Journal of Biology, Agriculture and Healthcare
ISSN 2224-3208 (Paper) ISSN 2225-093X (Online)
Vol 2, No.3, 2012

Reproductive biology of estuarine catfish, *Arius argyropleuron* (Siluriformes: Ariidae) in the northern part of Peninsular Malaysia

Mansor Mat Isa [1,2*] Nurul Shafikah Mohd Noor [1] Khairun Yahya [1,2], Siti Azizah Md Nor [1,2]

1. School of biological Sciences, Universiti Sains Malaysia, Minden, 11800, Penang, MALAYSIA.

2. Centre for Marine and Coastal Studies, USM, Muka Head, 11060, Teluk Bahang, Penang, MALAYSIA.

* E-mail of the corresponding author: drmansor@usm.my

Abstract

A preliminary study on reproductive biology of estuarine catfish, *Arius argyropleuron* was conducted using samples collected from Merbok estuary which is located in the northern part of peninsular Malaysia. The fish samples were collected in March-December 2009 using a barrier nets deployed on mudflat opposite vegetation of mangroves. Testes and ovaries were classified base on volume relative to abdominal cavity, gonad forms, size of gonad, colors and oocytes diameter. The gonado-somatic indices showed that the fish matured throughout the year with major spawning peak for females occurred in April and minor peak in July, whereas males recorded a higher peak in November. Absolute fecundity of mature ovary was ranged from 19 to 87 eggs and was linearly related to fish length and power function to fish body weight. Three groups of eggs for the ovary in stage II and two groups in stage III were recorded. The length at first maturity for both males and females was approximately 22.5 cm in fork length.

Keywords: *Arius argyropleuron*, Merbok estuary, peninsular Malaysia, reproductive biology

1. Introduction

Genera of Ariidea are widely distributed in temperate and tropical areas, both in coastal and estuaries (Marceniuk & Menezes 2007). *Arius argyropleuron* is one of the species widely found in Indo-West Pacific; East coast and eastern coastal India, Thailand, Indonesia, Malaysia, the Philippines, southern coast of New Guinea and the north coast of Australia (Kailola 1999, 2000). In Malaysia this species is commonly abundant in shallow, muddy coastal and estuary areas (Gambang & Khiok 2005, Mohsin & Ambak 1996, Ambak *et al*. 2010). They contribute to the socio-economics of the artisanal fisheries and are normally caught by gill nets, trammel nets and barrier nets; this fish is being marketed directly when caught, dried and salted (Mansor *et al.* 1998). The fish eggs are quite large and can be sold for RM15-RM20 per kilogram (approximately USD4.60-6.30).

Studies on the population biology of marine catfish in Malaysian waters are still scarce and little is known about the reproductive biology of the *Ariidae* fish species. However, studies on the reproductive biology and stomach content of *Arius maculatus* from the Matang mangrove reserves in Perak have been conducted by Mazlan *et al*. (2008). A study on morphometric and meristics characteristics of fives Arius spp from the coastal area of Kedah was conducted by Mansor *et al*. (2012a) and Mansor *et al*. (2012b) had studied the population dynamics of *Osteogeneiosus militaris* off the coastal waters of Penang. Beyond this, no similar studies have been conducted on the population dynamics of *A. argyropleuron* in Malaysia and elsewhere.

The present study aimed to describe the reproductive strategy such as period of spawning, length at first maturity, diameter of eggs and fecundity from the samples collected from the Merbok estuary which is located on the northern part of peninsular Malaysia.

2. Materials and methods

Samples of *A. argyropleuron* were collected from the catches of barrier nets deployed by artisanal fishers in the estuary area of Merbok, Kedah (Fig. 1). The nets used was 40-50 meters long, 3-5 meters deep with a mesh size of 2.5 mm. Fishing operation were normally took place at 2-3 days before and after the full moon and also during new moon phases, when there is strong current enable fish entangled in the net. The footrope of the net was at first secured to the mud flat opposite vegetation of mangrove during the low tide, then the head─rope was raised and secured to poles during the high tide, while harvesting was carried out during a low tide 12 hours after the net was set.

Samples of *A. argyropleuron* were collected from Merbok estuary from March 2009 until December 2009. Fifty to 100 fish were obtained every month. The fish samples were placed in a plastic bag and kept in an ice-box and transported to the laboratory.

In the laboratory, each individual fish was measured for the total length (TL), standard length (SL) and fork length (FL) to the nearest centimeter and for body weight (BW), recorded to the nearest grams.

Each gonad was examined to identify its maturity stages and were assigned as immature (stage I), initial and final maturity (stage II), ripe (stage III) and spent (stage IV) following to Gomes & Araujo (2004), according to the vascular irrigation intensity, color and percent volume of abdominal cavity occupied by gonads. Matured gonads that were needed for the fecundity study were preserved in Gilson's solution in order to loosen the tissues surrounding the eggs.

