

International Research Journal of Earth Sciences. Vol. **3(2)**, 13-17, February (**2015**)

Review Paper Foraminiferal diversity, Composition and their Evolution in the Kutch region of Gujrat, India A Mini Review

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Available online at: www.isca.in, www.isca.me Received 25th January 2015, revised 14th February 2015, accepted 22nd February 2015

Abstract

Investigation of foraminiferalmicro fauna of a site can provide a lot of information about the age and other aspects of the palaeontology of that region. Different hills of Kutch region are studied separately to reveal the diversity, composition and evolution of species present there. The main hills of interest and studied so far are Jumara, Keera and Jhurio hills. This mini review is focussed to combine all thosestudies into one and present an overview of foraminferal research done so far. An attempt is made to enlist all species found in the region with their composition and evolutionary inferences. The study will provide an insight of the foraminiferal diversity and composition of the whole Kutch region.

Keywords: Composition, Foraminifera, Jhurio Jumara, Keera, Kutch.

Introduction

Single celled protists with shells known as tests are called Foraminifera. These organisms based on their extinction and survival patterns can provide the evidences and causes of the main extinction events at the Permian-Triassic and Cretaceous-Palaeocene boundaries and in the Paleogene¹. The age of different events and details of many oceanographic events can be drawn from these microscopic shells of protozoan groups. An age of 120 million years before Paleogene (B.P.) for the opening of North Atlantic and its temperature estimate before 50 million years, can be concluded from the evidences left by these organisms.

Living both on the bottom and on the surface, these microorganisms and planktons have existed since Cambarian time and Mesozoic time. Their classification is mainly done into three major groups: the planktonics, the smaller benthics (infaunal and epifaunal), and the larger benthics based on their living habits, size and morphology. Due to long time span of evolution, a wide range of lineage forms have been identified and to organize and categorize this vast variety of forms, more than 35 schemes of classification have been proposed². An overview of this classification is presented in table-1.

The Kutch region of Gujrat has well developed marine Jurassic Parks and have been of extensive interest for geologists in India to study mega as well as micro fossils particularly foraminifera. There are mainly three east-west trending broken ridges as domal outcrops in the whole region which have been focus of micropaleontologists due to abundant and excellently preserved foraminiferal microfossils in their rocks. These are Jumara Hills, Keera Hills and Jhurio dome. The Jumara section is located in eastern Kutch, the Jhurio section in the West of Badi village (Central Kutch) and the Keera dome in between these two. The detailed studies are carried out so far are reported in Bhalla and Talib³, Pandey and Dave⁴, Gaur and Talib⁵ and Talib et al⁶.

Due to the large variety and abundance of microfossils in the region, the studies are focussed separately to a particular formation and hence describe the composition and evolution of the foraminerferal species of that particular formation only. A review study discussing the compositional aspects of foraminiferal species of the whole region will provide an insight of whole Kutch region and can help future researchers in identification of new research areas.

In view of this, the main focus of this mini review is to list out the various foraminiferal species, their composition and evolution of these three main formations of Kutch region. The information in this review is particularly engrossed on three main areas of Kutch i.e. Jumara hills, Keera Dome and Jhurio Hills (Central Kutch).

Study area

Location and stratigraphy: The study is concerned with the Jurassic of Kutch located in the Kutch region of Gujarat. The Kutch Peninsula is located between latitude 23.13°-24.68°N and longitude 68.10°-71.80°E, and it forms the most parts of western India. The region constitutes an area of 45,612 square km. It has length and width extensions of 320 km and 170 km, respectively through which passes the Tropic of Cancer.

The area is not disturbed by tectonics and hence does not show any major faulting and folding. A number of fossiliferous sections have been found in recent years in the region. The beds are horizontal with shallow dip of about 1-3° towards the South

International Science Congress Association

International Research Journal of Earth Sciences	ISSN 2321–2527
Vol. 3 (2), 13-17, February (2015)	Int. Res. J. Earth Sci.

Southwest (SSW) direction. About half of the area of the Kutch region is occupied by Jurassic rocks which lie in a nonconformable position with underlying and overlying rocks^{8,9}. Numerous dykes and sills that are genetically related to post Jurassic volcanic activity intrude the rocks of the region. Igneous activity has shaped the rocks to a dome type. As defined in the 'Code of Stratigraphic Nomenclature of India', the Jurassic rocks are classified into the Patcham, Chari, Katrol and Umia formations in ascending order. The first three formations are exposed in the Jumara dome which is one of the most prominent outcrops in the western portion of the middle ridge. Out of all, the Chari Formation is most commonly exposed in this dome. The rocks are mainly composed of carbonate including ammonites and vast number of fossils. The Chari Formation is visible in a circular outcrop and is separated by its green bioclastic wackestones from the grayish yellow stones

lying at its bottom. The Chari sequence ranges from Callovian to Argovian as reported by Rajnath¹⁰ but Biswas¹² has assigned a Callovian to Oxfordian age. Another dome known as Keera Dome has only Chari and Katrol formations exposed but the Katrol Formation is devoid of foraminifera. So these are here described in less detail. The Khavda Nala sectionis located on the Pachchham Island in northern Kutch and is about 1 km distant from Khavda village in the east.

