ANNELID *TEREBELLINA MACKAYI* (BATHER) FROM MIDDLE TRIASSIC KESKAIN FORMATION, MISOOL ARCHIPELAGO, WEST IRIAN JAYA

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ABSTRACT

Terebellina mackayi is an annelid fossil species which forms a tubular agglutinated body. It is a Middle Triassic taxon which has a common distribution in the world and has been recorded from Sumatera, Thailand, Misool, Timor, and New Zealand. A collection of small sized specimens of the species from the Keskain Formation (Misool) of Anisian to Ladinian age is here redescribed and a global correlation is attempted.

Terebellina mackayi is commonly found in a random orientation of distribution within beds. The organism which is constructed of tubular shape remains enigmatic but was probably suspension feeder rather than browser, deposit feeder or active predator. *Terebellina mackayi* lived in a fine grained black silt substrate (infauna) rich in organic detritus.

Keywords: Keskain Formation, Annelid, Terebellina mackayi, Anisian, Ladinian

SARI

Terebellina mackayi adalah fosil keluarga annelid dan berbentuk seperti tabung berdinding pasiran (*agglutinated tube*). Fosil ini berumur Trias Tengah dan umum ditemukan di dunia dan pernah ditemukan di Sumatera, Thailand, Misool, Timor, dan Selandia Baru. Koleksi *Terebellina mackayi* berukuran kecil dikumpulkan dari Formasi Keskain (Misool) yang berumur *Anisian* sampai *Ladinian* dideskripsi ulang dan dikorelasikan secara global.

Terebellina mackayi sering ditemukan dalam posisi yang acak di dalam lapisan batuan. Organisme ini berbentuk sisa-sisa pipa, tetapi kemungkinan merupakan organisme pemakan bahan yang mengapung dalam kolom air laut, bukan perayap untuk mencari makan, bukan pemakan sedimen ataupun pemangsa yang aktif. *Terebellina mackayi* hidup dalam sedimen (*infauna*) lanau hitam yang berbutir halus pada dasar laut yang kaya akan sisa detritus bahan organik.

Kata kunci: Formasi Keskain, Annelida, Terebellina mackayi, Anisian, Ladinian

INTRODUCTION

Specimens of the annelid were collected during the mapping of Misool Archipelago carried out in 1983. The specimens are identified as *Terebellina mackayi* comparable with those collected from Misool by Jaworski (1915) and Wanner (1931). No study has ever been done of the new collection since then. More detailed study of specimens of the species by Jaworski (1915) and Wanner (1931) is required. Subsequent examination in a broader context has led us to conclude that it is indistinguishable from *Terebellina mackayi* (Bather, 1905).

The species has been found in the Keskain Formation on Keskain Island, an islet immediately south of Misool at two localities, 81FH21 and 81FH24 respectively (Figure 1). Jaworski (1915) and Wanner (1931) recorded the species from the "Keskain Beds"of Late Triassic age.

GEOLOGICAL SETTING

The geological mapping of the Misool Archipelago was carried out by Geological Survey Institute (then Geological Research and Development Centre) in collaboration with Australian Geological Survey Organization or AGSO (then Bureau of Mineral Resources, Geology and Geophysics, Australia) which produced a geological map (Rusmana *et al*., 1982) of the archipelago. Pigram *et al*., 1981; 1982a,b discussed the geological result of their expedition to the archipelago and gave conclusions of the lithostratigraphy of the archipelago. The geological map of the Misool Archipelago is shown in Figure 1. A stratigraphic column of Paleozoic and Mesozoic of the archipelago is shown in Figure 2.

