Earliest Artinskian (Early Permian) fusulinids reworked in the Triassic Lercara Formation (NW Sicily)

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EARLIEST ARTINSKIAN (EARLY PERMIAN) FUSULINIDS REWORKED IN THE TRIASSIC LERCARA FORMATION (NW SICILY)

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ABSTRACT

The Permian limestone boulders reworked in the Triassic Lercara Formation (NW Sicily) contain carbonate microfossils consisting of algae, smaller foraminifers and fusulinids. The following fusulinids are described: *Quasifusulina ultima* Kanmera, *Robustoschwagerina* cf. *R. schellwieni* (Hanzawa), *Chalaroschwagerina* (?) *globosa* (Schellwien). The group of *Chalaroschwagerina* (?) *vulgaris* (Schellwien) is emended.

Based on this fusulinid assemblage, the limestone boulders of Lercara are age-dated as early Yakhtashian; i.e., earliest Artinskian (circa −280 to −275 Ma). Therefore at least two distinct olistostromes are present in Sicily: the post-Yakhtashian olistostrome studied here, and the second one post-Dorashamian in age.

Similar assemblages do not occur in adjacent European areas (Camic Alps, Montenegro or Greece), but they have been recorded in Darvas (North Pamir) and Japan, revealing constant paleoecological conditions throughout the Paleotethys.

THE PERMIAN IN SICILY

The Sosio valley, in the Central Monti Sicani, SW Palazzo Adriano, is famous for five large carbonate blocks of middle Permian age, first described by Gemellaro (1888–1899). Among these blocks, La Rocca di San Benedetto, La Rupe del Passo di Burgio and La Pietra di Salomone are considered by some (Castany, 1956; Broquet, 1968) to include the richest marine Tethyan Permian faunas. The boulders consist of massive fossiliferous limestones (Calcari del Sosio), tectonically associated with red to green marls and sandstones.

Other late Paleozoic carbonate rocks have also been recognized in Sicily; they are known from the localities Cozzo Rasolocollo in the Western Madonie (Tongiorgi and Trevisan, 1953), and Roccapalumba-Lercara Friddi in the Eastern Monti Sicani (Fabiani and Trevisan, 1937) (Fig. 1). They consist of redeposited limestones, intercalated within an extended siliciclastic complex known in NW Sicily under the name of the Lercara Formation (Schmidt di Friedberg, 1965).

THE LERCARA FORMATION

The best outcrops of the Lercara Formation are found in the area between Roccapalumba and Lercara Friddi. They represent the exposed base of the Roccapalumba Unit of the Sicano Palaeodomain (Catalano and Montanari, 1979), which thrusts over Cenozoic (Miocene) pelagic shales (Beneo, 1955).

The Lercara Formation, which makes up hills and valleys of the countryside, is mainly composed of marls, clays, and sandstones, with intercalations of thin bedded limestones and alkali-basaltic lavas; in the upper part of the formation, calcarenitic levels and carbonate breccias are characteristic. The breccia elements, sometimes meter-sized, derive from late Paleozoic shallow water limestones. The larger blocks are normally found isolated above the siliciclastic deposits; sometimes the blocks are accumulated along tracks by farmers, making it easier to collect fusulines.

The Lercara Formation has been assigned to the late Paleozoic, to the Triassic, and even to the Tertiary. The Paleozoic (early Permian) age of the formation was proposed by Fabiani and Trevisan (1937) on the basis of one Permian ammonite and some fusulinids. Castany (1956) shares this opinion, comparing the Lercara deposits with the Permian reefal complex of the Djebel Tebaga of Medenine in Tunisia. Broquet (1968) and Mascle (1979) consider the Lercara Formation, together with the overlying Triassic Mufara Formation, as part of the Permian-Triassic basement of the Campofiorito-Cammarata Unit.

Other authors (Montanari, 1967; Catalano and D'Argenio, 1978; Catalano and Montanari, 1979) accept a Triassic age for the Lercara Formation, based on the presence of some middle Triassic foraminifers. Cirilli and others (1990), and Montanari and Panzanelli-Fratoni (1990), confirmed the occurrence of middle Triassic foraminifers and palynomorphs, which make up the youngest assemblage of the Lercara Formation and which can be easily distinguished from the reworked Permian microfossils.

Recently, Kozur and collaborators (see particularly Kozur and others, 1996) considered the ''Olistostrome Unit'' of the Sosio valley as Roadian (i.e., early middle Permian) in age. In fact, this olistostrome cannot be older than post-Midian (late middle Permian) on the basis of the fusulinids described by Skinner and Wilde (1966) and Flügel and others (1991). The presence of *Colaniella* (Jenny-Deshusses and others, in press) in the Pietra di Salomone, also confirms a younger age (i.e., post-Dorashamian, probably Triassic) for the ''Olistostrome Unit''. The middle Permian conodonts described by Gullo and Kozur (1992) are presumably reworked in the sandy or shaly olistoliths.

In spite of large areas covered by the Lercara Formation (Fig. 1), the reconstruction of the primary succession of deposits remains difficult because of tectonic effects and limited exposures. However, two main stratigraphic intervals can be recognized: the lower part of quartzwackes, quartzarenites and shales, and the upper part of red-green shales, sandstones, marls, and reworked calcarenites and carbonate breccias with Carboniferous and mainly Permian boulders

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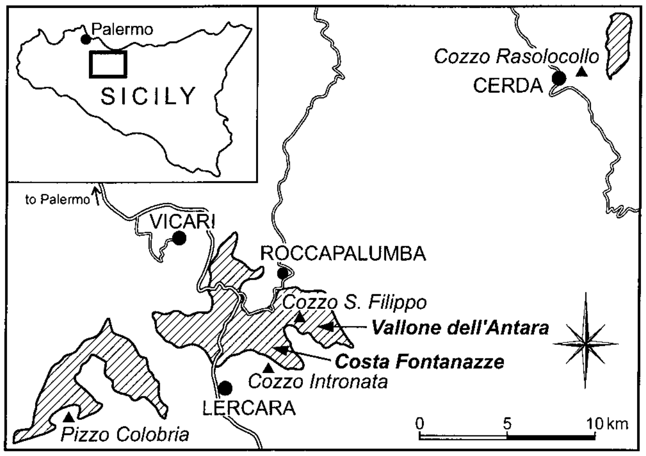


FIGURE 1. Location of areas (hachured) covered by the Lercara Formation.

(Fig. 2). The depositional environment of the Lercara Formation, at least the upper interval, is interpreted as a ''deep marine basin'' by Montanari and Panzanelli-Fratoni (1990).

MICROPALEONTOLOGY OF THE PERMIAN BOULDERS

Samples from the Permian blocks and associated calcarenites were collected in the South Roccapalumba area, in the Costa Fontanazze localities near Cozzo Intronata, and in the Vallone dell'Antara near Cozzo San Filippo (Fig. 1). The shallow water Permian boulder facies consist of white to grey limestones, either of algal-foraminiferal packstones to floatstones, or of boundstones with sponges and *Tubiphytes.* Both facies are characteristic of a reef-lagoon platform complex. The boundstones developed in higher energy areas, whereas the foraminifers and algae were deposited in lower energy lagoonal environments.

In the boundstones, the frame builders are essentially calcisponges belonging to the Inozoa and Sphinctozoa (Senowbari-Daryan and Di Stefano, 1988) and associated with *Tubiphytes* and different types of large bryozoa. The calcisponges normally exhibit thick coatings of *Archaeolithoporella.* Rare bioclasts of foraminifers, including fusulines, and fragments of bivalves, echinoderms and gastropods are present.

The richest associations of the Lercara Formation are contained in the peloidal and bioclastic floatstones showing several generations of calcareous cements and speleothemic cavities filled by red microsparite. The fossil assemblages are also composed of:

Metazoan fragments—polyaxon sponge spicules, Inozoan calcisponges, gastropods, bivalves, rare Orthoceratids, brachiopods, bryozoa, ostracods, crinoids;

Smaller foraminifers—*Diplosphaerina inaequalis* (Derville), *Diplosphaerina* sp. indet. (Pl. 1, Fig. 1), *Endoteba* cf. *controversa* Vachard and Razgallah (Pl. 1, Fig. 2), *Endothyra* cf. *E. asymmetrica* Morozova, *Climacammina* sp., *Globivalvulina* sp., *Lasiodiscus tenuis* Reichel, *L. minor* Reichel, *Pseudovidalina delicata* (Lin) (Pl. 1, Fig. 3), *Calcitomella* sp., *Pseudovermiporella* ex gr. *nipponica* (Endo), *Neodiscus* (?) *ovatus* (Grozdilova), *Nodosaria potievskayae* (Mamet and Pinard), *Nodosaria* sp., *Geinitzina* sp.;

Fusulinids—*Schubertella* sp., *Minojapanella* (?) sp. (Pl. 1, Fig. 5), *Quasifusulina ultima* Kanmera (Pl. 1, Figs. 6–7), *Robustoschwagerina* cf. *R. schellwieni* (Hanzawa) (Pl. 1, Figs. 8–11), *Chalaroschwagerina* (?) *globosa* (Schellwien) (Pl. 2, Figs. 1–8), *Verneuilites* (?) sp. (Pl. 2, Fig. 9); gen. indet. (Pl. 2, Fig. 10);

Cyanobacteria and algae—*Archaeolithoporella hidensis* Endo (Pl. 3, Fig. 7), *Girvanella* sp., *Koivaella permica* Chuvashov (Pl. 3, Figs. 1, 5), *Bacinella* sp. indet. (Pl. 3, Figs. 4, 6–7), *Tubiphytes obscurus* Maslov (Pl. 3, Figs. 2–3), *Archaeolithophyllum missouriense* Johnson (Pl. 3, Figs. 8–9) and other phylloid algae (Pl. 3, Fig. 7).

