SEX DETERMINATION AND GONAD MATURATION OF HUMPHEAD WRASSE, *Cheilinus undulatus* IN CAPTIVITY

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ABSTRACT

The aim in this present study was to identify the sex and gonad maturation of humphead wrasse, *Cheilinus undulatus* in captivity based on body sizes and histological assessment. A total of 65 tails *C. undulatus* broodfish were reared in 150 tonnes cylindrical fiber-reinforced plastic (FRP) tanks with water circulation system throughout six months. *C. undulatus* were fed until satiation once daily, six times a week with prey fish (*Sardinella* sp.) enriched with 0.1 ml pure cod liver oil and squid. Growth parameters and morphological measurement, such as presence of eyeline, shape of genital papillae and hump on head, of the *C. undulatus* as well as observation on gonad maturation were carried out. This finding reveled in captivity, female of *C. undulatus* (n=13) attained an average body weight of 2.78 kg and total length 47.10 cm meanwhile male of *C. undulatus* attained larger body weight (14.62 kg) and total length exceeding size of female (89.30 cm). A total of 51 tails of *C. undulatus* were not be identified sex with average body weight and total length were recorded as 2.75 kg and 45.90 cm, respectively. The length-weight relationship showed that *C. undulatus* performed an isometric growth pattern (b = 2.9487) with condition factor of 0.23 and 0.24 for male and female, respectively. Morphologically, female was identified with the alleviation of the hump on its head and the visibility of eyeline behind its eyes which was not seen in male *C. undulatus*. Histological observation on gonad had confirmed the sex of the female of *C. undulatus* with the presence of primary-growth stage oocytes (O1), cortical-alveolus stage (O2) and vitellogenic stage (O3) was discovered in mature active female. On the other hand, only primary-growth stage oocytes (O1) was detected in another sampled of female *C. undulatus*. Unfortunately, no gametes were obtained from male and unknown sex of *C. undulatus* for further examination. In conclusion, sex of *C. undulatus* in captivity can be differentiated through body size and morphological features, thus brood fish management can be done effectively in future.

ABSTRAK

Penentuan jantina dan kematangan gonad Mameng, Cheilinus undulatus di dalam kurungan

Tujuan penyelidikan ini adalah untuk mengenal pasti jantina dan kematangan gonad ikan mameng, Cheilinus undulatus berdasarkan berat badan dan panjang keseluruhan ikan. Sejumlah 65 ekor induk mameng diternak dalam tangki bertetulang gentian berkapasiti 150 ton dalam sistem kitaran air sepanjang penyelidikan selama enam bulan. Induknya diberi makan sehingga cukup sehari sekali, dan enam kali seminggu dengan ikan kecil (Sardinella sp.) yang diperkaya dengan 0.1 ml minyak ikan kod dan juga sotong. Pertumbuhan parameter, pengukuran induk ikan seperti garisan memanjang di mata, bentuk dan benjolan di kepala dan pemerhatian terhadap pematangan gonad telah dijalankan. Hasil yang didapati adalah ikan betina C. undulatus (n=13) mencapai purata berat badan 2.78 kg and purata panjang keseluruhan 47.10 cm manakala ikan jantan pula mencapai berat badan (14.62 kg) dan jumlah kepanjangan (89.30 cm) melebihi ikan betina. Ikan yang selebihnya sebanyak 51 ekor tidak dapat dikenalpasti jantina dengan purata berat badan dan panjang keseluruhan yang dicatat masing- masing adalah sebanyak 2.75 kg dan 45.90 cm. Perkaitan panjang dan berat menunjukkan pertumbuhan isometric (b= 2.9487) dan faktor kondisi ikan masing- masing untuk ikan jantan dan betina adalah 0.23 dan 0.24. Dari segi luaran, ikan betina boleh dikesan dengan kebenjolan bonggol di kepala ikan dan garisan memanjang di mata ikan di mana tidak terdapat pada ikan jantan. Pemeriksaan histologi gonad ikan juga mengesahkan jantina ikan tersebut dan peringkat awal oosit utama (O1), peringkat alveoli-kortikal (O2) dan peringkat vitelogenik (O3) telah dikesan di ikan betina yang matang dan aktif. Sebaliknya, hanya peringkat awal oosit utama (O1) dikesan pada ikan betina yang matang tetapi tidak aktif. Akan tetapi, tiada gamet dapat diperoleh dari ikan jantan dan ikan yang tidak diketahui jantina untuk pemeriksaan selanjutnya. Sebagai kesimpulan, jantina C. undulatus yang diternak dapat dibezakan dari berat badan dan ciri-ciri luaran dan seterusnya meningkatkan keberkesanan dalam pengurusan induk ikan.