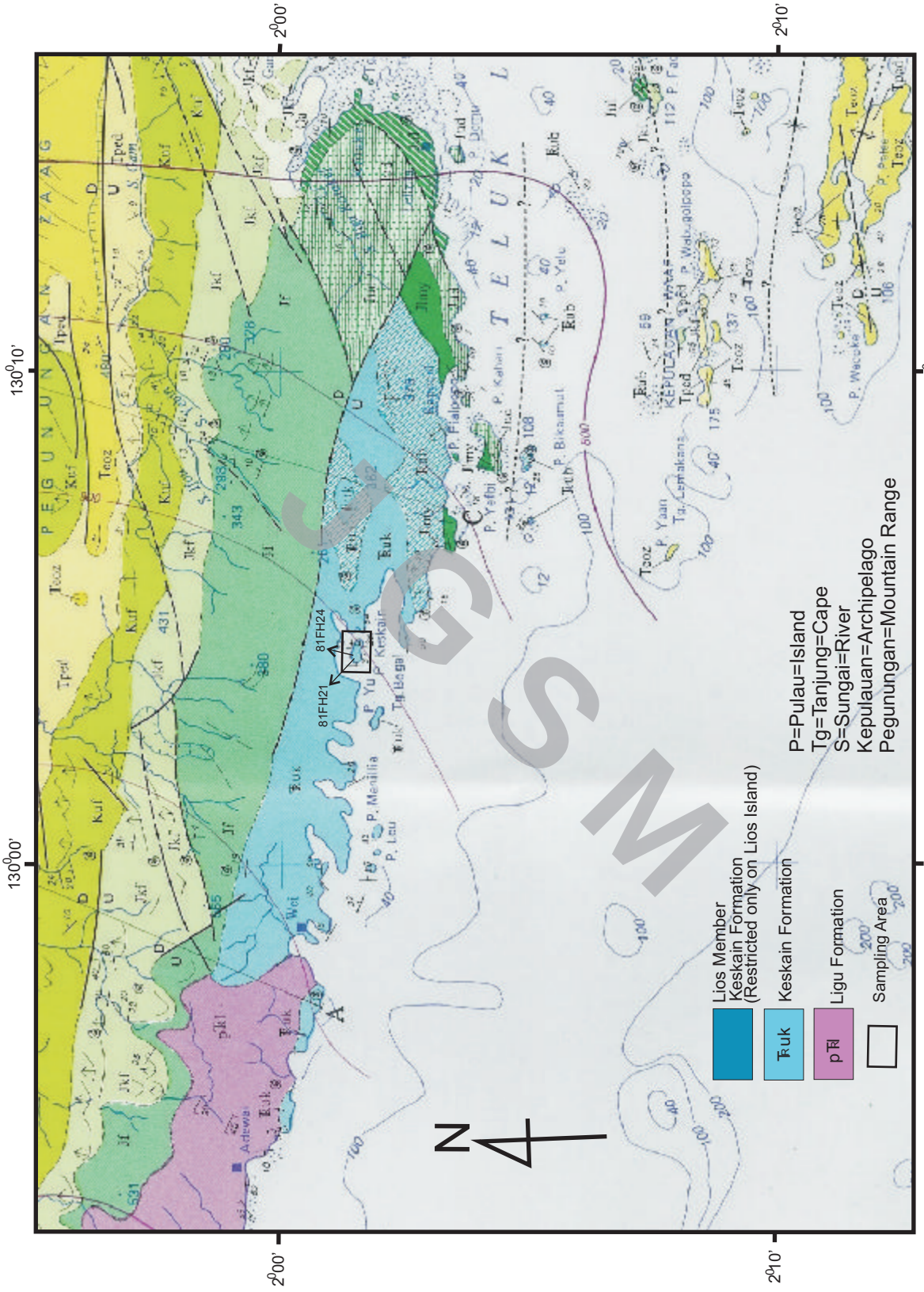

Figure 1. Distribution map of Keskain Formation on Misool Archipelago. (after Rusmana *et al.* 1989, 1:250.000 scale).

