

876. *NUMMULITES AND ASSILINA FROM TANSEN AREA, PALPA DISTRICT, THE NEPAL LESSER HIMALAYAS**

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Abstract. Middle Eocene (Lutetian) *Nummulites beaumonti* d'Archiac and Haime and *Assilina papillata* Nuttall are described from the Bhainskati Formation (Kirthar Series), Tansen Group in the Tansen area, Palpa district, the Nepal Lesser Himalayas. This is the first description of both species from Nepal. The specimens include only the megalospheric form and their internal morphology is discussed. Two species are useful in establishing a local and interregional correlation of marine Eocene strata. The paleoecology of the Nepal nummulitid bed is briefly described.

Key words. *Nummulites*, *Assilina*, Eocene, Nepal, Himalaya

Introduction

Much information concerning the geology and paleontology of the Nepal Lesser Himalayas has been accumulated in the last nineteen years (Hagen, 1969; Frank and Fuchs, 1970; Hashimoto *et al.*, 1973; Sharma, 1977; Sakai, 1982, 1983, 1985; Kimura *et al.*, 1985). Recently, the junior author, one of Japan Overseas Cooperation Volunteers has undertaken the geological survey around the Tansen-Palpa region, the Nepal Lesser Himalayas from 1980 to 1983. In the course of the survey, he could collect shaly limestone materials from the Bhainskati Formation (Kirthar Series), Tansen Group, and submitted them to the senior author for a paleontological study. The present paper contains an account of *Nummulites*

beaumonti d'Archiac and Haime and *Assilina papillata* Nuttall with a general discussion on species described from the middle Kirthar (Lutetian) of Kutch, northwestern India and the Middle Kirthar (Lutetian) of the Karachi district, Pakistan, respectively.

The hypotypes of *Nummulites* and *Assilina* and slides described herein have been deposited in the collections of Department of Geology, Faculty of Education, Saitama University. The specimens collected from the same locality are deposited in the Geological Museum of Department of Geology, Trichandra Campus, Tribhuvan University.

Fossil locality and notes on the geology

Nummulites beaumonti d'Archiac and Haime and *Assilina papillata* Nuttall are found from a new locality in the western part of Tansen, in a *Nummulites*-bearing shaly

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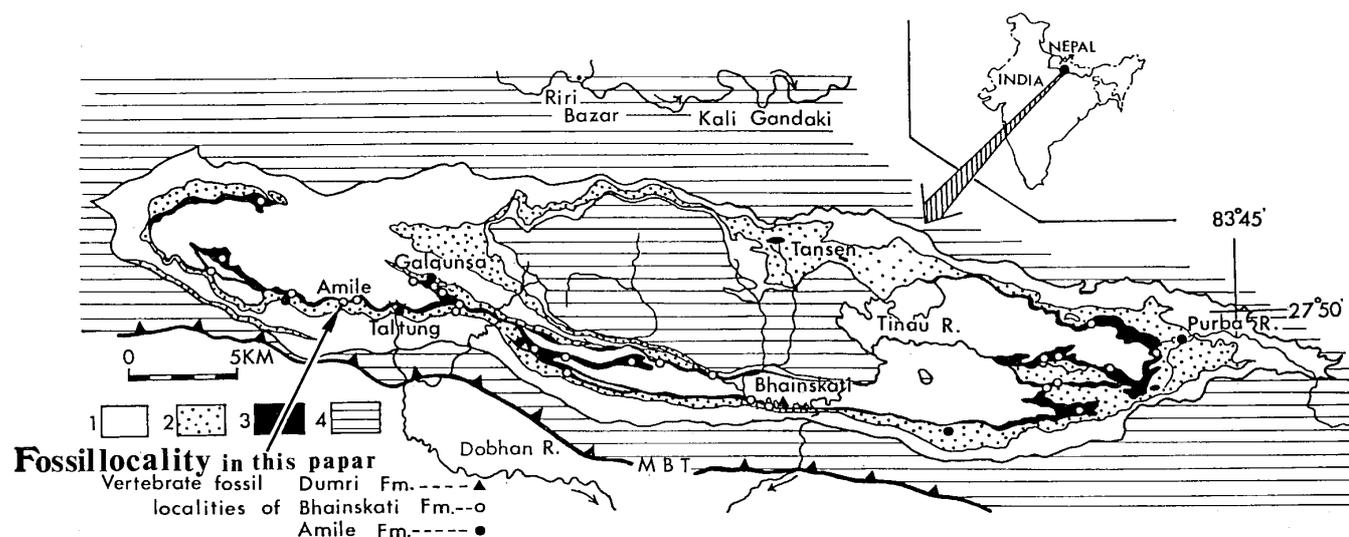


