

***Mikania micrantha* H.B.K. – a potential and economical threat to global biodiversity with special emphasis on Indian context**

Achyut Kumar Banerjee and Anjana Dewanji

Agricultural and Ecological Research Unit, Indian Statistical Institute, 203, B.T.Road, Kolkata-700108,
West Bengal, India
(banerjeeachyut31@gmail.com)

Summary Biological invasion is now a major threat to global biodiversity. As one of the worst invasive weeds in the world, research on various aspects of *Mikania micrantha* H.B.K. is increasing over the years. The plant was introduced in India after the Second World War and its profuse growth in Kerala and Assam over the years affected forests and tea plantations causing damage to the ecosystems and economy of the country. Since the 1980s it has started to spread and invade other Indian states and there is an urgent need to map and monitor the spread of this plant. This paper reviews the worldwide research trend over the years, the current status of the weed in India and reports the presence of this plant in an urban city like Kolkata in India.

Keywords *Mikania micrantha*, worldwide research, spread in India.

INTRODUCTION

One of the greatest threats to global biodiversity is species invasion. Biological invasions have been considered to be one of the three most difficult environmental problems in the world. *Mikania micrantha* H.B.K., a climbing perennial weed of the family Asteraceae native to Central and South America, has been listed as one of the 100 worst invasive alien species in the world (Lowe *et al.* 2001). The distribution of the plant in Australia has been reviewed by Day (2012) and the species has been put under high alert (Class 1 species) since 2002. The plant was introduced in Indonesia as ground cover in the 1940s and then spread to the Pacific islands, south-east Asia and New Guinea (Waterhouse 1994) and is now one of the worst exotic weeds in southwest and south Asia (Zhang *et al.* 2003).

In Asia, *M. micrantha* is known to be particularly problematic in plantation crops, but also threatens natural areas and disturbed ecosystems. After establishing itself in a new habitat, the plant kills all the other plants by smothering them and thus effectively reducing light beneath its canopy (Huang *et al.* 2000). Due to its high spreading and establishment capacity, the plant has the ability to be a potent threat to a nation's biodiversity as well as its economy. In south China, the plant causes problems to tropical fruit trees

and crops (Ye and Xia 2001) and commercial forests (Hills 1999) while in Nepal it is a threat to coconut, oil palm, banana and cacao plantations (Sapkota 2007). The seeds of the weed were found to germinate in the bare soil in coastal areas causing great damage to the mangrove forests (Yu and Yang 2011). This noxious weed cannot be eliminated by simple manual or mechanical means in places where it has posed as a potential threat—biological control is the only probable alternative (Ye and Xia 2001).

Several aspects of the biology and ecology of *M. micrantha* are discussed in a review paper by Tripathi *et al.* (2011). The history of spread of the plant and its control in China has been extensively reviewed by Zhang *et al.* (2003). In India the plant has been reported to be problematic in the north-east and south-west (Parker 1972) and a classical biological control strategy for this weed using a rust fungus (*Puccinia spegazzinii*) from Trinidad was implemented but no satisfactory result was obtainable (KFRI 1997). Therefore, early detection of new invaders and new foci of spread would allow implementation of intervention methods at an early stage of invasion with the potential to pre-empt severe problems.

The objective of the study is to chronologically review the volume of work done on *Mikania micrantha* worldwide highlighting the major focus areas of research. In the absence of a proper database on the spread of the plant in the Indian context, an attempt has also been made in this paper to ascertain the current status of the plant in the Indian context with emphasis on its presence in an urban city like Kolkata in India.

MATERIALS AND METHODS

Data sources A total of 105 reports all over the world (1967–2012 AD) were studied and analysed. The reports containing the genus name (*Mikania*) and the species name of the plant (*micrantha*) were taken into account. The database of the journal groups [like Springer, Wiley, Taylor & Francis, ScienceDirect] were searched with the key-word *Mikania micrantha*. The worldwide available databases [like Asia-Pacific Forest Invasive Species Network (APFISN), CABI, Invasive Species Specialist Group (ISSG)] were also

reviewed. The papers written in Chinese (with abstracts in English) were also considered. In the Indian context, the state and central biodiversity reports were also taken into consideration.

From available literature reports (the first one was in 1967), the distribution of the plant along with damage rating was mapped for the different Indian states. The available and published reports of *M. micrantha* were grouped into the categories which could throw light on the invasion process: effects of the plant on other plants, invasive strategy of the plant, allelopathic potential, soil characteristics during invasion, and reproductive strategy of the plant, molecular biology approaches and control of the plant.

