Research Technical Note
Urban Ecology Series
RTN
11-2012

Urban millipedes in Singapore

Authors: Trudy Maria Tertilt and Peter Decker
Edited by James Wang

Introduction

Millipedes are ground-dwelling invertebrates which are a common sight in urban parks and gardens worldwide. In recent years, populations of black and yellow millipedes have proliferated in a few locations in Singapore. These often reach high densities, and have become a management concern for horticulturalists in some localities. However, there is a general lack of understanding locally regarding what species these are, what factors drive their population increase, and how they should be managed. This article introduces basic aspects of millipede biology and ecology, identifies some common urban millipedes found in Singapore, and presents some preliminary hypotheses on how their populations could be controlled.

What are millipedes?

Millipedes (Diplopoda) are distributed almost all over the world, from the polar regions to the rain forests, and even up to the fringes of deserts. About 80, 000 species of millipedes are thought to exist worldwide; so far about 11, 000 species are already known to science. About 32 species are currently known from Singapore. Millipedes have a rigid calcareous exoskeleton, are often cylindrical in form, and have two pairs of legs on each of the trunk-segments. They have many legs, as the name suggests, ranging from 26 to 750 in total. Millipedes belong to the same phylum (Myriapoda) as Centipedes (Chilopoda), and inhabit the same dark, damp habitats. However, these two groups of organisms are distinct from each other. The latter display more active movement patterns than millipedes, have poison-claws, and only one pair of legs on each trunk-segment. While centipedes are predators, millipedes only feed on dead organic material. They do not bite and are generally harmless creatures.

Urban millipedes found in Singapore

Most of Singapore's millipedes can be found in its primary or secondary rain forests, e.g. the Bukit Timah Nature Reserve. Most of the indigenous species have not been observed to colonise man-made and influenced habitats such as gardens and parks. Non-native millipedes are more abundant in Singapore's urban areas, and are thought to be distributed between sites by the use of non-heated compost, particularly compost with high bark content.

Over a period of two rainy seasons, millipedes were collected in various urban areas of Singapore and sent to Mr. Peter Decker, a specialist on SE Asia millipedes, for identification (*address below). In public, many different names are used for "black millipedes with yellow stripes," but identification of the species is only possible by microscopic dissection of the male gonopods (sexual organs).

Fig 1. Millipedes in urban Singapore: (A) photo by T. Tertilt; (B) photo by Y. Cai; (C) photo by M. de Silva, www.nadiplochilo.com; (D) photo by P. Decker; (E) photo by T. Tertilt; (F) photo by P. Decker; (G) photo by P. Decker; (H) photo by P. Decker.

Checklist of Urban Millipedes in Singapore		
Species	**Origin**	**Photo**
Anoplodesmus saussurii	India, Ceylon	A
Benoitolus flavicollis	SE Asia	F
Chondromorpha xanthotricha	India, Ceylon	B
Cylindrodesmus hirsutus	Uncertain	H
Leptogoniulus sorornus	SE Asia	D
Orthomorpha coarctata	SE Asia	C
Orthomorpha hydrobiologica	SE Asia	
Prosopodesmus jacobsoni	Australia	
Pseudospirobolellus avernus	SE Asia	G
Trachyiulus nordquisti	SE Asia	
Trigoniulus corallinus	SE Asia	E

Short introduction of life cycle and habit

The most common urban millipede species in Singapore, *Anoplodesmus saussurrii*, has a life cycle of 6 - 7 months, which includes 4 - 6 weeks of adult activity, depending on temperature, moisture and food supply. Adults are active on the surface, and while they may mate during the day, the most active times for this invertebrate to mate are the hours of dawn and dusk. One adult female can lay 100 - 400 eggs into an earthen nest 25 days after copulation, and between 2-4 times in its lifetime. The high reproductive rate of this species and ability to withstand dry periods from early larval stages (6th stadia onwards) make it a highly successful coloniser. Mass populations (up to 200 individuals per sq metre) are reported from different parts of the tropics, usually from human modified landscapes near cement structures. These millipedes are attracted to light sources.

Interactions with other organisms

Most millipedes are detritivores, feeding on decaying organic matter. Many organisms have been observed to feed on millipedes in general, including spiders, beetles (dung beetles, ground beetles), assassin bugs, scorpions, centipedes, ants, mammals, birds, reptiles and amphibians. Millipedes have also been observed in civet cat faeces. In Singapore, the most common millipede *Anoplodesmus saussurii* secrets hydrogen cyanide when attacked, which may drive away many potential predators. However, antagonistic interactions observed between ants and this species have been reported here for Singapore. Over time, other predator-prey relationships may develop, and suppress the populations of *A. saussurii*.