Figure 1. Map showing the fossil locality of Nepal *Nummulites* and *Assilina*, and sketch-map of the geology of the studied area. 1, Sisne, Taltung and Dumri Formations; 2, Amile Formation; 3, Bhainskati Formation; 4, Kali Gandaki Supergroup; MBT, Main Boundary Thrust.

limestone bed whose exposure extends from the upper stream of the Badahare-Amile River to Taltung in the Tansen area, located midway between Pokhara and Butwal. The estimated position of this locality lies at Lat. $27^{\circ}50'N$, Long. $83^{\circ}20'E$. (Figure 1).

The Tansen area is situated in the Nepal Lesser Himalayas, which is bounded by the Main Boundary Thrust from the sub-Himalayan Siwalik belt comprising Neogene post-orogenic sediments in the south, and it is physiographically divided into the Mahabharat Range and the Midland Range. Those structurally complex, unfossiliferous and poor outcrop conditions of the Lesser Himalayas have hitherto impeded progress of geological studies.

The Lesser Himalayan rocks in the Tansen area are grouped into two major stratigraphic units, the Tansen Group and the Kali Gandaki Supergroup, by the junior author (1982, 1983, 1985). The Tansen Group consists of the Gondwana and post-Gondwana rocks of clastic sediments ranging in age from late Carboniferous to Tertiary. This group is separated from the underlying Kali Gandaki Supergroup ranging in age from late Precambrian to early Paleozoic by a distinct uncon-

formity. The Tansen Group is subdivided into the Lower Gondwana Sisne Formation (1020 m thick), Upper Gondwana Taltung Formation (250 m), Amile Formation (230 to 300 m), Bhainskati Formation (160 to 200 m) and Dumri Formation (100 to 725 m) in ascending order, based mainly on paleontological and lithostratigraphic evidence (Figure. 2). The *Nummulites*-bearing shaly limestone bed treated in the present study is included in the Bhainskati Formation, which is especially unique and important formation in the Lesser Himalaya because of the presence of fossiliferous beds yielding *Nummulites beaumonti* d'Archiac and Haime, *Assilina papillata* Nuttall, *Asteracantus* sp., land mammals, Teleostei, Chelonia and Trionichidae (Sakai, 1983). Furthermore, the Bhainskati Formation is sandwiched between the Cretaceous to probable Palaeocene Amile Formation consisting of thick massive quartzose sandstones and the Oligocene to possible early Miocene Dumri Formation comprising a series of fluvial sandstones intercalated with shale.

Paleoecology of the nummulitic shaly limestone or limy shale bands of the Bhainskati Formation of the studied area

As seen in the stratigraphic succession of the studied area (Figure 2), the Bhainskati Formation overlies the Amile conformably and is composed of a black shale which intercalates both molluscan fossil beds and nummulitic shaly limestone or limy shale bands in the lower part. In the upper part, the Bhainskati consists of a red-purplish and green

