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Travel Award – Chris Grupen to Attend the 9th International Conference on Pig Reproduction & Visit INRA – Poland/France

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Meeting Report

The 9th International Conference on Pig Reproduction was held at the University of Warmia and Mazury, in Olsztyn, Poland, from June 9th to 12th, 2013. Held every four years, this conference is regarded as the premier scientific meeting of basic and applied pig reproductive biologists, and was attended by over 160 scientists from 19 countries. The three day program included three plenary sessions and six concurrent breakout sessions on the topics of "gonads, gametes and embryos", "pregnancy, parturition and the neonate", and "reproductive biotechnology". The breakout sessions were organized so that the findings of basic research were presented separately from those of more applied research, allowing delegates to choose between talks on cutting-edge laboratory advances in the biotechnology sphere and on-farm studies focussing on aspects of pig production. In addition, over 70 posters were presented in three poster sessions.

Gonads, Gametes and Embryos

In the sessions on "gonads, gametes and embryos", the cellular and molecular mechanisms involved during oocyte maturation, fertilization and embryo development were discussed. Transcriptomic and metabolomic analyses have now been used by several research groups to elucidate the regulatory pathways of development and the metabolic processes of maturation. It was in the basic breakout session that I presented my research findings on the "Effects of season and follicle size on the metabolomic profile of porcine follicular fluid". The new information in this area is anticipated to lead to improvements in the quality of the oocytes and embryos produced both in vivo and in vitro.

An interesting effect of nutrition on embryo development was described by Oliver, of the University of Alberta, Canada. The findings she presented showed that a restricted level of feeding for 7 days during lactation resulted in litters with a skewed sex ratio (60% males). Restricting the level of feed at this time was proposed to alter the reproductive tract environment in a way that favours the development of male embryos, possibly via epigenetic mechanisms. The influence of nutrition on early embryo development was also reviewed by Langendijk, of the South Australian Research and Development Institute. Summarising the findings of several studies, he proposed that a high feed level for the first three days after mating may in fact be detrimental to embryo survival. After this brief period, a feed level over the next three weeks of pregnancy appears to be beneficial.

The results of field trials evaluating a new protocol for fixed time artificial insemination in gilts and sows using a single semen dose were reported by Driancourt, of MSD AH Innovation, France. Ovulation induction involved the administration of a GnRH agonist (buserelin) at 115-120 h after the last feeding of altrenogest in gilts, and at 83-89 h after weaning in sows. Single fixed time insemination was performed 30-33 h after the buserelin injection. In both gilts and sows, fertility and prolificacy (total born as well as live born) following the single fixed time insemination were similar to the controls. Kraeling, of L&R Research Associates, USA, presented the results of another study that showed the effectiveness of a proprietary gel formula to synchronize ovulation in cycling gilts for fixed-time insemination. "OvuGel", a product that contains the GnRH agonist, triptorelin acetate, induced 100% of gilts to ovulate within 48h of treatment (given 120 h following the last altrenogest feeding), compared with 63% of untreated control gilts. Implementation of these protocols may allow producers to reduce their labour and semen costs.

Flowers, of North Carolina State University, presented analyses of boar seminal plasma proteins that have been used to identify potential markers of fertility. As well as acting as a transport vehicle for sperm, it is now well established that seminal plasma components have profound effects on sperm functionality, the sow's reproductive tract, and the interactions between the two. Preliminary results of a field trial indicated that measuring the relative concentrations of 55kDa, pI 4.8 and 25 kDa, pI 5.9 seminal plasma proteins may allow the selection of boars with very high fertility. Also, a number of seminal plasma proteins have now been identified, including members of the spermadhesin family, that hold potential for improving the fertility of boar sperm subjected to cryopreservation and sex-sorting procedures.

Cryopreservation of pig oocytes for the preservation and distribution of genetically valuable lines remains a major challenge for researchers. The production of piglets derived from cryopreserved mature oocytes has not yet been achieved, despite the successful use of this technology in numerous species. The inability of cryopreserved mature pig oocytes to form normal nuclear structures after fertilization suggests the cytoplasmic factors involved are damaged by the cryopreservation procedure. Work in this area is focussing on developing ways to reduce this damage.

Pregnancy, Parturition and the Neonate

In the sessions on "pregnancy, parturition and the neonate", a new method that may help determine the physiological status of the sow during pregnancy was described by McNeel, of the ARS US Meat Animal Research Centre, Nebraska. High throughput sequencing was found to be a valid and versatile way to analyse gene expression in placental trophoblast cells extracted from sows at Day 85 of gestation. The functionality of these cells was associated with pathways involved in protein metabolism and cell survival. Now that a high quality draft genome sequence for the pig has been published, such analyses will provide further insights into placental function.

New knowledge about maternal and fetal amino acid metabolism in the gestating sow promises to improve fetal survival and growth. Recent studies show that increasing the dietary provision of arginine beyond that of typical corn- and soybean meal-based diets to gilts or sows increased placental growth, litter size, and litter birth weight. Feeding gilts a combination of arginine and glutamine during late gestation further improved fetal growth, and reduced variation in piglet birth weight. Arginine and glutamine are now recognised by the US Swine National Research Council as conditionally essential amino acids for growing and gestating pigs.

Wientjes, of Wageningen University, the Netherlands, presented data confirming that the uniformity of piglet birth weight is affected by sow body condition at mating. However, sows that were fed an insulin-stimulating diet during the weaning to oestrus interval did not have increased litter uniformity compared with controls. Only by extending the weaning to pregnancy interval from ≤7 days to >8 days was the total number born per litter increased and the within-litter variation in birth weight reduced.

