

REGRESSION MODEL ANALYSIS FOR DETERMINATION OF *Amyda Cartilaginea* MAXIMUM BREEDING AGE

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REGRESSION MODEL ANALYSIS FOR DETERMINATION OF *Amyda Cartilaginea* MAXIMUM BREEDING AGE. Harvest quota of Asiatic softshell turtle (*Amyda cartilaginea*) in Indonesia is the largest in the world. This has an impact on the decline in wildlife populations, given the lack of ex-situ conservation efforts and the fact that exporters prefer to take from nature. Information on the reproductive biology of the turtles is very important as a basis for conservation by estimating the speed of reproduction in order to maintain their population in nature. The purpose of this study was to determine the relationship between body weight and number of eggs on morphometric variations of the Asiatic softshell turtle (*A. cartilaginea*) as the basis for determining the maximum reproductive age. The method used is observational by measuring morphometric with Curved Carapace Length (CCL), Curved Carapace Width (CCW), Plastron Length (PL) and Plastron Width (PW) techniques. The results showed that the weight of the female ranged from 3 to 7.3 kg, CCL 20-48.4 cm, CCW 17.3-31.6 cm, PL 19.6-35.8 cm, and PW 17-34.5 cm. Weight (Y) is positively correlated with CCL (X) with the equation $Y = 4.031X + 4.1885$. The number of eggs (Y) can be estimated from Body Weight (X) with the allometric formula $Y = 0.0117 X + 2.9424$. These results indicate that the strongest correlation to the number of eggs is CCL. The age structure that produces the most eggs with good quality is from the adult age structure (CCL 35-40 cm) so that it can be recommended as a superior female for captivity.

Keywords: Asiatic softshell turtle, captive, maximum breeding age, model, regression.

ANALISIS MODEL REGRESI UNTUK PENENTUAN USIA REPRODUKTIF MAKSIMUM *Amyda Cartilaginea*. Kuota panen labi-labi (*Amyda cartilaginea*) di Indonesia merupakan yang terbesar di dunia. Hal ini berdampak pada penurunan populasi satwa liar, mengingat minimnya upaya konservasi ex-situ dan fakta bahwa eksportir lebih memilih mengambilnya dari alam. Informasi mengenai biologi reproduksi labi-labi sangat penting sebagai dasar konservasi dengan memperkirakan laju reproduksi guna menjaga kelestarian populasinya di alam. Penelitian ini bertujuan untuk mengetahui hubungan antara berat tubuh dan jumlah telur terhadap variasi morfometrik labi-labi (*A. cartilaginea*) sebagai dasar penentuan usia reproduktif optimal. Metode yang digunakan adalah observasional dengan pengukuran morfometrik menggunakan teknik Panjang Lingkar Karapas (Curved Carapace Length/CCL), Lebar Lingkar Karapas (Curved Carapace Width/CCW), Panjang Plastron (PL), dan Lebar Plastron (PW). Hasil penelitian menunjukkan bahwa berat tubuh betina berkisar antara 3 hingga 7,3 kg, dengan ukuran CCL 20–48,4 cm, CCW 17,3–31,6 cm, PL 19,6–35,8 cm, dan PW 17–34,5 cm. Berat tubuh (Y) berkorelasi positif dengan CCL (X) dengan persamaan $Y = 4,031X + 4,1885$. Jumlah telur (Y) dapat diperkirakan berdasarkan berat tubuh (X) menggunakan rumus alometrik $Y = 0,0117 X + 2,9424$. Hasil ini menunjukkan bahwa CCL memiliki korelasi terkuat dengan jumlah telur. Kelompok umur yang menghasilkan telur terbanyak dengan kualitas baik adalah kelompok umur dewasa (CCL 35–40 cm), sehingga dapat direkomendasikan sebagai induk betina unggul untuk penangkaran.

Kata kunci: *Amyda cartilaginea*, penangkaran, maximum breeding age, model, regresi

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I. INTRODUCTION

Individual growth rate and age at sexual maturity are important variables for understanding the population dynamics of a species. Currently, there is very little information and research on determining the maximum reproductive age, especially for soft-shell turtle species such as *Amyda cartilaginea*, even though this species is most widely used and traded. *A. cartilaginea* is a species of reptile that is vulnerable to illegal harvesting activities due to high demand; this can be the biggest threat to this species (Böhm et al., 2013; Lukošiušė et al., 2021). One effort that can be made to preserve animals is captive breeding. To obtain basic information about genetic quality so that the success of *A. cartilaginea* hatchlings and chicks produced is good, it can be seen from the morphometric characteristics and the number of good-quality eggs produced (Lukošiūtė et al., 2021).

Morphometrics is a study related to variations and changes in body size and is useful for knowing and describing the potential of livestock quantitatively (Takandjandji & Sawitri, 2015). Morphometric characteristics can be measured through: body weight, carapace circumference length (CCL), carapace circumference width (CCW), plastron length (PL), and plastron width (PW). According to the growth chart, the achievement of CCL is one of the main indicators of achieving optimal quality egg production when in a certain growth phase (Horvath et al., 2020). However, individual responses to feed and different environmental carrying capacities during the growth phase lead to large variations in body weight at sexual maturity.

