

Feasibility of using natural enemies to control *Cordia* (*Cordia alliodora*) in Tonga and the wider Pacific region

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Summary

Project and client

- The feasibility of developing a biological control programme targeting a tree species *Cordia alliodora* within Tonga and the wider Pacific region was assessed by the Bioeconomy Science Institute, Manaaki Whenua – Landcare Research Group,¹ for the Secretariat of the Pacific Regional Environment Programme (SPREP).
- The work fell under the GEF-6 Regional Invasives Project funded by the Global Environment Facility as part of the United Nations Environment Programme.

Objectives

- Undertake a literature review to identify potential biocontrol agents for *C. alliodora* and determine the feasibility of releasing them in the Pacific region.
- Assess the achievability of successful biocontrol of *Cordia alliodora* in the Pacific region.
- Estimate and outline the cost of implementing a biocontrol programme for *C. alliodora* in the Pacific region.

Background

- *C. alliodora* is a neotropical tree species native to Central and South America. It occurs naturally from southern Mexico through Central America, and its native range extends into the Caribbean (including Cuba, Jamaica, Puerto Rico, and the Lesser Antilles) and widely throughout South America, reaching as far south as northern Argentina and Paraguay.
- The species belongs to the Sebastena clade of the Cordiaceae family (*sensu* Boraginales Working Group) and is traditionally placed in the Boraginaceae (*sensu lato*) as a member of the Boraginales. The genus *Cordia* comprises about 229 species, which are native to tropical and subtropical regions of the Americas, Africa, Asia, and the Pacific.
- The global distribution of *C. alliodora* has expanded significantly through human-mediated introductions for use in agroforestry, as well as for light construction, boat timbers and oars, furniture and cabinetmaking, veneer manufacture, turnery, and carving.
- *C. alliodora* has a high propagule pressure, producing large numbers of viable seed that are wind and water dispersed. It can also resprout vigorously from a stump and spread short distances through root suckering. Plants can establish and grow quickly in open areas, with some planted sites in Vanuatu attaining up to 15 m height and 12 cm d.b.h. at 5 years old. *C. alliodora* colonises forests through disturbance events, changing the community structures and making the tree difficult to control. In Tanzania *C. alliodora* was recorded as doubling in population size every 20 years.
- *C. alliodora* was introduced to Fiji, Hawaii, Samoa, Solomon Islands, Tonga, and Vanuatu in the mid to late 19th century for forestry/agroforestry, where it has since become invasive in agricultural areas and native forest spaces.

¹ On 1 July 2025 Landcare Research New Zealand Ltd became the New Zealand Institute for Bioeconomy Science Ltd. Manaaki Whenua – Landcare Research operates as an internal group within this Institute, which is less formally known as the Bioeconomy Science Institute (BSI).

- The negative environmental, ecological, and socioeconomic impacts of *C. alliodora* are predicted to increase under climate change due to its ability to capitalise on disturbance events such as severe weather systems.
- There may be opposition to a biocontrol programme for *C. alliodora* in communities in the Pacific where it may be utilised for its wood or as part of an agroforestry system. Information about the harmful impacts of *C. alliodora* on the environment will need to be widely communicated. Consultation with local communities regarding the potential introduction of biocontrol agents targeting this tree will also be required.

Results

- A total of 171 arthropods associated with *C. alliodora* were found from online and literature searches, representing nine arthropod orders. Five of these species appear to be specialists of *Cordia alliodora* or *Cordia* species.
 - *Akermes cordiae* and *Cyclolecanium hyperbaterum* are scale insects from the family Coccidae reported from Panama, and have only been reported as present on *C. alliodora*.
 - *Stauripodes persimilis* is a noctuid moth described as a *Cordia* specialist and is found in Central America.
 - The chrysomelid beetle *Amblycerus atkinsoni* is a bruchid seed feeder endemic to Mexico and only recorded from *C. alliodora*.
 - A second chrysomelid beetle, *Coptocycla leprosa*, is recorded from Belize, Costa Rica, Mexico, Nicaragua, and Panama. It is described as a *Cordia* specialist with *C. alliodora* potentially as a main host. It has been recorded as highly damaging on *Cordia* when the beetle reaches high population densities, causing near defoliation of plants.
- A total of 35 fungal species have been found to be associated with *C. alliodora*. Among the fungal pathogens, *Puccinia cordiae* has been described as the most important disease on *C. alliodora*. Symptoms include rust pustules on leaves, deformed tissues and inflorescences, witch's broom, and canker. It has only been found on *Cordia* species.
- Two additional pathogens, *Pyrrhoderma noxium* and *Necator salmonicolor*, cause root rot and stem canker, respectively, on *C. alliodora* in Vanuatu, although both have a broad host range.
- Leafy mistletoes from the genus *Phoradendron* parasitise *C. alliodora*, reducing tree vigour and occasionally causing death. However, species from this genus are usually not host specific.

Conclusions

- No fungal pathogens or insects have been used as biocontrol agents against *C. alliodora*, but there are some promising natural enemies that could be investigated as biocontrol agents.
- The leaf-feeding chrysomelid beetle *Coptocycla leprosa* is the strongest arthropod candidate worth investigating as a potential biocontrol agent for *C. alliodora*, because it is reported to be both a *Cordia* specialist and capable of high damage.
- The noctuid moth *Stauripodes persimilis* and the bruchid beetle *Amblycerus atkinsoni* are potential biocontrol candidate agents that could be pursued if *C. leprosa* proves unsuitable.
- The two coccid scale insects *Akermes cordiae* and *Cyclolecanium hyperbaterum* may be worth following up because they are reportedly host-specific to *C. alliodora*. However, their

association with ant species will need to be investigated to determine if this would affect their efficacy as suitable biocontrol agents.

- One fungal pathogen, *Puccinia cordiae*, would also be worth pursuing as a potential biocontrol agent. It causes a variety of symptoms on *C. alliodora*, including leaf pustules, witch's broom, and canker.
- Host range testing should include the closely related species *C. dichotoma* (native to Samoa and Vanuatu), and *C. aspera* and *C. subcordata* (both native to Samoa, Tonga, and Vanuatu).
- Comprehensive surveys of the natural enemies of *C. alliodora* in its native range have not been undertaken and may well reveal other potential invertebrate and fungal candidates.
- It is unusual for a single biocontrol agent alone to achieve full control, and multiple species may be required to achieve the greatest efficacy

Recommendations

A project to develop natural enemies for a novel target typically costs between NZD\$1.5 - 3.5m over an up to 10 year period, depending on the complexity of the work involved. Our recommendations and the estimated costs for key aspects of a biocontrol programme targeting *C. alliodora* in the Pacific region are shown below. (Note: all cost estimates are in New Zealand dollars.)

- If *C. alliodora* seed source records are unavailable, complete a genetic analysis to determine the variability of *C. alliodora* in the Pacific region and its origin in the native range. **Estimated cost:** \$100,000–\$200,000.
- Organise shipment of the potential biocontrol agents identified in this report to containment facilities in New Zealand/Australia to establish rearing colonies. **Estimated cost per species:** \$50,000–\$100,000.
- Undertake rearing of agents in containment. **Estimated cost per species per year:** \$50,000–\$100,000.
- Undertake host-range testing. **Estimated cost per species:** \$100,000–\$200,000.
- If potential biocontrol agents identified in this report are not appropriate, conduct surveys of *C. alliodora* in climatically similar areas of the native range to identify other potential arthropod and pathogen biocontrol candidates. **Estimated cost:** \$200,000–\$600,000.
- Conduct studies to determine the impact of other potential biocontrol agents found in surveys, their life-cycle, and how to rear them. **Estimated cost per species per year:** \$50,000–\$150,000.
- If other potential biocontrol agents are identified, continue with the import, rearing, and host-range testing steps listed above.
- Assist Pacific Island nations seeking biocontrol against *C. alliodora* by preparing applications and going through the process to release agents. **Estimated cost per country:** \$16,500–30,000.
- Mass-rear and release agents in Pacific countries. **Estimated cost per country per species:** \$50,000–\$100,000.
- Monitor the establishment success of biocontrol agents. **Estimated cost per country:** \$50,000–100,000.
- Evaluate the biocontrol programme's success. **Estimated cost per country:** \$50,000–100,000.

Note: *Estimated costs are exclusive of GST and are based on 2025/26 figures. New estimates will need to be provided if work is to be undertaken beyond those years, and/or if complicating factors arise (e.g. disease infecting imported agents, ongoing disruptions due to global pandemics, etc.).*

1 Introduction

The feasibility of developing a biological control programme targeting *Cordia alliodora* (Ruiz & Pav.) Oken (Cordiaceae) within Tonga and the wider Pacific region was assessed by the Bioeconomy Science Institute (BSI) for the Secretariat of the Pacific Regional Environment Programme (SPREP).

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2 Objectives

- Undertake a literature review to identify potential biocontrol agents for *C. alliodora* and determine the feasibility of releasing them in the Pacific region.
- Assess the achievability of successful biocontrol of *C. alliodora* in the Pacific region.
- Estimate and outline the cost of implementing a biocontrol programme for *C. alliodora* in the Pacific region.

3 Background

3.1 Global distribution, biology, and ecology of *Cordia alliodora*

C. alliodora is a neotropical tree species native to Central and South America. It occurs naturally from southern Mexico through Central America, extending into the Caribbean (including Cuba, Jamaica, Puerto Rico, and the Lesser Antilles) and widely throughout South America, reaching as far south as northern Argentina and Paraguay (Murillo & Gutiérrez 2012; Greaves & McCarter 1990; POWO 2025c).

The species has a broad ecological range and is found in both dry and moist tropical forests, from sea level to around 1,500 m elevation. Genetic studies suggest its evolutionary origin is in the dry forests of South America (south of the Andes), where the species has the greatest genetic diversity and morphological variation (Rymer et al. 2013). Its current wide ecological niche is thought to be the result of more recent adaptations to wetter climates, facilitated by its expansion into Central America and wetter ecosystems (Rymer et al. 2013).

Within its native range *C. alliodora* is valued for its timber, shade provision, and multiple agroforestry uses, which has facilitated its deliberate planting and complicates the delineation of its true natural distribution (CATIE 2000). The global distribution of *C. alliodora* (Figure 1) has expanded significantly through human-mediated introductions. By the 20th century it was widely planted in tropical regions of Africa, Asia, and the Pacific as a multi-purpose agroforestry species, particularly in coffee and cacao plantations, where its open crown provides desirable shade (Evans 1992).

Today it is cultivated or naturalised across pantropical regions, including West and East Africa (e.g. Ghana, Nigeria, Tanzania, Uganda), South and Southeast Asia (India, Sri Lanka, the Philippines, Indonesia), and numerous Pacific islands (Figure 1) (Orwa et al. 2009). While its ecological impacts are not as well documented as those of other widely introduced tropical trees, it

demonstrates an ability to establish outside its native range. Its tolerance of varied ecological conditions, coupled with extensive planting, has ensured that *C. alliodora* is now a widespread pantropical species (Richardson & Rejmánek 2011).

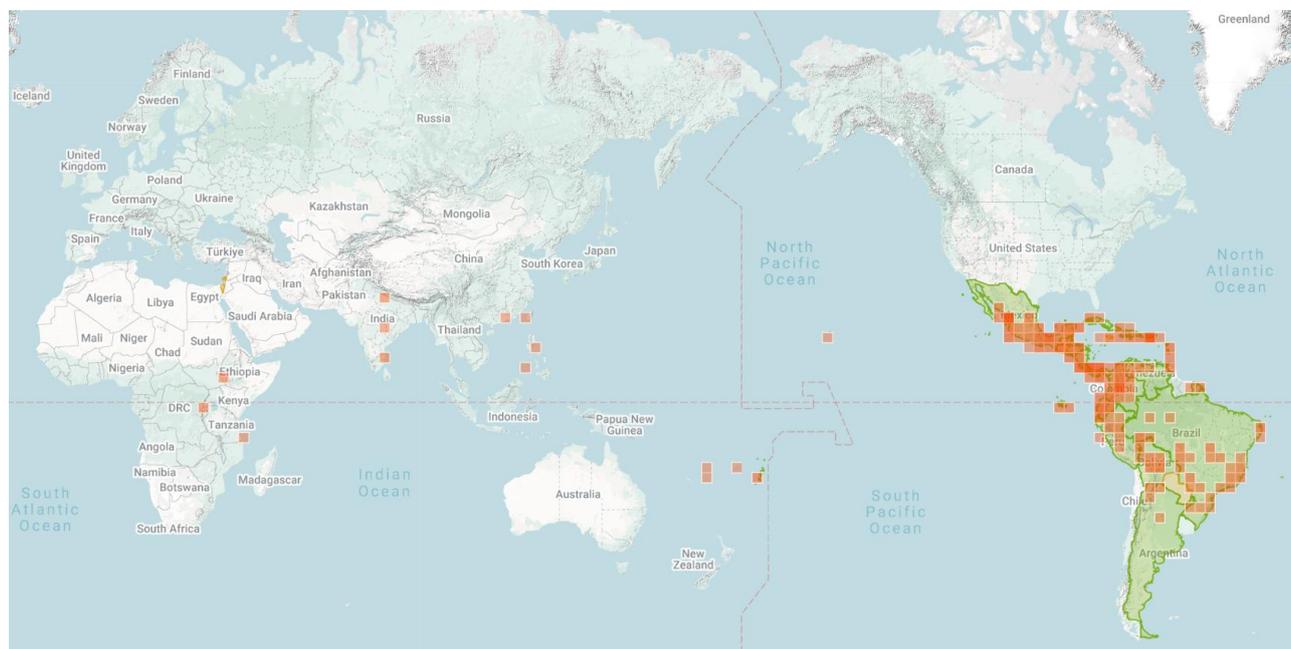


Figure 1. The global distribution of *Cordia alliodora*. (Source: <https://www.inaturalist.org/taxa/209896-Cordia-alliodora>. CC0, CC BY, CC-BY NC, © Map data)

C. alliodora is a medium to large deciduous tree (Figure 2), usually growing 15–25 m in height but capable of reaching up to 35 m tall. It has a straight bole that can exceed 100 cm in diameter under favourable conditions (Greaves & McCarter 1990). *C. alliodora* is a light-demanding tree, with generally, rapid growth in the early years. In Vanuatu, trees at better quality sites can attain 15 m height and 12 cm d.b.h. at 5 years, increasing to 23 m height and 27 cm d.b.h. at 10 years (Hudson 1984). The species may live for several decades, making it a long-term component of managed agroforestry systems (Evans 1992). Bark on older stems is greyish to brown and fissured (Figure 3), while younger stems are smoother, often with fine pubescence² when young (Murillo & Gutiérrez 2012). The root system consists of large, spreading, surface laterals and, when soil conditions are favourable, a deep tap root, making it very wind resistant and why it can often be a dominant species on hillsides (Johnson & Morales 1972).

Leaves (Figures 4–5) are simple, alternate, and elliptic to ovate in shape, typically 6–18 cm long and 3–7 cm wide, with a characteristic garlic-like odour when crushed – the feature from which the species takes its epithet *alliodora* ('garlic-scented') (Greaves & McCarter 1990). The leaf margin is usually entire or slightly undulate, with a short petiole. Leaves are shed during the dry season, which helps the tree conserve water and contributes to nutrient cycling in the soil through rapid litter decomposition (CATIE 2000).

² Pubescence: soft down on the leaves and stems.

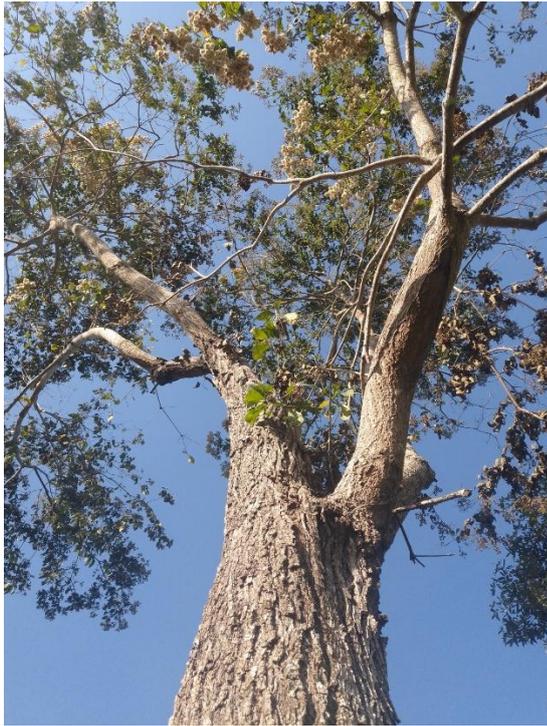


Figure 2. Mature tree habit of *Cordia alliodora*, Champotón, Campeche, México. (Source: © JOSE JAVIER MAY CHAN, <https://inaturalist.nz/observations/106129502> (CC-BY-NC))



Figure 3. Trunk of *Cordia alliodora*, showing the fissured, grey to brown bark, Champotón, Campeche, México. (Source: © JOSE JAVIER MAY CHAN, <https://inaturalist.nz/observations/106129502> (CC-BY-NC))



Figure 4. Alternately arranged leaves of *Cordia alliodora*, Champotón, Campeche, México. (Source: © JOSE JAVIER MAY CHAN, <https://inaturalist.nz/observations/108780349> (CC-BY-NC))



Figure 5. Leaf (upper and lower sides) of *Cordia alliodora*, Caimanera, Cuba. (Source: © Wayne Fidler, <https://inaturalist.nz/observations/24713976> (CC-BY-NC))

The small, white to cream-coloured flowers are borne on branched terminal or axillary panicles (Figure 6). Each flower (Figure 7) has a tubular corolla 4–7 mm long with five lobes and is hermaphroditic, pollinated primarily by insects (Murillo & Gutiérrez 2012).

The fruit (Figures 8 & 9) is a small, dry drupe about 3–6 mm long, surrounded by a persistent papery calyx that aids in wind dispersal (Greaves & McCarter 1990). Trees begin flowering and fruiting relatively early, often within 3–5 years, and produce abundant seed crops annually (Greaves & McCarter 1990). Seeds are dispersed by wind and water, which helps explain its ability to colonise disturbed areas (Orwa et al. 2009). The corolla acts as a parachute during seed fall and may assist wind dispersal. A single tree can yield up to 8 kg of seed, but the usual yield is 0.5–3 kg. In one study, those with a germination rate of 80% or more comprised 55,000–75,000 viable seeds per kilogram of seed (Greaves & McCarter 1990). In another study, more than 70% of the seed collected at the optimal time was likely to germinate. Such seed also had a short germination period of 8–15 days, whereas seed collected at the beginning of the maturing period required 25–28 days to germinate (Greaves & McCarter 1990).

C. alliodora thrives in tropical climates with mean annual temperatures between 22 and 28°C and annual rainfall ranging from 1,200 to 2,500 mm, often with a distinct dry season lasting up to 4–6 months (Evans 1992; CATIE 2000). While adaptable, it prefers well-drained, neutral to slightly acidic soils, often thriving on volcanic or alluvial substrates. It is considered moderately drought-tolerant but is sensitive to prolonged waterlogging and heavy frosts (Orwa et al. 2009).

Ecologically, *C. alliodora* performs best in open, sunny conditions and is an early to mid-successional species. It readily establishes in disturbed or secondary vegetation, along roadsides, pastures, plantations, and forest edges, and may form pure stands when planted in managed systems (Murillo & Gutiérrez 2012). The species is generally deciduous during the dry season, though the degree of leaf fall varies with climatic conditions. Its fast growth, tolerance of varied ecological conditions, and value in agroforestry systems have made *C. alliodora* one of the most important multipurpose timber trees in tropical Latin America, and, increasingly, in pantropical forestry and plantation systems.



