

The foraminiferal genus *Lakadongia* Matsumaru and Jauhri 2003, a re-evaluation

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ABSTRACT: *Lakadongia indica* n. gen., n. sp. erected by Matsumaru and Jauhri (2003) is a junior synonym of *Setia tibetica* Ferràndez-Cañadell 2002. The genus *Lakadongia* is based on ambiguous characters and misinterpretation of oblique sections, and it is considered invalid. The postulated evolutionary relationship of these Paleocene orbitoidiform foraminifera with those of Cretaceous age is not justified by structural similarities and inconsistent with the stratigraphical record.

INTRODUCTION

Matsumaru and Jauhri (2003) proposed a new Paleocene orbitoidiform foraminifer, *Lakadongia indica* n. gen., n. sp., from the Lakadong Limestone in Meghalaya, India. According to these authors, *Lakadongia* occurs together with *Orbitosiphon* Rao 1940, from which it differs in having "low trochospiral character of embryonic and nepionic chambers, and the duplication of equatorial chambers in the equatorial layer".

There has been much discussion on the genus *Orbitosiphon* Rao 1940. The author of the genus (Rao 1940, 1944) included in the description megalospheric specimens from the Salt Range described by Davies (1937) as *Lepidocyclina* (*Polylepidina*) *punjabensis* (the type species) and microspheric specimens from Tibet described by Douvillé (1916) as *Lepidorbitoides tibetica*.

Most authors recognized that there are two megalospheric forms (i.e. A1 and A2 forms of Rao 1944; "biserial" and "quadriserial" megalospheric specimens of Tan Sin Hok 1939 and Matsumaru and Jauhri 2002), but they all considered that such differences affect only the embryo and the initial chambers and thus are not important enough to differentiate either genera or species. The discussion then focussed on the validity of the genus and the assignation of these forms to a number of other genera (*Lepidorbitoides*, *Polylepidina*, *Orbitocyclina*, among others), mainly discussing the synonymy with the Paleocene American genus *Actinosiphon* Vaughan 1929.

A recent revision of these Paleocene orbitoidiform foraminifers (Ferràndez-Cañadell 2002), based on material from the Punjab Salt Range (Pakistan), demonstrated that actually, the two megalospheric forms differ not only in the embryonic apparatus, but they have a different architecture, mainly based on the presence or absence of a canal system, and thus belong to two different genera (text-fig. 1). One of this genus, for which the name *Orbitosiphon* was maintained, was identified on the species level as *O. punjabensis* (Davies 1937), the type species, originally described as *Lepidocyclina* (*Polylepidina*) *punjabensis* Davies. *O. punjabensis* has the usual orbitoidiform test, with an equatorial layer of arcuate orbitoid main chamberlets arranged in annuli and lateral chamberlets on both sides of the

test (text-fig. 1 a-i). The other structural type, for which the genus *Setia* Ferràndez-Cañadell 2002 was proposed, is also orbitoidiform, but it has lateral chamberlets only dorsally and a complex canal system ventrally (text-fig. 1 k-t). Within *Setia*, two species were differentiated, *S. tibetica* (Douvillé 1916) (the type species) and a new species, *S. primitiva* Ferràndez-Cañadell 2002. The former corresponds to the species originally described as *Lepidorbitoides tibetica* and *L. polygonalis* by Douvillé (1916). The second species, *S. primitiva*, is a smaller, structurally more simple and stratigraphically older species (Ferràndez-Cañadell 2002).

Matsumaru and Jauhri indicate the presence of "biserial" and "quadriserial" megalospheric specimens within *Orbitosiphon*, but regard the previously defined species as synonyms ("*Orbitosiphon*" *tibetica*, *O. punjabensis*, *O. praepunjabensis* Adams 1987, *Setia primitiva*). They justify the synonymy of *S. primitiva* and *O. punjabensis* only by the similarity of the embryonic apparatus. However, the two forms differ in the presence (*Setia*) or absence (*Orbitosiphon*) of a canal system. Matsumaru and Jauhri seem either not to take into account this structural difference, or to ignore the forms without canal system, as they include this character in their description of the genus *Orbitosiphon*. In foraminiferal systematics the shape of the embryo is of secondary importance (species level) when compared with a structural character (generic or suprageneric level) such as the presence (*Setia*) or absence (*Orbitosiphon*) of canal systems, which is a character important enough to be used to differentiate taxa at family level (Hottinger 1978). The validity of the new genus *Setia* is therefore justified. *Orbitosiphon* and *Setia* are considered to be endemic in the Paleocene of the India-Pakistan-Tibet region, and not related to the American genus *Actinosiphon* (Ferràndez-Cañadell 2002).

