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EDITORIAL

Pioneers of Plankton Research: Yoshine Hada (1905-1993)

Yoshine Hada (Fig. 1) was likely the first Japanese scientist who could be called a "planktologist". He was not the first to study plankton in Japan. That honor probably goes to Kintaro Okamura (1867-1935) who worked on marine phytoplankton. He is said to have been the first to translate 'plankton' into Japanese in 1900 (Omori, 2002). However, Hada, unlike Okamura, worked on a large variety of planktonic taxa and in a wide range of environments. He worked on copepods, rotifers, foraminifera, heliozoans, ciliates, amoeba, and many different taxa of phytoplankton. Hada published on the plankton of freshwater and saline lakes, and on marine plankton in sites ranging from the near shore waters of Japan, to the North Pacific, the Tropical Pacific, the Indian Ocean, and Antarctica. Today he may be best, but vaguely, known to the many plankton researchers who work on harmful algal blooms as he first discovered and described two troublesome flagellates species. In 1967, Hada described now known as *Heterosigma akashiwo*, naming it for its ability to form red tides as *akashiwo* is red tide in Japanese (Hada, 1967a). The species has since been known under many different names, see Hara and Chihara (1987) for an introduction to its confusing taxonomic history. Hada described another bloom-forming species now known as *Chattonella antiqua* in 1974 as *Hemieutreptia antiqua* (Hada, 1974a).

Here a brief sketch will be given of the little known career of Yoshine Hada and his remarkably diverse contributions to plankton research will be highlighted. The account of his career is based in large part on information graciously supplied by Takashi Ishimaru, Professor Emeritus (Plankton Research), Tokyo University of Marine Science and Technology and Akira Taniguchi, Professor Emeritus (Plankton Research), Tohoku University, Sendai. It should be noted that Hada published many more works than those mentioned here which are limited to publications that are relatively easy to access (all of his works cited here are available on request).

Fig. 1. Yoshine Hada in 1941, at age 36, from a group photo. Image courtesy of David Damkaer. In Damkaer and Onbé's book (Damkaer and Onbé, 2018), Hada is described as 'the planktologist Yoshine Hada'.

Yoshine Hada was born in Hiroshima, in the south of Honshu (the main island of Japan), in 1905. He earned his first degree at the Hokkaido Imperial University in 1929. The city of Hokkaido is on the northern most of Japan's main islands (also called Hokkaido). His academic advisor was Saburo Hatta a well-known zoologist. Hada was likely his last student likely as Hatta retired from Haikkado

University in 1930. Hada published his first paper at age 24. It was on foraminifera of shallow coastal waters of Japan near Haikkado collected by dredging for benthic forms and using a plankton net to collect planktonic forms (Hada, 1929). Just after graduation, he was hired as research assistant at the Asamushi Marine Biological Station of Tohuka University, on the northern most bay (called Mutsu Bay) of the main island of Japan. It was the third marine biology station of Japan, created just a few years earlier in 1924 (Inaba, 2015). Shortly after arriving, he published an experimental study of the feeding of pitcher plants (*Utricularia*) on zooplankton. In the laboratory he presented zooplankton to *Utricularia* from a bog lake with zooplankton from the lake. He found that copepods such as *Cyclops* species, and rotifers such as *Euchlanis dilatata*, were attracted to, and readily consumed by, *Utricularia* (Hada, 1930). He also continued to work on foraminifera but in the local waters, and produced a substantial monographic work (Hada, 1931)

A key event in the career of Yoshine Hada may have been the visit of Charles Atwood Kofoid, the renowned American authority on dinoflagellates and tintinnid ciliates of the marine plankton. Kofoid visited the Asamuchi Station in 1931 and worked for some time there pursuing his research on dinoflagellates and lecturing. The young (age 25) Research Assistant Hada met the senior (age 66) Professor Kofoid and helped him with the illustrations of the new dinoflagellate species Kofoid found in the nearshore plankton of Mutsu Bay. In his paper, Kofoid thanked Yoshine Hada "*for effective assistance in finishing my sketches for reproduction as illustrations*" (Kofoid, 1931). As Kofoid is known for having had others do his illustrations for him (Taylor, 1987), it is likely that the striking plates of Kofoid's 1931 article (e.g. Fig. 2) are largely Hada's work. Working with Kofoid was possibly of importance as Hada would later go on to describe many new species of dinoflagellates from the plankton himself and soon named a species of tintinnid ciliate for Kofoid, *Tintinnopsis kofoidi* (Hada, 1932a).

