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Invasion note

A potential native natural enemy of invasive aquatic weed – water hyacinth

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Abstract

A potential native natural enemy of invasive aquatic weed water hyacinth was found in Shanghai of China: Chironomus larva. The larva can dig into the bulbiform petiole of water hyacinth, the petiole will be broken and decomposed soon, and also, the canker of water hyacinth will fall off. So this larva will be a native natural enemy of water hyacinth for controlling its invasion. From other side, water hyacinth will be gradually naturalized to a component of native ecosystem, although it maybe needs a long time.

Invasive species often lack natural enemy in a new area, consequently, grow and increase crazily, and threaten the native biota. However, in original area of invasive species, there often exist natural enemy, which can restrain its growth and propagation to a certain extent. So many ecologists command to introduce natural enemy of invasion species from original area to control invasive species (e.g., Room et al. 1981; Harley et al. 1984; Cilliers 1987; Laup 1987; Harley 1990; Ding et al. 2001). But introducing natural enemy from original area often has a risk on ecology. And also, it was short of the technology of releasing natural enemies, and the natural enemy livability and propagation rate was low after being introduced into a new area. So, the effect of introducing natural enemies from original area was not significant, moreover, some ecologists were afraid that it will bring about the second biological invasion. On the contrary, searching and studying native natural enemy of invasion species is meaningful and interesting.

The aquatic weed, water hyacinth *Eichhornia crassipes* (Mart.) Solms., originated in the state of Amazonas, Brazi (Howard et al. 1998), is one of the most successful colonizers that interferes with agricultural, urban and recreational use of water (Kathiresan 2000). It is now widespread and recognized as one of the top 10 weeds (Holms et al. 1977). Considering the various uses of water, biological control has been suggested to control introduced and aggressive weeds dominating large areas (Andres 1977). Seven natural enemy species have been released around the world between 1974 and 1996. They are: two weevils, *Neochetina bruchi* and *N. eichhorniae*; two moths, *Niphograpta albiguttalis* and *Xubida infusellus*; a mite *Orthogalumna terebrantis*; and a bug *Eccritotarsus catarinensis* (Julien et al. 2001). But introducing natural enemies from original area to control water hyacinth still faced some troubles and risks, such as settling down, propagating, living through the winter, disease, etc. The effectiveness of *N. bruchi* could be reduced by a native entomopathogen *Beauveria bassiana* (Balsmo) Vuillemin (Chikwenhere et al. 2001). On the contrary, searching some native natural enemies and using them to control water hyacinth will have a less risk than introducing natural enemies from original area.

Based on this aim, we investigated the water bodies of Shanghai, which colonized by a great deal of water hyacinth in every water body from July to October every year. We found a new natural enemy of water hyacinth – Chironomus larva (Figure 1).

Chironomus (midge) larva, Diptera, local name blood worm or red worm, distributes in all kinds of water bodies. Every spring, Chironumus will lay eggs in the water when the temperature of water rise to 14 °C and the air temperature arrive 17 °C. After 2–7 days, the eggs can hatch out. The larva is pelagic at first. After 3–6 days, the larva will inhabit in the bottom of water, but we found the larva dug into the bulbiform petiole of water hyacinth (Figure 2), fed on spongy tissue of petiole. A pinhole will be seen on the bulbiform petiole if larva dug into the petiole. On the surface of laurel-green petiole appeared some red and yellow stripe. Gradually, the bulbiform petiole shrunk and decomposed, and also, the lamina began to canker. Without a long time, in the petiole will appear a big gap. After the petiole is broken, the lamina will fall off or wither away. Usually, one petiole has one to two Chironomus larvas. The Chironomus larva also digs into the base of petiole sometimes, and enters the curtate caudex, so the ramet will rot off and die. By our investigation, we found that a healthy ramet of water hyacinth often has five to eight generation ramets, but after being invaded by midge larva, only three to four generation ramets, and also, the stolon between parent and generation quickly rotted and separated from parent. The clonal groups of water hyacinth represented dead–alive vision (Figure 3). The ramet did not die quickly after infected by midge larva, but the clonal growth stopped, and the canker enlarged quickly, till the ramet die away.

