ORIGINAL PAPER

Comparing the abundance of microplastics in the wedge shell, *Donax semigranosus* from Ta Kuan and Leam Mea Phim beaches, Rayong Province

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Abstract. Microplastics, are the most abundant plastic debris items in the marine and coastal ecosystems. Abundance of microplastics in marine environment increase due to degradation of large plastic items. Therefore, microplastics are considered emerging pollutants to be recognized as a new threat to marine ecosystems. Marine bivalves are of particular interest as they are filter-feeders and can directly ingest microplastics from the water column, in the Gulf of Thailand. The wedge shell, *Donax semigranosus* is an abundant macro-invertebrate found on sandy beaches. This study aimed to compare the abundance of microplastics in the wedge shell, *D. semigranosus* form Ta Kuan and Leam Mea Phim beaches, Rayong Province between 1999 and 2014. The shell samples were collected and preserved in 10% buffered formalin. The abundance of microplastics in the shells was examined by hydrogen peroxide and floatation- filtration with saline (NaCl) solution treatments. The highest abundance of microplastics was found 14.3±7.3 particles/individual at Ta Kuan in 2014. Moreover, the abundance of microplastics in the shells at Ta Kuan beach was much higher than Leam Mea Phim beach in both years. The highest proportion of microplastic sizes at Ta Kuan was ranged from 100 to 500 µm in 2014, while the largest proportion of microplastic sizes at Leam Mea Phim was ranged from 1001 to 2000 µm. FTIR analyses were present four types of microplastic i.e, Poly (ethylene terephthalate), Polypropylene, Rayon, Polyethylene, Poly (vinyl alcohol). Our results imply that the commercial bivalves from the Gulf of Thailand may contain microplastics. It is urgently needed to investigate microplastic pollution in various marine organisms in the Gulf of Thailand.

Keywords: debris, *Donax*, Gulf of Thailand, microplastics, sandy beach

1. Introduction

Microplastics are fragments of plastic debris (less than 5 mm) that are accumulated in the water column and are widespread in the marine environment worldwide. Microplastics are generally defined as plastic particles which size is smaller than 5 mm, originating from the degradation of mega-, macro- and meso-plastics by solar UV radiation, wind, waves, animal bites, and human activities. The abundance of microplastics in marine environments are increased and are ingested by all kinds of marine organisms including commercially significant species of fish and shellfish (GESAMP 2015; Thompson 2015). Persistent organic pollutants (POPs) are hazardous chemical substances that widely spread in marine ecosystems such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs), and organochlorine pesticides like dichlorodiphynyltrichloroethane (DDT) or hexachlorobenzene (HCB) that are biologically accumulated through the food web. Therefore, microplastics are considered as emerging pollutants and a threat to marine ecosystems (Avio et al. 2016; Frias et al. 2010; Lusher et al. 2017; Smith et al. 2018).

Marine bivalves are of particular interest because they are filter-feeders and can directly ingest microplastics from the water column. There are several studies on commercially important species

of marine bivalves such as oysters (*Crassostrea gigas*), mussels (*Mytilus edulis*), black clam (*Cyclina sinesis*), ark clam (*Scapharca subcrenata*), and scallop (*Patinopecten yessoensis*) (Li et al. 2015; Mathalon and Hill 2014; Van Cauwenberghe and Janssen 2014). The wedge shells *Donax* spp. are consumed by Thai people in coastal areas, moreover, some species of *Donax* can serve as environmental bioindicators. The wedge shell, *Donax semigranosus*, is an abundant macroinvertebrate on sandy beaches in the Gulf of Thailand (Sanpanich 2011; Takada et al. 2016). However, there is no date to support scientific evidence of microplastics contained in the wedge shells. Therefore, this study aimed to compare the abundance of microplastics in the wedge shell, *D. semigranosus* at Ta Kuan and Leam Mea Phim beaches, Rayong Province in the years 1999 and 2014.

