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BeeConSel - Joint Effort for Honey Bee Conservation and Selection

DELIVERABLE 2

Knowledge transferred

– Trainers trained –

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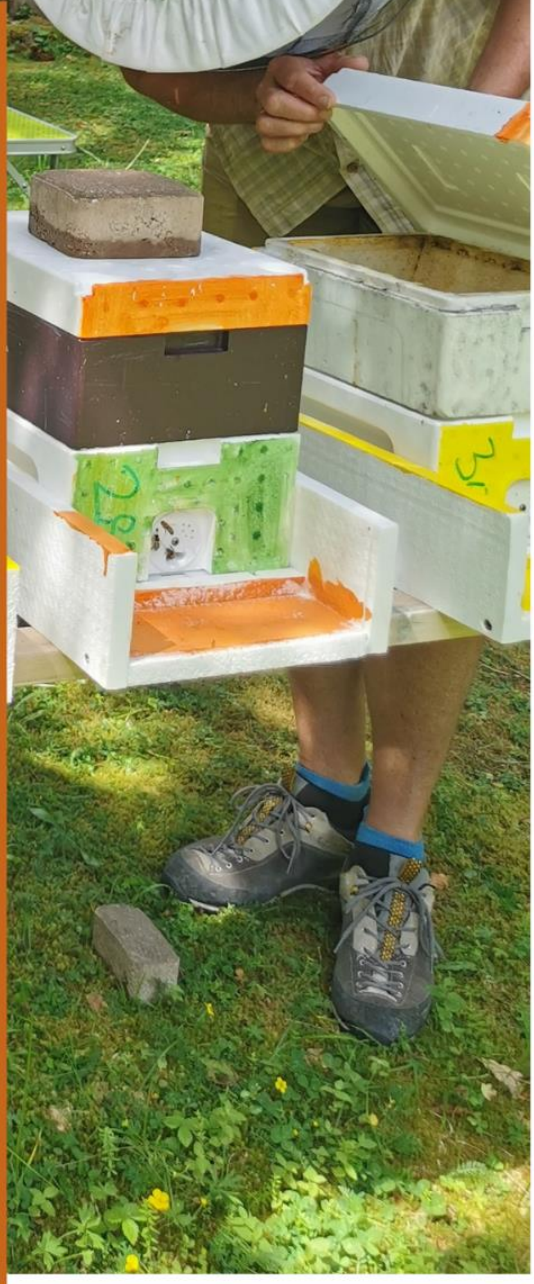

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EXECUTIVE SUMMARY

The main task of the WP2 - Knowledge transferred is to pass knowledge from expert partners and advisory group members to both beneficiary partners, and target group members. This knowledge is needed to 1) successfully perform the mating control tests both in beneficiary countries and in the donor country and 2) to implement mating control as an essential element in the breeding programs run by target group members (breeding associations, individual queen breeders and officials responsible for relevant legislation).

The expert partners NBA and SLU arranged three training workshops for project partners and members of the target groups. The first was to take place in Norway, hosted by NBA. However, due to Covid-19 travel restrictions it was moved to Skopje, North Macedonia where CARPEA and NBA jointly organize the workshop in May 2021. The participants of this workshop were trained in the methodology to be used in the field experiments and in principles of mating control. Locations of potential mating stations were discussed. The second workshop focused on instrumental insemination as a method of mating control that can be used in areas with a high honey bee colony density. The workshop with ten participants from the beneficiary countries and the donor country was organized in Krakow, Poland, in July 2022, where participants benefitted from the expertise of colleagues at Akademia Pszczelarza Merittum which was subcontracted for the workshop. The last workshop was organized by SLU, in Skopje, North Macedonia, in December 2022 for honey bee queen breeders, researchers supporting them, policy makers and state administrators involved in breeding programs in the beneficiary countries. It also provided training for basic aspects of breeding value estimation in honey bees, as one of the tools in the execution of breeding programs and evaluation of their success. The workshop sought to propagate the understanding of the methodology used in breeding programs regardless of their purpose, to look at the case examples and to discuss the existing legislation.

As a part of the transfer of knowledge from the expertise partner NBA to beneficiary countries, representatives from NBA visited the partners in the three beneficiary countries and assisted in their search for suitable locations for mating stations with geographic isolation. Due to Covid-19 restrictions, the visits had to be postponed to 2022. Dr B. Dahle and C. Sundby visited

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CALIS in Croatia in May 2022 when mating control utilizing geographic isolation and drone saturation were experimentally tested. Dr B. Dahle visited partner CARPEA in North Macedonia in the period between June 7th and June 11th 2022, where a location for geographic isolated mating was to be tested and the method and materials for mating control by temporal isolation were discussed and developed. The final scouting for mating stations was made in Slovenia between June 19th and June 22nd 2022, where Dr B. Dahle visited partner AIS in Slovenia. Here the focus was on the mating control by geographic isolation in two mountain valleys and how they can be approved by strategic placement of drone producing colonies.

Figure 1. Queen bee (with white marking) returned from mating flight. Worker bees tend her.

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INTRODUCTION

Animal breeding is controlled propagation of domestic animals to improve desirable qualities. Controlled mating procedures are widely accepted as a key aspect of successful breeding in almost all animal species, for both conservation purposes and genetic progress. In honey bees, however, controlled mating is hard to achieve, nevertheless it is as important. The main aim of the project is to improve or introduce mating control in honey bee breeding in the beneficiary countries where the remaining elements of honey bee breeding programs are in place, thus providing solution for common challenges.

