2. PREVIOUS WORK

This chapter presents a summary of some important palaeontological investigations carried out previously by various workers on the Deccan volcano-sedimentary sequences of the peninsular India.

Western Region

In this region, outcrops of intertrappean beds occur in the districts of Kutch and Surendranagar in Gujarat, Kota in Rajasthan and in and around Bombay.

The intertrappean beds of Kutch were first recorded by Wynne (1872). Recent detailed studies (Ghevariya, 1988; Bajpai, 1990; Bajpai et al., 1990) on these beds have yielded a diverse fossil assemblage including dinosaur teeth, fragmentary bones and eggshell fragments. These authors (op. cit.) assigned a Late Cretaceous (Maastrichtian) age to the beds and suggested that there exists no significant temporal differences between Kutch and other Deccan intertrappean localities. However, Ghevariya and Srikarni (1990), on the other hand, suggested a Lower Palaeocene and younger ages for these beds mainly on the basis of K-Ar ages (55±2 to 57±2 My).

The intertrappean beds of Rajasthan have not attracted as much attention as those from Maharashtra,
Andhra Pradesh and Karnataka. Dubey and Narein (1946) were the first to report a pterosaur jaw from a locality near Mamoni. Bhatia et al. (1990b) reported certain ostracode and charophyte taxa with Eurasiatic affinities from the same locality and revised the taxonomy of an earlier assemblage reported by Mathur and Verma (1980). Bhatia et al. (1990b) favoured a Late Cretaceous age for the Mamoni intertrappean beds and corroborated the view that the collision of the Indian subcontinent and Eurasian landmass took place close to the K/T boundary.

The intertrappean beds exposed at Bamanbor and Ninama in the Surendranagar district of Gujarat have yielded fossil fishes, *Horaclupa intertrappea*, *Palaeopristolepsis feddeni* and *Perca* sp.cf. *P. angusta* on the basis of which a Palaeocene age has been assigned to these beds (Borkar, 1973).

In Bombay, good exposures of intertrappean beds are found at Worli and Malabar Hill Sections. One of the first reports on the fossil biota from intertrappeans of Bombay was by Owen (1847) who described the samples of fossil frogs handed over to him by Dr. Leith. The specimens were found preserved in intertrappean black shales. On the basis of the postcranial characters such as, the nature of the sacrum and the absence of ribs or their rudiments in the dorsal vertebrae and the proportional expansion of the skull and length of the hind limbs, these specimens were placed in the Family Ranidae and described as *Rana pusilla* (Owen, 1847).
Carter (1850) was the first to carry out detailed investigations on the intertrappeans of Bombay. Describing the geology of Bombay, he envisaged four distinct periods in the formation of the island of Bombay viz. first, that of primary volcanic or trap eruptions; second, that of the deposition of freshwater strata; third, that of the secondary or subsequent volcanic eruptions; and fourth, the deposition of the marine strata. He also described the frog *Rana pusilla*, the ostracodes *Cypris semi-marginata*, *C. cylindrica* and some other fossils from the Worli Hill Section.

Stoliczka (1869) studied the fossil frog specimens of Owen and transferred them to genus *Oxyglossus* (= *Oxydozyga*) which is found in south-eastern Asia and the Indonesian Islands. He also reported a tortoise, *Hydrapsis (Platemys) leithii*.

Blanford (1867) studied the traps and intertrappean beds of the western and central India and observed the following features:

a) absence of cones and craters of elevation,
b) compact structure of traps,
c) conforming of the trap to the lowest of existing valleys, and
d) occasional intercalation of marine beds in the Lower Godavari valley.
Blanford (1867) also recorded the fossil frog *Rana pusilla*, some reptilian remains and a tortoise from the intertrappeans of Bombay. He compared intertrappean beds of Bombay to those of the central India and suggested that the Bombay and Nagpur intertrappean beds be assigned to one "series". However, he considered that the period of their formation differed considerably and was represented by the duration of trap accumulation. He concluded that the lowest traps appeared after the Middle Cretaceous Bagh Beds and the upper traps were of Lower Eocene age.

