Chapter 8

GENERAL DISCUSSION
8.1 PALAEOECOLOGY

8.1.1 Introduction:

The bryozoans are distributed in all oceans of the world throughout the geological periods since the Ordovician to the Recent. Their calcareous skeletons in the form of colony fragments have been found in various rock strata. Ecological studies of the fossil Bryozoa depend on an understanding of the present day forms. Hence, Palaeoecological studies of this group are mainly restricted to the Cenozoic fauna (Cheetham, 1971). The bryozoan colonies show environmental effects to varying degrees, which include depth, temperature, salinity, turbulence, rates of sedimentations and the type of the available substrate. Bryozoa are particularly sensitive to changes in the rates of sedimentation and populations show such changes in space and time (Cheetham, 1963; Lagaaij and Gautier, 1965; Wass and Yoo, 1975). The fossil bryozoans can be useful in determining the ancient sedimentary environments. Further, these organisms can tolerate wide range of salinities as well as temperatures. Thus, they can be used as tools to know the salinity fluctuations and even ancient water temperatures. The bryozoan distribution is controlled by the availability of suitable substrate for the larval settlement and their colonial growth. Hence, the relationship of the bryozoan colony with substrate is also an important aspect in their ecology.

8.1.2 PALAEOECOLOGICAL INTERPRETATIONS:

Relationships of bryozoan zoarial growth forms are influenced by ecological factors such as temperatures (Soule et al., 1979; Nelson et al., 1988), salinity (Ryland, 1977; Smith, 1995), nutrient supply (Ziko and Hamza, 1987), water depth (Harmelin, 1988), water energy (Stach, 1936), substrate (McKinney and Jackson, 1989, Hageman et al., 1997a) and Bryozoa are particularly sensitive to changes in rates of sedimentation and populations therefore they show such changes in space and time (Cheetham, 1963; Lagaaij & Gautier, 1965; Wass & Yoo, 1974). Apart from this, the usefulness of bryozoans in palaeoenvironmental analysis has been revealed by various authors (Stach, 1936; Lagaaij & Gautier, 1965; Schopf, 1969; Labracherie, 1973; Cuffey, 1981), bryozoan growth form is not restricted to a single habitat (Gordon,
In practice, it is the association and relative abundance of various growth forms that is most useful for palaeo environmental interpretation (Gordon, 1987; Nelson et al., 1988; Smith, 1995, Hageman et al., 1997b; Sonar et al., 2010). Although caution is needed, particularly in interpreting very ancient faunas, bryozoans are a tool of considerable value in palaeoenvironmental interpretation (Smith, 1995).

**Correlation of Zoarial form with habitat:**

Bryozoans are taxonomically complicated group giving difficulties in Systematic classification for non-specialists. As no zoarial growth form is restricted to a single habitat, it is the association and relative abundance of various colonial morphotypes that is above all useful for palaeoenvironmental interpretations. Stach (1936) correlated zoarial growth forms with habitat and showed importance of such study in knowing the bathymetry of bryozoans. He identified nine zoarial forms from different habitats. Lagaaïj & Gautier (1965), Schopf (1969), Labracherie (1973), Cook (1981) have given complex nomenclature of zoarial growth forms. The bryozoan zoarial growth form categorization adopted in the present study is a simple nomenclature schemes improved by Nelson et al. (1988) and Bones & James (1993). Table 3. In this classification, the calcareous skeletons of bryozoans are classified according to architecture and mode of disarticulation or fragmentation. Bryozoans belong to two orders viz., cheilostomes and cyclostomes which have been studied separately. The major growth forms including both cheilostomes and cyclostomes exhibit: erect-rigid (ER) - foliose (fo), robust-branching (ro), delicate branching (de), fenestrate (fe) and radiate (ra); Erect-flexible (EF) – articulated branching (ab) and articulated zooidal (az); Encrusting (EN) – unilaminar (ul), multilaminar (ml), massive (MA) and free-living types (FL). In Table: 2, detailed subdivision of categories along with abbreviated letter notations is given. Further, SEM images of representative bryozoans from different morphotypes are shown in figure: 2.

