# TAXONOMIC AND BIOSTRATIGRAPHIC REASSESSMENT OF *LITUOSEPTA RECOARENSIS* CATI, 1959 (FORAMINIFERA, LITUOLACEA)

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ABSTRACT

The large lituolid foraminifer, *Lituosepta recoarensis* Cati, 1959, is recorded from Early Jurassic shallow-water carbonate deposits of the Southern Tethys area. This species is usually not abundant and its taxonomic status, as well as its stratigraphic distribution, have not always been well defined. The analysis of Cati's stratigraphic section (Monti Lessini area, Monte Scandolara, north-eastern Italy, Southern Alps), from which the type material originates, yielded numerous well-preserved topotypes and permitted a detailed structural and morphological assessment of *Lituosepta recoarensis*. Microspheric and megalospheric generations are herein described and illustrated. Two generations of megalospheric forms, A1 and A2, are distinguished on the basis of morphological features.

Comparing the *Lituosepta* species, the genus *Planisepta* (type species *Lituosepta compressa* Hottinger) is considered invalid and the original nomenclature *Lituosepta compressa* is retained. In the southern Tethyan margin the stratigraphic occurrence of *Lituosepta recoarensis* spans the upper Sinemurian–Toarcian interval.

## INTRODUCTION

Lituolid larger foraminifera are widespread along lower Jurassic Tethyan margins and are considered useful for both biostratigraphy and paleobiogeography. The genus *Lituosepta* Cati, 1959 (Family Mesoendothyridae Voloshinova, 1958) is represented by two species, *Lituosepta recoarensis* Cati, 1959 and *L. compressa* Hottinger, 1967. Both species contribute, together with orbitopsellids, to the larger foraminiferal biostratigraphy of the Lower Jurassic southern Tethyan margin (e.g., Castellarin, 1972; Broglio Loriga & Neri, 1976; Hottinger, 1967; Septfontaine, 1984, 1985; Bassoullet, 1997).

The genus *Lituosepta* (type species *Lituosepta recoarensis*) was first named by Cati (1959) for a lituolacean foraminifer discovered in the Calcari Grigi Group of the Southern Alps, northern Italy. The Calcari Grigi Group is a well-known carbonate platform succession deposited on the Trento Platform (Southern Alps, north-eastern Italy) during the Early Jurassic (Hettangian–Domerian; Bosellini & Broglio Loriga, 1971; Castellarin, 1972; Beccarelli Bauck, 1988; Posenato & Masetti, 2012). The type locality of *L. recoarensis* is at Monte Scandolara, near Recoaro Terme, Vicenza, in the Monti Lessini area (northeast Italy; Fig. 1).

The genus *Lituosepta* was later considered a synonym of the Upper Jurassic genus *Labyrinthina* Weynschenk (1951) by Loeblich & Tappan (1964, 1987) and Fourcade & Neumann (1966). In agreement with what has been discussed by Pirini (1965, p. 1172) and by Hottinger (1967, p. 40), however, these two genera are herein considered separately.

Septfontaine (1984, p. 213) noted that “phylogénétiquement, *Lituosepta recoarensis* n'est pas reliée directement à “*Lituosepta*” *compressa*”” (trad. “phylogenetically *Lituosepta recoarensis* is not directly linked to “*Lituosepta*” *compressa*””). Consequently he introduced the new genus *Planisepta* (type species *Lituosepta compressa* Hottinger) which differs from *Lituosepta* in having "the lateral compression of the test" (Septfontaine, 1988, p. 242).

Descriptions of the morphological features of *Lituosepta recoarensis* from the literature are controversial and the stratigraphic distribution along with the biostratigraphic value of this species varies in the different regions where it has been recorded (e.g., Kabal & Tasli, 2003; BouDagher-Fadel & Bosence, 2007).

We measured and resampled the Monte Scandolara section (the type section of *L. recoarensis* Cati, 1959) (Fig. 2) in order (1) to collect new specimens (topotypes) to adequately describe the shell morphology of this species, and (2) to reassess its taxonomic status and the biostratigraphic setting.

