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Cover illustration *'Rokuro'* [Lathe], by Tachibana Minkō 橘岷江, in *Saiga shokunin burui* 彩畫職人部類 [Illustrations of different types of craftsmen], Edo, 1770

CONCEPTS OF NATURE AND TECHNOLOGY IN PRE-INDUSTRIAL JAPAN

Tessa Morris-Suzuki

One of the greatest dilemmas confronting human beings today is the problem of regulating our relationship with nature, of ensuring that our technological wizardry does not destroy the natural environment on which our very existence depends. In order to make sense of this dilemma it is important to understand past societies' attitudes to nature and to technology; and indeed during the last few years there has been rapidly growing interest in studying the history of technology and of the human impact on the environment.

A common theme in these studies has been the contrast between an exploitative 'Western' and a harmonious 'Eastern' approach to nature, the latter often being particularly closely associated with the philosophies of traditional Japan. One of the most influential exponents of this theme was the U.S. historian of technology, Lynn White, who suggested, in a much-quoted article, that Christian theology had endowed Western societies with a culture in which humanity is "superior to nature, contemptuous of it, willing to use it at the slightest whim." By contrast, White saw in Eastern religions like Zen Buddhism a view of the human being as equal to and part of the wider natural order.[1]

Since White's article was published in the 1960s, others have taken up and developed his message. Edward Olson, for example, emphasizes Japan's legacy of Shinto beliefs with their concept of "man as an integral part of nature,"[2] and suggests that this "latent essence of Japanese culture"[3] survived intact, although often submerged beneath overlays of cultural borrowing, until modern times. More recently, William LaFleur has carried out some fascinating research on the twelfth-century Japanese poet, Saigyō 西行, whose works, in LaFleur's words, "historically fixed a lasting nexus between Buddhism and nature in the popular consciousness of the Japanese people."[4] Against this background, it is not surprising that some writers have inter-

[1] Lynn White Jr., "The historical roots of our ecological crisis," *Science* 155 (1967): 1203-7.

[2] Edward A. Olson, "Man and nature: East Asia and the West," *Asian Profile*, 3 & 6, December 1975, p.643.

[3] ibid, p.645.

[4] William R. LaFleur, "Saigyō and the Buddhist view of nature," in *Nature in Asian traditions of thought: essays in environmental philosophy*, ed. J. Baird Callicott and Roger T. Ames (Albany: State University of New York Press, 1989), p.183.

preted Japan's twentieth-century environmental crises as the product of alien cultural and economic influences: "If Japan is offensive to 'ear, eye and nose', it is largely because Japanese civilization has been infected by Western technology and industrial methods."[5]

A similar set of ideas often appears in the writings of Japanese scholars. Over the past decade or so there have been signs of the emergence of an increasingly influential group of scholars who might be termed 'eco nationalists'. A good example is the social anthropologist Ishida Eiichirō 石田英一郎, who tries to define the essence of Japanese culture in terms of a unique national feeling for nature, a "broadly based, characteristic 'natural sense' *(shizensei* 自然性*)* stretching back to the pre-agricultural era."[6] The archaeologist Yasuda Yoshinori 安田喜憲 has also sparked some sharp debate by contrasting Europe's "civilization of deforestation" with Japan's "forest civilization," a culture characterized by a traditional concern for the preser-vation of woodlands.[7] Yasuda supports this distinction not only by referring to the wide range of measures introduced to preserve Japanese forests in the pre-industrial age, but also by emphasizing Japan's animist heritage, in which every grove and every tree was believed to be imbued with the spirit of the divine. Indeed, he goes so far as to present the animist vision embodied in Shintoism as a "grand model" which may "offer an answer to the pressing issue of how to preserve the global environment, and how to let nature and man coexist."[8]

Even those who see Japanese culture in a more critical light frequently echo the same theme. Thus the physicist Yukawa Hideki 湯川秀樹 has suggested that Japanese culture, in which "there was originally no such thing as alienation between man and nature," created little need for "adventure either in action or in thought," and so stifled the spirit of scientific enquiry.[9] From a slightly different point of view, Toyama Kazuko 富山和子 compares a pre-industrial Japan in which there was no concept of "human beings as subject and nature as object" with a modern Japan (originating in the early Meiji period) in which nature has been ravaged with peculiar thoroughness and remorselessness.[10]

The idea of a peaceful coexistence between humans and nature in traditional Japan, however, leaves important questions unanswered. Is it, in the first place, sensible to speak of a single 'traditional Japanese attitude to nature' spanning centuries and social divisions without change or variety? Is it not more realistic to suppose that, for example, Heian nobles, Kamakura warriors and Tokugawa peasants or merchants might have held very different visions of their place in the natural order? Secondly, how could Japan, which acquired so much of its cultural heritage from China, have failed to be influenced by China's long tradition of intervention in and control over nature (a tradition which resulted in the drastic deforestation of large parts of the Chinese countryside)? Lastly, if Japanese society really lacked the concept of 'humans as subject and nature as object,' why was Meiji Japan so

5 Eugene C. Hargrove, Foreword to Callicott and Ames, *Nature in Asian traditions of thought*, p.xix.

6 Ishida Eiichirō, "Nihon bunka no jaken to kankōsei: aru henkyō bunka no tokushitsu," in *Nihon bunka no kōzō*, ed. Umesao Tadao and Tada Michitarō (Tokyo: Kōdansha Gendai Shinsho, 1972), p.24; a similar point is also made by Ueda Masaaki in "Shintō to kisetsu: 'haru' to 'aki' no ibuki," in *Nihon bunka no hyōjō*, ed. Umesao Tadao and Tada Michitarō (Tokyo: Kōdansha Gendai Shinsho, 1972).

7 Yasuda Yoshinori, "Animism renaissance," *Nichibunken Newsletter* 5 (January, 1990): 2–4; for a reaction to Yasuda's views see Ian Reader, "The animism renaissance reconsidered: an urgent response to Dr Yasuda," *Nichibunken Newsletter* 6 (May 1990): 14–16.

8 Yasuda Yoshinori, "Passivity and activity of Japanese studies," *Nichibunken Newsletter* 3 (July 1989): 7–8.

9 Yukawa Hideki, "Modern trend of Western civilization and cultural peculiarities of Japan," in *The Japanese mind: essentials of Japanese philosophy and culture*, ed. C.A. Moore (Honolulu: University of Hawaii Press, 1967), p.55.

10 Toyama Kazuko, *Mizu to midori to tsuchi* (Tokyo: Iwanami Shinsho, 1971), p.102.

quick to adopt and absorb western scientific and technological ideas, to which this concept is central?