The Norwegian Beekeepers Association (NBA), represented by Dr Bjørn Dahle as a leader of WP2 - Transfer of knowledge, organized the activities, teaming up with Prof Dr Sreten Andonov of the Swedish Agricultural University (SLU) representative as the expert partner, and working closely with advisory group members, Prof Dr Alice Pinto (Portugal, Escola Superior Agrária, Bragança), Dr Peter Kozmus (Slovenia, Slovenian Bekeepers' Association, vice-president Apimondia), Dr Ralph Büchler (Germany, former director of LLH Bieneninstitut, Kirchhein, retired) and Dr Jakob Wegener (Germany, formerly in Landesinstitut für Bienenkunde, Hohen Neuendorf, in charge of breeding).

The NBA has a long tradition of breeding of honey bees with strict mating control achieved with isolated mating stations, and has set to work as an expertise partner to help achieve the project aim. However, project cooperation is a two-way process where also NBA benefits through gaining expertise in novel methods. SLU expertise lies with breeding programs in general and their optimization and design.

One of BeeConSel methods to transfer and gain knowledge and skills among project partners and target groups is through workshops where participants are trained in 1) methods used to study honey bee mating behaviour, 2) methods that can be used to achieve mating control and 3) the importance of mating control in honey bee breeding and how breeding values are used to improve genetic gain breeding programs including economic implications of implementing mating control.

NBA supported project partners in the beneficiary countries in their work to select locations suitable to tested as potential mating stations. The goal was to identify locations with as few of nearby honey bee colonies as possible. Due to Covid-19 travel restrictions the planned visits from NBA to project partners in Macedonia, Slovenia, and Croatia had to be postponed till May and June 2022.

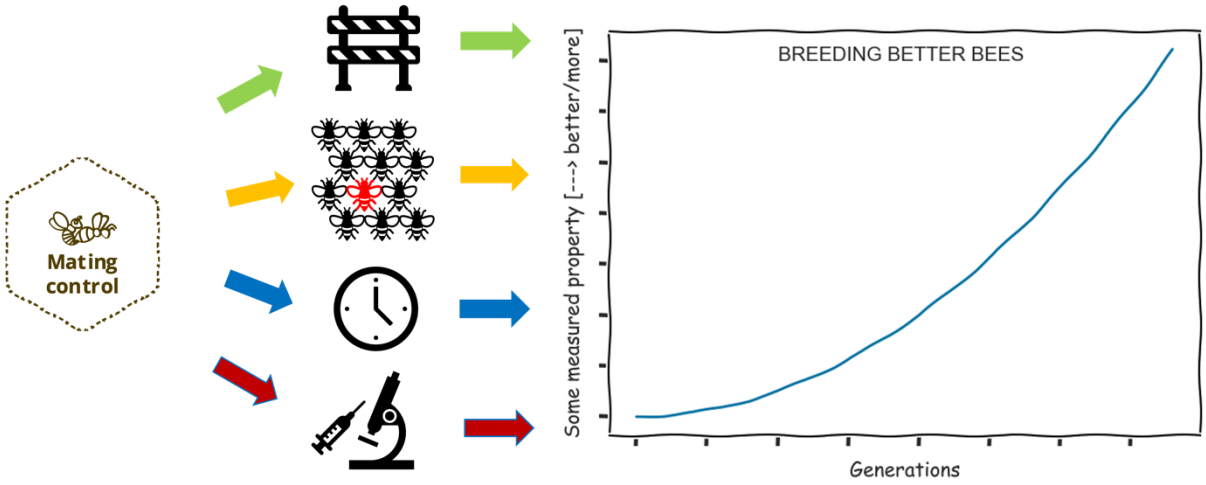

Figure 2. Methods of possible mating control in beekeeping to achieve progress in selection as postulated by NBA and BeeConSel Advisory Group. The three main concepts are geographic isolation, biological isolation, and temporal isolation (green, gold, blue, respectively). The red arrow marks instrumental insemination, which provides similar results but requires additional training and plenty of experience.

WORKSHOPS

Workshop 1: Training on nuptial flight observations

Skopje, N. Macedonia, 26-28th of May 2021

Initially, the first workshop was planned to be in Norway and hosted by the Norwegian Beekeepers Association. Due to Covid-19 restrictions the workshop had to be moved from Norway to North Macedonia where CARPEA had the role as local organizer. The NBA's expert advice was passed in the form of hybrid meeting. Environmental and climatic conditions in North Macedonia allowed earliest training period, which gave partners sufficient time to prepare for the field studies under their conditions.

Purpose

Multi-partner projects require standardisation of methods. The purpose of this workshop was to prepare and train project members, students, and queen breeders from beneficiary countries to perform observations on queen and drone mating flights and evaluate potential locations and methods for controlled mating before the first field season.

Methods

The workshop was organized with a combination of lectures and presentation followed by discussion and practical demonstration and training in both field and lab methods. The lectures were shared by members of consortium, who have necessary experience. The workshop programme covered aspects such as training of students and project members on observation of queen bee nuptial flights, recordkeeping (Appendix 1), demonstration of sampling procedure for molecular analysis, spermatheca evisceration, identification of Drone Congregation Areas (DCA) by use of pheromone traps and drone vehicles, then discussion on the methodology for economic evaluation of the proposed methods as well other related topics.

