REPRODUCTION PERFORMANCE OF WILD BROODSTOCK CORAL TROUT *(Plectropomus leopardus)*

Retno Andamari and Ketut Suwirya
Research Center for Mariculture,Gondol-Bali
Received July 6-2009; Received in revised form December 16-2009; Accepted March 30-2010

ABSTRACT

Coral trout is an important export commodity in many countries in southeast Asia. In Indonesia, the export of grouper currently relies on capture fisheries. To ensure sustainability of the wild catch as well as to develope mariculture, we need to better understand the performance of wild broodstock. The aim of this study was to understand the relationship size and maturation in the wild in order to identify potential spawners to be used as broodstock. A total of 311 fish from 14 areas in Indonesia were sampled between May 2002 and September 2004. Performance parameters measured included standard length, body weight and gonad size. Histological analysis of the gonad shows that this species was a protogynous hermaphrodite with sex reversal from female to male. About 75% of the samples were female, 11% were male and 12% were hermaphodites. The batch fecundity of female coral trout from 1.2-2.7 kg weight were varied from 45,768-492,243 eggs. The minimum size of mature coral trout that could be used as mariculture broodstock were 1 and 1.5 kgs for females and males respectively.

KEYWORDS: **coral grouper size, gonad somatic index, fecundity**

INTRODUCTION

Coral trout (*Plectropomus leopardus*) is an important export commodity in Indonesia that currently relies on capture fisheries. To ensure the sustainability of its abundance as a wild resources and its mariculture development as well, an understanding the perfomance relationship of its size and maturation is important.

The demand for grouper is rapidly increasing in Asia and the Pacific. Groupers are marine species that have a wide market and achieve a relatively high price particularly when sold internationally in countries such as Singapore, Hongkong, Taiwan, and Southern China (Rimmer *et al.*, 2004). Hongkong imported 30,000 ton of live grouper during the last 20 years (Anonymous, 2005). The price of live coral trout is Rp.300.000,-/kg (approximately 30 US$) to fishermen. The coral trout grouper culture has not been developed successfully yet, as a consequence those are marketed were mostly resulted from capture fishery. Exported grouper from Bali Province was 1,613 ton in 2001 (Anonymous, 2002); 2,082 ton in 2002 (Anonymous, 2003); 2,861 ton in 2003 (Anonymous, 2004); 1,181 ton in 2007, and 507 ton until August 2008 (Anonymous, 2009) respectively.

Since its culture still relies on seasonally wild juveniles supply, development of hatchery for this species has been implemented in the Research Institute for Mariculture, Gondol. It is understood that the success of hatchery is relies on the quality of the broodstock which caught from nature. The objectives of this study is to understand the reproduction performance of wild broodstock in order to support the hatchery technology development of coral trout (*Plectropomus leopardus*).

MATERIALS AND METHODS

Field Sampling

Reproductive parameters were determined by examination of 311 coral trout, *Plectropomus leopardus* (Figure 1), then wild fish ovary samples were collected from May 2002 to September 2004 within 14 different areas of Indonesia (Figure 2). All fish were measured in standard length (cm) and weighed (g). Gonads were removed and preserved in 4% formalin for further analyzed at the laboratory of Gondol Research Institute for Mariculture.

Corresponding author:
Jl. Baru Gondol, Kecamatan Gerokgak, Kabupaten Buleleng, Singaraja, Bali-81101

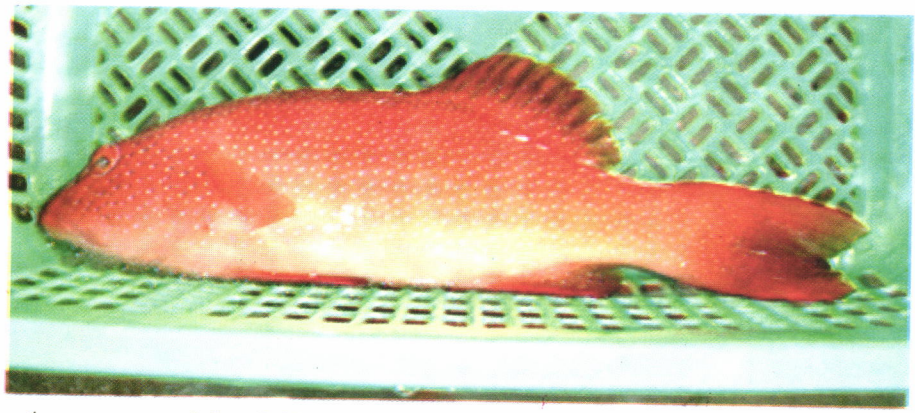

Figure 1. A live 0.8 kg adult coral trout (*Plectropomus leopardus*) from Sumbawa.

