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Short communication

Beetle on the battle: Defoliation of *Parthenium hysterophorus* by *Zygogramma bicolorata* in Kathmandu valley, Nepal

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Abstract

Zygogramma bicolorata, a Mexican beetle, is the most widely distributed biocontrol agent of the invasive weed *Parthenium hysterophorus*. The occurrence and distribution of this beetle in Nepal has been poorly documented. We monitored and mapped the occurrence of this beetle in Kathmandu valley for two years from August 2009 to September 2011. A small population of the beetle was first encountered in a wasteland at Sundarighat of Kirtipur Municipality in August 2010. By September 2011, the beetle has spread over half of the valley areas where *P. hysterophorus* was present, but damage to the weed was appreciable only at Sundarighat. The effectiveness of biocontrolling process is likely to be limited by shorter period of defoliating activity of the beetle, prolific seed production by *Parthenium* round the year, and environmental pollution.

Key-words: bio-control, Coleoptera, dispersal, herbivory.

Introduction

Zygogramma bicolorata Pallister (Coleoptera: Chrysomelidae), hereafter referred to as beetle, is the most widely distributed biocontrol agent for the noxious invasive weed *Parthenium hysterophorus* L. (Fam. Asteraceae, hereafter referred to as *Parthenium*). Due to the negative impact to native biodiversity, agriculture productivity, and animal and human health, control of *Parthenium* is becoming a new environmental issue in its invasive range of distribution such as South Asia, Australia and Eastern and Southern Africa (Dhileepan 2009). The beetle as well as *Parthenium* both are native to Central America. *Parthenium* was introduced accidentally to Asia, Australia and Africa, where it has been rapidly expanding in recent years and becomes a major invasive weed whereas the beetle was introduced deliberately to Asia and Australia as a biocontrol agent of *Parthenium* (Mahadevappa 2009). From Mexico, the beetle was first introduced to Australia in 1980 (McFadyen and McClay 1981, as cited in Dhileepan 2009) and to India in 1984 (Jayanth 1987). Along with this species, eight other species of insects and two of pathogens (fungal biocontrol agents) have been released as biocontrol agent for *Parthenium* in Australia (Dhileepan 2009). But this beetle is the major bicontrol agent of this weed introduced and applied in South Asia. In South Asia, the beetle was reported only from India and Pakistan until 2009 (Dhileepan and Senaratne 2009). Although there was no official record of deliberate introduction of this beetle into Nepal, it was first encountered in Hetanda municipality (Makawanpur district, central Nepal) in August 2009; a massive defoliation of *Parthenium* by the beetle was observed (Shrestha *et al.* 2010).

Mature beetle as well as its grubs voraciously feed on the leaves of *Parthenium* and significantly reduce growth,

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vigor, and seed production (Dhileepan *et al.* 2000). The beetle has not yet been reported to feed and complete its life cycle on any other plant species and caused a significant damage in its introduced range. There had been report that the beetle feed on leaves of sunflower but the damage was insignificant and it occurred only when pollens of *Parthenium* accumulated on the surface of sunflower leaves (Ganga Vishalakshy *et al.* 2008). In rare cases, the beetle also feeds on another invasive plant species *Xanthium strumarium* L. (Shrestha *et al*. 2010, Gupta *et al*. 2004). Therefore, it is less likely that the beetle would have any appreciable damage to natural ecosystem and economically important plant species of the region where *Parthenium* is expanding rapidly. In India, the natural dispersal of the beetle was felt inadequate, and it was released to new areas by mass rearing and release campaign (Mahadevappa 2009). Since the beetle has already entered into Nepal and has imparted appreciable damage to *Parthenium* at different parts of the country (Shrestha *et al*. 2010), it is now desirable to document the distribution pattern of the beetle across the country and prepare strategies to make the biocontrol process of *Parthenium* effective. In this communication we have reported the occurrence and distribution pattern of the beetle in Kathmandu valley, and discussed the possible limitations of this beetle as biocontrol agent of *Parthenium* in the valley.

