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Ōkunoshima and Japan's Chemical Arsenal: 1900-1945

Abstract

Up until 1944, Japan had been developing its own chemical weapons programme. This arsenal was primarily produced in what would become the country's largest facility, on the island of Ōkunoshima. Before the massive casualties inflicted on the continent, Japanese workers had been the first victims of the weapons of mass destruction they had been manufacturing. This paper seeks to provide a short overview of Japan's chemical arsenal, taking into account the workers' wartime conditions on the island. In the context of the rapid development of Western science at all costs, it will also highlight some of the structural deficiencies behind Japan's military endeavours, and their immediate consequences.

Keywords: Chemical warfare, history of sciences, Japan, logistics, World War II.

Between 1927 and 1944, the island of Ōkunoshima—located in Hiroshima prefecture—hosted Japan's largest chemical warfare facility. Production comprised both lethal and incapacitating agents, utilised almost exclusively against China during World War II. Under strict military supervision, Japanese volunteers and conscripts carried out the manufacturing process in dire conditions. Following prolonged exposure to poison gas with little or no protection, workers started developing diseases that would only become apparent throughout the 1950s and beyond, with physical, diplomatic and environmental consequences reaching far beyond the Japanese defeat.[1]

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[1] The post-war history of the island is discussed in the author's forthcoming publication. *The research leading to these results has received funding from the Swiss National Science Foundation (100011_169861) and from the European Research Council under the European Union's Seventh Framework Programme (FP7/2007-2013) / ERC grant agreement n° [313382].*

This short overview seeks to introduce the pre-1945 history of the island within the framework of Japan's chemical weapons programme—using some of the most significant research conducted by Japanese scholars—to an English-speaking readership. Besides, Ōkunoshima and Japanese chemical warfare highlight several structural deficiencies; a 'cultural impairment'[2] that explains the Japanese defeat in a wider context. Among other things, the absence of logistics, institutional weaknesses and lack of cohesion between army and naval forces hampered troops on the battlefield as well as the manufacturing and use of gas more specifically. As a result, the chemical arsenal developed by Tokyo was a structural nightmare with long-lasting significance, both from human and political perspectives.

To be sure, Japanese historians have addressed the history of Ōkunoshima and chemical warfare. Although topics such as cooperation between the military and the private sector remain partially unclear,[3] the post-war struggle of veterans to gain recognition and financial help has notably generated an abundant literature, in the forms of associative bulletins and pamphlets.

Outside the field of Japanese studies, however, the facility has been the object of sporadic mentions in chemical warfare-related publication, [4] but has generally remained unnoticed due to its geographical proximity to the city of Hiroshima, a place shrouded in a worldwide-accepted narrative of 'national victimology'.[5]The island's post-war image of 'Rabbit Island' (*usagi shima*), following its transformation into a holiday resort in 1963, also certainly contributed to the relative silence surrounding the history of Ōkunoshima.

In 1915, the German army proceeded with the first modern mass use of chemical weapons: during the second battle of Ypres, chlorine left fourteen thousand wounded and five thousand dead on the

[2] Mark Peattie, 'Japan's Defeat In The Second World War: The Cultural Dimension', in *War and Militarism in Modern Japan: Issues of History and Identity*, Guy Podoler (ed.), Leiden: Brill, 2009, p. 111-112.
[3] Seiya Matsuno, *Nihon gun no doku gasu heiki*, Tokyo: Gaifūsha, 2005, p. 85.
[4] For instance, Yuki Tanaka, 'Poison Gas, the Story Japan Would like to Forget', *Bulletin of the Atomic Scientists*, Vol. 44, No. 8, 1988, p. 10–19. Walter E. Grunden, 'No Retaliation in Kind: Japanese Chemical Warfare Policy in World War II', in *One Hundred Years of Chemical Warfare: Research, Deployment, Consequences*, Bretislav Friedrich et al. (ed.), Cham: Springer, 2017, p. 259–71.
[5] Takashi Fujitani, Geoffrey M. White, Lisa Yoneyama, (eds.), *Perilous Memories: The Asia-Pacific War(S)*, Durham, N.C: Duke University Press, 2001, p. 7.

Allied side. Immediately upon hearing the news, Koizumi Chikahiko[6] pushed for Japan to develop its own chemical arsenal. Fascinated by science at large to strengthen the nation, the Army Medical College (*Rikugun gun'i gakkō*) surgeon had been studying asphyxiant gas since 1911. Under his guidance, a thirty-men research team was formed, resulting in the establishment of the Chemical Weapons Laboratory (*Kagaku heiki kenkyū shitsu*) in 1917, Japan's first endeavour dedicated exclusively to chemical warfare. The creation of this structure was further justified by fears that such weapons could potentially be used against the Japanese Siberian Expedition (1918-1922).

