

# The effect of colony size and composition on almond pollen collection

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# Some hypothetical questions:

- Should colony rent vary by size?
- Is there an optimum colony size?
- Is there a minimum and maximum size?

## Back to earth:

- How much almond pollen do colonies of differing sizes collect?

# Colony sizes tested:

US 4-frame

US 6-frame

US 8-frame

US 10-frame

US 12-frame

US 14-frame

Also:

US 4-frame + 4lb AUS pkg

US 4-frame + US 4-frame

AUS established Dec 2006





















AUS colony established Dec. 2006





AUS colony established Dec. 2006



AUS colony established Dec. 2006





# Beginning and ending colony strength<sup>1</sup>

Colony Type	N	Begin CA bee count	End CA bee count
AUS 4-lb package	14	3.2 <b>a</b>	3.3 <b>a</b>
US 4-frame	13	4.0 <b>b</b>	5.5 <b>ab</b>
US 6-frame	14	6.0 <b>c</b>	4.4 <b>ab</b>
US 8-frame	14	8.2 <b>d</b>	6.0 <b>bc</b>
US 4-frame + US 4-frame	15	8.0 <b>d</b>	9.6 <b>de</b>
US 4-frame + AUS 4lb package	15	9.1 <b>e</b>	7.7 <b>cd</b>
US 10-frame	13	10.1 <b>f</b>	8.2 <b>de</b>
US 12-frame	15	12.3 <b>g</b>	8.5 <b>de</b>
US 14frame	14	14.6 <b>h</b>	10.1 <b>e</b>

<sup>1</sup> CA strength counting method



# Beginning and ending broodnest size

Colony Type	Beginning brood	Ending brood	% Change
AUS 4-lb package	1.5 e	2.5 d	68.6 b
US 4-frame	2.1 cd	3.0 cd	40.7 bc
US 6-frame	2.6 c	2.6 d	8.8 C
US 8-frame	3.2 b	3.6 bc	16.1 C
US 4-frame + US 4-frame	3.5 ab	4.6 a	39.7 bc
US 4-frame + AUS 4lb package	1.9 de	4.5 a	152.0 a
US 10-frame	3.6 ab	4.4 ab	35.0 bc
US 12-frame	3.9 a	4.2 ab	12.5 C
US 14frame	3.9 a	4.7 a	23.5 C