## STRATIGRAPHIC SETTING: THE TYPE LOCALITY OF *LITUOSEPTA RECOARENSIS*

The type specimens of *L. recoarensis* come from the south-western side of Monte Scandolara, next to Castrazzano (San Quirico; Alta Valle dell’Agno, Recoaro Terme, Vicenza, I.G.M. F 36, Recoaro Terme, II SO; 45°41'14" N, 11°17'47"E; Fig. 1). The Monte Scandolara sedimentary succession is geologically interpreted as a monocline along a NE-SW axis, outcropping toward the SE (Cati, 1959). Here the Calcari Grigi Group reaches up to 300 m in thickness and is locally strongly tectonized and dolomitized (Barbieri et al., 1980).

Cati (1959) designed the new species *L. recoarensis* from material collected in the Monte Scandolara section and in particular from a single sample ascribed to the highest part of the Calcari Grigi Group (as Formazione dei Calcari Grigi; Cati, 1959, p. 103), which there is represented by bioclastic limestone, locally oolithic. In the Cati’s original description *L. recoarensis* was recorded in association with *Pseudocyclammina* sp., valvulinids, textulariids, *Glomospira* sp., and calcareous algae (p. 111); *Orbitopsella* specimens are not reported by Cati from his published stratigraphic section.

Within the framework of the present study, the Monte Scandolara stratigraphic section was measured in detail and re-sampled (Fig. 2). The studied section embraces part of the topmost Oolite di Loppio formation (*ca*. 25 m thick) and the Formazione di Rotzo (*ca*. 35 m thick), all belonging to the Calcari Grigi Group (Hettangian–Pliensbachian), up to the stratigraphic contact with the overlying Rosso Ammonitico Veronese formation (Aalenian–Tithonian; Martire et al., 2006).

The lower part of the section consists mainly of poorly fossiliferous wackestones which are locally interbedded with marly horizons. These are followed by grainstone layers containing bioclasts, peloids, oncoids and ooids, and then by wackestone/packstones with bioclasts, peloids, oncoids and intraclasts, locally bioturbated or with thin shell (gastropods, bivalves, brachiopods) concentrations. The upper part of the section is characterized by the appearance of the *Lithiotis* fauna (De Castro, 1962; Bosellini & Broglio Loriga, 1971; Broglio Loriga & Neri, 1976;

Posenato & Masetti, 2012; Bassi et al., 2015), herein represented by *Cochlearites* banks. The latter are intercalated with irregular mudstones/wackestones almost devoid of fossils (S1, S1/); towards the top of the section, before the latest isognomonid-bivalve bed, wackestone and wackestone/packstone layers with bioclasts, micritic intraclasts and subordinately peloids and oncoids occur and correspond to the *Lituosepta recoarensis*-bearing beds (S0', S0, S-1). Between the *Lituosepta recoarensis* levels and the Ammonitico Rosso Veronese formation, condensation or hiatus (paraconformity) cannot be excluded, although there is no clear sedimentological evidence (Fig. 3).

The micropaleontological assemblage of these layers is dominated by *L. recoarensis* specimens, which are associated with *Orbitopsella* cf. *O. primaeva* Henson, *Pseudocyclammina liasica* (Hottinger) Septfontaine, *Everticyclammina* sp., *Bosniella* sp., *Amijiella amiji* (Henson), *Haurania deserta* Henson, *Duotaxis metula* Kristan, *Siphovalvulina variabilis* Septfontaine, and small ubiquitous benthic foraminifera such as *Glomospira* sp., *Planiinvoluta* sp., *Earlandia* sp. and valvulinids. Calcareous algal fragments (Dasycladales, *Sestrophaera liasina*? Pia) are also present. According to our sampling these levels likely correspond to the type levels from which Cati (1959) collected the original types.

This studied segment of the Calcari Grigi has to be assigned to the *Orbitopsella* Zone. Among the *Orbitopsella* species only *O.* cf. *O. primaeva* was identified; however the presence of *Pseudocyclammina liasica* and *Bosniella* sp. are indicative of the highest part of the *Orbitopsella* Zone in most of the Southern Alps sedimentary successions (Fugagnoli, 2004).

## MATERIAL AND METHODS

The study was carried out on material of the Calcari Grigi Group collected from Monte Scandolara (San Quirico, Alta Valle dell'Agno, Recoaro Terme, Vicenza, Venetian Southern Alps) and from Val Gola (Folgaria, Trento, Venetian Southern Alps), currently housed in the Museo di Paleontologia e Preistoria "P. Leonardi" of the Università degli Studi di Ferrara.

