Rearing bumble bees in laboratory
The picture supplement

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The book comprises the author's experience with rearing bumble bees in laboratory conditions. First, the biology of bumble bees is explained, followed by the description of the simple equipment used. The step by step technique aimed at obtaining *Bombus terrestris* colonies including the rearing of young queens is shown, as well as its application to other pollen stores (*B. lucorum, B. lapidarius, B. pratorum, B. soroeensis, B. cryptarum* and *B. hypnorum.* Similarly, *B. pascuorum*, which responded as the best to the artificial rearing conditions, served as the model for other pocket makers (*B. sylvarum, B. ruderarius, B. humilis, B. hortorum*, *B. ruderatus* and *B. subteraneus*). The list of enemies noted during the rearing in captivity and is added, as well as basic recommendations for placement of colonies in the open air. The simple guide allows recognizing Czech species of bumblebees and cuckoo bumblebees. As a supplement 111 colour photos illustrating the text are added. The book is written in Czech, the English version of the texts to pictures arised for the Journal of Pollination Ecology (http://www.pollinationecology.org/) to be available electronically for the community of researchers as well as bumble bee friends.

Key words: *Bombus*, *Psithyrus*, bumblebee, cuckoo bumblebee, *Aphomia sociella*, *Brachycoma*, *Melittobia*, management, rearing, pollination.

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The Picture appendix

Fig. 1: The queen of *Bombus* sp. collecting honeydew in Finland.

Fig. 2: Queen of *B. terrestris* incubating her brood.

