

The Development of Modern Science in Japan

Meiji Restoration to WWII

Overview, 1868-1900

- Around 13 new institutes for scientific research. All dedicated to *development* and *testing*.
- ~90 Foreign science professors and teachers.
- 200+ Foreign technical experts.
- Government grants for advanced study abroad.
- Rapid decline of traditional science and mathematics.
- 1893: The Civil Servant Appointment Law (文官任用令).
- 1894-5: Sino-Japanese War.

Overview, 1900-1918

- 1904-5: Russo-Japanese War.
- Shift to Japanese language & teachers in science education.
- Scientific contributions within a ‘Western’ framework.
 - 1904: Nagaoka’s ‘Saturn-like’ atomic model.
- 1917: Institute of Physical and Chemical Research.
- 1918: New Universities Law.

Importing Knowledge

- The policy of “Rich country, strong army” (富国強兵), was implemented by developing industry and military along Western lines.
- Western science was perceived *as foreign*.
- The idea was to import knowledge and technique *independently* of philosophy and social conditions.
- Western knowledge would be situated in the context of Neo-Confucian ethics.

Universities in the Meiji Period

- In early Meiji, Tokyo University was the only place one could study scientific research.
 - In the beginning, Tokyo University was meant to be a state censor, to train bureaucrats, Confucian scholars and scientists. (This different groups did not cooperate.)
- During the Sino-Japanese War (1894-5), Kyoto University was founded.
- During the Russo-Japanese War (1904-5), Tohoku University was founded.
- Gradually, more imperial universities were founded.

Academic Nepotism

- Scientists and journalists in the Meiji period often complained of academic “inbreeding.”
- Hiring professors with family connections. (Little evidence for this.)
- Hiring professors with other social connections. (Evidence for ~20%.)
- Hiring one’s own graduates. (Very prevalent.)

TABLE 6.3
Preferential Hiring in the Imperial Universities (1877-1920)^a

UNIVERSITY	MEDICINE		AGRICULTURE FORESTRY VETERINARY MEDICINE		SCIENCE		ENGINEERING	
	A	B	A	B	A	B	A	B
		N = 72		N = 44		N = 70		N = 89
Tokyo	62	90	52	82	72	90	89	94
		N = 72		N = 2		N = 24		N = 39
Kyoto	21	35	0	0	5	25	4	15
		N = 40		N = 4		N = 5		N = 33
Kyushu	2	13	0	0	0	0	0	0
		N = 25		N = 25		N = 27		N = 6
Tōhoku	0	0	26	76	6	19	2	17
Total N, A Columns	N = 622		N = 161		N = 177		N = 365	

