Thrips species diversity in urban green spaces of Hangzhou (Zhejiang Province), China

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Abstract

Research was conducted on the fauna of Thysanoptera in the urban green spaces of Hangzhou, Zhejiang Province, China, during 2008-2012. The thrips were collected in different plant communities (mainly in parks) in the city. A total of 26 species from 19 genera in three different families were collected, among them *Scolothrips latipennis* Priesner, which is newly recorded for the fauna of China. New distribution records of seven species in China are reported. Results of the research indicate that the fauna of thrips of green areas of Hangzhou was quite abundant and diversified, and the occurrence of *Selenothrips*, *Scirtothrips*, *Thrips*, *Frankliniella* and *Haplothrips* species seems diverse and should be investigated further.

Introduction

The urban environment is a complex of habitats developed by humans from natural sites or agricultural land. Houses, villages, towns, cities, buildings, roads, and other features that characterize the urban environment have gradually and irreversibly changed the landscape of natural and agricultural areas. As a part of this change, some habitats and their associated plant and animal communities have been eliminated, while others have been expanded and new ones created. Many of the new habitats were intentional - parks, waterways, street trees, turfgrass, food stores - but some were incidental; *e.g.*, standing water in roadside ditches, garbage and landfill sites near residential neighborhoods, and the underground sewer and storm drain networks in urban and suburban areas. These all provide habitats for a select group of insects and other arthropods, some of which have attained pest status (Robinson, 2005). Vegetation plays a key role in urban environments by providing food, breeding sites and shelter for animals and plants, and also by modifying the microclimate. Local conditions, climate, and available resources determine the distribution of some arthropods in the urban environment, and the abundance of some species is limited. Other species are broadly adapted to the resources and harborages in and around buildings, and these are cosmopolitan in their distribution and pest status (Rudd *et al*., 2002).

Thrips constitute the order Thysanoptera, of which there are presently over 6000 known species. The order is divided into two suborders, Tubulifera and Terebrantia. Tubulifera contains a single family, the Phlaeothripidae, whereas there are eight recognized families in the Terebrantia (Mound & Morris, 2007; Mirab-balou *et al*., 2011a). Thysanoptera comprise an order of minute insects of considerable scientific and economic importance. Their habits range from forest and grasslands, to gardens and crops. Members of many species are fungivorous, phytophagous or carnivorous, or are gall-makers or inquilines, and some are vectors of viral and bacterial diseases of plants, or pollinators of flowers (Lewis, 1973; Mound, 1997). A large number of thrips species are considered pests, because they feed on plants of commercial value. Almost all species of pest thrips (>90%) are in the Terebrantia family Thripidae; *i.e*., *Thrips tabaci*, *Frankliniella occidentalis*, *Scirtothrips dorsalis*, and *Thrips palmi* (Moritz *et al*., 2004; Mound, 2005). Only a few species of Phlaeothripidae are considered to be pests. These include *Gynaikothrips ficorum* (Marchal) and *Gynaikothrips uzeli* (Zimmerman) as pests of *Ficus,* and *Haplothrips* spp., which include pests of grains in Europe and central Asia (Reitz *et al*., 2011). Thrips in the genera *Frankliniella* (flower thrips) and *Thrips* also spread plant diseases through the transmission of viruses, such as Tospoviruses, Tomato Spotted Wilt Virus, and the Impatiens Necrotic Spot Viruses (Lewis, 1973; Mirab-balou & Chen, 2011; Mound, 2005; Tong & Lv, 2013).

In China, about 566 species of thrips have been recorded (Mirab-balou *et al*., 2011a), but a few of them, *i.e*., *Frankliniella occidentalis* (Pergande), *Scirtothrips dorsalis* Hood, *Thrips palmi* Karny, and *Thrips tabaci* Lindeman, are known as serious pests in this country (Reitz *et al*., 2011; Mirab-balou *et al*., 2012a, 2013).

Up to the present, only a few works have been conducted on thrips species associated with the urban environment. For example,

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Thysanoptera in the city of Lublin, Poland (Kucharczyk & Seczkowska, 1990; Czepiel, 2004) or a few common species of thrips in the globally urban environment were mentioned by Robinson (2005). In China, data concerning the species composition, ecological connections and the number of thrips in urban areas are scarce; the present research is the first attempt to document the biodiversity of thrips species in the urban green spaces of Hangzhou, China.

