THE STATUS OF *Macrobrachium* spp. AND STOCK ENHANCEMENT OF GIANT FRESHWATER PRAWN, *Macrobrachium rosenbergii* IN A COMMUNITY-BASED PROJECT IN PETAGAS RIVER, SABAH, MALAYSIA

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BORNEO MARINE RESEARCH INSTITUTE
UNIVERSITI MALAYSIA SABAH
2018

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I hereby declare that material in this thesis is my own except for quotations, citation, equations, summaries and references, which have been accordingly acknowledged.

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DEGREE : **MASTER OF SCIENCE (FISHERIES SCIENCE)**

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Mohd Samsul Rohizad Maidin
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ABSTRACT

The decline of the freshwater giant prawn, *Macrobrachium rosenbergii*, in rivers can be attributed to overfishing, habitat loss and pollution. In order to offset the pressure, a community-based stock enhancement project was initiated by Borneo Marine Research Institute (BMRI), University Malaysia Sabah, to increase the number of *M. rosenbergii* in Petagas River, Putatan, Sabah. This study was conducted to determine the distribution and abundance of different life stages of the freshwater prawn, population estimates and habitat preferences of adult freshwater prawn and molecular characterization of the prawns caught in Petagas River following the stock enhancement programme of *M. rosenbergii* juveniles produced from BMRI shrimp hatchery. Series of samplings were conducted at Petagas River after each stock enhancement programme from September 2013 to May 2015. The different life stages of the freshwater prawn were caught using hand net and modified prawn trap. A total of 539 specimens were caught and separated into PL, juvenile and adult. The distribution of PL prawn was found to be increased with increasing salinities (R^2=0.95) while for juvenile (R^2= 0.98) and adult prawns (R^2=0.921) were inversely correlated. Abundance of PL (53%) was found at the downstream region of Petagas River. Highest percentage of juvenile was found at the midstream region of Petagas River with 18.06% while 81.63% of adult prawn found at the upstream region. Highest percentage of adult individual caught was found at station with the presence of substrate (54.43%), followed by vegetation (27.22%) and mud sand (18.35%). The CPUE of PL, juvenile and adult were positively correlated with the increase of stocking juvenile following stocking programme with R^2=0.89, R^2=0.73 and R^2=0.87 accordingly. Estimated population sizes of adult prawn at the start, middle and end of the present study were 239, 351 and 559 individuals respectively. The result was corresponding to the enhancement programme which indicates the number of freshwater prawn in the river increased following stocking programme. However, two morphologically different species of adult freshwater prawn were found; WA (white colour adult with light brown carapace and shorter rostrum), and BA (blue colour adult with light blue carapace and extended rostrum) with composition of 97.7% and 2.3% respectively. Molecular analyses were then carried out on the adult and juvenile prawns caught in the Petagas River and compared with adult and juvenile from BMRI shrimp hatchery. Sequence similarity analyses showed the two distinct species of adult samples from Petagas River were determined as *M. rosenbergii* (89% to 95% sequence similarity) and *M. mammilodactylus* (83% to 99%) while all samples from BMRI shrimp hatchery were identified as *M. rosenbergii* (89% to 99%). Other juvenile samples from the Petagas River were determined as *Macrobrachium* sp. (84% to 86%), *Caridina gracilipes* (91% to 92%), *Caridina* sp. (81% to 87%), *Litopenaeus stylirostris* (83%) and *Metapenaeus ensis* (99%). The sequence similarity and phylogenetic tree analyses showed that *M. rosenbergii* from Petagas River is closely related to *M. rosenbergii* from BMRI shrimp hatchery. The phylogenetic tree of *COI* gene produced three clusters of *Macrobrachium* genus, separated with its closely related species. Genetic distances between *M. rosenbergii* from BMRI shrimp hatchery and *M. rosenbergii* caught in Petagas River ranged from 0.00% to 13.8%. It suggested that the *M. rosenbergii* released in stock enhancement programme were closely related to the *M. rosenbergii* caught in the river. Based on the results, it showed that *M. rosenbergii* is able to live and adapt in Petagas River as its population increased following the stocking

programme. Although the percentage of *M. rosenbergii* in the river is still low compared to *M. mammillodactylus*, however the appearance of ovigorous females of *M. rosenbergii* in the study indicates the possibility of future establishment of the stocking species in the river. The stock enhancement programme is suggested to be implemented continuously in order to improve the population of *M. rosenbergii* in the Petagas River. This study will provide baseline information on the effectiveness of stock enhancement programme of giant freshwater prawn especially in Malaysia.