Materials and Methods

We spotted the occurrence of this beetle and documented the defoliation patterns on *Parthenium* as well as factors affecting the effectiveness of the biocontrolling mechanism of this beetle through repeated surveys and monitoring of several localities of Kathmandu valley (the capital city of Nepal, 1300-1400 m asl) in last two years (August 2009 to September 2011). The occurrence of this beetle in Kathmandu valley was mapped using geographic information system (GIS). Since we encountered the beetle first in Hetanda in 2009 (Shrestha *et al*. 2010), we have been regularly searching and monitoring for the beetle in the Kathmandu valley, where *Parthenium* appears to be the most common plant species in roadside vegetation, fallow land, abandoned land, and grazing land. In August-September 2009, we did an extensive survey in different localities (examined at >200 points) of the valley. We conducted a reconnaissance survey, in August 2010, and encountered a small population of this beetle for the first time in a wasteland at Sundarighat of Kirtipur Municipality, south of Kathmandu valley. After having noticed the arrival of the beetle in the valley, we conducted a reconnaissance survey again in June 2011 and an extensive survey in August 2011 travelling the valley along the major road networks. Altogether, 163 points, where *Parthenium* was dominant, were examined for the presence of beetle and the defoliation of *Parthenium*. Geographic position of these points were recorded using Global Positioning System (Garmin GPSmap 60CSx).

Results and Discussion

In survey of 2009, we did not find the beetle in the Kathmandu valley although *Parthenium* has been residing in the valley for more than two decades; the weed has been supposed to invade in Kathmandu valley in late 1980s (Tiwari *et al*. 2005). During the reconnaissance survey of August 2010, a small population of this beetle was encountered in a wasteland at Sundarighat of Kirtipur Municipality, south of Kathmandu valley. At that time, the defoliation was only mild and limited to a small area (ca. 0.05 ha). A complete defoliation of individual plants of *Parthenium* was observed in June 2011 at the same site where the beetle was encountered first in August 2010 (Figure 1-2). By August 2011, the defoliation was expanded up to 3.1 ha of the wasteland in Sundarighat (Figure 2C). Complete defoliation of individual plant was not observed in other localities than Sundarighat area, but the beetle was encountered at 48.5% of the total localities (points) those examined (Figure 2B). Though the points of occurrence of the beetle concentrated around Sundarighat, the beetle has already spread over half of the valley areas where *Parthenium* was present. Its wide distribution became evident by the occurrence of this beetle from core area of the city (Army Stadium and Bhrikuti Mandap) to the periphery (e.g. Sallaghari, Jorpati, Kapan, Balaju, Naikap).

Spatial and temporal pattern of distribution of the beetle in Kathmandu and Hetaunda (Figure 2A) reveals that the beetle might have been carried to Kathmandu from Hetaunda by vehicles. The beetle is commonly found at parking areas of the vehicles in Hetaunda (BB Shrestha, personal observation). Every day, 300-400 vehicles enter Kathmandu valley from Hetaunda *via* Kulekhani; and the road passes along the side of the wasteland at Sundarighat (Kirtipur munici-

Figure 1. (A) Mature beetle (*Zygogramma bicolorata*), (B) Complete defoliation of *Parthenium* by the beetle while other species remained unaffected, (C) Re-growth of *Parthenium* after complete defoliation early in the growing season.