In the context of international cooperation to support the Russian White Army, both Koizumi and military attaché of the London embassy Hisamura Taneki were permitted to visit chemical weapon factories, in order to improve Japanese manufacturing capabilities.[7] Hisamura's return to Japan in 1919 (Koizumi in 1922) resulted in the creation of the Army Institute for Scientific Research (*Rikugun kagaku kenkyūjo, kaken*), which was to lead to the full-speed development of a chemical arsenal as well as of protective equipment. Koizumi initially considered both defensive and offensive technologies an utmost priority, and the expansion of the *kaken* attests to this. Starting in November 1922, its second section was performing research autonomously; and by 1925, experiments with yperite (mustard gas) had already been conducted in Hokkaido, Kyushu and in Chiba prefecture.[8]

Foreign consultants were hired to speed up the process. Walter Metzner, a student of Fritz Haber—the 'father' of chemical weapons—taught Japanese army and navy scientists between 1925 and 1927. Collaboration with Japanese universities was also frequent. From the 1920s onward—although their exact roles are not clear—several distinguished academics took part in the development of a chemical programme in army laboratories.[9] By 1945, fifty external consultants

[6] Koizumi (1884–1945) played a key role in establishing the Ministry of Health (*Kōsei shō*) in 1938. In 1932, he placed Ishii Shirō (1892-1959) as head of what would later become Unit 731. Koizumi was appointed surgeon general in 1934, and committed suicide in 1945, in Kei'ichi Tsuneishi, Asano Tomizō, *Saikin sen butai to jiketsu shita futari no igakusha*, Tokyo: Shinchōsha, 1982.

[7] Kei'ichi Tsuneishi, 'C. Koizumi: As a Promoter of the Ministry of Health and Welfare and an Originator of the BCW Research Program', *Historia Scientiarum*, No. 26, March 1984), p. 95-113.

[8] Haruyoshi Hasegawa (ed.), *Nihon rikugun kayaku shi*, Tokyo: Ōhikai, 1969, p. 187.

[9] Tanaka, 'Nihon doku gasu sen no rekishi', p. 212.

from all major academies were working with the military, encouraged by wages up to twenty per cent higher than those of their colleagues.[10] As the world was disarming after the end of World War I, Japan was closing in on the expansion of its chemical warfare programme.

The majority of studies on Japanese chemical weapons focus on the Japanese Imperial Army (JIA). However, the navy developed a similar programme. Research started in 1922 with much more humble beginnings: the study section of the Tokyo naval arsenal consisted of a single officer. Chemical weapons were never deployed at sea during World War I, which partially explains why the navy lagged behind. Moreover, because of the deep rivalry between the heirs of the Meiji-era forefathers of the army (Chōshū) and of the navy (Satsuma), Hisamura's plea for development was met with reluctance. The programme also lacked Koizumi's leadership, and no specific individual seems to have played a similar role in the navy.

The Navy Institute for Technological Research (*Kaigun gijutsu kenkyūjo, giken*) opened in May 1923, but was short-lived. Destroyed by the Kantō Earthquake in September, it was not resurrected before 1930. Furthermore, upon hearing that a phosgene tank leak in 1928 had injured over three hundred civilians in Hamburg, the laboratory was moved from Tokyo to the coastal town of Hiratsuka (Kanagawa prefecture). Research and production were oriented towards general technical supplies such as fire extinguishers, incendiary bombs and torpedoes,[11] and the institute acquired a section dedicated solely to the study of chemical warfare in 1934, by which time similar testing was already well under way in the army.

Until the end of the war, the *giken* would continually waver between independent research, rivalry and collaboration with the army. Experiments were occasionally conducted jointly in Narashino (Chiba prefecture), Ōkunoshima and Manchuria, but the *kaken* only allowed the presence of a single navy officer during tests. Similarly, only one army representative was permitted on-board ship during manoeuvres. Overall, mutual distrust and contention seem to have plagued the development of a common programme, just as they prevented the creation of a unified military high command in the larger picture.

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[10] Yoshiaki Yoshimi, *Doku gasu sen to nihon gun*, Tokyo: Iwanami shoten, 2004, p. 46.
[11] Harushi Nakane, Michiyo Arakawa, 'Shōgen kaigun doku gasu kōjō no hibi', *Chūkiren*, July 2010, p. 50-59.

Japanese gas manufacturing was initially hampered by a lack of technical abilities, and several industrial conglomerates, commissioned by the government, stepped in to boost the process. Both army and navy manufactured their own gas, but raw materials were mostly provided by civilian companies, without which large-scale production would have been impossible.[12]

Mass-production was first envisaged in 1928 and to this end, Ōkunoshima had already been selected in 1927.[13] Firstly, the seventy-hectare island, situated forty-three miles southeast of the city of Hiroshima, appeared safer than the Kantō area after the 1923 earthquake destroyed most of the military facilities in the Japanese capital.
Secondly, the insular nature of Ōkunoshima predictably guaranteed a certain degree of secrecy. Yet, its proximity to mainland Japan, only fifteen minutes by boat from the coastal town of Tadanoumi, ensured convenient access.

