

## **EVIDENCE FOR CYCADALES SEEDS OF JURASSIC AGE FROM TABBOWA, SRI LANKA**

**G. EDIRISOORIYA AND H.A. DHARMAGUNAWARDHANE**

*Department of Geology, University of Peradeniya, Peradeniya, Sri Lanka*

### **ABSTRACT**

Plant fossils occur in some sedimentary rocks deposited in a small faulted basin at Tabbowa in the Northwestern Province, Sri Lanka. The present study carried out recently in the Tabbowa sedimentary basin revealed the presence of seed bearing Cycadales prominently among other fossils. This paper describes some pioneering findings on Jurassic seed-bearing plant fossils of Sri Lanka.

**Keywords:** Tabbowa, seed-bearing plant fossils, Cycadales

### **INTRODUCTION**

Jurassic formations cover considerable areas in continental areas. Almost all Jurassic occurrences contain plant fossils which may reveal the palaeobotanical and climatic conditions under which the plants grew and evolved. The landmass once together during the Gondwana times and now separated due to continental drift shows similar or comparable plant fossils. Australia, India, Antarctica and Madagascar are known to have such fossils (Cantrill, 1991, 1992 and 1996). Sri Lanka had also been a part of the Gondwanaland.

Plant fossils of Jurassic age were reported in sedimentary rocks of two small faulted basins within the Precambrian crystalline terrain of Sri Lanka (Wayland, 1920). However, only a limited amount of work has been done on these fossils so far (Sitholey, 1942).

#### ***The Tabbowa Basin.***

Tabbowa village is situated in the northwestern part of the country (Figure 1) as a small sedimentary basin with an extent of few tens of square kilometres. It occurs as a faulted basin in the Precambrian crystalline basement rocks. Sedimentary rocks of Jurassic age, mainly

feldspathic sandstones and mudstones, are exposed at few locations. There are enough outcrops to collect sufficient amounts of plant fossils. Plant fossils at Tabbowa beds are those preserved in mudstone horizons and brownish siltstone found associated with sandstones. The mudstone consist of widespread plant impressions. The sediments appear to be shallow water deposits laid down in a rapidly subsiding or brackish water delta.

#### ***Fossil Record of Gymnosperms***

During the Jurassic period (150 million years ago), cycads were at their prime and covered vast areas of the earth's surface (Cooray, 1984). This group of Cycadophyta was much more widespread during the Mesozoic (Triassic, Jurassic and Cretaceous), which is sometimes called the "Age of Cycads". While most species of dinosaurs became extinct about 65 million years ago, cycads continued to survive on earth.

Megasporophylls of Mesozoic Cycads essentially resembles those of the present day. Typically, seeds tightly compacted together, are borne on the surface of a fleshy receptacle.

