Joseph G. Medlicott and the line of the Narmada and Son valleys

Prakash P. Roday and Manish K. Purohit

In this article we emphasize that the principal thesis 'that the Narmada and Son rivers flow in a straight line of disturbance from the Gulf of Cambay in the west to the Ganges valley in the east and that this line marks not only the southern boundary of the late Proterozoic Vindhyan Supergroup rocks but also the northern limit of deposition of the coal-bearing Gondwana rocks of peninsular India' was first shown by Joseph G. Medlicott, a member of the founding team of the Geological Survey of India, as early as in 1860, barely nine years after the founding of the Indian Geological Survey. Quoting profusely from the 150-year-old classic memoir 'On the geological structure of the central portion of the Nerbudda district', we urge the geological community in India that this geologist must not be deprived of the credit and recognition which he deserves. The entire memoir is an account of the Narmada–Son line, and its principal thesis is the focus only on the aspects of this geomorphic and tectonic feature, albeit with a rather rudimentary scientific knowledge base as could be expected of a mid-nineteenth century publication. It is interesting to note that Medlicott, after leaving GSI, acclaimed equal recognition in his non-geological work on the compilation of an exhaustive report on the cotton plantation in Bengal.

In central India, an important tectonic lineament occurs, viz. the Narmada–Son line stretching from Broach near the Gulf of Cambay, where the Narmada river meets the Arabian Sea, to as far east as Dehri-on-Son where the Son river drains into the Ganges[1–3]. The characteristic feature of this lineament along which two major rivers flow is that it marks the southern limit of deposition of the sediments (with sporadically occurring volcanics) of the late Proterozoic Vindhyan Supergroup; besides, it also forms the northern limit of the coal-bearing Gondwana Supergroup rocks (of Permian to Jurassic age) of peninsular India. The existence of this peculiar and tectonically significant feature was first very elaborately described a good 150 years ago by Joseph G. Medlicott[1] in a classic memoir titled 'On the geological structure of the central portion of the Nerbudda district'. In fact the entire memoir is devoted only to the aspects of this important tectonic and geomorphic feature. In this article we highlight aspects of this singular contribution and urge the Indian geological community that the monumental work by this geologist must not be forgotten and that J. G. Medlicott be given the credit and recognition as the first person to have discovered the unique features associated with the Narmada–Son line. It would be most fitting to reprint many such memoirs and records of the Geological Survey of India (GSI) so that posterity is reminded of the signal contributions made by dedicated geologists to the cause of development of a scientifically oriented society in which we live today.

General background

Thomas Oldham (father of the geologist and seismologist Richard D. Oldham who was Director of the Survey for many years later; http://en.wikipedia.org/wiki/Thomas_Oldham) had assumed charge on 4 March 1851 (ref. 4) as the first Superintendent of the newly formed GSI set up by the East India Company and the Government of Bengal. A contingent of 12 geologists joined in the year 1851 to work in the Survey and Medlicott was one amongst them. He was an Irishman like Thomas Oldham (later to be knighted; http://encyclopedia.jrank.org/NUM_ORC/OLDHAM_THOMAS_1816_1878_.html). The latter had been a curator with the Geological Society of Dublin (http://en.wikipedia.org/wiki/Thomas_Oldham) and later a 'local director' of the Geological Survey of Ireland, a branch of Geological Survey of Great Britain[5] and professor of geology at the university in Dublin[6,7] before coming to India in 1851. After his arrival in India, Medlicott was assigned the mapping programme that focused on the coal-bearing strata. The Industrial Revolution had set in, and the demand for coal (and for iron) was of prime importance for laying down of rail lines with steam engine locomotives. This was necessary for the governance of a vast country like India, not to speak of the difficult job of collection of royalties from nearly 700 princely states that were subservient to the East India Company and were later to swear their allegiance more or less permanently to the British Crown. Apart from Medlicott, there were many Irish geologists and so there was a fairly good sprinkling of the Irish in the Geological Survey. Medlicott had graduated from Trinity College, Dublin and was already an experienced geologist before coming to India (having formerly been a general assistant to Thomas Oldham in the Geological Survey of Ireland on an annual salary of 78 pounds sterling)[8]. Indeed, Medlicott was the first of the next contingent to be invited to join the GSI. Some years later, his younger brother Henry Benedict Medlicott also came to India initially as a professor of geology at the Thomson College of Civil Engineering in Roorkee, but later he too joined the GSI. It was this H. B. Medlicott who later coined the term 'Gondwana' in 1872 (http://en.wikipedia.org/wiki/Henry_Benedict_Medlicott)[9] for the coal-bearing rocks in India. Medlicott was assigned the job of determining the limits of distribution of coal-bearing Gondwana rocks. By then, it had nearly been established that the coal-bearing Gondwana rocks are fossiliferous and rich particularly in plant fossils. In his pursuit of discovery of the fossiliferous Gondwana rocks, J. G. Medlicott came across a vast succession of sandstones that were entirely unfossiliferous, what we know today as the Vindhyan quartz arenites of the Late Proterozoic age. Having found this, J. G. Medlicott was able to

