„Beehave 2013“ is the implementation of the model BEEHAVE, developed by Matthias Becher and colleagues:

Becher, M.A., Grimm, V., Thorbek, P., Horn, J., Kennedy, P.J. & Osborne, J.L. (2014)
BEEHAVE: A systems model of honeybee colony dynamics and foraging to explore multifactorial causes of colony failure. Journal of Applied Ecology.

„Beehave 2013“ is based on the software platform NetLogo (Wilensky 1999), and can be downloaded for free from
http://beehave-model.net/

This table shows the complete scheduling of all BEEHAVE procedures and reporter procedures. "Called by" refers to the procedure or button that calls the procedure.

"Condition" shows the condition, under which the procedure is called.

Level 1	Level 2	Level 3	Level 4	Level 5	called by	Condition
Setup					Buttons: "Setup", Scenario buttons ("DEFAULT", "2patches" etc.)	
	ReadFileProc				Setup	if ReadInfile = true
	ParameterizationProc				Setup	
	CreateFlowerPatchesProc				Setup	if ReadInfile = true
		FlowerPatchesUpdateProc			CreateFlowerPatchesProc	
	Create_READ-IN_FlowerPatchesProc				Setup	if ReadInfile = false
		FlowerPatchesUpdateProc			Create_READ-IN_FlowerPatchesProc	
	CreateImagesProc				Setup	
StartProc					Buttons: "Run", "1 Day", "1 Month", "1 Year", run x days", "Record video", "1-3 foraging file"	
	Go				StartProc	
		DailyUpdateProc			Go	
		SeasonProc_HoPoMo			Go	
		WorkerEggsDevProc			Go	
		DroneEggsDevProc			Go	
		NewEggsProc			Go	
		SwarmingProc			Go	if Swarming != "No swarming"
		WorkerEggLayingProc			Go	
		DroneEggLayingProc			Go	
		WorkerLarvaeDevProc			Go	
			MitesReleaseProc		WorkerLarvaeDevProc	if (numberDied > 0) and (age > INVADING_WORKER_CELLS_AGE) and (totalMites > 0)
		DroneLarvaeDevProc			Go	
			MitesReleaseProc		DroneLarvaeDevProc	if (numberDied > 0) and (age > INVADING_DRONE_CELLS_AGE) and (totalMites > 0)
		NewWorkerLarvaeProc			Go	
		NewDroneLarvaeProc			Go	
		WorkerPupaeDevProc			Go	
			MitesReleaseProc		WorkerPupaeDevProc	if (numberDied > 0) and (totalMites > 0)
			MitesReleaseProc		WorkerPupaeDevProc	if age = EMERGING_AGE and (number > 0) and (totalMites > 0)
		DronePupaeDevProc			Go	
			MitesReleaseProc		DronePupaeDevProc	if (numberDied > 0) and (totalMites > 0)
			MitesReleaseProc		DronePupaeDevProc	if age = DRONE_EMERGING_AGE and (number > 0) and (totalMites > 0)
		NewWorkerPupaeProc			Go	
		NewDronePupaeProc			Go	
		WorkerIHbeesDevProc			Go	
			AffProc		WorkerIHbeesDevProc	
		DronesDevProc			Go	
		BroodCareProc			Go	
			CountingProc		BroodCareProc	if ticks > 1
			MitesReleaseProc		BroodCareProc	while (stillToKill * number) > 0: if age DroneLarvaeCohort > INVADING_DRONE_CELLS_AGE and (totalMite
			MitesReleaseProc		BroodCareProc	while (stillToKill * number) > 0: if age LarvaeCohort > INVADING_WORKER_CELLS_AGE and (totalMites > (
			MitesReleaseProc		BroodCareProc	while (stillToKill * number) > 0: DronePupaeCohort: if (totalMites > 0)
			MitesReleaseProc		BroodCareProc	while (stillToKill * number) > 0: PupaeCohort: if (totalMites > 0)
		NewIHbeesProc			Go	
		NewDronesProc			Go	
		MiteProc			Go	if mites > 0
			CreateMiteOrganisersProc		MiteProc	

			CountingProc		MiteProc			
			MitesInvasionProc		MiteProc			
			MitePhoreticPhaseProc		MiteProc			
			MiteDailyMortalityProc		MiteProc			
			MiteOrganisersUpdateProc		MiteProc			
		BeekeepingProc			Go			
		DrawIHcohortsProc			Go			
		GenericPlotClearProc			Go			
		Start_IBM_ForagingProc			Go	if foragers > 0		
			ForagersDevelopmentProc		Start_IBM_ForagingProc			
			NewForagersProc		Start_IBM_ForagingProc			
			ForagingRoundProc		Start_IBM_ForagingProc	if (Day > SEASON_START) and (Day < SEASON_STOP) and (honeyEnergyStore < (0.95 * MAX_HONEY_EN		
				FlowerPatchesUpdateProc	ForagingRoundProc			
				Foraging_start-stopProc	ForagingRoundProc			
				Foraging_searchingProc	ForagingRoundProc			
				Foraging_collectNectarPollenProc	ForagingRoundProc			
				Foraging_flightCosts_flightTimeProc	ForagingRoundProc			
				Foraging_mortalityProc	ForagingRoundProc			
				Foraging_dancingProc	ForagingRoundProc			
				Foraging_dancingProc	ForagingRoundProc			
			WriteToFileProc		Start_IBM_ForagingProc	if (Day > SEASON_START) and (Day < SEASON_STOP) and (honeyEnergyStore < (0.95 * MAX_HONEY_EN		
			ForagersLifespanProc		Start_IBM_ForagingProc			
		CountingProc			Go			
		PollenConsumptionProc			Go			
		HoneyConsumptionProc			Go			
		DoPlotsProc			Go			
			DrawForagingMapProc		DoPlotsProc	if showAllPlots = true		
			GenericPlottingProc		DoPlotsProc			
	WriteToFileProc				StartProc	if WriteFile = true		
GoTreatmentProc					Setup	if Experiment = Experiment A, Experiment B		
	StartProc (see above)				GoTreatmentProc			
	StartProc (see above)				GoTreatmentProc			
createOutputFileProc					Button: "write file"			
	WriteToFileProc				createOutputFileProc			

es > 0)

0)

ERGY_STORE) or (PollenStore_g < IdealPollenStore_g) and (DailyForagingPeriod > 0)														
ERGY_STORE) or (PollenStore_g < IdealPollenStore_g) and (details = true) and (continueForaging = true)) and (WriteFile = true) and (DailyForagingPeriod > 0)														

This table lists all BEEHAVE procedures and reporter procedures. "Called by" refers to the procedure or button that calls the procedure.

Procedure	Description	called by
AffProc	calculates the actual age of first foraging	WorkerIHbeesDevProc
BeekeepingProc	Beekeeping activities: honey harvest once a year, varroa treatment	Go
BroodCareProc	Brood may starve/ freeze if ratio of brood to nursing bees is too high. Entities are processed in order of their age as death of brood affects more likely younger than older brood.	Go
CountingProc	Count all honey bee entities of the colony model.	Go, BroodCareProc, MiteProc
Create_Read-in_FlowerPatchesProc	a variable number of flower patches is defined via an input file	Setup
CreateFlowerPatchesProc	creates two flower patches with distance, nectar quantity and concentration being defined via input fields	Setup
CreateImagesProc	creates info signs (hive, beekeeper, dead larvae etc.)	Setup
CreateMiteOrganisersProc	Create every time step an entity called "miteOrganiser", which keeps track of all mites that invaded larvae cells in this time step	MiteProc
CreateOutputFileProc	creates a text file in which results can be written	Button: "write file"
DailyUpdateProc	Resetting of parameters once every time step (some model parameters change during simulations.)	Go
DoPlotsProc	Update all plots.	Go
DrawForagingMapProc	Draws visited or available food patches in the "foraging map" plot	DoPlotsProc
DrawIHcohortsProc	Number of bees in IH cohorts (workers & drones, brood & adults) is visualised via coloured bars in NetLogo's "View".	Go
DroneEggLayingProc	Creates a new drone egg cohort with "number" set to "NewDroneEggs"	Go
DroneEggsDevProc	Ageing by one day, then reduction due to mortality; oldest cohort is removed when it develops into larvae.	Go
DroneLarvaeDevProc	Ageing by one day, then reduction due to mortality; oldest cohort is removed when it develops into pupae.	Go
DronePupaeDevProc	Ageing by one day, then reduction due to mortality; oldest cohort is removed when larvae emerge and develop into adult drones.	Go
DronesDevProc	Ageing by one day, then reduction due to mortality; oldest cohort dies when reaching DRONE_LIFESPAN.	Go
FlowerPatchesUpdateProc	Update of nectar and pollen availability, handling time and auxiliary variables of flower patches	CreateFlowerPatchesProc Create_READ-IN_FlowerPatchesProc ForagingRoundProc
ForagersDevelopmentProc	Ageing of forager (squadrons) by one day.	Start_IBM_ForagingProc
ForagersLifespanProc	Foragers may die due to age, total flight distance, or background mortality.	Start_IBM_ForagingProc
Foraging_collectNectarPollenProc	Foragers arriving at a patch collect nectar or pollen	ForagingRoundProc
Foraging_dancingProc	Successful foragers may dance, depending on the energetic efficiency of the flower patch.	ForagingRoundProc
Foraging_flightCosts_flightTimeProc	Calculate energy and time spent on the foraging trip.	ForagingRoundProc
Foraging_mortalityProc	Active foragers may die, risk depends on trip duration.	ForagingRoundProc
Foraging_searchingProc	Searching foragers may find a flower patch.	ForagingRoundProc
Foraging_start-stopProc	Active foragers quit foraging with a probability of FORAGING_STOP_PROB; foragers abandon their current patch with a probability of ABANDON_PATCH_PROB; resting foragers start foraging with a probability of FORAGING_SPONTANEOUS_PROB; active foragers that are not experienced or have abandoned their patch search for a patch.	ForagingRoundProc
Foraging_unloadingProc	Successful foragers unload their crop and increase the colony's honey store.	ForagingRoundProc
ForagingRoundProc	Runs the submodels representing the actual foraging activity ("foraging rounds"; Table 5). This submodel is only called during the foraging season, defined by Season_Start and Season_Stop, and if honeyEnergyStore[i] < 0.95 * Max_Honey_Energy_Store.	Start_IBM_ForagingProc
GenericPlotClearProc	Clears the "generic plots" on the GUI	Go
GenericPlottingProc	Draws plots in GUI, accoring to the user's choice, called repeatedly	DoPlotsProc
Go	Daily time step	StartProc, GoTreatmentProc
GoTreatmentProc	similar to "Go", but used if colonies don't start on 1st January (to mimic empirical colony treatments)	Setup

HoneyConsumptionProc	Calculate need of honey on basis of number individuals in the different cohorts times their honey consumption rates	Go
MiteDailyMortalityProc	Determine mortality for the phoretic mites.	MiteProc
MiteOrganisersUpdateProc	Count mites, actualise miteOrganisers (age, xy-position).	MiteProc
MitePhoreticPhaseProc	Calculate the number of newly infected phoretic mites and in-hive workers.	MiteProc
MiteProc	Run varroa model	Go
MitesInvasionProc	Determine the number of mites invading drone and worker larvae cells in this time step.	MiteProc
MitesReleaseProc	Describe processes inside a brood cell: determine virus transmission from infected mites to bee pupae and back to healthy mites; calculate mortality of infected bee pupae; release mites from the cells, either with reproduction of mites (if adult bees emerge) or without reproduction (if pupae died); calculate mite drop. Procedure is called by WorkerPupaeDevProc and DronePupaeDevProc (in case of emerging bees or dying brood) and by WorkerLarvaeDevProc, DroneLarvaeDevProc and BroodCareProc (only in case of dying brood).	WorkerLarvaeDevProc (dying), DroneLarvaeDevProc (dying), WorkerPupaeDevProc (2x, for dying & emerging brood), DronePupaeDevProc (2x, for dying & emerging brood), BroodCareProc (4x, dying of drone & worker larvae & pupae)
NewDroneLarvaeProc	Eggs developed into larvae are now created as larvae.	Go
NewDronePupaeProc	Larvae developed into pupae are now created as pupae.	Go
NewDronesProc	Pupae developed into adult drones are created as adult drones, age reset to 0 (thus, for adults age refers to their actual lifetime as adults).	Go
NewEggsProc	calculates number of worker and drone eggs to be laid today	Go
NewForagersProc	In-hive bees that were determined to develop into foragers are created as forager squadrons.	Start_IBM_ForagingProc
NewIHbeesProc	Pupae developed into in-hive bees are created as in-hive bees, age reset to 0 (thus, for adults age refers to their actual lifetime as adults).	Go
NewWorkerLarvaeProc	Eggs developed into larvae are now created as larvae.	Go
NewWorkerPupaeProc	Larvae developed into pupae are now created as pupae.	Go
ParameterizationProc	sets start values of global variables	Setup
PollenConsumptionProc	Calculate need of pollen on basis of number of individuals in the different cohorts times their pollen consumption rates.	Go
ReadFileProc	reads data from input file	Setup
SeasonProc_HoPoMo	Day of year determines a seasonal factor (HoPoMo_seasont) that influences egg laying rate.	Go
Setup	initialises run	Buttons: "Setup", Scenario buttons ("DEFAULT", "2patches" etc.)
Start_IBM_ForagingProc	Run foraging module	Go
StartProc	calls "Go" and stops run in case of a BugAlarm	Buttons: "Run", "1 Day", "1 Month", "1 Year", run x days", "Record video", "1-3 foraging file"; GoTreatmentProc
SwarmingProc	calculates day of swarming, removal of parts of the colony, stores	Go
WorkerEggLayingProc	Creates a new worker egg cohort with "number" set to "NewWorkerEggs"	Go
WorkerEggsDevProc	Ageing by one day, then reduction due to mortality; oldest cohort is removed when it develops into larvae.	Go
WorkerIHbeesDevProc	Ageing by one day, then reduction due to mortality; oldest cohort is removed when in-hive bees develop into foragers. Entities are processed in order of their age for a correct transition of in-hive bees to foragers.	Go
WorkerLarvaeDevProc	Ageing by one day, then reduction due to mortality; oldest cohort is removed when it develops into pupae.	Go
WorkerPupaeDevProc	Ageing by one day, then reduction due to mortality; oldest cohort is removed when larvae emerge and develop into in-hive bees.	Go
WriteToFileProc	results can be written in an output file. Entities are processed in order of their ID for reason of presentation.	StartProc, Start_IBM_ForagingProc, createOutputFileProc

REPORTERS:		
FlowerPatchesMaxFoodAvailableTodayREP	calculates the amount of nectar and pollen available at each patch	DailyUpdateProc, CreateFlowerPatchesProc, FlowerPatchesUpdateProc
Foraging_PeriodREP	determines duration of todays foraging period (reflecting season and weather)	DailyUpdateProc
Foraging_ProbabilityREP	calculates the probability that a forager start spontaneously to forage, depending on season, food stores and colony size	Start_IBM_Proc
MiteDensityFactorREP	reports the (single) density factor for a certain number of invaded mites depending on ploidy of bee brood and chosen reproduction model	MitesReleaseProc
MiteOffspringREP	reports offspring per mite depending on ploidy of bee brood and chosen reproduction model	MitesReleaseProc
Season_HoPoMoREP	calculates the "seasonal factor" of the HoPoMo model based on day and input parameters X1..X5	FlowerPatchesMaxFoodAvailableTodayREP, SeasonProc_HoPoMo, Foraging_PeriodREP

input variables	described in ODD section
	7.7. Transition to foragers
	7.10. Beekeeping
	7.5. Brood care
	7.2. Updates
	5. Initialization
	5. Initialization
	5. Initialization
	7.III.1. CreateMiteOrganisersProc
	7.11. Graphic user interface & output
	7.2. Updates
	7.11. Graphic user interface & output
	7.11. Graphic user interface & output
	7.11. Graphic user interface & output
	7.3. Egg laying
	7.4. Brood development
	7.4. Brood development
	7.4. Brood development
	7.6. Development adults
	7.II.3. Foraging round
	7.II.2. Forager development
	7.II.2. Forager development
	7.II.3. Foraging round
	7.II.3. Foraging round
	7.II.3. Foraging round
	7.II.3. Foraging round
	7.II.3. Foraging round
	7.II.3. Foraging round
	7.II.3. Foraging round
	7.II.3. Foraging round
	7.II.3. Foraging round
	7.11. Graphic user interface & output
plotname plotChoice	7.11. Graphic user interface & output
	7.1. Time step
	7.1. Time step

7.8. Consumption

7.III.4. MiteDailyMortalityProc
7.III.5. MiteOrganisersUpdateProc
7.III.3. MitePhoreticPhaseProc
7.III. The Varroa Module
7.III.2. MitesInvasionProc

miteOrganiserID
ploidyMiteOrg
diedBrood
releaseCausedBy

7.III.6. MitesReleaseProc

7.4. Brood development
7.4. Brood development

7.6. Development adults

7.3. Egg laying
7.II.2. Forager development

7.6. Development adults

7.4. Brood development
7.4. Brood development

5. Initialization

7.8. Consumption

5. Initialization

5. Initialization

7.II.1. Foraging

7.1. Time step

7.3. Egg laying

7.4. Brood development

7.6. Development adults &
7.7. Transition to foragers

7.4. Brood development

7.4. Brood development

7.11. Graphic user interface & output

patchID foodType	7.II.3. Foraging round
	7.II.1. Foraging
	7.II.1. Foraging
ploidyMiteOrg mitesIndex	7.III.6. MitesReleaseProc
ploidyMiteOrg	7.III.6. MitesReleaseProc
today parameterList	7.II.3. Foraging round

This table lists all global variables. They can be defined on the interface ("GUI") or in the source code under "globals". Variables with a constant value are shown in capitals.

Variable	UNIT	Default (initial) value	References, calculations, comments	Explanation	data type	Category
ABANDON_POLLEN_PATCH_PROB_PER_S	1/s	0.00002		probability of experienced (but not necessarily active) pollen foragers to abandon their current pollen patch	float	foraging
AddPollen		FALSE		to improve colony growth in spring	boolean	beekeeping
Aff	d	AFF_BASE		current age of first foraging	float	development
AFF_BASE	d	21	deGrandi-Hoffman et al. (1989): 21d	default value of Aff	float	development
AllDaysAllPatchesList		-		data of all flower patches for all days, read in from text file	list	flowerpatch
AlwaysDance		FALSE		always 2 dance followers, irrespective of flower patch quality	boolean	foraging
BugAlarm		FALSE		used in assertions to stop run if set true	boolean	testing
ColonyDied		FALSE		set true as result of winter mortality or if no bees left, stops run if true	boolean	colony
ColonyTripDurationSum	s	-		sums up the duration of all nectar, pollen and empty foraging trips to calculate the duration of a foraging round	float	foraging
ColonyTripForagersSum	s	-		sums up the number of all nectar, pollen and empty foraging trips during a foraging round	float	foraging
CONC_G	mol/l	1.5	e.g. Seeley (1986) Fig. 2: sugar concentration of collected nectar: 0.5-2.5 mol/l	sucrose concentration in nectar of "green" patch	float	flowerpatch
CONC_R	mol/l	1.5		sucrose concentration in nectar of "red" patch	float	flowerpatch
ConstantHandlingTime		FALSE		if true, handling time does not increase with depletion of flower patch	boolean	foraging
CRITICAL_COLONY_SIZE_WINTER	bees	4000	Martin (2001): 4000 adult workers during winter (from Free & Spencer-Booth 1958, Harbo 1983)	threshold colony size for winter survival on julian day 365	float	colony
CROPVOLUME	µl	50	Winston (1987), Nuñez (1966, 1970), Schmid-Hempel et al. (1985)	volume of a forager's crop, is completely filled at flower patch	float	foraging
CumulativeHoneyConsumption	mg	-		total honey consumption of colony since start of the simulation	float	colony
DailyForagingPeriod	s	-		time per day, bees are allowed to forage	float	foraging
DailyHoneyConsumption	mg	-		total amount of honey consumed on current day	float	colony
DailyMiteFall	mites	0		# mites falling from comb and dying on the day of their emergence from cells	float	varroa
DailyPollenConsumption_g	g	-		total amount of pollen consumed on current day	float	colony
DANCE_INTERCEPT	dance cir	0	(Seeley (1994): min. 0.6 (Tab.2))	to calculate # circuits a bee dances for a patch, depending o the patch quality (energetic efficiency)	float	foraging
DANCE_SLOPE	dance cir	1.16	Seeley (1994): max. 1.16 (Tab. 2)	to calculate # circuits a bee dances for a patch, depending o the patch quality (energetic efficiency)	float	foraging
Day	julian da	-		current time step as Julian day (ordinal date)	float	environment
DeathsAdultWorkers_t	bees	-		sums up all deaths of all adult bees during a day	float	mortality

DeathsForagingToday	bees	-		sums up all deaths of foragers during a day	float	mortality
DecentHoneyEnergyStore	kJ	N_INITIAL_BEES * 1.5 * ENERGY_HONEY_per_g		amount of honey a colony should have stored to overwinter	float	colony
Details		TRUE		if true: results are recorded in output file after each foraging round	boolean	output
DETECT_PROB_G		0.2		probability, a searching foragerSquadron finds the "green" patch	float	foraging
DETECT_PROB_R		0.2		probability, a searching foragerSquadron finds the "red" patch	float	foraging
DISTANCE_G	m	500	e.g. Steffan-Dewenter & Kuhn (2003): foraging distance ca. 60 - 10000m, mean: 1500m	distance of the "green" patch to the colony	float	flowerpatch
DISTANCE_R	m	1500	e.g. Steffan-Dewenter & Kuhn (2003): foraging distance ca. 60 - 10000m, mean: 1500m	distance of the "red" patch to the colony	float	flowerpatch
DotDensity		0.01		affects # of visits shown in "foraging map" plot	float	display
DRONE_EGGLAYING_START	d	115	April 25 (Allen 1963: late April ..late August)	beginning of drone production	float	development
DRONE_EGGLAYING_STOP	d	240	August 28 (Allen 1963: late April ..late August)	end of drone production	float	development
DRONE_EGGS_PROPORTION		0.04	Wilkinson & Smith (2002): 0.04 (from Allen 1963, 1965)	proportion of drone eggs	float	colony
DRONE_EMERGING_AGE	d	24	Winston (1987)	age at which adult drones emerge from pupae	float	development
DRONE_HATCHING_AGE	d	3	Jay (1963), Hrassnig & Crailsheim (2005)	age at which drone larvae hatch from eggs	float	development
DRONE_LIFESPAN	d	37	Fukuda, Ohtani (1977): 14d in summer; 32-42d in autumn, 37 = average autumn life span	maximum lifespan of an adult drone	float	mortality
DRONE_PUPATION_AGE	d	10	Winston (1987)	age of pupation for drone	float	development
EggLaying_IH		TRUE		if true: egg laying is affected by available nurse bees	boolean	development
EMERGING_AGE	d	21	Winston (1987) p.50	age at which adult workers emerge from pupae	float	development
EmptyFlightsToday	flights	-		sums up all empty foraging flights during a day	float	foraging
ENERGY_HONEY_per_g	kJ/g	12.78	USDA: 304kcal/100g (http://www.nal.usda.gov/fnic/foodcomp/search/)	energy content of 1g honey (also used for fondant or syrup)	float	physics
ENERGY_SUCROSE	kJ/µmol	0.00582	wikipedia.org: sucrose: 342.3g/mol; 17kJ/g => 0.005819kJ/µmol	sucrose energy per molar concentration	float	physics
ExcessBrood	bees	-		amount of brood that dies due to lack of nurses or pollen	float	mortality
Experiment		"none"		sets up colony to match specific empirical experiments	string	testing
FeedBees		FALSE		if true: beekeeper may increase the colonies' honey store	boolean	beekeeping
FIND_DANCED_PATCH_PROB		0.5	ca. average of reported values: Seeley 1983: 0.21; Judd 1995: 0.25; references in Biesmeijer, deVries 2001: 0.95 (Oettingen-Spielberg 1949), 0.73 (Lindauer 1952)	probability for a recruit to find the advertised patch	float	foraging
FLIGHT_VELOCITY	m/s	6.5	derived from Seeley 1994, mean velocity during foraging flight see also Ribbands p127: 12.5-14.9mph (= 5.58-6.66m/s)	flight speed of a forager	float	foraging
FLIGHTCOSTS_PER_m	kJ/m	0.000006	Goller, Esch (1990): 0.000006531 kJ/m; Schmid-Hempl et al. (1985): 0.0334W (=0.000005138 kJ/m)	energy consumption on flight per meter	float	foraging
FORAGER_NURSING_CONTRIBUTION		0.2		contribution of foragers on brood care (i.e. foragers are 80% less efficient than inhive bees)	float	brood care
FORAGING_STOP_PROB		0.3		probability per foraging round that an active forager switches to "resting"	float	foraging

