



Digital supplementary material to

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1 **Supplementary file**

2 **Title:**

3 Adult-brood ration causes behavioural modifications to maintain transport performance during
4 colony relocation in the ponerine ant *Diacamma indicum* (Hymenoptera: Formicidae)

5
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19 **Supplementary Tab. S1:** Colony details for Control (CT) and Brood-depicted (B-) colonies-

<i>Colony ID</i>	<i>Date of Collection</i>	<i>Adults</i>	<i>Pupae</i>	<i>Larva</i>	<i>Eggs</i>	<i>First Exp</i>	<i>1st Exp Date</i>	<i>Second Exp</i>	<i>2nd Exp Date</i>	<i>Time Between two Exp (hour)</i>
DI-861	04-10-2018	122	40	37	96	B-	06-10-2018	CT	12-10-2018	139.43
DI-865	11-10-2018	121	1	0	44	CT	26-10-2018	B-	28-10-2018	46.21
DI-870	25-10-2018	85	13	4	13	CT	28-10-2018	B-	03-11-2018	139.88
DI-871	26-10-2018	52	7	0	3	B-	30-10-2018	CT	02-11-2018	68.35
DI-872	29-10-2018	53	20	12	26	CT	07-11-2018	B-	13-11-2018	137.94
DI-874	02-11-2018	54	6	10	12	B-	03-11-2018	CT	07-11-2018	87.16
DI-875	11-12-2018	38	0	0	12	CT	24-12-2018	B-	26-12-2018	44.09
DI-876	12-12-2018	77	0	0	27	B-	21-12-2018	CT	25-12-2018	91.83
DI-879	20-12-2018	74	1	0	18	CT	24-12-2018	B-	26-12-2018	44.69
DI-917	15-05-2019	87	13	16	34	CT	18-05-2019	B-	20-05-2019	40.88
DI-918	16-05-2019	155	38	34	12	CT	18-05-2019	B-	20-05-2019	48.16
DI-978	16-08-2019	104	12	3	18	CT	28-08-2019	B-	30-08-2019	46.80

21 Colony details for brood-enhanced (B+) colonies:

<i>Colony ID</i>	<i>Date of Collection</i>	<i>Adults</i>	<i>Initial Pupae</i>	<i>Initial Larvae</i>	<i>Eggs</i>	<i>Final Pupae</i>	<i>Final Larvae</i>	<i>1st Try</i>		<i>2nd Try</i>	
								<i>Date</i>	<i>Relocated</i>	<i>Date</i>	<i>Relocated</i>
DI 987	16-09-2019	55	6	4	49	21	36	26-09-2019	No	29-09-2019	No
DI 991	19-09-2019	132	20	25	28	44	45	23-09-2019	No	24-09-2019	No
DI 994	23-09-2019	115	31	18	48	48	52	24-09-2019	Yes		
DI 995	24-09-2019	60	22	15	13	22	36	30-09-2019	Yes		
DI 996	25-09-2019	58	21	18	26	31	21	30-09-2019	No	02-10-2019	No
DI 997	26-09-2019	121	25	27	22	75	36	30-09-2019	No	01-10-2019	Yes
DI 998	27-09-2019	101	20	15	29	69	23	04-10-2019	No	06-10-2019	Yes
DI 1000	30-09-2019	109	11	9	30	48	52	05-10-2019	Yes		
DI 1001	30-09-2019	119	9	4	9	75	36	03-10-2019	Yes		
DI 1002	30-09-2019	61	3	4	13	21	36	05-10-2019	Yes		
DI 1003	01-10-2019	83	43	12	14	75	25	03-10-2019	No	04-10-2019	No
DI 1004	03-10-2019	59	26	19	14	26	36	05-10-2019	No	06-10-2019	No

