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A COMPARISON OF LATE TRIASSIC AGGLUTINATED FORAMINIFERA OF WESTERN AND EASTERN TETHYS.

by

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With 2 figures and 2 plates

ZUSAMMENFASSUNG

In der folgenden Studie wird an Hand einer Reihe von stratigraphisch wichtigen und häufigen Arten von sand- und kalkschalig agglutinierenden triadischen Foraminiferen gezeigt, daß sie über den Gesamtraum der Tethys verbreitet waren.

ABSTRACT

This paper presents examples of common species of arenaceous and calcareous agglutinated foraminifera of Triassic age, distributed over the Tethys realm. Many taxa of calcareous agglutinated foraminifera extended to the eastern side of the Triassic Panthalassa along North and South America.

INTRODUCTION

Recent increases in our knowledge of the Triassic macro- and microfaunas of Tethys have shown remarkable taxonomic similarity of geographically distinct assemblages, both benthic, including sessile and planktonic ones.

Due to difficulties to acquire personal knowledge, also in the field, of fossil assemblages from the Far East, Orient and Occident, many investigators preferred to give local names to "new" taxa. This traditionally resulted in long, local lists of "endemic" forms. This practice also holds for the agglutinated foraminifera, subject of this review.

Today it can be demonstrated that many species in Triassic time not only inhabited the entire Tethys region, but also neighboring Panthalassa - the Triassic Pacific Ocean (Kristan-Tollmann and Tollmann 1983b; Kristan-Tollmann 1986a,c). The manner of spreading - particularly for sessile organisms - is of interest and may have been achieved during the planktonic larval stage or in a pseudoplanktonic way, fixed on seaweed and drift-wood. It was directed, in our opinion, by equatorial east-west currents, running in Triassic time from the tropic-subtropic western coasts of both Americas across the Pacific to the tropic Tethys ocean.

Further examples of unexpectedly close relations of Triassic macrofauna elements have recently been presented by the author (1986c, 1987), such as rare microfaunal elements like holothurian sclerites or anomuran coprolites.

In this review, we present for the first time some remarkable examples of benthic agglutinated foraminifera that spread over the whole Tethys area and often also beyond that in the Pacific realm.

GENERAL REMARKS

A survey of the agglutinated foraminifera of the Triassic Tethys furnishes the following results:

Kristan-Tollmann, E., Scheibenbergstr. 53/6, A-1180 Wien, AUSTRIA.

There exist two fundamentally different benthic groups of agglutinated foraminifera. Differences are due to shell structure, evolutionary development, stratigraphical value, and ecological behavior, as listed below.

1. The group of the arenaceous foraminifera:
This group comprises many primitive forms, either free-living or attached. An example are forms that consist of a proloculus and followed by a simple, long tube, coiled, or otherwise attached.

In a stratigraphic sense, this group contains long-living species, generally existing during the Middle and Upper Triassic; half of those even extended beyond the boundaries with the Upper Paleozoic or the Liassic.

In an ecological sense, the group lived in lagoons, near reefs, or the sill and basin environments. Assemblages in these environments differentiate taxonomically: there is a maximum diversity of species in the forereef and above the sill.

The bulk of the arenaceous species is spread over the Tethys realm, extending as far as New Zealand in the West Pacific.

2. The group of the Variostomatidae:
The agglutinantia with a calcareous shell, composed of calcareous grains in a calcareous cement, is a highly specific group as far as apertures, inner structure and other characters are concerned. It is lumped in the Variostomatidae. The group starts in Late Anisian time, after the great extinction of many foraminiferal groups at the Permian-Triassic boundary.

The representatives of this second group of calcareous agglutinantia show the following behavior:
Many of its species have a short stratigraphic distribution and are therefore reliable index fossils.