ForagingMap		"Nectar and Pollen"		specifies data that is shown in the "foraging map" plot, e.g. # nectar and pollen visits at each patch	string	display
ForagingRounds		-		counts foraging rounds on current day	float	foraging
ForagingSpontaneousProb		-		probability per foraging round for a resting bee to start foraging	float	foraging
HarvestedHoney_kg	kg	-		amount of honey gathered during a single honey harvest	float	beekeeping
HarvestingDay	julian da	135	May 15	first day of the year on which harvesting honey is possible	float	beekeeping
HarvestingPeriod	d	80		period of time during which harvesting honey is possible, starting on harvestingDay	float	beekeeping
HarvestingTH	kg	20		minimum honey store to actually harvest honey	float	beekeeping
HATCHING_AGE	d	3	Winston (1987) p.50	age at which worker larvae hatch from eggs	float	development
HONEY_STORE_INIT	g	0.5 * MAX_HONEY_STORE_kg * 1000		initial honey store	float	colony
HoneyEnergyStore	kJ	(HONEY_STORE_INIT * ENERGY_HONEY_per_g)		honey store of the colony (recorded in energy not in weight)	float	colony
HoneyEnergyStoreYesterday		-		saves yesterdays' energy (stored in the honey) to determine changes in the honey store	float	colony
HoneyHarvesting		FALSE		if true: beekeeper harvests honey, if possible	boolean	beekeeping
HoneyIdeal		FALSE		if true: honey store is set to maximum every day	boolean	testing
HoPoMo_seasont		-		seasonal factor from Schmickl&Crailsheim 2007, which affects egg-laying and food availability	float	environment
IdealPollenStore_g	g	POLLEN_STORE_INIT		amount of pollen foragers are trying to store	float	colony
InhivebeesDiedToday	bees	-		sums up all deaths of inhive bees during a day	float	mortality
INPUT_FILE		"Input_2-1_FoodFlow.txt"		contains data on food availability etc. of all flower patches for 365d	string	program
INVADING_DRONE_CELLS_AGE	d	DRONE_PUPATION_AGE - 2		age of drone larvae suitable for mite invasion	float	varroa
INVADING_WORKER_CELLS_AGE	d	PUPATION_AGE - 1		age of worker larvae suitable for mite invasion	float	varroa
InvadingMitesDroneCellsReal	mites	-		# mites that actually enter drone brood cells on that day	float	varroa
InvadingMitesDroneCellsTheo	mites	-		# mites that try to enter drone brood cells on that day	float	varroa
InvadingMitesWorkerCellsReal	mites	-		# mites that actually enter worker brood cells on that day	float	varroa
InvadingMitesWorkerCellsTheo	mites	-		# mites that try to enter worker brood cells on that day	float	varroa
LIFESPAN	d	290	Sakagami, Fukuda (1968): max. 290d	maximum lifespan of a worker bee	float	mortality
LostBroodToday	bees	0		counts amount of brood died in total due to lack of protein or nurse bees	float	output
LostBroodTotal	bees	0		counts amount of brood died today due to lack of protein or nurse bees	float	output
MAX_AFF	d	50	Winston (1987) p.92 (minimum AFF between 3 and 20 days, maximum AFF between 27 and 65 days)	maximum possible value age of first foraging (Aff)	float	development
MAX_BROOD_NURSE_RATIO		3	Free & Racey (1968): 3; Becher et al. (2010): 2.65	maximum amount of brood, nurse bees can care for, with nurse bees = totalIHbees + totalForagers * FORAGER_NURSING_CONTRIBUTION	float	brood care
MAX_BROODCELLS	cells	2000099	i.e. not limiting; alternative value: e.g. 20000	maximum brood space	float	colony
MAX_DANCE_CIRCUITS	dance cir	117	Seeley & Towne (1992): 117	maximum circuits a bee can perform per dance	float	foraging

MAX_EGG_LAYING	eggs / da	1600	Schmickl & Crailsheim (2007)	maximum egg laying rate per day	float	development
MAX_HONEY_ENERGY_STORE	kJ	MAX_HONEY_STORE_kg * ENERGY_HONEY_per_g * 1000		maximum amount honey that can be stores defined as energy not as weight)	float	colony
MAX_HONEY_STORE_kg	kg	50		maximum amount honey that can be stored (defined as weight)	float	colony
MAX_INVADED_MITES_DRONECELL	mites	4 (MiteReproductionMod	Martin (2001)	maximum number of mites allowed to invade a drone brood cell	float	varroa
MAX_INVADED_MITES_WORKERCELL	mites	4 (MiteReproductionMod	Martin (2001)	maximum number of mites allowed to invade a worker brood cell	float	varroa
MAX_km_PER_DAY	km	7299	i.e. not limiting; alternative: e.g. 72km (Neukirch (1982): mean flight distance per day: 59+-13.7 km)	maximum total distance a forager can fly on a single day (default value not limiting), if limiting: e.g. 72 km (= 2 * 36 km: Lindauer 1948, referring to Gontarski)	float	foraging
MAX_PROPORTION_POLLEN_FORAGERS		0.8	Lindauer (1952): 0.8	maximum proportion of pollen foragers	float	foraging
MAX_TOTAL_KM	km	800	Neukirch (1982): 838km max. flight performance in a foragers life (set to 800km in the model, as mortality acts only at end of time step)	maximum total distance a forager can fly during lifetime	float	mortality
MergeColoniesTH	bees	5000		beekeeper adds in autumn foragers to colonies smaller than this threshold, if MergeWeakColonies = true	float	beekeeping
MergeWeakColonies		FALSE		allows beekeeper to add forager to weak colonies in autumn	boolean	beekeeping
MIN_AFF	d	7	Winston (1987) p.92 (minimum AFF between 3 and 20 days, maximum AFF between 27 and 65 days)	minimum possible value age of first foraging (Aff)	float	development
MIN_IDEAL_POLLEN_STORE	g	250		minimum amount of pollen foragers are trying to store	float	colony
MITE_FALL_DRONECELL	1/emerg	0.2	Martin (1998): 20%	probability that a mite emerging from a drone cell will fall from the comb and die	float	varroa
MITE_FALL_WORKERCELL	1/emerg	0.3	Martin (1998): 30%	probability that a mite emerging from a worker cell will fall from the comb and die	float	varroa
MITE_MORTALITY_BROODPERIOD	mortality	0.006	Martin (1998): 0.006; Fries et al. (1994) (Tab. 6): 0.006	mite mortality rate per day during brood period	float	varroa
MITE_MORTALITY_WINTER	mortality	0.002	Martin (1998): 0.002; Fries et al. (1994) (Tab. 6): 0.004	mite mortality rate per day if no brood is present	float	varroa
MiteReproductionModel		"Martin"		choice between different paramerterisations for mite invasion and reproduction	string	varroa
ModelledInsteadCalcDetectProb		FALSE		choice between detection probabilities of flower patches either modelled in "BEEHAVE_Landscape" or calculated in "BEEHAVE_FoodFlow"	boolean	foraging
MORTALITY_DRONE_EGGS	mortality	0.064	Fukuda, Ohtani (1977): 100 eggs, 82 unsealed brood, 60 sealed brood and 56 adults	daily mortality rate of drone eggs	float	mortality
MORTALITY_DRONE_LARVAE	mortality	0.044	Fukuda, Ohtani (1977): 100 eggs, 82 unsealed brood, 60 sealed brood and 56 adults	daily mortality rate of drone larvae	float	mortality
MORTALITY_DRONE_PUPAE	mortality	0.005	Fukuda, Ohtani (1977): 100 eggs, 82 unsealed brood, 60 sealed brood and 56 adults	daily mortality rate of drone pupae	float	mortality
MORTALITY_DRONES	mortality	0.05	Fukuda Ohati (1977): Fig. 3, "summer", mean lifespan: 14d	daily mortality rate of healthy adult drones	float	mortality
MORTALITY_DRONES_INFECTED_AS_PUPAE	mortality	MORTALITY_INHIVE_INFECTED_AS_PUPA * (MORTALITY_DRONES / MORTALITY_INHIVE		daily mortality rate of adult drones, infected as pupae (no infection of adult drones possible)	float	mortality
MORTALITY_EGGS	mortality	0.03	Schmickl & Crailsheim (2007): 0.03	daily mortality rate of worker eggs	float	mortality
MORTALITY_FOR_PER_SEC	mortality	0.00001	Visscher & Dukas (1997): 0.036 per hour foraging	mortality rate of foragers per second foraging	float	mortality

MORTALITY_INHIVE	mortality	0.004	derived from Martin (2001), Fig. 2b (non-infected, winter)	daily mortality rate of healthy in-hive bees and foragers	float	mortality
MORTALITY_INHIVE_INFECTED_AS_ADULT	mortality	MORTALITY_INHIVE (DVW); 0.2 (APV)		daily mortality rate of in-hive bees and foragers, infected as adults	float	mortality
MORTALITY_INHIVE_INFECTED_AS_PUPA	mortality	0.012 (DWV); 1 (APV)	derived from Martin (2001), Fig. 2b (infected, winter)	daily mortality rate of in-hive bees and foragers, infected as pupae	float	mortality
MORTALITY_LARVAE	mortality	0.01	Schmickl & Crailsheim (2007): 0.01	daily mortality rate of worker larvae	float	mortality
MORTALITY_PUPAE	mortality	0.001	Schmickl & Crailsheim (2007): 0.001	daily mortality rate of worker pupae	float	mortality
N_FLOWERPATCHES		(2)		# of all flower patches	float	flowerpatch
N_GENERIC_PLOTS		8		# of "generic" plots shown on the interface	float	program
N_INITIAL_BEES	bees	10000		initial colony size (all foragers)	float	colony
N_INITIAL_MITES_HEALTHY	mites	0		initial number of healthy mites	float	varroa
N_INITIAL_MITES_INFECTED	mites	0		initial number of infected mites	float	varroa
NectarFlightsToday	flights	-		sums up all nectar foraging flights during a day	float	foraging
NewDroneEggs	bees	-		number of drone eggs laid today	float	colony
NewDroneLarvae	bees	-		number of drone eggs that developed into larvae today	float	colony
NewDronePupae	bees	-		number of drone larvae that developed into pupae today	float	colony
NewDrones	bees	-		number of drone pupae that developed into adult drones today	float	colony
NewDrones_healthy	bees	-		number of drone pupae that developed into healthy drones today	float	colony
NewForagerSquadronsHealthy	foragerSq	(N_INITIAL_BEES / SQUADRON_SIZE)		new healthy foragers at the age of first foraging	float	development
NewForagerSquadronsInfectedAsAdults	squadror	-		number of new forager squadrons that were infected as in-hive bees	float	colony
NewForagerSquadronsInfectedAsPupae	squadror	-		number of new forager squadrons that were infected as pupae	float	colony
NewIHbees	bees	-		number of worker pupae that developed into in-hive bees today	float	colony
NewIHbees_healthy	bees	-		number of worker pupae that developed into healthy in-hive bees today	float	colony
NewReleasedMitesToday	mites	0		number of mites released from brood cells today	float	varroa
NewWorkerEggs	bees	-		number of worker eggs laid today	float	colony
NewWorkerLarvae	bees	-		number of worker eggs that developed into larvae today	float	colony
NewWorkerPupae	bees	-		number of worker larvae that developed into pupae today	float	colony
PATCHCOLOR		38		background color of the Netlogo "world"	float	display
PhoreticMites	mites	N_INITIAL_MITES_HEALTHY + N_INITIAL_MITES_INFECTED		number of all (healthy and infected) phoretic mites	float	varroa
PhoreticMitesHealthyRate		N_INITIAL_MITES_HEALTHY / (N_INITIAL_MITES_HEALTHY + N_INITIAL_MITES_INFECTEI		proportion of not infected mites	float	varroa
POLLEN_DANCE_FOLLOWERS	bees	2		number of dance followers of a successful pollen forager	float	foraging
POLLEN_G_kg	kg	1		amount of pollen available at "green" patch	float	flowerpatch
POLLEN_R_kg	kg	1		amount of pollen available at "red" patch	float	flowerpatch
POLLEN_STORE_INIT	g	100		initial pollen store	float	colony
PollenFlightsToday	flights	-		sums up all pollen foraging flights during a day	float	foraging
PollenIdeal		FALSE		if true: pollen store is set to "IdealPollenStore_g" every day	boolean	testing

POLLENLOAD	g	0.015	Schmickl & Crailsheim (2007): 0.015g (from Seeley 1995)	amount of pollen collected during a single, successful pollen foraging trip, equals two pollen pellets	float	foraging
PollenStore_g	g	POLLEN_STORE_INIT		amount of pollen stored in the colony	float	colony
PollenStore_g_Yesterday	g	-		saves yesterdays' pollen store	float	colony
POST_SWARMING_PERIOD	d	0		defines period after swarming until egglaying etc. normalises	float	colony
PRE_SWARMING_PERIOD	d	3	Schmickl & Crailsheim (2007): 3d, Winston (1987) p. 184: "until the week before swarming"	defines period during which colony prepares for swarming	float	colony
ProbLazyWinterbees		0		probability of foragers with age > ageLaziness (100d) to not take part in foraging on that day	float	foraging
ProbPollenCollection		0		probability of a forager to collect pollen (if active), all other (active) foragers collect nectar	float	foraging
PropNewToAllPhorMites		-		proportion of mites that have become phoretic on that day	float	varroa
PROTEIN_STORE_NURSES_d	d	7	Crailsheim (1990): 7d	if no pollen is present and the brood to nurses ratio is at its maximum, then the protein stores of the nurse bees lasts for PROTEIN_STORE_NURSES_d days; if less brood is present, then the protein stores last proportionally longer	float	colony
ProteinFactorNurses		1		protein content of brood food produced by nurse bees	float	colony
Pupae_W&D_KilledByVirusToday	bees	-		counts number of worker and drone pupae that were killed due to virus infection on current day	float	mortality
PUPATION_AGE	d	9	Winston (1987) p.50	age of worker larvae pupation	float	development
QUANTITY_G_l	l	20		amount of nectar available at "green" patch	float	flowerpatch
QUANTITY_R_l	l	20		amount of nectar available at "red" patch	float	flowerpatch
Queenage	d	230	queen emerged on May 15	age of the queen, only relevant if QueenAgeing = true	float	colony
QueenAgeing		FALSE		if true: egg laying rate decreases with queen age (following BEEPOP) and the queen is replaced every year	boolean	colony
random-seed		RAND_SEED		seed of the pseudo-random number generator	float	program
ReadInfile		FALSE		if true: flower patch data are read from INPUT_FILE	boolean	program
RecruitedFlightsToday	flights	-		sums up all flights of recruits during a day	float	foraging
RemainingHoney_kg	kg	5		amount of honey the beekeeper leaves in the colony at honey harvest	float	beekeeping
SaveInvadedMODroneLarvaeToPupae	ID	-		saves ID of the relevant mite organiser when drone larvae develop into pupae	float	program
SaveInvadedMOWorkerLarvaeToPupae	ID	-		saves ID of the relevant mite organiser when worker larvae develop into pupae	float	program
SaveWhoDroneLarvaeToPupae	ID	-		saves ID of the drone larvae cohort that develops into pupae	float	program
SaveWhoWorkerLarvaeToPupae	ID	-		saves ID of the worker larvae cohort that develops into pupae	float	program
SEARCH_LENGTH_M	m	17*60*FLIGHT_VELOCITY	Seeley (1983): mean search trip: 17min	trip length of unsuccessful scout or recruit	float	foraging

SearchingFlightsToday	flights	-		sums up all flights of searching scouts during a day	float	foraging
SEASON_START	julian da	1	January 1	first day of foraging season	float	environment
SEASON_STOP	julian da	365	December 31	last day of foraging season	float	environment
SeasonalFoodFlow		TRUE		if true: seasonal pattern of food availability at flower patches, otherwise constant food flow	boolean	environment
SHIFT_G		-40		shifts the seasonal food flow of the "green" flower patch to earlier (positive) or later (negative) in the year	float	flowerpatch
SHIFT_R		30		shifts the seasonal food flow of the "red" flower patch to earlier (positive) or later (negative) in the year	float	flowerpatch
ShowAllPlots		TRUE		if true: all plots are in use, otherwise: "foraging map", "foragers today [%]" and "active foragers today [%]" are switched off	boolean	output
SimpleDancing		FALSE		if true: two dance followers for valuable flower patches, none for non valuable	boolean	foraging
SQUADRON_SIZE	bees	100		number of foragers in the super-individuals "foragerSquadron"	float	program
STEPWIDTH		50		to scale size of coloured bars in the colony histogram (GUI, "world") **of worker brood and adult workers**	float	program
STEPWIDTHdrones		5		to scale size of coloured bars in the colony histogram (GUI, "world") of drone brood and adult drones	float	program
stopDead		TRUE		if true: run stops, if colony is dead	boolean	program
SumLifeSpanAdultWorkers_t	d	-		sums up the age of all adult worker died today	float	mortality
SummedForagerSquadronsOverTime	squadror	-		total number of forager squadrons ever produced	float	colony
Swarming		"No swarming"		Swarming options: swarming and continue of parental colony or continue with prime swarm or no swarming at all	string	colony
SwarmingDate	julian da	0		julian day when swarming takes place; calculated in SwarmingProc to its acual value and reset to 0 at the end of a year	float	colony
Testing		"SIMULATION - NO TEST"		allows to add special parameterisations or changes to code to test the model with the option to easily remove them or switch them on or off	string	testing
TIME_NECTAR_GATHERING	s	1200	Winston (1987) p. 172: average: 30-80min; Note: modelled handling time can increase with depletion of the patch	time to fill crop with nectar if nectar quantity is not yet reduced in the flower patch	float	foraging
TIME_POLLEN_GATHERING	s	600	Winston (1987) p. 172: 10 min; Note: modelled handling time can increase with depletion of the patch	time to collect a pollen load if pollen quantity is not yet reduced in the flower patch	float	foraging
TIME_UNLOADING	s	116	Seeley (1994): 116s	time to unload nectar in the colony	float	foraging
TIME_UNLOADING_POLLEN	s	210	Ribbands (1953) p.131: 3.5 minutes (from Park 1922,1928b)	time to unload pollen in the colony	float	foraging
TodaysAllPatchesList		-		data of all flower patches for current day only	list	flowerpatch
TodaysSinglePatchList		-		data of a single flower patch for current day only	list	flowerpatch

TotalBeesAdded	bees	-		total number of bees ever added by the beekeeper	float	beekeeping
TotalDroneEggs	bees	-		current number of drone eggs present in the colony	float	colony
TotalDroneLarvae	bees	-		current number of drone larvae present in the colony	float	colony
TotalDronePupae	bees	-		current number of drone pupae present in the colony	float	colony
TotalDrones	bees	-		current number of drones present in the colony	float	colony
TotalEggs	bees	-		current number of worker eggs present in the colony	float	colony
TotalEventsToday		-		total number of all foraging events on the current day	float	foraging
TotalForagers	bees	newForagerSquadronsHealthy * SQUADRON_SIZE		number of all foragers of the colony	float	colony
TotalFPdetectionProb		-1		probability to find any flower patch during a single search trip	float	foraging
TotalHoneyFed_kg	kg	-		total amount of honey ever added by the beekeeper	float	beekeeping
TotalHoneyHarvested_kg	kg	-		total amount of honey ever harvested by the beekeeper	float	beekeeping
TotalIHbees	bees	-		current number of in-hive bees present in the colony	float	colony
TotalLarvae	bees	-		current number of worker larvae present in the colony	float	colony
TotalMites	mites	phoreticMites		all varroa mites present in the colony (phoretic and in brood cells)	float	varroa
TotalPollenAdded	kg	-		total amount of pollen ever added by the beekeeper	float	beekeeping
TotalPupae	bees	-		current number of worker pupae present in the colony	float	colony
TotalWeightBees_kg	kg	-		total weight of worker and drone brood and all adults	float	colony
TotalWorkerAndDroneBrood	bees	-		current number of all worker and drone eggs, larvae and pupae	float	colony
VarroaTreatment		FALSE		if true: colony is treated against varroa once a year	boolean	beekeeping
Virus		"DWV"		choice which virus is transmitted by infected mites (DWV, APV)	string	varroa
VIRUS_KILLS_PUPA_PROB	1/pupal (	0.2 (DWV); 1 (APV)	Martin (2001)	probability that an infected pupa will die	float	mortality
VIRUS_TRANSMISSION_RATE_MITE_TO_PUPA	1/pupal (	0.89 (Virus = "DWV"); 1 (\	Martin (2001)	probability that an infected mite will infect a healthy pupa	float	varroa
VIRUS_TRANSMISSION_RATE_PUPA_TO_MITES	1/pupal (	1 (DWV); 0 (APV)	Martin (2001)	probability that an infected pupa will infect a healthy mite	float	varroa
Weather		"Rothamsted (2009)"		choice between several weather scenarios and datasets	string	environment
WEIGHT_WORKER_g	g	0.1	Schmickl & Crailsheim (2007): 0.1g, Martin (1998): 1kg adults = 9000 bees; Calis et al. (1999): 0.125g; higher weight => less mites!	weight of a worker bee	float	colony

WriteFile		FALSE	if true: some model results are written in an output file	boolean	output
X_Days	d	7	defines "X" for the "run X days"-button	float	display

