

**SEVENTH ANNUAL REPORT (MARCH 2011)  
COMPARATIVE GENOMICS CENTRE, JAMES COOK UNIVERSITY**

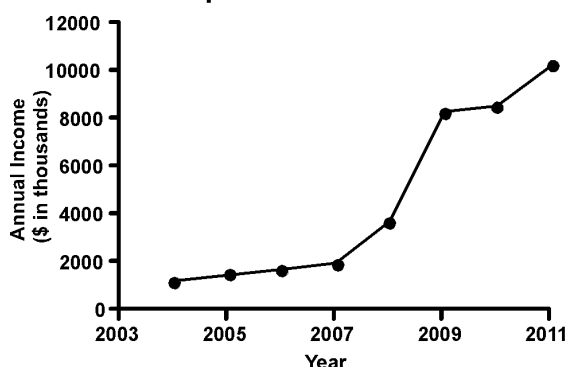
The Comparative Genomics Centre (CGC) is a research centre at James Cook University that studies the molecular basis of health, disease and traits of commercial importance in a wide range of organisms, including man, aquaculture species, staghorn coral, fruit fly and mice. The Centre provides capacity and expertise in molecular sciences and genetics for the University and the region, with member laboratories covering a broad range of applications of genetics and genomics, including diagnostics, recombinant crops, the science of coral reef management, gene/environment interactions in autoimmune diseases, genetic mapping and QTL discovery. Its member laboratories span three Schools in two Faculties.

The CGC now has an annual research income in excess of \$10.2 M from peer-reviewed grants and research contracts, and is funded by direct industry funding as well as the National Health and Medical Research Council (NHMRC), the Australian Research Council (ARC), The Great Barrier Reef Marine Park Authority, the Advanced Manufacturing Collaborative Research Centre, Dutch Science Foundation, Queensland's National and International Research Alliances Program, Fisheries Research & Development Corporation, Australian Centre for International Agricultural Research, MS Society, ARC Centre of Excellence for Coral Reef Studies, Lions Club and JCU intramural funding schemes.

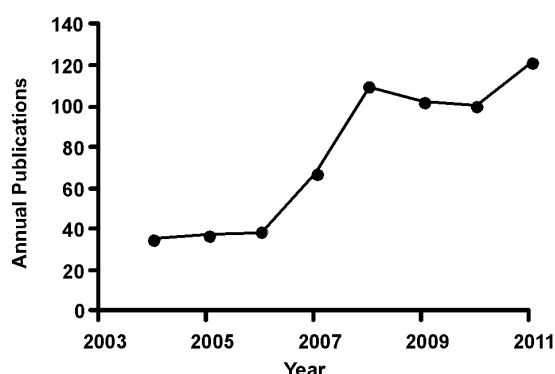
The Centre's 14 laboratories accommodated 16 honours students, 72 postgraduate students, 18 postdoctoral fellows and 12 research assistants. Over the last fifteen months, the CGC has had 122 scientific manuscripts published in internationally recognised scientific journals.

In December 2010, two of the Centre's laboratories relocated outside the region; that of Prof Heinrich Korner moved to the Menzies Research Institute in Hobart, where Prof Korner was appointed a New Star Professor. Prof Bernhard Baune's laboratory relocated to the University of Adelaide, where Prof Baune was appointed Chair of Psychiatry. We welcomed Dr Andreas Lopata, a molecular immunologist who studies the causes of seafood allergy. He brings with him a laboratory of 11 students and will make a major

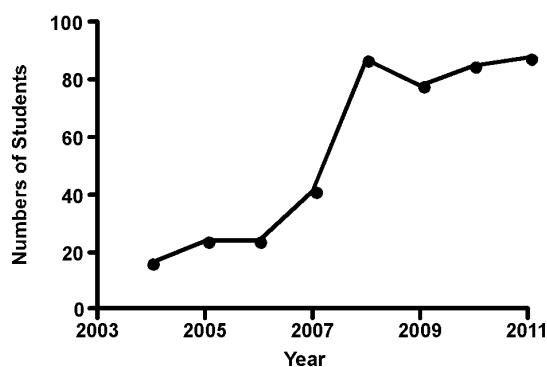
**Competitive Research Income**



**Journal Articles Published**



**Total Students**



impact to the Centre and contribute greatly to fisheries and aquaculture expertise in the region.