Morphometric characteristics have a positive correlation with body weight as body measurements increase, followed by an increase in body weight (Trisnawanto et al., 2012). Likewise with reproductive success, parents with certain morphometric characteristics will produce eggs of optimum quality (Trisnawanto et al., 2012; Lukošiušė et al., 2021). The

increasing age of the mother is followed by an increase in the ovulation rate, which causes productivity to reach optimal levels and will gradually decrease as the soft shell turtle gets older (Hong, 2022). Therefore, it is necessary to know the maximum breeding age for female turtles so that it can be used as a reference to determine good reproductive quality. Maximum reproductive age is the ideal age range in which an animal can produce the most optimal offspring. Therefore, it is important to know the ideal age range for reproduction. The fertility of female turtles will decrease with age. Females who have good reproductive quality are expected to have a high percentage of egg hatching success as well. So far, the predictors for knowing the reproductive age of turtles are body weight, length of carapace circumference, and width of carapace circumference (Hanscom et al., 2020 ; Hong et al., 2022), but this information still does not answer the question of the maximum reproductive age of turtles. The growth rate of freshwater turtles is characterized by juvenile growth, which can be seen from their morphometric increase (CCL, CCW, PL, and PW). Morphometric variations can affect body weight, which also affects the maximum breeding age in soft-shell freshwater turtles (Congdon et al., 1993; Naimi, 2012).

The reproductive quality of soft-shelled freshwater turtles can be seen based on how many egg follicles are produced in one female brood (Kayani et al., 2015). Morphometrics affect body weight and the number of eggs produced by the ovum. Body weight can affect the size of the CCL, and the size of the CCL will affect the quality and quantity of eggs produced. Good egg quality and quantity are characteristics of animals that have good reproductive quality. Good reproduction will affect the growth rate, which is the basis for determining demographic parameters (Hanscom et al., 2020). One of the factors that affects the maximum breeding age is the number of eggs produced by female sires. The number of turtle eggs is related to the number of oocytes produced in the ovaries. In this

process, the quality of egg cells is determined by a group of cells called follicular cells, whose development is stimulated by follicle stimulating hormone (FSH). FSH will affect the number of eggs because the greater the number of follicular cells, the better the quantity and quality of eggs (Toelihere, 1985). Longer CCL and heavier turtle weights have more FSH, resulting in more follicles (Dinkelacker et al., 2014). Therefore, it is necessary to know body weight and CCL in relation to the number of follicles so that it can be used as one of the determining characteristics of good reproductive quality.

II. MATERIALS AND METHODS

A. Time and Location of The Study

The research has been done from November 2021 until April 2022 at the Asiatic softshell turtle collector, CV. Mutiara Sunyi Pamanukan, Subang, West Java. Besides the collector, the research is also done in its natural habitat which is Mandrapaja, Subang, and Cisaat, Sukabumi, West Java. Mandrapaja and Cisaat tributary was located in at suburban area with calm flow river and sandy mud bottom water, shallow, and

there are also rocks underneath. The location of research is shown in Figure 1.

B. Material and Devices

The object used for maximum breeding age stipulation here is 10 individuals young adult and adult Asiatic softshell turtles with CCL size 20-24.9 cm (5 individuals) and CCL > 25 cm (5 individuals). Materials and equipment used in this research are hanging scales with 50 kg maximum capacity and 1 g accuracy, digital analytic scales with 5 kg maximum capacity and 0.1 g accuracy, a sack to make the scaling process easier, measurement tape with 0.1 cm accuracy, caliper and a set of minor surgical tools, namely a scalpel and scissors. The software used in data analysis is Minitab 17.0

C. Research Method

Morphometric parameters measurement was done with the curve line method, which measure by following the curvature of the body part measured (Kusrini et al., 2014). Morphometric measured includes carapace arch length (Figure 2A), carapace arch wide (Figure 2B), plastron length (Figure 2C), plastron wide (Figure