THE GENUS *LAKADONGIA*

The canal system of *Setia* is constituted by both tubular passages and enlarged interocular cavities (Ferràndez-Cañadell 2002). It is similar to the canal system in miogypsinids (De Bock 1976). The same architecture of the test and the same structural characters described in *Setia* by Ferràndez-Cañadell (2002) are found in *Lakadongia* (Matsumaru and Jauhri 2003).

The different parts of the canal system described by Ferràndez-Cañadell (2002) in *Setia* as “interlocular cavities” and “axial extension of the interlocular cavities” are described as “cavities” and “crude equatorial chambers” in *Lakadongia* in Matsumaru and Jauhri (2003).

According to Matsumaru and Jauhri, *Lakadongia* differs from “*Orbitosiphon*” in two characters: the “trochospiral” arrangement of the embryonic and nepionic chambers (“planispiral” in “*Orbitosiphon*”), and the “duplication” of the equatorial layer. Both characters are only apparent or based on erroneous interpretation of oblique sections. Due to the concave-convex shape of the test of *Setia*, the initial chambers are sometimes not arranged in the same plane but already initiate the concave-convex growth. That is, the supposed “trochospiral character” is only a feature of the ontogenetic variability of *Setia*, which includes specimens with different degrees of convexity of the test (see Ferràndez-Cañadell 2002: Pl. 2, figs. 10-19).

The second character that defines *Lakadongia*, the “duplication” of the equatorial layer, is only apparent, as it is based on oblique sections that cut two equatorial annuli. Actually, such “duplication” is visible only in two photographs (Pl. 1, figs. 2, 6 in Matsumaru and Jauhri 2003), the other ones showing a normal, simple equatorial layer (Pl. 1 fig. 5, Pl. 2 figs. 1-3, 5 in Matsumaru and Jauhri 2003).

The architecture of *Lakadongia* does not differ in any character to the architecture of *Setia*. Further, the embryonic and nepionic chambers of *Lakadongia indica* are identical in shape, size and arrangement to those of *Setia tibetica* (compare Pl. 3 figs. 1-5 in Matsumaru and Jauhri with Pl. 2, figs 22-29 and text-figures 1 and 7 in Ferràndez-Cañadell 2002). The specimens of *Lakadongia indica* figured by Matsumaru and Jauhri actually correspond to *Setia tibetica*.

In sum, two orbitoidiform foraminiferal genera occur in the Paleocene of Pakistan, Tibet and India, *Orbitosiphon* and *Setia*, which are similar in the concavo-convex shape of their test, but differ in their structure. *Lakadongia* is an invalid genus and *L. indica* is a junior synonym of *Setia tibetica*.

THE FAMILY ORBITOSIPHONIDAE

In the revision of these orbitoidiform foraminifers (Ferràndez-Cañadell 2002), because of the lack of centered sections of microspheric specimens of *O. punjabensis*, the phylogenetic relationship between *Orbitosiphon* and *Setia* could not be solved, and thus the author refrained from establishing for them new suprageneric taxa. Matsumaru and Jauhri (2003) erected the new family Orbitosiphonidae to include the genera *Orbitosiphon* (as they understand it, i.e. with canal system) and *Lakadongia*. The diagnosis of this new family includes the presence of canals, so that it would include the genus *Setia*, but not the nominotypic genus, *Orbitosiphon*, which has no canals (Ferràndez-Cañadell 2002).

In the author’s opinion it is likely that *Setia* originated from *Orbitosiphon* in the early Thanetian times by developing a canal system. In this case, the two genera could be included into the same family. Such a phylogenetic relationship would explain the similarities (e.g. the concave-convex shape of the test), but evidence is lacking, and alternatively these similarities could be explained as homoplasies. For example, there are many groups of orbitoidiform foraminifera, but only Paleocene-Eocene orthophragminids have rectangular equato-

rial chamberlets. This let many authors to think they had a common origin (most recently Drooger 1993). As the differences in their microspheric initial growth clearly show (Brönnimann 1946, 1951; Ferràndez-Cañadell 1998a, b), orthophragminids belong to two distinct families, Discocyclinidae and Orbitoclypeidae, that originated from different ancestors.

