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BIOLOGY, DISTRIBUTION, AND FIELD HOST PLANTS OF *MACROPLEA JAPANA* IN CHINA: AN UNSUITABLE CANDIDATE FOR BIOLOGICAL CONTROL OF *HYDRILLA VERTICILLATA*

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Hydrilla verticillata (L.f.) Royle (Hydrocharitaceae), a submersed aquatic macrophyte, is native to Asia, Australia, Europe, and Africa (Buckingham & Bennett 1996). This invasive species was first introduced to North America in the early 1950s in the Tampa Bay area (Schmitz et al. 1991) and dispersed rapidly to become one of the worst aquatic weeds in the US (Balciunas et al. 2002). Hydrilla is controlled mainly with chemical herbicides (Fox et al. 1996). However, both mechanical removal (Serafy et al. 1994) and biological control agents (Wheeler & Center 2001) play some role. Since the discovery of herbicide resistance in hydrilla populations in Florida (Michel et al. 2004), biological control has become a high priority. Foreign exploration for classical biological control agents of hydrilla was conducted in China between 1989 and 1995 and resulted in the discovery of many herbivores (Buckingham 1998). Among the most promising were 2 unidentified *Macrolea* species (Coleoptera: Chrysomelidae) whose specificity was unknown (Buckingham 1998). This note documents the rediscovery of this insect at several sites in China, a brief description of its biology, and its field host range.

From Jun 2006 to Nov 2008, we conducted intensive field surveys in China for biological control agents of hydrilla and found the beetle *Macrolea japana* (Jacoby) at 6 of 91 survey sites. These survey sites were located in Hubei, Hunan, Jiangxi, Jiangsu, Guangdong, Guangxi, Guizhou, Yunnan, Sichuan, and Chongqing provinces (Fig. 1). We collected larvae or pupae by hand-pulling the host plants from water. The plant samples with larvae and pupae were put in plastic bags and then in a cooler, prior to transport to the lab for observing immature development of the beetle in the lab. These field-collected samples were reared in 3-L plastic containers underwater. Mating adults were placed in plastic pots (10 pairs per pot), each with a host plant for oviposition. The leaves with eggs were excised from the plant and placed in Petri dishes (9 cm; 1 leaf/dish) containing tap water.

We found *M. japana* in Hubei (Xiaochang and Jiayu County), Hunan (Fenghuang County,

Changde City), and Guizhou (Guiding County, Guiyang City) provinces. This species has also been reported from the Chinese Provinces Jiasu, Gansu (possibly), Heilongjiang, Liaoning, and from Japan (Tan et al. 1985; Hayashi & Shiyake 2001; Kölsch et al. 2006).

In the field and laboratory, *M. japana* adults were observed on submerged host plants; however, when disturbed, they occasionally would emerge from the water and fly. Adults fed on submerged leaves of host plants. Adults were occasionally seen underwater with air bubbles that might serve for respiration attached to their hind legs and abdomen. After emergence from the pupal case, males immediately located a female and mated (Fig. 2A). Seven to 12 d after mating, females lay a row of 3 to 7 eggs among 2 or 3 leaves bound together in the hydrilla tips (Fig. 2B). Eggs are oblong with a yellow core. In total, 11 to 15 eggs are laid on each tip. Seven to 15 d after oviposition, the eggs begin to hatch. Larvae developed through 3 instars. First instars are yellow, 1 mm long, and attach to the stems and roots of hosts by spiracle hooks on their terminal abdominal segment. After ecdyses, the exuviae of first and second instars remain attached to the roots. If the host quality deteriorates, larvae will move to undamaged parts of the same plant or to a new plant and continue feeding. Mature larvae are white or pale green (Fig. 2C). The exarate pupae are white or yellow initially but turn dark brown with age and attach to stems near or on the roots (Fig. 2D). Field observations indicate that *M. japana* has 1 generation per year and lives through the winter underwater. Most often, overwintering individuals were attached to the base of plants as pupae or as adults, but occasionally as mature larvae or adults inside cocoons.