It is this third question which I find a particularly intriguing one. There can be no doubt that the diffusion of new ideas from the second half of the nineteenth century was swift and far-reaching. One Englishman who left a particularly perceptive account of his visit to Japanese silk-producing districts during the First World War, conveyed the point vividly when he observed that "the advance in scientific knowledge in the rural districts is remarkable, because it is in such contrast with the primitive lives of the country people. Picture the surprise of British or American farmers were they brought face to face with thermometers, electric light and a working knowledge of bacteriology in the houses of peasants in breech clouts."[11]

But recent studies of the transfer of technology suggest that objects like the thermometer and electric light are not value-free artefacts which can simply be moved from one setting to another without causing cultural frictions and adjustments. Instead, as A.K.N. Reddy puts it, technological objects are like genetic material, carrying with them "the code of the society in which [they were] produced and survived."[12] Western technology, in other words, is part of a system whose use involves some understanding of Western science, with all its assumptions about the relationship between human beings and the natural world. How did people in early industrializing Japan make sense of this system and reconcile its philosophical foundation with the social and environmental values to which they were accustomed?

[11] J. W. Robertson Scott, *The foundations of Japan* (London: John Murray, 1922), p.158.

[12] A. K. N. Reddy, "Alternative technology: a viewpoint from India," *Social Studies of Science* 5 (1975): 332.

Visions of Nature in Tokugawa Japan

Part of the answer to that question can be found, I would suggest, by looking at evolving ideas about nature and technology in eighteenth- and nineteenth-century Japan. Some thinkers in the Tokugawa period (1603–1868) certainly did put forward a vision of the universe in which human beings are inseparably integrated into the web of natural relationships. One of the most powerful examples of this approach is to be found in the writings of the Utopian eighteenth-century thinker, Andō Shōeki 安藤昌益 (1703-61). A little caution is needed here, because in Andō's writings, the word 'nature' *(shizen* 自然*)* means far more than 'the physical environment': rather, it is a metaphysical concept implying the self-existent, the ground of all being.[13] Nevertheless, Andō's works probably come closer than any other to illustrating that absolute absence of division between humans and nature emphasized by historians like Toyama:

> In the world of Nature, human beings work in accordance with the operation of Heaven and Earth: there is not the least divergence between man and Nature. Spring comes both in Heaven and Earth, giving life to blooming flowers and all other living things; in consonance with it, men begin to sow the seed of the five

[13] As Tellenbach and Kimura observe, the term *shizen*, which Japan adopted from China around the fifth to sixth century AD, resembles the ancient Greek notion of physis, implying that which 'comes into being' of itself. See H. Tellenbach and B. Kimura, "The Japanese concept of nature," in Callicott and Ames, *Nature in Asian traditions of thought*, pp.153–62. Although in modern usage the word *'shizen'* is used in a similar way to the Western word 'nature', in the Tokugawa context 'nature' perhaps approximates more closely to the expression *'manbutsu'*—'the myriad objects'—which Japanese philosophers, borrowing from China, used to denote the totality of the physical universe.

cereals and various vegetables. Summer comes both in Heaven and Earth and all things flourish; men cut grass and cultivate cereals and vegetables. Autumn comes both in Heaven and Earth brining all things to maturity, when men harvest the crops. Winter comes both in Heaven and Earth making everything dry; then men bleach the husks of various cereals which they put into granaries. . . . This truly indicates the very concord of man and Nature in which Heaven's way of giving growth to everything conforms to the human way of direct cultivation.[14]

The seventeenth-century philosopher Kumazawa Banzan 熊沢蕃山 (1619–91) is also often quoted as an example of the conservationist attitude of pre-modern Japanese philosophy, and it is true that his writings are full of references to the importance of *'chisan chisui'* (治山治水—the management of mountain and water resources). But even in Kumazawa's thought human beings are something more than an undifferentiated part of the natural order. In a charming and revealing simile, Kumazawa likens the universe to the plum tree in his garden:

> The roots which are hidden in the earth are the sky, the trunk is the nation, the leaves are the myriad things [i.e. the natural environment], and the flowers and fruits are human beings. Both leaves and fruits are born of the one tree, but the leaves do not serve to make a tree. They are many but they merely decay. Flowers and fruits are few, but they contain the whole tree within themselves. Therefore if they are planted in the earth they become a great tree.[15]

Kumazawa's plum tree suggests an image which recurs in much Tokugawa writing: the image of human beings as parts of a wider whole, but parts who have a special role to play in the survival and growth of the whole. The point to notice is the way in which the image allows for subtle shifts of interpretation, from emphasis on the wholeness of the whole to emphasis on the uniquely active role of human beings. In Tokugawa Japan we can trace the evolution of a current of ideas in which the second emphasis gradually became more and more important.

A key concept in this evolution of ideas was the notion of *kaibutsu* 開物, a term which literally means 'the opening up of things', but might be interpreted either as 'revealing the nature of things' or as 'developing' or 'making use of' the natural world.[16] Like many of the central concepts in Tokugawa thought, the idea itself was derived from classical Chinese writings (in this case from the *Yi jing* 易經) but was embellished and interpreted in ways which particularly suited the philosophical concerns of early modern Japan. The first Japanese scholar to put emphasis on the concept of *kaibutsu* was the rural philosopher and botanist Kaibara Ekiken 貝原篤軒 (1630-1714). In Kaibara's writings, ***kaibutsu***, in the sense of 'revealing the nature of things', is the motive behind his search for a universal principle in nature which would provide a basis for human morality. This search takes place at several levels: a deepening awareness of and reverence for nature makes human beings better people, but at the same time a richer

[14] Quoted in E.H. Norman, *Andō Shōeki and the anatomy of Japanese feudalism* (Tokyo: Asiatic Society of Japan, 1949), p.221.

[15] Kumazawa Banzan, *Shūgi Washo* (1672), reprinted in *Nihon shisō taikei* (Tokyo: Iwanami Shoten, 1971), vol.30, p.13.

[16] The concept of *kaibutsu* and its relevance to the history of Japanese technology was first discussed by Saegusa Hiroto in *Nihon no chisei to gijutsu* (1939); see *Saegusa Hiroto chōsaku shū* (Tokyo: Chūō Kōronsha, 1973), vol.10, pp.371–4.

understanding of the workings of nature also offers practical ideas for improving agricultural productivity and making people better off.[17]

This second idea was enthusiastically developed in the writings of Kaibara Ekiken's contemporary and associate, Miyazaki Antei 宮崎安貞 (1623–97), who was the author of the most influential Tokugawa treatise on agricultural techniques. Although he does not actually use the term *kaibutsu*, Miyazaki's vision of nature is very close to Kaibara's. In this vision nature is not a hostile force, but is instead abundant and benign: there is no place here for the notion that, as John Stuart Mill put it, "all praise of Civilization, or Art,

[17] ibid., p.373; see also T. Najita, *Visions of virtue in Tokugawa Japan* (Chicago: University of Chicago Press, 1987), pp.45–7.

