The Jurassic in Sri Lanka

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Background

Sri Lanka's configuration and morphology have been determined largely by its geological history, rock types and the structure. Structurally, Sri Lanka is related to India to which it was united through the greater part of the geological time, when both were a component of the super continent Gondwanaland (it included Antarctica, Australia, Madagascar and East).

Gondwanaland began to fragment in Jurassic times and the Indo-Sri Lanka landmass drifted northwards from a position far south of the equator, until it rammed Asia early in the Tertiary. The disruption of Gondwanaland and the movement apart of its components were accompanied by phases of sea-floor spreading which were responsible for the creation of the Indian Ocean.

The first signs of an Indo-Sri Lankan rift also appeared in Jurassic times, opening an ancient pre-Cambrian fault. This swing from India resulted in the creation of the Palk Strait, the Palk Bay and the Gulf of Mannar zone, which was infilled with Jurassic and Miocene sediments which attain thicknesses exceeding 1000m (Swan, 1983).

The North-west and North of Sri Lanka is of special interest since it contains a store of knowledge pertaining to Sri Lanka's isolation and to the entry of living things into it. This area used to extend periodically to form the land bridge connecting to India; it contains the earliest records of the presence of living things in its Jurassic deposits of 150,000,000 years ago; it contains Miocene deposits of 20,000,000 years which yielded the earliest vertebrate fossils from Sri Lanka; stone artefacts belonging to prehistoric man and access to several earliest settlements of civilized man.

Most of what constitutes the presence of the above findings is due to repeated land oscillation (elevation and subsidence) that has been prevalent here. In the sea off this area the five fathom isobaths or depth line lies at a distance of over eight miles, whereas elsewhere around Sri Lanka it is close to the shore. An aerial view of this submerged north-western shelf shows submarine channels. This is evidence that the existing rivers traversed it, and without doubt linking up with those in India. The arrangement of the isobaths as well as the zoological and palaeontological data also support this view. For example, the Hippopotamus fossils occurring in Sabaragamuwa indicate that the island contained rivers sufficiently large to support this bulky animal.

Indian animals entered Sri Lanka across this shelf whenever it was dry land. Periods of isolation also occurred when it was submerged and then the isolated animals evolved new characters.

The fossil accumulating troughs of Sri Lanka were possibly few, shallow and readily disrupted by earth movements. The earliest evidence of life in Sri Lanka occurs in the Jurassic at Andigama which are somewhat older than others from Tabbova. This is attributed to the evidence of remnants of plants that have altered into crystalline coal with age and are similar to the Rajmahal beds of India (Deraniyagala, 1955b).

The Jurassic period of Sri Lanka occurred 195-141 million yrs B.P (Cooray, 1984). This period is popularly known as the 'Age of the Dinosaurs'. The dinosaurs were the largest and powerful land animals. The flying reptiles (pterodactyls), birds and mammals made their first appearance on earth.

The vegetation consisted primarily of ferns and cycads. Flowering plants were almost unknown. The Jurassic is

represented geologically by shallow-water deposits of sandstones, mudstones and shale preserved below the ground surface.

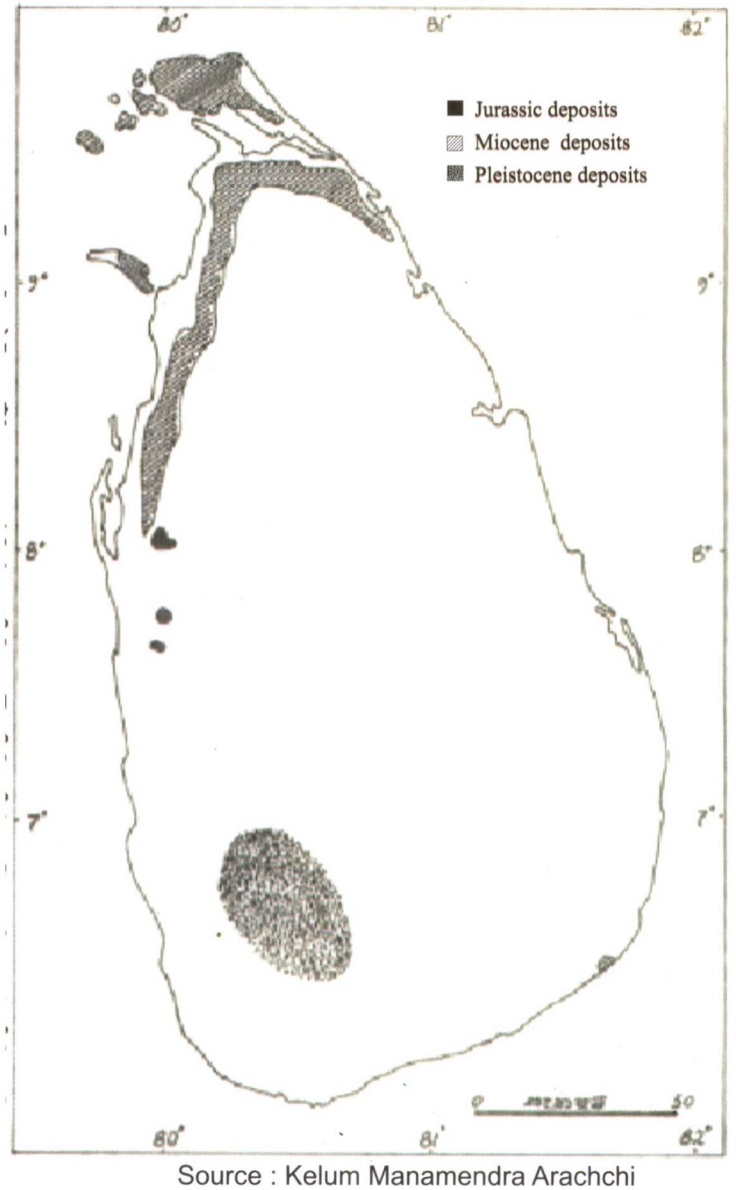
These sedimentary rocks are preserved within the crystalline Vijayan Complex in the north-west of Sri Lanka. This is evidenced at Tabbowa, Andigama and Pallama areas in the North-western Province. They also underlie younger Miocene limestone in the Mannar area.

