Effects of para grass (*Urochloa mutica* (Forssk.) T.Q.Nguyen) invasion on terrestrial invertebrates of a tropical floodplain

Michael M. Douglas\(^1\) and Ruth A. O’Connor\(^{1,2}\)

\(^1\) Charles Darwin University, Darwin, Northern Territory 0909, Australia

\(^2\) Present address: CRC for Freshwater Ecology, University of Canberra, Canberra, Australian Capital Territory 2601, Australia

**Summary** Para grass is becoming an increasingly common weed across Australia’s tropical rivers and floodplains. There are concerns about its effects on biodiversity, but there have been few attempts to quantify these. This study compared the terrestrial invertebrates found in para grass, two species of native grass, hymenachne, wild rice, and areas where para grass was removed with herbicide. Samples were collected in the dry season and the wet season. In both seasons, para grass had lower richness and abundance of terrestrial invertebrates than hymenachne. There were no noticeable differences between para grass and wild rice. Differences were probably due to the lower plant moisture and nutritional quality of para grass and could have effects on other floodplain fauna.

**Keywords** Para grass, weed invasion, biodiversity, floodplain, tropical, invertebrate.

**INTRODUCTION**

Large areas of tropical floodplain throughout northern Australia, are threatened by the invasion of several species of exotic grasses (Douglas *et al.* 1998) which dramatically alter floodplain plant communities (Cowie and Werner 1993). Para grass (*Urochloa mutica* (Forssk.) T.Q.Nguyen), a perennial stoloniferous grass from Africa, was introduced to Australia in 1884 to control river bank erosion, but has since been widely promoted as a pasture grass throughout northern Australia (Clarkson 1995). It is considered a weed outside pastoral systems, and its aggressive invasion of tropical wetlands has led to its listing among the 18 environmental weeds having potential to cause serious impact on a national scale (Humphries *et al.* 1991).

In the early 1900s, para grass was introduced as a pasture grass to the area now recognised as Kakadu National Park. By the early 1990s, para grass was identified as a species with fairly limited distribution throughout the park, but with the capacity to dominate large areas of relatively undisturbed floodplain communities (Cowie and Werner 1993). Park managers were concerned about the continued spread of the species, and considered the use of herbicide to control it, but had little information to assess the environmental impact of the weed.

The effects of para grass on aquatic food webs have been studied for a perennial lowland stream (Bunn *et al.* 1997), and the effects on tropical floodplain invertebrates (Douglas and O’Connor 2003) and fuel loads (Douglas and O’Connor in press) have also been studied. We examined the potential effects of para grass on the terrestrial invertebrates by comparing the invertebrate communities on para grass with those from two common native grasses that para grass displaces: the annual, wild rice (*Oryza meridionalis* N.Q.Ng), and the perennial, hymenachne (*Hymenachne acutigluma* (Steud.) Gilliland). Areas of para grass that were treated with herbicide were also sampled to determine the possible effects of weed management activities on terrestrial invertebrates.

**MATERIALS AND METHODS**

**Study site** The study was done on Magela Creek floodplain, a major tributary of the East Alligator River in Kakadu National Park, Northern Territory, approximately 25 km north of the township of Jabiru (12°40´S, 132°50´E). The climate is monsoonal, and consequently most of the 150 km\(^2\) floodplain is inundated seasonally, usually from January to July. The area contains a mosaic of different native vegetation types interspersed with patches of para grass. The most widespread native grassland communities were dominated by three species: *Hymenachne acutigluma* (~15% of floodplain area), *Pseudoraphis spinescens* (R.Br.) Vickery (~14%), and *Oryza meridionalis* (~12%) (Finlayson 1993). Para grass has displaced large areas of rice and hymenachne in this area (Cowie and Werner 1993), so these species were compared with para grass. All have simple, linear leaves of similar dimensions providing similar surface area of habitat for invertebrates (M. Douglas unpublished data).

Sampling sites were spread out over an area of approximately 2 km, separated by approximately 300 m. Sites were selected to contain a plot dominated by each of the three grasses. Plots ranged in size from 0.1 to 1 ha, and were separated by approximately 50 m. An additional plot of para grass was selected at each site, and these were aerially sprayed with herbicide (Roundup...
Biactive®, active constituent: 360 g L⁻¹ glyphosate) in December 1997, just prior to inundation.

**Sampling** At the end of the 1998 dry season (November), terrestrial invertebrates were sampled from six sites. Sampling was done using a standard insect net. The operator paced through the vegetation, sweeping the net across the tips of the vegetation at every step. A total of 25 paces (or 25 sweeps) constituted a sample, and two samples were taken in each stand. Invertebrates were then transferred to sealed plastic bags and refrigerated until they were preserved in 100% ethanol, within 48 h of collection. Plant cover was estimated within a 2 × 2 m quadrat located in the sampling area and subsamples of vegetation were collected and oven dried to a constant weight to determine moisture content.

Twice during the wet season (February and April), terrestrial invertebrates were collected from four sites. A standard insect net was swept repeatedly through emergent vegetation (or above the water surface if no emergent vegetation was present) along one side of the airboat (covering an area of 0.5 × 2 m) until no more invertebrates were captured. Specimens were transferred to labelled plastic bags then preserved in 100% ethanol. Emergent plant cover was visually estimated from the sampling area prior to invertebrate sampling.

**RESULTS**

Over 2600 invertebrates from 10 orders were collected during the dry season (Table 1). Over half of these were grasshoppers (Orthoptera), with spiders (Aranae), true bugs (Hemiptera) and beetles (Coleoptera) also numerically important (Table 1). Grass types were significantly different for mean richness ($F_{3,15} = 12.5$, $P < 0.001$) and abundance ($F_{3,15} = 14.3$, $P < 0.001$). The invertebrate richness was highest in hymenachne followed by para grass then sprayed para grass and finally rice (Figure 1). The invertebrate abundance in hymenachne was more than double that in para grass which had more than double the abundance of sprayed para grass and four times the abundance of wild rice.

