The Status of the Yellow Crazy ant (*Anoplolepis gracilipes*) on the Cocos (Keeling) Islands

Report to Parks Australia North, Cocos (Keeling) Islands

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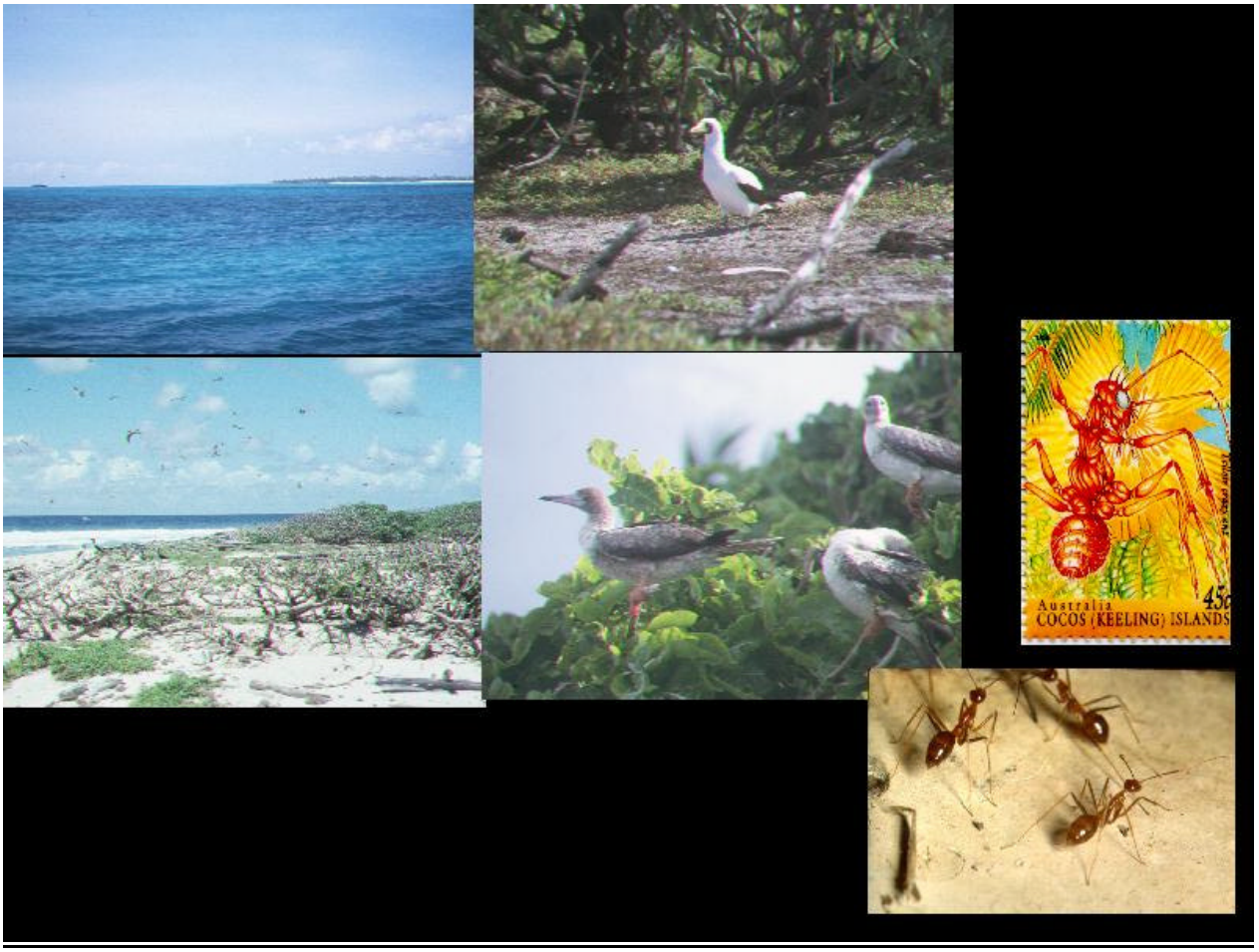