**Material and methods:**

Percentage of the various species and different zoarial growth forms in the bryozoan assemblage were calculated by taking 250 grams of the dry rock samples from each locality for processing. All the fragments of bryozoans were picked up and
counted locality wise and according to species and zoarial type the data has been summarized in the Fig. 3 and 5.

<table>
<thead>
<tr>
<th>Life Habit</th>
<th>Growth Forms</th>
<th>Chelostomes</th>
<th>Cyclostomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foliose (fo)</td>
<td>Eschariform</td>
<td>Bilaminar diastoporiform</td>
<td></td>
</tr>
<tr>
<td>Robust branching (ro)</td>
<td>Adeoniform</td>
<td>Horneriform</td>
<td></td>
</tr>
<tr>
<td>Delicate branching (dc)</td>
<td>Vinculariiform</td>
<td>Idmidroniform (A)</td>
<td></td>
</tr>
<tr>
<td>Fenestrate (fc)</td>
<td>Reteporiform</td>
<td>Pustaliporiform (B)</td>
<td></td>
</tr>
<tr>
<td>Radiate (ra)</td>
<td>—</td>
<td>Cavariad diastoporiform (C)</td>
<td></td>
</tr>
<tr>
<td>Articulated branching (ab)</td>
<td>Cellariiform</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Articulated zooidal (az)</td>
<td>Catenicelliform</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>Unilaminar (ul)</td>
<td>Membraniportiform</td>
<td>Stomatoporiform &amp; diastoporiform</td>
<td></td>
</tr>
<tr>
<td>Multilaminar (ml)</td>
<td>Celleporiform (A)</td>
<td>—</td>
<td></td>
</tr>
<tr>
<td>MASSIVE (MA)</td>
<td>Celleporiform (C)</td>
<td>Cerioporiform</td>
<td></td>
</tr>
<tr>
<td>FREE-LIVING (FL)</td>
<td>Lunulitiform</td>
<td>—</td>
<td></td>
</tr>
</tbody>
</table>
Table 3. Simplified zoarial growth form terminology and shape for cheilostome and cyclostome bryozoans. Note, sketches not to the scale (modified after Nelson et al., 1988; Bones & James, 1993 and Amini et al., 2004).

Table 4: Minimum number of species found in Tertiary Sediments of Kutch, per 250 gm samples.

<table>
<thead>
<tr>
<th>Name of the species</th>
<th>No. of specimens per 250 gms samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Crassimarginatella blandfordi</td>
<td>2</td>
</tr>
<tr>
<td>Porina nov.sp.</td>
<td>1</td>
</tr>
<tr>
<td>Exidmenea undata</td>
<td>1</td>
</tr>
<tr>
<td>Crisia elongata</td>
<td>1</td>
</tr>
</tbody>
</table>

Table 4 A: Maximum number of species found in Tertiary Sediments of Kutch, per 250 gm samples.

<table>
<thead>
<tr>
<th>Name of the species</th>
<th>No. of specimens per 250 gms samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nellia tenella</td>
<td>876</td>
</tr>
<tr>
<td>Aneteropora magnicapitata</td>
<td>672</td>
</tr>
<tr>
<td>Vincularia feddeni</td>
<td>276</td>
</tr>
<tr>
<td>Thalamoporella dorothea</td>
<td>240</td>
</tr>
</tbody>
</table>

Among the invertebrate fauna represented in the Tertiary sediments, Bryozoa is a dominant group. Numerically, there is not much difference in the bryozoan
content of fossiliferous yellowish limestones, white nummulitic limestones, argillaceous claystones, gypseous shales, and foraminiferal greyish marls. The fossiliferous yellowish limestone shows predominance of encrusting unilaminar (ul) i.e. membraniporiform zoarial types encrusting mollusks shells and larger foraminifers. But, erect articulated branching (ab) i.e. cellariiform zoarial growth form is equally dominant in all the lithologies. They constitute bulk of the bryozoan growth form percentages as shown in fig.3. Taylor (2005) showed that, in the modern and ancient environments, a wide range of different colony forms live together. Particular colony forms may not be precisely and/or uniquely most favourable to specific environments. Instead they can represent other approaches for surviving with the same environment.

