

Dasycladacean algae from the Niniyur Formation, Cauvery Basin, India

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The present paper documents five dasycladacean green algal species, viz., *Carpenterella jonesi*, *Decastroporella tergestina*, *Dissocladella* sp., *Dorbella slovenica* and *Terquemella gobularis* from the Periyakurichchi Biostromal Member (Thanetian) of the Niniyur Formation, Cauvery Basin, South India. The present dasycladacean algae suggest deposition of sediments of the studied section in shallow water marine environment with bathymetry ranging from 0 to 10 mts.

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INTRODUCTION

The dasycladalean algae are large unicellular benthic green algae of Chlorophyta and owing to their extensive calcification they are preserved in the rocks ranging in age from the Precambrian to the Holocene. The thallus of dasycladaleans possess an erect axis that bears whorls of branches with radial symmetry (Lee, 2008). The dasycladaleans are used as a potential tool to establish palaeoenvironment, palaeobathymetry and biostratigraphy (Bucur, 1999; Barattolo, 2002; Kundal, 2010; Kundal *et al.*, 2020). The global fluctuations in temperature and sea level during the past affected the dasycladalean biodiversity and their maximum diversification was recorded in the Permian, Early Cretaceous and Palaeocene times (Aguirre and Riding, 2005). In the present-day ocean, dasycladaceans reside in the shallow warm marine water environment of tropical and subtropical regions of the world.

Since 1932, the Cauvery basin has been known for the presence of fossil calcareous algae. Well preserved fossil calcareous algae have been documented from Cretaceous sediments of the Cauvery Basins (Rao and Prasannakumar 1932, Rao and Pia 1936, Rao and Gowda 1954; Misra and Kumar 1988; Rajanikanth 1992; Misra *et al.*, 2004 and 2006) and from Cenozoic sediments (Niniyur Formation) of Cauvery Basin (Misra *et al.*, 2000, 2001, 2003; Kishore *et al.*, 2003; Kishore, S. 2004a, 2004b; Kishore and Singh 2004; Kishore *et al.*, 2003).

The purpose of the present paper is to understand the distribution of dasycladaleans in the Periyakurichchi Biostromal Member of the Niniyur Formation and further to study palaeoenvironment.

GEOLOGICAL SETTING

The Cretaceous-Palaeocene sediments of Ariyalur, Tamilnadu are classified into four formations viz. Sillakudi, Kallankurichchi, Ottakoil and Kallamedu. The Niniyur Formation rests unconformably over Cretaceous sediments and it is further classified into two members i.e., Anandavadi Arenaceous Member and Periyakurichchi Biostromal Member (Sumdaram and Rao, 1986). Extensive work has been carried out in the field of Stratigraphy, Sedimentology and Palaeontology (Blanford, 1862; Kossmat, F. 1897; Sastry and Rao 1964; Sastry *et al.*, 1968, 1972, 1977; Venkatachala, 1974; Nair and Vijayam 1980; Ayyasamy, 1990; Ramasamy and Banerji, 1991; Radulovic and Ramamoorthy 1992; Tewari *et al.*, 1996; Chandrasekaran *et al.*, 1996; Govindan *et al.*, 1996, 2000; Yadagiri and Govindan, 2000; Hart *et al.*, 2000; Muthuvairvasamy *et al.*, 2003; Rajanikanth *et al.*, 2003) (Fig. 1).

MATERIALS AND METHODS

The studied outcrop is located 400 m east of Niniyur village (11°16' 8.03"N; 79°11' 3.67"E) (Fig.1). Twelve samples are collected from the present section. Multiple thin sections of limestones are prepared to understand morphological features of dasycladaleans. The petrographic and micropalaeontological studies are carried out using Lica DM750 trinocular microscope. The morphometric study of dasycladaleans is done under the same microscope. The abbreviations (after Deloffre and Génot, 1982) are used for determination of the dimensions of various algal species

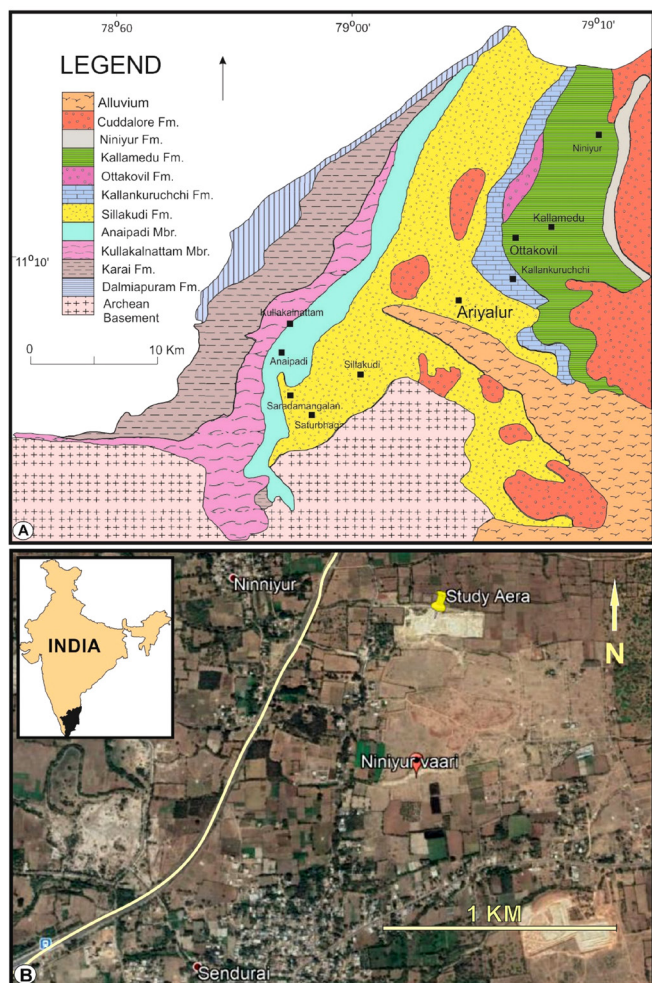


Fig.1: A) Geological Map of Study area (after Sundaram et al., 2001) and B) Location map