delineate the limits or extent of Gondwana rocks from those of the Vindhyan range (it is recorded that in this task, he was assisted by his younger brother H. B. Medlicott, then a professor of geology at the Thomson College of Engineering in Roorkee (http://en.wikipedia.org/wiki/Henry_Benedict_Medlicott), since rocks of both groups belonged to predominantly arenaceous facies. Oldham had established[10] a publications' programme for Indian geological observations thus providing timely output and rapid dissemination of survey results: the *Memoirs* in 1856, *Annual Reports* (which first appeared in 1859 but later in 1868, were continued to be published as the *Records*), *Palaeontologica Indica* in 1861. Oldham not only gave unstinting credit to his subordinates in the *Annual Reports*, but also encouraged his staff to publish papers under their own signatures and did not discourage speculative interpretations. At the request of J. G. Medlicott, Oldham visited areas in central India in 1856 and agreed that indeed there were two separate series of rocks, chiefly sandstones: those that were coal-bearing and the ones that were entirely devoid of coal; the term 'Vindhyan Series' for the unfossiliferous was born. This fact is reiterated by Medlicott[1] in this classical memoir. In his mapping programme, J. G. Medlicott was assisted by William Theobald Jr who had previously worked with the Geological Survey of Punjab. The memoir in question[1] (i.e. volume II, part 2) has three papers: the first by J. G. Medlicott runs from pp. 97 to 278; the second paper by William Theobald Jr on the Tertiary and recent deposits along the Narmada valley is from pp. 279 to 298; and the third paper is by Thomas Oldham himself on the correlation of rocks of Central India with those of Bengal running from pp. 299 to 340. Thus the bulk of the memoir constitutes Medlicott's paper. Part I of this memoir consists only of a single paper from pp. 1 to 96, 'On the Vindhyan rocks and their associates in Bundelkhand' by H. B. Medlicott at a time when he was professor of geology at the Thomson College of Civil Engineering in Roorkee.

Figure 1. Joseph G. Medlicott (after figure 7 of Leviton and Aldrich 2004).

Figure 2. Thomas Oldham, the first Superintendent of GSI.

The Narmada–Son line

J. G. Medlicott[1] mentioned that this physical feature of central India was of great importance and that the Narmada valley was an integral part of this feature. The physical features of the entire region were reflective of the geological structure. According to him[1] (p. 116), 'The Nerbudda taken altogether, from the source of the river to the sea, constitutes one of the most important and interesting features of the physical geography of western India; and in no part of the valley is its peculiar and characteristic configuration more strikingly exhibited than in that portion included in the map' (that accompanied his paper) and 'this peculiar configuration of the present surface of the ground was the direct result of geological structure'. He pointed out that there was a steep fall in elevation across the valleys to the south and that this was much analogous to an ancient coastline. Also in the later section of this memoir from p. 241 onwards he has elaborately described the nature of the faulted boundary as well as the fact that it has served as an ancient coastline. Quoting him further[1] (p. 117), 'Of these, the great rock escarpment of the Vindhyan hills running along the north side of the valley is unquestionably the most striking. This range of flat topped hills is marked by great uniformity of outline averaging from 300 to 400 feet above the level of the valley, in rare cases rising to 800. Seen from the south *it presents an almost uninterrupted series of headlands with projecting promontories and receding bays, like a weather-beaten coastline*; but these form the abrupt termination of a table land and are not an independent range of hills. It would be difficult to point out a finer example of cliffs once formed by the denuding action of shore-waves, but now far inland, than is exhibited along this range' (italics by authors). It was an extremely accurate description that though there is an escarpment reflective of a major fault, it did not occur beside a range of hills or ridges but by the side of a table land, typical of the faulted platform sediments.

