25 November 1985; Revised 15 February 1986

1. Rasso, S. C. and Fraenkel, K., *Ann. Ent. Soc. Am.*, 1954, **47**, 639.
2. Vanderzant, E. S., *J. Insect Physiol.*, 1963, **9**, 683.
3. Monroe, R. E., *Nature* (*London*), 1959, **184**, 1513.
4. Pearse, A. G. E., *Histochemistry, theoretical and applied.*, 1968, III edition, Vol. 1.
5. McManus, J. F. A. and Mowry, R. W., *Staining methods: histologic and histochemical*, New York, Paul B Hoeber and Co. 1960.
6. McManus, J. F. A., *Nature* (*London*), 1946, **158**, 202.
7. Mazia, Daniel, Brewes, Philips, A. and Alfred Max., *Biol. Bull.*, 1953, **104**, 57.
8. Kurnick, N. B., *Stain Technol.*, 1955, **30**, 213.
9. Einarson, L., *Acta Pathol. Microbiol. Scand.*, 1951, **28**, 82.
10. Tobe, S. S. and Pratt, G. E., *J. Exp. Biol.*, 1975, **62**, 611.
11. Jutsum, A. R., Agarwal, H. C. and Goldsworthy, G. J., *Acrida*, 1965, **4**, 47.
12. Minks, A. K., *Archs Neerl Zool.*, 1967, **17**, 175.
13. Bell, W. J. and Bohm, M. K., *Biol. Rev.*, 1975, **50**, 373.

ADDITIONAL EARLY CAMBRIAN (BOTOMIAN) BRACHIOPOD FOSSIL LOCALITIES IN TAL FORMATION, LESSER HIMALAYA, INDIA, AND THEIR SIGNIFICANCE

C. TRIPATHI, G. KUMAR, S. MEHRA, D. K. BHATT, V. K. MATHUR, ASHUTOSH JOSHI and B. S. JANGPANGI
Geological Survey of India, Lucknow 226 006, India.

THE recent find[1] of an assemblage consisting of ten taxa of fossil brachiopoda of Early Cambrian (Botomian Stage) from the Tal Formation of Lesser Himalaya, Uttar Pradesh, is of great biostratigraphic significance. This discovery was made from a shaly horizon in the basal part of the 'Upper Tal', viz Quartzite Member[2] or Phulchatti Quartzite Member[3], in the southern limb of the Mussoorie Syncline from a locality southeast of Loarkha. In view of its great importance a thorough search for new localities was made during May 1985, which resulted in finding of two more fossiliferous localities in the northern limb of the Syncline. The localities belong to the same stratigraphic level and contain the same fauna as recorded earlier[1]. A brief account of the new localities and the significance of this brachiopod level are discussed in this paper.

(i) Betagad (Jabarkhet) section

The brachiopod yielding horizon consists of light grey micaeous shale within massive quartzite of Phulchatti Member about 260 m above its base, and is well exposed on the Dehradun-Mussoorie-Chamba road cuttings, about 425 m before Jabarkhet (Betagad) Toll barrier (figure 1). Only the upper 7 m thick sequence of shale is exposed while the lower part is covered (figure 2). The brachiopods occur as black dots mostly sporadic on bedding surfaces measuring 1–2 mm in diameter. One of the rare, relatively better preserved brachiopod taxan Obolus sp, is illustrated (Figure 3).

