

New Distribution Record and Taxonomy of Two Cucullaeidae Species (Bivalvia: Arcacea) from Thermal Beach, Thoothukudi, South East Coast of India

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Abstract: Arcidae are predominantly marine bivalves. Cucullaeidae are a small family of Arcidae with four living species (Huber, 2010). Two species of Cucullaeidae; *Cucullaea labiata* (Lightfoot, 1786) and *Cucullaea petita* (Iredale, 1939) were collected from Thermal beach, Thoothukudi, Tamil Nadu. The detailed systematics, taxonomy and marked difference between these species are dealt with in this paper. The occurrence of two *Cucullaea* species such as *Cucullaea concamerata* (Martini) and *Cucullaea labiata* (Lightfoot) from Tamil Nadu coast was reported by Dey and Ramkrishna (2007). However, the exact distribution record and taxonomical description of these species are not available from India. Like other clams there are also commercially valuable species used as food in many countries. In this paper these two species are newly reported from Gulf of Mannar region of Tamil Nadu. These species are believed to be nearly extinct. The study area from where these species were collected was polluted with the effluents from thermal plants and salt pans. These species are highly disturbed due to climatic change and therefore strategies will be needed to conserve these species. The presences of these species indicate the rich marine bivalve diversity in the Gulf of Mannar region. The near extinction of these species should be viewed seriously and urgent steps should be initiated in order to conserve these species from further disappearance from the face of the earth for good.

Keywords: Bivalvia, *Cucullaea labiata*, *Cucullaea petita*, Gulf of Mannar region, Tamil Nadu

1. Introduction

The Arcacea are marine pelecypods which live most abundantly in shallow water. The order Arcoidea composed of Arcidae, Noetiidae, Cucullaeidae, Glycymerididae, Limopsidae and Philobryidae (Oliver and Holmes, 2005). The family *Cucullaea* is also known as false ark shells or common cowl shell (www.inaturalist.org/taxa/368642-cucullaea-labiata). The bivalve family Cucullaeidae has persisted for the past 200 million years. At the time of Jurassic period, due to radiation arcoid bivalves especially Cucullaeidae, diverged morphologically from their ancestors through modification of their taxodont dentition into distinct set of central and lateral hinge teeth. After that origination in the Early Jurassic, the bivalve genus, *Cucullaea* spread tremendously. At the time of Late Cretaceous, *Cucullaea* occupied habitats ranging from equatorial to Polar Regions (Buick, 2009).

During this time of peak richness, the genus was composed of approximately fifty designated species representing a diverse array of shell morphologies. Individuals lived semiinfaunally with in sandy to muddy substrates of shallow marine environment. Following this period due to the elevated global temperature and sea-level, cucullaeid species richness declined. A number of taxa become extinct at various times throughout the Cenozoic, with elevated extinction rates potentially associated with major cooling events and sea lowstands (Finlay and Marwick, 1937). With the continual loss of species, both the geographic range and morphologic disparity of *Cucullaea* also declined, eventually leading to the near extinction of this once- prolific genus (Buick, 2009).

Authors gave different account about the valid species of *Cucullaea* genus. There are only a single species remains (Nicol, 1950), however, according to Lamy (1907), there are two valid species namely *Cucullaea concamerata* and *Cucullaea granulosa*. Besides these, Iredale in 1939 gave the description of two more species namely *Cucullaea vaga* and *Cucullaea petita* from Eastern Australia. The other *Cucullaea* were first described by Chemnitz and in 1986 Abbot and Dance illustrated these two species. According to Huber (2010) four species were described namely *Cucullaea granulosa*, *Cucullaea vaga*, *Cucullaea labiata* and *Cucullaea petita*.

Nicol (1950) documented the geographic range for the species stretching from Eastern Africa, to South Eastern Australia, throughout Indonesia and north to southern Japan usually at depths ranging from 15-150 meters. Reeve (1869) well recognized these two specimens from the Indian Ocean locality, used the wrong name *Cucullaea concamerata* and *Cucullaea auriculifera* (Huber, 2010). The systematic position and valid name of the presently found Indian *Cucullaea* species are described in this paper.