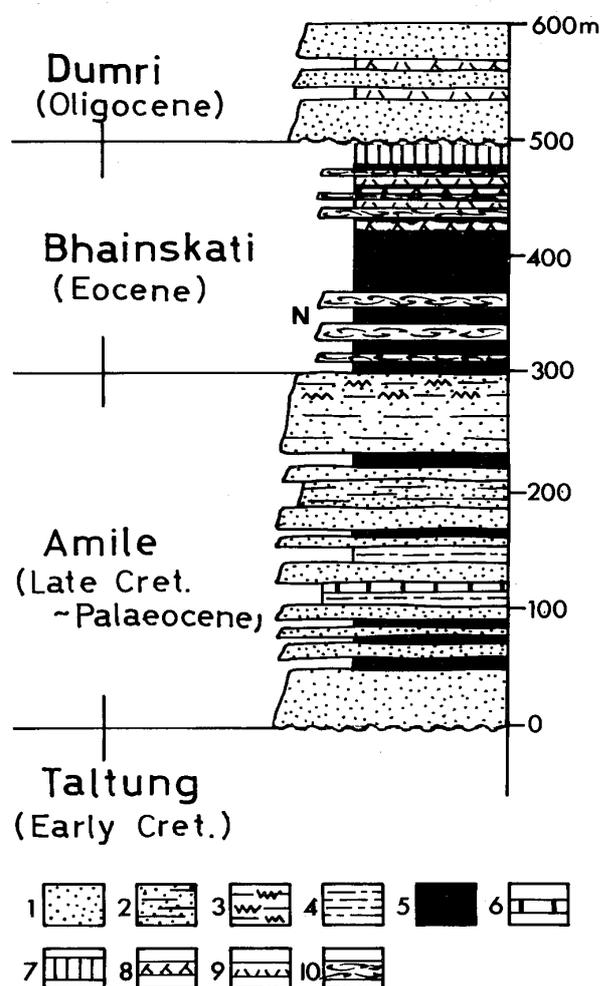


Figure 2. Map showing the stratigraphic succession of the Amile, Bhainskati and Dumri Formations, and nummulitic bed (N). 1, quartzose sandstone; 2, Sandstone with shale interbeds; 3, bioturbated mudstone; 4, siltstone; 5, black shale; 6, limestone; 7, variegated shale with oolitic hematite; 8, red shale; 9, green shale; 10, molluscan fossil beds.

mottled shale, molluscan fossil beds and oolitic hematite, and is disconformably overlain by the thick fluvial sandstones of the Dumri Formation. In the lower part of the Bhainskati, the interbedded limestone or limy shale bands indicate shallow warm marine conditions with the precipitation of carbonate rocks. This interpretation is conformable to a paleolatitude estimate of $10^{\circ} \pm 6^{\circ}$ S for the uppermost part of the Bhainskati Formation, based on the paleomagnetic study (Yoshida and Sakai, 1984).

In the Surkhet valley of western Nepal, 200 km further west of the Tansen area treated in this paper, Tewari and Gupta (1976) described a larger foraminiferal assemblage from a limestone of the Subathu Formation, including *Assilina* cf. *granulosa* (d'Archiac), *A. leymeriei* (d'Archiac and Haime), *A. granulosa* var. *chhumbiensis* Gill, *A. subdaviesi* Gill, *Nummulites* cf. *mamilla* (Fichtel and Moll), *N. atacicus* Leymerie and *N. djokjokartae* (Martin).

In this paper, the nummulitic limestone of the Subathu Formation, which is correlated with the Laki Formation of Pakistan (Nuttall, 1925), is interpreted to be indicative of shallow marine conditions where abundantly available carbonates led to the formation of nummulitic and other larger foraminiferal limestones. Although the Bhainskati Formation cannot directly be correlated with the Subathu Formation on the basis of the larger foraminiferal fauna. Nummulitic beds of both formations are similar in lithologic character and the paleoecological condition is referred to be shallow marine for both of them.

Description of species

Family Nummulitidae de Blainville, 1825

Genus *Nummulites* Lamarck, 1801

Nummulites beaumonti d'Archiac and Haime

Figures 5-1—14

- 1853 *Nummulites beaumonti* d'Archiac and Haime, p. 133, pl. 8, figs. 1a-e, 2-3.
 1926 *Nummulites beaumonti*, Nuttall, p. 130-131, pl. 1, figs. 4-5.
 1940 *Nummulites beaumonti*, Davies, p. 206-209, pl. 9, figs. 1-9.
 1959 *Nummulites beaumonti*, Nagappa, p. 180, pl. 8, figs. 15-17; pl. 9, figs. 1-2.
 1965 *Nummulites beaumonti*, Sen Gupta, p. 91-93, pl. 15, figs. 1-2, 5; pl. 16, figs. 3, 7, 9-10; pl. 17, figs. 1, 5-7, 12.
 1972 *Nummulites beaumonti*, Blondeau, p. 149, pl. 24, figs. 11-14.
 1981 *Nummulites beaumonti*, Schaub, p. 135-136, pl. 53, figs. 17-19, 22-25, tab. 14-p.

Description: —The test is small, thickly lenticular to biconvex, regularly sloping and sometimes depressive in the umbo. The sutures are visible as faint lines of radiating septal filaments near the surface. The spherical to subspherical protoconch is followed by a reniform deuteroconch of second chamber, and both chambers are followed by closely coiled whorls. The septa are straight, or slightly curved, usually near the distal end. The spiral wall is thick. The axial plugs are composed of radiating columns of shell materials. The measurements are given as follows:

Stratigraphic horizon: —A 5 to 10 cm thick shaly limestone bed bearing *Nummulites beaumonti* and *Assilina papillata*, lying about 50 m above the base of the Bhain-skati Formation (Kirthar Series), Tansen Group.