Constant/variable	Globals/GUI	initialized in	Used in procedures (without ParameterizationProc)
Constant	globals	ParameterizationProc	Foraging_start-stopProc
Variable	GUI ("Switch")	DEFAULT button	BeekeepingProc
Variable	globals	ParameterizationProc	GoTreatmentProc; SwarmingProc; AffProc; WorkerIHbeesDevProc; NewForagersProc; DoPlotsProc
Constant	globals	ParameterizationProc	AffProc
Variable	globals	(set to 0 in Setup by "clear-all")	DailyUpdateProc; Create_Read-in_FlowerPatchesProc; ReadFileProc;
Variable	GUI ("Switch")	DEFAULT button	FlowerPatchesUpdateProc
Variable	globals	ParameterizationProc	StartProc; GoTreatmentProc; FlowerPatchesMaxFoodAvailableTodayREP; DailyUpdateProc; WorkerPupaeDevProc; DronePupaeDevProc; BroodCareProc; CreateFlowerPatchesProc; ForagingRoundProc; Foraging_PeriodREP; Foraging_searchingProc; MitesInvasionProc; MiteOffspringREP; MitesReleaseProc; MitePhoreticPhaseProc; CountingProc; ReadFileProc;
Variable	globals	ParameterizationProc	StartProc; DailyUpdateProc
Variable	globals	(set to 0 in Setup by "clear-all"); rese	Start_IBM_ForagingProc; ForagingRoundProc; Foraging_flightCosts_flightTimeProc
Variable	globals	(set to 0 in Setup by "clear-all"); rese	Start_IBM_ForagingProc; ForagingRoundProc; Foraging_flightCosts_flightTimeProc;
Constant	GUI ("Input")	DEFAULT button	CreateFlowerPatchesProc
Constant	GUI ("Input")	DEFAULT button	CreateFlowerPatchesProc
Variable	GUI ("Switch")	DEFAULT button	FlowerPatchesUpdateProc
Constant	GUI ("Input")	DEFAULT button	DailyUpdateProc
Constant	globals	ParameterizationProc	DailyUpdateProc; SwarmingProc; FlowerPatchesUpdateProc; Foraging_searchingProc; Foraging_collectNectarPollenProc; DrawForagingMapProc;
Variable	globals	(set to 0 in Setup by "clear-all")	HoneyConsumptionProc;
Variable	globals	(set to 0 in Setup by "clear-all")	DailyUpdateProc; Start_IBM_ForagingProc; GenericPlottingProc;
Variable	globals	(set to 0 in Setup by "clear-all")	AffProc; HoneyConsumptionProc; GenericPlottingProc;
Variable	globals	ParameterizationProc	DailyUpdateProc; MitesReleaseProc; DoPlotsProc
Variable	globals	(set to 0 in Setup by "clear-all")	PollenConsumptionProc; GenericPlottingProc
Constant	GUI ("Input")	DEFAULT button	FlowerPatchesUpdateProc
Constant	GUI ("Input")	DEFAULT button	FlowerPatchesUpdateProc
Variable	globals	(set to 0 in Setup by "clear-all")	FlowerPatchesMaxFoodAvailableTodayREP; DailyUpdateProc; SeasonProc_HoPoMo; NewEggsProc; SwarmingProc; DroneEggLayingProc; Start_IBM_ForagingProc; Create_Read-in_FlowerPatchesProc; Foraging_PeriodREP; BeekeepingProc;
Variable	globals	(set to 0 in Setup by "clear-all") reset	DailyUpdateProc; WorkerIHbeesDevProc; Foraging_mortalityProc; ForagersLifespanProc; GenericPlottingProc;

Variable	globals	(set to 0 in Setup by "clear-all") reset	DailyUpdateProc; ForagingRoundProc; Foraging_mortalityProc; ForagersLifespanProc;
Variable	globals	ParameterizationProc	Start_IBM_ForagingProc; ForagingRoundProc; Foraging_ProbabilityREP; Foraging_start-stopProc;
Variable	GUI ("Switch")	DEFAULT button	Start_IBM_ForagingProc
Constant	GUI ("Input")	DEFAULT button	CreateFlowerPatchesProc
Constant	GUI ("Input")	DEFAULT button	CreateFlowerPatchesProc
Constant	GUI ("Input")	DEFAULT button	CreateFlowerPatchesProc
Constant	GUI ("Input")	DEFAULT button	CreateFlowerPatchesProc
Variable	GUI ("Input")	DEFAULT button	DrawForagingMapProc
Constant	globals	ParameterizationProc	DroneEggLayingProc
Constant	globals	ParameterizationProc	DroneEggLayingProc
Constant	globals	ParameterizationProc	NewEggsProc
Constant	globals	ParameterizationProc	NewEggsProc; DronePupaeDevProc; NewDronesProc; DrawIHcohortsProc; MiteOrganisersUpdateProc
Constant	globals	ParameterizationProc	NewEggsProc; DroneEggsDevProc; NewDroneLarvaeProc
Constant	globals	ParameterizationProc	DronesDevProc
Constant	globals	ParameterizationProc	NewEggsProc; DroneLarvaeDevProc; NewDronePupaeProc
Variable	GUI ("Switch")	DEFAULT button	NewEggsProc;
Constant	globals	ParameterizationProc	NewEggsProc; WorkerPupaeDevProc; NewIHbeesProc; DrawIHcohortsProc; MiteOrganisersUpdateProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	DailyUpdateProc; Foraging_flightCosts_flightTimeProc; GenericPlottingProc;
Constant	globals	ParameterizationProc	CreateImagesProc; GoTreatmentProc; DailyUpdateProc; SwarmingProc; AffProc; ForagingRoundProc; HoneyConsumptionProc; BeekeepingProc; DoPlotsProc;
Constant	globals	ParameterizationProc	FlowerPatchesUpdateProc; Foraging_collectNectarPollenProc
Variable	globals	(set to 0 in Setup by "clear-all")	BroodCareProc;
Variable	GUI ("Chooser")	DEFAULT button	Setup; GoTreatmentProc;
Variable	GUI ("Switch")	DEFAULT button	BeekeepingProc
Constant	globals	ParameterizationProc	Foraging_searchingProc
Constant	globals	ParameterizationProc	Start_IBM_ForagingProc; FlowerPatchesUpdateProc; Foraging_flightCosts_flightTimeProc; Foraging_mortalityProc
Constant	globals	ParameterizationProc	FlowerPatchesUpdateProc; Foraging_collectNectarPollenProc; Foraging_flightCosts_flightTimeProc
Constant	globals	ParameterizationProc	NewEggsProc; AffProc; BroodCareProc; PollenConsumptionProc; DoPlotsProc
Constant	globals	ParameterizationProc	Foraging_start-stopProc

Variable	GUI ("Chooser")	DEFAULT button	DrawForagingMapProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	Start_IBM_ForagingProc; ForagingRoundProc; GenericPlottingProc; WriteToFileProc
Variable	globals	(set to 0 in Setup by "clear-all")	Start_IBM_ForagingProc; Foraging_start-stopProc;
Variable	globals	(set to 0 in Setup by "clear-all")	BeekeepingProc
Variable	GUI ("Input")	DEFAULT button	BeekeepingProc
Variable	GUI ("Input")	DEFAULT button	BeekeepingProc
Variable	GUI ("Input")	DEFAULT button	BeekeepingProc
Constant	globals	ParameterizationProc	WorkerEggsDevProc; NewWorkerLarvaeProc; PollenConsumptionProc; HoneyConsumptionProc
Constant	globals	ParameterizationProc	only in ParameterizationProc
Variable	globals	ParameterizationProc	GoTreatmentProc; DailyUpdateProc; SwarmingProc; AffProc; Start_IBM_ForagingProc; ForagingRoundProc; Foraging_ProbabilityREP; Foraging_start-stopProc; Foraging_flightCosts_flightTimeProc; Foraging_unloadingProc; HoneyConsumptionProc; BeekeepingProc; DoPlotsProc
Variable	globals	(set to 0 in Setup by "clear-all")	CreateImagesProc; DailyUpdateProc; DoPlotsProc; GenericPlottingProc;
Variable	GUI ("Switch")	DEFAULT button	BeekeepingProc; DoPlotsProc
Variable	GUI ("Switch")	DEFAULT button	HoneyConsumptionProc
Variable	globals	(set to 0 in Setup by "clear-all")	SeasonProc_HoPoMo; NewEggsProc
Variable	globals	ParameterizationProc	GoTreatmentProc; AffProc; Start_IBM_ForagingProc, ForagingRoundProc; Foraging_ProbabilityREP; PollenConsumptionProc; DoPlotsProc
Variable	globals		WorkerIHbeesDevProc; MitePhoreticPhaseProc;
Constant	GUI ("Chooser")	DEFAULT button	ReadFileProc
Constant	globals	ParameterizationProc	DroneLarvaeDevProc; BroodCareProc; CreateMiteOrganisersProc; MitesInvasionProc
Constant	globals	ParameterizationProc	WorkerLarvaeDevProc; BroodCareProc; CreateMiteOrganisersProc; MitesInvasionProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	MitesInvasionProc;
Variable	globals	(set to 0 in Setup by "clear-all") reset	MitesInvasionProc;
Variable	globals	(set to 0 in Setup by "clear-all") reset	MitesInvasionProc;
Variable	globals	(set to 0 in Setup by "clear-all") reset	MitesInvasionProc;
Constant	globals	ParameterizationProc	ForagersLifespanProc;
Variable	globals	ParameterizationProc	BroodCareProc
Variable	globals	ParameterizationProc	BroodCareProc; DailyUpdateProc
Constant	globals	ParameterizationProc	SwarmingProc; AffProc
Constant	globals	ParameterizationProc	NewEggsProc; AffProc; BroodCareProc; PollenConsumptionProc; HoneyConsumptionProc; DoPlotsProc
Constant	GUI ("Input")	DEFAULT button	NewEggsProc
Constant	globals	ParameterizationProc	FlowerPatchesUpdateProc

Constant	globals	ParameterizationProc	NewEggsProc
Constant	globals	ParameterizationProc	GoTreatmentProc; Start_IBM_ForagingProc; Foraging_unloadingProc; HoneyConsumptionProc
Constant	GUI ("Input")	DEFAULT button	only in ParameterizationProc
Constant	globals		GoTreatmentProc; CreateMiteOrganisersProc; MitesInvasionProc; MitesReleaseProc
Constant	globals		CreateMiteOrganisersProc; MitesInvasionProc; MitesReleaseProc
Constant	GUI ("Input")	DEFAULT button	Foraging_start-stopProc
Constant	globals	ParameterizationProc	ForagingRoundProc
Constant	globals	ParameterizationProc	NewForagersProc; ForagersLifespanProc; BeekeepingProc
Variable	GUI ("Input")	DEFAULT button	BeekeepingProc
Variable	GUI ("Switch")	DEFAULT button	BeekeepingProc
Constant	globals	ParameterizationProc	AffProc; DoPlotsProc
Constant	globals	ParameterizationProc	PollenConsumptionProc
Constant	globals	ParameterizationProc	MitesReleaseProc
Constant	globals	ParameterizationProc	MitesReleaseProc
Constant	globals	ParameterizationProc	MiteDailyMortalityProc;
Constant	globals	ParameterizationProc	MiteDailyMortalityProc;
Variable	GUI ("Chooser")	DEFAULT button	MiteDensityFactorREP; MiteOffspringREP;
Variable	GUI ("Switch")	DEFAULT button	DailyUpdateProc; Create_Read-in_FlowerPatchesProc
Constant	globals	ParameterizationProc	DroneEggsDevProc
Constant	globals	ParameterizationProc	DroneLarvaeDevProc
Constant	globals	ParameterizationProc	DronePupaeDevProc
Constant	globals	ParameterizationProc	DronesDevProc
Constant	globals		DronesDevProc
Constant	globals	ParameterizationProc	WorkerEggsDevProc
Constant	globals	ParameterizationProc	FlowerPatchesUpdateProc; Foraging_mortalityProc

Constant	globals	ParameterizationProc	WorkerIHbeesDevProc; ForagersLifespanProc
Constant	globals		WorkerIHbeesDevProc; ForagersLifespanProc
Constant	globals		WorkerIHbeesDevProc; ForagersLifespanProc
Constant	globals	ParameterizationProc	WorkerLarvaeDevProc
Constant	globals	ParameterizationProc	WorkerPupaeDevProc
Constant	globals	CreateFlowerPatchesProc or ReadFile	DailyUpdateProc; CreateFlowerPatchesProc; Create_Read-in_FlowerPatchesProc; ReadFileProc;
Constant	globals	ParameterizationProc	ForagingRoundProc; Foraging_ProbabilityREP; GenericPlotClearProc;
Constant	GUI ("Input")	DEFAULT button	Setup
Constant	GUI ("Input")	DEFAULT button	Setup
Constant	GUI ("Input")	DEFAULT button	Setup; DailyUpdateProc; BeekeepingProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	DailyUpdateProc; Foraging_collectNectarPollenProc; GenericPlottingProc;
Variable	globals	(set to 0 in Setup by "clear-all")	NewEggsProc; SwarmingProc; DroneEggLayingProc
Variable	globals	(set to 0 in Setup by "clear-all")	SwarmingProc; DroneEggsDevProc; NewDroneLarvaeProc;
Variable	globals	(set to 0 in Setup by "clear-all")	SwarmingProc; DroneLarvaeDevProc; NewDronePupaeProc
Variable	globals	(set to 0 in Setup by "clear-all")	DronePupaeDevProc; NewDronesProc
Variable	globals	(set to 0 in Setup by "clear-all")	DronePupaeDevProc; NewDronesProc
Variable	globals	ParameterizationProc	WorkerIHbeesDevProc; NewForagersProc
Variable	globals	(set to 0 in Setup by "clear-all")	Go; WorkerIHbeesDevProc; NewForagersProc; MitePhoreticPhaseProc;
Variable	globals	(set to 0 in Setup by "clear-all")	Go; WorkerIHbeesDevProc; NewForagersProc; MitePhoreticPhaseProc
Variable	globals	(set to 0 in Setup by "clear-all")	WorkerPupaeDevProc; NewIHbeesProc;
Variable	globals	(set to 0 in Setup by "clear-all")	WorkerPupaeDevProc; NewIHbeesProc;
Variable	globals	ParameterizationProc	DailyUpdateProc; MitesInvasionProc; MitePhoreticPhaseProc
Variable	globals	(set to 0 in Setup by "clear-all")	NewEggsProc; SwarmingProc; WorkerEggLayingProc; GenericPlottingProc;
Variable	globals	(set to 0 in Setup by "clear-all")	SwarmingProc; WorkerEggsDevProc; NewWorkerLarvaeProc;
Variable	globals	(set to 0 in Setup by "clear-all")	SwarmingProc; WorkerLarvaeDevProc; NewWorkerPupaeProc;
Constant	globals	ParameterizationProc	
Variable	globals	ParameterizationProc	GoTreatmentProc; SwarmingProc; MitesInvasionProc; MitesReleaseProc; MiteDailyMortalityProc; MitePhoreticPhaseProc; MiteOrganisersUpdateProc; CountingProc; BeekeepingProc; DoPlotsProc
Variable	globals		
Constant	globals	ParameterizationProc	Foraging_dancingProc
Constant	GUI ("Input")	DEFAULT button	FlowerPatchesMaxFoodAvailableTodayREP; DailyUpdateProc; CreateFlowerPatchesProc
Constant	GUI ("Input")	DEFAULT button	FlowerPatchesMaxFoodAvailableTodayREP; DailyUpdateProc; CreateFlowerPatchesProc
Constant	globals	ParameterizationProc	only ParameterizationProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	DailyUpdateProc; Foraging_collectNectarPollenProc; GenericPlottingProc
Variable	GUI ("Switch")	DEFAULT button	PollenConsumptionProc

Constant	globals	ParameterizationProc	DailyUpdateProc; Foraging_searchingProc; Foraging_searchingProc; Foraging_collectNectarPollenProc; DrawForagingMapProc
Variable	globals	ParameterizationProc	CreateImagesProc; Foraging_unloadingProc; GoTreatmentProc; DailyUpdateProc; SwarmingProc; AffProc; Start_IBM_ForagingProc; ForagingRoundProc; Foraging_ProbabilityREP; Foraging_unloadingProc; PollenConsumptionProc; BeekeepingProc; DoPlotsProc
Variable	globals	(set to 0 in Setup by "clear-all")	CreateImagesProc; DailyUpdateProc; DoPlotsProc
Constant	globals	ParameterizationProc	SwarmingProc
Constant	globals	ParameterizationProc	SwarmingProc
Variable	GUI ("Input")	DEFAULT button	Start_IBM_ForagingProc
Variable	globals	ParameterizationProc	ForagingRoundProc; Foraging_start-stopProc
Variable	globals		MitesInvasionProc; MitePhoreticPhaseProc
Constant	globals	ParameterizationProc	PollenConsumptionProc
Variable	globals	ParameterizationProc	AffProc; BroodCareProc; PollenConsumptionProc; DoPlotsProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	DailyUpdateProc; MitesReleaseProc
Constant	globals	ParameterizationProc	WorkerLarvaeDevProc; NewWorkerPupaeProc; PollenConsumptionProc; HoneyConsumptionProc
Constant	GUI ("Input")	DEFAULT button	FlowerPatchesMaxFoodAvailableTodayREP; DailyUpdateProc; CreateFlowerPatchesProc
Constant	GUI ("Input")	DEFAULT button	FlowerPatchesMaxFoodAvailableTodayREP; DailyUpdateProc; CreateFlowerPatchesProc
Variable	globals	ParameterizationProc	DailyUpdateProc; NewEggsProc; SwarmingProc; BeekeepingProc
Variable	GUI ("Switch")	DEFAULT button	NewEggsProc; BeekeepingProc
Constant	globals (Netlogo primitive)		
Variable	GUI ("Switch")	DEFAULT button	Setup; DoPlotsProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	DailyUpdateProc; Foraging_searchingProc;
Variable	GUI ("Input")	DEFAULT button	BeekeepingProc
Variable	globals		DroneLarvaeDevProc; NewDronePupaeProc
Variable	globals		WorkerLarvaeDevProc; NewWorkerPupaeProc
Variable	globals		DroneLarvaeDevProc; NewDronePupaeProc
Variable	globals		WorkerLarvaeDevProc; NewWorkerPupaeProc
Constant	globals	ParameterizationProc	Start_IBM_ForagingProc; Foraging_flightCosts_flightTimeProc; Foraging_mortalityProc

Variable	globals	(set to 0 in Setup by "clear-all") reset	DailyUpdateProc; Foraging_searchingProc;
Constant	globals	ParameterizationProc	Start_IBM_ForagingProc
Constant	globals	ParameterizationProc	Start_IBM_ForagingProc
Variable	GUI ("Switch")	DEFAULT button	FlowerPatchesMaxFoodAvailableTodayREP; DailyUpdateProc; CreateFlowerPatchesProc
Constant	GUI ("Input")	DEFAULT button	FlowerPatchesMaxFoodAvailableTodayREP
Constant	GUI ("Input")	DEFAULT button	FlowerPatchesMaxFoodAvailableTodayREP
Variable	GUI ("Switch")	DEFAULT button	ForagingRoundProc; DoPlotsProc
Variable	globals	ParameterizationProc	FlowerPatchesUpdateProc;
Constant	GUI ("Input")	DEFAULT button	Go; DailyUpdateProc; WorkerIHbeesDevProc; CreateFlowerPatchesProc; Create_Read-in_FlowerPatchesProc; ForagingRoundProc; Foraging_searchingProc; Foraging_collectNectarPollenProc; Foraging_flightCosts_flightTimeProc; Foraging_mortalityProc; Foraging_unloadingProc; ForagersLifespanProc; MitePhoreticPhaseProc; CountingProc; BeekeepingProc; DoPlotsProc
Constant	globals	ParameterizationProc	DrawIHcohortsProc
Constant	globals	ParameterizationProc	DrawIHcohortsProc
Variable	GUI ("Switch")	DEFAULT button	StartProc; DailyUpdateProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	DailyUpdateProc; WorkerIHbeesDevProc; Foraging_mortalityProc; ForagersLifespanProc; GenericPlottingProc;
Variable	globals	(set to 0 in Setup by "clear-all")	NewForagersProc;
Variable	GUI ("Chooser")	DEFAULT button	Go; SwarmingProc
Variable	globals	ParameterizationProc	SwarmingProc;
Variable	GUI ("Chooser")	DEFAULT button	(currently not in use)
Variable	GUI ("Input")	DEFAULT button	FlowerPatchesUpdateProc
Variable	GUI ("Input")	DEFAULT button	FlowerPatchesUpdateProc
Constant	globals	ParameterizationProc	Foraging_flightCosts_flightTimeProc
Constant	globals	ParameterizationProc	Foraging_flightCosts_flightTimeProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	DailyUpdateProc; Create_Read-in_FlowerPatchesProc; FlowerPatchesUpdateProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	DailyUpdateProc; Create_Read-in_FlowerPatchesProc; FlowerPatchesUpdateProc;

Variable	globals	(set to 0 in Setup by "clear-all")	BeekeepingProc;
Variable	globals	(set to 0 in Setup by "clear-all") reset	MiteDailyMortalityProc; CountingProc; GenericPlottingProc;
Variable	globals	(set to 0 in Setup by "clear-all") reset	BroodCareProc; MiteDailyMortalityProc; CountingProc; PollenConsumptionProc; HoneyConsumptionProc; GenericPlottingProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	MiteDailyMortalityProc; CountingProc; GenericPlottingProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	CountingProc; PollenConsumptionProc; HoneyConsumptionProc; GenericPlottingProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	MiteDailyMortalityProc; CountingProc; GenericPlottingProc
Variable	globals	(set to 0 in Setup by "clear-all")	GenericPlottingProc
Variable	globals	ParameterizationProc	Go; GoTreatmentProc; DailyUpdateProc; NewEggsProc; SwarmingProc; AffProc; BroodCareProc; ForagingRoundProc; MitesInvasionProc; CountingProc; PollenConsumptionProc; HoneyConsumptionProc; BeekeepingProc; DoPlotsProc;
Variable	globals	ParameterizationProc	Foraging_searchingProc
Variable	globals	(set to 0 in Setup by "clear-all")	BeekeepingProc
Variable	globals	(set to 0 in Setup by "clear-all")	BeekeepingProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	GoTreatmentProc; DailyUpdateProc; NewEggsProc; SwarmingProc; AffProc; BroodCareProc; ForagingRoundProc; MitesInvasionProc; MitePhoreticPhaseProc; CountingProc; PollenConsumptionProc; HoneyConsumptionProc; BeekeepingProc; GenericPlottingProc;
Variable	globals	(set to 0 in Setup by "clear-all") reset	BroodCareProc; MiteDailyMortalityProc; CountingProc; PollenConsumptionProc; HoneyConsumptionProc; GenericPlottingProc;
Variable	globals	ParameterizationProc	Go; WorkerLarvaeDevProc; DroneLarvaeDevProc; WorkerPupaeDevProc; DronePupaeDevProc; BroodCareProc; MiteOrganisersUpdateProc; CountingProc; DoPlotsProc;
Variable	globals	(set to 0 in Setup by "clear-all")	BeekeepingProc
Variable	globals	(set to 0 in Setup by "clear-all") reset	MiteDailyMortalityProc; CountingProc; GenericPlottingProc;
Variable	globals	(set to 0 in Setup by "clear-all")	GenericPlottingProc
Variable	globals	(set to 0 in Setup by "clear-all")	DailyUpdateProc; NewEggsProc; SwarmingProc; AffProc; BroodCareProc; CountingProc; PollenConsumptionProc; HoneyConsumptionProc; GenericPlottingProc;
Variable	GUI ("Switch")	DEFAULT button	BeekeepingProc; DoPlotsProc
Variable	GUI ("Chooser")	DEFAULT button	Setup
Constant	globals		MitesReleaseProc
Constant	globals		MitesReleaseProc
Constant	globals		MitesReleaseProc
Variable	GUI ("Chooser")	DEFAULT button	Foraging_PeriodREP
Constant	globals	ParameterizationProc	MitesInvasionProc; DoPlotsProc

