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BROODSTOCK DEVELOPMENT PROGRAMMES

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What insides

Message from the Editor

Saadiah Ibrahim

Dear Readers,

I am proud to present the latest issue of the FRI Newsletter (Volume 21) which focuses on the broodstock development R&D implemented by the Fisheries Research Institute (FRI). Good quality broodstock will lead to good quality seed production which is very much needed to sustain the development of the aquaculture industry in Malaysia. Normally broodstock development programs are taken care of by the Government institutions as these activities require substantial capital and budget to function and normally involve a long time to be fruitful. In the Eleventh Malaysia Plan (RMK11) (20016-2010) FRI has continued the activities of broodstock development research initiated from the previous Malaysia Plan.

Currently the broodstock development programs cover marine, brackish water and freshwater fish species. Grouper *(Epinephelus fuscoguttatus)*, seabass *(Lates calcarifer)*, tiger shrimp *(Penaeus monodon)* and white shrimps *(Penaeus merguensis)* are the species that have been selected for marine and brackish water species candidates. On the other hand, the programs for freshwater species involve tilapia (*Oreochromis* sp.), kelah/Malaysian mahseer *(Tor tombroides)*, patin (*Pangasius* sp.) and freshwater prawn *(Macrobrachium rosenbergii)*. The broodstock development programs encompass genetic study of broodstock, broodstock management technology, broodstock maturation feed and disease prevention. The FRI Tanjong Demong, Terengganu focuses on marine fish, FRI Pulau Sayak, Kedah concentrates on marine shrimps and FRI Glami Lemi, Negeri Sembilan on freshwater fishes and prawn broodstock development programs. In addition, FRI Langkawi has also carried out some work on the sea cucumber broodstock development. Some of the FRIs act as a Nucleus Breeding Centre as well as Broodstock Multiplication Centre to support the potential broodstock dissemination to government aquaculture production centre and private sectors.

Last but not least, I would like to thank the contributors of the articles in this volume who submitted technical reports, short communications, updates and photos. The success of this Newsletter depends on your response. I appreciate your feedback. I may be reached via E-mail at sadiahibrahim7@gmail.com or saadiah@dof.gov.my.

Features

Selective Breeding: Prospect for Fish Broodstocks Improvement in Malaysia

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Introduction

Fish demand in Malaysia is expected to increase from 1.3 million metric tonnes (MT) (2010) to 1.9 MT (2020) due to population growth. Aquaculture is one of sources expected to produce healthy source of protein to the population. Besides supplying fish, aquaculture also generates income to fish farmers and commercial entrepreneurs. In 2016, 506,454 MT of fish (worth of RM3.3 billion, DOF, 2016) produced from aquaculture activities in Malaysia. In 2015, there were 23,832 fish farmers involved in aquaculture especially in freshwater sector (DOF, 2016). The suitable weather conditions in the country allow aquaculture production to be carried out throughout the year.

The main commodity that is preferred by fish farmers and investors is marine shrimp. Unfortunately, disease outbreak has led to decline in shrimp production since 2012. White shrimp (*Litopenaeus vannamei*) is mostly cultured followed by tiger shrimp (*Penaeus monodon*). For marine fish, seabass (*Lates calcarifer*), hybrid grouper (*Epinepehlus* sp.) and *Lutjanus* spp are the main species being cultured in cage systems. Seabass is also cultured in brackishwater pond. Total productions of marine fish and shrimp in 2015 were 47,085 MT and 52,580 MT respectively (DOF, 2016). For freshwater fish, more than 15 species are being cultured mainly by small fish farmers. Tilapia and African catfish are among the top commodities due to high demand and availability of seed supply. Other main culture species are giant freshwater prawn (*Macrobrachium rosenbergii*) and *Pangasius*. In 2016, 36,354 MT of African catfish and 35,996 MT of tilapia were produced while fresh water prawn showed a low yield of about 310 MT (DOF, 2017).

As aquaculture play a major role in supplying fish and contributing to the country's economy, fish selective breeding through genetic improvement program is crucial to increase aquaculture production efficiency. This is because the gains made through selective breeding can be permanent and can be transmitted from generation to generation, and that gains in a nucleus can be multiplied (in hatchery) and expressed in thousands or millions of individuals in the production sector (Ponzoni *et al*., 2011).

Approaches to improve aquaculture productivity

Improvement in aquaculture productivity can be achieved by various approaches namely selective breeding, better culture management, feeding, good health management and disease prevention. There are also several areas of research that have been explored such as crossbreeding, ploidy induction, DNA transfer and sex reversal to produce quality stocks for aquaculture. This article will focus on the selection approaches to improve aquaculture productivity for several species that are being implemented by Fisheries Research Institute (FRI) in Malaysia.

Selective breeding

The genetic approach which is in its simplest definition is termed as selective breeding or genetic improvement is the process of replacing a given population of genotypes with another one of superior phenotypic performance (Fredeen, 1986). It could increase aquaculture production (Gjedrem, 1998, 2000; Hulata, 2001).

This is a technique that attempts to improve the genetic merit of the population by mating only the selected fish with the desirable traits in the hope that the superior traits of the selected fish could be transferred to their offspring. It does not create new alleles but merely expedites the propagation of favoured alleles and promotes the progressive elimination of those with less favourable effects. As a result, in the case of selection for greater growth rate the next generation will grow faster, which will increase yields and lower the feed costs and may have a more desired colour if that too was taken into consideration during selection.

In order to implement selective breeding programme, genetic parameters (such as heritability and genetic correlations) of the trait under selection must be estimated. The estimate parameters are important to the estimation of the breeding value of the selection candidates and the prediction of the potential response to selection (Ponzoni *et al*., 2005). Genetic improvement will be successful when phenotypic variation exists and a significant portion of the phenotypic variation is heritable. In other words, selection is effective when a population has significant quantities of additive genetic variation, which is a significant heritability for the traits in question.

The main selection methods are mass or individual selection, family selection and combination of individual and family selection (or known as combined selection). All the methods focus on identification and evaluation of superior brood stocks to be used as parents of the future generation.

i. Individual selection

This approach is also known as mass selection where selection solely based on the individual's phenotype. The method is commonly practiced by hatchery operators. The approach is simple, does not require individual identification or maintenance of pedigree records and considered the least costly method. Improvement can be achieved if the heritability of the trait under selection is high. However, the risk of inbreeding especially for fish is high if progeny from only few parents is selected since a large number of progenies are produced by a female. This method is mostly used to select morphological traits such as body weight and size. It is not suitable for other traits such as flesh quality and disease tolerance.

There were cases of unsuccessful attempt to improve growth by individual selection for Nile Tilapia (Hulata *et al*., 1986). According to Gjerde *et al*, (1996), this method will result in problems unless the number of parents is large. The inbreeding rates can be kept low if a minimum of 50 pairs is mated and 30 to 50 progeny of each pair are tested. To date, majority of hatchery operators in Malaysia practicing this approach due to its simplicity

Measuring quantitative traits of giant freshwater prawn

Breeding programme of tiger grouper is being conducted at FRI Tanjung Demong, Terengganu

but producing inconsistent quality of fry due to inbreeding. The method is widely used in ornamental fish production as the qualitative traits namely colour and physical appearances are the main objectives of selection. Attractive strain of fish such as Arowana, Discus, guppy and *Betta* sp have been successfully produced mass selection. In aquaculture, evidence suggests that this method will results in problems (Lind et. al, 2012). Therefore, the approach is not advisable unless the number of parents is large (Gjerde *et al*., 1996; Villanueva et al., 1996). However, the chance to have a negative effect is still possible.

DOFia Red: an imbroved bred of red hybrid tilapia produced via selective breeding

As the genetic deterioration taking place is possible in mass selection, one of the measures to overcome the situation is by dividing brood stocks into several groups or cohorts. This approach was applied by FRI Pulau Sayak to improve growth of *M. rosenbergii*. Mating was performed between individuals from different cohorts on a rotational basis to avoid inbreeding. In this programme a base population was established by diallel cross of brood stocks from four selected wild populations. The progenies produced from the base population were divided into six cohorts consisting of five to six families per cohort. They were grown in separate hapas within a pond. At harvest, individuals of the heaviest weight in each cohort were chosen as parents of the next generation (selection line) whereas individuals of average weight were used as control. Prior to mating, the same number of individuals was selected from each cohort. Males selected in one cohort were mated with females selected in another one to avoid mating of related families. After five generations of selection, harvest weight in the selection line was 1.5 times higher than the control line.

The improved stock produced from this programme was used for family selection to further improve growth. Another two selected populations from the wild (i.e from Sarawak and Perak) were introduced to increase genetic variability of the base population. After three generations, a genetic gain of 6% was estimated for body weight. At the end of the programme, selected brood stocks from the best performed families will be disseminated to hatchery operators. It is hoped that this effort could overcome the insufficient supply of quality fry for grow-out.

ii. Family selection

This is the technique that requires identification of the families by maintaining them in separate tanks, hapas, cages or using fish tags. There are two types of family selection i.e between family and within family selection. In between family selection method, the mean values for each family are determined and ranked. The best family will be selected while the unselected family will be culled. In within family selection, the best fish from each family will be saved. Between family selections is used when the heritability is high and environmental effects between families are relatively low. By contrast, when the heritability is low and the environmental sources of between family variance are large, within family selection is more effective. However, a limitation in applying these methods is the need to increase manpower and facilities to rear the individual families separately.

