Journal of the Palaeontological Society of India
Volume 59(2), December 2014: 227-230

ISSN 0522-9630

RECORD OF *EUPATAGUS* L. AGASSIZ, 1847 (ECHINOIDEA) FROM THE SIJU FORMATION, GARO HILLS, MEGHALAYA, INDIA

D. K. SRIVASTAVA[1]* and **RAHUL GARG[2]**

1 DEPARTMENT OF GEOLOGY, CENTRE OF ADVANCED STUDY, UNIVERSITY OF LUCKNOW, LUCKNOW – 226007, INDIA
2 BIRBAL SAHNI INSTITUTE OF PALAEOBOTANY, 53 UNIVERSITY ROAD, LUCKNOW-226007, INDIA
E-mails: [1]deardrdk@gmail.com;[2]rahulbsip@gmail.com
*CORRESPONDING AUTHOR

ABSTRACT

A brissid echinoid is recorded and described from the Siju Formation exposed at about 7 km southeast of Adugiri village (along Dilni River), Garo Hills, Meghalaya, India and placed under the genus *Eupatagus* L. Agassiz, 1847. It is characterized by a large, oval test with mild frontal sinus; convex aboral surface; anteriorly eccentric ethmolytic apical system; long, petaloid ambulacral petals and imperforate, non crenulated tubercles. Calcareous nannofossils and dinoflagellate cysts indicate lower Bartonian age for the echinoid-bearing level of the Siju Formation.

Keywords: Brissid echinoid, *Eupatagus*, Siju Formation, Eocene (Bartonian), Garo Hills, Meghalaya, India

INTRODUCTION

The paper records a brissid echinoid (Fischer, 1966 and Smith, 2011) from the fossiliferous limestone-marl succession of middle Eocene age belonging to the Siju Formation exposed at about 7 km southeast of Adugiri village (along Dilni River), Garo Hills, Meghalaya, India (Fig.1). The single specimen is placed under the genus *Eupatagus* L. Agassiz, 1847 characterized by its large, oval test with mild frontal sinus; convex aboral surface; anteriorly eccentric ethmolytic apical system; long, petaloid ambulacral petals and imperforate, non-crenulated tubercles. Earlier, three other echinoid genera namely, *Echinolampas* Gray, 1825, *Gitolampas* Gauthier, 1889 and *Rhyncholampas* A. Agassiz, 1869 have been recorded from the fossiliferous limestone of middle Eocene age exposed in a quarry section on the Daluagiri-Chokpot Road, South Garo Hills, Meghalaya, India (Srivastava *et al*., 2008). The genus *Eupatagus* L. Agassiz, 1847 has so far been reported in India from the Cenozoic rocks of Kachchh (Duncan and Sladen, 1883; Srivastava, 1881; Srivastava, 2004), Assam (Spengler, 1923) and Rajasthan (Srivastava and Singh, 2008).

GEOLOGIC SETTING

The Garo Hills form the westernmost part of the Shillong Plateau where the area, lying to the south of the Tura Ranges, represents an extension of the Assam Shelf and is characterised by thick Cenozoic deposits. The thick sedimentary succession, unconformably overlying the Precambrian basement complex and ranging in age from Palaeocene to Recent, occupies the southernmost portion of the Garo Hills, Meghalaya. The pioneering work on the geology of Meghalaya by Oldham (1863) followed by Medlicott (1868, 1874), Chakraborty (1972) and Chakraborty and Baksi (1972) provided the lithostratigraphic classification of the Cenozoic succession of the Garo Hills and western part of Khasi Hills. Sinha *et al*. (1982) summarized the palaeontological researches in the north eastern states of India. The basal lithostratigraphic unit exposed in the area is represented by the Tura Formation (Palaeocene-Early Eocene) comprising coarse-grained, cross-bedded sandstone interbedded with ironstone, siltstone, shale and coal deposited in the coastal swampy environment. The Tura Formation is conformably overlain by foraminifera-rich Siju Formation, with its type locality in the Siju area, where it is composed of cliff forming, hard, massive, impure and buff-coloured limestone at the top with alternations of arenaceous limestone and calcareous shale or marl bands at the base. The Siju Formation is 120 meters thick in the Simsang River section (Chakraborty and Baksi, 1972) but towards the west, the formation rapidly thins out and is represented by only about 5 m sequence in the area southwards of Tura. The Siju Formation is considered to be equivalent of the upper Sylhet Limestone Formation of the Khasi-Jaintia Hills.