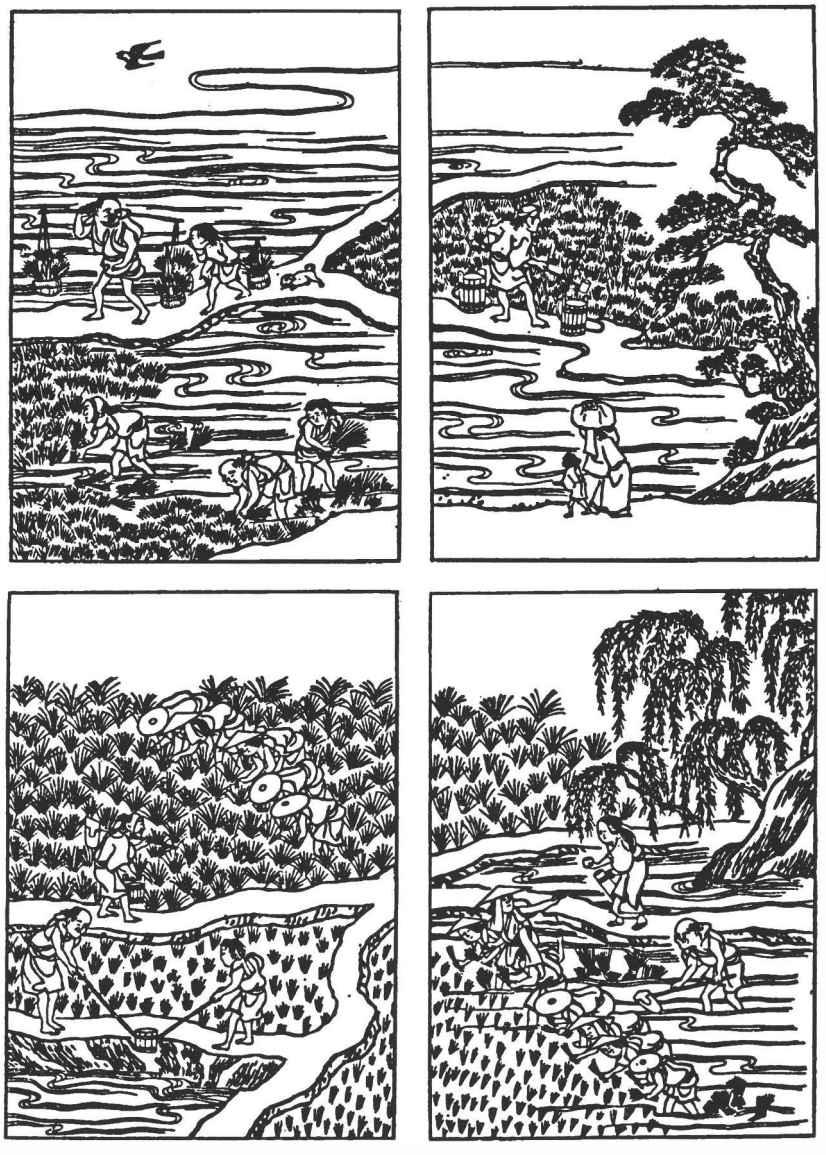


Figure 1
Illustration from Miyazaki Antei's Nōgyō zensho

or Contrivance, is so much dispraise of nature."[18] On the contrary, "art" or "contrivance" ('technology', in short) is the means by which the perfection of nature is revealed; and it is precisely human beings' ability to apply 'art' to 'nature' which gives them a special place in the natural order (see Figure 1). "Of all the myriad creatures of heaven," wrote Miyazaki, "none is more esteemed than human beings. This is because human beings have inherited the spirit of heaven—a spirit which cares for and nurtures all creatures under heaven."[19]

By applying agricultural knowledge and techniques to the natural environment—by selecting seeds, grafting trees, fertilizing the soil—human beings fulfil the purposes of nature itself. But the greatest of these purposes, as it turns out, is to provide the basis for moral human conduct. Writers like Kaibara Ekiken and Miyazaki Antei were fond of quoting the Confucian maxim that, until they had food and clothing, people could not be expected to behave with righteousness. Agricultural techniques, by increasing the abundance of nature, helped to create the foundations for human morality and therefore agriculture was, in Kaibara Ekiken's words, "the basis of government."[20]

The structure of this relationship between nature and morality is worth noting. Earlier Tokugawa scholars like Kumazawa Banzan, drawing on a long tradition of Confucian thought, believed in a sympathetic connection between the morality of the ruler and the smooth working of the laws of nature. "If the state is immoral," wrote Kumazawa, "the ether of Heaven is out of harmony, and the five cereals do not ripen completely."[21] Miyazaki Antei, however, represents a growing tendency to reinterpret this influence of the ruler on the natural world. In Miyazaki's philosophy, the harmony or disharmony of the political sphere is no longer passively reflected in the harmony or disharmony of nature: instead, it is the active study and application of natural laws which enables the good ruler to increase the abundance of the earth and avert the threat of natural disasters.

Taoism, Confucianism and Tokugawa Philosophy

At this point it may be useful to draw a distinction between two contrasting currents which run through the intellectual history both of China and of Japan. Olson describes these, in the Chinese context, as "two poles of thought represented by Confucius and Lao Tzu."[22] In the Taoist philosophy, identified with Laozi 老子 (Lao Tzu), human beings are a small part of a single, vast and dimly comprehended natural unity.

> Compared with the universe, the world as we know it is like a small depression in a huge swamp. Compared with the world, China as we know it is like one kernel of grain in a giant granary. There are a multitude of creatures, and man is only one of them. Even in China, which itself is a speck in the universe, man

[18] Quoted in A. Clayre, ed., *Nature and industrialization* (Oxford: Oxford University Press, 1977), p.307.

[19] Miyazaki Antei, *Nōgyō zensho* (1697), reprinted in *Kinsei kagaku shisō* (Tokyo: Iwanami Shoten, 1972), vol.1, p.84.

[20] Kaibara Ekiken, Introduction to Miyazaki, *Nōgyō zensho*, ibid., p.73.

[21] Quoted in I.J. McMullen, "Kumazawa Banzan and *jitsugaku*: toward pragmatic action," in *Principle and practicality: essays in Neo-Confucian and practical learning* ed. W.T. de Bary and I. Bloom (New York: Columbia University Press, 1979), p.357.

[22] Olson, *Man and nature*, p.638.

