

TAXONOMY OF THE BLOOD CLAMS *ANADARA* (*TEGILLARCA*)
GRANOSA (LINNAEUS, 1758) AND *A. (T.) RHOMBEA* (BORN, 1780)

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ABSTRACT

Descriptions of *A. (T.) granosa* and *A. (T.) rhombea* based on adequate material coming from different localities along the Indian Coast and outside India are given. The differences between these two species are brought out. It was gathered that the specimens of *A. (T.) granosa* in the Linnaean Society, London may not represent the type material, but the specimen of this species in the Zoological Museum of the University of Uppsala, Sweden can reasonably be considered as syntype.

INTRODUCTION

THE TWO SPECIES of the blood clams *Anadara* (*Tegillarca*) *granosa* and *A. (T.) rhombea* come under the Class Bivalvia, Family Arcidae and Subfamily Anadarinae. These two species are of fishery importance and their taxonomy was studied based on material coming from different localities along the Indian Coast and from outside India.

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Genus *Anadara* Gray, 1847

As per the ruling of the International Commission on Zoological Nomenclature in 1944, *Arca antiquata* Linnaeus, 1758 is the type species of this genus.

Salient characters of Anadara : Shell equivalve or inequivalve with large radial ribs which are nodulated or smooth, ligamental area with chevron markings, taxodont teeth in single straight series, inner margin of shell crenulated and byssus present or absent.

Thiele (1935), Reinhart (1935), Schenck and Reinhart (1938), Lim (1968) and Newell (1969) divided the genus *Anadara* into a number of subgenera. Lim (1968) divided *Anadara* into five subgenera namely *Anadara*, *Scapharca*, *Senilia*, *Tegillarca* and *Larkinia*. According to Yoloye (1974) the subgenus *Senilia* is not valid. Lim's classification of *Anadara* is followed here since it considers the characters of the soft body, in addition to the conchological features.

Subgenus *Tegillarca* Iredale, 1939

Type : *Tegillarca (granosa) bessalis* Iredale
(= *Arca granosa* Linnaeus)

Iredale characterised his genus *Tegillarca* as having 'few granose ribs' (p. 248) or 'few nodulose ribs' (p. 274) and described *Tegillarca (granosa) bessalis* using a single 38 mm long valve. Though he did not mention in his description whether the species is inequivalve or equivalve, he stated in the key for identification of genera, that the shell is inequivalve which is incorrect since the description of the species was based on a single valve. This mistake was also not commented upon by Lim (1968) who stated that *Tegillarca* is equivalve. Lim (1968) pointed out that the presence of nodulose ribs is an adaptive character of shallow water burrowers in soft mud and the nodules on the protruding ribs assist the animal from sinking too deep. He, therefore, opined that the presence of nodulose ribs does not merit generic status and relegated the position of *Tegillarca* to that of subgenus of *Anadara*.

***Anadara (Tegillarca) granosa* (Linnaeus, 1758)**

Arca granosa Linnaeus, 1758 (Type locality: Mediterranean Sea according to Linnaeus, but according to Dodge, 1952 this is probably an error).

Material: Kakinada Bay 107 clams measuring 25.4-71.2 mm, Bombay 50 clams 28.2-56.5 mm, 28 specimens of length range 23.7-71.2 mm in the Zoological Survey of India collections made at Karachi 1, Bombay 10, Cochin 1, Sri Lanka 6, Andamans 2, Bassein 1, Mergui 1, Malacca 1, Penang 1, Singapore 1, Philippines 2 and Australia 1.

Description: Shell of medium size, fairly thick, ovate, convex, inflated, equivalve and inequilateral; dorsal margin straight, anterior end rounded, sloping ventrally, posterior end obliquely rounded and ventral margin concave. Height 75.4-90.0 percent in length (mean 81.3); width 66.0-82.0% in length (mean 73.6); ligamental area narrow, rhomboidal with 3-4 dark complete chevron markings (an incomplete one may be present) and anterior part not

covered with ligament. Periostracum brown and smooth. Hinge line straight, 67.6-85.9% in length (mean 76.8) and 94.9-117.8% in width (mean 104.5), with taxodont dentition in one straight series of short fine teeth which become slightly larger at extremities; teeth 40-68, perpendicular to hinge line. Beaks prosogyrate; valves with 18-21 ribs (mean 19.30); ribs high, somewhat squaish, solid and sculptured with prominent blunt nodules. Interspaces between the ribs wider than the width of the ribs over most of the shell but reduced on the umbo. Inner shell white in colour; ventral, anterior and posterior margins of valves with crenulations corresponding to the ribs outside; impressions of ribs faintly visible. Pallial line faint without indentation; pallial sinus absent. Posterior adductor scar elongately squarish and anterior scar similar but smaller.