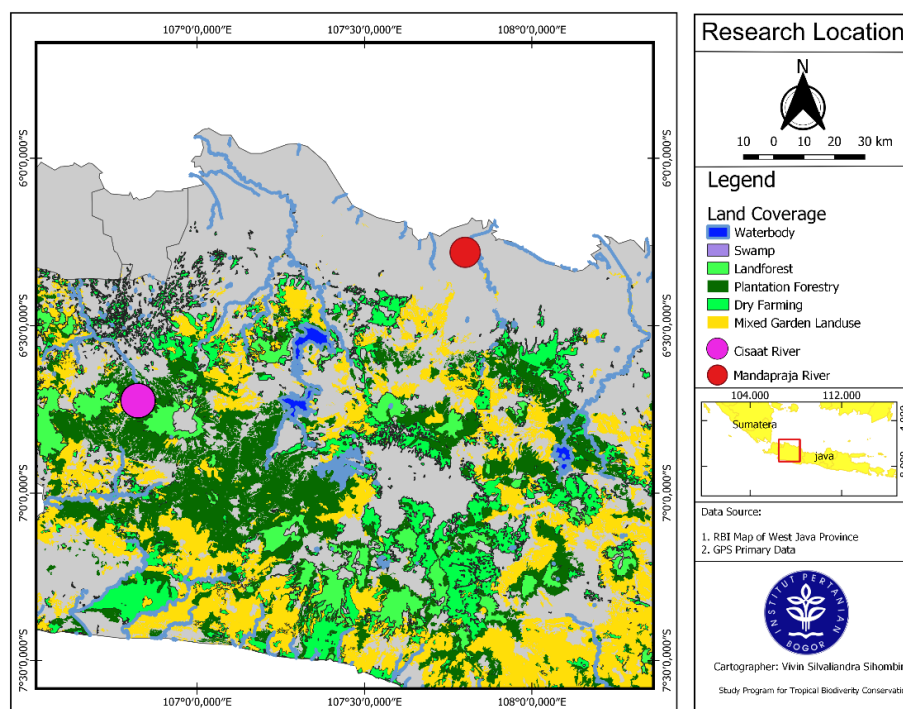


Figure 1. Map of Mandapraja and Cisaat River

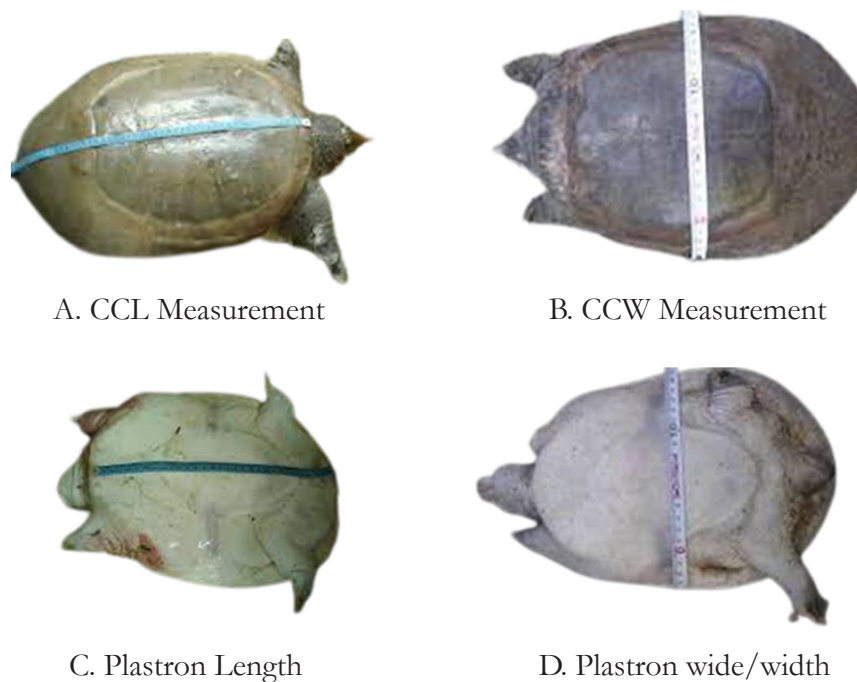


Figure 2. Morphometric parameters measurement of Asiatic softshell turtle

2D), and body weight. The Asiatic softshell turtle body mass measurement by scaling each individual obtained using a hanging scale.

Observation of the cross-section of adult male and female Asiatic softshell turtle reproductive organs and counting the number of eggs is carried out by performing surgery on young adult Asiatic softshell turtle individuals size CCL 20-24.9 cm and adult size CCL >25 cm (Kusrini et al., 2009). The Asiatic softshell turtle cut on the abdomen from anterior to posterior. The cut part is then split to open the abdomen and the eggs are counted. The eggs were grouped according to their diameter.

D. Data Analysis

Data The data that has been collected is grouped based on its age structure. Furthermore, it was analyzed according to Ghazali (2016), namely using the average difference test (t-test) to test the research hypothesis regarding the effect of each independent variable (X_1 = CCL, X_2 =CCW, X_3 = PL, and X_4 : PW) individually. partial to the dependent variable (Y: body weight). The regression test results were obtained with a 95% confidence level

and a significance level of 5% ($= 0.05$). If the significance value of the t test is 0.05, then H_0 is rejected and H_a is accepted. That is, there is an influence between body weight on CCL, CCW, PL, and PW and the number of eggs. Body weight distribution was analyzed using Minitab 17.0 software by inputting CCL and CCW data and the number of eggs in the distribution chart. The steps taken in determining the frequency distribution of CCL size and turtle body weight are to determine the maximum and minimum values of all CCL, CCW, and turtle body weight data; determine CCL and CCW from class intervals; determine the frequency class; and enter the frequency of each class of each variable. Linear regression analysis was conducted to examine the relationship between turtle body weight (independent variable) and the number of eggs laid (dependent variable).

III. RESULTS AND DISCUSSIONS

A. Adult Asiatic Softshell Turtle Morphology

Adult female Asiatic softshell turtle has longer, curvier, and wider carapace (Figure 3A)

and shorter tail (Figure 3C) rather than male adult Asiatic softshell turtle. Male adult Asiatic softshell turtle is shorter, smaller, more flat, and longer tail which protruding from the carapace (Figure 3D). The color of female carapace is blackish brown (Figure 3A), and the cloaca hole is grey (Figure 3C). Male carapace has light brown colour (Figure 3B), with pink tail base and cloaca hole is white (Figure 3D). Figure 3B, with pink tail base and cloaca hole is white (Figure 3D).

