Taxonomy of Body Fossils found from Wandhaya area of Kachchh, Gujarat

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Abstract : A distinct Marker horizon in Kachchh Mainland is Dhosa Oolite bed (M-IV), top-most part of the Jumara Formation that separates Jumara Formation and overlying Jhuran Formation. Dhosa Oolite is oolitic, medium grained and highly fossiliferous limestone. Among body fossils of Subkingdom Mollusca, *Nautilus intermedius* of Order Nautiloidea, *Euaspidoceras waageni*, *Volanoceras volanense*, *Peltoceras athleta*, *Perisphinctes Tiziany* and *Schlotheimia angulata* from Order Ammonoidea, *Belemnopsis calloviensis* of Order Dibranchiata and *Terebratula Phillipsi* from Class Brachiopoda have been found from M-IV of Jumara Formation.

IndexTerms **-** Taxonomy, Fossils, Ammonites, Wandhaya, Kachchh.

I. INTRODUCTION

The Kachchh basin in western India formed in the Late Triassic following rifting between India and Africa [1]. After an initial phase of terrestrial sedimentation, marine conditions dominated the area from the Bajocian until the Early cretaceous [2] [3]. Being a peri-cratonic and palaeo-rift basin on the westernmost fringe of the Indian peninsula, Kachchh basin is the southernmost end of the Indus shelf, bordered on the north by the fossil rifts of the Thar and Southern Indus Basins [4]. It has a thick succession of Mesozoic strata (+3000 m) followed by a thin sequence of Tertiary sediments (+900 m). The Mesozoic sediments of Kachchh are exposed in the form of six discontinuous domal areas: (a) Kachchh Mainland, (b) Pachham Island, (c) Khadir Island, (d) Bela Island, (e) Chorar Island and f) Wagad. These are major uplifts forming highlands that are separated by vast covered plain [1].
The Jurassic rocks of the Kachchh Basin have gained global significance because of their rich fossil assemblages, which range in age from Pliensbachian to Late Tithonian [2]. The Jurassic succession of the Kachchh basin is well known for its abundant fossil content including a diverse ammonite fauna.
In the Kachchh Mainland the Mesozoic sequence is represented by the Jhurio, Jumara, Jhuran and Bhuj Formations [1]. Jumara Formation is the most fossiliferous of the four formations of the Mesozoics [5]. Further Jumara Formation is divided in to four informal members M-I, M-II, M-III and M-IV in ascending order. A distinct Marker horizon in Kachchh Mainland is Dhosa Oolite bed (M-IV) top-most part of the Jumara Formation that separates Jumara Formation and overlying Jhuran Formation. Dhosa Oolite is oolitic, medium grained and highly fossiliferous limestone. Dhosa Oolite unit is very rich in fossils, especially ammonites and *Belemnites* along with, brachiopods, bivalves and scattered pieces of wood. According to Singh (1989) Dhosa Oolite bed is regarded as a slow transgressive, condensed sequence. Dhosa Oolite forms a highly condensed unit characterized by hard ground, intra-formational cobbles, reworked concretions, iron oncoids and shell lag deposits [2].
The study area Wandhaya (23.1133° N, 69.2701° E) is a village of Kachchh district. It is located 28 km towards southwest from Bhuj city. Mesozoic sedimentary rocks – M-III and M-IV of Jumara Formation, and Lower Member of Jhuran Formation are exposed in the study area. The aim of this study is to identify the body fossils at generic and species level. Five fossils of class Ammonoidea, one fossil from order Nautiloidea, along with Dibranchiata and Brachiopoda are found from the Dhosa Oolite bed.

II. SYSTEMATIC PALAEONTOLOGY

Five species from ammonites along with one species from each of Nautiloidea, Dibranchiata and Brachiopoda are described in the following section. All the specimens were photographed and collected during the field work and are treated by Ammonium Chloride.

