



Revised Conodont Biostratigraphy of Lower Silurian Strata of Southeastern Wisconsin

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| Southeast WI | | | | |
|--------------|------------|-----|---------------------------|-------------------------------------|
| Series | Stage | Age | Kuglitsch (1996, 2000) | Mikulic & Kluessendorf (1998) |
| | | | | |
| Pridoli | | 416 | ? | |
| | | 419 | | |
| | | 421 | | |
| | | 423 | | |
| Ludlow | Lud. | 421 | ? | |
| | | 423 | | |
| Wenlock | Hom. | 423 | ? | |
| | | 425 | | |
| Llandovery | Sheinwood | 425 | Racine | Racine Lannon Romeo |
| | | 428 | | Waukesha |
| | Telychian | 428 | Waukesha | Brandon Bridge |
| | | | "Brandon Bridge" | |
| | | | Manistique | Manistique |
| | | 436 | | |
| | Aeronian | | Burnt Bluff | Burnt Bluff |
| | | 439 | | |
| | Rhuddanian | 439 | Mayville | Mayville |
| | | 444 | | Wilhelmi |

Formations from Waukesha area quarries for which the conodont biostratigraphy has been revised.

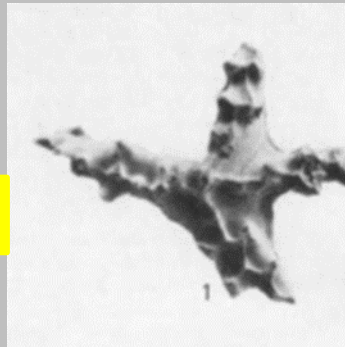
Modified from McLaughlin, P. I. et al. , 2013.

| Southeast WI | | | | | |
|--------------|-----------|-----|---------------------------|-------------------------------------|-----------------|
| Series | Stage | | Kuglitsch (1996, 2000) | Mikulic & Kluessendorf (1998) | |
| | Pridoli | Age | | | |
| Ludlow | | 419 | ? | | |
| | | 419 | ? | | |
| | | 421 | ? | | |
| | | 423 | ? | | |
| Wenlock | Hom. | 423 | ? | | |
| | | 425 | | | |
| Llandovery | Telychian | 425 | Racine | Racine | Lannon Romeo |
| | | 428 | Waukesha | Waukesha | |
| Llandovery | Aeronian | 428 | Waukesha | Brandon Bridge | |
| | | 430 | "Brandon Bridge" | rocks of this age missing | Manistique |
| | | 430 | Manistique | | |
| | | 430 | Burnt Bluff | Burnt Bluff | |
| Rhuddanian | | 430 | Mayville | Mayville | |
| | | 430 | | | |
| | | 440 | | Wilhelmi | |

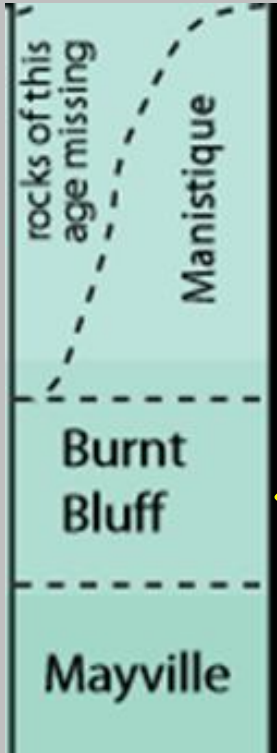
Formations from Waukesha area quarries for which the conodont biostratigraphy has been revised.

Conodont biostratigraphy developed in 1994-1998 based on sparse conodonts and partially on Llandovery brachiopod zonation: *Distomodus kentuckyensis* Zone.