B. The Asiatic Softshell Turtle Reproduction Biology

Softshell turtle sexually reproduces and need internal fertilization (Xinping et al., 2015). After doing surgery on the male Asiatic softshell turtle which has 3kg body weight and size CCL 29.4 cm and CCW 25 cm, the reproduction consists of a couple of testicles in a round shape, smooth surface, and yellow color which means it is mature for its gender. Testicles in male Asiatic softshell turtle located on the middle wall of

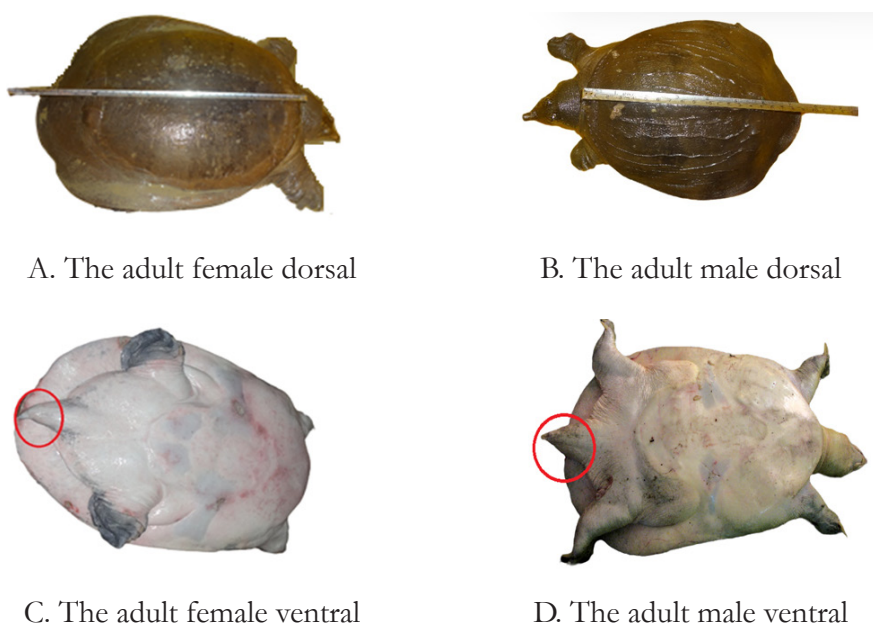


Figure 3. Asiatic softshell turtle morphology

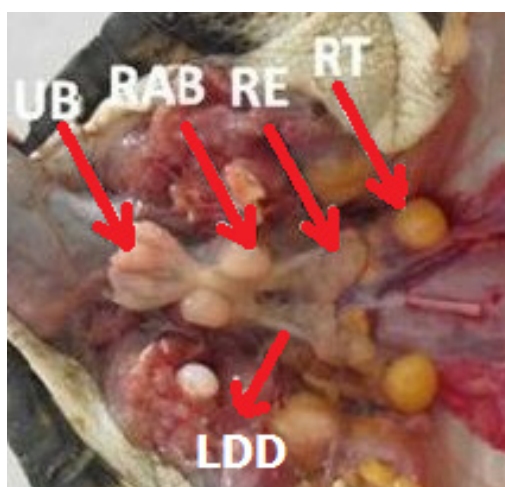


Figure 4. Male adult Asiatic softshell turtle reproduction organs. Notes: UB = urinary bladder, RAB = right accessory urinary, RE = right epididymis, RT = right testicles, LDD = left ductus deferens

the abdominal cavity (abdomen) and attached strongly. Weight for both testicles reaches 3% of the mass which is 90 g. Other than a couple of testicles, male reproduction could be seen in Figure 4. On an adult male Asiatic softshell turtle, there are a couple of ductus deferens that work to carry sperm to the penis. Testicles function to produce spermatozoa that would stream to the sperm tract to the urogenital hole. The urogenital hole is a hole where the gender and urine tract disembody, so through this urogenital hole spermatozoa would be taken out. The reproduction activity of the Asiatic softshell turtle happened by way of cloaca which also functioned to take out feces and urine. As stated by Olsson and Madsen (2006), most reptiles such as snakes and turtles have copulatory, that is the penis that is commonly pulled or inverted and put inside the body or the tail base.

Male reproduction organs and other organs that exist in the abdominal cavity of *A. cartilaginea* are covered by thick fat tissue and placed directly under the abdominal wall muscles. This fat tissue is also taken and heated up to turn into castor oil that believed could cure any disease. After the fat was taken, the male Asiatic softshell turtle's reproduction organs could be seen clearly in the abdominal cavity (Figure 8). For information, all procedures in this study were carried out by veterinarians with

attention to animal welfare and minimizing risks and discomfort, in accordance with applicable ethical guidelines and regulations.

After surgery on female adult Asiatic softshell turtle that weight 7 kg with size CCL 48.4 cm and CCW 31.6 cm, adult female Asiatic softshell turtle consists of uterus, ovarium, longitudinal formed oviduct, infundibulum, and follicle with various diameters (Figure 5). Follicles are liquid bags that contains mature oocyte to form egg cells. The sign of mature gender female Asiatic softshell turtle is follicles with diameter > 3 cm (Mumpuni & Riswanto, 2010). From the result of a research, the total eggs weight of Asiatic softshell turtle after scaling 3.150 g (45% from the Asiatic softshell turtle weight). Determination whether adult female an Asiatic softshell turtle has proper ovarium or not depends on the weight of antral follicles. If total follicles reach $>40\%$ from body weight it could be considered normal because the amount and supply of proper eggs to reproduce (Zhu et al., 2013).