**The member laboratories of the CGC are:**

1) The Medical Genomics Group (Group Head: Prof Alan Baxter)

The Medical Genomics Group is working to determine the genetic causes of autoimmune diseases using both cellular and genetic techniques. Current projects study: the genetics of autoimmune diabetes, multiple sclerosis, gastritis and lupus in mice; the effects of mycobacteria on autoimmune diseases; and the role of immunoregulatory NKT cells in childhood diabetes. A major program that has emerged over the last two years is a genomic study of the causes of Multiple Sclerosis. This program is currently funded by ARC and the Lions Clubs and involves a collaboration between the Royal Melbourne Hospital, The University of Melbourne, the Menzies Research Institute and the Centre. The lab is funded by the NHMRC, ARC and the Lions Clubs.

2) The Coral Genomics Group (Group Head: Prof David Miller)

The Coral Genomics Group is studying a local *Acropora* (staghorn coral) as a model system, in order to investigate issues central to the evolution of animal genomes and developmental mechanisms. The laboratory is a member of the world leading ARC Centre of Excellence for Coral Reef Studies. This year, the laboratory published both a Science brevia and a Nature letter, both of which attracted international attention. Prof Miller was an invited plenary Speaker Symposia in Kiel (Germany) and Amsterdam.

3) The Biotechnology Group (Group Head: Prof James Burnell)

Biotechnology Group clones and expresses biological products of potential utility and is developing genetic recombinant plant crops with improved disease resistance and greater yields. This year Prof Burnell is chairing the Combio2011 Organising Committee for the annual meeting of the Australian Society of Biochemistry and Molecular Biology, The Australian Society of Plant Scientists and the Australian and New Zealand Society for Cell Biology and Development.

4) The Supramolecular Biology Group (Group Head: Dr Patrick Schaeffer)

The Supramolecular Biology Group (SBG) focus is to study protein-ligand interactions and in particular Protein-DNA interactions. The discovery and characterization of novel protein interactions can lead to the production of new molecular tools with applications in the field of bio- and nanotechnology (e.g. molecular diagnostics, drug discovery, functional genomics and proteomics). The SBG is currently developing innovative methods for the discovery, characterization and quantification of such interactions as well as novel ultrasensitive diagnostics. The research undertaken in the SBG is multidisciplinary and spans across the disciplines of Biology, Biochemistry and Chemistry. The year was marked by the group being awarded a Queensland National and International Research Alliances Program grant in excess of \$1M.

5) The Cellular Immunology Group (Group Head Ass/Prof Heinrich Korner)

The Cellular Immunology Group studies infections and inflammatory diseases in mice bearing targeted deletions of key immunological genes, in order to dissect the critical pathways involved in the initiation and resolution of immune responses.

6) The Psychogenetics Group (Group Head: Prof Bernard Baune)

The Psychogenetics Group studies the genetic control of inflammatory processes involved in the aetiology of neuropsychiatric problems, such as depression and cognitive decline. Current projects study: the effects of TNF on cognitive function; the role of TNF in neurodevelopment of the central nervous system; development of TNF targeted treatment strategies in the CNS.

7) The Drosophila Genetics Group (Group Head: Assoc/Prof Bill Warren)

The Drosophila Genetics Group's main focus is to investigate human disease using the model organism *Drosophila melanogaster* (fruit fly). As *Drosophila* share many key genes regulating cell division in man, they can provide important insights into disorders of chromosome segregation and cell cycle regulation.

8) The Aquaculture Genetics Group (Group Head: Assoc/Prof Dean Jerry)

The research focus of the Aquaculture Genetics Group is to acquire the statistical information and develop molecular tools that will allow the design and conduct of highly efficient selection programs for aquaculture species, primarily those farmed in tropical waters. Research conducted by the group falls within four major research strands – quantitative genetics, population genetics and development of molecular tools, gene expression analyses and chromosome manipulation. Aquaculture species worked with include the pearl oysters *Pinctada maxima*, *P. margaritifera*, *P. fucata*, barramundi *Lates calcarifer*, redclaw *Cherax quadricarinatus* and the Pacific whitetailed shrimp *Litopenaeus vannamei*. Currently projects within the group are funded by ARC Linkage, Fisheries Research and Development Corporation, Department of Climate Change, Energy and Efficiency, Australian Centre for International Agricultural Research and through direct industry collaborative partnerships.

