NOTE ON *OPERCULINOIDES* HANZAWA 1935

by Y. NAGAPPA

ABSTRACT. *Operculinoides* Hanzawa as understood now consists of three distinct groups of forms typically represented by (*a*) *Nummulites willcoxi* Heilprin, (*b*) *Operculina ocalana* Cushman, and (*c*) *O. bermudezi* D. K. Palmer. It is shown that (*a*) can justifiably come under *Nummulites*, (*b*) may be regarded as involute *Operculina*, and for (*c*) there is Caudri's genus *Ranikothalia* which is based on valid grounds.

INTRODUCTION

AFTER a critical examination of *Operculina ocalana* Cushman, *Nummulites willcoxi* Heilprin, *O. floridensis* Heilprin, and *O. mariannensis* Vaughan, Hanzawa considered that they 'show peculiar characteristics intermediate between the typical *Operculina* and *Camerina* or *Assilina*' and proposed the generic name *Operculinoides*, with *N. willcoxi* as the type species, for the above and related forms (Hanzawa 1935, p. 18). Grimsdale and Smout (1949, p. 325) suggested that *Operculinoides* is a synonym of *Nummulites*, but later Smout (1954, p. 76) modified this observation and stated that '*Operculinoides* (Hanzawa 1935) is often taken as complanate and partly involute, but the type species, *O. willcox*i is a typical Nummulite'.

TABLE

Genera / *Characters*	*Nummulites*	*Operculinoides*	*Operculina*	*Ranikothalia*	*Miscellanea**
Shape . .	Lenticular, flat or unevenly globose	Type species evenly low lenticular	Complanate, lenticular in centre only	Evenly low lenticular to nearly flat	Lenticular to nearly flat
Form . .	Involute	Involute mostly, some tending to be evolute	Evolute to partially involute	Involute to partially evolute	Involute; flatter forms tending to be partly evolute
Chamber tops as seen in equatorial sections	Acute angle posteriorly	Type species as in *Nummulites*	As in *Nummulites*	Bluntly round generally	Bluntly round
Whorl wall .	Single, not differentiated, canaliculate	Type species as in *Nummulites*	As in *Nummulites*; spiral canals tend to be more numerous	Double; inner simple, outer coarsely canaliculate, 'degenerate'	As in *Ranikothalia* but often more 'degenerate'
Whorls . .	Many, variable	Few to many	Generally few	Generally few	Few to many

* *Miscellanea* has no marginal cord which is present in all the others.

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There are a number of American forms described under *Operculinoides* which are distinctly 'operculine' while others are as distinctly 'nummulitic'. A solution of the problem can only be arrived at after reconsidering firstly, the characters of the type species of *Operculinoides vis-à-vis* other forms included in this genus and, secondly, the nature of the differences between the forms now included in *Operculinoides vis-à-vis* true *Nummulites* on the one hand and true *Operculina* on the other. A summary of the characters, based on the study of actual specimens as well as published descriptions and figures, of the five genera *Nummulites*, *Operculinoides*, *Operculina*, *Ranikothalia*, and *Miscellanea* as understood now, is given in the table. Another genus, about which there was some confusion, was *Pellatispirella* Hanzawa; but Cole (1956*b*) has since demonstrated that this genus is not related to any of the above genera but is more allied to *Elphidium*.

DISCUSSION

Nummulites willcoxi Heilprin, the type species of *Operculinoides* Hanzawa, is a low lenticular completely involute form with a clear marginal cord. The septa in equatorial sections are straight for the most part, slightly oblique and sharply curved backwards where they meet the outer whorl wall. The chambers are slightly higher than broad with a clear acute angle formed in the upper posterior end. Apart from a little loose coiling there is nothing in this species which could not suggest placement in the genus *Nummulites*. Other forms included by various authors under the genus *Operculinoides* may conveniently be grouped under (*a*) *Operculinoides bermudezi* type, or (*b*) *Operculinoides ocalanus* type. These will be discussed below.

(*a*) *Operculinoides bermudezi* type.

