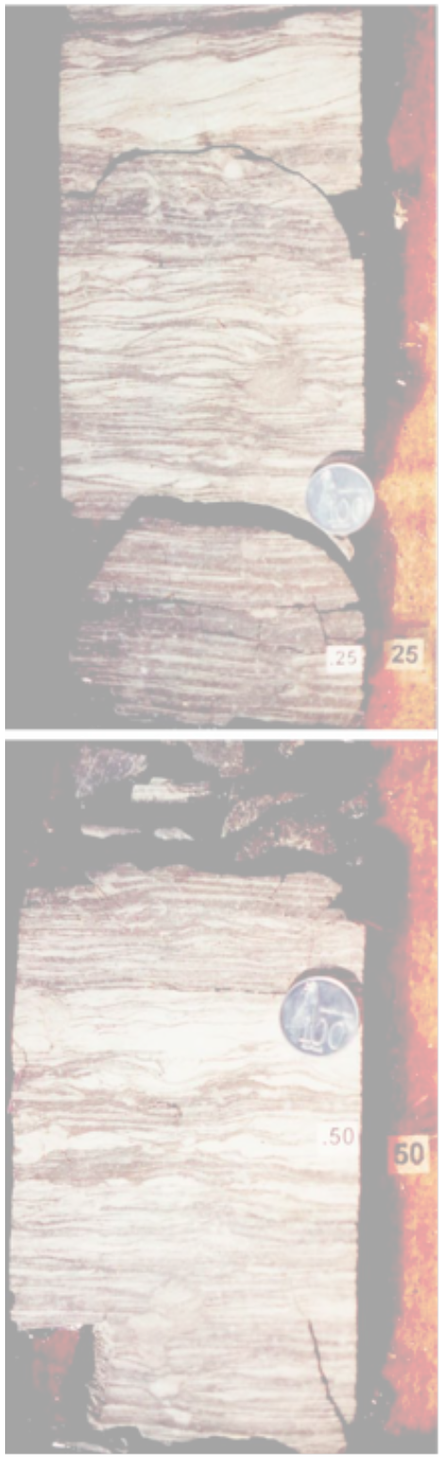

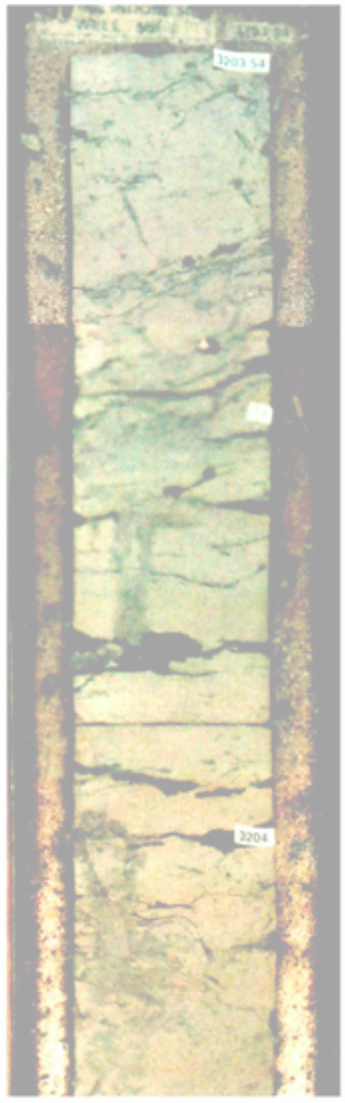

# Principles of ichnology


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***(10 November 2020)***


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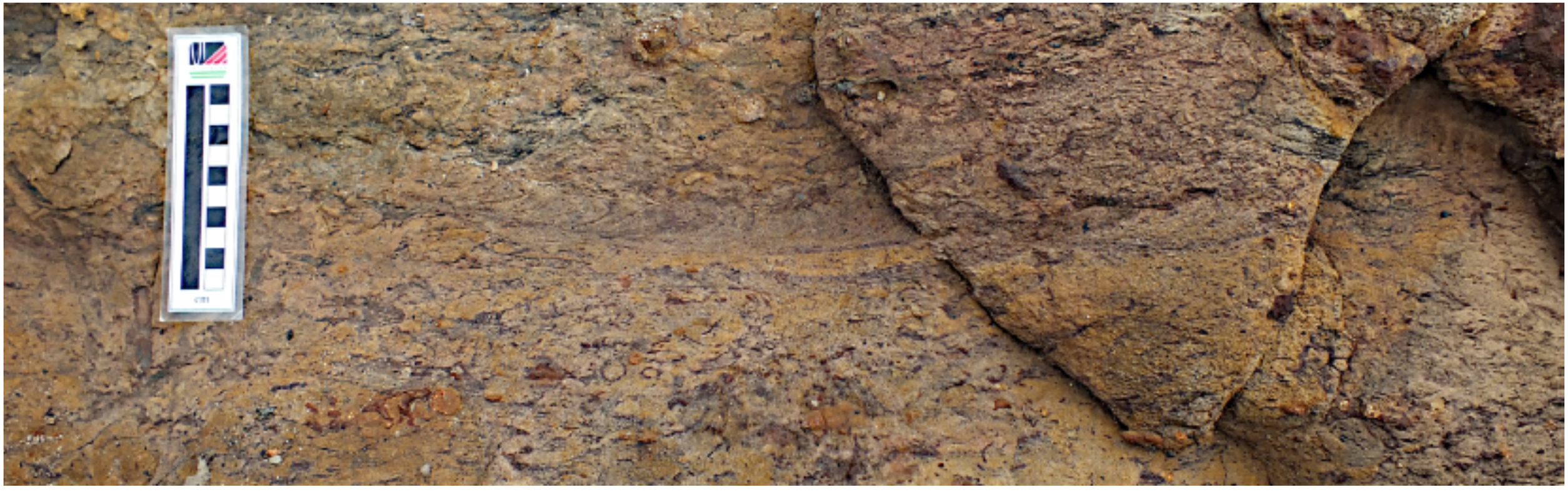
# Outlines

1. **Ichnology at a glance**
2. **Trendy approach**
3. **Unique approach**
4. **A case within Kutai Basin, Indonesia**
5. **Conclusion**

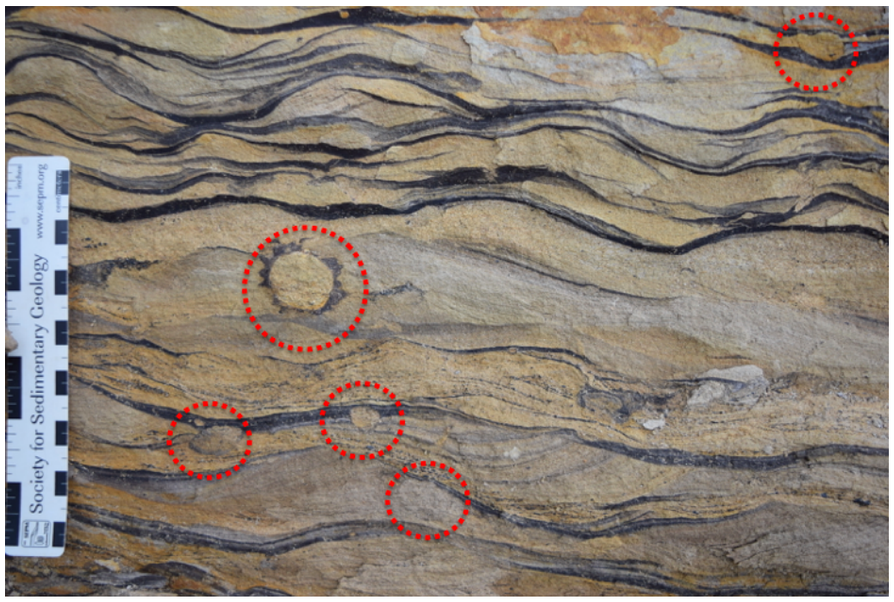
# Ichnology at a glance

Object of ichnology
is **trace (trace fossil)**
which represent the
***behavioral***



(Arifullah et al. 2019)

**exposed** & **visible** -> **practically easy to obtain & observe**

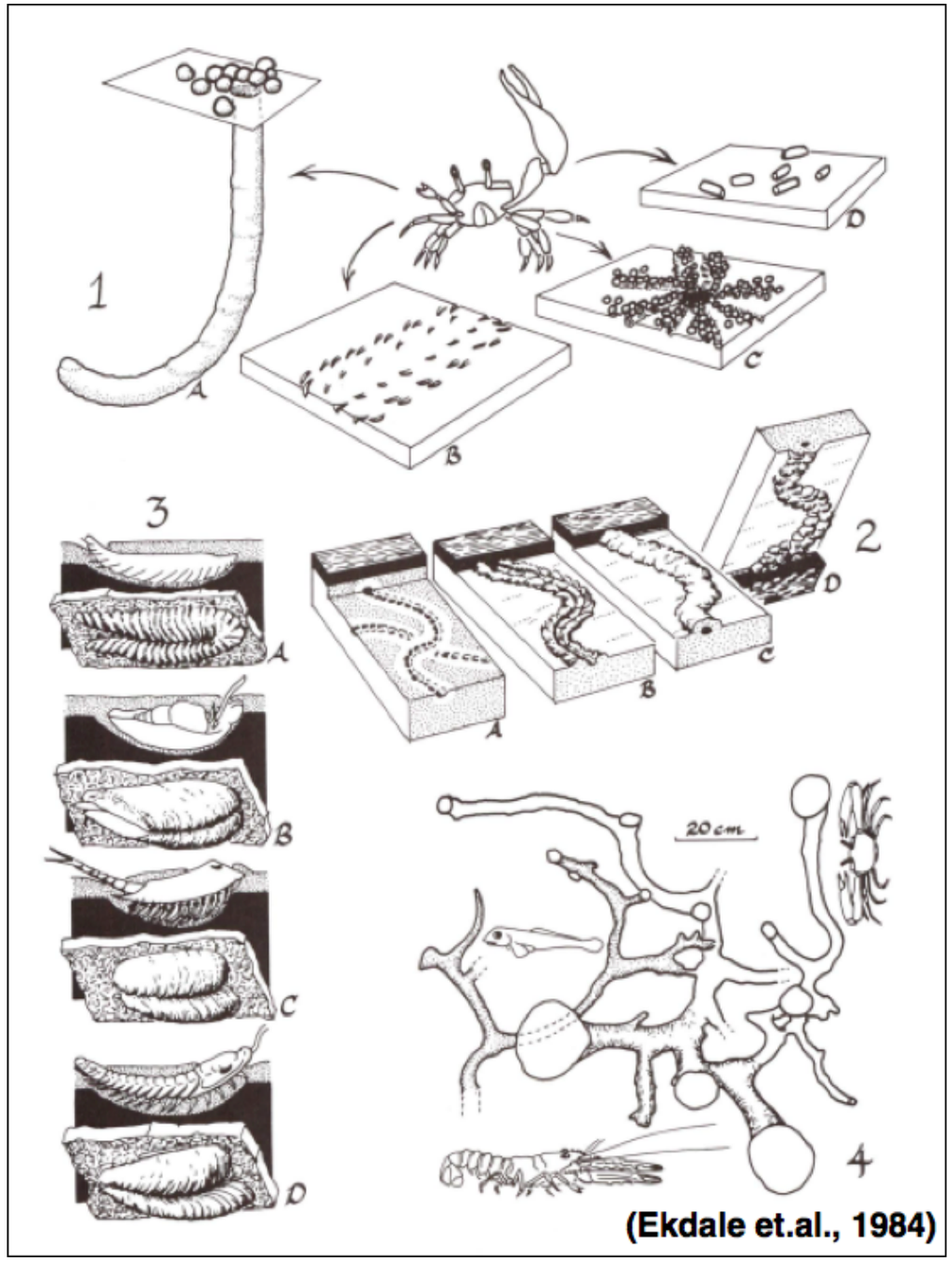




(Arifullah, 2019)

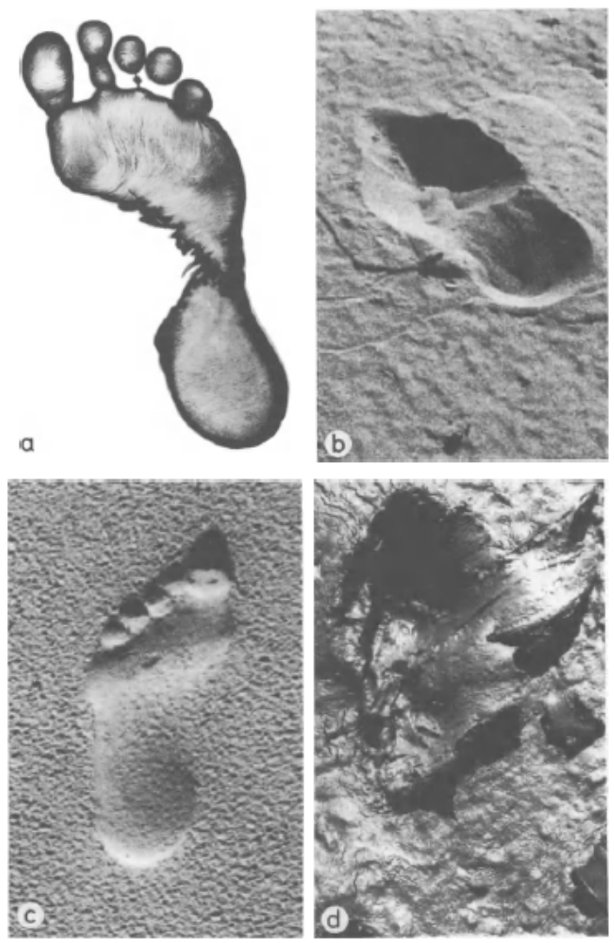
# Principles

( Modified from **Ekdale et al., 1984**)

1. The trace represents behavior
2. An animal produce several traces.
3. Differ animals with the same behavior producing similar traces.
4. A complex traces/burrow may constructed by some animals.
5. When traces preserved in different lithologies, the morphology may be different but doesn't mean the behavior is different.