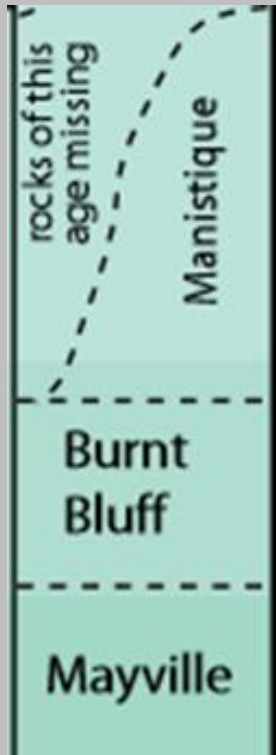
Modified from McLaughlin, P. I. et al. , 2013.



Broken P1/Pa elements likely representing *Distomodus kentuckyensis*



Pseudolonchodina fluegeli



Pseudooneotodus tricornis

| Southeast WI | | | | | |
|--------------|---------|-----------|-----|---------------------------|-------------------------------------|
| Series | Stage | | Age | Kuglitsch (1996, 2000) | Mikulic & Kluessendorf (1998) |
| | Pridoli | Ludlow | | | |
| Llandovery | | | 416 | ? | |
| | | | 419 | ? | |
| | | | 421 | ? | |
| | | | 423 | ? | |
| | Wenlock | Sheinwood | 425 | | |
| | | | 426 | Racine | Racine Lannon Romeo |
| | | | 428 | | Waukesha |
| | | | | Waukesha | Brandon Bridge |
| | | | | "Brandon Bridge" | rocks of this age missing |
| | | | | Manistique | Manistique |
| Rhuddanian | | | 430 | | |
| | | | | Burnt Bluff | Burnt Bluff |
| | | | | | |
| | | | | Mayville | Mayville |
| Aeronian | | | 432 | | |
| | | | | | |
| Rhuddanian | | | 434 | | |
| | | | | | Wilhelmi |