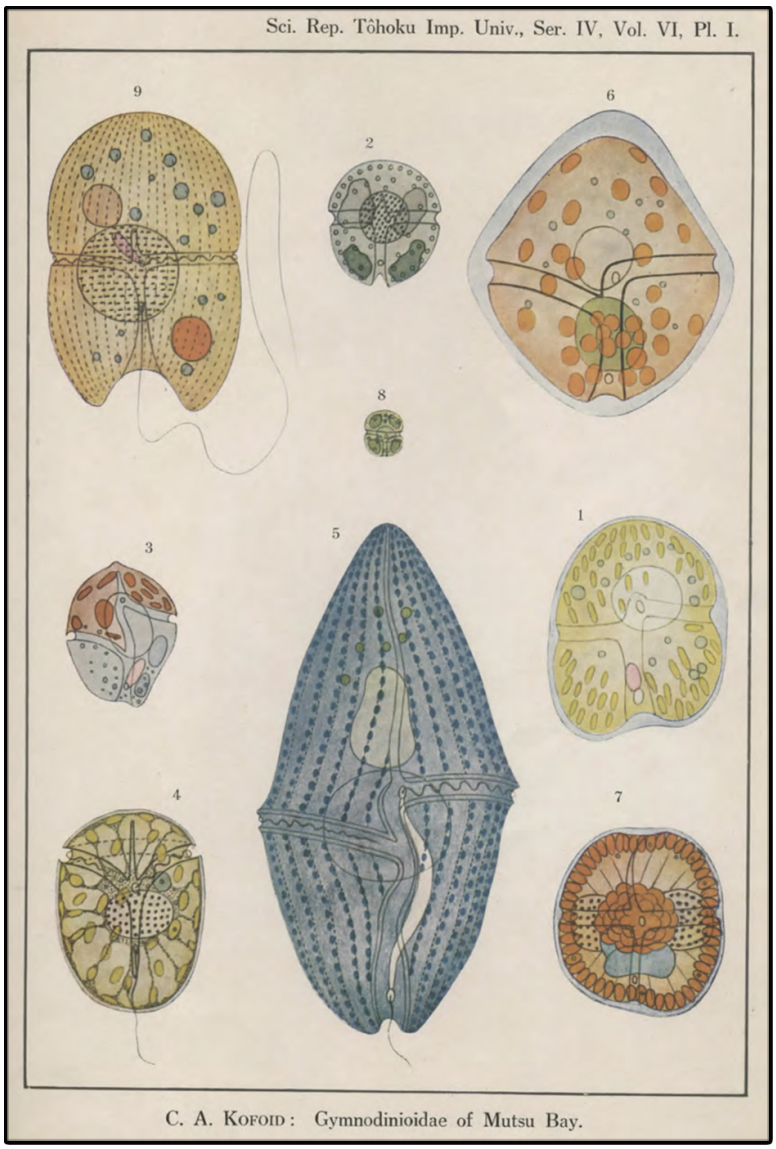


Fig. 2. Plate 1 from Kofoid's 1931 article on Gymnodinid dinoflagellates from Mutsu Bay. At the time of Kofoid's visit, Yoshine Hada was a research assistant at the Asamuchi Marine Biological Station. Kofoid was known for rarely doing his own artwork and in the paper Kofoid thanks Hada for *"for effective assistance in finishing my sketches for reproduction as illustrations*" so it appears that the plates were the work of Hada.

In 1932, Yoshine Hada moved from the Asamushi Marine Biological Station to the Akkeshi Marine Biological Station, the new marine station of his alma mater, Hokkaido Imperial University. The station was new, created only a year earlier (Inaba, 2015). We do not know what prompted Hada's move back to the north of Japan. However, he quickly set to work on plankton. One of his first publications, signed as 'Research Assistant at the Akkeshi Marine Biological Station' was a description of two new tintinnid ciliates of the marine plankton, *Tintinnopsis japonica*, and the species he named for Kofoid, *T. kofoidi*. The paper (Hada, 1932a) also included observations on a parasite of *T. kofoidi*, (Fig. 3), one of the early observations of parasitism among planktonic protists (Coats and Bachvaroff, 2013). Yoshine Hada stayed at Akkeshi Marine station until 1939.