Figure 6. Flower panicle of *Cordia alliodora*, Rio Branco, Brazil. (Source: © Mayk Oliveira, <https://inaturalist.nz/observations/56481119> (CC-BY-NC))



Figure 7. Close-up of five-lobed tubular flowers of *Cordia alliodora*, Pixaim, Mato Grosso, Brazil. (Source: © Allan Hopkins, <https://inaturalist.nz/observations/70082314> (CC-BY-NC-ND))



Figure 8. Maturing fruit of *Cordia alliodora*, Dzilam González, Yucatan, México. (Source: © victornc, <https://inaturalist.nz/observations/278638278> (CC-BY-NC))



Figure 9. Drupes of *Cordia alliodora*, San Francisco, Guatemala. (Source: © Juan Jose, <https://inaturalist.nz/observations/198066479> (CC-BY-NC))

3.2 Phylogeny and taxonomy

3.2.1 Classification of *Cordia alliodora*

Division:	Angiosperms
Order:	Boraginales
Family:	Cordiaceae <i>sensu</i> Boraginales Working Group (Luebert et al. 2016) / Boraginaceae <i>sensu lato</i>
[Subfamily:	Cordioideae (if within Boraginaceae s.l.)]
Clade:	Sebestena
Genus:	<i>Cordia</i>
Species:	<i>Cordia alliodora</i> (Ruiz & Pav.) Oken

Cordia alliodora (Ruiz & Pav.) Oken is a neotropical tree species traditionally assigned to the Boraginaceae family, and more recently considered by many to be in its own family, the Cordiaceae (Gottschling et al. 2005; Weigend et al. 2014; Luebert et al. 2016). The genus *Cordia* includes 200–300 species (229 species according to POWO 2025a), distributed primarily across tropical and subtropical regions of the Americas, Africa, Asia, and the Pacific (Miller 1988; Weeks et al. 2005). More than 30 botanical synonyms are associated with *Cordia alliodora* (Ruiz & Pav.) Oken, reflecting its complex taxonomic history and wide distribution. There are also several varietal and form names (e.g. *Cordia alliodora* var. *glabra* A.DC., *Cordia alliodora* f. *albotomentosa* Chodat & Hassl.), but these are currently considered synonyms (POWO 2025c) and part of the variation within the single accepted species, *C. alliodora* (GBIF.org 2025a). This variation has sometimes led to taxonomic confusion with other *Cordia* species, particularly *C. gerascanthus* Jacq., a closely related Caribbean taxon (Miller 1988).

C. alliodora is known by a wide range of common names. In English and Spanish-speaking regions it is often called Spanish elm, salmwood, cypre, laurel, or guarumo. Other local names include laurel blanco (Central America), salmwood (Caribbean), maria, and louro (South America) (Orwa et al. 2009; CABI 2022). In the Pacific region it is referred to as kotia in Samoa and Tonga (Space & Flynn 2001).

The genus *Cordia* is phylogenetically complex, with species groups that have historically been difficult to resolve due to morphological convergence, high intraspecific variation, and past reliance on variable floral traits (Miller 1988). Recent molecular studies support the monophyly of *Cordia* and clarify its placement within Boraginales.

3.2.2 Phylogenetic placement

The phylogeny of the Lamiidae, and the placement of the Boraginales and subordinate families within it, has been investigated by Refulio-Rodriguez and Olmstead (2014). Weigend et al. (2014) have investigated phylogenetic relationships in the Boraginales. Modern molecular data support the division of the traditional Boraginaceae into several distinct families – including Boraginaceae s.s., Cordiaceae, Coldeniaceae, Ehretiaceae, Heliotropiaceae, and others (Figure 10) – as recognised by the Boraginales Working Group (Luebert et al. 2016).

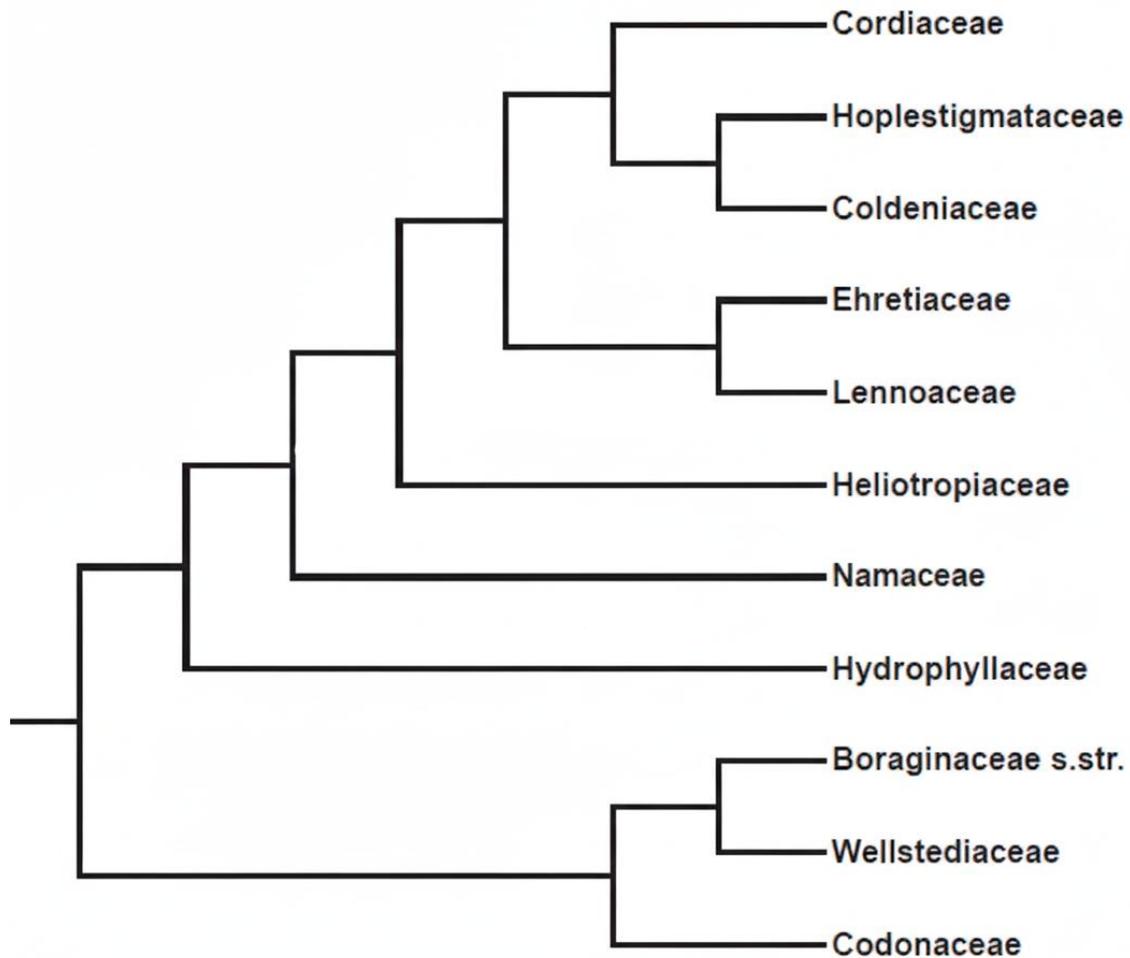


Figure 10. Eleven clades of the Boraginales, accepted by the Boraginales Working Group as morphologically well-defined and monophyletic families. (Adapted from Luebert et al. 2016).

Following Luebert et al. (2016)'s treatment, based on the earlier work of Refulio-Rodriguez and Olmstead 2014 and Weigend et al. 2014 (Figure 10), Cordiaceae is viewed as sister to the monogeneric Coldeniaceae (*Coldenia procumbens* L.) and Hoplestigmataceae (comprising two *Hoplestigma* Pierre spp.), although Weigend et al. (2014) advocated to include *Coldenia* and Hoplestigmataceae within Cordiaceae. The next most closely related are the Ehretiaceae (*Bourreria* P.Browne, *Ehretia* P.Browne, *Halgania* Gaudich., *Lepidocordia* Ducke, *Rochefortia* Sw., *Tiquilia* Pers.) and Lennoaceae (*Lennoa* La Llave ex Lex. and *Pholisma* Nutt. ex Hook.). Other families (including Heliotropiaceae, Namaceae, and Hydrophyllaceae) are more distantly related. Codonaceae + Wellstediaceae + Boraginaceae s.str. form another major clade. Li and Wei (2022) established a similar topology based on 80 protein-coding genes from the four families they sampled.

Within Cordiaceae (or Cordioideae, using the older classification), *Cordia alliodora* belongs in one of four well-supported clades, the Sebestena, based on molecular analyses of ITS1 sequence data (Gottschling et al. 2005) (Table 1, Figure 11).

Table 1. The four monophyletic assemblages in the Cordiaceae

Clade name	Primary genera / sections	Geographic distribution	Key relationship / notes
1. Myxa	Old World <i>Cordia</i> sect. <i>Myxa</i> , New World <i>Cordia dentata</i> and <i>Cordia lutea</i>	Pantropical (Old World species and a few New World species)	This clade includes the Assyrian plum (<i>C. myxa</i>), known for edible fruits. <i>Cordia dichotoma</i> , which is native to New Caledonia and Vanuatu, belongs to this clade (Vasile et al. 2025).
2. Collococcus	New World <i>Cordia</i> sect. <i>Myxa</i> (most), <i>Cordia</i> sect. <i>Superbiflorae</i>	New World (Americas)	A New World-dominant clade, including many New World members previously placed in <i>Cordia</i> sect. <i>Myxa</i> . <i>Cordia aspera</i> , native to parts of the Pacific, belongs to this clade (Gottschling et al. 2005).
3. Sebestena	<i>Cordia</i> sect. <i>Cordia</i> , <i>Cordia</i> sect. <i>Gerascanthus</i> , 3 species of <i>Cordia</i> sect. <i>Rhabdocalyx</i> , and the genera <i>Auxemma</i> , <i>Patagonula</i> , <i>Saccellium</i>	Pantropical	This clade includes the New World species grown for timbers, including <i>Cordia alliodora</i> . The small genera <i>Auxemma</i> , <i>Patagonula</i> , and <i>Saccellium</i> are nested within this lineage, making it part of the redefined <i>Cordia</i> genus. <i>Cordia subcordata</i> , which is native to many Pacific islands, belongs to this clade (Gottschling et al. 2005).
4. Varronia	<i>Varronia</i> (was recognised as <i>Cordia</i> sect. <i>Varronia</i> , now a resurrected genus)	Tropical & Subtropical America	This clade is sister to the 3 other major clades of <i>Cordia</i> , making it the most basal lineage. These species are typically multi-stemmed shrubs with serrate leaf margins.

Source: Summarised from Gottschling et al. 2005.

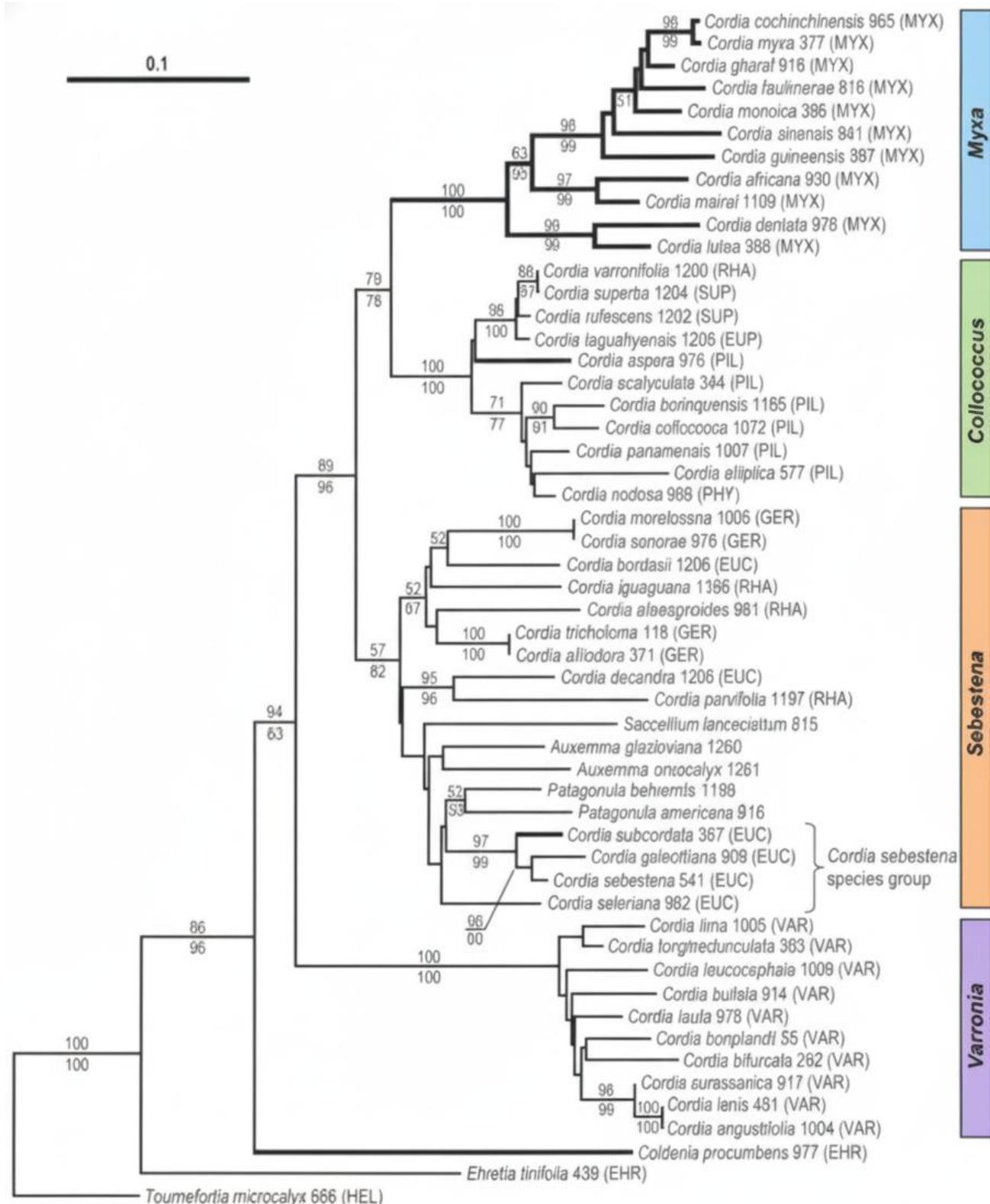


Figure 11. ITS1 neighbour-joining tree of *Cordia* and its allies, showing the four major clades Myxa, Collococcus, Sebestena and Varronia.

Notes: Thicker branches highlight Old World taxa, while New World taxa have thinner branches. The numbers on the branches are bootstrap support values. Abbreviations are: EHR: Ehretiaceae; EUC: *Cordia* sect. *Cordia*; GER: *Cordia* sect. *Gerascanthus*; HB: Botanical Garden; HEL: Heliotropiaceae; MYX: *Cordia* sect. *Myxa*; PHY: *Cordia* sect. *soclada* (i.e. *C. nodosa*); PIL: *Cordia* sect. *Pilicordia*; RHA: *Cordia* sect. *Rhabdocalyx*; SUP: *Cordia* sect. *Superbiflorae*; VAR: *Cordia* sect. *Varronia*. Adapted from Gottschling et al. 2005.

3.3 Pest status and distribution of *Cordia alliodora* in the Pacific region

C. alliodora is classed as native in Argentine Northwest, Belize, Bolivia, Brazil North, Brazil Northeast, Brazil South, Brazil Southeast, Brazil West-Central, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Haiti, Honduras, Leeward Islands, Mexico Central, Mexico Gulf, Mexico Northeast, Mexico Northwest, Mexico Southeast, Mexico Southwest, Nicaragua, Panamá, Paraguay, Peru, Puerto Rico, Southwest Caribbean, Suriname, Trinidad-Tobago, Venezuela, Venezuelan Antilles, and Windward Islands, and has been introduced to Borneo, Fiji, Galápagos, Hawaii (Gallaher et al. 2020), Mauritius, New Guinea (Conn et al. 2004+), Samoa, Seychelles, Solomon Islands, Tonga, and Vanuatu (GBIF.org 2025b; POWO 2025c).

C. alliodora was probably first recognised as having desirable characteristics as a plantation species in 1920s Trinidad. However, it wasn't until the mid-20th century that it began to be promoted for forestry, and not long after that trial plots started up in Samoa, Tonga, Vanuatu, and the Solomon Islands (Greaves & McCarter 1990).

The spread of *C. alliodora* in the Pacific has mainly been facilitated by humans for cultivation in forestry and agroforestry systems due to the plant's high-quality timber, persistent, tall, straight stem, and self-pruning habit, making it ideal for plantations (Bakeo & Qarani 2005).

In Tonga *C. alliodora* is listed as invasive under the 2023 Tonga National Invasive Species Strategy and Action Plan (Pierce et al. 2023). Under the Pacific Regional Invasive Species Management Support Service, the Natural Enemies – Natural Solutions Programme organised a workshop in February 2025, funded by the Restoring Island Resilience project, to prioritise target weeds in Tonga to be controlled using natural enemies. *C. alliodora* was voted in the top three priority weeds, alongside *Spathodea campanulata* and *Solanum torvum* (Q. Paynter, BSI, pers. comm., 17 February 2025). It was originally introduced as a forestry tree in Tonga (Space & Flynn 2001; Space 2002a) and has been noted as an invasive and potentially invasive species present on Tongatapu, 'Eua, and Vava'u (Space & Flynn 2001). *C. alliodora* is the main invasive weed dominating the Toloa Rainforest canopy (Atherton 2014), and it also significantly affects two Protection Areas: the 'Eua National Park and 'Eua Forest Plantation on 'Eua (S. Hamni, Ministry of Agriculture, Food and Forests 'Eua, pers. comm., 30 October 2025).

In Vanuatu, *C. alliodora* was introduced for forestry in the early 1970s by the Department of Forestry for lumber. By the late 1980s, 1,250 ha had been planted on 12 islands (Neil 1988). However, harvesting has not kept up with the natural spread of the plant and it has subsequently become invasive in areas where it was planted (Space 2002a; Bakeo & Qarani 2005).

In Samoa, *C. alliodora* was introduced as a forestry tree, but has since become weedy and is expected over time to become a major component of the forest (Space 2002a). It is of particular concern in Faleata Recreation Reserve at Tuanaimato, Faleata, where it is interfering with the regeneration of native species in the reserve following cyclone Evan in 2012 (SPREP 2022).

In the Solomon Islands, *C. alliodora* was introduced for forestry. Trial plots were set up in the 1960s on Kolombangara, Baga Island, and Gizo (Self 1968; Greaves & McCarter 1990). It is reported as being invasive in cocoa and coffee plantations, roadsides, and shifting cultivation (G. Harunari, Biosecurity Solomon Islands, pers. comm., 10 October 2025).

In Papua New Guinea there is one record of *C. alliodora*, from Kapogere Agriculture Station in Rigo, Central Province, suggesting the species may have been introduced, but if so, it is not widespread. However, the single database record is possibly an erroneous identification, because

it lacks both a collector name and a collection date (M. Pius, National Agriculture Quarantine Inspection Authority, pers. comm., 22 October 2025).

In Fiji there have been small-scale plantings of *C. alliodora* (Greaves & McCarter 1990). In Hawaii *C. alliodora* was introduced in the 1960s for forestry trials (Greaves & McCarter 1990). It may be present in Palau, but this has not been confirmed (J. Pisi, SPREP, pers. comm., 30 October 2025).

C. alliodora is not known to be present or a species of concern in American Samoa (T. Togia, Office of the Governor, pers. comm., 3 October 2025), French Polynesia (C. Brocherieux, Cellule biodiversité, pers. comm., 3 October 2025), New Caledonia (P. Barriere, Agence Néocalédonienne de la Biodiversité, pers. comm., 3 October 2025), Niue (H. Tongatule, Department of Environment Fonuakula, Alofi South, Niue Island, pers. comm., 3 October 2025), or Wallis and Futuna (S. Malau, Service Territorial de l'Environnement Wallis, pers. comm., 9 October 2025; A. Taugamo, Service Territorial de l'Environnement Futuna, pers. comm., 3 October 2025).

Although not present in many Pacific Islands, *C. alliodora* has considerable potential to spread and become more problematic in the future. In the Cook Islands and the Federated States of Micronesia, *C. alliodora* is not present but has been reported as a priority species for exclusion (Tolfts 1997; Space et al. 2000; Space 2002b; Space et al. 2003).

