

## Beach Litter in Amami Islands, Japan

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### Abstract

This study was performed to examine the types of beach litter in Amami Islands, Japan. The results of the study revealed that beach litter was more numerous in the northern parts of the islands than in the southern parts. Different types of litter were observed between the upper, middle, and lower levels of the beach. Pieces of broken glass dominated the lower part of the beach, while plastic materials were mostly found in the middle level. The upper level of the beach was mostly littered with formed plastic and plastic bottles. The origin of the litter was identified by labels on the litter, which were mostly in Chinese and Korean languages. About 70% of beach litter written in the languages originated from foreign countries in the spring (March - June), but the amount of beach litter from foreign countries decreased in Yoron Islands in November. These trends regarding beach litter are discussed as the Small Island Model and the Amami Islands Model.

**Key words:** Amami, beach litter, Kuroshio

### Introduction

The problem of garbage is an important topic in environmental pollution. Much garbage is discarded into the ocean and drifts ashore on the world's beaches (MADZENA and LASIAK 1997, WILLOUGHBY *et al.* 1997, ALTER *et al.* 1999, SOMERVILLE *et al.* 2003). This garbage has adverse effects on wildlife and ruins beach scenery as well as having a negative impact on fisheries, *etc.* Floating garbage in the sea may contain PCBs and other chemicals, affecting birds, fish, and marine mammals that swallow the small plastic pellets in the sea and on the beach (DA-SILVA *et al.* 2003). These plastic materials may release chemicals in the stomachs of animals, resulting in death or injury.

Many small islands have no active industry, and rely on tourism making the scenery an important factor in their economy. Dirty beaches may adversely affect tourism in such areas. The Amami Islands are located in the southern part of Japan and include eight islands. Kikai, Okinoerabu, and Yoron Islands belong to the Amami Islands and have very small areas of 56.87, 40.35, and 20.49 km<sup>2</sup>, respectively (AOYAMA 2001). Each island has many beautiful beaches, which are very popular not only for local people but also for tourists. However, large amounts of beach litter were observed on these islands (ex. YAMAGUCHI 1998, FUJIEDA 2002), which might adversely affect tourism and wildlife. Therefore, the reduction of beach litter is very important for conservation of both wildlife and the tourism-based economies of such islands.

To decrease the amount of beach litter, it is important to determine both its distribution pattern and origin. Therefore, the purposes of this study were: 1) to determine trends in observed beach litter in each of the Amami Islands, 2) to discuss these trends as the Small Island Model and Amami Islands Model.

### Materials and Methods

This study was carried out on Yoron Island from 11th to 12th March and from 11th to 12th November 2003, on Okinoerabu Island from 31st May to 1st June 2003, and on Kikai Island from 10th to 11th June 2003 (Fig. 1). Research areas were chosen in 2 beaches each in the northern and southern parts of each island. Research was carried out during low tide. Emerged area (from terrestrial fringe to wave break point) in each beach in Yoron and Okinoerabu Islands was divided into 3 tidal levels (upper, middle, and lower). A quadrat (10m × 10m) was fixed in each level. On the other hand, a quadrat (30m × 30m) was fixed in the middle intertidal level in Kikai Island.

