Studies on the Little Toothed Whales in the West Sea Area of Kyushu-XVI

Underwater Sound of the False Killer Whale

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The underwater sound of the false killer whale (*Pseudorca crassidens*) was recorded at the sea area between Iki island and Tsushima island north-west of Kyushu as well as at the Shimonoseki Aquarium where the false killer whale had been kept since 1960. The recorded sound was analysed by the sound spectrograph.

The false killer whale is taxonomically close to the killer whale (*Orcinus orca*), but the feeding migration of the false killer whale in winter is mixed with the bottlenosed dolphin (*Tursiops gilli*) and also the underwater sound of the false killer whale bears a remarkable resemblance to that of the bottlenosed dolphin.

The underwater sound of the false killer whale is divided into three types of signals, that is, whistle, clicks, and stratiform sound, and the function of these signals is the very same as that of the bottlenosed dolphin.

The whistle is in the range from 5 to 10kc being identical to that of the bottlenosed dolphin. However, unlike in the bottlenosed dolphin, it is rather toneless and its sound spectorographic pattern is parallel to the abscissa.

Next, the frequency of the clicks is not so high being within the limit below 13kc, but the repetition rate of the clicks is full of variety ranging from 2-per-second to 100-per-second.

Finally, the stratiform sound which is observed at the time of feeding and in the course of courtship is the same as that of the bottlenosed dolphin.

Generally speaking, these three types of signals are almost the same as those of the bottlenosed dolphin, but vary much more than the latter.

Introduction

The false killer whale (*Pseudorca crassidens*) is a cosmopolitan little toothed whale that lives in all sea areas of the world.

In the west sea area of Kyushu, there also live many false killer whales because the area is abundant in marine animals they feed on such as yellow-tail, horse mackerel, mackerel and cuttlefish. The predatory performance of the false killer whales always impedes the fisheries in this sea area that is considered to be a

valuable treasury to Japanese coastal fisheries.

The tuna long line fisheries are also greatly troubled by the false killer whales that steal hooked tuna from the line.

The false killer whales in nature are gregarious. In winter feeding migration they are observed together with a large shoal of the bottlenosed dolphin[1]. It has often been observed that they strand mingling with a large crowd of the bottlenosed dolphin around Goto islands and on the west coast of Kyushu[1]. In summer, however, they are found in their own independent groups.

It is obvious that the false killer whale is taxonomically close to the killer whale as shown by the scientific name and the form of skull.

From these facts mentioned above, it is considered that the underwater sound of the false killer whale is of great interest.

The underwater sound of the false killer whale recorded at offshore of Maryland was first reported by means of a phonograph record and sonagram by SCHEVILL and WATKINS in 1962[2].

On the other hand, the underwater sound of the false killer whales has also been recorded by the authors since 1960.

A great quantity of the recorded tapes were arranged and analysed by the sound spectrograph, and the results are reported herein.

The authors wish to express their hearty thanks to Iki-Katsumoto Fisheries Co-operation Association and also Shimonoseki Aquarium for their help in the recording of the underwater sound of the false killer whales.

Method

Efforts were made to record the underwater sound of the false killer whale in the west sea area of Kyushu which is the fishing ground of cuttlefish and yellowtail angling and where many false killer whales appear in winter. It is quite difficult to approach the false killer whales and moreover to record the underwater sound because the conditions of this sea area are rough in winter and there are always many fishing boats running about. However, some recording of the underwater sound of the false killer whales was available.

The Shimonoseki Aquarium has always kept about ten false killer whales in outdoor pool since February, 1960. In Japan, this aquarium is the only place where the false killer whales have ever been bred. The false killer whales of this aquarium were transported on three occasions from Senzaki, Yamaguchi prefecture, where they stranded on. These false killer whales are considered by MIZUE[1] to be of the same race as those in the west sea area of Kyushu.

The underwater sound of the false killer whales at the aquarium was recorded for a total of about fifty hours.

