

Length –Weight Relationship, Feeding and Reproductive Study of Wolf Herring, *Chirocentrus Dorab* (Clupieformes: Chirocentridae)

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Abstract:

*This study was conducted to investigate the morphometric and feeding and reproductive of dorab wolf herring in the coastal waters. Trophic level and some aspects of the feeding and reproductive biology of Wolf Herring were studied. Population growth was estimated using length (L) , weight (W) relationship with the equation $W = a L^b$. Results show that b value for *C. dorab* (3.043) was close to 3.0, showing*

*isometric growth pattern meaning that the increment of length are almost equal to increment of weight; also the intercept a was 0.00334 and ($r^2 = 0.99084$) indicating a high degree of positive correlation between total length and total weight for *C. dorab*. The dominant length of the *C. dorab* wolf herring is 33.9 – 89 cm and dominant weight ranges from 150 grams - 2800 grams. Estimation of reproductive potential through gonadosomatic index calculation was also conducted, which was at range between 0.546 - 11.078 with the calculated GSI mean of 4.13 and there is a positive relationship between GSI and total body length. The correlation coefficient, regression equation and significance correlation of fecundity found to be highly correlated with total fecundity of 187979, mean number of eggs (7968 ± 1861.4), mean total length of (72.4333 ± 3.3) cm and mean total weight of (1590 ± 157.7) grams. Results illustrated that small fish were the most abundant prey items in the stomach of wolf herring.*

Key words; Wolf Herring, feeding, reproduction, morphometrics.

Introduction

Limited previous studies have been found so far about the species itself (wolf herring), although the fact that many studies had been found about the order (clupeiformes). Therefore the present study is designed to investigate some biological information on wolf herring species, although it is not suit and detail due to time constrain.

The fish of the order clupeiformes include anchovies, herrings, sardine, menhadens, shads, gizzard shads, wolf herrings and their

relatives. A global capture production of the Clupeiformes was 19,000,000 tons in 2003, representing about 25% and in 2015 raised up to 53 % of the total annual catch of all fish (marine and freshwater). In regard to their economic importance, the clupeiforms have been the subject of many studies covering diverse biological areas related to fisheries sciences, yet relatively few studies have addressed the relationships among these fishes. A well-supported phylogenetic hypothesis among the major groups of clupeiforms is still lacking. The clupeiforms are distributed worldwide, with 401 valid species. Most of them inhabit marine tropical and sub-tropical coastal areas, with several groups being Euryhaline and anadromous ([Whitehead, 1985](#)). Several species, from various lineages of Clupeiformes, are also known to live exclusively in freshwater environments, such as the African pellonulins ([Whitehead, 1985](#); [Lavoué, Miya et al. 2007](#)). Such particularities make this group of great interest for studies of the mechanisms of marine/freshwater transitions and their associated physiological adaptations.

Chirocentrus dorab species of fish belonging to the family Chirocentridae, order Clupeiformes is exclusively marine in habitat, occurring in the Indian Ocean and in the western Pacific to Japan and eastern Australia. The fish's metric and meristic characters, age by scale, condition, sex and maturity stage (Maier's scale), and also their jaws are equipped with fanglike teeth for catching and holding prey. In addition, they superficially resemble members of the herring family, Clupeidae, having elongate, silvery bodies with forked tails. Because of their large

size [average length about 1.5 m (5 feet)] and predatory habits, wolf herrings are a threat to many other species of fish ([Whitehead, 1985](#)).

The differences in the morphometric and meristic characters of a species between regions may result of differences in genotype, environmental factors operating on one genotype, or both of these acting together ([Lewandowski, Scurlock *et al.* 2003](#)). While both morphometric and meristic characters respond to changes in environmental factors, their responses are different in some situations. The meristic characters, e.g., numbers of vertebrae and keeled scales are fixed in the early embryonic stage of the individual, which is a short period of the life span, and afterwards remain unchanged ([İşmen, 2001](#)). On the other hand, morphometric characters are not sensitive to short-term, local fluctuations, and reflect average differences over long periods between environmental factors in different areas ([Parrish, 1958](#); [Parrish, 1958](#)) and ([Weimerskirch, 2001](#); [Gushchin and Corten, 2015](#)).

