

# Red flags in a sea of green

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## Abstract

This article covers the author's experiences over many years, with invertebrates in general and with the spectacular and enigmatic Leichhardt's Grasshopper (*Petasida ephippigera*) (Orthoptera: Pyrgomorphidae) in particular. It recalls her initial introduction to CSIRO, then employment with this organisation in Kakadu National Park, then 'falling for' *Petasida ephippigera*, and finally her own studies on it at Davidson's Arnhem Land Safaris on the Cooper Creek system at Mount Borradaile. Many questions flow on from these initial observations, particularly the relationship between this insect and fire.

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## Introduction and history of discovery

Looking back over close to 30 years, it feels like we are now living through another period of 'lost knowledge' and intergenerational change, similar to that of the 1900s when Leichhardt's Grasshoppers went unseen for some 70 years. From 1991 onwards, many of the staff from Parks Australia North retired, moved onto other departments or took on other areas of interest. And the same holds true for scientific researchers. Therefore, currently, long-term memory and prior knowledge of this special species of grasshopper that forms the subject of this article and its habitat are at risk of being lost. Aboriginal elders have passed away and younger Aboriginal people might have lost or forgotten once widespread knowledge – as was noted by Ngukurr/Yugul Mangi Rangers of southeastern Arnhem Land who, on 20 January 2015, asked the researchers who were accompanying them: "Who or what are these grasshoppers?"

The adjective 'spectacular' comes to mind when describing the colouration of the Leichhardt's Grasshopper (*Petasida ephippigera*) (hereafter simply "the Grasshopper(s)"). Adults have a black and orange-red body, wings and legs, alternating dark and light antennal segments, and an orange-red and bright blue head and pronotum (Morris 1996; Holbery 2011; O'Dea 2014; McKay 2015). Adult females (measuring 60 mm) are larger than adult males (measuring 45 mm) (pers. obs.). I like to think of these strikingly coloured Grasshoppers as 'Little red flags in a sea of green' in the sandstone country of Arnhem Land. *Petasida ephippigera* is easily seen on its principal host plant, the lamiacean *Pityrodia jamesii*, a perennial mid-green coloured aromatic shrub with a sage-mint odour when crushed.

When handled, the Grasshoppers often exude a brown sticky liquid, like tobacco juice, from the mouthparts as a chemical defence (Fletcher *et al.* 2000). On one occasion I



**Figure 1.** Leichhardt's Grasshopper, a 'Street Art' wall painting by Jesse Bell on the exterior of the Darwin Entertainment Centre, Mitchell Street, Darwin. November 2019. Reproduced with the artist's permission. (Photograph by Paul Arnold)

decided to taste the liquid myself, as a Scottish scientist suggested “you have to eat your study animal at least once”. I don't remember the liquid being distasteful and am still around to tell the tale. The website for Kakadu National Park suggests: “the grasshoppers secrete a smelly brown substance that tastes awful to any animals looking for a snack” and Fletcher *et al.* (2000) suggest the Grasshoppers are rich in terpene glycosides, which are non-toxic but known to be bitter tasting. There seems to be no mammalian predators, although I have seen an adult female green praying mantid eating the Grasshopper from the head-end.

Adult males and females aggregate together. Copulating animals can be observed in ‘piggy-back’ position, which can continue for 24 hours. This long copulation is thought to eliminate insemination by other males (David Rentz pers. comm.).

The nearest relative of *Petasisida ephippigera* (the sole species in the genus) is *Scutillia verrucosa* (another monogeneric species) which is found in the heathlands of southwestern Western Australia. Both these species are in the tribe Petasidini, but isolated from each other.

A question which exercises my mind: “Is Africa a possible epicentre of the Pyrgomorphidae?” If so, how did these two Australian species come to be so widely separated – by approximately 2000 kilometres? I jokingly suggest that *Petasida* jumped aboard a northward-floating Australia after the breakup of Gondwana. *Scutillya* jumped aboard a little later. Or were they both already on that portion of the continent which floated away and became separated by desert as the continent dried? Key (1985) hypothesises that *Petasida* and *Scutillya* may have had a common ancestor in Poecilocerini (another tribe in the subfamily Pyrgomorphinae), as throughout the Cretaceous geological period Western Australia and India were in contact or near contact.