> constitutes merely one of the countless things it contains. In short, against the numerous things that exist, man is no more than the tip of a hair underneath the stomach of a horse.[23]

From this perspective, the destiny of humanity was thought to be fulfilled, not by acts of virtue, but by immersion within the flow of existence, the 'One'. This Taoist view of nature exerted a powerful influence on many Chinese Buddhist scholars, particularly those of the Chan 禅 (Zen) school, and their ideas in turn were eagerly absorbed by Japanese Buddhism, in part perhaps because they harmonized with the respect for nature implicit in age-old Japanese Shinto traditions.[24]

The opposite pole or ideal type, identified with Confucianism, was less concerned with the role of human beings in the natural order, and more interested in defining rules of conduct for the interaction of one human being with another. Virtue here was expressed through action, and, for the ruler, one of the most important forms of virtuous action was the dispensing of mercy and compassion to the common people. A corollary of this was that the sufferings of the people could be relieved by applying the wealth of nature to human purposes. At times, as in the writings of the Confucian philosopher Xunzi 荀子 (313–?238 BC) this could produce a highly interventionist attitude to nature:

> You glorify nature and meditate on her:
> Why not domesticate her and regulate her?
> You obey nature and sing her praise:
> Why not control her course and use it? . . .
> You depend on things and marvel at them:
> Why not unfold your own ability and transform them?[25]

The two poles of Taoism and Confucianism, however, represent only the opposite ends of a complex continuum of ideas. In between lay a wide range of syncretic philosophies which borrowed from both extremes. The most important of these, from the perspective of Tokugawa Japan, was the Neo-Confucianism of the Song Chinese philosopher Zhu Xi 朱熹 (1131–1200), whose teachings centred upon the twin concepts of *qi* 氣 (*ki* in Japanese) and *li* 理 (*ri* in Japanese). Of these, *qi* referred to the matter and spirit of which the universe was formed, and *li* to the pattern or 'organizing principle' underlying the workings of *qi*. This 'organizing principle', however, often came very close to the Taoist notion of the Way which unites and inspires the workings of the natural order. "*Li* is the *tao* 道 '[organizing] all forms from above, and the root from which all things are produced."[26] In spite of this, Neo-Confucianism continued to place a far greater emphasis than Taoism on the importance of the social order, and opposed the levelling impulses of Taoist thought with its own firm belief in the natural inequality of things.

Against this background, we can begin to place Tokugawa philosophy in its economic and political context. The early Tokugawa period marked the zenith of Confucian influence in Japanese society, but it was the Neo-

[23] Chuang Chou (c. 368–288 BC) "Autumn Floods," quoted in Dun Jen Li, *The civilization of China* (New York: Charles Scribner's Sons, 1975), p.48.

[24] LaFleur also suggests that the emphasis on "the Buddhahood of nature" in twelfth-century Shingon and Tendai Buddhism may have been a response to "pressures exerted on them by ancient and deeply ingrained experiences of the Japanese people." LaFleur, "Saigyō," pp.195–6.

[25] Quoted in Wing-tsit Chan, "The story of Chinese philosophy," in *The Chinese mind*, ed. Charles A. Moore (Honolulu: University of Hawaii Press, 1968), p.37.

Confucianism of Zhuxi in particular which was adopted and actively propagated by the first Tokugawa Shoguns. Andō Shōeki's writings, with their striking similarities to early Chinese Taoist writings,[27] represented the highly unorthodox and subversive views of a radical eccentric far removed from the centres of power and prestige. Kaibara Ekiken and Miyazaki Antei, on the other hand, occupied a somewhat different position in the spectrum of social ideas. Although they belonged to rural rather than urban society, they were neither radicals nor outsiders, and their works reached a wide readership in eighteenth-century Japan. Their aim was not to challenge the Confucianism of the Tokugawa rulers, but rather to make it more accessible to the common people. In order to do this, they reiterated and re-emphasized the Neo-Confucian idea that an active engagement with nature was the source both of morality and of physical well-being. The view of humans as the most active and important elements in the natural universe was part of their search for a Confucian code of ethics for farmers—an alternative to the aristocratic ethos which depicted the warrior class as the chief possessors of virtue.

26 Chu Hsi, quoted in Colin A. Ronan and Joseph Needham, *The shorter science and civilization in China* (Cambridge: At the University Press, 1978), vol.1, p.239.

27 See Norman, *Andō Shōeki*, p.225.

Hiraga Gennai and the Development of Nature

During the eighteenth and early nineteenth centuries, however, the notion of the opening up of nature—*kaibutsu*—came to be extended still further. As the merchant class prospered and craft production expanded, so *kaibutsu* became incorporated into a still more drastic reinterpretation of Confucian concepts of human morality. Some of the inspiration for the extension may also have come from the introduction into Japan of a remarkable Chinese technological text, *Tiangong kaiwu* 天工開物 (*Tenkō kaibutsu* in Japanese—[Development of the Works of Nature]), which was completed and privately published during the final years of the Ming Dynasty by an official named Song Yingxing 宋應星.[28] *Development of the Works of Nature* is a compendium of the technological achievements of over a thousand years of Chinese history, containing descriptions and illustrations of discoveries such as the chain-pump irrigation system and complex pedal-driven equipment for silk reeling.[29]

One curious point about Song's *Development of the Works of Nature* is that it seems to have been little known in China itself after the end of the Ming Dynasty. Although other encyclopedias of techniques (such as the *Nongzheng quanshu* 農政全書, or Complete Treatise on Agricultural Administration, written in the 1620s) remained in use in Qing China, Song's work disappeared from view until the 1920s when it was rediscovered by Chinese historians of science and technology.[30] In Japan, however, the story was very different. Song's text was probably imported from China around the end of the seventeenth century, and was published twice in Japanese editions, once

28 Sun E-tu Zen and Sun Shiou Chuan, trans., *Chinese technology in the seventeenth century*, (English translation of the *Tiangong kaiwu*) (University Park, Pa.: Pennsylvania State University Press, 1966). It is difficult to capture the full flavour of the book's title in English. Sun and Sun translate it as "The creations of nature and man," while Mark Elvin (personal communication) has suggested "The development of commodities by heaven and the artificer."

29 See Song Yingxing, *Tenkō kaibutsu*, trans. Yabuuchi Kiyoshi (Tokyo: Heibonsha, 1969).

30 Yabuuchi Kiyoshi, *Kagakushi kara mita Chūgoku bunmei* (Tokyo: N.H.K.Books, 1982), p.137.

31 Kikuchi Toshiyoshi, *Zufu Edo jidai no gijutsu* (Tokyo: Kōwa Shuppan, 1988), vol.1, p.85.

in 1771 and once in 1830.[31] Its considerable influence on Japanese writers can be seen from the enthusiasm with which they borrowed, adapted and embellished its illustrations (see Figure 2).

In Song's text the concept of *kaibutsu* is extended far beyond the limits of agriculture to include the making of textiles, dyestuffs, pottery, metals, and paper, the building of ships, the forging of armaments and the brewing of wines and beers. This wider vision of the application of human knowledge to nature is one which is repeatedly echoed in the writings of Japanese scholars of the late eighteenth and early nineteenth centuries—and not only in their writings, but also in the practical use to which they put their ideas.