which are as: Length of Thallus (L), External Diameter of Thallus (D), Diameter of Central Stem(d), Length of Primary Branches(l), Length of Secondary Branches(l’), Length of Tertiary Branches(l’’) , Width of Primary Branches(w), Width of Secondary Branches(w’), Width of Tertiary Branches(w’’), d/D ratio (d/D), Diameter of Sporangia(ds), Diameter of Disc (dd).

SYSTEMATICS

Division **Chlorophyta** Papenfuss, 1946
 Class **Dasycladophyceae** Hoek et al., 1995
 Order **Dasycladales** Pascher, 1931
 Family **Dasycladaceae** Kützing, 1843
 Genus **Dissocladella** Rao and Pia, 1936

Dissocladella Sp.
 (Pl. I, Figs. 1-5)

Material: FCP/D/NIN/L1/S4/2/2,7,8,10; FCP/D/NIN/L1/S4/1/7
 Dimensions (µm):

SN	L	D	d	d/D
S4-2-7	300	271	214	0.78
S4-2-2	1760	680	175	0.67
S4-2-8	632	240	160	0.66
S4-2-10 a	336	200	144	0.72
S4-2-10 b	228	228	142	0.62
S4-2-10 c	271	257	157	0.61
S4-1-7	2318	636	318	0.50

Description: The shape of the thallus is almost circular (ring shaped). The central stem is completely calcified. The cortical region is also highly calcified hence it is difficult to identify branching structures of the fragments.

Remarks: The overall characteristics of the fragments resemble the genus *Dissocladella*, but the central stem and branching structures are not very clear hence the observed fragment is inferred to be *Dissocladella* sp.

Horizon: White limestone of Periyakurichchi Member belonging to Niniyur Formation, Cauvery Basin.

Genus *Terquemella* Munier-Chalmas, 1878
Terquemella gobularis Elliott, 1968
 (Pl. II, Figs. 1-6)

Terquemella gobularis Elliott: Elliott 1968, P.78, Pl. 23, Fig. 5 & 8

Material: FCP/D/NIN/L1/S4/1/4,13, FCP/D/NIN/L1/S4/2/12, FCP/D/NIN/L1/S4/3/8 and FCP/D/NIN/L1/S4/3/5
 Dimensions: (µm)

SN	L	D	ds	Dd
S4-1-4	711	688	22	688
S4-3-8	818	527	72	527
S4-3-5	650	450	40	450
S4-1-13	536	218	27	410
S4-2-12	853	466	66	570
S4-01-3	1029	279	44	780

Description: Thallus can be observed as rounded to sub-rounded disc shaped. Sporangia are spherical to sub-spherical in nature. The sporangia are dispersed all over the disc.

Remarks: The given fragments show similar dimensions of the disc as well as sporangia as that of *Terquemella gobularis* Elliott and therefore the fragment is described as *Terquemella gobularis* Elliott.

Horizon: White limestone of Periyakurichchi Member belonging to Niniyur Formation, Cauvery Basin.