1. Executive Summary

The yellow crazy ant *Anoplolepis gracilipes* is a widespread species of ant currently with a pan-tropical distribution. In several locations it has become an environmental pest including on Christmas Island and in the Seychelles, and as this species is widespread on Cocos (Keeling) Islands the potential threat of this species was a concern. As a result almost all islands in the Cocos group of Islands were surveyed for the presence of *A. gracilipes* in May 2001. These islands included Pulu Keeling, Horsburgh, the Islands of the southern atoll, Home, West, and Direction Island. While almost ubiquitous on the atoll, *A. gracilipes* was only found in relatively low densities and not in the densities that cause environmental damage on Christmas Island.

Observations indicated that *A. gracilipes* nests were scattered and foraging workers were generally in relatively low numbers. While in other locations where they occur, *A. gracilipes* workers rely on a mutualistic relationship with scale insects in order to provide the carbohydrate source necessary for foraging, no scale insects were observed on the Cocos(Keeling) Islands. It appears that currently *A. gracilipes* workers rely on plant produced nectar for their source of carbohydrate and workers were recorded feeding on the flowers of *Morinda citrifolia*, *Scaevola taccada* and *Argusia argentea.*

Although not currently posing an environmental threat to the Pulu Keeling National Park, we recommend that a monitoring program be initiated on Pulu Keeling in order to assess any changes in the densities of *A gracilipes* over time. In the absence of honey dew producing sap sucking insects it seems unlikely that high densities of ants will occur. It is important to maintain a good quarantine barrier to the Cocos (Keeling) Islands, and internal quarantine barrier to Pulu Keeling in order to prevent the introduction of these insects.

As current densities of ants suggest there is no immediate threat to the environment we do not recommend embarking on any form of chemical control program now. However, should increased densities of *A. gracilipes* be detected and chemical control programs at other locations prove successful for this species, then an integrated control program aimed at eliminating all introduced ants should be considered.

2. Contents

3. Recommendations

- Begin a monitoring program on Pulu Keeling to establish base line densities of *Anoplolepis gracilipes* and detect any changes in densities. This program should be incorporated into the bird survey work using the same transects.
- Changes in distribution and abundance of *A. gracilipes* on Pulu Keeling should be monitored by way of a sampling grid covering all the major habitats and consisting of between 40 and 60 sites. This grid should be set up using GPS and GIS, and should be surveyed at least annually or more frequently should the transect data suggest change might be occurring.
- Ensure that quarantine barriers between Cocos (Keeling) Islands and the mainland and between Cocos (Keeling) Islands and Christmas Island are maintained to reduce the likelihood of scale insects being introduced.
- Ensure that an effective quarantine barrier is in place between Pulu Keeling and the southern islands of the Cocos group.
- Should any increases in *A. gracilipes* be detected on Pulu Keeling such that a clear environmental threat can be identified, then consideration should be given to an integrated control program aimed at eradicating *A. gracilipes* and other introduced ant species.

4. Introduction

The yellow crazy ant *Anoplolepis gracilipes* (Formicinae) is one of the worlds most invasive tramp ant species due to its ability to forage day and night, year round with an extremely generalised diet and nesting habit (for a description see Table 1). Originating in West Africa it now has a pan-tropical distribution and its range now extends from islands of the Carribean, the Indian Ocean and the Pacific as well as on the continents of Africa and Asia. In the Indian Ocean it is known from islands such as the Zanzibar, Seychelles, Mauritius, Reunion, and Christmas Island, while in the Pacific it is known from the Hawaiian Islands, French Polynesia, Okinawa, Vanuatu, Guam and Micronesia (Lewis *et al* 1976, Haines and Haines 1978, Veeresh and Gubbiah 1984, Passera 1994). It occurs on mainland Australia in an isolated population near Gove and there have been recent accidental introductions via shipping containers at Cairns and Townsville.