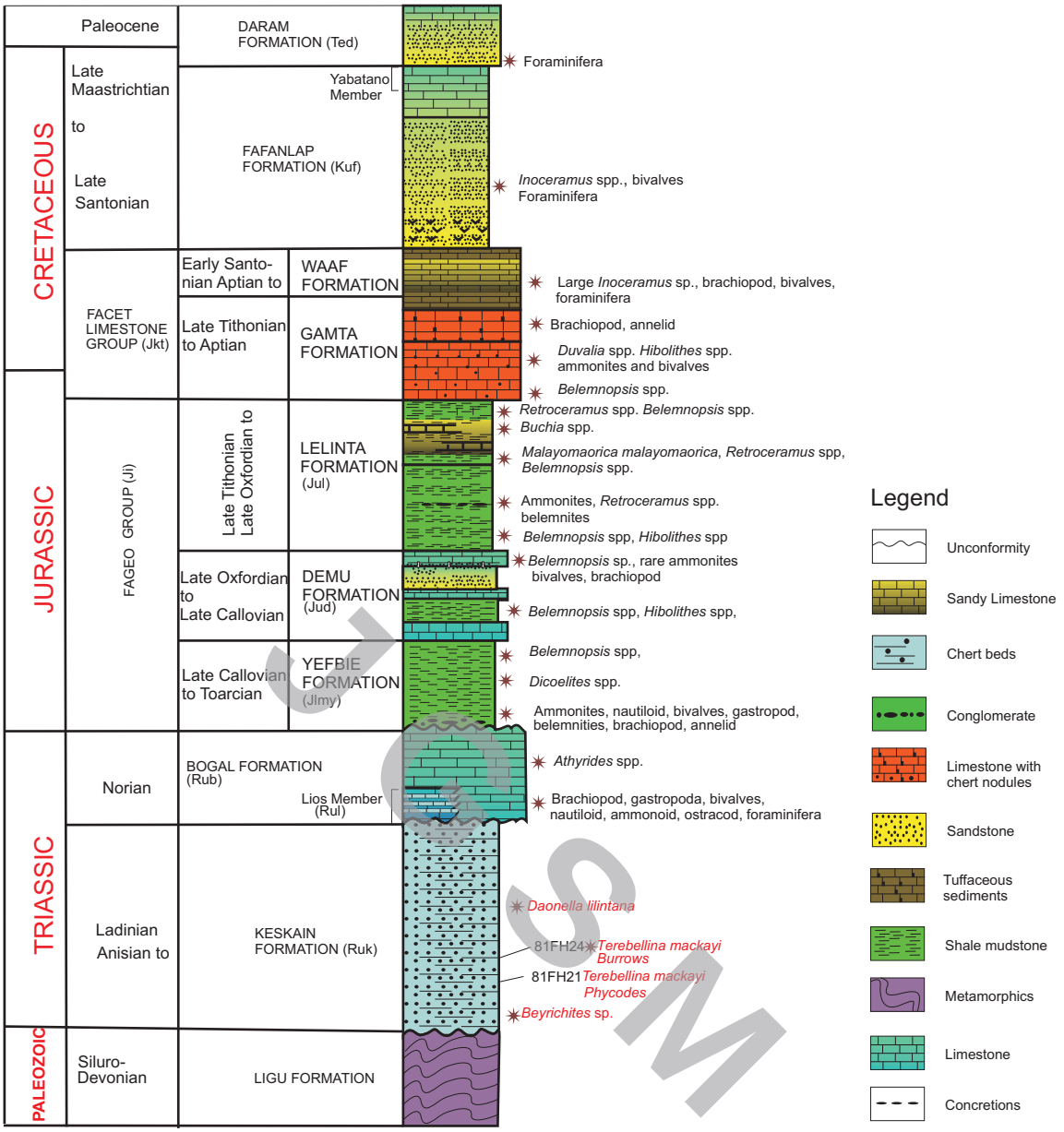

Figure 2. Paleozoic to Mesozoic stratigraphic column of Misool Archipelago(modified after Hasibuan, 1991)