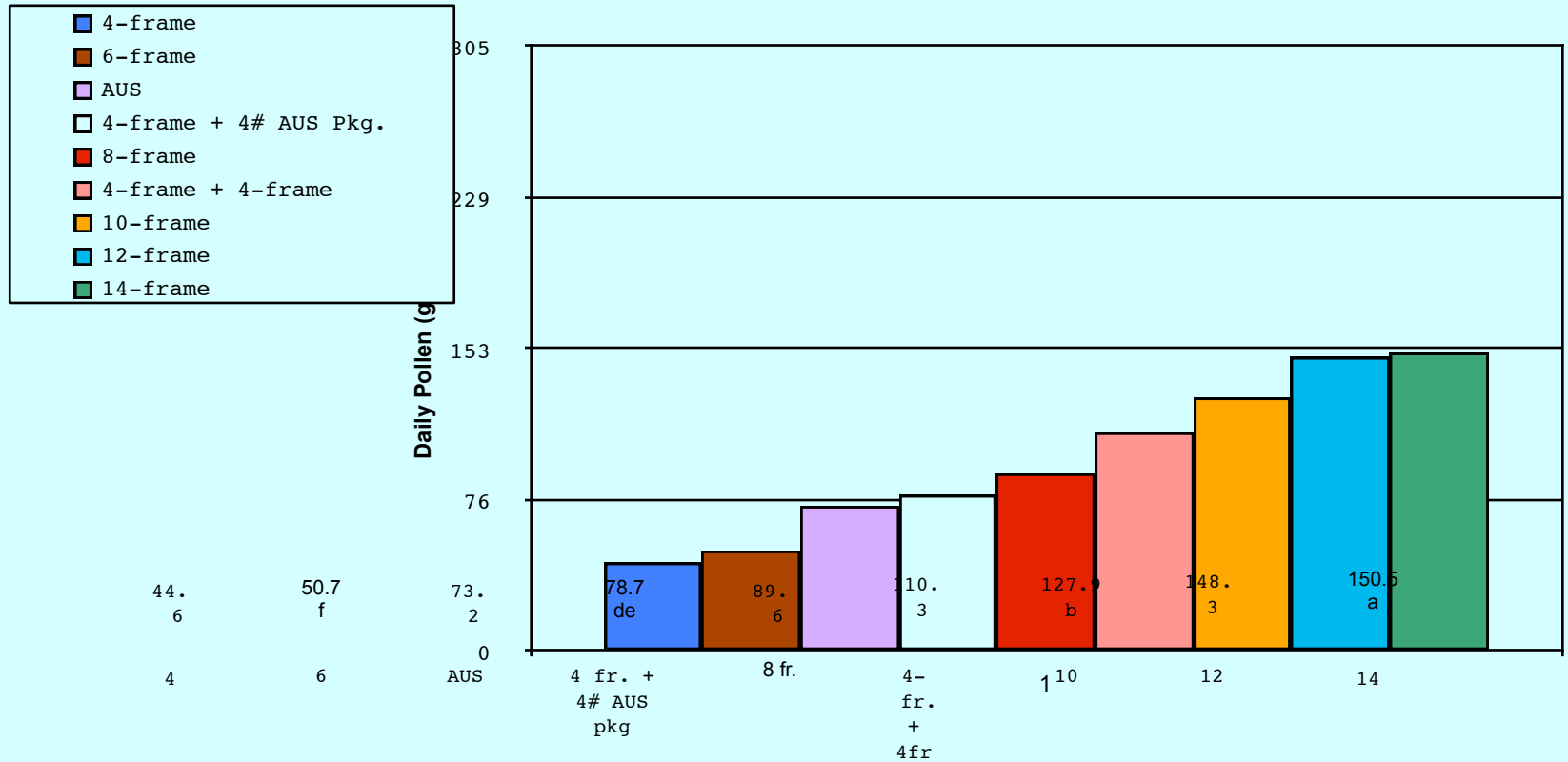


## Weight of pollen (g)

Colony Type	Weight of pollen per day (grams)
AUS 4-lb package	73.2 e
US 4-frame	44.6 f
US 6-frame	50.7 f
US 8-frame	89.6 d
US 4-frame + US 4-frame	110.3 C
US 4-frame + AUS 4lb package	78.7 de
US 10-frame	127.9 b
US 12-frame	148.3 a
US 14frame	150.5 a



# Average daily pollen collected (grams)



# Foraging rate (pollen collected per frame of bees)

Colony Type	Pollen per day per ending frame of bees (grams)
AUS 4-lb package	35.4 a
US 4-frame	13.6 d
US 6-frame	18.9 C
US 8-frame	22.2 C
US 4-frame + US 4-frame	16.0 d
US 4-frame + AUS 4lb package	15.5 d
US 10-frame	22.0 C
US 12-frame	26.2 b
US 14frame	21.7 C

# Returning pollen foragers on Feb. 24, 2007

Colony Type	Morning pollen foragers	Afternoon pollen foragers
AUS 4-lb package	26.9 e <sup>1</sup>	18.9 d
US 4-frame	32.4 de	25.0 dc
US 6-frame	39.6 cde	32.1 bc
US 8-frame	61.2 a	49.1 a
US 4-frame + US 4-frame	43.3 bcd	34.1 bc
US 4-frame + AUS 4lb package	37.9 de	32.1 bc
US 10-frame	<u>54.6</u> abc	<u>33.1</u> bc
US 12-frame	<u>63.6</u> a	<u>41.1</u> ab
US 14frame	<u>57.2</u> ab <sup>2</sup>	<u>40.4</u> ab

<sup>1</sup>Means in a column followed by the same letter are not significantly different.

<sup>2</sup> Underlined means in the same row are significantly different

# Collected pollen correlated with colony measures for Australian and US pollen-trapped colonies

Colony measures	Australian Correlation coefficients n=14	US Correlation coefficients n=83
Beginning bees	0.60*	0.60****
Beginning brood	0.37	0.33
Begin bees + brood <sup>1</sup>	0.53	0.57***
Ending bees	0.45	0.69****
Ending brood	0.43	0.64****
Ending bees + brood	0.45	0.69****