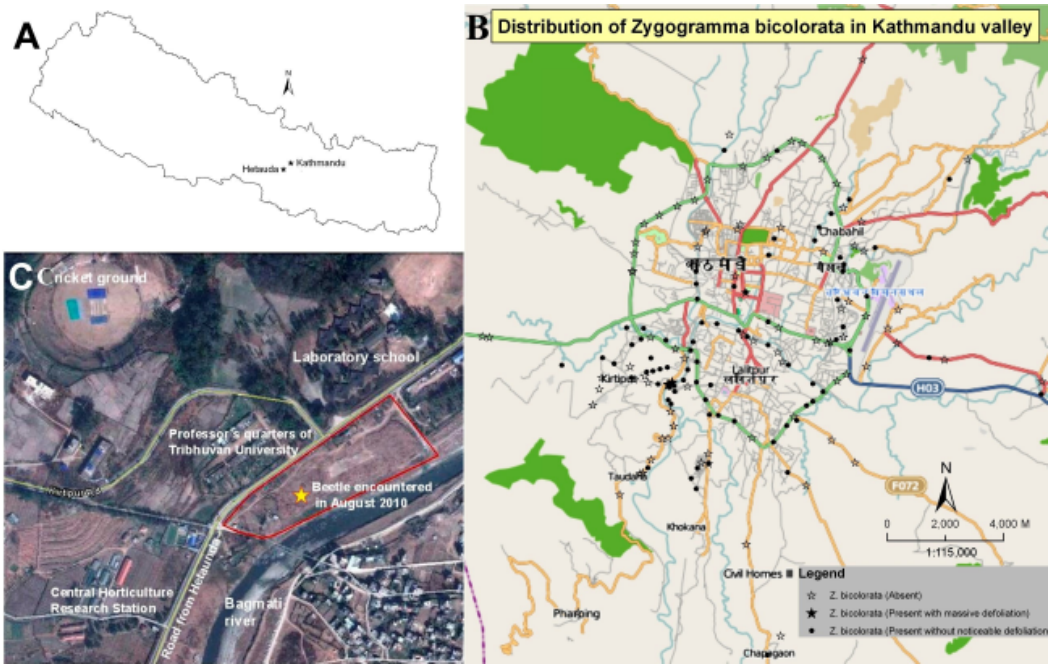

Figure 2. (A) Location of Kathmandu and Hetaunda in Nepal, (B) Distribution of *Zygogramma bicolorata* in Kathmandu valley. (C) Location (red polygon) of the wasteland with massive defoliation of *Parthenium* by *Z. bicolorata* at Sundarighat, Kirtipur (base map from Google-Earth).

pality) where the beetle was first encountered in August 2010 (Figure 2C). Possibility of its natural dispersal from Hetaunda to Kathmandu is ruled out since there is no population connectivity of *Parthenium* between these two cities.

A regional modeling based on climate data (CLIMEX) revealed that Kathmandu valley is climatically less suitable for the beetle with only the southern part of Nepal suitable for survival of this beetle (Dhileepan and Senaratne 2009). However, it is now evident that the beetle has already arrived in Kathmandu valley and its population to cause appreciable damage to *Parthenium* will build up within 2-3 years if current rate of expansion continues. Our examination also indicated that the effectiveness of this beetle as biocontrol agent of *Parthenium* would be limited by the diapausing behavior of, and timing of attack by, the beetle as well as environmental factors. It remained active in eating leaves only for five months of the year (May to early September) in Kathmandu valley whereas *Parthenium* can germinate and flower anytime throughout the year if it gets moisture. Depending on the moisture and vegetation cover of other species, 3-4 cohorts of *Parthenium* was observed in Kathmandu valley (K Pokhrel and BB Shrestha, unpublished data). The number of cohorts of *Parthenium* increased when vegetation cover of other species was frequently removed. Therefore, *Parthenium* growing from fall (September to November), to winter (December to February), and until mid-summer (March to April) can escape from defoliation by the beetle and remains expanding. Effectiveness of the beetle on controlling *Parthenium* may also be limited by heavy deposition of dust on the leaves of *Parthenium* growing along roadsides (Prof. Steve W Adkins, University of Queensland, Australia, personal communication on Nov 12, 2011). Deposition of dust may distract and discourage the beetle to feed on the leaves of *Parthenium*. Furthermore, timing of defoliation also affects the controlling mechanism; plants often died if a complete defoliation occurs in juvenile stage. But likelihood of plant survival was high if a complete defoliation at early flowering stage occurred, as there was re-growth from the lower parts of the plant leading to flowering (Figure 1C); that happened particularly at moist sites. Despite these limitations, this beetle is the major biocontrol agent available in Nepal to restrain rapid expansion of *Parthenium*. Mass rearing of this beetle and release campaign can make the biocontrol process more effective. Recently, the occurrence of another biocontrol agent *Puccinia abrupta* Diet. & Holw. var. *partheniicola* (Jackson) Parmelee (Uredinales) in Kathmandu valley has been confirmed but its impact on *Parthenium* appeared to be insignificant (BB Shrestha, unpublished data). For effective control of this weed, the biocontrol agents need to be supplemented by other environmentally friendly approaches such as uprooting before flowering, competitive replacement by other plant species, and minimizing disturbance to native vegetation (Dhileepan 2009).

