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THE EFFECT OF KNOWLEDGE OF INDIAN BIOTA ON ECOLOGICAL THOUGHT

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A most important stimulus in the development of ecological thought in early times was the information about Indian animals and plants that became known to philosophers who concerned themselves with scientific questions. Ecology is not a study that began only in modern times. Greeks such as Aristotle and Theophrastus pondered ecological questions and created the beginnings of ecological thought. Reports and observations from India, a region possessing ecosystems contrasting to those of Greece, stimulated much of that thought. In addressing ecological questions, examples from climes with contrasting habitats provided necessary evidence. India was the furthest and most dissimilar land known to the Greeks. The influx of information from there gave them examples of organisms and environmental relationships that upset some of their assumptions and challenged their powers of explanation. The exchange of scientific information across land and sea in those times, although slower and less dependable than today, provided the forerunners of biological science with data about contrasting climates, differing terrestrial and aquatic environments, and exotic biomes, that enabled their first steps toward ecology to be less halting than they might otherwise have been.

Key Words : Alexander, animals, Aristotle, biodiversity, biology, biome, biota, botany, climate, ecology, ecosystem, environment, Greece, India, plants, Theophrastus, zoology.

INTRODUCTION

Ecology is generally assumed to be a study that commenced only in modern times. Nonetheless, Greek philosophers pondered ecological questions and created what modern scholars would recognize as the beginnings of ecological thought, and it appears that reports and observations from eastern regions of ecosystemic character contrasting with Greece, particularly India, informed and stimulated much of that thought. The only extant ancient writers who made ecological observations and judgments in anything approaching a sustained manner, and who formulated the antecedents of ecological theory, were the Peripatetics, namely Aristotle, particularly in his zoological works, and Theophrastus, in his botanical works. Their investigation of nature, including inquiry into questions that would today be termed ecological, came at the time of Alexander's expedition to India, which provided opportunities

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for eyewitness observation and collection of specimens. The philosophers had unique opportunities to gain information on ecosystems that differed sharply from those known to them in Greece, since they had students, colleagues, and friends who traveled widely, talked to people who observed animals and plants, and sent or brought back living and nonliving specimens.[1] In answering ecological questions, examples from other climes with contrasting habitats provided necessary evidence. India was the most distant, and most dissimilar, land known to the Greeks. Of course, evidence would be worthless unless it were true. The further the country from which it came, the more difficult it might be to corroborate it. Although far from credulous, the Peripatetics were less critical than they needed to be about such reports.[2]

Sources of Peripatetic Knowledge of India

Curiosity about the natural history of India began as early as the first reports of travelers from that land that seemed to border the limit of the world. But the information about Indian natural phenomena that travelers brought back was often fantastic, erroneous, and calculated to arouse wonder. Some Peripatetic impressions of India derived from these accounts. As Klaus Karttunen remarked, "In early Greek sources [about India] everything is seen and interpreted in Greek light."[3] Ctesias, a physician, resided at the Persian court around 416 B.C.E. and collected reports about India, but possibly never traveled there. Aristotle terms him "no very good authority," but quotes him nonetheless.[4] Ctesias was fond of amazing anecdotes, and while most had some basis in fact, he embellished them. His description of the martichora, or man-eater, for instance, may refer to the tiger, but he says it has three rows of teeth, a tail like a scorpion, and the ability to shoot foot-long darts at its prey.[5] Other stories can be traced to the histories of Herodotus. Almost everyone in fifth century Greece who had heard of India knew the story of gold-digging ants there, the size of foxes, that he repeated from a Persian source. Even so bizarre an account was not made up out of whole cloth; scholars suggest that it echoes a reference in the Mahabharata to gold paid in tribute as pipṅlika, or "ant gold."[6] In the form in which it reached the West, it was hardly dependable biological, let alone ecological, knowledge. In his favor, it may be said that he knew of the reverence given by some Indians to animals and plants; he reported that they "refuse to take life in any form."[7] Even earlier, a ship's captain named Scylax was the first Greek known to have visited India (ca. 509 B.C.E.)[8] His account described landscape, flora, and fauna, but tantalizingly little survives. One fragment says "a high mountain range extends on both sides of the Indus river, covered with virgin forest and with the thorny kunara." Theophrastus identified this plant with kunosbatos, the dog-brier or wild rose.[9]

