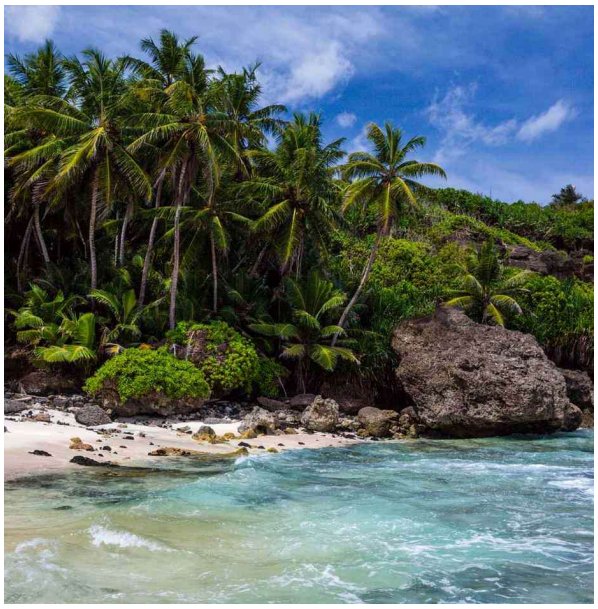
The Crazy Christmas Island Catastrophe 

Venu

Good afternoon everyone, Today I'm going to tell you about an ecological catastrophe unfolding on Christmas Island



Christmas Island sits 360 kilometers south of Java— with 135 square kilometers of luscious rainforest and beautiful beaches.

The annual migration of the red crab on Christmas Island, where tens of millions of red crabs emerge from the forest to travel to the coast to reproduce.

They close roads

“Keystone” species

1. Process leaf litter
2. Turn over soil
3. Control plant growth

But these crabs aren't just spectacular—they're keystone species. They process leaf litter, aerate soil, and control seedling recruitment. They are crucial members of the Christmas island ecosystem.

https://www.youtube.com/watch?v=NqnauxtCX6I

But what happens when you find that the population of these crabs are suddenly dwindling? Dead crabs found all across the forest floor.

Beeton, Robert & Burbidge, Andrew & Grigg, Gordon & Harrison, Peter & How, & Humphreys, William & McKenzie, Norman & Woinarski, John. (2010). Final Report of the Christmas Island Expert Working Group to Minister for the Department of Environment Protection, Heritage and the Arts.

The impact is visible. Left: healthy forest with active crab populations. Right: leaf litter accumulation, altered vegetation structure, ecosystem breakdown.

So what's causing this??

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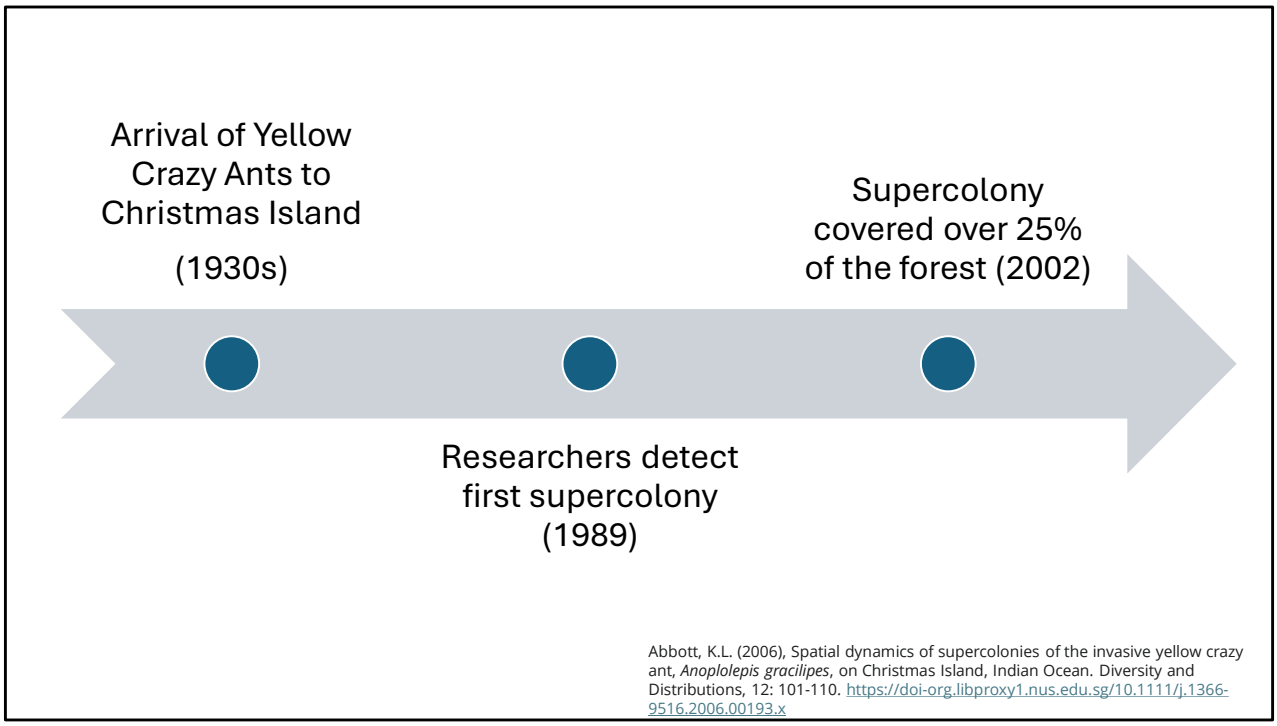
The Yellow Crazy Ant.

