

ธรณีวิทยาและบรรพชีวินวิทยาของหอยสกุลเลปโตดัส ไฟลัมแบรคิโอโพดา
จากจังหวัดเพชรบูรณ์ในภาคกลางของประเทศไทย

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ปีการศึกษา 2554

GEOLOGY AND PALEONTOLOGY OF *LEPTODUS*, BRACHIOPODA
FROM CHANGWAT PHETCHABUN IN CENTRAL THAILAND

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A Report in Partial Fulfillment of the Requirement
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Advisor's signature.....

(Dr. Yoshio Sato)

ชื่อโครงการ : ธรณีวิทยาและบรรพชีวินวิทยาของหอยสกุลเลปโตดัส ฟิลัมแบรคิโอพอดา

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บทคัดย่อ

เลปโตดัส เป็นชื่อสกุลหนึ่งของหอยแบรคิโอพอดที่เป็นซากดึกดำบรรพ์ดรรชนีในยุคเพอร์เมียนตอนกลาง โดยฟอสซิลนี้จะเก็บรักษาส่วนของโครงสร้างอ่อนไว้ ซึ่งต่างจากหอยแบรคิโอพอดสกุลอื่นที่มักจะมีโครงสร้างแข็งเป็นฟอสซิล เลปโตดัสนี้ได้ถูกนำมาศึกษาโดยใช้ความรู้ทางธรณีวิทยา และบรรพชีวินวิทยา เพื่อสร้างสภาพแวดล้อมโบราณและระบบนิเวศน์โบราณของมัน โดยพื้นที่ศึกษาอยู่ในบางส่วนของอำเภอบึงสามพันและอำเภอนองไผ่ ในจังหวัดเพชรบูรณ์ มีการลำดับชั้นหินและเก็บตัวอย่างจากการออกภาคสนาม หลังจากนั้นนำตัวอย่างหินมาตัดเพื่อศึกษาสัณฐานวิทยาได้กล้องจุลทรรศน์ในห้องปฏิบัติการ

ผลการศึกษาพบหอยเลปโตดัสทั้งหมด 69 ตัว มีขนาดเฉลี่ยอยู่ที่ความยาวประมาณ 13-25 มิลลิเมตร โดยสามารถระบุชนิดได้เป็น *L. sp. Cf. L. nobilis* (Waagen, 1883) ถูกพบในหินปูนที่มีแร่ดินปนอยู่ในเนื้อ โดยหินปูนมีสีสดสีเทาดำ และมีสีฝุ่นสีเทาน้ำตาล และพบในหินโคลนถึงหินดินดานที่มีความแข็งมากเนื่องจากซิลิกา ฟอสซิลอื่นที่พบร่วมได้แก่ไบรโอซัว, สาหร่าย, ไคนอยด์, หอยสองฝาเท่า, และหอยแบรคิโอพอดสกุลอื่น โดยจากผลของฟอสซิลที่พบร่วม, การลำดับชั้นหิน และศึกษาสัณฐานวิทยาสามารถบอกสภาพแวดล้อมโบราณของหอยสกุลนี้ได้ว่าอยู่ในบริเวณน้ำทะเลตื้น ในสังคมของเทือกประการังสันดอน โดยเกี่ยวข้องกับไบรโอซัว และฟอสซิลอื่นๆที่พบ

Title : GEOLOGY AND PALEONTOLOGY OF *LEPTODUS*,
BRACHIOPODA FROM CHANGWAT PHETCHABUN IN CENTRAL THAILAND

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Abstract

Important Middle Permian index fossil of brachiopod, *Leptodus*, which preserve with softpart instead hard part like another one's genus is studied by geology and paleontology for reconstruct paleoenvironment and paleoecology. Part of Amphoe Bueng Sam Pan and Amphoe Nong Phai in Changwat Phetchabun is study area. Lithostratigraphy was constructed and the samples were collected in field work. After that was prepared and studied thin section in laboratory.

In fossil localities found 69 *Leptodus*, size frequency length is about 13-15 mm. Identified to *L. sp.* Cf. *L. nobilis* (Waagen, 1883), that found in muddy limestone, fresh color is grey-black, weather color is brownish gray. And found in silicified mudstone too. The associated fossils are bryozoa, algae, crinoids, bivalve, and another genus of brachiopod. By all result, associated fossils, lithostratigraphy and thin section can reconstruct paleoenvironments to shallow marine, in barrier reef top community.

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The size frequency range is approximately 13 - 23 mm.

CHAPTER 1

ABOUT THE PROJECT AND DATA

- 1.1 General Statement
- 1.2 Objectives
- 1.3 Scope of Work
- 1.4 Study Area
- 1.5 Expected Results
- 1.6 Methodology

1.1 General statement

Leptodus, Brachiopoda, Class Articulata, Superfamily Lyttoniaceae (Williams, 1965). *Leptodus* is an extinct genus of articulate brachiopods, of the Permian Period (299 million to 251 million years ago). It is a very specialized form characterized by an aberrant morphology, had an Oysterlike pedicle valve, which anchored the shell to the substrate and was probably attached to other shells by the cementation. This research is to reconstruct paleoenvironments and paleoecology of *Leptodus* by using geological and paleontological studies. Facies analysis consists of identification of sedimentary structures, preparation of lithologic columnar section and petrography and the present genus is an important index fossil in Middle Permian.

1.2 Objectives

1. To analysis Size frequency of *Leptodus* from measured data of the fossil
2. To reconstruct the paleoenvironments and taphonomy of *Leptodus*
3. To reconstruct paleoautoecology while *Leptodus* were lived.

1.3 Scope of study

Investigation on lithostratigraphy from outcrops in study area, from Amphoe Bung Samphan to Amphoe NongPhai, Changwat Phetchabun has to be proceeded to provide lithostratigraphic column for reconstructing and identifying paleoenvironments. Moreover, reconstructing paleoecology, taphonomy and analyzing size frequency distribution of *Leptodus*.

1.4 Study area

Study areas are in the red box, part of topographic map scale 1:50,000, Sheet 5140I (Ban Sap Mai Deang) cover part of Amphoe Bueng Sam Phan and Amphoe NongPhai in Changwat Phetchabun.

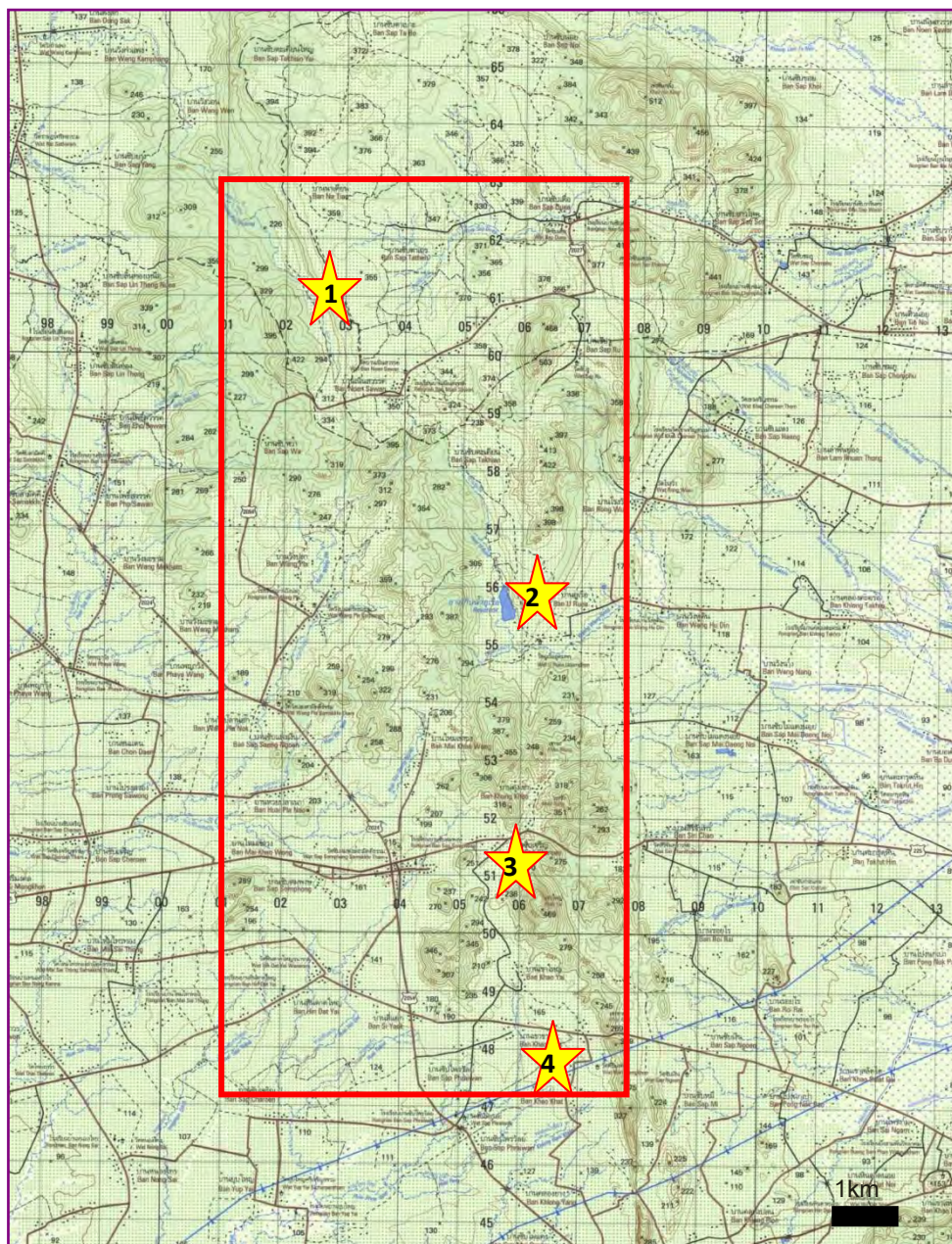


Figure 1.1) Study area (Red box) and location of fossil (Yellow stars), in Changwat Phetchabun, Central Thailand Map: Ban Sap Mai Daeng .WGS 84 Series L7018 Sheet 5140I Thailand 1:50,000.