Materials and methods

Area of research

Hangzhou is the largest city of Zhejiang Province, and is located in northern Zhejiang Province, eastern China, at the southern end of the Grand Canal of China, on the plain of the mid-lower reaches of the Yangtze River. The prefecture-level region of Hangzhou extends west to the border with the hilly Anhui Province, and east to the flatland near Hangzhou Bay. The city center is built around the eastern and northern sides of West Lake (Xihu), just north of the Qiantang River. Hangzhou's climate is humid subtropical with four distinctive seasons, characterised by long, very hot, humid summers and short, chilly, cloudy dry winters (with occasional snow).

Collection of specimens

To establish the occurrence of Thysanoptera species associated with urban green spaces of Hangzhou, different sites (*i.e.*, parks, street trees, turfgrass, etc.) (Figure 1A-D) were randomly sampled from 2008-2012. Thrips collection methods included sweep net, aspirator, and shaking plants into a white dish; all specimens were preserved in 70% ethanol.

Preparation of material for identification

All collected material was macerated in 5% KOH and subjected to dehydration in an ethanol series before being mounted onto glass slides in Hoyer's medium [see Mirab-balou and Chen (2010), for details on slide mounting]. All descriptions, measurements and photos were made with a Leica DM IRB microscope, and a Leica MZ APO microscope with a Leica Image 1000 system.

Identification of slide-mounted specimens

Slide-mounted specimens were identified using published keys (Reyes, 1994; Han, 1997; zur Strassen, 2003; Moritz *et al*., 2004; Masumoto, 2010). Species identity was confirmed by comparison with identified slide-mounted material held at the Institute of Insect Sciences, Zhejiang University, Hangzhou, China (ZJUH); the Insect Collection of Department of Entomology, South China Agricultural University (SCAU); Entomological Museum, Northwest A. & F. University, Yangling, Shaanxi Province, China (NWAFU); and National Zoological Museum of China, Institute of Zoology, Chinese Academy of Sciences, Beijing, China (IOZ).

Depository for thrips specimens

The specimens are deposited in the Institute of Insect Sciences, Zhejiang University, Hangzhou, China (ZJUH).

Results

Among the 26 species listed in Table 1, some are graminicolous: *Anaphothrips obscurus*, *Anaphothrips sudanensis* and *Chirothrips manicatus*; these species are also common in China; most of them are

Table 1. Thrips species associated with urban green spaces of Hangzhou (Zhejiang Province).

Family	Sub-family	Species	Thrips-associated plants
Aeolothripidae	-	*Aeolothrips fasciatus* (Linnaeus)*	Different plants infested with mites and thrips
Thripidae	Dendrothripinae	*Dendrothrips ornatus* (Jablonowski)*	*Ligustrum* sp., *Rhododendron simsii*
Thripidae	Panchaetothripinae	*Heliothrips haemorrhoidalis* (Bouche)*	Feeding on the leaves of a very wide range of trees and shrubs
Thripidae	Panchaetothripinae	*Selenothrips rubrocinctus* (Giard)	*Viburnum odoratissimum*, *Rhododendron simsii*
Thripidae	Sericothripinae	*Sericothrips houji* (Chou & Feng)	Clover
Thripidae	Thripinae	*Anaphothrips obscurus* Müller	Grasses
Thripidae	Thripinae	*Anaphothrips sudanensis* Trybom	Grasses
Thripidae	Thripinae	*Chaetanaphothrips orchidii* (Moulton)*	*Fatsia japonica*
Thripidae	Thripinae	*Chirothrips manicatus* (Haliday)*	Grasses
Thripidae	Thripinae	*Frankliniella intonsa* (Trybom)	Highly polyphagous; flowers of different plants
Thripidae	Thripinae	*Lefroyothrips lefroyi* (Bagnall)	*Camellia sinensis*
Thripidae	Thripinae	*Megalurothrips distalis* (Karny)	*Ophiopogon japonicus*; on flowers of plants family Fabaceae
Thripidae	Thripinae	*Microcephalothrips abdominalis* (Crawford)	Various Asteraceae
Thripidae	Thripinae	*Mycterothrips glycines* (Okamoto)	*Glycine max*, *Alnus japonica*
Thripidae	Thripinae	*Scirtothrips dorsalis* Hood	Highly polyphagous
Thripidae	Thripinae	*Scolothrips latipennis* Priesner**	*Thuja* sp. infested with mites
Thripidae	Thripinae	*Scolothrips takahashii* Priesner	*Thuja* sp. infested with mites
Thripidae	Thripinae	*Taeniothrips eucharii* (Whetzel)	*Ophiopogon japonicus*
Thripidae	Thripinae	*Thrips flavus* Schrank	Highly polyphagous
Thripidae	Thripinae	*Thrips hawaiiensis* (Morgan)	Highly polyphagous
Thripidae	Thripinae	*Thrips palmi* Karny	Highly polyphagous
Thripidae	Thripinae	*Thrips tabaci* Lindeman	Highly polyphagous
Phlaeothripidae	Phlaeothripinae	*Bagnalliella yuccae* (Hind)	*Yucca* flower
Phlaeothripidae	Phlaeothripinae	*Gynaikothrips ficorum* (Marchal)*	*Ficus* trees
Phlaeothripidae	Phlaeothripinae	*Haplothrips* (*Haplothrips*) *ganglbaueri* Schmutz	Grasses
Phlaeothripidae	Phlaeothripinae	*Haplothrips* (*Haplothrips*) *reuteri* (Karny)*	Flowers of various Asteraceae