The current study is aimed to figure out the morphomeristic characters of wolf herring, Investigate the feeding and reproduction biology of wolf herring.

Materials and Methods:

Sample Colocation:

Samples were collected from south-eastern coastal water of Peninsular Malaysia using otter trawler. Additional samples were obtained from central market Seri Kembangan Selangor.

Analytical Work:

Morphometrics Approach: is applied which a field is concerned with studying variation and change in the form (size and shape) of organisms. The studying characteristics are total length (TL), standard length (SL), head length (HL), dorsal fin length (Ld), pectoral fin length (PL), eye diameter ([Blaber, Brewer *et al.* 1999](#)), snout length (SnL), body depth ([Amenzoui, Ferhan-Tachinante *et al.*, 2006](#)). The length and body depth, head length, depth of the body and eye diameter were measured with the help of meter scale to the nearest millimeter. All morphometric measurements were made following Pillay (1957). The LWR is principally important in parameterizing income equations and in valuations of stock mass. This relationship is useful for calculating the weight of a fish of a given length and can be used in studies of gonad growth, level of feeding, metamorphosis, maturity and condition ([Froese, Tsikliras *et al.* 2011](#)). Length-weight relationships were calculated using the least squares regression on log transformation of the equation:

$$W = a L^b$$

Where W = body weight (g) & L = the total length (cm), (a) is the intercept, and (b) is the slope (fish growth rate) ([Sangun, Akamca *et al.* 2007](#); [Pathak, Zahid *et al.* 2013](#)). A computer programme Microcal Origin Version 6.0 was used to calculate values of a and b, ([Simon and Mazlan, 2008](#)). The calculated value of b provides information on fish growth. If the value of b = 3 the growth is isometric .When the value of b is other than 3, weight increase is allometric, (positive allometric if b>3, negative allometric if b<3) ([Sangun, Akamca *et al.* 2007](#)). Analysis of Stomach was conducted by composition and trophic level.

After calculating the individual lengths and weights of the sixty (60) samples of wolf herring fish, the stomach from 30 fish were removed and its contents were analyzed under a microscope. A digital balance (Ohaus, Adventurer Model) was used for all weight measurements to the nearest 0.01 g. The total weight was determined by subtracting the weight of an emptied stomach tissue from the weight of a stomach before its contents was emptied. The samples of stomach contents were then separately placed inside plastic containers and preserved further in 10% buffered formalin solution.

Stomach contents of wolf herring were recognized according to the food items listed in TrophLab. The food items were verified in percentage and evaluated with TrophLab. Trophic levels are normally expected from diet structure data, covering the entire range of food items eaten by *C. dorab*. Troph (and its standard error) can be predictable, from the mean trophic level of the wolf herring.

The fecundity examination:

It was distinguished between ovaries and testes in a mature samples during examination. Fecundity, considered as the total number of eggs present in mature gonad (ripe), was estimated from 3 females which selected randomly. The length (cm) and the weight (g) of each sample were measured, then the ovaries of the female were taken out very carefully and gonad weight was also recorded. 5mm from three different locations of each ovary: interior, posterior and middle sections were taken, weighed (g) and preserved in labeled vials with 20 ml Gilson's fluid. The three sections for each fish were left for one week in Gilson's

fluid. The eggs were counted under a microscope with help of a needle. Gravimetric method was followed for determining the fecundity of the fish.

$$\text{Fecundity} = \frac{\text{total Gonad wt (g)} \times \text{No. of eggs}}{3 \text{ part wt}}$$

The Gonadosomatic Index (GSI): 16 of female samples were calculated separately as $\text{GSI} = (\text{GW}/\text{BW}) \times 100\%$, where GW is gonad wet weight (g), and BW is body wet weight (g) (excluding gonad weight).

$$\text{GSI} = \frac{\text{Gonad weight} \times 100}{\text{Fish weight}}$$

Results and Discussions:

Diagnostic Characters:

Physical diagnostics characters of the wolf herring found to be very elongated, highly compressed and the fish is blue-green above, often with a tinge of violet, and silvery on the sides and belly (Figure 1.1) but without pelvic scutes along the abdomen. The compressed body and silvery scales serve as camouflage in the open waters of the ocean, scattering light and helping to conceal herring from predators attacking from the deep ([Moyle, 1995](#)). However, sex cannot be determined from external characters.