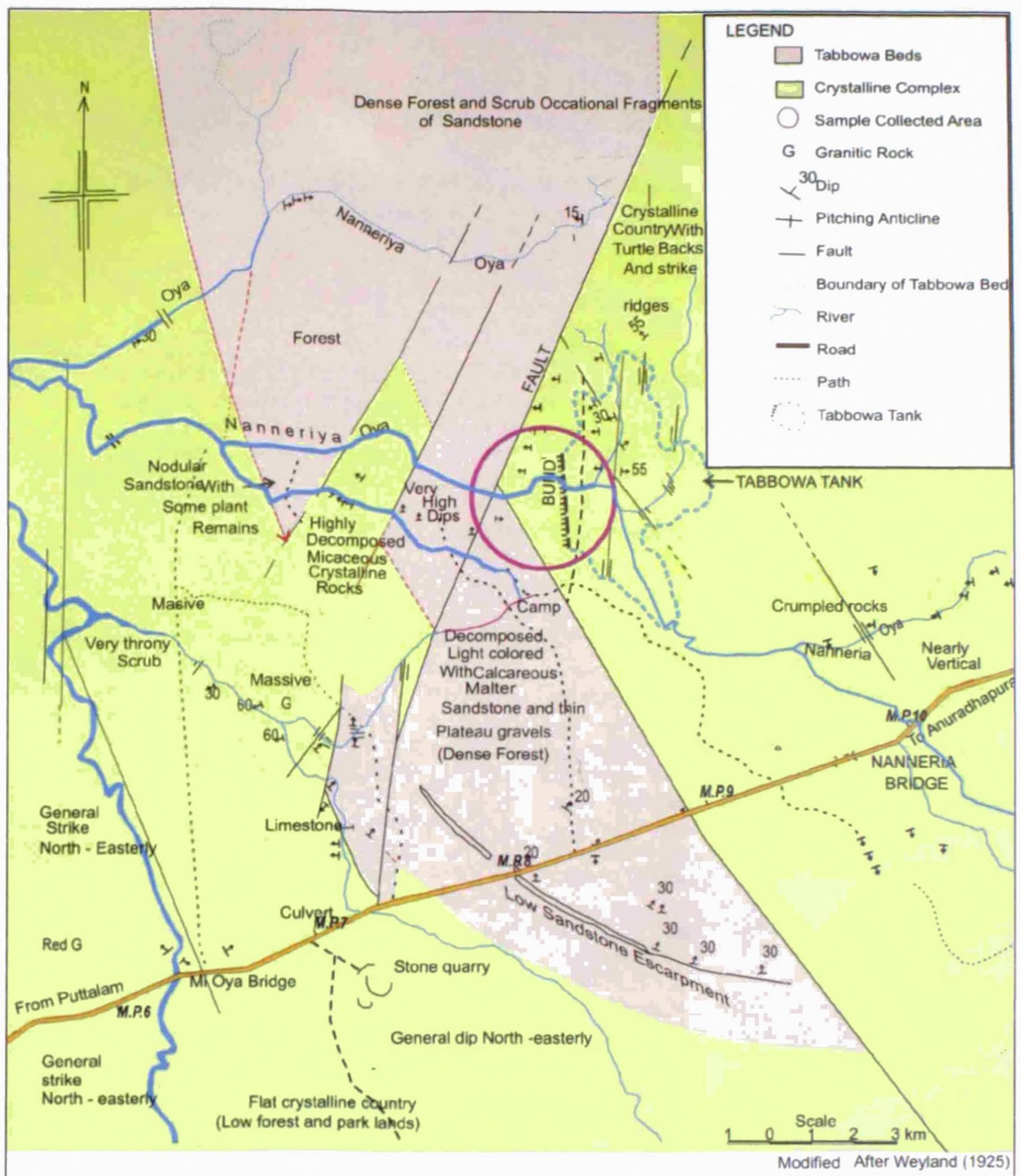


Figure 1: Location of the study area and Geology of Tabbowa Basin.

## MATERIALS AND METHODS

Sedimentary rock samples with fossil imprints were collected in the field for laboratory studies. Observations on samples were made directly and under the Leitz polarizing microscope. All specimens were photographed to reveal surface details. Features of the samples were also

compared with those found in literature. New specimens collected from Tabbowa (Figure 2a and 2b) impressions are preserved in fine-grained mudstone. Most fossils are fragmentary. In many cases, it is difficult to interpret the features due to leaf degradation prior to fossilization. Rock samples collected in the field were transferred for laboratory studies and specimens were examined

under a polarizing microscope. All specimens were photographed with a digital camera using either polarized light and polarizing filters to enhance contrast or low angle lighting to reveal surface details.

Line drawings were made using a drawing attachment. Samples were identified based on observations and comparisons with known examples.

Morphological terminology by Sitholey (1942) and Douglas (1969) was used in the present study. All illustrated specimens are lodged in the Palaeontology collection of the museum at Department of Geology, University of Peradeniya, Sri Lanka for reference and for further studies. Specimens have been assigned to Tabbowa Mudstone collection, numbers starting from "T 1000".

### SYSTEMATIC PALAEOBOTANY

All samples of this study were preserved as imprints in mudstone as a result of low energy depositional environments. Seed-bearing structure found as lithified fossils in mudstone (Figure 2a) is 11cm long and 6cm wide and well preserved as a whole specimen. Host rock has high iron oxide content. This is a very rare fossil specimen found in Tabbowa beds.

### RESULTS

Three samples were identified during this study and their features are described below.

#### Material examined

Sample number 1; 1 specimen: *T1005.1a. i*

#### Remarks

This species was found in Jurassic beds of Tabbowa for the first time and no previous data on megasporophylls are available from Sri Lanka.

