Apidologie

Supplementary Materials (Tables and Figures)

Internal hive temperature as a means of monitoring honey bee colony health in a migratory beekeeping operation before and during winter

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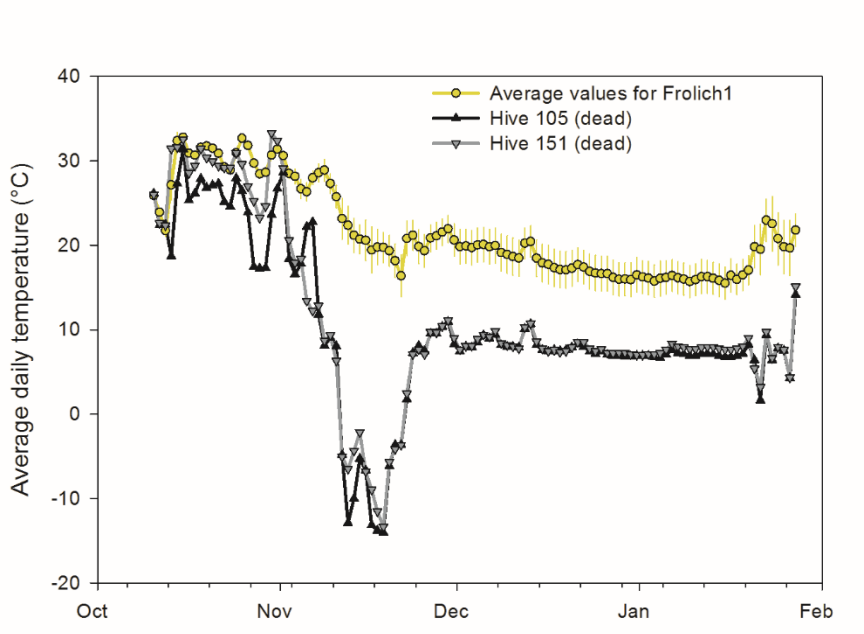

Figure S1. Temperature changes in hives which died during overwintering compared to average values for surviving hives in the same treatment (Frolich1).

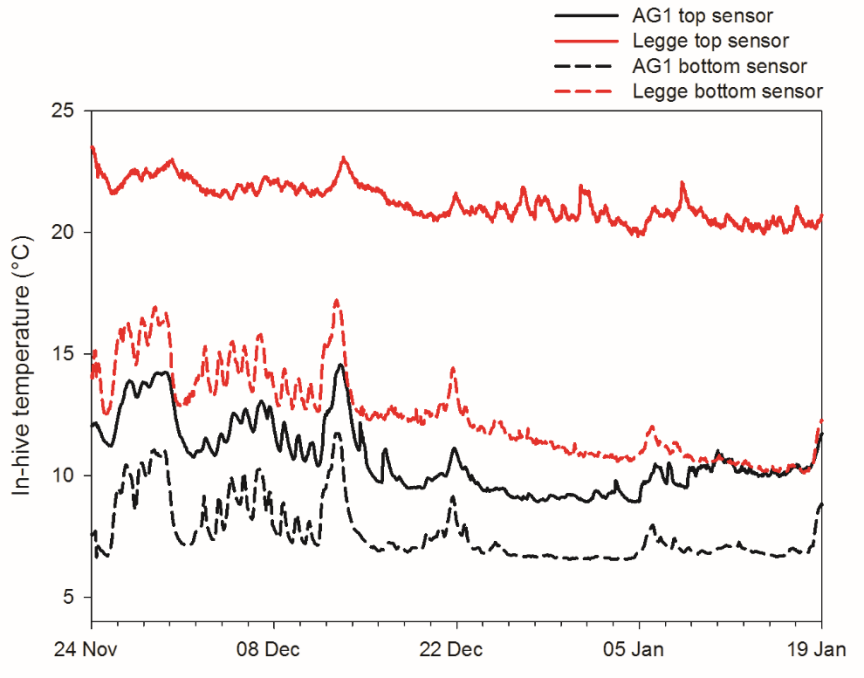

Figure S2. Average hive temperature for Legge (red lines) and AG1 (black lines) treatment groups (see text for details) at the top of the middle frame (solid lines) and the bottom of the middle frame (dashed lines) in a warehouse of roughly constant temperature in Firth ID (see text for details).

