

## First hybodont shark assemblage from the Cretaceous of Malaysia: updated report

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**Abstract** - A new hybodont assemblage was found in Cretaceous freshwater sediment of Peninsular Malaysia. This is the first discovery of Mesozoic nonmarine fishes from Malaysia. A faunal comparison with the Khorat Group has also been carried out. Approximately 100 specimens were prepared and examined in this study. The Malaysian material provides a finer understanding of morphological variation in the teeth of freshwater hybodont sharks from Southeastern Asia, as well as of their distribution. It points out for the first time to a biostratigraphical correlation between the Cretaceous freshwater deposits in Peninsular Malaysia with those of the Khorat Group in Thailand.

**Keywords:** Cretaceous, *Heteroptychodus*, *Isanodus*, *Mukdahanodus*, Malaysia

### 1. Introduction

A new hybodont assemblage was found in Cretaceous freshwater sediment of Peninsular Malaysia. This is the first discovery of Mesozoic nonmarine fishes from Malaysia. The assemblage consists mainly of isolated teeth, scales, coprolites and a centrum. Since the last preliminary report (Teng *et al.*, 2015), detailed comparative studies have been carried out to understand the dental characteristics and heterodonty patterns of the hybodonts from Malaysia. A faunal comparison with the Khorat Group has also been carried out.

### 2. Material and method

Approximately 100 specimens were prepared and examined in this study. The fossil preparation was done by removing matrix mechanically using sharp tools under a stereo microscope. Paraloid and liquid-form super glue were applied on the specimens to strengthen them. Photos of the specimens were taken using a Nikon D300 DSLR camera and a Field Emission Scanning Electron Microscope (FESEM).

### 3. Results

The Malaysian assemblage yielded four species of hybodont, namely *Heteroptychodus kokutensis* Cuny, Laojumpon, Cheychiw and Lauprasert, 2010, *Isanodus paladeji* Cuny, Suteethorn, Khamha, Buffetaut and Philippe, 2006,

*Mukdahanodus trisivakulii* Cuny, Cavin and Suteethorn, 2009 and *Hybodus* sp.

Based on comparative studies, all material of *Heteroptychodus* in the Malaysian assemblage is better attributed to a single species, *H. kokutensis* instead of two species as previously reported. However, although the Malaysian specimens possess the main characteristics of *H. kokutensis*, they also exhibit some features that are only seen in *Heteroptychodus steinmanni* Yabe and Obata, 1930 and *Heteroptychodus chuvalovi* (Nessov, Glückman and Mertiniene, 1991, in Mertiniene and Nessov, 1991). This seems to have blurred the diagnostic characteristics of each species and complicate the identification of the Malaysian form.

Another important species of the Malaysian assemblage is *Isanodus paladeji*. The Malaysian specimens support a strong heterodonty pattern of the species as previously proposed in Cuny *et al.* (2006) and Khamha *et al.* (2016). Nevertheless, the new material suggests a gradient-monognathic heterodonty as opposed to a non-gradient monognathic heterodonty as interpreted by previous workers. Finally, *Mukdahanodus trisivakulii* from Malaysia demonstrates some variations when compared with the Thai specimens, namely an additional cusplet under the main cusp and a less prominent notch.

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#### 4. Discussion

The Malaysian assemblage shares at least three species of hybodont sharks, namely *H. kokutensis*, *I. paladeji* and *M. trisivakuli*, with the Sao Khua Formation. These three species were hitherto all endemic to Thailand. Two of them (*H. kokutensis* and *I. paladeji*) are also shared with the Sao Khua equivalent deposit of Kut Island located offshore SE Thailand. On the contrary, no obvious similarities are notable with hybodonts from either the Phu Kradung Formation (?Late Jurassic–Barremian) or the Khok Kruat Formation (Aptian–Albian) of the Khorat Group (Table 1). The similarities of the Malaysian fauna with the Sao Khua fauna indicate a strong linkage between them, suggesting the fact that they were most probably coeval during the Early Cretaceous (Barremian–early Aptian).

#### 5. Conclusion

The Malaysian material provides a finer understanding of morphological variation in the teeth of freshwater hybodont sharks from Southeastern Asia, as well as of their distribution. It points out for the first time to a biostratigraphical correlation between the Cretaceous freshwater deposits in Peninsular Malaysia with those of the Khorat Group in Thailand. However, as highlighted above, variations exist between the Malaysian and Thai species. They are for the time being interpreted as intraspecific variations, but more studies are necessary to decide whether they are due to geographical differentiation or if they could be better explained by an age difference between the faunas.

**Table 1.** Distribution of freshwater hybodont sharks in Thailand and Malaysia.

		Thailand				Malaysia
		Khok Kruat Fm.	Sao Khua Fm.	Ko Kut beds	Phu Kradung Fm.	Pahang beds (this study)
Hybodont sharks	<i>Hybodus</i> spp.	○	○	○	○	○
	<i>Thaiodus ruchae</i>	○				
	<i>Acrorhizodus khoratensis</i>	○				
	<i>Khoratodus foreyi</i>	○				
	<i>Heteroptychodus steinmanni</i>	○	?		○	
	<i>H. kokutensis</i>		○	○		○
	<i>H. cf. kokutensis</i>				○	
	<i>Mukdahanodus trisivakulii</i>		○			○
	<i>Lonchidion khoratensis</i>		○			
	<i>Lonchidion</i> sp.				○	
	<i>Parvodus</i> sp.		○			
	<i>Isanodus paladeji</i>		○	○		○
	<i>I. nongbualamphuensis</i>		○			
	<i>Jaiodontus</i> sp.				○	
	<i>Acrodus kalasinensis</i>				○	
<i>Acrodus</i> sp.				○		

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