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Urban Sanitation in Preindustrial Japan

The sudden increase in Japan's urban population in the century and a half from the 1580s to the mid-1700s may well have had no parallel in world history prior to industrialization. Edo, renamed Tokyo in 1868, was a cluster of fishing villages around a castle in 1590, but, during the eighteenth century, it is readily acknowledged to have been one of the largest, if not the largest, city in the world. Even by 1700, Edo was certainly larger than any European city, including London at 575,000, and rivaled or exceeded in population the largest of the Chinese cities at the time, Peking. But urban growth was not limited to Edo; cities sprang up throughout the country from the late sixteenth century on and both Kyoto and Osaka had populations in the hundreds of thousands. By the late eighteenth century, Japan had about 3 percent of the world's population, but it is estimated to have had more than 8 percent of the people in the world who lived in cities of more than 10,000. By this standard, about 10 percent of the total population of Japan was urban in 1800.[1]

To support a metropolitan population, food and other daily necessities must be adequately supplied, and demands for housing, water, transportation, a monetary system, and numerous other requirements must be met. Even if all other requirements are

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1 Ōishi Shinzaburō, "Kyodai toshi Edo no jinkō wa dore kurai ka," *Rekishi to jimbutsu*, CX (1980), 76–81; E. Anthony Wrigley, "A Simple Model of London's Importance in Changing English Society and Economy 1650–1750," in Philip Abrams and Wrigley (eds.), *Towns in Societies* (Cambridge, 1978), 215; G. William Skinner (ed.), *The City in Late Imperial China* (Stanford, 1977), 29. Gilbert Rozman, *Urban Networks in Ch'ing China and Tokugawa Japan* (Princeton, 1973), 6, estimates Japan to have been 10% urban while Sekiyama Naotarō, *Kinsei Nihon no jinkō kōzō* (Tokyo, 1957), 239, considers 12% of the population to have been urban.

satisfied, however, if sanitation is inadequate, one would not expect the population of a city to reach a million, much less be maintained at this figure over centuries. Yet Edo, which lacked modern water supply and sewage systems, and which relied primarily on manpower or boats to carry away garbage, refuse, and other human wastes, is estimated to have had a population in the range of a million from about 1700 on. How did Japan manage to maintain such an enormous urban concentration of people for two centuries prior to industrialization?

Numerous studies have discussed urban sanitation and water systems in the West, as well as the negative rate of natural increase in the population of urban areas in premodern times. However, scholars in Japan have begun to research these subjects only in the last decade, and no one has attempted to evaluate as a whole the various aspects of sanitation in premodern Japanese cities and their significance in Japanese history. Here my focus will be on the problem of sanitation in the major metropolises of Japan from approximately 1590 to 1890 and will include an assessment of the sanitation standards in light of Western standards for the same centuries. This is not intended to be an exhaustive study that will provide full evidence, but one that provides a new perspective on Japan and, through comparison, on the West as well.

The lack of interest in these topics in Japan results primarily from the political-institutional focus that historians traditionally have had. Perhaps equally important is the fact that Japanese have not had to contend with the urban problems that Westerners faced in early modern times. Thus, the wealth of personal observations, proposals for improvement, and other materials so widely available in the West from at least the early nineteenth century are, by and large, lacking for Japan. But from Japanese laws, regulations, and political concerns, a good deal of information can be extracted about Edo's water supply and waste disposal systems and on Osaka's system for disposing of night soil.

This article examines how the premodern Japanese provided a water supply system for urban residents and developed systems to rid the cities of waste, ranging from garbage and rubbish to water and human excreta, or night soil. It also looks at Japanese customs that had an effect on levels of sanitation and disposal of night soil and compares urban conditions in Japan with those in the West. The article is divided into four main parts: 1) a brief

summary of the growth and changes in the city population in the Tokugawa period (1600–1868); 2) a description of Edo's water supply system and brief comparison with how other Japanese cities were supplied; 3) an analysis of how the cities handled the crucial problems of waste disposal; and 4) a comparison of sanitation and hygiene in Japan from the seventeenth through the nineteenth centuries with sanitation levels in Western cities. The implications of the findings and their possible relationship to the course of industrialization in Japan are discussed in the conclusion.

THE URBAN POPULATION IN THE TOKUGAWA PERIOD The growth of Edo in the seventeenth century was the most remarkable event in Japan's urban history. In the sixteenth century, the site was occupied only by a number of small fishing villages and a castle, but it was strategically located on one of the largest bays in Japan and at the edge of its largest plain. Here, in 1590, the founder of the Tokugawa Shogunate began to build his new administrative capital. Edo grew so rapidly in the seventeenth century that the first survey of its population taken in 1678 listed a total commoner population of 570,361. In the period from 1734 to 1867, Edo's commoner population was always above 500,000, with a low of 501,166 in 1743 and a peak of 559,497 in 1844. However, there also existed a large unregistered population in Edo, estimated at 80,000 in the second half of the nineteenth century. Thus, a figure of 600,000 for the commoner population of Edo for much of the Tokugawa period is a reasonable estimate.[2]

Added to the commoner population must be that of the samurai class and their servants. Since the number of people connected with the warrior class was not included in the surveys of urban population, we have to "guesstimate" the number of people who occupied two thirds of the space of the city. The direct retainers of the Shogun numbered approximately 22,500 in the beginning of the eighteenth century and 26,000 at the start of the nineteenth. At a minimum, these retainers plus their households would have added 100,000 to Edo's population. But most of the space in Edo allocated to the samurai was taken up by the official residences of the 260-odd daimyo who each maintained a

2 See Takeuchi Makoto, "Edo no chiiki kōzō to jūmin ishiki," in Toyoda Takeshi et al. (eds.), *Nihon no hōken toshi* (Tokyo, 1983), II, 300; Ōishi, "Kyodai toshi Edo," 77–80.

residence and one or two additional establishments in the city. The daimyo had to spend half of their time in Edo to "pay attendance upon the Shogun," but in reality this requirement enabled the Shogun to keep an eye on them—a polite hostage system. Although some of the smallest daimyo probably had only a hundred or so people in residence in Edo, some of the largest had thousands. The largest daimyo, the Maeda of Kaga, maintained a regular staff of about 1,000 retainers, who with their families constituted at least 4,000 permanent residents. When the daimyo himself was in residence, it is estimated that as many as 8,000 people were in attendance. Thus even a conservative estimate of the daimyo population would require adding a few hundred thousand to the population of Edo, and this number does not include servants.[3]

To estimate Edo's population, from a base of 600,000 commoners, we would have to add a very conservative estimate of 100,000 for the Shogun's direct retainers, a minimum of 200,000 in the samurai class from the daimyo establishments, plus an unknown number of servants. Clearly a total of 1 million for Edo's population is not wild speculation. Edo was certainly much larger than London in 1700 and rivaled it in population in 1800.