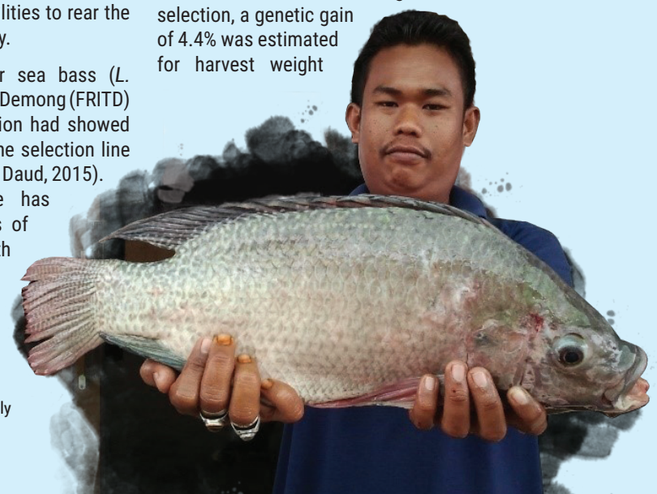
A breeding programme for sea bass (*L. calcarifer*) initiated at FRI Tg. Demong (FRITD) in 1998 using family selection had showed 21% better weight gain of the selection line compared to the control (Nik Daud, 2015). Currently, this programme has produced three generations of selection with better growth trait and no unfavourable effects on survival and reproductive performance. To further improve growth, a collaboration works with Centre for Marker Discovery and Validation (CMDV) is being conducted where molecular marker is used to improve the trait.

Beside sea bass, tiger grouper (*E. fuscoguttatus*) is gaining high market demand especially for export. A breeding programme for this species is crucial due to the limited supply of quality seeds. Seeds collected from the wild are widely used for aquaculture. Thus, FRITD has initiated a breeding programme in 2016 to enhance growth trait of the species. Wild brood stocks were obtained from two selected local populations and a stock from Indonesia. They were diallel crossed to develop a base population for family selection. To date, 30 families have been successfully produced through induced spawning. They are being nursed in tanks until achieved certain size for tagging.

iii. Combined selection

This technique involves both within family and between family selections. With this method, both the best families as well as the best fish from each of the selected families will be selected. In general, most research work attempting to improve several traits in cultured fish using this method has shown successful results. For instance, a breeding program for Atlantic salmon initiated by AKVAFORSK in 1971 had showed 10 to 12% genetic gain for growth rate per generation (Gjedrem, 1999). After six generations of selection, the improved salmon was 80 to100% heavier at marketing compared with wild salmon. The remarkable impact of this program to the salmon farming industry in Norway is that marketable size (4kg) can be achieved within 20 to 25 months of culture period compared to 35 to 40 months in the 70's.

Selective breeding of *Litopenaeus vannamei* is being carried out at FRI Pulau Sayak (FRIPS) since 2017 to improve growth and disease resistance against EHP, following the same programme for *L. vannamei* that was carried out by The Oceanic Institute, USA 1994 to 1997. Results of their study showed that after one generation of selection, a genetic gain of 4.4% was estimated for harvest weight



GIFT breeding programme has successfully produced 17th generations in Malaysia

Wild broodstocks of Penaeus monodon are ready for mating

and 12.4% for survival after challenged test with Taura Syndrome Virus (TSV) (Gjedrem, 1999). The founder stocks at FRIPS are three genetically improved stocks imported from Nucleus Breeding Centres. They are maintained in tanks and used to form a base population for the programme using half diallel cross mating. Natural mating and artificial insemination (AI) techniques have been applied to produce full and half sib progenies. The families produced from the mating are being maintained in separate tanks until achieving suitable size (5g) for tagging using VIE colour tag.

Meanwhile, the same approach is also being applied in improving growth of *P. monodon* at the FRIPS. Founder stocks were recruited in 2017 from the wild of Sarawak, Kelantan and Terengganu. These programmes are still at initial stage and expected to produce the first selection line in 2019. Growth evaluation will be conducted in pond environment at FRI Gelang Patah.

For Nile tilapia, several selective breeding programmes have been implemented. For instance, strains that have been established are GIFT (Genetic Improvement of Farmed Tilapia; Eknath *et al*., 1993; Eknath and Acosta, 1998), FaST (Bolivar *et al*., 2002), GET-EXCEL (Tayamen, 2004) and GST (GenoMar Supreme Tilapia; Zimmermann and Natividad, 2004).

Breeding programme of GIFT strain in Malaysia which is being conducted by FRI and WorldFish has showed that the average selection response in growth rate per generation was 12% and the accumulated response was 120% (Azhar *et al*., 2014). In 2009, a breeding programme of red hybrid tilapia (*Oreochromis* spp) initiated by FRI in collaboration with WorldFish has improved 12.5% of harvest body weight per generation (Azhar *et al*., 2017). The selection for body weight has also resulted in correlated increase in other body traits (length, width and depth) and survival rate. This programme shows that there are prospects for future improvement of this population of red tilapia.

Another breeding programme of red hybrid tilapia to produce a resistant strain to *Streptococcus* infected disease is being conducted at FRI Glami Lemi. In this study, families produced in each generation were challenged test with certain doses of *Streptococcus* sp. The survived individuals and families after the test were selected to become parents of the next generations. Results also shows that there was no negative effect on growth performance of the progenies produced from the selected individuals. The success of this ongoing programme is expected to overcome the mortality problem of cultured tilapia due to Streptococcus disease in the country.

Challenges and limitation to implement the program in Malaysia

In principle, the genetic improvement in aquatic species for aquaculture is applicable but there are many issues to be considered. Fish are generally produce very small fry or fingerlings. Since family must be identified in family or combined selection methods, the fry must be nursed and maintained according to their family groups until they are suitable to be tagged and communally reared in ponds or cages. The nursing phase in separate tanks or hapas will result in common environmental effect in traits such as growth rate. In addition, higher investment cost is required as more facilities must be set up in order to maintain the family groups separately. Once the fry is suitable for tagging, a suitable tagging method must be considered and this will also incur extra investment since physical tagging namely PIT (passive integrated transponder) is expensive. Alternatively, DNA technology can be used for progeny identification soon after spawning occurred. This method could eliminate common environmental effect of maintaining them in separate tanks or hapas and may help reducing grow-out period before selection can be carried out. However, the cost of using this method is also high.

Limitations of financial and knowledge capacity are common in conducting the breeding programmes at FRI. Hence, long term financial commitment and training of staff in quantitative genetics and breeding programme must be a priority. The training should also involve higher ranking officials in the organisation to ensure that they understand what is being done in this field.

Conclusion

Selective breeding programme is important in Malaysia because of its potential to increase sustainable aquaculture production. However, its implementation requires long term research and investment.

References

Hamzah, A., Ponzoni, R.W., Nguyen, N.H., Khaw, H.L.,Yee, H.Y.,Siti Azizah M.N. (2014) Genetic evaluation of the Genetically Improved Farmed Tilapia (GIFT) strain over ten generations of selection in Malaysia. *Pertanika Journal of Tropical Agricultural Science* 37(4), 411-429.

Hamzah, A., Thoa, N.P. & Nguyen, N.H. (2017) Genetic analysis of a red tilapia (Oreochromis spp.) population undergoing three generations of selection for increased body weight at harvest. *Journal of Applied Genetics* 58: 509. https://doi.org/10.1007/s13353-017-0411-8.

Bolivar, R.B., Newkirk, G.F. (2002) Response to within family selection for live weight in Nile tilapia (Oreochromis niloticus) using a single-trait animal model. *Aquaculture* 204, 371–381.

Department of Fisheries, Malaysia (DOF). (2016) Annual Fisheries Statistic.

Department of Fisheries, Malaysia (DOF). (2017) Annual Fisheries Statistic.

Eknath, A.E., Tayamen, M.M., Palada-de Vera, M.S., Danting, J.C., Reyes, R.A., Dionisio, E.E.,Capili, J.B., Bolivar, H.L., Abella, T.A., Circa, A.V., Bentsen, H.B., Gjerde, B., Gjedrem, T., Pullin, R.S.V. (1993) Genetic improvement of farmed tilapias: the growth performance of eight strains of Oreochromis niloticus tested in different farm environments. *Aquaculture* 111, 171–188.

Eknath, A.E., Acosta, B.O. (1998) Genetic Improvement of Farmed Tilapias (GIFT) Project: Final report, March 1988 to December 1997. International Center for Living Aquatic Resources Management, Makati City, the Philippines.

Fredeen, H. (1986) Monitoring genetic change. *Aquaculture* 57, 1-26.

Froese, R., Pauly, D. (Eds.) (2000) FishBase 2000: concepts, design and data sources. ICLARM, Los Banos, Laguna, Philippines.

Gjedrem, T. (1998) Developments in fish breeding and genetics. *Acta Agriculturae Scandinavica*, Section Animal Science Supplement 28, 19–26.

Gjedrem T. (1999) Aquaculture needs genetically improved animals. The Advocate, December 1999. pp. 69-71.

Gjedrem, T. (2000) Genetic improvement of cold-water species. *Aquaculture Research* 31, 25–33.

Gjerde, B., Simianer, H., Refstie, T. (1996) Estimates of genetic and phenotypic parameters for body weight, growth rate and sexual maturity in Atlantic salmon. *Livestock Production Science* 38, 133-143.

Hulata, G. (2001) Genetic manipulations in aquaculture: a review of stock improvement by classical and modern technologies. *Genetics* 111, 155–173.

Hulata, G., Wohlfarth, G. W., Halevy, A. (1986) Mass selection for growth rate in the Nile tilapia (Oreochromis niloticus). *Aquaculture*, 57(1-4), 177–184.