Sachs (1957) has made a detailed study of *O. bermudezi* (D. K. Palmer) and related forms. As pointed out earlier by Caudri (1944, p. 17), there are two important characters in which this group of forms differs from *N. willcoxi*, viz. (*a*) the chambers have generally rounded tops and the acute angle formed by the septa on the upper posterior corner of the chambers as seen in *Nummulites* and *Operculina* is usually absent; (*b*) there is a distinct inner lining on the roofs of the chambers which separates the coarsely canaliculate whorl wall above. This latter character is an important one and readily helps in distinguishing this group of forms from typical *Nummulites* and *Operculina*. Cole, who is quite familiar with *O. bermudezi* and related forms, stated: 'American species which were assigned formerly to *Miscellanea* and which are considered here to be *Operculinoides* uniformly possess a coarse marginal cord. At the beginning of this study it was thought that this structure might be of generic significance' (Cole 1953, p. 10). Although, as he states, the marginal cord in *Nummulites* s.l. is extremely variable, forms of the *O. bermudezi* group do exhibit a coarseness in the marginal cord which is not present in any of the true *Nummulites*. According to Vaughan, the American forms of the type *O. bermudezi* 'are intermediate between typical *Miscellanea* and typical *Camerina*' (Vaughan 1945, p. 25). Davies is also of the same view (Davies 1949, p. 113).

The type species of *Ranikothalia* Caudri is *Nummulites nuttalli* Davies. *Operculina sindensis* Davies is a closely related form and, as Davies (1949, p. 113) has pointed out,

there is every gradation from one to the other. However, they can generally be distinguished by the following characters:

	Nummulites nuttalli	*Operculina sindensis*
(*a*)	Whorls gradually increasing in width.	Whorls rapidly increasing in width.
(*b*)	Test generally slightly convex.	Test usually flat or most flat.
(*c*)	Marginal cord usually strong on the last whorl.	Marginal cord generally strong on all whorls.
(*d*)	Megalospheric form lenticular; rather inflated.	Megalospheric form not much different from the microspheric form, though slightly more biconvex.

EXPLANATION OF PLATE 21

Fig. 1. *Nummulites beaumonti* d'Archiac and Haime, microspheric form from the Crab Marls (M. Eocene), Bugti, Baluchistan, West Pakistan; equatorial section showing thick whorl wall and nearly straight septa, ×5.

Fig. 2. *Nummulites pengaronensis* Verbeek, megalospheric form from the Kopili Stage (U. Eocene), Jaintia Hills, Assam; equatorial section showing curved septa, ×68.

Fig. 3. *Nummulites irregularis* Deshayes, microspheric form from the Tarkhobi Shales (*Irregularis* Bed), L. Eocene, Tarkhobi, West Pakistan; equatorial section showing irregular coiling and delicate, strongly curved septa, ×5.

Fig. 4. *Nummulites sp.*, microspheric form from the Khirthar Shales (L. Eocene), Kirta, Baluchistan, West Pakistan; equatorial section showing delicate, curved septa, ×22.

Fig. 5. *Nummulites intermedius* d'Archiac, microspheric form from the Nummulitic Limestone (Oligocene), Cutch; equatorial section showing thick whorl-wall and delicate, widely spaced septa, ×30.

Fig. 6. *Nummulites willcoxi* Heilprin; section showing septa nearly straight, slightly oblique, reproduced from Cole 1953, pl. 1, fig. 12, ×12·5.

EXPLANATION OF PLATE 22

Fig. 1. *Operculina sp.* from the Upper Chocolate Clays (U. Eocene), Rakhi Nala, West Pakistan; equatorial section showing septa initially straight and normal, sharply curved at the end, ×45.

Figs. 2, 3. *Operculina sp.* from the Kopili Stage (U. Eocene), Dareng River, Garo Hills, Assam; 2, equatorial section showing delicate and strongly curved septa, ×30; 3, same specimen, portion of whorl-wall ×200 to show canal system (note the numerous spiral canals).

Figs. 4, 5. *Ranikothalia sindensis* (Davies), equatorial sections; 4, microspheric form from the Zinda Pir Limestone (Palaeocene), Zinda Pir, West Pakistan, ×10; 5, megalospheric form from the Lakadong Stage (Palaeocene), Khasi and Jaintia Hills, Assam, ×15.