Being a single specimen, it is difficult to make comparisons without previous findings of this fossil type from the area. Therefore, the comparisons were made with the examples given in literature on Cycadaceae megasporophyll.

#### Description

Seed-bearing fossil structure (sporophyll) shown in Figure 2a is 11 cm long and about 6 cm wide with sporophyll along its entire length. About 8 cm long sporophyll rises from the axis at an 80<sup>0</sup>-90<sup>0</sup> angle and curves forward, subtending a seed which

appears to be fused to the sporophyll. The sporophyll on the basal portion of the cone appears to be a seed attached cavity either less developed or probably immature. The seed arrangement is open and the sporophyll is free and distant from each other with little or no overlap. The shape of the apex is acute and basal shape is flat being inserted into the axis and covered with iron oxide deposits. Abaxial side of the sporophyll is not smooth and has a seed attachment cavity whereas the adaxial side is smooth without any distinguishable features. Whole specimen habit is woody. The seed attachment cavity is about 2 cm in diameter and 1.5 cm deep. The shape is rounded to slightly oval; attachment of seeds is probably sessile. The axils, peduncles and bracts are not evident.

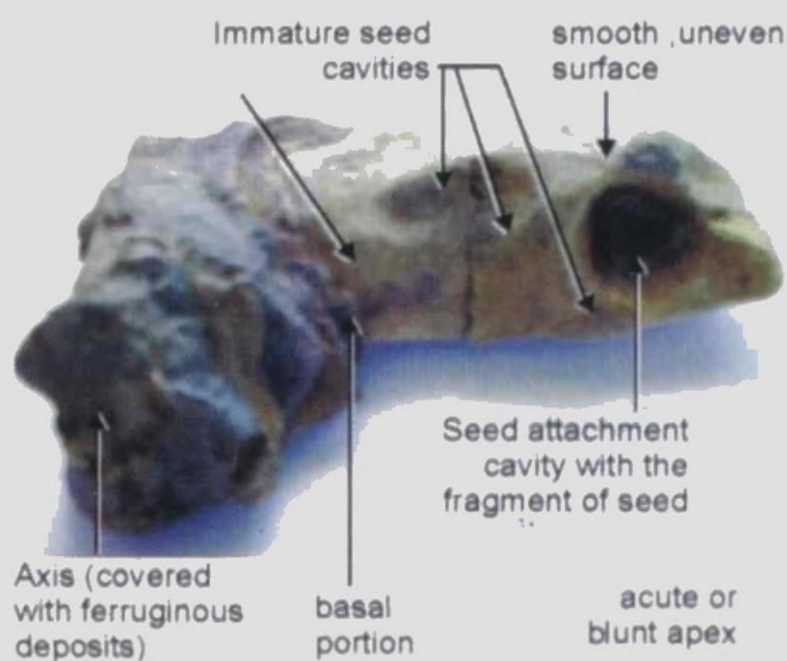