Thirdly, Japanese prefectures were competing to attract military structures in a context of economic crisis. Because his son was head of the Tadanoumi council, Mochizuki Keisuke, Minister of Telecommunications, suggested the location to his friend, Army Minister Shirakawa Yoshinori.[14]

Fourthly, the island was equipped with pre-existing military structures, following the plan of the French Military Mission to Japan (1872-1880). By 1902, the island – and several others nearby – had been turned into a fortification network (*geiyo yōsai*) to protect the military bases of Hiroshima (army) and Kure (navy).

Fifthly, Ōkunoshima was blessed with enough running water to give it autonomy. Thanks to its scarce population – three families and two small fisheries – requisition and relocation could be arranged in a discreet and prompt manner. All were moved to Tadanoumi with a compensation of 150 yen,[15] and with construction complete in May

[12] Tanaka, 'Nihon doku gasu sen no rekishi'. 216, Yoshiaki Yoshimi, *Doku gasu sen to nihon gun*, Tokyo: Iwanami shoten, 2004, p. 14.
[13] Gunjika, 'Rikugun Zōheishō Kagaku Heiki Seizō Kikan Haichi Ni Kan Suru Ken', 1927, Rikugunshō mitsu dainikki S2-1-9, The National Institute for Defense Studies, Ministry of Defense, https://www.jacar.archives.go.jp.
[14] Tanaka, 'Poison Gas, the Story Japan Would like to Forget', p. 12.
[15] The loss of fishing rights was compensated in 1932, Rikugun shō, 'Gyogyōken Sonshitsu Hoshō No Ken', 8 September 1932, Rikugun shō rikumanfu dainikki, pp. 7-40-49, The National Institute for Defense Studies, Ministry of Defense, https://www.jacar.archives.go.jp. 4.

1929, Ōkunoshima officially became the 'Army Arsenal's Tadanoumi Weapons Manufacture' (*Rikugun heiki heishōka kōshō Tadanoumi heiki seizōjo*).

The inauguration of the complex triggered an 'Ōkuno boom'. Jobs were scarce in the region, and over six thousand applications were received, for eighty positions initially available. Working in an army factory was not only appealing to unskilled workers. The formation for qualified personnel, not unlike that of civil servant, took three years of unpaid work, but guaranteed a stable position as engineer or technician. Younger workers were also lured by the promise of material luxuries otherwise unavailable, such as coffee, sugar, or sweets.[16]

Initially, following Koizumi's interest in the reinforcement of the nation by technical enterprises, workers were not solely manufacturing gas for offensive purposes. Production ofinsecticides such as *sairōmu* (potassium cyanide),a descendant of prussic acid, began in 1930.[17] In the late nineteenth - early twentieth centuries, science in Japan was understood as a means to catch up with the West and finalise national maturity. Koizumi emphasised this perspective as early as 1925:

> 'Poison gases are very fearful weapons. But we should not forget they take an important cultural role in peacetime. For example, chlorine is a necessity as a disinfectant for water supply and soil and its rarefied gas is recommended as a method to cure bronchitis. […] Phosgene is necessary for dyes industry, and it is well known that chloropicrin is used to expel harmful insects from rice'.[18]

[16] Eiko Takeda, *Chizu kara kesareta shima: Ōkunoshima doku gasu kōjō*, Tokyo: Domes shuppan, 1987, p. 94.

[17] In Germany too, the process for extracting nitrates was used to manufacture fertilisers and explosives, in Kim Coleman, *A History of Chemical Warfare*, Basingstoke, Hampshire; New York: Palgrave Macmillan, 2005, p. 16.

[18] Kei'ichi Tsuneishi, 'C. Koizumi: As a Promoter of the Ministry of Health and Welfare and an Originator of the BCW Research Program', *Historia Scientiarum*, No. 26, March 1984, p. 101.

Strong and clean bodies also allowed for an efficient army, and one of the fundamental causes of this concern can be traced back to the late nineteenth century. During the first Sino-Japanese war (1894-95), disease-induced casualties were ten times higher than fatalities inflicted by the enemy, and over twenty per cent of troops deployed during the Russo-Japanese war (1904-1905) were afflicted by beriberi, which was at the time thought to be of bacterial origin.

Conversely, Ōkunoshima was primarily a military factory, and rapidly became a mere first step. The *kaken*, responsible for the development of gas warfare, was further expanded in 1941, and employed 715 individuals with an annual budget of 2.9 million yen (1945).[19] These developments led to the launch of formative procedures in the JIA, to instruct selected troops in the use of gas weapons.

The Narashino Army School (*Rikugun Narashino gakkō*) specifically opened to that aim in August 1933. Until 1945, it provided training to an ever-increasing number of men – from 225 in 1933 to 1,371 in 1941.[20] The school also coordinated joint tests between the Kwangtung Army chemical weapons section, the Army Medical College, and the chemical section of the China Expeditionary Army (*Shina haken gun kagaku bu*). Trials were conducted on animals, and later on Chinese and Russian prisoners, but starting in 1934, troops were also experimented upon: given various levels of protection, they were exposed to yperite, with occasional fatal outcomes.[21] Between 1925 and 1945, 41 large-scale tests were conducted all over the empire (Taiwan in 1928, Korea in 1930)[22] with gas manufactured on Ōkunoshima.