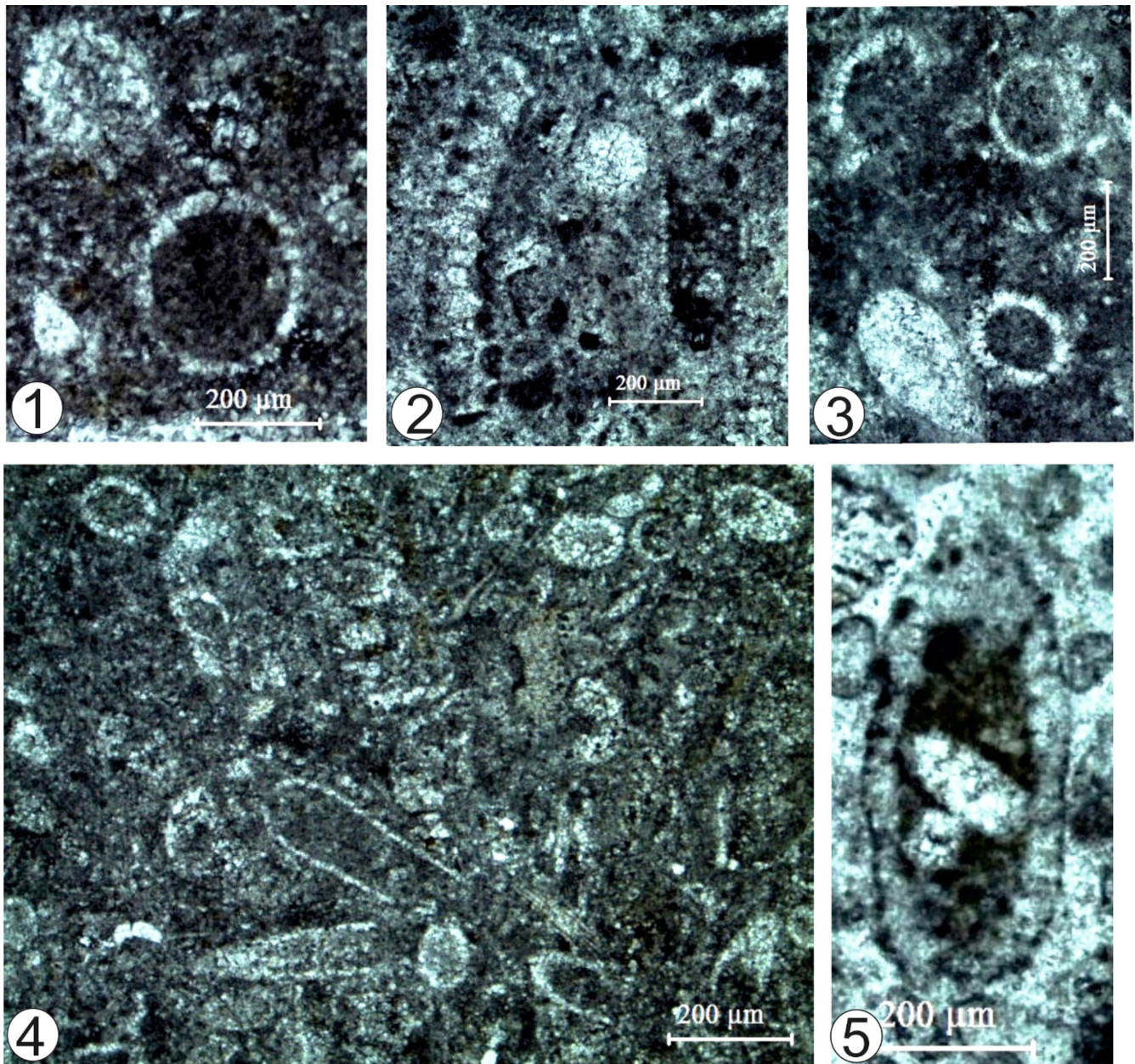
Carpenterella jonesi Morellet 1922
 (Plate III, Figs. 4 and 9)

Carpenterella jonesi Morellet: Morellet,1922: Pl.14, figs. 6-15

Carpenterella jonesi Morellet: Barattolo, 1998, p.65-127, Figs.11, pl.16

Material: FCP/D/NIN/L1/S10/2/8; FCP/D/NIN/L1/S8/1/1
 Dimensions: (µm)

SN	L	D	Ds
S10-2-8	363	354	45
S8-1-3	1029	279	44



EXPLANATION OF PLATE I

Figs. 1 to 5: *Dissocladella* sp, Specimen nos. FCP/D/NIN/L1/S4/2/2,7,8,10; FCP/D/NIN/L1/S4/1/7

Description: The thallus is circular to semi-circular in shape. Several pores are present in the thallus. Morellet (1992) considered this genus as isolated ampullae and pores as cysts, like *Terquemella*.

Remarks: The thallus resembles *Carpenterella jonesi*. The cysts are also visible and can be observed and are very similar to the suggested species. Therefore the present species is described as *Carpenterella jonesi*.

Horizon: White limestone of Periyakurichchi Member belonging to Niniyur Formation, Cauvery Basin.

Family: -? Triploporellaceae (Pia, 1920) Berger and Kaever (1992)

Genus *Decastroporella* (Barattolo, 1998)
Decastroporella tergestina (Barattolo, 1998)
 (Pl III, Figs. 1, 2, 3 & 6)

Decastroporella tergestina: Barattolo, 1998, p.65-127, Figs.11, pl. 16

Material: FCP/D/NIN/L1/S4/3/1, 4, 11, 14

Dimensions: (µm)