Harudi Formation:

In Harudi Formation, the dominant morphotype varies with depth. Fig.4. Erect-flexible-articulated branching cheilostomes are most dominant. These are shallow water (Lagaaï & Cook, 1973; Lagaaïj, 1969; Cheetham, 1966; Brood, 1976; Ryland, 1963). These are all cellariiform cheilostomes, i.e. having erect, branching, flexible, articulated internodes, which are attached to their substratum of rock, indurated sediments, plants etc. by rootlets. The kinetic energy of the water must have been moderate to high for their survival. Flexible branches are able to bear moving water where rigid forms can break. Bone & James (1993) have stated that, they are also abundant below swell wave. Nelson et al., (1988) demonstrated that erect-flexible
articulated forms are very common in moderate to high energy inner shelf environment. Smith (1995) while studying modern sediments of New Zealand also proved that erect-flexible forms are dominant at inner to middle shelf depths. Moissete et al. (2007) reported that this zoarial form is particularly abundant in shallow waters (around 10m) and due to flexibility, is adapted to moderate to high sedimentation rate and energy. Further, erect-rigid delicate branching cheiostomes is next dominant group in Harudi Formation. They indicate deep quiet water conditions (Stach, 1936; Lagaaïj & Gautier, 1965; McKinney & Jackson, 1989). However, they can also survive in tranquil shallow water microenvironments, viz., caves (Kobluk et al., 1988). According to Nelson et al. (1988) the majority of erect-rigid-growth forms, particularly delicate branching forms, require a hard substrate. Moissete et al.(2007) showed that this type is abundant in relatively deep waters (40 to 80 m), but may also occupy various shallow-water (<10m) and sheltered habitats such as cavities within bioherms. The Harudi Formation also shows erect-flexible-articulated-zoooidal cheiostomes in minor percentages. This type is also attaching hard substrates by chitinous rootlets. This zoarial form is adapted to high water energy, is abundant at very shallow depths (0-40 m) Moissete et al.(2007). Bryozoan encrustations mainly occur on Xancus and Bolis, Nummulites and Discaster. Foraminiferal assemblage in Harudi Formation shows littoral to lagoonal in the lower part and inner-shelf in the upper part. Further, general lithology and the foraminiferal assemblage represent a transgressive phase of deposition (Biswas, 1992).

**Fig. 4. Percentage Distribution of growth forms of bryozoans in Harudi Formation**

![Percentage Distribution of growth forms of bryozoans in Harudi Formation](image)

**Fulra Formation:**

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In Fulra Formation Fig.4A, Erect-flexible-articulated branching cheilostomes are most dominant group. They live in shallow waters (around 10m) and can survive moderate to high sedimentation rate and energy. This zoarial form indicates inner to middle shelf environments. Another next dominant group is erect-rigid-delicate branching cheilostomes which are deep water forms but also occur in various-shallow waters. In Fulra, the bryozoan encrustations particularly found on oysters, *Pectin*, echinoids, *Discocyclina* etc. Indicate that the depositional environment is a low energy, clear waters probably under middle shelf depths as indicated by lithology and foraminiferal assemblage (Biswa, 1992).