Colonies of *Anoplolepis gracilipes* can, under certain conditions, develop into extremely high density infestations known as supercolonies. These can become extensive and spread over tens or even hundreds of hectares and can have profound effects on the environment. For example, on Bird Island in the Seychelles, *A. gracilipes* spread across half the island and prevented nesting by an estimated 60,000 sooty terns, killed shrubs and trees, and eliminated endemic skinks from theses areas. On Christmas Island *A. gracilipes* has infested about 2,500 ha of rainforest, eliminated land crabs, severely impacted on most other ground dwelling fauna such as reptiles and leaf litter invertebrates, and the associated scale insects have caused serious canopy dieback. Because the red crab plays an important role in determining the structure and function of the Christmas Island rainforest, eliminating local populations of red crabs has caused changes to the structure and composition of the rainforest.

In the Seychelles *A. gracilipes* became a household pest, invading dwellings, encouraging the increase in plant pests and diseases and disturbing or even killing domestic animals (Lewis *et al.*

1976). *A. gracilipes* was introduced into New Guinea to control crop pests in coconut plantations (Baker 1976).

The Cocos (Keeling) Islands were known from the early seventeenth century but they remained uninhabited until 1825. While the crazy ant was first identified on the Cocos(Keeling) Islands in 1905 (Wood Jones 1909), earlier records suggest that it probably arrived there soon after settlement. Charles Darwin visited the atoll in 1836 and collected specimens of insects including two types of ant (Darwin 1845). The next naturalist to visit the atoll was H. O. Forbes in 1879 who recorded that "ants were abundant; a minute fire-ant (*Camponotus*), the common Javan long-legged venomless species and several black sorts" (Forbes 1885). Although not identified to scientific name it seems likely that the long-legged species was *A. gracilipes*, and the small fire ant *Solenopsis geminata.*

In the early days of settlement the island was in trade contact with Mauritius and to a lesser extent Java, but by the 1860's contact with Mauritius ceased and trade was largely with Javanese ports with occasional ships sailing directly to and from Europe (Gibson Hill 1950). After the settlement of Christmas Island in 1888 there was regular contact with Christmas Island and also with Singapore. In the early days of settlement soil was brought to the atoll from Mauritius in the early part of the nineteenth century and later from Christmas Island (Gibson Hill 1950). Thus, there was the possibility of insects colonising the atoll in soil or in trade goods from Mauritius, Java, Singapore and Christmas Island. Crazy ants probably arrived on Cocos (Keeling) Islands from either Mauritius or Java. If the crazy ant was one of the ants that Darwin saw during his visit then Mauritius would seem most likely with Java the next most likely alternative. Since the early days of settlement the number of insect species on the islands have increased from 13 in 1836 (Darwin 1845), to 94 in 1905-06 (Wood Jones 1909), to 217 in 1941 (Gibson Hill 1950).

Because *A. gracilipes* has become an environmental problem in several locations including Christmas Island and the Seychelles, the potential threat of this species to cause ecological

damage on Cocos (Keeling) Islands needed to be assessed. The aims of this report were to assess the distribution of *A. gracilipes* on the Cocos (Keeling) Islands, assess the potential environmental risks that *A. gracilipes* might present to the Cocos (Keeling) Islands, particularly to Pulu Keeling National Park, and make recommendations for future actions.

5. *Anoplolepis gracilipes*.

The crazy ant, *Anoplolepis gracilipes*, is a widespread tramp ant throughout the tropics. Like all ants it requires a carbohydrate source for energy and a proteinaceous food source for reproduction. Carbohydrate is usually supplied through sugary substances from fruits, plant exudates and honey-dew-producing insects. Proteinaceous food usually comes from other insects such as ants, cockroaches, centipedes, and spiders, small vertebrates such as geckos and skinks, and from any carcasses of invertebrates or vertebrates, such as dead birds or dead crabs.

