

Appendix A: Additional Crayfish Data

In order to organize the data collected throughout this project, several tables were developed to display male dominance data and Y-maze data. Through the use of these different organizations, data can be more easily understood. All of the data displayed in the following figures was used for statistical analysis which can be found in the results section.

Additional Male Dominance Data

Several tables were developed to display the male data using different formats. These tables include information on each individual male throughout the male dominance trials. The data on the individual males and the individual rounds from the tournament was used as a reference to investigate anomalies found in the statistical analysis.

Male Dominance Ranking. From the raw data of the small and large male tournament, each individual male was given a dominance score. These dominance scores were based on the number of wins and losses throughout the tournament. In addition, each male's carapace length and claw size were put into a ratio for possible analysis. Figures A & B present the agnostic bout results for each round as well as each male's overall dominance score and their size information. In this figure, the data is arranged by claw size in both figures.

Figure A. Ranked Small Male Data

#	Overall Dominance	T1	T2	T3	T4	Carapace	Claw	Claw/Carapace
75	0	0	0	0	0	34	24	0.71
8	0	0	0	0	0	33.5	24.1	0.72
43	1	0	0	0	1	34.2	24.9	0.73
51	2	1	0	0	1	35.1	25	0.71
46	0	0	0	0	0	34.9	25.2	0.72
40	2	1	0	1	0	32.8	25.5	0.78
23	2	0	1	1	0	32.5	26	0.8
55	3	1	1	1	0	36.5	26	0.71
39	2.5	1	1	0.5	0	37.1	27.1	0.73
59	4	1	1	1	1	35.3	27.5	0.78
57	3	0	1	1	1	36	28	0.78
37	4	1	1	1	1	37	28.1	0.76

Figure B: Ranked Large Male Data

#	Overall Dominance	T1	T2	T3	T4	Carapace	Claw	Claw/Carapace
21	1.5	1	0.5	0	0	41	29.5	0.72
98	2	1	1	0	0	38	30	0.79
99	2	0	0.5	1	0.5	40	30	0.75
77	2	0	1	0.5	0.5	38.1	31.5	0.83
83	0	0	0	0	0	39	31.5	0.81
90	2.5	0	0.5	1	1	42	31.5	0.75
100	0	0	0	0	0	39	32	0.82
18	2	0	1	1	0	39.5	32.1	0.81
101	3	1	0.5	0.5	1	41	33	0.8
26	3	1	0.5	0.5	1	41	33.9	0.83
29	2.5	1	0	1	0.5	40.1	34	0.85
86	1.5	0	0	1	0.5	41	34	0.83
30	4	1	1	1	1	41.8	35	0.84
89	2.5	1	0.5	0.5	0.5	40	36	0.9

Male Tournament Data. The data from the male tournament was recorded and organized in order to investigate the occurrence of a large male winning a round over a small male. In order to check this difference, the difference in carapace lengths of the two competing individuals was calculated along with the difference in claw size of the two. When determining whether the male who won was smaller or larger, the carapace length and the claw size of the individuals was compared separately. Figure C present this data for each individual round of the tournament. In the figure, an ID # highlighted in yellow indicates the winner of the interaction, blue highlighting indicates a draw and purple highlighting indicates that there was data missing for that interaction due to circumstances such as a contestant's death.

Figure C: Small Ranked Male Bout Data

Round 1

By ID#	Carapace	Claw	ID #2	Carapace	Claw	Big Won Carapace	Big Won Claw	Carapace Difference	Claw Difference
51	35.1	25	46	34.9	25.2	Y	N	0.2	0.2
59	35.3	27.5	57	36	28	N	N	0.7	0.5
43	34.2	24.9	37	37	28.1	Y	Y	2.8	3.2
75	34	24	55	36.5	26	Y	Y	2.5	2
8	33.5	24.1	40	32.8	25.5	N	Y	0.7	1.4
92	36.7	26.7	61	36.0	25.5				
23	32.5	26	39	37.1	27.1	Y	Y	4.6	1.1
					Larger Wins	4 of 6	4 of 6		

Round 2

ID#	Carapace	Claw		Carapace	Claw	Big Won Carapace	Big Won Claw	Carapace Difference	Claw Difference
61	36.0	25.5	37	37	28.1	Y	Y	1.0	2.6
39	37.1	27.1	51	35.1	25	Y	Y	2.0	2.1
57	36	28	43	34.2	24.9	Y	Y	1.8	3.1
55	36.5	26	40	32.8	25.5	Y	Y	3.7	0.5
8	33.5	24.1	59	35.3	27.5	Y	Y	1.8	3.4
46	34.9	25.2	92	36.7	26.7	Y	Y	1.8	1.5
23	32.5	26	75	34	24	N	Y	1.5	2.0
					Larger Wins	6 of 7	7 of 7		

