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Distribution of Hg in mangrove trees and its implication for Hg enrichment in the mangrove ecosystem

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ABSTRACT

The aim of this study was to evaluate Hg distribution in mangrove plants and changes of Hg content during leaf aging; the contribution of litterfall to Hg enrichment in mangrove ecosystems is also discussed. Contents of total Hg (THg) and methylmercury (MeHg) in mangrove plants and sediments were determined. Contents of THg and MeHg in the sediments were 225 ± 157 ng/g and 0.800 ± 0.600 ng/g. Concentrations of THg and MeHg in the mangrove plants were 1760 ± 1885 ng/g and 0.721 ± 0.470 ng/g (dry weight), respectively, which were much higher than those in terrestrial plants. Enrichment of THg in mangrove plants was different, following the order *Rhizophra apiculata* > *Rhizophora stylosa* > *Kandelia candel* > *Aegiceras corniculatum* > *Avicennia marina*; while MeHg contents in mangrove plants decreased in the order of *R. stylosa* > *K. candel* > *A. corniculatum* > *R. apiculata* > *A. marina*. There were obvious inter-species differences, regional differences, individual differences and tissue differences between THg and MeHg contents of mangrove plants, all of which were closely related to the environmental and the physiological characteristics of mangrove plants. In juvenile leaves, mature leaves and leaf litter, THg contents ranged 55.3–1760 ng/g, 204–1800 ng/g, and 385–2130 ng/g (dry weight), respectively; MeHg contents ranged 0.17–2.39 ng/g, 0.01–1.28 ng/g, and 0.13–1.47 ng/g (dry weight), respectively. Except for *A. corniculatum* and *Bruguier gymnorrhiza*, THg content of mature leaves was always higher than that in juvenile leaves, but MeHg showed a contrasting trend. THg content of litter leaves was between that of juvenile leaves and mature leaves, while MeHg content was generally lower than that of juvenile leaves and mature leaves. In the mangrove ecosystem, Hg enrichment contributed by the litterfall decreased in the order of *K. candel* > *A. corniculatum* > *A. marina*.

1. Introduction

Mercury is a contaminant of great concern, and can, in soil, sediment and water, be converted to gaseous Hg (Schroeder and Munthe, 1998). Several plants and plant parts have been used as biomonitors such as lichens, broom, pine needles (Barghigiani and Bauleo, 1992) and black spruce (Zhang et al., 1995). Enhancement of Hg concentrations in ecosystem is attributed to plant absorption through roots and leaves (Ferrara et al., 1991; Barghigiani et al., 1991; Grigal, 2002). Plants play an important role in the biogeochemical cycle of Hg (Guentzela et al., 1998; Hanson et al., 1995). Plant uptake is dependent upon plant species and age, as well as atmospheric Hg concentrations (Ferrara et al., 1991). Obvious differences in Hg uptake can be found among plant species and tissues. Undoubtedly plants have the potential to contribute substantial Hg to the food web through decomposition of litterfall.

Mangroves provide breeding and feeding habitats for various organisms through litterfall (Lin and Fu, 1995; Lin, 1997). Mangrove swamps differ from the surrounding wetlands and possess special properties such as high salinity, high S content, abundant organic matter and acids because of biogenic alteration (Lin and Lin, 2001). Due to tidal cycling and waterlogging, Hg is released from remnants of mangrove plants through anaerobic decomposition (Liu and Ding, 2007; St. Louis et al., 1994). Even though present in trace quantities in water or sediment, Hg and Hg compounds, especially methylmercury (MeHg), show a marked tendency to bioaccumulate in organisms, particularly in fish (Ouddane et al., 2008), and can harm human beings through the food web (Driscoll et al., 1994; St. Louis et al., 1994). A number of studies have been carried out in mangrove ecosystems. Zheng and his colleagues have investigated cycling of C, H, N and metals in mangrove

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ecosystems (Zheng and Lin, 1996a,b; Zheng et al., 1995a,b,c, 1996a,b,c). Zheng et al. (1998) reported seasonal variation of litterfall of *K. candel* mangrove, and Wang et al. (1997) studied changes of metals in mangrove leaves; Ding et al. (2009) studied the distribution and speciation of Hg in mangrove sediments, but no work has dealt with Hg in mangrove plants. The aim of this study was to examine contents of Hg and MeHg in mangrove plants and to discuss the distribution of Hg and MeHg during leaf aging, and the contribution of litterfall to Hg accumulation in the mangrove ecosystem.