With the increased use of hyper-prolific sows, it is now evident that the number of piglets a sow can support to weaning (10.6 ± 0.6) is much lower than the average litter size (13.5 ± 0.8). Therefore, piglet management practices have become even more critical to improving neonatal survival. In the talk by Oliviero, of the University of Helsinki, Finland, the following management practices were recommended:

- Provide sow with a substrate (like straw) 1-2 days before the start of parturition, in a free farrowing space when possible.
- Use measures to reduce piglets' body heat loss.

- Evaluate teat functionality and whether the functioning teats are in accordance with the number of piglets born.
- Ensure colostrum intake to all piglets in the litter by assisting suckling, hand feeding and split suckling.
- Cross foster piglets during their first day of life, levelling the litters by weight.
- Use nurse sows to rear excess piglets of several large litters.

The importance of colostrum to neonatal survival was highlighted in other presentations. Evidence suggests that the quantity and quality of colostrum ingested by piglets can be increased by supplemental feeding of sows during the last week of gestation. Although the findings of the relatively few studies in this area are inconsistent, further studies are definitely warranted. In a separate study, piglet access to colostrum was improved in a split-suckle management program, which resulted in a significantly lower rate of pre-weaning mortality. Colostrum intake by piglets can be measured effectively using the simple "immunoglobulin immunocrit" test.

Reproductive Biotechnology

In the sessions on "reproductive biotechnology", presentations included discussions on the selection of gilts for reproductive traits and the use of the pig as an animal model for developing biomedical applications.

Knol, of the TOPIGS Research Centre, the Netherlands, predicted that over the next 10 years in the European pig industry, sow numbers per farm will double and the number of piglets weaned/sow/year will increase from 30 to 34. The main challenges to future production include labour, which may only increase by about 25%, disease, climate, feed composition and uniformity. To meet the labour challenge, a major goal is to improve the ease of production. Avoiding cross-fostering was highlighted as one way to achieve this. Therefore gilts are being selected for the number of teats they have, as clearly an extra teat is needed for every extra piglet born per litter. Teat number is one of the few reproductive traits that can be selected for early, as all other indicators occur after gilt selection at 6 months (e.g. litter size, mothering ability, colostrum, milk production).

It appears that traits can be under different genetic control depending on the environment. Recent evidence suggests that farrowing rate may be an indicator trait for the quality of the environment, and that farrowing rate shows more genetic variation under adverse environments. Also, litter size was reported to decrease by 2.5 piglets when the temperature increased from 22 to 32°C. The recent publication of a porcine genome reference sequence will enable faster and more accurate selection for traits that are expressed late in life, are sex specific, or are difficult to measure. Late in life traits, such as longevity/"stayability" and disease resistance/tolerance, are prime candidates for genomic selection.

The utility of the pig as a biomedical model for studying human diseases and developing novel therapies was discussed by Niemann, of the Federal Research Institute for Animal Health, Germany. The rapidly growing list of human diseases for which transgenic pig models have now been produced already includes Alzheimer's disease, atherosclerosis, Retinitis Pigmentosa, breast cancer, diabetes and cystic fibrosis. The detailed annotation of the pig genome heralds the next era of transgenic pig production for biomedical research. Lines of transgenic pigs are also expected to be available as organ donors within the next five to ten years. Of the methods used to generate genetically modified pigs, the advantages of somatic cell nuclear transfer (cloning) guarantee the continued expansion of this technology.

Ezashi, of the University of Columbia, Missouri, reviewed progress in the derivation and characterization of embryonic stem (ES) cells and induced pluripotent stem (iPS) cells from pigs. Attempts to derive "true" ES cell lines from pig embryos have been frustrated for over 20 years, but recent reports suggest that significant progress has been made towards achieving this goal. Using the pig as a model for retinal stem cell transplantation, rod photoreceptors generated from porcine iPS cells were recently shown to integrate successfully into damaged pig retinas. The availability of iPS cells will also facilitate the production of genetically modified pigs.

Keynote Lecture

The concluding keynote lecture of the conference was given by Stig Einarson, of the Swedish University of Agricultural Sciences, Sweden. Titled "What research is needed to improve commercial pig reproduction?", the lecture highlighted some of the recent advances discussed over the preceding days. His summation of the future research directions was:

- Use a more holistic approach to assess proteomic data.
- Enrich diluents with seminal plasma proteins found to benefit the fertility of boar sperm.
- Develop IVF and embryo transfer technologies for commercial pig production.
- Further refine fixed-time AI using lower sperm doses.
- Use genomic and transcriptomic information to improve the selection of breeding animals and increase our understanding of reproductive processes.
- Couple environmental and nutritional interventions with a balanced selection program to improve piglet survival.
- Improve the quality and rigour of the research into different group-housing systems.

Visit to INRA

After the conference, I travelled to the French National Institute of Agricultural Research (INRA) in Tours to meet with collaborators and other researchers. The study I presented at the conference in Poland was a collaborative effort involving Michael Bertoldo, who, after completing his PhD studies under my supervision at the University of Sydney, took on a postdoctoral researcher position in the lab of Pascal Mermillod. The other researchers involved in that study, Nadine Gerard and Lydie Desbarats, also met with me to discuss future collaborations. One of the proposed studies is a metabolomic species comparison of follicular fluid collected from dominant and sub-ordinate follicles in sows, cows and mares.

Following a tour of the facilities, I presented an institute-wide seminar on my research. Over the three days of my visit, I met with numerous group leaders to discuss their present research findings and future research plans. These meetings proved to be very productive, as I identified a number of new potential collaborators whose research interests and skills are of relevance to my work. Since my return, I have corresponded further with some of them, and have begun developing a collaborative proposal with Svetlana Uzbekova.