**Fig. 4 A. Percentage distribution of growth forms of bryozoans in Fulra Formation**

Maniyara Fort Formation (Waiorian Stage):

The dominant zoarial growth in Waio is erect-flexible-articulated branching, and encrusting cheilostomes and erect-rigid-delicate-branching cheilostomes Fig.4B. Shallow water erect-flexible-articulated-branching and encrusting forms are also present in middle and deep shelf environments with relatively slow sedimentation rate. According to Bone & James (1993) the encrusting forms that attach to soft organic substrate will easily disintegrate after death and become fragmented and transported across the seafloor by tidal and wave action, but if they were attach to hard substrates they will be preserved intact. These shallow-water encrusting forms, are abundant in infra-to sublittoral environment bathymetry not exceeding 30 m
(Biswas, 1992). Bone and James (1993) have also noticed that erect-flexible forms due to their articulated nature disintegrate upon death in to sand and silt sized grains and get dispersed across the shelf by waves and current systems. It could therefore be argued that the ecological value of erect flexible and encrusting growth forms is limited as they could have been transported from shallow shelf habitats. Erect-rigid-delicate Cheilostome is the next group that occurs in minor percentage. They may survive in shallow water calm environment. The encrustations are found on gastropods, bivalves, and larger foraminifers.

**Fig.4 B Percentage Distribution of growth form of bryozoans in Maniyara Fort Formation**

Khari Nadi Formation (Aidian Stage):

This stage has been observed in four localities such as, Laiyari, Murachban, Waghot and Haripar Fig.4C, Erect-flexible-articulated branching cheilostomes abundant in Laiyari and Haripar indicating shallow water environment and relatively low sedimentation rate. However, free-living-lunulitiform cheilostomes are very abundant in Waghot and Murachban and minor percentages occur in Laiyari and Haripar. McKinney & Jackson (1989) reported that, they are found as shallow as 2 m on sandy shoals swept by waves or tidal currents of about $100^{−1}$ cm sec$^{−1}$, to the depths greater than 500m, but are more abundant on continental shelves between 20 to 70m where population densities are reported to reach 15,000 per m$^{2}$. Erect-rigid-delicate forms are abundant in Laiyari represented by 192 species. It shows shallow water calm environments. Erect-rigid-fenestrate cheilostomes are also occurring at
Waghari in minor percentages. This zoarial form generally lives attached by cementation to hard substrates at depths of 20 to 80 m (Moissette et al., 2007). Foraminifera like Miogypsina, Nephrolepidina, Austrotillina and spaerogypsina, Turritella, Ostrea and echinoids. Plant fossils are the associated fauna occurring with bryozoans indicating deposition in Khari Nadi Formation that took place in tidal flat, littoral, to shallow inner-shelf environment, in a slowly transgressive sea over a stable shelf (Biswas, 1992).

![Fig. 4C Percentage distribution of growth forms of bryozoans in Khari Nadi Formation](image)

**Chhasara Formation (Vinjhanian Stage):**

This Formation has been observed in three localities showing abundance of bryozoans viz., Chhasara, Lakdi river, and Vinjhan. Fig.4D, In Chhasara and Lakdi river erect-flexible-articulated branching cheilostomes are most abundant. Both localities represent 55 and 26 species respectively. These shallow water forms survive in moderate to high energy waters and sedimentation rates. They occur in inner-shelf environment. Free-living lunulitiform cheilostomes are also abundant in Vinjhan, representing 444 discoidal concavo-convex morphotypes. These zoarial growth forms are abundant in 20 to 70m depths on continental shelves. Multilaminar-encrusting growth form is third major group in Lakdi river represents 26 species. They constitute nodular massive or multilaminar colonies. This zoarial growth form also indicates shallow depths, with an optimum around 30m (Moissette, 2000, Moissette et al., 2007).
2007). In Chhasara Formation the associated fauna includes gastropods like *Turritella, Physa, Conus*, and others, bivalves constitute *Ostrea, Pectin, Arca, Venus* etc., echinoids like *cidaris, clupeaster, scutella* on which bryozoan encrustations occur. Further larger foraminifers mainly *Miogypsina* also shows bryozoan encrustations. *Miogypsina* occur in both lagoon and shallow subtidal environments. This biota clearly indicates deposition in sublittoral environment during the highest stand of the sea. Foraminifers show a fluctuating marginal marine to shallow inner-shelf environment of deposition (Biswa, 1992)

![Fig. 4D Percentage distribution of growth forms of bryozoans in Chhasara Formation](image)