Fecundity was estimated by counting the total number of mature eggs in both ovaries (Nikolsky *et al.* 1973, Nikolsky 1974). The relationship between the oocyte number, FL and body weight was estimated. The diameter of the eggs was also measured, as recommended by Lampert *et al*. (2004) and Mesa *et al*. (2007). However, only the diameter of eggs from stages II and III were measured using the image analyzer stereomicroscope, Olympus SZX9.

3. Results

A total of 477 of *A. argyropleuron* were studied. Out of this number, 273 fish had reached their sexual maturity stages (stage II and stage III). Ovaries or testis were separated by connective tissue and are situated ventrally to the kidneys and swim bladder. The outer layer of the testis (Plate 1) tend to be white to pink in color in stage I (Plate 1A), white and well developed in a stage II (Plate 1B) and become yellow to orange in stage III (Plate 1C) as compared to the ovaries (Plate 2) where the outer layer is white to light yellow in stage I (Plate 2a), creamy yellow in stage II (Plate 2B) and yellowish gold to orange in stage III (Plate 2C). Both the testis and ovaries turn to flaccid and shrink in stage IV or spent (Plates 1 and 2). Some of the eggs in this stage were already released.

From the samples observed, 45 fish were in the juvenile stage, 286 fish were males and 146 females. Ripe males or stage III fish were observed in higher percentages during April and October and spent males occurred throughout the year (Fig. 2). While, the ripe females were recorded in July and spent female fish occurred in August-September (Fig. 3).

3.1. Fecundity

Thirty of the *A. argyropleuron* at stage II and III were examined. The number of eggs was ranged from 19 to 87; they were linearly regressed to the fish length and powered function to body weight. The correlation between fecundity and fork length was positively related at regression coefficient, $R^2 = 0.2448$ with less significant at $P < 0.005$ (Fig. 4). Where as the correlation between fecundity and fish body weight was related at regression coefficient, $R^2 = 0.1529$, which also not significant at $p < 0.04$.

3.2. Egg diameter

A total of 806 eggs were measured under the stereomicroscope from 18 individual fish in stage II and III. Eggs at stage IV were not measured because at this stage, some of the eggs have been released or spawned. Oocytes diameter in stage II showed at least trimodal frequencies (Fig. 5A). The three groups of oocytes were clearly distinguished with the major group of eggs at mean size 3.88 ± 1.09 mm in diameter, the second group was 7.20 ± 1.01 mm and the third group was 11.19 ± 0.70 mm approaching towards stage III. The egg sizes in stage III were composed of two distinctive groups 3.16 ± 0.80 and 9.25 ± 1.63 mm, respectively (Fig. 5B).

3.3. Gonado-somatic indices (GSI)

Spawning period for *Arius argyropleuron*, males and females as determined by the monthly mean GSI of both sexes, were significantly different (Fig. 6). Males reached higher maturity in November, where as females reached maturity in April followed by June, this corresponds with bimodal pulses of eggs as shown in Fig. 5B. However the spawning season between males and females was not synchronized.

3.4. Length at first maturity

Two hundred and thirthy-seven of the males and 36 of the females at maturity stage II and III and were analyzed for the length at first maturity using cumulative percentage (Murua *et al.* 2003). Fig. 7 showed the smallest ripe males, which measured at 10.5 cm in fork length or at 2.11% level, while the smallest ripe females were observed at 17.5 cm or 2.78% level, given the length at first maturity at 50% were approximately 22.5 cm in FL.

4. Discussion

Reproductive strategy and fecundity was necessary to evaluate the reproductive potential of individual fish species (Murua *et al*. 2003). The description of the phases of gonadal development was of great importance for understanding the dynamics of the gonad and to assess reproductive mechanisms of a species. Gonadosomatic index has been used thoroughly as an indicator of the spawning period in teleosts (De Vlaming 1972, De Vlaming *et al.* 1982) and its use in reproductive biology has been considered more appropriate when associated with other indicators of reproduction. Macroscopic examination of the gonads of fish revealed that during maturation processes the ovaries and testis underwent gradual macroscopic changes (De Martini & Lau 1999). The present study on *A. argyropleuron* from estuaries of the northern part of Peninsular Malaysia was the first attempt to estimate reproductive potential including size structure, establishment of gonadal stages, on-set of maturity, spawning periods, fecundity and length reach at first maturity.

The testis and ovaries were located right under the gas bladder and attached to the body cavity by mesenteric tissues. As for the testis, they were connected to the body cavity by mesorchia tissue and they appear like a cylindrical sac. Five gonadal stages including the immature stage were described, based on gonad form, size, weight, color and oocyte diameter.

