The ecology of Ward's Weed *(Carrichtera annua; Brassicaceae);* a weed of the southern rangelands of Australia

Julia Cooke[1,3], Dr. Julian Ash[1], Dr. Richard Groves[2]

[1] Department of Botany and Zoology, Australian National University
[2] CSIRO Plant Industry, Canberra
[3] Current address: Biological Sciences, Macquarie University (jcooke@bio.mq.edu.au, Tel. 9850 8160)

Ward's Weed (*Carrichtera annua*: Brassicaceae) is a widespread but relatively unpalatable annual herb that now dominates wide areas in the semi-arid rangelands of southern Australia. The aim of this Honours project was to identify the main factors effecting the abundance and distribution of this species with a view to developing control methods.

Collated herbarium records show the spread of the weed since its accidental introduction at Port Pirie, South Australia in the early 1900s, and suggest the limits of its distribution may now have been reached (Figure 1).

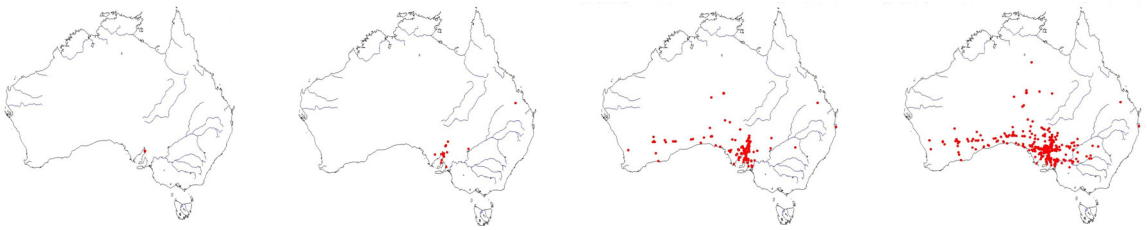

Figure 1. The spread of *C. annua* over time as shown by herbarium records.

Climate analysis using BIOCLIM showed that Ward's Weed appears to be restricted to areas with winter-dominated rainfall and mild winter temperatures (Figure 2) and preliminary studies suggested a link with calcareous soils (Figure 3).

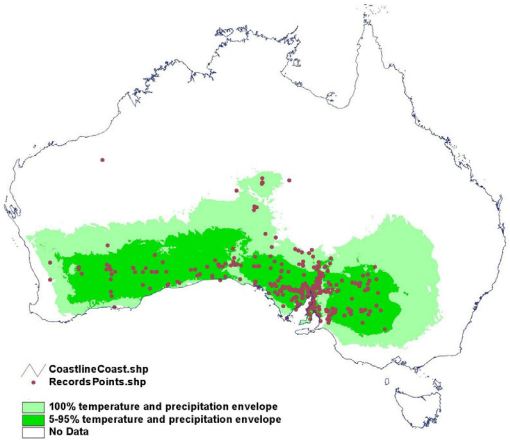

Figure 2. Current (red dots) and predicted (green) distribution of *C. annua* using the temperature and precipitation of the hottest and coolest quarters.

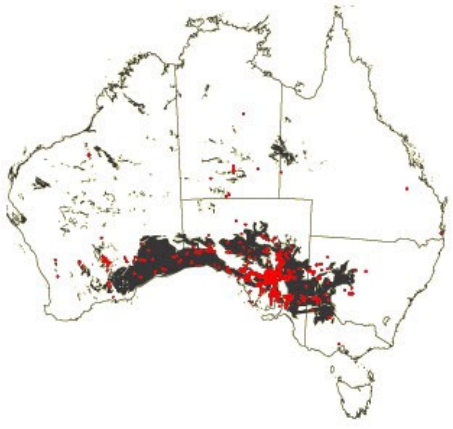

Figure 3. Overlay of *C. annua* location points (red) on a map of calcareous soils (Australian Audit Atlas).

The annual life cycle is shown in Figure 4. *Carrichtera annua* is capable of producing 30,000 seeds/m^2 annually. Interestingly, this invasive species has two distinct seed banks; a pod seed bank (where seeds are retained in lignified pods on dead adult plants between growing seasons) and a soil seed bank (where a mucilaginous coat on the seed allows adherence of seeds to the soil surface) The adaptive significance of this seed coat became obvious during our experimental studies.

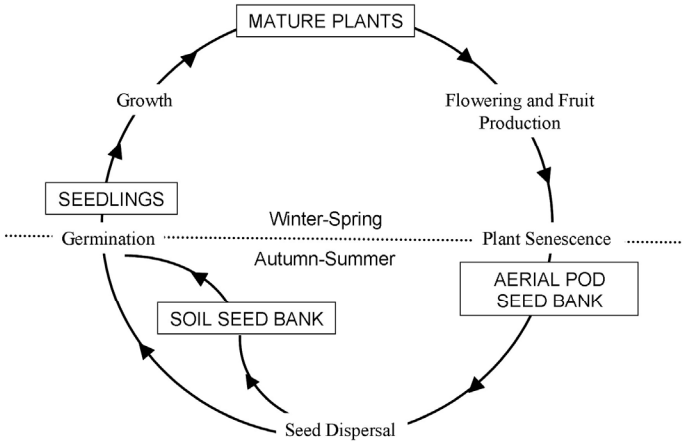

Figure 4. Lifecycle of *C. annua*

Field studies were conducted in the Flinders Ranges National Park where *C. annua* forms dense ground cover (Fig. 5); the more interesting results are as follows:

- In 24 hour periods ants removed 70% of free seeds and 40% of adhered seeds from experimental plots
- Ant predation could remove up to 90% of loose seed annually
- In the dark (e.g. seed buried by ants, Figure 6) 1% of seed germinated but 90% germinated in light conditions
- Fire effectively removed the pod seed bank and germinations the following year were equivalent to the size of the much smaller soil seed bank
- After 12 months 5% of surface seed and 50% of buried seed remained viable

Figure 5: Field site in the Flinders Ranges showing a burnt area and a roof used to manipulate rainfall in the field.

Figure 6: Cross section of ant nest showing *C. annua* seeds (the pale seeds have been husked).

Together with published data, the experimental findings were used to create a population dynamics model. The model, which included competition from a perennial plant, illustrated that the success of this weed can mainly be attributed to its massive seed production, low palatability and the unusual aerial seed bank, though the latter offers a vulnerable seed store that could be targeted in control procedures. However, the model also predicted that *C. annua* could recover from removal of the pod seed bank after only one or two growing seasons.

An integrated management approach using burning, reestablishment of perennial plants and reduction in grazing pressure is proposed to reduce the abundance of *C. annua* but the model highlighted the severity of control measures required to significantly reduce populations.