2. Materials and Methods

2.1 Sample collection

The wedge shell samples were collected at Ta Kuan beach (12°40′08″ N 101°10′55″ E) and Leam Mea Phim beach (12°39′04″ N 101°36′41″ E) between 1999 and 2014, during low tides by using a 25 cm2 quadrat, preserved in 10% buffered formalin and stored at Marine Biodiversity Research Group laboratory, Department of Biology, Faculty of science, Ramkhamhaeng University. The sizes of wedge shells were measured ex situ.

2.2 Microplastics Isolation

The sampled wedge shells were dissected and cleaned with distilled water. The wedge shell samples were digested with 30% hydrogen peroxide (H_2O_2) and heated up to 55-65 °C until they were completely digested. The microplastics were separated from the digested samples by flotation in saturated sodium chloride solution (250 g/L), the methods were described in Mathalon and Hill (2014). The microplastics were detected by visual identification using a stereomicroscope. Type of microplastic by Fourier transform infrared spectroscopy (FTIR) spectra.

2.3 Data Analysis

Abundance of microplastics was expressed as particles/individual and the difference in abundance of microplastics between 1999 and 2014 was tested using student t-test in R Program version 3.3.2 package “vegan”.

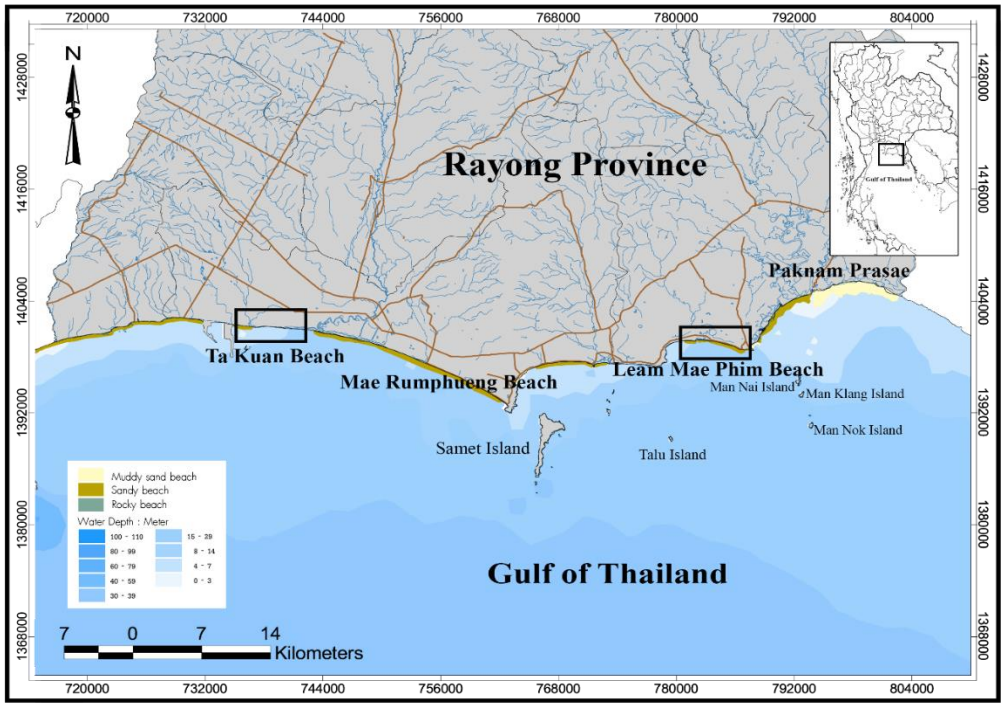

Figure 1. Location of sampling sites, Ta Kuan and Leam Mea Phim beaches, Rayong Province

3. Results

The abundance of microplastics in the wedge shell at Ta Kuan was higher than Leam Mea Phim in both years. The number of microplastics found in the wedge shells at Ta Kuan in 2014 was much higher than in 1999 (Figure 2.), while the number of microplastics at Leam Mea Phim in 2014 was lower than in 1999. The highest number of microplastics in the *D. semigranosus* was found with 20 particles/individual at Ta Kuan in 2014, although this year had larger fluctuation, with the lowest record being 4 particles/individual. The number of microplastics in 1999 varied from 8–12 particles/individual. The abundance of microplastics in the years 1999 and 2014 was not significantly different ($p<0.05$).

