STONES AND OTHER ALIENS IN THE STOMACHS OF SPERM WHALES IN THE BERING SEA

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Sperm whales, the largest odontoceti, are very famous for their feeding on large squids in diving in the deerper waters of the open sea. The large deep sea living fish also occupy the considerable part of the diet of the sperm whales according to the repserch hitherto done (Clarke, 1956).

As a consequence, sperm whales are well known for their deep diving to feed, and they are sometimes entagled by the telephone cable in the deep sea bottom over 1000 meter, and Clarke (1956) also states the sperm whales occassionaly visit the sea floor to feed from the records of dents on the forehead part. Heezen (1957) further suggests the digging up the sea bottom with their strong lower jaws to feed causes the entaglement of the cable set on the sea bottom. Sperm whales become entangled while swimming along with their jaws plowing through the sediment in search of foods.

From the observation on sperm whales caught in the Bering sea, stones and rock fragments have been found in the stomachs of whales suggesting that sperm whales are feeding in the sea bottom and swallowed these stones as stated by Heezen and Clarke.

We think also stones and rock fragments found in the stomachs of sperm whales are direct evidence that sperm whales are often feeding in the sea bootom and digging the bottom to swallow their foods, such as deep sea fish ocotopus and sometimes even crabs. Here we would examine the occurrence of stones and rock fragments with other aliens such as coconuts, sea sponge, shells and glass balls. These aliens would suggest the pecurial feature of the ecology of sperm whales to some extent. For example, in the diving in their feeding, how far they do it may also be suggested by considering the distribution of these aliens.

MATERIALS

The materials treated here have been collected from 1954 to 1961 in the Japanese whaling expeditions in the Bering sea and adjacent waters. Following aliens are found and examined here.

Stone and rock fragment
Sand
Glass bouy (for long line fishing)
Coconut
Deep sea sponge
Cut meat of the baleen whale
Crab (As stated before crabs are considered as a food of sperm whales.)

Shell of bivalves

Stones and other samples are mostly collected from the first stomachs of sperm whales but some stones are also found in the second stomach.

Stones and rock fragments

It is sometimes observed that stones and gravels are found in the stomachs of gray and little-piked whales (Andrews, 1954; Jonsgard, 1951). These cases suggest that those baleen whales sometimes seek their food in the bottom strata in their feeding. On the other hand, sperm whales are deeper divers and they apparantly seek their foods in the deep sea bottom as suggested by Heezen (1957). Sperm whales must have dug the sea bottom or chased the bottom living animals such as crabs and rays and angler fish as considered by Heezen, because considerable many stones and sand are found in the stomachs of sperm whales caught in the Bering sea. The positions where stones and sand are found in the stomachs of sperm whales are illustrated in Fig. 1. As shown in Fig. 1 the positions ditribute along Aleutian