EXPLANATION OF PLATE 23

Fig. 1. *Ranikothalia sindensis* (Davies), equatorial section of megalospheric form from the Khairabad Limestone (Palaeocene), Salt Range, West Pakistan, ×15.

Figs. 2, 3. *Ranikothalia nuttalli* (Davies), equatorial sections; 2, microspheric form from the Zinda Pir Limestone (Palaeocene), Zinda Pir, West Pakistan, showing wall structure and nature of septa, ×4; 3, megalospheric form from Baluchistan, West Pakistan, showing rounded-top chambers, ×15.

Fig. 4. *Ranikothalia sp.* from the Brecciated Limestones and Shales (Palaeocene), Tarkhobi, West Pakistan; equatorial section showing double layer of whorl-wall, ×68.

Figs. 5, 6. *Ranikothalia bermudezi* (D. K. Palmer), equatorial sections; reproduced from Cole 1953, pl. 3, figs. 4 and 12, ×20.

Figs. 7, 8. *Miscellanea miscella* (d'Archiac and Haime), equatorial sections; 7, megalospheric form, Zinda Pir Limestone (Palaeocene) Zinda Pir, West Pakistan, ×10; 8, microspheric form from the lower part of the Tarkhobi Shales (Palaeocene), Tarkhobi, West Pakistan, ×10.

In India and Pakistan these forms are restricted to the Palaeocene (perhaps rarely extending into the basal Lower Eocene) and since they also exhibit characters different from both *Miscellanea* and *Nummulites*, Caudri's erection of the genus *Ranikothalia* appears justified. Both *Nummulites nuttalli* and *Operculina sindensis* have the typical round topped chambers and there is also the inner lining on the roof of the chambers. The rest of the whorl wall is perhaps less 'degenerate' as compared with *Operculinoides bermudezi*. In spite of such differences from *Nummulites*, Smout (1954, p. 75) has suggested that the type species of *Ranikothalia* is a Nummulite. Hanzawa (1957) has recently placed *Ranikothalia* as a synonym of *Miscellanea*. This is unacceptable, for *Miscellanea* lacks the marginal cord so characteristic of the other nummulitid genera while this forms a very important feature in *Ranikothalia*; the marginal cord in the type species is very strong and forms one of the diagnostic characters of the species. It thus appears that recognition of *Ranikothalia* as a valid genus provides not only a link between *Miscellanea* and *Nummulites* but also enables a clearer and more comprehensive grouping of the forms generally referred to *Operculinoides* in America and the West Indies. It is also of interest to note that forms of the *O. bermudezi* group are all confined, as the related forms *Nummulites nuttalli* and *Operculina sindensis* in India and Pakistan, to the Palaeocene rarely extending into the basal Lower Eocene.

Ranikothalia can thus be shown to be a useful genus both stratigraphically and palaeontologically. Its geographical distribution extends from western part of Burma through north-east India and Tibet into West Pakistan and from thence westwards through Middle East into French West Africa (Davies 1949, p. 114; 1952, pp. 155–7); it is next known from the British West Indies and southern U.S.A. Palaeocene rocks are known to occur in North Africa from the evidence of echinoids and *Assilina*, although at present *Ranikothalia* is not known from this area. Davies (op. cit.) has suggested a possible link with India.

(*b*) *Operculinoides ocalanus* type

As regards forms of the *O. ocalanus* type which show typical operculine septa and mode of coiling, it is clear that they too show considerable differences from *N. willcoxi*. As pointed out earlier, *N. willcoxi* is a typical nummulite and loose coiling is not uncommon in *Nummulites*. Bannink (1948) has already demonstrated that most operculines are in fact involute in the early stage and, in some, this character extends in part to the later stage also. It seems to be purely a case for stretching this point a little farther to include forms which are completely involute but which are operculine in all other respects. Sachs (1957) has demonstrated the existence of considerable variation from completely involute forms to partially evolute forms in the *O. bermudezi* group and, if only the same latitude is conceded to *Operculina*, forms of the *O. ocalanus* type can easily be accommodated under this latter genus. They do not resemble the *N. willcoxi* group of forms in their mode of coiling, in the nature of their septa, or in the shape of chambers. It seems therefore logical to exclude such forms from *Operculinoides* s.s. and if indeed a separate grouping for these completely involute operculinids is considered necessary, they may be regarded as a subgenus of *Operculina*.

