INTRODUCTION

*Pareuchaetes pseudoinsulata* Rego Barros (Lepidoptera: Arctiidae), initially identified as *Ammalo insulata* (Walker), was the first insect to be considered as a biological control agent for the noxious weed, *Chromolaena odorata* (L.) King and Robinson (Bennett and Rao, 1968; Cruttwell, 1968). The weed has proven to be a significant economic and ecological burden to many tropical and subtropical regions of the world. The problem of *C. odorata* in Africa has been reviewed by Timbilla et al. (2003).

*P. pseudoinsulata* is native to the Americas including eastern Venezuela and Trinidad (Cock and Holloway, 1982). A high population of the larvae can cause large-scale defoliation of *C. odorata*. The moth was first released in Ghana and Nigeria in the early 1970s but failed to established (Cock and Holloway, 1982). *P. pseudoinsulata* was also released in India, Sri Lanka and Malaysia (Sabah), where establishment was recorded except in India (Dharmadhikari et al., 1977). In the 1980s, the moth was released in Guam and re-released in India. Establishment of *P. pseudoinsulata* was confirmed in both cases, causing sporadic damage to *C. odorata* in India while complete control was achieved in Guam (Seibert, 1989; Joy et al., 1993). The moth was reintroduced into Ghana during the 1990s; it established, spread and initially caused substantial damage to *C. odorata* (Braimah and Timbilla, 2002). *P. pseudoinsulata* failed to establish in Vietnam, Thailand and South Africa (Julien and Griffiths, 1998). Releases of the moth in Indonesia and Papua New Guinea resulted in establishment of the moth in few locations (Desmier de Chenon et al., 2002; Bofeng et al., 2004).

Despite reports of the non-establishment of *P. pseudoinsulata* in Nigeria during the initial biological control programme in the 1970s, the insect was recently recovered in southern Nigeria. In this paper, the discovery and origin of the moth are discussed.

DISCOVERY OF *P. PSEUDOINSULATA*

Several small populations of *P. pseudoinsulata* have recently been discovered in Edo State in the Niger Delta Region of Nigeria. This is the first confirmed record of *P. pseudoinsulata* in Nigeria, about 40 years after its initial release. On 19 April 2009, three adults were collected on a *C. odorata* infestation along a farm roadside in Uson village near Benin City (6° 19’ 55.67”N; 5° 37’ 18.58”E, 85 m asl.), Nigeria. The collected samples were confirmed to be *P. pseudoinsulata* after larvae were reared through on *chromolaena* by the author. The recovery of the moth prompted the author to carry out further surveys on 22 and 28 April 2009 around the area where the moths were discovered, which revealed the presence of three late-instar larvae of *P. pseudoinsulata*. During subsequent surveys, conducted on 7 and 16 May 2009, about eight larvae and four adults were found along roadsides and in abandoned farmlands at Evboabogun village (6° 15’ 39.33”N; 5° 38’ 58.29”E, 63 m asl.), 4km south of Benin City. In a survey conducted on 18 and 20 March 2010 at Evboabogun village, four adults of the moth were recovered. The preliminary results of a more recent but detailed survey conducted at the Evboabogun site...
showed that the moth is abundant in field, with up to 115 larvae along two transects of 45m long (Table 1). Although data collection at the Evboabogun site is ongoing, the population of the moth seems to be on the increase as the rainy season progresses. The site of this discovery at Evboabogun is 65km northwest of the initial discovery site at Uson. Based on the presence of *P. pseudoinsulata* at these two sites, it is likely that the moth is present elsewhere in southern Nigeria.