\* P<0.05 \*\*\*P<0.001 \*\*\*\*P<0.0001

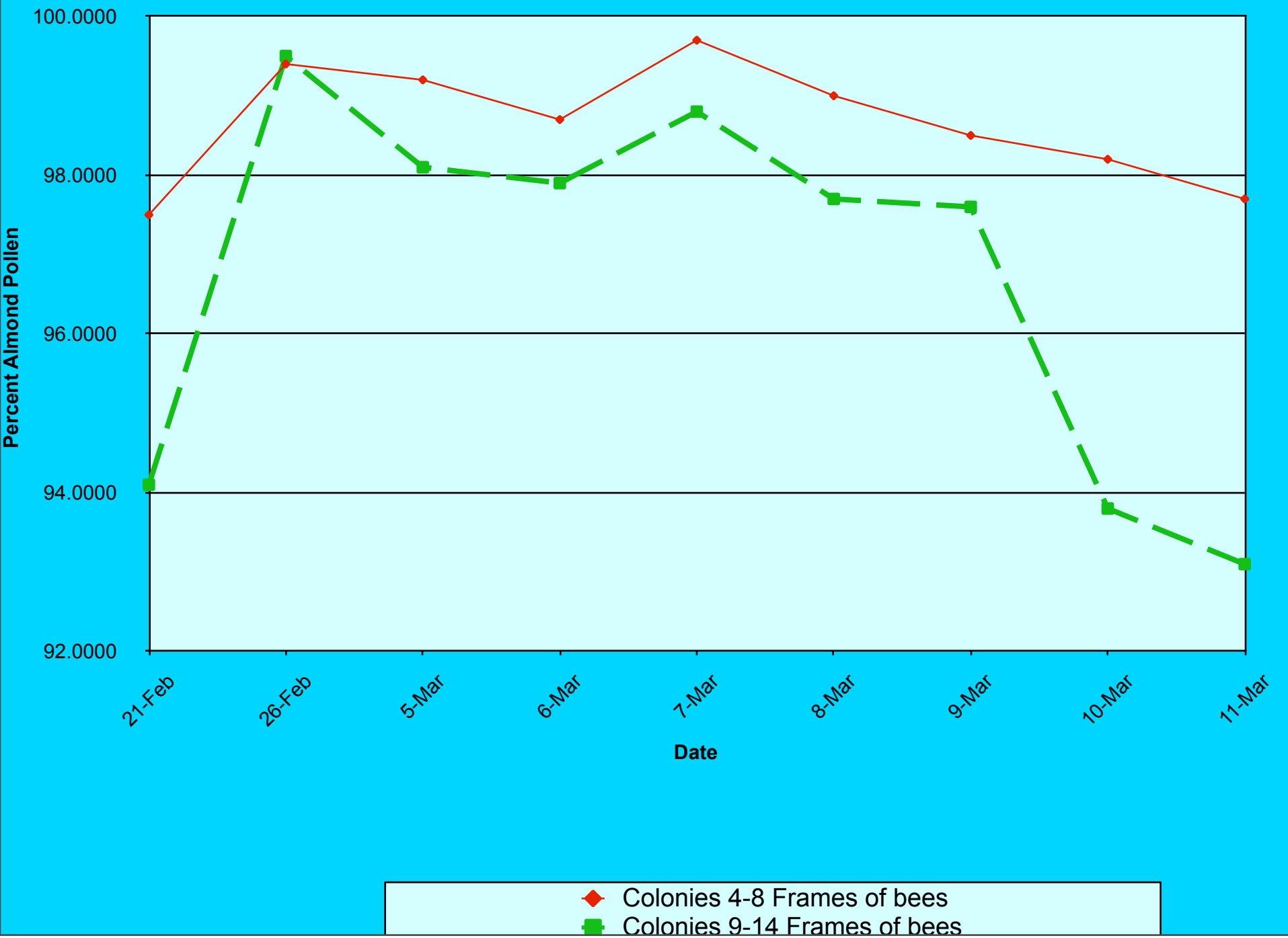


# The effect of colony size on fidelity to almond pollen collection

Date	% almond collected by US 4-8 frame colonies, n=18	%almond collected by US 9-14 frame colonies, n=12
9 Mar	98.5 a	97.6 b
10 Mar	98.2 a	93.8 b
11 Mar	97.8 a	93.1 b
Pooled data <sup>1</sup>	98.7 a	96.8 b

<sup>1</sup>Several days data not shown.

# Fidelity to almond pollen



# Forewing length of Australian and US worker bees, 2006 and 2007

Colony origin Year	n <sup>1</sup>	Forewing length (mm)
Australian 2007	100	9.31 a
Australian 2007 (Bennett)	100	9.23 b
US 2007	100	9.15 C
US 2006	100	9.37 y
Australian 2006 (J. Brown)	100	9.40 yz
Australian 2006	100	9.44 Z

<sup>1</sup> Twenty bees randomly chosen from each of five colonies in each treatment group also randomly chosen.