Lind, C.E., Ponzoni, R.W., Nguyen, N.H., Khaw, H.L. (2012) Selective breeding in fish and conservation of genetic resources for aquaculture. *Reproduction Domestic. Animal* 47 (Supp, 4), 255-263.

Nik Daud, N.S. (2015) Performances of first generation, F1 Asian seabass (Lates calcarifer). *Malaysian Fisheries Journal* Vol.2, 48-52.

Ponzoni, R.W., Hamzah, A., Tan, S., Kamaruzzaman, N. (2005) Genetic parameters and response to selection for live weight in the GIFT strain of Nile tilapia (Oreochromis niloticus). *Aquaculture* 247, 203–210.

Ponzoni, R.W., Nguyen, N.H., Khaw, H.L., Hamzah, A. (2011) Genetic improvement of Nile tilapia (Oreochromis niloticus) with special reference to the work conducted by the WorldFish Center with the GIFT strain. *Reviews in Aquaculture* 3, 27-41.

Tayamen, M.M. (2004) Nationwide dissemination of GET-EXCEL, tilapia in the Philippines. In: Bolivar, R.B., Mair, G.C., Fitzsimmons, K. (Eds) New dimension of farmed tilapia, Proceeding of the Sixth International Symposium on Tilapia in Aquaculture, pp. 89. September 12-16, Manila, Philippines.

Zimmermann S, Natividad, J.M. (2004) Comparative pond performance evaluation of GenoMar Supreme TilapiaTM GST1 and GST3 groups. *In*: Bolivar, R.B., Mair, G.C., Fitzsimmons, K. (Eds) New dimension of farmed tilapia, Proceeding of the Sixth International Symposium on Tilapia in Aquaculture, pp. 89. 12-16 September, Manila, Philippines.

Effects of Different Forms of Feeds on Fecundity of Freshwater prawn, *Macrobrachium rosenbergii* Broodstock

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Crustaceans supply from captured fisheries has been almost static since several years ago. Meanwhile, the freshwater crustacean production was reduced from 525,089 tonnes in 2010 to 430,504 tonnes in 2014 (FAO, 2016). However the demand for crustacean from both marine and freshwater prawn is ever increasing. Freshwater prawns are good candidates for aquaculture industry and may fulfil the demand from local and export. Among the freshwater prawns, giant freshwater prawn, *Macrobrachium rosenbergi*i is one of the most popular species being cultured in Asia and other parts of the world.

The supply of good quality and adequate amount of seed are much needed by aqua culturists. At present, the production of M. rosenbergii is very much depending on seed produced from the hatcheries. Many studies have been initiated in increasing the production of giant freshwater prawns. Suggestions and recommendations on selection of good quality broodstock, maturation diet, larval feed, stocking density, feeding regime and management of larval (Cavalli et al., 2003, Nhan, Wille, Hung, & Sorgeloos, 2010; Habashy, 2013; Kitcharoen, Koonawootrittiron, & Na-nakorn, 2010; Chand et al., 2015; Chareontawee *et a*l., 2007) have been reported.

Maturation diet plays a crucial role in producing quality seed in freshwater prawn. Thus a good quality and complete diet is needed for fast maturation of broodstock. Common maturation diet used in the hatchery are fresh food including fresh squid, bivalves, fish fillet and marine worm which are known to be rich in polyunsaturated fatty acid (PUFA). The use of fresh food has been reported to result in positive effects on growth, reproductive performance and larval development (Wu et al., 2011; Cavalli et al., 2003; Coman et al., 2007) and hence used by most of hatchery operators. However fresh food may be a disease carrier and the the quality varies with batch and supply. Some hatchery operators use commercial pellet for their broodstock. However the commercial pellet is usually for "grower stage" type and not specifically formulated for maturation purposes. There is a need to develop maturation diet to replace the usage of fresh food or frozen fresh food. Formulated feeds especially in dry form offer many advantages over the use of fresh-frozen diets including reliable supply, minimal preparation time, known nutrient content and lower pathogens/ bacterial load.

Thus, this experiment was carried out to evaluate the performance of prawn broodstock (fecundity and eggs quality) fed with different forms of maturation diets.

Table 1: The formulation of the experimental diets (dry weight/100g), except diet FD and SM which use fresh ingredients

Ingredients	DB	DM	SM	FD
	Dry weight (g)		Wet weight(g)	
Dried fresh squid	-	12.06	-	
Dried fresh cockle	-	16.52	-	
Fresh squid	-	-	68.62	35
Fresh cockle	-	-	67.13	30
Fresh catfish fillet	-	-	63.33	35
Fishmeal	41.07	13.69	-	-
Others	58.9	58.9	57.7(dry)	-
Proximate composition				
Protein	45.84	45.51	45.82	73.71*
Lipid	10.93	11.26	11.63	7.23*
Ash	12.46	10.80	10.91	3.61*

Note: * are mean of all three fresh feed used

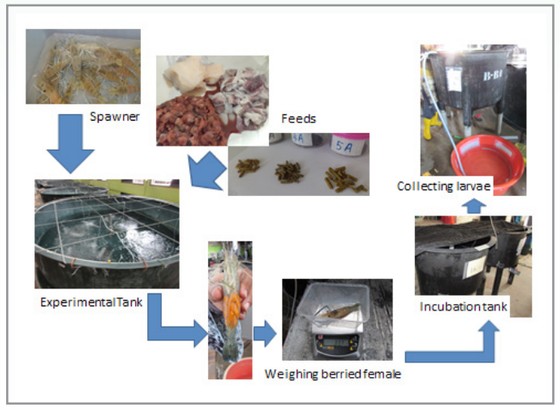


Figure 1: The flow diagram for the methodology of the experiment

The egg and larval fecundity are calculated using formula as below:
Fecundity of eggs = (weight of total eggs X number of eggs of sample portion) / weight of sample eggs
Fecundity of larvae = number of larva per female weight (larva/g female)
The volume of egg is calculated using a formula:

$$V = \pi l h^2 / 6$$

Where l and h are long and short axes of ellipsoidal eggs

Methodology

Three isonitrogenous (45%) and isolipidic (10%) diets were formulated to meet nutritional requirement of broodstock *M. rosenbergii* as suggested by Cavalli et al., (1999) (Table 1). The forms of diet were dry basic (DB), dry mixed (DM), semi moist (SM) and fresh (CD). The basic formulation for all diets is listed in Table 1.

Results and Discussions

The fecundity of eggs and larvae per/gram broodstock is shown in Figure 2. The result indicates that the broodstock fed with CD diet (which served as control diet) gave the best larval hatch fecundity than other forms of diets. The experimental diets that show the best hatch larval fecundity was recorded in broodstock fed with SM (1155.3±318.47), followed by DB (951.3±343.20) and DM diets (793.5±276.20g^{-1}), however they were not significantly different (P>0.05).

Meanwhile, the highest egg fecundity was observed in broodstock fed with DB (1868.8 ± 967.98) followed with SM (1768.8 ± 417.67), CD (1513.8 ± 430.68) and DM diets (1066.5 ± 200.35) (Fig. 2). Again, the readings were not significantly different (P>0.05). Between the dry diets (DB and DM), DB gave better performance in terms of larval hatch and egg fecundity as illustrated in Figure 2. Among the fresh and semi-moist diets (SM and CD), CD gave significantly higher performance in larval hatch and egg fecundity than SM diets (P<0.05).

The quality of eggs in terms of volume demonstrates that the egg produced by broodstock fed with CD (0.098 mm^3) was higher followed by DB (0.085 mm^3), SM (0.083 mm^3) and DM diet (0.068 mm^3) (Fig. 3). The width and length of eggs fed with different form of diets are shown in Table 2. The width and length of eggs from diet DB and SM showed no significant difference (P>0.05).

Based on the results, the performance of broodstock fed with CD, DB and SM diets showed no significant difference in larval and egg fecundity (P>0.05). Thus, moist diet could be replaced with dry diet in the hatchery since it is better handled, managed and stored. In addition, dried feed is more practical as it could be supplemented with other essential additives to improve reproductive performance and more water stable than moist/semi moist diet.

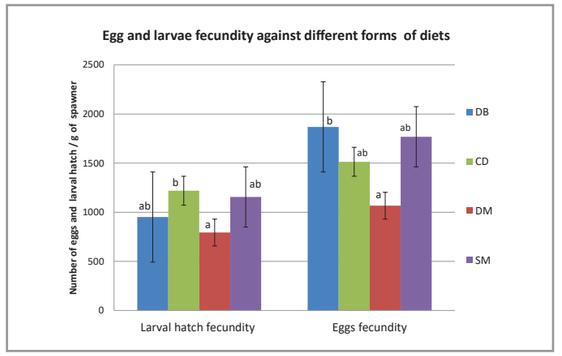


Figure 2: Mean (± SE) of larval hatch and eggs fecundity of different form of feeds

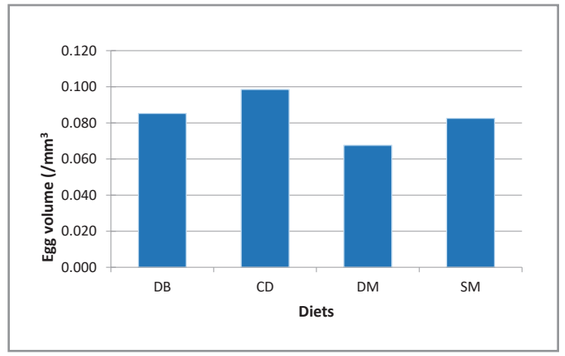


Figure 3: Mean (± SE) of egg volume against different form of feeds

Table 2: The performance of broodstock fed with different forms of diets

	Diet DB	Diet FD	Diet DM	Diet SM
Initial weight of broodstock/g	24.8 ± 3.6	24.8 ± 3.9	24.7 ± 4.2	25.8 ± 4.3
Berried female weight/g	24.0 ± 5.8 [a]	28.4 ± 6.8 [a]	27.2 ± 7.6 [a]	27.9 ± 5.4 [a]
% berried female	48.3 ± 11.8 [a]	76.7 ± 0.0 [a]	61.7 ± 11.8 [a]	46.7 ± 14.1 [a]
Number of larvae hatched per broodstock (x 10^3); (n=6)	22.7 ± 9.2 [ab]	33.9 ± 5.8 [c]	20.7 ± 5.5 [a]	31.7 ± 9.0 [bc]

Mean value (mean ± SE) with different superscripts indicates significant differences (P <0.05)

Conclusion

The results obtained from this experiment suggest that diet using combination of normal ingredients used in prawn feed that contained the right nutritional requirement for broodstock in diet DB gave comparable performance as fresh ingredients (CD) and semi-moist feed (SM) for larval and egg fecundity as well as quality of egg.