3.4 Detrimental impacts of *Cordia alliodora*

3.4.1 Environmental and ecological impacts

C. alliodora is able to colonise disturbed areas rapidly due to prolific seed production, wind-assisted seed dispersal, and vigorous growth after germination, all traits that result in high propagule pressure of the plant (Edward et al. 2009). *C. alliodora* is able to regenerate easily from the stump and is often found, following forest clearance, as pure stands of varying densities in its native range (Rymer et al. 2013). It is a long-lived pioneer or gap species that is moderately fire-resistant. In its native range it is able to compete in the dry forest, where both crown competition and species diversity are more restricted, but it does not do so well in mature wet forests (Sebbenn et al. 2007; Rymer et al. 2013).

Although we could find no evidence of it being considered a problem weed in the native range, Rymer et al. (2013) suggest that *C. alliodora* has spread more recently, during the Quaternary period, from South America, around the Andes, into Central America and Mexico, facilitated by 'weedy' traits (fast-growing, ecological generalists able to disperse over long distances). *C. alliodora* has adapted to different climates in its Central and South American range by evolving ecotypes that tolerate different moisture levels. Populations sourced from wet zone provenances in South America show better survival, growth, and form, in tropical regions, including Costa Rica, Colombia, Fiji, the Solomon Islands, Ivory Coast, Liberia, Ghana, and Nigeria (Sebbenn et al. 2007). *C. alliodora* is also homostylous (flowers have stigmas and stamens of the same length, allowing for self-pollination) and partly self-compatible (Greaves & McCarter 1990). These traits give *C. alliodora* a greater ability to colonise areas far from existing stands.

C. alliodora requires full sun to grow (Parresol & Devall 2013), meaning it is unlikely to penetrate established intact forest, but it does opportunistically spread into cleared forest areas caused by disturbance events such as tropical cyclones, which are expected to increase under climate change (Edward et al. 2009). A 2009 study monitoring the spread of *C. alliodora* from a roughly 0.2 ha plantation planted in the 1930s in the East Usambara submontane rain forests in northeastern Tanzania showed the *C. alliodora* annual population growth to be 3.5%, which is the

equivalent to the population doubling every 20 years (Edward et al. 2009). In the study area *C. alliodora* has now become locally dominant, spreading into a matrix of home gardens, plantations, and secondary forests in the area (Edward et al. 2009).

In the Pacific *C. alliodora* was introduced for forestry. It has since spread from the original planting sites and become invasive in local areas. Agricultural land is vulnerable due to the typically fertile soils and open landscape that are ideal for *C. alliodora* colonisation (Neil & Jacovelli 1985; Space & Flynn 2001; Space 2002a; Bakeo & Qarani 2005). *Cordia alliodora* has also penetrated native forest areas in the Pacific after severe weather events, creating large monoculture stands. As mentioned above, in Samoa's Faleata Recreation Reserve at Tuanaimato, Faleata, it is interfering with the regeneration of native species within the reserve following cyclone Evan in 2012 (SPREP 2022). In Tonga, *C. alliodora* has a strong presence in the Toloa Rainforest on Tongatapu, and in two Protection Areas on 'Eua: the 'Eua National Park and 'Eua Forest Plantation, where it is severely affecting forest health (S. Hamni, Ministry of Agriculture, Food and Forests 'Eua, pers. comm., 30 October 2025).

C. alliodora may also facilitate other non-native species. It is known to host two common fungal diseases that infect a wide range of plant species: *Pyrrhoderma noxium*, which causes brown root rot, and *Necator salmonicolor*, which causes stem canker (Orwa et al. 2009). In Vanuatu, brown root rot has been reported as widespread in *C. alliodora* plantations, and stem canker was found on up to 4.4% of trees in Vanafo and up to 8.8% in Shark Bay (Neil 1989; Boshier & Lamb 1997). Many ant species are associated with *C. alliodora* in its native range (Wheeler [1929] recorded 58 species), using the tree as a nesting site but obtaining no direct food source from it (Novais et al. 2021). This may occur with ant species in the Pacific, but the extent is unknown.

3.4.2 Socioeconomic impacts

In Vanuatu *C. alliodora* was introduced for forestry in the early 1970s. In order to address local concerns over forestry usage of land, and the requirement of *C. alliodora* for fertile soils that were usually reserved for subsistence gardening, agroforestry systems were developed, focusing on local subsistence crops to show the lack of impact forestry would have on traditional land use (Neil & Jacovelli 1985). Planting trials were initiated on the islands of Santo, Vanua Lava, Mota Lava, Ureparapara, Malekula, Ambae, Maewo, Pentecost, Efate, Epi and Eromango (Bakeo & Qarani 2005). By the late 1980s 1,250 ha had been planted on 12 islands (Neil 1988).

However, the natural spread of the plant has outpaced harvesting and it has subsequently become invasive in areas where it was planted, taking away valuable agricultural land and increasing costs and labour for land owners to control it (Neil & Jacovelli 1985; Space 2002a; Bakeo & Qarani 2005). *C. alliodora* is now also invading native forest spaces, which is likely to reduce the availability of culturally and nutritionally important species traditionally harvested as food by local communities (D. Moverley, SPREP, pers. comm., 30 October 2025).

Tropical cyclone intensity is expected to increase with climate change, although frequency is anticipated to decrease slightly (Turton 2012). Severe weather can defoliate large areas of forest, and landslides can occur on mountain slopes, enabling colonisation by *C. alliodora* seedlings or other invasive plant species. In the Samoan island of Upolu, cyclone Evan destroyed more than half of the remaining primary forest, damaging 80% of forest cover and destroying 20% of the forest (Government of Samoa 2013). This type of event will contribute to the rapid spread of invasive weeds, including *C. alliodora*, to more open areas, as was observed after cyclone Evan in Samoa.

The environmental, ecological, and socio-economic impacts of *C. alliodora* are predicted to increase under climate change. These impacts have been listed in Appendix 7 and show a potential alarming future for native ecosystems if *C. alliodora* is not managed.

3.5 Beneficial uses of *Cordia alliodora*

Cordia alliodora is a hardwood that has many desirable traits for use in agroforestry. These include fast growth, a straight and cylindrical bole that is often clear of branches for 50–60% of its height (i.e. it is self-pruning), and a compact crown (Greaves & McCarter 1990). It is easy to grow on cleared sites typical of those associated with agricultural activity, and it can be generated from seedlings or left to resprout from the stump. It has above-average resistance to stem break and windthrow when exposed to hurricanes and cyclones, especially in its early years (Greaves & McCarter 1990).

The timber is easy to work and has an attractive appearance (Greaves & McCarter 1990). The heartwood is light brown to yellowish-brown, often with a fine texture and attractive grain, which makes it suitable for high-quality carvings, furniture, cabinetry, and decorative veneer (Greaves & McCarter 1990).

It is a moderately heavy wood, resistant to decay and dimensionally stable (it experiences minimal shrinking and swelling from changes in moisture content) (Greaves & McCarter 1990). It has a basic density ranging from 0.45 to 0.60 g/cm³ and is relatively durable under dry conditions, making it valued for general light construction as well, flooring, joinery, boat timbers and oars, and plywood manufacture (Evans 1992; CATIE 2000; Greaves & McCarter 1990).

C. alliodora is one of the most widely used shade trees in coffee and cacao agroforestry systems across Latin America and beyond. Its open, high crown structure provides filtered shade that reduces heat stress for understorey crops without excessively reducing photosynthesis (CATIE 2000). The species also improves soil fertility through rapid decomposition of its nutrient-rich leaf litter, contributing organic matter, nitrogen, calcium, and potassium to the soil (Nichols et al. 2001). Its deep rooting system allows it to access water and nutrients from deeper soil layers, reducing direct competition with shallow-rooted crops (Beer et al. 1997).

In addition to soil enrichment and shade, *C. alliodora* can provide multiple outputs for farmers. Timber and firewood can be harvested periodically without eliminating the shade function, and its rapid growth allows frequent thinning or selective logging in mixed systems. The tree's phenology is also favourable: being deciduous in the dry season, it reduces competition for water with crops during critical stress periods and allows more light to reach the understorey. Because of these traits, *C. alliodora* has become a global keystone species in sustainable agroforestry systems, integrating economic, ecological, and agronomic benefits (CATIE 2000; Orwa et al. 2009).

In the Pacific region *C. alliodora* was introduced for agroforestry, but its use in this context has declined. In Tonga it is being used for fencing, light construction, and a small amount of carving (S. Hamni, Ministry of Agriculture, Food and Forests 'Eua, pers. comm., 30 October 2025). It is unknown if *C. alliodora* is being used for any of its beneficial qualities elsewhere in the Pacific region.

Standley (1924) also noted, 'The fruit is edible. A decoction of the leaves is employed as a tonic and stimulant, especially in the ease of catarrh and affections of the lungs, and an ointment made with the pulverized seeds has been used in the West Indies as a remedy for cutaneous diseases.'

C. alliodora can also be a major source of nectar for bees (Crane et al. 1984, cited in Greaves & McCarter 1990).

3.6 Potential for opposition to biocontrol

Opposition to invasive species control programmes can have detrimental effects on their success. During a multi-weed species eradication programme in the Galápagos Islands in the 1990s and 2000s, 'lack of support' was found to be a key factor in determining weed control success (Gardener et al. 2010). This lack of support was attributed to not involving farmers in decision-making and having minimal public consultation about the aims of the programme. Many farmers were only informed of the programme when asked for land access on the day control regimes were scheduled. Some species targeted were perceived as beneficial by farmers and, as a result, many refused land access. Institutions providing resources for the control efforts were also not supportive. This led to the failure of 16 of the 30 weed target projects in the programme (Gardener et al. 2010). It is therefore important to involve all stakeholders from an early stage in any biocontrol programme to ensure buy-in and support to enhance programme success.

In the Pacific nations, *C. alliodora* was mainly introduced for forestry and agroforestry systems, and, as mentioned, the wood has many uses. There may still be some groups that utilise the plant and who could be economically affected by a biocontrol programme. In Tonga, *C. alliodora* is currently used for fencing and light construction, and a very small amount for carving (S. Hamni, Ministry of Agriculture and Fisheries, pers. comm., 30 October 2025). A study in French Polynesia found that discrepancies in attitudes toward weed species are prevalent, with those in more remote communities with lower socioeconomic development and/or limited resources viewing some weed species more positively because they can be used for tools, construction, wood fuel, improving soil nutrients, or as a food source (Meyer & Fourdrigniez 2019).

Given that *C. alliodora* has many beneficial properties, consultation with Pacific communities will be required to discuss its impacts on the environment and to determine how the development of a biocontrol programme against would be received. Information on the threat *C. alliodora* poses to natural habitats and urban areas, the benefits of a biocontrol programme, and any queries regarding the specificity of biocontrol agents would need to be provided to those affected. For those communities that rely on *C. alliodora* as a valuable resource, alternative suitable resources would also need to be considered. Given the threat *C. alliodora* poses, it would be prudent for Pacific nations to explore options for using non-invasive tree species to replace any current uses. Alternatively, biocontrol agents that only target the reproductive structures (i.e. seed feeders) could be a viable control option, because they would reduce the spread of the weed without destroying the beneficial properties of established trees.

Finally, there may be concern or opposition from groups that value species closely related to *C. alliodora*, such as *C. subcordata* (Pacific rose wood, eongo, kou, tou), a tree valued for traditional medicine, coastal protection, and timber, among other properties (Patil & Khulbe 2025; Chambon et al. 2023). There are four species indigenous to Pacific countries where *C. alliodora* is present that belong to the Cordiaceae family, and six species indigenous to Pacific countries where *C. alliodora* is present that belong to the wider Boraginales group listed in POWO 2025b and GBIF.org 2025a. Details of these species have been compiled in Appendix 1 of this report.

There are also three introduced species from the Cordiaceae family and seven introduced species from the wider Boraginales group present in Pacific countries where *C. alliodora* is present. Details of these species have been compiled in Appendix 2 of this report. The number of closely related species present varies from country to country, as does the number of culturally and economically

important species. A list of closely related species of significance to local communities would need to be compiled for each country / Pacific Island group to be included in host-range testing.

3.7 Control options

Common control methods include one or more of the following options.

- 1 *Mechanical control*: Hand-pulling or cutting seedlings and saplings is effective when infestations are small. However, larger trees regenerate readily from stumps and root suckers, meaning felling alone is rarely sufficient (Pono 2023). For established stands, mechanical removal often needs to be combined with herbicide treatment to prevent regrowth.
- 2 *Chemical control*: Herbicide application (e.g. cut-stump or frill treatment with systemic herbicides) has been reported as being effective against regrowth when trees are felled. Spot-spraying of seedlings in plantation and agroforestry settings has also been suggested to suppress regeneration (Lucidcentral 2024).
- 3 *Prevention and biosecurity*: In countries where the species has not yet established (e.g. the Cook Islands), prevention is the most effective strategy. Reports to government agencies have specifically recommended that *C. alliodora* not be introduced due to its demonstrated invasive behaviour in Samoa, Tonga, and Vanuatu (Space 2002b).
- 4 *Ecological restoration*: Where *C. alliodora* has displaced native vegetation, restoration requires integrated management – removal of mature trees combined with replanting of resilient native species to accelerate recovery and reduce reinvasion risk. In Samoa’s Faleata Reserve, removal programmes are linked with wider invasive plant control efforts following cyclones, where disturbance opens niches for aggressive colonisers (SPREP 2022).

In Tonga, recommendations have included:

- for small seedlings – hand pulling
- for saplings – cutting the stump near the ground and applying 25% glyphosate immediately to the exposed cambium, phloem, and collar root to the ground
- for saplings <10 cm DBH – applying glyphosate to the whole cut stump area
- for larger trees – using stem injection or ring chopping, which involves cutting into the cambium layer in a downward direction every 6–10 cm around the trunk and applying herbicide immediately (Atherton 2014).

It is common for landowners to do most of the felling (S. Hamni, Ministry of Agriculture and Fisheries, pers. comm., 30 October 2025). There is also a larger-scale control programme that has been implemented in the ‘Eua National Park and Toloa rainforest (J. Pisi, SPREP, pers. comm., 31 October 2025). The cost of *C. alliodora* control in ‘Eua National Park ranges from NZ\$100,000 to NZ\$150,000 per year, from an operational scale to a comprehensive project if other expenses are considered, such as monitoring, technical advice, logistics, etc. (J. Pisi, SPREP, pers. comm., 31 October 2025).

In Samoa, the most common action is to cut the plants down during replanting with native vegetation or when clearing for plantations (Samoa Go 2019). In the Solomon Islands the species is controlled by hand weeding and chemicals (G. Harunari, Biosecurity Solomon Islands, pers. comm., 10 October 2025).

C. alliodora is difficult, costly, and labour intensive to control, but no biological control options have been investigated for this species. On smaller, more remote Pacific islands, mechanical and

chemical control may not be feasible due to lack of resources. In addition, there are dangers and risks associated with herbicides: herbicide run-off and contamination of waterways, plus the dangers faced by animals such as fish and birds, restrict the use of herbicide in many areas.

3.8 Potential advantages and disadvantages of biological control

The management of *C. alliodora* through biological control (biocontrol) agents would be advantageous because of the prohibitive cost of physical and chemical control options. *C. alliodora* produces large amounts of seed that can establish prolifically in open and disturbed areas with fertile soils, such as those common in agricultural landscapes. The removal or death of a *C. alliodora* tree can enable the emergence of new seedlings, which will also need to be controlled. Sites need to be revisited if trees are chemically or physically controlled due to the propensity of *C. alliodora* to resprout from the stump. Classical biological control would provide a long-term, more cost-effective solution because it offers continuous activity and self-dispersal to areas unlikely to be controlled by other means. (The different steps involved in classical biological control are listed in Appendix 3.) Biocontrol is often used once all other control options have been exhausted.

The potential benefits of biological control as a tool for weed invasion management are numerous, but success may not be guaranteed (Schwarzländer et al. 2018). Globally, approximately 65.7% of weed biocontrol targets are successfully controlled (Schwarzländer et al. 2018). Within the Oceania region this figure is 78.9%, which is the highest weed biocontrol rate in the world (Schwarzländer et al. 2018). Biocontrol of weeds in the Pacific has at least a hundred-year history, with many successes. However, in recent decades it has been overlooked or forgotten as a tool by many Pacific Island countries and territories (Day & Winston 2016). Recent funding provided by the New Zealand Government is allowing biocontrol of weeds to be revived as a critical control tool in the Pacific.

For those cases where complete biological control of a target species is not achieved, substantial or partial control is often still attained, which can then be integrated into weed management alongside other control methods (Paynter & Flanagan 2004). Unsuccessful weed biocontrol programmes are rare, but they can occur when there is a failure to find a suitable candidate agent, establishment of the control organism is unsuccessful, or the control agent fails to have a significant impact on the target weed. In most cases, failure of weed biocontrol programmes is due to a lack of resources for continuing a programme until all viable options have been explored (Paynter & Flanagan 2004).

Predictable damage of non-target plant species from biocontrol agents is a potential consequence of biological control (Paynter et al. 2020). These non-target plants are predominantly species that are closely related to the target weed, and damage caused to them by agents is usually minor. Suckling and Sforza (2014) found that, of 512 insect agents released for weed biocontrol in 75 countries, 7.6% had minor non-target impacts and only 0.8% had adverse effects. Of the recorded non-target impact species, 77% belonged to the same family and 54% to the same genus as the target weed (Suckling & Sforza 2014).

Careful assessment before the introduction of a biocontrol agent is a reliable way to determine the risk of non-target impacts it poses to native and valued plants (Suckling & Sforza 2014; Downey & Paterson 2016). Non-target attacks, when they occur, are often localised events and are generally predictable because of the shared ancestry of the target weed and non-target species (Taylor et al. 2007). In the Pacific region, cases of non-target attacks on native plant species are rare. Pemberton (2000) found that four out of five biocontrol agents targeting weeds with native

congeners in Hawaii also caused minimal damage to the native congener. However, three of these biocontrol agents were released in Hawaii in the 1960s and one in 1925, before improved and stringent host-specificity testing procedures were adopted (Pemberton 2000). Despite minor non-target impacts and the potential risks of failure, the potential benefits of biological control are even greater, making it a highly effective weed control method.

Weed biocontrol programmes can have huge economic benefits. In Australia, an economic analysis revealed an overall strong positive return on investment for weed biocontrol programmes, with a benefit of AU\$23.10 generated for every dollar invested in Australian weed biocontrol (Page & Lacey 2006). In South Africa, the benefit:cost ratios of biological control to ecosystem services ranged from 50:1 for subtropical shrubs to 3726:1 for weedy Australian trees (e.g. *Acacia*, *Leptospermum*, *Paraserianthes*) (de Lange & van Wilgen 2010). For New Zealand, independent estimates of the net annual benefits from weed biocontrol were NZ\$11–NZ\$217 million (Suckling 2013) or NZ\$58–NZ\$86 million (Fowler et al. 2023). Biocontrol of ragwort (*Jacobaea vulgaris* Gaertn.) by the ragwort flea beetle alone was thought to benefit the New Zealand dairy sector by NZ\$44 million up to 2015 (Fowler et al. 2016).

Financial gains are also likely to be realised in Pacific Island nations that undertake weed biocontrol programmes, particularly for important commercial industries such as agriculture. The long-term approach of biological control to weed management solutions provides a lasting and substantial economic benefit unattainable by other conventional control methods.

3.9 Predicting the establishment of biocontrol agents

Successfully predicting the likelihood of establishment of biocontrol agents, such as fungal pathogens and arthropods, is a required step in any effective weed biological control programme. Factors such as climate matching (van Klinken et al. 2003), phenology (flowering and fruiting times) of target weeds, interspecific competition (Day et al. 2004), the number and size of agent releases (Memmott et al. 1998; Paynter et al. 2016), predation (Reilly et al. 2004), site fertility (Hovick & Carson 2015), and the timing of agent release (Day et al. 2004) can all affect the successful establishment of agents.

