

The reinvigorated mass-rear and release program of a past biological control agent, *Lagocheirus funestus* (brown prickly pear stem borer) on Opuntoid cacti in Australia.

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Summary

Australia has over a century of experience in using biological control to manage invasive Opuntoid cacti. While *Cactoblastis cactorum* is celebrated for its success in the 1920s, other agents, like *Lagocheirus funestus* (brown prickly pear stem borer), also played a significant role. Introduced in 1935, *L. funestus* effectively targeted *Opuntia tomentosa* and *O. streptacantha*, but its long-term impact remained unclear. In 2023, interest in *L. funestus* was renewed, leading to a mass-rearing and release program initiated by Queensland's Department of Primary Industries (QDPI) in 2024. This paper examines the historical and modern efforts to utilise *L. funestus* in controlling prickly pear infestations, highlighting advancements in rearing and release techniques and the agent's potential to combat invasive cacti in Australia.

Keywords Opuntia, biocontrol, mass-rearing, prickly pear, Australian Government, Drought Funding, CISS.

INTRODUCTION

The Commonwealth Prickly Pear Board was formed in 1920 to address the growing prickly pear invasion problem. In 1928, the Board expanded its program to target *Opuntia tomentosa* (velvety tree pear) and *Opuntia streptacantha* (Westwood pear), two invasive tree Opuntoid cacti species classified as 'less important prickly pears' (Dodd 1940). This initiative built on the success of the earlier *Cactoblastis cactorum* release program.

In 1935, following exploratory efforts in southern Mexico, the Commonwealth Prickly Pear Board initiated a mass-rearing program for the cerambycid longicorn beetle, *Lagocheirus funestus* Thomson 1865 (formerly *Archlagocheirus funestus*).

Rearing facilities in Queensland facilitated the release of adult beetles and pupal cases across

southeastern Queensland and northern New South Wales. The larval stage of *L. funestus* caused significant structural damage to the stems and trunks of the cacti by burrowing into them to feed, leading to the collapse of limbs and entire plants.

Despite the program's success, researchers noted that the beetles gradually disappeared from most districts from 1969 onwards (Mann, 1970). While *L. funestus* was deemed successfully established and extensive damage to the prickly pear population observed (Dodd 1940), it was later classified as possibly extinct in Australia (Slipinski and Escalona 2013). Notably, *L. funestus* is rarely mentioned in the literature on Australia's or Queensland's cacti control success stories.

Lagocheirus funestus faded into obscurity until 2023, when it was rediscovered. During monitoring of *Opuntia tomentosa* in southern Queensland, research scientists from the QDPI observed larval damage and identified an adult *L. funestus* (Shortland and Callander 2023). This discovery reignited interest in the beetle as a biological control agent, leading to a renewed mass-rearing and release program, alongside enhanced monitoring efforts to assess its impact.

In early 2025, adult beetles were released across central and southern Queensland from two QDPI facilities, marking the resumption of the program 90 years after its initial implementation. The program received additional funding from mid-2025 as part of the Centre for Invasive Species Solutions project, Weed Biocontrol Network for Drought Resilience, funded through the Australian Government's Future Drought Fund. This funding has enabled the expansion of mass-rearing and release activities on a national scale, with plans to continue through to June 2028.

LAGOCHEIRUS FUNESTUS BIOLOGY

The adult beetle, measures 20–40 mm in body length with a mottled black and brown appearance (Figure 1a) and size varies due to food availability in the larval stage. Adults live up to 89 days (Dodd 1940). Males can be distinguished by a short, curved hair projecting on the inner tip of the antennae. Adults are primarily nocturnal, feeding on the outer surfaces of prickly pear (*Opuntia* spp.) trunks, stems, or cladodes, and often sheltering in leaf litter at the base of plants (Mann 1969).

Under natural conditions, the species completes one generation per year, with adult emergence triggered by mid-summer rainfall (Mann 1969). Females create intricate egg furrows on the stem surface, typically beneath branch attachment points or at the lower portion of the main stem. Each female lays 50–75 oval eggs (1–2 mm in length), primarily during spring and summer months following rainfall events (Mann 1969). Eggs incubate for 7–12 days and are sensitive to low humidity.

Newly hatched larvae burrow into the stem and feed gregariously, growing to 25–30 mm in length over 80–100 days (Figure 1b). Mature larvae construct cocoons or pupal cases (30–50 mm in length) from macerated fibrous stem material (Figure 1a), where they pupate for 18–30 days before emerging as adults. The total life cycle ranges from 105 to 175 days (Mann 1969).

Figure 1a-c. *Lagocheirus funestus* newly emerged adult on a pupal case, mature larvae and furrowed *Opuntia tomentosa* stem.



