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The Gills Area of Two Species of Marine Water Crabs: The Blue Swimming Crab, *Portunus pelagicus* (Linnaeus, 1758), and the Chinese Mitten Crab, *Eriocheir sinensis* H. Milne Edwards, 1853 from the North- West Arabian Gulf and Shatt Al-Arab River , Iraq.

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Abstract : The present study was conducted on the gills structure and the gill surface area of 40 individuals of the Blue swimming crabs, *Portunus pelagicus*, and 40 Chinese mitten crabs, *Eriocheir sinensis*, specimens of the species were collected from the different regions of Shatt Al- Arab and North-west Arabian gulf. Both species were having eight phyllobranchiatesas of the same structure but different in length and surface area. The second gill in *P. pelagicus* shows major difference in shape from the other gills with missing platelets from one side of the filament. The results showed there were positive relationships between dry body weight with gill surface area, total number of platelets and number of platelets surface area in each gill. The gill surface area had no significant difference (p>0.05) with dry weight in the two species.
Key words: *Portunus pelagicus*, *Eriochrir sinensis*, gill structure, Crustacea.

Introduction

Crustaceans are one of the most various types of animals, they range from microscopic creatures to massive spider crabs; there were nearly 44000 species had been identified to date in all over the world (Sternberg *et al*., 1999). The two most common crabs species the blue swimming crab, *Portunus pelagicus* (Linnaeus, 1758), and the Chinese mitten crab *Eriocheir sinensis* H. Milne Edwards, 1853 were belonging to the brachyuran, decapods, distributed throughout the coastal margins of the tropical regions of the Indian and Pacific Oceans, including Australia and Thailand (Clark *et al*., 2006; Tina, 2015). The first actual record of a "mitten crab" in Iraq may date back to 1980 when S.D. Salman (pers. comm. in letter to J.M. Bishop dated 17th April, 2006) reported possible collection of mitten crabs from the Shatt Al-Arab and later from the Marshes, Shatt Al-Arab and Shatt Al-Basrah. This suggests that there has already been a long period (over 30 years) (Clark *et al*., 2006). The crab life -cycles is characterised by migrations in waters with changing salinities. The migrating species occurs in rivers, estuaries and marine habitats of cold temperate to tropical climate areas, these species are tolerant to High pollution waters (Onken *et al*., 1995).

The Aquatic crustaceans respiratory system operates similarly in all of them, as the organism's breath dissolved oxygen water in gills, the spongy structure of the gills is thought to aid in their functions as water storage areas for long periods (Garcia *et al*., 2004). Hawkins & Jones, 1982 have suggested that the crab *Helica crassa* which constructs burrows in sediment towards high tide limits and in semi-terrestrial area, has the same gill formula and weight specific gill platelet number as *Macrophthalmus hirtipes*. Sultan (1993) reported that the gill area per gram, number of platelet per gram and platelet surface area are correlated strongly with dry body weight in the crab *Sesarma boulengeri* (=*Chiromantes boulengeri*). Sultan (2010) showed that the gill area, number of platelets, platelet surface area and filament length per gram are strongly correlated with dry body weight. There is reduction in both gill area per gram and number of platelets per gram from small sized to large sized crabs. The present study aimed to investigate the gill structure, gill surface area of the crabs, *P. pelagicus* and *E. sinensis* and compare our findings with that reported for other species.

Material and Methods

Eighty crabs were collected by fishing net (trawler) from different regions of Shatt Al-Arab and North- West Arabian Gulf during 2017. The specimens were brought alive to the laboratory. To distinguish *Eriocheir sinensis* from *E. hepuensis*, *E. japonica* and *E. ogasawaraensis* the morphometric characteristics are followed by Guo *et al*. 1997; Komai *et al*. 2006; Naser *et al*., 2012). Then weighted (the dry weight). To observe the branchial chambers, first and second maxilla and first maxillipeds were removed. The exposed gills were examined under a microscope and classified according to position of region. Gills were removed from one side of the animal and each mounted in distal water. The images were taken by digital Sony camera. Using Varneir Caliper to the nearest 0.1 mm. The length of each filament was measured and the number of platelets were determined. The gill area measurement was made, according to Hawkins & Jones (1982) and calculated from the formula:

$$A = 2N_g \Sigma\, 2N_P\, a$$

Where,

N_g: the number of gills (1-8 for each species).