Figure 2a: Seed Bearing Structure

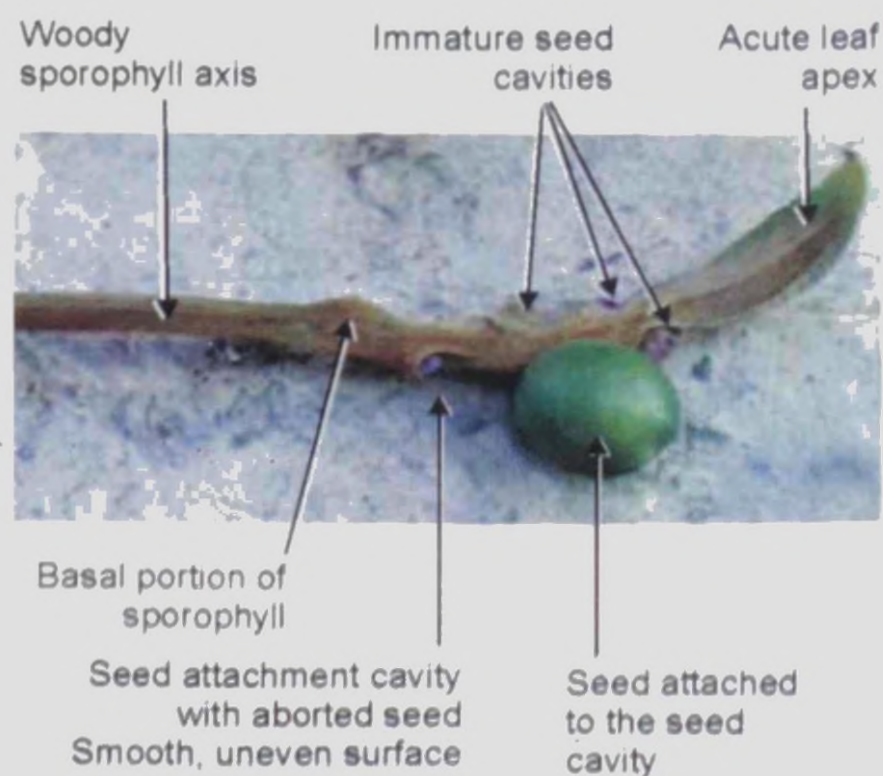


Figure 2b: Seed cone (megasporophyll) of Jurassic Cycad (Harris, 1964)

**Material examined**

Sample number 2; 1 specimen: T1005.1b. i (Seed fossil)

**Remarks**

This species was also found in Jurassic sedimentary beds of Tabbowa for the first time and there is no previous record available on these seeds from Sri Lanka. Comparisons were done based on Cycadaceae seed's characters reported in literature.

**Description**

In this seed fossil, only fragmentary portion of the outer layer is preserved. However, it appears to be ellipsoidal or oval shaped with a coarse surface. The inner side of the seed coat is smooth. It could be distinguished from the surrounding rock by its yellowish brown colour. The outer surface is featureless. Gross outer dimensions of this specimen are 3.5 cm, 2.3 cm and 0.2 cm in length, breadth and thickness respectively.

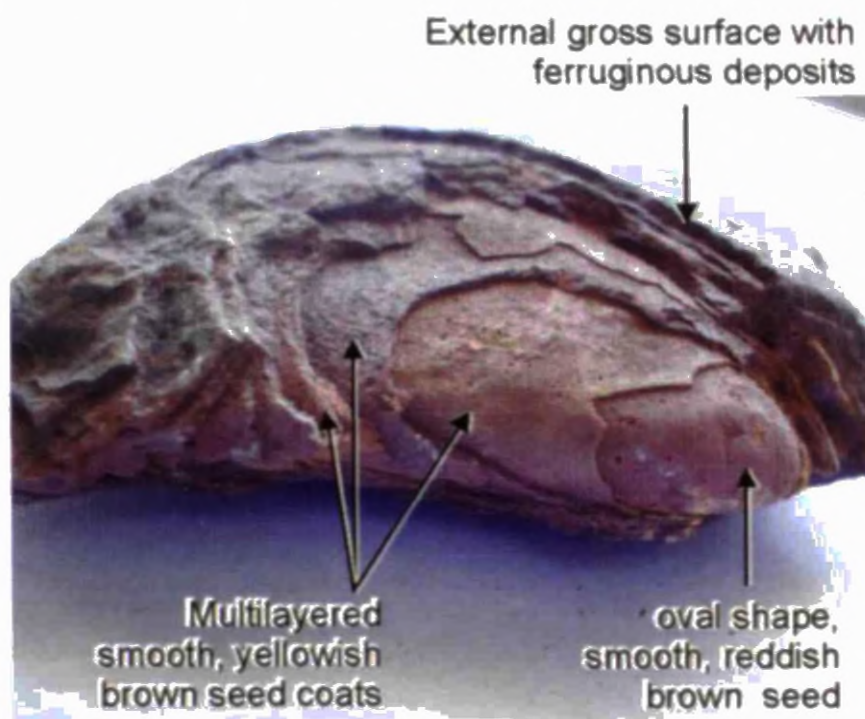


Figure 3: Seed fossil (x 3/4)

**Material examined**

Sample number 3; 1 specimen: T1005.1c. i (leaf fossil imprint - Figure 4b)

**Remarks**

This leaf-bearing fossil was found from Tabbowa, Sri Lanka. Comparisons were made with leaf fossils found previously from Tabbowa (Edirisooriya *et al.*, 2007) and those described in literature on Cycadaceae family.