Original conodont zonation

Revised conodont zonation

Distomodus kentuckyensis Zone

D. staurognathoides Zone

Pseudolonchodina fluegeli Zone

D. kentuckyensis Zone

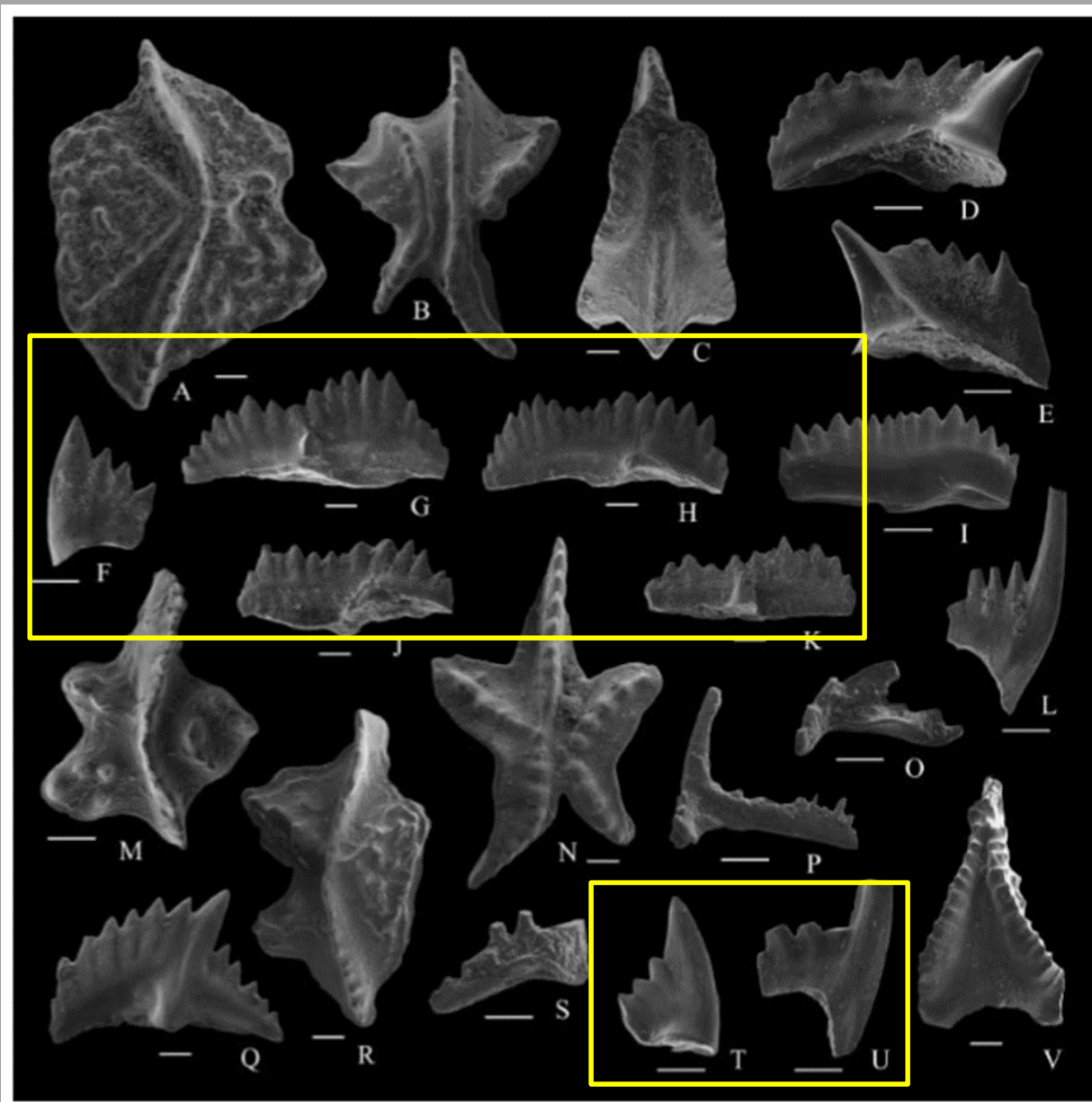
| Southeast WI | | | |
|--------------|-----------|-----|---------------------------|
| Series | Stage | Age | |
| Pridoli | | 416 | |
| | | | ? |
| | | 419 | |
| | | | ? |
| Ludlow | Lud. | 421 | |
| | Gor. | | ? |
| | | 423 | |
| Wenlock | Hom. | | ? |
| | | 426 | |
| Llandovery | Sheinwood | | Racine |
| | | | Racine Lannon Romeo |
| | | | Waukesha |
| | | 428 | |
| | | | Waukesha Brandon Bridge |
| | Telychian | | "Brandon Bridge" |
| | | | rocks of this age missing |
| | | | Manistique |
| | | | Manistique |
| | | 436 | |
| Aeronian | | | Burnt Bluff |
| | | | Burnt Bluff |
| | | | |
| Rhuddanian | | 439 | |
| | | | Mayville |
| | | | Mayville |
| | | 444 | |
| | | | Wilhelmi |

Conodont biostratigraphy developed in 1994-1998 based on recovery and identification of many elements of species recognized as *Pterospirifer celloni*, *Pterospirifer pennatus*, and *Pterospirifer amorphognathoides*, and other species typical of the *Pterospirifer celloni* and *Pterospirifer amorphognathoides* Zones.

Brandon
Bridge





Recognized as
Pterospathodus celloni in
1994-1998



Elements Männik (1998) described as belonging to a newly recognized species *Pterospathodus eopennatus*, not *Pt. celloni* or *Carniodus carnulus*.