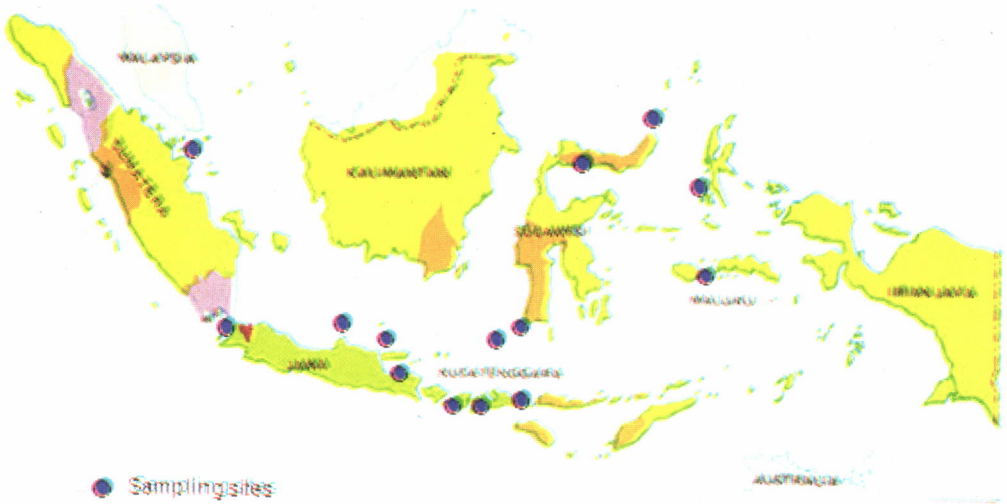

Figure 2. Map of the 14 sample collection sites where *Plectropomus leopardus* were obtained from 2002-2004.

Histological Samples

The maturity stages of ovaries were determined from histological interpretation of preserved ovarian tissues. Ovaries were thawed, blotted dry, and weighed (±0.001 g). Subsamples were taken and preserved in 70% ethanol for subsequent histological preparation. For histological processing each ovary was dehydrated in a graded series of alcohols, cleared in xylene, impregnated with and embedded in paraffin. Six micrometer serial sections were stained with Harris's haematoxylin and eosin (Anonymous, 1998) then mounted and examined.

Gonad maturity was defined following the stages of (Andamari *et al.*, 1998; Cyrus & Blaber, 1984; Hunter & Goldberg, 1980) that criteria are shown in Table 1. The gonads were scored according to the relative number of cells in each developmental stage, and the presence of post-ovulatory follicles was also noted.

Table 1. Criteria used for staging female gonads of *Plectropomus leopardus*

Stage	Remarks	Histology
I	Immature	Oogonia present
II	Developing/resting	Previtellogenic oocytes
III	Maturing	Yolk precursor stage; some non staining yolk
IV	Ripe	Non staining yolk; developed chorion
V	Ruuning ripe	Homogeneous red staining yolk; oocytes hydrated; development complete
VI	Spent	Atresia of ripe oocytes plus previtellogenic oocytes; presence of post-vitellogenic follicles

Batch Fecundity Estimation

Fish that had ripe eggs in a hydrated but preovulatory condition were used to estimate batch fecundity following the approach of (Effendie, 1997; Hunter & Goldberg, 1980; Rimmer *et al.*, 2004).

$$F=(Wg/Ws)*n \quad \ldots\ldots (1$$

where:
- F = batch fecundity
- Wg = gonad weight (g)
- Ws = gonad weight in subsample (g)
- n = number of eggs in subsample

Gonado somatic index of the ovaries was determined by the relationship (Nikolsky, 1969):

$$GSI=Wg/Wx100\% \quad \ldots\ldots (2$$

where:
- GSI = gonado somatic index (%)
- Wg = gonad weight (g)
- W = body weight (g)

A length-weight relationship was determined for the fish based on the relationship (Royce,1984):

$$W=aL^b \quad \ldots\ldots (3$$

where:
- W = weight (g)
- L = length (cm)
- a, b = constant

RESULTS AND DISCUSSION

The relationship of length and weigh are based on the collection of 311 *Plectropomus leopardus* from 14 sites in Indonesia. A detail description of the length and weight of the fish by collection region can be seen in Tables 2. The length-weight relationship of *Plectropomus leopardus* is shown in Figure 3. The value *b* appears not to be equal to 3 (based on t-test), so it can be concluded that coral grouper exhibit a positive allometric growth pattern (b=3,15) i.e. the growth in length is not directly proportional to growth in weight.

