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Abstract.—In Japan three freshwater Limnomedusae have been reported: *Craspedacusta sowerbii*, *C. iseana*, and *Astrohydra japonica*. The latter two species, though known only from Japan, have not been reported in ninety and thirty years, respectively. The type material for *C. iseana* is lost, and the only known specimens of *A. japonica* have recently been deposited in the National Museum of Natural History, Smithsonian Institution, Washington, D.C. *Craspedacusta sowerbii*, on the other hand, is a cosmopolitan species found throughout the archipelago of Japan. Reports of *C. sowerbii* in China, Europe, and North America are commonplace in international publications, but particulars about the occurrence of this freshwater jellyfish, known as *mamizu kurage* in Japan, were previously not well understood by the international scientific community due to a lack of related English-language publications. The aim of this paper is to provide naturalists and citizen scientists in Japan with a means to both locate and identify *mamizu kurage* in all nine geographical regions of Japan. Here we provide an extensive history of the occurrence of *mamizu kurage* in Japan from the time of its first sighting in 1928 until 2011, while also providing personal observations on populations of *C. sowerbii* in Okinawa, Shiga, and Shizuoka Prefectures. The distribution list and map herein represent the most extensive compilation of data on the 217 reports of *mamizu kurage* in Japan, and should serve as the basis for future molecular genetics studies on its phylogeography to determine if all accounts correspond to a single species called *C. sowerbii*.

Keywords: *Astrohydra japonica*, Cnidaria, *Craspedacusta sowerbii, Craspedacusta iseana*, distribution, Limnomedusae, polyps, taxonomy

Freshwater jellyfish are a favorite of naturalists worldwide due to their charm and non-threatening presence in a variety of natural and artificial bodies of water. They belong to the class Hydrozoa, and almost exclusively to the order Limnomedusae. Their appellation in Chinese literature as "peach blossom fish" as far back as the Tang Dynasty (618–907 A.D.) suggests a fondness for these apparently familiar aquatic organisms (Sowerby 1941, Kramp 1950, Ohno 1987). Like many marine

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hydrozoan taxa, the life cycle of freshwater jellyfish is metagenetic, having a microscopic benthic polyp stage and a free-swimming medusa stage. Unlike most of its marine counterparts, however, the freshwater jellyfish *Craspedacusta sowerbii* Lankester, 1880 has two additional life stages—minuscule motile frustules and desiccated podocysts—that have allowed this cnidarian to colonize freshwater ecosystems on every continent, except Antarctica (Jankowski 2001, Jankowski et al. 2008). While any of these four life stages might be present in a natural or artificial freshwater habitat at a given time, the conspicuous medusa is the form usually detected by unsuspecting bathers or naturalists searching for interesting organisms in reservoirs, ponds, and lacustrine ecosystems.

The first freshwater jellyfish known to Japan, *Craspedacusta iseana* (Oka & Hara, 1922), was discovered in an old well in Tsu City, of the former Ise Province (now Mie Prefecture) in 1921 (Oka & Hara 1922, Fukui 1957, Sakakibara 1964). These medusae were differentiated from *C. sowerbii* based on the lack of velar canals, smaller bell size at maturity, fewer tentacles, and differences in statocyst shape and nematocyst pattern (Oka & Hara 1922). The well in which medusae of *C. iseana* were found was soon after destroyed (Komai 1947), and since the species has not been reported again in Japan, it is believed to be extinct (Uchida 1951). Only mature male medusae of *C. iseana* (5–18 mm bell diameter) were observed (Oka & Hara 1922), and the polyp form has not been reported.

In 1928 the polyp form of *Craspedacusta sowerbii* was discovered in a tropical fish aquarium on the leaves of an aquatic plant, imported from California, at Tokyo University's Agricultural Department (Amemiya 1930). No records existed for this species in Japan in a natural habitat until the medusa form was reported in a pond in 1946 (Komai 1947). In the 30 years to follow, *C. sowerbii* was reported more than 175 times throughout Japan (Ohno 1978, 1987). With sightings of *C. sowerbii* on the rise and no subsequent accounts of *C. iseana*, the name *mamizu kurage* (literally "pure water jellyfish"), which originally denoted *C. iseana*, was formally reassigned to C. *sowerbii*, and the presumably extinct species was dubbed posthumously *ise-mamizu kurage* (literally "pure water jellyfish from Ise region") (see Tateishi 1967, Ohno 1978). All experts that examined the material declared it to represent a species distinct from *C. sowerbii* (Oka & Hara 1922, Komai 1947, Uchida 1955, Fukui 1957, Sakakibara 1964). Despite allegations that type lots of *C. iseana* were held in the collections at Mie University and the Tokyo University of Education (Komai 1947, Yamamoto 1966, Ohno 1987), our search for the material failed, leaving *C. iseana* unrepresented.

The polyp form of a third species of freshwater Limnomedusae, *Astrohydra japonica* (*yume-no-kurage*, or "dream jellyfish''), was discovered in 1974 in Nomorinoike pond (Shizuoka Prefecture), which was also inhabited by medusae of *Craspedacusta sowerbii* (Hashimoto 1981). Unlike polyps of *C. sowerbii*, which lack tentacles and are either solitary or colonial, with 2–7 polyps, the tiny polyps (0.2–0.3 mm diameter) of *A. japonica* were found to be solitary and multitentaculate, prompting Hashimoto (1981) to erect a new genus and species for the newly found freshwater polyp. Hashimoto reared these polyps for over 10 years in the laboratory, as well as polyps of *A. japonica* collected from another Shizuoka pond (Kujiragaike pond) in 1983, and witnessed four buds of medusae of *A. japonica* liberated in vitro (Hashimoto 1985, 1987). Hashimoto's (1985) medusae died within one month of liberation and did not develop gonads or obtain a bell diameter of more than 1.35 mm (29 tentacles); thus, the morphology of mature madusae of *A. japonica* remains

unknown. Recently, two medusae from Hashimoto's Nomorinoike Pond population were deposited in the collections at the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM 1147829, USNM 1147830). The material is in poor condition and attempts to extract DNA and amplify mitochondrial markers (16s and COI) from one specimen were unsuccessful, likely due to DNA degradation.