(ii) Marora section

This is located on the Maldeota-Kaddukhal-Dhanaulti road, about 100 m downstream of the bridge over Song river at Marora (figure 1). Here also the brachiopod fauna occurs in 26 m thick shale horizon within the thick quartzite beds of the Phulchatti Member 130 m above its base. The shale sequence reveals two fossiliferous bands interspersed

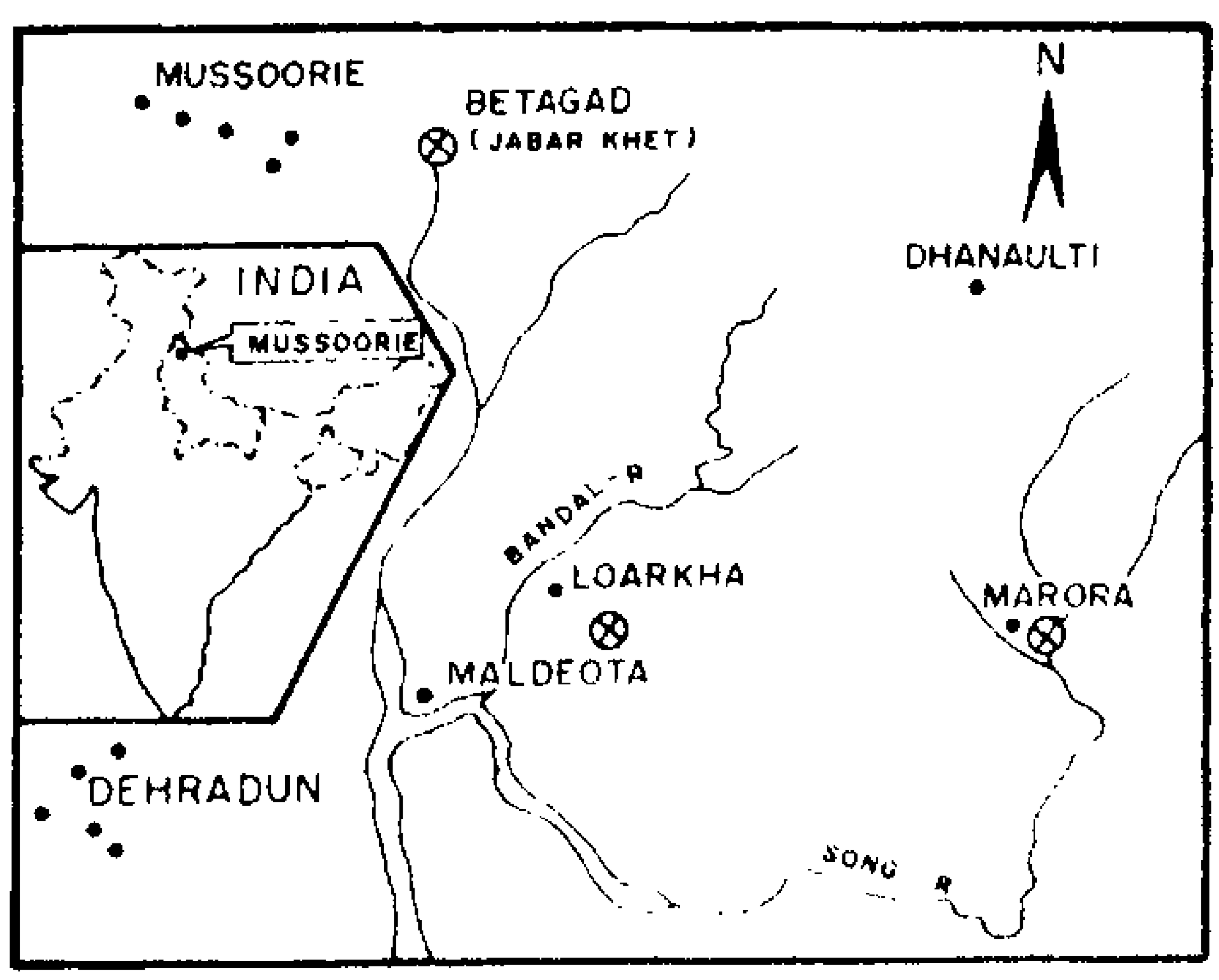

Figure 1. Map showing fossil localities.

