THE EXTERNAL MORPHOLOGY OF THE WHITESPOTTED WHIPRAY

Himantura gerrardi

(GRAY, 1851)

LEE HUI XIAN

DISSERTATION SUBMITTED IN PARTIAL FULFILLMENT
FOR THE DEGREE OF BACHELOR OF SCIENCE
WITH HONOURS

MARINE SCIENCE PROGRAMME
FACULTY OF SCIENCE AND NATURAL RESOURCES
UNIVERSITI MALAYSIA SABAH

2015
Mengaku membenarkan tesis *(LPSM/Sarjana/Doktor Falsafah) ini disimpan di Perpustakaan Universiti Malaysia Sabah dengan syarat-syarat kegunaan seperti berikut:-

1. Tesis adalah hak milik Universiti Malaysia Sabah.
2. Perpustakaan Universiti Malaysia Sabah dibenarkan membuat salinan untuk tujuan pengajian sahaja.
3. Perpustakaan dibenarkan membuat salinan tesis ini sebagai bahan pertukaran antara institusi pengajian tinggi.
4. Sila tandakan (/)
   - SULIT (Mengandungi maklumat yang berdarjah keselamatan atau kepentingan Malaysia seperti yang termaktub di AKTA RAHSIA RASMI 1972)
   - TERHAD (Mengandungi maklumat TERHAD yang telah ditentukan oleh organisasi/badan di mana penyelidikan dijalankan)
   - TIDAK TERHAD

_Perpustakaan Universiti Malaysia Sabah_ Disahkan oleh:

NURULAIN BINTI ISMAIL
LIBRARIAN
UNIVERSITI MALAYSIA SABAH
(TANDATANGAN PUSTAKAWAN)

Dr. B. Mabel Manjaji-Matsumoto
(NAMA PENYELIA)
(TANDATANGAN PENULIS)

Alamat Tetap: 91, Jalan 9/62
Bandar Menjalara, Kepong
52200, Kuala Lumpur

TARIKH: 16/6/15

Catatan:
* Poton
* Jika te menyal
* Tesis i bagi pe

Perpustakaan UMS

-irkan surat daripada pihak berkuasa/organisasi berkenaan dengan s ini perlu dikelaskan sebagai SULIT dan TERHAD.
ah Doktor Falsafah dan Sarjana Secara Penyelidikan atau disertai rjan Projek Sarjana Muda (LPSM).
DECLARATION

I hereby declare that the material in this proposal is my own except for quotations, excerpts, equations, summaries and references, which have been duly acknowledged.

LEE HUI XIAN
BS12110274
16\textsuperscript{th} JUN 2015
VERIFICATION

VERIFIED BY

1. SUPERVISOR
   (Dr. B. Mabel Manjagi-Matsumoto)

2. EXAMINER 1
   (Dr. Pushpalatha M. Palaniappan)

3. EXAMINER 2
   (Dr. John Madin)

4. DEAN
   (Dr. Baba Musta)
ACKNOWLEDGEMENT

This project could not have succeeded without the help and support of many people. First and foremost I would like to thank God for giving me the strength, love, grace, knowledge and wisdom throughout this study.

I would like to convey my deepest gratitude to my supervisor, Dr. B. Mabel Manjaji-Matsumoto who was very supportive in carrying out this study. She spent valuable time and energy to discuss various matters over, to check my work and to teach me the right methods of photography and lab measurements. She was willing to share her experience and knowledge to improve my study. With her supervision I have learnt many valuable lessons.

Thirdly, I am indebted to Yee Jean Chai, and Farah Farina who accompanied me to the SAFMA fish market in the middle of the night and for assisting me while I was taking photograph and measuring the specimens on field. I am also thankful for Mr. Herman for showing me all the apparatus in the ecosystem lab while I was conducting my lab work.

Without my family I would have not made it this far, I thank them especially my parents for their moral support, love, and advice. Their encouragement has motivated to strive and not give up.

