

## **REPRESENTATION OF NATURAL WORLD IN THE POPULAR SCIENCE TEXTS DURING NINETEENTH CENTURY TAMIL NADU**

**T. V. VENKATESWARAN\***

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The nineteenth century is seen as a period of transition from a largely amateur 'natural history' to a professionalized science of 'biology'. That is, a new understanding of the natural world was being reconstructed at the knowledge production level. In this context, it might be pertinent and interesting to study the status of new ideas that were assimilated and disseminated into the popular culture. The paper examines the natural history contents in the Readers (class books), Periodicals and Books published during the nineteenth century with a view to garner further insights into the social history of Tamil region and appraises the place of sciences (in particular natural history) in the popular culture.

First section documents the feature of natural history in the popular literature while the second examines the illustration and visuals used in the natural history text books/publications. The third section identifies the varied moral messages contrived from natural history and the diverse narratives of natural history fabricated by distinct social groups. It appears that the appropriation of natural history, its framework and narratives by the Tamil literati was a sort of balancing act. On the one hand they had yearning for material progress while desiring to maintain the unequal and unjust traditional social order, on the other their effort was as how to wriggle out of the burden of 'moral progress' mandated by the colonial writers.

Having analyzed the diffusion of the new ideas in life sciences on the basis of nineteenth century texts and drawing certain conclusions regarding knowledge re-production, the study reveals that the transformations in pedagogic texts were not a result of just an impact of the changes, but discerns the complex socio-cultural influence.

**Key words:** Cultural re-appropriation, Popularization of science, Science in popular culture, Spread of modern science, Tamil.

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\*Principal Scientific Officer, Vigyan Prasara, New Delhi, E-mail tvven@sancharnet.in

## INTRODUCTION

The nineteenth century is seen as a period of transition from a largely amateur 'natural history' to a professionalized science of 'biology' at the metropolis<sup>1</sup>. The social uses of 'biology' at the metropolis<sup>2</sup> has been well documented, and studies reveal that establishment of botanical gardens and zoological museums during the nineteenth century acted as the exhibition of the colonial possession of the British and the 'displays of strange animals in zoos and exotic plants in gardens were in a way public manifestation of the industrialized nations' ability to dominate the world<sup>3</sup>.

During the nineteenth and early twentieth centuries, biology was dominated by the naturalist and the zoologist, whose goal were to document the myriad forms of life, classify them properly thereby concentrating on the differences between varieties of plants and animals. Studies of the nineteenth century popular science journals indicate that with the exception of medicine, 'more articles were about natural history than any other scientific disciplines'<sup>4</sup>. The public communication of this new knowledge on life and life forms were not without theoretical interpretations. English science popularizers, in particular Anglican educationist, saw in natural history (and then emergent Botany and Zoology) a logical and systematic arrangement suggesting contrivance that was deciphered to mean the intelligent hand of God, *à la* Paley. Bridgewater treatise, entrenched in the framework of argument from design, <sup>5</sup>'ranked among the scientific best sellers during the early nineteenth century England'. This type of blending of nature theology and popular science attracted extraordinary contemporary interest. Before the advent of British colonialism and missionary schools, a system of education was prevailing in Tamil regions, called *payal* schools<sup>6</sup>. *Nighantū*, one of the traditional texts in Tamil was providing information on facts, divisions and classification of knowledge. The school were also imparting instruction on the 'names of deities, the quarters, musical instruments, the division of earth, the towns, the plants, animals'<sup>7</sup>. An investigation into how the traditional ideas and conceptual framework of the natural history was reconfigured would be interesting and may offer insight into the process of cultural transformation. But this enquiry is well beyond the scope of this paper, which limits to examining the printed texts, in particular those published in Tamil to look at the appropriation of modern frameworks and ideas on natural history by the Tamil literati.

It is not surprising that during the nineteenth century, European missionaries, who were also the earliest modern educationists<sup>8</sup> in Tamil region, were elated and euphoric about natural history and its potential for moral upliftment and enlightenment of the 'natives'. Books composed and compiled by European missionaries replaced traditional texts even in the indigenous schools. This trend was further attenuated with the indigenous schools metamorphosing into vernacular schools consequent to the policy of grant in aid from the State<sup>9</sup>.

In the provincial schools established around 1830s, the scheme of studies prescribed in the 'rules of school discipline and instruction' stipulated<sup>10</sup> Geography for class 4 & 5, study of Globe and Natural Philosophy (Calcutta's introduction to Natural history) for class 5, Natural Philosophy and Chemistry for class 6' in addition to study of vernacular language and arithmetic.' This implies that even as early as 1830s Natural History was one of the subjects taught in the government organized schools.

Factors such as, Missionary's enthusiasm towards natural history (due to its perceived function of providing 'evidence' of Creation), inclusion of the subject in the school curriculum and the potential of the themes from natural history to arouse public interest (curiosity of the unfamiliar; fascination of the exotic) resulted in natural history being one of the hot favourite of the popularizers of science<sup>11</sup> in Tamil region, perhaps as elsewhere. With a view to inform our understanding of the social history and to locate the place of science (in particular natural history) in popular culture, this paper examines the textbooks and popular literature in Tamil on natural history (and then emergent botany, zoology and at times biology texts) published during the nineteenth century.

#### NATURE OF READERS

During the nineteenth century, in Madras Presidency, especially the vernacular school education, the curriculum was limited to language, smattering of English, geography and mathematics. An introduction to natural theology and natural history were also provided through the language Readers<sup>12</sup> compiled and prescribed for the each class. Readers, typically had lessons on 'the history of the province or kingdom in which the seminary was located, an ethnological view of the rise, progress and fall of kingdoms and empires', 'a compendium

of general geography with a view to learning statistical facts', 'history of India, history of England, a description of the wonders of nature and art in India'<sup>13</sup>.

By middle of nineteenth century, the Colonial Government, European missionaries as well as few native educational societies promoted popular science literature in Tamil. Assertion of English education by the Macaulay's (in)famous minutes of 1835, stalled the progress of modern education in vernaculars, however, the unrealistic policy of exclusive English education did not last long, and the Governor General Lord Auckland in his minutes of 1839 departed from the stringent policy of Bentinck and noted that spread of mass education through English is not a feasible one. Lord Auckland's minute desired that the "leading facts and principles of our literature and science be transferred by translation into vernacular tongues"<sup>14</sup> and argued "the justness and importance of the advice of the Honorable' Court that such a series of class books should be prepared under one general scheme of control and superintendence". In conclusion, the Government of India in its order<sup>15</sup> stated that 'class book consisting of selections from English work, or, of compilation drawn up and adapted for native pupils should be prepared at the charge of education funds of all the Presidency'. This resulted in establishing a Government book depot and publishing books in the principal vernacular languages of the Madras Presidency.