Additionally, the partners presented NBA with potential experimental locations to be used in the field season in 2021. After discussion among all project partners and advice from NBA the consortium agreed on the locations to be used in 2021.

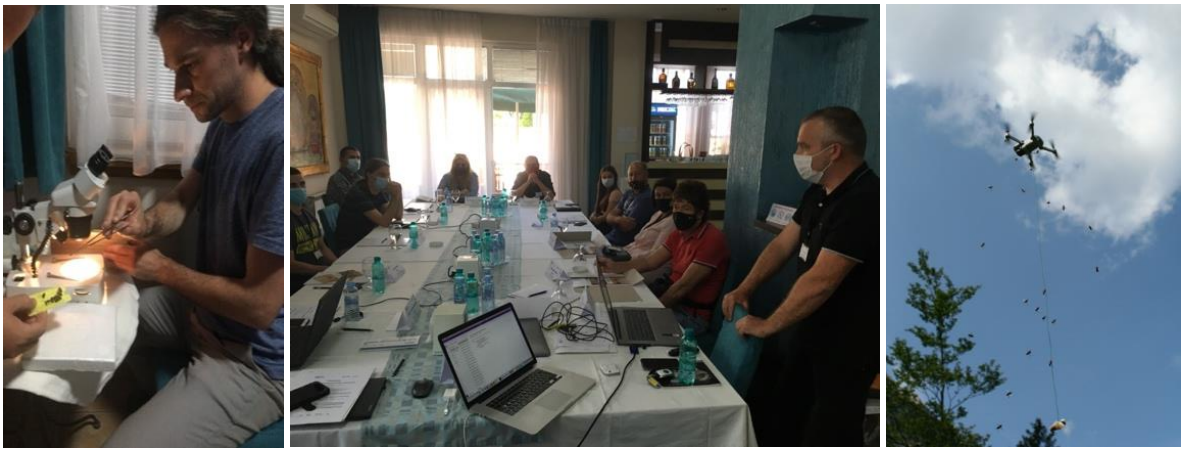

Figure 3. Demonstration of tissue sampling in honey bee queens (left). Passing the practical field advice (middle). Honey bee drones following drone with pheromone bait close to drone congregation area (right).

Presentations

During the workshop the following presentations were given:

- Protocol for observation of mating flights (A. Uzunov)
- Field demonstration of the Protocol for observation of mating flights (A. Uzunov, B. Pavlov)
- Identification of drone congregation areas and potential mating station location (A. Uzunov, B. Dahle)
- Sampling for molecular analysis (J. Prešern)
- Survey of economy in bee breeding (M. Kovačić, L. Dimitrov)

Participant feedback

> *"...as the representative of beneficiary country with pressing issues I have felt that the passed advice regarding the putative locations of mating stations was very valuable. Our team was able to follow the standardized method and retrieve valuable results; with minor adjustment based on 2021 experience and NBA advice given in the field, we were able to successfully complete two years of experimental work"* - Janez Prešern, Coordinator of BeeConSel consortium.

Workshop 2: Instrumental insemination

Krakow, Poland, 7-9th of July 2022

Purpose

Instrumental insemination of honey bee queens is one of the methods where beekeepers can fully control paternity of the queen's offspring. The method is not commonly used in the partner countries and requires training and experience to be applied successfully. The purpose of this workshop was to train project personnel and

Figure 4. Group photo of the Krakows' workshop participants

target group participants in instrumental insemination so this technique can be implemented as one method of mating control in partner countries.

Methods

Figure 5. Queen bees in nursing hive, prepared for insemination.

For the workshop in instrumental insemination, NBA subcontracted Akademia Pszczelarza Merittum sp. z o.o. which is recognized as one of the leading companies in various aspects of beekeeping education including instrumental insemination in Europe. In collaboration with NBA, Monika Lelen at Akademia Pszczelarza Merittum developed the course plan for a 32-hour course on instrumental insemination. The course was performed at Akademia Pszczelarza Merittum premises in Krakow, Poland. The workshop was attended by 2 members of the Researchers/Scientists Target group, 4 students, 2 beekeepers and 2 BeeConSel team members (G. Aleksovski, M. Kojek). The course included lectures on topics such as bee breeding in Poland and Europe, standard equipment for instrumental insemination, preparation of queens and drones, anatomy and physiology of queens and drones. Most of the time was devoted to practical instructions and training. Based on the feedback of the participants, of which some are given below, the workshop was a success and an important step towards better mating control in the beneficiary countries, but also in the donor country where another method of mating control can be added as an alternative to geographically isolated mating stations.

