

# First record of the genus *Pleuromya* Agassiz (Bivalvia: Anmalodesmata) from the Anaipadi Formation of Trichinopoly Group, Cauvery Basin, South India

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**Abstract:** This research article contains the first report of the genus *Pleuromya* Agassiz (family Pleuromyidae) from the Late Cretaceous Anaipadi Formation of Trichinopoly Group, Cauvery Basin. This genus has been represented here by the record of its three species *Pleuromya ligeriensis* (d'Orbigny, 1845), *Pleuromya servesensis* (Choffat, 1902) and *Pleuromya robustus* n. sp. from Anaipadi Formation. *Pleuromya ligeriensis* (d'Orbigny, 1845) and *Pleuromya servesensis* (Choffat, 1902) are yet not known from any of the Late Cretaceous horizons of the Indian sub-continent. However, these have been reported from the other parts of the world (Europe, Africa, Middle East and North America). Their first record from the Cauvery Basin, south India is of utmost importance in global correlation of the strata. The third one, a new species, *Pleuromya robustus* n. sp. is also recorded here in this study.

**Index Terms:** Bivalvia, Cauvery Basin, Late Cretaceous, Pleuromyidae, Trichinopoly Group.

## I. INTRODUCTION

The Anaipadi Formation is a stratigraphically important fossiliferous litho-unit of the Ariyalur Sub-basin of the Cauvery Basin, South India (Figure 2). It represents the youngest unit of the Trichinopoly Group under the three-fold lithostratigraphic scheme of the basin (Table 1). Lithostratigraphically, the Anaipadi Formation is characterized by concretionary siltstone,

mudstone and fine micaceous sandstone. This formation has conformable contacts respectively with underlying Kulkalnattam Formation of the Trichinopoly Group and Sillakadi Formation of the Ariyalur Group. This study is based on the detailed taxonomy of bivalves collected from the exposed upper part of the 264m thick sediments of Anaipadi Formation. The collected specimens have been prepared, catalogued and repositied in the Stratigraphy and Invertebrate Palaeontology Laboratory, Department of Geology, Banaras Hindu University, where the systematic study has been carried out. Out of the 100 bivalve specimens collected under the present investigation, 40 bivalve specimens have been systematically found to belong to the genus *Pleuromya* Agassiz of the Family Pleuromyidae. This genus has been represented by its three species for the first time from the Ariyalur Sub-basin of the Cauvery Basin in particular and the Indian subcontinent in general. The systematic description of all these three species have been attempted. The systematic organization follows here the works of Bieler et al. (2010) and Carter et al. (2011). The morphological terms are used according to the glossary of Cox (1969) given in the Treatise on Invertebrate Palaeontology. All dimensions (L: shell length; H: shell height; I: inflation of shell) are measured in millimeters with help of Vernier Calipers (Figure 1). The other abbreviations used under the text are Sl. No: (Serial Number of

the measured specimens), RV (Right valve), LV (Left valve) and BV (Both valves).

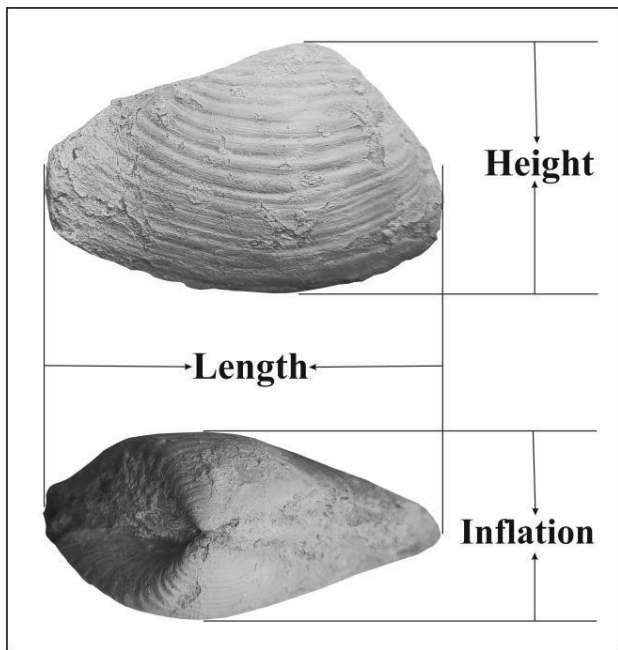


Figure 1. Measurement of *Pleuromya* bivalve shell.