Table 2. The mean standard length (mm) and weight of *Plectropomus leopardus* from 14 locations

Locations	Years	n	Length (mm)			Weight (g)		
			Min	Max	Mean±SE	Min	Max	Mean±SE
Labuan Bajo (NTT)	Jun-02	9	229.0	400.0	308.2±17.1	400.0	1,805.0	941.1±153.8
Labuan Bajo (NTT)	Jul-02	6	285.0	355.0	333.3±1.71	580.9	1,400.0	1,027.0±153.8
Labuan Bajo (NTT)	Agust-02	20	203.0	305.0	255.7±6.55	200.0	925.0	451.9±38.1
Labuan Bajo (NTT)	Nov-02	5	265.0	332.0	301.6±11.3	496.8	992.5	779.5±84.0
Masalembu (Sul-Sel)	Mei-02	4	290.0	370.0	331.8±16.6	773.5	1,484.8	1,117.8±145.7
Selayar (Sul-Sel)	Sept-02	21	245.0	414.0	315.14±12.78	336.0	2,247.5	964.49±129.34
Sumbawa (NTB)	Jun-02	10	209.0	420.0	313.0±19.49	260.0	2,150.0	989.0±178.13
Sumbawa (NTB)	Okt-02	6	315.0	371.0	342.67±9.12	848.5	1,587.0	1,156.93±118.36
Sumbawa (NTB)	Nov-02	4	340.0	408.0	369.5±14.82	1,385.5	2,407.0	1,737.63±233.84
Madura (East Java)	Jun-02	5	325.0	404.0	357.8±15.51	910.0	1,950.0	1,353.0±200.26
Madura (East Java)	Agust-02	2	386.0	460.0	423.0±37.0	1,750.0	2,425.0	2,087.5±337.5
Situbondo (East Java)	Sept-02	5	285.0	455.0	355.4±35.92	665.5	2,562.5	1,409.44±194.74
Situbondo (East Java)	Okt-02	3	334.0	430.0	376.3±28.29	973.4	2,351.6	1,577.6±406.81
Madura (East Java)	Nov-02	4	320.0	365.0	342.0±10.72	902.0	1,414.0	1,157.0±129.43
P. Bawean (East Java)	Apr-03	4	285.0	473.0	381.75±16.05	625.0	2,900.0	1,912.75±198.63
Sirai Isl (Riau Arch)	Mei-03	30	194.0	393.0	261.47±8.7	166.1	1,743.0	487.62±60.34
P. Karimun Jawa	Agust-03	31	271.0	432.0	345.35±9.5	540.0	2,605.7	1,312.31±114.62
Sunda Strait (Banten)	Okt-03	21	193.0	355.0	252.05±8.68	213.5	1,404.6	542.23±66.44
Maluku	Mar-04	30	221.0	437.0	333.7±12.8	300.0	2,750.0	1,249.0±141.30
Manado	Apr-04	26	210.0	428.0	309.08±11.19	300.0	2,525.0	1,014.73±118.66
Gorontalo	Apr-04	7	260.0	321.0	296.0±8.12	575.0	825.0	726.43±36.22
Bacan Is (N. Maluku)	Sept-04	35	185.0	430.0	299.49±11.57	230.0	2,475.0	946.57±102.42
Gorontalo	Sept-04	23	225.0	420.0	315.39±12.02	300.0	2,125.0	969.57±108.92
	Total	**311**	**185.0**	**473.0**	**308.96±3.56**	**166.1**	**2,900.0**	**969.84±35.07**

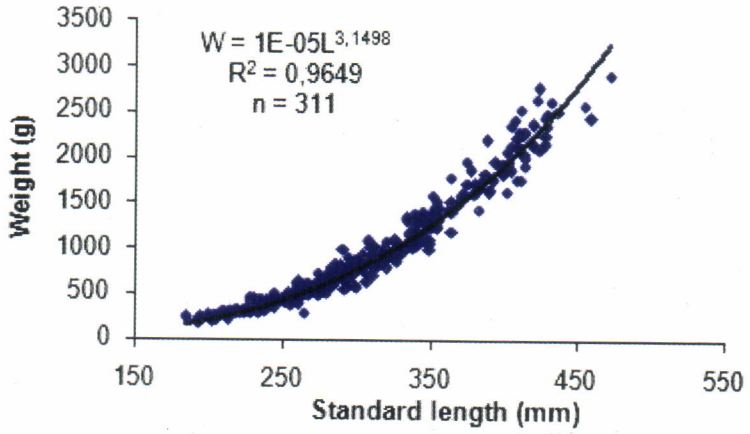

Figure 3. Length-weight relationship of *Plectropomus leopardus* combined from 14 locations.

