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Mercury Distribution and Accumulation in Typical Wetland Ecosystems of Sanjiang Plain, Northeast China

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Abstract: Total mercury in soil, water, plant, insects, fishes and bird feathers were determined to study mercury distribution and accumulation in typical wetland ecosystems in the Sanjiang Plain, Northeast China. Results show that total mercury concentrations in soils of *Deyeuxia angustifolia* wetland and *Carex lascarpa* wetland are 0.046 mg/kg and 0.063 mg/kg, respectively. Total mercury concentration in water bodies is 0.053 μg/L on average. Of four plants studied, total mercury in moss is the highest with the mean of 0.132 mg/kg. Of 10 terrestrial insect species studied, total mercury in centipede (*Scolopendra* spp.) is the highest with the mean of 0.515 mg/kg while total mercury in grasshopper (*Oxya* spp.) bodies is the lowest. Total mercury concentrations in the herbivorous, omnivorous and predatory insects are 10.18 ng/g, 16.47 ng/g and 213.35 ng/g on average, respectively. Total mercury concentrations of the adult feather (549.88 ± 63.04 ng/g), nestling feather (55.15 ± 23.53 ng/g), and eggshell (22.05 ± 5.96 ng/g) of the Grey heron (Ardea cinerea) are higher than those of the Great egret (Egretta alba) (adult feather: 446.57 ± 90.89 ng/g; nestling feather: 32.99 ± 17.15 ng/g; eggshell: 21.02 ± 3.17 ng/g) in the wetlands of the Sanjiang Plain. The bioconcentration factors decrease in the order of piscivorous fish muscle > omnivorous fish muscle > herbivorous fish > insect.

Keywords: mercury; soil; plant; insect; fish; waterbird; bioconcentration; Sanjiang Plain; Northeast China

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1 Introduction

Mercury (Hg) is a common pollutant in wetlands of some remote regions without any history of an identifiable Hg point-source (Heath and Frederick, 2005). Hg in wetlands comes mainly from atmospheric deposition (Liu *et al.*, 2002a). Hg deposition has increased 1.5–3.0 times since the worldwide industrial revolution, and Asia is the most seriously affected area of atmospheric Hg pollution (Pirrone *et al.*, 1996; Pirrone, 2001). The results of previous studies show that wetlands are active pools of Hg and are the sources of methylmercury to the ambient environment (Paterson *et al.*, 1998; Wang *et al.*, 2002; Sunderland *et al.*, 2004). Hg in soil and plant is released when organic matters decompose underwater. The released Hg then accumulates along the food chain, and then threats health of wildlife and human beings (Paterson *et al.*, 1998; Wang *et al.*, 2002; Sunderland *et al.*, 2004). There are many researches about mercury transport and fate in wetlands polluted by mercury (Zhang *et al.*, 2009).

Although efforts have been made to understand Hg cycling in the wetlands (Garcia *et al.*, 2006), it is not fully understood how elevated Hg in waterbird accumulated from background THg in environmental media. Hg in sediment and water is generally considered to be mo-

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bile and bioavailable (Ravichandran, 2004). The classic wetland food web composed of plant, insect, fish and waterbird. The distribution of Hg among different ecosystem compartments critically influences Hg fate and bioaccumulation in the food web (Liu *et al.*, 2008).

Researchers have found that Hg concentrations in animals such as predatory fish and waterfowls occupying higher trophic levels in the aquatic food chain increased obviously (Ayas, 2007; Houserova *et al.*, 2007; Ferreira, 2010). The studies on Hg accumulation in seabirds are more abundant than those in inland waterbirds (Kim *et al.*, 1996; Gray, 2002; Savinov *et al.*, 2003). Heron species, common in inland wetlands, have always been used as bio-indicators of Hg exposure (Ayas, 2007; Ferreira, 2010). Metals in animal bodies may be incorporated in hard tissues such as eggshells, chitin, bones, feathers and fur. This incorporation may be the potential protective mechanism of such animals against metal poisoning because the metabolism process in feathers, fur, and corneous skins are often weaker than in other tissues (Hare, 1992; Hendriks and Heikens, 2001). Feathers are more closely related with accumulated Hg than other tissues, and collecting sample feathers cause no injury (Spalding *et al.*, 2000). The Grey heron (*Ardea cinerea*) and Great egret (*Egretta alba*) are common summer residents in the Sanjiang Plain. However, little research has been done on mercury accumulation in these two birds in the Sanjiang Plain. The results of this study will reflect the mercury pollution and possible risk of mercury exposure to local people in the Sanjiang Plain as the local people and these two birds both feed on the fish in the wetlands.