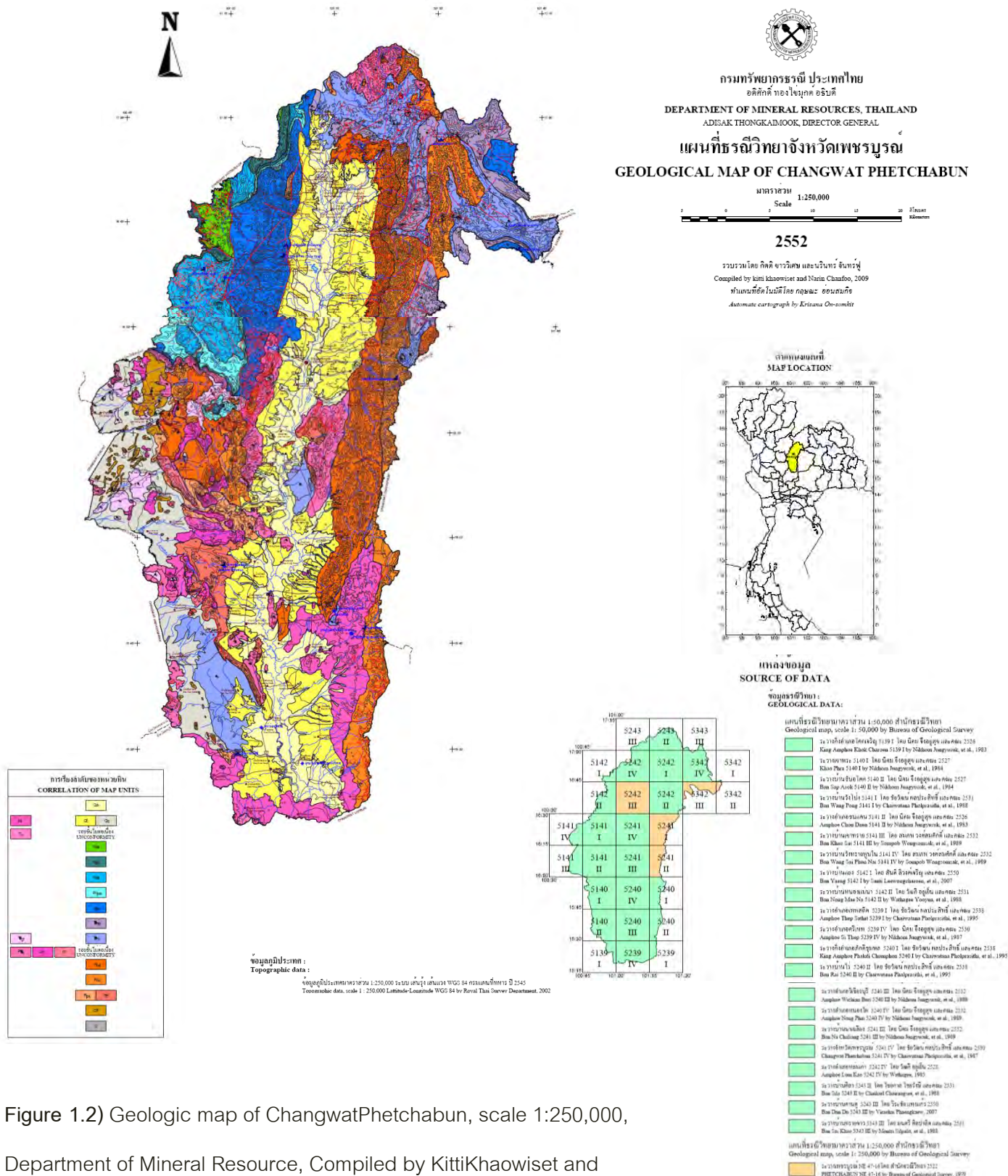


Figure 1.2) Geologic map of Changwat Phetchabun, scale 1:250,000, Department of Mineral Resource, Compiled by Kitti Khaowiset and Narin Chanfoo, 2009. Green box shows geologic map around the study

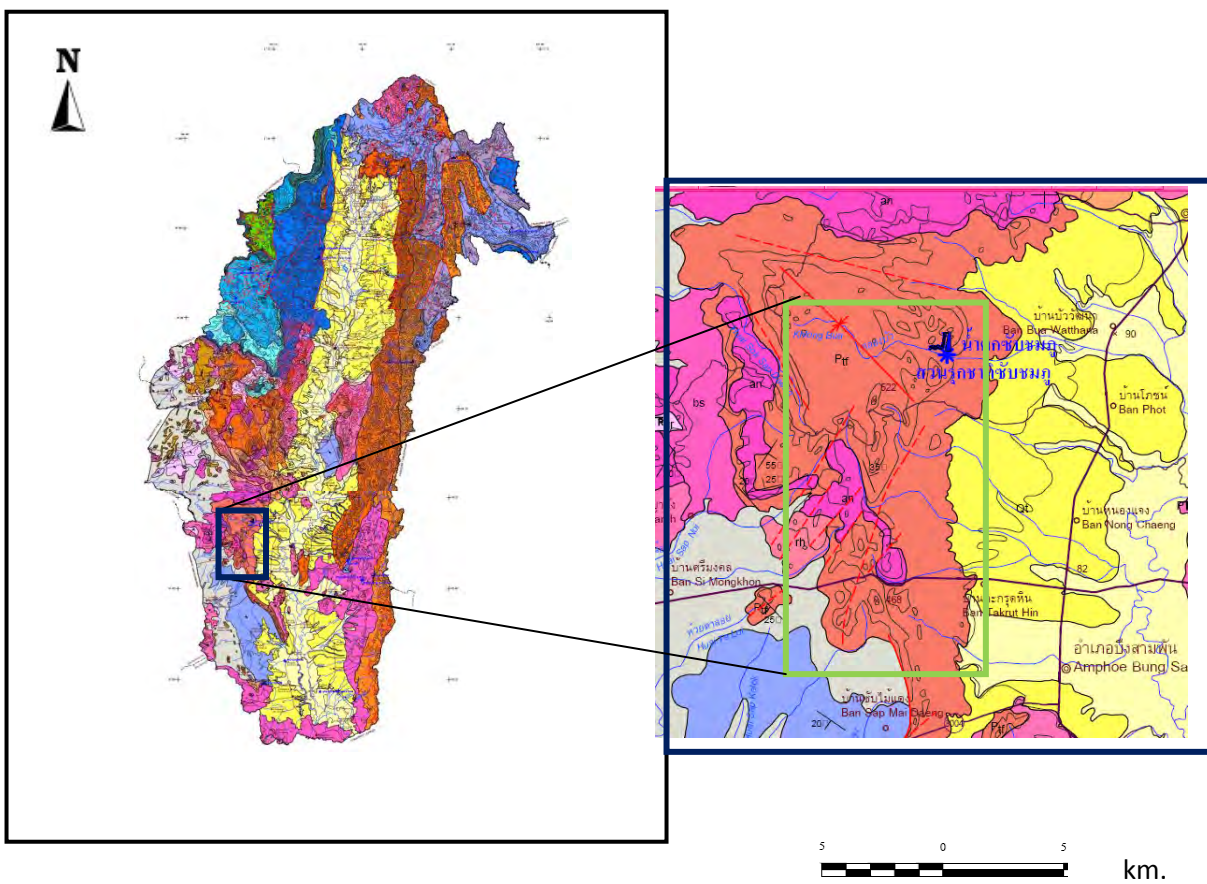


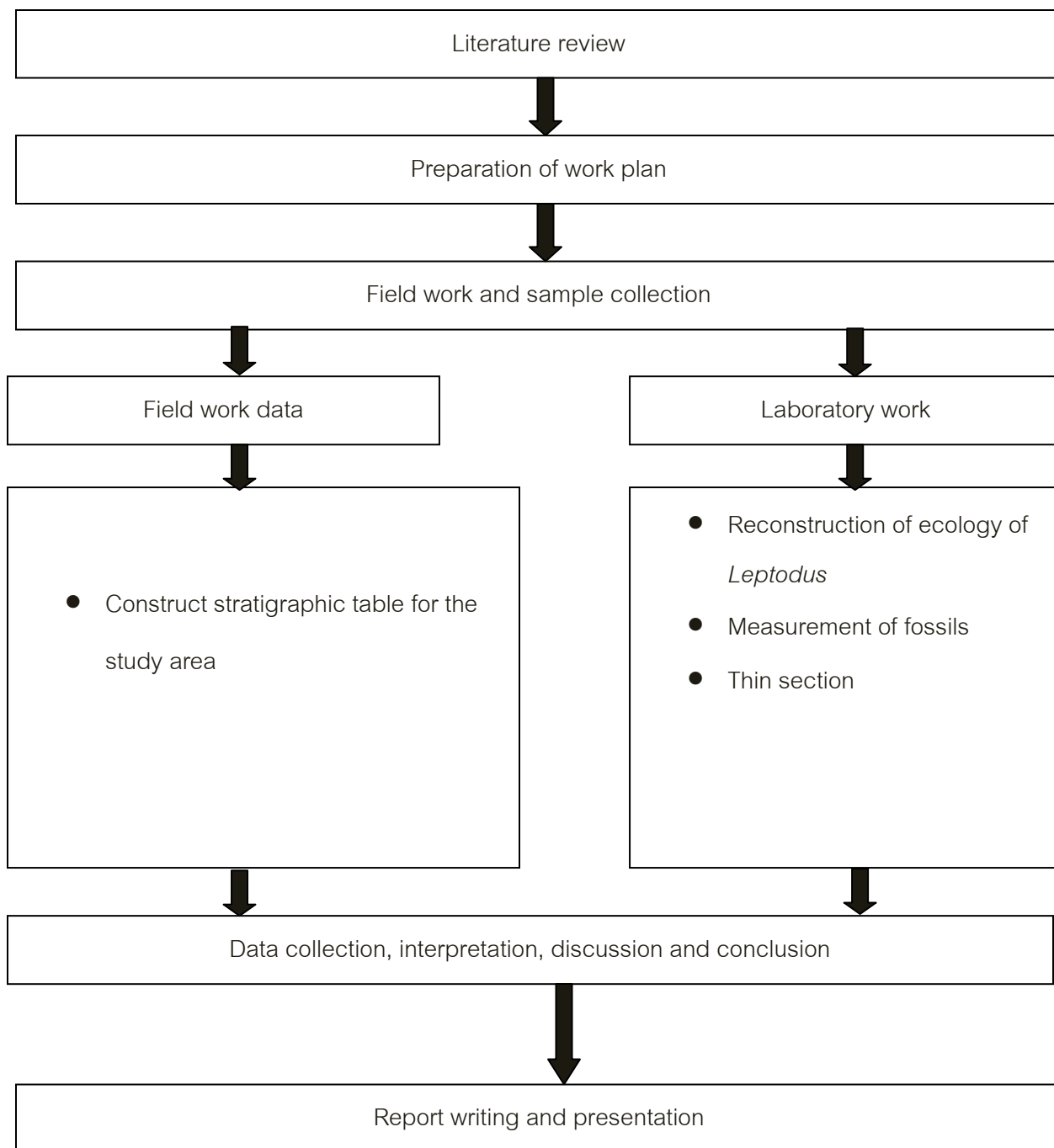
Figure 1.3) Geologic map of Changwat Phetchabun, Department of Mineral Resource and the in the green box is study area.

