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**Brief report on improvement of slaughtering method in dolphin drive fisheries in Taiji, Japan
during the years between 2000 and 2010**

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1. Back ground

During 52nd annual meeting of the International Whaling Commission, Scientific Committee (IWC/SC) in Adelaide, Australia in 2000, a certain NGO displayed the video footprint of drive fishery operation in 1999 in Futo, Ito city, Shizuoka, Japan. Slaughtering method in that footprint was not so sophisticated and promoted severe criticism anti those fisheries. After the IWC/SC meeting, Fisheries Agency of Japan (FAJ) requested activities for improvement of dolphin slaughtering method. Since drive fishery operation in Futo was not as frequent as that in Taiji, National Research Institute of Far Seas Fisheries and Taiji Fisheries Cooperative Association started the experiments for the improvement of dolphins slaughtering method in Taiji. It was expected that improvement would prevent criticism anti fishery and ensure the safe operation for the engaged fishermen.

2. Consideration on previous slaughtering methods for driven dolphins and livestock

We compared the existent killing methods for dolphins caught by drive fishery and those for livestock, in order to elucidate requirement for the efficient and safe slaughtering method.

Previous method in Taiji (until 1999 year)

Drive fishery in Taiji is licensed to hunt seven species including false killer, southern form short-finned pilot whales, Risso's, bottlenose, striped, spotted and Pacific white-sided dolphins. Fishermen drove dolphins to a small cove and closed its mouth with net. In most cases, slaughtering process started early in the morning of the next day of the drive. To avoid the presence of unnecessary gallery, fishermen tried to finish the slaughtering process as hasty as possible. Fishermen threw lance (Figure 1, approximately 3m in length) from the small boat to dolphins swimming inside the net. Fishermen aimed the neck region of the dolphins (they considered it vital part); however it was difficult to hit it. Most dolphins died of bleeding. In average, it took approximately five minutes to slaughter a striped dolphin. The reason why Taiji drive fishermen threw the lance was to avoid injury from struggling dolphins. Once there occurred the accident that a fisherman, who kept holding the lance after hit, was injured by the lance end on his face because a dolphin struggled. After this process, the beach water was dyed with blood and it sometimes remained until afternoon. Fishermen tied short ropes (approximately 1m in length) on tails of dead dolphins on the beach and carried dolphins to a boat having flat deck (Figure 2) approximately 200m off the beach. On the boat deck, fishermen incised almost median line of dolphins, extracted viscera and washed off the blood with sea water. And then, fishermen carried viscera and carcass to the fish market. In general, carcass was processed to blubber and meat. In the case for smaller species such as striped and spotted dolphins, carcass was sold as it was. Viscera were sold as they were for all target species.

Previous method in Futo (until 1999 year)

Drive fishery in Futo is licensed to hunt four species including false killer whale, bottlenose, and striped, spotted and Pacific white-sided dolphins. Fishermen drove dolphin schools into the Futo harbor and closed the mouth of the harbor with net. Slaughtering was carried out in the daytime. Fishermen hooked blowhole and draw the dolphins to secure the short ropes on tails of

the dolphins. Hooks were not as blunt as those in the Faroe Islands (see later part). Fishermen landed live dolphins with ropes to the pickup truck waiting on the berth using a derrick boom of a fishing boat. The pickup truck carried dolphins to the fish market of the harbor. In the market, fishermen slaughtered dolphins cutting cervical blood vessels with ordinary knives. Killing time data were not available, but dolphins struggled and bled until death. Dead dolphins were processed and sold at the market. Fishermen in Futo seemed not to mind that their slaughtering was being seen or recorded by the gallery.