J. G. Medlicott stated two important points about this unique feature of tectonic significance in central India. He focuses repeatedly on these two aspects.

(i) The conspicuous feature of the Vindhyan escarpment and the valleys of the Narmada and the Son rivers being extremely straight or rectilinear for an appreciable distance.

(ii) The rocks of the Vindhyan Series occur only to the north of the two valleys and are not found anywhere to the south of these valleys; further, the rocks containing coal were to be found only to the south of this linear feature and not to the north of it in the vast stretch of area that was covered.

Regarding the first of these points of great significance, Medlicott remarked[1] (p. 228): '*This line of escarpment joins the north side of the valleys of the Nerbudda and of the Sone; it deviates little from a straight line, when considered as a whole, and even within shorter limits, its rectilinear direction is very remarkable*' (italics by authors). On p. 241 he says, '*Moreover the deviations from the rectilinear direction are often seen to be curiously rectilinear in detail*; that is, the approximately straight line of the general boundary is made up of shorter straight lines, and not, as might be conceived from an inspection of the map, of the curved outlines of the boundary of the

rocks as determined relatively to the alluvium.'

On the second point of significance J. G. Medlicott had a lot to say. He emphasized this second point at numerous places in the text of this 340 pages memoir, of which nearly 200 pages are devoted to his paper alone. Also, the name Vindhyan was coined by the GSI during this period. He remarks[1] (p. 115): 'The entire group of Sandstones, Shales, & Co. of Bundelcund and Rewah which lie north of the River Nerbudda (or more correctly of that part of the River Nerbudda included in our map) *the great scarp of which rocks is well seen along that valley as well as that of the Sone, was separated totally from the Sandstone rocks associated with coal, & Co., which occur to the south of those rivers*, and with which it had previously been confounded: to this great group the name of the Vindhyan was applied, as being best seen in the Vindhyan range' (italics by authors).

He then points out that the rocks of the Vindhyan Series, though mostly sandstones, are *different* and they were therefore separated from those such as the Talchir Series and the Mahadeva Series. For example, on p. 119, he states[1] that the 'Table land of Malwah and Bundelcund is formed of the sandstones seen in the Vindhyan escarpment' and was described 'under the name of "Vindhyan Sandstones", *a group of rocks not known to occur anywhere south of this line of the north escarpment of the Nerbudda valley, at least not within the area mapped. In a similar manner the line of escarpment bounding the valley on the south, marks the northern limit of a series of rocks, which will be found, as including those formations called "Talcheer", "Damuda", "Mahadeva" & Co. and no rocks belonging to any of these groups are known, within our area, to occur north of this line of escarpment'* (italics by authors).

About the general extent of the Narmada–Son line and the disposition of rocks of two different types occurring to the north and the south, Medlicott said[1] (p. 228): 'The remarkable physical features... characterize with more or less distinctness, the band of country stretching *from the Gulf of Cambay on the west, to the Ganges valley on the east, and including the Sone as well as the Nerbudda River*. Most maps of British India show a marked range, called the Vindhyan Range, running along this line; Mandu stands near the western extremity of it, as generally shown on the published maps and Rotasgur at the eastern end. Running parallel to this line, is a much less regular range, very different in general aspect, formed as has been stated, of other rocks, and lying on the south side of the Nerbudda valley, within our area. *Beyond the district surveyed, a very similar arrangement is known to form a continuation of the range along the banks of the Sone, the south side of whose valley has been found, (in part of its course at least) to be formed, like that of the Nerbudda, of rocks different from those of the Vindhyan escarpment*' (italics by authors).

Again on p. 146, he emphasizes[1] the distribution of the Vindhyans and the Gondwanas as occurring on two sides of this major conspicuous lineament: 'If we take together the sub-divisions §5, §6 and §7 (*Talchir, Damuda and Mahadeva*) of our list, it will be seen from the map that rocks belonging to these groups, form the ranges which bound the Nerbudda valley on the south, as the Vindhyans do that which bounds it on the north' (parenthesis by authors). And quoting further: '*Nowhere have the Vindhyans been seen in contact with any of these rocks (Gondwanas) and between the boundaries which respectively limit the two groups, a long strip of country lies, which may be considered as occupied by the crystalline rocks, these being however, for the most part, covered by the more recent ossiferous sands, and gravels, and surface clays*' (italics by authors).