ABSTRAK

PENILAIAN PROJEK KOMUNITI TERHADAP PENAMBAHBAIKAN STOK UDANG GALAH, Macrobrachium rosenbergii DI SUNGAI PETAGAS, SABAH

Penurunan populasi udang galah, Macrobrachium rosenbergii di dalam sungai boleh disebabkan oleh penangkapan berlebihan, kehilangan habitat dan pencemaran. Bagi mengurangkan permasalahan ini, satu program komuniti penambahbaikan stok telah dilancarkan oleh Institut Penyelidikan Marin Borneo (IPMB) bertujuan meningkatkan populasi udang galah di Sungai Petagas, Putatan, Sabah. Kajian ini dilakukan untuk menentukan taburan dan kelimpahan setiap peringkat hidup udang galah, keutamaan habitat, anggaran populasi udang dewasa dan analisis molekul udang galah yang ditangkap di Sungai Petagas berikutan daripada program penambahbaikan. Beberapa siri kajian lapangan telah dilakukan selepas setiap program penambahbaikan stok udang galah dari September 2013 sehingga May 2015. Setiap peringkat udang galah telah ditangkap dengan menggunakan sauk tangan dan perangkap udang yang telah diubah suai. Sebanyak 539 spesimen telah ditangkap dan dikategorikan kepada postlarva (PL), juvenil dan udang dewasa. Taburan PL udang didapati meningkat apabila kemasinan air meningkat (R^2=0.95) manakala untuk juvenil (R^2= 0.98) dan sebaliknya korelasi songsang berlaku untuk udang dewasa (R^2=0.921). Limpahan PL paling tinggi adalah di bahagian muara Sungai Petagas (53%). Manakala bagi juvenil di temui tertinggi di pertengahan sungai (18.06%) dan bagi udang galah dewasa pula 81.63% di bahagian atas atau hilir sungai. Peratusan tertinggi udang galah dewasa ditangkap pada stesen dengan kehadiran substrata (54.43%) diikuti dengan vegetasi (27.22%) dan lumpur sahaja (18.35%). Hasil tangkapan per unit usaha (CPUE) bagi PL, juvenil dan udang galah dewasa menunjukkan peningkatan secara positif berikutan program penambahbaikan stok udang galah (R^2=0.89, R^2=0.73 and R^2=0.87). Anggaran saiz populasi udang galah di Sungai Petagas pada mula, pertengahan dan akhir kajian ialah masing-masing 239, 351 and 559 individu. Hasil kajian ini sesuai dengan program penambahbaikan, dimana jumlah udang galah di dalam sungai meningkat kesan daripada program penambahbaikan stok. Secara fizikal, dua spesis udang galah yang berbeza iaitu WA (cengkerang bewarna coklat muda dan rostrum yang pendek) dan BA (cengkerang bewarna biru muda dan rostrum yang panjang) telah ditemui di Sungai Petagas dengan komposisi masing-masing 97.7% dan 2.3%. Analisis molekul telah dilakukan pada udang galah juvenil dan dewasa dari Sungai Petagas dan dibandingkan dengan udang galah juvenil dan dewasa dari hatcheri udang IPMB. Analisis persamaan siri menunjukkan kedua-dua spesis udang galah dewasa yang berbeza fizikalnya ditangkap dari Sungai Petagas telah dikenalpasti sebagai M. rosenbergii (89% to 95%) dan M. mammilodactylus (83% to 99%). Semua sampel dari hatcheri udang IPMB pula dikenalpasti sebagai M. rosenbergii (89% to 99% persamaan) sahaja. Sampel juvenil yang lain dari Sungai Petagas dikenalpasti sebagai Macrobrachium sp. (84% to 86%), Caridina gracilipes (91% to 92%), Caridina sp. (81% to 87%), Litopenaeus stylirostris (83%) dan Metapenaeus ensis (99%). Hasil analisis filogenetik dan persamaan siri menunjukkan M. rosenbergii yang ditangkap dari Sungai Petagas adlah berkait rapat dengan M. rosenbergii dari hatceri IPMB. Analisis filogenetik menunjukkan terdapat tiga bahagian genus Macrobrachium, terpisah daripada spesis yang berkait rapat. Jarak genetik antara sampel M.