Field host range of *M. japana* was determined on site by searching the different plant species adjacent to hydrilla. We found the larvae and/or adults of *M. japana* feeding on 9 plant species including *H. verticillata*, *Vallisneria spiralis* L. (Hydrocharitaceae), *Ottelia acuminata* (Gagnep.)

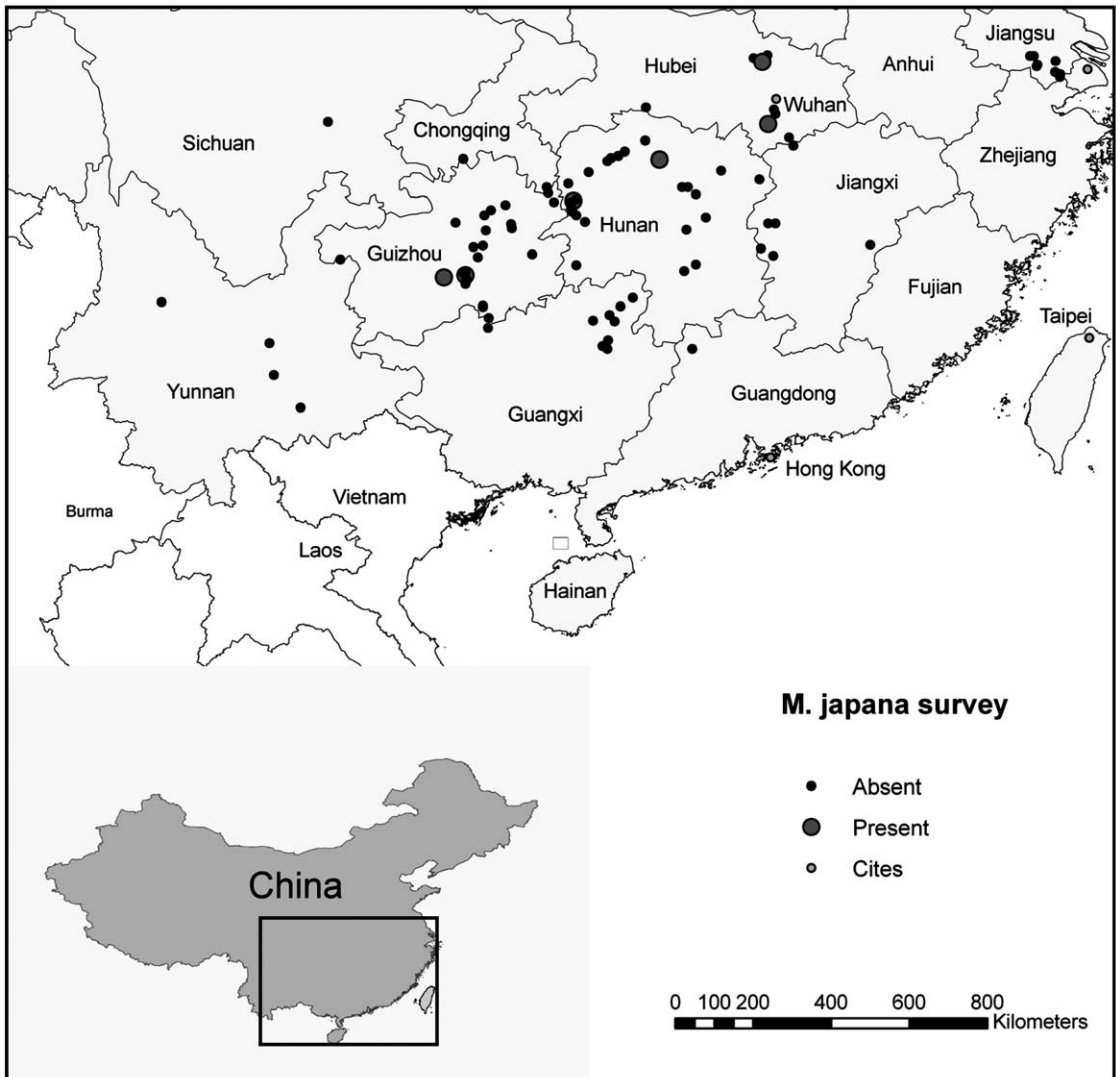


Fig. 1. Hydrilla survey sites in south/central China. Gray bigger dots indicate where *M. japona* beetles were found, black smaller dots indicate where no beetles were found.