There he became an expert on tintinnid ciliates. Hada published on the tintinnid fauna of Japanese coastal waters (Hada, 1932b,c; Hada, 1937a), the East Indies (Hada, 1935), the tropical Pacific (Hada, 1938a) and even in freshwaters of Japan (Hada, 1939a). In these early years, Hada also worked on the rotifer fauna of Japan (Hada, 1939b) and of "Manchukou" (Hada, 1938b), in Northeast China, at that time part of the Japanese Empire. He also continued to work on foraminifera (Hada, 1936a). However, at Akkesshi his research interests expanded to include studies of the basic limnology and the plankton of freshwater and brackish water lakes that abound in the vicinity of Hokkaido. By the end of his career, Hada had worked on the limnology and plankton of a remarkable variety of different kinds of lakes, mostly in the region of Hokkaido. These ranged from bog lakes, for which he appears to have had a particular fondness (Hada, 1936b; Hada, 1937b,c; Hada, 1958a,b) to volcanic lakes (Hada and Chiba 1937; Hada 1967b), a lake with anoxic hypolimnion harboring crustacean plankters (Hada and Kuski, 1938), brackish water lakes (Hada, 1940; Hada, 1957a), high altitude lakes (Hada, 1959) and even an artificial urban lake (Hada, 1966a; Hada and Kojiro, 1966). One of his many studies of bog lake plankton concerned determining which taxa served as prey for pond smelt, and surprisingly, he found dinoflagellates to be the most commonly prey found in gut contents of the fish (Hada 1958b).

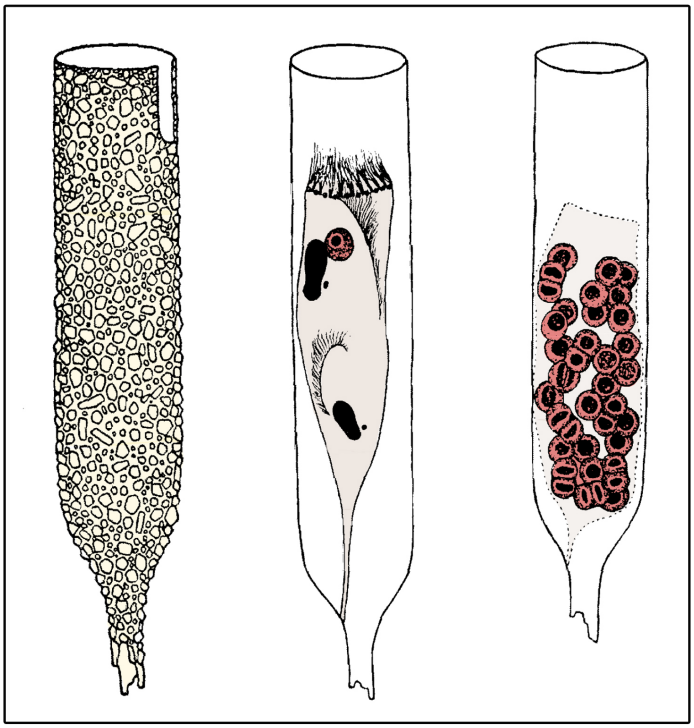
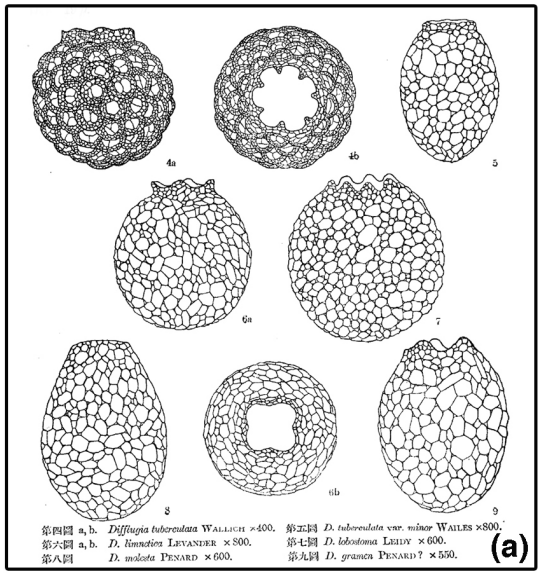
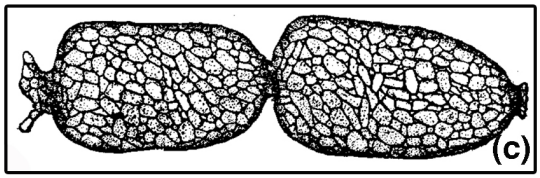


