Stenacron

Mayflies

2020

Mack A Beacon

Larvae and Adults

Back story

I have had an interest in mayflies from about the age of 7 in fly fishing. The book Hatches II by Al Caucci, Bob Nastasi with their excellent book and photographs. Really planted a seed, as it does for most.

In 1987 at Lyman Run PA I found a *heterotarsale* on the roof of my car. Upon returning home from the USA 2009 I started collecting what I thought were Stenonema according to their book. This is where it started because my adults were free of black marks and theirs was not. The facts they were so different it made me want to know more.

In their selected bibliographies there were two books I had to have. The taxonomy and Ecology of Stenonema Mayflies, and the Biology of a Mayfly. While starting this project in 2010 I accidentally reared a female *heterotarsale* she sat looking at me even crawling up my arm. She molted to a Spinner and stayed till she died. So most of the time from 2010 till 2020 I have been working on this poor forgotten Genus.

Mack A Beacon

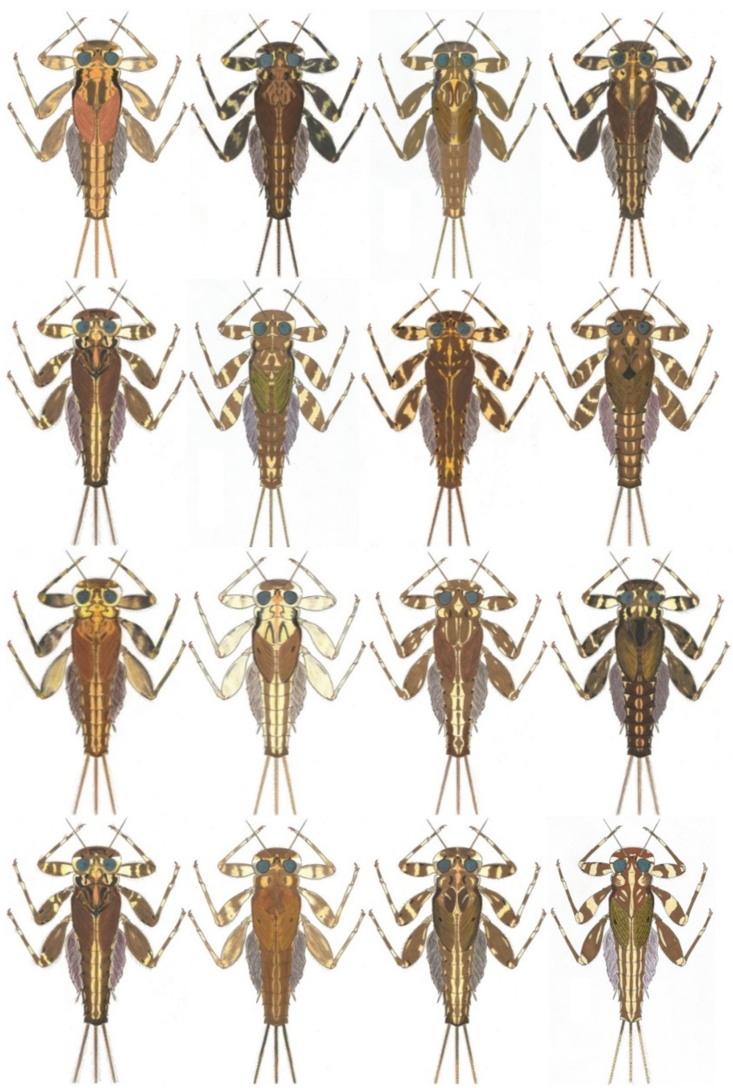
The Stenonema Rangers Of Ontario

Fighting for clean waters

Stenonema Rangers are Mack A Beacon & Benjamin R Beacon

Who is Who?

When put in the right basic size perspective you can see why they are so hard to tell apart, by the time you are done with this book you will see how different they really are, even these samples that are larger than life by 2X the real size.



Biographies

Thomas Say (June 6, 1787 – October 10, 1834),

U.S. self-taught naturalist.

New Harmony (Indiana), 10 October 1834)

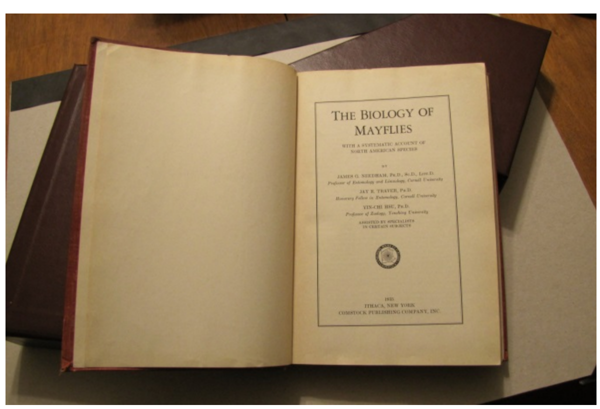
For true *interpunctatum* Say 1839.

Thomas Say 1817, public domain
Artist
Wilson Peale (1818)

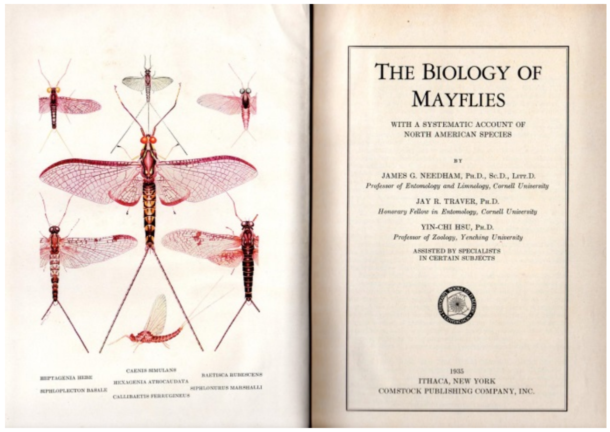
The histories of somethings are very endearing and very intriguing. What I find most interesting is how we know a lot of information on some people and times frames, and little on others. Without the complete writings of Thomas Say I suspect little would be know of him. Although Thomas Say died in 1834, some of his work was not published. It is unclear to me whom erected the species concept *interpunctatum* Say in 1839 after his death. I have not yet read the book The Complete Writings of Thomas Say 1853 so I cannot say who erected *interpunctatum* on his behalf. It is very likely that in his notes and samples he had collected and wrote about it, but had not created the species status officially.

He was born in Philadelphia into a prominent Quaker family. As a boy, Say often visited the family garden, where he frequently collected butterfly and beetle specimens. A self-taught naturalist, Say helped found the Academy of Natural Sciences of Philadelphia. He continued collecting and writing for the Academy till his death of Tuberculosis.

In 1935 the Bible of Mayflies was written, it would go onto become the greatest book very written on the subject. Here is an inside view of one of my copies. It is actually a very rare version; it is a **[first-first-edition].** The first 200 copies where setup prototypes of sorts and lacked the white page to the left with the colored Mayfly plate, and more important the text was tilted to the left for the first 23 pages. This version in mint condition signed by all three authors in 1937 sold at auction for more than $4000 USD in the 2000’s.



Now here is a standard 1935 first edition even the paper is different.



The senior author and the books concept was Professor James G Needham’s. The other two junior authors are Dr Jay R Traver, and Dr Yin-Chi-Hsu. I would like to spend some time here on Dr Traver. First thing is who Dr Traver was. With a name like Jay the first thought is that must be a man. I thought so for a period of time. It was when I was reading deep in to discussions on a species in Lewis 1974 where I read “she”.

Dr Traver is in fact a woman. As a matter of fact there are many very important female entomologists like Anna H Morgan. Velma Knox-Mayo. It should also be noted that a lot of the illustrations for the Biology of Mayflies were illustrated by Dr Velma Knox-Mayo. It was actually her work that inspired mine, page 137 and 138, and most importantly page 131 for the Stenacron *frontale* larva, and her *proximum* abdomen figure 93.

To be quite honest I am not that much of a reader but I am now. I have never truly read an entire book. It never interests me that much. But there is one author that I really took a shine to and have read nearly very thing they wrote, and that is Jay R Traver. There is something about how she wrote that speaks to me. I can’t explain it like I knew her at one time. When I read her work it is like she is talking to me in person. So because she did all the systematics for the book and wrote all the species descriptions she needs to be talked about. I recently received from the Cornell University Archival Department a complete file on her and her carrier post cards and all. Very little is known about her and I have just enough to piece together a profile of her. So let’s start with the principles of my book!

“**Putting a face to a name**”

Miss Jay R Traver in 1918

Jay R Traver 1894 – 1974

In the newspaper article from the Springfield Union, Springfield Mass Friday Sept 6th 1974, she died on the 5th in the Cooley Dickerson Hospital at the age of 80 from cancer.

Let’s start at the beginning. She was born August 2nd 1894 in Willoughby Ohio at the Willoughby Hospital. She grew up on 112 River St in Willoughby and used that address often throughout her life until moving to Massachusetts. Here is a photo of the house at 112 River St from the archive. I imagine the tree in the front was smaller back then. There is no date for the photo.

Somewhere between 1935 and 1952 the city Willoughby made changes to the addresses on river St. If you google search these two address they are the same. 112 River St and 4566 River St is the same house. What is ironic is there is a river right across the street called Chagrin. I suspect her interest in mayflies started very early as they would have been drawn to the outside lamp of her house. *Candidum, gildersleevei* and *conjunctum* are from that river near her house.

Somethings are unclear like how did she get the name Jay. I have no birth certificate to indicate another name and it appears throughout her whole life. Records show her father died 3 weeks before her birth, and her mother named her after her father. Her mother, Mrs. Mable M Traver is present till after 1952.

We know that she attended Willoughby high school and graduated in 1912. There are no recorded of what she did between then and entering Cornell in 1914 at the age of 20. All records indicate she entered Cornell under the classes of Arts General, and Sciences, and on July 16th 1918 got her BA, Dr Traver showed an obvious interest in teaching right away.

While doing her Masters 1918-1919 she was also acting as an assistant of biology in an official capacity. November 1st 1919 received her Master's diploma and likely stayed at Cornell till June 1920.

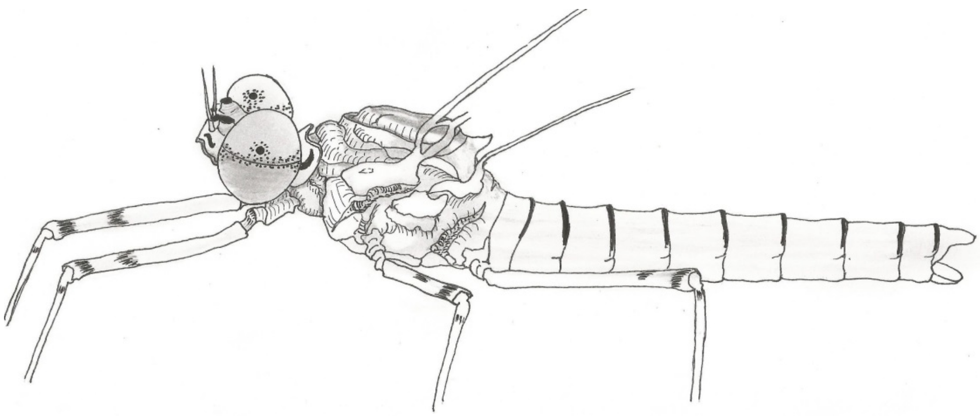
Although the length of time is not indicated she did spend a very short period of time at 430 West 188th St New York City in upper Manhattan. With it being in her alumni records it must have occurred between Cornell 1919 and her first job.

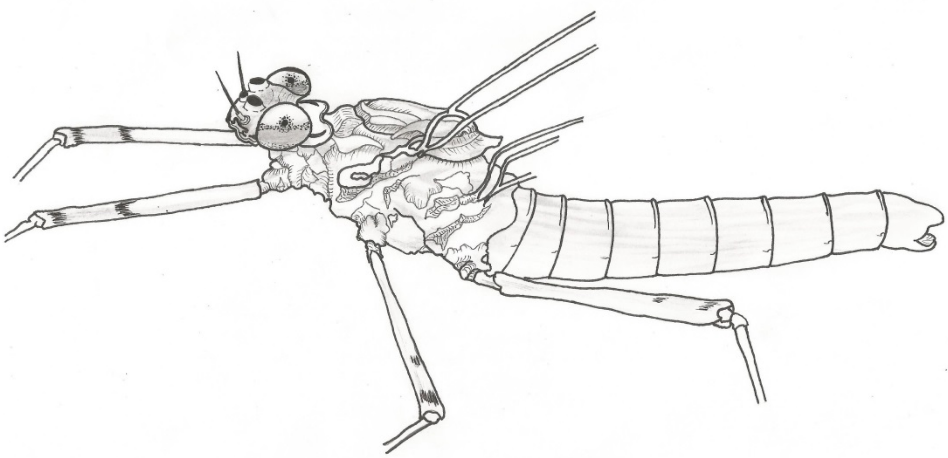
She took her first official job from her Cornell education in 1920 as The Supervisor of Natural History Study for the Wilmington Delaware public school system. From what I read she did not work in a school per say. The only thing very clear is she was moving around a lot in Wilmington there are four different addresses inside a three year job position ending in 1923.

In 1924-1925 came a job that was a big stepping stone. She took the official position of Head of the Biology Department of Shorter College in Rome Georgia. This position certainly set her up for the job and location that would be life changing.

From 1924 through 1930 came the job that defined her. It was actually more than the job it was the location. The new job she took was Assistant Professor of Biology at Woman's-College University of North Carolina in Greensboro.

If we read deep many new species concept of hers are located very close by like *affine*. The amount of personal collection and study must have been very high because this lead to her published thesis "The mayflies of North Carolina" in 1931 and she received her PhD on September 30th 1931.





You can contact the author

Mack A Beacon if there is

Anything I can help you with.

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Mack A Beacon

Stenacron

1839 - 2020

INTRODUCTION

Welcome to the secret world of

Stenacron mayflies

This is an advanced guide that will enable you to identify all the different forms in the genus in the Larvae & adult stages. With the current taxonomic conditions of the genus we will go to form, rather than species. Once form is identified, you are encouraged to go to Mayfly Central on the internet to locate the current species status. Using this guide is simple! First compare the collected larvae or adult to the general illustrations. Second look up that form and stage in the description section to make a confident identification. Third in order to verify your findings, dissection of the mouthparts of the larvae, and male genitals and comparing them to the genital illustrations provided in this guide is critical also to the characteristic feature table.

Acknowledgements

I would like to take a moment express my gratitude to some special people. First I wish to sincerely thank Dr Jeff Webb for his great advice and encouragement with the creation of this guide, and the entire study project. I wish to thank Dr Luke Jacobus for excellent advice and helping create these digital files and making them available. I wish to thank Dr N J Kluge for my online education with classifications. I also wish to thank both Bill Christmas and Don McGregor for all the years of fly fishing and for what they taught me. I would like to thank my mother for being such a great proof reader, and supporter of all of my endeavors. This book dedicated to the memory of Don McGregor of the “Hackle House”. I am a much fuller and richer man by having had his friendship throughout the years.

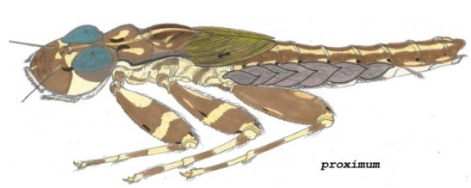


Table of contents larvae

Classification

(Ephemeroptera:Heptageniidae)

Stenacron

Common names

Male; light Cahill

Female; Salmon spinners

Concept and Goals

So just what is the concept of this book and what goals did we set out to achieve. The very first thing one must understand this book was developed with usage as the primary function. A book that a 4 years old child can use to the world's leading Taxonomists with revisionary and revolutionary concepts.

"A picture is worth thousand words"

That is the concept every form in this genus was treated equal. Every illustration, except the labrums, anatomy, and genitals were colored in on printed master templates. This way every illustration would reflect the same except maculation and some fine details. Supreme illustrations have a great advantage to pictures; there is no focal, background, or angle issues.

We were also able to put a face to a name in all stages. This book puts an enormous effort into the larva. For the first time showing them side by side. This genus has been without any doubt one of the most difficult in history. The level of accuracy in the details of this book is mind blowing. Thousands of samples, studied in great detail.

The goal was to revolutionize bug books by making them scientifically correct but simple enough for any education level. Because these are not designed to be scientific manuals. Another goal was how to approach a truly never ending revolution of taxonomic revisions.

As soon a one species becomes a synonym of another species both can lose their original clarity. The greatest example is Spieth 1947 synonymizing *ohioense* to *canadense*. By doing this it changed the description of *canadense* and we lost clear sight of *ohioense*, but more important we lost the original concept of the species *canadense*.

By going to form rather than species in this book regardless what comes out of the future revisions this book will never go taxonomically out of date. It also clarifies species concepts; you can’t have a species without form. Every valid species is in fact is a form in this genus.

So using form here in this book brings the ultimate clarity available to each of the 16 forms that reside in this genus. We hope this will inspire others to do research, but more importantly new collection and sightings to make a better visual profile of this genus.

Although the concept of peer-review is great it was never a concern with the concepts of this book. Getting the facts right was. We put all the information needed about this genus in one place for the first time in 178 years, to the memory of Thomas Say.

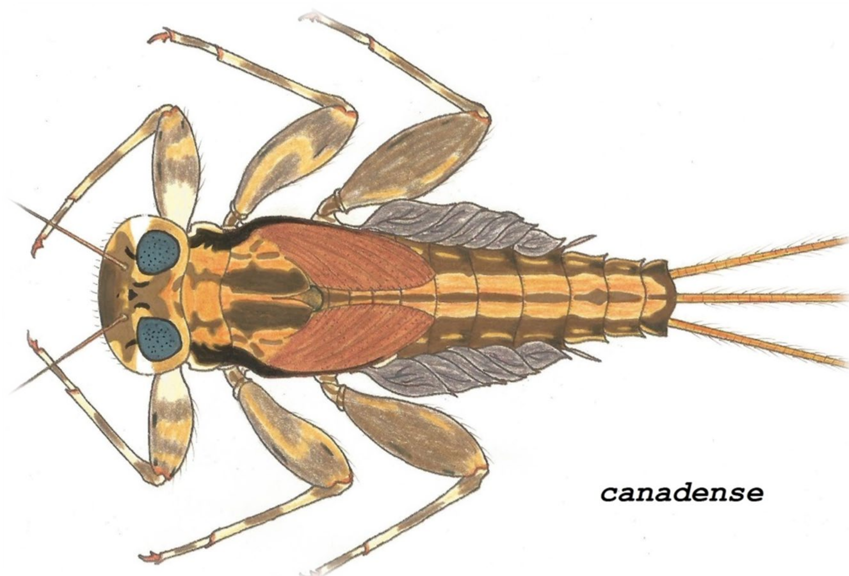
“Darwin’s species concept was not peer-reviewed”

Thomas Say started the *interpunctatum* adventure before dying in 1834. Someone one his behalf after his passing on erected true *interpunctatum* in 1839 after his death and before the book The Complete Writings of Thomas Say.

It is a nice feeling to finally have the genus all in one place and as complete as possible.

Stenacron Mayflies

Larvae



Illustrations by the author except

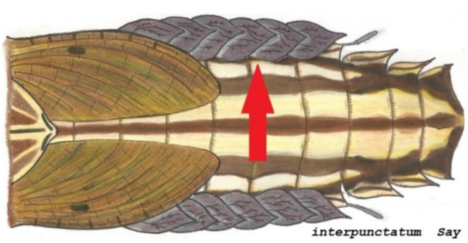
Page 103 figure 1, YIN-CHI-HSU

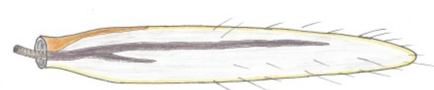
Preface

The main objective of this guide is to provide a platform that enables everybody to be able to use it. Whether you are young child, or a biologist. You can utilize just the illustrations, to make a reasonable identification. The illustrations presented are from verified samples by the author, and they meet the criteria of all past taxonomic studies, by way of descriptions and moreover by intense rearing. Each illustration represents each form in the genus as an average perspective, but are typically made on one particular sample. Although like everything in life, variation is an important thing to understand as no two samples are truly the same. There are many variations created by geological substrate composition. These kinds of samples are not hybrids but rather form variations and should be viewed as the nearest form.

Characteristics of the genus

All Stenacron larvae regardless of form or species are Characteristics from all other Heptageniidae by their gills. Gills 1-6 are pointed at the apex with a submarginal rib and have fibril gills on the ventral side. Gill 7 is thread like, with fine setae on the posterior edge. See anatomy section for more details.





Gill 1-6 7th gill

By using this character you can establish that your sample is in fact a Stenacron. In most samples they will also often have pale stripes on the dorsal side of the abdomen as seen in the illustration above.

Valid species list for 2020

Stenacron *candidum*

Stenacron *carolina*

Stenacron *floridense*

Stenacron *gildersleevei*

Stenacron *interpunctatum* Say

Stenacron *minnetonka*

Stenacron *pallidum*

Stenacron *interpunctatum / interpunctatum*

Interpunctatum complex synonym forms;

Interpunctatum / affine ……………… (syn)

Interpunctatum / areion ……………… (syn)

Interpunctatum / canadense …………(syn)

Interpunctatum / conjunctum……….(syn)

Interpunctatum / frontale ……………(syn)

Interpunctatum / heterotarsale (syn)

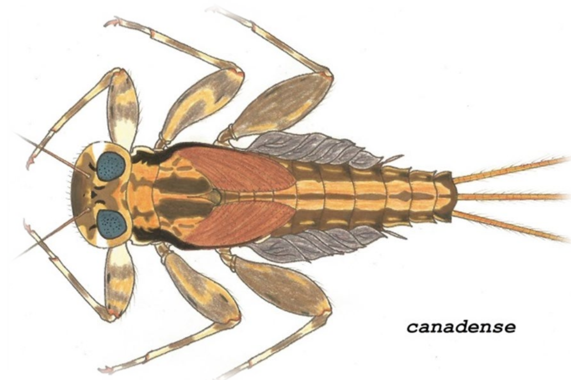
Interpunctatum / majus ………………… (syn)

Interpunctatum / proximum…………… (syn)

Interpunctatum / ohioense…………… (syn)

Life cycle

The life cycle or life history of Stenacron is basically the same as most mayflies. Stenacron have a one year life span of which most of it is spent as a larva under water.



They start as an egg then become the larva. The larva stage has 24 molting cycles where they shed their skin by growing larger. Once the wing-pads reach the 2nd segment of the abdomen their length has been established. When they reach the 24th instars or last molting stage the wing-pads have reached the 4th segment and they will hatch within one week, as seen in the larva illustration above. At the end of the last instar they swim to the surface of the water, split their skin and become the dun or subimago. In 24hrs to the hour, they split the subimago skin and become a spinner or imago the final stage. Next they mate in the air, and then females drop the eggs into the stream and die. The cycle then starts again with new eggs and larva.

Collecting larva

Collecting Stenacron larva is unlike any other genus. In the case of Stenacron because of environmental preferences, using the typical technic of a kick net or Seine will not provide good results. We filmed a video on collection that we strongly suggest you watch. You can access the video on YouTube under this title;

Stenacron comadidum mayfly ecology documentary

Collecting larva requires you to lift larger rocks typically larger than 6x6 inches with flat bottoms. You must slowly lift the rock out of the water, flip it over and examine the under

surface for their presence. You will need to carefully remove the larva from the underside of the rock. We have adopted utilizing artist brushes to remove the larva from the rock. Be very gentle with the larva so as not to remove their gills. You must encourage the larva onto a fan blender brush. Then simply place them in a bucket of water from the stream. See behavior and ecology for a complete understanding of the environmental preferences.

Rearing larva

Rearing Stenacron larva is quite simple. Collecting them is far more difficult. You will need a small fish tank with a basic oxygen pump. In the early spring in the end of March place rocks and debris on the bottom from your local stream and fill ½ way with stream water. It is very advisable to find one rock covered in green algae. The typical green algae is long and stringy and typically is the species *Cladophora*. Place the tank in heavy sunlight with the tank oxygen pump running. By the end of the month you will have algae growing on the glass sides. Once you have a good environment for the larva move the tank to an area that has sunlight for several hours each day. Try to keep the water temperature between 16-22˚ Celsius. Don’t worry about having moving water they prefer slow moving waters. The most important thing is to make sure the pump is making bubbles in the water. Now collect larva and place them in the tank with a lid on it. When they hatch the adults will typically be on the underside of the cover.

Geographical distribution

Stenacron can likely be found anywhere east of the rocky mountain range and have been somewhat reported in many water systems in the eastern half of the continent.

With the common misunderstandings in the genus we should always consider it possible that most of the forms could be in your local area. We have solid scientific reporting for the valid species as to their specific ranges, but little for the *interpunctatum* complex. The further north you travel the darker they seem to be. The darker forms are very common in southern Ontario, but pale forms are more common in the southern tier like North Carolina to Florida.

Historical Outline

It all started for this genus in (1839) when Thomas Say a self-taught naturalist found what is now known as true *interpunctatum* Say. There are many synonym forms that are part of a complex that is referred to as the *interpunctatum* complex, but there is only one true *interpunctatum* Say.

As time moved on after Thomas Say founded the species *interpunctatum* other forms for the genus were found. Dr. Walker an English entomologist found a form he named *canadense* in (1853).

The next form found was Dr. Banks (1910) for the species *frontale*. It was not until (1933) when Dr. Jay R. Traver erected the Stenonema genus that the *interpunctatum* group was elevated to super famous in the world of fly fishing and became a household name.

Stenonema as a genus had 3 groups in it and one of them was the *interpunctatum* group. In (1974) Dr. Steven L. Jensen erected the genus Stenacron for the *interpunctatum* group. So from there forward the genus sat pretty much untouched.

There have been many studies done since (1974) but little to sort out the taxonomic confusion of the genus as a whole. In (1947) Dr. Herman T. Spieth attempted to revise the *interpunctatum* group. Yet more damage was done to the genus by his study.

However he really was on the right track. He even established a *frontale* complex, but then synonymized it into *interpunctatum* as a subspecies group. The most damage to the genus comes from the two forms that are most common to see and photograph *canadense* and *ohioense*.

When Dr. Spieth synonymized *ohioense* with *canadense* he wrote a new description including *ohioense* for *canadense* and this is where the trouble really started, and just were this book takes off.

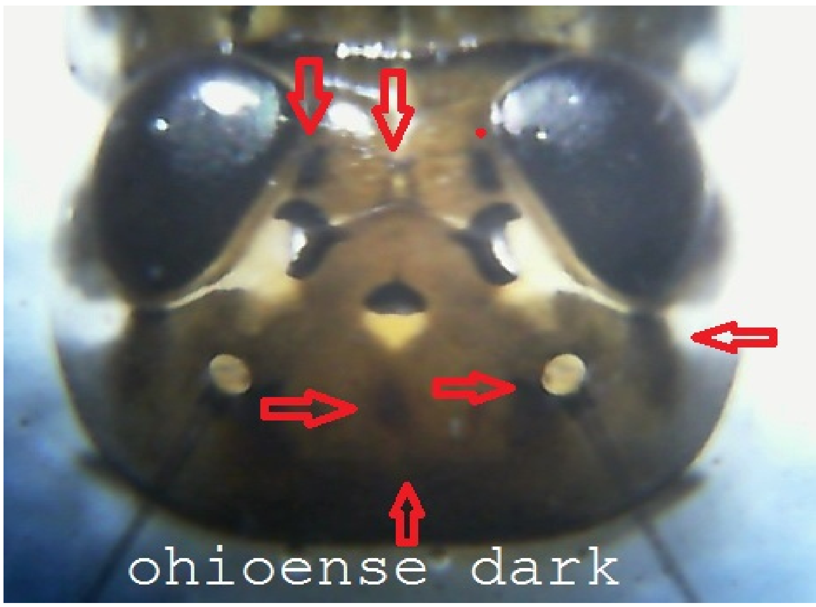
In order to offer options to the past problems we had to pick a point in time were the genus was in its most correct state and best overall condition.

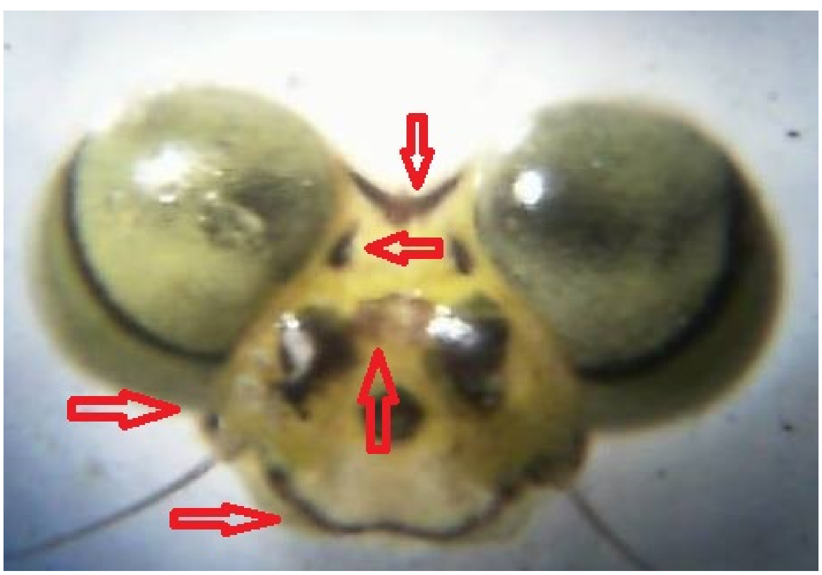
Being a proud owner of a first addition of the Biology of a Mayfly 1935 that seemed to be the most logical place to start. Dr. Travers work here is the best one could ask for regarding this genus. All the forms were well understood and very well described.

She erected many new species concepts in the book for the *interpunctatum* group. The area missing was she only described the adults and not the larva. Unfortunately the larvae are the most misunderstood. She did however create a table of keys and couplets for the larva.

Transcending Maculation

In this section we will review and come to understand the transcending maculation marks. All Stenacron regardless of form or species have genetic markings that are in the imago or spinner stage. These marks no matter how faint are present in the other two stages. Let's take a look at the larva head of *ohioense* the dark type. All the blackish marks marked in red arrows will transcend in to the adult stage.

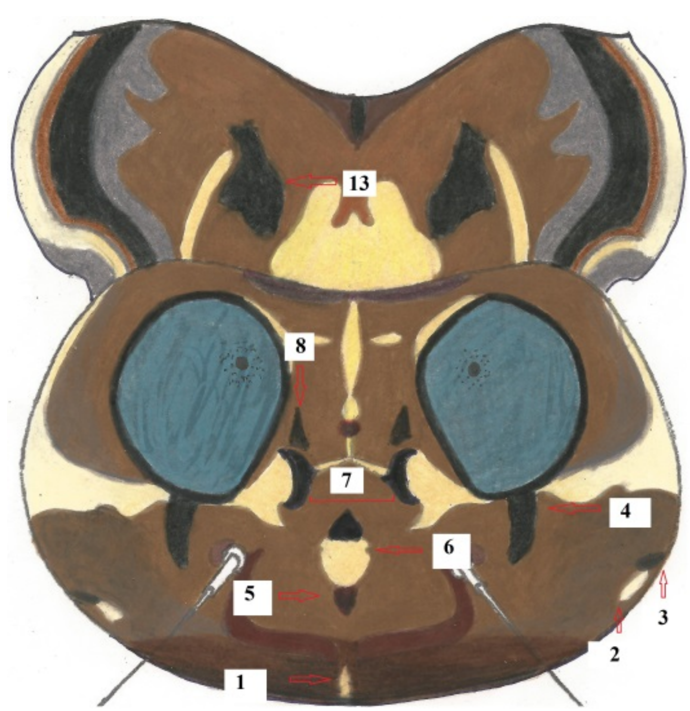


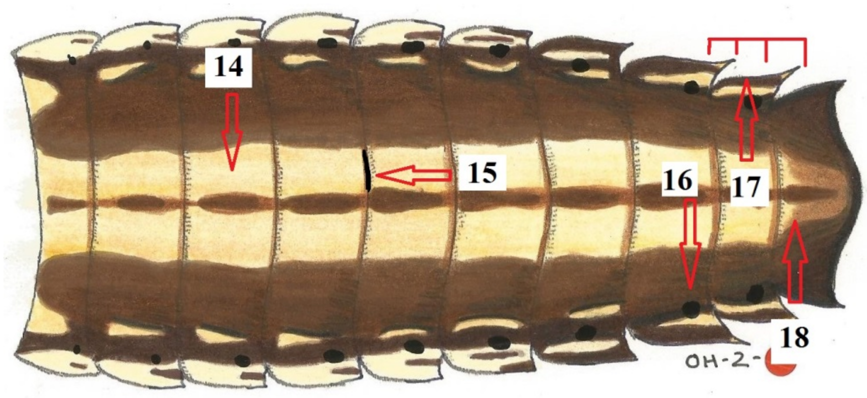


Below the larva head capsule is the head of the subimago or dun stage of *ohioense* dark. We must always remember that the adult stage is merely and very temporary reflection of the larva.

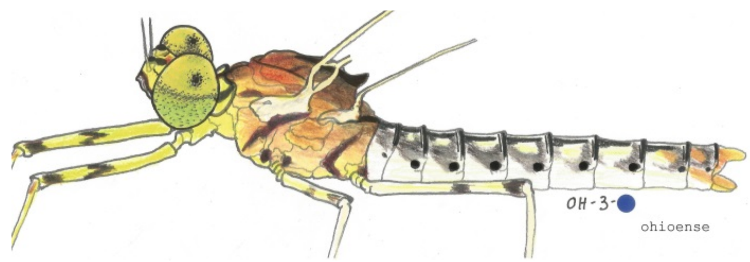
Now when we look at the larva illustrations we can see all the body and facial markings that transcend from the larva stage into the adult stage.

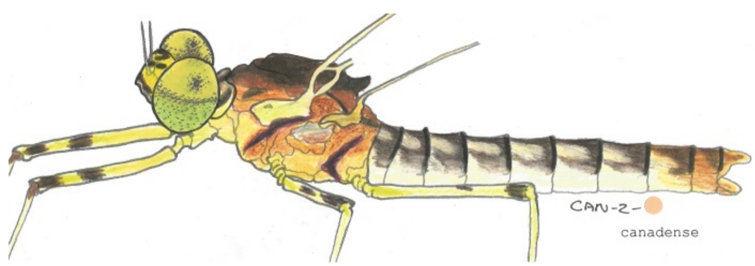
Notice all the arrows and numbers. They are there because in the guide there is a table list of critical feature markings that will help you best determine the form and or species. The tables we have made are similar to the paint by numbers concept but we are just following the numbered patterns.





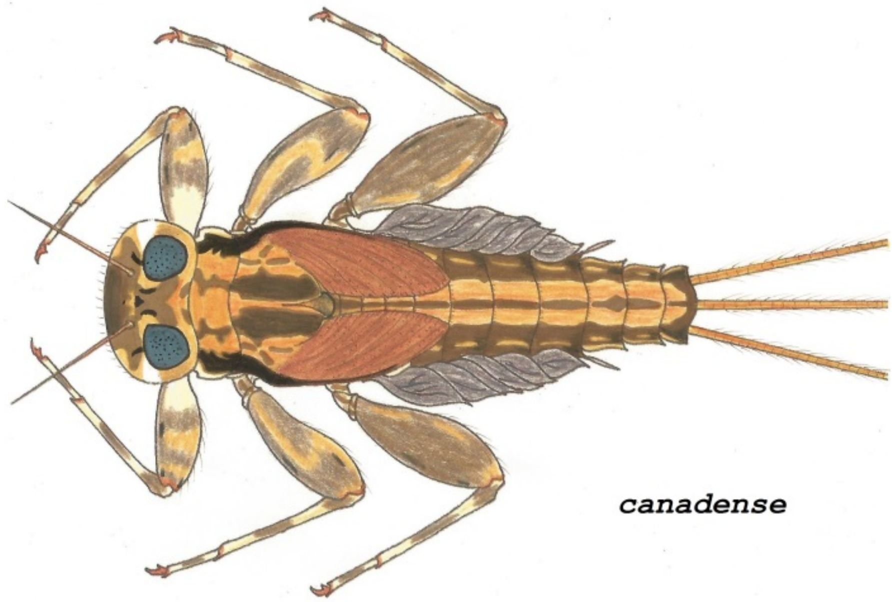
The comparative discussions will really help you understand the differences. Here we look at and compare the two closest forms. You will quickly see that although very similar and they do share a lot in common, they can be separated by more features than they share. Here are some illustrations that show two samples that are very similar but yet very different, and in this guide you will learn to separate all the forms.



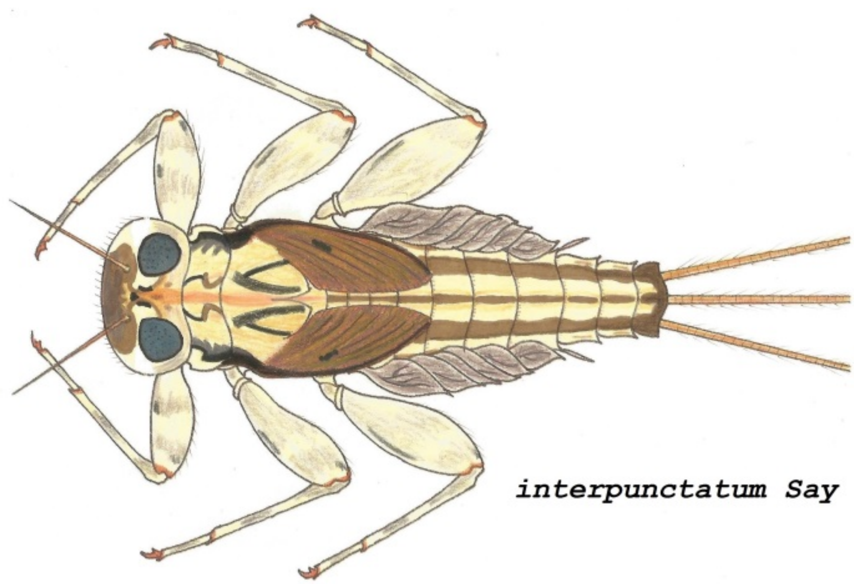


The biggest and most important separating features are the black spiracular spots on the sides of the abdomen and the physical size. If you can see the difference between them you have just done what was very difficult to do prior to this guide. Even some of the finest biologists of the day have trouble separating them until now. The two used for the sample are the two hardest to separate in the entire genus being *ohioense* and *canadense*.

Here is a larva sample of two forms that are very hard to separate. The forms are *canadense* and *interpunctatum* (Say) the real *interpunctatum* not one of the synonym forms.

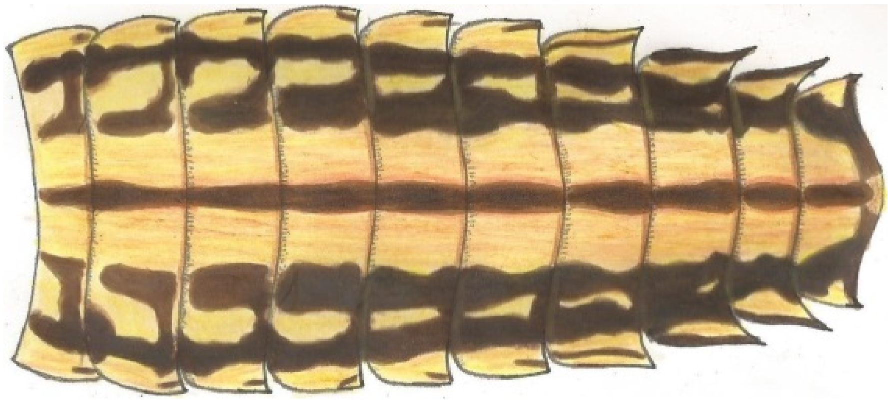


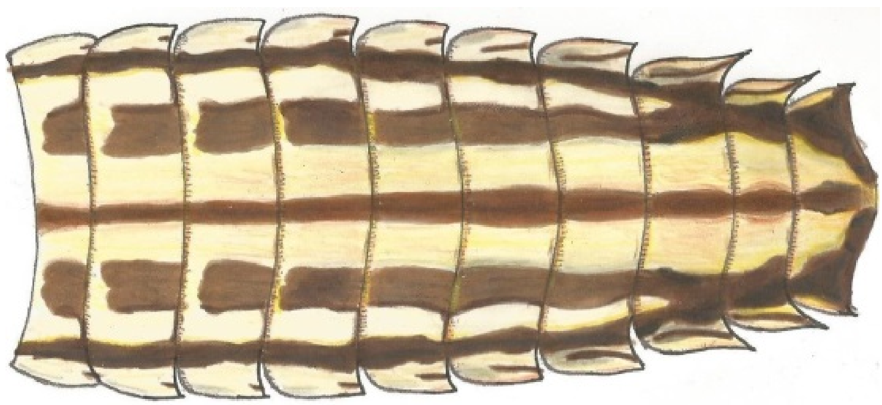
canadense



interpunctatum Say

One important note is the *canadense* illustration was based on a female sample not a male as in the *interpunctatum*. This is the reason it is orangey in color. It is not hard to see why these two are so difficult to separate. Now let's look at them from just the abdomen perspective. They are in the same order *canadense* first *interpunctatum* Say second.





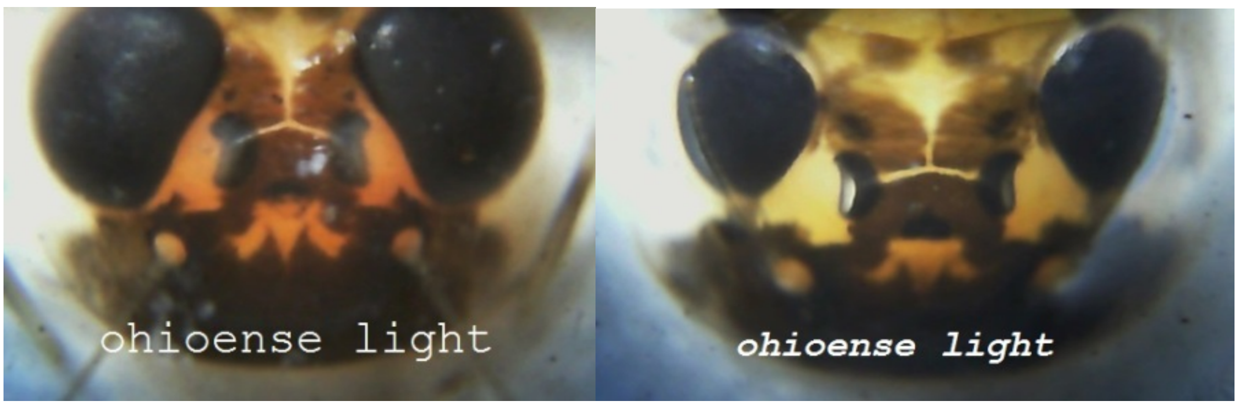
The principle difference is the sublateral streaks. These are the pale stripes that are closer to the lateral edge. The other interesting note is the brownish coloring. In the *interpunctatum* that coloring is very pale cinnamon colors rather that darker brown as in the *canadense*.

The physical size is the most important feature. *Canadense* is much larger than *interpunctatum* Say. This now gives you an understanding of the guide and how it works.

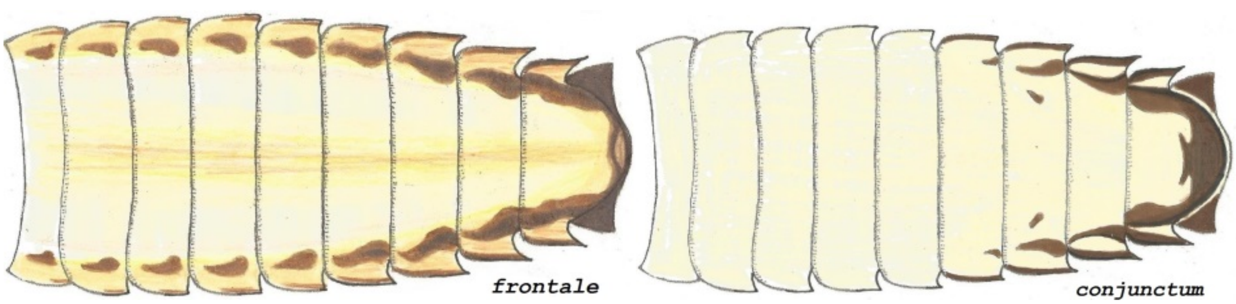
By putting samples side by side it makes it very easy to see the differences. The very detailed individual descriptions and the tables of features will further aid you through your research.

Male from Female

It is quite easy to tell a male larva from the female larva. Here are three things that allow separation. First the male will have claspers at the end of the 10th segment on the ventral side. Second is the size and spacing of the compound eyes. The first photo is a male the second is a female.



Notice how large the male eyes are and tightly they are placed together. An interesting and unknown fact is the markings on the underside of the abdomen.



The lateral markings on the female typically start on the 1st or 2nd segment to the 9th. On the male they are generally from the 6th–9th. In some of the valid species like *candidum* the markings are the same from the 6th-9th in the male and female. Also if the females are relatively mature they will be orangey in color in the abdomen as they carry the mature orange eggs.

Hatching Periods

These dates are based on historical records and are put together here to help hypothesis local hatching performance. All the ones marked with a star are the original collection dates.

There has always been talk about the darker forms hatching in spring and the lighter smaller forms hatching in summer through fall.

We are not sure that this thinking is correct for this genus. Some of the original darker forms were collected in the latter part of the season. An example is *gildersleevei*. According to Traver they hatched in late August through September, and we have collected the larva at that time frame in only the 21th instar. That means that the larva collected was not set to hatch till October.

Moreover we have collected and reared *ohioense* from the middle of June through to middle October.

From my rearing and study we propose that based on historical data and current studies that most Stenacron like hatch all season long. And they likely have bursts of hatching throughout the entire season.

***affine* (Traver 1933);**

*Traver April 29th - June 10th 1929 Sophia NC Halotypes

***areion* (Burks 1953);**

*June 25th 1948 Oakwood Illinois Halotypes

***canadense* (Walker 1853);**

Clemens reports Ontario 1913; June 25th - July 15th

May 22nd Lowville park 2014

***candidum* (Traver 1935);**

*Traver June 18th 1929 Black mountain NC Halotypes

***carolina* (Banks 1914);**

*Banks says Black mountain NC, (May) Halotypes

***conjunctum* Traver 1935;**

*August 24 1932 through mid-September NY. Halotypes

August 28th 2014 Progreston dam

***floridense* (Lewis 1974);**

*No collection dates known Gadsden county Florida Halotypes, hatches throughout the year

***frontale* (Bank 1910);**

*Banks Gloversville NY May 15 1910 Halotypes

Clemens reports Ontario June 15th - July 10th 1913

***gildersleevei* (Traver 1935);**

*Kirkland Ohio 1930 Halotypes August 31st to early September 3rd

***heterotarsale* (McD 1933);**

*July 2nd 1924 Halotypes / Paratypes

June 27th - August 9th Ottawa Ontario

***interpunctatum* (Say) 1839;**

*Say 1839 Washington Indiana no dates Halotypes

Hagan 1861 Trenton falls Chicago Illinois

Hagan 1861 Allegany mountains Virginia

Beacon Lowville park July 1 first 2014

***majus* (Traver 1935);**

*Traver July 16th 1932 Ithaca NY Halotypes

***minnetonka* (Daggy 1945);**

*June 14th 1930 Mound Minnesota Halotypes

***pallidum* (Traver 1933);**

*Traver May 12th 1929 - May 18th 1930 piedmont NC Halotypes

***proximum* (Traver 1935);**

*June 10th - June 20th White church Ithaca NY Halotypes

May 30th Progreston dam

***ohioense* light (Traver 1935);**

*August 7th - Aug 18th Painesville Ohio Halotypes

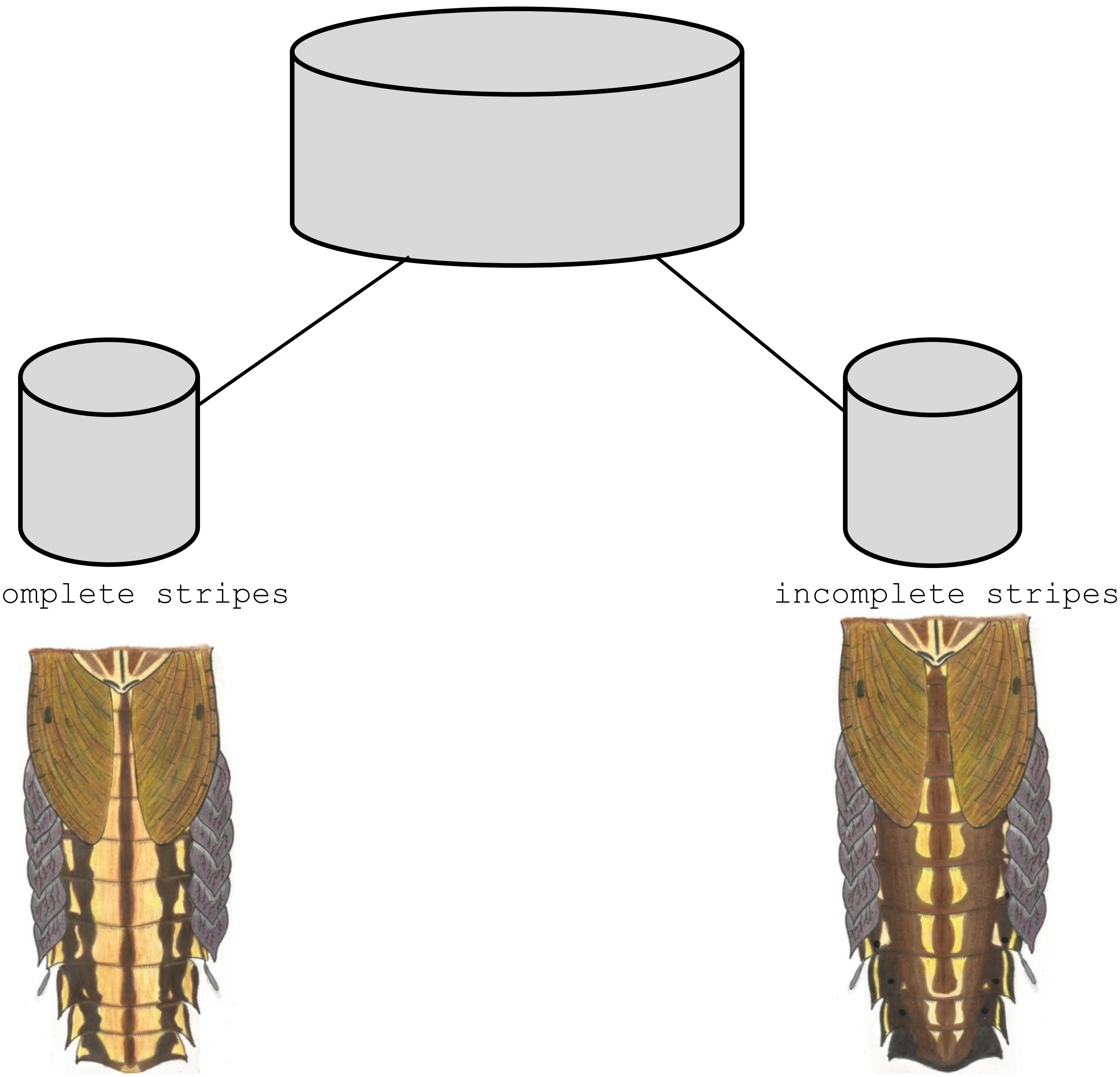
June 13th Lowville park 2014

***Ohioense* dark (Beacon 2014);**

August 26 2014-October 20th 2014 Progreston dam Bronte creek, southern Ontario.

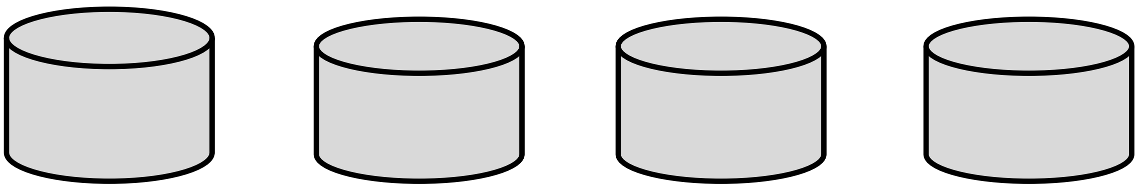
Sorting Larvae on site or in the lab

Get a main sorting container with a full mix of larvae samples. Every sample that has a wingpad less than the posterior edge of the 2^{nd} tergite can be put back, diagnosis is too difficult. Once Stenacron larvae wingpad's reach the posterior or the back of the 2^{nd} segment the larva is full grown in length. When it reaches the back of the 4^{th} segment the larva will hatch anytime within a week.



The greener the wingpad are the sooner they will hatch. Next divide them in two major groups. Ones with complete pale stripes on the top of the abdomen, and ones with incomplete stripes in

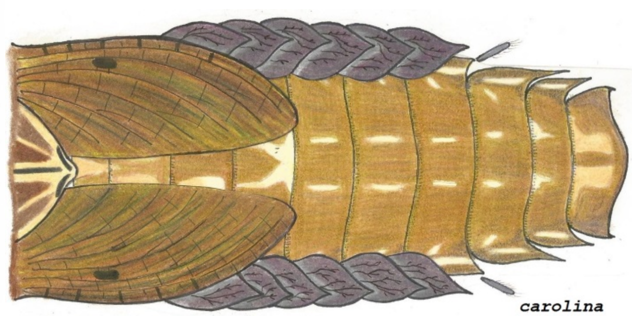
the other container. Once you have sorted them by stripes the next is to sort them by lateral projections of the 8^{th} and the 9^{th} as per lengths regarding equal or shorter, and still include stripes. You now need to use 4 containers. Be sure to only sort samples from the same substrate. If you change the geological fundamentals of the substrate being dark or light you will find variations of form making sorting extremely difficult.



A B C D

Container A; for complete stripes with equal lateral projection.
Container B; complete stripes shorter 8^{th} lateral projection.
Container C; incomplete stripes with equal lateral projection
Container D; incomplete stripes with shorter 8^{th} lateral projections

If you have a sample that has a longer 8^{th} projection and has discontinuous stripes it is Stenacron *carolina* as it is the only one in the genus with a longer 8^{th} than 9^{th} and this is what *carolina* looks like.



Now you can further dived the group until everyone in each group looks the same. Once this is done you can use the head capsule/pronotum maculation markings and the pale spots in front of the median ocelli or simple eye and very important the size. Here is an up to date copy we made of Travers original larva table 1935. We were able to add 5 forms. All up dates are

highlighted. Larva must be measured while alive, abdomens expand at death.

Species or form	1 ♂–♀	2	3	4	5	6 (8^{th} is)
Affine	7-9	N	Y	Y	N	equal
Areion / unknown	7-9	--	--	-	-	unknown
canadense	10-13	N	Y	Y	N	equal
candidum	8.5-10	N	N	Y	N	shorter
carolina	10-11	N	N	Y	N	longer
conjunctum	8-10	N	Y-N	Y	N	equal
frontale	8-10	Y	Y	Y	N	equal
floridense	8-10	Y	N	Y	N	unknown
Gildersleevei	11-13	N	N	Y	Y	equal
heterotarsale	9-11	N	Y	Y	N	equal
Interpunctatum *	7-9.5	N	Y	Y	N	equal
majus	10-12	Y	Y-N	Y	N	equal
minnetonka	8-10	Y	Y	Y	N	unknown
ohioense	10-13	N	Y-N	Y	N	sub-equal
pallidum	6- 7.5	N	Y	Y	Y	Shorter
proximum	9-11	Y	Y-N	Y	N	shorter

1; Body length is expressed in millimeters (♂ is the smaller number)
2; Median pale spot on the frontal shelf of head capsule.
3; Continuous pale submedial streaks on abdomen.
4; Ventral markings on the lateral areas of the abdomen.
5; Posterior edge of tergites dark or blackened.
6; Later projection of the 8^{th} VS 9^{th} for spine size.

Note; regarding column 3; there is new evidence of geological variations. When they affect the table they are noted as Yes and No mean that they have both continuous and discontinuous stripes.

Note; there are no records for lateral projections for any new species after Travers 1935 table. So *Minnetonka* and *floridense* are unknown, and *areion* was never collected as a larva stage.

For a clear understanding of light and dark types of the same form you must read the leopard larva changed its spots. The dark type only comes from a black-dark brown substrate.

The light type only comes from medium to light colored substrates. Knowing this aids you in sorting to the most logical form and or species.

Container A; continuous stripes, equal projections

- *canadense*
- *interpunctatum* Say
- *conjunctum* light type Light substrate only
- *frontale*
- *majus* light type Light substrate only
- *heterotarsale*
- *affine*

Container B; continuous stripes, shorter 8th projections

- *ohioense* light type Light substrate only
- *proximum* light type Light substrate only
- *pallidum*

Remember *ohioense* has sub-equal projections

Container C; discontinuous stripes, equal projections

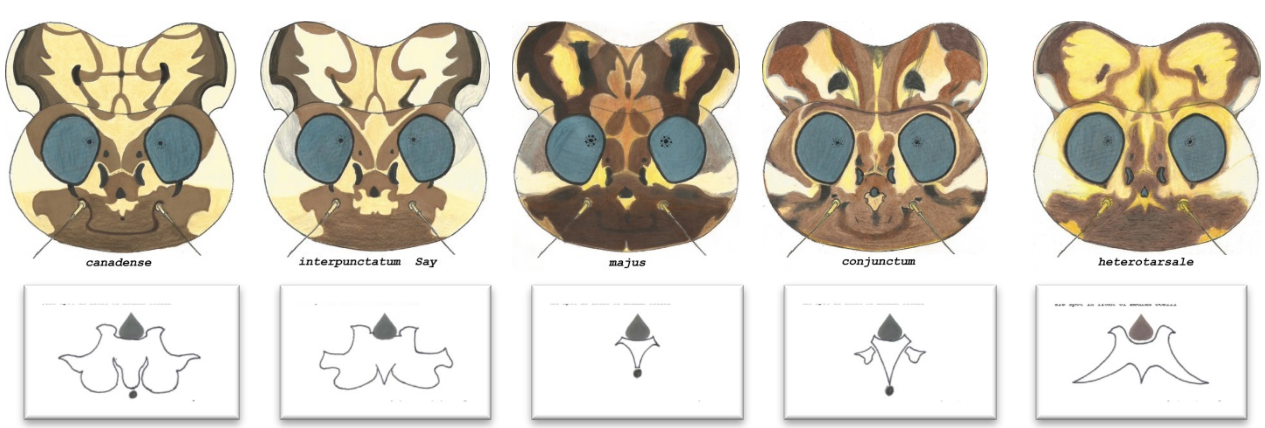
- *gildersleevei*
- *conjunctum* dark type Dark substrate only

Container D; discontinuous stripes, shorter 8th projections

- *candidum*
- *ohioense* dark type Dark substrate only
- *proximum* dark type Dark substrate only

Remember *ohioense* has sub-equal projections

We can clearly see that container A is the most difficult to sort out. Here are samples of head capsules and median ocelli markings. All 5 below are in group A, so use the head capsules, and median ocelli marks to help you.



If further diagnosis is needed remove the labrum and compare to samples that we blueprinted in this book. Everything in group A was blueprinted except *affine*.

Behavior and Ecology

Stenacron larvae have very specific ecological requirements that are found in all moving watersheds in North America. However they seem to prefer lower altitudes and meandering waterways. Stenacron can likely be found anywhere east of the rocky mountain range, and have been somewhat reported in many water systems in the eastern half of the continent.

The basic substrate requirements are. Slower moving currents generally under (10) MPH, with light sedimentary levels. Light plant growth is important, with larger loose rocks that are not cemented in by sedimentation.

The sizes of the rocks are critical to Stenacron. They must be larger than 6x6 inches and about 2 inches thick with flat bottoms that are clean of sedimentation and slime.

Stenacron tend to hide on the underside during the daytime and actively feed on the topside of the rocks during the night.

There also seems to be some levels of social society during none hatch times. They spend a great deal of time in non-foraging situations in a community based environment. However in the evening when feeding it’s every larva for himself and there does seem to be a pecking order with food resources.

In most situations the larger male larva will chase of others, even females from a debris pile. The females are nonaggressive and tend to not participate in the pecking orders but rather move from one area to another when foraging.

Stenacron *interpunctatum* larvae according to McCshaffrey & McCafferty (1986) are not scrapers but rather collectors and gatherers and are considered opportunistic feeders. Gut contents of studied larva showed a wide range of organic matters.

Their study clearly indicated that mineral material and organic detritus are the most important, and that diatoms from scrapping were only found in few samples.

In our rearing experiments with the genus and the form *ohioense* in an enclosed tank, the algae growth on the glass is clearly desired by the larva. In the middle of the night after 1:00 am and before 4:30 am they are on the glass sides feeding on what appears to be the algae growth of *Cladophora*.

Although very sensitive to light, after a few days in the tank they seem to not run for cover by the usage of a flashlight when on the glass sides. However if they are on the topsides of the flat rocks, or collecting on the bottom in the debris, they quickly move to the underside of anything to avoid the light.

In the form *ohioense* their eyes are very reflective to light in the larva stage suggesting they have excellent night vision. Another interesting thing about Stenacron is the lighter forms like *heterotarsale* and *interpunctatum* Say are less sensitive to light and the larva’s compound eyes are less reflective. These forms also operate in the day light as far as hatching and feeding goes.

The preferred time frame for molting of the form *ohioense* larva between instars seems to take place early in the morning around 5:00 AM. This does seem to align with the amount of time required for the maculation process to be completed. In our observations it takes around 8hrs, in the tank to completely return to their dark coloration. The tanks water temperature is typically 2-6 degrees warmer than the river system.

So that suggests it is very reasonable to assume that in colder water the time frame would likely take a little longer more like 12 hrs. This lines up nicely with the time to come out and forage on the topside of rocks. Other experiments with *ohioense* in captivity with oxygen depletion per environment.

This involved the testing of survival in lowered dissolved oxygen or (**DO)**. Stenacron *ohioense* and many other forms in the genus show the ability to survive with little oxygen in water that is not moving.

Experiments were carried out in several different size containers ranging from a small bucket to a petri dish. Interesting is their ability to adapt by slowing the rate of their gill pulsing to seemingly suit their environments.

Stenacron larva can bring their breathing rate down to the point that little gill movement is seen. Yet one might first think that they may be expiring, but a genital touch with a brush, and they start to breath normal.

Before we go too far let's take a minute to discuss another relative topic. In our observational studies, Stenacron have the ability in the larva stage to suffer high anxiety. Stenacron show a panic attack type state when in tight confinement. After an initial adjustment to a new environment they tend to relax remain somewhat motionless and eventually adjust their breathing rate to fit their current environment.

Stenacron can survive in low dissolved oxygen (**DO)** for extended periods of time. One of our experiments involved placement in a petri dish in 10ml of oxygenated water for up to 6 hours and they showed no discomfort or desire to be removed. Other experiments are the rearing to adulthood in 5ml of water. Stenacron seem to be very adaptable with a strong sense of their environmental requirements and surroundings.

When faced with a choice they seem to show a great affinity to choose what they best need. Taking the dark type of the form *ohioense* for this experiment, when faced with a choice to pick a dark rock or a light rock to cling to, this dark form always picks the darker rock. They may at times first pick the light rock but will change rocks to the darker one. What this suggests is they are aware of their pigmentational value and their environmental needs. This does not suggest any specific level of intelligence but rather a strong intuitive natural instinct for survival.

The hatching behavior of the form *ohioense* is also unlike most Stenacron, and other Ephemeroptera. This form only hatch's to the adult stage between the hours of 11:30 PM and 4:30 AM. Adapting to this hatching strategy is quite interesting to say the least. It certainly shows great adaptability for survival as a whole. The predators of all mayflies are birds, spiders, and dragonflies and of course fish. Hatching in the night time removes two of the main predators because birds and dragonflies rest in the evenings.

Most Ephemeroptera hatch in the lowering light at the end of the day in the summer and into the early fall. In the spring many genus hatch from midafternoon till dusk when the water temperature is warmest.

Stenacron *ohioense* seem to prefer the cooler temperature for hatching. Although it may have more to do with them being a form that utilizes the darkness for all aspects of their existence. In the headwaters of streams and dealing with the darker forms like *ohioense, canadense*, and *gildersleevei* that hatch in smaller numbers it is interesting that they pick the night to hatch and feed. By removing the two main predators from the equation the survival rate would very likely go up.

Headwaters have smaller areas that hold Stenacron populations being mostly at the sides of the system and tails of pools. Which in turn suggest that the headwater populations are in fact smaller than in the larger systems? Historically Stenacron or at least some of the forms are known for being able to live and even flourish in populations in compromised water conditions. With so little known about the larva in the past and present, this is very hard to confirm.

Lewis (1974) commented on *heterotarsale* as being the only Stenacron form to live in waters on the Ohio River just below a sewage treatment plant. This very much suggests a higher tolerance to toxic waters. Yet more than 90% of all *heterotarsale* larvae in our collection came from cleaner or less compromised waters.

The form *ohioense* both light and dark types are collected from headwaters and midstream areas. What is really striking is that the greatest numbers of *ohioense* are in very close proximity to 6 different forms of Epeorus in high (**DO**). Epeorus have set standards for water qualities, and show the water must be very clean with a high **DO**, and spring feed is preferred.

With that said it leads us to only presume that *ohioense* is a clean water dweller. Yet we can collect a few here and there in waters that would normally be considered compromised. Here in the great lakes area some waterways historically were compromised by agricultural pesticides and industry.

