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LETTER

Sato's beaked whale: A new cetacean species discovered around Japan

Of the 91 known species of living cetaceans, 25% are beaked whales in the Family Ziphiidae (*n* = 23). Most beaked whales are cryptic and difficult to study because they are deep divers, spend very little time on the surface, and difficult to approach with a vessel. The first beaked whale was described in 1770, when Johann Reinhold Forster, the naturalist on Captain James Cook's second voyage, named *Hyperoodon ampullatus* based on a whale that stranded in 1717 at Maldon, Essex, England. By the start of the 19th century, 12 additional beaked whales had been discovered and named. Eight new species were discovered during the 20th century and one more since 2000. The newest ziphiid, *Berardius minimus,* was reported from Hokkaido, Japan (Yamada et al., 2019).

Two beaked whale genera, *Hyperoodon* and *Berardius*, have an antitropical distribution. The northern bottlenose whale, *Hyperoodon ampullatus,* is found in the cold-temperate waters of the North Atlantic and the southern bottlenose whale, *Hyperoodon*

planifrons, has a circumpolar range in the Southern Hemisphere (Davies, 1963; Kasuya, 2009). Baird's beaked whale, *B. bairdii,* is endemic to the North Pacific and Arnoux's beaked whale, *B. arnuxii,* is circumpolar in the Southern Hemisphere (Davies, 1963; Kasuya, 2009). The new species, *B. minimus*, is partially sympatric with Baird's beaked whale in the northern part of the western North Pacific around Hokkaido and at least in the eastern Bering Sea and eastern Aleutian Islands, Alaska.

For centuries, Japanese whalers have hunted various species of beaked whales, starting with Baird's beaked whale in the early 17th century. The whalers called Baird's beaked whale *tsuchi kujira* (= "mallet whale") because its beak projects beyond the melon and a severed head had the appearance of a mallet. This whale was first hunted in the cold temperate waters around the entrance of Tokyo Bay at the southern limit of their distribution in the western Pacific. Later, especially after World War II when whale meat was in high demand, it was also hunted farther north. In the southern Okhotsk Sea, off the northern coast of Hokkaido, Japan, the whalers recognized and hunted several species of beaked whales. The hunting of *tsuchi kujira* was first reported in English by Omura et al. (1955), who noted that whalers recognized two forms of *tsuchi kujira*: the more common, slate-gray Baird's beaked whale, plus another,

smaller form that was black. Baird's beaked whale was first described from a skull collected in 1881 from Bering Island, Commander Islands, Russia, by Nikolai A. Grebnitsky. The skull was given to Leonhard Hess Stejneger (1851–1943) during his stay on Bering Island in 1882. Stejneger's trip to the Commander Islands was arranged by Spencer Fullerton Baird (1823–1887), Secretary of the Smithsonian Institution in Washington, DC. Therefore, the *B. bairdii* was named after Baird (Stejneger, 1883). A few months later in 1883, a partial *Berardius* skull also collected from Bering Island during the Swedish *Vega Expedition* in 1879, was described as *Berardius vegae* (Malm, 1883). It is now considered a junior synonym of *B. bairdii* Yamada *et al*. 2019) The Stejneger and Malm publications were likely unknown to Nobutoshi Okada (1857–1932) who first identified the *tsuchi kujira* as *H. ampullatus* (Okada, 1891). However, the true identity of *tsuchi kujira* was not confirmed in Japanese waters until Roy Chapman Andrews from the American Museum of Natural History visited the Tokyo Imperial Museum in 1910 and identified a locally collected specimen as *B. bairdii* (Andrews, 1912). Nishiwaki (1965) reported that Okhotsk Sea whalers sometimes captured a smaller type of beaked whale, similar to Baird's, including a 7.6 m female that was pregnant in April–June. Nishiwaki (1965) suggested this smaller form

might be *H. ampullatus* because female Baird's beaked whales are not sexually mature until they reach a length of at least 9.8 m (Kasuya et al., 1997). However, Nishiwaki (1965) also noted that the skull of this smaller type had never been examined and was needed to determine the species identification.

Russian observers were also having difficulty identifying beaked whales in Far East waters. Several thousand kilometers to the northeast of Japan, near Kamchatka, possible Baird's beaked whales were known to the explorer Stepan P. Krasheninnikov (1711–1755) in the early 1700s as *cheshkhak* (Krasheninnikov, 1764) before they were formally described as a species by Stejneger in 1883. In 1933/1934, when the first Russian factory ship, the *Aleut,* operated off Kamchatka with Norwegian gunners, the Norwegians misidentified the local beaked whales as bottlenosed whales because of their superficial likeness to the northern bottlenose whale, *H. ampullatus*, commonly hunted off Norway (Tomilin, 1957). However, Tomilin noted that the purported Far Eastern bottlenose whales were too large to be *H. ampullatus.* Perhaps for the same reason, Zenkovich (1947) named them as a new species, *Rostrifer nestormirnovi*, which Tomilin (1957) noted is a *nomen nudum*. Finally, in 1952, the Zoological Museum of the Moscow State University received a skull taken in the whaling operations stationed at Paramushir, in the northern

Kuril Islands during the summer of 1951 that was labeled "Bottlenose" (Tomilin, 1957). This whaling station was operated by the Japanese until the end of WW II when it was seized by the USSR. It then became clear, based upon its size and other characters, that the Far Eastern bottlenose was in fact *B. bairdii* (Tomilin, 1957). Heptner et al. (1996) published two photographs (figures 364 and 366) of a beaked whale taken by M. M. Sleptsov. The figures were labeled as *B. bairdii* from the Pacific Ocean, but we do not believe they are of either *B. bairdii* or *B. minimus*. The photographs appear to us to be of a northern bottlenose whale, *Hyperoodon*. If they are a northern bottlenose whale that was photographed in the North Pacific, the only place where Sleptsov worked, the records should be considered as extralimital.