The first series of a Tamil Readers compiled by Rev. Percival, the professor of vernacular literature in the Presidency College was designed to have reading lessons on natural philosophy, natural history and physical sciences<sup>16</sup>. While the first book of lessons was preparatory, the second book of lessons had elementary introduction to natural philosophy and natural history; lessons on physiology like ear, trunk, on natural history like crow, cow, ass, sheep, cat, and on natural objects like sun, moon, stars and so on. The Third Reader had lessons on natural history, including minerals, vegetable and animal kingdom. The lessons in these Readers were of on elementary and descriptive nature. For example curious specifics like 'whale is the biggest of fishes', 'bat is neither a bird nor a mammal' were communicated to arouse interest among the children and tune them towards the 'new' natural history. These Readers were in use for more than twenty years (though, revised marginally from time to time) till they were discarded and new ones produced around 1875.

During 1873, a committee was appointed to examine the textbooks used in the Government schools, which, after scrutinizing the Readers being used in the government schools remarked, <sup>17</sup> ‘the least satisfactory of the lessons on nature history are those on the animal kingdom. There is no attempt to convey any interesting on the habits or peculiarities of the animals treated. Many of these lessons are simply fables, which are of no value except for the moral which some of them convey.’ Revised Readers compiled subsequently Committee Report included among other things, <sup>18</sup> ‘anecdotes, biographies, travels, and natural history.’

Since 1880s, subsequent to the adoption of revised curriculum and textbooks, natural history was a subject of study in the school education, and lessons on natural history were prescribed in the vernacular readers. For instance, the Second Reader (1890)<sup>19</sup> had the following lessons on natural history: - the horses and ass; the cow, buffalo, sheep & goat; dog & cat; poultry, the lion, the elephant, the camel & tiger, bear & rhinoceros, the monkey, the eagle, hawk & vulture, kites & crow (see the Appendix A). Careful scrutiny of the lessons on natural history prescribed in the Readers during the nineteenth century indicate that it was dominated by the naturalist and the zoologist, whose goal were to document the myriad forms of familiar life, and describe their curious behaviours.

In addition to natural history in Readers, quite a few publications were also made in Tamil to communicate the fascinating and curious information on natural history during the nineteenth century. Many of these works were also used as supplementary texts in the schools, as well as literature for general reading. A careful scrutiny of the bibliography of popular science books in Tamil published, compiled by the author <sup>20</sup> indicates that the early natural history books in Tamil were compiled by the European missionaries. Natural History of Animals<sup>21</sup> published by the Government Book Depot was used as a textbook in the schools run by the Government, and in school that received grant in aid from the government. Missionaries were yet another significant educational service provider in the Madras Presidency and books such as *Vana Vilangiyal*<sup>22</sup>, *Urthiri Vilangiyal* <sup>23</sup> were produced by the missionary societies.

Progress of vernacular textbook production attained further impetus from formation of schoolbook societies, some of which had limited patronage of the

Government, but managed by the ‘natives’. Madras School Book and Vernacular Literature Society (MSB&VLS), refurbished in 1860s from the then dormant Madras School Book Society originally established in 1820, Christian Vernacular Literature Society (CVES), *Madras Upayukta Granda Karna Sabha* (society for production of useful books), South Indian Christian School Book Society (which subsequently merged with CVES) industrially indulged in preparation and production of textbooks in vernacular language in the Madras Presidency since the middle of nineteenth century.

Consequently during 1860 there was a renewed enthusiasm and interest in popular science publications in Tamil. Arguably, inspired by the books of Anglican minister John George Wood’s *Common Objects of the Sea-Shore* (1857) and Charles Alexander’s *Flowers of the Field* (1853) and the like, the Anglican missionary publishers CVES, published books on the topics such as sea birds, animals found in the *Bible*, pictures and stories of wild animals, pictures and stories of birds, reptiles, book on insects, fish and whale, and pearls animalcules<sup>24</sup>. Vernacular Book publication agency setup under native management and with government patronage, MSB&VLS, brought titles such as *Natural History of Wild Animals*, *the Friends and Foes of Forest and Tidbits about Animals*<sup>25</sup>.

In addition to school texts and books, periodicals too disseminated a popular introduction to natural history. Rev. Percival commenced a periodical, *Tamizhar Magazine*, in Tamil with a specific objective of education. A bibliographic survey<sup>26</sup> documents that more than 91 periodicals in Tamil during the period of 1830-1930 was primarily involved in science popularization. Though quite a few among them did not last long, or were focused towards health, medicine or technology, three periodicals published during the nineteenth century merit close scrutiny. *Janavinuthini* published by the MSB&VLS since 1870, *Vivekachinthamani* since 1892 and *Tamilar Nesan* since 1917 not only lasted for many years but also had wider reach and impact<sup>27</sup>.

Often deployed narrative device by the authors of the natural history to bring the public’s attention to some of the more “scientific” aspects of science was the regular use of “interesting facts”. Thus to explicate the concept of

‘mammals’ in contrast to ‘birds’, in the framework of the natural history, discussion on bats are used. Regeneration of mutilated parts in certain life forms (like worms, tail of lizards, plant parts)<sup>28</sup>, exotic and curious species like, ostrich, kangaroo, hippopotamus were some of the often-found topics typically written in a narrative style that generates a sense of wonder and curiosity in the reader<sup>29</sup>. Even the familiar animals like cats and cow that formed part of many readers were in such a way that the lessons focused on features of these life forms that are strange and intriguing<sup>30</sup>. Microscopy, for instance, was pursued chiefly as an object of wonder, even while orthodox elements were reported upon. Neither the optical principles nor the use of the microscope in health merited attention in the works till in the early twentieth century. Among the merely curious items discussed was the microscopic examination of a drop of water with multitude of teeming “microscopic” life (Fig.1). Plants and self defense mechanisms, plants that eat insects, place of man in nature, races among the living beings, infant stage in life forms, parasitism in plants, fungus, mushroom, emigration of plants, flowers- their colour and scent are for instance, some of the articles that is found in *Tamilar Nesan*.

Time and again, the popular image of botany and zoology was perceived as a source of aesthetic pleasure and rested in large measure upon curious facts and exotic plants and animals or their fascinating behaviour and features. At the least in popular literature in Tamil during the nineteenth century indulgence in theoretical was rather rare, but simple curiosity was the datum of popular scientific interest in so far as natural history is concerned. Recurrent use of the word “curious”<sup>31</sup> to describe accounts of the natural history, for sure was a journalistic habit, yet curiosity was more than a convention. ‘Without it there could be no interest in science; with it came an attitude towards the natural world – a stance of contemplation – which urged the observer towards the twin notions of majesty and grandeur and which fed a continuing interest in science’<sup>32</sup>. In addition, rendering classical poetry into textual prose with vivid descriptions and use of flowery language was a trend dominant in the development of prose during the nineteenth century Tamil literature.<sup>33</sup> Most of the authors were themselves literary writers that they deployed the trope of “marvelous” even in their popular science writings, contributing to the presence of element of “curiosity” in the natural history writings.<sup>34</sup>



Fig. 1. Microbes under microscope (*Munram Vasaka Pusthagam*, Madras p.81, not dated).