1.5 Expected Results

1. Size frequency of *Leptodus*
2. Paleoenvironments and taphonomy of *Leptodus*
3. Paleoautoecology while *Leptodus* were *alived*.

1.7 Methodology

Figure 1.5) Methods of study can be divided into 7 steps as summarized in the schematic diagram and detail is described below.



1. Literature review

- Study previous works that are related to this project from published papers about *Leptodus*, Geology of Phetchabun and reconstruction of paleoenvironments of *Leptodus*.

2. Preparation of work plan

- Design scope of work, methodology, and time schedule for preparation of next process.

3. Field work and sample collection

- Preparation of geologic map of the study area.
- Fix fossil localities, the stratigraphical position of the study area.
- Construct stratigraphic table for the study area.
- Collect samples to prepare thin sections for laboratory works.

4. Laboratory work

- Prepare and study thin section.
- Reconstruction of ecology of *Leptodus*.
- Measurement of fossils.

5. Discussion and Conclusion

- Collect and interpret the data from laboratory.
- Discuss and conclude all results for leading to presentation and report.

6. Writing report and Presentation.

CHAPTER 2

RESULTS

2.1 Field Investigation

2.1.1 Lithostratigraphy

2.2 Petrography

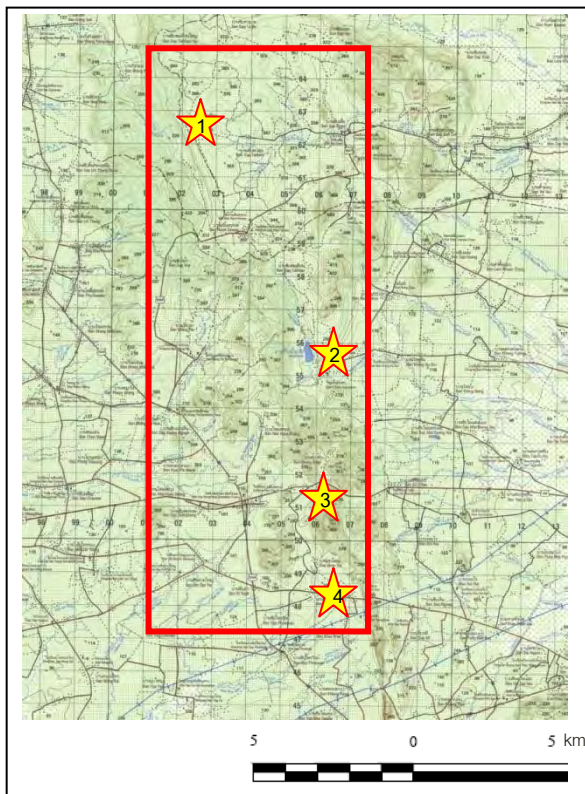
2.2.1 Thin section

2.3 Paleontological study.

2.3.1) General description of *Leptodus*.

2.3.2) Size frequency analysis of *Leptodus*.

2.3.3) Fossil list in each locality



2.1 Field Investigation

There are 4 fossil localities in study area.

The name is Ban Phot, Ban U Ruea, Khao Yai, and Khao Khad Quarry (order form North to South)

Stratigraphy of fossil localities was constructed except Ban Phot's fossil locality

Figure 2.1) The red box is study area, the yellow stars represent fossil localities which are as;

1. Ban Phot
2. Ban U Ruea
3. Khao Yai
4. Khao Khad Quarry



Figure 2.2) The Study area showing predominantly argillaceous limestone and silicified mudstone exposed.



Figure 2.3) Khao Khad Quarry representing obviously bedded argillaceous limestone interbedded with silicified mudstone.

2.1.1 Lithostratigraphy

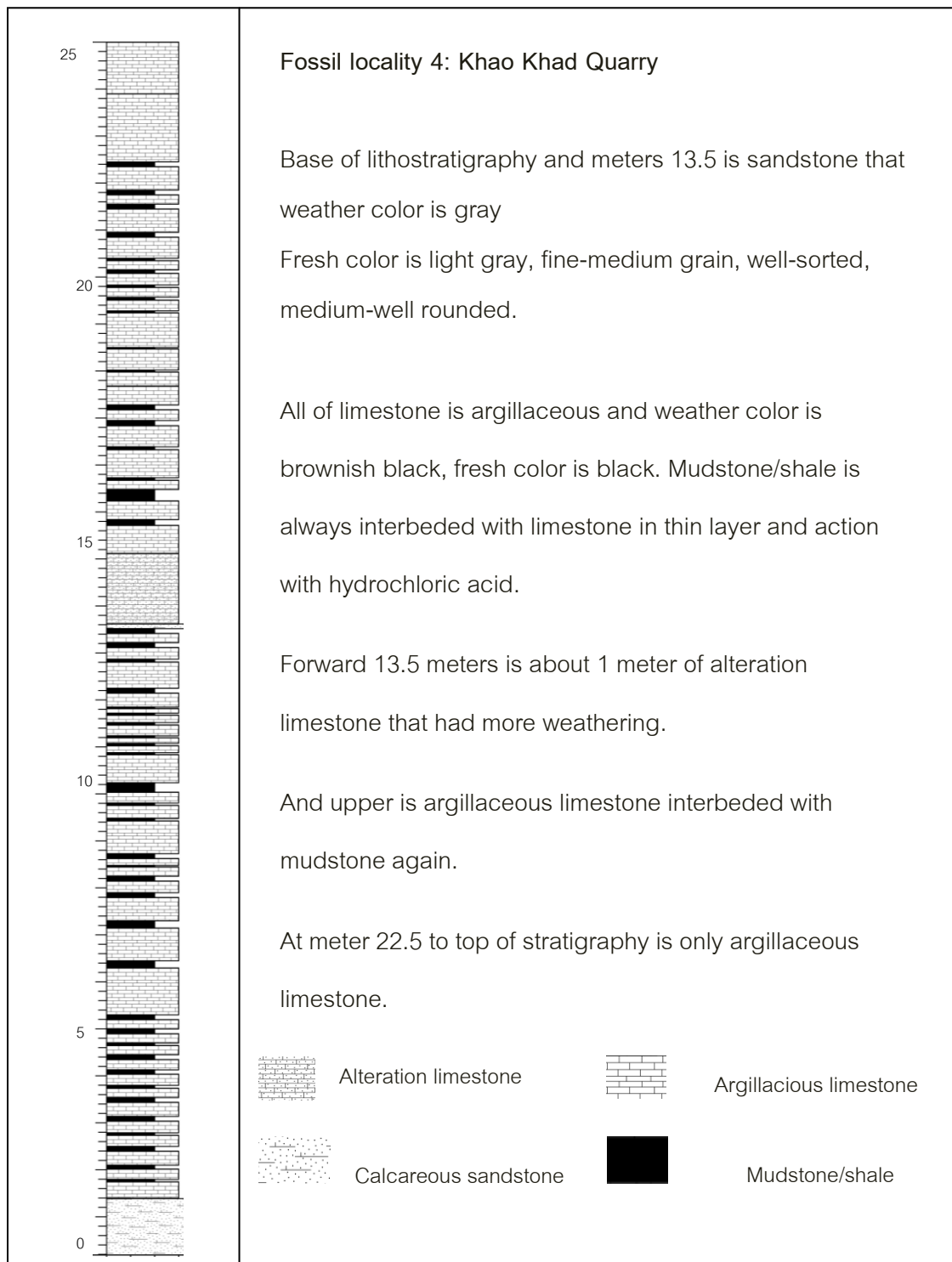


Figure 2.4) showing the lithostratigraphy in Khao Khad Quarry

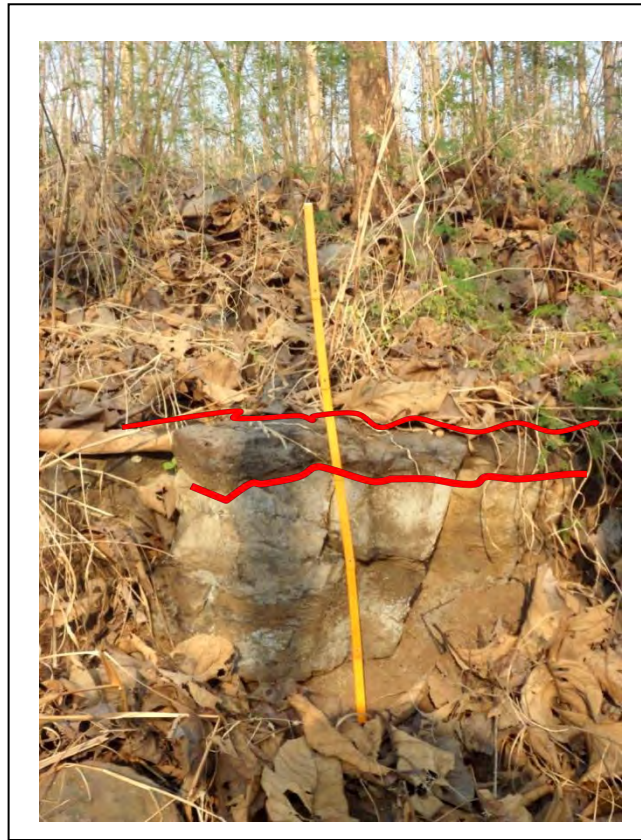


Figure 2.5) Ban U Ruea outcrop showing bedded of argillaceous limestone which is overlaid by calcareous mudstone (in red line).

Calcareous Shale/calcareous Mudstone:

Weather: medium-dark brownish gray, yellowish gray, there are *Leptodus* in this part.