# Corbicular pollen loads of Australian and US colonies

Colony Type	Number of colonies <sup>1</sup>	Pollen load weight (mg)
US 8-frame	11	6.32 a
US 4-frame	15	6.12 a
Australian	10	5.31 b

<sup>1</sup> 100 pellets/colony were mass weighed and their average calculated

# Beginning and ending stored pollen

Colony Type	End stored pollen
AUS 4-lb package	1.00 d
US 4-frame	2.12
US 6-frame	1.54
US 8-frame	2.36
US 4-frame + US 4-frame	2.87
US 4-frame + AUS 4lb package	2.72
US 10-frame	2.70
US 12-frame	3.19 a
US 14frame	2.99



## Other types of colonies tested:

US 8-frame + brood

US 8-frame free-flying

# Effect of adding brood on almond pollen collection

Measurement	US 4-frame: no brood added	US 4-frame: brood added
Beginning bee strength	3.3 <b>a</b>	3.1 <b>a</b>
Ending bee strength	3.8 <b>a</b>	3.9 <b>a</b>
Beginning brood	2.4 <b>a</b>	2.2 <b>a</b>
Ending brood	3.2 <b>a</b>	3.8 <b>a</b>
Average daily pollen (grams)	67.3 <b>a</b>	48.8 <b>b</b>
Average daily pollen per frame of ending bee strength	20.1 <b>a</b>	13.2 <b>b</b>

<sup>1</sup>Brood was added on 17 Feb 9 (just before bloom) and again on 27 Feb 2007.

# Comparison of pollen-trapped and free-flying colonies

Measurement	Trapped (n=11)	Free-flying (n=10)
Beginning bee strength	5.7 <b>a</b>	5.8 <b>a</b>
Ending bee strength	4.0 <b>a</b>	6.7 <b>b</b>
Change in bee strength	-1.7 <b>a</b>	1.0 <b>b</b>
Beginning broodnest size	3.2 <b>a</b>	2.8 <b>a</b>
Ending broodnest size	3.5 <b>a</b>	4.8 <b>b</b>
Ending stored pollen	2.0 <b>a</b>	3.2 <b>b</b>

Do strong colonies begin flying earlier  
on cool morning than weak colonies?





# Early morning (cool temperatures) forager counts from weak and strong colonies

Date	Time---°C	US 4-frame (n=9)	US 8-frame (n=11)
Ending bee		3.6 a	7.4 b
Exiting foragers 28 Feb 2007		4.7 a	9.9 a
Exiting foragers 1 Mar 2007		11.3 a	50.8 b
Exiting foragers 2 Mar 2007		30.6 a	98.0 b
Exiting foragers 3 Mar 2007		46.7 a	105.5 b
Pooled		23.3 a	66.1 b
Exiting foragers per end frame of		5.3 a	8.9 b
Returning pollen		7.1 a	22.6 b

Do east facing colonies begin foraging  
earlier than west facing colonies?







# Morning and afternoon forager counts for colonies oriented into and away from the sun, i.e. East vs. West

Measurement	Start Time <sup>1</sup>	Temp °C	East orientation	West orientation
Ending bee strength (Langstroth frames)	---	---	10.0 <b>a</b>	9.9 <b>a</b>
Average # foragers	---	---	15.8 <b>a</b>	12.5 <b>b</b>
Exiting foragers, late morning 22 Feb 2007	11:15 am	19.0	23.0 <b>a</b>	26.9 <b>a</b>
Exiting foragers, afternoon 23 Feb 2007	15:15 pm	15.2	1.0 <b>a</b>	1.9 <b>a</b>

<sup>1</sup> Foragers leaving the entrance during a 30 second count on cool mornings. These are the combined counts of two counts during a one hour period. Start time began when the first foragers for the day flew from the colonies.



# Sheelsey and Poluska 1970 study

- 4-frame minimum
- Pollen collection plateau at about 12-frames

## Conclusions:

- Colonies should have been fed protein supplement prior to bloom.
- Colonies increased pollen collection as their size increased to about 12 frames.
- The addition of an Australian package improved pollen collection by 4-frame colonies.
- The addition of the AUS package greatly improved brood rearing.
- When two US 4-frame colonies were united they collected more pollen than two separate 4-frame colonies.



- Large colonies begin foraging earlier than small colonies.
- Colonies facing east begin foraging earlier than those face west.
- The addition of brood decreased pollen collection.
- Australian colonies collected more pollen than their size would indicate, we suspect this was due to their handling the trap differently.

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