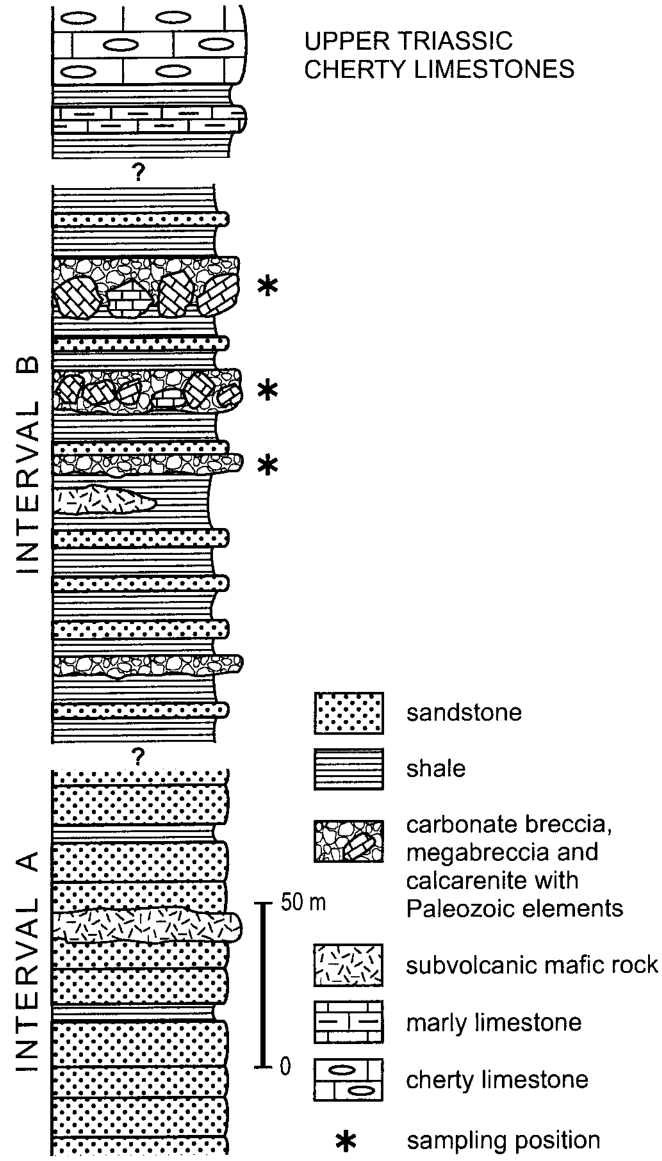


FIGURE 2. Lithostratigraphic section of the Lercara Formation.

Only one atypical microfacies (Si111A) is a calciturbidite, whose bioclastic components are entirely represented by *Schubertella silvestrii* Skinner and Wilde (Pl. 1, Fig. 4), described from the Murgabian/Midian assemblage of the

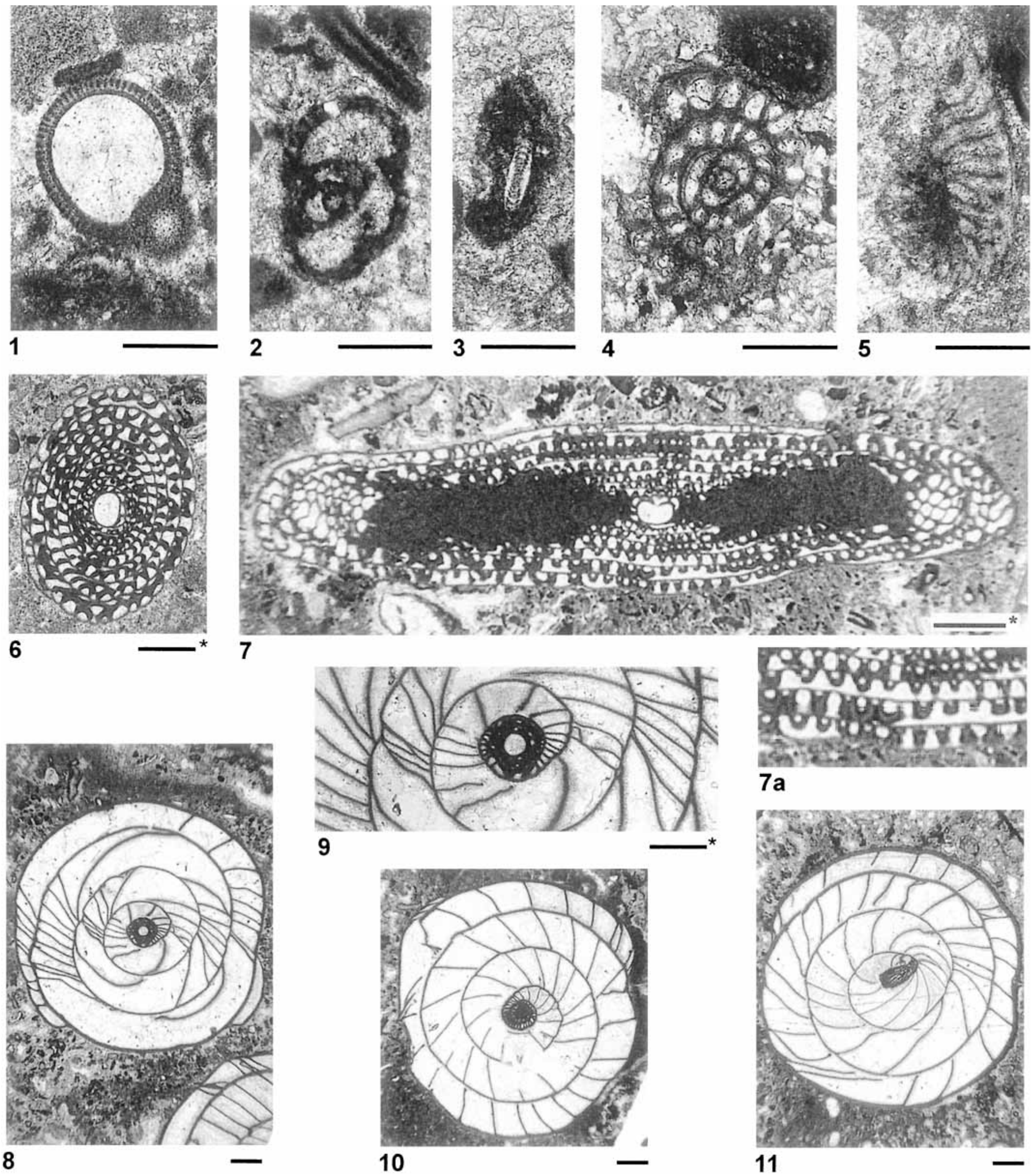


PLATE 1.
Smaller foraminifers and fusulinids

1 *Diplosphaerina* sp. indet.; longitudinal section showing both spheres and their walls, slide Si133A. 2 *Endoteba* cf. *E. controversa* Vachard and Razgallah, 1988; transverse section, slide Si133A/1B. 3 *Pseudovidalina delicata* (Lin, 1984); axial section, slide Si133A. 4 *Schubertella silvestrii* Skinner and Wilde, 1966; transverse section, slide Si111A. 5 *Minojapanella* (?) sp.; subtransverse section, slide Si133/2D. 6, 7, 7a *Quasifusulina ultima* Kanmera, 1958; 6 Transverse section, slide Si133E/2B; 7 Axial section, slide Si133/2D. 7a Detail of the tunnel region, slide Si133/2D. 8–11 *Robustoschwagerina* cf. *R. schellwieni* (Hanzawa); 8 Axial section, slide Si133/2B; 9 Detail of the Fig. 8-juvenarium, slide Si133/2B; 10 Transverse section, slide Si133/1; 11 Paratype, subtransverse section, slide Si133/2. Asterisked scale bar is 500 μm; other scale bar is 250 μm.

Sosio Valley (Skinner and Wilde, 1966). This species has been often identified as *Dunbarula nana* Kochansky-Devidé and Ramovs (e.g. Hamaoui, 1983; Panzanelli-Fratoni and others, 1987; Lys, 1988), an unquestionable Midian fusuline distinguishable by its vigorously fluted septa. Therefore in the Lercara Formation, the levels with *S. silvestrii* are not precisely dated herein.

AGE OF FUSULINIDS

An assemblage consisting of the species of *Quasifusulina, Robustoschwagerina*, and *Chalaroschwagerina* (?) of the group *vulgaris* is considered characteristic of the Artinskian *sensu stricto,* or of the lower part of the Artinskian *sensu lato*, or its equivalent Yakhtashian (Figs. 3, 4).

The Yakhtashian, introduced by Leven (1981a), is a fusulinid-bearing Tethyan stage, especially known in Asia, Turkey and Transcaucasia to Japan (Leven, 1994, 1995). It equivalent to the early Leonardian in North America (Ross and Ross, 1994) (Fig. 4).