2. Material and methods

Chinese mangrove swamps are mainly located on the coast of The Northern Gulf and the coast of Hainan Island. The study areas include Dongzhaigang Mangrove National Reserve, Sanya Mangrove Provincial Reserve (Hainan Province), Shenzhen Mangrove National Reserve, Zhanjiang Mangrove National Reserve (Guangdong Province), Daguanshan Mangrove Provincial Reserve (Guangxi Autonomous Regions), and Fugong Mangrove Provincial Reserve (Fujian Province) (Fig. 1). Thirty-nine samples of mangrove plants and six samples of sediments were collected in July and August, 2008. In the mean time, concentrations of atmospheric Hg were also determined in six areas. In each area, surficial sediments (0–20 cm), roots, stems, and leaves of mangrove plants were hand sampled during low tide. Some leaves of different ages (juvenile leaves, mature leaves and litter leaves) were collected to study changes of Hg content of leaves in growing season. Litter leaves that fell naturally and remained fresh were chosen. All samples were put into clean plastic bags and transported in an ice box to the laboratory. A fraction of fresh sediment sample was separated to determine the MeHg content. Next, the sediment samples were air dried and weighed. All plant samples were washed thoroughly with double distilled water, and dried at 60 °C. Then, the samples were ground with an agate mortar and sieved with a 100-mesh sieve.

Atmospheric Hg was pre-enrichment with Au-coated quartz sand in the mangrove forest (Tang et al., 2007), and determined with a ZYG-II cold vapor atomic fluorescence spectrometer (CVAFS). The sediment samples were digested with HNO_3–H_2SO_4–$KMnO_4$ (Ding and Wang, 2003), and plant samples were digested with HNO_3–HCl (3:1 v/v)-$HClO_4$ (Li, 2008). Total Hg was measured with a CVAAS. Methyl-Hg was determined with a GC–CAAFS (He et al., 2004; Qiu et al., 2005). Quality control for the Hg and MeHg determinations was addressed with certified reference materials (GSD-3; IAEA356) and blind duplicates. Limits of determination were 0.01 ng/g for THg and 0.003 ng/g for MeHg in sediment samples, respectively. The average THg concentration of the geological reference material GSD-3 was 0.016 ng/g ($n = 5$), which is comparable with the certified value of 0.018 ± 0.002 ng/g. An average MeHg concentration of 5.56 ± 0.54 ng/g ($n = 7$) was obtained for IAEA356 which has a certified value of 5.4 ± 0.89 ng/g. The percentage of recoveries on spiked samples ranged from 95.5% to 118.8% for methyl-Hg in sediment samples. All measurements were replicated three times and the results were calculated on an air-dried basis for sediment samples and a dry basis for plant samples. All data were analyzed using SPSS 16.0 for Windows.

3. Result and discussion

3.1. THg and MeHg concentrations in mangrove plants

Concentrations of THg and MeHg in different mangrove tissues and sediments are given in Table 1. For the whole plant, THg concentrations of the mangrove plants ranged from 462 to 3120 ng/g (dry weight) and the average value was 1760 ng/g (dry weight); while MeHg concentrations of the mangrove plants ranged from 0.222 to 1.76 ng/g (dry weight) and the average value was 0.721 ng/g (dry weight). Generally, THg contents of terrestrial plants range from 10 to 50 ng/g, and the average is 24 ng/g (Barghigiani et al., 1991; Ferrara et al., 1991; Rasmussen et al., 1991; Moore et al., 1995; Lindberg, 1996; Fleck et al., 1999; Grigal, 2002). The concentrations of THg in mangrove plants were greater than those in terrestrial plants.

