Shigeru FUJIEDA[1*], Masataka HIGASHI[2], Masaaki HABANO[2], Takafumi AZUMA[2], Youichi ARITA[2] and Humihiro MAKINO[2]：Ingestion of plastic debris by tuna caught in the North Pacific Ocean

藤枝　繁[1]・東　政能[2]・幅野正明[2]・東　隆文[2]・有田洋一[2]・牧野文洋[2]：北太平洋で漁獲されたマグロ類によるプラスチックの誤食

Marine litter, mainly plastic waste, is a major issue in many parts of the world（Ocean Conservancy 2013）. In summer 2012, a number of tuna caught in the North Pacific Ocean were found to have ingested plastic debris. This paper reports cases of plastic ingestion by tuna caught in the North Pacific Ocean.

Kagoshima University's training vessel, the *Kagoshima Maru*, conducted a survey voyage in the Central North Pacific in the summer of 2012. The objective of the survey was visual observation of drifting marine debris caused by the tsunami that hit Northeastern Japan in March 2011. The survey was conducted in cooperation with nine fishing boats from the Japanese Fisheries High School. We found not only large amounts of drifting marine debris on the sea surface, but also caught approximately 100 tuna by long-line fishing in the area of 31°N-32°N, 161°W-165°W. One bigeye tuna *Thunnus obesus* was found to have ingested a 60-cm rope and a 1.5-cm plastic pipe（Table 1）. Figure 1 shows the ingested items found in the stomach of this tuna.

Short plastic pipes used for spat collection in oyster farms are a major component of beach litter along the shores of the oyster farming area of the Seto Inland Sea（Fujieda 2011）and Ise Bay（Fujieda 2009）. The densities of these short pipes on 251 beaches in the Seto Inland Sea were extremely high in 2006 with an average of 7.5 pipes/m^2（Fujieda 2011）. They have also frequently washed up on beaches of the Midway Atoll, Hawaiian Islands and West Coast of North America（Fujieda and Ohkura 2012）, and were reported to have been ingested by Laysan albatrosses *Diomedea immutabilis* in the North Pacific Ocean（Longobardi 2009）. Ropes are also a major component of the marine debris on the Northwestern Hawaiian Islands（Boland and Donohue 2003, Morishige et al. 2007）.

Fig.1　Stomach contents of a bigeye tuna *Thunnus obesus*. The large, flat white object（center: A）is a squid and the black triangular objects（upper center: B）are squid beaks. A short, black plastic pipe（center: C）and a rope（lower center to upper center: D）are visible.

In February 2012, the *Riasu Maru*, a fishing boat participating visual observation of the tsunami debris from Miyako Fisheries High School in Iwate Prefecture, caught a number of tuna in the North Pacific Ocean that were identified to have ingested marine debris such as paint fragments,

Table 1　Marine debris ingested by fish caught in the North Pacific Ocean during the *Kagoshima Maru* and *Riasu Maru* surveys.

Fishing boat	Kagoshima Maru	Riasu Maru	Riasu Maru	Riasu Maru
Fish	Bigeye tuna *Thunnus obesus*	Bigeye tuna *Thunnus obesus*	Yellowfin tuna *Thunnus albacares*	Shortbill spearfish *Tetrapturus angustirostris*
Weight	103 kg	ND	ND	ND
Total length	161 cm	ND	ND	ND
Date（UT）	Aug. 29, 2012	Feb. 6, 2012	Feb. 7, 2012	Feb. 8, 2012
General location	32°17' N 160°52' W	14°43' N 178°11' W	14°46' N 177°58' W	14°25' N 177°42' W
Fishing gear	Long-line	Long-line	Long-line	Long-line
Ingested items（length）	Short plastic pipe（1.5 cm） Rope（60 cm）	Paint fragment（3.8 cm）	Plastic cap of felt pen（4.0 cm）	Plastic fragment（3.6 cm）

ND: not determined.

the plastic cap of a felt pen and other plastics (Table 1). Cases of ingested plastic by a black marlin *Makaira indica* and a lancet fish *Alepisaurus ferox* have previously been reported in the East Indian Ocean (Fujieda et al. 2008).

Although tuna is among the most widely consumed seafood species in the world, many consumers are unaware of the problem because the ingested marine debris is removed when the entrails are disposed of aboard fishing boats. At present, there is no known direct impact between human health and the consumption of marine animals that have ingested marine debris.

As a result of the March 11, 2011 tsunami, a massive outflow of plastic debris entered the Pacific Ocean. It is difficult to differentiate the tsunami debris from debris from other sources because most marine debris is composed of the same plastics and other items. In the future, the increased outflow and spread of marine debris across the world's oceans will likely increase the possibility of interactions between marine animals and plastic marine debris and we are concerned that this will increase plastic ingestion by marine animals.

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