Variable	GUI ("Switch")	DEFAULT button	createOutputFileProc; StartProc; Start_IBM_ForagingProc
Variable	GUI ("Input")	DEFAULT button	only in GUI

code snip example (might be shortened or modified)

```
if random-float 1 < 1 - (1 - ABANDON_POLLEN_PATCH_PROB_PER_S) ^ [ tripDurationPollen ] of flowerPatch knownPollenPatch  [ set knownPollenPatch -1 ...]

if AddPollen = true and day = 90 [ set TotalPollenAdded TotalPollenAdded + addedPollen_kg]
see AffProc & WorkerIHbeesDevProc
if Aff < AFF_BASE - 7 [ set Aff Aff + 1 ]   if Aff > AFF_BASE + 7 [ set Aff Aff - 1 ]
 while [ not file-at-end? ] [ set AllDaysAllPatchesList sentence AllDaysAllPatchesList (list (list file-read file-read..file-read)) ]

if AlwaysDance = true [ set danceCircuits 40 ]


if id != who [  user-message "Error in id / who!" set BugAlarm true  ]


if (stopDead = true) and (ColonyDied = true) [ stop ]


set ColonyTripDurationSum ColonyTripDurationSum + tripDuration + TIME_UNLOADING


set ColonyTripForagersSum ColonyTripForagersSum + 1

 set nectarConcFlowerPatch CONC_G
 set nectarConcFlowerPatch CONC_R

ifelse ConstantHandlingTime = true  [ set handlingTimeNectar  set handlingTimePollen ]

if (Day = 365) and (totalIHbees + totalForagers < CRITICAL_COLONY_SIZE_WINTER) [ set ColonyDied true ]

ask flowerPatch knownNectarPatch [ set quantityMyl (quantityMyl - ( CROPVOLUME * SQUADRON_SIZE))]

set CumulativeHoneyConsumption CumulativeHoneyConsumption  + DailyHoneyConsumption

set DailyForagingPeriod Foraging_PeriodREP
set DailyHoneyConsumption needHoneyAdult + needHoneyLarvae + TotalWorkerAndDroneBrood * THERMOREGULATION_BROOD

repeat infectedMitesInSingleCell [ if random-float 1 < miteFallProb [ set DailyMiteFall DailyMiteFall + 1 ] ]

set DailyPollenConsumption_g (needPollenAdult + needPollenLarvae) / 1000

set danceCircuits DANCE_SLOPE * EEF + DANCE_INTERCEPT


set danceCircuits DANCE_SLOPE * EEF + DANCE_INTERCEPT


set Day round (ticks mod 365.00001)

set DeathsAdultWorkers_t DeathsAdultWorkers_t + deathsCounter
```

```
set DeathsForagingToday DeathsForagingToday + SQUADRON_SIZE

set DecentHoneyEnergyStore (totalIHbees + totalForagers ) * 1.5 * ENERGY_HONEY_per_g

 if ((details = true) and (continueForaging = true)) [ if WriteFile = true [ WriteToFileProc ] ]

 set detectionProbability DETECT_PROB_G

 set detectionProbability DETECT_PROB_R

 set distanceToColony DISTANCE_G

 set distanceToColony DISTANCE_R

repeat nectarVisitsToday * DotDensity [plotxy xplot yplot ]
if Day < DRONE_EGGLAYING_START or Day > DRONE_EGGLAYING_STOP [ set number 0 ] ; (with number = number of newDroneEggs)
if Day < DRONE_EGGLAYING_START or Day > DRONE_EGGLAYING_STOP [ set number 0 ] ; (with number = number of newDroneEggs)
set newDroneEggs floor(newWorkerEggs * DRONE_EGGS_PROPORTION)
if age = DRONE_EMERGING_AGE [  set newDrones number ]
if age = DRONE_HATCHING_AGE [ set newDroneLarvae number ]

if age >= DRONE_LIFESPAN [ die ]

if age = DRONE_PUPATION_AGE [ set newDronePupae number ]

if EggLaying_IH = true and ELRt_IH < ELRt_HoPoMo [ set ELRt ELRt_IH ]

if age = EMERGING_AGE [ set newIHbees number ]
set EmptyFlightsToday EmptyFlightsToday + SQUADRON_SIZE
set HoneyEnergyStore HoneyEnergyStore - (DailyHoneyConsumption / 1000) * ENERGY_HONEY_per_g

set EEF ((nectarConcFlowerPatch * CROPVOLUME * ENERGY_SUCROSE) - flightCostsNectar) / flightCostsNectar

set ExcessBrood ceiling ( TotalWorkerAndDroneBrood - (TotalIHbees + TotalForagers * FORAGER_NURSING_CONTRIBUTION) * MAX_BROOD_NURSE_RATIO )

if (Experiment = "LF (low, free)") or (Experiment = "LR (low, restricted)") [ set N_INITIAL_BEES 3000..]

if FeedBees = true .. and HoneyEnergyStore / ( ENERGY_HONEY_per_g * 1000 ) < minSummerStore_kg [set HoneyEnergyStore HoneyEnergyStore + (addedFondant_kg * ENERGY_HONEY_per_g * 1000)]

 ifelse random-float 1 < FIND_DANCED_PATCH_PROB [..set activity "bringingNectar"]

set tripDuration 2 * distanceToColony * (1 / FLIGHT_VELOCITY ) + handlingTimeNectar

set HoneyEnergyStore HoneyEnergyStore - ( SEARCH_LENGTH_M * FLIGHTCOSTS_PER_m * SQUADRON_SIZE )

 set excessBrood ceiling ( totalWorkerAndDroneBrood - (totalIHbees + totalForagers * FORAGER_NURSING_CONTRIBUTION) *  MAX_BROOD_NURSE_RATIO )

 if random-float 1 < FORAGING_STOP_PROB [ set activity "resting" ]
```

```
 if ForagingMap = "Nectar foraging" [..  plotxy xplot yplot ]

set ForagingRounds ForagingRounds + 1

set ForagingSpontaneousProb Foraging_ProbabilityREP

set HarvestedHoney_kg (HoneyEnergyStore  / (ENERGY_HONEY_per_g * 1000)) - RemainingHoney_kg

if ((Day >=  harvestingDay) and (Day <  harvestingDay + harvestingPeriod)) ... [ set harvestedHoney_kg (honeyEnergyStore  / (ENERGY_HONEY_per_g * 1000)) - remainingHoney_kg ..]

if ((Day >=  harvestingDay) and (Day <  harvestingDay + harvestingPeriod)) ... [ set harvestedHoney_kg (honeyEnergyStore  / (ENERGY_HONEY_per_g * 1000)) - remainingHoney_kg ..]

if HoneyEnergyStore / ( ENERGY_HONEY_per_g * 1000 ) > harvestingTH [ set harvestedHoney_kg (honeyEnergyStore  / (ENERGY_HONEY_per_g * 1000)) - remainingHoney_kg ]
if age = HATCHING_AGE [ set newWorkerLarvae number ]
set HONEY_STORE_INIT 0.5 * MAX_HONEY_STORE_kg * 1000



set HoneyEnergyStoreYesterday HoneyEnergyStore

 if ((Day >=  harvestingDay) and (Day <  harvestingDay + harvestingPeriod) and (HoneyHarvesting = true)) [ set HoneyEnergyStore HoneyEnergyStore - (harvestedHoney_kg * ENERGY_HONEY_per_g * 1000)]
if HoneyIdeal = true [ set HoneyEnergyStore MAX_HONEY_ENERGY_STORE ]

set HoPoMo_seasont Season_HoPoMoREP day []

set IdealPollenStore_g DailyPollenConsumption_g * pollenStoreLasting_d
set InhivebeesDiedToday DeathsAdultWorkers_t

file-open INPUT_FILE

 ask droneLarvaeCohorts with [ age = INVADING_DRONE_CELLS_AGE ] [ set suitableDroneCells number ]
ask larvaeCohorts with [ age = INVADING_WORKER_CELLS_AGE ] [ set suitableWorkerCells number ]
set InvadingMitesDroneCellsReal InvadingMitesDroneCellsTheo  - exitingMites + (InvadingMitesWorkerCellsTheo - InvadingMitesWorkerCellsReal)

set InvadingMitesDroneCellsTheo InvadingMitesDroneCellsTheo + 1

set InvadingMitesWorkerCellsReal InvadingMitesWorkerCellsTheo - exitingMites

set InvadingMitesWorkerCellsTheo InvadingMitesWorkerCellsTheo + 1

ask foragerSquadrons [ if age >= LIFESPAN [die]]

set lostBroodToday lostBroodToday + excessBrood

set lostBroodTotal lostBroodTotal + excessBrood

if Aff > MAX_AFF [ set Aff MAX_AFF ]


set excessBrood ceiling ( totalWorkerAndDroneBrood - (totalIHbees + totalForagers * FORAGER_NURSING_CONTRIBUTION) *  MAX_BROOD_NURSE_RATIO )

if TotalWorkerAndDroneBrood + ELRt > MAX_BROODCELLS [ set ELRt MAX_BROODCELLS - TotalWorkerAndDroneBrood ]
if danceCircuits > MAX_DANCE_CIRCUITS [ set danceCircuits MAX_DANCE_CIRCUITS ]
```

```
let ELRt_HoPoMo (MAX_EGG_LAYING * (1 - HoPoMo_seasont))
if HoneyEnergyStore > MAX_HONEY_ENERGY_STORE [ set HoneyEnergyStore MAX_HONEY_ENERGY_STORE ]
set MAX_HONEY_ENERGY_STORE MAX_HONEY_STORE_kg * ENERGY_HONEY_per_g * 1000
if MiteReproductionModel = "Fuchs&Langenbach"  [ set MAX_INVADED_MITES_DRONECELL 16 ]
if MiteReproductionModel = "Fuchs&Langenbach"  [ set MAX_INVADED_MITES_WORKERCELL 8 ]

ask foragerSquadrons [ if km_today >= MAX_km_PER_DAY [ set activity "resting"] ]
set ProbPollenCollection (1 - PollenStore_g / IdealPollenStore_g) * MAX_PROPORTION_POLLEN_FORAGERS
ask foragerSquadrons [ if mileometer >= MAX_TOTAL_KM [ die ] ]

if MergeWeakColonies = true and (totalIHbees + totalForagers) < MergeColoniesTH and day = winterPauseStart [create-foragerSquadrons (MergeColoniesTH / SQUADRON_SIZE)]

if MergeWeakColonies = true and (totalIHbees + totalForagers) < MergeColoniesTH and day = winterPauseStart [create-foragerSquadrons (MergeColoniesTH / SQUADRON_SIZE)]
if Aff < MIN_AFF [ set Aff MIN_AFF ]
if IdealPollenStore_g < MIN_IDEAL_POLLEN_STORE [ set IdealPollenStore_g MIN_IDEAL_POLLEN_STORE ]
let miteFallProb MITE_FALL_DRONECELL

if ploidyMiteOrg = 2 [ set miteFallProb MITE_FALL_WORKERCELL ]
 if (totalEggs + totalLarvae + totalPupae + totalDroneEggs + totalDroneLarvae + totalDronePupae) > 0 [ set phoreticMites (phoreticMites - random-poisson (phoreticMites *  MITE_MORTALITY_BROODPERIOD))]
 if (totalEggs + totalLarvae + totalPupae + totalDroneEggs + totalDroneLarvae + totalDronePupae) = 0 [ set phoreticMites (phoreticMites - random-poisson (phoreticMites *  MITE_MORTALITY_WINTER))]
 if MiteReproductionModel = "Martin" [ set MAX_INVADED_MITES_DRONECELL 4 set MAX_INVADED_MITES_WORKERCELL 4 ]

ifelse modelledInsteadCalcDetectProb = true [ set detectionProbability modelledDetectProb ] [ set detectionProbability calcDetectProb ]

set number (number - random-poisson (number * MORTALITY_DRONE_EGGS))
set numberDied random-poisson (number * MORTALITY_DRONE_LARVAE)
set numberDied random-poisson (number * MORTALITY_DRONE_PUPAE)
set number_healthy (number_healthy - random-poisson (number_healthy * MORTALITY_DRONES))
set number_infectedAsPupa (number_infectedAsPupa - random-poisson (number_infectedAsPupa * MORTALITY_DRONES_INFECTED_AS_PUPAE))
set number (number - random-poisson (number * MORTALITY_EGGS))
 set mortalityRisk 1 - ((1 - MORTALITY_FOR_PER_SEC) ^ tripDuration)
```

```
let dailyRiskToDie MORTALITY_INHIVE

if infectionState = "infectedAsAdult" [ set dailyRiskToDie MORTALITY_INHIVE_INFECTED_AS_ADULT ]

if infectionState = "infectedAsPupa" [ set dailyRiskToDie MORTALITY_INHIVE_INFECTED_AS_PUPA ]

set numberDied random-poisson (number * MORTALITY_LARVAE)
set numberDied random-poisson (number * MORTALITY_PUPAE)
repeat N_FLOWERPATCHES [ set ... ]
while [ i <= N_GENERIC_PLOTS ] [..]
set newForagerSquadronsHealthy (N_INITIAL_BEES / SQUADRON_SIZE)
set phoreticMites N_INITIAL_MITES_HEALTHY + N_INITIAL_MITES_INFECTED
set phoreticMites N_INITIAL_MITES_HEALTHY + N_INITIAL_MITES_INFECTED
set NectarFlightsToday NectarFlightsToday + SQUADRON_SIZE
set NewDroneEggs floor(NewWorkerEggs * DRONE_EGGS_PROPORTION)

if age = DRONE_HATCHING_AGE [ set NewDroneLarvae number ]

 if age = DRONE_PUPATION_AGE [ set NewDronePupae number ]

if age = DRONE_EMERGING_AGE [ set NewDrones number ]

if age = DRONE_EMERGING_AGE [ set NewDrones_healthy number_healthy ]

if age >= Aff [ set newForagerSquadronsHealthy floor (number_healthy / SQUADRON_SIZE) + newForagerSquadronsHealthy ]

set NewForagerSquadronsInfectedAsAdults floor (number_infectedAsAdult / SQUADRON_SIZE)  + NewForagerSquadronsInfectedAsAdults

set NewForagerSquadronsInfectedAsPupae floor (number_infectedAsPupa / SQUADRON_SIZE) + NewForagerSquadronsInfectedAsPupae

if age = EMERGING_AGE [ set NewIHbees number ]

if age = EMERGING_AGE [ set NewIHbees_healthy number_healthy ]

set NewReleasedMitesToday NewReleasedMitesToday + mitesHealthy&InfectedSumUncappedCells
set NewWorkerEggs round ELRt

if age = HATCHING_AGE [ set NewWorkerLarvae number ]

if age = PUPATION_AGE [ set NewWorkerPupae number ]

set PATCHCOLOR 38 ask patches [ set pcolor PATCHCOLOR ]

set PhoreticMites PhoreticMites + allMitesInSingleCell

let healthyPhoreticMites round (PhoreticMites * PhoreticMitesHealthyRate)

ask n-of POLLEN_DANCE_FOLLOWERS foragerSquadrons with [ activity = "resting" ] [ set knownPollenPatch patchNumberDanced ]

ask flowerPatch 1 [set amountPollen_g POLLEN_G_kg * 1000  ]
ask flowerPatch 1 [set amountPollen_g POLLEN_R_kg * 1000  ]
set PollenStore_g POLLEN_STORE_INIT
set PollenFlightsToday PollenFlightsToday + SQUADRON_SIZE

if PollenIdeal = true [ set PollenStore_g IdealPollenStore_g ]
```

```
ask foragerSquadrons with [ activity = "bringingPollen" ] [ set collectedPollen POLLENLOAD ]

set PollenStore_g PollenStore_g - DailyPollenConsumption_g

set PollenStore_g_Yesterday PollenStore_g
if SwarmingDate > 0 and Swarming = "Swarm (daughter colony)" and day > SwarmingDate and day <= SwarmingDate + POST_SWARMING_PERIOD [ set newWorkerEggs 0 ...]

if SwarmingDate > 0 and day >= SwarmingDate - PRE_SWARMING_PERIOD and day <= SwarmingDate [ set newWorkerEggs 0  ...]

 ask foragerSquadrons [ if age > ageLaziness and random-float 1 < ProbLazinessWinterbees and random-float 1 < (honeyEnergyStore / DecentHoneyEnergyStore)  [ set activity "lazy"]

set ProbPollenCollection (1 - PollenStore_g / IdealPollenStore_g) * MAX_PROPORTION_POLLEN_FORAGERS

set PropNewToAllPhorMites NewReleasedMitesToday / ( PhoreticMites + InvadingMitesWorkerCellsReal + InvadingMitesDroneCellsReal)

ifelse PollenStore_g > 0 [ set ProteinFactorNurses ProteinFactorNurses + (1 / PROTEIN_STORE_NURSES_d) ]  [ set ProteinFactorNurses ProteinFactorNurses - (workloadNurses / PROTEIN_STORE_NURSES_d) ]

let starvedBrood ceiling ((totalDroneLarvae + totalLarvae) * (1 - ProteinFactorNurses))
if pupaAlive = 0 [ set Pupae_W&D_KilledByVirusToDay Pupae_W&D_KilledByVirusToDay + 1 ]

if age = PUPATION_AGE [ set newWorkerPupae number ]
 ask flowerPatch 1 [ set quantityMyl QUANTITY_G_l * 1000 * 1000 ]
ask flowerPatch 0 [ set quantityMyl QUANTITY_R_l * 1000 * 1000 ]

if QueenAgeing = true [ let potentialEggs (MAX_EGG_LAYING + (-0.0027 * Queenage ^ 2) + (0.395 * queenage))]

if QueenAgeing = true [ if Queenage >= 375 [ set Queenage 10 ]]

if RAND_SEED != 0 [ random-seed RAND_SEED ]

if ReadInfile = true [ ReadFileProc ]

set RecruitedFlightsToday RecruitedFlightsToday + SQUADRON_SIZE

set HoneyEnergyStore HoneyEnergyStore - (harvestedHoney_kg * ENERGY_HONEY_per_g * 1000)

set saveInvadedMODRONELarvaeToPupae invadedByMiteOrganiserID

set SaveInvadedMOWorkerLarvaeToPupae invadedByMiteOrganiserID

if age = DRONE_PUPATION_AGE [ set SaveWhoDroneLarvaeToPupae who ]

if age = PUPATION_AGE [ set SaveWhoWorkerLarvaeToPupae who ]

ask foragerSquadrons with [ activity = "searching" ] [ set mileometer mileometer + ( SEARCH_LENGTH_M / 1000 )]
```

```
set SearchingFlightsToday SearchingFlightsToday + SQUADRON_SIZE
if ( Day > SEASON_START ) and (Day < SEASON_STOP ).. [ while [ continueForaging = true ] [..ForagingRoundProc..]]
if ( Day > SEASON_START ) and (Day < SEASON_STOP ).. [ while [ continueForaging = true ] [..ForagingRoundProc..]]
 if SeasonalFoodFlow = false [ ask flowerPatch 0 [ set quantityMyl QUANTITY_R_l * 1000 * 1000 set amountPollen_g POLLEN_R_kg * 1000  ]]

ifelse SeasonalFoodFlow = true [ let patchDayG day + SHIFT_G ]

ifelse SeasonalFoodFlow = true [ let patchDayR day + SHIFT_R ]

if showAllPlots = true [ DrawForagingMapProc ]

if SimpleDancing = true [ ifelse EEF > 20 [ set danceCircuits 40 ]   [ set danceCircuits 0 ] ]

 set NewForagerSquadronsHealthy floor (number_healthy / SQUADRON_SIZE) + NewForagerSquadronsHealthy

repeat ceiling( 10 * number / STEPWIDTH) [ fd 0.1 set pcolor color ]

repeat ceiling( number / STEPWIDTHdrones) [ fd 1 set pcolor color ]

if (stopDead = true) and (ColonyDied = true) [ stop ]
set SumLifeSpanAdultWorkers_t SumLifeSpanAdultWorkers_t + (age * SQUADRON_SIZE)
set SummedForagerSquadronsOverTime SummedForagerSquadronsOverTime + NewForagerSquadronsHealthy + NewForagerSquadronsInfectedAsPupae + NewForagerSquadronsInfectedAsAdults

if Swarming != "No swarming" [ SwarmingProc ]

if totalWorkerAndDroneBrood > 7000 and SwarmingDate = 0 [ set SwarmingDate (day + PRE_SWARMING_PERIOD) ]

if Testing = "xy_Test" [ ...]

if ConstantHandlingTime = true  [ set handlingTimeNectar TIME_NECTAR_GATHERING ]

ifelse ConstantHandlingTime = true [ set handlingTimePollen TIME_POLLEN_GATHERING ]

set ColonyTripDurationSum ColonyTripDurationSum + tripDuration + TIME_UNLOADING

set ColonyTripDurationSum ColonyTripDurationSum + tripDurationPollen + TIME_UNLOADING_POLLEN ]

set TodaysAllPatchesList fput TodaysSinglePatchList TodaysAllPatchesList
set TodaysSinglePatchList (item counter AllDaysAllPatchesList)
```

set TotalBeesAdded TotalBeesAdded + MergeColoniesTH

set TotalDroneEggs (TotalDroneEggs + number)

set TotalDroneLarvae (TotalDroneLarvae + number)

set TotalDronePupae (TotalDronePupae + number)

set TotalDrones (TotalDrones + number)

set TotalEggs (TotalEggs + number)

set TotalEventsToday NectarFlightsToday + PollenFlightsToday + EmptyFlightsToday

set totalForagers (count foragerSquadrons) * SQUADRON_SIZE

set TotalFPdetectionProb (1 - cumulative_NON-detectionProb)

set TotalHoneyFed_kg TotalHoneyFed_kg + addedFondant_kg

set TotalHoneyHarvested_kg TotalHoneyHarvested_kg + HarvestedHoney_kg

set TotalIHbees (TotalIHbees + number)

set TotalLarvae (TotalLarvae + number)

ask miteOrganisers [set TotalMites TotalMites + cohortInvadedMitesSum] set TotalMites TotalMites + PhoreticMites

set TotalPollenAdded TotalPollenAdded + addedPollen_kg

set TotalPupae (TotalPupae + number)

set TotalWeightBees_kg (totalEggs*0.0001+ totalLarvae * 0.0457 + totalPupae * 0.16 + (totalIHbees + totalForagers) * WEIGHT_WORKER_g   + totalDroneEggs * 0.0001 + totalDrones * 0.22   + totalDroneLarvae *(0.1 * (0.22 / WEIGHT_

set TotalWorkerAndDroneBrood TotalEggs + TotalLarvae + TotalPupae + TotalDroneEggs + TotalDroneLarvae + TotalDronePupae

 if ((varroaTreatment = true) and (Day >= treatmentDay) and (Day <= treatmentDay + treatmentDuration) and (N_INITIAL_MITES_HEALTHY + N_INITIAL_MITES_INFECTED > 0))   [set PhoreticMites round(PhoreticMites * (1 - treatmentE

if Virus = "DWV" [set VIRUS_TRANSMISSION_RATE_MITE_TO_PUPA 0.89 ...]

if pupaInfected = true [if random-float 1 < VIRUS_KILLS_PUPA_PROB [set pupaAlive 0]]

if random-float 1 > (1 - VIRUS_TRANSMISSION_RATE_MITE_TO_PUPA) ^ infectedMitesInSingleCell [set pupaInfected true]

if random-float 1 < VIRUS_TRANSMISSION_RATE_PUPA_TO_MITES [set healthyMitesInSingleCell healthyMitesInSingleCell - 1 set infectedMitesInSingleCell infectedMitesInSingleCell + 1]

if Weather = "Rothamsted (2009)" [set foragingHoursList foragingHoursListRothamsted2009]

let adultsWeight_g (totalIHbees + TotalForagers) * WEIGHT_WORKER_g

if WriteFile = true [WriteToFileProc]

repeat X_days [startProc]