The radiometric boundaries of the Artinskian *s.s.*/Yakhtashian are situated between −283 and −275 Ma (Ross and others, 1994), or −274 and −266 Ma (Ross and Ross, 1995a). The age of the succeeding Kungurian/Bolorian is between −275 and −273 Ma or −270 and −258 ± 12 Ma, respectively (Fig. 3).

A compilation of the works of Leven (1981a, 1992, 1993a), Sheng (1992), Ross and Ross (1994, 1995b), Leven and Okay (1996) and Davydov and others (1996), reveals 28 main fusulinid genera for the Tethyan Yakhtashian stage: *Acervoschwagerina, Biwaella, Boultonia, Chalaroschwagerina, Chusenella* (?), *Darvasella, Darvasites, Eoparafusulina, Laxifusulina, Mesoschubertella, Minojapanella, Monodiexodina, Nagatoella, Nankinella, Neofusulinella, Ozawainella* (?), *Pamirina,* ''*Parafusulina*'' (*sensu lato,* probably *Paraskinnerella* Bensh), *Praeskinnerella,* ''*Pseudofusulina*'' (*sensu lato*), the last *Pseudofusulinoides, Quasifusulina, Robustoschwagerina, Rugosochusenella, Russiella, Schubertella, Toriyamaia, Wutuella.* Provincialism of Yakhtashian fusulinids is poorly understood; therefore, accurate biostratigraphy of this stage is still questionable. The *Eoparafusulina staffella* zone, the *Darvasites ordinatus* zone, the ''*Schwagenina*'' (now *Praeskinnerella*) *cushmani* zone, the *Staffella moellerana* zone and the *Pamirina nagatoella* (*Nagatoella*) zone of China (Tang and Wang, 1989), are probably all part of the Yakhtashian. Figure 5, indicates the possible correlations into the Yakhtashian stage around the world.

Whereas *Robustoschwagerina schellwieni* is considered as a marker of the Sakmarian (Leven, 1992), *Chalaroschwagerina* (?) ex gr. *C. vulgaris* is clearly recognized as the Artinskian *s.s.*/Yakhtashian index fossil in numerous fusulinid zonations (Kochansky-Devidé, 1964; Toriyama, 1967 and 1984; Leven, 1981a, 1981b, 1992, 1993a, 1993b and 1997; Bensh, 1982; Kotlyar and others, 1987 and 1991; Ishii, 1990; Ozawa and others, 1990, 1991 and 1992; Ota and Ota, 1993; Ross and Ross, 1995a; Davydov, 1996; Davydov and others, 1996; Ueno, 1996a and 1996b; Jin, 1996; Jin and others, 1994 and 1997; Izart and others, 1998; Krainer and Davydov, 1998) (Fig. 5A–C). Particularly interesting are the correlations with the Japanese assemblages, as *Robustoschwagerina schellwieni* and *Chalaroschwagerina* (?) *vulgaris* were primarily identified in the classic Paleozoic Akasaka Limestone of Japan (see review in Toriyama, 1967).

It should be noted that in his compilation of the Permian stratigraphy, Waterhouse (1976) confused two ''*Pseudofusulina*'' *vulgaris*: *Sphaeroschwagerina vulgaris* (Shcherbovich) from the early Asselian and *Chalaroschwagerina* (?) *vulgaris* (Schellwien) from the Yakhtashian. This mistake is probably frequent among the non-specialists of fusulinids.

Generally in the standard-scales, the biozone of *Chalaroschwagerina* (?) *vulgaris* directly overlies the Sakmarian *Robustoschwagerina schellwieni* zone, but sometimes the zones are separated by an earliest Yakhtashian subzone that is variously called (Fig. 5A–C): *Chalaroschwagerina solita* zone (Leven, 1981a; Toriyama, 1984; Kotlyar and others, 1987; Davydov and others, 1996: sic *solida*); *Chalaroschwagerina inflata-Chalaroschwagerina exilis* zone (Ueno, 1996a and b); *Chalaroschwagerina solita-Pseudofusulina kraffti* zone (Ross and Ross, 1995a); *Chalaroschwagerina solita-Pamirina pulchra* zone (Leven, 1997); *Chalaroschwagerina solita* and *Pamirina chinlingensis* (synonym of *P. darvasica* Leven according to Ueno, 1991a) zone (Kriner and Davydov, 1998). Our *Robustoschwagerina* cf. *R. schellwieni-Chalaroschwagerina* (?) *globosa* assemblage can be assigned to the *Chalaroschwagerina solita* zone of Leven.

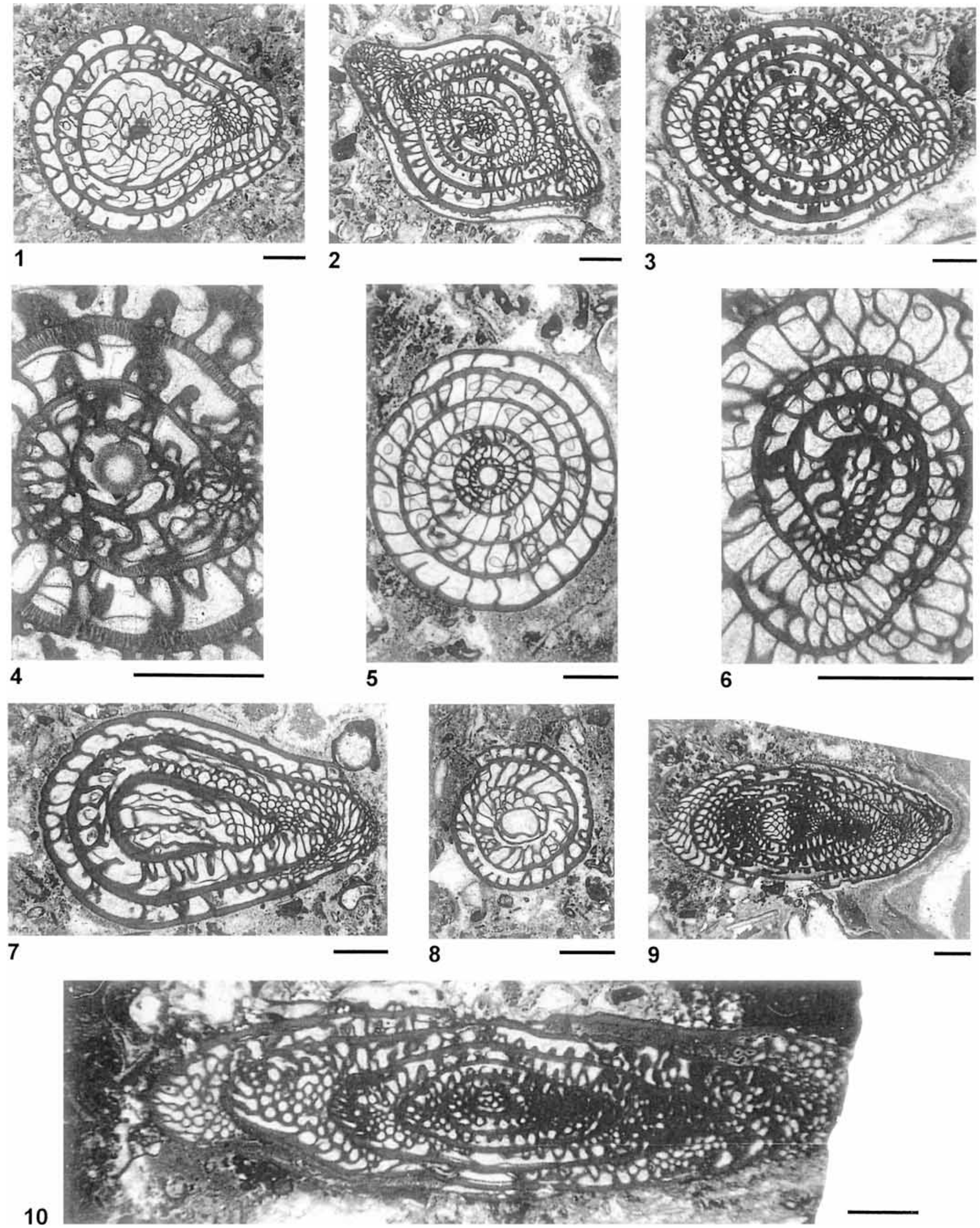
ARTINSKIAN FUSULINIDS IN THE WESTERN TETHYS

Comparisons between the Sicilian fusulinid assemblage and others from the Western Tethys reveal the uniqueness of the Lercara Permian association. In the Carnic Alps, the best known Permian area in Europe, the Artinskian is represented by the upper part of the Trogkofel Group, with the Tressdorf Limestone, Goggau Limestone and Tarviser Breccia (Kahler, 1980; Krainer, 1993; Kahler and Krainer, 1993; Forke, 1995; Flügel and others, 1997; Izart and others, 1998; Krainer and Davydov, 1998) (Fig. 5B–C). The lower part