Presentations

During the workshop the following presentations were given:

- Discussion about the bee breeding in Poland and Europe (M. Lelen)
- Standard equipment necessary for artificial insemination – available options and selection rules (M. Lelen)
- Technique of insemination (M. Lelen)
- Anatomy and physiology of queen bees and drones (M. Lelen)
- Biology of queen bee insemination (M. Lelen)
- Breeding of bees (M. Lelen)

- Factors influencing the quality of artificially inseminated queen bees (M. Lelen)
- Rules of hygiene and disinfection (M. Lelen)
- Methods of assessing correctly conducted artificial insemination of queen bees (M. Lelen)
- Problems with artificially inseminated queens (M. Lelen)

Participant feedback

"... I left for training in the instrumental insemination of queen bees in Krakow, Poland. I met the colleagues I had previously met during the project, who also participated in the training. The organizers of the training were great, and they had a lot of patience with us while we, unfortunately, had to destroy a "million" drones to get some practice in extracting the sperm. The thought that I will be among the first to introduce instrumental insemination in the practice of Macedonian beekeeping led me not to regret for a moment that, after 8 hours a day, I sat at the microscope and inseminated the queens. The best feeling was when I did it successfully ..."
- Magdalena Jovanovska, a target group member from North Macedonia (Regional Cooperation Magazine, issue 10)

Figure 6. Instrumental Insemination Workshop in Krakow, Poland. Magdalena Jovanovska from North Macedonia uses microscope (left) to study the situation underneath (right).

"... I am really thankful that I was able to be a part of the Instrumental insemination workshop in Krakow. Not only that I learned so many new things which I will later use in my apiary, but I also got to meet people with so similar yet so different beekeeping lifestyles. It was a one-in-a-million experience that I will never forget..." - Tadeja Vidmar, a target group member from Slovenia (Regional Cooperation Magazine, issue 9)

"The course was very well prepared. We had a lot of practical work and teachers were helpful and patient, showing us all the details in drone semen collection and queen insemination. We also obtained knowledge about housing drones prior to and queens after insemination. Obtained knowledge will enable us to work and maintain pure A.m. carnica lines and achieving substantial genetic gain for different traits." - Jernej Bubnič, PhD student from Slovenia

Figure 7. Collecting drone sperm for the Instrumental insemination

"On the workshop in Krakow, Poland we gained all the necessary knowledge to independently inseminate queen bees: from preparation of the equipment to the introduction of the queens into colonies. The workshop was well organized. The instructors were always on hand during many training lessons, and they also shared their knowledge on other topics of queen rearing. I will use the acquired knowledge in selection program on Agricultural Institute of Slovenia and hopefully, after some more practice, I will be able to share it among other queen breeders and beekeepers in Slovenia." - Manca Kojek, AIS team member, Slovenia

"The training workshop was very well organized and useful and the methods we learnt gives us in the Mandal area the opportunity to get pure bred bees. At this, have no purebred area and insemination means that we can continue to keep pure breeds. We will get a strain that we can go back to and get clean breeding material. I personally will work to have more lines of pure bred available. At the same time, these are subjected to a test protocol and the necessary selection based on its results." - Marc Hillen, queen breeder, Southern Norway

Workshop 3: Estimation of Breeding Values and its use in breeding programs

Skopje, N. Macedonia, 6-8th of December 2022

This workshop hosted by SLU was organized in Skopje with local support from CARPEA.

Purpose

The workshop was aimed at honey bee breeders, researchers supporting them, and policy makers and state administrators involved in breeding programs in the beneficiary countries. The workshop sought to propagate the understanding of the methodology used in breeding programs regardless of their purpose, to look at the case examples and to discuss the existing legislation. Special emphasis was given to the use of breeding values in the breeding program and how they can be estimated.

Figure 8. Workshop host, Dr Sreten Andonov, from SLU, holds lecture at the workshop (left). Lazo Dimitrov explains the economic principles of selection in breeding (middle). Egoitz Galara (Spain) lectures on his experience in mating control and evaluation of its success (right).

Methods

The lecturers engaged the listeners with own presentations, after which the intensive debate have developed. We have especially paid attention to address the policy makers and obtain their feed-back and view upon the problematics. In-between the intensive sessions in the lecture room, we also had the chance to discuss methods and used in the experiments for mating control by temporal isolation

Presentations

Figure 9. Borče Pavlov, MSc, (CARPEA) presents relevant Macedonian legislation. Andrej Šalika (Ministry of Agriculture, Forestry and Food; Slovenia) discusses Slovenian legislation and its roots in EU animal husbandry legislation.

During the workshop the following presentations were given:

- Elements of breeding program w. discussion (S. Andonov)
- Honey bee breeding programs w. discussion (A. Uzunov)
- A breeding program in Croatia (M. Kovačić)
- A breeding program in Slovenia (J. Prešern)
- The national breeding program in Norway (B. Dahle)
- A breeding program in Macedonia (A. Uzunov)
- Estimation and interpretation of Breeding Values – procedures, steps, and examples (S. Andonov)
- Honey bee breeding program in New Zealand – online (G. Petersen)
- Challenges in mating control and breeding program in honey bees in Basque Country (G. Egoitz)
- Effects of selection and local adaptation on resilience and economic suitability in *A. m. carnica* (M. Kovačić)
- The economic implication of breeding honey bees (L. Dimitrov)

- Honey bee breeding legislation in Slovenia (A. Šalika)
- Honey bee breeding legislation in Croatia (D. Jurković)
- Honey bee breeding legislation in Macedonia (B. Pavlov)
- Honey bee breeding legislation in Norway (B. Dahle)

Participant feedback

The participants were asked to anonymously fill in the questionnaire to assess their satisfaction with the Workshop, covering content, quality of presentations, knowledge, and technical aspects. The scoring was on a scale from 1 to 5, expressing high appreciation by 5. The scores given by the participants were 4.88 for Workshop fulfilling the expectations and presented topics, 5 for the gained knowledge and 4.75 for the method of training. The topics presented were also highly scored from 4.63 to 5. Overall, the scores are high and prove the success of providing such a Workshop.