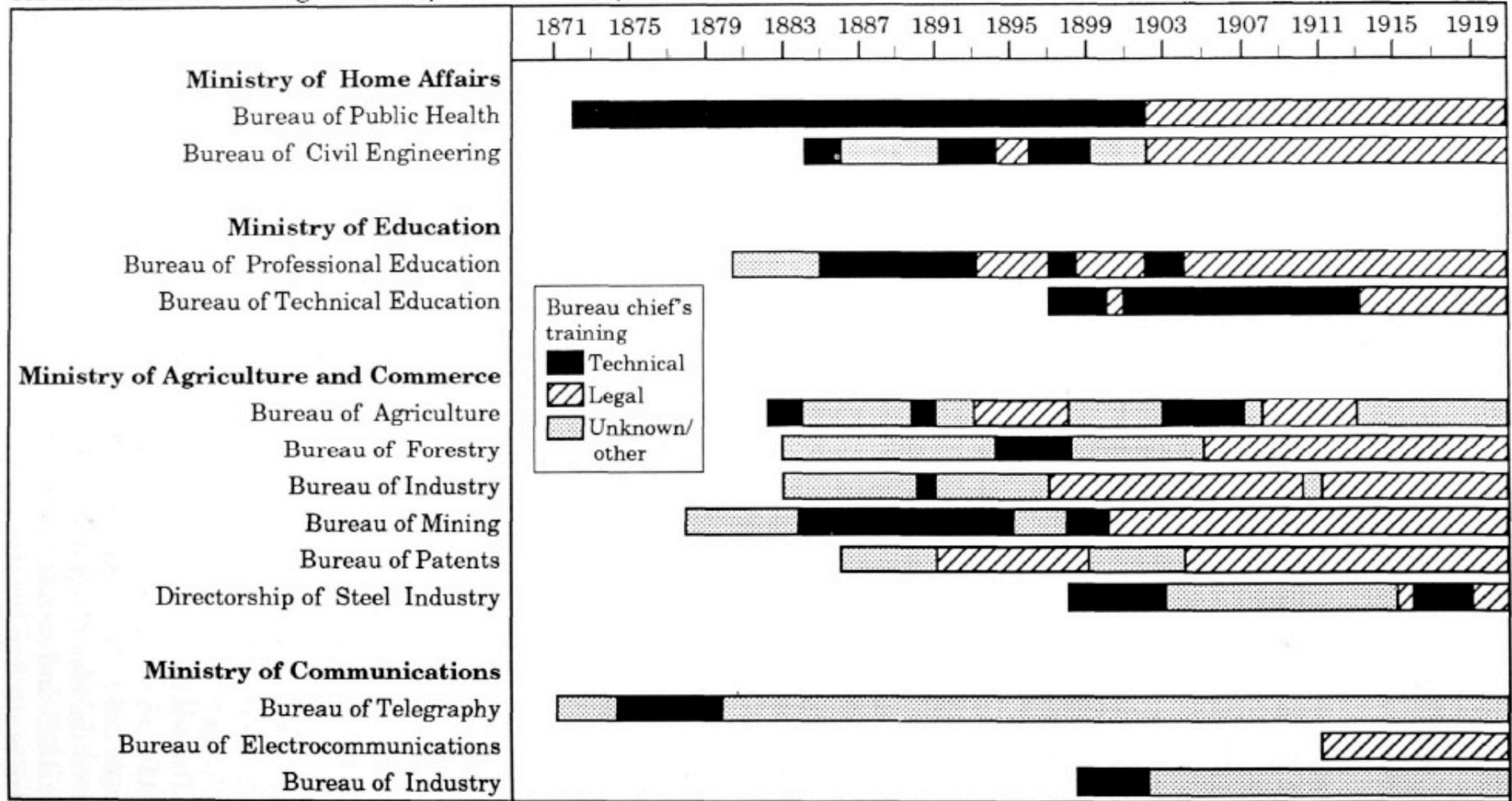
Sources: *Dai jimmei jiten*, 10 vols. (1957). *Dai Nihon hakushi roku*, 5 vols. (1921-30) *Jinji kōshin roku*, 1st ed. (1903), 2d ed. (1908); 4th ed. (1915); 7th ed. (1925); 8th ed. (1928); 9th ed. (1931); 11th ed. (1937) *Who's Who in Japan*, 2d ed. (1913); 17th ed. (1936). *The Japan Biographical Encyclopedia and Who's Who*, 1st ed. (1958).

^aFigures exclude Hokkaido University.

Administration and Funding

- The main goal of the Meiji rulers was to create a strong centralized government, which would control all aspects of the country's development.
- The administrators often had different ideas about the role and purpose of science than the scientists.
- In particular, there were debates about the importance of basic research. (With the blockades of Germany during WWI, the government finally came to realize the importance of basic science.)

5.1 Educational Backgrounds of Bureau Chiefs (1872–1919)



Source: Ijiri Tsunekichi, ed., *Rekidai kenkan roku* (Tokyo: Hara Shobō, 1967).

John Milne (1850-1913)

- Born to a middle class family in Liverpool, England.
- Educated at King's College, London, and the Royal School of Mines.
- Did field work Newfoundland, Labrador and Arabia.
- Was hired by the Meiji government at the Imperial College of Engineering (1875-1895).
- Retired to the Isle of Wight, England.

Milne's Work

- Carried out geological surveys of many regions.
- He helped found the science of seismology with his colleagues in Japan.
- Co-founder of the Seismological Society of Japan.
- Co-developed seismographs which could detect different types of waves and determine their velocities.
- Worked on the anthropology of the Japanese islands, particularly the Ainu and the ethnic origins of modern Japanese.

Seismology in Japan

- Following a large earthquake in Yokohama, 1880, Milne and a number of others began to work on earthquakes.
- He began with £25 funded by the BAAS.
- With a physicist, Gray, he developed seismographs which made continuous readings on graph paper.
- By setting up seismographs all over the country, Japan became the most important center for earthquake research.