In this time frame most of the agricultural is gone, and industrial regulations have increased which has helped improve the water conditions, or so we can believe. With the highest populations of *ohioense* within 60 yards of Epeorus, and having the ability to survive in a low **DO**. We can only conclude that the water must be clean in this area of Bronte creek. This in turn says a lot about the entire genus needing clean waters over higher dissolved oxygen's. Cohabitation of other forms of Stenacron with *ohioense* is very high. For example all of the following forms can be found within 5 miles of *ohioense* and more typically within 2 miles.

Canadense, frontale, majus, proximum, candidum, interpunctatum Say, conjunctum, & gildersleevei.

This in turn completely suggests most Stenacron should be considered clean water dwellers. This however does not change the fact that *interpunctatum* Say and *heterotarsale* are commonly collected in somewhat compromised waters.

The form *candidum* seems to also be collectable from the same location as *heterotarsale* in Selkirk Ontario.

The following table was created to directly reflect Lewis 1974 for the EBI biotic list. The scale is 1-10; 0 being intolerent to any toxic or organic pollutions, and 10 being toxic satutation or uninhabitable. The forms at the bottom and marked with a star are collected by me and the rating given was based on *ohioense* being a clean water dweller. Lewis posted *frontale* as **ID** insuficiant data. Our collections show it in proximity to *ohioense* but with *proximum* and *majus*. Untill futher data can be created these numbers should be considered resonable.

It is our hope that further studies of the genus will create even more accurate numbers that provide a greater understanding of the entire genus.

Form	1 --- 10	ID
Candidum	**0**	
Canadense	**1**	
Carolina	**0**	
Floridense	**0**	
Frontale	**2**	X
Gildersleevei	**0**	
Heterotarsale	**7**	
***Interpunctatum* s.s**	**4**	
Minnetonka	**6**	
Pallidum	**1**	
***Conjunctum* ***	**1**	
***Majus* ***	**2**	
***Ohioense* ***	**0**	
***Proximum* ***	**2**	
***Interpunctatum* Say ***	**2---------4**	

All of the *herterotarsale* collected by us are in a waterway known to us as Selkirk creek in Selkirk Ontario which is effected by moderate local agriculture and the water quality is unknown to us. Based on the historical levels provided by Lewis, and the poor conditions of the creek, we can only conclued it is effected by the local agriculture. This brings us to the discussion regarding *candidum*. The table created by Lewis states that *candidum* has a rating of 0, but our primary collections of this form show it in Selkirk creek alongside *heterotarsale*. It is also collected in Bronte creek in good numbers along-side *conjunctum, majus, proximum, and ohioense*. So the question now is. Should Stenacron as a rule be considered intolerent to compromised waters? Or are they just that adaptible that they can live in all conditions and would just prefer cleaner water? Based solely on collection population numbers collected per area, Stenacron seem to show a direct preference to cleaner waters. Creating laboratory studies with controlled toxic conditions is likely the only way to truly determine the tolerance levels for each form. However unlike any past studies larvae scrutiny must be very high and all samples must be identifide to their legitamate forms prior to study, and must be stated as such.

The Leopard Larva Changed It Spots

New larva morphological information has been found! Before we review these findings let me quote a few important statements from previous authors on this genus to set the pace.

Spieth 1947; “No experimental evidence exist to indicate how much or how little coloration of the imaginal individuals of this genus is independent of the environment in which the nymphs develop. Circumstantial evidence Spieth (1938) indicates, and such evidence is constantly accumulating, that the environment may play a part in determining the degree of coloration of the adults”.

Spieth 1947; “When confronted with a large series, especially from the areas around the Great Lakes, more “intermediate” than “typical” specimens are invariably found”.

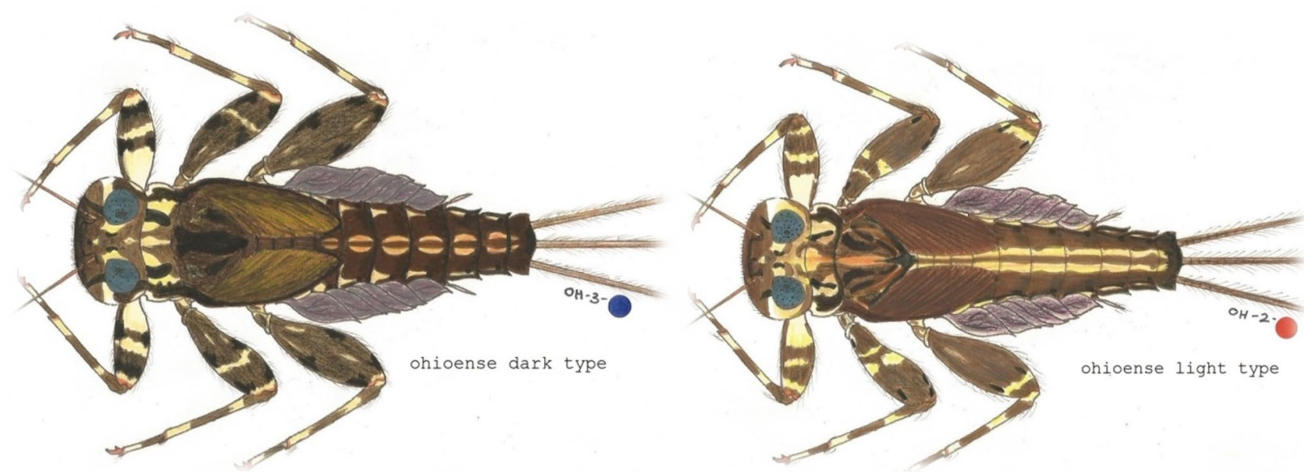
Lewis 1974; “Studies should be designed to ascertain whether the apparent hybrids are truly hybrids or are environmental variants within species. The influence of glaciation and biogeography on the distribution of several populations needs investigation”.

This genus is without question a special one as to have created such a mystery surrounding them. So much effort was spent on the hybrid theory that the truth was never found until 2014. A recent discovery through isolation rearing has shown all the true variations.

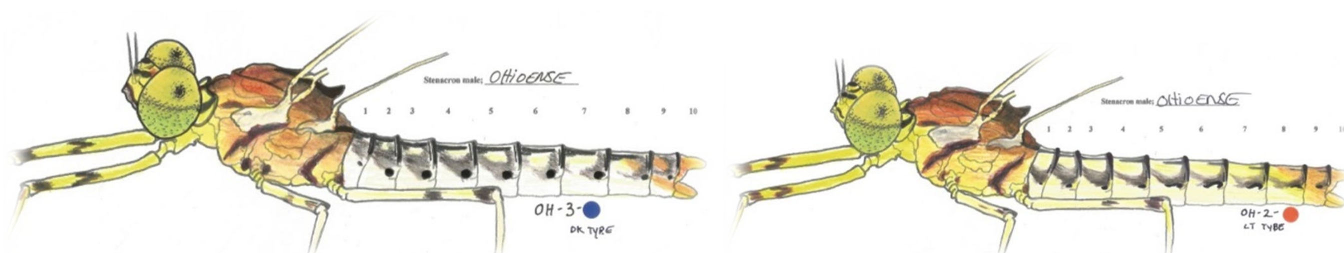
This genus has very special qualities to it that no other to my knowledge has. There are multiple forms of larvae for one adult form. The variations are caused from the **geological substrate composition** and not geography as previously thought to be.

On August 26th 2014, larvae were found that did not match any larva known in the genus. The adults seemed to align somewhat with Travers 1935 *ohioense*. Without males we could not conclude with assurance that it was that form. After reviewing 4 males the conclusion was, it is in fact a geological variation of the form *ohioense*.

Interestingly enough there are at least 2 distinct larvae forms that reared out to *ohioense*. Referring to them as the light type, which meets the criteria of the historical profile created by Traver (1935), for this form in the larva state. The other is the dark type, which is only found on very dark background substrates.



The principle difference in the adults is the lack of median line, and the sublateral shading on the dorsal side of all tergites. The principle difference in the larvae is the discontinuous submedial abdominal stripes in the dark type and continuous stripes in the light type.



In the adults the light type has a deletion in maculation of the median stripe making them look like a hybrid of *ohioense* & *majus* or a true *frontale*. The dark type rears out with a complete median line.

With this new information a review of all the larva forms began, to see if others possibly have this very distinct morphological trait and *conjunctum* and others, also have this substrate camouflaging trait.

Both *ohioense* and *conjunctum* type larvae were collected on Bronte creek and the two collection sites are 3.9 miles apart. The stream has a very dark bottom with blackish sediments, and is turbulent, as you go upstream to Progreston dam. And, becomes meandering with higher levels of pale clay sedimentation as you go down stream to Lowville Park.

Substrates of the Niagara Escarpment;

1: Very dark black rocks and dark soil sedimentation to represent the Progreston dam site for the dark forms.

2: Moderate coloring, having lime stone rocks with red clay sedimentation with appropriate *Cladophora* algae levels to represent Lowville Park for the intermediate forms.

3: Very pale background consisting of white and red clay sedimentation, to represent collection sites at the mouth of the watersheds for the lightest forms like *interpunctatum* Say and *heterotarsale*.

In the following picture we can clearly see the difference in the two substrates of the upper areas of Bronte creek in Southern Ontario. On the left are rocks removed from the upper areas of the creek. To the right are rocks from the site at Lowville Park.

The geographical fundamentals of the Great Lake region are. All streams or rivers that flow from the Niagara Escarpment to the Great Lakes all possess these three basic substrate types. In their uppermost headwaters they are spring feed with dark substrates.

As they fall over the Escarpment they enter the red clay plane region and become meandering in nature. Red clay bluffs become the rule, and during rains flood with red clay silt runoff. When we enter the lower basins they are completely saturated in both white and red clay sedimentation to the point that little aquatic life exist.

However with regards to Stenacron having a diet that mostly consist of mineral content it is not uncommon to find the forms *heterotarsale* and *interpunctatum* Say, where little or nothing else exists.

By replicating their environments we can anticipate that each form should have at least 3 variable larvae and adult types that rear out with the mid-range adults matching the historical profiles. This intense type of rearing program can help create new revealing data.

It will allow for boundaries in understanding the variability to be set, in what is an acceptable variation from the true historical profile. We can surmise the following based on the new current larva evidence.

ohioense; very dark form with 3 types that represent the total forms historical profile. The lighter of the type looking very much like a dark *frontale* and the darkest similar to *gildersleevei*.

frontale; a moderate form that could have 3 types that represent the total form with the lightest variation being very much like *proximum*, and the darkest more towards *ohioense*.

proximum; one of the lighter forms in the complex that should also have 3 distinct types, the lightest looking like *conjunctum* or *majus*, the darker nearing *frontale*.

conjunctum; one of the lightest forms in the complex, with likely 3 different types, the lightest like *majus* and the darkest similar to *proximum*.

majus; being the lightest overall in the complex and having likely 2 distinct types, with the lightest missing pleura streaks, spiracular spots, and the median dorsal line, and looking like *interpunctatum* in appearance, the darker form similar to *conjunctum*.

Clearly with this new information and a well-planned rearing platform we can expect there are no hybrids, but we can anticipate and document all the variable types within each form, and create expected variation boundaries. At this point we see no evidence for the hybrid theory. We find more evidence against it, but no one can truly rule out nature at this point.

Range and Distribution

Serious taxonomic confusion exist in this genus, so finding and establishing true range boundaries is nearly impossible. Therefore it is my opinion based on spending the last 8 years looking at every photo on the internet and its location. Stenacron seem to be everywhere the altitude is moderate to low, with an average altitude of about 700 feet.

To try to get a better handle on this we are offering here an altitude table above sea level from the very first locations where species was established. We have seen here on Bronte Creek in Southern Ontario that forms and species distribution in this one watershed is specific to their special ecological and dietary needs. We suspect in all situations there are large areas of overlap and we have seen high cohabitation of forms inside 3.9 miles range. Altitude is feet above sea level based on original site. Walker 1853 only states Canada, for *canadense*.

Form / species	Holotypes location	founder	year	altitude
affine	Sophia NC	Traver	1933	1315
areion	Oakwood IL	Burks	1953	591
canadense	No true location	Walker	1853	0
candidum	Eddyville IL	Traver	1935	680
carolina	Black mountain NC	Banks	1914	2199
conjunctum	Pleasant valley NY	Traver	1935	192
floridense	Gadsden county FL	Lewis	1974	134
frontale	Gloversville NY	Banks	1910	750
gildersleevei	Kirkland Ohio	Traver	1935	1163
heterotarsale	Ottawa ON	McD	1933	210
interpunctatum	Washington IN	SAY	1839	495
majus	Ithaca NY	Traver	1935	369
minnetonka	Mound MN	Daggy	1945	2301
pallidum	Piedmont NC	Traver	1933	1100
proximum	Ithaca NY	Traver	1935	369
ohioense	Painesville Ohio	Traver	1935	618

This table suggests that *affine*, *candidum*, *carolina*, *gildersleevei*, *minnetonka*, and *pallidum* all prefer headwaters of the systems at higher altitudes where the water is spring feed with a higher dissolved oxygen (DO).

Now we will use the same chart for forms and species taken from Bronte creek in Sothern Ontario. The higher the elevation the cleaner the water and the faster it is moving with higher dissolved oxygen levels (DO). Bronte in the very headwaters is totally derived from springs. The upper areas have less appropriate environments for the genus being the sides of the system meaning smaller populations.

Form / species	location	founder	year	altitude range
canadense	Lowville ON	Walker	1853	350 - 400
candidum	Selkirk ON	Traver	1935	540 - 720
conjunctum	Progestin Dam	Traver	1935	350 - 720
frontale	Lowville ON	Banks	1910	350 - 270
gildersleevei	Lowville ON	Traver	1935	350 - 270
heterotarsale	Selkirk ON	McD	1933	540 -
interpunctatum	Lowville ON	SAY	1839	350 -
majus	Lowville ON	Traver	1935	350 - 500
proximum	Lowville ON	Traver	1935	350 - 400
ohioense	Progestin Dam	Traver	1935	350 - 720

The high percentage of collected samples was at about 400 feet above sea level. Ide 1935 commented that on the Mad River here in Ontario at 750 feet that *frontale*, *canadense*, preferred the upper areas, and *heterotarsale* preferred the mid 300 feet range but they did overlap making streamside identification difficult. The reason for disusing range and altitude is we believe that most forms likely utilize a lot of the eastern seaboard.

With the darker forms mostly occupying the northern range and higher altitudes, and the lighter forms occupying the middle to lower range and lower altitudes. It has been the common thinking for decades that the dark forms are more northern and lighter forms are more southern.

There is no question until this guide taxonomic confusion was very high regarding the larva everything with stripes was basically *interpunctatum*, when nothing could be further from the truth.

With misunderstandings in laboratories and in the field getting a true range in this genus is near impossible. You should likely expect to see a high percentage of these forms all over the east coast range. Darker forms or species tend to prefer darker substrates and the lighter forms and species a moderate color density substrate. Reading the section the (Leopard larva changed its spots) we go more in detail about this. You will likely find a form or species in one area of the system, with a moderately dark substrate, and 2 miles upstream find the same form or species and it would look totally different in color maculation if the upper area has a darker substrate.

The original range established by Lewis 1974 *floridense* is in the upper west areas of Florida near Mobile Alabama. We are showing here some samples that are outside the reported range that could be Stenacron *floridense*.

The larva of *floridense* has a very specific maculation pattern on the dorsal side of the abdomen. We did our illustrations for this species based on Lewis description 1974 and 3 samples in the Bold System Museum website. We also have a sample of *frontale* from the same location and same source showing the very pale maculation in the photo plate section.

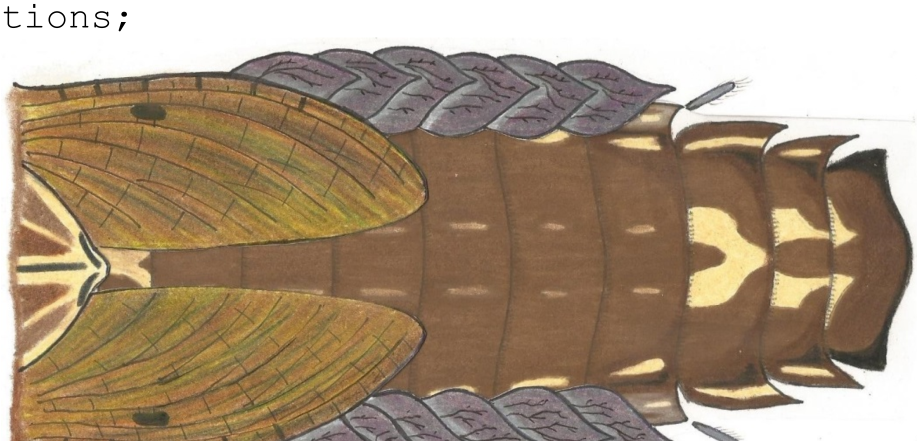
The characteristic submedial stripes on all Stenacron get bigger as the substrate lightens and the same in reverse. We know and trust the source as a very reliable and accurate collector. This sample larva was taken from the shoreline of Norris Lake Tennessee. Sharon has confirmed that the substrate is very pale mineral based going to the pale color. The adult female is also from the same location.

Without dissection of the larva there is no 100% assurance but with the tergite pattern confirmation from a photo is very high from our perspective. The female imago has a special marking that no other in the genus has, being a moderately sized red spot on the vertex of the adults with black ringed ocelli. This is not a brownish-red, but rather true reddish spot as stated by Lewis 1974. We are using this sample as a reason to always consider range as “suspect” for Stenacron. Here are the samples of the larva first including samples from Bold Systems.

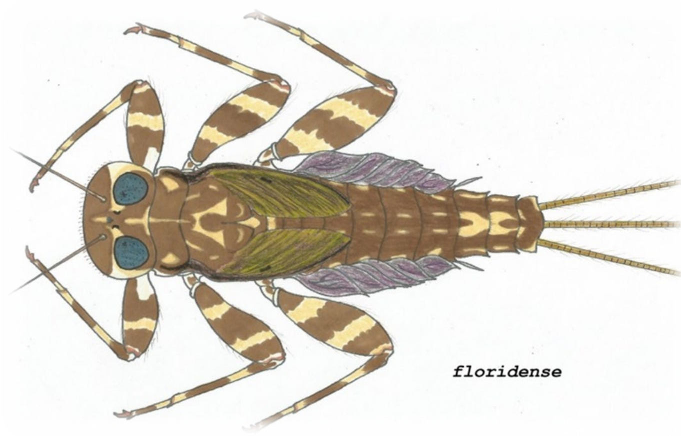
Bold Systems 2 samples photos Jeff Webb; *floridense*

Notice the submedial spots on the 3rd segment are slightly enlarged

Our illustrations;

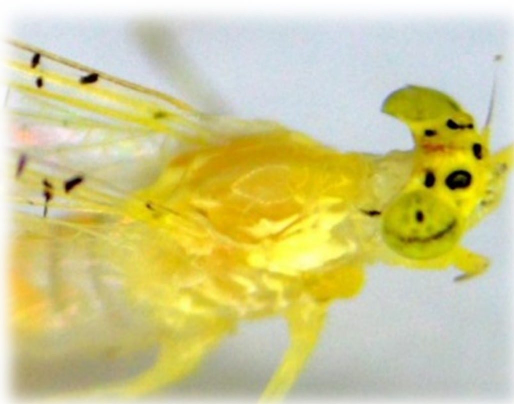


floridense



Now this is the sample taken by Sharon Moorman; La Follette Norris Lake, Campbell County, Tennessee, July 29, 2014.

We think it’s clear from this exercise with the larva and this headshot of a female imago that are suggestive that *floridense* range might go nearly to the boarder of Kentucky in the lower elevations. The red spot and black ringed lateral ocelli are very noticeable as per Lewis. Whether it is *floridense* is not as important as the reasons to be “suspect” about Stenacron ranges.



Of course without laboratory results this is only a reasonable conclusion. We hope that this will encourage science to more intense reviews and collect more Stenacron to try to give some basic geographical and geological boundaries to the forms and species that reside in this genus.

The sample from Fort McCoy FL also has a pale brown-red like spot and is only 90.2 miles from the set boundaries by Lewis 1974. For the Bug Guide site we have marked it as *floridense*. After a second review Roger and I relisted it as *interpunctatum* Say Lewis Berner 1986 has Stenacron *interpunctatum* Say as far south as the Fort Meyers Florida range so having *floridense* that far south would also not be a surprise.

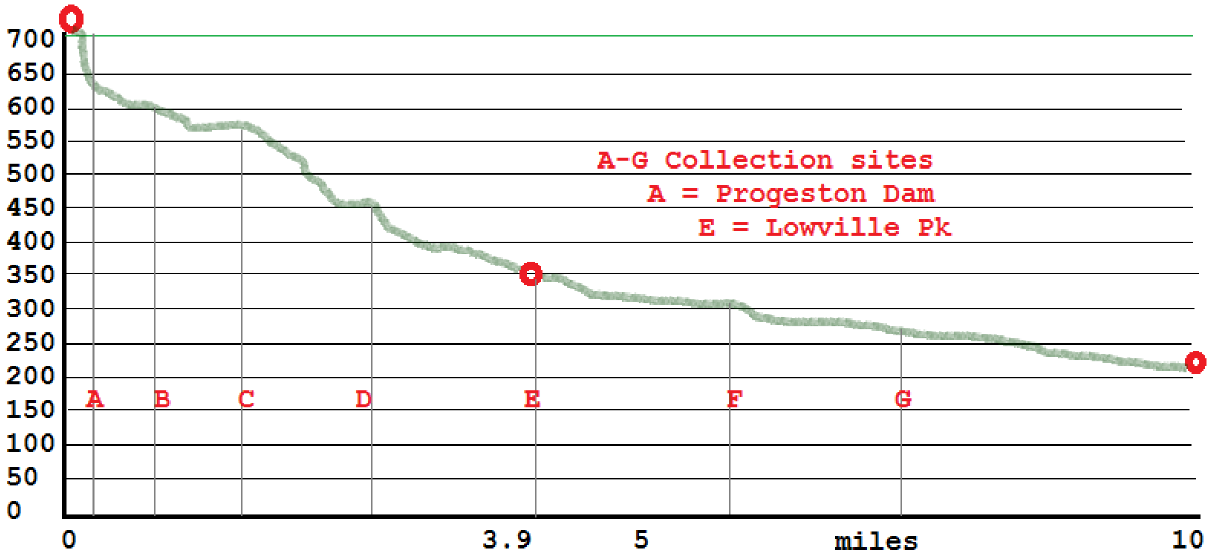
Biodiversity

Here we will breakdown Bronte Ck collections for all of the forms in that creek, and map out all the forms in the genus from it. We have not collected *heterotarsale* in Bronte. In the chart-graph below you can see the elevation drop. At location (A) it is Progreston Dam at 720 feet above sea level. Location (E) is Lowville Pk at 350 ft. At collection site (F) few Stenacron were found. Collection site (G) only 6 was found all being *interpunctatum* Say, and *canadense*.

Primary collections took place at (A-B-C-D-E) in total nearly 400 sample per year were collected from the combined locations on just Bronte. It is important to remember the substrate variation. At site (A) it is very dark and at site (E) it is intermediate in color density. Site (A) has very little sedimentation and it is dark chocolate brown black. At site (E) it is principally limestone rocks and red-clay-shale shaped and rounded into flat reddish rocks, with heavy clay sedimentation.

Between site (A) and (E) there is an altitude drop of 370 feet for the 3.9 mile span. The water is cleaner, faster, and darker at site (A). It is slower, not as pure and paler causing pigmentation shifts in the larva. We will now group collections from (A-B-C-D-E) and show you the forms collected but also whether they were the dark types, or light types, and a basic collection population breakdown per area.

Elevation collection site Bronte Ck. Progreston dam 720, Lowville 350, 3.9 miles from Progreston dam, lake Ontario 243 feet.



Site (A); <u>Progreston dam Carlisle On</u>

- *ohioense* dark 60%
- *conjunctum* dark 20%
- *proximum* dark 10%
- *frontale* dark 8%
- *candidum* 2%

Site (B); <u>1000-3000- yard down stream</u>

- *ohioense* dark 40%
- *conjunctum* dark 30%
- *proximum* dark 20%
- *majus* dark 8%
- candidum 2%

Site (C); <u>½ mile west of Cedar Springs rd.</u>

- *ohioense* dark 40%
- *conjunctum* dark 30%
- *proximum* dark 20%
- *majus* dark 8%
- *candidum* 2%

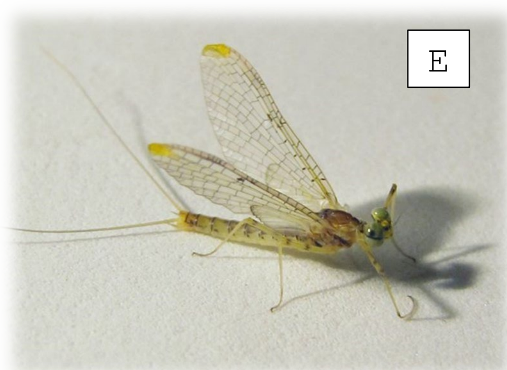
Site (D); <u>intermediate maculation</u>

- *ohioense* 30%
- *conjunctum* 30%
- *proximum* 20%
- *majus* 15%
- *frontale* 10%
- *canadense* 5%

Site (E); <u>Lowville park, Lowville On</u>

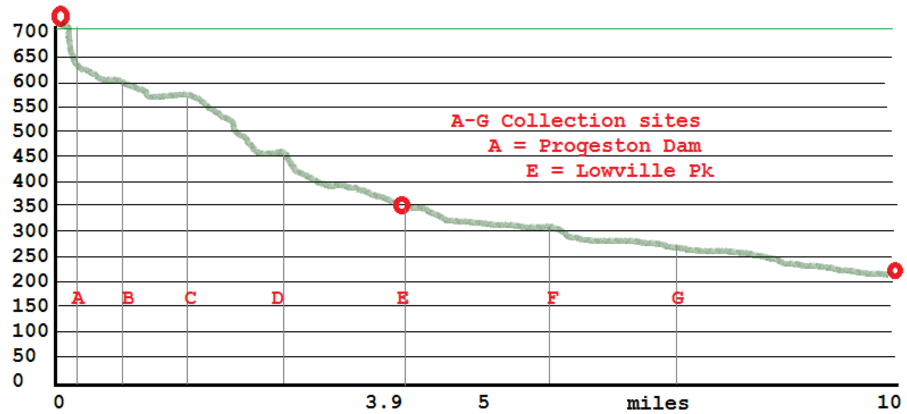
- *ohioense* light 30%
- *conjunctum* light 25%
- *proximum* light 15%
- *majus* light 10%
- *canadense* 10%
- *interpunctatum* Say 10%

Now we will look at two males for *ohioense*, dark from site (A) left, and a sample from site (E) right which is clearly the light type. Even the yellow sheath covering the wings is paler from the pale substrate. The one on the left from the dark substrate clearly has a yellow abdomen, and yellow forewings. Both samples are in the subimago stage and were reared in isolation.

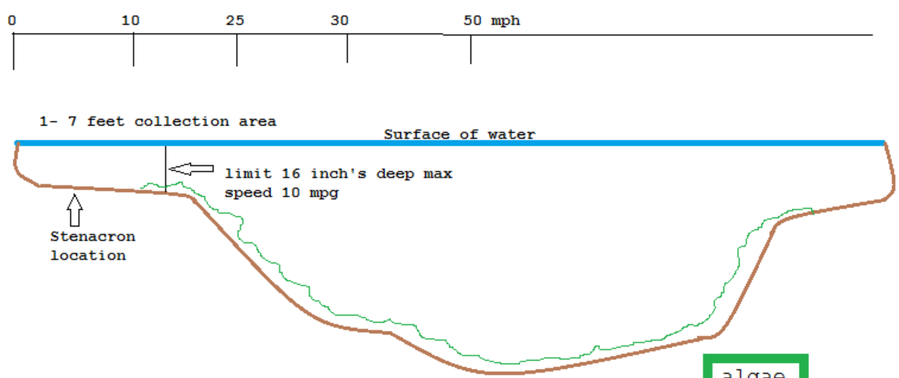


Not only are there differences in the general appearance there are differences in population per area. At site (A) 60% of the population was *ohioense* dark. By the time you get to site (E) *ohioense* light population was down to 30%. You will also notice that between site (D) and site (C) the forms were all moderate in maculation density to light types.

Elevation collection site Bronte Ck. Progreston dam 720, Lowville 350, 3.9 miles from Progreston dam, lake Ontario 243 feet.

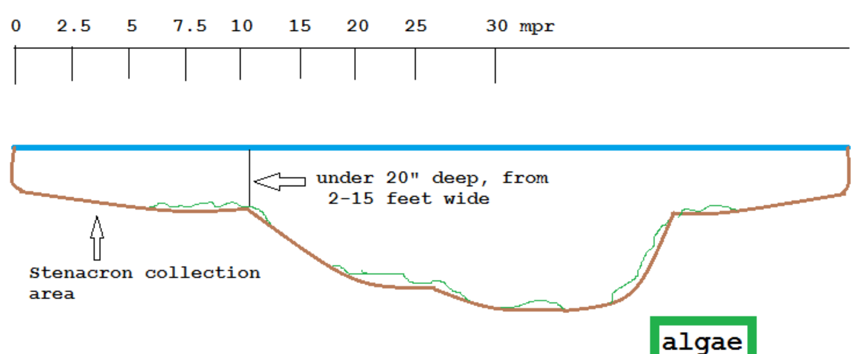


Cutaways of site location (A)



collection site A elevation 720 feet

Cutaway of site location (E)



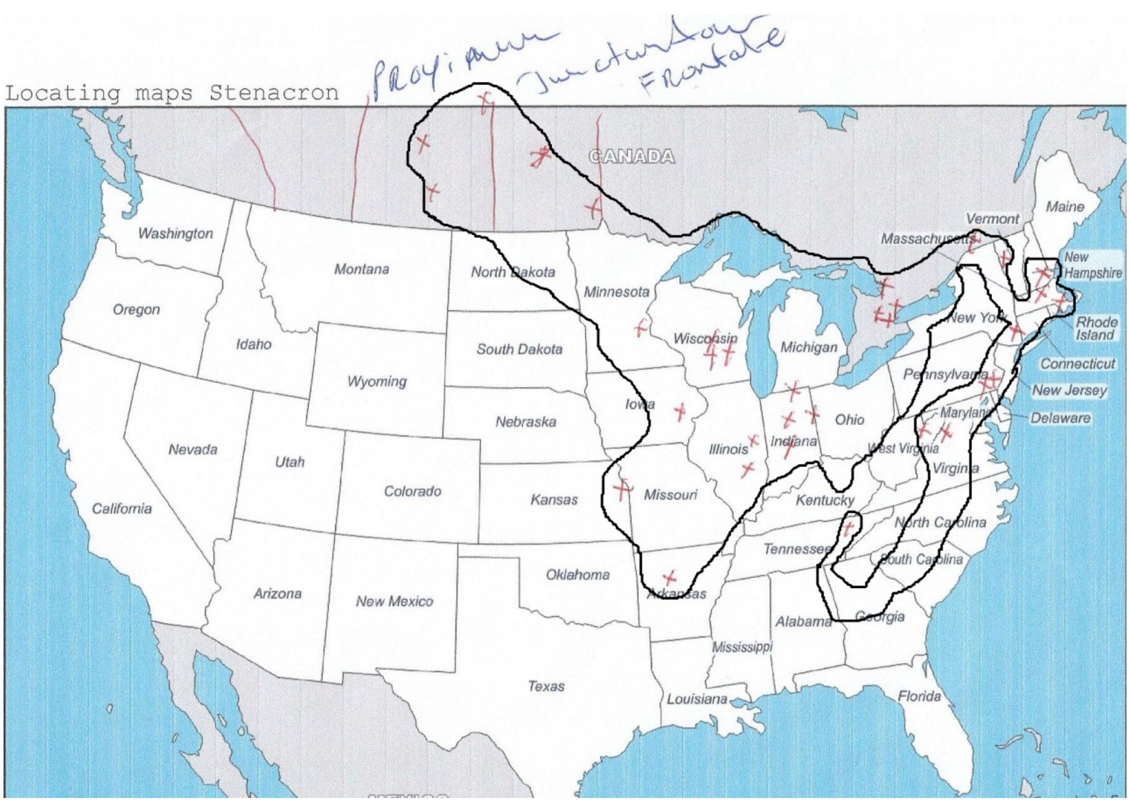
Lowville park collection site E

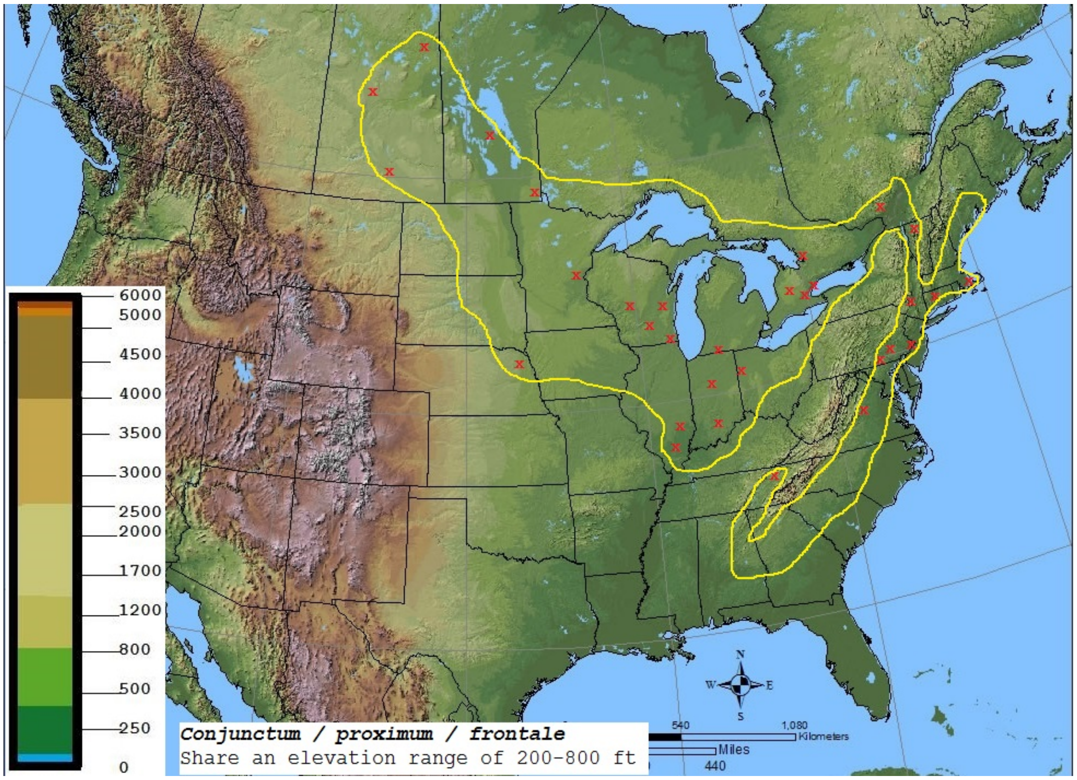
All of the above information gave us and hypothesis what if all Stenacron can be tracked by the elevations found in Bronte creek. We could have never dream of the level of accuracy that was involved. What we did was print out the following map and look at every photo ever taken of any Stenacron.

What we did was identify the photo to form with at least 95% assurance. Marked it on a non-elevation map as seen below. Then transported the markings to a special elevation map.

Once all the red **X'**s where in place based on' sightings and elevation we found that our collection elevation sites having certain forms in each area we found a geological and geographical home for each species and form.

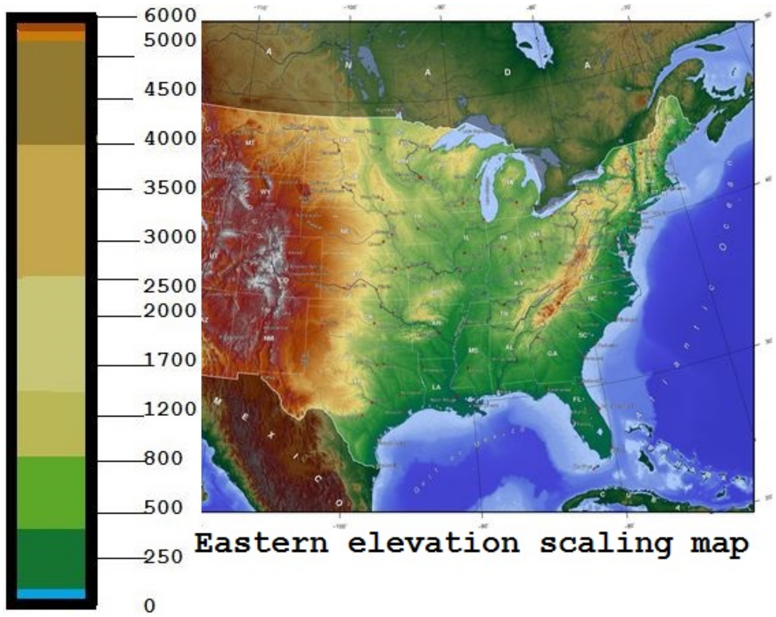
The map below is for 3 forms that all reside in Bronte Ck at a certain elevation range being 350-720 ft above sea level. We expanded the elevation to be likely as high as 800 ft. Map 1 was transferred to map 2 the mountain range map.





The yellow line is the outside of the elevation boundary, so forms and species are found inside that area. Stenacron do tend to use low level corridors for range extension. This is how they can be on two sides of a mountain range they crossover in the elevation that suits their needs. Also crossing over at the headwaters at the top of a mountain. At the watersheds beginnings they are the same on both side of the mountain.

Before we present the final maps for every form and species there are two things to mention. First we did not mark out *areion* as no range would be known all the samples came from the same basic areas. Second is very important to know. The Appalachian mountain range is the eastern continental division for Stenacron. There has never been a sighting publically known of a Stenacron in the Rocky mountain Range they have always be viewed and seen as an eastern genus and this is correct. Elevation from sea level is the cause there is more appropriate environments and ecologies in lower altitudes as the water moves slower which is the primary need for this genus, slower rivers make billions of homes. This first map was perfect for the job of building an elevation scale from to put inside each map so we could find the basic elevations. The colors are not as accurate as they could have been but it is enough to show this theory works.

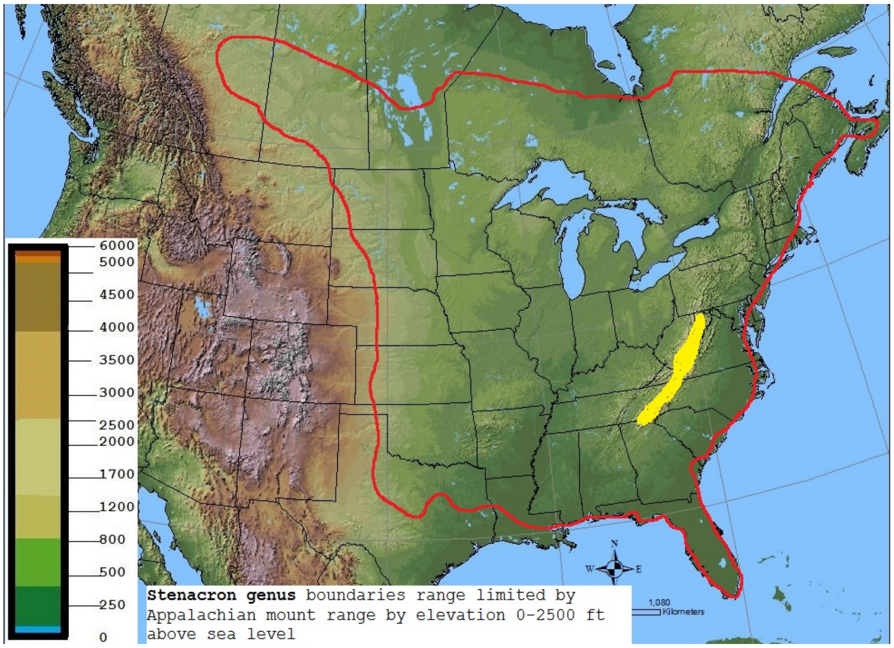


The absolute maximum elevation we found was a female *canadense* on Bold Systems from Alberta. Bold Systems inventory number is **ABMAY015-09 - Stenacron interpunctatum [COI-5P:658]** the elevation is 3840 ft making that the second highest elevation for the genus ever recorded, other than *carolina* at up to 5200 feet.

The furthest west is also at Bold Systems being from the Yukon Territory, Kluane National Park Canada, and the elevation is 2100 ft and here is the inventory number **BBGCO934-15 - Stenacron interpunctatum [COI-5P:534]**. Because there is no photo, we could not identify the form but it is most likely a true *canadense*.

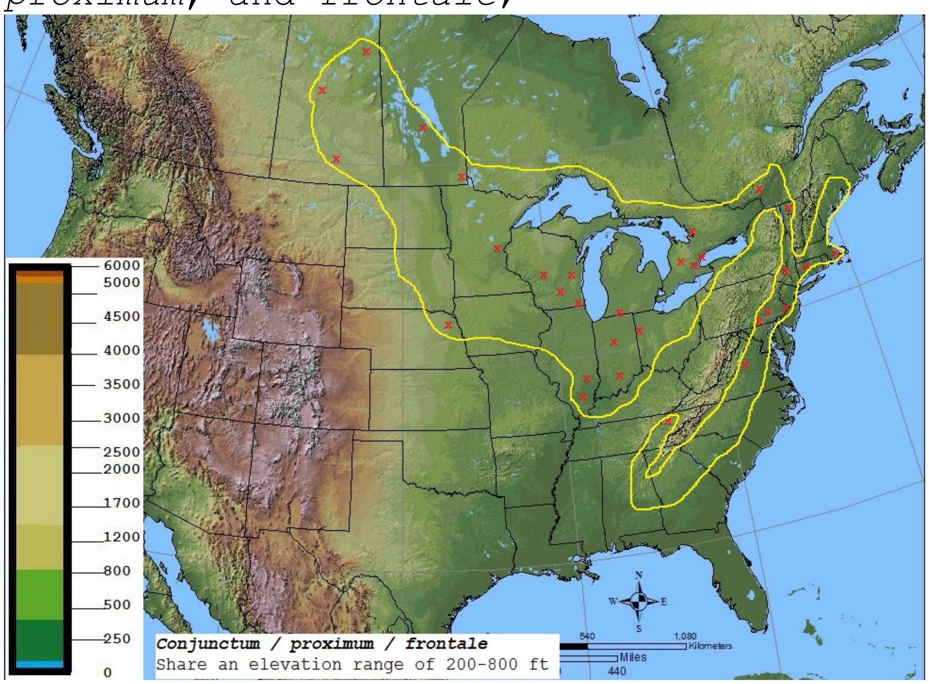
The furthest east is a female *canadense* from Bold Systems as well-being, New Brunswick, Miramichi Canada, at the Atlantic inlet and its inventory number is, **EPHNB005-09 - Stenacron interpunctatum [COI-5P:658]**.

So we can determine that coast to coast Stenacron can exist but only at certain elevations. We suspect that they will never be found in the Rocky mountain range especially in the USA the elevation is too high. The next map is a genus only distribution map showing the general locations of the entire genus.



There is at this point no reason to believe that with this very far west sighting we may still find a few samples in between the mountains from Alberta to the Yukon site but certainly not at high altitudes. With the forms *conjunctum*, *proximum*, and *frontale* all showing high cohabitation in elevation range, and being responsibly difficult to separate we placed them all on one map.

conjunctum, *proximum*, and *frontale*;



The most northern sighted sample that could be identified to form is a female that aligns with Traver 1935 for *proximum* on Bold Systems inventory number, **BBEPT142-10 - Stenacron interpunctatum [COI-5P:658].** The furthest south is Fort McCoy, Marion County, Florida, USA on the bug guide. It is a female sample that aligns within reason with *floridense* and is only 90.2 miles south east of the collection range set by Lewis 1974. Identification in the subimago state is sketchy but we can see in the head shot a faint but distinct pale brownish-red spot on the vertex of the head. True *interpunctatum* Say does not have that feature and is the only other form in that area. The furthest south on record as we know it is in the Fort Meyers Florida in Lee County from the out flow of Lake Okeechobee, Berner and Pescador 1986 The Mayflies of Florida.

The first maps to review now is *affine* and *heterotarsale*. At the behest of Dr Needham, Dr Traver synonymized *affine* to *heterotarsale* and we believe for reasonable conclusions. In her writings and on page 303 of The Biology of a Mayfly it is clear she did not totally agree with the synonym. On page 303 below the larva table she indicates "5, assuming that *affine* equal's *heterotarsale*". *Affine* in the bottle here in the book shows *affine* as having a dark brown mesonotum more like *interpunctatu*m Say. However our illustration was based on her descriptions and has a lighter mesonotum. We are not sure and think the synonym was questionable. *Heterotarsale* is much larger and has a yellowish mesonotum. *Interpunctatum* Say is also closer in size. Now reflecting on Lewis 1974 regarding *areion* he found all Burks types to be dark brown on the entire notum rather than mars orange, as stated in Burks 1953, and synonymized it to *interpunctatum* then to the *interpunctatum* complex. Also regarding DNA Jeff Webb told me they did not include Travers samples as they would have been too old and degraded for the 2012 DNA paper. As it stands there are 15 Bins, or clusters in the genus. It will take an NC worker to go back to the type location site and do a rearing study, and compare with the Cornell collection, to create clarification. Dr James H McDunnough first described *heterotarsale* February 1933, and Traver described *affine* April 1933. Most of the *heterotarsale* described are from Illinois from around 1927 and Ottawa Ontario. The earliest collected *affine* was April 1930 so priority goes to *heterotarsale*.

With only 6 collection sites for *affine* little was known. However today with altitude and ecology they are very likely differences in the mouthparts of the larva. Just using Bronte Ck in the form *ohioense* dark and light types there are mouthpart modifications for dietary differences. The darker samples came from 720 feet with high levels *cladophora* algae nearing 60% of the square footage, and at the 350 foot range the *cladophora* algae amount drops to near 20%.

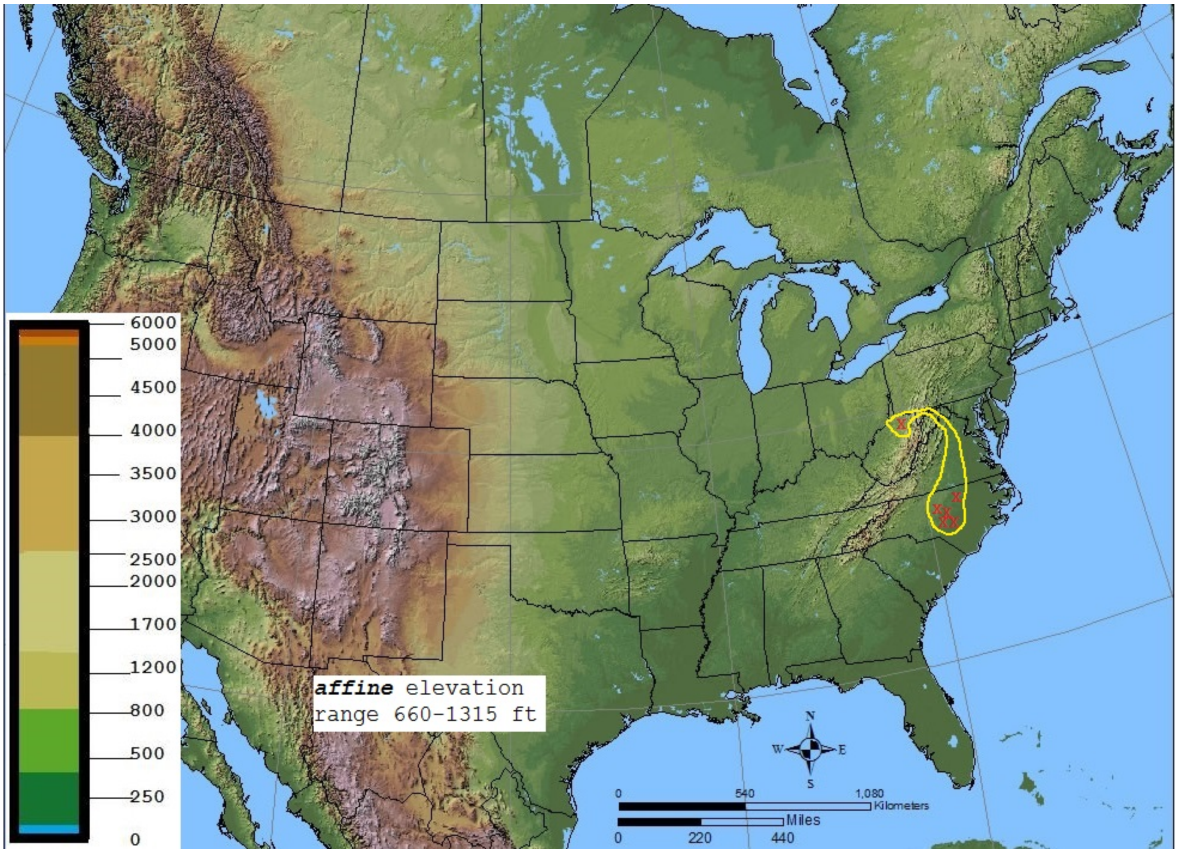
Our gut content studies agree with McCshaffrey & McCafferty (1986) having a gut content of mostly minerals and debris at 300-400 feet. However our dark form of *ohioense* from the upper areas gut content for *cladophora* algae was very high, with minerals and debris present, concluding they are opportunistic feeders as stated by McCshaffrey & McCafferty (1986). However as seen in the rearing tank with *cladophora* algae they can act as scrapers.

Regarding *affine* and *heterotarsale* there is still differences in them especially size. But with this new mapping technic there is some other things to now be considered and that is altitude which constitutes different ecology, geology, and dietary differences similar to Bronte creek.

The higher the elevation the faster the water moves, and the closer you are to natural spring water. Using Bronte as a benchmark. In its upper altitudes it is dark with a very high (DO) with water moving in speeds likely in excess of 40 mph.

Therefore the sized of the environment that Stenacron can live in shrinks and populations go down. This also explains why most photographed samples come from elevation ranges of 250-800 ft. The highest altitude species is *carolina* having the highest elevation within 5 miles of mount Mitchell NC at Bear gap Black mountain with the collect site about 4400-5200 ft, mount Mitchell is at an elevation of 6609 ft the highest of the Appalachian Mountain range.

Affine;



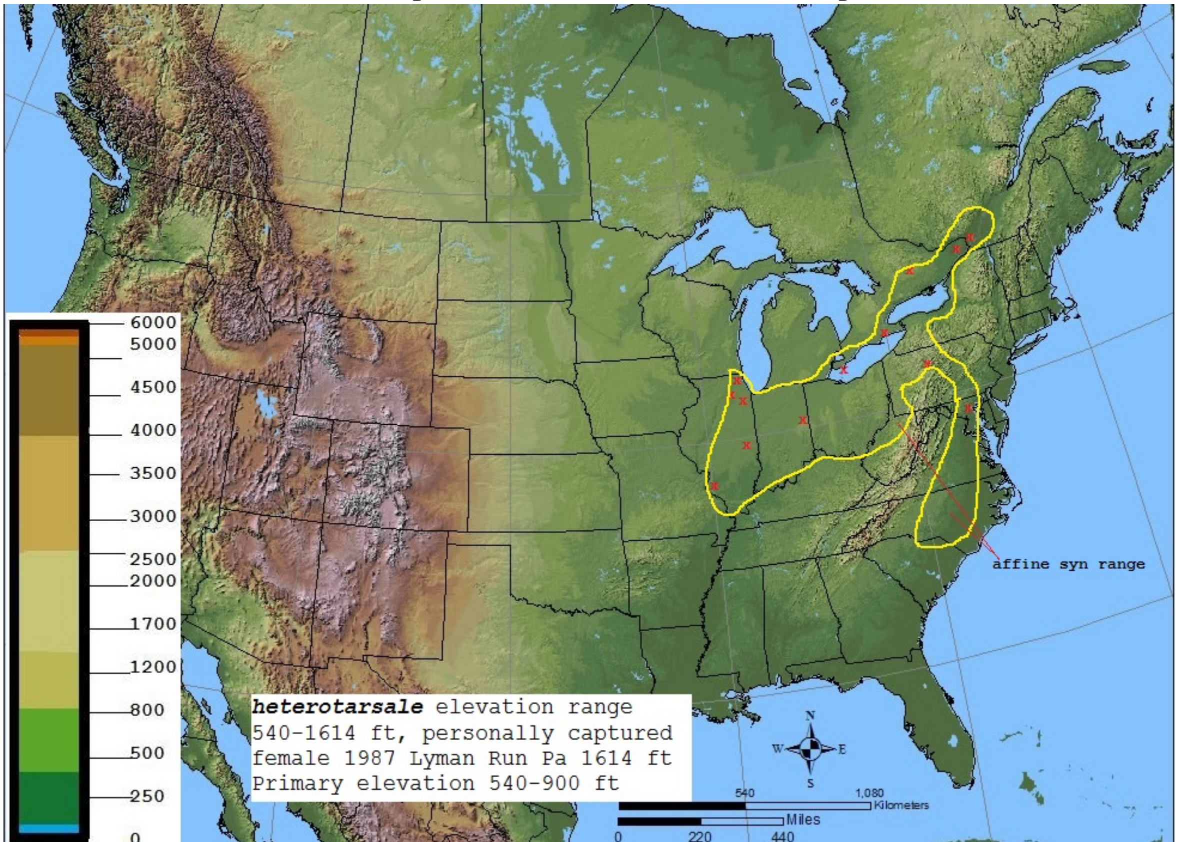
Affine collection sites NC, Caraway Ck 1424 ft, Sophia 1522, Uharie Mountain 1153, Spero 1504, and Denton at 660 ft. There is one site in north eastern WV being Smoke Hole at 1100 ft, giving an average elevation preference of 1227 feet.

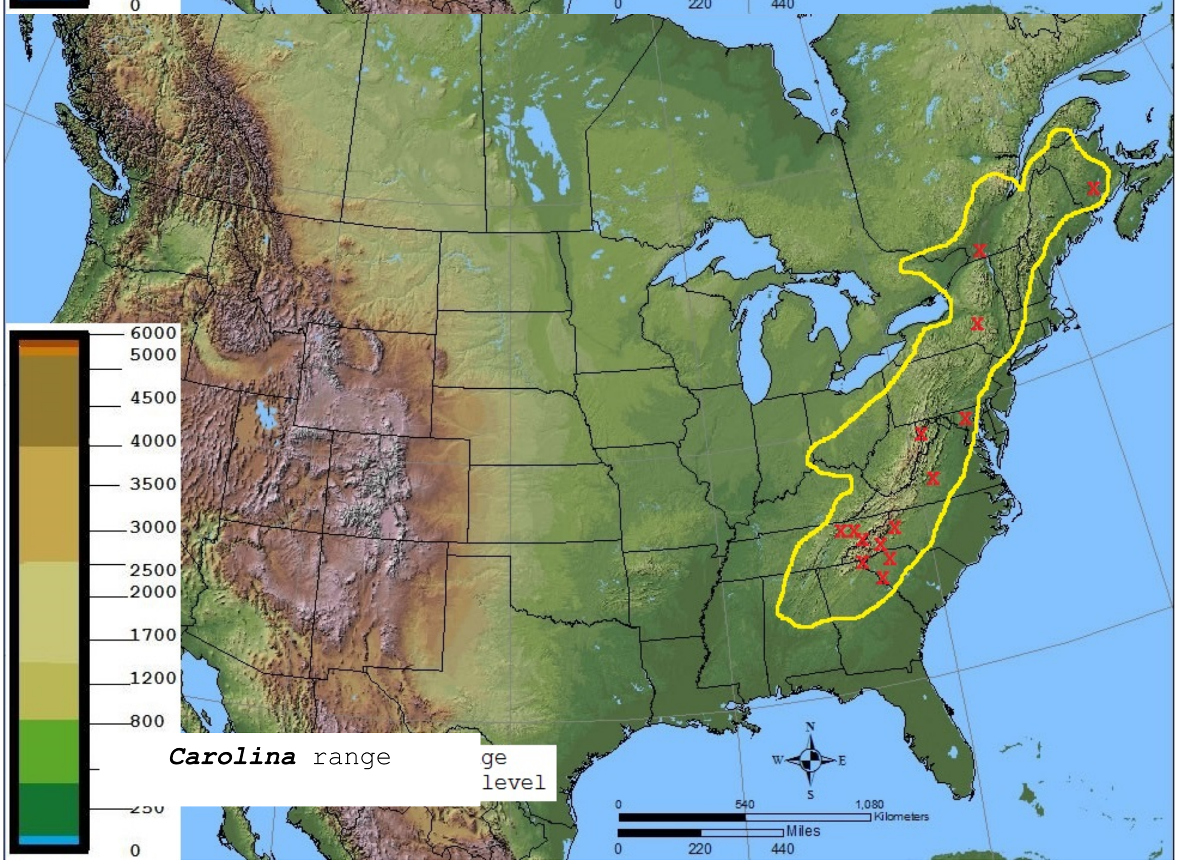
Heterotarsale clearly indicates a preferred range from 250-900 as a base line making about 500 feet a likely average. However I personally collected my very first Stenacron *heterotarsale* May 24th weekend 1987 at Lyman Run PA at an altitude of 1614 feet. We suspect the diets of *affine* and *heterotarsale* would be very different.

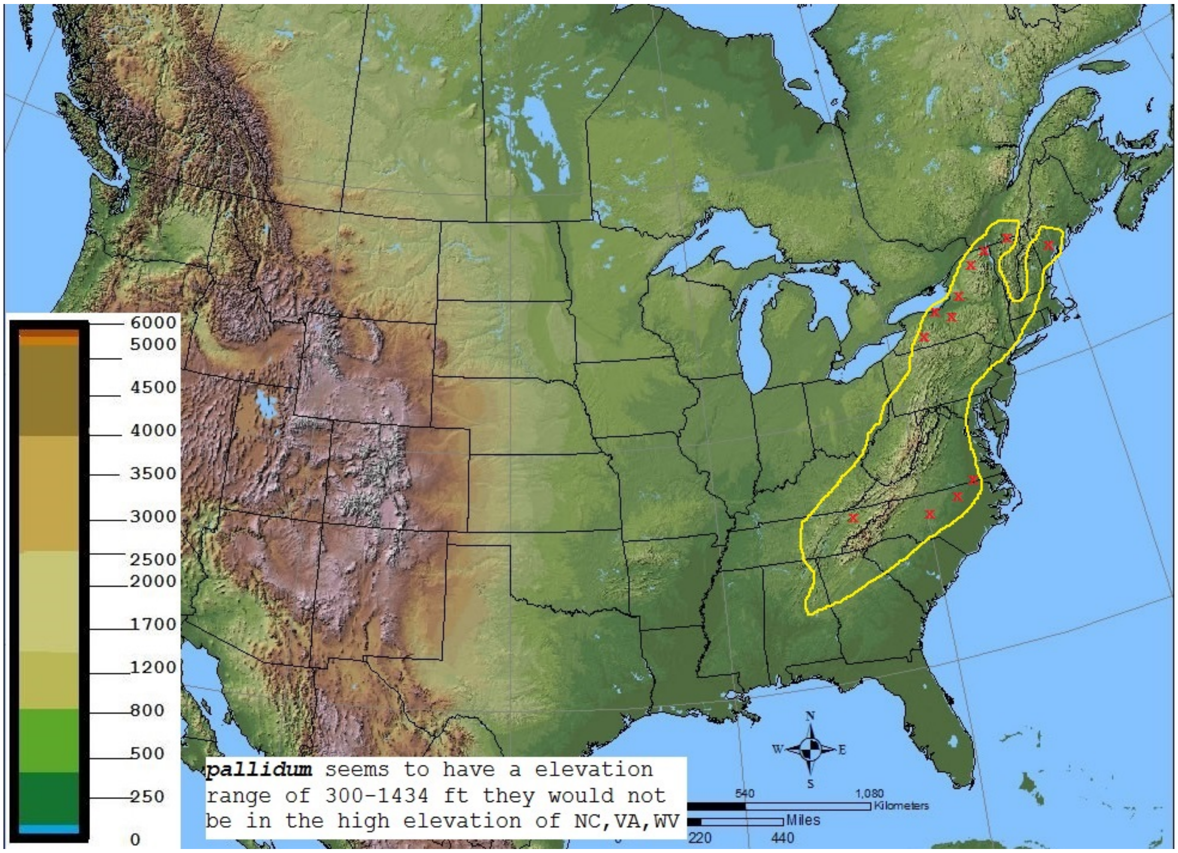
Remember just because you can't see it doesn't mean it isn't there. In other words just because it has not been officially mapped doesn't mean it is not there.