Crazy ants nest predominantly on the ground but their nests can be quite transient. Nests can occur under fallen vegetation, including logs, branches and leaves, in cracks in the ground and sometimes in trees.

6. Survey of all islands of the Cocos(Keeling) Islands

6.1 Pulu Keeling

Anoplolepis gracilipes was recorded on Pulu Keeling in 1941 (Gibson Hill 1948, 1950) although it probably established there much earlier as regular visits were made from the main atoll in order to collect coconuts and timber, and to hunt birds from the early days of settlement until 1929.

In the present survey *A. gracilipes* were located in several areas of Pulu Keeling but its distribution on the island was patchy although widespread. Ants were never observed in very high densities. Ants were recorded on the path from the shed to the camp area near the lagoon. From the lagoon edge ants were present from the camp path up to transect F. They were present

on transect F only on the beach side for about 10m. Ants were absent 50m from the beach on transect F. The numbers of ants pick up again from transect I in the centre and along the beachfront. More nests were present between transect I and the shed. Overall it appeared that ants were in heavier densities in the *Pisonia* stands than in the *Cordia* stands. No ants were recorded in the stands of *Pemphis* or in the coconut groves, although ants were recorded trailing up and down some coconut trees. Ants were observed coming down from coconut trees with extended gasters, suggesting they were feeding on sugary exudate from the coconut flowers. A few scattered nests were detected in the Pisonia/Coconut fringe all the way from the Masked Booby nests to the Emden Memorial site. No ants were detected in the forest near the Malay graves or on transect P. At least four other ant species were recorded on Pulu Keeling and are listed in Table 2.

6.2. Horsburgh Island

A. gracilipes were found in low numbers on this island although nests with pupae and queens were observed. The nests were very patchy in distribution, but widely scattered thoughout the island including areas around the mangrove fringed lagoon and the cleared areas. *A. gracilipes* were recorded feeding on *Scaevola taccada* flowers. Seven other species of ant were recorded on Horsburgh Island (Table 2).

6.3 Direction Island

A. gracilipes were found in low numbers on this island. They were present around the camp area and around the tip site. They were also present in the centre of the island, although this area was only accessed along a small track dissecting the island through the *Scaevola taccada*. A total of five ant species were recorded on this Island (Table 2).

6.4 Islands of the Southern Atoll

6.4.1 Pulu Atas - This island was surveyed from the southern end to the northern end, although only the eastern side was walked completely with searches conducted on the western (laggoon) side opportunistically. *A. gracilipes* were recorded in low numbers feeding in the *Scaevola taccada*. Scattered nests were present all over the island.

6.4.2 Pulu Labu – *A. gracilipes* were recorded on this island, which is the first island north of Pulu Atas. Ants were present in low numbers and were feeding on the flowers of *Scaevola taccada*. No other ant species were recorded on this island.

6.4.3 Pulu Siput – *A. gracilipes* were not recorded on this island.

6.4.4 Pulu Pandan – A single nest of *A. gracilipes* was recorded on this island. No other ant species were recorded on this island.

6.4.5 Pulu Wak Banka – *A. gracilipes* were recorded in low numbers on this island. Other ant species were recorded on this island (see Table 2).

6.4.6 Pulu Cepelok – *A. gracilipes* were recorded on this island in very low numbers

6.4.7 Pulu Kembang – *A. gracilipes* were very sparse on this island. No other ant species were recorded.

6.4.8 Pulu Blekok – *A. gracilipes* were recorded on this island in very low numbers.

6.4.9 Pulu Wak Idas – *A. gracilipes* were recorded in low numbers on this island (note: this island was separated from Pulu Blekok by a rock platform and is recorded separately for the purposes of this survey.