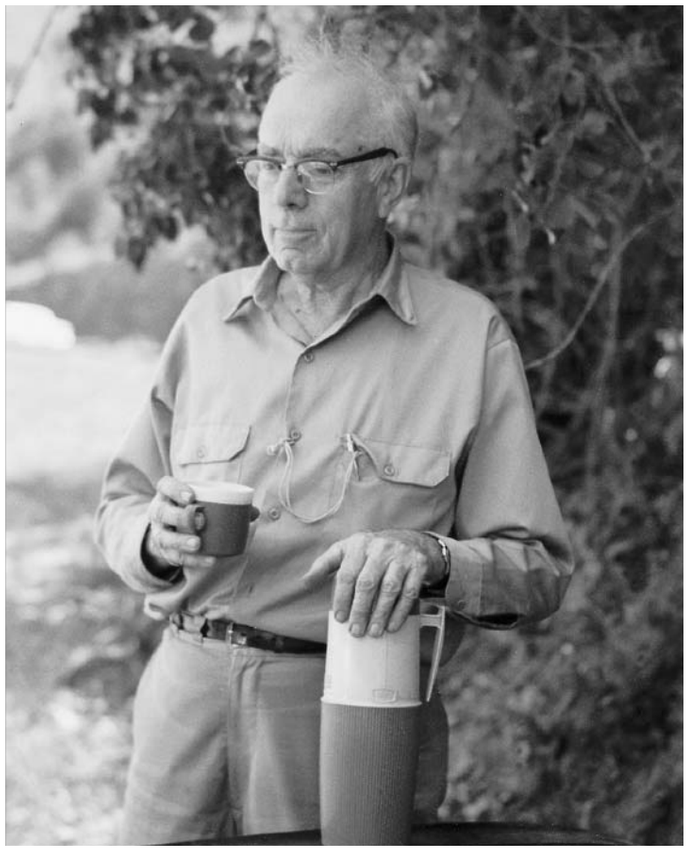

(Ekdale et.al., 1984)




***<—- (figures from Bromley, 1996)***

- **Trace fossil** is a **biogenic sedimentary structure** that can be a **primary** or **secondary** sedimentary structure (see Potter & Pettijohn, 1964)

**P.E. Potter, 1965**



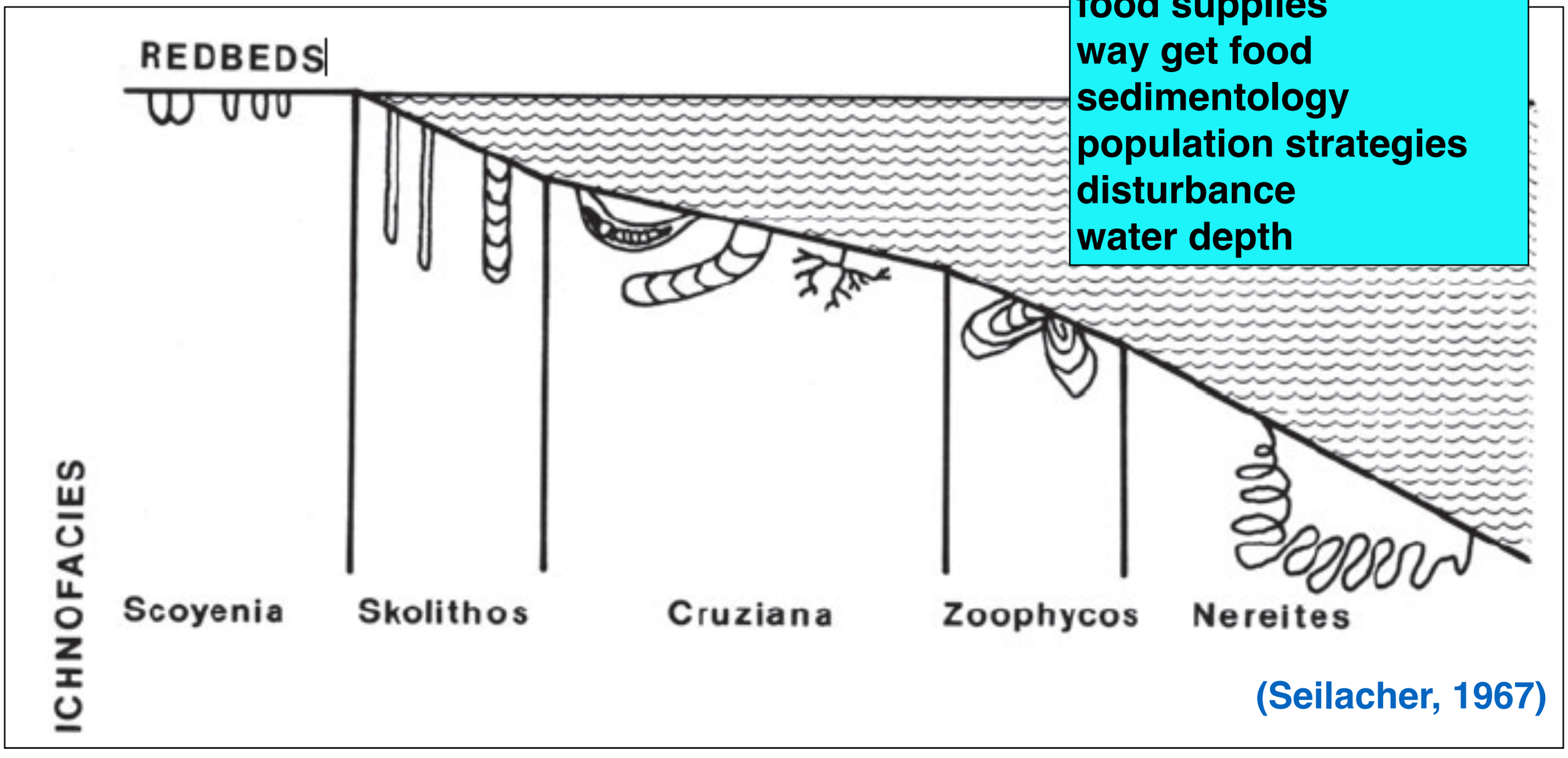
**F.J. Pettijohn, 1965**

***photos from* Okada, 2005**

Fauna is one most important agent in the formation of final fabric (*e.g.,* Dapples,1942; Moore & Scruton,1957; Van Straaten, 1959; Allen,1965)


**(Arifullah et al. 2017)**

**oxygenation**
**salinity fluctuation**
**temperature fluctuation**
**community structure**
**food supplies**
**way get food**
**sedimentology**
**population strategies**
**disturbance**
**water depth**




**(Seilacher, 1967)**

**not bathymetry indicator** (*see* Byers, 1982; Goldring, 1993)

**Links:**


1. https://www.youtube.com/watch?v=cgwp8qH58Ho.
2. https://www.youtube.com/watch?v=n3wsUYg3XV0
3. https://www.youtube.com/watch?v=hsBVvIJjNtc.
4. https://www.youtube.com/watch?v=0Z6FdcIuEfg.
5. https://www.youtube.com/watch?v=4seOKS95EDM.
6. https://www.youtube.com/watch?v=Y6vgAnMhGxs
7. https://www.youtube.com/watch?v=w77zPAtVTuI

# 2 Trendy approach

# not optimized

(Van Wagoner et al. 1991)

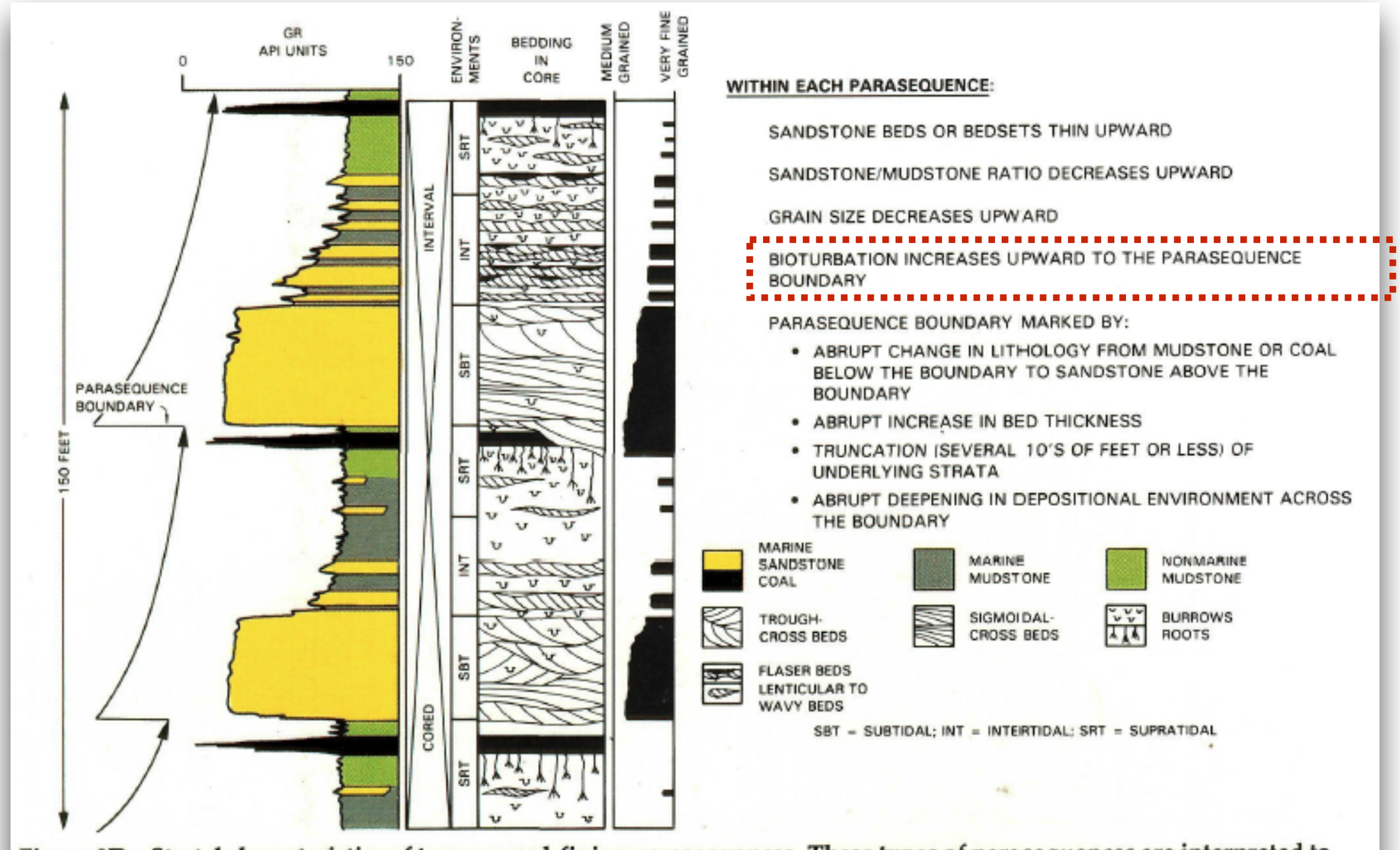
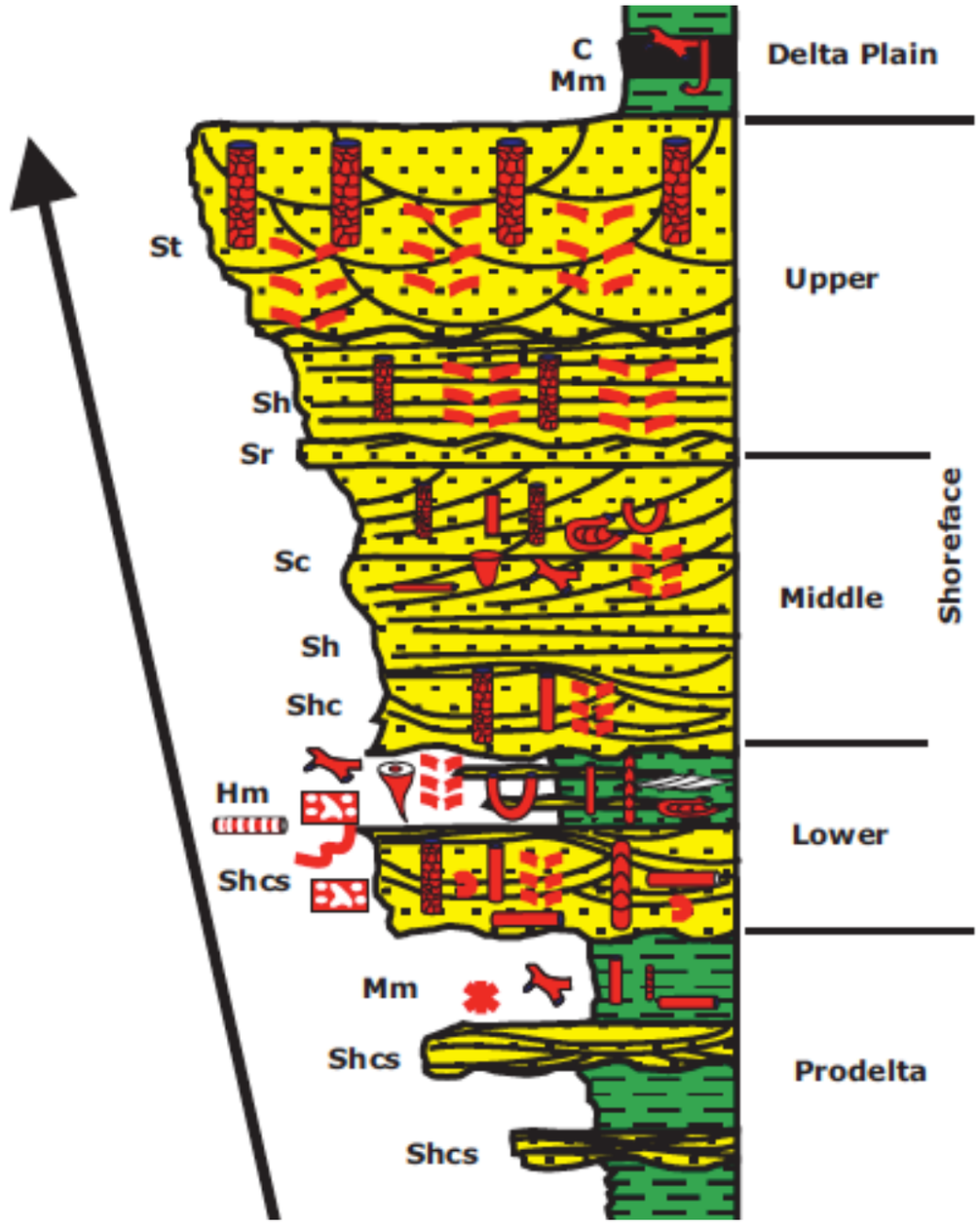



**Figure 3D—Stratal characteristics of two upward-fining parasequences. These types of parasequences are interpreted to form in a tidal flat to subtidal environment on a muddy, tide-dominated shoreline.**