Currently, the leading predictor of successful establishment of new organisms is the number and size of agent releases. High rates of weed biocontrol agent establishment (c. 70%; Schwarzländer et al. 2018) in New Zealand are helped by a BSI large-scale technology transfer programme, which operates in conjunction with community groups, the Department of Conservation (DOC), farmers, forest companies, iwi, and regional councils (Fowler et al. 2000; Hayes 2000). These networks promote the rapid release of substantial numbers of agents across multiple regions of the country and help to ensure that successful establishment of biocontrol agents within New Zealand will continue to increase. The Pacific region has c. 55% agent establishment (Schwarzländer et al. 2018). The ongoing collaboration between BSI, other New Zealand and Australian organisations, and Pacific network groups will help to ensure that successful establishment of biocontrol agents within the Pacific region will continue to increase.

Coevolution of potential weed biocontrol agents and their host plants implies that both should be adapted to similar climatic conditions. This should, in theory, limit the difficulties posed by climate matching, but there are certain circumstances where climate may become an issue. Target weed species often have a wider climatic distribution than pathogen or arthropod agents (Goolsby et al. 2006). Establishment of some exotic weed species in novel ecosystems within the introduced range (i.e. in ecosystems that do not occur in the native range) is possible (Gallagher et al. 2010). Control of target weed species by potential agents that are unable to adapt to these new

ecosystems may be poor, or effective only in parts of the introduced range that are climatically similar to the native range.

For example, in New Zealand, insect agents for *Lantana camara* L. were deemed unsuitable for New Zealand's climate and two rust agents were released instead. Changes in day length can affect the number of generations an agent may produce annually, and this can influence the likelihood of successful agent establishment, especially when it is compounded by climate sensitivity (Grevstad & Coop 2015). If agents are collected from a restricted region within the native range, they may be ineffective at controlling a target weed, particularly if the distribution of the weed species encompasses a wide range of climatic and ecological conditions (van Klinken et al. 2003).

However, biocontrol agents acquired from a specific region within a target weed's native distribution could prove beneficial when control in a subset of that target weed's fundamental niche is needed (Robertson et al. 2008). In instances such as these, species distribution modelling and climate-matching techniques would help identify and locate suitable biocontrol agents. These modelling techniques may also be increasingly necessary for making predictions about successful biocontrol agent establishment when confronted with climate change (Olfert et al. 2016).

3.10 Predicting the impact of biological agents

The *a priori* prediction of biocontrol agent efficacy is more challenging than predicting the likelihood of successful establishment (Cock et al. 2015). Of course, factors affecting the likelihood of establishment (e.g. climate, competition, predation) may also influence the degree of impact an agent has on both the target weed and potential non-target species. Preliminary testing significantly reduces the risk of potential harm to native species and ecosystems, but criteria for predicting agent impacts on target weeds in field situations are less reliable (de Castro-Guedes & de Almeida 2017). The most accurate means of assessing the impacts of biocontrol agents in the field is to conduct empirical tests and post-release monitoring (Blossey & Skinner 2000).

As with establishment, increasing the number of released agents can raise the likelihood of successful biological control (Denoth et al. 2002): two or three different agents are generally required to provide effective control of a target weed. However, effective control can also be obtained when the most damaging agent has been identified and released in substantial numbers, rather than multiple biocontrol agents (Denoth et al. 2002). Identifying the agent most likely to effectively control target weed populations is challenging, but it can substantially increase the efficacy of biocontrol programmes.

Higher success rates of weed biocontrol are often achieved when using agents from specific taxonomic groups. A global analysis of establishment rates and agent success revealed that coleopteran, hemipteran, and fungal pathogens have the highest proportions of taxa causing heavy impact (or a combination of medium, variable, or heavy impact) on target weeds (Schwarzländer et al. 2018). Two coleopteran families – Curculionidae (weevils) and Chrysomelidae (leaf beetles) – have been identified as the most effective taxa for controlling target weeds (Crawley 1989; Clewley et al. 2012). Only 6.4% of biocontrol agents released are fungal pathogens (Schwarzländer et al. 2018), none of which have been found on non-target plants (Barton 2004). These pathogens are mainly rust fungi that can complete their life cycle on a single host (i.e. are host-specific), are highly virulent, and can disperse over a long distance (Barton 2004). An example of a highly host-specific rust is the lantana rust fungus, *Prospodium tuberculatum* (Speg.) Arthur. This rust fungus only infects pink-flowered *Lantana camara* biotypes in New Zealand, and among the 40 Australian biotypes only 15 pink-flowered forms are susceptible (Thomas et al. 2006).

Parasitism, predation, and interspecific competition can all affect the outcome of weed biological control programmes. Parasitism has significantly undermined the impact of five weed biocontrol agents in New Zealand, with parasitism ranging from 41% to 100% (Paynter et al. 2010). Using agents that do not have a native analogue (i.e. avoiding a closely related and ecologically similar species to the agent) in the natural fauna is one method of avoiding the detrimental effect of parasitism. This is because it reduces the chance that the biocontrol agent will accumulate parasitoids that specialise on the native analogue as a host (Paynter et al. 2018).

Predation is thought to be responsible for significantly reducing the impacts of another four biocontrol agents introduced to New Zealand (Paynter et al. 2018). Using the native analogue approach to predict predation impacts on biocontrol agents is less useful, because predators tend to be generalist feeders (Snyder & Ives 2001; Petráková et al. 2015; Paynter et al. 2018). One way to limit predation risk is to investigate the food webs and trophic structures of the target weed and its potential biocontrol agents in their native range. This may provide insight into how predation impact can be mitigated or avoided in the introduced range (Paynter et al. 2018).

Interspecific competition, especially from other biocontrol agents, can also reduce the efficacy of weed biocontrol programmes. An example of this is the interference competition between the coleopteran *Larinus minutus* Gyllenhal and *Urophora affinis* Frauenfeld, a dipteran; these are two biocontrol agents that have been released against spotted knapweed (*Centaurea stoebe* L. subsp. *micranthos*). Interference competition between these agents reduced overall seed destruction of knapweed relative to the destruction caused by the weevil alone (Crowe & Bouchier 2006). When considering multiple biocontrol agents for release against target weeds, selecting agents that damage different structures of the target weed (e.g. leaves, flowers, seeds, stems, roots) can help reduce potential competition.

Prioritising host-specific agents for biocontrol programmes can help reduce impacts on non-target species. However, some biocontrol agents are highly specialised and, in some cases, can only thrive on certain subspecies, varieties, or even genotypes or forms of the target weed. For example, the level of impact of the rust fungus *Puccinia chondrillina* Bubák & P.Syd on skeleton weed (*Chondrilla juncea* L.) is significantly correlated to the weed's morphological form (Burdon et al. 1981).

Studies have attempted to predict the impact of biocontrol based on attributes of the target weed and agent attributes. For example Paynter, Overton et al. (2012) investigated whether the impact of biocontrol varied according to plant traits by analysing an international data set of completed programmes. They found that three factors were predictors of impact

- **Ecosystem:** where the average impact of biocontrol on wetland and aquatic weeds is greater than for terrestrial weeds.
- **Mode of reproduction:** where the average impact of biocontrol is higher on clonal and apomictic weeds compared to weeds that reproduce sexually. This factor may be a surrogate measure of genetic diversity of an invading weed (clonal weeds tend to have low genetic diversity compared to outcrossing sexual weeds).
- **Major weed in native range:** Biocontrol programmes targeting plants that are regarded as weeds in the native range tend to have lower impacts compared to programmes that target weeds that are not weedy in the native range. This factor may be a surrogate measure of relative abundance. For example, if a target plant is uncommon or a minor component of the native flora it is unlikely to be considered a weed. Species that are not abundant in the native range that become abundant in the introduced range may do so because they benefit from the absence of specialist natural enemies in the introduced range. Species that are abundant

enough to be considered weeds in the native range may be less regulated by natural enemies. For example, spatial models indicate that under certain disturbance regimes, Scotch broom *Cytisus scoparius* can be invasive in the native range, despite the known chronic impacts of natural enemies on growth and fecundity (Rees & Paynter 1997).

Paynter, Overton et al. (2012) also demonstrated that the success of pioneering programmes predicts the success of repeat programmes against the same target weed in other regions. In other words, if a pioneering programme against a weed was successful, then there is a good chance that this success can be repeated in other regions.

C. alliodora has not been the target of a biocontrol programme and is a sexually reproducing terrestrial weed that is not weedy in the native range. Based on the analysis by Paynter, Overton et al. (2012), it is an intermediate target for biocontrol (Table 2).

Table 2. Predictions of the percentage reduction achieved by biocontrol for each of the eight combinations of predictor variables

Major weed in native range	Reproduction	Ecosystem	Mean percentage reduction from biocontrol
No	Asexual	Aquatic/wetland	93
No	Sexual	Aquatic/wetland	77
No	Asexual	Terrestrial	80
No	Sexual	Terrestrial	50
Yes	Asexual	Aquatic/wetland	69
Yes	Sexual	Aquatic/wetland	36
Yes	Asexual	Terrestrial	41
Yes	Sexual	Terrestrial	15

Source: Paynter, Overton et al. 2012

Biocontrol impact has also been correlated with agent traits. For example, Paynter (2024) analysed a data set of 36 agents released in New Zealand. He found that agents that were observed to be highly damaging (i.e. completely defoliating or killing plants or reducing populations in the field) in the native range were almost invariably highly damaging in New Zealand. In contrast, species that were subject to apparent competition mediated by parasitoids shared with closely related 'native analogue' species (*sensu* Paynter et al. 2010) failed to have an impact on the target weed.

Agent guild (e.g. borer, defoliator, gall-former) also helped predict impact. In particular, the use of agents that only attack reproductive parts of the plant (e.g. seed and flower feeders) is unlikely to result in reduced weed populations (but can reduce the rate a weed invades). Paynter's (2024) simple framework was developed to score candidate agents as an initial way to prioritise the most promising agents to focus on at the start of a project.

Much larger data sets were analysed by Cullen et al. (2022) for Australia (196 agents), and by (Panta et al. 2024) (436 agents) globally. The authors found that certain agent feeding guilds were associated with higher biocontrol success. Agents attacking below-ground plant tissues and sucking insects were most frequently associated with heavy impact (Panta et al. 2024). Similarly, Cullen et al. (2022) found that biocontrol agents that feed on roots or root-crowns and sap feeders, as well as rusts and smuts, were associated with higher biocontrol success. Panta et al. (2024) also found that agents were more successful when both adults and immature life stages feed and damage the target weed, when they have a multivoltine life cycle, and when feeding on vegetative

plant tissues compared to those feeding on reproductive plant parts, confirming the findings of Paynter (2024).

The human factor in biocontrol programmes can often affect their efficacy. Consolidating the knowledge and understanding of multiple experts (e.g. scientists) and other professionals (e.g. rangers, farmers) can help to determine the likelihood of biocontrol success (van Klinken et al. 2003). However, failure to identify differences between stakeholders in what constitutes a 'successful' biocontrol programme can hamper progress towards achieving biocontrol goals. For instance, some stakeholders may anticipate that biocontrol agent impacts will occur more quickly than is reasonably feasible, which could negatively affect their impression of the biocontrol programme's success. As with all biocontrol programmes, a programme targeting *C. alliodora* needs clearly defined aims from the outset that are known to all stakeholders so that the success or failure of the programme can be accurately and objectively assessed.

3.11 Biological control initiatives in Pacific Island nations

The Pacific region has a long history of biological control endeavours. In 1902, 23 insect species were imported from Mexico to Hawaii to help control the weed *Lantana camara* (Swezey 1923, cited in Day & Winston 2016). This is the earliest known case of the deliberate introduction of biocontrol agents in the Pacific region. One of these agents, a fruit-mining fly, *Ophiomyia lantanae* Froggatt, was further introduced into New Caledonia and Fiji in 1911 (Gutierrez & Forno 1989).

To date (2024), 71 biocontrol agents have been intentionally released against 30 weed species in 18 Pacific countries (not including Australia, New Zealand, and the state of Hawaii) (Day & Witt 2019). Of these 30 weed species targeted, 14 have been successfully controlled where their biocontrol agents have established, including the weeds *Chromolaena odorata* (L.) R.M.King and H.Rob., *Pontederia crassipes* Mart. (formerly *Eichhornia crassipes* (Mart.) Solms), *Mimosa diplotricha* C.Wright, *Pistia stratiotes* L., *Salvinia molesta* D.Mitch., and *Sida acuta* Burm.f. (Day & Witt 2019). However, most of these weeds have a wide distribution within the Pacific region, and this means that biocontrol agents are often only providing successful control in a small fraction of a weed's realised distribution within the Pacific (Day & Winston 2016).

Fiji has been the most active of the 22 Pacific Island countries and territories (PICTs) in terms of intentionally releasing biocontrol agents against weeds. Fiji has released 30 biocontrol agents to provide control against 11 weed species (Day & Winston 2016). Other PICTs that have been especially active include Papua New Guinea (19 agents against 12 weed species), Guam (16 agents against 4 weed species), Federated States of Micronesia (13 agents against 3 weed species), and Palau (11 agents against 4 weed species) (Day & Winston 2016). Only four PICTs – Kiribati, Pitcairn Island, Tokelau, and Wallis and Futuna – have not deliberately released any weed biocontrol agents (Day & Winston 2016). The most recent PICTs to adopt biocontrol were the Marshall Islands and Tuvalu in 2024 with the release of the chromolaena gall fly, *Ceichidochare connexa*, to attack *Chromolaena odorata*, and the leucaena psyllid, *Heteropsylla cubana*, to attack *Leucaena leucocephala*, respectively (L. Hayes, BSI, pers. comm., 26 September 2025; S. Morton, BSI, pers. obs., 13 May 2024).

Seven of the weed species targeted for biocontrol in the PICTs are considered under complete control (where agents have been released) because the agents have had a high impact (Day & Winston 2016). The psyllid *Heteropsylla spinulosa* Muddiman, Hodkinson & Hollis is the most widespread and effective biocontrol agent to be released thus far in the PICTs. Its target weed, *Mimosa diplotricha* C.Wright ex Sauvalle, occurs in 16 countries, into 13 of which the psyllid has been successfully introduced and established (Day & Winston 2016). *Calligrapha pantherina* Stål is

a leaf-feeding beetle that has successfully controlled *Sida acuta* Burm.f. and *S. rhombifolia* L. in three of the four countries in which it was intentionally released. The remaining four weed species deemed under complete control in the PICTs include an unspecified *Opuntia* sp., *Opuntia stricta* (Haw.) Haw., *Salvinia molesta* D.Mitch., and *Tribulus cistoides*.

Recent success stories include a biocontrol programme focusing on invasive weeds (including vines) in the Cook Islands (Rarotonga). Funding for this programme began in 2012 by the New Zealand Ministry of Foreign Affairs and Trade (MFAT) and targeted several invasive weed species, including *Cardiospermum grandiflorum* Sw., *Mikania micrantha* Kunth, *Passiflora rubra* L., *Psidium cattleyanum*, *Spathodea campanulata* P.Beauv., and *Xanthium pungens* Wallr. Three of these species, *C. grandiflorum*, *M. micrantha* and *X. pungens*, each had a different rust fungus from the genus *Puccinia* released against them in 2016/17, and there has been rapid, successful control of these weeds on Rarotonga since then. Biocontrol programmes for the other four weeds are ongoing and are showing promising signs.

Currently, BSI is leading a multi-year project entitled 'Improving Productivity of the Beef Industry in Vanuatu through the Management and Biocontrol of Weeds', which is also funded by MFAT. The project began in July 2018 and aims to reduce pasture weeds in the island nation of Vanuatu through the long-term biocontrol of three important novel target weeds (*Solanum torvum* Sw., *Senna tora* (L.) Roxb., and *Urena lobata* L.), as well as some lesser weeds for which biocontrol agents are available. Partner organisations also involved in this project include Biosecurity Vanuatu and Biosecurity Queensland.

MFAT has also funded the 4-year 'Managing Invasive Species for Climate Change Adaptation in the Pacific' (MISCCAP) project, which began in March 2020 and ended in October 2024. The MISCCAP project was designed to support invasive species management programmes carried out by the Pacific Regional Invasive Species Management Support Service (PRISMSS) and to complement projects funded by other organisations, such as the GEF-6 Regional Invasives Project, which began in 2019 and ends in November 2025, and involves the Marshall Islands, Niue, Tonga and Tuvalu. MISCCAP was a collaboration between SPREP, BSI, and DOC and involved eight Pacific Island countries and territories. Biocontrol programmes funded by this project include those targeting *Epipremnum pinnatum* cv 'Aureum' (taro vine), *Decalobanthus peltatus* (L.) A.R.Simões & Staples (merremia), *Sphagneticola trilobata* (L.) Pruski (Singapore daisy), and *Falcataria moluccana* (albizia).

In 2023 the 3-year 'Restoring Island Resilience Programme' began, funded by MFAT and administered by SPREP, to ensure the continuation and extension of work begun under MISCCAP. This will end in June 2026.

4 Methods

4.1 Identifying closely related plants in the Pacific

Closely related plants in the Pacific were limited to plants belonging to the Cordiaceae *sensu* Boraginales Working Group and close families that are present in Pacific countries and territories where *C. alliodora* is known to be present. Appendix 1 lists native closely related species and Appendix 2 lists introduced closely related species. Information was acquired by searching online databases, the published literature, and from SPREP member country representatives. The following databases were used:

- Global Biodiversity Information Facility (GBIF.org 2025a): <https://www.gbif.org/> – search criteria were ‘Cordiaceae + Ericaceae + Heliotropiaceae + Boraginaceae + Oceania’ and other close families in Boraginales (Luebert et al. 2016)
- Plants of the World Online (POWO 2025b): <https://powo.science.kew.org/>
- Flora of Solomon Islands: <http://siflora.nmns.edu.tw/specimens/>

For the published literature, Google Scholar and Google were searched, using the terms ‘*Cordia*’, ‘Cordiaceae’, ‘Boraginaceae’, and ‘Boraginales’, paired with each current country member of SPREP: ‘American Samoa’, ‘Northern Mariana Islands’, ‘Cook Islands’, ‘Fiji’, ‘French Polynesia’, ‘Guam’, ‘Kiribati’, ‘Marshall Islands’, ‘Nauru’, ‘New Caledonia’, ‘Niue’, ‘Palau’, ‘Papua New Guinea’, ‘Samoa’, ‘Solomon Islands’, ‘Tokelau’, ‘Tonga’, ‘Tuvalu’, ‘Vanuatu’, and ‘Wallis and Futuna’.

4.2 Identifying arthropod and non-arthropod invertebrate biological control agents for *Cordia alliodora*

A list of arthropods and non-arthropod invertebrates reported as associated with *C. alliodora* in both its native and introduced ranges is tabulated in Appendix 4. Information was acquired by searching online databases and internet sites. The following databases were used.

- HOSTS – a Database of the World’s Lepidopteran Hostplants, the Natural History Museum’s world listing (Robinson et al. 2023): <https://nhm.ac.uk/our-science/data/hostplants/search/index.dsmi>
- SCALENET – a database of the world’s scale insects (Garcia 2016): <https://scalenet.info/>
- CABI Invasive Species Compendium (CABI 2022): <https://www.cabidigitalibrary.org/product/qj>.

Current Contents, Google, Google Scholar, Science Direct, and Web of Science were searched using the terms ‘*Cordia alliodora*’ or ‘*C. alliodora*’ or ‘laurel’ or ‘Spanish elm’ or ‘salmwood’ and ‘invertebrate’ or ‘arthropod’ or ‘insect’ or ‘herbivor*’.

Species belonging to the family Formicidae (ants) were not included. Many ant species are found associated with *C. alliodora* (Wheeler [1929] records 58 species), using the tree as a nesting site while obtaining no direct food source from it (Novais et al. 2021).

4.3 Identifying fungal pathogens of *Cordia alliodora*

A table was compiled of the fungi that have been reported associated with *Cordia alliodora* (Appendix 5). The information was obtained by searching online databases and internet sites. Online databases searched included:

- USDA Fungus-host database or FDSM (Farr & Rossman 2023): <https://fungi.ars.usda.gov/>
- MyCoPortal (Mycology Collections Portal): <https://www.mycportal.org/portal/>
- Biota of New Zealand: <https://biotanz.landcareresearch.co.nz/>.