Tabbova

The exposed Jurassic beds at Tabbova is situated below the Tabbova tank (parallel to the bund) to the north of 8th milepost (Puttalam-Anuradhapura). The total extent of the Tabbova Beds is about 2 or 3 sq miles, and it is surrounded on almost all sides by granites and gneisses of the Tonigala Complex.

The Tabbova Beds consist mainly of a well bedded series of feldspathic sandstones, arkoses, siltstones and mudstones. A few thin beds of nodular limestone are also present. The sediments vary in colour from white or light grey to dark brown and purplish red, and in texture from course-grained to fine-grained. These sequences show a cyclic sedimentation patterns.

Wayland was the first to discover and describe the Tabbowa beds in 1925. He described the stratigraphic sequence displayed in the area as follows: in descending order alluvium (recent), Red-earth with occasional gravels (Pleistocene), Tabbowa beds (Jurassic), and Crystalline complex (age unknown). The Tabbowa beds consist of a group of shallow-water-non-marine accumulations. Intercalated with the sandstones at Tabbowa is a thick layer of pipe clay full of plant impressions. The plants were identified as *Cladophlebis reversa* (Fiest), *C. denticulate* (Brongn), *Taeniopteris spatulata* (mcChell), *Araucarites cutchensis* (Feist), *Brachyphyllum mamillare* (Brongn), *Elatocladus plana* (Feist) and *Desmiophyllum* sp. They have been classified as belonging to lower Oolite and is presumed to be similar to those found in the Madras beds (Wayland, 1925).



Source : Kelum Manamendra Arachchi

Wayland also speculates that the age of rocks of the lower part of the sandstone cliff at Kudremalai are coincided with Tabbova beds and some highly metamorphosed sediments exposed in some low sea cliffs at Wellipatanwilla (Southern Province) are presumed to belong to the Jurassic series.

After Wayland's discovery in the 1920's of the lower plants, 19 years later, Deraniyagala reported the presence of an impression of a pinnate cycadean frond. This was the first indication of the existence of two distinct plant bearing horizons in the Tabbova beds. The two layers can be tentatively termed as Wayland's Cladophlebis horizon of pipe clay and the Ginkgophyte horizon of coarse grit. Both possibly belong to the latter part of the Jurassic and have been heavily affected by faulting (Deraniyagala, 1955a).

Another fossil was also obtained from Tabbova about 3km from the spill on the part of the bank known as Ismathe' pitiya of the Lunu ale stream. These specimens are the first completely silicified fragments of timber discovered in Sri Lanka. Since it had lain loose it could be assumed that these may have been washed out from a higher elevation. This petrified wood belonged to a coniferous tree which displays araucarian affinities (Deraniyagala, 1940).

So far, only fossilised impressions of plants have been found at these sites. The fossils at Tabbova consist mainly of leaves, stem fragments and shoots of coniferous trees, cycads and ferns (*Pteridophyta*). It is also known that sediments similar to those at Tabbova are found in the Mannar area, lying below 250 ft of Miocene limestone

Evidence of several of the species of fern such as *Ptilophyllum* indicates that the Tabbova beds belong to the Upper Gondwana system of Upper Jurassic age.

Several of the species found at Tabbova are similar to those found in the Upper Gondwana deposits of Rajmahal in the Damodar Valley and of the Madras Basins. Deraniyagala regards the Tabbova beds as equivalent to the Kota stage.