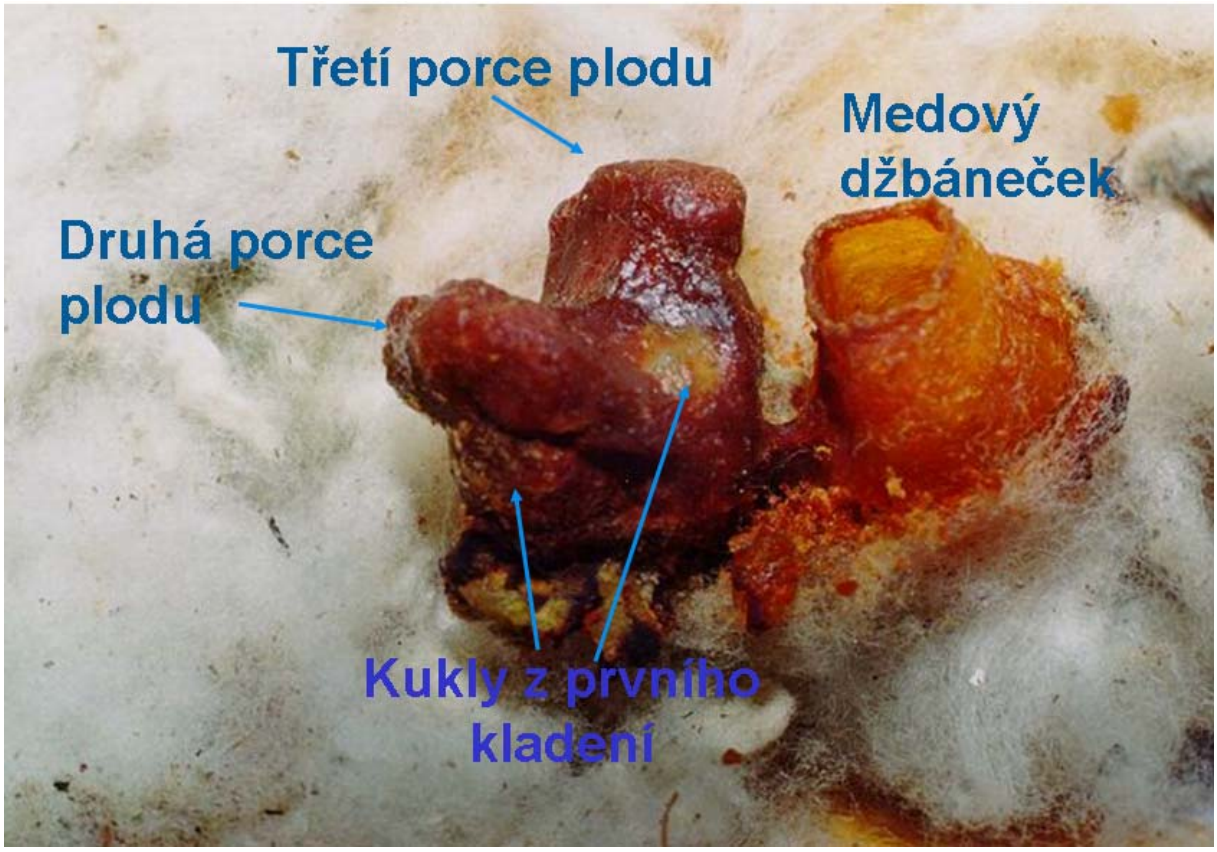

Fig. 3: The structure of the first brood in *B. lapidarius*. Cocoons from the first eggs are below; above them are the second and the third portions of larvae and eggs making the incubation groove. Right, toward the entrance, there is the honey pot.


Fig. 4: Freshly emerged workers (*B. pratorum*) are grey. Yellow are cocoons containing pupae, some of them have dark eyes. Brownish clumps of wax cover the larvae. Empty cocoons (left) serve as honey pots. Just below on the pictures there are anther 3 honey pots.

Fig. 5: The queen of *B. lapidarius* laying several eggs into one wax cell constructed on the cocoons.

Fig. 6: The natural nest of *B. hypnorum* in artificial hive. The central pollen store is surrounded with clumps of larvae in various stage of development. The egg cell is below (button like). The lower shells are cocoons.

Fig. 7: Pollen pocket in *B. pratorum*. The species is considered to be pollen storer and is able to take pollen also from stores.

Fig. 8: The colony of *B. lapidarius* in early stage of development.

Fig. 9: Just emerged young queen at the top of colony development (*B. terrestris*).

Fig. 10: As the constant conditions (a thermostat) the whole rearing room is used.

Fig. 11: Red light is used while working in the rearing room, here gluing cocoons containing pupae onto the pieces of the cardboard underlay.

Fig. 12: Several types of rearing boxes. The best accepted were the largest ones.

Fig. 13: The protective plastic cover above the hive.

Fig. 14: Aquaria for mating queens or storing bumblebee adults.
The refrigerator is at the back side

Fig. 15: The refrigerator is used to store wintering queens (each in a box for the photography films). The losses of humidity must be avoided (photo A. Bucankova).

Fig. 16: Various types of feeders.
Fig. 17: The only opening prevents leaking of the sugar solution.

Fig. 18: Pollen pellets from various plant species.
The mixture of species is usually better than one source only.

Fig. 19: The part of the pollen trap containing pollen is taking out of the hive bottom.

Fig. 20: Plastic containers (also feeders) filled with delicately pressed fresh pollen pellets are ready for feeding colonies.

Fig. 21: The queen of *B. terrestris* constructed the brood cell in attendance of honeybee workers.

Fig. 22: The queen of *B. terrestris* with her brood, which was stimulated by placing male cocoons into the rearing box..

Fig. 23: *B. terrestris* queen, which has the brood in the larval stage (the clump above), is able to adopt the young *B. terrestris* worker.

Fig. 24: The divided rearing box. To enhance the oviposition of *B. terrestris* pair of queens, male cocoon was added to each of them. The queen on the right is incubating it.

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Fig. 26: The colony of *B. terrestris* having hungry larvae.

Fig. 27: The colony *B. terrestris* strong in workers can be used for pollination.

Fig. 28: The colony of *B. terrestris* having larvae of young queens.

Fig. 29: The *B. terrestris* colony with cocoons of young queens.