→

PLATE 2.
Schwagerinoidea

1–8 *Chalaroschwagerina* (?) *globosa* (Schellwien). 1 Oblique section with phrenothecae and insulae, slide Si133/2D; 2 Subaxial section showing septal folding and inconspicuous tunnel slide Si135B2; 3 Axial section with convex or slightly concave lateral slopes and uniform increase of volutions, slide Si133/2C; 4 Detail of Fig. 3 with proloculus, internal volutions and phrenothecae, slide Si133/2C; 5 Transverse section with numerous loops of the phrenothecae, slide Si133/2C; 6 Detail of an oblique section showing other aspects of insulae and phrenothecae, slide Si133/2B; 7 Oblique section showing the important septal folding, the insulae (left) and the phrenothecae, slide Si135B2; 8 Immature transverse section showing an irregular proloculus, slide Si133/2A; 9 *Verneuilites* (?) sp.; axial oblique section, slide Si113E/1A; 10 *Genus* indeterminate, subaxial section showing the septal folding, the tunnel, and phrenothecae, slide Si135A. Scale bar is 1000 μm.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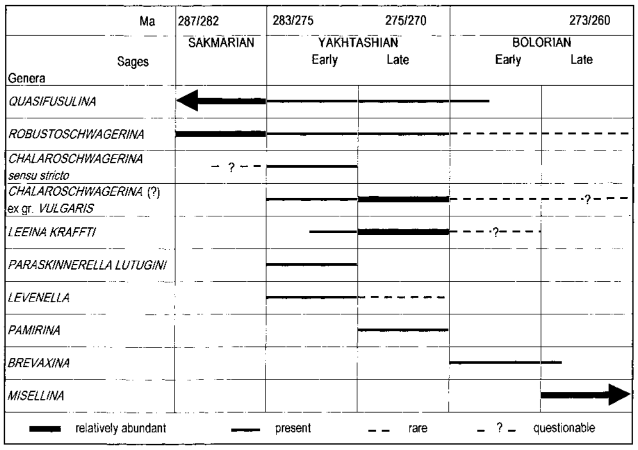

FIGURE 3. Biostratigraphic range of the main fusulinid genera of the late early Permian (explanations in text).

SYNONYMS: ex - USSR				CHINA	USA		Main fusulinid markers	Europe (this study)
ARTINSKIAN *sensu lato*	LATE ARTINSKIAN	KUNGURIAN	BOLORIAN	CHIHSIAN	LEONARDIAN	CATHEDRALIAN	*Misellina* - *Cuniculinella*	Well Amanda 1bis / Tarviser Breccia
							Brevaxina - *Praeskinnerella*	Not identified
	EARLY ARTINSKIAN	ARTINSKIAN *sensu stricto*	YAKHTASHIAN			HESSIAN	*Chalaroschwagerina* (?) ex gr. *vulgaris* - *Pamirina* - *Robustoschwagerina*	Goggau Limestone
							Chalaroschwagerina - *Levenella* - *Robustoschwagerina*	Tressdorf Limestone / Lercara Formation

FIGURE 4. Simplified nomenclature of the Artinskian stage (mainly according to Ross and Ross 1994, 1995 a–b).

of the Group, with the Trogkofel Limestone, belongs to the Sakmarian. The Tressdorf and Goggau Limestones correspond to the early Artinskian and respectively to the Burchevsky and the Irginsky of Russia; the Tarviser Breccia is coeval with the late early Artinskian (Sarginsky and Saraninsky) or with the *Misellina* zone (Kahler, 1980) (Fig. 5A–B).

Forke (1995) indicated two important data for the biostratigraphy of the Carnic Alps: (a) *Quasifusulina* and *Robustoschwagerina* disappear at the top of the Trogkofel Limestone; (b) the overlying Goggau Limestone is characterized by *Chalaroschwagerina* (?) *vulgaris* and *Pamirina.* Consequently, the assemblage of the Lercara Formation, with *Quasifusulina, Robustoschwagerina* and *Chalaroschwagerina* (?), but without *Pamirina,* can correspond to an intermediary level between the Trogkofel and the Goggau Formations [i.e., the Tressdorf Limestone, with an ultimate survival in Europe of *Quasifusulina* and *Robustoschwagerina* and a precocious appearance of *Chalaroschwagerina* (?)]. We propose an early Yakhtashian (= earliest Artinskian) age for the Lercara samples and a correlation with the Tressdorf Limestone (Fig. 4), although the contained fusulinids are slightly different. In particular, the marker of the Tressdorf Limestone, *Paraskinnerella lutugini* (Schellwien), frequently mentioned from Austrian and Italian localities (Kahler, 1992; Pasini, 1991, 1994; Pasini and Vai, 1997), is absent in the Lercara Formation.

The Goggau Limestone, which yields various algae and foraminifers (Flügel, 1986a and b), is clearly younger than the Lercara Formation, because of the presence of *Nagatoella* aff. *N. orientis* (Ozawa), *Darvasites* cf. *D. fornicatus* Kanmera and *Pamirina darvasica* Leven.

In other European areas, the accurate Artinskian biostratigraphy is poorly known. In southern Karawanken and Julian Alps (Italy, Austria and northern Slovenia), the marine Permian carbonates seem to be better preserved from erosion because of the intra-Permian Saalian tectonic phase (Argyriadis, 1978); however, very few Artinskian fusulinids are mentioned in the equivalents of the Trogkofel Limestone. In Slovenia, Kochansky-Devidé (1973), Kochansky-Devidé and Ramovs (1978), and Ramovs (1986), mentioned a few black carbonate lenses with ‘‘*Pseudofusulina*’’ aff. *P. rakoveci* and *Darvasites* ex gr. *contractus.* Other *Darvasites,* which may be indicative of Yakhtashian deposits, are summarized in several ex-Yugoslavian localities (Kochansky-Devidé, 1975).

Representatives of the group *Chalaroschwagerina* (?) *vulgaris* were found, with the species *C.* (?) *vulgaris, C.* (?) *globosa* and *C.* (?) *rugosa,* in the Goggau Limestone (Kahler, 1980 and 1992), and in Montenegro, near the Tara river (Kochansky-Devidé and Milanovic, 1962; Kochansky-Devidé, 1964), where the fusulinid assemblage was dated as Yakhtashian or Bolorian by Leven (1993a). The genera *Chalaroschwagerina* and *Cuniculinella* are also known in Kalymnos and Kos Islands, Greece (Kahler, 1987).

The Greek form identified as *Chalaroschwagerina* (?) *vulgaris* in Hydra (Römermann, 1968; Kahler, 1988; Baud and others, 1991; Grant and others, 1991), is rather *C.* (?) *globosa,* and the misinterpreted *Triticites* aff. *T. montiparus* (Baud and others, 1991), also from Hydra, probably belongs to *C.* (?) *vulgaris sokolovi* (Miklukho-Maclay, 1949). According to Argyriadis (1978), the other early Yakhtashian marker, *Leeina kraffti,* is also present in Hydra.

The Verbeekinoid genera or subgenera, *Pamirina, Levenella, Brevaxina* or *Misellina,* are rare in the Western Tethys, especially the species *Pamirina darvasica* Leven with only four citations, respectively, in the Goggau Limestone from the Carnic Alps and in the reworked pebbles of the Triassic Monte Facito Formation (Lagonegro Basin, southern Italy) (Kahler, 1980; Kahler and Kahler, 1980; Kahler, 1992; Pasini and Vai, 1997). *Brevaxina,* the index genus for the early Bolorian, has never been identified in Europe.

The late Bolorian-early Kubergandian genus *Misellina* has been formerly reported in eastern Turkey (Ishii and others, 1985), but no recent publication about Turkish fusulinids (Leven, 1995 and 1998, and Leven and Okay, 1996) confirms this fact. *Misellina* has also been recorded from Albania (Kahler and Kahler, 1968; Lys, 1986), and in the Amanda 1 bis-well of the Adriatic Sea (Sartorio and Rossa, 1991), but the unique illustration of *Misellina claudiae* (Deprat) from this locality looks more like *M. postclaudiae* Ueno (1991b) or the subgenus *Cancellina* (Maklaya); both taxa belong to the Kubergandian and not to the Bolorian. Without palaeontological evidence, the Tarviser Breccia is attributed to the *Misellina* zone by Kahler (1980 and 1985) and Flügel (1986b). The clasts of this breccia contain numerous algae and pseudo-algae (according to Flügel 1986b),