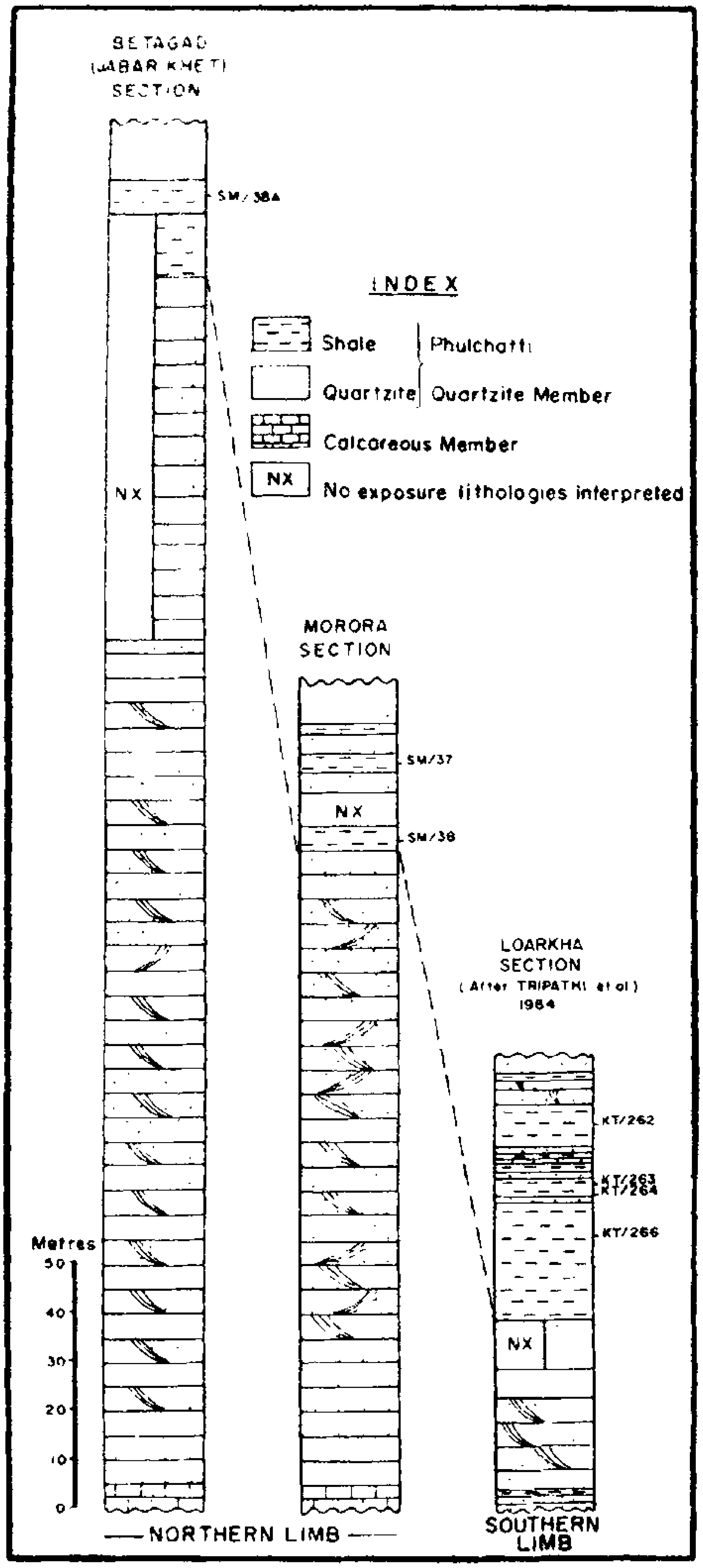

Figure 2. Lithocolumn of basal part of the Phulchatti Member, Tal Formation in Mussoorie Syncline showing position of brachiopod horizon.

with sandy beds (figure 2). The upper fossiliferous band (SM/37) is crowded with *Lingulella* spp, *Obolella* spp, *Magnicanalis* sp, brachiopod Form A[1], brachiopod Form B[1] (figures 3.2 to 3.4 and 3.6 to 3.8) and