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LIST OF ABBREVIATIONS

%	percentage
µm	micrometer
BW	body weight
TL	total length
DO	dissolved oxygen
FAO	*Food and Agriculture Organisation*
FRP	fiberglass reinforced plastic
g	gram
kg	kilogram
mg	milligram
mL	milliliter
mm	millimeter
cm	centimeter
°C	degree celcius
pH	potantra of hydrogen (power of hydrogen)
kj	kilojoule
/	litre
SGR	specific growth rate
h	hour
HDPE	high density poly ethylene
IU	international unit

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CHAPTER 1

GENERAL INTRODUCTION

Figure 1.1: Adult Humphead Wrasse, *Cheilinus undulatus*

1.1 Status of Humphead Wrasse, *Cheilinus undulatus*

Humphead wrasse is scientifically known as *Cheilinus undulatus*, while the common names are Moari wrasse, Napoleon fish, "Somoi" in Chinese, and also called "Mameng" in Malay (FAO, 2004). It is well known as the world's largest member in Labridae family, and its maximum size could be exceeded 2m in total length and 190kg in body weight (Donaldson, 1995; Donaldson & Sadovy, 2001; FAO, 2007).

Humphead wrasse are sedentary where it can be spotted in many commercial dive sites and thus making it as a favourite species for divers in many areas (FAO, 2010). The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) Appendix II (Russell, 2004) has listed humphead wrasse as the first coral reef fish been endangered. Therefore, in order to export humphead wrasse, the volume of export needed to be determined whether it will detrimental to the survival of this species (FAO, 2004).

Humphead wrasse is widely distributed in the range of entire Indo-Pacific region starting from the Middle East to Africa, also to the Southeast Asia and Pacific (Letourner *et al.*, 1998; Donaldson & Sadovy, 2001; Sadovy *et al.*, 2003, FAO, 2007). Despite of its distribution, it is not common or rarely to be found exceeding 20 fish per 10,000 m^2 for the adult fish (Donaldson & Sadovy, 2001; Sadovy *et al.*, 2003; FAO, 2007).

Parallel to its availability, humphead wrasse has been known as one of the expensive fish which can costs up to RM350 to RM500 per kg (Lee & Sadovy, 1998; Sadovy *et al.*, 2003) and RM 350 per kg at the current price in seafood restaurant borneo FAO (2011) reported that humphead wrasse was traded at a preferred market size of 0.5 to 1 kg. Due to its excellent taste, humphead wrasse is sought after throughout Southeast Asia, especially in Hong Kong and Singapore where the world's largest seafood industry located. In addition to its role in the live reef food fish trade, the humphead wrasse is valued for several reasons, especially for local food and for its role in dive tourism (Gillett, 2010).

According to Sadovy *et al.* (2003), Hong Kong had been one of the major global importers for the live reef fish trade for humphead wrasse since it offers the

highest price among all fishes in the trade also imported both for local consumption as well as for transhipment to mainland China. Indonesia, Malaysia and Philippines were the major exporter countries of humphead wrasse (Sadovy *et al.*, 2003). In the year of 2000 until 2006, the total international live trade for this species were recorded ranged from about 58 to 138 tonnes (FAO, 2010) and it is undoubtedly has increased annually. This indicates the popularity as well as the potential of this species as aquaculture candidate.

1.2 Reproduction of Humphead Wrasse, *Cheilinus undulatus*

Generally, the adults of humphead wrasse are blue-green with large scales and a yellow posterior margin to the caudal fin, small individuals are pale with black markings (Donaldson & Sadovy, 2001). It has a thick, fleshy lips and a hump that forms in its head above the eyes becoming more prominent as the fish ages. The male humps appear bright electric blue to green, a purplish blue or relatively dull blue or green (FAO, 2004).