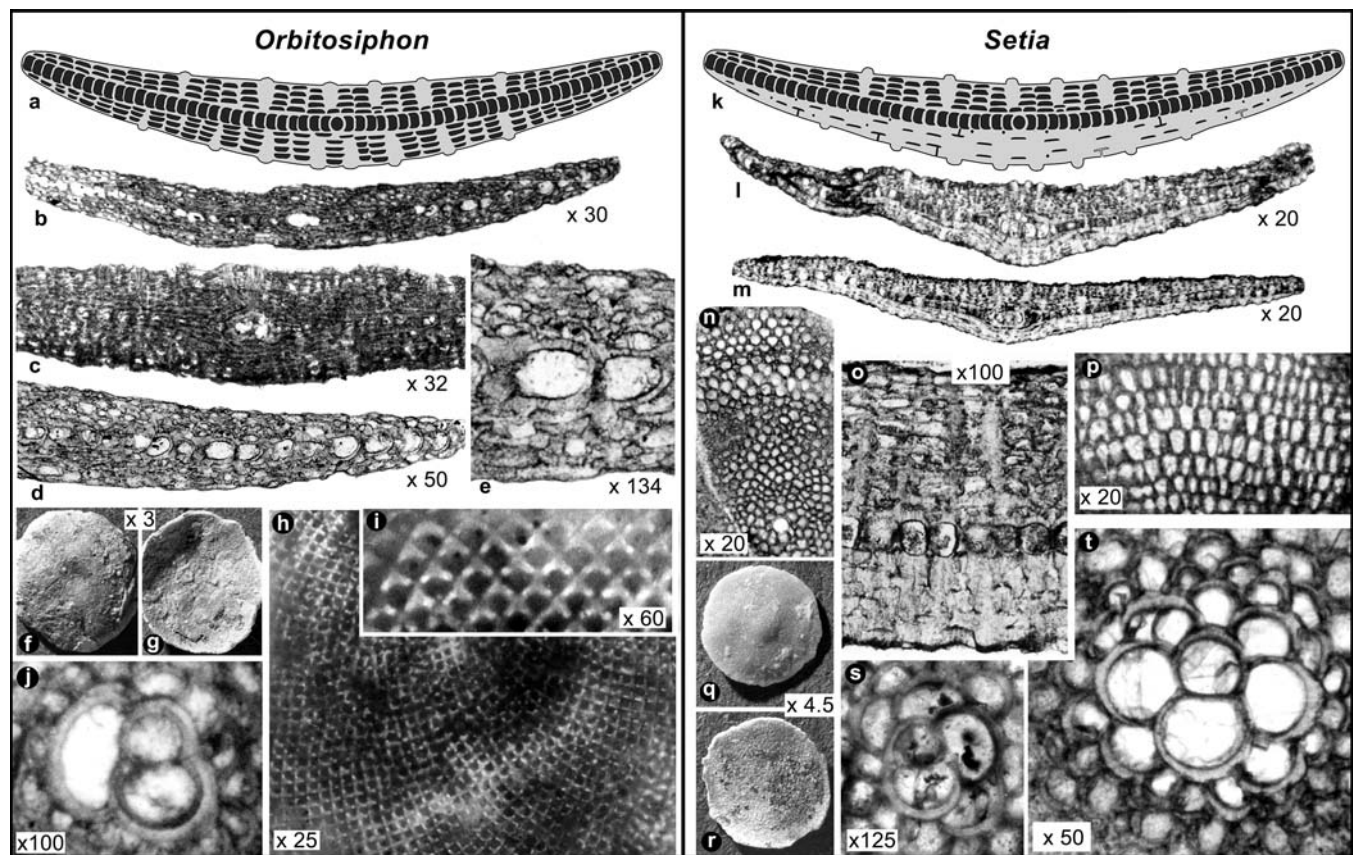
The similarity in the concave-convex shape of the test in *Orbitosiphon* and *Setia* is not enough to justify a phylogenetic relationship between two genera that differ in structural characters (presence or absence of a canal system). Further evidences (mainly a similar microspheric juvenarium) are needed. Either if the two genera are shown to be or to be not phylogenetically related the family Orbitosiphonidae should be emended. The diagnosis, which states “canals present”, should be changed either to include forms with and forms without canals (*Setia* and *Orbitosiphon*) or to include only forms without canals (*Orbitosiphon*). In the latter case, a new family should be created to include *Setia*.

RELATIONSHIP WITH CRETACEOUS GENERA

Following earlier authors, Matsumaru and Jauhri hypothesize that “*Lakadongia*” (= *Setia*) evolved from a Maastrichtian orbitoidiform species, either *Orbitocyclina ariyalurensis* Rao 1942, *O. minima* (Douvillé 1927) or *Orbitocyclinoides schencki* Brönnimann 1944. Such phylogenetic hypothesis is not supported by structural similarities between the genera. The orbitoidiform structural type of foraminiferal test has evolved recurrently from late Cretaceous times (e.g. in Lepid-orbitoididae, Orbitoididae, Discocyclinidae, Orbitoclypeidae, and Lepidocyclinidae, to cite the main groups). Paleocene-Eocene orthophragminids have also been phylogenetically related to Cretaceous orbitoidiform genera, mainly *Lepid-orbitoides* (Douvillé 1916, 1922, van der Weijden 1940, Drooger 1974, van Gorsel 1978, Fermont 1982). Such phylogenetical proposals are based on mere morphological or biometrical similarities, and ignore the structural features that contradict them. Fermont (1982) represents an extreme in this erroneous phylogenetical approach. According to this author, *Lepid-orbitoides* evolved into *Discocyclina* and *Asterocyclina*, *L. minor* (Schlumberger 1901) being the ancestor of *A. taramellii* (Munier-Chalmas 1891) and *L. socialis* (Leymerie 1851) the ancestor of *D. augustae* Weijden 1940. Fermont based his phylogenetic inference purely on biometric similarities, whereas the structural characters (mainly a different type of initial growth in microspheric forms) clearly indicate a different origin for *Discocyclina* and *Asterocyclina* (Brönnimann, 1946, 1951).