The instruments used in these observations were SONY's model "EM-2" and

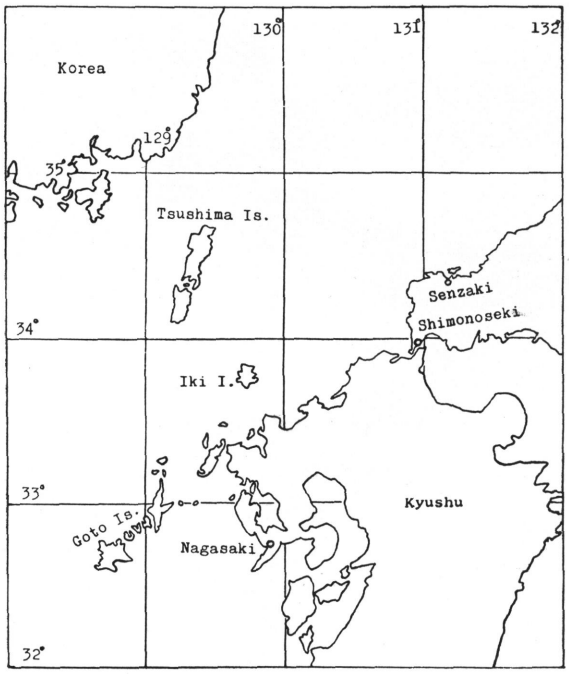

Fig. 1. West sea area of Kyushu.

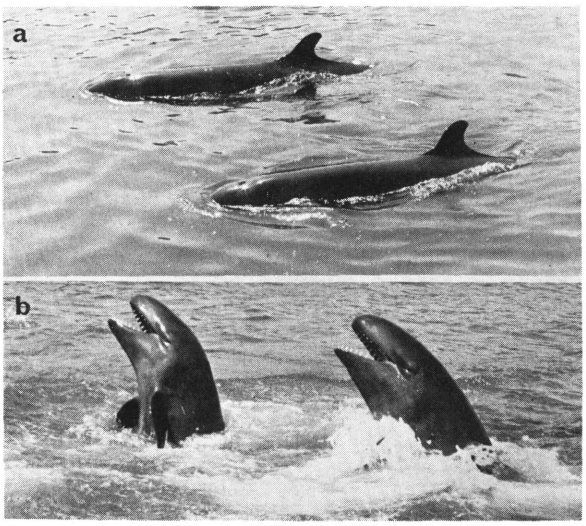

Fig. 2. False killer whales in Shimonoseki aquarium.

NAGRA III tape recorders, OKI's model "57-TA-2" and "ST-6501" hydrophones and OKI's "ST-65" pre-amplifier. The recorded sound was analysed by RION's model "SG-04A1" sound spectrograph.

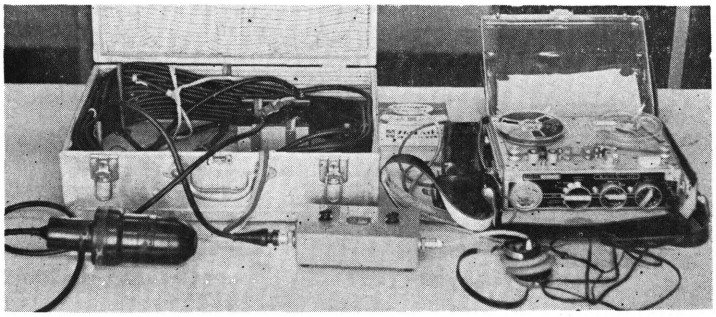

Fig. 3. Instruments

Analysis and Discussion

It has already been reported [2,3,4,5,6,7] that there are three types of signals emitted by the little toothed whales, namely, whistles, clicks and stratiform sound. However, it does not necessarily follow that all little toothed whales emit these three signals. For example, while it is true that the bottlenosed dolphin emits these three signals [3], the group of Phocaenidae such as common porpoise [5], chinese finless porpoise [4] and Dall's porpoise [7] do not emit whistle, and the sperm whale [6] which belongs to the large toothed whale emits only clicks.