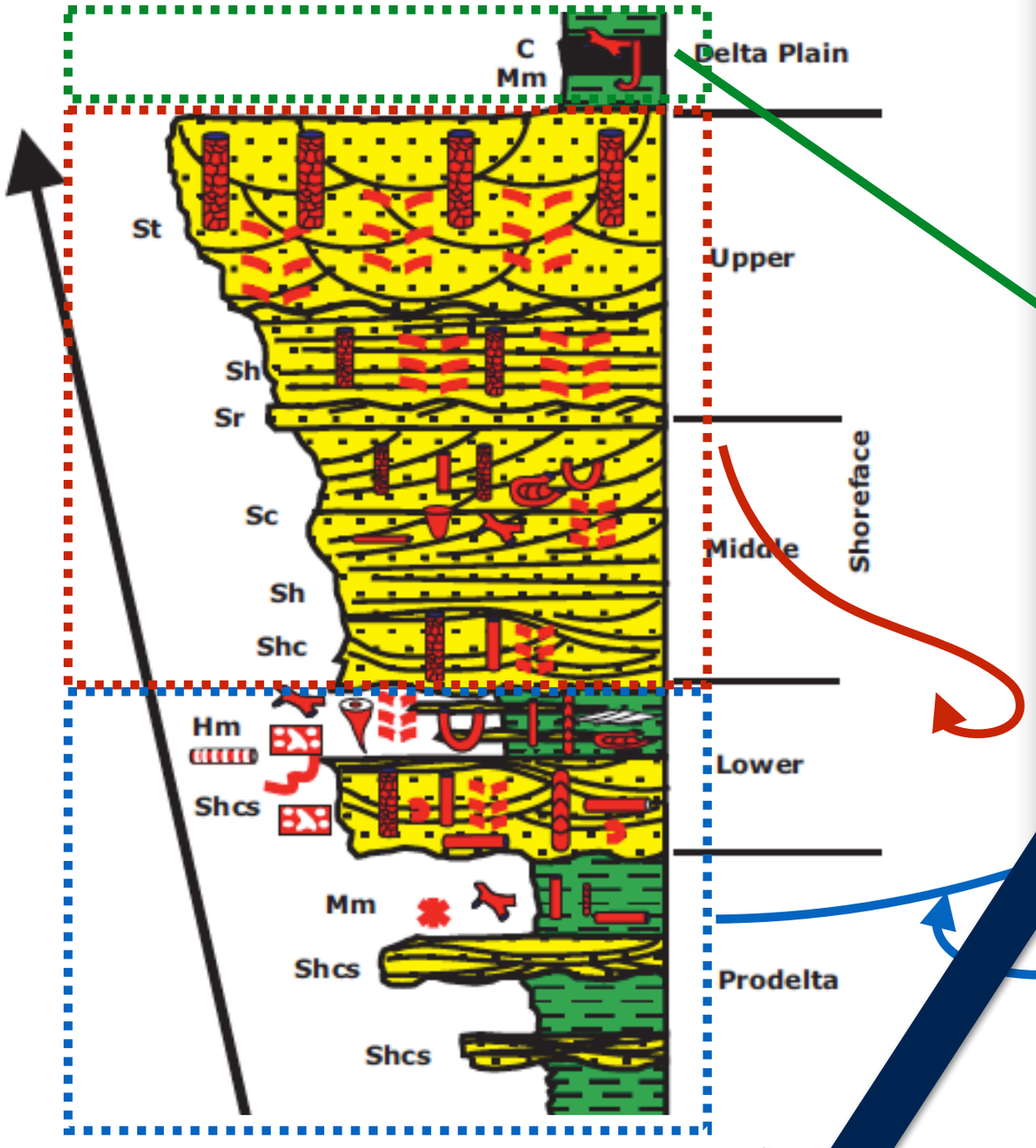
**only ichnofossil inventory!**

**Wave dominated delta?**




(Arifullah, 2005)

## Wave dominated delta?

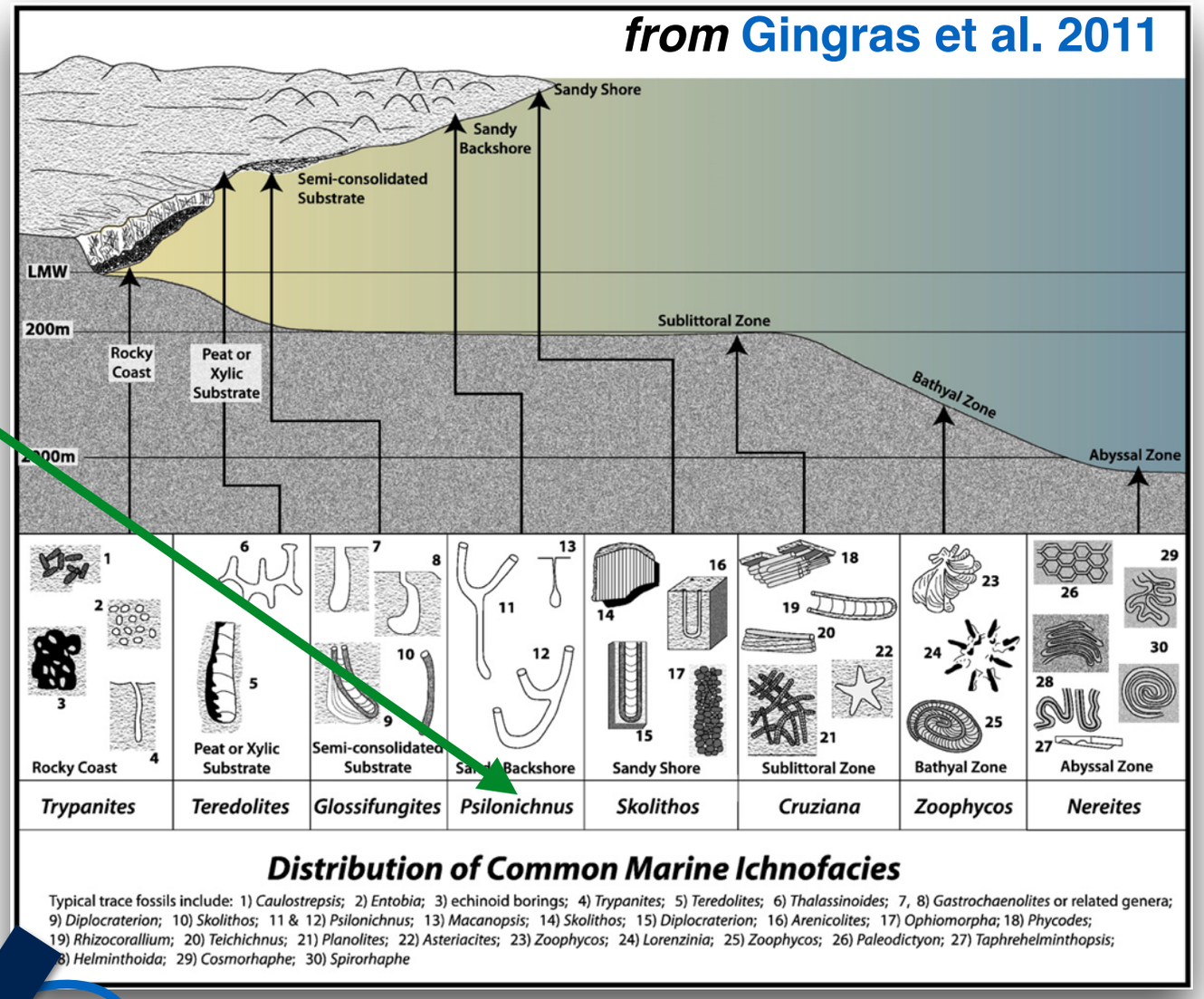



*Arifullah (2005)*

## how it's generated?

*see* Seilacher, 1967

*from* Gingras et al. 2011



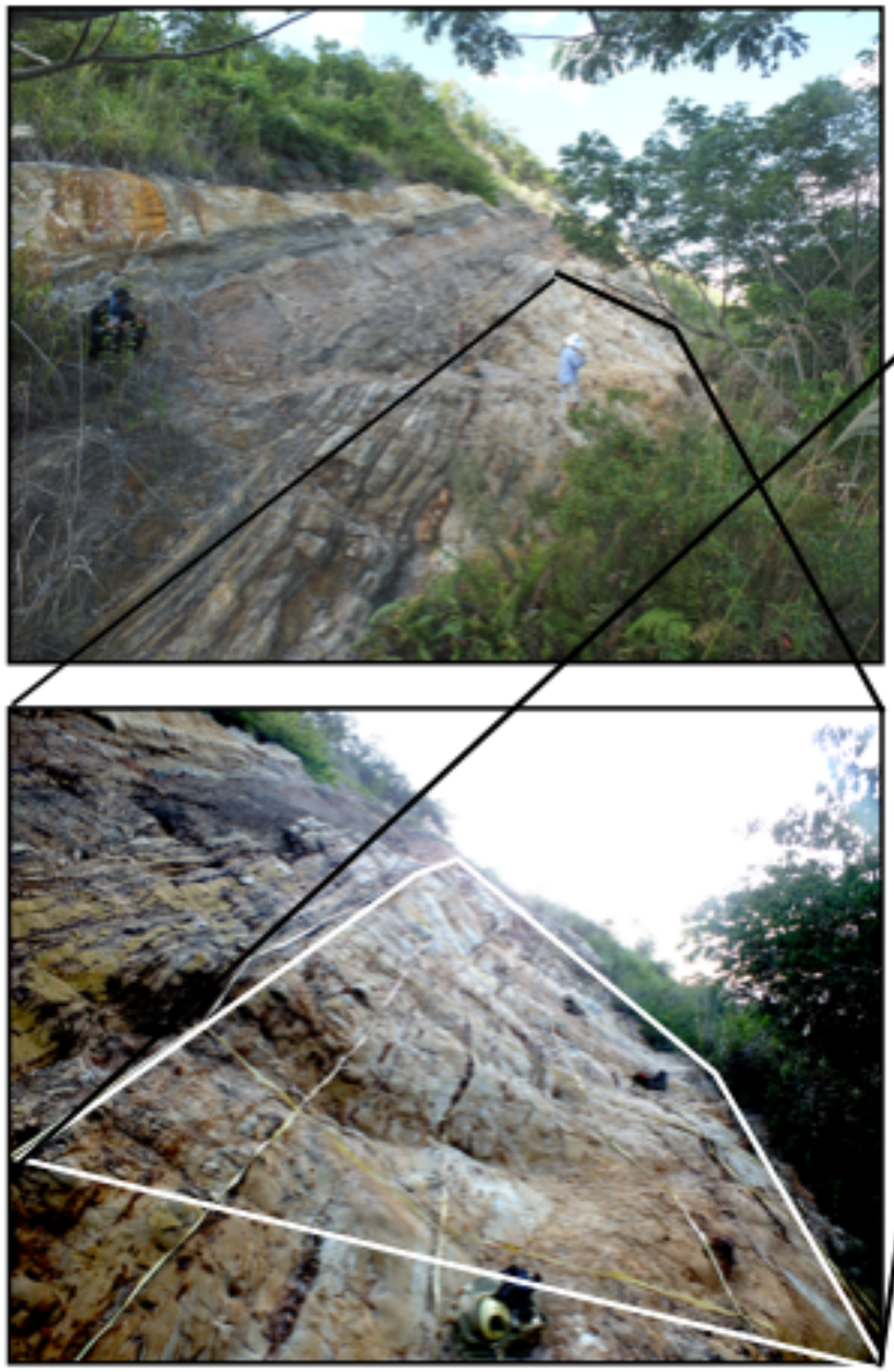

- **Referring to mainstream ichnofossil model.**
- **Considering** and **comparing** its **regional stratigraphy.**