Stenacron follow geology and geography they don't skip spaces that they can use to thrive in.

heterotarsale; including *affine* in the range






6000
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1700
1200
800
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0
pallidum seems to have a elevation range of 300-1434 ft they would not be in the high elevation of NC,VA,WV
540
1,080
Kilometers
Miles
220
440
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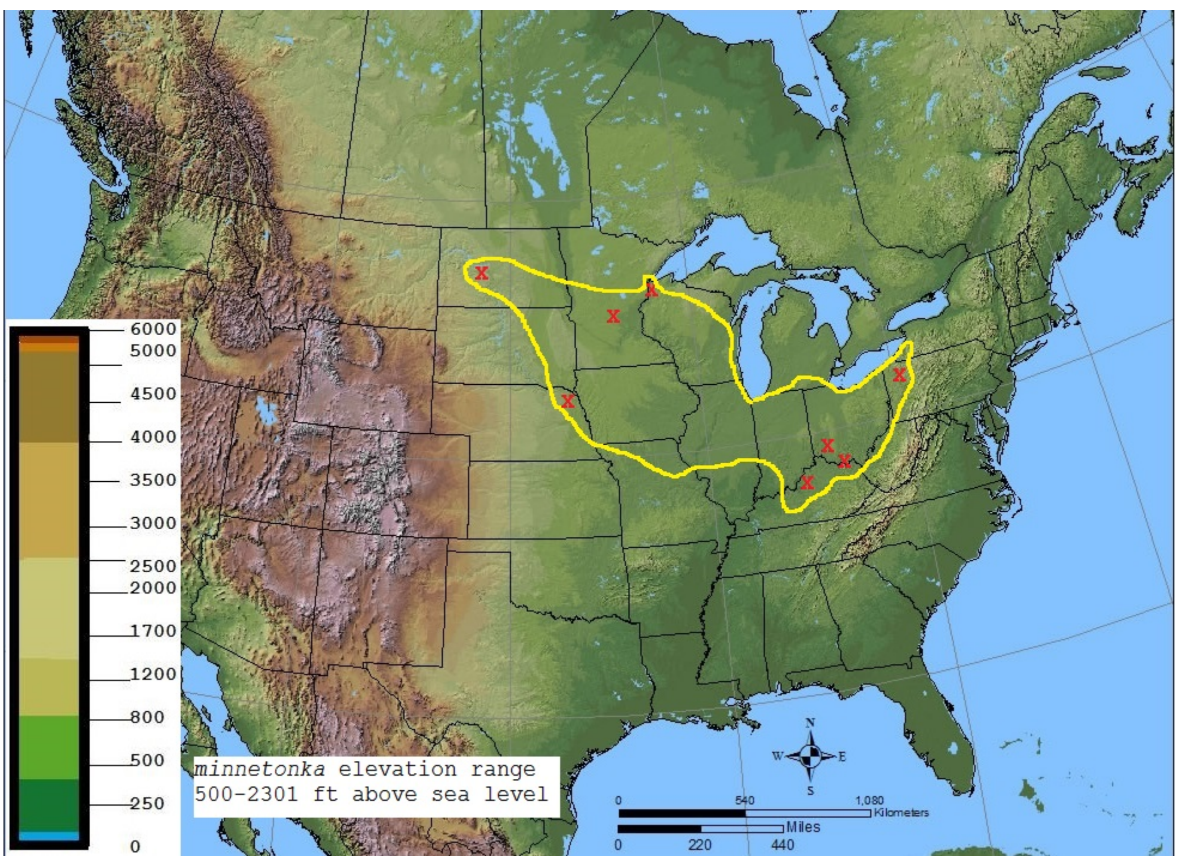
S
W
E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800
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minnetonka elevation range 500-2301 ft above sea level
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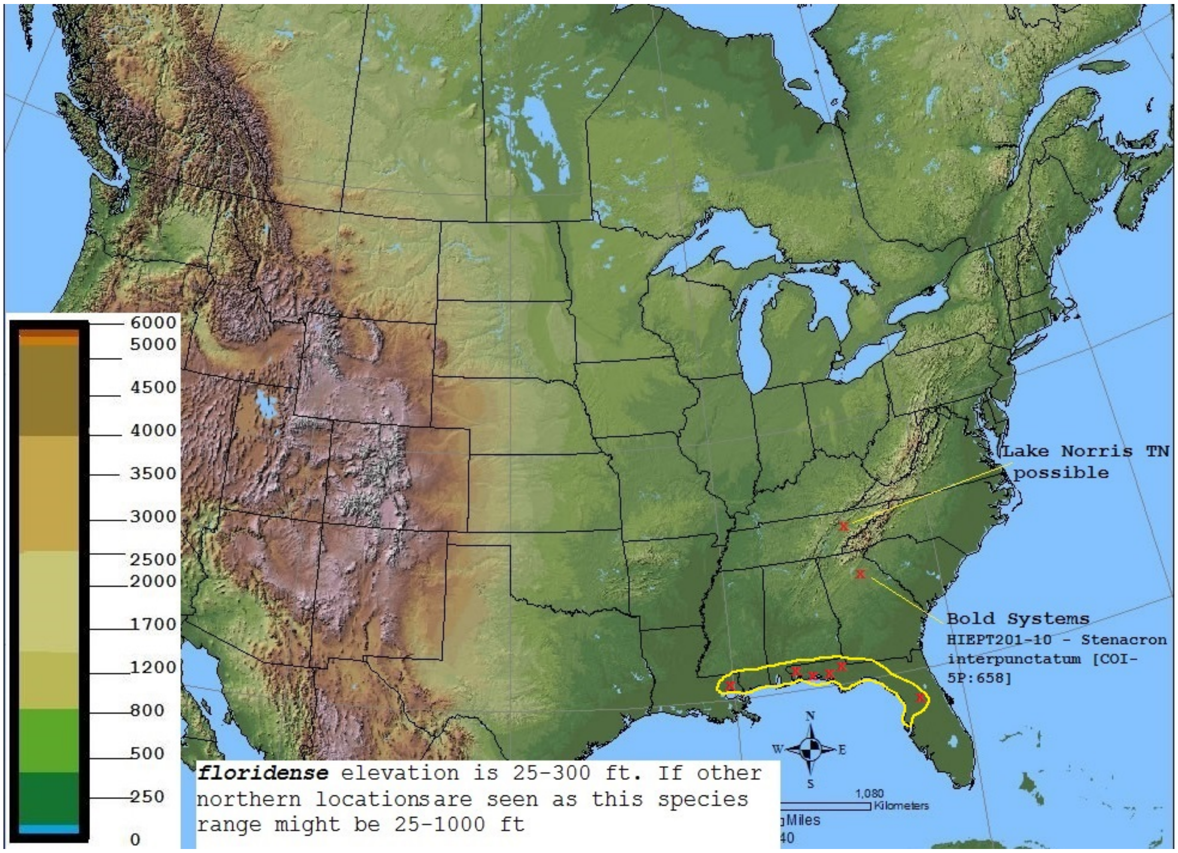
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1200
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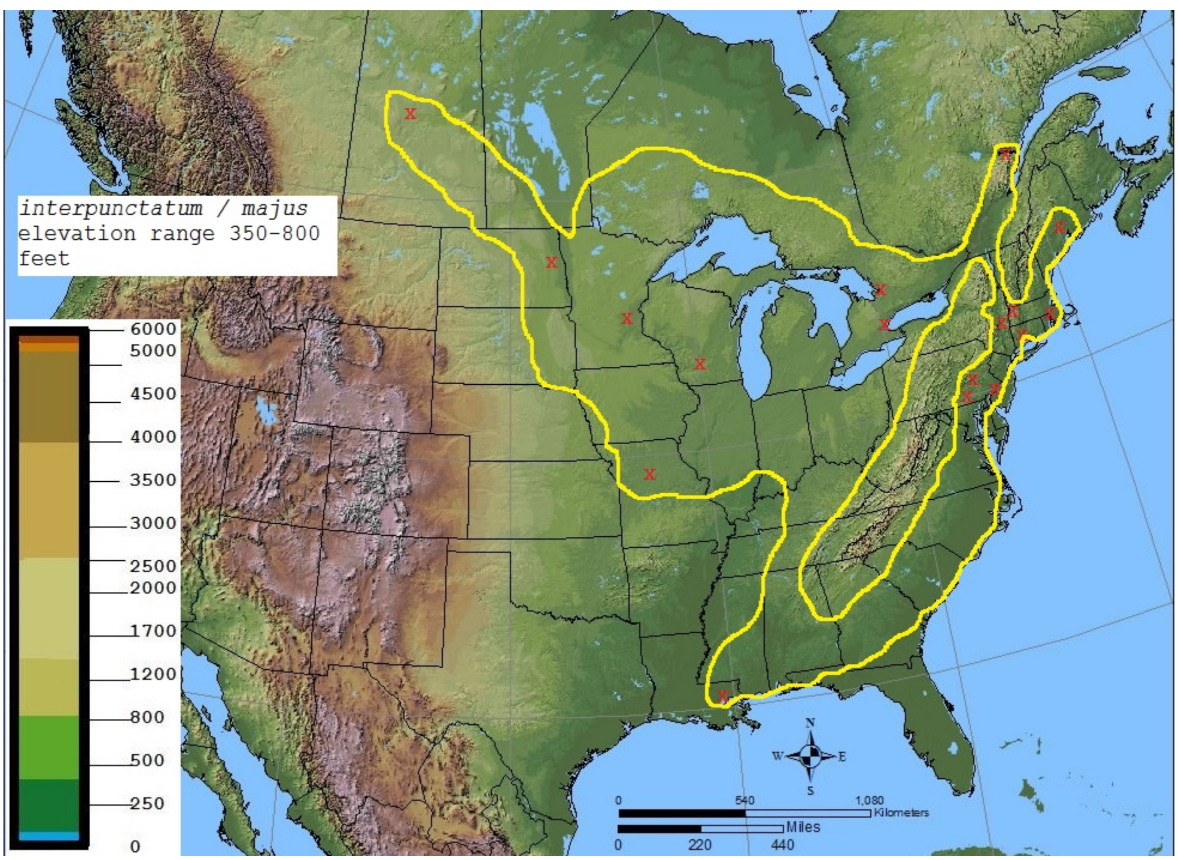
0
Lake Norris TN possible
Bold Systems
HIEPT201-10 - Stenacron interpunctatum [COI-5P:658]
floridense elevation is 25-300 ft. If other northern locations are seen as this species range might be 25-1000 ft


interpunctatum / majus
elevation range 350-800 feet
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Kilometers
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220
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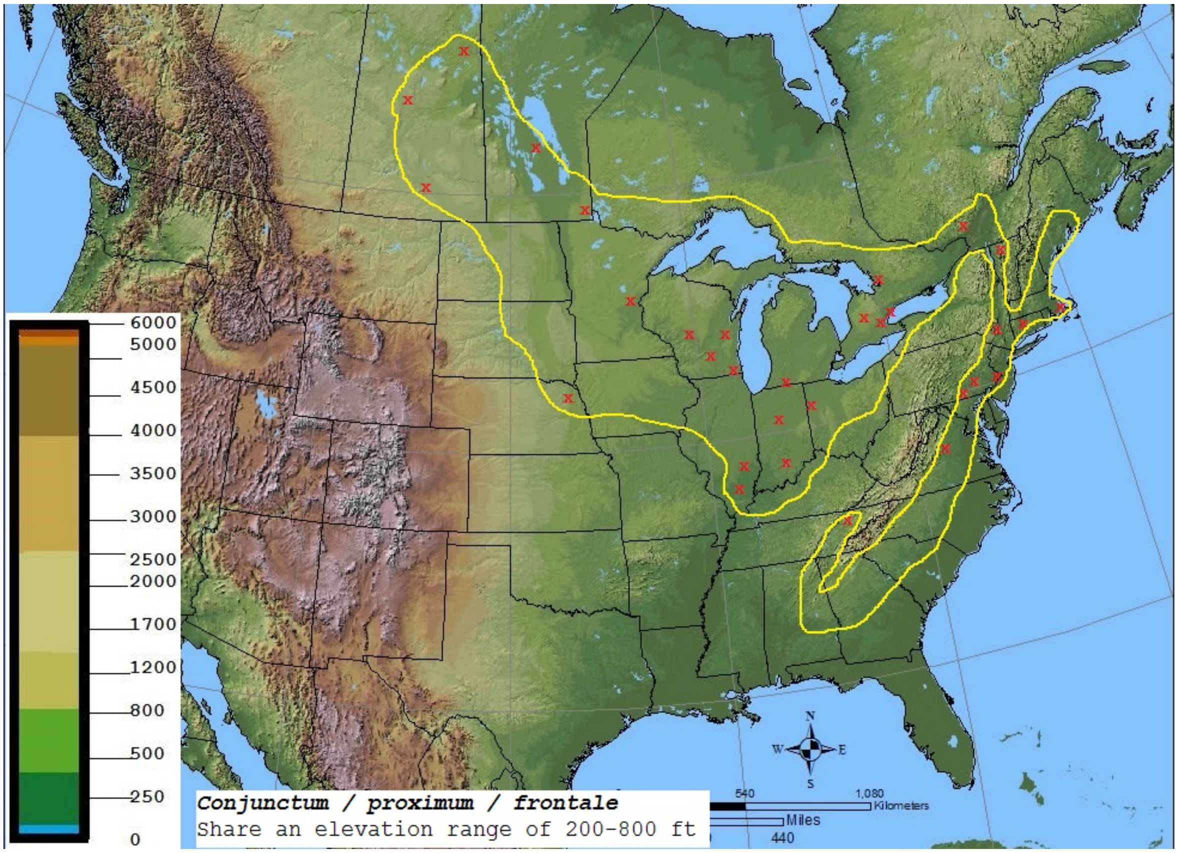
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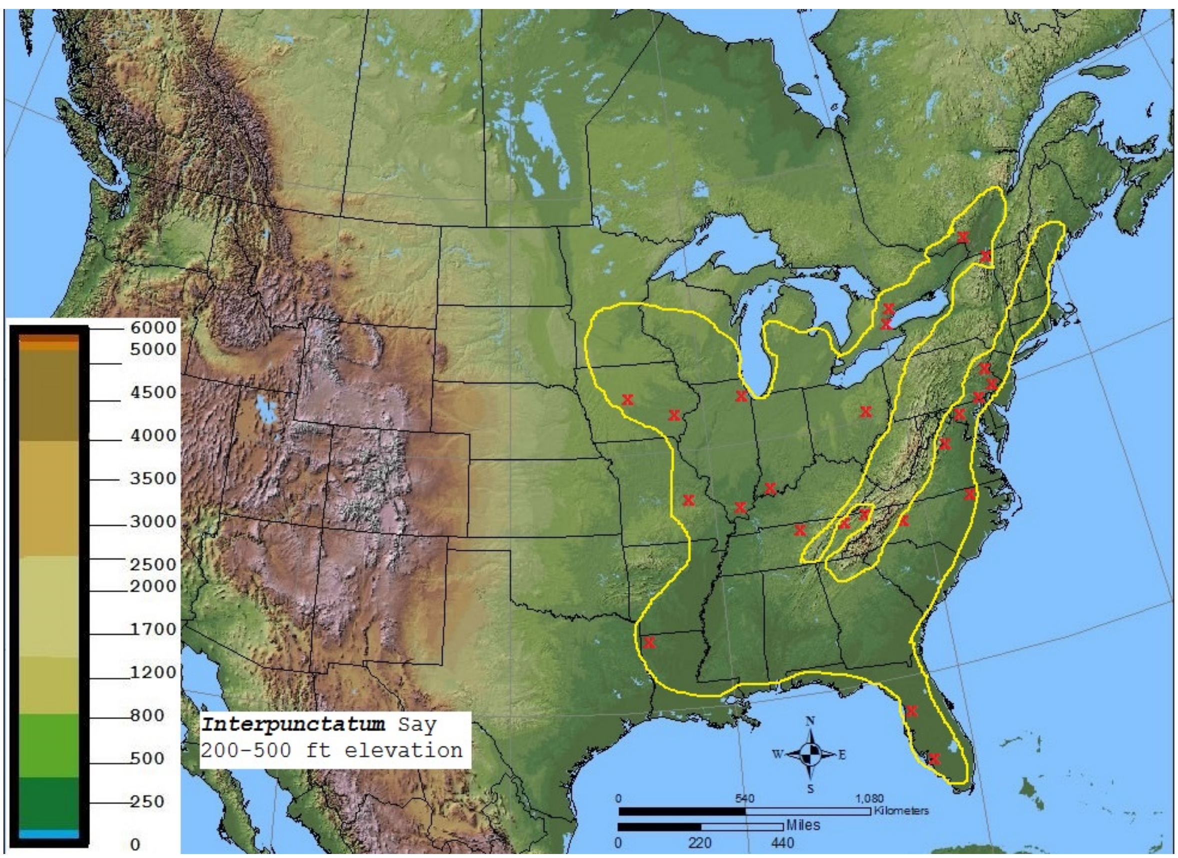
Conjunctum / proximum / frontale
Share an elevation range of 200-800 ft
540
1,080
Kilometers
Miles
440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Interpunctatum Say
200-500 ft elevation
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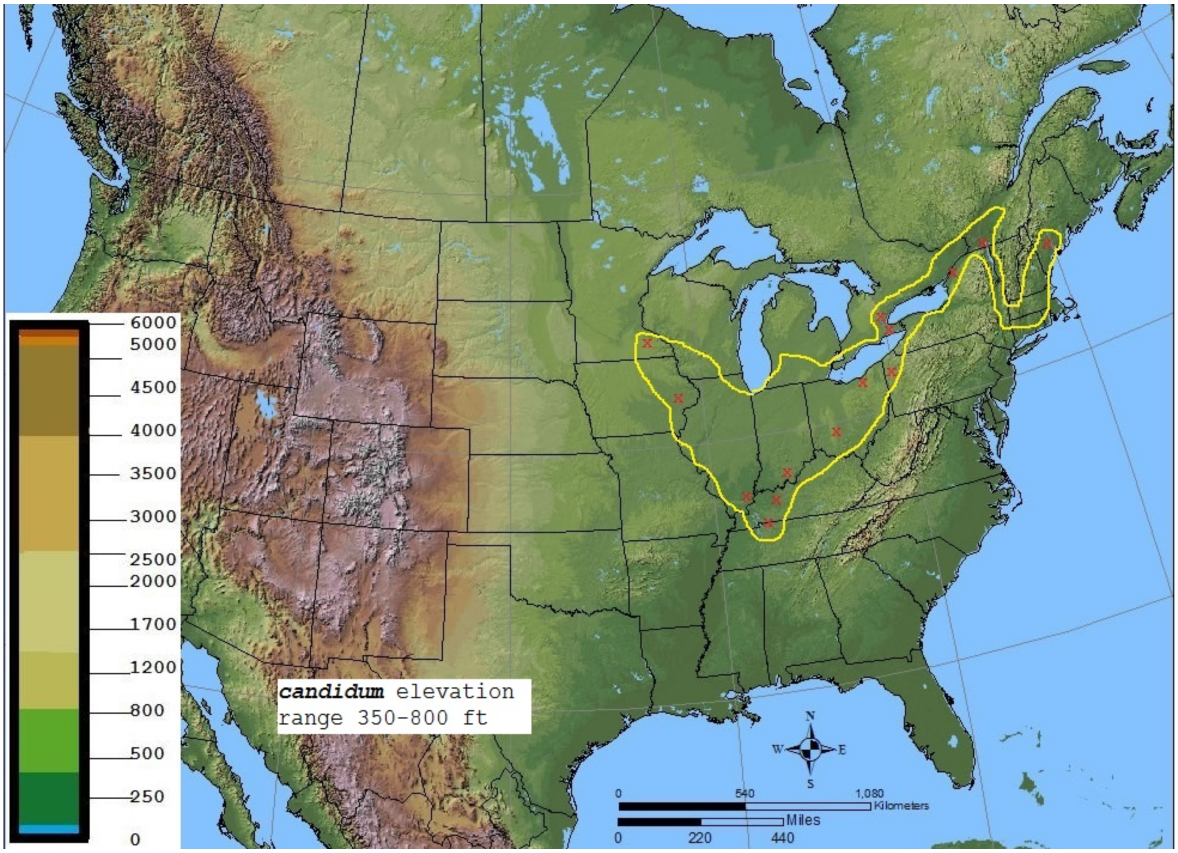
540
1,080
Kilometers
Miles
0
220
440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candidum elevation
range 350-800 ft
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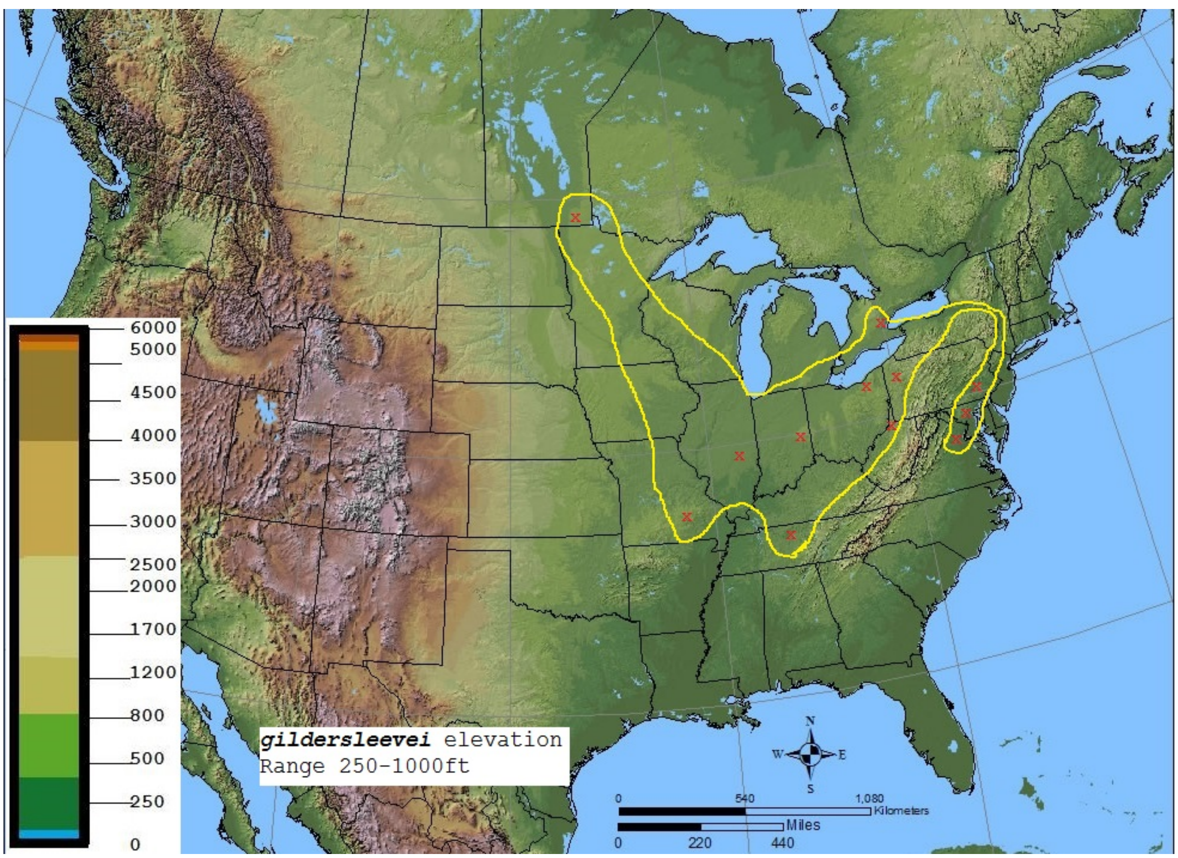
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gildersleevei elevation
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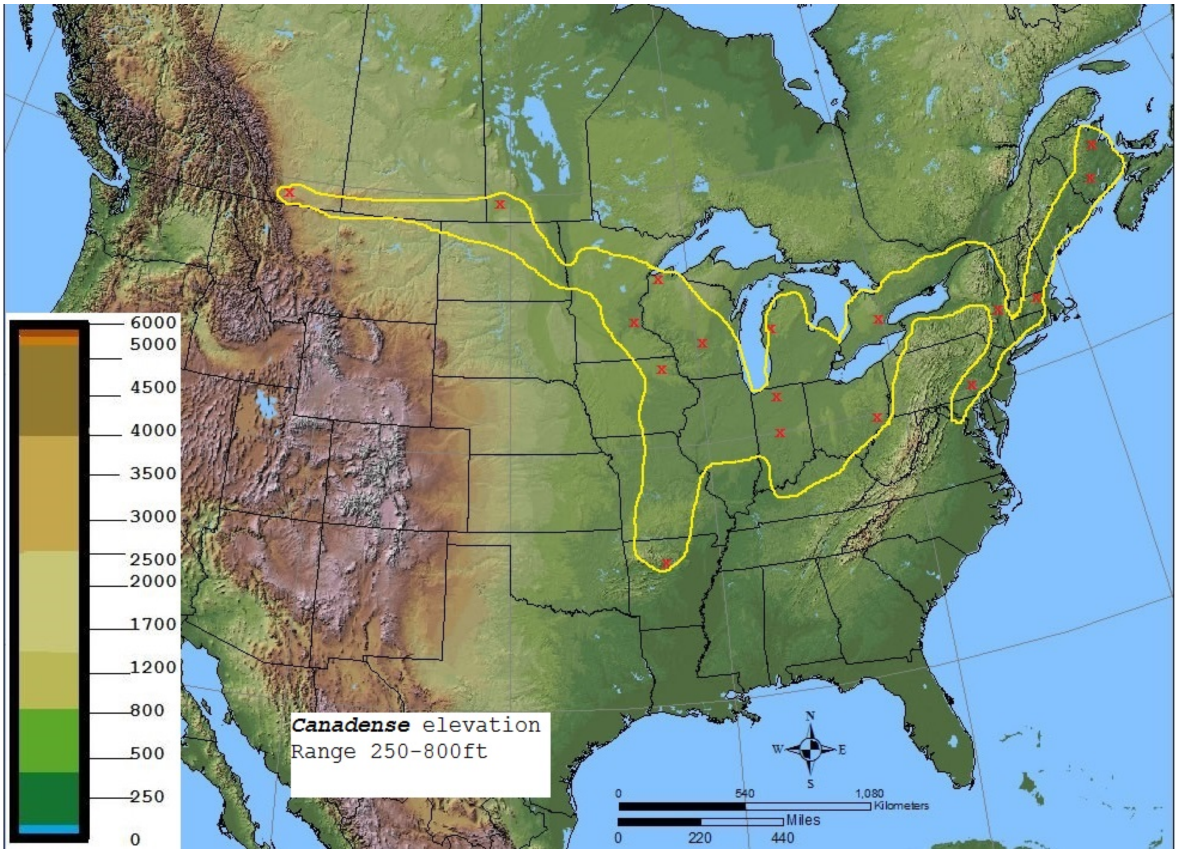

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Canadense elevation
Range 250-800ft
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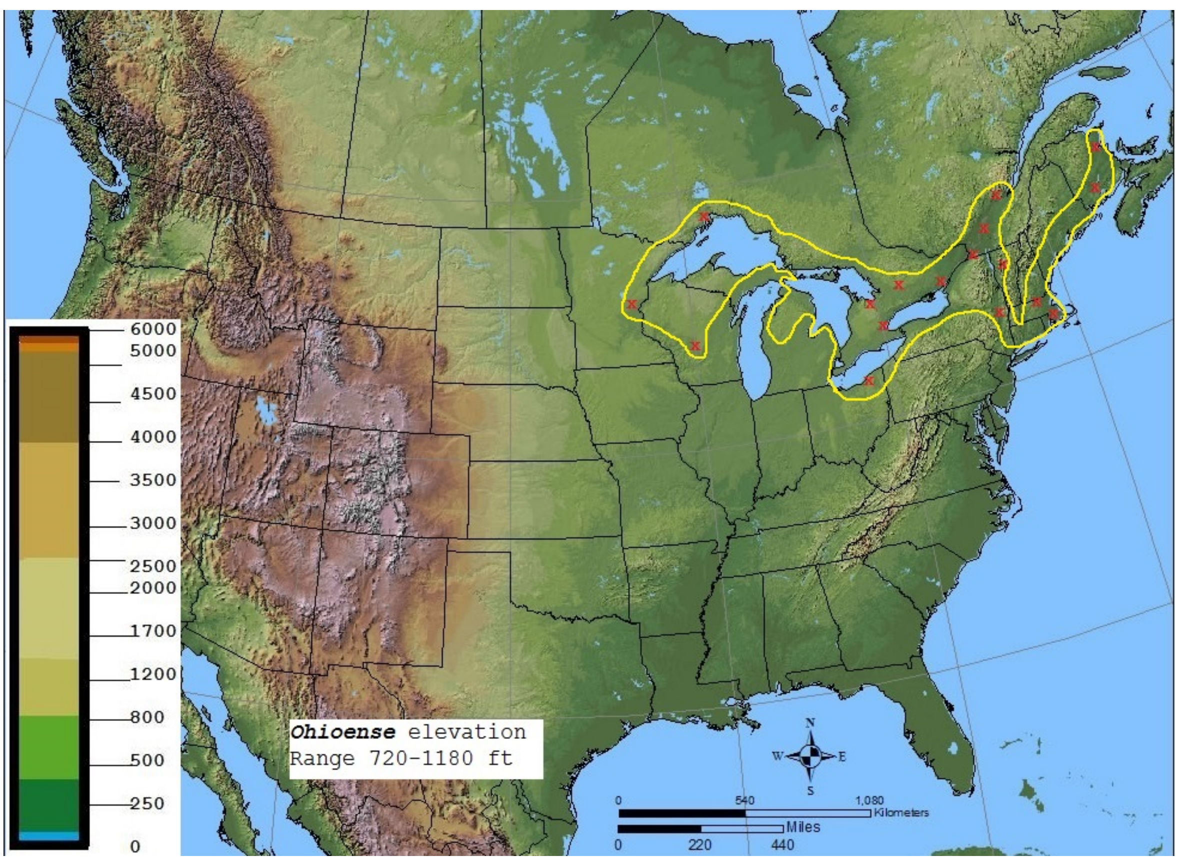

6000
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Ohioense elevation
Range 720-1180 ft
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540
1,080
Kilometers
Miles
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220
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Anatomy of Stenacron

In this section we will explore the basic anatomy of Stenacron. Having a good understanding of what you will see, should you choose to do a dissection is very important. This will enable you to clearly see and understand the entire dissection process. Dissection of all the mouthparts is critical for positive diagnosis in the larva.

However by just removing and mounting the labrum that is enough to confirm form, providing the labrum has been blueprinted in this guide. Removal of the maxillae and mandibles is highly recommended to make further confirmation. The maxillae are the hardest part to mount they are thin and fragile and great care must be taken.

Starting at the larva head capsule. We will work from the ventral or underside side moving upward through the head. The labium is the lowest part and it is basically the lower lip of the larva. Next is the hypopharynx which is referred to as the tongue. Right above this is the maxillae or the lower jaw area. Moving upward next comes the mandibles which are considered the upper jaw area. Finally there is the labrum or better known as the upper lip. Before we go too far if you really want to understand mouthpart morphology we encourage you to locate and read, McShaffrey & McCafferty (1986) "Feeding behavior of Stenacron *interpunctatum*".

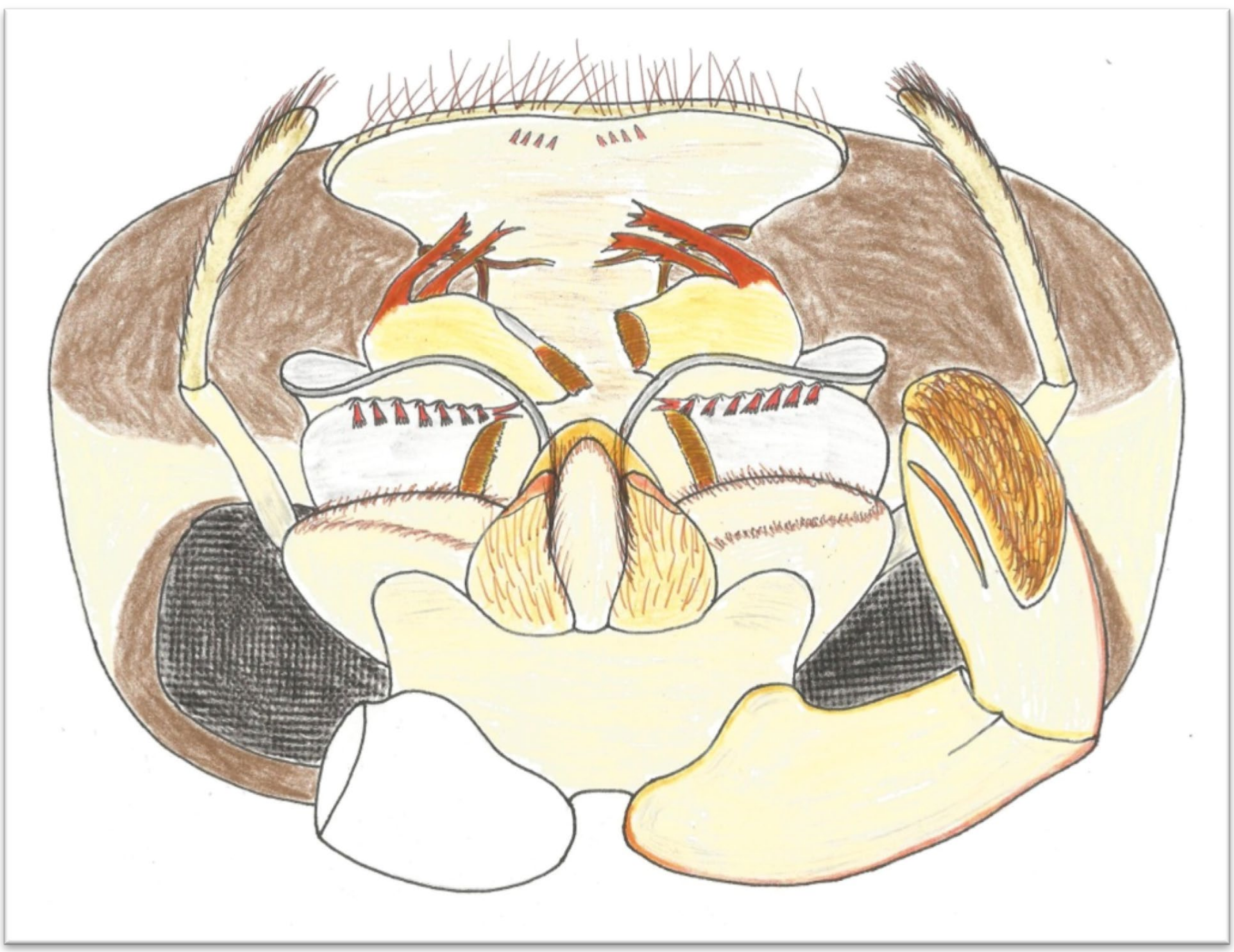
In their document they fully explain the mouthparts and their specific functions; you can locate a free copy at;

http://www.ephemeroptera-galactica.com/mfbib.php

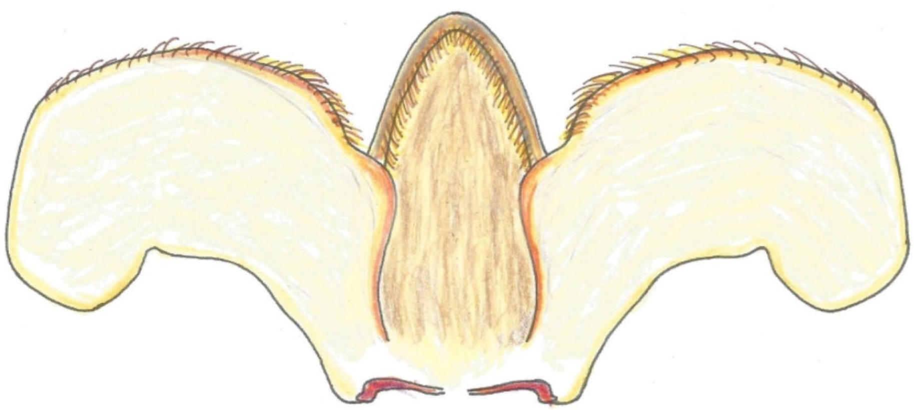
At this website you can also locate copies of everything listed in the selected bibliographies in the back of this book that are currently available.

The first illustration is a general overview of the head from the ventral side. It shows the entire head with mouthparts in there correct placement.

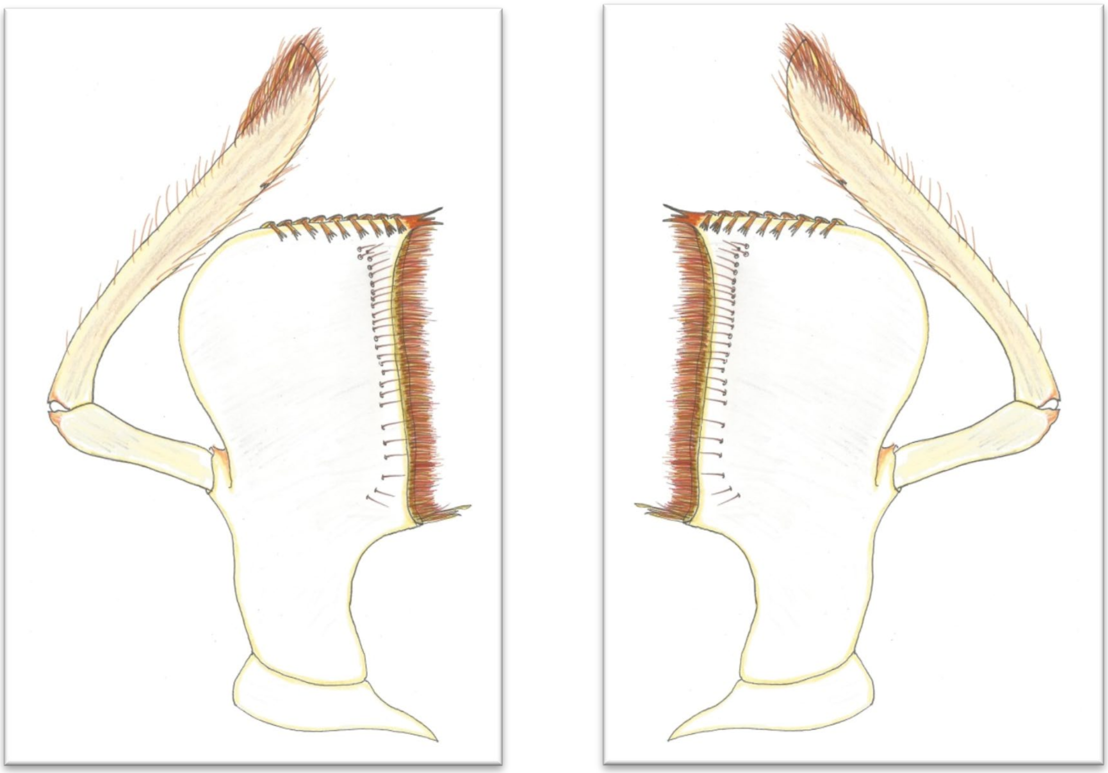
The illustration below was based on McShaffrey and McCafferty (1986) for figure (2). It is a modified variation to be genus specific. None of the following illustrations are species or form specific, they are general genus illustrations.



labium



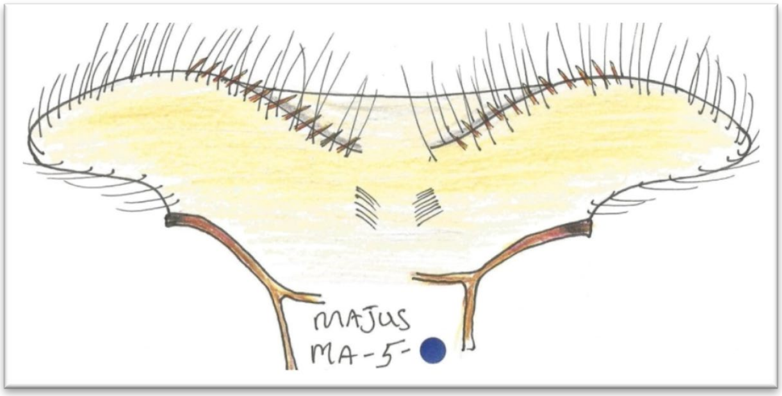
hypopharynx



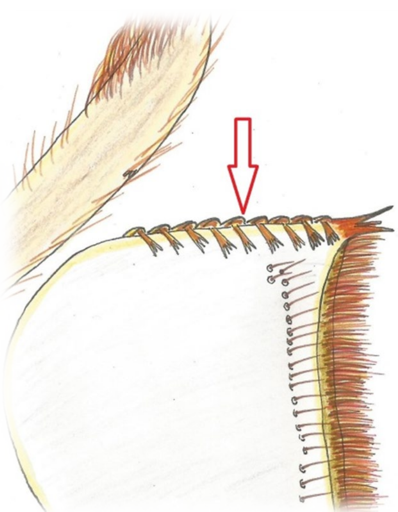
Maxillae

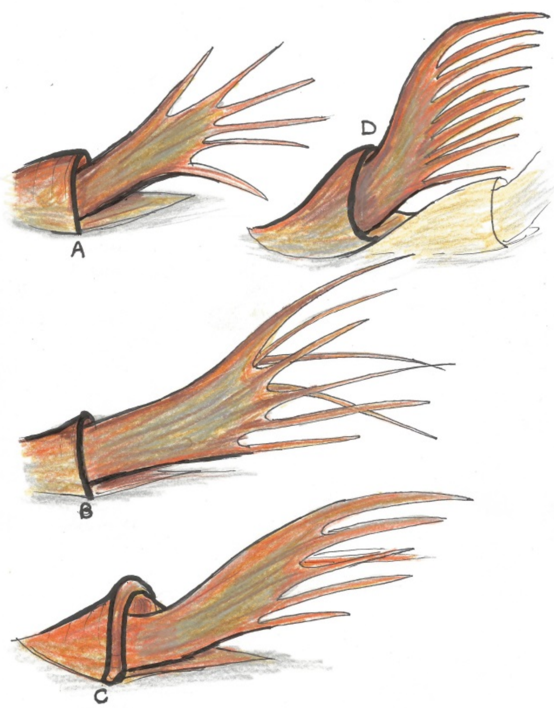
left *mandible* **right *mandible***

Labrum

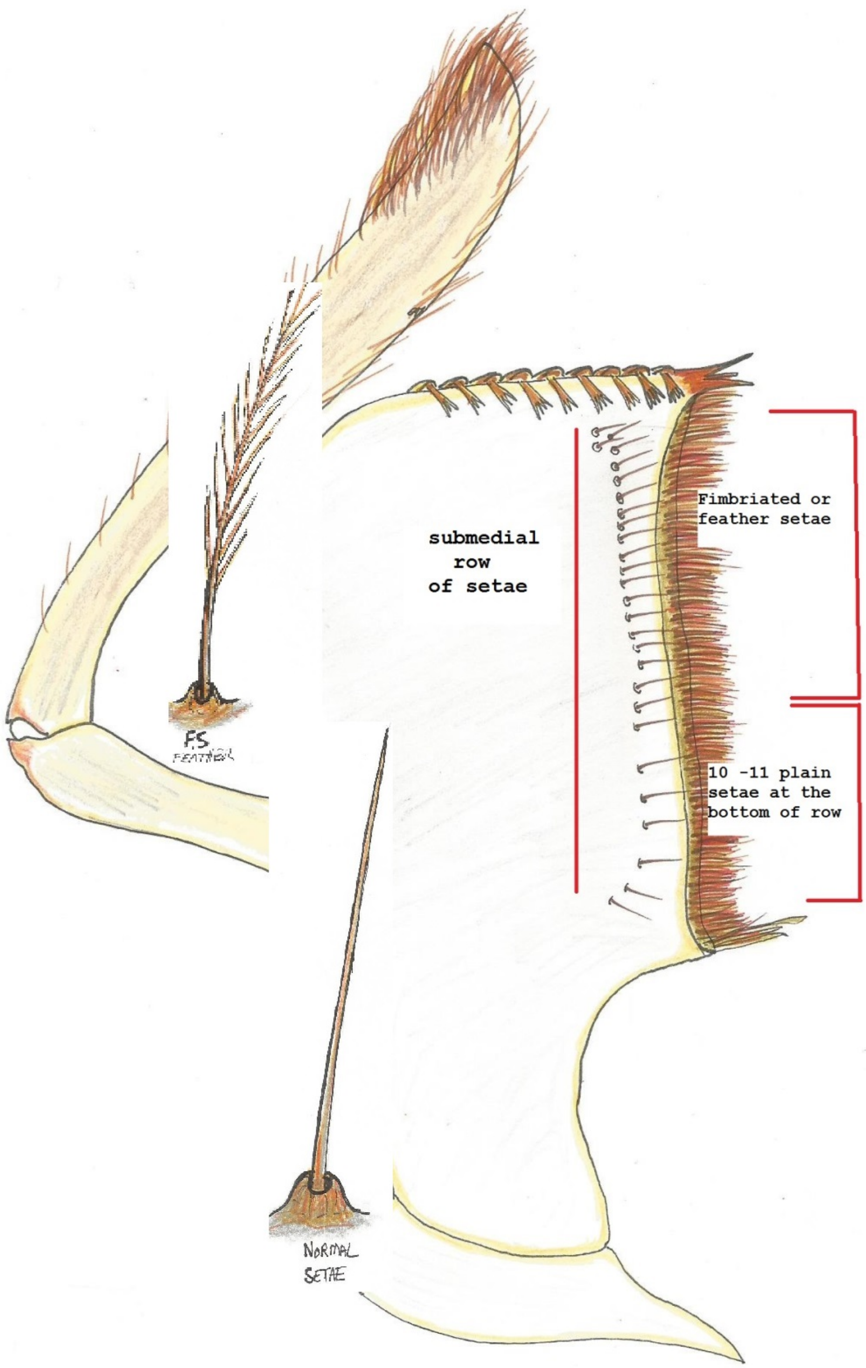


As mentioned in the text on the crown of the maxillae there are pectinate setae combs. Taking a closer look at them on the maxilla illustration the red arrow is pointing to them. In the illustration beside it, there are many types of setae combs used by other Heptageniidae genera. Regarding Stenacron they only utilized style **D** on the chart, and are the ones you will see under dissection.

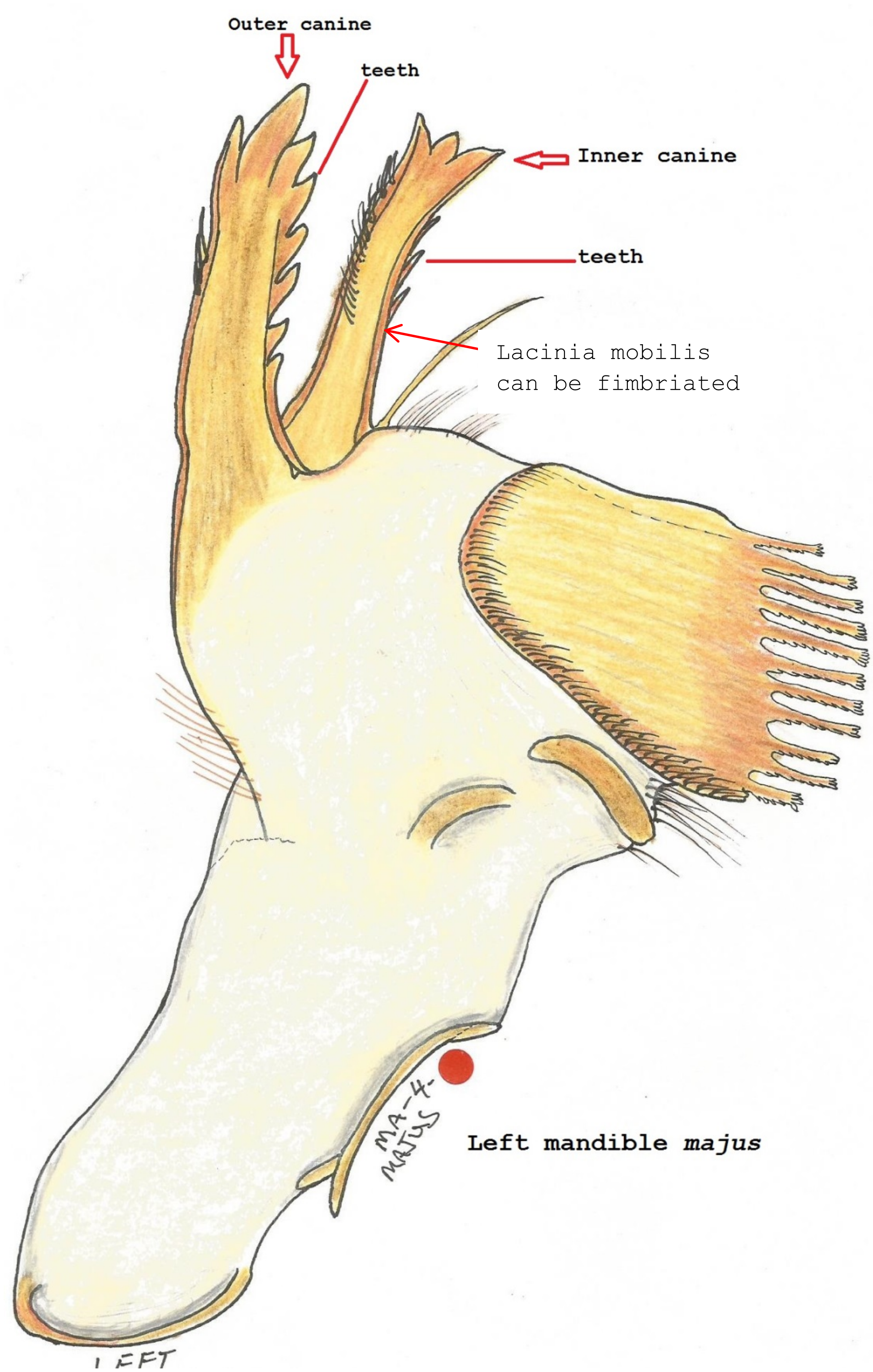




All Stenacron appear to have a submedial row of setae that is divided into 2 distict types. The submeadial row is on the dorsal side of the maxilla in and toward the medial area see below. In this row there are typically 10-11 plain setae at the bottom, the remaining are fibriated or feather looking in nature. See the setae chart for a closer view of them.



Close up of the left mandible from the form *majus* indicating inner and outer canines, and the teeth to count for diagnostics clarification.



Here is a sample from my slide set log book typed as hand written is hard to read. This shows just how much detail was put into the mouthpart studies. See the Leperod larva changed it’s spots for OH-2-RED *ohioense* light type, and OH-3-BLUE *ohioense* dark type.

Stenacron mandible morphology study

1; prominent spines outer side of outer canine
2; tooth count inner side of outer canine
3; prominent spines outer side of inner canine
4; tooth count inner side of inner canine
5; lacinia mobilis fimbriated or with spines **Y/N**
6; setae count lateral edge to joint
7; setae count interior molar edge

form type *ohioense* light / dark variations

LEFT SIDE

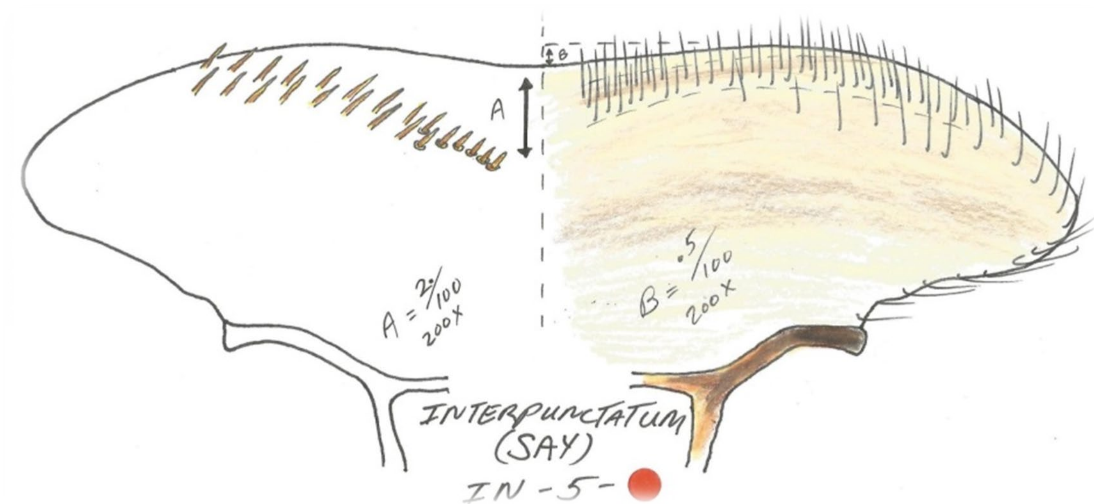
SL-set	dot	1	2	3	4	5	6	7	
OH-2-	●	2	7	1	3	N	30	15	-
OH-3-	●	3	6	1	0	Y	45	25	-

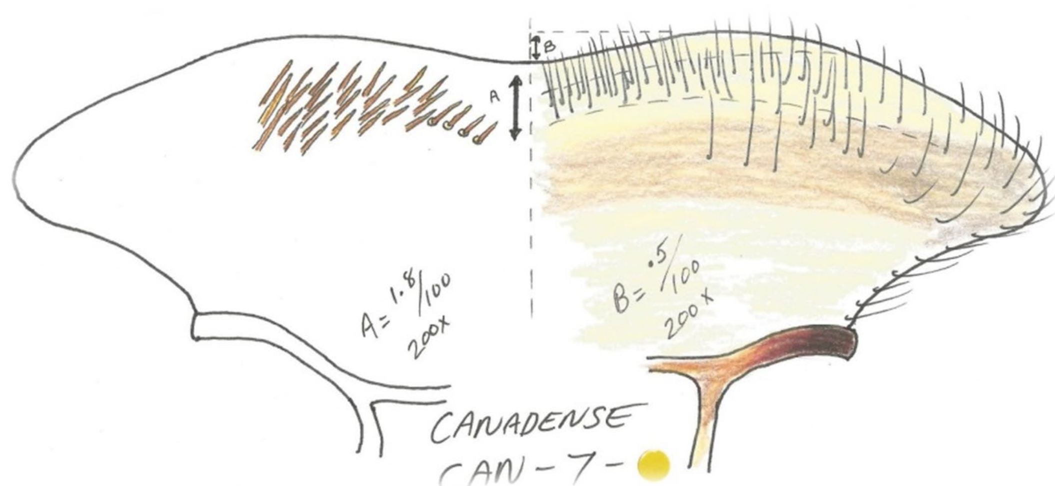
RIGHT SIDE

SL-set	dot	1	2	3	4	5	6	7	
OH-2-	●	1	8	0	4	-	30	12	-
OH-3-	●	1	6	0	0	-	40	22	-

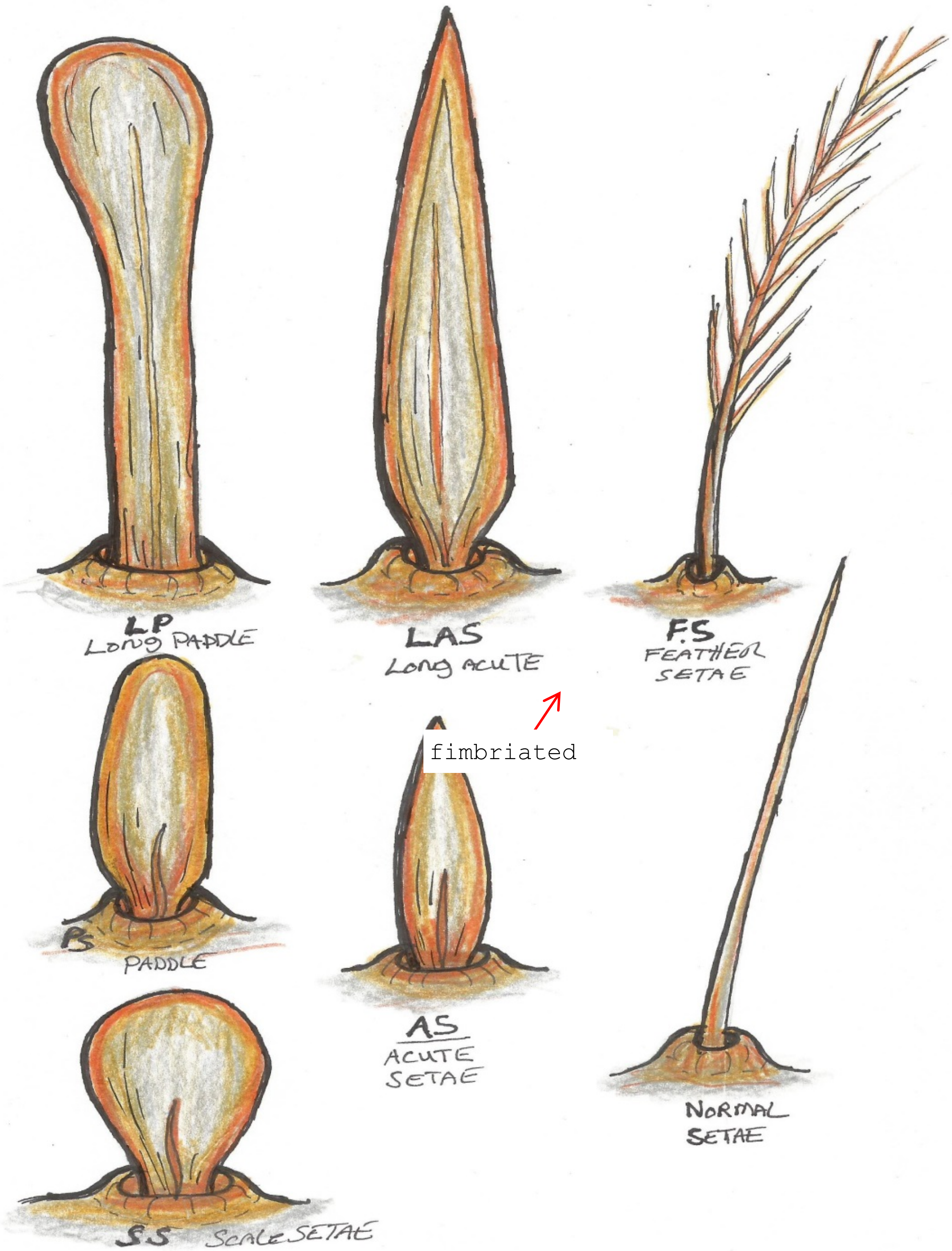
One thing that needs carification is the location of certain mouthparts. The mandile in most everything is the lower jaw, and the maxille are the upper parts of the mouth. In some of the Heptageniidae they are reversed like in Stenacron. Although not in the normal location a maxille is still called the maxilla and same for the mandibles.

We did a very intense study of the labrums of the 11 forms and species in our geographical range. We hope this will inspire someone to bluprint the 6 of the 16 forms in the genus we had no access to like *affine*. We can conclued that every form can be identifed by just the labrum with the usage of measurments on a microscope. Measuremnet **A** is how far the median robust setae is from the frontal margin. Measurment **B** is the depth of the indenture of the forward margin. All forms have slight variation in the overall frontal margin shape. All illustarted match in all aspects to it's specific form or species. Althought *canadense* and true *interpunctatum* Say are very similar there is little question that the labrums are very distinct from each other just by the configuration in the robust setae, *canadnse* doesn't even come to the frontal margin.





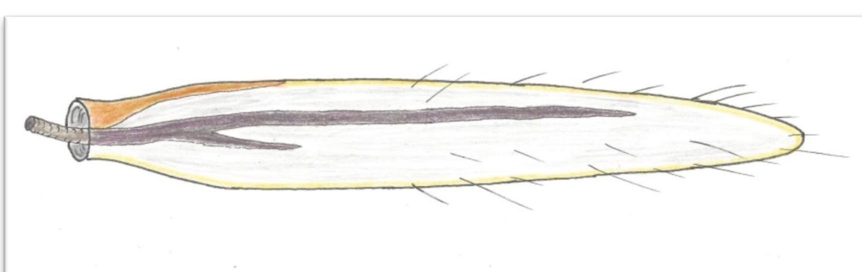
Now with the mouthparts complete we will look at basic body setae styles. On the following chart not every style on this chart is utilized by Stenacron. The one mark (“**SS**”= **scale setae**) is the only one Stenacron does not utilize. All the others are found throughout the body from the labrum to the tail spines. The ones marked (LAS & AS) are more commonly called robust setae in most of the modern manuals.



The most important genus key to Stenacron larva is the gills on the sides of the abdomen. Stenacron are characterized as having gills that have a submarginal anal rib and are pointed at the apex on gills 1-6. Gill 7 is thread like with fine setae and typically having a single trachea. Here is an illustration of what gills 1-6 look like up close. The submarginal anal rib is the part that has a general color of orangey-amber. This rib is also present on the 7th gill as seen in the illustration below. All Stenacron we have viewed the 7th gill has fine setae hairs on them in the posterior areas but are not considered fringed.

Gills 1-6

Gill 7



Gills and respiration

The tracheation and respiration system is truly befuddling. It is also very difficult to map out things that are hard to see. In the larva of true *interpunctatum* Say this system is reasonably visible because they are so pale. However we do agree with Dr Needham 1935 with the usage of a freshly molted larva. When the larva is creamy the dark gray trachea stands out more than normal. The biggest problem we had was the time frame to illustrate the internal anatomy.

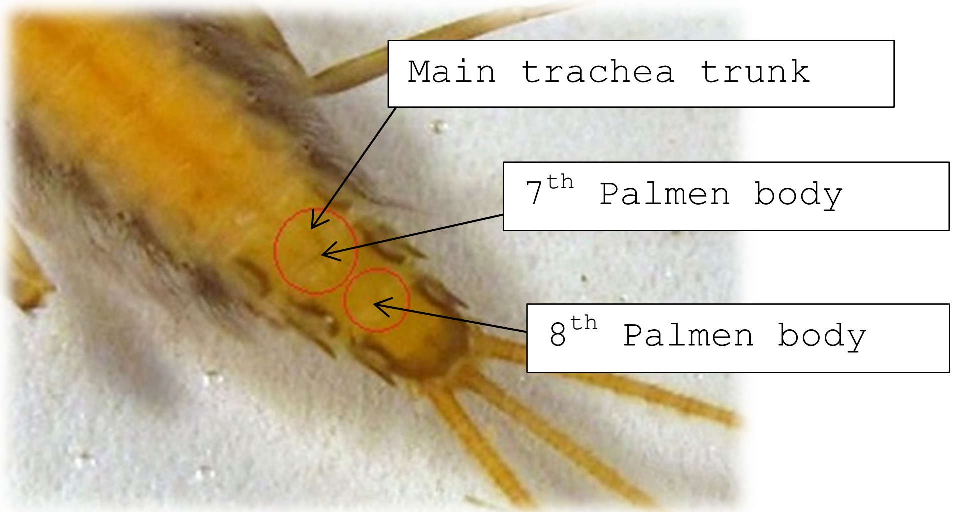
All Stenacron in captivity seem the molt between 4-6 am so by 10 am the maculation process is underway making it all that much more difficult. If we killed the larva the maculation process was stopped but so was the movement of air in the internal system. So what needed to happen was we observed them while living and made notes then composed an illustration that represents to the best of our ability what we saw as a composition.

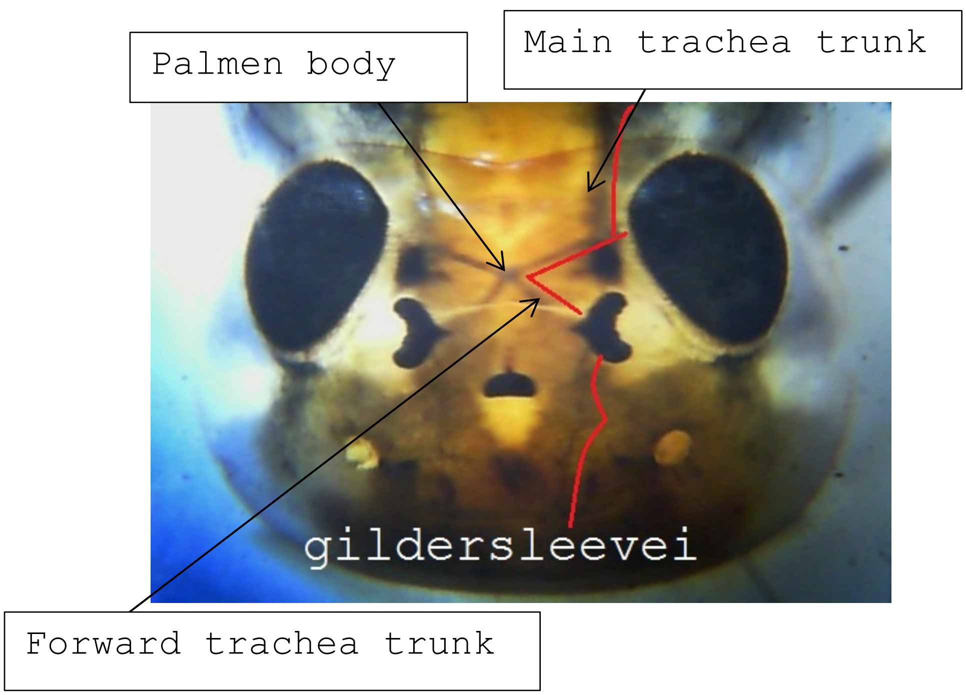
Some parts were very difficult to see as they lay deep in the middle of the thorax. Some parts are under the pronotum and the side of the head capsule. The one area where trachea tubes are very visible is in the rear of femora. We conducted an experiment several times to see what happened and the result was the same. If we removed all the gills from the larva including the 7th gills the larva dies. If we remove all the gills from the right side the larva will live but struggle. This made me ask one question. Why? First as a gill is lost in the natural world the larva grows a replacement at a moderate pace.

We know that both the left and right abdomen trachea trunks are connected together at the posterial area of the 7th and 8th Sternites. The primary trunks are dorsal lateral from the 1st till the posterial area of the 7th. They then grow downwards quickly to the ventral side. At the posterior-ventral-median area there is a palmen body at each sternite. In the next photo there is a ventral photograph of a *heterotarsale* female larva that we have marked with red circles.

They are hard to see but inside each circle is a palmen body. We will place arrows with explanations. All palmen body in the larva is basically considered a heart. There are 3 in each larva

the primary one is in the head capsule; there are two more in the rear ventral areas of the 7th and 8th sternites.

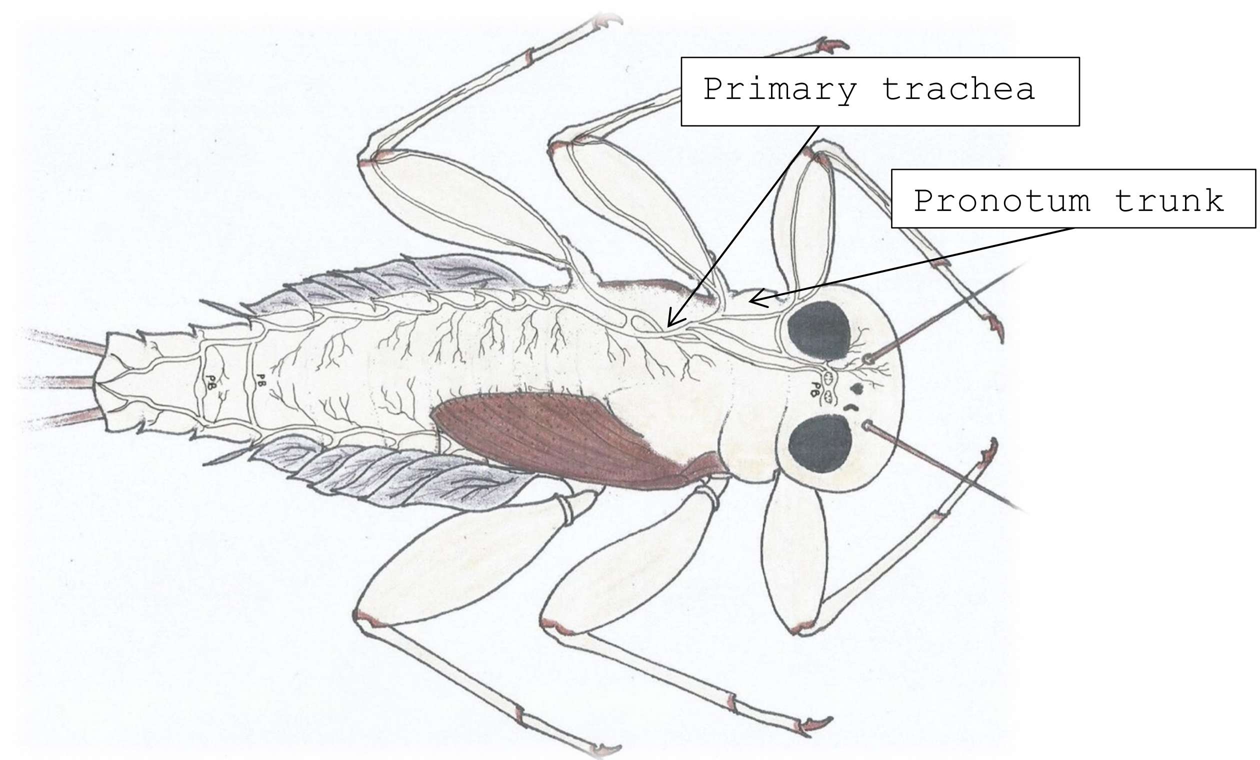




We have created a general illustration of the entire primary trunk system from the 10th segment to forward area of the palmen body in the head capsule. Ironically in the head the palmen body and forward trachea trunks reside right under the cranium suture.

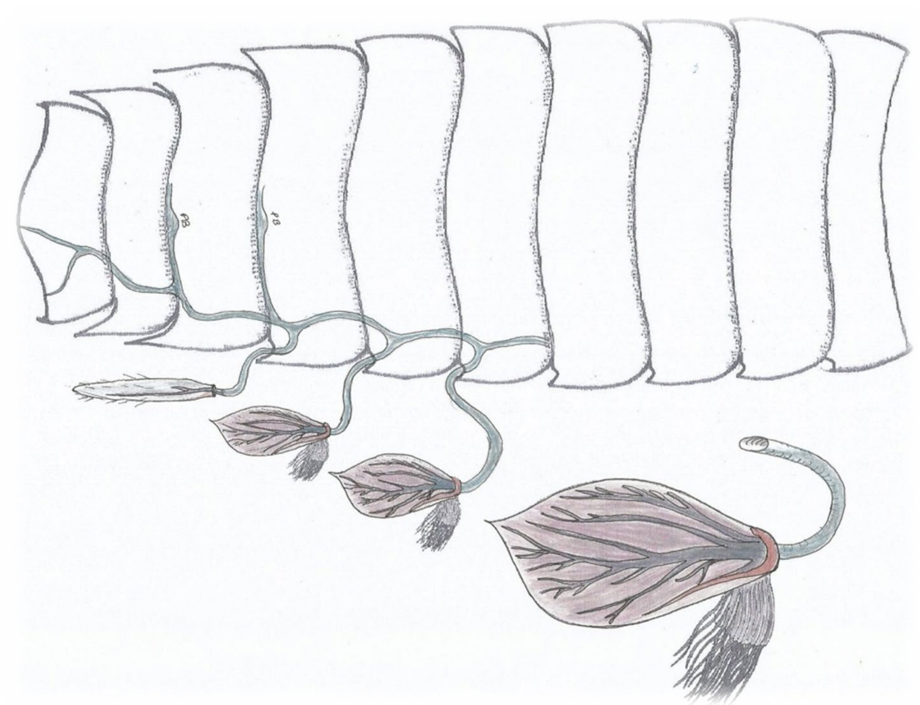
In the following full body illustration the trachea we made the palmen body much larger than it is in real life so you can get a better view of it. Marked by an arrow is the primary trachea trunk that can be seen in the head shot of *gildersleevei*. The

other one we call the pronotum trunk as it resides under the pronotum area and feeds the forward legs from under the head capsule, while connected to the primary trunk. If you have never seen nor own The Biology of a Mayfly you would not get to see this that is part of the reason in attempting to show the internal workings of the larva.