The false killer whale emits all these three signals like the bottlenosed dolphin, and especially its tone quality and frequency are much the same as those of the bottlenosed dolphin. To be exact, however, these three signals emitted by the false killer whale are more complicated and various than those of the bottlenosed dolphin.

1. Whistles

Generally speaking, the whistle emitted by the false killer whale is toneless as compared with that of the bottlenosed dolphin.

Fig. 4 shows the whistles emitted by some false killer whales at the same time. The whistles recorded at an aquarium such as Shimonoseki Aquarium where about ten false killer whales are kept almost always turn out to be like this figure. A model pattern of whistles emitted by a false killer whale is shown in Fig. 5.

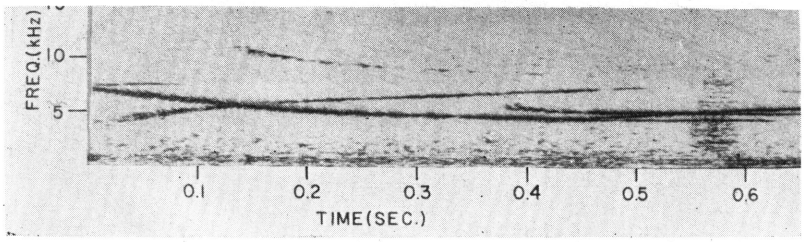

Fig. 4. Sonagram of whistles emitted by some false killer whales, the effective filter bandwidth of the analyzer is 150 c/s.

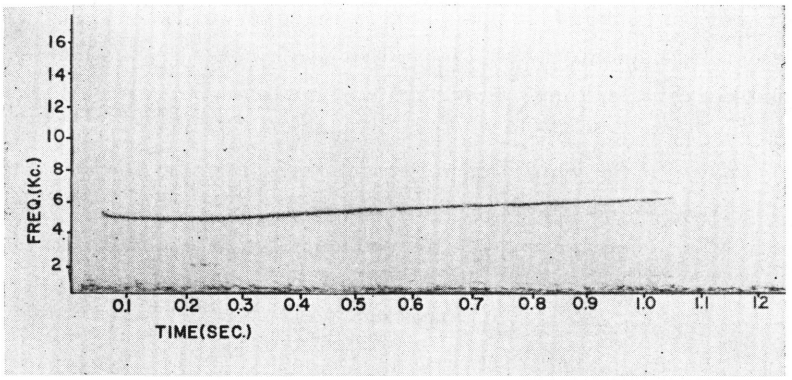

Fig. 5. A model pattern of whistle of a false killer whale, the effective filter bandwidth of the analyzer is 90 c/s.

Besides these, the false killer whale often emits a pure tone that differs timbre. An example of the pure tone that is a part of the successive sound which is similar to a chirp, is shown in Fig. 6 and this is not so rare.

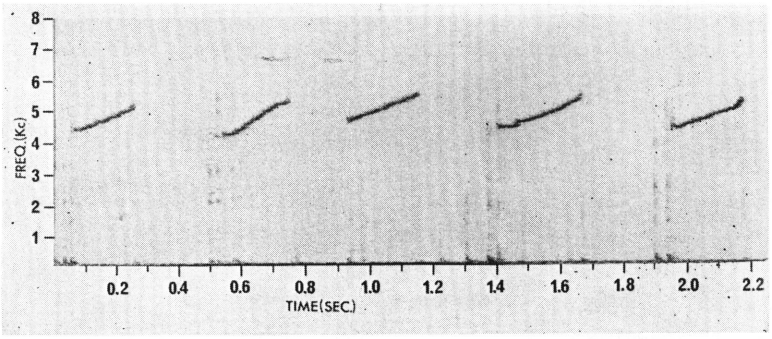

Fig. 6. Successive short whistles which is similar to a chirp, the effective filter bandwidth of the analyzer is 45 c/s.