At the Museum of Natural History of Basel, Switzerland, we observed the specimens of *Lituosepta recoarensis* and *Lituosepta compressa* of the Hottinger's and Septfontaine's collections from Early Jurassic (i.e., Liassic) of Morocco and Bassoulet's material from Morocco (topotypes of *Lituosepta compressa* from Moulay Yacoub). Analysed specimens *of Lituosepta compressa* come from other localities of Southern Alps (e.g., Val Gola and Rotzo, samples Rt6, R9520; Fugagnoli, 2004). These specimens are deposited in the Museo di Paleontologia e Preistoria "P. Leonardi" of the Università degli Studi di Ferrara.

Shell structural analysis was performed on thin sections. Morphological terms are those adopted by Hottinger (1967, 2006). Suprageneric classification follows that of Septfontaine (1988).

## SYSTEMATIC PALEONTOLOGY

Superfamily LITUOLACEA de Blainville, 1827
Family MESOENDOTHYRIDAE Voloshinova, 1958
Subfamily ORBITOPSELLINAE Hottinger and Caus, 1982
Genus *Lituosepta* Cati, 1959
Type species: *Lituosepta recoarensis* Cati, 1959

*Lituosepta recoarensis* Cati, 1959
Figs. 3.1–3.9; Figs. 4.1–4.7; Figs. 5.1–5.4.

*Lituosepta recoarensis* Cati, 1959, p. 113, pl. 1, figs. 1–5, 7, 11, 14.
*Lituosepta recoarensis* Cati. Sartoni & Crescenti, 1959, p. 20, pl. 2, fig. 6.
*Lituosepta recoarensis* Cati. Sartoni & Crescenti, 1962, p. 274, pl. 13, fig. 2, pl. 47, fig. 7.
*Lituosepta recoarensis* Cati. Hottinger, 1967, p. 34–35, pl. 4, figs. 14–16, pl. 8, figs. 27–29, text-figs. 15–16.
*Labyrinthina recoarensis* (Cati). Gusić, 1969, p. 63–64, pl. 4, figs. 1–2, pl. 5, fig. 5.
*Lituosepta recoarensis* Cati. Benzaquen, 1963, pl. 9, fig. 3.
no *Lituosepta recoarensis* Cati. Nikler & Sokac, 1968, pl. 6, figs. 2–3.
*Lituosepta recoarensis* Cati. Chiocchini, 1977, p. 168, pl. 8, fig. 2.
*Lituosepta recoarensis* Cati. Kabal & Tasli, 2003, pl. 2, figs. 1–7.
*Lituosepta recoarensis* Cati. Fugagnoli, 2004, pl. 1, fig. 8.

*Lituosepta recoarensis* Cati. BouDagher-Fadel & Bosence, 2007, pl. 1, fig. 3; pl. 3, figs. 1, 4.

*Lituosepta recoarensis* Cati. Velić, 2007, pl. 2, figs. 5–8.

*Lituosepta recoarensis* (Cati). BouDagher-Fadel, 2008, pl. 4.13, figs. 8–9.

*Lituosepta* sp. var. A, Gale, 2014, p. 129–130, pl. 2, figs. 14–16.

*Description*. This species is a comparatively large form with a microgranular test, a simple exoskeleton (only beams) and few endoskeletal pillars. The proloculus is simple and followed by a very close-coiled spiral stage and a later uncoiled stage that is sometimes fan-shaped. Shell is laterally compressed but less than in *L. compressa*.

Two generations of megalospheric forms, A1 and A2, are distinguished on the basis of morphological features. The A1 forms are characterized by a simple proloculus (lumen diameter of 80 to 120 μm) followed by 1.5–2 planispiral whorls consisting of 10 to 15 chambers (the first whorl consisting of 7–8 chambers); this younger portion of the test is followed by a variably developed uncoiled rectilinear stage of 5-12 chambers. Length varies between 0.8 and 1.5 mm; diameter of planispiral portion is about 0.4-0.7 mm. The proloculus size of the A2 forms is very similar (80–100 μm) to A1 forms, and is followed by two planispiral whorls of 12–16 chambers. No uncoiled later part is developed (Table 1).

The microspheric forms (B) are characterized by a planispiral stage made up of 1.5–2 whorls; this portion of the test is not clearly visible due to the random orientation of specimens, but it is somewhat irregular in the very initial part which, seems to tend to a streptospiral coiling. In few specimens a simple proloculus was observed and shows a lumen diameter which is about 50–60 μm. An uncoiled uniserial portion is well developed and is constituted by 6–15 chambers which sometimes increase rapidly in width assuming a fan-shaped outline. Length (i.e., maximum diameter) varies between 1 and 1.6 mm; diameter of spiral stage is 0.32–0.5 mm approximately (Table 1).