2. Materials and Method

Specimens were collected from Thermal beach, Thoothukudi (8.81°N 78.14°E), Tamil Nadu (Fig.1). One fresh full specimen of *Cucullaea labiata*, two half of the old specimen of the same species and half valve of the *Cucullaea petita* were collected from the Thermal beach area on 10-09-2013. This is one of the accepted marine biodiversity rich area belongs to Gulf of Mannar region. The specimens were

identified using FAO identification keys and data collected from online data base. Systematics were done using A full-color Guide to 3,300 of the World's Marine Bivalves; Compendium of Bivalves (Huber, 2010) and WoRMS. The specimens were deposited in the Marine Biodiversity Museum, Central Marine Fisheries Research Institute (CMFRI) Kochi. The accession numbers of the specimens are *Cucullaea labiata* (Lightfoot, 1786) DC. 2.1.2 and *Cucullaea petita* (Iredale, 1939) DC. 2.1.3



Fig.1. Study site

3. Results and Discussion

The three most obvious shell characters that define *Cucullaea* genus are the taxodont dentition, radially arranged hinge teeth and prominent, chevron-shaped grooves on the broad ligament area. The myophoric flanges are present and the posterior adductor muscle attaches to the shell. The shell is boxy shaped and highly inflated (Huber, 2010). The common identification character of the collected specimen is shown in Fig. 2.

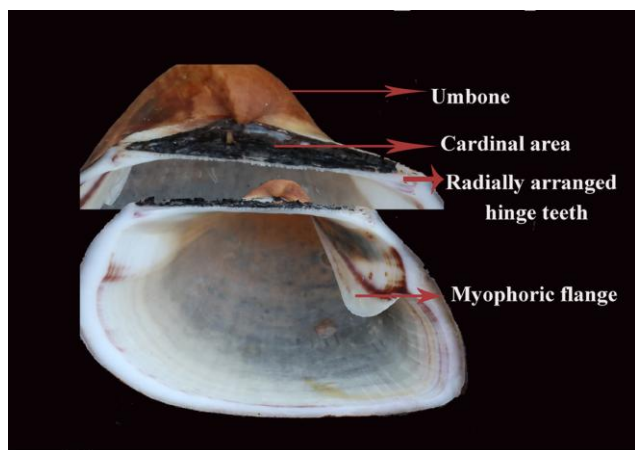


Fig.2. Common identification characters of *Cucullaea* species

1. *Cucullaea labiata* (Lightfoot, 1786)

Parent : *Cucullaea* Lamarck, 1801
Class : Bivalvia
Subclass : Pteriomorpha
Order : Arcoida
Superfamily: Arcoidea

Family : Cucullaeidae

Genus : *Cucullaea*

Locality : Thoothukudi, Tamil Nadu, India

Habitat : sandy shore

Synonym: *Arca concamera* (Bruguiere, 1789); *Arca concamera* (Dillwyn, 1817); *Arca cucullata* (Roding, 1798); *Arca cucullus* (Gmelin, 1791); *Arca labiata* (Lightfoot, 1786); *Cucullaea auriculifera* (Lamarck, 1801); *Cucullaea cucullata* (Roding, 1798); *Cucullaea plicata* (Theobald, 1860).

Description

The shell is 3.5-4.0 cm in length and 2.8-3.4 cm in height. Shape of the shell is roughly quadrate. Beaks are prominent seen sub centrally. The cardinal area is well developed chevron shaped grooves. The periostracum is orange brown. Cardinal area is covered by black ligament and prominent myophoric flanges are present.

2. *Cucullaea petita* (Iredale, 1939)