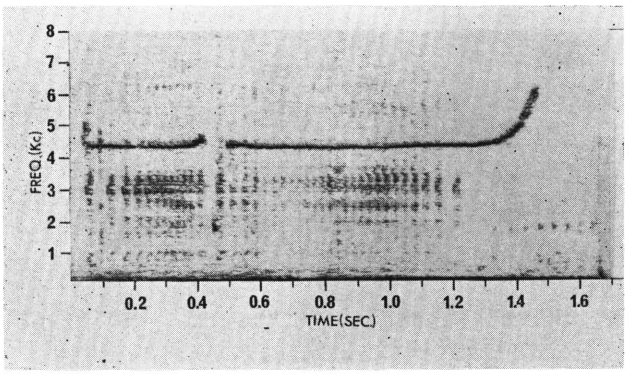

Fig. 7. Whistles which were accompanied with clicks at a time, the effective filter bandwidth of the analyzer is 45 c/s.

Next, as shown in Fig. 7, it was observed that the whistle emitted by the false killer whale is accompanied with clicks, that is, a false killer whale emits both whistle and clicks at a time. This fact was not observed with the bottlenosed dolphins.

The frequancy of the whistle mentioned above was within the range from 4 to 9kc and this range was much the same as the bottlenosed dolphins. The duration of a whistle was about 1.5 seconds at the longest and about 0.2 second at the shortest.

2. Clicks

Generally speaking, the clicks of the false killer whale are emitted with a long time interval, in other words, the repetition rate is low. An extreme case of time interval was one-third seconds and sometimes it resembles the slow clicks so-called "Morse" emitted by the sperm whale.

Fig. 8 shows the clicks of not so low repetition rate and in this case the frequency limit is below 15kc.

Fig. 9 shows the clicks of high repetition rate, and in this case the frequency limit is comparatively low and its substantial portion is found at 1 - 5kc.

Special clicks with a limited frequency within the range of 1 - 2kc is shown in

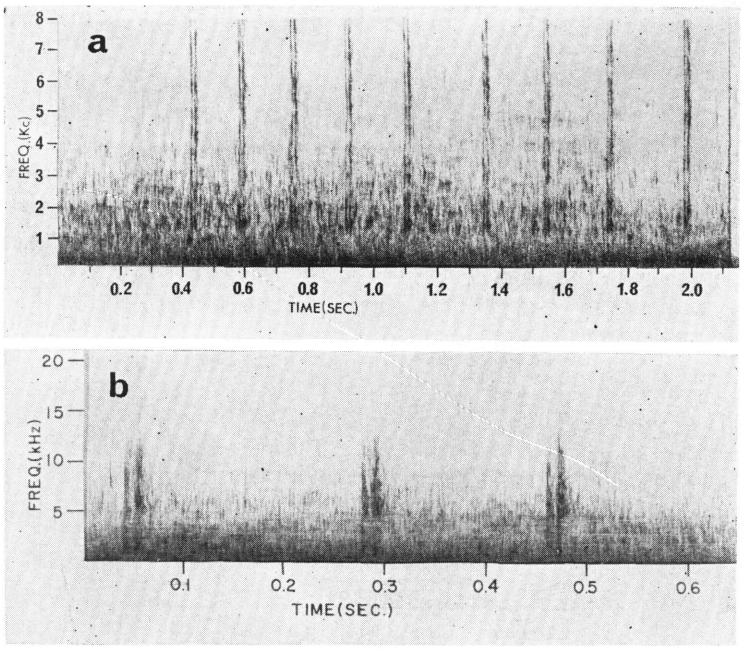

Fig. 8. a ; Clicks of the slow repetition rate, the effective filter bandwidth of the analyzer is 300 c/s.
b ; Same clicks of 25kc spectrographic analysis, the effective filter bandwidth of the analyzer is 1,000 c/s.