6.4.10 Pulu Ampang – *A. gracilipes* was present on this island.

6.5 Home Island

Anoplolepis gracilipes were recorded in low numbers all over this island. Several large nests were recorded on the southern end of the island near the big house. Another large nest with pupae and queens present was recorded at the base of a *Terminalia cattapa* tree at the entrance to the cemetery. *A. gracilipes* were recorded trailing up and down this same tree and were observed feeding on the extra floral nectaries. *A. gracilipes* were also recorded near the chicken coops, although in very low numbers as the fire ant *Solenopsis geminata* was present in large numbers in this area. Nine other species of ant were recorded on Home Island (Table 2).

6.6 West Island

Anoplolepis gracilipes were recorded in low numbers all over West Island. At the southern end of the island a single nest was recorded near the yacht club, although no ants were recorded in Scout Park. They were observed feeding on the flowers of *Scaevola taccada* along the road back to the airstrip but were not recorded in the grass verge along this road. However, they were recorded along the road to Rumah Baru and at the boat ramp. In the settlement area *A. gracilipes* were recorded in low numbers and several nests were found under pot plants outside the National Parks Office. They are common in and around houses on West Island. Seven other ant species were recorded on this island (Table 2).

7. Conclusions

Anoplolepis gracilipes was not found in densities high enough to suggest an immediate environmental threat on Pulu Keeling or on any other of the Cocos (Keeling) Islands during this survey. Only relatively low numbers of foraging workers were observed with widely scattered nests, and other ant species were present. When high density supercolonies form on Christmas Island, most other species of ant, particularly those species identified from Cocos (Keeling) Islands are usually excluded (PANCI, unpublished data).

The trailing activity of ants was confined largely to coconuts (*Cocos nucifera*) where the workers appeared to be feeding on the extra floral nectaries or flowers. Workers were also observed feeding on the flowers of *Morinda citrifolia*, *Scaevola taccada*, and *Argusia argentea*. In addition, despite careful searching on Pulu Keeling, no scale insects were detected. On Christmas Island *A. gracilipes* are not generally observed feeding on nectar in flowers on Christmas Island where scale are present (K. Abbott unpublished data). These are significant observation as many of the leguminous tree species such as *Tristiropsis acutangula, Inocarpus fagifer* and *Planchonella nitida* that are associated with ants and scale insects, and are thought to be key factors in supercolony formation on Christmas Island, are absent from Pulu Keeling. The absence of these leguminous or nitrogen fixing trees, together with the absence of scale insects, suggest that *A. gracilipes* is currently not present in high enough densities on Pulu Keeling to pose a serious environmental threat. Although our understanding of why supercolonies form is still limited, the absence of scale insects from Pulu Keeling would appear to be a key factor and suggests that without the scale these ants are unlikely to develop into the densities that occur on Christmas Island and on the Seychelles. Also, *A. gracilipes* has been present in the Cocos (Keeling) Islands for at least 50 years longer than they have been on Christmas Island, and almost 100 years more than on some islands of the Seychelles.

However, there remains the possibility that in spite of quarantine efforts, scale could colonise Pulu Keeling and the situation may change. While *A. gracilipes* remains in low, scattered densities it might be possible to eradicate them but it would be a difficult, labour intensive job that should be balanced against the risks, and the potential environmental threats.

Should the crazy ant form into high density supercolonies on Pulu Keeling the likely risks would be to the land crabs, birds such as the Buff-banded rail, the white tern, and possibly the red footed boobies and frigate birds. While there are chemical treatments available for *A. gracilipes* it is likely that any broad scale chemical treatment, while highly likely to succeed against the ants, might have serious impacts on the land crabs of Pulu Keeling. Particularly at risk would be the Coenobitidae including the robber crab *Birgus latro,* and the three hermit crabs *Coenobita perlata, C. brevimana,* and *C. rugosa* as experience on Christmas Island has shown that these all find the ant bait appealing. It might be possible to deliver the bait using crab proof bait stations. Bait stations have been successfully used to eradicate crazy ants from an area along a drainage channel in Cairns where it was considered too risky to broadcast bait (DPI Qld, unpublished data). However, the baiting was not as effective as broadcasting and took several treatments to have an impact. In addition, developing a crab proof bait station that ants still find attractive is a challenge that to our knowledge has not been successfully achieved. If a baiting program is to be seriously contemplated, a trial on one of the smaller islands in the southern group might be advisable, before moving to Pulu Keeling.

