



HoloRuminant

Understanding microbiomes of the ruminant holobiont

Newsletter - Issue 2

October 2023



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Editorial

Welcome to the latest issue of the HoloRuminant Newsletter. We have completed the second year of the project and everything is progressing as planned. We are currently conducting animal studies and, for many of them, already analyzing the collected data. In this issue, we are sharing some of the initial results.

The focus of this issue is on HoloRuminant's participation to the Joint International Congress on Animal Science 2023 co-organised by the European Federation of Animal Science (EAAP), the World Association for Animal production (WAAP) and Interbull that was held in Lyon, France. Also, we are now proud members of the EuroFAANG project group where we will be able to provide microbiome and phenotypic data from farmed ruminants. As ever, we value your feedback and encourage stakeholders to contact us or join our stakeholder groups to share their experiences and opinions with us.

We want to thank Emna Ben-Hamza for her excellent work as project manager for the first year and a half of HoloRuminant. Emna left to pursue other opportunities. We wish her success in her new job. We welcome Lydia Brunault as our new project manager (see the Meet HoloRuminant section for more information).

I hope you enjoy reading and become interested in following our project's updates on our website (<https://holoruminant.eu/>) and social media channels.

Diego Morgavi
Project Coordinator

News

The HoloRuminant Stakeholder event on the 10th of November

HOLORUMINANT STAKEHOLDER EVENT

RUMINANT MICROBIOME MANAGEMENT AND ITS SOCIO-ECONOMIC IMPACT

REGISTER TO THE EVENT

HoloRuminant
Understanding microbiomes of the ruminant holobiont

Wageningen University & Research
Wageningen,
The Netherlands

Friday, November 10th
13:30-15:30
Networking lunch is available at 12:00.

Online participation is also possible

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101000213

Join us on November 10, 2023, for an exclusive HoloRuminant project stakeholder event! This event will provide an opportunity to learn about the latest research findings, discuss the implications of the project, and provide feedback on the solutions being developed.

Please find our detailed agenda [here](#).

The event will be held in person at Wageningen University campus, but online participation is also possible. Registration is mandatory, so sign up today: <https://form.jotform.com/232892932335361>

HoloRuminant session at EAAP 2023

On Wednesday, the 30th of August, HoloRuminant was honoured to sponsor and host a project session at the EAAP conference in Lyon titled “Leveraging the microbiome for resilience and sustainability in ruminant production”. Five of HoloRuminant’s finest researchers shared their recent research findings, on which we are happy to provide an overview of the key messages here.



Stephanie O’donoghue (TEAGASC) presented her research that emphasised

the critical role of the respiratory microbiome in the health of cattle, mainly focusing on the Bovine Respiratory Syncytial Virus (BRSV), a significant cause of respiratory disease in cattle. The research highlights that BRSV infection leads to changes in the nasal microbiome, potentially disrupting the balance of bacteria in the respiratory tract. Farmers should be aware of the impact of BRSV on the microbiota of their dairy calves and consider appropriate management strategies to maintain respiratory health in their herds, especially during BRSV outbreaks. Regular monitoring and proactive measures can help manage and prevent the dysbiosis caused by viral infections, ultimately ensuring better health and productivity of the cattle.

Following Stephanie, Joana Lima(SRUC) highlighted the often-overlooked impact of the parasitic nematode *Ostertagia ostertagi* on the rumen microbiome, a crucial aspect of cattle health and performance. The findings emphasise that this parasitic infection can significantly influence the composition and functionality of the rumen microbiome. Importantly, the severity of infection, reflected in faecal egg counts, plays a crucial role in shaping these microbial changes.

For farmers, this underscores the importance of monitoring and controlling parasitic infections like *Ostertagia ostertagi* in their cattle herds. Implementing effective parasite control strategies, such as vaccination, is essential for maintaining a healthy rumen microbiome, which directly impacts the cattle's overall well-being and productivity. The study suggests that targeted interventions can potentially mitigate the negative effects of parasitic infections on the rumen microbiome, ultimately promoting better livestock performance and welfare.

Abimael Ortiz’ (INRAE) research linked the critical role of the rumen microbiota in feed efficiency, fundamental concern for farmers facing environmental and economic challenges in livestock production. While no specific microbiota pattern directly links to feed efficiency, the research emphasises that the rumen ecosystem's composition and structure are influenced by the diet fed to the cattle.