With regard to *N. willcoxi* and related forms there is really no need to consider them as anything but what they are, *Nummulites*. It would thus appear that the genus *Oper-*

culinoides Hanzawa becomes superfluous since, if the arguments submitted in this note are accepted, forms now under this genus can be allocated to *Nummulites*, *Operculina*, or *Ranikothalia*.

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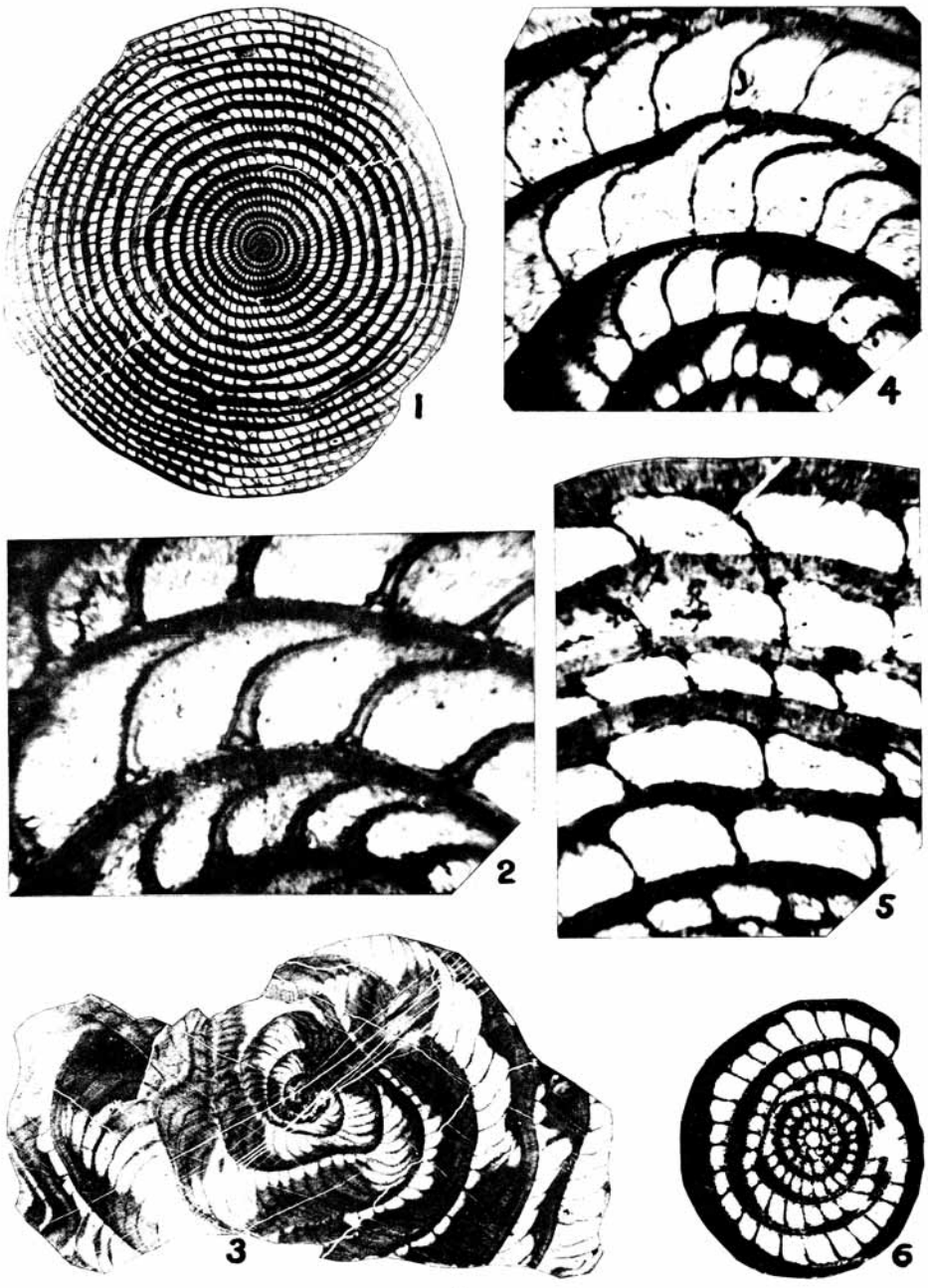
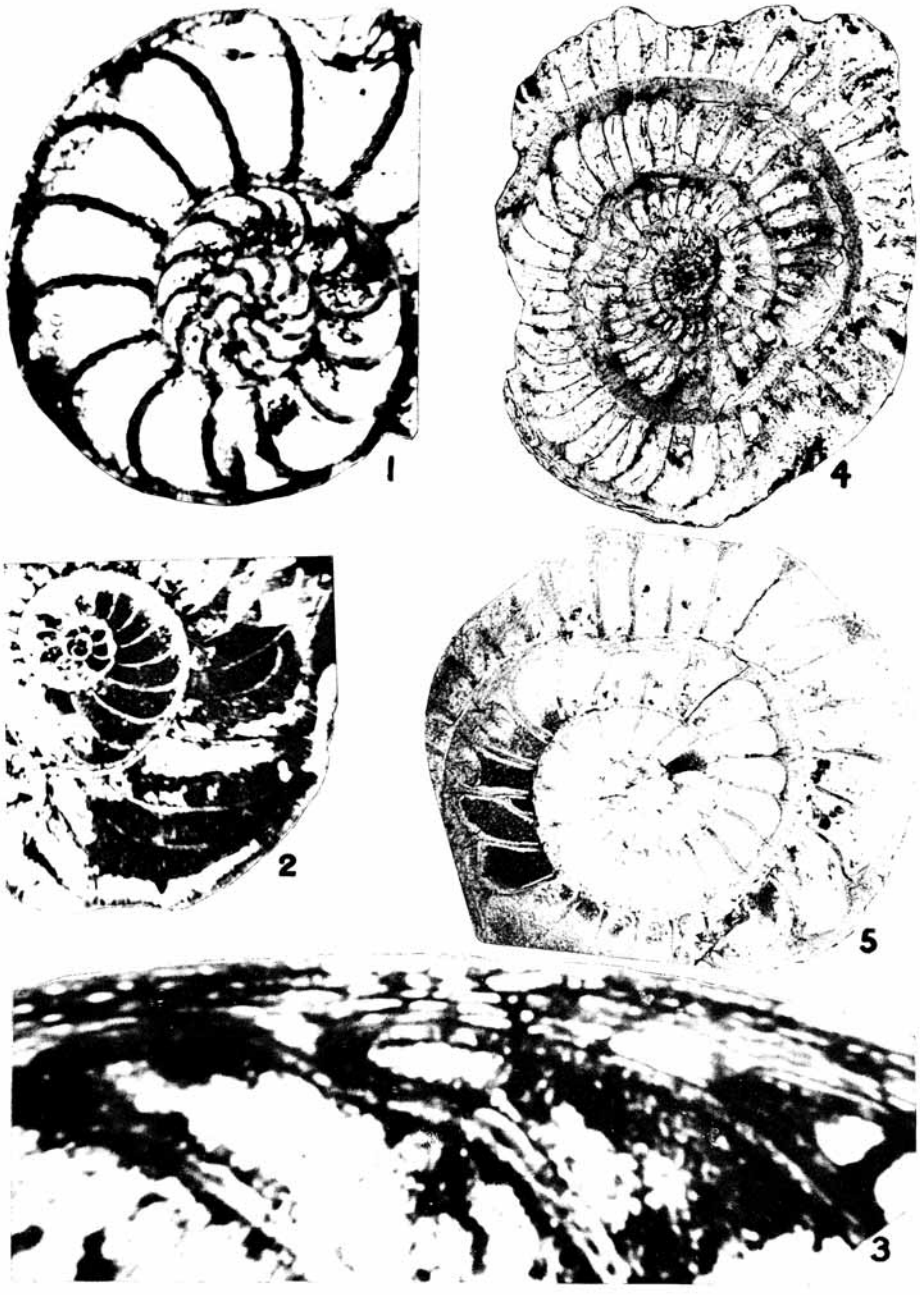