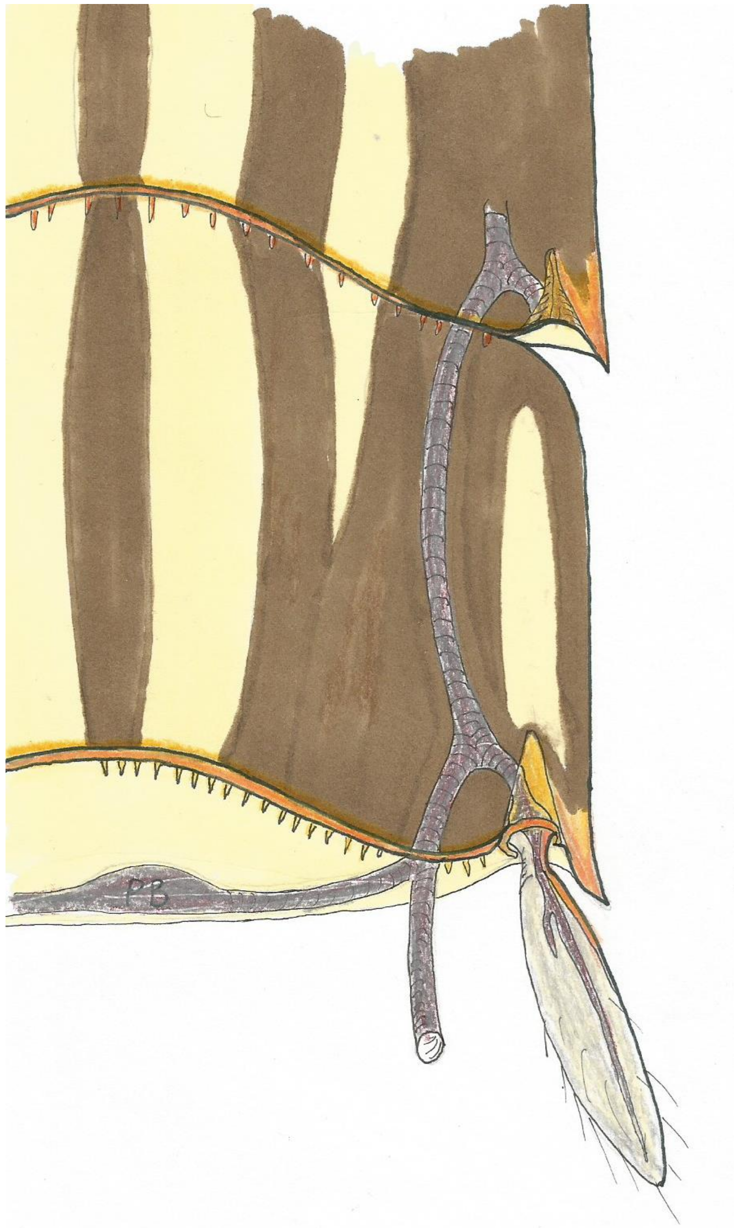
This gives you the general concept of the breathing and tracheation system, and how it is basically configured according SHU 1935. In the next illustration is an exploded view if the system in the abdomen.

If you could pull a gill away from the abdomen without the gill breaking off this is what you would see. The idea is to show how the gills are attached to the trachea tubes. At the dorsal-lateral area of each lateral projection there is a small elevated ∩ shaped indenture on the dorsal side that the gill is formed out of called spiracle duct.



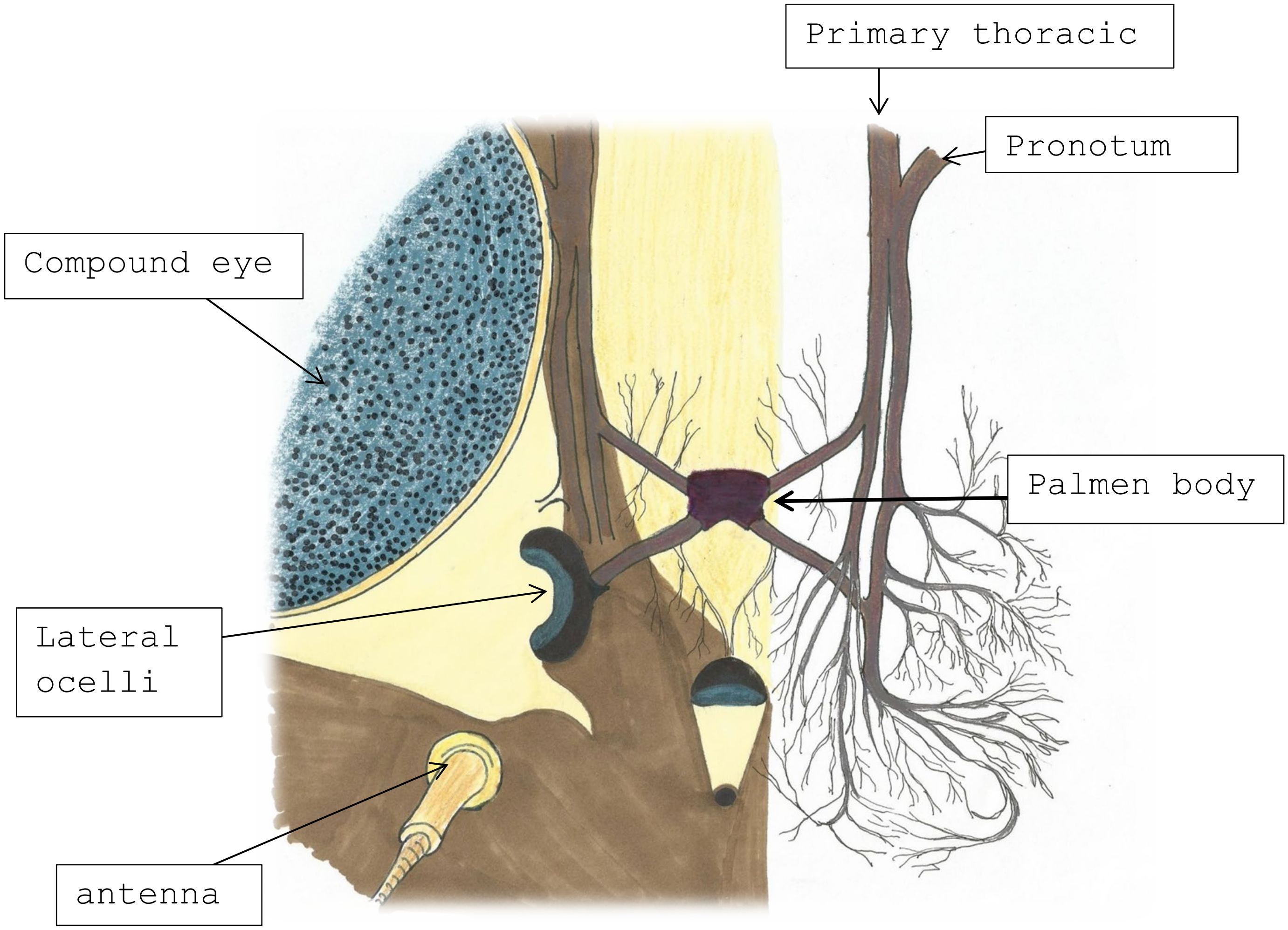
On the next page is a relatively 3D model of the abdomen from the 7th tergite. The view point is dorsal but looking forward and up the abdomen. It is an actual cross section and it gives a clear view of how the 7th gill is attached to the primary abdominal trachea trunk.

The spiracle duct is amber in color as it is part of the lateral projection. This also shows you that the ventral side of the larva is very flat other than where the underbelly meets the lateral projection. It is also very evident that from a dorsal view Stenacron abdomens are highly elevated in the median area and not flat like others in the Heptageniidae family. The palmen body we made very large so its location is easily seen.



Moving to the head now let’s look at the trachea system in the head. First what you are about to see it based on a female *gildersleevei* larva that was filmed on video and later dissected and put on slides.

We studied from Hsu 1932, 1935, Wodesedalek 1912 *interpunctatum* Say. The illustration is a section of the center of the head capsule showing part of one compound eye, lateral ocelli, median ocelli, antenna, and the entire tracheation system including the palmen body so easily seen in the head shot below of the female illustrated from.



So now comes my question and we have not found a clear answer to it. We know that a gill can come off and regrow. We know we can remove many gills and the larva will live, and we know if we take of all gills the larva die.

With that said and what we have seen in dissection we believe there is a (one way valve) like a venous valve in the human body

to stop reverse flow. It must be at the actual connection point where the gill connects to the trachea trunk. The distance from the gill connection point to the **Y** in the trunk is about .5 mm. We have never seen a valve at the **Y** in the trunk. What we are saying is when we remove gills the tube valve closes to stop the intake of water also meaning the system is enclosed and under pressure. So when we remove all the gills did the larva drown or did it suffocate by not having any gills to separate the oxygen molecules.

It is an interesting question. To me it seems more reasonable to conclude our valve theory or the larva would drown losing any gills. While on this topic just how are the oxygen molecules taken in. Here is what we have seen in observations of many Ephemeroptera not just Heptageniidae. The flat gill plates are actually hollow. There are two layers that trap the internal trachea. First gills 1-6 are basically the same but range in size and look like this illustration below. The gills actually have to different functioning trachea systems. There is the trachea that is inside the main flat part in between the two layers.

Then there is the fimbriated gills section, or hairy looking ones on the bottom with trachea inside. When against the abdomen the gill plate covers over the very fragile fimbriated trachea as this is on the ventral side of the gill plate. We on many occasions have viewed the gills as inflated like a balloon. One document we read showed on an electron microscope scan that the lamella or gill plates are in fact covered with tiny and very microscopic setae hairs that are typically short and curled over. This clearly suggests they are there to separate the oxygen molecule from the hydrogen molecules.

The lamella layers are bound together at the outside seems all around the gill except for the connection area to the trachea. This acts like a sack or bag and are commonly semi inflated with air. I have actually seen air bubbles trapped inside a gill bag. From what we understand the lamella is a permeable membrane that oxygen can pass through to the primary trachea between the lamella plates. It is therefore a reasonable deduction that part of the oxygen intake is by this method. However Eastham 1937 suggest that the lamellas are there to pump oxygen over the fimbriated gills which we agree makes sense. Why protect something that is of no use, they must draw oxygen to.

Now comes an even bigger question. What happens to the argon and CO_2 gasses created by breathing? In most living things the respiratory system is a principally a closed system other than the point of intake and exhaust. So where does the waste go? Maybe it is disposed out through the fimbriated trachea?

Now that can’t work either or it would interfere with and alter the intake of the lamella plates. We have spent 100’s of hours watching the larva and have never seen them produce even one exhaust bubble. So where do the gasses go, or does this now pose another huge question. Does the larva somehow recycle the gases as part of the excretion process?

One think is clear from Wodsedalek 1911 *interpunctatum* nymphs are very phototaxis when CO_2 is intermixed into the water, they flee with distress. This to me clearly states the exhaust of argon and CO_2 cannot be near the gills or they would be highly reactive to it and morphologically it makes no sense.

With this question we have read though the following to try to locate an answer; Marshall 1927, Kluge 1994, 2004, Wodsedalek 1911, 1912 A, B, C, Ide 1935, Hsu 1935, Eastman 1937, Wingfield 1939, Landa 1948, 1969, and Fink 2008. A lot was learned from these papers but no one has a clear answer about the Argon and CO_2 discharge. In recent days we collected a very small 3.5 mm Maccaffertium larva that had just molted that has some interesting features that can help bring a better understanding to the question.

There is one thing very evident in Landa 1948 table 2 figures 2; the trachea system is connected to the entire digestive track. This is also seen in all his figures in both 1948, and 1969. The trachea is also connected to the ganglionic nervous system at the 3 primary divisions in the thorax.

In recent days we have photographed the 7th tergite divisional trachea that connects to the Malpighian tubules and the exoliner of the ileum valve. Looking at the configuration of the trachea **Y** at the each spiracle tergite duct the primary air flow is pointing to the rear area.

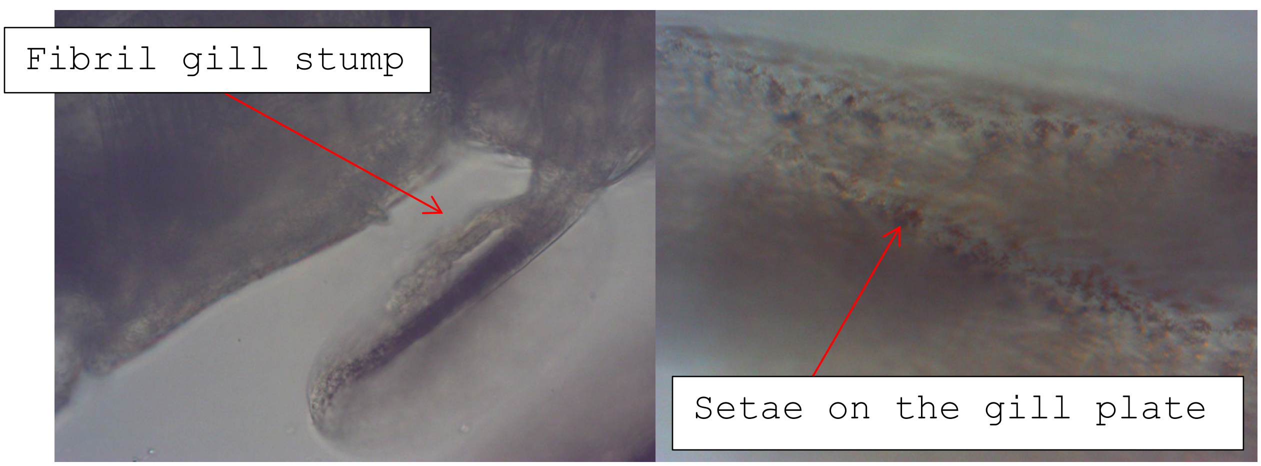
With that said we now believe that the oxygen enters trough the gill plate's heads back to the 2 rear palmen bodies, and from there directly enters the main blood vessel or artery and heads to the primary palmen body in the head for full body distribution. Looking at this photo of the 6th gill connection point this clearly indicates air flow to the rear.

One other interesting thing is unlike an animal there is no visible micro arterial or venial system. There is one primary trachea trunk system, and one primary artery system. This is highly suggestive of reabsorption of waste back into the body as there is no point of discharge other than the anus.

Moving over to the gills for a minute this every young Maccaffertium collected also states one evident thing. The fibrilliform parts of the gills are not the primary of the intake system the gill plates are.

How can that statement be made? Simple in this 3.5 mm sample that was alive there are no fibrilliform trachea present see below photo. There is a very minor branch or root on some gills in the developmental state but not enough to generate the oxygen needed for life see first picture dorsal view of 5th gill.

We were also able to some degree photograph the very fine setae covering the dorsal side of the lamella plate or top of the plate in the second photo @ 1200X. It is not very clear so an illustration is also made to indicate these very fine curled setae hairs we saw in a document.



So far as it stands Stenacron, Ephemerella, Maccaffertium, Stenonema, Paraleptophlebia all have an elliptical breakaway joint where the gill connects to the trachea. It is commonly amber and often connected to the anal rib.

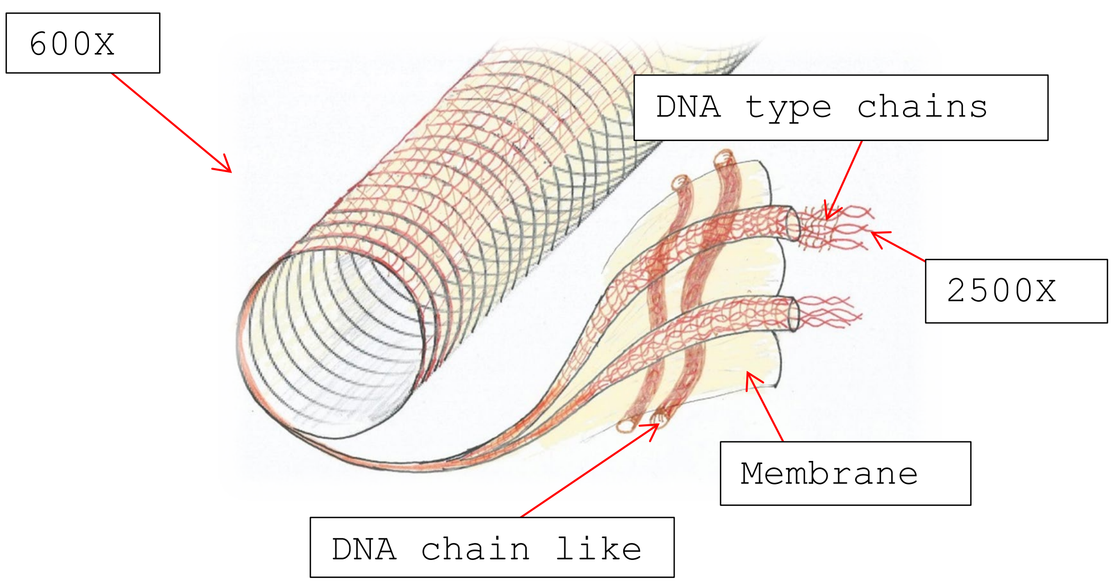
As the trachea extends from the **Y** in the trunk heading for the gills it flattens out a bit and becomes elliptical in shape in the entire genus above.

This cuticle connection point is also bulbous. The trachea tubes themselves are in fact coiled strands that are in pairs with a membrane connecting them as they form a long slinky like tube.

Actually these strings are more link DNA chains that intertwined in the artery wall exoliner there are 3 or more chains that make up one line in the coil see illustrations and photographs.

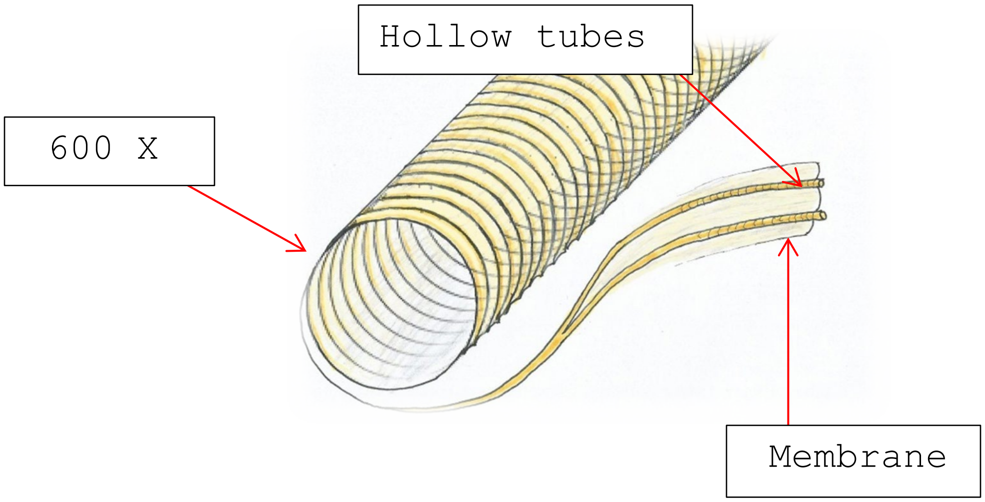
The illustration below is a view of the exoliner of the artery showing the chain like strains that are coiled to form a tube. They also have crossbanding patterns that are longitudinal forming a matrix fabric like membrane.

Artery exoliner



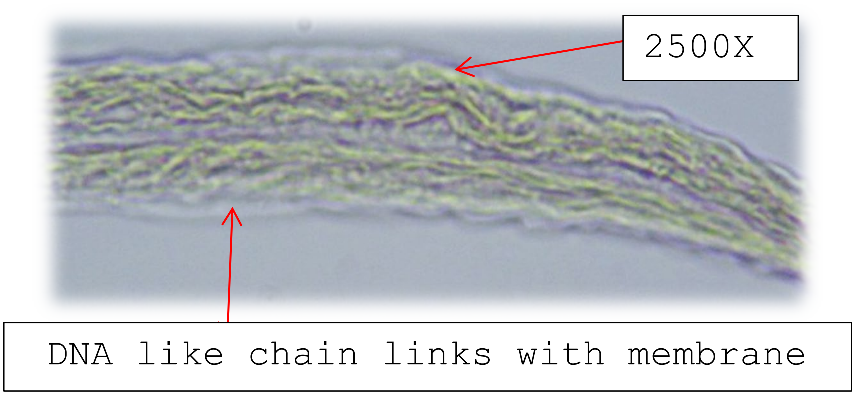
In the trachea the pair of strands are more like the complete trachea tubes. They seem to be hollow but bound by a membrane. Then they are bound to each other by the visible membrane that holds the spiral tube together as a long flexible tube for longitudinal flexibility. We have noticed in areas in the thorax the tubes are reinforced at the unions with longitudinal cross members appearing similar to the artery exoliner seen above with a slight amber color.

Trachea tube;



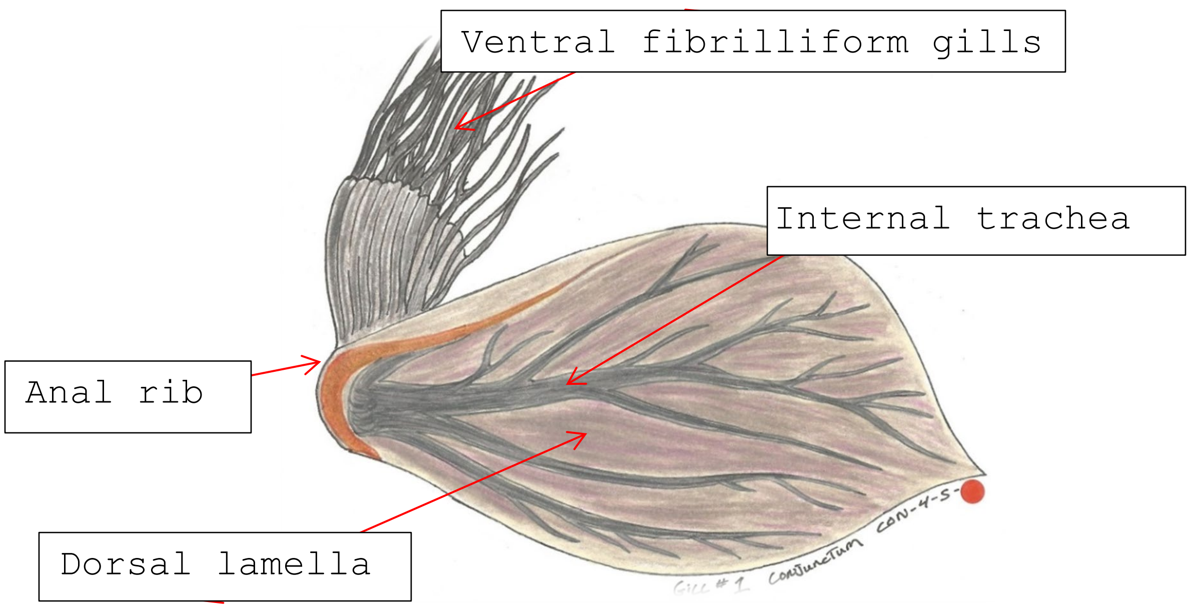
When we look at the tube as a solid psychical element the two tubes together appear to look like only one rib spiraled around covered with a clear film. Microscope objectives can be a bit of a barrier as the field of view and light with a 100X objective X 10X eyepieces it is very hard to clearly see things.

We find it is more effective to use standard 40X or 60X objective and bring the eyepiece strength to 25X or even 30X when viewing fine details. My new 8 Megapixel CCD camera out of the box seems to be preset at about 25X. It is not calibrated and once we calibrate it we may lose the magnification range we have that is allowing us to photograph down to 2500X. When you go down that far you get to see things you just can’t see otherwise. An example is the DNA like strings that makeups each strand of the spiral exoliner.

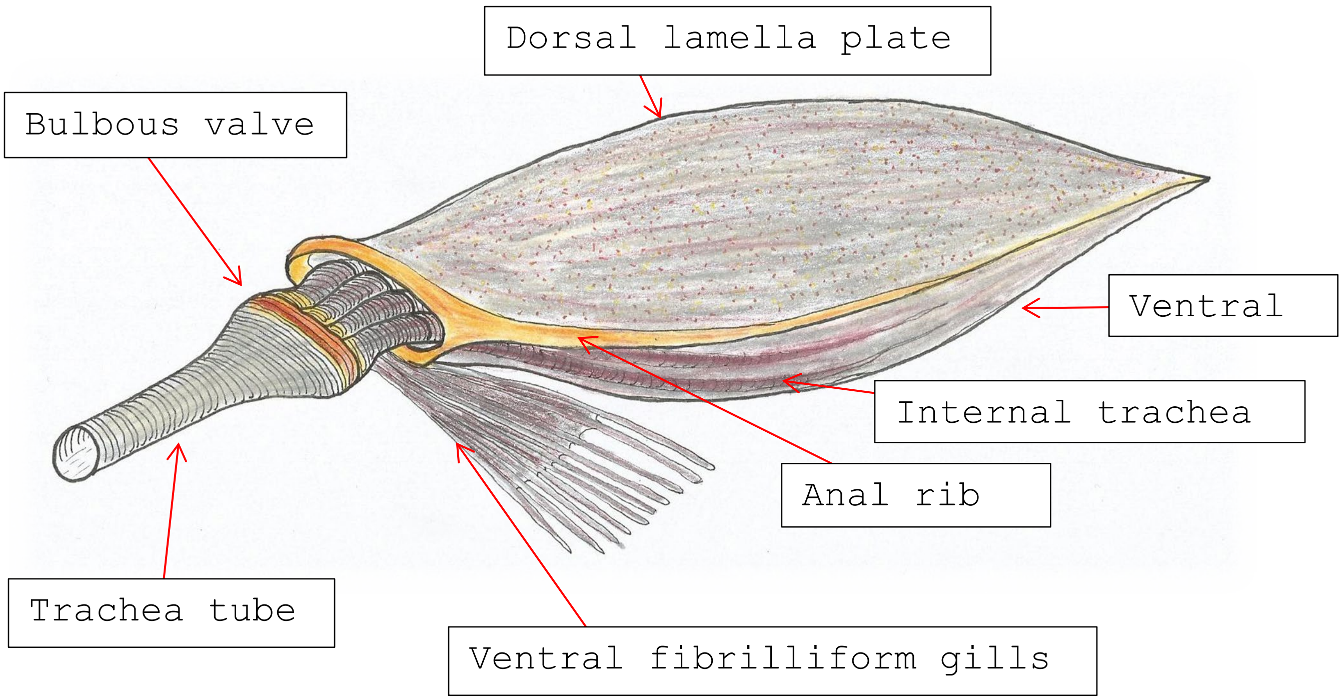


Let's look at the gills now and what we see and just how the gills might actually function. First is a flat illustration of gill # 1 from a Stenacron then a 3D view showing the trachea entering the "gill-bag" two layers with trachea trapped in between the layers?

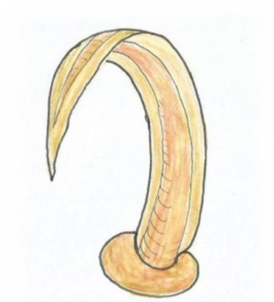
The layers are referred to as lamella. We wish we could relocate that electron microscopic gill scan document so we could cite it. What we have done is illustrate what the scanned image looked like.



Now the same gill except we are inflating it partway between the lamella plates. You will notice that the internal trachea is actually attached to the ventral lamella but on the inside. You will also right way notice that the trachea as it enters the "gill-bag" there is an oval bulbous area that is amber in color and there is a special muscle attached to it. Then the trachea breaks into many primary internal branches.

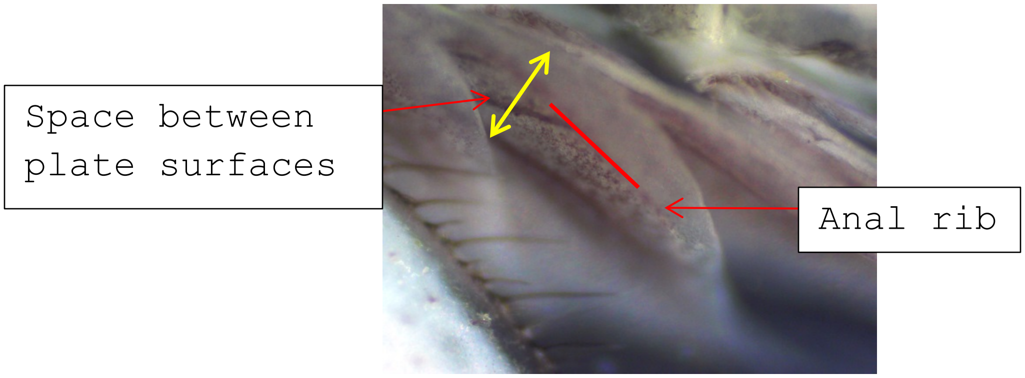


Now let's look closer at the dorsal surface and what we would likely see at about 3000X or more based on the electron scans. First is a look at a small patch of these setae then what a curled setae looks like.

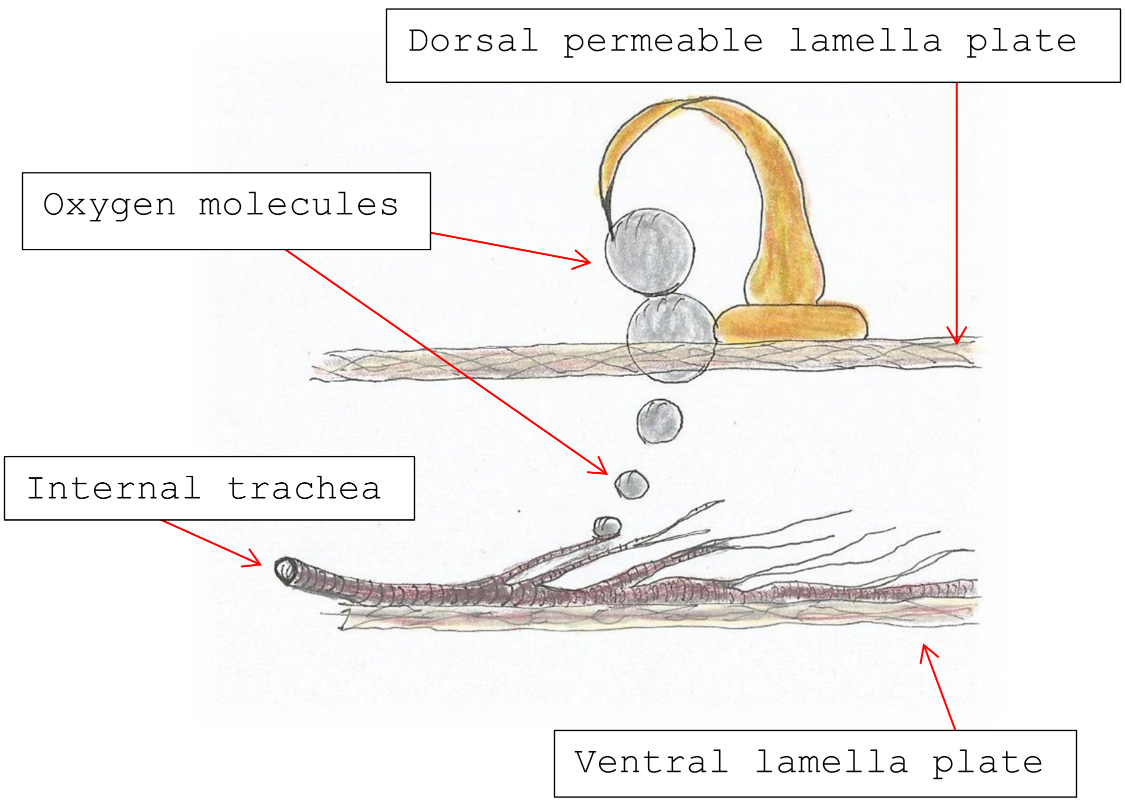


Now we can start to conclude the function and foundation of the gills. First our 3.5 mm Maccaffertium without fibrilliform ventral gills states that they are not the primary source of oxygen or the larva would not survive, and if the fibrilliform trachea were more important they would surely metamorphically develop well before the plate gills.

This next illustration is just how we think it happens. We have many times seen the lamella plates that form a "gill-bag" be partly inflated and with micro bubbles inside. We have also read that the lamella plates are permeable. Here is a photo of gill 5 of a Stenacron larva with the gill-bag inflated while alive.



We now believe that the curved setae attract the oxygen molecules and separate it from the hydrogen. It is looking like they capture them, collect them on the surface and they are broken down to a smaller sizes and drawn through the lamella plate on the dorsal side to the internal trachea.

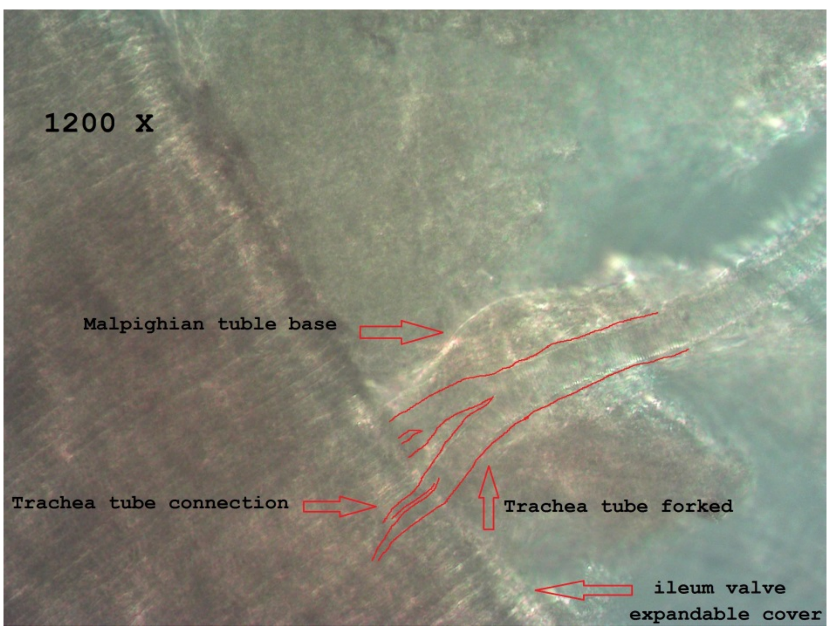


This is looking like a very plausible explanation but it still leaves several points that are not explained. First is the question that started this adventure, then there is the exhaust factor of the argon and CO_2. What we now feel is there is a one way valve at the trachea joint at the gill. We are now starting to see that there is a diaphragm plate inside the trachea in the center of the bulbous joint.

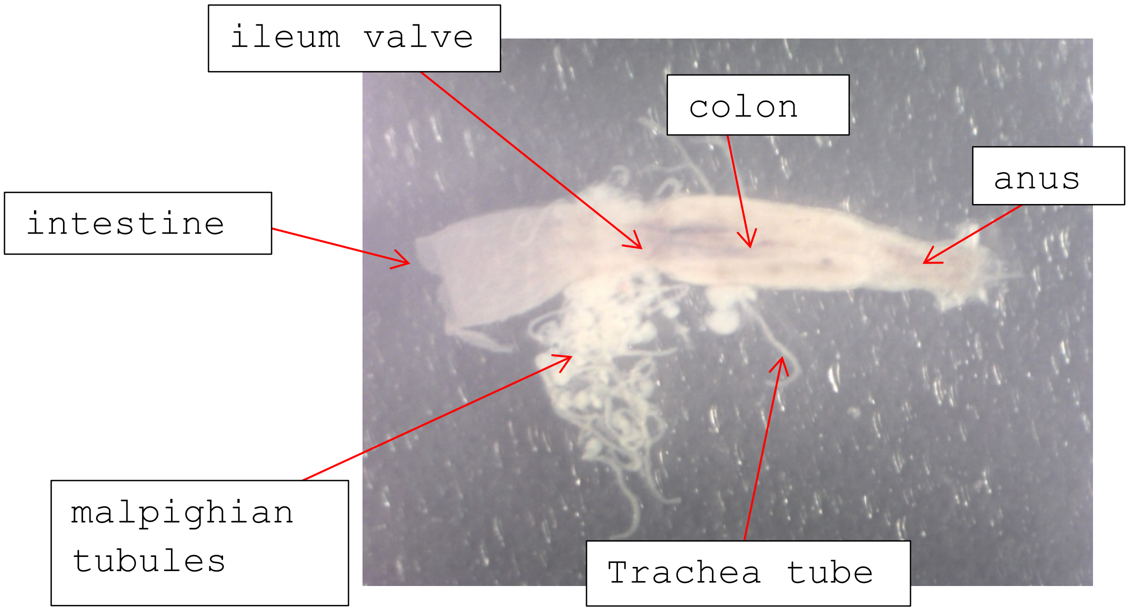
There is also a special muscle in the spiracle duct connected to the bulbous joints. The bulbous joint is also connected to the anal rib cuticle via muscles. Therefore we are concluding that when a gill breaks off the elliptical bulbous joint with internal diaphragm collapses in on itself to seal the end of the tube.

This would instantly blocking water from flooding the tracheation system thus allowing the larva to live and regrow a replacement gill. The other fact to include is the tracheation system is an enclosed system therefore it would have an internal vacuum circulation function. This vacuum would help suck the closure of the elliptical bulbous joint.

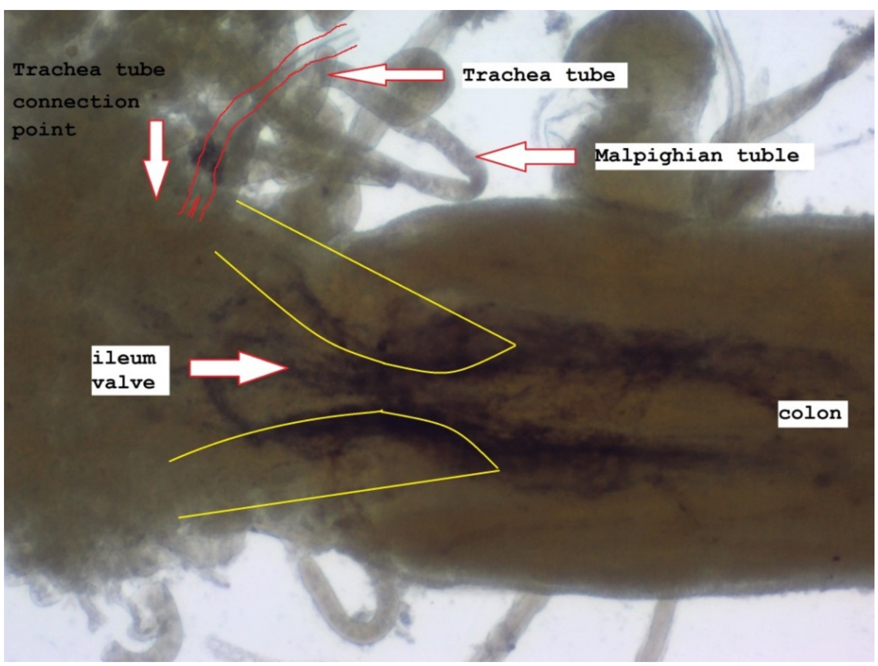
Landa clearly indicates that the tracheation system is completely connected to the intestinal track from the entry point of the esophagus to the anus track. There is also many trachea forks that connect to Malpighian tubules which are part of the excretionary process this is evident in Marshall 1927. Here is a photo we took of the connection points of the trachea to the exoliner of the ileum valve and the Malpighian tubules.



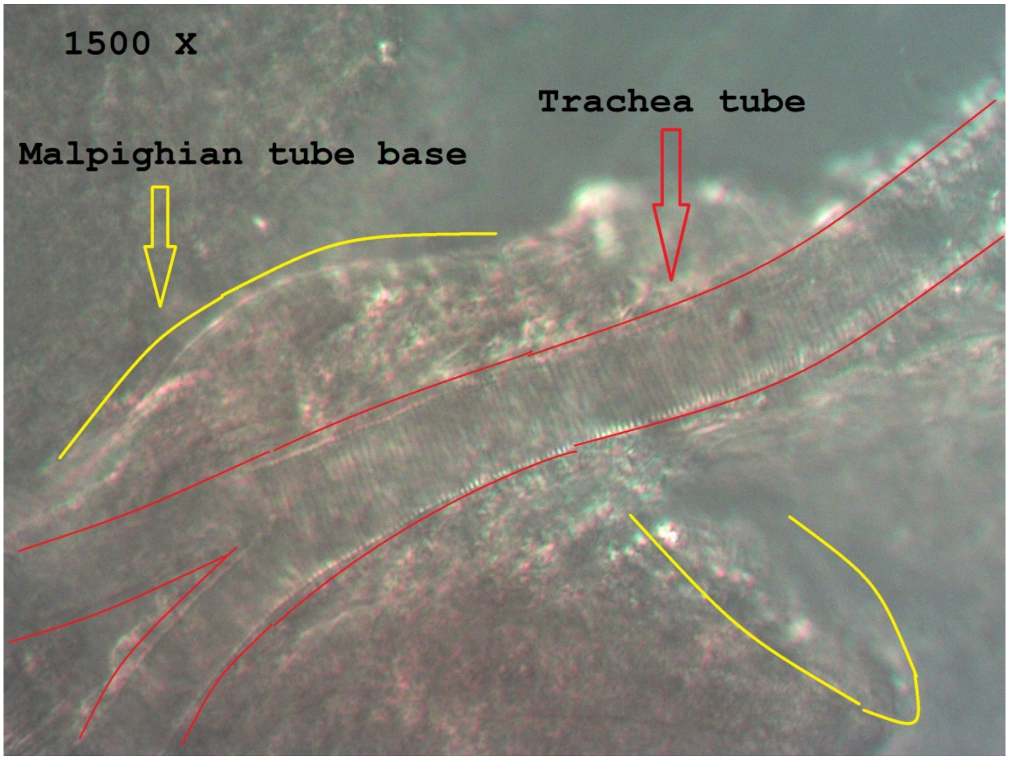
Now to get a better understanding of this photo we need to start out looking at what you are seeing farther away than zoomed in. The first photo below is the end of the stomach coming into the ileum valve then becoming the colon.

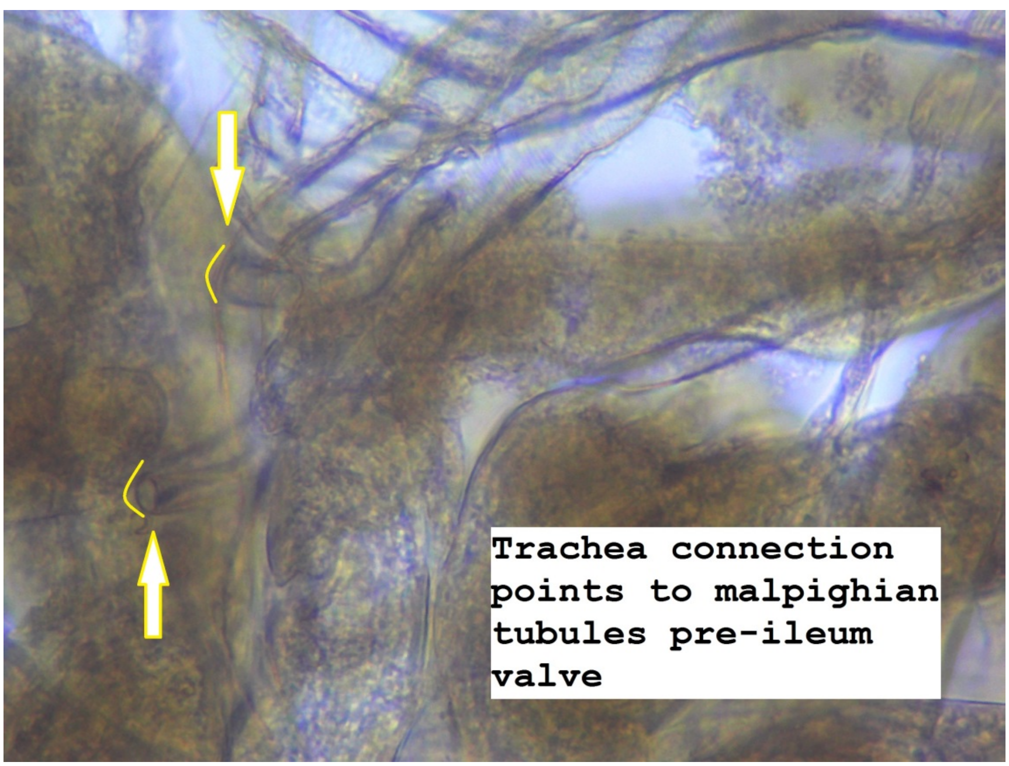


Now let's look inside the ileum valve to see just how it pushes digested elements into the colon as a one way valve. There is also a valve like this called the esophageal valve at the frontal of the esophagus.



Now here is a photo of the trachea connecting to the malpighian tubules and where they connect to the ileum valve exoliner. The trachea connects but can also pass right through the base as seen in the photo.

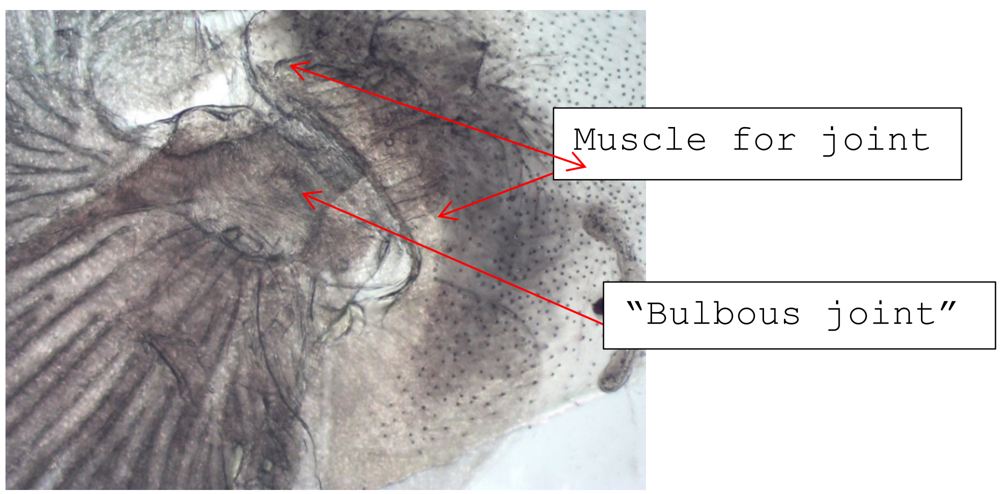

1500 X
Trachea tube
Malpighian tube base

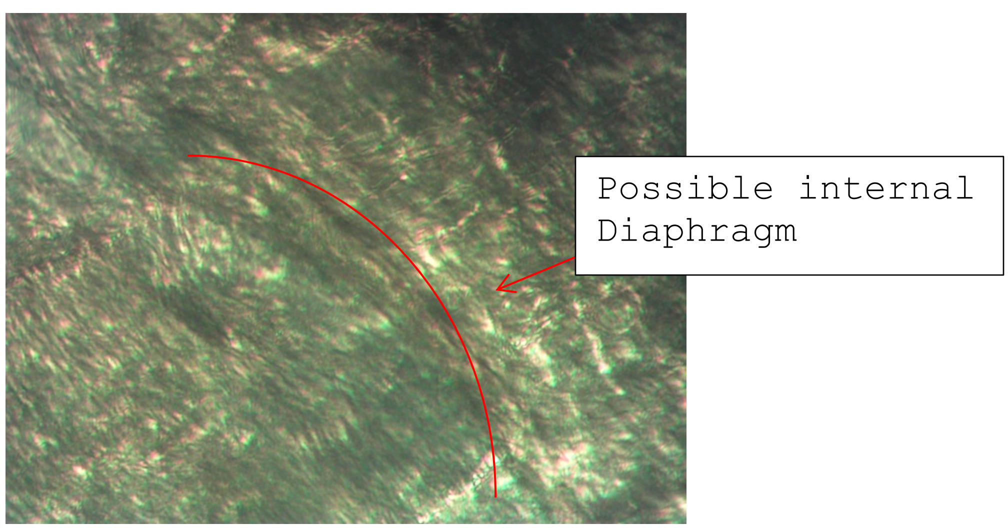

Trachea connection
points to malpighian
tubules pre-ileum
valve

With Landa and what we see here the most logical conclusion is in the forward or thoracic area the oxygen is likely used from the connection points from the esophagus to the rear intestine area as part of the digestion process.

From the ileum valve to the anus we now believe that the argon and CO_2 are reabsorbed into the digestion track and aid in the clearing of the excretion process there by not interfering with intake at the gills but also aid the dietary process and keeping the tracheation process as an enclosed system.

Before we move on let’s look at what we are calling the “Bulbous joint” at the attachment of the gill of a Maccaffertium and what might be the diaphragm inside.

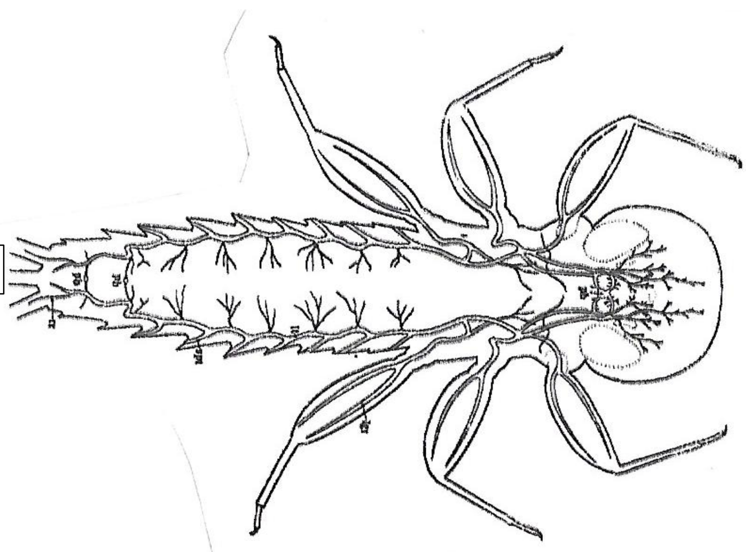




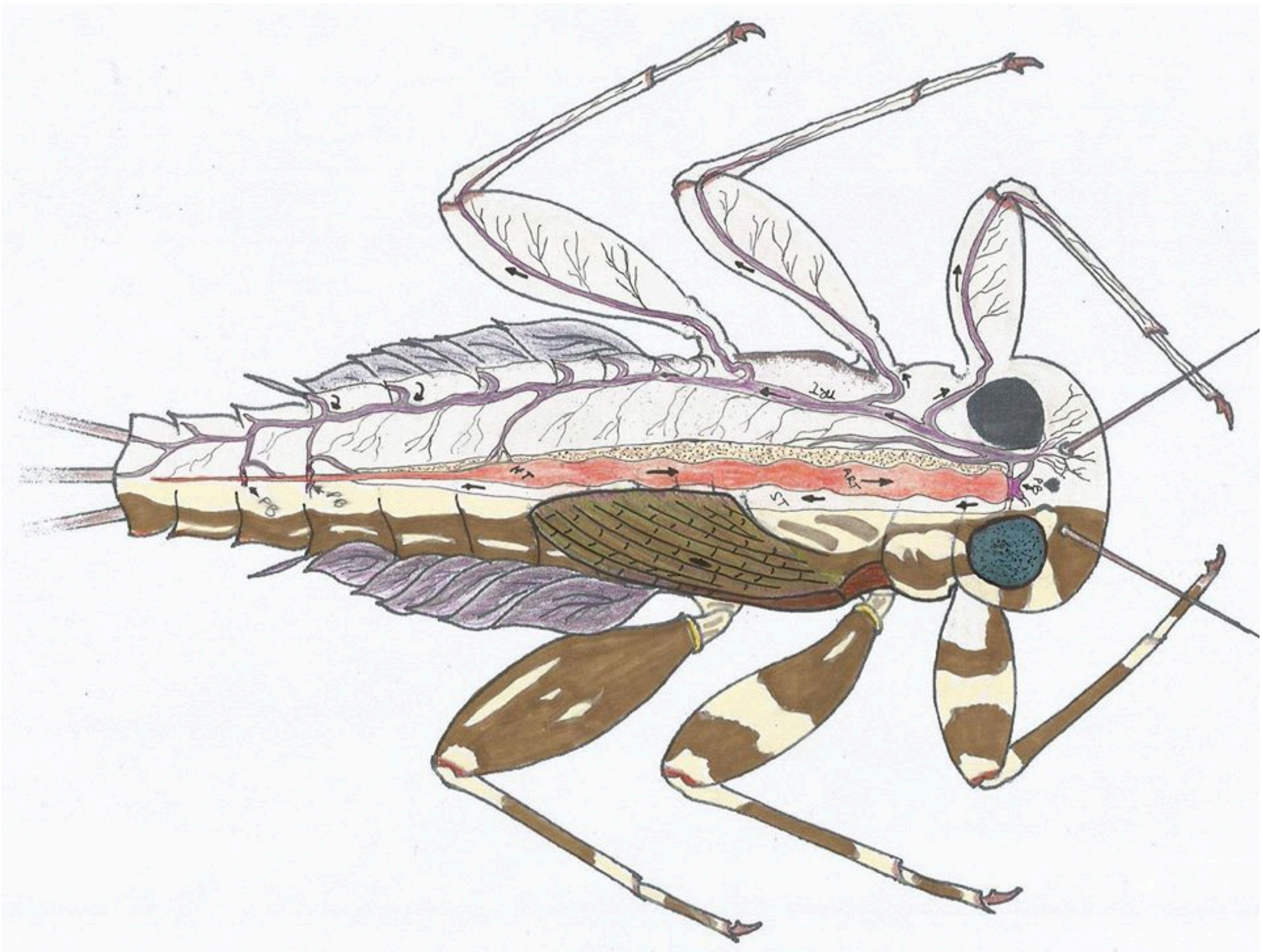
As we progress with technology and with more advanced study comes more questions, more answers, and clarity of past work on internal anatomy. In recent days we have learned that the illustration by Hsu 1935 in The Biology of Mayflies is in fact not just the genus. Stenonema in general it was actually based on an interpunctatum Say, making it an illustration representing a Stenacron larva, figure 1 plate VII page 39 for the trachea system. Our current anatomy studies now indicate that this illustration was likely more broad as it does not properly reflect the genus Stenacron actually; it is closer to Maccaffertium.

The first problem was any easy error made by YIN-CHI-SHU 1932 and then 1935 or shall we say miss interpretation as there is no primary trachea in the anterior area of each femur as he illustrated. The other is the primary thoracic trunk. Here is his illustration from his 1932 paper figure 1

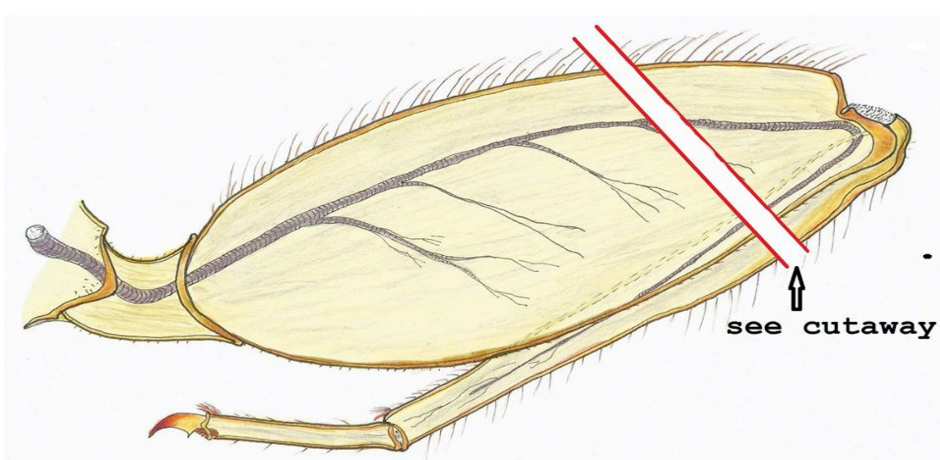
1

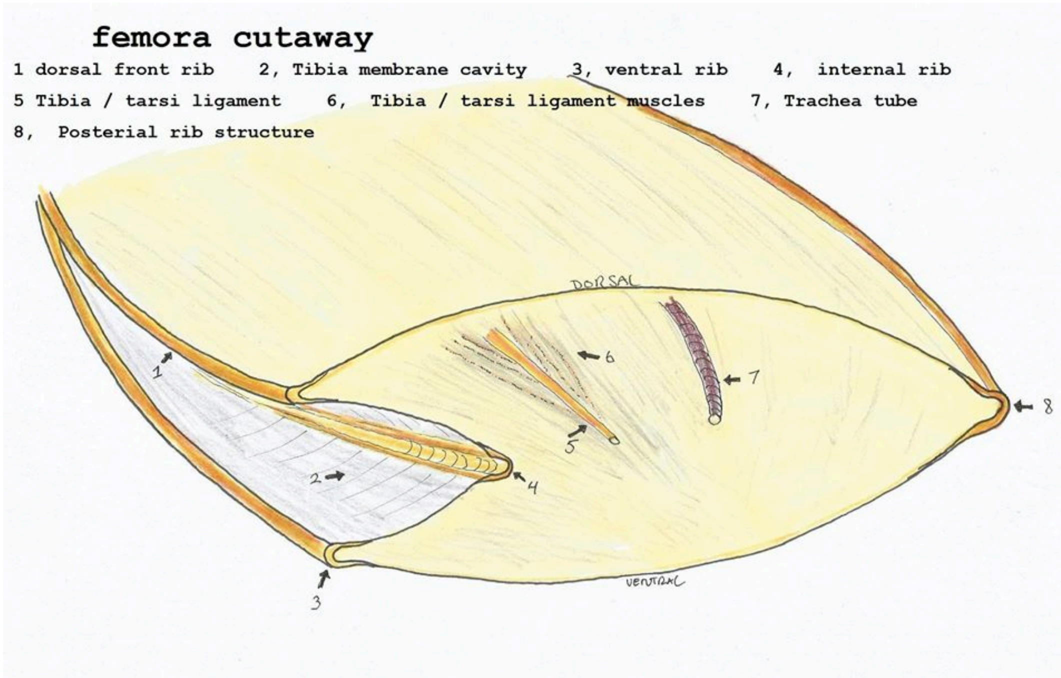


We have not yet viewed a Stenonema femoratum to clarify but as it stands this multi part trachea system illustrated in the thorax are not correct. All Stenacron and Maccaffertium have a large single tube that travel very near the primary artery from the first tergite to the palmen division into the head capsule. The other problem with his illustration is the location of the fore femora. In Stenacron they come out from under the head capsule making trachea more difficult to see. All Stenacron the fore coxa is located at the anterior area of the pronotum making the median area of the femora appearing to come out from just behind the compound eye. Now here is our illustration.



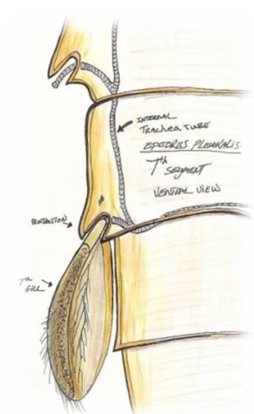
Now the next problem he illustrated in the femora a in and out of the trachea system and that too is not the case. That makes it appear like the air/blood/protein mix goes in and the waste is returned. We have solved this misunderstanding there is a channel in front of the femora where the tibia can rest as seen in our next illustration.

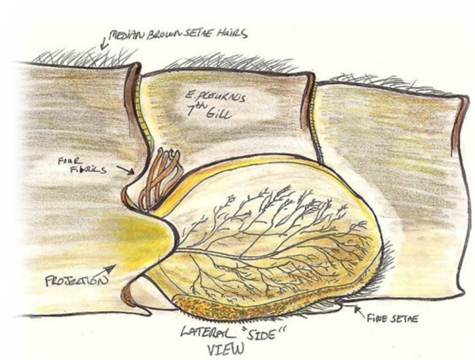




This explains his simple error but also adds to our hypothesis of reabsorption. So these femora drawings with removing SHU illustration that the trachea in all appendages is to aid in the growth that eventually makes all internal mussels so large they eventually molt. Now another possibility in the evacuation process is that the of gasses might become a silky membrane barer to help the new stage emerge with ease.

The next area to cover is the lateral projections and how they relate to the protection of the gills. Years back I was studying Epeorus *plueralis* larva a noticed that the projection is much more than a sharp spike in fact depending on the view it was not sharp at all. It is in fact a flat shield with a rounded end. The following two E *plueralis* illustrations clarify the value of the projection.

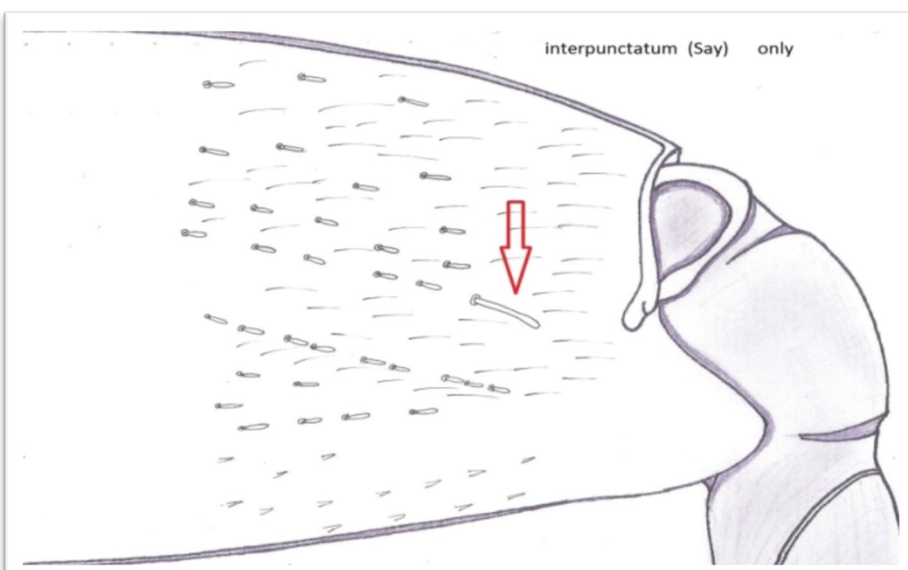




Here we clearly seeing what looks very sharp from the ventral view are in fact a rounded plate. On the subject of lateral projections the first document we know of that teaches the method of classification of lateral projections is Bednarik and McCafferty 1979 Biosystematics Revisions of the Genus Stenonema. On page 3 they clarify how to measure to insure that your projection qualifies to be a projection. This system is excellent but not of any concern regarding Stenacron. All Stenacron in the genus only have two lateral projections that meet the scientific criteria. These are the 8th and the 9th. If you are reading older documents you will hear that all Stenacron actually have a projection on all 10 tergites. All of them are minute and undersized for qualification criteria but are still a projection to protect the gills. One thing we have learned is the more questions we ask the more questions we have.

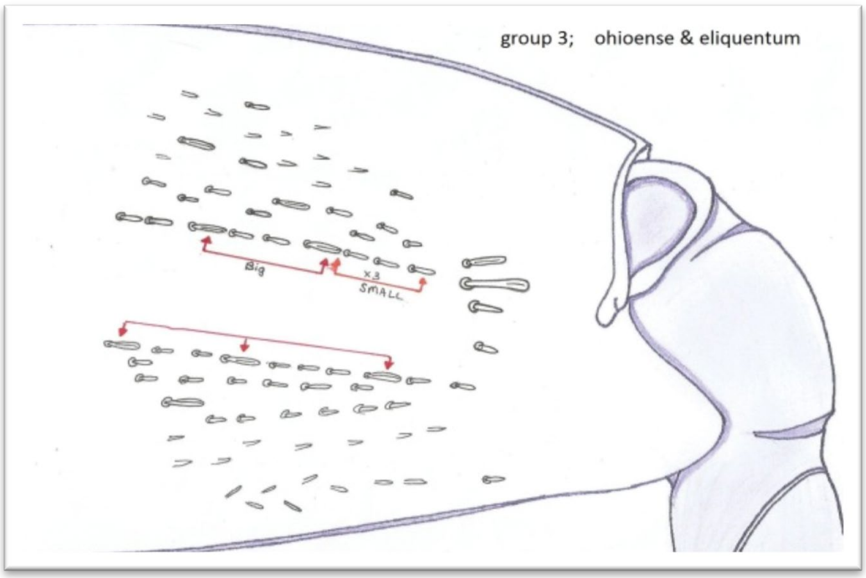
Moving over to other parts of interest. All Stenacron we have observed and mapped out all have the following. In the median-apical-dorsal area of each femur, there are single long paddle setae.