N_p: the number of platelets along each filament.

a: the surface area of an average sized platelet.

It was assumed that the gill area sized of the right branchial chamber is the same as that of the left side.

Results

The branchial chamber of the crabs *P. Pelagicus* and *E. sinensis* contains eight phyllobranchiate gills and three epipods in the thoracic appendages on each side. No sexual dimorphism was found in the gill structure or in the gill area, therefore the data are treated jointly from both sexes.

P. pelagicus showed that the maxillipeds region contains the first three gills and all epipods (Plate 1). The second gill shows major difference shape from the other gills, with missing platelets from one side of the filament as seen in (Plate 2a). The fifth gill is the longest one while the first is the smallest one (Plate 2b). The shape of the platelet gill is like a triangle (Plate 3).

E. sinensis contains eight phyllobranchiate gills and three epipods (plate 4), all the gills are in the same shape and structure but with different length. The fifth gill is the longest one while the first is the smallest one (Plate 5). The shape of the gill platelet is triangular (Plate 6)

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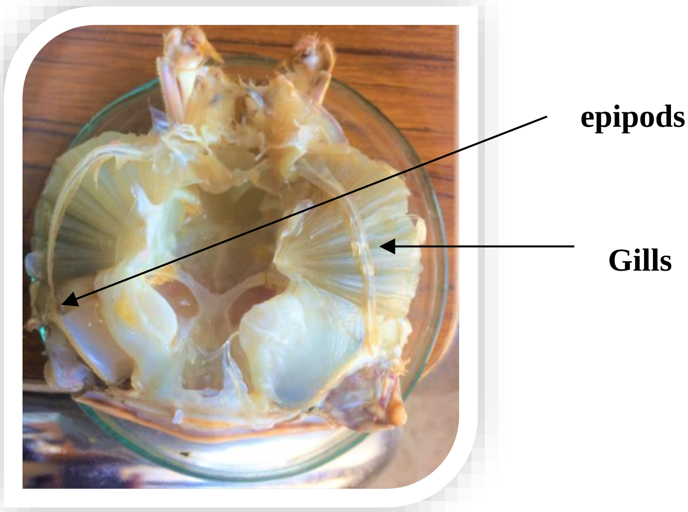

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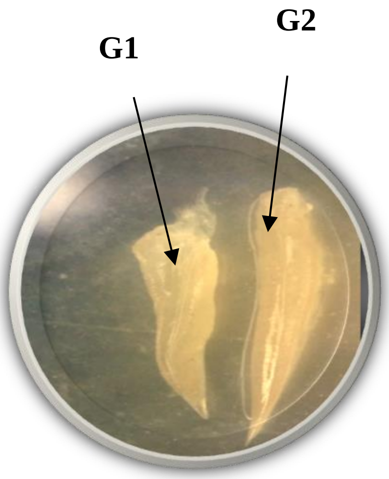

3 b

3 a

Plate (1): *P. pelagicus*, gills and epipods.

Plate (2). *P. pelagicus*, the shape of the gill platelet:

plate (3a): The 8 gills, plate (3b), The first and second gills of *P. pelagicus* .

G1: First gill, G2: Second gill, G5: Third gill.

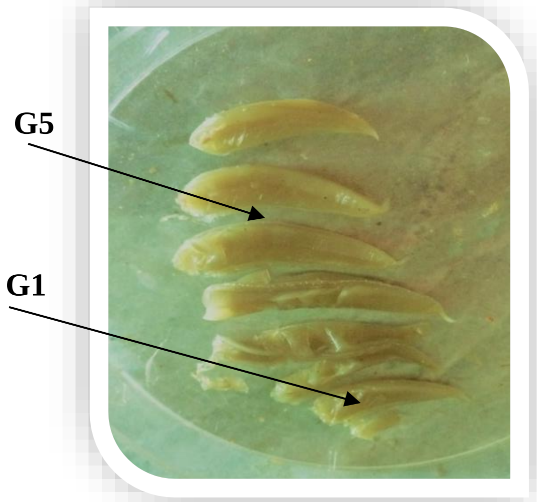

Plate (5): *E. sinensis*, the eight gills.