Concentration of THg and MeHg in mangrove sediment was 225 ± 157 ng/g and 0.800 ± 0.600 ng/g (Table 2). THg is much

Fig. 1. Study areas.

Table 1
Contents of THg and MeHg in several mangrove species (ng/g).

Area	Mangrove species[a]	Root		Stem		Leaf		Whole plant		Note
		THg	MeHg	THg	MeHg	THg	MeHg	THg	MeHg	
Sanya	*Rhizophra apiculata* (2)	4300	0.619	3610	0.389	1430	0.322	3120	0.443	Salt-excluding
Dongzhaigang	*Avicennia marina* (1)	703	0.175	2250	0.283	587	0.209	1180	0.222	Salt-secreting
Daguansha	*Avicennia marina* (5)	106	0.274	728	0.326	551	0.690	462	0.430	Salt-secreting
Shenzhen	*Kandelia candel* (2)	–	–	2780	1.180	1440	0.573	2110	0.879	Salt-excluding
	Avicennia marina (1)	–	–	1620	0.553	1990	0.720	1810	0.637	Salt-secreting
Fugong	*Kandelia candel* (2)	2170	1.140	2960	1.370	663	0.095	1810	0.838	Salt-excluding
	Aegiceras corniculatum (2)	1460	0.285	1290	0.672	998	0.743	1250	0.567	Salt-secreting
	Rhizophora stylosa (1)	2380	1.490	2890	2.860	1760	0.915	2340	1.760	Salt-excluding
Average		1850	0.664	2270	0.954	1180	0.533	1760	0.721	
SD		1450	0.500	1860	0.866	1260	0.291	1880	0.470	

– Indicates no sample.
[a] Numbers in brackets = number of samples.

Table 2
Contents of THg and MeHg in sediments and the air of the study areas.

Area	Sediment		Atmospheric Hg (ng/m^3)	Reference
	THg (ng/g)	MeHg (ng/g)		
Sanya	165	0.241	61.4	This paper
Dongzhaigang	314	0.582	86.0	This paper
Daguansha	26.1	1.86	86.0	This paper
Shenzhen	180	0.854	62.0	This paper
Fugong	438	0.467	67.5	This paper
Average	225	0.800	72.5	This paper
SD	157	0.600	12.5	This paper
Scheldt Estuary			1.06–8.86	Leermakers (1998)
Sweden			1.5–4.0	Lindqvist et al. (1991)
Global			1.6	Lamborg et al. (2002)
Huangshi, China			4–1257	Li et al. (2005)

higher than the average value of Hg in sediments of the China shelf sea (25 ng/g; Zhao and Yan, 1994). The atmospheric Hg was up to 72.5 ± 12.5 ng/m^3, which is higher than that in other places, but lower than that in Huangshi city, China. Determination of atmospheric Hg only once cannot give an absolute value but does reflect high atmospheric Hg in the mangrove ecosystem (Table 2).

Aquatic plants appear to be quite successful in accumulating Hg (Zillioux et al., 1993). Their special physiological structures are the main reason for the high levels of Hg in the mangrove plants. Compared with terrestrial plants, one distinct characteristic of mangrove leaves is that periclinal walls of epidermal cells are surrounded with continuous thick keratose layers (Li and Lin, 2006). The keratose layers are helpful in preventing water loss and Hg emission from the leaves. In addition, mangrove plants have very well-developed root systems, and contaminants absorbed by roots can enter through the stelar cells of the roots, and translocate to the aboveground parts.