Yamakawa Kenjiro (山川健次郎, 1854-1931)

- Born into a samurai family.
- Sent by the Meiji government to study physics at Yale University.
- Was the first Japanese professor of physics at Tokyo University.
- Was ennobled (男爵).
- Moved into administration and politics.

Yamagawa's work

- He worked to introduce Western physics to Japan and to train the next generation of physicists.
 - Dictionary of physics terminology in Japanese, English, French and German.
- He carried out original research on cathode rays and x-rays.
- He worked to expand Japan's university system and to found new institutions for scientific research.

Overview, 1918-1945

- Concentration on basic research.
- 1932: Establishment of the Japan Society for the Promotion of Science (日本学術振興会).
- Funding of research groups and collaborative projects.
 - 1935: Yukawa's meson theory.
- The rise of ultranationalism: All science and technology for military purposes.

Technocracy

- *Technocracy* can be understood as a movement by the technical elite to secure power in the government.
- The Civil Servant Appointment Law (文官任用令, 1893) made it almost impossible for anyone who did not have a law degree to serve as head of a ministry.
- Hence, there was a growing conflict between law-bureaucrats and technology-bureaucrats.

Kojin Club (工人俱樂部)

- In 1920, a group of young engineers from Tokyo Imperial University organized a trade union to advocate for the advancement of engineers and technocrats.
- They formed the Kojin Club, which they conceived of in the social and political ideas of the time (strongly Marxist, socialist).

Kojin Club Manifesto I

- “1. Technology is a cultural creation that unites the natural sciences and technique. Technology is creation and an end, not a means, it is absolute, not relative. Culture is not created by technology alone, but human culture in a way has always be a form of technical culture.
- 2. Engineers are creators. Engineers are not materialists, they should go beyond materialism. It is the responsibility of engineers to actively engage in political economy through the mission of cultural creation. Our activities should not only concern one aspect of society but should embrace the whole of human life. (...)

Kojin Club Manifesto II

- 5. The Kojin Club uses rational means. It is a worldwide trend that economic movements for class struggle are becoming political movements. The Kojin Club does not only aim to protect the *technological class*. Considering the vocational responsibility of engineers to advance the level of social life for the the human race, we avoid radical direct actions and strive to realize our ideas by leading a social movement with our delegates to the Diet and by raising the consciousness of the political masses.”

Proletarian Politics

- During Taisho, a growing number of engineers were from the working class.
- The Kojin Club, took a stance on the side of the working class and gave up its claim to mediation.
- Club Journal, 1925: “Our nation has only a weak sense of class... and this is true even among engineers. If we do not wake up now, we will never be able to escape from our lot as slaves... We cry out for the unionization of engineers and demand social justice... Engineers will not be ruled forever. We envision the day when Japan will establish itself through industry and be ruled by engineers.”

“Technological class?”

- In a general period of class struggle, the members of the Club could not agree on whether they were members of the middle class (中間階級) or the working class (無產階級). (The definition of *proletariat* (無產階級) was not clear in the national discourse.)
- The other proletariat groups would not accept the engineers, and there were internal struggles within the Kojin Club.

Nationalism

- Kojin Club Journal, 1925: “Legal supremacy, bureaucratic supremacy, capitalist supremacy and party supremacy: all these unpleasant evil practices that deepen domestic conflicts are a crime to the nation because they prevent national efficiency... We engineers will be the vanguard. Now is the time we stand at society’s front line under the banner of what we in the Kojin Club have been advocating for years. When the iron arms of engineers are put into full force, how the nation will flourish! Mighty engineers gather under one banner! Unite! Advance! For our homeland, for our homeland!”

A middle ground

- The engineers advocated a middle ground between Marxism and the political right.
- If a national science education was instituted, the people would be trained in the “exact” and “experimental” attitude and they would see that Marxism was irrational.
- On the other hand, the myth of the imperial house was also questioned. “As long as the nationalist and patriotic movement is based on mythologies and anecdotes, it will deny science, dry out culture, and prevent the development of the nation (民族).”

Colonial Technocrats

- Following the Manchuria Incident, 1931, most engineers joined in the “war fever.”
- The Kojin Club began to advocate for the development of Manchuria by Japanese firms.
- Kojin Club Journal, 1931: “Japan and China can create a heaven of truly mutual prosperity by having Japan provide China with ‘organization’ and ‘technology’ and China supply its ‘resources.’”
- In Manchuria, technocrats could secure the senior positions that were usually reserved for law-bureaucrats at home.