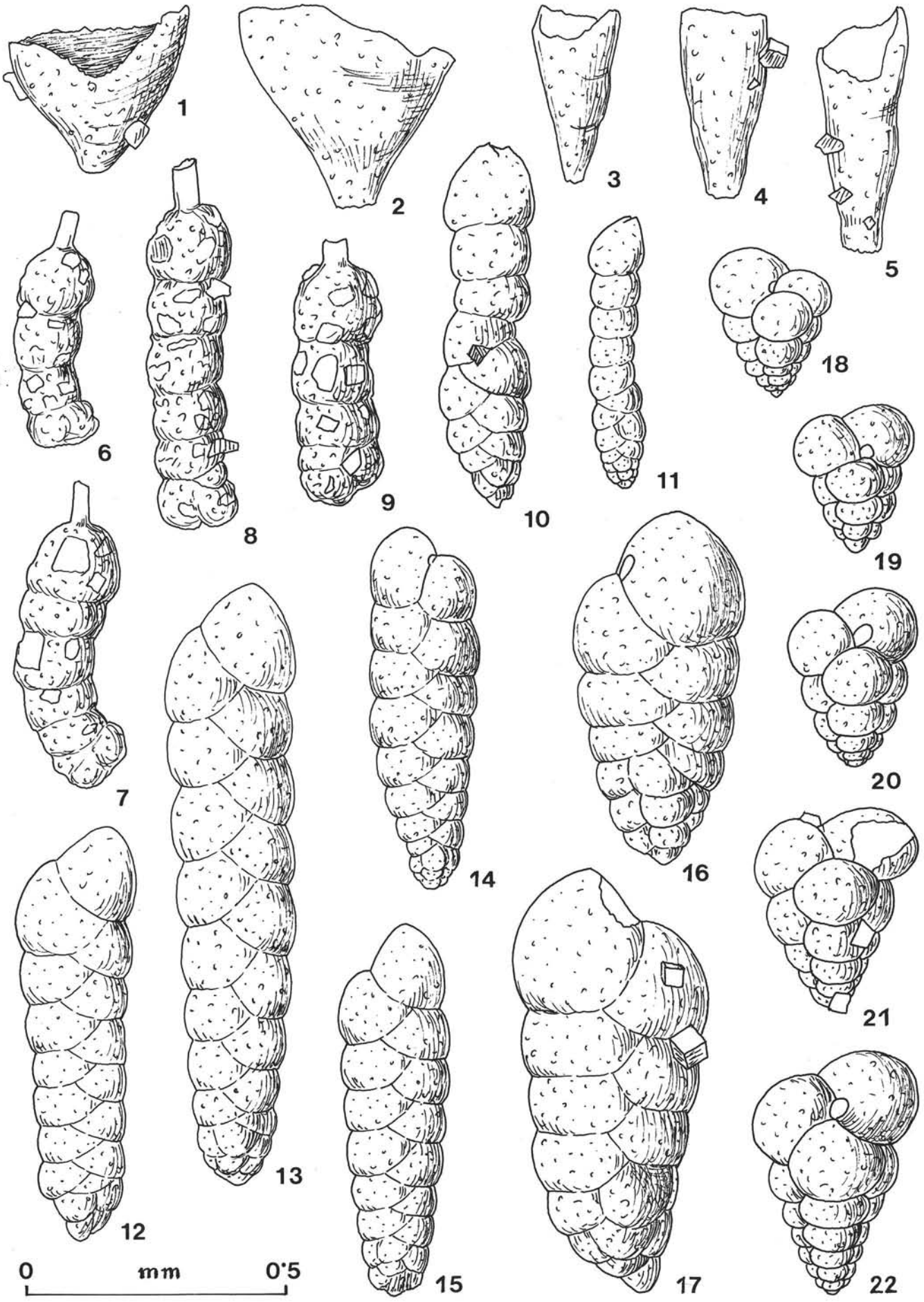
Several species prefer specific types of sediments, *e.g.* the Zlambach Marls which form an Upper Triassic basin facies.

In a regional sense, the species of this group are also spread over the Tethys, and furthermore over the tropic to subtropic area of the Triassic Pacific, the Panthalassa, to Nevada and other regions of the USA.

SOME CHARACTERISTIC EXAMPLES OF AGGLUTINANTIA, SPREAD OVER THE TETHYS.

1. Arenaceous agglutinated foraminifera:
Ammobaculites tzankovi (Trifonova, 1962), figure 1; 6-9, is one of the most common representatives of the Upper Triassic agglutinantia of the Tethys. It was described at first from the Carnian and Norian Hallstatt Limestone near Kotel in Bulgaria. This species can be found by dissolving Carnian to Rhaetian limestones of basin and sill sediments in the whole area of Western Tethys.