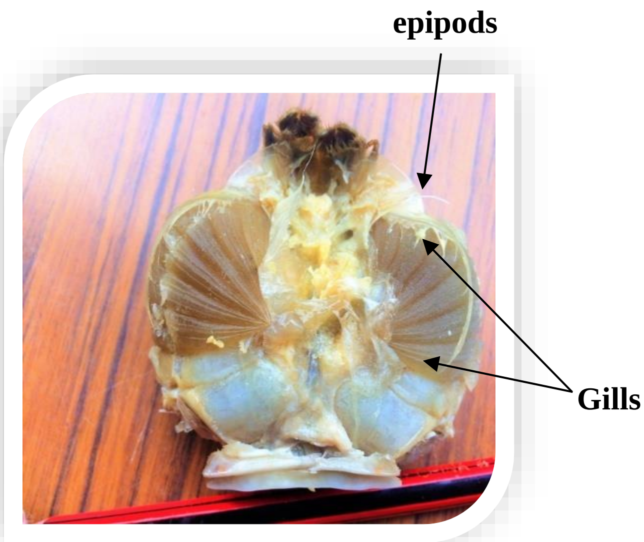

Plate (4). *E. sinensis*, gills and epipods.

Plate (6): The shape of the gill platelet in the *E. sinensis*.

To find the correlation between dry body weight and gills measurement using curve liner regression (the power formula):

$Y=aX^b$

Y= Gills measurement (the platelet surface area in each gill, the length of filament, total number of platelets in each gill, gill area)

X = Dry body weight (g).

Figs. (1 and 2) shows the power form of the positive correlation,(r= 0.83 and r = 0.81) between dry body weight and total number of gill platelet in the eight gills for both species *P. pelagicus* and *E. sinensis* respectively. The relationship between dry body weight and average of gill platelet area (mm^2) of both species are shown in Figs. (3 and 4), r = 0.84 and r = 0.74 respectively. Figs. (5 and 6) shows the variation in the relationship between the dry body weight and average filament length (mm), r= 0.84 and r= 0.75, of both species respectively. Figs. (7 and 8) show the relationship between the average platelet area in each species and the dry weight, r=0.8 and r=0.54, respectively. The total surface area(mm^2) has been shown in Figs. (9 and 10), show the regression formulae between dry body weight and the

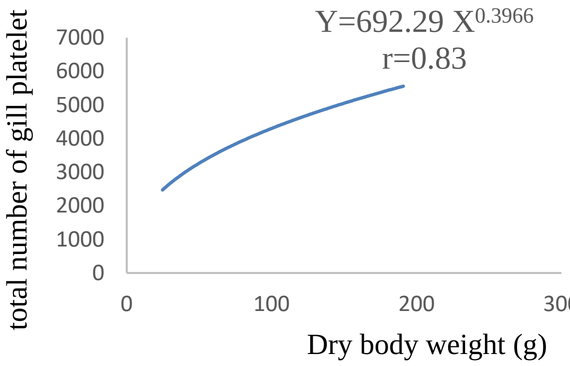

Fig. (1): Total number of gill platelet in eight gills of *P. pelagicus*.

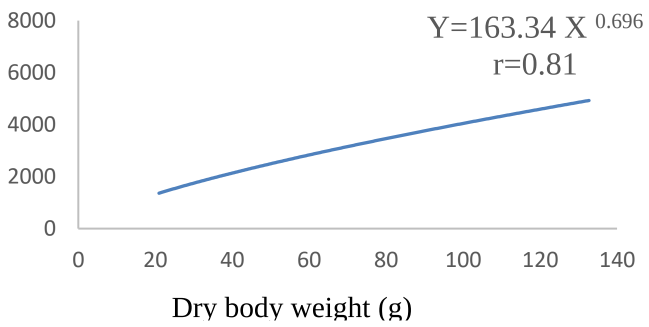

Fig. (2): Total number of gill platelet in eight gills of *E. sinensis*.