Obvious interspecies differences in Hg contents could be found in the mangrove plants. The contents of THg and MeHg in the whole plant were 1150 ng/g and 0.430 ng/g for *A. marina*, 1960 ng/g and 0.859 ng/g for *K. candel*, 3120 ng/g and 0.443 ng/g for *R. apiculata*, 1250 ng/g and 0.567 ng/g for *A. corniculatum* and 2340 ng/g and 1.76 ng/g for *Rhizophora stylosa*. Enrichment of THg in mangrove plants is different, following the order of *R. apiculata* > *R. stylosa* > *K. candel* > *A. corniculatum* > *A. marina*; while MeHg contents in mangrove plants decreased in the order of *R. stylosa* > *K. candel* > *A. corniculatum* > *R. apiculata* > *A. marina*. As a pioneer plant, *A. marina* grows on the foreshore, while *K. candel* is distributes in the middle of intertidal zone; then *A. corniculatum* occurs at the back of the intertidal zone. From sea to land, the mangrove in China usually occurs in the order of *A. marina*, *K. candel*, *A. corniculatum*, *R. apiculata* and *R. stylosa*. Different mangrove plants are stressed with different salinity and waterlogging time, which is one important reason why mangrove plants have obvious differences in Hg contents. Liu et al. (2004) found similar result in Sanjiang Plain.

A significant regional difference in contents of THg and MeHg was found among individuals of the same species of mangrove plant (Fig. 2). Total Hg contents of *A. marina* decreased in the order Dongzhaigang (1180 ng/g) > Daguansha (462 ng/g), while the MeHg contents were exactly the opposite and in the order Daguansha (0.430 ng/g) > Dongzhaigang (0.222 ng/g). The THg and MeHg concentrations of *K. candel* in Shenzhen were greater than that in Fugong. The result also showed that plants have a great influence on the THg concentrations of sediments. Different plant communities corresponded to different Hg concentrations in sediments.

In addition to interspecies difference and regional difference, the contents of THg and MeHg in different tissues of the same species varied greatly (Table 1). This may be due to different physiological features of plant tissues, and the speciation of Hg in the environment (Liao, 1989; Liu et al., 2004). For *A. marina, K. candel* and *R. stylosa*, THg content decreased in the order stem > root > leaf; but, for *A. corniculatum* and *R. apiculata*, the highest THg content was recorded in the root, followed by the stem and leaf. Methyl-Hg content decreased in the order of leaf > stem > root in *A. marina* and *A. corniculatum*, *while K. candel* and *R. stylosacandelas* showed a slightly different pattern, following the order stem > root > leaf. The highest content of MeHg in *R. apiculata* was detected in the root, followed by the stem and the leaf. Enrichment of Hg in mangrove tissues is different from terrestrial plants'. Liu et al. (2004) found that THg concentrations of plants from freshwater wetlands had the characteristics of root > stem > leaf. Ding et al. (2007)