The Keskain Formation was erected by Pigram *et al*. (1982a,b) for the "Keskain Beds" of Wanner (1910) with a type located in Keskain (=Kaini) Island, immediately south of Misool Island. The formation consists of interbedded indurated dark grey shale and siltstone, calcareous fine sandstone, sandy limestone and quartz sandstone, the lithologies are typically thinly bedded up to 25 cm thick (Pl.1, Fig.1). It attains about 1.000 m in thickness. However, the structural complexity has prevented the thickness to be measured. It is distributed on the south coast of the main island of Misool as well as on the small islands to the west about 20 km long and 3 km wide.

The sedimentary structures observed in this formation include slumping (Pl. 1. Fig 2), ripple marks, small scale and low angles crossbedding, convolute bedding, and graded bedding. These structures support the conclusion that this lithostratigraphic unit is of turbidite origin (Pigram *et al.,* 1982a,b; Simbolon *et al.,* 1984). It lies unconformably on the Ligu Formation (Siluro-Devonian) and in turn is overlain unconformably by the Bogal Formation (Carnian - Late Norian) (Pigram *et al*. (1982a,b; Hasibuan, 1991).

Apart from *Terebellina mackayi* (Bather), the formation also contains ichnofossil and other fossils such as U-shape burrow at a low angle, trace fossil *Phycodes* in the lower part. Two metres below the *Terebellina mackayi* (Bather) containing bed, about 5 m thick of dark grey mudstone was found to contain *Daonella lilintana* and bivalve (gen. et sp. indet). About 2 m below the 5 m thick grey mudstone, a thin limestone bed was bearing a fragment of ammonite *Beyrichites* sp. occurs.

On the basis of fossil content, this formation is probably Ladinian, but the presence of *Beyrichites* sp. suggests it could also be Anisian in age.

SYSTEMATIC PALEONTOLOGY

ANNELIDA

Phylum	:	Annelida Lamarck, 1809
Class	:	Polychaeta Grube, 1850
Order	:	Sedentarida Lamarck, 1818
Family	:	Terebellidae Grube, 1850
Genus	:	*Terebellina* Ulrich, 1904
Type species	:	*T. palachei*, Yakutat Formation, Alaska, Jurassic

Diagnosis

Genus description by Ulrich (1905): tube long, subcylindrical, gently curved, acuminate at lower end, with rather thick walls composed of cemented minute siliceous grains and with surface obscurely striated transversely. Jurassic, North America; Triassic, New Zealand, Thailand, Indonesia.

***Terebellina mackayi* (Bather)**

Pl. 2, Fig. 1-11

1905. *Torlessia mackayi* Bather: 2(12), 532-541.
1915. *Terebellina mackayi* Bather. Jaworski: 2(5), Pl. XLV(3), fig. 22, 139.
1982a,b. *Terebellina mackayi* Bather. Cave: fig. 2, 38-39.
1983. *Terebellina mackayi* Bather. Begg *et al*.: 26, fig. 1, 121-122

Materials

About 11 moderately preserved specimens have been collected from localities 83FH21 and 83FH24 of the Keskain Formation, Misool Archipelago.

Mode of occurrence and dimensions

Most specimens of the *Terebellina mackayi* are found resting well aligned to mostly aligned or randomly oriented on or oblique to bedding planes, particularly in some fine grained units. Some tubes are occasionally found perpendicular to bedding (this paper and Cave, 1982a,b). Specimen lying on the bedding plane are invariably flattened, and often abraded and fragmentary, this is also the case with New Zealand specimens (Andrews, 1974; Hicks, 1981). These are interpreted as representing transported faunas removed from their life position by erosion and scattered by bottom currents. Fragmentary material lying at various oblique angles within beds are interpreted as essentially *in situ* assemblages that have been disrupted by bioturbation (Campbell and Campbell, 1970; Speden, 1976), and possibly predation and compaction effects.