In addition, CAB abstracts, Current Contents, PubMed, Ingenta, Web of Science, Agricola, Science Direct, and Google were searched, using the terms '*Cordia alliodora*' or '*Cerdana alliodora*', and sub-searched using the terms 'pathogen' or 'fungi' or 'disease'. Once a list had been created, we sought further information about each fungus in the published literature as well as in the online databases listed below.

- Index Fungorum database: <http://www.indexfungorum.org/Names/Names.asp>
- Global Biodiversity Information Facility (GBIF): <https://www.gbif.org/>
- MycoBank database: <https://www.mycobank.org/>

4.4 Identifying current unpublished practices and traditional knowledge

A questionnaire was sent to representatives of member countries and territories of SPREP, via email, to seek input on the local experience of *C. alliodora*. Countries where *C. alliodora* is known to be present were asked the following questions:

- Is *Cordia alliodora* classed as invasive or potentially invasive? Are there any important areas or species impacted by the plant invasion?
- What do you use *Cordia alliodora* for in your country?
- How do landowners or the government control *Cordia alliodora*?
- How much does *Cordia alliodora* cost to control?
- Does *Cordia alliodora* have any socio-economic impacts?
- Are there any groups that you think would oppose a control programme for *Cordia alliodora*?
- Is there any traditional knowledge in relation to *Cordia alliodora* that might be important to know?

Countries where *C. alliodora* is not known to be present were asked if the plant was present in their country and if it was a plant of concern. These countries were also sent a description of the plant with some images. Respondents who did recognise the plant, or noted it as being of concern, were then asked the aforementioned questions. Respondents are listed in Table 3.

Table 3. Respondents from Pacific Islands countries and territories that provided feedback on *Cordia alliodora*

Country/territory	Respondent
American Samoa	Tavita Togia, Office of the Governor
French Polynesia	Christophe Brocherieux, Cellule biodiversité Direction de l'environnement
New Caledonia	Patrick Barriere, Pôle Menaces – Coordinateur, Agence Néo-calédonienne de la Biodiversité
Niue	Huggard Tongatule, Biodiversity and Conservation Officer, Department of Environment, Fonuakula, Alofi South, Niue Island
Tonga	Steven Temaric Hamni, OIC, Ministry of Agriculture, Food and Forests 'Eua
Papua New Guinea	Michelle Pius (Ms), Botanist – Plant Health, Technical and Advisory Division, National Agriculture Quarantine Inspection Authority
Solomon Islands	George Harunari, Biosecurity officer – Biosecurity Solomon Islands
Wallis and Futuna	Sosefo Malau, Technicien d'intervention en Environnement, Service Territorial de l'Environnement (based in Wallis)
Wallis and Futuna	Alefosio Taugamoa, Technicien de surveillance des milieux, Service Territorial de l'Environnement (based in Futuna)

On 30 October 2025 a meeting was held online to determine the ecosystem and socioeconomic impact scores for *Cordia alliodora* (Appendix 7). BSI staff Lynley Hayes, Stephanie Morton, and Dr Quentin Paynter met with Pacific representatives David Moverley and Josef Pisi of SPREP.

5 Results

5.1 Arthropod and non-arthropod invertebrates attacking *Cordia alliodora*

A total of 171 arthropods were found associated with *C. alliodora* from online and literature searches (Appendix 4). These include representatives from nine orders: Acari (2), Coleoptera (44), Diptera (15), Hemiptera (70), Hymenoptera (11, excluding ants), Lepidoptera (18), Neuroptera (2), Orthoptera (2), and Thysanoptera (5). Most of these species (around 74 %) were unidentified species only recorded to the order taxonomic level and so have no recorded distribution or host specificity.

Of the 46 remaining arthropods, 10 species had unknown host ranges and damage severity, and 31 species were polyphagous and thus unsuitable as biocontrol agents. The remaining five species appeared to be specialists of *Cordia alliodora* or *Cordia* species. Two of these species – *Akermes cordiae* and *Cyclolecanium hyperbaterum* – are scale insects from the family Coccidae. Both are recorded from Panama and have only been reported as present on *C. alliodora* (Garcia et al. 2016).

However, the damage severity of both species is unknown, and both are tended by ant species that live on *C. alliodora* (Garcia et al. 2016), which may be problematic for a biocontrol programme. For example, it was shown that scale insects interfered with the biocontrol of boneseed *Osteospermum moniliferum* in New Zealand by attracting ants onto the plant, resulting in greatly elevated levels of predation of biocontrol agents (Paynter, Forgie et al. 2012).

A noctuid moth – *Stauripodes persimilis* – has been described as a *Cordia* specialist (Pringle & Gordon 2013), but the extent of damage it causes is unknown. This species has been recorded from Costa Rica, Ecuador, Mexico, and Trinidad (Ziegler 2025).

Two chrysomelid beetles are worth further investigation. The first beetle, *Amblycerus atkinsoni*, is a bruchid beetle endemic to Jalisco, Mexico (Pringle 2014). It has only been recorded from *C. alliodora* and was described as the most common beetle seed predator (Pringle 2014). The extent of damage is unknown, but Pringle (2014) recorded a mean proportion of c. 0.4 from *C. alliodora* seeds with bruchid exit holes when ants were not present. One caveat is that this species is not listed in GBIF (including as a synonym), although it is included in at least three scientific papers (Romero & Johnson 2004; de Loera-Barocio et al. 2006; Pringle 2014). Seed-feeders have been used to reduce the invasiveness of some trees valued for their wood (e.g. some invasive acacias in South Africa) because they reduce propagule pressure without damaging beneficial aspects. This may be preferable in regions where people value *C. alliodora*.

The second beetle, *Coptocycla leprosa*, is a tortoise beetle recorded from Belize, Costa Rica, Mexico, Nicaragua, and Panama. Wheeler (1929) suggests that *C. leprosa*'s true host (which he describes as *Psalidonota leprosa*) is *C. alliodora*, while Trager and Bruna (2006) describe it as a *Cordia* specialist. It has been recorded as highly damaging on *Cordia* when the beetle reaches high population densities, causing near defoliation of plants (Trager & Bruna 2006).

5.2 Fungal pathogens associated with *Cordia alliodora*

Species from 32 fungal genera have been isolated from *C. alliodora* (Appendix 5). Fourteen species were not identified to species level and often lacked symptom descriptions. Fungi isolated from *C. alliodora* caused damage to leaves, branches, stems and roots. Symptoms include:

- leaf spots – caused by *Cylindrotrichum* sp., *Colletotrichum* sp., *Cercospora* sp., *Pseudocercospora cordiae-alliodorae*, and *Phyllachora orbicularis*
- powdery mildew – caused by *Blumeria* sp.
- sooty mould – caused by *Chaetocapnodium microglobulosum* and *Leptoxiphium ophidioglossum*
- rust on leaves – caused by *Puccinia ciliata*, *Puccinia cordiae*, and *Puccinia johnsonii*
- stem dieback – caused by *Lasiodiplodia theobromae*
- stem canker – caused by *Necator salmonicolor*, *Puccinia cordiae*, and an unknown fungus
- witch's broom – caused by *Puccinia cordiae*
- root rot – caused by *Armillaria fuscipes* and *Pyrrhoderma noxium*.

Most pathogens isolated from *C. alliodora* have a very wide host range and would therefore not be suitable for biocontrol. Of the 35 fungal species isolated, *Campylocarpon amazonense* and *Koordersiella cordiae* were recorded only once on *C. alliodora* and are unlikely to be damaging to this tree species.

Pseudocercospora cordiae-alliodorae and *Puccinia cordiae* were only recorded on *Cordia* species. Although *P. cordiae-alliodorae* is unlikely to be damaging (Braun & Urtiaga 2013), *Puccinia cordiae* has been described as the most important disease of *C. alliodora* (Johnson & Morales 1972). *P. cordiae* completes all rust spore stages on *Cordia* species, making it both macrocyclic and autoecious (Hernández & Hennen 2003). Spermogonia and aecia develop on witch's brooms, which are formed due to distortion and hypertrophy from systemic infection (Hernández & Hennen 2003). Uredinia appear on the undersides of leaves and, occasionally, on flowering structures, while telia form on both leaf surfaces and sometimes on flowering structures (Hernández & Hennen 2003). *P. cordiae* also initiates cankers at the base of young lateral branches, creating open wounds that are subsequently colonised by secondary pathogens (Johnson & Morales 1972). These infections can expand into large stem cankers, usually confined to one side of the tree, but when multiple cankers coalesce and girdle the stem they can lead to stem breakage and eventual tree death (Boshier & Lamb 1997). Disease severity depends on tree provenance as well as weather and soil conditions. Incidence is greatest in nutrient-poor soils and under periods of high humidity (Boshier & Lamb 1997).

Two additional pathogens have been described as damaging to *C. alliodora*: *Pyrrhoderma noxium* and *Necator salmonicolor* (Orwa et al. 2009). *P. noxium* causes brown root rot on a wide range of plant species (Neil 1988; Cannon et al. 2022). Neil (1988) listed all the potential tree hosts in Vanuatu. On *C. alliodora*, symptoms include wilting and yellowing of foliage, followed by leaf death and eventual whole-tree mortality, accompanied by a dark brown encrusting mat at the base of the trunk (Neil 1986). The pathogen has been reported as widespread in *C. alliodora* plantations in Vanuatu (Neil 1989; Boshier & Lamb 1997). Disease incidence was found to correlate with high rainfall, elevated inoculum levels in natural forests, nutrient-poor soils, and extreme weather events such as hurricanes (Neil 1986, 1989). Provenance trials in Vanuatu showed that up to 6.9% of trees were attacked by *P. noxium* in Vanafo, but susceptibility to the pathogen was dependent on tree provenance (Neil 1989). On Pentecost Island up to 35.5% of tree losses were observed (Neil 1986).

Necator salmonicolor has been reported in Vanuatu as causing stem canker on *C. alliodora* (Neil 1989). Provenance trials in Vanuatu found that up to 4.4% of trees were attacked in Vanafo and up to 8.8% in Shark Bay (Neil 1989). This pathogen affects a wide range of woody plants (PlantwisePlus Knowledge Bank 2019). Neither *N. salmonicolor* nor *P. noxium* would be suitable to use as a biocontrol agent.

An unknown fungal pathogen was described in the Solomon Islands as causing stem canker and was reportedly linked to high humidity (Liegel & Stead 1990). No further details on the identity of the causal agent were provided, but it is unlikely to be host specific.

5.3 Other organisms associated with *Cordia alliodora*

An unknown bacterium was reported to cause canker on *C. alliodora* stems (Appendix 6). These stem cankers were characterised by longitudinal bark cracks, and when cutting into the margins of fresh cankers a secretion of black, oily substances appeared (Liegel & Stead 1990). The causal agent was not identified, and symptoms were associated with *C. alliodora* plants exhibiting growth limitations, indicating possible abiotic stress factors (Liegel & Stead 1990).

Plant parasites from the genus *Phoradendron* have been reported on *C. alliodora* in Costa Rica (Appendix 6) (Johnson & Morales 1972; Arguedas & Chaverri 1999). These leafy mistletoes parasitise *C. alliodora* by attaching to branches and trunks with haustoria that penetrate the bark to extract water and nutrients. They develop long stems with well-formed leaves and may grow into dense clumps up to 2.8 m across. Their fruits are dispersed by birds, and heavy infestations can significantly reduce tree growth and timber quality (Arguedas & Chaverri 1999). Occasionally they can cause tree death (Johnson & Morales 1972). *Phoradendron* spp. are unlikely to be host specific and therefore would not be suitable biocontrol agents.

6 Conclusions

Cordia alliodora is expected to become a major problem in the Pacific and the costs of control will continue to increase. The long-term approach of biological control to weed management solutions provides a lasting and substantial economic benefit unattainable by other conventional control methods. Biocontrol of *C. alliodora* appears to be a potentially viable control option, provided the candidate agents identified here are adequately host specific. No fungal pathogens or insects have been used as biocontrol agents against *C. alliodora*, but there are some promising natural enemies that could be investigated as biocontrol agents.

- The chrysomelid beetle *Coptocycla leprosa* is the strongest arthropod candidate worth investigating further as a potential biocontrol agent for *C. alliodora* because it is reported as both a *Cordia* specialist and capable of high damage.
- The noctuid moth *Stauropides persimilis* and the bruchid beetle *Amblycerus atkinsoni* are also potential biocontrol candidate agents that could be pursued if *C. leprosa* proves unsuitable. The bruchid beetle could also be pursued if there is a desire to target only plant reproduction to reduce spread, as this species is a seed feeder.
- Two coccid scale insects, *Akermes cordiae* and *Cyclolecanium hyperbaterum*, may be worth following up as they are reportedly host-specific to *C. alliodora*. However, their associations with ant species will need to be investigated to determine if this would affect their efficacy as suitable biocontrol agents.

- The fungal pathogen *Puccinia cordiae* is also a strong candidate and worth investigating further as a potential biocontrol agent for *C. alliodora*. *Puccinia cordiae* causes a variety of symptoms on *C. alliodora*, including leaf pustules, witch's broom, and canker, and appears likely to be host specific.

Among the Cordiaceae family (to which *C. alliodora* belongs) there are four indigenous species and three introduced species present in Pacific countries and territories where *C. alliodora* is present (Appendix 1 and 2). The importance of all these species to local communities will need to be determined before host-range testing can be undertaken. Closely related native and introduced species valued by local communities will need to be tested for their susceptibility to any potential biocontrol agents. For Samoa, Tonga and Vanuatu, in particular, host range testing should include *Cordia dichotoma* (native to Vanuatu), *C. aspera*, and *C. subcordata* (both of which are native to Samoa, Tonga and Vanuatu).

Opposition to control has not been reported but is a possibility from communities that use the tree in forestry and agroforestry systems, especially if they are unaware of the harmful impacts of this plant. Consultation and informational workshops will be necessary to determine whether a biocontrol programme for managing this weed would be widely supported.

With high propagule pressure combined with tropical cyclone events, *C. alliodora* has the capacity to continue to expand its invasive range in the Pacific. Although chemical and mechanical removal of large trees in urban areas will still be required, a biological control programme as a long-term control solution is likely to be needed.

7 Recommendations

A project to develop natural enemies for a novel target typically costs between NZD\$1.5 - 3.5m over an up to 10 year period, depending on the complexity of the work involved. Our recommendations and the estimated costs for key aspects of a biocontrol programme targeting *C. alliodora* in the Pacific region are shown below. (Note: all cost estimates are in New Zealand dollars.)

- If *C. alliodora* seed source records are unavailable, complete a genetic analysis to determine the variability of *C. alliodora* in the Pacific region and its origin in the native range. **Estimated cost:** \$100,000–\$200,000.
- Organise shipment of the potential biocontrol agents identified in this report to containment facilities in New Zealand/Australia to establish rearing colonies. **Estimated cost per species:** \$50,000–\$100,000.
- Undertake rearing of agents in containment. **Estimated cost per species per year:** \$50,000–\$100,000.
- Undertake host-range testing. **Estimated cost per species:** \$100,000–\$200,000.
- If potential biocontrol agents identified in this report are not appropriate, conduct surveys of *C. alliodora* in climatically similar areas of the native range to identify other potential arthropod and pathogen biocontrol candidates. **Estimated cost:** \$200,000–\$600,000.
- Conduct studies to determine the impact of other potential biocontrol agents found in surveys, their life-cycle, and how to rear them. **Estimated cost per species per year:** \$50,000–\$150,000.
- If other potential biocontrol agents are identified, continue with the import, rearing, and host-range testing steps listed above.
- Assist Pacific Island nations seeking biocontrol against *C. alliodora* by preparing applications and going through the process to release agents. **Estimated cost per country:** \$16,500–30,000.
- Mass-rear and release agents in Pacific countries. **Estimated cost per country per species:** \$50,000–\$100,000.
- Monitor the establishment success of biocontrol agents. **Estimated cost per country:** \$50,000–100,000.
- Evaluate the biocontrol programme’s success. **Estimated cost per country:** \$50,000–100,000.

Note: *Estimated costs are exclusive of GST and are based on 2025/26 figures. New estimates will need to be provided if work is to be undertaken beyond those years, and/or if complicating factors arise (e.g. disease infecting imported agents, ongoing disruptions due to global pandemics, etc.).*

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9 References

Note: This reference list includes reference for Appendices 1, 2, 4, 5, 6, and 7 as well as those in the main paper.

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Appendix 1 – *Cordia alliodora* – related plant species indigenous to the Pacific

Note: References for Appendix 1 are included in the References section of the main report.

Family ^a	Species ^b	Native to ^b	Introduced to
Cordiaceae	<i>Cordia aspera</i> G.Forst.	American Samoa (Whistler 1998), Australia, Fiji, French Polynesia, Indonesia, New Caledonia, New Guinea (Conn 2004+), Philippines, Samoa, Solomon Is., Tonga (Yuncker 1959; Atherton et al. 2014), Vanuatu, Wallis and Futuna	
Cordiaceae	<i>Cordia dichotoma</i> G.Forst. (syn. <i>Varronia dichotoma</i> Ruiz & Pav., syn. <i>Cordia wallichii</i> G.Don)	Australia, Fiji, French Polynesia, Indonesia, New Caledonia, New Guinea (Conn 2004+), Philippines, Samoa, Solomon Is., Vanuatu, Wallis and Futuna	Guam, rare in cultivation (Stone 1970)
Cordiaceae	<i>Cordia lutea</i> Lam.	Colombia, Ecuador, French Polynesia (Gottschling et al. 2005), Galápagos, Peru	Hawaii, Tonga (Orrell & Stewardship 2025)
Cordiaceae	<i>Cordia subcordata</i> Lam.	American Samoa (Whistler 1998; Ragone & Lorence 2006), Australia, Cook Is. (McCormack 2007), Federated States of Micronesia, Fiji (Franklin et al. 2008), French Polynesia, Guam (Stone 1970), Hawaii, Indonesia, Kiribati (Fosberg & Sachet 1987; Thaman 1992), Marianas, Marshall Is. (Fosberg 1990), Nauru (Thaman et al. 1994), New Caledonia, New Guinea (Conn 2004+), New Zealand, Niue (Yuncker 1943; Gardner 2021), Palau, Philippines, Pitcairn Is., Samoa (Christophersen 1935), Solomon Is. (Tanaka et al. 2020), Tokelau (Whistler 1988), Tonga (Yuncker 1959; Atherton et al. 2014), Tuvalu (Thaman 2016), Vanuatu, Wake I., Wallis and Futuna (St John & Smith 1971)	
Ehretiaceae	<i>Ehretia microphylla</i> Lam.	Guam (Stone 1970), New Guinea (Conn 2004+), Philippines, Solomon Is.	Hawaii, Marianas, Samoa, Vanuatu
Heliotropiaceae (Weigend et al. 2014)	<i>Euploca ovalifolia</i> (Forssk.) Diane & Hilger	Guam (Stone 1970), Kiribati, Solomon Is.	
Heliotropiaceae	<i>Heliotropium arboreum</i> (Blanco) Mabb. (syn. <i>Heliotropium foertherianum</i> Diane & Hilger, syn <i>Tournefortia argentea</i> L.f.)	American Samoa (Ragone & Lorence 2006), Australia, Caroline Is., Christmas I., Cook Is., Fiji (Franklin et al. 2008), French Polynesia, Federated States of Micronesia (Falanruw 1987), Guam (Stone 1970), Kiribati (Fosberg & Sachet 1987), Marianas, Marshall Is. (Fosberg 1955, 1990), Nauru (Thaman et al. 1994), New Caledonia, New Guinea (Conn 2004+), Niue (Gardner 2021; Sykes 2024), Philippines, Pitcairn Is., Samoa (Christophersen 1935), Solomon Is. (Tanaka et al. 2020), Tokelau (Whistler 1988), Tonga (Sykes 1981), Tuvalu (Thaman 2016), Vanuatu, Wake I., Wallis and Futuna (St John & Smith 1971)	Hawai'i

Family ^a	Species ^b	Native to ^b	Introduced to
Heliotropiaceae	<i>Heliotropium anomalum</i> Hook. & Arn.	American Samoa (Whistler 1998), Caroline Is., Cook Is. (McCormack 2007), Guam (Stone 1970), Hawaii, Line Is., Marianas, Marshall Is. (Fosberg 1955, 1990), New Caledonia, Niue (Yuncker 1943; Gardner 2021), Pitcairn Is., Society Is., Tuamotu, Tubuai Is., Wake I.	
Heliotropiaceae	<i>Heliotropium sarmentosum</i> (Lam.) Craven (syn. <i>Tournefortia horsfieldii</i> Miq.)	Australia, New Guinea (Conn 2004+), Philippines, Solomon Is., Vanuatu	
Boraginaceae	<i>Trichodesma zeylanicum</i> (Burm.f.) R.Br.	Australia, New Guinea (Conn 2004+), Philippines	Fiji, Vanuatu introduced, but presence unconfirmed (Plunkett et al. 2022)

^a Proposed classification by Luebert et al. (2016)

^b Where not specifically referenced, the plant species and countries in these columns have come from the Global Biodiversity Information Facility (<https://www.gbif.org/>) and Plants of the World Online (<https://powo.science.kew.org>) online databases.