rosenbergii dari Sungai Petagas dan hatcheri IPMB adalah antara 0.00%-13.8%. Ini membuktikan M. rosenbergii yang dilepaskan ke dalam Sungai Petagas melalui program penambahbaikan stok adalah berkait rapat dengan M. rosenbergii yang ditangkap di Sungai Petagas. Hasil kajian ini menunjukkan M. rosenbergii mampu untuk hidup dan beradaptasi di Sungai Petagas sepertimana dapat dilihat melalui peningkatan populasinya sepanjang program penambahbaikan stok dilaksanakan. Walaupun peratusan M. rosenbergii di dalam sungai itu rendah berbanding peratusan M. mammillodactylus, namun kehadiran udang galah betina M. rosenbergii di dalam kajian ini membuktikan bahawa spesis ini mempunyai potensi untuk terus hidup dan meningkat. Penambahbaikan stok udang galah dicadangkan untuk diteruskan pada masa akan datang sehingga populasi M. rosenbergii menjadi mapan. Kajian ini menunjukkan tahap keberkesanan dalam program penambahbaikan stok udang galah seterusnya menyediakan data asas bagi penilaian tahap keberkesanannya di Malaysia.

LIST OF CONTENTS

		Page
TITLE		i
DECLARATION		ii
CERTIFICATION		iii
ACKNOWLEDGEMENT		iv
ABSTRACT		v
ABSTRAK		vii
CONTENTS		ix
LIST OF TABLES		xiv
LIST OF FIGURES		xvi
LIST OF ABBREVIATIONS		xx
LIST OF SYMBOLS		xxii
LIST OF APPENDICES		xxiii
CHAPTER 1: INTRODUCTION		1
1.1	Background of study	1
1.2	Problem statement	3
1.3	Objectives	4
1.4	Significance of study	4
1.5	Research approach	5
CHAPTER 2: LITERATURE REVIEW		6
2.1	*Macrobrachium* spp. and *Macrobrachium rosenbergii*	6
	2.1.1 Morphology and Taxonomy	6
	2.1.2 Life Cycle of *Macrobrachium* spp. and *M. rosenbergii*	7
	2.1.3 Distribution and Habitat Preferences of *Macrobrachium* spp.	9
2.2	Stock Enhancement Programmes	11
	2.2.1 Stock Enhancement Attempts around the Globe	13
	2.2.2 Problems in Stock Enhancement	19
2.3	Method to Estimate Population Abundance	20
	2.3.1 Lincoln Petersen Capture-recapture Method	20
2.4	Genetic Variation of *Macrobrachium* Genus	21

2.4.1 Mitochondrial Cytochrome C Oxidase Subunit I Gene (*COI*) 23
2.4.2 Molecular Phylogenetics 25
2.4.3 Genetic Distance Analysis 27
2.5 Petagas River 28
2.5.1 "*Tagal*" System 28

CHAPTER 3: METHODOLOGY 30

3.1 Study Site 30
3.2 Source and releasing of *M. rosenbergii* Juveniles 30
3.2.1 Sources of *M. rosenbergii* Broodstocks and Juveniles 30
3.2.2 Releasing Sites and Dates 31
3.3 Selection of Sampling Stations 33
3.4 Distribution and Abundance of *Macrobrachium* spp. 34
3.4.1 Measurement of *In-situ* Parameter 38
3.4.2 Catch per Unit Effort (CPUE) 38
3.4.3 Species and Sex Composition of *Macrobrachium* spp. 38
3.5 Habitat Preferences and Population Estimate of *Macrobrachium* spp. 38
3.6 Molecular Analyses of *Macrobrachium* spp. 42
3.6.1 *Macrobrachium* spp. Samples 42
3.6.2 DNA Extraction 42
3.6.3 Polymerase Chain Reaction (PCR) Amplification of the *COI* Gene 43
3.7 Data Analyses 44
3.7.1 Population Study of *Macrobrachium* spp. 44
3.7.2 Sequences Analyses 44
CHAPTER 4: RESULTS 46