Although we do not have data to testify the effect of controlled water hyacinth reproduction, the autoeciousness of midge larva in bulbiform petiole constrained the clonal growth of ramet or made it die. About 19 of 43 species have been indentified as potential control agents of water hyacinth either because of the damage they cause

Figure 1. Chironomus larva (bloodworms), 15 mm size. (cited from Canterbury Environmental Education Centre of UK).

Figure 2. Chironomus larva dug into the bulbiform petiole of water hyacinth, and the bulbiform petiole shrunk and decomposed gradually (photos taken in Shanghai rivers).

Figure 3. Water hyacinth ramets infected by Chironomus larvae, arrowhead showed the canker on the petiole (photo taken in Shanghai river).

or because of their narrow host range (Perkins 1974). But no one has reported midge larva as a potential natural enemy of water hyacinth till today. The Chironomus larva will be a native natural enemy of water hyacinth, from this point, due to its constraint to the growth and invasion of water hyacinth.

Chironomus larva usually lives in fresh water ponds, lakes and rivers with slow current and abundant organic matter. The larvae can tolerate very low oxygen levels and are often found in very large numbers in the sludge at the bottom of stagnant ponds. The universal viewpoint is that the larvae often eat dead organic matter (plant and animal). However, when the Chironomus larva inhabits water hyacinth, it can be seen in all kinds of water floating with water hyacinth, even in wavy river. In summer and autumn, there is a mass of Chironomus larvae in the river. The invasion of water hyacinth provided abundant organic matter, and the detritus of water hyacinth made the water body eutrophic. Also, in recent years, the river was greatly polluted by people's activity, and the diversity of benthic-zoo decreased significantly, on the contrary, the Chironomus larva just adapts to live in eutrophic water, and the biomass of Chironomus larva often occupy 50~90% of all the benthic-zoo biomass. Chironomus larva often inhabit shady environments of water. Therefore the dense cover of water hyacinth provides a shady environment for Chironomus larva. Due to the growth of water hyacinth, various physical characteristics of water body were changed, such as dissolved oxygen and temperature of water decreased, but Chironomus larva can still live because of its broad tolerance to water environment, even in low dissolved oxygen for a long time or in anoxic for a short time. So, the invasion of water hyacinth has provided an advantaged environment for Chironomus larva, and the number of Chironomus larvae increased greatly.

However, the water environment of Chironomus larvae must have a slow current, the climatic changes will also impact the growth of Chironomus larvae. In 2003, the annual mean temperature of Shanghai was 17.6 °C, towered above 1.4 °C than 2002, and the annual rainfall of 2003 was 929 mm, 22% less than 2002. Especially from May to October, the rainfall was onle 291 mm, 52% less than 2002. For these reasons, the flood was weak and the flood season was short. There were no quick current, and the population of Chironomus larva increased greatly. In 2002, the office of Shanghai water hyacinth salvaged water hyacinth 1686.7×10^{3}t (Gao 2005), and in 2003, there was no salvage data due to a spot of salvaging work for a few of water hyacinth. For the reason, the diminishment of water hyacinth in 2003 is related to the increasing population of Chironumus larva in higher temperature and low rainfall, except climatic changes.

Water hyacinth was introduced into mainland of China from Taiwan in 1930s (Diao 1989), and is now broadly distributed in 15 provinces and 2 cities (Shanghai and Chongqing) (Ding et al. 2001). In a 70 years process of invasion, the potential native natural enemies of water hyacinth need a long time to accept water hyacinth. When the potential native natural enemy became the effective enemy of water hyacinth, it will be gradually naturalized. The naturalization process maybe needs a long time, but at least it was found a native natural enemy – Chironomus larva of water hyacinth. Of course, native natural enemy controlling invasive species is a spontaneous process, and it doesn't need people's activity or help. So the effect of controlling invasive species is limited, and also, it needs a long time. But, when invasive species becomes a component of native ecosystem after a long time, and connects with other species of ecosystem, the invasive species will be controlled and naturalized really.

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