WORKER_g))+ totalDronePupae * (0.16 * (0.22 / WEIGHT_WORKER_g))) / 1000

fficiency))

This table lists all local variables, which are used only in the procedure, where they are defined (some variable names are used in several procedures). Local variables with a const

Variable name	initial value, calculation	Unit	Reference/comment	used in procedure
addedFondant_kg	1	kg		BeekeepingProc
addedPollen_kg	0.5	kg		BeekeepingProc
adultsWeight_g	(TotallHbees+TotalForagers)*WEIGHT_WORKER_g	g		MitesInvasionProc
affYesterDay	Aff	d		AffProc
ageLaziness	100	d		Start_IBM_ForagingProc
allInfectedMitesSwitchingHosts	round (PhoreticMites * PropNewToAllPhorMites * (1 - PhoreticMitesHealthyRate) + mitesReleasedFromInhivebees * (1 - PhoreticMitesHealthyRate))			MitePhoreticPhaseProc
allMitesInSingleCell	-1			MitesReleaseProc
averageOffspring	random-poisson (MiteOffspringREP ploidyMiteOrg * MiteDensityFactorREP ploidyMiteOrg mitesIndex)			MitesReleaseProc
broodSwarmingTH	17000	bees	Fefferman & Starks 2006 (model)	SwarmingProc
broodTH	0.1			AffProc
calcDetectProb	item 11 TodaysSinglePatchList			Create_Read-in_FlowerPatchesProc
cell	-1			MitesInvasionProc
cellCounter	0			MitesReleaseProc
cellListCondensed	[]			MitesReleaseProc
chosenPatch	-1	id		Foraging_searchingProc
continueForaging	true			Start_IBM_ForagingProc
counter	(Day - 1)			DailyUpdateProc
counter	0			Create_Read-in_FlowerPatchesProc; MitesInvasionProc; MiteOrganisersUpdateProc
cumulative_NON-detectionProb	1			Foraging_searchingProc
currentLazy	SQUADRON_SIZE * count foragerSquadrons with [activity = "lazy"]	bees		ForagingRoundProc
currentNectarForagers	SQUADRON_SIZE * count foragerSquadrons with [activity = "expForaging" and pollenForager = false]	bees		ForagingRoundProc
currentPollenForagers	SQUADRON_SIZE * count foragerSquadrons with [activity = "expForaging" and pollenForager = true]	bees		ForagingRoundProc
currentRecruits	SQUADRON_SIZE * count foragerSquadrons with [activity = "recForaging"]	bees		ForagingRoundProc
currentResters	SQUADRON_SIZE * count foragerSquadrons with [activity = "resting"]	bees		ForagingRoundProc
currentScouts	SQUADRON_SIZE * count foragerSquadrons with [activity = "searching"]	bees		ForagingRoundProc

DAILY_HONEY_NEED_ADULT_DRONE	10	mg/d	Winston(1987) p62: resting drone 1-3mg sugar/hr; flying drone: 14mg/hr (Mindt 1962); assumptions: 22h resting, 2h flying; 1 mg sucrose = 17J; 1kJ = 0.008013g Honig	HoneyConsumptionProc
DAILY_HONEY_NEED_ADULT_RESTING	11	mg/d	Rortais et al 2005: Winter bees: 11 mg/d	HoneyConsumptionProc
DAILY_HONEY_NEED_DRONE_LARVA	19.2	mg/d	Rortais et al 2005: 98.2mg sugar in 6.5d; sugar to honey: x1.272 i.e. 124.9mg honey in total or 19.2 mg/d	HoneyConsumptionProc
DAILY_HONEY_NEED_LARVA	65.4/(PUPATION_AGE-HATCHING_AGE)	mg/d	Schmickl & Crailsheim (2007): 65.4 mg / 6 days	HoneyConsumptionProc
DAILY_HONEY_NEED_NURSES	53.42	mg/d	Rortais et al 2005: average for "brood attending" 34-50mg sugar/d => 43-64mg/d honey	HoneyConsumptionProc
DAILY_POLLEN_NEED_ADULT	1.5	mg/d	Pernal, Currie (2000): value for 14d old bees, Fig. 3	PollenConsumptionProc
DAILY_POLLEN_NEED_ADULT_DRONE	2	mg/d	estimation	PollenConsumptionProc
DAILY_POLLEN_NEED_DRONE_LARVA	50	mg/d	estimation, Rortais et al. 2005: "The pollen consumption of drone larvae has never been determined."	PollenConsumptionProc
DAILY_POLLEN_NEED_LARVA	142/(PUPATION_AGE-HATCHING_AGE)	mg/d	(=23.6 mg/d) Schmickl & Crailsheim (2007): 142mg in total	PollenConsumptionProc
dailyRiskToDie	MORTALITY_INHIVE	mortality/d		ForagersLifespanProc
danceFollowersNectarNow	random-poisson [danceFollowersNectar] of flowerPatch knownNectarPatch	bees		Foraging_dancingProc
dataList	[]			MiteDensityFactorREP
deathsCounter	0	bees		WorkerIHbeesDevProc
droneCellListTemporary	n-valuessuitableDroneCells[0]			MitesInvasionProc
dustbin	file-read-line			ReadFileProc
EEFdancedPatch	-999			Foraging_dancingProc
ELRt	ELRt_HoPoMo	eggs/d		NewEggsProc
ELRt_HoPoMo	(MAX_EGG_LAYING * (1 - HoPoMo_seasont))	eggs/d		NewEggsProc
ELRt_IH	(TotalIHbees + TotalForagers * FORAGER_NURSING_CONTRIBUTION) * MAX_BROOD_NURSE_RATIO / EMERGING_AGE	eggs/d		NewEggsProc
emergencyProb	0.2			Foraging_ProbabilityREP
emptyTripDuration	SEARCH_LENGTH_M / FLIGHT_VELOCITY	s		Foraging_mortalityProc
energyConsumption	0	kJ		Foraging_flightCosts_flightTimeProc
energyFactor_onFlower	0.2		Kacelnik et al 1986 (BES:19): 0.3 (rough estimation, based on Nunez 1982)	FlowerPatchesUpdateProc
exitingMites	0	mites		MitesInvasionProc
factorDrones	6.49		Boot etal. (1995), Martin (2001)	MitesInvasionProc
factorWorkers	0.56		Boot etal. (1995), Martin (2001)	MitesInvasionProc
filename	"Output.txt"			CreateOutputFileProc
FORAGE_AUTOCORR	0			Foraging_start-stopProc
foragersAlive	SQUADRON_SIZE * count foragerSquadrons	bees		ForagingRoundProc
foragerSquadronsToBeCreated	NewForagerSquadronsHealthy + NewForagerSquadronsInfectedAsPupae + NewForagerSquadronsInfectedAsAdults	forager squadrons		NewForagersProc
foragerToWorkerTH	0.3		Beshers et al. 2001	AffProc

foragingHoursList	[ ]			Foraging_PeriodREP
foragingHoursListBerlin2000	[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 (	h	(Hours sunshine if Tmax > 15degC)	Foraging_PeriodREP
foragingHoursListBerlin2001	[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 (	h	(Hours sunshine if Tmax > 15degC)	Foraging_PeriodREP
foragingHoursListBerlin2002	[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 (	h	(Hours sunshine if Tmax > 15degC)	Foraging_PeriodREP
foragingHoursListBerlin2003	[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 (	h	(Hours sunshine if Tmax > 15degC)	Foraging_PeriodREP
foragingHoursListBerlin2004	[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 (	h	(Hours sunshine if Tmax > 15degC)	Foraging_PeriodREP
foragingHoursListBerlin2005	[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 (	h	(Hours sunshine if Tmax > 15degC)	Foraging_PeriodREP
foragingHoursListBerlin2006	[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 (	h	(Hours sunshine if Tmax > 15degC)	Foraging_PeriodREP
foragingHoursListRothamsted2009	[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	h	(Hours sunshine if Tmax > 15degC)	Foraging_PeriodREP
foragingHoursListRothamsted2010	[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	h	(Hours sunshine if Tmax > 15degC)	Foraging_PeriodREP
foragingHoursListRothamsted2011	[0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0	h	(Hours sunshine if Tmax > 15degC)	Foraging_PeriodREP
foragingPeriod_s	-1	s		Foraging_PeriodREP
foragingProbability	0.01		0.01	Foraging_ProbabilityREP
fractionSwarm	0.6		Winston (1987) p. 187: 0.6	SwarmingProc
HANGING_AROUND	SEARCH_LENGTH_M / FLIGHT_VELOCITY	s		Start_IBM_ForagingProc
healthyMitesInSingleCell	allMitesInSingleCell-infectedMitesInSingleCell	mites		MitesReleaseProc
healthyPhoreticMites	round(PhoreticMites*PhoreticMitesHealthyRate)	mites		MitePhoreticPhaseProc
healthyPhoreticMitesSwitchingHosts	round (mitesReleasedFromInhivebees * PhoreticMitesHealthyRate + PhoreticMites * PropNewToAllPhorMites * PhoreticMitesHealthyRate)	mites		MitePhoreticPhaseProc
healthyRateMiteOrg	0	mites/mites	proportion of healthy mites in the current cohort (miteOrganiser)	MitesReleaseProc
highForProb	0.05		0.02	Foraging_ProbabilityREP
honeyTH	35* (DailyHoneyConsumption / 1000) * ENERGY_HONEY_per_g			AffProc
i	1			ForagingRoundProc; Foraging_ProbabilityREP; GenericPlotClearProc
i	0			MitesReleaseProc
id	item 1 TodaysSinglePatchList	id	patch number	DailyUpdateProc
infectedMitesInSingleCell	0	mites		MitesReleaseProc
infectedMitesSwitchingHostsInThisCohort	(allInfectedMitesSwitchingHosts / TotalIHbees) * number	mites	# of infected mites switching their host in current bee cohort: # mites per ih-bee * number of ih-bees in this cohort (assumes an equal distribution of mites)	MitePhoreticPhaseProc
infectedPhoreticMites	PhoreticMites-healthyPhoreticMites	mites		MitePhoreticPhaseProc
inputYear	2011 + round ((ceiling (ticks / 365)) mod 3)	year		Foraging_PeriodREP
inputYear	2006 + round ((ceiling (ticks / 365)) mod 7)	year		Foraging_PeriodREP
invadingBroodCellProb	0			MitesInvasionProc
invadingWorkerCellProb	0			MitesInvasionProc
lackNurses	false			BroodCareProc
lackProtein	false			BroodCareProc
lastSwarmingDate	199	Julian day	Winston 1980: prime: 14.05.(134) after swarm: 18.07.(199)	SwarmingProc
meanTripDuration	0	s		Start_IBM_ForagingProc
memoColor	0			Foraging_collectNectarPollenProc

memory	-1			MitesInvasionProc
minSummerStore_kg	3	kg		BeekeepingProc
minWinterStore_kg	16	kg		BeekeepingProc
miteFallProb	MITE_FALL_DRONECELL			MitesReleaseProc
mitesHealthy&InfectedSumUncappedCells	0	mites	sums up the healthy and infected mites of the current cohort	MitesReleaseProc
mitesHealthySumUncappedCells	0	mites	sums up the healthy mites of the current cohort	MitesReleaseProc
mitesIndex	allMitesInSingleCell			MitesReleaseProc
mitesInfectedSumUncappedCells	0	mites		MitesReleaseProc
mitesReleasedFromInhivebees	precision (phoreticMitesPerIHbee * (InhivebeesDiedToday + SQUADRON_SIZE * (NewForagerSquadronsHealthy + NewForagerSquadronsInfectedAsPupae + NewForagerSquadronsInfectedAsAdults))) 5	mites		MitePhoreticPhaseProc
modelledDetectProb	item 12 TodaysSinglePatchList			Create_Read-in_FlowerPatchesProc
nectarAvailable	quantityMyl/CROPVOLUME	nectar loads	# crop loads available	DrawForagingMapProc
needHoneyAdult	(TotalIHbees + TotalForagers) * DAILY_HONEY_NEED_ADULT_RESTING + TotalDrones * DAILY_HONEY_NEED_ADULT_DRONE	mg/d		HoneyConsumptionProc
needHoneyLarvae	TotalLarvae * DAILY_HONEY_NEED_LARVA + TotalDroneLarvae * DAILY_HONEY_NEED_DRONE_LARVA	mg/d		HoneyConsumptionProc
needPollenAdult	((TotalIHbees + TotalForagers) * DAILY_POLLEN_NEED_ADULT + TotalDrones * DAILY_POLLEN_NEED_ADULT_DRONE)	mg/d		PollenConsumptionProc
needPollenLarvae	(TotalLarvae*DAILY_POLLEN_NEED_LARVA + TotalDroneLarvae * DAILY_POLLEN_NEED_DRONE_LARVA)	mg/d		PollenConsumptionProc
newCreatedBees	0	forager squadrons		NewForagersProc
newlyInfectedIHbeesInThisCohort	0	bees		MitePhoreticPhaseProc
newlyInfectedMites	0	mites		MitePhoreticPhaseProc
nowAvailablePatchesList	[ ]			Foraging_searchingProc
nPhoreticMitesBeforeEmergenceHealthy	round(PhoreticMitesHealthyRate*PhoreticMites)	mites		MitesReleaseProc
nPhoreticMitesBeforeEmergenceInfected	PhoreticMites-nPhoreticMitesBeforeEmergenceHealthy	mites		MitesReleaseProc
overagedIHbees	0	bees		WorkerIHbeesDevProc
p	random-float probSum		to decide which flower patch is found	Foraging_searchingProc
patchCounter	0			Foraging_searchingProc
patchDayG	day + SHIFT_G			FlowerPatchesMaxFoodAvailableTodayREP
patchDayR	day + SHIFT_R			FlowerPatchesMaxFoodAvailableTodayREP
patchNumberDanced	-999	id		Foraging_dancingProc
phoreticMitesPerIHbee	0	mites		MitePhoreticPhaseProc

plotname	(word "Generic plot " i)			ForagingRoundProc; Foraging_ProbabilityREP; GenericPlotClearProc
pollenAvailable	amountPollen_g/POLLENLOAD	pollen loads		DrawForagingMapProc
pollenStoreLasting_d	7	d	Seeley 1995, p. 193: "a week or so", HoPoMo: "FACTORpollenstorage" = 6	PollenConsumptionProc
pollenTH	0.5			AffProc
potentialEggs	(MAX_EGG_LAYING + (-0.0027 * queenage ^ 2) + (0.395 * queenage))	eggs		NewEggsProc
probSum	0		to decide, which flower patch is found	Foraging_searchingProc
proportionPollen	0			DrawForagingMapProc
proteinTH	1			AffProc
pupaAlive	1		(0 or 1) 1: = "yes", pupa is alive 0: = "no", pupa is dead	MitesReleaseProc
pupaInfected	FALSE		a young larva is healthy	MitesReleaseProc
radius	sqrt(size_sqm/pi)	m	the (hypothetical) radius of the patch (assumed to be circular)	DrawForagingMapProc
randomCell	(random totalCells) + 1	id	choses a random cell -> 1..totalCells (+1 as: random n = 0, 1, ..n-1)	MitesReleaseProc
rD	0		rD: Rate of invasion into drone cells (Boot et al. 1995)	MitesInvasionProc
releasedPupaeCohortsID	-1	id		MitesReleaseProc
repetitions	MAX_INVADED_MITES_WORKERCELL+1			MitesReleaseProc
requeening	TRUE			BeekeepingProc
result	0			MiteOffspringREP
rW	0		rW: Rate of invasion into worker cells (Boot et al. 1995)	MitesInvasionProc
saveWho	who	id		NewWorkerPupaeProc; NewDronePupaeProc
seas1	(1 - (1 / (1 + x1 * e ^ (-2 * today / x2))))			Season_HoPoMoREP
seas2	(1 / (1 + x3 * e ^ (-2 * (today - x4) / x5)))			Season_HoPoMoREP
starvedBrood	ceiling ((TotalDroneLarvae + TotalLarvae) * (1 - ProteinFactorNurses))	bees		BroodCareProc
stillToKill	ExcessBrood	bees		BroodCareProc
suitableDroneCells	0	cells		MitesInvasionProc
suitableWorkerCells	0	cells		MitesInvasionProc
summedTripDuration	0	s		Start_IBM_ForagingProc
THERMOREGULATION_BROOD	(DAILY_HONEY_NEED_NURSES-DAILY_HONEY_NEED_ADULT_RESTING) / MAX_BROOD_NURSE_RATIO	mg/d	additional cost per broodcell (= Thermoregulation): difference between nursing and resting divided by # broodcells	HoneyConsumptionProc
totalCells	0	cells		MitesReleaseProc
totalHealthyWorkers	0	bees		MitePhoreticPhaseProc
totalInfectedWorkers	0	bees		MitePhoreticPhaseProc
totalNectarAvailableToDay	0	µl		GenericPlottingProc
totalPollenAvailableToDay	0	g		GenericPlottingProc
treatmentDay	270	Julian day		BeekeepingProc
treatmentDuration	40	d	(28-40d) Fries et al. 1994	BeekeepingProc
treatmentEfficiency	0.115			BeekeepingProc

tripDurationDancedPatch	-999	s	trip duration for advertised pollen patch; not defined yet	Foraging_dancingProc
uncappedCells	0	cells	number of cells that are uncapped...	MitesReleaseProc
whoMO	who	id	stores the "who" of the current miteOrganiser	MitesInvasionProc
winterPauseStart	320	Julian day	320 = midNovember	BeekeepingProc
winterPauseStop	45	Julian day	45 = midFebruary	BeekeepingProc
workerCellListTemporary	n-values suitableWorkerCells [0]			MitesInvasionProc
workloadNurses	0			PollenConsumptionProc
x1	385		Schmickl & Crailsheim 2007	Season_HoPoMoREP
x2	25		(Schmickl & Crailsheim 2007: x3 = 30; value of 25 results in increased egg laying in spring)	Season_HoPoMoREP
x3	36		Schmickl & Crailsheim 2007	Season_HoPoMoREP
x4	155		Schmickl & Crailsheim 2007	Season_HoPoMoREP
x5	30		Schmickl & Crailsheim 2007	Season_HoPoMoREP
xplot	0	m	x coordinate randomly chosen from centre +- radius	DrawForagingMapProc
year	ceiling(ticks/365)	year		WriteToFileProc
yplot	0	m		DrawForagingMapProc
yRange	sqrt((radius^2)-((xplot-xcorMap)^2))	m		DrawForagingMapProc

ant value are shown in capitals.

This table lists all state variables of entities.

Entity	Variable	Unit	comment
droneCohorts	number_healthy	bees	# uninfected bees in this cohort
droneCohorts	number_infectedAsPupa	bees	# bees infected as pupae in this cohort
dronePupaeCohorts	number_healthy	bees	# uninfected bees in this cohort
dronePupaeCohorts	number_infectedAsPupa	bees	# bees infected as pupae in this cohort
flowerPatches	amountPollen_g	g	quantity of available pollen [g]
flowerPatches	danceCircuits	circuits	calculated from EEF, following Seeley 1994
flowerPatches	danceFollowersNectar	bees	number of possible recruits for nectar patches, calculated from danceCircuits
flowerPatches	detectionProbability		probability that a scout finds the flower patch
flowerPatches	distanceToColony	m	distance of the patch to the colony
flowerPatches	EEF		energetic efficiency calculated from nectar concentration and costs
flowerPatches	flightCostsNectar	kJ	energetic costs calculated from trip length and handling time
flowerPatches	flightCostsPollen	kJ	energetic costs calculated from trip length and handling time
flowerPatches	handlingTimeNectar	s	handling times based on depletion of nectar/pollen at patch
flowerPatches	handlingTimePollen	s	handling times based on depletion of nectar/pollen at patch
flowerPatches	mortalityRisk		risk to die during nectar foraging trip, calculated from trip length and handlingTimeNectar
flowerPatches	mortalityRiskPollen		risk to die during pollen foraging trip, calculated from trip length and handlingTimePollen
flowerPatches	nectarConcFlowerPatch	mol/l	sugar concentration of provided nectar
flowerPatches	nectarVisitsToday	bees	# of bees collected nectar from that patch today
flowerPatches	oldPatchID	id	refers to the ID of a flower patch in a separate landscape module, where real landscapes can be analysed
flowerPatches	patchType		crop type of the flower patch, e.g. "oilseed rape"
flowerPatches	pollenVisitsToday	bees	# of bees collected pollen from that patch today
flowerPatches	quantityMyl	µl	quantity of available nectar
flowerPatches	size_sqm	m^2	size of the patch (used for visualization in 'foraging map' plot)
flowerPatches	summedVisitors	bees	number of visits by forager squadrons x Squadron size
flowerPatches	tripDuration	s	duration of trip calculated from distance and handlingTimeNectar
flowerPatches	tripDurationPollen	s	duration of trip calculated from distance and handlingTimePollen
flowerPatches	xcorMap	m	x-coordinate of patch centre (used for visualization in 'foraging map' plot)
flowerPatches	ycorMap	m	y-coordinate of patch centre (used for visualization in 'foraging map' plot)
foragerSquadrons	activity		the current activity
foragerSquadrons	activityList		record of all activities performed during a day
foragerSquadrons	collectedPollen	g	amount of collected pollen
foragerSquadrons	cropEnergyLoad	kJ	energy load of nectar in the honey stomach
foragerSquadrons	infectionState		healthy, infectedAsPupa or infectedAsAdult
foragerSquadrons	km_today	km	summed flight distance during a day
foragerSquadrons	knownNectarPatch	id	patch id
foragerSquadrons	knownPollenPatch	id	patch id
foragerSquadrons	mileometer	km	total flight distance
foragerSquadrons	pollenForager		true or false; if false: nectar forager!
IHbeeCohorts	number_healthy	bees	# uninfected bees in this cohort
IHbeeCohorts	number_infectedAsAdult	bees	# bees infected as adults in this cohort
IHbeeCohorts	number_infectedAsPupa	bees	# bees infected as pupae in this cohort
miteOrganisers	cohortInvadedMitesSum	mites	sum of all mites that invaded a worker or drone cell on that day
miteOrganisers	droneCellListCondensed		sums up the drone cells entered by 0, 1, 2..n mites in the mitesOrganisers own list
miteOrganisers	invadedDroneCohortID	id	ID of the drone cohort, which is invaded by mites
miteOrganisers	invadedMitesHealthyRate		proportion of uninfected mites in those mites, invading brood cohorts today
miteOrganisers	invadedWorkerCohortID	id	ID of the worker cohort, which is invaded by mites
miteOrganisers	workerCellListCondensed		sums up the worker cells entered by 0, 1, 2..n mites in the mitesOrganisers own list

pupaeCohorts	number_healthy	bees	# uninfected bees in this cohort
pupaeCohorts	number_infectedAsPupa	bees	# bees infected as pupae in this cohort
turtles	age	d	age
turtles	invadedByMiteOrganiserID	id	ID of the miteOrganiser, which stores # and distribution of mites in the brood cells
turtles	number	bees	number of individuals in this cohort
turtles	numberDied	bees	number of individuals died in this cohort
turtles	ploidy		ploidy (1: drone, 2: worker)

This table lists the parameter values set by the initialisation buttons. Only values for global variables defined on the interface are set.