My appreciation also goes to all my course mates for sharing their knowledge and for supporting me in this study. Last but not least, my church members for their prayers and constant encouragement, their presence has truly been blessing in my life.
ABSTRACT

The Whitespotted Whipray *Himantura gerrardi* is presently known to be a cryptic species. This means that it has more than one species lumped under the same scientific name, it is also grouped into the ‘Uarnacoids’ species complex. The Whitespotted Whipray is an important commercial species, as it is one of the abundant species caught in the fisheries. The objective of this study is to obtain external morphological data of Whitespotted Whipray, *Himantura gerrardi* collected and to compare the colour variation between female and male, and between the four life stages (embryo, immature, maturing, and mature). This study follows standard morphometric and meristic methods to obtain the data. The specimens were collected from the Kota Kinabalu, SAFMA, fish market. A total of 36 specimens were examined; 21 specimens were purchased and measured in the lab whereas 15 specimens were examined on field. Meristic data showed dimorphic characters, useful for describing ontological characteristics. The results indicated no sexual dimorphic characteristics. There are three types of variation in the degree of spotting on the dorsal surface (low, medium and high); low degree shows spots only congregated at the posterior end of disc, with <20 spots; Medium degree have >20 spots and distributed at the posterior half of the disc; High degree have spots distributed across the posterior to the anterior of the disc. Individuals with low degree of spotting are speculated to be of another subspecies or species. There are two types of spot morphology seen (elongated clusters of spots with ‘C’ or ‘O’ shape and solid round spots). The findings may be useful to identify possible subspecies or new species, and provides useful insight to *Himantura gerrardi* species complex. Internal anatomical characters and DNA sequence analysis could be carried out for future research.
ABSTRAK

# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>DECLARATION</td>
<td>ii</td>
</tr>
<tr>
<td>VERIFICATION</td>
<td>iii</td>
</tr>
<tr>
<td>ACKNOWLEDGEMENT</td>
<td>iv</td>
</tr>
<tr>
<td>ABSTRACT</td>
<td>v</td>
</tr>
<tr>
<td>ABSTRAK</td>
<td>vi</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>vii</td>
</tr>
<tr>
<td>LIST OF TABLES</td>
<td>ix</td>
</tr>
<tr>
<td>LIST OF FIGURES</td>
<td>xi</td>
</tr>
<tr>
<td>LIST OF SYMBOLS AND ABBREVIATION</td>
<td>xv</td>
</tr>
</tbody>
</table>

## CHAPTER 1 INTRODUCTION

1.1 Stingrays

1.1.1 *Himantura gerrardi*  

1.2 Objectives  

1.3 Hypothesis  

1.4 Significance of study

## CHAPTER 2 LITERATURE REVIEW

2.1 Phylogeny and Taxonomy of Stingrays  

2.1.1 The Uarnacoides Species Complex  

2.1.2 External Morphology of *H. gerrardi*

2.2 Biology of the Stingrays  

2.2.1 Size composition of *H. gerrardi*  

2.2.2 Sexual dimorphism and ontogenetic changes  

2.3 Distribution of *Himantura gerrardi*  

2.4 Habitat and Fisheries

## CHAPTER 3 METHODOLOGY

3.1 Study Area  

3.2 Materials and Methods  

3.2.1 Field sampling
LIST OF TABLES

<table>
<thead>
<tr>
<th>Table No.</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>3.1</td>
<td>Proposed field sampling dates.</td>
<td>14</td>
</tr>
<tr>
<td>3.2</td>
<td>Definition of the morphometric and meristic data</td>
<td>16</td>
</tr>
<tr>
<td>4.1</td>
<td>Number of sample examined in the lab and on field according to gender and life stages.</td>
<td>25</td>
</tr>
<tr>
<td>4.2</td>
<td>Morphometric measurements in percentage of DW, Tail height at base of sting, Mouth width, orbit diameter, interorbital, spiracle length, internasal, prenasal, nasal length, gill slit width and head length for embryos and neonates <em>Himantura gerrardi</em>, ranges from (142-192 mm DW; n=4).</td>
<td>28</td>
</tr>
<tr>
<td>4.3</td>
<td>Morphometric measurements in percentage of DW, Tail height at base of sting, mouth width, orbit diameter, interorbital, spiracle length, internasal, prenasal, nasal length, gill slit width and head length for male juvenile <em>Himantura gerrardi</em>, ranges from (261-297 mm DW; n=5).</td>
<td>34</td>
</tr>
<tr>
<td>4.4</td>
<td>Morphometric measurements in percentage of DW, tail height at base of sting, mouth width, orbit diameter, interorbital, spiracle length, internasal, prenasal, nasal length, gill slit width and head length for female juvenile <em>Himantura gerrardi</em>, ranges from (254-290 mm DW; n=5).</td>
<td>35</td>
</tr>
<tr>
<td>4.5</td>
<td>Morphometric measurements in percentage of DW, Tail height at base of sting, Mouth width, orbit diameter, interorbital, spiracle length, internasal, prenasal, nasal length, gill slit width and head length for maturing male <em>Himantura gerrardi</em>, ranges from (400-476 mm DW; n=5).</td>
<td>41</td>
</tr>
<tr>
<td>4.6</td>
<td>Morphometric measurements in percentage of DW, Tail height at base of sting, Mouth width, orbit diameter, interorbital, spiracle length, internasal, prenasal, nasal length, gill slit width and head length for maturing female <em>Himantura</em></td>
<td>42</td>
</tr>
</tbody>
</table>
4.7 Morphometric measurements in percentage of DW, Tail height at base of sting, Mouth width, orbit diameter, interorbital, spiracle length, internasal, prenasal, nasal length, gill slit width and head length for adult male *Himantura gerrardi*, ranges from (478-556 mm DW; n=5).