In all generations, chamber lumen is higher than thickness of septa (about 50 μm). Thickness of test wall is 25–30 μm. A few pillars (two to four) start to appear in the adult stage (sometimes in the ninth chamber; more often in the fourteenth chamber). In the microspheric forms, pillars are very massive and clearly visible as straight rows, whereas in the megalospheric forms they appear sometimes as more irregular.

In axial and sub-axial section the test is laterally quite compressed and parallel-sided. It is compressed especially in those forms that develop a large fan-shaped uncoiled portion. Transverse sections through the uniserial part are, in fact, more likely to be circular in those specimens that are not fan shaped; however, no such sections were observed that can be assignable undoubtedly to this species. In those forms whose later chambers increase rapidly in width, the test is certainly laterally compressed as no transverse (or oblique) section with a circular outline and a very large diameter is recognizable in the available material, and most of axial sections indicate a compressed shape.

*Remarks and comparisons.* From material collected in the Monte Scandolara succession of the Formazione di Rotzo formation, Cati (1959) provided the first diagnosis and description of *Lituosepta recoarensis* based on forms only from the megalospheric generation. He recognized only megalospheric forms with elongated and sub-cylindrical shape, slightly inflated in correspondence with the initial spiral portion of the test. In cross section, the uncoiled part is circular; it also tends to become narrower, assuming a truncated-cone shape. The thickness of test is 28 μm on average.

Subsequently, a detailed description was made by Hottinger (1967), who also re-illustrated the Cati's material. Other morphometric parameters (Table 1) are compared with those of specimens from Morocco (Hottinger, 1967) and with those from the Formazione di Rotzo formation described herein. According to the description of *Lituosepta recoarensis* provided by Hottinger (1967), the specimens from Morocco do not show a circular transverse section.

In the specimens figured by Cati (1959) in pl. 1, figs. 11, 13–14, the test morphology appears to be laterally compressed, as also shown in the new specimens collected from the Monte Scandolara section (Figs. 3.4, 3.8; Figs. 4.1, 4.4, 4.6–4.7; Figs. 5.2, 5.4). Furthermore, according to Hottinger (1967), specimens illustrated by Cati (1959) in pl. 1, figs. 6, 8–10 have to be assigned to transverse and transverse-oblique sections of *Haurania deserta* Henson.

Septfontaine (1984) described some *Lituosepta recoarensis* specimens from the Aganane Formation of Morocco as "à stade adulte dérulé cylindrique" (trad., "an uncoiled cylindrical adult stage") in which "la section transversale est parfaitment circulaire" (trad., "the transversal section is perfectly circular"; Septfontaine, 1984, pl. 1, figs. 7–10). He reported that these morphotypes are phylogenetically related to the orbitopsellids (*Orbitopsella* spp.), as they

"représente une forme ancestrale du phylum des Orbitopsellidés" (Septfontaine, 1984, p. 212), and that these forms correspond to *Lituosepta recoarensis sensu* Cati (1959).

According to Septfontaine (1984), the specimens of *L. recoarensis* described and figured by Hottinger (1967) and found together with *Orbitopsella* cannot be assigned to the same species of Cati (1959), but they should be assigned to *Lituosepta compressa* species with laterally compressed tests. Furthermore, Septfontaine (1984, p. 212–213) stated that "phylogénétiquement, *Lituosepta recoarensis* n'est pas reliée directement à "*Lituosepta* *compressa*" (Septfontaine, 1984, p. 213). Hence the new genus *Planisepta* (type species *Lituosepta compressa* Hottinger) was introduced (Septfontaine, 1988) which differs from *Lituosepta* in "the lateral compression of the test" (Septfontaine, 1988, p. 242).

Septfontaine (1988) initially did not formally described *Planisepta* but only remarked "see complete description and figures in Hottinger, 1967 and Septfontaine, 1984" (p. 342). This genus was later validated by Kaminsky (2000), who repeated the description provided by Septfontaine (see also Mikhalevich, 2004, p. 259).