The differences in size and form could only be recognizable in stage II, where the size of gonads are much bigger and occupy almost one third of the abdominal cavity. Sometimes, we can see the difference of ovaries in each stage based on their color. Ovaries of stage II changing their color from white to light yellow with translucent granules and the shape of the eggs were irregular as compared to ovaries stage III of which the color turns to yellow to orange with regular shape of eggs granule and the wall of the ovary is surrounded with heavy blood vessels. The testis did not show accentuated differences in size and form, being prolonged and broader filiform.

Males were found in greater numbers as compared to females and immature, this was probably due to the behavior of mouth brooding fish. These results showed agreement with the study conducted by Rimmer & Merrick (1983) and Rimmer (1985) for *A. graeffi* in Australia and Offem *et al*. (2008) for silver catfish, *Chrysichthys nigrodigitatus* in the Cross River, Nigeria.

Fecundity is necessary to evaluate the reproductive potential of individual fish species. From this study *A. argyropleuron* showed a positive correlation between fecundity and fork length, and powered function of

fecundity verses body weight. Fecundity was found to vary from 19 in fish of 20.5 cm fork length and body weight of 143.33 g to 87 in fish of 25.6 cm and body weight of 194.1 g, respectively. This result indicated that bigger sized fish contributed a higher number of fecundity and smaller fish had a smaller number of eggs. The linear relationship observed in *A. argyropleuron* seems to represent a general pattern among Ariidae fish species in agreement to Coates (1988) and Pinheiro *et al*. (2006); a positive correlation between egg size and fish length. This was due to the fact that Ariidae produce one of the largest eggs among teleosts (Wallace & Selman 1981).

The occurrence of eggs varying in size was also an indication of multiple spawning by this species. The egg diameter varied in fish of the same length or weight. This present study showed that there are three size classes of the ovary in stage II and two classes in stage III. It was known that the sizes of oocytes in the Ariidae are large compared with those of other teleost fishes. The frequency distribution of oocytes diameter can be important in defining the spawning type of a given species and by using classification proposed by Wallace & Selman (1981) and Vazzoler (1986), the frequency distribution of oocytes diameter of female *A. argyropleuron* during the reproductive periods suggested concurrent development of two batches of oocytes, inline with the two spawning peaks in April and July. This spawning type had also been reported for the marine catfish, *Netuma barba* in the Patos Lagoon Estuary, Brazil (Reis 1986).

According to Chaves (1991) females are better indicators of spawning period than males, since males stay in the mature stage for a wider period of time. Because of this reason, the spawning season between male and female for this species was not synchronized.

The length at first maturity for males and females was most likely similar size. This species attained their first maturity at similar length, 22.5 cm. The smallest ripe male was 10.5 cm or 2.11% while the smallest ripe females were 17.5 cm or 2.78%.

5. Conclusion

In conclusion this study revealed that the *A. argyropleuron* population in the Merbok estuary was between 6.5 and 31.5 cm in fork length. They attained length at first maturity at around 22.5 cm with the maximum GSI recorded in April and July in females. Their absolute fecundity ranged from 19 to 87 and linearly related to fish length and powered function to weight. Three groups of eggs were observed in stage II and two groups in stage III for females.

Acknowledgements

We wish to thank the School of Biological Sciences of University Science Malaysia for providing all the physical facilities to carry out this study. Secondly, we would like to extend our appreciation and gratitude to proof reader Mary Claire Buell for her valuable comments and suggestions on the manuscript and special appreciation goes to Research University Grant, 1001/PBiologi/851048 for allowing us to publish this

paper.

References

Ambak, M. A., Mansor, M. I., Mohd-Zaidi, Z. & Mazlan, A.-G. (2010), "Fishes of Malaysia", Publisher Universiti Malaysia Terengganu. 344 pp.

Bagenal, T.B. (1978), "Method for assessment of fish production in fresh waters", Third edition. IBP Handbook No.3. Blackwell scientific publication. Oxford.

Chaves, P.T.C. (1991), "Testiculos: Estrutura e dinamica de maturacao", In: Chaves, P.T.C. Histologia de peixes-I Semana sobre histologia de peixes da FCAVJ-UNESP. *Jaboticabal*, ed. FUNEP, 47-54p.

De Vlaming, V.L. (1972), "Environmental control of teleost reproductive cycles: A brief review", *Journal of Fish Biology* 4, 131-140.

De Vlaming, V.L., Grossman, G.R. & Chapman, F. (1982), "On the use of the gonadosomatic index", *Comparative Biochemistry and Physiology* **73**A(1), 31-39.

