# Discovery of Late Devonian (Frasnian) conodonts from the "Sanai limestone", Guar Jentik, Perlis, Malaysia

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**Abstract**: Late Devonian (Frasnian) conodonts (*Ancyrodella, Ancyrognathus, Palmatolepis, Polygnathus, Icriodus, Ozarkodina* and *Belodella*) of *linguiformis* Zone, which includes the Upper Kellwasser Event recorded in Europe, North America, China and elsewhere, are for the first time recorded from Perlis, Malaysia. The conodonts are fairly rich in the uppermost part of the "Sanai limestone" which was previously reported as of the upper part of Upper Devonian (Famennian) age. Stratigraphically it is located near the top of the Jentik Formation, unconformably overlain by the Lower Carboniferous Kubang Pasu Formation. The limestone is pelagic in nature and consists of planar bedded, grey micritic limestone, with thin shale partings and styliolites. In addition to the conodonts, the limestone contains abundant fossils of tentaculitids, straight-coned nautiloids, trilobites and bivalves. The "Sanai limestone" has a limited distribution in Malaysia and the assemblage of Malaysian Frasnian conodonts are closely compared with some conodont fauna (*linguiformis* Zone) of northwestern Thailand.

Keywords: Malaysia, Late Devonian, Frasnian, conodonts

# INTRODUCTION

Late Devonian (Frasnian) conodonts have not been previously reported from Perlis, Malaysia, in fact even the presence of Late Devonian conodonts (asymmetricus Zone) were described from the Public Works Department Quarry, Gunong Kantang, District of Kinta, Perak, Malaysia (Lane et al., 1979). Meor & Lee (2002) had mapped the area in this study and first proposed the Jentik Formation with a brief description of the "Sanai limestone" and consequently, the limestone has been described in detail (Meor & Lee, 2003). Field trips were carried out in 2011 to 2012 at Hill B locality, in the Kampung Guar Jentik by two of us (AKA & MHH) and some postgraduate and undergraduate students from the Geology Department, University of Malaya (Mahfuzah, Atirah, Zahid and Kadeah). The comprehensive reports on the stratigraphy of the Hill B sections at Guar Jentik, produced by Meor (2004), Meor & Lee (2003, 2005) and Noor Atirah (2010) are essentially being used as the frame of the present report.

#### **"THE SANAI LIMESTONE"**

The "Sanai limestone" (Meor & Lee, 2003) was named after Guar Sanai ridge, in Kampung Guar Jentik, Beseri District, Perlis, just south of the Timah Tasoh Dam, approximately 10 km north of Kangar (Figure 1). The section exposed in the northwestern part of the ridge is about 50m thick and the beds dip about 60° towards northeast. It consists of fine-grained limestone. Fresh samples are light grey in colour, weathering to reddish white. Large, black coloured mottles in the rock may be impurities of either carbonaceous or intraclastic material. Large bivalve shells and cephalopod fossils are commonly found in it. Petrographically, the limestone is a sparse biomicrite, or wacke, with skeletal grains representing crinoid, trilobite, tentaculitid and ostracod fossils (Meor & Lee, 2003).

The limestone contains abundant pelagic fossils including tentaculitids, conodonts, straight-coned nautiloids together with some ostracods and trilobites. The depositional environment is interpreted as relatively deep water marine. The limestone shows many sedimentary features of deeper water, pelagic limestone facies, including the fine-grained, thin-bedded nature of the limestone with shale partings and the predominance of pelagic fossils (Scholle *et al.*, 1983). The conodonts give further support to this interpretation. Following the conodont biofacies classification of Sandberg & Dreesen (1984), the palmatolepid-polygnathid association (most abundant conodonts in the section) is restricted to their biofacies II, which indicates a slope to basin environment.

The unit is strictly confined to Hill B and stratigraphically restricted laterally. The lithologic boundaries of the "Sanai limestone" is marked by two unconformities with the Lower Devonian Timah Tasoh Formation below and the Lower Carboniferous Kubang Pasu Formation) above in this area (Figure 2).