**Description**

Incomplete strap-like leaf at least 12mm long and 6mm wide with entire to delicate (serrate) margin. The venation of the leaf is well marked and the midrib is prominent (Figure 4 a and b). The leaf has

very thick square shaped or flat and long midrib at 2-3mm width (Figure 4(b)). Primary veins arise almost perpendicular to the midrib and secondary ones are nearly at right angles. Veins are parallel and are arranged very close to one another at 0.2- 0.3 mm distances. Vein density per 5mm of margin is about 17-18. Lower side of the leaf fragment becomes narrow and this end can be towards the point of attachment to the axis. Leaf base is not preserved. Some concentric layers also can be observed near the plant specimen. This structure can be formed due to the preservation of unknown material.

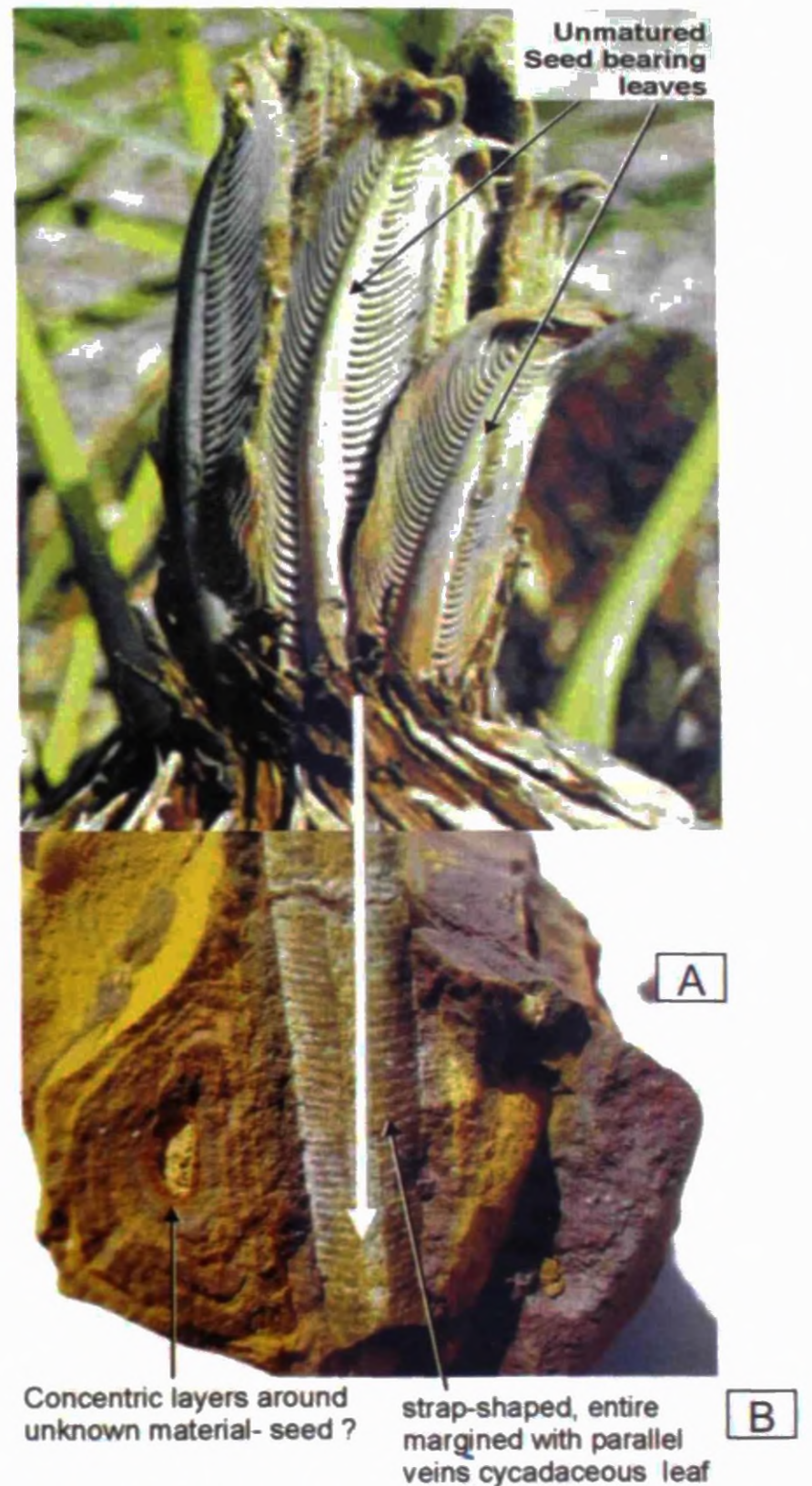


Figure 4: Strap-shaped leaf of living Cycadales (4-A)(x1/4) and Strap-shaped fossil (4b) (x 3/4)