The most striking example of this is provided by the life of Hiraga Gennai 平賀源内 (1729–80), the irascible, eccentric polymath who produced the Japanese version of the illustration shown in Figure 2.[32] Hiraga's unusual life began conventionally enough: he was a low-ranking samurai from the domain of Takamatsu, who, like many eighteenth-century scholars, acquired an interest in the study of natural history *(honzōgaku* 本草學*)* and compiled a number of studies of Japanese animals, plants and minerals. In addition to these orthodox scholarly activities, however, Hiraga also, *inter alia*, experimented (unsuccessfully) with sheep farming; established a pottery where he planned to produce ceramics for export; studied the properties of asbestos in an attempt to develop a fireproof fabric; made the first Japanese copies of Dutch thermometers; assisted the domain of Akita in the development of its copper and silver mines (using techniques probably derived from Song Yingxing's *Development of the Works of Nature*); and built several machines for generating static electricity, which he copied from Dutch models but then unblushingly claimed as his own invention.[33] These machines, like similar devices in eighteenth-century Europe, were used to treat various medical disorders, with dubious results (see Figure 3). Although he mastered the technology of reconstructing the Dutch machines, Hiraga interpreted their scientific principles in terms of traditional Chinese concepts: the sparks which they generated reflected their power to unleash the most fundamental of all the natural elements, fire.[34] It may be fair to say, however, that eighteenth-century European medical views were not very much more enlightened. (There, as Singer and Underwood observe, "humbug and misunderstanding in connexion with

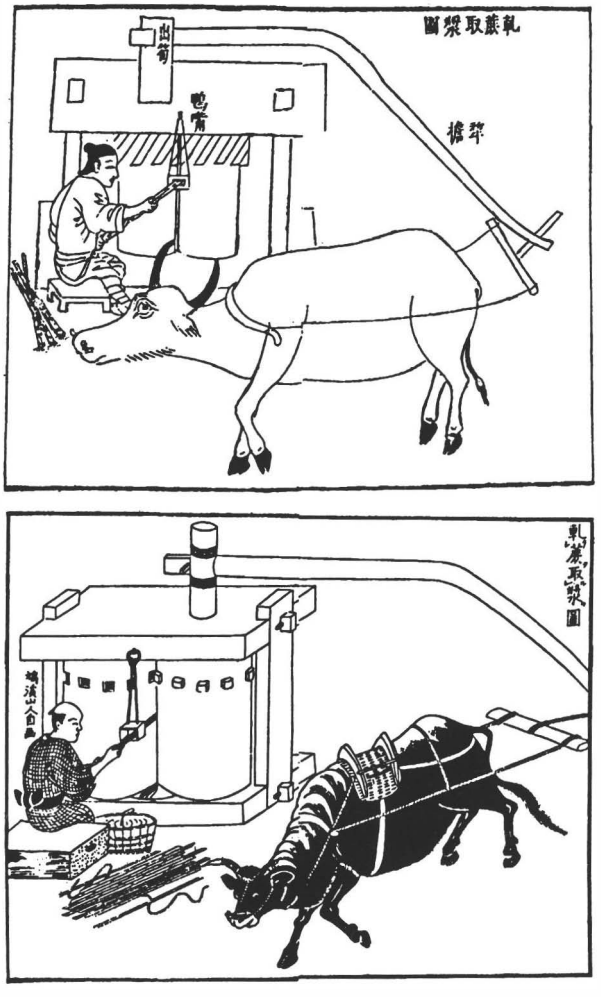
[32] It is interesting to note that perspective techniques existed in China by the seventeenth century, but seem to have been less widely used than they were in Japan. Hiraga's drawings may have been influenced by his knowledge of Western art, of which he was one of the first Japanese emulators.

[33] For an outline of Hiraga's life see Jōfuku Isamu, *Hiraga Gennai* (Tokyo: Furukawa Kōbunkan, 1986).

[34] ibid., p.135.

Figure 2

Illustrations of a sugar-crushing mill from Song Yingxing's Tiangong kaiwu *(top) and Hiraga Gennai's* Butsurui hinshitsu *(bottom)*



the electrical relations of living tissues were rife" until the middle of the nineteenth century.)[35] In between times Hiraga also acquired a reputation as a writer of popular and somewhat scurrilous literature, and as one of the first people to introduce the techniques of Western painting to Japan.[36]

Hiraga Gennai was in many ways a man ahead of his time. His more exotic enterprises were often greeted with derision by his contemporaries, and his colourful life came to an appropriately dramatic conclusion in 1780 when he killed a colleague in a drunken brawl, attempted to commit suicide and died in prison of self-inflicted wounds.[37] But Hiraga's ambitious (if often unsuccessful) schemes were part of a wider stream of evolving attitudes to nature and technology in eighteenth-century Japan. The tradition of natural history to which Hiraga was heir had, of course, been imported from China. As far back as the sixth century AD, Japanese scholars had been aware of the Chinese practice of studying and compiling encyclopedic lists of plants and minerals, particularly those with medicinal properties, but it was not until the late seventeenth century that detailed surveys of Japan's own natural history began to be produced. One of the leading collectors of botanical specimens was Kaibara Ekiken, whose 18-volume *Yamato honzō* 大和本草 [Natural History of Japan] contained over 1,500 entries.[38]

Natural history in Japan was thus the first major practical application of the philosophical concept of *kaibutsu*. In the early stages, however, it tended to be much concerned with categorization and classification. It was not until Hiraga's time that the emphasis shifted from the correct naming of plants and animals to exploring the practical uses of natural resources, whether animal, vegetable or mineral.[39] This approach to natural history was popularized from the 1750s onwards by 'exhibitions of products' *(bussankai* 物産會*)*, which introduced an insatiably curious public to natural rarities and wonders

35 C. Singer and E.A. Underwood, *A short history of medicine* (Oxford: Clarendon Press, 1962), p.161.

36 ibid., pp.89–94.

37 ibid., pp.141–51.

38 Shirai Mitsutarō, "A brief history of botany in old Japan," in *Scientific Japan: past and present* (Papers presented to the Third Pan-Pacific Science Congress), (Tokyo: 1926), pp.213–21.