Asiatic softshell turtle's ovarium is placed close to the intestines, filling two per three abdominal cavities or nearly covering organs inside the body. Ovarium functioned to produce egg cells or ovum (Kitayama et al., 2021). Furthermore, according to Lubian et al. (2025) ovum is taken out from the ovarium to the oviduct (eggs tract) which later goes to

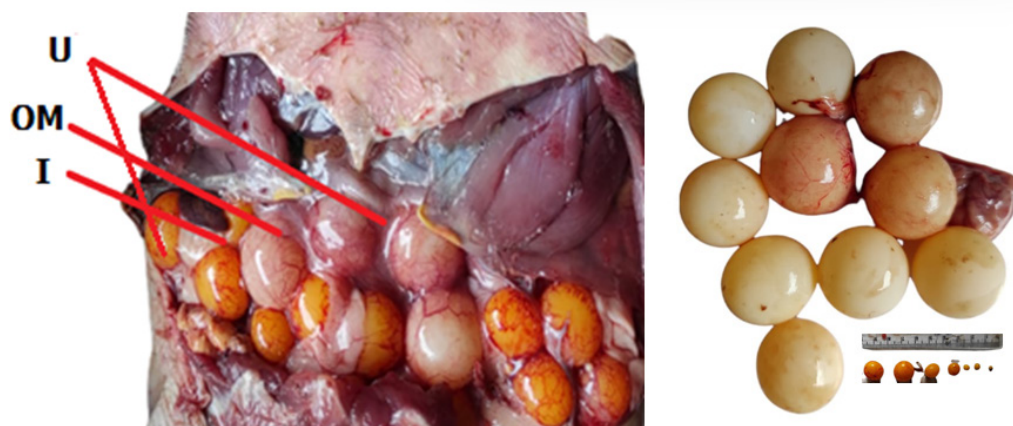


Figure 5. Adult female reproduction organs and various sizes of follicles. Notes: U = uterus, OM = ovum, I= isthmus

the infundibulum. When the ovum is mature enough, it will be collected by infundibulum, then to the oviduct, and if it is ready to fertilize it would go out through the cloaca. As the male, feces and urine are also thrown out through the cloaca

C. Morphometric Size of Asiatic Softshell Turtle

The results of morphometric data measurements on 10 individual turtles, including carapace circumference length (CCL), carapace circumference width (CCW), plastron length (PL), plastron width (PW), and body weight (BB), are presented (Table 1).

The results of morphometric data and body weight according to Kusrini et al. (2009) classified into two age categories: young adult (3.9 – 5 years old with 20-24.9 cm CCL) and adult (> 5 years old with >25 cm CCL). Data grouped according to weight and morphometric data to test the results of the regression equation that could determine which variables that mostly related. The result of Olukole (2014) research, for African side-neck turtle (*Pelusios castaneus*), it is considered an adult if it is have 15-25 cm CCL (1,1 – 2 years old) and the CCL is >30 cm (>3 years old).

D. Correlation Between Body Weight with Morphometric Data Asiatic Softshell Turtle

Understanding the correlation between body weight with morphometric has several important functions, including: assessing health and physical condition, this correlation can be used as an indicator of softshell turtle health. For example, if a turtle's weight does not match its carapace circumference, it could indicate a health problem or nutritional deficiency. In conservation or captive breeding programs, understanding this relationship helps determine growth standards, determine age, and identify healthy turtles optimal for reproduction. Based on this relationship, breeders and researchers can make more accurate decisions regarding food, environment, and care that support optimal turtle growth.

The results of the CCL analysis with body weight obtained positive allometric values as presented in Figure 6 and Table 2. Based on the graph, the following equation is obtained: $Y = -1.18 + 0.103X_1 + 0.112X_2$; This means that for every 1 cm increase in the length of the carapace circumference, it will increase the turtle body weight by 0.103 kg, and if there is an increase of 1 cm in the carapace circumference,

Table 1. Morphometric size of *A. cartilaginea*

No	CCL (X_1) (cm)	CCW (X_2) (cm)	PL (X_3) (cm)	PW (X_4) (cm)	BB (Y) (kg)
1	48.4	31.6	35.8	34.5	7.3
2	40.2	31.0	33.5	33.2	6.7
3	36.0	30.8	33.0	30.0	5.8
4	34.0	30.0	30.8	29.0	5.5
5	30.0	28.0	28.0	27.4	5.0
6	28.0	26.0	27.3	26.0	4.6
7	26.0	25.0	24.5	22.5	4.5
8	25.0	20.4	22.0	20.3	3.4
9	23.0	18.8	20.7	19.7	3.2
10	20.0	17.3	19.6	17.0	3.0
Average	31.06	25.9	27.52	25.96	4.9
SD	8.23	5.09	5.42	5.62	1.38

it will increase the turtle body weight by 0.112 kg. This gives an indication that the potential of aquatic resources (rivers), which are the natural habitat of the turtles, including their carrying capacity, feasibility, habitat suitability, and feed availability, is still lacking. This has implications for the condition of the turtles caught in the Mandrapaja River, which are generally rather thin when compared to the turtles in East Kalimantan. The physical condition of the turtles caught in West Java tends to be emaciated as a result of the small intake of feed required

for their feasibility to grow and develop. Other factors that make the morphology of the spiders in West Java smaller than those caught in Kalimantan are the relatively fast currents, the influx of household waste, and the heavy metal content. These factors make the waters in West Java not optimal for the optimal development and growth of turtles. The value of the correlation between body weight and morphometric data can be seen in Table 2. For graphical images of the correlation of body weight and CCL, see Figure 6.