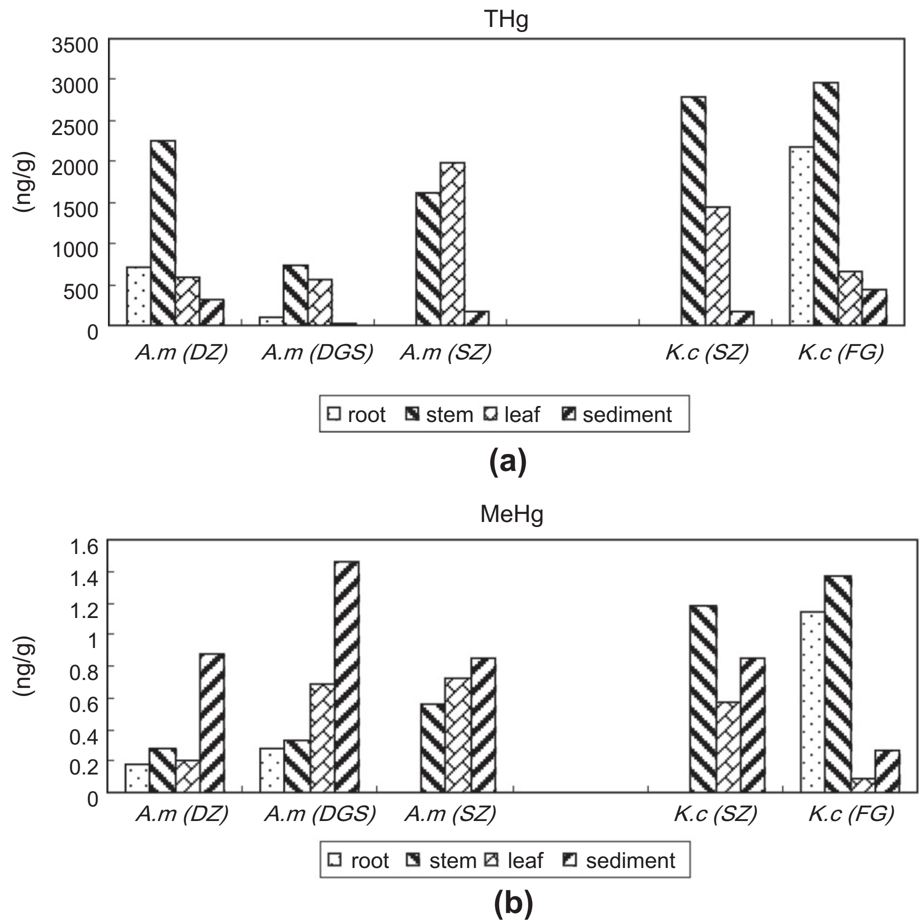

Fig. 2. Concentrations of THg (a) and MeHg (b) in different tissues of *Avicennia marina* and *Kandelia candel*. *A. m* indicates *Avicennia marina; K. c* indicates *Kandelia candel*. DZ, DGS, SZ indicate Dongzhaigang, Daguansha and Shenzhen.

found that THg concentrations decreased in the order of leaf > root > stem in plants from a landfill. With developed root systems, especially breathing roots and aerial roots which have plenty of lenticel, mangrove plants can assimilate Hg from sediment and water during the flow phase, as well as from air during the ebb phase. Because of strong resistance in roots and other parts, some researchers have suggested that Hg absorbed by the root had difficulty in migrating to other parts (Schwesig and Krebs, 2003; Patra and Sharma, 2000). However, others have suggested that Hg was transferred from roots to other tissues (Gaggi et al., 1991; Bishop and Lee, 1998; Todal et al., 1998). How Hg absorbed by roots and leaves is transferred between different parts of plants is unknown with any certainty.

With one methyl group, MeHg combines easily with a sulfhydryl group (–SH) of protein, and enters into cells by symplastic transport. So, compared to inorganic Hg, MeHg migrates more easily between different tissues of plants. Therefore, it is difficult to judge how much MeHg in the plant has come directly from the environment and how much is formed in situ, however, it is undoubted that MeHg in plant results of both sources.

The ratio of MeHg to THg (%MeHg) represents the fraction of THg potentially available for conversion to MeHg and thus reflects the degree of Hg methylation (Sunderland et al., 2006). Usually, the MeHg content of plant tissue is thought to be low (1–2% of THg; Grigal, 2002; Ericksen et al., 2003). Percentages of MeHg in different tissues of mangrove plants are listed in Table 3. The concentration of MeHg was very low in sediments and possibly indicates that methylation of Hg in plants, in vivo, makes negligible contribution to the environment.

Mercury contents of various tissues in mangrove plants are related to their physiological characteristics, especially towards salt. For example, (Fig. 3), THg was mainly concentrated in roots and stems of mangrove plants in Fugong, but THg concentration of leaves was near that of roots and stems in *A. corniculatum*, while THg concentrations of leaves were much lower than those of roots and stems in *K. candel* and *R. stylosa*. *K. candel* and *R. stylosa* are salt-excluding plants, while *A. corniculatum* is a salt-excreting plant. In addition, THg and MeHg concentrations of *A. corniculatum* were much lower than those of *K. candel* and *R. stylosa*. Methyl-Hg can be transferred to leaves through salt glands of salt-excreting plants, but it is hard for salt-excluding plants to transfer MeHg from roots to leaves. The same result was also reported by Kraus et al. (1986), who found that Hg in plants can be excreted into the environment through salt glands.

