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ECOLOGY AND BIOLOGY OF THE BENTHIC BIVALVE *AMIANTIS UMBONELLA* (LAMARCK) IN KHOR AL-ADAID, QATAR

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ABSTRACT

Monthly investigations on a population of *Amiantis umbonella* were conducted from September 1999 to August 2000 at Khor Al-Adaid south of Qatar. A total of 29 fauna and flora were recorded associated with *Amiantis umbonella* in the study area. These species included 6 algae, 2 seagrasses, 9 gastropoda, 9 bivalvea and 3 crustacea. The minimum water temperature was recorded during January (10°C) while the maximum one was observed during August and September (35-36°C). Salinity and dissolved oxygen are positively correlated with temperature. The population density, biomass and growth increment were measured and compared with some physic-chemical parameters. Relationships between shell length, total weight and flesh weight of clam revealed that the growth of these features is isometric.

1.INTRODUCTION

Ecology, diversity and biology of most bivalves on the coasts of Qatar and Arabian Gulf waters has not been fully explored as yet. There are few studies on *Amiantis umbonella* pertaining to specific areas and locations.

1.1. Previous studies

Basson *et al.* (1977) studied the biotopes and benthic communities of Saudi Arabia. Smythe (1982) described some of the sea shells of the Arabian Gulf and McCain (1984) and MacCain *et al* (1984) has studied the marine ecology of the intertidal in fauna of Saudi Arabia. Bosch *et al.* (1995) completed a revision of the sea shells of eastern Arabia confirming the status *of Amiantis umbonella* throughout the western Gulf. Recently Al-Mohanna *et al*. (2001) studied the morphology of the cells during spermatogenesis in *Amiantis umbonella*. Studies on the biology of the pearl oyster, *Pinctada radiata* are related to the pearl oyster fishery (Al-Matar *et al*., 1983, 1993), to morphometric characters (Al-Sayed *et al*., 1993) and to growth rate (Mohammed, 1995) in Kuwaiti, Bahraini and Qatari waters.

1.2. Area of investigation

Unlike the most other parts of the Qatar coastal zone, the dominant sediment type within Khor Al-Adaid is silicaclastic sand derived from the surrounding aeolian dunes. Preliminary microscopic examination of near shore sediments indicates that the sediment consists of well rounded and well sorted medium to fine grained quartz with few shell fragments. Accessory particles include iron oxide minerals. The nearshore sediments containing some skeletal carbonate sand are multi-model. The beach sediments are relatively finer than the nearshore sediments and comprise to a great extent sand grade size materials. The sediments collected from the coastal sand dunes reveal a small range in grain size which lie between fine to medium sands (Mean 1.95 phi).

There has been no study on the ecology, biology and allometric relationship for intertidal clams in the Arabian Gulf or Qatari waters. The clam *Amiantis umbonella* (Lamark, 1818) occurs in sand flats (lower shore and below lower shore) (Bosch *et al.,* 1995) and is widely distributed along the Qatari coast. At Khor Al-Adaid (Lat. 24 42 N; Long. 51 27 E) located in the southeastern part of Qatar peninsula there is large embayment with an average depth of 3-5 m (Fig.1). This is almost completely isolated from the open waters of the Arabian Gulf, and only connected through a narrow channel that extends some 15 km in length.

Little published information exists on fisheries for demersal mollusks (bivalves and gastropods) apart from pearl oysters. This is probably because their importance is primarily to local fishermen, with little commercial exploitation (Cheppard *et al*, 1992). Bivalves *Pinna muricata*, *Pinna muricata*, *Pinctada margaritifera*, *Pinctada radiate*, *Saccostrea cucllata* and *Amiantis umbonella* were taken throughout the Gulf area especially Kuwait and Bahrain. These species were collected and consumed by expatriate population (Carpenter, 1997). Abalon (Bivalve) is the largests of commercial fisheries along the southeast coast of Oman (Cheppard *et al*, 1992). In Qatar, Bivalves *Amiantis umbonella* and gastropods *Mondonta nebulosa*, *Turbo coronatus* were still sold in small amounts in the local markets as sea shells for consumption by local and expatriate population.

The aim of the present investigation is to study the ecology and biology of *Amiantis umbonella* in an intensive clam bed area at Khor Al-Adaid and to correlate seasonal growth changes with some environmental parameters.