Dandy (Hydrocharitaceae), *Nymphoides peltatum* (S.G.Gmel.) O.Ktze. (Menyanthaceae), *Potamogeton malaianus* Miq. (Potamogetonaceae), *P. maackianus* A. Benn., *P. perfoliatus* L., *Myriophyllum verticillatum* L. (Haloragaceae) and *Alopecurus aequalis* Sobol. (Poaceae). These results indicate that *M. japona* utilizes many host species in the field and thus will not be considered further as a biological control agent.

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SUMMARY

The beetle *Macroplea japona* was evaluated for its potential as an agent for biological control of hydrilla. Our field surveys and lab observations indicate that all stages of this beetle live underwater feeding upon the base of their host plant near the hydrosol. Surveys for the beetles were

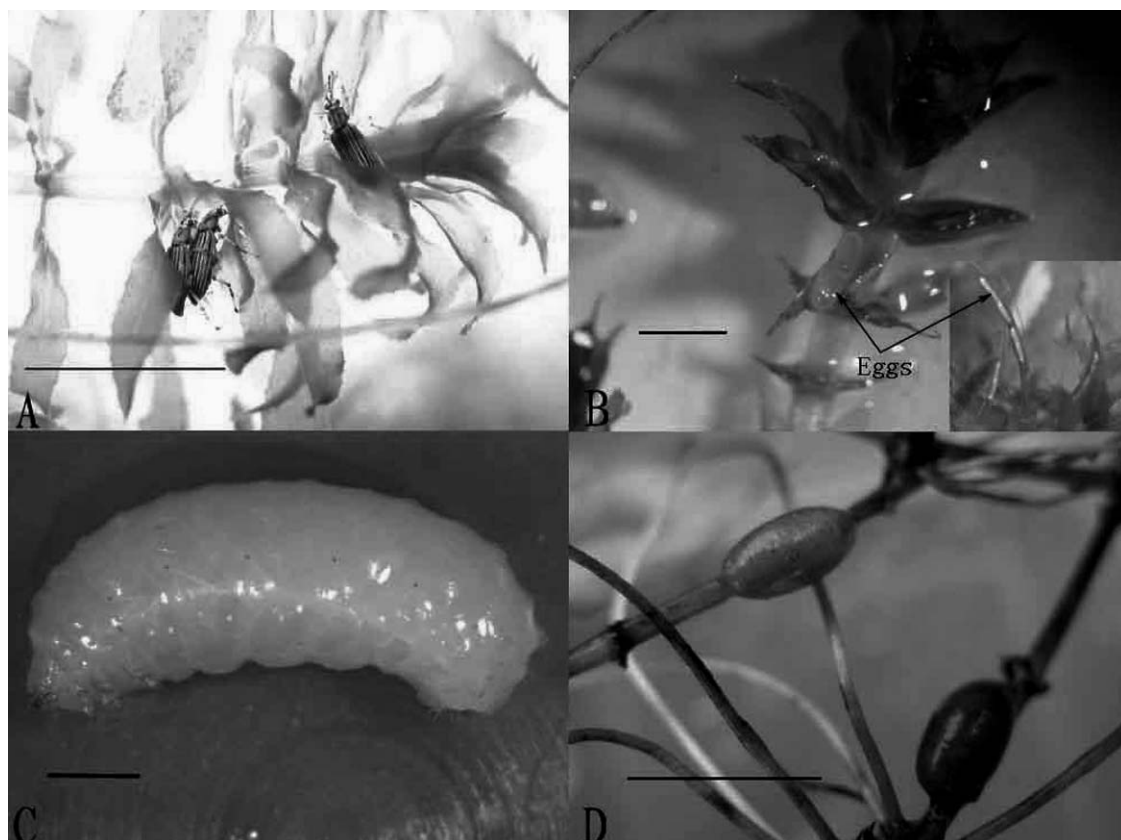


Fig. 2. Life stages of *M. japana*. A: adults under water; B: eggs between leaves; C: the mature larva; D: pupae on stems (A, D scales = 10 mm; B, C scales = 1 mm)

conducted in 10 provinces but they were found only in Hubei, Hunan, and Guizhou. In the field, we found the beetle fed and completed its development on 9 plant species in 7 different genera. Considering this wide host range, it is unlikely that *M. japana* will be developed as a biological control agent for hydrilla.