The sizes of the microplastics ranged from 100 μm to 5 mm in the bodies of the wedge shells (Figure 3.). The results show that the sizes of microplastics at Ta Kuan were mostly between 1001-2000 μm at 51.6 % of the total microplastics calculated in 1999 and were mainly found in a range of 100-500 μm in 2014. Whereas, the sizes of microplastics at Leam Mea Phim were ranged between 501-1000 μm in 1999 and were mainly found in a range of 1001-2000 μm in 2014.

Microplastics were identified type of microplastic in *D. semigranosus* by Fourier transform infrared spectroscopy (FTIR) spectra. Four microplastic types were Polypropylene, Rayon, Polyethylene, and Poly (vinyl alcohol). The dominant microplastic type was Poly (ethylene terephthalate at all study sites.

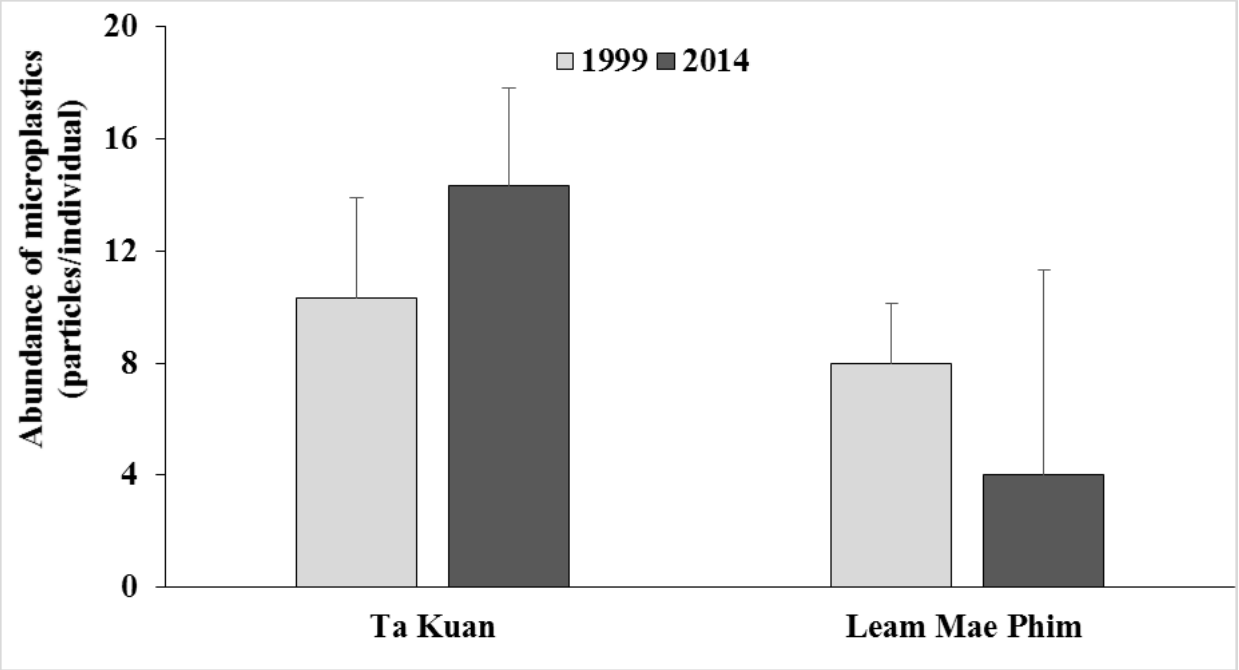

Figure 2. Abundance of microplastics accumulated in *D. semigranosus* between Ta Kuan and Leam Mae Phim beaches in the years 1999 and 2014