9) The Symbiosis Genomics Group (Group Head: Dr Bill Leggat)

Symbiosis Genomics group focuses on linking changes in the gene expression of the dinoflagellate *Symbiodinium* to physiological alterations of the algae and the intact coral holobiont (its host), and subsequent effects on ecology. Research of this type can broadly be called ecological genomics. In particular, this group is interested in how dinoflagellates respond to human induced stress, such as climate change, what effects these changes have on the coral host and how the responses of the alga affect coral reefs. This year, Dr Leggat was awarded the James Cook University Supervisor of the Year award in the Early Career category. This laboratory is a member of the world leading ARC Centre of Excellence for Coral Reef Studies.

10) Parasite and Pest Genetics (Group Head: Prof David Blair)

The organisms studied by the Parasite and Pest Genetics Group are parasitic flatworms, mainly the trematodes that infect humans, such as the Asian blood fluke and the lung flukes. Most of the field-work on parasites and some lab work is done in countries such as China, Japan, Sri Lanka, Vietnam and India. We are also getting more involved with work on blood flukes of marine turtles. These are a major, and apparently increasing, cause of morbidity and mortality. In conjunction with the Algal Biology Group (see below), we are undertaking molecular identification of endemic and invasive microalgae in waters of the Great Barrier Reef. Prof Blair was invited to speak at International Symposium of Schistosomiasis Control and Research, Chengdu, Sichuan, China, and the International Congress of Parasitology, Melbourne.

11) The Conservation and Ecological Genetics Group (Group Head: Dr Michelle Waycott)

This group performs problem solving research utilising a broad range of molecular genetic approaches on a diverse group of organisms. Research include numerous collaborative projects with other CGC groups, other JCU researchers and external researchers. Studies incorporate population genetic, phylogenetic, molecular ecological and plant breeding approaches with molecular and whole organism approaches. Current and recent research includes studies on seagrasses, mangrove, dugong, turtle, flying foxes, sea snakes, tassel ferns, mistletoes, *Melaleuca*, sandalwood and invasive species such as Green Mussel. Recent research directions involve the assessment of thresholds of vulnerability to changing climates and species adaptability, DNA barcoding to assess species diversity, evolutionary diversification rates and marker assisted screening of population genetic health. Dr Waycott established the Global Initiative to Barcode Seagrasses (GIBS) as a pilot for adopting DNA barcoding to assist in ecological and evolutionary studies of taxonomically difficult groups.

#### 12) Algal Biology Group (Group Head: Dr Kirsten Heimann)

The Algal Biology Group runs the North Queensland Algal Identification / Culturing Facility, which isolates and establishes microalgal cultures from the Great Barrier Reef to screen for: biotechnological applications (such as biofuel potential, antiviral etc. effects), industrial purposes (such as potential animal feeds and aquaculture), morphological and genetic identification of invasives and novel organisms and potential for genetic enhancement of desirable traits for industrial / biotechnological applications. This has been an outstanding year for the group with the award of an Advanced Manufacturing Collaborative Research Centre grant worth \$4.6M. Dr Heinman was also the recipient of the Queensland Telstra Business Women Nokia Innovation Award.

#### 13) Molecular Immunology Group (Group Head: Dr Andreas Lopata)

The Molecular Immunology Research group focuses on the health effects of natural and recombinant seafood proteins, understanding allergic reactions to seafood reactions at molecular and cellular levels, the molecular modification of allergenic proteins in commercial seafood processing, and the development of improved and novel diagnostic approaches for seafood allergies. The Group is funded by the NHMRC, the Advanced manufacturing CRC and the Australian Biological Resource Study.

#### 14) The Coral Reef Fish and Fisheries Genetics Group (Group Head: Dr Lynne van Herwerden)

This group performs applied and problem solving research by applying a broad range of molecular genetic approaches to a diverse group of coral reef fishes. Research focuses on questions that include: i) the evolutionary history, diversification patterns and processes that have brought about one of the most diverse vertebrate groups on earth; ii) the identification of genetic partitioning between populations of Indo-Pacific wide distributed species of coral reef fish and how this relates to their conservation; iii) the identification of evolutionary and demographic connectivity between populations of coral reef fishes, with application to fisheries management and the efficacy of networks of Marine Protected Areas; iv) manipulative experiments on tropical fisheries species and transcriptomics to identify adaptation to temperature and which genes are associated with this. Many collaborative projects with other CGC groups, other JCU researchers and external researchers are underway. Studies incorporate population genetic, phylogenetic, and transcriptomic approaches. Current and recent research includes studies on elasmobranchs (sharks and sawfish) as well as a huge diversity of coral reef fishes.