Parent : *Cucullaea* Lamarck, 1801

Class : Bivalvia

Subclass : Pteriomorpha

Order : Arcoida

Superfamily: Arcoidea

Family : Cucullaeidae

Genus : *Cucullaea*

Locality : Thoothukudi, Tamil Nadu, India

Habitat : sandy shore

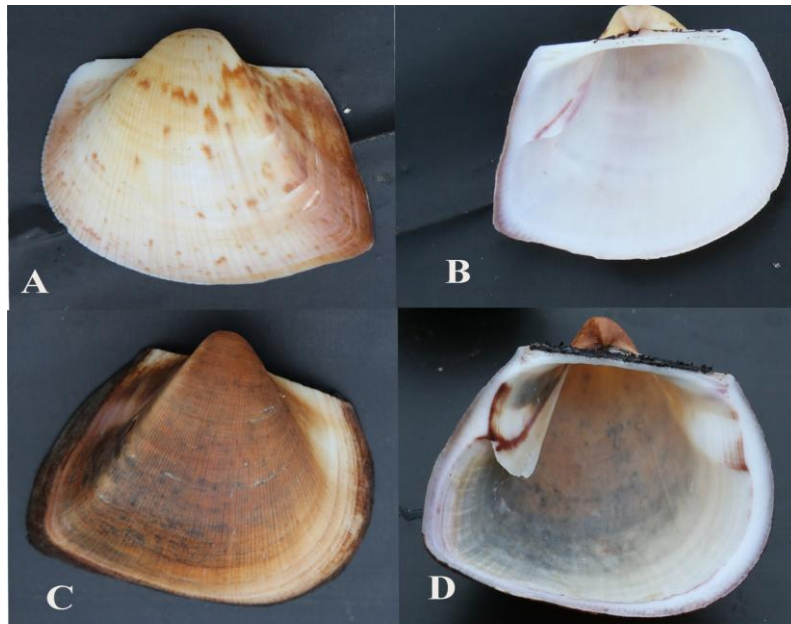
Synonym : *Cucullaea concamera* (G.B. Sowerby 11, 1869); *Cucullaea petita* (Iredale, 1939).

Description

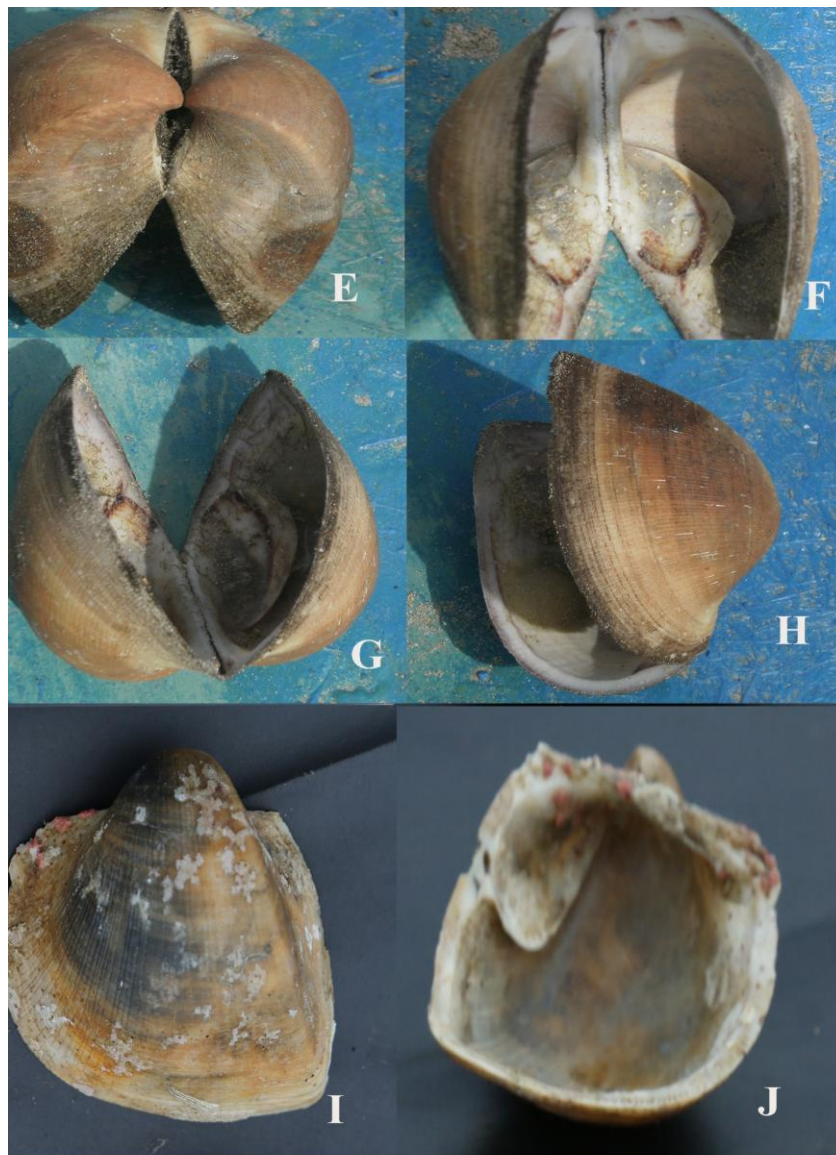
The shell shape and size of the specimen are almost similar to *Cucullaea labiata*. The periostracum is yellow-whitish, with light orange-brown coloured dots and lines. The umbone is dorsally short compared to the *Cucullaea labiata*. The differences between the two *Cucullaea* species are presented in Table.1.