Medlicott[1] also elaborately describes the disposition of the rock types and states the possibility of the boundary being a faulted one[1] (p. 241): 'Little less striking than this rectilinear feature, it will be noticed that the boundary is, as far as our area is concerned, absolute and complete, that is, *no vestige of the Vindhyan rocks is known to occur to the south of it*. All those rocks from the Talcheer up, which are so frequently seen, on the south of the Nerbudda valley, have nowhere been found resting on Vindhyan beds, even where, as is sometimes the case, these come within 12 or 15 miles of the boundary we are now describing. If the Vindhyan rocks stretched thus far to the south of their present boundary, they were all removed prior to the deposition of any of these formations. It certainly seems extremely improbable that such a formation had an original coastline so straight as to be its present boundary...'. And later on the same page he mentions that 'from these two considerations, namely the rectilinear direction of the boundary, and the fact of its certainly not being the original limit of the basin of deposit of the formation, we come to the conclusion that it has been determined by a great line of fault. But the observer in the field will have this conviction forced on him by evidence of the fact that the line we are describing is itself, at many points along its course, is indeed a fault'. Medlicott then describes in detail the nature of this fault and the breccia deposits associated with it. Regarding the timing of this fault, Medlicott states that it was before the deposition of the Talcheer beds and that these beds were deposited on the completely denuded Vindhyan surface to the south. Quoting him[1] (p. 254), 'From these considerations we are led to the conclusion that the Vindhyan fault is almost certainly older than the lowest Talcheer beds'.

Medlicott also noted[1] that the entire range and the valleys had a singularly uniform trend of ENE–WSW or more precisely a trend N75°E–S75°W (p. 141): 'The rocks of the Vindhyan series cover an immense area in Central India (see map Pl. III). The great table land of Bundelcund and Malwah is mainly formed of them, and their southern boundary, continuous as it is with that of the table land itself, is marked, as has been stated, by one of the finest physical features imaginable: the vast plateau terminates on the south in a line of escarpment which, stretching from east to west (or more correctly E15°N), (*that is N75°E*) forms the north side of the Nerbudda valley, and farther on towards the east holds a similar position in that of the Sone river' (italics by authors).

The Vindhyans are known to have a monotonous composition over extremely large areas and lateral sedimentological variations are but few. This fact was noted by Medlicott and he also stated that despite the uniformity of composition, there are variations at many places in this predominantly arenaceous facies. Quoting him[1] (p. 142): 'its most marked characteristic certainly is the persistency of this lithological aspect over great areas. This sameness of texture is strongly in contrast with the prevailing character of *all those more recent sandstone for-*

mations to the south…' And further, 'this general constancy in lithological character does not, of course, imply the entire absence of varieties among the beds of the series: instead of clear quartz grits slightly earthy sandstones are found, and in many places ferruginous clay has been so strongly accumulated as to form a considerable ingredient in the mass'. Regarding the subhorizontality of the Vindhyans everywhere in the basin and their only intensely deformed southern margin, Medlicott remarked[1] (p. 141), '…that a slight undulating dip is the rule, so slight as to leave most commonly an impression of general horizontality, *in spite of great disturbances which have locally affected the rocks along their southern boundary*' (italics by authors).

Medlicott also suggested that at many places where there were several faults parallel to each other, these most certainly were along formation boundaries and the fault timings along these were not simultaneous but of different geological ages. Quoting him[1] (p. 255): '…the results at which we have arrived, go to show that in our district important displacements of the rocks of several distinct formations, along lines rectilinear in directions, and remarkably parallel to each other, are due to movements which were not synchronous, but on the contrary occurred at intervals separated by the lapse of whole geological epochs'.

Both the rivers, the Narmada and the Son have a NNW–SSE trend near their source in the region close to Amarkantak and they turn east and west and start flowing in opposite direction after traversing about 20–25 km. In this area, the scarp seems to be absent and the line is less conspicuous. Quoting Medlicott[1] (p. 142), 'Across the high ground of the Jubbulpur district (lying between the valleys of the Nerbudda and the Sone) the prolongation of the line of the Vindhyan boundary, although still clearly indicated in the form of the ground, is very much less prominently and distinctly marked'. This was the area that Oldham *et al.*[11] had suggested to be examined in detail.