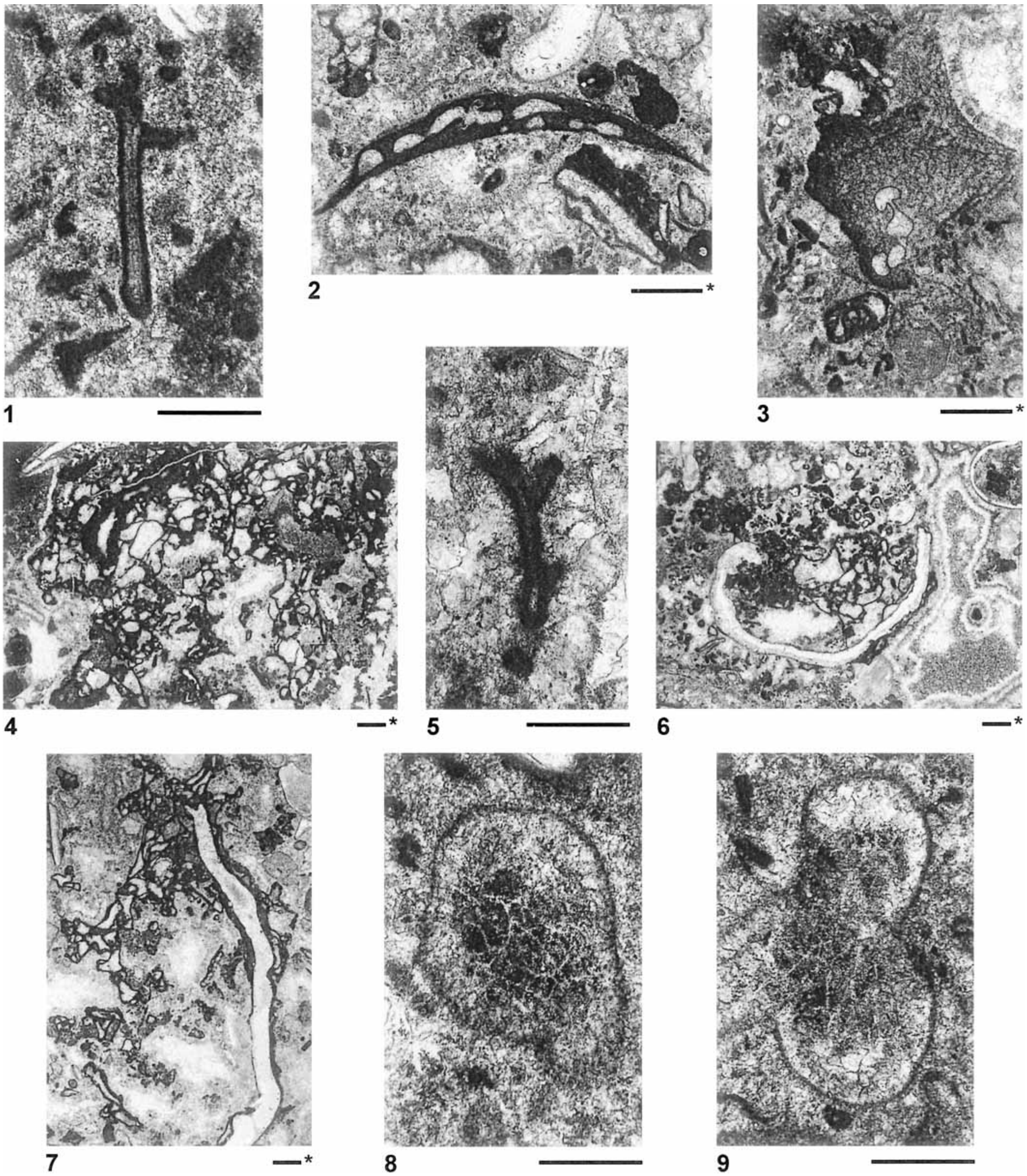

PLATE 3.
Associated cyanobacteri and algae

1, 5 *Koivaella permica* Chuvashov, 1974. 1 Bifurcated filament, slide Si133/2A; 5 Specimen with two bifurcations, slide Si133/1. 2, 3 *Tubiphytes obscurus* Maslov, 1956. 2 A narrow specimen with numerous cavities, slide Si135B2; 3 A more typical specimen, but with cavities evoking a Nubeculariid foraminifer, and with a rather differentiated ''wall'' slide Si133/2. 4, 6, 7 *Bacinella* sp. indet. 4 Typical aspect, slide Si133E/1A; 6 In a microfacies showing a cavity filled by a red micritic internal sediment (right, below), slide Si133B/1; 7 Encrusting a phylloid alga primarily covered by *Archaeolithoporella hidensis* Endo, a problematic alga, slide Si133A/A. 8, 9 *Archaeolithophyllum missouriense* Johnson, 1956. 8 Transverse section with hypothallus and perithallus, slide Si133/2A; 9 Similar subtransverse section, slide Si133/2A.
Asterisked scale bar is 1000 microns; other scale bar is 500 microns.

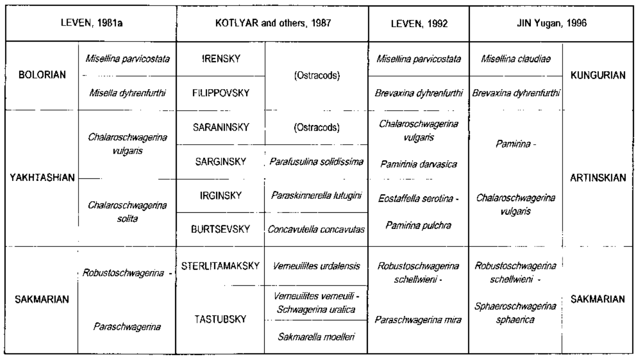

FIGURE 5A, B, C. Ages and biostratigraphic correlations of the late early Permian (Sakmarian—Yakhtashian—Bolorian): (A) Correlation of the principal chrono- and biostrigraphical scales; (B) Correlations of various international scales (Japan, Carnic Alps and USA); (C) Correlation of several fusulinid scales.

but no fusulinid. Questionable Murgabian *Misellina* have also been mentioned in Yugoslavia (southern Crna Gora) by Kochansky-Devidé (1975).

CONCLUSIONS

In conclusion, the new biostratigraphic data concerning the lower Permian of Sicily resemble more strongly ?? reports from Japan (Fig. 5B–C), rather than from the European Western Tethys.

1) Lower Permian shallow-water carbonate microfauna and microflora (15 species of smaller foraminifers, 8 species of fusulinids, and 7 species of cyanobacteria and algae), never found in Sicily, are reworked into the Triassic Lercara Formation.
2) Assemblages indicate an early Yakhtatshian (i.e., earliest Artinskian) age.
3) The association of *Robustoschwagerina schellwieni* and *Chalaroschwagerina* (?) *globosa*, reported for the first time in Sicily, is unique in Europe. Isolated representatives of *Robustoschwagerina* are known from northern Italy (Forni Avoltri, Carnic Alps) and Greece (Attica and Kalymnos); *Chalaroschwagerina* (?) of the group *C. vulgaris* has been reported in the Carnic Alps and in Croatia

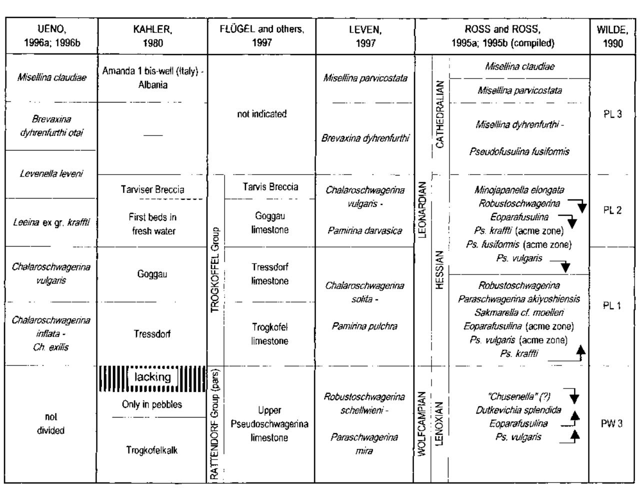

FIGURE 5A, B, C. Continued

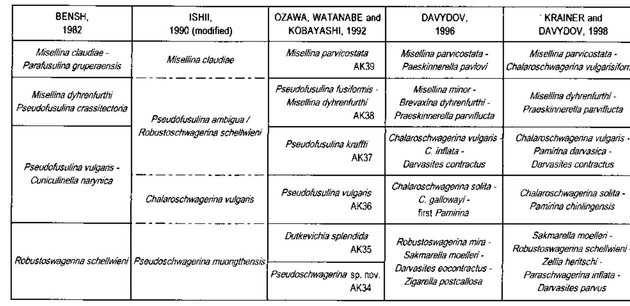

FIGURE 5A, B, C. Contined

(see Appendix 1); however, both species are not directly associated.
4) The fusulinid assemblage is typically Paleotethyan, not Neotethyan, and exhibits more affinities with microfaunas from Darvaz (north Pamir) and Japan, rather than from the Western Tethys. This situation establishes the paleogeographical link of Sicily with Central and Eastern Asia, and confirms the uniformity of the Tethyan Province and the free-dispersal of the fusulinids along the carbonate platforms of the Tethyan ocean.
5) The Permian fossiliferous shallow water boulders are clearly reworked into the deep water Triassic Lercara Formation.
6) Two olistostromes probably exist in the Sosio valley. The first one is possibly of Cathedralian (late early Permian) age, as postulated by Kozur and others (1996), the second one of Triassic age.

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APPENDIX I

Superfamily FUSULINACEA nomen translat. Pasini, 1965;
ex family
Family FUSULINIDAE von Moeller, 1878
emend. Rauser-Chernousova and others, 1996
Subfamily QUASIFUSULININAE Putrya, 1956
Genus *Quasifusulina* Chen, 1934

Type species. Fusulina longissima von Moeller, 1878.

Remarks. Quasifusulina is known throughout the Western and Eastern Tethys and has also been reported from Spitsbergen and British Columbia (compilation in Vachard, 1990). It ranges from the early Kasimovian to the late Yakhtashian, where it is associated with *Pamirina* (Kahler and Kahler, 1980; Leven and others, 1983; Sheng, 1992). The phylogenetic relationship between *Fusulina* (*sensu stricto*), *Quasifusulinoides* and *Quasifusulina* at the Moscovian-Kasimovian boundary is based on the Russian platform material (summarized in Davydov, 1988). More precise data on the uppermost occurrence of *Quasifusulina* was given by Leven and others (1983) in the Bolorian stratotype, Southeast Pamir, where *Quasifusulina* ex gr. *nimia* occurs in bed 16 of the Chelamchin Suite, some meters above the appearance of *Brevaxina dyhrenfurthi* in bed 12. Therefore the latest occurrence of *Quasifusulina* belongs to the earliest Bolorian. The definition of the genus is well established (Loeblich and Tappan, 1988). Rarely, cuniculi (Kahler, 1988) and a peculiar aspect of the wall called the ''prokeriotheca'' (Yang and Zhang, 1993), have been described.