Table 1 *Chronostratigraphic levels in the Tal Formation, Lesser Himalaya, India*

LITHOSTRATIGRAPHY			CHRONOSTRATIGRAPHY		FOSSIL BASIS
Manikot Shell Limestone			CRETACEOUS		
TAL FORMATION	UPPER TAL	Phulchatti Quartzite Member		?	
				Botomian Stage	Brachiopod assemblage[1]
	LOWER TAL	Calcareous Member	EARLY CAMBRIAN	Atdabanian Stage	Ancient gastropod & brachiopod[9]
		Arenaceous Member			
		Argillaceous Member		Tommotian Stage	Ichno-fossils[8]
		Chert-Phosphorite Member			Stromatolite[7] Small shelly fossils[6]
Krol Formation			?-?-?-? Precambrian		

Obolus sp. The lower fossiliferous band (SM/38) contains less common fossil occurrences. The dominant taxon is *Lingulella* sp (figure 3.5).

The brachiopod taxa recorded from the above two localities bear a close identity with those described earlier from Loarkha[1].

Prior to the discovery of Early Cambrian brachiopod fauna from the 'Upper Tal', the succession of the underlying 'Lower Tal', consisting of Chert-Phosphorite, Argillaceous, Arenaceous and Calcareous Members in ascending order, had been recently considered to be of Tommotian and Atdabanian Stages of Early Cambrian[4]. The fossil evidences for such an age derivations, in contrast to long entrenched view of Mesozoic[5] and recently Cambro-Ordovician[6,7] ages for the Tal sequence, came through the records of non-conventional fossils, viz small shelly fossils[8] stromatolite[9], and large assemblage of ichnofossils[10] for Tommotian Stage, and ancient gastropods and brachiopod for the Atdabanian Stage[11] (table 1). The record of fossil brachiopod assemblage of Botomian age from the strata of 'Upper Tal', therefore, establishes for the first time, the extension of the Early Cambrian age-span into 'Upper Tal'. Significantly, the Botomian horizon in the Tal has been delineated on the basis of conventional fossil group, and its demarcation has imparted added credence to the Tommotian and Atdabanian levels.

The above data on inter-relation between the conventional and non-conventional faunas near the Precambrian-Phanerozoic boundary beds is relatively rare even in the global context. The few areas exposing