Investigative approaches in teaching of biology, shifting toward the study of micro-organisms and theories that focused on those vital phenomena common to all species, was to emerge only during the 1930s. Nonetheless, the natural history was not devoid of theoretical undertone, and in fact encouraged the belief that the 'order of nature' was imposed by its Creator. Much effort was expended on the simple description of species and their behaviour, with the complex habits of insects and other lower animals being seen as evidence of the divine workmanship by which the Creator adapted his living structures to their environment. For instance, in the Readers published during this period, often the distinct shapes of the feet of birds are compared and contrasted with



their habits and behaviour, and complexity of natural adaptations are used as ruse to proclaim the existence of a God<sup>35</sup>. To take another example, a text prescribed in a Reader reads thus ‘Children, have you understood the reason why the eyes, ears, legs, nails, tongue and so on of cat is made differently from that of ours? God has made each and every living being in this world to undertake a specific purpose (use). The body of the living organisms are also structured by Him to fulfill this task. His skill is visible in the arrangement of each and every organ of cat. The more we contemplate, more we are astounded at the immense might and kindness of the *Paramathma* (Supreme Soul). Though cat is an everyday animal, daily seen, we neither observe it nor take effort to



Fig. 2. Eyes of Cat (Subramaniam MS, *Elementary Science Pedangal* (Vth class) in Tamil, ARVPress, Trivandrum, 1933, p.21)

comprehend. Just look, how many mysteries we have been able to unveil [just by close and keen observation].’(Fig. 2)<sup>36</sup>

In such narratives, the consistency established between the structure and functions of organism on the one hand and the habits and behaviour on the other are presented as awesome to be anything but accidental. The narrative, seamlessly hint at contrivance and allude to a ‘supreme intelligent’ i.e., the divine hand of the Creator. Another favourite subject of the compliers of Tamil Readers from the animal world as a shining example of the divine workmanship was that of cats. Special shape of the claws, fascinating function of the eyes, the form and structure of the hind and fore legs and the special way in which bones are arranged in the legs that provide impulse for the cat to spring to an height as well as protect itself when it falls from a height was one of the dominant *idée fixe*(Fig. 3). One popular text<sup>37</sup> went even to say that Cats are nothing but just a machine designed to catch rats!



Fig. 3. Organs of Cat and its purpose (*Manram Vasaka Pusthagam*, Madras, p. 17, not dated)

ILLUSTRATING NATURE OF TEXTS

Visual aids such as wall charts, illustrations in the texts, woodcuts and even preserved specimens were increasingly used in the natural history teaching/popularization, in particular since late nineteenth century. Standing order for Government schools specifically instructed that <sup>38</sup> ‘coloured engraving of varieties of human race, the costumes of the principal nations, strange beasts and birds’ should be displayed in the classroom and instruction should be using these aids. Stuffed animals and those preserved in alcohol, complete and disarticulated skeletons, life like porcelain, clay, metal and leather models, lantern slides, wall pictures of all animals, glass cases of typical insects, scorpions, spiders, snails and crabs, eggs, grubs, caterpillar and cocoon of insects, egg nests, feathers, beaks and feet of birds; teeth, claws, nails, hoofs and horns of beasts; frog eggs and tadpoles, glass jars, aquaria, butterfly nets, magnifying glass etc were readily available<sup>39</sup> for teaching zoology and botany in schools (Fig.4). Authors too encouraged the readers and teachers to use the visual aids



Fig.4. Beaks of Birds (Namachivaya Muthaliyar, K. Nuthana Nangam Vasaca Pusthagam, C. Kumaraswamy Muddaliyar & Sons, Madras, 1927, pp.52-53)

while teaching botany and zoology. Duraiswami Sastri, then a professor of zoology in Presidency College zoological laboratory, encouraged the teachers to use <sup>40</sup>‘pictures, diagrams of animals, or stuffed specimens, models and lantern slides’ even while cautioning that these are ‘of immense use, as aids, but they should never usurp the place of the actual animals’. Samuel V. Koil Pillai argued <sup>41</sup>‘while teaching nature study, one should use aids/tools that are easily available’ and in particular observed ‘drawing and wherever possible live demonstration’ be used with the view to ‘train the students in their capacity for observation.’ V.K. Narayanaswami Aiyar was candid when he remarked <sup>42</sup>‘though we have to follow modern methods of teaching by resorting to use of direct experience, only some are actually in the ambit of students and teachers. Hence at times we have to resort to models and charts.’

The illustrations that accompany the natural history texts were not merely a visual treat to arouse curiosity and a sense of wonder among the readers. While engravings used in the books published earlier were to introduce a strange beast or bird, increasingly, the purported meaning implications of the plates can no longer be gained spontaneously from the illustrations alone. Intended meaning of illustrations was evident only with the mediation of accompanying text passages, without which meaning is nearly impossible to comprehend. Concomitantly, the image contributes crucially to the communication of the complex ideas and concepts<sup>43</sup>. This is achieved in particular by allocating the individual phenomena certain ‘places’ within the picture, often also, marked with reference letters. The text no longer needs to be convoluted and long-winded; with the aid of suitable illustrations, the authors could now to briefly and concisely refer to these markers in the pictures, without always having to repeat the overall pattern, facets and features that play a part. Moreover, the image enables the viewer to form a fair idea at a glimpse. The elaborate system of cross-referencing between text and image setup makes it possible for an intense interaction between the illustrations and texts. They stimulate a mental dialogue, which persuade the reader to read text and images simultaneously. The readers can thus, while continuing to read the textbook, repeatedly allow their eyes to wander effortlessly to and fro between text and illustration<sup>44</sup>. Such style and presentations were novel and unorthodox to traditional Tamil prose.

Even when the illustrations are found unsuitable or inadequate, the idiom of visual was deployed. Thus phrases such as ‘see’, ‘look’, ‘can you notice’,

‘observe’, ‘look carefully’, ‘there look at ...’, ‘have you seen....’ were profuse in the new biology texts. To illustrate, Rangachariyar<sup>45</sup>, in his book on *Life of a Bean Plant*, uses not only the first person narrative style but also profusely use words that allude to visuals.

The teaching of natural history and life sciences was lacking the equivalent of laboratory experiments in physics or chemistry, that is, a real, live encounter with its objects. Though the authors and writers were talking of direct interaction with the animals, observation in captivity and so on, in actuality it is clear that this is not practicable at least in the school environment. The new percepts of scientific naturalism required the ‘science’ to be testified, and observation was one epistemic norm. The rhetoric of direct observation, scrutiny of details and study of behaviour in captivity that were demanded out of the schoolteachers and children was to meet the new norms of science. Emergent disciplines of biology/botany/zoology met the norms for empirical testimony through the profuse use of illustrations and a language of visual (not unlike the thought experiments that was to be used by modern physics such as Quantum Mechanics and Theory of Relativity).