That an Indian might have made the journey in the opposite direction is at least possible. The dubious story of an Indian sage's conversation with Socrates was told on the authority of Aristoxenus, who lived about eighty years after the philosopher's

death. If the conversation did occur, it must be supposed that no ecological knowledge was transferred; Socrates was notably uninterested in science, and his Indian visitor is said to have told him that he should turn his attention to matters of the divine rather than the human.[10]

More substantial knowledge of the environment and life forms of India came from the expedition of Alexander, who directed those traveling with him to record information and collect specimens to send back to Aristotle's school, the Lyceum, where exotic plants were grown in the arboretum and exotic animals kept in the vivarium. Alexander took philosopher-scientists along with him, and although the most famous, Aristotle's nephew Callisthenes, died without seeing the wonders of India, others survived to collect specimens and record information, and some of the commanders dabbled in natural history. As Pliny the Elder said: "King Alexander the Great being fired with a desire to know the natures of animals and having delegated the pursuit of this study to Aristotle as a man of supreme eminence in every branch of science, orders were given to some thousands of persons throughout the whole of Asia..., all those who made their living by hunting, fowling, and fishing and those who were in charge of warrens, herds, apiaries, fishponds and aviaries, to obey his instructions, so that he might not fail to be informed about any creature born anywhere. His inquiries addressed to those persons resulted in the composition of his works on zoology, in nearly fifty volumes."[11]

Although Pliny's attribution of scientific motive to the king rather than the philosopher rings false, there can be no doubt that information as well as specimens, some of them living, reached the Lyceum from India and were subjects of study. Aristotle had a falling out with Alexander over the death of Callisthenes, whom the conqueror accused of abetting an assassination plot. Aristotle would hardly have let that issue prevent him from using the mass of interesting evidence that was flowing back to Greece from India. The exstudent never lost his respect for his teacher, who continued to enjoy his patronage, and it would have been in character for Alexander to have tried to patch up the breach by sending specimens—even an elephant, if that occurred to him.

It is interesting to recall a work of historical fiction entitled An Elephant for Aristotle.[12] The author, L. Sprague De Camp, based it on the idea that Alexander sent an Indian elephant to his old tutor. An ancient tradition suggests the mission, and H. H. Scullard, a scholar of ancient elephant lore, proposed something like it.[13] Aristotle showed knowledge of elephant anatomy, and recorded the daily amounts of barley, wheat, wine, and water that an elephant consumed in Macedonian units of measure, items he could have had at first or second hand.[14] At least one ancient source contradicts the story told in the novel. Philostratus wrote that when Apollonius of Tyana reached the Indus River, he found a huge elephant named Aias, which had been captured by Alexander from King Porus after carrying the Indian ruler in battle and defending his master bravely.[15] Aias is the name given by De Camp to his animal hero.

After the deaths of Alexander and Aristotle within a year of each other, Theophrastus headed the Lyceum and continued the peripatetic interest in biology. He earnestly questioned those who had traveled with Alexander. For example, he recorded that Androsthenes, the commander of a ship in Alexander's fleet that sailed from the mouth of the Indus to the Tigris-Euphrates delta, gave him an account of coastal mangrove forests.[16]

In forming an impression of the information Greek science received from India through Alexander and his companions, it is important to remember that the part of India visited by them was limited to the watershed of the Indus and its tributaries. Through no lack of desire on his part, Alexander was prevented from advancing to the Ganges. Accounts of India preserved by the historians include general descriptions of the environment like this one from Diodorus: "Now India has many lofty mountains that abound in trees of every variety including those that bear fruit, and many large and fertile plains, which are remarkable for their beauty and are supplied with water by a multitude of rivers. The larger part of the country is well watered and for this reason yields two crops each year; and it abounds in all kinds of animals."[17] He mentions the crops and the climate, with a description of the monsoon: "The rains come with astonishing regularity, in a kind of fixed cycle, every year in the summer, since warm showers fall in abundance from the enveloping atmosphere and the heat ripens the roots in the marshes, especially those of the tall reeds."[18]

Plant species that received notice from the companions included the impressive banyan, cotton (which they called a tree), bamboo, and food plants. Animals were a source of interest, particularly elephants, snakes, monkeys, lions, tigers, parrots, crocodiles, and the large, tenacious Indian dogs. The story about the big ants came back to India with the Greeks, and some marketplace opportunists showed Nearchus what they claimed were ant-skins, spotted like those of leopards.[19] Alexander was curious about Indian animals. According to Plutarch, he once asked an Indian wise man, "Which is the most cunning of animals?" The gymnosophist replied, "That animal which man has not yet discovered."[20] A remark on this exchange deserves more than a footnote. A recent French play, Mahabharata, by Jean-Claude Carrière, was made into a popular film directed by Peter Brook, which contains the identical exchange. The question is asked by the Yaksha of the Lake, which is Dharma in disguise, and Yudhishthira gives the answer. If the passage existed in the Mahabharata, it would be a unique example of Sanskrit influence on the Alexandrian tradition. Unfortunately, neither it nor any other question found in Plutarch exists in the Indian epic. Brook introduced the question and answer from Plutarch into the film.[21]