> *"At the workshop, I had the opportunity to familiarize myself with different models and approaches to implementing a breeding program for bees, as presented by experts from different countries involved in the project. I must admit that at this workshop I gained more information about selection, methods of implementing the breeding program and calculation of genetic value in the field of beekeeping, than I have gained in ten years of my work at the Ministry. From this point of view, the workshop will help me in the preparation of national regulations in the field of beekeeping."* - Andrej Šalika, Ministry of Agriculture, Forestry and Food, Slovenia

Figure 10. Dr Aleksandar Uzunov (CARPEA) explained the use of their use of cooling chambers in the experiments with temporal mating control and discusses the pros and cons of its use in day-to-day breeding operations.

"As a professional beekeeper with almost 300 hundred colonies and 600 small bee nucs for queen production, I am glad for the opportunity to be here with the researchers, state administrators, professional beekeepers, and queen breeders. I saw a lot of presentations, good discussions, and an exchange of experiences... I will follow further results and I hope to stay connected to this group." - Mitja Nakrst, queen breeder, Slovenia.

SCOUTING FOR MATING STATION LOCATIONS IN BENEFICIARY COUNTRIES

Norwegian travel restrictions due to Covid-19 made it impossible for NBA to execute the planned scouting in 2021. However, potential locations were discussed among project partners and selected for testing in summer of 2021 at meeting in Skopje 2021. Based on the experiences made at the experimental mating stations NBA discussed with AIS, CARPEA and CALIS, adjustment for the field season in 2022. A plan for field visits by NBA to the beneficiary countries were made and performed in May-June 2022.

Visit to CALIS and Croatia

13th-16th May 2022

Dr Bjørn Dahle and Camilla Sundby of the NBA visited Croatia where Dr Marin Kovačić and Dr Zlatko Puškadija of the project partner CALIS were hosts during their stay.

Biological isolation

Biological isolation uses high number of drone producing colonies with selected genetic constitution. The production of drones in these colonies must be advanced to achieve the drone saturation thus ensure that the drones present at the mating station are predominantly from these selected drone producing colonies. NBA team visited the location near

Figure 11. Dr Marin Kovačić, Camilla Sundby and Bjørn Dahle at the Flatlands apiary. Mating nucs are placed directly on the ground.

Osijek where biological isolation concept was tested using 96 drone producing colonies. Inspection of drone production satisfactory quality of drones thus providing grounds for successful testing of the concept.

Figure 12. Mating nucs in Flatlands location. Every white dot is one mating nuc.

Geographic isolation

Even in countries with high density of apiaries some areas are less attractive for beekeeping due to very limited floral resources. Fir forests of western Croatia are not used by beekeepers before end of June as they do not support the colonies with feed before the appearance of honey dew at the end of June (Figure 13). This makes the area worth of consideration as a potential location for an isolated mating station in period between mid-May to mid-June. In this area, a selected location was tested without drone producing colonies in 2021. Based on the results, the NBA and CALIS revisited this location in May 2022 to evaluate its suitability to serve as a mating station. One of the topics discussed and advised at the location was the number and location of drone producing colonies to be used in the test in 2022. In comparison with the Flatlands of NE Croatia, this location very likely requires less drone-producing colonies. If so, such situation might be more cost-efficient and thus more attractive to queen breeders.

