Planned Master Thesis: Austrian Beekeepers Citizens Science Survey, the Financial Burden to Fight *Varroa Destructor*

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Introduction

Our planned research deals with beekeeping in Austria and the expenses involved in the use of medication against the parasitic mite *Varroa destructor*. In the foreground of the work is an exploratory analysis of survey data from the years 2018/19 and 2019/20. The survey is carried out since 2008 by the Institute of Biology at the University of Graz to collect data on winter losses of bee colonies [2]. In this survey, with about 3,000 participants, the costs of treatment per bee colony were also questioned over the last two years. Such a descriptive analysis of treatment costs has never been carried out in Austria in this form before. However, the data could clearly show how great the economic burden for beekeeping, caused by the introduced aggressor, is and could yield valuable information about the dimensions of the Austrian treatment agent market.
Secondly, I would like to deal with the hypothesis whether there is a connection between the amount of costs used for control and the loss rates of bee colonies in winter. Since different methods are not always equally successful in treatment [2, 4, 5] and also cause different expenses, the expenditure per colony could mean a direct correlation with the winter colony losses for the beekeeper. Higher losses mean additional costs for the beekeeping business.

(Info Box) Varroa Mite

The parasitic mite *Varroa destructor* is the most important bee pest worldwide and has been widespread in Austria since the 1980s. An active treatment against this parasite is still unavoidable in order to become a successful beekeeper due to the lack of adaptation of our domestic honeybee. The parasitic mite is found mainly in the brood and there preferable in the drone brood [1]. In Austria most beekeepers use a combination of organic acids to treat their colonies against the varroa mite [5].

Figure: Honeybee dronebrood highly invested with Varroa Mites.

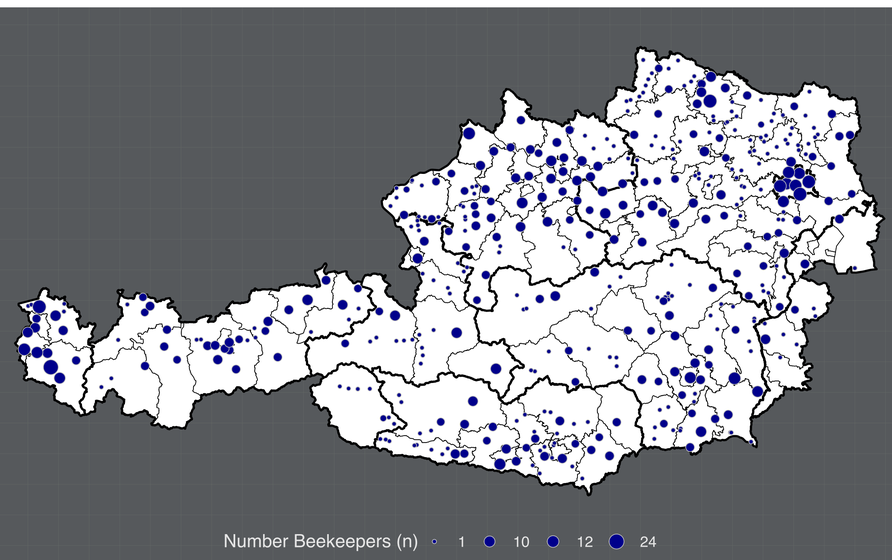

Figure: The approximate location of the main winter apiary showed a nationwide coverage all over Austria from the 2019/20 survey. Shapefiles "Creative Commons": `https://www.data.gv.at/`

Material and Methods

The survey consisted of question from the international COLOSS questionnaire and some additional questions, which were only present in the Austrian survey. Our main interest in this study are the surveyed questions about the "Estimated Costs of Treatment against Varroa Mites per Colony", the number of colonies wintered, number of colonies lost (without natural disasters) and the methods and application time of varroa control.
Data validation and error control was performed with logical operators, for example to exclude responses which did answers treatment costs but said they did no treatment against Varroa mites ($\boldsymbol{n = 3}$). Zero costs answers which were unplausible ($\boldsymbol{n = 19}$) or got a sponsorship ($\boldsymbol{n = 4}$) (e.g. local community) were removed. Participants which did answers with a very high expenses did mostly answer not per colony but per operation and therefore the costs were divided by the number of colonies wintered ($\boldsymbol{n = 118}$).
Statistical analysis is performed with R and for full reproducibility we want also to publish the source on Github and as Docker Container after the results are published. Categorical predictor variables are compared with ANOVA and by significant difference ($\boldsymbol{p < 0.05}$) followed with $\boldsymbol{p}$-value family-wise error corrected (Holm, Step Down) pairwise t-test. Loss rates estimations and confidence intervalls are computed with with a quasibinominal generalized linear model (GZLM) link "logit" function [3].
Both survey years are analysed separately as we because of the anonym design of the questionnaire we don't know if participants in both survey years independent.