Most reports on freshwater jellyfish in Japan are published exclusively in Japanese, making it difficult for the international scientific community to stay informed of the status of the group there. The bulk of our current understanding of the distribution of *Craspedacusta sowerbii* is from Ohno's (1987) extensive compendium of sightings of *mamizu kurage* on the four main islands of Japan: Honshu, Hokkaido, Kyushu, and Shikoku. Ohno's document, which covers 59 reports from 1928 to 1987, is written in Japanese and is, therefore, not easily accessible to most foreign researchers. The 1987 list mainly comprises mere mentions of sightings of *mamizu kurage* and is almost devoid of information on medusa size, maturity, sex, or the environment in which the medusae were seen (Ohno 1987). While a good portion of Ohno's data on *mamizu kurage* in Japan was gathered from scientific papers (e.g., Komai 1947, Sumi et al. 1948, Uchida 1951, 1955, 1965; Ito 1953, Oka 1955, Fukui 1957, Mizuno 1958, Yamamoto 1966), many accounts were relayed to Ohno by word-of-mouth or via newspaper and magazine articles, and television broadcasts (Ohno 1987). Numerous reports from 1947 to 1987 came from residents in the area where the medusae were reported and, thus, were not confirmed by scientists familiar with the morphological characters of *Craspedacusta sowerbii*, a fact that introduces some speculation about the validity of all reports on *mamizu kurage* documented in Japan during this period. Following the publication of Ohno's paper in 1987, a resurgence of interest in freshwater jellyfish occurred among cnidarian researchers and naturalists alike, giving rise to more credible scientific documentation of populations of *C. sowerbii* in Japan in recent years (e.g., Masuda 1994, Eda & Yamasaki 1998, Izawa 1998, 2004; Masuda & Izawa 1999, Yasui & Takeda 2000, 2002; Kubota & Tanase 2006, Yamamoto et al. 2006, Onoue & Okamoto 2008).

Herein we provide a distribution map and species diagnoses for the three freshwater limnomedusan jellyfish in Japan. In addition, we provide several illustrations of key morphological characters of *Craspedacusta sowerbii*. Our aim is to provide a tool to facilitate correct identification of *C. sowerbii* by naturalists and citizen scientists who may be unfamiliar with jellyfish taxonomy or lack access to relevant scientific literature or reference specimens for comparison. We believe that individuals with a great interest in jellyfish tracking in Japan will profit from the information we disseminate from Ohno's (1987) Japanese publication and numerous other reports since 1987. We also include our observations of *C. sowerbii* on the subtropical island of Okinawa, where its presence was previously not well known, and more recently of a population in Lake Biwako. The distribution list and map we provide covers a period of 83 years. We hope it will serve as a foundation to stimulate future studies on biogeography, molecular systematics, and phylogeography of freshwater jellyfish in Japan, similar to those conducted recently in China (Zhang et al. 2009) and Germany and Austria (Fritz et al. 2009).

Materials and Methods

Nomenclatural note.—All scientific literature from Japan related to this freshwater hydrozoan uses the spelling *C. sowerbyi* instead of *C. sowerbii* for the species name.

This can likely be attributed to the influential works of prominent cnidarian researchers such as Kramp (1950) and Russell (1953) who used the spelling *sowerbyi* to reflect that the species was named after William Sowerby. Despite this spelling also being in common usage in much of the scientific literature published worldwide (see Fritz 2007), it must be noted that the spelling of the species name originally introduced by E. Ray Lankester in 1880, *Craspedacusta sowerbii* has priority, thus rendering *C. sowerbyi* a junior synonym that should not be used.

While conducting this study one of the authors (CL) was informed of two populations of *mamizu kurage* on the subtropical Japanese island of Okinawa by professors at the University of the Ryukyus. The first population was observed prior to 1993 by M. Yamaguchi in Kinjo Dam in the Shuri District (26°13′N, 127°43′E) on the southwest portion of the island. The second population was discovered by K. Tachihara in an inlet stream (Sannumata River) of Fukuji Dam Reservoir (26°39′N, 128°09′E), from August 1994 to January 1995, and again in that summer until December 1995.

On 28 November 1995, 23 live medusae were collected by net from Sannumata River (22°C), which branches off Fukuji Dam. Medusae were maintained alive in a 10 l glass aquarium (22°C) at the Coral Reef Laboratory of the Faculty of Science (University of the Ryukyus, Okinawa, Japan) in the original water containing mud, rocks, and plants taken from the river. A subsample of seven medusae was selected for comparison with morphometric data available for medusae of *C. sowerbii* from other Japanese islands. Several medusae were preserved in 10% formalin and deposited in the collections at the National Museum of Natural History, Smithsonian Institution, Washington, D.C. (USNM 1105514).