From Männik 2007

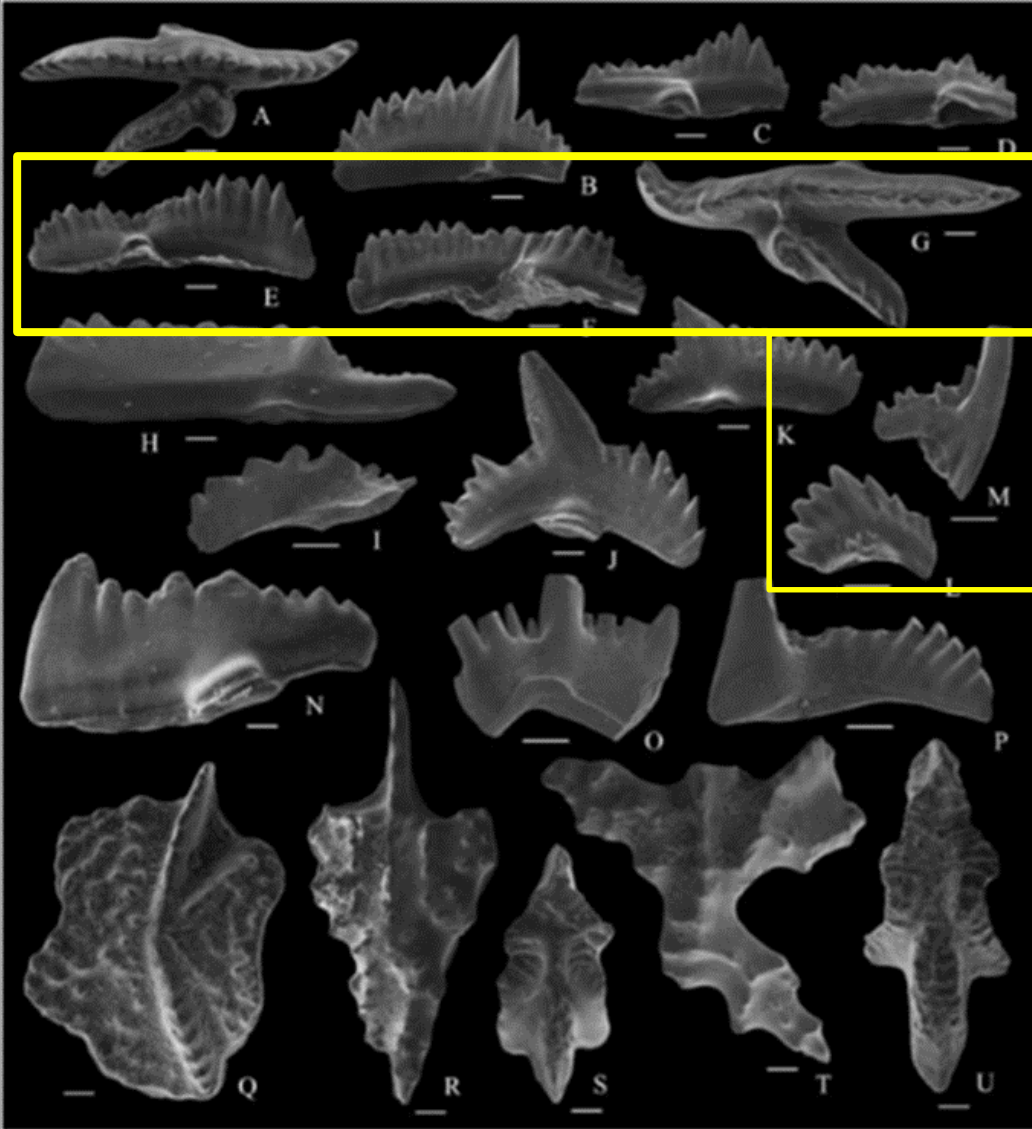
An updated Telychian conodont zonation

| Walliser 1964 | Aldridge 1972 | Bischoff 1986 | Brazauskas 1987 | SUPER-ZONE | ZONE | SUBZONE | GRAPTOLITE ZONE |
|--|---|--|--|-----------------------------------|--|--------------------------------|--|
| <i>P. amorphognathoides</i> | <i>P. amorphognathoides</i> Assemblage Zone | <i>P. amorphognathoides</i> = <i>P. latus</i> | <i>P. procenus</i>  <i>P. amorphognathoides</i> | <i>Ps. bicornis</i> | Upper <i>Ps. bicornis</i> | | <i>C. muchisoni</i> |
| | | | | | Lower <i>Ps. bicornis</i> | | |
| | | | | | | <i>P. a. amorphognathoides</i> | Upper <i>P. a. amorphognathoides</i> Lower <i>P. a. amorphognathoides</i> |
| Not studied? (shales) | <i>Icriodella inconstans</i> Assemblage Zone | <i>P. celloni</i> | <i>P. celloni</i>  <i>P. angulatus</i> | <i>P. celloni</i> | <i>P. a. lithuanicus</i> | | <i>O. spiralis</i> |
| <i>Llandoverygnathus pennatus</i> | | | <i>P. a. lennarti</i> | | | | |
| | | | <i>P. a. angulatus</i> | | Upper <i>P. a. angulatus</i> Lower <i>P. a. angulatus</i> | <i>M. crenulata</i> | |
| | | | | | | | |
| Not studied (shales) or gap in the section | | | | <i>A. irregularis-P. pennatus</i> | <i>Aulacognathus latus</i> | <i>P. eo-pennatus</i> | <i>P. eo-pennatus</i> ssp. n. 2 |
| | <i>P. eo-pennatus</i> ssp. n. 1 | | | | | | <i>St. crispus</i> |
| | | | | | | | |

From Männik, 2007





Recognized as *Pterospathodus pennatus pennatus* and *Pterospathodus pennatus angulatus* in 1994-1998, known to have ranges within the *Pterospathodus celloni* Zone.



Elements Männik (1998) described as belonging to a newly diagnosed subspecies *Pterospathodus amorphognathoides angulatus* and *Pterospathodus amorphognathoides lennarti*, not *Pt. pennatus angulatus* or *Pterospathodus pennatus pennatus* and *Carniodus carnulus*.

From Männik (2007)