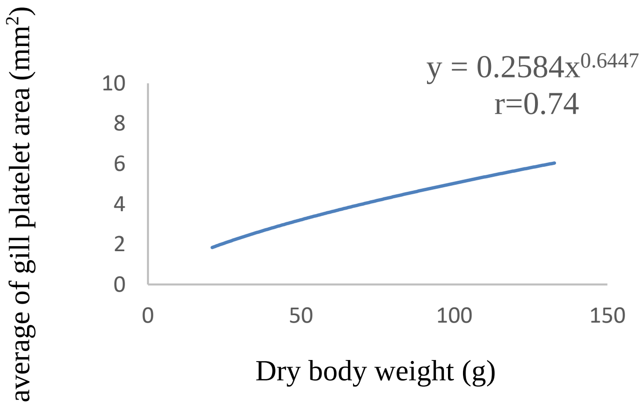

Fig. (3): Average of gill platelet area of *P. pelagicus*.

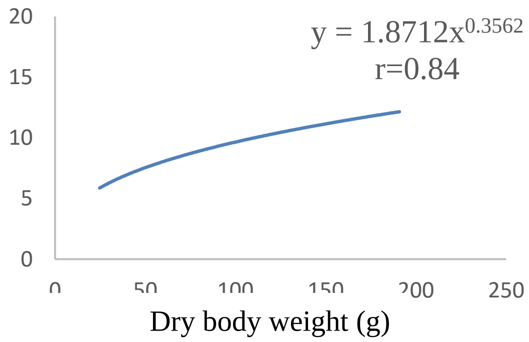

Fig. (4): Average of gill platelet area of *E. sinensis*.

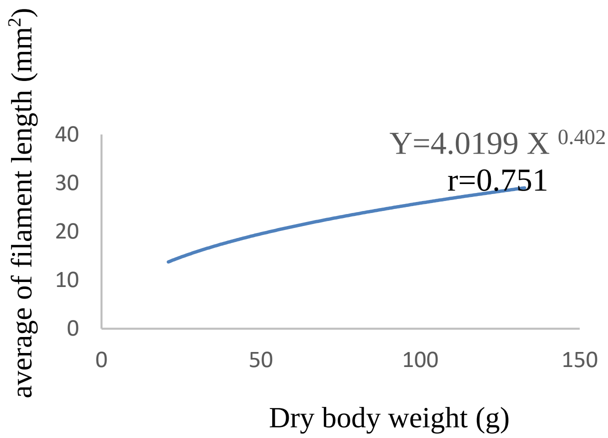

Fig. (5): Average filament length of *P. pelagicus*.

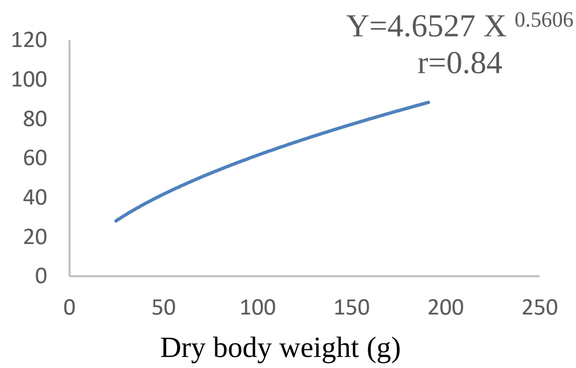

Fig. (6): Average filament length of *E. sinensis*.