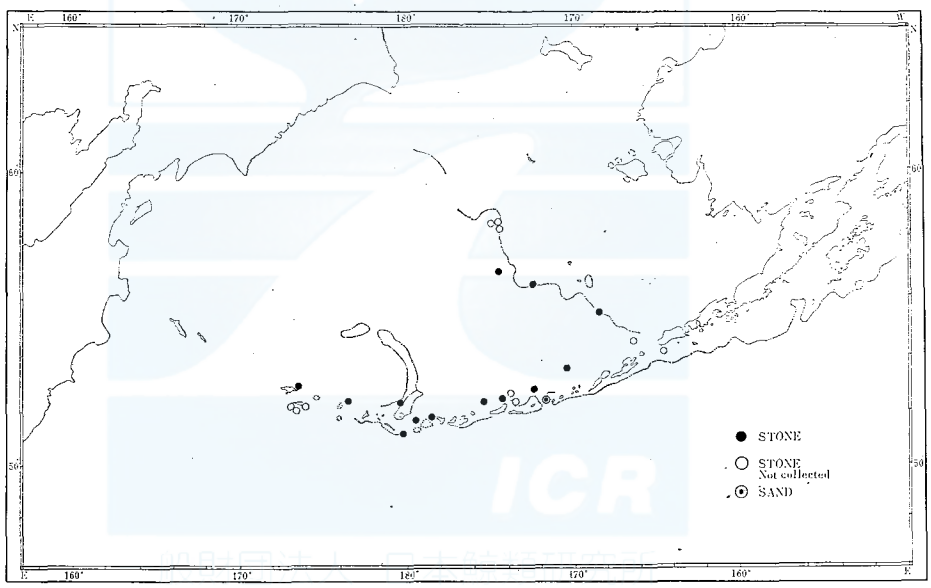

Fig. 1. Distribution of stones and sand found in stomachs of sperm whales caught in the Bering sea.

archipelago and Alaskan continental shelf. We should think the position may have the relation to the distribution of food fish and crabs, which distribute along the shelf waters more abundantly. Although sperm whales have been caught in the waters of Bowers Bank and the center part of the Bering sea, no sperm whale with stones in the stomachs has been caught in the said waters. Considerable many sperm whales have been caught in the deeper waters of the Bering sea, but sperm whales with stones have not been caught in the center waters.

Many sperm whales with one stone in stomachs of whales but some 40 and

50 stones are also found in two sperm whales. The latter cases may prove that the sperm whales digged over again to take their food in the bottom.

The weight of the stones found in the stomachs of sperm whales varies from 20 to 1,400 gram as shown in Table 1. Almost all stones are less than 300 g, but two stones are between 500 g and 1,000 g, and only one stone is 1.4 kg. The weight of the jaws of large squids is also heavy and may be unpleasant for sperm whales. However, jaws of squids are often found in vast number undigested in their stomaches. So stones may be not so uncomfortable for the phisical condition of sperm whales like those jaws of squids.

TABLE 1. NUMBER OF STONES FOUND IN THE STOMACHS OF SPERM WHALES

Number of stones									
1	2	3	4	5	6	7	8	ca. 40	ca. 50
14	1	2	—	2	—	—	1	1	1

TABLE 2. WEIGHT OF STONES FOUND IN THE STOMACHS OF SPERM WHALES

Weight of stones in gram						
1~49	50~99	100~149	150~199	200~300	500~999	1000~
4	9	7	1	5	2	1

It is not certain whether these stones swollowed are disgorged again from the mouth or go down to the intestine to be discharged from the anus, however, the sperm whales taking stones are mostly caught along the shelf of the Islands and continent, so it may be considered the swallowed stones are cleaned out fairly speedy in eather way above stated. The one case that stones are found in the second stomach suggests that stones are sometimes cleaned out through intestine and anus.

These stones include following species.

Andesite
Propylite
Basalt
Siliceous shale
Shale
Liparite
Liparitic tuff
Quartz andesite
Andestic aglomeratic tuff
Gray wacke sandstone
Psolite (in the tuff)

As it is shown in the table, andesite stones are numerous and account 60% of the total stones found in the stomachs of sperm whales, Although the examined samples are rather few, andesite is found in the stomachs of sperm whales caught

from the central part to the eastern part of the Aleutian Islands. In the future investigation, it will be possible to get a little knowledge about geological feature of Bering sea bottom from the stones found in stomachs of sperm whales.

Among the collected stones, the most part of the stones found in the same whales are related each other. Two cases in which 5 stones are found respectively consist of all andesite stones. One liparite stone and liparitic tuff stones make third case, and two stones found in stomachs of a sperm whale are quartz andesite and andesite respectively.

Above cases suggest sperm whales take those stones in the neighbouring position or simultaneously with their foods.