#### MATERIAL AND METHODS

A number of spot samples were first collected from the prominent limestone outcrops occurring within the "Sanai Limestone" in 2011. Preliminary work on the conodonts from the "Sanai limestone" in Guar Jentik showed that they are richest in the top section (Table 1) with 50 conodonts per kilogram of the samples, especially in palmatolepids and polygnathids. More selective re-collecting of previously collected limestone outcrops was made during the second trip in 2012. The detrital limestones from the sequence were sampled between 3 to 10 meter intervals or at closer when necessary. Twenty two samples with an average weight of 10kg from three biostratigraphic sections at Hill B (B1-3) were collected (Table 1). Conodonts were richest in the light grey, fine-grained limestone containing 2043 specimens from 80 kg of samples. Laboratory work and conodont taxonomy were undertaken at Geology Department, University of Malaya. The limestone samples were leached in 60 % industrial acetic acid for a period of two days. The dissolved material was then sieved. Mesh of 16 microns was set up over 180 microns mesh. The residues were thoroughly washed. The mixed solution was then slowly poured through the sieves. Any residue in upper part sieve is returned to a plastic container for further acid treatment. The residue was dried overnight on a hot plate at a very low setting or under a heat lamp or in low-temperature oven. The conodonts were picked from the dried residues under a binocular microscope and stored in wall slides.

The photographs of the conodonts were taken using a digital camera (Nikon D300) attached to a Nikon Opthiphot microscope illuminated using a Nikon fiber optic light source. The camera was connected to a computer and the exposure was set manually using the software Nikon Camera Control Pro. The microscope stage was adjusted until the top-most part of the conodont is in focus and a photograph was taken. The stage was then raised so that a slightly lower part of the conodont is in focus and another photograph was taken. This was repeated until the lowest-most part of the conodont was photographed. Generally, for a single conodont, between



Figure 1: Location map of Hill B, Guar Jentik, Perlis, Malaysia and outcrop of the Sanai Limestone.

10 to 20 photographs, each focused at different parts of the conodont were taken. These photographs were merged using the focus stacking software Combine ZM, which produce a sharp image of the whole conodont.

# SANAI CONODONT FAUNAS

The conodonts examined in this study and figured specimens are housed in the Department of Geology, University of Malaya (prefix UM). The zonal classification of Frasnian conodont zones used in this paper follows (Klapper & Becker, 1999, Text-fig. 1).

One conodont zone, *linguiformis* Zone has been recognized in the three measured stratigraphic sections sampled for conodonts (B1, B2, and B3) (Figs 1&3). The section B1 is in the southern part of the outcrop at Hill B where there is a clear lithologic contact between the "Sanai limestone" and the underlying Lower Devonian Timah Tasoh Formation. The section B2 is through the larger "Sanai limestone" lens where the base of the limestone is faulted, and B3 at northern part of Hill B (Figure 3). Conodonts recovered from the measured sections indicate that the "Sanai limestone" represents only one conodont zone, *linguiformis* Zone of Upper Frasnian age. The yields are low in the lower beds (B1-42, B2-1, 2) become more common in beds B2-2, 5 and are highest in bed B3 at the top of the section. The systematic study of the Sanai conodonts is in progress.

The stratigraphically lowest sample (B1-42) at 2 m above the base of section B1, produced a useful single conodont, *Palmatolepis linguiformis* Müller (1956), the zonal form for the uppermost zone (*linguiformis* Zone) of Frasnian, and (B2-1) at 3 m above the base of section B2, contains five specimens of *Ozarkodina* sp. and one *Belodella* sp. with no other conodonts occuring in this level. The conodonts are barren in other two beds of the "Sanai limestone" (B1-45, 48) in section B1. The sample from bed B2-2, at 4m above the base of the section produced three specimens of *Palmatolepis linguiformis* co-occur with large number of *Palmatolepis hassi*, Müller & Müller,

	VISEAN	KUBANG PASU FORMATION					
	TOURNAISIAN						
D	FAMENNIAN	No record					
E		JENTIK					
v	FRASNIAN						
0	GIVETIAN						
N	GIVETIAN	No record					
I	EIFELIAN						
Α	EMSIAN						
N	PRAGIAN	Thinan Tason Formation					
14	LOCHKOVIAN						
SILURIAN	PRIDOLIAN	MEMPELAM LIMESTONE					

Figure 2: Stratigraphic units of the Guar Jentik area, Perlis, northwest Peninsular Malaysia.