The existence of another, less common form of *tsuchi kujira*, known to Japanese small-type whalers as *kuro* (black) *tsuchi kujira* or *karasu* (crow or raven), has been debated for years (Kasuya, 2011, 2017). In July 2004, Hal Sato, an independent researcher in eastern Hokkaido, obtained photographs of a mother and a calf of an unfamiliar-looking beaked whale taken as bycatch and landed at Shibetsu, Hokkaido (Yamada et al., 2019, figure 1). Sato also photographed a pod of three unidentified beaked whales (Yamada et al., 2019, figure 2) she

encountered in Nemuro Strait, off Rausu (Shiretoko Peninsula) in May 2009 that were similar to the Shibetsu whales. These photographs consistently indicated the existence of a smaller, darker *tsuchi kujira* with a shorter rostrum. This seemed to confirm the earlier observations made by the small-type whalers and it made her suspect that this could be a beaked whale species unknown to the scientific world. For this reason, the authors who described *B. minimus* suggested that the common name should be Sato's beaked whale.

The type specimen for *B. minimus* stranded at Tokoro (常呂町) Town (44°07′14.5″N, 144°06′29.6″E), Hokkaido, on the coast of the Okhotsk Sea, in June 2008. The almost complete skeleton of this specimen was deposited in the National Museum of Science and Nature, Tsukuba, Japan. Most records (n = 6) for this new species are from Hokkaido (southern Okhotsk Sea and Nemuro Strait; Yamada et al., 2019). Two additional specimens are from Sakhalin and Kunashir Islands (Fedutin et al., 2020). A few more specimens have been biopsied or stranded in the eastern Bering Sea as far east as the eastern Aleutian Islands (Unalaska Island) and the Alaskan Peninsula (Morin et al., 2017, figure 1).

Sato's beaked whales have numerous bites from cookie-cutter sharks, *Isistius* spp., and these sharks are known mainly from

tropical to warm temperate waters (Yamada et al., 2019). This suggests that *B. minimus* could be found further south than its current southern range.

This new species brings the world's total number of beaked whale species to 23. As new species of beaked whales continue to be added to the family, often from just a few specimens, it will continue to be difficult to demystify the diversity, biology, and zoogeography of ziphiid whales for some time. This is especially true for these two North Pacific *Berardius.* Externally they are similar, but the Sato's beaked whale differs from both of its congeners by having the following unique external characters: remarkably smaller body size of physically mature males (661 cm [*n* = 4] vs. 998 cm [*n* = 34] in males from the Okhotsk Sea), a proportionately shorter beak, and a darker, almost black, body color rather than the slate gray of the other two species. There are also strong genetic differences between *B. arnuxii, B. bairdii,* and *B. minimus*, and the new species is more different from the other two than they are from each other (Kitamura et al., 2013; Morin et al., 2017; Yamada et al., 2019). Within a 431 base pair segment of the mtDNA control region, *B. miminus* can be differentiated from *B. bairdii* and *B. arnuxii* by 16 and 22 diagnostic sites, respectively (see figure 3 in Morin *et al*, 2017).

Although Sato's beaked whale is now recognized as a separate species, we still know little about its biology and nothing about its population status. The only abundance estimate for Baird's beaked whales (which may include the new species) is 663 from the southern Okhotsk Sea in the 1980s (Miyashita, 1990). Also largely unknown are potential threats to this species, other than commercial whaling in the Okhotsk Sea. Baird's beaked whales have been hunted off Japan's main island of Honshu for centuries, but this region is south of where the new species is known to occur. When hunting of Baird's beaked whales off the northern coast of Hokkaido (Okhotsk Sea) began after WW II, both species were likely taken. Numbers killed by Japanese small-type whaling operations are unknown, as all whales landed to date have been recorded as *tsuchi kujira*. These operations could have taken mostly *B. bairdii*, which is said by whalers to be easier to approach and is larger in body size.

Baird's beaked whale is well known acoustically (Baumann-Pickering et al., 2013), and now we need to record and describe the calls of Sato's beaked whale. This will allow us to use passive acoustics to learn more about the distribution, movements, and population status of this cryptic beaked whale. Also, whalers and biologists still need to see a live or dead *B. minimus* together to confirm that Sato's whale is what the

whalers call *kuro tsuchi kujira*. Hopefully, now that Japan has restarted its commercial whaling operations for minke whales, there will be less pressure to hunt *Berardius*, as the same vessels are used in both hunts. This would be especially important for Sato's beaked whale, which appears to have a small population size and restricted range that is largely within Japanese waters. However, the best outcome would be if catches of Sato's beaked whales were prohibited.

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