23 **Supplementary Tab. S2:** Details of the fisher test-

24 The 3×3 matrix:

Number of Colonies Treatment	Number of colonies relocated in the first attempt	Number of colonies relocated in the second attempt	Number of colonies did not relocate
CT	12	0	0
B-	12	0	0
B+	5	2	5

25

26 The result of the fisher test:

27 p-value= 0.0002846

28 alternative hypothesis: two.sided

29 **Supplementary Tab. S3.a:** Effect of treatment on discovery time:

Response variable				
Model	glmmTMB(Discovery_time ~ Treatment + (1 Colonyid) + (1 Colonyize), family= Gamma (link = log))			
Fixed effects	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	3.43624	0.26732	12.854	< 0.01
TreatmentB+	0.53249	0.37804	1.409	0.159
TreatmentCT	-0.07038	0.37805	-0.186	0.852
Random effects	Name	Variance	Std. Dev.	
Colonyid	(Intercept)	3.213e-08	1.792e-04	
Colonyize	(Intercept)	1.065e-12	1.032e-06	
Dispersion estimate for Gamma family (sigma^2): 0.858				
Number of obs: 36, groups: Colonyid, 24; Colonyize, 23				

30

31 For pairwise comparison, we used emmeans function with Tukey adjustment method

Contrast	Estimate	SE	df	t. ratio	p. value
CT ~ B-	-0.0704	0.378	30	-0.186	0.9811
CT ~ B+	-0.6029	0.378	30	-1.595	0.2635
B- ~ B+	-0.5325	0.378	30	-1.409	0.3494

32

33 Details of GLMM analysis followed by pairwise comparison for studying the effect of control
 34 (CT), brood depleted (B-) and brood enhanced (B+) treatments on discovery time considering
 35 a gamma distribution.

36 **Supplementary Tab. S3.b:** Effect of treatment on latency:

Response variable				
Model	glmmTMB(Latency ~ Treatment + (1 Colonyid) + (1 Colonyize), family= Gamma (link = log))			
Fixed effects	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	3.1340	0.1706	18.366	< 0.01
TreatmentB+	0.7735	0.2811	2.751	0.0059
TreatmentCT	0.3037	0.2413	1.258	0.2082
Random effects	Name	Variance	Std. Dev.	
Colonyid	(Intercept)	4.936e-09	7.026e-05	
Colonyize	(Intercept)	5.540e-09	7.707e-05	
Dispersion estimate for Gamma family (sigma ²): 0.349				
Number of obs: 31, groups: Colonyid, 19; Colonyize, 18				

37

38 For pairwise comparison, we used emmeans function with Tukey adjustment method

Contrast	Estimate	SE	df	t. ratio	p. value
CT ~ B-	0.304	0.241	25	1.258	0.4321
CT ~ B+	-0.470	0.281	25	-1.671	0.2359
B- ~ B+	-0.773	0.281	25	-2.751	0.0283

39

40 Details of GLMM analysis followed by pairwise comparison for studying the effect of control
 41 (CT), brood depleted (B-) and brood enhanced (B+) treatments on latency considering a gamma
 42 distribution.

43 **Supplementary Tab. S3.c:** Effect of treatment on transport time:

Response variable				
Model	glmmTMB(Transport_Time ~ Treatment + (1 Colonyid) + (1 Colonyize), family= Gamma (link = log))			
Fixed effects	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	4.42294	0.07876	56.15	< 0.01
TreatmentB+	0.19760	0.12965	1.52	0.127
TreatmentCT	0.12574	0.09336	1.35	0.178
Random effects	Name	Variance	Std. Dev.	
Colonyid	(Intercept)	2.262e-02	0.1504	
Colonyize	(Intercept)	1.530e-09	3.911e-05	
Dispersion estimate for Gamma family (sigma ²): 0.0513				
Number of obs: 31, groups: Colonyid, 19; Colonyize, 18				

44

45 For pairwise comparison, we used emmeans function with Tukey adjustment method

Contrast	Estimate	SE	df	t. ratio	p. value
CT ~ B-	0.1257	0.0934	25	1.347	0.3834
CT ~ B+	-0.0719	0.1300	25	-0.553	0.8460
B- ~ B+	-0.1976	0.1297	25	-1.524	0.2971

46

47 Details of GLMM analysis followed by pairwise comparison for studying the effect of control
 48 (CT), brood depleted (B-) and brood enhanced (B+) treatments on transport time considering
 49 a gamma distribution.

