SUMMARY AND CONCLUSION

The present work entitled “PALEONTOLOGICAL STUDIES OF MACRO ANIMAL FOSSIL FAUNA OF DISTRICT JHABUA AND DHAR, MADHYA PRADESH” aimed to study the highly controversial problem of the age of Bagh Beds in relation to the varied group of macro fossil fauna, faunal affinities of the fossil heritage with allied species at global level and their provincial relationship. The paleoecology of the fossils assemblage has been studied to unravel the facts of their habitats. The investigation is based on numerous excavations and fossil collections from different areas of Jhabua and Dhar district. It might provide a complete coherent picture of the distribution of different taxonomic groups of the macro fossil fauna in Cretaceous period in the study area. In the upper Cretaceous time marine rock sequences of Bagh Beds with fluviatile characters were deposited along the northern bank of lower portion of Narmada valley.

The duration of the Cretaceous period is from 135 to 65.5 million years in the Mesozoic era. A remarkable event, as splitting of continents has been beheld by this period. The other notable events are: formation of fissure among continents, drastic marine transgression (Cenomanian-Turonian), the extensive chalk deposition, expansion of oceans (the Atlantic), Mesozoic marine rebellion and finally it stopped with huge extinction. During the early Eocene, India finally bumped into Asia, after its voyage towards north.

In that period, the western coast of India was linked with Madagascar & Seychelles. Madagascar was detached from India during the Lower Upper Cretaceous. The sea water traversed its way into western and central India from the Turonian - Coniacian marine transgression and also alongside the new and revitalizes E-W drifting Narmada graben. Due to this, Bagh group of carbonates was found to be dumped there.

The Bagh Beds constitute a significant paleontological unit in the Narmada Valley. These beds comprise of Nimar Sandstones, Nodular Limestone and Bryozoan Limestone. They show variable thickness ranging from 8 to 45 meter in the Bagh area.
of Dhar district. These beds are richly fossiliferous having the macro invertebrate fauna consist of Bivalves, Gastropods, Cephalopods, Echinoids, Brachiopods, and Bryozoans. The micro fauna of these beds is characterized by Foraminifera, Ostracoda and Algae, while the vertebrate fauna is represented by remains of dinosaurs and fishes.

In the recent work, the detailed systematic study of the Cephalopods, Bivalves, Gastropods, Echinoids and Brachiopods has been presented. Apart from that, author observed many dinosaur eggs, egg shell fragments & nesting sites from the Lameta formation in the study area. The study reveals the presence of a fairly rich assemblage of macro invertebrate fauna including seventeen species of Bivalves viz. *Inoceramus concentricus* Park.; *I. concentricus* Park. var. *subsulcatus* Willshire; *I. cripssi* Mantell; *I. cripssi* var. *rechensis* Etheridge; *I. concentricus* Park. var. *baghensis*; *I. lamarcki* Park. var. *cuvieri* Sowerby; *I. tenus* Mantell; *I. cf. teshioensis* Nagao & Matsumoto; *Nelthea morrisi* Pictet & Renevier; *Plicatula instabilis* Stoliczka; *Plicatula deodikari* Badve; *Modiolus typicus* Forbes; *Pholadomya* cf. *elliptica* Munster; *Astarte similis* Munster; *Astarte sinuicostata* Badve; *Nucula baghensis* Dassarma & Sinha and *Cytheria* cf. *lassula* Stoliczka. Eight species of Gastropods viz. *Turritella chikliensis* Chiplonkar and Badve; *T. sitapurensis* Chiplonkar and Badve; *Haustator* cf. *meadi* Baily; *Fulguraria elongata* d’ Orb; *Cerithium* cf. *scalaroideum* Forbes; *Neptunia excavata* Blandford; *Gyrodes* cf. *tenellus* Stoliczka; and *Fasiolaria rigida* Baily. Two species of Cephalopods ammonoids, one is *Placenticeras kaffrarium* with five morphotypes viz. *Placenticeras kaffrarium* morph *umkwelanense* Etheridge, Type – 2; *Placenticeras kaffrarium* morph *umkwelanense* Etheridge, Type – 3; *Placenticeras kaffrarium* morph *subkaffrarium* Spath, Type – 4; *Placenticeras kaffrarium* morph *subkaffrarium* Spath, Type – 5; *Placenticeras kaffrarium* morph *kaffrarium* Etheridge, Type – 6 and another one is *Barroisiceras onilahyense* Basse. Seven species of Echinoids viz. *Dorocidaris namadica* Duncan; *Cyphosoma namadicum* Fourtau; *Echinobrissus rajnathi* Chiplonkar; *Hemiaster fourtaui* Chiplonkar; *Hemiaster holoambitatus* Chiplonkar; *Hemiaster subsimilis* Fourtau; *Salenia keatingei* Fourtau and 2 species of Brachiopods *Acanthothyris* sp. and *Malwirhynchia subpentagonalis* Chiplonkar.
Among the ammonoids, *Placenticeras kaffrarium* with five morphotypes and *Barroisiceras onilahyense* were explored by the author for first time from the study area. Beside this, one Brachiopod genus, *Acanthothyris*; several other molluscan and echinoids species are being reported for the first time in this area by the author.