Recently, on 14 July 2011, one of the authors (MM) discovered polyps of *mamizu kurage* on some rocks partly covered in algae, collected seven months earlier on 7 November 2010 at a depth of 0.3 m in Lake Biwako (Ohmihachiman City, Shiga Prefecture). When the rocks, which had been held in a plastic container with the original lake water, were observed using a dissecting microscope; polyps covering the rocks were found to either be solitary or have 1–3 polyp buds. These observations were similar to those of another author on this study (HH) who photographed bipolar and tripolar polyps collected on rocks in Nagashima (Shimada City, Shizuoka Prefecture) in 1974 (Fig. 1a–d). Medusa buds were not observed in the Lake Biwako colony, but the culture is being maintained for future observation.

Collection and Identification of Freshwater Jellyfish

Freshwater jellyfish can be collected using either a handheld net or a bucket. Subsequently, medusae can be transferred to a small transparent glass dish and observed in filtered fresh water using a dissecting microscope. Alternatively, rocks or other sunken objects, such as wood or concrete blocks, can be collected from ponds, streams, and other freshwater bodies and maintained in a large bucket or tub, in the original pond water, and inspected for signs of polyps using a magnifying glass. It should be noted that light microscopy is required in order to observe finer details of polyps and nematocysts, and to distinguish between male and female gametes.

The following species diagnoses and figures illustrate key morphological characters that can be used to positively identify individuals of *Craspedacusta sowerbii*. Additionally, descriptions of *C. iseana* and *Astrohydra japonica* are provided to facilitate proper identification in the event that populations of either are dis-

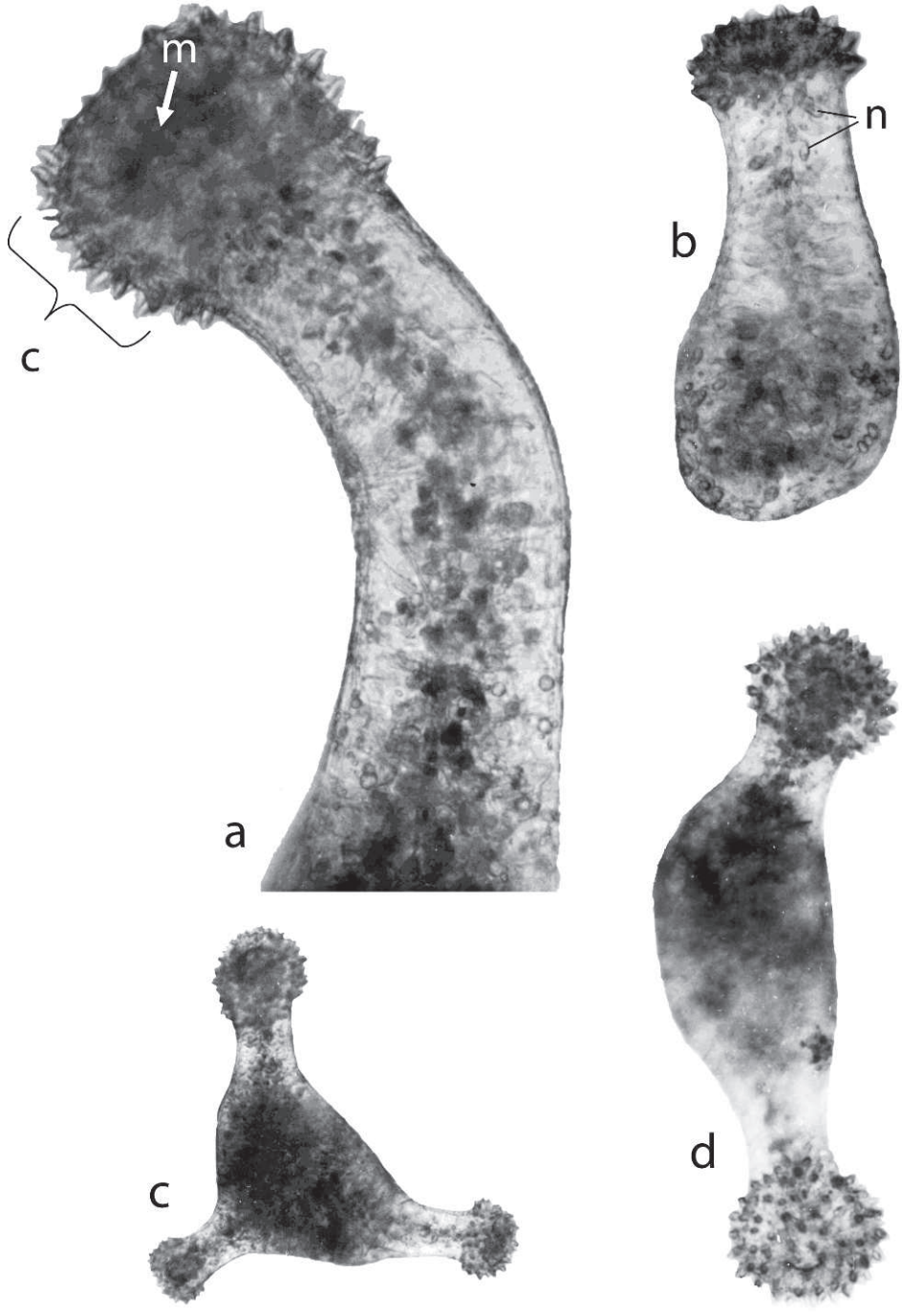

Fig. 1.—Images of solitary (a, b), tripolar (c), and bipolar (d) polyps of *Craspedacusta sowerbii* collected on rocks in Nagashima (Shimada City, Shizuoka Prefecture) in 1974 by one of the authors (HH). Individual polyps in this colony measured 0.2–1.0 mm in length, whereas bipolar and tripolar polyps grew longer than 2.0 mm in length and about 0.2 mm in diameter (exact measurements for each polyp cannot be provided). Abbreviations: c, capitulum; m, mouth; n, nematocyst.

covered in Japan, or elsewhere, in freshwater habitats.