*Newly recorded from the Zhejiang Province; **newly recorded for fauna of China.

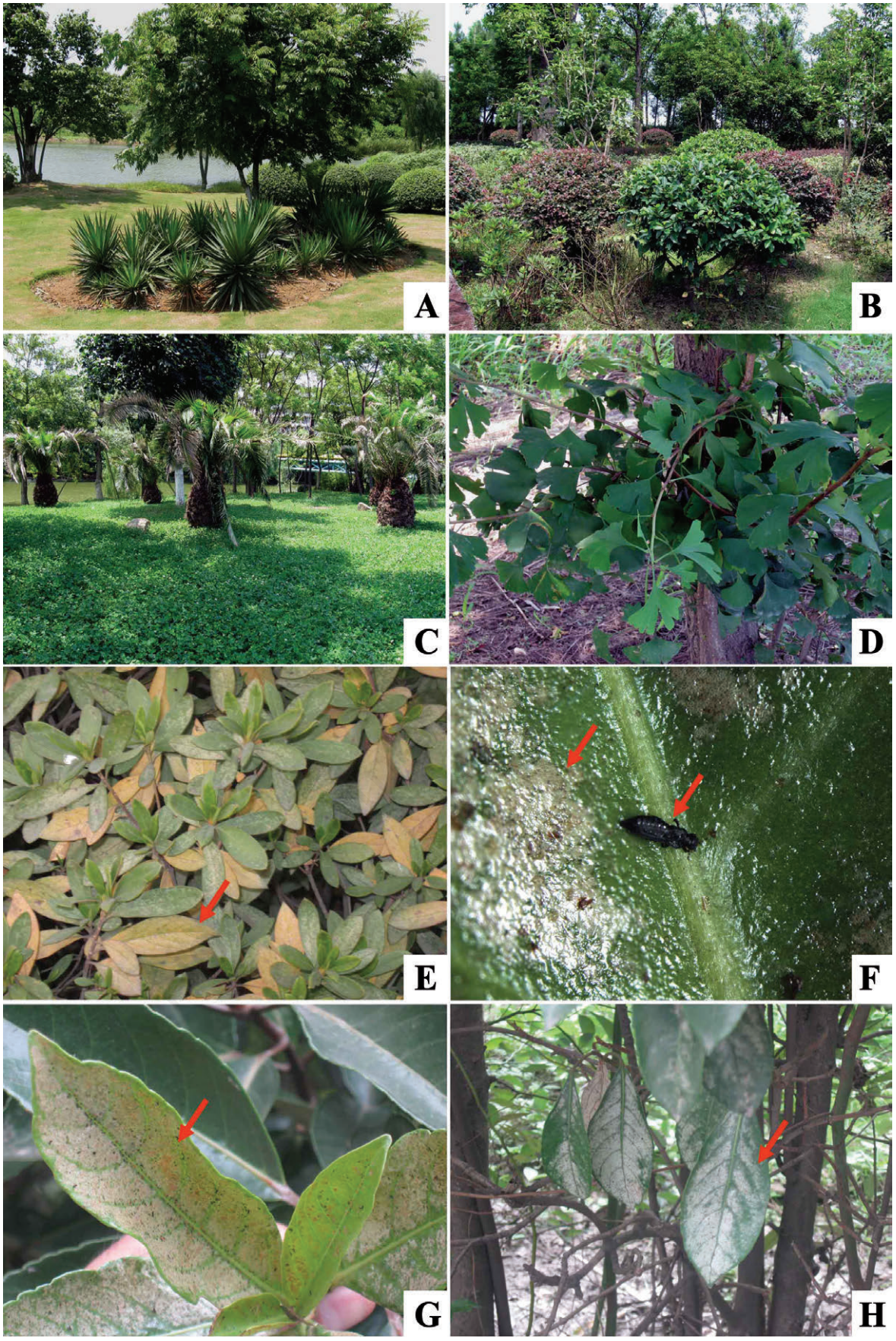

Figure 1. A-C) A view of some sites sampled in the urban environment of Hangzhou; D) leaves of the Gingko tree, infested by thrips; E-H) leaves damaged by *Selenothrips rubrocinctus*.

florivorous, such as *Frankliniella intonsa*; a few of them, such as *Selenothrips rubrocinctus* and *Scirtothrips dorsalis*, are regarded as pests in this ecosystem, whereas *Scolothrips* and *Aeolothrips* species are predatory and feed on other small arthropods.

Predatory thrips

Three species, *Aeolothrips fasciatus* (Linnaeus), *Scolothrips latipennis* Priesner and *Scolothrips takahashii* Priesner, represent predators that play an important role in this ecosystem by feeding on other small arthropods. Among them, *S. latipennis* Priesner is a newly recorded species for China.

Scolothrips latipennis Priesner (new record)

Scolothrips latipennis Priesner, 1950: 54

MATERIAL EXAMINED. 6♀2♂ (in ZJUH), CHINA: Huajiachi Campus at Zhejiang University, Hangzhou, Zhejiang Province, on *Thuja* sp. (Cupressaceae) (infested with tetranychid mites), 13.v.2011, Coll. M. Mirab-balou.