On the island, the number of buildings doubled between 1929 and 1932, and new quarters were inaugurated in 1939. A year later, the factory was incorporated into the second Tokyo arsenal (*Tōkyō dai ni rikugun zō heishō Tadanoumi seizō jo*), under direct supervision from the Ministry of the Army. In 1933, the neighbouring islands of Awashima, Ōmishima, as well as army barracks in Tadanoumi were converted into

[19] Kei'ichi Tsuneishi, 'The Research Guarded by Military Secrecy', *Historia Scientiarum*, No. 30, March 1986, p. 81.
[20] Yoshiaki Yoshimi, *Doku gasu sen to nihon gun*, Tokyo: Iwanami shoten, 2004, p. 41.
[21] Gō Miyatake, *Shōgun No Yuigon: Endō Saburō Nikki*, Tokyo: Mainichi shinbunsha, 61, p. 77.
[22] Yoshiaki Yoshimi, Seiya Matsuno, *Jūgo nen sensō gokuhi shiryō shū*, Tokyo: Fuji shuppan, 1997, p.14.

warehouses for toxic gas waiting to be transported to the Sone factory. This new plant – set up in Kitakyushu and completed in 1937 – was chosen because of its proximity to the Kokura arsenal, which provided empty shells and bombs, subsequently filled locally with gas before shipping to the continent.

Likewise, the number of employees augmented exponentially. There were 116 staff in December 1933, and after increasing – from 194 to 1,009 – as Japan extended its offensive against China, the number of personnel had reached five thousand by the end of 1937. Five hundred more employees were working in the Sone factory by 1943. In total, the island employed more than 6,800 citizens over a period of sixteen years of activity. In 1929, Japan was making four different types of gas and by 1937; six other varieties were produced on a regular basis.[23] Based on German classification and for secrecy purposes, all were codenamed with colours.[24] In 1945, the military controlled twenty-seven factories and research facilities, of which Ōkunoshima had become the largest.

If chemical weapons were developed under the seal of confidentiality, they had also become a symbol of imperial pride, unequivocally integrated into the national polity narrative (*kokutai*). The first gas mask was codenamed '87', because it was produced in 1927, equivalent to year 2587 of the Japanese imperial chronology (*kōki*).[25] The same year, financial compensation was implemented for troops injured by chemical weapons.[26]

Similarly, gas was presented as a 'humane weapon' (*jindō heiki*). A 1936 military textbook highlights the ability of this new technology to diminish the enemy's fighting capacity. Trainees were taught that the widespread use of chemical ammunition, just like that of landmines, was the future of combat since gas – men were told – was not lethal. Thanks to what was believed to be an extremely low casualty

[23] Phosgene (blood agent), phenacyl chloride (lachrymatory agent), benzyl bromide (lachrymatory agent), and arsenic trichloride (lewisite component), followed by diphenylcyanoarsine (vomiting agent, 1933), lewisite (blister agent, 1933), French and German yperite (blister agents, 1936), frost-free yperite (1937) and prussic acid (blood agent, 1938).

[24] White (fumigants), brown (blood agents), red (vomiting agents), green (lachrymatory agents), yellow (blister agents), blue (pulmonary agents).

[25] Matsuno. 31.

[26] Yoshiaki Yoshimi, *Doku gasu sen to nihon gun*, Tokyo: Iwanami shoten, 2004, p. 45.

rate, chemical warfare was 'the weapon of the Emperor's army' (*kōgun heiki*)[27], the product of an advanced technology that did not exterminate. This eagerness even extended to the general public, as articles written by military officers started to appear in popular science magazines. The April 1933 issue of *Science Illustrated* (*Kagaku gahō*) featured a cover picture of a gas mask, and an article requesting a gas mask association.[28] A chemical arsenal was the quintessence of a 'modern' army, a showcase at the crossroads between science, discipline and humanity.

Statistics confirm this trend. In 1925, Japan only manufactured a hundred kilos of phosgene, and the rest was imported from the *Sociéte chimique des usines du Rhône*. In 1929, production had risen to three tons yearly. As Japan became engulfed in what would soon become total war, combat gas seemed to offer a way out of the impasse. Between 1936 and 1937, yperite production went up from fifteen to 125 tons yearly, skyrocketing to 1,138 tons in 1941.[29] Between 1931 and 1945, 6,616 tons of gas was produced on Ōkunoshima.[30] In total, the JIA manufactured over two million shells and ammunitions containing lethal gas, and just fewer than five million hand grenades filled with non-lethal agents. In contrast, Japanese Imperial Navy production never exceeded 760 tons for seventy thousand shells. No gas was ever made specifically for naval forces on the island.