Argillaceous limestone:

Weather: medium-dark purplish gray, medium-dark pinkish brown, pinkish black

Fresh: dark gray, black

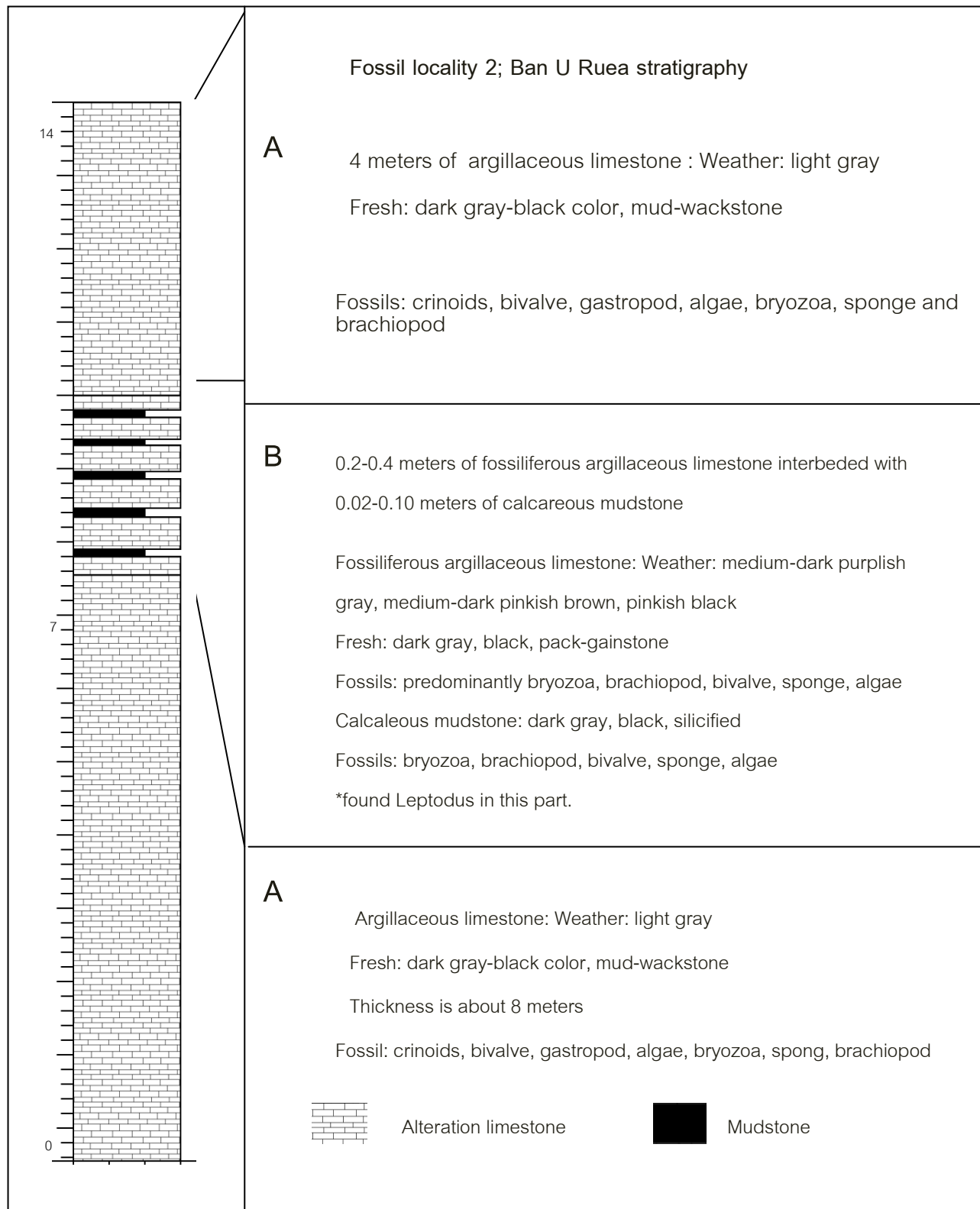


Figure 2.6) Showing the lithostratigraphy of Ban U Rea

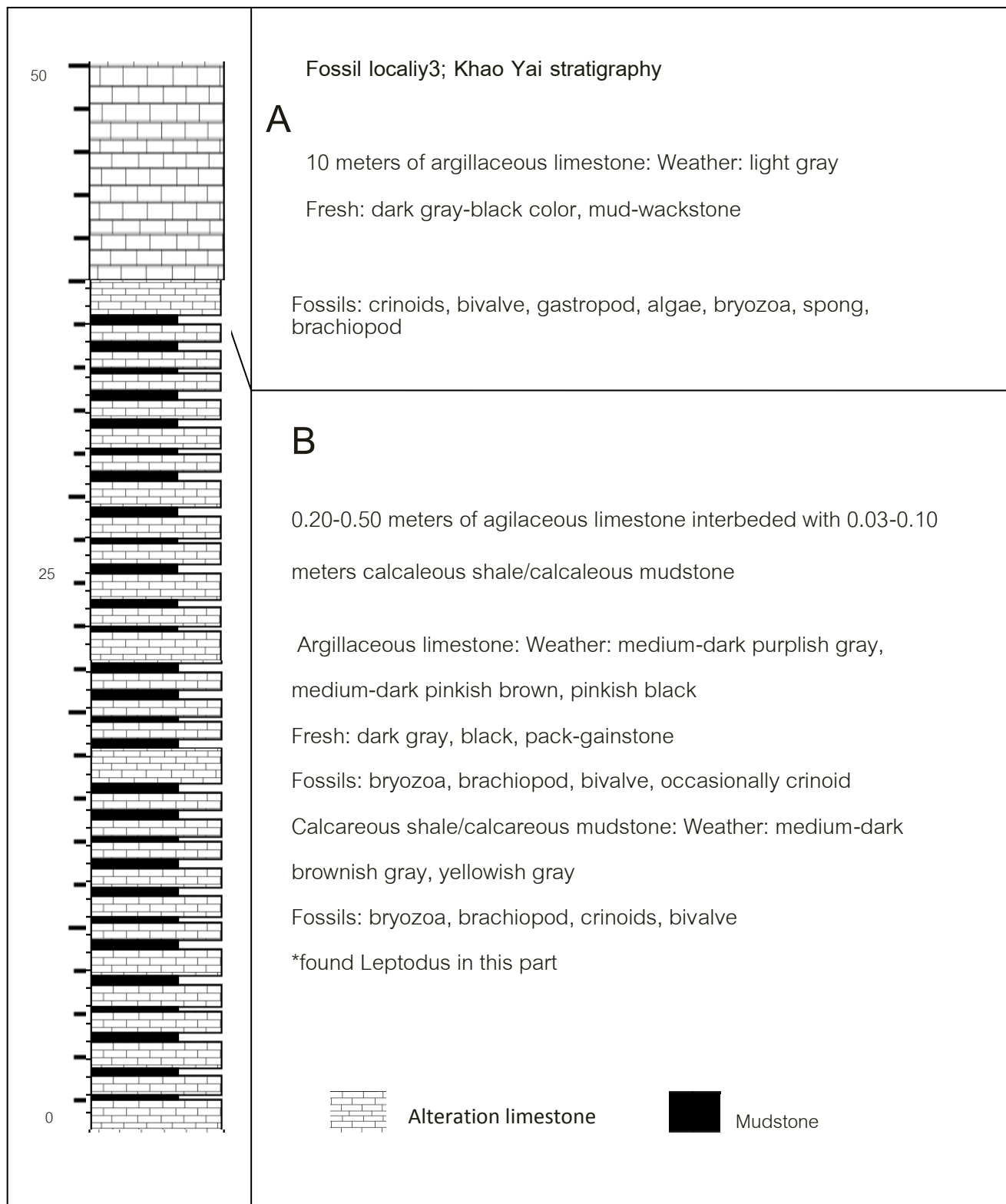


Figure 2.7) Showing lithostratigraphy of Ban Khao Yai



Figure 2.8) Khao Yai outcrop representing generally bedded argillaceous limestone interbedded with calcareous mudstone (in red line).

2.2 Petrography

2.2.1 Thin section

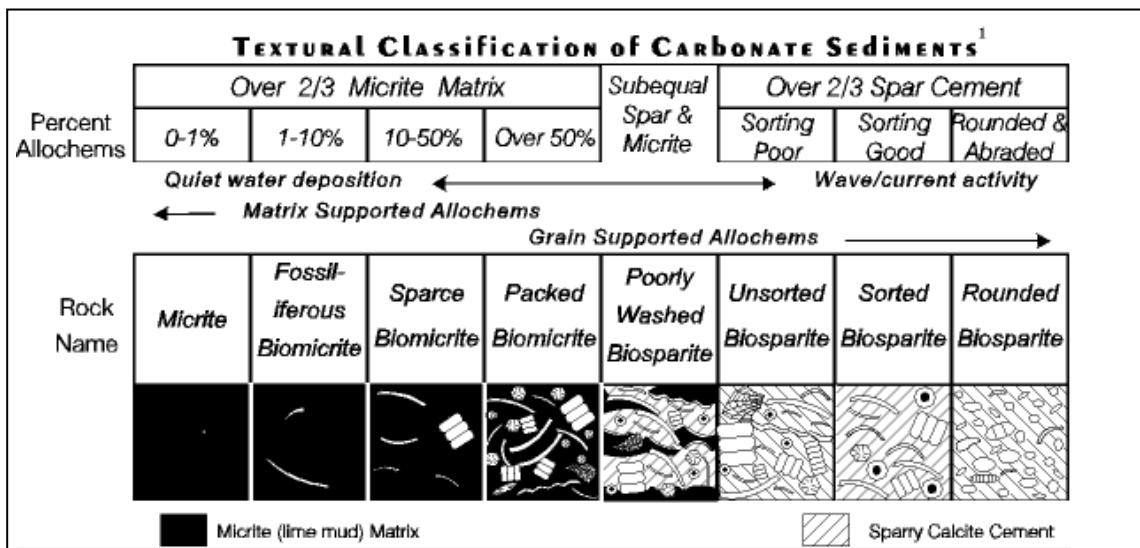
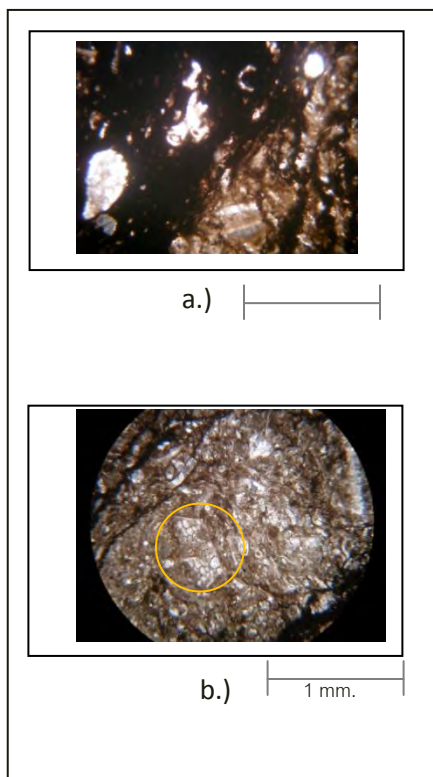