**8.1.3 Conclusions:**

In this study bryozoans are grouped into seven morphotypes: (1) articulated branching, (2) delicate branching, (3) fenestrate, (4) articulated zooidal, (5) unilaminar, (6) multilaminar and massive, and (7) free-living. Erect-flexible (Cellariiform), Erect-rigid (Vinculariiform), free-living (Lunulitiform), and unilaminar-encrusting (Membraniporiform) cheilostomes are consistently the most extensive growth forms (see fig. 3). In Fulra and Harudi Formations, mainly argillaceous lithologies like gypseous shales are productive for bryozoans and erect-flexible, erect-rigid forms signifying moderate to high sedimentation rate and deposition in inner shelf environment where large foraminifers like *Discocyclina*, bivalves, echinoids are the available substrates for bryozoans.
In Maniyara fort formation the dominance of erect forms observed in which erect-flexible, erect-rigid are again dominant and encrusting-unilaminar cheilostomes are fairly observed. All these forms show shallow water conditions, moderate to high sedimentation rate and deposition in shallow inner-shelf areas where coral bioherms are formed and provided shelter to erect-rigid forms. Further, echinoids, bivalves, and larger foraminifers are available substrates for encrusting cheilostomes.

Laiyari, Murachban, Haripar and Waghot, are lower Miocene (Aquitanian) localities most productive for the most favourable growth of bryozoans where bivalves and gastropods have provided substrate for unilaminar-encrusting and fenestrate cheilostomes and free-living colonies indicating slow sedimentation rate and sandy or shelly bottoms in shallow tidal waters.

Chhasara, Lakdi River, and Vinjhan are Lower Miocene (Burdigalian) localities are also productive for the optimum growth of bryozoans along with bivalves, gastropods. During the high stand of sea erect-flexible, erect-rigid, free-living and unilaminar encrusting and multilaminar-encrusting forms like *Lagenipora* suggest moderate to high sedimentation rate and shallow inner-shelf environments.

In general, only cheilostomes are abundant in Kutch area and they are able to live in a wide range of water depths. Bryozoan abundance and growth form diversity increases with depth. Although depth ranges of different growth forms coincide and bryozoan fragments may be transferred from their growth habitats, bryozoan morphotype associations, occupying different depth zones, are giving significant information on palaeoenvironment. Where K is a locality such as :(K1) Harudi, (K2) Fulra, (K3) Maniyara, (K4) Khari Nadi, (K5) Waghot, (K6) Chhasara and (K7) Lakdi.
8.2 Evolutionary significance of Kutch Bryozoa:

The Kutch region is exceptional among other marine Phanerozoic fossiliferous rock formations of the Peninsular India as far as Bryozoa is concerned. The number of bryozoan species available in Kutch exhibits the high degree of diversity. There are certain genera and species which show unique morphological characters which have evolutionary and phylogenetic significance while, others have palaeobiogeographic significance.