“A promised land”

- The Continental Science Institute: “Manchuria aims to construct a heavenly land under the mottoes ‘harmonious coexistence of five ethnicities’ (五族共和) and ‘coexistence, co-prosperity’ (共存共榮) under Japan’s leadership. However, can this be achieved without taking science seriously? National defense, industry, and all are shaped by science. Politics and economy cannot ignore science...”

“Virgin land”

- The engineers created the image of Manchuria as a blank slate, waiting for Japan to develop it.
- The media helped promote this image and encouraged 350,000 Japanese farmers to immigrate. In fact, however, there was already a large workforce in Manchuria.
- The engineers moved into administration.
 - Since the expression 工人 in Chinese meant coolie (manual laborer), the Kojin Club now felt this word was inappropriate for their group.

The Japan Technology Association

- “When we renamed the Kojin Club the Japan Technology Association, we also set up a new slogan: to lead the nation through technology. It clearly reveals our conversion (転向) from trade unionism to nationalism.”
- Although the technocrats now had considerable power in Manchuria, they still had very little in Tokyo.

War with China

- Following the incident on the Marco Polo Bridge, 1937, Japan declared war on China.
- The wartime economy favored the interest of the technocrats.
- The government set up the Asia Development Agency, staffed and run by technocrats.
- They began to develop an ideology of *technological imperialism*.
 - Technology should be progressive, synthetic, and local.

Science-Technology

- Fujisawa, Planning Agency, 1940: “As we have been talking to many people recently, there is one thing we keep in mind - language. We use ‘science-technology’ (科学技術) because we want to create a new term... This is because if we say “science” it is broad, including human and natural sciences. What is at stake is not science in this broad sense, but technological science.”

Science for Empire

- The technocrats argued that science has nothing to do with *truth*, *natural laws* or *objective existence*.
- They claimed that any idealization of the scientific project was misguided. That science was produced by technology and that it was not possible to understand one without the other.
- Moreover, the aims of science must be subsumed under the national good.

- Shinohara, “Theory of Science-Technology,” 1940: “Scientific research needs to be done in an organized and systematic fashion with a certain plan and control toward a clear objective for social production. Mere preference of individual psychology such as love of knowledge and admiration for truth needs to be absolutely excluded. It is imperative that scientific research be always conducted for practical purposes and that its results be materialized and industrialized immediately...”

- Science is not simply a system of scientific laws; it needs to be interpreted as part of a wider activity that creates and applies such laws. Thus, the real issue in science is how to create the most efficient laws and how to apply such laws in a most efficient manner. This is precisely the issue in technology. Science is nothing but a system of technology in our intellectual activity.”

A “Scientific” Japan

- To the technocrats, at this time, a scientific Japan meant a Japan that could develop the technologies necessary to win the war and maintain the empire.
- The technocrats hoped that they themselves would maintain these systems and administer the resources.
- Of course, not all Japanese had the same idea about what a scientific Japan would be.

The university chair system

- Before WWII, Japanese universities functioned on a chair system (based on the German system).
- Each department (school) had a small number of chairs and each chair had control over the activities of those under him.
- Research grants were given directly to the chairs. Since, chairs did not work together, even generous funding of individual chairs did little to promote research productivity.

JSPS (日本学術振興会)

- In 1932, the Japan Society for the Promotion of Science was founded to administer grants from the government and private endowments.
- Coordinated large scale research projects with industrial and military goals.
- Established subcommittees of technical experts to oversee the allocation of funds.
- Developed funding for collaborative projects.