In the 1980s and 1990s the Cocos (Keeling) Islands had an effective quarantine barrier in place. It is crucial that this continues, particularly the barrier between Cocos (Keeling) and Christmas Island, and that any imports of plant material are carefully examined to ensure they are scale free. There are a number of species of scale that provide honey-dew for *A. gracilipes*. These range from hard bodied lac scales to soft scale and waxy scale. Examples of some of the main types of scale found in association with *A. gracilipes* on Christmas Island are shown in Fig. 3.

There several possible approaches to the management of invasive ants on Pulu Keeling:

i) Do nothing. This is a justifiable option in that there is no immediately identifiable environmental threat. However, given the scale of potential threats and the difficulty of successful action once ant densities have reached levels that cause environmental damage this is not a recommended approach.

ii) Set up a program to monitor crazy ant density and detect changes in abundance, distribution and behaviour. This approach provides an early warning signal should the situation change and threaten the environment.

iii) Attempt to eradicate crazy ants from Pulu Keeling. This would be a difficult and resource intense action that may or may not be successful. As the current situation suggests that the threat to the environment is not immediate then it might be better to keep this option in mind for the future. It is likely that crazy ants could be eradicated from Pulu Keeling but the environmental risks would need to be carefully balanced against the benefits.

iv) Reinforce the quarantine barrier between the mainland and Cocos (Keeling) Islands and between Christmas Island and Cocos (Keeling) Islands to prevent introduction of any sap sucking insects that produce honey dew. Also, diligence is required to avoid transferring insects from the Southern Atoll to Pulu Keeling. This action is independent of the above.

The recommended course of action for managing crazy ants on Pulu Keeling is to set up a monitoring program that is sensitive enough to detect changes in ant density and give an early warning to any change from the current situation. Such a program could easily be incorporated into the regular booby survey work. There are many methods available to determine the density of ants, but to be effective it needs to be a simple and repeatable method. The preferred method used by Parks Australia staff on Christmas Island is to use a 10 cm x 10 cm laminated plastic card which is placed flat on the ground, allowed 30-60 seconds for ant activity to return to normal,

then a count is made of each ant that moves onto the card over a 30 second period. Ant densities even in crazy ant supercolonies can be extremely variable. In order to accommodate this, several card counts of ants must be taken along a transect to establish a mean ant activity index along that transect. Transects should be set up in convenient locations, preferably using the same transects as for the bird counts, although additional transects could also be established. The number of counts required is a function of the length of the transect, but if 50 metre transects can be used then a card count should occur every 5 metres. The actual location of the card can be semi random and does not have to occur on exactly the same point each time. However, the number of counts along the transect needs to be standardised.

An alternate method of estimating ant density is to use pit fall traps made up of test tube sized traps filled with alcohol that are placed inside a sleeve which is left in the ground permanently. This method is relatively simple as it also makes use of the same transects as the bird survey work and field staff are only required to drop new traps into the already dug sleeve each time they visit the island and remove them after a standardised time, usually 24 hours. Another advantage of this method is that it will give information about other species of ants and other invertebrates which may be useful in interpreting changes to *A. gracilipes*. The main disadvantages of pit-trapping are that it takes longer to analyse the samples and that some expertise in identification of invertebrates is required. A combination of these two methods might be the preferred approach.

This program could use the10 existing transects that are used for monitoring seabirds. These transects are located on the western, northern and southern sides of the island and sample the closed forest habitat types. The frequency of surveying should coincide with that of the bird surveys. In addition there are several other observations that may be important indicators that the status of the crazy ants might be changing. These include observations of which tree species the ants are trailing, and observations of dead animals including whether the ants are feeding on them

or carrying them away. Monitoring should occur in conjunction with the bird surveys, and if these occur several times per year, this should be adequate.