Foraminiferal composition and age

The most popular generic classification of foraminifera proposed by Loeblich and Tappan¹³ is used almost by all authors to provide a systematic classification. Generally different species within a particular genus are arranged in alphabetical order with a consideration for reduction of synonymies.

Super family/genera	Туре	Morphological features	Test Features	Era
Lagynacea	Benthic sessile and vagile	Single-chambered; tubular, round, or flask shaped	Agglutinated material in some genera	Paleozoic— recent
Endothyracea	Benthic sessile or vagile	Multi-chambered; septate; spirally or serially arranged, single or multiple apertures	Calcitic microgranular, primarily double- layered	Triassic
Globigerinacea	Planktonic	Multi-chambered; septate; spirally and/or cyclically arranged; interiomarginal aperture; with or without accessory and supplementary Apertures;	Calcitic, radial; lamellar	Jurassic Recent
Endothyracea	Benthic sessile or vagile	Multi-chambered; spirally, single or Multiple apertures;	Calcitic microgranular, with agglutinated material in addition	Triassic
Miliolacea	Benthic vagile	Multi-chambered; most septate, some with apertural tooth or multiple tooth plates (buttresses)	Calcitic porcelaneous	Triassic— recent
Cassidulinacea	Benthic vagile	Multi-chambered; septate; plurilocular, trochospirally arranged; Comma-shaped aperture and toothplate	Calcitic with granular	Cretaceous— recent
Anomalinacea	Benthic Vagile	Multi-chambered; septate, trochospirally arranged	Calcitic With granular appearance	Cretaceous— recent
Robertinacea	Benthic vagile	Multi-chambered, septate; trochospirally arranged; single aperture, Toothplate and secondary foramina	Aragonitic	Triassic— recent
Rotaliacea	Benthic vagile	Multi-chambered; septate; trochospirally, planispirally or cyclically Arranged; single or multiple apertures with tooth plate	Calcitic, Radial; lamellar	Cretaceous— recent

 Table-1

 An outline of classification (Adapted from Haq and Beaursma)⁷



Figure-1 Location of sections in the Kutch region, Gujarat, India (after Andreu et al.)¹¹

Jumara Dome: In Jumara hills, foraminiferal species are abundant in Chari Formation and abundant contribution in the identification of species is done by Gaur and Talib⁵. They recovered a total number of fifty one species from this location and the majority of the species were identified to belong to the family of Vaginulinidae, Nodosariidae, Lituolidae, Trocholinidae, and Lagenidae (Table 2). The percentages of these species were 43.1 %, 21.56%, 11.76%, 5.88% and 3.92% respectively. However Saccamminidae, Ammodiscidae, Hormosinidae, Haplophragmoididae, Sprillinidae, Polymorphinidae, and Epistominidaeconstitute lowest percentage of 1.96%.

The foraminiferal species are good indicators of the age of their formation. For example, the species like *Garantella*, *Reinholdella*, and reticulate *Epistomina* support the Jurassic biostratigraphy¹⁴. In Chari Formation, the major exposed part is reported to form in the Callovian times while as some parts are identified to deposit during the Oxfordian. The reported age was based on the presence of the species like *Citharinella rhomboidea and Astacolus aphrastus and Astacolus pauperatus, Citharinella clathrata, Marginulina bhatiai*, and *Epistomina mosquensis* which are described from the sediments of Oxfordian and Callovian sediments by Loeblich and Tappan¹⁵ and Pandey and Dave⁴ respectively.

Keera Dome: In Keera dome, Chari Formation also constitutes abundant foraminifers. Most of the work is reported by Talib et al^6 in which they recovered an assemblage comprising thirty foraminiferal species. Family Vaginulinidae dominates the dome of Keera represented by 12 species and constituting a percentage of 40% of total species. Lituolidae, Nodosariidae and Epistominidae constitute 20%, 13.3% and 10% respectively. However, Saccamminidae, Hormosinidae, Haplophragmiidae, Spirillinidae, and Nubeculariidae families represent only 3.3% each with one species per family.Most of the species were characterized by calcareous component which constitute 70% of the total foraminiferal species. Others were characterized as agglutinated species. The ratio reported is 1: 2.3. The list of species prominent in these hills is listed in table-3.

Likewise species of Jumara hills, the foraminiferal assemblage of Keera dome contain short range species like *Ammobaculites aff.*, *A. hagni, Spirillina polygyrata, Laevidentalina gümbeli, Lenticulina varians*, and *Citharina rhomboidea* which are reported from Callovian to Oxfordian strata. The *Ammobaculites hagni* has been also reported from the other Callovian-Oxfordian sediments in other domes of Kutch region like Jumara.