Descriptive Statistics

Table: Number of participants answering the question for estimated costs per colony in the survey for both survey years.

Year	Total [$\boldsymbol{n}$]	Answered [$\boldsymbol{n}$]	Percent [%]
18/19	1534	1195	77.9
19/20	1539	1170	76.0

Table: Descriptive statistics of expenses and estimates in Euro, based on our standard cost calculations.

Type	Minimum	1. Quantile	Median	Mean	3. Quantile	Maximum
Survey	0.00	5.00	8.33	9.98	12.50	250.00
Estimated	0.00	8.05	10.65	12.18	14.02	167.32

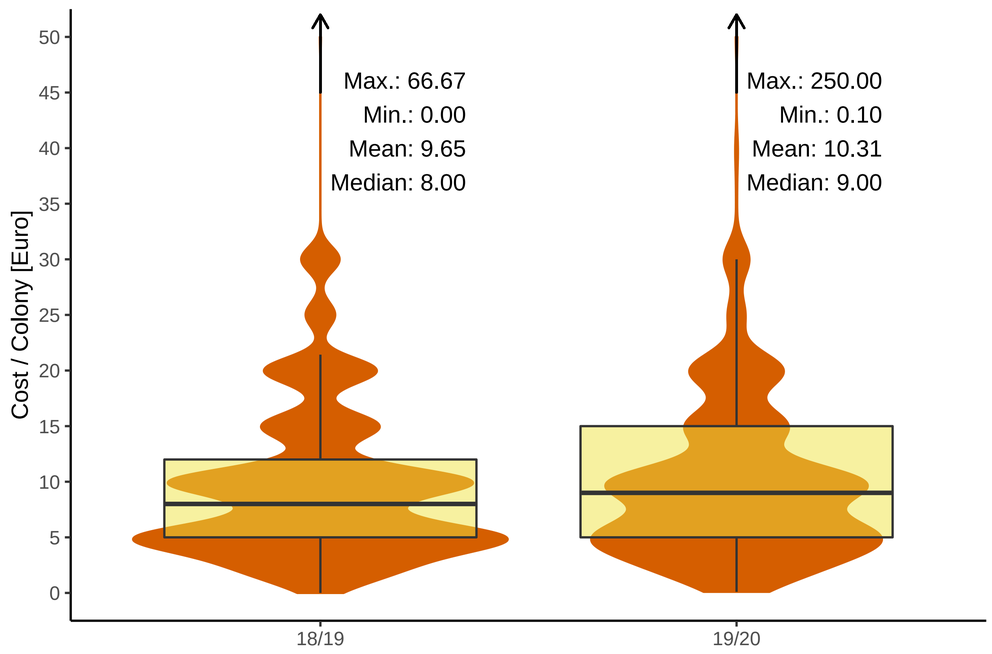

Figure: Distribution of costs in the surveys.