50 **Supplementary Tab. S3.d:** Effect of treatment on total relocation time:

Response variable				
Model	glmmTMB(Total_Relocation_Time ~ Treatment +(1 Colonyid) + (1 Colonysize), family= Gamma (link = log))			
Fixed effects	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	4.92765	0.09464	52.07	< 0.01
TreatmentB+	0.24312	0.15592	1.56	0.119
TreatmentCT	0.12783	0.13384	0.96	0.340
Random effects	Name	Variance	Std. Dev.	
Colonyid	(Intercept)	6.095e-10	2.469e-05	
Colonysize	(Intercept)	3.913e-10	1.978e-05	
Dispersion estimate for Gamma family (sigma ²): 0.107				
Number of obs: 31, groups: Colonyid, 19; Colonysize, 18				

51

52 For pairwise comparison, we used emmeans function with Tukey adjustment method

Contrast	Estimate	SE	df	t. ratio	p. value
CT ~ B-	0.128	0.134	25	0.955	0.6113
CT ~ B+	-0.115	0.156	25	-0.739	0.7427
B- ~ B+	-0.243	0.156	25	-1.559	0.2815

53

54 Details of GLMM analysis followed by pairwise comparison for studying the effect of control

55 (CT), brood depleted (B-) and brood enhanced (B+) treatments on total relocation time

56 considering a gamma distribution.

57 **Supplementary Tab. S3.e:** Effect of treatment on total number of successful transport:

Response variable				
Model	glmmTMB(No_of_Transport ~ Treatment +(1 Colonyid) + (1 Colonyize), family= Gamma (link = log))			
Fixed effects	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	4.24479	0.09881	42.96	< 0.01
TreatmentB+	0.18202	0.08127	2.24	0.02511
TreatmentCT	0.08057	0.02840	2.84	0.00455
Random effects	Name	Variance	Std. Dev.	
Colonyid	(Intercept)	1.375e-10	1.173e-05	
Colonyize	(Intercept)	1.551e-01	3.938e-01	
Dispersion estimate for Gamma family (sigma^2): 0.00493				
Number of obs: 31, groups: Colonyid, 19; Colonyize, 18				

58

59 For pairwise comparison, we used emmeans function with Tukey adjustment method

Contrast	Estimate	SE	df	t. ratio	p. value
CT ~ B-	0.0806	0.0284	25	2.837	0.0233
CT ~ B+	-0.1014	0.0815	25	-1.245	0.4384
B- ~ B+	-0.1820	0.0813	25	-2.240	0.0839

60

61 Details of GLMM analysis followed by pairwise comparison for studying the effect of
 62 control (CT), brood depleted (B-) and brood enhanced (B+) treatments on total number of
 63 successful transport considering a gamma distribution.

64 **Supplementary Tab. S3.f:** Effect of treatment on percentage of transporters:

Response variable				
Model	glmmTMB(Percent_Transporter ~ Treatment +(1 Colonyid) + (1 Colonysize), family= Gaussian)			
Fixed effects	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	11.3105	1.2048	9.388	< 0.01
TreatmentB+	3.7813	1.9849	1.905	0.0568
TreatmentCT	-0.1764	1.0887	-0.162	0.8713
Random effects	Name	Variance	Std. Dev.	
Colonyid	(Intercept)	1.031e+01	3.2103354	
Colonysize	(Intercept)	6.621e-08	0.0002573	
Residual		7.112e+00	2.6668618	
Dispersion estimate for Gaussian family (sigma^2): 7.11				
Number of obs: 31, groups: Colonyid, 19; Colonysize, 18				