Fig. 1.
Some characteristic arenaceous agglutinated foraminifera from the Late Triassic from both the western and eastern end of the Tethys.
Nos. 1– 2: *Jaculella* cf. *expansa* (PLUMMER)
No. 1: Late Triassic Hallstatt Limestone, region of Berchtesgaden, Northern Calcareous Alps.
No. 2: Rhaetian reef limestone (Kuta Limestone), Gurumugl W Kundiawa, Central Highlands, Papua, New Guinea.
Nos. 3– 5: *Jaculella* sp.
No. 3: Locality as No. 1.
No. 4: Locality as No. 2.
No. 5: Locality as No. 2.
Nos. 6– 9: *Ammobaculites tzankovi* (TRIFONOVA)
No. 6: Locality as No. 1.
No. 7: Locality as No. 1.
No. 8: Locality as No. 2.
No. 9: Locality as No. 2.
Nos. 10–11: *Gaudryinella elegantissima* KRISTAN-TOLLMANN
No. 10: Locality as No. 2.
No. 11: Marly horizon in Pedata Limestone, Sevat, new Pötschen route W Aussee, Styria, Northern Calcareous Alps (U667).
Nos. 12–15: *Gaudryina triassica* TRIFONOVA
No. 12: Sevatian Hallstatt Limestone, Taubenstein near Gosau, Upper Austria, Northern Calcareous Alps.
No. 13: Locality as No. 12.
No. 14: Upper Ladinian? Reifling Limestone, Großreifling, Styria, Northern Calcaraeous Alps.
No. 15: Locality as No. 2.
Nos. 16–17: *Gaudryina kelleri* TAPPAN
No. 16: Locality as No. 1.
No. 17: Locality as No. 2.
Nos. 18–22: *Verneulinoides mauritii* (TERQUEM)
No. 18: Locality as No. 1.
No. 19: Lower Carnian Hallstatt limestone from Saklibeli, 30 km SW Antalya, Taurus Mts., Turkey.
No. 20: Upper Carnian Hallstatt Limestone from Bihati Brook near Baun, western Timor.
No. 21: Locality as No. 2.
No. 22: Locality as No. 20.



The species has been found also in the Rhaetian limestone of Gurumugl in the Central Highlands of Papua, New Guinea (figure 1; 8-9). This region, with its few marine Triassic Tethyan sediments, represents one of the easternmost areas of the Tethys realm. *Ammobaculites tzankovi* therefore is spread over the entire Tethys area.

A similar stratigraphic and regional range is shown by the important Triassic species *Gaudryina triassica* Trifonova, 1962. Figure 1; 12-15 illustrates this species from the western end (Northern Calcareous Alps) and from the easternmost part of the Tethys (Papua, New Guinea).

The species *Gaudryinella elegantissima* Kristan-Tollmann, 1964, is restricted to the Norian and Rhaetian stage of the Triassic (figure 1; 10-11). It is known from marls and limestones of basin, sill and forereef areas. As a result of its recent discovery in the Rhaetian limestone of Papua, New Guinea, its distribution over the Tethyan realm is now demonstrated.

Species discussed below are found in Upper Triassic limestones and also overlying Liassic ones:

Gaudryina kelleri Tappan, 1955, was originally recorded from the Liassic series of the South Barrow Test Well 3, northern slope of Alaska. Recently, this species was found in limestones in the Tethys of the Upper Triassic, from Carnian to Sevatian. It occurs often in remarkable abundance in Hallstatt Limestones. Figure 1; 16-17 shows two specimens, one from the Upper Triassic Hallstatt Limestone of the Northern Calcareous Alps (no. 16), the other one from the Rhaetian reef limestone from Papua, New Guinea (no. 17), which demonstrates once more the occurrence of this species in the whole Tethys. *Gaudryina kelleri* belongs to the few arenaceous foraminifera that occur at the eastern side of the Pacific Ocean.

Verneuilinoides mauritii (Terquem, 1866) was originally described from the Liassic of France. This characteristic species is common to abundant in the Upper Triassic limestones of the whole Tethys area. I have documented several specimens in figure 1; 18-21, deriving from Hallstatt Limestone sites of Berchtesgaden in the Northern Calcareous Alps in Austria (no. 18), from the Taurus Mts. in Turkey (no. 19), and from the Bihati Brook near Baun in Timor (nos. 20, 22) as well as from the reef limestone of Gurumugl in Central Papua, New Guinea (no. 21).