These humphead wrasse inhabit in a well-established coral reef area (Sadovy *et al.*, 2003). Larger humphead wrasse are mainly found on outer or deep reefs, steep slopes, either singly or in small groups, while small individuals are typically associated with high coral cover (Letourner *et al.*, 1998; Donaldson & Sadovy, 2001; Donaldson & Sadovy, 2001; Sadovy *et al.*, 2003; FAO, 2007). According to Sadovy *et al.*, (2003), the total reef area suitable for humphead wrasse was 11 892 km^2 in Indonesia, 941 km^2 in Malaysia and 5 254 km^2 in Papua New Guinea, however the previous estimates available of reef areas were only 50 875 km^2 and 4 006 km^2 in Indonesia and Malaysia, respectively (Burke *et al.*, 2002).

Humphead wrasse preys on crustaceans, mollusks, fish also toxic animals, and it possess a rare and remarkable immunity to the toxic spines on thorns starfish, boxfish and sea hares (FAO, 2010). This species were often observed in solitary male and female pairs or groups of two to seven tails. This species is known to be long-lived but have low replacement rates (Donaldson & Sadovy, 2001; Sadovy *et al.*, 2003; FAO 2007).

Humphead wrasse is a protogynous hermaphrodite where it changes sex from female to male (Sadovy *et al.*, 2003), it was also being reported that many humphead wrasse have been found to change sexes when there were no opposite sex mates available (Chaot *et al.,* 2006), the time for female to achieve maturation is earlier than male. In the natural habitat, generally the female reaches sexual maturity at 5 years of age and in average total length of 35 to 50 cm (Sadovy *et al.*, 2003). Then, the sex changed to male after 9 years of age (Chaot *et al.*, 2006), and males continue to grow rapidly while the growth rate of fish remaining female slows compared to males.

Slamet *et al.* (2005b) reported that the mature humphead wrasse females have a spherical egg 620 – 670 um in diameter, and the newly hatched larvae around 1.6 – 1.7 mm in total body length. However, it is not presently amenable to aquaculture, having proven difficult to rear in large numbers, and has tremendous slow growth (6 months) in early stage of rearing in order to grow to 5 - 6 cm in body length. Because an artificial condition is necessary for mass production through aquaculture of humphead wrasse, an investigation of the reproductive biology becomes the fundamental of artificial breeding.

However, there was a few study describing the sex identification and gonad maturation of humphead wrasse and nil report particularly in captivity. In aquaculture, the ability to control sex is one of the most important factors for the commercialization and efficient propagation of fish species, due to influences on reproduction, growth and product quality. The absence of both important primary information on the sex and gonad maturation status of humphead wrasse has led its production impossible.

Sex identification is one of the most significant and highly targeted areas of aquaculture research due to impacts on husbandry management, productivity and economics. Without the ability to regulate sexual differentiation, maturation, and reproduction, farmers have little control over breeding processes throughout its production. Arguably, in aquaculture species that have become global commodities, knowledge over sex and reproduction has been the primary facilitator for large-scale industrial production. In humphead wrasse that are yet to reach industrial scale production, elucidation of sex differentiation and improved reliability of reproduction remains a key area of applied research.

Thus, the present study was to identify the sex and gonad maturation of humphead wrasse in captivity based on body sizes, and histological assessment.

1.3 Problem Statement

Only a few publications have been made on this species mainly those in the wild and natural habitat since there were limited information on the successful seed production and it was not traded as live fish legally. In addition, limited researches were done on the sexual maturation of humphead wrasse in the captivity. The

tremendously increased of annual international live trade tonnage indicate it as highly sought after fish triggered the needs of aquaculture for this species. Sex identification methods vary from histological examination up to morphological observations can be implemented on humphead wrasse. Sadovy *et al.* (2010) reported that the sexual maturation can be determined based on their gonad histological criteria. Since humphead wrasse is a protogynous hermaphrodite, the information on determining sex and sexual maturation is equally important for successful seed production and hence large- scale production of humphead wrasse to fulfil the increasing needs of this fish.