Blanford (1867) further described the geology of Bombay and adjoining areas of Gujarat and gave the following succession:

| Later Tertiary | Gravel, sub-alluvial etc. |
| Older Tertiary | Older Tertiary of Surat, Broach, Perim island bone beds and Laterite of the Deccan |
| Deccan Series | Deccan Traps |
| Deccan Series | Intertrappean beds of Bombay |
| Deccan Series | Intertrappean beds of Nagpur and Narmada valley |
| Deccan Series | Cretaceous beds of Bagh |
| Oolitic series | Jurassic of Kutch |
| Vindhyan series | Sandstone and limestone |
| Submetamorphic and metamorphic rocks | Champaner beds, granite, gneiss and mica schist |
Noble (1930) studied the fossil frogs from the Worli Hill and transferred them to the genus *Indobatrachus* from the genus *Oxyglossus*.

Chiplonker (1940) reported another specie of frog i.e. *Indobatrachus trivialis* from the intertrappean beds of Bombay. When he compared *Indobatrachus pusillus* (Owen) with the other specie i.e. *I. trivialis* he found the latter more elongated and robust in appearance. He assigned a Lower Eocene age to the upper part of the Deccan Trap series which included the frog beds of Bombay, since they were unconformably succeeded by the Nummulitics of Surat and Broach.

Sukheswala (1953) studied the intertrappean beds exposed at Worli and Malabar Hills of Bombay. He, while emphasizing the importance of fossil evidence for assignment of age to stratified rocks stated that in the case of Bombay Island, complete reliance could not be laid on the fossil record of intertrappeans.

Verma (1965) described a third specie of frog, *Indobatrachus malabaricus* from the intertrappean beds exposed at the foot of the Malabar Hill, West of Chowpatty Bunder, Bombay. These fossils occurred in dark grey to bluish grey argillaceous rock with very thin black shaly partings and were found to be associated with ribbed fragments of plants and large pieces of carbonized matter.
Subramanyam and Verma (1966) examined the Miliolite Limestone/Littoral Concrete (Pascoe, 1964) of Fort area, Bombay and recovered some foraminifera and ostracodes and suggested a Pleistocene to Sub-Recent age for these beds.

Mathur (1968) recovered a lone specimen of *Scylla serrata* (supposedly from an intertrappean-derived boulder) from the sea beach at Versova, Salsette Island, Bombay. Previously, *Scylla serrata* had been reported by Dasgupta (1925) from the Miocene beds of Kathiawar. Stoliczka (1871) had reported *S. sindensis* from Sind, Pakistan. Based upon his studies, Mathur (1968) presumed *Scylla serrata* to be from the intertrappean beds of Bombay. Thus, he assigned a relatively younger age to the intertrappean beds of Bombay since *Scylla serrata* has a range of Oligocene to Recent.

For the last thirty years, no significant fossil find from the Bombay intertrappeans has been reported till the present work.

**Southern Region**

In this region, outcrops of intertrappean beds are exposed at Asifabad, Narsapur, Nizamabad, Rajahmundry and Vikarabad in Andhra Pradesh and Gulbarga and Belgaum in Karnataka.

Foote (1876) was the pioneer to work in this region who described the geology of "South Maratha Country" and
adjoining districts. His contribution also included a brief account of intertrappean beds exposed near Bilgi (Dodihal) and Gokak (Upperhatti and Madmapur). He (op. cit.) reported Physa prinsepii, Lymnaea sp. and Unio deccanensis along with some other fossils from a 1.8 m to 2.5 m thick marl bed at Dodihal and suggested a freshwater origin for these beds.

Kazim (1941) mapped in Gurmatkal and surrounding areas of Yadgir Taluq in Gulbarga district and proposed the following stratigraphic succession:

1. Laterite and soil
2. Deccan Traps including intertrappeans
3. Infratrappeans
4. Bhima Series (Vindhyan)
5. Post-gneissic dolerite dykes
6. Peninsular gneissic complex
7. Dharwar

The presence of a few gastropods and lamellibranchs (Paludina, Lymnaea, Physa, and Unio) in the intertrappean beds of Gurmatkal was also reported by Kazim (1945).