Finally I also showed two representatives of the primitive type of agglutinated foraminifera, belonging to the genus *Jaculella*. Specimens derive both from the western and eastern end of the Tethys, that is the site of Berchtesgaden Alps (Eastern Alps, Bavaria) with Upper Triassic Hallstatt Limestone (figure 1; 1, 3) and the locality of Gurumugl in Papua, New Guinea with Rhaetian reef limestone (figure 1; 2, 4-5). In this last mentioned locality, the species is common, whereas in the Hallstatt Limestone, it is rare.

2. Agglutinated calcareous foraminifera - Variostomatidae: The family of Variostomatidae comprises, as mentioned above, taxa with rather complicated internal structures of the shell. Many index fossils with a short vertical range belong to this family. They are spread over the Tethys and in tropic to subtropic areas of Panthalassa (Triassic Pacific Ocean) - today often shifted in higher latitudes as displaced terranes. The family is useful for stratigraphic correlation, although some species are restricted to specific facies. Below, we present some examples (figure 2, plates 1,2):

Variostoma cochlea Kristan-Tollmann, (1960) (plate 1, figures 1-10; plate 2, figures 11-13) is a characteristic representative in Rhaetian sediments of basin, sill and forereef facies. It is well documented from the Rhaetian of the Alps (Kristan-Tollmann 1960, p. 63, plates 12-14; 1964, plate 7; Tollmann 1976, figure 169) and Eastern Carpathians (Mirauta and Gheorghian 1978, plate 10). This species has also been mentioned from several areas of Southern Asia. Gupta *et al.* (1977), plate 2, figures 4, 5, 7 (juvenile forms of *V. cochlea*, non *V. crassum*), figures 11-12 (adult specimens), and Gupta and Kristan-Tollmann (1987) have shown this species from the Rhaetian part of the Kioto Limestone and Kioto Marls from Kumaun in the Himalayas, India, and Ho and Hu (1971, plate 5, figures 1-2) from Yunnan in SW China. On plate 1, figures 2, 5-6 of this paper, additional specimens from the Kioto Marls from Kumaun are figured. Until now the easternmost site in the Tethys of this species is Papua, New Guinea: Kristan-Tollmann (1986a), plate 2, figure 5 (young specimen), plate 4, figure 11; (1986b), figure 1; 9-14. It was found in the Rhaetian Kuta Limestone and reef limestone of Gurumugl in the Central Highlands - *cf.* plate 2, figure 13.

Beyond the Tethys realm and reaching the eastern side of Triassic Panthalassa the following species occur: *Variostoma coniforme* Kristan-Tollmann, (1960) (plate 2, figures 1-5) has been described frequently from the Northern Calcareous Alps in Austria, particularly from the Rhaetian Zlambach Limestones and Marls (*e.g.* Kristan-Tollmann 1960, p. 62, plate 12, figures 1-5; *in*: Tollmann and Kristan-Tollmann 1970, plate 8, figure 32). Now this species has also been found in the Rhaetian reef limestone of Papua, New Guinea (plate 2, figure 2) and in the Norian limestones of western North America (Shoshone Mts. in Nevada and Wallowa Mts. in Oregon; Kristan-Tollmann and Tollmann (1983), p. 229, plates 9-10; p. 239, plate 16) - *cf.* plate 2, figures 3-5 in this paper, which demonstrates its