Appendix 2 – *Cordia alliodora* – related plant species introduced to the Pacific

Note: References for Appendix 2 are included in the References section of the main report.

Family ^a	Species ^b	Native to ^b	Introduced to Pacific	Cultivated/invasive
Cordiaceae	<i>Cordia alliodora</i> (Ruiz & Pav.) Oken	Argentine Northwest, Belize, Bolivia, Brazil North, Brazil Northeast, Brazil South, Brazil Southeast, Brazil West-Central, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, French Guiana, Guatemala, Guyana, Haiti, Honduras, Leeward Is., Mexico Central, Mexico Gulf, Mexico Northeast, Mexico Northwest, Mexico Southeast, Mexico Southwest, Nicaragua, Panamá, Paraguay, Peru, Puerto Rico, Southwest Caribbean, Suriname, Trinidad-Tobago, Venezuela, Venezuelan Antilles, Windward Is.	Fiji, Galápagos, Hawaii (Gallaher et al. 2020), Samoa, Solomon Is., Tonga, Vanuatu	Invasive or potentially invasive
Cordiaceae	<i>Cordia myxa</i> L.	Assam, Bangladesh, India, Iran, Laos, Myanmar, Nepal, Pakistan, Sri Lanka, Vietnam	Australia, Fiji, Marianas, New Caledonia, New Guinea, Vanuatu	Naturalised in Australia (Kodela 2024). Can be an ornamental, cultivated or wild; is edible; has medicinal uses (Tropical Plants Database 2024)
Cordiaceae	<i>Cordia sebestena</i> L.	Bahamas, Belize, Cayman Is., Colombia, Cuba, Dominican Republic, El Salvador, Guatemala, Haiti, Honduras, Jamaica, Mexico Gulf, Mexico Southeast, Mexico Southwest, Nicaragua, Panamá, Southwest Caribbean, Turks-Caicos Is., Venezuela, Venezuelan Antilles	Australia, Cook Is., Federated States of Micronesia, French Polynesia, Guam, Kiribati, Marianas, Marshall Is., New Caledonia, Palau, Tuvalu	Cook Is. recent introduction; not naturalised (McCormack 2007). Tuvalu recent introduction; occasional (Thaman 2016). Guam introduced; planted in Guam as a street tree (Stone 1970)
Cordiaceae (Gottschling et al. 2005)	<i>Varronia cylindristachya</i> Ruiz & Pav.	Bolivia, Colombia, Ecuador, Peru, Venezuela, Venezuelan Antilles	Tonga	Unknown

Family ^a	Species ^b	Native to ^b	Introduced to Pacific	Cultivated/invasive
Heliotropiaceae	<i>Euploca procumbens</i> (Mill.) Diane & Hilger	Argentine Northeast, Argentine Northwest, Arizona, Arkansas, Bahamas, Belize, Bolivia, Brazil North, Brazil Northeast, Brazil South, Brazil Southeast, Brazil West-Central, California, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Haiti, Honduras, Jamaica, Leeward Is., Louisiana, Maryland, Mexico Central, Mexico Gulf, Mexico Northeast, Mexico Northwest, Mexico Southeast, Mexico Southwest, Mississippi, Nicaragua, Oklahoma, Panamá, Paraguay, Peru, Puerto Rico, Texas, Trinidad-Tobago, Turks-Caicos Is., Uruguay, Venezuela, Venezuelan Antilles	American Samoa (Whistler 1996), Caroline Is., Guam (Whistler 1996), Hawaii (Whistler 1996), Line Is., Marianas, Marshall Is. (Fosberg 1955, 1990), Nauru (Thaman et al. 1994), Palau (Space et al. 2003), Samoa, Solomon Is. (Tanaka et al. 2020), Wake I.	Uncommon to occasional in dry coastal areas of Hawaii and American Samoa and rarely found inland; more common in Guam, where it was introduced in 1905 (Whistler 1996). American Samoa recent introduction; common in disturbed places in lowlands (Whistler 1998). Naturalised in Hawaii (Daehler & Faccenda 2024).
Heliotropiaceae	<i>Euploca strigosa</i> (Willd.) Diane & Hilger	Afghanistan, Algeria, Angola, Assam, Bangladesh, Benin, Botswana, Burkina, Cambodia, Cameroon, Chad, China Southeast, Djibouti, DR Congo, East Himalaya, Eritrea, Eswatini, Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Gulf States, India, Ivory Coast, Kenya, KwaZulu-Natal, Laos, Malawi, Mali, Mauritania, Mozambique, Myanmar, Namibia, Nepal, Niger, Nigeria, Northern Provinces, Oman, Pakistan, Philippines, Rwanda, Saudi Arabia, Senegal, Socotra, Somalia, Sri Lanka, Sudan-South Sudan, Tanzania, Thailand, Togo, Uganda, Vietnam, West Himalaya, Yemen, Zambia, Zimbabwe	New Guinea (Conn 2004+), Tonga	Unknown
Heliotropiaceae	<i>Heliotropium amplexicaule</i> Vahl	Argentine Northeast, Argentine Northwest, Bolivia, Brazil South, Brazil Southeast, Brazil West-Central, Réunion, Uruguay	Hawaii (Whistler 1996), Fiji (Whistler 1996)	Unknown
Heliotropiaceae	<i>Heliotropium indicum</i> L.	Argentine Northeast, Argentine Northwest, Bolivia, Brazil North, Brazil Northeast, Brazil South, Brazil Southeast, Brazil West-Central, Paraguay, Peru, Uruguay	Caroline Is., Galápagos, Guam (Glassman 1948; Stone 1970), Marianas (Fosberg et al. 1975), New Caledonia, New Guinea (Conn 2004+), Palau (Space et al. 2003), Philippines, Solomon Is. (Tanaka et al. 2020), Vanuatu.	Unknown

Family ^a	Species ^b	Native to ^b	Introduced to Pacific	Cultivated/invasive
Boraginaceae	<i>Cynoglossum amabile</i> Stapf & J.R.Drumm.	China North-Central, China South-Central, Eastern Himalayas, Nepal, Thailand, Tibet	Fiji, Hawaii, Kermadec Is., New Zealand	Naturalised on Hawaii (Imada et al. 1989). Thought to have died out on Raoul I. (Sykes & West 1996). In Fiji it was naturalised in eastern slopes of Mt. Nanggaranambuluta, probably as an escape from a European garden at Nandarivatu. However, it no longer appears to be grown (Smith 1952).
Boraginaceae	<i>Symphytum asperum</i> Lepech.	Iran, North Caucasus, Transcaucasus, Turkey	Niue, Fiji, Tokelau	Cultivated (Heenan & Tongatule 2025)
Boraginaceae	<i>Symphytum officinale</i> L.	Altay, Austria, Belarus, Belgium, Bulgaria, Central European Russia, Czechia and Slovakia, East European Russia, France, Germany, Great Britain, Hungary, Italy, Kazakhstan, Krym, Netherlands, North Caucasus, Northwest European Russia, Northwest Balkan Peninsula, Poland, Romania, Sardinia, Sicily, South European Russia, Spain, Switzerland, Turkey, Turkey-in-Europe, Ukraine, West Siberia	Federated States of Micronesia, Fiji	Unknown

^a Proposed classification by Luebert et al. (2016)

^b The plant species and countries in these columns have been compiled from the Global Biodiversity Information Facility (<https://www.gbif.org/>) and Plants of the World Online (<https://powo.science.kew.org>) online databases.

Appendix 3 – Steps in a classical biocontrol project

A classical biocontrol programme typically works through the following steps. Usually these steps are performed sequentially, but activities may occur concurrently.

- 1 Explore the project's feasibility. If feasibility is confirmed, proceed with the project.
- 2 Survey the target weed in regions where biocontrol is desired. If potential biocontrol agents are located, explore ways to maximise them. Find ways to mitigate any impediments to the project that may arise.
- 3 Perform molecular studies of the weed to help ascertain the best region in the native range to locate natural enemies, or to determine the native and introduced ranges if this is necessary.
- 4 Survey the weed in its native range to detect natural enemies (if not already well known). Identify and study the life-cycles of any natural enemies found.
- 5 If necessary, evaluate whether it is still feasible for a project to proceed.
- 6 Identify the host range for potential biocontrol agents. Cease further work on any species that appear to be unsafe or ineffective.
- 7 Apply to the necessary agencies for permission to release the agents.
- 8 Once permission is granted, import the agent(s) and clear them through containment. Following this, develop rearing techniques for the agent(s) (if not already known).
- 9 Mass-rear and release the agents over several years.
- 10 Monitor the establishment success and dispersal of the agents over several years.
- 11 Harvest and redistribute the agents.
- 12 Evaluate the success of the project. Decide whether further agents are needed to help control the target weed.

Appendix 4 – Record of arthropod and non-arthropod invertebrates feeding on *Cordia alliodora*

Note: References for Appendix 4 are included in the References section of the main report.

Order and family	Species	Type of organism	Geographic range	Likely to be sufficiently host specific?	Present in the Pacific? Likely to be highly damaging?
ACARI					
	Unidentified acari × 2	Mite	Found on <i>C. alliodora</i> in Mexico (Novais et al. 2021).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
COLEOPTERA					
Cerambycidae	<i>Anelaphus misellus</i> (Bates, 1885)	Longhorn beetle	Costa Rica, Nicaragua, Panama (Lanuza-Garay et al. 2021; GBIF 2025b).	Unlikely. Also found on <i>Luehea seemannii</i> and <i>Castilla elastica</i> (Lanuza-Garay et al. 2021).	Unknown from the Pacific. Extent of damage unknown.
	<i>Ataxia fulvifrons</i> (Bates, 1885)	Longhorn beetle	Costa Rica, Panama (Lanuza-Garay et al. 2021; GBIF 2025c).	Unlikely. Also found on <i>Luehea seemannii</i> , <i>Anacardium excelsum</i> , and <i>Castilla elastica</i> (Lanuza-Garay et al. 2021).	Unknown from the Pacific. Extent of damage unknown.
Chrysomelidae	<i>Amblycerus atkinsoni</i> (Romero, Johnson & Kingsolver, 1996)	Bruchid beetle	Mexico (Pringle 2014).	Potentially. Only cited as being present on <i>C. alliodora</i> , on which it was the most common beetle in Mexico (Pringle 2014).	Unknown from the Pacific. Extent of damage unknown but is a seed predator.
	<i>Amblycerus scutellatus</i> (Sharp, 1885)	Bruchid beetle	Central and South America. Found on <i>C. alliodora</i> in Mexico (Pringle 2014).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
	<i>Coptocycla leprosa</i> (Boheman, 1855) (tortoise beetle). Described in Wheeler 1929 as <i>Psalidonota leprosa</i>	Leaf beetle	Central America (Belize, Costa Rica, Mexico, Nicaragua, Panama) (GBIF 2025d).	Potentially. Has been described as a specialist on <i>Cordia</i> (Trager & Bruna 2006) and <i>C. alliodora</i> its true host plant (Wheeler 1929).	Unknown from the Pacific. Has been described as highly damaging at high population densities, causing near defoliation of plants (Trager & Bruna 2006).
	<i>Ischnocodia annulus</i> (Fabricius, 1781) (ringed tortoise beetle)	Leaf beetle	Central and South America.	No. Feeds on both Lauraceae and Borgeinaceae species (Lopes & Antunes 2016).	Unknown from the Pacific. Found to be the major herbivore of <i>C. alliodora</i> seedlings on Barro Colorado Island, Panama (Downey et al. 2018).

Order and family	Species	Type of organism	Geographic range	Likely to be sufficiently host specific?	Present in the Pacific? Likely to be highly damaging?
Chrysomelidae (Cont.)	Unidentified coleopteran × 38	Coleopteran	Found on <i>C. alliodora</i> in Panama (Wheeler 1929).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
Curculionidae	<i>Diaprepes abbreviatus</i> (Linnaeus, 1758)	Weevil	Native to Caribbean. CABI (2022) lists <i>C. alliodora</i> as a host of this species.	No. Polyphagous on many species.	Unknown from the Pacific. Damage can be extensive, especially from root-feeding larvae (CABI 2022; Grafton-Cardwell 2025)
DIPTERA					
Cecidomyiidae	<i>Neolasioptera</i> sp. Felt, 1908	Gall midge	Found on <i>C. alliodora</i> in Mexico (Pascual-Alvarado et al. 2008).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
	Unidentified dipteran × 14	Dipteran	Found on <i>C. alliodora</i> in Panama (Wheeler 1929).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
HEMIPTERA					
Aleyrodidae	<i>Aleurodicus dugesii</i> Cockerell, 1896 (giant whitefly)	Whitefly	Native to Mexico (Hoddle 2025). Introduced to several countries throughout the globe (GBIF 2025a)	No. A pest of c. 200 ornamental plants (Hoddle 2025).	Present in Cook Islands and Hawaii (GBIF 2025a). Can cause severe defoliation, stunting, and even death of host plants (Hoddle 2025).
Coccidae	<i>Akermes cordiae</i> Morrison, 1929	Scale insect	Panama.	Potentially. Only host listed as <i>C. alliodora</i> (Garcia et al. 2016).	Unknown from the Pacific. Extent of damage unknown. Attended by the ant <i>Cryptocerus</i> sp. (Garcia et al. 2016).
	<i>Aztecalecanium</i> sp. Kondo & Williams, 2004.	Scale insect	Unknown. Found on <i>C. alliodora</i> in Mexico (Pringle 2011).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
	<i>Coccus hesperidum</i> subsp. <i>hesperidum</i> (Linnaeus, 1758) (brown soft scale)	Scale insect	Cosmopolitan.	No. Polyphagous on many plant species (Garcia et al. 2016).	Present throughout the Pacific (Garcia et al. 2016). Damage can be significant – important pest of fruit trees (Garcia et al. 2016).
	<i>Coccus viridis</i> (Green, 1889) (green coffee scale)	Scale insect	Cosmopolitan.	No. Polyphagous on many plant species (Garcia et al. 2016).	Present throughout the Pacific (Garcia et al. 2016). Damage can be significant – important pest of coffee and citrus (Garcia et al. 2016).
	<i>Cryptostigma biorbiculus</i> Morrison, 1929	Scale insect	Colombia, Costa Rica, and Ecuador.	No. Also found on <i>Croton gossypifolius</i> and <i>Tetrathylacium macrophyllum</i> (Garcia et al. 2016)	Unknown from the Pacific. Extent of damage unknown.

Order and family	Species	Type of organism	Geographic range	Likely to be sufficiently host specific?	Present in the Pacific? Likely to be highly damaging?
Coccidae (Cont.)	<i>Cryptostigma inquilina</i> (Newstead, 1920)	Scale insect	Central and South America, Caribbean.	No. Polyphagous.	Unknown from the Pacific. Extent of damage unknown.
	<i>Cryptostigma reticulolaminae</i> Morrison, 1929	Scale insect	Costa Rica, Mexico, Panama.	Unlikely. Also found on <i>Triplaris americana</i> (Garcia et al. 2016)	Unknown from the Pacific. Extent of damage unknown.
	<i>Cyclolecanium hyperbaterum</i> Morrison, 1929	Scale insect	Panama.	Potentially. Only reported from <i>C. alliodora</i> (Garcia et al. 2016)	Unknown from the Pacific. Extent of damage unknown. Associated with several ant species (Garcia et al. 2016)
	<i>Prococcus acutissimus</i> (Green, 1896) (banana-shaped scale)	Scale insect	Found in Africa, Asia, US, Pacific.	No. Polyphagous on many species.	Found in French Polynesia, Hawaii, Palau, Papua New Guinea, and Western Samoa (Garcia et al. 2016). Somewhat damaging – considered a minor pest.
	<i>Pulvinaria psidii</i> Maskell, 1893 (green shield scale)	Scale insect	Widespread distribution. Found in 104 countries (Garcia et al. 2016).	No. Polyphagous on many species.	Found throughout most of the Pacific. Can be damaging to fruit crops.
	<i>Saissetia neglecta</i> De Lotto, 1969 (Caribbean black scale)	Scale insect	North, Central, and South America, as well as China, Ireland, Netherlands, Thailand, and Vanuatu (Garcia et al. 2016).	No. Polyphagous on many species.	Present in Vanuatu. Extent of damage unknown.
Margarodidae	<i>Crypticeria multatrices</i> Kondo & Unruh, 2009 (multicatrices fluted scale)	Scale insect	Colombia, Ecuador.	No. Polyphagous on many plant species (Garcia et al. 2016).	Unknown from the Pacific. Can be quite damaging, leading to death of host plant in severe attacks (Garcia et al. 2016)
Margarodidae	<i>Icerya purchasi</i> Maskell, 1879 (citrus fluted scale)	Scale insect	Cosmopolitan.	No. Polyphagous on many species.	Found in Fiji, French Polynesia, Guam, Hawaii, Kiribati, Marshall Islands, New Caledonia, Palau, Papua New Guinea, Solomon Islands, and Tonga (Garcia et al. 2016). Can be quite damaging and is a pest mainly of the citrus industry.
Pseudococcidae	<i>Cataenococcus cualatensis</i> (Cockerell, 1903)	Mealybug	Found on <i>C. alliodora</i> in Mexico (Pringle 2011).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.