Figure 1.1: Diagnostic Characters

Mouth directed upwards. Eyes are relatively small with eyelids completely covering the eyes. Dorsal fin is short and set behind midpoint of the body.

Size Composition:

Length ranges between 32.5cm to 89 cm. The average total length is (48.6 ± 14.5) cm. Weight ranges between 121.74 grams to 2800 grams. The average total weight of 61 samples is (876.4 ± 642.8) grams.

Morphometric Measurement:

Morphometric measurements have been conducted in all sixty (60) samples using Pearson Correlation. The morphometrics measurement is summarized in Table (1.1) and it illustrates the mean representing the average characteristics of wolf herring.

Table 1. 1: Statistical Results Using Pearson Correlation of the Morphometric Characters

No	Variables	Mean	SD	1	2	3	4	5	6	7
1	Pectoral Fin Length	5.64	1.86	1						
2	Snout Length	2.63	0.97	0.985**	1					
3	Dorsal Fin Length	3.42	1.05	0.978**	0.974**	1				
4	Head Length	7.51	2.47	0.985**	0.974**	0.964**	1			
5	Body Depth	8.39	2.81	0.985**	0.981**	0.982**	0.973**	1		
6	Eye Diameter	1.29	0.36	0.991**	0.974**	0.978**	0.976**	0.984**	1	
7	Standard Length	41.04	12.98	0.989**	0.989**	0.989**	0.983**	0.989**	0.983**	1

**** Significant at (p < 0.01)**

In defining the relationship between standard length as the dependent variable over all of the independent variables (Snout, Pectoral Fin, Dorsal Fin, Head length, Body Depth and Eye Diameter), the results (Table 4.1) have proved all variables have positive strong significant relationship with standard length, and it is almost perfect. Where all of the ($r = 0.98$, $p < 0.01$) and only 1% probability of error in determining all of the relationship of all the parameters. The relationships between all the morphometric characteristics are correlated between one another and all showed positive and strong significant relationship.

Length and Weight Relationship:

Length and weight statistics obtained from all sixty (60) specimens of *C. dorab* are given in table 1.2.

Table 1. 2: Length and weight results for 60 samples:

No	Construct	Mean	SD	1	2
1	Total Length	48.6	14.5	1	
2	Total Weight	876.4	642.8	0.973**	1

**** Signifant at (p < 0.01)**

Table 1.2 shows the relationship between the total weight and total length. Total weight has a very strong relationship with total length with the value of 0.973. The total length ranged between 32.5 – 89 cm and the mean length of the fish is 48.6±14.5. The total weight for *C. dorab* locates between 142-2800 gram and the mean weight of the fish is 876.4± 642.8 gram. The differences between the length and weight may be caused by the difference in location and therefore differing growth characteristics, also differences in exploitation and density. In proving the relationship between length and weight of Wolf Herring fish, all regressions were highly significant($r = 0.973$, $p < 0.01$) and showed an absolutely strong relationship between both contract and only 1% would be tendency of error in determining the relationship.

The linear relationship of weight and length are shown in Figure (1.2) Length-weight relationship was derived from 60 *C. dorab* samples. The *C. dorab* ranged from 33.9 to 89 cm in total length and 150 to 2800 g in total body weight. The exponent b value for *C. dorab* (3.043) was close to 3.0, showing isometric growth pattern meaning that the increment of length are almost equal to increment of weight. Similar results have been

found for the thread herring, *Opisthonema oglinum* (Clupeidae) by (Vega-Cendejas, Mexicano-Cíntora *et al.* 1997).

In contrast, the mean exponent ($b = 2.66$) of the length-weight relationships of 12 populations of *Pellonula leonensis* (clupeidae) (Ezenwaji and Offiah, 2003). Indicated negative allometric function .The intercept a for *C. dorab* was 0.00334 and correlation coefficient r^2 was 0.99084 indicating a high degree of positive correlation between total length and total weight for *C. dorab* (Fig. 4.2). The length-weight relationships of *C. dorab* have not been formerly recorded in Malaysia or in another place.