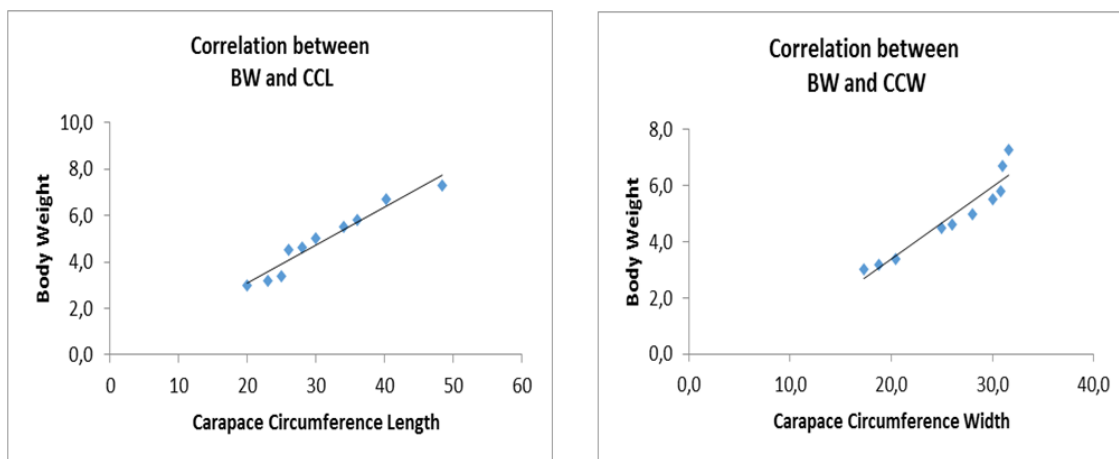


Figure 6. Weight correlation between CCL and CCW

Table 2 . The relationship between the length of the carapace circle and the width of the carapace circle on the turtle body weight

Regression Statistics				
Multiple R				0.992196284
R Square				0.984453465
Adjusted R Square				0.980011598
Standard Error				0.206391632
Observations				10

	Coefficients	Standard Error	t Stat	P-value
Intercept	-1.184851522	0.352235259	-3.363807256	0.0120216
CCL (X_1)	0.102905688	0.016805269	6.12341825	0.0004799
CCW (X_2)	0.111572068	0.027168458	4.106676546	0.0045348

Based on the results of the analysis, a multiple correlation value of 0.99 was obtained, this stated that the relationship between the length of the carapace circumference and the width of the carapace circumference on the turtle body weight was very strong (Table 2).

Based on results, P-values of 0.0005 for CCL and 0.0045 for CCW. This indicates that both variables have a statistically significant effect on the softshell turtle's body weight at the 0.05 significance level. Furthermore, since the P-value for shell circumference (X1) is lower, it can be concluded that shell circumference is the most significant predictor of the turtle's body weight. Therefore, the CCL can be used to predict the weight of a softshell turtle without the hassle of weighing the heavy turtle. Simply measuring the CCL allows us to predict the weight of a softshell turtle.

E. Correlation Between Body Weight and Eggs Number

Data on body weight and number of eggs are presented in Table 3. The relationship between body weight and the total number of turtle eggs ranged from 130 to 340 eggs per brood. Based on the results of the analysis, a correlation value of 0.8995 was obtained, which means that the correlation between turtle body weight and the number of eggs is high. The relationship between the body weight of

the turtles and the number of eggs tends to be linear (Figure 7). By using analysis of variance, the value of $P = 0.047 \pm 0.05$ was obtained, so it can be concluded that the body weight of the turtles has a significant effect on the number of eggs; it also means that the correlation between turtle body weight and the number of eggs is significant.

Based on the data above, it can be seen that those that produce the best eggs are in the CCL of 30-36 cm, which in the CCL has the most number of eggs among the others, namely as many as 288, 300, and 340 eggs.