This distinction between the genera *Lituosepta* and *Planisepta* is based mainly on the lateral compression of the test; such a compression characterizes *Planisepta* while *Lituosepta* is considered circular in cross-section. The criteria adopted by Septfontaine (1984, 1988) to separate the two genera focused mainly on proportions of the variable test elements rather than on the presence or absence of structural elements. These arguments are herein not considered as sufficient to distinguish two different genera, as first noted by Caus et al. (1994). Consequently the genus *Planisepta* Septfontaine is invalid and the original nomenclature *Lituosepta compressa* should be used in the future.

Detailed comparisons between *Lituosepta recoarensis* and *Lituosepta compressa* were discussed by Hottinger (1967, 1971) and are herein confirmed. In *Lituosepta compressa,* Hottinger (1967, 1971) noted smaller dimensions, a finer wall texture and a higher development of pillars in the adult stage. However, neither Cati (1959) nor Fourcade & Neumann (1966) recognized endoskeletal structures such as the pillars. Furthermore in *L. compressa* "la spire, plus serrée dans le stade juvénile, s'élargit ensuite beaucoup plus vite" (trad., "the planispiral whorl, very close-coiled in the juvenile stages, widens faster"; Hottinger, 1967, p. 38). Hottinger (1967) regards both species *L. recoarensis* and *L. compressa* as being laterally compressed, even if compression in *L. recoarensis* is less accentuated than in *Lituosepta compressa.*

Furthermore Cati's (1959) types do not show development of a fan-shaped adult stage, whereas both in Hottinger's (1967, 1971) specimens and in the new collected topotypes from Monte Scandolara, some forms possess a well developed fan-shaped uncoiled part, especially those belonging to the microspheric generation. In *L. compressa* the chambers grow more rapidly in width while in *L. recoarensis* an adult stage develops with chambers rather constant in width, sometimes with a tendency to narrowing.

As a whole, since no marked differences occur between these two species, distinguishing the two by random sections is extremely difficult ("… en coupe non orientée, il est extrêmement difficile de distinguer les deux espèce"; Hottinger, 1967, p. 38; trad. "… it is extremely difficult to distinguish the two species in not oriented section"). This is particularly true for specimens belonging to A2 generations.

With regard to the genus *Planisepta* Septfontaine, which is not considered to be phylogenetically related to *Lituosepta* (see Septfontaine, 1984), its designation may have been based upon the stratigraphic gap between the disappearance of *L. recoarensis* and the appearance of *L. compressa*, at least in the lower Jurassic (as Liassic in Hottinger, 1967) stratigraphic successions of Morocco. In the Apennines and Southern Alps the stratigraphic distribution of *L. recoarensis* is not always well-defined, and therefore the stratigraphic gap between the two species is not evident (see discussion below).

The absence of differences in shell structure and the strong morphological affinities therefore do not justify the taxonomic separation of the two genera. The evolutionary stasis between *L. recoarensis* and *L. compressa* might be explained by their paleoecologies. Their presence in different stratigraphic levels during the Early Jurassic (see also Kabal & Tasli, 2003; BouDagher-Fadel & Bosence, 2007) may be related to adaptation to specific paleoenvironmental conditions which have been described for instance in the trophic evolution of the Trento Platform setting (Fugagnoli, 2004).

*Stratigraphic and paleogeographic distribution. Lituosepta recoarensis* belongs to the group of lower Jurassic larger foraminifera with a rather wide geographical distribution since it has been recognized in several regions of the south Neotethyan margin (e.g., Italy, Morocco, Spain, Turkey, Greece, Slovenia, Middle East). The stratigraphic distribution of this species seems, however, to be variable and not well-defined.

In northern Italy (Monti Lessini, Southern Alps) this species was discovered by Cati (1959) in the Lessini area, where the type locality of Monte Scandolara is located. Cati (1959) found it associated with *Pseudocyclammina* sp., valvulinids, textulariids, *Glomospira* sp. and calcareous algae (*Diplopora* sp., *Boueina* sp., *Palaeodaycladus mediterraneu*s Pia, *Thaumatoporella parvovesiculifera* (Raineri)) and referred this assemblage to a more or less undefined **"**Middle–Upper Liassic", in accordance with the available literature of those years (e.g., Tausch, 1890; Negri, 1891; Fabiani, 1911; Sartoni & Crescenti, 1959; in Cati, 1959, p. 8).