De Martini, E.E. & Lau, B.B. (1999), "Morphometric criteria for estimating sexual maturity in two snappers, *Etelis carbunculus* and *Pristopomoides sieboldii*", *Journal of Fish Biology* **97**, 449-458.

Gambang, A.C. an& Khiok, A.L.P. (2005), "Checklist of fishes recorded from river estuarys of Sarawak, Malaysia", In: Chee, P.E., Devakie M.N. and Rosly H. (eds.). Proceeding of Biodiversity Seminar. Fisheries Research Institute, Department of Fisheries Malaysia.

Gayanilo Jr, F.C., Sparre, P. & Pauly, D. (1997), "The FAO-ICLARM Stock Asssessment Tools (FiSAT)", FAO Computerized Information Series (Fisheries). No.8. Rome, FAO.

Gomes, I.D. & Araújo, F.G. (2004), "Reproductive biology of two marine catfishes (Siluriformes, Ariidae) in the Sepetiba Bay, Brazil". *Revista de Biologia Tropica* / *International Journal of Tropical* **52**(1), 12 pp.

Kailola, P.J. (1999), "Ariidae (=Tachysuridae): sea catfishes (fork-tailed catfishes)". In: Carpenter, A.K.E. and Niem, V.H. (eds.), FAO species identification guide for fishery purposes. The living marine resources of the Western Central Pacific. Batoid fishes, chimaeras and bony fishes part 1 (Elopidae to Linophrynidae) **3**, 1827-1879.

Kailola, P.J. (2000), "Ariidae (sea catfishes)". In: Randall, A.J.E. & Lim, K.K.P. (eds.), "A checklist of the fishes of the South China Sea", *Raffles Bulletin of Zoology* **8**, 569-667.

Lampert, V.R., Azevedo, M. A. & Fialho, C.B. (2004), "Reproductive biology of *Bryconamericus*

iheringgii, from Rio Vacacai, RS, Brazil", *Neotropical Ichtyology* **2**, 46-54.

Mazlan, A.G., Abdullah, S., Shariman, M.G. & Arshad, A. (2008), "On the biology and bioacoustic characteristic of spotted catfish *Arius maculatus* (Thunberg 1792) from the Malaysian Estuary", *Research Journal of Fisheries and Hydrobiology* **3**(2), 63-70.

Mansor, M.I., Kohno, Ida, H., Nakamura, H.T., Aznan, Z. & Syed-Abdullah, S.A.K. (1998), "Field guide to important commercial marine fishes of the South China Sea". Marine fishery Resources Development and Management Department, Southeast Asian Fisheries Deveopment Center. 332 pp.

Mansor, M.I., Nur-Syazwani, R., Siti-Azizah, M.-N. and Khairun, Y. (2012a), "Morphological and meristics characteristics of estuarine catfish (Siluriformes: Ariidae) from Merbok Estuary, Kedah", *Malaysian Fisheries Journal* (in press).

Mansor, M.I., Mohd-Shamsul, S., Zulfigar, Y. & Tan, S. H. (2012b), **"**Reproductive biology, growth and mortality of soldier catfish, *Osteogeneiosus militaris* (Linnaeus, 1758) off the coastal waters of Penang", *Journal of Applied Ichthyology* (in press).

Marceniuk, A.P. & Menezes, N.A. (2007), "Systematics of the family Ariidae (Ostariophysi, Siluriformes), with a redefinition of the genera", Zootaxa 1416, Magnolia Press, New Zealand 126pp.

Mc Millan, D.B. (2007), "Fish Histology: Female reproductive systems". Publisher Springer.

Mesa, L.M., Caputo, V. & Eastman, J.T. (2007), "Gametogenesis in the Dragonfishes, *Akarotaxis nudiceps* and *Bathydraco marrii* (Pisces, Notothenizidae: Bathydraconidae) from the Ross Sea", *Antarctic Science* **19**, 64-70.

Mohsin, A.K.M. & Ambak**,** M.A. **(**1996), "Marine fishes and fisheries of Malaysia and neighbouring countries", University of Pertanian Malaysia Press, Serdang, Malaysia, pp 744.

Murua, H., Kraus, G., Saborido-Rey, F., Witthames, P.R., Thorsen, A. & Junquera, S. (2003), "Procedures to estimate fecundity of marine fish species in relation to their reproductive strategy". *Journal of Northwest Atlantic Fishery Science* **33**, 33-54.

Nikolsky, G.V., Bogdanov, A. & Lapin, Y. (1973), "On the fecundity as a regulatory mechanism in fish population dynamics", *Rapports et Proces-verbaux des Réunions. Conseil International pour l'Éxploration de la Mer* **164**, 174-177.

Nikolsky, G.V. (1974), "Theory of the fish stock dynamics", Pishchevaja Promyshlennost' Press. Moscow.