Mercury distribution among compartments in the wetlands and the implications of this distribution on Hg fate are not fully understood (National Research Council Committee on Restoration of Greater Everglades Ecosystem, 2005). In this paper, we estimated Hg distribution and accumulation in soil, water, plant, insects, fish and birds of the Sanjiang Plain. The results of this study could be applicable for other wetlands on interpreting Hg cycling and bioaccumulation in wetland ecosystems without mercury pollutant source.

2 Materials and Methods

2.1 Study area

The Sanjiang Plain is located in the east of Heilongjang Province, China (Fig. 1), where the Songhua River, the Heilong River and the Wusuli River are confluent in a vast alluvial floodplain. It is one of the largest areas for freshwater marshes in China and an important stopover and breeding site for waterbirds in Northeast Asia. *Deyeuxia angustifolia* and *Carex lascarpa* are typical vegetation in the Sanjiang Plain. Most wetlands in the plain have been reclaimed into arable farmlands since the 1950s. Wetland areas have decreased from 5 340 000 ha in 1949 to 1 349 000 ha in 2000 (Liu, 2005). Therefore, the Sanjiang Plain is also one of the most important commodity grain base in China. As an Hg sink, wetlands have become an Hg source following the reclamation of the Sanjiang Plain (Liu *et al.*, 2002b). The Qixinghe National Nature Reserve is located at the cen-

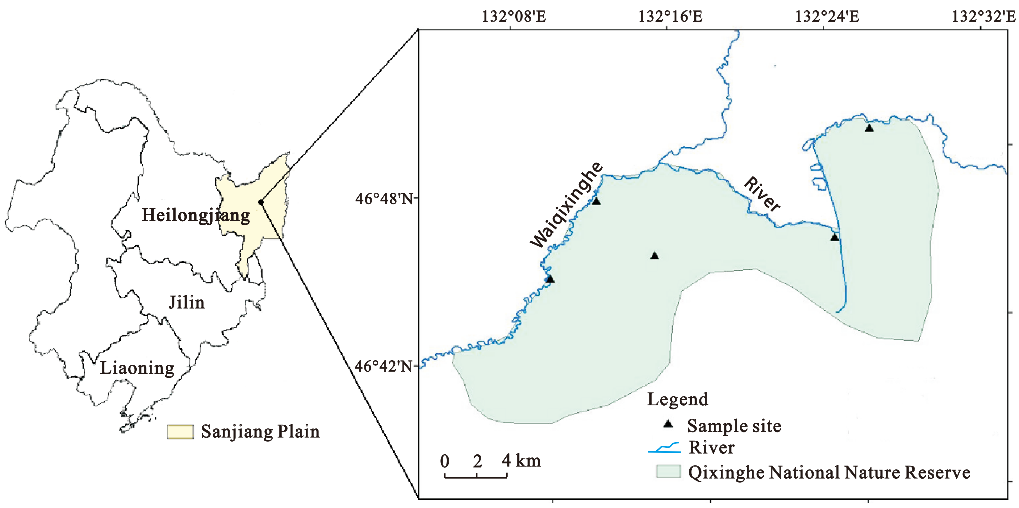


Fig. 1 Location of study area and sampling sites in Qixinghe National Nature Reserve, Sanjiang Plain

ter of the Sanjiang Plain. There are 15 fish species and 60 bird species (summer resident) in this reserve, and they constitute complex food chains in the wetlands. Therefore, in this study we selected the Qixinghe National Nature Reserve as the study area and analyzed the total mercury distribution among the compartments in the wetlands.

2.2 Methodology

2.2.1 Sample collection and preparation

In the five breeding sites (Sampling sites in Fig. 1) of the Grey heron and Great egret, soil, plant and terrestrial insect samples were collected in typical in August, 2010. Soil profile was 30 cm depth with three replications in each site. Soil cores were sectioned into 2 cm increments in the field and sealed in polyethylene bags. Plant collected including *Deyeuxia angustifolia*, *Carex lascarpa*, *Carex meyeriana* and moss, which are the predominant species in the Sanjiang Plain. Plant samples were sealed in paper bags, and then brougnt back to laboratory. Ten terrestrial insect species were collected by the method of pit fall traps, including ground beetle, fly, moth, grasshopper, wasp, ant, longicorn, cricket, spider and centipede. Biological samples were washed by water in field, sealed in polyethylene bags, and then preserved in a vehicle refrigerator at 4℃.