Conodont zone	linguiformis										
Sample no.	B2-1	B2-2	B2-3	B2-4	B2-5	B2-6	B2-7	B2-8	B2-9	B3	
Meters above base of section	3	4	5	5.5	6	9	15	18	19	48	
Sample weight (kg)	1	3	1	1	1	1	1	1	1	70	
Ancyrodella gigas	0	0	0	0	6	0	0	0	0	23	
Ancyrodella nodosa	0	0	0	0	3	0	0	0	0	13	
Ancyrognathus asymmetricus	0	0	0	0	1	0	0	0	0	3	
Palmatolepis hassi	0	58	0	0	34	0	0	0	0	951	
Palmatolepis jamieae	0	0	0	0	12	0	0	0	0	15	
Palmatolepis rhenana	0	0	0	0	2	0	0	0	0	0	
Palmatolepis linguiformis	1	3	0	0	2	0	0	0	0	16	
Polygnathus decorosus	0	8	0	0	17	0	0	0	0	759	
Polygnathus webbi	0	3	0	0	4	0	0	0	0	8	
Icriodus alternatus	0	4	0	0	3	0	0	0	0	77	
Ozarcodina sp.	5	2	0	0	1	0	0	0	0	3	
Belodella sp.	1	0	0	0	3	0	0	0	0	2	

**Table 1:** Distribution of the conodonts in the section (B2) at lower to middle part, and B3, the topmost part of the Sanai Limestone, HillB, Guar Jentik, Perlis, northwest Peninsular Malaysia.

1957, Polygnathus decorosus Stauffer, 1938, Polygnathus webbi Stauffer, 1938, Icriodus alternatus Branson & Mehl, 1934 and Ozarkodina sp. (Table 1), suggests this particular horizon to be already within the linguiformis Zone and possibly not many metres below the Frasnian-Famennian boundary. The next sample, 6m above the base (B2-5), yielded more conodonts faunas including Ancyrodella gigas Younquist, 1947, Ancyrodella nodosa Ulrich & Bassler, 1926, Ancyrognathus asymmetricus Ulrich & Bassler, 1926, Palmatolepis linguiformis Müller, 1956, Palmatolepis hassi, Polygnathus decorosus, Polygnathus webbi, Icriodus alternatus, Ozarkodina sp., and Belodella. sp.

The conodont fauna from the higher bed of section B3 at 48 m above the base of the section, is heavily dominated by palmatolepids, polygnathids, and icriodids, and it includes the recently described *Palmatolepis linguiformis*, *Palmatolepis hassi*, *Palmatolepis jamieae*, Ziegler & Sandberg, 1990, *Polygnathus decorosus*, *Ancyrognathus gigas*, *Ancyrognathus nodosa*, *Icriodus alternatus* and *Palmatolepis rhenana* Bischoff, 1956. The two palmatolepid species, *Pa. hassi* and *Pa. rhenana* are likely to be among the few survivors from the lower level (*rhenana* Zone). All the above conodonts are illustrated in (Figures 6 & 7). It therefore appears that the "Sanai limestone" is of latest *linguiformis* Zone age.

# DISTRIBUTION OF FRASNIAN CONODONTS IN SOUTHEAST ASIA

Apart from the "Sanai Limestone" at Hill, B, Guar Jentik, Perlis, the Frasnian conodonts are only known from only one locality in Perak, Peninsular Malaysia. Lane *et al.* (1979) first reported and described Devonian and Carboniferous conodonts from a slightly metamorphosed sequence of carbonates at the Public Works Department Quarry at Gunong Kantang in Perak. The fauna includes standard Euro-North American conodont zones from the late Lower Devonian *gronbergi* Zone to the early Upper Devonian *asymmetricus* Zone and Carboniferous faunal assemblages of late Visean or early Numurian age. They also described a new conodont genus (*Klapperina*, Lane *et* 



**Figure 3:** a. Stratigraphic measured section across Hill B showing locations of the conodont sampling, b. Sketch of outcrops at Hill B.

*al.*, 1979) of Frasnian age. The Late Devonian (Frasnian-Famennian) conodonts (late *rhenana* to middle *triangularis* Zones) are known from the Thong Pha Phum area, western Thailand (Savage *et al.*, 2006). The Frasnian-Famennian conodonts, mostly of cosmopolitan species are abundant with 80 conodont faunas from 10 zones (late *rhenana*, *linguiformis, triangularis, crepida, rhomboidea, marginifera, trachytera, postera, expansa,* and *praesulcata* Zones) from the Mae Sariang section of Northwestern Thailand (Savage, 2013).