Table 3. Correlation between Body Weight and Eggs Number

Body wight (kg)	Egg number
7.3	280
6.7	277
5.8	340
5.5	300
5.0	288
4.6	230
4.5	279
3.4	244
3.2	267
3.0	130

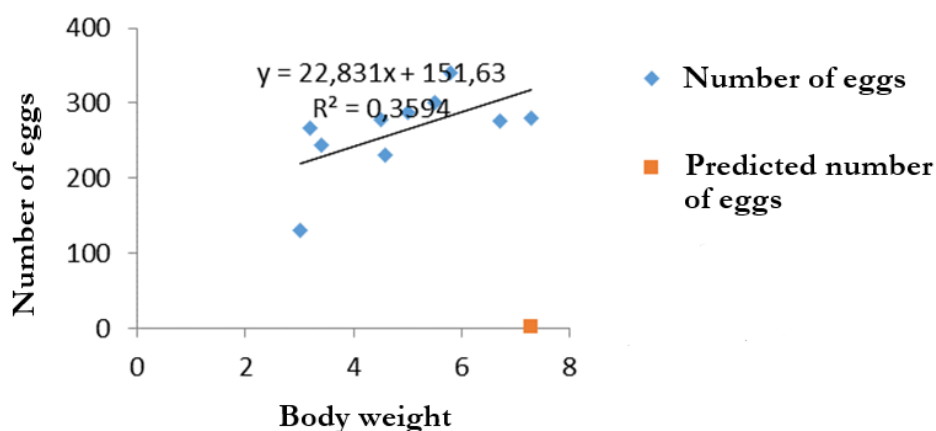


Figure 7. Correlation of body weight with number of eggs

Based on the results above, it can be concluded that the regression equation is $Y = 151.63 + 22.83X$, which states that every 1 kg increase in turtle body weight will increase the number of eggs by 23 eggs. According to the results of Olukole's (2014) research, every 1 kg increase in body weight of the African sideneck turtle (*Pelusios castaneus*) will increase the number of eggs by 15 eggs. One that affects the number of eggs is the feed. According to Swarth et al. (2013), the number of softshell turtle eggs that are fed fish and molluscs can reach 250-350 eggs per parent.

F. Correlation Between CCL Size and Asiatic Softshell Turtle Reproduction

As many as 10 females with the longest CCL were used to see how many immature eggs (eggs with <3 mm follicles), mature eggs (mature eggs that have >3 mm and have corpora lutea) such as shown in Figure 8A, and maturing eggs (eggs that have size >5 mm but clear, aqueous with defective/damaged/no egg yolk) such as shown Figure 8B. The average reproduction range and parameters of adult female Asiatic softshell turtle could be seen in (Table 4).

Relationship between morphometric parameters and average reproduction range of female adult Asiatic softshell turtle used 10 individuals with biggest CCL which i.e. range 40 - 48.4 cm could be seen in Table 4 and Figure 9. The result of CCL research affected egg production, quality, and hatching

success rate. It is because CCL is related closely to the age and gender maturing of the Asiatic softshell turtle mother. The longer the distance between the oviduct and the cloaca, the bigger and the more advance the mature egg to come out. The result of this research is in accordance with Iverson and Moler (1997) whom it stated that the increase of carapace circumference on Florida softshell turtle (*Apalone ferox*) would give a significant change to the clutch egg rate, production, eggs eight, and hatching weight.

Table 4. Female adult *A. cartilaginea* reproduction range and parameters average

Variable	N	Mean $\pm$ SD	R a n g e (scope)
CEL (mm)	10	24.65 $\pm$ 2.26	21-28.2
CEW (mm)	10	24.4 $\pm$ 2.34	21.4-27.8
CS (jumlah)	10	17.3 $\pm$ 4.93	12-27
RCS (%)	10	2.91 $\pm$ 0.49	2-3.97
EM (g)	10	0.19 $\pm$ 0.04	0.16-0.28
REM (%)	10	0.033 $\pm$ 0.003	0.03-0.04
CM (gr)	10	270.41 $\pm$ 13.98	2.8-5.6
RCM (%)	10	0.78 $\pm$ 0.091	0.65-0.92

Notes: Clutch Egg Length, CEW = Clutch Egg Width, CS = Clutch Size, RCS = Relative Clutch Size (CS/BB), EM = Egg Mass, REM = Relative Egg Mass (REM = EM/BB), CM = Clutch Mass, RCM = Relative Clutch Mass (CM/BB)