Ecological function

Within forest ecosystems, leaf litter decomposition constitutes an intrinsic component of nutrient cycles and energy flows, and millipedes, together with earthworms, termites and cockroaches, are one of the most important decomposer groups in the tropics. High density populations of *Anoplodesmus saussurii* can break down up to 1 kg of leaf litter per sq metre per year. Another important aspect of diplopod activity is the mixing of various soil layers through burrowing activity, which counteracts soil compaction, allowing greater infiltration of rainwater into the soil, and increases soil aeration.

Management

Anoplodesmus saussurrii has recently become a species of management concern in Singapore, because of the high masses of individuals which can develop, particularly in newly applied compost with a high content of wood and bark. Typically, these millipedes arrive at new sites along with the transfer of compost, plants and turf sods which contain adults, larvae or eggs from sites with established populations. Particular care should be taken to screen new plants and soil brought into areas where these millipedes have not yet colonised.

Although no systematic research has been conducted on the management of this species, it is suggested that three general horticultural practices could assist to counter infestations of this species. Firstly, the use of compost made from leaf mulch on-site would reduce the risk of importing eggs and juveniles contained in compost of unknown origin. Secondly, heat treatment of compost (minimum 70°C for 1 hour) could reduce transmission of millipedes and their eggs between sites of compost production and deployment. Thirdly, anecdotal observations suggest that the use of compost which has been processed to maturity could limit the populations of this species. Soil chemistry, in particular pH, nitrogen and carbon content, is reported to influence millipede distribution and abundance in natural environments (Warren and Zhou 2002, Ashwini and Sridhar 2006, Loranger-Merciris et al. 2008, Murphy et al. 2008). Regardless of the type of compost used, not using more compost than necessary in an area should also reduce millipede densities.

On-site control measures for millipedes in general have included setting up physical barriers, such as smooth plastic belts on the bottom of residential buildings or roof gardens which will prevent millipedes to climb up and spread. Another method could be the use of pitfall traps with a light source. A container (tin, jar) is buried in the ground with its rim at surface level. The container can contain a killing and preservation fluid. Next to the pitfall trap a light source (garden solar light) is installed. Millipedes attracted to the light will fall into the jar. This method is often used by Australian residents against another invasive millipede species, *Ommatoiulus moreletti*.

If the need to control the millipede population in an area is urgent, the following pesticides are currently in use: Imidacloprid 200 SC, Malathion and Deltamethrin. However, such pesticides should only be used as a last resort, as they may have undesirable effects on other soil biota, aquatic ecosystems and humans.

Comprehensive studies and monitoring of occurrences, dispersion and development of millipede populations and also field studies of different planting substrates and traps are needed to document and understand the factors that benefit these mass populations and to develop effective strategies and methods to prevent such massive millipede infestations.

References

Ashwini, K.M. & Sridhar, K.R. 2006. Seasonal abundance and activity of pill millipedes (*Arthrosphaera magna*) in mixed plantation and semi-evergreen forest of southern India. *Acta Oecologica* 29: 27-32.

Decker, P. & Tertilt, T. 2012. First records of two introduced millipedes *Anoplodesmus saussurii* and *Chondromorpha xanthotricha* (Diplopoda: Polydesmida: Paradoxosomatidae) in Singapore. Nature in Singapore 2012 5: 141-149. http://rmbr.nus.edu.sg/nis/bulletin2012/2012nis141-149.pdf

Murphy, C.M., González, G., Belén, J. 2008. Ordinal abundance and richness of millipedes (Arthropoda: Diplopoda) in a subtropical wet forest in Puerto Rico. *Acta Científica* 22: 57-65.

Loranger-Merciris, G., Imbert, D., Bernhard-Reversat, F., Lavelle, P., Ponge, J-F. 2008. Litter N-content influences soil millipede abundance, species richness and feeding preferences in a semi-evergreen dry forest of Guadeloupe (Lesser Antilles). *Biology and Fertility of Soils* 45: 93-98.

Warren, M.W. & Zou, X. 2002. Soil macrofauna and litter nutrients in three tropical tree plantations on a disturbed site in Puerto Rico. *Forest Ecology and Management* 170: 161-171.

Looking for samples:

Researchers and park managers who are interested to work with Peter Decker may contact him at:

Peter Decker, Senckenberg Museum of Natural History Görlitz, Department of Soil Zoology, P.O. Box 300154, 02806 Görlitz, Germany E-Mail: Peter.Decker@senckenberg.de