### Table 1. Abundance of *P. pseudoinsulata* at Evboabogun village.

<table>
<thead>
<tr>
<th>Date</th>
<th>No. 45m-transects</th>
<th>No. plants sampled</th>
<th>No. larvae</th>
<th>No. adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>24.04.2010</td>
<td>2</td>
<td>30</td>
<td>96</td>
<td>2</td>
</tr>
<tr>
<td>25.04.2010</td>
<td>2</td>
<td>30</td>
<td>115</td>
<td>3</td>
</tr>
<tr>
<td>02.05.2010</td>
<td>1</td>
<td>15</td>
<td>52</td>
<td>2</td>
</tr>
</tbody>
</table>

### MEANS OF ESTABLISHMENT AND SPREAD

There are two alternative scenarios to explain the presence of *P. pseudoinsulata* in Nigeria:

(i) The moth may have established after its initial release in Nigeria during the 1970s. Earlier reports (Cock and Holloway, 1982; Greathead, 1989; Julien and Griffiths, 1998) indicated that these releases had failed to result in establishment of *P. pseudoinsulata*. If *P. pseudoinsulata* did establish from its initial released population in Nigeria, it means that the moth has spread from the establishment site(s) in and around Ibadan (7° 23' 10.97"N; 3° 53' 35.05"E, 161 m asl.), in the south-west of Nigeria, travelling over a distance of 300km to the present recovery sites in Edo State, in the south of the country. In this case the lack of reports regarding establishment following its release may have been due to a lack of committed personnel to monitor and evaluate the biological control programme. This brings to light that biological control efforts against *C. odorata* in Nigeria were not sustained.

(ii) Another possibility is that the biological control agent spread from the release sites in Ghana to Nigeria following its establishment in Ghana in the early 1990s. A recent study by Uyi (2008) reported the presence of the insect in south-eastern Ghana, 400km from the sites where it has been found in Nigeria. *P. pseudoinsulata* has been reported to have spread to several islands in the Philippines unaided, probably from Malaysia (Zachariades et al., 2009), indicating that *P. pseudoinsulata* has good dispersal abilities. The presence of *C. odorata* infestations in southern Togo and Benin may have facilitated the spread of *P. pseudoinsulata* to southern Nigeria. If the insect spread from Ghana, it should be present in these intermediate countries.

Of these two possible sources, no one can be chosen to be more likely. Even if *P. pseudoinsulata* is found to be present in Togo and Benin, it could have either spread east from Ghana or west from Nigeria.

The recent recovery of *P. pseudoinsulata* in Nigeria argues for a survey for the insect throughout the regions of Nigeria in which *C. odorata* is present. If the moth is absent from certain regions, there is potential for its augmentative release in those areas. The advantage of this proposed renewed biological control effort is that no host-specificity studies and no release permission would be required, because the agent is already present in the field in Nigeria. Also, host-range testing was conducted and release permission sought before its initial introduction into Nigeria in the 1970s. Even if *P. pseudoinsulata* is found to be widespread on *C. odorata* in Nigeria, the plant is still under insufficient biocontrol and further agents are required. Efforts should be made to initiate a new biological control programme, involving a collaborative effort specifically from countries and institutions that are active in the biological control of *C. odorata* and other alien weeds. The Nigerian Government also needs to take responsibility for the biological control of *C. odorata* and other alien weed species in the country.

### REFERENCES


Biological control agents released and established on Chromolaena odorata worldwide

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The biological control programme on Chromolaena odorata (L.) King & Robinson (Asteraceae) was initiated in the late 1960s by the Commonwealth Institute for Biological Control (now CABI), with the first releases of biological control agents being conducted in the early 1970s, almost 40 years ago (Waterhouse, 1994; Zachariades et al., 2009). Visual (Zachariades et al., 2009) and tabular (ARC, 2009) records of biological control agents released and/or established on C. odorata in its invasive range in Asia, Africa and Oceania have recently been published. This article acts as a brief update of these records.

As of May 2011, a total of 11 species of arthropods have been released, ten intentionally and one unintentionally, on C. odorata through its invasive range (Table 1). Of those agents released, seven have established, while for Lixus aemulus Petri (Coleoptera: Curculionidae), it is too early to determine whether it will establish. Of these agents, five have established in Asia, five, or possibly six, in Africa and three in Oceania (Table 1). Pareuchaetes pseudoinsulata Rego Barros (Lepidoptera: Arctiidae) has crossed national borders in Asia and possibly Africa, while Acalitus adoratus Keifer (Acarina: Eriophyidae) has spread widely on its own. Cecidochares connexa Macquart (Diptera: Tephritidae) and Calycomyza eupatorivora Spencer (Diptera: Agromyzidae) may also have moved between neighbouring countries, although no records exist on such migration as yet.