References

Cavalli, R. O., Lavens, P., & Sorgeloos, P. (1999). Performance of Macrobrachium rosenbergii broodstock fed diets with different fatty acid composition. *Aquaculture*, *179*, 387–402.

Cavalli, R. O., Batista, F. M. M., Lavens, P., Sorgeloos, P., Nelis, H. J., & De Leenheer, A. P. (2003). Effect of dietary supplementation of vitamins C and E on maternal performance and larval quality of the prawn Macrobrachium rosenbergii. *Aquaculture*, 227(1–4), 131–146.

Chand, B. K., Trivedi, R. K., Dubey, S. K., Rout, S. K., Beg, M. M., & Das, U. K. (2015). Effect of salinity on survival and growth of giant freshwater prawn Macrobrachium rosenbergii (de Man). *Aquaculture Reports*, 2, 26–33.

Chareontawee, K., Poompuang, S., Na-Nakorn, U., & Kamonrat, W. (2007). Genetic diversity of hatchery stocks of giant freshwater prawn (Macrobrachium rosenbergii) in Thailand. *Aquaculture*, *271*(1–4), 121–129.

Coman, G. J., Arnold, S. J., Callaghan, T. R., & Preston, N. P. (2007). Effect of two maturation diet combinations on reproductive performance of domesticated Penaeus monodon. *Aquaculture*, 263(1–4), 75–83.

FAO. 2016.The State of World Fisheries and Aquaculture 2016.Contributing to food security and nutrition for all. Rome. 200 pp.

Habashy, M. M. (2013). On the breeding behaviour and reproduction of the freshwater prawn, Macrobrachium rosenbergii (de Man 1879) (Decapoda-Crustacea) under laboratory conditions. *Aquaculture Research*, 44, 395–403.

Harrison, K. 1990. The role of nutrition in maturation, re- production and embryonic development of decapod crustaceans, A review. *Journal of Shellfish Research*. 9, 1-28

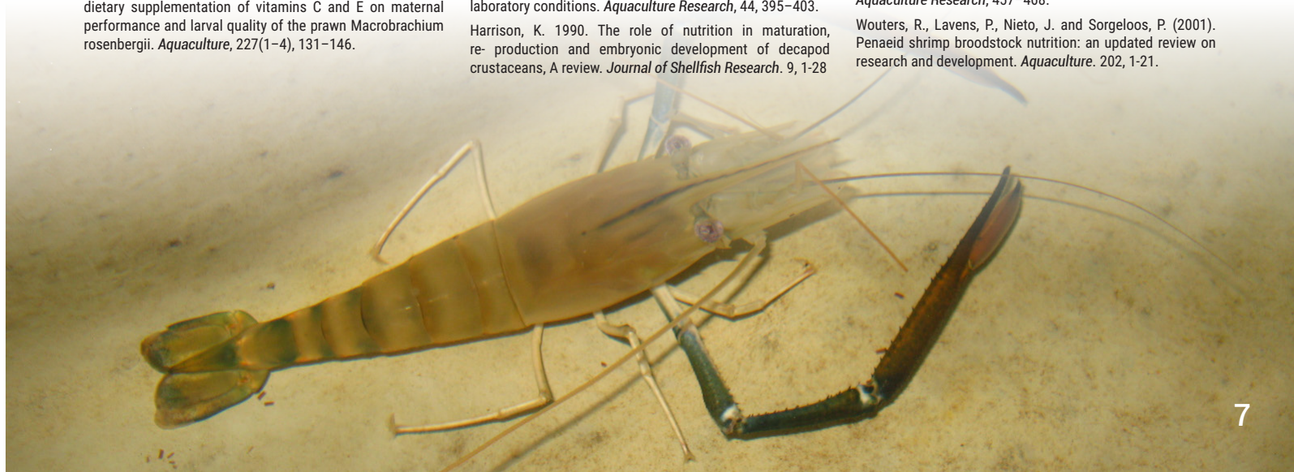
Hoa, N. D., Wouters, R., Wille, M., Thanh, V., Dong, T. K., Van Hao, N., & Sorgeloos, P. (2009). A fresh-food maturation diet with an adequate HUFA composition for broodstock nutrition studies in black tiger shrimp Penaeus monodon (Fabricius, 1798). *Aquaculture*, 297(1–4), 116–121.

Kitcharoen, N., Koonawootrittiron, S., & Na-Nakorn, U. (2010). Selection of brooders from early maturing freshwater prawns (*Macrobrachium rosenbergii*) results in faster growth rates of offspring than in those selected from late maturing prawns. *Aquaculture*, 306(1–4), 362–364.

Nhan, D. T., Wille, M., Hung, L. T., & Sorgeloos, P. (2010). Effects of larval stocking density and feeding regime on larval rearing of giant freshwater prawn (Macrobrachium rosenbergii). *Aquaculture*, 300(1–4), 80–86.

Wu, X., Wang, Z., Cheng, Y. X., Zeng, C., Yang, X., & Lu, J. (2011). Effects of dietary phospholipids and highly unsaturated fatty acids on the precocity , survival , growth and hepatic lipid composition of juvenile Chinese mitten. *Aquaculture Research*, 457–468.

Wouters, R., Lavens, P., Nieto, J. and Sorgeloos, P. (2001). Penaeid shrimp broodstock nutrition: an updated review on research and development. *Aquaculture*. 202, 1-21.



Development of Maturation Diet to Enhance Reproductive Response of Domesticated Kelah (*Tor tambroides*)

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Kelah (*Tor tambroides*) or Malaysian Mahseer is a riverine cyprinid. Claimed to possess an exquisite taste, the price is expensive and may fetch USD 180 – 300 for a 1 kg live specimen. This has led to an increase in fishing pressure on the natural resources. Artificial breeding of Kelah for conservation and aquaculture is important as it will assist in ensuring their survival thus reducing the negative impacts on natural stocks. In order to support artificial breeding, there is a need for the development of specially formulated maturation diet to optimise and enhance broodstock maturity. Arachidonic acid (ARA) that could be found in beef liver was known to be a precursor for prostaglandins 2 hormone (PGE2) production believed to enhance maturation activity of fish broodstock. The objective of this study is to evaluate the effect of maturation diet incorporated with beef liver meal (BLM) in enhancing the reproductive responses of Kelah.

The study was conducted for 18 months using an indoor recirculating aquaculture system (RAS) tanks. A total of 40 individual's female Kelah broodstock of same parental breeding pair was individually tagged using PIT tag and randomly distributed in four 5 tonnes RAS tanks. The experimental fish was fed with treatment diet, KM and control diet (commercial diet) in duplicates. All diets were isonitrogenious with 34% CP and 6% CL. After six months of feeding scheme, the sampling for breeding performance was conducted at three-month intervals after undergoing artificial propagation for Kelah according to De Silva *et al.* (2004). The parameters measured were breeding response, gonadosomatic index (GSI), relative fecundity, hatching rate, water hardened egg diameter and water hardened of individual egg weight. Data obtained were analysed and statistical tested using T-test.

After 18 months, the domesticated Kelah broodstock (final average size of 1.7 ± 0.2 kg) fed with the KM (BLM inclusion) maturation diet demonstrated a significantly ($P < 0.01$) higher breeding response (about 40%) within the population. On the other hand, there is no breeding response or spawning activity recorded by Kelah fed with control diet. The comparison of breeding performance of Kelah broodstock fed with different diets are illustrated in the figure below.

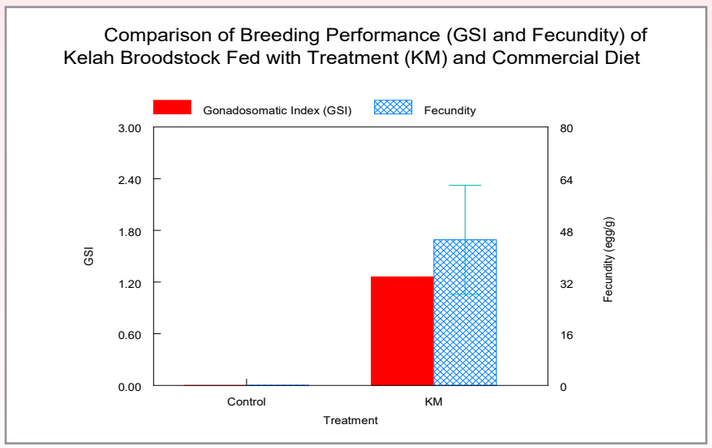

Fig: Comparison of Breeding Performance (GSI and Fecundity) of Kelah Broodstock Fed with Treatment (KM) and Commercial Diet

The results obtained suggest that Kelah broodstock fed with BLM formulated diet could have influence the fish reproductive physiology. Further experiment is still being continued to determine the effects of BLM formulated diet on the PGE2 hormone level and reproductive performance of Kelah specifically.