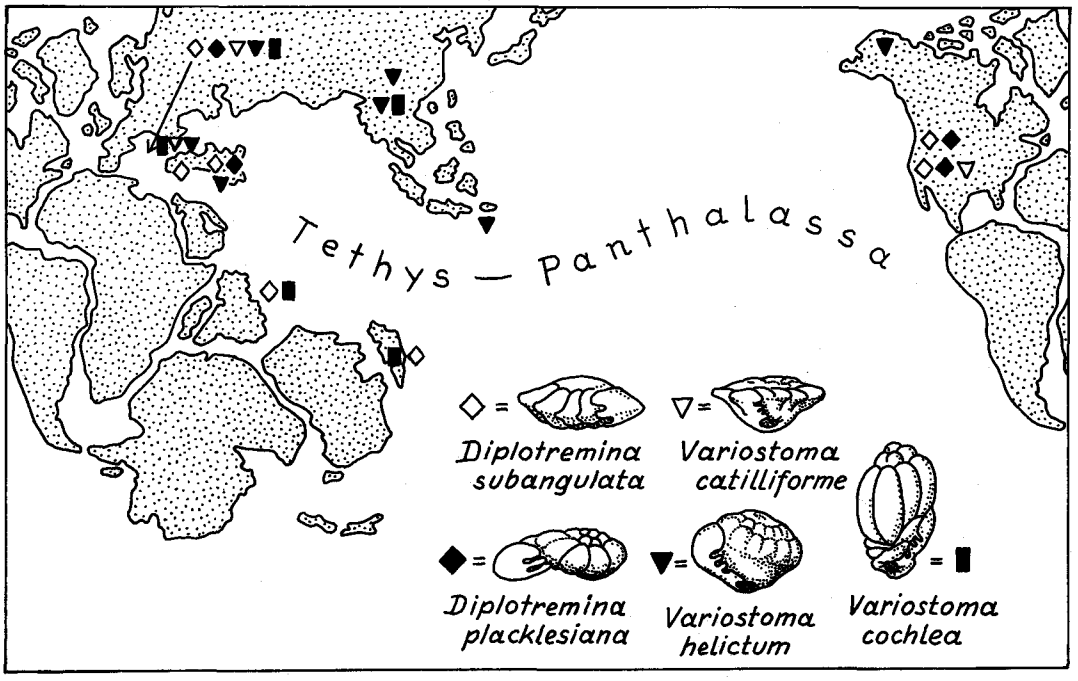


Fig. 2.
Circumtropic distribution and localities of some characteristic Variostomatidae (calcareous agglutinated foraminifera) of the Norian and Rhaetian stage.
- *Diplotremina subangulata* KRISTAN-TOLLMANN
  Rhaetian of the Northern Limestone Alps/Austria; Konya/Turkey; Esfahan/Iran, Kumaun in the Himalayas/India; Central Highlands/Papua, New Guinea; Oregon and Nevada/USA.
- *Diplotremina placklesiana* KRISTAN-TOLLMANN
  Rhaetian of the Northern Limestone Alps/Austria; Esfahan/Iran; Oregon and Nevada/USA.
- *Variostoma catilliforme* KRISTAN-TOLLMANN
  Norian–Sevatian of the Northern Limestone Alps/Austria; Kotel/Bulgaria; Nevada/USA.
- *Variostoma helictum* (TAPPAN) (= *V. crassum* KRISTAN-TOLLMANN)
  Sevatian of the Northern Limestone Alps/Austria; Kotel/Bulgaria; Waliabad/Iran; Sichuan and Yunnan/China; Timor/Indonesia; NE Alaska/USA.
- *Variostoma cochlea* KRISTAN-TOLLMANN
  Rhaetian of the Northern Limestone Alps/Austria; E-Carpathians/Rumania; Kumaun in the Himalayas/India; Yunnan/China; Central Highlands/Papua, New Guinea.

distribution over the Tethyan and tropic-subtropic Pacific realm.

Variostoma helictum (Tappan, 1951), (plate 1, figure 15; plate 2, figures 9-10) is a characteristic and abundant index fossil for the Sevatian (formerly Upper Norian, today Lower Rhaetian stage) basin and sillfacies. This species was originally described by Tappan (1951) (p. 3, plate 1, figures 7-9) from the "Norian" beds of the Shublik Formation, Alaska. Perhaps synonymous to this name is *Variostoma crassum* Kristan-Tollmann (1960, p. 59, plate 9, figures 9-11; plate 10, figures 1-4). The holotype of *V. helictum* still has to be examined under this aspect. *V. crassum* was described at first from the type locality of the Pötschen Limestone in the Northern Calcareous Alps in Austria, later from many other sites in this Cordillera - *cf.* plate 1, figure 15 in this paper. *V. crassum* was furthermore reported from the "Norian" of Kotel in Eastern Balkan Mts. in Bulgaria (Trifonova 1962, p. 164, plate 5, figures 4-6), from the Sevatian of Waliabad in Iran (Kristan-Tollmann *et al.* 1979, p. 148, figures 6; 1-3), from the Upper Triassic of the Lancang River area in Yunnan, China (Ho and Hu 1977, p. 22, plate 4, figures 5-8; *cf.* Kristan-Tollmann and Tollmann 1983a, p. 207f.). In this last mentioned paper (p. 208, plate 14), sections of this species are figured for the first time in thin sections of Sevatian Hallstatt Limestones from the Bihati Brook in Baun, western Timor. (*cf.* plate 2, figures 9-10 in this paper).