Furthermore, the use of accurate illustrations also made natural history a public rather than a secretive science. Ordinary people could read the descriptions of animals and feel that the study of Nature was something that they could participate in. Thus, accurate descriptions and illustrations contributed to undermining the traditional framework within which animals and plants were studied, privileging the ‘observation’ over traditional ways of knowing.

### NATURAL THEOLOGY/SCIENTIFIC NATURALISM

The element of wonder in natural history had, before the middle of the 19th century, taken a religious form, influenced by the traditions of natural theology. ‘Many popularizers of science during the second half of the century provided their readers with a readily accessible natural theology, whose narrative of natural history contained a revised natural theology’<sup>46</sup>. The tradition of natural history writing for public in English even if did not directly ‘strengthen religious creeds, it was supposed to provide the basis for an ethics’, as well as ‘it encouraged outdoor activities and reasoning’ and was a source of aesthetic pleasure.<sup>47</sup>

Influenced by the ethos of scientific naturalism, latter day natural history (Botany & Zoology) was presented in an accessible manner to the reading public using the narrative of natural history and infused the stories of nature with a cosmic dimension that represented a secularized version of similar themes in natural theology. A text in a Reader reads; ‘Did you see the picture of the kitten? Yes I saw it. There is a silk scarf on its neck. Is it playing with a ball? Yes it is playing. Just like children are interested in games, kittens also love to play. What occupation does a kitten have? It has to just drink milk, roll on the grass mat, slumber into sleep keeping the eyes closed; these only are its daily chore. Does it have to go to school or read a lesson? Is there a school for kittens? Are there lessons/textbooks for kittens? You have education and school, isn’t? Therefore you should not desire to play, eat and sleep and while away the time. You should read, write, do maths and with great care study’.<sup>48</sup> This narrative derives moral, but not just theological, but of civic behaviour demanded from a child, in particular in a modernized society. ‘Going to school and studying’ are the norm for a child, so says the text, but through a narrative of natural history. The norms are discursively derived from the alleged behaviour of cat (one can discern a soft form of sociobiology in the above mentioned text’s narrative argumentation).

The social organization of bees, it is contented has a lesson for the humans. Styled as a conversation between two bees, the article argues that while those who are strong and sturdy should slog and bring ‘nectar’, those who are smart and bright should take the burden of governance<sup>49</sup>. Actually the physically powerful bee tries to usurp the role of queen bee, and approaches a smart bee to help it to stage a revolution. The smart and wise bee advises the strong bee (which is also labeled as ‘juvenile’ while the wise bee is labeled as ‘mature’) that each will have an assigned role according to his ability and nature. Humans, who have acquired intelligence (non-natural), should learn from the innate intelligence exhibited in nature, is the moral lesson with which the article concludes. Another text reads thus, <sup>50</sup>‘for the expediency of governance of a State, some are employed to protect it, some for trade and industry, some to make law and dispense justice, some to collect taxes and in like manner citizens are deployed in varied occupations. In like manner, the cells found in different parts of the plants perform distinct functions that lead to overall growth of the

plant.’ While the metaphor seems to educate on the differentiated cell function, reflexively it is also a statement on the new social order then emerging. Thus, it was not only theological messages that were drawn, but quite a few secular precepts were also contrived from the purveying of natural history.

It is revealing when we compare the titles published during the early nineteenth century by the missionaries with that of those published during the early twentieth century, in particular authored by the ‘natives’. For the use of Revenue Department of the government, a book titled *Trees and its uses* was published in 1904. It is pertinent to note qualifier ‘uses’ in the title of the text. Textbooks with explicit titles like ‘textbook of botany’ and ‘textbook of zoology’, and textbooks for ‘nature study’ appear only from 1900s, signaling the arrival of scientific naturalism into the school science curriculum.

Yet another trend that one notices during the early twentieth century is a series of publications of quasi agricultural/horticultural in nature. Titles<sup>51</sup> on Indigo plant, Mango, Paddy and Sugar cane were published. These books while popularizing the botanical features of these (then) commercial plants also provided advice for ‘improved’ cultivation. The Readers no longer talked of only curious and exotic flora and fauna, but a dash of commercially useful’ plants and animals was a norm. Thus Narayanaswami Aiyar’s nature study<sup>52</sup> had a section on economic products both in Botany and Zoology and discussed plants such as cotton, coffee, vegetable oils, vegetable secretions in botany and hides, skins, leather, ivory, whale and silk in zoology section.

*Vivekachinthamani*, a Tamil periodical lamented<sup>53</sup> ‘though Indians take great pain to prepare for their BA and MA examinations, they hardly exert to involve in research. Palpably they do not take any effort in studying the varied plants (flora) and investigating their properties; or surveying the country for mines and finding ways to mine them; and thereby develop a strong industry through the application of science and technology that would make the nation progress.’ But why Indians are lacking in their effort at research and application of the research for development! The author contents that the reason that our countryman have scant interest in learning about the objects and thier observation capacity is trivial. On the other hand the author claims Europeans, ‘even while they are small children spend time in chasing curious birds, collect flowers and shrubs and observe the activities of the insects closely’. Furthermore the author

notes that 'European mothers encourage their children to collect plants, creepers, flowers, shells, insects etc for amusement', and thereby inculcating a sense of observation right from their infancy. The centrality the author wishes to ascribe to 'observation' in being instrumental for industrial development and national progress is evident, but what is even more striking is that all the manners and conduct that the author content would inculcate a culture of observation are related to natural history! It is in this context that the confident suggestion by the author that 'botanical textbooks should be prepared in Tamil and prescribed as texts in the elementary education' assumes significance. Rangachari also notes that <sup>54</sup>'nature study [will greatly] strengthen the sprit of enquiry and improve the powers of observation in children'. Ramiyar in his essay 'Civilization and Progress' asserts <sup>55</sup>'we should agree that science has a potential inspiring material for progress of Man' and goes even far to say that the age we live is Kali Yuga and all other Yuga like Kṛta Yuga and Satya Yuga are yet to be realized in future, with the help of science.

While still giving prominence to the classification of living beings and morphological classification of species, the natural history presented in the Readers in the late nineteenth century and in particular early twentieth century is replete with discussion on 'useful' plants and animals or at the least what can be derived as use from the flora and fauna. While the earlier books and readers were confined to classification as methodology and uncovering divine plan as its goal, the new texts went beyond to place observation as the crucial methodological means of acquiring knowledge of the living world and material qualities so discerned as its object. The transition to a natural history based on the observation of material qualities had ideological overtones; idiom of "application" and ethos of 'usefulness' are aplenty in the new texts. This trend was further accentuated, discursively, due to the employment of the word '*upayogam*' as the corresponding Tamil word to denote purpose; in Tamil '*upayogam*' also connote use.