Kelkar and Gupte (1943) studied the petrological features of the intertrappean beds of Upparhutti exposed near Gokak in the district of Belgaum. They (op. cit.) concluded that the material constituting the intertrappean beds was derived from the Archaean metamorphic rocks and Kaladgi sediments without any significant contribution from
the Deccan Traps themselves. Kelkar and Gupte (1943) also reported *Physa, Lymnaea, Unio* and skeletal fragments of turtles and compared these beds to the intertrappean beds of central India on a faunal basis.

Shivarudrappa (1972a, 1972b and 1977) studied the intertrappean beds in and around Gurmatkal and described several charophytes including *Chara foetida, C.microcera, C.wrightii, C.indica, C.vermiformis, Rhabdochara, Spherochara, Psilochara* and *Gyrogonites medicaginula* and assigned an Upper Eocene to Lower Oligocene age to intertrappean beds on their basis. He (1977) further stated that these intertrappean beds were coeval with other peninsular occurrences including those in Vikarabad, Mohgaonkalan, Takli, Chhindwara and Kutch. Shivarudrappa (1989) again asserted a Lower Oligocene age for intertrappeans in and around Gurmatkal.

Srinivasan (1991) recovered a rich microfossil assemblage comprising of fishes, ostracodes, gastropods and charophytes from the intertrappean beds of Gurmatkal. He assigned an uppermost Cretaceous (Maastrichtian) age to the intertrappeans beds on the presence of characteristic Late Cretaceous ostracode assemblage, *Talicypridea-Altanicypris-Crypridea-Candona-Darwinula-Mongolianella*. He supported Maastrichtian dating of the Gurmatkal intertrappeans further by the presence of fish, *Apateodus cf. A. striatus* and the
characteristic Upper Cretaceous charophytes, *Platychara perlata* and *P. compressa*. Thus, he contradicted the previously held Oligocene age for these intertrappean beds and suggested that there is no appreciable southward younging in the Deccan basaltic province, at least not of the order of 10 My scale.

In Adilabad district, good exposures of intertrappean beds are found near village Ada, located on the Asifabad-Adilabad road. The first well-documented discovery of sauropod dinosaur remains was made here by Rao and Yadagiri (1981). Later, Prasad (1985) made a detailed micropalaeontological study in this area and reported a diverse assemblage including thin dinosaur eggshell fragments and dinosaur teeth (Prasad and Sahni, 1987). The fauna recorded was similar to that of Takli assemblage but for a larger marine component represented mainly by the batoid fishes.

The intertrappean beds of Rajahmundry (Kateru, Duddukuru and Pangadi) are marine in nature and have been studied extensively. General Cullen and Benza (in King, 1880) were the first to notice these intertrappean beds and the first publication was produced by Benza in 1837 (King, 1880). The intertrappean beds of Kateru were first discovered by Walter Elliot in 1854 (King, 1880) and the first fossil collection was made by Stoddart and Elliot, which was studied by Hislop (1860), who assigned a Lower
Eocene age to them. Hislop (1860) also suggested an estuarine environment of deposition for these beds. King (1874), described the traps and intertrappeans of Kateru and gave a comprehensive account of the geology of the area. He (1880) supported the Early Eocene age suggested by Hislop (1860) for these beds.

Das Gupta (1933) reported Cardita beaumonti from the intertrappean beds of Pangadi and assigned a Late Cretaceous age to them. Rao and Rao (1935) reported Rotalia, Discorbina, Pulvinulina, Globigerina, miliolids and some radiolarians from the intertrappean beds of Pangadi, Rajahmundry. They (1937) reported eleven species of foraminifera from the intertrappean beds of Kateru and suggested an estuarine environment. Rao and Rao (1939) further made a comprehensive study of thirteen species of charophytes from intertrappean beds of Kateru and favoured a Palaeocene age for these beds.

