Historical sketch of the difference in the development of the marine sciences between Japan and the occidental countries

by

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Abstract: At the time of the Meiji Restoration in 1868, Japan was completely underdeveloped in various aspects, prompting the government to become aware of the importance of education for the common people. One of the most important factors toward universal education was the invention of the Hiragana and Katagana alphabets, each consisting of about 50 characters, which greatly simplified and reduced the complicated Chinese symbols. This change from a cumbersome writing system to a more manageable one, made education possible to all levels of Japanese society. The Challenger Expedition (1872–1876) is said to have been the dawn of oceanography. Although the main orientation was research in marine biology, varios institutes in the world were founded by the beginning of the 20th century, all springing from this research in marine biology.

In Japan marine science started with basic study of the sea by the physists. After World War I (1920), the Imperial Marine Observatory was established in Kobe with a small research ship (125t). This was the beginning of physical and chemical oceanography in Japan. In 1934 severe cold weather badly affected crops in the northern part of Japan, perhaps due to the effects of the cold Oyashio current, which prompted the Central Meterological Observatory (CMO) to prepare a large research ship, "Ryofu–maru" (1200t) to study these phenomena. After the War, the three agencies, CMO, the Hydrographic Office and the Fishery Agency began to cooperate in synoptic research of the ocean near Japan. Based on these experiences, the Japanese delegate to UNESCO stressed in 1952 the importance of marine exploitation. Perhaps stimulated by this argument the Intergovernmental Oceanic Commission (IOC) was established in 1960. Since the first session of IOC in 1961, many topics on marine sciences have been discussed, but the improvement of science and technology of recent years has been so rapid that international cooperation between the developed and developing countries has become very complicated.

BRIEF HISTORY OF JAPAN TO THE MEIJI RESTORATION

In ancient Japan there were no written symbols. About the 3rd century or so,

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it seems that many civilized Chinese people were expelled by the Huns and began to migrate to Japan. From them the Japanese learned many techniques about various subjects. These new migrants tried to express themselves in the language of their adopted country (Japanese) by using the complex Chinese symbols. Fortunately in the 7–8 century, two types of alphabets were developed: Hiragana and Katakana that greatly simplified the complex Chinese letters (Fig. 1). Although, Hiragana and Katakana comprise about 50 symbols each, our ancestors succeeded in combining them with Chinese symbols to write Japanese sentences.

Originally, reading and writing in Japan was limited to the highly educated, precisely due to the difficulty of learning the many and complex Chinese characters. In the Middle Ages, education was carried out mainly in the temple lodge (Terakoya). In the 17th century, the teaching of the simplified alphabets to common people began to spread rapidly, especially in Edo' (Tokyo). Many merchants, priests and unemployed warriors (Ronin) were the teachers of the private elementary schools, Terakoya; education for common people flourished and elementary mathematics was taught with a hand calculator, *Soroban* or Japanese abacus.

GRADUAL DEVELOPMENT OF MARINE SCIENCES IN JAPAN UPTO WORLD WAR II

From the beginning of the Meiji era, the government established the Military and its training school. As the coast-lines of Japan are too complicated for safe navigation, some foreign-style light houses were established at the mouth of Tokyo Bay in 1870. In 1871 the Hydrographic Office under the Military was established for surveying the coasts of Japan. In 1872 the Military was divided into the Army and the Navy and the Hydrographic Office was transferred to the latter (the same year as the beginning of the Challenger expedition). The government also put much emphasis on education for the common people and the primary school system started early in 1870. After the establishment of a secondary or higher school system, the Imperial University of Tokyo was founded in 1877 (just 100 years ago). In 1875 the Central Meteorological Observatory was established. Weather forecasting by this observatory was commenced in 1883, along with the publication of the first weather map. In 1887 the Marine Biology Experimental Station was installed by Tokyo University at Misaki (Aburatsubo Bay). In 1893 Dr. Wada, member of the Central Meteorological Observatory, studied the ocean currents near Japan by the drifting bottle method (the results were published in 1922). Around 1900, the Fishery Agency initiated coastal and pelagic oceanographic observations. The severe damage of the 1876 tsunami, prompted Drs. K. Honda, K. Terada and D. Ishitani of Tokyo University to study the secondary undulation of various bays of Japan, and at the same time to carry out synthetic model experiments during 1903 and 1906 and to publish a voluminous paper in 1908.

As for marine sciences up to then, the main objectives were universally concentrated in the area of marine biology, therefore this research carried out by the physicists was considered a special contribution.

After World War I, the southern islands of the North Pacific came under the control of Japan as mandatory territories. The ship owners of Kobe donated funds for the establishment of the Imperial Marine Observatory in 1920 and a small ship "Syumpu-maru" (115t) was built in 1927. This was the beginning of physical and chemical oceanographic studies in Japan, and many oceanographers, especially

those graduated from physical and chemical sections of the Faculty of Science of the University, were trained and later became the pioneers in this newly developed science. Since then many scientists have contributed much to marine science; for example, an excellent study of tides and tidal currents by Dr. Ogura (1930); the publication of text books on oceanography by Dr. Nomitsu (1931) and by Dr. Suda (1933); excellent contributions to the research of seiches and ocean currents by Dr. Hidaka (1934).

