Zayed University Research جامعة زايد البحوث

Research Incentive Fund (RIF) Grant Proposal APPLICATION FORM

Please read the RIF Faculty Handbook before c
All fields will expand as needed. Submit completed form to research@zu.ac.ae
Please note: When saving this application form, please use the naming convention, 'your surname'_RIF_2011_proposal.doc, e.g.: Martin_RIF_2011_proposal.doc

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SECTION A: PROPOSAL SUMMARY

Project Title:	Factors driving the thermal tolerance of Arabian Gulf corals			
Principal Investigator (PI):	Name:	David Abrego	College/Dept:	CSSH - NSPH
	Title:	Assisstant Professor	Highest Degree:	PhD
	Tel:	02 599 3368	Year Awarded:	2009
	Email:	David.abrego@zu.ac.ae		

List all Co-Investigators below, including those from other institutions:

Name	Email	Highest Degree	University/ College
Emily Howells	Emily.howells@nyu.edu	PhD	New York University Abu Dhabi
John Burt	John.burt@nyu.edu	PhD	New York University Abu Dhabi

1. Abstract - Please provide a concise summary of the proposed research in plain language (max. 150 words).

Corals in the Arabian Gulf grow in the harshest environment in the world, experiencing temperatures predicted for the end of the century in other areas where reefs grow. Despite their tolerance to these conditions, there is little research investigating the underlying mechanisms that have allowed them to survive in the Gulf. Addressing this knowledge gap is critical because corals in the Gulf are also some of the most endangered worldwide. This proposal aims to address part of this gap by investigating the contribution of their micro-algal symbionts (Symbiodinium) to their physiological tolerance. Given the obligate nature of the symbiosis between corals and Symbiodinium, this research will provide important insights on the role of the symbionts in shaping the survival of corals in the Gulf. Due to their unique position and thermal history, research on Gulf corals also has important implications to conservation of corals elsewhere in the world.

2. Time Period – are you requesting a one-year or two-year grant?

☒ one-year grant ☐ two-year grant

3. Students – Does the project contribute to student research training?

☒ Yes, describe briefly This project will provide opportunities for students interested in gaining research skills. These opportunites include DNA extractions, set-up and maintenance of aquarium systems and some fieldwork if properly qualified.

☐ No

4. Budget - What is the total budget requested for this proposal over the entire research period?

AED 86,435.00

5. Facilities and Equipment - Are you requesting space for a research assistant(s) and/or special equipment? If so, please describe briefly:

Yes, this research proposal includes allocation for hiring one research assistant and for expenses associated with equipment used for field sampling and monitoring as well as equipment to be used during heat stress experiments and expenses for purchasing laboratory reagents for processing of samples.

6. Ethical Clearance - Does this proposed research involve human or animal subjects?

☒ **Yes** – you will be required to apply for ethical clearance through the Research Ethics Committee if your proposal is successful

☐ **No**

SECTION B: DESCRIPTION OF RESEARCH PROJECT

Please provide a detailed project description using the six (6) section headings below.
Please write in plain language, limiting the use of jargon and acronyms.

1. Statement of the research problem(s)
(maximum 400 words)

Coral reefs are hotspots of biodiversity. They also provide immense benefits to humans by supporting fisheries, a tourism industry worth billions of US dollars, and by contributing to coastal protection (1). Unfortunately these ecosystems are in serious decline globally due to multiple threats including warming oceans, destructive storms, disease outbreaks, ocean acidification, pollution, overfishing, and destruction of habitat by coastal alterations (2). Of these threats, warming oceans is one of the most serious because prolonged exposure to above-average summer temperatures leads to bleaching, characterized by loss of algal symbionts (Symbiodinium) from coral tissue and in many cases full colony mortality. Mass bleaching events caused by prolonged exposure to high temperatures have already killed many reefs worldwide and the number and intensity of these events is predicted to increase with warming oceans (3). The current pace of warming has raised significant concerns on whether corals will be able to acclimatize or adapt to waters that may be up to 4° C warmer by the end of the century (4). The Arabian Gulf is currently the warmest environment in the world supporting coral reefs. Corals in the Arabian Gulf are already experiencing temperatures predicted for the end of the century elsewhere in the Indo-Pacific or Atlantic Oceans. This presents a unique opportunity to study the response of corals already adapted to warm oceans. Despite living in such harsh environments, corals

