THE REPRODUCTIVE DEVELOPMENT OF THE LARGE WRASSES

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THIS THESIS IS PART OF THE
REQUIREMENTIN OBTAINING THE DEGREE IN BACHELOR OF SCIENCE
(*Hons.*)

CONSERVATION BIOLOGY
SCHOOL OF SCIENCE AND TECHNOLOGY
UNIVERSITI MALAYSIA SABAH

MARCH 2005

PUMS 99:1

UNIVERSITI MALAYSIA SABAH

BORANG PENGESAHAN STATUS TESIS@

JUDUL: THE REPRODUCTIVE DEVELOPMENT OF LARGE WRASSES.

Ijazah: SARJANA MUDA SAINS BIOLOGI PEMULIHARAAN

SESI PENGAJIAN: 2002/2003

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DECLARATION

I hereby declare that the work in this project is of my own except for the quotations and summaries from the references which have been fully acknowledged.

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ACKNOWLEDGMENTS

I am grateful to Associate Professor Dr. Annadel S. Cabanban of the Borneo Marine Research Institute for her guidance in the conduct of this Project and providing the funds of her grant from the World Wide Fund for Nature-Malaysia for the cost of the field work. I am thankful to Mr. Tay Kean Boon and Ms. P'ng Huey Juin, and the team members of Greenforce (period) because this study could not have been completed without the support and encouragement. I also thank Dr. Yukinori Mukai who taught me the histology technique and contributed the chemical for the histological examination. I would like to thank Mr. Ismail Tajul and Mrs. Doreen @ Roslind Juhan, laboratory assistants at the Borneo Marine Research Institute and at the School of Science and Technology, for providing all the support during the laboratory procedures in the conduct of this study.

ABSTRACT

Biological information for large, hermaphroditic wrasses (Labridae) are very limited although populations of these species are exploited sustenance for the market. Large wrasses, such as *Choerodon anchorago, Cheilinus trilobatus, Choerodon schoenleinii* and *Hemigymnus melanopterus*, although not highly important commercially as Napoleon wrasse, *Cheilinus undulatus*, were found in the market of Kudat District. Samples of these large species were collected from Kudat fish market from middle of August 2004 to end of November 2004 to gather information on some aspects of growth and reproduction of these species. Measurements of length and weight of otolith, gonad, and body were made and gonadal examination was made for sex and stage of maturation of *C. anchorago*. These were gathered to get information on the growth of these species and to attempt in testing the hypotheses that maturation of fishes is 50 % of the maximum length and that sex reversal occurs at 80 % of the maximum length. The linear correlation is found for the length-weight relationship between the otolith length and standard length for *C. anchorago* ($R^2 = 0.668$) and *C. trilobatus* ($R^2 = 0.273$). The large wrasses are found to be protogynous hermaphrodites, where individuals change sex from female to male like other labrids. For expected (i.e., < 50 % of maximum length and 80 % of maximum length); maturation of *C. anchorago* was found at size 14.5 cm, *C. trilobatus* in size 13.9 cm and *H. melanopterus* matured at size more than 24 cm. The maturity of *C. schoenleinii* cannot be determined because limitation of samples and resources. These findings on maturation and sex reversal on *C. anchorago, C. trilobatus* and *H. melanopterus* indicate that fishing pressure is causing an adaptive change in these populations. For further studies, more samples, are needed to confirm these initial findings.

ABSTRAK

Maklumat biologi tentang wrasse (Labridae) yang besar, hermafodik adalah terhad walaupun populasi spesies ini diekploitasi sebagai sumber makanan dalam pasaran. Wrasse yang besar termasuklah *Choerodon anchorago, Cheilinus trilobatus, Choerodon schoenleinii* dan *Hemigymnus melanopterus* tidak begitu penting dalam dagangan seperti Napoleon wrasse, *Cheilinus undulatus* tetapi boleh dijumpai di pasar yang terletak di Daerah Kudat. Sampel bagi spesies besar ini dikumpul daripada pasar ikan di Kudat dari pertengahan Ogos 2004 hingga ke akhir November 2004 untuk mendapatkan maklumat tentang pertumbuhan dan reproduktif spesies berkenaan. Pengukuran panjang dan berat dalam otolik, gonad dan badan dilakukan dan pemeriksaan gonad dalam penentuan seks dan peringkat kematangan untuk *C. anchorago*. Kaedah ini dilakukan untuk pengumpulan maklumat pertumbuhan spesies dan percubaan dalam hipotesis di mana kematangan ikan adalah 50 % daripada saiz maksimum dan perubahan seks berlaku dalam 80 % daripada panjang maksimum badan. Kolerasi lurus telah dijumpai bagi perhubungan panjang-berat antara panjang-otolik dan panjang-badan bagi *C. anchorago* (R^2 = 0.668) dan *C. trilobatus* (R^2 = 0.273). Wrasse yang besar ini dijumpai sebagai hermafoditik protogenus di mana individu mengubah seks daripada betina ke jantan menyerupai labrid yang lain. Data yang diperolehi bagi spesies ini dalam kematangan dan perubahan seks menunjukkan kemunculan individu yang lebih kecil daripada jangkaan (contoh, panjang maksimum kurang daripada 50 % dan 80 %) di mana kematangan *C. anchorago* dijumpai dalam saiz 14.5 cm, *C. trilobatus* dalam saiz 13.9 cm dan kematangan *H. melanopterus* adalah lebih daripada 24 cm. Kematangan bagi spesies *C. schoenleinii* tidak boleh diperolehi disebabkan sampel dan sumber yang terhad. Maklumat yang diperolehi tentang kematangan dan perubahan seks bagi *C. anchorago, C. trilobatus* dan *H. melanopterus* menunjukkan bahawa tekanan perikanan telah menyebabkan perubahan adaptasi populasi ini. Kajian lanjutan dengan menggunakan sampel lebih banyak diperlukan untuk memastikan pencarian awal ini.