Prakash (1960), summarized the intertrappean flora collected from various places viz. Rajahmundry, Chhindwara, Nagpur, Sagar, Jabalpur, Vikarabad, Mohgaonkalan, Takli, etc. which included plant fossils belonging to Thallophyta (with algae, fungi and charophytes), Pteridophyta, gymnosperms (conifers) and angiosperms with both monocotyledons and dicotyledons. This flora, as indicated by the presence of Nipa and Rodeites suggested a tropical
climate and the occurrence of Cyclanthaceae, *Rodeites* and *Simaruba* provided a link between the Tertiary flora of the Deccan intertrappeans and the modern flora of the tropical South America.

Sastri (1961, 1963) described fourteen species of foraminifera, ostracoda and charophytes from the intertrappean beds of Kateru and suggested Eocene age and estuarine environment of deposition for these beds. Vaidyanathan (1963) mapped an area of 240 sq.km near Rajahmundry and after working out stratigraphic section of the Kateru area from bore hole data pointed out two bands of intertrappeans separated by Deccan Traps.

Bhalla (1965) reported sixteen species of ostracoda from the intertrappean beds of Pangadi, Rajahmundry and assigned a Lower Eocene age and suggested alternating marine and brackish water environmental conditions of deposition for these beds. Later on, he (1966) described eight species of foraminifera from the intertrappeans of Pangadi, Rajahmundry and inferred a shallow marine, inner neritic environment of deposition and a Palaeocene age for these beds. Bhalla (1967), further reported eight species of foraminifera and suggested a Lower Eocene age for intertrappean beds of Pangadi, Rajahmundry. Bhalla and Khan (1969) reported eight species of foraminifera, several forms of ostracoda, ophiuroid ossicles, shark teeth and
charophytes from the intertrappean beds of Kateru and suggested a shallow, warm, near shore, brackish water environment of deposition for these beds. Bhalla (1974), assigned Eocene age to the intertrappean beds of Pangadi on the basis of recovery of *Eotrigonodon*, a teleost fish. Guha and Raju (1978) on the basis of their microfossil collection suggested a Late Palaeocene age and a shallow marine environment of deposition for the intertrappean beds of Duddukuru, Rajahmundry. Bhalla (1979) described a new specie of podocopid ostracode, *Quadracythere tewarii* from the intertrappean beds exposed near Pangadi and suggested a near shore, epi-neritic, open marine environment of deposition for these beds.

Govindan (1981), recovered *Globotruncana stuarti* and *G.gagnebini* from the intertrappean beds of ONGC’s Narsapur Well, around 72 Km from Pangadi and suggested a Late Maastrichtian age and deep inner shelf (approximately 20-30 m) environment of deposition for these beds.

Recently, considerable amount of work has been carried out in localities around Vikarabad (Naskal, Rangapur, Timsanpalli and Marepalli), West of Hyderabad by Prasad and Sahni (1988), Rana (1988) and Prasad (1989). The first record of a Cretaceous mammal from India is attributed to Prasad and Sahni (1988). The find, a paleoryctid named *Deccanolestes hislopi* indicated a Maastrichtian age.
Eastern Region

In this region, the major occurrences of intertrappean beds fringing the eastern border of Deccan Traps are known from Jabalpur, Mandla and Chhindwara in Madhya Pradesh and Nagpur, Pisdura and Dongargaon in Maharashtra.