39 Hubert Maes, *Hiraga Gennai et son temps* (Paris: Ecole Française d'Extrême Orient, 1970), pp.46–8.

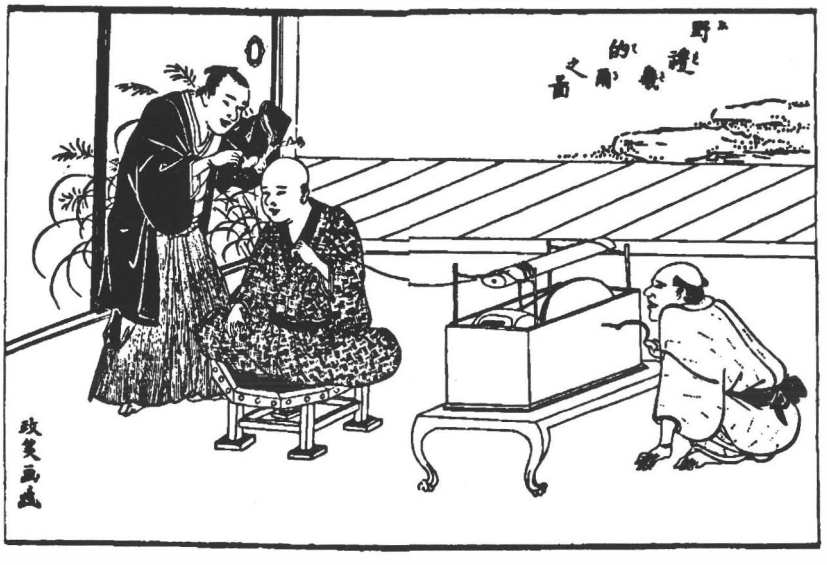


Figure 3
The treatment of patients with Hiraga Gennai's static electricity device

collected from all over the country. Hiraga Gennai and his teacher, Tamura Ransui 田村藍水, were leading organizers of these exhibitions.[40]

For Tamura Ransui, Hiraga Gennai and their associates, the study of nature was less concerned with elucidating the laws of the universe than with harnessing natural resources for human use. As another disciple of Tamura's put it:

> Man . . . is, of all the living creatures, the one with the greatest spirit: that is why he uses natural products to serve his needs. The natural products serve the needs of man, and it is with their help that man achieves the greatest heights.[41]

By this time, however, a significant new element was beginning to enter the notion of the opening up of nature, an element which is particularly apparent in the writings of Hiraga Gennai. From the 1630s onwards the Tokugawa Shoguns had imposed tight restrictions on Japan's foreign trade, but in spite of this there proved to be some essential commodities which could not be produced at home. (These included many of the ingredients of Chinese medicines.) Japan therefore continued to conduct a limited import trade via the Dutch and Chinese merchants in Nagasaki, and, since the country had relatively little to export, this trade led to a constant outflow of precious metals to foreign countries. The national dilemma was repeated at local level in many Japanese domains. The spread of the money economy and the expenses of the alternate residence system resulted in a steady flow of wealth from outlying domains to the metropolises of Edo and Osaka, and during the eighteenth and early nineteenth centuries, one domain after another faced financial crisis. To address the crises, many regions began to introduce policies for 'developing industry and promoting enterprise' *(shokusan kōgyō* 殖産興業)—in other words, for exploiting local resources to create commodities which could be sold on the market. These included schemes for the production of cash crops such as raw silk and sugar, for the expansion of mining, and for the creation of handicraft industries such as lacquer, which made use of naturally-occurring rare plants and minerals.

It was this economic problem, rather than the higher issues of human morality, which provided the main motive behind Hiraga's study of natural history. By discovering new natural resources and experimenting with their uses, he argued, the state could strengthen the basis of its wealth and power. This was an idea which he applied both in the advice he provided to various Domain governments, and also at a national level in his advice to the Shogunate. In the handbill which he wrote to advertise his 'exhibition of products' in 1762, for example, Hiraga suggested that "if we but search the deepest mountains and ravines," most of the materials which were currently imported would be found to exist in Japan itself. The study of natural history should therefore be used as a means of opening up these undiscovered resources and so solving the trade imbalance.[42] To put his own precepts into practice, Hiraga undertook a number of scientific expeditions which resulted, for example, in the discovery of sources of a medicinal chemical,

[40] ibid., pp.47–8; Jōfuku, *Hiraga Gennai*, pp.25-8.

[41] Quoted in Maes, *Gennai et son temps*, p.48.

[42] Jōfuku, *Hiraga Gennai*, p.27.

probably magnesium sulphide (used as a purgative in Chinese and Japanese medicine), previously unknown in Japan.[43] The same mercantilist perspective inspired the plans for developing the ceramics industry which Hiraga submitted to the authorities in the 1770s:

> The Japanese place great value on foreign things and we lay out great sums of money for them. . . . In the case of pottery, . . . if the Japanese ware is good, then naturally we will not spend our gold and silver on the foreign commodity. Rather to the contrary: since both the Chinese and the Hollanders will come to seek out these wares and carry them home, this will be of everlasting national benefit. Since it is originally clay, no matter how much pottery we send out, *there need be no anxiety about a depletion of resources.*[44]

Hiraga's writings and scientific exploits, therefore, extended the concept of the development of nature in two ways. First, inspired by Song Yingxing, they emphasized the value not only of agriculture but also of mining and manufacturing technologies as a means of tapping the potential wealth of nature. They therefore implicitly offered a justification for the activities of the expanding class of merchant manufacturers, with whom Hiraga, despite his samurai origins, had close contacts. Second, by harnessing the concept of *kaibutsu* to the service of nationalism, they helped to create a powerful mixture which was to find a wide and receptive audience in the closing phases of the Tokugawa age. Although Hiraga's more ambitious developmental schemes were too radical to be accepted in his own day, they foreshadowed ideas which were to be put forward with increasing force in the century which followed his death.

Kaibutsu in the Writings of Satō Nobuhiro

The most complete expression of these evolving ideas appears in the early nineteenth-century writings of the agricultural expert and political philosopher Satō Nobuhiro 佐藤信淵 (1769–1850). Satō was a prolific writer whose practical handbooks on everything from silk farming to armaments gave his opinions wide currency beyond the ranks of the scholarly élite. His approach both to science and to politics was an extremely eclectic one, cheerfully combining ideas from the Chinese classics with Shinto mythology (which he learnt from the arch-nationalist Hirata Atsutane 平田篤胤) and Western knowledge derived from the Dutch. His major work on astronomy, for example, uses the Shinto creation stories as an intellectual framework for explaining the astronomical theories of Copernicus and Kepler.[45]

The basis of Satō's ideas was a belief in a benign creative life-force which he associated with the gods of the Shinto pantheon. But, far from leading to a sense of peaceful co-existence between humans and nature, this theology led Satō to the conclusion that the most important task for human beings was to improve and make use of the resources provided by benevolent

[43] ibid., p.35.

[44] Quoted in S.H. Jones, *Scholar, scientist, popular author: Hiraga Gennai 1728–1780* (PhD diss., Columbia University, 1968), p.56. (Italics added.)