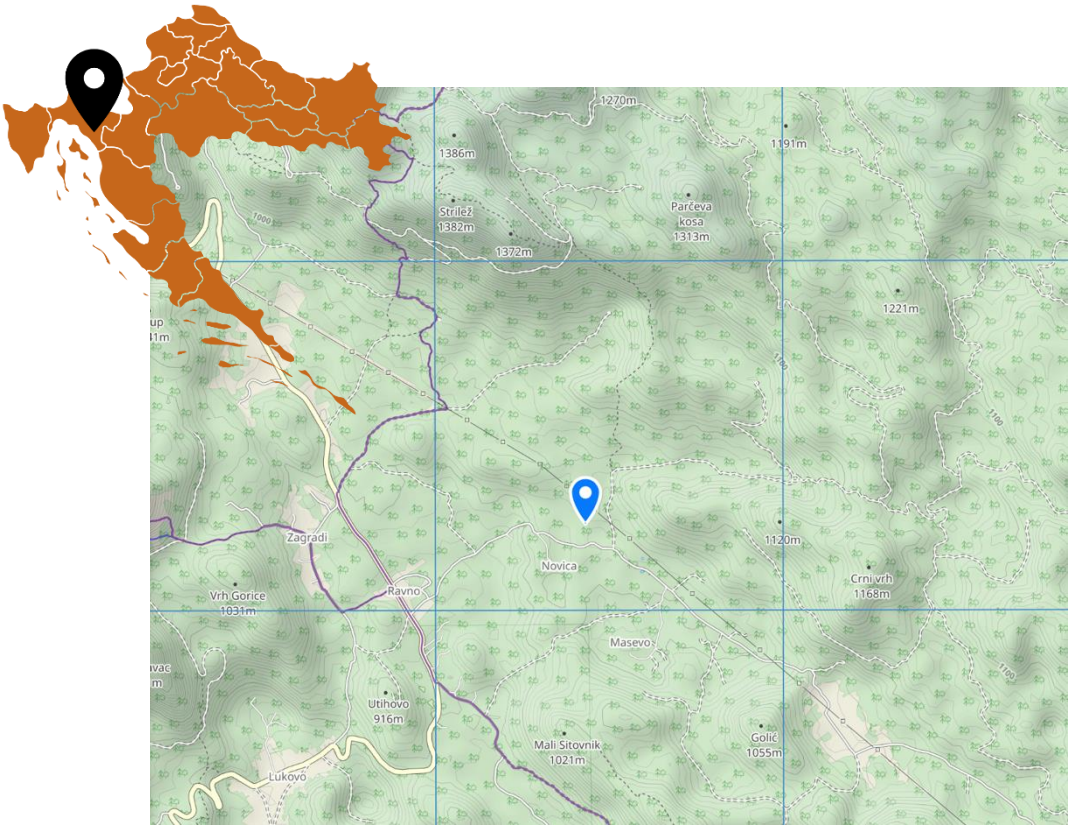

Figure 13. Deep Forest location. Map shows huge areas of fir forests which are not interesting for other beekeepers except in case of honey dew appearance.

Figure 14. Test location for isolated mating station at the Deep Forest location in western Croatia. Mating nucs ready for observation (bellow).

Visit to CARPEA and North Macedonia

7th-11th June 2022

Geographic isolation

The density of honey bee colonies in Macedonia is high and Macedonian partner CARPEA used its knowledge about areas of minor or no interest in beekeeping to suggest potential test locations for isolated mating stations. These locations were discussed with NBA and four locations were selected for experiments in 2021. During the experiments in 2021 it became evident that the locations were influenced by - until then - unknown apiaries. Dr Bjørn Dahle from NBA visited Macedonia and together with Dr Aleksandar Uzunov scouted a new test location for 2022 on the southeastern shore of lake Mavrovo (Figure 16). Based on the distance to neighbouring apiaries and the topography, NBA advised to use a high number of drone producing colonies to reduce the queens' motivation to perform long-distance mating flights and mate with non-selected drones.

Figure 15. Dr Aleksandar Uzunov and Dr Bjørn Dahle in front of the drone producing colonies at the test location for geographic isolation mating station in Mavrovo, MK.