4.1 Distribution and Abundance of Different Life Stages of *Macrobrachium* spp. 46
4.1.1 Adult *Macrobrachium* spp. 46
4.1.2 Juvenile and Post-Larvae of *Macrobrachium* spp. 47

4.1.3 Overall Distribution and Abundance 49
4.2 *In-situ* Parameter of Petagas River 51
4.2.1 Relationship between Distribution of *Macrobrachium* spp. and Water Parameters 53
4.3 Habitat Preferences and Population Estimate of Adult prawn 55
4.3.1 Habitat Preferences of Adult Prawn, *Macrobrachium* spp. 55
4.3.2 Population Estimate of Adult Prawn, *Macrobrachium* spp. 57
4.4 Adult Freshwater Prawn Morphological Analyses 57
4.5 Molecular Characterization of Prawns in Petagas River 59
4.5.1 Genomic DNA Extraction 60
4.5.2 PCR Amplification and Sequencing of the mtDNA *COI* gene 61
4.5.3 Phylogenetic Analyses 64
4.6 Effectiveness of Stock Enhancement Programme in Petagas River 67
4.6.1 Trend of Catch per Unit Effort (CPUE) of Freshwater Prawns following Stocking Programme 67
4.6.2 Composition of Adult *M. mammillodactylus* (WA) and *M. rosenbergii* (BA) following Stocking Programme 68
4.6.3 Genetic distances of *COI* gene of all *M. rosenbergii* samples from BMRI hatchery (stocking species) and Petagas River 70

CHAPTER 5: DISCUSSION 72

5.1 Distribution and Abundance of *Macrobrachium* spp. and *M. rosenbergii* 72

5.1.1 Mean Total Length Size 72

5.1.2 Abundance and Distribution of PL, Juvenile and Adult of *Macrobrachium* spp. and *M. rosenbergii* in Petagas River 73

5.1.3 Correlation between Abundance of PL, Juveniles and Adult *Macrobrachium* spp. and *M. rosenbergii* with Water Parameters 75

5.2 Habitat Preferences and Population Estimate of Adult Prawn 78

5.2.1 Substrates as Habitat Preferences 78

5.2.2 Population Estimation of Adult *Macrobrachium* sp. 80

5.3 Adult Prawn Morphological Analyses 81

5.3.1 WA and BA Adult Freshwater Prawn 81

5.4 Molecular Characterization of Juvenile and Adult Freshwater Prawn Samples 82

5.4.1 Characterization of two morphologically different BA and WA Adult Freshwater Prawns 83

5.4.2 Characterization of Juvenile and Adult Freshwater Prawns from Petagas River 84

5.5 Effectiveness of Stock Enhancement in Petagas River 85

5.5.1 Trend of CPUE following Stocking Programme 85

5.5.2 Establishing of Stocking Species *M. rosenbergii* (BA) 87

5.5.3 Close Genetic Divergence between *M. rosenbergii* from BMRI Hatchery and *M. rosenbergii* from Petagas River 89

CHAPTER 6: CONCLUSION 92

6.1 General Conclusion 92

6.2 Recommendations 93

REFERENCES 94

APPENDICES 118

LIST OF TABLES

		Page
Table 2.1:	Species reported to be allied with success in stock enhancement and sea ranching around the globe	14
Table 2.2:	Stock Enhancement programme in Asian countries	15
Table 2.3:	Stock Enhancement programme conducted in Malaysia	17
Table 3.1:	Number of giant freshwater prawn juveniles, *M. rosenbergii* released by BMRI into Petagas River	32
Table 3.2:	Sampling stations with their divisions of downstream, midstream and upstream respectively	34
Table 3.3:	Assessment of stock enhancement of *M. rosenbergii* juvenile following stocking timeline	37
Table 3.4:	Sampling stations and station's description	39
Table 3.5:	Estimation was based on single mark and single recapture based on three occasions during start, middle and end of stocking programme	42
Table 3.6:	Additional mtDNA *COI* sequences of prawn and outgroup used in this study obtained from GenBank	45
Table 4.1:	The total length of sampled prawn in Petagas River	46
Table 4.2:	Water Parameters at different sampling stations in Petagas River	52
Table 4.3:	The estimated population size of adult prawn, *Macrobrachium* spp. in Petagas River	57
Table 4.4:	Prawn samples from BMRI Shrimp Hatchery and Petagas River	60
Table 4.5:	Sequence similarity analyses of prawns used in this study i.e. samples from BMRI shrimp hatchery and samples caught in Petagas River. Sample abbreviations, maximum identity (%) based on BLAST and Accession numbers are provided	62
Table 4.6:	Genetic distances of the *COI* gene between *M.*	71