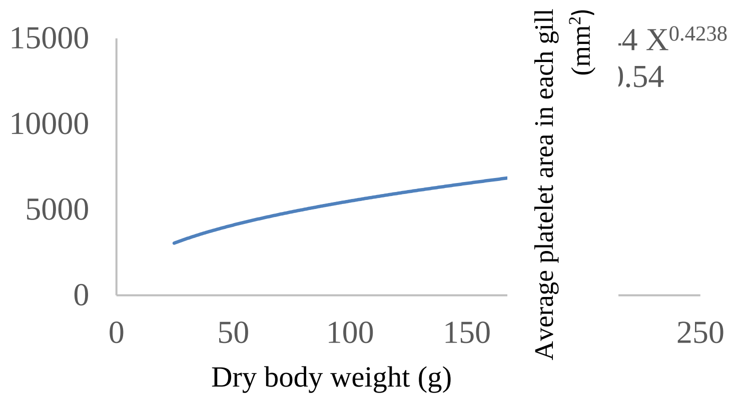

Fig. (7): Average platelet area in each gill *E. sinensis.*

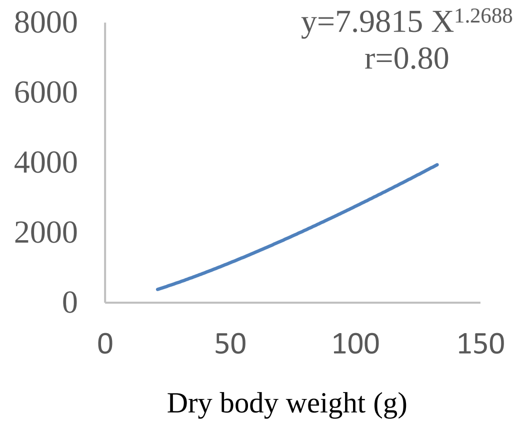

Fig. (8): Average platelet area in each gill *P. pelagicus* .

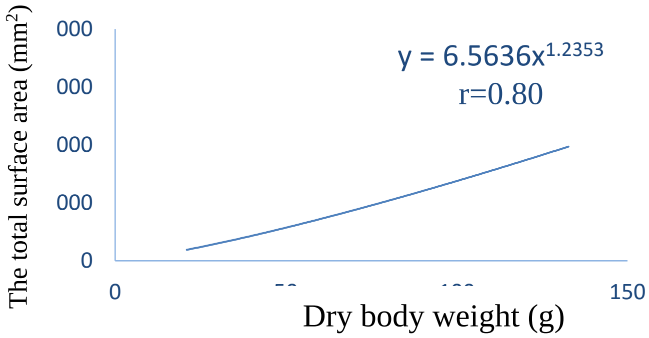

Fig. (9): The total surface area of 16 gills of *P. pelagicus.*

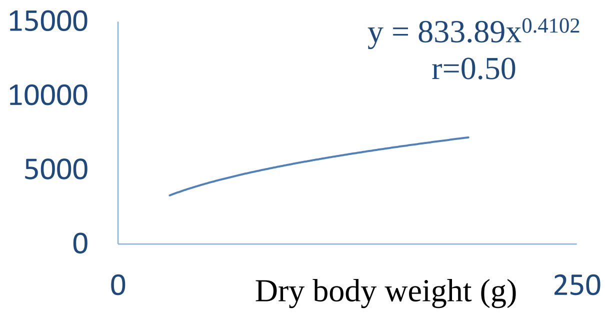

Fig. (10): The total surface area of 16 gills of *E. sinensis*.

total surface area of 16 gill of both species, r= 0.5 , r= 0.8 respectively.

Discussion

Clark *et al*. (2006) recorded *Eriocheir sinensis* based on single non-ovigerous female mitten crab captured in Iraq. Naser *et al*. (2012) caught additional from Iraq and Kuwait, and studied morphological and DNA analysis and confirmed that the species identified as *E. hepuensis* Dai, 1991 instead of *E. sinensis*. The mitten crab of present study identified as *E. sinensis* based on the distinguishing characters between dorsal carapace morphology between closely species (*E. hepuensis* and *E. sinensis*) that demonstrated by Naser *et al.* (2012).

Due to the catadromy of mitten crab species, and considering the natural distribution of *E. hepuensis* and its congeners, it appears that the Hepu mitten crab inhabits subtropical and tropical regions, while *E. sinensis* is restricted to more temperate climates. Therefore *E. sinensis* has successfully invaded mainly temperate regions in central and northern Europe and North America and *E. hepuensis* might be much better adapted for the subtropical climate in the Gulf region, thus implying that an even larger area of the world may be at risk of *Eriocheir* invasions (Naser *et al*, 2012), while, Low *et al*. (2013) reported the sighting of *E. sinensis* in Singapore, the first record of this species in the wild from the tropics and subtropical. Most recently, it was recorded in subtropical western Asia (northern Iran). The crustacean are breath to that of fish in the way that they function. Gills are necessary for gas exchange and osmotic regulation, waste disposal and ammonia, high levels can be caused huge harm, distortions in gill's morphology and histology structure of the gills for crabs, and dissolved oxygen in water through their gills, a crustacean respiratory system is very similar caused mortality (Weihrauch *et al*., 2009). Aquatic crabs generally have large gills with very thin closely packed lamellae, which greatly increase the diffusing capacity of the respiratory system (Farreley & Greenaway, 1994).