In conclusion, after nearly three decades of arrival of *Parthenium* in Kathmandu valley, its biocontrol agent *Zygogramma bicolorata* has also been arrived here accidentally. This biocontrol agent alone, however, cannot control and wipe out the weed due to its shorter period of defoliating activity, prolific seed production by *Parthenium* round the year, and environmental pollution. The beetle needs to be complemented by other environment friendly approaches to win this battle.

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References

Dhileepan K, Setter S.D. and McFadyen R.E. 2000. Impact of defoliation by the biocontrol agent *Zygogramma bicolorata* on the weed *Parthenium hysterophorus* in Australia. *BioControl* 45**:** 501–512.

Dhileepan K. 2009. Managing *Parthenium* across diverse landscapes: prospects and limitations. In: *Management of Invasive Weeds* (Inderjit, ed.), pp. 227-259. Springer Science.

Dhileepan K. and Senaratne K.A.D.W. 2009. How widespread is *Parthenium hysterophorus* and its biological control agent *Zygogramma bicolorata* in South Asia? *Weed Research* 49:557–562.

Ganga Visalakshy P.N., Jayanth K.P., Ghosh S.K. and Chaudhary M. 2008. Post introductory risk assessment studies on *Zygogramma bicolorata* (Coleoptera: Chrysomelidae), a classical biological control agent of *Parthenium hysterophorus* (Asteraceae) in India. *Biocontrol Science and Technology* 18:1083-1086.

Gupta R.K., Khan M.S., Bali K., Nomobrullah Md. and Bhagat R.M. 2004. Predatory bug of *Zygogramma bicolorata* Pallister: an exotic beetle for biological suppression of *Parthenium hysterophorus* L. *Current Science* 87:1005-1010.

Jayanth K.P. 1987. Introduction and establishment of *Zygogramma bicolorata* on *Parthenium hysterophorus* at Bangalore, India. *Current Science* 56:310-311

Mahadevappa M. 2009. *Parthenium: Insight into its Menace and Management*. Studium Press (India) Pvt. Ltd., New Delhi, India.

McFadyen R.E. and McClay A.R. 1981. Two new insects for the biological control of *Parthenium* weed in Queensland. In: *Proceedings of the Sixth Australian Weeds Conference* (Wilson B.J. and Swarbrick J.D. eds.), pp. 145–149. Weed Science Society of Queensland, Queensland, Australia.

Shrestha B.B., Poudel A., Khattri-Chettri J., Karki D., Gautam R.D. and Jha P.K. 2010. Fortuitous biological control of *Parthenium hysterophorus* by *Zygogramma bicolorata* in Nepal. *Journal of Natural History Museum* 25: 332-337.

Tiwari S., Adhikari B., Siwakoti M. and Subedi K. 2005. *An Inventory and Assessment of Invasive Alien Plant Species of Nepal*. IUCN Nepal, Kathmandu.