Order and family	Species	Type of organism	Geographic range	Likely to be sufficiently host specific?	Present in the Pacific? Likely to be highly damaging?
Pseudococcidae (Cont.)	<i>Cataenococcus larai</i> Williams, 1969	Mealybug	Found on <i>C. alliodora</i> in Costa Rica (Pringle 2011).	Unlikely. Found on banana fruits (Williams 1969).	Unknown from the Pacific. Extent of damage unknown.
	<i>Dysmicoccus brevipes</i> (Cockerell, 1893) (pineapple mealybug)	Mealybug	Cosmopolitan	No. Polyphagous on many species.	Present throughout the Pacific. Can be damaging and can also transmit diseases (Garcia et al. 2016).
	<i>Dysmicoccus neobrevipes</i> Beardsley, 1959 (gray pineapple mealybug)	Mealybug	Present in 46 countries around the world (Garcia et al. 2016).	No. Polyphagous on many species.	Present in American Samoa, Cook Islands, Fiji, Guam, Hawaii, Kiribati, Marshall Islands, Western Samoa (Garcia et al. 2016). Can be damaging and can also transmit diseases (Garcia et al. 2016).
	<i>Dysmicoccus probrevipes</i> (Morrison, 1929)	Mealybug	Guatemala, Guyana, Panama.	Unlikely. Also found on <i>Triplaris cumingiana</i> and <i>Coffea</i> (Garcia et al. 2016).	Unknown from the Pacific. Extent of damage unknown.
	<i>Paraputo ingrandi</i> Matile-Ferrero, 1978	Mealybug	Colombia, Costa Rica, Guatemala, Mexico, Panama.	No. Known hosts include species from 13 genera (Garcia et al. 2016).	Unknown from the Pacific. Extent of damage unknown.
	<i>Planococcus minor</i> (Maskell, 1897) (Pacific mealybug)	Mealybug	Widespread. Found in 71 countries (Garcia et al. 2016).	No. Polyphagous on many species.	Found in American Samoa, Cook Islands, Fiji, French Polynesia, Hawaii, Kiribati, New Caledonia, Niue, Papua New Guinea, Solomon Islands, Tokelau, Tonga, Vanuatu, Wallis and Futuna, Western Samoa (Garcia et al. 2016). Can be damaging. Known pest of many crops.
Pentatomidae	<i>Edessa panamensis</i> spec. nov. Fernandes von Doesburg and Greve	Stink bug	Only reported from Panama and Colombia (Montes-Rodríguez et al. 2022). Found on <i>C. alliodora</i> in Colombia (Montes-Rodríguez et al. 2022).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
Tingidae	<i>Corythucha gossypii</i> (Fabricius, 1794) (cotton lace bug)	Lace bug	Widespread, but absent in Africa (Jackson 2021).	No. Reported from at least 24 different host plants (Miller & Nagamine 2005).	Present in Vanuatu and Hawaii (GBIF 2025f). Can cause considerable defoliation of young trees, and causes twig dieback (Greaves & McCarter 1990)

Order and family	Species	Type of organism	Geographic range	Likely to be sufficiently host specific?	Present in the Pacific? Likely to be highly damaging?
Tingidae (Cont.)	<i>Dictyla monotropidia</i> (Stål, 1858)	Lace bug	Central and South America.	No. Other genera listed as host plants include <i>Gossypium</i> , <i>Jatropha</i> , <i>Laurus</i> , and <i>Phaseolus</i> (Melo et al. 2025)	Unknown from the Pacific. Damage likely high – one of the main insect pests of <i>C. alliodora</i> in Colombia (Martínez et al. 2012).
	Unidentified hemipteran	Heteropteran	Found on <i>C. alliodora</i> in Mexico (Novais et al. 2021).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
	Unidentified hemipteran × 35	Hemipteran	Found on <i>C. alliodora</i> in Panama (Wheeler 1929).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
	Unidentified hemipteran × 10	Heteropteran	Found on <i>C. alliodora</i> in Panama (Wheeler 1929).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
HYMENOPTERA					
	Unidentified hymenopteran × 11	Hymenopteran (excluding ants)	Found on <i>C. alliodora</i> in Panama (Wheeler 1929).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
ISOPODA					
	Unidentified isopoda	Isopod	Found on <i>C. alliodora</i> in Panama (Wheeler 1929).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
LEPIDOPTERA					
Crambidae	<i>Conchylodes diphteralis</i> Geyer, 1832	Grass moth	Southeastern United States, West Indies, South America. Found on <i>C. alliodora</i> in Puerto Rico (Robinson et al. 2023).	Larval host plant list as <i>Cordia</i> sp. but also listed on <i>Carya</i> (pecan) (Heiman 2013).	Unknown from the Pacific. Extent of damage unknown.
Crambidae (Cont.)	<i>Conchylodes salamisalis</i> Druce, 1895 (blush conchylodes moth)	Grass moth	Central America.	Unknown host range.	Unknown from the Pacific. Damage not extensive, except in outbreaks of moth (Van Bael et al. 2004).
Erebidae	<i>Hypercompe</i> sp.	Tiger moth	Unknown. Species of this genus are found in North and South America.	No. Generalist species (Llandres et al. 2010).	Unknown from the Pacific. Extent of damage unknown.
	<i>Munona iridescens</i> Schaus, 1894	Tiger moth	Central America. Found on <i>C. alliodora</i> in Panama (Van Bael et al. 2004).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.

Order and family	Species	Type of organism	Geographic range	Likely to be sufficiently host specific?	Present in the Pacific? Likely to be highly damaging?
Gracillariidae	<i>Acrocercops</i> sp. Wallengren, 1881 (leaf blotch miner moth)	Leaf miner moth	Found on <i>C. alliodora</i> in Puerto Rico (Robinson et al. 2023).	Unsure as unidentified to species level. According to Moth Photographers Group (2019) there are 5 species of <i>Acrocercops</i> present in Puerto Rico. At least 2 species feed on other plant species (De Prins & De Prins 2025a, 2025b)	Distribution unknown. Extent of damage unknown.
Noctuidae	<i>Cropia connecta</i> Smith, 1894	Owlet moth	Central and South America.	Unlikely. Specialist of both Boraginaceae and Malvaceae species (Pringle & Gordon 2013).	Unknown from the Pacific. Extent of damage unknown.
	<i>Cropia philosopha</i> Schaus, 1911	Owlet moth	Central America (Costa Rica and Panama) (GBIF 2025g). Found on <i>C. alliodora</i> in Panama (Van Bael et al. 2004).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
	<i>Stauropides persimilis</i> Hampson, 1909	Owlet moth	Costa Rica, Ecuador, Mexico, Trinidad (Ziegler 2025).	Potentially. Has only been found to eat <i>Cordia</i> sp. (Pringle & Gordon 2013)	Unknown from the Pacific. Extent of damage unknown.
Pyralidae	<i>Paridnea holophaealis</i> Ragonot, 1891	Snout moth	Central America (Costa Rica and Panama) (GBIF 2025). Found on <i>C. alliodora</i> in Panama (Van Bael et al. 2004).	Unlikely. Specific to Boraginaceae but feeds on both <i>Cordia</i> and <i>Varronia</i> species (Pringle & Gordon 2013).	Unknown from the Pacific. Extent of damage unknown.
Pyralidae (Cont.)	<i>Paridnea squamicosta</i> Walker, 1867	Snout moth	Central and South America. Found on <i>C. alliodora</i> in Colombia, Costa Rica and Panama (Montes-Rodriguez et al. 2022).	No. Larvae have been reported on host plants from multiple plant families (Montes-Rodriguez et al. 2022).	Unknown from the Pacific. Potentially severe damage. Larval leaf consumption was estimated to be 134.1 cm ² with a larval duration of 15.64 days (Montes-Rodriguez et al. 2022).
	<i>Ramphidium pselaphialis</i> Ragonot, 1891 (scaly-legged pyralid)	Snout moth	Central and South America. Possibly documented on <i>C. alliodora</i> in Colombia (Montes-Rodriguez et al. 2022).	Unlikely. Has been reared from stems of <i>Varronia curassavica</i> (black sage – synonyms in genus <i>Cordia</i>) (Cock et al. 2023).	Unknown from the Pacific. Reportedly quite damaging on <i>C. alliodora</i> in Colombia.
Saturniidae	<i>Automeris rubrescens</i> Walker, 1855	Saturniid moth	Central America.	No. Polyphagous on many species (Robinson et al. 2023)	Unknown from the Pacific. Extent of damage unknown.

Order and family	Species	Type of organism	Geographic range	Likely to be sufficiently host specific?	Present in the Pacific? Likely to be highly damaging?
Saturniidae (Cont.)	<i>Hylesia lineata</i> Druce, 1886	Saturniid moth	Central America	No. Polyphagous on many species (Janzen 1984).	Unknown from the Pacific. Extent of damage unknown.
	Unidentified lepidopteran × 5	Lepidopteran	Found on <i>C. alliodora</i> in Panama (Wheeler 1929).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown. Described as devouring the leaves of seedlings and saplings (Wheeler 1929).
NEUROPTERA					
	Unidentified neuropteran × 2	Net-winged insect	Found on <i>C. alliodora</i> in Panama (Wheeler 1929).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
ORTHOPTERA					
Acrididae	<i>Coscineuta coxalis</i> (Serville, 1838)	Short-horned grasshopper	Colombia, Panama (GBIF 2025e).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
	Unidentified orthoptera. (Described in Wheeler 1929 as <i>Osmilia flavolimbata</i> De Geer but otherwise this name does not exist.	Orthopteran	Found on <i>C. alliodora</i> in Panama (Wheeler 1929).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.
THYSANOPTERA					
	Unidentified thrip × 2	Thrip	Unknown. Found on <i>C. alliodora</i> in Panama (Wheeler 1929).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown. One species noted as abundant on leaves (Wheeler 1929).
	Unidentified thrip × 3	Thrip	Unknown. Found on <i>C. alliodora</i> in Mexico (Novais et al. 2021).	Unknown host range.	Unknown from the Pacific. Extent of damage unknown.

Appendix 5 – Records of fungal pathogens associated with *Cordia alliodora*

Note: References for Appendix 5 are included in the References section of the main report.

Phylum/order/family	Species (synonym ^a)	Symptoms or lifestyle	Geographic range on <i>Cordia alliodora</i>	Likely to be sufficiently host specific?	Likely to be highly damaging? ^b Present in the Pacific? ^c
ASCOMYCOTA					
Amphisphaeriales					
Amphospaheriaceae	Seiridium sp. (= Pestalotia sp.)	Affects fruits and seeds.	Costa Rica (Arguedas & Chaverri 1999)	Species not specified.	Unlikely to be damaging. Not considered an important pathogen according to Arguedas & Chaverri (1999).
Botryosphaeriales					
Botryosphaeriaceae	Lasiodiplodia theobromae (Pat.) Griffon & Maubl.	Stem dieback.	Venezuela (Urtiaga 2011)	Over 500 hosts (Rodríguez-Gálvez et al. 2025).	Causes dieback, blights, root and fruit rots, gummosis, stem necrosis, leaf spots and witch's broom disease on different hosts (Tovar Pedraza et al. 2013). Present in the Pacific.
Phyllostictaceae	Phyllosticta sp.	Not specified. On old leaf.	Venezuela (Urtiaga 2011)	Unknown species. Usually wide host range (Wikee et al. 2011).	Species from this genus can be endophytes, saprophytes or pathogens that cause leaf spots and dieback (Wikee et al. 2011).
Capnodiales					
Capnodiaceae	Chaetocapnodium microglobulosum (Bat. & Cif.) S.A. Khodaparast (= Chaetasbolisia microglobulosa Bat. & Cif.)	Sooty mould.	Brazil (Mendes et al. 2019)	Has been reported on <i>C. alliodora</i> in Brazil (Mendes et al. 2019), on chilli in the Solomon Islands (Tsasia & Jackson 2022), and on <i>Citrus sinensis</i> and <i>Actinidia deliciosa</i> in Iran (Khodaparast et al. 2020).	Saprophyte; feeds on honeydew produced by insects (Khodaparast et al. 2020; Tsasia & Jackson 2022). Unlikely to be damaging. Present in the Solomon Islands.
	Leptoxyphium ophidioglossum (Cif., Bat. & Nascim.) S. Hughes (= Megaloxypium	Sooty mould.	Brazil (Mendes et al. 2019)	Has been reported on <i>C. alliodora</i> and <i>Polyscias guilfoylei</i> in Brazil (Mendes et al. 2019), and on <i>Croton</i>	Saprophyte; feeds on sugary exudates from insects growing on the surface of leaves (Jayasiri et al. 2015; The Mushroom

Phylum/order/family	Species (synonym ^a)	Symptoms or lifestyle	Geographic range on <i>Cordia alliodora</i>	Likely to be sufficiently host specific?	Likely to be highly damaging? ^b Present in the Pacific? ^c
	ophidioglossum Cif., Bat. & Nascim.)			flavens var. rigidus in Puerto Rico (Stevenson 1975).	Research Foundation 2021). Absent.
Cladosporiales					
Cladosporiaceae	Cladosporium sp.	Green mould; fruit, seed and leaf associate.	Costa Rica (Arguedas & Chaverri 1999)	Species not specified. Likely wide host range.	Saprophyte; secondary pathogen; endophyte. Unlikely to be damaging.
Dothideales					
	Koordersiella cordiae Bat. & I.H. Lima	Not specified.	Brazil (Mendes et al. 2019)	Only recorded once from <i>C. alliodora</i> from Brazil (Mendes et al. 2019).	No. Species from this genus are usually associated with lichens (Hawksworth et al. 2024). Absent.
Eurotiales					
Aspergillaceae	Penicillium sp.	Affects fruits and seeds.	Costa Rica (Arguedas & Chaverri 1999)	Species not specified. Likely wide host range.	Saprophyte; secondary pathogen; endophyte. Unlikely to be damaging.
Glomerellales					
Reticulascaceae	Cylindrotrichum sp.	Leaf spot.	Cuba (Urtiaga 1986)	Unknown species; usually saprophytic on wood and litter (Seifert et al. 2011; Bundhun et al. 2020)	Saprophyte (Bundhun et al. 2020). Unlikely to be damaging.
Helotiales					
Erysiphaceae	Blumeria sp. (= Oidium sp.)	Powdery mildew.	Venezuela (Urtiaga 2011)	Unknown species; usually affects a wide range of plant species (Wall 2000).	Pathogen. Causes powdery mildew.
Hypocreales					
Nectriaceae	Albonectria rigidiuscula (Berk. & Broome) Rossman & Samuels (= Fusarium decemcellulare Brick, = Nectria rigidiuscula Berk. & Broome)	Not specified.	Brazil (Mendes et al. 2019)	Wide host range, including cocoa, rice, durian, mango and pigeon pea (PlantwisePlus Knowledge Bank 2021).	Causes twig dieback and branch canker on several plant species (PlantwisePlus Knowledge Bank 2021). Present in the Pacific.
	Campylocarpon amazonense Gordillo & Decock	Found on asymptomatic roots.	Ecuador (Gordillo & Decock 2017)	Only reported once (Gordillo & Decock 2017).	Endophyte; no damage reported (Gordillo & Decock 2017). Absent.

Phylum/order/family	Species (synonym ^a)	Symptoms or lifestyle	Geographic range on <i>Cordia alliodora</i>	Likely to be sufficiently host specific?	Likely to be highly damaging? ^b Present in the Pacific? ^c
Nectriaceae (Cont.)	<i>Fusarium</i> sp.	Affects fruits and seeds.	Costa Rica (Arguedas & Chaverri 1999)	Not specified species. Likely wide host range.	Unlikely to be damaging. Not considered an important pathogen according to Arguedas & Chaverri (1999).
Glomerellales					
Glomerellaceae	<i>Colletotrichum</i> sp.	On leaves and seedlings; likely leaf spots.	Costa Rica (Arguedas & Chaverri 1999)	Unknown species.	Unlikely to be damaging. Not considered an important pathogen according to Arguedas & Chaverri (1999).
	<i>Colletotrichum tropicale</i> Rojas, Rehner & Samuels	Endophyte in leaf.	Panama (Rojas et al. 2010)	Wide host range (Rojas et al. 2010).	Endophyte (Rojas et al. 2010). Absent.
Meliolales					
Meliolaceae	<i>Meliola longipoda</i> Gaillard	Not specified. Fungi from this genus cause black mildew (Khan et al. 2025).	Dominican Republic (Ciferri 1961)	Reported on <i>Cordia</i> spp., <i>Tournefortia</i> spp., <i>Ehretia tinifolia</i> (Ciferri 1961).	<i>Meliola</i> spp. cause black mildew on leaves (Khan et al. 2025). Unlikely to be damaging. Absent.
Mucorales					
Rhizopodaceae	<i>Rhizopus</i> sp.	Affects fruits and seeds, mould.	Costa Rica (Arguedas & Chaverri 1999)	Unknown species. Likely wide host range.	Saprophyte.
Mycosphaerellales					
Mycosphaerellaceae	<i>Cercospora</i> sp.	Affects leaves. Likely leaf spots.	Costa Rica (Arguedas & Chaverri 1999)	Unknown species.	Species from this genus cause leaf spots. Unlikely to be damaging. Not considered an important pathogen according to Arguedas & Chaverri (1999).
	<i>Pseudocercospora cordiae-alliodorae</i> U. Braun & Urtiaga	Leaf spots (Braun & Urtiaga 2013).	Venezuela (Braun & Urtiaga 2013)	Reported on <i>C. alliodora</i> (Braun & Urtiaga 2013) and <i>C. toqueve</i> (Braun & Urtiaga 2013).	Causes diffuse leaf spots on <i>C. alliodora</i> (Braun & Urtiaga 2013). Unlikely to be damaging. Absent.
Phyllachorales					
Phyllachoraceae	<i>Phyllachora orbicularis</i> Speg.	Not specified. Fungi from this genus cause tar spots on leaves (Su et al. 2025).	Puerto Rico (Stevenson 1975)	Reported on <i>Cordia</i> spp. (Stevenson 1975; Eboh 1986; Minter et al. 2001).	<i>Phyllachora</i> spp. cause tar spots on leaves (Su et al. 2025). Unlikely to be damaging. Absent.

Phylum/order/family	Species (synonym ^a)	Symptoms or lifestyle	Geographic range on <i>Cordia alliodora</i>	Likely to be sufficiently host specific?	Likely to be highly damaging? ^b Present in the Pacific? ^c
Pleosporales					
Pleosporaceae	<i>Alternaria</i> sp.	Affects fruits and seeds.	Costa Rica (Arguedas & Chaverri 1999)	Unknown species. Likely wide host range.	Unlikely to be damaging. Not considered an important pathogen according to Arguedas & Chaverri (1999).
	<i>Pyrenophora</i> sp. (= <i>Drechslera</i> sp.)	Found on old leaf.	Venezuela (Urtiaga 2011)	Unknown species.	Thought to be a secondary invader (Urtiaga 2011). Unlikely to be damaging.
	<i>Phoma</i> sp.	Affects fruits and seeds.	Costa Rica (Arguedas & Chaverri 1999)	Unknown species.	Endophyte or weak pathogen. Not considered an important pathogen according to Arguedas & Chaverri (1999).
	<i>Exserohilum</i> sp. (= <i>Setosphaeria</i> sp.)	Affects stems and branches.	Costa Rica (Arguedas & Chaverri 1999)	Unknown species.	Unlikely to be damaging. Not considered an important pathogen according to Arguedas & Chaverri (1999).
Venturiales					
Symptoventuriaceae	<i>Scolecobasidium constrictum</i> E.V. Abbott (= <i>Ochroconis constricta</i> (E.V. Abbott) de Hoog & Arx)	Not specified. Likely on dead leaves.	Vanuatu (Manaaki Whenua – Landcare Research 2025)	Wide host range (Ellis 2025c).	No. Found on dead leaves (Ellis 2025c). Present in the Pacific.
Xylariales					
Beltraniaceae	<i>Beltrania rhombica</i> Penz.	Found on old leaf.	Venezuela (Urtiaga 2011)	Wide host range (Ellis 2025a).	No. Found on dead leaves (Ellis 2025a). Thought to be a secondary invader (Urtiaga 2011). Present in the Pacific.
BASIDIOMYCOTA					
Agaricales					
Physalacriaceae	<i>Armillaria fuscipes</i> Petch	Root rot.	Ethiopia (Gezahgne et al. 2004)	Various hosts including <i>Pinus</i> spp., <i>Acacia</i> spp. and <i>Camellia sinensis</i> (Coetzee et al. 2000; Gezahgne et al. 2004; Mwenje et al. 2006).	Collar and root rot of trees, wilting, chlorosis and death (Gezahgne et al. 2004). Absent.