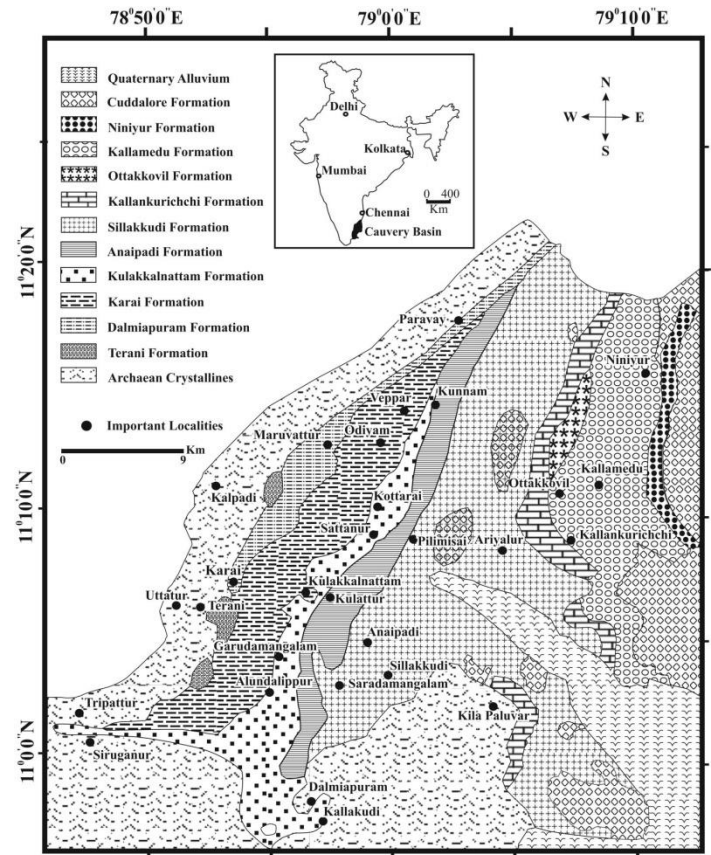


Figure 2. Geological map of the Ariyalur Sub-basin (modified after Sathish et al., 2017; Jaitly et al., 2021; Pandey et al., 2021b).

Table I. Lithostratigraphic framework of the Cretaceous of Cauvery Basin, south India (after Pandey et al., 2021a, b)

GROUP	FORMATION	MEMBER	AGE
Ariyalur	Kallamedu		Maastrichtian
	Kallankurichchi		Santonian - Campanian
	Sillakkudi		
Trichinopoly	Anaipadi		Turonian - Coniacian
	Kulakkalnattam		
Unconformity			
Uttatur	Karai	Kunnam	Albian-Cenomanian
		Odivam	
	Dalmiapuram		Barremian-Aptian
Terani			
Unconformity			
Crystalline Basement (Precambrian)			

## II. SYSTEMATIC PALEONTOLOGY

Class: Bivalvia Linnaeus, 1758

Subclass: Anomalodesmata Dall, 1889

Order: Pholadomyoidea Newell, 1965

Superfamily: Pholadomyacea Gray, 1847

Family: Pleuromyidae Dall, 1900

Genus: *Pleuromya* Agassiz, 1842

Type species: *Mya gibbosa* J. de C Sowerby, 1823

***Pleuromya ligeriensis* (d'Orbigny, 1845)**

(Pl. I, Figs 1-5)

1845 *Pholadomya ligeriensis* (d'Orbigny), p. 355, pl. 363, figs 8-9.

1862 *Pholadomya Molli* (d'Orbigny) - Coquand, ? p. 189, pl. 6, figs 6-7.

1887 *Homomya profunda* (sp. nov.) - White, p. 105, pl. 7, fig. 5.

1912 *Liopistha (Psilomya)* cf. *L. ligeriensis* (d'Orbigny) - Pervinquière, p. 292, pl. 20, fig. 22.

1937 *Homomya profunda* (d'Orbigny) - Maury, p. 77, pl. 10, fig. 13.

1958 *Liopistha ligeriensis* (d'Orbigny) - Barber, p. 29, pl. 9, fig. 7.

