

## Malabar and van Rheede

Mohan Ram's article<sup>1</sup> not only captures the botany as documented by van Rheede (obviously well presented by K. S. Manilal), but also other interesting and related aspects including those of 17th century Kerala and socio-linguistics brilliantly. The following information may also interest readers of *Current Science*, in support of Mohan Ram's powerful and passionate article. Anglicization (used so here, for want of a better word to represent adoption into 'Dutch') of *tchakka* (Malayalam name for *Artocarpus heterophyllus*, Moraceae) as 'jack' was done by van Rheede during his botanical adventures in erstwhile Malabar.

Incidentally, van Rheede also saw the insect-induced galls<sup>2</sup> on *Hopea ponga*

(= *H. wightiana*) (Dipterocarpaceae), which resemble sea urchins<sup>3</sup>, during his travels in Malabar; mistaking the galls for 'miniature fruits', he assumed that the specimens of *H. ponga* bearing galls were *Artocarpus* (because van Rheede was already familiar with *A. heterophyllus*)! van Rheede also described the galls on the leaves of *Garuga pinnata* (Burseraceae) induced by *Phacopeteron lentiginosum* (Homoptera; Psyllidae)<sup>4</sup>, and, interestingly, these as galls only and not as fruits or nuts! If my memory serves right, Manilal has mentioned the above in one of his earlier publications, for which unfortunately, I do not have the bibliographic details with me presently, nor could I locate it in the bibliography in the Mohan Ram article.

1. Mohan Ram, H. Y., *Curr. Sci.*, 2005, **89**, 1672–1680.
2. Raman, A. and Takagi, S., *Insecta Matsum.*, 1992, **47**, 1–32.
3. Mani, M. S., *Plant Galls of India*, Macmillan India, New Delhi, 1973, p. 353.
4. Raman, A., *Phytophaga*, 1987, **1**, 141–159.

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## Chandra–Eddington episode

This is concerning the review<sup>1</sup> of the book *Empire of the Stars* by Arthur Miller and the criticism<sup>2</sup> of the accuracy of the book's contents and analysis, including the review itself.

Most accounts of the Chandra–Eddington encounter of January 1935 are overcritical of Eddington, perhaps unfairly so. In retrospect, it is surprising that at that time nobody seems to have taken seriously the work of Baade and Zwicky<sup>3</sup> at least one year before (in 1934), about neutron stars. As they clearly state 'We advance the view that supernovae represent transitions from ordinary stars to neutron stars, which in their final stages consist of extremely packed neutrons'. In their January 1934 work, they even estimate the neutron star binding energy (as  $3 \times 10^{53}$  ergs!), which is the total energy emitted by the supernovae. So, a white dwarf cannot be the remnant of a supernova. They also conjecture that cosmic rays are produced in such cataclysms. Here then was the possible answer to Eddington's worry about 'speculating on other possibilities'. The neutron was discovered by Chadwick in 1932 and soon after, Landau got the limiting mass for a degenerate neutron star (or core) as 1.4 solar masses. Indeed, several neutron stars (pulsars) seem to have masses around 1.3–1.4 solar masses! One can understand Eddington's concern. Masses of several stars were already

known in the early decades of the twentieth century to be several times the solar mass, e.g. Plaskett's star has a mass 60 times the solar mass. Stellar evolution studies were then in a very primeval stage. Even the source of stellar energy was not clear. If one reads the earlier edition of Gamow's *Birth and Death of the Sun*, even in the early 1950s, red giants were thought to be still contracting pre-main-sequence stars. In a later edition, Gamow says 'our views of red giants have meanwhile undergone a complete change!' The idea that massive stars can lose a considerable amount of mass during evolution was unheard of in Eddington's time. Naturally, he was worried about the low value of the limiting white dwarf mass (just 1.4 solar mass!). He did not question the mathematical accuracy but felt that relativistic degeneracy formula used by Chandra perhaps does not hold. Indeed, electron interactions (later considered by Salpeter) do lower the mass somewhat. Besides composition is important. A pure iron white dwarf would have a limiting mass less than 1.2 solar mass. Again it may be pointed out that despite a lot of progress in nuclear physics of dense matter, we still do not have a definitive limiting value for the neutron star mass. It ranges from 1.8–2.5 solar masses in most models (some authors obtain larger values!). Recently, a pulsar was estimated to have a

mass of 2.1 solar masses. Even now we are not sure of the equation of state for the neutron star.

So, Eddington did not delay any progress. He just did not believe in black holes. Nor did Einstein for that matter. It was only after great progress in observational astronomy in the 1960s and 1970s and later, in all bands of the electromagnetic spectrum from radio to gamma rays, that evidence has become compelling for neutron stars and black holes.

Again, it must be pointed out that Fowler's formula for non-relativistic degenerate stars is perfectly valid for the hundreds of white dwarfs with masses less than a solar mass<sup>2</sup>. Indeed, it (Fowler's result) has been applied (apart from neutron stars) to supermassive degenerate neutrino configurations of  $10^{12}$ – $10^{16} M_{\text{Sun}}$  (with the neutrino mass replacing the electron or proton mass), where the neutrino degeneracy pressure balances the self gravity of the neutrino (dark matter) dominated structure. The same  $MR^3 = \text{constant}$  result is used. This use of Fowler's degeneracy formula for massive neutrinos has a long tradition going back at least to Markov, Hayakawa, Zeldovich and others and lastly Cowsik and McClland (see reference list<sup>4</sup>).