As the common name Leichhardt's Grasshopper suggests, the specimens collected by the explorer Ludwig Leichhardt were the second in a series of collections made in northern Australia in the 1840s. Leichhardt collected them on 17 November 1845 to be exact, at Deaf Adder Creek in the headwaters of the South Alligator River – now within Kakadu National Park. Imagine the scene; storms brewing over the Arnhem Land plateau, and thunder and lightning strikes [Normand (2017) describes the idea of “a pale skinned travelling Ceremony Man carrying a spear which shot lightning”]. No wonder the Aboriginal people mistook Leichhardt for *Namarrkon* the Lightning Man. Gundjehmi speakers call the Grasshoppers *Alyurr* and believe they are the children of *Namarrkon* the Lightning Man; a powerful creator ancestor/being. *Alyurr* call out to their father who answers with storms and lightning when clinking his stone axes (Chaloupka 1993).

Another perspective comes from a quote by Leichhardt himself: “Whilst on expedition we observed a great number of grasshoppers, of a bright brick colour dotted with blue, the posterior part of the corselet, and the wings were blue, it was two inches long, and its antennae three quarters of an inch” (Leichhardt 1847).

The three initial/early collections were:

- By purser John Dring aboard HMS *Beagle* during Matthew Flinders' circumnavigation and mapping of the Australian coast between 1837 and 1843. The *Beagle* travelled 260 km along the Victoria River. The holotype (a female specimen) was taken to London, described by White in 1845, and deposited in the British Museum of Natural History in London.
- By Ludwig Leichhardt at Deaf Adder Creek headwaters on 17 November 1845 as mentioned above.
- The third collection was made during the A.C. Gregory expedition of 1855–1856 at a site very close to the present day township of Timber Creek (Calaby & Key 1973). The Gregory expedition set out to find Leichhardt, who had disappeared on an earlier inland expedition.

There were no further collections for well over 100 years until mining activities and pastoralism commenced in Arnhem Land. Although the Grasshoppers are obvious in the Wet season, they went unrecorded due to limited accessibility of the country.

Early in 1970, Aboriginal people from Milingimbi approached Bob (R.L.) Collins, a Technical Officer with CSIRO. [Bob later become Member of the Legislative Assembly of the Northern Territory after Self Government in 1978.] They had in excess of 20 live Grasshoppers and they asked Bob: “Who or what are these?” Bob sent the specimens to CSIRO (Australian National Insect Collection, hereafter ANIC) in Canberra. They were fed a diet of lettuce (as little was known of their food plants). After they died they were curated and deposited in the ANIC collection.

Anecdotal evidence from Tony Press (pers. comm.) [Director of Parks Australia North] early in 2000 suggests there was an “explosion” of populations of the Grasshopper on the sandstone escarpment at Spring Creek where there were thousands eating themselves out of “house and home” until no vegetative parts remained on the host plants.

The lack of collections and sightings of the Grasshoppers seems relevant to the present time, where our ‘working life’ span comes to an end. Knowledgeable and experienced people transfer to other government departments, or even states, as they retire or move away from the Northern Territory. So, with a lack of management interest and funds, as well as the passing of Aboriginal elders, knowledge is not being passed on and becomes lost altogether.

### **My interest in the Grasshoppers**

My interest piqued when I was working for the CSIRO. Dr David Rentz [Curator of Orthoptera at ANIC] visited the Tropical Ecosystems Research Centre, which was part of CSIRO in Darwin, in 1991 to study the orthopteran collection. He suggested a visit to Kakadu National Park to locate the Grasshoppers. We visited but did not find any of them. I revisited the Park regularly over the following year, and in January 1992 I came across 19 individuals close to Baroalba Springs carpark.

During the years 1992–1994 I observed the Grasshoppers along the Baroalba Springs Road, Koongarra Saddle and Little Nourlangie Rock, all within Kakadu National Park. Fire was a threat to people and Park assets, as well as the Grasshoppers. If they survived fire, but their food plant was burnt, then what? If they died, then there was no reproductive event. This fate of ‘death by fire’ also happened in other areas of the Northern Territory. Or did they all die? Perhaps their eggs persisted underground like other invertebrates. Or did juveniles drop to the ground ahead of the fire? Or did the adults fly ahead of the fire?