The military travelers noted forests as places to find shelter, fuel, and resources for siegecraft and shipbuilding. Historians describe "remote, tree-clad mountains," "interminable tracts of forest darkened by tall trees that reached extraordinary heights," and "well-shaded woods," giving the undoubtedly accurate impression that the Indus Valley was much more heavily forested than it is today.[22] Speaking

of war, Arrian was deeply impressed by an Indian attitude reported by his sources that war ought to be waged so as to spare the productive environment and those who were responsible for its care. He said, "If there is internal war among the Indians, it is not lawful for them to touch these land workers, nor even to devastate the land itself."[23]

Peripatetic Reflections on Indian Evidence

It is time to turn to the ecological reflections made by the philosophers on the evidence from India. The fact about India that most impressed them was the exotic nature of its fauna and flora. Theophrastus marveled that there was "hardly a single tree or shrub or herbaceous plant" in India like those in Greece, with certain exceptions, such as the fact that Alexander's men found ivy, with other Greek plants, on Mount Merus in the northwest Indus basin.[24] The Greeks thought that the nearby town of Nysa was a place visited by the god Dionysus, to whom ivy was sacred.

Some of the comments on the Indian environment are sophisticated and accurate. Theophrastus knew of the monsoon's effects on plant growth and the timing of crops.[25] Other pronouncements were of questionable validity. There was a persistent Greek idea, which Aristotle attributed to Ctesias, that due to the influence of the abundant Indian environment, most animals were of great size there.[26] This idea was also given currency by Herodotus: "It seems as if the extreme regions of the Earth were blessed by nature with the most excellent productions,... In India, which... is the furthest region of the inhabited world towards the East, all the four-footed beasts and the birds are very much bigger than those found elsewhere, except only the horses."[27] Other authors repeated the incorrect assertion about the size of Indian animals, and it is possibly the reason they insisted that the Indian elephant was larger than the African.[28] To this Theophrastus added the assertion that the climate of hot and dry countries, like parts of India, produced plants that were more aromatic than similar species elsewhere.[29]

The ecological question that was elucidated most importantly for Aristotle and Theophrastus by information from eastern lands has to do with the relationship between a species and its habitat. The philosophers noted that animal and plant species exhibit preferences for certain localities rather than others. Such a preferred range they termed an "appropriate place" (oikeios topos) or "appropriate country" (oikeia chra) which corresponds to what modern ecologists call its "niche."[30] Oikeios implies a harmonious relationship between an organism and its environment. By the way, oikeios and ecology have the root of oikos (house, domicile, habitat) in common, and Ernst Haeckel, who coined the name of the science, may have had this use by the Peripatetics in mind.[31]

Aristotle noted, "Each [animal species] has its situation in the appropriate regions."[32] Theophrastus made the same generalization in respect to plants, "Each

tree seeks out its appropriate locality, that locality being appropriate in which it is at its ease."[33] By being at its ease, he means that a species gets the climate and soil that allow it to grow and reproduce at its optimum. That is, it shows its full nature, and it is in such localities that it ought to be studied.[34] He observed that this innate harmony between plant and environment varies according to species. "Trees...seek their appropriate localities;...for some the preferred locality is dry, for others well-watered or wintry or sunny or shady: in a word, some favor the mountain, some the swamp."[35] Therefore a country with a diversity of conditions will "bear all sorts" of species.[36] He knew that this was true of India due to differences in topography, soils, and the availability of water, and remarked, "Moreover this country [India] shows differences, in that part of it bears certain things which another part does not; thus the mountain country has the vine and the olive and the other fruit-trees."[37]