in the Gulf still bleach and die when temperatures exceed local summer maxima and overall, they are classified as some of the most endangered reefs in the planet. Because of the obligate nature of the symbiosis between corals and their micro-algal symbionts, the physiological tolerance of corals to stress is linked to the performance of their symbionts but the contribution of each partner to holobiont (coral plus algal partner) physiology may not be equal. The research in this proposal will provide important insights into the potential contribution of the micro-algal symbionts living within corals to the persistence of these organisms on Gulf Reefs. Understanding the mechanisms that have allowed corals in the Gulf to persist in such hot water will allow us to develop critical management strategies to protect them and prevent further degradation.

2. Literature review – a concise and current review of scholarly research or important information relating to your research topic
(maximum 600 words)

The obligate symbiosis between corals and their micro-algal symbionts (Symbiodinium) has been critical for the evolutionary success of corals as reef builders (5). Most corals have to acquire their symbionts from the environment during early ontogeny (6). This likely occurs as coral larvae search for suitable surfaces on which to settle to begin forming a coral colony, or during early juveniles stages after settlement. This mode of symbiont acquisition provides young corals with the opportunity to take up symbionts that differ from those in parental colonies (7-8). Symbiodinium are extremely diverse (9) and this diversity has fuelled a lot of research investigating their contribution to the physiology of the holobiont. Symbiodinium within clade D have received a lot of attention due to studies documenting their dominance in corals living in hot environments (10), or in corals that recovered from bleaching events (11-13). Experimental evidence using the common Indo-Pacific coral Acropora millepora supported the view that clade D Symbiodinium could enhance the thermal tolerance of corals (14). However, experiments using the closely related coral Acropora tenuis show that clade D does not always confer thermal tolerance (15). These studies show clear contributions of the algal symbiont to holobiont physiology but they also highlight that generalizations about the physiological attributes of particular symbionts cannot be extended to the holobiont. Besides the contribution of the symbionts, the coral host has mechanisms to deal with temperature stress. These include the production of photo-protective (16), anti-oxidant (17), and/or heat shock proteins (18) in addition to a switch in feeding modes to compensate for loss of nutrients from algal symbionts19. Moreover, both partners have the capacity to adapt to local environmental conditions (20-21), but the rate at which local adaptations occur remains a wide-open area of research.

The Arabian Gulf is the harshest environment in the world where corals grow. Temperature and salinity commonly reach levels that would kill corals elsewhere in the world (22). These conditions provide an ideal natural laboratory to study what coral reefs of the future may look like. The enormous selective pressure of living in an environment where summer temperatures can exceed 35C has probably contributed to corals in the Gulf having the highest bleaching thresholds in the world (23). For comparison, corals on the central Great Barrier Reef will bleach after only 5 days of exposure to 32.5C whereas corals in the Gulf will take almost 100 days at this temperature before bleaching. However, the underlying causes of this extreme difference remain to be investigated. Addressing this knowledge gap is critical because despite having the highest bleaching thresholds in the world, corals in the Gulf still bleach and temperatures within the Gulf are likely to increase in the future so the persistence of these corals is as uncertain as it is for corals elsewhere (24-25). There are only

3 studies documenting Symbiodinium diversity within the Gulf and only one of these deals with corals on UAE reefs (26). Virtually no experimental evidence exists on the types of Symbiodinium available for uptake by young corals in the Gulf or whether some host-symbiont combinations are better than others. Similarly, there is a need to study the genetic basis leading to local adaptations in both partners because this information can feed into local conservation/management plans to try to prevent further coral degradation.