Brookfield and Sahni (1987) described Lameta sediments around Jabalpur as deposited in an alluvial plain environment under semi-arid conditions. The Lameta sediments around Jabalpur were described as fluvial and pedogenically modified semi-arid, fan-palustrine flat system by Tandon et al. (1990). Prakash et al. (1990) and Mathur and Sharma (1990) investigated intertrappean beds of Padwar and Ranipur near Jabalpur and reported Maastrichtian pollen assemblages including *Aquilapollenites*. At Ranipur, the pollen *Aquilapollenites*-yielding horizon underlying a bed containing a dinosaur pelvis, provided a unique tie-up between the two lines of evidence (Sahni and Tripathi, 1990). Mohabey et al. (1993) inferred an alluvial-limnic environment of deposition for Lameta sediments on the basis of lithological and palaeontological observations. Sahni and Khosla (1994) reported a rich assemblage of ostracodes from Jabalpur having close affinities to Chinese and Mongolian forms of Upper Cretaceous and also comparable to the forms reported from other Deccan volcano-sedimentary sequences of India.
In the South of Jabalpur, intertrappean beds of Nagpur-Chhindwara region have been studied extensively. Important localities in this region are Takli, Paharsingha, Mahurzari, Chikni and Sichal Hill in the Nagpur district and Mohgaonkalan and Linga in the Chhindwara area. The fossil flora of this area has been investigated among others by Sahni (1931, 1941), Sahni and Rode (1937), Sahni and Rao (1943), Sahni and Surange (1953), Prakash (1960, 1972), Lakhanpal (1970, 1973, 1974), Singhai (1975), Prakash et al. (1979), Patil and Upadhye (1980) and Bande and Prakash (1982). Later on, Bande et al. (1986a) gave a synthesis of the intertrappean flora which comprised algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms. The angiosperms were the most dominant, represented largely by various palm elements like woods, fruits, petioles and roots. Further, the fossil flora investigated suggested an Early Tertiary (Palaeocene) age for the Deccan intertrappean beds and a humid, tropical climate with deltaic regimes as well as sand bars and coastal vegetation (Bande et al., 1986b). However, subsequent reinterpretations by Horrell (1991) favoured arid to semi-arid climatic conditions.

Hislop and Hunter (1855) pioneered work on the intertrappean beds of Nagpur and neighbouring areas. Later work by Lydkeker (1890), Sahni et al. (1982), Rana 1984), Gayet et al. (1984), Vianey-Liaud et al. (1987), and Rana
and Sahni (1989) on these beds yielded mainly a terrestrial faunal assemblage comprising fishes, pelobatid frogs, anguid lizards, booid snakes, turtles, crocodiles, and more importantly, various eggshell fragments. The fauna also included some coastal elements like rays, *Dasyatis* and *Rhinoptera*. The dental remains of latter two were identified as lateral teeth of *Igdabatis* (Prasad and Capetta, 1993). The other microfossils recovered from the area included charophytes and ostracodes (Bhatia and Mannikeri, 1976; Bhatia and Rana, 1984). The taxonomy of Takli ostracodes was revised by Bhatia et al. (1990a) favouring a Late Cretaceous age to the previously held Palaeocene age. Interpretation of palaeomagnetic data indicated that the Takli intertrappean beds occur within the basalts of reversed polarity, most likely correlatable with chron 29R (Courtillot et al., 1986b; Jaeger et al., 1989). Bhandari and Shukla (1990) analyzed geochemical signatures of these beds indicating negligible iridium concentration.

To the south-west of Nagpur, Hora (1938) described a rich assemblage consisting of fossil fish scales from the intertrappean beds of Deothan and Kheri. These fish scales belonged to the Families Osteoglossidae, Clupeidae, Cyprinidae, Polycanthidae, Serranidae, Nandidae and Pristolepidae and a "Lower Tertiary" age was assigned to the intertrappean beds on their basis (Hora, 1938).
A large number of fossil plants have been described from the intertrappean beds of the Mandla district, Madhya Pradesh by Bande (1973, 1974), Bande and Khatri (1980), Bande and Prakash (1980, 1983), Mehrotra et al. (1984), Ambwani (1984a and 1984b), Trivedi and Srivastava (1985) and Bande et al. (1986). The faunal assemblage included both palms and dicots. The Mandla assemblage showed a greater percentage of evergreen species than the Nagpur-Chhindwara-Nawargaon assemblage (Bande and Prakash, 1982). The Deccan intertrappean flora was also found to contain an element from Australia, another continent belonging to the Gondwanaland (Bande et al., 1986).