000.000 and Comment with a Map of Major Landforms, pp. 85–87, Firenze.

Dainelli G. (1943) - Geologia dell'Africa Orientale. 4 volumes. R. Acc. Italia, Centro Studi Africa Orientale Italiana, Roma.

Dominco E. (1966) - Geology of the Baidoa–Oddur Area. Hammar Petroleum Co., Unpubl. Rept., Mogadiscio.

Eller M. G. (1981) - The red Chalk of Eastern England: A Cretaceous Analogue of the Rosso Ammonitico. In: Farinacci A. & Elmi S. (Eds.) – Rosso Ammonitico Symposium Proceedings, pp. 207–231, Roma.

Flores G. (1960) - Suggested origin of the Mozambique Channel. *Trans. Geol. Soc. South Africa*, v. 73, pp. 1–16, Pretoria.

Fucini A. (1900) - Ammoniti del Lias medio dell'Appennino centrale. *Palaeont. Ital.*, v. 6, pp. 17–78, Pisa.

Fucini A. (1908) - Synopsis delle Ammoniti del Medolo. *Ann. Univ. Tosc.*, v. 28, pp. 1–102, Pisa.

Goldberg M. & Friedman G. M. (1974) - Palaeoenvironments and palaeogeographic evolution of the Jurassic system in Southern Israel. *Geol. Surv. Israel Bull.*, v. 61, pp. 1–44, Jerusalem.

Guex J. (1973) - Aperçu biostratigraphique sur le Toarcien inférieur du Moyen–Atlas marocain et discussion sur la zonation de ce sous–étage dans les séries méditerranéennes. *Ecl. Geol. Helv.*, v. 66, pp. 493–523, Basel.

James G. A. & Wynd J. G. (1965) - Stratigraphic nomenclature of Iranian Oil Consortium Agreement Area. *Am. Ass. Petr. Geol. Bull.*, v. 49, pp. 2182–2245, Tulsa.

Jenkyns H. C. (1974) - Origin of the red nodular limestones (Ammonitico Rosso, Knollenkalk) in the Mediterranean Jurassic: a diagenetic model. In: Hsü K. J. & Jenkyns H. C. (Eds.) - Pelagic sediments: On Land and Under the Sea. *Int. Ass. Sediment.*, Spec. Publ., v. 1, pp. 249–271, Oxford.

Hallam A. (1975) - Jurassic Environments. Cambridge University Press, 269 pp., Cambridge.

Hallam A. (1978) - Eustatic Cycles in the Jurassic. *Palaeogeogr. Palaeoclimat. Palaeoecol.*, v. 23, pp. 1–32, Amsterdam.

Howarth M. K. (1973) - Lower Jurassic (Pliensbachian and Toarcian) Ammonites. In: Hallam A. (Ed.) - Atlas of Palaeobiogeography. Elsevier, pp. 275–282, Amsterdam.

Kamen–Kaye M. (1978) - Permian to Tertiary Faunas and Palaeogeography: Somalia, Kenya, Tanzania, Mozambique, Madagascar, South Africa. *Journ. Petrol. Geol.*, v. 1, pp. 79–101, Beaconsfield.

Kamen–Kaye M. & Barnes U. S. (1979) - Exploration Geology of Northeastern Africa – Seycelles Basin. *Journ. Petrol. Geol.*, v. 2, pp. 23–45, Beaconsfield.

Merla G. (1979) - Summary of the geological history. In: Merla G., Abbate E., Azzaroli A., Bruni P., Canuti P., Fazzuoli M., Sagri M. & Tacconi P. - A Geological Map of Ethiopia and Somalia (1973), 1:2.000.000 and Comment with a Map of Major Landforms, pp. 7–18, Firenze.

Powell C., Johnson B. & Veevers J. (1980) - A revised fit of east and west Gondwanaland. *Tectonophysics*, v. 63, pp. 13–30, Amsterdam.