A survey was conducted in Kolkata, the state capital of West Bengal and one of the largest and most populous cities of the world. Within Greater Kolkata (area = 1886.67 km²), a total of 86 sites were surveyed and the presence or absence of the plant (identified from the Botanical Survey of India, Kolkata) was recorded. In the sites visited, the spread of the plant was recorded as large when area was [$>5 \times 5 \text{ m}^2$] and moderate when area was [$>2 \times 2 \text{ m}^2$]. The habitat of the plant was categorised into two main groups namely: terrestrial (further subdivided into 4 categories namely, the abandoned plot, plants found in roadside areas, field/ garden/ plantations and forest) and littoral areas (further subdivided into 2 categories namely wetlands in use and wetlands not in use).

RESULTS

Research in India and other countries A lot of attention is being focused on *M. micrantha* which is reflected from research that has been conducted during the last 46 years as can be seen from Figure 1.

An increasing pattern ($R^2 = 0.616$) is evident from the year 2000 onwards which could have a possible explanation in Figure 2 which shows a huge spurt of growth in research contributions from China after the year 2000 as compared to other countries. This was probably due to the accelerating spread of this plant as a result of China’s reform after 1999 resulting in focused attention on this plant through concentrated efforts of national and local government agencies (Zhang *et al.* 2003).

Before the year 2000, the contribution of papers from India (mostly reporting presence of the plant) compared to the rest of the world (presence and some control measures) was almost equal with no contribution from China. Thus in comparative scenario, India (contributing 11%, Figure 2B) is lagging far behind its neighbouring country China (71%) where the problem of the weed is profuse.

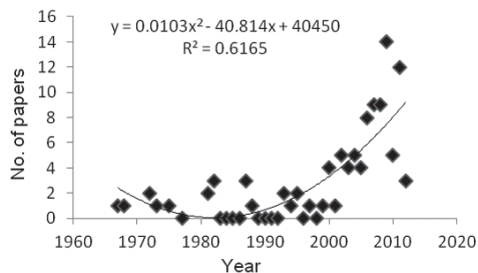


Figure 1. Research papers on *Mikania micrantha* during the period from 1967–2012.

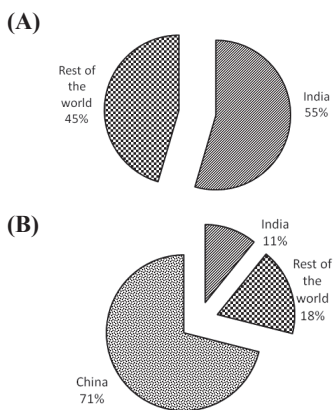


Figure 2. Contribution percentage of India, China and other countries in *M. micrantha* research (A: before and B: after 2000 AD).

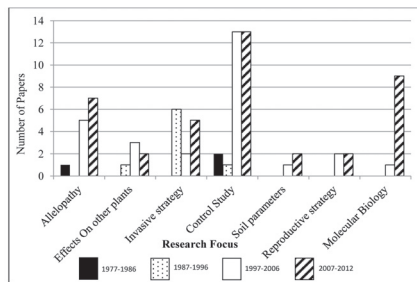


Figure 3. Number of papers in different research areas of *Mikania micrantha* in four decades.

Main areas of focus Figure 3 shows the number of papers on *M. micrantha* published for 7 categories of interest over 4 block year periods. During the period 1977–1986, allelopathy as the cause of invasion was being explored. During the next block period

1987–1996, interest shifted to the invasive strategy of this plant and its effect on other plants. Keeping in pace with the modern trends, the last two block periods witnessed a spurt in molecular biology methods to understand population genetic structure of this plant. However maximum studies have been conducted over the last 2 block periods showing the increasing problems associated with this plant. It is of interest to note that the focus on control was present throughout all block periods suggesting that control was a necessity right from the beginning.

***Mikania micrantha* in India** The plant was reported in Assam in the 1950s (Choudhury 1972) during the World War II. The elderly forest villagers believed that the climber came to that region along with the fodder grass of the mules which were largely used as means of transport, but there was confusion over the identity of the species. Distinguishing features between *M. micrantha*, *M. scandens* and *M. cordata* can be found in Vaid (1973) but it was Holmes in 1982 who confirmed that *M. micrantha* was the only species that was found in India.