Offem, B.O., Akegbejo-Samsons, Y. & Omoniyi, I. T. (2008), "Diet, size and reproductive biology of the silver catfish, *Chrysichthys nigrodigitatus* (Siluformes: Bagridae) in the Cross River, Nigeria", *Revista de Biologia Tropica / International Journal of Tropical* **56**(4), 1785-1799.

Pinheiro, P., Broadhurst, M.K., Hazin, F.H.V., Bezerra, T. & Hamilton, S. (2006), "Reproduction in *Bagre marinus* (Ariidae) off Pernambuco, northeastern Brazil", *Journal of Applied Ichthyology* **22**, 189–192.

Reis, E.G. (1986), "Age and Growth of the marine catfish, *Netuma barba* (Siluriformes, Ariidae), in the estuary of the Patos Lagoon, Brazil", *Fisheries Bulletin* **84**(3), 679-686.

Rimmer, M.A. & Merrick, J.R. (1983), "A review of reproduction and development in the fork-tail catfishes (Ariidae)", *Proceeding of Linnaeus Society, New South Wales* **107**, 41-50.

Rimmer, M.A. (1985), "Reproductive cycle of the fork-tailed catfish *Arius graeffei* Kner & Steindachner (Pisces : Ariidae) from the Clarence river, New South Wales", *Australian Journal of Marine and Freshwater Research* **36**, 23-32.

Vazzoler, A.M.A.M. (1996), "Biologia reprodutiva de peixes teleósteos: Teoria e prática. Maringá, Editora Universidade Estadual de Maringá e Sociedade Brasileira de Ictiologia, Brasília, CNPQ/Programa Nacional de Zoologia: 169 p.

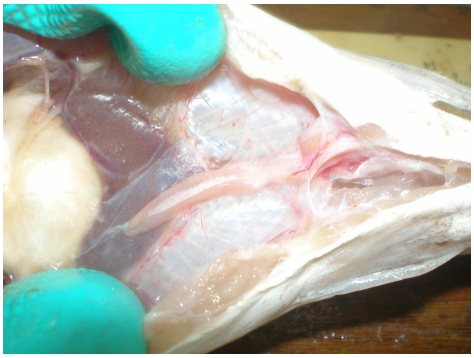
Wallace, R.A. & Selman, K. (1981), "Cellular and dynamic aspects of oocyte growth in teleosts", *American Zoology* **21**, 325-343.

First Author:

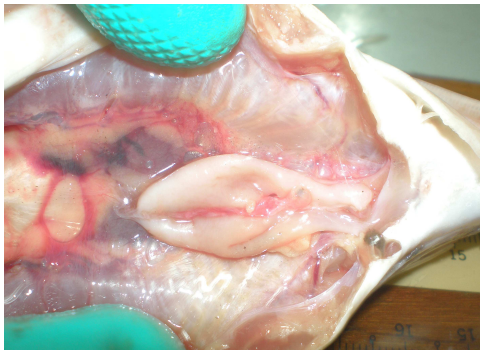
MANSOR MAT ISA, born at Tokai, Kedah, Malaysia on 4th Aug 1955.

Graduated from National University of Malaysia in 1981.

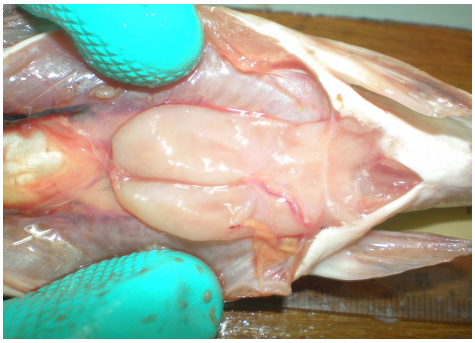
Obtained Ph.D. on Fish Population Dynamics and Management from University College of Swansea, Wales, U.K. in Sept 1993.



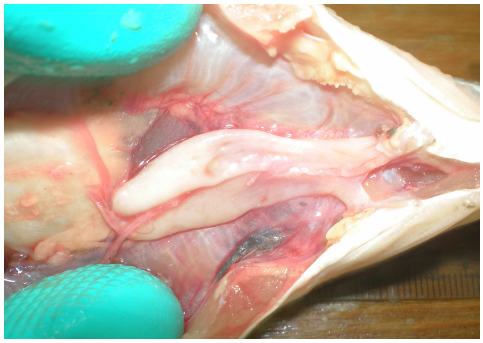
(A) testis at stage I − mature I.



(B) testis at stage II − mature II.



(C) Testis at stage III − ripe.