Species Diagnoses

Craspedacusta sowerbii Lankester, 1880

Figs. 1a–d, 2a, b, 3a–d; Table 1

(= *Microhydra ryderi* = *Microhydra germanica* = *Limnocodium victoria* = *Limnocodium sowerbii* = *Limnocodium kawaii* = *Limnocodium sowerbii var. kawaii* = *Craspedacusta ryderi* = *Craspedacusta germanica* = *Craspedacusta xinyangensis*)

Japanese name: *Mamizu kurage*.

Description from Kramp (1950), Izawa (2004), and authors' observations.—Newly released medusae tiny (0.7–1.0 mm diameter), mature medusae with umbrella (5–22 mm diameter) slightly flatter than hemispherical, jelly rather thick; velum broad; well-developed marginal nematocyst ring; stomach large, upper portion conical with broad square base, tapering into cross at distal region; mouth with four lips (simple or folded), extending beyond umbrella margin; four straight radial canals extending from each corner of stomach down to well-developed marginal ring (circular canal); umbrella margin undulated due to numerous deep cleft-like bays containing radially elongated statocysts in marginal vesicles ending blindly as velar canals; tentacles numerous (152–528), increasing in number and type (primary, secondary, tertiary, etc.) with growth of umbrella margin; older and thicker primary tentacles migrating up exumbrella, creating deeper marginal bays compared to those containing newer tentacles; statocysts, regularly distributed in sets of 2 to 5, with interruptions occurring below each of larger primary tentacles, generally half as numerous (109–216) as tentacles, but varying with medusa age; tentacular nematocysts concentrated in tiny round warts (papillae), arranged in closely packed transverse belts along tentacle length, with varying degrees of continuity depending on tentacle type; gonads, khaki green colored stocking cap-shaped, wide at base and tapering off as they extend below umbrella margin or pale yellowish-ochre colored walnut-shaped; hue of stomach, radial canals, and marginal ring generally similar to that of gonads; polyp colonial, lacking tentacles, hypostome covered in cnidae – microbasic euryteles only. Note: since the sting of *C. sowerbii* is not painful to humans, no precautions are necessary to avoid contact with medusae.

The behavior of medusae of *Craspedacusta sowerbii* is illustrated in Fig. 3a–d. During this study, medusae collected in Fukuji Dam (Okinawa) were seen swimming at the water surface, or ascending to the surface of the glass aquarium and then immediately descending either right side up (oral opening down) or upside down (oral opening up) with tentacles extended up or down. These observations are consistent with observations by Masuda (1994) and Izawa (1998, 2004) who have successfully reared *mamizu kurage* for public exhibits in Japan, and with in situ observations on *C. sowerbii* capturing zooplankton in the water column in other parts of the world (Jankowski et al. 2005).

Craspedacusta iseana (Oka & Hara, 1922)

(= *Limnocodium iseanum* = *Craspedacusta iseanum*)

Japanese name: *Ise-mamizu kurage*.

Description from Oka & Hara (1922) and Uchida (1955).—Medusae small (5–18 mm diameter), newly released medusa form unknown; umbrella flatter than hemisphere; manubrium with four simple lips extending beyond umbrella margin; stomach large, upper portion conical with broad square base, narrowing downwards; gonads massive, developed from junction point of radial canals in mature medusae; marginal ring somewhat undulated; statocysts round or oval in shape (similar in number to tentacles), lacking tubular projections; tentacles arranged in 6–7