Larger foraminifera have recurrently originated from microforaminiferal stocks after extinctions (e.g. Hottinger 1984) and, as noted by Smout (1954: p. 38), “the adaptations possible in Foraminifera are limited, and parallel evolution is inevitable”. Evolutive convergence of Cretaceous and Tertiary forms is found in several other architectural types, such as the alveolinids. Sometimes the two convergent forms are so much similar that they are assigned to the same genus despite of their recognized different origin and stratigraphical range, such as Cretaceous and Tertiary conical agglutinated *Dictyoconus* or porcelaneous complex miliolids (*Idalina*, *Periloculina*, *Lacazina*). Due to this recurrent origin of similar architectural types, a general similarity in the test morphology is not enough to postulate phylogenetic relationships between foraminiferal groups.

On the other hand, the phylogenetic relationship postulated by Matsumaru and Jauhri is inconsistent with the stratigraphical re-



TEXT-FIGURE 1
Main features in *Orbitosiphon* and *Setia*.

Synthesis of the main morphological and structural features in the genera *Orbitosiphon* and *Setia*, shown in external views and in axial and equatorial sections of material from the Punjab Salt Range (Pakistan). Both genera have a test of concave-convex shape, but differ in their structure. *Orbitosiphon* has lateral chamberlets at both sides and always an embryo followed by an unique chamber at one side. *Setia* has lateral chamberlets at the dorsal side and a canal system at the ventral side; its megalospheric embryo is followed by a single chamberlet in *S. primitiva* (s) and by two symmetrical chamberlets in *S. tibetica* (t). Note the different appearance of the equatorial sections: *Orbitosiphon* (h, i) has arcuate chamberlets with crosswise-oblique and annular stolons, *Setia* (n, p) has rounded equatorial chamberlets which become rectangular in distal annuli and show passages and canals in the walls.

Orbitosiphon

- a schematic drawing of the axial section;
- b, c, axial sections (b, d, e: base of Lockhart Limestones, Dhak Pass, c: base of Patala Fm., Nammal Gorge);
- d, e
- f, g external ventral (f) and dorsal (g) view of the same specimen (Patala Fm., Dandot);
- h, i equatorial section and detail showing the stolon pattern (Patala Fm., Dandot);

Setia

- k schematic drawing of the axial section;
- l, m, o axial sections (l, m: Patala Fm., Makervall; o: Lokhart Limestone, Dhak Pass);
- n, p equatorial sections (Lokhart Limestone, Dhak Pass);
- q ventral external view (Patala Fm., Nammal Gorge);
- r d+orsal external view (Patala Fm., Dandot);
- s embryo of *Setia primitiva* in equatorial section (paratype NHMB-C 37917, Naturhistorisches Museum of Basel, Switzerland, Hangu Fm., Dhak Pass);
- t embryo of *Setia tibetica* in equatorial section (Lokhart Limestone, Dhak Pass). For further details, see Ferràndez-Cañadell (2002).

cord. The first true larger foraminifera after the K/T extinction are found in the Thanetian, with an interval of at least 7myr without larger foraminifera comprising the Danian and Selandian. Such an interval is close to the “about 10myr” postulated by Hottinger (1996) as the recovery time of larger foraminiferal stocks (K-strategist with symbiotic algae) after extinctions.

CONCLUSIONS

Two orbitoidiform foraminiferal genera occur in the Paleocene of Pakistan, Tibet and India, *Orbitosiphon* and *Setia*, which are similar in the concavo-convex shape of their test, but differ in their structure. *Orbitosiphon* has lateral chamberlets on both sides of the test and has no a canal system. *Setia* has lateral chamberlets only dorsally and a canal system ventrally (Ferràndez-Cañadell 2002). Despite of this structural difference, Matsumaru and Jauhri (2003) include both architectural types within the genus *Orbitosiphon* and define a new genus, *Lakadongia*, which is based on apparent features. The genus *Lakadongia* is invalid and *L. indica* is a junior synonym of *Setia tibetica*.

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