SN	L	D	d	d/D
S4-3-1	2318	636	318	0.5
S4-3-4	228	228	142	0.6
S4-3-11	1562	437	187	0.42
S4-3-14	1578	184	131	0.7

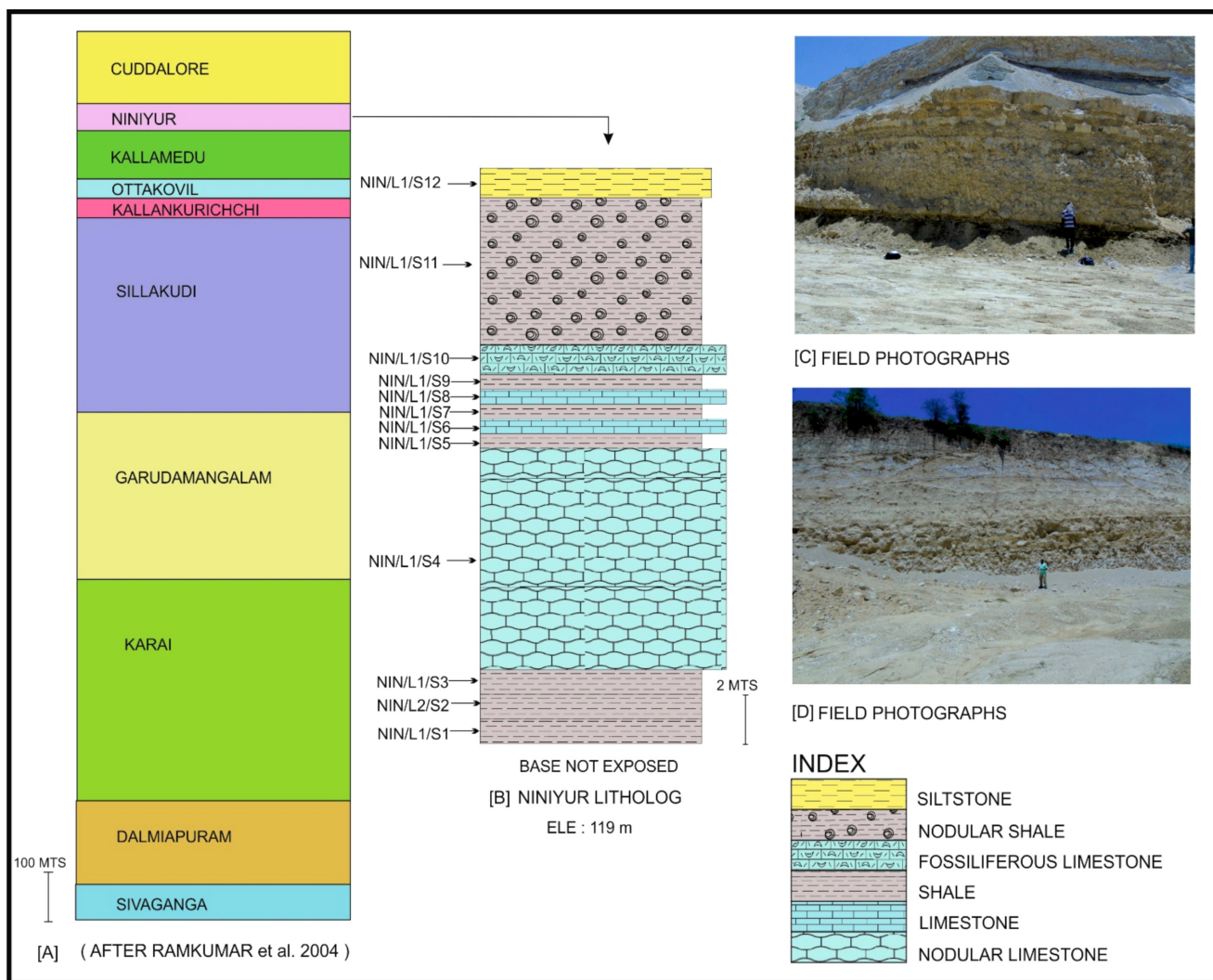


Fig. 2: A) Composite litholog after Ramkumar *et al.* 2004, B) Litholog of presently studied section, C) and D) Field photographs of the section studied.

Description: The thallus is elongated and tapers as we move to the apex. The medullary region is visible. The branches are arranged without clear order. The transverse section shows article bearing subtle branches, though they are not well preserved. Longitudinal to axial sections of articles i.e. stalked parts of the thallus are also visible.

Remarks: This specimen shows much similarities to the *Decastroporella tergestina* (Barattolo, 1998), hence the present species is described as *Decastroporella tergestina*.

Horizon: White limestone of Periyakurichchi Member belonging to Niniyur Formation, Cauvery Basin.

Division: Chlorophyta or Charophyta?

Genus Drobnella (Barattolo, 1998)

Drobnella slovenica (Barattolo, 1998)
(Pl. III, Figs. 5, 7 and 8)

Drobnella slovenica (Barattolo, 1998): Barattolo, 1998, p.65-127, Figs.11, pl. 16