References:

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3. Goals of the research – anticipated outcomes including potential problem solutions, or contribution to knowledge or understanding of issues
(maximum 400 words)

The research within this proposal aims to enhance our understanding of the factors that allow corals to persist in the extremely hot waters of the Arabian Gulf. Specifically, I will assess the diversity of Symbiodinium acquired by coral juveniles originating from corals within the Gulf and compare them to patterns of uptake outside the Gulf. This comparison will serve several purposes: First, it will document the diversity of Symbiodinium potentially available within hot (inside the Gulf) and cool water regions (outside the Gulf). If differences are detected, they will become the basis for testing whether these symbionts enhance the thermal tolerance of corals in subsequent experiments. If no differences are detected, the results will still contribute to filling the gap on information regarding Symbiodinium diversity in the region and will allow for testing of coral thermal tolerance between corals originating in the Gulf versus corals outside of the Gulf. Second, by reciprocally transplanting coral juveniles between two locations with different thermal regimes I will test whether corals originating in the harsh environment within the Gulf perform well outside of it. This has important implications for conservation of corals within the Gulf as well as for conspecifics outside the Gulf. Given the lack of published studies in the field of coral-Symbiodinium symbioses in the region and the relevance of Gulf corals in the context of warming oceans, the results of this research should provide data for 1-2 publications in high quality refereed journals. This research will also provide valuable information for further investigations into the factors contributing to the resilience of corals in the Gulf. This project will also provide training opportunities for one or two undergraduate students because some of the sample processing and laboratory work can be done by students interested in gaining practical research skills. These opportunities include DNA extractions, set-up and maintenance of aquarium systems and some fieldwork if properly qualified.

4. Research methodology – anticipated methods to be used in your research process, including main research questions, data gathering, documentation or analysis planned
(maximum 400 words)

In order to assess diversity of Symbiodinium acquired by coral juveniles on reefs within and outside the Gulf I will carry out reciprocal transplantation experiments using coral juveniles obtained following the predicted coral spawning event of April 2014. Symbiodinium diversity will be assessed by identifying the types of symbionts found within the juveniles using molecular methods (DGGE and cloning/sequencing). Coral spawning, larval rearing, and settlement of corals will be carried out in the Marine Laboratory at New York University Abu Dhabi (NYUAD). The Marine Laboratory has aquarium facilities where coral-spawning work has been carried out in the past. It also has a boat that will be used for monitoring trips to local reefs. Parental colonies of the coral Platygyra daedalea will be collected from reefs in the Gulf (Saadiyat Reef, Ras Ghanada) and outside the Gulf (Fujairah) a few days before the predicted spawning event of April 2014 and transported to the Marine Lab at NYUAD. Once the corals spawn, gametes will be collected and fertilized using 1um-filtered seawater to ensure that no Symbiodinium are available to coral larvae. Coral larvae will be reared in filtered seawater until they reach settlement competency (around 3-5 days after spawning). Terracotta settlement tiles will be introduced to the larval rearing tanks and if necessary, larvae will be induced to settle on tiles by use of crustose coralline algae. In order to maximize the number of settled corals available to transplant, 150 small tiles per parental location will be placed in larval rearing tanks. Once corals are settled (6-9 days after spawning), they will be reciprocally transplanted between parental reefs (half going to their parental reef and half to transplant reef). The number of settled juveniles on each tile will be counted prior deployment on the

reef. Monitoring of symbiont uptake will be done by subsampling 30 juveniles per location (by reef of origin) thirty days after deployment. Survival of corals will be monitored once a month for six months by visual census of all tiles at each location. After six months of growth, juveniles from both locations will be transported to the lab for a heat stress experiment to compare their heat tolerance by measuring oxidative stress, photo-physiology, and survival/tissue loss. Temperature treatments of 33° C, and 36° C will be selected to reflect bleaching levels at both locations in addition to a control temperature of 30° C.