1997 *Pleuromya ligeriensis* (d'Orbigny) - Smettan, p. 132, pl. 7, figs 12-13.

1999 *Liopistha (Psilomya) ligeriensis* (d'Orbigny) - Seeling, p. 136, pl. 6, fig. 5.

1999 *Liopistha (Psilomya)? cf. alta* (d'Orbigny) - Seeling, p. 137.

2011 *Liopistha (Psilomya) ligeriensis* (d'Orbigny) - Andrade and Santos, p. 233, figs 2, 3-4

2014 *Pleuromya ligeriensis* (d'Orbigny) - Ayoub-Hannaa et al., p. 128, pl. 13, fig. 1.

2015 *Pleuromya ligeriensis*(d'Orbigny) - Ayoub-Hannaa et al., p. 50, figs 10 I, J.

#### Material

Five articulated specimens (BHUSM/26, BHUSM/27, BHUSM/28, BHUKN/40 and BHUANP/57).

#### Horizon

Anaipadi Formation of Trichinopoly Group, Cauvery Basin, south India.

#### Locality

West of Sardhamangalam village.

#### Dimension

Sl. No	Specimen no.	H (mm)	L (mm)	I (mm)
1.	BHUSM/26	43	62	34 (BV)
2	BHUSM/27	47	72	38 (BV)
3	BHUSM/28	41	63	33 (BV)
4	BHUKN/40	40	64	28 (BV)
5	BHUANP/57	47	72	34 (BV)

#### Description

The specimens are moderate in size, transversely ovate, strongly inequilateral and well inflated. The posterior- half of the shell is much larger than anterior- half. Umbones broad, prosogyrous, bent inwardly and twisted anteriorly. Lunule is large, oval in shape and moderately deep. Escutcheon well elongated, moderately shallow and lanceolate in shape. Maximum inflation lies almost on mid-shell region from where shell is tapering posteriorly to broad rostrated end. Anterior margin short, narrowly rounded joining the gently convex ventral margin in nearly acute angle. Posterior margin broadly rounded, meeting ventral margin in obtuse curve. Postero-dorsal margin large, straight to feebly concave and antero-dorsal smaller, slightly convex. Ligament is external almost opisthodontic. Umbo is bounded on both anterior and posterior sides by obtusely rounded thick ridges. The anterior umbonal ridge is a bit more prominent, surrounding a deep anterior depression and extends up to mid-anterior region. The posterior umbonal ridge fades out before reaching mid-posterior region. All the specimens have large posterior gapes, which are longitudinal to the posterior margin. The surface is ornamented with both fine and moderately coarse commarginal ribs which are irregularly distributed and separated by interspaces of variable width.

#### Remarks

Only the two complete specimens (BHU KN/40, BHUSM/28) are almost identical to *Pleuromya ligeriensis* (d'Orbigny) especially recorded by Ayoub-Hanna et al. (2014, 2015) from the Cenomanian-Turonian of Sinai and Sergipe Basin. The three incomplete specimens (nos BHUSM/26, BHUSM/27 and BHUANP/57), which are broken along anterior, dorsal and posterior margins have been tentatively kept within *P. ligeriensis*. Specimen no BHUANP/57 is bit more tapering towards anterior and superficially resembling to *Pleuromya servesensis* Choffat (1902) reported by Ayoub-Hanna et al. (2015, p. 50, figs 10 I, J) from the same *P. ligeriensis* yielding horizon.

*Pleuromya servesensis* Choffat (1902) appears to be most closely allied species but differs from *P. ligeriensis* in having absence of lunule and more gibbose umbonal region. Andrade and Santose (2011, p. 233, figs 2.3-4) described *Liopistha (Psilomya) ligeriensis* from Turonian of Sergipe Basin appears to belong to the genus *Pleuromya*. However, it is poorly preserved and but for its large size, smaller umbo and much inflated shell, no other character is properly visible.

This is the first record of *Pleuromya ligeriensis* (d'Orbigny) from India.

#### *Pleuromya robustus* n. sp.

(Pl. I, Figs 6-11)

#### Etymology

Due to robust nature of shells.

#### Diagnosis

*Pleuromya* with robust, moderately large, subquadrate shells having submesial umbo and coarse commarginal ribs.