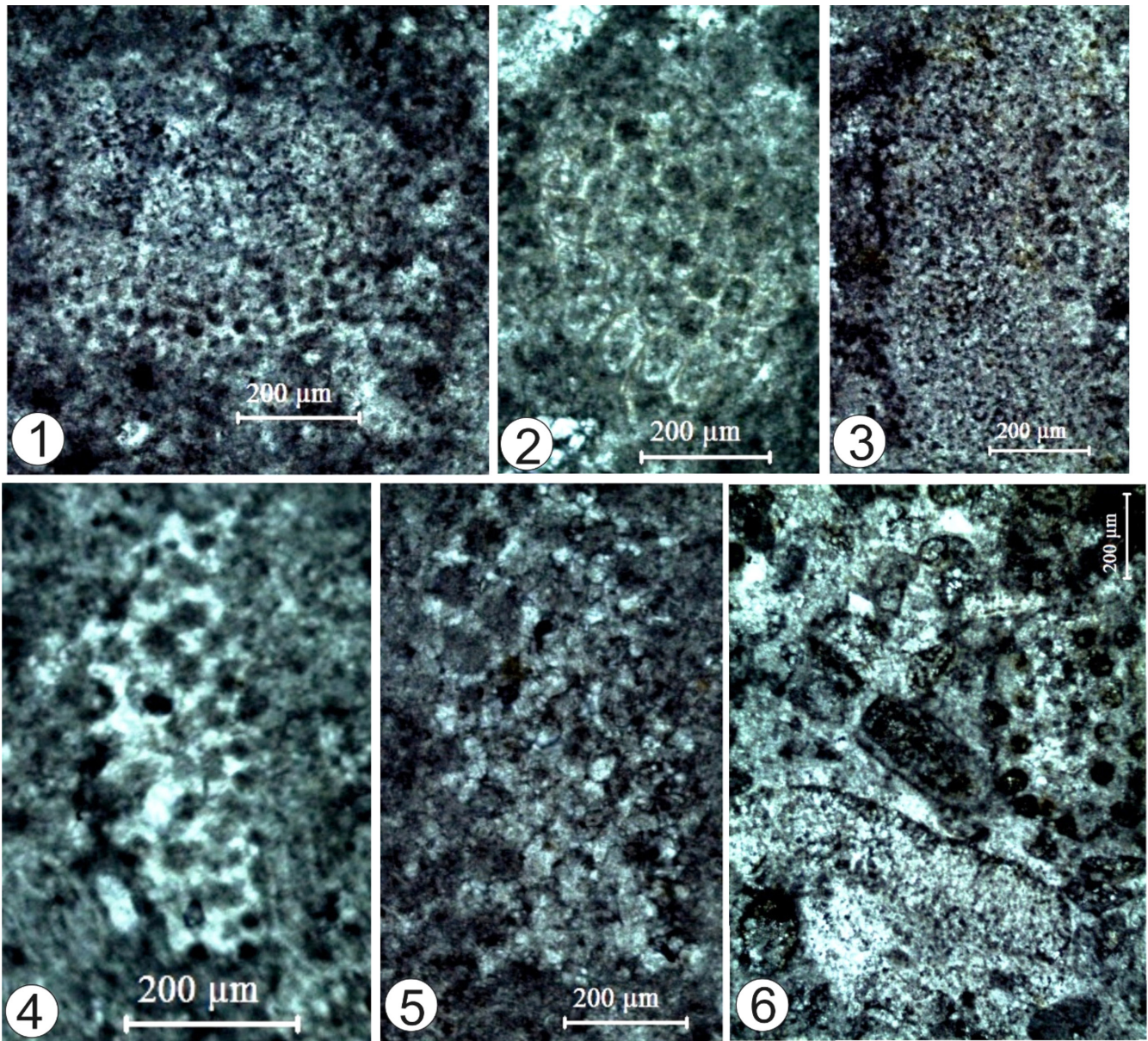
Material: FCP/D/NIN/L1/S4/1/1; NIN/L1/S8/1/5
Dimensions: (µm)

SN	L	D	d	d/D
S4-1-16	600	600	306	0.51
S4-3-2	488	577	277	0.48
S8-1-5	705	500	279	0.55

Description: The thallus is mostly circular in shape resembling the oblique section of the stem of the algae. The important thing to notice is the rough surface that is visible.

Remarks: The thallus shows much similarities to *Drobnella slovenica* (Barattolo, 1998) and hence the present species is described as *Drobnella slovenica*.

Horizon: White limestone of Periyakurichchi Member belonging to the Niniyur Formation, Cauvery Basin.



EXPLANATION OF PLATE II

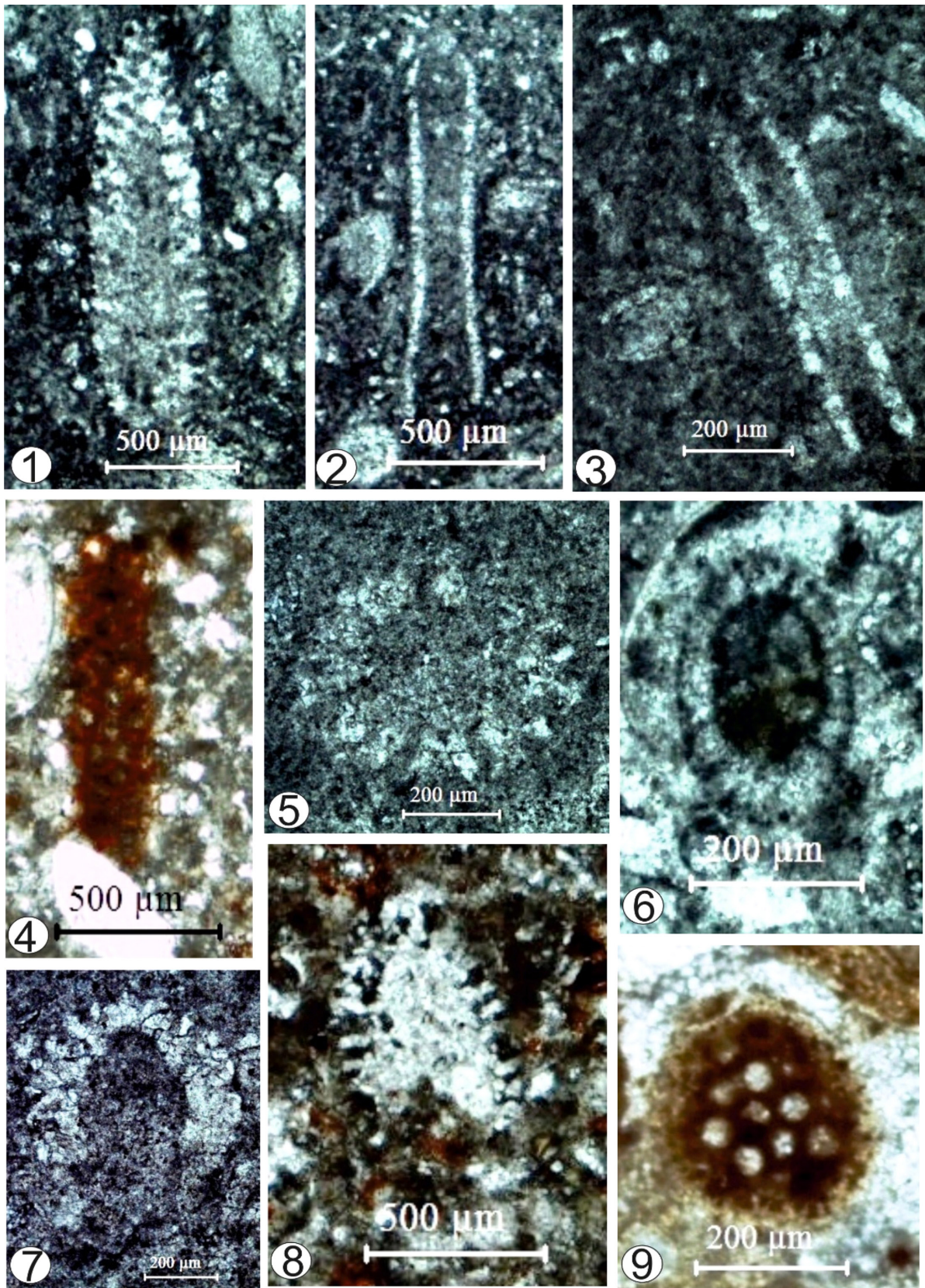
Figs. 1 to 6. *Terquemella gobularis*, Specimen nos. FCP/D/NIN/LI/S4/1/4, FCP/D/NIN/LI/S4/3/8; FCP/D/NIN/LI/S4/3/5; FCP/D/NIN/LI/S4/1/13, FCP/D/NIN/S4/2/12 and FCP/NIN/LI/S8/1/3.