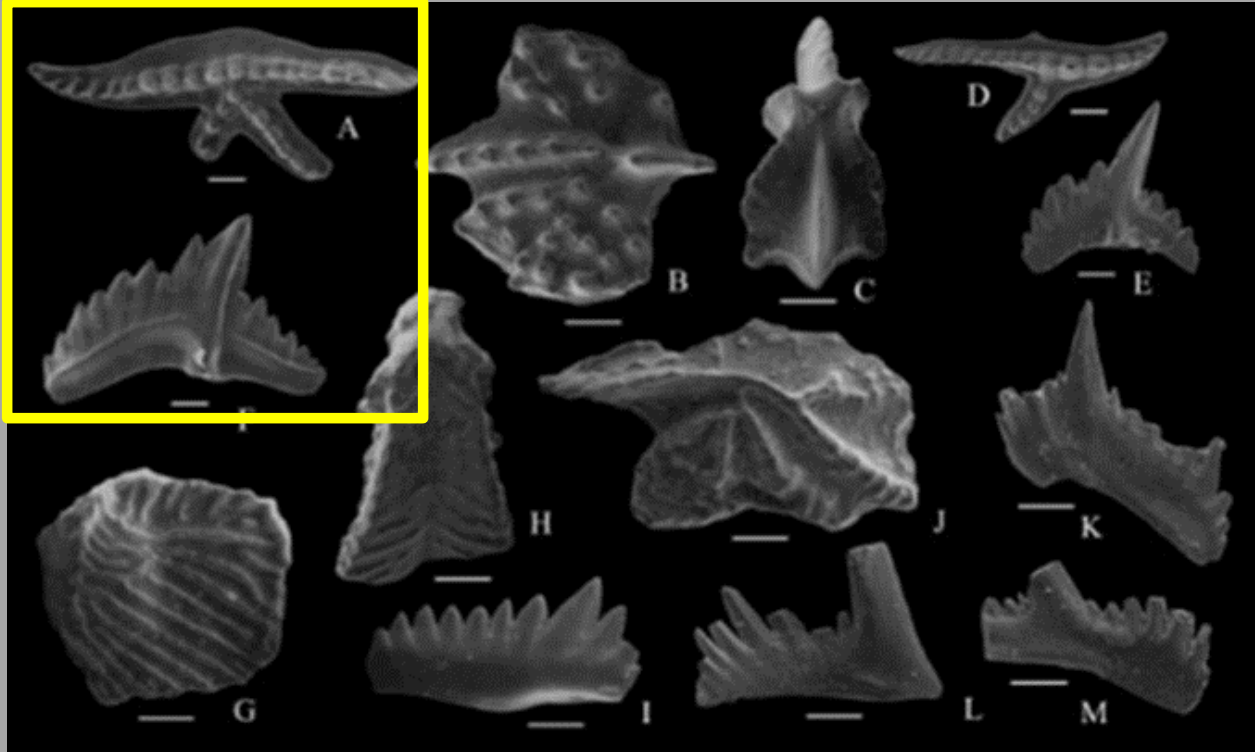
An updated Telychian conodont zonation

| Walliser 1964 | Aldridge 1972 | Bischoff 1986 | Brazauskas 1987 | SUPER-ZONE | ZONE | SUBZONE | GRAPTOLITE ZONE |
|--|---|--|--|-----------------------|--|--|--|
| <i>P. amorphognathoides</i> | <i>P. amorphognathoides</i> Assemblage Zone | <i>P. amorphognathoides</i> = <i>P. latus</i> | <i>P. procenus</i>  <i>P. amorphognathoides</i> | <i>Ps. bicornis</i> | Upper <i>Ps. bicornis</i> | | <i>C. muchisoni</i> |
| | | | | | Lower <i>Ps. bicornis</i> | | |
| | | | | | <i>P. a. amorphognathoides</i> | Upper <i>P. a. amorphognathoides</i> Lower <i>P. a. amorphognathoides</i> | <i>C. centrifugus</i> <i>C. insectus</i> <i>C. lamprognathus</i> |
| Not studied? (shales) | <i>Icriodella inconstans</i> Assemblage Zone | <i>P. celloni</i> | <i>P. celloni</i>  <i>P. angulatus</i> | <i>P. celloni</i> | <i>P. a. lithuanicus</i> | | <i>O. spiralis</i> |
| <i>Llandoverygnathus pennatus</i> | | | <i>P. a. lennarti</i> | | | | |
| | | | <i>P. a. angulatus</i> | | Upper <i>P. a. angulatus</i> Lower <i>P. a. angulatus</i> | <i>M. crenulata</i> | |
| | | | | | | | |
| <i>P. celloni</i> | | | | | | | |
| Not studied (shales) or gap in the section | | <i>A. irregularis-P. pennatus</i> | <i>Aulacognathus latus</i> | <i>P. eo-pennatus</i> | <i>P. eo-pennatus</i> ssp. n. 2 | Upper <i>P. eo-pennatus</i> ssp. n. 2 Lower <i>P. eo-pennatus</i> ssp. n. 2 | <i>M. griestoniensis</i> |
| | | | | | <i>P. eo-pennatus</i> ssp. n. 1 | | <i>St. sartorius</i> |
| | | | | | | | <i>St. crispus</i> |

From Männik, 2007





Recognized as *Pterospathodus
amorphognathoides* in 1994-1998.