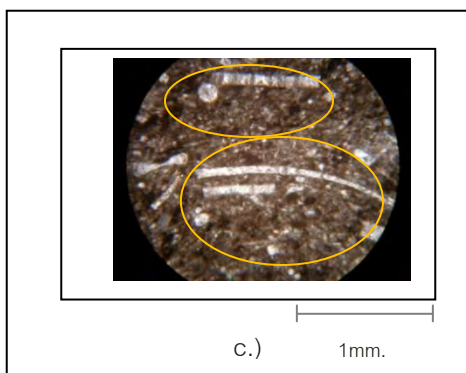
Figure 2.9) showing textural classification of carbonate sediments reference to Folk (1959)



These resulting thin sections of limestone can view under the microscope in plane-polarised light. The section shows calcite (CaCO₃), the main mineral in the rock. However, most of it is in the form of small fossil fragments (bioclasts) in a lime mud matrix (micrite)

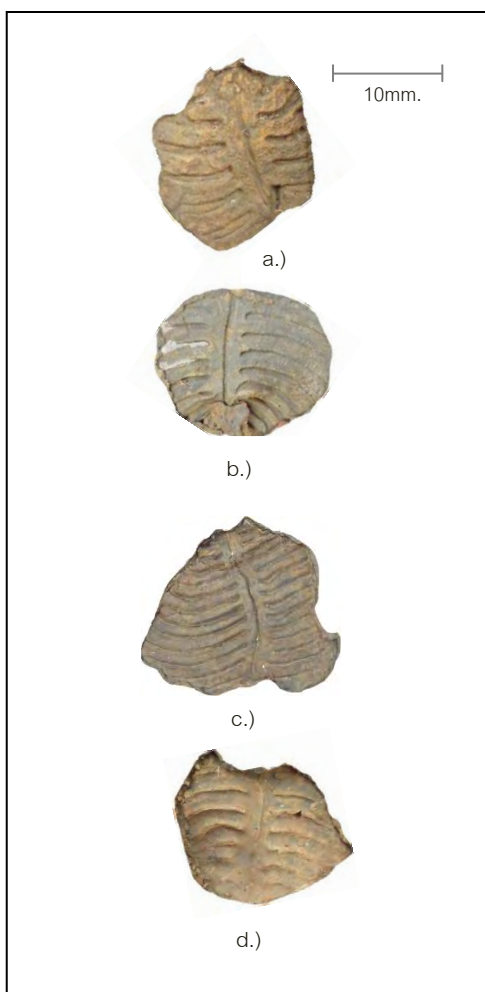
0.5mm.

Figure 2.10) showing thin section in PPL
 a.) Brachiopod and crinoids fragment in lime mud matrix
 b.) Bryozoa fragments in yellow circle



c.) Crinoid and brachiopod fragments in yellow circles

2.3 Paleontological study



2.3.1) General description of *Leptodus*.

At first, Kayser (1882) described this genus (*Leptodus*) as fish teeth by using the ill preserved specimens collected from China. After that, Kayser (1882) described this genus as Brachiopoda, *Lyttonia*, by the well preserved specimens collected from Salt Range in Islamic Republic of Pakistan. So *Lyttonia* is the synonym of *Leptodus*. Only the name *Lyttonia* remained as family name, Lyttoniidae.

Figure 2.11) Showing example of *Leptodus* which is found in each fossil locality

a); *Leptodus* in Ban Phot (fossil locality 1)

b); *Leptodus* in Khoa Khad Quarry (fossil locality 2)

c); *Leptodus* in Khoa Yai (fossil locality 3)

d); *Leptodus* in Ban U Rueva (fossil locality 4)

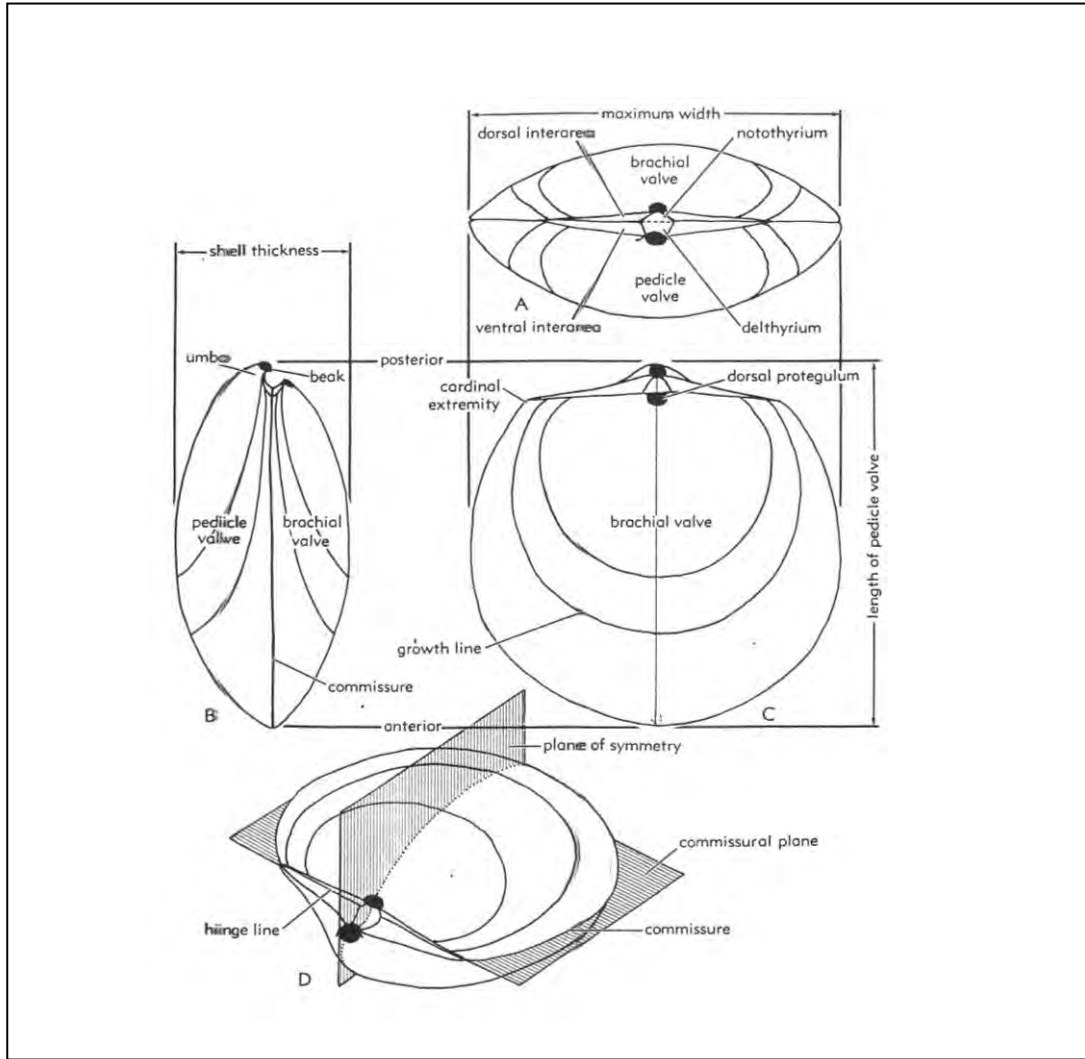


Figure 2.12) Fundamental morphology of Brachiopoda shell consists of pedicle valve and brachial valve.

Taxonomical position of *Leptodus*

1. Taxonomy

Phylum	TENTACULATA
Class	BRACHIOPODA
Subclass	ARTICULATA
Order	Strophomenida
Suborder	Oldaminidina
Superfamily	Lyttoniaceae
Genus	Leptodus (Kayser, 1882)
Species	<i>L. sp.</i> Cf. <i>L. nobilis</i> (Waagen, 1883)

2. Superfamily

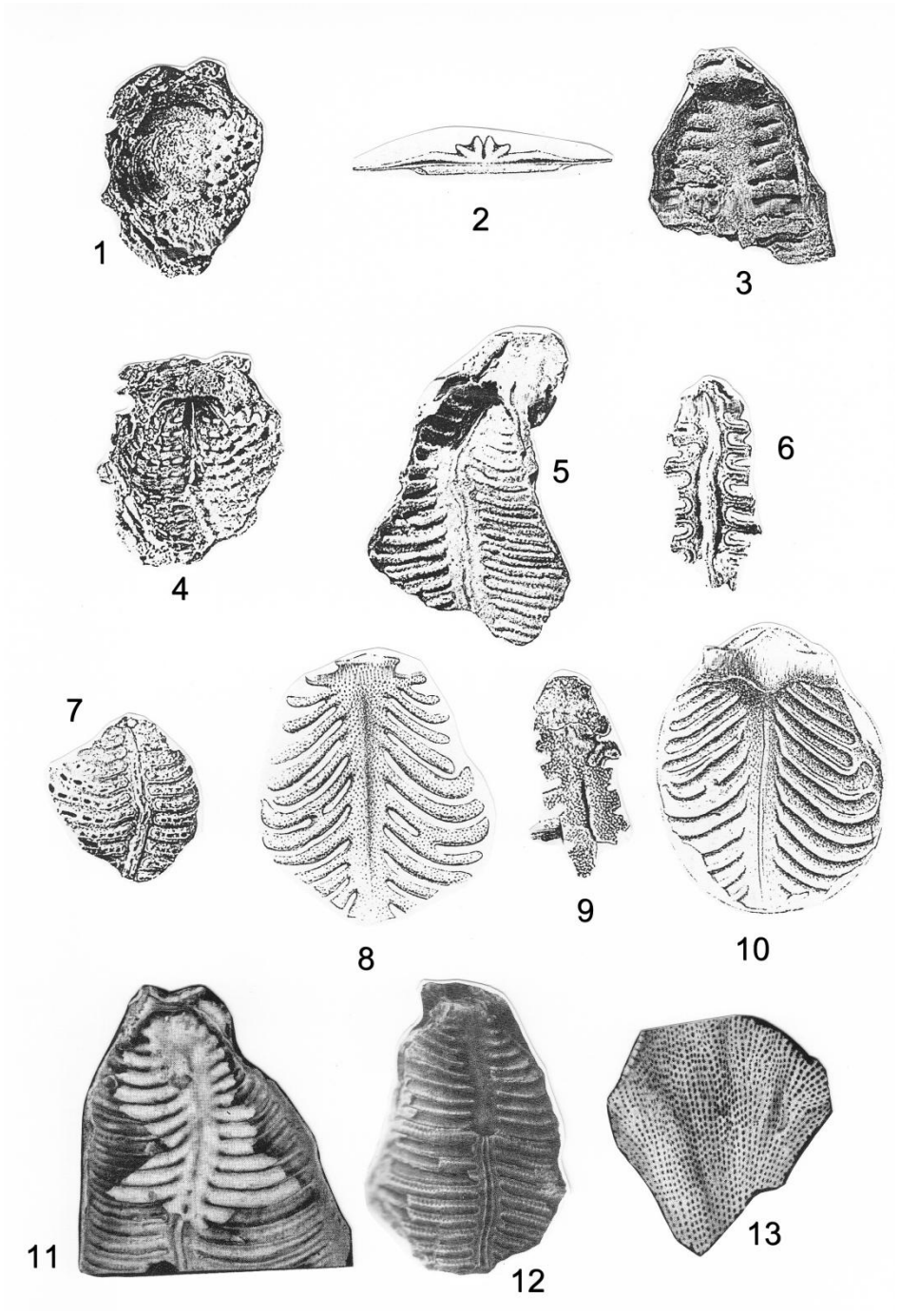
This curious widespread group of fewer than 20 genera flowered in the Carboniferous, Permian and ligeredon into the Triassic. The brachial valve was sometimes vestigial, barely covering the lophophore, and the pedicle valve was usually cemented to the substrates. *Leptodus* is very important index fossil for middle Permian from Leonnordian to Guadalupian. In practical, it is easy to correlate south Asia to Japan and USA.