Geological age: —Middle Kirthar, Middle Eocene (Lutetian).

Remarks: —As seen in the equatorial and axial sections of this form from the Tansen area, its small protoconch, a tight coiling of spiral wall, rhombic style of chamber form, and regularly straight and radial septa are the same as those in *Nummulites beaumonti* d'Archiac and Haime from Egypt, Lybia, and the type area of the Lower Tertiary rocks of the Pakistan-Indian region (d'Archiac and Haime, 1853; Nuttall, 1926; Davies, 1940; Nagappa, 1959; Sen Gupta, 1965 and others). Although isolating the Tansen specimens from the matrix for the examination of their surface markings was difficult, oblique and tangential sections of this form show radiating and regularly curved septal filaments, and nonpapillate surface. These features have already been observed in figures of *Nummulites beaumonti* d'Archiac and Haime by some of the authors stated above.

Diameter (mm), 2.3-3.3; thickness (mm), 1.6-2.2; form ratio, 1: 1.4-1: 2.0								
Protoconch (inner diameter, μ), 90-136; protoconch (outer diameter, μ), 126-167								
Number of whorls, 7 1/2-8								
Number of chambers in whorls (one specimen shown on Figure 5-13)								
Whorls	1	2	3	4	5	6	7	7 1/2
Chambers	13	25	34	38	41	44	42	36
Rate of growth of whorls (4 specimens measured, μ)								
Whorls	1	2	3	4	5	6	7	8
Height range	197— 286	340— 391	442— 525	609— 656	782 816	952— 966	1150— 1187	1360
mean	247.5	365.5	494.3	630.8	797.3	960	1149.3	—
Thickness of spiral lamellae (4 specimens measured, μ)								
Whorls	1	2	3	4	5	6	7	8
range	26-34	24-40	34-48	36-54	36-54	36-60	40-54	44
mean	29.5	33.5	41.5	43.5	46.7	45.3	48	—

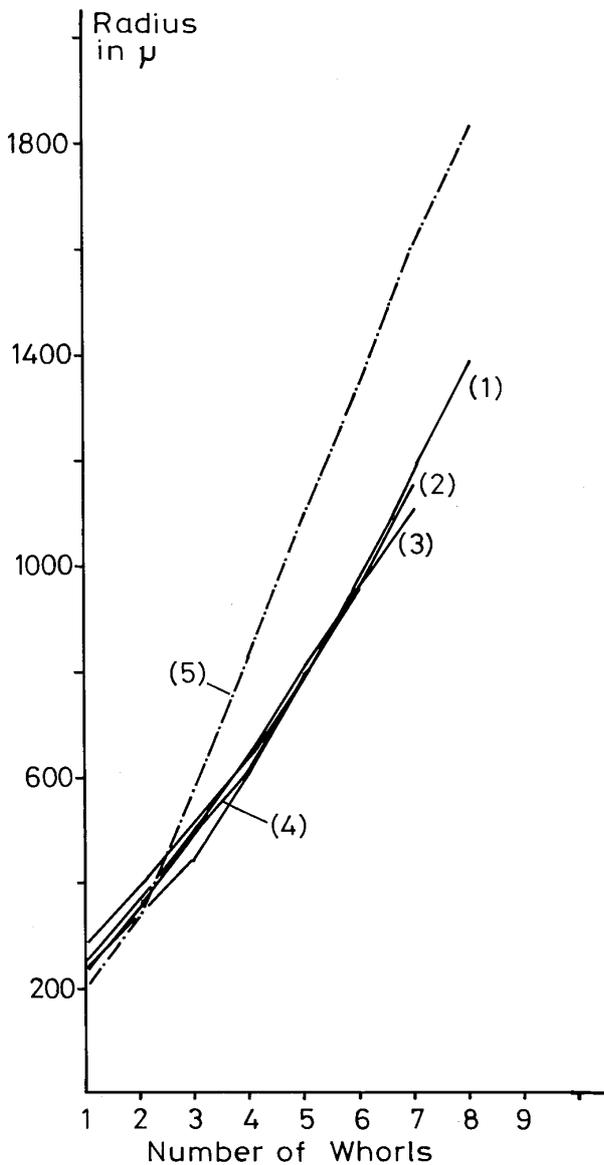


Figure 3. Spira-diagram of *Nummulites beaumonti* d'Archiac and Haime from (1) slide 18, (2) slide 14, (3) slide 2 (including a specimen of Figure 5-13), (4) slide 2 of the *Nummulites* bed of the Bhainskati Formation, Nepal and (5) one based on the average of 5 specimens from the Lutetian of Kutch, India (Sen Gupta, 1965, fig. 1), respectively.

