University of Glasgow | College of Medical, Veterinary & Life Sciences

Institute of Biodiversity, Animal Health and Comparative Medicine

A multidisciplinary Institute with a key strength of working on interdisciplinary boundaries. Unique in the UK in our ability to link research on animal diseases, production and welfare with ecological and evolutionary approaches.

- Comparative medicine - physiological control of reproduction, effect of environmental toxins on fertility, mechanisms and biomarkers of ageing (applications to ageing in human reproductive medicine and development)
- Animal health and welfare – understanding and managing stress in wildlife, companion and production animals (applications to conservation management, farming systems and food security, veterinary diagnostics)
- Ecophysiology – adaptation, fitness and responses of organisms (fish, bird and mammals) to different environmental factors; thermal ecology - temperature regulation in animals and applications of body temperature measurement to ecological, behavioural and animal welfare problems
- Assessing effect of environmental change on biodiversity, and human & animal health - influence on molecular, physiological and behavioural processes through to population dynamics, species interactions and community structure (applications to renewable energy developments, pollution and over-exploitation of natural resources, disease dynamics)
- Marine sciences – marine biodiversity and conservation; ecophysiology of marine organisms - fish, seabirds and marine mammals (applications to marine resources and services -sustainable fishing practices, impacts of marine energy developments).
- Spatial ecology – understanding the basis for and mapping distributions and movement of organisms (applications to fisheries management, applied conservation, epidemiology and risk management)
- Quantitative biology – significant body of specialists in mathematical modelling of populations integrating spatial, temporal and genetic data (applications to disease and drug resistance surveillance, vaccinology, ecosystem risk assessment, predictive modelling)
- Disease ecology – specialist strengths in infectious disease epidemiology and control (FMDV, MCF, rabies, bovine TB , bovine mastitis), vector biology (vector control strategies, mosquitoes/malaria, tick-borne diseases of human and production animals, tsetse flies) uniting veterinary scientists, infectious disease ecologists, mathematical biologists, evolutionary biologists and geneticists.
- Resistance biology – evolution of disease resistance in plants, drug resistance in parasites and their vectors, antiviral and antibacterial drug resistance and its epidemiology.

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Case studies: Collaborating towards innovative solutions

Collaborating to tackle problems of riverine impoundment

The impoundment of rivers for water supply to industry, irrigation and for hydro-electric power is a huge international environmental problem. Over 1 million man-made river dams and weirs worldwide impact many rare and high value freshwater species Research conducted at the Scottish Centre for Ecology and the Natural Environment (SCENE) develops ways to mitigate these problems. With partners from the hydropower industry (including Scottish and Southern Energy) and from regulators (Scottish Environment Protection Agency) and policy makers (Scottish Natural Heritage) the team are investigating what environmental cues aquatic animals such as fish use to find their way around natural and artificial river barriers, and which types of turbines cause the least harm. This work will allow engineers to design fish-friendly pass-ways around barriers and to mitigate the impacts of impoundment.

Cute-Egg, improvement of eggshell cuticle quality to reduce vertical transmission of zoonotic and pathogenic organisms

The poultry industry relies on artificial incubation of eggs to prevent transfer of microorganisms from one generation to the next. The cuticle, a proteinaceous layer on the outer surface of the egg, forms the first line of defence to the penetration of bacteria derived from vertical transmission in the cloaca (where the egg and faeces exit the chicken) or by horizontal transmission from the environment e.g. contact with collecting belts or egg handling equipment. The ongoing CUTE EGG project (a Link Project Funded by BBSRC) relies on collaboration between Prof. Maureen Bain, Edinburgh University (Roslin Institute and School of Chemistry) and 2 major poultry breeding companies.

The project focuses on the physiochemical, physiological and genetic parameters that characterise the cuticle as a quality trait and will deliver improved understanding of the role of the cuticle and the tools to measure it to allow genetic selection for improved cuticle coverage in both meat type and egg laying flocks.