According to the present study of the Monte Scandolara stratigraphic section, *L. recoarensis* occurs with *Orbitopsella* cf. *O. primaeva* Henson, *Pseudocyclammina liasica*, *Everticyclammina* sp., *Bosniella* sp., *Amijiella amiji* (Henson), *Haurania deserta* Henson, *Duotaxis metula* Kristan, *Siphovalvulina variabilis*, *Glomospira* sp., *Planiinvoluta* sp., *Earlandia* sp., and valvulinids. This assemblage might be, therefore, referred to the *Orbitopsella* Zone as defined by Fugagnoli & Loriga Broglio (1998) and BouDagher-Fadel & Bosence (2007). The presence of a possible hiatus between the *Lituosepta recoarensis* levels and the Ammonitico Rosso Veronese formation (Aalenian–Tithonian; Martire et al., 2006) cannot be determined, hence the stratigraphic position within the *Orbitopsella* Zone, even with the presence of *Pseudocyclammina liasica* and *Bosniella* sp., indicates that the fossils do not occur within the lower part of this biozone (Fugagnoli, 2004; Posenato et al., 2013a).

In the Venetian Southern Alps, Castellarin (1972, p. 42, 72) recorded *L. recoarensis* in the Formazione di Rotzo within the *Orbitopsella* Zone ("Middle Lias") together with *Lituolipora termieri* (Hottinger) (as "*Mayncina" termieri*) and *Pseudocyclammina* cf. *P. liasica*. The stratigraphic order of appearance of these species is not specified. *Lituosepta compressa* occurs instead after this association as a marker of middle–late Liassic. *Lituosepta recoarensis* has been found also in Val Gola (Altopiano di Folgaria; Posenato et al., 2013a, b), where it appears before *Orbitopsella primaeva* and is associated with this species only in the lowest part of the Formazione di Rotzo.

In the central Apennines *L. recoarensis* is recorded above the *Orbitopsella* Zone (Sartoni & Crescenti, 1959; Chiocchini & Mancinelli, 1978; Chiocchini et al., 1994). In particular it has been referred to the Toarcian, together with *Lituolipora termieri* (as "*Mayncina*" *termieri*), in "carbonate platform margin and debris pelagic facies" (Chiocchini & Mancinelli, 1978, pl. 1): however no stratigraphic evidence justifies this age. *Lituosepta recoarensis* has been also recognized together with *Orbitopsella praecursor*, *O. dubari*, and *Pseudocyclammina liasica* in a stratigraphic unit referred to "middle Liassic" (Gran Sasso d'Italia, Abruzzo) and in a same faunal assemblage (also with *O. praecursor africana*) in the *Paleodasycladus mediterraneus* Zone (Monti Aurunci, southern Lazio; Chiocchini & Mancinelli, 1977). In this latter area *Lituosepta compressa* appears only after the disappearance of the *Orbitopsella* species; however the disappearance of *Lituosepta recoarensis* cannot be determined.

In Morocco, *Lituosepta recoarensis* is recorded just above the *Orbitopsella praecursor* levels and is found together with *Pseudocyclammina liasica* and *Haurania deserta* (Hottinger 1967, 1971). The stratigraphic distribution is referred to the "middle Liassic" (fig. 51, p. 103), before the first appearance of *Lituosepta compressa*. On the other hand, in Morocco, Septfontaine (1984) noted that *L. recoarensis* precedes the appearance of *Orbitopsella* and co-exists also with *O. primaeva* in levels that are dated as late Sinemurian by indirect correlation through an ammonite (*Uptonia* sp.) bearing bed located above the *L. recoarensis* levels and referred to as early Carixian. A late Sinemurian age is also supported by brachiopods (*Hesperithyris renierii* Catullo var. *minor* Dubar), located below the *Orbitopsella* levels. Septfontaine (1984) considered *Lituosepta recoarensis* as a biozonal marker of a phyletic zone referred to late Sinemurian. The lower limit of this zone corresponds to the first appearance of *L. recoarensis*, the upper limit is marked by the first appearance of *Orbitopsella*.