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LIST OF ABBREVIATIONS

AO	American optical
ao	Atretic vitellogenic oocytes
bb	brown bodies
BG	body girth
BW	body weight
cm	centimeter
cns	chromatin nucleolus
css	central sperm sinus
D	distal
dss	dorsal sperm sinus
eps	early perinucleolus
g	gram
GSI	gonadosomatic index
hy	hydrated oocytes
i.e.	example
IUCN	World Conservation Union
la	lamellae still female in shape
lps	late preinucleolus
M	medial
mns	migratory nucleus stage
OE	over-exploitation
oo	oogonia
P	proximal
SL	standard length
sp.	species

st	spermatids
sz	spermatozoa
UE	under exploitation
vac	vacuoles
yg	early and late yolk globule
yv	yolk vesicle
%	percent
<	less than
>	more than
√	exist
?	status not available source
&	and
°C	degrees centigrade
I	stage one
II	stage two
V	stage four
IV	stage five
VI	transitional stage
μm	micrometer

CHAPTER 1

INTRODUCTION

1.1 BACKGROUND

Basic biology of coral reef fishes is important in conservation of exploited fish populations. However, very little is known about important a species of biology, particularly reproductive biology of coral reef fishes. Thus, only a few authors have investigated the reproductive biology of temperate labrids (Gillanders, 1995). This is probability because of the lack of commercial value of these species; basic aspects for studies on reproductive biology have received no attention. For an example, no published information is known on the factors influencing sex reversal in the genus *Choerodon*. Therefore, little is known of the life history of members of this genus (Platten *et al.*, 2002). Although a number of studies have been carried out on the biology of some of these species, they have concentrated mainly on aspects such as sex inversion, reproduction, parental care, social behavior, parasites and in depth studies of its mating system (Gordoa *et al.*, 2000). However, there are few records of the size which natural sex change occurs for some of the coral reef fishes. There are no records of the size when natural sex changes occur in the coral reef fishes such as potato grouper, *Epinephelus tukula* (Yeh *et al.*, 2003).

The study of the reproductive biology of coral reef fishes is important so that fisheries managers will be able to institute regulations to ensure the sustainable use of resource. Coral reef fish populations provide sustenance and income to coastal village (Koh *et al.*, 2002). It also contributes to the economy of state and country. For example, Sabah exports to Hong Kong coral reef fishes, particularly groupers and wrasses, for the live fish trade (Johannes and Riepen, 1995). It is important to know the biology and ecology of commercially important fishes, such as coral reef fishes to provide the scientific information for biological regulations.

Sabah is the principal source of coral reef fishes in Malaysia because a location central to the geographic range of the species with habitat suitable for the species where contains 75 % of all Malaysian reefs (Burke *et al.*, 2002). In Sabah, most of the research has been done on the conservation and management to maintain the biomass of large marine organisms and genetic biodiversity. Therefore, less of detailed research has been carried out for the reproductive biology of coral reef fishes. Research in the reproductive biology of coral reef fishes should be carried out because declining size of large fishes occurs nowadays cause of the impact of over-fishing has made the large coral reef fishes either disappear or become very rare. While this issue is critical because the impact of human activity may lead the fish shunted toward maturation at early ages or become smaller sizes.

Basically, published studies on the large wrasses biology and ecology are limited. This is because most of the studying has been done for the largest fish species such as Napoleon wrasse because it is category in the World Conservation Union (IUCN) Red List. Therefore, the four large most common species of wrasses are selected for the present study such as *Cheilinus trilobatus, Choerodon schoenleinii, Choerodon anchorago* and *Hemigymnus melanopterus* because it is commonly find in the fish market in Kudat, Sabah. This town is chosen because it is known to many large purchasers as second the major supplier of coral reef fishes for the live food fish trade.