65

66 For pairwise comparison, we used emmeans function with Tukey adjustment method

Contrast	Estimate	SE	df	t. ratio	p. value
CT ~ B-	-0.176	1.09	25	-0.162	0.9856
CT ~ B+	-3.958	1.98	25	-1.994	0.1345
B- ~ B+	-3.781	1.98	25	-1.905	0.1581

67

68 Details of GLMM analysis followed by pairwise comparison for studying the effect of
 69 control (CT), brood depleted (B-) and brood enhanced (B+) treatments on percentage of
 70 transporters considering a gaussian distribution.

71 **Supplementary Tab. S3.g:** Effect of treatment on the first leader time spend in the new nest:

Response variable				
Model	glmmTMB(Leader_timespend ~ Treatment +(1 Colonyid) + (1 Colonyize), family= Gamma (link = log))			
Fixed effects	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	1.42411	0.17139	8.309	< 0.01
TreatmentB+	-0.43705	0.28237	-1.548	0.122
TreatmentCT	-0.06207	0.24239	-0.256	0.798
Random effects	Name	Variance	Std. Dev.	
Colonyid	(Intercept)	2.533e-10	1.592e-05	
Colonyize	(Intercept)	1.813e-10	1.346e-05	
Dispersion estimate for Gamma family (sigma ²): 0.353				
Number of obs: 31, groups: Colonyid, 19; Colonyize, 18				

72

73 For pairwise comparison, we used emmeans function with Tukey adjustment method

Contrast	Estimate	SE	df	t. ratio	p. value
CT ~ B-	-0.0621	0.242	25	-0.256	0.9646
CT ~ B+	0.3750	0.282	25	1.328	0.3934
B- ~ B+	0.4371	0.282	25	1.548	0.2866

74

75 Details of GLMM analysis followed by pairwise comparison for studying the effect of
 76 control (CT), brood depleted (B-) and brood enhanced (B+) treatments on the time spend by
 77 the first leader in the new nest considering a gamma distribution.

78 **Supplementary Tab. S3.h:** Effect of treatment on leader latency:

Response variable				
Model	glmmTMB(Leader_Latency ~ Treatment +(1 Colonyid) + (1 Colonyize), family= Gamma (link = log))			
Fixed effects	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	2.8281	0.2270	12.461	< 0.01
TreatmentB+	0.1062	0.3876	0.274	0.784
TreatmentCT	0.0741	0.2885	0.257	0.797
Random effects	Name	Variance	Std. Dev.	
Colonyid	(Intercept)	9.183e-09	9.583e-05	
Colonyize	(Intercept)	1.547e-01	3.934e-01	
Dispersion estimate for Gamma family (sigma^2): 0.434				
Number of obs: 31, groups: Colonyid, 19; Colonyize, 18				

79

80 For pairwise comparison, we used emmeans function with Tukey adjustment method

Contrast	Estimate	SE	df	t. ratio	p. value
CT ~ B-	0.0741	0.288	25	0.257	0.9643
CT ~ B+	-0.0321	0.380	25	-0.084	0.9961
B- ~ B+	-0.1062	0.388	25	-0.274	0.9595

81

82 Details of GLMM analysis followed by pairwise comparison for studying the effect of control
 83 (CT), brood depleted (B-) and brood enhanced (B+) treatments on leader latency considering
 84 a gamma distribution.

