

# CONTENTS

List of Figures	III	
List of Tables	V	
Abstract	VII	
<b>Chapter 1:</b>		
<b>Introduction and Common Methodologies</b>		
1.1	General Introduction	1
1.2	Objectives	7
1.3	Materials and Methods	7
1.3.1	Collection of fish samples and getting morphometric data	7
1.3.2	Data and Statistical analysis of morphometric characters	8
1.3.2.1	Preliminary examination of data	8
1.3.2.2	Standardization of morphometric data	9
1.3.2.3	Testing for normal distribution of data	10
<b>Chapter 2:</b>		
<b><i>Puntius dorsalis</i>: Sexual dimorphism and population variation in morphometrics</b>		
2.1	Introduction	11
2.2	Materials and Methods	14
2.2.1	Sampling of <i>Puntius dorsalis</i>	14
2.2.2	Morphometrics of <i>Puntius dorsalis</i>	16
2.2.3	Data and Statistical analysis	18
2.2.3.1	Testing for sexual dimorphism	18
2.2.3.2	Univariate testing using one-way ANOVA	19
2.2.3.3	Multivariate testing using Discriminant Function Analysis (DFA)	20
2.2.3.4	Canonical Analysis	20
2.2.3.5	Principal Component Analysis (PCA)	21
2.2.3.6	Weighted Pair Group Mean Centroid (WPGMC) method for clustering	21
2.3	Results	22
2.3.1	Size effect	22
2.3.2	Sexual dimorphism	22
2.3.3	Population comparison	24
2.4	Discussion	45
<b>Chapter 3:</b>		
<b><i>Puntius vittatus</i>: Sexual dimorphism and population variation in morphometrics</b>		
3.1	Introduction to <i>Puntius vittatus</i>	50
3.2	Materials and Methods	53
3.2.1	Sampling of <i>Puntius vittatus</i>	53
3.2.2	Morphometrics of <i>Puntius vittatus</i>	55

3.2.3	Data and Statistical analysis	58
3.2.3.1	Testing for sexual dimorphism	58
3.2.3.2	Univariate testing using one-way ANOVA	58
3.2.3.3	Multivariate testing	59
3.3	Results	59
3.3.1	Size effect	59
3.3.2	Sexual dimorphism	59
3.3.3	Population comparison	61
3.4	Discussion	89

#### **Chapter 4:**

#### **Common Discussion**

4.1	Contribution of the research for biodiversity and taxonomy of ichthyofauna in Sri Lanka	96
4.1.1	Significance of the present study	98
4.1.2	Evidence for geographic populations in Sri Lanka	99
4.1.3	Comparative results for Sri Lankan and Indian specimens	102
4.1.4	Contributions to taxonomy studies of Sri Lankan cyprinids: proposing diverging taxa	104
4.1.5	Contribution to conservation planning	108
4.1.6	Remarks on methodological limitations	108
4.2	Conclusions and further studies	109
4.3	References	111
4.4	Appendices	127

## LIST OF FIGURES

1.0	Photograph of <i>Puntius dorsalis</i> from Nilwala River, Sri Lanka	14
2.0	The collection localities of <i>Puntius dorsalis</i> specimens in Sri Lanka	15
3.0	Schematic diagram of <i>Puntius dorsalis</i> used in measuring morphometric characters	16
4.0	Graphs of size-standardized Caudal peduncle depth (STA CPD) of <i>Puntius dorsalis</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	32
5.0	Graph of size-standardized Eye diameter (STA EYED) of <i>Puntius dorsalis</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	33
6.0	Graph of size-standardized Post orbital length (STA POL) of <i>Puntius dorsalis</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	34
7.0	Graph of size-standardized Head depth (STA HD) of <i>Puntius dorsalis</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	35
8.0	Graph of size-standardized Maximum body depth (STA MBD) of <i>Puntius dorsalis</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	36
9.0	Graph of size-standardized Dorsal fin length (STA FLD) of <i>Puntius dorsalis</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	37
10.0	Graph of size-standardized Pelvic fin length (STA FLPelv) of <i>Puntius dorsalis</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	38
11.0	Results of Principal Component Analysis (PCA) in ten populations of <i>Puntius dorsalis</i> of Sri Lanka and including one Indian population	43
12.0	Results of Hierarchical cluster analysis with the Weighted Pair Group Mean Centroid (WPGMC) tree in ten populations of <i>Puntius dorsalis</i> of Sri Lanka including one Indian population	44
13.0	Photograph of <i>Puntius vittatus</i> from Kalu River, Sri Lanka	51
14.0	The collection localities of <i>Puntius vittatus</i> specimens in Sri Lanka	54