In Slovenia the distribution of *L. recoarensis* is recorded in the *Palaeodasycladus mediterraneus* Zone (topmost early Liassic to late Liassic) together with *Orbitopsella praecursor* (Farinacci & Radoičić, 1964; Radoičić, 1966). Besides, from the Jurassic of Gorski Kotar, Cosović (1987) described a fossil assemblage in which *L. recoarensis* is associated with *Orbitopsella praecursor*, *Amijiella amiji*, *Haurania deserta*, and *Palaeodasycladus mediterraneus,* and all characterize the *O. praecursor* subzone of middle Liassic age (the biozonation follows that of Sartoni & Crescenti, 1962). Moreover, the distributions of *L. recoarensis* and *O. praecursor* are coincident (fig. 2, p. 87). In the Karst Dinarides Velić (2007) divided *O. primaeva* Zone into (a) Late Sinemurian–earliest Early Pliensbachian *O. primaeva–L. recoarensis* concurrent-range subzone, ranging from the first occurrence of *O. primaeva* to the last occurrence of *L. recoarensis*, and (b) Early Pliensbachian *L. recoarensis –O. praecursor* interval subzone. In the Central Slovenia (Ljubljana, External Dinarides) *L. recoarensis* marks the early Late Sinemurian (Gale, 2014).

In Greece Zambetakis-Lekkas (1995) recorded *Lituosepta recoarensis* in association with *Orbitopsella praecursor, Palaeodasycladus mediterraneus, Palaeodasycladus* cf. *P. elongatulus* (Praturlon), and *Lituolipora termieri* (as ?*Mayncina termieri*); this assemblage has been ascribed to Pliensbachian age.

In Turkey *Lituosepta recoarensis* (as "*Labyrinthina*" *recoarensis*) was found in the middle Liassic together with "*Haurania*" gr. *amiji*, *Pseudocyclammina liasica*, and *Mayncina* sp. (Bassoullet & Poisson, 1975), and in levels corresponding to the *O. praecursor* subzone of Sartoni & Crescenti (1962) associated with *Orbitopsella* cf. *O. praecursor*, *Haurania amiji*, *Mayncina* sp. (Bassoullet & Bergougnan, 1981); *L. recoarensis* is not recorded above the disappearance of the orbitopsellids.

Furthermore Bassoullet et al. (1985), in a study concerning the paleogeographic distribution of benthic foraminifera along the Southern Tethyan margin, compared the distribution of *Lituosepta recoarensis* (as *Labyrinthina recoarensis*) with that of *Pseudocyclammina liasica*. Otherwise Septfontaine et al. (1991) in the biochronological scale of index foraminifera for the Jurassic Tethyan realm, indicated the genus *Lituosepta* as restricted to the upper Sinemurian; this interpretation is mainly derived from the records from Morocco (Septfontaine, 1984, 1985).

In a biostratigraphic study carried out in the Central Taurides (Southern Turkey), Kabal & Tasli (2003) found that *Lituosepta compressa* is first recorded in the *L. recoarensis* Zone, below the lower limit of the *Orbitopsella* Zone. This record places the stratigraphic distribution of *L. recoarensis* in the upper Sinemurian. Moreover, *Lituolipora termieri* is first found together with *L. recoarensis*, the ranges of both species are partially overlapping.

The Early Jurassic (Hettangian–Pliensbachian) of the Western Tethys has been subdivided into four biozones by BouDagher-Fadel & Bosence (2007). The authors considered *L. recoarensis* as late Sinemurian–lower Aalenian in age and *L. compressa* (as *Planisepta compressa*) early Pliensbachian in age.

In conclusion, according to the examined literature, *Lituosepta recoarensis* has been so far recorded from lower Jurassic shallow-water carbonate platform successions along the southern Tethyan margin in different larger foraminiferal assemblages and stratigraphic levels, which are sometimes located before, in correspondence with, or above the *Orbitopsella* Zone, and whose age spans the whole Sinemurian–Pliensbachian interval. In the Apennines the records of this species in Toarcian deposits need a stratigraphic reassessment.

## SUMMARY AND CONCLUSIONS

1. The study of type material of *Lituosepta recoarensis* Cati from the Monte Scandolara stratigraphic section allowed the taxonomic reassessment of topotypes belonging to microspheric and megalospheric generations.

2. Some of the specimens of *Lituosepta recoarensis* illustrated by Cati are assigned to transverse and transverse-oblique sections of *Haurania deserta* Henson.

3. The genus *Planisepta* (type species *Lituosepta compressa*) is invalid and the original nomenclature, *Lituosepta compressa,* is retained. The strong affinities concerning morphology and structural elements between *Lituosepta recoarensis* and *Lituosepta compressa* do not justify the ascription of *L. compressa* to a different genus, despite different stratigraphic distributions.