Anoplolepis gracilipes

The culprit? Yellow Crazy Ants.

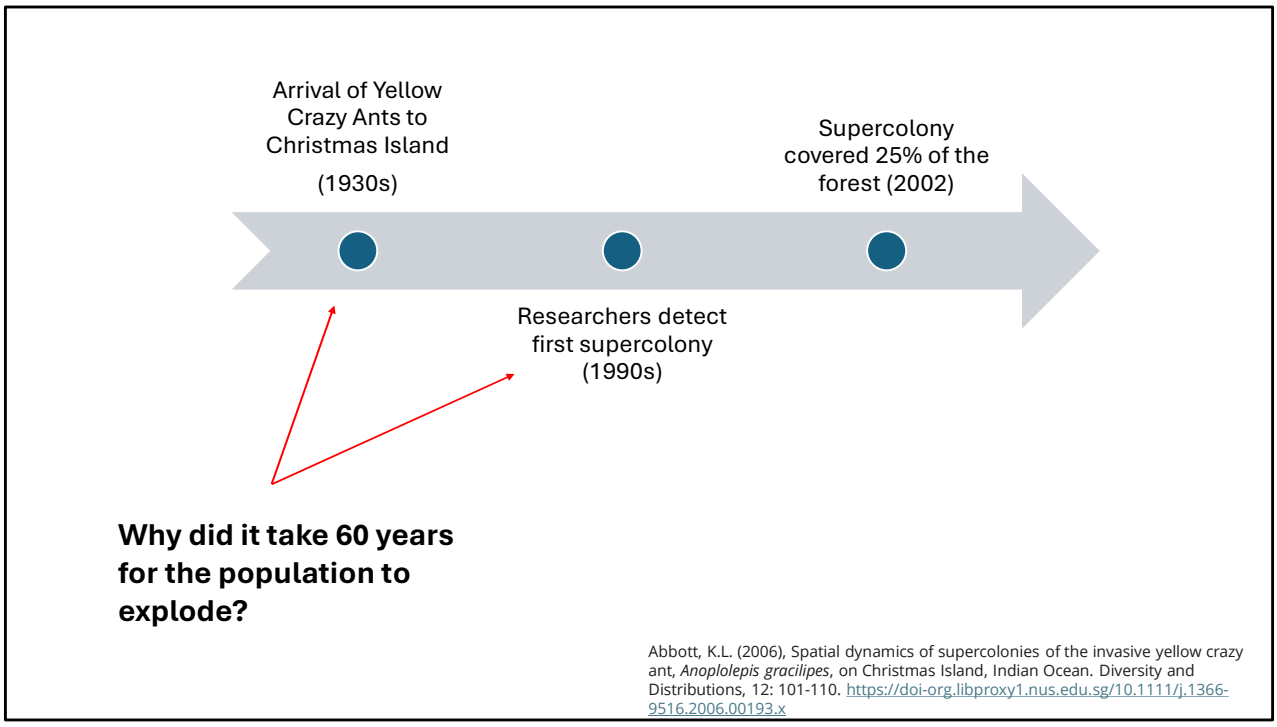
https://www.youtube.com/watch?v=NqnauxtCX6I