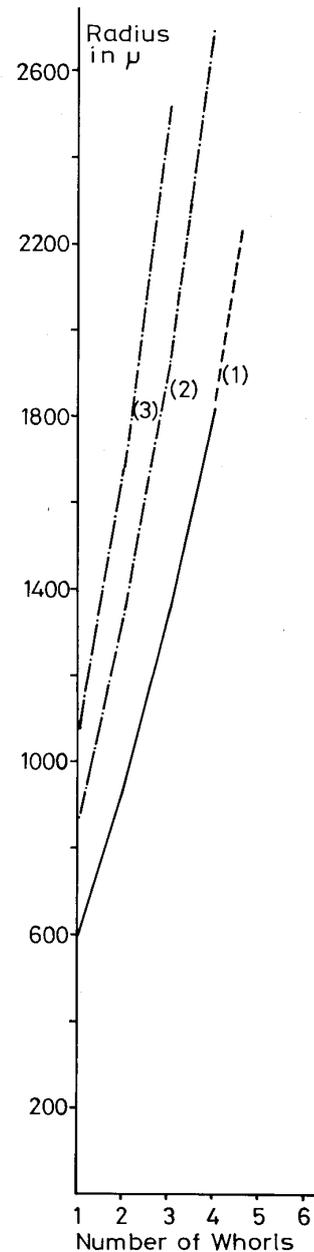
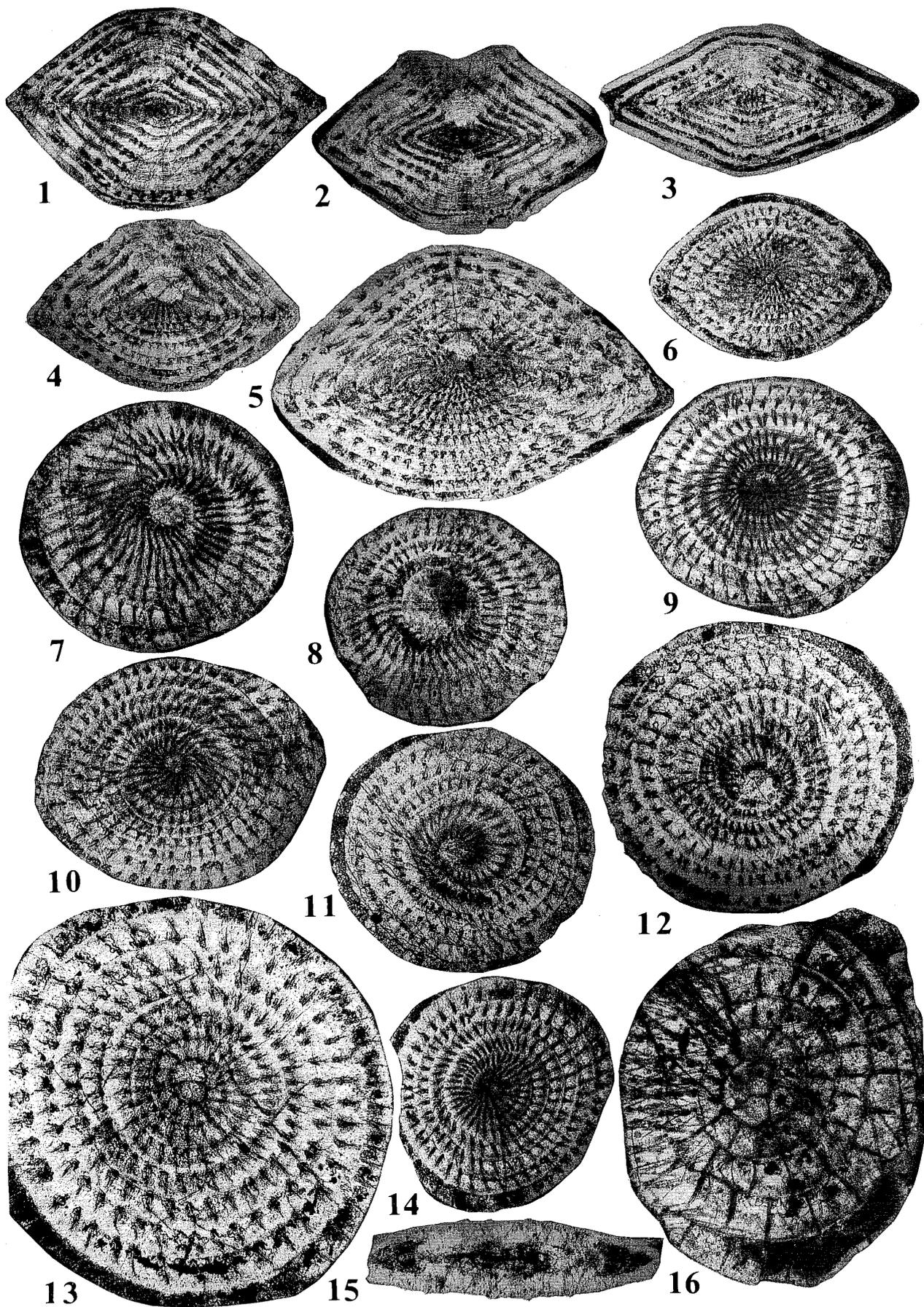