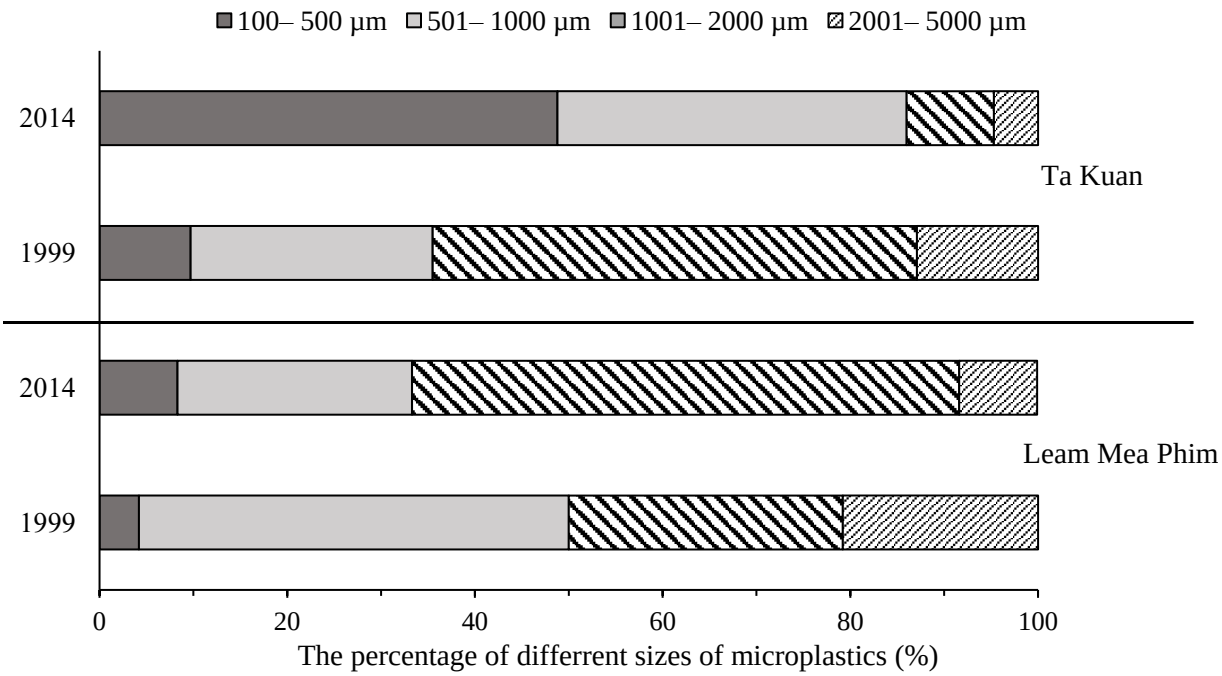

Figure 3. Size proportion of the different microplastics particles in *D. semigranosus* between 1999 and 2014 at Ta Kuan and Leam Mae Phim Beaches