Table S1. Statistical results from 2014-15 experiment for three different time periods: Fall, Winter and Post-winter. “Transf.” refers to the data transformation to improve normality and “Brood area” refers to the surface area of capped brood.

Period	Dates	Dep. var.	Transf.	Factors	Num. d.f.	Den. d.f.	F	P
Fall	10 Oct.-21 Nov.	Temp. ampl.	log	Treatment	1	67.6	9.93	0.0024
				Date	8	77.5	10.47	<0.0001
				Treatment*Date	8	77.5	1.20	0.3113
				Fall ad. mass	1	53.3	0.01	0.9881
		Temp. avg	none	Treatment	1	42.5	13.64	0.0006
				Date	8	74.7	181.27	<0.0001
				Treatment*Date	8	74.7	6.01	<0.0001
				Fall ad. mass	1	1	0.02	0.9008
Winter	22 Nov.-18 Jan.	Temp. avg	none	Treatment	1	46.6	13.78	0.0007
				Date	11	117.1	12.34	<0.0001
				Treatment*Date	11	117.1	1.34	0.0240
				Post-winter ad. mass	1	52.2	27.55	<0.0001
Post-winter	19-26 Jan.	Temp. ampl.		Treatment, Date, Post-winter ad. mass				NS
		Temp. avg	none	Treatment	1	42.1	11.10	0.0018
				Date	1	40	3.38	0.0733
				Treatment*Date	1	40	10.36	0.0026
				Post-winter ad. mass	1	39	29.38	<0.0001

Table S2. Statistical results from 2015-16 for three different time periods: Fall, Winter and Post-winter. "Transf." refers to the data transformation to improve normality and "ad. mass" refers to the total adult bee mass.

Period	Dates	Dep. var.	Transf.	Factors	Num. d.f.	Den. d.f.	F	P
Fall	1 Sept.-15 Nov.	Temp. ampl.		Treatment, Date, Fall ad. mass				NS
		Temp. avg	none	Treatment	2	86.2	5.49	0.0057
				Date	15	199	36.26	<0.0001
				Treatment*Date	30	302.8	2.25	0.0003
				Fall ad. mass	1	80.16	1.59	0.2105
Winter	16 Nov.-31 Jan.	Temp. avg		Treatment, Date, Post-winter ad. mass				NS
Post-winter	1-5 Feb.	Temp. ampl.		Treatment, Date, Post-winter ad. mass				NS
		Temp. avg	none	Treatment	2	55	11.50	<0.0001
				Post-winter ad. mass	1	55	60.10	<0.0001

Table S3. Comparison of continuous temperature data of Frolich1 and Frolich2 hive groups before and during overwintering in a warehouse. Data were collected exactly one year apart. “Transf.” refers to the data transformation to improve normality

Period	Dep. var.	Transf.	Factors	Num. d.f.	Den. d.f.	F	P
11 Oct.-15 Nov.	Temp. ampl.	log	Treatment	1	31.7	10.33	0.0030
			Date	7	28.4	3.97	0.0039
			Treatment*Date	7	28.4	13.85	<0.0001
			Fall ad. mass	1	37.1	1.46	0.2351
	Temp. avg	none	Treatment	1	26.4	9.39	0.0050
			Date	7	26.8	11.30	<0.0001
			Treatment*Date	7	26.8	18.28	<0.0001
			Fall ad. mass	1	34.7	7.98	0.0078
25 Nov.-19 Jan.	Temp. avg	log	Treatment, Date, Post-winter ad. mass				NS

Table S4. Pesticide residue, in ppb±s.e, found in bee bread. Results for 2014-15 show averages across multiple samples before and after overwintering; only single composite samples from 2015-16 were submitted. We assumed if a given compound was not detected, the concentration was "0", and if trace amounts were detected, then the concentration was (LD -1) where LD is Limit of Detection. A dash indicates no detection.