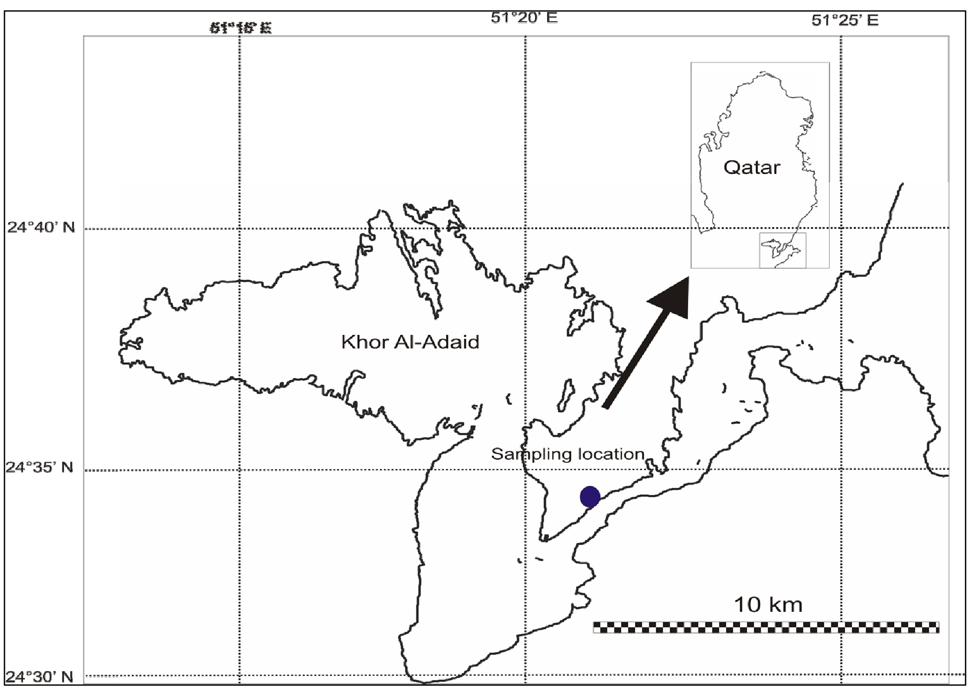

Fig. (1): Map of sampling location of *Amiantis umbonella* at Khor Al-Adaid.

2. MATERIAL AND METHODS

Specimens of *Amiantis umbonella* were collected on bimonthly basis from October 1999 to September 2000 in Khor Al-Adaid of Qatar. All samples were collected by hand from an area of 0.5 m^2 by seiving sand to a depth of 10-15 cm with 3 replicates on each sampling process. The smallest sizes has been discarded to avoid the possibility of its misidentification. Specimens were cleaned where total length was measured from the umbo to the ventral edge of the shell to the nearest 1mm using vernier callipers. Individuals smaller than 10 mm were not found and the maximum size observed was 45mm. The total wet weight, shell weight and flesh weight of each specimen were recorded to the nearest mg using a top loading balance. Tissue dry weight was obtained by removing the shell and drying flesh at 60°C for 48h. Estimation of *Amiantis umbonella* abundance was undertaken on bi-monthly basis. Temperature, salinity, pH, oxygen concentration were recorded at a depth of 40-50 cm below the water surface simultaneously with sampling of organisms, using a water Quality logging system (Model 3800-YSI Inc).

3. RESULTS

3.1. Environmental parameters

Monthly and seasonal recorded values of temperature, salinity, pH and oxygen concentration are presented in Figs. 2 and 3. It can be indicated that air and water temperature follow a seasonal cycle, with maximum temperature during August-September (35-36°C) while the lowest water temperature was recorded during January (10°C). Seawater salinity showed paraller variation throughout the year with values over 52‰, with the exception of low value which ranged from 45 to 52‰ during winter.

Dissolved oxygen ranged from 3.03 to 6.7 mg/L, with the highest concentration in January (6.7 mg/L). The pH displayed only very limited variation in Khor Al-Adaid, where the highest values occurred during the winter season and the lowest pH was recorded in August associated with a decrease in the concentration of dissolved oxygen.

3.2. Macrofauna associated with *Amiantis umbonella*

The species composition of the macro-floral and faunal community associated with a natural population of *Amiantis umbonella* in Khor Al-Adaid is presented in Table 1. It can be indicated that the common plant species belong to the chlorophyta and seagrasses, each represented by 2 species. The Phyaeophyta and Rhodophyta were unattached and drifted by water currents to the clam bed from open sea. Each of these alga groups was also presented by 2 species.