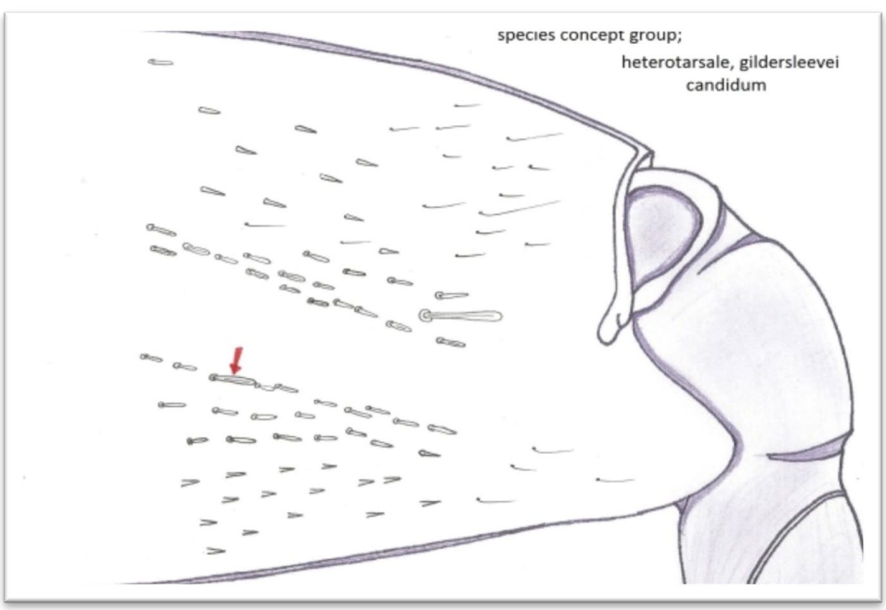
It is often accompanied by other smaller paddle setae on the rear femora, but often singular on the middle and fore femora.



It is still unclear if this is a key to genus and or species. We have mapped out 10 forms out of the 16 in the genus, and all of them have this lone long paddle setae present.

There also are 4 distinct groups having related setae patterns composed of robust and short paddle. On true *interpunctatum* Say this singular setae is never accompanied by other setae.





The distinct groups are; Species concepts, containing all valid species concepts other than true *interpunctatum*: the *canadense* group; the *ohioense* group; and by itself is true to form *interpunctatum* Say.

Interpunctatum / conjunctum middle femora

Interpunctatum / proximum middle femora

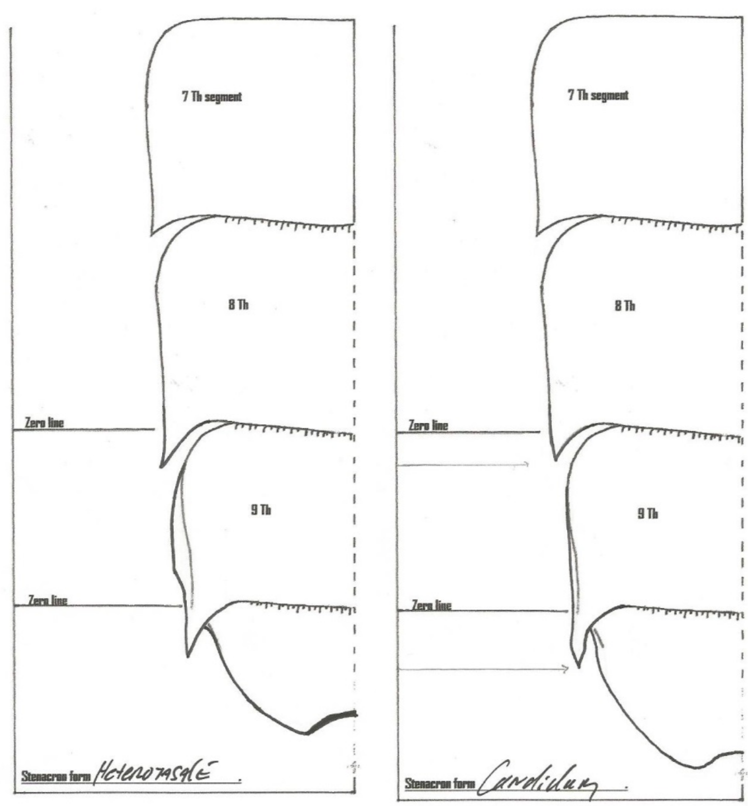
Other area's that requires more study and we hope our work inspires others is the subanal plates of males and females.

Looking at the larva only you can see we were doing a massive amount of odd and interesting studies on the genus this one we wish we had of spent more time on. The larva and adults have consistence in forms and species with the shape of their subanal plates.

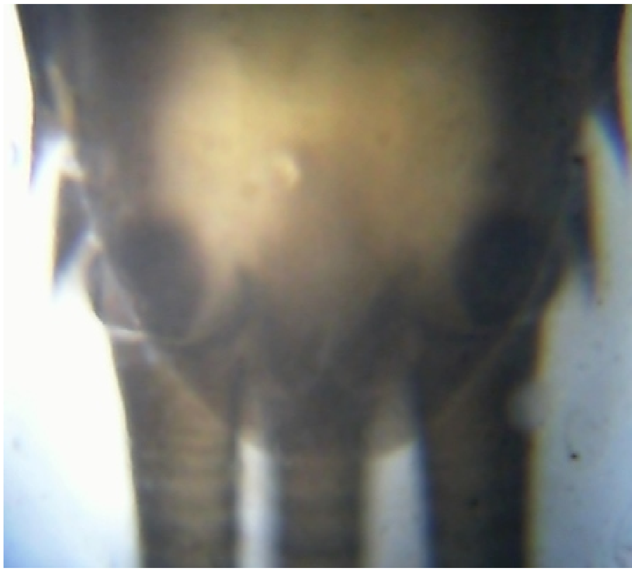
The Subanal plate is the posterior margin of the ventral side of the 9th Sternite that overlaps the 10th segment. Each form and species seems to have distinct shapes.

For example look at the following 2 venter illustrations and the shape of the plates. As you will see size and shape variations in the lateral projections.

The first illustration is the form and one day to be species *heterotarsale*, notice the shape of the subanal plate but the equal length of projections and the shape of the 9th projection. The one on the right is *candidum*.

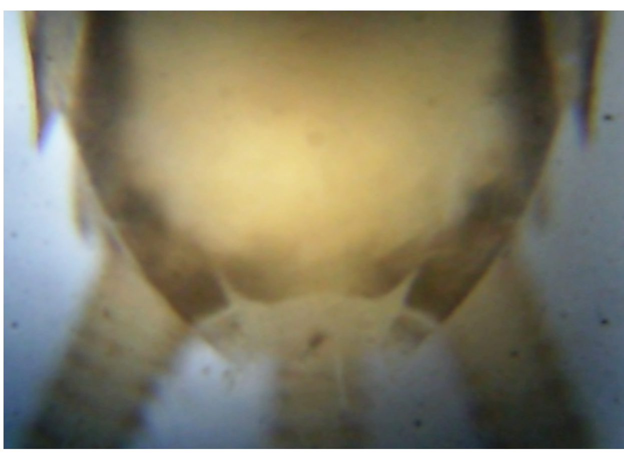


Not only are there differences in the shape of the projections there are differences in the shape of the indentures of the Subanal plates, but also the radius of the lateral area of the plate. Now we will look at some sample from the microscope. The photos are not the highest of quality but we can still see different shapes.



Conjunctum flat bottom

frontale minor indenture



Interpunctatum Say
soft indenture

canadense
almost no indenture

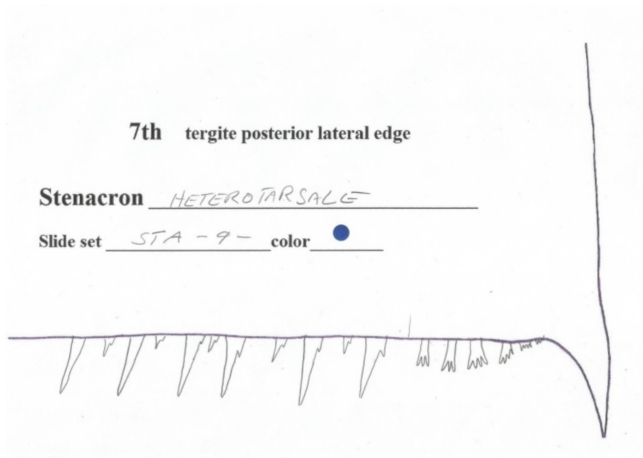
These Subanal plates' configurations follow into adulthood. Both the male and female adult subanal plates match in all we viewed. This was another aid in matching females to males for positive identification. This we believe warrants more investigations.

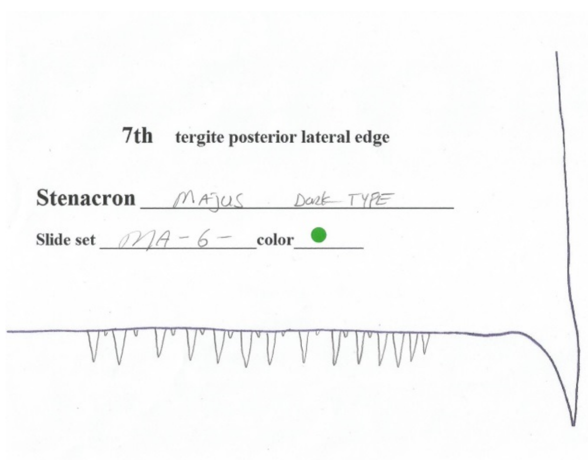
You can see by the magnitude of our study. Our time was spent in many places, but very honed in on things that needed the most work like mouthparts. As far as maculation the larva are very reliable in their markings. On the next page we will look at foreleg maculation patterns.

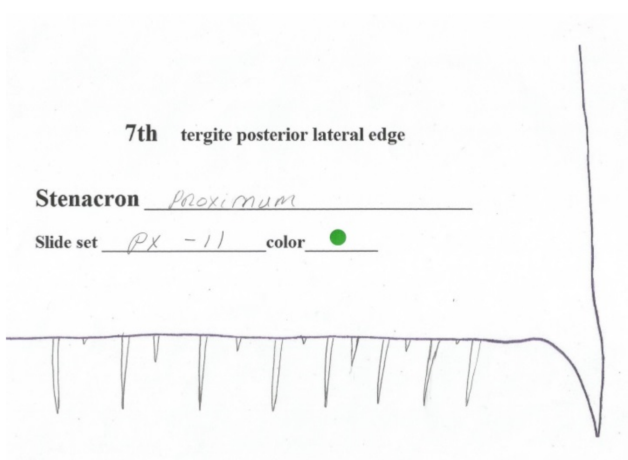
Each form or species has its own maculation pattern. We unfortunately didn't spend much time on this but it is worth pointing out.

These are *candidum*, *heterotarsale*, and *proximum* and form and species samples will align with the illustrations and often very closely.

Another experimental study we did that seems to hold up is also one we never put much time into. In the larva stage the dorsal-posterior margin of the 7^{th} tergite has unique spine arrangements. We only mapped out 3 forms and compared them to multiple samples and they seem to be constant to form. We hope this might inspire interest for someone else in the future. Forms mapped out are; *heterotarsale*, *majus*, and *proximum*.

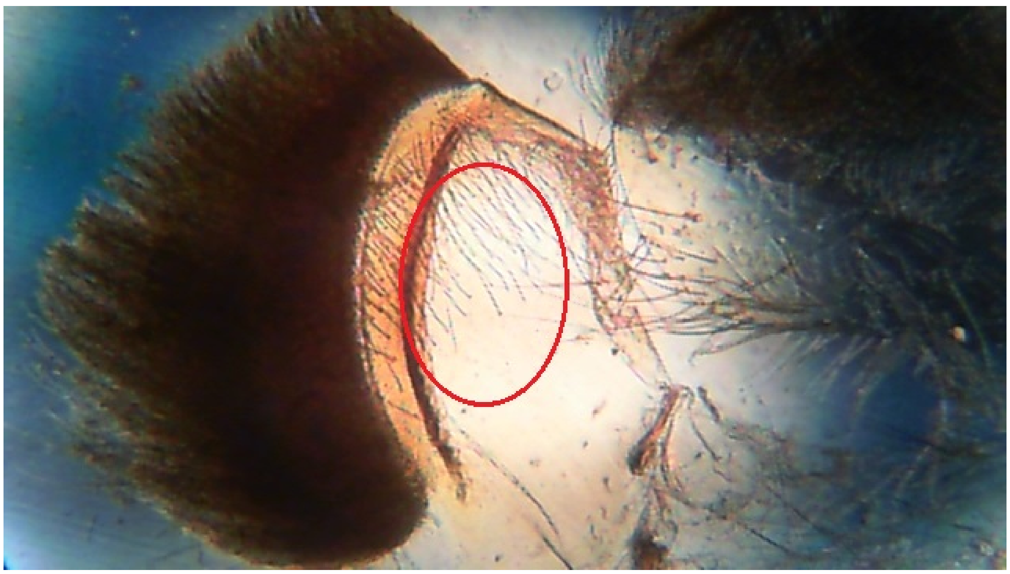




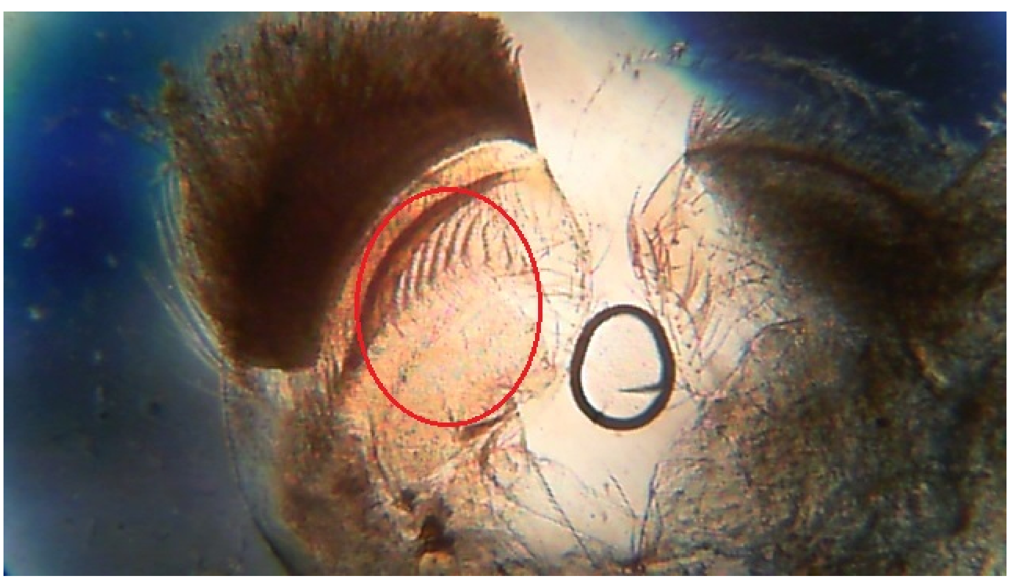


Regarding the light type and dark types there are other minor variations in mouthparts. One of the minor differences we photographed under the microscope. It was OH-2-RED larva, and OH-3-BLUE larva exuvia of the right labium palps. This oddity was not restricted to the left or right but rather both sides regarding variation of form. There is some type of strange teeth on the ventral side on the dark type, and plain setae hairs on the light type, see red circles in photos.

OH-2-RED; *ohioense* light type



OH-3-BLUE; *ohioense* dark type

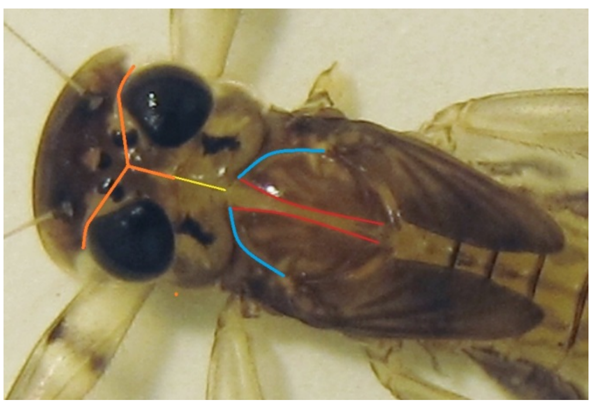


At this point we are leaving the anatomy of the larva so it’s fair to say we should finish with the emergence process of leaving the larva and becoming an adult. This is not an easy stage for the insect mortality rates in captivity are in our studies about 20%. In the real world floating in the surface film for too long is not a great idea as you are likely to become a meal. There is no average time that we can find but we have seen up to 3 minutes to evacuate the exuvia. Often times in 40 seconds it just depends. The process of evacuation is multiple stages of suture ruptures in the exuvia. Before we start the sample used is a male proximum light type and it was reared and dissected. You will see two pictures both are the same. However the first it is marked in colors for step by step explanation. The second is unmarked so you can learn to look for these things yourself.

Stage one is hours and in some cases a day before evacuation takes place. Stage one is the separation on top of the [notum/thorax] on what we call the longitudinal suture. As you can see there are two red lines. The reason is in the photo the longitudinal suture is already cracked open. The space in the center area is the notum of the soon to be subimago stage underneath. In our observations we now believe that all Stenacron crack this suture early by many hours. It is our feeling that they do this to allow water in between the exuvia and the subimago skin. Water in between would act as a lubricant between the two surface areas reducing surface tension.

This longitudinal suture remains cracked open for hours prior to heading for the surface. The next stage is the head deformation. The head capsule becomes highly elevated in the vertex area like someone is squeezing the head from the sides inward. They then start to point their head downwards on about a 40° angle and hold that position for most of evacuation period. Once on the water surface with the head pointed down the cranium suture starts to break this is the orange line. It will start the crack not at the back of the head capsule but right above the brain and forward of the palmen body.

Next as this is taking place the pronotum median suture breaks away this is the yellow line. At that point the transverse sutures the blue lines start to break away. Now the longitudinal suture breaks far apart and past the scutellum to the 3rd tergite or segment. Now the head tills to about a 60° angle the cranium suture ruptures all the way to short of the lateral margins of the head capsule. The head pops out then the pronotum and transverse sutures break far apart in the front the wings start to come out. It seems to us at this point there is some kind of muscular pull from the underside of the thorax. The forewing wings are not strong and at this point there is a massive force in play like a pull from the underside. The longitudinal suture becomes ¾ the width of the entire larva's width very fast. The longitudinal suture breaks to the 4th and sometimes 5th tergite and the adult wiggles out. Even the legs hang back and slightly under the thorax.



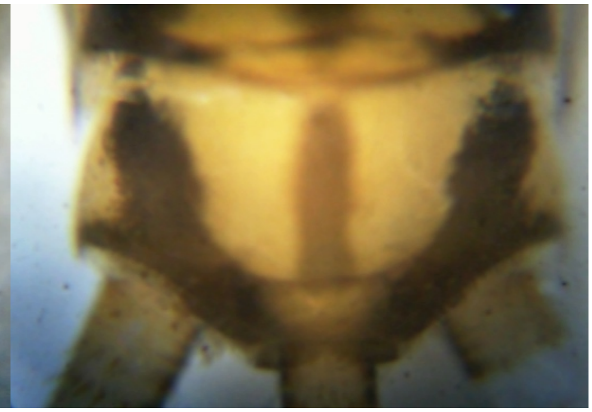
The following photo is from our other rearing study on Maccaffertium *mediopunctatum* and we hatched one in a petri dish in a photo session by chance. They hatch very similar to Stenacron. This will give you a better look at what they look like in the evacuation process.

Larva under the microscope

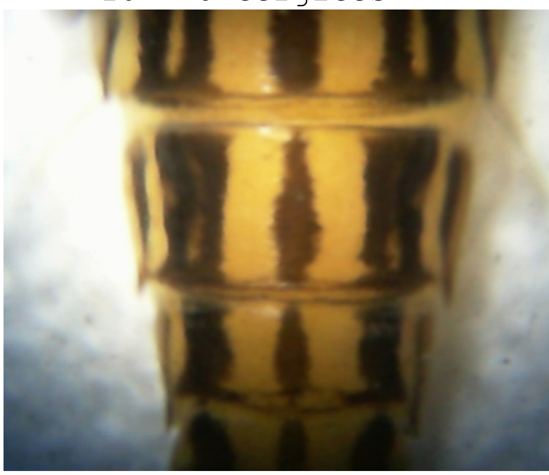
interpunctatum / canadense

Female larva from Bronte creek watershed

10 – 8 tergites



tenth tergite



9 – 7 tergites

7th tergite

Female head capsule

pronotum

Subanal plate

interpunctatum / conjunctum light type

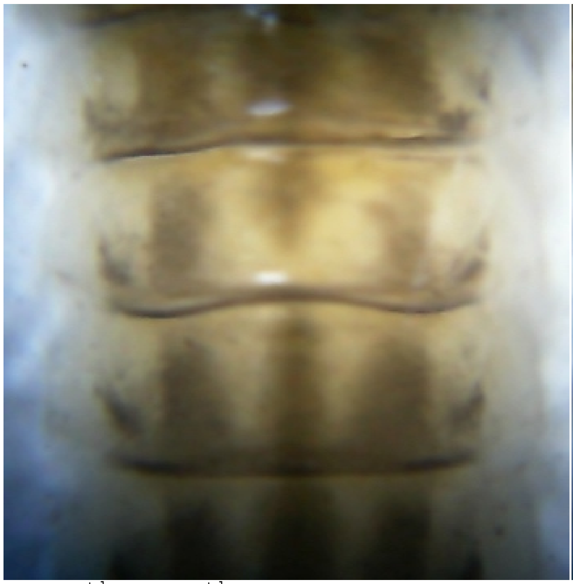
Male larva from the Bronte creek watershed in southern Ontario
conjunctum-2-pink slide set (2014)

10^{th} – 8^{th} tergites

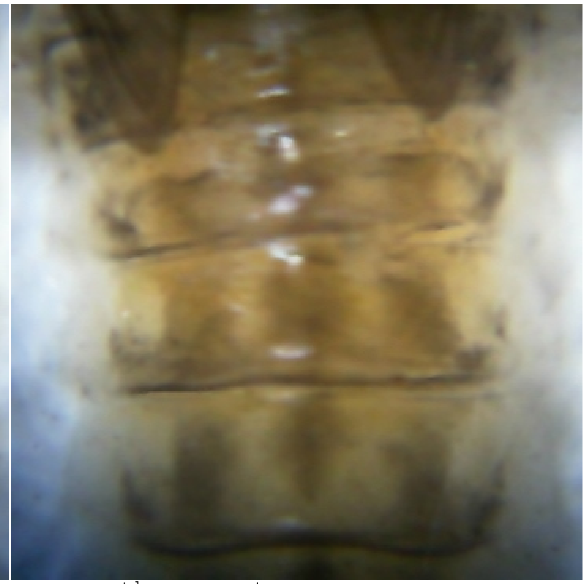
10^{th} – 7^{th} tergites

8^{th} – 6^{th} tergites

7^{th} – 5^{th} tergites



6^{th} – 4^{th} tergites

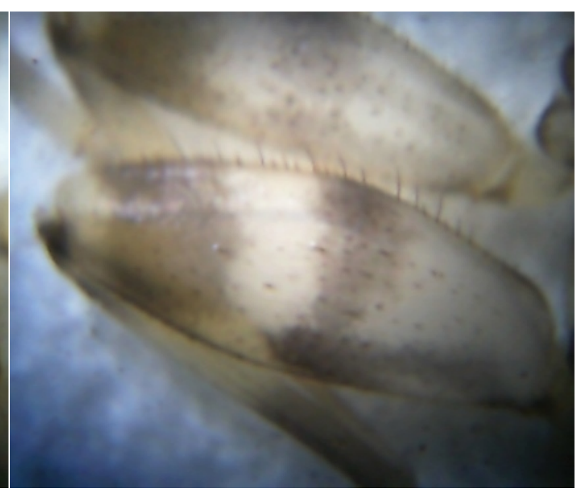


4^{th} – 1^{st} tergites

3^{rd} – 1^{st} tergites

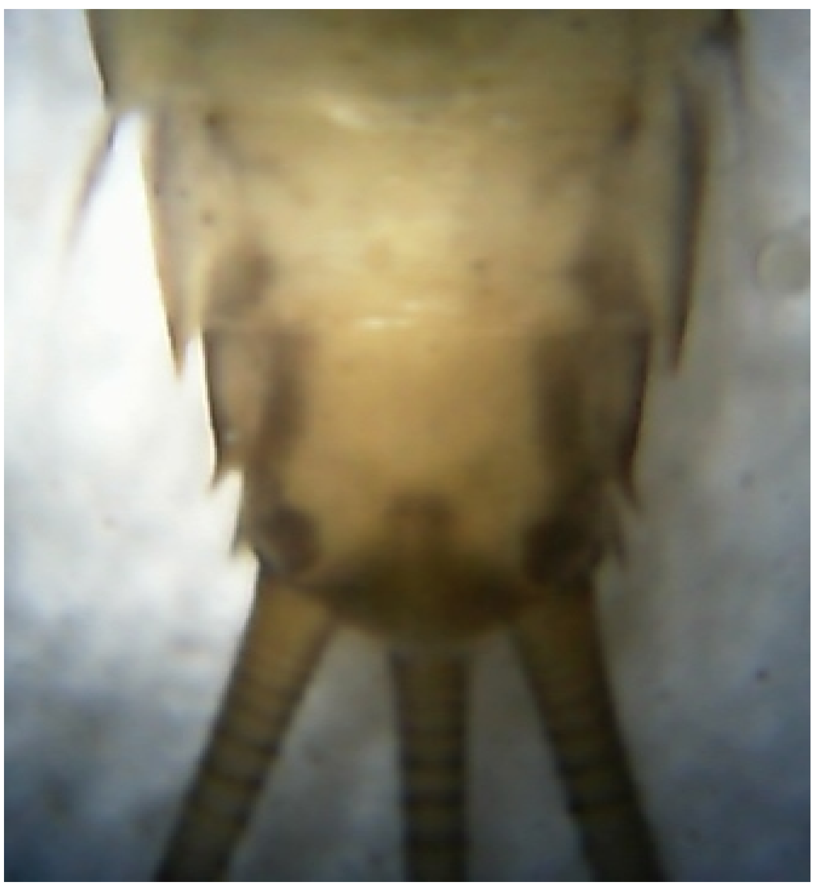
head capsule

Pronotum



middle and hind femora

Single long paddle setae on middle femora

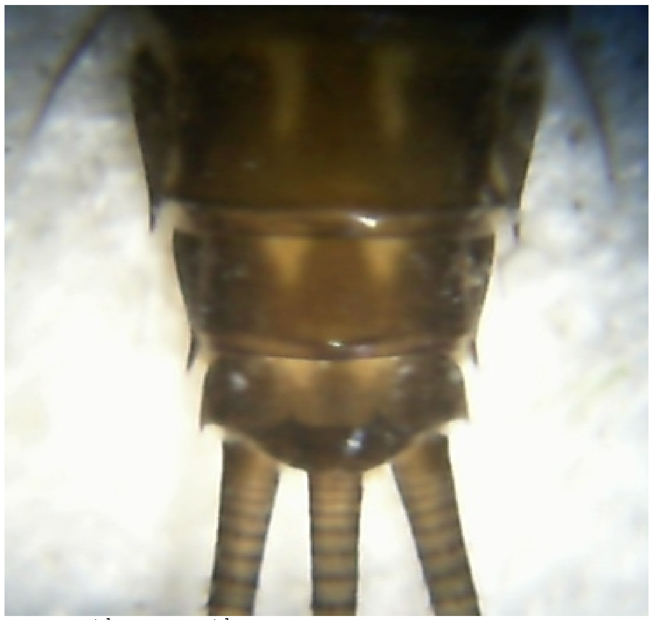


Round Subanal plate

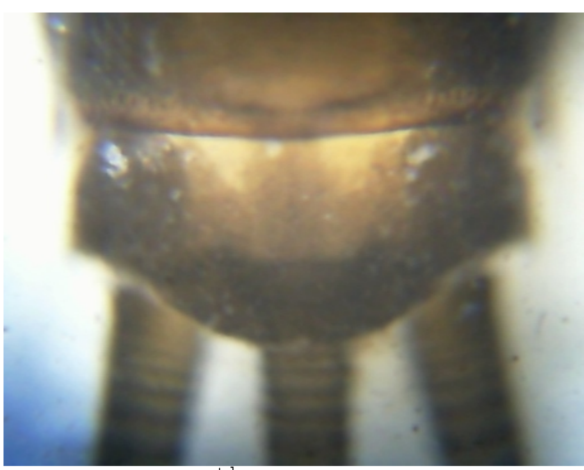
interpunctatum / conjunctum dark type

Female larva from the Bronte creek watershed in southern Ontario

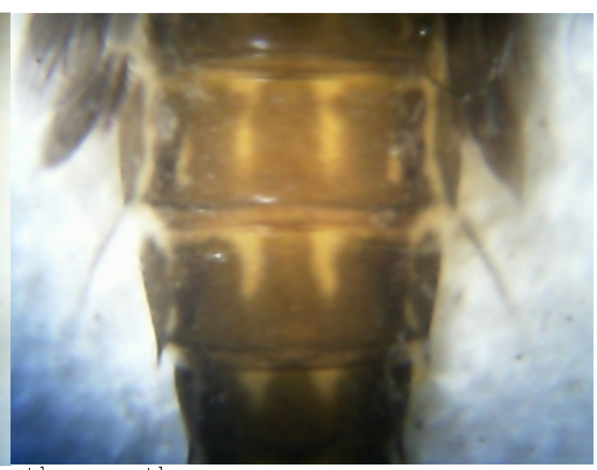
STC-1-blue slide set (2014)



10th - 8th / = projections

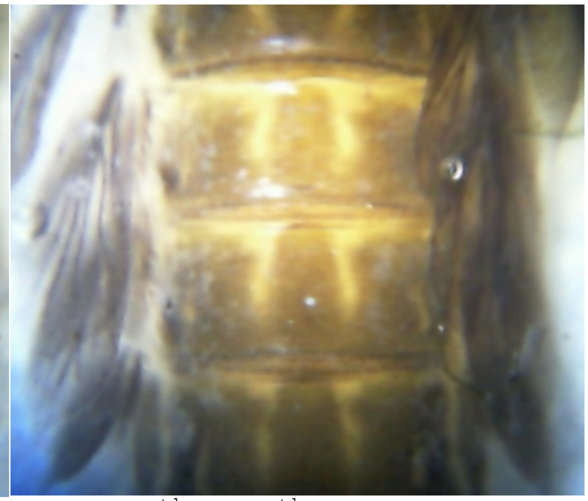


10th



9th - 7th tergites

8th – 6th tergites



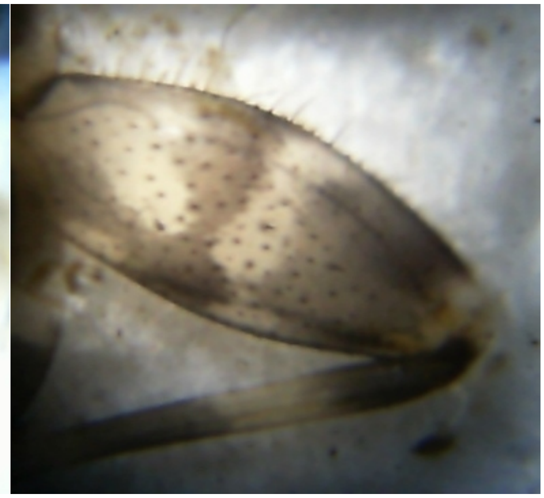
7th – 5th tergites

6th – 3rd tergites

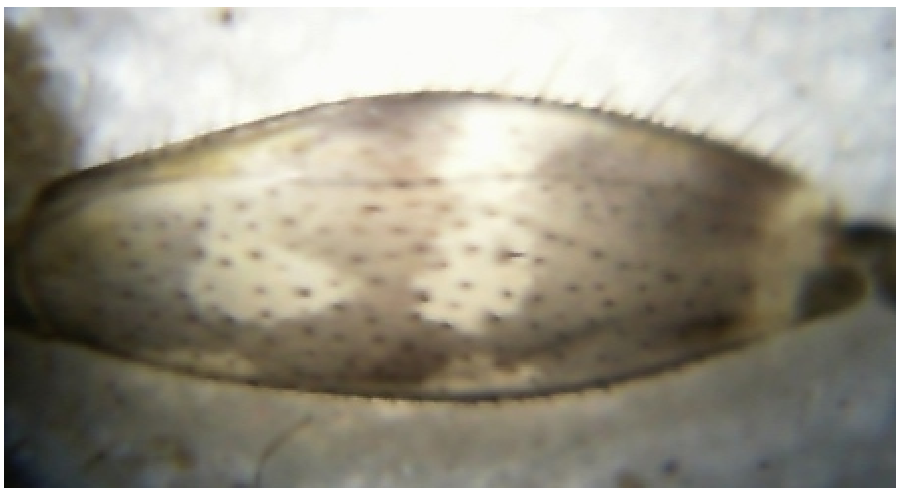
4th – 1st tergites

Head capsule

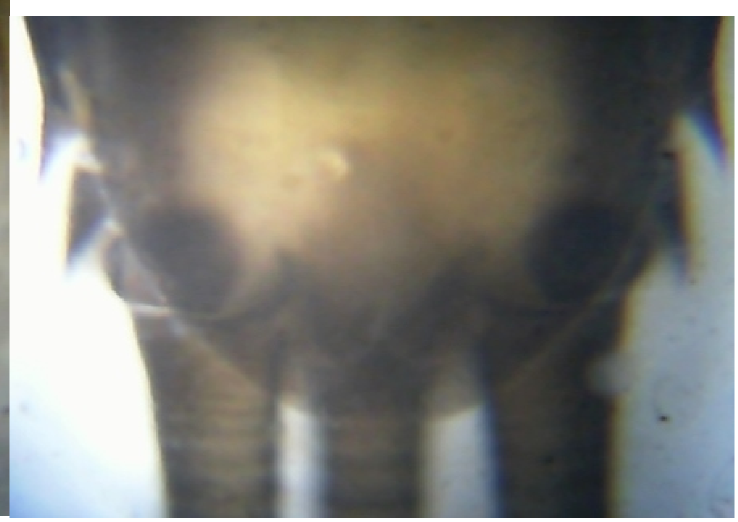
pronotum

Pronotum and notum fore femora



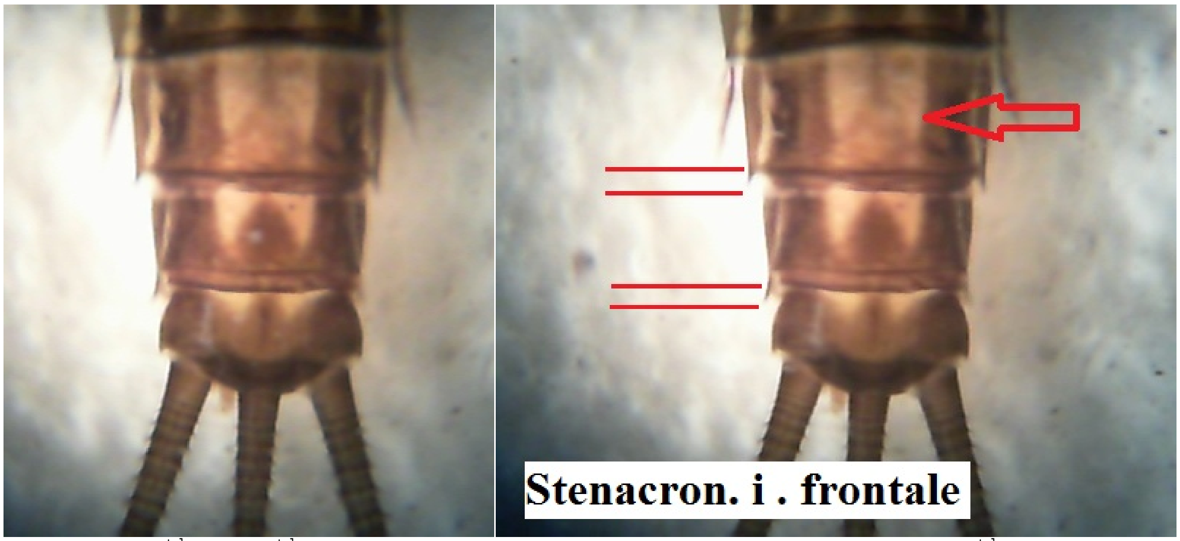
Middle femora

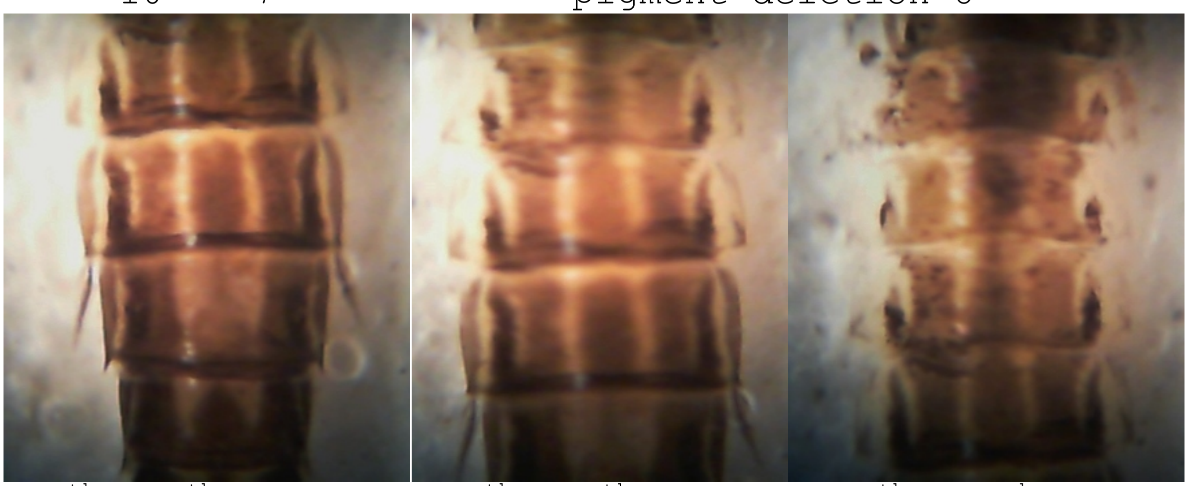
9th and 8th lateral projections equal / Subanal plate

***interpunctatum* / frontale**

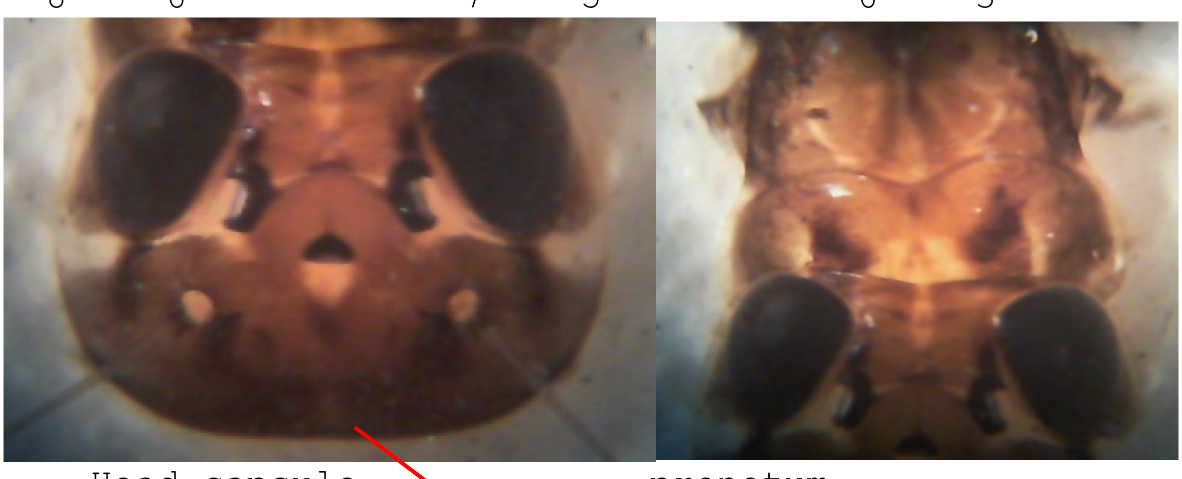
Male larva photo plate



10th – 7th pigment deletion 8th

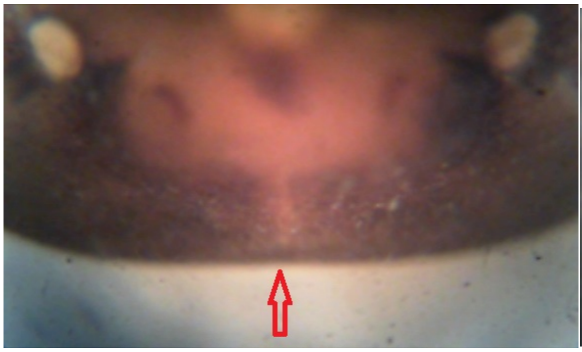


8th – 6th 7th – 5th 6th – 3rd



Head capsule pronotum

Pink stripe



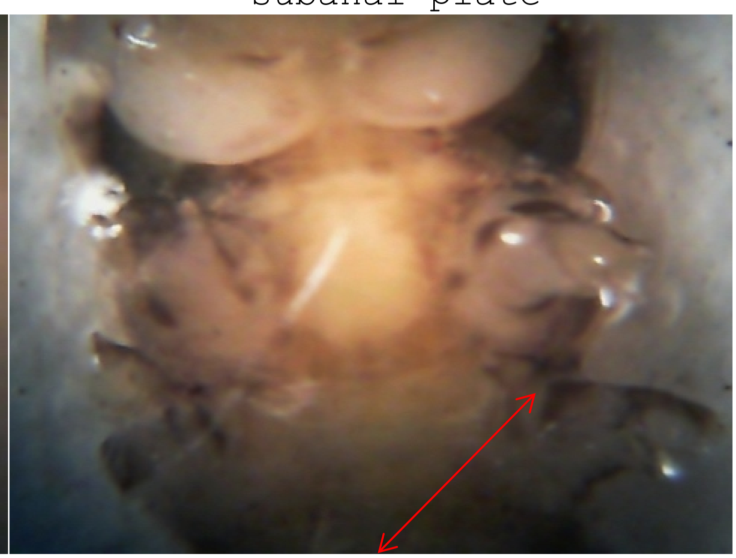
Frontal margin pale spot

fore femora

10^{th} – 8^{th}

subanal plate

8^{th} – 5^{th}

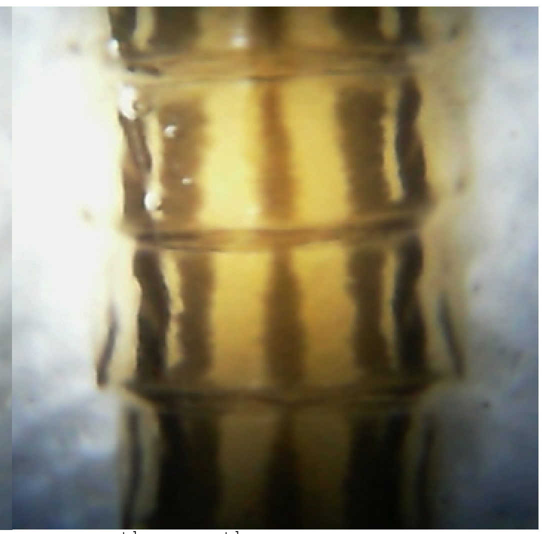


pleura streaks

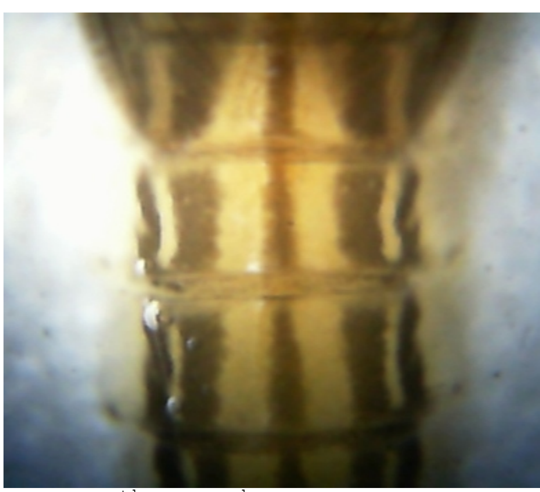
interpunctatum (Say 1839)

Male larva from Bronte creek watershed in southern Ontario
ST-3-BLUE slide set 2014

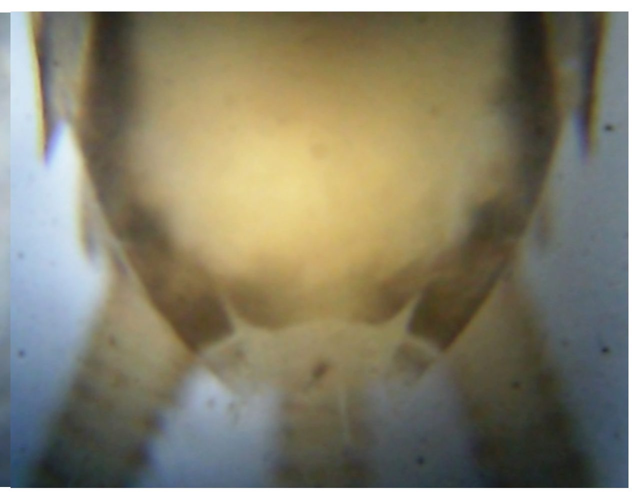
10th – 8 tergites



7th – 5th tergites

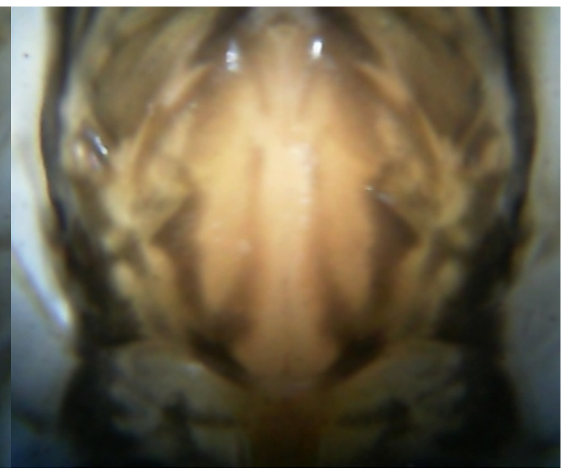


5th – 3rd tergites



Subanal plate


9th – 8th = projections head capsule

Pronotum mesonotum

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interpunctatum / proximum

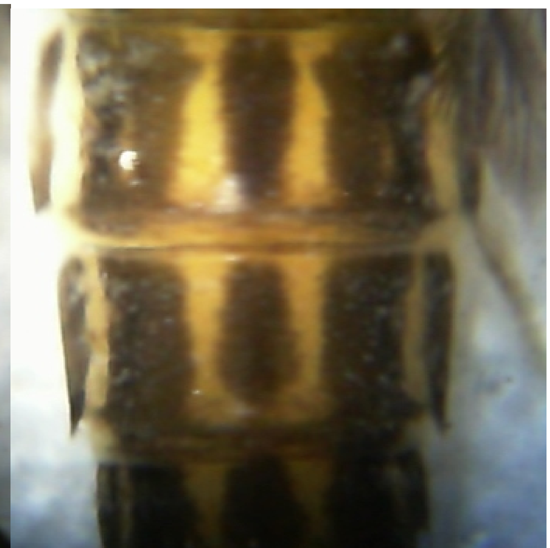
Male larva from Bronte creek watershed in southern Ontario

ST-2-RED slide set (2014)


Ventral view

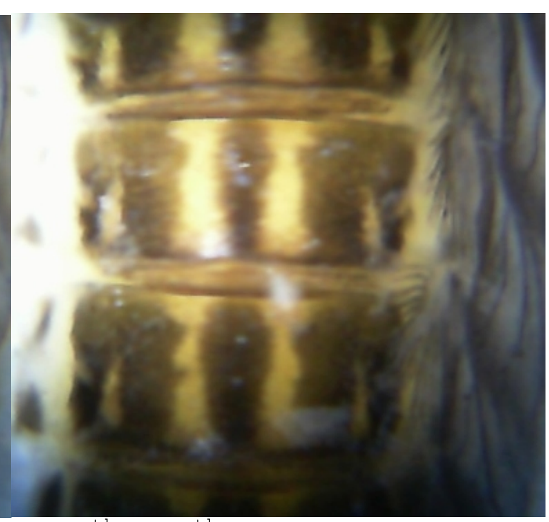
8th and 9th 8 is shorter

10th – 8th tergite



8th – 7th tergite

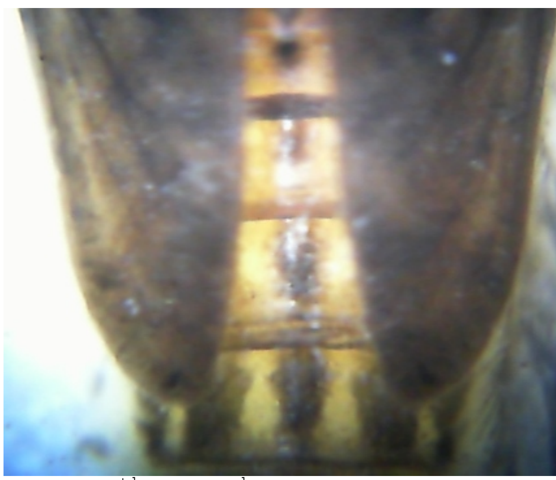
7th – 6th tergites



6th – 5th tergites

5th – 4th tergites

4th – 3rd tergites

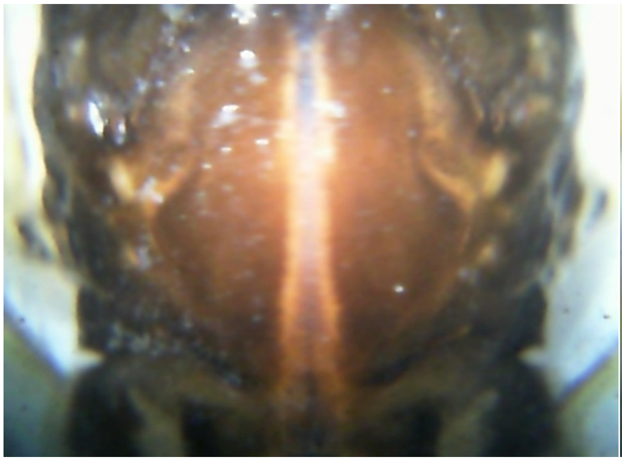


4th – 2nd tergites

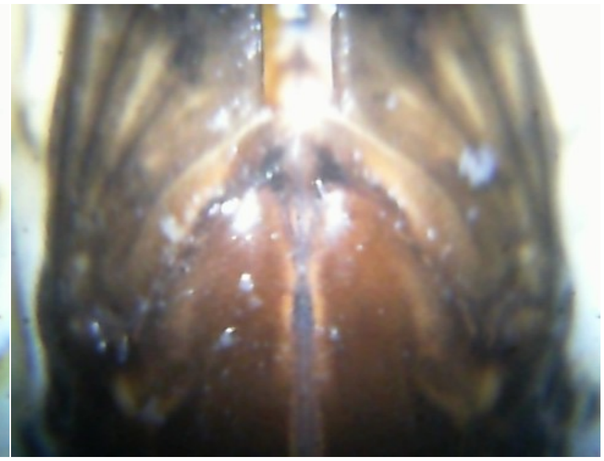
3rd – 1st tergites

Male head capsule

pronotum



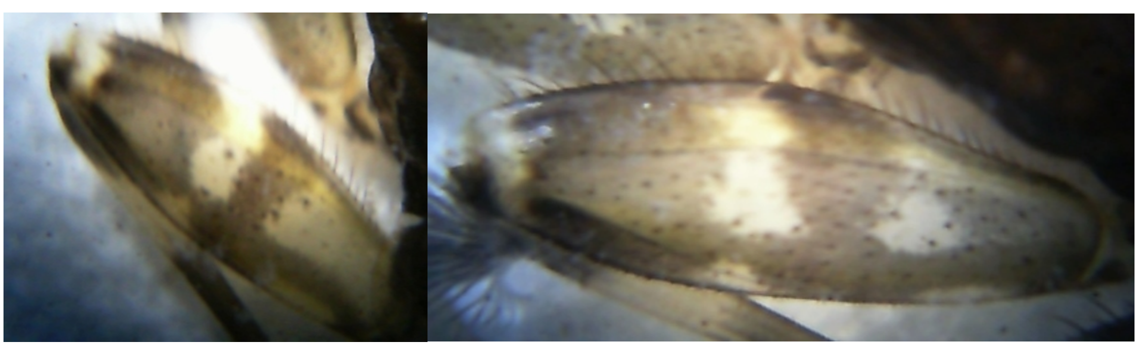
Mesonotum



scutellum

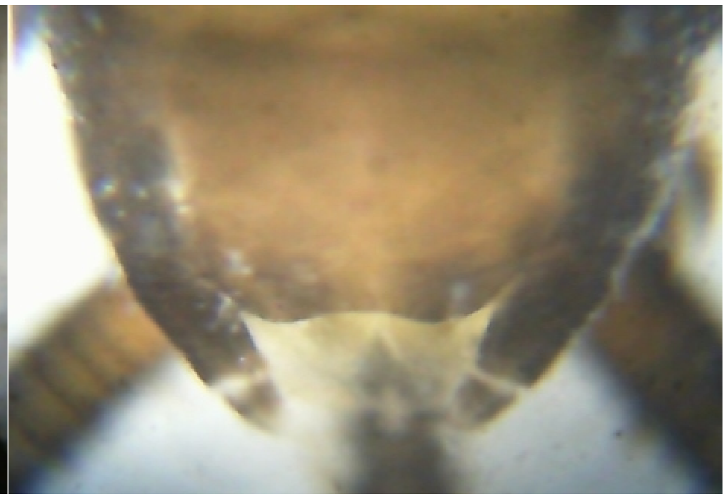
Frontal margin pale spot

median ocelli pale spot

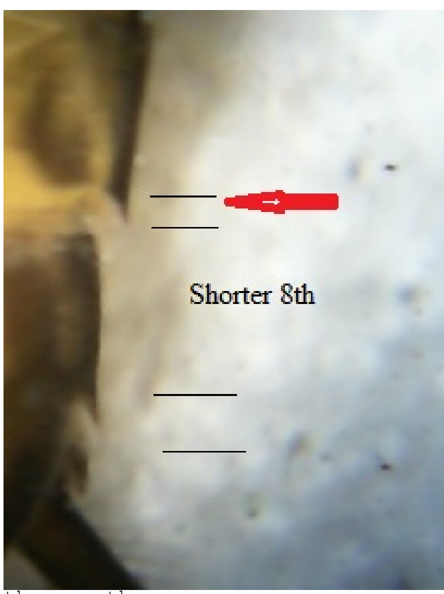


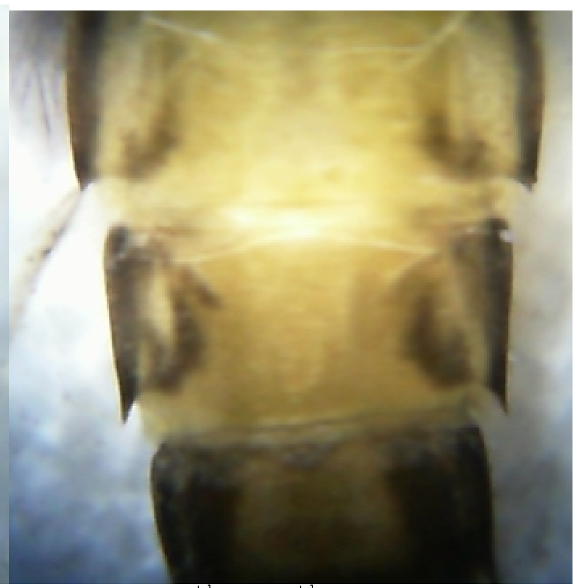
Middle femora

Middle femora showing long single paddle setae



10th – 8th Sternites Subanal plate



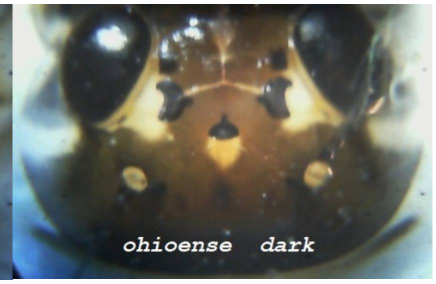


8th – 9th lateral projections 8th – 7th Sternite

Larva Heads

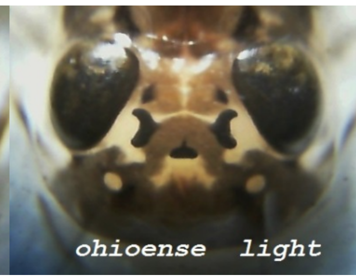
female

female



female

male



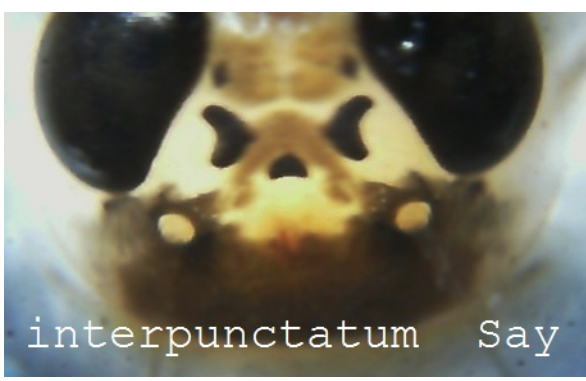
male

female

female

female

male



male

female

Photo Plate Larva

All samples except last 2 photos and the female *canadense* all were reared to adulthood giving clear indication and identification. The retracing from the larva exuvia made identifying live larva relatively easy. Stenacron from a maculation standpoint in the larva stage are quite consistent within form.

Travers table 1935 indicated lateral projections as a key. Our studies agree and confirm this lost key to larva. We mapped out multi samples of larva to get an average tooth count per form which is found in the tables in the back, we also blueprinted the labrums of 10 forms showing identification of the 10 form by just the labrums alone is now possible see that section.

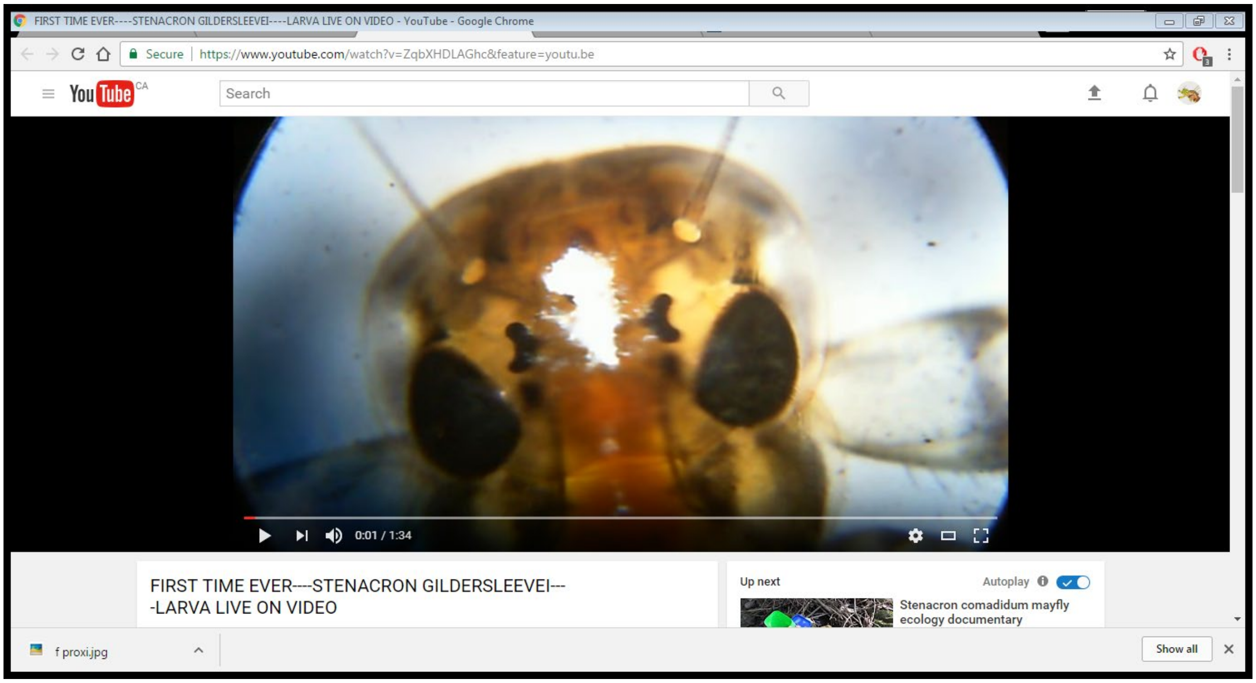
We will start this photo plate with the very first photos of Stenacron *gildersleevei*. Even Lewis 1974 was unable to offer quality photos of this species. Not only are we offering photos we filmed a video of a live female larva under my microscope.

Stenacron *gildersleevei* has a very district feature not seen in any other larva in the genus we reviewed. From right between the lateral ocelli in the head capsule there is blood red fluid being pumped from the 4th gill to center of the head. We saw this in 8 *gildersleevei* samples. All *gildersleevei* larvae had 13 pectinate setae combs on the crown of the maxilla.

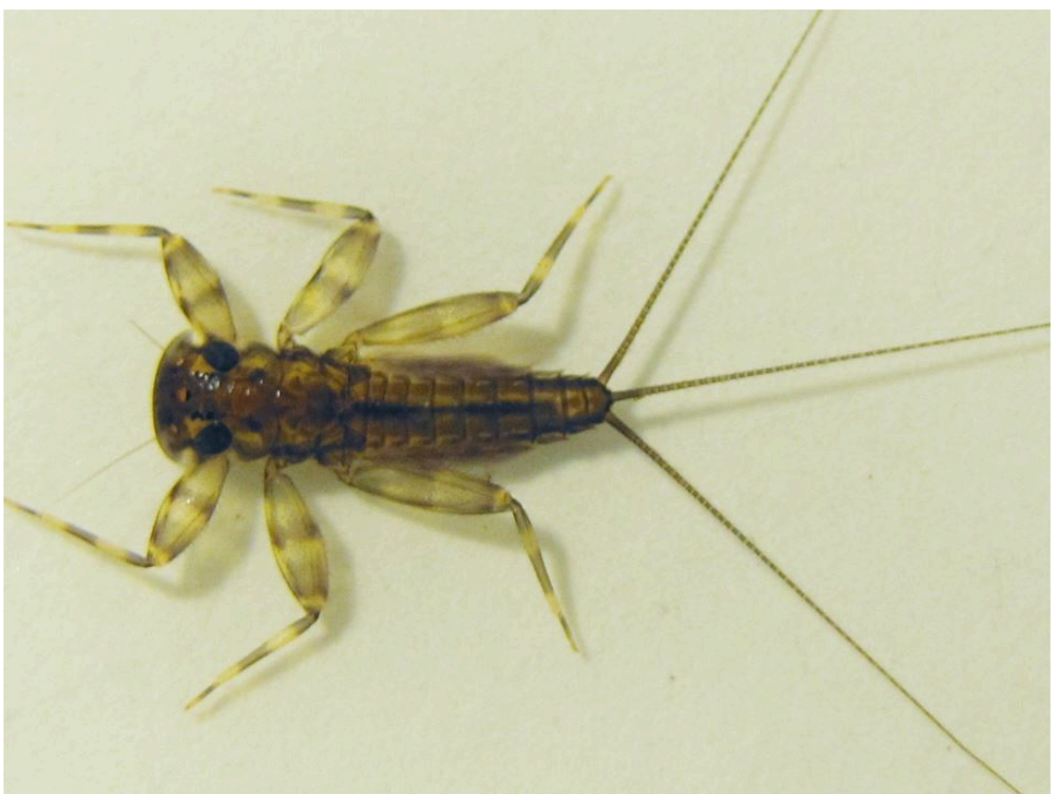
So we will start this photo plate with this species. On the link above the screen shot you can search out and watch the live video showing strange red fluid.

Stenacron *gildersleevei* female larva alive on video

https://www.youtube.com/watch?v=ZqbXHDLAGhc&feature=youtu.be



Stenacron *gildersleevei* female larva



Last photo of *gildersleevei*

Male *interpunctatum / majus*

Female *interpunctatum / proximum*

Female *interpunctatum / majus*

Female *candidum*

Female *heterotarsale* note the median line

Female *heterotarsale* ventral view

You can see the deep indenture of subanal plate

Female *interpunctatum / conjunctum* light type

Female *interpunctatum / conjunctum* dark type

Male True *interpunctatum* Say 1839

Male True *interpunctatum* Say 1839

True *interpunctatum* Say 1839 has little to not markings in the way of banding on the legs very pale toned. If you look close enough you can see these are two different samples clearly indicating leg maculation.