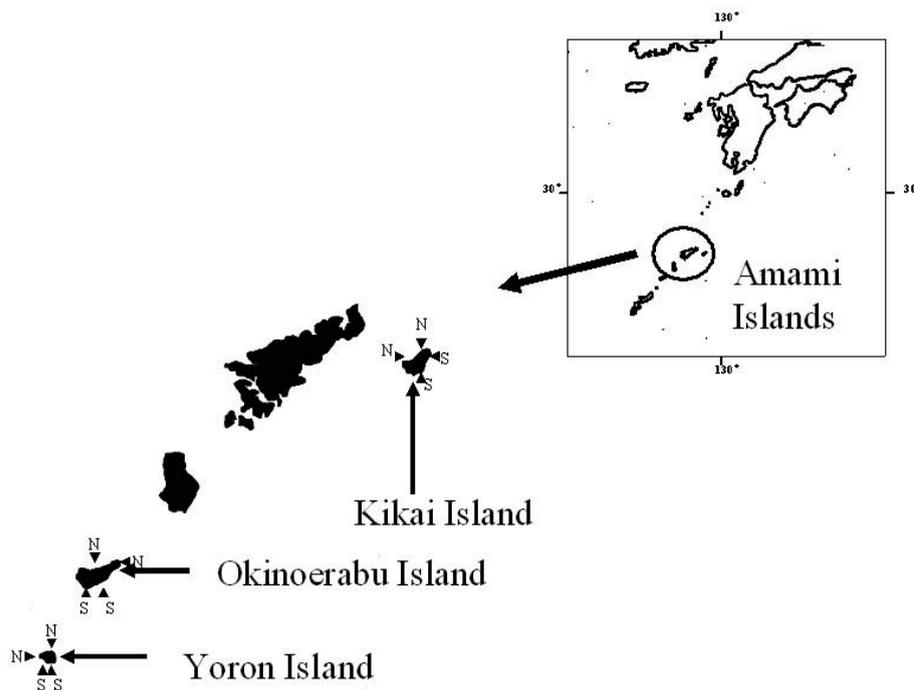


Fig. 1. Map showing the Amami Islands and the islands examined in this study (Yoron, Kikai, and Okinoerabu). Small arrow showed research beach in each island. N and S showed northern and southern beach, respectively.

All artificial beach litter was collected in each quadrat of Yoron and Okinoerabu Islands and divided into 7 categories: broken glass, plastic materials, formed plastic, glass bottles, cans, plastic bottles, and other. As formed plastic is broken easily, only pieces larger than 3cm × 3cm × 3cm were counted.

The origins of the litter on the beaches of each of the 3 islands were determined from the language on the labels.

## Results

### Type of beach litter

Beach litter was divided into 7 categories. Larger amounts of beach litter were seen in the northern parts of the islands than in the southern parts.

### Plastic Materials

Plastic materials were more numerous in the southern as compared with the northern parts of the three islands. They were mainly observed at the middle and upper intertidal levels in Okinoerabu and Yoron islands (Fig. 2). The majority of plastic materials were pieces of plastic materials and fishing floats.

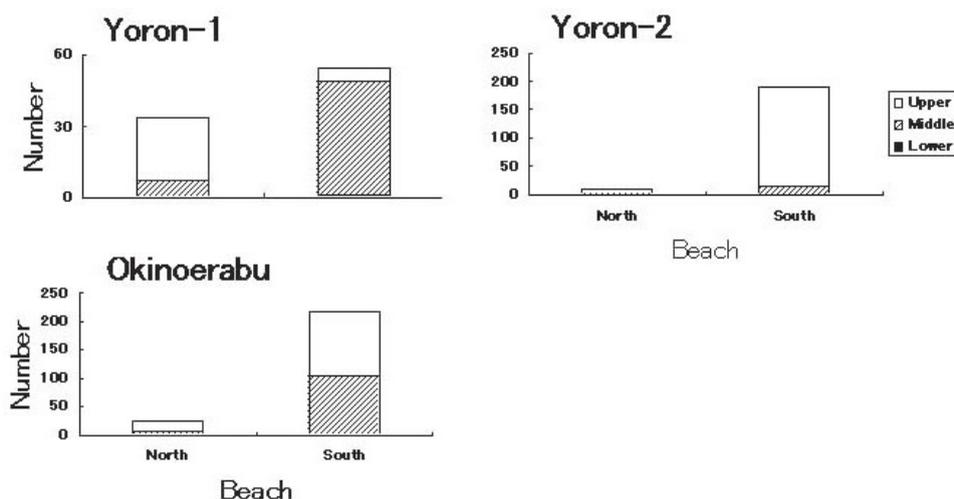


Fig. 2. Average numbers (/quadrate) of plastic materials in a beach in Yoron and Okinoerabu Islands. Yoron1 and Yoron 2 indicated a research in Yoron Island in March and November, respectively.

### Broken Glass

Broken glass was observed frequently in both northern and southern parts of all three islands, and was mainly observed at the lower intertidal level in Okinoerabu and Yoron Islands (Fig. 3). The pieces of glass were most likely from bottles that had floated onto the beach and broken.

### Formed plastic

Formed plastic was greater in number in the northern than in southern parts of the three islands. Formed plastic was observed mainly at the upper intertidal level in Okinoerabu and Yoron islands (Fig. 4).