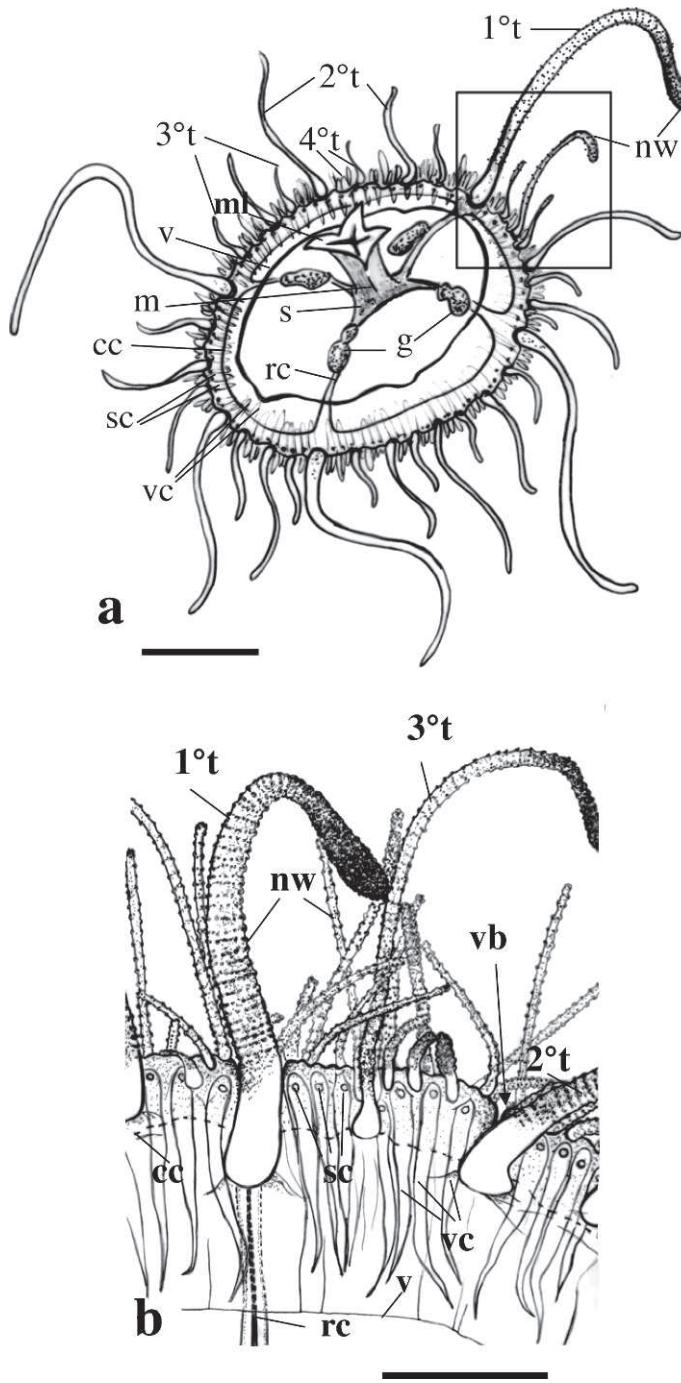

Fig. 2.—Schematic illustrations of key morphological characters of medusae of *Craspedacusta sowerbii* reared in vitro in Okinawa, Japan. a, Oral view of medusa. Scale bar approximately 5 mm; b, Enlargement of rectangular area in Fig. 2a (partially traced from Tateishi 1967). Scale bar approximately 2 mm. Abbreviations: 1°t, primary tentacle; 2°t, secondary tentacle; 3°t, tertiary tentacle; 4°t, quaternary tentacle; cc, circular canal; g, gonads; m, manubrium; ml, manubrium lip; nw, nematocyst warts; rc, radial canal; s, stomach; sc, statocyst; v, velum; vb, velar bays; vc, velar canals.