Phylum/order/family	Species (synonym ^a)	Symptoms or lifestyle	Geographic range on <i>Cordia alliodora</i>	Likely to be sufficiently host specific?	Likely to be highly damaging? ^b Present in the Pacific? ^c
Auriculariales					
Auriculariaceae	<i>Auricularia nigricans</i> (Sw.) Birkebak, Looney & Sánchez-García (<i>Auricularia polytricha</i> (Mont.) Sacc.)	Wood ear.	Vanuatu (Manaaki Whenua— Landcare Research 2025)	Wide host range.	No. Saprophytes on dead wood. Present in the Pacific.
Corticiales					
Corticaceae	<i>Necator salmonicolor</i> (Berk. & Broome) K.H. Larss. (= <i>Corticium salmonicolor</i> Berk. & Broome)	Stem canker.	Vanuatu (Neil 1989)	Wide host range (PlantwisePlus Knowledge Bank 2019).	Pathogen. Symptoms include necrotic spots on leaves, wilting, stem canker, bark discolouration, gummosis, mycelium present (PlantwisePlus Knowledge Bank 2019). Present in the Pacific.
Helicobasidiales					
Helicobasidiaceae	<i>Tuberculina vinosa</i> (Sacc.) Sacc.	Not specified. Species of this genus are hypoparasites of rusts.	Not specified (USDA Fungal Databases 2025)	Has been reported to infect <i>Puccinia cordiae</i> (USDA Fungal Databases 2025).	Not damaging to <i>C. alliodora</i> . Absent.
Hymenochaetales					
Hymenochaetaceae	<i>Pyrrhoderma noxium</i> (Corner) L.W. Zhou & Y.C. Dai (<i>Phellinus noxius</i> (Corner) G. Cunn.)	Brown root rot.	Vanuatu (Neil 1986, 1988, 1989)	Wide host range, including oil palm, rubber, forest crops and other crops (Neil 1988).	Pathogen. Causes brown root rot (Neil 1988). Present in the Pacific (Greaves & McCarter 1990).
Pezizales					
Pezizaceae	<i>Peziza varia</i> (Hedw.) Röhl. (= <i>Peziza repanda</i> Wahlenb.)	Brown cup fungus.	Vanuatu (Manaaki Whenua – Landcare Research 2025).	Various hosts (Ellis 2025b).	No. Wood-decay fungus (Ellis 2025b). Present in the Pacific.
Pucciniales					
Pucciniaceae	<i>Puccinia ciliata</i> Mains	Rust on leaves.	Belize (Mains & Smith 1939)	Reported on <i>C. alliodora</i> from Belize (Mains & Smith 1939) and on <i>Primula</i> spp. from Finland (MyCoPortal 2025a).	Minor damage was observed on <i>C. alliodora</i> in Belize (Mains & Smith 1939). Absent.

Phylum/order/family	Species (synonym ^a)	Symptoms or lifestyle	Geographic range on <i>Cordia alliodora</i>	Likely to be sufficiently host specific?	Likely to be highly damaging? ^b Present in the Pacific? ^c
Pucciniaceae (Cont.)	<i>Puccinia cordiae</i> Vestergr.	Forms brown rust pustules on leaves, deformed tissues and inflorescences, witch's broom, and causes cankers on shoots and stems (Spaulding 1961; Hernández & Hennen 2003).	Brazil, Dominican Republic, Guatemala, Mexico, Puerto Rico, Trinidad and Tobago, Virgin Islands, El Salvador, Colombia, Panama (Spaulding 1961; Pardo Cardona 1998; Hernández & Hennen 2003; Perdomo-Sánchez & Piepenbring 2008; MyCoPortal 2025b)	Reported on <i>C. alliodora</i> , <i>C. gerascanthus</i> , <i>C. sonorae</i> , <i>C. trichotoma</i> and <i>Cordia</i> sp. from South America and USA (Hernández & Hennen 2003; MyCoPortal 2025b).	Causes witch's broom (distortion and hypertrophy caused by systemic infection); rust spores on tissues, including leaves and inflorescences; cankers on shoots and stems; sometimes killing entire trees (Hernández & Hennen 2003). Very likely damaging. Absent.
	<i>Puccinia johnsonii</i> Arthur	Rust on leaves.	Colombia (Pardo Cardona 1998)	Reported on <i>Cordia</i> spp. (Pardo Cardona 1998), <i>Sideroxylon foetidissimum</i> and <i>Sideroxylon salicifolium</i> (Arthur & Johnston 1918).	Rust on leaves (Arthur & Johnston 1918; Spaulding 1961; Pardo Cardona 1998). Extent of damage unknown. Absent.
UNIDENTIFIED FUNGUS					
Unknown	Unknown	Canker on stems.	Solomon Islands (Liegel & Stead 1990)	Unknown species.	Canker on stem; reported to be linked to high humidity (Liegel & Stead 1990).

^a Synonyms (old, invalid names for a taxon) are only given here where that (old) name is the one reported in the literature.

^b Includes description of symptoms on other host plants when species has wide host range.

^c Presence in the Pacific not specified for unknown species.

Appendix 6 – Records of other organisms associated with *Cordia alliodora*

Note: References for Appendix 6 are included in the References section of the main report.

Phylum/order/Family	Species	Symptoms or lifestyle	Geographic range on <i>Cordia alliodora</i>	Likely to be sufficiently host specific?	Likely to be highly damaging? Present in the Pacific?*
BACTERIA					
Unknown	Unknown	Canker on stems.	Costa Rica (Arguedas & Chaverri 1999)	Unknown species.	Stem cankers, characterised by longitudinal bark fissures, with fresh lesions exuding black, oily secretions at the advancing margins (Arguedas & Chaverri 1999).
PLANTA					
Santalales					
Viscaceae	<i>Phoradendron</i> sp.	Parasitic plant (leafy mistletoe).	Costa Rica (Johnson & Morales 1972); Venezuela (Urtiaga 2011)	Unknown species, likely various hosts.	Forms witch's broom; can be fatal to trees (Johnson & Morales 1972).
	<i>Phoradendron robustissimum</i> Eichler	Parasitic plant (leafy mistletoe).	Costa Rica (Johnson & Morales 1972).	Several hosts.	Forms witch's broom; can be fatal to trees (Johnson & Morales 1972). Absent.

* Presence in the Pacific not specified for unknown species.

Appendix 7 – Potential future increases in the ecosystem and socioeconomic impacts of *Cordia alliodora* under climate change

Note: References for Appendix 6 are included in the References section of the main report.

Impact categories have been adopted from the impact magnitude definitions in the Environmental Impact Classification of Alien Taxa (EICAT) and the Socio-Economic Impact Classification of Alien Taxa (SEICAT). EICAT has been adopted by the International Union for Conservation of Nature (IUCN) as a means to standardise evidence-based information on the impacts of alien taxa and the mechanisms responsible for these impacts (Hawkins et al. 2015). The increase in magnitude of EICAT impact categories corresponds to increases in the level of biological organisation (individual, population, community) (Hawkins et al. 2015). The increase in magnitude of SEICAT impact categories is based on increasing detrimental effects of alien taxa on people's activities (Bacher et al. 2018). Note that here only the impact category definitions have been adopted from the EICAT and SEICAT frameworks.

The score card given below is based on observations from countries/territories within the Pacific region where *Cordia alliodora* is currently problematic, rather than giving a Pacific-wide overview. Countries that are not currently experiencing detrimental impacts of *C. alliodora* could expect the same impacts noted in the scorecard if *C. alliodora* becomes recognised as established and invasive.

Impact magnitude definitions from the Environmental Impact Classification of Alien Taxa (EICAT) (as adopted by the IUCN)

Minimal Concern

A taxon is considered to have impacts of Minimal Concern when it causes negligible levels of impacts, but no reduction in performance of individuals in the native biota. Note that all alien taxa have impacts on the recipient environment at some level, for example, by altering species diversity or community similarity (e.g. biotic homogenisation), and for this reason there is no category equating to 'no impact'. Only taxa for which changes in the individual performance of natives have been studied but not detected are assigned a minimal category. Taxa that have been evaluated under the EICAT process but for which impacts have not been assessed in any study should not be classified in this category but should be classified as Data Deficient.

Minor

A taxon is considered to have Minor impacts when it causes reductions in the performance of individuals in the native biota but no declines in native population sizes, and has no impacts that would cause it to be classified in a higher impact category.

Moderate

A taxon is considered to have Moderate impacts when it causes declines in the population size of at least one native taxon but has not been observed to lead to the local extinction of a native taxon.

Major

A taxon is considered to have Major impacts when it causes community changes through the local or sub-population extinction (or presumed extinction) of at least one native taxon, that would be naturally reversible if the alien taxon was no longer present. Its impacts do not lead to naturally irreversible local population, sub-population or global taxon extinctions.

Massive

A taxon is considered to have Massive impacts when it causes naturally irreversible community changes through local, sub-population or global extinction (or presumed extinction) of at least one native taxon.

Data Deficient (no colour)

A taxon is categorised as Data Deficient when the best available evidence indicates that it has (or had) individuals existing in a wild state in a region beyond the boundary of its native geographic range, but either there is inadequate information to classify the taxon with respect to its impact, or insufficient time has elapsed since introduction for impacts to have become apparent. It is expected that all introduced taxa will have an impact at some level, because by definition an alien taxon in a new environment has a non-zero impact. However, listing a taxon as Data Deficient recognises that current information is insufficient to assess that level of impact.

Impact magnitude definitions from the Socio-Economic Impact Classification of Alien Taxa (SEICAT)

Minimal Concern

No deleterious impacts have been reported despite the availability of relevant studies with regard to its impact on human well-being. Taxa that have been evaluated under the SEICAT process but for which impacts have not been assessed in any study should not be classified in this category, but should be classified as Data Deficient.

Minor

There is a negative effect on people's well-being, such that the alien taxon makes it difficult for people to participate in their normal activities. Individual people in an activity suffer in at least one constituent of well-being (i.e. security; material and non-material assets; health; social, spiritual, and cultural relations). Reductions of well-being can be detected through, for example, income loss, health problems, higher effort or expenses to participate in activities, increased difficulty in accessing goods, disruption of social activities, or induction of fear. However, no change in activity size is reported (i.e. the number of people participating in that activity remains the same).

Moderate

Negative effects on well-being are leading to changes in activity size, fewer people are participating in an activity, but the activity is still carried out. Reductions in activity size can be due to various reasons; for example, moving the activity to regions without the alien taxon or to other parts of the area less invaded by the alien taxon; partial abandonment of an activity without replacement by other activities; or switching to other activities while staying in the same area invaded by the alien taxon. Also, spatial displacement, abandonment, or switch of activities does not increase human well-being compared to levels before the alien taxon invaded the region (i.e. there is no increase in opportunities due to the alien taxon).

Major

There is local disappearance of an activity from all or part of the area invaded by the alien taxon. This could be due to collapse of the specific social activity, switch to other activities, abandonment of the activity without replacement, or emigration from the region. Change is likely to be reversible within a decade after removal or control of the alien taxon. 'Local disappearance' does not necessarily imply the disappearance of activities from the entire region assessed, but refers to the typical spatial scale over which social communities in the region are characterised (e.g. a human settlement).

Massive

There is local disappearance of an activity from all or part of the area invaded by the alien taxon. Change is likely to be permanent and irreversible for at least a decade after removal of the alien taxon due to fundamental structural changes of socioeconomic, community or environmental conditions ('regime shift').

Data Deficient (no colour)

There is no information to classify the taxon with respect to its impact, or insufficient time has elapsed since introduction for impacts to have become apparent.

Key to colour coding for impact categories

Massive (red), Major (yellow), Moderate (dark blue), Minor light blue), Minimal Concern (grey), Data Deficient (no colour), conflicting categorisation (multi-colour).

Category	Now	Future under climate change	Comments
Environmental impact			
Native biodiversity	Dark blue	Yellow	<p>In the Pacific, <i>C. alliodora</i> is spreading from the forestry blocks where it was introduced and has become invasive in the local landscape. This is occurring in Samoa, Tonga, and Vanuatu, where it colonises agricultural spaces and disturbed forest spaces (Space & Flynn 2001; Space 2002a; Bakeo & Qarani 2005).</p> <p><i>C. alliodora</i> is a fast-growing and aggressive coloniser of disturbed vegetation. It displays 'weedy' traits (fast-growing, ecological generalists able to disperse over long distances) in its native range, with a relatively recent spread in the Quaternary period from South America into Central America and Mexico, moving around the Andes (Rymer et al. 2013). <i>C. alliodora</i> is often found, following forest clearance, as pure stands of varying densities in its native range and has developed haplotypes adapted to different climates (Rymer et al. 2013). In a study in East Usambara submontane rain forests, in northeastern Tanzania, the population was estimated to be spreading from a plantation block at a rate of 3.5% per year and has become a locally dominant species in the area in which it was introduced (Edward et al. 2009).</p>
Endangered or iconic species	Dark blue	Red	<p><i>C. alliodora</i> can rapidly colonise cleared areas creating monospecific stands that block other species from growing (Rymer et al. 2013). In Samoa's Faleata Recreation Reserve at Tuanaimato, Faleata, <i>C. alliodora</i> is interfering with the regeneration of native species within the reserve following cyclone Evan in 2012 (SPREP 2022).</p> <p>In Tonga, <i>C. alliodora</i> affects two Protection Areas: the 'Eua National Park and 'Eua Forest Plantation (S. Hamni, Ministry of Agriculture, Food and Forests 'Eua, pers. comm., 30 October 2025). Due to large monospecific stands in 'Eua, native birds are likely be affected by the loss of habitat (J. Pisi, SPREP, pers. comm., 30 October 2025).</p>
Facilitation of non-native species	Dark blue	Red	<p><i>C. alliodora</i> is known to host two common fungal diseases: <i>Pyrrhoderma noxium</i> and <i>Necator salmonicolor</i> (Orwa et al. 2009). <i>P. noxium</i> causes brown root rot on a wide range of plant species (Neil 1988). In Vanuatu, brown root rot has been reported as being widespread in <i>C. alliodora</i> plantations (Neil 1989; Boshier & Lamb 1997). Disease incidence was found to correlate with high rainfall, elevated inoculum levels in natural forests, nutrient-poor soils, and extreme weather events such as hurricanes (Neil 1986, 1989). Provenance trials in Vanuatu showed that up to 6.9% of trees were attacked by <i>P. noxium</i> in Vanafo. However, susceptibility to the pathogen was dependent on the tree provenance (Neil 1989). On Pentecost Island, up to 35.5% tree loss was observed (Neil 1986).</p> <p>In Vanuatu, <i>N. salmonicolor</i> has also been reported to cause stem canker on <i>C. alliodora</i> (Neil 1989). Provenance trials in Vanuatu found that up to 4.4% of trees were attacked in Vanafo and up to 8.8% in Shark Bay (Neil 1989). This pathogen affects a wide range of woody plants (PlantwisePlus Knowledge Bank 2019).</p> <p>Many ant species are associated with <i>C. alliodora</i> in its native range (Wheeler [1929] records 58 species), using the tree as a nesting site while obtaining no direct food source from it (Novais et al. 2021). This may occur with ant species in the Pacific, but the extent is unknown.</p> <p>At Toloa Rainforest and 'Eua National Park in Tonga, a programme to remove <i>C. alliodora</i> resulted in the reinvasion of other weed species, probably due to the suitable open habitat left behind by the large trees (J. Pisi, SPREP, pers. comm., 30 October 2025).</p>

Category	Now	Future under climate change	Comments
Socio-economic impact			
Human health			<p>Data Deficient. In Tonga's Toloa rainforest, during <i>C. alliodora</i> weeding, it was noted that staff skin became itchy after handling of the plant. <i>C. alliodora</i> also produces a lot of pollen that may cause allergy symptoms (J. Pisi, SPREP, pers. comm., 30 October 2025).</p> <p>Standley (1924) noted, 'The fruit is edible. A decoction of the leaves is employed as a tonic and stimulant, especially in the ease of catarrh and affections of the lungs, and an ointment made with the pulverized seeds has been used in the West Indies as a remedy for cutaneous diseases.' It has not been reported that <i>C. alliodora</i> is used for any of these purposes in the Pacific.</p>
Food security			<p><i>C. alliodora</i> invasions in the Pacific are significantly degrading native forest ecosystems by forming dense monocultures that suppress biodiversity. This reduction in native plant diversity limits the availability of culturally and nutritionally important species traditionally harvested by local communities. Wildlife, including forest birds, may decline or shift to other areas as habitat quality is reduced, making it more difficult to access (D. Moverley, SPREP, pers. comm., 30 October 2025).</p> <p><i>C. alliodora</i> was introduced into the Pacific for forestry and agroforestry systems, but harvesting in these systems has not kept up with the natural spread of the plant. It has subsequently become invasive in the agricultural areas around where it was planted, reducing the usable agricultural land available and increasing costs for farming (Space 2002; Bakeo & Qarani 2005).</p>
Control costs			<p><i>C. alliodora</i> favours open spaces with fertile soil and full sun, conditions typically found in agricultural landscapes. Costs to control <i>C. alliodora</i> in these areas will be ongoing for landowners due to the high propagule pressure from the plant. In Tonga, the cost of <i>C. alliodora</i> control in 'Eua National Park ranges from NZ\$100,000 to NZ\$150,000/year, ranging from an operational scale to a comprehensive project if other expenses such as monitoring, technical advice, logistics, etc. are considered (J. Pisi, SPREP, pers. comm., 31 October 2025).</p>
Animal health			<p>There are no known major physiological impacts on livestock health. Recommended agroforestry systems can include <i>C. alliodora</i> sharing fields with livestock: the wood is not palatable to animals, so the trees provide shade while remaining undamaged (Greaves & McCarter 1990).</p> <p>There may be indirect negative impacts on the health of wild animals harvested for food from native forest systems due to habitat decline caused by <i>C. alliodora</i> (D. Moverley, SPREP, pers. comm., 30 October 2025).</p>
Incomes/livelihoods			<p><i>C. alliodora</i> was originally introduced in the Pacific to improve economic outcomes by boosting land productivity, but it is no longer utilised for this purpose. In more recent years, <i>C. alliodora</i> has become economically costly to landowners by invading valuable productive agricultural spaces. Its control is costly and labour intensive, and is expected to continue to increase as the invasions worsen. In areas where there are no resources available to control the <i>C. alliodora</i> populations, usable agricultural land may be lost.</p> <p>Access to economically important native species may also become prohibitive as they become marginalised by <i>C. alliodora</i> monocultures within native forest systems. Tourism may also be affected due to the loss of sea views (<i>C. alliodora</i> usually grows 15–25 m in height) and loss of native forests (e.g. Samoa's Faleata Recreation Reserve at Tuanaimato, Faleata; SPREP 2022).</p>

Category	Now	Future under climate change	Comments
Access to species with beneficial uses			Severe <i>C. alliodora</i> invasions create large monoculture stands that push out native plants and animals from the local area. This can reduce access to beneficial species (animals hunted for food, medicinal plants, edible plants etc.) by either reducing population numbers or causing beneficial species to relocate to other areas not invaded by <i>C. alliodora</i> .
Mobility			In Tonga and Samoa, <i>C. alliodora</i> grows in dense thickets that are difficult to navigate when traversing the forest. Seedlings also readily establish on forest tracks and require continual clearing (J. Pisi, SPREP, pers. comm., 30 October 2025).
Leisure activities			<i>C. alliodora</i> can invade open areas where leisure activities take place, such as sports fields, parks, and forests. These invasions are currently reducing the scenic and aesthetic value of Samoa's Mt Vaea and Faleata Recreation Reserve at Tuanaimato, Faleata (SPREP 2022). Mt Vaea now has reduced access to rivers due to the tree's invasion (J. Pisi, SPREP, pers. comm., 30 October 2025). <i>C. alliodora</i> invasions have increased maintenance costs for leisure areas. Rangers are needed to regularly clear out <i>C. alliodora</i> on the tracks in 'Eua Park, Tonga (J. Pisi, SPREP, pers. comm., 30 October 2025). Activities such as whale watching could also be affected if sea views are obscured.
Infrastructure			Data Deficient. <i>C. alliodora</i> has the potential to affect powerlines due to the trees' typical growth height of 15–25 m. If thickets establish under power lines, they require removal or continual trimming to ensure they do not interfere with cables. <i>C. alliodora</i> is susceptible to brown root rot (<i>Pyrrhoderma noxium</i>) so in areas where brown root rot is present, trees may be more unstable and prone to falling and damaging property and infrastructure.
Other considerations			
Tropical storms, cyclones			On Pacific islands, severe weather can defoliate large areas of forest, and landslides can occur on mountain slopes, enabling colonisation by <i>C. alliodora</i> seedlings or other invasive plant species. With climate change, tropical cyclone intensity is expected to increase – although frequency is anticipated to decrease slightly (Turton 2012). In Samoa's Mt Vaea and Faleata Recreation Reserve at Tuanaimato, Faleata, <i>C. alliodora</i> has already shown rapid colonisation of disturbed areas following cyclone Evan in 2012 (SPREP 2022).
Wildfires			Wildfire frequencies and total area burned per year may increase with climate change (Newman et al. 2018). <i>C. alliodora</i> is moderately fire-resistant, meaning it could out-survive native species in bush fires and rapidly re-colonise the newly disturbed area to create large monostands in islands where wild-fires are common (Rymer et al. 2013). Currently, in areas where <i>C. alliodora</i> is an issue forest fires are not common, but this may change under climate change.