The key takeaway is the importance of understanding and managing the rumen microbiota, especially concerning diet variations. Tailoring diets for better feed efficiency could positively impact the

microbial community within the rumen. Strategies that promote a healthy microbial composition, such as adjusting diet components or supplementing beneficial bacteria, may enhance feed efficiency. Ultimately, optimising the rumen microbiota can improve feed conversion, reduce environmental impact, and increase profitability in livestock farming. Further research is warranted to uncover precise microbiota strategies that can contribute to enhanced feed efficiency in cattle.

Sabine Scully (TEAGASC) presented her research which emphasized the crucial role of colostrum source and calf breed in managing diarrhoea incidents in pre-weaned dairy calves. Farmers need to prioritize providing high-quality colostrum, either from the dam or a carefully pooled source, within the first two hours of a calf's birth. This timely colostrum intake significantly impacts the calf's health and resistance against diarrhoea.

Furthermore, understanding the breed-specific differences, such as those between Holstein (HO) and Jersey (JE) calves, is essential. Being aware of these breed dynamics helps farmers tailor management and healthcare practices accordingly. Monitoring calf health through faecal scoring and rectal temperature assessments is critical for early detection and intervention in cases of diarrhoea.

By focusing on appropriate colostrum management and considering breed-specific characteristics, farmers can reduce the incidence of diarrhoea, enhance calf health, and ultimately minimise economic losses in their dairy operations. Additionally, ongoing microbial analysis promises valuable insights into improving calf health strategies.

Finally, Jarkko Niemi (LUKE) took us on a journey regarding stakeholders' views regarding new practices in controlling the microbiome. Recognising the vital role of microbes in livestock farming is essential for sustainability and economic viability. Farmers play a crucial role in adopting practices utilising these microbes to optimise animal health and productivity. Although financial aspects are strong drivers for the adoption of rules, endogenous factors such as the perceived impact of diseases, the lack of knowledge, and technical skills were found to be barriers for the adoption of new practices. The importance of early establishment of a 'good' microbiome for young animals was understood well. However, many participants were reluctant towards feed additives to reduce methane emissions, especially because of doubts about their long-term effects.

Next to the theatre presentations, Michelle Stafford (TEAGASC), Laurianne Voland (INRAE), and Jeyamalar Jeyanathan (UGent) were elected for the poster sessions. Keep an eye out for our socials, as we will spotlight their posters soon!

EuroFAANG session at EAAP 2023



The EAAP 2023 Conference in Lyon, France, hosted a well-attended session on August 31st, titled "EUROFAANG: Genotype-to-phenotype research across Europe & beyond." The session commenced with an enlightening introduction by Emily Clark of the University of Edinburgh and Christa Kühn from FBN, shedding light on "EuroFAANG - An infrastructure for farmed animal genotype to phenotype research in

Europe and beyond." Amongst the notable presentations, Yulixaxis Ramayo-Caldas represented the HoloRuminant project, he explained how HoloRuminant fits within the EuroFAANG framework and provided an overview of how the project will establish the genetic basis of ruminant microbiomes.

Notably, the panel discussion, chaired by Emily Clark and Christa Kühn, brought together industry stalwarts, including Abe Huisman, Romain Morvezen, Olivier Demeure, and Clotilde Patry, to deliberate on how the European animal breeding sector can harness the EuroFAANG Research Infrastructure and its evolving knowledge. The session encapsulated cutting-edge research to reshape animal breeding practices across Europe and beyond.

The EuroFAANG panel discussion emphasised the significance of genetic diversity, the integration of new information, and the need for basic research and cost-efficient tools to advance genotype-to-phenotype research in farmed animals. Collaboration between industry and research was recognised as a vital component in addressing the challenges and seizing the opportunities within the field of animal breeding.

First Joint Dissemination Network webinar series

It's exciting to share that the HoloRuminant Joint Dissemination Network has hosted its very first webinar series this September and October. We bring together five European research projects in the JDN that aim to reduce livestock production's environmental and climate impact while improving animal health, genetic diversity, and sustainability.

The schedule looked as follows:

Webinar 1 - 5th of September 11:00-12:00 CEST

- Jeremie vandenplas (RUMIGEN)
- Birgit Gredler-Grandl (Re-Livestock)
- Florence Bedoin and Elise Vanbergue (HoloRuminant)

Webinar 2 - 19th of September 11:00-12:00 CEST

- Antton Alberdi (3D'omics)
 - diving into micro-scale host-microbiota interactions
- Victoria Drauch and Jenny Merkesvik (3D'Omics)
 - *In vivo* models in poultry and pig for host-microbiota interplay
- Bryan Wang (3D'omics)
 - Spatially resolved multi-omic landscape of the animal gut microbiome