[45] See Satō Nobuhiro, *Tenchūki* (1825), reprinted in *Nihon shisō taikei* (Tokyo: Iwanami Shoten, 1977), vol.45, pp.361–423.

nature. "The development of products *(bussan no kaihatsu*物産の開発*)* is the first task of the ruler."[46] What this means in practice is evident from the fascinating, if slightly sinister, Utopian text in which Satō put forward his image of an ideal society. Here an all-powerful government is divided into six ministries (based on the six-fold divisions of ancient Chinese administration). These include a Ministry of Basic Affairs—or agriculture—*(Honji-fu* 本事府*)*, whose duties involve experimentation with new crops and seed types; a Ministry of Development *(Kaibutsu-fu* 開物府*)*, which is responsible both for forest management and for the surveying and opening up of new mines; and a Ministry of Manufactures *(Seizō-fu*製造府*)*, whose tasks include the building of roads and bridges as well as the supervision and improvement of manufacturing techniques.[47]

In Satō's writings, ***kaibutsu*** provided the basis for another crucial concept, again borrowed from the Chinese classics but given a special emphasis by scholars in late Tokugawa Japan. This is the idea of "enriching the nation" *(fukoku* 富國*)* which was sometimes linked with phrase "strengthening the army" *(kyōhei*強兵*)* to create the term which became the key political slogan of the Japanese government in the early phases of industrialization.[48] His *Keizai yōryaku* 經濟要略 [Economic Digest] for example, presents four principles of sound economic policy. Two of these are 'development' *(kaibutsu)*, defined as "making the nation fertile by developing grains, fruits and all sorts of marine and land products," and "enriching the nation" *(fukoku)*, which means "bringing together all the fruits of nature within your borders to create great national wealth."[49] Through ***kaibutsu***, Satō argued, the ruler could create the conditions not only for national welfare but also for the military expansion which he eagerly espoused in many of his writings.[50]

Satō Nobuhiro, then, brings together a number of recurring themes in the Tokugawa vision of nature. Like Kaibara Ekiken and Miyazaki Antei, he sees nature as a creative force whose full potential can only be realized through the application of human knowledge. Like them, too, he envisages the development of nature as a path to human morality. By reducing poverty, ***kaibutsu*** is a way of preventing the evils born of desperation, such as the practice of infanticide, which Satō fiercely condemned. Like Hiraga, however, Satō also links the opening up of nature not just to personal virtue but to national power, and in so doing provides an apologia for the increasingly active role of the state in promoting the exploitation of natural resources.

Many aspects of Satō's writings echo the teachings of the Chinese classics as far back as Xunzi and beyond. His concept of a strong state has a lineage stretching back to the ***Zhou li*** 周禮 [Rites of Zhou], and his emphasis on "enriching the nation and strengthening the army" is particularly reminiscent of the ideas of the eleventh-century Chinese statesman Wang Anshi 王安石.[51] At the same time, however, Satō's position also seems

[46] Satō Nobuhiro, *Keizai yōryaku* (1822), reprinted in ibid., p.536.

[47] Satō Nobuhiro, *Suitō hiroku*, reprinted in ibid., pp.488–517.

[48] See for example Satō, *Keizai yōryaku*, part 3; practical proposals for strengthening the army are given in *Sonka zateki ron*, reprinted in *Satō Nobuhiro kagaku zenshū* (Tokyo: Iwanami Shoten, 1925), vol.2, pp.867–79.

[49] Satō, *Keizai yōryaku*, p.525.

[50] See e.g. Satō Nobuhiro, *Kondo Hisaku*, reprinted in *Nihon shisō taikei* (Tokyo: Iwanami Shoten, 1977), vol.45, pp.426–85.

[51] See James T.C. Liu, *Reform in Sung China: Wang An-shih (1021–1086) and his new policies* (Cambridge, Mass., Harvard University Press, 1959), pp.56–8.

to reflect a recurring pattern in Japanese intellectual history. As Japan underwent repeated cycles of influence and semi-isolation from the Asian mainland, so Japanese philosophy tended to pick up certain elements of Chinese tradition and develop them to an extreme unparalleled in China itself. Which elements were picked up, and which were neglected, depended very much on the particular political and social problems that occupied the Japanese scholars of the time. During the 'semi-seclusion' of the late Heian period, it was the notion of a unity between human beings and nature that was pursued to its outermost limits by Japanese Buddhists like Saigyō;[52] in the late Tokugawa period, on the contrary, it was the idea of a human duty to use and develop nature for human ends. By grafting snippets of Western developmentalism onto the rootstock of Chinese and Japanese traditions, writers like Satō could produce a hybrid philosophy in which the vision of *kaibutsu* reached its apotheosis.

[52] See LaFleur, "Saigyō"; the term 'semi-seclusion' is taken from Masayoshi Sugimoto and David L. Swain, *Science and culture in traditional Japan* (Rutland, Vt., Charles E. Tuttle, 1989), chap.103.

Concepts of Nature at the Start of Industrialization

The idea of *kaibutsu*—the opening up of nature—as a fundamental human duty was not the only approach to the environment which existed in Tokugawa Japan, any more than the mechanistic world view was the only view of nature which flourished in early modern Europe. *Kaibutsu*, however, was an increasingly influential concept, and, as Japan opened its doors to the West, it proved to be a concept which could offer a bridge between familiar Japanese notions of morality and the new ethos of Western science and technology. This point comes out very clearly in the writings of early Meiji scholars like Sakatani Shiroshi 阪谷素, the oldest and most cautious of that group of Westernizers known as the 'Meirokusha' 明六者 or '1873 Society'. Sakatani's essays reveal the huge philosophical challenges posed by Westernization. To what extent, he asks, are Western ways compatible with Confucian ethics? How could Japan import Western social and scientific ideas without sinking into cultural subservience to foreign countries? For Sakatani, the answer to these questions lay in the notion of *kaibutsu*, which he used primarily in Kaibara Ekiken's sense of "revealing the true nature of things." If one studied and understood the laws of nature, he concluded, one could create the proper foundations for a combination of Japanese and Western knowledge.[53] The basis for this combination was a recognition of the way in which human activity (whether political or technological) fulfils the workings of nature:

> When looking down from an elevated position, affairs of the universe seem to be entirely encompassed by Heaven's Reason and Nature without room for human contributions. On the other hand, when one looks up from the humble position . . . it appears that matters of the universe are wholly human and wholly

[53] Sakatani Shiroshi, "Descending from heaven" (1875), in Meiroku Zasshi: *journal of the Japanese enlightenment*, ed. W.R. Braisted (Tokyo: University of Tokyo Press, 1976), pp.428–35.