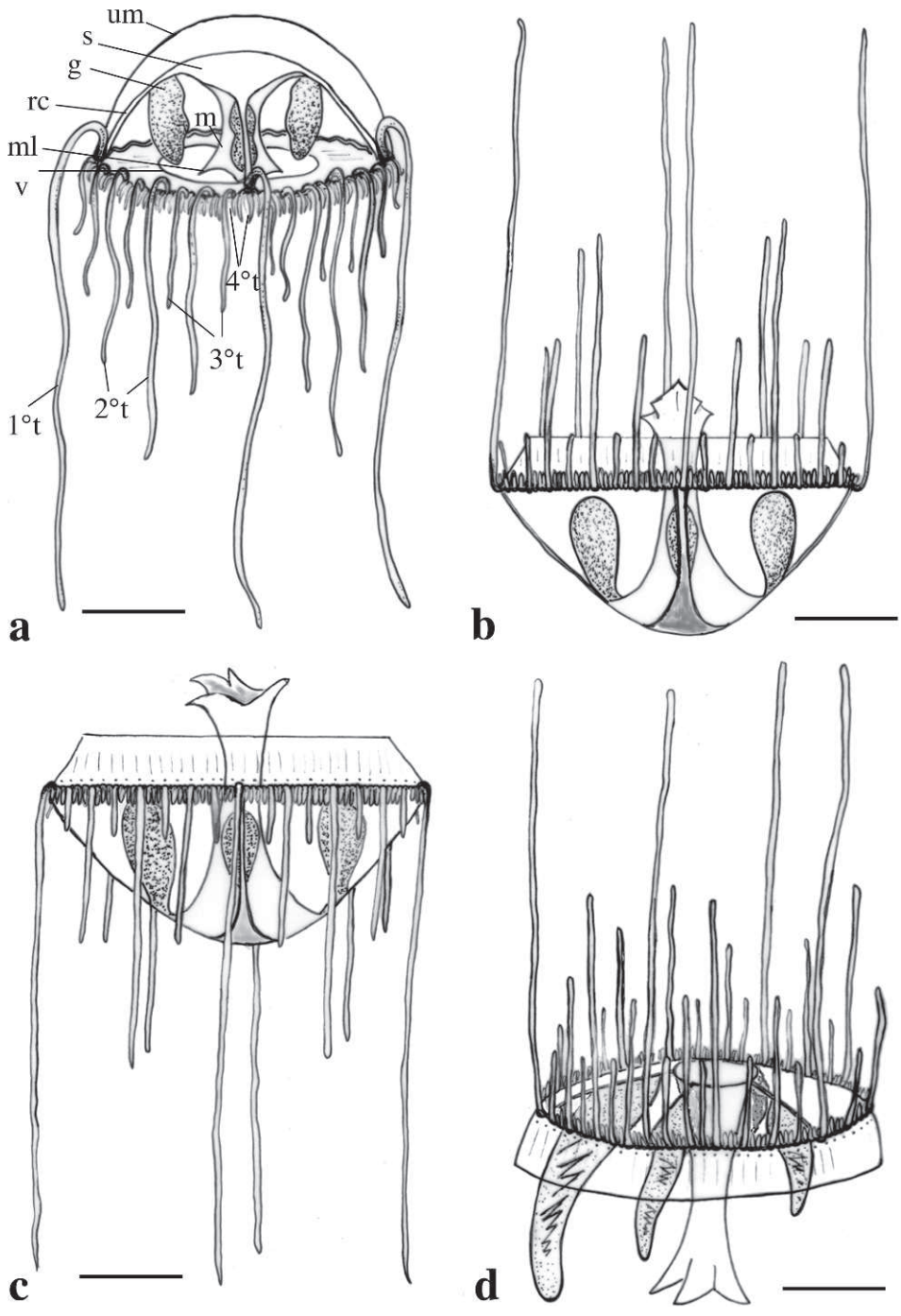

Fig. 3.—Schematic illustrations of typical swimming and feeding behavior of *Craspedacusta sowerbii*, as seen in situ and in vitro in Okinawa, Japan. a, Medusa hovering in the water column or actively swimming right-side-up, tentacles extended downward (partially traced from Oka 1907); b, Medusa drifting down from water surface upside-down, tentacles extended upward; c, Medusa drifting down in water column upside-down, tentacles extended upward; d, Medusa drifting down in water column right-side-up, tentacles extended upward. Gonads asymmetrical; longer gonads extending beyond umbrella margin. Scale bars approximately 5 mm. Abbreviations: 1°t, primary tentacle; 2°t, secondary tentacle; 3°t, tertiary tentacle; 4°t, quaternary tentacle; g, gonads; m, manubrium; ml, manubrium lip; rc, radial canal; s, stomach; um, umbrella; v, velum.

series (104–128 in number), perradial tentacles largest and arising from exumbrella, older tentacles higher up on umbrella; nematocysts sparsely covering tentacle shaft near base but thick near tips; polyp form unknown.

Astrohydra japonica Hashimoto, 1981

Japanese name: *Yume-no-kurage*.

Description from Hashimoto (1981, 1985, 1987).—Newly released medusa tiny (0.5 mm), up to 1.35 mm diameter after one month, mature medusa form unknown; umbrella hemispherical; manubrium forming quadrangular prism (four oral lips), of which basal portion holds stomach; tentacles hollow consisting of long perradial and shorter interradial ones (8–29 in number), bearing many bristle-like papillae with 1–3 nematocysts on apices, papillae consisting of single vacuolated epidermal cell; statocysts (up to 15 in number) lacking tubular projections; nematocysts scattered on surface of tentacles; polyp solitary, with fine tentacles.

Distribution of Freshwater Jellyfish

A distribution map (Fig. 4) of freshwater jellyfish in Japan was compiled from a collection of reports on *mamizu kurage* gathered from various sources, including television broadcasts, newspaper and magazine articles, word-of-mouth accounts (see Ohno 1987), additional reports published between 1988 and 2011, and personal observations. Not all reports of *mamizu kurage* have been positively confirmed by experts as *Craspedacusta sowerbii*; thus, we cannot rule out the possibility of the existence of more than one extant species of *Craspedacusta* jellyfish in Japan. Supplemental material for the map in Fig. 4 is available online as an Excel file at the following URL: http://si-pddr.si.edu/dspace/handle/10088/17433.

Table 1.—Maximum and minimum values of morphometric (umbrella diameter, number of tentacles, number of statocysts, gonad length) and environmental (water body temperature and pH) characters of medusae of *Craspedacusta sowerbii* collected in the nine Japanese regions between 1928 and 2011. (Data were provided for only 12 of the 217 reports, making it difficult to determine true averages for these data.)

Morphological character	Minimum	Maximum
Umbrella diameter (mm)	2	22
Number of tentacles	152	528
Number of statocysts	109	216
Gonad length (mm)	2	11.5
Temperature (°C) of habitat	12	33
pH of habitat	5.4	8.4

Results

History of freshwater jellyfish in Japan.—Japan is divided into 47 sub-national jurisdictions, known as Prefectures in English, which are grouped into nine regions by geographical location. Based on 217 records compiled from the literature over 83 years, spanning the period from 1928 to 2011, the presence of *Craspedacusta sowerbii* (*mamizu kurage*) was confirmed in 36 (77%) of the 47 Prefectures and in all nine regions of Japan. *Craspedacusta iseana,* however, has only been reported once from Mie Prefecture, and *Astrohydra japonica* from two localities in Shizuoko and one in Kanagawa Prefecture.

Table 2 shows that of the 217 accounts of *mamizu kurage* in Japan from 1928 to 2011, 63 accounts were from natural habitats, 104 were from man-made habitats, and 52 did not specify habitat. Table 3 indicates that the Japanese region with the largest number of reports of *mamizu kurage* to date is Kanto (64 reports), followed by Chubu (57 reports), and Kinki (37 reports). Some regional variation exists with respect to the months in which *mamizu kurage* was observed. More reports occurred during summer and fall months, with medusae being reported in