Finally we wish to demonstrate *Diplotremina subangulata* Kristan-Tollmann, 1960 (plate 1, figures 11-14; plate 2, figures 6-8 in this report). This species shows a wide distribution comparable to that of *Variostoma helictum* - *cf.* figure 2 of this report and figure 4b in Tollmann and Kristan-Tollmann (1985). Now this taxon is recorded from the Rhaetian limestone of the Gurumugl reef near Kundiawa in Papua, New Guinea (plate 2, figure 6).

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PLATE 1

Variostomatidae from Late Triassic marls (Rhaetian) of the Tethys.

Figures 1-10 *Variostoma cochlea* Kristan-Tollmann in lateral view showing specimens in different stages of growth. Juveniles in figures 1-9 and adult ones in figure 10. Specimens also show different modes of preservation: outside partially weathered (figure 1), strongly corroded (figures 2, 5-6), or well preserved (figures 3, 4-10). Specimens in figures 3, 8, 9, 10 show lamellae around the umbo.
Figures 1, 4: Zlambach Marl, Rhaetian, Brandwald SE to E Gössl (B1040), Styria, Northern Calcareous Alps.
Figures 2, 5-6: Kioto Marl, Sevatian, Kumaun (material Gupta), Himalayas.
Figures 3, 9: Marls intercalated in Hallstatt Limestone, Sevatian, Steinbergkogel (S359) near Hallstratt, Upper Austria.
Figures 7,8: Marl intercalated in Hallstatt Limestone, Sevatian, basis of the rock behind Hernstein Castle (S545), Lower Austria.
Figure 10: Zlambach Marl, Rhaetian, southern branch of the Grünbach ditch (R62), SW St. Leonard, Salzburg, Northern Calcareous Alps.

Figures 11-14 *Diplotremina subangulata* Kristan-Tollmann
Figure 11: Juvenile specimen, view from below. Zlambach Marl, Rhaetian, Plackles, Hohe Wand, Lower Austria.
Figure 12: Oblique lateral view from below. Locality as figure 10.
Figure 13: The lateral view of the shell shows the typically subangulate outline. Locality as figure 11.
Figure 14: View from below, last chamber squeezed. Locality as figure 10.

Figure 15 *Variostoma helictum* (Tappan)
Juvenile specimen in lateral view, the large umbo below is visible. The walls of the chambers are more or less corroded. Marls intercalated in Hallstatt Limestone, Sevatian, Stambach (Z96) 3 km ENE of Goisern, Upper Austria.