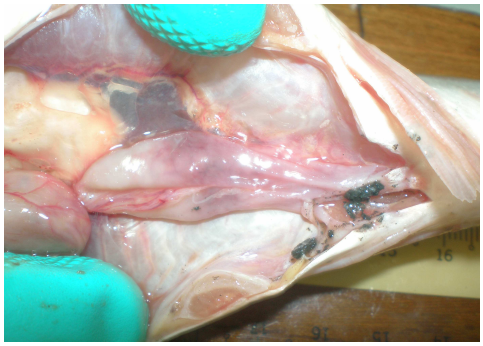
(D) Testis at stage IV − spent.

Plate 1: Maturity stages of the testis *Arius argyropleuron* from Merbok estuary, Kedah.

(A) Ovaries at stage I-mature I

(B) Ovaries at stage II-mature II

(C) Ovaries at stage III – ripe.



(D) Ovaries stage IV – spent.

Plate 2: Maturity stages of ovaries *Arius argyropleuron* from Merbok estuary, Kedah.

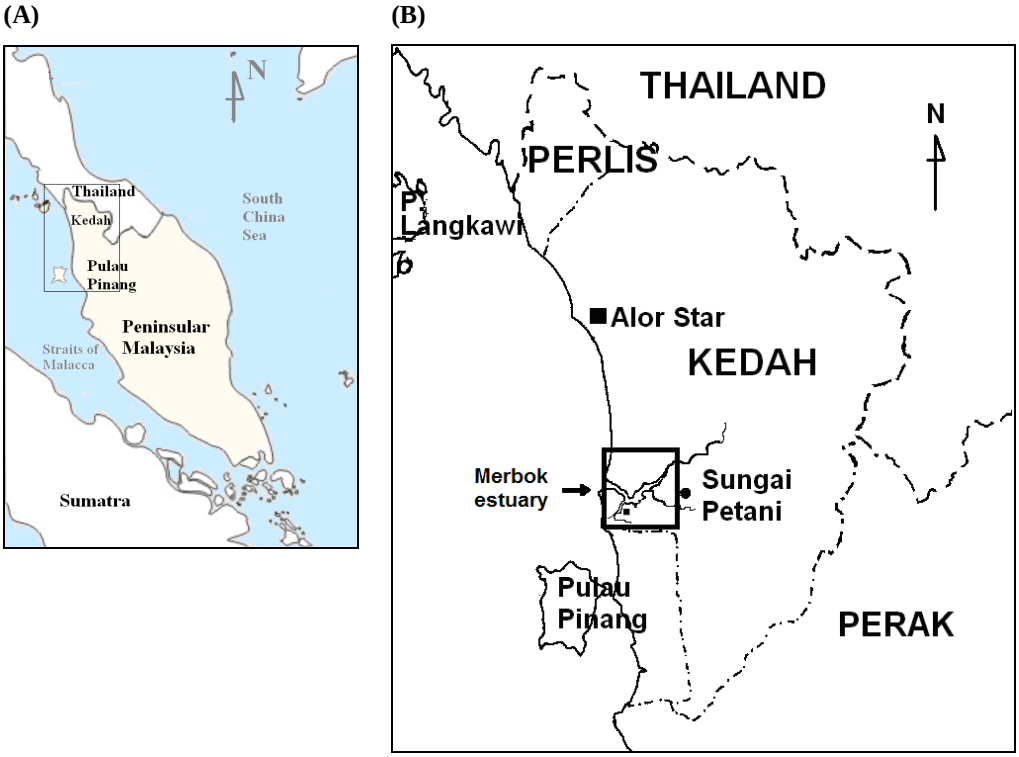


Figure 1: The Peninsular Malaysia (A), showing the state of Kedah (B) and Merbok estuary (inset square).

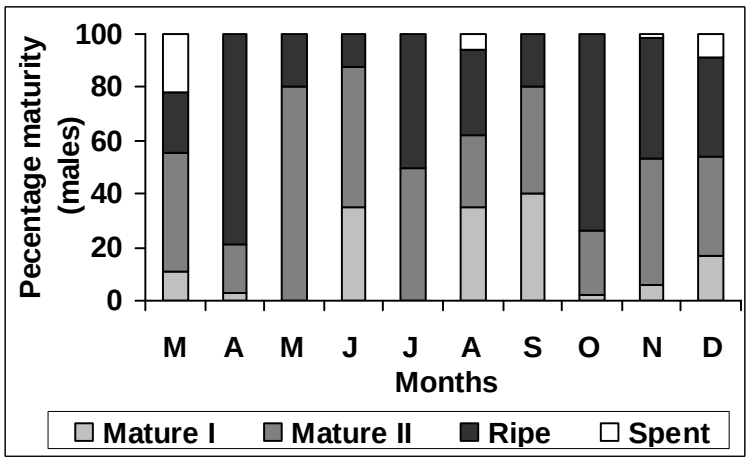


Figure 2: Percentage maturity of males *Arius argyropleuron* from Merbok estuary, Kedah.