Compound	Month	2014-15				2015-16		
		AG1	AG2	Legge	Frolich1	WestThil	EastThil	Frolich2
2,4 DMPF	Oct	19±5	37±12	95±48	67±21	116	130	58
	Jan	35±18	15±8	23±5	37±11	-	-	-
Chloropyrifos	Oct	34±34	24±24	11±11	8±8	21.3	17.9	144
	Jan	6±6	4±4	29±29	-	-	-	-
Coumaphos	Oct	-	1±1	4±4	7±6	-	-	-
	Jan	-	-	4±0	9±9	-	-	-
Cyhalothrin	Oct	-	-	-	-	-	3.8	-
	Jan	-	-	-	3±3	-	-	-
Cyprodinil	Oct	-	-	-	-	-	-	87.6
	Jan	1±1	-	-	1±1	-	-	-
Fenpyroximate	Oct	-	-	-	217±217	-	-	-
	Jan	-	-	12±5	481±244	-	-	-
Fluridone	Oct	-	-	219±219	-	-	-	-
	Jan	4±4	-	-	-	-	-	-
Fluvalinate	Oct	15±15	-	-	46±46	-	-	-
	Jan	10±10	-	-	101±59	-	-	-
Methoxyfenozide	Oct	-	-	-	98±98	-	-	73
	Jan	66±66	-	-	156±80	-	-	-
Pendimethalin	Oct	20±5	-	-	67±21	-	-	112
	Jan	35±18	-	-	37±11	-	-	-
Tebuconazole	Oct	34±34	14±14	17±17	8±8	-	7	-
	Jan	6±6	30±22	22±11	-	-	-	-
Thymol	Oct	-	82±82	70±70	7±6	851	221	-
	Jan	-	-	95±95	9±9	-	-	-

Table S5. Pesticide residue, in ppb, found in composite wax samples in 2014-15. We assumed if trace amounts were detected, then the concentration was (LD -1) where LD is Limit of Detection. A dash indicates no detection.

Compound	Month	2014-15			
		AG1	AG2	Legge	Frolich1
2,4 DMPF	Oct	427	263	1070	723
	Jan	437	3370	332	502
Boscalid	Oct	25.7	-	-	-
	Jan	15.3	42.4	58.2	46.0
Carbendazim	Oct	7.5	15.4	24.7	19.9
	Jan	TR	5.7	8.3	7.4
Chlorferone	Oct	-	146	-	-
	Jan	-	1080	-	-
Chlorothalonil	Oct	246	204	173	340
	Jan	215	-	171	170
Chloropyrifos	Oct	-	16.0	-	-
	Jan	14.3	10.9	-	10.2
Coumaphos	Oct	145	202	21.0	14.0
	Jan	11	641	16.9	13.4
Coumaphos ox.	Oct	231	117	54.7	31.3
	Jan	-	78.0	16.4	19.4
Cyprodinil	Oct	15.7	32.4	-	60.0
	Jan	-	-	15.4	-
Fenpyroximate	Oct	124	24.5	58.9	73.1
	Jan	43.6	66.3	117	58.3
Fluridone	Oct	1740	-	531	750
	Jan	-	484	371	-
Pendimethalin	Oct	-	-	-	90.2
	Jan	-	-	-	-
Pyraclostrobin	Oct	-	-	19.1	-
	Jan	-	20.4	56.7	37.1
Tebuconazole	Oct	-	22.3	-	-
	Jan	-	17.5	-	-
Thymol	Oct	1950	3520	3020	2250
	Jan	1790	2250	2870	4320