Water samples were collected from rice field (RF), *Carex lascarpa* wetland (CW), fishpond (FP), pond (P) and some pools near to the *Deyeuxia angustifolia* wetland (PD). Water samples firstly passed through a 0.45 μm filter membrance, and then pH was adjusted to 2 using HNO_3 (12 mol/L) in field immediately. Water samples were preserved in a vehicle refrigerator at 4℃ and analyzed within 48 h.

A mixed colony of Grey herons and Great egrets were found in June 2008. Feathers were collected from around 15-day-old nestlings (nine Grey heron and nine Great egret) and from adult birds (six Grey herons and five Great egrets). The birds were released afterward. Additionally, five Grey heron and six Great egret eggshells were collected.

Fishes and hydrophilid were extruded from disgorged brd craws. A total of eight Crucians (*Carassius auratus*), five Amur sleepers (*Perccottus glehni*), six Amur bitterlings (*Rhodeus sericeus*), seven Loaches (*Misggurnus moloity*), and five hydrophilids (*Cybister japonicus*) were collected. Fish samples were sealed in polyethylene bags. From the same colony, the feathers, fishes, shells, and soil were all sealed in polyethylene bags and preserved in a car refrigerator at 4℃ in the field.

In the laboratory, soil was air dried after plant roots and stones were picked out. Soil was ground to pass through an 80 mesh nylon sieve and preserved in polyethylene bags before used. Plant samples were firstly washed by deionized water to remove the contaminants adhering to surface, air dried and then ground to homogeneous powders. Terrestrial insects, fish muscle (muscle from the back cut behind the head and up to the lateral line) and bird feather samples were cleaned with mild detergent and water, and then sucking the water drops on the surface of the samples using filter papers. Insect samples were oven dried to consistent weight at 50℃, ground to homogeneous powders in an agate bowl. Bird feathers were cut into 2 mm long segments using a clean stainless steel scissor. All samples were preserved in polyethylene bags before determination.

2.2.2 Digestion and analysis

Soil, plant, feathers, fish muscles, and insects were digested using H_2SO_4-HNO_3-V_2O_5, and the eggshells were digested with HNO_3. The Hg in all the samples were converted into Hg^{2+}, and then reduced to elemental Hg by adding 20% $SnCl_2$ solution. This procedure was performed for Hg analysis by using Cold Vapor Atomic Absorption spectrophotometer (Model F-732, Jintan, China; detection limit is 0.05 ng/mL). In this study, total Hg concentrations in soil, plant, terrestrial insects, eggshells and bird feathers were on dry weight base, while the concentrations of total Hg in fish and hydrophilids were on wet weigh base in order to study mercury transfer from water to fish.

For determining total Hg concentration in water, 40 mL of water samples, 1.5 mL of HNO_3, and 2.0 mL of brominating agent were mixed in a 50 mL volumetric flask. After oxidation for 30 min at room temperature, a drop of 20% $NH_2OH{\cdot}HCl$ was added to reduce the residual brominating agent before it was analyzed by using cold vapor atomic fluorescence spectrophotometry (Tekran-2600, Tekran inc., Canada; detection limit is 5×10^{-3} ng/mL).

Blank samples were included in the analysis. A blank sample in each batch and 5%–10% of the samples were analyzed in duplicate to ensure good reproducibility. A standard reference material of human hair (GBW-07601) was carried through the digestion and was analyzed as part of the quality control (accuracies within 100% ± 20%).

2.2.3 Data analysis

The bioconcentration factor (BCF) is often used to quantify the bioaccumulation of environmental pollutants in aquatic or terrestrial biota with respect to a particular medium or route of exposure (Streit, 1992; Chiou, 2002; Hsu *et al.*, 2006). In this study, total Hg concentration of water samples collected in the study area were considered as the reference value to calculate the BCF for the aquatic ecosystems. The BCF is calculated as follows:

$$BCF = C_{\text{biota}} / C_{\text{water}} \quad (1)$$

where C_{biota} and C_{water} are the total mercury concentrations in fish and insect, and water, respectively (Hsu *et al.*, 2006).