The fauna contained gastropods, bivalves and crustaceans. Gastropods and bivalves were represented by 9 species from each, with the most abundant gastropods *Nassarius arcularia*, *Priotrochus obscura*, *Cerithidea cingulata* and *Pirinella conica*. The most abundant bivalve species was *Brachidontes variabilis*. Crustacea were represented by 3 species, the barnacle *Balanus amphitrite* and burrowing crab *Scopimera crabricauda* together with the swimming crab *Portunus pelagicus*.

Table (1): Composition of the macro-floral and faunal community associated with a natural population of *Amiantis umbonella* in Khor Al-Adaid.

	Species	Density
Division: Chlorophyta		
	Chaetomorpha aerea (Dillwyn) Kützing	P
	*Caulerpa sertulariodes (*Gmelin)	P
Division: Phyaeophyta		
	Dictyota divaricata Lamouroux	P
	Sargassum binderi Sonder	P
Division: Rhodophyta		
	Laurencia papillosa (Forskål) Greville	P
	Hypnea valentiae (Turner) Montagne	P
Sea grass		
	Halophila ovalis (Brown)	P
	Halodule uninervis (Forskål)	P
Phylum: Mollusca **Class: Gastropoda**		
	Nassarius arcularia plicatus (Röding)	A
	Strombus decorus persicus Moolenbeek & Dekker	C
	Priotrochus obscura ()	A
	Umbonium vestiarium (Linnaeus)	C
	Cerithidea cingulata (Gmelin)	A
	Mitrella blanda (Sowerby)	C
	Cerithium scabridum Philippi	C
	Pirinella conica (Blainville)	A
	Littorina sp.	R
Phylum: Mollusca **ivalvia**		
	Circe scripta (Linnaeus)	F
	Gari roseus (Gmelin)	C
	Marcia optima (Gmelin)	F
	Marcia hiantina (Lamark)	F
	Callista florida (Lamark)	C
	Brachidontes variabilis (Krauss)	A
	Meretrix meretrix	C
	Dosina caelata (Reeve)	C
	Tellina sp.	F
Phylum: Arthropoda **Class: Crustacea**		
	Balanus amphitrite Darwin	A
	Scopimera crabricauda Alcock	C
	Portunus pelagicus (Linnaeus)	C

* P indicates presented algae and sea grass.

* Qualitative density estimated per $1m^2$:

- A = abundant, ≥ 20 individuals, C = common, 6-19 individuals
- F = fair, 1-5 individuals, R = rare, ≤ 1 individuals.

3.3. Population density and biomass of *Amiantus*.

Monthly fluctuations in *Amiantis umbonella* abundance (no.m^{-2}) and biomass (g.m^{-2} dry wt.) are shown in Fig. 4. Population density was highest in April, and lowest in January. The biomass reflects the same pattern and values ranged from 1.31-2.94 gm/m^2.

3.4. Monthly size frequency distribution

Size frequency distributions of *Amiantis umbonella* based on shell length are illustrated in (Fig. 4). There are a varying number of modes, few of which can be followed through successive sampling periods. The population tended to concentrated in the larger size classes (30-40 mm). There were more individuals in mid range size classes from September to December 1999 and from May to June 2000. Smallest sizes occurred in April-May and in September-October.

3.5. Length weight relationship

Logarithmic relationships were obtained when the values for total weight, shell weight and flesh weight are plotted against the values for shell length (Figs. 6-8). Regression lines for these values were calculated by the method of least squares using the equation for linear regression, Log W = a + b Log L

Where y = is weight, x is shell length and a & b are constant to be determined empirically. The following formula represents the values estimated for:

Total weight-shell length

Log W = 0.3845 + 2.8084 log L (r^2 =0.8512)

Shell weight-shell length

Log W = 0.3545 + 2.5311 log L (r^2 =0.7502)

In all cases, the values of the correlation coefficient "r" was nearer to 1, which indicated that the total weight-shell length and shell weight-shell length were found to be strongly correlated. In both cases, the "b" vale was approximately nearer to 3, which indicated that the relationship between length and shell weight was more or less isometric.

Flesh weight-shell length

Log W = 4.249 + 2.37374 log L (r^2 =0.6554)

The logarithmic relationship of flesh weight and shell length was calculated and the regression equation was obtained. In both cases, the "r" value indicated that relationship between flesh weight and shell length was significant and represented graphically a strong relationship.

