Notes on Hive insulation compiled by David Heaf, Novembe, 2019

Philips & Demuth (Philadelphia, 2018)

"It is impossible to insulate bees too heavily during the winter. [...]In warmer climates less will be needed, but the
beekeeper must not think that si mply because he lives south of Washington he can be safe with less packing or none at all. "

Philips, E. F. & Demuth, G.S. (1918) The preparation of bees for outdoor wintering. Farmers Bulletin 1012, USDA, p.6.

Free & Racey (UK, 1968)

Free, J.B. & Racey, P. A. (1968) The effect of the size of honeybee colonies on food consumption, brood rearing and the longevity of bees during winter. Ent. exp. & appl. **11,** 241--249.

From October to April, larger colonies consumed less food per bee than smaller ones.

Merrill (Kansas, 1920, 1923)

Merrill compared wintering of insulated (packed) hives with uninsulated ones. The insulation comprised a box surrounding the hive with up to a 200 mm thickness of dry leaves on all six sides. The hives were weighed throughout the winter. The insulated hive consumed more stores throughout the winter, totalling almost double that of uninsulated hives after the 151 day monitoring period through one winter. Furthermore, the insulated hives had up to three times the number of bees by 'the beginning of the honey flow' (May). As the insulated colonies had around 36,000 bees by May it is highly probable that they used their stores to raise a lot of brood in early spring.

Merrill, J.H. (1920) Preliminary notes on the winter protection for bees. J. Economic Entomol. **13**, 99-111.

"The most marked results on the value of winter protection were those obtained during the winter of 1920-1921,which was very mild and open with frequent opportunities for the bees to take flight. In fact, it was very similar to winters in those parts of the country where the remark is oftenheard that "there is no need of packing our bees because we have such mild, open winters.""

Merrill, J. H. (1923) Value of winter protection for bees. J. Econ. Entomol 16, 125-130.

Derek Mitchell (UK, 2015)

This laboratory study looked at heat loss from various types of enclosure occupied by bees.

Lumped enclosure thermal conductance (WK^{-1})
Cedar Warré hive 1.28
Simulated tree cavity 0.47

Clearly the Warré hive was vastly inferior in terms of heat retention compared with a tree cavity.

Mitchell, D. (2015) Ratios of colony mass to thermal conductance of tree and man-made nest enclosures of Apis mellifera: implications for survival, clustering, humidity regulation and Varroa destructor. Int J Biometeorol DOI 10.1007/s00484-015-1057-z
https://static1.squarespace.com/static/5994976fc534a540838f3351/t/5cc1f0a7419202bb8ede360e/1556213933897/Mitchell+Ratio+Of+Mass.pdf

Guzmán-Novoa (Ontario, 2010)

This observational study of 400 colonies included the assessment of hive population in autumn. The authors wrote:

"Colonies that died during the winter had significantly lower bee populations and food reserves as well as higher mite infestation levels than surviving colonies during the previous fall ($P < 0.001$)"

Guzmán-Novoa, E., Eccles, L., Calvete, Y. et al. (2010) Varroa destructor is the main culprit for the death and reduced populations of overwintered honey bee (Apis mellifera) colonies in Ontario, Canada. Apidologie **41**: 443. https://doi.org/10.1051/apido/2009076

Villumstad (Norway, 1974)

Villumstad compared stores consumption over winter and a couple of other performance features in hives with three different wall thicknesses:

Double walled 60 mm 8.5 kg
Double walled 45 mm 9.8 kg
Single walled 22 mm 11.8 kg

Thick walls clearly reduced stores consumption.

Villumstad E (1974) Importance if hive insulation for wintering, development and honey yield in Norway. Apiacta 9:277–281

Owens (Wisconsin, 1971)

He gave no information on the size of his colonies or their weights of honey stores. He says that all hives had three bodies measuring 20 x 20 x 6 5/8 inches. Allowing for 3/4" wood this works out as an internal volume of 114 litres. This is vastly in excess of median cavity volumes occupied by wild honey bee colonies (45 litres)[Seeley & Morse] or cavities selected by swarms (40 litres preferred to 100 litres)[Seeley & Morse].
Large colonies are more likely to survive regardless of the lumped thermal conductance of their enclosure. Also a superabundance of stores would cushion colonies against the effects of cold. Both these factors could mask the need for insulation.

Even so, Owens writes: "A cluster held for long periods under freezing conditions declines in strength. The rate of decline is dependent on pollen stores available, but it is slower in insulated than in unprotected colonies." So this indicates in favour of insulation. Owens was experimenting before Varroa arrived, so his colonies were under less stress than those post Varroa. A colony in autumn whose population is reduced by Varroa and Deformed Wing Virus is at greater risk of failing in winter.