Gonad somatic index was used to determine the gonad maturation stage where the gonads could not be investigated by histology (Nikolsky, 1969). The results of 14 monitoring locations can be seen in Figures 4 and 5. It appears that *Plectropomus leopardus* reach gonad maturity when the GSI>1.5%. However, there is not a direct relationship between gonad somatic index and fish length or between gonad somatic index and fish weight. This means that the longer fish or heavier fish do not necessarily have a higher gonad somatic index. The stage of gonad maturity is possibly more directly linked to timing of spawning season. Sex and stage of gonad maturity was determined for all the sampled coral trout and results are detailed in Table 3.

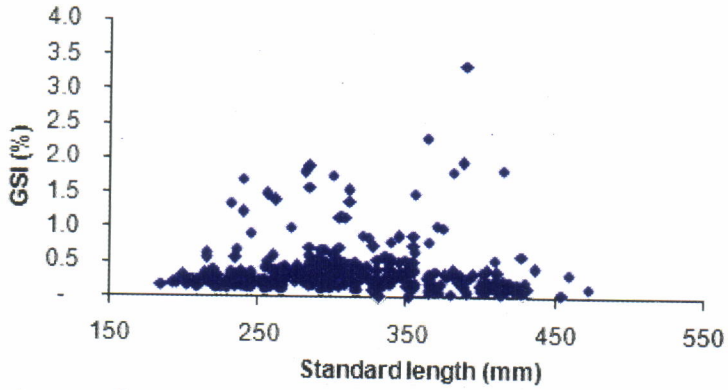

Figure 4. Gonado somatic index and body length relationship of *Plectropomus leopardus* from 14 locations (n=311).

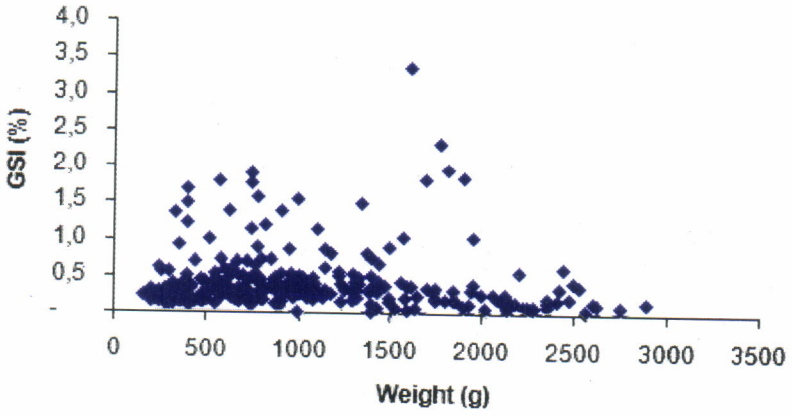

Figure 5. Gonado somatic index and body weight relationship of *Plectropomus leopardus* from 14 locations (n=311).

Table 3. Sex determination of coral trout (*Plectropormus leopardus*)

2002	n	Length (mm)			Weight (g)		
		Min	Max	Mean±SE	Min	Max	Mean±SE
Male	6	280.0	460.0	381.83±27.62	500.0	2,425.0	1,652.5±316.27
Female	88	203.0	414.0	303.58±5.27	200.0	2,025.0	862.14±47.85
Hermaphrodite	10	305.0	455.0	385.90±15.19	600.0	2,562.5	1,742.18±200.92
Unidentified							
Total 2002	**104**	**185**	**437**	**312.9±0.58**	**230**	**2,750**	**1,027.83±57.18**
2003							
Male	3	389.0	473.0	422.33±9.10	2,177.4	2,900.0	2,475.8±77.03
Female	65	194.0	393.0	271.51±9.56	166.1	1,819.6	606.48±77.38
Hermaphrodite	16	275.0	432.0	376.63±9.40	719.0	2,605.7	1,665.69±114.99
Unidentified	2	193.0	236.0	214.5±6.21	213.5	439.7	326.6±32.65
Total 2003	**86**	**193**	**473**	**295.0±13.67**	**166.1**	**2,900.0**	**864.51±134.92**
2004							
Male	27	185.0	430.0	308.3±1.45	230.0	2,625.0	1,041.48±132.63
Female	82	205.0	428.0	301.9±0.59	260.0	2,750.0	902.17±59.46
Hermaphrodite	9	380.0	437.0	409.3±0.55	1,600.0	2,500.0	2,043.89±100.69
Unidentified	3	341.0	365.0	354±0.70	1,025.0	1,500.0	1,291.67±140.19
Total 2004	**121**	**185**	**437**	**312.9±0.58**	**230**	**2,750**	**1,027.83±57.18**