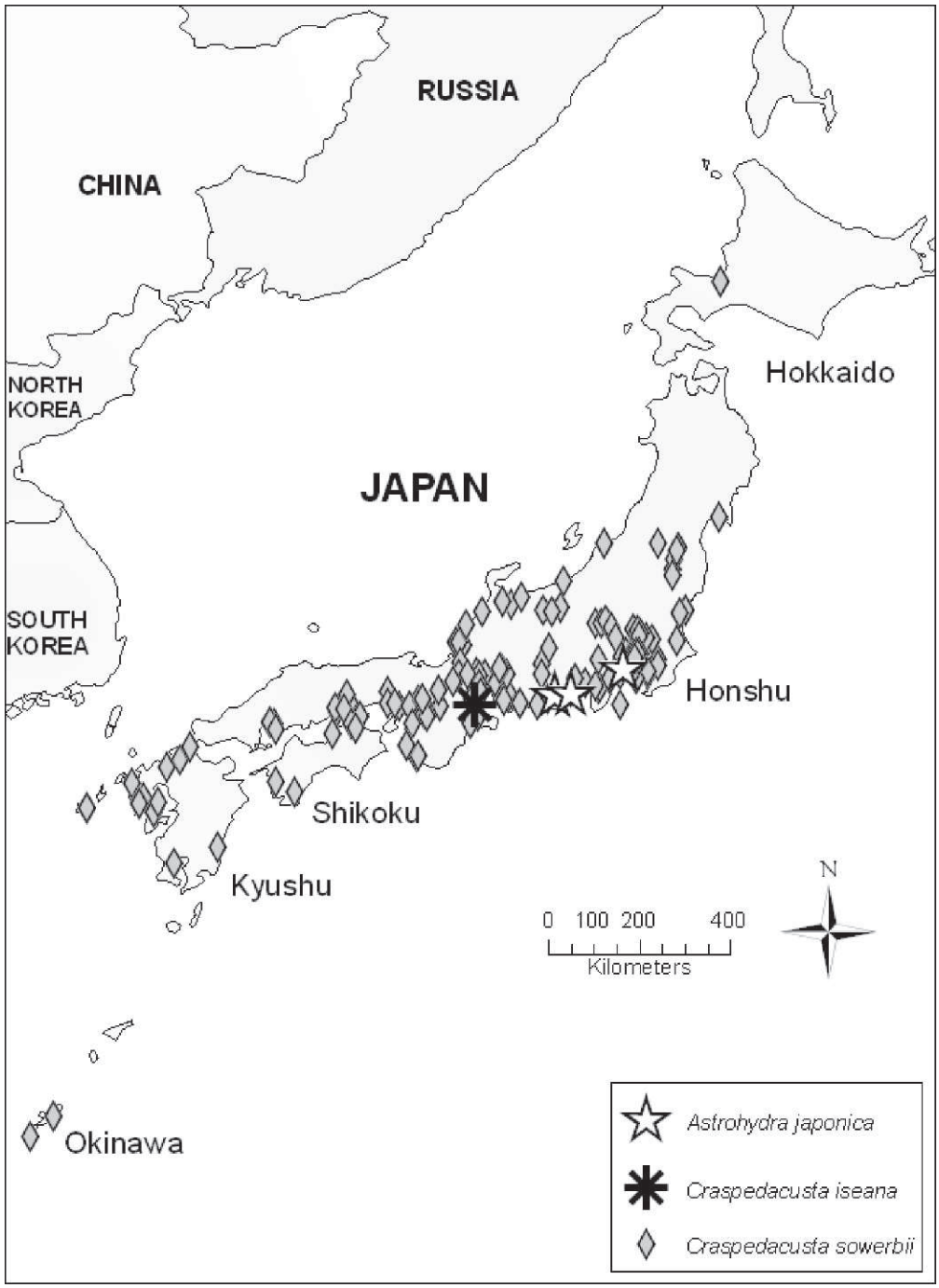

Fig. 4.—Map showing occurrence of *Craspedacusta sowerbii* (as *mamizu kurage*) throughout the nine regions of Japan from 1928 to 2011. (Data compiled to make this map are available in the form of an Excel file online at the following URL: http://si-pddr.si.edu/dspace/handle/10088/17433).

Table 2.—Reports of *Craspedacusta sowerbii* (*mamizu kurage*) in various natural and manmade water bodies in Japan from 1928 to 2011, compiled from Ohno (1987), more recent publications, and personal observations between 1988 and 2011. The number of reports from each type of water body is provided, with the percentage of overall reports for each given in parentheses.

Type of water body	Number of Reports
Manmade reservoir	79 (36.4%)
Natural pond	43 (19.8%)
Not specified	50 (23%)
Concrete tank	10 (4.6%)
Marsh	8 (3.7%)
Glass aquarium	7 (3.2%)
Lake	5 (2.3%)
Swimming pool	5 (2.3%)
River	4 (1.8%)
Dike	2 (0.9%)
Drainage basin	1 (0.5%)
Artesian basin	1 (0.5%)
Hot spring	1 (0.5%)
Rice paddy	1 (0.5%)
Total	217 (100%)

all regions during August and September and none reported from February to April. The longest continual season appeared to be in subtropical Okinawa where medusae were seen over a six-month period (from June to December), followed by the intermediate temperate Kanto region where various reports spanned a five-month period from May to September, while cold-temperate Hokkaido appears to have the shortest season, as medusae were only reported in the month of August (Table 3).

Discussion

Craspedacusta sowerbii is the most studied and widely distributed freshwater jellyfish in the world. It is speculated to have made multiple journeys from its original Yangtze River habitat in China to a wide array of freshwater habitats on every continent but Antarctica (Jankowski et al. 2008, Fritz et al. 2009). However,

Table 3.—Date of observation, type of habitat, and distribution range of *Craspedacusta sowerbii* (*mamizu kurage*) in the nine regions of Japan from 1928 to 2011. The year in which the original report ("from") and most recent report ("until") occurred, as well as earliest and latest month in which *mamizu kurage* was observed are provided for each region.