REFERENCES CITED

- BALCIUNAS, J. K., GRODOWITZ, M. J., COFRANCESCO, A. F., AND SHEARER, J. F. 2002. Hydrilla, pp. 91-114 In R. G. Van Driesche, S. Lyon, B. Blossey, M. S. Hoddle, and R. Reardon. [eds.] USDA Forest Service Morgantown, WV.
- BUCKINGHAM, G. R. 1998. Surveys for insects that feed on Eurasian watermilfoil, *Myriophyllum spicatum*, and Hydrilla, *Hydrilla verticillata*, in the People's Republic of China, Japan, and Korea, pp 1-131 In U.S. Army Engineer Waterways Experiment Station Vicksburg, MS.
- BUCKINGHAM, G. R., AND BENNETT, C. A. 1996. Laboratory biology of an immigrant Asian moth, *Parapoynx diminutalis* (Lepidoptera: Pyralidae) on *Hydrilla verticillata* (Hydrocharitaceae). Fla. Entomol. 79: 353-363.
- CENTER, T. D., GRODOWITZ, M. J., COFRANCESCO, A. F., JUBINSKY, G., SNODDY, E., AND FREEDMAN, J. E. 1997. Establishment of *Hydrellia pakistanae* (Diptera: Ephyridae) for the biological control of the submersed aquatic plant *Hydrilla verticillata* (Hydrocharitaceae) in the southeastern United States. Biol. Control 8: 65-73.
- FOX, A. M., HALLER, W. T., AND SCHILLING, D. G. 1996. Hydrilla control with split treatments of fluridone in Lake Harris, Florida. Hydrobiologia 340: 235-239.
- HAYASHI, M., AND SHIYAKE, S. 2001. The identity and distribution of *Macrolepta japana* (Jacoby) (Coleoptera, Chrysomelidae, Donaciinae). Bull. Osaka Mus. Nat. Hist. 55: 15-22.
- KÖLSCH, G., BISTROM, O., AND PEDERSEN, B. V. 2006. Species delimitation in the leaf beetle genus *Macrolepta* (Coleoptera, Chrysomelidae) based on mitochondrial DNA, and phylogeographic considerations. Insect System. Evol. 37: 467-479.
- MICHEL, A., ARIAS, R. S., SCHEFFLER, B. E., DUKE, S. O., NETHERLAND, M., AND DAYAN, F. E. 2004. Somatic mutation-mediated evolution of herbicide resistance in the nonindigenous invasive plant hydrilla (*Hydrilla verticillata*). Mol. Ecol. 13: 3229-3237.
- SCHMITZ, D. C., NELSON, B. V., NALL, L. E., AND SCHARDT, J. D. 1991. Exotic Aquatic Plants in Florida: A Historical Perspective and Review of the Present Aquatic Plant Regulation Program, pp 303-

326. In National Park Service, United States Department of Interior Washington, D.C.
- SERAFY, J. E., HARRELL, R. M., AND HURLEY, L. M. 1998. Mechanical removal of hydrilla in the Potomac River, Maryland: Local impacts on vegetation and associated fishes. *J. Freshwater Ecol.* 9: 135-143.
- TAN J., YU, P., LI, H., WANG, S., AND JIANG, S. 1985. Coleoptera: Chrysomeloidea (I). Economic Insect Fauna of China, pp. 1-213 In Science Press Beijing.
- WHEELER, G. S., AND T. D. CENTER. 2001. Impact of the biological control agent *Hydrellia pakistanae* (Diptera: Ephyridae) on the submersed aquatic weed *Hydrilla verticillata* (Hydrocharitaceae). *Biol. Control* 21: 168-181.