Owens, C. D. (1971) The thermology of wintering honey bee colonies. Tech. Bull. U.S. Dept. Agric. 1429: 1-32.
http://www.beesource.com/resources/usda/the-thermology-of-wintering-honey-bee-colonies/

Langstroth (Massachusetts, 1853)

Langstroth in his early book favoured a triple walled hive with two inner glass walls enclosing a one inch air space and an outer wall of wood, the cavity between which and the outermost glass wall was filled with plaster of Paris or other insulator. Unfortunately he gave no winter survival data with this superinsulated hive.

Langstroth L L. (1853) Langstroth on the Hive and the Honey-Bee A Bee Keeper's Manual, NORTHAMPTON: HOPKINS, BRIDGMAN & COMPANY.

Mobus (Scotland, 1998)

Mobus placed an insulated and an uninsulated hive on recording scales and monitored weight loss over one winter from 19 October to 25 February. In the uninsulated hive, the loss was double that of the insulated hive.

Mobus, B. (1998) Rethinking Our Ideas About the Winter Cluster, Part II. Am. Bee. J. 138(8), 597-591. (Article follows on from B. Mobus, 'Brood rearing in the winter cluster. Am. Bee J., 138(7), 511-514, 1998.)

Farrar (Wisconsin, 1949 & 1968)

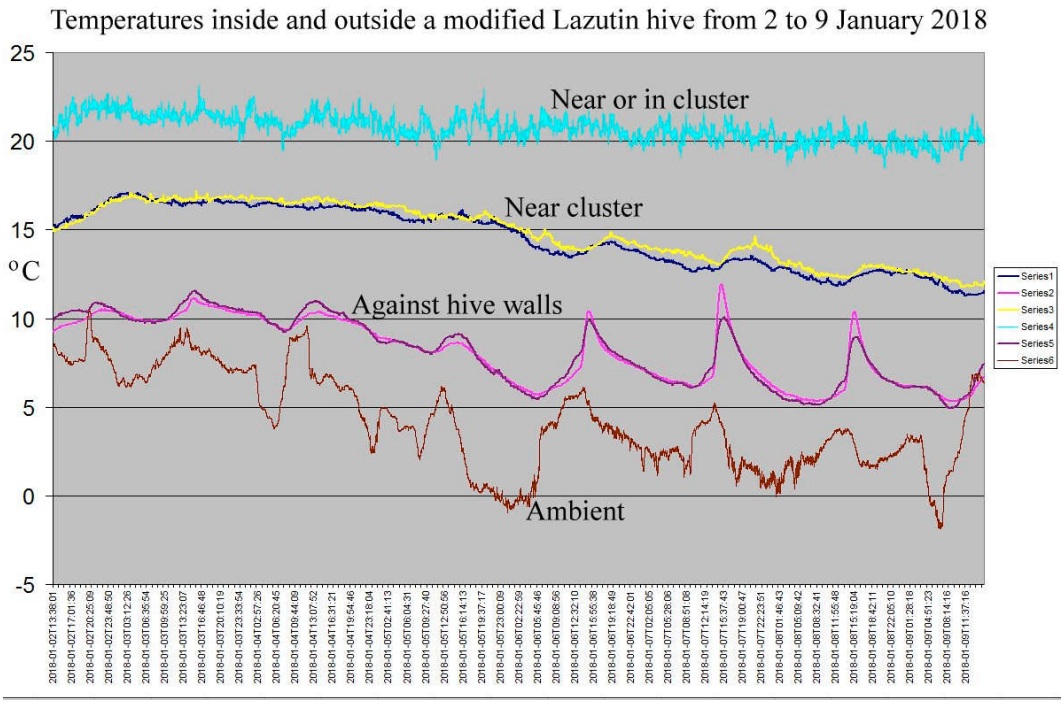
In a 1949 article on the overwintering of colonies, he writes:

"Packing fails to conserve the energy of the bees because the winter cluster does not attempt to heat the inside of the hive."

And in a series of articles in 1968 on productive beekeeping in general he writes:

" The cluster does not heat the unoccupied space in the hive. During a protracted cold period the temperature in this space will become almost as low in a well insulated hive as in one with no protection. Too much hive packing prevents the colony from responding to warm periods during the day which otherwise might allow the cluster to shift its position on the stores or the bees to take cleansing flights."

Of course, the winter cluster does not try to heat the inside of the hive! It would be folly to do so. However, plenty of studies and my own observations using six sensors in a double-walled insulated hive do not support Farrar's statement that 'packing fails to conserve the energy of the bees'. The hive dissipates heat from the winter cluster and that dissipation can be more or less inhibited by insulation.



Temperatures against the walls, even remotely from the winter cluster are always higher than the ambient (outside) temperature. The following chart shows a week of recordings in January. That the two sensors near the walls are at a higher temperature, as much as 7°C higher, shows that the double wall and insulation is resisting heat outflow. That there is a thermal gradient shows that there is heat loss from the only source of heat in the hive, namely the cluster. This loss is made at the expense of honey. Note also that when the ambient temperature falls below zero, the inside hive environment is cushioned against this drop.