And here we can see a baby red crab getting attacked by The Yellow Crazy ants



Abbott, K.L. (2006), Spatial dynamics of supercolonies of the invasive yellow crazy ant, *Anoplolepis gracilipes*, on Christmas Island, Indian Ocean. Diversity and Distributions, 12: 101-110. https://doi-org.libproxy1.nus.edu.sg/10.1111/j.1366-9516.2006.00193.x

Anoplolepis gracilipes—the Yellow Crazy Ant—arrived around 1930, likely via shipping. For 60 years, they remained at low density. Then in 1989, the first 'supercolony' was observed by scientists. By 2002, supercolonies covered 3,000 hectares— over 25% of the rainforest.



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This 60-year lag phase is interesting. But what triggered the explosion here? O'Dowd and colleagues' 2003 study provided the first clue."

Experimental Set-Up (Field Observation)

- Six 1-hectare invaded sites and six matched uninvaded control sites within 200 meters of each other
- Sampled five 4m × 4m plots to assess forest floor impacts and five canopy trees to evaluate canopy effects.
- Measurements:
  - Crazy ant activity
    - Using sugar baits
  - Red crab burrows
  - Dead crabs
  - All seedlings less than 200cm in height
  - Ant densities
  - Scale insects
  - Sooty mold
  - Dieback presence

O'Dowd, D.J., Green, P.T. and Lake, P.S. (2003), Invasional 'meltdown' on an oceanic island. Ecology Letters, 6: 812-817. https://doi-org.libproxy1.nus.edu.sg/10.1046/j.1461-0248.2003.00512.x

O'Dowd used a paired-site design: six invaded versus six uninvaded areas, matched for forest type and substrate. They sampled 960 square meters total—measuring ant activity with sugar baits, counting crab burrows and carcasses, and critically, quantifying canopy arthropods.

Activity Index = Total number of ants on bait / Time exposed (minutes)

Variable	Invaded (mean ± 1 SE)	Uninvaded (mean ± 1 SE)	$F_{1,5}$	P-value
Forest floor				
(a) *Anoplolepis* activity index*	6.96 (1.42)	0.06 (0.06)	45.40	0.001
(b) Land crabs				
Crab burrows/80 m^2	2.3 (1.6)	95.7 (24.5)	44.82	0.001
Dead crabs/80 m^2	51.8 (17.5)	0.0 (-)	18.81	0.007
(c) Litter cover (%)	87 (3)	43 (13)	21.43	0.006
(d) Seedlings				
Number of seedlings/80 m^2	1375.8 (166.2)	44.7 (16.7)	123.59	<0.001
Number of spp./80 m^2	22.2 (2.6)	6.3 (1.3)	34.06	0.002
Forest canopy				
(e) *Anoplolepis*/100 cm^2 bole	4.5 (0.4)	0.3 (0.1)	137.65	<0.001
(f) Scale insects				
Stem (no./20 cm)	114.7 (35.6)	8.2 (4.9)	17.85	0.008
Leaf (no./leaf)	122.5 (45.0)	7.1 (3.0)	59.29	0.001
(g) Sooty mould rating†				
Stem	2.2 (0.4)	0.4 (0.2)	43.39	0.001
Leaf	2.0 (0.6)	0.2 (0.1)	26.11	0.004
(h) Percentage growing shoots	72.7 (8.9)	96.0 (0.9)	10.14	0.024

*Ants per sugar bait divided by minutes bait exposed.
†Qualitative index of percentage cover on stems and leaves.