Female *interpunctatum / ohioense* light type

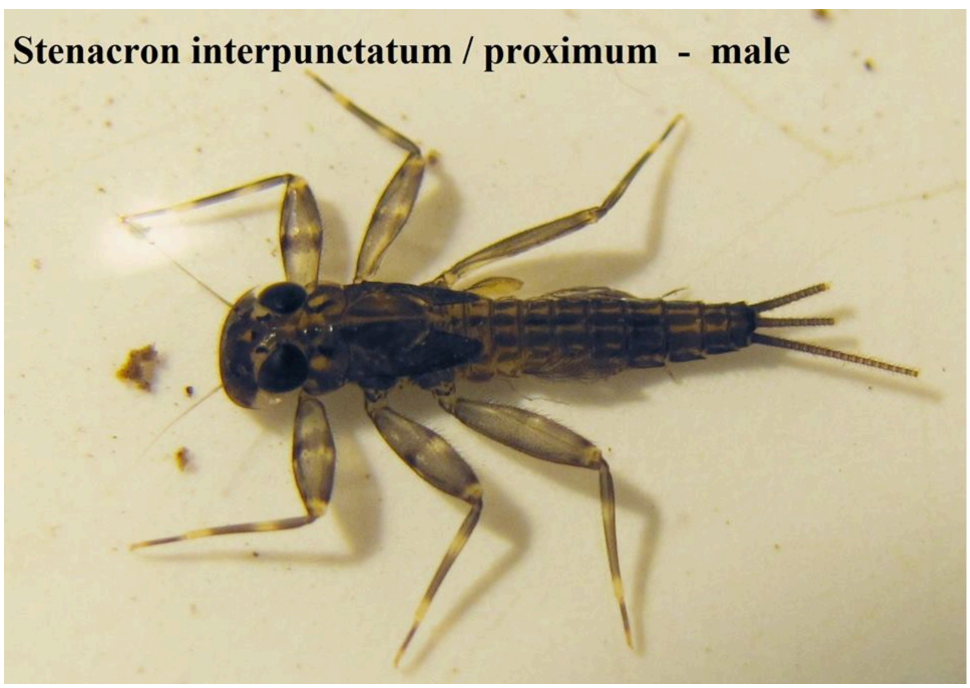
Female *interpunctatum / ohioense* dark type

Female *interpunctatum* / *canadense*

Female *interpunctatum* / *canadense*

Male *interpunctatum / proximum* light type

Male *interpunctatum / proximum* dark type

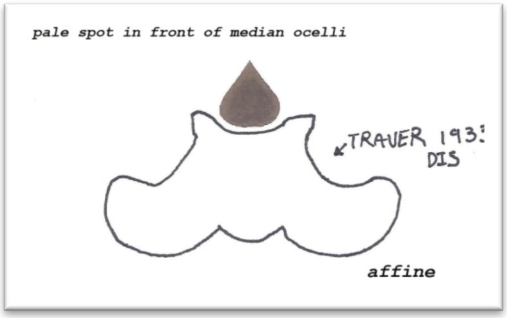


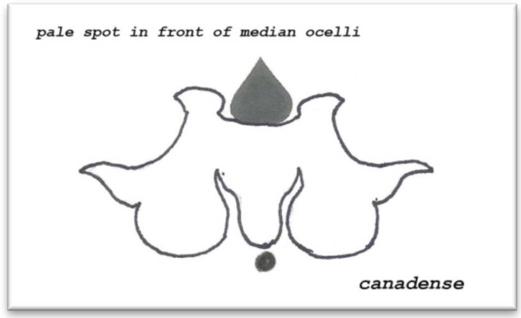
Female Stenacron; 1; *majus* 2; *proximum* 3; *canadense* 4; *heterotarsale* 5; *ohioense* LT 6; *heterotarsale*

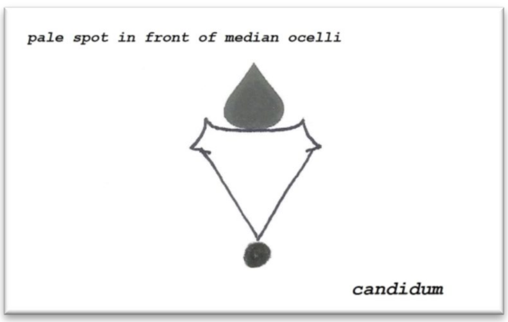
None of the following were reared by Sharon.
Sharon Moorman; Stenacron *carolina* lake Norris TN

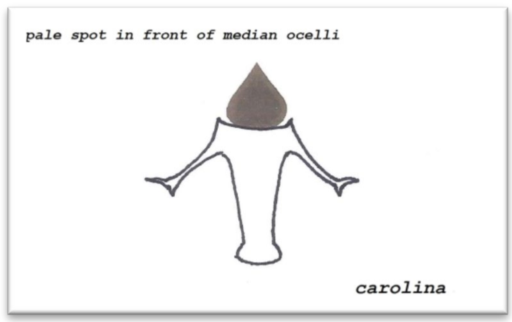
Sharon Moorman; *frontale* lake Norris TN

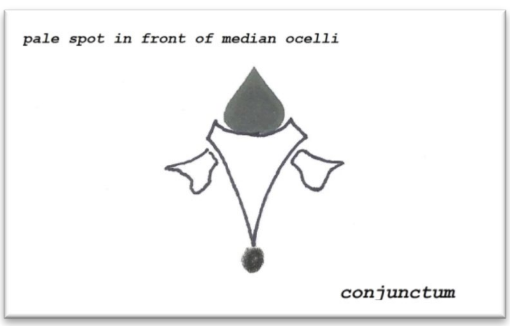
Spots in front of median ocelli

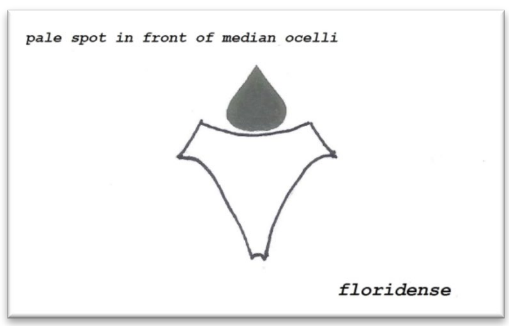


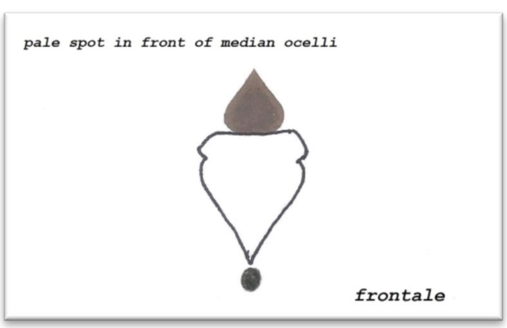


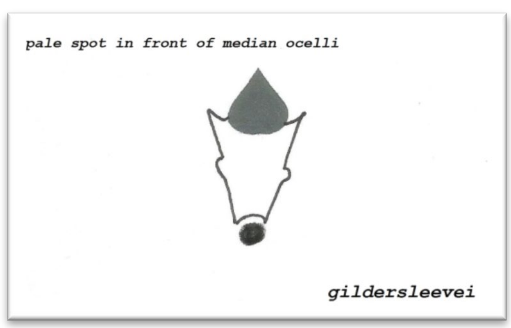


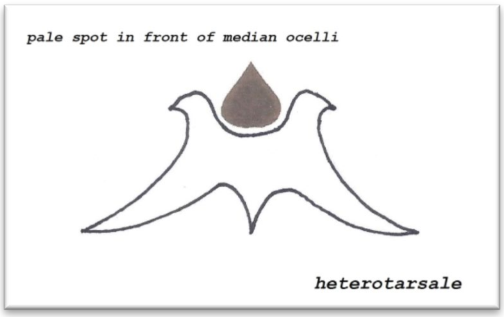


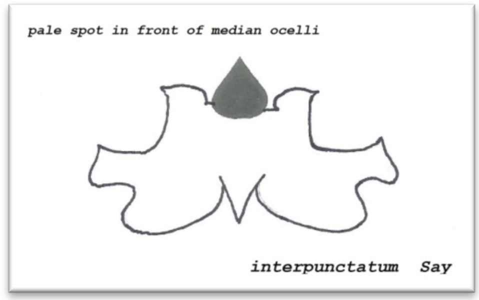


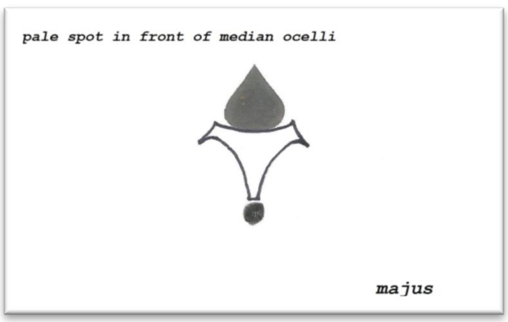


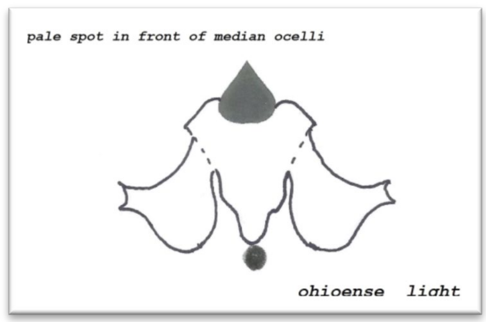




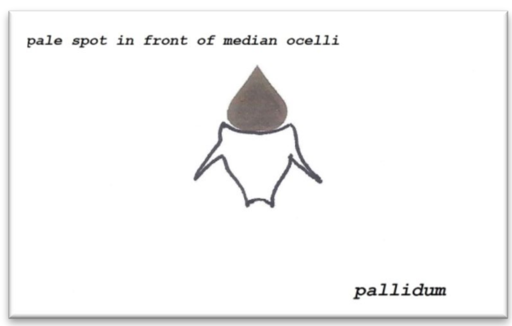

pale spot in front of median ocelli
heterotarsale

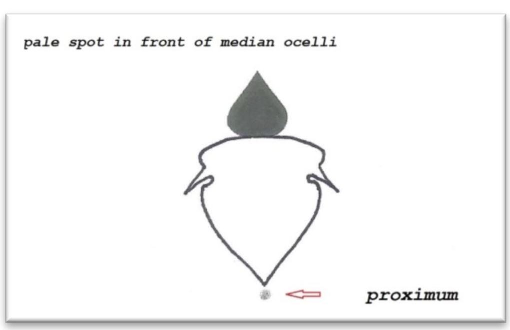

pale spot in front of median ocelli
interpunctatum Say


pale spot in front of median ocelli
majus

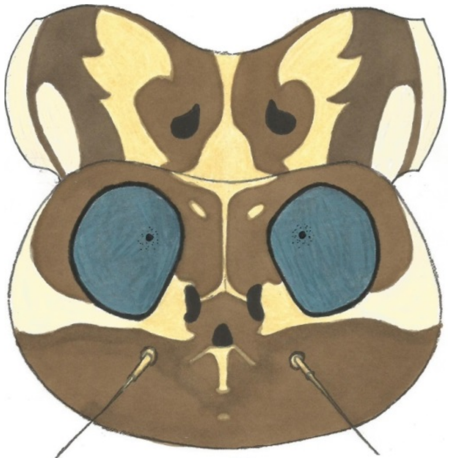

pale spot in front of median ocelli
ohioense light


pale spot in front of median ocelli
ohioense dark


pale spot in front of median ocelli
pallidum

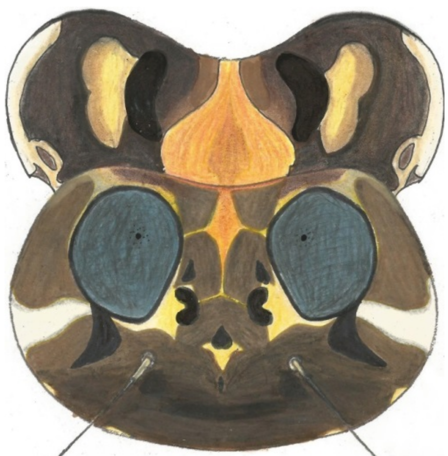

pale spot in front of median ocelli
proximum

Head Capsules



carolina

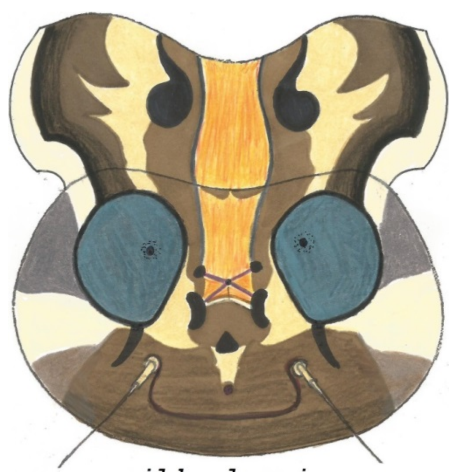
canadense



candidum

conjunctum

frontale



gildersleevei

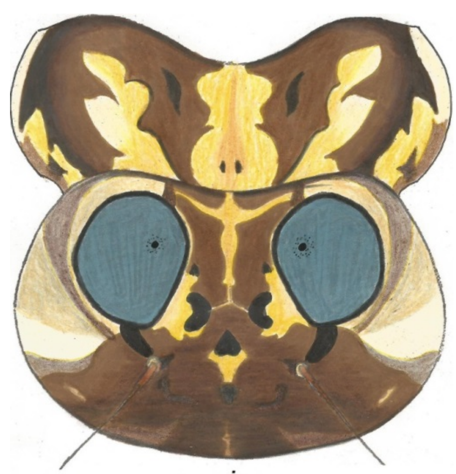
heterotarsale

interpunctatum Say

majus

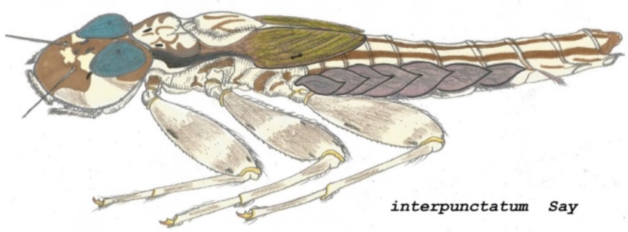
ohioense dark

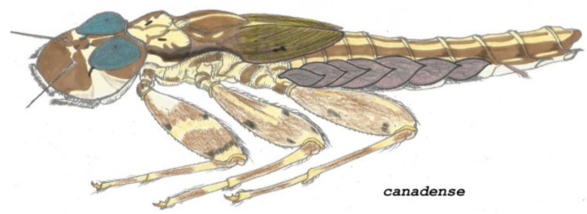
ohioense light

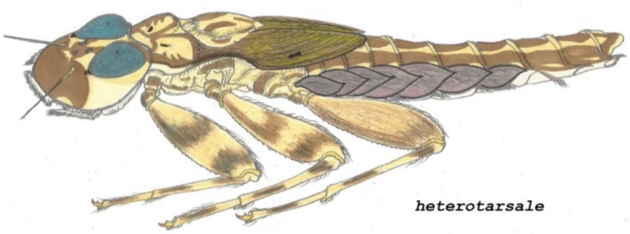


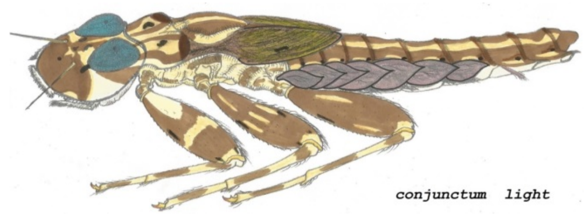
proximum

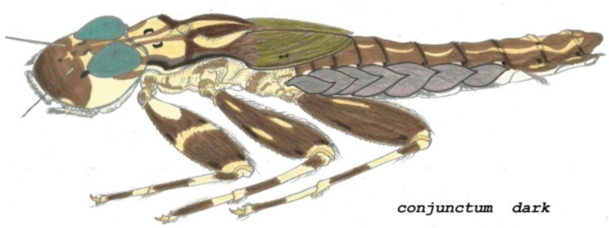
3D lateral views


interpunctatum Say


canadense

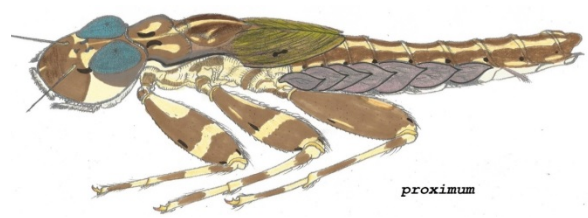

heterotarsale

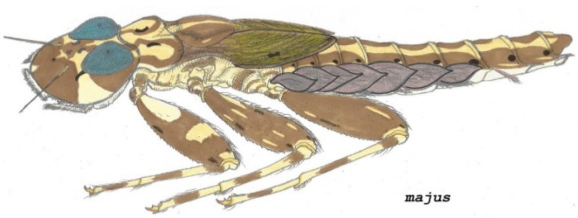

conjunctum light


conjunctum dark


candidum


frontale


proximum

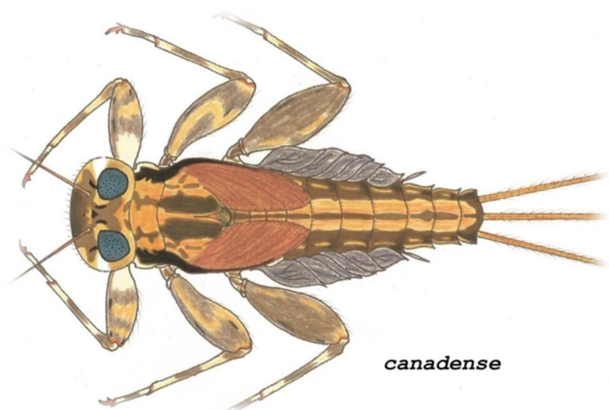

majus

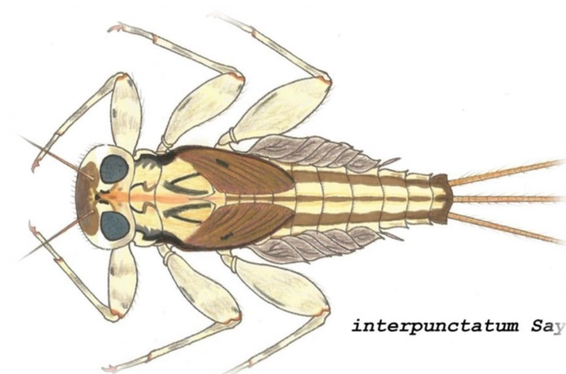

gildersleevei


ohioense light

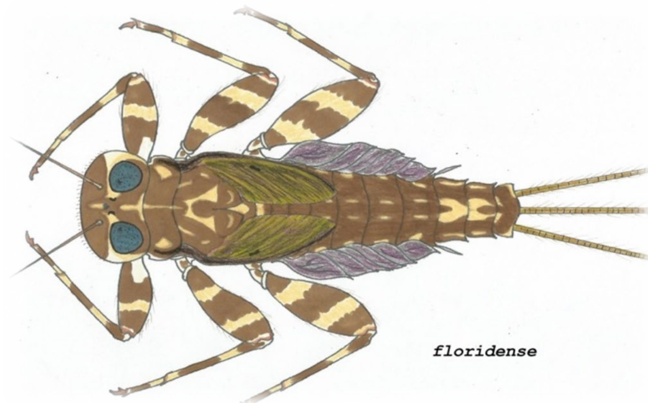

ohioense dark

General Top Views



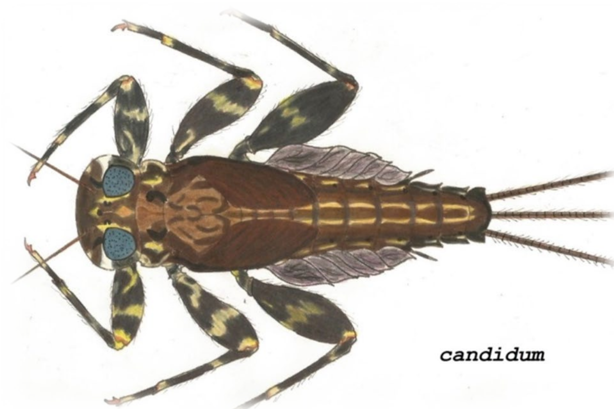


carolina



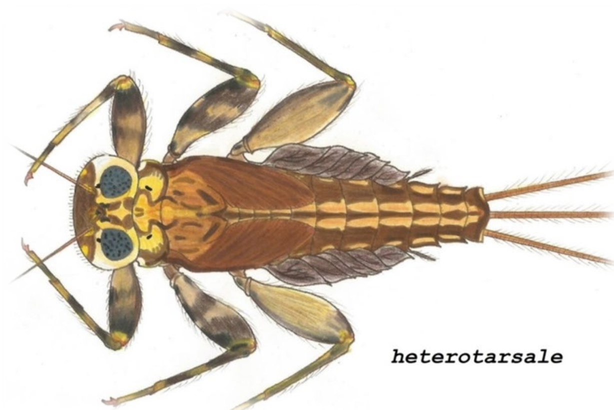
floridense

gildersleevei

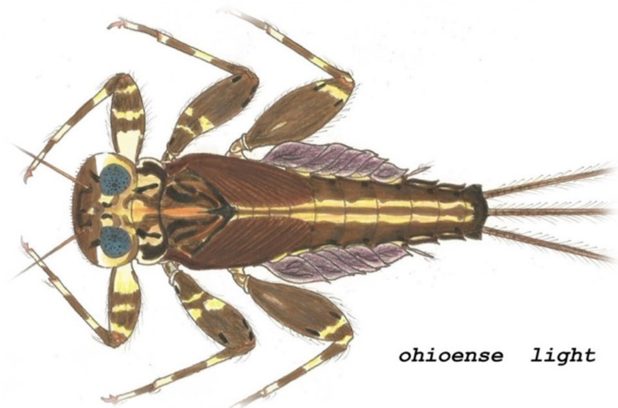


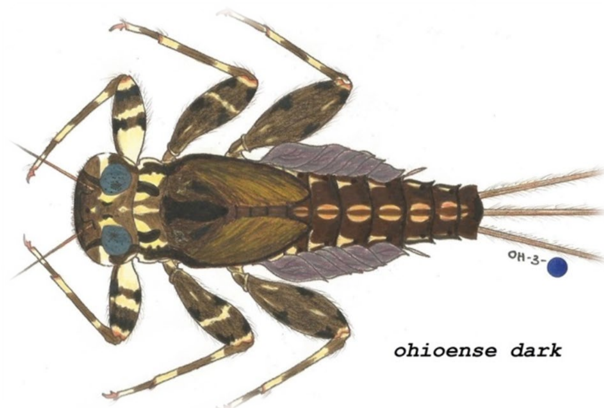
candidum

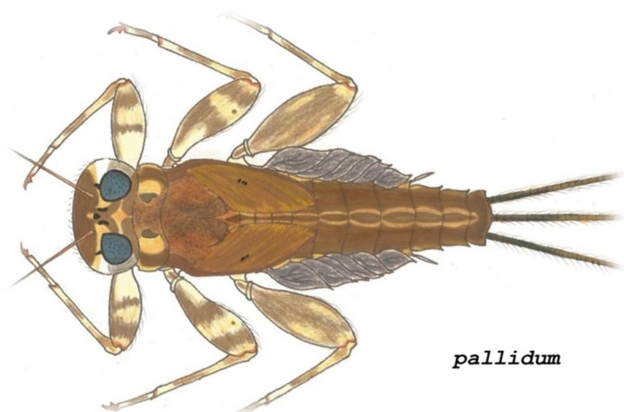
majus

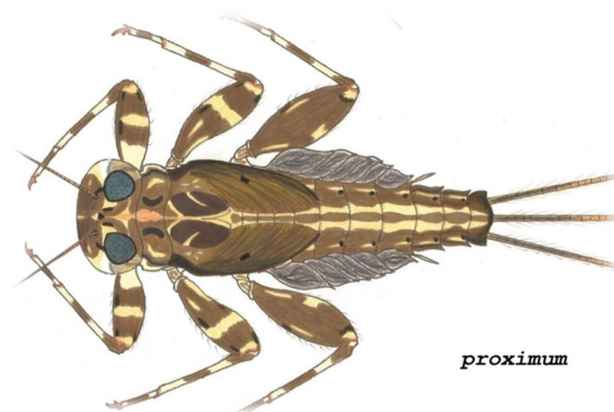


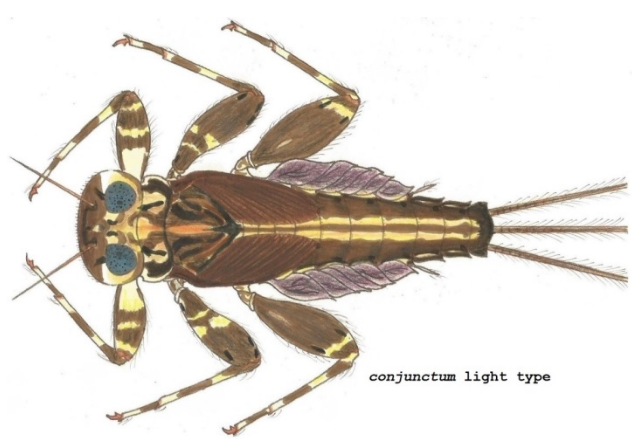
heterotarsale

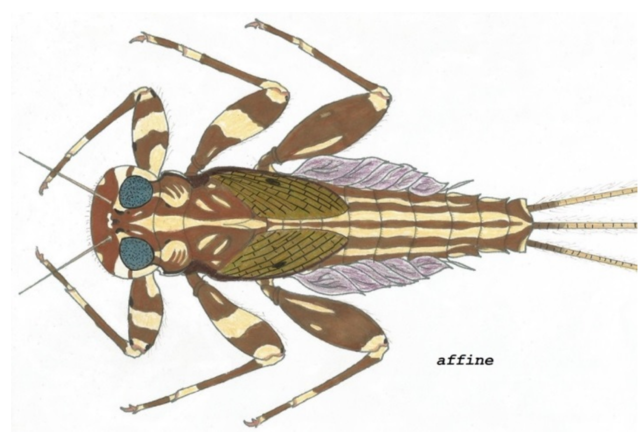

ohioense light


OH-3-
ohioense dark

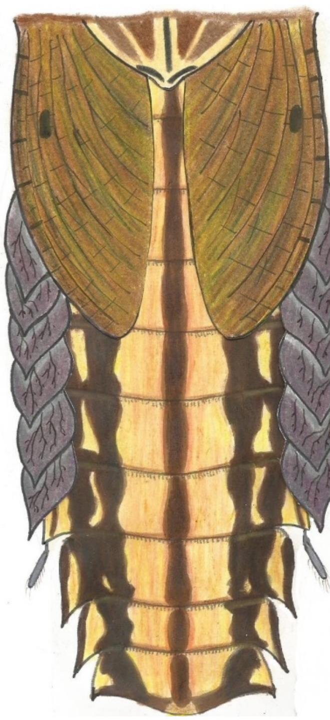

pallidum

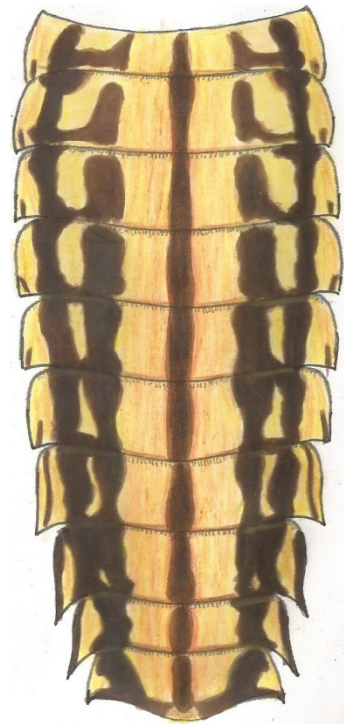

proximum

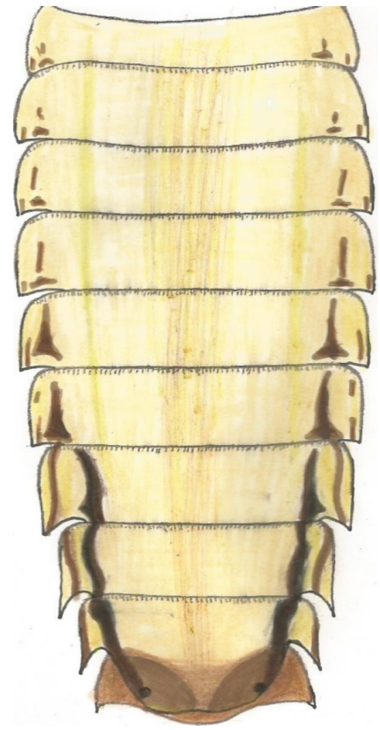

conjunctum light type


affine

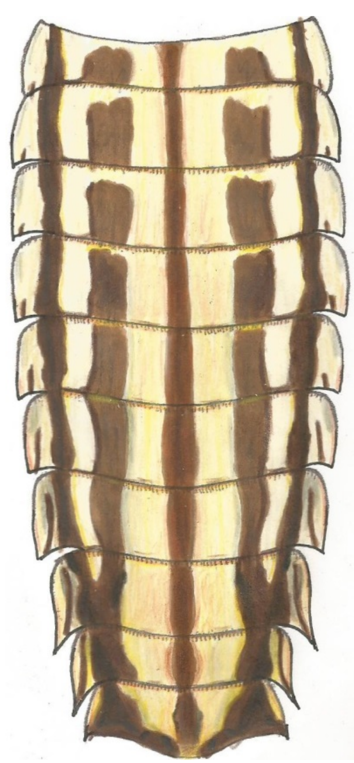
canadense *canadense* venter

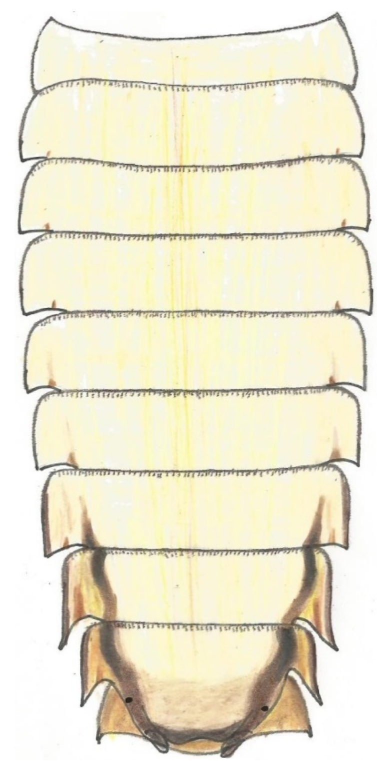




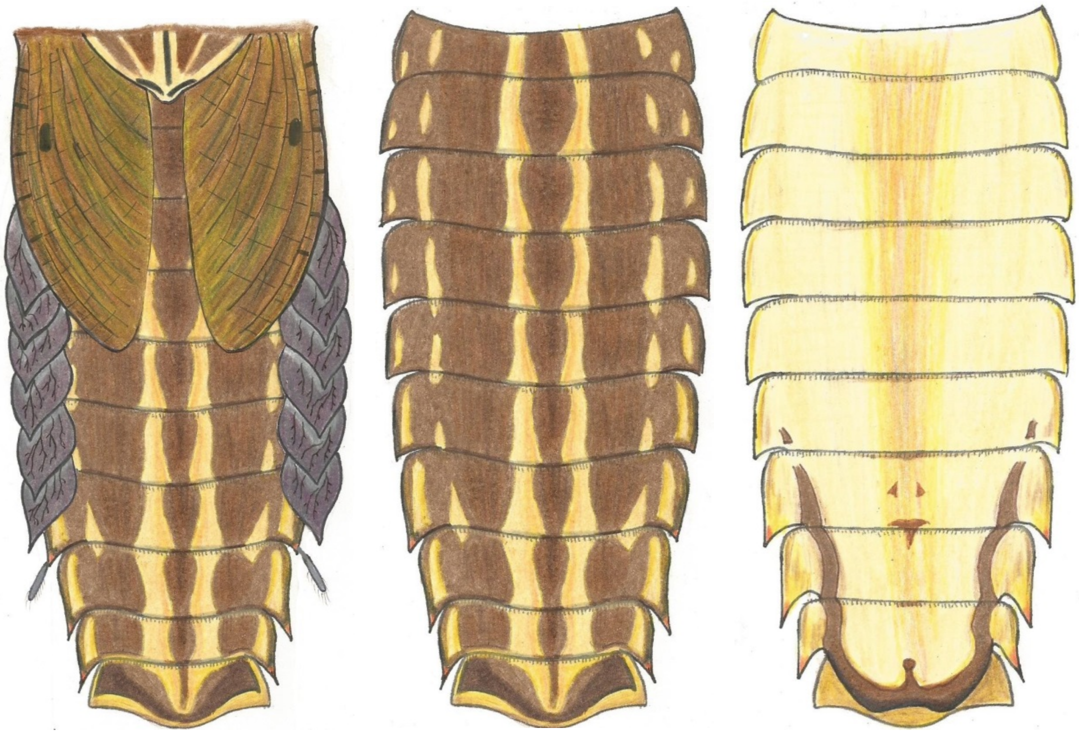


***interpunctatum* Say**



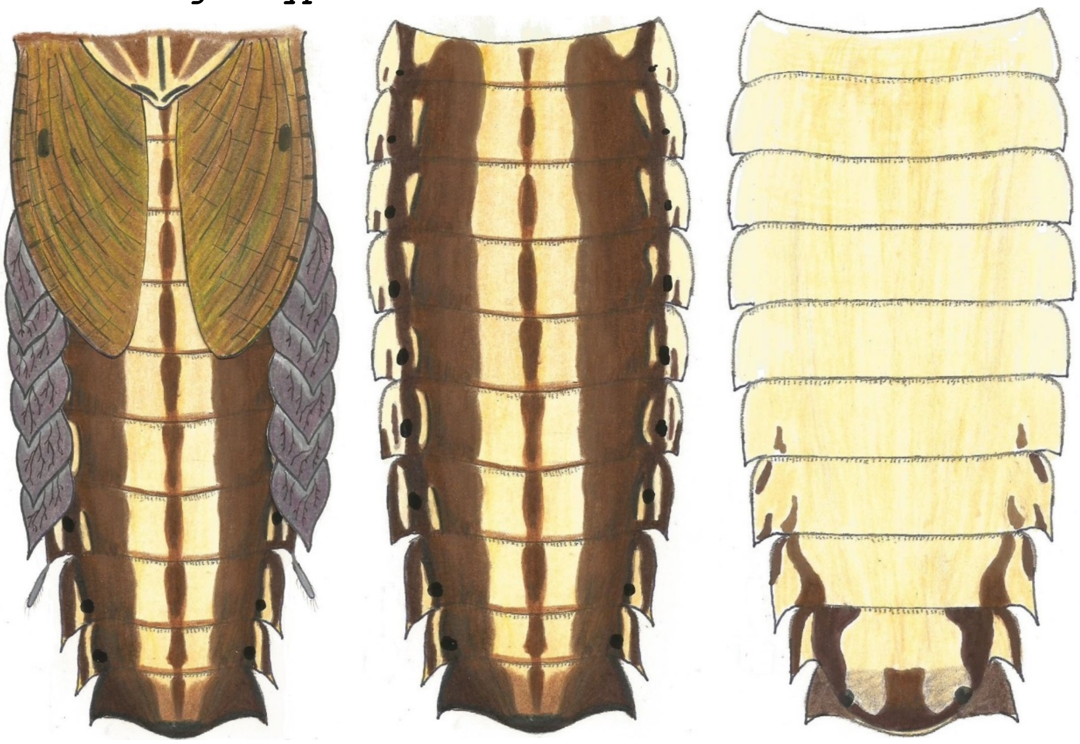


Heterotarsale

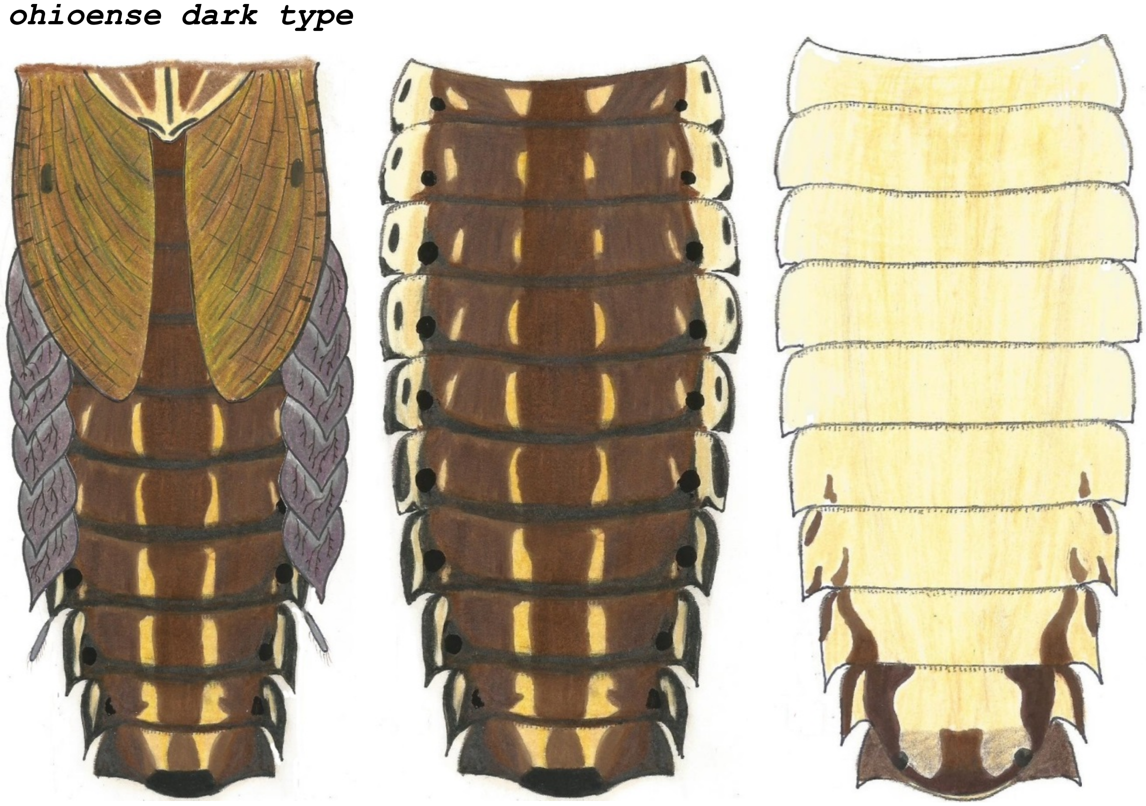


proximum

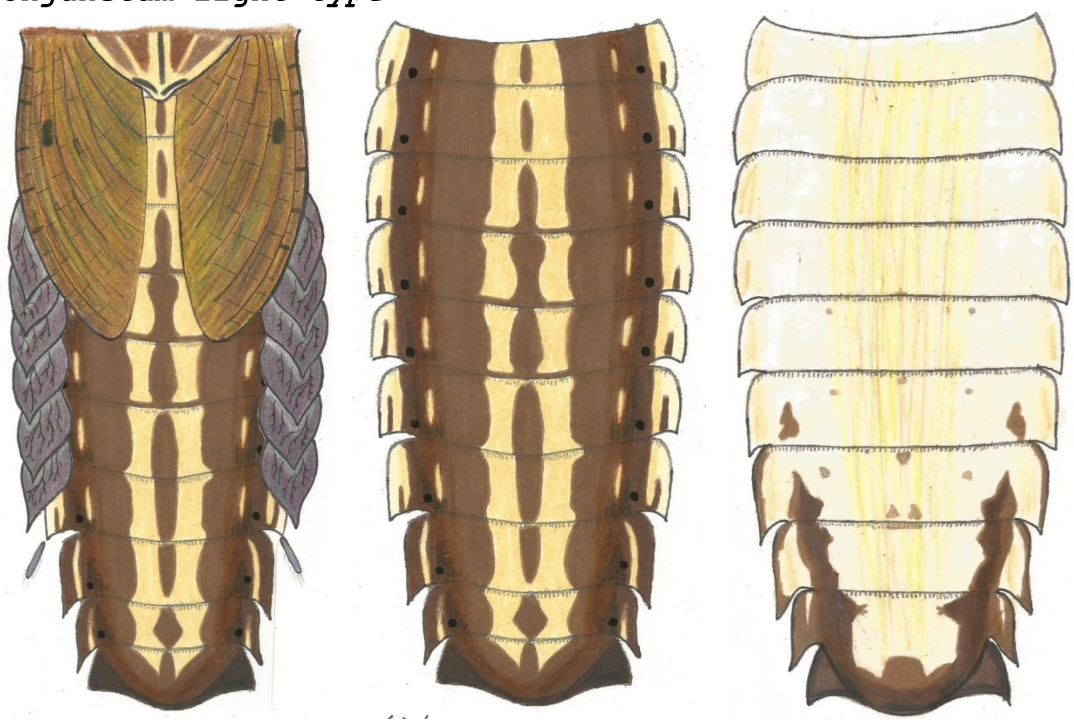
***ohioense* light type**



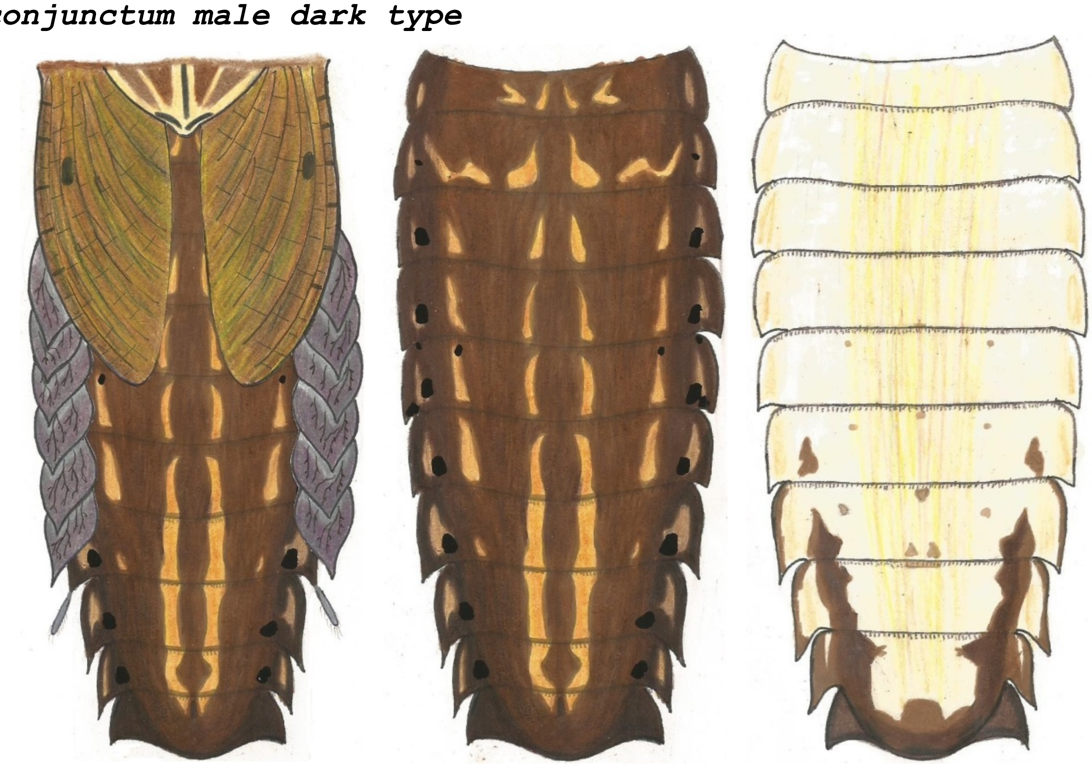
***ohioense* dark type**



conjunctum light type

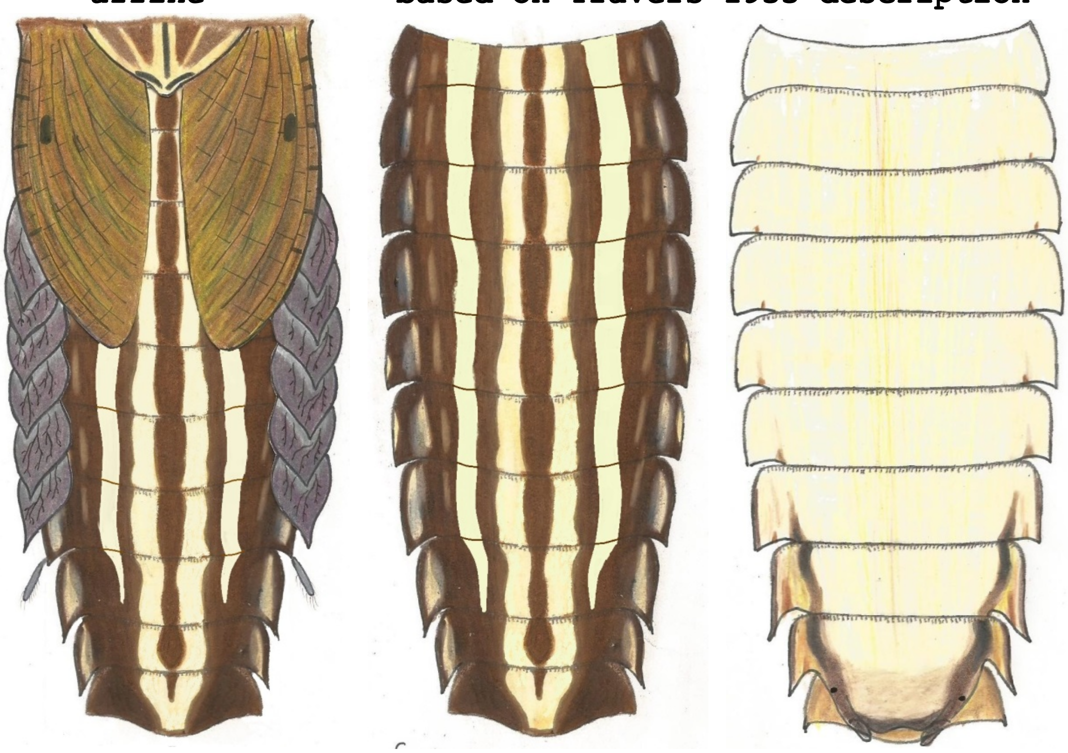


conjunctum male dark type

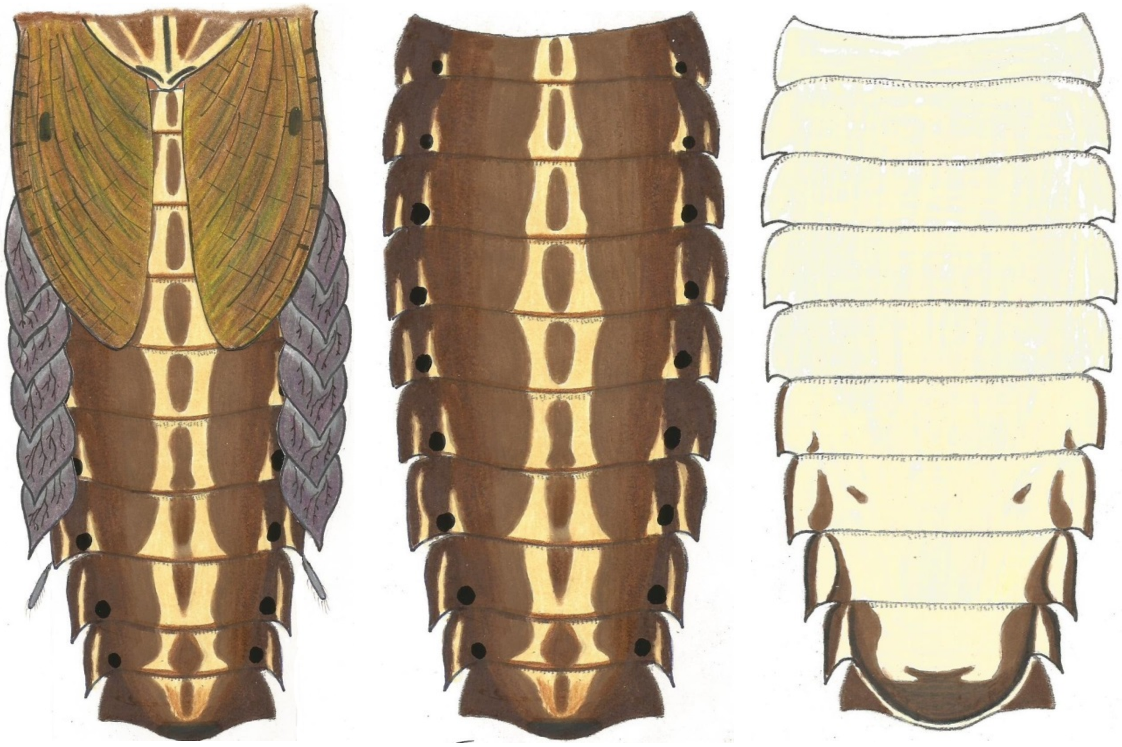


***conjunctum* female dark type**

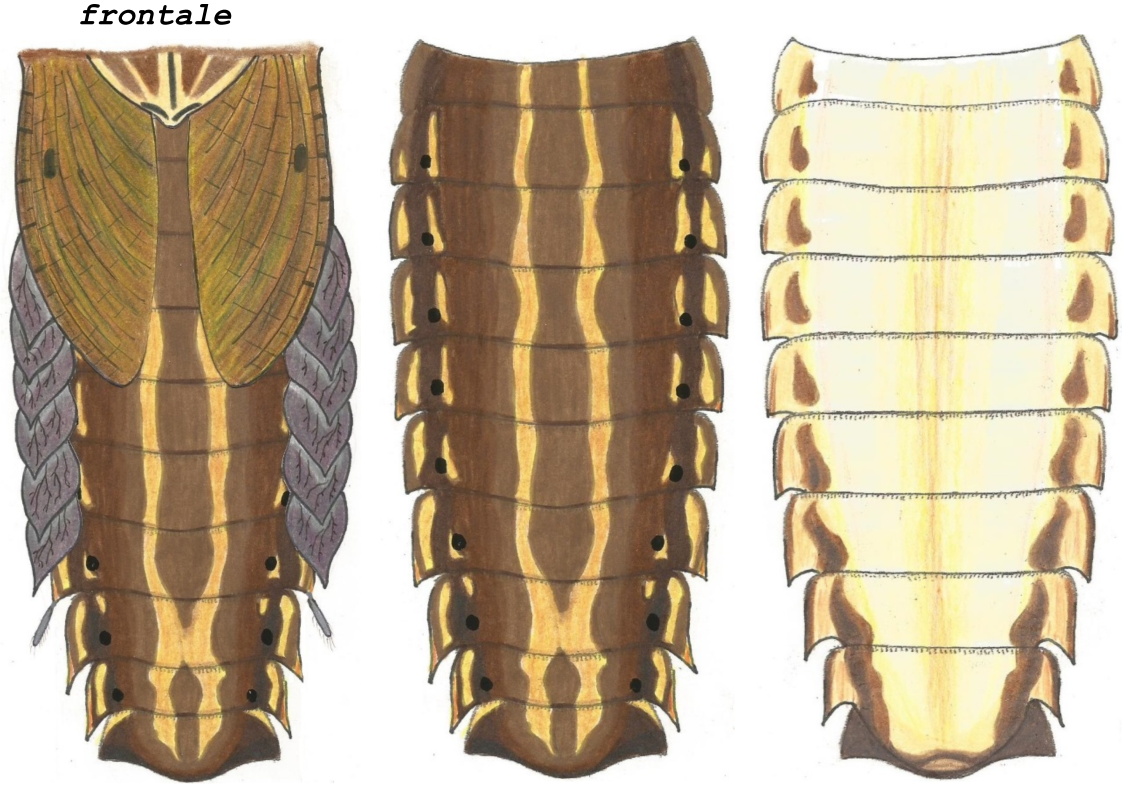
affine **based on Travers 1933 description**



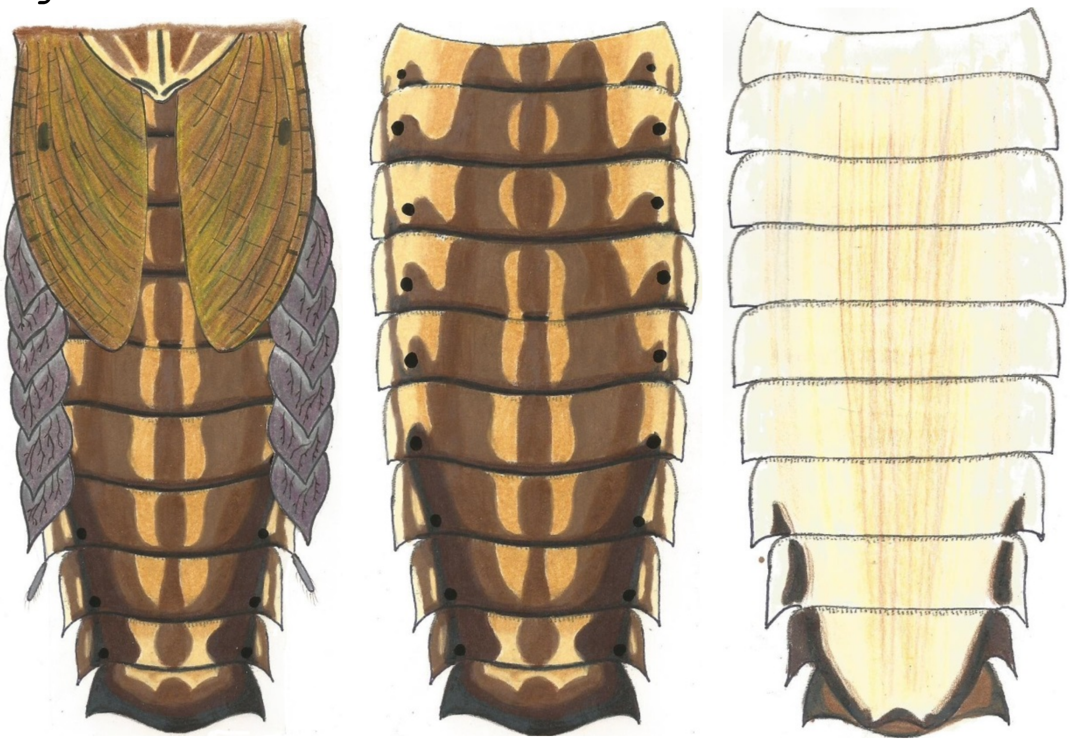
majus



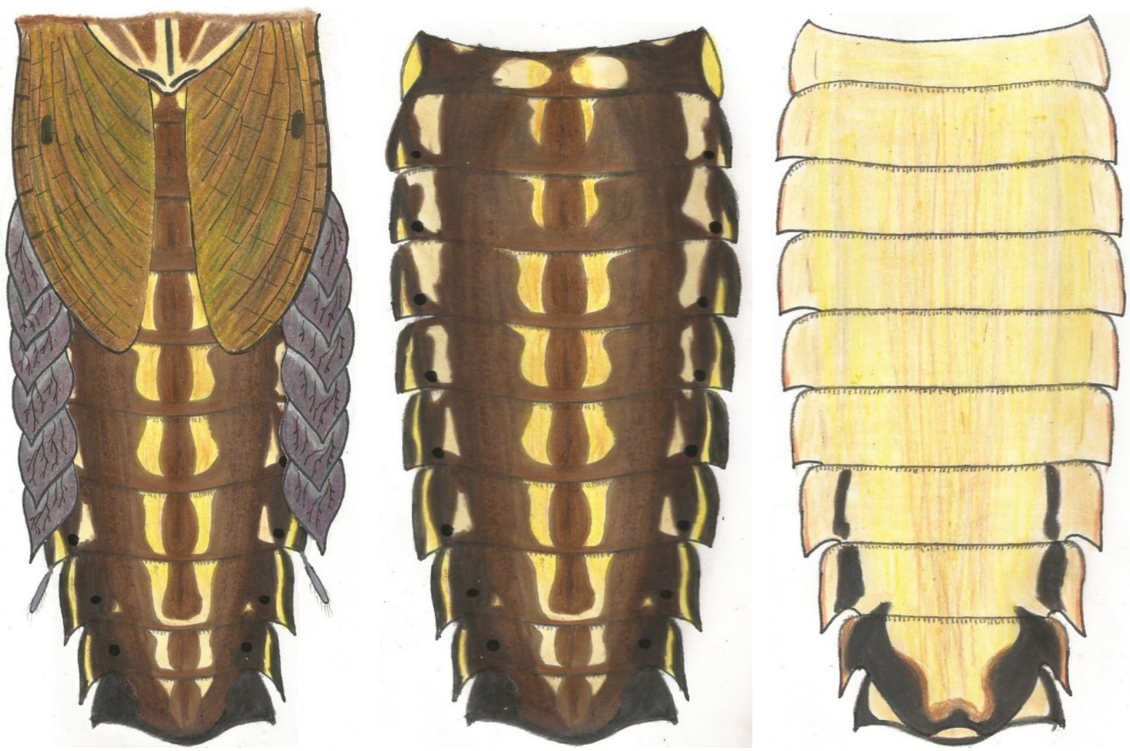
frontale



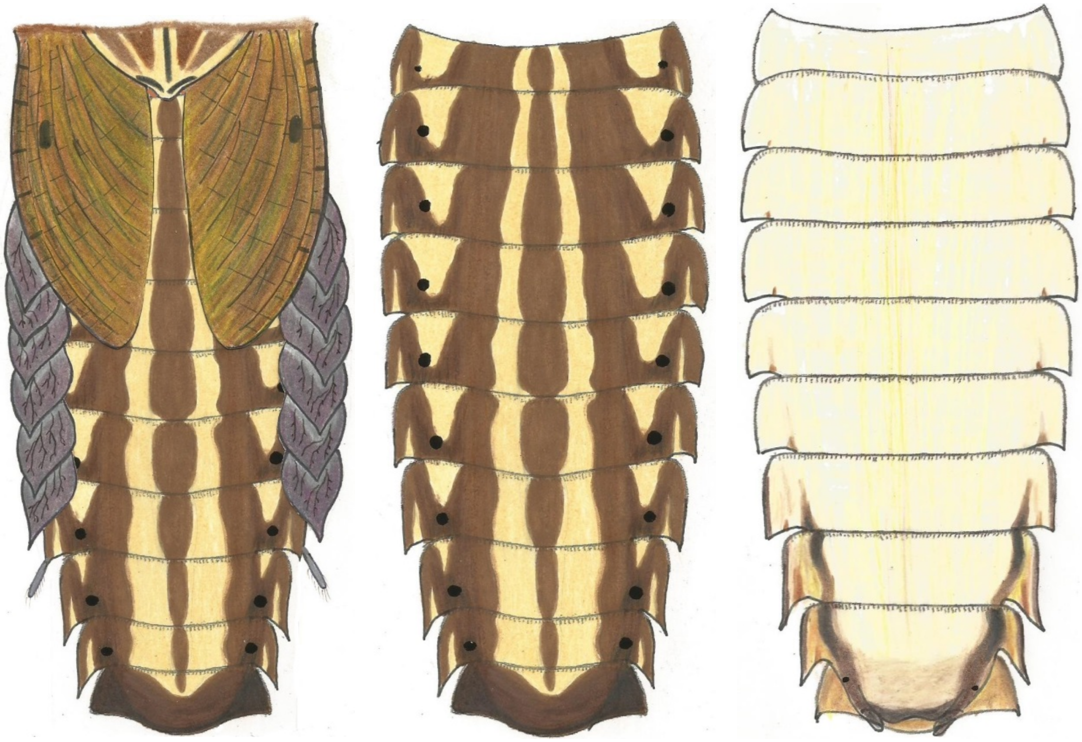
gildersleevei



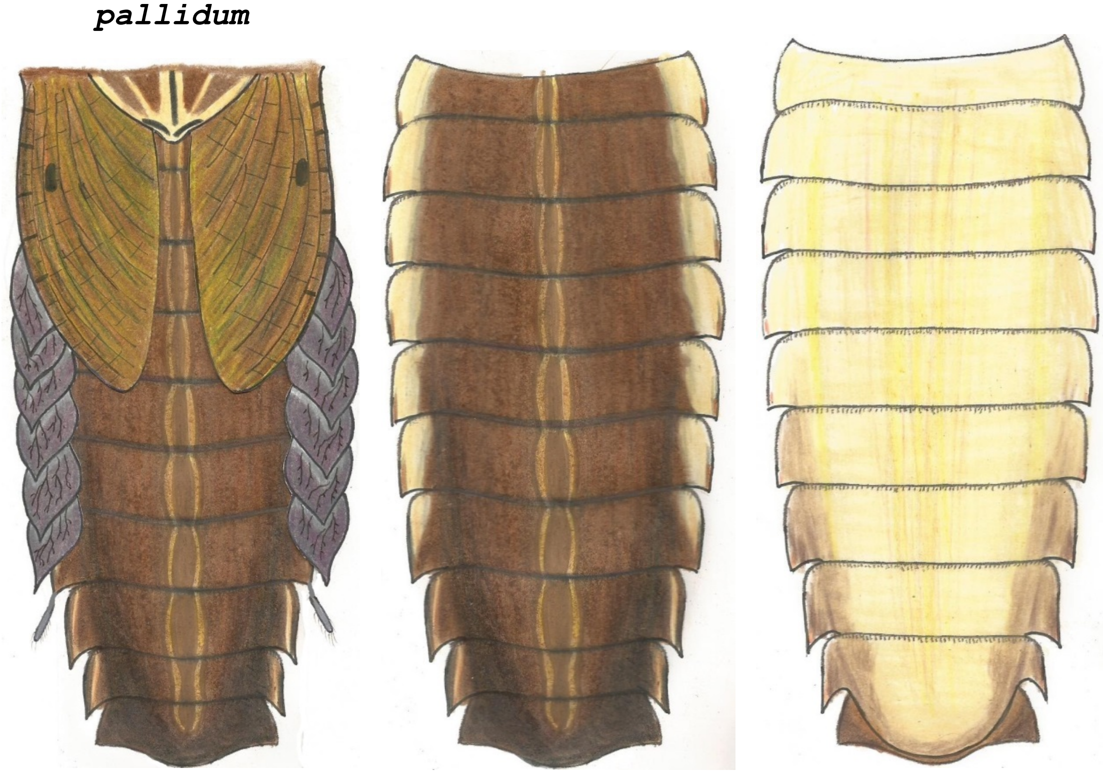
candidum



***minnetonka* based on Lewis 1974 and entire genus study**

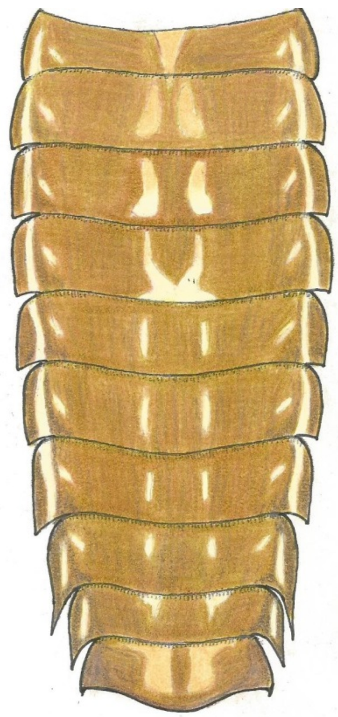


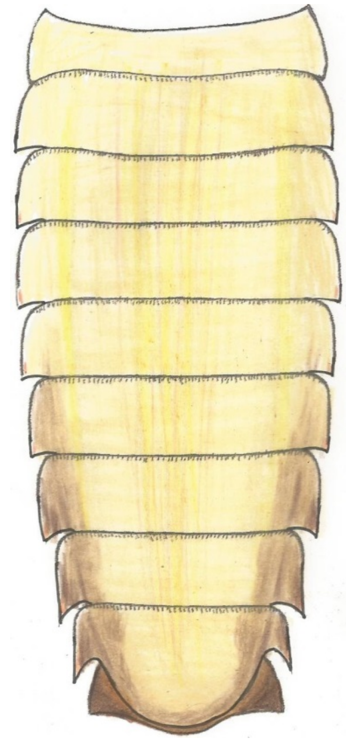
pallidum



carolina

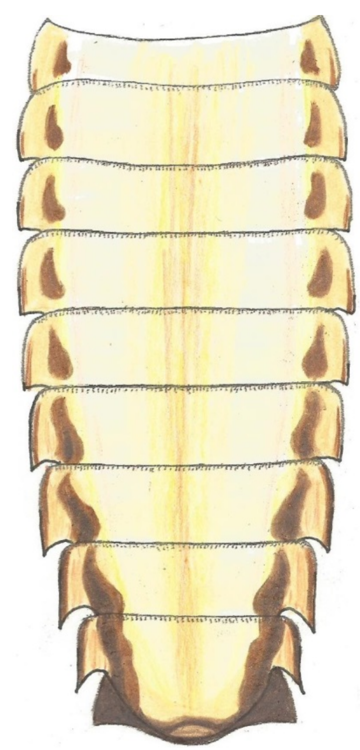
based on Bold Systems collection





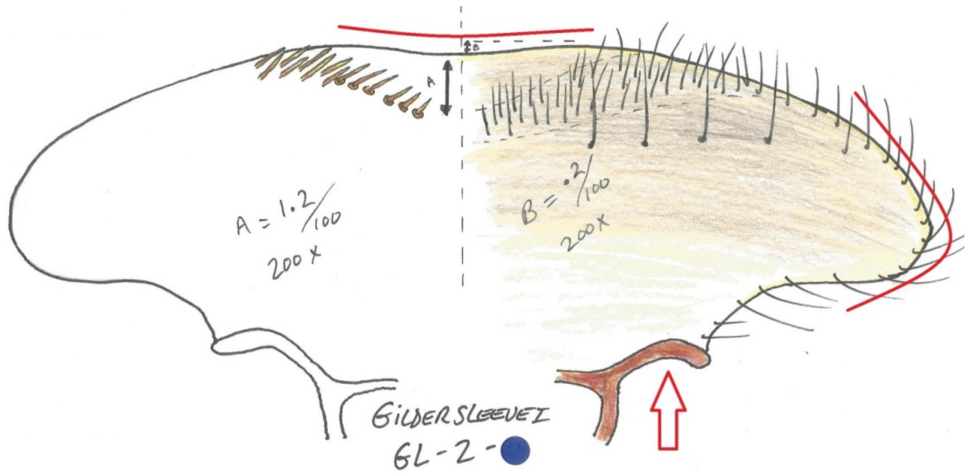
floridense

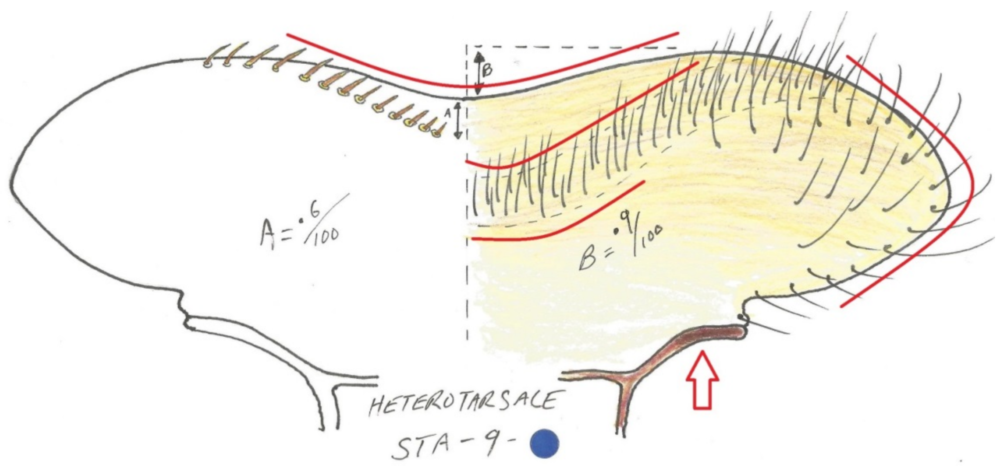
based on Bold Systems collection



Labrum Blueprints

To show the value of the labrum as a diagnostic tool and not a key, let's look at the valid species concept of *gildersleevei* and the one day to be valid species of *heterotarsale*, and just how different the labrums are.