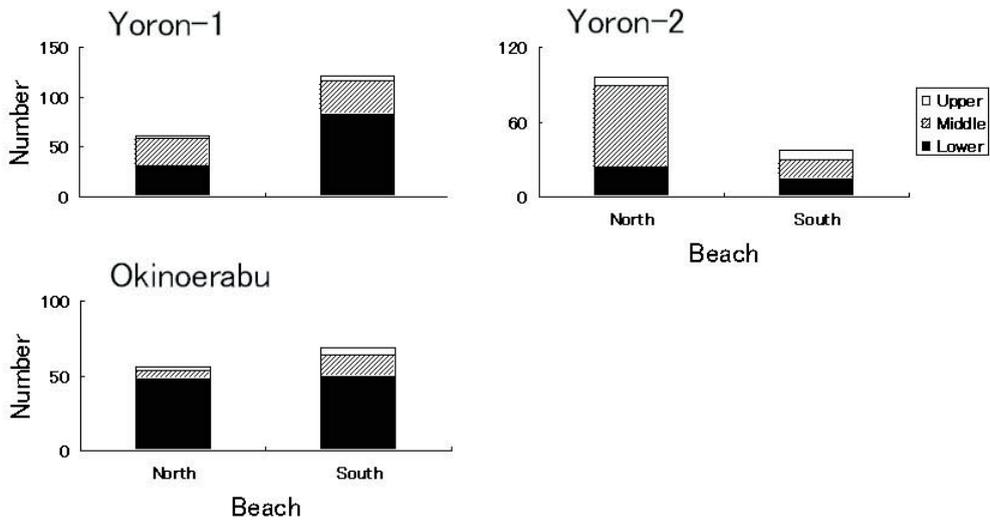


Fig. 3. Average numbers (/quadrate) of pieces of broken glass in a beach in Yoron and Okinoerabu Islands. Yoron1 and Yoron 2 indicated a research in Yoron Island in March and November, respectively.

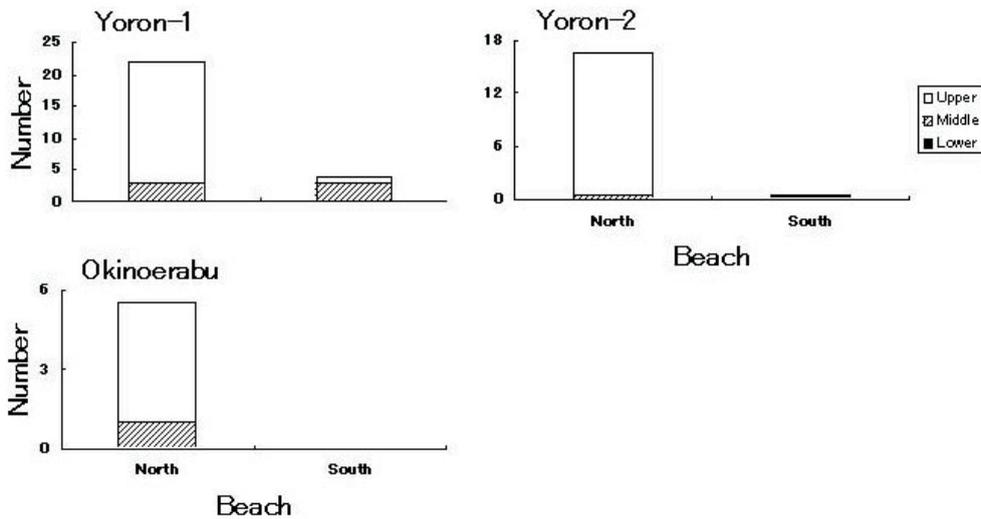


Fig. 4. Average numbers (/quadrate) of pieces of formed plastic in a beach in Yoron and Okinoerabu Islands. Yoron1 and Yoron 2 indicated a research in Yoron Island in March and November, respectively.

*Plastic bottles, Glass Bottles, Cans*

Plastic bottles showed a pattern similar to that of formed plastic, with greater numbers in northern as compared with southern parts of the three islands. They were mainly observed at the upper intertidal level in Okinoerabu and Yoron islands (Fig. 5a).

Although glass bottles were seldom observed on the beach, small glass bottles (50ml) were sometimes observed (Fig. 5b). There were no differences in number of floating glass bottles between the northern and southern parts of the islands.

Cans were sometimes observed only in the northern parts of islands (Fig. 5c).