To be sure, the destructive capacity of the Japanese chemical arsenal is not to be denied.[31] However, total production was five times lower than that of the United Kingdom, ten times lower than that of Germany, and twenty times lower than that of the United States. Furthermore, Japanese production pales in significance when compared to World War I figures. Until 1945, the empire produced 2,240 tons of blister agents, whereas Germany used just short of 2,500 tons in Ypres over ten days in 1917.[32] Statistics vary according to sources, but until 1918, it

[27]*Kagaku heiki no riron to jissai*, 1936, in Kamata, 'Tsūfun no genjō wo aruku kyū nihon gun no doku gasu wo seisō shite ita Hiroshima', p. 32.
[28] Hiromi Mizuno, *Science for the Empire: Scientific Nationalism in Modern Japan*, Stanford: Stanford University Press, 2011, p. 156.
[29]*Rikugun zō hei shō shi* (Tokyo: 1941) in Tatsumi, *Kakusaretekita 'Hiroshima': doku gasu shima kara no kokuhatsu*, p. 171.
[30]Yoshiaki Yoshimi, *Doku gasu sen to nihon gun*, Tokyo: Iwanami shoten, 2004, p. 149.
[31]For yperite, exposure to 2.7 milligrams (about 1 teaspoon) for thirty minutes is fatal, in 'The National Institute for Occupational Safety and Health', Centers for Disease Control and Prevention, accessed 15 October 2017, https://www.cdc.gov/niosh/index.htm.
[32] Tsuneishi, 'Tokushū kenkyū kaigun no kagaku sen kenkyū kaihatsu shi', p. 196.

is estimated that the Great Powers produced approximately 190,000 tons of gas, causing 1.3 million casualties. By the end of the war, the United States was producing 140 tons a day, an amount greater than the production of Germany, Great Britain, and France combined.[33] The appeal of gas warfare was obvious if one considers that a ton of yperite caused 36.4 casualties, against 4.9 victims for regular ammunition.[34]

For the JIA, chemical weapons represented a dilemma. Following the disastrous Siberian Expedition, Army General Staff (*sanbō honbu*) envisaged an offensive, but Army Minister Tanaka Giichi himself buried the idea for humanitarian reasons.[35] All major countries were nonetheless developing a similar arsenal. The 1925 Geneva Protocol only applied to countries that signed and ratified the convention, a nuance that undoubtedly reinforced Tokyo's fickleness *vis-à-vis* a document it would only ratify in 1970. It merely prohibited the first use of chemical and bacteriological arms but did not prevent retaliation-in-kind. Moreover, the protocol did not regulate the production, testing and stockpiling of gas, nor did it apply to internal or civil conflicts.

Consequently, the first recorded use of gas by Japan can be traced back to the colonial context: during the 1930 Wushe rebellion (*Musha jiken*) in Taiwan, imperial troops bombed the rebels with prussic acid, phosgene and yperite. The decision, never sanctioned by Tokyo, was taken by the Japanese garrison stationed in the colony. Similarly, the Ministry of the Army authorised riot control agents in 1932 in the puppet state of Manchukuo, but forbade deadly gas at the beginning of the Sino-Japanese War, for fear of international repercussions.

The year 1937 marked the start of the widespread usage of non-lethal agents, but it is estimated that gas (fatal or not) was used over two thousand times against Chinese troops and civilians alike.[36] Particularly

[33] Paul F. Walker, 'A Century of Chemical Warfare: Building a World Free of Chemical Weapons', in *One Hundred Years of Chemical Warfare: Research, Deployment, Consequences*, Bretislav Friedrich et al. (ed.), Cham: Springer, 2017, pp. 379–400.

[34] Ramesh Chandra Gupta (ed.), *Handbook of Toxicology of Chemical Warfare Agents*, Amsterdam: Elsevier, 2009, p. 18.

[35] The first planned use of gas (non-lethal) dates back to the attempted military coup of February 26, 1936. The rebels surrendered before gas was fired.

[36] The use of vomiting and lachrymatory agents is difficult to prove and did not necessarily result in lethal outcomes. Estimates vary but some mention eighty thousand victims, in Yamauchi, 'Doku gasu seizō kōjō ato ga tō kagai sekinin: Ōkunoshima doku gasu kōjō ato', pp. 35-36.

between December 1938 and July 1940, Japan made regular use of deadly agents in China – which did not possess the technical ability to retaliate in kind – possibly following the League of Nations' feeble condemnation of the Italian use of gas during the Second Abyssinian War.[37] It is however certain that chemical weapons were used with the emperor's approval, and that he was fully aware of the existence of the programme. In 1929, Hirohito visited the Army Medical College, where Koizumi himself lectured him on chemical warfare protection.[38]

Utilisation of chemical agents against American, Commonwealth and Soviet troops was briefly envisaged in 1944 as a last resort measure.[39] To be sure, tear gas was sporadically used, notably against British troops in February 1942,[40] however, during his term as Prime Minister (1942-44), Tōjō Hideki vehemently opposed the use of lethal gas against non-Asian opponents.[41] Ultimately, following Roosevelt's declarations of 1942 and 1943 threatening to use similar ordnances should imperial troops fire their own, Army General Staff prohibited the use of all chemical shells on July 15, 1944 and withdrew their stocks from frontline storage facilities.