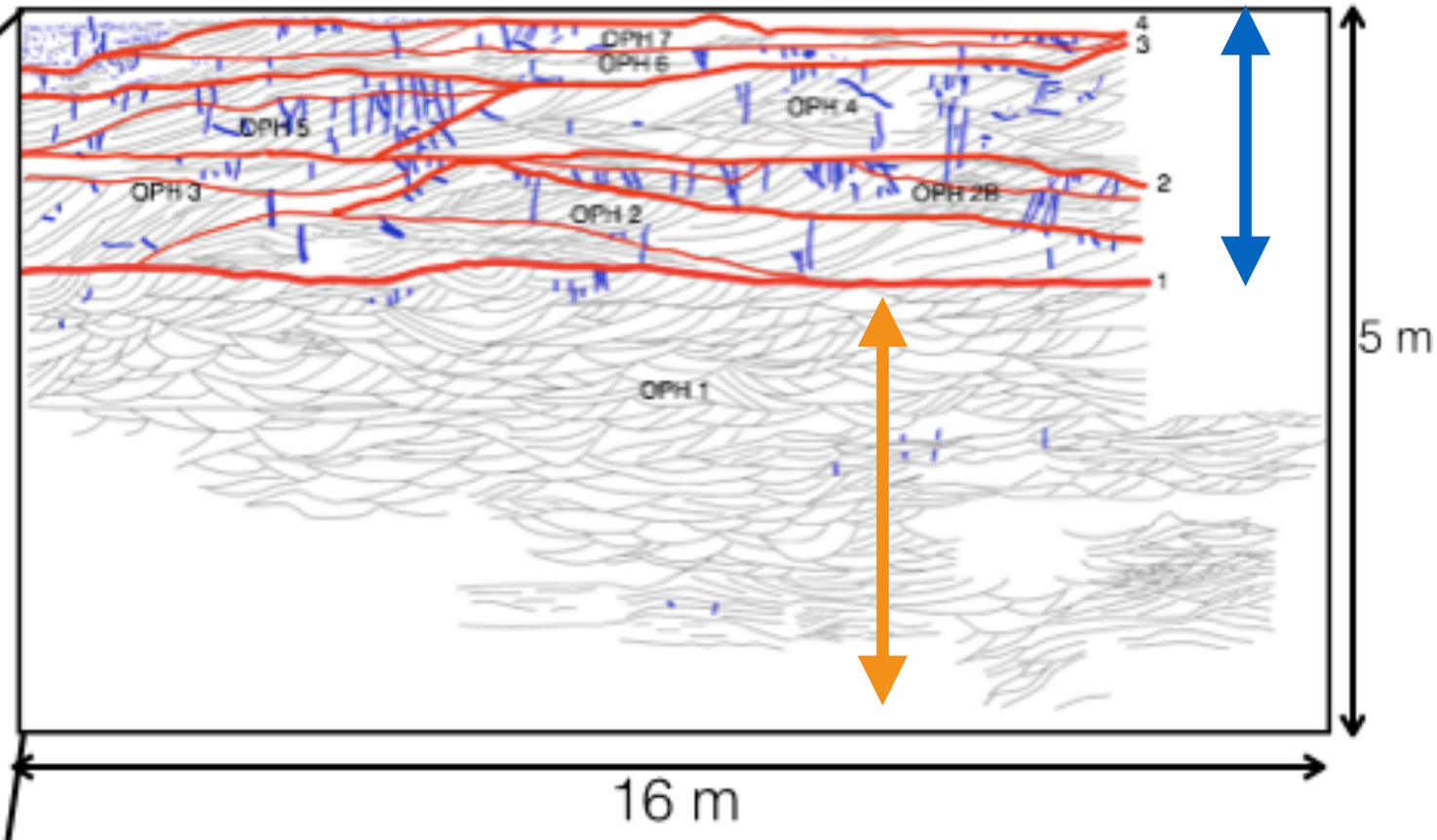
3

# Unique approach

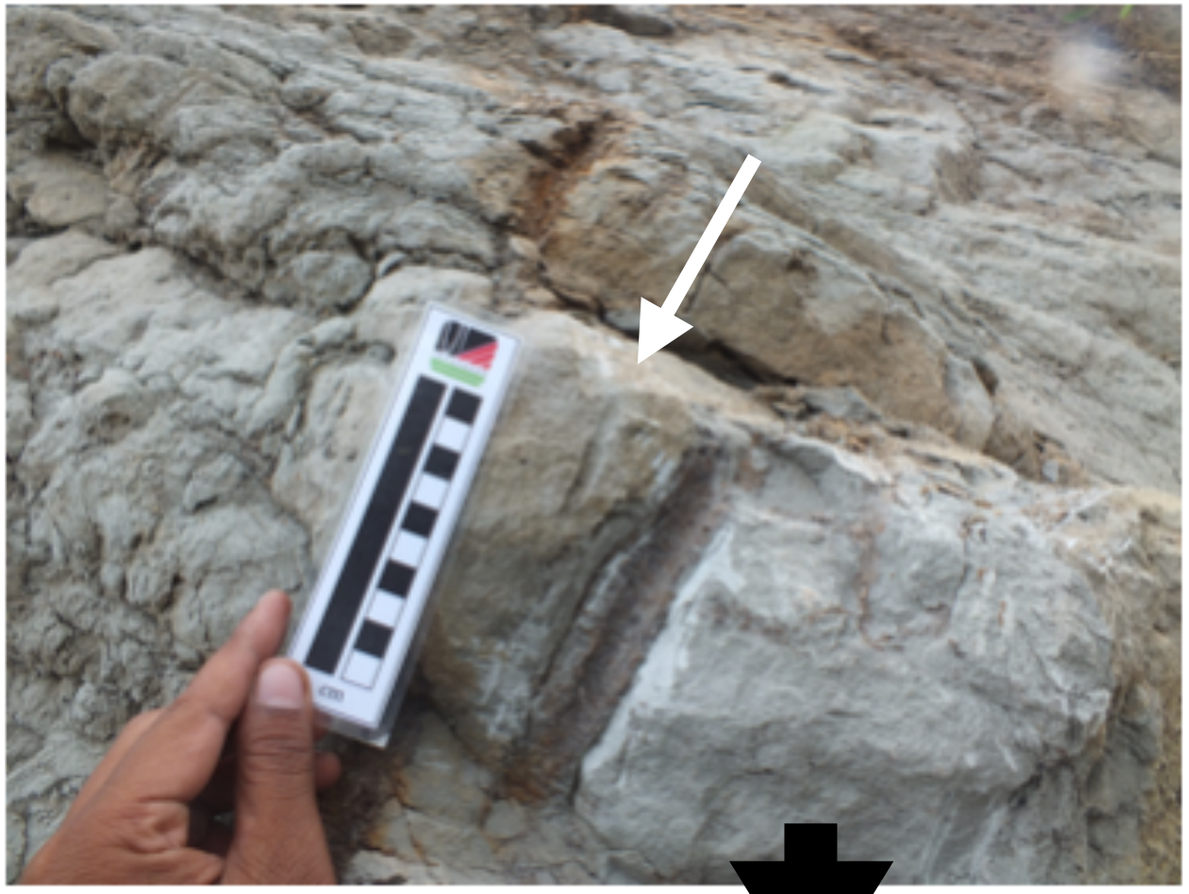
- Make a sketch
- Determination of ichnotaxon
- Ichnofabric work

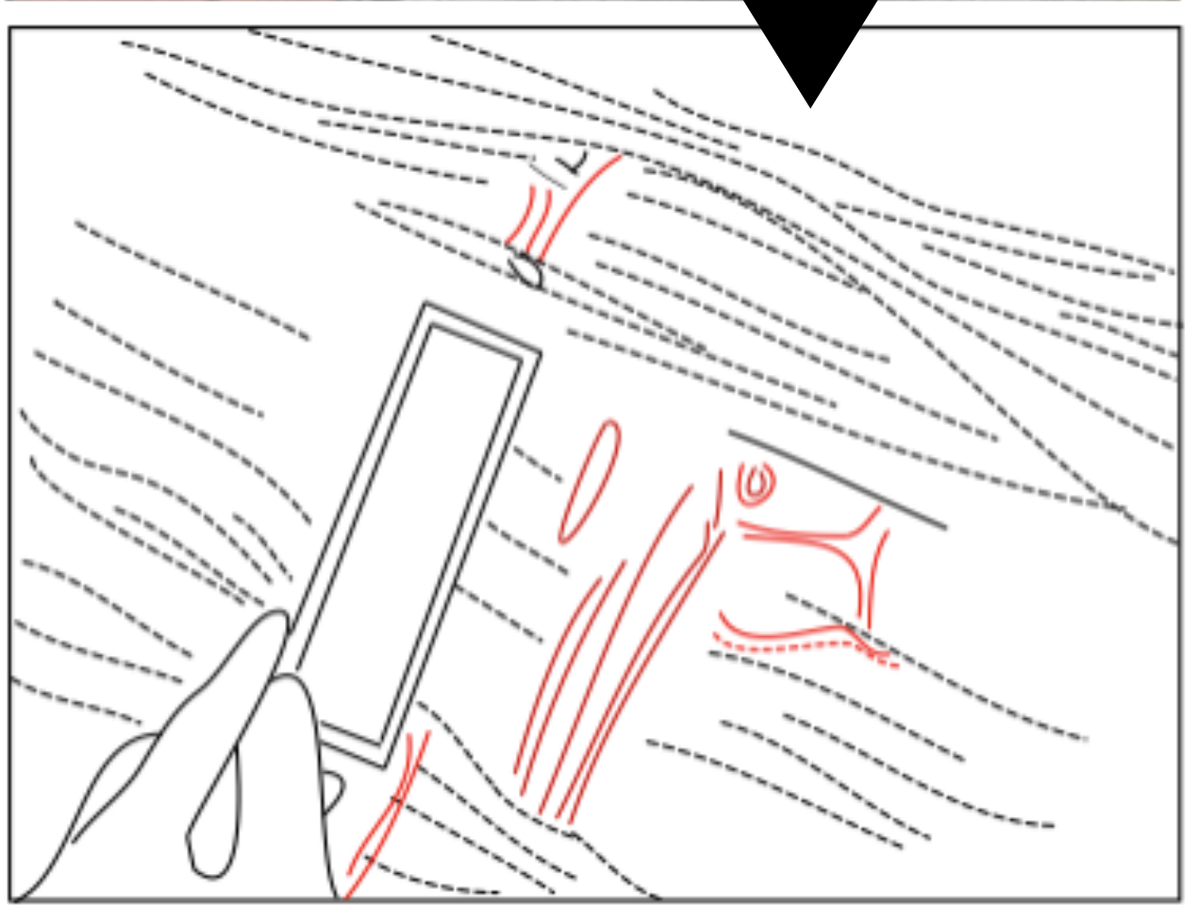
# Make a sketch

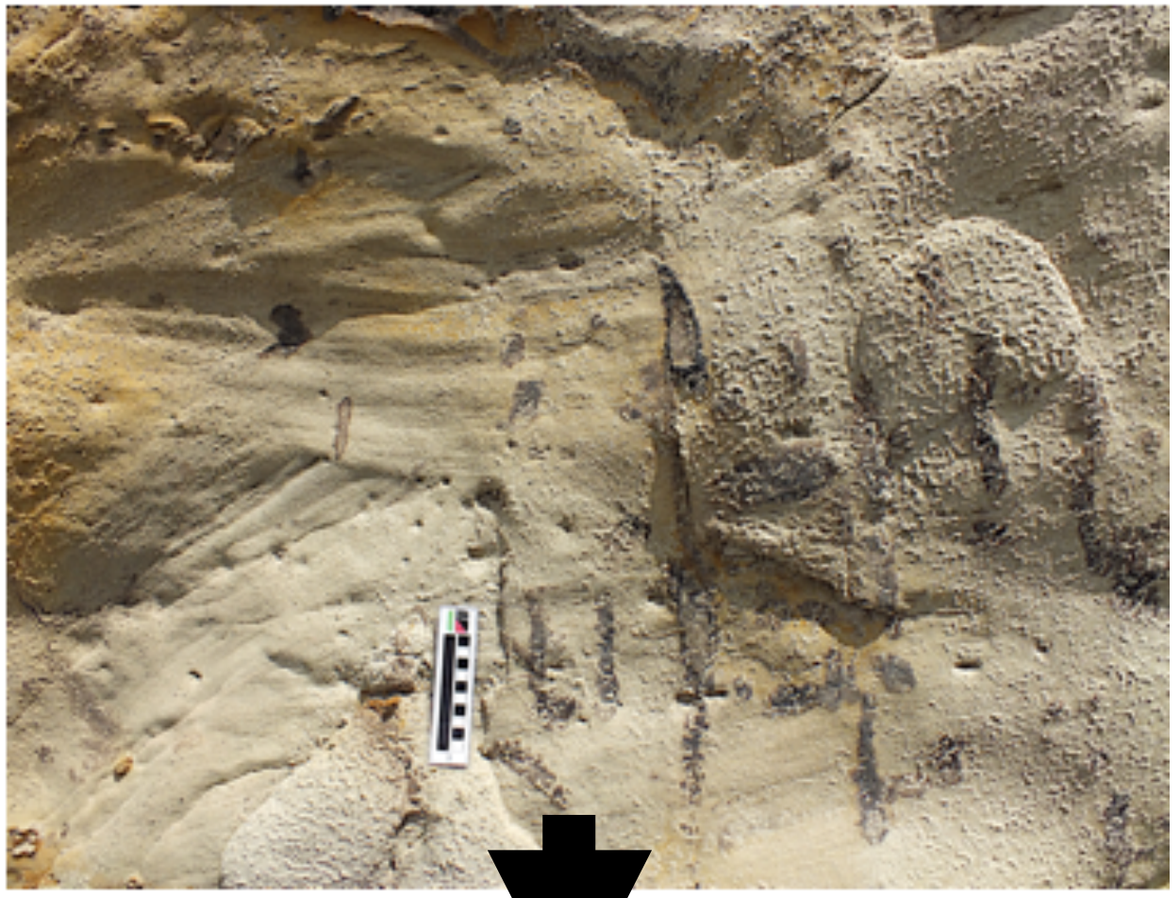


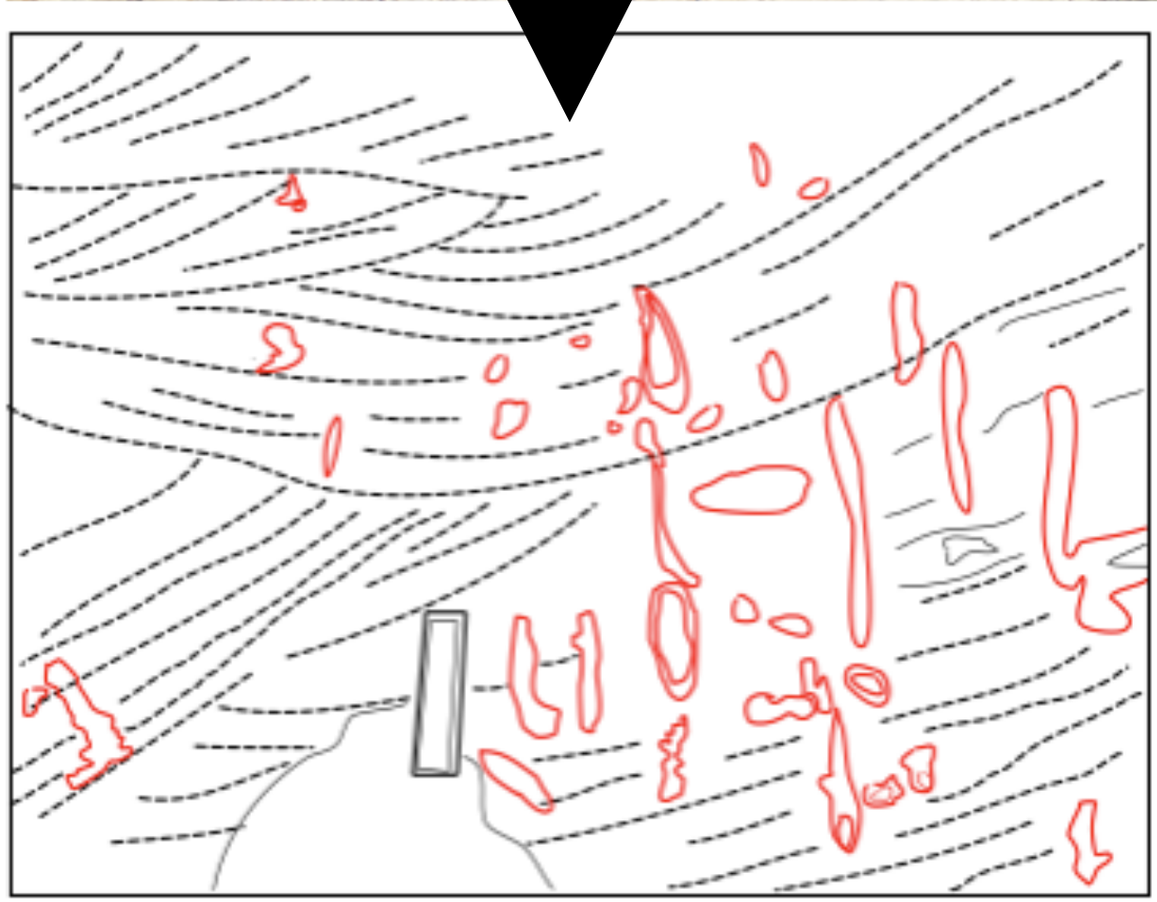



(Arifullah, 2016)