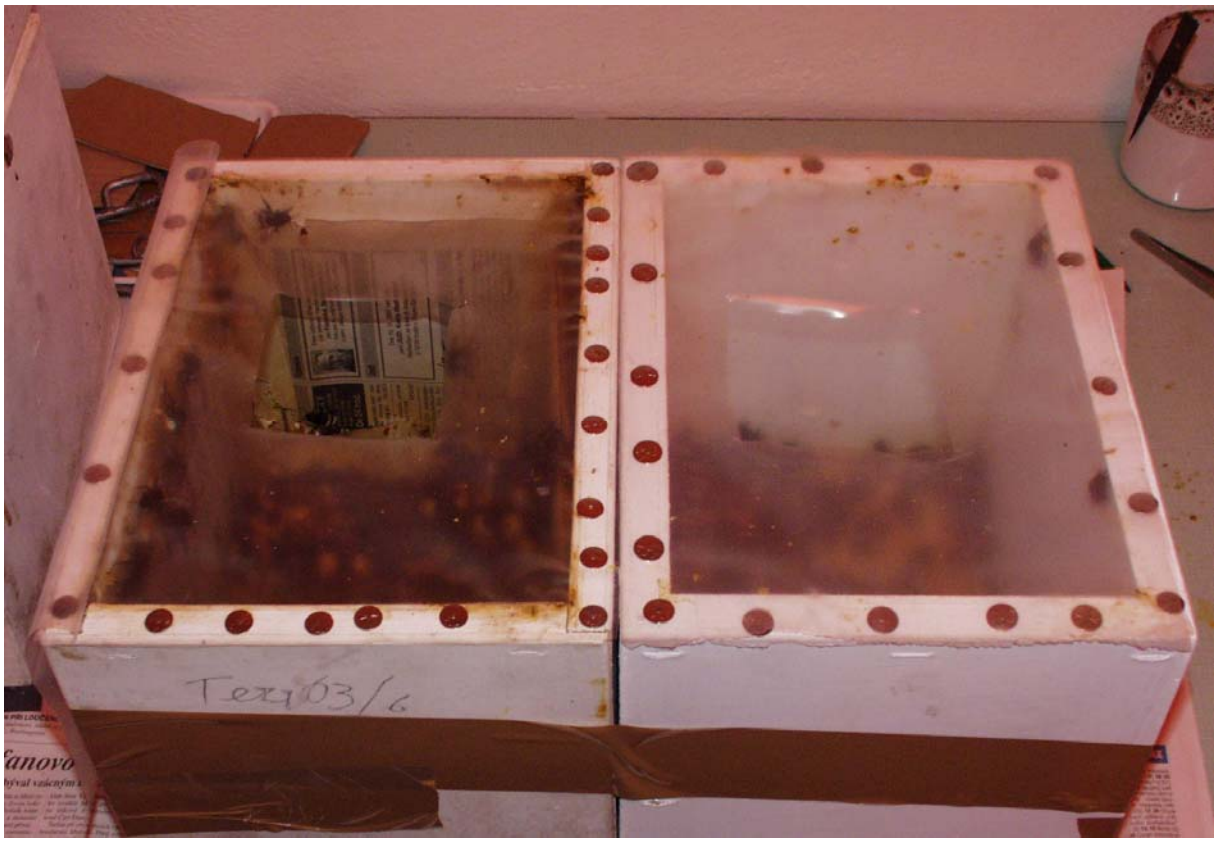

Fig. 30: Two hives connected during the queen rearing of the colony.


Fig. 31: Young queens which emerged out of the colony. They are consuming pollen immediately after the emergence.

Fig. 32: Mated queens ready to enter the diapauses.

Fig. 33: The deliberate queen production - orphaned *B. terrestris* colony feed young larvae as the queens ones (right in the picture).

Fig. 34: The *B. terrestris* colony having only 22 tiny workers fed 26 larvae as queens. The worker ability to feed queen larvae is considerable.

Fig. 35: Exceptional mating in *B. terrestris* even within the hive.