Processing maturation diet using 'Mini Pelleting Machine'

Selected 'ready-to-spawn' Kelah were recorded and induced with hormone to stimulate breeding activity

The domesticated Kelah brooders were stocked in the FRI Glami Lemi's own developed 5MT RAS tanks

The fertilized eggs were recorded and placed in a specially designed hatching incubator system for 72 hours

The Kelah larvae aged ten days after hatch

References

De Silva S.S, Ingram B.A., Sungan S., Tinggi D., Gooley G. & Sim S.Y. (2004) Artificial Propogation of the Indigenous Tor species, Empurau (T. *tambroides*) and Semah (Tor *douronensis*), Sarawak, East Malaysia. In: Proceeding of the International Symposium on the Mahseer 2006, Kuala Lumpur. MFS Publication.

Tamaru, C.S., Pang, L., Ako H. (2000) Effects of Three Maturation Diets on Spawning of the Armored Catfish (*Corydoras aeneus*). Aquatips, *Reg. Notes, Cent. Trop. Subtrop. Aquac.* 11 (3), 4-6.

University Putra Malaysia (2013) Researchers Search for Best Feed for the 'King' of the Rivers. https://www.sciencedaily.com/releases/2013/05/130524103501.htm

Wing-Keong N. & Wang Y. (2011) Inclusion of Crude Palm Oil in the Broodstock Diets of Female Nile Tilapia, Oreochromis niloticus, Resulted in Enhanced Reproductive Performance Compared to Broodfish Fed Diets with Added Fish Oil or Linseed Oil. *Aquaculture* 314, 122-131.

The fertilized eggs were recorded and placed in a specially designed hatching incubator system for 72 hours

Moments in FRI

"Konvensyen Penyelidikan Perikanan 2018", RI Batu Maung, 1-3 August 2018.

Harvesting broodstock F1 (1300pieces) from FRI Pulau Sayak and transferred to PPUG Kg Acheh for larvae production program on 15th August 2018.

Workshop on "Pengurusan Biodiversiti Sumber dan Ekosistem Perikanan Darat", FRI Glami Lemi, 10 – 11 July 2018.

Courtesy visit by the new Director of Fisheries JIRCAS, Dr Osamu Abe to FRI Batu Maung on 16 August 2018.

Visit by Herbs group to FRI Langkawi on 8 April 2018.

Training course "Pembenihan Udang Galah" at FRI Pulau Sayak on 10-23rd Oct 2018.

Visit by the KSU to the FRI Langkawi on 22nd April 2018.

Consultation with farmers and the Department of Fisheries Brunei on control of marine leech by NaFisH team on 22-31 January 2018.

Treatment for injured turtles and releasing them back to the sea is one of the activity by FRI Rantau Abang.

Symposium of Marine Capture Fisheries Research, on 2-3 October 2018 at Auditorium Hall, RECSAM, Penang.

Discourse session during the Symposium of Marine Capture Fisheries Research, 2-3 October 2018, RECSAM, Penang.

The last clock out by Mr. Mohammed bin Mohidin, the Director of FRI Bintawa on 22 Oct 2018 at FRI Bintawa.

Inauguration ceremony of "MyDoF Galeri Tuna" by TYT Pulau Pinang, Tun Abdul Rahman Abas, FRI Batu Maung on 21st April 2018.

The last clock out, R.A. Roki Mohamad at FRI Langkawi on 23 Oct 2018.

Signing the Inauguration Plat for opening of the *Galeri Tuna*.

Yang diPertua Negeri Pulau Pinang during the opening ceremony.

Modular Production of Red Tilapia Fry in Broodstock Multiplication Center, FRI Glami Lemi

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Red tilapia is the second largest fish produced after catfish in Malaysia. However, the production of tilapia was found to decrease each year starting from 2012 (51,554 metric tonnes (MT)) to 2017 (31,544 MT) (DOF, 2017). The Minister of Agriculture and Agro-Based Industry on 3 June 2013 has proposed the production of fish to be of the ratio 50:50 i.e 50% from aquaculture and 50% from capture fisheries. This new policy also targeted to produce a total aquaculture production of 1.443 million MT with 313 thousand MT from freshwater aquaculture by 2020. Based on 2017 production, 30.7% of freshwater aquaculture production is contributed by tilapia. It is projected that by 2020, tilapia production must be increased to 96,000 MT. In order to achieve this target, it is crucial to emphasize the fry production. Thus, the objective of this project is to introduce the use of modular system in the Broodstock Multiplication Centre (BMC) to propagate tilapia fry production in Malaysia.

Modular System for 10,000 Fry Production/ Month

Modular system for production of 10,000 fry/ month with sizes of 2-3" consisted of; a) 40 breeding tanks (5.00 m x 3.00 m x 0.47 m); b) 10 nursery tanks (5 m x 3 m x 0.47 m); c) 1 eggs incubator station (consisting of 21 funnels) and d) 3 earthen ponds (600 m^2). The quantity of female and male broodstock used are 800 and 400 pieces; respectively. In general, each female broodstock can produce up to 5 to 6 eggs per gram of body weight. However, fry production is not always positively correlated to the increased of body weight at the later stage of culture period. Even though it was reported that tilapia reproduced monthly, but the production cycle for each broodstock was only 2 to 3 times after 4 months of monitoring. In addition, there are many factors involved in the mating process such as feed intake, genetics, broodstocks conditions, environment etc (Baroiller & D'Cotta, 2001; Campos-Mendoza *et al*., 2004; Coward & Bromage, 1998, Desprez *et al*., 2003; Tsadik & Bart, 2007).

Broodstock selection and management

Broodstock are selected based on several criteria. The male and female broodstock must be selected from unrelated families to avoid inbreeding. This in turn may lead to low quality fry (low survival, low quantity, stunted, easily infected with the diseases etc.). The broodstock should be obtained from the Nucleus Breeding Centre (NBC) where they have been selected for several generations through selective breeding programme.

The initial size of the broodstock should lie in the range of 15-20 cm or approximately weighted of 150-300 g and already matured. During the mating period, the difference in size between male and female broodstock should not be more than 30% and must be healthy and free from parasite or disease sign. The ratio of male to female that are usually adopted by farmers are 1:2; 1:3 or 1:4, however FRIGL prefer to use the ratio of 1:2. The spent broodstocks should be replaced after 18 months of usage or after fry production started to decrease to maintain the production volume.

The ideal stocking density of broodstock is 2 fish/m^2. Higher stocking density may stunt the growth since tilapia needs enough space to build nest. The cement tanks were divided into 2 sections using an aluminium frame with netting, the smaller section (1/3) has been placed with male while the bigger section (2/3) with female (Fig 1). The mating period was conducted for 28 days in each cycle. The male and female broodstocks was initially separated for 10 to 12 days prior to the mating. The male will be separated again from the female broodstocks during the egg collection after 28 days of mating period. The non-brooding female broodstocks were placed back in the mating tanks for another 15 days. The intervals time of 4 to 6 weeks has been obtained by Campos-Mendoza *et al.* (2003) and Macintosh & Little (1995) at the sexual maturation and if environmental conditions are favourable for successive series of spawning. Broodstocks were given commercial starter feed with high crude protein (32-34%) and the pellet size of 4 mm during the culture period. The feed was given twice daily, until satiation

Egg Incubation

Tilapia is a mouthbrooder fish where the female broodstock will keep the eggs in its mouth after being fertilized (Fig 2). Fry will be released once it is free-swim. The current practise by farmers is to collect the fry by using net in pond. This collection method is not effective, needs a lot of workers and hardly predicts the production value. In addition, the swim-up fry is prone to predator after being released from the broodstock's mouth. There is a need to change the current practice of using pond collection fry method to alternative method such as tank system of fry production.

Photo 1: Tanks (3 m x 5 m) with partition, were used for breeding program

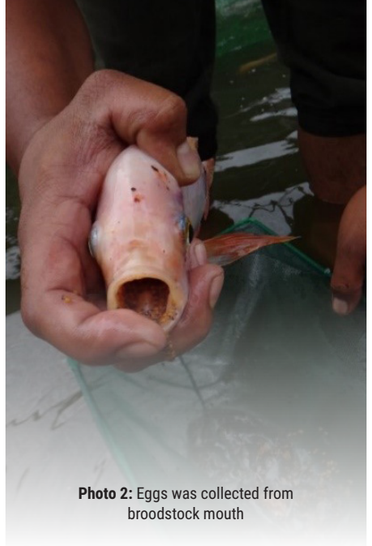
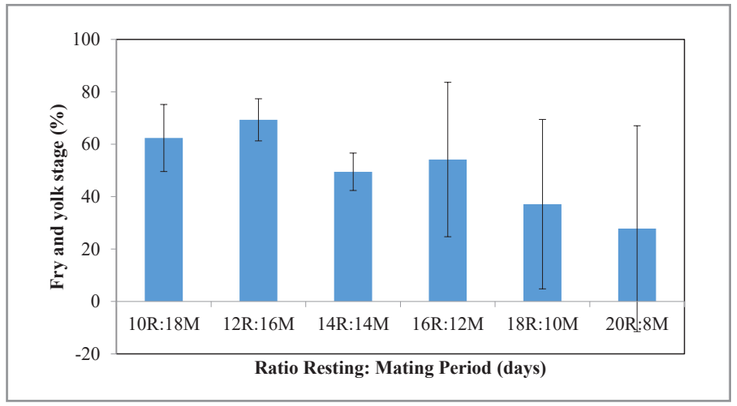


Photo 2: Eggs was collected from broodstock mouth



Mean percentage of seeds in yolk-sac and swim-up fry stages

The eggs collection was suggested instead of traditional approach since it can be properly planned, produce more fry and predict the monthly production. In addition, this approach requires minimal space and workers. The eggs collection method has also been reported to enhance the female broodstock to reproduce faster (Watson & Chapman, 2002). In this method, the collected eggs were transferred into the incubator jar (Fig 3). It will take 3-8 days for the eggs to hatch depending on the eggs developmental stage. The eggs developmental stages can be determined based on the colour such as yellow for eggs that have been fertilized after 24 h and brownish for eggs that just started to develop. The collection of eggs with eyes and yolk-sac are preferable than the brownish coloured eggs since it will result in higher hatching percentage. This method however has several disadvantages such low percentage of hatching if immature eggs were collected. Besides the electrical power failure may also cause a total loss of the incubated eggs. Findings from the research in FRIGL had shown that longer mating time will produced more yolk-sac type eggs compared to shorter mating period (Fig 4).