In addition to the transect data, a grid covering all major habitats on the island and containing between 40 and 60 points should be set up in order to monitor changes in the distribution and abundance of *A. gracilipes* on an island wide scale. The distance between the points would vary depending on the geometry of the island. For example, points should be about 200 metres apart on the long axis of the island and be about 50 metres apart across the narrow axis of the island. At each point a 25 metre transect should be established and ant densities measured through either card counts (about 10 card counts would be required) or through pit traps (the number required would be less but depend on the variability of the catch). This grid should be set up using GPS and GIS, and grid surveys should occur annually, but could occur more frequently if resources permit.

8. Acknowledgments

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Table 1: The crazy ant, *Anoplolepis gracilipes*. Description is courtesy of the Japanese Ant Database (Dr. Hirotami Imai).

Anoplolepis gracilipes (Fr. Smith)

Common names: crazy ant, yellow crazy ant, long-legged ant

Synonyms:

Formica longipes Jerdon (Jerdon, 1851)

Plagiolepis longipes Emery (Emery, 1887)

Anoplolepis (*Anoplolepis*) *longipes* Emery (Emery, 1925)

Description:

Total length of workers around 4 mm. Body colour yellow, gaster brownish. Antennae and legs remarkably long. Head oval. Clypeus produced medially, with convex anterior margin. Eyes relatively large and produced. Mandibles with 8 teeth. Antennae 11-segmented; scapes twice as long as the length of the head, or longer; their second to terminal segments each more than three times as long as wide. Mesosoma slender. Pronotum narrow, with almost straight dorsum in profile. Anterior portion of mesonotal dorsum, back to the propodeum, gently concave in profile. Propodeal dorsum convex in profile. Petiole thick, with a reverse U-shaped node. Erect hairs present on head and gaster, lacking on dorsum of mesosoma.

Table 2: Distribution of ant species recorded on five main islands and the chain of islands between West Island and Home Island (Southern Islands) in the Cocos Keeling group in May 2001.

Sub Family/Species	**Islands of the Cocos (Keeling) Islands**					
	Pulu Keeling	Home Is.	West Is	Direction Island	Horsburgh	Southern Islands
Formicinae						
Anoplolepis gracilipes	*	*	*	*	*	*
Camponotus maculatus		*	*	*	*	*
Camponotus reticulatus	*	*	*		*	
Paratrichina longicornis		*	*	*	*	*
Paratrichina obscura		*	*		*	
Myrmicinae						
Solenopsis geminata		*	*			*
Tetramorium bicarinatum	*			*	*	*
Tetramorium simmilum	*					
Monomorium destructor					*	
Pheidole oceanica		*	*		*	
Cardiocondyla nuda		*				
Ponerinae						
Odontomachus simmilus	*		*			*
Anochetus sp		*				
Dolichoderinae						
Technomyrmex sp				*		
Ochetellus glaber		*				
Total species	5	10	8	5	8	6

Fig. 1: Map of Pulu Keeling indicating the main areas where *Anoplolepis gracilipes* were located. Note that the survey was not systematic and this does not indicate the only areas where these ants may be present.

Fig. 2: *Anoplolepis gracilipes* workers.