Quasifusulina ultima Kanmera, 1958
Plate 1, Figs. 6–7

Quasifusulina longissima ultima Kanmera, 1958, p. 158–160, pl. 24, figs. 1–8; Nogami, 1961, p. 162–163, pl. 1, figs. 1–3; Kochansky-Devidé, 1966, p. 308–309, pl. 2, figs. 1–4, pl. 3, fig. 2, pl. 11, fig. 1; Kahler and Kahler, 1966, p. 397 (not illustrated).
Quasifusulina ultima Kahler, 1983, p. 55–56, pl. 4, fig. 2 (with synonymy); Chen and Wang, 1983, p. 43–44, pl. 3, fig. 11; Kahler, 1985, p. 45, pl. 2, fig. 3; Liu and Zhang, 1992, pl. 4, fig. 11; Kahler, 1992, p. 316 (not illustrated).
Quasifusulina longissima (pars) Kochansky-Devidé, 1959, p. 18–19, pl. 2, figs. 5–6.
Quasifusulina nimia (pars) Kahler, 1973, p. 169–170, pl. 3, fig. 15.

Description. With the heavy but incomplete axial filling, the irregular proloculus and by the dimensions, our material corresponds exactly to *Q. ultima.* Dimensions: width 12.40 mm (diagnosis: 9.50–12.20 mm), diameter 2.80 mm (diagnosis: 1.90–2.50 mm), width/diameter 4.4 (diagnosis: 4.5–5.0) for 7.5 whorls (diagnosis: 6–6.5), proloculus 0.30–0.60 mm (diagnosis: 0.23–0.52 mm).

Material. One axial section in Si133/2D (Pl. 1, Fig. 7); two subtransverse sections in Si133E/2B (Pl. 1, Fig. 6).

Occurrence. Carnic Alps, Karawanken, Japan and South China; first mention in the Yakhtashian of Sicily.

Superfamily SCHWAGERINACEA nomen translat. Solovieva *in* Rauser-Chernousova and others, 1996; ex family
Family SCHWAGERINIDAE Dunbar and Henbest, 1930
Subfamily PSEUDOSCHWAGERININAE Chang, 1963
Genus *Robustoschwagerina* Miklukho-Maclay, 1956

Type species. Pseudoschwagerina tumida Likharev, 1939.

Diagnosis. (slightly modified from Igo, 1964). Shell large, about 7.00 to 12.00 mm in diameter, spherical to subspherical with umbilicate poles and straight axis of coiling. Shell consisting of six to eight volutions; one to four inner volutions are *Triticites*-like (cf. *T. ventricosus* or *T. plummerr*), fusiform or inflated fusiform with acutely pointed poles, and prominent chomata. The middle two or three volutions rapidly increase in height; outer one or two volutions slightly declining in height. Adult stage with very faint chomata and widely spaced septa.

Remarks. The definition of *Robustoschwagerina* remained unchanged from Thompson in Loeblich and Tappan (1964), and Loeblich and Tappan (1988), but Sheng and others (1984) and Yang and Hao (1991) divided the genus *Robustoschwagerina* into *Robustoschwagerinoides, Robustoschwagerina* and *Longlinia,* based on the increasing size of the juvenarium (see discussion in Vachard and others, 1993). In our opinion, the subdivisions of *Pseudoschwagerina* and *Robustoschwagerina* based on the development of the juvenaria do not appear to be very useful. Nevertheless, the characteristics of the juvenarium remain important criteria for understanding the differences between all the genera exhibiting a short fusiform juvenarium, followed by a spherical or inflated fusiform adult stage (i.e. *Sphaeroschwagerina* Miklukho-Maclay, 1959 emend. Davydov, 1984; *Pseudoschwagerina* Dunbar and Skinner, 1936; *Robustoschwagerina* Miklukho-Maclay, 1959; *Alpinoschwagerina* Bensh, 1972; *Rugososchwagerina* Miklukho-Maclay, 1959; *Paraschwagerina* Dunbar and Skinner, 1936; *Occidentoschwagerina* Miklukho-Maclay, 1959; *Carbonoschwagerina* Ozawa and others, 1992) (summarized Fig. 6).

Pseudoschwagerina and *Robustoschwagerina* exhibit a *Triticites*-like juvenarium; contrary to *Rugososchwagerina* identified by a *Chusenella*-like juvenarium (Skinner and Wilde, 1966; Rozovskaya, 1975). Davydov (1984) indicated that *Sphaeroschwagerina* displays a juvenarium that is more or less *Biwaella*-like. *Alpinoschwagerina,* which is more difficult to characterize, seems to possess a *Triticites*-like juvenarium, like *Pseudoschwagerina,* and only differs from this genus by a spherical adult stage. *Carbonoschwagerina,* which is very similar to *Pseudoschwagerina,* appears to have a different phylogenetic origin, evolving directly from *Montiparus* (Ozawa and others, 1992).

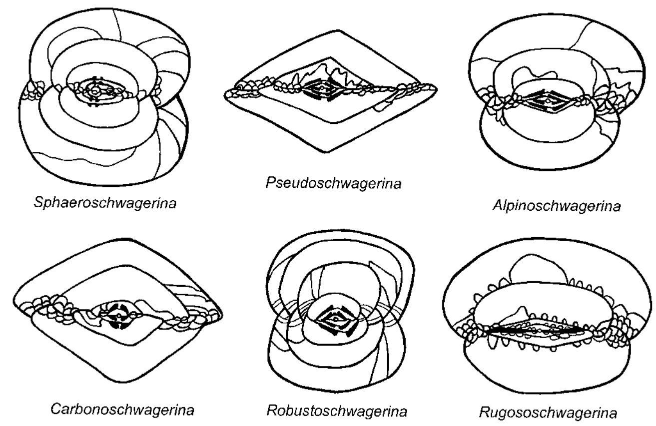

FIGURE 6. Comparative schemes of various Schwagerinoidea with different juvenaria and adult volutions (approximate scale).

Occurrence. Late Sakmarian (Sterlitamakian) to early Artinskian (Yakhtashian) of: (a) the Western Tethys: Carnic Alps (Austria: Troghöhe 2004, Langbühl; Italy: Forni Avoltri), Greece (Attica, Kalymnos island), Slovenia (Karawanken), Croatia; (b) Central Tethys: Turkey, North Pamir (Darvaz), Central Pamir (West Pshart), Tian Shan (Fergana), North Afghanistan; (c) Eastern Tethys: Tibet/Xinjiang, North China (Kelpin), South China (until the Bolorian according to Sheng, 1992), North Viet-Nam, Thailand, Sumatra, Japan; (d) Grandian Province: very rare in only one locality of Texas (Wilde, 1995). First mention in the late Sakmarian (Sterlitamakian) to early Artinskian (Yakhtashian) of Sicily.

Robustoschwagerina cf. *R. schellwieni* (Hanzawa, 1939)
Plate 1, Figs. 8–11

Pseudoschwagerina schellwieni Hanzawa, 1939, p. 71–72, pl. 4, figs. 1–3; Kahler and Kahler, 1941, p. 82, 94–95, pl. 11, figs. 3–4; Hanzawa, 1961, pl. 35, fig. 1; Chang, 1963, pl. 8, fig. 4, pl. 9, fig. 11; Choi, 1973, p. 42–43, pl. 11, fig. 1–3, pl. 12, fig. 9.
Pseudoschwagerina (*Robustoschwagerina*) *schellwieni* Hanzawa. Igo, 1964, p. 287–290, pl. 46, fig. 1–2; Kanmera and Mikami, 1965, p. 284–285, pl. 46, fig. 2–5; Toriyama, 1967, p. 86 (not illustrated).
Robustoschwagerina schellwieni (Hanzawa). Kahler and Kahler, 1966, p. 770–771 (with synonymy); Kochansky-Devidé, 1970, p. 206–207, 236, pl. 14, fig. 1, pl. 16, fig. 1–5; Rozovskaya, 1975, p. 165; Leven and Shcherbovich, 1980, pl. 17, fig. 1–2; Kahler, 1983, p. 98–100, pl. 11, fig. 4 (with synonymy); Li and Zhang, 1983, pl. 3, fig. 14; Sheng and others, 1984, p. 527–528, pl. 3, fig. 1–2; Zhang, 1984, p. 451 (not illustrated); Sun and Zhang, 1985, p. 57–58, pl. 3, fig. 7–8; Wei and others, 1987, pl. 2, fig. 12; Zhou and others, 1987, pl. 4, fig. 21; Ding and others, 1989, pl. 1, fig. 6; Ozawa and others, 1990, pl. 8, fig. 1–2; Yang and Hao, 1991, pl. 4, fig. 1.
Pseudoschwagerina cf. *P. meranginensis* Thompson. Tien, 1989, pl. 14, fig. 7.