3.2. Changes of Hg contents during aging of leaves

Leaves of mangrove plants are major ingredients of litterfall and food resources of the aquatic system (Wang, 1997). Enrichment of Hg in leaves is the main source for Hg entry into the food chain. Contents of THg and MeHg in juvenile leaves, mature leaves and litter of mangrove plants are listed in Table 4. In juvenile leaves, mature leaves and litter leaves, THg concentrations ranged through 55.3–1755.8 ng/g, 203.7–1800.6 ng/g, and 384.7–2131.6 ng/g (dry weight), respectively; MeHg concentrations ranged through 0.17–2.39 ng/g, 0.01–1.28 ng/g, and 0.13–1.47 ng/g (dry weight) respectively.

Table 3
MeHg in different tissues of mangrove plants (%).

Area	Mangrove species	Root	Stem	Leaf	Sediment	Whole plant
Sanya	*Rhizophra apiculata*	0.0144	0.0108	0.0225	0.146	0.0142
Dongzhaigang	*Avicennia marina*	0.0249	0.0126	0.0356	0.185	0.0188
Daguansha	*Avicennia marina*	0.258	0.0448	0.125	7.12	0.0932
Shenzhen	*Kandelia candel*	–	0.0426	0.0397	0.475	0.0416
	Avicennia marina	–	0.0341	0.0361		
Fugong	*Kandelia candel*	0.0526	0.0462	0.0143	0.107	0.0462
	Aegiceras corniculatum	0.0195	0.0521	0.0744		
	Rhizophora stylosa	0.0628	0.0988	0.0521		

– Indicates no sample.

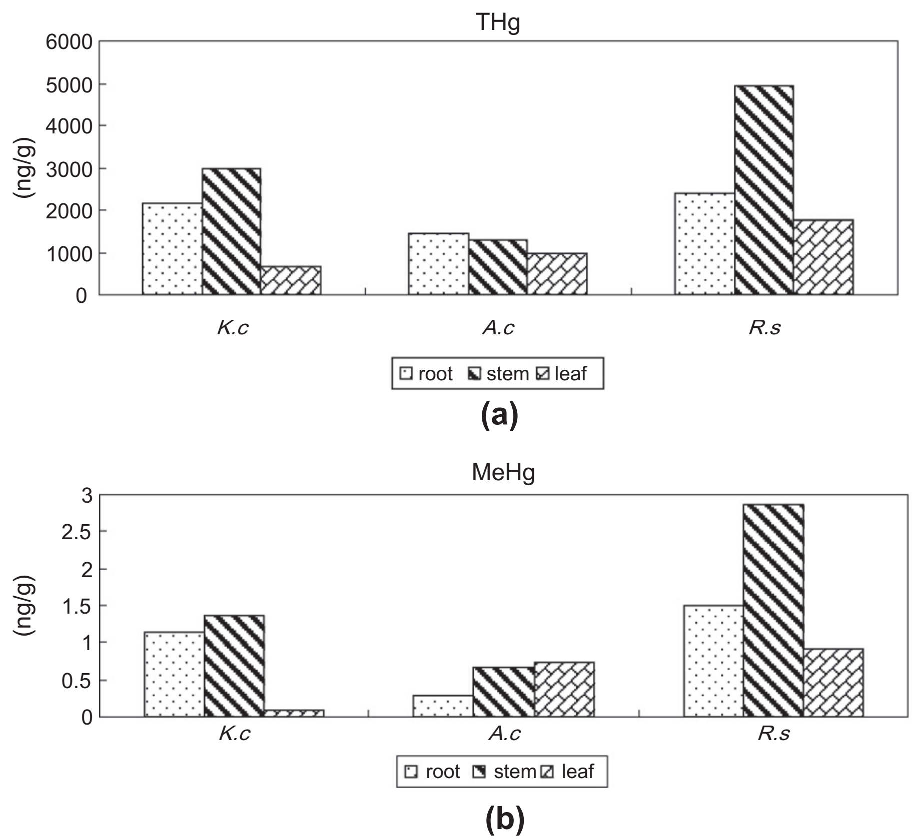

Fig. 3. Contents of THg (a) and MeHg (b) in different mangrove species from Fugong. *K. c*, *A. c* and *R. S* indicate *Kandelia candel*, *Aegiceras corniculatum* and *Rhizophra stylosa*.