Mantle covering the bulk of visceral mass is thin, but at edges thick and muscular and bears the impressions of crenulated shell margin. Foot large, laterally compressed with a ventral groove. Byssus absent. Soft body blood red in colour.

Distribution: Widely distributed in the Indo-Pacific region.

Taxonomic note: The nodules on the ribs in the Singapore and Australian specimens are slightly curved and pointed. The number of ribs does not vary in relation to length. Patel and Patel (1974) made similar observation. These authors observed two complete and two incomplete chevron markings and Lim (1968) reported one incomplete and four complete ones. This character appears variable.

Linnaeus (1758) described *Arca granosa* briefly and the descriptions are identical in both the 10th and 12th editions of *Systema Naturae* and the specimen was not figured. In a review of the molluscs described by Linnaeus, Dodge (1952) stated that there was a single

specimen in the Linnaean shell collection which agrees with the description by different authors and wrote, that 'As the species was on 'Linnaeus' list of his shells this specimen may be taken as the type of the species' (p. 151). Dance (1967) gave an excellent historical account on the Linnaean shell collections. After his father's death, Carol Linnaeus retained them for five years and during this time, whenever possible, he added further specimens, which activity reduced the scientific value of the originals. In 1784, J. E. Smith purchased nearly all of Linnaeus' scientific effects, including shells and retained them until his death in 1828. Smith introduced material having no connection with the originals. They were purchased from his widow in 1829 by the Linnaean Society of London. During the decade following the Society's purchase, the Linnaean shells were further disarranged by a person or persons unknown. The collection was tampered with during 1850-1855 before Hanley (1855) published his account. The specimens of *Arca granosa* in the Linnaean Society consist of two valves, a right valve (length 48.2 mm, height 38.00 mm, width 16.50 mm) with 19 nodulose ribs and a left valve (length 37.30 mm, height 31.10 mm, width 17.00 mm) with 18 nodulose ribs. The two valves obviously belong to two different specimens. Dodge (1952) stated that there was a single specimen in the Linnaean shell collection. It is of interest to note, as pointed out by Dance (1967), that Dodge '...wrote without having seen the Linnaean shells (although he may have derived occasional assistance from a microfilm of them)' (p. 6). It is well nigh impossible to prove that the two valves now available with the Linnaean Society were once owned by Linnaeus and recognised by him as representative of his *Arca granosa*. It is also difficult to be satisfied that Linnaeus could have owned these specimens at the time the species was described. Ms. Solene Morris of British Museum wrote (per, comm.): 'From the

information available it is apparent that the specimens in the Linnaean collection may not actually be types'. Hence the specimens in the Linnaean shell collection cannot be taken as type material.

Arca granosa was also cited by Linnaeus in 1764 in the *Museum Ludovicae Ulricaе*, p. 519, No. 93. In this work he included reference to the original description and two of the originally cited figures. This publication was the belated outcome of Linnaeus' study of the Queen's collection. As pointed out by Dance (1967), Linnaeus actually prepared the descriptions for the *Museum Ludovicae Ulricaе* four years before he published the 10th edition of the *Systema Naturae* in 1758. The specimen (of *A. granosa*) of which the description was given by Linnaeus in his 1764 publication is in the collection of the Zoological Museum, Institute of Zoology, University of Uppsala, Uppsala, Sweden. It measures 45.7 mm in length, height 37.0 mm and width 31.8 mm and has 20 ribs (a faint 21st one is discernible) which bear prominent nodules. It is for these reasons that, Ms. Solene Morris wrote (per. comm.): 'I would suggest that the material in Uppsala is more reasonably considered *syntype* material than the specimens here in London' (i.e., the specimens in the Linnaean Society, London).

A. granosa is known to show considerable variations in some characters and several species or subspecies were described by several authors on the basis of specimens showing such variations. Variation of *A. granosa* in Japan was discussed by Kotaka (1953). Lamy (1907), Prasad (1932) and Habe (1965) considered some of the following 12 species (including subspecies) namely *Arca corbula* Chemnitz 1784, *A. granosa* minor Chemnitz 1784, *A. aculeata* Bruguiere 1792, *A. corbicula* Gmelin 1790, *A. cuneata* Reeve 1843-1844, *A. zangibarensis* Nyst 1848, *A. oblonga* Philippi 1849, *Anomalacardia pulchella* Dunker 1868, *Arca granulosa minuta* Neumyer 1898, *Anadara*

thackwayi Iredale 1927, *Anadara bisensis* Schenck and Reinhart 1938 and *Anadara (Tegillarca) obessa* Kotaka 1953, as junior synonyms of *Anadara granosa*. Attempts were not made to compare the present specimens of *A. granosa* with the descriptions of the above nominal species.