Based on the detailed larger foraminiferal studies (Samanta, 1968) and later correlated with planktic foraminiferal zonation (Samanta, 1969), the age of the Siju Formation is considered to be late Lutetian to early Bartonian. In the type area, the older sediments of the Siju Limestone are richly fossiliferous characterised by foraminiferal marl, limestone interbedded with shale and glauconitic sandstone, whereas the younger sediments are hard, massive foraminiferal limestone and show the presence of rich assemblages of foraminifera, algae, molluscs, echinoids, etc. Samanta (1968) recorded important age-diagnostic larger foraminifera (*Discocylina omphalus*, *Nummulites beaumonti*, *N. perforatus*) from the Siju Formation of the Siju area which are considered by Samanta (1969) to be associated with the planktic foraminifera of Zones P13 and P14. The larger foraminifera of the Siju Formation are widely distributed in the middle Eocene successions of the Tethyan belt, corresponding to zones SBZ15-SBZ18 of the Shallow Benthic Zonation (Serra-Kiel *et al*., 1998), zones P12-lower P15 of the planktic zonation of Berggren and Miller (1988) and Berggren *et al*. (1995).

The present study is based on the succession exposed in the Dilni River along the Tura-Dalu road about seven km south eastward of Adugiri (Fig. 1). The Siju Limestone in the studied section is characteristically much reduced in thickness (~5m) as compared to the Siju Cave Section or the Simsang River Section. Lithologically, the Siju Limestone Formation is represented here by foram-rich marls interspersed with nodular sandy bands.

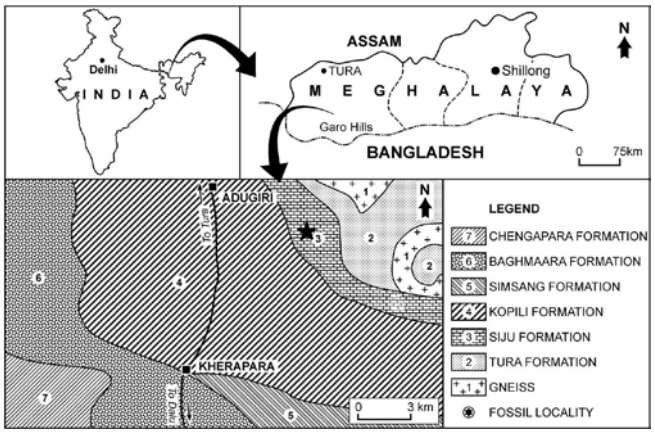


Fig. 1: Geological map of a part of South Garo Hills, Meghalaya showing fossil locality (after *Geological Survey of India*, 1976).

(Fig.2). It conformably overlies the Tura Formation (Early Eocene) and is overlain by the Rewak Formation of Late Eocene (Priabonian) age. The single echinoid specimen is recovered from the sample no. DN 18b (Fig.2).

SYSTEMATIC PALAEONTOLOGY

(The taxonomic classification of Spantagoids followed here is after Fischer, 1966).

Order **Spatangoida** Clauss, 1876
Family **Brissidae** Gray, 1855
Genus ***Eupatagus*** L. Agassiz, 1847
Subgenus ***Eupatagus*** L. Agassiz, 1847
Eupatagus (*Eupatagus*) sp.
(Pl. I, figs. 1- 6)

Material: One specimen, preservation is fairly good.

Description: The specimen is characterized by a large, oval test with mild frontal sinus, convex aboral surface and highest point of the test at the centre of the test; margin tumid and well rounded. The test is longer than wide and wider than high, truncated towards posterior side and moderately keeled. Apical system anteriorly eccentric and ethmolytic. Paired ambulacra petaloid and flush with the test. Petal III indistinct, petals I & V longer than the petals II & IV. Poriferous zones slightly depressed and consists of inner circular and oval to slit like outer pores which are conjugated by a deep groove. The peripetalous fasciole passes around the petals and do not indent in the interambulacral areas. The test is ornamented with imperforate, non-crenulated tubercles which are sunken in small scrobicules. These are large, scarce and circumscribed by the peripetalous fasciole on the aboral side.