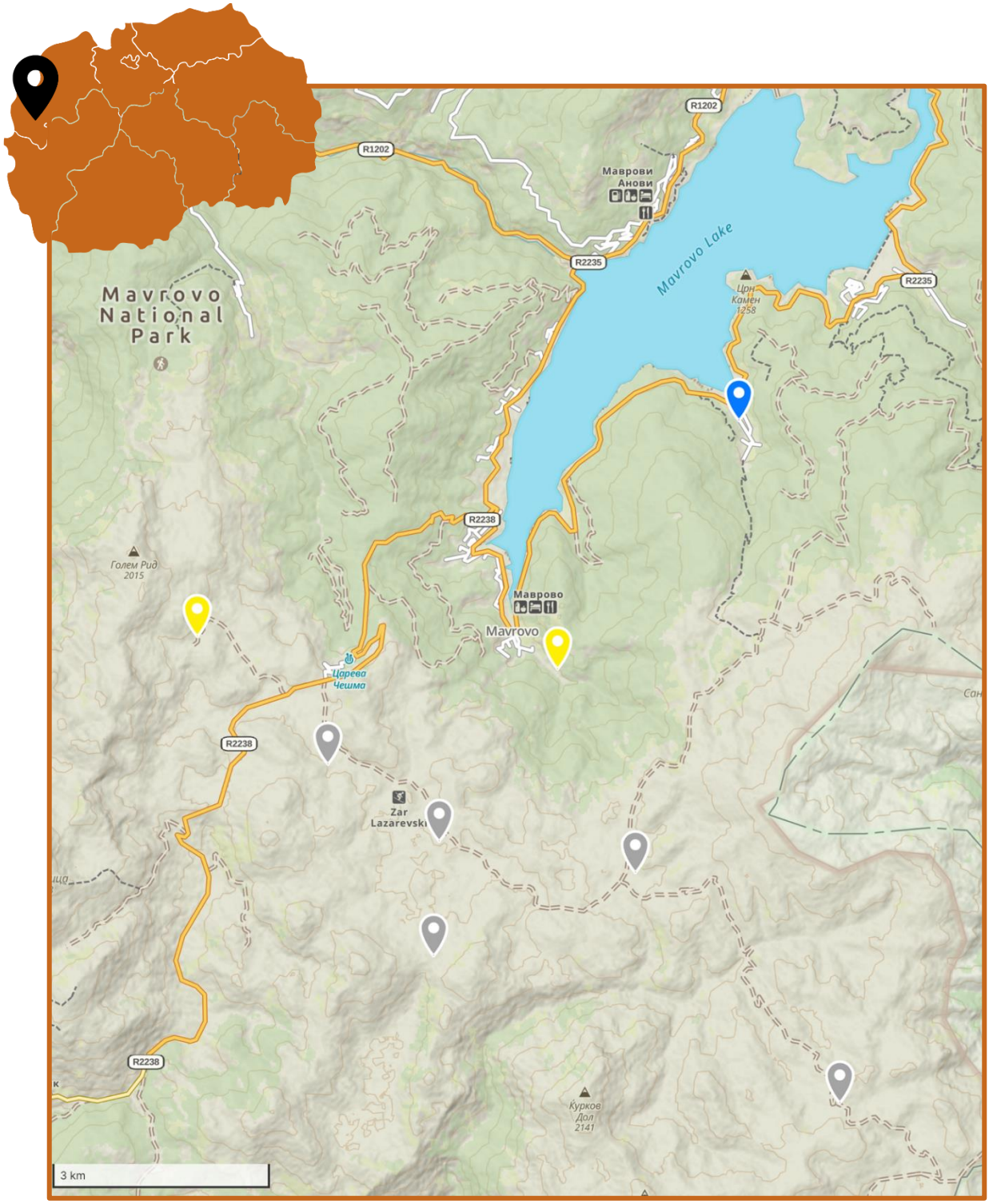

Figure 16. The map shows putative mating station locations in Highlands of North Macedonia. Grey markers show locations evaluated in 2021 and dropped after *in situ* inspection by Dr Bjørn Dahle who proposed new location (blue). Yellow markers show private apiaries not aligned with the BeeConSel project.

Temporal isolation

Mating of queens after the normal mating behaviour ceases in the afternoon, is termed temporal isolation. This method might be another possible choice for mating control in areas where it is hard to obtain geographic isolation. Dr Bjørn Dahle and CARPEA team discussed the two main approaches: i) the use of cooling chambers which resets queens' and drones' biological clock by simulating cooler period of day and ii) the use of mating boxes with a labyrinth as means of preventing access of the external light to the inside of the hive (and thus decrease the motivation for the nuptial flights of the queen) while allowing workers to carry on as normal. The queen is let out by opening direct pass-through corridor at selected suitable hour. The design of the labyrinth was discussed in dedicated session with Dr Jakob Wegener, member of Advisory Group who also provided the labyrinth schematics for mating boxes. The design, which was used used in Norway and North Macedonia was finally discussed (Figure 17) with a company that in the end produced the labyrinths used in both countries.

Figure 17. Manufacturing of the labyrinth. Dr Dahle and Dr Uzunov (middle, right) are testing the fitting of the labyrinth in to the mating nuc (left pane). Manufactured wooden labyrinth prior to its embedding into the mating nuc. Left-side corridor is a pass-through allows direct light access for permitting nuptial flight, which is normally closed during the day. The right-side corridor is constructed as a labyrinth to block the light but allow normal traffic for worker bees. Queen is prevented exit by means of small queen excluder (right pane).

Visit to AIS and Slovenia

19th-23rd of June 2022

Geographic isolation

Principal involvement of partner AIS is in geographic isolation experiments in Alpine region. Slovenian partner AIS proposed several possibilities for geographic isolation, most of them in various valleys in Alps. In preliminary discussions held between partners at periodic meetings before the season 1 and at workshop in Skopje 2021, the use of Triglav valley Vrata in Julian Alps was suggested by NBA (Figure 19, top). After an inspection *in situ*, Slovenian partner decided to use the valley, since it was logistically manageable and fenced in with high mountain walls with nearest apiary several kilometres away. Prior to first experimental season, NBA also suggested AIS to approach the commercial queen breeder in neighbouring valley Krma (Figure 19, bottom) and to invite him to cooperate as a member of target groups due to similar location and his own stock which would allow genetic evaluation of how close the experimental and real-life situations are and to use opportunity to promote project findings. Dr Bjørn Dahle of NBA visited Slovenian partner AIS between 19th and 23rd of June 2022, as soon as COVID-19 situation permitted and was relevant season-wise.

Figure 18. NBA representative Dr Bjørn Dahle in field inspection of locations in Vrata (left) and Krma (right) with Slovenian student Anja.