CONCLUSIONS

The present paper reports five dasycladacean algal species from Thanetian sediments of the Periyakurichchi Member of the Niniyur Formation. All the dasycladacean algal species are mostly present in the lower most limestone unit, indicate that the deposition of the lower most limestone unit occurred in shallow water marine environment with bathymetry ranging between 0-10 mt.

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EXPLANATION OF PLATE III

Figs. 1, 2, 3 and 6, *Decastroporella tergestina* Specimen nos. FCP/D/NIN/L1/S4/3/1, 4, 11, 14; Figs. 4 and 9: *Carpenterella jonesi*, Specimen no. FCP/D/NIN/L1/S8/1/1; FCP/D/NIN/L1/S10/2/8, Figs. 5, 7 and *Drobnella slovenica*, Specimen no. FCP/D/NIN/L1/S4/1/1; FCP/D/NIN/L1/S8/1/5

REFERENCES

- Ayyasamy, K. 1990. Cretaceous heteromorph ammonoid biostratigraphy of southern India: Newsletters on Stratigraphy, 22(2-3): 111-118.
- Barattolo, F. 1998. Dasycladacean green algae and microproblematica of the uppermost Cretaceous–Paleocene in the Karst area (NE Italy and Slovenia). In: Hottinger L, Drobne K (Eds.) Paleogene shallow benthos of the Tethys, 34: 65–127.
- Barattolo, F. 2002. Late Cretaceous–Paleogene dasycladaceans and the K/T Boundary problem, p. 19-40. In: (Eds.) Bucur, I. and Filipescu, S., Research advances in calcareous algae and microbial carbonates, Cluj University Press.
- Bassoullet, J. P., Bernier, P., Conrad, M. A., Deloffre, R. and Jaffrezo, M. 1978. Les algues dasycladales du jurassique et du Cr.tac.. Geobios, paleontologie, stratigraphie, paleoecologie, m. moirespeciea , 12: 330.
- Berger, S., and Kaefer, M.J. 1992. Dasycladales. An Illustrated Monograph of a Fascinating Algal Order: G. Thieme Verlag, Stuttgart : 247
- Bizzozero, G. 1885. Flora Veneta Crittogammica. Part 2. Seminario, Padova, 255pp.
- Blanford, H.F. 1862. On the Cretaceous and other rocks of the South Arcot and Trichinopoly districts. Memoirs of Geological Survey of India, 4: 1–217.
- Bucur, I. 1999. Stratigraphic significance of some skeletal algae (Dasycladales, Caulerpaes) of the Phanerozoic, p. 53-104. In: Depositional episodes and bioevents. Palaeopelagos (Eds.) Farinacci, A. and Lord, A. R. Special Publication, 2.
- Chandrasekaran, V.A. Ramkumar, M. and Jacob, M. 1996. Sediment deformational structures from the Sillakkudi Formation (Campanian) Ariyalur Group, Tiruchy district, Tamil Nadu. Journal of the Indian Association of Sedimentologists, 15: 43–49.
- Elliott, G. F. 1968. Permian to Palaeocene calcareous algae (Dasycladaceae) of the Middle East. Bulletin British Museum of Natural History, London, Supplement, 4: 1-111.
- Gray, J.E. 1864. Handbook of British Water-Weeds or Algae. pp. i-iv, 1–123. London: R. Hardwicke.
- Govindan, A., Ananthanarayanan, S. and Vijayalakshmi, K.G. 2000. Cretaceous petroleum system in Cauvery basin, India. In: Govindan, A. (ed.), Cretaceous stratigraphy—An update. Memoirs of the Geological Society of India, 46: 365–382.
- Govindan, A., Ravindran, C.N. and Rangaraju, M.K. 1996. Cretaceous stratigraphy and planktonic foraminiferal zonation of Cauvery basin, South India. In: (Ed.), Sahni, A., Cretaceous stratigraphy and palaeoenvironments. Memoirs of the Geological Society of India, 37: 155–187.
- Hart, M.B., Bhaskar, A. and Watkinson, M.P. 2000. Larger foraminifera from the upper Cretaceous of the Cauvery basin, S.E. India. In: (Ed.) Govindhan, A., Cretaceous stratigraphy – An update. Memoirs of the Geological Society of India, 46: 159–171.
- Heydrich, F. 1897. Corallinaceae, insbesondere Melobesieae. Berichte der Deutschen Botanischen Gesellschaft 15(1): 34-70
- Kishore, S. 2004a. Palaeo-ecological significance of Palaeocene Calcareous algae from the Cauvery Basin, India, Ecoprint, 11(1): 59-63.
- Kishore, S. 2004b. Occurrence and significance of the Palaeocene Green alage (Dasycladacean and Utoteacean) from Cauvery Basin, India. Geophytology, 33(1&2): 39-46.
- Kishore, S. and Singh S.K. 2004. Coralline alage from the Niniyur Formation (Thnetian) of the Cauvery Basin, South India. Our Nature, 2: 1-6.
- Kishore, S., Misra, P.K., Jauhri, A.K. and Singh, S. K. 2003. Calcareous algal association from the Niniyur Formation (Palaeocene) of the Cauvery Basin, India, Ecoprint, 10(1): 13-17.
- Kossmat, F., 1897. The Cretaceous deposits of Pondicherry (Translated by Mr. and Mrs. Ford). Records of the Geological Survey of India, 30: 51–110.