Region of Japan	Year reported		Number of reports				Months reported		Distribution range (north to south)			
	From	Until	Natural habitat ($n = 63$)	Man-made habitat ($n = 104$)	Unknown habitat ($n = 50$)	Total reports ($n = 217$)	Earliest	Latest	From: latitude	From: longitude	To: latitude	To: longitude
Hokkaido	1952	1968	1	1	0	2	Aug	Aug	43.07	141.35	43.07	141.35
Tohoku	1949	1987	5	8	4	17	Jul	Sep	38.42	141.30	37.28	140.38
Kanto (includes Izu Island Chain)	1928	2011	12	31	21	64	May	Sep	36.60	140.65	34.73	139.37
Chubu	1946	1999	11	32	14	57	Aug	n/a	37.92	139.03	34.72	137.73
Kinki	1946	2011	20	11	6	37	Jul	Nov	35.55	136.20	33.68	135.35
Chugoku	1957	2007	3	5	1	9	Sep	Oct	34.93	133.97	34.25	132.57
Shikoku (includes Seto Inland Sea Islands)	1966	1974	2	6	0	8	Aug	Sep	34.48	134.23	33.00	132.93
Kyushu (Goto Archipelago)	1949	1987	8	8	4	20	Jun	Dec	33.88	130.88	31.60	130.55
Okinawa	1993	2001	1	2	0	3	Aug	Jan	26.63	128.18	26.22	127.72

strong evidence to support this postulation is currently lacking. Most of what we know about the ecology, morphology, development, and molecular systematics of *Craspedacusta* comes from reports from the United States (Acker & Muscat 1976), Europe (Jankowski et al. 2005), and China (Zhang et al. 2009). Although numerous publications exist in Japanese on its morphology and development (Mizuno 1958, Tateishi 1967, Hashimoto 1987, Kato & Hirabayashi 1991, Kubota & Tanase 2006), and distribution in Japan (Ohno 1978, 1987), much of this information is not easily accessible to the international scientific community because of the language barrier. In fact, Japanese researchers are among those that have achieved the most success in rearing medusae of *C. sowerbii* in a laboratory setting. Izawa (1998, 2004) successfully reared *mamizu kurage* polyps through various developmental stages to mature medusae (20 mm bell diameter) by feeding them rotifers, *Daphnia* and *Artemia* nauplii, mosquito larvae, frozen bloodworms, and pond plankton (Izawa 1998, 2004). The medusae were reared as part of a temporary exhibit at Hekinan Seaside Aquarium in Aichi (Izawa 1998, 2004; Masuda & Izawa 1999) and Suma Aqualife Park in Kobe, Japan (Yasui & Takeda 2000, 2002), with hopes of making them part of the permanent exhibit (Izawa 2004).

Dispersal of polyps and podocytes of *Craspedacusta sowerbii* has long been thought to coincide with translocation of stocked fish, shellfish, ornamental aquatic plants, the movement of waterfowl, or human activity (Uchida & Kimura 1933, Komai 1947, Kramp 1950, Yasui & Takeda 2002). While these hypothetical agents of dispersal are plausible, they are not easy to validate. Several Japanese authors (Uchida 1951, 1955, 1965; Ito 1953, Oka 1955, Yamamoto 1966) speculated that the post-World War II freshwater jellyfish boom in Japan was a result of the sudden influx of allied occupation forces from the Kentucky River drainage-basin in the U.S.A. or from activities associated with Japanese soldiers returning from the Yangtze River drainage-basin in China, as *C. sowerbii* was already widely reported from both countries by that time.

Craspedacusta sowerbii was once among as many as nine nominal species of the genus *Craspedacusta* (Jankowski 2001). While the medusa form of mature *C. sowerbii* is easily identifiable, specifically by the radially prolongated statocysts that end as blind velar canals (see Species Diagnosis), there is no real differential diagnosis for distinguishing between its congeners. However, results of recent molecular systematic studies conducted on medusae of *Craspedacusta* (in China, Germany, and Austria) indicate that only three valid species exist, *C. sowerbii*, *C. kiatingi*, and *C. sinensis*, with the possibility of *C. ziguiensis* being a fourth (Fritz et al. 2009, Zhang et al. 2009). *Craspedacusta iseana* is also considered a valid species, but molecular data can not be obtained in the absence of fresh material. Furthermore, despite the ubiquity of *mamizu kurage* throughout the archipelago of Japan, no molecular efforts have been undertaken to determine whether more than one species of *Craspedacusta* exists or if there is any genetic population structure across the range of geographical regions. Future research efforts that would involve sampling freshwater medusae and polyps from all nine geographical regions—from Hokkaido to Okinawa—coupled with ecological, developmental, and molecular systematic studies would shed light on the biodiversity of freshwater jellyfish in Japan. In addition, as more information becomes available on effective in vitro rearing techniques, researchers and teachers alike could utilize *C. sowerbii* as a model organism for instruction on cnidarian metagenetic life histories.

Polyps of *Astrohydra japonica*, the sole species of the other freshwater limnome-

dusan genus found in Japan, were last collected from a natural habitat (Mekujiri River, Kanagawa Prefecture) during the spring of 1989 by one of the authors (HH). The striking resemblance between the multitentaculate solitary polyp form of *A. japonica* and that of another freshwater hydrozoan, *Calpasoma dactyloptera* Fuhrmann, 1939, known from Europe, Brazil, U.S.A., and Israel (Bouillon et al. 2004), suggests the two are the same species. Collins et al. (2008) report having sequenced 16s and 28s genetic markers from a colony of polyps of *A. japonica* collected in Hamburg, Germany ("Bramfelder Fischteiche" 53°36′55″N, 10°05′25″E) and reared for many years by Dr. G. Jarms. However, with no molecular data available for *Calpasoma*, or *Astrohydra* from Japan, and a medusa form known only of the latter, one can only speculate about their possible conspecificity with the putative population of *A. japonica* in Germany.

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