### SOCIAL MESSAGE

Natural history had broader ideological implications. The passion for describing the structure and habits of exotic flora and fauna exploited the public interest in Nature in order to articulate a social message. To being with, this message was linked to traditional religious beliefs, through the narrative of



argument from design. It is evident that the Tamil compilers extracted these implications from the then popular notions prevalent in England, particularly amongst Anglicans. As most of the early compliers were themselves European missionaries, such an allusion is rather expected. Evidently, native interlocutors too conveyed these ideas and frameworks, however to conclude that the native popular works are essentially derivative would be an opinion in haste.

Moral messages derived by the missionaries through the purveying of natural history was not offensive to the then emergent articulate section of Tamil society, nonetheless it was inadequate to their project of material progress. Firstly, idiom, ethos and their expected function in maintaining social order were different for the European missionaries and for the natives. In a strict sense Creation in Christian theology (in so far as it was purveyed by the missionaries) implies ‘giving being to things which had no being before’; however in Hindu tradition, the Almighty needs only to be a *Viśvakarmā*, that is material cause of all things (like earthen pot from clay)<sup>56</sup>.

The natives were not averse to argument from design, for it did not in any way challenge traditionally held religious views, in contrast, often strengthened their religious precepts. A Christian theologian, to avoid rhetoric of conflict with science and to construct one that is of harmony, had to labour for argument from design in justifying revelations. In contrast, native (Hindu) religion being not based upon revelations need not labour hard to corroborate its theological precepts with that of the study of the natural world; rhetoric of segregation- two distinct domains- sufficed<sup>57</sup>. Hence the shift from natural theology to scientific naturalism did not cause alarm among the ‘natives’ as much as it did say during the same period in England<sup>58</sup>.

The narrative of many of the lessons, say of cats, or of flowers, what ever be their purported topic, was aimed at showing how the parts of their bodies interacted to give a harmoniously functioning organism. Since in every case the structure was carefully adapted to the species’ way of life, the argument also proved the benevolence of the Creator. This of course was adopted by all the authors, be it missionaries or be it natives. But in the hands of the natives this narrative was furthered to have additional discursive function; that of calling attention to *usefulness*.

Missionary labour in Tamil region confidently purveyed a framework drawn from Butler's *Evidences*<sup>59</sup>, which emphasized more on the evidences of the revelations that the study of nature provided. Till middle of nineteenth century missionaries were at the helm of vernacular publications, in particular as they were the only 'experts' with 'higher education' around. The missionaries could disseminate undeterred the ideology of 'moral progress' and 'natural theology'. However, with the scientific naturalism sweeping out the natural theology, clerics could no longer claim sole expertise and had to make way for the 'scientifically educated', which by then in Tamil region included quite a few educated natives too<sup>60</sup>. Not having to carry the burden of 'moral progress', the natives could explore far more narratives that could be marshaled than the colonialists. Arguably, the source for reading 'usefulness' in natural history by the Tamil literati could have been from the intellectual tradition inaugurated by Paley. Although there was little originality in Paley's argument from design, in his work *Natural Theology* (1802)<sup>61</sup>, and little new in his approach to natural history, his emphasis on the *usefulness* of organic structures struck a renewed chord in the minds Tamil literati, and lend itself for cultural appropriation. Krishnamachari was clear in endorsing Paley directly<sup>62</sup>, while most other authors were drawing from English works such as Vincent. T. Murche's *Object lessons in Elementary Science and Geography*, W. Done and F. Trickner's *Object lessons in Geography and Elementary Science*, J. M. Coulter's *a Textbook on Botany* and so on.

*Usefulness* was not the only social message derived by the natives. An idea of social order, segregated but each part working in harmony and in tandem with other parts was yet another metaphor that is loud and clear in the narratives by the natives. Thus far 'natives' were considered as if they form an undifferentiated social class; such a view is anything but fact. Typically belonging to the Brahminical classes and few other high caste sections (such as Saiva Vellalars), 'native' interlocutors while enthusiastic to enjoy the fruits of the modern education and in privileging the material progress were not radicals. While they desired material progress for themselves, they were not inclined to radically change the society on the principles of equality and social justice. Thus they had to make a balancing act between the need to come out of the cultural shackles imposed by the colonialist in the form of privileging of moral progress and the need to keep a check on the traditional order not being

overturned. The Secretary of the Madras Graduates Association in 1890 in a missive to the Government of India rebuffed the charges that modern education is ‘resulting in growth of tendencies favourable to indiscipline and irreverence’ and claimed that ‘increasing interest is being taken by the educated natives in question of social and religious reform and that growing reverence is shown to ancient institutions’.<sup>63</sup> The secretary is clear, social and religious reform is on, but not at the cost of ‘ancient institutions’.

### CULTURAL APPROPRIATION

Evolution of characteristics due to incessant interaction with environment, an idea from evolutionary theory was marshaled to substantiate an ancient adage in Tamil that advised to have relationship only with the ‘men of character (*nallor*)’<sup>64</sup>. The concept of contagious diseases due to spread of germs are used to justify the social segregation practiced in the form of caste (albeit obliquely). Discursively ‘men of character’ is redefined to mean ‘men of high caste (*uyarntor*)’, and goes on to justify the caste segregations. The ideas of sanitation are again culturally appropriated and discursively used to scorn at the idea of assimilation of all castes and creeds<sup>65</sup>. Denial of right to draw water from the common well by the ‘*panchamas*’<sup>66</sup> in the same breath justified on the grounds that they are ‘habitually dirty’ and allowing them to use the water would result in the common water source getting polluted; thus the ancient institution it is shown was after all right! In these discourses, pollution in its biological and chemical sense is semantically shifted to allude to religiously sanctioned ‘pollution’ and thereby ancient social order is purported to be substantiated by the conceptual frameworks of modern science. Thus, when the missionaries found ‘natives’ as a whole to be deficient in moral and appropriate messages advocating moral progress, the native interlocutor had to negotiate a rightful place for material progress as well as a moral message that would suite their social expectations. Perhaps, the above reading also instructs that methodologically one should shift from looking at the popularization efforts as mere ‘derivative’ discourse to that of a cultural appropriation. For, metaphor of cultural appropriation enables us to<sup>67</sup> ‘acknowledge the change in a previously established idea, theory, technique or practice as it enters a new historical (and perhaps geographical) location. If the practice, idea or whatever takes root it is because it serves the continuing need of the appropriators.’

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## APPENDIX A

**Chapters related to Natural History found in the Tamil Readers**

*Irاندam Pada Pusthagam, (Second book of lessons), for the use of schools (Tamil),* Graver Cookson & Co., Scottish press, Madras, 1873.