Not only was Edo larger than any European city, but both Osaka and Kyoto were larger than the European capitals of Vienna, Moscow, and Berlin even at the beginning of the nineteenth century and were surpassed in size only by London and Paris. After the Battle of 1614/15, Osaka was built to become the commercial entrepôt of Japan. At its peak in 1763, it had a commoner population of 418,537. Even after Edo gradually took over many of the marketing and financial functions of Osaka, the city remained the second largest in the country with a population of 314,370 in 1858. Kyoto, the seat of the emperor, had a population recorded at 410,000 by 1534, and then, as other urban areas grew,

3 The samurai were originally warriors, but by the Tokugawa period this was the general term for the warrior estate or class. During the Tokugawa period, the daimyo were regional military lords who held domains assessed at 10,000 or more *koku* (a unit of rice, approximately 5 bushels). The direct retainers of the Shogun were his vassals: a minority of daimyo (*fudai*), the bannermen (*hatamoto*), and the housemen (*gokenin*). For information on the samurai, see Kozo Yamamura, *A Study of Samurai Income and Entrepreneurship* (Cambridge, Mass., 1974), 10; Naitō Akira, "Edo no toshi kōzō," *Edo jidai zushi* (Tokyo, 1975), IV, 169; Toshio G. Tsukahira, *Feudal Control in Tokugawa Japan: The Sankin Kōtai System* (Cambridge, Mass., 1966), 95.

its population fell into the mid-300,000 range from the late 1660s on.[4]

Japan's urban growth in the seventeenth century was not limited to the three largest metropolises; equally important in the long run was the proliferation of the castle towns in the same period. From the last quarter of the sixteenth century and into the seventeenth, numerous cities sprang up in the Japanese countryside. These originated as the headquarters of major daimyo and were known as castle towns, because at the center of each was the castle, which served as the domain's administrative center. Quartered here were the daimyo's forces, and to supply them there was a need for merchants and artisans. A domain's castle town usually maintained about 10 percent of the domain's total population. The commoner population of the major castle towns ranged from 10,000 up to more than 60,000 (Kanazawa) and, although their commercial activities began to be taken over by smaller towns in outlying areas in the late Tokugawa period, most of these towns remained vital centers. Half of the sixty most populous cities in Japan today originated as castle towns during the late sixteenth century.[5]

Japan also had a score of ports by the sixteenth century that ranged in size from 10,000 to 50,000, and an even larger number of cities or towns with populations in excess of 5,000. With the establishment of formal shipping routes in the Tokugawa period, the number and size of port towns increased. By the late eighteenth and nineteenth centuries, villages in the countryside had become towns, and towns had grown into cities. After the formation of the castle towns, Japan was no longer dominated by its capital, and two centuries later, with the growth of outlying centers, the castle towns were no longer the only urban areas in many domains. The Tokugawa period witnessed not only the rise of one of the largest cities in the world, but also the urbanization of Japan.[6]

4 Sekiyama, *Kinsei Nihon,* 220, 232; Osaka-shi Sanjikai, *Osaka shishi* (Tokyo, 1927), I, 482–483, 602, 880–882; (1928), II, 107, 180–181, 546, 758–759.

5 See John W. Hall, "The Castle Town and Japan's Modern Urbanization," in *idem* and Marius B. Jansen (eds.), *Studies in the Institutional History of Early Modern Japan* (Princeton, 1968), 169–188; Thomas C. Smith, "Pre-modern Economic Growth: Japan and the West," *Past & Present,* 60 (1973), 127–160; Jansen and Rozman (eds.), *Japan in Transition* (Princeton, 1986), 273–374.

6 For discussions of pre-Tokugawa urban development, see Toyoda, *Chūsei Nihon shō-*

EDO'S WATER SUPPLY SYSTEM When Tokugawa Ieyasu selected Edo for his capital, he recognized from the outset the problem of obtaining an adequate water supply and ordered a former retainer, Ōkubo Tōgorō Tadayuki, to construct a water supply system. In 1590, Ōkubo first went to Edo to assess the situation and make plans. The system he began was so large in scale and so successful that it has been compared to that of the Romans.[7]

Although Edo was strategically situated, much of it was on low, marshy ground near the sea. The potable water was originally obtained from ponds and underground springs, but wells had to be deep because of the depth of the aquifer. The first system constructed, the Kanda system, drew its water from the Inokashira spring east of the city. Water was carried to the city limits mainly in exposed aqueducts, and then in underground aqueducts or wooden pipes within the city. The Kanda system was over forty-one miles in length and had 3,663 subsidiary ducts which drew water from the main source and distributed it to various parts of the city. Whenever possible, natural waterflow was used, but the Japanese did increase pressure at selected points to lift water from one level to another. However, the Kanda system was designed for delivering water to the lower-lying sections of the city, so that natural waterflow was usually sufficient. A problem with this system was that the water from the Inokashira spring was limited in quantity and, if too much was pumped out, the quality suffered—the water turned muddy. By the mid-seventeenth century, this system was inadequate for the growing city's needs, and a new system was begun in 1652.[8]

The second system took its water from the Tama River. Well over fifty miles in total length, it was larger than the Kanda system and carried a far greater volume of water. The Tama River system brought water up to the Yotsuya gate of Edo castle, a distance of nearly twenty-seven miles, supplying first of all the Shogun and then the nearby areas, Kōjimachi, Yotsuya, Kyōbashi, and Aka-

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gyō-shi no kenkyū (Tokyo, 1952), 364–386; Sasaki Ginya, *Shōgakkan Nihon rekishi* (Tokyo, 1975), XIII, 260–271; Yagi Akio, "Chūsei no shōkōgyōsha to toshi," in Nakamura Kichiji (ed.), *Taikei Nihon-shi sōsho* (Tokyo, 1965), VIII, 328–345.

7 Higuchi Kiyoyuki, *Edo* (Tokyo, 1968), IV, 233.

8 Descriptions of Edo's water supply system are to be found in Horikoshi Masao, *Ido to suidō no hanashi* (Tokyo, 1981); Sabata Toyoyuki, *Suidō no bunka: Seiō to Nihon* (Tokyo, 1983); Itō Kōichi, "Edo no suidō seido," in Nishiyama Matsunosuke (ed.), *Edo chōnin no kenkyū* (Tokyo, 1978), V, 283–308; Higuchi, *Edo,* IV, 231–247.

saka. When first constructed, there was sufficient water to serve the city and also to irrigate rice paddies in Musashino, a farming area west of Edo. However, as the city expanded, the use of the Tama River system's water for irrigation had to be curtailed.