85 **Supplementary Tab. S3.i:** Effect of treatment on number of visits at new nest by first leader:

Response variable				
Model	glmmTMB(No_of_Visit ~ Treatment +(1 Colonyid) + (1 Colonyize), family= Gamma (link = log))			
Fixed effects	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	1.0956	0.1554	7.049	< 0.01
TreatmentB+	0.3027	0.1285	2.355	0.0185
TreatmentCT	0.4066	0.2292	1.774	0.0761
Random effects	Name	Variance	Std. Dev.	
Colonyid	(Intercept)	1.880e-09	4.336e-05	
Colonyize	(Intercept)	2.081e-01	4.562e-01	
Dispersion estimate for Gamma family (sigma^2): 0.0953				
Number of obs: 31, groups: Colonyid, 19; Colonyize, 18				

86

87 For pairwise comparison, we used emmeans function with Tukey adjustment method

Contrast	Estimate	SE	df	t. ratio	p. value
CT ~ B-	0.303	0.129	25	2.355	0.0664
CT ~ B+	-0.104	0.233	25	-0.446	0.8966
B- ~ B+	-0.407	0.229	25	-1.774	0.1988

88

89 Details of GLMM analysis followed by pairwise comparison for studying the effect of control
 90 (CT), brood depleted (B-) and brood enhanced (B+) treatments on the number of visits by the
 91 first leader before first transport at the new nest considering a gamma distribution.

92 **Supplementary Tab. S3.j:** Effect of treatment on transport per leader:

Response variable				
Model	glmmTMB(Transport_per_Leader ~ Treatment +(1 Colonyid) + (1 Colonyize), family= Gamma (link = log))			
Fixed effects	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	2.1178	0.1277	16.588	< 0.01
TreatmentB+	-0.1537	0.2102	-0.731	0.465
TreatmentCT	0.1425	0.1043	1.366	0.172
Random effects	Name	Variance	Std. Dev.	
Colonyid	(Intercept)	1.312e-01	3.622e-01	
Colonyize	(Intercept)	1.412e-09	3.757e-05	
Dispersion estimate for Gamma family (sigma^2): 0.0631				
Number of obs: 31, groups: Colonyid, 19; Colonyize, 18				

93

94 For pairwise comparison, we used emmeans function with Tukey adjustment method

Contrast	Estimate	SE	df	t. ratio	p. value
CT ~ B-	0.154	0.210	25	0.731	0.7476
CT ~ B+	-0.143	0.104	25	-1.366	0.3733
B- ~ B+	-0.296	0.210	25	-1.407	0.3525

95

96 Details of GLMM analysis followed by pairwise comparison for studying the effect of control
 97 (CT), brood depleted (B-) and brood enhanced (B+) treatments on number of transports per
 98 leader considering a gamma distribution.

99 **Supplementary Tab. S3.k:** Effect of treatment on percentage transport by maxTL:

Response variable				
Model	glmmTMB(Percent_Transport ~ Treatment +(1 Colonyid) + (1 Colonyize), family= Gamma (link = log))			
Fixed effects	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	3.43105	0.11849	28.598	< 0.01
TreatmentB+	-0.42302	0.19521	-2.167	0.0302
TreatmentCT	0.12993	0.09965	1.304	0.1923
Random effects	Name	Variance	Std. Dev.	
Colonyid	(Intercept)	1.091e-01	3.303e-01	
Colonyize	(Intercept)	2.595e-09	5.094e-05	
Dispersion estimate for Gamma family (sigma^2): 0.0581				
Number of obs: 31, groups: Colonyid, 19; Colonyize, 18				

100

101 For pairwise comparison, we used emmeans function with Tukey adjustment method

Contrast	Estimate	SE	df	t. ratio	p. value
CT ~ B-	0.130	0.0996	25	1.304	0.4062
CT ~ B+	0.553	0.1952	25	2.832	0.0236
B- ~ B+	0.423	0.1952	25	2.167	0.0968

102

103 Details of GLMM analysis followed by pairwise comparison for studying the effect of control
 104 (CT), brood depleted (B-) and brood enhanced (B+) treatments on the percentage of transport
 105 performed by the maxTL considering a gamma distribution.