It can be surmised from the structural and depositional evidences that very little vegetation grew in the actual region where the beds were deposited. The plants that were carried down to the delta probably grew in a cooler wetter mountainous region nearby and it was the weathered products that were brought down and deposited in the delta. The alternation of sediments indicate that periods of flood with turbulent water was present periodically. Amongst these flood periods there also existed periods of quieter conditions where leaves and stems from of the cycads and ferns were deposited and preserved in the soft clays. Furthermore, other structural evidences indicate that degrees of atmospheric weathering and oxidation changed from time to time. At the time of deposition of these beds, the Gondwana continent had begun to break up and its sediments to drift apart. Incursion of the sea took place between these sediments (Cooray,1984).

Photo: Gamini Gamage

Impression of a fossil plant

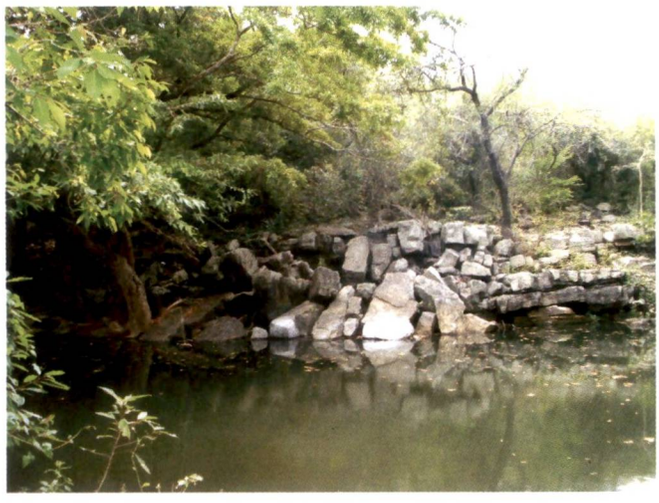
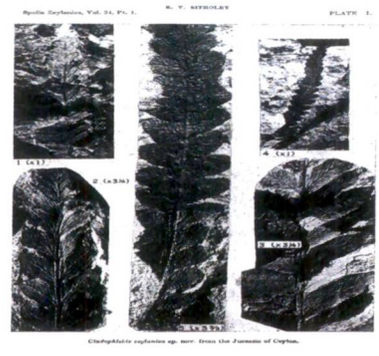


Photo: Gamini Gamage

Tabbova Wewa

Fossil Plants



Andigama and Pallama beds

A small basin of Jurassic sediments somewhat similar to those at Tabbova are to be found at Andigama (a small village 8 miles east of Kiriyankali) which is near 63 ½ milepost on the Colombo-Puttalam road. These beds do not appear as outcrops but can only be seen in dug-wells over an area of several square miles. Drilling activities conducted in the late 1960's indicate that the Andigama bed covers an area of 13 sq. miles or more, and that it extends to Pallama, 7 miles south of Andigama.

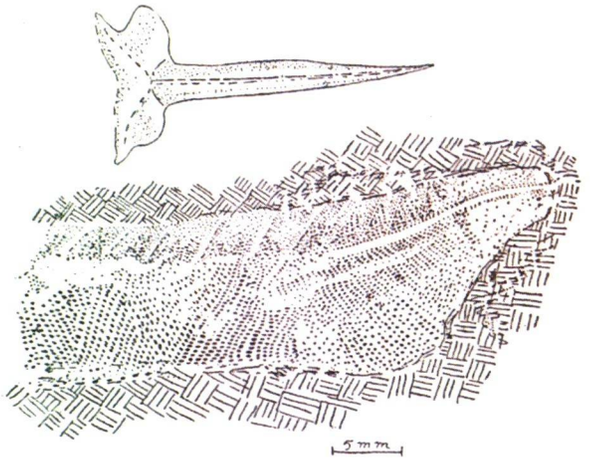
There is evidence to also indicate that it has been fragmented into several smaller basins. Gravity surveys conducted at the time indicate that the basin is 20 km long and that it varies in thickness from 900m in the east to 1,200m in the west. Lithological succession (alternating sequences of dense hard, black carbonaceous shales and calcareous or arkosic sandstones) and spores, pollen, cuticles and other plant remains indicate the age of the beds to range from Middle to Upper Jurassic (Upper Gondwana) (Cooray,1984).

At that time, the only known macro fossils from Andigama was a piece of stem recorded by Deraniyagala and *Elatocladus plana* and *Cladophlebis* sp. Described by Dr. Sitholey in 1944 which was obtained from a concretionary haematite/ crystalline coal.

The specimens examined by Dr. Satish Chandra Das Sah (1953) had been obtained from two wells. One was labelled as a sample from the Andigama school well which was a carbonaceous shale obtained at a depth of 30-40 feet. The shale was hard, compact and dark-brown in colour with black carbonised streaks. The other had been obtained from the Andigama estate well i.e 1-3/4 mile W.S.W of the school well. The shale was similar to the other sample and had been obtained from a depth of 30-40 feet.