The Tama River system proved to be inadequate, not so much because of the insufficiency of water, but because of the difficulties of raising the water to higher ground as the city expanded outward. A major stimulus for continued construction of water systems was also the problem of frequent and devastating fires in Edo, which was largely constructed of wood. In the great Meireki fire of 1657, approximately two thirds of the city was destroyed; deaths were estimated in the tens of thousands. Subsequently, a policy was implemented to decrease the density of the population at the center, and many samurai mansions and temples were relocated on the outskirts of the city, leaving open spaces within the city to serve as fire breaks. Four new water systems were added—the Honjo, Aoyama, Mita, and Sengawa—all of which relied on the Tama River for their water supply and were really subsidiary to the main system. These newer systems seem not to have been entirely satisfactory for, by the mid-nineteenth century, Edo relied primarily on the original Kanda and Tama River systems. Since the Kanda system now received some of its water supply from the Tama River, Edo's water supply came mainly from that one river.

During the century that it took to build Edo's water systems, the engineering techniques became increasingly sophisticated. In the early part of the seventeenth century, ditches were the most common conduit outside city limits. For its underground aqueducts, the Kanda system used square pipes of red pine, but other early systems had pipes made of other kinds of wood, stone, earth, and bamboo. By the time the Tama River system was constructed, the engineers designing it were using triangulation, which made accurate surveying possible and helped solve the problems created by differing heights of land. Siphons were used to draw water up into Edo castle from the ducts of the Tama River system. The newer the system, the more pipes it had rather than open channels, and thus much more of the later systems were underground.[9]

9 Higuchi, *Edo,* IV, 244.

The government was not only responsible for the building of the water systems supplying Edo, but it also tightly regulated their use. No individual was permitted to draw water directly from the main system unless he were a samurai of high status, usually a daimyo or a high-ranking retainer of the Shogun. The public was supplied with water from wells built into the aqueduct system; people were required to go to the nearest well and draw water there rather than tap the nearest duct themselves. This control ensured an adequate flow of water and proper maintenance of the system.

Clearly Edo was a special case. Its water supply system was designed at the same time the city was, and the system was expanded as the city grew. Edo's system was vastly superior to the water supply systems in all other Japanese cities, most of which relied on rivers and wells for their water supply. However, with the building of the castle towns from the late sixteenth century on, water supply systems were constructed in various regions, no longer primarily for irrigation but to supply drinking water to urban populations. The first major system built primarily to supply drinking water was the Kanda, followed by systems constructed for cities not only in central Japan but also in such far-flung places as the southern tip of Kyushu. Many were built in the early seventeenth century, followed by continued construction of new systems throughout the Tokugawa period. In addition to systems designed specifically for supplying cities with potable water, numerous irrigation projects supplied drinking water as well.[10]

WASTE DISPOSAL IN OSAKA AND EDO The methods developed for disposing of various kinds of wastes in both Edo and Osaka can be documented through regulations, contracts, and records of challenges or conflicts. The number and variety of the sources indicate that from the mid-seventeenth century on, waste disposal was a major concern for urban administrations. Osaka provides the best example of how different sewage disposal was in Japan, in contrast to Western nations, whereas Edo illustrates how complex waste disposal in a premodern Japanese metropolis was and how the problems were managed.

10 Horikoshi, *Ido to suidō*, 98–99.

The most important difference between waste disposal in Japan and in the West was that human excreta were not regarded as something that one paid to have removed, but rather as a product with a positive economic value. The night soil of Japanese cities—and Chinese as well—was long used as fertilizer. With the growth of Japan's population, the limitation of the amount of arable land and the increasingly intensified use of land to feed the growing population, combined with the relative scarcity of animal wastes and other fertilizers, meant that human waste had a value as fertilizer that far exceeded its value in the West.

Long before Edo was even established, Osaka's night soil was used as fertilizer for the surrounding farm villages. Most of it was collected, loaded onto ships, and distributed to nearby farm areas. The huge volume brought to the wharves resulted in such an unpleasant odor that there were complaints. In the Tokugawa period, the magistrates deliberated upon these complaints but concluded that "it was unavoidable for the manure boats to come into the wharves used by the tea and other ships."[11]

In the early years of the Tokugawa regime, boats were sent into Osaka loaded with vegetables and other farm produce which were exchanged for the night soil of the city. But as the price of fish and other fertilizers rose, the value of night soil rose correspondingly, and vegetables were no longer sufficient to pay for it. By the early eighteenth century, with the increase in new paddies in the Osaka area, the price of fertilizer had jumped to the point that even night soil had to be purchased with silver.

The value of human wastes was so high that rights of ownership to its components were assigned to different parties. In Osaka, the rights to fecal matter from the occupants of a dwelling belonged to the owner of the building whereas the urine belonged to the tenants. Feces were considered more valuable and hence commanded a higher price. Generally speaking, the price of fecal matter from ten households per year amounted to between two and three *bu* of silver, or over one half a *ryō* of gold. This was a considerable sum since a *ryō* during much of the Tokugawa period was sufficient to buy all the grain staple one person would eat during a year. Rent was adjusted on the basis of how many tenants there were and was raised if the number of occupants dropped.[12]

11 Wakita Osamu and Kobayashi Shigeru, *Osaka no seisan to kōtsū* (Osaka, 1973), 127.

12 Although urine is usually higher in nitrogen and potash than solid excreta and is

With the rapid growth of Osaka in the seventeenth century, the city government found by mid-century that it had to step in and form guilds to insure that waste disposal was handled properly. As the price of fertilizer rose, by the end of the century farmers from neighboring areas were forming associations for the purpose of obtaining monopsony rights to purchase night soil from various areas of Osaka. Eventually fights broke out over collection rights and prices. In the summer of 1724, two groups of villages from the Yamazaki and Takatsuki areas fought over the rights to collect night soil from various parts of the city. Other disputes arose between the guilds in the city and farmers' associations, and examples exist for the neighboring provinces of Kawachi and Settsu as well, indicating that this type of conflict was neither a localized nor an isolated event.[13]

In the three major areas of Osaka, neighboring farm villages held the rights to collect night soil from households, but they either could not or did not want to collect all of the urine. The remainder was left to be collected by *shōben nakagainin,* literally, urine jobbers. The number of jobbers gradually increased, as did jurisdictional problems. Eventually they created their own association, and in 1772 they paid a fee to the Osaka authorities to establish a *kabunakama* (guild based on ownership of shares) with the authority to enforce jurisdiction and to set prices. However, the rights to collect the urine from containers left for passersby on the street corners in Osaka were given to an outcast village named Watanabe, but even though the price of urine was lower than for fecal matter, there were constant conflicts over these collection rights. Periodically, other people tried to get these privileges away from Watanabe, but the village managed to maintain its monopoly throughout the Tokugawa period, despite sabotage of its containers, challenges by others to its collection rights, and offers to buy the rights.[14]

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especially useful as an activator in converting crop residues to humus, it is more difficult to transport and store than solid excreta, which probably accounts for its lower price. For the price of fecal matter, see Watanabe Minoru, *Mikaihō buraku-shi no kenkyū* (Tokyo, 1965), 297. The value of a *ryō* was calculated from Yamasaki Ryūzō, "Edo chūki no bukka dōkō to keizai hendō," in Harada Toshimaru and Miyamoto Matao (eds.), *Rekishi no naka no bukka* (Tokyo, 1985), 78.