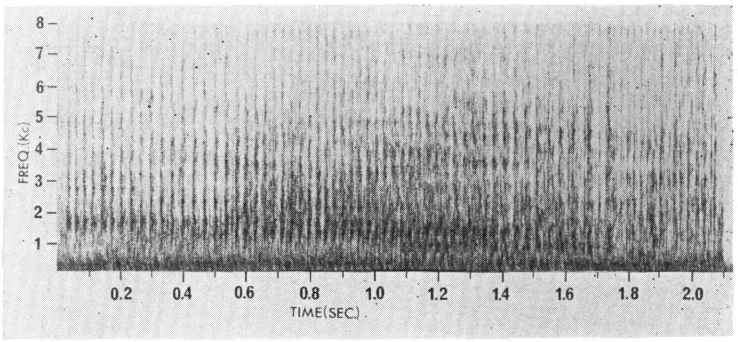

Fig. 9. Clicks of quick repetition rate, the effective filter bandwidth of the analyzer is 300 c/s.

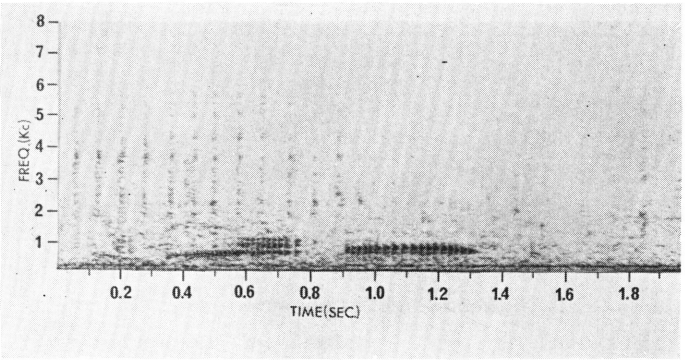

Fig. 10. Special clicks whose compass is limited to the range of low frequency, the effective filter bandwidth of the analyzer is 45 c/s.

Fig. 10, and this is an example that is often emitted by the false killer whales.

3. Stratiform sound

The stratiform sounds of the false killer whale were found in greatest abund-

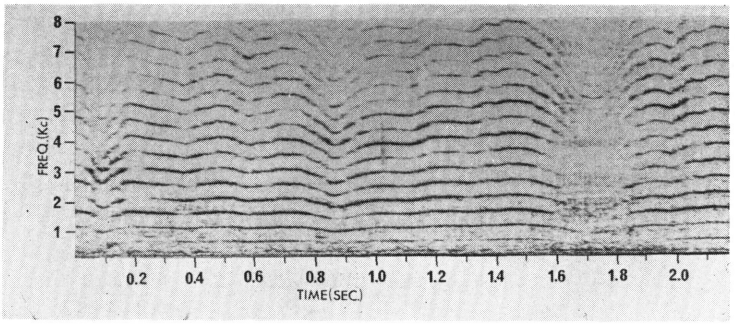

Fig. 11. Sonagram of signals emitted by false killer whale immediately before feeding, the effective filter bandwidth of the analyzer is 45 c/s

ance and richest variety. Some of these sounds were clearly recognized as such by otic hearing while some others were identified by spectrographic analysis though these sounded like clicks of high repetition rate.

The bottlenosed dolphin emits the sound like mewl and this has been found to be the call of food intake. The false killer whale also emits the sound like mewl

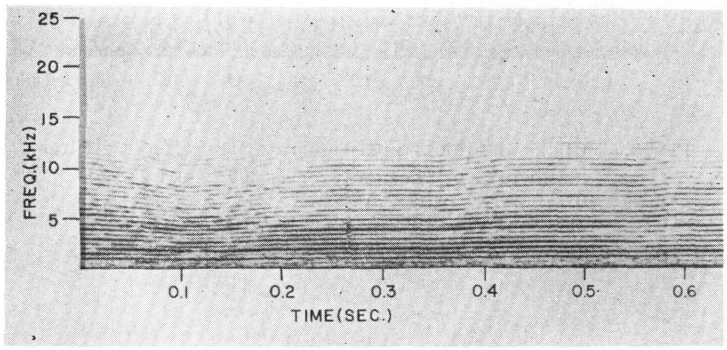

Fig. 12. 25kc spectrographic analysis of Fig. 11, the effective filter bandwidth of the analyzer is 150 c/s.

and it is shown in Fig. 11. Fig. 12 shows the same call of 25kc spectrographic analysis, and it was found that the limit is as high as about 13kc or so. The mating call of the false killer whale is shown in Fig. 13. It is considered to be somewhat different from that of the bottlenosed dolphin in regard to the tone quality which appears as a mixture of loud cry and signals of courtship, and in regard to the intermittent sound.