TABLE 3. THE SPECIES OF STONES AND NUMBERS OF STONES AND ROCK FRAGMENTS

Andesite	17
Propylite	1
Basalt	1
Lipartie	2
Liparitic tuff	1
Quartz andesite	2
Andestic aglomeratic tuff	1
Siliceous shale	1
Shale	1
Sandstone	1
Gray wacke sandstone	1
Psolite (in the tuff)	1

As stated above, andesite stones show the dominant occurrence, 60.5% for the total, and igneous rocks occupy the almost all part of the stones founds in the stomachs of the sperm whales. This phenomenon is surely owing to the distribution of the stones in sea bottom of feeding grounds of sperm whales in the Bering sea to some extent. Distribution of stones in the sea bottom may be drawn from the examination of the stones too. The andesite stones are found in the stomachs of sperm whales caught in the adjacent waters to the middle and east Aleutian Islands as illustrated in Fig. 2.

According to Hess (1948) and Kuenen (1950), the andesite line is drawn on the outer convex side of the arculate trenches and basaltic central area is divided from the peripheral regions as illustrated by Kuenen (1950). In the landward of the boundary line along the Aleutian Islands where many sperm whales are feeding, the andesites are found.

The basaltic stone is found only one occasion, suggesting that the caught sperm whales have not been feeding in the outer basaltic zone so heavily. This assumption also may be shown by the composition of foods of sperm whales in which the bottom or deep sea living fish occupy the considerable part. Those fish are apparently considered to be living more numerous within the line where the sperm whales are more actively feeding.

It is reported that birds sometimes carry stones to the unexpected area and it is said it makes some confusion in geology, espcially in the distribution of rock

fragment and stones. So, if sperm whales swim with stones in the stomachs considerably speedy in a short period, there may be also some confusion in the determination of distribution of stones found in the sea bottom. The delivered sediment stones and rock fragments by sperm whales may be considered as a possible reason if extraordinary occurrence of stones in the sea bottom is observed.

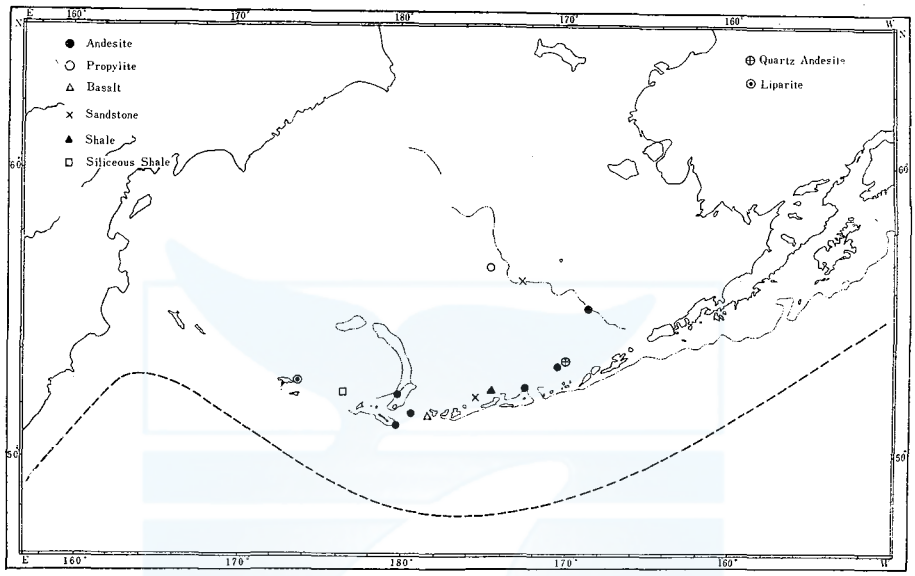

Fig. 2. Distributiin of stones found in stomachs of sperm whales caught in the Bering sea. Bnoken line—Andesite line (Kuenen, 1950)

Sand

It is very interesting to note that a gallon can of sand is observed in the stomachs of a sperm whale. This is also a illustration that sperm whales are usually feeding on the bottom living organisms with digging sand and chasing over again by their jaws as stated by Heezen (1957).