I was unsuccessful in obtaining a Research Permit from Parks Australia North to investigate these questions, but in April 1995 I met Max Davidson of Davidson’s Arnhem Land Safaris. The Davidson’s safari camp was on a leased area along the Cooper Creek system at Mount Borradaile, 55 km north of Kakadu National Park in western Arnhem Land. Max offered me support in the form of accommodation, food and transport (in an old-style Toyota open back safari wagon). During a trip to the camp with a Japanese film crew late in 1999, he and I discussed the possibility of an

observational study. Max was concerned about the survival of the Grasshoppers on his lease, noting the populations were in decline. Our observations began with a visit to the camp to walk the lease and find the Grasshoppers and their habitat. The Grasshoppers are one of many (tourist) attractions at the camp (and in the Northern Territory in general) and we agreed to proceed with our study. Our observations were initiated in January 2000 and the last survey was in March 2005. A traditional owner of his mother's country – Mount Borradaile area – visited the camp frequently and was in attendance during discussions. The areas where we found the Grasshoppers included the causeway, the paperbark beds, the swimming hole sand sheet, the white stone line trail (north of the camp), and others. I visited regularly every five to six weeks for three to five days at a time. All the grasshoppers we located were counted (Queen Bee Labels were used to tag them initially, but were ultimately unsuccessful), as well as the *Pityrodia jamesii* shrubs on which they were living.

Adult male and female Grasshoppers were distinguishable and sedentary; they were observed to remain on their host plant for their entire life. Sometimes they were easily disturbed and responded, as do Frilled-neck lizards (*Chlamydosaurus kingii*), by creeping to the other side of the stem from the observer – a typical avoidance behaviour.

### **The Grasshoppers; juvenile and adult**

Early in the study at Mount Borradaile I thought the Grasshoppers hatched after the first rains of the Wet season. However, hatching is now thought to be irregular and variable. Recently, Peter Holbery [a local naturalist] has suggested that hatching of the Grasshoppers has become more variable and juveniles are found in May to November. He has suggested that above-average rainfall and a pronounced Wet season could result in a longer growing season for the food plants and this, in turn, might be resulting in better quality nutrition, thus enabling the Grasshoppers to mature earlier than usual (Holbery 2011).

Juveniles hatch early in the oncoming Dry season and measure approx. 10 mm in length; their colouration is pale green with black spots on the body and alternating pale and black antennal segments. When viewed against the apical tips of the host plant, the alternating segments of the antennae are easily seen, but they are well camouflaged in profile. Juveniles transform from one instar to the next and the colours gradually darken. Barrow (2009) observed the nymphs are elaborately patterned but cryptic, and Rentz (1996) suggested there are six or seven instars (moult) before maturity. The spectacular colouration is most obvious at the last two instars with the appearance of wing buds.

I found that females carry 80 or more eggs. Barrow (2009) found the eggs of the Grasshoppers are laid in wet sand below the host plants and within 2.5 cm of the soil surface.

As adults age, their wings become tatty or break. They die, and may get hung up in the twigs of *Pityrodia jamesii*, where they are consumed by ants.

## Where are the Grasshoppers found?

The Grasshoppers are known to occur in scattered localities north of 16°S in western and northern Arnhem Land and the eastern Kimberley-western Victoria River District (Calaby & Key 1973; Lowe 1995; Wilson *et al.* 2003; ALA 2020). Within this range they have been found in Nitmiluk National Park, where I encouraged further study by rangers by forwarding a Research Plan and data sheet. They are also found in Keep River National Park, but those individuals appear paler than those further east. Anecdotal evidence includes occurrences in areas on the mainland adjacent to the Wessel Islands off the eastern Arnhem Land coast, and at Bulman. Local fishermen suggest they occur also at the Fitzmaurice River mouth along the Northern Territory coast (pers. comm. to author by an officer of Northern Territory Police at Timber Creek Police Station 1994).

Fire has changed the habitat. In February 2014 I was invited to participate in a survey of the Grasshoppers conducted by rangers and Aboriginal family members at a site near the Bowali Visitor Centre at Kakadu National Park Ranger Headquarters. Numerous adults were observed on recently burnt, low vegetation and within sight of the escarpment. I commented to a ranger that “the vegetation had thinned remarkably” since the days of my initial visits in 1991, wherein the escarpment walls were unable to be seen through the thick vegetation. The ranger was unaware of the thinning, and looked worried as he spoke. In 1994, along the road to Baroalba Springs, the previously dense vegetation was heavily impacted by fire, following years of burning by Parks and Wildlife to prevent late season hot fires burning into Kakadu National Park from Bulman in the south. Incendiaries were dropped from helicopters onto the sandstone escarpment country and the resulting fires burned for weeks at a time – on two occasions in excess of two weeks.

## Host plants

*Pityrodia* is an Australian endemic genus of lamiacean plants of Gondwanan origin (Specht 2012). *Pityrodia* was first described by Robert Brown in 1810 while on Matthew Flinders’ circumnavigation of the Australian coast. *Pityrodia jamesii* is the host to the Grasshoppers at Mount Borradaile and other areas within Kakadu National Park. The type specimen of *Pityrodia jamesii* was collected during the 1948–1951 American-Australian Scientific Expedition to Arnhem Land. The plant is endemic to the Northern Territory, and occurs widely in the East and South Alligator Rivers region.