## DISCUSSION

The seed-bearing structure (Figure 2a) is probably from a Gymnospermous plant though the plant group position cannot be established from visible features. It has an open seed sporophyll-like feature. Apparent textural features suggest woody habit. There is no evidence of subtending bracts either at the base or the apex of the sporophyll. The curvature of the basal portion suggests this sporophyll to be a peduncle. Well developed seed cavity suggests that there had been a mature seed. The rest of the cavities are not well developed. No modern Gymnosperms have seed-bearing leaves of this type. In recent varieties seeds are covered with bracts. This fossil sporophyll specimen is similar in several ways to the seed cone (megasporophyll) of Jurassic Cycad described by Harris (1964) as shown in Figure 2(b). This evidence suggests that this seed-bearing structure can be considered as belonging to the order - Cycadales.

The seed shown in Figure 3, does not indicate any clear diagnostic features other than the oval shape and integument layering and therefore needs further investigations prior to this clarification.

The fossil shown in Figure 4, the earliest seed-bearing Cycadaceous foliage was an entire-margined, strap-shaped leaf with parallel veins very similar to the vegetative leaf of *Taeniopteris* (Mamay, 1976). Characteristic venation of these leaves means that they can be assigned unequivocally to *Taeniopteris* (Edirisooriya, 2006) which belongs to Cycadales family.

## CONCLUSIONS

During the present study of the Tabbowa basin, Sri Lanka, it was possible to identify a seed-bearing structure (megasporophyll of Cycadales), seed fossil and a leaf fossil belonging to division of Gymnosperm.

There are no previous records of the existence of seeds or seed-bearing Jurassic plants from Sri Lanka. Therefore, we consider the present observations as pioneering evidence for Jurassic seed-bearing plants in Sri Lanka.

## REFERENCES

- Cooray, P.G., 1984. An Introduction to the Geology of Ceylon. (2nd edition). National Museum Department, Colombo. 117-134
- David J. Cantrill, 1991. Broad Leaves Coniferous foliage from the lower cretaceous Otway group, South eastern Australia. *Alcheringa* 15; 177-190
- David J. Cantrill, 1992. Araucarian foliage from the lower Cretaceous of southern Victoria, Australia. *International journal of Plant science* 153(4); 622-645.
- David J. Cantrill and G.J. Nichols., 1996. Taxonomy and Palaeoecology of Early Cretaceous (Late Albian) angiosperm leaves from Alexander Island, Antarctic. *Review of Palaeobotany and Palynology* 92; 1-28.
- Douglas, J.G., 1969. The Mesozoic floras of Victoria part 1 & 2. Geological Survey Victoria Melbourne, Memorial 28; 1-310
- Edirisooriya, E.M.S.G., 2006. A study of Jurassic Plant Fossils in Tabbowa Sediments, Sri Lanka (MSc Research Report). Postgraduate Institute of Science, University of Peradeniya.
- Edirisooriya, E.M.S.G., Dharmagunawardhane, H.A. and Yakandawala, D.M.D., 2007. Assessment of Jurassic Plant fossils in Gondwana Sediments of Tabbowa: Some recent findings. *Geological Society of Sri Lanka, Proceedings of 23rd Annual Sessions*; 11.
- Harris, T.M., 1964. The Yorkshire Jurassic flora 11. Caytoniales, Cycadales and Pteridosperms London: British Museum ( Natural History); 75-98.
- Mamay, S.H., 1976. Paleozoic Origin of the Cycads. U.S. Geological Survey Professional Paper; 934.
- Sitholey, R.V., 1942. Jurassic Plants from the Tabbowa series in Ceylon, *Journal of Indian Botanical Society*, 24; 3-17.
- Wayland, E.J., 1920. Preliminary note on some fossiliferous beds in Ceylon. *Spolia Zeylanica*, 11; 191-197.