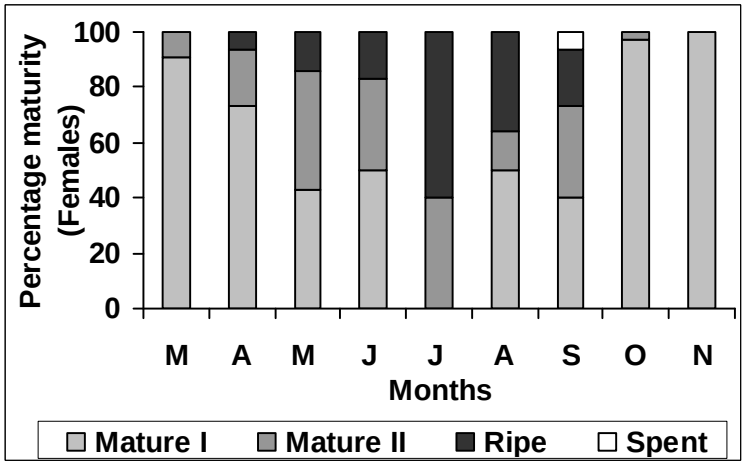
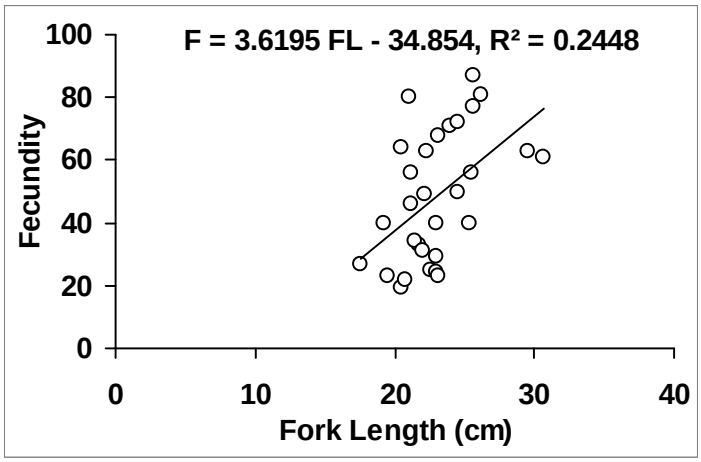


Figure 3**:** Percentage maturity of females *Arius argyropleuron* from Merbok estuary, Kedah.

(A)



(B)

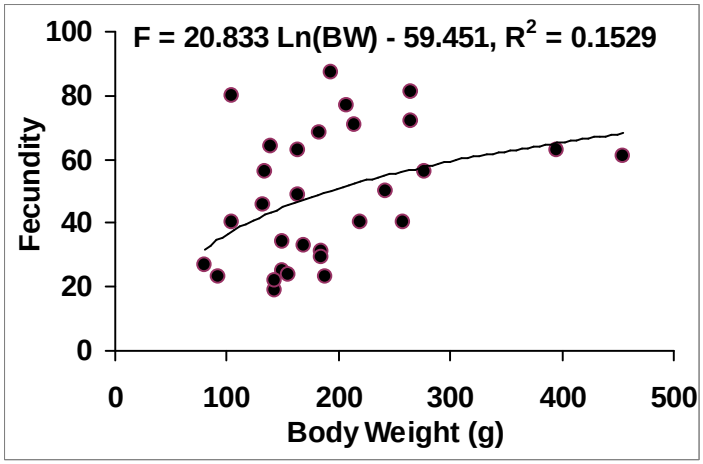
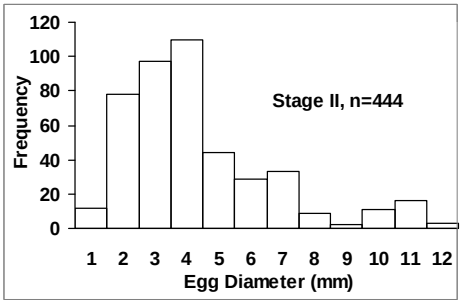
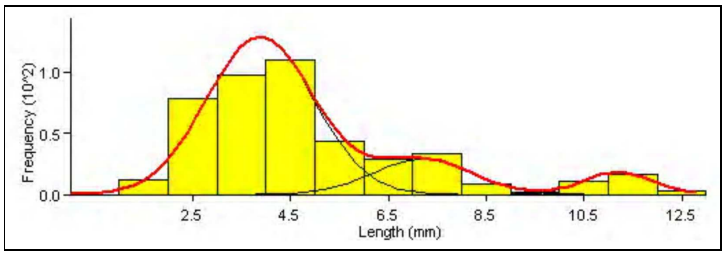


Figure 4: The relationships between fecundity verses fork length (A) and fecundity verses body weight (B) of *Arius argyropleuron* from the Merbok estuary, Kedah.