Table 4
Concentrations of THg and MeHg in mangrove leaves of different age.

Area	Mangrove species	THg (ng/g)			MeHg (ng/g)		
		Juvenile	Mature	Litter	Juvenile	Mature	Litter
Dongzhaigang	*Acanthus ilicifolius (1)*	119	346	–	0.87	1.05	–
	Sonneratia apetala (2)	229	261	–	0.90	0.01	–
	B.Sexangula (3)	288	804	385	0.46	1.18	0.19
	B.s. var. rhynochopetala (2)	155	345	419	0.32	0.13	0.29
	Laguncularia racemosa (2)	55.3	204	–	0.49	0.99	–
Zhanjiang	*Aegiceras corniculatum (2)*	1270	825	860	1.46	1.05	0.37
	Kandelia candel (3)	431	662	511	0.17	0.23	0.23
	Excoecaria agallocha (3)	427	611	598	0.96	0.16	0.13
	Bruguiera gymnorrhiza (2)	1760	645	614	2.39	1.28	0.21
	Avicennia marina (3)	527	1800	2130	0.64	1.09	0.49
Daguansha	*Avicennia marina (5)*	218	394	415	1.77	0.42	1.06

Numbers in brackets = number of samples; – indicates no sample.

Table 5
Hg contribution from litter of different mangrove species (μg/m^2 a).

Area	Plant	Litterfall (g)[a]		Hg contribution		Sediment	Reference
		Leaf	Stem	THg	MeHg	THg (μg/g)	
Zhanjiang	*Aegiceras corniculatum*	60.2	14.4	93.2	0.032	0.112	Zheng et al. (1995b)
	Kandelia candel	643	142	569	0.330	0.405	Zheng et al. (1995a)
	Avicennia marina	56.2	76.6	321	0.062	0.047	Zheng and Lin (1996a)
Daguansha	*Avicennia marina*	56.2	76.6	60.5	0.085	0.026	Zheng and Lin (1996a)

[a] Data from references quoted.

Except for *A. corniculatum* and *Bruguiera gymnorrhiza*, THg concentrations in mature leaves was higher than in juvenile leaves. But the case of MeHg was more complicated. MeHg concentrations in juvenile leaves of *Acanthus ilicifolius*, *Bruguiera sexangula*, *Laguncularia racemosa* and *K. candel* were lower than in mature leaves. In contrast to the above-mentioned plants, MeHg concentrations in juvenile leaves of *Sonneratia apetala*, *B. sexangula var. rhynchopetala*, *A. corniculatum, Excoecaria agallocha, Bruguiera gymnorhiza*, and *A. marina* were higher than in mature leaves. In general, THg levels in litter leaves were between those in juvenile leaves and mature leaves, but, MeHg levels in litter leaves were lower than juvenile leaves and mature leaves.

Changes of THg concentration in mangrove leaves were similar to those of terrestrial plants. Leaves are the tissues with the highest contents of THg in sorghum, beans, sweet potatoes and rice (Chen, 1994; Chen et al., 1999). THg content increased gradually from juvenile leaves to mature leaves (Chen, 1994; Jiang et al., 1995). Rasmussen (1995) reported a significant increase in the Hg content of needles of *Abies balsamea* and *Picea glauca* over the course of a growing season: Hg content increased from 5 to 125 ng/g. The THg content of leaf tissue was shown to increase approximately 10-fold over the growing season for *Betula alleghaniensis*, *Acer saccharum*, and *Fagus grandifolia* (Bushey et al., 2008).