4.8 Morphometric measurements in percentage of DW, Tail height at base of sting, Mouth width, orbit diameter, interorbital, spiracle length, internasal, prenasal, nasal length, gill slit width and head length for adult female *Himantura gerrardi*, ranges from (539-716 mm DW; n=7).
## LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure No.</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1</td>
<td>The classification of the stingrays according to (Last et al., 2010).</td>
<td>5</td>
</tr>
<tr>
<td>2.2</td>
<td>Eight diagnostic characteristics of <em>Himantura gerrardi</em>; LHXKK3, immature male (297mm DW, fresh, Kota Kinabalu, SAFMA fish market, 17th Dec 2014): A. dorsal surface; B. Nuchal area. (Scale bars: 10cm)</td>
<td>7</td>
</tr>
<tr>
<td>2.3</td>
<td>Pelvic fins and region of reproductive organs: A. LHXKK5, mature female (625mm DW, fresh, Kota Kinabalu, SAFMA fish market, 17th Dec 2014); B. LHXKK13, maturing male (476mm DW, fresh, Kota Kinabalu, SAFMA fish market, 4th Feb. 2015). (Scale bars: 10cm)</td>
<td>8</td>
</tr>
<tr>
<td>2.4</td>
<td>Geographic range of <em>H. gerrardi</em>. Adapted from &quot;<em>Himantura gerrardi</em>&quot; by IUCN, (2009).</td>
<td>11</td>
</tr>
<tr>
<td>3.1</td>
<td>Marine fish landing districts of the West Coast of Sabah (DOF Sabah, 2007).</td>
<td>14</td>
</tr>
<tr>
<td>3.2</td>
<td>Diagram of the morphometric characteristics, dorsal view.</td>
<td>19</td>
</tr>
<tr>
<td>3.3</td>
<td>Diagram of the morphometric characteristics, dorsal view of head.</td>
<td>20</td>
</tr>
<tr>
<td>3.4</td>
<td>Diagram of the morphometric characteristics, lateral view of head.</td>
<td>20</td>
</tr>
<tr>
<td>3.5</td>
<td>Diagram of the morphometric characteristics, lateral view of body.</td>
<td>21</td>
</tr>
<tr>
<td>3.6</td>
<td>Diagram of the morphometric characteristics, lateral view of the posterior end of the body.</td>
<td>21</td>
</tr>
<tr>
<td>3.7</td>
<td>Diagram of the morphometric characteristics, ventral view.</td>
<td>22</td>
</tr>
</tbody>
</table>
3.8 Diagram of the morphometric characteristics, Ventral view of the snout, nostrils and mouth.