The distribution and damage rating of *Mikania micrantha* in India is shown in Figure 4. Reports from Kerala came in 1968 (Nair 1968) followed by West Bengal in 1981 (Palit 1981). After about 12 years, the plant was reported from Western Ghats (1993) and Karnataka (1997) and became a source of serious concern in Kerala, Assam and Western Ghats. In the last 5 years, the presence of this plant has been reported from 5 more Indian states (denoted by small circles in Figure 4) namely Tamilnadu (Ramachandran *et al.* 2008), Uttar Pradesh (Uttar Pradesh State Biodiversity Board, 2009), Andhra Pradesh (Reddy *et al.* 2009), Orissa and Meghalaya thereby showing its potential to spread in other areas also.

Presence of the weed in Greater Kolkata Among the 84 sites surveyed, large infestations of the weed was found in 13 sites (10.92%) while moderate infestation was found in 39 sites (32.76%). In terrestrial habitats, the large infestations were more evident (8 times more) as compared to moderate infestations (2 times more) than that in littoral zones as can be seen from Figure 5.

Table 1 shows the habitat subdivision of *M. micrantha* infestation (large and moderate) found in Greater Kolkata. In case of large infestations, the most affected sites were found to be abandoned plot (32%), then roadside (27%), field or garden or plantations (26%) and forest (5%). The wetlands in use and not in use showed same percentage of large infestation (5% each). But in case of moderate infestation, the most

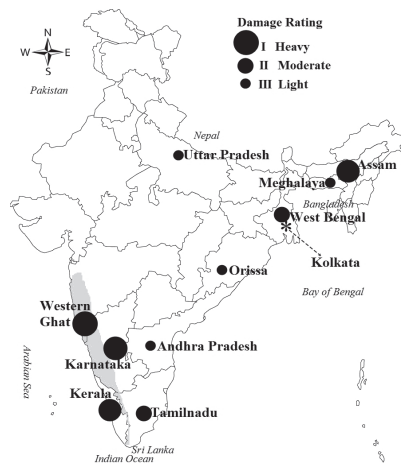


Figure 4. Distribution and damage rating of *Mikania micrantha* in Indian states.

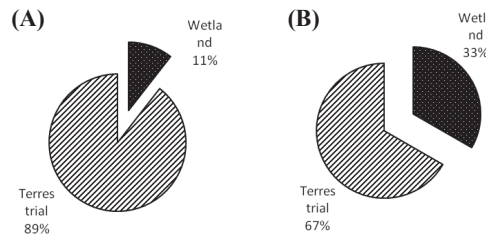


Figure 5. Infestations of *M. micrantha* in both terrestrial and littoral habitats (A-large infestations; B-moderate infestations).

Table 1. Percentage of *Mikania micrantha* infestation in different types of terrestrial and littoral habitats.

Habitat	Infestation	
	Large	Moderate
Terrestrial		
Roadside	27%	12%
Field/Garden/Plantations	26%	31%
Abandoned plot	32%	24%
Forest	5%	NIL
Littoral		
Wetlands In use	5%	21%
Wetlands Not in use	5%	12%

affected sites were field or garden or plantations (31%) and abandoned plot (24%). In this case, the wetlands in use showed more moderate infestation (21%) than roadside or wetlands not in use (12% each).

DISCUSSION

All the invading organisms show a sigmoidal growth curve involving a lag phase i.e. the time to prepare for invasion after gaining entry in a new habitat, followed

by an exponential phase which is continued till the saturation and thereafter stabilisation (Lonsdale 2002). Looking at the invasion pattern in India, it seems that the invasive weed *M. micrantha* had already completed its lag phase in the south western and north western part of the country and has now started to invade new territories. Since control methods for this noxious weed have not so far proved satisfactory, attention should be focused on regular monitoring to record its pattern of spread so that effective measures can be initiated to contain its growth before it reaches explosive proportions. The results of the Greater Kolkata survey showed that the plant has expanded its habitat and the wetlands in use are affected by this plant. This would amount to loss of biodiversity. Kolkata is well connected to all the cities of India, and a significant presence of the weed along the roadside could provide a faster route of spread of this plant to new sites. General awareness about the negative impacts of this plant should also be raised so that people can report its presence in new areas for proper records of its spread.