Successful interactions with Industry have been built from previous EU research grants; these led to the direct involvement of two world leading primary breeding companies (Aviagen and Lohmann Tierzucht) in this project, facilitating direct access to key resources such as pedigree information whilst ensuring the knowledge generated by the project is directly transferable to a major industry.

Paraben Transfer from a Hyaluronic Acid-based fertility gel

Studies have shown that chemicals in personal care products, when applied to the skin, can be absorbed across the epithelium and into the bloodstream. For some chemicals e.g. parabens, there is concern over their potential oestrogenic activity.

Vaginal gels for aiding sperm motility and conception contain parabens as a preservative. However, it is not known whether absorption of parabens from the gel can occur across the vaginal epithelium and pose another route by which chemicals can enter the body. Through collaboration with the Dr Michelle Bellingham, Bescot Healthcare were able to access expertise in toxicology, plasma chemical measurements and an appropriate animal model with which to quantify transvaginal transfer of paraben preservatives to ensure the safety of their gel product.

Parasite Control

Norbrook, a UK-based pharmaceutical company that manufactures veterinary pharmaceuticals contacted Prof. Eileen Devaney and Dr Collette Britton to utilise their expertise in nematode models.Their aim was to determine whether a particular compound could stimulate the arrested larvae of parasitic nematodes to re-initiate development in the free-living model nematode *Caenorhabditis elegans*.

An appropriate assay was established, obtaining good and reproducible results, confirming Norbrook's preliminary findings.

However, results were unable to show that the compound had an effect on the larvae of *Haemonchus contortus*, an important parasitic nematode of sheep. So, whilst the collaborative work confirmed the hypothesis, further work was not progressed. This did however provide valuable experience in working with Industry whilst also establishing a new assay.

Dr Kirby from Norbrook wrote "Senior management are happy for you to reference the work which you did, and were very satisfied with it in every aspect. Despite this experiment not advancing, we would gladly work with you and fully endorse the University of Glasgow as a suitable industrial research partner".

Biomarkers of Disease in Livestock and Aquaculture

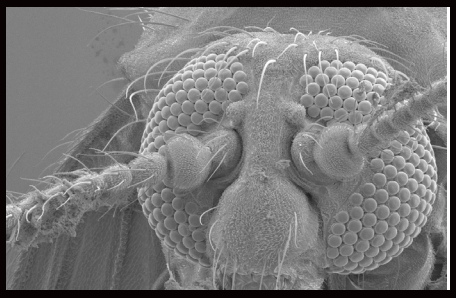
Prof. David Eckersall's group studies acute phase proteins, found in blood but which increase in concentration following infection, inflammation and trauma. Their research has shown that measuring the concentration of acute phase proteins provides significant diagnostic information for use in animal health assessments. They have shown that every species has a differing profile of the protein changes that take place, for example in dogs and pigs (as in man) C-reactive protein can change over 1000 fold within 24 hours of disease onset, while in cows sheep and buffaloes this protein is hardly affected but instead haptoglobin shows a large increase in concentration. An especially valuable discovery they have made is that the acute phase proteins are synthesised and secreted in milk during bovine mastitis and are biomarkers of this economically important disease of dairy cows. Research in collaboration with Biomar Ltd and Marine Harvest Ltd, leading companies in aquaculture, has revealed that measuring enolase in the serum of Atlantic salmon is a potential biomarker of infection by salmon alpha-virus.

Reproductive Therapeutics

The collaborative project was initiated following informal discussion between the University and Controlled Therapeutics Scotland Ltd. (CTS) in 2007. CTS expertise was product development in the pharmaceuticals business, specialising in vaginal and buccal drug delivery with particular emphasis on the birth process in humans. CTS were interested in the possible use/development of animal models to run alongside *in vitro* and commercial product development. Prof. Neil Evans, as a reproductive physiologist had existing interests in manipulation of ovarian cyclicity and the possible use of intravaginal drug delivery devices to regulate reproductive and other physiological systems.