In addition to the above invertebrate fauna, author observed many dinosaur eggs, eggshell fragments and nesting sites. By means of thin sectioning and SEM study, the dinosaur eggs are identified as a single oospecies, *Megaloolithus jabalpurenensis* from this area. The marking of eggs in the nesting sites denotes arrangement of eggs and also indicates the laying behavior of dinosaurs.

Based on the collected macro faunal assemblage, a few generalizations have been postulated regarding the age of Bagh Beds. The conclusion arrived is enumerated below:

1. In the present study, the collected Brachiopod fauna do not contribute much in the precise age determination of these beds because the comparable material and literature of this group is lacking in the Bagh bed area. Though the genus *Malwirhynchia* shows close affinities with fauna ranging from Albian to Senonian, very probably the age indicated by this genus can be taken as Gault to Cenomanian.

2. Echinoid fauna even though dominated by Turonian aspects but have with some indications of Albian and Senonian elements.

3. Bivalve fauna shows dominant representation of Cenomanian to Turonian affinities with a few Aptian – Senomanian elements.

4. Gastropods pointing mainly towards the Cenomanian to Turonian affinities like bivalves, but one of the genus *Turritella* shows resemblance with Campanian and Maastrichtian age.

5. The Cephalopods dominated by remains of ammonoids indicating Coniacian age of Bagh Beds.

On the basis of detailed systematic study of macro invertebrate fossil fauna, author concluded that the Bagh Beds age must be ranging between the Cenomanian to Coniacian. On the basis of the study of dinosaur eggs and nesting sites, the age of Lameta formation is found to be of Maastrichtian period.
As for as the provincial relationship is concerned, it is concluded that the marine Cretaceous zoological province of Narmada valley had connections with that of Europe, South India, Madagascar, Pondoland, France etc. and was not restricted to Mediterranean zoological province.

Upper Cretaceous Bagh basin has kept evidences of marine incursion (Upper Turonian to Middle Coniacian times) both lithologically (marine carbonate set up) as well as paleontologically (Presence of undoubted marine fossils like those of inoceramids, bryozoans and ammonites). Lithologically it is a shallow marine carbonate sequence---the lower portion is popularly known as Nodular Limestone which is devoid of current induced primary sedimentary structures like cross-stratification which is plenty in upper sub unit. So, from lithology and other primary sedimentary structures, it can be said that this shallow marine epicontinental basin gradually shallowed upwards.