Round 3

ID#	Carapace	Claw		Carapace	Claw	Big Won Carapace	Big Won Claw	Carapace Difference	Claw Difference
8	33.5	24.1	23	32.5	26	N	y	1	1.9
92	36.7	26.7	39	37.1	27.1	n/a	n/a	0.4	0.4
59	35.3	27.5	43	34.2	24.9	Y	Y	1.1	2.6
55	36.5	26	61	36.0	25.5	Y	Y	0.5	0.5
40	32.8	25.5	51	35.1	25	N	Y	2.3	0.5
57	36	28	75	34	24	Y	Y	2	4
37	37	28.1	46	34.9	25.2	Y	Y	2.2	2.9
					Larger Wins	4 of 6	6 of 6		

Round 4

ID#	Carapace	Claw		Carapace	Claw	Big Won Carapace	Big Won Claw	Carapace Difference	Claw Difference
92	36.7	26.7	55	36.5	26	Y	Y	0.2	0.7
40	32.8	25.5	57	36	28	Y	Y	3.2	2.5
46	34.9	25.2	59	35.3	27.5	Y	Y	0.4	2.3
39	37.1	27.1	37	37	28.1	N	Y	0.1	1
51	35.1	25	8	33.5	24.1	Y	Y	1.6	0.9
75	34	24	61	36.0	25.5				
43	34.2	24.9	23	32.5	26	Y	N	1.7	1.1
					Larger Wins	5 of 6	5 of 6		
					Total Larger Wins	19 of 25	22 of 25		

Additional Y-Maze Data

After the Y-maze data was taken, it was organized to better display the outcome of each individual trial. Additionally, the difference in the time spent in the male arm versus the control arm was calculated. Figures D & E presents the data from the Y-maze experimentation, along with the Male ID, Male Dominance, Tape number on which the trial was recorded, the female ID number, and the carapace length. Trials highlighted in purple indicated that data was missing due to a contestant's death.

Figure D. Round 1 Y-Maze Data

ID #	Carapace Length (mm)	Tape R1	Male Location	Male ID	Male Dominance	Time Spent in Right Arm	Time Spent in Left Arm	Difference
2	37.6	13a	r	89	2.5	188	194	6
10	33.0	5b	r	43	1	153	66	87
14	34.1	12a	r	83	0	179	136	43
32	31.0			46				
35	32.9	1b	l	21	1.5	196	115	81
37	36.9	13b	r	98	2	53	63	10
39	32.9	5a	l	39	2.5	134	99	35
46	43.0	11b	r	84	0	175	248	68
31	36.1	6b	r	46	0	197	100	97
50	38.5	16	l	101	3	273	37	236
54	43.0	15a	l	100	0	254	140	114
58	32.0	7	r	51	2	106	197	91
60	34.0	8	r	55	3	219	124	95
61	30.0	9b	l	64	2	124	134	10
64	33.0	6a	r	40	2	201	55	146
76	36.2	14a	r	90	2.5	335	113	222

67	30.5	12b	r	86	1.5	294	91	203
71	34.0	11a	r	77	2	211	75	136
73	37.1	4b	l	37	4	129	95	34
80	46.0	2a	l	18	2	78	153	75
84	39.0	3a	l	26	3	77	64	13
85	39.0	4a	r	29	2.5	300	83	217
86	43.0	10b	l	75	0	135	147	12
97	39.5	9a	r	57	3	208	279	71
99	37.0	2b	r	23	2	69	107	38
101	43.0	3b	r	30	4	141	68	73
105	38.0	1a		8				
109	29.0	10a	r	59	4	155	304	149

Figure E. Round 2 Y-Maze Data

ID #	Carapace Length (mm)	Tape R1	Male Location	Male ID	Male Dominance	Time Spent in Right Arm	Time Spent in Left Arm	Difference
1	31.9	22b	R	51	2	264	190	74
8	34.0	17b	L	23	2	242	107	135
11	31.0	21b	L	46	0	177	111	66
15	38.8	20a	L	30	4	45	0	45
16	38.5	26a	R	64	2	176	119	57
17	43.1	21a	R	40	2	273	186	87
21	45.5	25b	R	75	0	198	134	64
27	37.4	27b	R	86	1.5	174	192	-18
47	37.0	25a	R	59	4	187	92	95
36	38.1	18a	R	21	1.5	210	126	84

42	38.7	22a	R	43	1	167	140	27
49	42.0	X	L	8 missing	0	X	X	
53	44.0	23	L	55	3	102	25	77
57	37.0	19b	L	37	4	19	157	-138
59 died	31.0	28a	R	83	0			0
65 dead 104 subst	31.0	29a	R	90	2.5	126	162	-36
62 died	33.0	27a	L	84	0			
63	30.0	18b	R	26	3	213	91	122
68	34.0	30b	R	101	3	353	75	278
70	44.9	X	L	99 dead	2	X	X	
72	41.9	19a	L	29	2.5	102	161	-59
75	37.4	17a	L	18	2	139	103	36
82 lost claw	39.5	24	L	57	3	192	132	60
83 dead 107 subst	39.5	29b	L	100	0			
95	41.5	28b	L	89	2.5	169	124	45
102	45.5	26b	L	77	2	147	101	46
103	38.5	20b	R	39	2.5	273	75	198
108	30.5	30a	L	98	2	0	11	-11
49 x2	42.0	31	R	83	0	213	27	
67 substitute for F83		32	L	100	0			0

Appendix B: Statistics

Several statistical tests were done to confirm previous tests and provide additional evidence supporting or disproving our hypothesis. These tests were not included in the results section due to their repetitive nature. All of these tests provided similar significance values as their counterpart tests used in the results. Additionally, this appendix includes tables containing data necessary for analysis.