13 Wakita and Kobayashi, *Osaka,* 128.

14 Watanabe, *Mikaihō,* 292–299. See also Osaka-shi, *Osaka shishi,* I, 866–868.

In Osaka, by the mid-eighteenth century, night soil was so clearly an economic good that ownership and monopoly/monopsony rights were assigned, the formation of officially recognized associations and guilds was permitted, and the price was determined by these organizations. The price was so high that the poorer farmers had difficulty in obtaining sufficient fertilizer, and incidents of theft began to appear in the records, despite the fact that going to prison if discovered was a real risk.

In Edo, judging from official records, disputes over night soil seem not to have been the problem that they were in Osaka, but the government did have to step in to handle problems of orderly waste disposal. Edo's waste, other than night soil, can be divided into four major types: 1) household waste, probably mostly kitchen garbage; 2) trash discarded along the roads and in the waste water drains; 3) junk floating in waterways—moats, rivers, and the harbor; and 4) waste from fires. In addition, Edo had the problem of disposing of its waste water since its ample water supply meant that enormous quantities of water had to be discarded somewhere.[15]

Regulations regarding waste began to appear in Edo during the mid-seventeenth century. The focus at this time was not waste collection per se, but the growing problem of keeping the streets, open areas, and drainage ditches free from rubbish. This was clearly viewed as a problem within the purview of city government. At the same time, problems relating to the disposal of night soil came to the attention of the authorities. In 1648, city regulations required small huts and toilets along the banks of rivers to be torn down. The repeated issuance of this and other regulations over the next half century indicates that Edo residents must have been slow to comply with the new, more sanitary arrangements for waste disposal.[16]

These regulations also indicate that demand for Edo's night soil was probably not high during the early Tokugawa period and much potential fertilizer must have been wasted. However, as truck gardening developed in the area around Edo and the city

15 Hayashi Reiko, "Kinsei ni okeru jinkai shori," *Ryūtsū keizai ronshū*, VIII (1974), 72–86.

16 For information on waste disposal in Edo, see Itō, "Edo ni okeru gomi, gesui, shinyō no shori," in Toyoda, *Nihon no hōken toshi*, 431–455; Kawazoe Noboru, *Uragawa kara mita toshi* (Tokyo, 1982), 152–190.

came to rely less on a supply of daily goods from afar, the demand for night soil rose. The market for the night soil of Edo was the farm villages surrounding the city within a radius of about ten miles. By the first half of the eighteenth century, the sudden withdrawal of a particular supply of night soil could be devastating to a farmer, as alternate supplies were not easily found. A village head in the neighboring district of Tama lost his supply of fertilizer in 1725 when the main residence of the daimyo of the Owari Tokugawa burned. Before the mansion could be rebuilt, the farmer suffered major crop losses.

Contracts were given to farm villages for the night soil from specific areas in Edo. Usually each daimyo contracted out these rights, with the price determined on the basis of the market demand. For example, the Hitotsubashi daimyo sold the rights to night soil from the residence in 1742 to one Hanbei from Tanashi village in the district of Tama for the price of 1,500 large *daikon* (large white radishes), or 2,000 middle-sized *daikon,* or two *ryō* in cash, whichever Hanbei preferred, to be paid at the end of the year. Each year this daimyo house decided the price by bidding out the rights. Each daimyo made different arrangements, sometimes with the payment made twice a year, and the price as high as six *ryō* or more.

As the price of night soil rose, entrepreneurs sought rights to place containers to collect urine on busy street corners in Edo, but these petitions were denied. Since Edo was the seat of government, officials were concerned with appearance more than they seem to have been in Osaka, but they also worried about the impeding of the narrow streets and the problem of odor. One particularly innovative petition in 1789 requested permission to set out soy sauce and *sake* barrels, which would be less of an eyesore than urinals. The petitioner argued that allowing the collection of urine from passersby would add to the quantity of fertilizer, thereby reducing the price of other fertilizers, enabling farmers to use more fertilizer and produce larger harvests, and ultimately would lower price levels in general.

At the same time that the first regulations about night soil appeared, the disposal of other forms of waste was also specified. By 1655, the people of Edo were ordered to dispose of their garbage and rubbish on the island of Eitai in Edo Bay, rather than just dump it in the rivers. During the decade from 1655 to 1665, basic disposal policies were gradually put into effect: collection

points for refuse collection were established in each ward; transport was contracted to specific jobbers; and the wards were ordered to bear the costs. From the ward collection points, the rubbish was loaded onto boats and transported to Eitai Island. Although the original purpose of these measures was to keep the river channels open for commerce and traffic, they resulted in the establishment of an official dump for the city located outside city limits. These policies remained in effect for the next two centuries.

The designation of Eitai Island as a dump eventually resulted in the creation of new land from the swampy ground in eastern Edo. Several other landfills also resulted in the creation of fields, so that disposing of Edo's wastes became a very profitable business. By the 1820s at least eighty contractors were involved in collecting the rubbish from Edo, encouraged in part by the creation of official organizations, the *kabunakama*. Now the townspeople had only to deposit their refuse at a collection site within the ward and pay for its collection and transportation for final disposal by a contractor. Ward fees were assessed by length of frontage and location of the property, so that, in effect, people paid a property tax. Whether renters were assessed depended on the ward.