Interestingly, Holbery (2011) claimed that all developmental stages of the Grasshoppers were more often found on less vigorous plants of *Pityrodia jamesii*. Vigorously-growing food plants appear to be avoided (Holbery 2011).

*Dampiera conospermoides* was one of the host plants on which the Grasshoppers were found during the American-Australian expedition, as well other species of *Pityrodia*. A species of native *Gardenia* is also recorded as a food plant (Key 1985). In Nitmiluk National Park the host plant is *P. pungens*, but in Keep River National Park it is *P. ternifolia* (Wilson *et al.* 2003).

Some years ago the Territory Wildlife Park at Berry Springs near Darwin had proposed an invertebrate display that included the Grasshoppers. However, the Park was unsuccessful in propagating the host plant, thus making it difficult to keep the Grasshoppers in captivity. I have had similar difficulty when trying to grow the host plant.

## Fire

Fire is a common occurrence in the sandstone heath country in the Top End of the Northern Territory and *Pityrodia* is an aromatic plant which burns readily. However it regenerates quickly from root stock and grows to approximately 6 or 7 cm within three weeks. In the early years of my interest in the Grasshopper, I observed late Dry season fires burn in, and around, Nourlangie Rock for many weeks. So I wondered how populations of this insect reacted to fire. One possibility is that individuals could fly out of range of the advancing flames (I observed a flight of more than 100 m by adults at Mount Borradaile). Another possibility is that individuals sit atop the host plants as fire/smoke draws near and then fall to the ground taking refuge under rocks before the fire strikes. During the Kapalga Fire Experiment I observed many other (different) species of grasshoppers flying ahead of the fire, and crickets and other readily mobile invertebrates racing up tree trunks well in advance of fire fronts, and certainly well before awareness of the impending fire by humans. Maybe the Grasshoppers possess this fire sense too?

What do the Grasshoppers feed on after a fire? And do they escape burnt areas and feed on other resources? Or do they starve and die? I observed that after a fire near Baroalba Springs, juveniles feed on the furry bark of dead/burnt *Pityrodia* plants, and Barrow (2009) made similar observations. While the plants themselves regenerate from the root stock, their seeds have dropped onto sandstone rock surfaces and, following Wet season monsoon rains, they are funnelled by flowing water between rocks and drainage lines where nutrients accumulate. I have seen germination by seeds that were caught up amongst fire debris.

During repeat visits to sites in the early years of the Mount Borradaile study I noticed that Grasshoppers rarely hatched out at the same sites on consecutive seasons, and Barrow (2009) in his study recorded only one site at which their eggs hatched on two consecutive years. Early in my 'orthopteran career' David Rentz mentioned that the eggs of the Grasshoppers might remain viable underground for seven to 10 years. So perhaps the soil could insulate the eggs at this depth provided their viability remained intact (pers. obs. based on observations made during CSIRO's Kapalga Fire Experiment in 1995).

Grimaldi & Engel (2005) suggest cicadas have existed for between 40 and 200 million years; so is it possible these pyrgomorphs had a similar life history initially? Is it possible that the Grasshopper pre-dates the breakup of Gondwana and the strategy of having eggs that remain underground might be an adaptation to unpredictable, fluctuating climatic conditions or environmental uncertainty? Later Aboriginal burning practices

and contemporary European burning practices using incendiaries might also have impacted populations. Barrow (2009) reminds us that the Grasshopper certainly pre-dates Aboriginal burning practices.

Through this process of writing it seems clear to me now that David Rentz may have harboured these thoughts and questions long ago, but at that time I had not ‘connected the dots’ to understand these connections.

## Acknowledgements

I am grateful to David Rentz for instigating my voyage of discovery on this fascinating insect. I hope that my experiences and reflections will stimulate readers’ interest in this ancient animal and landscape. I must also thank the late Max and Phillipa Davidson for their generous support of the project at Mount Borradaile. This article was one of a series of essays written for a museum exhibition by Melbourne-based artist Simon Normand on Ludwig Leichhardt that was planned to be published in 2020, but unfortunately COVID-19 took care of that. Simon describes the exhibition as being in a “comatose” state now so he generously agreed that I publish the essay as an article in *Northern Territory Naturalist* to stimulate discussion on the content and the questions posed. I am very grateful to him for this agreement. Jesse Bell has approved the reproduction of his artwork. In the Northern Territory, the 2021 Wet season is underway as are the adult Grasshoppers, so it is a very opportune time to publish this article.

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