Plant cover during the dry season was significantly higher in hymenachne and para grass than in rice and sprayed para grass ($F_{3,15} = 22.4$, $P < 0.001$, Figure 2). Hymenachne had higher moisture content than all other grasses ($F_{3,15} = 10.8$, $P < 0.001$, Figure 2).

During the wet season over 1200 invertebrates from 11 orders were collected (Table 1). Some of these were adults of insects with an aquatic juvenile stage (e.g. Odonata and some Diptera), whereas others were truly terrestrial (e.g. Orthoptera, Hymenoptera and Aranae). True flies (Diptera), wasps and ants (Hymenoptera), and spiders (Aranae) were the most abundant groups (Table 1). Grass types were significantly different for mean richness ($F_{3,9} = 50.6$, $P < 0.001$) and abundance ($F_{3,9} = 26.5$, $P < 0.001$). The invertebrate richness in hymenachne was about double that in para grass and the abundance was about three times higher (Figure 3). There were no differences between para grass and wild rice but both were higher than sprayed para grass (Figure 3). Plant cover in the wet season was highest

Table 1. Summary of per cent abundance of terrestrial invertebrates collected during the dry season and the wet season over two years.

<table>
<thead>
<tr>
<th>Order</th>
<th>Dry season</th>
<th>Wet season</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aranae</td>
<td>21</td>
<td>7</td>
</tr>
<tr>
<td>Blattodea</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Coleoptera</td>
<td>6</td>
<td>19</td>
</tr>
<tr>
<td>Diptera</td>
<td>3</td>
<td>26</td>
</tr>
<tr>
<td>Ephemeroptera</td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Hemiptera</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Hymenoptera</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Lepidoptera</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Mantodea</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Odonata</td>
<td>1</td>
<td>12</td>
</tr>
<tr>
<td>Orthoptera</td>
<td>51</td>
<td>3</td>
</tr>
<tr>
<td>Thysanoptera</td>
<td>&lt;1</td>
<td></td>
</tr>
<tr>
<td>Trichoptera</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

$n$ = 2618 1209

Figure 1. Mean (±SE) terrestrial invertebrate richness and abundance for the four grass types during the dry season. Letters indicate significant differences; lower case for richness, upper case for abundance.
DISCUSSION

In the dry season, there was evidence of adverse effects of para grass invasion on terrestrial invertebrates, but only compared with hymenachne. Mean richness and abundance in para grass were both lower than in hymenachne. This cannot be attributed to plant cover (Figure 2) or biomass (Douglas and O’Connor, in press), as both are uniformly high in the two grass types. Instead it is more likely due to the higher moisture content of hymenachne. This would be particularly important for taxa feeding directly on these grasses, such as grasshoppers, bugs and caterpillars, which collectively dominated the dry season invertebrate community. In contrast, richness and abundance in para grass was higher than in wild rice or sprayed para grass. This pattern is almost certainly due to the much lower plant cover in these grass types. Wild rice is an annual and had only recently germinated at the time of sampling so plant cover was minimal and offered limited cover or food for invertebrates. Similarly the sprayed areas where vegetation regrowth was fairly limited following the removal of para grass afforded poor resources.

In the wet season, there was evidence that para grass invasion would lead to reduced invertebrate biodiversity and abundance relative to Hymenachne, but not compared with wild rice. Again, plant cover or moisture content could not explain these differences, as these factors were similar across treatments (M. Douglas unpublished data). The differences in invertebrates between the three grass species may also be a reflection of the differences in their nutritional quality. Carbon to nitrogen ratios indicate that hymenachne is a superior food source to para grass, which is better than wild rice (S. Bunn unpublished data). Together with moisture content this may explain the major differences although microhabitat and microclimatic differences within the grass communities may also contribute. The much lower richness and abundance in the sprayed para grass is most likely due to the substantially lower cover of emergent plants.

The reduction in abundance and richness of the invertebrate fauna following a transition from
hymenachne to para grass has implications for floodplain fauna that consume invertebrates such as birds, fish and frogs. This may contribute to the substantially lower abundance of birds and frogs reported for areas dominated by para grass compared with areas without para grass (Beggs et al. 2003).

It is interesting to note that terrestrial and aquatic invertebrates show very different responses to para grass invasion. Aquatic invertebrates were also sampled at these sites (Douglas and O’Connor 2003) but they showed no consistent differences between grass types although there was some evidence of lower abundance in hymenachne. Clearly these two groups of invertebrates are responding to very different influences and this demonstrates the advantages of a comprehensive sampling program to detect the impacts of weed invasion.

Our results add to a growing body of literature documenting the effects of para grass invasion in northern Australia (Bunn et al. 1997, Douglas and O’Connor 2003 in press). Para grass invasion will have variable impacts on terrestrial invertebrate richness and abundance depending on the grass communities that it displaces. While there may be no detectable changes where para grass displaces wild rice, where it displaces hymenachne, the changes will be great and this will likely have implications for other floodplain fauna. Thus our study supports the need for control of para grass infestations but it also identifies that spraying para grass, while effective in reducing its cover, will also reduce invertebrate richness and abundance in the short term.

ACKNOWLEDGMENTS
Funding was provided by Charles Darwin University, Environment Australia and Land and Water Australia as part of the National Wetlands R and D program. The Department of Environment and Heritage (formerly the Environmental Research Institute of the Supervising Scientist and Parks Australia) provided logistic support. We thank the traditional owners of Kakadu National Park for allowing access to the sites.

REFERENCES