Nautilus intermedius
Sub-Kingdom **Mollusca** Linnaeus, 1758
Class **Cephalopoda** Cuvier, 1797
Order **Nautiloidea** Agassiz, 1847
Sub-Order **Orthochoanites** Martin, 1904
Family **Nautilidae** Blainville, 1825
Genus ***Nautilus*** Linnaeus, 1758
Species ***Nautilus intermedius*** Sowerby, 1816

Description: Shell more or less globose, coiled in one plane and more or less completely embracing. The last whorl or body whorl more or less completely covers all the preceding whorls, so coiling is involute. Umbilicus is large and deep. The body chamber is much larger than all other air chambers. The shell is divided into number of chambers by means of transverse partitions called septa. Siphuncle is centrally placed and suture line is simple and gently undulating i.e. it is Nautiloid type. Surface of the shell is ornamented with ribs and brown coloured bands. The Kachchh specimen has diameter of 22 cm.
Remarks: Earliest forms were having highly curved shells but later on, the shell became straight or slightly curved. Between Ordovician and Carboniferous periods the decline of *Nautilus* started. *Nautilus intermedius* first appeared in Upper Cambrian

period and continue to Recent time. Nautiloidea with straight and simple suture line (Nautiloid type) are widespread in the Kachchh basin [6].

Euaspidoceras waageni
Order **Ammonoidea** Zittel, 1884
Genus ***Euaspidoceras*** Spath, 1931
Species ***Euaspidoceras waageni*** Spath, 1931

Description: Fossil shell small to moderately large, evolute, septate with sub-quadrangular whorl section. Two rows of tubercles connected by the primary ribs develop comparatively early in ontogeny. Inner tubercles are comparatively small, subcircular, irregular, and occasionally slightly elongated along the rib. Outer tubercles are larger, elongated parallel to the periphery, and develop slightly earlier than inner tubercles. Ribbing distance is irregular. Rarely, an isolated inner tubercle is developed. High and steep umbilical wall.
Remarks: The present specimen matches *Euaspidoceras waageni*, Spath in ornamentation, whorl section, and dimensions. The species shows a transition from inner compressed to outer depressed whorls, but the diameter at which this change occurs can vary considerably (Spath, 1931). The irregular shape and position of tubercles, together with the almost quadrangular whorl section, differentiates the species from other members of *Euaspidoceras* in the Kachchh basin. The slightly younger *Euaspidoceras perarmatum* (Sowerby, 1822) has stronger ribs, which are also seen on the venter and thus, differ from *Euaspidoceras waageni* [7].

Volanoceras volanense
Family **Aspidoceratidae** Zittel, 1895
Genus ***Volanoceras*** Schweigert, 2002
Species ***Volanoceras volanense*** Oppel, 1863

Description: Specimen is somewhat distorted with loose coiling, a subquadrate to depressed whorl section, and blunt ribs between two rows of tubercles in specimen. Prominent ribs terminating in coarse tubercles on the shoulders. Earlier volutions having two row of tubercles, inner row of tubercles developed first and never keeled [8]. Suture line is highly complex and Ammonoid type of suture line.
Remarks: Sutures of specimen resemble to family Dactyliodae but saddles and lodes are broader and dorsal sutures with only one pair of inner or first dorsal lobes, the outer or second pair being incomplete in more discoidal species. *Volanoceras* bears resemblance in young or throughout life to *Perisphinctes* [8]. Schweigert (2002) reinterpreted *Volanoceras*, a younger synonym of genus *Simoceras* [9].

Peltoceras athleta
Genus ***Peltoceras*** Waagen, 1871
Species ***Peltoceras athleta*** (non Phillips), Waagen, 1875

Description: Fossil shell moderately large, evolute, slightly compressed and septate. Whorl section suboval (between tubercles) to subrectangular (at tubercles) with rounded umbilicus. Venter broad, slightly rounded, slightly elevated, broad ridges connecting the tubercles at the ventrolateral shoulder. Ornamentation consists of thick, rounded, straight primary ribs connecting an inner and outer row of tubercles. Inner row of tubercles elongated parallel to the rib. Outer row of stronger tubercles which are higher, slightly backwards-directed, and moderately elongated perpendicular to the ribs. High and vertical umbilical wall [7]. The Kachchh specimens have 14 cm and 17 cm in diameter.
Remarks: The morphology of the tubercles (i.e. smaller, elongated inner tubercles and higher, backwards-directed outer tubercles), the slightly rounded venter with rounded, obscure ridges connecting the ventrolateral tubercles, and the shape of the whorl section of the present specimens match *Peltoceras athleta* Phillips, 1829 which has been described by Phillips (1829) from the Gypsiferous Shale member of Samatra, south of Bhuj [7].
Members of the genus *Peltoceras* usually have comparatively densely ribbed inner whorls with secondary ribs on the venter [10]. There are also no imprints of secondary ribs visible on the dorsal side of the fragments. This might support their assignment to the genus *Euaspidoceras.* However, no comparable species of *Euaspidoceras* are known from contemporaneous deposits in the Kachchh Basin. *Euaspidoceras waageni* Spath, 1931 seems to be closely related, but occurs only in the Dhosa Oolite member and has somewhat weaker tubercles. In addition, Waagen (1875) described specimens later on assigned to *Peltoceras kachhense* by Spath (1931) as showing secondary ribs on the inner whorls thereby justifying its assignment to the genus. It can therefore be assumed that tubercles appear relatively early in *Peltoceras athleta* connected with a comparatively early disappearance of secondary ribs.
Prasad and Kanjilal (1985) recorded *Peltoceras athleta* (Phillips, 1829) in gypsiferous shales of the Jara Dome on the Kachchh Mainland. Their specimens differ from the present specimen in having a more depressed shell. Furthermore, the inner tubercles of *Peltoceras athleta* (Phillips, 1829) grow much stronger than the outer ones during ontogeny. This is in contrast to *Peltoceras kachhense* Spath, 1931, whose inner tubercles are always smaller than the outer ones [7].