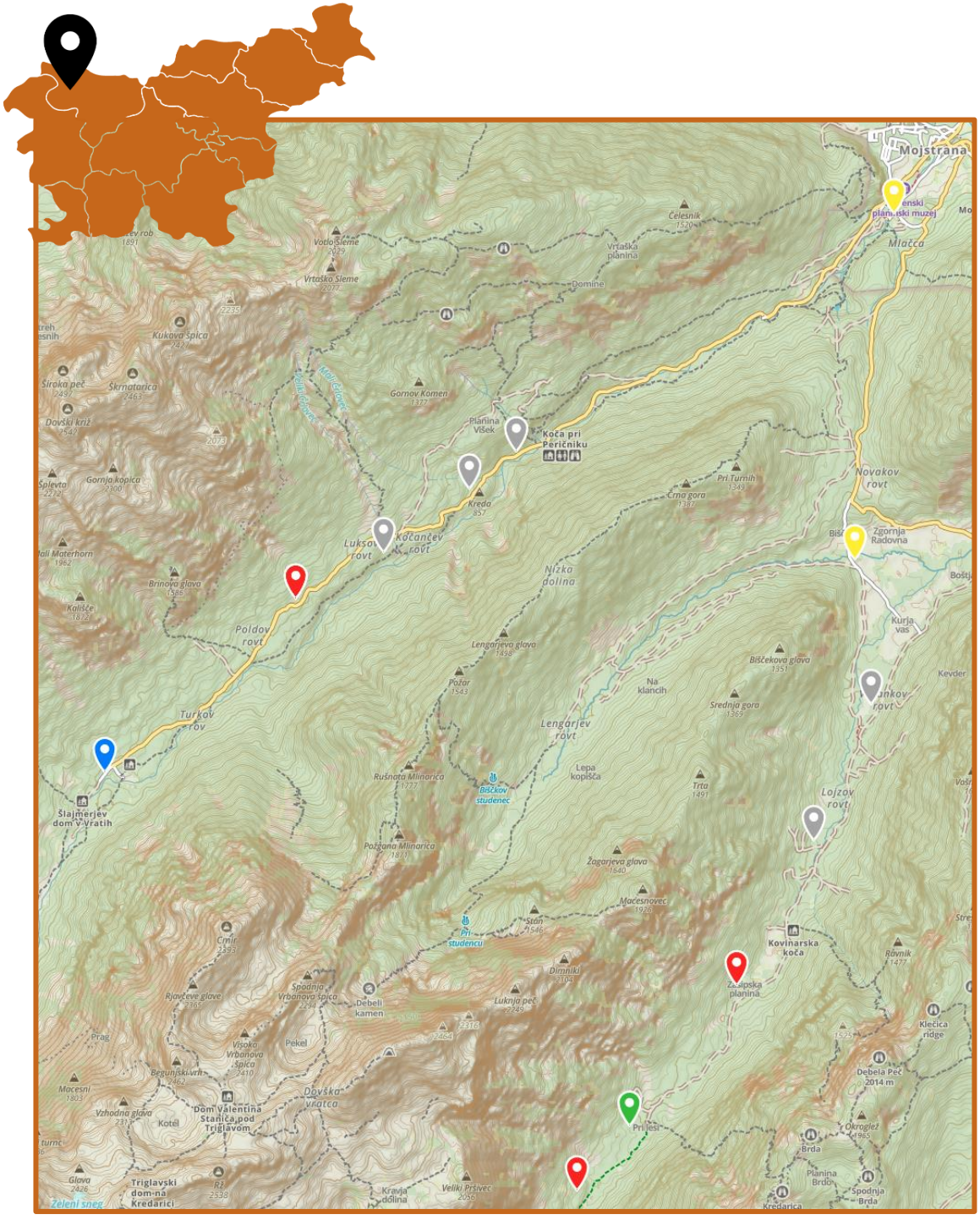

Figure 19. Locations in Slovenia in »Alpine« *settings*. Markers label experimental positions in valley Vrata (top) and Krma (bottom). Blue marker in Vrata marks putative mating station location, while green marker in Krma marks private mating station of a queen breeder who was keen to be included as a target group. Red markers signify experimental locations in 2021 and 2022. Grey markers mark locations in 2021 that were dropped after consultation between NBA and AIS. Yellow markers show closest private apiary to each location (Vrata cca 10 km, Krma cca 6 km). Both valleys are fenced with high mountains walls climbing up over 2000 m.a.s.l. at relevant positions.

Both valleys were visited, experimental locations inspected and discussed. Specifically, partners have discussed the local placement of mating nucs relative to sun exposition and daily temperatures according to the guidelines passed from NBA to partners in Skopje 2021. Dr Dahle advised AIS on running of mating behaviour experiments, specifically on the placement of drone-producing colonies in Vrata to induce different mating of queens. Moreover, Dr Dahle advised AIS to drop several of test locations and strengthen the remaining ones to give depth to the analysis.

Temporal isolation

Slovenian partner AIS is also involved in temporal isolation testing. Equipment for that purpose was discussed at biannual meeting in Osijek, Croatia (November 8th-11th 2021) for the first year of experiments. These experiments were carried out at Ljubljana moor, a location with extremely high colony density, in June and July 2022, once without and once with manipulated drone-producing colony. Target group member Tadeja Vidmar was actively involved in the experiment as a part of her BSc thesis; NBA advice and advice of the Advisory group member, Dr Jakob Wegener, allowed her to successfully complete here work. Her results were presented at Biannual meeting in Skopje (December 8th 2022).

Figure 20. Dr Janez Prešern and Dr Bjørn Dahle in front of mating nucs in Krma valley

Date:		Location:		Observer:	

		Flight 1	Flight 2	Flight 3	Flight 4	Flight 5	Flight 6	Flight 7
Mating box No.	Departure (hh:mm)							
	Arrival (hh:mm)							
	Flight duration (minutes)							
	Mating sign (+/-)							
	Mating sign removal (minutes)							
Mating box No.	Departure (hh:mm)							
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	Mating sign removal (minutes)							

		Flight 1	Flight 2	Flight 3	Flight 4	Flight 5	Flight 6	Flight 7
Mating box No.	Departure (hh:mm)							
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	Mating sign removal (minutes)							

Weather conditions									
Hour:		T °C		Humidity %		Wind cat. *		Cloud coverage %	
Hour:		T °C		Humidity %		Wind cat. *		Cloud coverage %	
Hour:		T °C		Humidity %		Wind cat. *		Cloud coverage %	
Hour:		T °C		Humidity %		Wind cat. *		Cloud coverage %	
Hour:		T °C		Humidity %		Wind cat. *		Cloud coverage %	
Hour:		T °C		Humidity %		Wind cat. *		Cloud coverage %	

Abbreviations/signs	
Mating sign	(+ mated) (- non mated) (o open)
* Wind caegories	(1 = low), (2 = medium), (3 = strong)
Cloud coverage	Percentage of cloud coverage on horizon

Comment:

Appendix 1