REMARKS (Figure 2A-D). The species of *Scolothrips* are predators of tetranychid mites and other small arthropods; they can be easily recognized by the presence of six pairs of very long setae on the pronotum and fore wings with dark bands (Masumoto, 2010). Presently, five species of this genus has been recorded from China (Mirab-balou *et al*., 2011a); *S. lattipennis* Priesner is here recorded for the first time among the fauna of China.

DISTRIBUTION. China (Zhejiang Province); Iran, Egypt, Crimea, Spain, Morocco, Canary Islands (zur Strassen, 2003), and Australia (Mound, 2011).

Phytophagous thrips

The remaining 23 species listed in Table 1 are phytophagous thrips that feed on different plant parts. The onion thrips, *Thrips tabaci*, is a widespread pest around the world. It is highly phytophagous and is also widely distributed on agricultural crops, fruit trees, flowers and other plants in Hangzhou. The chilli thrips or yellow tea thrips, *Scirtothrips dorsalis*, is another species distributed in China, and is a common pest in southern China, in particular in Guangdong, Guangxi, Hunan, Jiangxi, Fujian, Anhui and Yunnan provinces (Han, 1997; Mirab-balou *et al*., 2011a). Due to *S. dorsalis*' polyphagous behavior and very large host range, this species has the potential to cause significant economic damage. It has been reported as a serious pest of a diverse variety of commodities in several countries. This species is widely distributed in Hangzhou, especially on Ginkgo trees. Recently, another species of *Scirtothrips*, *S. ginkgoe* Mirab-balou & Chen