Plate I

Explanation of Plate I

1. ***Nautilus intermedius*** Sowerby, lateral view of the specimen. 2. Ventral view of ***Nautilus intermedius***, Sowerby. 3. ***Euaspidoceras waageni*** Spath lateral view of the specimen. 4. ***Euaspidoceras waageni*** Spath, fragment of body whorl. All specimen found from M-IV of Jumara Formation. Coin diameter is 2.5 cm.

Plate II

Explanation of Plate II

1. ***Volanoceras volanense*** Oppel, lateral view of the specimen. 2. Ventral view of ***Volanoceras volanense*** Oppel with distinct ammonoidea type suture line. 3. ***Peltoceras athleta*** Waagen, lateral view of the specimen. 4. ***Peltoceras athleta*** Waagen, Ventral view of specimen with complex suture line.All specimen found from M-IV of Jumara Formation.

Perisphinctes Tiziany
Family **Perisphinctidae** Steinmann, 1890
Genus ***Perisphinctes*** Waagen, 1869
Species ***Perisphinctes Tiziany*** Oppel, 1863

Description: Shells moderately large, evolute and compressed. Ornamentation consists of isocostate, sharp, primary ribs, which branch into two or, more rarely, three secondary ribs at the ventrolateral region. Rarely, isolated secondary ribs occur, giving the appearance of trifurcation or polygyrate ornamentation. Ribs on outer marginal part are moderately sharp.
Remarks: Specimen is fragment of large ammonite with a whorl shape and ornamentation similar to *Perisphinctes Tiziany*, Oppel with well-preserved ribs. Its ornamentation and proportional dimensions match *Perisphinctes Tiziany*, Oppel. This species has been originally described from Middle Oxfordian rocks of Portugal [11]. Despite this, the name of the species has also been used for Upper Oxfordian to Lower Kimmeridgian forms [12] [13], which were assigned to the genus *Orthosphinctes* Schindewolf. So far, this genus has not been recorded from Middle Oxfordian rocks and although specimen with its small lappets at the aperture resembles other forms of this taxon from younger rocks, it has been retained in *Perisphinctes* [14].

Schlotheimia angulata
Family **Schlotheimiidae** Spath, 1923
Genus ***Schlotheimia*** Bayle, 1878
Species ***Schlotheimia angulata*** Schloth, 1908

Description: Fossil specimen is fragment of the outer whorl. More or less compressed and costated shells, the costae sometimes crossing the venter in the young or extreme age, but usually interrupted in the adult by a smooth and occasionally median zone. Sutures inclined apicad near lines of involution, more complex in outline than in typical Arietidae, and with phylliform marginals more like those of *Psiloceras*. The ornamentation of shell containing sharp primary ribs that bent at the margin.
Remarks: Specimen's ribs are simple, sharp, incline forward on the flanks, become a little stronger ventrally, arch forward on the venter, and are only slightly reduced in strength along the midline of the venter. The ribbing on this specimen resembles that on the inner whorls of *S. angulata*. The species is also reported from unnamed beds in the Puale Bay area on Alaska Peninsula at USA [15].