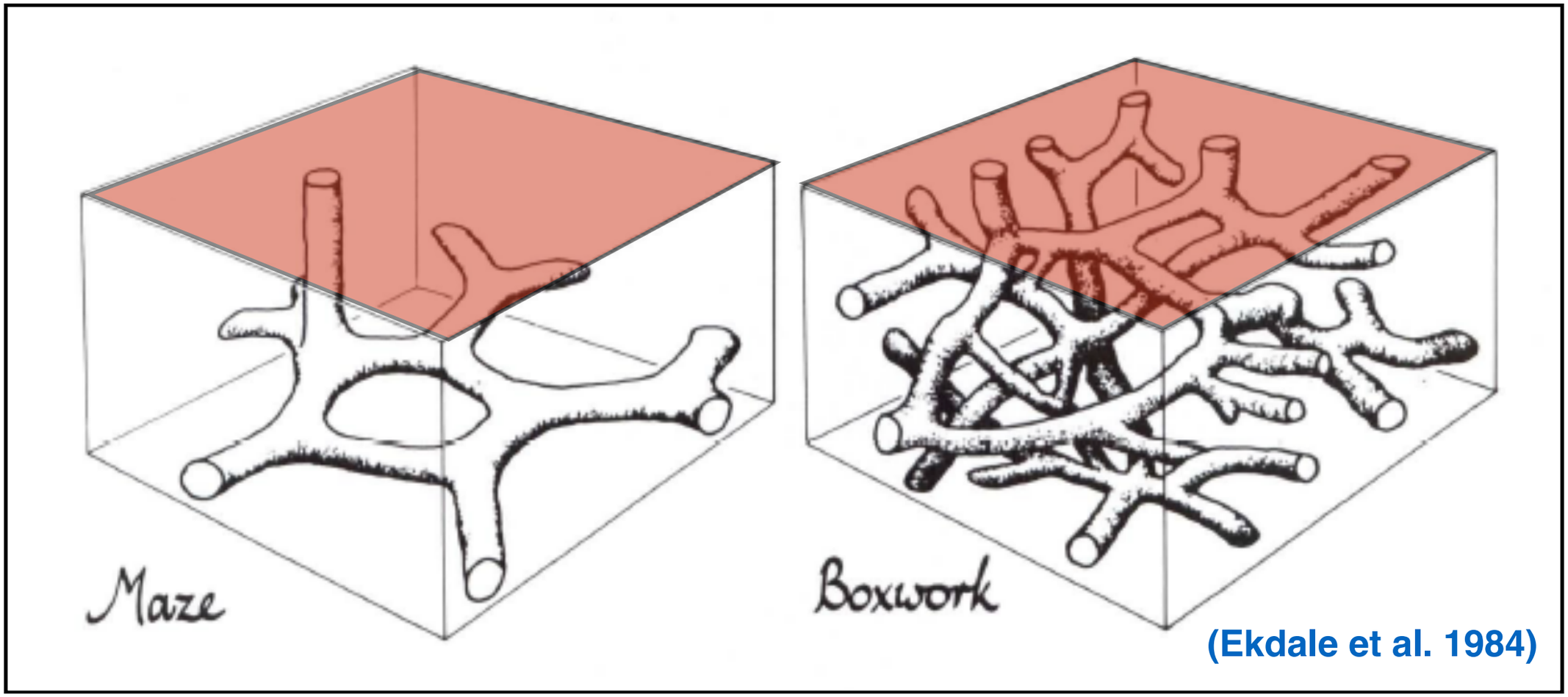


# Determination of ichnotaxon

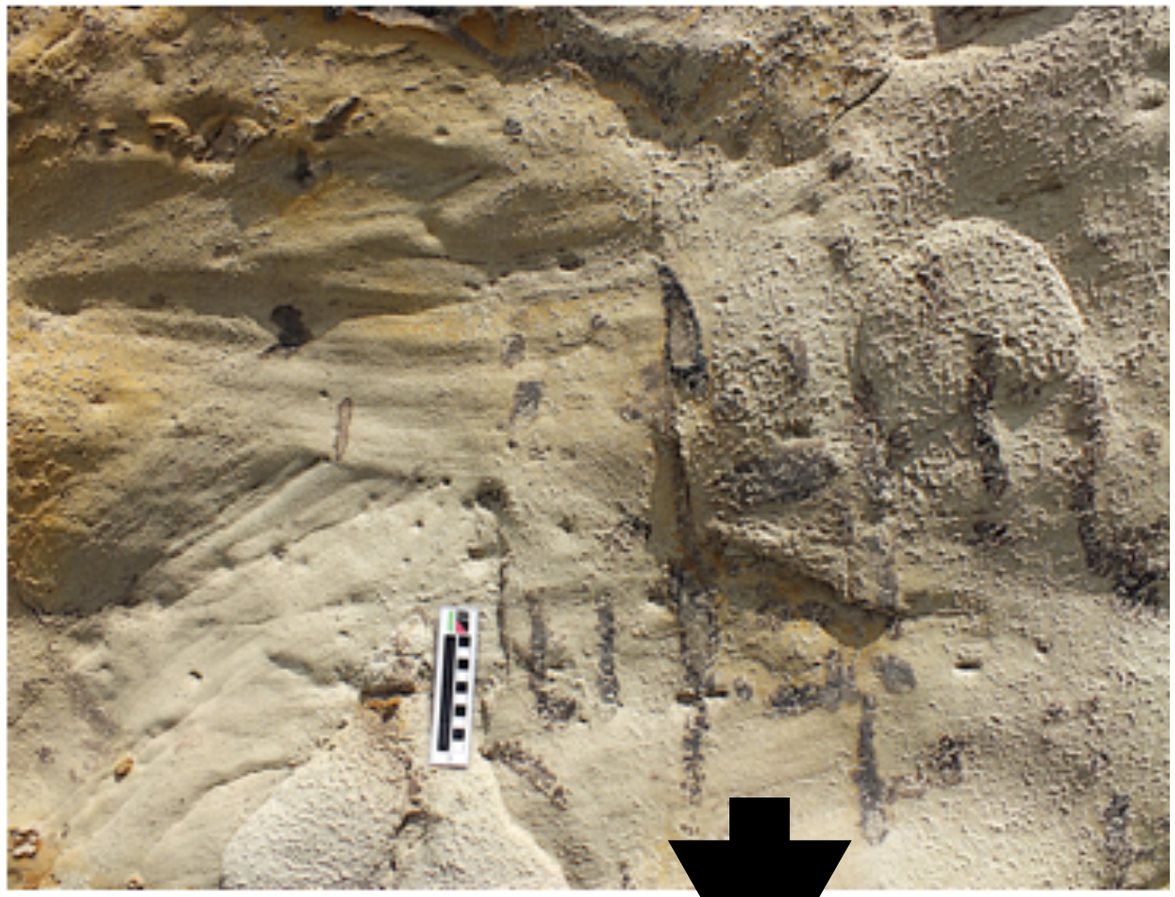
**(see Knaust, 2012)**

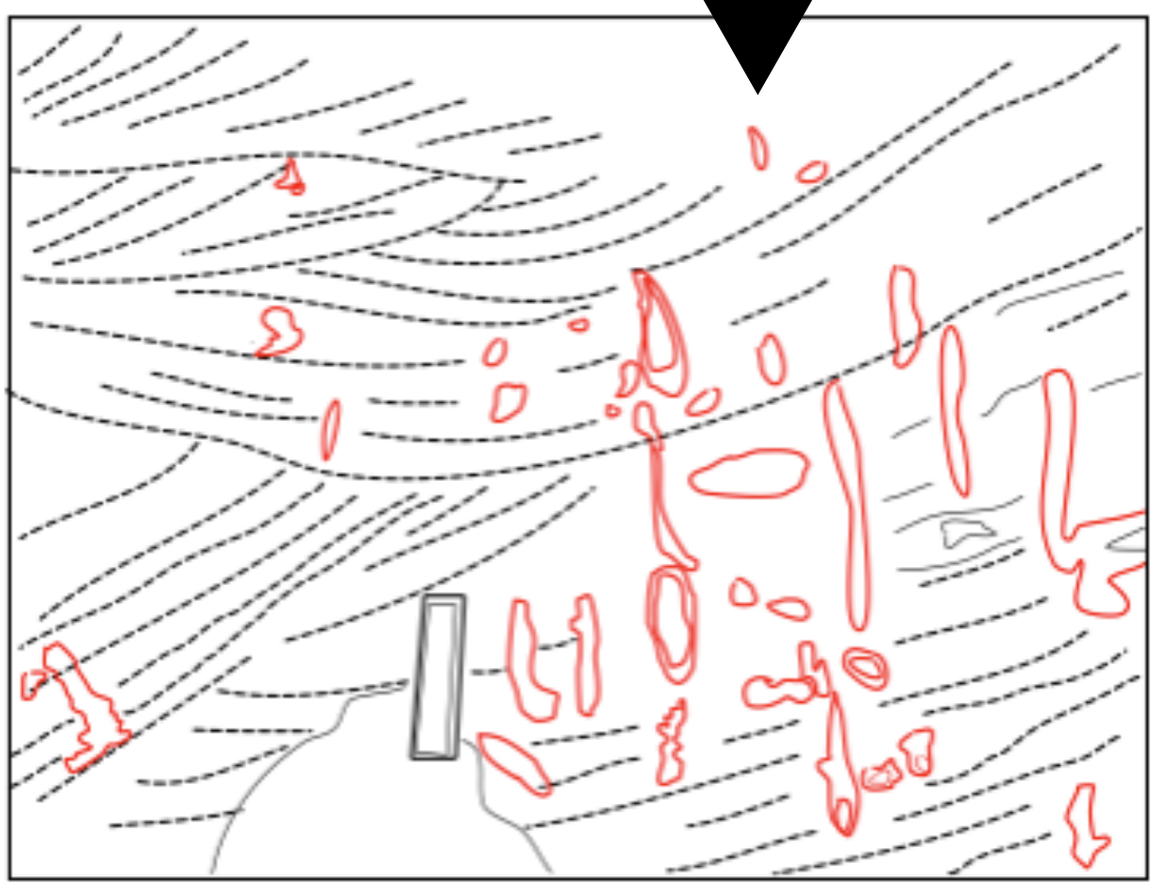
1. The **orientation** of trace fossil to the plane of **bedding surface.**
2. Presence or absence of **branching**.
3. Presence or absence of **burrow lining.**
4. **Burrow fill.**

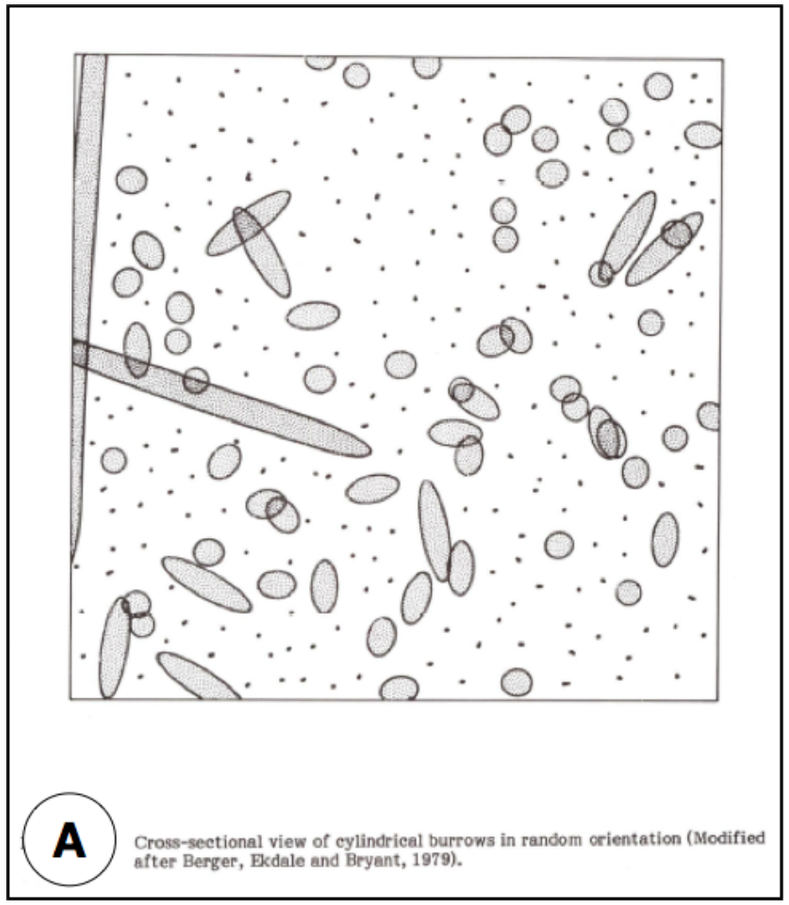
# Orientation of trace fossil against the plane of bedding surface




(Ekdale et al. 1984)

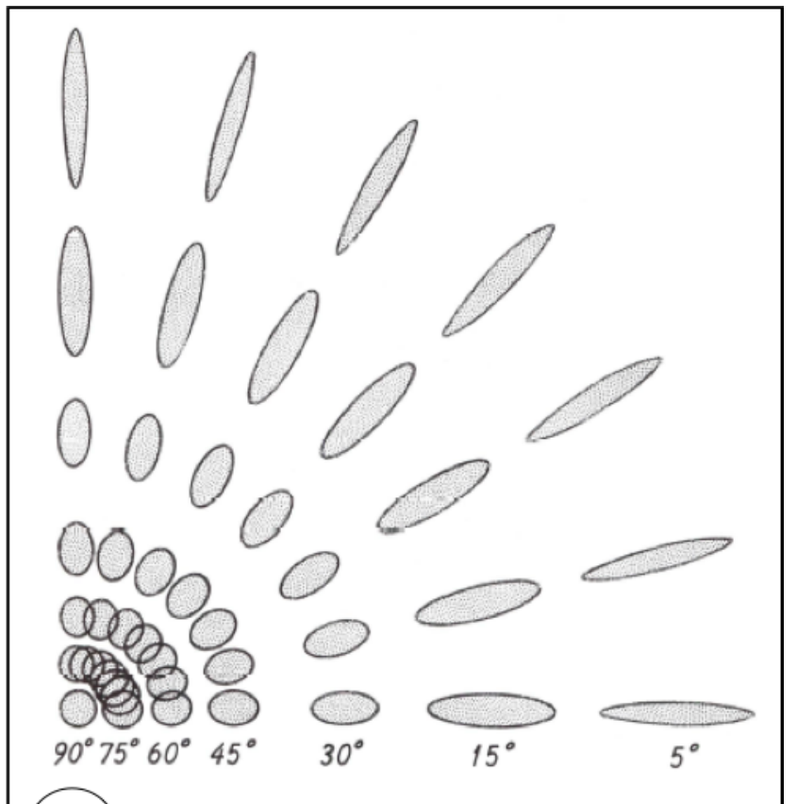






A

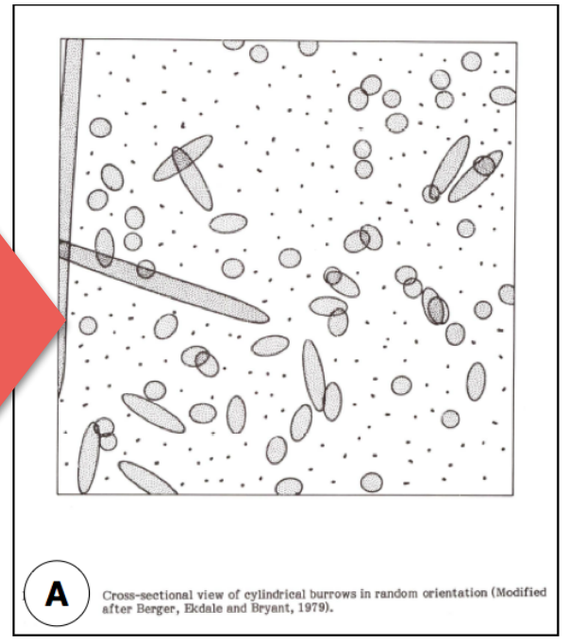
Cross-sectional view of cylindrical burrows in random orientation (Modified after Berger, Ekdale and Bryant, 1979).