Our specimens are slightly larger than Cave's (1982a,b) specimen from Waimakariri Gorge and Gebbies Pass, Lyttelton, New Zealand. The longest dimension of the latter material is only 40 mm.

Specimen no.	Length (mm)	Diameters (min.-max.) (mm)	Orientation to the bedding plane
Loc. 81FH21			
1.	48	1.3-3.0	parallel
2.	+40	1.0-1.2	oblique (10°)
3.	17	1.8-2.0	oblique (65°)
4.	30	1.0-1.1	oblique (38°), curved
5.	39	1.0-2.2	oblique (30°)
6.	12	1.2-2.2	parallel
7.	8	2.0-2.2	parallel
8.	20	1.2-1.5	parallel, curved
Loc. 21FH24			
9.	20	2.0-3.0	oblique (60°)
10.	20	2.0-2.8	oblique (60°),curved
11.	14	2.2	Vertical to oblique (60°), curved

DESCRIPTION

The description of the species provided by Cave (1982a) (Pl. 2, Fig. 12) fits well for the present specimens which compare with specimens no. AU1129, 4498, 4501, 6648 (University of Auckland Paleontological Collection). The tubes are small with average diameter of only 2.12 mm, and maximum length of 48 mm (spec. no. 1), noncalcareous, with faint longitudinal striae or less commonly transversely, cylindrical or slightly tapering tube. Under the binocular microscope it has the sugary appearance, typical of *T. mackayi* and suggestive of an agglutinated construction. It is a smooth simple tube. The tube wall is composed of detrital quartz or occasionally feldspar grains held

together by a siliceous cement. The tube material is well sorted and fine grained (medium to coarse silt).

The tubes are open ended cylinders or cone closed at one end (see also Cave, 1982b, from Waimakariri Gorge, New Zealand). Several specimens of *Terebellina mackayi* from New Zealand display abrupt changes in tube diameter (Plate 2, Fig. 12). It may represent a normal ontogenetic growth step, or an aberrant growth form caused, for example, by injury and occurring only in a few numbers of the specimens. More typical *Terebellina* specimens are slightly tapering with gradual, even increase in diameter of the tube.

Mode of Life

This species clearly shows that the organism was infaunal, living vertical in the sediment and that the tube apparently opened into seawater at or immediately above the sediment-water interface. The presence of flattened tubes lying on the bedding plane indicates that this was a precarious existence. The organism was most likely a suspension feeder and not a browser, deposit feeder or active predator. The organism buried itself in the sediment indicated by the presence of deformed cross-beds and homogenized sediment immediately adjacent to the tube fossil.

Terebellina mackayi appears to have preferentially occupied parts of the sea floor lacking current action where finer grained, organically rich black silts are accumulated. This species preferred or required a lower energy environment.

Remarks

The occurrence of *Terebellina mackayi* (Bather) seems to be cosmopolitan, making this species useful for world wide correlation (see Table 1).
Terebellina mackayi was first recorded by Jaworski (1915) (Pl. 2, Fig. 13) and then by Wanner (1931) from "Keskain Beds' in Misool Archipelago of Late Triassic age. In New Zealand where *Terebellina mackayi* was originally described (Bather, 1905) it is very widespread in Torlesse (Kaihikuan to Warepan) and rare in Murihiku (Oretian) Supergroups and its age ranges possibly from Ladinian to Norian (Campbell and Warren, 1965; Force and Force, 1978; Begg *et al*. 1983). Campbell and Warren (1965) recorded the species from Lower Hutt, New Zealand (Pl.2, Fig. 14) whereas Begg *et al*. (1983) from Wairaki Hills, New Zealand (Pl. 2, Fig. 15).

Terebellina is also present in Thailand in Carnian strata, and in Malaysia in shale of Ladinian age with *Daonella* (J.A. Grant-Mackie, pers. comm. 2006). Hasibuan (1987) also reported the present of *Terebellina mackayi* in the Kwalu Formation of Carnian age in North Sumatera. Table 1 summarizes the distribution of *Terebellina mackayi* in the world.