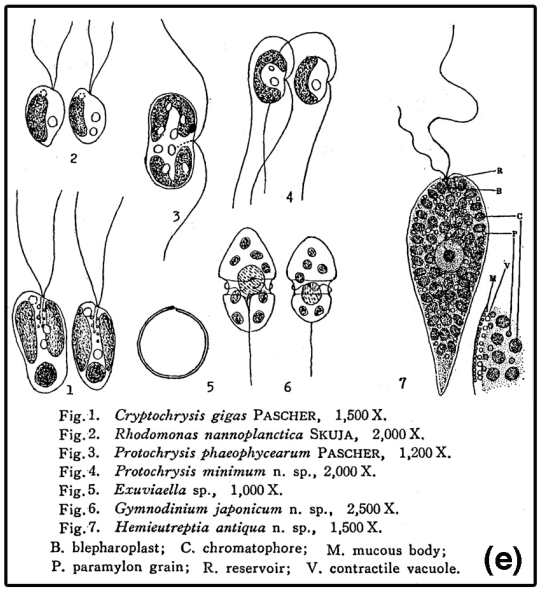
Fig. 3. Figures of *Tintinnopsis kofoidi*, the tintinnid species Yoshine Hada named for Charles Atwood Kofoid, from Hada, 1932a. At the left: gross morphology of the lorica of *T. kofoidi*; center: a sketch of a tintinnid cell in the early stage of division developing a new mouth (arc of short lines in the cell center) which had ingested a parasite (red ball); right: spores of the parasitic dinoflagellate filling the remnants of the ciliate cell. Color was added to the original black and white figures to provide improved contrast.

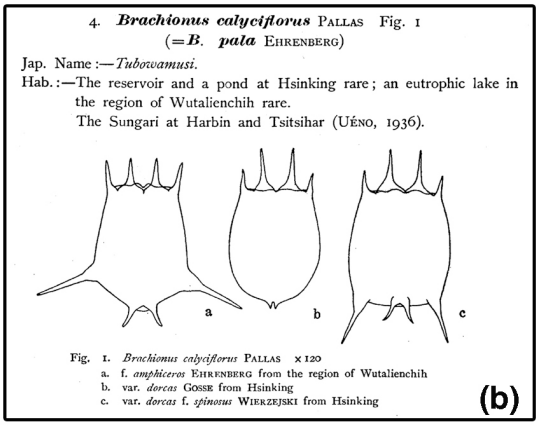
In 1940, Yoshine Hada was named Assistant Professor at Faculty of Agriculture, Hokkaido Imperial University and occupied the post until 1944 when he was called to military duty as a 'Military Technician' at the Southern Institute for Fuel Technology, apparently his only participation in World War II. During his wartime tenure at Hokkaido, Hada published on brackish water lakes in the Hokkaido region (Hada, 1940) and the foraminifera of the Java Sea from samples gathered in 1933 (Hada, 1943). At the end of WWII, Hada returned to the Hiroshima area where he was born. Rebuilding of the city, following its destruction by the first atomic bomb, was underway by 1949. In Hiroshima, Hada was first a principle of the Shinjyo Gakuen High school from 1948 to 1950, and then was named Professor at the Suzugamine Women's College where he remained until 1965 when he was named Professor at the Hiroshima Shudo University. Yoshine Hada spent the rest of his career at the University, becoming a Professor Emeritus in 1980 at the age of 75. Although located in Hiroshima, he produced a substantial study of the freshwater flagellates found in the lakes of the Hokkaido region based on the many collections he had made since 1926 (Hada, 1959b) and of course, he did not ignore the marine protozoan plankton of the waters near Hiroshima (Hada, 1964a, Hada, 1967a, Hada, 1968). He published his last paper in 1981 with his last student, Akira Taniguchi. It was a description of a new tintinnid ciliate, *Eutintinnus Haslae*, named for an eminent plankton researcher, Grethe Rytter Hasle (1920-2013), the Norwegian diatom specialist (Taniguchi and Hada, 1981). Thus, his last paper recalled one of his early papers, that one naming a new tintinnid for Charles Atwood Kofoid, published nearly 50 earlier (Hada, 1932a).