Table 1 Impacts on the forest floor and in the canopy following alien ant invasion. F and P are statistics derived from separate randomized block ANOVAs for each variable; all block effects were not significant ($P > 0.05$)

An estimated **10-15 million** red crabs had been killed or displaced by Yellow Crazy Ants by 2003

O'Dowd, D.J., Green, P.T. and Lake, P.S. (2003), Invasional 'meltdown' on an oceanic island. Ecology Letters, 6: 812-817. https://doi-org.libproxy1.nus.edu.sg/10.1046/j.1461-0248.2003.00512.x

Direct Impact on Red Crabs

Crazy ant activity was over 100-fold higher at invaded sites, while red crab burrow density dropped 42-fold (from 1 burrow/m^2 to 0.03 burrows/m^2), with dead crabs abundant only at invaded sites.

https://www.youtube.com/watch?v

=NqnauxtCX6I

"Keystone" species

1. Process leaf litter
2. Turn over soil
3. Control plant growth

Now why is it a problem that these ants were killed?

Well. as I mentioned earlier they're keystone species

Forest Floor Changes
Following crab extirpation, litter cover doubled, seedling density increased 30-fold, and seedling species richness was 3.5-fold higher in invaded areas. The seedling species composition differed significantly between invaded and intact sites, while canopy tree composition showed no relationship to invasion status.

Images: Peter Green & Dennis O'Dowd.

Canopy Impacts

Ant densities on canopy trees were dramatically higher at invaded sites, coinciding with significantly larger scale insect populations and extensive sooty mold coverage on stems and leaves. At invaded sites, 51% of trees showed canopy dieback compared to only 18% at uninvaded sites.

Canopy dieback is the gradual death of a tree's branches and foliage, starting from the tips and moving inward, which is a symptom of overall tree decline

Scale insect populations were **14-17 times higher** than normal.

O'Dowd, D.J., Green, P.T. and Lake, P.S. (2003), Invasional 'meltdown' on an oceanic island. Ecology Letters, 6: 812-817. https://doi-org.libproxy1.nus.edu.sg/10.1046/j.1461-0248.2003.00512.x

The other interesting observation is that the scale insect population had also skyrocketed

Why would an ant invasion cause a scale insect explosion?
Can we be certain that there is a relationship between the two?
Even more strongly can we determine if there is a dependency between the two?

How can we test the impact of Scale Insects on Yellow Crazy Ants (or vice versa)?

- "Baited" Crazy Yellow Ants
- Three separate colonies each with a nearby unbaited colony
- Sampling populations thrice
  - Before baiting
  - 11 weeks after
  - 12 months after

Abbott, K. L., & Green, P. T. (2007). *Collapse of an ant–scale mutualism in a rainforest on Christmas Island. Oikos, 116*(7), 1238–1246. https://doi.org/10.1111/j.2007.0030-1299.15629.x

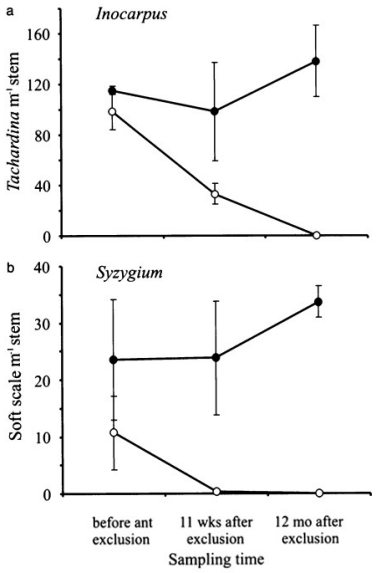
Abbott and Green designed a Before-After-Control-Impact experiment.

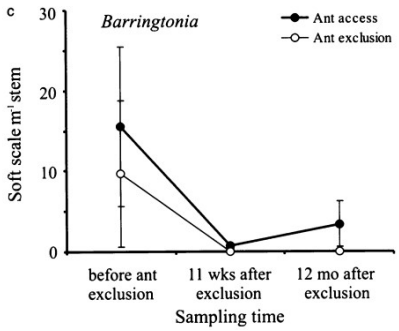
Fipronil bait at 5.2 kg per hectare—a slow-acting neurotoxin that ants carry back to nests

IMPORTANT: ground application meant canopy scale insects had zero direct exposure to the toxin. Any effect on scales would be indirect—through ant removal.

They selected three isolated supercolonies: 9.1, 15.0, and 35.6 hectares, each paired with a nearby untreated control supercolony to account for environmental variation.