Later life of Medlicott

The exact date of birth of J. G. Medlicott is not known, but since he is known as the elder brother of H. B. Medlicott who was born in 1829, he must have been born before 1829 and certainly after 1816, the year of birth of Thomas Oldham, who died in 1878 at the age of 62. The general longevity of people in those days was apparently 60 years. From the general reading of history of the GSI of that period, it appears that J. G. Medlicott was only slightly younger to Thomas Oldham. It is known that he was the son of Samuel Medlicott, the Rector of the Church of Ireland. Soon after the publication of the memoir in question, Medlicott appears to have retired from the Survey (the total period he served with the GSI was 11 years from 1851 to 1862 (http://cires.colorado.edu/~bilham/Oldham/List%20Of%20GeolSurv%20Officers.htm) because the literature shows that he was assigned a job by Lord Canning (http://www.medlicott.uk.com/fam/6_dunmurry.htm), the then Governor General of Bengal province to compile a report on the cotton plantation[12] in the Bengal province. Indeed, J. G. Medlicott is generally credited with the three-fold subdivision of the Gondwanas into Talchir, Damuda and Mahadeva (http://www.portal.gsi.gov.in/portal/page?_pageid=127,528968&_dad=portal&_schema=PORTAL). It appears that J. G. Medlicott's leaving the Survey and H. B. Medlicott's joining it were related events. This is quite plausible to believe since in the British system of working it was a general rule that two persons from the same family cannot be employed together in an organization at any given time. For his work on the cotton plantation report, Medlicott appears to have been rewarded in money and made a member of the Senate of the Calcutta University (http://www.medlicott.uk.com/fam/6_dunmurry.htm). He was a frequent writer in the *Calcutta Review*, Darwin (http://www.medlicott.uk.com/fam/6-dunmurray.htm) wrote out to India to discover the author of an essay on his *Origin of the Species* and finding it was Medlicott, he wrote a most flattering letter to him saying that his was the best essay on the book. In 1862, he joined the Education Department of Bengal as Inspector of Schools. He was struck with paralysis in 1863 and went home to Dublin but could not stand inactivity there and returned to India, where after a short resumption of his duties, his health entirely gave way; he died on 10 May 1866. In an article in a newspaper it was mentioned (http://www.medlicott.uk.com/fam/6_dunmurry.htm): 'By the death of Mr J. G. Medlicott the Government loses one of its few enthusiastic servants, and India one of its few scientific men'. Another article in *Pioneer* says: 'The deceased gentleman was an accomplished scholar and an able writer and his death is a public loss to the literary world of India' (http://www.medlicott.uk.com/fam/6_dunmurry.htm). He was survived by his wife Agnes and son Samuel (born in 1860). The latter is reported to have died in 1900 in British Columbia, Canada. An account of J. G. Medlicott after his death was given in the annual report of the Asiatic Society of Bengal in 1867 which mentioned that 'Mr J. G. Medlicott was well known as one of the earliest and most energetic members of the Geological Survey of India'.

Conclusions

It is thus clear that J. G. Medlicott is the one who found the peculiarities of the tectonic and geomorphic features of the Narmada–Son line. He was the very first to show that the rivers flow in a straight line and that to their north occur the Vindhyans and to the south the Gondwanas. However, the Gondwana outcrops are scattered and do not form a definite physical feature close to the two valleys as the Vindhyans do. It is only unfortunate that geology was not so well developed and scientific a field in the 1850s and Medlicott was not able to afford a fully logical and scientific explanation of this tectonic feature, though he did stress on the existence of a fault and that the Vindhyans were considerably deformed or 'tectonically disturbed' at their southern margin. And his observations were extremely accurate. The geological time scale was not established and the precise ages of different rocks were not known at that moment of time in history. At that time Medlicott did not quite grasp or realize that he had made the most significant discovery for all time to come. Probably it came a hundred years too soon. Medlicott was much ahead of his times. He only reported, extremely honestly, all his observations. This feature is not so simple that anyone can know of its existence by looking at maps. Perhaps the only thing that can be discerned from the map is the rectilinearity of the feature as marked by the rivers flowing along the weak and tectonically disturbed zone. But the distribution of rock types on its two sides can only be known to a person