Additional Male Statistics

Several tables were developed to display the male statistical data. These tables include results for the male dominance trials. The statistically data used is referenced throughout the results proving or disproving the proposed predictions.

Pearson's Correlations. A Pearson's Correlations was done to statistically test relationships between carapace length and claw size. Due to limited data, this relationship was only explored for small males. Additionally, Pearson's tests were also used to explore relationships between male dominance and claw size for both small and large male data.

Figure A: Pearson's Correlation of male claw size and carapace length

		Male Dominance	Male Claw
Male Dominance	Pearson Correlation	1	.884**
	Sig. (2-tailed)		.000
	N	12	12
Male Claw	Pearson Correlation	.884**	1
	Sig. (2-tailed)	.000	
	N	12	12

** Correlation is significant at the 0.01 level (2-tailed).

Figure B: Pearson's Correlation of male size and dominance for small males

		Male Dominance	Male Claw
Male Dominance	Pearson Correlation	1	.459
	Sig. (2-tailed)		.098
	N	14	14

Male Claw	Pearson Correlation	.459	1
	Sig. (2-tailed)	.098	
	N	14	14

** Correlation is significant at the 0.01 level (2-tailed).

Figure C: Pearson's Correlation of male size and dominance for large males

		Male Dominance	Male Claw
Male Dominance	Pearson Correlation	1	.884**
	Sig. (2-tailed)		.000
	N	12	12
Male Claw	Pearson Correlation	.884**	1
	Sig. (2-tailed)	.000	
	N	12	12

** Correlation is significant at the 0.01 level (2-tailed).

Chi-squared test. A chi-squared test was performed to test the probability that the larger crayfish in a bout will win. Since claw size and carapace length were considered directly related for this study, claw was used to represent the size of the crayfish. All results of the chi-squared tests were confirmed using an online chi-squared calculator (www.psych.ku.edu/preacher/chisq/chisq.htm).

Figure D: Chi-squared test for probability of large male winning

Null Hypothesis, Ho: Probability, $\Pr\{\text{Big Claw Wins}\} = 1/2$
Alternative Hypothesis, Ha: $\Pr\{\text{Big Claw Wins}\} > 1/2$
$X^2 = 14.44$
Df=1
P value = 0.0001, $p < 0.005$

Y-Maze Data

Several tables were developed to display the Y-maze statistical data. These tables include results for the Y-maze trials. The statistically data used is referenced throughout the results proving or disproving the hypothesis.

Time Difference Data. The mean difference that a female spent in the male containing arm of the Y-maze was sub grouped by dominance ranking of the male. Within each sub group, the number of crayfish belonging to each group is represented by N. A negative time difference indicated more time was spent in the arm not containing the male.

Figure E: Y-maze time difference data

Male Dominance	Mean Time Difference	Std. Deviation	N
0	-6.00	84.91	5
1	87.00	0	1
1.5	61.00	200.81	2
2	32.57	89.38	7
2.5	99.50	139.08	4
3	-56.25	138.17	4
4	-36.67	111.02	3
Total	18.08	114.45	26

ANCOVA. ANCOVA tests were performed to study the effects that the independent variables (female size and male dominance) had on the dependent variable (time difference). One ANCOVA was performed on the joint interactions of the independent variables. A second ANCOVA was performed to test the effects of each the independent variables separately on the dependent variable.

Figure F: ANCOVA with Interactions

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis	29989.053	1	29989.053	2.095	.169
	Error	206951.696	14.46	14312.083*		
Male Dominance	Hypothesis	122540.608	5	24508.122	2.423	.092
	Error	131486.834	13	10114.122**		
Female Size	Hypothesis	29963.764	1	29963.764	2.962	.109
	Error	131486.834	13	10114.372**		
Male Dominance x Female Size	Hypothesis	125122.457	5	25024.491	2.474	.087
	Error	131486.834	13	10114.372**		

Figure G: ANCOVA without interactions

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept	Hypothesis is	51.218	1	51.218	.004	.953
	Error	261034.726	18.356	14221.052*		
Female Size	Hypothesis is	456.840	1	456.840	.032	.860
	Error	256609.291	18	14256.072**		
Male Dominance	Hypothesis is	68469.507	6	11411.584	.800	.582
	Error	256609.291	18	14256.072**		