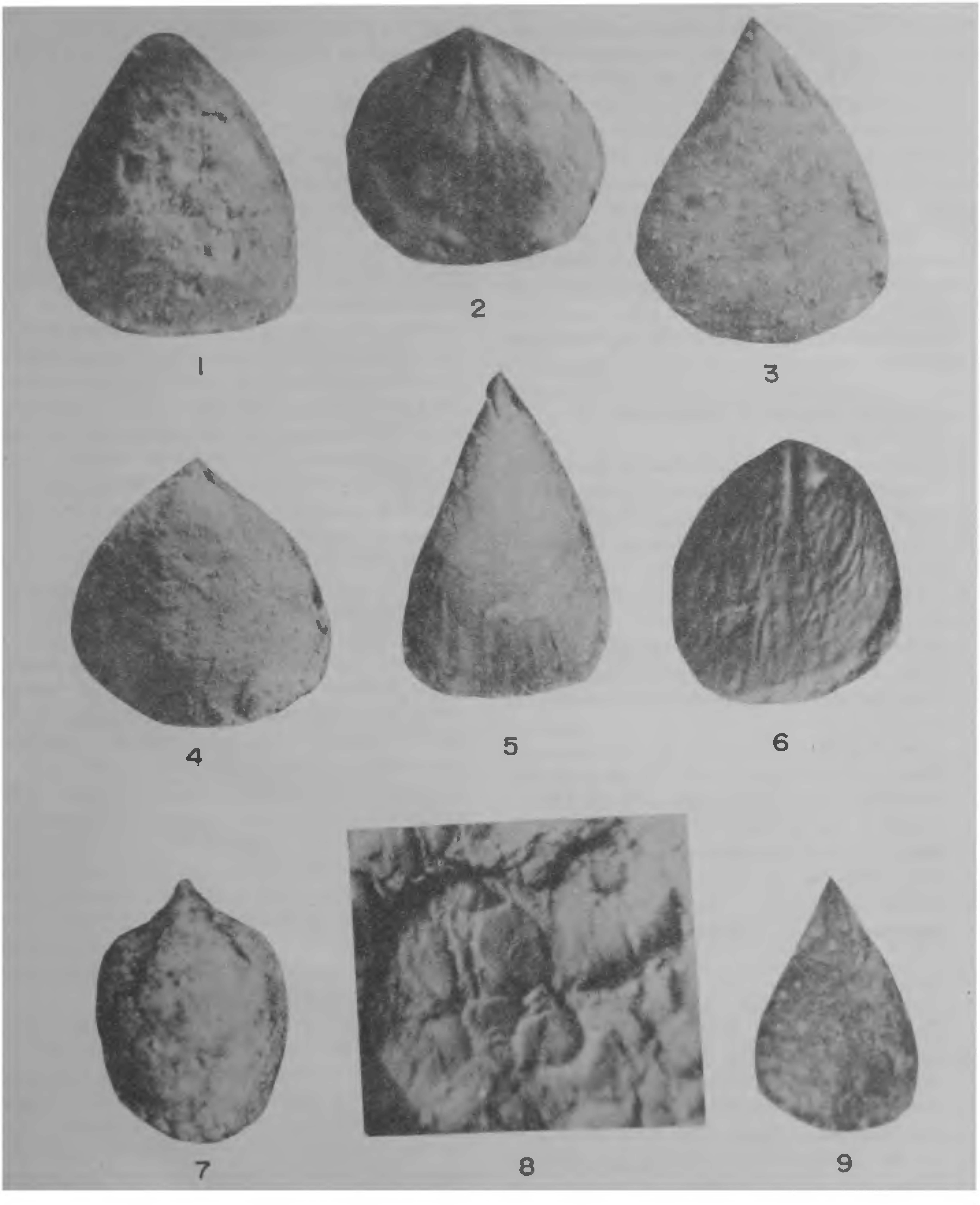

Figure 3. **3.1.** *Obolus* sp, sample No. SM/38A × 10; **3.2.** *Magnicanalis* sp, sample No. SM/37 × 11; **3.3.** *Lingulella* sp, sample No.SM/37 × 20; **3.4.** *Obolella* sp, sample No. SM/37 × 16; **3.5.** *Lingulella* sp, sample No. SM/38 × 11; **3.6.** From A, sample No. SM/37 × 13; **3.7.** Form B, sample No. SM/37 × 13; **3.8.** The rock specimen gives an idea of clustering of brachiopod fauna, sample No. SM/37 × 3; **3.9.** *Lingulella* sp, sample No. SM/38 × 10. The relevant GSI type Nos are 20123 to 20131, respectively.

these fossil-sequences in the world are Siberian and East European Platform[12], Mongolia[13] and China[14], now reinforced by discoveries in the Tal Formation.

Considering the present record to be the extension of the studies carried out earlier[1], it is apparent that the brachiopod assemblage of Early Cambrian (Botomian Stage) constitutes a widely developed chronostratigraphic level in the lower part of the Phulchatti Quartzite Member of Tal Formation in Lesser Himalaya, and with further search can be located in other Synclines of Lesser Himalaya exposing Krol-Tal succession.

The authors are thankful to Mr H. M. Kapoor for discussions.