Crabs

As we said in the former part, bottom living crabs are considered to be taken as a food by sperm whales. The occurrence of benthos crabs has been described also in former reports (Clarke, 1956). In the stomachs of sperm whales, crabs are mostly digested, but two species of crabs are identified among the collected legs and carapace fragments of the crabs. Warry crabs and king crabs are them. Those crabs are considered moving in the sea bottom, and sperm whales must have chased them as their foods by some method such as ultrasonic detection. If we examine more carefully the stomachs of sperm whales, more fragments of crabs may be found.

Glass buoy

A glass buoy is found in the stomach of a whale caught at 58–10N and 174–37W

in 1961. This glass buoy is ordinary one and it is usually used as a buoy in the gillnet or longline fishing.

From the finding of glass buoy and many coconuts in the stomachs of sperm whales, it is considered that sperm whales sometimes follow floating substances on the surface of the sea from the under water. But of cource it is not certain if sperm whales have fed them as their foods or not. Some curiosity for the floating may cause this swallowing such strange aliens.

Cocunut

Six cases of the finding coconut in the stomachs of sperm whales are described in the records of the biological survey on the sperm whales caught in the Bering sea and the northern part of the north Pacific. In each case, only one cocunut is found in the first stomachs of those sperm whales, the capture positions of which are illustrated in Fig. 3. From the Fig. 3, the sperm whales taking cocunut in their

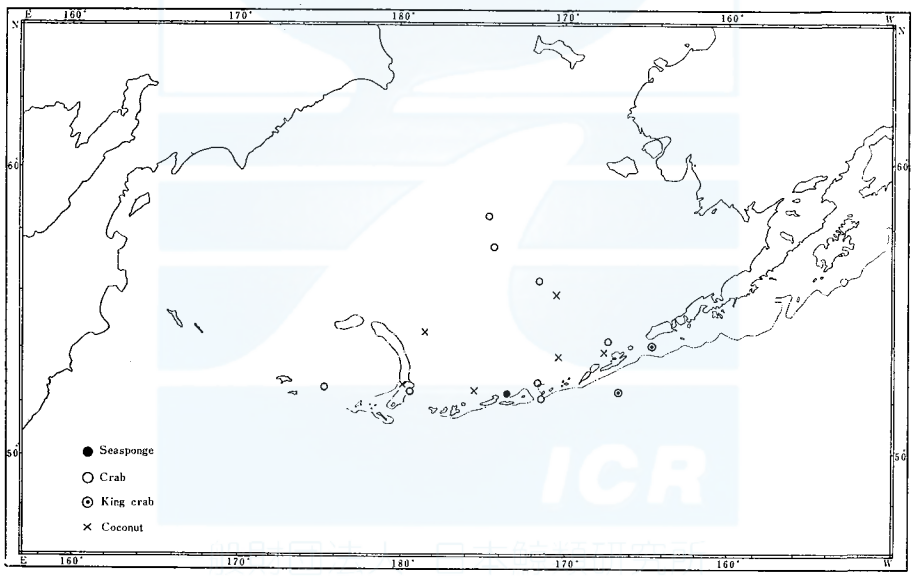

Fig. 3. Distribution of sea sponge, crab, and coconut in stomachs of sperm whales caught in the Bering.

stomachs are caught in the off waters of the Bering sea different from the whales taking stones in their stomachs which distribute along the continental shelf and Aleutian Archipelogo. This may suggest that they drifted to the Bering sea and swallowed by sperm whales. From the observations on the external condition of coconuts, the outer covering of coconuts are not so fresh.

We would think these coconut have not been swallowed directly in the south waters where the coconut trees are growing, but they have been floating to the northern waters in the currents and swallowed by sperm whales.

Cut meat of the baleen whale

The very interesting case of a sperm whale taking cut meats of the baleen whale are observed in 1960. In the Aleutian waters, Japanese and Russian whaling have been operating in the Bering sea, and the meat of the caught baleen whale is flensed to make the products on the factory ships. These cut meats are considered one of the flensed meats from the factory ship.