Figure 4. Spira-diagram of *Assilina papillata* Nuttall from (1) slide 6 of the *Nummulites* bed of the Bhainskati Formation, Nepal and (2) slide C31455/3 and (3) slide C31455/2, both from the Middle Kirthar (Lutetian) of Karachi District, Pakistan (Schaub, 1981, pl. 97, figs. 3-4), respectively.

→ **Figures 5.1-14.** *Nummulites beaumonti* d'Archiac and Haime, 1-3. Axial sections. The axial plug is very conspicuous in a specimen of 2; 4-7. Oblique sections. The radial septal filaments are shown in the central part near the surface of test of 7; 8-12, 14. Tangential sections. 13. Equatorial section. 15-16. *Assilina papillata* Nuttall, 15. Axial section. The whorls are not embracing to the umbonal region of test.; 16. Equatorial section. All figures $\times 16$, except $\times 30$ of 13.



As shown in Figure 3, the spira-diagram of *Nummulites beaumonti* from the *Nummulites* bed of the Tansen area shows that ontogenetic growth curves of coiled whorls of specimens are more tightly than those of *Nummulites beaumonti* d'Archiac and Haime from the Middle Eocene (Lutetian) of Kutch, western India (Sen Gupta, 1965). Sen Gupta (op. cit., p. 92) has once considered that *Nummulites beaumonti* d'Archiac and Haime may be a species showing much variation not only in external shape and size, but also in internal structure. Thus, difference between ontogenetic growth curves from Tansen specimens and Kutch ones shown in Figure 3 can be considered as a species variation of *Nummulites beaumonti*.

De la Harpe (1883, p. 166) once indicated that there is a shade of difference among the three species, *Nummulites beaumonti* d'Archiac and Haime, *N. discorbinus* (Schlotheim) and *N. striatus* Bruguière, on the view point of a tight coiling of spiral wall, chamber form and septa. This problem will be discussed near future.

Sen Gupta (1965) considered *Nummulites pengaronensis* Verbeek, *N. stamineus* Nuttall and *N. kelatensis* (Carter) to be a synonym of *N. beaumonti* d'Archiac and Haime. After all, Sen Gupta identified *Nummulites stamineus* Nuttall as a synonym of *N. beaumonti* d'Archiac and Haime, because he considered that the figures of *N. beaumonti* published by Davies (1940, pl. 9) are closely related to those of *N. stamineus*. Meanwhile, Smout (1954) considered *Nummulites stamineus* from Qatar as a synonym of *N. discorbinus* (Schlotheim), and he retained *N. beaumonti* as a valid species. Sen Gupta (1965) considered that although there is some confusion about the identity of *Nummulites kelatensis* of Carter (1861), *N. kelatensis* is closely connected with *N. beaumonti*. The present authors consider that the forms from Timor described as *Nummulites kelatensis* Carter by Henrichi (1934, p. 30–32) are definitely *N. beaumonti*, based on the increas-

ing whorl, regular spacing of the septa and polar plug.