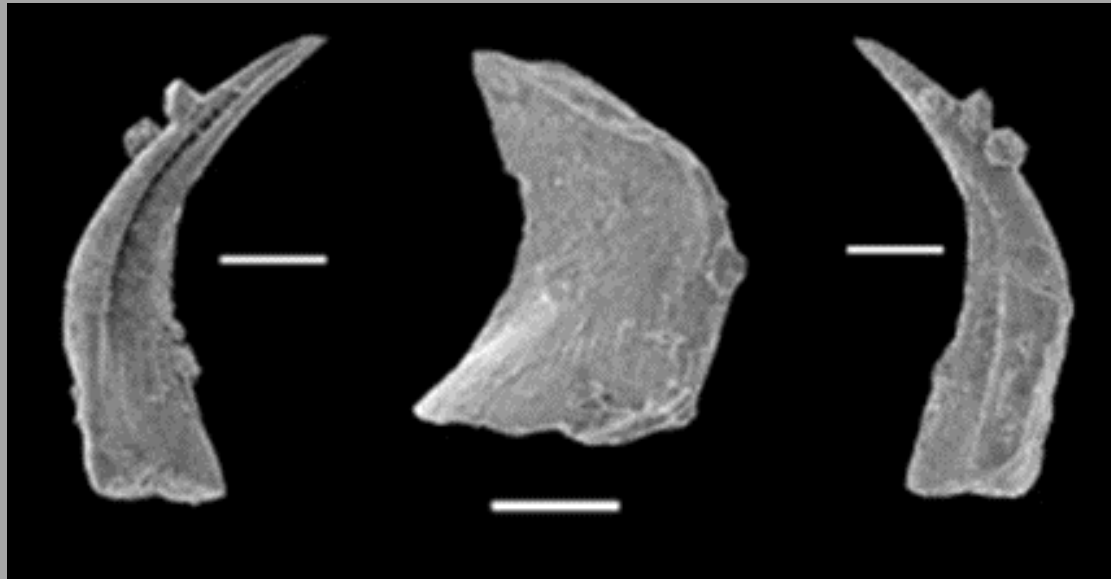
Männik (1998) assigned elements of *Pterospathodus amorphognathoides* to a newly diagnosed subspecies, *Pt. amorphognathoides amorphognathoides*.

From Männik (2007)

An updated Telychian conodont zonation

| Walliser 1964 | Aldridge 1972 | Bischoff 1986 | Brazauskas 1987 | SUPER-ZONE | ZONE | SUBZONE | GRAPTOLITE ZONE |
|--|---|--|--|-----------------------|---------------------------------|--|--|
| <i>P. amorphognathoides</i> | <i>P. amorphognathoides</i> Assemblage Zone | <i>P. amorphognathoides</i> = <i>P. latus</i> | <i>P. procerus</i>  <i>P. amorphognathoides</i> | <i>Ps. bicornis</i> | Upper <i>Ps. bicornis</i> | | <i>C. muchisoni</i> |
| | | | | | Lower <i>Ps. bicornis</i> | | |
| | | | | | <i>P. a. amorphognathoides</i> | Upper <i>P. a. amorphognathoides</i> Lower <i>P. a.</i> | <i>C. centrifugus</i> <i>C. insectus</i> |
| Not studied? (shales) | <i>Icriodella inconstans</i> Assemblage Zone | <i>P. celloni</i> | <i>P. celloni</i>  <i>P. angulatus</i> | <i>P. celloni</i> | <i>P. a. lithuanicus</i> | | <i>O. spiralis</i> |
| | | | <i>P. a. lennarti</i> | | | | |
| <i>P. celloni</i> | | | | | <i>P. a. angulatus</i> | Upper <i>P. a. angulatus</i> Lower <i>P. a.</i> | <i>M. crenulata</i> |
| Not studied (shales) or gap in the section | | <i>A. irregularis-P. pennatus</i> | <i>Aulacognathus latus</i> | <i>P. eo-pennatus</i> | <i>P. eo-pennatus</i> ssp. n. 2 | Upper <i>P. eo-pennatus</i> ssp. n. 2 Lower <i>P. eo-pennatus</i> ssp. n. 2 | <i>M. griestoniensis</i> <i>St. sartorius</i> |
| | | | | | <i>P. eo-pennatus</i> ssp. n. 1 | | <i>St. crispus</i> |
| | | | | | | | |



From Männik, 2007



From Männik et al. (2009)

The last occurrence of elements of *Nudibelodina sensitiva* is above the top of the Brandon Bridge Formation, in the basal beds of the overlying Waukesha Dolomite. The top of the *Pterospathodus amorpho.gnathoides* Zone is defined by the extinction level of that species.