Sampling occurred at three timepoints: immediately before baiting, 11 weeks post-treatment, and 12 months post-treatment. At each timepoint, they quantified ant activity using card counts—counting ants crossing a 10cm card in 30 seconds—and scale insect density on five canopy tree species.





"Our experiment demonstrates that scale insect outbreaks are sustained by high densities of the invasive yellow crazy ant, Anoplolepis gracilipes"

Abbott, K. L., & Green, P. T. (2007). *Collapse of an ant–scale mutualism in a rainforest on Christmas Island. Oikos, 116*(7), 1238–1246. https://doi.org/10.1111/j.2007.0030-1299.15629.x

Here are the results.

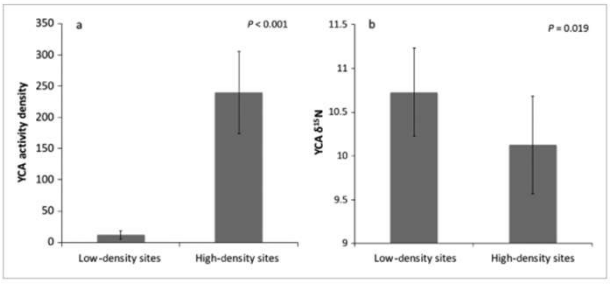
In baited Inocarpus sites, lac scale density crashed from 99 scales per stem to 33 within 11 weeks—a 67% decline. By 12 months: zero. Complete local extinction.
Soft scales on Syzygium collapsed even faster: from 11 per stem to zero within 11 weeks.
Meanwhile, control sites maintained densities above 98 scales per stem throughout. This isn't predator release or environmental change—it's the removal of one species causing the collapse of another.

Note that the complication that Barringtonia, we can't really make a conclusion, the researchers just left it as no conclusion.

Ultimately they conclude that the experiment demonstrates ...

What about the reverse? Do you think that removing the scale insects would

cause the collapse of the ants?



Wittman, S. E., D. J. O'Dowd, and P. T. Green. 2018. Carbohydrate supply drives colony size, aggression, and impacts of an invasive ant. *Ecosphere* 9(9):e02403. 10.1002/ecs2.2403

Increase in Yellow Crazy Ants

Yellow Crazy Ants protect Scale Insects

ANT-SCALE MUTUALISM

Increase in Scale Insects

More honeydew for Yellow Crazy Ants

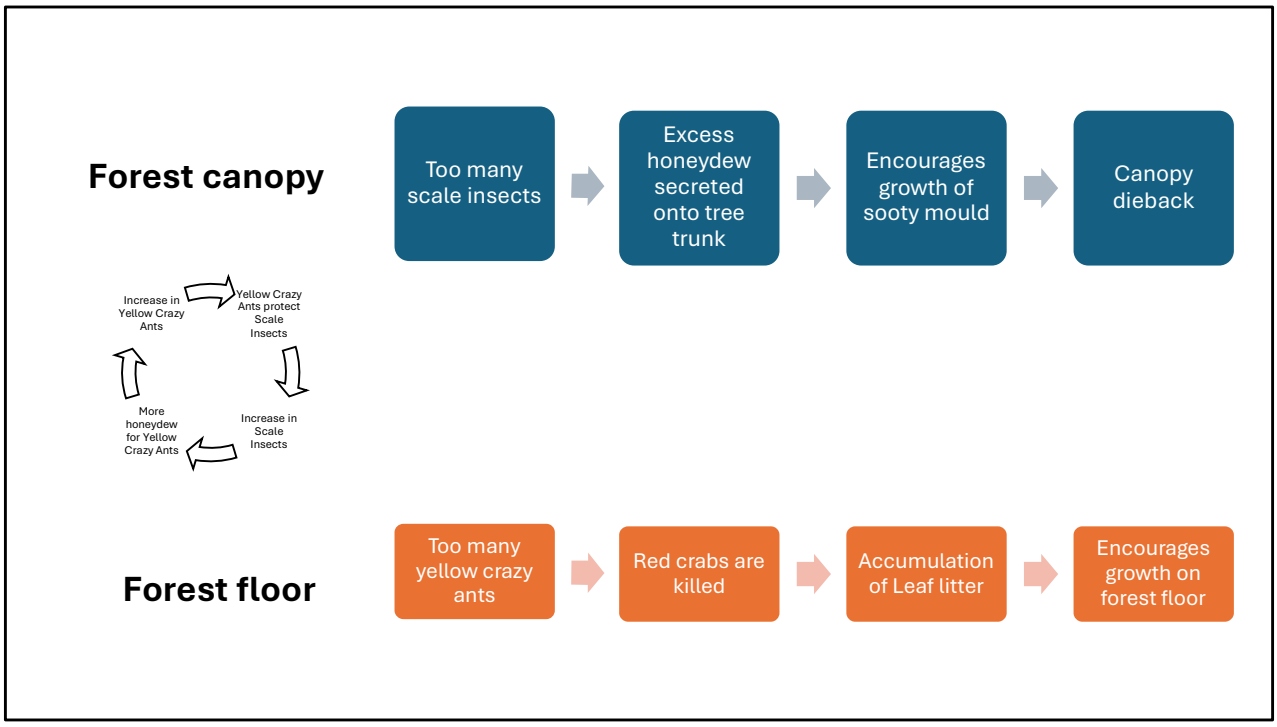
So what's happening here?? Why are the two species facilitating each other?