Tabel 1. Global Records of *Terebellina mackayi* (Bather) (modified after Hasibuan, 1991)

AGE / INTERNAT. STAGES / NEW ZEALAND STAGES / LOCALITIES		ANISIAN	LADINIAN	CARNIAN	NORIAN		PALEOENVIRONMENT
		ETALIAN	KAIHIKUAN	ORETIAN	OTAMITAN	WAREPAN	
INDONESIA	MISOOL	X	X				Interbedded mudstone and fine sandstone (turbiditic origin) with *Daonella lilintana* and *Beyrichites* sp.
	SUMATERA			X			Shaly grey, dark carbonaceous flaggy limestone (rhytmic formation)
NEW ZEALAND	TORLESSE		X	X	X		- flysh-like origin - submarine fan sequence - low energy sea-floor
	MURIHIKU			X			Bedded fawn to blue grey tuffaceous, very fine sandstone to siltstone
THAILAND				X			Black shale (argillite) with *Halobia*
MALAYSIA			X				Shale, banded shale, siltstone, quartzite, greywacke and conglomerate (rhythmic formation)

Based on its distribution in Triassic time, it can be concluded that the the species lived along the coast line of Tethyan Sea.

Age

Terebellina mackayi was found in Misool Archipelago in association with bivalve *Daonella (D.) lilintana,* 5 m below which an ammonite *Beyrichites* sp. (Pl. 2, Fig. 16) has been collected.

Kobayashi (1964) distinguishes six horizons of Daonella in Southeast Asia and its age range is from Anisian to Carnian. Kobayashi (1964) and Kobayashi and Tamura (1984) correlated the *Daonella (D.) lilintana* bearing beds with the Japanese