The most widespread agents, in terms of the numbers of countries in which they are present, are P. pseudoinsulata (11 -14 countries), C. connexa (10-11) and A. adoratus (17-24), while the most effective are C. connexa and P. pseudoinsulata (Zachariades et al. 2009). At the 8th IOBC International Workshop on Biological Control and Management of Chromolaena odorata and Other Eupatorieae it was recommended that C. connexa be more widely introduced where the Asian/West African biotype of C. odorata occurs.

The three species of agents which did not establish, viz. Apion brunneoingrum Beguin-Billecoq (Coleoptera: Brentidae), Pareuchaetes aurata aurata (Butler) (Lepidoptera: Arctiidae) and Phestinia costella Hampson (Lepidoptera: Pyraulidae), were all released in the first twenty years of the start of the biological control programme on C. odorata. Within the past twenty years, most agents that were released have established.

Establishment of agents in some countries (indicated with a ‘?’ in Table 1) can be confirmed by contacting the author, with locality details and evidence in the form of specimens and/or photographs.

REFERENCES


Table 1. Biological control agents released and established on Chromolaena odorata in its invasive range.

<table>
<thead>
<tr>
<th>Species</th>
<th>Released</th>
<th>Established</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>LEPIDOPTERA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pareuchaetes insulata (Arctiidae)</td>
<td>Africa: ZA</td>
<td>Africa: ZA</td>
</tr>
<tr>
<td>Pareuchaetes aurata aurata (Arctiidae)</td>
<td>Africa: ZA</td>
<td>-</td>
</tr>
<tr>
<td>Actinote anteas (=thalia thalia) (Nymphalidae)</td>
<td>Asia: ID</td>
<td>Asia: ID</td>
</tr>
<tr>
<td>Actinote thalia pyrrha (Nymphalidae)</td>
<td>Asia: ID</td>
<td>Asia: ID</td>
</tr>
<tr>
<td>Phestinia costella (Pyralidae) (=Mescinia nr. parvula)</td>
<td>Oceania: GU</td>
<td>-</td>
</tr>
<tr>
<td><strong>COLEOPTERA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Apion brunneonigrum (Brentidae)</td>
<td>Africa: GH, NG, Asia: IN, MK, Oceania: GU</td>
<td>-</td>
</tr>
<tr>
<td>Lixus aemulus (Curculionidae)</td>
<td>Africa: ZA</td>
<td>Africa: ZA - too early to tell</td>
</tr>
<tr>
<td><strong>DIPTERA</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cecidochares connexa (Tephritidae)</td>
<td>Africa: CI, Asia: ID, IN, TH, TP, Oceania: GU, FM, MP, PG, PW</td>
<td>Africa: CI, Asia: ID, IN, TH, TP, Oceania: GU, FM, MP, PG, PW</td>
</tr>
<tr>
<td>Calycomyza eupatorivora (Agromyzidae)</td>
<td>Africa: ZA, Asia/Oceania: PG</td>
<td>Africa: ZA</td>
</tr>
<tr>
<td><strong>ACARINA</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1Released accidentally, possibly in Malaysia with A. brunneonigrum.
2Spread from neighbouring country.
8th IOBC International Workshop on Biological Control and Management of Chromolaena odorata and Other Eupatorieae

Nairobi, Kenya, 1-2 November 2010

This workshop took place in combination with the First IOBC Workshop on Biological Control and Management of Parthenium hysterophorus, held under the auspices of the recently-formed IOBC Working Group on this weed on 4-5 November 2010. Both C. odorata and P. hysterophorus are in the earlier stages of invading East Africa, so it was hoped that by holding the workshop in Kenya, it would encourage early awareness and mitigating action in the region. During the interleading day between the two workshops, participants visited Nairobi National Park to view encroaching invasive alien plants.