#### Material

Three specimens (specimen no. BHU7/15- Holotype; BHU25/15 and BHU20/15- Paratypes).

#### Horizon

Anaipadi Formation of Trichinopoly Group, Cauvery Basin, south India.

#### Locality

West of Sardhamangalam village

#### Dimension

Sl. No	Specimen no.	H (mm)	L (mm)	I (mm)
1.	BHUSM/7/15	52	66	40 (BV)
2	BHUSM/20/15	54	69	40 (BV)
3	BHUSM/25/15	51	64	42 (BV)

#### Description

The present specimens are large in size, robust, subquadrate, inequilateral, equivalved and highly inflated. Umbones broad, slightly incurved and twisting anteriorly, located at one-fourth of the shell- length from the anterior end. The area of maximum inflation lies along the dorsal region of umbo making it quite gibbose. Antero- dorsal and postero - dorsal margins are of equal length but former is slightly concave while later is feebly convex. Both anterior and posterior margins are broadly

rounded, but anterior is vertically truncated. Both margins are meeting almost straight to slightly arched ventral margin in obtuse curves. An obtusely rounded faint oblique ridge runs just anterior to umbo towards venter, but fades in the midway. The area anterior to this ridge is gradually sloping and becomes almost flat at the anterior end. Though posterior margins of all the specimens are partially damaged but it appears to have large posterior gape of almost of same height of posterior margin. The surface is primarily ornamented with coarse commarginal ribs, which are irregular in both thickness and distribution. The interspaces are wider than the thickness of commarginals, which also contain secondary commarginals ribs, which at places bunching together to give coarser appearance.

#### Remarks

The present three specimens especially due to typical positions of the umbones are different to all the species of *Pleuromya* described so far in the available literatures. In all of the closely resembling species of *Pleuromya* [e.g. *P. elongate* Roemer (1841, p. 75, pl. 10, fig. 5); *P. servesensis* Choffat (1902, p. 132, pl. 9, figs 1-3); *P. ligeriensis* d'Orbigny (1845, p. 355, pl. 363, figs 8-9)], the umbones are more anteriorly placed in contrast to submesial in the present specimens. The ornamental pattern is also different in the present specimens. These specimens show some resemblance to *Homomya solida* Cragin, 1893 describe by Scott and Cloggett (2018) from the Albian of Texas. But this Texas species is taller and having well elevated umbones. *Homomya solida* has been tentatively assigned to *Homomya* by Scott and Cloggett (2018). Perhaps it does not belong to the genus *Homomya*, which has quite a different shape and may belong to the genus *Pleuromya*. The present specimens also superficially resemble to the earlier described *Pleuromya lingerieusis* (d'Orbigny, 1845) somewhat in nature of anterior, posterior and ventral margins and inflation but present specimens are not so oblong and umbones are not so anteriorly placed, besides different surface ornamentation. *Pleuromya servesensis* Choffat 1902 described by Ayoub-Hanna et al. (2015, P. 52, figs 11 A-E) from Cenomanian-Turonian of Brazil is nearest approaching species especially in nature and position of umbones, which is as broad and situated at about one-third of total shell length like in present specimens. But *P. servesensis* is still more oblique in shape and the interspaces in between coarse commarginals lack secondary commarginal ribs.

#### *Pleuromya servesensis* Choffat, 1902

##### (Pl. I, Figs 12-13)

*Pleuromya servesensis* Choffat, 1902, p. 132, pl. 9, figs 1-3.

*Pleuromya servesensis* Choffat, Ayoub-Hanna et al., 2015, p. 52, figs 11A-E.

#### Material

Two specimens (BHUANP/80/17, BHUANP/4/17)

#### Horizon

Anaipadi Formation of Trichinopoly Group, Cauvery Basin, south India.

#### Locality

West of Sardhamangalam village.