Plate 1

Figure 1. Finely bedded and laminated Keskain Formation at locality 81FH25

Figure 2. Soft sediment deformation in the Keskain Formation at locality 81FH24

Plate 2

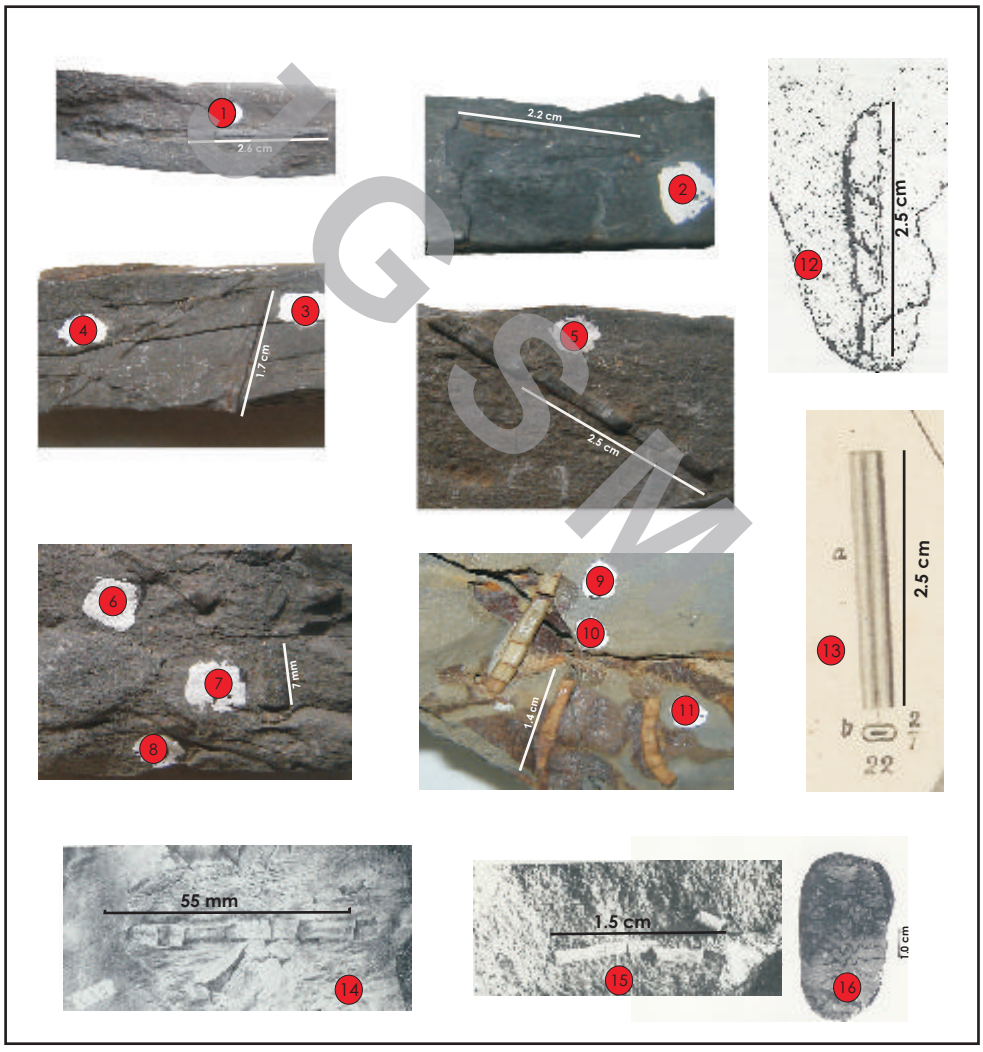

Figure 1 to 11: *Terebellina mackayi* (Bather) from Keskain Formation, Misool Archipelago (this study)
12: *Terebellina mackayi* (Bather) from Lower Makariri Gorge, New Zealand (Cave, 1982)
13: *Terebellina mackayi* (Bather) from Keskain Formation, Misool Archipelago (Jaworski,1915)
14: *Terebellina mackayi* (Bather) from Mt. Hutt, New Zealand (Campbell & Warren, 1965)
15: *Terebellina mackayi* (Bather) from Wairaki Hills, New Zealand (Begg *et al*., 1983)
16: *Beyrichites* sp. with from Keskain Formation, Misool Archipelago (this study)

Ladino-Carnic Atsu Series and *Daonella yoshimurai* zone of Kobayashi and Tokuyama (1959).

Beyrichites (B.) yuati Skwarko (1973) from Late Scythian to Anisian of New Guinea has a similar whorl cross section and suture pattern with 4 lateral saddles in addition to the ventral and internal lobes and comparable in size with the Misool specimen. *B. falciforme* Smith (1914) has a simple suture. *B. (B.) kesava* (Diener, 1908) from Himalaya has a more acute angle on the venter.

In Vietnam, *Beyrichites* sp. has been recorded from Anisian strata (Vu Khuc *et al*. 1965). Hirsch (1977) reported *Beyrichites cognatus* from Late Anisian strata of Catalogne (Spain). *Beyrichites (B.) srikanta* Diener from Changwat Lampang, Thailand, is also Anisian (Chonglakmani, 1981) in age.

Based on the association of bivalve *Daonella (D.) lilintana* and ammonite *Beyrichites* sp. it can be concluded that the age of the *Terebellina mackayi* bed in Misool Archipelago is Anisian to Ladinian where the older and the younger species are not identified so far.

CONCLUSION

Terebellina mackayi is rather enigmatic tube fossil having agglutinated tube wall composed of mainly quartz grains held together by a siliceous cement. The specimens commonly occur either as current reworked bedding plane assemblages or as obliquely oriented assemblages within beds. They probably lived vertically in the sediment and were suspension feeders.

This species appears to have occupied parts of the sea floor where finer grained, organically rich black silts were accumulated. This species had lived in a lower energy environment.

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