3.9 Diagram of the morphometric characteristics, ventral view of the gill slits

3.10 Diagram of the morphometric characteristics, ventral view of the pelvic fins, and pelvic girdle (in dashed line).

4.1 *Himantura gerrardi* LHXKK6, female prenatal pulp (142mmDW, fresh, Kota Kinabalu, SAFMA fish market, 17th Dec 2014): A. dorsal surface; B. ventral surface. LHXKK21 male neonate (185 mm DW, fresh, Kota Kinabalu, SAFMA fish market, 4th Feb.2015): C. dorsal surface; D. ventral surface. (Scale bars : 10cm)

4.2 Colour variation between pulp and mother; A. Dorsal surface of female prenatal pulp LHXKK6, 142mm DW, offspring of B. mature female LHXKK5, 625mm DW. (Specimens were fresh, Kota Kinabalu, SAFMA fish market, 17th Dec 2014). (Scale bars : 10cm)

4.3 Degree of spotting from lowest to the highest. A. Dorsal surface with low degree of spotting, male neonate LHXKK21 (185 mm DW, fresh, Kota Kinabalu, SAFMA fish market, 4th Feb.2015); B. Dorsal surface showing medium degree of spots, female prenatal pulp LHXKK6 (142mmDW, fresh, Kota Kinabalu, SAFMA fish market, 17th Dec 2014); C. High degree of spotting, female prenatal pulp LHXKK 19 (172mm DW, fresh, Kota Kinabalu, SAFMA fish market, 4th Feb. 2015).(Scale bars : 10cm)

4.4 Nuchal area of *Himantura gerrardi* : A. Prenatal female pulp LHXKK19 (172 mm DW, fresh, Kota Kinabalu, Safma fish market, 4th Feb. 2015); B. Female neonate LHXKK20 (192mm DW , fresh, Kota Kinabalu, SAFMA fish market, 4th Feb. 2015)
4.5 Himantura gerrardi LHXKK3, immature male (297mm DW, fresh, Kota Kinabalu, SAFMA fish market, 17th Dec 2014): A. dorsal surface; B. ventral surface. (Scale bars: 10cm) LHXKK18 (418 mm DW, fresh, Kota Kinabalu, Safma fish market, 4th Feb. 2015).

4.6 Degree of Himantura gerrardi: A. Adult male LHXKKVIII, Few spots; tail removed (556mm DW, fresh, Kota Kinabalu, Safma fish market, 31st Jan. 2015); B. Adult female LHXKKIII, Medium degree of spot; tail removed (573mm DW, fresh, Kota Kinabalu, Safma fish market, 28th Jan. 2015); C. Adult female LHXKKV, tail damaged (550mm DW, fresh, Kota Kinabalu, Safma fish market, 31st Jan. 2015).

4.7 Nuchal area of Himantura gerrardi, Stage 1: A. Immature male LHXKK9 (264mm DW, 2nd Feb 2015); B. Immature female LHXKK12 (254mm DW, 2nd Feb 2015). Stage 2: C. Immature male LHXKK3 (297 mm DW, 17th Dec. 2014); D. Immature female LHXKK4 (290mm DW, 17th Dec. 2014); Male: A and C. Female: Band D. All fresh, from Kota Kinabalu, SAFMA fish market.

4.8 Himantura gerrardi LHXKK13, maturing male (297mm DW, fresh, Kota Kinabalu, SAFMA fish market, 17th Dec 2014): A. dorsal surface; B. ventral surface. (Scale bars: 10cm)

4.9 Degree of spotting from lowest to the highest according to gender. Low degree of spotting: A. Maturing male LHXKK16 (449mm DW, 4th Feb. 2015); B. Maturing female LHXKK17 (421mm DW, 4th Feb 2015). Medium degree of spots: C. maturing male LHXKK18 (418mm DW, 4th Feb 2015); D. maturing female LHXKKVXVI (386mm DW, 7th Apr 2015). High degree of spotting: E. Maturing male LHXKK13 (476mm DW, 4th Feb. 2015); F. Maturing female LHXKKXIII (300mm DW, 7th Apr. 2015). Maturing male: A, C, and E. Maturing female: B, D, and F. All specimens are fresh, from Kota
4.10 Nuchal area of *Himantura gerrardi*: A. Early stage 4 denticle developments, maturing female LHXKKXV (366mm DW, fresh, from Kota Kinabalu, SAFMA fish market, 7th Apr. 2015). B. Mid-stage 4, denticle development, Maturing male LHXKK18 (418 mm DW, fresh, Kota Kinabalu, Safma fish market, 4th Feb. 2015).