8.2.1 Evolutionary significance of species of Neocheilostomina:

Phylogenetic analysis was carried out using PAST (version-2.06). Six species of neocheilostomine Bryozoa have been taken for analysis. There are very few characters available in fossil neocheilostomine species. Important specific characters are chosen for data matrix. A matrix of 13 skeletal characters was prepared for all species of *Nellia, Poricellaria, and Vincularia* from the studied area. Most characters are binary. Phylogram clearly shows two different assemblages, each one representing a set of similar morphological characters. Assemblage-I has three species out of which *Poricellaria complicata?* and *P. sakurkari* are in the same cluster. Both species belong to Lutetian-Chattian stages. Both species have zooids in four longitudinal alternating series, with semicircular to nearly circular orifices and are obliquely located to the axis of zooid; gymnocyst and cryptocyst are well developed. Further, avicularia in both species have rounded rostrum. According to Cheetham (1968)
poricellariids have evolved from *Nellia* in Late Cretaceous time with the beginning of zooidal asymmetry, completion of the cryptocyst and restriction of ovicells to lateral zooids. During mid-Tertiary time there is generation of distinct zooidal dimorphism and the trend was allometric with respect to zooidal series. However, *Nellia tenella* is on higher linkage and does not show any similarity with poricellariids. Thus, it is different. *Poricellaria waioiriensis* is also from Lutetian-Chattian stage occurs at a higher linkage distance having club shaped zooids making an angle of $45^\circ$ with axis of internode and elongated parallel sided avicularia. Assemblage-II constitutes two species out of which *Vincularia feddeni* and *V. kutchensis* are in the same cluster. Both of these species belong to Lutetian to Burdigalian. These species form one cluster and are more closely related than other species of the Neocheilostomina in the remaining clusters. Both species have erect growth habit with quadrirerial, articulated colonies. Further, both species have single avicularium with acute rostrum located at distolateral tip of zooid. Hence, as stated by Cheetham (1968) these two species are closer to similar lines of evolution of the genus *Vincularia* in which the budding pattern is highly regular, but different from that of the advanced poricellariids. *Nellia tenella* from Lutetian to Burdigalian stages occurring at a higher linkage distance having small paired avicularia with rounded rostrum. According to Cheetham (1968), the genus *Vincularia* Defrance, 1829 has evolved from the genus *Nellia* Busk, 1852 in Palaeocene time on similar lines of evolution with poricellariids through the development of zooidal asymmetry and dimorphism, appearance of adventive avicularian asymmetry, restriction of ovicells to lateral zooids and adaptation of the budding pattern to greater regularity. Further, He concluded that these trends indicate the genus *Nellia*, formerly regarded as far distant from this group, as ancestral to the poricellariids. Hence, *Nellia tenella* is out group and it does not become ancestor of both *Poricellaria* and *Vincularia* (Pers. Comm. Dr. P.D. Taylor, October 2011).
8.2.2 Evolutionary Significance of the species of Steginoporella:

Phylogenetic analysis was carried out using PAST (version-2.06). Four species of Steginoporellid Bryozoa have been taken for analysis. Except, Steginoporella sp. indet because, its generic placement is not confirmed and is provisionally placed under Steginoporella. There are very few characters available in fossil Steginoporellid species. Important specific characters are chosen for data matrix. A matrix of 11 skeletal characters was prepared for all species of Steginoporella. Most of the characters are binary. Phylogram clearly shows one assemblage, which represents a set of similar morphological characters. Assemblage-I consists of two species namely, Steginoporella murachbanensis and S. bhujensis, former species belongs to the Burdigalian and later from the Chattian. Both of these species forming same clade and they exhibits similarity in their growth habit, nature of condyles, distal sclerite etc. However, S. chiplonkari is occurring on the higher branch length and has erect, cylindrical growth habit, distal sclerite straight and
presence of A/B–zooids is not clear. Thus, this species is different from the species included by Pouyet and David (1979b) in group IA. *S. mathuri* belongs to Aquitanian is far distant from the above three species of *Steginoporella*.

Branch length=18, CI= 1, RI=1.

### 8.3 Affinities and Endemism of the Steginoporellid fauna:

From Kutch region, Guha and Gopikrishna (2007) reported a rich and diverse assemblage of steginoporellid bryozoans. These genera are *Labioporella* (Harmer, 1926), *Reniporella* (Guha & Gopikrishna, 2004) and *Steginoporella* (Smitt, 1873). Among them they have reported two species of *Labioporella* and one species each of *Steginoporella* and *Reniporella*. In the present study we are reporting five species of *Steginoporella*. These species are very diverse in morphological characters. However, all these species show very close affinity with Harmer’s division (I), in which B-opercula has inverted U (∩) shaped main selerite and A-opercula undifferentiated or with two teeth on the main sclerite (Harmer 1900). Pouyet and David (1979b) considered this group as IA in which they have included many species as already discussed by Guha and Gopikrishna (2007). In Kutch region, we are reporting *Steginoporella* from the Middle Eocene (Lutetian), Lower Oligocene (Rupelian) Upper Oligocene (Chattian), and Early Miocene (Aquitanian and Burdigalian) periods.
(see Table.3). So far there is no record of steginoporellids or other bryozoans from the Middle Miocene-Pliocene sediments. Oyster bands occurring in the Sandhan formation are to be critically searched for bryozoan encrustations. This clearly shows that in Kutch region during the Tertiary period two radiations occurred like the lower and middle Eocene of Central American province and a second radiation similar to the European Tethyan province during Upper Oligocene and early Miocene. However, the third stage of radiation in Australian province during the late Miocene and the Pliocene is either absent or overlooked for bryozoans. The species we reported shows Indo-Pacific affinities. Therefore, from 35-20 m. y. period the Kutch region experienced warm tropical currents suitable for optimal intensification of bryozoans (Guha & Gopikrishna, 2007).