15.0	Schematic Diagram of <i>Puntius vittatus</i> used in measuring morphometric characters	56
16.0	Plot of the distribution of Principal Component Analysis (PCA) in three populations of <i>Puntius vittatus</i> in India	70
17.0	Plot of the distribution of Principal Component Analysis (PCA) in seven populations of <i>Puntius vittatus</i> of Sri Lanka	74
18.0	Results of Hierarchical cluster analysis with the Weighted Pair Group Mean Centroid (WPGMC) tree in seven populations of <i>Puntius vittatus</i> of Sri Lanka	74
19.0	Graph of size-standardized Caudal peduncle length (STA CPL) of <i>Puntius vittatus</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	76
20.0	Graph of size-standardized Pre dorsal length (STA PrDL) of <i>Puntius vittatus</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	77
21.0	Graph of size-standardized Pectoral fin length (STA PecFL) of <i>Puntius vittatus</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	78
22.0	Graph of size-standardized Head length (STA HL) of <i>Puntius vittatus</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	79
23.0	Graph of size-standardized Post orbital length (STA POL) of <i>Puntius vittatus</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	80
24.0	Graph of size-standardized Head depth (STA HD) of <i>Puntius vittatus</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	81
25.0	Graph of size-standardized Maximum body depth (STA MBD) of <i>Puntius vittatus</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	82
26.0	Graph of size-standardized Transverse length (STA TrL) of <i>Puntius vittatus</i> (mean $\pm$ SE) for all locations of Sri Lanka and India	83
27.0	Plot of the distribution of Principal Component Analysis (PCA) in all populations of <i>Puntius vittatus</i> including three Indian populations	88
28.0	Results of Hierarchical cluster analysis with the WPGMC tree in all populations of <i>Puntius vittatus</i> of Sri Lanka and India	88

## LIST OF TABLES

1.0	Morphometric characters studied in <i>Puntius dorsalis</i>	17
2.0	The results of the t-test of <i>Puntius dorsalis</i> at Godapitiya Location	23
3.0	Collection localities, sample size (n) and size statistics (based on standard length, SL) of adult <i>Puntius dorsalis</i> samples	24
4.0	Summary of the Descriptive statistics of the morphometric characters studied in population comparison of <i>Puntius dorsalis</i> within all populations	25
5.0	Summary results of the forward stepwise discriminant function analysis of standardized morphometric data of ten locations of <i>Puntius dorsalis</i> of Sri Lanka and India	39
6.0	Standardized Coefficients for the ten significant discriminant functions (Roots) derived for morphometrics of <i>Puntius dorsalis</i> in Sri Lanka and India	40
7.0	Results of Classification Success of eleven populations of <i>Puntius dorsalis</i> of Sri Lanka and India	41
8.0	Factor coordinates of the variables, based on correlations for morphometrics of <i>Puntius dorsalis</i> in Sri Lanka and India	42
9.0	Lateral line scales of <i>Puntius dorsalis</i> in all locations of Sri Lanka and India	45
10.0	Morphometric characters studied in <i>Puntius vittatus</i>	56
11.0	The results of the t-test of <i>Puntius vittatus</i> at Nilwala River	60
12.0	Collection localities, sample size (n) and size statistics (based on standard length, SL) of adult <i>Puntius vittatus</i> samples	61
13.0	Summary of the Descriptive statistics of the morphometric characters studied in population comparison of <i>Puntius vittatus</i> within all populations	62

14.0	Summary results of the forward stepwise discriminant function analysis of standardized morphometric data of three locations of <i>Puntius vittatus</i> of India	67
15.0	Results of Classification Success of three populations of <i>Puntius vittatus</i> of India	68
16.0	Standardized Coefficients for the two not significant discriminant functions (Roots) derived for morphometrics of <i>Puntius vittatus</i> in India	69
17.0	Summary results of the forward stepwise discriminant function analysis of standardized morphometric data of seven locations of <i>Puntius vittatus</i> of Sri Lanka	71
18.0	Standardized Coefficients for the five significant discriminant functions (Roots) derived for morphometrics of <i>Puntius vittatus</i> in Sri Lanka	72
19.0	Results of Classification Success of seven populations of <i>Puntius vittatus</i> in Sri Lanka	73
20.0	Summary results of the forward stepwise discriminant function analysis of standardized morphometric data of ten locations of <i>Puntius vittatus</i> of Sri Lanka and India	84
21.0	Standardized Coefficients for the seven significant discriminant functions (Roots) derived for morphometrics of <i>Puntius vittatus</i> in Sri Lanka and India	85
22.0	Results of Classification Success of ten populations of <i>Puntius vittatus</i> in Sri Lanka and India	86
23.0	Factor coordinates of the variables, based on correlations for morphometrics of <i>Puntius vittatus</i> in Sri Lanka and India	87
24.0	Comparative analysis of descriptive statistics of the proposed diverging <i>Puntius vittatus</i> group (i.e. Kalu River & Gin River), other Sri Lankan <i>P. vittatus</i> populations and Indian <i>P. vittatus</i>	107
25.0	Comparative analysis of size-standardized Head Length (STA HL) and STA POL of the proposed diverging <i>P. vittatus</i> group, other Sri Lankan <i>P. vittatus</i> populations and Indian <i>P. vittatus</i> .	107