The initial trial was planned to last approximately three months but the results using an ovine animal model exceeded expectations and the collaboration has now been running for seven years. Vaginal delivery of a variety of drugs, using a variety of polymers has been tested, including antivirals and drugs that influence the autonomic nervous system. During the period of collaboration CTS were acquired by Ferring Pharmaceuticals. Since then the utility of ovine animal models has again been verified for Ferring compounds. A drug delivery formulation has now been developed that is progressing to clinical trials.

Biting midges as indicators of climate change and disease risk in Scotland



Midges (Culicoides sp.) are infamous for their nuisance biting, which can significantly impact on Scotland's tourism and outdoor industry (e.g. forestry). They are potential vectors of diseases in wildlife (e.g. Avian malaria) and livestock (Schmallenberg, Blue Tongue Virus). However, they also serve as early indicators of the impacts of climate change. Facilitated by resources at the field station SCENE, MVLS Researchers with expertise in insect vector ecology (Dr Heather Ferguson) and seasonal biology (Dr Barbara Helm) are collaborating with Dr. Alison Blackwell, CEO of APS Biocontrol, to investigate the potential impacts of climate change on Scottish ecosystems, animal health and tourism. This collaboration, initiated by UG researchers, was sought because APS Biocontrol are the world leading experts in ecology and control of Scottish biting midges.

Key collaborative scientific questions include (i) what is the diversity and prevalence of pathogens within Scottish midge populations, (ii) are midge-borne pathogens with known impacts on livestock or wildlife health on the increase in Scotland? (iii) what is the impact of predicted changes in climate on the disease transmission capacity of Scottish midges and (iv) can disease exposure risk be reduced through midge control measures, including the use of topical repellants such as "Smidge"™ developed by APS Biocontrol.

Soluble Carbohydrate Overload of the Rumen

Ruminants have evolved to accommodate microorganisms that can digest fibrous feeds, which are generally low in soluble carbohydrates (starch and sugars) but high in insoluble carbohydrates (cellulose and pectins). However, the growth rate and lactational performance of ruminants can be dramatically increased by feeding concentrates with high levels of starch, a soluble carbohydrate. There is a limit to how much starch a cow can be fed before the rumen content becomes too acidic to maintain a healthy microbiome. Prof. Nick Jonsson's group is working on three related, industry-funded projects intended to optimise the feeding of high energy concentrates to cattle. One project is a BBSRC Industrial Partnership Award, led by University of Aberdeen, with University of Strathclyde, Harbro, Chr Hansen, Ab Vista, Quality Meat Scotland and DairyCo support. This project is a field study to characterise the pathology associated with high levels of soluble carbohydrate feeding and to identify new probiotics for cattle to prevent acidosis. Another project, funded by AB Vista, is comparing the metabolomic, metagenomic, and transcriptomic responses to concentrate feeding of cattle and sheep, with a view to determining the extent to which sheep can substitute as a model for cattle. A third study is a collaboration between Well Cow; Silent Herdsman and Glasgow to develop a new device for monitoring rumen function.

Welfare consequences of beak trimming in laying hens

Injuries caused by bird-to-bird pecking affect laying hens in all production systems are a major welfare and economic problem in the egg industry. Beak trimming is routinely applied in an attempt to minimise production losses and protect welfare. In work which was jointly commissioned by the Department for Environment, Food and Rural Affairs and the British Egg Industry Council, research by Dr Dorothy McKeegan at the University of Glasgow characterised the chronic sensory (and, thus, welfare) consequences of infrared beak trimming, a novel yet widely used technique. The results suggested that infrared trimming does not result in chronic pain or other adverse consequences for sensory function.