Scenario-button	Global variable	Value
"DEFAULT" button	AddPollen	FALSE
"DEFAULT" button	AlwaysDance	FALSE
"DEFAULT" button	CONC_G	1.5
"DEFAULT" button	CONC_R	1.5
"DEFAULT" button	ConstantHandlingTime	FALSE
"DEFAULT" button	CRITICAL_COLONY_SIZE_WINTER	4000
"DEFAULT" button	Details	TRUE
"DEFAULT" button	DANCE_INTERCEPT	0
"DEFAULT" button	DANCE_SLOPE	1.16
"DEFAULT" button	DETECT_PROB_G	0.2
"DEFAULT" button	DETECT_PROB_R	0.2
"DEFAULT" button	DISTANCE_G	500
"DEFAULT" button	DISTANCE_R	1500
"DEFAULT" button	Dot_Density	0.01
"DEFAULT" button	EggLaying_IH	TRUE
"DEFAULT" button	Experiment	"none"
"DEFAULT" button	FeedBees	FALSE
"DEFAULT" button	ForagingMap	"Nectar and Pollen"
"DEFAULT" button	GenericPlot1	"aff & lifespan"
"DEFAULT" button	GenericPlot2	"colony structure workers"
"DEFAULT" button	GenericPlot3	"broodcare [%]"
"DEFAULT" button	GenericPlot4	"mites"
"DEFAULT" button	GenericPlot5	set GenericPlot5 "nectar availability [l]"
"DEFAULT" button	GenericPlot6	"pollen availability [kg]"
"DEFAULT" button	GenericPlot7	"mean trip duration"
"DEFAULT" button	GenericPlot8	"foragers today [%]"
"DEFAULT" button	HarvestingDay	135
"DEFAULT" button	HarvestingPeriod	80
"DEFAULT" button	HarvestingTH	20
"DEFAULT" button	HoneyHarvesting	FALSE
"DEFAULT" button	HoneyIdeal	FALSE
"DEFAULT" button	INPUT_FILE	"Input_2-1_FoodFlow.txt"
"DEFAULT" button	MAX_BROODCELLS	2000099
"DEFAULT" button	MAX_km_PER_DAY	7299
"DEFAULT" button	MAX_HONEY_STORE_kg	50
"DEFAULT" button	MergeColoniesTH	5000
"DEFAULT" button	MergeWeakColonies	FALSE
"DEFAULT" button	MiteReproductionModel	"Martin"
"DEFAULT" button	ModelledInsteadCalcDetectProb	FALSE
"DEFAULT" button	N_INITIAL_BEES	10000
"DEFAULT" button	N_INITIAL_MITES_HEALTHY	0
"DEFAULT" button	N_INITIAL_MITES_INFECTED	0
"DEFAULT" button	POLLEN_G_kg	1
"DEFAULT" button	POLLEN_R_kg	1
"DEFAULT" button	PollenIdeal	FALSE
"DEFAULT" button	ProbLazinessWinterbees	0
"DEFAULT" button	QUANTITY_G_l	20

"DEFAULT" button	QUANTITY_R_l	20
"DEFAULT" button	QueenAgeing	FALSE
"DEFAULT" button	ReadInfile	FALSE
"DEFAULT" button	RemainingHoney_kg	5
"DEFAULT" button	SeasonalFoodFlow	TRUE
"DEFAULT" button	SHIFT_G	-40
"DEFAULT" button	SHIFT_R	30
"DEFAULT" button	ShowAllPlots	TRUE
"DEFAULT" button	SQUADRON_SIZE	100
"DEFAULT" button	StopDead	TRUE
"DEFAULT" button	Swarming	"No swarming"
"DEFAULT" button	Testing	"SIMULATION - NO TEST"
"DEFAULT" button	TIME_NECTAR_GATHERING	1200
"DEFAULT" button	TIME_POLLEN_GATHERING	600
"DEFAULT" button	VarroaTreatment	FALSE
"DEFAULT" button	Virus	"DWV"
"DEFAULT" button	Weather	"Rothamsted (2009)"
"DEFAULT" button	WriteFile	FALSE
not defined in "Default" button:		
	(Rand_Seed)	*not defined*
	(X_Days)	*not defined*
	(Input_File)	*not defined*

"2 patches" button	ReadInfile	FALSE
"2 patches" button	QUANTITY_R_l	20
"2 patches" button	QUANTITY_G_l	20
"2 patches" button	CONC_R	1.5
"2 patches" button	CONC_G	1.5
"2 patches" button	POLLEN_R_kg	1
"2 patches" button	POLLEN_G_kg	1
"2 patches" button	DISTANCE_R	1500
"2 patches" button	DISTANCE_G	500
"2 patches" button	ConstantHandlingTime	FALSE
"2 patches" button	seasonalFoodFlow	TRUE
"2 patches" button	SHIFT_R	30
"2 patches" button	shift_G	-40
"2 patches" button	TIME_NECTAR_GATHERING	1200
"2 patches" button	TIME_POLLEN_GATHERING	600
"2 patches" button	DETECT_PROB_R	0.2
"2 patches" button	DETECT_PROB_G	0.2

"1 feeder" button	ReadInfile	FALSE
"1 feeder" button	QUANTITY_R_l	20
"1 feeder" button	QUANTITY_G_l	0
"1 feeder" button	CONC_R	1.5
"1 feeder" button	POLLEN_R_kg	2
"1 feeder" button	POLLEN_G_kg	0
"1 feeder" button	DISTANCE_R	1500

"1 feeder" button	ConstantHandlingTime	TRUE
"1 feeder" button	seasonalFoodFlow	FALSE
"1 feeder" button	TIME_NECTAR_GATHERING	79
"1 feeder" button	TIME_POLLEN_GATHERING	120
"1 feeder" button	DETECT_PROB_R	0.01
"RRes" button	Weather	"Rothamsted (2009-2011)"
"RRes" button	INPUT_FILE	"Input_2-1_FoodFlow_RRes.txt"
"RRes" button	ReadInfile	TRUE
"varroa" button	N_INITIAL_MITES_HEALTHY	10
"varroa" button	N_INITIAL_MITES_INFECTED	10
"varroa" button	Virus	"DWV"
"varroa" button	MiteReproductionModel	"Martin"
"varroa" button	GenericPlot4	"mites"
"beekeeping" button	VarroaTreatment	TRUE
"beekeeping" button	FeedBees	TRUE
"beekeeping" button	HoneyHarvesting	TRUE
"beekeeping" button	MergeWeakColonies	TRUE
"beekeeping" button	MergeColoniesTH	5000
"beekeeping" button	AddPollen	TRUE
"beekeeping" button	HarvestingDay	135
"beekeeping" button	HarvestingPeriod	80
"beekeeping" button	RemainingHoney_kg	5
"beekeeping" button	HarvestingTH	20

This table lists the simulations presented in the main article together with the parameter setting. The actual model versions we used with all scenarios ar

Simulation:	Default	Artificial weather	Ideal conditions
Comment:			
Beehave version used:	Becher_etal_2013_JApplEcol_Default	Becher_etal_2013_JApplEcol_Artificial-Weather	Becher_etal_2013_JApplEcol_IdealFood
Name of the experiment:	JPEbecherSA3_Beehave2013	JPEbecherSA3_Beehave2013	JPEbecherSA3_Beehave2013
Results presented in:	Colony dynamics (Fig. 2; control in Fig. 6).	Colony dynamics (Fig. 2)	Colony dynamics (Fig. 2)
n time steps	1825 (shown: 365, 1825)	1095 (shown: 365)	1095 (shown: 365)
N replicates	["RAND_SEED" 1 2 3 4 5 6 7 8 9 10]	["RAND_SEED" 1 2 3 4 5 6 7 8 9 10]	["RAND_SEED" 1 2 3 4 5 6 7 8 9 10]
Parameters different from default setting:		["Weather" "HoPoMo_Season"]	["HoneyIdeal" true] ["PollenIdeal" true]
Parameters with default values:			
	["AddPollen" false]	["AddPollen" false]	["AddPollen" false]
	["AlwaysDance" false]	["AlwaysDance" false]	["AlwaysDance" false]
	["CONC_G" 1.5]	["CONC_G" 1.5]	["CONC_G" 1.5]
	["CONC_R" 1.5]	["CONC_R" 1.5]	["CONC_R" 1.5]
	["ConstantHandlingTime" false]	["ConstantHandlingTime" false]	["ConstantHandlingTime" false]
	["CRITICAL_COLONY_SIZE_WINTER" 4000]	["CRITICAL_COLONY_SIZE_WINTER" 4000]	["CRITICAL_COLONY_SIZE_WINTER" 4000]
	["DANCE_INTERCEPT" 0]	["DANCE_INTERCEPT" 0]	["DANCE_INTERCEPT" 0]
	["DANCE_SLOPE" 1.16]	["DANCE_SLOPE" 1.16]	["DANCE_SLOPE" 1.16]
	["details" true]	["details" true]	["details" true]
	["DETECT_PROB_G" 0.2]	["DETECT_PROB_G" 0.2]	["DETECT_PROB_G" 0.2]
	["DETECT_PROB_R" 0.2]	["DETECT_PROB_R" 0.2]	["DETECT_PROB_R" 0.2]
	["DISTANCE_G" 500]	["DISTANCE_G" 500]	["DISTANCE_G" 500]
	["DISTANCE_R" 1500]	["DISTANCE_R" 1500]	["DISTANCE_R" 1500]
	["DotDensity" 0.01]	["DotDensity" 0.01]	["DotDensity" 0.01]
	["EggLaying_IH" true]	["EggLaying_IH" true]	["EggLaying_IH" true]
	["Experiment" "none"]	["Experiment" "none"]	["Experiment" "none"]
	["FeedBees" false]	["FeedBees" false]	["FeedBees" false]
	["ForagingMap" "Nectar and Pollen"]	["ForagingMap" "Nectar and Pollen"]	["ForagingMap" "Nectar and Pollen"]
	["GenericPlot1" "trips per hour sunshine (E-3)"]	["GenericPlot1" "trips per hour sunshine (E	["GenericPlot1" "trips per hour sunshine (I

["GenericPlot2" "colony structure workers"]
["GenericPlot3" "active foragers today [%]"]
["GenericPlot4" "mites"]
["GenericPlot5" "nectar availability [l]"]
["GenericPlot6" "pollen availability [kg]"]
["GenericPlot7" "colony structure workers"]
["GenericPlot8" "foragers today [%]"]
["HarvestingDay" 135]
["HarvestingPeriod" 80]
["HarvestingTH" 20]
["HoneyHarvesting" false]
["HoneyIdeal" false]
["INPUT_FILE" "Input_2-1_FoodFlow_Exp2011good.txt"]
["MAX_BROODCELLS" 2000099]
["MAX_HONEY_STORE_kg" 50]
["MAX_km_PER_DAY" 5099]
["MergeColoniesTH" 5000]
["MergeWeakColonies" false]
["MiteReproductionModel" "Martin"]
["modelledInsteadCalcDetectProb" false]
["N_INITIAL_BEES" 10000]
["N_INITIAL_MITES_HEALTHY" 0]
["N_INITIAL_MITES_INFECTED" 0]
["POLLEN_G_kg" 1]
["POLLEN_R_kg" 1]
["PollenIdeal" false]
["ProbLazinessWinterbees" 0]
["QUANTITY_G_l" 20]
["QUANTITY_R_l" 20]
["QueenAgeing" false]
["ReadInfile" false]
["RemainingHoney_kg" 5]
["SeasonalFoodFlow" true]
["SHIFT_G" -40]
["SHIFT_R" 30]
["ShowAllPlots" true]
["SQUADRON_SIZE" 100]
["stopDead" true]
["Swarming" "No swarming"]
["Testing" "SIMULATION - NO TEST"]
["TIME_NECTAR_GATHERING" 1200]
["TIME_POLLEN_GATHERING" 600]
["VarroaTreatment" false]
["Virus" "DWV"]
["Weather" "Rothamsted (2009)"]
["writeFile" false]
["X_Days" 134]

["GenericPlot2" "colony structure workers"]
["GenericPlot3" "active foragers today [%]"]
["GenericPlot4" "mites"]
["GenericPlot5" "nectar availability [l]"]
["GenericPlot6" "pollen availability [kg]"]
["GenericPlot7" "colony structure workers"]
["GenericPlot8" "foragers today [%]"]
["HarvestingDay" 135]
["HarvestingPeriod" 80]
["HarvestingTH" 20]
["HoneyHarvesting" false]
["HoneyIdeal" false]
["INPUT_FILE" "Input_2-1_FoodFlow_Exp2
["MAX_BROODCELLS" 2000099]
["MAX_HONEY_STORE_kg" 50]
["MAX_km_PER_DAY" 5099]
["MergeColoniesTH" 5000]
["MergeWeakColonies" false]
["MiteReproductionModel" "Martin"]
["modelledInsteadCalcDetectProb" false]
["N_INITIAL_BEES" 10000]
["N_INITIAL_MITES_HEALTHY" 0]
["N_INITIAL_MITES_INFECTED" 0]
["POLLEN_G_kg" 1]
["POLLEN_R_kg" 1]
["PollenIdeal" false]
["ProbLazinessWinterbees" 0]
["QUANTITY_G_l" 20]
["QUANTITY_R_l" 20]
["QueenAgeing" false]
["ReadInfile" false]
["RemainingHoney_kg" 5]
["SeasonalFoodFlow" true]
["SHIFT_G" -40]
["SHIFT_R" 30]
["ShowAllPlots" true]
["SQUADRON_SIZE" 100]
["stopDead" true]
["Swarming" "No swarming"]
["Testing" "SIMULATION - NO TEST"]
["TIME_NECTAR_GATHERING" 1200]
["TIME_POLLEN_GATHERING" 600]
["VarroaTreatment" false]
["Virus" "DWV"]
["writeFile" false]
["X_Days" 134]

["GenericPlot2" "colony structure workers
["GenericPlot3" "active foragers today [%]
["GenericPlot4" "mites"]
["GenericPlot5" "nectar availability [l]"]
["GenericPlot6" "pollen availability [kg]"]
["GenericPlot7" "colony structure workers
["GenericPlot8" "foragers today [%]"]
["HarvestingDay" 135]
["HarvestingPeriod" 80]
["HarvestingTH" 20]
["HoneyHarvesting" false]
["INPUT_FILE" "Input_2-1_FoodFlow_Exp2
["MAX_BROODCELLS" 2000099]
["MAX_HONEY_STORE_kg" 50]
["MAX_km_PER_DAY" 5099]
["MergeColoniesTH" 5000]
["MergeWeakColonies" false]
["MiteReproductionModel" "Martin"]
["modelledInsteadCalcDetectProb" false]
["N_INITIAL_BEES" 10000]
["N_INITIAL_MITES_HEALTHY" 0]
["N_INITIAL_MITES_INFECTED" 0]
["POLLEN_G_kg" 1]
["POLLEN_R_kg" 1]
["ProbLazinessWinterbees" 0]
["QUANTITY_G_l" 20]
["QUANTITY_R_l" 20]
["QueenAgeing" false]
["ReadInfile" false]
["RemainingHoney_kg" 5]
["SeasonalFoodFlow" true]
["SHIFT_G" -40]
["SHIFT_R" 30]
["ShowAllPlots" true]
["SQUADRON_SIZE" 100]
["stopDead" true]
["Swarming" "No swarming"]
["Testing" "SIMULATION - NO TEST"]
["TIME_NECTAR_GATHERING" 1200]
["TIME_POLLEN_GATHERING" 600]
["VarroaTreatment" false]
["Virus" "DWV"]
["Weather" "HoPoMo_Season"]
["writeFile" false]
["X_Days" 134]

e provided in the appendix.

AFF free flight (modified BEEHAVE version)	Pesticide / Forager mortality (modified BEEHAVE version)	Seeley's feeder test (modified BEEHAVE version)
Modification: two more variables for foragerSquadrons: markedOnDay (= hatching date) and onsetForaging (= AFF for this bee); additional output in the "Command centre": Rand_Seed who markedOnDay onsetForaging ageOfDeath	Modifications, to increase the foraging mortality of a specific patch by MORTALITY_FACTOR, starting on day TREATMENT_DAY and lasting for TREATMENT_PERIOD	Modifications, to simulate feeder experiments on day 171. Food patches on that day are replaced by feeders, according to Seeley et al. 1991.
Becher_etal_2013_JApplEcol_AFF_Output-CommandCenter JPEbecherSA10_modBhave-AFF	Becher_etal_2013_JApplEcol_Henry_Conc_G1.5_1year_constantLowFoodFlow Becher_etal_2013_JApplEcol_Henry_Conc_G1.5_5years_constantHighFoodFlow Becher_etal_2013_JApplEcol_Henry_Conc_G1.5_1year_constantHighFoodFlow Becher_etal_2013_JApplEcol_Henry_Conc_G1.5_5years_constantLowFoodFlow JPEbecherSA7_modBhave-Pesticide	Becher_etal_2013_JApplEcol_SEELEY-TEST JPEbecherSA8_modBhave-SeeleyTest
Onset of foraging and lifespan (Fig. 3) 1095 (shown: 365) ["RAND_SEED" 1 2 3 4 5 6 7 8 9 10]	Forager mortality after pesticide treatment (Fig. 7) 1825 ["RAND_SEED" 1 2 3... 18 19 20] ["TREATMENT_DAY" 1 32 60 91 121 152 182 213 244 274 305 335 9999] ["TREATMENT_PERIOD" 30] ["MORTALITY_FACTOR" 2] ["POLLEN_G_kg" 0.5 (low) or 1 (high)] ["QUANTITY_G_l" 3 (low) or 10 (high)] ["DISTANCE_G" 1000] ["QUANTITY_R_l" 0] ["POLLEN_R_kg" 0] ["SeasonalFoodFlow" false]	Simulating Seeley's feeder experiment (Fig. 4) 172 ["RAND_SEED" 1 2 3 4 5 6 7 8 9 10]
["AddPollen" false] ["AlwaysDance" false] ["CONC_G" 1.5] ["CONC_R" 1.5] ["ConstantHandlingTime" false] ["CRITICAL_COLONY_SIZE_WINTER" 4000] ["DANCE_INTERCEPT" 0] ["DANCE_SLOPE" 1.16] ["details" true] ["DETECT_PROB_G" 0.2] ["DETECT_PROB_R" 0.2] ["DISTANCE_G" 500] ["DISTANCE_R" 1500] ["DotDensity" 0.01] ["EggLaying_IH" true] ["Experiment" "none"] ["FeedBees" false] ["ForagingMap" "Nectar and Pollen"] ["GenericPlot1" "trips per hour sunshine (E-3)"]	["AddPollen" false] ["AlwaysDance" false] ["CONC_G" 1.5] ["CONC_R" 1.5] ["ConstantHandlingTime" false] ["CRITICAL_COLONY_SIZE_WINTER" 4000] ["DANCE_INTERCEPT" 0] ["DANCE_SLOPE" 1.16] ["details" true] ["DETECT_PROB_G" 0.2] ["DETECT_PROB_R" 0.2] ["DISTANCE_R" 1500] ["DotDensity" 0.01] ["EggLaying_IH" true] ["Experiment" "none"] ["FeedBees" false] ["ForagingMap" "Nectar and Pollen"] ["GenericPlot1" "aff & lifespan"]	["AddPollen" false] ["AlwaysDance" false] ["CONC_G" 1.5] ["CONC_R" 1.5] ["ConstantHandlingTime" true] ["CRITICAL_COLONY_SIZE_WINTER" 4000] ["DANCE_INTERCEPT" 0] ["DANCE_SLOPE" 1.16] ["details" true] ["DETECT_PROB_G" 0.2] ["DETECT_PROB_R" 0.2] ["DISTANCE_G" 500] ["DISTANCE_R" 1500] ["DotDensity" 0.01] ["EggLaying_IH" true] ["Experiment" "none"] ["FeedBees" false] ["ForagingMap" "All patches"] ["GenericPlot1" "stores & hive [kg]"]

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["GenericPlot2" "colony structure workers"]
["GenericPlot3" "active foragers today [%]"]
["GenericPlot4" "mites"]
["GenericPlot5" "nectar availability [l]"]
["GenericPlot6" "pollen availability [kg]"]
["GenericPlot7" "colony structure workers"]
["GenericPlot8" "foragers today [%]"]
["HarvestingDay" 135]
["HarvestingPeriod" 80]
["HarvestingTH" 20]
["HoneyHarvesting" false]
["HoneyIdeal" false]
["INPUT_FILE" "Input_2-1_FoodFlow_Exp2011goo
["MAX_BROODCELLS" 2000099]
["MAX_HONEY_STORE_kg" 50]
["MAX_km_PER_DAY" 5099]
["MergeColoniesTH" 5000]
["MergeWeakColonies" false]
["MiteReproductionModel" "Martin"]
["modelledInsteadCalcDetectProb" false]
["N_INITIAL_BEES" 10000]
["N_INITIAL_MITES_HEALTHY" 0]
["N_INITIAL_MITES_INFECTED" 0]
["POLLEN_G_kg" 1]
["POLLEN_R_kg" 1]
["PollenIdeal" false]
["ProbLazinessWinterbees" 0]
["QUANTITY_G_l" 20]
["QUANTITY_R_l" 20]
["QueenAgeing" false]
["ReadInfile" false]
["RemainingHoney_kg" 5]
["SeasonalFoodFlow" true]
["SHIFT_G" -40]
["SHIFT_R" 30]
["ShowAllPlots" true]
["SQUADRON_SIZE" 100]
["stopDead" true]
["Swarming" "No swarming"]
["Testing" "SIMULATION - NO TEST"]
["TIME_NECTAR_GATHERING" 1200]
["TIME_POLLEN_GATHERING" 600]
["VarroaTreatment" false]
["Virus" "DWV"]
["Weather" "Rothamsted (2009)"]
["writeFile" false]
["X_Days" 134]
```

```
["GenericPlot2" "colony structure workers"]
["GenericPlot3" "broodcare [%]"]
["GenericPlot4" "mites"]
["GenericPlot5" "nectar availability [l]"]
["GenericPlot6" "pollen availability [kg]"]
["GenericPlot7" "mean trip duration"]
["GenericPlot8" "foragers today [%]"]
["HarvestingDay" 135]
["HarvestingPeriod" 80]
["HarvestingTH" 20]
["HoneyHarvesting" false]
["HoneyIdeal" false]
["INPUT_FILE" "Input_2-1_FoodFlow_Exp2011good.txt"]
["MAX_BROODCELLS" 2000099]
["MAX_HONEY_STORE_kg" 50]
["MAX_km_PER_DAY" 7299]
["MergeColoniesTH" 5000]
["MergeWeakColonies" false]
["MiteReproductionModel" "Martin"]
["modelledInsteadCalcDetectProb" false]
["N_INITIAL_BEES" 10000]
["N_INITIAL_MITES_HEALTHY" 0]
["N_INITIAL_MITES_INFECTED" 0]
["PollenIdeal" false]
["ProbLazinessWinterbees" 0]
["QueenAgeing" false]
["ReadInfile" false]
["RemainingHoney_kg" 5]
["SHIFT_G" -40]
["SHIFT_R" 30]
["ShowAllPlots" true]
["SQUADRON_SIZE" 100]
["stopDead" true]
["Swarming" "No swarming"]
["Testing" "SIMULATION - NO TEST"]
["TIME_NECTAR_GATHERING" 1200]
["TIME_POLLEN_GATHERING" 600]
["VarroaTreatment" false]
["Virus" "DWV"]
["Weather" "Rothamsted (2009)"]
["writeFile" false]
["X_Days" 180]
```