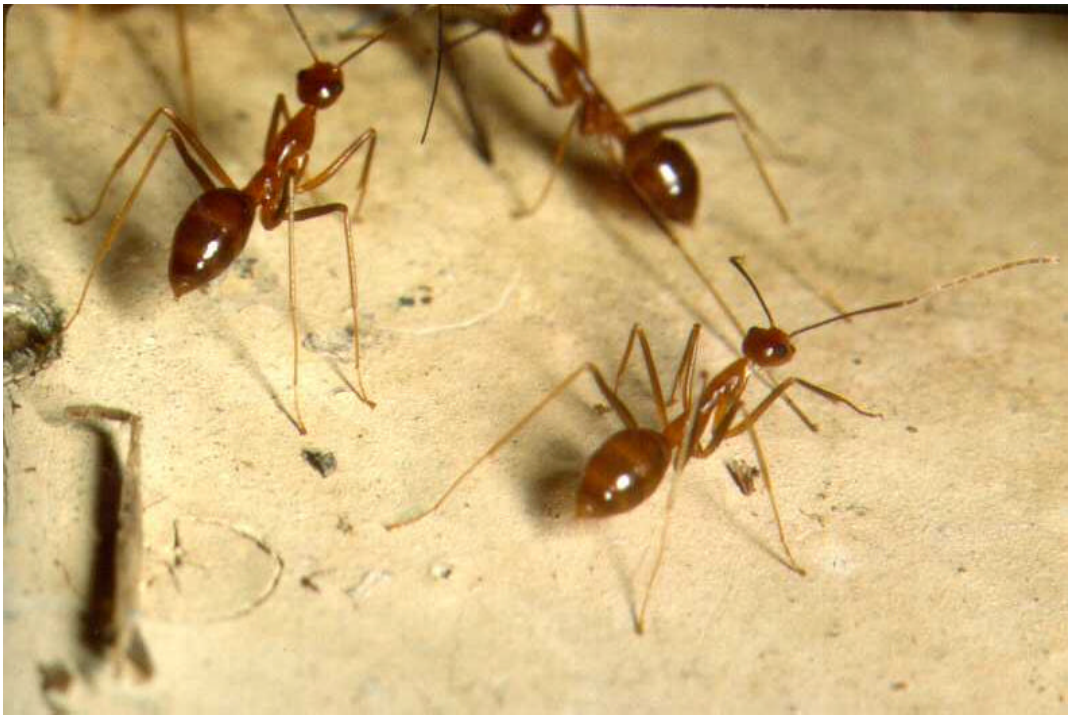
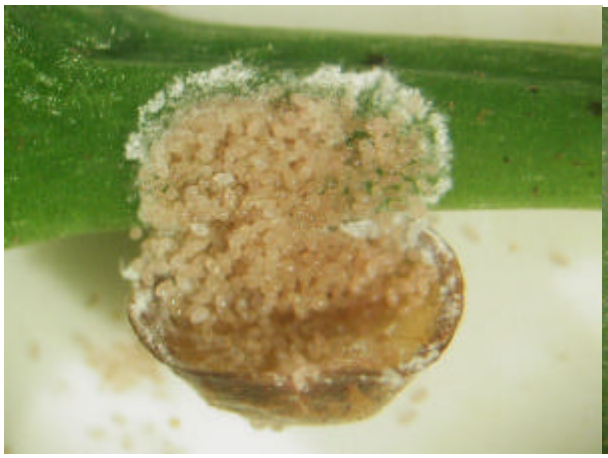


Fig 3: Examples of scale insects associated with *Anoplolepis gracilipes* in high density supercolonies on Christmas Island.

a) Lac scale (Family Kerridae): Mature female, species to be determined

b) Lac scale *Tachardina aurantiaca* (Family Kerridae) Crawler stage on leaf, mature females on twig.

c) & d) Soft scale (Family Coccidae): *Coccus* spp.; exact species to be determined. Mature females bulbous.



e) Soft scale (Family Coccidae): mature female with eggs

f) Armoured scale (Family Diaspididae): species to be determined. This family does not produce honeydew.

Fig 3 continued: Examples of scale insects associated with *Anoplolepis gracilipes* in high density supercolonies on Christmas Island.

g) Thought to be *Ceroplastes ceriferus* (Family Coccidae) or white wax scale. Species to be confirmed.

h) Thought to be *Ceroplastes destructor* (Family Coccidae) or white/pink wax scale.] Species to be confirmed.