Head, eye, nose & mouth, ear, trunk, limbs, hand & feet, quadrupeds and other animals, ass, cow, sheep, dog, cat, crow, monkey, plantain tree, coconut tree, panther, language of animals.

*Nangam Vasaga Pusthagam (Fourth Reader)* SPCK press, Madras 1886

Lessons on Human physiology and organs; knowledge of insects.

Walter Joyes, *Second Reader, Tamil- Madras School Book Series*, Madras School Book Society and Vernacular Literature Society, Old College, Nungampalkam, Madras 1890.

Natural History: Horses and ass; the cow, buffalo, sheep & goat; dog & cat; poultry, the lion, the elephant, the camel & tiger, bear & rhinoceros, the monkey, the eagle, hawk & vulture, kits & crow.

Krishnamachari V, *Nankam Pata Pusthagam (Fourth Reader, Part II), Madras Irrigation works, Locusts, School Series*, Empress of India press, 1893.

Physiology and laws of health (on Human organs etc.).

Viswantha Pillai V, (Tr.), *Intham Standard Pusthagam, (Tamil Fifth Reader New Series)*, Christian Literature Society, SPCK Press, Madras 1895:

Sheep, fox and a goat, crocodile, sparrows, lion, fox and bear, tortoise, frog and a plantain tree, stomach and its organs, spider, sowing and harvesting, frog and rat.

*Ezham Vasaga Pusthagam (Tamil Seventh Reader ), Revised*, CLS, Madras (14<sup>th</sup> Edn.) 1907.

The hippopotamus, the kangaroo, earthworms, the changes in insects, the microscope.

*Irاندam Vasaga Pusthagam, (Second Standard Reader), New Series, CLS (17<sup>th</sup> Edn.), Madras 1908.*

Human body, cow, creation and creator, soul, note & mouths, buffalow, a corn of grain, eyes, ears, crow, hen, plantain, owl, flowers and grass, cat, trees, duck, eagle, fish.

Marsden E, *Nangam Vasaga Pusthagam , Macmillan Series of textbooks for Indian schools (Fourth Reader)* Tamil, SPCK Press, Vepery, Madras, 1901.

The lion, the coconut tree, the tiger, the elephant, the leopard, the crocodile, the camel, Indian corn, the vulture, the owl, the bear, the monkey, the date palm, the ocean the cobra, the frog, the spider.

*Mundram Vasaga Pusthagam, (Third Reader), SPCK Press, Madras 1905.*

The dog, the parrot, the cat, plants must have food, the wolf, how plants feed!, plantain, deer, the cat and fowls, plants want air, the crane, the crow, the rabbit, the horse, the banyan tree, the hawk and the cock, the nose, food, the swan, the turtle, the eagle.

Marsden E and Vellupillai JM, *Intham Vasaga Pusthagam, (Tamil Fifth Reader)* MacMillan & Co, Madras (revised edn.), 1907.

The ostrich, the squirrel, the whale, the lotus, the monkey, the camel leopard, the hippopotamus, tomatoes, the rhinoceros, trees, turpentine, trees, trees and their bark, bees, Indian rubber.

Namasivaya Muthaliyar, *Nuthana Nangam Vasaga Pusthagam (Modern Fourth Reader)*, C Kumaraswami Naidy & sons, Madras 1927.

Family of cats, stem and trunk, family of dogs, beaks of birds, mosquito, leavers, sense organs and sensations, flower, fruit.

*Muladham Iyyarkeri Sasthram (Nature Study) (3<sup>rd</sup> forms) n.d*

(A) Class study: plant life, paddy, ragi & cholam. The pumpkin, the watter lilly, simple experiment to show how plants behave towards light; plants and seed duspersal. The defence of plants, animal life. The cat family, the dog family, the covering of animals, the study of egg. The beak and feel of birds. The garden snail, mosquito, bees, ants and wasps. Protective coloration. (B) Garden study: field study.

## NOTES AND REFERENCES

1. See J. Peter Bowler, *Fontana History of the Environmental Science*, Fontana press, London 1992 for an accessible overview. Also, A. Joseph Caron, "Biology in the Life Sciences: A historiographical Contribution", *History of Sciences*, 26 (1988) 223-268 for a discussion on the historiography of the history of 'biology'.
2. See for instance Daniel Hendrick., *The Tentacles of Progress*, Oxford, 1988; H. Lucille Brockway, *Science and the Colonial Expansion*, Academic Press, New York, 1979; Beinart William, The politics of Colonial Conservation, *Journal of Southern African Studies*, 15.2 (1989) 145-162, January.
3. J. Peter Bowler, *Fontana History of the Environmental Science* p. 257. The height of audacity could be discerned from the fact that few "natives" from India and other British possession were taken to the Great Exhibition held at London.
4. Jean-Marc Drouin and Bernadette Bensaude Vincent, "Nature for the people", in N Jardine, J A Secord and E C Spary (eds) *Cultures of Natural History*, Cambridge University Press, Cambridge, 1996, p. 409.
5. Bernard Lightman , "Marketing Knowledge For The General Reader: Victorian Popularizers of Science" , *Endeavour* 24.3 (2000) 100-106.
6. For an overview see, Dharampal, *The Beautiful Tree- Indigenous Indian Education in the Eighteenth Century*, Biblia Impex, New Delhi 1983 and for a critical appraisal of indigenous schools in the Madras Presidency see P Radhakrishnan 'Caste Discrimination in indigenous Indian education I: Nature and extent of education in early 19th century British India', *Working paper No 63*, Madras Institute of Development Studies, Madras 1986
7. Campbell, "On the State of Education of the natives of South India", *Madras Journal of Literature and Science*, October (1834) 350-59. See also Raja Sivalinga and Sivalinga Raja Saraswathi, *Pathonpatham Nutrandil Yzhapanathu Tamizh Kalvi (Tamil education in Jaffna in the Nineteenth century)* Kumaran Press, Colombo 2000 for a discussion on vernacular school at northern part of Srilanka.
8. see S.Saththianandan, *History of Education in the Madras Presidency*, Christian Literature Society, Madras 1894 for an overview and Frykenberg E.R., "Modern Education in South India 1784-1854: its roots and its role as a vehicle of integration under Company Raj", *American Historical Review*, 91.1 (1986) for the specific role of missionaries and the company Raj.
9. See T.V. Venkateswaran , "*Content and Character of Natural Sciences in the Vernacular School Education in the Madras Presidency (1820-1900)*", presented at *Indian History Congress*, Bhopal, 2001 (unpublished) forthcoming for a discussion on the place of science education in the nineteenth century Tamil region.