rosenbergii from BMRI shrimp hatchery (BS and JH) and *M. rosenbergii* (BA) caught from Petagas River following the stock enhancement programme using Kimura-2-parameter

LIST OF FIGURES

		Page
Figure 2.1:	Morphology of *Macrobrachium* spp. and *M. rosenbergii*	6
Figure 2.2	Taxonomy of *Macrobrachium* spp. and *M. rosenbergii*	7
Figure 2.3:	Life Stages of *Macrobrachium* spp.	9
Figure 2.4:	Distribution of *M. rosenbergii* around the globe including China, India, Indonesia, Malaysia, Thailand, Bangladesh, Vietnam, Philippines, Brazil, Mexico, Israel, and the United States of America (New 2002; New, 2005; FAO, 2006)	10
Figure 2.5:	An example of rooted phylogenetics tree	26
Figure 2.6:	NJ method: (a) an unresolved star-like tree (b) the closest terminals 1 and 2 are joined and a branch is inserted between them and the remainder of the tree	27
Figure 2.7:	*"Tagal"* system sign boards along Petagas River	29
Figure 3.1:	The study area of Petagas River	30
Figure 3.2:	a)The larvae produced were then transferred and reared in 10 ppt salinity water; b) Juvenile prawn reached 20 mm; and c) A batch of juvenile of *M. rosenbergii* was released onto structured habitat to reduce mortality or prey-predator factor	32
Figure 3.3:	a)Illustration of modified prawn trap (*bubu*); and b) The modified *bubu* used in Petagas River	33
Figure 3.4:	Sampling stations which represent the downstream, midstream and upstream regions of the Petagas River	35
Figure 3.5:	Dip net or hand net used to capture juvenile and PL	36
Figure 3.6:	Cross section of a littoral zone displaying the position of dip or hand net sampling attempts, A to B with 10 times catch effort during high tide. All sampling attempts were conducted at depths between 0.1 and	36

1.0 m

Figure 3.7:	Sampling stations located at the upstream region of Petagas River	39
Figure 3.8:	a) Station with the presence of vegetation; b) Station with presence of substrates (i.e dead logs, tree roots and rocks); and c) Station with no shelter or mud sand only	40
Figure 3.9:	Marking using white thread tied at the eyestalk of the shrimp.	40
Figure 4.1:	Cumulative number of adult caught at each stations in four different sampling periods	47
Figure 4.2:	Cumulative number of juvenile caught at each station in four different sampling periods	48
Figure 4.3:	Cumulative number of PL caught at each stations in four different sampling periods	49
Figure 4.4:	The total number of prawn at the three main regions of the Petagas River	50
Figure 4.5:	The composition of PL, juvenile and adult freshwater Prawn caught at three main regions of the Petagas River	50
Figure 4.6:	a) Salinity in ppt at stations along Petagas River during high tide; and b) Salinity in ppt at stations along Petagas River during low tide	51
Figure 4.7:	Life stages distribution of freshwater prawns based on salinity along Petagas River	53
Figure 4.8:	Life stages distribution of freshwater prawns based on pH along Petagas River	54
Figure 4.9:	Life stages distribution of freshwater prawns based on dissolved oxygen (DO) along Petagas River	54
Figure 4.10:	Life stages distribution of freshwater prawns based on temperature along Petagas River	55
Figure 4.11:	Total number of adult individuals caught at different types of habitat stations	56