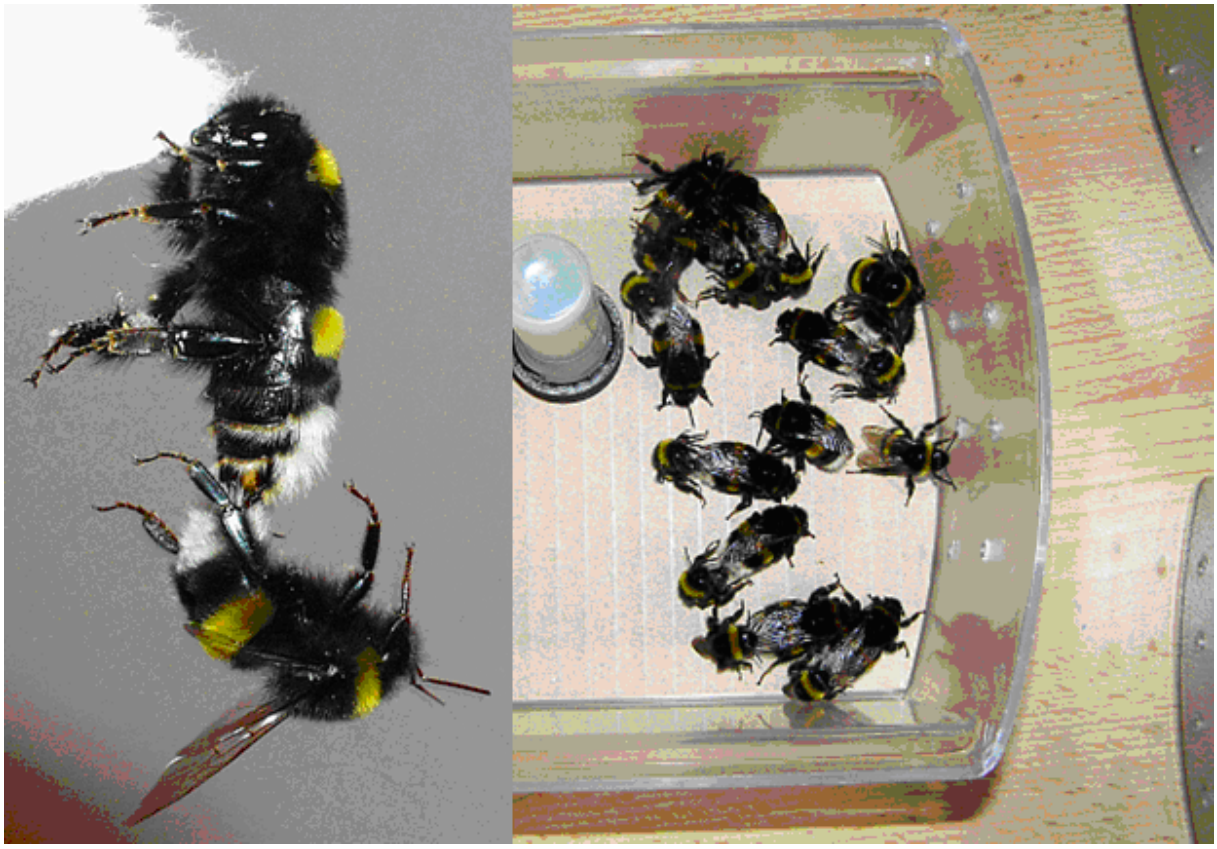

Fig. 36: Copulating pairs of *B. terrestris* collected separately in a box. Males are taken out after the copulation and queens are let another 2 – 3 days to fill their honey stomachs in darkness.