Method for cattle and pigs

Restrained cattle will be struck by a captive bolt pistol in the middle point between both eyes and temporarily stunned because of brain damage (not dead). Immediately, they will be cut in their cervical blood vessels. For the safety of the operators, spinal cord of cattle used to be broken with stainless steel wire penetrated through bolt wound (pithing) in order to prevent reflex movement of hind limb. However, now pithing is banned by the Government of Japan to prevent transmission of bovine spongiform encephalopathy (BSE). Cattle will die in less than 30 seconds after pistol hit. Bleeding is major cause of death.

In the case for pigs, operators restrained animals with electric shock and immediately they speared heart and cut cervical blood vessels. Killing time seemed slightly shorter than those for cattle probably due to smaller body size.

Method in the Faroe Islands (spinal cut)

In the operation of the Faroese drive fishery, the boats drive dolphin schools to the beach. Hunters on the beach restrain and draw dolphins with a blunt blowhole hook. With a short lance called whaling knife, they slaughter dolphins by breaking cervical spinal cord and blood vessels surrounding vertebra simultaneously (Olsen 1999). Killing time was reported shorter than 30 seconds. Olsen (1999) pointed out that blood supply to dolphin brain depends on blood vessel plexus surrounding vertebra. It means that single hit on the spinal cord simultaneously destroys large blood vessels. These double effects bring a prompt fatal result.

Requirement for dolphin slaughtering method

From above comparison, we could extract requirement for dolphin slaughtering method. First, operators must restrain the animal. Second, during the restraint the operators must bleed as much and quick as possible by breaking large blood vessels or heart. Third, it is necessary to break the spinal nerves in order to ensure the death and to prevent reflex movement of the animal.

A captive bolt pistol, electric shocker and blunt blowhole hook help to restrain the animal. In addition, underwater environment seemed to minimize a stress on the animal. Bleeding is common for all the four methods. Spinal cord is the target in cattle and the Faroese methods.

However, we recognised some restrictive factors. In Japan, it is necessary to have license for holding and usage of a captive bolt pistol. In addition, it is not permitted to use the pistol for the purpose other than slaughtering cattle in an appropriate facility. It was concerned that the electric shocker would cause a shock to the operators/fishermen on the beach, if the shocker were introduced to dolphin slaughtering.

3. Experiments in Taiji during the years between 2000 and 2001

Preliminary experiments

In Taiji during October-November 2000, the junior author had tried stunning by bolt, blunt blowhole hook and a whaling knife assisted by dolphin drive fishermen. The junior author tried to stun Risso's and bottlenose dolphins. Stunning bolt was modified from a screwdriver. Tip of the bolt was 5cm in length. It was possible to stun the dolphin for a few minutes, but at last he used traditional lance for slaughtering. Olsen (1999) reported that a captive bolt pistol is not applicable for slaughtering of dolphins, because dolphins will show severe cramp after short stunning and it is dangerous for operators. The junior author also examined the effect of pithing on a bottlenose dolphin. It brought stunning but not fatal.

Introducing spinal cut

During the period between December 2000 and February 2001, the junior author and drive fishermen in Taiji applied spinal cut to nine Risso's, four striped and two spotted dolphins and one southern form short-finned pilot whale. In the case of Risso's dolphins, it was easy to draw and beach the dolphin with ropes on tails. Then operators cut spinal nerves and blood vessels with knife. Operators confirmed death by disappearance of movement/breath. Biologically, this criterion is not correct but practical for fishermen. Killing time ranged between five and 40 seconds (n=9). In the case of striped dolphins, it was impossible to restrain the intact animals because they struggled

before beaching or stranded on rocky part of the beach (slaughtering should be done on sandy beach). Then operators used traditional lances to make dolphins weak. After that, it was easy to cut spinal nerves. Killing time after spinal cut ranged between five and 30 seconds ($n=4$). Criterion of death was similar to that of Risso's dolphins. The junior author also recorded killing time by the traditional method as ca. 5 mins ($n=1$). In the case of spotted dolphins, situation was similar to striped dolphins. Spinal cut was applied for two spotted dolphins after lance hit. Killing time data were eight and ten seconds ($n=2$). In the case of a pilot whale, it was easy to restrain and killing time was 25 seconds.