3. Description of *Leptodus*

Leptodus Kayser, 1882

Subcircular to irregularly elongate outline of thick pedicle valve, with thin serrated-eaged brachial valve. Massive posterior flap on pedicle valve umboused for cementation. Interior of pedicle valve with lateral ridges (into which the brachial valve fitted) and with median septum; hingeline short; brachial valve with median channel. Average adult length 3 to 5 cm. Lower to Middle Permian, cosmopolitan, cemented on to hard substrates on pedicle valve.

Plate I



Explanation of Plate I

There are comparison pictures of Lyttoniidae (Waagen, 1883)

1,4,7 *Coscinophora*-Like *Leptodus* but with median and lateral ridges of symmetrical septal apparatus broken into series of discrete beads; internal plate of brachial valve with lobes united by dissepiments to define series of holes complementary to ventral beads (Cooper & Stehli, 1955)

2,8,10 *Oldhamina*-Pedicel valve strongly convex, probably unattached in adult stages of growth with recurved posterior flap; septal apparatus symmetrical with many lateral pairs of high, sharp septa; median incision of internal plate of brachial valve, vestigial (Waagen, 1883)

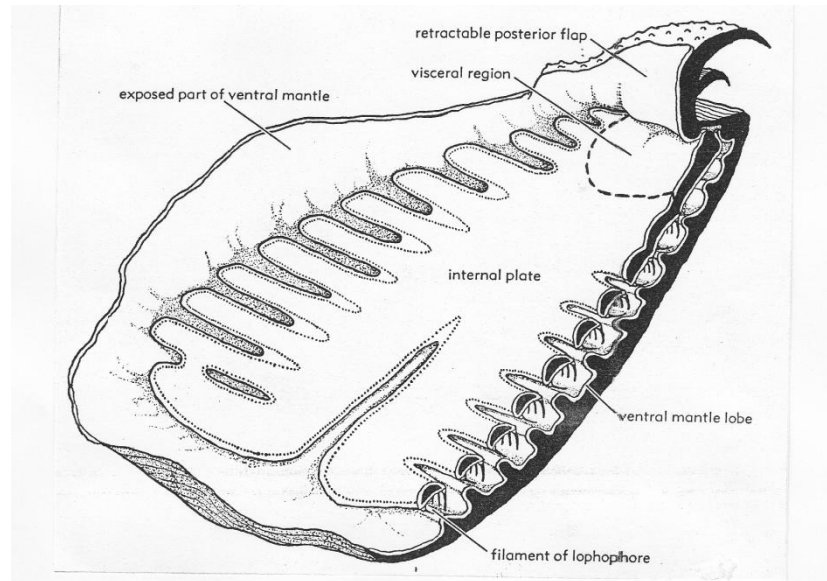
3,5,6,9 *Leptodus*-Pedicel valve attached to variable extent, irregular in outline, commonly with great expansion of peripheral zone, posterior flap everted; septal apparatus symmetrical with up to 33 pairs of blunt septa; median incision of internal plate of brachial valve vestigial (Kayser, 1882)

11 *Leptodus* found in USA.

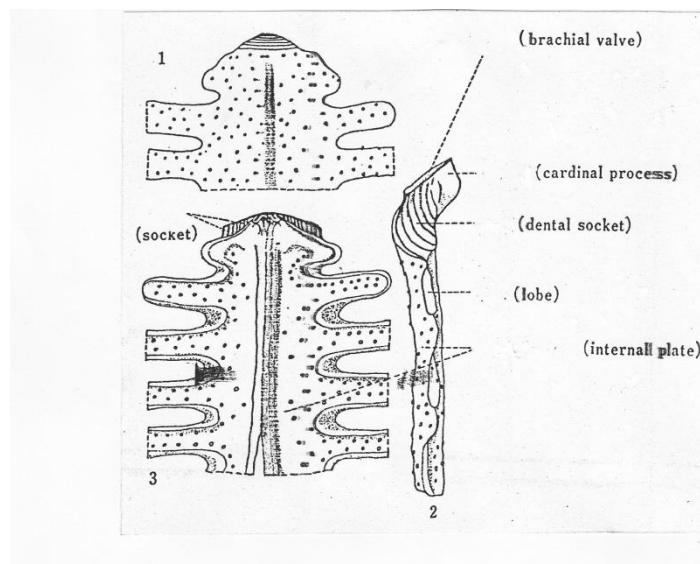
12 *Leptodus* found in Japan that associated with Bryozoa

13 Bryozoa in USA that is found in associate with number 11

Figure 2.13) a); Morphology of inner plate in *Leptodus* modified from Williams,



b); Reconstruction of inner plate of *Leptodus* modified from Rudwick, 1970

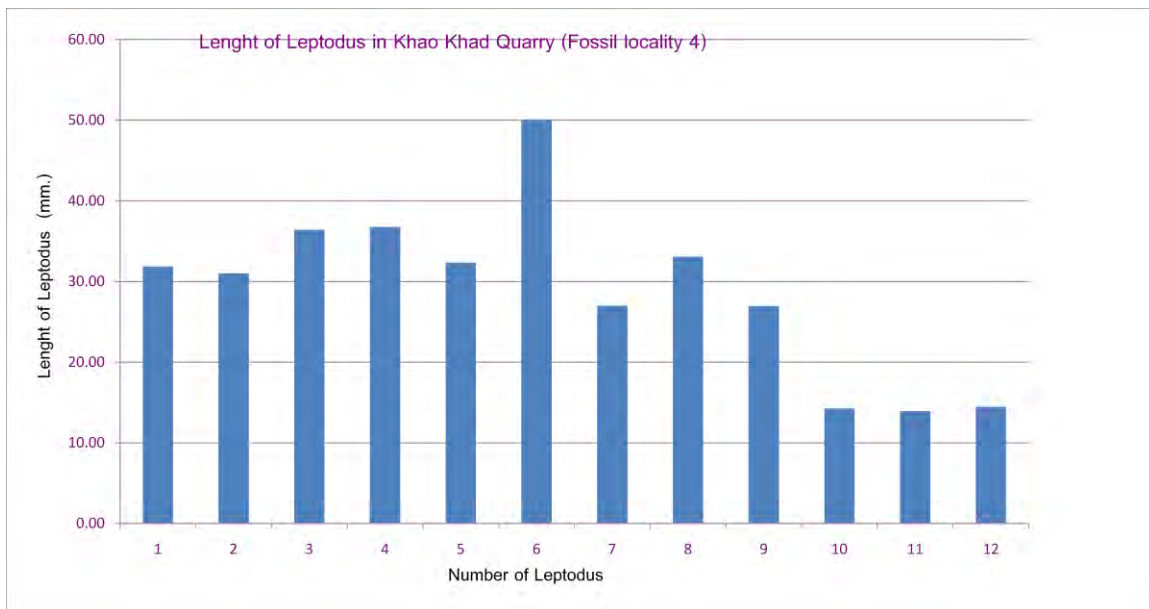


2.3.2) Size frequency analysis of *Leptodus*.

There are 69 sample of *Leptodus* found in all locality, Kho Khad Quarry, Ban Phot, Ban U Ruea and Khao Yai

Khao Khad Quarry		
Numbers	Size (mm.)	
	Width	Length
1	26.65	31.85
2	27.90	31.00
3	32.50	36.40
4	31.25	36.75
5	29.55	32.35
6	45.55	50.00
7	23.50	27.00
8	30.00	33.10
9	24.45	26.95
10	13.35	14.25
11	11.50	13.95
12	11.85	14.45

Table 2.1) Showing total number and size of *Leptodus* in Khao Khad Quarry



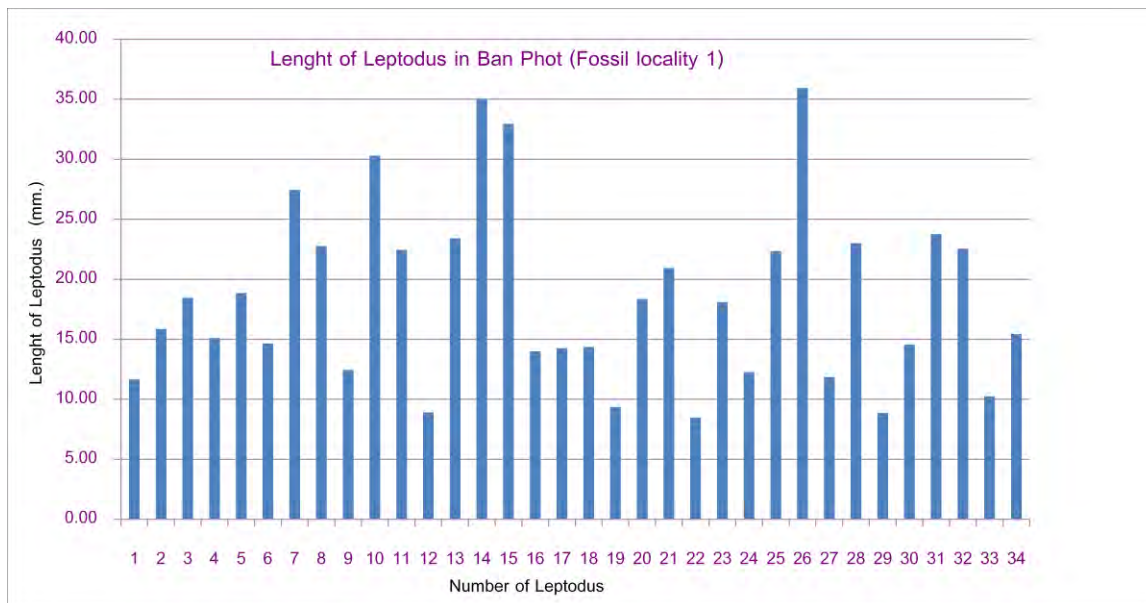
Graph 2.1) represents the Lenght of *Leptodus* in Khao Khad Quarry (Fossil locality 4).