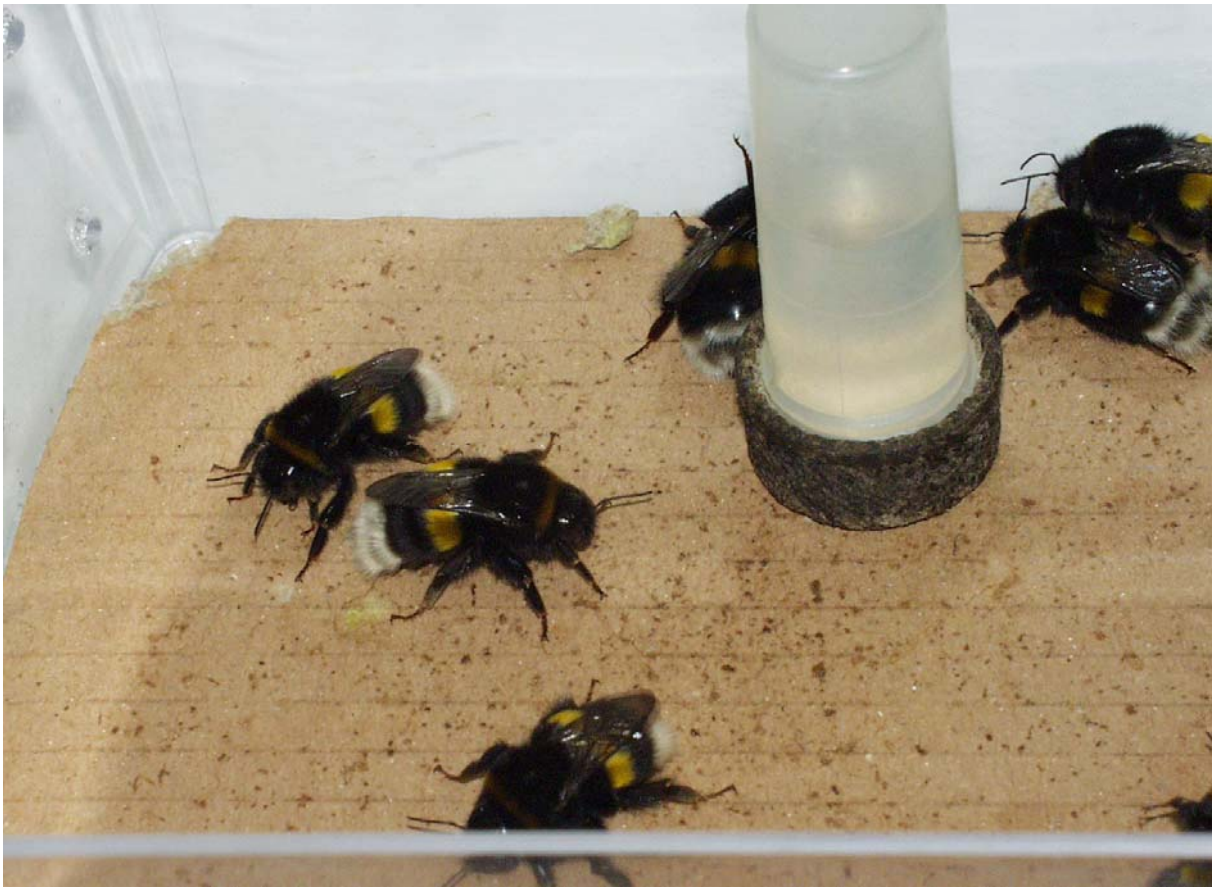

Fig. 37: The heavy *B. terrestris* queens are ready for the cold storage.

