A new species of Somalina (Somalina hottingeri) with partially vacuolate lateral walls from the Middle Eocene of Oman

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ABSTRACT - Somalina hottingeri, a new species with partially vacuolate lateral walls is described from the Middle Eocene of Oman. It is distinguished from the only previously recorded species with this wall structure (S. transtorius (Hottinger)) by having equatorial chambers that are relatively low throughout the test. On the basis of this character, it is suggested that S. hottingeri evolved from the Operorbitolites douvillei Group (redefined here) and that it gave rise to the true somalines. S. transtorius is regarded as arising from O. latimarginalis (ex. O. latimarginalis Group, introduced in this study) but not to have given rise to any other species.

Since forms of Somalina with only partially vacuolate walls appear to be confined to the late Early Eocene to early Middle Eocene, it is concluded that the presence of this wall structure provides a useful stratigraphic marker.

INTRODUCTION
The type species of Somalina (S. stefaninii Silvestri, 1939; Pl. I, fig. 1) is distinguished from that of Operorbitolites (O. douvillei Nuttall, 1925; Pl. 1, fig. 2) in having vacuolate rather than non-vacuolate lateral lamellar walls. Morphologically intermediate individuals in which the lateral walls are partially vacuolate, however, also exist (Pl. 1, figs 3–5; Pl. 2, figs 1–3).

Operorbitolites sensu stricto first appeared in the Late Palaeocene (Alveolina cucumiformis Zone, see Operorbitolites gracilis (Lehmann), in Lehmann, 1961) and Somalina sensu stricto is not known from rocks older than the Early Eocene (probably late Alveolina violae Zone). Since the oldest known occurrence of individuals with an intermediate morphology is also Early Eocene (A. trempina Zone; Hottinger & Krusat, 1972), they undoubtedly represent a transitional evolutionary stage.

Hottinger (in Hottinger & Krusat, 1972) assigned the only previously recorded species with partially vacuolate lateral walls to Operorbitolites transitorius (Pl. 2, fig. 3). However, vacuolate lateral walls are characteristic of Somalina, to which genus these transitional forms are here assigned.

S. hottingeri (Pl. 1, figs 3–5, Pl. 2, figs 1–2), also with partially vacuolate lateral walls, is described below and its likely evolutionary relationships with the Operorbitolites douvillei and O. latimarginalis groups, S. transitorius and Somalina sensu stricto are discussed.

SYSTEMATIC DESCRIPTION
The classification of Loeblich & Tappan (1987) is followed and localities mentioned in the text are shown on Fig. 1. Range charts for each of these localities are given in White (1994), to which the reader is referred for more stratigraphical information. All specimens examined are deposited in the palaeontological collections of the Natural History Museum, London.

Suborder Miliolina Delage and Herouard, 1896
Superfamily Soritacea Ehrenberg, 1839
Family Soritidae, Ehrenberg, 1839
Genus Somalina Silvestri, 1939
Somalina hottingeri n. sp.
(Pl. 1, figs 3–5, Pl. 2, figs 1–2)
Explanation of Plate 1

Fig. 1. *Somalina stephaninii* Silvestri. Vertical section of a megalospheric form. Wadi Bani Khalid, WBK 10. P 52860. ×20. fig. 2. *Opertorbitolites douvillei* Nuttall. Holotype. Vertical section of a megalospheric form. Locality 151, Parri Nala, West of Bibi Nani, Bolan Pass, Baluchistan. Figured by Nuttall (1925), Pl. 27, figs 4 & 5. Sedgwick Collection C 2516. ×15. figs 3-5. *Somalina hotfingeri* n. sp: 3. Holotype. Vertical section of a megalospheric form. Wadi Fatah, F 17. P 52861, ×15; 4. Holotype. Enlargement of part of fig. 3. ×30. 5. Paratype. Equatorial section of a microspheric form. Wadi Rusayl, WR 33a. P 52862. ×15.
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Explanation of Plate 2

Figs 1-2. Somalina hottingeri n. sp. paratypes. 1. Equatorial section of a megalospheric form. Wadi Fatah, F 17. P 52863. ×15; 2. Vertical section of a probable microspheric form. Wadi Rusayl, WR 33a. P 52864. ×25. fig. 3. Somalina transitorias (Hottinger). Paratype. Vertical section of a megalospheric form. Ager Valley, west of Agullo, Lerida Province, Spain. Figured by Hottinger in Hottinger & Krusat (1972), Pl. 8, fig. 2. Naturhistorisches Museum Basel, C 29774. ×20. fig. 4. Opertorbitolites sp. cf. O. gracilis Lehmann. Vertical section through a megalospheric form. Wadi Rusayl, WR 33a. P 52865. ×20. Note relatively unthickened lateral walls and lenticular shape. fig. 5. Opertorbitolites sp. cf. O. douville Nuttall. Vertical section of a probable microspheric form. Wadi Rusayl, WR 8. P 52866. ×30. Note relatively thickened lateral walls without the test being lenticular (see text for discussion).
Type locality. Wadi Rusayl (approximately 56°16' E, 23°75' N), northeastern Oman.

Type level. Middle Eocene (early Alveolina stipes Zone).