Powers R. W., Ramirez L. F., Redmond C. D. & Elberg E. L. (1966) - Geology of the Arabian Peninsula: sedimentary geology of Saudi Arabia. *U. S. Geol. Surv. Prof. Paper*, v. 560 D, pp. 1–147, Washington.

Ricateau R. & Riche P. H. (1980) - Geology of the Musandam Peninsula (Sultanate of Oman) and its surroundings. *Journ. Petrol. Geol.*, v. 3, pp. 153–174, Beaconsfield.

Smith A. G. & Hallam A. (1970) - The fit of Southern Continents. *Nature*, v. 225, pp. 139–144, London.

Somaliland Oil Exploration Co. (S. O. E. C.) (1954) - A geological reconnaissance of the sedimentary deposits of the Protectorate of British Somaliland. Crown Agents, 42 pp., London.

Stefanini G. (1931–1936) - Paleontologia della Somalia. *Palaeont. Ital.*, v. 32 and supplements. Pisa.

Swarts D. H. & Arden D. D. (1960) - Geologic history of Red Sea Area. *Am. Ass. Petr. Geol. Bull.*, v. 44, pp. 1621–1637, Tulsa.

Thévenin A. (1908) - Paléontologie de Madagascar, v. 5, Fossiles liasiques. *Ann. Paléont.* v. 3, pp. 105–144, Paris.

Thompson A. O. & Dodson R. G. (1960) - Geology of the Bur Mayo–Tarbaj Area. *Geol. Surv. Kenya*, Rept 47, 33 pp., Nairobi.

Vail P. R., Mitchum R. M. & Thompson S. III (1977) - Seismic stratigraphy and global changes in Sea Level. Part 4: Global Cycles of relative changes in sea level. In: Payton C.E. (Ed.) – Seismic Stratigraphy: applications to hydrocarbon exploration. *Am. Ass. Petr. Geol., Mem.*, v. 26, pp. 83–97, Tulsa.

Von Hillebrandt A. (1973) - Die Ammonitengattungen *Bouleiceras* und *Frechiella* im Jura von Chile und Argentinien. *Ecl. Geol. Helv.*, v. 66, pp. 351–363, Basel.

Wiedenmeyer F. (1980) - Die Ammoniten der mediterranean Provinz im Pliensbachian und unteren Toarcian auf Grund neuer Untersuchungen in Generoso–Becken (Lombardischen Alpen). *Mém. Soc. Helv. Sc. Nat.*, v. 93, pp. 1–195, Basel.

PLATE 2

Fig. 1 – *Hildaites* sp. ind. Waaney section, sample S.80.160.

Fig. 2 – *Protogrammoceras madagascariense* (Thévenin). Waaney section, sample S.80.160.

Fig. 3 – *Protogrammoceras madagascariense* (Thévenin). Waaney section, sample S.80.167.

Fig. 4 – *Protogrammoceras madagascariense* (Thévenin). Waaney section, sample S.80.167.

Fig. 5 – *Protogrammoceras madagascariense* (Thévenin). Waaney section, sample S.80.167.

Fig. 6 – *Protogrammoceras madagascariense* (Thévenin). Waaney section, sample S.80.167.

Fig. 7 – *Protogrammoceras madagascariense* (Thévenin). Waaney section, sample S.80.167.

Fig. 8 – *Protogrammoceras madagascariense* (Thévenin). Waaney section, sample S.80.167.

Fig. 9 – *Protogrammoceras madagascariense* (Thévenin). Waaney section, sample S.80.167.

Fig.10 – *Protogrammoceras* (?) sp. ind. Waaney section, sample S.80.167.

Fig.11 – *Protogrammoceras* (?) sp. ind. Waaney section, sample S.80.167.

Fig.12 – *Protogrammoceras* (?) sp. ind. Waaney section, sample S.80.167.
To be noted (12b) that the sutural line of the specimen is slightly indented and that the lobe E is abnormally small (x 2).

All figures, except otherwise indicated, natural size.


1
2
3
4
5
6
10
8
7
9
11
12
2a
4a
8a
9a
5a
6a
U2 L A E A
12b
12a