Here, the overall environmental aspects of Bagh Beds along with different fossil groups have been discussed. In this part of the basin, ammonite genus *Placenticeras* dominates all through while *Barroisiceras* is present only in the upper part of the Bryozoan limestone. According to Westermann (1990) *Placenticeras* were inhabitants of proximal sublittoral (<100m) marine environment. On the other hand keeled ammonite *Barroisiceras* lived in the shallowest offshore region of warm epicontinental sea (30-50m). From this point of view of ammonites, the Bagh basin is supposed to be a shallow epicontinental sea in the past. Hence on the basis of ammonite study, it can be said that the Bagh basin progressively becoming shallow upwards which has already been deld lithologically.

The bivalves described in this research work, have the dominance of Inoceramids, which also points to a very shallow nature of the Bagh basin as has already been proved by ammonite study.

On the basis of the study of gastropods, it is clear that Bagh basin was much nurtured shallow beach to subtidal zone. In a nutshell, it could be said that both brachiopods and echinoids point to a very shallow subtidal to near shelf environment, which have already been discussed in detail in a separate chapter.
Summary and Conclusion

So, to sum up, the overall picture of Bagh fossil assemblage reveals mainly the sublittoral or shallow shelf communities.

The present research is dedicated to several areas of Paleontological investigations which help researchers to link the past with present. It will also continue to provide important results in the future by collection and thorough study of more fossils from Bagh Beds. It is the fact that reminiscence of the past is relevant to the present and future context.

It is no exaggeration to say that Paleontology formed a major pillar for understanding relative chronologies and evolutionary trends. Future and extensive research is required by exploring more fossils for the completeness of the record which may unfold the mystery so that more conclusions could be drawn about evolutionary pattern and trends. Perfect facts about climatic and environmental variations in past can be determined by gathering more fossils from different parts of the world and correlating them with continental drift. They also contribute in understanding ecological relationship, the challenges of global warming and extinction dynamics.

Many anthropogenic activities are going on knowingly or unknowingly like manufacturing cement by squashing fossils have been done for constructing house. Even some people made houses with fossils instead of stones. As these fossils form India’s rich fossil heritage, they ought to be preserved for our future generations. There is critical need for endorsement of legislation that will not only permit systematic study of vertebrate and invertebrate fossils but also definitely deal with planned act of vandalism, business and smugglings of these fossils. Jumbled gathering of dinosaur egg fossils and their nesting sites should not be allowed.

Before fossiliferous rocks vanish forever, the valuable fossils should be recovered as early as possible. The invertebrate fossiliferous areas should also be restricted, to protect the valuable, rare and time diagnostic fossils having high evolutionary values only found in Bagh areas, Jhabua and Dhar in India.
All the collected fossils may be housed in the national parks and museum. A workshop of paleontologists was held on 28 July 2013 at Indore for contributing suggestions regarding establishment of “Dinosaur Fossil National Park” at Bagh-Kukshi, Dhar district of Madhya Pradesh, so that their proper conservation could be achieved.

In addition to constructing the national park, in Madhya Pradesh, an advanced paleontological research center and fossil repository will be more fruitful in this area, for preservation and proper scientific study of the collected fossils on global level.

Excursions should be planned for college and school students in Bagh Beds and other fossiliferous areas to educate and to make them aware about the fossil exploration, especially the local students of this area should be encouraged in this field to approach new and interior sites for fossils collection.

To indicate the importance of history of fossils and its prosperity of time, geotourism spots should be emerged. They can attract national and international tourists and contributes in improving national economy.

Harmonized research at institutional level is mandatory for preservation and conservation of fossils. As dinosaurs were huge and extinct animals, it is very much interesting to interpret the cause of dinosaur extinction and to determine their continual existence period on earth in the past. Dinosaur remains are the important constituents in considering dinosaur paleobiology and evolution, but they are scarcely recovered. More exploration of these remains in future may clarify more facts about dinosaurs.

Restructuring measures, such as strong interdisciplinary ties of geology and zoology, collaborative efforts and new orientation like Paleoinformatics should also be considered for further Paleontological research.