ACKNOWLEDGMENTS

We would like to thank Indian Statistical Institute, Kolkata, India for their financial support and Botanical Survey of India, Kolkata for identification of the plant specimen. We are also grateful to Sandip Chatterjee, Anindita Chatterjee and Susant Mahankur for their invaluable contribution during field investigation.

REFERENCES

- Choudhury, A.K. (1972) Controversial *Mikania* climber – a threat to the forests and agriculture. *Indian Forester* 98, 178-86.
- Day, M. (2012). *Mikania micrantha* Kunth-mile-a-minute In, 'Biological Control of weeds in Australia' pp. 368-372 (CSIRO 2012).
- Holm, L.G., Plucknett, D.L., Pancho, J.V. and Herberger, J.P. (1977). 'The world's worst weeds: Distribution and Biology' p.320 (University Press of Hawaii, Honolulu, USA).
- Holmes, W.C. (1982). Revision of the old world *Mikania* (Compositae). *Botanische Jahrbücher* 103(2), 211-246.
- Huang, Z.L., Cao, H.L., Lang X.D., Ye, W.H., Feng H.L. and Cai, C.X. (2000). The growth and damaging effect of *Mikania micrantha* in different habitats. *Journal of Tropical and Subtropical Botany* 8, 131-8.
- Lonsdale, W.M. (2002). Biological invasions. In, 'Encyclopedia of Global Environmental Change' pp.11-19. (Wiley).
- Lowe, S., Browne, M., Boudjelas, S. and De Poorter, M. (2001). 100 of the World's Worst Invasive Alien Species: A selection from the Global Invasive Species Database. The Invasive Species Specialist Group (ISSG) 12 pp.
- Muniappan, R. and Viraktamath, C.A. (1993). Invasive alien weeds in the Western Ghats. *Current Science* 64, 555-7.
- Nair, V.K.B. (1968). *Mikania cordata*, B.L. Robins, an Alien New to South India. *Rubber Board Bulletin* 9, 28-9.
- Palit, S. (1981). *Mikania* – a growing menace in plantation forestry in West Bengal. *Indian Forester* 107, 96-101.
- Parker, C. (1972) The *Mikania* problem. *Tropical Pest Management* 18(3), 312-5.
- Ramachandran, A. and Soosairaj, S. (2008). *Mikania micrantha* Kunth – a climbing exotic weed- a new report to the flora of Tamilnadu. *Journal of Swamy Botanical Club* 25, 15-18.
- Rao, R.R. and Sagar, K. (2012). Invasive alien weeds in the tropics: the changing pattern in the herbaceous flora of Meghalaya in North-east India. In, 'Invasive alien plants: An Ecological appraisal for the Indian subcontinent'. (eds) Bhatt, J. R. Singh, J. S. Singh, S. P. Tripathi, R. S. Kohli, R. K. p.194. (CAB International, Wallingford, UK).
- Reddy, C.S. and Raju, V.S. (2009). *Aeschynomene Americana* L. and *Mikania micrantha* Kunth- new invasive weeds in flora of Andhra Pradesh, India. *Journal of Economic and Taxonomic Botany* 33, 540-1.
- Sapkota, L. (2005). Ecology and management issues of *Mikania micrantha* in Chitwan National Park, Nepal. *Nepal Banko Janakari* 17 (2), 27-39.
- Tripathi, R.S., Khan, M.L. and Yadav, A.S. (2011). Biology of *Mikania micrantha* H.B.K.: A Review. In, 'Invasive alien plants: An Ecological appraisal for the Indian subcontinent'. (eds) Bhatt, J. R. Singh, J. S. Singh, S. P. Tripathi, R. S. Kohli, R. K. p. 99-107. (CAB International, Wallingford, UK).
- Vaid, K.M. (1973). A preliminary note on the identity of the controversial *Mikania*. *Indian Forester* 99 (1), 19-22.
- Waterhouse, D.F. (1994). Biological control of weeds: Southeast Asian Prospects, 125. ACIAR, Canberra, Australia.
- Ye, W.H. and Zhou, X. (2001). The plant killer- *Mikania micrantha* in South China. *Aliens* 13, 7.
- Yu, X.M. and Yang, F.J. (2011). Ecological characters and invasion route of *Mikania micrantha* in Shenzhen Bay. *Journal of Northeast Forestry University* 39 (2), 51-52.
- Zhang, L.Y., Ye, W.H., Cao, H.L. and Feng, H.L. (2003). *Mikania micrantha* H. B. K. in China – an overview. *Weed Research* 44, 42-49.