C. bed B2-2; D. bed B2-5; E. B2-9 (black shale) and outcrops of the topmost part.



MP – Mempelam Limestone (Silurian), TT – Timah Tasoh Formation, black shale (Lower Ancyrodella gigas Younquist, 1947; 7. Palmatolepis rhenana Bischoff, 1956; 8. Palmatolepis Müller, 1965; 2a-c. Icriodus alternatus Branson & Mehl, 1934; 3. Ozarkodina sp.; 4a,b. Figure 5: The Frasnian conodont succession at Hill B: 1a-d. Palmatolepis linguiformis jamieae Ziegler & Sandberg, 1990; 9. Ancyrognathus asymmetricus Ulrich & Bassler, 1926; Polygnathus decorosus Stauffer, 1938; 5. Ancyrodella nodosa Ulrich & Bassler, 1926; 6. Devonian), SN – "Sanai Limestone" with black shale intercalations (Upper Devonian), KP 10. Polygnathus webbi Stauffer, 1938; 11. Polygnathus sp. (conodont figures not to scale). Kubang Pasu Formation, sandstone – shale interbeds (Lower Carboniferous).



**Figure 6:** Frasnian (*linguiformis* Zone) conodonts of the Sanai Limestone, Guar Jentik, Perlis, Malaysia. 1A, B; 6A, B) *Ancyrodella gigas* Younquist, 1947, 1A, B) oral views of P element UM10565; 6A, B) oral and aboral views of P element UM10567; 2A, B. *Ancyrodella nodosa* Ulrich & Bassler, 1926, oral and aboral views of P element UM10566; 3A, B) *Ozarkodina* sp. A, lateral views of P element UM10576; 13 A, B) *Ozarkodina* sp. B, lateral views of P element UM10577; 4A, B) *Polygnathus webbi* Stauffer, 1938, aboral and oral views of P element UM10575; 5A-C; 8A, B) *Icriodus alternatus* Branson & Mehl, 1934, 5A-C) aboral and lateral views of P element UM10569; 7A-C) *Ancyrognathus asymmetricus* Ulrich & Bassler, 1926, aboral, lateral and oral views of P element UM10570; 9A, B; 14A, B) *Pelmatolepis hassi* Müller & Müller, 1957, 9A, B) oral and aboral views of P element UM10574; 10A, B) *Polygnathus decorosus* Stauffer, 1938, lateral and oral views of P element UM10572; 11A, B) *Belodella* sp., lateral views of coniform element UM10588 ; 12A, B) *Pelmatolepis jamieae* Ziegler & Sandberg, 1990, oral and aboral views of P element UM10571; 15A, B) *?Polygnathus* sp., aboral and oral views of P element UM10589.

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**Figure 7:** Frasnian (*linguiformis* Zone) conodonts of the Sanai Limestone, Guar Jentik, Perlis, Malaysia. 1A, B; 2; 3A, B; 4A, B; 5) *Palmatolepis linguiformis* Müller, 1965, 1A, B) oral and aboral views of P element UM10590; 2) oral view of P element UM10591; 3A, B) oral and aboral views of P element UM10592; 4A, B) oral and aboral views of P element UM10593; 5) *Palmatolepis* sp., aboral view of P element UM10594; 6A, B) *Ancyrognathus asymmetricus* Ulrich & Bassler, 1926, oral and aboral views of P element UM10595; 7A, B) *Palmatolepis rhenana* Bischoff, 1956, oral and aboral views of P element UM10596; 8) *Polygnathus decorosus* Stauffer, 1938, oral view of P element UM10597; 9A, B) *Ancyrodella* sp., oral and lateral views of P element UM10598; 10A, B) Icriodus alternatus Branson & Mehl, 1934, oral and lateral views of P element UM10599; 11) *Ozarkodina* sp. B, lateral view of P element UM10600; 12) *Bellodella* sp., lateral view of coniform element UM10601.

## CONCLUSION

Available conodont data indicate that at Hill B, Kg. Guar Jentik, Perlis, the "Sanai limestone" is of latest Frasnian (latest linguiformis Zone age). The conodonts confirm that the recognized species are mostly cosmopolitan. The Hill B-Sanai section includes the global Upper Kellwasser event that marks at the top of Frasnian (Figure 5) recorded in other part of the world. There is no conodont evidence which may represent the presence of Famennian age in this section. This suggests that there may be two regional unconformities present. The first is between this limestone and Timah Tasoh Formation of Lower Devonian age below, and the second is with the Kubang Pasu Formation of Lower Carboniferous age above. The Perak conodonts of early Upper Devonian (asymmetricus Zone) are much earlier than that of the Perlis late Upper Devonian (late linguiformis Zone) which are in part contemporary to those of north-western Thailand.

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