Enrichment of Hg in leaves increased with aging. Leaves are the most active metabolic tissues in which organic matter is synthesized. Assimilated by the root, elements enter into root xylem vessels, and are then transported to leaves with the transpiration stream, and accumulate in leaves (Lin et al., 2000). During the aging process, nutrients in leaves are transferred to roots, stems and new leaves (Wang and Lin, 1999). Mercury may be transferred and re-assigned with nutrients. Transpiration and respiration are the main driving forces for element transport in plants.

Besides the physiological characteristics of plants, levels of THg and MeHg in leaves were affected by Hg levels in the sediments and in the air. Even in the same species such as *A. marina*, the contents of THg and MeHg changed greatly in juvenile leaves, mature leaves and litter leaves in different areas, which showed an apparently regional distinction.

The Hg concentration of litter leaves is dependent on Hg exchange between litter and the environment (Liu et al., 2005). With decomposition of the organic matter, Hg in litter is lost. On the other hand, Hg in the water of wetlands is absorbed by litter (Zhuang and Lin, 1992). Therefore, the Hg concentration in litter is in a homeostasis and reflects environmental conditions.

3.3. Implication for Hg enrichment in mangrove ecosystem

Plants are considered a net sink for atmospheric Hg (Ericksen et al., 2003). Litterfall has been recognized as the most important pathway of Hg inputs to forest systems from atmospheric Hg (St. Louis et al., 2001; Frescholtz and Gustin, 2004; Millhollen et al., 2006; Driscoll et al., 2007). In many places, it ranges from 52% to 60% of the total input. Lindberg et al. (2004) estimated the global flux of Hg in litterfall to be around 2400–6000 Mg/a. Using data acquired from the quantity of litterfall, the Hg input of litterfall was calculated for three species of mangrove plants; results are presented in Table 5. The three species of mangrove plants are *A. corniculatum, K. candel* and *A. marinam*. The contribution of litterfall to Hg accumulation in the ecosystem is based on the amount of litterfall and its Hg contents. In different areas, even for the same species, such as *A. marina*, contributions changed greatly due to different Hg contents.

With abundant litterfall, the Hg input of *K. candel* was highest, and its contribution to Hg accumulation in the ecosystem was also the largest. Contributions of *A. corniculatum and A. marina* were relatively small. By not taking account of the contribution of other litterfall such as fruit, flowers etc., the real input of Hg to the ecosystem through litter will, in fact, be higher than the calculated values in this paper. As a result, litterfall is an important factor which affects sediment Hg level.

4. Summary

Concentrations of THg and MeHg showed wide ranges in several mangrove plants. Total Hg and MeHg concentrations of the mangrove plants were in the range of 462–3120 ng/g, 0.222–1.76 ng/g, with a mean value of 1760 ng/g and 0.721 ng/g, respectively. The capacity for mangrove plants to assimilate THg decreased in the order of *R. apiculata* > *R. stylosa* ≫ *K. candel* > *A. corniculatum* > *A. marina*; but the MeHg concentrations decreased in the order of *R. stylosa* > *K. candel* > *A. corniculatum* > *R. apiculata* > *A. marina*. The particular physiological structure causes high Hg levels in mangrove plants. Total Hg and MeHg contents in mangroves showed obvious variation in species, regional, individual plants and organic matter. This is closely related to the environmental and physiological characteristics of mangrove plants. In plant tissues, the ratio of Hg methylation is very low; methylation in vivo for plants is negligible in terms of impact on the environment.

Except for *A. corniculatum* and *B. gymnorrhiza*, THg contents in mature leaves was always higher than that in juvenile leaves, but MeHg showed the opposite trend. THg content of litter leaves was between that of juvenile leaves and mature leaves, while the MeHg level was generally lower than that of juvenile leaves and mature leaves. For the same species, different habitats led to the regional differences of THg and MeHg levels in juvenile, mature and litter leaves. In the mangrove ecosystem, Hg input contributed by the litterfall was in the order *K. candel* > *A. corniculatum* > *A. marina*.

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