8.4 Age and Affinities:

Out of sixty species of Bryozoa, Biflustra barchanensis, Vincularia feddeni, Steginoporella mathuri, Steginoporella murachbanensis, Steginoporella chiplonkari, Thalamoporella harudiensis, Thalamoporella naliensis, Thalamoporella badveii, Planicellaria guhaii, Poricellaria waioriensis, Poricellaria sakurkari, Ditaxipora lakdiensis, Schizomavella ghareii, Margaretta amplipora, Malakosaria gordonii, Siphonicytara robertsonae, Iodicytum brevipora, and Exidmonea badiensis are reported for the first time. Crassimarginatella blandfordi, Reptoporina chhasraensis, Nellia narayani, Vincularia kutchensis, ‘Vincularia’ ramwarensis, Microporina biswasi, Steginoporella bhujensis, Thalamoporella arabensis, Thalamoporella domifera, Thalamoporella Kutchensis, Thalamoporella dorothea, Thalamoporella reniformis, Crepis gurjarensis, Margaretta rajui, Consciniopsis parilis, Consciniopsis tuberosa, Therenia indica, Syphonicytara confusiata, Lagenipora chedopadiensis are restricted to Kutch while, Nellia tenella ranging in age from the Palaeocene to the Recent and has cosmopolitan distribution throughout the world. Poricellaria complicata? has alpine origin reported from the Middle Miocene and also found in the Recent waters and Exidmonea cf. undata is ranging from the Middle Eocene to the Miocene. Both these species are Mediterranean elements. However, this species is presently recorded from the Lutetian-Chattian stages of Fulra Formation and Maniyara Fort Formation of Waioian stage. Cupuladria guineensis ranging in age
from the Miocene to the Recent; *Skylonia sandbergi* ranging from the Lower Miocene to Upper Miocene; *Tetraplaria tuberculata* ranges from the Eocene to the Recent and *Didymosella larvalis* ranging from Middle the Oligocene to the Recent and have Indo-Pacific distribution. *Micropora parvicella* ranges from the Middle Eocene to the Miocene and *Margarreta cereoides* are Mediterranean and Atlantic elements. *Crisia elongata* is also long ranging species ranging from the Miocene to the Recent and has circumtropical distribution. *? Lichenopora aff. Radiata ranges* from the Middle Eocene to the Recent and has Indo-Pacific-Atlantic distribution.

8.5 Suggestions for future Research:

There is a scope for further study of the bryozoans by using the sequence stratigraphy of this region. As suggested by Winston (1977) there is lack of basic research on the salinity tolerance of the bryozoans. Thus, there is need to study this aspect on the Indian coast on large scale.

8.6 Achievements of the Present Study:

The present work makes unique contribution to the bryozoology in the systematic part of the formerly very studies have been done till date from this region. It gives geological and geographical ranges of most of the palaeoecologically important species. Further, on the basis of statistical analysis of the bryozoan assemblages the author has deduced the paleoecology of the Western Kutch. On the basis of phylogenetic analysis using PAST programme the author has studied the evolutionary aspects of some important genera and species. Finally, the present study has opened new avenues and opportunities for further research in the Indian bryozoology on the sound footings.