seriously engaged in *mapping the entire region*. In fact, the entire thesis of the memoir is the fact that the line is so important as to be a boundary between two different groups of rocks separated in age by an appreciable time gap. Medlicott's[1] conclusion that 'Vindhyan fault is almost certainly older than the lowest Talcheer beds' clearly sums up his analysis of the correct situation seen in the field. The Gondwana Supergroup rocks are restricted to the south of the line, but one cannot actually see the two types of rocks juxtaposed to each other near the line of tectonic disturbance. The Vindhyans do form the escarpment all along both the valleys except where there has been extrusion of basaltic flows. But the Gondwana rocks do not do so, and only careful mapping of the region of Central India will reveal their restriction only to the south of the two valleys. Medlicott's work has therefore been very unique and truly a landmark type of contribution to the geology of India. West[2] published a note in *Current Science* but most astonishingly, he did not say anything different from what Medlicott had said a hundred years before him. Choubey[3], nine years after West, simply reiterated him. Medlicott's work remained unknown because the later workers in the region failed to cite his work. Another reason for the memoir escaping attention is the political scenario in India since the time of Queen Victoria's proclamation in Allahabad in 1858 up to the time of India's independence. During this period, whatever geological developments occurred were on the economic front and centred around coal, manganese and iron ore deposits, all far from academic. Thus, Medlicott's find was one of the most significant finds for all time to come.

1. Medlicott, J. G., *Mem. Geol. Surv. India*, 1860, **2**, 97–278.
2. West, W. D., *Curr. Sci.*, 1962, **31**, 143–144.
3. Choubey, V. D., *Nature*, 1971, **232**, 38–40.
4. Arnold, D., *The New Cambridge History of India, The Indian Empire and the Beginnings of Modern Society*, Cambridge University Press, Cambridge, UK. 2000, vol. 3, p. 214.
5. Davies, G. L. H., *North from the Hook: 150 Years of the Geological Survey of Ireland*, Geological Survey of Ireland, Dublin, 1995, p. 342.
6. Auden, J. B., Ghosh, P. K., Ghosh, S. R., Ghosh, A. M. N. and Jhingran, A. G., *Centenary of the Geological Survey of India, 1851–1951: A Short History of the First Hundred Years*, Special Publication, Geological Survey of India, Calcutta, 1951, vol. 2, p. 122.
7. Fermor, L. L., *Nature*, 1951, **167**, 10–12.
8. Secord, J. A., *Hist. Sci.*, 1986, **24**, 223–275.
9. Medlicott, H. B. and Blanford, W. T., *A Manual of the Geology of India*, Government of India, Calcutta, 1879, p. 444.
10. Leviton, A. E. and Aldrich, M. L., *Proc. Californian Acad. Sci.*, 2004, **55**, 117–137.
11. Oldham, R. D., Vredenburg, E. and Dutta, P. N., *Mem. Geol. Surv. India*, 1901, **31**, 1–187.
12. Medlicott, J. G., Cotton hand-book, for Bengal: being a digest of all information available from official records and other sources on the subject of the production of cotton in the Bengal provinces. Savielle and Cranenburgh, Calcutta, 1862, p. 512.

ACKNOWLEDGEMENTS. The Medlicott memoir is now a part of the Jawaharlal Nehru library of Dr H. S. Gour University, Sagar, but it is a volume from a collection of the presentations made by late Sir Lewis L. Fermor to late Dr W. D. West before the former's leaving permanently for the UK in 1951. Each memoir and record of the GSI is beautifully and securely hard bound and gold embossed with initials LLF which stand for the name of the owner. We would like to add that the plates mentioned in the text of the memoir were not found in the pouch at the back; probably someone forgot to place them back there. This has been the most unfortunate and frustrating part during the write up of this paper, since frequent reference is made in the body of the memoir to these plates which simply were found missing in the copy to which we had access. We thank Prof. D. Mukhopadhyay (of the Raman Institute in Kolkata) for reviewing the paper.

Prakash P. Roday lives at 7, Vastu Vihar, Khajuri Kalan Road, Piplani, Bhopal 462 022, India and Manish K. Purohit is in the Department of Applied Geology, Dr H. S. Gour University, Sagar 470 003, India.*
**e-mail: pproday@yahoo.com*

Edited and published by P. Balaram, Current Science Association, Bangalore 560 080.
Typeset by WINTECS Typesetters (Ph: 2332 7311), Bangalore 560 021 and Printed at Printek Printers, Bangalore (Ph: 2328 7763)