Webinar 3 - 3rd of October 11:00-12:00 CEST

- Marie-Jose Mercat (GEroNIMO)
 - Stakeholders' perception of pig and chicken local breeds - a broad survey by GEroNIMO
- Leon Borgdorff (GEroNIMO)
 - Perceptions of Genome Editing of Farmed Animals in Germany, Slovenia, France, and the Netherlands: a first impression
- Rasmus Mikkelsen (RUMIGEN)
 - From Lab to Landscape: Integrating social acceptance and ruminant research

We are happy to report that the recordings of the first and second webinars are already available on the HoloRuminant YouTube Channel:

https://www.youtube.com/watch?v=0E-ajGea_4U&list=PL115BffUH_IK1mKqx3Qb7hdTkohbMn7Ue

HoloRuminant at the TEAGASC Open Days



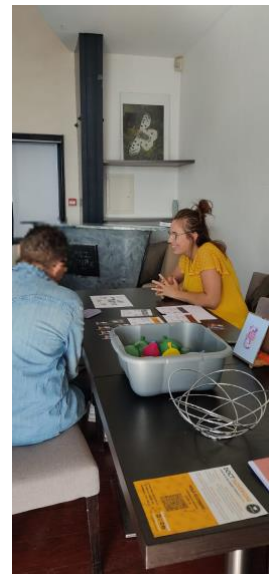
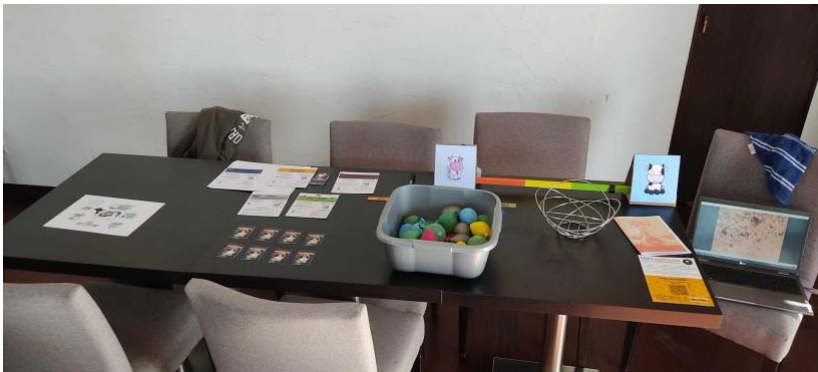
As a part of Teagasc's public outreach efforts, a variety of open days are held every two years to highlight ongoing research in a particular enterprise. This year, the Dairy open day was held on July 4th at Moorepark Research Centre, Teagasc, Fermoy, Co. Cork. The open day provided attendees with

the opportunity to see and learn about the results of the comprehensive, broad-spectrum dairy research programme undertaken by Teagasc. Many thousands of farmers, industry stakeholders and researchers attend these events. In line with this year's theme of "Securing a Sustainable Future", researchers from across Teagasc worked together to present findings and best practices necessary to ensure sustainable dairy production. As a part of HoloRuminant, Teagasc is working to develop an understanding of the role of bovine microbiomes on animal performance, health, welfare and environmental mitigation strategies. For the open day, Michelle Stafford and Sabine Scully contributed two papers entitled "HoloRuminant- Understanding the rumen microbial colonisation of calves and its impact on performance" and "Calf diarrhoea- prevention and the role of microbes." The papers were included in a booklet, which was distributed to visitors and is available online. Accompanying these articles, a display board was presented in the "One Health, One Welfare" village, where Sabine and Michelle discussed their research. This was a wonderful opportunity to inform farmers and other visitors about microbiomes and their role in ruminant health and production. There was great interest in our research projects. We enjoyed the interaction with attendees and we look forward to disseminating our research findings at future outreach events.

For more information about the Teagasc Dairy 2023 Open Day, and the Open Day booklet that includes information on HoloRuminant, please visit: <https://www.teagasc.ie/corporate-events/moorepark-open-day/>

Helping Children Understand the Importance of Microbiota

On Saturday afternoon, with a magnificent view of the Puy de Dôme, several UCA doctoral students hosted games in various fields including HoloRuminant PhD Student Laurianne Volland. Young and old alike came to play a number of games, including one that I ran with two other colleagues. We introduced our cow ROSA to the rumen and its microbiota. A game in several parts to try and understand the importance of the rumen microbiota and microbiota in general, the game was a fun and educational way for children to learn about the importance of microbiota. The students were pleased with the turnout and the enthusiasm of the participants.