Finally, there was the matter of drainage and disposal of waste water in Edo, which had a number of rivers and canal-like moats flowing through the city. From the number of regulations issued, the major problem seems to have been keeping the moats and river channels free from rubbish, rather than providing for drainage itself. Detailed instructions were issued: people were ordered to construct drainage channels along the fronts of their houses, under the eaves. These ditches collected runoff from the streets and roofs, as well as people's waste water. The channels, about a foot wide and a couple of feet deep, partially covered by stones to prevent people from falling in, are still to be seen in many cities, including the outskirts of modern Tokyo. Archaeological excavations in Tokyo reveal clearly the fine network of drainage ditches even within the compounds of what would be considered crowded working-class housing at best and slums at worst.[17]

Edo and Osaka were not alone among Japanese cities in their emphasis on the proper disposal of waste material and the necessity of keeping streets and waterways clean and open. Even the

17 Koizumi Hiroshi, *Edo o horu* (Tokyo, 1983), 64.

main streets in most castle towns were relatively narrow, about twenty-four feet wide, but they were "extremely well maintained and immaculately clean." The regulations regarding the maintenance of public roads were detailed and infractions were reported. In Tottori, for example, streets had to be cleared and then sprayed with water (which probably reduced the incidence of respiratory disease). In Hirado orders were issued to the effect that all bridges, gutters, and waterways should be repaired, maintained, and cleared; to make certain that this was done, officers of the town were to inspect them constantly. "No corner shall be left uncleaned." Judged by regulations alone, cleanliness and proper sanitation were of high priority among Tokugawa urban administrators.[18]

WHY JAPANESE CITIES WERE MORE HYGIENIC THAN EUROPEAN CITIES

Metropolitan sanitation in Japan from the mid-seventeenth through the mid-nineteenth centuries was almost certainly better than in the West in terms of quality and quantity of the water supply and in terms of waste disposal, resulting in a healthier environment for urban populations as measured by the size of the population and mortality rates. But Japanese city life was also more sanitary than that in the West because of various customs concerning hygiene, food, and drink, and because of a lack of domestic animals. Finally, the government played a major role in setting and maintaining standards of sanitation in the cities. Evidence to support these hypotheses comes not only from descriptive material, but from comparisons made by observers from the West who visited Japan, and from the few quantitative measures we have on water quality, mortality, and life expectancy.

As already elaborated, an important difference between Japan and the West was that human excrement was an economic good in Japan, and was carefully collected for use as fertilizer, thus protecting the water supply in all phases, from source to urban pipes, and also preventing people from coming into contact with waste matter while walking on the street or in or near dumping grounds. In contrast, Westerners traditionally relied on pits in the ground, such as cesspools, for the disposal of human wastes, and

18 Murai Masuo, "Hōken-sei no seiritsu to toshi no sugata," in Morimatsu Yoshiaki et al. (eds.), *Taikei Nihon-shi sōsho* (Tokyo, 1965), XVI, 128.

the danger of polluting water supplies was ever present. Even in the 1880s, Cambridge, England, was described as "an undrained, river-polluted cesspool city." In the nineteenth century, "Leicester was typical of many towns in the way it tackled the problems of excrement removal. At mid-century it had almost 3,000 uncovered cesspits, covering 1¼ acres." Only by the end of the century had it managed to convert to a system of pails, which put an end to seepage into the sub-soil.[19]

Much has been made of the English invention of the water closet, but in the early years this system caused more problems than it solved. First, it required both a water supply and sewer system that could safely supply and remove the large quantities of water that the system used. When the water closet was first invented, Londoners flushed their wastes into the Thames, thinking that at last they were rid of a nasty problem in their houses. What they did not realize for decades was that the cause of the epidemics of infectious disease sweeping the city was the flushing of sewage into the upper Thames, since much of the city's water was taken from it downstream. Furthermore, faulty drains caused sewer gases to waft up into homes, and people with fixed basins in their bedrooms often had to cover them with towels at night, a rather primitive method of coping with this problem.[20]

Nor was the new world immune: "As late as 1849, physician John H. Griscom described the unhealthy sanitary state created on Manhattan Island by 'these thirty thousand cesspools studding it up and down, and filling the atmosphere with nauseous gases'." Stone comments that "even after the introduction of water supply systems, conditions in cities and towns remained unsanitary until properly engineered sewers replaced cesspools, beginning about 1850." Pinkney's assessment of Paris in the same year is that there was "one shockingly direct connection" between sewage disposal and the water supply. "The city drew part of its water supply from that main collector sewer, the Seine, and pumped it largely at points downstream from the mouths of sewers emptying into the river. Most of the remainder of the city's water supply came from sources little more inviting."[21]

19 Anthony S. Wohl, *Endangered Lives: Public Health in Victorian Britain* (Cambridge, Mass., 1983), 73–74, 95.

20 Thomas McKeown, *The Modern Rise of Population* (New York, 1976), 125.

21 John H. Griscom, *The Uses and Abuses of Air* (New York, 1854), 183, as quoted in

Japanese cities did not have the horrendous problems of sewage contamination of their main water supplies that London and Paris did, not only because they did not flush sewage into the rivers, but also because water in Japan tended to be purer at the source. Japan's four main islands are all dominated by mountain ranges, resulting in short, swift rivers. In addition, Japan's abundant rain, particularly during the typhoon season, helps flush out the rivers, preventing the pollution that occurs in slow, meandering water courses.

More than one scientific examination of Tokyo's water quality in the nineteenth century exists. In the mid-1870s Atkinson, an Englishman, tested Tokyo's water at various points in the system for the existence of solids, chlorine, ammonia, nitrogen, etc. At this time, it was not possible to test for bacteria content, or "germs" as they were called by Atkinson, but scientists could chemically test water for organic content which would indicate the approximate contact with raw sewage, and thus the likelihood that it would cause disease. Atkinson's survey of the Tokyo system revealed that the water was usually close to pure at the source, but the farther the samples were taken from the source, the more contaminated they proved to be. It is not surprising that his samples from surface water were contaminated; what is surprising is that early Tokyo had a water supply purer than did London. Remember that he was comparing the water supply system of a city yet to begin using modern technology with the largest city in Europe's first industrialized nation.[22]

Furthermore, Edo's system was so well designed that when it was modernized at the end of the nineteenth century, the only

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May N. Stone, "The Plumbing Paradox," *Winterthur Portfolio*, XIV (1979), 292, 284. For good overviews, see Joel A. Tarr et al., "Water and Wastes: A Retrospective Assessment of Wastewater Technology in the United States, 1800–1932," *Technology and Culture*, XXV (1984), 226–263; Tarr, James McCurley, and Terry F. Yosie, "The Development and Impact of Urban Wastewater Technology: Changing Concepts of Water Quality Control, 1850–1930," in Marton V. Melosi (ed.), *Pollution and Reform in American Cities, 1870–1930* (Austin, 1980), 59–82. David H. Pinkney, *Napoleon III and the Rebuilding of Paris* (Princeton, 1958), 21.

22 R. W. Atkinson, "The Water Supply of Tokio," *Transactions of the Asiatic Society of Japan*, VI (1878), Pt. I, 96. In addition, O. Korschelt, in a paper read before the Asiatic Society of Japan on December 12, 1883, assessed the quality of wells in Tokyo and concluded that artesian wells were a suitable means of supplying water to areas of Tokyo not reached by piped in water. He was even more salutary in his assessment of Tokyo's water supply than was Atkinson.

major change was to replace the wooden pipes with impervious metal ones. Thus, the Japanese were able to use the main features of a system constructed in the seventeenth century when converting to a water supply system based on modern technology more than two centuries later. The engineering feat involved in building such a sound and large-scale system was remarkable, especially considering that dirt from the excavations for the channels and works was hauled away in baskets or straw mats.