It was apparent that different species often preferred different kinds of country. "The best locality is not best for all."[38] Some seek cold climes and others hot. A major ecological principle investigated by Aristotle was the adaptation of various species to particular environments. For instance, some animals are aquatic and others terrestrial. Here he was using his characteristic descriptive method, which established sets of two opposed characteristics. In attempting to make this particular distinction, Aristotle ran into two Indian examples that seemed to be liminal cases. One was the elephant; since it "is found by the banks of rivers,... he can make his way through water, as long as the tip of his trunk can be above the surface, for he blows with his trunk and breathes through it," it might be considered aquatic. But Aristotle does not consider it a river animal, since it "is a poor swimmer owing to the heavy weight of its body."[39] He was mistaken; elephants have been observed swimming across the deepest rivers. The opposite situation was noted in the case of certain "little fishes" of South India, "which wander about on the dry land, and run away again into the river."[40] They were adapted to a riverine environment in spite of their unusual ability. Though this report might have seemed incredible to Greek readers, there are several species of fish in South Asia that travel out of water for periods of time, such as Pseudapocyrtes and Anabas.

A further ecological problem that concerned Aristotle was the effect of human intervention, particularly domestication, on animals and plants. Again, this involved the applicability of opposed characteristics; in this case, wildness and tameness. Aristotle maintained that this distinction is not inherent in species, but is developed within them by the influence of human tendance. "For," he said, "in almost all species in which some members are tame, there are others that are wild."[41] He evinces India, where there were wild dogs as well as domestic ones. The Indian ones were particularly fierce, and a spurious tale explained why: they were the offspring of male tigers and female dogs, in cases when the dogs were the objects of lust rather than hunger.[42] Aristotle said it required a third generation cross, since the first-generation offspring was a savage creature (a result consistent with Mendelian genetics if the whole story were not so ludicrous). Aristotle could not swallow the

story whole, and speculated that it was not a tiger at all, but a wild dog-like animal.[43] Interestingly, the tiger story may derive from an Indian source; the Ramayana says Bharata's dogs had the strength and courage of tigers.[44] The possibility of the origin of new species through crosses between disparate wild organisms occurred to Aristotle elsewhere.[45]

Theophrastus' treatment of Indian plants is systematic and remarkable for its time. He tried to identify the habitat of each plant that had come to him from India. He could not always reconcile descriptions he had received with the specimens, and could not always give them names. His works mention more than 25 kinds of plants from India. Among these are the wool tree (cotton), which was new to the Greeks, sorghum, and the Indian reed (bamboo). He was impressed by the size of bamboo, took care to record that it grew near the Acesines River, and described its ability to sprout after it was cut or burnt.[48] His account of the so-called Indian fig or banyan is the best in Greek or Roman sources.[49] He properly described its habit of growth, size, fruiting, and preferred range, but its diminutive fruits led him to a faulty generalization: "As a rule all trees with small fruit are larger, and trees whose drive has been to a large size have smaller fruit."[50] The banyan was a wonder mentioned by many writers who marveled at its dimensions, its ability to shelter many people at once, and the way it drops roots from its branches. Though not all described the latter characteristic correctly, Theophrastus did. Surprisingly, no Greek or Latin writer knew of its epiphytic habit and destruction of the host tree, although this is a familiar element in early Indian literature.[51] Both Aristotle and Theophrastus speculated on the symbiotic relationship of the fig and fig wasp, but for Mediterranean rather than Indian figs.[52]

Theophrastus cited "those returning from India sent out by Alexander" as his source of information about the mangrove forest, an ecological community new to the Greeks.[53] He gave a fairly accurate description of this tidal association, including its periodic flooding by salt water, and the unusual growth habit of the roots. While he clearly described a plant community in a particular environment, he was not able to distinguish all the species. Doubtless he worked with descriptions as well as specimens, and could not always reconcile the two. Still, his is the first extant botanical treatment of mangroves, and it is impressive. The tides were an unfamiliar phenomenon to the Greeks, who lived by an almost landlocked sea where they were negligible.

After Theophrastus

Theophrastus marks the end of ecological inquiry in the history of Greek and Roman science; he had successors who copied him assiduously, but none who continued his work, let alone any who surpassed him. The biological works of Strato of Lampsacus, the last great early Aristotelian, are almost completely lost. The fragmentary writings of later Peripatetics indicate that the school lost its concern

for ecological questions. Subsequent Greek and Latin writers on natural history only rarely concerned themselves with ecology. This is not to say that no further knowledge of Indian plants and animals came to the West. Megasthenes, ambassador of Seleucus to Chandragupta around 300 B.C.E., went to parts of India that Alexander had not visited and recorded observations in his Indica, much of which is preserved in Arrian's work of the same title. Alexander may or may not have sent an elephant to Aristotle, but Chandragupta presented several hundred of them to Seleucus, and Indian elephants fought in the wars of the successors.[54] Ptolemy II included Indian people in a grand parade in Alexandria, and exhibited many Indian animals.[55] The Museum, founded with the aid of the Peripatetics Demetrius of Phalerum and Strato, possessed an arboretum like that of the Lyceum and a zoological garden in which Indian biota were displayed and studied. Augustus welcomed an Indian delegation with animals including tigers, tortoises, and a python on Samos in 21 B.C.E.[56]