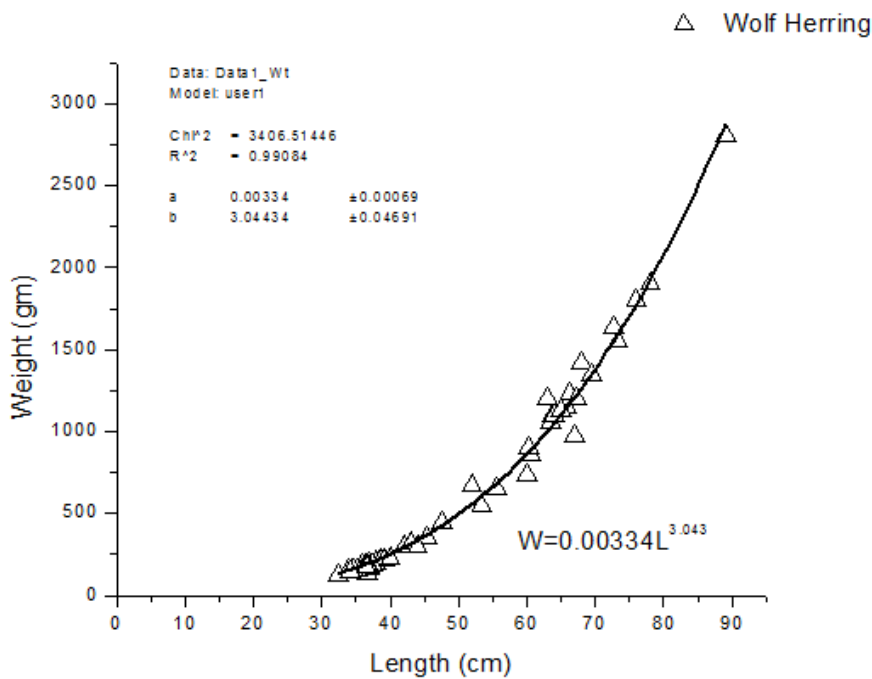
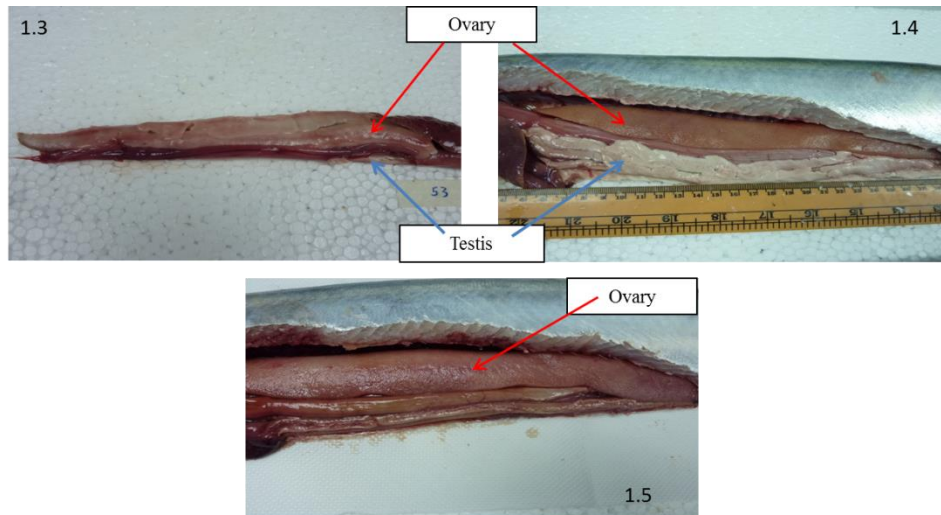


Figure 1.2: Length – Weight Relationship of Wolf Herring

Reproductive Biology of Wolf Herring:

Fecundity:

Results of sixteen dissected fish for the weight and length of gonad have showed that wolf herring has testis only and the ovary is thin undeveloped (Fig 1.3) when the fish is small size (less than 900 gram and length ranges between 32 -50 cm). However, as the wolf herring is growing (approx. between 900 – 1800 gram and length between 50-70 cm) It is evident that *C. dorab*, is a protandrous hermaphrodite fish where both ovaries and testes found in a single fish (Fig 1.4) .The ovary increases in size and traces of testis can be seen when it becomes very big in size (approx. more than 1800 gram and length is more than 70 cm) (Fig 1.5) consecutively the fish change from male to female (protandry).