Mercury contamination level of the soil in the study area was estimated by using the index of geoaccumulation (I_{geo}) which is calculated as follows (Ji *et al.*, 2008).

$$I_{\text{geo}} = \log_2^{(C_n/1.5B_n)} \quad (2)$$

where C_n is the measured concentration of the element n in soil dust, and B_n is the geochemical background value of the element n.

SPSS 13 was used for statistical analyses. Differences among means were determined by the nonparametric Kruskall-Wallis one-way ANOVA. Differences between two independent variables were compared by the Mann-Whitney U test. A nonparametric test was used because it is best suited for small datasets. A $P < 0.05$ was considered statistically significant.

3 Results

3.1 Total mercury in soil and water

In the soil, the mean concentrations of total Hg in the depth of 0–30 cm of *Deyeuxia angustifolia* wetland and *Carex lascarpa* wetland were 0.046 mg/kg and 0.063 mg/kg, respectively. In vertical direction, mercury distribution in the two wetlands soils was not accordant with each other (Fig. 2). In *Carex lascarpa* wetland, the total mercury concentration reached the highest value in the depth of 8–10 cm, while in the profile of *Deyeuxia angustifolia* wetland it has the highest value at the depth of 2–4 cm.

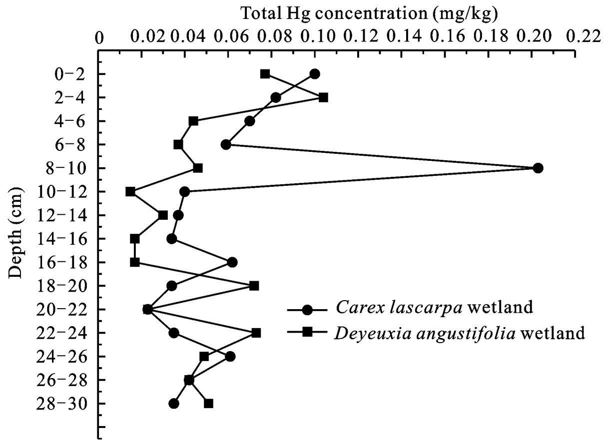
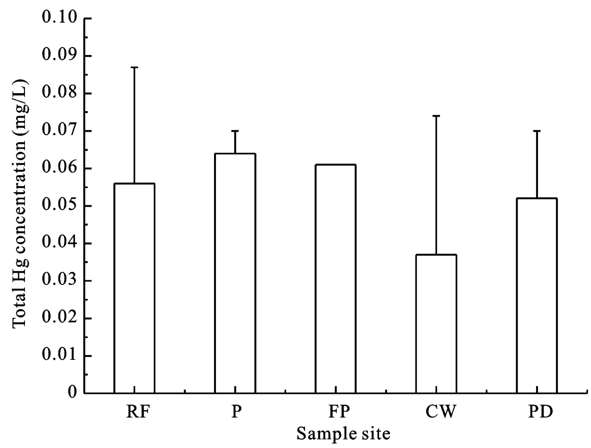


Fig. 2 Mercury distribution in soil profile in *Deyeuxia angustifolia* wetland and *Carex lascarpa* wetland

Total mercury concentration in surface water of the study area was in the range of 0.034–0.078 μg/L with the mean of 0.053 μg/L. Total mercury concentrations differed greatly among the sample sites, and showed the order of pond (P) > fishpond (FP) > rice field (RF) > some pools near to the *Deyeuxia angustifolia* wetland (PD) > *Carex lascarpa* wetland (CW) (Fig. 3).



RF, rice field; CW, *Carex lascarpa* wetland; FP, fishpond; P, pond; PD, some pools near to the *Deyeuxia angustifolia* wetland

Fig. 3 Total mercury concentration in surface water

3.2 Total mercury in plant

Total mercury concentrations in the plants of the study area were in the order of moss > *Carex meyeriana Deyeuxia angustifolia* > *Carex lascarpa* (Fig. 4). Total mercury concentration in moss was very high with the mean of 0.132 mg/kg, which was several or dozens of times than those in other plants, suggesting that moss could absorb mercury effectively from the ambient.