Khao Yai		
Numbers	Size (mm.)	
	Width	Length
1	17.30	22.25

Table 2.2) Showing total number and size of *Leptodus* in Khao Yai

Ban Phot		
Numbers	Size (mm.)	
	Width	Length
1	15.00	11.65
2	13.55	15.85
3	18.60	18.45
4	12.35	15.10
5	15.75	18.85
6	13.35	14.65
7	19.95	27.45
8	19.45	22.75
9	9.40	12.45
10	25.75	30.30
11	18.45	22.45
12	7.00	8.90
13	22.10	23.40
14	30.80	35.00
15	25.45	32.95
16	9.25	14.00
17	12.55	14.25
18	12.75	14.35
19	9.10	9.35
20	16.65	18.35
21	18.35	20.95
22	7.00	8.45
23	15.00	18.10
24	11.35	12.25
25	19.35	22.35
26	30.40	35.95
27	9.55	11.85
28	20.35	23.00
29	7.20	8.85
30	10.00	14.55
31	20.00	23.75
32	18.35	22.55
33	8.95	10.25
34	11.55	15.45

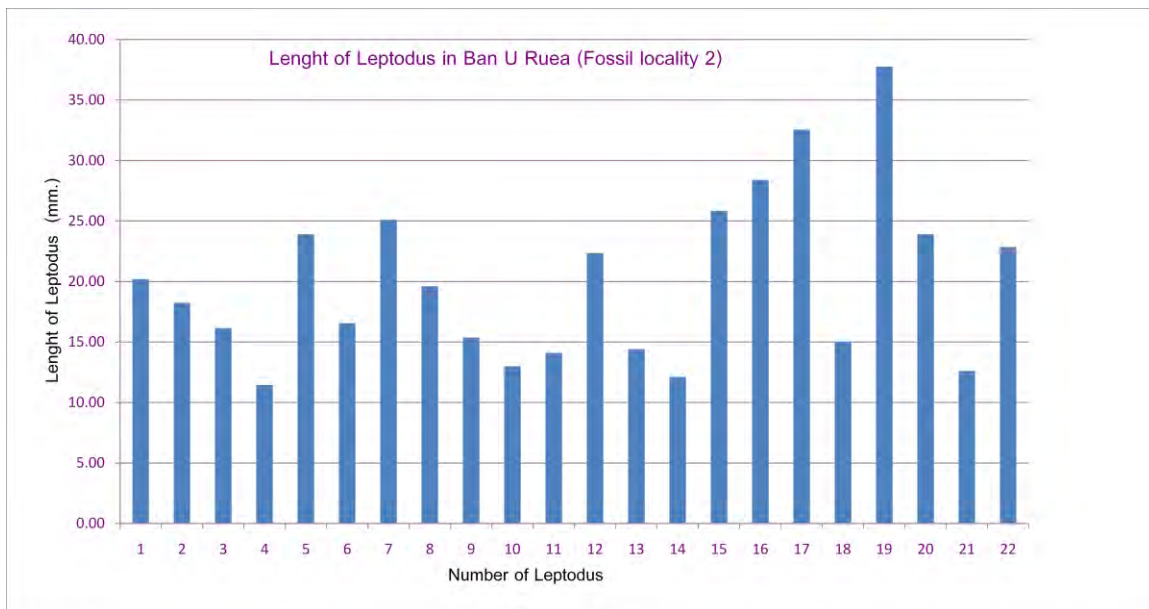
Table 2.3) Representing total number and size of *Leptodus* in Ban Phot, This fossil locality has the most number of fossils because these are well preserve in silicified



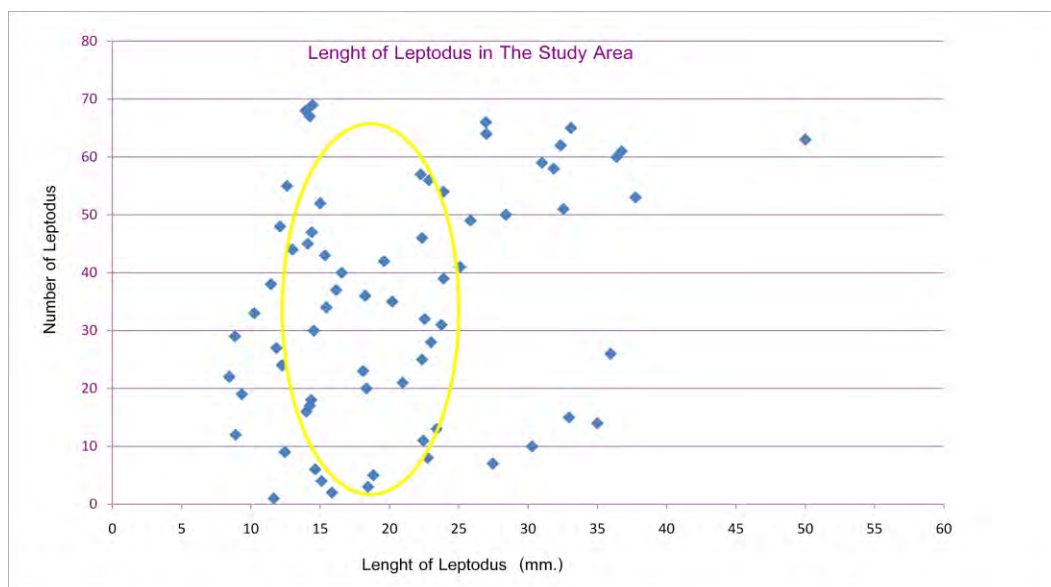
Graph 2.2) represents the length of *Leptodus* in Ban Phot (Fossil locality 1)

Ban U Ruea		
Numbers	Size (mm.)	
	Width	Length
1	18.55	20.20
2	15.00	18.25
3	12.55	16.15
4	9.10	11.45
5	19.60	23.90
6	15.25	16.55
7	16.70	25.10
8	12.85	19.60
9	11.30	15.35
10	8.45	13.00
11	12.25	14.10
12	18.05	22.35
13	11.00	14.40
14	9.75	12.10
15	21.90	25.85
16	25.25	28.40
17	27.80	32.55
18	10.30	15.00
19	35.10	37.75
20	18.70	23.90
21	9.45	12.60
22	17.00	22.85

Table 2.4) Showing total number and size of *Leptodus* in Ban U Ruea



Graph 2.3) represents the Lenght of *Leptodus* in Ban U Ruea (Fossil locality 2).



Graph 2.4) represents the Lenght of *Leptodus* in the study area. The size frequency range is approximately 13 - 25 mm.

2.2.3) Fossil list in each locality

Location	Number of <i>Leptodus</i>	Main Fossil Associated	Rock Type
Ban Phot (fossil locality 1)	34	Predominantly Bryozoa, Brachiopod, Bivalve, Algae, and Sponge	Argilaceous Limestone interbedded with thin calcareous shale
Ban U Ruea (fossil locality 2)	22	Predominantly Bryozoa, Brachiopod, Bivalve, Algae, and Sponge	Bedded Argilaceous Limestone interbedded with thin calcareous shale
Khao Yai (fossil locality 3)	1	Predominantly Bryozoa, Brachiopod, Bivalve, and Algae	Bedded Argilaceous Limestone interbedded with thin calcareous shale
Khao Khad Quarry (fossil locality 4)	12	Bryozoa, Brachiopod, Bivalve, Algae, and Ammonoid	Bedded Argilaceous Limestone interbedded with thin calcareous shale

Table 2.5) shows fossils that found with *Leptodus*

CHAPTER 3

DISCUSSION AND CONCLUSION

3.1 Discussion

3.1.1 Occurrence of *Leptodus*

3.1.2 Paleoenvironments and taphonomy of *Leptodus*

3.1.3 Paleoautoecology of *Leptodus*

3.2 Conclusion

3.1 Discussion

3.1.1 Occurrence of *Leptodus*

Brachial and pedicle valve are separated and inarticulated, only brachial valves and internal plates are found in the limestone. Fragmentation, alteration and life position in the limestone are index for occurrence.

Autochthonous occurrence is as follows;

Life position of coral is perpendicular to bedding plane. Bryozoa, Ammonoid, Brachiopoda and Bivalve are associated each other. Pedicle valves are found as lower convex position. Spines on the pedicle valve are preserved. Inner plates are nearly perfect.

Allochthonous occurrence is as follows;

All the elements in fossil assemblage are transported from the reef rocks and deposited in the sediment. Fragmentation and abrasion are observed. The fragments of crinoids are observed. Inner plates are all fragmental.

Fossil locality	Occurrence
1: Ban Phot	Autochthonous
2: Ban U Ruea	Autochthonous
3: Khao Yai	Autochthonous
4: Khao Khad Quarry	Allochthonous

Table 3.1) Occurrence in each fossil locality.