4. DISCUSSION

Due to the relatively shallow depth of seawater at the area investigated, it is clear that salinity and dissolved oxygen are positively correlated with temperature. The temperature has a pronounced effect in increasing the evaporation rate and eventually raises salinity. Hence highest air and water temperatures in summer coincide with the higher salinity. According to experiments by Carpenter, 1965; 1966 (cited from Riley and Skirrow, 1975) and Weiss's table of oxygen solubility, even though relationships are not linear, the higher the temperature and salinity of water, the less solubility of the oxygen and other gasses (Parsons et al., 1984). In addition to physical process, biological production and composition could also effect the dissolved oxygen concentration in sea water (Riley and Skirrow, 1975). In this study dissolved oxygen is negatively correlated with water temperature with maximum values in winter and minimum values during summer.

The shore of Khor Al-Adaid is primarily an area of fine to medium sand with the clam *Amiantis umbonella* concentrated at the mid-tidal level. The size range of *Amiantis umbonella* varied from 10 to 45 mm. The smallest clams found to be measured 10 mm in length, which suggest, that this is probably the young recruits might be missed. The differences in settlement of clam juveniles can be accounted for the different substratum and waters conditions.

The environmental conditions play an important role in the growth and survival of the bivalve molluscs (Littlewood, 1988) such conditions might have a considerable effect on the growth and survival of *Amiantis umbonella* during the present investigation. The fluctuations also play an important role in the distribution of bivalve spat (Seed, 1969; Newell, 1970; Wallace, 1980; Littlewood, 1988) of bivalve molluscs, as the amount of food intake is a limiting factors. Ardial (1993) found that *Amiantis umbonella* contain micro-growth tidal bands and increments which vary in width along the entire length of the shell. Ardial (1993) also found that the tidal bands in *Amiantis umbonella* lie closest to each other during the cool November to January period. This suggest that the growth is slowest when water temperatures are at a minimum, as in *Cerastoderma edule* in temperate waters (Richardson *et al*., 1980). Coastal waters in the Arabian Gulf reach 10°C in winter, such a temperature drop could reduce the metabolism of the clams and hence rate of shell formation (Ardial, 1993).

The observed monthly variation of *Amiantis umbonella* may be due to the seasonal changes of the environmental conditions prevailed at the studied site of Khor Al-Adaid. Al-Kaisi (1976), Huq *et al*. (1978), Jacob and Zarba (1979) and Halim (1984) showed a significant variable distribution of the biomass along the western side of the Arabian Gulf.

The lack of literature on the biology and ecology of *Amiantis umbonella* in the Arabian Gulf, mean that it is not yet known which season favours fastest growth in the species. Yearly productivity variations of zooplankton in the Gulf have been described by Michell *et al* (1982). Biomass measurements obtained showed productivity was greatest in winter and summer and the lowest in October and April. Fluctuations in zooplankton biomass are profoundly influenced by phytoplankton bloom and there tends to be a lag between phytoplankton and zooplankton production. This suggests that phytoplankton productivity should be highest in the late spring and autumn. Availability of plankton is probably important in determining growth rates of *Amiantis umbonella* since its morphology indicates it is a filter feeder, not a sediment feeder (Ardila, 1993).

Allometric growth was observed between the various shell length-total weight; shell length-shell weight; shell length-flesh dry weight relationships. This biological characteristic study of Khor Al-Adaid intertidal clam *Amiantis umbonella* has revealed detailed information on their population dynamic in Qatari waters.

Since the values of "b" for the logarithmic relationships between shell length-total weight equation calculated for *Amiantis umbonella* are close to 3 (Figs. 6-8). It can be concluded that the weight of this species increased approximately as the cube of its length. Shell total weight and flesh weight was also positively allometric to shell length. This indicates that shell weight and flesh weight relatively increasing isometric with the increase of shell length.