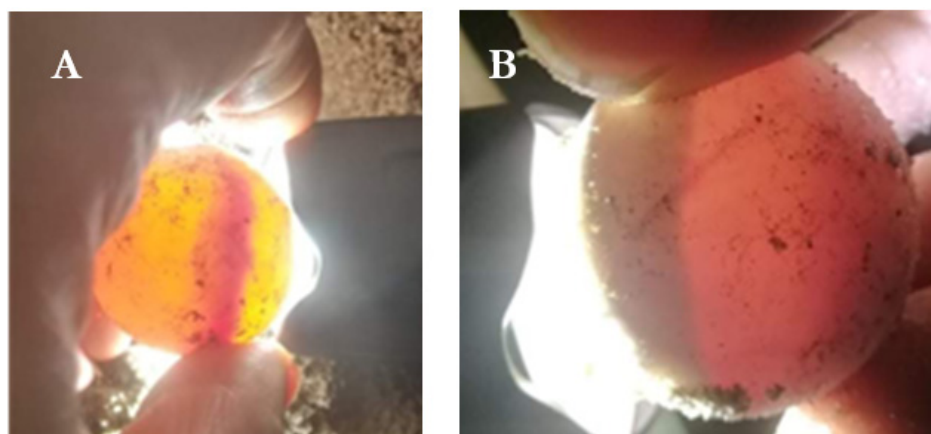


Figure 8. Mature (A) and immature egg (B) of female asiatic shoftshell turtle

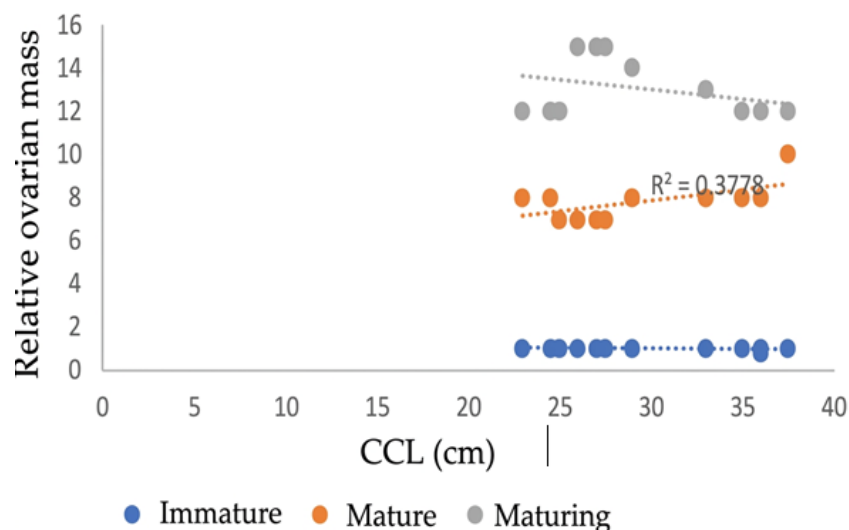


Figure 9. The relation between CCL and ovarium mass

Mature eggs' regression coefficient value is 0.377. Each addition 0.005% of maturing eggs, then mature eggs decreased by 0.377. Generally, the determination value from this equation is 74.3% which means mature eggs number are influenced by the 74.3% CCL variable, and the rest of it is affected by other variable factors such as CCW, PL, and PW ($r = 0.96$; $P < 0.0001$). Based on the result of Olukole et al. (2014) research, the number of *Pelusios castaneus* eggs could be seen from CCL, the bigger the carapace circumference, the more eggs produced.

Based on the results of the analysis above, a correlation value of -0.58 was obtained, indicating that the relationship between turtle body weight and immature egg quality was moderate and had a negative direction. Based on the results of the analysis above, a correlation value of 0.46 was obtained, indicating that the relationship between turtle body weight and mature egg quality was moderate and had a positive direction. Based on the results of the analysis above, a correlation value of 0.57 was obtained, indicating that the relationship between turtle body weight and maturing egg quality was moderate and had a positive direction. This means that the increasing weight of the turtles is followed by the decreasing number of immature eggs.

Research shows that softshell turtles can reproduce between the ages of 5 and 8 years and reach peak reproductive productivity at a specific age, usually at full maturity and maximum breeding age (around 8 to 12 years). During this age range, turtles typically exhibit optimal reproductive performance, including maximum egg production and good reproductive quality. Before reaching adulthood, egg production tends to decrease, and after a certain age, egg production can decline due to aging.

IV. CONCLUSIONS AND RECOMMENDATIONS

A. Conclusions

From the result of the research for young adult and adult group Asiatic softshell turtle obtained average value, standard deviation, Asiatic softshell turtle population growth pattern coefficient analysis is positive allometric for the relation between carapace circumference length with body weight. This condition gave meaning that growth pattern length development is more dominant than biomass growth. It indicates that water resource potential especially the compatibility of habitat and the availability of food resource in the natural habitat Mandrapraja river relatively less so it implicates on the Asiatic softshell turtle

morphometric condition that generally a bit skinny. For carapace width growth pattern with body weight is also positive allometric which means the addition of body weight is faster than body width.

For correlation between CCL and egg number, it could be concluded that the size of the carapace of the Asiatic softshell turtle could be used to determine the reproductive level of the Asiatic softshell turtle. The bigger CCL the number of eggs are produced. But, the egg quality that is healthy and could be hatched well needs a mother who has 20-40 cm CCL to be a superior female Asiatic softshell turtle because on that CCL size of Asiatic softshell turtle are experiencing peak reproductive period. >40 cm CCL and weighted >7 kg produced many immature eggs which are not good for the success of hatching eggs but are in demand for consumption because of the larger egg size. According to the research result, CCL could be used as a benchmark to determine the maximum reproductive age for an Asiatic softshell turtle. Asiatic softshell turtle reproductive age based on the research result is 9-12 years old range.

B. Recommendations

The high demand for reptiles, especially freshwater turtles such as *Amyda cartilaginea* makes the Asiatic softshell turtle prone to overuse. Entrepreneurs often relied on harvests from nature to export raw materials. Harvesting has to be accompanied by preservation so that its availability in nature is not disturbed. Not all of the reproduction efforts in Asiatic softshell turtle captivity succeed, a lot of obstacles appeared and not working. To improve egg hatching success rate, the result of this research recommends using superior females with 9-12 years old age range and 3.5-6 kg weight also ideal CCL (20-40 cm). This paper could be a recommendation for entrepreneurs or trade managers in carrying out captive business as well as a guide on how to select healthy brooders that could reproduce well to save costs.

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