HoloRuminant updates

WP1

WP1 activities have been focussing on the development of the underlying algorithms for the HoloR database in preparation for the sequencing data from the other WPs. Additionally, WP1 has been leading the collation of SOPs from other WPs and developing the training resources for the consortium for handling, naming and deposition of sequencing data. Finally, WP1 has been analysing existing data from Ruminant-associated microbial communities in order to identify key-stone species and taxa which have previously been identified as being associated with Host traits.

WP2

WP2 is focused on understanding the temporal dynamics of the microbial communities (i.e., microbiome) establishing at different body sites in cattle and sheep from birth until they become productive adults.

Within WP2, one of our main goals is to characterise microbiome profiles throughout the calf's lifetime until it becomes a milking cow. To do this, partners within the HoloRuminant project have enrolled more than 500 cattle and 130 sheep into the WP2 study, of which more than 470 cattle and 120 sheep have been weaned.

Since the focus of this project on microbiomes that are potentially associated with the development of calf diseases, samples are being collected from multiple body sites, including deep nasopharyngeal swabbing (potentially associated with pneumonia), faecal samples (potentially associated with scouring, and hoof swabbing (characterization of the environmental potentially impacting the development of the microbiomes through their lifetime).

The rumen microbiome is one of the most studied communities in ruminants, because of its close association with host performance traits, including daily feed intake and feed conversion ratio. The

rumen microbiome is also influenced by dietary changes, and therefore rumen fluid samples are being collected from animals shortly after and two weeks post weaning.

To explore the microbiome, we will mostly focus on two pieces of information: the microbiota and the metagenome. Whereas the microbiota includes information on which microbes are present in an environment and at which abundance, the metagenome includes information on the genes of these microbes, i.e., their functional potential. Our first analyses will focus on characterising the microbiota of the rumen microbiome at weaning and at two weeks post weaning. This information, together with information on health and disease events of these calves, will be used as a criterion to identify samples worthy of further investigation, including the functional potential of the rumen microbiome associated with health and disease.

In addition, the rumen microbiome profiles in the adult animal, known to be associated with feed conversion efficiency and other traits of interest for producers, are influenced by external factors, for example factors associated with the birth moment. These effects are being explored by the WP2 team, looking at the effects of birth delivery method, dam and environment factors on the composition and functionality of microbiomes in key tissues of neonatal calves. This part of the project uses samples that had been collected prior to the HoloRuminant project, and a scientific publication will soon be available.

WP3

An analysis of faecal microbiome before, during and after an episode of diarrhoea showed that there was no effect of calf breed or colostrum source on the overall diversity or composition of the faecal microbiota present throughout the pre-weaning period. There was a health status (having diarrhoea or healthy) × time interaction whereby the diversity increased with time, and diarrheic calves experienced reduced microbial diversity during diarrhoeal incident. Changes in composition confirms dysbiosis of the hindgut microbiota prior to and during disease manifestation. *Alloprevetolla*, a bacteria normally associated with gut health, dominated the bacterial faecal microbiota in diarrheic calves at time of diarrhoea.

A study has been completed in Teagasc, using the MK1C device, where we successfully characterised the bacterial nasal microbiota of BRSV infected calves (bovine respiratory disease or commonly known as pneumonia). Analysis of the microbiota indicates that BRSV infection alters the bacterial nasal microbiome. *Pasteurella*, *Moraxella* and *Mannheimia spp.* were the top genera identified.

The first part of the research at Ghent University (Belgium) aimed to identify variations in subacute ruminal acidosis (SARA) susceptibility among dairy cows during the challenging post-calving period. Rumen microbiota of SARA-susceptible cows exhibited enhanced fermentative capacity, with an enrichment of starch-degrading and lactate-producing bacteria. Additionally, an in vitro experiment revealed that the rumen metabolic environment of SARA-susceptible phenotypes could modify bacterial composition and fermentation. Inter-animal variation in SARA susceptibility was reflected in both post- and prepartum fecal bacterial communities. It is of interest to assess whether these insights could be used for SARA-preventive strategies.

WP4

To improve our understanding of rumen microorganisms WP4 is developing approaches to build near-complete genome sequences for populations directly from their native rumen environment. This involves using 3rd generation long-read sequencing technology that significantly improves genomes assembly and overall integrity. These improved genomes will be instrumental in interpreting how these microorganisms contribute to the host animal health and nutrition.

Meet the project

Chris Creevy, leader of WP1 – Consolidation of existing and development of novel knowledge on ruminant microbiomes.