Of the 311 fish, sex could not be determined for 5 fish (2.5%). Of the remainder, 235 were female (75%), 36 male (11.5%), and 35 hermaphrodite (transition) fish (11%). Most of the female were immature (Figure 6a) and only 14 fish had mature gonads (stage V) or higher (Figure 6c).The smallest female with immature gonads had standard length of 20 cm and body weight of 250 g, while the smallest in transition phase from female to male was 32.3 cm SL and weighted 962.5 g. This study was unable to determine length at first maturity because of the influence of seasonality and the number of sample was very small. Spawning observation of coral trout grouper in the tank showed that spawning peak occur in December to March (Suwirya *et al.*, 2005) but according to Heemstra & Randall (1994) the spawning season of coral trout occurs at the end of November-beginning of December in the Great Barrier Reef.

Plectropormus leopardus are protogynous hermaphrodites and change sex from female to male. The length of the smallest mature male was 30 cm SL (Figure 6b) (age 3 years) while the smallest mature female was 21 cm SL (age 2 years) and the largest 47 cm SL (4 years). Two of the mature females in this study, of 38.8 cm SL and 36.4 cm SL had batch fecundity of 343.980 and 429.259 oocytes respectively. Their relative fecundity was 241.8 and 189.0 oocytes/grams body weight respectively. By comparison, Heemstra & Randall (1994) estimated the fecundity of 4 year old *Plectropormus leopardus* to be 457,900 oocytes. Sampled *Plectropormus leopardus* showed asynchronous gonad development and several stages of development were observed in a single gonad. This means that in one spawning season *Plectropormus leopardus* are able to spawn several times (Figure 6d). The diameter of oocytes ranged from 425-475 µm for mature gonad (stage V) but with oocytes not fully hydrated. By comparison, in Gondol Research Institute reported the diameter of *Plectropormus leopardus* eggs in plankton is 700 to 800 µm.

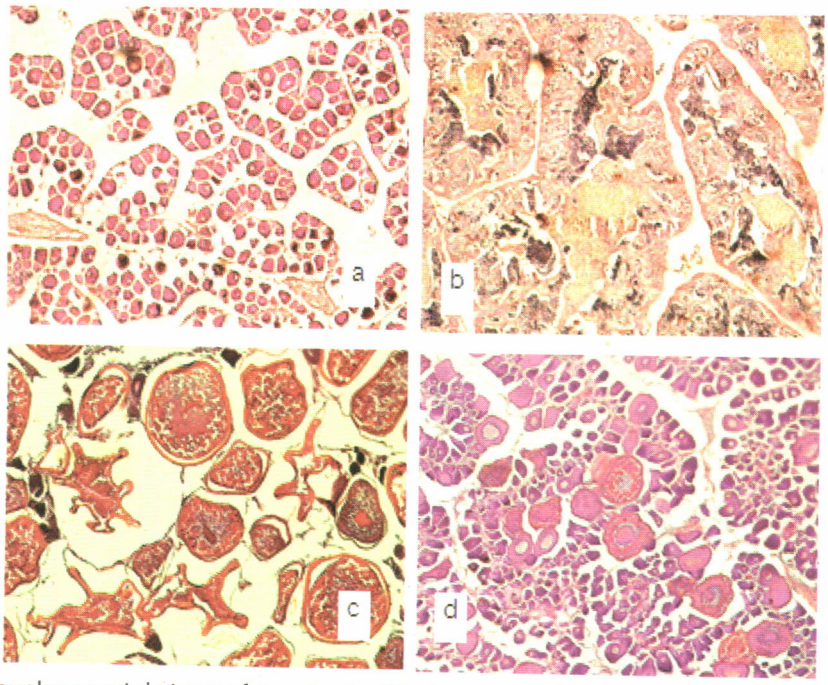

Figure 6. Developmental stage of oocytes in *Plectropormus leopardus* ovaries: (a) immature ovary, (b) transition, (c) prespawning ovary with hydrated oocyte, and (d) asynchronous oocyte stage I and II. (H and E 100x magnification).