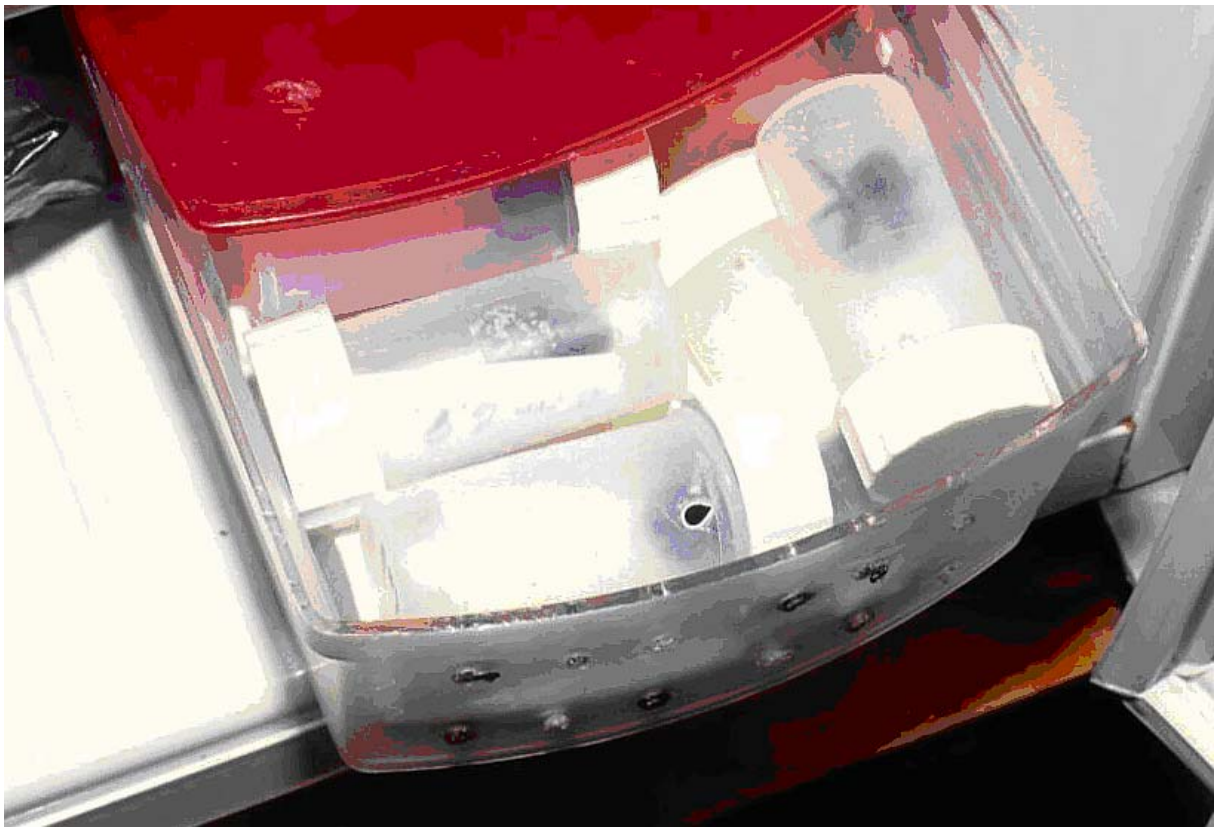

Fig. 38: The set of queens placed in the refrigerator. (Here, the rearing equipment is used.)

Fig.39: The *B. lucorum* queen collaborating with the *B. terrestris* worker (above); two young workers are the own ones. Yet the colony produced males rather early.

Fig. 40: The comparatively young colony of *B. lucorum* produces young queens (the large cocoons) after the early switch point.

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Fig. 44: The colony of *B. lapidarius*, which is advanced in development.

Fig. 45: The matured colony of *B. lapidarius* has cocoons and larvae of young queens.

Fig. 46: The male level of *B. lapidarius* colony after the death of the old queen.
The yellow heads and prothorax have males the black ones are workers

Fig. 47: The copulating pair of *B. lapidarius*.
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Fig. 48: The queen of *B. pratorum* with her brood and one worker of *B. terrestris* as a helper. The colony produced males soon.

Fig. 49: The young colony of *B. pratorum* built a pollen pocket under the brood (above).

Fig. 50: Mating of *B. pratorum* in laboratory – the day light is necessary.

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Fig. 53: The queen of *B. cryptarum* incubating her brood.

Fig. 54: The developing colony of *B. cryptarum*.

Fig. 55: Another developing colony of *B. cryptarum*.

Fig. 56: Variability in the colour pattern of *B. cryptarum* males.
The queen is left below in the picture

Fig. 57: Copulation in *B. cryptarum* progeny reared in laboratory.

Fig. 58: The young colony of *B. hypnorum* started under the cooperation with *B. pratorum* worker (above in the picture).

Fig. 59: The small colony of *B. hypnorum* having constructed the pollen pocket under the clump of larvae, tough the species is considered to be the pollen storer The case is similar as in *B. pratorum*.

Fig. 60: The matured colony of *B. hypnorum* reared under the laboratory conditions.

Fig. 61: The free pair of *B. pascuorum* queens (the pocket makers).
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Fig. 62: The young brood of *B. pascuorum* with the wax pocket;
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Fig. 63: The brood of *B. pascuorum* in the stage proper for the shift outdoors. The colony has 5 workers (put away), 4 cocoons (right) with one egg cell, and 4 well fed larvae (left) under which there is a pocket partially filled with pollen.

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Fig. 65: Young queen of *B. pascuorum*; she can be taken of for the controlled mating.

Fig. 66: The copulation of *B. pascuorum* in laboratory conditions is easy.

Fig. 63: The young colony of *B. sylvarum* ready to be transferred out of door.

Fig. 64: A good colony of *B. sylvarum* with plentiful workers, brood and larvae of young queens. It is able to use the supplemental feeding of pollen placed into the plastic lids.

Fig. 65 The queen of *B. ruderarius* cooperating with the *B. pascuorum* worker (left).

Fig. 66: The laboratory started colony of *B. humilis tristis*.

Fig. 67: The laboratory mating of the queen *B. humilis tristis* with the male of another variety. The species mateed in the direct sun shine.