Strabo included a chapter on India in his geography. His treatment of the environment derives from Eratosthenes and from Aristobulus, who had been there.[57] Pliny the Elder recorded many supposed facts about Indian biota in his Natural History, but few that were new to the literature. He used sources of varying value; among the best was Theophrastus.

Biological description took a turn in the direction of medieval bestiaries with Claudius Aelianus. His work On Animals included a compendium of all the most undependable zoological stories about India. He reported that snakes there are so huge that they can strangle elephants, which is probably the source for the whimsical story of the elephant-swallowing python in Antoine de Saint-Exupnry's Le Petit Prince.[58] He is the only author to record Alexander's sighting of gigantic apes in the mountains of India, perhaps the first extant reference to abominable snowmen or yetis.[59]

With Westerners making the round trip to India, and Indians coming west with products and specimens, it might be expected that Greek and Latin literature on Indian biology would have become more accurate. Such was not the case. Writers remained dependent on earlier ones. This approach had the single advantage of preserving fragments that might otherwise have been lost. Clearly, after Theophrastus came a decline in critical investigation of ecological evidence.

Conclusion

The transfer of biological information from India and other eastern countries was of great use to both of the great Peripatetic philosophers. Aristotle's biological principles, and his observations of living species, introduced "ecologic considerations into scientific literature."[60] He directed his philosophical inquiry toward the natural world more than any other subject, and emphasized the concepts of organismic development and function. He studied not only individual organisms but also

relationships among living things and between them and the physical environment. In the Metaphysics he said, "All things are ordered together somehow, but not all alike, including fishes and fowls and plants; and the world is not such that one thing has nothing to do with another, but they are connected."[61] This statement offers a basis for the study of ecology, and Aristotle's biological writings contain observations on ecological relationships. Among these are comments on nutritional preferences and the food chain, competition for food, reproductive potential and fluctuations in populations of predators and prey, territoriality, parasitism, and symbiosis.

Theophrastus followed Aristotle in giving attention to relationships between organisms and their environments. As far as ecological questions are concerned, he advanced beyond his teacher. This was because he emphasized efficient causes rather than final causes, according to plants an autonomous purpose in interaction with other organisms and the environment which was not dependent on their place in an anthropic hierarchy.[62] His viewpoint was ecological in the sense that he customarily discussed a form of life in the context of its environment. His ecological hypotheses included "mutation according to the place,"[63] or adaptation to the environment, competition between plants, plant symbiosis, the role of the environment in plant diseases, effects of cultivation and acclimitization, and anthropogenic changes in climate. Of the two thinkers, he is the more consistent ecologist.[65]

Many of these advances in ecological theory would have been more difficult, and some of them perhaps impossible, had these two Peripatetic philosopher-scientists not availed themselves of the information from India and other eastern lands and peoples. The influx of information from the East gave them examples of organisms and environmental relationships that upset some of their home-based assumptions, and challenged their powers of explanation. The exchange of scientific information across the lands and seas in these early times, slower and less dependable than today, nonetheless provided the Peripatetics with data about contrasting climates, differing terrestrial and aquatic environments, and exotic biomes, that enabled their first few steps toward ecology to be less halting than they might otherwise have been.

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8. Karttunen. *India in Early Greek Literature.* Pp. 64-68; Wilhelm Reese. *Die griechischen Nachrichten Éber Indien bis zum Feldzuge Alexanders des Grossen,* Leipzig : 1914, pp. 47-48.

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14. Arist. HA 596a3.

15. *Philostratus Vita Apollonii* 2.12.

16. *Theophrastus Historia Plantarum* 4.7.5-6; de Causis Plantarum 2.5.5.

17. *Diodorus Siculus* 2.35.3.

18. *Ibid.*, 2.36.5. Strabo 15.1.17 says that Aristobulus described the monsoon weather in detail.

19. Arrian. Indica. 8.15.4; Strabo 15.1.44.

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22. Strabo 11.7.2; Curtius 8.10.19; 9.1.8-10; 9.1.13.