All scale bars 200 microns

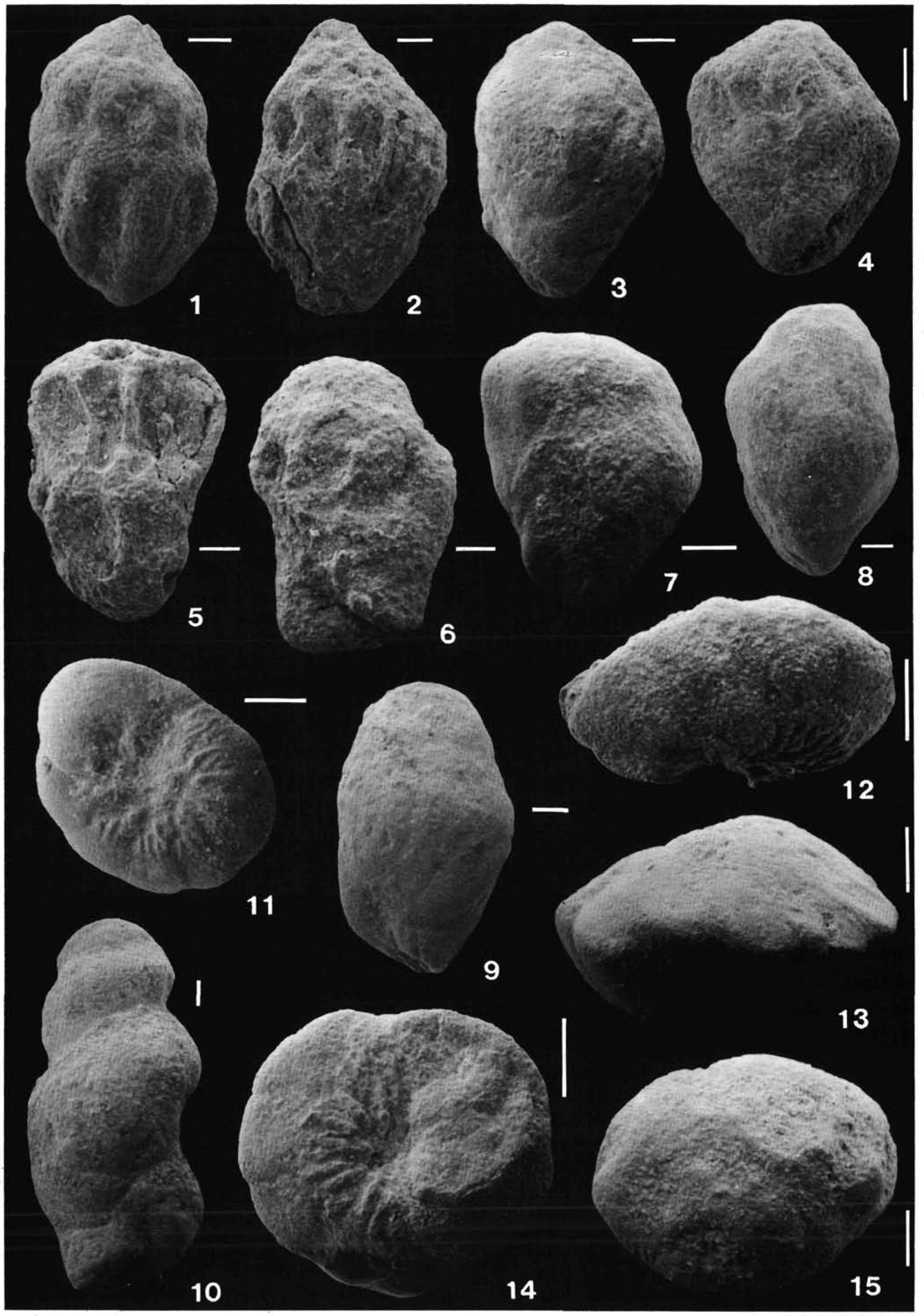


PLATE 2

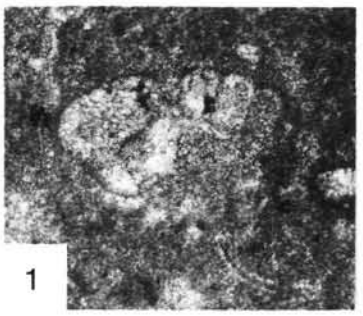
Variostomatidae from Late Triassic limestones (Norian, Rhaetian) of the Tethys and the Peripacific.

Figures 1-5 *Variostoma coniforme* Kristan-Tollmann in lateral view, mostly somewhat oblique.
Figure 1: Zlambach Limestone (Rhaetian) from Plackles, Hohe Wand near Wiener Neustadt, Lower Austria.
Figure 2: Kuta Limestone (Rhaetian) from the Gurumugl reef (85/4) W Kundiawa, Central Highlands, Papua, New Guinea.
Figures 3-4: Norian limestone from the Union Canyon (P262) in the Shoshone Mts., Nevada, USA.
Figure 5: Norian limestone from the Eagle Creek region (P221), southern Wallowa Mts., Oregon, USA.

Figures 6-8 *Diplotremina subangulata* Kristan-Tollmann in lateral view - see plate 1, figures 12, 13.
Localities: figure 6 as figure 2, figure 7 as figure 5, figure 8 as figures 3-4.

Figures 9-10 *Variostoma helictum* (Tappan) in oblique thin sections. Sevatian Hallstatt Limestone from Bihati Brook near Baun, western Timor.