4. In several regions of the south Neotethyan margin (e.g., Italy, Morocco, Spain, Turkey, Greece, Slovenia, Middle East) the stratigraphic distribution of *Lituosepta recoarensis* is as a whole variable and not always well defined. This species has so far been recorded in shallow-water carbonate-platform deposits whose age spans the Sinemurian–Pliensbachian interval. This stratigraphic assessment allows use of *Lituosepta recoarensis* as a local biostratigraphic marker.

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**TABLE and FIGURE CAPTIONS**

TABLE 1. Morphometric parameters of *Lituosepta recoarensis*. n.: number.

FIGURE 1. Geographic map showing the type locality of *Lituosepta recoarensis* (1, Monte Scandolara, Recoaro; Alta Valle dell'Agno; Vicenza; Southern Alps).

FIGURE 2. Stratigraphic section of Monte Scandolara, from which the Cati's (1959) type material and the new topotypes used in this study were collected. The distributions of benthic foraminiferal species and calcareous algae are also shown.

FIGURE 3. *Lituosepta recoarensis* Cati, 1959: Monte Scandolara, Recoaro, Vicenza, northern Italy. Samples located in Fig. 2. Scale bar = 0.500 mm in 1–4, 6–9; scale bar = 0.250 mm in 5.
**1, 6**–**7** Megalospheric forms, oblique sections. The young stage is not well-preserved and cut obliquely; probably all belonging to A1 generation; samples S-1, S0'.
**2**–**3** Almost equatorial sections (A1) showing a young planispiral coiling and an uniserial fan-shaped later stage in which pillars are visible; samples S-1, S0.
**4, 8**–**9** Axial sections of megalospheric specimens (?A2 and A1) showing the lateral compression of the test and pillars; samples S0', S0.
**5** Oblique centered section through a megalospheric form (probably A2); sample S0.

FIGURE 4. *Lituosepta recoarensis* Cati, 1959: Monte Scandolara, Recoaro, Vicenza, northern Italy. Samples located in Fig. 2. Scale bar = 0.500 mm.
**1, 4** Axial sections of megalospheric specimens (A1); sample S-1.
**2**–**3** Equatorial/oblique sections of microspheric (2, ?3); samples S0', S0.
**5** Almost equatorial sections of megalospheric (A1) and probably microspheric specimens respectively; sample S0'.
**6**–**7** Equatorial sections of megalospheric (A2) specimens in which the uncoiled later stage is not developed; sample S0.

FIGURE 5. *Lituosepta recoarensis* Cati, 1959 (1–4) from Monte Scandolara, Recoaro, Vicenza, northern Italy (samples located in Fig. 2) and *Lituosepta compressa* Hottinger, 1967 (5–6) from the Rotzo stratigraphic section, Altopiano di Asiago, Vicenza (Bosellini & Broglio Loriga, 1971). Scale bar = 0.500 mm.
**1, 3** Oblique and equatorial/oblique sections of megalospheric (A1) specimens; samples S0, S-1.
**2, 4** *Lituosepta recoarensis* microfacies; note the presence of oblique and axial/oblique sections of *L. recoarensis* associated with *Orbitopsella* cf. *primaeva* (op, axial section), *Glomospira* sp. (gl), valvulinids (va), and calcareous algal fragments (af); samples S0, S0'.
**5** Microspheric form of *Lituosepta compressa* Hottinger; equatorial section showing a well-developed uniserial stage fan-like shape and numerous pillars; sample Rt6.
**6** *Lituosepta compress*a microfacies showing random oriented specimens; note the smaller dimension and the more compressed test compared with *L. recoarensis*; sample R9520.

| | Cati (1959) | Hottinger (1967) | This paper |
|---|---|---|---|
| proloculus diameter (mm) | 0.125–0.135 (A) | 0.08–0.1 (A) | 0.08–0.1(A)/0.05–0.06 (B) |
| length (mm) | 0.74–1.3 (A) | 2.5 (B) | 0.4–1.5 (A)/1–1.6 (B) |
| spiral diameter (mm) | 0.36–0.53 (A) | 0.7 | 0.4–0.7 (A)/0.3–0.5 (B) |
| n. of spiral whorls | 1.5–1.75 (A) | 1.5–2 (A)/2 (B) | 1.5–2 (A, B) |
| n. chambers (first whorl) | 7–8 (A) | 8 (A) | 7–8 (A) |
| n. uncoiled chambers | 3–6 (A) | 15 (B) | 5–12? (A)/6–15 (B) |