1.2 OBJECTIVES

The purpose of the study is to know the reproductive biology of large wrasses in Kudat, Sabah. The second objective is to determine whether large wrasses change sex. The final study of the project is to gather information of the relationship of length-weight and otolith length to standard length (SL) of fishes as the fishes mature.

CHAPTER 2

LITERATURE REVIEW

2.1 REPRODUCTIVE BIOLOGY OF CORAL REEF FISHES

Coral reefs fishes show an extreme variety of sex determination and differentiation patterns in marine environment. Thus, studies have shown that most of the coral reef fishes exhibit sequential hermaphroditism (Warner, 1984) where most of the fish are born one sex and change sex sometime during the course of life. However, two patterns in sequential hermaphroditism were protandry where sex change from male to female meanwhile protogynous was from female to male. Beside that, some coral reef fishes were generally as gonochorists which the species functions as only and male or female throughout their life time.

Few authors have studied the growth patterns of female and male in protogynous hermaphroditic species (Dipper *et al.*, 1977) where functional protogynous is commonly observed in coral reef fishes (Kuwamura and Nakashima, 1998). Basically, protogynous is the species function as females first and later in life change sex as males, but never occur at both sexes at the same time (Sadovy and Shapiro, 1987). Therefore, the sex pattern for protogynous hermaphroditism was in great quantity for the coral reef fishes such as the family Labridae was one of the best studied group of fish compared with other (Gillanders, 1995). Godwin *et al.* (2003) noted that changing sex from male to female (protandry) was rare in fishes, it has documented only in anemonefishes. Basically, sequential hermaphroditism was the most widely accepted evolutionary example of the adaptive significance of sex change (Warner, 1988).

2.1.1 Behavioral Control of Sex Change

The presumed evolutionary advantage of sex change is increased reproductive opportunity on spawning grounds (Shapiro, 1983). Basically, sex change of the fishes was investigated by the social and temperature factors.

a. Social control

Sex change for tropical coral reef fishes is best known as sociodemographically controlled. For example, sex change in two coral reef fish species which was controlled by social influenced was described in the early 1970. Therefore, sex determination that is controlled by social interactions can occur before or after sexual maturation. This sex determination by social influence in fish is best known for the understanding the examples of sexual ability (Godwin *et al.*, 2003).

In most cases, removal of dominant individuals from social groups or housing potential sex changers will cause induced sex change in the population. This has been shown that the number of female *Thalassoma bifasciatum* changing sex closely matched the number of large males which have been removed (Warner and Swearer, 1991). Thus, socially controlled showed that removal of males from haremic groups of *Anthias squamipinnis* induced female to male sex change in the largest female (Fishelson, 1970). Meanwhile, similarity also found in the cleaner wrasse *Labroides dimidiatus* where sex change from largest female to become male within a short period (Robertson, 1972). Since this studies proposed, it has become clear the functional sex change is common in several families of fishes common on coral reefs.

b. Temperature control

Fewer research has been done on temperature control of fishes in sex determination ever thought it is recognized as a part of species life history. For temperate control, selection will be favour for males in a situation where an individual find itself in a sufficient environment to become a below average female or an above average male because it can pass on more of its genes than female (Charnov and Bull, 1987). Particularly, sex change may occur in freshwater species at a genetically in size or age or may be brought by changes in temperature or photoperiod.

The mortality of captive wrasse was high in winter because inability to cope with low temperature. Sayer and Reader (1996) have shown the distinct differences in the ability of the three wrasse, goldsinny, rock cook and corking wrasse to survive in such temperature. During winter, rock cock went into the deep crevices and become inactive (Sayer *et al.*, 1994). However, corking wrasse was more active because they were captured in trawls throughout the winter near the shallow area.

2.1.2 Spawning Behavior

Spawning can occur in groups or in pair which mostly depending on the species. However, in some species both pair and group spawning can be found. Spawning patterns of coral reef fishes have been documented from various points of view according on the ecological resources (Jan, 2000). Thus, the studies have shown complex spawning systems have been found in reef fishes. Beside that, various hypotheses have been proposed to explain the occurrence of various spawning patterns was cause by natural selection (Jan, 2000). However, only few of the hypotheses have been accepted.

Many species of fish aggregate to spawn and many of the coral reef fishes show this habit. Particularly, tropical fish associated with coral reefs aggregate at specific times and locations to spawn. However, spawning aggregations of fishes are influenced by season, lunar phase and temperature and commonly form at traditional spawning sites. For example, spawning behavior of the Nassau grouper was different between gag and red hind because the Nassau grouper (*Epinephelus striatus*) spawns in very large aggregations for only a few weeks of the year (Colin, 1992) meanwhile gag

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