4.11 *Himantura gerrardi* LHXKKS, mature female (625mm DW, fresh, Kota Kinabalu, SAFMA fish market, 17th Dec 2014): A. dorsal surface; B. ventral surface. (Scale bars: 10cm)

4.12 Elongated spots of “C” and “O” shape found on the dorsal surface of mature female LHXKKV (550mm DW, 31st Jan. 2015, fresh, from Kota Kinabalu, SAFMA fish market)

4.13 Degree of spotting from lowest to the highest according to gender. Low degree of spotting: A. mature male LHXKXVIII (556mm DW, 31st Jan. 2015); B. Mature female LHXKKX (624mm DW, 31st Jan. 2015). Medium degree of spots: C. Mature male LHXKXI (502mm DW, 2nd Feb 2015); D. Mature female LHXKK5 (625mm DW, 17TH Dec. 2014). High degree of spotting: E. Mature male LHXKKVI (478mm DW, 31st Jan. 2015); F. Mature female LHXKKV (550mm DW, 31st Jan. 2015). Mature male: A, C, and E. Mature female: B, D, and F. All specimens are fresh, from Kota Kinabalu, SAFMA fish market. (Scale bars : 10cm)

4.14 Nuchal area of *Himantura gerrardi*: A. Late-stage 4, denticle band development, mature female LHXKK5 (625mm DW, fresh, from Kota Kinabalu, SAFMA fish market, 17th Dec. 2014)
LIST OF SYMBOLS AND ABBREVIATIONS

%  percentage
°  degree
cm  centimetre
mm  millimetre
g  gram
DW  Disc width
ca.  Circa
CHAPTER 1

INTRODUCTION

1.1 STINGRAYS

Stingrays are classified under the order Myliobatiformes, Family Dasyatidae (Aschliman et al., 2012). They are usually found endemic in the sub-tropical and tropical areas, taking over the roles of the skates from colder regions (White & Sommervile, 2010). Stingrays are rays that have venomous stings present on its tail. The number of sting varies from 1 to 4 according to the species (Moyle & Cech, 1996). Stingrays that have whip-like tails, slender longer tails, and have no caudal fins are grouped into the family Dasyatidae (Compagno, 1999; Last et al., 2010).

The genus *Himantura* is the largest member of the family Dasyatidae, known as the Whiprays. A majority of the *Himantura* species are distributed in the Indo-West Pacific region (White & Sommervile, 2010). This genus was described by Müller and Henle in 1837. The diagnostic characteristic of the *Himanura* are: the absence of tail fin-folds and absence of long sharp thorns at the sides of the disc (Last et al., 2010; Lovejoy, 1996). This genus is studied intensely among taxonomist today due to the complexity and confusion of classifying and identifying the species within its members (Arlyza et al., 2013).

Members of *Himantura* that have reticulated, spotted, and oscillated colour patterns can be grouped into a subcategory known as 'Uarnacoides' species complex as suggested by Manjaji (2004) in Last et al. (2008). *Himantura gerrardi* is a member of the 'Uarnacoides' species complex, alongside with 7 other sister species which are: *H. astra* Last, Manjaji-Matsumoto and Pogonoski (2008), *H. fai* (Jordan and Seale,
1906), *H. jenkinsii* (Annandale, 1909), *H. leoparda* Manjaji-Matsumoto & Last, 2008, *H. toshi* Whitley, 1939, *H. uarnak* (Frosskal, 1775), *H. undulata* (Bleeker, 1852), and 3 other undescribed species (Last et al., 2012). Furthermore, because the “Uarnacoides” species complex has almost similar growth stages and because they have almost similar morphology, *H. gerrardi* are often confused with its sister species, especially with the *H. uarnak* a reticulated whipray (Last et al., 2008).

### 1.1.1 *Himantura gerrardi*

This species was first described by Gray in 1851, it is widely distributed in the Indo-West Pacific region, the Eastern Indian Ocean, and the Northwest Pacific and Central West Pacific regions, caught by hook and line, and trawlers (Manjaji-Matsumoto et al., 2009). It is generally utilised as food protein sources, and its skin is used for leather (Last et al., 2010).

The classification of *H. gerrardi*:

- **Kingdom**: Animalia
- **Phylum**: Chordata
- **Class**: Chondrichthyes
- **Order**: Myliobatiformes
- **Family**: Dasyatidae
- **Genus**: Himantura
- **Species**: *Himantura gerrardi*

The common English name for the *H. gerrardi* is the Whitespotted Whipray, and Banded Whiptail Ray. In the Malay language it is known as “Pari Bintik Putih”, and “Pari Batik” in Malaysia; “Pari Bintang”, “Pari Batu”, and “Pari Super” in Indonesia (Last et al., 2010).
1.2 OBJECTIVES

This study aims to investigate the possible species variation of the *H. gerrardi* species complex by observing the morphological features.