- Kundal, P. 2010. Biostratigraphic, Paleobiogeographic and Paleoenvironmental Significance of Calcareous Algae, Kundal, P. and Humane, S.K. (Guest Eds). In: Special issue on “Applied Micropaleontology”. Gondwana Geological Magazine, 25(1): 125-132.
- Kundal, P., Kishor, S., Humane, S. K., and Wanjarwadkar, K. M. 2020. Cymopolia (Dasycladales) from the Early Middle Miocene of Kachchh, India: Global Reduction of its species diversity in the Neogene. Journal of the Palaeontological Society of India, 65(2): 185-192
- Kützing, F. T. 1843. Phycologia generalis oder Anatomie, Physiologie und Systemkunde der Tang. Leipzig: F.A. Brockhau.
- Lamouroux, J. V. F. 1812. Extrait d' un Memoire sur la classification des polypiers coralligenes non entierement pierreux. Nouveau Bulletin des Sciences, Publie par la Société Philomatique de Paris 2: 38-44.
- Morellet, D. 1922. Nouvelle contribution a l'Ötude des dasycladac.es Tertiaires. Mémoires de la Société géologique de France, 58: 35 (2 pl.).
- Muthuvairavasamy, R., Stüben, D., Berner, Z. 2003. Lithostratigraphy, depositional history and sea level changes of the Cauvery Basin, southern India: Geoloski anali Balkanskog poluostrva, 65: 1-27.
- Misra, P.K. and Kumar, P. 1988. Fossil algae from the Cretaceous of Varagur, Tiruchirapalli District, Tamil Nadu. Palaeobotanist, 37(1), pp. 36-51.
- Misra, P.K., Jauhri, A.K., Kishore, S. and Chowdhury, A. 2000. Calcareous algae (Dasycladaceans and Gymnocodiacean) from the Palaeocene deposits of the Tiruchirapalli (= Trichinopoly) are, Tamil Nadu, India. Journal of the Palaeontological Society of India, 45: 151-164.
- Misra, P.K., Jauhri, A.K., Chowdhury, A. and Kishore, S. 2001. Palaeocene Rhodophycean alage from the Niniyur Formation of the Cauvery Basin, Southern India. Palaeobotanist, 50(2 and 3) : 311-339.
- Misra, P.K., Kishore, S., Jauhri, A.K. and Singh, S. K. 2003. Coralline alage from the Niniyur Formation, Cauvery Basin, South India. Journal of the Palaeontological Society of India 48: 89-97.
- Misra, P.K., Rajanikanth, A., Jauhri, A.K., Kishore, S. and Singh, S.K. 2004. Albian limestone building algae of Cauvery Basin, South India. Current Science, 87: 1516-1518.
- Misra, P.K., Jauhri, A.K., Singh, S.K., Kishore, S. and Rajanikanth, A. 2006. Non-geniculate coralline algae from the Uttatur Group (Early Cretaceous), south India. Palaeobotanist, 55(1-3): 29-40.
- Munier-Chalmas, E. 1877. Observations sur les algues calcaires appartenant au groupe des Siphonées verticillées (Dasycladées Harv.) et confondues avec les Foraminifères. Compte Rendu Hebdomadaire des Séances de l'Académie des Sciences. Paris, 85: 814–817.
- Nair, K.M. and Vijayam, B.E. 1980. Sedimentology of limestones in Niniyur Formation, Palaeocene, Cauvery basin, South India. Journal of the Geological Society of India, 21: 503–510.
- Pascher, A. 1931. Systematische Übersicht über die mit Flagellaten in Zusammenhang stehenden Algenreihen und Versuch einer Einreihung dieser Algenstämme in die Stämme des Pflanzenreiches. Beihefte zum Botanischen Centralblatt, 48: 317–332.
- Pia, J. Von. 1920. Die Siphoneae verticillatae vom karbon bis zurkreide. Abhandlungen der Zoologisch-Botanischen-Gesellschaft, 11(2): 1-263 (8 pl.).
- Rabenhorst, L. 1863. Kryptogamen-Flora von Sachsen, der Ober-Lausite, Thuringen und Nordbohen. Abteilung I.E Krummer, Leipzig.
- Radulovic, V. and Ramamoorthy, K. 1992. Late Cretaceous (Early Maastrichtian) brachiopods from south India. Senckenbergiana Lethaea, 72: 77–89.
- Rajnikanth, A. 1992. Rock building Cretaceous-Tertiary algae from India - An ecological perspective. Palaeobotanist, 40: 399-412.
- Ramkumar, M., Stüben, D. and Berner, Z. 2004. Lithostratigraphy, depositional history and sea level changes of the Cauvery basin, South India. Annals of Geology of Balkan Peninsula, 65: 1–27.
- Rajanikanth, A., Venkatachala, B.S. and Kumar, A. 2000. Geological age of the Ptilophyllum flora – A critical reassessment. In: Govindhan, A. (ed.), Cretaceous stratigraphy – An update. Memoirs of the Geological Society of India, 46: 245–256.
- Ramasamy, S. and Banerji, R.K. 1991. Geology, petrography and systematic stratigraphy of pre-Ariyalur sequence in Trichirapalli district, Tamil Nadu, India. Journal of the Geological Society of India, 37: 577–594.
- Rao, L.R. and Prasannakumar, C. 1932. Occurrence of *Lithothamnion* in the South Indian Cretaceous. Nature, 129: 776-777.