Scale insects feed on phloem sap—high in carbohydrates but low in nitrogen. To get enough nitrogen, they must process enormous volumes of sap, excreting excess sugar as honeydew. This creates two problems: honeydew can asphyxiate them, and they're vulnerable to predators.

Ants solve both problems. They remove honeydew, protect scales from parasitoids and predators, and even transport the mobile crawler stage to optimal feeding sites. In return, honeydew provides ants with abundant carbohydrate fuel—sustaining supercolony densities of 1,000+ ants per square meter.

This mutualism is what probably led to the explosion of the populations of both.

In fact, it probably took a while for this mutualism to take hold, and that's probably why it took so long for the Yellow Crazy Ant population to explode.



We've seen how the

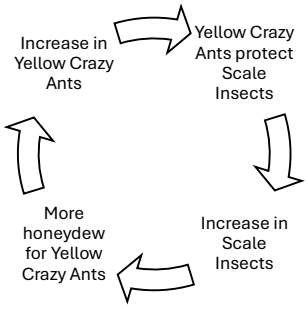
Canopy dieback is the gradual death of a tree's branches and foliage, starting from the tips and moving inward, which is a symptom of overall tree decline

Supercolony

Beeton, Robert & Burbidge, Andrew & Grigg, Gordon & Harrison, Peter & How, & Humphreys, William & McKenzie, Norman & Woinarski, John. (2010). Final Report of the Christmas Island Expert Working Group to Minister for the Department of Environment Protection, Heritage and the Arts.

How can we resolve this?

- Baits
- Biological Control: *Tachardiaephagus somervillei*



Scientists hope Malaysian micro-wasp will send Christmas Island's pest ants marching

By Lucie Bell | ABC Rural | Agricultural Pest Control

Tue 2 Jun 2015

https://www.abc.net.au/news/rural/2015-06-02/wasp-tackle-christmas-island-ant-swarms/6511636

NOTE: THIS IS SPECIFIC TO CHRISTMAS ISLAND

Johnston's Atoll

CRAZY ANT STRIKE TEAM 😎

- 20 Teams, 130,000 field hours
- Baiting with hydrogel crystals containing dinotefuran
- Official eradication declared in June 2021

https://www.fws.gov/story/2021-06/saving-seabird-paradise-invasive-yellow-crazy-ants

2.6 square kilometers, 57 hectares infested. Yellow Crazy Ants discovered in 2010. Within 11 years—by December 2017—the last ant was spotted. Official eradication declared in June 2021 after detection dogs surveyed 118 miles without finding a single individual.
The formula: 20 Crazy Ant Strike Teams, 130,000 field hours, experimental baiting with hydrogel crystals containing dinotefuran, hand-searching, and finally, trained detection dogs. Success rate: 100%.

Thank you!

https://www.youtube.com/watch?v=NqnauxtCX6I

Q&A

https://www.youtube.com/watch?v=NqnauxtCX6I