Remarks: The absence of internal fasciole and transversally fused crescent petals II & IV in the present specimen distinguished it from the members of the Family Loveniidae Lambert, 1905. However, the overall shape of the specimen fits well with that of *Eupatagus* L. Agassiz, 1847. The specimen is close to *E. alatus* Arnold and Clark described from the Eocene sediments of Jamaica (Arnold and Clark, 1927) but it differs in having longer petals I & V, posteriorly protruded test and lesser number of tubercles. It also differs from *Eupatagus* cf. *antillarum* (Cotteau) reported from the mid-middle to low-late Eocene sediments of Clarimont Formation, White Limestone Group, Jamaica (Donovan and Rowe, 2000) in having less broad oval test which is broadest in the middle and more anteriorly eccentric apical system. The described specimen differs from *Eupatagus* (*Eupatagus*) *rostratus* (d'Archiac) reported from the Eocene and Oligocene (Srivastava, 2004) and Oligocene and Miocene rocks of Kachchh (Duncan and Sladen, 1883) and *Eupatagus* (*Eupatagus*) *rajasthanensis* Srivastava and Singh described from the sediments of the Khuiala Formation (early Eocene) exposed near Habur, Jaisalmer district, Rajasthan, India (Srivastava and Singh, 2008) in not having flexuous petals II & IV. It also differs from *Eupatagus* (*Eupatagus*) *singhi* Srivastava described from the Middle Oligocene sediments of Kachchh (Srivastava, 1981) in having moderate frontal sinus.

Locality: About 7 km southeast of Adugiri village (along Dilni River), Garo Hills, Meghalaya, India.