Prof Chris Creevey (Wp leader) is an expert in Rumen Systems Biology and a world leading specialist in computational biology with extensive experience working with highthroughput sequencing data from complex microbial communities and non-model organisms. Funded by the BBSRC, Newton Fund, DEARA and EU Horizon 2020 his group develops de novo computational strategies for metagenomic and metatranscriptomic data from natural microbial communities and their hosts. His group currently consists of five PhD students and two post-docs. He has published over 80 papers including several in Nature, PNAS and Science and has been cited over 6,000 times.

Hauke Smidt, deputy leader of WP1 – Consolidation of existing and development of novel knowledge on ruminant microbiomes.

Prof Smidt is personal chair Complex Microbial Ecosystems at MIB. Hauke is coordinator of the UNLOCK infrastructure for research on microbial communities and has previously coordinated the EU-FP7 project INTERPLAY focusing on the interplay between intestinal microbiota and intestinal development and health in pigs. Hauke currently supervises 20 PhD students in national and EU projects, including 11 PhD students working on intestinal microbiota of humans and farm animals.



Lydia Brunault, European Project Manager



Lydia Brunault is the new European Project Manager at INRAE Transfer in charge of the HoloRuminant project. She has 10 years of experience in building and managing EU projects. She is the main contact regarding all project management aspects.

Meeting the Joint Dissemination Network

The HoloRuminant project has established a Joint Dissemination Network that contains 5 projects. Together, these projects provide a complementary effort in reducing the environmental and climate footprint of livestock production by focusing on mitigation of GHG emissions, improving the health and welfare of farmed animals and increasing the sustainability of animal production systems. Additionally, the projects will contribute to maintaining diversity at multiple levels (genetics, epigenetics, microbial) and the resilience of production systems. The research to achieve these goals ranges from micro-level research to increase knowledge on microbiomes, towards implementation of new breeding strategies and a broader systems approach.

The Joint Dissemination Network has applied for and will participate in a Horizon Results Booster to strengthen and improve its communication and dissemination activities.

3D'Omics

The project looks into the microbiome of pigs and chickens. The project is extending the knowledge that is developed in the ending HoloFood project. The project objectives can be described as:

Elucidation of the three-dimensional (3D) conformation of biomolecules in cells and tissues is an essential element for understanding biomolecular interactions. The EU-funded 3D-omics project aims to develop, optimise and implement knowledge of biomolecular interactions in application to animal production. The goal is to generate 3D omics landscapes, achieving reconstructions of intestinal host microbiota ecosystems. Using poultry and swine production systems, the project will analyse the effects of different factors, including animal development, diet, exposure to pathogens, and management practices on the 3D omics landscapes. The innovative research will pave the way to improved animal breeding practices, development of microbiota- and host-tailored feeds and animal health treatments, increasing production efficiency and animal welfare. 3D'omics and HoloRuminant have been funded from the same call. More information on the project can be found: <https://www.3domics.eu/>

Rumigen & GEroNIMO

The RUMIGEN and GEroNIMO projects are funded from the same call and both focus on genome & epigenome enabled livestock breeding. RUMIGEN focuses on cattle and GEroNIMO focuses on pigs and chicken. The main aim of both projects is to improve quantitative genetic tools by new traits, epigenetic data and new breeding techniques. An important part of the project revolved around the evaluation of societal acceptability of these new breeding techniques.

For more information on these projects: www.rumigen.eu and www.geronimo-h2020.eu

Re-Livestock

The overall objective of Re-Livestock is to understand and mobilize adoption of innovative practices, applied cross-scale (animal, herd/farm, sector and region), to reduce the greenhouse gas (GHG) emissions of livestock farming and to increase the capacity for dealing with climate change impacts, in order to ultimately increase the overall resilience of the livestock sector.

For more information on the re-livestock project visit: <https://re-livestock.eu>

Upcoming events

EVENT 	DATE 	LOCATION 
4th International World of Microbiome Conference	26 th – 28 th October 2023	Sofia, Bulgaria
2 nd HoloRuminant AM	8 th – 10 th November 2023	Wageningen, the Netherlands
One Health Conference	13 th November 2023	Luxembourg, Luxembourg
Microbiome Movement: Animal Health and Nutrition	28 th - 30 th November 2023	Raleigh, USA
Microbes symposium for young Researchers	5 th – 6 th February 2024	Gif-sur-Yvette, France
Annual Conference of the Microbiology Society	8 th – 11 th April 2024	Edinburgh, UK
6th International conference on functional metagenomics	2 nd – 5 th June 2024	Skuzuka, South Africa
19th International Symposium on Microbial Ecology	18 th – 23 th August 24	Cape Town, South Africa

Coordinator: **Diego Morgavi (INRAE)**

For more information visit our website:

www.holoruminant.eu



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