Table (1): Comparison of the gill area (mm^2) and gill platelets number in various branchyuran from different habitat obtained from Gray (1957).

Brachyuran Crab	Average of body W.w (g)	Average. of platelet no.g^{-1}	Average of gill area $mm^2.g^{-1}$	Habitat
Callinectes sapidus	142	62	1367	Aquatic
Areneus criberus	122	53	1301	
Ovelipes ocellatus	17.7	192	1288	
Hepatus epheliticus	44.3	84	1099	
Portunus gibesii	10.3	321	1003	
Portunus spinimanus	29.8	170	901	
Libinia dubia	147.2	48	748	
L. emarginata	194.9	31	566	
Portunus pelagicus	190.2	125.2	865	
*Portunus pelagicus**	217.99	533.5	5581	
Menippe meroenaria	162.7	56	887	Low tide
Panoneous herbstii	19.2	135	874	
*Eriocheir sinensis**	174.34	397.5	1502.9	
Uca pugnax	2.1	487	770	Intertidal
U. pugilator	2.3	321	624	
Sesarma reticulates	8.9	183	579	
S. boulengeri	4.17	1229	1026	
S. cinerea	1.5	840	638	Above tide
Ocypoda albicans	45.8	31	325	

***Crab of present study**

In general, both aquatic species *P. pelagicus* and *E. sinsesis* are living in the same aquatic habitats at low tide zone therefore they didn't bear drought. for long time (Gray, 1957). It was found that both species have eight pairs of filaments (16 gills). Takeda *et al*. (1996) recorded that the number of gill platelet and gill area differ in different habitat, some other is difference in the of filaments. In view of the fact that the number of platelets are closely related to the habitat, Josileen & Menon (2004) suggested that the aquatic brachyurans breath by gills as is the case in *P. pelagicus*.

Figs. (3 and 4) showed that the gill area increased when the crab grow larger, the higher rate is found in large- sized crabs than in small ones, similar relationship was reported in *Libinia emarginata* (Greenaway, 2003). The second gill in *P. pelagicus* vary among the other gills by lacking the platelets from one side as the cases in *Macrophthalmus* sp., *Uca* sp. and *Ocypode* sp. (Romano & Zeng, 2007), whereas in *E. sinsesis* the gills are all of the same structure, and similar pattern of gills is found in *Sesarma boulengeri* (= *Chiromantes boulengeri*), *Helicacrassa* (Sultan, 1993). The relationships between total platelet surface area and dry body weight in the two species were significantly different. The present results indicated that large crabs of 50-200 g in *P. pelagicus* and 25-150 g in *E. sinensis* had specific gill area 5581mm^2 and 1502.9 mm^2 respectively, indicating that the dry body weight increase with the total number of gill platelet however, individuals with more than 150 g were more tolerant of variety of conditions and has the lesser number of gill platelets (Burd & Brinkhurst, 1984).

Comparatively, the number of gill platelets in crabs which live in high and low littoral zone are more than those in the inter- tidal zone, this associated with development of respiratory efficiency of about 100 times more than gills (Dejours, 1981).

Data on the platelets number and gill area of different weight of crabs are arranged according to habitat are given in table (1). The present results of *P. pelagicus* and *E. sinensis* are compared with those of other species. The number of platelets and gill area showed that both species are aquatic and are of low-tide zone. Gary (1957) has reported that the rate of metabolism and habitat have an effect on the gill area of the various species.

Sultan (2010) reported that the total surface of gill area depended on the gill platelet area in *P. pelagicus* and the regression coefficient (b) of the relationship between the platelets surface area and the dry body weight is significantly less than 1 for all the eight gills. Inter sample regression analysis indicated no significant differences ($P > 0.05$) between platelet surface area and dry body weight for all the eight gills.

Conclusion

A clear variation were noticed among the lengths of the swimming crab, *P. pelagicus* where, the first is the smallest one while the fourth and fifth are the longest. The shape of the second gill shows major difference from those of the other gills with missing platelets from one side of the filament. Each gill contain filaments and number of platelets. The branchial chamber in the mitten crab, *E. sinensis* contain eight phllobranchiate gills that were of the same shape and structure but different in size, the fifth was the longest one and the first was the smallest. All of them were triangular.

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