#### Dimension

Sl. No	Specimen no.	H (mm)	L (mm)	I (mm)
1.	BHUANP/80/17	42	56	23 (BV)
2	BHUANP/4/17	32	43	20(BV)

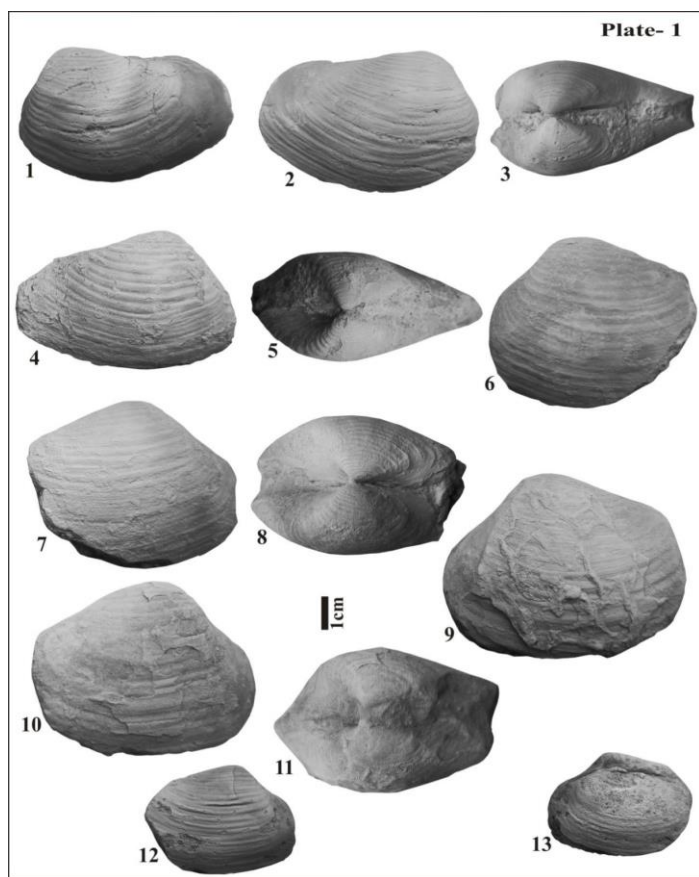
#### Description

These shells are medium in size, subquadrate in shape, inequilateral and laterally compressed. Umbones wide and quite gibbose, beaks moved laterally over each other. Umbones submesial, prosogyrous and slightly incurved dorsally. Antero-dorsal margin is slightly convex and postero-dorsal margin equally broadly rounded, both meeting slightly arched ventral margin in obtuse angles. Both the specimens are moderately inflated (may be due to pathologically compressed nature). An obtusely rounded ridge runs from anterior of umbo and fades before reach antero-ventral corner, separating a relatively more flat anterior area. The shells are gaping posteriorly. The surface is ornamented with unevenly spaced coarse commarginal ribs of irregular thickness. Broadly interspaces are widening towards ventral margin and contain finer commarginal ribs.

#### Remarks

These two specimens, though pathologically compressed but adequately resemble to *Pleuromya servesensis* Choffat recorded by Ayoub-Hanna et al. (2015) from Upper Cenomanian- Lower Turonian of Sergipe (Brazil). Earlier as discussed by Ayoub-Hanna et al. (2015), this species has been assigned to *Liopistha* Meek by Barber (1958) due to resembling outline. However, *Liopistha* has characteristic radial ornamentation which is absent in *Pleuromya*. *P. congoensis* described by Dartevelle and Freneix (1957, p. 208, pl. 32 figs 9, 10; pl. 33, figs 1, 2) from the Maastrichtian of Congo resembles *P. servesensis* in overall shape and proportionate size, but it has much finer concentric ornamentation than *P. servesensis*. *P. molli* Coquand (1862, p. 189, pl. 6, figs 6, 7) from Turonian of Algeria is also superficially identical to the present specimens but differs in having terminal umbones and finer ornamentation.

This is the first record of the species from India.



**Figure 1- 5** *Pleuromya ligeriensis* (d'Orbigny, 1845), 1- (BHU SM/28) × 1, External view of right valve; 2- (BHU SM/28) × 1, External view of left valve; 3- (BHU SM/28) × 1, Dorsal view; 4- (BHU KN/40) × 1, External view of right valve; 5- (BHU SM/28) × 1, Dorsal view. **6-11** *Pleuromya robustus* n.sp, 6- (BHU SM/25/15) × 1, External view of left valve; 7- (BHU SM/25/15) × 1, External view of right valve; 8- (BHU SM/25/15) × 1, Dorsal view; 9- (BHU SM/7/15) × 1, External view of left valve; 10- (BHU SM/7/15) × 1, External view of right valve; 11- (BHU SM/7/15) × 1, Dorsal view. **12- 13** *Pleuromya servesensis* (Choffat, 1902), 12- (BHU ANP/4/17) × 1, External view of right valve; 13- (BHU ANP/4/17) × 1, External view of left valve.