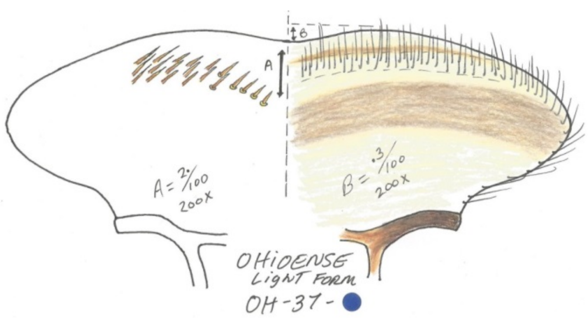


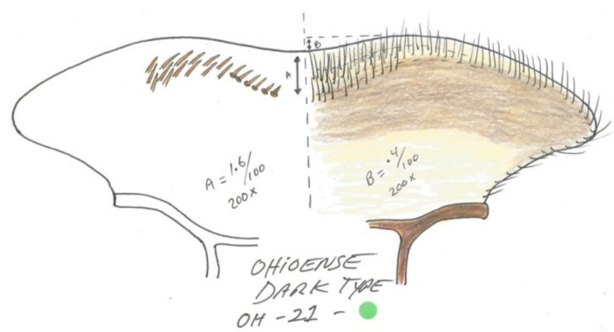
The first thing that stands out is the size and shape of the frontal margin with regards to the indenture. Next the entire posterior-sublateral area around to the forward margin shape is very different. There are distinct differences in the posterior ligaments see red arrows.

Even the accordion like muscle tissues between the left and right ligaments varies in the forms and species with regards to the range of extension in and out. Next are the ventral robust setae spines working from the median spine to the lateral spines? *Gildersleevei* has a single row of 6, followed by 8 rows of 2.

On the *heterotarsale* sample it is only a single row of robust setae. On the dorsal side the setae hair density is different in configuration and in its placement. On the lateral right dorsal area on the *heterotarsale* there are sporadic fine setae.

On the *gildersleevei* there are 4 well spread out extra-long course setae not coming to the median area, and both having lateral margin setae. It is also important to note that each species and or forms have their own head capsule shapes. We never attempted to illustrate the different shapes but *candidum*, *ohioense*, *proximum*, all have different head capsule shapes and they reflect the shape of the forward-indenture and forward margin of the head capsule and labrum. Within form the only time there is variation in the labrums of the dark type verses the light type of the same form. This difference is so minor that we only did the *ohioense* light and dark type to show the minor difference as an example of variation in form.

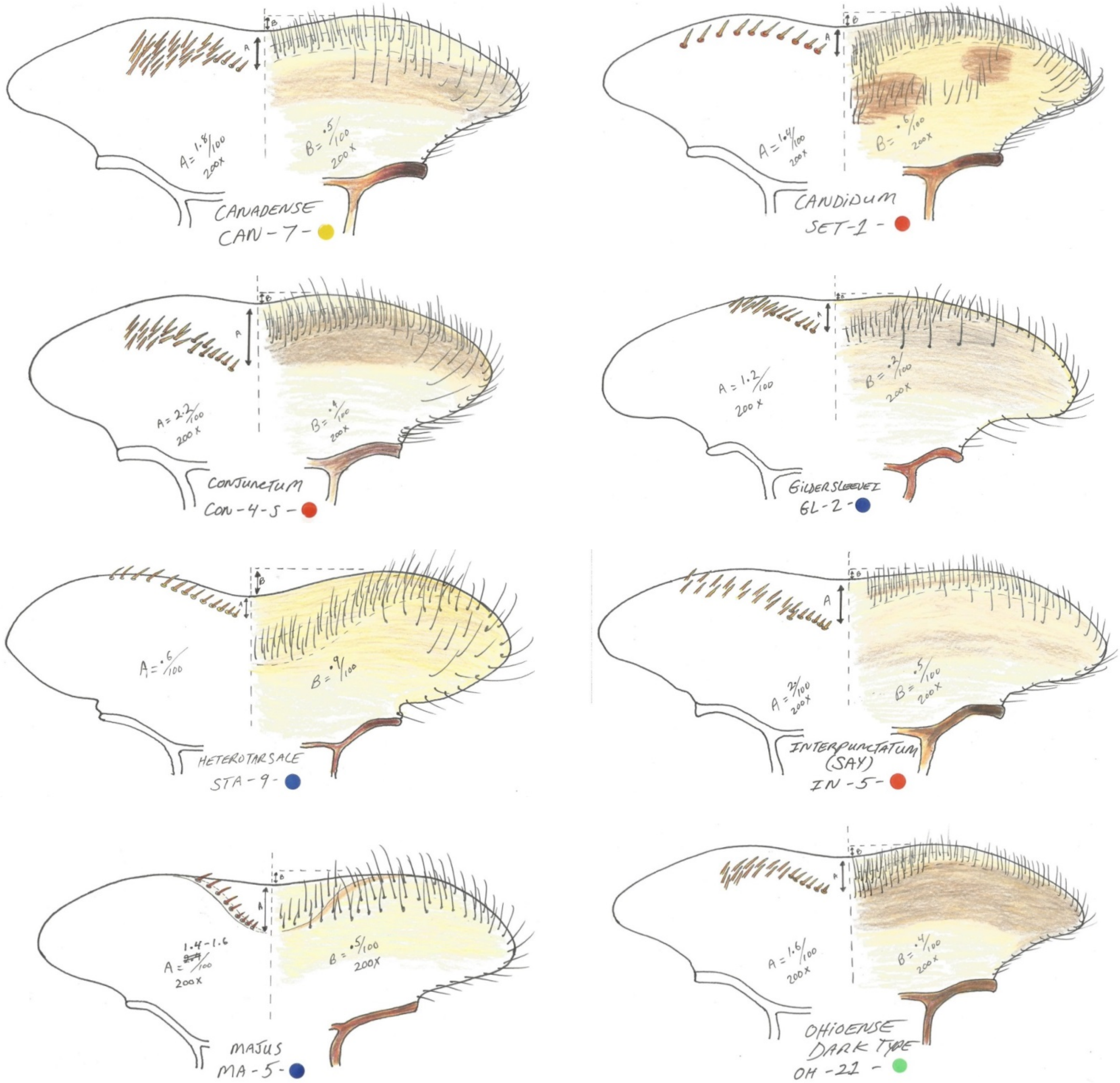


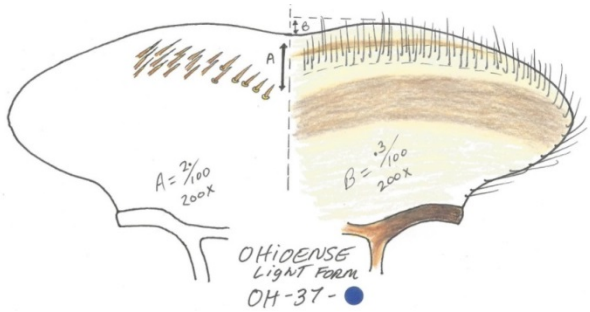


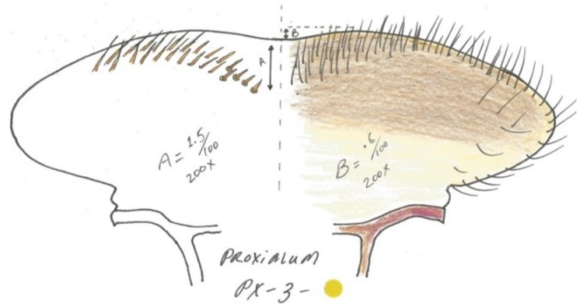
However when it comes to the maxilla and the mandibles there is a big difference. Example *ohioense* light mandible has 6 teeth on the innerside of the outer canine, and 0 teeth on the innerside of the inner canine. The *ohioense* dark type has 7-8 teeth on the innerside of the outer canine, and 3-4 teeth on the innerside of the inner canine. Based on our obersvations of the form *ohionense* dark type late at night in the rearing tank a diet of *claudaphora* algae was highly prefered.

This also seems to align with a need for more teeth to properally process the algae. There is also an increase in the amount for pectinated setae combs on the crown of the maxilla, and fimbriated setae in the submedial row. While viewing the dark type *Ohioense*. The light type *ohioense*, *proximum*, *conjunctum*, *proximum*, *majus* all tended to prefer the lose debria at the bottom of the tank. *Ohioense* dark commonly left a trail

in the algae as they scaped their way onlong on the glass. *Ohioense* dark comes from a dark substrate with lots of *claudaphora* algae. The lighter type is 3.9 mile down stream with heavier sedimentations and lighter amounts of *claudaphora* algae. Clay sedimentation saturation suggests a mineral and debria diet as per McShaffery and McCafferty 1986.

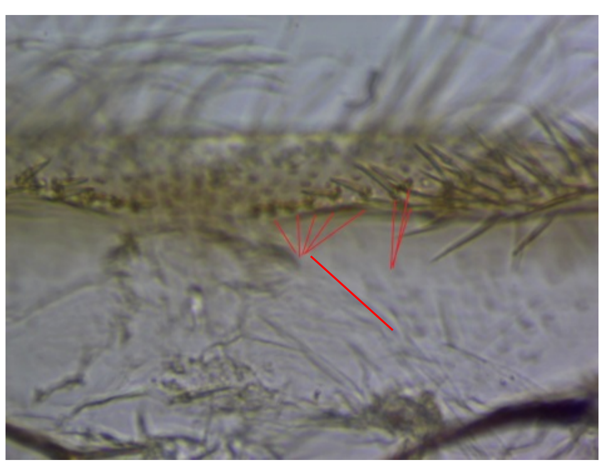






You will notice on every blueprint there is a coding number system. The *proximum* right above says [PX-3-yellow dot] that is my slide set numbers and color coding so we could keep track when we were comparing multi samples at the same time to insure deviation for the blueprints. This was also a slide set filing system so finding a set was easily done.

We would really like encourage someone with collection access to review *affine* Traver 1933. It is very likely that because Traver synonymized *affine* to *heterotarsale* 1935 as per doctor Needham that nobody has examined the former species since. Spieth 1947 lightly discussed it and we think he saw the samples that have been at the Cornell collection since 1933. We are not even sure that larva or larva exuvia exist in the collection. Because DNA states *heterotarsale* should at some point be a valid species, *affine* will need to be re-reviewed. There is distinctly a size difference in the two; as well she also never illustrated the male genitals. At the closing of this book we were able to dissect and photograph the labrum of S *Carolina* showing a row of 6 robust setae followed by a group of 3 then random ones all at the frontal margin.



Comparative Discussions

In this section we will compare the larva. Until this guide little was known about the larva stage. The larvae as far as maculation goes are reliable for consistency in their patterns and trends. Some species have never been seen before, and illustrations of those species or forms were created by descriptions and morphological studies of the entire genus, to give a good overall facsimile to work with.

A new diagnostic tool has come out of intense rearing and larva mouth morphology studies. The labrums of all larvae are consistent and should be viewed as a valid tool to identify larva. At this point only larvae that we collected have been mapped out with a blueprint of the labrum and can be used this way. Dr Jeff Webb has stated this is not a key as it is not dichotomous. It is however a remarkably accurate form and species identification tool.

There are currently 6 forms out of the 16 in the genus that we have not blueprinted. Everywhere this new tool can be employed it will be shown and described in this section of the guide and elsewhere. There is a section just on the blueprinted labrums in front of the general descriptions.

Currently as of 2017 the species and forms that are not mapped out are as follows; *affine*, *areion*, *carolina*, *floridense*, *minnetonka*, and *pallidum*. Some of these are not in our research areas of southern Ontario and therefore access to samples is difficult to obtain.

Some of these forms may never be mapped out as few samples exist in any collections being *affine* and no larvae exist for *areion*. Another important key is the lost key. The lateral projection length of the 8th verses the 9th are reliable to all known forms as per Traver 1935.

larva verification table

This is a basic replica of Travers 1935 table. We have added *interpuntatum* Say as new information was available from current collections. This version is modified with numbers on the top rather than abbreviations. Anywhere this table could be updated we have done so and have marked it by highlighting.

Species or form	1 ♂–♀	2	3	4	5	6 (8th is)
Affine	7-9	N	Y	Y	N	equal
Areion / unknown	7-9	--	--	-	-	unknown
canadense	10-13	N	Y	Y	N	equal
candidum	8.5-10	N	N	Y	N	shorter
carolina	10-11	N	N	Y	N	longer
conjunctum	8-10	N	Y-N	Y	N	equal
frontale	8-10	Y	Y	Y	N	equal
floridense	8-10	Y	N	Y	N	unknown
Gildersleevei	11-13	N	N	Y	Y	equal
heterotarsale	9-11	N	Y	Y	N	equal
Interpunctatum *	7-9.5	N	Y	Y	N	equal
majus	10-12	Y	Y-N	Y	N	equal
minnetonka	8-10	Y	Y	Y	N	unknown
ohioense	10-13	N	Y-N	Y	N	sub-equal
pallidum	6- 7.5	N	Y	Y	Y	Shorter
proximum	9-11	Y	Y-N	Y	N	shorter

1; Body length is expressed in millimeter (♂ is the smaller number)

2; Median pale spot on the frontal shelf of head capsule.

3; Continuous pale submedial streaks on abdomen.

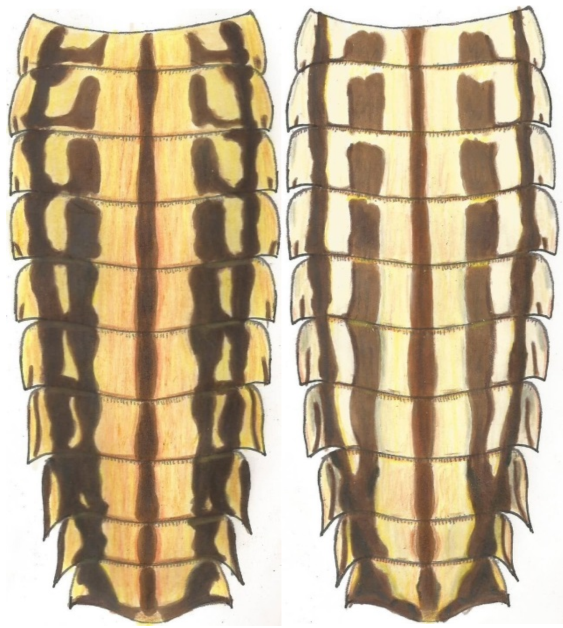
4; Ventral markings on the lateral areas of the abdomen.

5; Posterior edge of tergites dark or blackened.

6; Later projection of the 8th VS 9th for spine size.

Note regarding column 3; there is new evidence of geological variations. When they effect the table they are noted as Yes and No mean that they have both continuous and discontinuous stripes. **Note**; there are no records for lateral projections for any new species after Travers 1935 table. So *minnetonka* and *floridense* are unknown, and *areion* was never collected in the larva stage.

Below for the first time we can see two forms that are very confused when not side by side. The two below are true *canadense* on the left and true *interpunctatum* Say on the right.



Here it is easy to see the differences in them. We will look at the larva from a dorsal view of the abdomen, and the pale maculation mark directly in front of the median ocelli on the head capsule. Both are reliable and useful to aid you in coming to a reasonable conclusion of form, which in turn will bring you to valid species status prior to dissection.

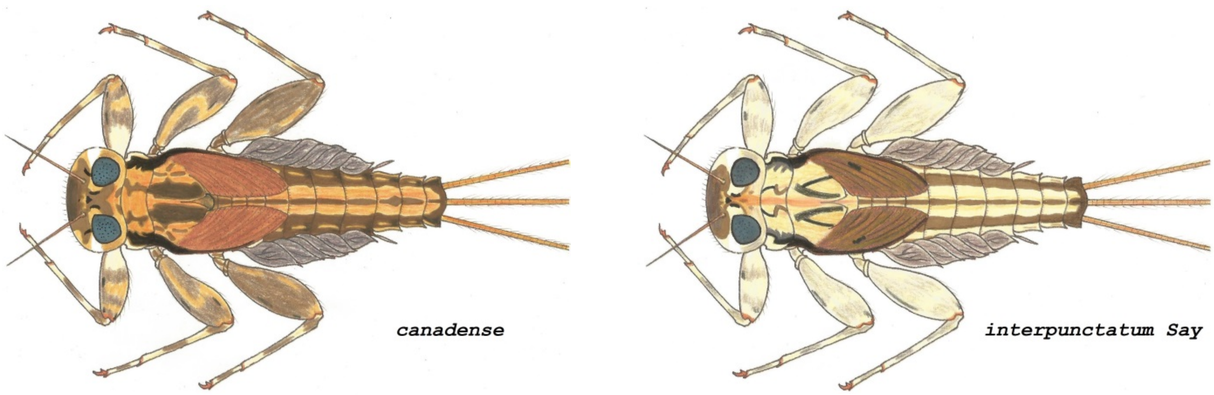
In order to come to positive identification for all larvae they must be dissected and matched to the tables provided in this guide. Dissections of the mouthparts are the only keys to distinguishing them from each other than size, maculation patterns, and the lateral projections.

Lewis 1974 The Taxonomy and Ecology of Stenonema Mayflies really made leaps and bounds to establish mouthpart taxonomy in the different forms. Rearing and researched filed in the blanks of the past 5 years.

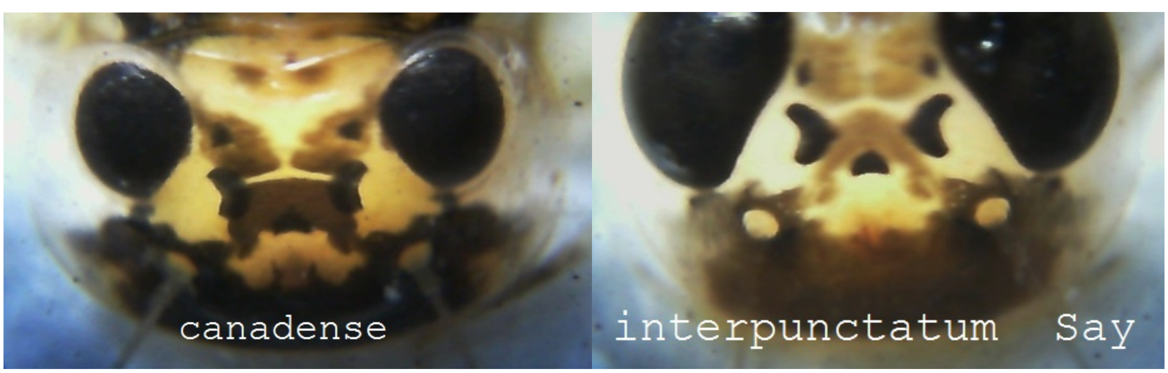
(**Stenacron *interpunctatum / canadense***)

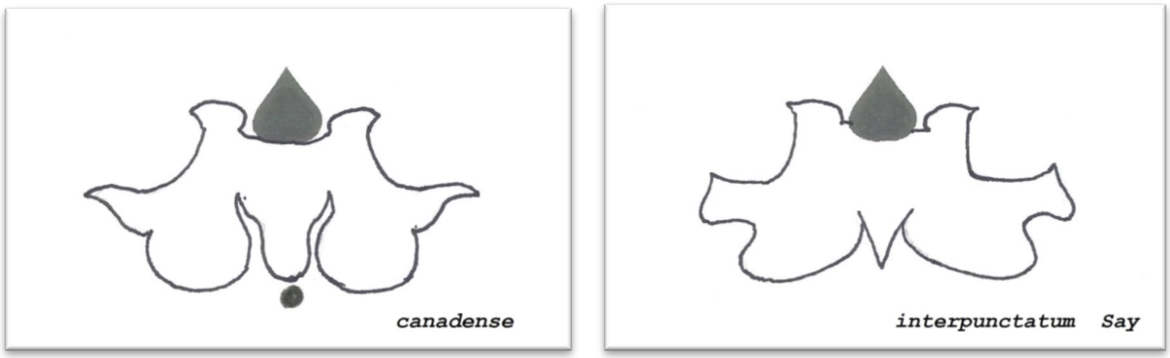
(Stenacron *interpunctatum*) true (SAY)

Clemens (1915) clearly impressed that there is little to no difference in the larva of these two, and that *canadense* should be viewed as a larger form of true *interpunctatum*. While this is reasonably true for the larva stage there are some very reliable and consistent markings to separate them in the larva stage besides their physical size.



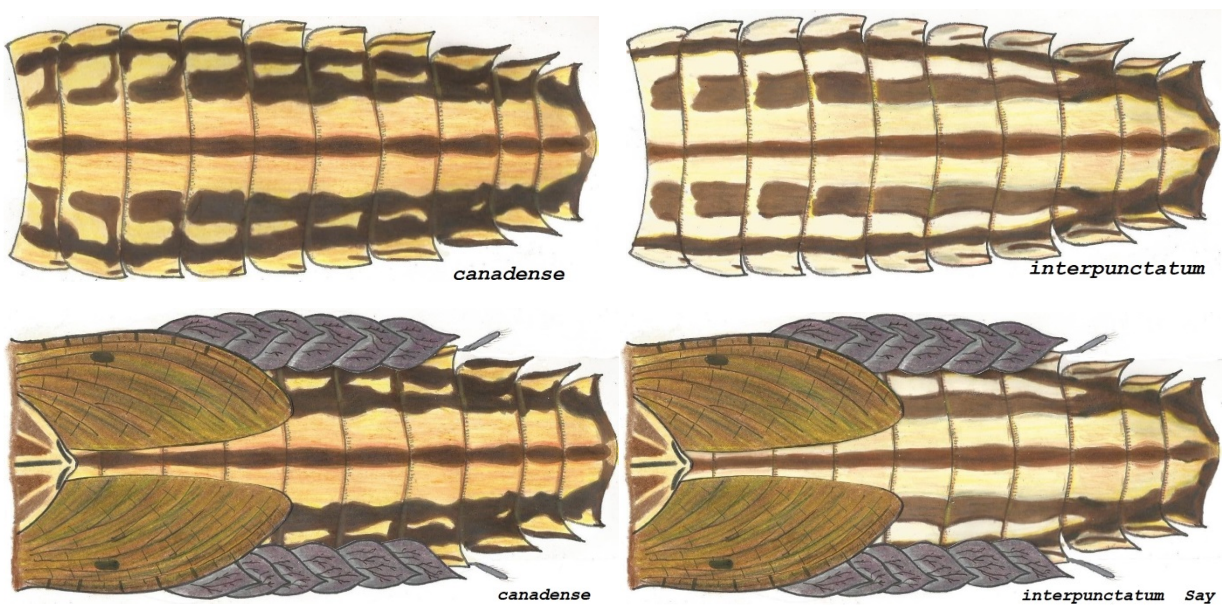
Starting with the heads of these two, here are some head shots for them under the microscope at 40**X**. Although the *canadense* is a female sample the pale median ocelli spots are still consistent between the males and females.



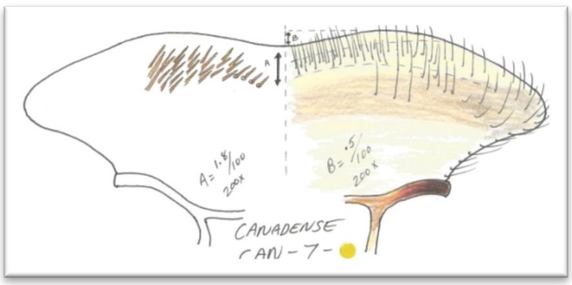


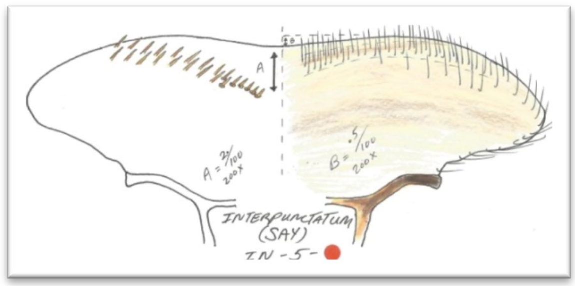
Looking at the pale spot in front of the median ocelli we can see the differences in the spots. On the *interpunctatum* the pale spot is very large almost connecting to the lateral ocelli pale markings near the compound eyes. The pale spots on the head capsule of *interpunctatum* are larger and the background darker coloring is paler and there is no midcrania spot on the *interpunctatum,* but there is on *canadense*.

The abdominal continuous submedial pale streaks on all tergites are wider and more defined on true *interpunctatum* Say. The sublateral abdominal spots are a very important feature. In *interpunctatum* they connect like the submedial streaks and are continuous rather than discontinuous as in *canadense*. The overall color is paler, and the legs on *interpunctatum* the background color is pale hyaline whitish rather than the yellow-brown coloring found on *canadense*.



The size is a strong feature *interpunctatum* male larva being 7 mm and *canadense* males being 10 mm. Both also share equal length in lateral projection of the 8th and 9th segments. If we look at the labrums of these two we can see differences in them.





Here we can see that true *interpunctatum* Say has a single row of 5 in the median area turning into a double row of robust setae. On the *canadense* labrum there is a single row of 4 turning into rows of 3 then quickly into two rows of 4-5 for the robust setae.

We can clearly see as in the abdomens above that they are very similar but yet distinct from each other. They can also be distinguished from each other by the maxillae. On the *canadense* there are 10-11 pectinate setae combs on the crown of the maxilla, and on *interpunctatum* there are 9-10.

Canadense has 25-30 setae in the submedial row, and *interpunctatum* Say has 25 or less according to Lewis (1974) and our studies concur with Lewis.

The mandibles are also diagnostic by *canadense* having 6 teeth on the inner side of the outer canine and 0 on the inner side of the inner canine. *Interpunctatum* Say has 7 teeth on the inner side of the outer canine and 4 on the inner side of the inner canine.

(*Stenacron interpunctatum / ohioense*)

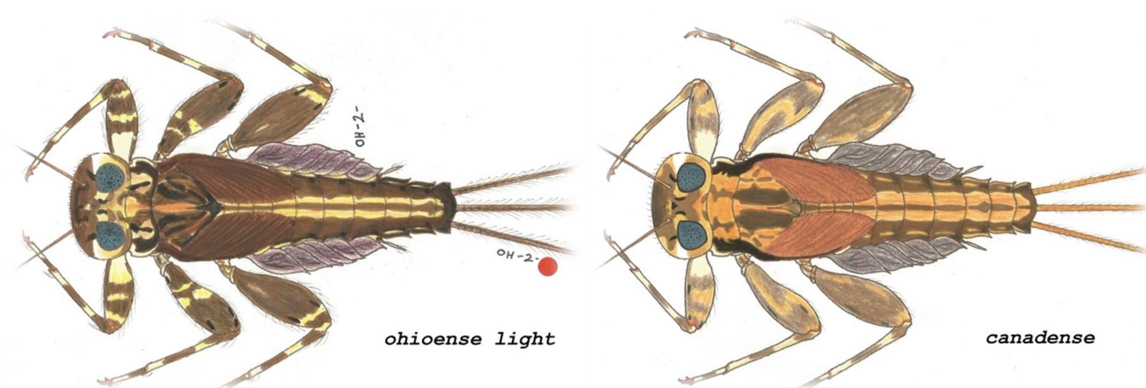
(*Stenacron interpunctatum / canadense*)

We have no doubts that Dr Traver erected *ohioense* in (1935) to separate it from *canadense*. Until that time there was a large amount of taxonomic confusion between these two in the larva in particular. The adults of these two are less likely to be confused. Dr Walkers (1853) description for *canadense* does not mention that the species has spiracular spots and Traver (1935) also agrees with Walker.

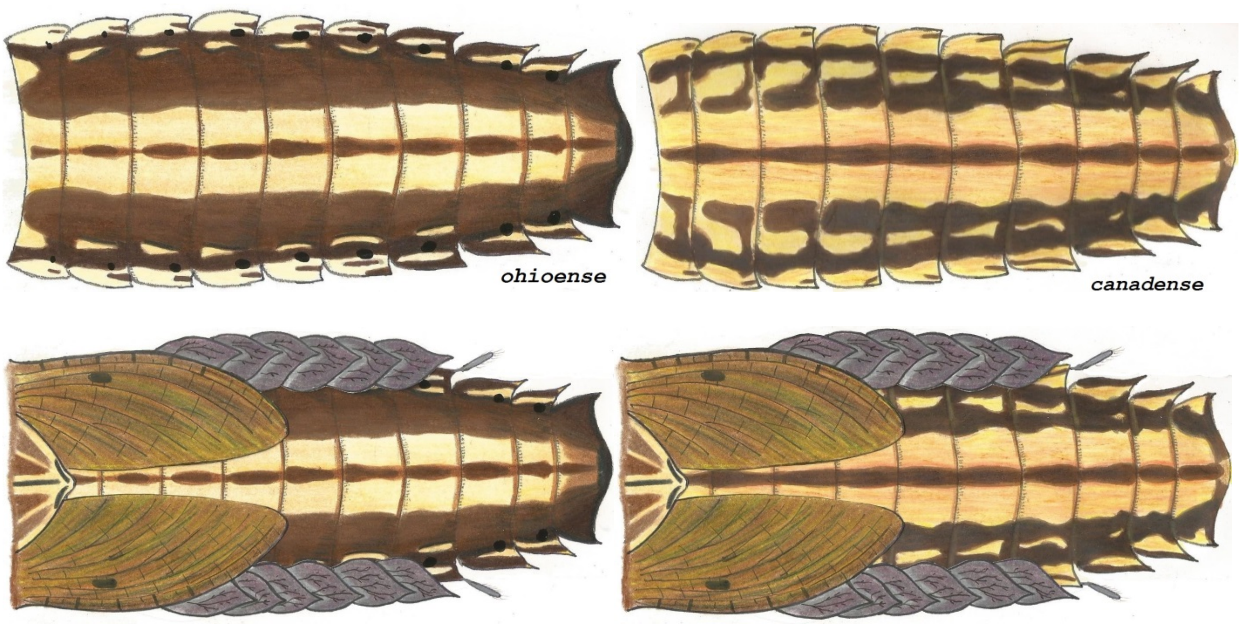
The first sign of confusion over spiracular spots was Clemens (1915) where he stated that *canadense* in the larva stage has spiracular spots. Clearly he was looking at the light type for *ohioense* as it has spots and even today it is hard to differentiate it from *canadense*.

Currently there are two types of *ohioense* larva and both have spots. One has discontinuous submedial stripes on the abdomen the other has continues stripes.

See the chapter *the leopard larva changed it spots* for more details on that. For this section we will only utilize the light type of *ohioense* larva as it matches Dr Travers description for that form in the larva stage.



We can see a true difference between them when placed side by side. Now let’s look at the complete abdomens for these two with and without wing pads and gills.



The abdominal view makes it very clear who is who. But even at that, it can be very hard to separate them. The sublateral spots are hidden under the gills on the *ohioense*, and the spiracular spots are hard to see. However without dissection they can be separated by two key features.

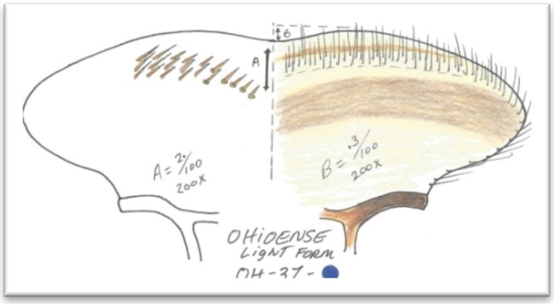
On the *ohioense* larva the 8th and 9th lateral projections are not quite equal. They are referred to as sub-equal by Dr Traver (1935).

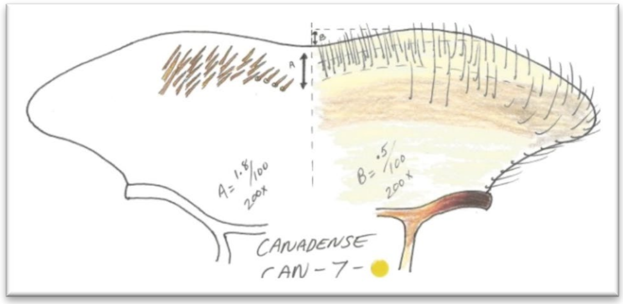
The 8th projection is slightly shorter than the 9th. On average the difference is the 8th is typically 6-7/100th of a millimeter at 200**X**, and the 9th is commonly 9-11/100th of a millimeter long. Though not a big difference, it is visible under lower powered magnification.

The second feature to separate *ohioense* is the spiracular spots at the lateral areas. They can be hard to define on tergites 6-9, but on the first through the 6th they are easily seen hiding within the gills. True *canadense* will not have spots.

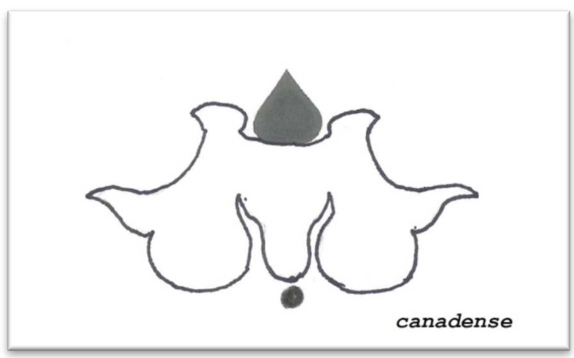
It will however have blackish shading in the spiracle areas. But this blackish shading is typically only present on tergites 6-9.

Therefore tergites 1-6 should be void of blackish marking but may still be darker.





Looking now at the labrum on the *ohioense* it has a median single row of 4 followed by 2 rows of 2, then 4 rows of 3 robust setae. Using this combination **(labrums + lateral projections + maculation) =** form and then species under preliminary dissections. Further dissection of the maxillae and mandibles will confirm you findings on any larva.



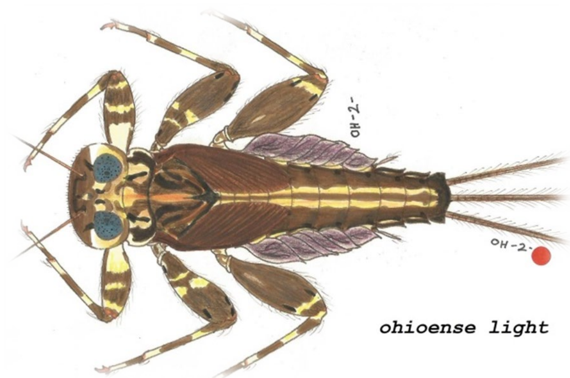
Looking at the median ocelli pale spots we can see the difference in the two forms. The larva of *ohioense* light can be confused with *proximum* and that is the next situation we will review.

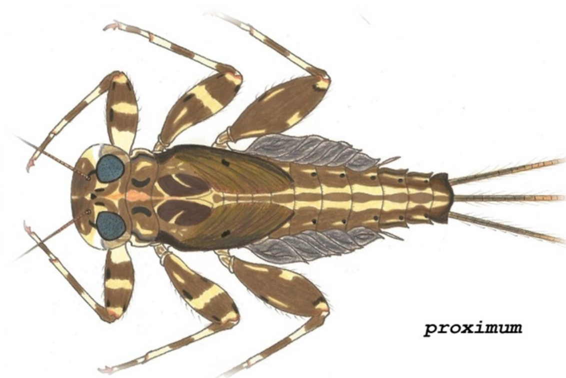
(***Stenacron interpunctatum / ohioense***)

(*Stenacron interpunctatum / proximum*)

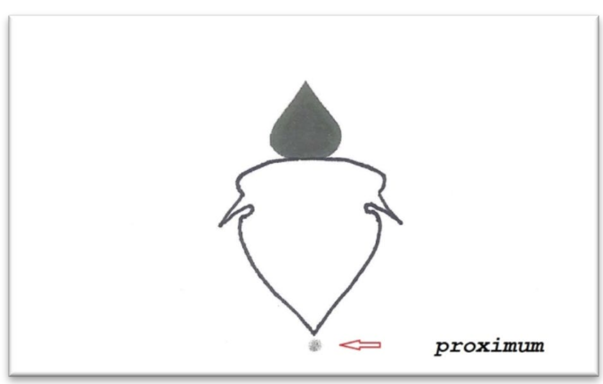
Confusion of these two larvae is very likely mostly because of the lateral projection. As discussed above *ohioense* has sub-equal lateral projections and *proximum* has a shorter 8th projection. They both also share continuous submedial streaks. We can separate them by two delimitating factors. The labrum is critical for separation as is the physical size.

Proximum is smaller in overall size. Looking at the full larva we see how these two are confused without great care.



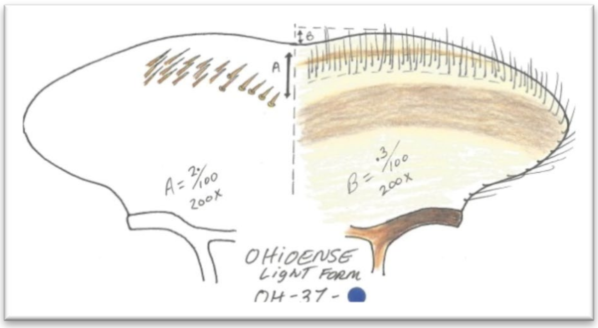


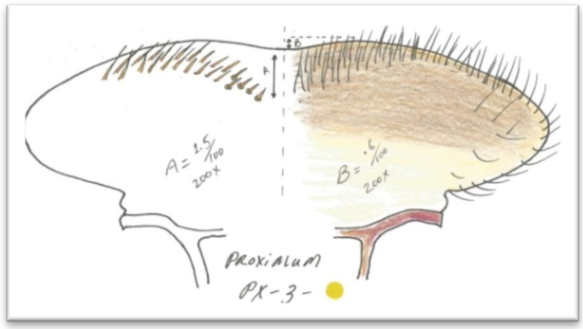
Clearly too really separate them we will have to do a full diagnosis. Let's start at the head capsule. One defining feature is *proximum* has a very fine pale pinkish median stripe on the frontal shelf. Next the pale spot in front of the median ocelli is quite a bit different.



The other unique and fine feature is the median crania spot. On the *ohioense* this is a very strong feature that transcends into the adult stage as part of the complete smile or transverse band across the frontal shelf. In *proximum* as seen by the red arrow has very faint shading or no spot at all.

The adults of *proximum* do not have a true median crania spot but rather fine gray shading as seen in the larva head capsule. Looking at the labrums we can see differentiation in the number of robust setae and their placement.



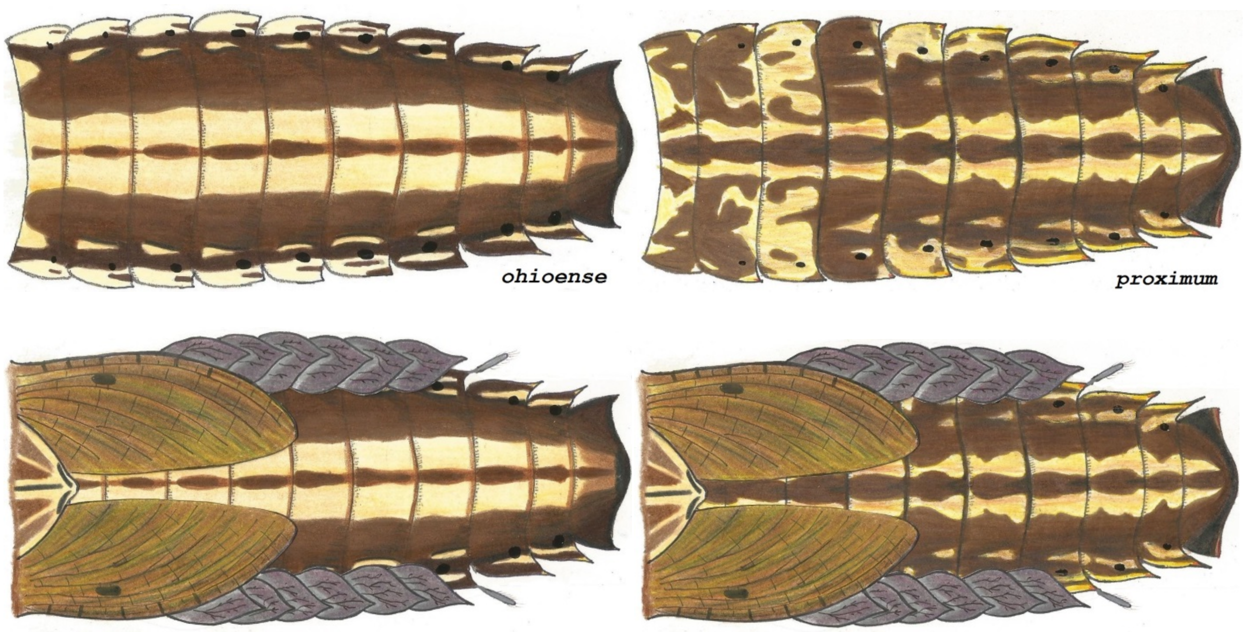


Another feature of the labrum lies on the dorsal side. The placement of the fine setae hairs on the *ohioense* are forward of the robust spines and on the *proximum* most of this setae hair covers over the robust spines. The other interesting feature is on the *proximum* the robust setae reach the lateral anterior edge and this does not occur on the *ohioense*. Measurement **A=** will help you determine between the two as *ohioense* median robust spines are set much further back from the anterior edge.

Moving to the other mouthparts to further separate them. The maxillae of *ohioense* have 10 pectinate setae combs on the crown of the maxilla, and on *proximum* there are 10L–11R. In the submedial row of *ohioense* there are 25-30 setae, and on *proximum* there are 28-32.

The mandibles are of more help than the maxilla. On the *ohioense* there are 6 teeth on the inner side of the outer canine, and 0 teeth on the inner side of the inner canine. On *proximum* there are 6 teeth on the inner side of the outer canine, and 2 teeth on the inner side of the inner canine. Clearly with this information combined with the fine details they are different.

The length of the 8th lateral projection on proximum is considerable. When viewing these two side by side we can clearly see the difference in the 8th projections. Moving over now to the abdomens for comparisons. Side by side there is not much to compare as they are clearly different. One striking difference is on the *proximum* the sublateral areas of the 3rd tergite are almost completely pale which is not visible with the wing pads present.



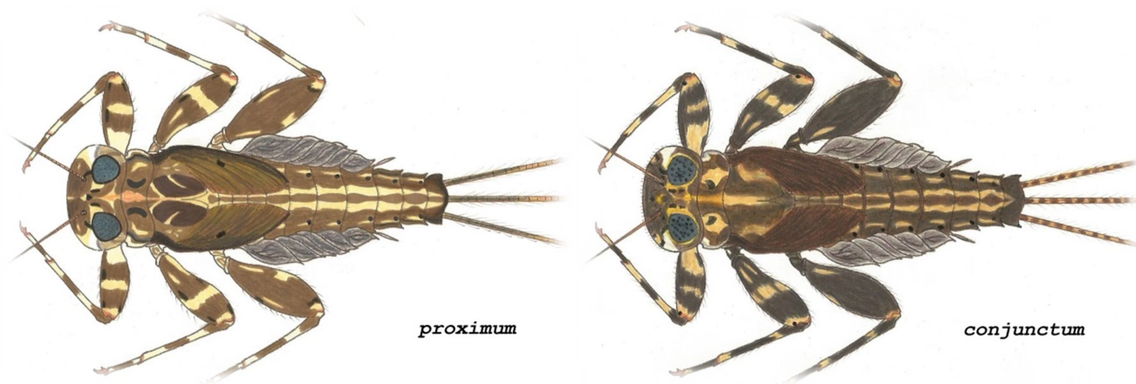
Now we will move to compare *proximum* with *conjunctum*.

(***Stenacron interpunctatum / proximum***)

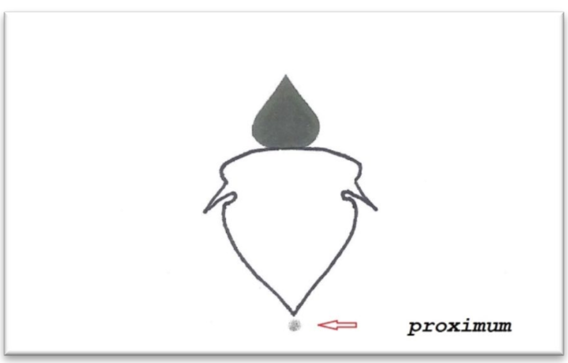
(*Stenacron interpunctatum / conjunctum*)

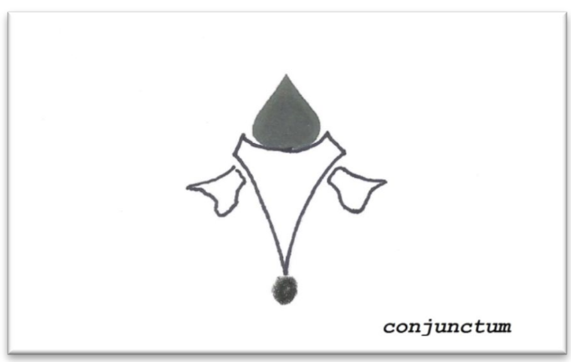
These two are extremely similar in the larva and especially in the adult stages. There are times when separating the two is impractical. However they can still be defined by some very fine points.

The most critical feature in the larva stage is that *proximum* has a shorter 8th lateral projection and the 8th and 9th are equal in *conjunctum*. Let's start by looking at the full larva views.



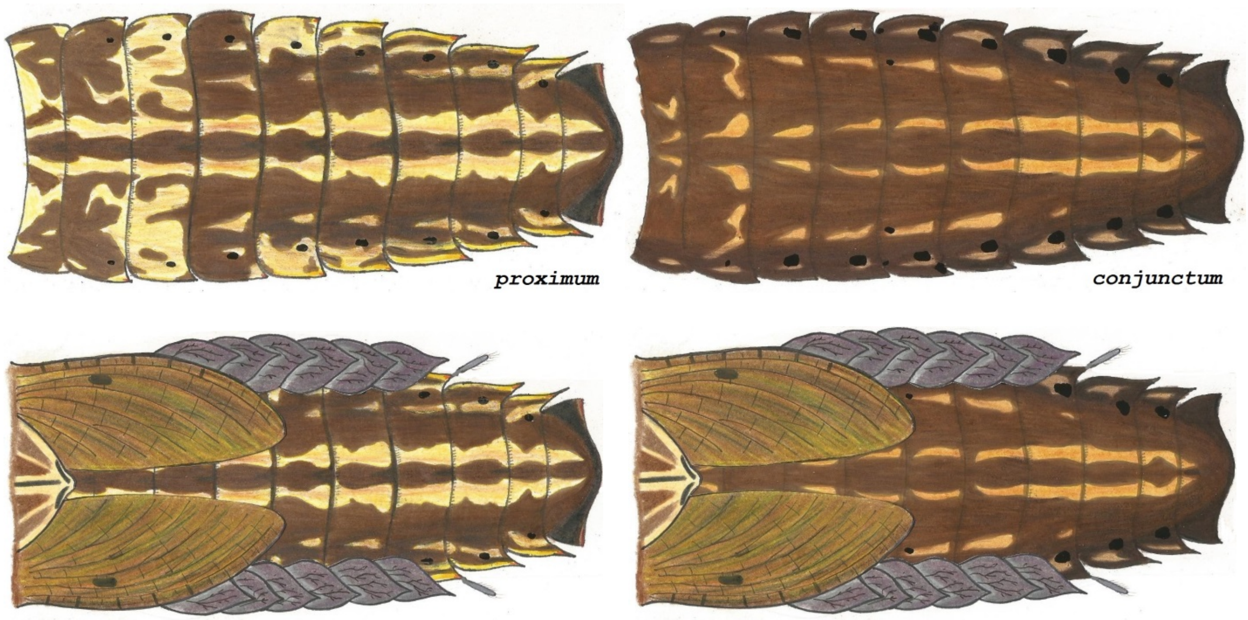
There is also a small difference in the overall size of the two. *Proximum* male is normally 9.5 mm and *conjunctum* is typically 8 mm. The standard geological variation of *conjunctum* is very dark grayish black as seen above and *proximum* is much paler. Turning to the pale spot in front of the median ocelli. We can clearly see that they are shaped different but more so are that *conjunctum* has a median crania spot that is strong and clear. This spot also is a strong feature in the adult stage.





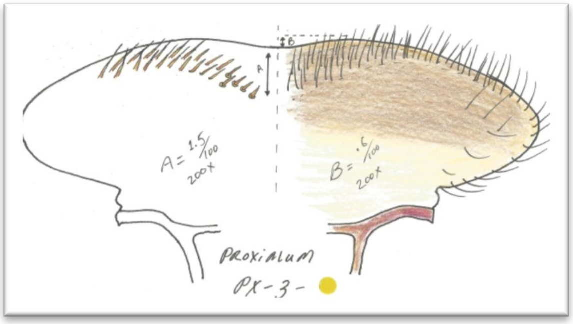
Looking at the abdomens there is one feature that clearly stands out. The submedial stripes on *proximum* are continuous and on *conjunctum* they are discontinuous.

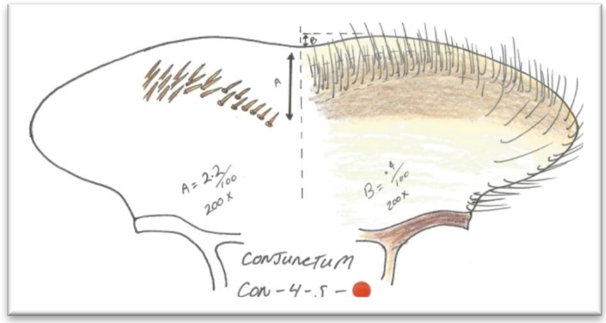
The other interesting feature is the way the submedial stripes intrude into the 10th segment. On the *proximum* they are fully intruded, and on *conjunctum* they barely intrude past the anterior edge.



Notice that the terminal lateral edges are lighter on the *proximum* and darker on the *conjunctum*. While on the topic of the abdomen we should look at the female *conjunctum*. Notices on the male *conjunctum* above the submedial stripes are only discontinuous from the 1^{st} to the 6^{th}. In the female seen below they are discontinuous throughout. The other interesting factor was mentioned by Dr Traver in her (1935) couplets that *conjunctum* has a ♦ diamond shaped spot in the median area of the 9^{th} tergite as seen in the illustrations.

It was important to mention this because of the confusion that could occur if not mentioned now. Backing up now we shall move to the mouthparts of the two. The labrums of the two are very close as we would expect see with them having so much in common.





The most important feature is how far back the robust setae rows are from the anterior edge in the median area. Notice on the *proximum* the robust seta comes out to the lateral areas of the anterior edge. Also on the *conjunctum* all the dorsal setae hairs are set well forward of the robust setae.

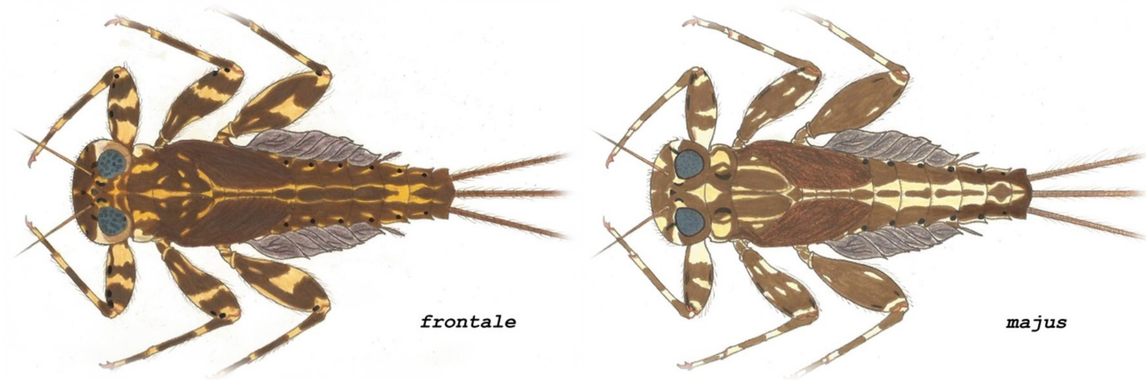
In *proximum* they are almost on top of them. The measurement **A=** will also separate them from each other. The other mouthparts of interest are the maxilla and the mandibles. On the crown of the maxilla on *proximum* there are 10L and 11R pectinate seat combs, and on *conjunctum* there are 10 on each. In the submedial row on *proximum* there are 28-32 setae, and on *conjunctum* there are 34-37 present.

On the mandibles of *proximum* there are 6 teeth on the inner side of the outer canine, and 2 teeth on the inner side of the inner canine. On *conjunctum* there are 6 or 7 teeth on the inner side of the outer canine and 1 or 2 on the inner side of the inner canine. This diagnostic work allows separation of these two.

(***Stenacron interpunctatum / frontal***)

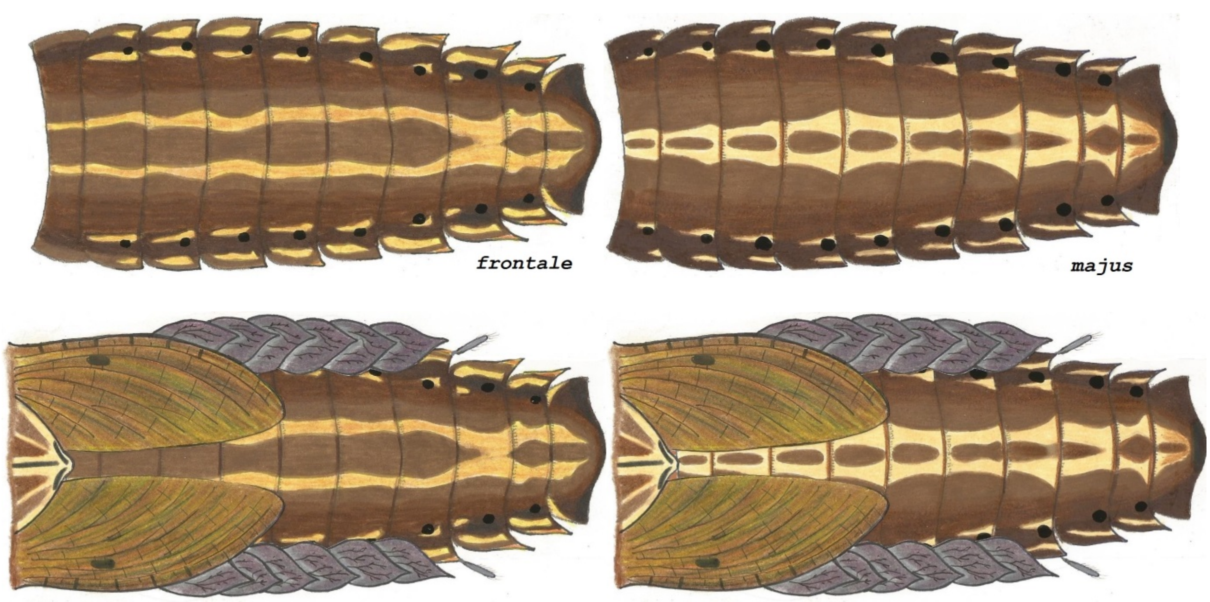
(*Stenacron interpunctatum / majus*)

These two are very likely to be misidentified in the larva by two basic features. They both have a pale spot on the frontal shelf of the head capsule, and they both share a deletion of pigmentation in the median posterior area of the 8th tergite.



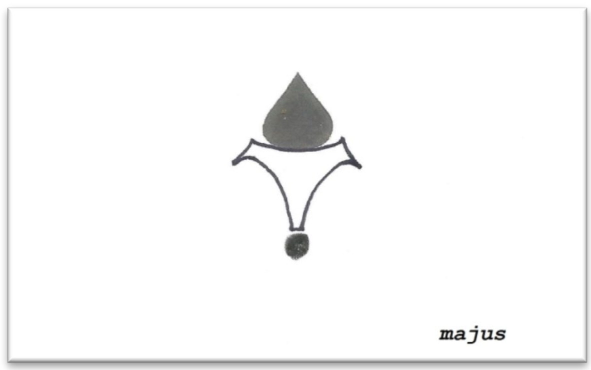
Although this deletion is typically very minor in *majus*. When both are side by side we see many differences in them. The deletion is typically very large in *frontale* as we see in the full abdomens.

Both have continuous submedial streaks but notice how wide the median line is on the *frontale* from the 1^{st}-7^{th}. On *majus* the median line is smaller and broken up. Each median section is typically shaped like a "lens" as noted by Dr Traver (1935). On the *majus* there is also an interesting feature not seen in any other in the genus. Looking at tergites 4, 7, and 9 the posterior area of the submedial streaks, they flair out towards the lateral edge from the median areas rather bell shaped.

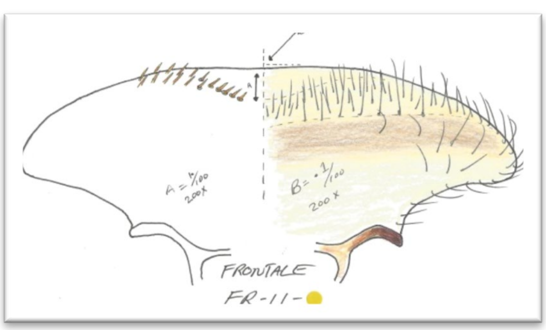


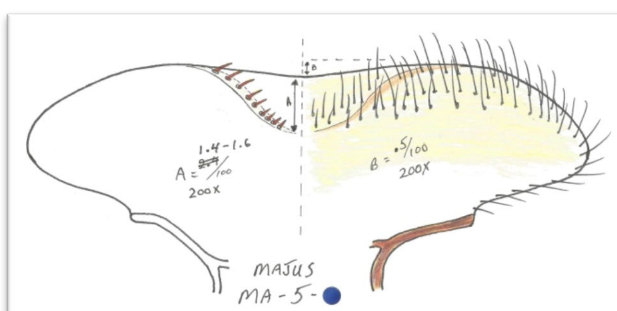
The spiracular spots on the *frontale* are commonly very small and hard to see, in the *majus* they are very large and standout as they do in the adult stages. On the *majus* with regards to the posterior of median area of the 7^{th} tergite there is commonly a slight deletion in pigment of the median stripe as seen above. This does not occur in typical samples of *frontale*.

The pale spot in front of the median ocelli is also very different from each other. However they both share a median crania spots that transcends in to the adults stage. The *frontale* spot is much more of a heart ♥ shape and on *majus* it is more or less and **T** shaped spot.



On the mouthparts the labrum will greatly help to separate them. The *majus* has very prominent stout robust setae in a single row that commonly but not always follows a ridge like fold. This fold has been found in more than 80% of all larva examined by us. It is still unclear if this ridge fold has any specific value.





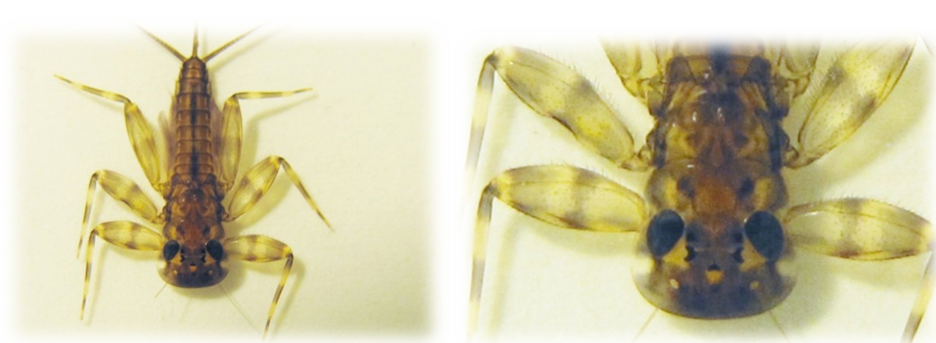
On the *frontale* the robust setae start out as a single row of 5 then become a row of 2. The indenture **B=** is very shallow on the *frontale* and the overall shape is quite different. Both the maxilla and the mandibles have separation value. The maxillae of *frontale* according to Lewis (1974) are as follows, (and our studies concur with him). There are 9 pectinate setae combs on the crown of the maxilla, and there are 9L and 10R on *majus*. There are 39-46 setae in the submedial row on *frontale* and typically 34-35 on *majus*.

The mandibles of *frontale* have 6 or 7 teeth on the inner side of the outer canine, and 2-4 on the inner side of the inner canine. On *majus* there are 6-8 teeth on the inner side of the outer canine, and typically 0-2 teeth on the inner side of the inner canine. Both of these forms share lateral projections of the 8th and 9th that are equal in length.

(***Stenacron gildersleevei***)

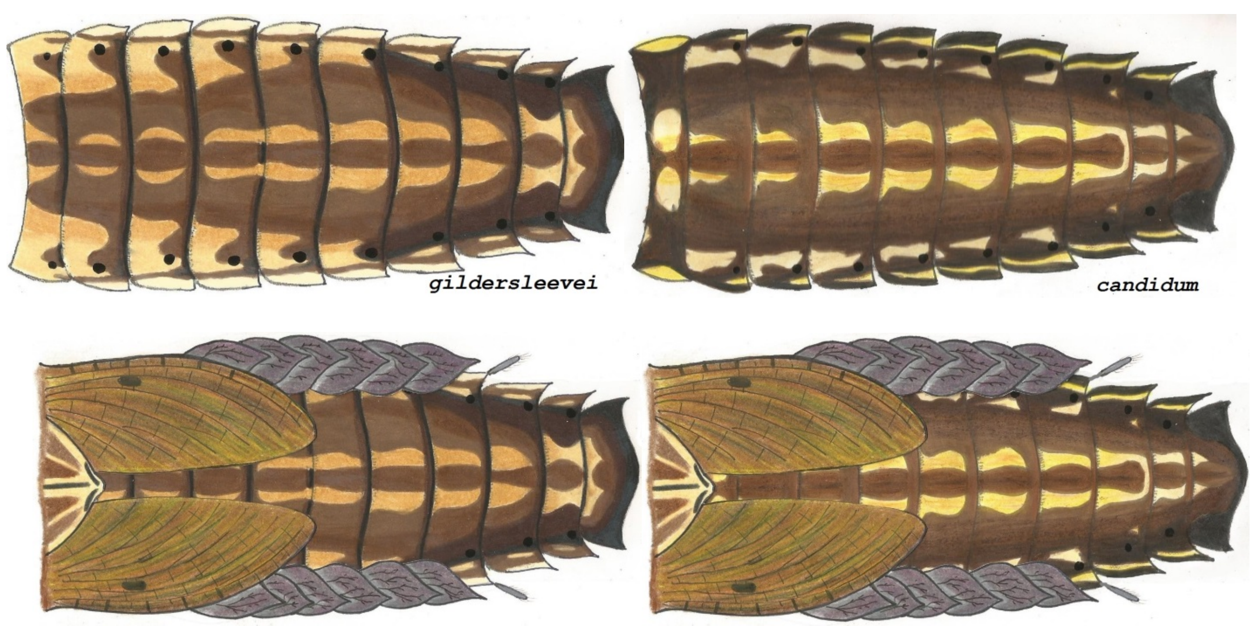
(*Stenacron candidum*)

These two are very likely to be confused for two very specific reasons. First there are no known photos of *gildersleevei* till now, as we are offering photos of this species in this guide. The second is both are very distinct from all others in the genus by their discontinuous submedial abdominal stripes. Here are photos of *gildersleevei* for the first time.



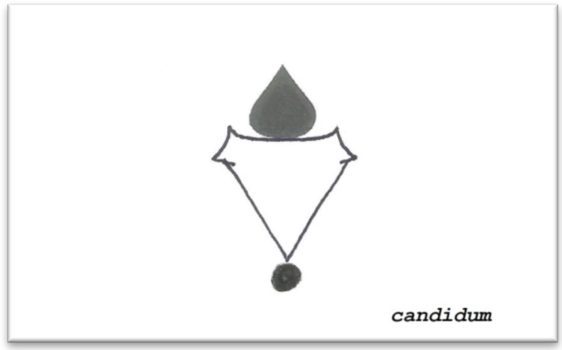
We should look at the full larva views of these two. The first major difference is *candidum* is very dark, almost black and *gildersleevei* is more of a cinnamon like in coloring. Without them being side by side it is very difficult to separate them. But they are very different when we look really close at them. *Gildersleevei* is also much larger than *candidum*.

The very first clue to separate them is *candidum* has a shorter 8th lateral projection and on *gildersleevei* they are equal. Now let's look closer at their abdomens.