Figure 4.12:	Percentage of adult prawn in different habitat preferences	56
Figure 4.13:	a) Light blue carapace (blue arrow) and extended rostrum (red arrow) and abbreviated as BA; and b) Light brown carapace (blue arrow) and shorter rostrum (red arrow) and abbreviated as WA	58
Figure 4.14:	Composition of WA and BA adult of freshwater prawn caught	59
Figure 4.15:	Genomic DNA isolated from adult freshwater prawn samples on 1% agarose gel. (M: Lambda/*Hind*III DNA ladder, Lane 1: BS01, Lane 2: BS02, Lane 3: JH01, Lane 4: JH02)	61
Figure 4.16:	PCR amplification of *COI* gene on 1.5% agarose gel. (M: 100 bp DNA ladder, Lane 1: Negative control, Lane 2: BS01, Lane 3: BS02, Lane 4: JH01, Lane 5: JH02)	62
Figure 4.17:	Molecular phylogenetic tree of prawn samples based on cytochrome oxidase subunit I (*COI*) sequences generated by neighbour-joining (NJ) method. Percentage of bootstrap values above 50% after 1000 replications are shown above the line of each node	66
Figure 4.18:	Correlation in CPUE of different life stages of freshwater prawn, *Macrobrachium* spp. following stocking timeline in Petagas River	67
Figure 4.19:	Number of *M. mammillodactylus* (WA) and *M. rosenbergii* (BA) adult individuals following the stocking programmes in Petagas River	69
Figure 4.20:	*M. rosenbergii* (BA) Composition at the three main regions of Petagas River	69

LIST OF ABBREVIATIONS

BA	Light blue carapace and extended rostrum
BA	Adult prawn with light blue carapace and extended rostrum caught from Petagas River
BAM	*M. rosenbergii* male
BANOF	*M. rosenbergii* non-ovigorous female
BAOF	*M. rosenbergii* ovigorous female
BLAST	Basic local alignment search tool
BS	Broodstock of *M. rosenbergii* from BMRI hatchery
CL	Confidence level
COI	Cytochrome oxidase subunit 1
CPUE	Catch per unit effort
DNA	Deoxyribonucleic acid
DO	Dissolved oxygen
FAO	Food and agriculture organization
GPS	Global positioning system
HDPE	High-density polyethylene
JH	Juvenile *M. rosenbergii* from BMRI hatchery
JS	Juvenile prawns caught from Petagas River
K2P	Kimura-two-parameter
M1	Mud sand 1
M2	Mud sand 2
ML	Maximum likelihood
ML	Maximum Likelihood
mtDNA	Mitochondrial DNA
NCBI	*National Center for Biotechnology Information*
nDNA	Nuclear DNA
NJ	Neighbor joining
PCR	Polymerase chain reaction
PL	Postlarva
rDNA	Ribosomal deoxyribonucleic acid
rRNA	Ribosomal ribonucleic acid

S1	Substrates 1
S2	Substrates 2
SPSS	Statistical package for social sciences
ST	Station
TL	Total length
UV	Ultraviolet
V1	Vegetation 1
V2	Vegetation 2
WA	Light brown carapace and shorter rostrum
WA	Adult prawn with light brown carapace and shorter rostrum caught from Petagas River

LIST OF SYMBOLS

ppt	Part per thousand
mm	Millimeter
%	Percent
L	Liter
km	Kilometer
mg/L	Milligram per liter
cm	Centimeter
g	Gram
cm^2	Centimetre square
m	Meter
mg	Milligram
µl	Microliter
°C	Degree celcius
ml	Milliliter
s	Second
rpm	Revolutions per minute
V	Volt
µM	Micrometer
U	Unit
km^2	Kilometer square
µg/ml	Microgram per milliliter
bp	Base pair
kb	Kilobyte
m^3	Meter cubic

LIST OF APPENDICES

		Page
APPENDIX A	Sampling of freshwater prawn	117
APPENDIX B	Statistical analyses between the number of adult prawns and month	120
APPENDIX C	Statistical analyses between the number of juvenile prawns and month	121
APPENDIX D	Statistical analyses between the number of pl prawns and month	122
APPENDIX E	Statistical analyses between the salinities during high tide (ht) and months	123
APPENDIX F	Statistical analyses between the abundance of adult and regions	125
APPENDIX G	Statistical analyses between the abundance of adult prawns and months (habitat preferences)	127
APPENDIX H	Genomic DNA isolated from freshwater prawn samples on 1% agarose gel	128
APPENDIX I	PCR amplification of *COI* gene of freshwater prawn on 1.5% agarose gel	132
APPENDIX J	Publications output and awards recieved	136