Table 1: Differences between two species of *Cucullaea*

<i>Cucullaea labiata</i> (Lightfoot, 1786)	<i>Cucullaea petita</i> (Iredale, 1939)
Myophoric flanges more prominent and larger	Myophoric flanges narrower
Periostracum is orange brown	Periostracum is whitish with brown scattered zigzag lines
Umbones are prominent dorsally higher	Umbones are prominent dorsally lower
Inner part of the valve is dirty white or brownish white corresponding to the upper surface	Inner part of the valve is glossy white
Radially arranged hinge teeth are thick	Radially arranged hinge teeth are thin



**Fig.3 A-D.A-*Cucullaea petita* outer valve B- inner valve
C-*Cucullaea labiata* outer valve D- inner valve**



**Fig.3.E-J. Different positions of *Cucullaea labiata*
Views of outer and inner valve of older specimen**

Distribution of *Cucullaea* species indicates that they have an affinity for warm water environments, fossil record also attests the fact that ocean temperature as a spatially limiting factor (Beu, 1990). In the case of Gulf of Mannar the atmospheric temperature is varied from 37° to 40°C. The atmospheric temperature of study region reflects sea water temperature in shallow seashore (Kumaraguru *et al.*, 2006). The water temperature varied from 29° to 35°C. The air temperature recorded at the sites was higher when compared to that of surface water and sediment temperatures (30.2° to 37°C). This would indicate that the water and sediment temperatures are basically influenced by air temperature Kannan and Kannan (1996).

The fresh water input from rivers in Gulf of Mannar is only limited. High temperature may be one of the reasons for the presence of *Cucullaea* species in that region. From the west coast of India where the temperature is much lower than that of the east coast, the presence of *Cucullaea* species was not reported and hence the occurrence of these species along the east coast is justifiable. Individuals are found buried into fine sand and muddy substrates with the posterior margin located just above the sediment water interface for respiration and suspension feeding (Morton, 1981). In Thermal beach area of Thoothukudi the substrate is composed of 99% of fine sand. This may be another reason for the occurrence of *Cucullaea* species along this region.

Cucullaea species are economically very important. The meat of the *Cucullaea* species is economically and commercially valuable. This seafood is commonly known as butterfly-cut ark shell meat (Fig.4). The main markets are North America, South America, Southeast Asia, Africa, Mid East and Eastern Asia (www.21food.com).



Fig. 4. Advertisement image of butterfly-cut ark shell meat (www.21food.com)

The fossil as well as the live *Cucullaea* species are widely used for palaeontological study as they have growth rings as in trees, which shows the climatic condition of the earth in ancient times. The growth of clams mainly depended on the availability of food and heat. The change in the environmental conditions at that time is still reflected in the width of the growth rings (News released by Helmholtz Association of German Research Centers, 2011).

4. Conclusion

Gulf of Mannar, Tamil Nadu, on the south-east coast of India, is very rich in molluscan resources. The presence of these *Cucullaea* species which were once believed to be near extinction is seen in this area reveal the fact that the climatic condition are conducive for the survival of them. The habitat

should be conserved for the survival of the remaining species because they are nearer to extinction. Urgent conservation measures are to be initiated in order to protect and conserve them from further disappearance from this part of India where they are still occur.

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