Nursery

Nursery of fry and fingerling can be carried out either in hapas, tanks or ponds. In FRIGL, fry are nurse in the cement tank for 3-4 weeks before being transferred to the ponds. The stocking density of fry is 1000/m^2. During the first month of nursery, fry should be fed with high level of crude protein content feed or high-quality feed to speed up its growth. However, lowest growth was recorded for the fry nursed in the hapas. This might be due to the powders fed to the fry was leaching out through the hapa mesh holes. The tanks and ponds systems are the best as it can retain the powdered feed and nourish the water. Green water contains supplementary food for fish fry. There are several factors that affect the survival rate of and the most is handling of fry during transferring as they are still weak and fragile. Besides that, too strong of oxygen supply could also contributed to low survival. In addition, higher stocking density at nursery stage will slow down the growth of the fry.

Fry were cultured for 2 months in the ponds after being nursed for 1 month in the cement tanks. The stocking density used is 25 fry/ m^2. Fish were fed with the starter feed, with protein content of 32-34%. Crumble and 1.5-2.0 mm pellet size was used during this period.

Conclusion

The advantages of modular system with proper hatchery management plan could improve the fry quality, quantity and better managed the production time.

Photo 3: Incubation of eggs in the incubators

References

Baroiller JF & D'Cotta H. 2001. Environment and sex determination in farmed fish. *Comparative Biochemistry and Physiology*, 130, 399-409.

Campos-Mendoza A, Bromage N, McAndrew B. 2003. The effect of photoperiod on the reproductive performance of the Nile tilapia, *Oreochromis niloticus*. *Fish Physiology and Biochemistry,* 28(1-4), 503-504.

Campos-Mendoza A, McAndrew, BJ, Coward K & Bromage N. 2004. Reproductive response of Nile tilapia (*Oreochromis niloticus*) to photoperiodic manipulation; effects on spawning periodicity, fecundity and egg size. *Aquaculture*, 231(1), 299-314.

Coward K & Bromage R. 1998. Histological Classification of Oocyte Growth and the Dynamics of Ovarian Recrudescence in *Tilapia zillii*. *Journal of Fish Biology*, 53, 285-302.

Department of Fisheries Malaysia, DoF (2017). The Annual Fisheries Statistics Book http://www.dof.gov.my/web/guest/perangkaan-perikanan-tahunan-2016. Acessed on November 11 (2018).

Desprez D, Mélard C, Hoareau MC, Belleméne Y, Bosc P & Baroiller JF. 2003. Inheritance of sex in two ZZ pseudofemale lines of tilapia *Oreochromis aureus*. *Aquaculture*, 218, 131-140.

Macintosh DJ & Little DC. 1995. Nile tilapia, In: Bromage, NR, Roberts, RJ. (eds.) Blackwell science Ltd, Oxford UK, pp. 227-330.

Tsadik GG & Bart AN. 2007. Effects of feeding, stocking density and water-flow rate on fecundity, spawning frequency and egg quality of Nile tilapia, *Oreochromis niloticus* (L.). *Aquaculture*, 272(s 1–4):380-388.

Watson CA & Chapman FA. 2002. Artificial Incubation of Fish Eggs. Department of Fisheries and Aquatic Science, Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. Fact Sheet FA-32. http://edis.ifas.ufl.edu

Selective Breeding Program of Asian Sea Bass (Lates Calcarifer) Broodstock at Fisheries Research Instutute, Tg Demong

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Sorting of seabass larvae

Based on the National Agro-Food Policy (Dasar Agro Makanan (DAN) (2011 - 2020), the target aquaculture production (excluding shells) by 2020 is 790 thousand metric tonnes. In order to achieve the goal, it is to be expected that the need for fish and shrimp seedlings in 2020 is around 13.6 billion fingerlings with an annual production rate of 11.2%. One of the most important factors to support the fish fingerlings production target, is the qualified broodstock with selected genetic characteristics.

The marine fish selective breeding program especially for grouper and sea bass are a very important requirement and should be the main focus of each Research Centre under the Department of Fisheries of Malaysia. Despite its prevalence and importance as an alternative to wild fish, Malaysian aquaculture is not without problems. The Malaysian aquaculture industry has been threatened with entrepreneurs who have lost their operations and some are still struggling. This is due to various problems that hit the aquaculture industry with chronic diseases such as Viral Nervous Necrosis (VNN), Iridovirus, Vibriosis and unproductive, slow-growing fish larvae; stunts and so on, have affected the development of the country's aquaculture industry.

This negative development is often associated with the use of non-quality seedlings produced in local hatcheries and exacerbated by the inclusion of imported seedlings that lack control over their health status. These situations are hampers by the absence of a quality broodstock breeding program for use in hatcheries for production of quality seeds. This scenario is closely linked to the high demand of fish seed in the country, while the current situation of production of fish fingerlings in the country is insufficient. This state has led to many local hatcheries operators producing as many fish fingerlings as possible and set aside the quality factors that should be preferred.

At present, a selective breeding program for Asian sea bass is being implemented in FRI Tg Demong Broodstock Development Programme to ensure the quality of sea bass seedlings production. Breeders from different locations were used to ensure wide genetic variation in the base population. The breeders procured from three different places; Malaysia, Thailand and Indonesia were used in a diallel cross design. Three pairs of selected breeders were used for each trial and the spawning performance was recorded. The natural spawning activity occurred every month. The hatchling and fingerling were nursed in the hatchery tank up to 200-300 g in body weight prior to transfer into floating net cage and reared until they attained broodstock size. The growth performance in the nursery and cage stages were recorded.

The project demonstrated the potential of using selective breeding to genetically enhance the production performance of Asian sea bass. For the moment, the first stage result showed that growth performance criteria were significantly better for F_1 compared to base population. By the end of 2020, the results will point towards solving the Asian sea bass seedlings production with the dissemination of quality broodstock to the local aquaculture industry to ensure the production of quality eggs and seedlings consistently, in line with the 2011-2020 plan. Hence, the role of the broodstock development program should be the main focus of the Department to ensure that hatcheries operating in the country receive a high-quality supply of seed for the purpose of seeding and thereby ensure the development of a sustainable aquaculture industry. This broodstock development program needs to be implemented with meticulous and continuous plan to ensure that the native broodstocks are conserved and the genetic features are retained.

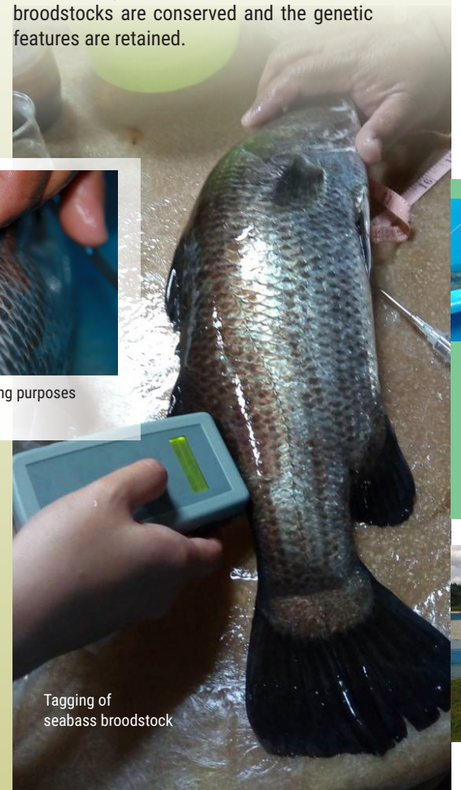
Grading of seabass larvae into groups of similar individual sizes


Harvesting of seabass larvae from concrete pond


Cannulation for breeding purposes


Transferring of seabass broodstock for spawning purposes


FRI TD seabass group team


Tagging of seabass broodstock

Improving Growth Performance of Giant Freshwater Prawn Broodstock (Macrobrachium rosenbergii)

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Macrobrachium rosenbergii or giant freshwater prawn is a Malaysian native species which gains high market price compare to the other freshwater fish species. The prawn is normally cultured in earthen pond system. Fish farmers usually purchased fry from local hatcheries and stocked in their ponds for 5 to 6 months before harvest. Despite the good price and demand of this species, its aquaculture production in the country decreased from 456.61 tonnes in 2003 to 398.10 tonnes in 2014 exhibiting 13% decrease in production (DOF, 2013; 2014). This is likely due to the lack of good quality brood stocks as well as the depletion of wild brood stocks for hatchery operations. To address these problems, a selective breeding programme has been initiated at FRI Pulau Sayak (FRI PS) aimed to improve the growth of this species. In a long term, this project is aimed to develop a genetically high yielding strain for aquaculture.