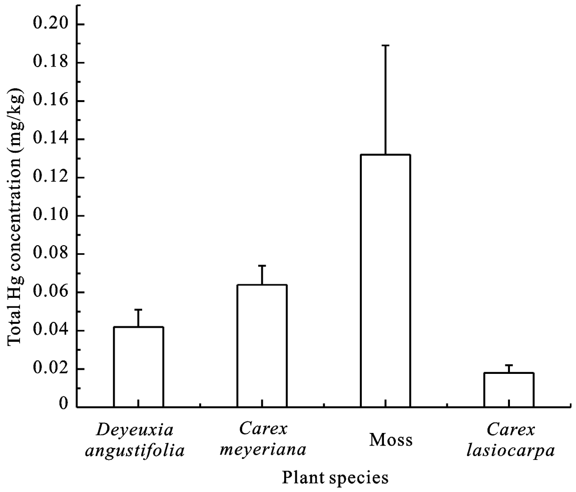


Fig. 4 Total mercury concentration in plant

3.3 Total mercury in insect

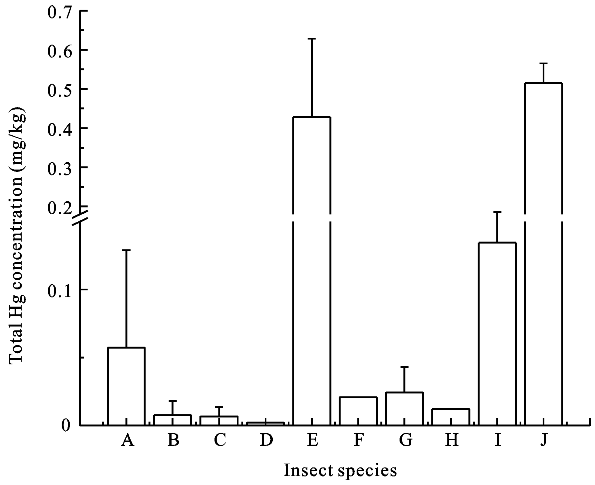
In this study, ten terrestrial insect species were studied, and total mercury concentrations in these species are shown in Fig. 5. Total mercury concentration in centipede was the highest with the mean of 0.515 mg/kg, that in wasp was the second and the mean was 0.425 mg/kg. The total mercury concentrations in spiders and ground beetles were also relatively higher, while that in grasshoppers was the lowest.

3.4 Total mercury in fish

In the Qixinghe National Nature Reserve, the four dominant fish species are Crucians, Amur sleepers, Amur bitterlings, and Loaches. These fishes are also the main foods of Grey heron and Great egret. During the present study, the body lengths of the fishes which the two birds prey on were in the range of 6.24–22.70 cm, and the sizes may be more suitable for feeding nestlings. Crucians had the longest average body length (14.9 ± 5.48 cm). The average body lengths of the Amur sleepers, Amur bitterlings, and Loaches were 11.54 ± 4.19 cm, 8.38 ± 1.27 cm, and 12.48 ± 3.67 cm, respectively. The total mercury concentrations of the four fish muscles differed significantly among the species (Krushall–Wallis one-way ANOVA, $P < 0.01$). The ranking of the total mercury concentrations was Amur sleepers > Amur bitterlings > Crucian > Loaches (Fig. 6).

3.5 Total mercury in feather and eggshell of waterbirds

For both Grey heron and Great egret, the total mercury concentrations in adult feathers were the highest, and they were approximately ten times of that in the nestling's feathers, respectively (Fig. 7). Total mercury



A, ground beetle; B, fly; C, moth; D, grasshopper; E, wasp; F, ant; G, longicorn; H, cricket; I, spider; J, centipede