106 **Supplementary Tab. S3.1:** Effect of treatment on the percentage of relocation time when
 107 gamergate was transported to the new nest:

Response variable				
Model	glmmTMB(%relocation_time ~ Treatment +(1 Colonyid) + (1 Colonysize), family= Gaussian)			
Fixed effects	Estimate	Std. Error	Z value	Pr(> z)
(Intercept)	42.975	6.727	6.389	< 0.01
TreatmentCT	2.413	5.452	0.443	0.658
Random effects	Name	Variance	Std. Dev.	
Colonyid	(Intercept)	186.1	13.64	
Colonysize	(Intercept)	178.5	13.36	
Residual		178.4	13.36	
Dispersion estimate for Gaussian family (sigma^2): 178				
Number of obs: 31, groups: Colonyid, 19; Colonysize, 18				

108

109 For pairwise comparison, we used emmeans function with Tukey adjustment method

Contrast	Estimate	SE	df	t. ratio	p. value
B- ~ CT	-2.41	5.45	19	-0.443	0.6630

110

111 Details of GLMM analysis followed by pairwise comparison for studying the effect of control
 112 (CT), brood depleted (B-) treatments on the percentage of relocation time when gamergate was
 113 transported to the new nest considering a gaussian distribution.

114 **Supplementary Tab. S4:** Effect of treatments on progress of transport with respect to
 115 relocation time:

116 **Model:** gls (work ~ category + time, correlation = corAR1(form = ~1))

Coefficients				
	Value	Std. Error	t –value	p value
Intercept	-19.045604	5.776207	-3.29725	0.0010
B-	0.202178	5.005529	0.04039	0.9678
B+	0.019041	6.873677	0.00277	0.9978
Time	1.053147	0.010938	96.28584	0.0000
For comparison between the other types of transports, we releveled the variable ‘category’ to change the base level, and then re-ran the model. The respective test parameters are depicted below				
	Value	Std. Error	t –value	p value
CT ~ B-	0.202178	5.005529	0.04039	0.9678
CT ~ B+	0.019041	6.873677	0.00277	0.9978
B- ~ B+	-0.183137	5.166431	-0.03545	0.9717

117

118 Details of GLS analysis for comparison of the progress of transport in control (CT), brood
 119 depleted (B-) and brood enhanced (B+) treatments. The response variable “work” is the
 120 cumulative percentage of transports, the fixed effect “category” is the category of transports
 121 in the different treatments, and the fixed effect “time” is the relocation time binned across
 122 5%.

123 **Description of variables used in the models mentioned above:**

124 Discovery_time: time taken by an explorer to discover a potential intact new nest.

125 Treatment: the three different treatments; control (CT), brood depleted (B-) and brood
126 enhanced (B+).

127 Colonyid: colony identity.

128 Colonysize: number of adults present in a colony.

129 Latency: after discovering a new nest, the times it takes before a successful transport reaches
130 the new nest.

131 Transport time: the time difference between first successful transport and last successful
132 transport.

133 Total relocation time: the total time it takes from the start of the experiment till the last
134 successful transport.

135 No_of_Transport: total number of successful transports performed during an experiment
136 session.

137 Percent_Transporter: percentage of the colony that becomes transporters.

138 Leader_timespend: total timespend by the first transporter inside the new nest before
139 completing first successful transport.

140 Leader_Latency: after discovering the new nest the time taken by the first transporter before
141 finishing the first successful transport at the new nest.

142 No_of_Visit: total number of visits in the new nest by the first transporter before first
143 successful transport.

144 Transport_per_Leader: number of transport per leader for different relocation.

145 Percent_Transport: percentage of transport performed by MaxTL i.e. the adult who
146 performed maximum number of transport during a single relocation experiment.

147 %relocation_time: percentage of relocation time when the reproductive female, gamergate
148 was transported to the new nest.

149 work: cumulative percentage of transports for each 5% of relocation time.

150 category: the three different treatments; control (CT), brood depleted (B-) and brood
151 enhanced (B+).

152 time: relocation time binned across 5%