In September of 1934, the central part of Japan (coast of Osaka) was damaged by a severe typhoon. K. Wadati and K. Terada (both of CMO) and other scientists quickly analyzed this storm surge which contributed much to marine science.

In the summer of 1934, the Tohoku area and Hokkaido suffered from cold waves, rice and other crops were badly damaged. Some oceanographers and meteorologists considered that this was due to the cold weather originating from the Oyashio current, and in order to verify this it was necessary to make continuous oceanographic observations and analyses. Study of these phenomena was initiated in 1937 by the research ship "Ryofu-maru" (1200 t), commissioned by the Central Meteorological Observatory. This research ship triggered the rapid development of marine science by the Observatory and at the same time it served as a training vessel for many scientists. As research in the marine sciences increased, the Oceanographical Society of Japan was founded in 1941 (current membership 1500). Until 1941 the survey ships Mansyu and Komahashi of the Hydrographic Office made frequent systematic surveys of various regions of the North Pacific.

MARINE SCIENCE FROM THE END OF WORLD WAR II TO FOUNDATION OF IOC

After World War II, Japan was still behind in the development of marine science, but Japanese scientists tried to narrow this gap in spite of restrictions of the peace treaties. After the war, Japan came under control of the General Head Quarters of the Allied Nations (GHQ) and the Japanese Army, Navy, Air Force and related institutes were disbanded, thus the Hydrographic Office was placed under civil control. Soldiers and civilians from various parts of Asia came back to Japan and the country experienced a food shortage. GHQ permitted the whaling fleet to be sent to the Antarctic Ocean for supplying animal protein in 1947. This year the Central Meteorological Observatory was ordered to carry out continuous meteorological observations by the Ocean Weather Stations (OWS) in the eastern and southern oceans of Japan. The total OWS's numbered about 20 in the world and according to the development of the global research system, their activities became conspicuous and even now many contribute effectively to oceanography. At the same time GHQ accepted the proposal of CMO of establishing the Nagasaki and the Maizuru Marine Observatories. Thus in CMO, the oceanographic section and the Division of OWS began their activities in 1947.

In 1948 the Fishery Agency decided to establish eight regional institutions for the purpose of investigating the food resources around Japan. Some years later, three agencies: the Central Meteorological Observatory with 4 marine observatories; the Hydrographic Office; and the Fishery Agency with 8 institutions, began to use ships for their respective purposes and marine research began to flourish.

In 1951 Japan joined UNESCO and in 1952 a Japanese delegate stressed the

importance of marine research at the General Conference. Negotiations for the creation of an International Institute of Oceanography began in 1949, perhaps stimulated by the Japanese proposal. UNESCO sponsored the Typhoon Symposium in 1954 and that of Physical Oceanography in 1955, both held in Tokyo, and discussed the establishment of IACOMS (Interim–later International Advisory Committee on Marine Sciences). In 1960 the IOC (Intergovernmental Oceanographic Commission) was founded.

In 1956 the Central Meteorological Observatory became the Japan Meteorological Agency (Director General: Dr. K. Wadati) and its Marine Division (Chief: Dr. K. Terada) began operating with four sections, including the maritime meteorological and the oceanographical sections. Since then JMA has taken the initiative in a joint survey of the ocean near Japan with two other agencies, the Hydrographic Office and the Fishery Agency. Members of these agencies later joined international oceanographic expeditions such as NORPAC, EQUAPAC and IIOE (International Indian Ocean Expedition). In those days there were many important contributions to marine science on a world-wide basis: for example the study of the deep Philippine trench by "Galathea" (1950-52); Cousteau's research of continental shelves by equalung; hydrogen bomb experiments at Bikini Atoll (1954). The most important of these contributions was the geological survey of the longest submarine mountain range, the Mid-Ocean Ridge, running 40,000 miles around the world, which later provided the basis for the development of the theory of plate tectonics.

In 1957, supported by a donation of $130,000.00 from the Rockefeller Foundation, the "Ryofu-maru" was equipped with 15,000 m of tapered wire for deep sea research, and JMA arranged to carry out a national study of the deep sea with various Japanese scientists.

During the International Geophysical Year (IGY) in 1957 SCOR (Special–later, Scientific Committee on Oceanic Research) was established under ICSU (International Council of Science Unions), contributing greatly to the IOC. One of the topics of SCOR was the implementation of the IIOE for a better understanding of the interaction between monsoons and ocean currents in the Indian Ocean.

In 1959 the severe typhoon "Vega" attacked the central part of Japan killing about 5000 people. Dr. Miyasaki of the Marine Division of JMA analyzed thoroughly the storm surge by utilizing the newly arrived IBM computer. The Marine Division explored in 1961 the "Call System" for accurately predicting tidal, normal and abnormal effects of typhoons by analyzing the data of daughter stations scattered at various coastal points. This system has been successfully installed at various places in Japan.

In the 1960s, the bathyscaphe and various submarine vehicles greatly advanced deep sea research. Also during this period Japan could be counted among the more advanced nations in the marine sciences.