Talking of colonial attitudes, Eddington did not halt Chandrasekhar from becoming Fellow of the Royal Society and a distin-

guished Professor barely *a decade after* their unpleasant encounter. Again, Einstein is sometimes blamed for not giving Bose enough credit. It was he who translated the Bose paper pointing out its importance and it was Einstein, who discovered the Bose–Einstein condensation in a later paper.

1. Sreeram Chaulia, *Curr. Sci.*, 2005, **89**, 401–402.
2. Mallik, D. C. V., *Curr. Sci.*, 2005, **89**, 1455–1456.
3. Baade, W. and Zwicky, F., *Phys. Rev.*, 1934, **45**; *Proc. Natl. Acad. Sci. USA*, 1934, **20**, 254–259; 259–263.
4. Markov, M. A., *Phys. Lett.*, 1964, **10**, 122; Hayakawa, *Progr. Theor. Phys. Suppl.*, 1965,

**33**, 538; Zeldovich, *JETP Lett.*, 1966, **4**, 120; Cowsik and McClelland, *Ap. J.*, 1973, **180**, 7.

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## Disposal of dredge spoil from Sethusamudram Ship Channel Project

The Sethusamudram Ship Channel Project (SSCP) across the Palk Strait and Adam's Bridge between India and Sri Lanka is finally commissioned and it was inaugurated by the Prime Minister of India on 2 July 2005 at Madurai. The SSCP has already generated a lot of controversies over its implementation and the consequent environmental issues with regard to dredging and safe disposal of dredged spoil<sup>1–3</sup>. As per the present alignment, dredging is needed only in two stretches covering a distance of 89 km along the proposed 167 km long channel between Tuticorin and Kodiyakkarai – in a NS stretch for a length of 35 km (east of Danushkodi) in the Adam's Bridge and 54 km in the Palk Strait in a NE–SW direction south of Kodiyakkarai and east of Manalmelkudi (Figure 1). No dredging is needed for the rest of 78 km stretch (Figure 1) as the depth is more than 20 m.

The total quantum of materials that will be dredged from these two sectors amounts to 82.5 million cubic metres of which the Adam's Bridge sector will generate 48 million cubic metres while the Palk Bay sector will generate 34.5 million cubic metres of sediments. As per the plan, the materials dredged from Adam's Bridge area will be dumped in the Gulf of Mannar region at 20–30 km water depths within the Indian territorial waters about 30 km away from Adam's Bridge. Sediments dredged from Palk Bay will be dumped in the Indian Ocean at about 25–30 m water depths. Dredging Corporation of India is assigned to carry out the first phase of dredging in the Palk Bay to the tune of about 13 million cubic metres of sediments. During dredging several environmental management acts will have to be followed including cessation of dredging during the fish breeding

and spawning period. Another condition is that the suspended matter at the dredging sites should not spread more than a km on either side of the channel route.

Dumping 82.5 million cubic metres in the highly turbulent open sea either in the Gulf of Mannar or in the Bay of Bengal east of Kodiyakkarai will naturally generate turbidity in the water column and submergence of large bottom community by the sand contained in the dredged sediments. Such environmental effect over vast areas for considerably long time-span will have long-term impact. It is suggested here that instead of disposing the dredged spoil in the distant open sea, it may be dumped at one or two specified areas within the shallow western Palk Bay so that considerable land area can be reclaimed. The Palk Bay region does not have any island within the Indian territorial waters. Ever since Katchatheevu (Figure 1) was transferred to Sri Lanka, there is a demand from politicians and fishermen communities of Tamil Nadu to get back the island for the use of fishermen. In case an island is made artificially using the dredged spoil within the Palk Bay it will help the fishermen as temporary landing area or the Coast Guard/Navy for regular monitoring of the territory in the future. Acquiring of land using dredged spoil is a common phenomenon globally. For instance, the Wellington Island near Cochin port was formed mostly by the dredged spoil. Such large-scale land reclamation is going on in places where acute land scarcity exists like in Singapore.

In case a major part of the dredged spoil generated through the capital dredging is dumped at one place in the western Palk Bay (location A; Figure 1), having a water depth of about 12 m (30–35 km off Tondi), it will create an island with land

area of about 6 km<sup>2</sup> (2000 m × 3000 m × 12 m). Location A is suggested as it is midpoint between Adam's bridge and Palk Strait and it is sufficiently away from the Mandapam group of coral islands and Muthupet mangrove swamps. On the other hand if the total dredged spoils are dumped at water depth of <10 m (location B; Figure 1) it will create land area of more than 8 km<sup>2</sup> (8000 m × 1000 m × 10 m). The dredged sediment from Palk Strait alone will create a small island if dumped in the shallow western Palk Bay, which will be a boon to fishermen for safe landing in case of an emergency. Dumping of sediment in a limited area will minimize spreading of suspended sediments to larger areas and havoc to bottom communities. Since the Palk Bay is very shallow with water depths ranging from 5 to 10 m along the coastal areas and less than 20 m in most other places (Figure 1), the sea becomes turbid during southwest and northeast monsoon periods<sup>4</sup> due to re-suspension of bottom sediments. However, in general the Palk Bay is very calm during most of the time because of the protection offered by the shallow Palk Strait on the north and Pamban Pass and Adam bridge on the south (Figure 1) and so powerful currents and waves do enter into Palk Bay. The sediments are primarily silty clay close to coast and sandy mud little away from the coast. The sediment contains high organic matter due to decay of sea grass. During NE monsoon huge quantum of fine sediments are transported into the Gulf of Mannar from Karikal–Nagapattinam–Vedaraniyan coast<sup>5–7</sup>. Therefore, dumping of dredged sediments in a selected site within the shallow Palk Bay will not add further stress to existing marine environment. Furthermore, the amount of dredged spoil that