> contrived and that nothing depends on Nature or on Heaven's Reason. Yet the fundamentals of Heaven's Reason and the Human Way are one, and the two function by mutually assisting one another.[54]

In Sakatani's writings, the laws of nature, or "Heaven's Reason," define the different environmental and cultural conditions which exist in each country. Once we understand those laws, we can use the "Human Way" to develop resources and enterprises appropriate to the conditions of our own country. Nature, in other words, provides the parameters for human action, but as Sakatani put it, consciously quoting the Western cliché, "God helps those who help themselves."[55]

The practical extension of this approach is obvious from the writings of leading architects of Japan's industrialization such as Ōkubo Toshimichi 大九保利通 (1830-78). According to Ōkubo, Britain's rise as an industrial power was a shining example of a wise government building upon the laws of heaven and nature *(tenzen no ri*天然の理*)*, Nature had endowed Britain with an environment ideal for maritime trade, and Britain's rulers had extended the blessings of nature by actively supporting the country's shipbuilding and commerce until Britain emerged as the world's leading economic power.[56] Japan's "laws of heaven and nature" (that is, its natural environment) resembled Britain's, and, in Ōkubo's eyes, it was only a weakness in the temperament of the Japanese people which had prevented them from building on their natural resources as Britain had done. The duty of the government, then, was to help the Japanese people overcome this spiritual weakness and acquire the knowledge and technology to exploit their natural environment to the full.[57]

Conclusions

The lineage of ideas which we have traced from Tokugawa scholars to Meiji politicians helps to show how Western notions of technological development were interpreted and assimilated in nineteenth-century Japan. It also, I think, helps to explain some of the paradoxes of Japan's environmental history. One way of understanding that history is to assume that there must have been a sharp cultural fissure between Tokugawa and Meiji society. The former, after all, developed a system of forest protection which would be the envy of many modern environmentalists, while the latter pursued industrialization giving hardly a thought to its environmental consequences. But the approach to nature implied by the concept of ***kaibutsu*** suggests a rather different way of looking at things.

Most of the Japanese thinkers whom we have discussed saw human beings as the crowning glory of a rich and benign natural order. Humans had not just a right but a duty to develop the resources of nature for their own purposes. Careless use of these resources—a use not based on the "laws of

[54] ibid., pp.428–9.

[55] ibid., p.429.

[56] From *Ōkubo Toshimichi hunsho*, reprinted in *Nippon kagaku gijutsushi taikei*, ed. Nippon Kagakushi Kyōkai (Tokyo: Daiichi Hōki Shuppan, 1964), vol.1, p.219.

[57] ibid., p.220.

heaven and nature"—was wrong because it made people (and the state) worse rather than better off. Thus, writers like Kumazawa Banzan condemned deforestation because it caused flooding, landslides and other environmental disasters. Forest conservation, and particularly the planting of useful tree species, was an important part of the wise management and development of nature for human use.[58] But because human beings and their environment were not separate but were part of the single tree of life, there was no particular value in an independent nature, untouched by human hands. On the contrary, the notion of *kaibutsu,* as it evolved in late Tokugawa and early Meiji Japan, implied that the most perfect nature was the nature most thoroughly improved by human beings.

This approach was very different from the vision, apparent in some European writing, of nature as a force separate from and hostile to human beings—a force which, without human control, was perpetually inclined to "fall back into the old Chaos."[59] However, the idea of nature as an enemy to be subdued did leave room in European thought for the romantically inclined to take the side of the enemy, and to argue that the very wildness of nature was something to be preserved for its own sake. So in eighteenth- and nineteenth-century Europe there tended to be a clear dichotomy between, on the one hand, writers who celebrated the triumph of industrial civilization and, on the other, those who mourned the disappearing wilderness and argued for the preservation of nature in its own right. This dichotomy persists in contemporary environmental debates, where some 'deep ecologists' depict humans as a plague attacking the fabric of Gaia (Mother Earth). One recent US environmental best-seller, indeed, pronounces that nature is defined by "its separation from human society," and that this sense of separation is not limited to certain cultures but "survives because it agrees with our instinctive sense of the world."[60]

For the ideologues of *kaibutsu,* that definition of nature would have made little sense. Since they saw human beings as an integral, if uniquely important, part of the natural order, there was no place in their philosophies for a romantic yearning for 'unspoilt' nature. Ironically, it was precisely their emphasis on the integration of humans and nature which provided an intellectual basis for the Meiji government's supreme indifference to the destruction of nature by the process of industrialization; for how could industrial growth be a threat to the ecosystem when, as one Meiji entrepreneur and social thinker put it, "industry itself is an instrument for achieving the moral principles of nature"? [61]

An exploration of Tokugawa intellectual history shows that it is far too simple to identify 'traditional' Japanese attitudes to nature with an animist respect for the spirit of trees. On the other hand, it would be rash to leap to the opposite conclusion, as some recent critics have done, and suggest that Japan is condemned by its culture to be "the world's number one environmental despoiler and exploiter."[62] The point about the ideas discussed here is that they provided a particular and distinctive framework

[58] For further discussion of attitudes to forest protection in Japan, see Conrad Totman, *The green archipelago* (Berkeley, University of California Press, 1989), particularly pp.179–88.

[59] Francis Bacon, quoted in Carolyn Merchant, *The death of nature* (London: Wildwood House, 1980), p.171.

[60] Bill McKibben, *The end of nature* (London: Viking, 1990), p.60.

[61] Yoshida Heijirō, *Kōgyō shinkōron* (1885), reprinted in *Kagaku to gijutsu,* in *Nihon kindai shisōtaikei* (Tokyo: Iwanami Shoten, 1989), vol.14, p.285.

[62] See Reader, "Animism renaissance," p.15. Reader notes that some British critics have related Japan's destruction of South-east Asian rain forests to features of Japanese culture such as "an inherent Japanese view of the world as created for the benefit of humans (a concept that is readily found in Shintō myth)," and "the traditional Japanese divisions between inside and outside." ibid, p.16.

for viewing environmental problems, one in which ecological destruction was to be judged by its negative effects on human welfare rather than by its effects on the aesthetics of the wilderness. This framework, I would (tentatively) suggest, has continued to have some influence on a wide range of Japanese environmental thought in the modern age.[63]

Most importantly, though, the history of ideas also shows that Japanese attitudes to nature, even in pre-industrial society, were both diverse and dynamic. Alternative visions, like that of Andō Shōeki, existed alongside the emerging notion of the 'opening up of nature'. The ideas of writers like Satō Nobuhiro came to be influential above all because they coincided with the needs of powerful groups in Japanese society, and because they made sense of the ways in which Japanese intellectuals perceived the problems of their day. Even in the isolated world of Tokugawa Japan, philosophies of nature were not imprisoned like fossils in a cultural bedrock, but changed over time as successive generations gave new meaning to inherited ideas. If there is any lesson to be drawn from all this, it is surely that, instead of retreating behind the barricades of eco-nationalisn, our own generation should be reinterpreting tradition in its own ways, ways which may help us to confront environmental challenges which transcend the boundaries of culture and nation.

[63] This influence is, for example, evident in the importance of the concept of *kōgai* ('public injury') in the environmental debates of the 1960s.

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