ROLE OF JAPAN IN MARINE SCIENCE UNDER THE UNITED NATIONS

The first Plenary Session of the United Nations was held in London in 1946, with the assistance of a very small number of countries. Under the umbrella of the UN, there are many organizations connected with marine science, such as: UNESCO, FAO, WMO, IMCO, ITU, IAEA, and WHO. These organizations are implementing marine science in their respective categories.

TABLE 1

Classification of Marine Science
(Personal Opinion)

Item	Basic science	Technology	Equipment	Capital
Stationary Satellite (about 36,000 km above Equator)	**	**	**	***
Satellites (Tiros, Essa, etc.)	**	**	**	**
Airplane or airship	*	*	**	*
Meteorology (WWW) & Climate	#*	* (telecom.)	#	#
Air-sea interaction	#*	–	#	–
Bouys (manned/Unmanned-IGOSS)	*	*	*	#
Oceanographic survey	#*	–	#	#
Analysis of sea water	#*	–	–	–
Analysis of deep sea	*	–	#	#
Marine biology				
Coastal research	#	–	–	–
Plankton	#	–	–	–
Fisheries	#	#	#	–
Submarine geology	#*	#	#	#
Sea bed coring	*	*	*	*
Manganese nodules	*	*	**	**
Marine pollution	#	–	–	–
Energy from the ocean				
Wave energy	*	*	*	*
Tidal energy	*	*	**	**
Thermal energy	*	*	**	**
Tidal observation	#	–	–	–
Coastal civil engineering	*	*	*	**
Pure water from sea water	*	*	*	**
Nuclear fission (in future)	**	**	**	***
Administrative oceanographer.....	necessary for every item			

Remarks:
- # possible for a person of common education in the sciences and/or technology. Possible with simple equipment and large capital outlay not necessary.
- * very important for basic knowledge of science/technology (number shows the degree of importance)
- – not so important

Research in oceanography is very expensive, for example the cost of constructing research ships and outfitting them for observation is beyond the possibilities of private individuals. Therefore, it is absolutely necessary to rely on governmental assistance. In the first and succeeding several meetings of IOC, discussions were mainly scientific but later they veered toward economical assistance to the developing countries, through TEMA (Training, Education and Mutual Assistance) of IOC. Although this aspect is very important, promotion of marine science in the developing countries is of a higher priority and depends on the implementation of necessary education and the augmentation of suitable manpower.

CONCLUSION AND MY PERSONAL OPINION

Taking into consideration my experiences in Japan and my impression while attending several sessions of IOC, I would like to present here my personal opinion in the next section.

In the beginning of the 20th century, marine sciences sprang from marine biology. Physical and chemical phenomena such as dynamic analyses of ocean currents, chemical analyses of sea water and the geological investigation of the ocean bed became the foundation of marine sciences. Near the end of World War II, ocean technology began to flourish, various instruments became highly sophisticated, utilizing computer techniques. At the same time various submarine vehicles were developed. Offshore drilling for oil, which requires very complicated equipment, developed rapidly and contributed greatly to the advancement of the marine sciences. The drilling depth of the ocean bed is increasing year by year.

Many countries have begun exploring the possibility of exploiting the manganese nodules on the deep ocean floor. This point is under discussion in the "Law of the Sea Conferences" of the United Nations.

Progress in marine science and technology has gone beyond our expectations. I think that there is a very great difference between the science and technology of the developed countries and that of the developing nations, and therefore, joint projects between nations are impractical under the present levels of development. Nevertheless, there are many projects that could be undertaken with less sophisticated equipment and/or technology. Thus, I dare to classify these problems according to the basic knowledge, technique, equipment and capital required, as shown in Table 1. This table reflects my personal views and does not express the precise scope, but the general tendency of marine science.

In the IOC sessions the developing countries are requesting budgetary assistance from the United Nations, which is not the correct procedure for the promotion of marine science in these countries. Marine sciences require highly trained personnel, not only at the scientific levels, but all down the line. For example, oceanographic observations would be impossible without the cooperation of a first class captain, very good sailors, and specialized administrative personnel. From our experiences, it becomes clear that the education of the common people is the basic point in every branch of science but this takes an unexpectedly long time. The developing countries should be introduced step by step into oceanography; education should be adapted to the nature of the oceans off their own coasts. At the same time, it would be wise to select the research items, taking into consideration the priorities of the respective countries. The above table may be considered as a guideline in selecting such items.

The Japanese historical description is an example of how a developing country became a developed country in the field of marine science. Quite naturally, the highly sophisticated oceanic science must simultaneously continue in the more developed countries from where advances and discoveries will gradually spread to other nations and finally to all countries.

Chinese characters	Simplify	Japanese syllabic characters	Pronunciation
		(Hiragana)	
安	あ	あ	a
以	いく	い	i
宇	宀	う	u
衣	え	え	e
於	於	お	o
		(Katakana)	
阿	阝	ア	a
伊	伊	イ	i
宇	宀	ウ	u
江	江	エ	e
於	於	オ	o