Figures 1.3 the dissected wolf herring with large testes and thin undeveloped ovary
Figure 1.4: the wolf herring with both ovaries and testes (hermaphrodite) in single fish
Figure 1.5: the wolf herring that contains ovary only when this species change from male to female

The hermaphrodite life history form of this species was previously unidentified, but is similar to that of protandrous tropical Shad *Tenualosa macrura* (Clupeidae) ([Blaber, Brewer et al. 1999](#)), *T. toli* ([Blaber, Milton et al. 1996](#)), although *C. dorab* has different body weight and length from tropical shad. The fisheries for *C. dorab* target the larger females. It is now identified that it is protandrous hermaphrodites. Probably the protandrous habit has reduced these species exposed to overfishing and directed to their severe population and geographic declines.

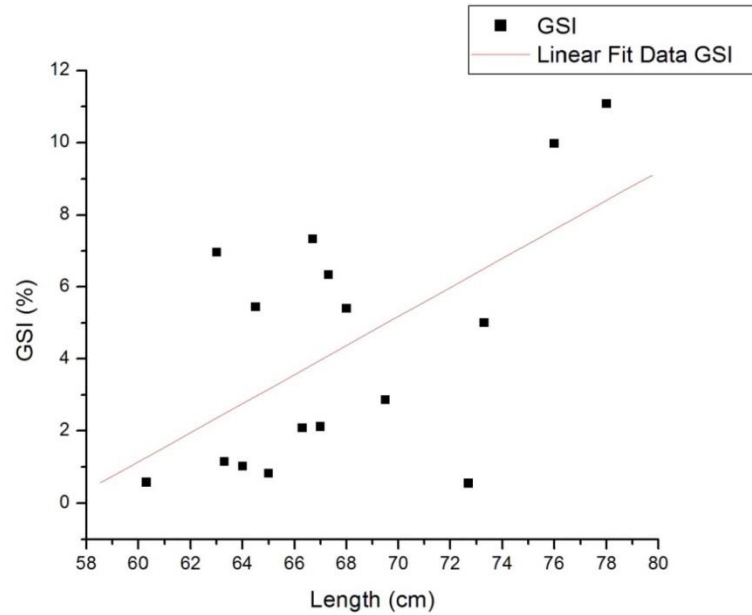
For the fecundity examination of Wolf Herring, three samples those selected randomly from the 16 fish as shows in Table (1.3) displayed a data with mean number of eggs of (7968 ± 1861.4) , a mean total length of (72.23 ± 3.3) cm and mean total weight of (1590 ± 157.7) grams and produces mean of total fecundity of 187979. The highest fecundity of 226761 was observed in a sample 3 fish having 1800g body weight and 76cm total length. The lowest fecundity was 163784 was found in the fish with 68cm and 1420 body weight. This study revealed that the bigger body size and longer the length of the fish, the most fecund is the fish. These results are consistent with those of ([Óskarsson and Taggart, 2006](#)) who studied Icelandic summer-spawning herring (*Clupea harengus*). Similar finding was also observed for tropical shad *T. macrura* (Clupeidae) ([Óskarsson and Taggart, 2006](#)), carp *Lepidocephalus guntea* by Banu et al. (1992), catfish *Mystus tengra* by Khan et al. (1992) and *Plotosus canius* by Khan et al. (2002). Fecundity of fishes may vary depending on several factors among them are population, species, size, age and ecological conditions ([Rohul, Ahammad et al. 2008](#)).

Table 1. 3: Mean Fecundity Counts at various length parameters:

Sample	Total Length	Total No. of eggs	Weight of sub sample	Total Body Weight	Gonad Weight	Fecundity
1	68	6311	2.8	1420	72.77	163784
2	73.3	7025	2.99	1550	73.8	173393
3	76	10568	7.61	1800	163.29	226761
Mean± sd	72.4±3.3	7968±1861.4	4.5 ±2.2	1590±157.7	103.3±42.4	187979±27701.9

Gonadosomatic Index:

The gonadosomatic index is an indicator of the gonad development of the Wolf Herring. The length of 16 sample of *Chirocentrus dorab* ranged from 60.3 cm to 78cm .The gonadosomatic index varied between 0.546 to 11.078 and the calculated mean GSI was (4.3±3.3) for *C. dorab*. The GSI was calculated using the formula $GSI = (GW/BW) \times 100$ and all data including weight of ovary, total weight of fish, eviscerated weight are measured.