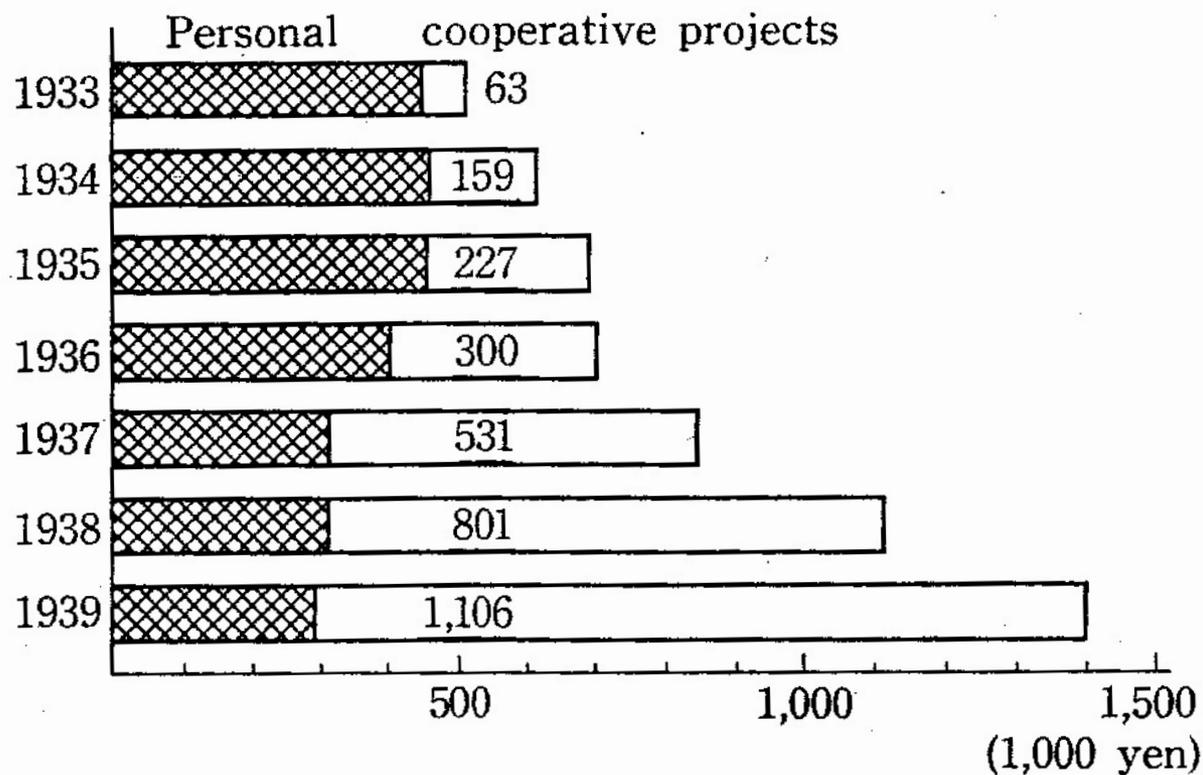


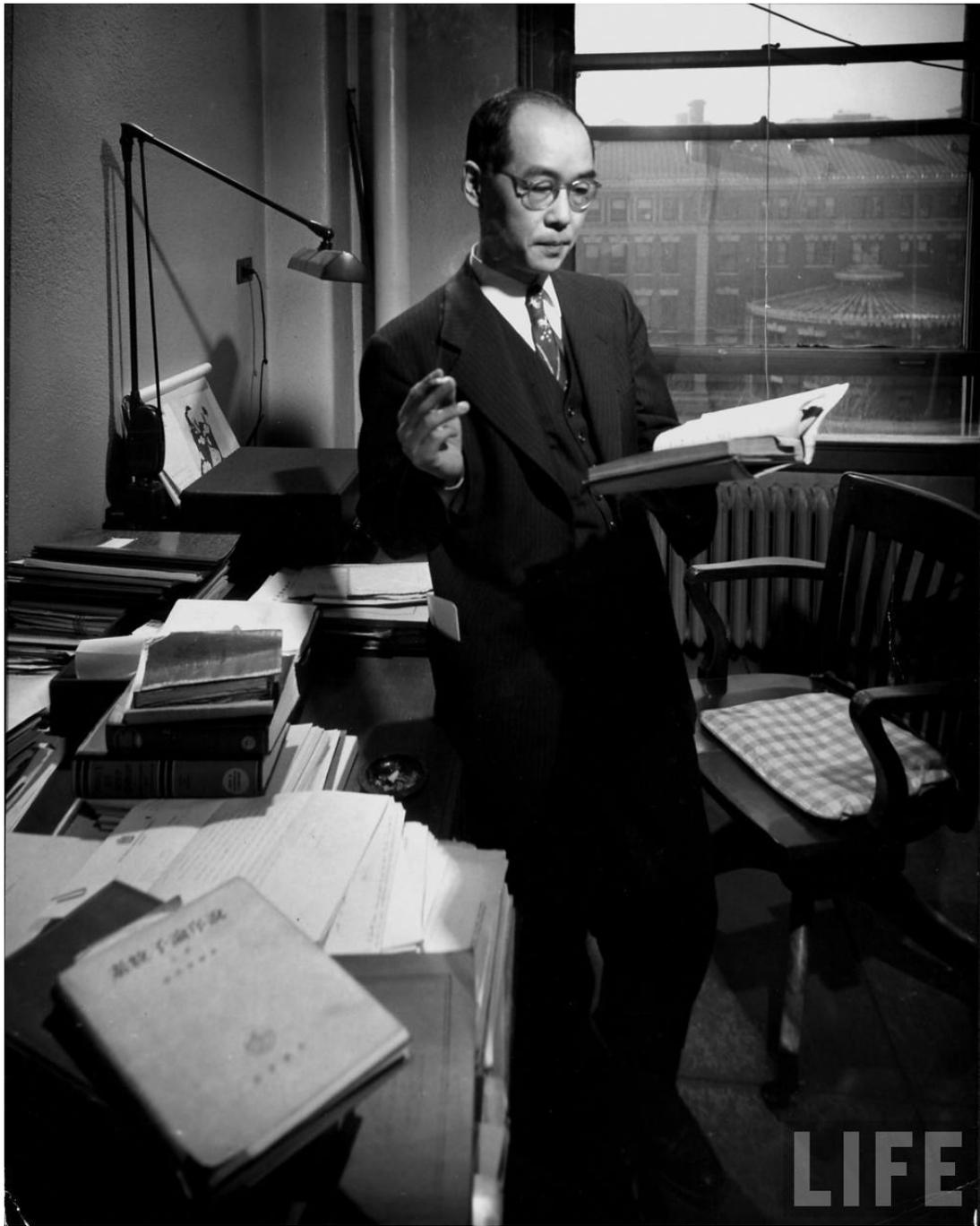
Fig. 1. Ratio of personal research grants to cooperative research project grants made by the Japan Society for the Promotion of Scientific Research, 1933-1939.

JSPS Subcommittees, 1933-40

- No. 1: Wireless instruments. (¥206,345)
- No. 2: Economic exploitation of Manchuria, Mongolia and China. (¥101,912)
- No. 3: Japanese encephalitis. (¥111,211)
- No. 7: Airplane fuel. (¥366,256)
- No. 10: Cosmic ray and atomic nucleus. (¥326,927)
- No. 19: Special steel. (¥135,945)
- No. 24: Metal casting. (¥110,800)

Yukawa Hideki (湯川 秀樹, 1907-1981)

- Born in Tokyo, educated at Kyoto Imperial University.
- Worked at Osaka and Kyoto Universities.
- 1935, published his theory of mesons.
- 1949, received the Nobel prize and became a professor at Columbia University.
- He headed the (Yukawa) Institute for Theoretical Physics, Kyoto, 1953-70.



LIFE



Proposing new particles

- There was some difficulty involved in applying the new theory of quantum mechanics to a phenomena produced by cosmic ray studies known as beta-decay.
- Fermi had proposed a new particle, the neutrino, but it had not been observed.
- Yukawa combined Fermi's idea with Heisenberg's idea that a neutron can be converted into a proton by emitting an electron + neutrino (and the contrary).

Proposing new fields

- The mathematical model required new fields of short range forces.
- This required a new particle some 200 times the mass of the electron.
- When Neils Bohr visited in 1937, Yukawa explained the theory to him, but Bohr was unimpressed.
- However, cloud chamber photos from the Institute of Physical and Chemical Research, in Tokyo, and elsewhere, soon showed the existence of such large particles.

Military reaction

- The nationalists did not react well to the new science, especially as many of the scientists were politically left-wing.
- The editors of *World Culture* (世界文化), a left-wing magazine were arrested along with Taketani Mituo, one of Yukawa's collaborators.
- Taketani was charged because he published his analyses of quantum mechanics, nuclear physics and his approach to the meson theory in *World Culture*.
- Eventually, he was released with Yukawa's help.

Overview

- Although the Meiji period set the groundwork for scientific development, it was the two great wars that did most to direct energy and funds toward scientific research and change the institutional structure of science administration.
- Not all of this development was positive. As in other countries, the nationalists were often deeply suspicious of pure science and they harassed scientists to produce only the kind of technoscience that they wanted.