1. To obtain morphometric and meristic data of the Whitespotted Whipray *H. gerrardi* collected.
2. To compare the colour variation between female and male, and between the four life stages (embryo, juvenile, adolescent, mature) of the Whitespotted Whipray.

1.3 HYPOTHESIS

The hypothesis of this study is:

Meristic data (i.e. the variation and degree of spotting and squamation) in Whitespotted Whiprays reflect dimorphic and ontological characteristics, and give useful insight to the *H. gerrardi* species complex whilst the morphometric data is less useful due to overlapping values.

1.4 SIGNIFICANCE OF STUDY

This work may contribute towards the conservation of the sharks and rays in Malaysia. The present study is able to help provide taxonomic knowledge in species identification. The results of this study will also provide morphological information and range of the study species for future studies. The results obtained may provide a useful insight into the problem of 'Uarnacoides' species complex.
CHAPTER 2

LITERATURE REVIEW

2.1 PHYLOGENY AND TAXONOMY OF STINGRAYS

The stingrays (family: Dasyatidae) are classified into the order Myliobatiform alongside with seven other families: Gymnuridae (butterfly rays), Hexatrygonidae, Mobulidae (Manta rays), Myliobatidae (eagle rays), Platyrrhinidae, Plesiobatidae, Potamotrygonidae (river stingrays), Urolophidae, Urotrygonidae, and Zanobatidae (Frisk, 2010). The interrelationship between the Myliobatiformes members was broadly charted by Lovejoy (1996). He found that both the genus Hirnantura and Dasyatis are non-monophyletic, this findings were similar with the research done by Rosenberger (2001) in (Aschliman et al. 2012). Lovejoy (1996) suggests that the basal clades for the Myliobatiformes are Hexatrygon, Plesiobatids, and Urolophus. Furthermore, he grouped the members of this order into 3 major clades, where the amphi- American Hirnantura and the Indo-West Pacific Himantura are of different clades.

The Dasyatidae family is generally characterised by its slender tail, the presence of the poisonous sting on its tail and the absence of dorsal and caudal fins on its tail (Compagno, 1999; Yano et al., 2005; Last et al., 2010). The sting is an adaptation of the placoid scale as the spine contains a venom gland at its base (Moyle & Cech 2004). The stingrays generally whips its tail to sting its predators due to defence, they do not sting unless threatened (Moyle & Cech 2004). Moreover members in this taxa, has no dorsal or caudal fin. In addition to the features illustrated, members with no skin fold on the tail and no sharp thorns on the sides of the disc (Compagno, 1999; Yano et al., 2005; Last et al., 2010) are further classified
into the genus *Himantura*. The taxonomic classification of the stingrays can be seen in Figure 2.1.

![Diagram showing the classification of stingrays]

**Figure 2.1** The classification of the stingrays according to (Compagno, 1999; Moyle and Cech, 2004).

The *Himantura* was first described by Müller and Henle in 1837 (Manjaji and Last, 2006). Over the recent years, this genus has been studied intensely and has gained much attention from taxonomist, due to the presence of a taxonomically confusing group occurring within this genus (Arlyza et al., 2013). Four new species were recently described (Last et al., 2006; Manjaji & Last, 2006; Last et al., 2008; Last et al., 2012).
2.1.1 The Uarnacoides species complex

Members of the Indo-West Pacific *Himantura* with oscillated, spotted and reticulated colour patterns on its body, are categorized under the "Uarnacoides" species complex (Last et al. 2006). The complex comprise of 7 species which are *H. fai* (Jordan and Seale, 1906), *H. jenkinsii* (Annandale, 1909), *H. leoparda* Manjaji-Matsumoto & Last, 2008, *H. toshi* Whitley, 1939, *H. uarnak* (Frosskal, 1775), *H. gerrardi* (Gray, 1851), *H. undulata* (Bleeker, 1852). In 2008 Last, Manjaji- Matsumoto and Pogonoski divided *H. toshi* and introduced a new species *H. astra*, furthermore among the 3 of the undescribed species, one of the species has now been identified and known as *H. randalli* (Last et al., 2012).