Although London's "New River" was constructed in the same period as Edo's Kanda system, the success in bringing spring water to London in 1613 was scarcely the equivalent of the construction of the Kanda system in Edo in the same period. In London, most of the pipes were on the surface and watchmen had to be hired to deter tampering. As London expanded, the water supply became increasingly inadequate, but, unlike Edo, no ready solution was found. Pipes could be added but the supply was not increased, and so by the mid-eighteenth century Londoners could draw water only seven hours a day, three days a week. In contrast, Edo's pipes were not as strong, but they were buried and there was always a sufficient water supply twenty-four hours a day. Stoppage of water was so rare that Edo-ites made no backup arrangements for emergencies. Indeed, the Tama River system brought so much water into Edo that a waterfall in the center of the city was created from the excess, and when the Ebisu Beer Company was founded in the late nineteenth century, it was able to use the water from the Tama system.[23]

This is not to argue that the premodern Japanese water supply and waste disposal systems were without problems. When human excreta are used for fertilizer, there is always the danger of contamination—transmission of pathogens to the food supply and pollution of the water supply through runoff from fields or inadequate storage or transportation of the night soil. Although some human excreta were sold as fertilizer in the West, for the most part night soil was wasted, particularly in the largest urban areas after sewerage, or water carriage systems, were adopted. By the end of the nineteenth century, the West had some advocates of sewage farming, but public health officials, as well as the general public, had a strong bias against using human waste for

23 Sabata, *Suidō no bunka*, 32.

fertilizer. They "maintained that the raw sewage exposed farm employees to possible infection and that the vegetables grown on the farms could be the carriers of 'dangerous microbes or other parasites,' even though there was no clear evidence" of this. In fact, Asians did not merely dump raw night soil onto their fields, but they stored it at least a month in the knowledge that direct application of raw exreta was dangerous.[24]

The combination of heat and time necessary to kill various pathogens varies. Scientists also disagree or are uncertain as to the degree of contamination of water by an enteric virus that will infect a community. There are numerous documented cases of outbreaks of disease in both Asia and the West through the use of night soil or sewage for fertilizer. Thus it is difficult to determine today how safe treatments of human excreta or manure were 200 years ago. "The great majority of illnesses associated with sewage, however, appear to have been caused by application of raw or inadequately treated sewage wastewater, raw sludges, and night soil to crops which were consumed raw." And at least two studies indicate that "the predominant method of transmission of enteric viruses appears to be a direct fecal-to-oral route."[25]

It is difficult to assess the sanitation and hygiene standards of the populace in premodern times, but some information exists for elites, making possible a comparative evaluation for various nations. Although the sanitary conditions and the customs regarding personal hygiene of the elite cannot be considered representative of a society as a whole, they are indicative of what one would expect the highest standard to be. For example, in seventeenth- and eighteenth-century France, "the palaces of the Louvre, Vincennes or Fountainebleau in places became mere latrines." A house steward wrote: "In many places in the courtyard, in the upper passages, behind the doors and almost everywhere, one can see a thousand heaps of ordure, one can smell a thousand

24 Tarr, "From City to Farm: Urban Wastes and the American Farmer," *Agricultural History*, XLIX (1975), 610. F. H. King, *Farmers of Forty Centuries* (Emmaus, Pa., n.d.; orig. pub. 1911), 193–215; Reginald Reynolds, *Cleanliness and Godliness* (Garden City, 1946), 253.

25 Wylie D. Burge and Paul B. Marsh, "Infectious Hazards of Landspreading Sewage Waste," *Journal of Environmental Quality*, VII (1978), 7. Studies by G. Berg (1966) and J. W. Mosley (1972) cited in *ibid.*, 3.

unbearable stenches caused by the necessities of nature which everybody discharges there daily."[26]

In contrast, João Rodrigues, a Jesuit, who was in Japan from the late sixteenth into the early seventeenth century, noted that the Japanese

> provide their guests with very clean privies set apart in an unfrequented place far from the rooms. . . . The interior of the privies is kept extremely clean and a perfume-pan and new paper cut for use are placed there. The privy is always clean without any bad smell, for when the guests depart the man in charge cleans it out if necessary and strews clean sand so that place is left as if it had never been used. A ewer of clean water and other things needed for washing the hands are found nearby, for it is an invariable custom of both nobles and commoners to wash their hands every time after using the privy for their major and minor necessities.[27]

By the mid-nineteenth century, conditions in France were no longer so primitive, but the problems with sewage and contamination of the water supply indicated that major sanitation problems remained. In mid-nineteenth century Britain, even royalty was not immune from the effects of inadequate sewage disposal. Prince Albert, Queen Victoria's consort, is thought to have died of typhoid fever contracted from faulty drains. In contrast, in Japan in the 1870s in the privies in the "better class of private homes," an American visitor found "less annoyance and infinitely less danger . . . than are experienced in many houses of the wealthy in our great cities." His description of the privies is similar to Rodrigues' in the sixteenth century, except that attendants did not clean out the receptacle after every use, but rather it "was emptied every few days by men who have their regular routes." Morse was taken not only by the cleanliness of Japanese toilets, but also by the amount of artful carpentrywork that decorated them in homes that he visited. He was not describing the

26 Frantz Funck-Brentano, *The Old Regime in France* (London, 1929), 156. Nicholas de la Mare was house steward to the Comte de Vermandois.

27 João Rodrigues, as quoted in Michael Cooper (ed.), *They Came to Japan* (Berkeley, 1965), 221.

toilet facilities of the elite but those in the houses that he visited during his extensive stays in Japan.[28]

This is not to say that contamination from human wastes did not occur in Japan, but it was probably less frequent than in the West. And custom helped prevent Japanese from becoming ill even when their water supply was not free from impurities. The Japanese customarily drank their water boiled, usually in the form of tea, a custom remarked on by foreign visitors to Japan from the sixteenth century. With the exception of Japanese "pickles," preserved by fermentation and salt, the Japanese usually ate their food cooked, so that even if night soil was improperly applied as a fertilizer, it was less likely to make everyone sick. Within the household, each member had his own set of chopsticks, rice bowl, and teacup, which no one else used, so that it did not matter much that washing was perfunctory and in cold water. Food served outside the home was frequently finger food, and chopsticks used in restaurants were usually lacquered for easy cleaning and were not put in the mouth as were spoons in the West. By the mid-nineteenth century, disposable chopsticks had come into use.[29]

Moreover, the Japanese had strong notions about what was dirty and clean, many of which can be traced back to the Japanese native religion of Shinto and its concepts of pollution. Much of the pollution in Shinto is ritualistic, but what is considered polluting and what is purifying are related to contamination and cleanliness. Anything to do with blood, death, and illness—such as childbearing, menstruation, contact with a sick or dying person, and funerals—is considered unclean, and people used to be prohibited from participating in religious rituals, mixing with

28 The quotes are from Edward S. Morse, *Japanese Homes and Their Surroundings* (Rutland, 1972; orig. pub. 1887), 228, 231. See also, Wohl, *Endangered Lives*, 127; Morse, "Latrines of the East," *The American Architect and Building News*, XXXIX (18 Mar. 1893), 170–174.