Fig. 68: The free pair of *B. hortorum* queens with the started brood cell.

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Fig. 70: The colony of *B. hortorum* developed entirely in the lab. Though told as pocket makers, workers were able to feed numerous young queen larvae through the tiny opening on the top of the wax envelope. The old queen is right in the photo.

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Fig. 75: The queen of *B. terrestris* killing the tiny *Melittobia acasta* adults, which are emerging from one infested cocoon – dead they lay on the cardboard underlay close to the brood (black spots). (The first young worker did emerge also.)

Fig. 76: The pheromone trap for males of *P. interpunctella*.

Fig. 77: The female of *Aphomia sociella*. It destroys colonies placed outsides.

Fig. 78: The female, caterpillar and pupae of *Aphomia sociella*

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Fig. 80: Pupae of *Brachycoma devia* in the hive cover below the former colony.

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Fig. 82: Females and males of *Psithyrus bohemicus* produced in the colony of *B. terrestris*.
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Fig. 89: The queen of *B. subterraneus* with her brood in the Čížek's lab (photo J. Čížek).

Fig. 90: The *B. subterraneus* colony in the developmental stage placed in the hive outside (photo J. Čížek).

Fig. 91: Males and queens of *B. subterraneus* in the mating cage (photo J. Čížek).

Fig. 92: Queens and males of *B. ruderatus* in the mating cage (photo J. Čížek).

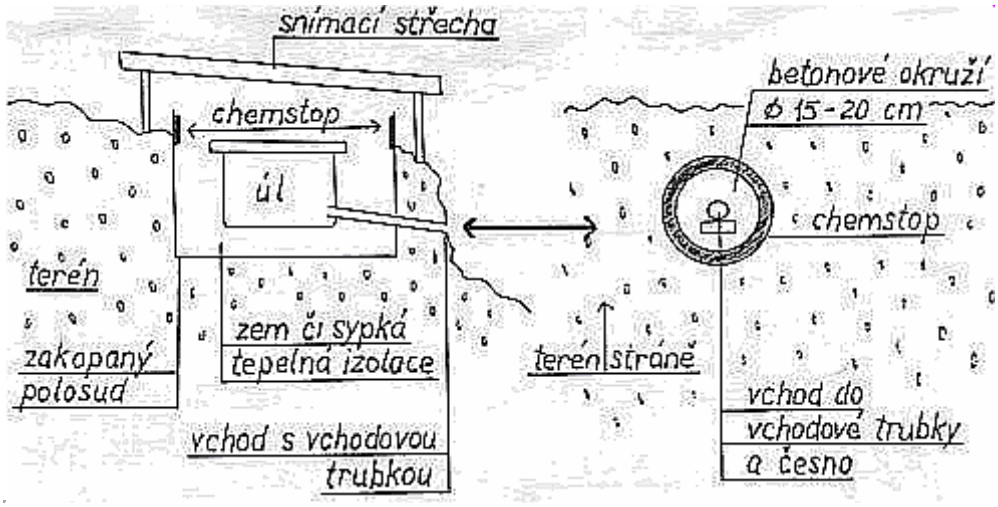

Fig. 93: Scheme of the hives buried in the soil according to M. Stuchl.

Fig. 94: The entrance barrier according to Krenz (2006) against *Aphomia sociella* (photo J. Čížek).

Fig. 95: The entry into the hibernaculum of *B. lapidarius* (photo Čížek).

Fig. 96: The closed entry into the hibernaculum of *P. vestalis* (photo Čížek).

Fig. 97: The hive stand equipped with the protection against ants.

Fig. 98: Hives of *B. terrestris* colonies managed for fruit tree pollination in a garden.

Fig. 99: The wooden trap hives for the outdoor placement. Those equipped with the corridor are more attractive for searching queens. (The necessary inner insulation material is not shown at the picture.)

Fig. 100: Typically coloured queen of *B. cryptarum*.

Fig. 101: The *B. cryptarum* queen from the same colony as on the Fig 100.

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Fig. 104: The *B. ruderarius* queen is typical by the red hairs on the last pair of tibias.

Fig. 105: Copulation of *B. humillis* queen and male, both of the *tristis* variety.

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