Description. R. schellwieni is characterized by a large size, very weak umbilici and a small number of adult whorls (three and a half). Width 9.50–10.00 mm, diameter 8.50–10.20 mm, width/diameter 1.0–1.2 for 6 volutions (with 2.5 for the juvenile stage and 3.5 for the adult stage). Proloculus diameter 0.40 mm, and 23–25 septa at the last whorl. The triticitid juvenarium shows strong chomata and measures: width 1.10–1.70 mm, diameter 1.10–1.50 mm, width/diameter 1.00–2.30. Its shape is generally elongate-fusiform, but seems more rhombic in one of our specimens (Pl. 1, Figs. 8–9). The juvenarium of *R. schellwieni* presents numerous variations according to the literature (e.g., compare the two illustrations of Chang, 1963); one of our specimens shows an atypical juvenarium similar to *Triticites* of the group *T. plummeri,* but this character seems insufficient for creating a new species.

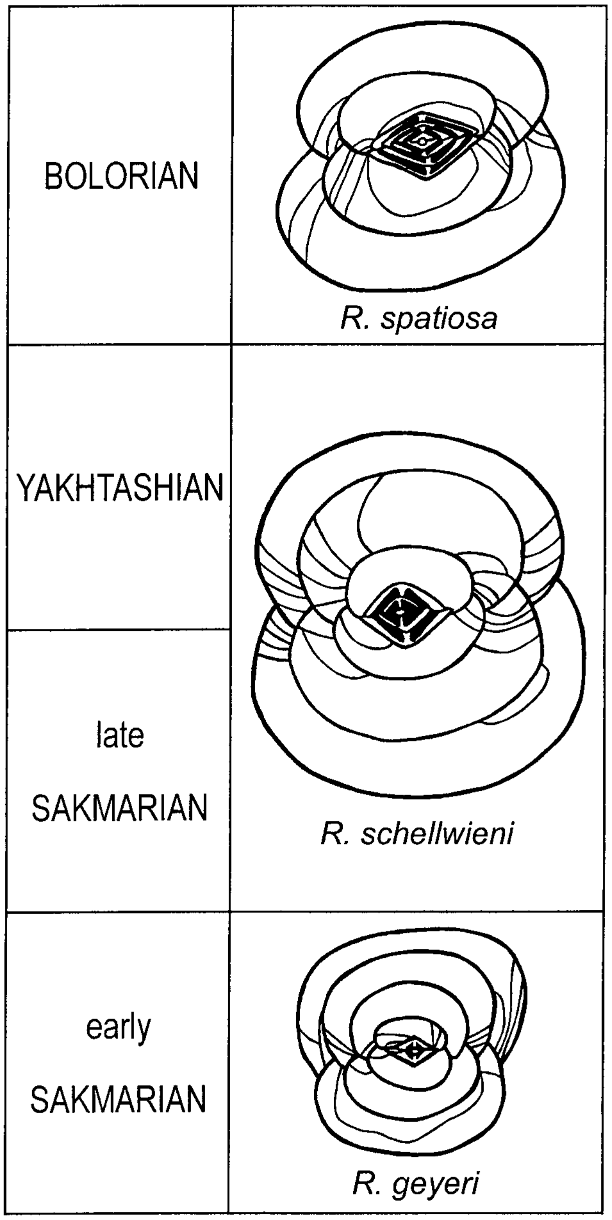

FIGURE 7. Comparative schemes and hypothetical phylogeny of different *Robustoschwagerina* (approximate scale).

Material. 7 specimens.

Comparisons. The closest species to *R. schellwieni* is the type-species *R. tumida* (Likharev), smaller (width until 8.00 mm) and more deeply biumbilicated. *Robustoschwagerina meranginensis* (Thompson), from Sumatra, diversely interpreted (Tien, 1989; Vachard and others, 1993), is probably the smallest form of the group of *R. tumida schellwieni.* The Chinese species ''*Longlinia*'' *spatiosa* (Lin *in* Lin and others, 1977) differs only by the 6 whorls juvenarium, the ''generic'' characteristic of *Longlinia. R. schellwieni* is probably the link between the primitive *Robustoschwagerina geyeri* (Kahler and Kahler, 1941 non 1938), which is early Sakmarian in age according to Forke (1995), and the advanced *R. spatiosa,* a Bolorian species, while associated with Misellinids (Sheng and others, 1984) (Fig. 7).

Occurrence. Sakmarian-Yakhtashian of Japan (Kitakami, Manganzi, Akasaka, Akiyoshi), North Italy (Forni Avoltri), Austria and Slovenia (Trogkofelkalk). Late Sakmarian of Darvaz. Early Permian of Sumatra, China: North China (Kelpin basin), Xinjiang (Altun Mountains), Shaanxi (East Qinling Range), South China (Guizhou, Yunnan). First mention in the Yakhtashian of Sicily.

	DAIXINA	*BOSBYTAUELLA = ULTRADAIXINA*	*OCCIDENTO-SCHWAGERINA*	*CHALARO-SCHWAGERINA*	*CHALARO-SCHWAGERINA (?)*	*CUNICULINELLA*	*TAIYUANELLA*	*SCHWAGERINA (= GLOBIFUSULINA)*
Cuniculi	No	No	No	No	No	Yes	No	No
Shape	Inflated fusiform	Inflated fusiform	Elongate fusiform	Fusiform to inflated fusiform	Rhomboidal to globose	Rhomboidal	Rhomboidal	Rhomboidal
Juvenarium	No	No	Yes	No	No	No	No	No
Chomata (adult shell)	No	No	No	No	No	No	No	No
Septa folds	Very high	Very high and irregular	Irregular	Very high and irregular	High and regular	High and irregular	High and regular	Very high and irregular
Axial filling	No	No	Absent to weak	No	No	Absent to weak	No	No
Septa folds thinner as wall	Yes	Yes	Yes	Yes	Yes	Yes	Yes and Stalatotheca	No
Tunnel	No	No	Yes ?	No ?	Badly conspicuous	Badly conspicuous	Yes	Yes
Poles	Buntly pointed	Buntly pointed and protruding	Buntly pointed	Buntly or acute	Buntly pointed	Buntly pointed	Buntly pointed	Buntly pointed
Lateral slopes	Convex	Concave	Weakly incurved	Concave	Convex to concave	Convex to concave	Convex to pointed	Convex to concave
Volutions	4 - 7 (4,5 - 6)	4 - 5,5	5,5 - 7,5	4 - 7 (5,5 - 6)	4 - 8 (5 - 6)	4 - 8 (5,5 - 6,5)	4 - 7,5	4 - 8 (5,5 - 6,5)

FIGURE 8. Characteristics of the genus *Chalaroschwagerina* compared with other genera of Schwagerinoidea. Main volution frequencies underlined.

Subfamily SCHWAGERININAE Dunbar and Henbest, 1930
nomen translat. Yabe and Hanzawa, 1932; ex family
Genus *Chalaroschwagerina* Skinner and Wilde, 1965

Type species. Chalaroschwagerina inflata Skinner and Wilde, 1965.

Remarks. Chalaroschwagerina is a genus with various phylogenetic trends, and various groups of species: (1) the typical *C. inflata* group, (2) the *C. globularis* group which looks like *Bosbytauella*/*Ultradaixina*; (3) the *C. eximia* group rather similar to *Paraschwagerina,* and (4) *C.* (?) *vulgaris* group convergent with *Globifusulina*/*Schwagerina sensu stricto,* and initially not assigned to *Chalaroschwagerina* Skinner and Wilde, 1965.

We are especially interested here with the group *C.* (?) *vulgaris.* Many subspecies of *C.* (?) *vulgaris* and very similar species exist in the literature (Schellwien *in* Schellwien and Dyhrenfurth, 1908; Ozawa, 1923; Lee, 1927; Huzimoto, 1936; Miklukho-Maclay, 1949; Morikawa, 1955; Chen, 1956; Toriyama, 1958; Kanuma, 1958; Kochansky-Devidé and Milanovic, 1962; Skinner and Wilde, 1965; Kochansky-Devidé, 1970; Choi, 1973; Shcherbovich *in* Akopian, 1974; Sheng and Sun, 1975; Lin *in* Lin and others, 1977; Zhou, 1982; Leven, 1995, 1997).

The *C.* (?) *vulgaris* group is characterized by a shell moderate in size, inflated fusiform to spherical, generally rhomboidal, with convex to concave lateral slopes, and more or less prominent bluntly pointed poles. The shell retains almost the same axial profile throughout the coiling, and the height of each volution is rather uniform. Mature specimens have 3 or 4 to 8 volutions with a diameter of 4.00 to 11.00 mm and a width of 2.00 to 6.00 mm, width/diameter 1.0 to 2.4. Spirotheca composed of tectum and fine to coarse keriotheca (never a stalactotheca). Septa rather thin, strongly and highly folded from pole to pole. Septal folds narrow, extending generally to the top of the chambers. Proloculus moderate in size (0.20–0.54 mm), generally spherical or rarely irregular in shape. Phrenothecae are well developed, especially in the central or outer parts; numerous loops of the phrenothecae are obvious in transverse section. Tunnel narrow, low and irregular, or absent. Chomata and axial filling weakly developed.

Comparisons. True *Chalaroschwagerina* has an irregularly shaped test, a stronger septal folding, and less developed phrenothecae (Fig. 8).

Schwagerina sensu stricto (=*Globifusulina* of the authors; see Loeblich and Tappan, 1988) differs from *Chalaroschwagerina* ex gr. *vulgaris* by a large tunnel and the absence of phrenothecae.

Cuniculinella differs only by the presence of cuniculi. Kanmera and others (1976) who seem to attribute *Chalaroschwagerina vulgaris* to *Cuniculinella,* stated (p. 146): ''the *Parafusulina*-stage with cuniculi as in *Cuniculinella* (=species-group of *Pseudofusulina vulgaris*)''.