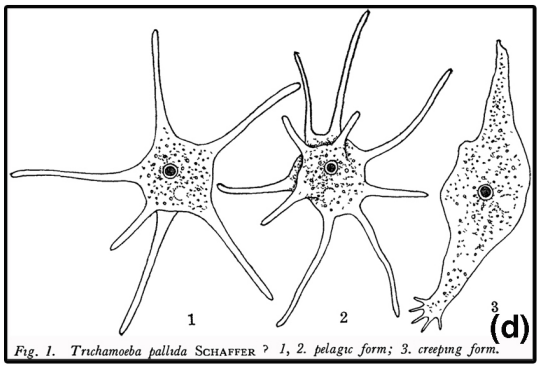
Most of Yoshine Hada's work can be classified as field studies, in which he described and documented the occurrences of organisms in samples he or others had collected. For example, in the latter part of his career he published extensively on the plankton of Antarctica based on samples gathered during the Japanese expeditions (Hada, 1961; Hada, 1964b; Hada, 1967c; Hada, 1970). However, as mentioned previously, Yoshine Hada dealt with a surprising variety of planktonic organisms from a very wide range of environments (Fig. 4). Interestingly, some of his early studies could be considered as accidents of history as there were of sites in lands occupied or de-facto part of the Japanese empire before World War II. These include Hada's study of the plankton of "Lake Seiko" (Hada, 1936c), now known as Seoho Lake in Suwon-City, when Japan controlled the Korean peninsula and called Korea "Chosen". The study is credited as being the first report on rotifers from a Korean site (Song and Kim, 2000). Likewise his study of the rotifer fauna of the area of 'Manchoukuo' (Hada, 1938b) is the area known today as Manchuria in China.

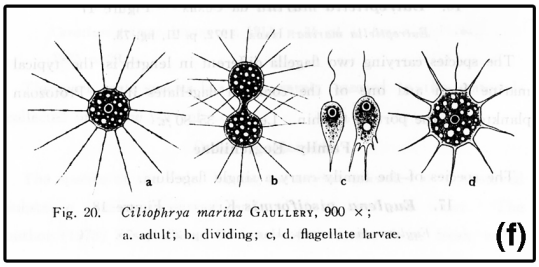












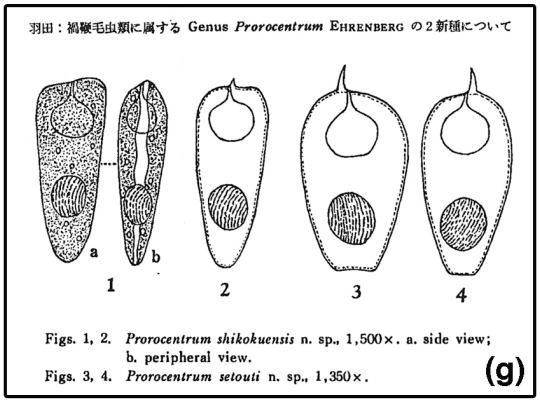


Fig. 4. The diversity of planktonic organisms Yoshine Hada studied. **a.**: from Hada 1936c, *Diffulgia* (testate amoeba) in the plankton of "Lake Seiko"; **b.**: From Hada 1938b on rotifers of "Manchoukuo"; **c.**: From Hada 1957b on foraminifera from the Northwest Pacific; **d.**: From Hada 1969 on pelagic amoeba from the Indian Ocean; **e.**: From Hada 1974a on flagellates from polluted water; **f.**: From Hada 1974b, Heliozoans from the coast of India; **g.**: From Hada 1975 on two new species of *Prorocentrum*.

The wide range of Yoshine Hada's plankton studies are reminiscent of the wide-ranging studies of early naturalists of the 19th and early 20th centuries. Before the specialization and professionalization of biologists, researchers often worked on very diverse topics, for example, ranging from primordial life and plankton to development biology (e.g., Ernst Haeckel or Thomas Huxley). Hada's career commenced in the 1920's coinciding with the period, still with us today, of increasing specialization of workers, and the creation and recognition of new research specialties. Yoshine Hada's relative obscurity today is likely due at least in part to the fact that his many contributions to plankton research were not concentrated in one area but rather concerned taxa or topics that today constitute distinct areas of research. For example, the foraminifera and red tide organisms on which he worked today have their own journals, the *Journal of Foraminiferal Research* (dates from 1971) and *Harmful Algae* (dates from 2002) and of course, plankton research has its own journal, the *Journal of Plankton Research* (dates from 1979). Furthermore, Hada often published in Japanese (but almost always with a summary in English) and in journals not easily accessible today. Nonetheless, Hada has received some recognition. Several species have been named for Hada, but most are species of benthic foraminifera. It appears that only 2 species of the plankton have been named for Hada and both were named by the Argentinian planktologist, Ernesto Balech: the tintinnid ciliate *Undella hadai* in 1962 (Balech, 1962) and the dinoflagellate *Amphidinium hadai* in 1976 (Balech, 1976). Hopefully here the considerable, interesting, yet little known contributions of Yoshine Hada have been brought to light, one of the first and perhaps last, Japanese scientist who could be called a "planktologist".

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