This programme involved the following steps;

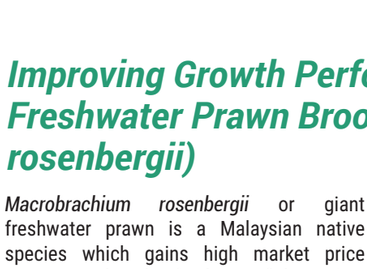

Figure 1: Steps involved in the genetic improvement programme of *Macrobrachium rosenbergii* being carried out at FRI Pulau Sayak

1. Collection of founder stocks
The founder stocks comprised of a domesticated stock maintained at FRI hatchery and three wild populations collected from Kedah, Sarawak and Perak. The wild stocks were transported to FRI PS and quarantined in $10m^3$ fibreglass tanks according to their origin for three weeks. At the meantime, they were screened for the presence of disease once a week by using PCR. Only the disease-free stocks were maintained to form a base population.

2. Establishment of the base population
The base population was formed using half diallel cross design involving brood stocks from the four populations. One male was mated to three females in $1m^3$ tank. A total of fifty mating tanks were used to produce as many families as possible. Samples of each family were identified using VIE colour code before growth performance test was carried out in earthen ponds. The performance of pure and crossbreed progeny resulting from the half diallel were ranked based on their growth performance. The best performing individuals irrespective of their origin were used to form the base population to produce subsequent generations for selection.

3. Family production
Selection of males and females was mainly based on body weight and length. Individuals with the highest body weight in each family were selected to become parents of the next generation. The selection procedure will be repeated throughout this programme. Currently, two generations of selection had been produced.

4. Performance test & selection
Post larvae (PL) from each of the families were nursed in fine mesh hapas (3m x 3m x 1.2m) installed in an earthen pond (0.05ha) at a stocking density of 150 PL/hapa in two replicates for a month. They were fed twice daily with commercial feed at 20% of biomass a day. Once they attained taggable size (2.0g) 150 juveniles/family were tagged using VIE tag. The tagged juveniles were communally stocked in bigger mesh hapas (10m x 10m x 1.5m) at a density of 7 juveniles/m^2 for four months. The prawns were fed with commercial pellet at 5 to 10% of the biomass twice a day. Feeding rate was modified based on the body weight obtained during sampling. Pond water quality was maintained by frequent water exchange from a nearby river. At the grow-out period, body weight and total length were measured during sampling which was carried out once in a month. At harvest, the family was identified and the individuals were sexed and measured for body weight and total length. The measured prawns were released in another hapas for a week before being transferred back to broodstock tanks ($40m^3$) at FRI PS.

To date, the selection line produced in this program showed better growth and survival than the control line. The growth has improved 5% per generation while the survival rate was 10% higher (60% vs 50%). Furthermore, there is no unfavourable effect on reproductive performances (fecundity and hatching rate) of the selected females. This suggests that there is a scope to improve growth of this species through selective breeding.


Mate allocation where selected best male from best family assigned to the best female from unrelated best family


Figure 3: Mating tanks for the selected males and females


Figure 4: Larvae rearing in 100 litre tanks for three to four weeks until they metamorphosed to post larvae

Post larvae were transferred to hapas (A) installed in earthen pond for further rearing until attained 2g body weight before tagging using VIE tag (B)


Communal grow-out of the tagged juveniles was carried out in hapas (C) for four months until average harvest size at 30g achieved (D). Measurements of body traits were recorded and analysed before selecting brood stock

Sea Cucumber (Holuthuria scabra) Broodstock Maturation Trials at FRI, Langkawi

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Measurement activities at the sea pen.

Advances of sea cucumber aquaculture activities were hindered by the slow progress in the seed production. Among the issues emerged were the shortage of healthy and productive mature broodstock. The industry cannot rely solely on wild broodstocks which are influenced by season, maturity and supply. Generally, sea cucumber breeds during the breeding seasons that occur twice a year, which is in March-May and August-September.

The broodstock used was collected from the natural habitat. Upon arrival at the hatchery, the sea cucumber broodstocks were acclimatized in tanks for 1-2 weeks depending on the gonads maturity level as preparation for breeding induction. This study was based on sea cucumber research findings conducted by other parties. Firstly, the density of the gamat used was 1 kg/square meter. Secondly, the natural food in original habitat like mud, weeds and decayed material on the seafloor were used. Thirdly, the maximum water exchange either using a flow through system or 50% daily water exchange was adopted. This is due to the low seawater exchangeability. A 40-tonne concrete tank at FRI Pulau Sayak with approximate surface area of 10 m square base was used. The stocking density was 2 sea cucumber (200g each)/m^2. A sea pen constructed at Teluk Yu, Pulau Langkawi was used as comparison. The sea cucumber in the hatchery was fed with 200g fresh mud every two days for the duration of this study. The success of the feeding program was determined by the increased in sea cucumber weight after being cultured for 2 months. At the end of the duration, the results showed that both the sea cucumber cultured in the tank and sea pen gain weight. No weight gain was recorded for sea cucumber in the tank during the second sampling, may be the sea cucumber were still acclimatizing to the environment before gaining weight. On the other hand, the weight gain of sea cucumber in the sea pen was positive. The weekly weight gain for sea cucumber in the sea pen was 13 g while the sea cucumber in the tank was 5g. Natural habitat in the Langkawi sea pen shows a better result compared to the hatchery. This study shows the possibility of maintaining broodstock in the hatchery but further study will be carried out until the juvenile reach maturation and completed the life cycle.

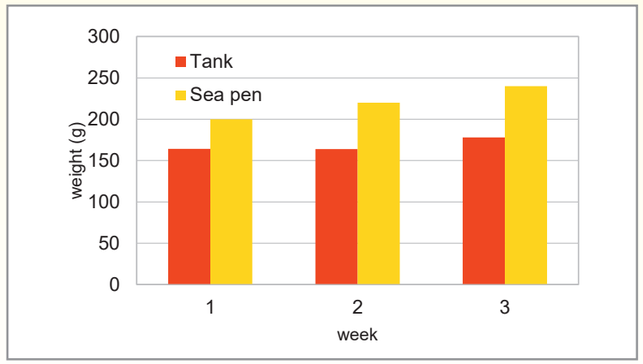
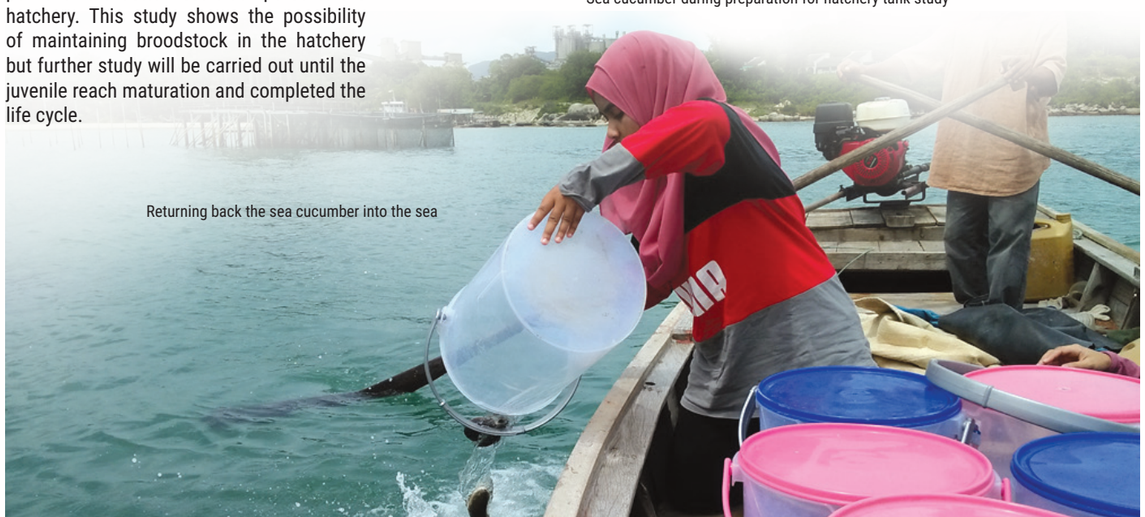


Figure 1: Body weight gained during the three weeks study compared in percentage

Sea cucumber during preparation for hatchery tank study



Returning back the sea cucumber into the sea

Issues and Challenges of Cockle Production

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Cockles (*Anadara Granosa*) is abundant in the west coast of Malaysia covering the state of Penang, Kedah, Perak, Selangor and Johor. Statistics from the Department of Fisheries Malaysia (2013-2016) showed an increase of 98% cockles' production in the State of Johor i.e from 29.40 metric tonnes (MT) in 2014 to 1 263.21 MT in 2016. However, the cockles' production in Penang, Kedah, Perak and Selangor showed 95, 89, 79 and 62% decreased in production respectively.