The 8th IOBC workshop was attended by a total of 34 participants from 14 countries (Australia, Bangladesh, Ghana, India, Jamaica, Kenya, Mauritius, Nigeria, Pakistan, Papua New Guinea, South Africa, Tanzania, Thailand, USA); an additional 11 participants attended the parthenium section. The keynote address by Arne Witt (CABI Africa) focused on invasive alien plants in Africa and prospects for their control. Thereafter, presentations were made on distribution, spread, impacts, ecology and control of C. odorata and the related weeds Mikania micrantha, Ageratina adenophora and Campuloclinium macrocephalum.

Holding the workshops of the two IOBC Working Groups in combination was successful from both logistical and technical aspects. In many delegates’ countries, more than one of the species is either present or a potential invader, and many issues were common to both workshops. The intention is thus to consider a future combination of these workshops, when appropriate.

Apart from formal recommendations (below), some of the envisaged outcomes of the chromolaena section of the workshop are:

i) the initiation of a project on biological control of chromolaena in West Africa, focused on Ghana and Nigeria, with particular emphasis on determination of current distribution and impact of the biocontrol agents Pareuchaetes pseudoinsulata and Cecidochares connexa. Redistribution of these agents would also be a priority.

ii) production of an identification kit for Chromolaena odorata, particularly for lower altitude areas of East Africa where it is believed to be encroaching but is unknown.

Apart from ARC and CABI Africa, the following organizations are thanked: the IUCN and GISP groups based in Nairobi, who also contributed substantially to the organization and sponsorship of these workshops, and to the IOBC, CTA and AusAID for sponsorship of several participants.

Recommendations

1. *Chromolaena odorata* (chromolaena) established and became an invasive weed in West Africa about half a century ago and has recently established in East Africa. The participants at this workshop are encouraged to inform their respective government officials and other interested parties of the need to conduct distribution surveys and of the urgency for government to take up measures to tackle this weed immediately using an integrated approach.

2. The workshop recognizes that the natural enemies *Pareuchaetes pseudoinsulata* and *Cecidochares connexa* have proven effective against chromolaena in Asia. It is recommended these agents be favourably considered for introduction in all countries in Africa and Asia where Asian/West African chromolaena is present.

3. The participants of this workshop encourage the creation of awareness and capacity building (e.g. early detection and control/management) to tackle chromolaena and other Eupatorieae in affected countries.

4. The workshop recommends that it is essential for West African countries to continue to monitor established, introduced chromolaena natural enemies (*P. pseudoinsulata* and *C. connexa*), and for concerned agencies to support these activities.

5. The workshop encourages institutions to conduct research on impacts on biodiversity and socioeconomic of chromolaena and other Eupatorieae, and benefits of biocontrol.

6. The workshop recommends that the next IOBC Chromolaena Working Group workshop also be organized as a combined workshop with the IOBC Parthenium working group, if the hosting country and organization is affected by both chromolaena and/or other Eupatorieae, and parthenium.

7. Countries where *Mikania micrantha* is invasive should consider introducing the appropriate pathotypes of *Puccinia spaggiazzinii*.
8th IOBC International Workshop on Biological Control and Management of Chromolaena odorata and Other Eupatorieae
Nairobi, Kenya, 1-2 November 2010


About this newsletter…

- The Chromolaena odorata Newsletter is published at irregular intervals. To contribute articles pertaining to biological control and management of C. odorata, please contact C. Zachariades, ARC-PPRI, Private Bag X6006, Hilton 3245, South Africa. E-mail: ZachariadesC@arc.agric.za
- This newsletter is produced at the Agricultural Research Council (ARC), South Africa, in association with the Chromolaena odorata Working Group of the International Organization of Biological Control of Noxious Animals and Plants (IOBC).
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For information on the biological control of Chromolaena odorata, please visit the website of the IOBC Working Group on this weed, hosted by the ARC, at http://www.arc.agric.za/home.asp?pid=5229.