- Rao, L.R. and Pia, J. 1936. Fossil algae from the uppermost Cretaceous beds (The Niniyur Group) of the Trichinopoly District, S. India. *Memior Geological Survey of India*, 21(4): 13-40.
- Rao, L.R. and Gowda, S.S. 1954. Solenoporaceae in the Cretaceous rocks of south India. *Current Science*, 23: 177178.
- Sastry, M.V.A., Rao, B.R.J. and Mamgain, V.D. 1968. Biostratigraphy zonation of the Upper Cretaceous formation of the Trichinopoly district, south India. *Memoirs of the Geological Society of India*, 2: 10-17.
- Sastry, V.V., Raju, A.T.R., Sinha, R.N. and Venkatachala, B.S. 1977. Biostratigraphy and evolution of the Cauvery basin, India. *Journal of the Geological Society of India*, 18: 355-377.
- Sastry, M.V.A. and Rao, B.R.J. 1964. Cretaceous-Tertiary boundary in south India. *Proceedings on the XII International Geological Congress on Cretaceous-Tertiary boundary including volcanic activity*, 3(3): 92-103.
- Sastry, M.V.A., Mamgain, V.D. and Rao, B.R.J. 1972. Ostracod fauna of the Ariyalur Group (Upper Cretaceous), Trichinopoly district, Tamil Nadu. *Palaeontologica Indica*, 40: 1-48.
- Silva, P. C. and Johansen, H. W. 1986. A reappraisal of the order Corallinales (Rhodophyceae). *British Phycological Journal* 21: 245-254.
- Sundaram, R., Henderson, R.A., Ayyasami, K. and Stilwell, J.D. 2001. A lithostratigraphic revision and palaeoenvironmental assessment of the Cretaceous System exposed in the onshore Cauvery Basin, southern India. *Cretaceous Research*, 22: 742-762.
- Sundaram, R. and Rao, P.S. 1986. Lithostratigraphy of Cretaceous and Palaeocene rocks of Tiruchirapalli district, Tamil Nadu, South India. *Records of the Geological Survey of India*, 115: 9-23.
- Tewari, A., Hart, M.B. and Watkinson, M.P. 1996. A revised lithostratigraphic classification of the Cretaceous rocks of the Trichinopoly district, Cauvery basin, Southeast India. In: Pandey, J, Azmi, R.J, Bhandari, A. & Dave, A. (Eds.), "Contributions to the XV Indian Colloquium on Micropalaeontology and Stratigraphy", 789-800.
- Venkatachala, B.S. 1974. Palynological zonation of the Mesozoic and Tertiary subsurface sediments in the Cauvery basin. In: Surange, K.R. et al. (Eds.), "Aspects and appraisal of Indian Palaeobotany", Birbal Sahni Institute of Palaeobotany, Lucknow, 476-495.
- Verheij, E. 1993. The genus *Sporolithon* (Sporolithaceae fam. Nov. Corallinales, Rhodophyta) form the spermmunde Archipelago, Indonesia. *Phycologia*, 32: 184-196.
- Yadagiri, K. and Govindan, A. 2000. Cretaceous carbonate platforms in Cauvery basin: Sedimentology, depositional setting and subsurface signatures. In: Govindan, A. (Ed.), "Cretaceous stratigraphy - An update". *Memoirs of the Geological Society of India*, 46: 323-344.