Sen Gupta (1965, p. 93) described that another synonym of *Nummulites beaumonti* d'Archiac and Haime is *N. pengaronensis* Verbeek. He mentioned as the typical features of *Nummulites beaumonti* are a tight coiling of spiral wall, which is almost uniformly thick, and small embryonic chambers. He also noted that these features are clearly recognized in the figures of *N. pengaronensis* by Cole (1957).

Doornink (1932) reported in detail the original descriptions of *Nummulites pengaronensis* from Borneo by Verbeek (1871) and *N. nanggoelani* from Java by Verbeek (1891), in addition to Vlerk's description and illustration of *N. pengaronensis* (1929, p. 20–21, figs. 12, 35a–b). He concluded that *Nummulites pengaronensis* is the megalospheric form and *N. nanggoelani* is the microspheric of the former. Doornink has the same opinion as Douville (1912) on this matter. Cole (1957) identified both megalospheric and microspheric specimens from the Eniwetok Atoll under the name *Camerina pengaronensis* (Verbeek), and Hashimoto *et al.* (1979) and Hashimoto and Matsumaru (1981) reported *Nummulites* cf. *pengaronensis* from Philippines, respectively. However, nobody except Sen Gupta identified *Nummulites pengaronensis* as a synonym of *N. beaumonti*.

Genus *Assilina* d'Orbigny, 1839

Recently, Hottinger (1977) included the genus *Assilina* in the *Operculina* d'Orbigny, 1826, based on the similarity of structures of stolons and canal systems in the wall of test. Schaub (1981) regarded the *Assilina* to be the subgenus of *Operculina*, being accepted with Hottinger's opinion. The authors do not have any data about the wall structures of *Assilina* specimens from Nepal, but regard as the *Assilina* having the peculiar characters of evolute form and straight septa, following a classification of Blondeau (1972).

Assilina papillata Nuttall

Figures 5-15-16

- 1926 *Assilina papillata* Nuttall, p. 144, pl. 6, figs. 5-7b.
 1926 *Assilina subpapillata* Nuttall, p. 145, pl. 6, figs. 2-3a.
 1940 *Assilina papillata*, Davies, p. 214, pl. 11, figs. 1, 3, 6, 8, 10-12b.
 1959 *Assilina papillata*, Nagappa, p. 178, pl. 5, fig. 2.
 1981 *Assilina papillata*, Schaub, p. 205-206, pl. 96, figs. 26-39; pl. 97, figs. 1-6, 8-12.

Description: —The diameter of the specimens would be more than 5 mm from the incomplete portions of the available sections in measurement. The thickness of the specimens through the centre of test is from 0.9 to 1.1 mm. The opening of the spire shows evolute form. The test is composed of approximately 5 volutions, with 7 chambers in the first whorl and 22 chambers in the 4th whorl. The chambers are higher than broad. The chamber walls are evenly and regularly straight, and are radial with a sharp curvature at distal ends. Transverse sections show the marginal cord with well developed pillar structures at the whorl junction. The chambers in transverse sections much higher than broad and typically tapering in shape.

Stratigraphic horizon: —The same bed as *Nummulites beaumonti* d'Archiac and Haime.

Geological age: —Middle Kirthar, Middle Eocene (Lutetian)

Remarks: —Although uncertainty of specific identification may exist in dealing with material of this type, these specimens are referred to *Assilina papillata* Nuttall on the basis of descriptions and illustrations given by other workers stated above. There are agreements in the peculiar curve of the spiradiagrams between only one investigated specimen from Nepal and those of *Assilina papillata* from the Middle Kirthar in Gandbo Hill, northwest Karachi, Pakistan (Schaub, 1981), as shown in Figure 3. Therefore, the present form is identified with *Assilina papillata*

Nuttall.

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ネパール小ヒマラヤ山脈パルパ地方タンセン地域産 *Nummulites* および *Assilina*: 上記地域のキルタール統バインスカチ累層から酒井は *Nummulites* 属および *Assilina* 属を採集し、松丸は両者についてそれぞれ *beaumonti* 種、*papillata* 種を同定し、それらを酒井に報告していた (酒井, 1982, 1983)。今回、両名は両種について記載を行い、他種間との同物異名についても議論した。これはネパールに認められる両種についての最初の記載論文である。両種産出層の古環境も簡単に触れた。

松丸国照・酒井治孝