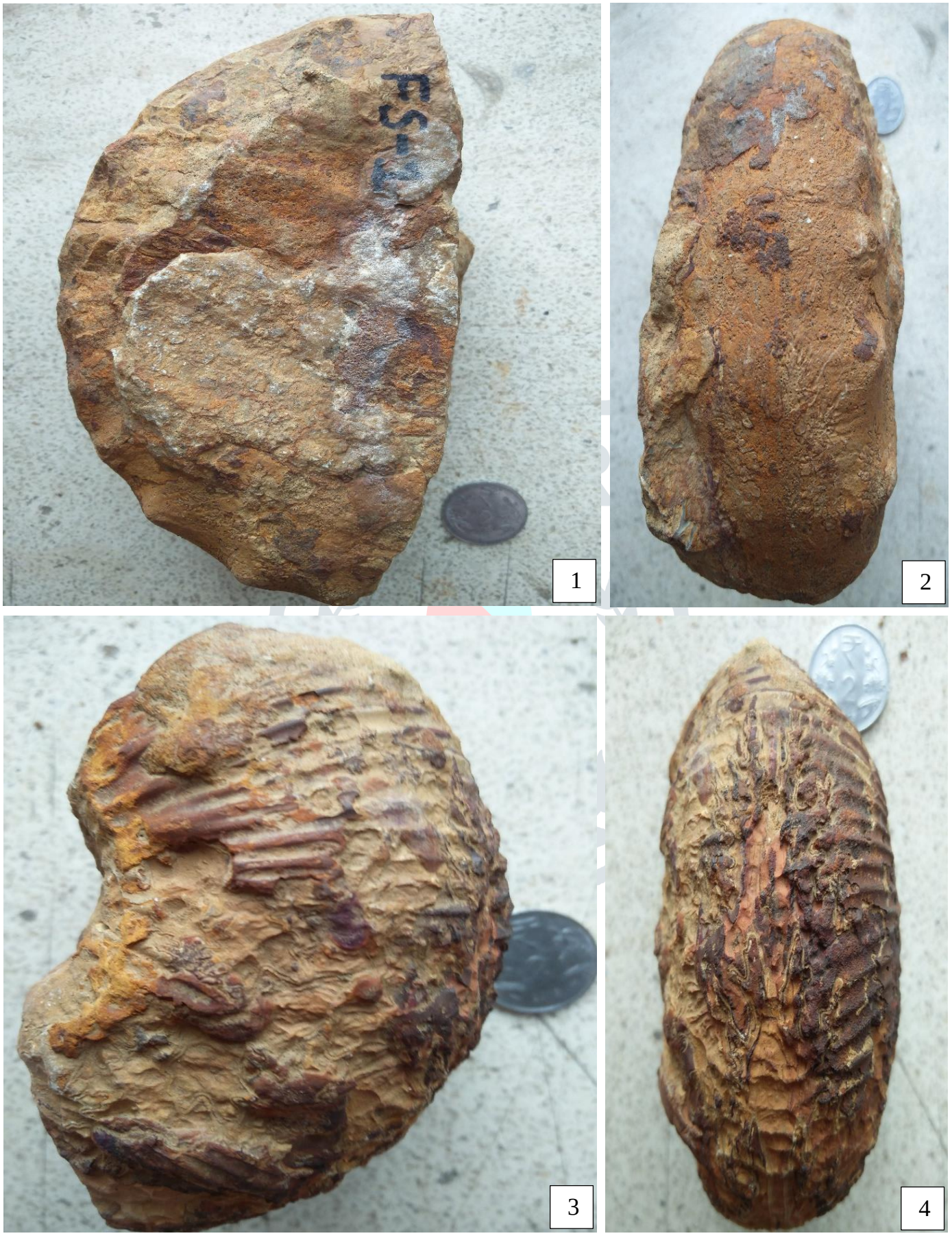
Belemnopsis calloviensis
Subclass **Coleoidea** Bather, 1888
Order **Belemnitida** Zittel, 1895
Sub-Order **Belemnopseina** Jeletzky, 1965
Family **Belemnopseidae** Naef, 1922
Genus ***Belemnopsis*** Bayle, 1878
Species ***Belemnopsis calloviensis*** Oppel, 1857