This work provided evidence that infrared beak trimming represents a refinement compared with previous approaches used and that the low welfare cost of beak trimming might be outweighed by the benefits (reducing suffering and mortality in laying hens). The results of this research directly influenced UK policy debate, preventing a ban on beak trimming that was due to be enacted in 2011 and would have exposed 35 million UK laying hens to potential pecking injury or death as well as costing the industry an estimated £4.82–£12.3 million annually.

Breeding for disease resistance

The project was developed by Profs. Stear, Mable, Haydon and Dr Matthews, as a means to address contemporary problems in aquaculture. The team obtained a Lord Kelvin Adam Smith Fellowship and employed Dr Karim Gharbi with the remit to develop links with industry to study the genetics of resistance of Atlantic salmon against sea lice. Karim established contact with Ron Roberts of Landcatch Natural selection and carried out pilot trials to determine a suitable way of measuring resistance. The team then obtained funding from DEFRA and set up large scale trials to estimate heritability of resistance. This subsequently led to a project funded by the TSB led by Dr Alastair Hamilton of Landcatch to develop a genomic selection tool - the SNP chip - to identify resistance and other traits in Atlantic salmon. We are very happy with the project and look on it as a rare example of taking an idea to commercial use within 10 years.

Host adaptation of an emerging pathogen in fish

In a multi-institutional collaboration, Prof. Ruth Zadoks has combined team expertise in epidemiology of multi-host pathogens and molecular bacteriology with expertise in aquaculture to investigate the potential host adaptation of an emerging pathogen in fish. The organism, *Streptococcus agalactiae*, is increasingly recognized as a production limiting organism, particularly in aquaculture of tilapia, one of the world's most common and fastest growing aquaculture species. Through comparison of isolates from multiple continents and host species, the team has identified specific fish-associated strains of the pathogen. This epidemiological association was confirmed through development of challenge models in the target host. Genome sequencing of fish-associated strains and comparison with strains from other host species led to identification of putative fish-specific genomic content. Work is now in progress to confirm the functional relevance of these loci and to explore opportunities for vaccine development in collaboration with a leading fish health company.

Strategic research strengths

- A multidisciplinary Institute with a key strength of working on interdisciplinary boundaries
- Unique in the UK in our ability to link research on animal diseases, production and welfare with ecological and evolutionary approaches
- Strategic research capacity in fundamental and applied veterinary research, integrated within interdisciplinary 'One Health' research into global human and animal health
- An open and inclusive research environment enabling the fluid development of teams to address emerging problems
- Strong and enduring strategic partnerships (Pirbright Institute, Moredun Research Institute), consortia (EPIC – Scottish Government advisors on animal health; Afrique One – global health network; International Association for Ecology and Health) and COST Action on Farm Animal Proteomics
- International agenda with investment in research and capacity building in sub-Saharan Africa

Facilities

- The Scottish Centre for Ecology & the Natural Environment (SCENE) field station provides unique research opportunities for environmentally sustainable development. SCENE's facilities have been re-launched in 2014 following major (£7m) investment, offering state-of-the-art infrastructure for terrestrial and aquatic research, teaching and training. Studies address conservation concerns, resource management, ecology, physiology, disease dynamics, and environmental change.
- Cochno research farm, part of the Scottish Centre for Production Animal Health & Food Safety, provides us with a well-equipped and well stocked 850 acre research farm with on-site animal holding facilities, nutrition and laboratory facilities for research into production systems, animal health, nutrition, animal breeding and reproduction, and epidemiology.

Contact Us:

Institute Director
Professor Dan Haydon
Daniel.Haydon@glasgow.ac.uk

Deputy Director
Professor Maureen Bain
Maureen.Bain@glasgow.ac.uk

Institute Contact
Professor David Eckersall
David.Eckersall@glasgow.ac.uk

www.glasgow.ac.uk/researchinstitutes/bahcm

For more information on working with MVLS, contact the MVLS Research and Business Development team:
mvls-rbd@glasgow.ac.uk
www.glasgow.ac.uk/mvlsrbd