10. "Rules of school Discipline and Instruction", in J Alexander Arbuthnot, *Selections from the Records of the Madras Government No II, Papers Relating to Public Instruction, Comprising a Memorandum of the Proceedings of the Madras Government in the Department of Public Instruction with an appendix consisting of all important papers recorded in the Subject*, Madras 1855. (pp. cxlii to cliii)
11. Little more than 74 titles out of the 412 published between 1830 and 1930 were on natural history (& life sciences). See T .V. Venkateswaran. , *Pathonbatham Nutrandil Arivial Parvigalum Purithalkalum (Popular Perception of science during the nineteenth century Tamil Nadu)*, in Tamil, (unpublished) PhD Thesis, Tamil University, Thanjavour, 2001.
12. Readers are class books that contained lessons on varied topics such that at the same time it is an educational tool for language acquisition as well as to provide an elementary knowledge on varied subjects.
13. J. A. Richey, *Selections from the Educational Records, Part II, 1840-1859* Superintendent of Government Printing, Calcutta, 1822.
14. H. Sharp (ed), *Selections form the Educational Records 1781-1839; Part I* Calcutta, 1920, pp.156-157.
15. Order dt 21<sup>st</sup> Nov, 1839
16. see *Report of the Committee for the revision of English, Telugu and Tamil School Books in the Madras Presidency*, Government Gazette press, Madras 1874 for a review of the Readers used in Government schools.
17. *Report of the Committee for the revision of School Books* (p. 64)
18. John Murdoch . *Education in India: A letter to His Excellency the mostHonorable the Marquis of Ripon KG GMSI, Viceroy and Governor General of India*, CKS Press, Vepery, Madras 1881, p.115.
19. Joyes Walter, *Second Reader, Tamil- Madras School Book Series*, Madras School Book Society and Vernacular Literature Society, Old College, Nungampalkam, Madras 1890.
20. T.V. Venkateswaran, *Pathonbatham Nutrandil Arivial Parvigalum Purithalkalum (Popular Perception of science)*, 2001.
21. *Natural History of Animals*, Government Book Depot, Madras (Nd).
22. *Vana Vilangiyal (Animals of The Wild)* Nagercoil (Nd). The missionaries also alleged that 'Hindus as a rule are deficient in habits of observation. Lessons on the plants and animals around them would be valuable in several respects'. John Murdoch , *The Indian Teachers Manual with hints on the management of vernacular schools*, CVES, Madras 1885, p. 178. This prompted them to even present familiar flora and fauna as novel.

23. *Urthiri Vilangiyal (Domestic Animals)*, Nagercoil, 1836.
24. *Chennai Peoples Parkukana Vazhikatti (Guide To Peoples Park)* J Heart, Higgins-botoms, Madras, 1876, Modes Iyer Rr, *Kadar Paravaigal (Sea Birds)*, Madras Tract Society, CMS Press Palayamcotta, 1876., *Vivilia Nulil Varum Mirugangal (Animals Found In Bible)* Madras Religious Tract & Book Society, CKS Press, Madras, 1879. *Vanavilangukalin Padangalum Kathaigalum, (Pictures And Stories of Wild Animals)*, CVES, CKS Press, Madras, 1888. *Kattu Mirugangalin Padangalum Kathaigalum, (Pictures And Stories On Wild Animals)*, CLS, Madras, SPCK Press, Madras, 1894. *Pakshigalin Padangalaum Kathaigalum, (Pictures and Stories of Birds)*, CVES, SPCK Press, Madras, 1894. *Pampugal Muthaligal Matrum Urvana, (Snakes, Crocodile Etc)*, CLS, SPCK Press, Madras, 1898. *Aboorva Siru Manitharkal Allathu Arpa Janthugalai Patriya Vilakam, (A Book on Insects)*, CLS, SPCK Press, Madras, 1899. *Meengalum Thimingalamum, (Fish And Whales)*, CLS, SPCK Press, Madras, 1899. *Muthugalum Kadal Vaz Athisiyangalum, (Pearls Animalcules And Other Wonders)*, CLS, SPCK Press, Madras, 1899.
25. *Katin Nabarkalum Pagaivarkalum (The Forest Friends And Foes)* MSB&VLS, CKS Press Vepery, Madras, 1875., *Vanavilangukalin Varalaru, (Natural History of Wild Animals)*, MSB&VLS, Madras, Addison Press, Madras, 1887. V Krishnamachariyar, *Vilangu Kurithu Seithi Thunuku, (Tidbits About Animals)*, SPCK Press, Madras, 1901.
26. Era Pavendan, *Tamizhil Ariviyal Ithazhkal (Science periodicals in Tamil)*, Samuel Fish Green Press, Coimbatore, 1998.
27. See, E Sundaramoorthy and Ma Ra Arasu (ed) *Indhiya Viduthalaiku Munthiya Tamizh Ithalkal (Tamil periodicals before Indian Independence)*, Vol International Institute of Tamil Studies, Chennai, 1998.
28. For instance see “*Aruntha Avayangal Marupadi Valarthal*” (*regeneration of mutilated organs*) *Janavinohini*, Vol. vi, 1875. See also Appendix A.
29. See for instance Marsden and J M Vellupillai , *Intham Vasaga Pusthagam (Fifth Reader)* Macmillan & Co, Madras, (revised edn.) 1907.
30. See for instance Muthaliyar Namasivaya, *Nuthana Nangam Vasaga Pusthagam (Modern fourth Reader)*, C Kumaraswami Naidy & sons, Madras 1927.
31. The Tamil equivalent often used is ‘*Vinotham*’
32. Donald Zochert , *Science and the Common Man in Ante-Bellum America*, in Reingold Nathan (ed) *Science in America 1820*, Science History publications, New York, 1976, (p. 22)
33. S. Sivagami , *Pattonpatam Nurrantut Tamil Illakkiyam (Tamil literature in nineteenth century)*, International Institute of Tamil Studies, Chennai, 1994. (see esp. pp 74-74)