Occurrence. Wadi Fatah (F 12, 16, 17, 18, 19, 20); Jebel Hafit (HN 1157, 1155, 1154); Wadi Bani Khalid (WB 9, WBK 2, 4, 5, 10); Wadi Rusayl (WR 33a, 46, 49a, 51, 52, 56, 59, 60) and Wadi Tiwi (HN 1189, 1188).

Type description. Megalospheric test medium to large, lenticular, occasionally slightly to strongly undulate. Surface smooth. Embryonic apparatus comprising a small proloculus and a flexostyle. Post embryonic chambers arcuate, not increasing in height significantly from the centre to the periphery of the test. The lateral walls attain a thickness of up to 0.8 mm over the umbo and are partially vacuolate.

Microscopic test of medium size with partially vacuolate lateral walls (see Remarks below).

Dimensions of holotype. (mm)
- Diameter 21
- Height at centre 1.83
- Height at periphery 0.41

Dimensions of megalospheric paratypes.
- No. of specimens | Max. | Min. | Mean |
  - Diameter (mm)  | 3 | 11.60 | 5.76 | 10.15
  - Height at centre (mm) | 2 | 1.36 | 0.80 | 1.08
  - Height at periphery (mm) | 2 | 0.40 | 0.20 | 0.30
  - Max. internal diameter of proloculus (µm)* | 2 | 400 | 360 | 380

*measured in equatorial section

Dimensions of microspheric paratypes.
- No. of specimens | Max. | Min. | Mean |
  - Diameter (mm) | 3 | 8.4 | 8.00 | 8.26

Remarks. The only specimen in which a microspheric embryonic apparatus has been seen (Sample WR 33a; Pl. 2, fig. 1), occurs together with specimens that also appear to belong to this generation (e.g. Pl. 2, fig. 2). These have smooth surfaces and post embryonic chambers that do not increase significantly in height from the centre to the periphery of the test. Microspheric and megalospheric forms have not been recorded together. However, the vacuolate nature of the lateral wall, and the low chambers apparently present in both generations leaves little doubt that they belong to the same species.

Although S. hottingeri is characterized by having partially vacuolate walls, this feature is best seen in tangential or near equatorial sections (e.g. Pl. 1, fig. 5; Pl. 2, fig. 1). S. hottingeri differs from S. transitorius in having low equatorial chambers throughout the test, and from all other species of this genus by its partially vacuolate lateral lamellar walls.

Faunal association. Nummulites sp. Alveolina drobneae White, A. elliptica nuttalli Davies, A. frumentiformis Schwager, A. lukasi White, A. cf. rufosa Hottinger, A. cf. schwageri Checchia-Rispoli, A. stercus muris Mayer-Eymer, A. cf. subpyrenaica flosculina Silvestri, Assilina, Dictyoconoides cooki (Carter), Linderina rajasthanensis Singh, Lockhartia hunti Ovey, Operorbitolites cf. gracilis (Lehmann), Somalina stefaninii.

Stratigraphic range. Early to Middle Eocene (probably late Alveolina violae Zone to early Alveolina stipes Zone; see White, 1994, figs 14.7, 14.9, 14.11, 14.12 and 14.15).

DISCUSSION

Lehmann (1961) distinguished two groups of Operorbitolites with relatively low equatorial chambers throughout the test, and separated O. latimarginalis (Lehmann), in which the equatorial chambers increase significantly in height towards the periphery. He regarded biplanar forms with only slightly thickened lateral walls as belonging to his biplanus Group and placed those with lenticular tests and strongly thickened lateral walls in that of O. douvillei. Forms with relatively unthickened lateral walls, however, may also be lenticular (e.g. O. sp. cf. O. gracilis Lehmann, Pl. 2, fig. 3), and those with thick lateral walls are not always so (e.g. O. sp. cf. O. douvillei, Pl. 2, fig. 5). Consequently, the present author does not recognize the distinction between these two groups. Instead, the O. douvillei Group of Lehmann is redefined here to comprise species (including those originally placed by Lehmann in his douvillei and biplanus groups) characterized by relatively low equatorial chambers. The O. latimarginalis Group is introduced for those species with equatorial chambers that increase significantly in height towards the periphery of the test.

The low equatorial chambers in S. hottingeri, combined with its partially vacuolate lateral walls and its first appearance in the late Early Eocene strongly suggest that it evolved from the O. douvillei Group, probably O. douvillei itself which is known from the Laki Series (Early Eocene) in Pakistan (Nuttall, 1925). In contrast, the relatively rapid increase in height of the equatorial chambers in S. transitorius implies that this arose from O. latimarginalis (Alveolina trempina Zone, see Lehmann, 1961), the only known species belonging to the O. latimarginalis Group.

From the above, it seems certain that S. hottingeri and S. transitorius belong to separate lineages (Fig. 2). Of these, the latimarginalis-transitorius line does not appear to have evolved
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Further. On the other hand, the close similarity between *S. hottingeri* and *Somalina sensu stricto* (particularly their low equatorial chambers) leaves little doubt that they belong to a single evolutionary lineage. The later appearance of *O. latimarginalis* compared with the *O. douvillei* Group is tentatively interpreted as the former having evolved from the latter. It is of course possible that the two *Opertorbitolites* groups have separate origins.

The relatively short combined stratigraphical range of *S. transitorius* and *S. hottingeri* (i.e. *Alveolina trempina* -- early *Alveolina stipes* zones) makes their characteristic wall structure a useful age indicator even when the species cannot be identified (e.g. from fragments in thin section).

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