There are 6 basic methods to aid in the taxonomic studies: (1) morphometric measurement, (2) meristic trait, (3) anatomical characteristics, (4) colour patterns, (5) karyotypes, (6) biochemical (genetic) characteristics. Members of this taxonomically complex group are constantly confused among each other, because it has similar morphology and the juvenile growth stages are similar (Last et al., 2008). Others suggested species hybridization, although this idea is speculated as rare based on the fact that elasmobranch fertilization is internal and possible interspecific matching difference between male clasper and female urogenital sinus. In addition, they justify that meristic data such as spotting patterns can be used to differentiate two cryptic species (Arlyza et al., 2013).

Two cryptic species have been successfully distinguished as a new species *H. astra*, which was previously known to be a synonym of *H. toshi* (Last et al., 2008). Though molecular data was not available, the new species was able to be distinguished based on comparing the morphological data and the distribution between both species. *Himantura randalli* which was previously misidentified as *H. gerrardi* was re-identified and distinguished based on both morphological data and molecular techniques (Last et al., 2012). *H. gerrardi* (Whitespotted Whipray) which was first discovered by Gray in 1851, seems to be similar where it might be a cryptic species, the existence of "*H. cf gerrardi*" (Borneo Whitespotted Whipray) shows this possibility, but there is still a gap of knowledge to prove that it is a different species than that of Gray's (1851) (Manjaji- Matsumoto et al., 2009; Last et al. 2010).
2.1.2 External Morphology of *Himantura gerrardi*

*Himantura gerrardi* have eight diagnostic characteristics, (1) a clear alternating dark and light bands along the tail to tail tip, (2) only one sting and situated at the anterior part of the tail, (3) no skin folds on the tails, (4) tails are longer than the length of the disc, (5) dorsal surface white spots are present, the white spots are regularly distributed, largest to the smallest from the posterior to the anterior of the disc, (6) central disc are usually 1-5 small suprascapular denticles, (7) the granular denticles are usually closely packed, (8) the disc is quadrangular in shape (figure 2.2) (Last et al., 2010).

![Figure 2.2](image)

**Figure 2.2** Eight diagnostic characteristics of *Himantura gerrardi*; LHXKK3, immature male (297mm DW, fresh, Kota Kinabalu, SAFMA fish market, 17\textsuperscript{th} Dec 2014): A. dorsal surface; B. Nuchal area. (Scale bars: 10cm)

2.2 BIOLOGY OF THE WHITESPOTTED WHIPRAY

2.2.1 Size and Age

The stingrays is measured by the disc width (DW), the disc width determines the size class of the individual and its maturity stage. The partiality in the calcification of the claspers of the male stingrays shows that it is an immature individual whereas...
mature individuals have fully calcified claspers (White & Dharmadi, 2007). Moreover, the sex of the stingrays is determined based on the male and female reproductive organ. The male have claspers in the shape of cylinder formed at their pelvic fins, it is use for internal fertilization, female lacks the presence of clasper (figure 2.3) (Compagno, 1999).

Figure 2.3 Pelvic fins and region of reproductive organs: A. LHXKK5, mature female (625mm DW, fresh, Kota Kinabalu, SAFMA fish market, 17th Dec 2014); B. LHXKK13, maturing male (476mm DW, fresh, Kota Kinabalu, SAFMA fish market, 4th Feb. 2015). (Scale bars: 10cm)

White & Dharmadi (2007) found that H. gerrardi, males mature at 481mm (480 - 492mm DW) base on the calcification of the claspers. While female mature range was found to be 644 – 848mm. Width of birth of the embryo is in the range of (180 – 210 mm). H. cf gerrardi female range was undetermined; while male mature at 591mm (521 - 626mm DW) base on the calcification of the claspers. Though members of the Himantura gerrardi are able to grow up to 1000mm DW, but the average DW hardly exceeds 850 mm. Mature males are >480 mm DW (White & Dharmadi, 2007), mature females are >540mm DW (mature at 540 mm DW) (Manjaji et al., 2009). Maturing adolescent males are individuals within the 410-480 mm DW range while females are in the 410-540 mm. Female and male juveniles are about 220-400 mm DW and the embryos are individuals directly taken out of the mother's womb (180 – 210 mm) (Manjaji-Matsumoto et al., 2009; Last et al., 2010).
REFERENCE