#### CONCLUSION

Three species of the family Pleuromyidae belonging to the genus *Pleuromya* are described here from the Late Cretaceous Anaipadi Formation of Trichinopoly Group, Cauvery Basin, South India. Two species *Pleuromya ligeriensis* (d'Orbigny, 1845) and *Pleuromya servesensis* (Choffat, 1902) are recorded for the first time from the Cauvery Basin. The present study also records a newly erected species *Pleuromya robustus* n. sp. established on the basis of unique morphological characters. These pleuromyid species of Cauvery Basins have a close affinity to different species of Tethyan regions in Europe, Africa, Middle East and North America.

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#### REFERENCES

- Andrade, E. J. & Santos, M.T. (2011). Moluscos bivalvios do Turoniano (Cretáceo Superior) da bacia de Sergipe. In: I. S. Carvalho, N. K. Srivastava O. Strohschoen Jr. & C. C. Lana (eds.) *Paleontologia: Cenários de Vida*, Interciência, 4, p. 229-238.
- Ayoub-Hannaa, W., Fürsich, F. T., & El Qot, G. M. (2014). Cenomanian - Turonian bivalves from eastern Sinai, Egypt. *Palaeontographica, Abteilung A*, 301, 63-167.
- Ayoub - Hannaa, Bengtson, P., Fürsich, F. T., & Andrade, E. J. (2015). Cenomanian - Coniacian (Upper Cretaceous) Bivalves of the Serg Ipe Basin, Brazil: Order Pholadomyida. *Rev. bras. Paleontol.*, 18(1), 31-70.
- Barber, W. (1958). Upper Cretaceous Mollusca from north-eastern Nigeria. *Records of the Geological Survey of Nigeria*, 14-46.
- Bieler, R., Carter, J. G., & Coan, E. V. (2010). Nomenclature of bivalve families with classification of bivalve families, *International Journal of Malacology*, 52: 2, 113-84.
- Carter, J. G., Altaba, C. R., Anderson, L.C., Araujo, R., Biakov, A. S., Bogan, A. E., Campbell, D. C., Campbell, Jinhua, M. C., John, C. W., Cope, J. C. W., Delvene, G., Dijkstra, H. H., Zong-jie, F., Gardner, R. N., Gavrilova, V. A., Goncharova, I. A., Peter, J., Harries, P. J., Hartman, J. H., Hautmann, M., Hoeh, W. R., Hylleberg, J., Bao-yu, J., Johnston, P., Kirkendale, L., Kleemann, K., Koppka, J., Machado, Jiri Kříž D., Malchus, N., Márquez - Aliaga, A., Masse J., Mc Roberts, C. A., Middelfart, P. U., Mitchell, S., Nevešskája, L. A., Özer, S., Pojeta, J., Polubotko, I. V. Jr., Pons, J. M., Popov, S., Sánchez, T., Sartori, A. F., Scott, R.W., Sey, I. I., Signorelli, J. H., Silantiev, V. V., Skelton, P. W., Steuber, T., Waterhouse, J. B., G. L., Wingard & Yancey, T. (2011). *A Synoptical classification of Bivalvia (Mollusca)*, *Palaeontological Contributions*, p. 1-47.
- Cragin, F. W. (1893). A contribution to the invertebrate paleontology of the Texas Cretaceous: *Geological Survey of Texas*, 4th Annual Report, 141-246.
- Choffat, P. (1902). Espèces nouvelles ou peu connues: quatrième série. Espèces diverses. *Recueil d'études paléontologiques sur la faune crétacique du Portugal*, 1, 105-171.
- Coquand, M. H. (1862). Géologie et paléontologie de la région Sud de la province de Constantine. *Mémoires de la Société d'Emulation de la Provence*, 2, 5-342.