3.1.2 Paleoenvironments and taphonomy of *Leptodus*

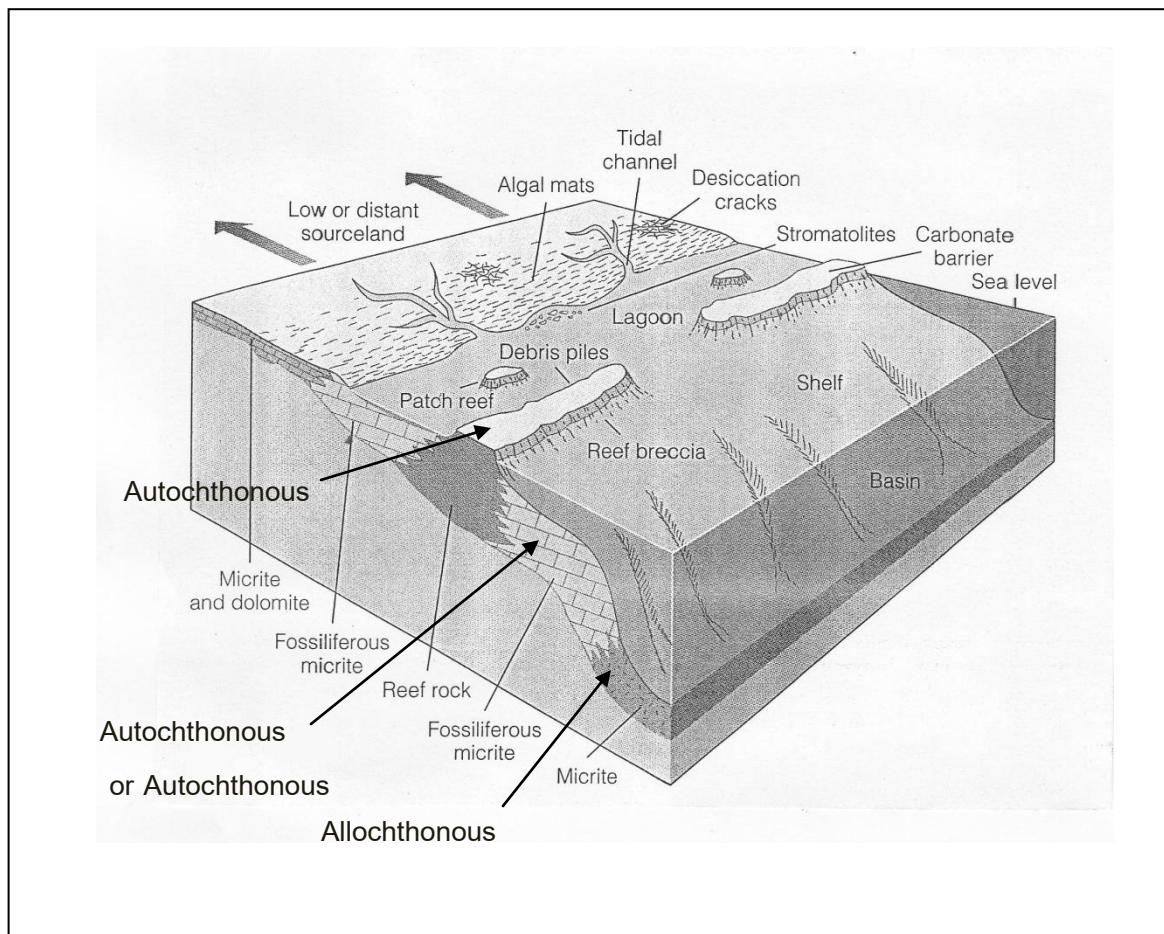


Figure 3.1) Reconstruction of Paleoenvironment and carbonate sediments on a shelf to continent

Leptodus Leptodus generally were found in argillaceous fossiliferous limestone and calcareous mudstone. They always were found with Bryozoa, Bivalve and Brachiopod. And limestone type is fossiliferous micrite (Folk, 1959)

From all result of limestone facies analysis, thin section, and associated fossil, it is possible to reconstruct three kinds of paleoenvironments. According to the Figure 3.1, Reef top on the reef rock, rather deeper fossiliferous and deeper micrite

Fossil locality	Paleoenvironment
1: Ban Phot	Coral reef top or near to the fore reef coral.
2: Ban U Ruea	Coral reef top or near to the fore reef coral.
3: Khao Yai	Coral reef top or near to the fore reef coral.
4: Khao Khad Quarry	Rather deep, 1000m

Table 3.2) Paleoenvironment in each fossil locality

Taphonomy of *Leptodus*

Leptodus, Benthic fossil lived and died on the seafloor, after that, sedimentary deposited and covered them (such as mudstone, limestone). The hard part of the organism was dissolved and the soft part was replaced with minerals (SiO_2 or CaCO_3) over time, totally they become to petrification, and preserved.

3.1.3 Paleoautoecology of *Leptodus*

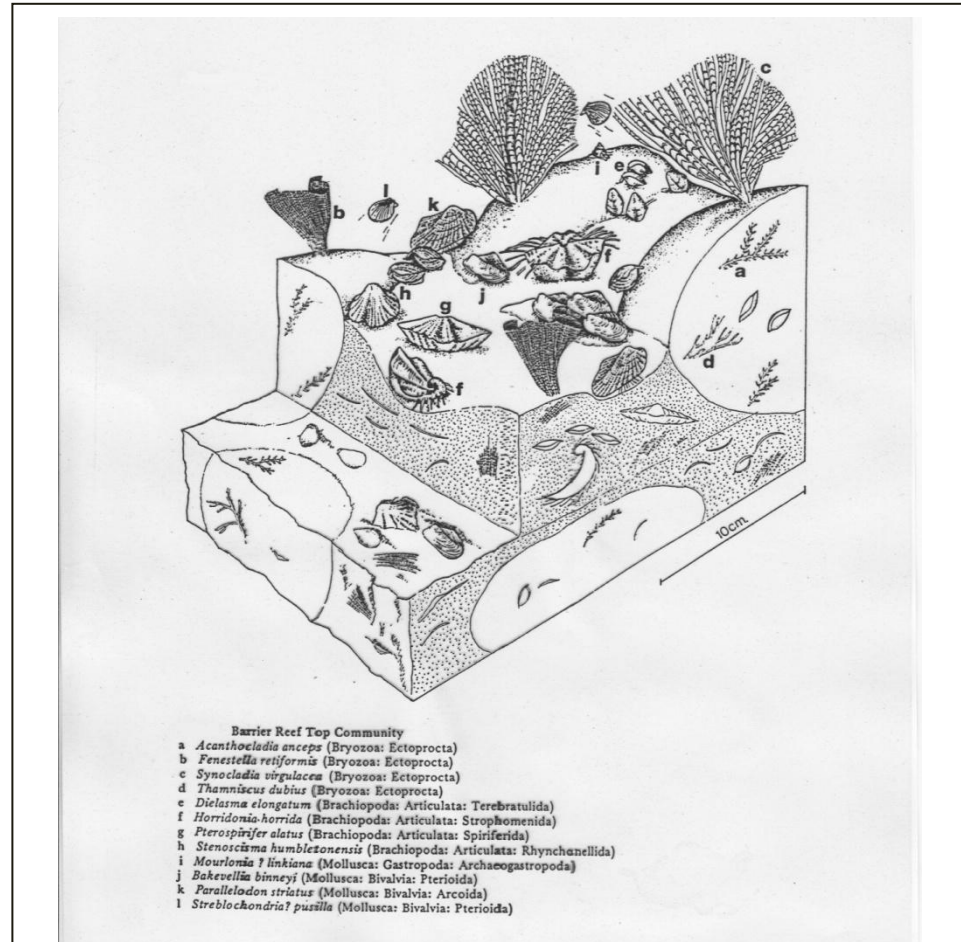


Figure 3.2) Reconstruction of paleoecology of fossil assemblage.

Paleoecology of fossil assemblages are reconstructed Paleosynecologies from the results of associated fossils, bryozoa, brachiopod, bivalve, algae, and sponge. They are in barrier reef top community. (Figure 3.2) This assemblage is characterized by the *Productus* type brachiopoda. They have so many species on the brachial valve. Like those assemblage is reconstructed by the brachiopoda and bryozoa.

Explanation of Figure 3.2

Bryozoa (Ectoprocta) are in zone a, b, c and d

a - *Acanthoclaxdia anceps*

b- *Fenestella retiformis*

c- *Synocladia virgulacca*

d- *Thamniscus dubius*

Brachiopoda (Articulata: Terebratulida) was in zone e

e- *Dielasma elongatum*

Brachiopoda (Articulata: Rhynchonellida) was in zone h

h-*Stenosisma humbletonensis*

Mollusca (Bivalvia: Pterioida) was in zone j and l

j-*Bakevellia binneyi*

l-*Streblochonudria pusilla*

(Bivalvia: Arcoida) was in zone k

k-*Parallelodom striatus*

Paleoautoecology; *Leptodus* had been living on the surface of rather muddy limestone. To collect the foods effectively, brachial valve is disappeared. So they need the natural turbulence of water or they make turbulence by using the tentacles on the inner plate. Tentacles may be strong enough to make a big current. If they do not have the strong tentacles system, they will be buried with the sediments. In the samples I collected, there are no distinct spines on the surface of pedicle valve. So micro environments for the *Leptodus*, they may prefer the calm environment without harder turbulence of water. It is impossible to recognize the younger stage. At the young state, *Leptodus* had been attaching to the another animal, crinoids, bryozoa, coral and sponge. After that, they moved to the mud surface of bottom.

3.2 Conclusions

- There are 4 fossil localities in study area those are Ban Phot, Ban U Ruela, Khao Khad Quarry, and Khao Yai. Each localities had different amount, Ban Phot found 34 , Ban U Ruela found 22, Khao Khad Quarry found 12 and Khao Yai found only 1 *Leptodus*. Generally, *Leptodus* was explored along N-S mountain trend in study area. Especially in Ban U ruela location, being well preserved as soft part by silica replacement, another place was CaCO₃.
- The occurrence is *Leptodus*, Benthic fossil lived and died on the seafloor, after that, sedimentary deposited and covered them (such as mudstone, limestone). The hard part of the organism was dissolved and the soft part was replaced with minerals (SiO₂ or CaCO₃) over time, totally they become to petrification, and preserved.

Size frequency of *Leptodus* in study area is ~10-22 mm. & ~13 - 25 mm. width and length respectively.

- *Leptodus* could be frequency found in Argillaceous Limestone which is associated with bryozoa, brachiopod ammonoids and bivalve, There became Bryozoa-*Leptodus* community.(Fenestella)

Base on associated fossil and lithology, it can be referred that *Leptodus* were dominantly in continental shelf, shallow marine environment, warm water and in tropical area. So, they could distribute by the equatorial current system all over the world in a short time.

- The *Leptodus* collected in Phetchabun, Central Thailand is identified to *Leptodus* sp. cf. *L. nobilis* (Waagen, 1883)
- *Leptodus* changed its life style from attaching to bryozoa and another animal in younger stage to sessile to the sediments in adult stage. In the younger stage it is may easy to move by the currents.

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