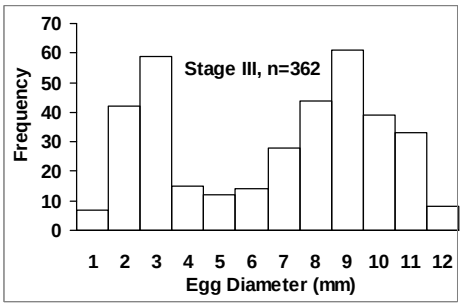
(A)

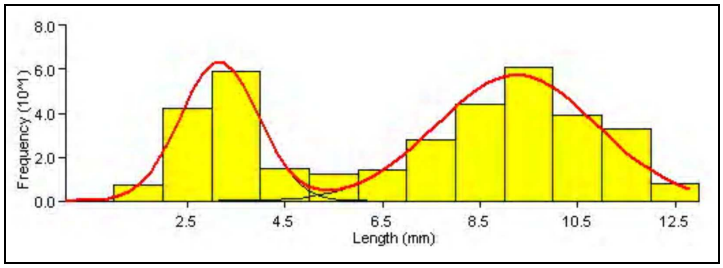




Mean size of eggs Stage II; 3.88 ± 1.090 mm, 7.20 ± 1.01 mm and 11.19 ± 0.70 mm.

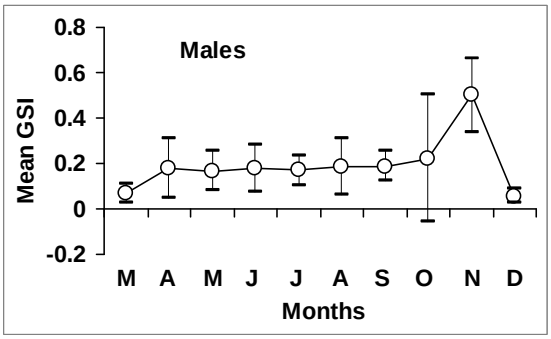
(B)





Mean size of eggs Stage III; 3.16 ± 0.80 mm and 9.25 ± 1.63 mm.

Figure 5: The frequency size of eggs from the ovary of stage II (A) and III (B) of *Arius argyropleuron* from the Merbok estuary, Kedah. The through on the right was derived using the Bhatacharya's plot (FiSAT software packages; Gayanilo Jr *et al.* 1997).



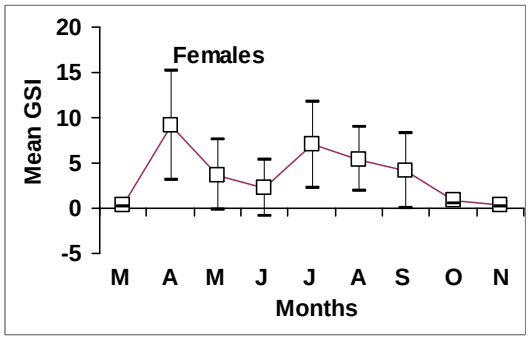


Figure 6: Monthly variation in mean gonado-somatic indices for males and females *Arius argyropleuron* from Merbok estuary, Kedah.

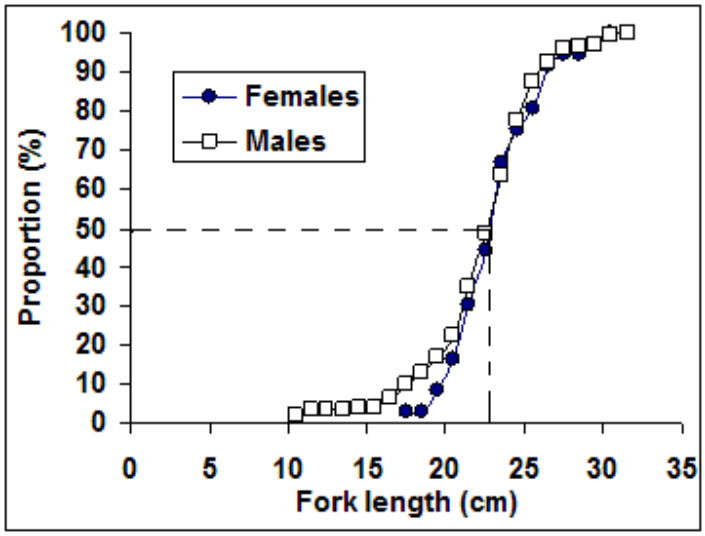


Figure 7: Length at first maturity (50% - approximately 22.5 cm) for males and females of *Arius argyropleuron* from Merbok estuary, Kedah.