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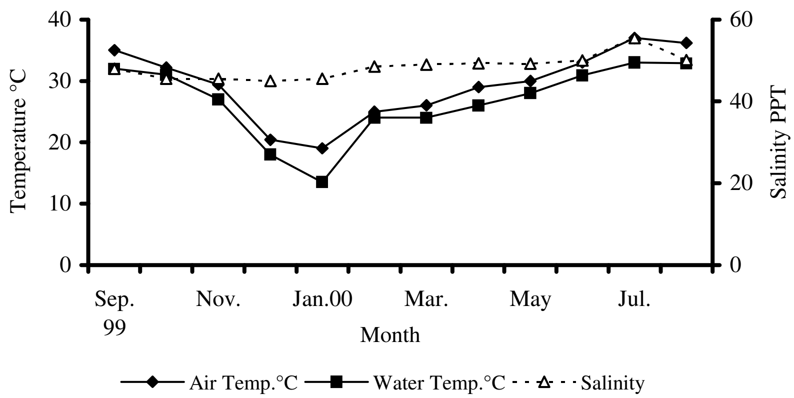

Fig. (2): Temperature of the air, surfase sea water and salinity in Khor Al-Odid.

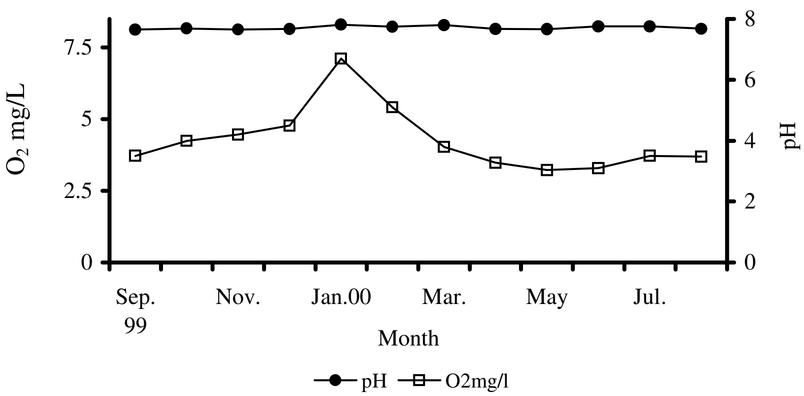

Fig. (3): The Monthly of oxygen and pH of sea waterin the Khor Al-Odid.

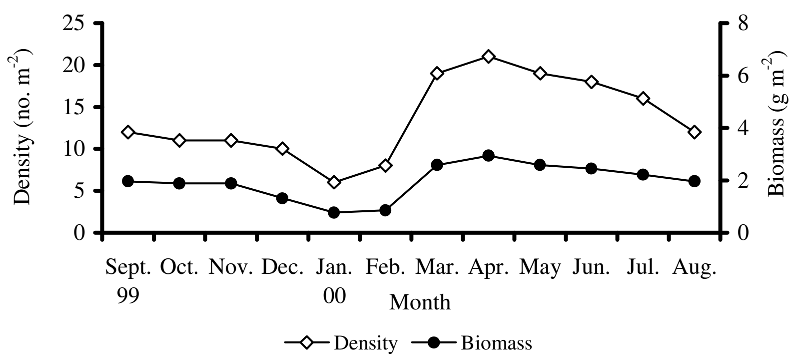

Fig. (4): Abundance and total biomass of *Amiantis umbonella* during different months.