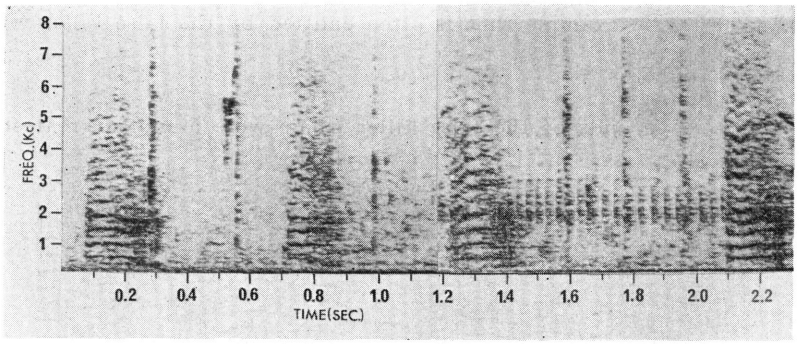

Fig. 13. Mating call of false killer whale, the effective filter bandwidth of the analyzer is 45 c/s.

Moreover, the calls like those of the killer whale and songs of birds were often observed and it was found by spectrographic analysis that both of these calls were stratiform sounds.

Next, the grating sound was observed. The grating sound emitted by the

bottlenosed dolphin was clicks of high repetition rate. However, it was found by spectrographic analysis that the grating sound emitted by the false killer whale is the stratiform sound as shown in Fig. 14 even if it was clearly recognized as clicks by otic hearing.

It was already reported that if the repetition rate of clicks is momentarily increased, its analyzed pattern becomes similar to the stratiform sound [8]. In this study, however, it was obtained that clicks is shown in sonagram by a train of pulse when repetition rate of clicks is less than 100-per-second and by the strati-