23. Arrian 8.11.10.

24. Theophr. HP 4.4.1,5; cf. Arrian 5.1.6.

25. Theophr. CP 3.3.3.

26. Arist. HA 606a9.

27. Herodotus. 3.106.

28. For the statement that all Indian life forms are larger, see Diod. Sic. 2.35.3-4; Strabo 15.1.22. For the larger size of the Indian elephant, see Diod. Sic. 2.35.4; Pliny 8.11-12; see also Pliny 6.24, where he asserts that the elephants of Taprobane (Sri Lanka) are largest of all.

29. Theophr. HP 4.4.14; 9.7.2.

30. E.g., Theophr. CP. 1.9.3, 1.16.11, 2.3.7, 3.6.6-7, etc. The expression is typical of Theophrastus and is found throughout his botanical works.

31. J. Donald Hughes. 'Theophrastus as Ecologist.' *Theophrastean Studies : On Natural Science, Physics and Metaphysics, Ethics, Religion, and Rhetoric* (edited by William W. Fortenbaugh and Robert W. Sharples). Rutgers University Studies in Classical Humanities, Vol 3 Transaction Books. New Brunswick and Oxford : 1988; 67 and No. 3, p. 74.

32. Aristotle de Respiratione 477a30.

33. Theophr. CP 2.16.7.

34. Theophr. HP 2.2.8; 2.5.7; 3.3.2; CP. 1.9.3; 2.19.6; 3.1.6.

35. Theophr. CP 2.7.1.

36. Theophr. HP 3.2.5.

37. *Ibid.*, 4.4.11.

38. Theophr. CP 2.16.8.

39. Arist. HA 630b19-31.

40. Aristotle de Mirabilibus Auscultationibus 835b5. This example is used with some caution because although this work is in the Aristotelian corpus, it is considered by scholars to be pseudonymous. If it is not by Aristotle, however, it may still be considered typical of Peripatetic reasoning.

41. Aristotle de Partibus Animalium 643b6; cf. Problemata 895b25.

42. Arist. HA 607a4.

43. Aelian 4.19; Ctesias f. 1.5; Curtius 9.1.31-34, 17.92; Strabo 15.1.31; Aelian 8.1; Arist. HA 607a4. Aristotle is careful to preface the story with "they say." Also Aristotle de Generatione Animalium 746a34.

44. *Ramayana* 2.64.21. Indian dogs had been imported to Greece before Alexander's expedition; they are mentioned in Herodotus 1.192; 7.187 and Xenophon Cynegeticus 9.1; 10.1.

45. Arist. GA 746b6.

46. Theophr. HP 4.4.8.

47. *Ibid.*, 4.4.9.

48. *Ibid.*, 4.11.13.

49. *Ibid.*, 1.7.3, 4.4.4.

50. Theophr. CP 2.10.2.

51. Arrian 8.11.7; Curtius 9.1.8-100 Pliny HN 12.11; Strabo 15.1.21; M. B. Emeneau, The Strangling Figs in Sanskrit Literature. University of California. Publications in Classical Philology, Vol. 13, No. 10. Berkeley : 1949; pp. 345-370.

52. Arist. HA 557b25-31; Theophr. HP 2.8.1-3; CP 2.9.5-6.

53. Theophr. HP 4.7.2-8; Arrian 6.19.1-2; Curtius 9.9.9.

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57. Eratosthenes, fr. 3. B. 12; Strabo 15.1.22-24; Hugo Berger (ed.). *Die geographischen Fragmente des Eratosthenes.* Amsterdam : 1880 (reprint, 1964), pp. 232-33.

58. Aelian de Natura Animalium. 6.21; Antoine de Saint-Exupnry, Le Petit Prince. Gallimard. Paris : 1946.

59. Aelian NA 17.25.

60. George Sarton. *A History of Science: Ancient Science through the Golden Age of Greece.* Harvard University Press, Cambridge, MA : 1952; p. 565.

61. *Aristotle Metaphysica* 107a 17-20.

62. *Theophrastus Metaphysica* 9.32-34.

63. Theophr. Caus. Pl. 2.13.1.

64. Hughes. *'Theophrastus as Ecologist,'* pp. 67-75.

65. J. Donald Hughes. 'Early Greek and Roman Environmentalists'. *Historical Ecology : Essays on Environment and Social Change* (edited by Lester J. Bilsky). Kennikat Press, Port Washington, NY : 1980; p. 56.