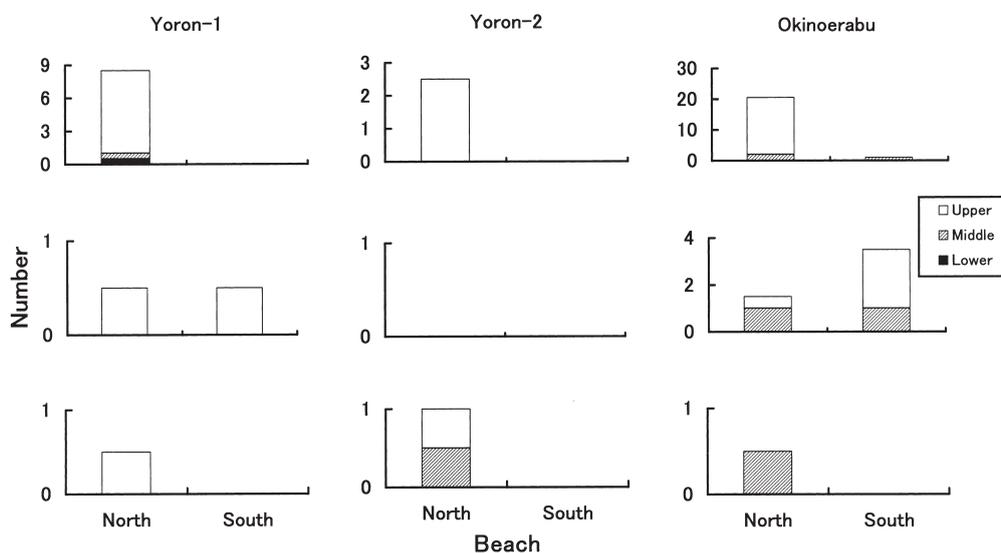


Fig. 5. Average numbers (/quadrant) of plastic bottles, glass bottles and cans in a beach in Yoron and Okinoerabu Islands. Yoron1 and Yoron 2 indicated a research in Yoron Island in March and November, respectively.

#### Other

Electric light bulbs and fluorescent lights were also observed on the beach, although in relatively small numbers.

#### Origin of Beach Litter in Amami Islands

About 10% of collected beach litter in these islands was revealed the originated country. About 70% of beach litter written in languages originated from foreign countries in the spring (March - June) as determined from the labels of the litter, which were mostly written in Chinese and Korean languages (Fig. 6), although the amounts of beach litter in Yoron from foreign countries decreased in November. Products written in both languages were mainly observed in fishing floats, plastic lighters, and plastic bottles. Other countries included Malaysia, Indonesia, the Philippines, and Thailand. Products written in these languages were mainly observed in plastic bottles. Products made in the USA, such as cigarette packs and plastic materials, were also observed. Products written in Japanese were observed in plastic bottles, cans, glass bottles and plastic materials.

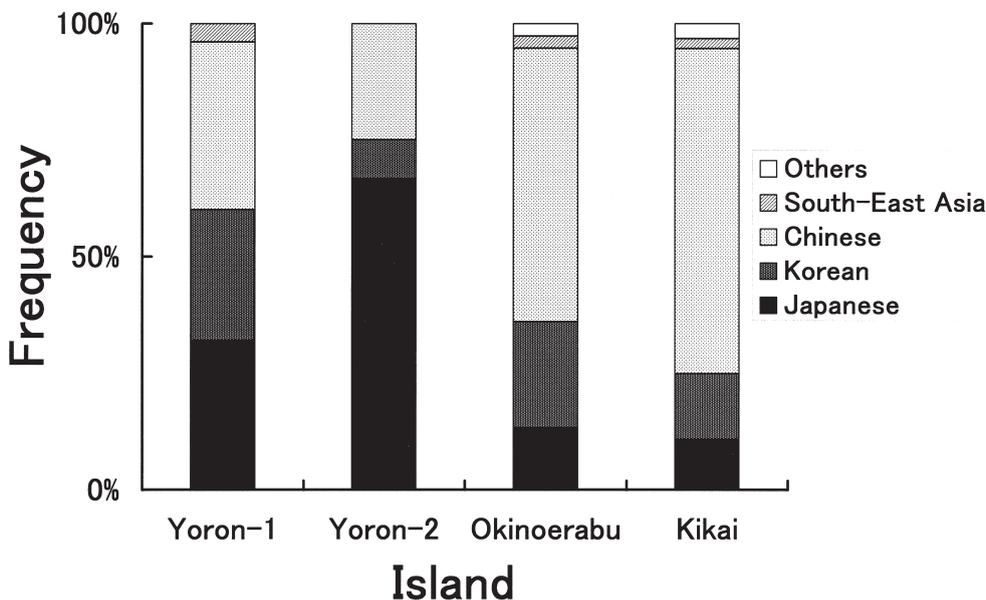


Fig. 6. Frequency of beach litter related to original area which distinguished by language in Yoron and Okinoerabu Islands. Yoron1 and Yoron 2 indicated a research in Yoron Island in March and November, respectively.