MASS-REARING

Historical

A mass-rearing program for *Lagocheirus funestus* was initiated in 1935 at Sherwood, Brisbane, before being relocated to the primary rearing facility at Gogango, central Queensland. Additional rearing activities were also conducted at Scone, New South Wales. Wire cages measuring 0.9 x 0.9 x 1.8 m were used located outside in shaded positions. A layer of moist sawdust was added to the flooring to increase humidity and the cages were watered weekly. Each cage contained 12 cut stems, 90 cm in length, placed

upright with a few pads to facilitate oviposition. Six pairs of adults were introduced into each cage for breeding. After oviposition, the stems were transferred to separate cages and laid horizontally, where they were watered fortnightly. Once pupal cases were formed, the stems were dismantled, and the pupae were collected (Dodd 1940).

The program successfully produced two complete generations annually at the Gogango facility, with peak adult emergence occurring in November–December and April–May, although adults emerged throughout the year (Dodd 1940, Mann 1969). The first rearing generation in 1935 yielded 2,850 adults from 788 individuals, with an average return of 12 adults per female. In one instance, 342 females (684 total males and females) produced 12,462 adults, equating to an average of 36 adults per female (Dodd 1940).

Current

In December 2023, a rearing program for *L. funestus* was initiated at the Queensland Department of Primary Industries' (QDPI) Ecosciences Precinct (ESP) in Brisbane. The program began with five adults collected from the field in southern Queensland, along with *O. tomentosa* stems containing *L. funestus* collected in July 2023. By July 2024, 21 adults (12 females and 9 males) were transferred to QDPI's main mass-rearing facility, Tropical Weeds Research Centre (TWRC) in Charters Towers to establish a colony. An additional 12 adults (6 females and 6 males) were sent to TWRC in October 2024. The rearing activities at ESP concluded in April 2025, with TWRC continuing the mass-rearing of *L. funestus*.

Field collected *O. tomentosa* stems, ranging in diameter from 5 cm to 25 cm, are sourced and stored in a dry, open room for up to one month prior to use. The stems are cut into 30–40 cm lengths and placed into 0.9 x 0.87 x 0.80 m rearing cages housed in climate-controlled glasshouse conditions (Murree and Butler 2025). Each cage contains three to four stems of varying sizes, a potted *O. tomentosa* plant, and numerous cladodes, which are positioned horizontally and slightly ajar on an overturned seedling tray. This provides ample food, oviposition sites and places for the adults to hide.

Between two and four newly emerged adult males and female pairs are introduced into each cage and remain there until death or are released within one month of emergence. Overcrowding in the cages is avoided, as higher densities result in increased

mortality, antennal damage (particularly in males), and reduced egg furrow production. If adult mortality occurs, additional individuals are introduced to maintain numbers. Cages are maintained for a maximum of two months, after which they are cleaned with chlorine before being reused.

Adult females exhibit a preference for furrowing on darkened stems, with diameters of 13–15 cm, with activity declining after one month of adult age. Furrows are predominantly located on the underside of the stems and at the cut ends (Figure 1c). Stems are removed and replaced every 10–14 days once egg furrowing is observed. Removed stems are labelled with the cage setup/insertion date and stored horizontally on gauze-covered metal benches within the glasshouse (Figure 2a). The cage floor and walls are cleaned before new stems are introduced and dead adults removed to prevent ant activity. Stems with minimal or no furrowing may be reused.

Benched stems are lightly sprayed with water every second day to facilitate egg eclosion and larval development. After eclosion, larvae burrow into the stems, initiating macerating feeding activity that softens the interior of the stems, causing them to ooze from the furrowed ends. As larval feeding progresses, fibrous material and liquid sap are extruded from the stems. Additional cladodes are placed beneath the stems as supplementary feeding material for the developing larvae, if required.

Figure 2a & b. Furrowed *Opuntia tomentosa* stems and adult eclosion stem tubs in the glasshouse at TWRC and packed adults for distribution.



After two months, the benched stems and associated plant material are transferred to 50–75 L plastic tubs with aerated lids or secured gauze (Figure 2a). The tubs have multiple 10 mm drainage holes at the base to prevent waterlogging from decomposing material. Four to eight stems from similar cage timeframes are placed in each tub, with additional cladodes layered between the stems. Initially, 2 cm of river sand was added to the base of the tubs to absorb excess moisture and provide pupation sites. However, this practice was discontinued due to an increase in *Beauveria* fungus populations and

subsequent pupal mortality, even after rinsing and chlorinating the sand between uses. To maintain a moist but not overly wet environment for pupation, benched stems are transferred to the tubs only after oozing has slowed. The tubs are kept in the glasshouse and lightly sprayed with water weekly, or more frequently if the stems appear dry.