As Japan was plunging into total war, conditions increasingly became tougher on the home front and Ōkunoshima was no exception. The Army General Staff enforced absolute secrecy. Workers, originally all of them volunteers, were hired as military auxiliaries, and the manufacturing process as well as the comings and goings of staff were monitored day and night by the Japanese *gendarmerie (kempeitai)*. Employees were forbidden to discuss their work under threat of being charged with treason. In 1935, friendship groups and associations were disbanded. The following year, trade unions were prohibited locally, and by 1937, the island had been removed from Japanese official maps.The windows of regional trains with a view of the coastline were obstructed with wooden planks to prevent passengers from seeing the factory.

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[37] Matsuno, *Nihon gun no doku gasu heiki*, p. 237.

[38] *Rikugun gun i gakkō 50 nen shi*, Fuji shuppan [1988] (Tokyo: Rikugun gun i gakkō, 1936), p. 138. See notably Yoshiaki Yoshimi and Toshiya Ikō, *Nana san ichi butai to tennō rikugun chūō*, Tokyo: Iwanami shoten, 1995; Herbert P. Bix, *Hirohito and the Making of Modern Japan*, 1st edition, New York: Harper Collins, 2000.

[39] Tatsuya Yamamoto, Daisuke Kusanagi, *Nihon no kagaku heiki 1, hōheiyō gasudan no hyōshiki to kōzō*, Gifu: Zen nippon gunsō kenkyūkai, 2010, p. 12.

[40] Yoshimi and Matsuno, *Jūgo nen sensō gokuhi shiryō shū*, p. 391.

[41] 'Interrogation of General Hideki TOJO, 2 April 1946', p. 2, disc 3, in Shōji Kondō, *Nana san ichi butai, saikin sen shiryō shūsei*, 8 vols, Tokyo: Kashiwa shobō, 2003.

Until 1935, manufacturing was typically limited to two or three months per year, with shifts of thirty to sixty minutes, but the JIA subsequently required staff to work in non-stop shifts of twelve hours. Former employees invoke two main reasons for their relatively short stay on the island. Firstly, most were injured by gas briefly after their arrival, and upon recovery, were immediately sent to the front or discharged. Secondly, with the army in constant need of men, even those who had managed to avoid injuries were shipped to the battlefield, to be progressively replaced by children and teenagers.

In 1937, the first high-school girls had been recruited locally to manufacture vomiting agents and self-igniting smoke devices. Following the creation of the National Patriotic Labour Corps (*Kokumin kinrou houkoku kyouryoku*) in 1941, over three hundred girls and fifty boys were forcibly enrolled on Ōkunoshima. After the start of the Pacific War, the island's training centre was mostly recruiting from schools in Tadanoumi and neighbouring areas, and by 1945, a total of 1,084 youngsters (aged thirteen - sixteen) had served in the factory.[42]

Before mobilisation, economic concerns had been the primary motive to work on Ōkunoshima. In 1935, a carpenter earned less than one yen per day. Conversely, a worker manufacturing chemical weapons received a minimum of one yen and ten sen daily,[43] and was sometimes paid overtime as high as sixty per cent, plus a yearly bonus. The possibility of postponing – or avoiding – being sent to the front also pushed many to apply regardless of the dangers involved.

A small minority of qualified technicians aside, employees were completely ignorant of the finality of the substances they were manufacturing. A teenage girl at the time later recalled: 'I had heard my parents say that Ōkunoshima was the island of toxic gas, but I did not know what a toxic gas was.'[44] They were simply told to contribute to 'victory',[45] and the *kempeitai*'s constant surveillance ensured no one would reveal details pertaining to the larger purpose of their labour. This sense of forced secrecy endured well beyond 1945 and was to become a major hindrance for the physicians' initial diagnosis of the strains afflicting former workers.

[42] Yukutake, *Hitori hitori no Ōkunoshima: doku gasu kōjō kara no shōgen*, p.114.
[43] Tanaka, 'Poison Gas, the Story Japan Would like to Forget', pp. 14-15.
[44] Takeda, *Chizu kara kesareta shima: Ōkunoshima doku gasu kōjō*, p. 87.
[45] Yasusaburō Sugi, 'Seto Naikai No Doku Gasu Shima', *Bungei Shunjū* 5, May 1956, pp. 238-251.