### Discussion

The two islands showed similar trends in distribution of beach litter on each type of beach throughout the year (Figs. 2, 3, 4, 5). The origin of beach litter showed similar trends in the three islands (Fig. 6).

#### Distribution Pattern of Litter on Beaches

The amounts of beach litter were greater in northern than in southern parts of all islands, although each type of beach litter showed different trends. HIGASHIYAMA-GAKUEN (1996) discussed the relationship between environmental factors (wind, wave action, and current) and distribution of beach litter. Light and floatable materials were observed frequently in the northern parts of the islands (Figs. 4, 5a). However, relatively heavy materials (e.g., plastic materials) (Fig. 2) were observed frequently in southern parts of the islands. "Kuroshio" warm current passes through the Amami Islands but the slope countercurrent makes complicate current system in this area. These currents are probably closely related with these distribution patterns of the beach litter, however, the system is unknown. Further studies are required to reveal the relationship with the current and distribution of the beach litter. On the other hand, light and floatable materials were observed frequently at the upper intertidal level, while relatively heavy materials such as plastics were observed frequently at the middle intertidal level. Wave action carries both light and relatively heavy materials to the middle level of the beach. Winds might carry

light materials to the upper intertidal level, while relatively heavy materials would remain at the middle intertidal level.

The two islands showed similar trends in distribution of beach litter on each type of beach throughout the year. Therefore, the trend of observed beach litter on the beach in the Amami Islands was summarized as the Small Island Model (Fig. 7). Broken glass was observed frequently at the lower tidal level in both northern and southern parts of all islands. Plastic materials were more numerous in the middle intertidal level in southern parts of the islands. Plastic bottles, formed plastic, and floatable plastic materials were observed frequently in the upper intertidal areas on the northern parts of the islands.

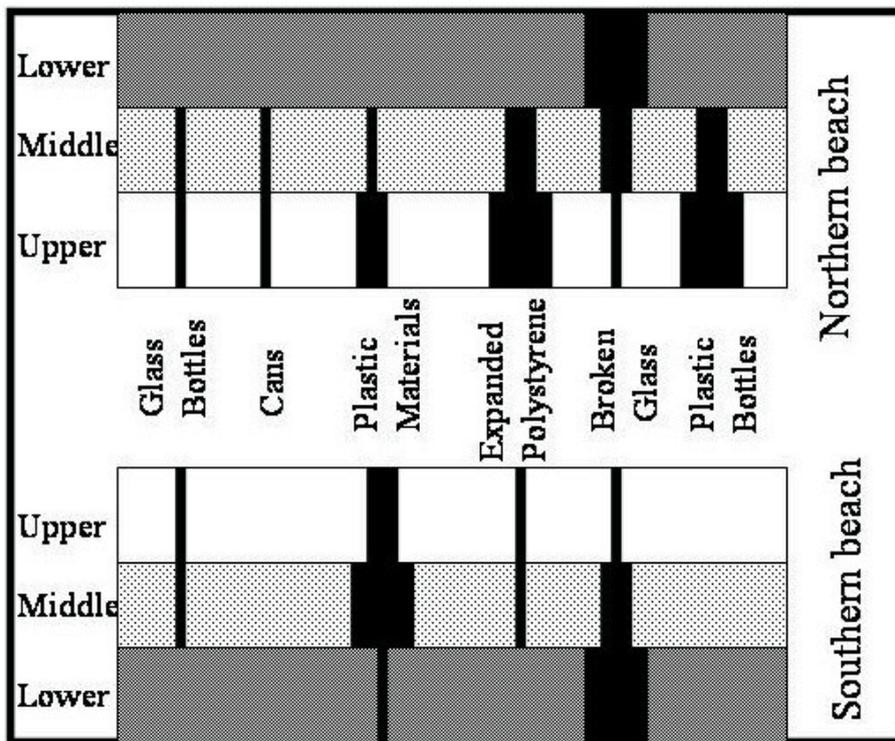


Fig. 7. Summary (the small Islands model) of beach litter in Yoron and Okinoerabu Islands. Width of solid bar in three tidal levels showed amount of beach litter. The wider solid bar is, the more beach litter was observed.