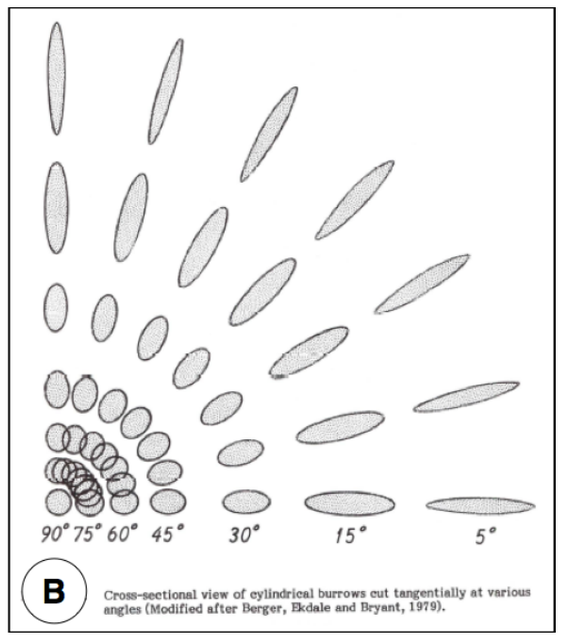


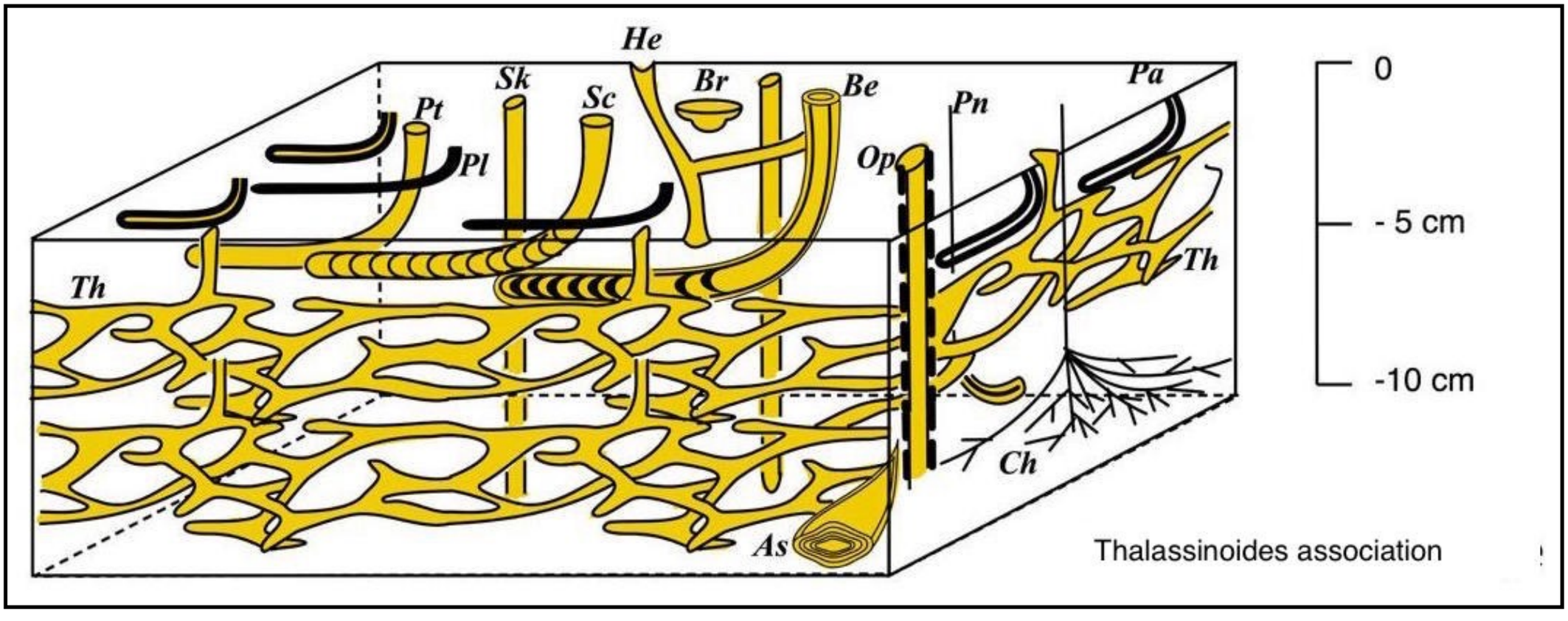

B

Cross-sectional view of cylindrical burrows cut tangentially at various angles (Modified after Berger, Ekdale and Bryant, 1979).

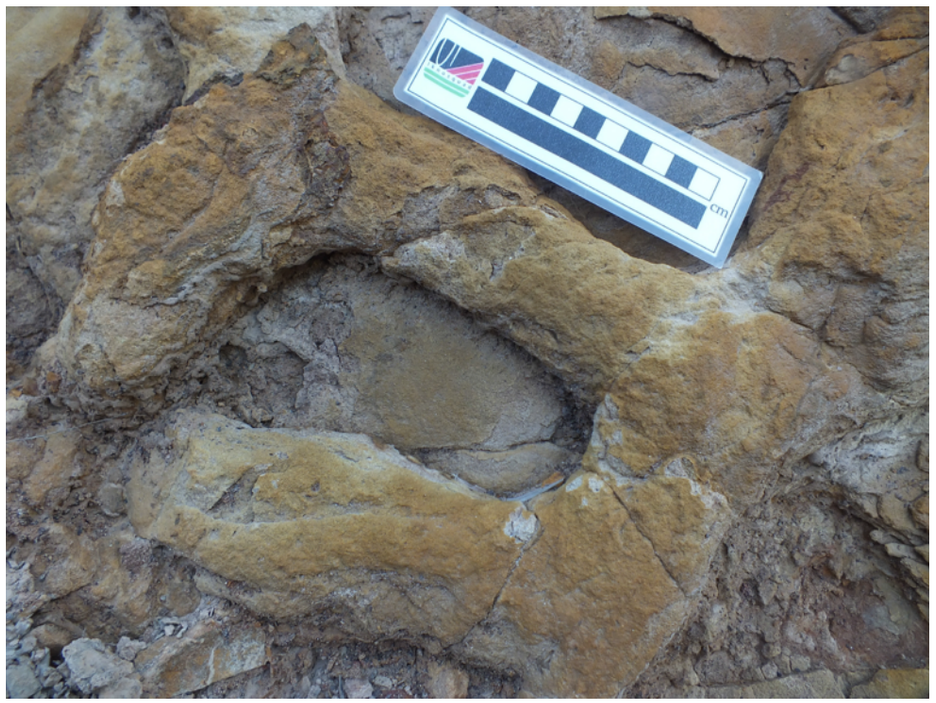

(Arifullah, 2019)



# Presence or absence of branching



(Arifullah, 2019)

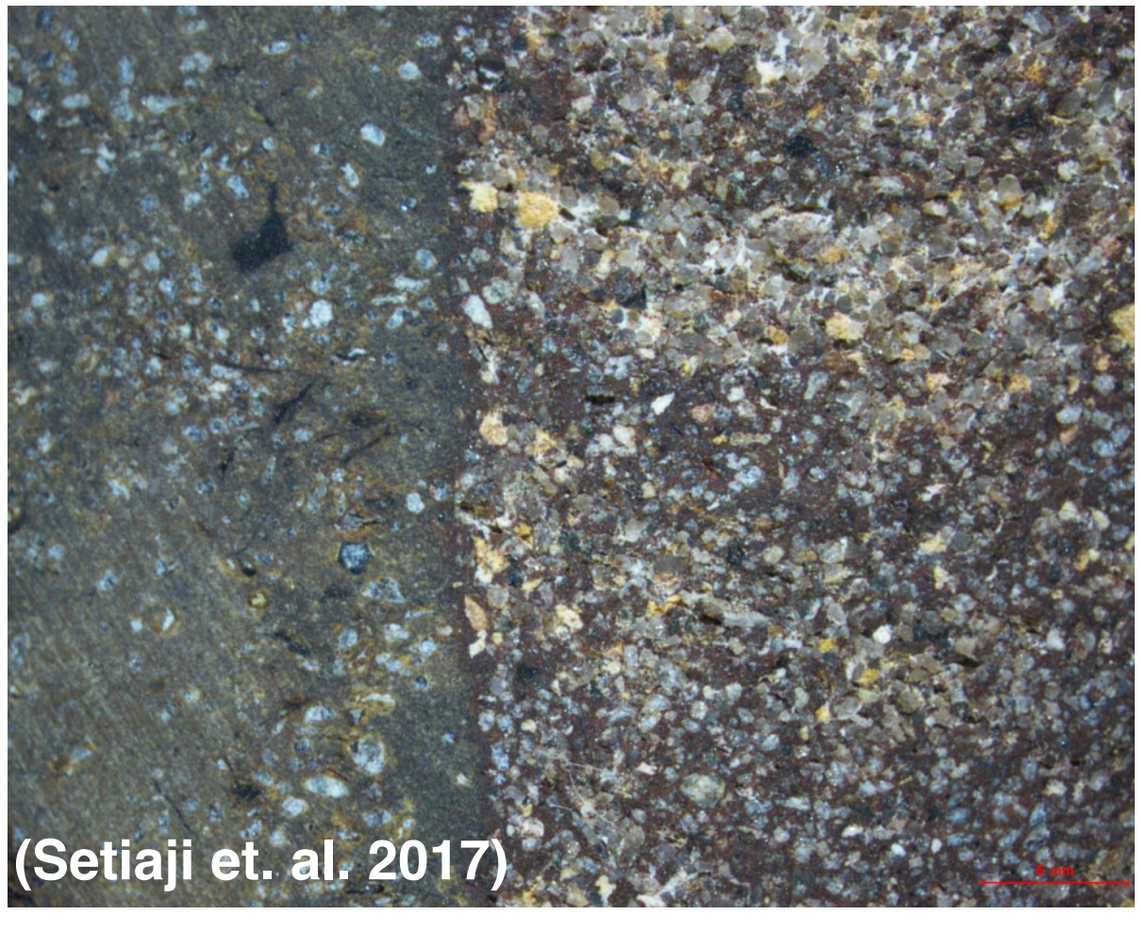
# Presence or absence of burrow lining




(Arifullah, 2019)

# Burrow fill

(Arifullah, 2019)

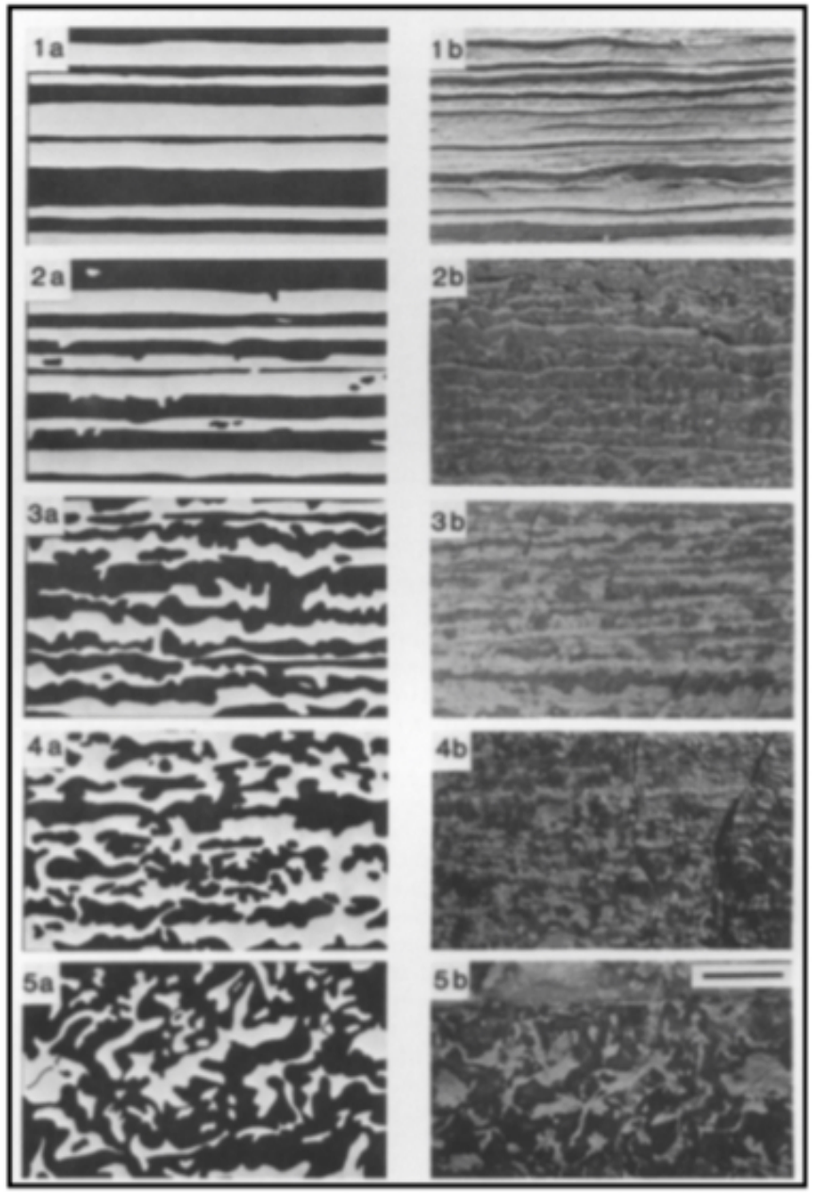



# Ichnofabric work

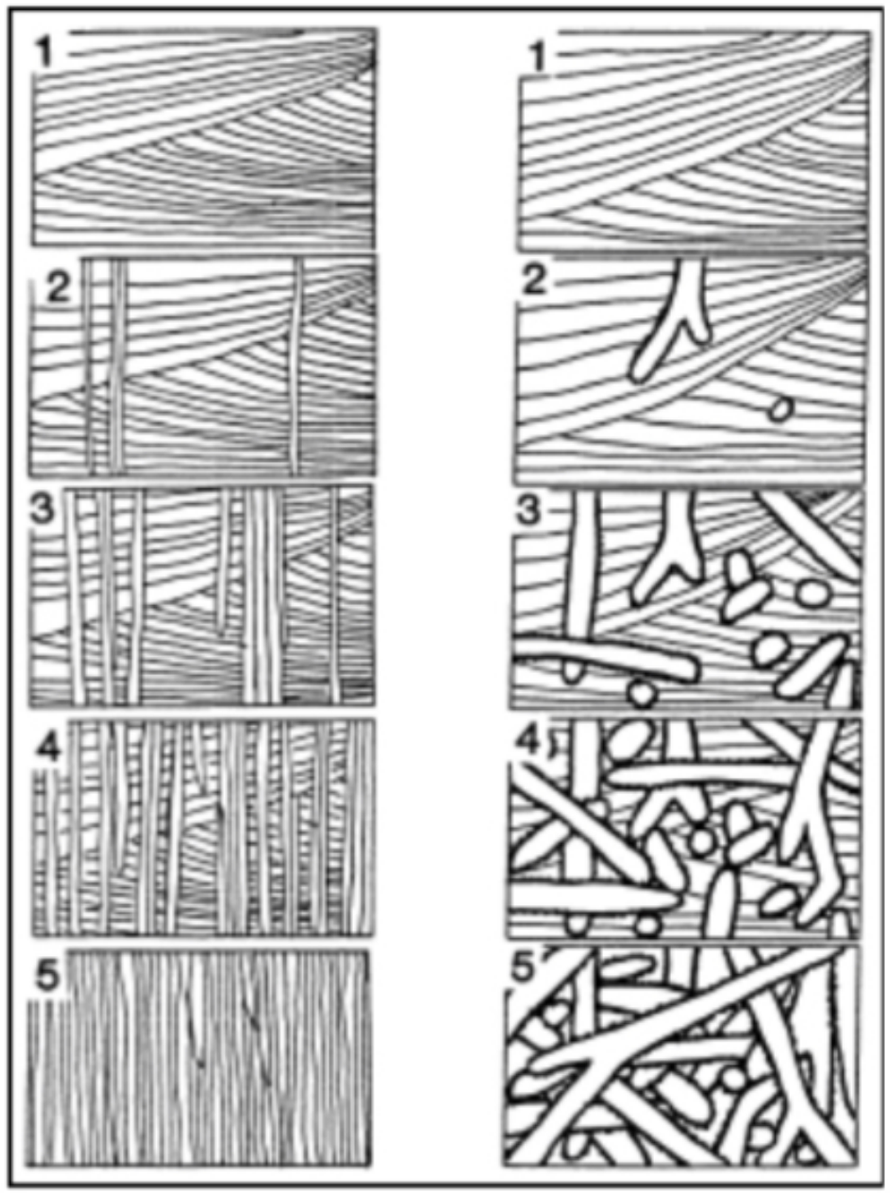
**(see Arifullah, 2009)**

1. Degree of bioturbation.
2. Diverse of trace fossil.
3. Number of behavior.
4. Penetration depth.
5. Diameter of burrow.