NAGAPPA, *Nummulites*



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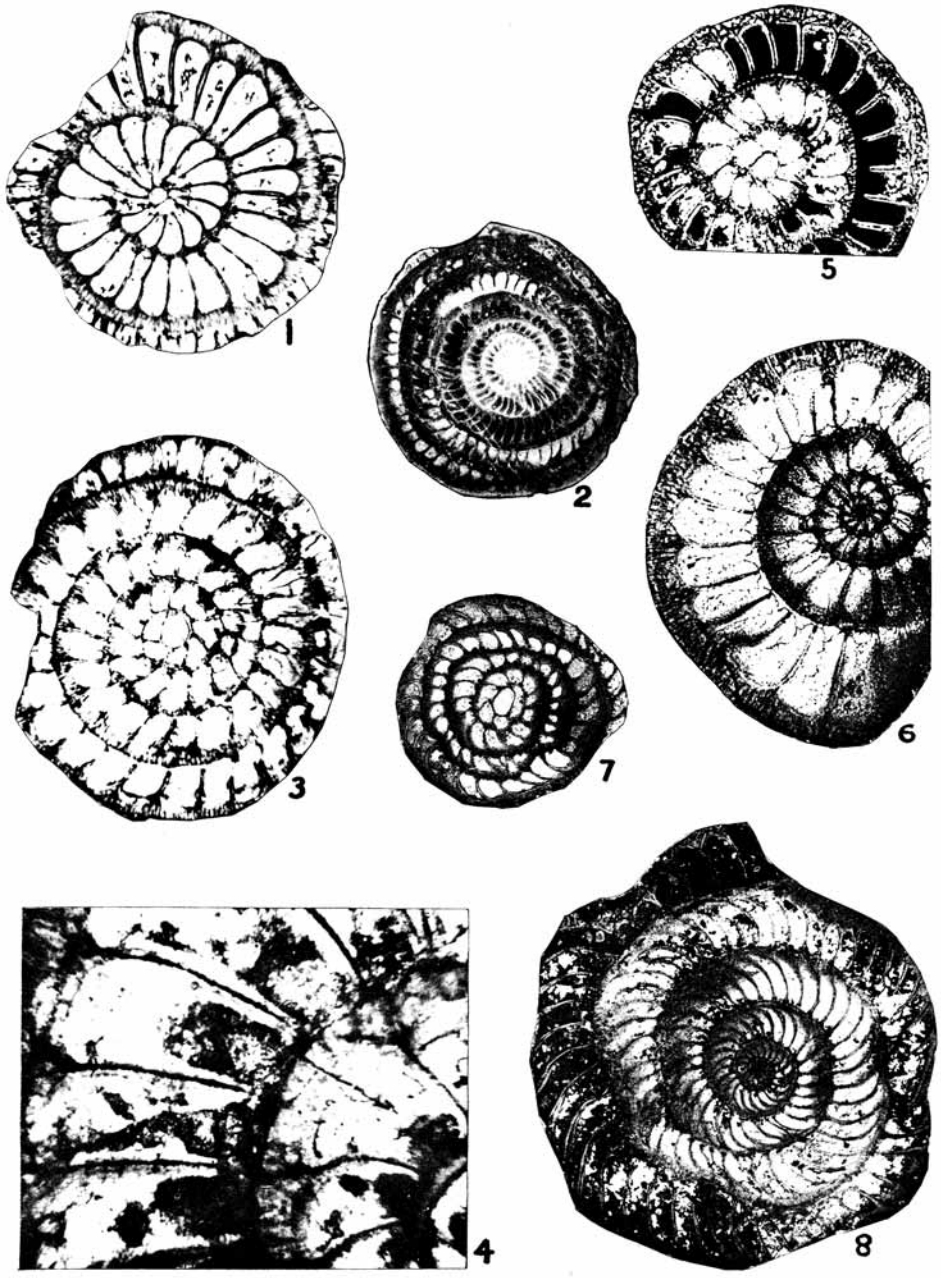

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