The organic matter revealed spore, pollen, cuticles and wood fragments. They indicate the presence of the plant groups Pteridophyta, bennettitales and coniferales. These have also been reported from Tabbova. Deraniyagala (1955b) considers the Andigama beds to be equivalent to the Rajmahal.

Jurassic fauna



A fin spine and tail of an Acanthodes fossil.

The first vertebrate fossils recorded in Sri Lanka was from Tabbova. The type locality is the bank of the Nanneri Oya about 100m north west of the new spill of Tabbova reservoir. On closer examination a fin spine and tail belonging to a *Acanthodes* fossil was revealed. He surmises that since these are aquatic forms the carbonaceous shales appear to have been laid down underwater (Deraniyagala, 1939).

Conservation and sustainable management

Out of the Jurassic sites noted so far, only the site at Tabbova has been clearly identified. Tabbova tank belongs to the Irrigation Department whilst its surrounding area has been declared as Sanctuary by the Department of Wildlife Conservation. Despite this fact, the rocks of Tabbova are being destroyed by tourists who search for samples of fossils. Strict monitoring is necessary to protect this fragile environment. While protecting the environment this site could be sustainably managed to promote geo and eco tourism. A visitor centre could display specimens and disseminate knowledge to the public. Furthermore, visitors could traverse the area on a guided geo tour of this unique Jurassic site.

Research

Further research needs to be carried out at Tabbova, Andigama and Pallama. The southern area too needs to be investigated for Jurassic evidence. Since Indian dinosaur fossils from the periods immediately before and after the Jurassic are well known, it is highly possible that dinosaur fossils will be discovered in Sri Lanka in the near future.

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Plants		Tabbova	Andigama
Pteridophyta	*Cladophlebis zeylanica* Sitholey *Cladophlebis reversa* (Feist.) Seward and Holtum *Cladophlebis denticulate* (Brogn.)Seward and Holtum *Cladophlebis* cf. *Browniana* Jacob *Cladophlebis sp.* *Sphenopteris hymenophylloides* (Brogn) *Sphenopteris wadiai* Fern like fragments		
Cycadophyta	*Taeniopteris spatulata* McClelland *Nilssonia schaumburgensis* *Anomozamites* (nilssonia) sp. *Ptillophyllum* sp *tozamites* sp.		
Coniferales	*Elatocladus plana* (Feist.) Seward and Sahni		

	Elatocladus sp. *Araucarites cutchensis* (Feist.) Seward and Holtum *Brachyphyllum mamillare* (Brogn.)Seward and Holtum *Desmiophyllum* (?*Podozamites*) sp.		
Petrified wood Fish Acanthodidae	*Araucarites sp.* *Acanthodus* Agassiz 1833		

Appendix 2

List of spores and pollen classified according to Naumova's classification. The spores are classified according to the sculpturing of the exine. These were all found in the carbonaceous shale of Andigama.

Spore Group	Possible species	Comments
Triletes: Azonotriletes (i) Leiotriletes Naum.	*a)Phlebopteris hirsute* *b)Triquitrites deltoids* *C)Granulati-sporites* *d)Granulati-sporites concavus* e)Microspore of a heterosporous lycopod	Common in the Andigama shale
(ii) Chomotriletes Naum.	Could belong to Genus Cyathia	Common in the Andigama shale (this type has also been recorded from the Surma series of Lower Miocene age in Assam)
(iii) Acanthotriletes Naum. (iv) Lophotriletes Naum		Similar fossil spores have been recorded from the Barail series (Lower Olgocene) of Assam

(v) Camptotriletes Naum.		Only one spore of this type has been found in the Andigama shale
(vi) Dictyotrilites Naum.	One spore type resembles *Lycopodium scariosum*	Six distinct types can be found
		Does not fit into any sub group
Triletes: Zonotriletes		
Walts		
(Viii)Euryzonotriletes Naum.		
Monoletes Ibr.	Some may be of	
(ix)Azonomonoletes Luber.	pteridophytic nature	
Irremales Naum		
(x) Aletes Ibr.		Fairly common in the shale
Pollen group	**Possible species**	**Comments**
Trilobata Naum		
(xi) Dolichotrilistrium Naum.		
(xii) Brachytrilistrium Naum.		Similar pollen ypes have been described from the Tertiary rocks of Assam
Saccata Naum. (xiii) Oedemosaccus Naum	Coniferous pollen probably belonging to *Pityosporites*	Common in both Upper and Lower Gondwana rocks of India.
(xiv) Coniferous pollen with 3 bladders	Resembles the 3 winged pollen of Podocarpineae	Described from the Rajmahal hills, Behar.