The fresh meats of baleen whales sink in the sea, however, fatty meat or rot meat float in the surface of the sea for a while. It is considered the sperm whale follow the meats in the surface stratum like coconuts.

Shells of bivalves

Ten shells of the bivalve are found in a stomach of sperm whale caught in the Bering sea on 19th July in 1960 at 52–30N and 173–59W. Among these shells, two species of bivalves are identified. One is *Chlamys islandicus* Muller. The bivalve distributes from the northern part of the north Pacific to the Arctic sea. It occurs circumpolar in the northern hemisphere also in the Atlantic, and is also found in Puget Sound and adjacent waters to Kamtchatka peninsula. It usually inhabits in the bottom of the sea from 200 to 400 meter depth in above regions.

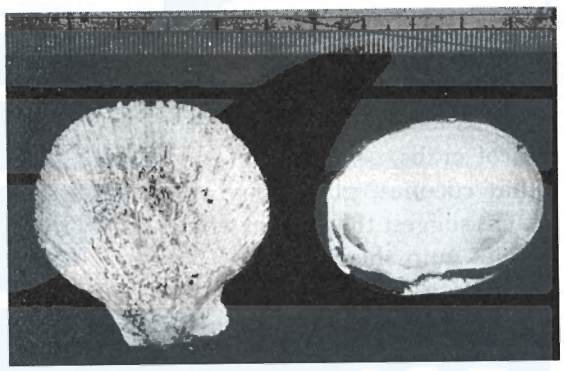

Fig. 4. Two shells swollowed by a sperm whale in the Bering sea. Left—*Limopsis vaginatus* Dall, Right —*Chlamys islandicus* Müller. Photo by T. Okutani.

As the next species, *Limopsis* (*Empleconia*) *vaginatus* Dall is found among them. The *Limopsis vaginatns* is firstly descrived from the shore of Unalaska Islands in the Bering sea from the 600 meter depth. Above two bivalves have remained ligaments consideravly fresh especially in the latter. From the stage of the ligaments, it is considered these bivalves were living when they were swallowed by the sperm whale. This also affirm that sperm whales feed actively on the livings on the sea bottom of the Bering sea, and these bivalves may be swallowed in the feeding.

Deep sea sponge

Besides above stones and other aliens, a deep sea sponge is found in the stomach of a sperm whale caught at 52–20N and 173–30W on 9th July in 1960. This sponge

is considered a deep sea living sponge belonging to the order Hexasterophora and it is usually found in 200–400 meter depth or deeper waters. From the skeletons of the body, the sponge was alive when it was swallowed by the sperm whale.

The sponge has tough root and it must have attached to the sea bottom with considerable strong fixing power. So the sperm whale must have digged it with lower jaw and swallowed it with other bottom living food such as crabs and rays etc.

Clarke (1956) already notes the occurrence of a gorgonid in the stomach of a sperm whale caught in the Azores.

ACKNOWLEDGEMENT

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SUMMARY

1. Stones and other aliens found in the stomachs of sperm whales caught in the Bering sea and the northern part of the north Pacific are examined in view of the distribution of aliens and feeding habits of sperm whales. These aliens contain stones, sand, glass bouy, coconuts, sea sponge, cut meat of the baleen whales and fragments of crabs.

2. The cases that coconut, glass bouy and cut meat of the baleen whales are found in the stomachs suggest that sperm whales follow the drifters on the surface of the sea and sometimes gulp them.

3. The finding of deep sea sponge, deep sea crabs, living shells, stones and rock fragments and sand prove that deep diving of sperm whales and their feeding is also active in the deeper layer and the sea bottom.

4. The most part of stone and rock fragments are andesite and almost all stones are igneous, which suggest the bottom distribution of the stones in the shelf of the Bering sea along the Aleutian Islands. The further collection of stones and rock fragments will add something to the study of geology of the Bering sea.

5. From the finding of the many stones and fragments of rocks in the stomacks of sperm whales, they are considered to dive deeper than 200 meter to feed in the Bering sea.

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