Over time, pupal cases form within the stems or in the fibrous material at the base of the tubs. As the stems decompose, the stems become lighter, with peeling bark providing shelter for newly emerged adults. Adults are collected from the tubs every 1–2 days and are either released, transferred to new rearing cages, or used to supplement existing cages. Care is taken not to disrupt the stems or pupal cases, as mortality increases if the pupal case is ruptured or disturbed. Emerged adults can have deformed elytra or wings, these adults are not used for rearing purposes. To prevent adult escapes, fresh cladodes are placed in the tubs, as adults may chew through the gauze in search of food or mates during the nights. Escaped adults have been predated upon by unwanted toads or frogs in the glasshouse.

When adult emergence declines or ceases, the tubs are emptied, and any remaining intact pupae are collected and transferred to smaller lidded containers. These containers are kept moist to facilitate eclosion. Alternatively, intact stems are placed in holding cages or upright 75 L lidded bins and maintained in a moist environment for an additional two months to accommodate late-emerging adults.

Rearing cages are set up throughout the year to maintain a mixed developmental stage colony. To date, 655 cages have been established, resulting in the emergence of 2,741 adults, with 45% of emergence occurring between December – February. On average, two generations are produced annually, with a mean life cycle duration of 150 days and a maximum recorded duration of 285 days.

RELEASING

Historical

Releases started in May 1936 and continued until 1940, with a total of 119,060 adults or pupa in 70 liberations, occurring mainly in central Queensland in the dense thickets of *O. tomentosa* (Dodd 1940). The board terminated in 1939, with the Queensland Government forming the Biological Section of the Department of Public Lands taking over in Queensland. Mass-rearing continued in Queensland and New South Wales, until 1953, and a total of 247 liberations were made of 523,320 adults released from May 1936 into central Queensland, Taroom and

Maranoa districts, southern Queensland and Hunter Valley in New South Wales (Mann 1970). No details on release strategy have been found in literature.

Current

In early 2025, adult *L. funestus* beetles were released across central and southern Queensland from two QDPI facilities as part of a biological control program targeting invasive Opuntoid cacti. In mid-2025, the program received funding through the aforementioned Australian Government's Future Drought Fund. This funding facilitated the expansion of mass-rearing and release activities to a national scale, with operations planned to continue through to June 2028. The expansion has enabled the introduction of *L. funestus* to new release sites in South Australia, coastal New South Wales, and additional locations within Queensland.

Adult beetles, less than one month old, are transported via overnight courier in individual paper tubes containing a small segment of *O. tomentosa* cladode (food source) and sealed each end with crunched paper towel. Males and females are shipped in separate containers, with five tubes placed per rectangular takeaway container (Figure 2b). The containers are packed in a Styrofoam box with an ice brick to maintain a cool temperature during transit. A plant movement permit is attached to shipments destined for South Australia. Upon arrival, beetles are released within 48 hours, either in the late afternoon or early morning. Mortality during transit is minimal and some individuals consume the paper tubing during transport.

The current release strategy involves introducing 5–6 paired adults directly onto every second or third Opuntoid tree within a 30 m × 30 m area. Trees under 1 m in height are excluded from releases, and sites are selected to include at least two large plants to ensure sufficient resources for establishment. Existing populations of *Cactoblastis cactorum* and *Dactylopius spp.* are documented at release sites, as these species target younger plants and regrowth, complementing the activity of *L. funestus*.

Releases have been conducted across a range of land types, including private properties, state land, local council reserves, road verges, national parks, state forests, and mine sites. The program involves collaboration with landholders, state and local government agencies, and private enterprises to facilitate the implementation of the biocontrol strategy.

To date, the ESP has conducted four releases, liberating a total of 78 adults, while the TWRC has co-ordinated 27 releases, liberating 1,783 adults. These releases have targeted five Opuntoid species across Queensland, New South Wales, and South Australia, with releases occurring throughout the year, but mainly during spring and summer. Due to the geographic location of TWRC, releases are carried out by recipients of the beetles, who are provided with detailed instructions.

DISCUSSION

The historical efforts in rearing and releasing *L. funestus* since the 1930s have provided a critical foundation for contemporary mass-rearing initiatives. Despite the significantly higher release numbers achieved in the past, current strategies are optimising release locations and timing to enhance the establishment and spread of the agent. Public awareness of *L. funestus* has notably increased following its detection in 2023, aided by the utilisation of citizen science platforms such as iNaturalist Australia website.

The persistent challenge posed by invasive Opuntoid cacti across all Australian states underscores the importance of continued biological control efforts. The recent expansion of *L. funestus* to new release sites and the inclusion of further states is anticipated, which will likely enhance the biocontrol impact on Opuntoid cacti populations across Australia.

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