The 1944 decision to stop using chemical ammunition did not signify the end of forced labour on Ōkunoshima. In July, production was switched from gas to explosives, and until February 1945, children nationwide manufactured balloon bombs (*fusen bakudan,fugō*). These incendiary devices attached to spheres made of paper and konjac fibre were filled with hydrogen, and sent afloat to detonate on the United States Pacific coast.[46]

Logistics play a major part in understanding not only pre-war and wartime Ōkunoshima, but also the Japanese armed forces to a larger extent. Scholars have long recognised the multiple logistics failures of Japan's military, as well as complete disregard for human life, factors responsible for innumerable casualties.[47] Insufficient intelligence and scarcity of protective and medical supplies were recurring factors behind lost battles. The gas masks of the JIA are a case in point. They were completely ineffective against cyanogen chloride; a gas that the United States envisaged using, had the invasion of mainland Japan been necessary in 1945. In most cases, only officers were offered such a device, and many turned out to be defective. Soldiers lucky enough to be equipped with one seldom received training for adequate use. With nine hundred thousand masks and thirty thousand protective suits for 2.25 million men,[48] protection towards the end of the war was even more mediocre, to say the least, a situation partially aggravated by the belief that the fighting spirit of troops mattered more than their equipment.[49]

Ōkunoshima was plagued by similar inadequacies, and Japan's stalemate on the continent sounded the death knell of the development of protective measures. Gas had to be produced rapidly, regardless of human and material costs. With the exception of qualified technicians, staff was put to work after four days of elementary training. No manuals were available, and blister agents' decontamination procedures were only incompletely described in a short text issued as late as 1937. Access to protection was also rudimentary, at best. Equipped with

[46] Ross Allen Coen, *Fu-Go: The Curious History of Japan's Balloon Bomb Attack on America*, Studies in War, Society, and the Military, Lincoln, NB: University of Nebraska Press, 2014.
[47] For instance, Jōji Hayashi, *Taiheiyō sensō no logistics*, Tokyo: Gakken publishing, 2013; Akira Fujiwara, *Uejini Shita Eirei Tachi*, Tokyo: Aoki shoten, 2001.
[48] Takeda, *Chizu kara kesareta shima: Ōkunoshima doku gasu kōjō*, p. 167.
[49] Peattie, 'Japan's Defeat In The Second World War: The Cultural Dimension', p. 113.

parakeets in cages, the workers' only chance to avoid a gas leak was to run away, should the birds drop dead. Initially, employees were provided with rubber suits they nicknamed 'octopus' (*taco*),[50] but overalls were impractical in the extreme summer heat, and did not effectively protect from gas. Besides, a large part of the workforce had to remove their gloves to carry out delicate tasks, and protective clothing was already in short supply as early as 1941, forcing personnel to rely on paper masks.

In the context of severe *kempeitai* surveillance, adults and children alike were naturally subjected to psychological and physical disregard. Testimonies recall the case of a boy, injured and hospitalized during gas production, whose parents received six daily visits from the *kempeitai* for weeks, to ensure the victim would come back to work upon recovery.[51] Similarly, most teenagers and women were unable to use the gas masks provided. Not only were they too large, but their poor quality and inadequate shape also prevented them from adhering to the faces.

The primitive configuration of the factory was equally a source of danger. Tear gas solidified in the conduits had to be scraped off manually. Tanks were leaking. Storage containers filled with tons of blister agent were stowed outdoors with bamboo mesh as the sole protection. Gas infiltrated through clothes and buildings, contaminating even toilet paper and lunch boxes. Skin and respiratory diseases were the most common, but eyes, genitals and internal organs also suffered frequent damage.

Ōkunoshima was of course equipped with a dispensary, but medical staff was incapable of handling respiratory and internal injuries. Decontamination was limited to applying bandages and talcum, occasionally followed by a bath. Nurses were instructed to alleviate pain by prompting patients to keep in mind the suffering of soldiers of the battlefield. For extreme cases, an average of three to four weeks rest was granted, but always running at full capacity, the facility's twenty beds were insufficient for a daily intake of seventy patients.[52] Upgraded to

[50] The name refers to the round, ocular spaces of the gas mask, reminiscent of the cephalopod's body.
[51] Yukutake, *Hitori hitori no Ōkunoshima: doku gasu kōjō kara no shōgen*, p. 153.
[52] Tomoji Tatsumi, 'Nihon gun doku gasu iki dan mondai', *Kinyōbi* 46, December 1996, p. 16–17.

a military hospital in 1937, it was never able to treat the ever-growing number of injuries that stemmed from the expansion of the facility.
In their haste to develop a chemical arsenal, Japanese armed forces (and companies)[53] also neglected the larger-picture infrastructure. Gas was conveyed by ship to the Japanese mainland and subsequently loaded on trains, before reaching the Sone factory by horse coach, a process that amplified the likelihood of incidents. At the end of the war, the extreme scarcity of resources jeopardised production even further: workers started stealing and selling the factory's acid-resistant pipes and remaining parts. By 1945, Ōkunoshima had been dubbed 'treasure island' by the local workforce.[54]

In stark contrast to British and American equipment and policies,[55] this 'cultural impairment' was also observable throughout the empire. To be sure, following the 1931 invasion of Manchuria, military authorities advocated the development of civilian-use gas masks as part of the general air-raids defence strategy. However, masks were not issued freely, and with inflation rising, such equipment was simply out of reach. The Ministry of Home Affairs' efforts to produce cheaper versions also turned out to be a failure, since masks were simply ineffective. As an emergency measure, the *kaken* proposed that civilians use bamboo tubes lined with cloth and coal to cover the mouth, block their nose with clothes pins, and protect their eyes with swimming goggles should chemical weapons be used against the population.[56]