Expenses Estimations

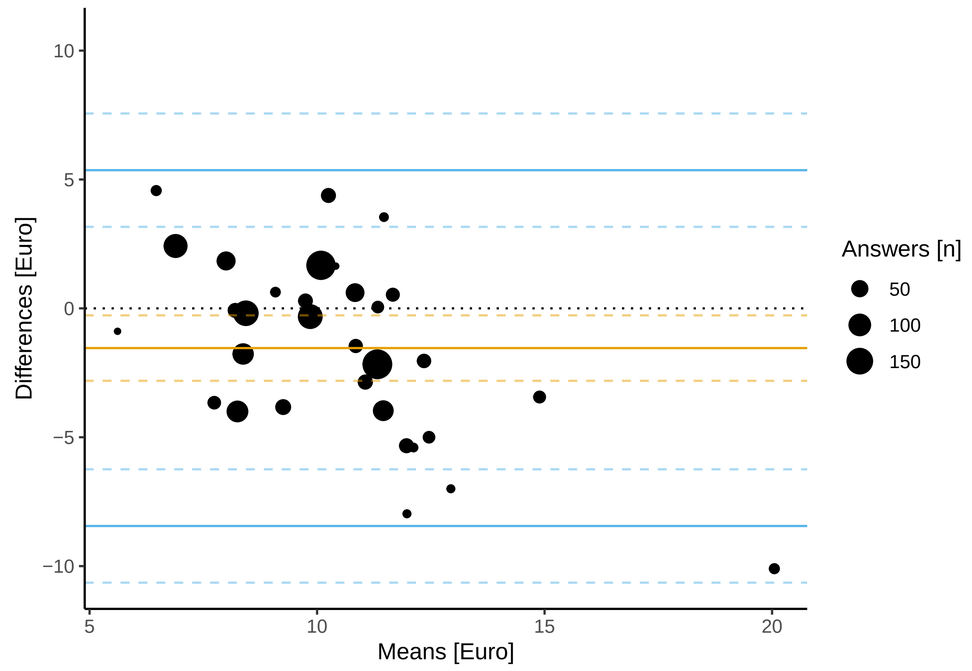

Figure: Analysing of our calculated estimates with the survey results for common treatment methods was done with Bland-Altman plot (differences plot). Blue horizontal lines indicating 95% CI and orange line represents the mean difference. We can observe that most combinations are inside our defined CI, but survey is expenses on average below our calculated estimates

Operation Size

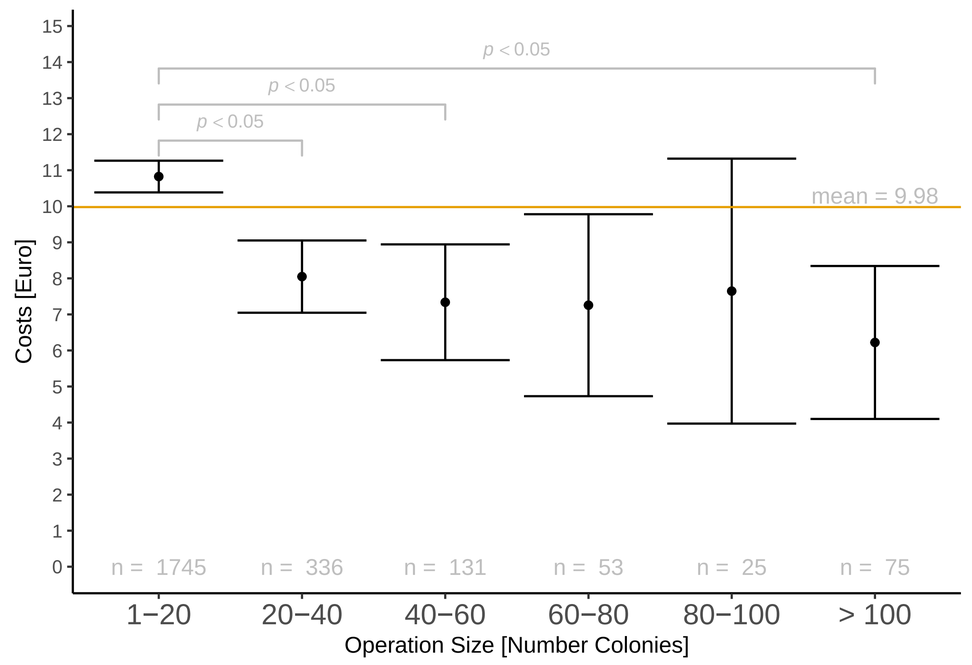

Figure: To compare different operation size groups, we used the number of hives wintered from the survey to group the beekeepers in their respective operation size group. Confidence intervalls were generated with GLM (formular: $\boldsymbol{Cost \sim 0 + OperationSize}$), significant test with pairwise t-test and family-wise error corrected $\boldsymbol{p}$-value (Holm, Step Down).

Preemptive Conclusion

With our first data exploration we can already see different expenses for different operation size groups. Our estimates which were calculated beforehand are in range with the survey expenses. It seems the question in the survey was not clear, as many participants did answers the complete expenses and not per colony. Further data cleanup and also comparison of treatment compinations needs to be done.

References

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[5] Hannes Oberreiter and Robert Brodschneider. "Austrian COLOSS Survey of Honey Bee Colony Winter Losses 2018/19 and Analysis of Hive Management Practices". In: *Diversity* 12.3 (2020), p. 99. ISSN: 1424-2818.

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