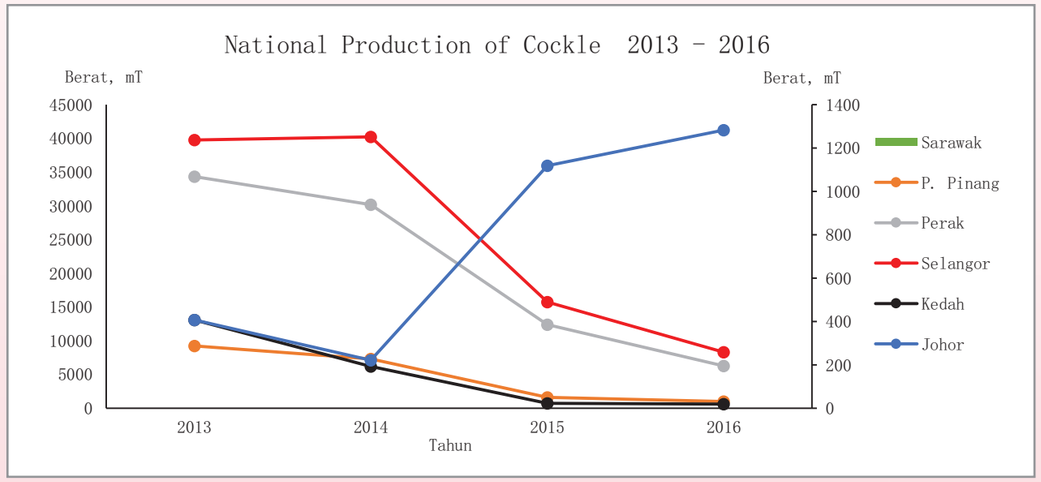
The declining rate of cockles' production has negative impact to the cockles industry. Limited resource and prices being controlled by middlemen resulted in the rise of cockles' price from around RM8.00/kg to RM12.00/kg from 2014 to 2017. Therefore, making cockles as high value seafood. Issues that led to the declining trend of cockles' production in Malaysia and resolving methods in overcoming the problems were identified through the procurement of information and surveys at relevant locations.

Among the identified issues led to the decline of cockles production in Malaysia were water pollution in cockles habitats and breeding areas, uncontrolled cockles harvesting, the production of shell-off cockles using less than 25 mm cockles in length, smuggling of cockles seed abroad, unsustainable planning and implementation of cockles culture, individual / fisherman conflicts and cockles / seed genetic factors. Addressing the issues that have led to the decline of national cockles' production is a challenge to the nation and cockles industry player.

Among the steps that can overcome the reduction of cockles production is to ensure that the marine water quality is in compliance with the marine water standards regulated by the Department of Environment Malaysia, enforcement to any effluent discharged exceeding the marine water quality standard and periodic water quality monitoring. Other than that, it is essential to implement further studies on cockles breeding, development of sorting technologies to separate undersized cockles (<25 mm) during harvest, information dissemination on cockles management in ensuring the sustainability of cockles stock, technical advice to entrepreneurs, and the development of an effective SOPs on cockles culture. Cockles' market price needed to be stabilized through enforcement activities and monitoring of price set by middlemen.

In addition, the occupational safety and health aspects of fishermen should be taken into account in ensuring the wellbeing of fishermen. An ergonomic tool in carrying out harvesting process ensures the productivity of cockles to be in line with the awareness of the occupational safety and health.

The declaration of Pontian as National Cockles Hub by Y.B. Minister of Agriculture and Agro-based Industry, Dato' Salahuddin bin Ayob on July 14, 2018, could be the best example for the cockles production in the country. Cooperation between the Department of Fisheries Malaysia, fishermen's associations in Malaysia and other related agencies were important in addressing the declining of nation's cockles' production issues in order to ensure the sustainability of the cockles stock in the nation.



National Production of Cockle 2013-2016

Centre in the News

Induction Course for New Research Officers at FRI Pulau Sayak

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Participants with their certificate on the last day of training

A total of 18 newly appointed Q41 research officers comprising 11 women and 7 men attended the 2-week induction course at FRI Pulau Sayak on 5 to 16 August 2018. The course aims to provide them knowledge on the role, strategy, approach and direction of fishery research conducted by Fisheries Research Institute. Such exposure will give them a clear picture of the responsibilities that need to be taken as researchers.

Speakers invited to deliver lectures comprised of FRI directors and senior research officers. Lecture topics cover broodstock development, capture fisheries, shrimp culture, fish breeding & culture technology, environmental impact, innovation, commercialization of R&D, fish diet, research management, water quality, tuna fisheries, data analysis, aquatic plants, freshwater fisheries, deep sea fishing, diseases, toxicity analysis, coral reefs and aquarium fishes.

All participants have demonstrated good commitment in each lecture session. In the second week, they were given group assignments. All groups were able to present their assignment well. On the last day of the course, assessment test was held to evaluate the participants' understanding. The test results show that the participants have been able to answer well indicating that the purpose of this course is achieved.

Certificate of attendance was presented by Dr Zainoddin Jamari, Senior Research Director in a closing ceremony held on 16 August 2018.

SIMFONI ALAM Documentary Shooting at FRI Pulau Sayak

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The production of the cockles in Peninsular Malaysia has shown a gradual decline over the last few years. This event has been linked to various reasons such as inconsistent spat fall, weather changes, pollution, changes in water current and cockle's soil bed quality. All these issues are threatening the cockle farming industry in Malaysia. In order to create awareness to the public on this issue and at the same time to highlights what have being done by the Department of Fisheries (DOF), a meeting between the DOF and Radio and TV Malaysia (RTM) were held at Wisma Tani, Putrajaya on 19th February 2018 to produce a documentary on the declining cockles production in Peninsular Malaysia. On 21st and 22nd April 2018, the documentary shooting took place at Mollusc Hatchery in FRI Pulau Sayak, led by Mr. Jabir bin Shafie, the producer of the documentary and RTM crews. Within the two days at Mollusc Hatchery, the production team manage to cover two methods of cockle spawning used in the hatchery i.e stripping method and thermal induced spawning method. In addition, the team have successfully gathered information from other offices related to the cockles issues including the Selangor State Fisheries Office, the Perak State Fisheries Office, the National Fish Health Research Division (NaFisH), the Lembaga Urus Air Selangor (LUAS), the FRI Batu Maung and the Geology Science Department. The information shots at mollusc hatchery FRI Pulau Sayak was one of the sub-component in the 30 minutes SIMFONI ALAM documentary titled "ANADARA" which were aired on TV1 on 14th August 2018.

Shooting on cockle spawning method via thermal induced spawning of the cockles using the new mollusc spawning system developed at FRI Pulau Sayak

Cockle spawning method via stripping gonad of the blood cockle *Anadara granosa*

Symposium of Marine Capture Fisheries Research 2018

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There are several projects that have been carried out by the Capture Fisheries Division, FRI Kampung Acheh. These projects were conducted by using budget under RMK-11 for the Research Program on "The Survey of Sustainable Marine Fisheries". The research projects that have been and are currently ongoing include the assessment of pelagic fish stocks (oceanic and neritic tuna), demersal fish and shellfish (clams and crabs). Biological studies also have been conducted for both large pelagic species (tuna) and small pelagic (pelaling), sepalopods, anchovies and nebula. In order to share the research findings with other FRI and foreign agencies, a symposium was organized by FRI Kg. Acheh on 2-3 October at Auditorium Hall, RECSAM, Penang. With the theme of "Research towards Sustainability of Marine Resources", this symposium aimed to provide a platform for researchers to share their research findings and to discuss their idea on how to enhance their research performance. This symposium was also aimed to expose the stakeholders towards research findings and management framework of DOF. This symposium was inaugurated by Dr. Zainoddin Jamari, Senior Research Director and was attended by 60 participants consisting of DOF staff, representatives of the Fishermen's Association, Association of Anchovies Entrepreneur, Association of Tuna Entrepreneur and local universities.

A total of 60 participants participated in the Symposium of Marine Capture Fisheries Research 2018

Senior Research Director, Dr. Zainoddin was delivering the keynote address

The inauguration of the symposium was completed by senior research director, Dr. Zainoddin Jamari

A total of 20 oral presentations and seven poster presentations were successfully presented in this symposium. The presenters consist of researchers from FRI Kg. Acheh, Perak; FRI Batu Maung, Penang and Southeast Asia Fisheries Development Center (SEAFDEC), Chendering Terengganu. Presentations were divided according to the research category and three expert panels were assigned to evaluate the presentations.

The symposium was concluded with a discourse session entitled "Research Towards Sustainable Management - Reality and Challenge". The panels who were invited to discuss this topic consist of Tuan Haji Bohari Bin Haji Leng (Director of Resources Management Division), Mr. Abu Talib Bin Ahmad former Senior Research Director) and Dr. Alias Bin Man (Senior Research Officer from Fisheries Headquarters, Putrajaya) whereas Haji Samsudin, FRI Kg. Acheh's senior research officer act as moderator for this session.

Introductory and Biology of Commercial Fish Species Training Course at FRI Kg. Acheh

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Participants and Speaker for the training course, held at FRI Kg. Acheh, Sitiawan on 8th-11th October 2018

The ability to identify the fish species is very important to ensure the accuracy of the recorded data, which then will be used by Research Department for conducting study on fisheries stock assessment. Thus, in order to provide guidance and exposure to DOF staff on the method of identification of commercial fish species, a short course on Introductory and Biology of Commercial Fish Species was held at FRI Kg. Acheh, Sitiawan on 8th-11th October 2018. A total of 18 participants; 10 participants from G scheme, 5 participants from Q scheme, 2 participants from J scheme and a contract worker attended this course. The speakers of this course were Mr. Osman bin Muda, Mr. Sallehudin bin Jamon and Mr. Syed Yusof bin Wan Drahman. Apart from lectures, this course also had a study trip to fisheries landing jetty at Bagan Panchor. Participants were also exposed to laboratory practices on methods of identifying fish species and fish measurement techniques. Upon completing the 4-days course, participants were able to identify and classify all the commercial fish species correctly. They were also got the basic information on biology of fish species, method of fish measurement and improve skills in recording the landing data of commercial fish. This course should be conducted again in the future to provide a wider understanding of the DOF staff especially those who directly involved with the landing of fisheries.