```
["GenericPlot2" "colony structure workers"]
["GenericPlot3" "loads returning foragers [%]"]
["GenericPlot4" "mites"]
["GenericPlot5" "nectar availability [l]"]
["GenericPlot6" "pollen availability [kg]"]
["GenericPlot7" "colony structure workers"]
["GenericPlot8" "foragers today [%]"]
["HarvestingDay" 135]
["HarvestingPeriod" 80]
["HarvestingTH" 20]
["HoneyHarvesting" false]
["HoneyIdeal" false]
["INPUT_FILE" "Input_2-1_FoodFlow_Exp2011good.txt"]
["MAX_BROODCELLS" 2000099]
["MAX_HONEY_STORE_kg" 50]
["MAX_km_PER_DAY" 5099]
["MergeColoniesTH" 5000]
["MergeWeakColonies" false]
["MiteReproductionModel" "Martin"]
["modelledInsteadCalcDetectProb" false]
["N_INITIAL_BEES" 10000]
["N_INITIAL_MITES_HEALTHY" 0]
["N_INITIAL_MITES_INFECTED" 0]
["POLLEN_G_kg" 0]
["POLLEN_R_kg" 0]
["PollenIdeal" false]
["ProbLazinessWinterbees" 0]
["QUANTITY_G_l" 20]
["QUANTITY_R_l" 20]
["QueenAgeing" false]
["ReadInfile" false]
["RemainingHoney_kg" 5]
["SeasonalFoodFlow" false]
["SHIFT_G" -40]
["SHIFT_R" 30]
["ShowAllPlots" true]
["SQUADRON_SIZE" 100]
["stopDead" true]
["Swarming" "No swarming"]
["Testing" "SIMULATION - NO TEST"]
["TIME_NECTAR_GATHERING" 79]
["TIME_POLLEN_GATHERING" 600]
["VarroaTreatment" false]
["Virus" "DWV"]
["Weather" "Rothamsted (2009)"]
["writeFile" false]
["X_Days" 171]
```

Varroa, Varroa + Foraging

Becher_etal_2013_JApplEcol_Varroa,
Becher_etal_2013_JApplEcol_Foraging-3dist-G
JPEbecherSA3_Beehave2013
Varroa mites, virus infection and acaricide treatment (Fig. 5).
Interaction between varroa and forage availability (Fig. 6).
1825
["RAND_SEED" 1 2 3 4 5 6 7 8 9 10]

["Virus" "DWV" "APV"]
["MiteReproductionModel" "Martin" "Fuchs&Langenbach"]
["VarroaTreatment" false true]
["DISTANCE_G" 250 500 1000]
["N_INITIAL_MITES_INFECTED" 10]
["N_INITIAL_MITES_HEALTHY" 10]

["AddPollen" false]
["AlwaysDance" false]
["CONC_G" 1.5]
["CONC_R" 1.5]
["ConstantHandlingTime" false]
["CRITICAL_COLONY_SIZE_WINTER" 4000]
["DANCE_INTERCEPT" 0]
["DANCE_SLOPE" 1.16]
["details" true]
["DETECT_PROB_G" 0.2]
["DETECT_PROB_R" 0.2]

["DISTANCE_R" 1500]
["DotDensity" 0.01]
["EggLaying_IH" true]
["Experiment" "none"]
["FeedBees" false]
["ForagingMap" "Nectar and Pollen"]
["GenericPlot1" "trips per hour sunshine (E-3)"]

["GenericPlot2" "colony structure workers"]
["GenericPlot3" "active foragers today [%]"]
["GenericPlot4" "mites"]
["GenericPlot5" "nectar availability [l]"]
["GenericPlot6" "pollen availability [kg]"]
["GenericPlot7" "colony structure workers"]
["GenericPlot8" "foragers today [%]"]
["HarvestingDay" 135]
["HarvestingPeriod" 80]
["HarvestingTH" 20]
["HoneyHarvesting" false]
["HoneyIdeal" false]
["INPUT_FILE" "Input_2-1_FoodFlow_Exp2011good.txt"]
["MAX_BROODCELLS" 2000099]
["MAX_HONEY_STORE_kg" 50]
["MAX_km_PER_DAY" 5099]
["MergeColoniesTH" 5000]
["MergeWeakColonies" false]

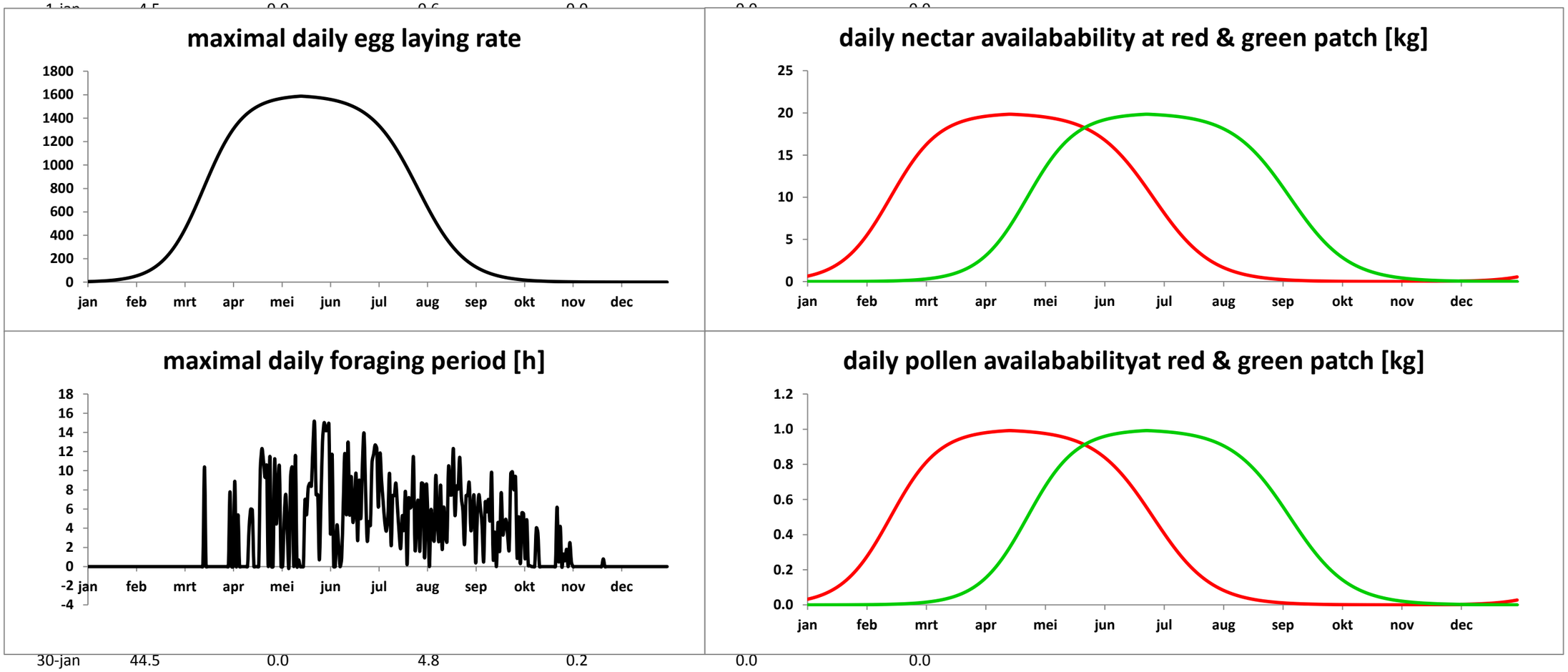
["modelledInsteadCalcDetectProb" false]
["N_INITIAL_BEES" 10000]

["POLLEN_G_kg" 1]
["POLLEN_R_kg" 1]
["PollenIdeal" false]
["ProbLazinessWinterbees" 0]
["QUANTITY_G_l" 20]
["QUANTITY_R_l" 20]
["QueenAgeing" false]
["ReadInfile" false]
["RemainingHoney_kg" 5]
["SeasonalFoodFlow" true]
["SHIFT_G" -40]
["SHIFT_R" 30]
["ShowAllPlots" true]
["SQUADRON_SIZE" 100]
["stopDead" true]
["Swarming" "No swarming"]
["Testing" "SIMULATION - NO TEST"]
["TIME_NECTAR_GATHERING" 1200]
["TIME_POLLEN_GATHERING" 600]

["Weather" "Rothamsted (2009)"]
["writeFile" false]
["X_Days" 134]

This table shows imposed factors that strongly affect the colony dynamics.

day	eggs	foraging period [h	Nectar (red patch)	Pollen (red patch)	Nectar (green patch)	Pollen (pollen patch)
1-jan	4.5	0.0	0.6	0.0	0.0	0.0
30-jan	44.5	0.0	4.8	0.2	0.0	0.0
31-jan	48.1	0.0	5.1	0.3	0.0	0.0
1-feb	52.0	0.0	5.4	0.3	0.0	0.0
2-feb	56.2	0.0	5.7	0.3	0.0	0.0
3-feb	60.7	0.0	6.1	0.3	0.0	0.0
4-feb	65.5	0.0	6.4	0.3	0.0	0.0
5-feb	70.8	0.0	6.8	0.3	0.0	0.0
6-feb	76.4	0.0	7.1	0.4	0.0	0.0
7-feb	82.4	0.0	7.5	0.4	0.0	0.0
8-feb	88.9	0.0	7.9	0.4	0.0	0.0
9-feb	95.8	0.0	8.3	0.4	0.1	0.0
10-feb	103.3	0.0	8.6	0.4	0.1	0.0
11-feb	111.3	0.0	9.0	0.5	0.1	0.0
12-feb	119.9	0.0	9.4	0.5	0.1	0.0
13-feb	129.1	0.0	9.8	0.5	0.1	0.0
14-feb	138.9	0.0	10.2	0.5	0.1	0.0
15-feb	149.4	0.0	10.6	0.5	0.1	0.0
16-feb	160.6	0.0	11.0	0.6	0.1	0.0



17-feb	172.5	0.0	11.4	0.6	0.1	0.0
18-feb	185.2	0.0	11.8	0.6	0.1	0.0
19-feb	198.7	0.0	12.2	0.6	0.1	0.0
20-feb	213.1	0.0	12.6	0.6	0.1	0.0
21-feb	228.3	0.0	12.9	0.6	0.1	0.0
22-feb	244.4	0.0	13.3	0.7	0.1	0.0
23-feb	261.4	0.0	13.7	0.7	0.2	0.0
24-feb	279.4	0.0	14.0	0.7	0.2	0.0
25-feb	298.3	0.0	14.3	0.7	0.2	0.0
26-feb	318.2	0.0	14.6	0.7	0.2	0.0
27-feb	339.1	0.0	15.0	0.7	0.2	0.0
28-feb	361.0	0.0	15.3	0.8	0.2	0.0
1-mrt	383.8	0.0	15.5	0.8	0.3	0.0
2-mrt	407.7	0.0	15.8	0.8	0.3	0.0
3-mrt	432.4	0.0	16.1	0.8	0.3	0.0
4-mrt	458.1	0.0	16.3	0.8	0.3	0.0
5-mrt	484.7	0.0	16.5	0.8	0.3	0.0
6-mrt	512.2	0.0	16.8	0.8	0.4	0.0
7-mrt	540.4	0.0	17.0	0.8	0.4	0.0
8-mrt	569.4	0.0	17.2	0.9	0.4	0.0
9-mrt	599.1	0.0	17.4	0.9	0.5	0.0
10-mrt	629.4	0.0	17.5	0.9	0.5	0.0
11-mrt	660.2	0.0	17.7	0.9	0.6	0.0
12-mrt	691.4	0.0	17.9	0.9	0.6	0.0
13-mrt	722.9	0.0	18.0	0.9	0.7	0.0
14-mrt	754.8	0.0	18.2	0.9	0.7	0.0
15-mrt	786.7	0.0	18.3	0.9	0.8	0.0
16-mrt	818.7	10.4	18.4	0.9	0.8	0.0
17-mrt	850.6	0.0	18.5	0.9	0.9	0.0
18-mrt	882.4	0.0	18.6	0.9	1.0	0.0
19-mrt	913.9	0.0	18.7	0.9	1.0	0.1
20-mrt	945.1	0.0	18.8	0.9	1.1	0.1
21-mrt	975.8	0.0	18.9	0.9	1.2	0.1
22-mrt	1006.0	0.0	19.0	0.9	1.3	0.1
23-mrt	1035.5	0.0	19.1	1.0	1.4	0.1
24-mrt	1064.4	0.0	19.1	1.0	1.5	0.1
25-mrt	1092.5	0.0	19.2	1.0	1.6	0.1
26-mrt	1119.8	0.0	19.3	1.0	1.7	0.1
27-mrt	1146.3	0.0	19.3	1.0	1.9	0.1
28-mrt	1171.8	0.0	19.4	1.0	2.0	0.1
29-mrt	1196.4	0.0	19.4	1.0	2.2	0.1
30-mrt	1220.1	0.0	19.5	1.0	2.3	0.1
31-mrt	1242.8	0.0	19.5	1.0	2.5	0.1
1-apr	1264.5	7.8	19.5	1.0	2.7	0.1
2-apr	1285.2	0.0	19.6	1.0	2.9	0.1
3-apr	1304.9	0.0	19.6	1.0	3.1	0.2
4-apr	1323.7	8.9	19.6	1.0	3.3	0.2
5-apr	1341.5	0.0	19.7	1.0	3.5	0.2
6-apr	1358.4	5.4	19.7	1.0	3.7	0.2
7-apr	1374.4	0.0	19.7	1.0	4.0	0.2

8-apr	1389.4	0.0	19.7	1.0	4.2	0.2
9-apr	1403.6	0.0	19.7	1.0	4.5	0.2
10-apr	1417.0	0.0	19.8	1.0	4.8	0.2
11-apr	1429.6	0.0	19.8	1.0	5.1	0.3
12-apr	1441.4	0.0	19.8	1.0	5.4	0.3
13-apr	1452.4	4.1	19.8	1.0	5.7	0.3
14-apr	1462.8	6.0	19.8	1.0	6.1	0.3
15-apr	1472.5	5.9	19.8	1.0	6.4	0.3
16-apr	1481.6	0.0	19.8	1.0	6.8	0.3
17-apr	1490.1	0.0	19.8	1.0	7.1	0.4
18-apr	1498.0	0.0	19.8	1.0	7.5	0.4
19-apr	1505.4	0.0	19.8	1.0	7.9	0.4
20-apr	1512.2	10.1	19.8	1.0	8.3	0.4
21-apr	1518.6	12.3	19.8	1.0	8.6	0.4
22-apr	1524.6	11.0	19.8	1.0	9.0	0.5
23-apr	1530.1	9.3	19.8	1.0	9.4	0.5
24-apr	1535.3	10.5	19.7	1.0	9.8	0.5
25-apr	1540.1	0.0	19.7	1.0	10.2	0.5
26-apr	1544.5	11.5	19.7	1.0	10.6	0.5
27-apr	1548.7	0.0	19.7	1.0	11.0	0.6
28-apr	1552.5	0.0	19.7	1.0	11.4	0.6
29-apr	1556.0	11.2	19.6	1.0	11.8	0.6
30-apr	1559.3	4.5	19.6	1.0	12.2	0.6
1-mei	1562.4	8.0	19.6	1.0	12.6	0.6
2-mei	1565.2	10.3	19.6	1.0	12.9	0.6
3-mei	1567.8	0.0	19.5	1.0	13.3	0.7
4-mei	1570.3	0.0	19.5	1.0	13.7	0.7
5-mei	1572.5	5.2	19.5	1.0	14.0	0.7
6-mei	1574.6	7.5	19.4	1.0	14.3	0.7
7-mei	1576.5	3.2	19.4	1.0	14.6	0.7
8-mei	1578.3	0.0	19.3	1.0	15.0	0.7
9-mei	1579.9	9.4	19.3	1.0	15.3	0.8
10-mei	1581.5	10.3	19.3	1.0	15.5	0.8
11-mei	1582.9	0.0	19.2	1.0	15.8	0.8
12-mei	1584.2	11.6	19.2	1.0	16.1	0.8
13-mei	1585.4	0.0	19.1	1.0	16.3	0.8
14-mei	1586.5	0.7	19.0	1.0	16.5	0.8
15-mei	1587.5	0.0	19.0	0.9	16.8	0.8
16-mei	1587.6	0.0	18.9	0.9	17.0	0.8
17-mei	1586.7	0.0	18.8	0.9	17.2	0.9
18-mei	1585.8	6.9	18.8	0.9	17.4	0.9
19-mei	1584.8	5.4	18.7	0.9	17.5	0.9
20-mei	1583.8	8.2	18.6	0.9	17.7	0.9
21-mei	1582.7	8.7	18.5	0.9	17.9	0.9
22-mei	1581.5	8.4	18.4	0.9	18.0	0.9
23-mei	1580.3	12.5	18.3	0.9	18.2	0.9
24-mei	1578.9	15.0	18.2	0.9	18.3	0.9
25-mei	1577.5	7.5	18.1	0.9	18.4	0.9
26-mei	1576.0	7.5	18.0	0.9	18.5	0.9
27-mei	1574.3	0.7	17.9	0.9	18.6	0.9

28-mei	1572.6	6.7	17.7	0.9	18.7	0.9
29-mei	1570.8	13.0	17.6	0.9	18.8	0.9
30-mei	1568.8	15.0	17.4	0.9	18.9	0.9
31-mei	1566.7	14.2	17.3	0.9	19.0	0.9
1-jun	1564.4	14.3	17.1	0.9	19.1	1.0
2-jun	1562.0	14.9	17.0	0.8	19.1	1.0
3-jun	1559.5	3.4	16.8	0.8	19.2	1.0
4-jun	1556.8	11.7	16.6	0.8	19.3	1.0
5-jun	1553.9	0.0	16.4	0.8	19.3	1.0
6-jun	1550.8	0.0	16.2	0.8	19.4	1.0
7-jun	1547.5	4.3	16.0	0.8	19.4	1.0
8-jun	1544.0	2.5	15.8	0.8	19.5	1.0
9-jun	1540.3	0.0	15.5	0.8	19.5	1.0
10-jun	1536.3	0.9	15.3	0.8	19.5	1.0
11-jun	1532.1	6.5	15.1	0.8	19.6	1.0
12-jun	1527.7	11.8	14.8	0.7	19.6	1.0
13-jun	1522.9	5.4	14.6	0.7	19.6	1.0
14-jun	1517.9	13.0	14.3	0.7	19.7	1.0
15-jun	1512.5	5.4	14.0	0.7	19.7	1.0
16-jun	1506.8	9.4	13.7	0.7	19.7	1.0
17-jun	1500.8	4.7	13.4	0.7	19.7	1.0
18-jun	1494.4	6.0	13.1	0.7	19.7	1.0
19-jun	1487.7	9.7	12.8	0.6	19.8	1.0
20-jun	1480.5	2.7	12.5	0.6	19.8	1.0
21-jun	1472.9	9.0	12.2	0.6	19.8	1.0
22-jun	1464.9	5.0	11.9	0.6	19.8	1.0
23-jun	1456.4	10.6	11.6	0.6	19.8	1.0
24-jun	1447.5	13.9	11.2	0.6	19.8	1.0
25-jun	1438.0	8.0	10.9	0.5	19.8	1.0
26-jun	1428.0	2.7	10.6	0.5	19.8	1.0
27-jun	1417.5	4.7	10.3	0.5	19.8	1.0
28-jun	1406.5	4.3	9.9	0.5	19.8	1.0
29-jun	1394.9	10.8	9.6	0.5	19.8	1.0
30-jun	1382.6	11.7	9.3	0.5	19.8	1.0
1-jul	1369.8	12.7	8.9	0.4	19.8	1.0
2-jul	1356.4	12.3	8.6	0.4	19.8	1.0
3-jul	1342.3	6.2	8.3	0.4	19.7	1.0
4-jul	1327.5	11.8	7.9	0.4	19.7	1.0
5-jul	1312.1	9.0	7.6	0.4	19.7	1.0
6-jul	1296.0	6.8	7.3	0.4	19.7	1.0
7-jul	1279.3	4.7	7.0	0.4	19.7	1.0
8-jul	1261.9	3.7	6.7	0.3	19.6	1.0
9-jul	1243.7	5.2	6.4	0.3	19.6	1.0
10-jul	1224.9	9.7	6.1	0.3	19.6	1.0
11-jul	1205.4	2.2	5.9	0.3	19.6	1.0
12-jul	1185.3	7.4	5.6	0.3	19.5	1.0
13-jul	1164.5	7.4	5.3	0.3	19.5	1.0
14-jul	1143.0	8.7	5.1	0.3	19.5	1.0
15-jul	1121.0	6.1	4.8	0.2	19.4	1.0
16-jul	1098.3	3.6	4.6	0.2	19.4	1.0

17-jul	1075.1	1.9	4.3	0.2	19.3	1.0
18-jul	1051.3	5.3	4.1	0.2	19.3	1.0
19-jul	1027.0	3.8	3.9	0.2	19.3	1.0
20-jul	1002.3	7.8	3.7	0.2	19.2	1.0
21-jul	977.1	0.2	3.5	0.2	19.2	1.0
22-jul	951.6	7.1	3.3	0.2	19.1	1.0
23-jul	925.7	6.1	3.1	0.2	19.0	1.0
24-jul	899.6	6.5	3.0	0.1	19.0	0.9
25-jul	873.2	11.4	2.8	0.1	18.9	0.9
26-jul	846.7	1.8	2.6	0.1	18.8	0.9
27-jul	820.1	5.1	2.5	0.1	18.8	0.9
28-jul	793.4	6.8	2.3	0.1	18.7	0.9
29-jul	766.8	1.6	2.2	0.1	18.6	0.9
30-jul	740.2	8.7	2.1	0.1	18.5	0.9
31-jul	713.7	8.6	2.0	0.1	18.4	0.9
1-aug	687.5	0.9	1.9	0.1	18.3	0.9
2-aug	661.5	8.5	1.7	0.1	18.2	0.9
3-aug	635.8	5.4	1.6	0.1	18.1	0.9
4-aug	610.4	0.0	1.5	0.1	18.0	0.9
5-aug	585.5	5.9	1.4	0.1	17.9	0.9
6-aug	560.9	3.2	1.4	0.1	17.7	0.9
7-aug	536.9	2.7	1.3	0.1	17.6	0.9
8-aug	513.4	9.5	1.2	0.1	17.4	0.9
9-aug	490.4	4.8	1.1	0.1	17.3	0.9
10-aug	468.0	2.7	1.1	0.1	17.1	0.9
11-aug	446.3	8.5	1.0	0.0	17.0	0.8
12-aug	425.1	1.8	0.9	0.0	16.8	0.8
13-aug	404.7	6.2	0.9	0.0	16.6	0.8
14-aug	384.8	3.2	0.8	0.0	16.4	0.8
15-aug	365.7	2.6	0.8	0.0	16.2	0.8
16-aug	347.2	10.4	0.7	0.0	16.0	0.8
17-aug	329.4	7.5	0.7	0.0	15.8	0.8
18-aug	312.3	7.5	0.6	0.0	15.5	0.8
19-aug	295.9	12.3	0.6	0.0	15.3	0.8
20-aug	280.2	5.4	0.6	0.0	15.1	0.8
21-aug	265.1	8.4	0.5	0.0	14.8	0.7
22-aug	250.7	8.1	0.5	0.0	14.6	0.7
23-aug	236.9	11.4	0.5	0.0	14.3	0.7
24-aug	223.8	7.3	0.4	0.0	14.0	0.7
25-aug	211.2	5.8	0.4	0.0	13.7	0.7
26-aug	199.3	2.3	0.4	0.0	13.4	0.7
27-aug	188.0	7.4	0.4	0.0	13.1	0.7
28-aug	177.2	7.4	0.3	0.0	12.8	0.6
29-aug	167.0	8.7	0.3	0.0	12.5	0.6
30-aug	157.2	3.8	0.3	0.0	12.2	0.6
31-aug	148.0	5.7	0.3	0.0	11.9	0.6
1-sep	139.3	7.3	0.3	0.0	11.6	0.6
2-sep	131.1	0.4	0.2	0.0	11.2	0.6
3-sep	123.3	5.2	0.2	0.0	10.9	0.5
4-sep	115.9	7.5	0.2	0.0	10.6	0.5

5-sep	108.9	6.1	0.2	0.0	10.3	0.5
6-sep	102.4	4.3	0.2	0.0	9.9	0.5
7-sep	96.2	0.5	0.2	0.0	9.6	0.5
8-sep	90.3	6.7	0.2	0.0	9.3	0.5
9-sep	84.8	5.7	0.2	0.0	8.9	0.4
10-sep	79.6	7.0	0.1	0.0	8.6	0.4
11-sep	74.7	4.8	0.1	0.0	8.3	0.4
12-sep	70.1	9.8	0.1	0.0	7.9	0.4
13-sep	65.8	0.8	0.1	0.0	7.6	0.4
14-sep	61.7	3.6	0.1	0.0	7.3	0.4
15-sep	57.8	0.0	0.1	0.0	7.0	0.4
16-sep	54.2	4.6	0.1	0.0	6.7	0.3
17-sep	50.9	1.6	0.1	0.0	6.4	0.3
18-sep	47.7	7.7	0.1	0.0	6.1	0.3
19-sep	44.7	3.4	0.1	0.0	5.9	0.3
20-sep	41.9	4.4	0.1	0.0	5.6	0.3
21-sep	39.2	4.9	0.1	0.0	5.3	0.3
22-sep	36.8	3.3	0.1	0.0	5.1	0.3
23-sep	34.5	1.8	0.1	0.0	4.8	0.2
24-sep	32.3	9.7	0.1	0.0	4.6	0.2
25-sep	30.2	9.9	0.1	0.0	4.3	0.2
26-sep	28.3	8.0	0.0	0.0	4.1	0.2
27-sep	26.5	9.3	0.0	0.0	3.9	0.2
28-sep	24.8	0.9	0.0	0.0	3.7	0.2
29-sep	23.3	5.2	0.0	0.0	3.5	0.2
30-sep	21.8	0.3	0.0	0.0	3.3	0.2
1-okt	20.4	5.6	0.0	0.0	3.1	0.2
2-okt	19.1	5.5	0.0	0.0	3.0	0.1
3-okt	17.9	0.8	0.0	0.0	2.8	0.1
4-okt	16.7	4.9	0.0	0.0	2.6	0.1
5-okt	15.7	0.1	0.0	0.0	2.5	0.1
6-okt	14.7	0.1	0.0	0.0	2.3	0.1
7-okt	13.7	0.0	0.0	0.0	2.2	0.1
8-okt	12.8	0.0	0.0	0.0	2.1	0.1
9-okt	12.0	0.0	0.0	0.0	2.0	0.1
10-okt	11.3	4.0	0.0	0.0	1.9	0.1
11-okt	10.5	3.5	0.0	0.0	1.7	0.1
12-okt	9.9	0.0	0.0	0.0	1.6	0.1
13-okt	9.2	0.0	0.0	0.0	1.5	0.1
14-okt	8.6	0.0	0.0	0.0	1.4	0.1
15-okt	8.1	0.0	0.0	0.0	1.4	0.1
16-okt	7.6	0.0	0.0	0.0	1.3	0.1
17-okt	7.1	0.0	0.0	0.0	1.2	0.1
18-okt	6.6	0.0	0.0	0.0	1.1	0.1
19-okt	6.2	0.0	0.0	0.0	1.1	0.1
20-okt	5.8	0.0	0.0	0.0	1.0	0.0
21-okt	5.4	0.0	0.0	0.0	0.9	0.0
22-okt	5.1	0.0	0.0	0.0	0.9	0.0
23-okt	4.8	6.2	0.0	0.0	0.8	0.0
24-okt	4.4	0.5	0.0	0.0	0.8	0.0

25-okt	4.2	4.2	0.0	0.0	0.7	0.0
26-okt	3.9	0.0	0.0	0.0	0.7	0.0
27-okt	3.6	1.3	0.0	0.0	0.6	0.0
28-okt	3.4	0.6	0.0	0.0	0.6	0.0
29-okt	3.2	1.8	0.0	0.0	0.6	0.0
30-okt	3.0	0.0	0.0	0.0	0.5	0.0
31-okt	2.8	2.5	0.0	0.0	0.5	0.0
1-nov	2.6	0.5	0.0	0.0	0.5	0.0
2-nov	2.4	0.0	0.0	0.0	0.4	0.0
3-nov	2.3	0.0	0.0	0.0	0.4	0.0
4-nov	2.1	0.0	0.0	0.0	0.4	0.0
5-nov	2.0	0.0	0.0	0.0	0.4	0.0
6-nov	1.9	0.0	0.0	0.0	0.3	0.0
7-nov	1.8	0.0	0.0	0.0	0.3	0.0
8-nov	1.6	0.0	0.0	0.0	0.3	0.0
9-nov	1.5	0.0	0.0	0.0	0.3	0.0
10-nov	1.4	0.0	0.0	0.0	0.3	0.0
11-nov	1.3	0.0	0.0	0.0	0.2	0.0
12-nov	1.3	0.0	0.0	0.0	0.2	0.0
13-nov	1.2	0.0	0.0	0.0	0.2	0.0
14-nov	1.1	0.0	0.0	0.0	0.2	0.0
15-nov	1.0	0.0	0.0	0.0	0.2	0.0
16-nov	1.0	0.0	0.0	0.0	0.2	0.0
17-nov	0.9	0.0	0.0	0.0	0.2	0.0
18-nov	0.8	0.0	0.0	0.0	0.2	0.0
19-nov	0.8	0.0	0.0	0.0	0.1	0.0
20-nov	0.7	0.0	0.0	0.0	0.1	0.0
21-nov	0.7	0.8	0.0	0.0	0.1	0.0
22-nov	0.6	0.0	0.0	0.0	0.1	0.0
23-nov	0.6	0.0	0.0	0.0	0.1	0.0
24-nov	0.6	0.0	0.0	0.0	0.1	0.0
25-nov	0.5	0.0	0.0	0.0	0.1	0.0
26-nov	0.5	0.0	0.0	0.0	0.1	0.0
27-nov	0.5	0.0	0.0	0.0	0.1	0.0
28-nov	0.4	0.0	0.0	0.0	0.1	0.0
29-nov	0.4	0.0	0.0	0.0	0.1	0.0
30-nov	0.4	0.0	0.0	0.0	0.1	0.0
1-dec	0.4	0.0	0.0	0.0	0.1	0.0
2-dec	0.3	0.0	0.1	0.0	0.1	0.0
3-dec	0.3	0.0	0.1	0.0	0.1	0.0
4-dec	0.3	0.0	0.1	0.0	0.1	0.0
5-dec	0.3	0.0	0.1	0.0	0.0	0.0
6-dec	0.3	0.0	0.1	0.0	0.0	0.0
7-dec	0.2	0.0	0.1	0.0	0.0	0.0
8-dec	0.2	0.0	0.1	0.0	0.0	0.0
9-dec	0.2	0.0	0.1	0.0	0.0	0.0
10-dec	0.2	0.0	0.1	0.0	0.0	0.0
11-dec	0.2	0.0	0.1	0.0	0.0	0.0
12-dec	0.2	0.0	0.1	0.0	0.0	0.0