CONCLUSIONS

1. Of 311 *Plectropormus leopardus* sampled from 14 locations in the wild, only 14 females had ripe gonads. We were able to confirm that coral trout are protogynous hermaphrodites and are multiple spawning. Management implication for multiple spawning is that broodstock could be used for long period and obtained egg all over the period.

2. The standard length at sexual maturity of female and male coral trout was 21 and 30 cm respectively, while the batch fecundity estimation of the fishes that has 1.2-2.7 kgs weight were varied from 45,768-492,243 oocytes.The minimum size of coral trout broodstock should be approximately 1-1.5 kg for female and male respectively.

3. It appears that *Plectropormus leopardus* reach gonad maturity when the GSI>1.5%. However, there is not a direct relationship between gonado somatic index and fish length or between gonado somatic index and fish weight. This means that the longer fish or heavier fish do not necessarily have a higher gonado somatic index. The stage of gonad maturity is possibly more directly linked to timing of spawning season.

4. Future research is needed integration analysis between size, location, season, and genetic to get best source of broodstock.

ACKNOWLEDGEMENT

This study is based on the data collected from the project study of biological reproduction aspects and gene variation of coral trout (*Plectropormus leopardus*) in 2002; bio reproduction and genetic variation characteristic of coral trout (*Plectropormus leopardus*) in 2003 and 2004, funded by Research Center for Mariculture Gondol, Bali. I thanks to Mujimin for collecting samples and assistance with histology sample preparations and B. T. Trihandoyo and Dr. David Milton for assistance with manuscript preparation.

REFERENCES

Andamari, R., M. Farmer, U. Chodriyah, & A. N. Susanto. 1998. Gonad maurity stages of anchovies (*Encrasicholna heterolobus*) from Bacan Island. *Indonesian Fisheries Research Journal.* IV (2): 47-51.

Anonymous. 1998. *Manual of Histological Staining Methods.* CSIRO.

Anonymous. 2002. *Export Data of Fisheries Product Bali Province 2001.* Laboratory Quality Control of Fisheries Product Bali Province 2002. (In Indonesia).

Anonymous. 2003. *Export Data of Fisheries Product Bali Province 2002.* Laboratory Quality Control of

Fisheries Product Bali Province 2003. (In Indonesia).

Anonymous. 2004. *Export Data of Fisheries Product Bali Province 2003*. Laboratory Quality Control of Fisheries Product Bali Province 2004. (In Indonesia).

Anonymous. 2005. *Mengenal Pasar Ikan Kerapu di Hongkong*. Departemen Kelautan dan Perikanan.

Anonymous. 2009. *Export Data of Fisheries Product Bali Province 2007 and 2008*. Laboratory Quality Control of Fisheries Product Bali Province 2009 (In Indonesia).

Cyrus, D. P. & Blaber, S. J. M. 1984. The reproductive biology of Gerres (Teleostei) Bleeker 1859, in Natal estuaries. *Journal Fisheries Biology*. 24: 491-504.

Effendie, M. I. 1997. *Biologi Perikanan*. Yayasan Pustaka Nusatama. Yogyakarta. 163 pp.

Hunter, J. R. & S. R. Goldberg. 1980. Spawning incidence and batch fecundity in northern anchovy Engraulis mordax. *Fish. Bull. U. S.* 77: 641-652.

Heemstra, C. P. & J. E. Randall. 1994. *FAO Species Catalogue*. Vol.16. Groupers of the world. FAO Fisheries Synopsis. 125: 16.

Suwirya, K., N. A. Giri, & R. Andamari. 2005. Studi awal pembenihan dan pertumbuhan kerapu sunu halus (*Plectropomus leopardus*). *Prosiding Seminar Agribisnis Rusnas Kerapu*. BPPT. 47-51.

Nikolsky, G. V. 1969. *Theory of fish population dynamics, as the biological background of rational exploitation and the management of fishery resources, translated by Bradley Oliver and Boyd*. 323 pp.

Royce, W. F. 1984. *Introduction to the Practice of Fishery Science*. Academic Press. California. U. S. A. 423 pp.

Rimmer, M. A., S. McBride, & K. C. William. 2004. *Advances in Grouper Aquaculture*. Canberra. ACIAR. Monograph. 110.