Table-2
Species recovered from the Chari formation, Jumara Hills of
Kutch, Guirat (Gaur and Talib) ⁵

Species	Super family/family
Thurammina diforamens	Astrorhizacea
Ammodiscus sp	Ammodiscacea
Reophax tener	Hormosinacea
Haplophragmoides bartensteini	Lituolacea
Ammobaculites gowdai Bhalla Ammobaculites formosus Ammobaculites reophacoides Ammomarginulina cragini	Lituolidae
Flabellammina bharatica Triplasia emslandensis Bartenstein	Flabellammininae
Trocholina conosimilis Trocholina nodulosa Trocholina sp	Involutinidae
Laevidentalina guembeli Laevidentalina aff.L. sarthacensis Nodosaria cylindracea Nodosaria aff. N. marginata Nodosaria simplex Pyramidulina cf. P. radiata	Nodosariidae
Frondicularia kutchensis Frondicularia lignaria Terquem, Frondicularia nodosaria	Frondiculariinae
Lenticulina quenstedti Lenticulina subalata Lenticulina tricarinella Lenticulina varians Lenticulina sp. Marginulinopsis instabilis Saracenaria cornucopiae	Vaginulinidae
Astacolus anceps Astacolus aphrastus Astacolus beierana Astacolus filos Astacolus pauperatus Hemirobulina curvature Marginulina bhatiai Vaginulinopsis aff. V. stephensoni	Marginulininae
Citharina clathrata Citharinella rhomboidea Vaginulina ectypa Vaginulina inspissata Vaginulina misrensis Vaginulina woodi	Vaginulininae
Lagena sulcata Lagena sp.	Lagenidae
Ramulina apheilolocula	Polymorphinidae
Epistomina mosquensis	Ceratobuliminacea

_ ISSN 2321–2527

Table-3
List of various species reportedfrom Jhurio Hill and Keera
Hill of Kutch region

Hill of Kutch region				
Keera Dome ⁶	Jhurio Dome ¹⁶			
Lagenammina	Multi Qcularis			
pseudodifflugiformis				
Reophax sterkii	Psamminopelta			
	bowsheri			
Ammobaculites alaskensis	Reophax hounstoutensis			
A. coprolithiformis	Haplaphragmoides			
	h1tidorsatum			
Ammobaculites aff. A. hagni	A. coprolithiformis			
Ammobaculites sp	A. cf. A. reophacijormis			
Triplasia emslandensis	N. hortensis			
T. althofi jurassica	Y. radiala			
Haplophragmium aequale	Textularia 'jurassica			
Spirillina polygyrata	Amm omarginulina cf.			
Vinelloidea aff. V. bigoti	A. pauperatus			
Laevidentalina gümbeli	Citharina clathra ta			
Nodosaria aff. N. biloculina	C. hetropleura			
N. simplex	C.rhnmboidea			
Pseudonodosaria sowerbyi	Marg inulina curvature			
Lenticulina nodosa	M . oolithica			
L. quenstedti	M. woodi			
L. subalata	Tribrachia inelegans			
L. varians	Lenliculina gaultina			
Astacolus anceps	L. quenstedti			
A. pauperatus	L. subalata			
Vaginulinopsis aff. V. enodis	L. tricarinella			

Jhurio Dome: In Jhurio hills of Central Kutch, the foraminiferal assemblage is dominated by species belonging to the families of Nodosariidae (64.15%) followed by Lituolidae (13.20%), Spirillinidae, Hormosinidae and Ceratobuliminidae (3.77 % each). Other species like Texturalidae, Discorbidae and Polymorphonidiae constitute 1.89% of total foraminiferal species¹⁶ (table 3). Some specimens having signs of wind borne sediments are believed to reach here by strong winds from west during summers and get deposited due to the rains in monsoons. These were identified as post Jurassic foraminiferal species. Based on the presence of few foraminiferal species like Epistomina mosquenesis, Citharina hetropleura, Tribrachia inelegens the lower portion of the hills can be thought of Callovian age. The extent of this lower portion is 82.5 m from the base. While as the remaining upper portion is considered to be of Oxfordian age. The main species in this portion were Margunilina oxfordiana and Epistomina alveolata.

Conclusion

The foraminiferal species of the three formations of Kutch region are reviewed in this paper. The compositions as well as name of the species are also discussed for each region. Vaginulinidae family is most dominant in Jumara and Keera hills and family Nodosariidae is dominant in Jhurio hills. The age of all these formations derived from these species date backto Oxfordianto Callovian times particularly upper portions of Jumara dome and Keera dome are of Oxfordian age. The information summarized in this review will be helpful to researchers and geologists interested in unfolding of remaining aspects of micropaleontology of this region.

Acknowledgement

The author is thankful to the Council for Scientific and Industrial Research (CSIR), New Delhi for providing research fellowship during the preparation of this study.

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