Taiyuanella Zhuang, 1989, has an inflated fusiform morphology, similar to *Chalaroschwagerina,* but differs by its stalactothecal wall. Although rarely used by the fusulinacean specialists, this character seems to be very important, for example to distinguish the *Pseudochusenella* Bensh of the early Permian, without stalactotheca, and the true *Chusenella* Hsu, from the late Permian, which exhibits a stalactothecal wall. Phrenothecae are absent in *Taiyuanella subsphaerica*

Zhuang, 1989, the type species, but exist in *Chalaroschwagerina tumentis* Skinner and Wilde, 1965, which was assigned by Zhuang to the genus *Taiyuanella.*

Occurrence. Chalaroschwagerina (?) *vulgaris* and *C.* (?) *globosa,* are both present in various Japanese localities (Toriyama, 1967). *Chalaroschwagerina sensu lato* is a Yakhtashian to Bolorian western to eastern Tethyan genus; it has been recorded in the Carnic Alps, ex-Yugoslavia, Sicily, Hydra, Turkey, Armenia, Kazakhstan, Iran ?, Pamir, Fergana, Afghanistan, Thailand, Viet-Nam, China (Xinjiang, Qinghai), Japan, but the genus *Chalaroschwagerina* is also present in California and Nevada, with *C.* (?) *corpulenta* (Skinner and Wilde) and *C.* (?) *rotunda* (Skinner and Wilde), since the late Wolfcampian (zones F and G of Mccloud Limestone; Skinner and Wilde, 1965).

Chalaroschwagerina (?) *globosa* (Schellwien, 1908)
Plate 2, Figs. 1–8

Fusulina vulgaris var. *globosa* Schellwien *in* Schellwien and Dyhrenfurth, 1908, p. 164–165, pl. 14, figs. 3–7.
Schellwienia vulgaris var. *globosa* (Schellwien). Ozawa, 1925, p. 24–25, pl. 7, figs. 1–2; [not] Lee, 1927, p. 67, pl. 9, fig. 12 [=''*Likharevites*'' ex gr. *ingloria* (Bensh)].
Pseudofusulina vulgaris var. *globosa* (Schellwien). Huzimoto, 1936, p. 77–78, pl. 12, figs. 1–7, pl. 14, figs. 1–2; Toriyama, 1958, p. 168–170, pl. 21, figs. 16–18, pl. 22, figs. 1–7; Chang, 1963, p. 216–217, pl. 9, fig. 4; Kahler and Kahler, 1966, p. 631 (not illustrated; with synonymy); Ota and Ota, 1993, pl. 3, fig. 7.
[?] *Schwagerina vulgaris* var. *globosa* (Schellwien). Bensh, 1987, p. 32 (not illustrated); Ross, 1965, p. 81, pl. 12, figs. 12–14 (rather *Schwagerina sensu stricto* or *Paraschwagerina*).
Pseudofusulina vulgaris globosa (Schellwien). Kanmera and Mikami, 1965, p. 297–298, pl. 51, figs. 4–9; Toriyama, 1967, p. 89, 96, 98, 100, 104, 109, 110?, 115 (not illustrated); Ozawa and others, 1991, p. 331 (not illustrated); Ota, 1998, p. 80–83, pl. 7, figs. 1–3 (with Japanese synonymy).
[?] *Pseudofusulina* cf. *P. vulgaris* var. *globosa* (Schellwien). Kahler and Kahler, 1980, p. 236 (not illustrated).
Pseudofusulina globosa (Schellwien). Miklukho-Maclay, 1949 p. 90 (not illustrated); Kalmykova, 1965, p. 119–120, pl. 1, figs. 1–4; Kahler and Kahler, 1966, p. 593 (not illustrated; with synonymy); Rozovskaya, 1975, p. 168 (not illustrated); Zhang, 1984 p. 451 (not illustrated).
Chalaroschwagerina globosa (Schellwien). Leven, 1981b, p. 48 (not illustrated); Bensh, 1987, p. 32 (not illustrated); Zhou, 1989, p. 264–265, pl. 3, figs. 4–5 (with Chinese synonymy); Leven, 1998, pl. 4, fig. 8.
Pseudofusulina sp. Hanzawa, 1961, pl. 35, fig. 1; [?] Kahler, 1988, fig. 15 in text p. 141 (a questionable equatorial section).

Description. Shell moderate in size, inflated fusiform to subglobular, with convex to concave lateral slopes and weakly protruding bluntly pointed poles, more or less lemon-shaped. Mature specimens normally have 4 to 6 volutions (minimum 2, maximum 6 and a half), and measure: width 3.90 to 8.40 mm, diameter 1.80 to 5.40 mm, width/diameter 1.10 to 1.62, with a large, spherical to irregular proloculus of 0.30–0.70 mm, and 35–37 septa at the last whorl. Coiling relatively tight at all stages of growth. Spirotheca composed of tectum and rather coarse keriotheca. Phrenothecae strongly developed in all the test and forming numerous loops (see our Pl. 2, fig. 5, and the paratype of Schellwien *in* Schellwien and Dyhrenfurth, 1908, pl. 14, fig. 7). Septa relatively regularly fluted throughout shell; septal folds high, usually reaching the top of the chambers. Cuniculi absent. Tunnel poorly conspicuous. Chomata and axial filling absent.

Material. 12 specimens; Si133/2C (Pl. 2, Figs. 3–4); Si133/2D (Pl. 2, Fig. 1); Si135/B 2 (Pl. 2, Fig. 2); Si133/2C (Pl. 2, Fig. 5); Si133/2B (Pl. 2, Fig. 6); Si132C (Pl. 2, Fig. 7); Si133/2A (Pl. 2, Fig. 8).

Remarks. Fusulina vulgaris var. *globosa* Schellwien *in* Schellwien and Dyhrenfurth, 1908, cannot be confused with *Fusulina globosa* Deprat, 1912 transferred to *Cuniculinella* Skinner and Wilde, 1965 emend. Bensh, 1987, either as *C. globosaeformis* (Leven, 1967); or with *Cuniculinella vulgarisiformis* (Morikawa, 1952), as proposed by Lys (1994).

Comparisons. The species *Chalaroschwagerina*(?) *globosa* resembles *C.*(?) *vulgaris,* but is distinguished by the shape of the test (subspherical versus inflated-fusiform), and the more developed insulae of the phrenothecae. It differs from the very similar *Cuniculinella inflata* and *C. globosaeformis* by the absence of cuniculi.

Occurrence. Yakhtashian of Darvaz (North Pamir), Transcaucasia, Ural; Japan (Kwanto, Akiyoshi); Karakorum; North China (Kelpin basin); South China (Guizhou, Guangxi, Fujian, Ordos basin), Viet-Nam. Questionable in the Goggau Limestone (Camic Alps); in Hydra (Greece), Spitsbergen (Norway) and Turkey. First mention in the Yakhtashian of Sicily.

Vemeuilites(?) sp.
Plate 2, Fig. 9

Description. This subaxial section measures: width 9.00 mm, diameter 3.80 mm, width/diameter 2.4; with four external whorls, and inner whorls not conspicuous. By its strong axial filling and the more or less hexagonal-shaped test, this species looks like the genera *Vemeuilites* Bensh and Kireeva *in* Bensh, 1987, and especially *V. plicatissima* (Rauser-Chemousova, 1940).

Occurrence. First mentioned in the Yakhtashian of Sicily.

Genus indeterminate
Plate 2, Fig. 10

? *Pseudofusulina fusiformis* Kochansky-Devidé, 1970, p. 200, 234, pl. 10, figs. 1–3.

Description. This taxon remains indeterminate as we have only one specimen. The dimensions of this rather large, elongate, subcylindrical shell, with bluntly pointed poles, are as follows: width 11.70 mm; diameter 3.00 mm, width/diameter 3.9 for at least 6 volutions. The proloculus is not observed due to the slightly oblique section. Phrenothecae are well developed, and axial fillings are weak. The tunnel is moderately wide and about one-half as high as chambers. Cuniculi are well conspicuous in the three last volutions.

Comparisons. By the general shape, the phrenothecae and the cuniculi, this specimen resembles ''*Parafusulina*'' *calx* Thompson and Wheeler *in* Thompson and others, 1946, but our material is too poor for an accurate determination, and this species is larger with a different width/diameter ratio (2.8–3.0). Our specimen is also similar to some *Pseudofusulinoides* of the literature, for example *P. instabilis* Bensh, 1972; *P. subobscurus* Bensh, 1972; or *P. parasecalicus* (Chang, 1963) emend. Bensh, 1972, but *Pseudofusulinoides* is smaller, with weaker cuniculi. Some species of *Cuniculinella,* figured by Skinner and Wilde (1965) or Magginetti and others (1988), and of ''*Praeparafusulina*'' *sensu* Tumanskaya (1962) or ''*Parafusulina*'' *sensu* Leven (1967), are also similar. True *Parafusulina* are larger, with more developed cuniculi, and no phrenothecae. Kanmera and others (1976, p. 139) have already indicated that ''the genus ''*Parafusulina*'' implies the horizontal grouping of parallel grades''. It is possible that some erroneous determinations of European *Leeina fusiformis* and *Paraskinnerella lutugini* concern our taxon.

Occurrence. First mentioned in the Yakhtashian of Sicily.