29 Cooper, *They Came to Japan*, 198–199; *idem*, *This Island of Japon* (Tokyo, 1973), 263; Engelbert Kaempfer, *The History of Japan Together with a Description of the Kingdom of Siam, 1690–92* (Glasgow, 1906), III, 238–240. Although raw fish became popular during the Tokugawa period, particularly in large cities, it was most frequently partially preserved and fermented and not served as slices of fresh raw fish as is common today. In any case, fish came from the sea and would not have been contaminated by fertilizers. For Tokugawa dietary habits, see Watanabe, *Nihon shoku seikatsu shi* (Tokyo, 1964), 190–269; Hanley, "The Material Culture: Stability in Transition," in Jansen and Rozman (eds.), *Japan in Transition*, 454–461.

other people, and even returning home from a funeral without being purified. Salt, water, and fire were all considered purifying agents and were used both to perform religious rituals and to clean and purify. This emphasis on purification is not unique to Japan; it can be found throughout Asia, but it is particularly strong in Japan and has persisted into modern times. The strong avoidance of things dirty, while at one level almost superstitious, most certainly resulted in lack of bacterial or viral contamination for many, and impeded the spread of diseases and infections in Japan. At the everyday level, it resulted in the compulsory removal of footwear when entering a house or any other building raised from the ground, and the washing of hands after using the toilet.[30]

Japanese are known for their frequent bathing, a custom that became widespread in the Tokugawa period. Originally bathing was associated with temples, which often maintained public baths. Then, in the late sixteenth century, public baths began to appear in the largest cities, and these became so popular that by the early nineteenth century there were an estimated 600 public baths in Edo alone. The earliest baths worked on the principle of the sauna; people used relatively little hot water to steam their pores open and the dirt out. Gradually baths in which the bathers soaked in tubs of hot water began to predominate, and in time, the size of both the tubs and the bath houses increased as well. But how widespread the use of these baths was by the general public, especially women and children, is still open to question, as the bath houses had the same type of reputation as in Western cultures. Social aspects were often as important as the act of cleansing, and many of the women employed in the public baths were prostitutes. However, families that could afford them began to install baths in their homes, and the frequent mention of baths and bathing in popular literature and the depiction of them in drawings and paintings indicates how widespread the custom was. Regular laundering of clothing by the common people also began in the Tokugawa period, and the new emphasis on cleanliness must certainly have had a salutary effect on hygiene and sanitation.[31]

30 Ishige Naomichi, "Jūkyo to jū-seikatsu," in Umesao Tadao (ed.), *Nihonjin no seikatsu* (Tokyo, 1976), 29; H. Byron Earhart, *Japanese Religion* (Encino, 1974; 2nd ed.), 7; Emiko Ohnuki-Tierney, *Illness and Culture in Contemporary Japan* (Cambridge, 1984), 24.

31 Ochiai Shigeru, *Arau fūzoku-shi* (Tokyo, 1984), 71–85.

Although customs relating to hygiene within the Japanese family depended for effectiveness on individual conformity, at the public level maintenance of sanitation also depended on government. A major reason that clean streets and an adequate water supply of high quality could be maintained was the high degree of control that existed over the populace during the Tokugawa period.[32]

Government control was enhanced by two factors. First, the samurai as a class had a monopoly on government positions during the Tokugawa period. The raison d'être of this group was to govern Japan, and explicit in the neo-Confucian philosophy that the samurai adopted was the concept of rulers as benevolent, as responsible to the ruled, and as moral examples. Not only did the rulers expect such conduct from themselves, but there is evidence that the ruled expected it as well, and let the rulers know it. Second, by the mid-Tokugawa period there were more samurai than were needed to govern, and overstaffing resulted in numerous detailed regulations and sufficient officials to see that these regulations were carried out.[33]

The effect of this benevolent but thoroughgoing government can be found in the governance of Edo. The city was divided into *machi*, which were village-sized units responsible for government at the local level. This division enabled authorities to have tight control over the enormous population of the city. At large intersections in the city, the premodern equivalents of the police box were set up, not only to keep an eye out for criminal activities, but, among other things to ensure that no water pipes were leaking and that the streets were kept clear. In addition, the city authorities made use of the outcastes who lived within the city. These people not only served to keep the streets free from any dead animals, to carry away corpses, and to handle anything which ordinary residents would not touch, but also to report on anything suspicious that they found on their rounds. Thus, in the late nineteenth century, Morse could comment favorably on what

32 Hall, "Rule by Status in Tokugawa Japan," *Journal of Japanese Studies*, I (1974), 39–49.

33 Irwin Scheiner, "Benevolent Lords and Honorable Peasants: Rebellion and Peasant Consciousness in Tokugawa Japan," in Tetsuo Najita and Scheiner (eds.), *Japanese Thought in the Tokugawa Period* (Chicago, 1978), 46; Yamamura, *A Study of Samurai Income*, 47–48.

were the slums of the new city of Tokyo, less than a decade from when it had been called Edo. "In Tokio one may find streets, or narrow alleys, lined with a continuous row of the cheapest shelter; and here dwell the poorest people. Though squalid and dirty as such places appear to the Japanese, they are immaculate in comparison with the unutterable filth and misery of similar quarters in nearly all the great cities of Christendom."[34]

Finally, the Japanese did not have to cope with the density in cities that Westerners did. Tenements in Japan were one story high, not six as they commonly were in Europe. The families of the poorest daily laborers in Edo were often crammed into one-room apartments approximately nine feet square with a small entry for storing tools and footwear and for cooking. They shared toilets and access to water with other tenants in the block. But however densely these families were packed in, they were not on top of each other in multi-story buildings, nor did people live in basements. The ever-present danger from earthquakes and the light construction of Japanese housing precluded tall buildings, and the authorities forbade their construction by anyone who might be inclined to be so imprudent.[35]

Statistical evidence for the assertion that sanitation was substantially better in Japan than in Europe during the eighteenth and nineteenth centuries comes from estimates of life expectancy. Estimates for various village samples for Tokugawa Japan indicate that, by the nineteenth century, life expectancy was probably in the low forties, with five-year averages ranging from the low thirties to as high as seventy-five years. Even in the city of Takayama, for which records exist for the century from 1773 to 1871, birth and death rates were similar to the village rates: the average crude death rate for this century was 27.3 per thousand. As a metropolis, Edo probably had higher death rates than the farming villages in central Japan and certainly a lower birth rate, as the sex ratio was skewed due to the high proportion of samurai

34 Morse, *Japanese Homes*, 5–6. See Tamura Eitarō, *Chōnin no seikatsu* (Tokyo, 1966), 194–197; Harada Tomihiko, *Nihon hōken toshi kenkyū* (Tokyo, 1957), 438.