1.4 Significance of Study

Establish a guide line in identifying sex and gonad maturation of in- captive humphead wrasse to enable large-scale production. According to Collin (2010), the sexual transformation from female to male can be influenced by the number of males present in the population. The importance of this research with an established guide line would ensure the cultivated of humphead wrasse's population adapt and ensure sustained reproduction to occur under balanced male and female ratio.

1.5 Objectives

1. To elucidate sex determination and differentiation in humphead wrasse, *C. undulatus* in relation to body sizes and external morphology characteristics in captivity.
2. To understand the gonad maturation stage of humphead wrasse domesticated in captivity in relation to its sex and morphology characteristics.

CHAPTER 2

LITERATURE REVIEW

2.1 Biology of Humphead Wrasse, *C. undulatus*

Cheilinus undulatus is also known as Giant wrasse, Humphead wrasse, Maori wrasse, Napoleon, Truck wrasse and undulatus wrasse (Russell, 2004). Large cycloid scales covered the elongated body of coloured humphead wrasse. They display a myriad of color and shapes (Choat *et al.*, 2006). The mouth structure was relatively small, retractable, also very thick and fleshy lips (FAO, 2004).

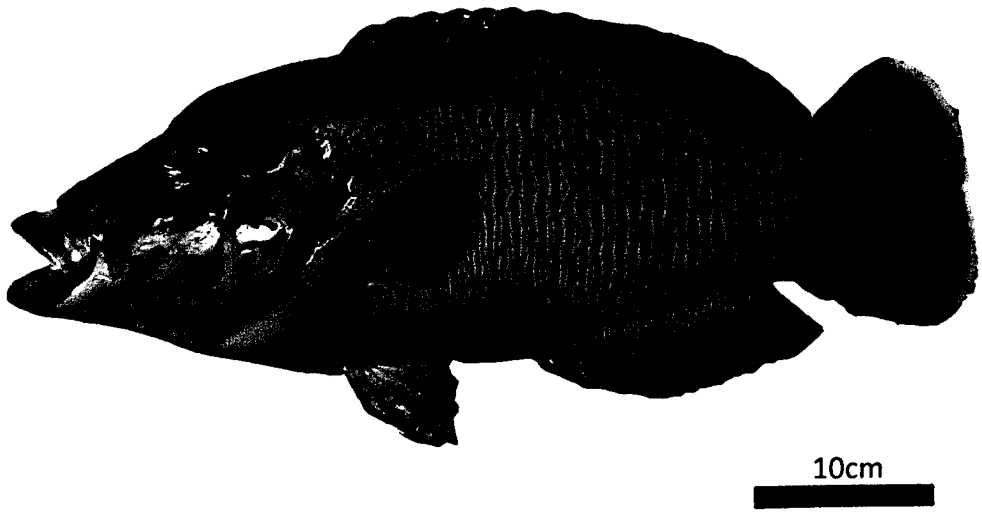

Figure 2.1: Adult Humphead Wrasse, *Chelinus undulatus*

Mostly humphead wrasse can be identified by their pointed snouts and prominent canine teeth in the front of the jaws with a protractile mouth (Sadovy *et al.,* 2003). It has a hump that forms on its head above the eyes, becoming more prominent as the fish ages (Colin, 2010). A single continuous dorsal fin lacking an obvious notch between the soft and spiny portions. The lateral line may be continuous or interrupted. In the wild, some males were reportedly grow very large reaching up until 2.29 m long and weighed 190.5 kg.

Humphead wrasse is known as protogynous hermaphrodites where it changes sex as they grow older (Choat *et al.,* 2006). FAO (2004) had mentioned that during spawning, the adults of humphead wrasse were even more accessible in predictable areas.

2.2 Sexual Identification and Maturation of Humphead Wrasse, *C. undulatus*

Only a few publications have been made on this species mainly those in the wild and natural habitat since there were limited information on the successful seed production and it was not traded as live fish legally. In addition, limited researches were done on the sexual maturation of humphead wrasse in the captivity. Sex identification methods vary from histological examination up to morphological observations can be implemented on humphead wrasse.

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