34. I thank Dhruv Raina who brought my attention to this point.
35. *Multhara Iyarkai Sasthran (elementary Science)* for third form (n.d.) (p. 76) and also Muthaliyar Namasivaya, *Nuthana Nangam Vasaga Pusthagam* (p. 57) also Sristiyin Arambam (Creation of the universe), *Janavinothini*, 13 (1882) 220 'though ancient and modern thinkers are contemplating on the origin of the life, nature of life and organization of life, the result of these investigations are nothing but unorthodox (unscientific) sacrilege. Ultimately, Creator made this world with myriad form of life with appropriate organs befitting its habit is the only framework that seems to be satisfying'
36. See for instance Muthaliyar Namasivaya, *Nuthana Nangam Vasaga Pusthagam (Modern fourth Reader)*, C Kumaraswami Naidy & sons, Madras 1927, pp. 50-51.
37. V.R. Duraiswami Sasthri, *Jeeva Varga Bothini, (Lessons from Zoology) with numerous illustrations, Part II (mammals, molluscs, insects, worms etc)*, The Guardian Press, Madras, 1910, p. 3.
38. *Standing order for Government Schools and District Book Depots*, Government central book depot, Madras, 1880.
39. see the advertisement by Punt & Co, Booksellers and taxidermist, Madras in Duraiswami Sasthri, *Jeeva Varga Bothini, (part II & III)*, The Guardian Press, Madras, 1910.
40. Duraiswami Sasthri, *Jeeva Varga Bothini, (part II & III)*, (hints to teachers)
41. V. Koil Pillai Samule, *Civics, Nature Study and Elementary Science* (in Tamil), Kalaratnakaram Press, Madras, 1912, (preface).
42. V. K. Narayanaswami Aiyar, *Iyarkai Porutpadam (Nature Study) Vol I, (Botany, Zoology, Physiology and Hygiene)*, Ananda Steam Press, Madras 1910. (preface)
43. see J.S. Rudwick Martin, 'The Emergence of a visual language for Geological Science 1760-1840', *History of Science*, 14 (1976) 149-195; Jay Lemkey, 'Multiplying meanings: Visuals and Verbal Semiotics in Scientific texts' (in) JR Martin and Robert Veil (ed) *Reading Science- Critical and Functional Perspectives on Discourses of Science*, Routledge, London 1998.; Martin Kemp, 'Seeing and Picturing: Visual Representation in Twentieth Century Science' (in) John Krige & Dominique Pestre (ed) *Science in the Twentieth Century*, Harwood Academic, Amsterdam 1997 (pp. 361-390); Pyle. M Cynthia, *Art as Science: Scientific illustration, 1490-1670 in drawing, woodcut and copper plates*, *Endeavour*, 24.2 (2000) 69-75; Bucchi Massimiano, Images of Science in the Classroom: Wallcharts and Science Education 1850-1920, *British Journal of History of Science*, 31(1998) 161-184 for a discussion of the use of illustration in science.

44. Jay Lemkey, 'Multiplying meanings: Visuals and Verbal Semiotics in Scientific texts' (in) JR Martin and Robert Veel (ed) *Reading Science- Critical and Functional Perspectives on Discourses of Science*, Routledge, London, 1998.
45. A. Rangachariyar, *Avarai Chetiyin Vazhkai (life of a bean plant)*, PR Ramaiyar & Co., Coimbatore, 1910.
46. Bernard Lightman, *Marketing Knowledge For The General Reader*, p. 103.
47. Jean-Marc Drouin and Bernadette Bensaude Vincent, *Nature for the people*, p.423.
48. *Irاندام Padapusthagam (Second book of lessons for the use of schools)* (Tamil), Graver Cookson & Co., Scottish Press, 1873, pp. 42-43.
49. *Thenikalin Sambhashanai (conversation between two bees)*, *Janavinoothini*, 25 (1884) 237-247.
50. V. K. Narayanaswami Aiyar, *Iyarkai Porutpadam (Nature Study)*, pp. 8-9.
51. For instance; A Sethurama Iyar *Paruthi Payir Sakupadi*, (*Growing Cotton*), G A Natesan & Co, Madras, 1902; G Rajagopal Naidu, *Thennai*, (Coconut) M/S. Godwin And Co., Madras, 1904; *Karumbu*, (*Sugarcane*), Minerva Press, Madras, 1906; *Nel*, (*Paddy*) G., Cn Orphenage Press, Madras, 1908; M Appavu Pillai, *Choolam*, (*Corn*), Ho & Co, Madras, 1914.
52. V. K. Narayanaswami Aiyar, *Iyarkai Porutpadam (Nature Study)*
53. A Pleas for Instruction of Science Through The Media of Vernacular, *Vivekachnthamani*, Vol 25, Apr 1917- March 1918, p. 37.
54. K. Rangachariyar, *Thavara Nul (elementary Botany in Tamil)*, with 181 illustrations, ME Publishing House, Madras, 1908. (p. vii)
55. R. Ramiyar "Civilization and Progress", *Tamilar Nesan*. Vol. II, 1918-19, pp. 250-260 .
56. Missionary's discomfort with Deistic ideas of Hinduism can be discerned in John Murdoch , *Religious Reform Part II, Philosophical Hinduism*, CVES, SPCK press, Madras 1887 (pp. 29-30).
57. see David Gosling , *Religion and Ecology in India and South East Asia*, Routledge, London & New York, 2001.
58. See Dhruv Raina & S.Irfan Habib, 'The Moral Legitimation of Modern Science: Bhatralok Reflections in Theories of Evolution', *Social Studies of Science*, 26 (1996) 9-42 for a discussion of how modern science was appropriated and moral justification for modern science was fabricated.

59. Neil Stephen an historian of Christianity in India says 'The missionaries used Butler's methods in the instruction of their converts', Neil Stephen, *History of Christianity in India (Vol. I)*, Cambridge University Press, Cambridge, 1985, pp. 396- 97.
60. for instance: V. Krishnamachariyar , was a official in educational department, past Proficient from Madras University; G. Rajagopal Naidu, Superintendent, Agricultural board; K. Rangachari, Asst. Professor College of Agriculture.
61. See Jonathan Topaham , Science And Popular Education in the 1830s: The Role of The Bridgewater Treatises, *British Journal of History of Science* 25 (1992) 397-430, for the influence on British writers. Also see Fyfe Aileen, 'The Reception of William Paley's Natural Theology in the University of Cambridge', *British Journal of History of Science*, 30 (1997) 321-335.
62. *Kan, (the Eyes) Janavinothini*, 2 (1871) 206-209. The importance of Eyes, and the significance of 'observation' are legitimized through quotes from Paley. Also drawing on Paley Janavinothini counsel 'Know the Creator through the (observation of) Creation' *Janavinothini*, 7 (1876) 280-284.
63. *From the Secretary, Madras Graduates Association, Madras to the Director of Public Instruction*, in *Selections from the Records of the Government of India, home Dept, No CCLXV Home Dept Series No 8, Papers relating to Discipline and Moral Training in Schools and Colleges in India*, Calcutta, 1890, pp.70-71.
64. *Nallorinakam, (Relationship with people of character) Janavinothini*, (1882) 81-82 also *Abiprayabetham (divergent opinion)*, *Janavinothini* 19 (1888) 9-12.
65. *Jalathai Patriya Upanyasam (lecture on the use of water) Janavinothini*, 13 (1882) 95-102. The article also extols the readers to follow the modern advice of European sanitary inspectors as well as what is ordained in *Sasthras*; for it contents in essence they do not differ. Incidentally this statement is also a reflection on the exclusivist public sanitation policy of the colonial administration.
66. *Panchamas* are caste placed at the lowest in the social hierarchy. In some cases, women belonging to this section were not even allowed to have their upper part covered, leave alone denial of right to draw water.
67. Peter Barker cited in J. Margaret Osler., 'Mixing Metaphors: Science and Religion or Natural Philosophy and Theology in Early Modern Europe', *History of Science*, 35 (1997) 101-102.