Description: The guard are long – 10 to 30 mm in length, broad, robust, outline hastate to cylindrical in some specimens. Sides asymmetrical to semi-parallel, start converging gradually towards the apex. Apex is slightly dorsal. In the apex, ventral surface converges more rapidly than dorsal surface. Ventral groove prominently broad, commencing from alveolar margin till mid apex; at anterior margin the groove is deeper forming prominent "U" shape, which gradually disappears near the apex. Dorsal groove is absent. Alveolar and post alveolar cross section increasingly strongly depressed for the growth rings in adult reveals that in the juvenile stage the shell would have attained equidimensional to slightly compressed nature of cross section. Apical line strongly placed ventrally.
Remarks: The cross sectional profile observed at three levels (near protoconch, in midguard section and near apex) of the specimens indicates that it changes from slightly compressed in the protoconch region to equidimensional/squarish between protoconch and midguard and to strongly depressed after midguard. Waagen (1873) while describing this species has also shown such changes in the cross section. *Belemnopsis calloviensis* differs from *Belemnopsis moluccana* in having a wider width of vertical groove (1.6 to 4.3 mm).
According to Waagen (1873) *Belemnopsis calloviensis* Oppel and *B. subhastus* Zeiten are restricted to the Early Callovian "Macrocephalus beds". Five nearly complete specimens of *Belemnopsis calloviensis* were found associated with *Peltoceras athleta* of Callovian age. It is possible that the lower boundary of *B. calloviensis* in Kachchh may range up to Early Callovian (or still older) [16]. This is envisaged on the basis of the recovery of eighteen specimens of *B. calloviensis* from Middle Callovian sediments in the study area.

Terebratula Phillipsi
Phylum **Brachiopoda** Dumeril, 1806
Order **Terebratulida** Waagen, 1883
Family **Terebratulidae** Gray, 1840
Genus ***Terebratula*** Muller, 1776
Species ***Terebratula Phillipsi*** Morris, 1863

Description: The fossil specimen is biconvex shell, slightly elongated, pedicle opening present, so perforated umbo in *Terebratula*. Hinge line is curved and anterior margin with single fold. Concentric growth lines are present. Umbo short, incurved. Foramen small to large, oval to circular. Shallow to moderately deep sulcus, divided by a median ridge, and low to moderately high fold,

Plate III



Explanation of Plate III

1. ***Peltoceras athleta*** Waagen, lateral view of the specimen. 2. Ventral view of ***Peltoceras athleta*** Waagen, with distinct ammonoidea type suture line. 3. ***Perisphinctes Tiziany*** Oppel, lateral view of the specimen. 4. ***Perisphinctes Tiziany*** Oppel, Ventral view of fragmenty of body whorl with complex suture line.All specimen found from M-IV of Jumara Formation.

Plate IV

Explanation of Plate IV

1. ***Schlotheimia angulata*** Schloth, lateral view of the specimen. 2. Ventral view of ***Schlotheimia angulata*** Schloth, with rounded margin. 3. ***Belemnopsis calloviensis*** Oppel. 4. ***Terebratula Phillipsi*** Morris.

divided by a median furrow; ridge and furrow clearly marked at front. Greatest thickness of shell at front. Numerous divided and intercalated costae, flattened and provided with median narrow grooves. Costae bundles never present. Slender dental plates. Thick, divided hinge plate. Shallow cup shaped septalium. Short cardinal process with numerous low ridges. Ventral muscle field deeply impressed. Dorsal muscle field only slightly impressed [17].

Remarks: *Terebratula Phillipsi* is similar to *Dictyothyris* of Jurassic age, but *Dictyothyris* differs from *T. Phillipsi* by having concentric radial ribs and concentric lines. *T. Phillipsi*, *Coenothyris* of Triassic age are distinguished from *Terebratula* of older age by the possession of well-developed dental plates [18].

III. CONCLUSION

M-III and M-IV of Jumara Formation as well as Lower and Upper Member of Jhuran Formation are exposed in study area. All body fossil specimens are collected from M-IV of Jumara Formation famously known as "Dhosa Oolite" bed that is the marker horizon between Jumara Formation and overlying Jhuran Formation. Numerous fossils of Mollusca including Cephalopoda (Nautiloidea, Ammonoidea and Dibranchiata) along with Brachiopoda have been collected from M-IV of Jumara Formation. *Nautilus intermedius* from order Nautiloidea of class Cephalopoda, *Euaspidoceras waageni*, *Volanoceras volanense*, *Peltoceras athleta*, *Perisphinctes Tiziany* and *Schlotheimia angulata* from order Ammonoidea, *Belemnopsis calloviensis* from order Dibranchiata of class Cephalopoda and *Terebratula Phillipsi* of Brachiopoda have been identified in present work. All fossils were densely crowded in Dhosa Oolitic Conglomeratic top most band of M-IV of Jumara Formation that indicating Fossil shell Lag deposit.

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