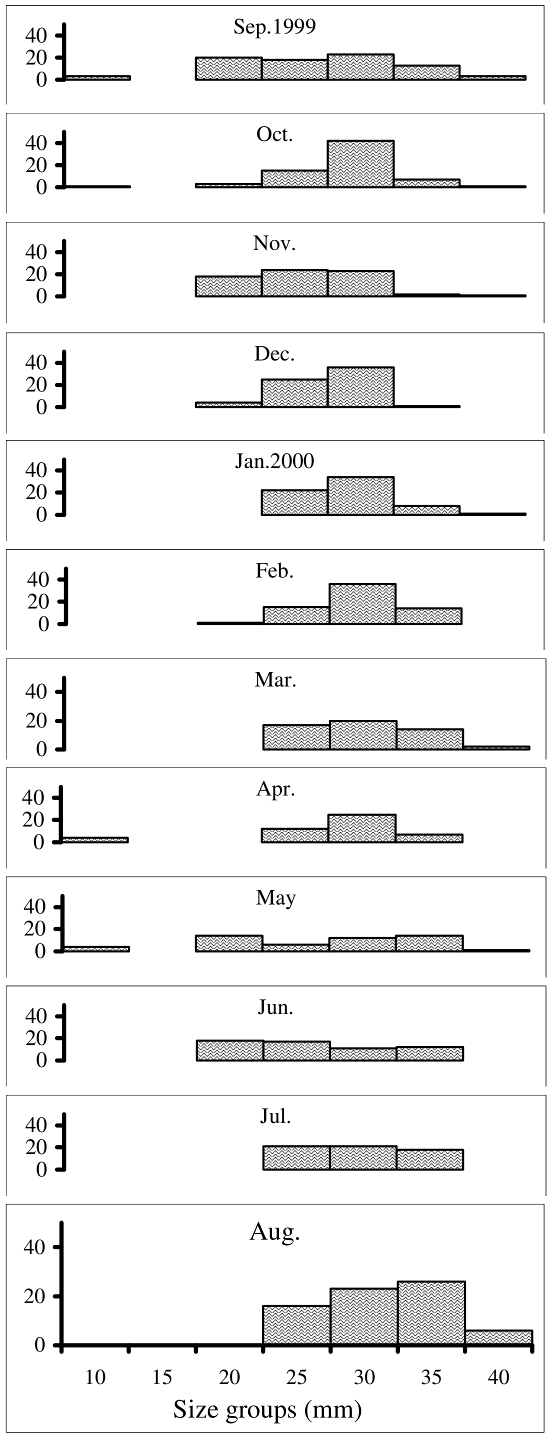

Fig. (5): Length frequency distribution for shell length classes of 5 mm of Amiantis umbonella.

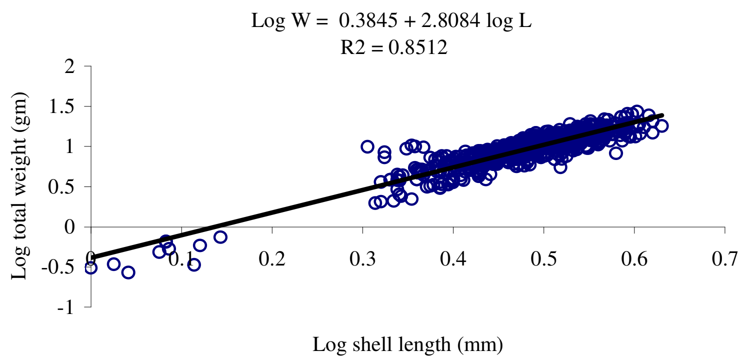

Fig. (6): Log Shell length and total weight relationship of *Ammiantis umbonella.*

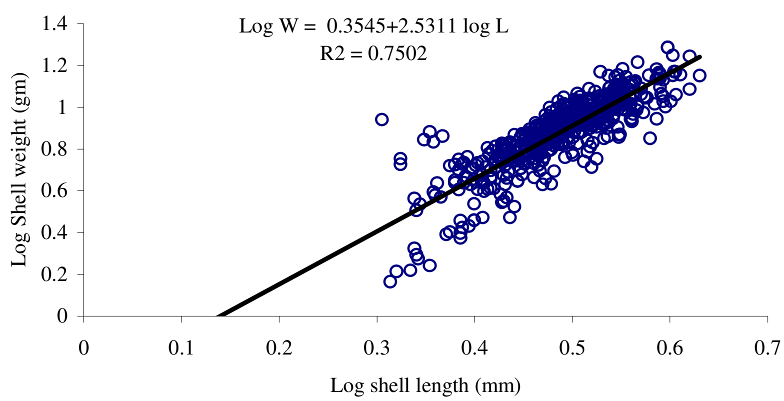

Fig. (7): Log shell length and shell weight relationship of *Ammiantis umbonella.*

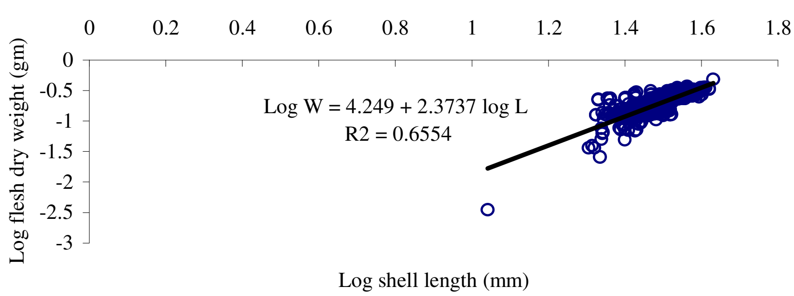

Fig. (8): Log shell length and flesh dry weight relationship of *Amiantis umbonella.*

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