26 August 1985; Revised 28 October 1985

1. Tripathi, C., Jangpangi, B. S., Bhatt, D. K., Kumar, G. and Raina, B. K., *Geophytology*, 1984, **14**, 221.
2. Shanker, R., *J. Palaeontol. Soc. India*, 1971, **16**, 1.
3. Kumar, G. and Dhaundiyal, J. N., *J. Palaeontol. Soc. India*, 1980, **23–24**, 58.
4. Kumar, G., *Proc. V Indian Geophys. Conf., Palaeobot. Soc.*, 1984, 98.
5. Auden, J. B., *Rec. Geol. Surv. India*, 1934, **67**, 357.
6. Azmi, R. J., Joshi, M. N. and Juyal, K. P., *Contemporary Geosci. Researches in Him.*, 1981, **1**, 245.
7. Azmi, R. J., *Him. Geol.*, 1983, **11**, 373.
8. Bhatt, D. K., Mamgain, V. D., Misra, R. S. and Srivastava, J. P., *Geophytology*, 1983, **13**, 116.
9. Tewari, V. C., *Curr. Sci.*, 1984, **53**, 319.
10. Singh, I. B. and Rai, Vibhutti, *J. Palaeontol. Soc. India*, 1983, **28**, 67.
11. Kumar, G., Raina, B. K., Bhatt, D. K. and Jangpangi, B. S., *J. Palaeontol. Soc. India*, 1983, **28** 106.
12. Raaben, M. E. (ed.), *The Tommotian Stage and the Cambrian lower boundary problem*, Amerind Pub. Co., New Delhi, 1981, p. 359.
13. Rosanov, A. Yu., *The Precambrian/Cambrian Boundary in the Geosynclinal areas* (the reference section of Salany-Gol MPR), 1982, p. 150.
14. Luo, H., Jiang, Z., Wu, X., Song, X., Quyang Lin *et al*, *The Sinian-Cambrian boundary in Eastern Yunnan, China*, 1982, p. 265.

FRICTIONAL CHARACTERISTICS OF LEADED ALUMINIUM BEARING ALLOYS

S. N. TIWARI, J. P. PATHAK
and S. L. MALHOTRA
Department of Metallurgical Engineering, Institute of Technology, Banaras Hindu University, Varanasi 221 005, India.

One of the basic functions of a bearing interposed between two surfaces in relative motion is to reduce the friction between them. During our investigation, frictional characteristics of some leaded aluminium bearing alloys were studied under dry sliding conditions at room temperature using a pin-on-disc type machine[1]. The rise in specimen (cylindrical pin) temperature due to frictional heating near the mating interface was taken as a measure of the frictional resistance of the specimen alloy. An iron-constantan thermocouple was fixed in contact with the test specimen at 2 mm above the mating interface and this was connected to a potentiometer via an ice bath to facilitate measurement of temperature rise of the specimen due to frictional heating. Figure 1 shows the relationship between the sliding distance and temperature rise of the specimen for different alloys. It may be noticed that with increasing sliding distance, a progressive increase in specimen temperature of the base metal occurs. However, as lead is added to aluminium, there is a lower rise in specimen temperature and at or above 10% wt. Pb, little or practically no increase in temperature occurs after the specimen has slid a certain distance. This suggests that lead reduces frictional heating effectively only when it is present in a certain concentration in aluminium base alloys. It is, however, interesting to note that as the lead content of the alloy exceeds 35 wt.%, there is no further decrease in temperature rise of the specimen and it rather increases. The above observations may be explained as follows.

Lead acts as a solid lubricant and reduces friction between the specimen and the steel disc by smearing and forming a thin layer of low shear strength material spread over a stronger substrate. It may be envisaged that in the beginning of the sliding, asperities of the steel disc under the influence of applied load and speed impress the relatively strong matrix of the bearing alloy deeper causing an extrusion and smearing of lead over the surface of the test-pin. In further traverses of the pin, lead is gradually built up over the pin surface and some of it is transferred to the steel disc and is smeared over the wear track. In the next few runs, over the entire pin surface, a uniform film of smeared lead is