Results from a series of trial indicated that spinal cut is the efficient primary slaughtering method for dolphin species other than striped or spotted dolphins. Then drive fishermen prepared slaughtering knife (Figure 3) and introduced spinal cut to commercial operation for false killer and southern form short-finned pilot whales, Risso's and bottlenose dolphins. However, traditional slaughtering method remained for striped and spotted dolphins.

After the partial introduction of spinal cut in Taiji, fishermen in Futo followed it in November 2004 (No drive fishery was conducted in Futo since that time).

4. Further improvement in Taiji from 2008 to 2010

In 2008, FAJ reiterated the request for improvement of dolphin slaughtering method. Fishermen in Taiji considered that spinal cut would be applicable if they could lead striped and spotted dolphins to sandy beach. In December 2008, fishermen covered the rocky part of the beach with a vinyl sheet (3m in depth and 25m in length, Fig. 4) and drove dolphins to sandy beach. This attempt was successful. Dolphins in the net were guided as expected and safely slaughtered by spinal cut. Remained technical difficulty was resolved.

In 2009, fishermen in Taiji started next attempt to prevent blood spill on sea water during slaughtering, because anti-whaling activists used photos and movies of sea water dyed with blood to advertise bad image of the dolphin fishery. Fishermen made a modified knife having small blade (almost similar to a shaft of 13 mm in diameters, Figs 5 and 6) to minimise wound and blood spill. The knife seemed like a needle. Immediately after hit on spinal nerves, operators inserted wooden plug into the wound to minimise blood spill (Figs 5 and 6). Damage on spinal nerves immobilized the dolphins. Following this, fishermen carried dolphins to the "dissection" boat and incised as described above. Blood was released on the boat to sea water off the beach. Initially, Taiji fishermen considered that remaining blood in the body until dissection did not affect meat quality. However, it is recently reported that a part of carcasses showed a decline of meat quality and coagulated blood mass in the muscle.

In 2010, the fishermen preliminarily introduced a device which guides bleeding blood stream to a bottle via rubber tube. It seemed to be a possible way to keep environmental sanitation, but this attempt did not work well in the case of weak blood pressure. For improvements, the senior author is planning a vacuum blood suction system combined with slaughtering needle.

The senior author recognises the necessity to re-examine or calibrate killing data obtained from current killing time criteria with those from mydriasis.

5. Conclusion

Application of spinal cut method for Japanese dolphin drive fisheries brought significant improvement on killing time (e.g. five minutes to 30 seconds for striped dolphins) and safety for the engaged fishermen. Modified method will keep hygiene of the local coastal sea water.

6. Acknowledgment

Dr. Justines Olsen in Torshavn repeatedly gave valuable advice to the senior author on application of spinal cut method for the Japanese fisheries. Messrs. Shinji Hiruma and Joji Morishita of FAJ and Dr. Hajime Ishikawa of Institute of Cetacean Research, Tokyo, Japan gave us valuable critical comments.

7. Literature cited

Olsen, J. (1999) Killing methods and equipment in the Faroese pilot whale hunt. *North Atlantic Marine Mammal Commission, report to the working group meeting in hunting methods: NAMMCO/99/WS-2: 1-14.*



Fig. 1 Lance formerly used in Taiji.



Fig. 2 Flat deck of a boat for dissection.
On the deck fishermen extract viscera.



Fig. 3 Prototype of slaughtering knife (upper) and blowhole hook (lower) for Taiji fishery.
Blowhole hook is now seldom used.



Fig. 4 a striped dolphin swims along a vinyl sheet which covers the rocky part of the beach.



Fig. 5 Modified slaughtering knife and wooden plug (a piece attached to the knife is an indicator float when dropped into water)



Fig. 6 Application of modified slaughtering knife



Fig. 7 Insertion of wooden plug into a knife wound to prevent blood spill.