**Origin of Beach Litter in Amami Islands**

Products with labels written in Chinese, Korean, and English (made in Malaysia, Indonesia, the Philippines, Thailand, and the USA) were observed on the beaches of the Amami islands (Fig. 6). On the other hand, other researchers reported that products with labels written in Chinese, Korean, English, Russian, and Arabic were observed in

parts of Japan lying further north than the Amami Islands (HIGASHIYAMA-GAKUEN 1996, YAMAGUCHI 1998, FUJIEDA 1999). Therefore, the beach litter on the Amami Islands was characterized by a dominance of items with labels in Chinese and Korean floating in from Southeast Asia. The results of the present study were similar to research at Kagoshima Japan reported previously by FUJIEDA (1999), which indicated that beach litter originated in China and Taiwan.

Most of the beach litter originated from foreign countries. There are two possible explanations for this trend. First, the Amami Islands are located in the southern part of Japan and only two large Japanese cities (Naha and Naze Cities) are located nearby. Therefore, little Japanese litter floated onto the beaches of the Amami Islands. Second, a warm current arising near the Philippines passes through the Amami Islands and flows to southern Honshu. Large amounts of beach litter from foreign countries were observed on the Japanese coast beside the Japan Sea (THE MINISTRY OF CONSTRUCTION 2000), suggesting that garbage may float in the Japan Sea and the East China Sea. Therefore, large amounts of beach litter originating in other countries were observed in the Amami Islands. A few products made in the USA were also found on these islands. These might have been consumed in Southeast Asia or might have been taken to these islands by both the "Equatorial" and "Kuroshio" Currents.

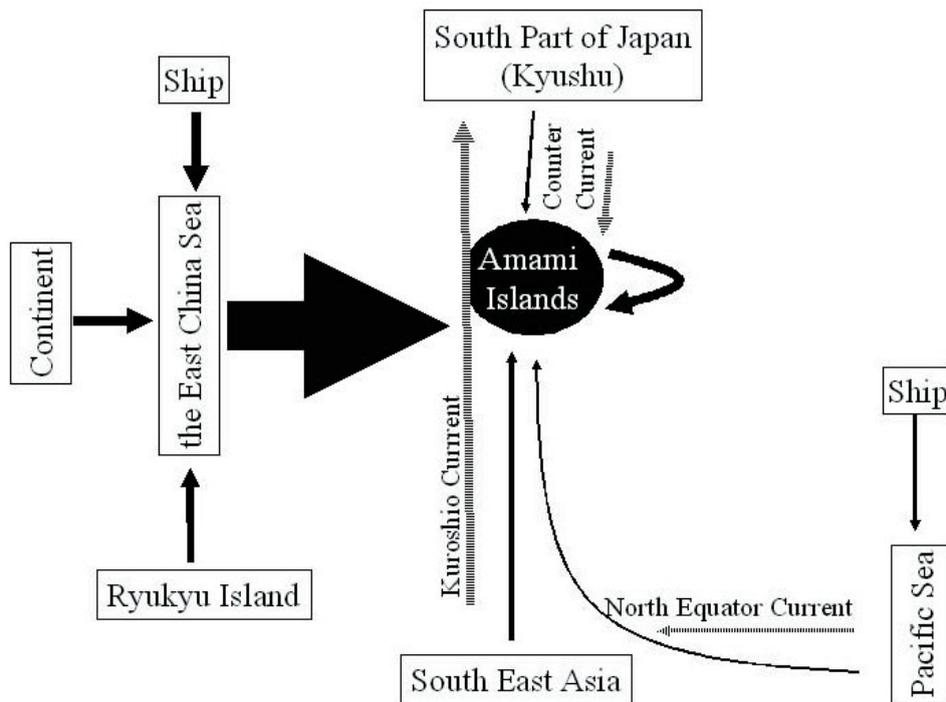


Fig. 8. The Amami Islands Model. This was made by the result of Fig.6 and showed flow of garbage near Amami Islands. Solid arrow showed flow of garbage. The wider solid bar is, the more beach litter was observed. Striped arrow showed flow of current.

### Amami Islands Model

The flow of beach litter in the Amami Islands was summarized as the Amami Islands Model (Fig. 8). The pattern of litter on the Amami Islands was characterized by a dominance of litter from foreign countries. Large amounts of garbage might be floating in the East China Sea and might be taken to the Amami Islands by the current. Large amounts of beach litter were also from South East Asian countries or were dumped from fishing boats and passenger liners. The beach litter originating from Japan might have originated from the islands themselves and from southern Kyushu and Ryukyu Islands.

Beach litter is transported by current, wave action, and wind, and there are seasonal changes in all of these factors. Therefore, further studies are required to determine the seasonal changes in the patterns of litter.

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