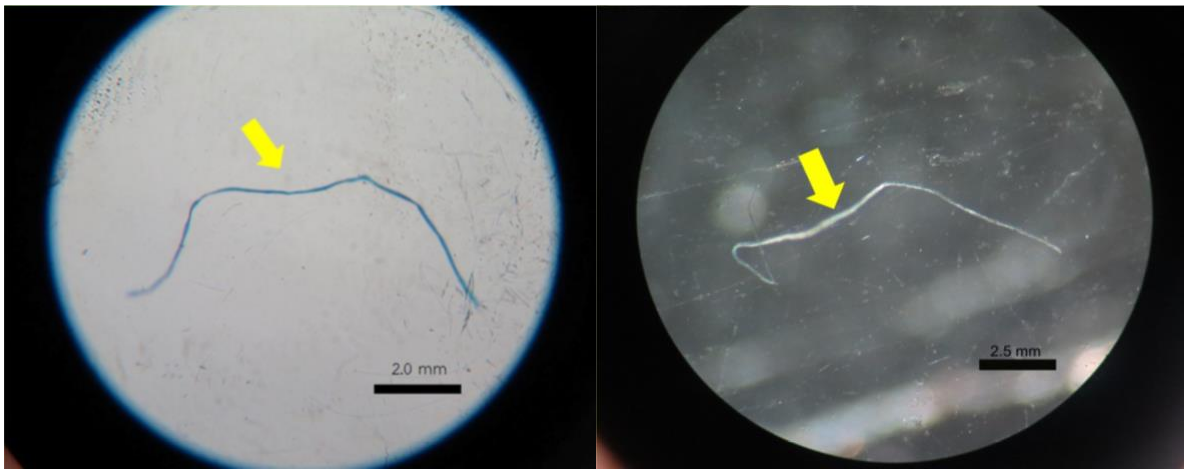

Figure 4. Microplastics in *D. semigranosus* under stereomicroscope

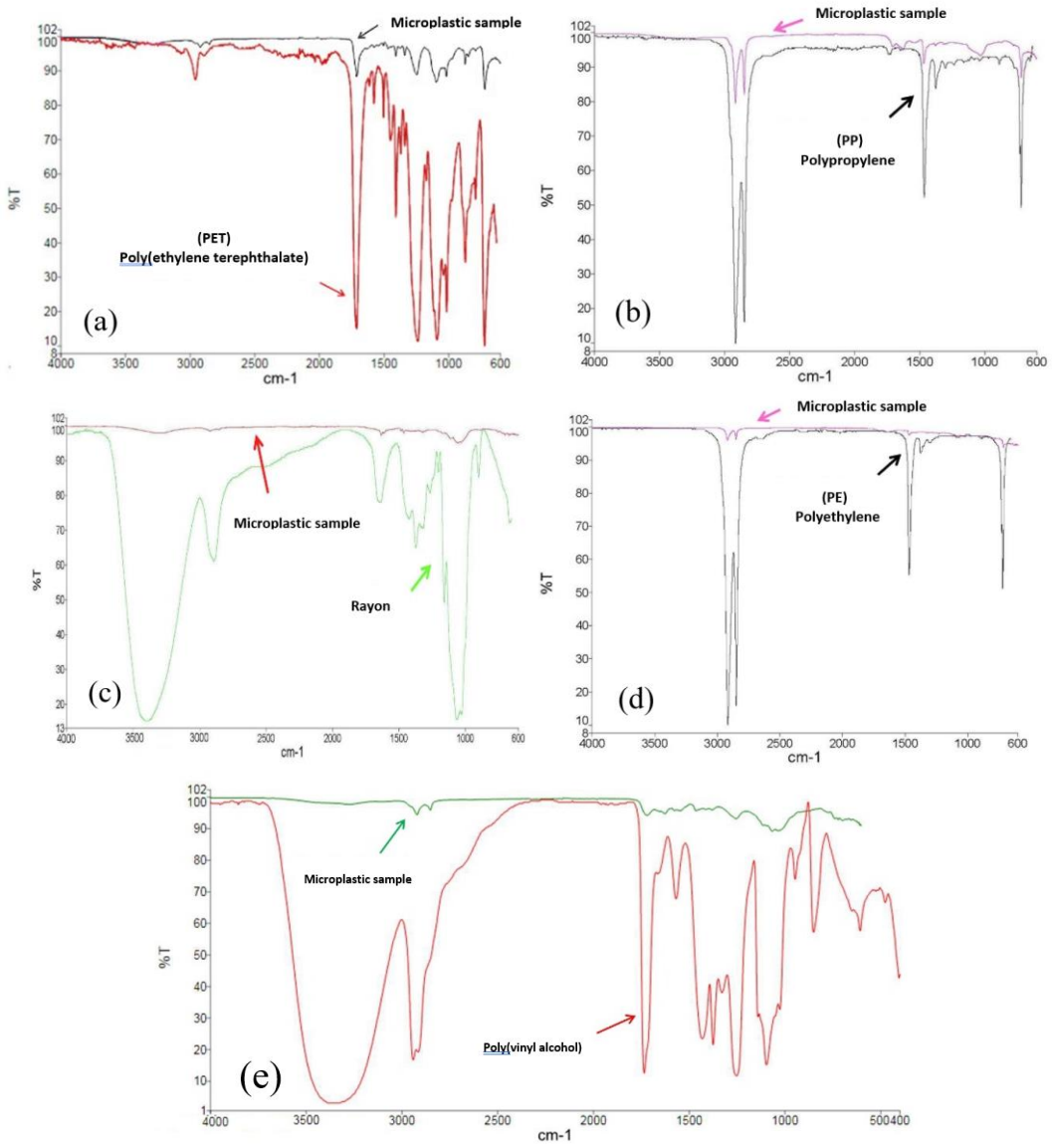

Figure 5. FTIR spectra analyses of microplastics in *D. semigranosus*; (a) Poly (ethylene terephthalate); (b) Polypropylene; (c) Rayon; (d) Polyethylene; (e) Poly (vinyl alcohol)