5. Research schedule and deliverables – what are the major phases of your research anticipated, and what do you realistically plan to accomplish at what stage

The following list outlines the schedule of research and deliverables. Note that due to the nature of fieldwork, some dates may change by a few days to accommodate favorable weather windows.
1. Collection of parental colonies for spawning. Early April 2014 (before 10 April). Colonies are ready to spawn in the lab.
2. Spawning activities, larval rearing, and settlement of corals. 15-25 April 2014. Coral larvae and settled juveniles on tiles.
3. Deployment of corals on reef. Last week of April 2014. List with number of juveniles deployed at each reef.
4. Sampling for uptake of symbionts and monitoring of survival in the field. Last week of May 2014. Partial survival results.
5. Survival monitoring in the field. Once at the end of each month from June-October 2014. Report on survival.
6. Laboratory analysis of symbiont uptake. End of June 2014. Report on symbiont uptake by coral juveniles.
7. Heat stress experiment. October 2014. Report on heat stress experiment.
8. Laboratory analysis of samples from heat stress experiment. October-December 2014. Report of results and preparation of manuscript for submission for publication in scientific journal.

6. Budget narrative – describe and justify your main budget items. An itemized budget spreadsheet will also be attached to this proposal

The total cost of this project is AED 86,435.00. Major expenses include cost for supplies and services (AED 31,485), travel-associated costs for field sampling and monitoring (AED 31,150), and salary costs for one research assistant to help with laboratory processing of samples (AED 20,000). Minor expenses include costs associated with eventual publication of results, software for data loggers, and cutting/drilling of tiles to be used for larval settlement (AED 3800). Costs associated with supplies and services are essential to this project as they include all the necessary gear for field sampling, heat stress experiments, and laboratory kits needed for processing and analysis of samples. Costs associated with travel for field sampling and monitoring are also essential to this project as they are required to deploy and sample juveniles in the field and form the basis of the research in this proposal. Accommodation is required for sampling trips to Fujairah due to travel time to/from field sites and the amount of time required for sampling on the reef. A quote for accommodation is difficult to provide due to the uncertainty in the dates when travel for monitoring will occur. Nevertheless, an email from ZU Travel Services is included which provides estimated costs of accommodation. This estimate was used in the budget attached on the excel spreadsheet. Note that travel costs for sampling and monitoring would actually be higher if the NYUAD Marine Laboratory boat and truck was not being used for the sampling trips to reefs in Abu Dhabi. The truck will also be used to travel to/from Fujairah, obviating the cost of hiring a vehicle for these trips. Salary costs of hiring a research assistant to help with laboratory processing of samples are also essential to the project because the number of samples generated for molecular and oxidative stress analysis will be high. The PI will spend a significant amount of time carrying this work with the research

assistant. This time may also be used to train students interested in gaining research skills.

SECTION C: RIF BUDGET SPREADSHEET

Please attach your completed RIF Budget Spreadsheet.
Please use the naming convention 'your surname'_RIF_budget.xlsx eg Martin_RIF_budget.xlsx

SECTION D: SEDONA CV

Please attach your updated SEDONA CV
Please use the naming convention 'your surname'_SEDONA_CV.doc eg Martin_SEDONA_CV.doc

SECTION E: DEAN'S EVALUATION

You must obtain the physical signature of your Dean before submitting this application form. Applications without signatures will not be accepted.
If you do not have access to digital signatures, it is recommended to:
- print the completed form
- obtain the Dean's signature
- sign the application yourself
- scan and email to research@zu.ac.ae Please note: When saving this application form, please use the naming convention, 'your surname'_RIF_2011_proposal.doc eg Martin_RIF_2011_proposal.doc

Dean's Name:	Christopher Southgate	College/Department	CSSH/NSPH
I endorse that this project is appropriate for the unit to undertake as part of its educational, service or research programs; that appropriate and sufficient staff are available and willing to supervise; and that adequate space and facilities are available.		☐Yes ☐No	
I approve the request for facilities and equipment. (Arrangements will be made directly with the Principal Inve[illegible]tor)		☐Yes ☐No ☐ NA	
Comments:			
Dean's Signature:	APPROVED Dr. Chris Southgate Dean, CSSH 26 November 2013	Date:	

I certify that all information provided is true and correct at the time of submission.

Submit to research@zu.ac.ae

PI's Signature:		Date:	22/Nov/13