Fig. 5 Total mercury concentration in insect

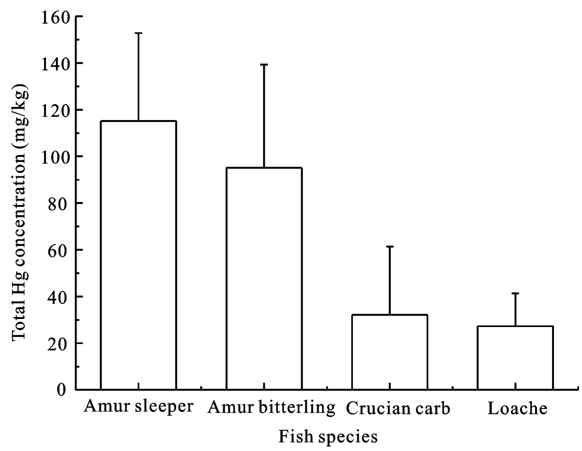


Fig. 6 Total mercury concentration in fish muscle

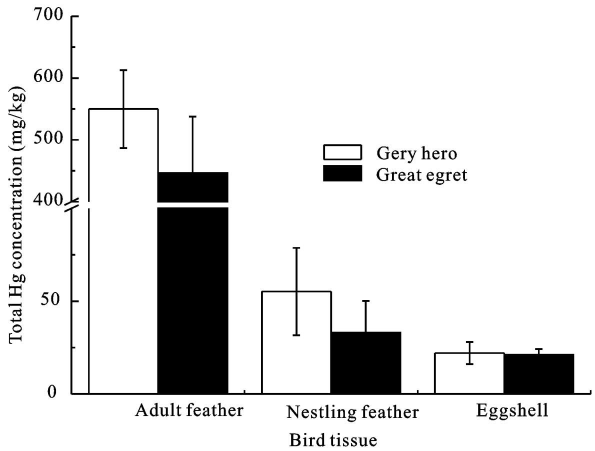


Fig. 7 Total mercury concentration in feather and eggshell of Grey heron and Great egret

concentrations decreased in the order of adult feather > nestling feather > eggshell, and the differences were statistically significant for both species (Krushall-Wallis one-way ANOVA; Grey heron, $P < 0.05$, Great egret, $P < 0.05$).

The adult feather, nestling feather, and eggshell of the Grey heron accumulated more Hg than those of Great egret. The difference between the eggshells of the two species was statistically significant (Mann-Whitney U test; $P < 0.05$), while those for the feathers were not (Mann-Whitney U test; adult feather, $P > 0.05$; nestling feather, $P > 0.05$).

4 Discussion

4.1 Mercury accumulation in soil, water, plant and insects

As a global contaminant, mercury could transport in global scale with general circulations, resulting in mercury accumulating in some remote regions without pollutant sources and bringing poisons to wildlife and local residents. Wetland soil is often with high moisture, low Eh and high levels of undecomposed organic matter, which are all in favor of mercury sequestration in soils. The results of previous researches found that mercury concentrations in the wetland soil were often in high levels, so the wetlands often were the mercury sources to the ambient areas (Wang *et al*., 2002).

There were some ecological risks caused by mercury pollution in the study area. Total mercury concentrations in the soil of *Deyeuxia angustifolia* wetland and *Carex lascarpa* wetland were in the range of 8.7–239.8 ng/g and 0.1–500.8 ng/g, respectively, which were all higher than those in the sediment of the wetlands (1–219 ng/g) from previous research (Kannan *et al*., 1998). Mercury contamination in the soil was estimated by using the index of geoaccumulation (I_{geo}). The results showed that I_{geo} in the soil was 0.52, implying the low-medial mercury contamination risk in the study area.

Total mercury concentration in surface water was relatively high and was about 50 times of the average mercury concentrations in global rivers, and it was almost the same as the mercury concentration in water of the Second Songhua River in 2003 (Zhang *et al*., 2010). Of the four plant species studied, the moss showed the high ability to mercury absorption, and the total mercury concentration in the moss was about 2.5 times of that in the wetland soil.

Mercury storage in wetland plants was considerable. For example, mercury storage in ground biomass of *Deyeuxia angustifolia* was 24.9 μg/m^2 (Liu *et al*., 2004). The mercury concentrations were determined by dominant plant species, as well as soils, in the wetlands (Willis *et al*., 2011). Plant roots and soil with higher organic matter contents can promote Hg methylation (Sun *et al*., 2011). Therefore, wetland plant and soil might contribute to high total mercury in food chain greatly.

Insects are the important components of ecosystems and they exist widely in environments. Biodiversities in the wetland are high and there are lots of insect species, which play important roles in metal transport in the wetland. The results of previous researches have showed that some predatory insects would accumulate heavy metal such as Hg efficiently and they could be used to monitor heavy metal pollution (Hsu *et al*., 2006). In this study, total mercury concentration in the centipede was very high. The centipede is a typical soil arthropod and carnivorous insect, it feed on small insects, including cricket, grasshoppers, fly, wasp, spider and earthworms. Trophic position of the centipede was high, and mercury biomagnifications in terrestrial food chains might contribute to the high mercury in the centipede bodies. In this study, ten insect species were studied and classified to three groups by their food strategy. The three groups are herbivorous, omnivorous and carnivorous insects, and the total mercury concentrations of them were 10.18 ng/g, 16.47 ng/g and 213.35 ng/g, respectively, decreased in the order of carnivorous > omnivorous > herbivorous.