Figures (1.6) illustrate the relationship between the length of fish and GSI. The correlation between GSI and total body length was made for each sample and a positive relationship between GSI and total body length were found, as the length of *C. dorab* rise the GSI also increase. Similar trends have been found for other clupeids such as *Sardina pilchardus* where GSI trends by size ([Amenzoui, Ferhan-Tachinante et al. 2006](#)) and for anchovy (*Engraulis encrasicolus*; [Fabbri, Chen et al. 2008](#)).

Stomach Content:

Stomachs content from 30 specimens of wolf herring were analyzed (Fig 4.7); up to 9 preys were found per stomach. Although 63% of stomachs were nearly full of the preys of which mainly fishes, 37% were found empty. Result from this study indicated that the dorab Wolf Herring primarily feeds on small fish only and certain food could not be identified because of their advanced state of digestion. (For example

sample no. 10). This finding was expected, because it is in broad agreement with that of other studies ([Hardy, 1924](#); [Beverton, 1987](#); [Ludsin and DeVries 1997](#); [Dalpadado, Ellertsen et al. 2000](#); [Darbyson, Swain et al. 2003](#)).

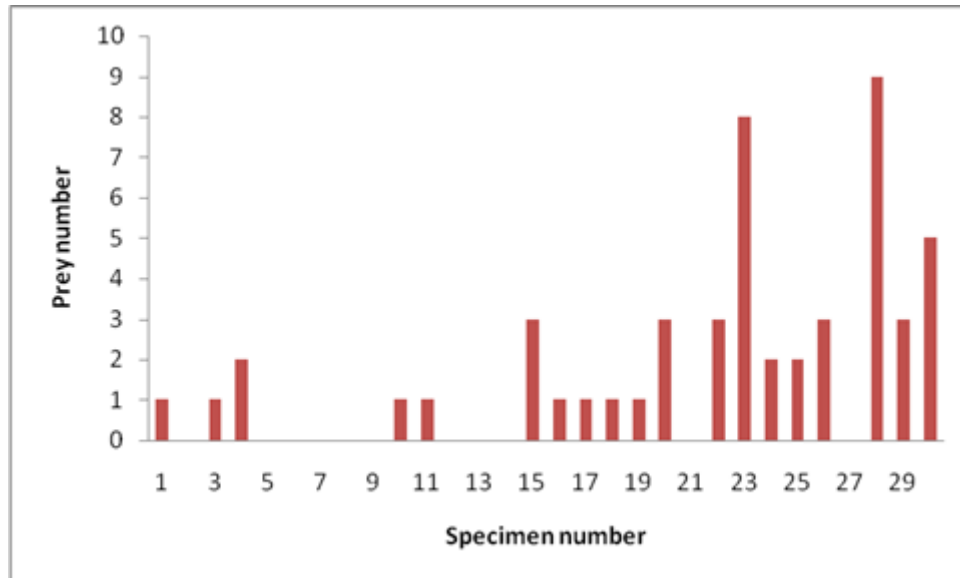


Figure 1.7 Food Content in the Stomach of Wolf Herring

The result of the study indicated that this species feeds primarily on small fish and nearly half of the samples were empty even in the bigger sample size which is in contrast with other studies where the fish feeds on variety of preys like crabs, shrimp ([Darbyson, Swain et al. 2003](#)). In comparison another clupeidae such as the thread herring, *Opisthonema oglinum* showed that immature individuals feed mostly on plants, molluscs and crustaceans (70%), while during the maturation process fishes are the main prey ([Vega-Cendejas, Mexicano-Cíntora et al. 1997](#)). Different results on Norwegian springs herring *Clupea harengus* showed

that this herring feeds on copepods during immature herring while mature herring consume various organisms where the copepods, euphausiids, and hyperiids are major prey groups ([Huse and Toresen 1996](#); [Dalpadado, Ellertsen et al. 2000](#); [Darbyson, Swain et al. 2003](#); [Darbyson, Swain et al. 2003](#)). In contrast, some pelagic fish such as sardine (*Sardinops sagax*) ([Libster, Bugna et al. 2010](#)) and anchoveta (*Engraulis ringens*) feed mainly on zooplankton and few phytoplankton ([Prokopchuk, 2009](#)).