35 Robert Higgs and David Booth have found that "density effects on mortality were uniformly positive and statistically significant" in 17 American cities in 1890: "Mortality Differentials within Large American Cities in 1890," *Human Ecology*, VII (1979), 353. See also Tamura, *Chōnin no seikatsu*, 198–199; Nishikawa Kōji, *Nihon toshi-shi kenkyū* (Tokyo, 1972), 250. M. Dorothy George, *London Life in the Eighteenth Century* (New York, 1964), provides graphic descriptions of life in London.

without their families and males who migrated to the city to work. But had the death rate been significantly higher, the city would not only have had difficulty maintaining a population above a million, but contemporary Japanese would also have noted the high death rates.[36]

Tokugawa Japan and Europe in the same centuries had strikingly similar life expectancies. Life expectancy at birth in Europe in 1800 has been estimated as high as thirty-five to forty for some countries, a number higher than in the preceding centuries. Female life expectancy at birth was 42.18 in England and Wales in 1841 and 40.83 in France in 1817 to 1831. A composite figure for life expectancy for males in Western Europe in the nineteenth century, as calculated by the United Nations, is 30.6 in 1840, 41.1 in 1860, and 48.9 in 1900. Female life expectancy is estimated to have risen from 42.5 in 1840 to 52.1 by 1900. These estimates are similar to those we have for Tokugawa Japan.[37]

Although the demographic statistics available for Japan and Europe indicate a similarity in the figures, by the nineteenth century Western European nations had available modern technology and by 1850 were well into the process of industrialization with its concomitant rising standard of living. Japan, however, did not begin to use any modern technology until nearly the end of the century. Given the high proportion of Japanese who lived in cities, had sanitation been poor and the level of living low, this combination would have been reflected in high rates of morbidity and mortality.

In fact, Japan seems to have been surprisingly free from the devastating effects of epidemics. The plague never reached Japan, and cholera came only in the nineteenth century when it spread throughout the world. Intestinal worms and enteric infections—those that enter through the mouth and are spread through contamination of food and water—tended to be localized and to

36 Hanley and Yamamura, *Change in Preindustrial Japan*, 216–225; Dana Morris and Smith, "Fertility and Mortality in an Outcaste Village in Japan, 1750–1869," Hanley and Arthur P. Wolf (eds.), *Family and Population in East Asian History* (Stanford, 1985), 238–239; Yōichirō Sasaki, "Urban Migration and Fertility in Tokugawa Japan: The City of Takayama, 1773–1871," in *ibid.*, 137.

37 Joseph J. Spengler, "Demographic Factors and Early Modern Economic Development," *Daedalus* (Spring 1968), 440; United Nations, Department of Economic and Social Affairs, *The Aging of Populations and Its Economic and Social Implications* (New York, 1956), 54.

appear in endemic rather than epidemic form. This situation is what would be expected in a society which used human wastes for fertilizer. It was true for Tokugawa Japan, which would explain the relatively high death rates for children between the ages of one and four or five. Children after weaning were particularly susceptible to these diseases, but if they did not die early, they tended not to succumb to them. However, the fact that the cities with a single water source, such as Edo, Osaka, and Kyoto, did not experience rampant epidemics meant that the water supply must have been generally good.[38]

Based on the evidence available on water supply and sewage disposal systems in cities in Japan and in the West from the seventeenth through the nineteenth centuries, I argue that the level of sanitation was higher in Japanese cities than in Western ones during the same period. Not only was Japan able to provide better water and disposal systems, but Japanese customs led to better hygiene and sanitation than did Western modes of behavior. Thus Japan was able to maintain large urban populations from the sixteenth century because sanitation was better and because the Japanese had the control necessary to carry out large-scale engineering projects, to implement various systems connected with water supply and waste disposal, and to see that measures were enforced.

It might well be argued that none of the above systems, customs, or beliefs in themselves would necessarily have created more healthful conditions or been better than any sample found in the West. But the combination of them, combined with near universal application, resulted in more sanitary conditions in the city and more hygienic homes than were the norm in the West, either just prior to industrialization or in the first century of industrialization.

What has obscured the realization that the level of sanitation was higher in premodern Japanese cities than in the cities of the West in the same centuries is the fact that the situation has been the reverse in the twentieth century. In 1985, only 34 percent of Japanese communities had modern sewer systems and the resi-

38 Ann Bowman Jannetta, *Epidemics and Mortality in Early Modern Japan* (Princeton, 1987).

dents of Tamagawa Josui (Tama River Water Supply) were still without a sewer hook-up. Even after World War II, the Japanese continued to use night soil as a fertilizer and thus were seen as backward by Westerners. But it was the very success of the premodern methods for dealing with night soil that made the Japanese slow to modernize their toilet and sewage systems. In the first half of the twentieth century, the Japanese had neither the income—either private or government—nor the imminent need to spend the vast sums necessary to install flush toilets and construct water-carriage sewage systems to remove the waste water. Indeed, the very success of the premodern waste disposal system inhibited modernization in this area, for, despite the shortcomings of sanitation, the Japanese today have the longest life expectancy of any major nation in the world.[39]

The rapid urbanization of the Tokugawa period and the experience of the Japanese living in and administering urban centers may well have smoothed the transition of Japan from a preindustrial to an industrial society. The Tokugawa legacy left Japan with major cities that could be easily converted into modern governmental and industrial centers, towns of 10,000 to 40,000 scattered throughout the country at strategic locations for governmental and economic purposes, the experience of millions of Japanese who had migrated to work in these cities under contract, and the capacity to administer large populations. This legacy meant that Japan could be transformed within decades into a modern society and could adopt modern technology more readily than if the Tokugawa experience had not occurred. It is easier to set up a modern water system if the basic system is already in place and the major task is to put in metal pipes, just as it is easier to establish universal education if education already is widespread.

The Japanese have lived in a densely populated society for nearly a millennium and have learned to live with limited resources on the 15 percent of the land that is not mountainous. By the Tokugawa period, the Japanese had evolved a life style that enabled them to maintain large urban populations, and this life style may well be part of the key to the success that Japan enjoys today.

39 Susan Chira, "Most Japan Houses Still Lack Comforts of Those in the U.S.," *New York Times*, 30 Oct. 1985, 1, 41.