Figures 11-13 *Variostoma cochlea* Kristan-Tollmann in lateral view.
Figures 11-12: Zlambach Marl (Rhaetian) from the Brandwald, Salza valley, Styria, Austria - see plate 1, figures 1- 4.
Figure 13: Kuta Limestone (Rhaetian) from the Gurumugl reef W Kundiawa, Central Highlands of Papua, New Guinea - see plate 1, figures 5-7.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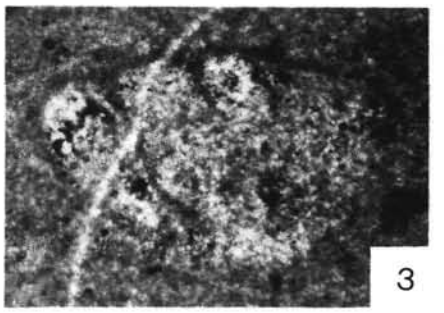
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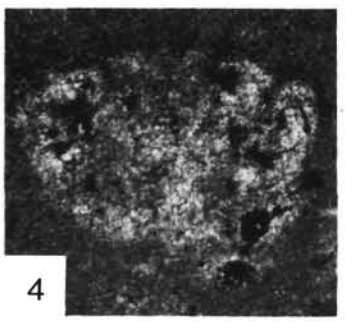
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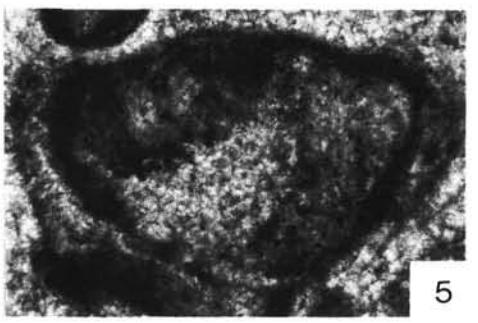
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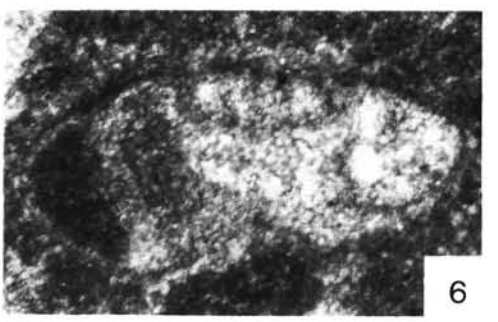
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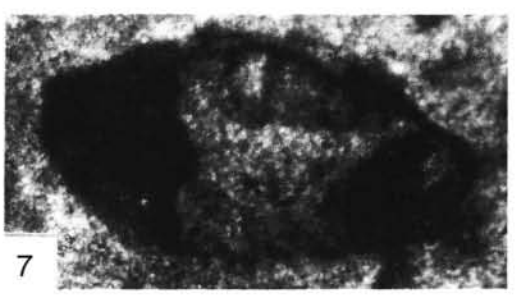
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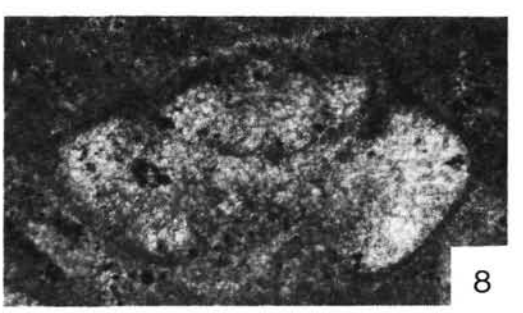
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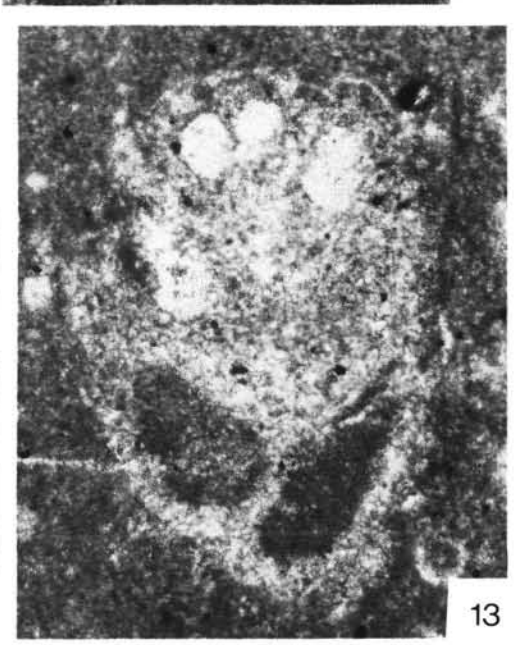
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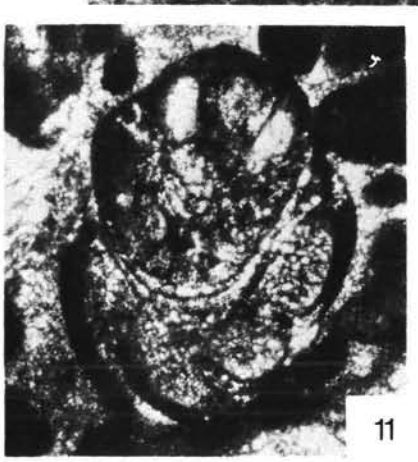
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