- Cox, L. R., & Hertlein, L. G. (1969). Family Plicatulidae Watson, 1930. In R. e. Moore, editor. *Treatise on Invertebrate Paleontology N. Mollusca* 6, 1, N377 - N378.
- Dartevelle, E., Sornay, J., & Freneix, S. (1957). Fossil molluscs from the West Coast of Africa from Cameroon to Angola. II. *Annales du Musée Royal du Congo Belge*, Tervuren (Belgique), 20, 1-271.
- Dall, W. H. (1889). On the hinge of pelecypods and its development, with an attempt toward a better subdivision of the group: *American Journal of Science and Arts*, ser. 3, (38), 228, 445 - 462.
- D'Orbigny, A. (1844 - 1847). French Paleontology: Description of the Molluscs and Rayon Fossils of France. Cretaceous III terrain, Lamellibranchs. G. Masson, Paris, 1-807.
- Gray, J. E. (1847). A list of the genera of Recent Mollusca, their synonyms and types. *Proceedings of the Zoological Society of London*, 15, 129-219.
- Linnæus, C. (1758). *Systema naturæ per regna tria naturæ, secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. Tomus I. Editio decima, reformata Holmiæ, impensis L. Salvii*, 1- 824.
- Maury, C. J. (1937). O Cretaceo de Sergipe. Rio de Janeiro, *Serviço Geológico e Mineralógico do Brasil*, p, 283. (Monografia 11).
- Newell, N.D. (1965). Classification of the Bivalvia: American Museum Novitates, v. 2206, p, 25.
- Orbigny, A.d'. (1845). *Paléontologie française: description zoologique et géologique de tous les animaux mollusques et rayonnés fossiles de France: Terrains crétacés: Tome troisième* [livraisons 91-102]. Paris, Arthus Bertrand, p. 289-448.
- Pandey, B., Gautam, J. P., Jaitly, A. K., & Tiwari, D. N. (2021a). Record of the Middle Albian (Lower Cretaceous) ammonoids from the Cauvery Basin, southern India. *Historical Biology*, DOI:10.1080/08912963.2021.1954636.
- Pandey, B., Jaitly, A. K., Gautam, J. P., & Tiwari, D. N. (2021b). Ammonoid biozonation in the lower Albian (Lower Cretaceous) succession of the Ariyalur Sub-basin, Cauvery basin, south India. *Journal of the Palaeontological Society of India*, 66(2), 182-189.
- Pervinquière, L. (1912). Études de paléontologie tunisienne: II. Gastéropodes et Lamellibranches des terrains crétacés. Paris, *Carte géologique de la Tunisie*, p, 352.
- Roemer, F.A. (1841). Die Versteinerungen des norddeutschen Kreidegebirges [2. Lieferung]. Hannover, Hahnschen Hofbuchhandlung, 49-145.
- Scott, R. W., & Claggett, B. W. (2018). Albian infaunal Pholadomyida (Cretaceous Bivalvia), Comanchean Carbonate Shelf, Texas, *Journal of Paleontology*, p, 1 -23, Doi: 10.1017/jpa.2017.139.
- Seeling, J. (1999). Palaeontology and biostratigraphy of the macroinvertebrate fauna of the Cenomanian–Turonian transition of the Sergipe Basin, northeastern Brazil, with systematic descriptions of bivalves and echinoids. Heidelberg University, Ph.D. thesis, p, 185.
- Seeling, J., & Bengtson, P. (1999). Cenomanian oysters from the Sergipe Basin, Brazil. *Cretaceous Research*, 20, 747-765.
- Smettan, K. (1997). Bivalven, Gastropoden und Serpuliden aus den Branderfl eckschichten (Cenoman) der Fahrenbergmulde (Nördliche Kalkalpen, Bayern): Taxonomie und Palökologie. *Zitteliana*, 21, 99 -15.
- Sowerby, J., & Sowerby, J. de C. (1812-1846). Coloured Figures and Description of those Remains of Testaceous Animals or Shells Which Have Been Preserved at Various Times and Depths in the Earth, 1812–1846: London, B. Meredith, v. 1- 8.
- White, C. A. (1887). Contribuições á Paleontologia do Brazil. *Archivos do Museu Nacional do Rio de Janeiro*, 7:1-273. (Reprinted 1888 with errata sheet and preface by the author as "Contribution to the Paleontology of Brazil, Comprising Descriptions of Cretaceous Invertebrate Fossils, mainly from the Provinces of Sergipe, Pernambuco, Para and Bahia". Smithsonian Institution, Washington, DC.).

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