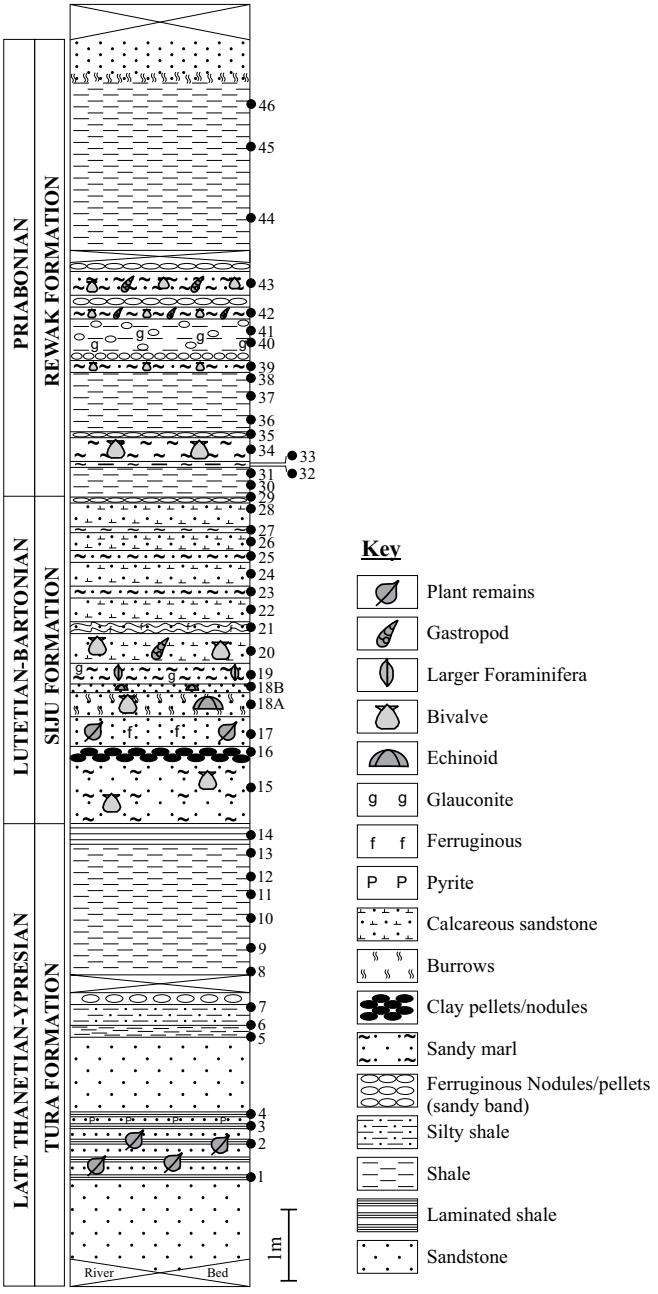
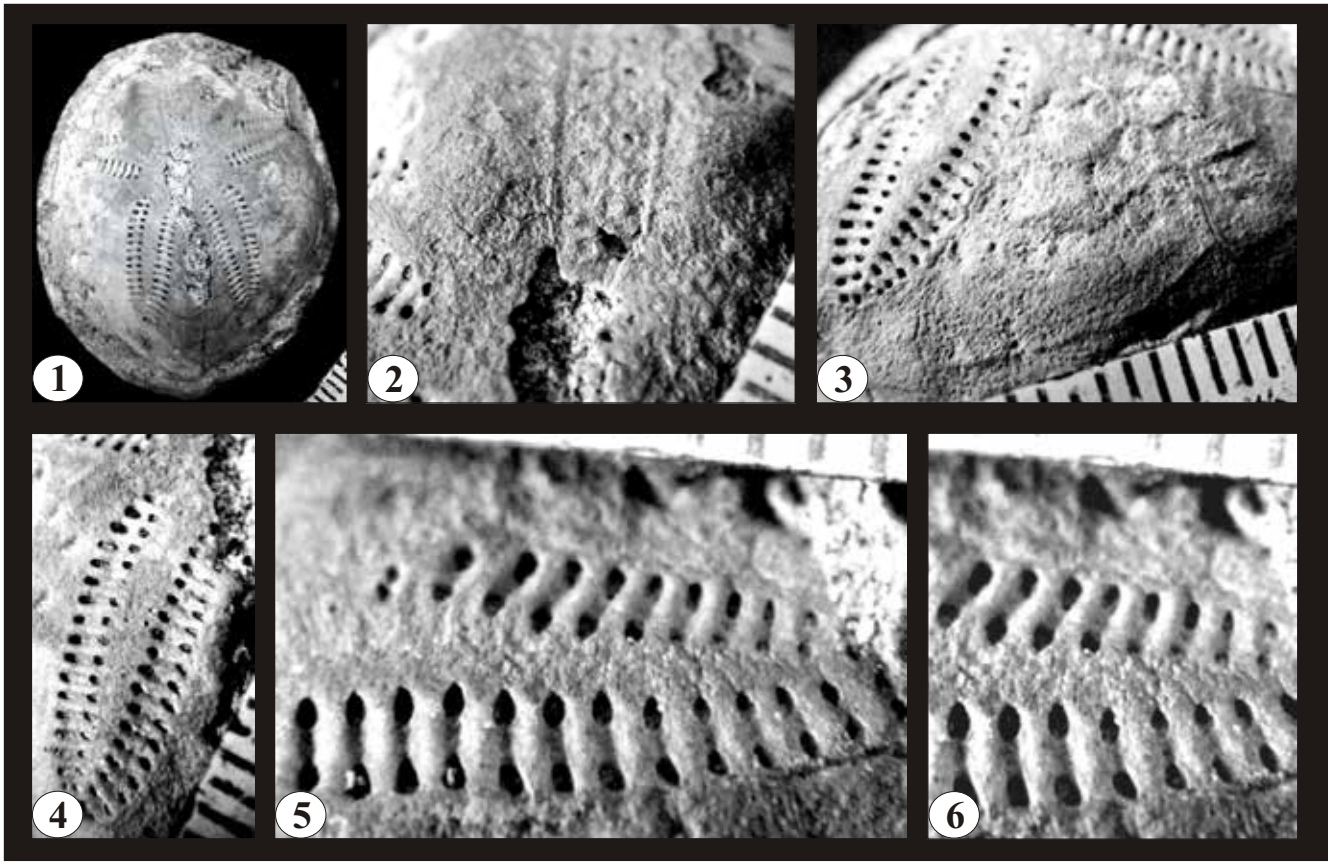


Fig. 2. Lithologic succession exposed in the Dilni River section, Tura-Dalu road, Garo Hills along with the sample numbers. The echinoid bearing sample is DN 18B.