4. Discussion

Different shellfish compose a main sector of seafood production in Thailand, such as blood cockle, green mussel, oysters and scallop. Moreover, there are still more species of shellfish for human consumption in Thailand such as *Meretrix meretrix* (Hard clam), *Scapharca inaequivalvis* (Ark clam) (Ngamprasertkit 2018; Rangkadilok et al. 2014) including the *Donax* spp. (wedge shell) that were mainly consumed by people who live along coastal areas. In our study, the wedge shell *D. semigranosus* indicate that the abundance of microplastics at Ta Kuan beach in 2014 increased approximately 4 particles/individual compared to 1999. Moreover, the abundance of microplastics at Ta Kuan beach was higher than the at Leam Mea Phim beach in both years. The microplastics accumulation in *D. semigranosus* should be a concern due to their size are small, with the average length and width of 12.33± 1.76 and 9.16±1.40 mm, respectively. Studies conducted by Van Cauwenberghe and Janssen (2014) reported the estimated that in European countries with high shellfish consumption, up to 11,000 microplastic particles (size range 5–1000μm) ingested by consumers per year were, whereas in countries with low shellfish consumption, an average of 1800 microplastics were ingested per year. A study of microplastics accumulation

in commercial bivalves in China revealed that the abundance of microplastics varied from 4–57 particles/individual (Li et al. 2015). Moreover, the microplastics accumulation of *Mytilus edulis* in China waters varied from 1.5-7.6 particles/ individual (Li et al. 2016) while total microplastics varied from 3.7–17.7 particles/individual in bivalve species of the Persian Gulf (Naji et al. 2018). The study of microplastic accumulation in Saccostrea forskalii (Rock oyster) in Thailand's coastal ecosystems have shown that the rock oyster can accumulate microplastics varying from 0.37–0.57 particles/g (Thushari et al. 2017). Our results imply that the commercial bivalves from the Gulf of Thailand may contain a considerable amount of microplastics.

Size measures in our study indicate that the average microplastics at Ta Kuan beach in 1999 were larger than in 2014. Conversely, the average size of microplastics at Leam Mea Phim beach in 1999 was smaller than in 2014. The size microplastics ingestion in our results was difference with three edible bivalves from Persian Gulf that showed approximately 75–85% are smaller than 250 µm (Naji et al. 2018). Microplastics are degraded by several factors such as biodegradation from microbial, UV radiation, oxidants and physical stress. Sandy beaches are shown moderate to high degradation rates due to exposure to high solar UV radiation, high temperature and oxygen available that make the size of microplastics on several beaches are varied (Andrady 2015; Andrady 2017; Cooper and Corcoran 2010; Corcoran et al. 2009; Gewert et al. 2015; Gong et al. 2018; Song et al. 2017; UNEP 2016). The results in our study indicated that the different size of microplastics between 2 locations might be resulted from anthropogenic activities that Ta Kuan beach is near a local fishery village, in addition to a major industrial estate, Map Ta Phut Industrial Estate that hosts both petrochemical and heavy industries. During its operation, there have been many reports indicating the release of toxic chemicals and other pollutants that are oxidant stressor for degradation processing (Jadsri et al. 2006; Langkulsen et al. 2011). Our results show most microplastic in the sample were PET; Poly (ethylene terephthalate). PET, PP, PE were mainly used to make plastic bottles, food packages pipes including fishing gear (Park et al. 2004; Claessens et al. 2011; (Qiu et al. 2015). Further works are urgently needed to investigate microplastic pollution and generate data on the types of microplastics in various marine organisms in the Gulf of Thailand.

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