Anadara (Tegillarca) (Born, 1780)

Arca rhombea Born, 1780 (Type locality: "India Orientali")

Material examined: Kakinada Bay 100, Porto Novo 62 and Mangalore 37 specimens measuring 25.1-89.7 mm, ZSI collections 13 specimens from Jamnagar, Ennur, Chilka lake, Andamans and Sri Lanka of length range 30.3-72.3 mm.

Description: Shell fairly thick, somewhat heart-shaped, convex, much inflated, equivalve and distinctly inequilateral. Dorsal margin straight, anterior end rounded sloping ventrally, posterior end rounded and obliquely produced in the ventral side and ventral margin concave. Height 76.6-95.2% in length (mean 84.5), width 69.6-83.8% in length (mean 75.5); ligamental area broad, rhomboidal and with brownish black chevron markings consisting one complete marginal chevron with numerous vertical markings. Periostracum dark brown, smooth for major part except for the posterior part where it is hairy. Hinge long, slightly concave 52.0-72.1% in length (mean 63.2) and 69.2-89.9% in width (mean 83.7) with taxodont dentition in single straight series. Teeth 35-52, become slightly longer at the

TABLE 1. Percentage frequency distribution of ribs

	No. of ribs										
	18	19	20	21	22	23	24	25	26	27	Mean
<i>A. (T.) granosa</i>	..	15.9	47.7	29.9	7.5	--	--	--	--	--	19.3
<i>A. (T.) rhombea</i>	..	--	--	--	--	--	22.1	43.3	27.9	6.7	25.2

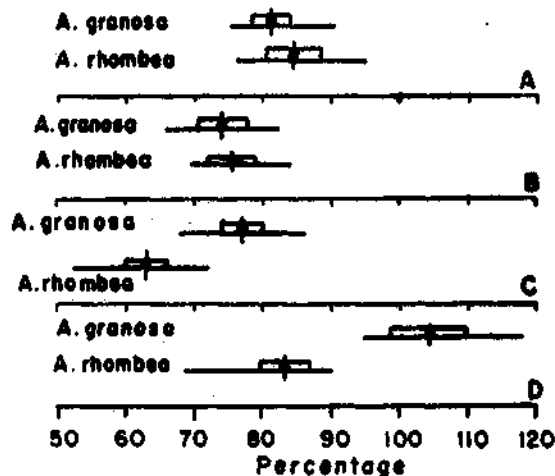


FIG. 1. Height (A), width (B) and hinge length (C) expressed as percentage of shell length and hinge length (D) expressed as percentage of shell width in *A. granosa* and *A. rhombea*. In each case the horizontal line shows the range, the small vertical line the mean, the shaded and open boxes together one S.D. and the shaded box alone one S.E. on either side of the mean.

extremes; the anterior and posterior ones slightly curved forwards and backwards respectively; remaining teeth perpendicular to the hinge line. Beaks prosogyrate; umbones widely separated. Valves with 24-27 high, squarish solid ribs; ribs sculptured with closely set transverse flat nodules; posterior 9-10 ribs without nodules interspaces between; nodules much smaller than nodules. Interspaces between ribs narrower than ribs. Inner shell white in colour. Ventral, anterior and posterior margins of valves with strong crenulations corresponding to the external ribs. Impression of ribs not visible in the inner valves. Pallial line without siphonal indentation; pallial sinus absent. Posterior adductor scar elongately squarish and anterior scar similar but smaller.

Mantle covering the bulk of the visceral organ is thin but edges are thick and muscular, bearing impressions of crenulations of the shell margin. Foot large, laterally compressed with a ventral groove. Byssus absent. Soft body blood red in colour.

Distribution : Restricted to the Indian Ocean.

Taxonomic note : The description given by Patel and Patel (1974) agrees with the present observations. The number of ribs does not vary in relation to length.

Of the type material only the right valve is available in the Vienna Museum. Dr. Erhard Wawra of Vienna Museum wrote (per. comm.) 'Since Brauer (1878) did not make any remarks in this respect the second valve was probably misplaced during the century after his account of Born's specimens'. This species is closely related to *granosa* and Lamarck (1819) described some specimens having 25-26 ribs and large umbones as variety 'a' of *A. granosa*. According to Reeve (1843-1844) this variety is only *A. granosa*.

A. (T.) rhombea differs from *A. (T.) granosa* in having the posterior end of the shell obliquely produced on the ventral side, raised umbones with broader, rhomboidal ligamental area, more number of ribs (24-27) with less prominent nodules on them and in the lower proportion of hinge length in shell width (Table 1, Fig. 1).

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