The Japanese surrender did not bring about the end of the logistics nightmare. Casualties – sometimes fatal – were rife for the workforce in charge of the post-war sanitisation of the island, and deprived from any form of protective gear to handle yperite-loaded bombs, peacetime did not lessen the severity of their injuries.[57] No clear-cut line divides the wartime and early post-war experiences on Ōkunoshima. Seven decades after the defeat, the ecological, political and social consequences of Japan's chemical warfare endeavours still

[53] Matsuno, *Nihon gun no doku gasu heiki*, p. 114.
[54] Yūji Okano, ed., *Doku gasu tō: Ōkunoshima doku gasu kōjō sono higai to kagai*, Hiroshima: Hiroshima heiwa kyōiku kenkyūjo, 1987. 11. Kikumatsu Inaba, '"Daitōa sensō" no tsumeato Ōkunoshima no jittai', in *Doku gasu no shima*, Higuchi Kenji, Tokyo: Kobushi shobō, 2015, p. 188–99.
[55] Kim Coleman, *A History of Chemical Warfare*, Basingstoke, Hampshire; New York: Palgrave Macmillan, 2005, p. 54-55, 59.
[56] Matsuno, *Nihon gun no doku gasu heiki*, p. 118.
[57] *Teijin no ayumi*, Vol. 5, Teijin, 1970 , p. 194-217.

haunt the area. As late as 2009, cans containing vomiting agents were drifting ashore around Ōkunoshima. Post-war sightings and explosions of gas canisters also afflicted the rest of the archipelago. A 2003 survey indicated that 822 such occurrences had been listed in twenty-two prefectures since 1945.[58] Countrywide, over two thousand people still suffer from gas-related wounds,[59] to say nothing of explosions and casualties throughout East Asia.

Ultimately, Ōkunoshima represents a noteworthy case of micro history. Largely absent from the national storyline, its narrative was originally a marginalised one. Recognition of the workers' afflictions was hindered by the geographical location of the island, since any mention of wartime trauma in Hiroshima prefecture was systematically associated with atomic victimhood. The situation was further exacerbated by Tokyo's refusal to fully acknowledge the existence and use of its chemical arsenal until the 1980s. Historical accounts specifically centred on the island would only start to emerge in the 1970s, based both on testimonies and on the work of historians in the larger context of war crimes studies.

As an instance of the weaponisation of science, Ōkunoshima mirrors the Meiji era rapid industrialisation of Japan. In line with the preoccupation to catch up with and integrate Western technology at all costs, the island is a pertinent example of the joint involvement of the State and the industrial sector in times of war and peace. It had become impossible to separate 'warlike purposes from peaceful purposes',[60] and the late nineteenth century slogan urging to 'enrich the country and fortify the army' (*fukoku kyōhei*) clearly illustrates this aspect. Originally preoccupied with the constitution of efficient, healthy armed forces by scientific means, the military elites favoured policies that eventually brought about opposite results, notably through the elaboration of a chemical arsenal.

As a gas factory, the island verifies both the limited scope and the rapid development of Japanese chemical weapons. Although

[58] Kankyōshō, 'Shōwa 48 Nen No "Kyū Gun Doku Gasu Tama Nado No Zenkoku Chōsa" Foro-Appu Chōsa Hōkoku Sho', Tokyo: Kankyōshō, 31 March 2003, https://www.env.go.jp/chemi/report/h15-02/index.html.kan., p. 22-43.

[59] 'Hiroshima Peace Media Center', Hiroshima Peace Media Center, http://www.hiroshimapeacemedia.jp/?p=52294, (accessed 11 November 2017).

[60] Kim Coleman, *A History of Chemical Warfare*, Basingstoke, Hampshire; New York: Palgrave Macmillan, 2005, p. 60.

Germany never used poison gas on the battlefield during World War II, it had twenty factories, and a monthly production capacity of twelve thousand tons of gas.[61] In contrast, Japan's twenty-seven facilities could only manufacture 2,700 tons per month. The amount of Japanese gas may have been insignificant on a global scale, however, compared to similar endeavours worldwide, Tokyo's arsenal was not only a latecomer created with the most haste, but also the only one ever put to use during World War II.

Perhaps above all, Ōkunoshima represents both the foundation and the consequences of Japan's military structural deficiencies until 1945. Stuck in an inextricable conflict, it never managed to develop new gas-related technology. Emphasis was put on the production and use of weapons regardless of the human factor. This policy would later dramatically impact not only the country's landscape but also its war memories, and spark a national debate on the wartime responsibilities of the military, scientific and industrial elites.

[61] Kim Coleman, *A History of Chemical Warfare*, Basingstoke, Hampshire; New York: Palgrave Macmillan, 2005, p. 62.