13-dec	0.2	0.0	0.1	0.0	0.0	0.0

14-dec	0.1	0.0	0.1	0.0	0.0	0.0
15-dec	0.1	0.0	0.2	0.0	0.0	0.0
16-dec	0.1	0.0	0.2	0.0	0.0	0.0
17-dec	0.1	0.0	0.2	0.0	0.0	0.0
18-dec	0.1	0.0	0.2	0.0	0.0	0.0
19-dec	0.1	0.0	0.2	0.0	0.0	0.0
20-dec	0.1	0.0	0.2	0.0	0.0	0.0
21-dec	0.1	0.0	0.3	0.0	0.0	0.0
22-dec	0.1	0.0	0.3	0.0	0.0	0.0
23-dec	0.1	0.0	0.3	0.0	0.0	0.0
24-dec	0.1	0.0	0.3	0.0	0.0	0.0
25-dec	0.1	0.0	0.3	0.0	0.0	0.0
26-dec	0.1	0.0	0.4	0.0	0.0	0.0
27-dec	0.1	0.0	0.4	0.0	0.0	0.0
28-dec	0.1	0.0	0.4	0.0	0.0	0.0
29-dec	0.1	0.0	0.5	0.0	0.0	0.0
30-dec	0.1	0.0	0.5	0.0	0.0	0.0
31-dec	0.0	0.0	0.6	0.0	0.0	0.0

This table shows all plots that can be chosen on the interface in the order they are listed.

plot title	data series	x-axis	y-axis
colony structure workers	worker eggs, larvae, pupae, in-hive bees, foragers, total adult workers, total worker brood	time [d]	# bees
drones	drone eggs, larvae, pupae, total adult drones	time [d]	# bees
egg laying	new eggs	time [d]	# eggs
broodcare [%]	protein, workload, pollen	time [d]	protein, workload, pollen [%]
age forager squadrons	foragersHealthy, foragersDiseased, foragersCarrier	age [d]	# forager squadrons
aff & lifespan	aff, lifespan	time [d]	age [d]
mileometer	km	distance [km]	# forager squadrons
stores & hive [kg]	hony, pollen x 20	time [d]	honey, pollen [kg]
colony weight [kg]	weight	time [d]	weight [kg] of colony
consumption [g/day]	honey, pollen	time [d]	honey, pollen consumed [g]
honey gain [kg]	gain	time [d]	honey gain [kg]
mites	totalMites, phoreticMites, phoreticMitesInfected, phoreticMitesHealthy, miteDrop x 10	time [d]	# mites
proportion infected mites	proportion	time [d]	proportion
active foragers [%]	active%	time [d]	proportion [%]
active foragers today [%]	active%, deaths%	time [foraging round]	proportion [%]
foragingPeriod	period	time [d]	foraging period [h]
foraging probability	ForProb	time [d]	probability
foragers today [%]	nectar, pollen, scouts, resters, lazy, recruits	time [foraging round]	proportion [%]
loads returning foragers [%]	nectar, pollen, empty	time [d]	proportion [%]
mean trip duration	trip [min]	time [d]	duration [min]
mean total km per day	km/d	time [d]	distance [km]
# completed foraging trips (E-3)	# trips	time [d]	# trips x10^(-3)
trips per hour sunshine (E-3)	trips/h	time [d]	# trips x10^(-3)
nectar availability [l]	Patch 0, Patch 1 OR: all patches	time [d]	nectar [l]
pollen availability [kg]	Patch 0, Patch 1 OR: all patches	time [d]	pollen [kg]
foraging map	show nothing, nectar, pollen, nectar and pollen, all visits, all visits, all patches, available patches	x-coordinate distance to colony [m]	y-coordinate distance to colony [m]

description

workers alive
drones alive
drone & worker eggs laid today
relative protein content of nurses' brood food; workload of nurses in relation to max. amount of brood they could care for; relative pollen store in comparison to 'ideal' pollen store
histogram of the age of forager squadrons, infected as pupae (diseased), as adults (carrier) or not infected (healthy)
age of first foraging (aff) and mean lifespan of adult workers died today
histogram of the total distance travelled by foragers
honey stores and pollen stores (increased by factor 20)
weight of all bees (workers, drones, brood, adults)

amount of honey and pollen consumed today
day-to-day changes in the amount of stored honey, reduction of honey store shown in red
total mites, phoretic mites, phoretic mites with or without virus infection, mites dropped from comb (increased by factor 10)
proportion of virus infected, phoretic mites
percentage of foragers (alive) that were involved in foraging today (relative to all foragers alive)
percentage of foragers (alive) that were involved in foraging in the current foraging round, relative to all foragers alive in that round; cumulative proportion of foragers died during foraging on that day, relative to all foragers alive in foraging round 1
foraging period, i.e. time foragers are alloed to do foraging per day
probability for a resting forager to start foraging spontaneously
percentage of nectar & pollen foragers, scouts, recruits, resters and lazy foragers in each foraging round of current day, relative to all foragers alive in this round
percentage of nectar, pollen and unsuccessful foraging trips
mean duration of all foraging trips of a day
mean travelled distance of all foragers on that day
# of all completed foraging trips (nectar, pollen, empty) divided by 1000
# of foraging trips per hour sunshine (divided by 1000)
amount of nectar available, either at the two default patches or summed up for all patches (if ReadInfile is true)
amount of pollen available, either at the two default patches or summed up for all patches (if ReadInfile is true)
shows an approximate map with those flower patches, where bees collected nectar (yellow) or pollen (orange) or of all patches currently offering nectar or pollen, or of all defined patches

This table shows all "activities" of foragers, together with the abbrevations of activities, listed in the foragers "activityList".

(The activities of all foragers during the current time step can be shown in the Netlogo "Command center" by pressing the button "activityList" on the BEEHAVE interface.)

ACTIVITIES of foragers:	
lazy	lazy bees won't forage on that day and can't be recruited
resting	resting bees, can be recruited to an advertised flower patch by dancers or might start foraging spontaneously in a following foraging round
expForaging	experienced foragers, engaged in nectar or pollen collection at a certain patch
searching	scouts, searching a new flower patch for nectar or pollen
bringingNectar	successful nectar foragers, bringing back nectar
bringingPollen	successful pollen foragers, bringing back pollen
recForaging	foragers, recruited to an advertised flower patch by a dancer. They will search for this patch in the next foraging round

ABBREVATIONS of foraging activities (as used in the activityList of foragerSquadrons):	
An	forget nectar patch while resting
Ap	forget pollen patch while resting
AnSn	abandon current nectar patch and search a new one (and maybe find and use the same patch again)
ApSp	abandon current pollen patch and search a new one (and maybe find and use the same patch again)
AfR	abandon foraging and rest
bN	bring nectar into colony, unload it and increase honey energy store of the colony
bP	bring pollen into colony and increase amount of stored pollen in the colony
DIES	forager dies while searching a patch or collecting pollen or nectar
Dn	dances for nectar patch; at least two resting foragers must be present in the colony for recruitement to take place.
Dp	dances for pollen patch; at least two resting foragers must be present in the colony for recruitement to take place.
E	scout returns empty
End	end of today's foraging period
eSn	search a new nectar patch, as the just visited patch is now empty (provides no nectar)
eSp	search a new pollen patch, as the just visited patch is now empty (provides no pollen)
feN	found empty nectar patch
feP	found empty pollen patch
fN	found a nectar patch
fP	found a pollen patch
frN	found a nectar patch after being recruited
frP	found a pollen patch after being recruited
L	lazy forager, won't forage spontaneously and can't be recruited
mSn	recruited forager missed the patch and searches a new nectar patch
mSp	recruited forager missed the patch and searches a new pollen patch
N	collect nectar at flower patch
P	collect pollen at flower patch
PF	pollen forager, i.e. the bee, searches or collects pollen, or would do it, if it would not be resting. If no "PF" is shown, then the bee is a nectar forager.
R	resting
Rx	resting of an experienced pollen forager, who knows a nectar patch but no pollen patch or of an experienced nectar forager, who knows a pollen patch but no nectar patch.
rFnNF	dance follower, who doesn't know a nectar patch is recruited to forage at a certain nectar patch and chooses nectar as forage type
rFpPF	dance follower, who doesn't know a pollen patch is recruited to forage at a certain pollen patch and chooses pollen as forage type
rFnxNF	dance follower, who only knows a worse nectar patch is recruited to forage at a certain nectar patch and chooses nectar as forage type
rFpxPF	dance follower, who only knows a worse pollen patch is recruited to forage at a certain pollen patch and chooses pollen as forage type
Sn	searching nectar patch
Sp	searching pollen patch
uS	unsuccessful searching the searching scout didn't find a patch

Xn	experienced nectar forager
Xp	experienced pollen forager
Xnr	experienced nectar forager, who was recruited by following a dance but starts foraging at her own nectar patch, as this has not a lower quality than the advertised nectar patch
Xpr	experienced pollen forager, who was recruited by following a dance but starts foraging at her own pollen patch, as this has not a lower quality than the advertised pollen patch

This table lists all "BugAlarms" (assertions), added to the code.

Conditions to raise a "BugAlarm"	Message	Procedure
ifelse SeasonalFoodFlow = true [..if foodType != "Nectar" and foodType != "Pollen"]	"BUG ALARM in FlowerPatchesFoodAvailableTodayREP - Wrong 'foodT	**FlowerPatchesMaxFoodAvailableTodayREP**
ifelse SeasonalFoodFlow = true [..if patchID != 0 and patchID != 1	"BUG ALARM in FlowerPatchesFoodAvailableTodayREP - Wrong 'who'	**FlowerPatchesMaxFoodAvailableTodayREP**
ifelse SeasonalFoodFlow = true [..if ReadInfile = true]	"BUG ALARM in FlowerPatchesFoodAvailableTodayREP - called althou	**FlowerPatchesMaxFoodAvailableTodayREP**
if N_INITIAL_MITES_INFECTED = 0 [if (count foragerSquadrons with [infectionState = "infectedAsPupa"] + count foragerSquadrons with [infectionState = infectedAsAdult"]) > 0 or (count IHbeeCohorts with [number_infectedAsPupa > 0] + count IHbeeCohorts with [number_infectedAsAdult > 0]) > 0]	"BUG ALARM! Infected bees from out of the blue!"	**DailyUpdateProc**
ask flowerPatches [if detectionProbability < -1]	"Wrong detection probability! Set 'ModelledInsteadCalcDetectProb' 'f	**DailyUpdateProc**
ask flowerpatch id [.. if id != who]	"Error in id / who!"	**DailyUpdateProc**
if EMERGING_AGE <= 0	"EMERGING_AGE <= 0"	**NewEggsProc**
ask pupaeCohorts [.. if number_infectedAsPupa > 0]	"BUG ALARM!!! number_infectedAsPupa > 0 in WorkerPupaeDevProc	**WorkerPupaeDevProc**
ask dronePupaeCohorts [.. if number_infectedAsPupa > 0]	"BUG ALARM!!! number_infectedAsPupa > 0 in DronePupaeDevProcs!	**DronePupaeDevProc**
if ExcessBrood > 0 [.. if stillToKill > 0]	"BUG ALARM! stillToKill > 0"	**BroodCareProc**
if readInfile = true	"BugAlarm in CreateFlowerPatchesProc! Check read-in!"	**CreateFlowerPatchesProc**
if sqrt ((foragersAlive - currentNectarForagers - currentPollenForagers - currentResters - currentScouts - currentRecruits - currentLazy) ^ 2) > 0.0000000001	"BUG ALARM in ForagingRoundProc: wrong number of forager activiti	**ForagingRoundProc**
if foragingPeriod_s = -1	"BugAlarm in Foraging_PeriodREP! Weather not defined!"	**Foraging_PeriodREP**
ask foragerSquadrons with [activity = "searching"] [..ifelse random-float 1 < TotalFPdetectionProb [..if (knownNectarPatch < 0 and knownPollenPatch < 0)]]	"BUG: negative flower patches!"	**Foraging_searchingProc**
if PhoreticMites < 0	"Error in MitesInvasionProc - negative number of phoretic Mites"	**MitesInvasionProc**
if ploidyMiteOrg != 1 and ploidyMiteOrg != 2	"BUG ALARM in MiteOffspringREP! Wrong ploidyMiteOrg: "	**MiteOffspringREP**
ask miteOrganisers with [who = miteOrganiserID] [..if releaseCausedBy != "dyingBrood" and releaseCausedBy != "emergingBrood"]	"BUG ALARM in ReleaseMitesProc(1)! releaseCausedBy: "	**MitesReleaseProc**
if healthyMitesInSingleCell + infectedMitesInSingleCell != allMitesInSingleCell	"BUG ALARM in ReleaseMitesProc(2)! allMitesInSingleCell: "	**MitesReleaseProc**
if item mitesIndex cellListCondensed < 0	"BUG ALARM in ReleaseMitesProc(3)! Negative number in cellListConc	**MitesReleaseProc**
if totalCells < 0	"BUG ALARM in ReleaseMitesProc(4)! Negative number of total cells i	**MitesReleaseProc**
if mitesInfectedSumUncappedCells + mitesHealthySumUncappedCells != mitesHealth	"BUG ALARM in ReleaseMitesProc(5)! mitesInfectedSumUncappedCell	**MitesReleaseProc**
if mitesInfectedSumUncappedCells < 0 or mitesHealthySumUncappedCells < 0	"BUG ALARM in ReleaseMitesProc(6)! mitesInfectedSumUncappedCell	**MitesReleaseProc**
ask miteOrganisers with [who = miteOrganiserID] [..if (ploidyMiteOrg != 1) and (ploidyMiteOrg != 2)]	"BUG ALARM in releaseMitesProc(7)! Wrong ploidyMiteOrg: "	**MitesReleaseProc**
if mitesReleasedFromInhivebees > PhoreticMites	"BugAlarm!!! mitesReleasedFromInhivebees > PhoreticMites! mitesRe	**MitePhoreticPhaseProc**
if (healthyPhoreticMitesSwitchingHosts - healthyPhoreticMites) > 1	"BugAlarm!!! (MitePhoreticPhaseProc) healthyPhoreticMitesSwitchin	**MitePhoreticPhaseProc**
if newlyInfectedIHbeesInThisCohort > number_healthy	"Bug Alarm! newlyInfectedIHbeesInThisCohort > number_healthy!"	**MitePhoreticPhaseProc**
if number_healthy < 0	"BUG ALARM!!! (MitePhoreticPhaseProc) Negative number of healthy	**MitePhoreticPhaseProc**
if number_healthy + number_infectedAsPupa + number_infectedAsAdult != number	"BUG ALARM!!! (MitePhoreticPhaseProc) Wrong sum of healthy + infe	**MitePhoreticPhaseProc**
if healthyPhoreticMites < 0	"BUG ALARM!!! Negative number of healthy mites (MitePhoreticPhas	**MitePhoreticPhaseProc**
if TotalEggs < 0 OR TotalLarvae < 0 OR TotalPupae < 0 OR TotalIHbees < 0 OR TotalFo	"BUG ALARM! negative number in total bees"	**CountingProc**
ask turtles [if number < 0]	" BUG ALARM! negative number in turtles: "	**CountingProc**
if TotalMites < 0 or PhoreticMites < 0 or PhoreticMitesHealthyRate > 1 or PhoreticMi	"BUG ALARM! Check number of mites and PhoreticMitesHealthyRate!	**CountingProc**

ask (turtle-set pupaeCohorts dronePupaeCohorts droneCohorts) [if number != number_infectedAsPupa + number_healthy]	"BUG ALARM! (CountingProc) number <> healthy + infected"	**CountingProc**
ask IHbeeCohorts [if number != number_infectedAsAdult + number_infectedAsPupa + number_healthy]	"BUG ALARM! (CountingProc) number <> healthy + infected (IH-bees)"	**CountingProc**
while [not file-at-end?] [..if (N_FLOWERPATCHES mod 1) != 0]	"Error in Infile - wrong number of lines"	**ReadFileProc**