4.2 Mercury accumulation in feathers of birds

The total mercury concentrations in the feather of Grey heron (Adult: 0.550 ± 0.063 mg/kg; Nestling: 0.055 ± 0.024 mg/kg) and Great egret (Adult: 0.447 ± 0.091 mg/kg; Nestling: 0.033 ± 0.017 mg/kg) were relatively lower than those in the areas suffering mercury pollution (Table 1). In the feather of birds from the shore of the Shiranui Sea, Japan, the total mercury concentration was 7.1 ± 3.7 mg/kg which was much higher than that in the study area. However, compared with the total mercury concentration in the feather of birds occupying high trophic positions in terrestrial ecosystem, the total mercury concentrations in the feather of wetland waterbirds

Table 1 Total mercury concentrations in feathers of birds

Bird	Total mercury concentration (mg/kg)	Country	Reference
Fish-eating sea bird	7.1±3.7	Japan	Doi *et al*., 1984
Omnivorous water fowl	5.5±5.6	Japan	
Predatory bird	3.6±2.9	Japan	
Omnivorous terrestrial bird	1.5±1.2	Japan	
Herbivorous water fowl	0.9±0.4	Japan	
Anatidae	0.11–0.4	Chilean	Ochoa-acuña *et al*., 2002
Laridae	0.94–2.5	Chilean	
Phalacrocoracidae	0.7–2.0	Chilean	
Procellaridae	1.0–7.3	Chilean	
Golden eagle	0.103–0.260	China	Guo *et al*., 2001
Red-footed falcon	0.069–0.149	China	
Brown-eared pheasant	0.015–0.043	China	
Little egret	0.53–8.28	Greece	Goutner and Furness, 1997
Night heron	0.53–9.54	Greece	
Roseate spoonbill	2.0	America	Beyer *et al*., 1997
Great blue heron	3.5	America	
Great white heron	4.7	America	
Great egret	7.1	America	

were relatively high. Guo *et al*. (2001) found that the total mercury concentration in the feather of Golden eagle (*Aquila chrysaetos*) and Red-footed falcon (*Falco vespertinus*) from Taiyuan City, Shanxi Province, China were in the range of 0.103–0.260 mg/kg and 0.069–0.149 mg/kg, respectively, which were both lower than those in adult Grey heron and Great egret in this study.

The results of previous studies indicated that adult birds accumulated more Hg for more food intake, and more Hg is assimilated (Charles *et al*., 2002; Eagles *et al*., 2008). High Hg levels in feathers may be the potential protective mechanism of the birds against Hg poisoning. Sepúlveda *et al*. (1999) found that Grey heron nestlings could eliminate most dietary Hg by producing new feathers. As a result, the total mercury concentration in the feather of that bird is much higher than that in the eggshell. Although adult bird feathers contain more total mercury, nestling feathers are more suitable for evaluating Hg pollution in breeding sites because the food of nestlings are localized while their feathers are still growing (Burger, 1993; Houserova *et al*., 2007).

There were some differences of total mercury concentration between Grey Heron and Great egret, and different food components may be responsible for the Hg accumulation in both birds, even though they both are piscivorous birds (Thompson *et al*., 1998; Duvall and Barron, 2000). Statistical results of fish species which Grey heron and Great egret preyed on, indicated that Amur sleepers (*Perccottus glehni*) and Loaches (*Misggurnus moloity*) were the main food and the Crucians (*Carassius auratus*), Amur bitterlings (*Rhodeus sericeus*) and hydrophilids (*Cybister japonicus*) were the secondary choice for Grey heron (Table 2). Crucians is the predominant food for Great egret. The total mercury concentration in the Crucians was low, which resulted in low mercury concentration in the feather of Great egret. The result of evident accumulation was in good agreement with previous studies (Gnamus *et al*., 2000; Gray, 2002; Houserova *et al*., 2007). In addition, age might play an important role in mercury accumulation for the birds, and the adult birds could accumulate Hg more effectively than nestling birds did, which was related to the increased health risks in adults via food intake.