Journal of the Palaeontological Society of India
Volume 59(2), December 2014

Plate I



EXPLANATION OF PLATE I

[Scale: 1 division = 1 mm]

***Eupatagus* (*Eupatagus*) sp.**; figs. 1 – 6. Fig 1. Aboral view; Fig 2. Apical disc; Fig 3. Peripetalous fasciole; Fig 4. Petal V; Fig 5. Petal II; Fig 6. Petal II (close up).

Horizon: Siju Formation, Eocene (Bartonian).

DISCUSSION

Rai and Garg (2009) recorded rich nannofossil assemblages of Bartonian age from Siju Formation from the Dilni River section. The nannofossil assemblage containing *Cribrocentrum reticulatum* and *Discoaster distinctus,* is calibrated with NNTe 11 (= NPl7-lower NPl8) *Chiasmolithus grandis* Zone of Varol (1989) and is also found to be comparable with well-diversified nannofossil assemblage of *Discoaster saipanensis* NP 17 Zone present in the Kachchh Basin, western India (Rai, 2007). Rich and well diversified dinoflagellate cyst assemblages have been recovered from the upper part of Tura Formation and the Siju Limestone Formation exposed at the Dilni River Section which also indicate Lower-Middle Eocene (Ypresian- early Bartonian) age (Khowaja-Ateequzzaman *et al.,* 2007; Garg, *personal observation*). Based on these evidences, age of the echinoid bearing level is considered to be early Bartonian.

The Siju Limestone succession was deposited in a shallow shelf environment developed during the late middle Eocene transgression designated as the Kirthar Transgression (Nagappa, 1959; McGowran, 1991; Jauhri and Agarwal, 2001). The predominant fossil group in the Siju Limestone, is dominated by foraminifera. The larger foraminiferal fauna characterized by *Nummulites*, *Assilina*, *Discocyclina* and *Alveolina* indicate extentsion of the 'Nummulitic Sea' in the Garo Hills (Jauhri and Agarwal, 2001; Srivastava *et al*., 2008) and suggest deposition in shallow ramp environment with depths ranging from 10 to 40 m (Hottinger, 1983). Based on analysis of rich assemblages of the bivalves, gastropods and echinoids, besides larger foraminifera, Srivastava *et al*. (2008) opined that an open, shallow, warm sea existed in the area during the late middle Eocene that was characterized by inner- to shallow mid-ramp environments with depths less than 30 m. The cassiduloid echinoids occurring in the Siju Limestone (Srivastava *et al*., 2008), though comparable with those described from early Cenozoic of Pakistan showing strong affinities with the Indo-Pacific elements, are quite distinctive and appear to be endemic to the study area. Further, the present finding of *Eupatagus* from southern margins of the Shillong Plateau in addition to its earlier records from Kachchh, Rajasthan and Assam attests to the possible existence of a marine seaway connecting north eastern and western sectors facilitating dispersal of the benthic fauna.

REPOSITORY

The described specimen of fossil echinoid has been deposited in the Museum, Department of Geology, Centre of Advanced Study, University of Lucknow, Lucknow, India.

ACKNOWLEDGEMENTS

The authors express thanks to the Head, Department of Geology, Centre of Advanced Study, University of Lucknow, Lucknow and Director, Birbal Sahni Institute of Palaeobotany for providing working facilities. We are grateful to Prof. A. K. Jauhri, Department of Geology, Centre of Advanced Study, University of Lucknow, Lucknow for suggestions. We thank Dr. Abha Singh, Birbal Sahni Institute of Palaeobotany for help in drafting the figures.

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Manuscript Accepted July 2014