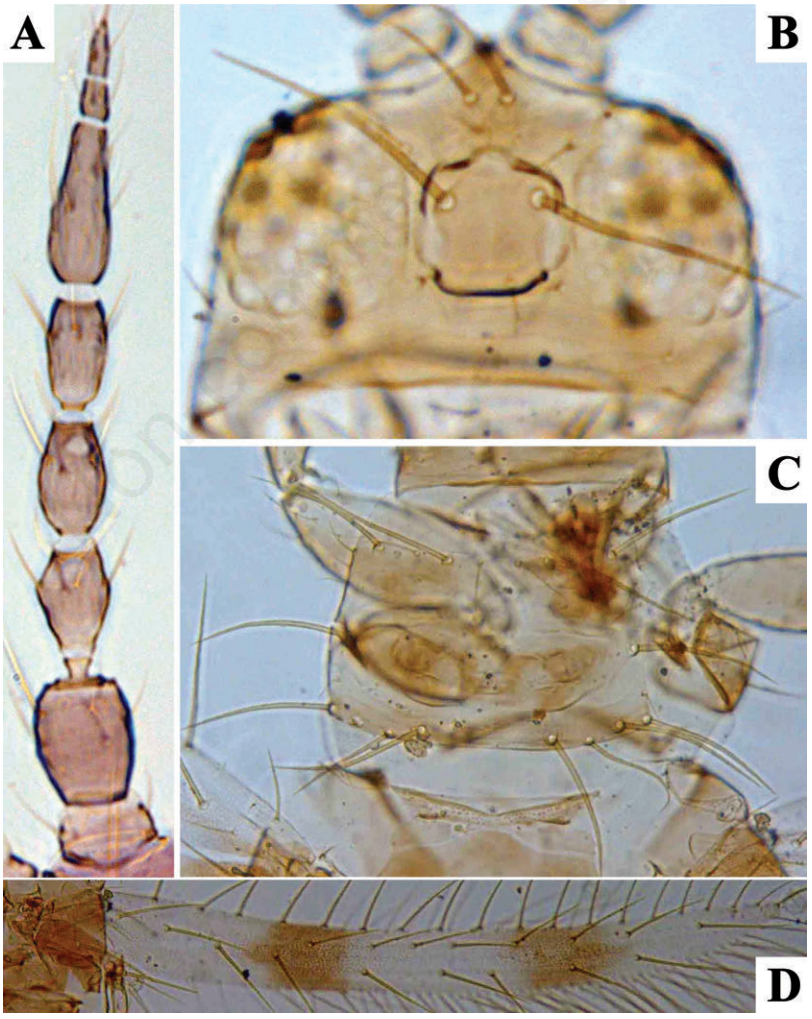

Figure 2. ***Scolothrips latipennis*** **(♀): A) antenna, B) head, C) pronotum, D) fore wing.**

(2012b), was also recorded as a new pest in the urban environment of Hangzhou by Mirab-balou *et al*. (2012b). The red-banded thrips, *Selenothrips rubrocinctus* (Figure 1F), is polyphagous (Reyes, 1994) and recently noted to be widely distributed on different plants in Hangzhou. In this investigation, we observed a high level of damage (Figure 1E-H) caused by this species on plants near West Lake (Xihu), mostly in parks. Symptoms of red-banded thrips injury to plants result from feeding by the adults and/or larvae on the leaves and pods. On leaves, the feeding punctures cause the development of chlorotic spots and premature leaf drop, while on the pods, they cause brown patches that coalesce in severe infestations to form a dark brown, corky layer of dead cells that makes the determination of pod ripeness virtually impossible. Necrotic lesions are produced in the leaves and pods by adults and larvae, and in the flowers by adults. Small brown patches of excretory droplets, typical of thrips infestation, are an obvious means of identifying damage (Figure 1E-H).

Clover is cultivated in many regions in the environs of Hangzhou; consequently, *Sericothrips houji* (Chou and Feng) has become established on this plant at high populations (Mirab-balou *et al*., 2011b), which indicates a need for studies of its biology and potential control methods.

The Japanese Aralia, *Fatsia japonica* (Thunb.) Decne. and Planch. (Araliaceae), has been cultivated as a popular ornamental flower in many regions of Hangzhou, especially around West Lake (Xihu) and most roadsides, gardens and parks. *Chaetanaphothrips orchidii* (Moulton) is one of the important thrips species collected from flowers of Japanese Aralia, and is established on this plant within Hangzhou's landscape.

Aside from the above thrips species, other species such as *Bagnalliella yuccae* (Hind) are widely distributed on Yucca flowers (Mirab-balou *et al*., 2011a); *Frankliniella intonsa* (Trybom), *Lefroyothrips lefroyi* (Bagnall), *Haplothrips* spp. and *Megalurothrips distalis* (Karny) are also found on different varieties of plants (mostly on flowers), and *Mycterothrips glycines* (Okamoto) is found on leaves of trees in Hangzhou's urban environment.

Discussion and conclusions

Thysanoptera have been used as indicators of changes in agroecosytems (Lewis, 1973; Vasiliu-Oromulu, 2002), and as indicators of climatic changes (Vasiliu-Oromulu, 1995, 2002) and air pollution (Vasiliu-Oromulu *et al*., 2008, 2009). In this regard, some of the species listed here have the capability of serving as biomonitoring indices of polluted urban green spaces, such as *Bagnalliella yuccae*, *Thrips tabaci*, and *Frankliniella intonsa*.

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