# Degree of bioturbation (bioturbation index)




For (sub) horizontal oriented ichnofossil **(Drosser & Bottjer, 1986)**




For (sub) vertical oriented ichnofossil **(Drosser & Bottjer, 1989)**


*Arifullah (2017)*

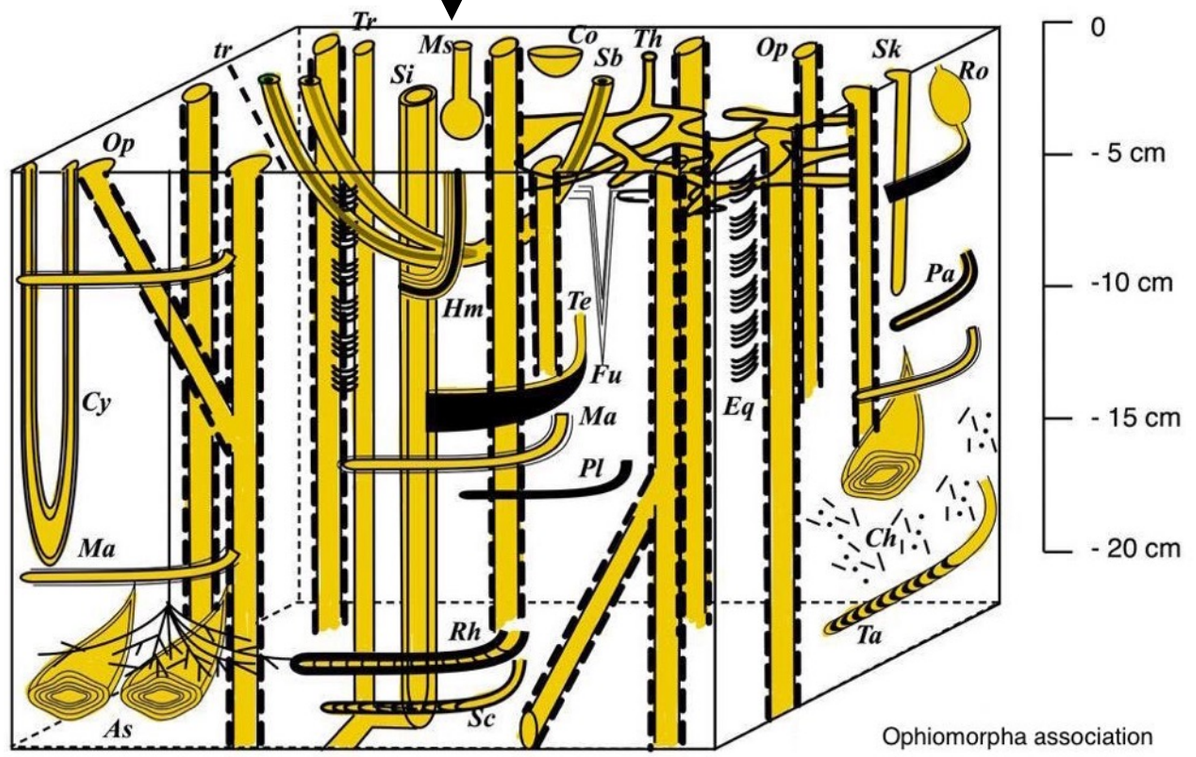
Bioturbation Index

2

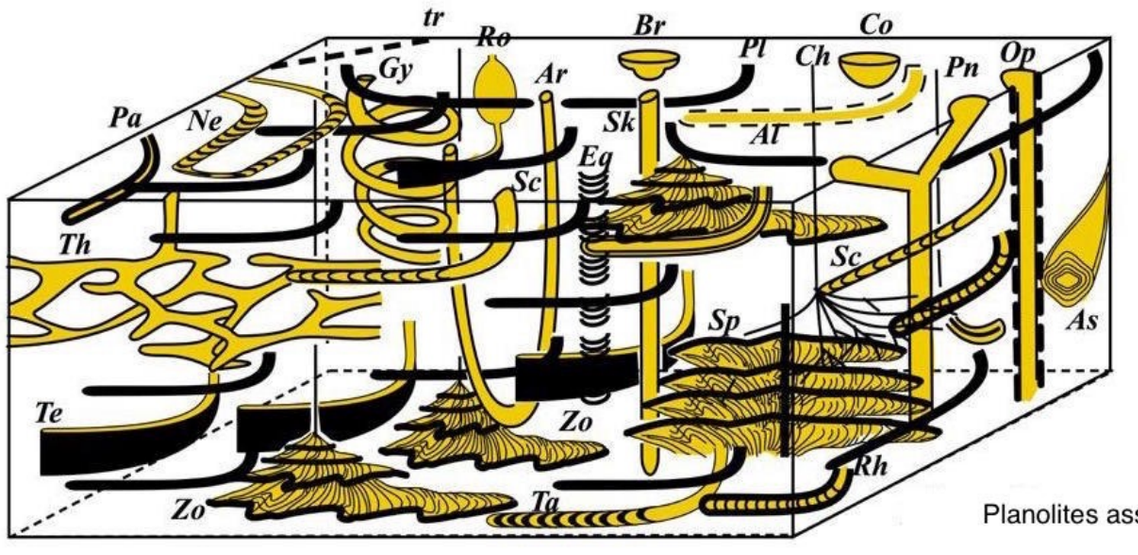
3

4

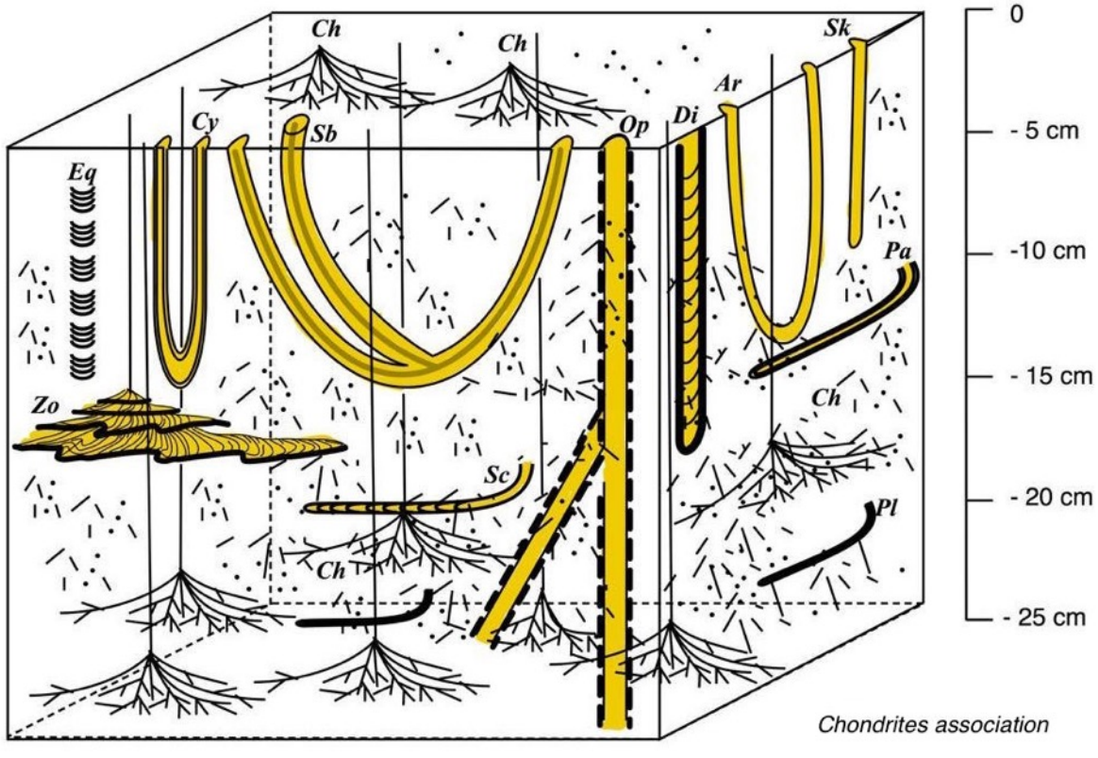
# BI *Planolites* > BI *Ophimorpha* > BI *Chondrites*