This study includes only mature fish which feeds only on small fish but may be the immature fish has different food content or the feeding of this fish could be affected by environmental and ecological conditions like temperature, season, competition, feeding area. Feeding of wolf herring could be affected also by factors related to the fish itself like the length, weight, the growth. For example, Prokopchuk (2006) stated that as fish grows the maximal size of its available prey increases([Prokopchuk, 2009](#)).

The estimated trophic level for *C. dorab* showed with trophic level of 3.6 ± 0.34 (Table 1.4) This study show that wolf herring is largely carnivorous or predator. From Figure (1.8), *C. dorab* shows fluctuates trophic level range from 3.1 to 4.50. There were no individual among 19 fish with trophic level less than 3 which means that wolf herring is not herbivorous although there were digested food besides the fish in the stomach of wolf herring which couldn't be identified due to digestion. The highest trophic value (4.5) belongs to wolf herring which has more prey items in the stomach than digested food; this is may be because it was in very fresh condition.

Table 1.4 Trophic level of C. dorab:

Trophic (C. dorab)	Mean	Sd	Se	Min	Max
	3.6	0.341	0.0783	3.09	4.5

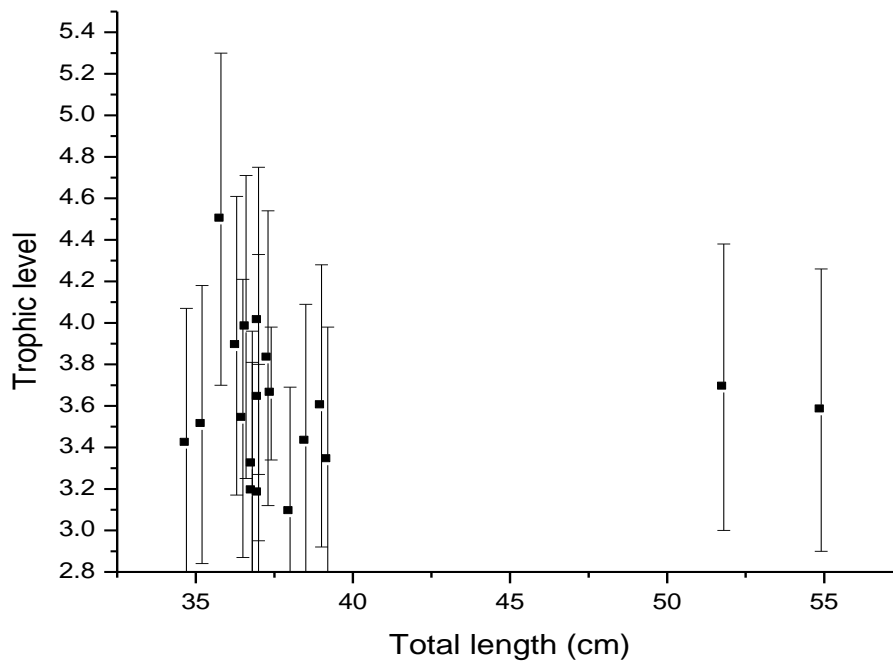


Figure `1.8 Trophic level of wolf herring C.dorab

Conclusion:

This study contributed to a growing understanding of the biology and morphometric characters of wolf herring, *Chirocentrus Dorab* locally known as “*Ikan parang*”. There were 60 specimens measured and analyzed. The morphometric characters selected for the study were total

length, standard length, snout length, body depth, dorsal fin length, head length and eye diameter. Dorab wolf herring fish shows a length range from 33.9 – 89 cm while the weight ranges from 150 grams - 2800 grams. The study of length-weight relationship with the equation $W = a L^b$ indicated a positive strong relationship between length and weight also showed that this species was isometric growth. Wolf herring apparently highly fecund and fecundity increases linearly with body length, body weight, ovary weight, and eviscerated weight. However, this study proved that *C. dorab* is protandrous hermaphrodite fish. Also, the correlation between gonadosomatic index (GSI) and total body length found to have a positive relationship. *C. dorab* has trophic level ranged between 3.1 ± 0.6 and 4.5 ± 0.8 . So, this species was carnivores where it preys on small fish.

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