Farrar, C. L. (1949) The overwintering of productive colonies. In 'The Hive and the Honey Bee', Ed. Grout, R. A. Ch. XIV, 337-362 .
Farrar, C.L. (1968) Productive management of honey-bee colonies. American Bee Journal, **108**, 95-97, 141-143, 183-185, 228-230, 271-275, 316-317, 392-393. https://beesource.com/resources/usda/productive-management-of-honey-bee-colonies/

fao.orf and Google Scholar Farrar 1973 ?? Productive management of honey-bee colonies II. American Bee Journal 328-330 113 (8): 288-290; (10): 373-375; (11): 415-417.

Bornus & Nowakowski (Poland 1974)

They compared stores consumption over several winters in 'warm' hives with 32 mm walls with 'cold' hives with 26 mm walls. The consumption was 0.5-1.1kg higher in 'cold' hives. They also noticed that hives with top and bottom entrances consumed more than those with just bottom entrances.

Bornus, L., Nowakowski, J. 1974. Wintering of bees in one-wall hives in cold climate. Beekeeping in regions with cold climate. International symposium, Helsinki, 1-4. August: Apiacta 3, 105-106. http://www.fiitea.org/cgi-bin/index.cgi?sid=&zone=download&action=download_file&file_id=456&categ_id=80

Dodologlu et al. (Turkey, 2004)

These authors compared 36 polystyrene and 36 wooden Langstroth hives as regards a number of wintering parameters. The wooden hives had 25 mm thick walls and the polystyrene hives 30 mm thick walls. 5 of the colonies in wooden hives died and 12 of the colonies in polystyrene hives died. Polystyrene hives consumed much less food (6.2 v. 8.6 kg). The decrease in the overwintering population was greater in the polystyrene hives. The authors suggested that the lower food consumption in the polystyrene hives is due to their higher overwintering loss of bees.

Dodologlu, A., Dülger, C., Genc, F. 2004. Colony condition and bee behaviour in honey bees (Apis mellifera) housed in wooden or polystyrene hives and fed `bee cake´ or syrup. Journal of Apicultural Research 43 (1): 3-8.

Genersch et al. (Germany, 2010)

In contrast to the Dodologlu study, Genersch et al., analysing 4,313 colony winters found no difference in losses between wooden and polystyrene hives, 11% in both cases.

Genersch, E., von der Ohe, W., Kaatz, H., Schoeder, A., Otten, C., Büchler, R., Berg, S., Ritter, W., Mühlen, W., Grisder, S., Meixner, M., Liebig, G., Rosenkranz, P. 2010. The German bee monitoring project: a long term study to understand periodically high winter losses of honey bee colonies. Apidologie 41: 332-352.

Olszewski (Poland, 2007)

Olszewski found that in overwintered hives between two and three times as many bees died in uninsulated compared with insulated hives. Furthermore, depending on bee breed, uninsulated colonies consumed 19-24% more 'food stores'.

Olszewski, K. (2007) Winter-hardiness of Buckfast bees under specific weather conditions of areas with alternating influences of maritime and continental climate. J. Apicultural Sci. **51**(1), 73-82.

Marcinkowski (Poland, 1985)

Marcinkowski J., (1985) Estimation of the usability in apiculture of styrofoamed hives on pallets. Pszczelnicze Zeszyty Naukowe (Poland) XXIX, 169-185.

Marcinkowski studied colonies over three winters in polystyrene hives and wooden hives. It appears that the wooden hives had 35 mm thick walls and an unstated amount of insulation, Consequently they might have actually had lower lumped enclosure thermal conductances than the polystyrene hives. Food consumed was 7% lower in wooden hives, but the results were very inconsistent from winter to winter. There were more dead bees in wooden hives in all three winters, but the styrofoam hives were noticeably wetter. There was a slightly higher rate of Nosema in the wooden hives. Ambient temperatures dropped to -12°C over the winter but remained more than 2°C above freezing in the polystyrene hives, dropping to only -1.2°C in the wooden hives.

Haydak (Minnesota, 1958)

Haydak experimented on hundreds of colonies over 10 winters and showed that 'heavily packed' hives showed dramatically lower winter losses compared with uninsulated ones, 18.4% as against 2.9%.

Haydak, M. H. (1958) Wintering bees in Minnesota. J. Econ. Entomol. 51(3), 332-334.

Wedmore (UK, 1947)

"During the period of close clustering any packing will make a negligible difference unless there is a lot of it." (p. 53)

"As a result of the studies in earlier chapters I take a more rosy view of the possibilities and advantages of dispensing with all packing than is yet taken even by those who are beginning to follow this course. In any case it is now certain that there is no justification for the use of any such packing in any part of Great Britain." (p. 107)

Wedmore, E. B. (1947) The Ventilation of Bee-Hives. Northern Bee Books, facsimile edition 2013.