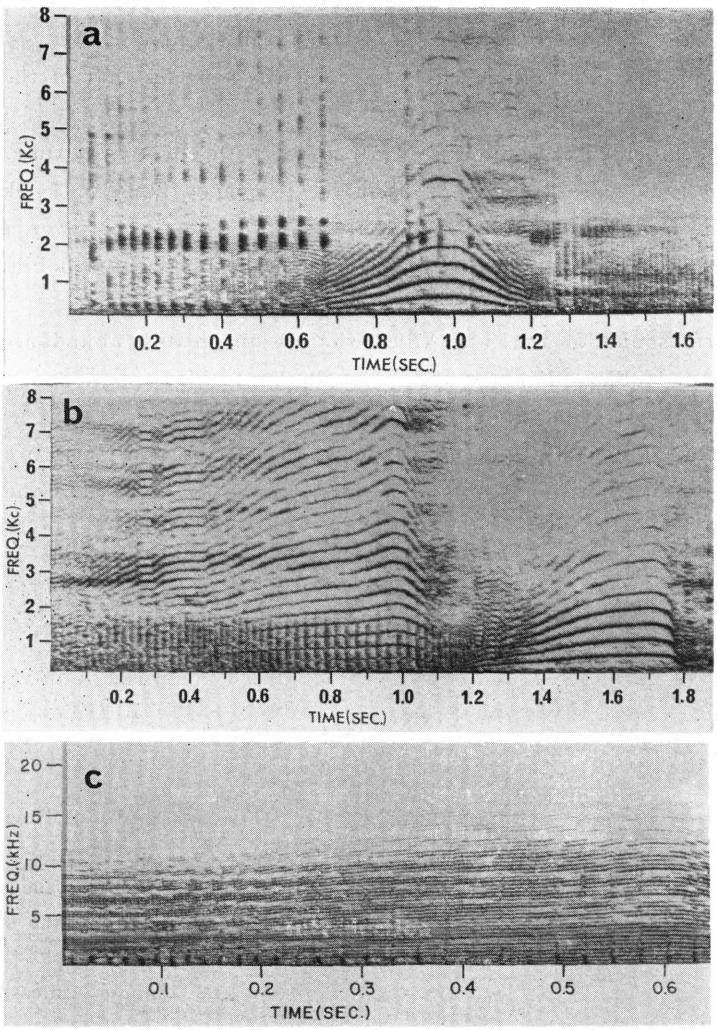

Fig. 14. a ; Grating sound by false killer whale, the effective filter bandwidth of the analyzer is 45 c/s.
b ; Grating sound by false killer whale
c ; 25ks spermatographic analysis of b, the effective filter bandwidth of the analyzer is 150 c/s.

form sound when the repetition rate is more than 100-per-second. This was obtained by counting the number of pulse on the sonagram between the points where clicks take the form of the stratiform sound and vice versa. And moreover, the frequency of this type of stratiform sound is generally wide in range.

Summary

1. The underwater sound of the false killer whales had been recorded since 1960 mainly at the Shimonoseki Aquarium and partly at the sea area of Iki-Tsushima.
2. The underwater sound of the false killer whales is roughly classified into three types of signals, i. e., whistle, clicks and stratiform sound.
3. Whistle of the talse killer whale is much the same as that of the bottlenosed dolphin, but with less intonation.
4. The false killer whale emits whistle together with clicks at a time.
5. Whistle of the false killer whale is in the frequency range of 4 - 9kc.
6. There are many kinds of clicks of the false killer whale, however, generally the repetition rate is low as compared with that of the bottlenosed dolphin. And the frequency range of these clicks is below 15kc.
7. Stratiform sound of the false killer whale is in greatest abundance and richest variety. Mating call, food intake call, calls similar to bird songs, and grating sound all belong to the stratiform sound.
8. The clicks of the false killer whale show the sonagraphic pattern of the stratiform sound when repetition rate is momentarily increased to be more than 100 pulses per second.

References

1) Mizue, K. & K. Yoshida : Studies on the little toothed whales in the west sea area of Kyushu-VII, About *Pseudorca crassidens* caught at Arikawa, Bull. Fac. Fish. Nagasaki Univ., **11**, 39-48 (1961) (in Japanese)
2) Schevill, W. E. & W. A. Watkins : Whale and porpoise voices, A phonograph record 24pp, and a phonograph disk, Woods Hole, Mass, Woods Hole Oceanographic Institution (1962)
3) Mizue, K., A. Takemura, & K. Nakasai : Studies of the little toothed whales in the west sea area of Kyushu-XIII, Mating calls and others of the bottlenosed dolphin caught at Arikawa, Bull. Fac. Fish. Nagasaki Univ., **23**, 197-204 (1967)
4) ——— : ——— -XV, Underwater sound of the chinese finless porpoise, ———, **25**, 25-32 (1968)
5) Busnel, R. G. & A. Dziezic : Acoustic signals of the pilot whale *Globicephala melaena* and of the porpoise *Delphinus delphis* and *Phocaena phocaena*, Whales Dolphins and porpoises, Univ. Calf. Press, Berkeley and Los Angeles, 607-646 (1966)

6) BACKUS, R. H. & W. E. SCHEVILL : Physter Clicks, ——— , ——— , 510-528 (1966)

7) RIDGWAY, S. H. : Dall porpoise, ***Phocaena dalli,*** Observation in captivity and at sea, Norsk Hvalfangst-Tidende, **5**, 97-110 (1966)

8) WATKINS, W. A. : The harmonic interval fact or artifact in spectral analysis of pulse trains, Marine Bio-acoustics, **2**, 13-43 (1967)