Ophiomorpha association




Planolites association

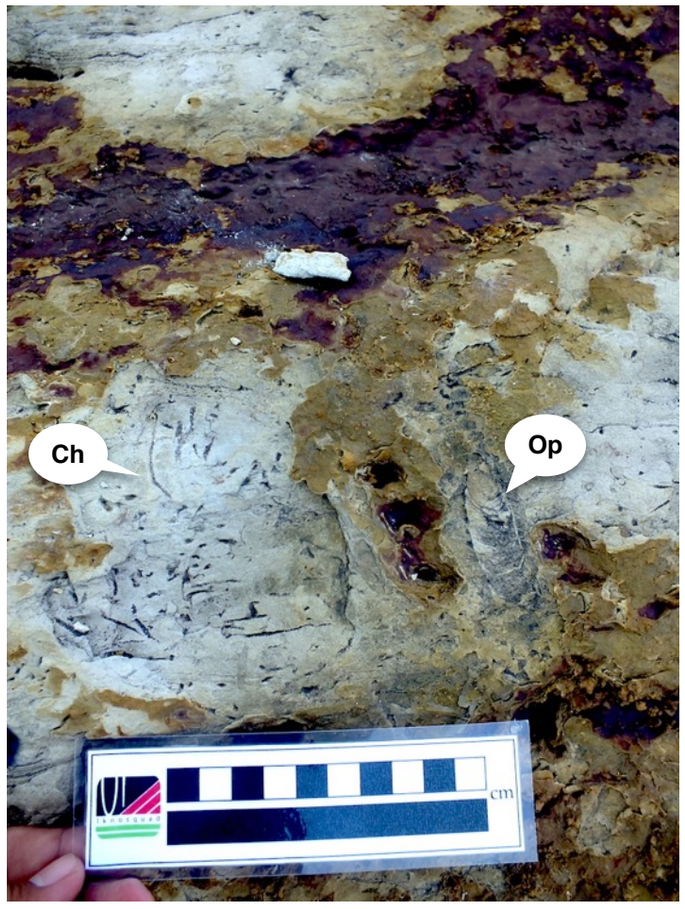


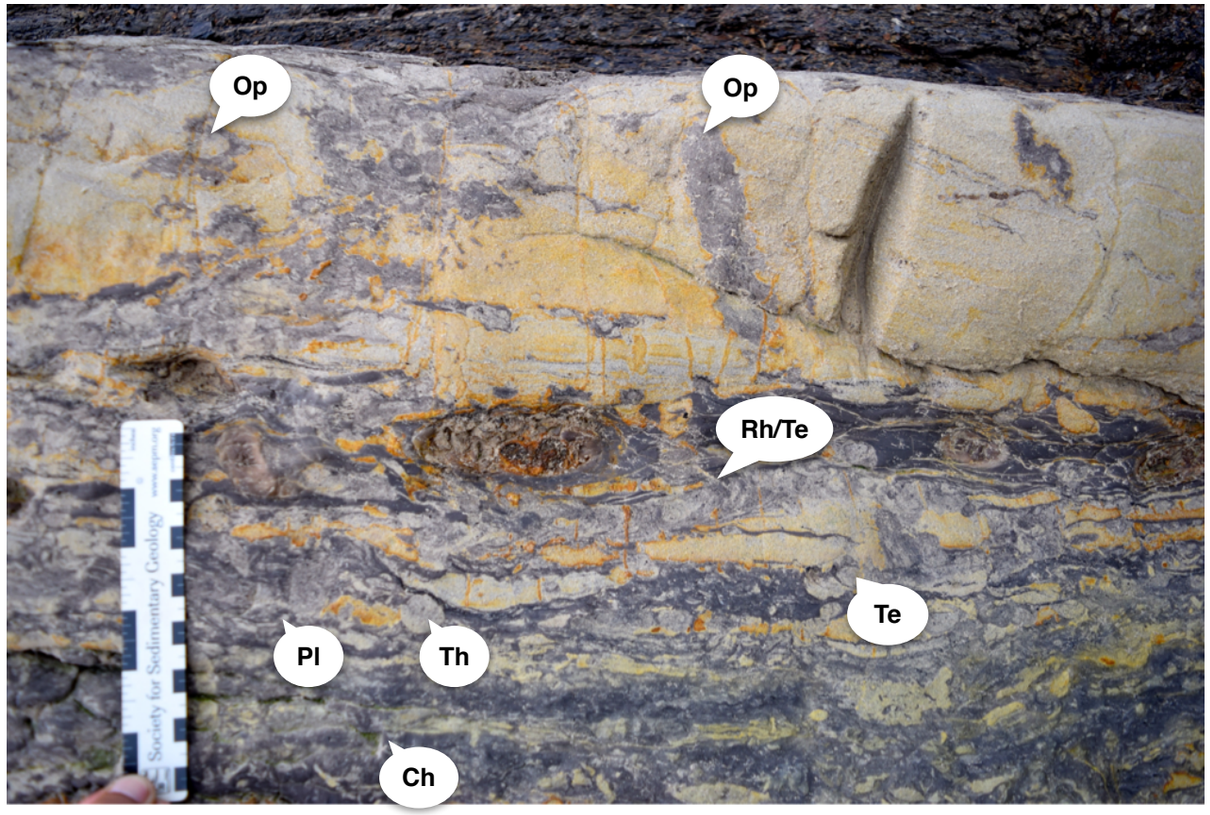

*Chondrites association*

***Arifullah (2019)***

# Diverse of trace fossil

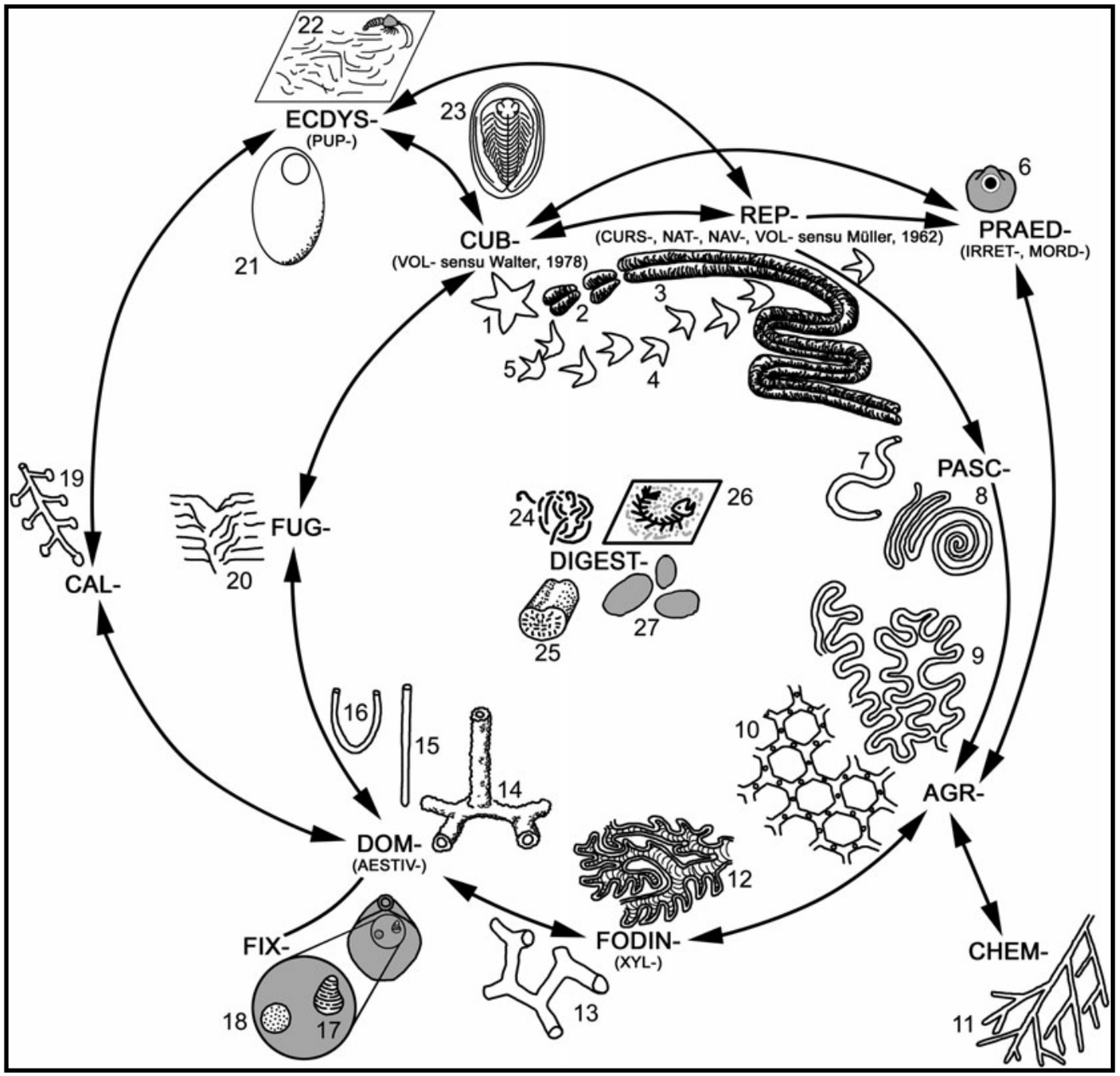
- **Ichnodiversity (ID)** : number of ichnotaxon variations that exist within the ichnofabric unit *(modified from Buatois & Mangano, 2013)*.



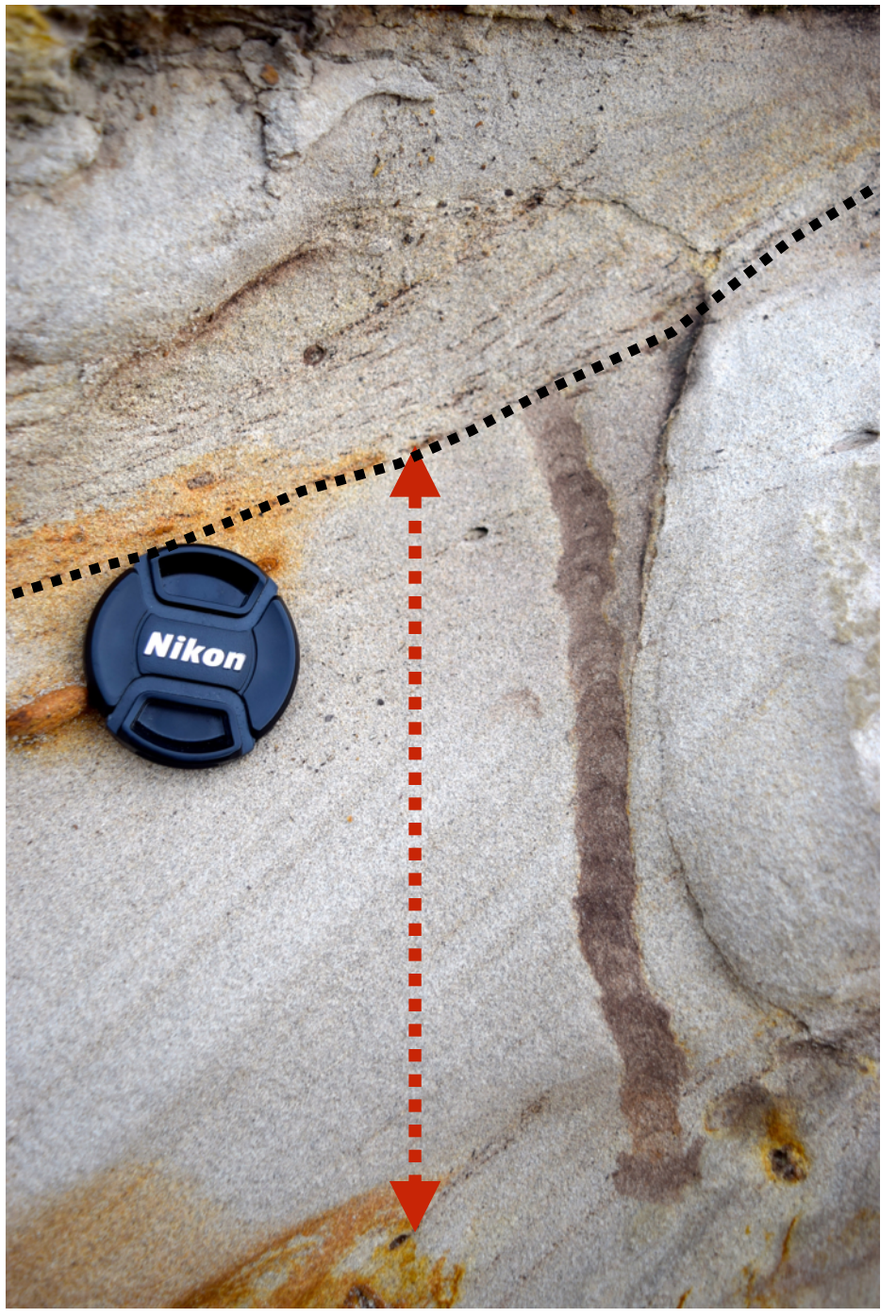
# Number of behavior (NB)?

**Behavior:** the **habits of organisms towards their environment**, to maintain internal conditions, to remain constant against fluctuating external environmental conditions (Vallon et al. 2015).



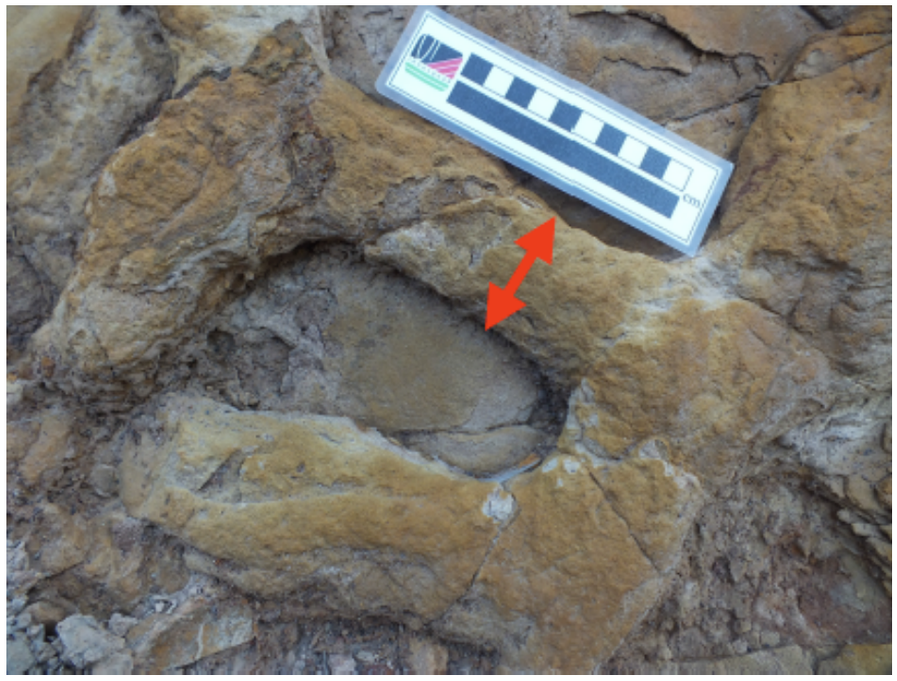

(Vallon et al. 2015, also Bromley, 1996)

# Penetration depth (PD)?




*Arifullah (2017)*

# Diameter (DM)?



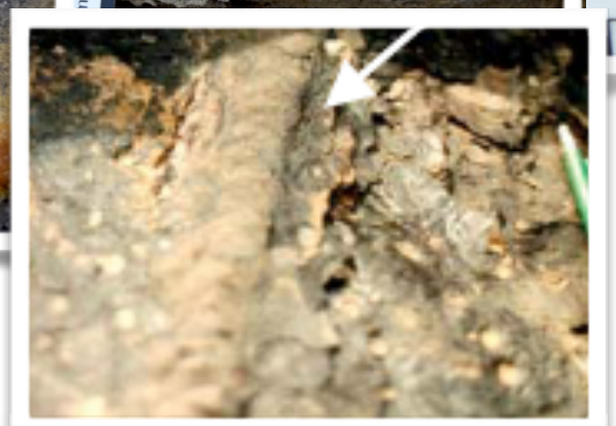

tary Geology
www.sepm.org
centimeters

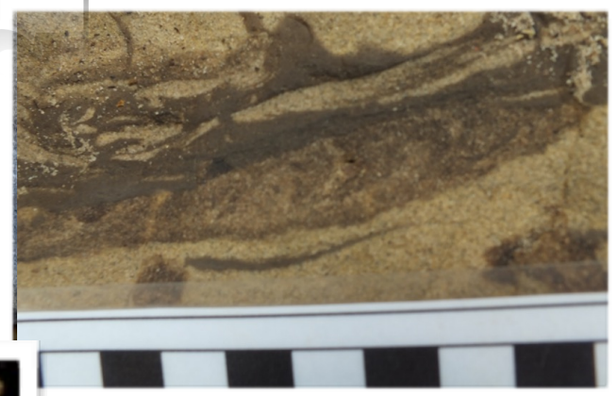

Geology
www.sepm.org
inches
centimeters


entary Geology
www.sepm.org
inches
centimeters

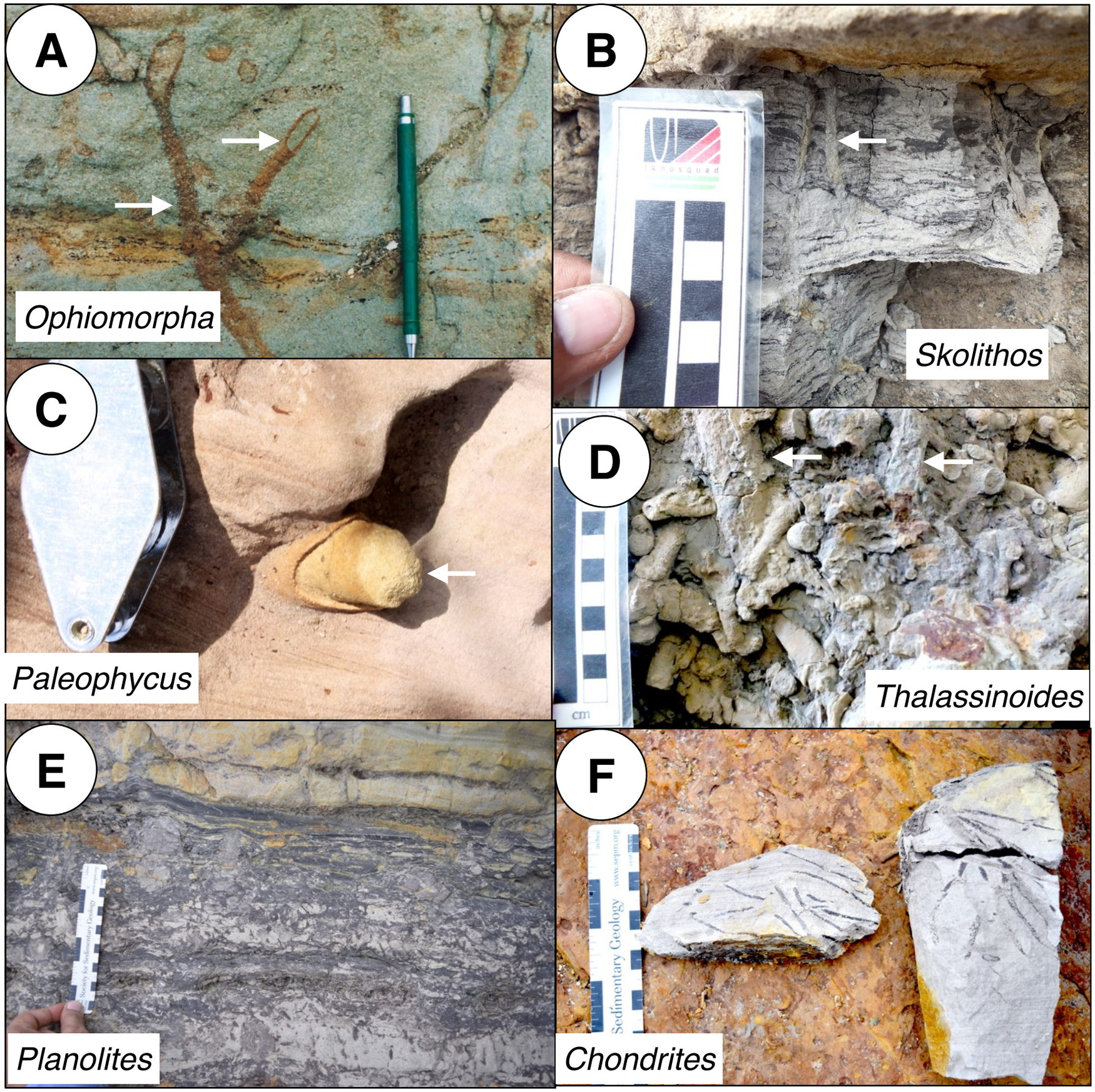
# 4 A case within Kutai Basin, Indonesia: Serravallian-Tortonian

# 34 ichnotaxa



# 6 ichnotaxa




(Arifullah, 2019

# Conclusion

5

- Ichnology is useful in sedimentology, stratigraphy and paleoecology and of course basin analysis.

- Ichnology is a blossoming field with clear directions for future study.

- In ichnological study, you need more not merely ichnofossil inventory.