4.3 Mercury bioaccumulation in food chains

In this study, the bioconcentration factor (BCF) decreased in the order: predatory fish muscle > omnivorous fish muscle > herbivorous fish > insect. The differences among the various trophic species were statistically significant (Krushall-Wallis one-way ANOVA, $P < 0.01$).

Kannan *et al*. (1998) found that Hg was biomagnifi-

Table 2 Species components in food pallets of Grey heron and Great egret

Species	Grey heron		Great egret	
	Number	Percentage (%)	Number	Percentage (%)
Amur sleeper	3	25.00	2	18.18
Crucian	2	16.67	6	54.55
Loache	3	25.00	1	9.09
Amur bitterling	2	16.67	2	18.18
Hydrophilid	2	16.67	0	0.00

cated along aquatic food chains and reached the high levels in predatory fishes. In this study, the muscle tissues of predatory fishes contained significantly higher concentration of total mercury than non-predatory fishes (Table 3). This result agrees well with that from previous researches (Burger, 1993; Burger and Gochfeld, 1996; Gray, 2002; Boncompagni *et al*., 2003; Houserova *et al*., 2007). The total mercury concentrations in fishes determined in this study were also lower than the food hygienic standard of China (0.3 mg/kg), and they were also lower than that in Florida wetland fishes (2–3 mg/kg) (Fleming *et al*., 1995).

Table 3 Bioconcentration factor in food chains of aquatic ecosystem in study area

Feeding strategy	Species	Bioconcentration factor
Predatory fish	Amur sleeper	2348.78
Omnivorous fish	Amur bitterling	1939.80
Hervivorous fish	Crucian	656.12
Hervivorous fish	Loach	556.33
Insect	Hydrophilid	10.20
Water		1.00

The factors affecting Hg accumulation are species, trophic level, age, exposure route, and so on (Covaci *et al*., 2006; Burger and Eichhorst, 2007). Age may cause an adult fish to accumulate more Hg in their bodies. Of four fishes studied, the total mercury concentrations in muscles increased with the fish body length (Fig. 8). Otherwise, Hg biomagnificated up in the food chains are complex and does not always increase along the gradient of trophic levels. For example, despite occupying higher positions in food chains, the Hg levels in odonates and crayfish were much lower than that in amphipods (George and Batzer, 2008). Therefore, futher research is necessary to assess the wetland food chain in the Sanjiang Plain.

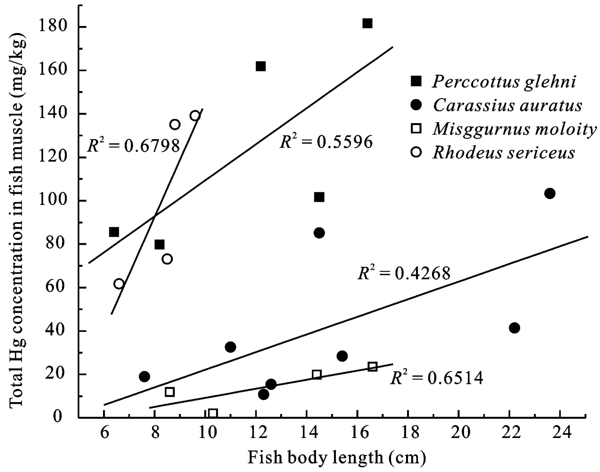


Fig. 8 Relationship between total mercury concentration in fish muscle and fish body length

5 Conclusions

Mercury pollution exists to some extent in the wetland ecosystem of the Sanjiang Plain, although there is not pollutant source. The total mercury concentrations in soil and surface water are relatively higher, and the total mercury concentrations in some plants (moss) and insects (centipede) are extremely high. The total mercury concentrations in adult waterbird feathers are almost 10 times of that in the nestling feathers. The total mercury concentrations of the four fish muscles differed significantly and extremely among the species. Mercury biomagnifications along food chains are confirmed in wetland ecosystems. In terrestrial food chain of the herbivorous-carnivorous insects, the total mercury concentrations have increased by 20 times, and in the water, the Hervivorous fish-predatory fish food chain, the BCFs are 556.33 and 2348.78, respectively.

The results in this study reflect the distribution pattern of the total Hg concentrations in the wetland ecosystem of the Sanjiang Plain and demonstrate that the Hg contamination in the aquatic ecosystem is not significant. More attention should be devoted to the mercury cycling in the wetland ecosystem. In addition, mercury species distribution among different compartments in the wetlands and the implications of the distribution on Hg fate need further research.

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