**Recent key publications include:**

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- Baird FJ, Taki AC, Lopata AL, Smooker PM. (2011) DNA Vaccines: a modern-day vaccine revolution. Editors: Christian J. Villanueva, "*Immunogenicity*". Nova Publishers. 153-188.
- Baune BT, Dannlowski U, Janssen DAG, Jordan MA, Ohrmann P, Bauer J, Domschke K, Arolt V, Kugel H, Baxter AG, Suslow T. (2010) The interleukin 1 beta (IL1B) gene is associated with failure to achieve remission and impaired emotion processing in major depression. *Biol Psychiatry*. 67:543-9.
- Berzins SP, Smyth MJ, Baxter AG. (2011) Presumed guilty: NKT cell defects and human disease. *Nature Reviews Immunology* 11:131- 142.
- Boldt, L., Yellowlees, D., Leggat, W. (2010) Measuring *Symbiodinium* sp. gene expression patterns with quantitative real-time PCR. *Proceedings of the 11th International Coral Reef Symposium*, Ft Lauderdale, Florida 7-11 July 2008.
- Burnell JN (2011) Hurdles to engineering greater photosynthetic rates in crop plants: C4 rice. In *Advances in Photosynthesis and Respiration* volume 32 Chapter 4
- Burnell JN (2010) Cloning and characterization of *Escherichia coli* DUF299; a bifunctional ADP-dependent kinase -Pi-dependent pyrophosphorylase from bacteria. *BMC Biochemistry* 11:1
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- De Santis, C., Smith-Keune, C. and Jerry, D.R. (2010). Normalising RT-qPCR data: are we getting the right answers? An appraisal of normalization approaches and internal reference genes from a case study in the finfish *Lates calcarifer*. *Marine Biotechnology* 13:170-80
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- Ezzeddine N, Chen J, Waltenspiel B, Burch B, Albrecht T, Zhuo M, Warren WD, Marzluff WF and Wagner EJ (2011). A Subset of *Drosophila* Integrator Proteins is Essential for Efficient U7 snRNA and Spliceosomal snRNA 3' End Formation. *Mol Cell Biol*. 31:328-41
- Flint M, Blair D, Patterson-Kane J, Kyaw-Tanner M, Mills PC. (2010) Blood flukes (Spirorchiidae) as a major cause of marine turtle mortality in Queensland. XII International Congress of Parasitology. Melbourne, Australia, August 15-20 *Medimond International Proceedings*. 57-61.
- Godfrey DI, Stankovic S, Baxter AG. (2010) Raising the NKT family. *Nature Immunology* 11:197-206.
- Gordon, B., Leggat, W. (2010) *Symbiodinium*-invertebrate symbioses and the role of metabolomics. *Marine Drugs*. 8:2546-2568

- Guy, J., Rowland, S., and Jerry, D.R. (2011). Age-dependent heterosis, sex ratios and fillet yield and composition in silver perch (*Bidyanus bidyanus* Mitchell). *Aquaculture Research* (In Press)
- Hardy, C.M., Adams, M., Jerry, D.R., Court, L.N., Morgan, M.J. and Hartley, D.M. (in press). DNA barcoding to support conservation: species identification, genetic structure and biogeography of fishes in the Murray-Darling River Basin, Australia. *Marine and Freshwater Research*.
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- Jones, D.B., Zenger, K.R. and Jerry, D.R. (2011) In-silico whole-genome EST analysis reveals 2322 novel microsatellites for the silver-lipped pearl oyster, *Pinctada maxima*. *Marine Genomics* (In Press)
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- Kirstein F, Horsnell WGC, Kuperman DA, Huang X., Erle D.J., Lopata AL, Brombacher F. (2010) Expression of IL 4 Receptor alpha on smooth muscle cells is not necessary for development of experimental allergic asthma. *Journal of Allergy and Clinical Immunology*. 126:347-54.
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- Lind, C.S., Evans, B.S., Taylor, J.U.U., and Jerry, D.R. (2010). The consequences of differential family survival rates and equalizing maternal contributions on the effective population size ( $N_e$ ) of cultured silver-lipped pearl oysters, *Pinctada maxima*. *Aquaculture Research* 41:1229-1242.
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