An updated Telychian conodont zonation

| Walliser 1964 | Aldridge 1972 | Bischoff 1986 | Brazauskas 1987 | SUPER-ZONE | ZONE | SUBZONE | GRAPTOLITE ZONE |
|---|---|--|--|-----------------------|---------------------------------|--|--|
| <i>P. amorphognathoides</i> | <i>P. amorphognathoides</i> Assemblage Zone | <i>P. amorphognathoides</i> = <i>P. latus</i> | <i>P. procenus</i>  <i>P. amorphognathoides</i> | <i>Ps. bicornis</i> | Upper <i>Ps. bicornis</i> | | <i>C. muchisoni</i> |
| | | | | | Lower <i>Ps. bicornis</i> | | |
| Not studied? (shales) | | | <i>P. celloni</i>  <i>P. angulatus</i> | | <i>P. a. lithuanicus</i> | Upper <i>P. a. amorphognathoides</i> Lower <i>P. a.</i> | <i>C. centrifugus</i> <i>C. insectus</i> |
| | | | | | <i>P. a. lennarti</i> | | |
| <i>P. celloni</i> | <i>Icriodella inconstans</i> Assemblage Zone | <i>P. celloni</i> | <i>Llandoverygnathus pennatus</i> | <i>P. celloni</i> | <i>P. a. angulatus</i> | Upper <i>P. a. angulatus</i> | <i>O. spiralis</i> <i>M. crenulata</i> |
| | | | | | | Lower <i>P. a.</i> | |
| Not studied (shales) or gap in the section | | <i>A. irregularis</i> - <i>P. pennatus</i> | <i>Aulacognathus latus</i> | <i>P. eo-pennatus</i> | <i>P. eo-pennatus</i> ssp. n. 2 | Upper <i>P. eo-pennatus</i> ssp. n. 2 | <i>M. griestoniensis</i> <i>St. sartorius</i> |
| | | | | | <i>P. eo-pennatus</i> ssp. n. 1 | Lower <i>P. eo-pennatus</i> ssp. n. 2 | |
| | | | | | | | <i>St. crispus</i> |

From Männik, 2007

Brandon
Bridge

Pt. amorphognath. amorphognathoides Zone

Pterospathodus
celloni
Superzone

Pt. amo. lennarti Zone

Pt. amo. angulatus Zone

Pterospathodus eopennatus Superzone

| | | | | Southeast WI | |
|------------|------------|-----|---------|---------------------------|-------------------------------------|
| Series | Stage | Age | Pridoli | Kuglitsch (1996, 2000) | Mikulic & Kluessendorf (1998) |
| | | | | | |
| Llandovery | Ludlow | 416 | | ? | |
| | | 419 | | ? | |
| | | 421 | | ? | |
| | | 423 | | ? | |
| | Wenlock | 426 | | | |
| | | 428 | | | |
| | Telychian | | | Racine | Racine Lannon Romeo |
| | | | | | Waukesha |
| | | | | Waukesha | Brandon Bridge |
| | | | | "Brandon Bridge" | |
| Aeronian | Aeronian | | | Manistique | Manistique |
| | | | | Burnt Bluff | Burnt Bluff |
| | | | | | |
| | | | | Mayville | Mayville |
| Rhuddanian | Rhuddanian | 439 | | | |
| | | 444 | | | Wilhelmi |

Conodont biostratigraphy developed in 1994-1998 based on recovery and identification of elements of *Pterospiriferus amorphognathoides*, *Ozarkodina polinclinata*, *Kockelella ranuliformis*, and *Kockelella walliseri*, species representing several conodont zones.



Waukesha Dolomite

Lower Kockelella walliseri Zone

*Kockelella ranuliformis Superzone –
Ozarkodina sagitta rhenana Zone*

Pterospathodus procerus Superzone

Pseudooneotodus bicornis Superzone

Pterospathodus am. amorphognathoides Zone