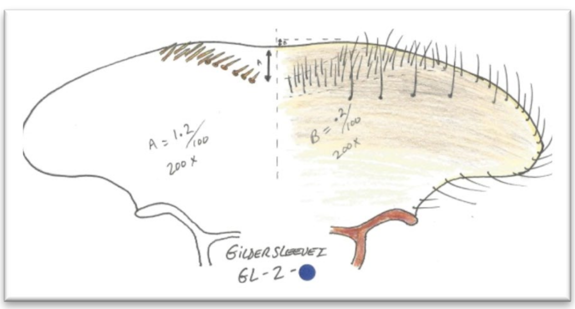


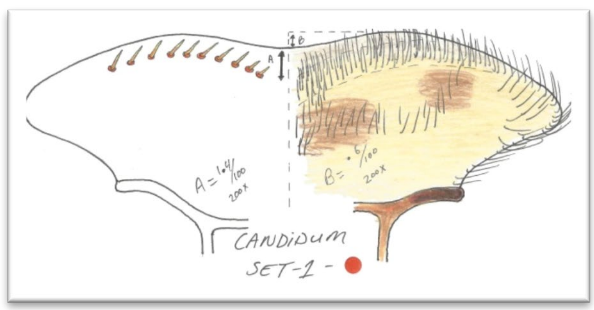
They are really starting to look the same. The first striking feature is their submedial stripes. They are both quite discontinuous but interestingly enough both have "vase" shaped spots.

What really stands out is the amount of pale areas on *gildersleevei* when the gills and wing pads are absent. The most important thing before dissection to tentatively identify them is *gildersleevei* has blackened posterior margins at the end of each tergite and *candidum* does not.



Moving on to the head capsules and the mouthparts. The pale median ocelli markings are similar but different. The mark on *candidum* is very triangle shaped agreeing with Burks 1953. The mark on *gildersleevei* similar but it is more elongated on *gildersleevei*.





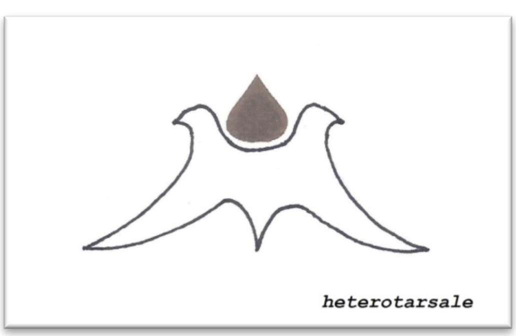
The labrums offer a lot to separate them. First is the general shape they are distinct, but the robust setae is the bigger clue. On the *gildersleevei* there is a single row of 6 in the median area then they turn into a row of 2. On the *candidum* there is only a single row of very stout robust setae. The largest and most significant key is the maxilla. On the maxilla crown of *gildersleevei* there are 11-13 pectinate setae comb with 13 as a true average. On *candidum* there are only 7-8 with 7 being the average. All this should allow complete allow separation.

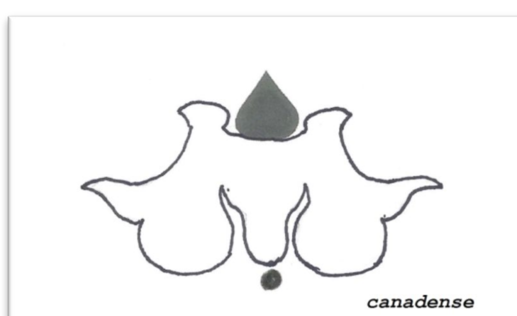
(***Stenacron interpunctatum / heterotarsale***)

(Stenacron interpunctatum / canadense)

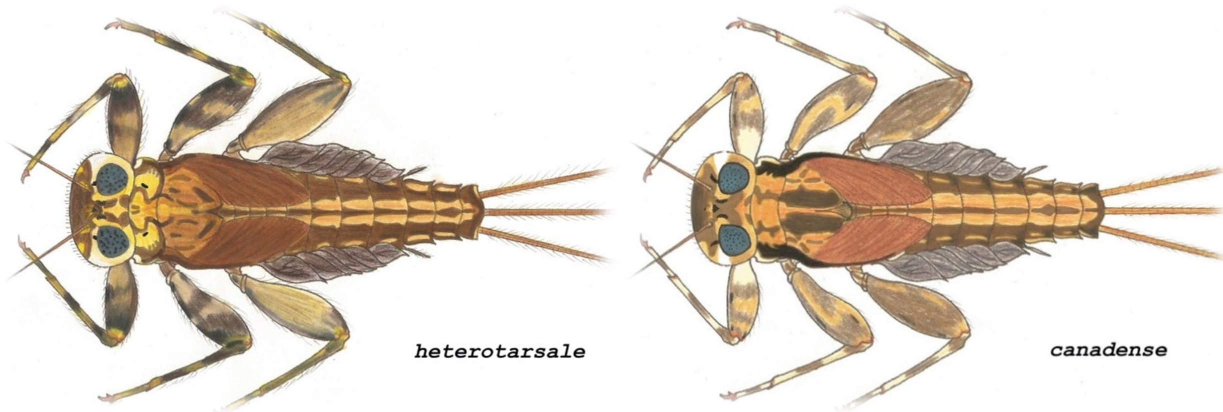
Historically in all books there has always been confusion regarding *heterotarsale*. Because DNA to our understanding states that should in fact be a valid species we should put the spot light on this form, as one day it will likely become a valid species again.

The only other larva that can look similar and could be confused with it is *canadense*. Therefore we will compare these two. The very first thing to mention is Dr Travers couplets (1935) regarding the spot in front of the median ocelli. Dr Traver noted it as being somewhat in the shape of **"la fleur de lis"**. We can say from rearing and dissecting that this feature is quite reliable as a character feature of this form. We can clearly see there is a very big difference in the two with regards to this marking.

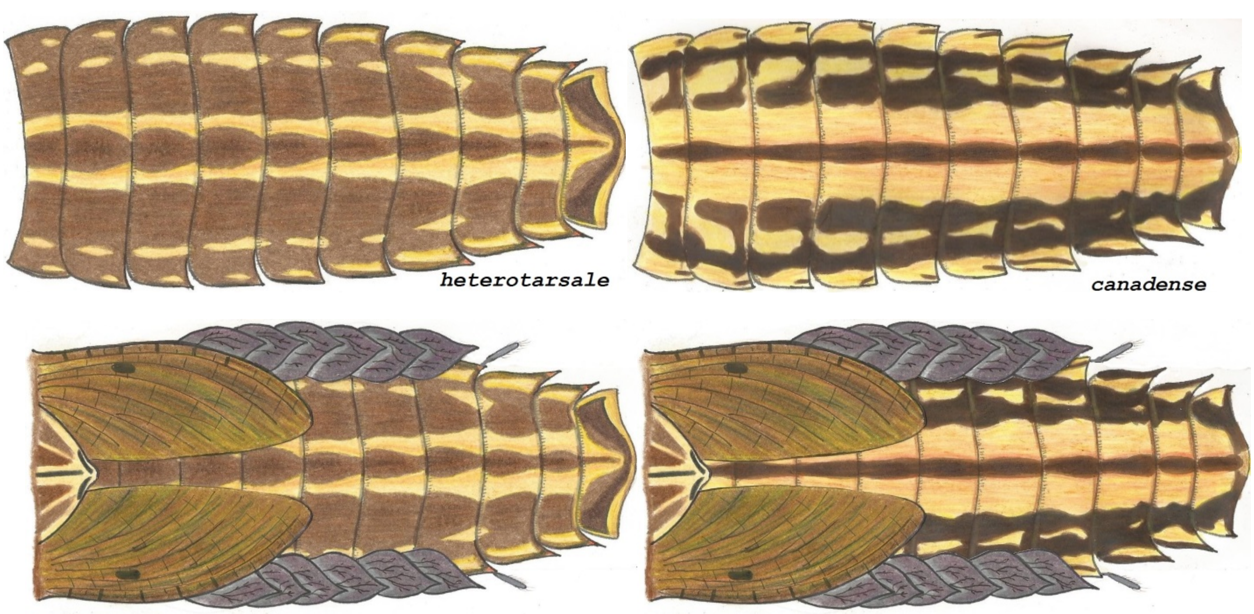




Moving over to the full larva view we quickly notice they are both fairly pale in coloring, and both have very continuous submedial stripes.

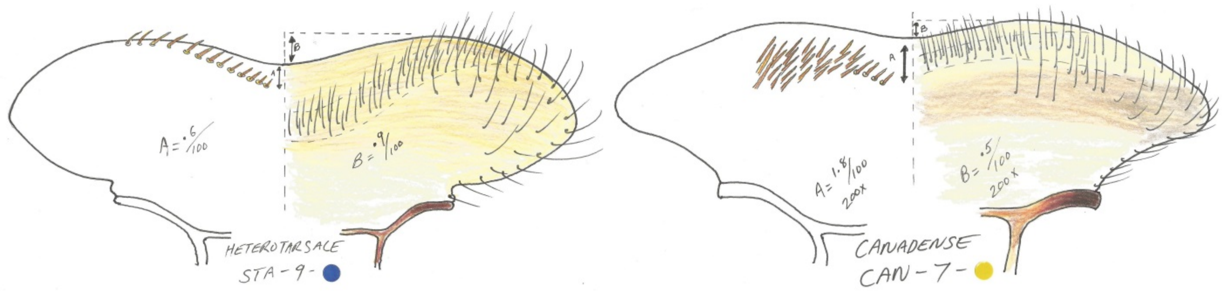


The first important feature to separate is that *canadense* has very wide and somewhat straight submedial stripes on the abdomen. *Heterotarsale* has stripes that look a bit like a bell shapes on each tergite. The median line on the abdomen of *canadense* is thin and uniformed throughout the entire abdomen.



The other interesting maculation character in the median line on *heterotarsale* is, the somewhat arrow shaped spots pointing backward on each tergite. Another feature to note on *heterotarsale* is the 10th segment has a pale yellow posterior and lateral edge. The other common factor for these two is they both have equal lateral projections of the 8th and 9th segment.

The mouthparts are also quite distinct from each other. Turning to the labrums we can see that they are pretty self-explanatory as they have little in common and not likely confused.



On the maxillae of *heterotarsale* there are 9 pectinate setae combs on the crown of each maxilla. On the *canadense* there are typically 10L and 11R. In the submedial row of setae there are between 30-35 on the *heterotarsale*, and 25-30 on the *canadense*.

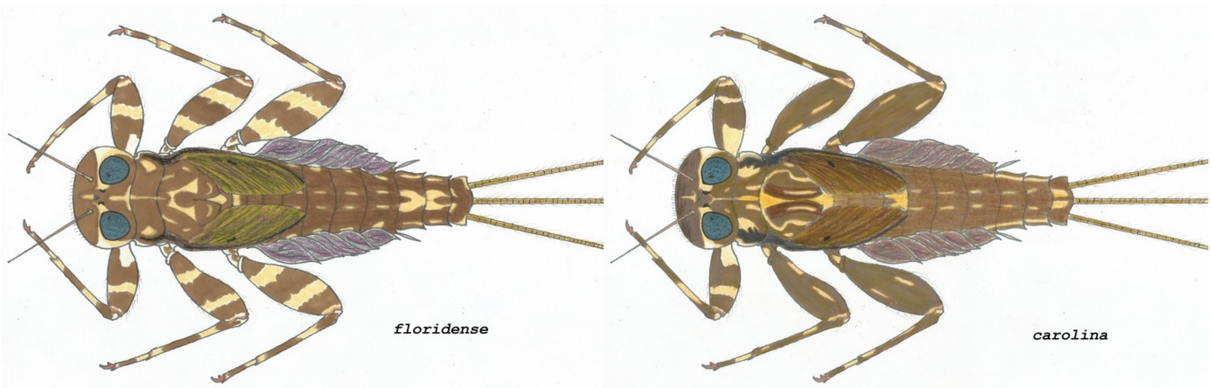
The mandibles are very useful to separate them as *heterotarsale* has 5-7 teeth on the inner side of the outer canine, and 3-4 on the inner side of the inner canine. On *canadense* there are 6 teeth on the inner side of the outer canine, and 0 on the inner side of the inner canine.

The physical size is also a factor as *canadense* is much larger the *heterotarsale*. With all the information above confusion through dissection is not very likely. Without a complete dissection these two could be confused.

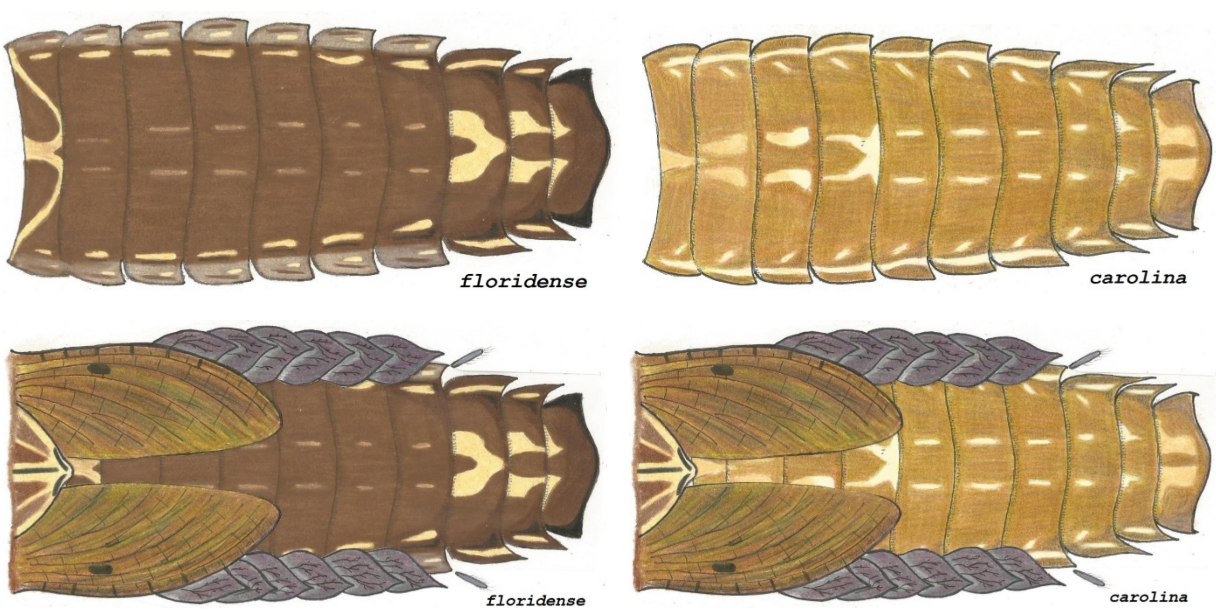
(***Stenacron floridense***)

(*Stenacron carolina*)

These two are easily confused for several reasons. First they share similar geographical ranges. Second the maculation patterns of the submedial stripes are very similar on tergites 1-7.



When side by side it is reasonably clear which is which. The most important feature to separate them is *carolina* has an 8^{th} lateral projection that is longer than the 9^{th}. The lateral projections of *floridense* are unknown but likely equal in length. Moving over to the full abdomens for a closer comparison we see the true differences.

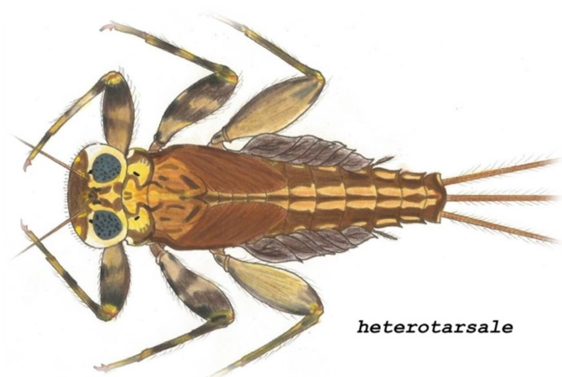


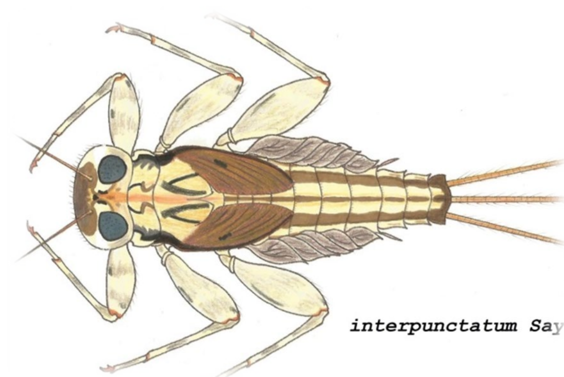
The mouthparts of the two also allow separation. See the table at the back of this guide for the features and keys that completely separate these two.

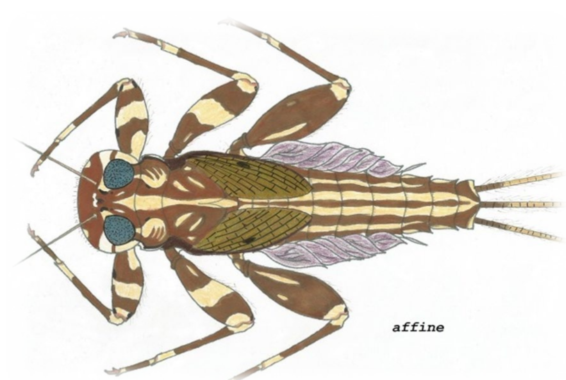
Now it is time to put on my boxing gloves and fight for the underdog. It is now becoming very apparent that geology, elevation, and dietary factors have a large impact on mouthpart morphology, and that the ecosystems are constantly changing and evolving as they move down stream. So why would we expect the insects to not self-modify for these changes.

We can see labrum and mandible modifications in the same form in a very short distance and elevation change on Bronte. The pigmentational impacts, slight labrum modification, tooth counts on mandibles, and scraper like teeth on the ventral side of the labium palps of *ohioense*. Surely we can deduce that all Stenacron are self-modifying in the same way based on their specific environmental needs.

There is little doubt in my mind that *heterotarsale* and true *interpunctatum* Say share very similar ecosystems and elevations, and are without any doubt very distinct from each other in the larva and adults stages. Here is the larva of the two and below them is an illustration that directly reflects Traver 1933 for affine.







There is no question they have very little in common. Both the *heterotarsale* and *interpunctatum* are reared samples and are confirmed adults to their historical profiles. Looking at the *affine* it is clearly more related to true *interpunctatum* Say.

Heterotarsale and *interpunctatum* Say share the same environments and elevation here in southern Ontario. From every photo known true *interpunctatum* and *heterotarsale* clearly cohabitate in an average elevation of 250-700 feet above sea level. Now moving to affine it was collected at much higher elevation with an average of 1227 feet and as high as 1424 feet.

These ecosystems would have little in common. The upper mountain areas are heavily treed typically State forest with lots of shade over the waterways. They would be very clean pure water with high dissolved oxygens making plant growth very high just like on Bronte Creek.

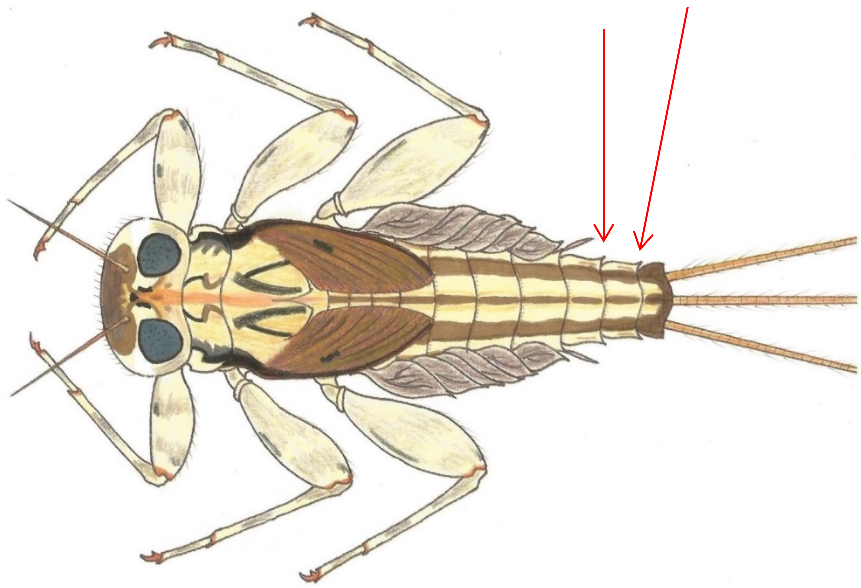
As the system is coming into the lower elevation the systems modify in every aspect. Often meandering slowly with fewer trees for shade making the water warmer. Lower dissolved oxygens less plant growth, less food for insects. In Bronte in the lower areas there is no aquatic life at all in some areas. Too much sedimentation, water warm, and low (DO) equal's no plants.

All watersheds are built on the very same principals except human interaction take place more often in the lower areas. We clear all the trees for houses and shopping malls, and leave little room for anything else.

We think after reviewing all these interesting facts and having 16 DNA clusters in the genus and *affine* was not even at the DNA convention, we truly believe that we all owe *affine* a second look.

Larva Couplets

Key to larva are lateral projections of the 8th vs the 9th for length as per Traver 1935, they work and are reliable. As per Lewis mouthparts are diagnostic, and labrums are accurate to form and species that are mapped out. Lateral projections 8th & 9th.



1. ***affine;*** mouthparts unknown, prominent continuous stripes on abdomen, lateral projection equal, no spiracular spots.

2. ***areion;*** larva never collected or reared, unknown.

3. ***canadense;*** mouthparts diagnostic, labrum distinct, pleura streaks on mesosternum, abdomen prominent pale wide continuous submedial streaks, no spiracular spots, lateral projection equal.

4. ***candidum;*** very dark all over, distinct triangle in front of median ocelli, mouthparts very diagnostic, labrum very distinct, discontinuous submedial stripes on abdomen, spiracular spots, lateral projections the 8th is shorter.

5. ***carolina;*** distinct T shape spot in front of median ocelli, mouthparts diagnostic, labrum unknown, abdomen absent of typical submedial stripes; on the 4^{th} tergite moderate pale spots, 1-2-3 small pale spots, 5-6-7-8 very small pale submedial spots, in some samples absent, tergite 9 a pair of submedial spots, 10^{th} two distinct stripes deeply intruding into the 10^{th}, lateral projection 8^{th} is noticeably longer than the 9^{th} the only one in the genus to have this.

6. ***conjunctum;*** mouthparts are diagnostic, labrum is distinct, mesosternum pleura streaks, continuous submedial stripes on abdomen, dark type discontinuous stripes, lateral projections equal, with spiracular spots, ♦ diamond-ish shaped spot median tergite 9 as per Traver 1935.

7. ***floridense;*** mouthparts diagnostic labrum unknown, abdomen tergite 1-7 very small pale submedial spots may be absent on some samples, 8^{th} very prominent submedial spots connecting having a deletion of pigment in the median posterial area, 9^{th} pair of submedial stripes, 10^{th} slight stripe intrusion, lateral projections unknown, Bold Systems sample appear equal.

8. ***frontale;*** pale median spot on frontal margin of head capsule, mouthparts diagnostic, labrum distinct, mesosternum pleura streaks, abdomen very wide medial dark stripe from 1-7, 8^{th} large deletion of pigment median area, thin submedial strips from tergite 1-8 then on the 9^{th} an 10^{th}, deeply intruded into the 10^{th}, spiracular spots, lateral projection equal.

9. ***gildersleevei;*** mouthparts very diagnostic, labrum very distinct, discontinuous submedial stripes on all tergites, all tergites black transverse bands on posterial margins, having spiracular spots, lateral projection equal in length.

10. ***heterotarsale;*** spot in front of median ocelli distinct as per Traver like the shape of fleur-de-lis, mouthparts diagnostic, labrum very distinct, abdomen continuous

submedial stripes bell shaped, lateral projection equal, subanal plate very indentures.

11. ***interpunctatum* Say;** very pale all over especially the male, prominent pale spot in front of median ocelli, mouthparts diagnostic, labrum very distinct, pale legs with faint banding, abdomen submedial and sublateral pale predominant streaks, lateral projections equal.

12. ***majus;*** pale spot on frontal margin of head capsule, mouthparts diagnostic, labrum very distinct, mesosternum pleura streaks, abdomen very continuous submedial stripes, having spiracular spots, with lateral projection equal.

13. ***minnetonka;*** pale spot on frontal margin of head capsule, mouthparts diagnostic, labrum unknown, abdomen with continuous stripes with spiracular spots, lateral projections are unknown.

14. ***pallidum;*** mouthparts are diagnostic, labrum unknown, abdomen very faint pale submedial stripes unlike any in the genus continuous, blackish tergite transverse bands, lateral projections 8^{th} is shorter.

15. ***proximum;*** pale pinkish stripe on the frontal margin of head capsule, mouthparts diagnostic, labrum distinct, mesosternum pleura streaks, abdomen with continuous pale submedial stripes, lateral projections the 8^{th} is noticeably shorter.

16. ***Ohioense* dark type;** very dark all over, mouthparts diagnostic, labrum distinct, mesosternum pleura streaks, abdomen with very discontinuous stripes all pale spots coma shaped, spiracular spots, lateral projections sub-equal, 8^{th} slightly shorter.

17. ***Ohioense* light type;** pale stripe frontal margin of head capsule, dark cinnamon color all over, mouthparts diagnostic, labrum distinct, mesosternum pleura streaks, abdomen with very wide continuous stripes, spiracular spots, lateral projections sub-equal, 8th slightly shorter.

Some of the following descriptions are first descriptions for;
Conjunctum, majus, proximum, and ohioense

Full Larva Descriptions

affine

Traver 1933
This is the original description plus 1937 updates

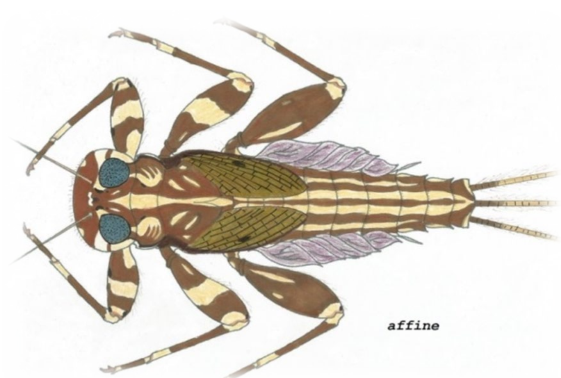
To the best of our knowledge *affine* has never been reviewed since 1937

It took me 4 years to consider doing a complete illustration of the larva. But on behalf of all that Dr Traver did for us and this genus, I felt we should try to represent her thoughts from 1933, and see if what she said could be made into something we can all see for the first time.

Body size; 7-8 ♂ mm; Tails; 15 ♂ mm

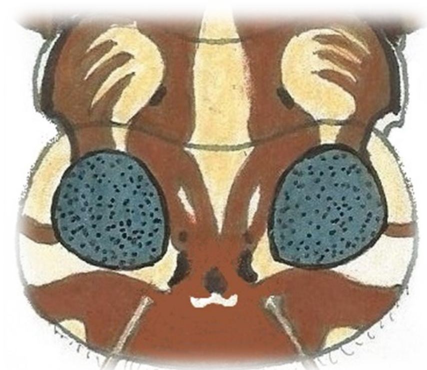
Male description based on white mesosternum and size.

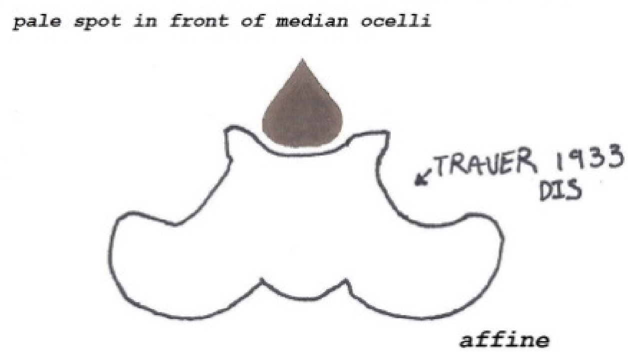
General appearance; Small slender nymph. Light brown in color, the head particularly reddish. Abdomen dorsally with 6 longitudinal stripes, Lateral projections equaled in size as in *interpunctatum* Say.



Head capsule; bright red-brown. Anterior to median ocelli, a large white mark shaped like a mayflies hypopharynx above. Another large white mark lateral to each lateral ocellus. Lateral margins pale yellowish, with narrow central brown band.

Small light dot on each side of the frontal boarder. A median and two lateral light spots on the occiput. Antennae pale brown.



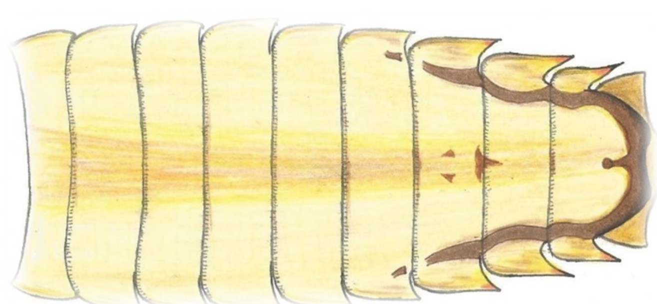


Thorax; Wide pale mid-dorsal band the length of the thorax; widest at the anterior margin of the pronotum. Pronotum white on lateral margins except anterior angle, which is brown (similar to sample). Remainder of pronotum brown except for three parallel transverse white dashes on each side. Few small white marks on mesonotum near wing roots. Ventrally whitish, with transverse brown band across the mesosternum.

Legs; pale brown. Femora pale yellowish at each end, and with a pale central band. Tibia white apically, and a white band near basal end. Apical half of tarsus white.

Abdomen; (illustration is a reasonable facsimile) A wide white longitudinal white band the length of the abdomen on each side of the median dorsal streak. These bands somewhat irregular, since the brown median streak is widest at the center of each tergite. A narrow light line on each side close to the lateral border, and between this and the central wide light bans, another narrow light line. Lateral projection of the 8th and 9th are about equal.

Ventrally; yellow, prominently bordered and marked with reddish-brown. Sternite 9 brown except semi-circle area on the posterior margin at median line, and a narrow light area on each side like illustration but with tan transverse band at each Sternite, and the 9th being more brownish.



Canadense

Walker 1853

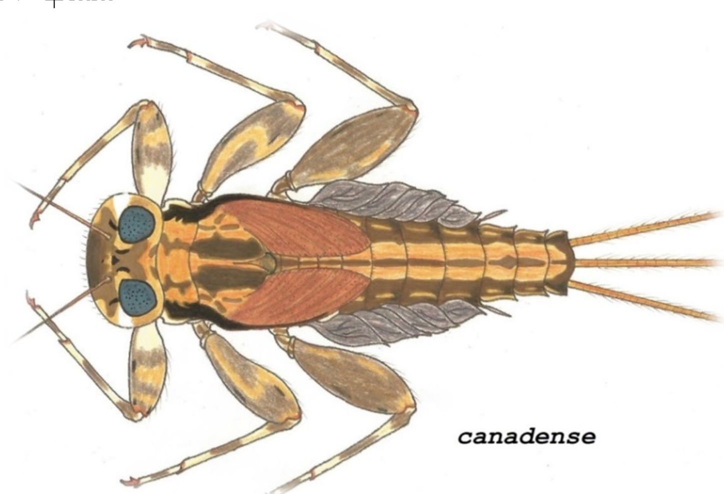
Modern re-description to original form

Without synonyms

Notes; this description is based on; Clemens 1915, Traver (1935) couplets, and many collected, reared, and dissected samples from the Bronte creek watershed in southern Ontario. This form in the larva state does not have another "type" regarding maculation. In the adults we see great variation, see the adult section description showing 3 variations of abdominal maculation. It is my suspicion and we suspect that the potential larva we are holding under the temporary name of "*eliquentum*" is in fact a geologically substrate variation. As in the *ohioense* the mouthparts are metamorphically different. We will insert the larva illustration here under *canadense* as we now feel this is where it should be until further notice. We will also include pictures of the larva in the photo plate section.

General appearance; medium brown-yellow with continuous submedial streaks, with lateral projections of the 8th and 9th being equal in length.

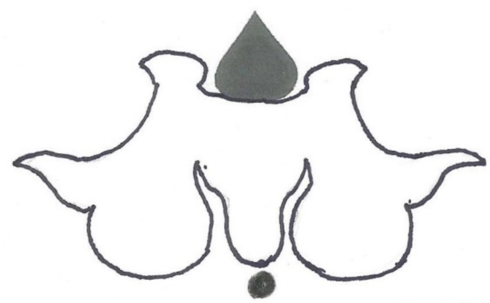
Body size; 11 mm ♂, 13 mm ♀,
Tails; 22 ♂ 15-17 ♀mm



canadense

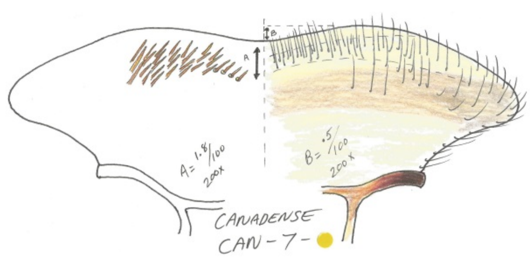
Head capsule; no pale spot on median frontal margin, large pale lateral areas just lateral to the antenna bases, without black spots, U shaped distinct purple line from antenna base to antenna base, with a median crania spot, spot in front of median ocelli kind of clover ♣ shaped spot, there are two small black spots behind the lateral ocelli, sometime a reddish mid cranium

spot at the palmen body, with a large pale area in the median area to the posterior edge.

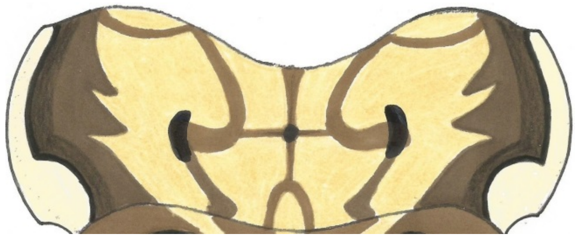


Mouthparts; head capsule if more square shaped than others but not elliptical like candidum, and ohioense dark, on the crown of the maxilla there are 10-11 pectinate setae combs, and 25-30 setae in the submedial row with 15-18 being fimbriated in nature, on the mandibles there are 6 teeth on the inner side of the outer canine, and commonly 0 on the inner side of the inner canine, all other mouthparts besides the labrum are indistinguishable from others in the genus.

Labrum; moderate indenture on the frontal margin, median robust setae set well back, 4 single setae followed by 2 rows of 3, then 2 rows of 4, then 3 rows of 5, most dorsal setae forward of robust setae.



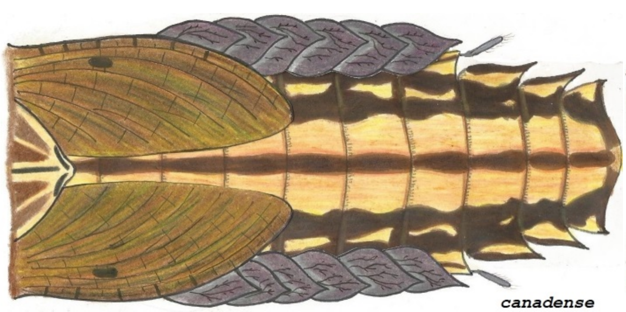
Pronotum; principally pale yellow, hyaline yellow lateral boarders, followed inward by long brownish-black streaks pale on the median area kind of leaf shaped, large pale median area broken up with fine brown lines sort of forming an X in the middle often a small black median spot, lateral to the middle a smaller black coms shaped spots that transcends into the adult stage.

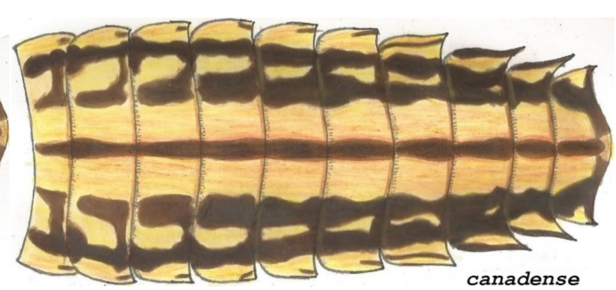


Notum; very much like the pronotum mostly pale yellowish with brown spots, in very mature samples the scutellum will be black, the lateral boarders are very dark near black at the forewing roots, pleura streak are present and often wrapping the sternum.

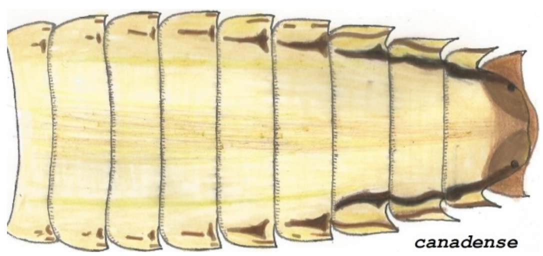
Legs; not typically clearly marked as others, often a ruddy-tan colored but not dark, fore femora with a median dark band followed by a large pale spot, followed by a darker spots terminating at the joint with a pale area. Middle femora often a longitudinal median line bending to the posterior edge. Rear femora pale line restricted to the posterial margin. All femora have black spots that coincide with femoral bandings in the adults.

Abdomen; having very wide pale continuous submedial stripes that surround a very fine median brown line that deeply intrude into the 10th, lateral boarders narrowly pale yellow on all tergites, there are a series of pale spots almost forming a secondary sublateral pale streak between the gills and the submedial stripes, most samples with have black shading in the spiracle areas (but not spot).



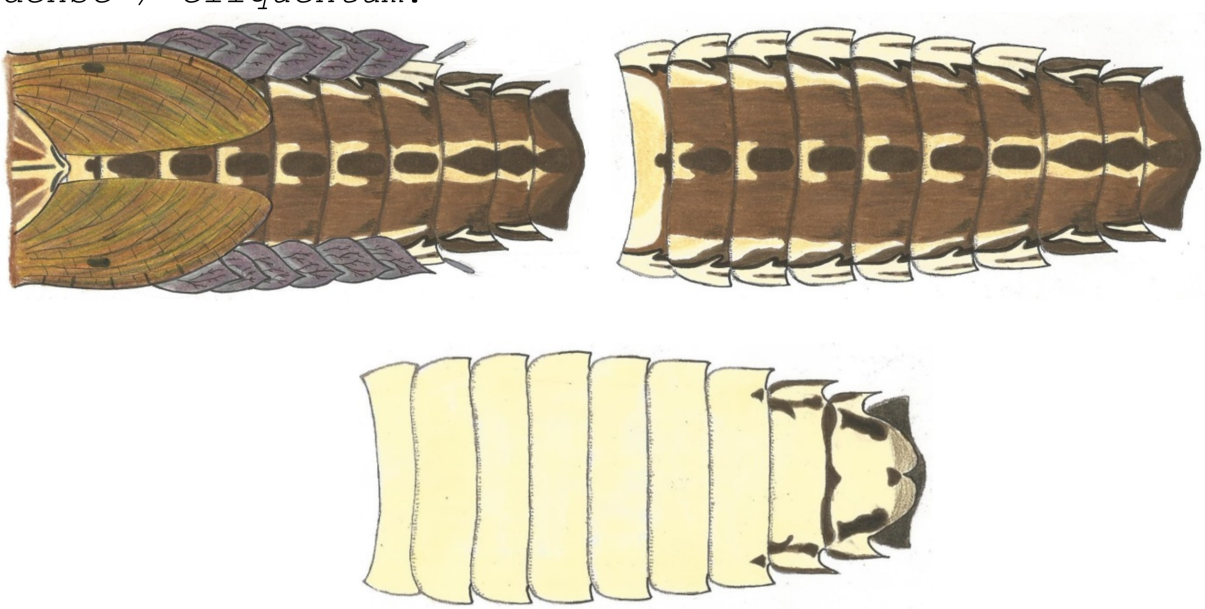


<u>Ventral view;</u> This illustration is a female sample and they have sublateral ventral brown stains from the 1st to the 9th, on the male these marks are often from the 6th through the 9th, from the 7th through the 9th these spots form a blackish longitudinal bar that often terminate in the 9th with black spots, posterior area of 9th brown.

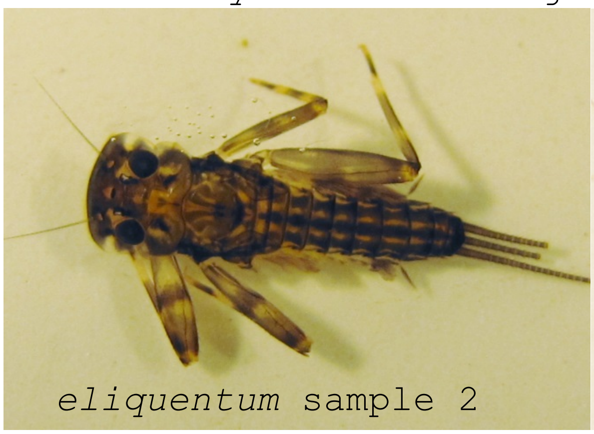


***<u>Canadense</u>* <u>variation type;</u>** we will continue to study this potential form that we are placing here as *canadense,* that we have temporary named *eliquentum*. There is very little in common in the larva maculation both dorsal and ventrally, but from a mouthpart morphology stand point they are different but it is way too close to *canadense*, and the adult female we have aligns very well with *canadense* see female imago page over. The other very distinct feature is there are commonly two complete tracheas in the 7th gill which we have not seen in any forms in this genus.
So for now until we know otherwise it is fair to hold *eliquentum* as a geological substrate variation of *canadense*.

Canadense / eliquentum?



One strange anomaly is the how the black line forms a **~** shape around the spiracle folds; they are not spots but in fact true black outlines of the spiracle area. Here is a picture of the full larva and the adult female imago. This is not a one of, we have 3 matching larva and the adult, and David Funk has a male sample on Bold System that aligns with our female.


eliquentum sample 2


eliquentum sample

We will be doing a full rearing study of this variation to see what it potentially is. With both the larva and adult both having strange black outlined spiracle lines more investigation is need, but for now it works within the true *canadense* form. The name *eliquentum* was chosen to represent the very eloquent black markings.

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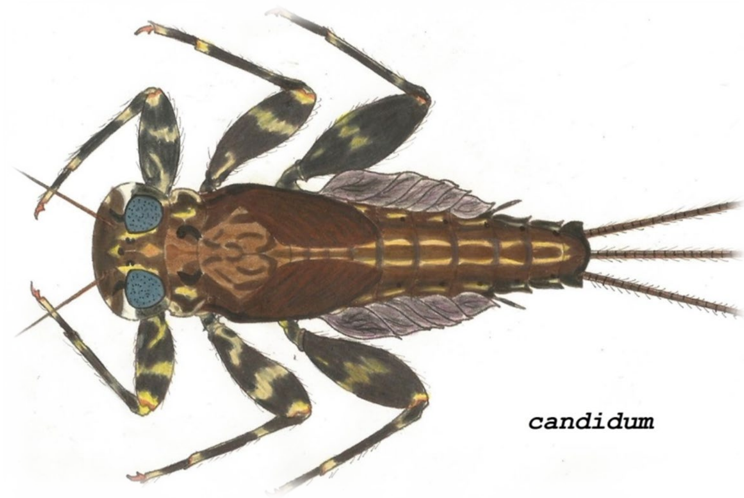
candidum

Traver 1935

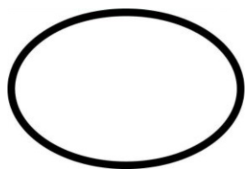
Notes; Spieth 1947 unjustifiably synonymized *candidum* to a *frontale* complex then made it a subspecies of *interpunctatum* Say. Burks 1953 reinstated *candidum* and it has remained a valid species since. This description is based on Traver 1935 couplets and larva table, Burks 1953, Lewis 1974 A, and reared samples from southern Ontario.

General appearance; blackish-brown with discontinues submedial stripes 8th lateral projection is shorter than the 9th.

Body size; 7.5 ♂ mm, 9 ♀ mm.
Tail size; 18-20 ♂ mm, 15 ♀ mm.

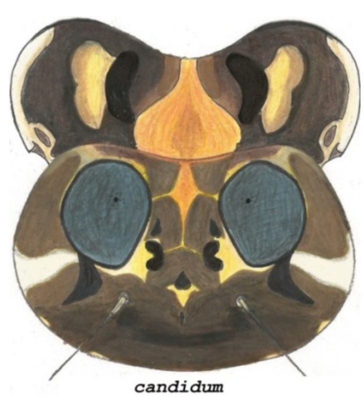


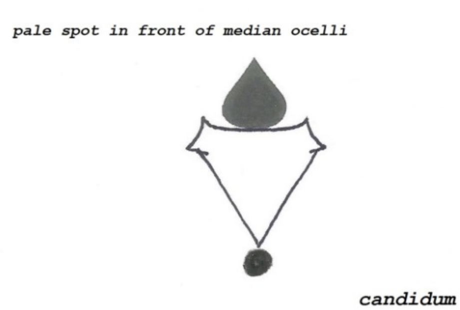
Truer head shape;



Head; candidum has a very distinct head shape it is very oval, all head capsule illustrations where done on a genus friendly template and were never intended to represent every form in the genus by shape but rather by maculation. No pale spot on the frontal margin but very dark brown almost black on the frontal margin, 2 very small pale spots on either side of the antenna on

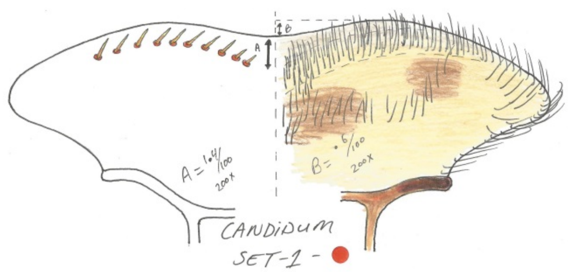
the forward lateral margin, small pale white to hyaline areas from the compound eyes to the lateral margin, with big black coma spots = **(**from compound eyes towards the lateral boarder, spot in front of median ocelli historically very triangle ▼ shaped as noted by Burks and Lewis, in front of that is a black midcrania black spot, each lateral ocelli have a black triangle ▼ shaped spot behind it.





Mouthparts; Lewis 1974 indicates 7-8 pectinate setae combs on the crown of the maxilla, our Ontario samples all had 7, there are 15-25 setae in the submedial row with less than 10 being non fimbriated, the mandibles commonly have 8 teeth on the left inner side of the outer canine, and 5-6 on the right. The inner side of the inner canines there are no teeth present. All other mouthparts are indistinguishable from others except the labrum.

Labrum; without a doubt very distinct, having a single row of ventral robust setae that is in a curved line and not coming near the forward margin moderately indentured frontal margin.



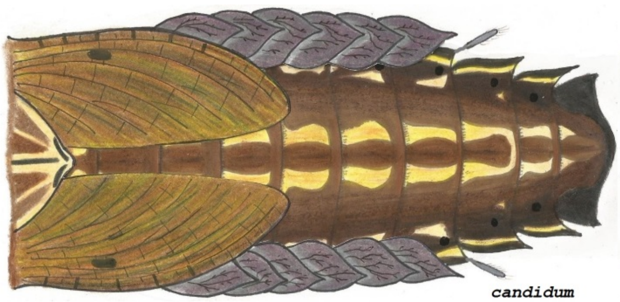
Pronotum; lateral edges very pale white or hyaline, often a very small blackish spot encapsulated in the forward lateral area, moving inward with a large dark coma shaped streak, with a submedial pale area, then a very large black coma that becomes the black marks on the pronotum in the adult, with a large onion shaped spot in the median area.

Notum; lateral areas black moving inward with large pale areas that have dark marks inside, center of notum orangey-yellow in the longitudinal suture, scutellum and post scutellum areas black.

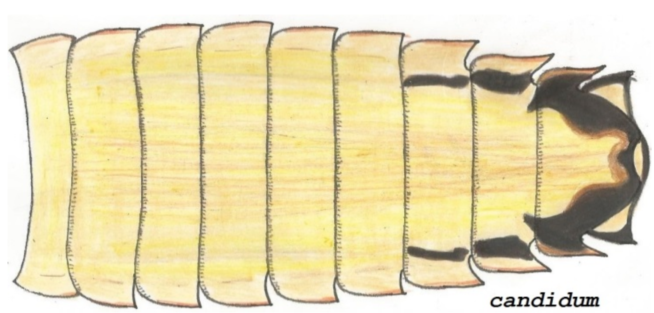
Legs; fore femora dark median band followed by a thin pale band, with another wide black band terminating with a large pale area at the joint, tibia and tarsi black banded. Middle femora as in fore femora, hind a few pale spots mostly blackish. All femora having back spots in the median and apical areas as in the adults.

Pleura; unmarked but coxa and trochanters are spotted with blackish-brown spots, middle and rear are striped.

Abdomen; very distinct discontinuous submedial stripes and the 8^{th} lateral projection is noticeable shorter that the 9^{th}. Submedial pale spots on tergite 1 large and round and are unable to be seen in fully mature samples, see immature sample in photo plate, all submedial spots create a vase shaped pattern from tergite 2-9  as in *gildersleevei*, median line barely intruding into the 10^{th} tergite, lateral margins very dark often a distinct yellow stripe on the spiracle folds, spiracular spots present but small from 2-9 some adults may have a trace of a spot on the 1^{st}. Spot on the 9^{th} is often very small and hard to see as black shading is present, lateral areas of 9^{th} and 10^{th} black.



Ventral; pale yellow to orange on females silvery-white laterally for males, both male and female share the same ventral marking patterns, the females do not extend their spots to the 1^{st} or 2^{nd} segment as many in the genus do. Ventral markings are very distinct and consistent to form, having a black lateral longitudinal line on the 7^{th}, a larger black line on the 8^{th} and a distinct black **U** shaped mark that is widest at the anterior area almost shaped like a "Blue Jay" bird wrapping around the posterior area of the 9^{th} and coming to a black spot, anteriorly shaded with brown.



Tails; yellow-blackish-brown with articulations

Carolina

Banks 1914

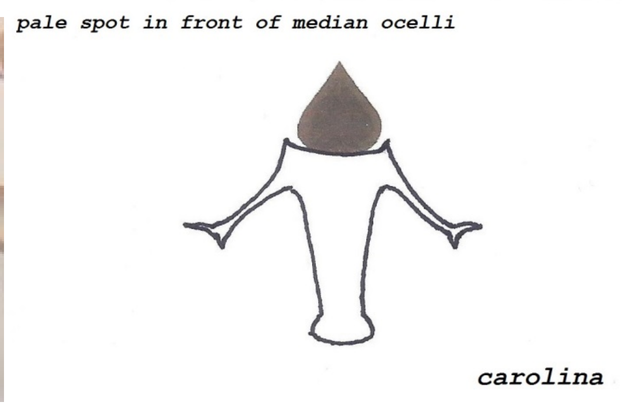
Notes; we have no S *carolina* in our area of southern Ontario they are only eastern towards the Covey Hill PQ area. This description is based on Traver 1935 larva table page 303, Burks 1953, Lewis 1974 A, samples at Bold Systems Museum, and 3 samples sent to me from Ashville NC area for dissection from Joshua Doby. Substrate does affect the adults and therefore also affects the larva. We have seen several photos that are golden yellow gray in color, but most samples are very pale gray to dark gray.

General appearance; pale gray throughout with little in the way of pale markings, Traver 1935 states lateral projection of the 8^{th} is longer than the 9^{th}. This character is not reliable in immature samples. When full grown the character is creditable but must be employed on samples at the 22^{nd} to the 24^{th} instars, so the wing pad is reaching the back of the second segment, or to the back of the 4^{th} segment, being the 24^{th} instars.

Body size; 10 ♂ mm, 12 ♀ mm.
Tails; 18-22 ♂ mm 15-17♀ mm.

Head; compound eyes are very wide spread in both male and females; use the ventral side of the 9^{th} sternite to look for claspers, head is generally very brownish-gray reddish-purple between the antenna bases and the frontal margin, no pale spots on frontal margin, slim and defined pale lines from the compound eyes to the lateral boarder, with small pale black smears that become the small black spots at the corners of the compound eyes

seen in the adults; **[<u>Pale spot in front of median ocelli</u>]**, although in use now as a key of sorts it must be noted that these spots are variable in all forms in the genus. As a rule they are a great tool to help sort larva to form. They are variable in and near the molting phase. The interior head capsule slowly pulls away from the soon to be exuvia. These actions do alter the size and shape of the spots at times, for a period of time. Usage should be employed in combination with other characteristics of the form; Spot in front of median ocelli is often **T** shaped without a midcrania spot. Most samples will have very faint gray spots behind the lateral ocelli, cranium suture most often pure cream colored.

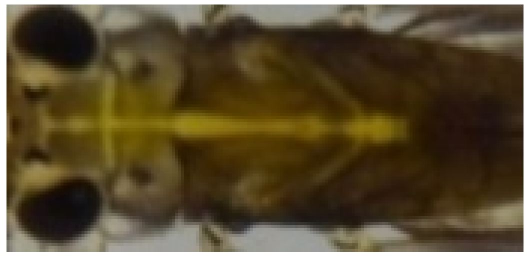


<u>Mouthparts;</u> (Lewis 1974 A), 10 pectinate setae combs on the crown of the maxilla, 20-30 setae in the submedial row, 7-8 teeth on the inner side of the outer canine, and 2 blunt teeth on the inner side of the inner canine, all the other mouthparts are indistinguishable from others in the genus other than the labrum.

<u>Labrum;</u> See Labrums blueprinted

<u>Pronotum;</u> variable hyaline lateral margin can be very large, obscured sublateral black stripe, submedial pale are, a black spot on either side submedial, median area orangey-gray-brown.

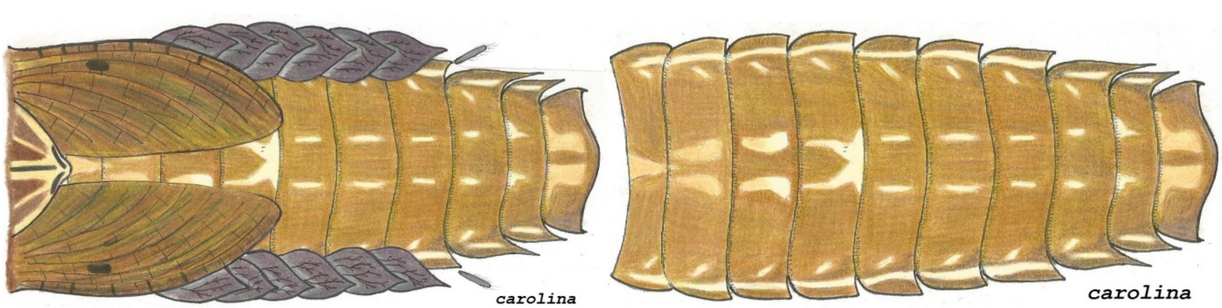
Notum; variability is clearly seen in these two different samples, this one does show a prominent median stripe; it should be noted that the stripe is in fact the opening longitudinal suture, with the pronotum suture, and cranium suture all in the rupture state.



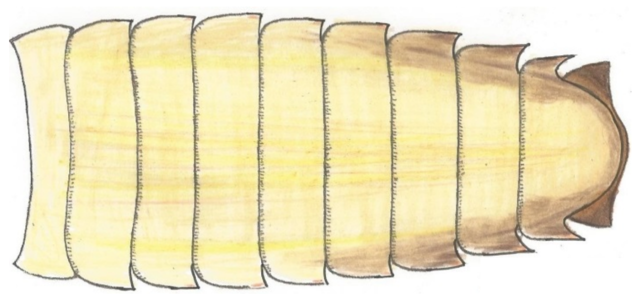
Legs; all femora with little in the way of pale markings, all femora joints are pale, a slight pale median spot on each femora but vey obscured.

Abdomen; **(**very distinct from all others **e**xcept *floridense* both species a very under maculated on the dorsal surface of the entire abdomen, and may share similar geography). Illustration based on Bold Systems sample HIEPT027-09 - Stenacron *carolina* [COI-5P:407].

No continuous submedial stripes, rather short thin pale submedial spots from tergites 2-9, some samples as illustrated, the 3-4th may be enlarged, the 9th are typically fine points on the anterior area of the 9th. Stripes deeply intrude in to the 10th. Lateral area hyaline to tan colored with pale stripes, no spiracular spots; slightly forward of spiracle folds a small pale spot aslant often covered by the gills.



Ventral; generally pale throughout, brownish lateral maculation shading from sternite 6-10, some sample can be rather blackish at the terminal lateral areas almost forming a line.



Tails; smoky with pale articulated areas, turning dark gray at the end.

Conjunctum

Dark types

Traver 1935

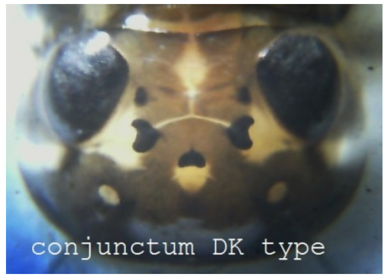
First description

Notes; this description is based on many collected and reared samples that keyed out as adults to this form described in the Biology of a Mayfly Needham, Traver, and Hsu (1935). The larva exuvia of reared samples key to larva of this form. There currently are two distinct geological variations for this form. They are the same for the most part in the larva stage; However in the dark variation the abdominal submedial stripes are discontinuous. In the light type the stripes are continuous.

General appearance; Blackish brown throughout with partial discontinuous dorsal median stripes. 8th and 9th lateral projections about equal in length.

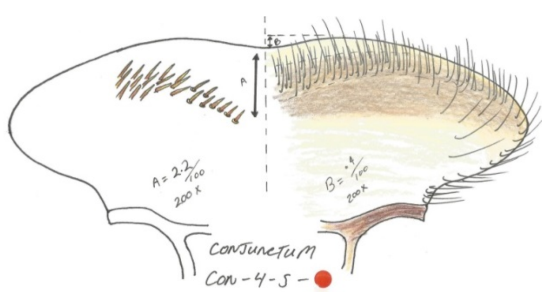
Body size; 8-9 ♂ mm 10-11 ♀ mm

Tails; 18-22 ♂ mm



Head capsule; oval in shape and depressed as in other forms and species in the genus. Typically having many black marks. No pale spot on the median frontal margin as in (*frontale*) and other forms. Pale spot in front on median ocelli often ♥ shaped. Black spot in front of this spot as to coincide with a midcrania spot seen in the adult stages. Small pale spots present below and lateral to the antenna bases on the anterior margin. These spots often surrounded by two small black spots. Triangular pale spots on either side of the lateral ocelli, these spots extent to the lateral margin as in all forms in the genus in the general shape of a stripe. Black markings in front of the compound eyes streak like in shape that almost connects with the spots in front of antenna bases. There are two black spots on the vertex behind and close to the lateral ocelli. Often a red spot in between these black spots where the pulmonary body is located. Posterior edge of head capsule dark brownish-black.

Mouthparts; on the crown of the maxilla there are most often 10 heavy pectinate setae combs on the left and 11 on the right. Submedial row of setae has 30-37 setae in it and typically 29 of them are fimbriated in nature. The mandibles have 6 teeth on the interior side of the outer canine on both the left and right side. Regarding the inner canine, in most samples there is 1 tooth on the left and 2 teeth on the right on the inside. All other mouth parts coincide with and are reasonably indistinguishable from all other species and forms in the genus except the labrum.



Labrum; both the light and dark type labrums are almost identical. There is a single row of 4, then a row of 2, then 5 rows of 3 robust setae, and the dorsal side fine hairs are forward of the ventral robust setae.

Pronotum; similar to others in the group by having pale lateral edges and a crescent shaped pale spot in the submedial region. The remaining areas blackish-brown. Often having small black marks in the anterior submedial area that coincides with pronotum makings in the adult stages.

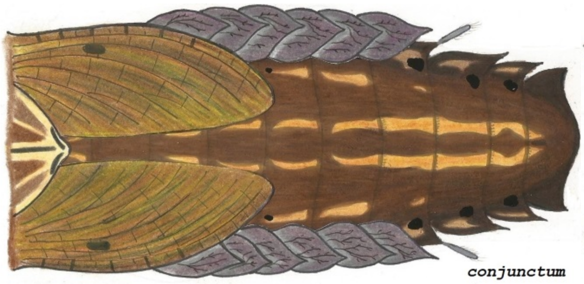
Mesonotum; Blackish-brown with small pale areas often having black lateral edges. Wing pads dark blackish with greenish-yellow hue from the fully formed adult wings encapsulated.

Mesosternum; Pale yellow, pleura marks are present at the lateral edges in front of the mid and rear legs.

Forelegs; There is commonly a black spot on the forecoxa. The femora in general having the appearance of banding. There is a darker longitude band in the median area, laterally followed by a light band and then a very dark band at the terminal end. Often a large black area at the joint on the dorsal side. Tibia basil area very dark at the joint, followed by a pale area, another dark area and terminating at the tarsi joint as pale yellow-whitish. Tarsi marked as in tibia, fore claws not denticulate.

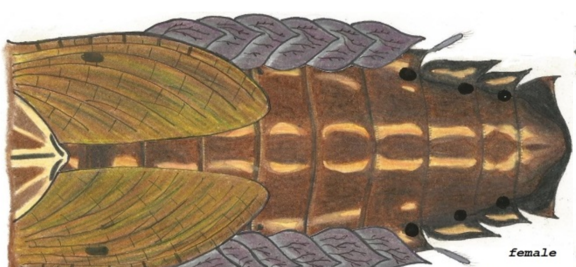
Middle leg; Coxa heavily marked in black, median longitudinal stripe restricted to the posterior edge followed by a pale stripe that is broken. Apex of femora very dark. Tibia marked as if fore tibia.

Rear leg; Coxa slight black spots. Femora almost entirely blackish. Pale median spots with a pale apex edge that has dark spots. The posterior edge often having large blackish spots that are restricted to the posterior edge.


conjunctum


conjunctum

<u>Abdomen dorsum male dark type;</u> Lateral projections on the 8^{th} & 9^{th} are equal in length. Dorsally having discontinuous submedial pale streaks. The general color is a dark umber tone with black overtone hues. Submedial streaks on the 1^{st} to the 6^{th} tergite are incomplete and do not connect to the anterior or posterior edges of each segment as in, S *carolina*, S *gildersleevei*, S *candidum* and S *floridense*. However on some samples these stripes can connect to the posterior edge of the 6th tergite. From the 7^{th} through the 9^{th} tergite the stripes are continuous and the median area of the 9^{th} tergum has a ♦ diamond-ish shaped spot as noted by Traver. Submedial streaks in the 10^{th} tergite often barely intrude into anterior of the 10^{th} as mere faint yellow arrows. In the male these streaks are most often yellow. There are pale sublateral spots or streaks present from the 1^{st} tergite through to the 6th and often a very small pale spot near the posterior-sublateral region on the 7^{th}. These spots can all be partially concealed by gills 1-6. Inside and posterial to the sublateral pale spots is where the black spiracular spots are located. These spots are often small and defused. In the male larva they are more prominent and are from tergum 2 through the 9^{th}. In the female they are most often incomplete being difficult to see and are typically from the 3^{rd} to the 8^{th}. Gills are purple-gray in color and oval in general shape terminating in a point with internal branched trachea and with external fibril trachea. The seventh gill is fingerlike in shape with one trachea present with a few very fine setae hairs at the terminal end.


female
conjuctum

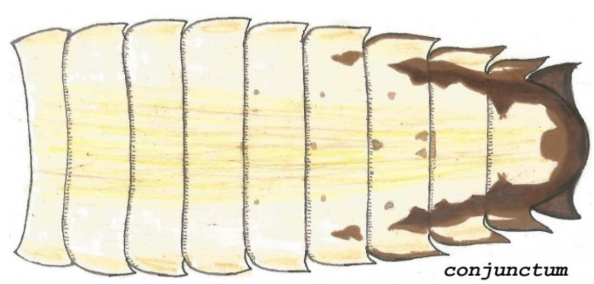

conjunctum

Abdomen dorsum female dark type; Lateral projection on the 8th & 9th are equal in length. Dorsally having discontinuous submedial pale streaks throughout. The general color is a dark umber tone with black overtone hues most often darker than the male. Submedial streaks on the 1st to the 9th all discontinuous. In most samples not touching ether the anterior or posterior edges of the segments. Thus looking very much like the illustration by Dr V K Mayo in the Biology of a Mayfly 1935 (fig) 92 page 315 for S *gildersleevei*.

The median line is wide and continuous from the 1st through the 9th. Each one slightly lens shape thus; (). The female can be very difficult to separate from S *gildersleevei*. Having short wide coma shapes surrounding the wide medial line. All posterior edges of tergite very dark with transverse shading that can be almost black like in S *gildersleevei* and S *pallidum*. The spiracular spots are larger and more intense than the male but are blended into dark background that transfers into the adult stages.

The 9th tergite the stripes are discontinuous and in the median area of the 9th tergite has a ♦ diamond-ish shaped spot as noted by Traver. Submedial streaks in the 10th tergite often barely intrude into anterior of the 10th as mere faint yellow arrows.

In female samples these discontinuous stripes will appear orange in color as the eggs are present in the abdominal cavity. The sublateral marks from the 1st through 6th like the male. The subanal plate in both the female and male are squareish and has no indenture on the apex of posterior edge.



Abdomen sternum; Female orange in color, male yellow pale whitish in general color. The female has sublateral cinnamon colored longitude maculation stains from the 1st or 2nd segment to the 9th. From the 5th to the 9th often dark brownish and highlighted with black on the 8th and 9th. On the male these marks are darker and are present from the 6th through the 9th.

On the posterior edge of the 9th the sublateral streaks wrap around the posterior edge to form a crescent shape facing posteriorly. There is often an indentured stain in the median area of the crescent shaped stain on the 9th facing anteriorly.

Posterior edge of the 9th and 10th blackish. Ganglionic median stains from the 1st to the 8th are often visible in the female. Sometimes looking very much like the shape of a boat anchor facing anteriorly.

Tails; Blackish brown with pale articulations.

Conjunctum

Light types

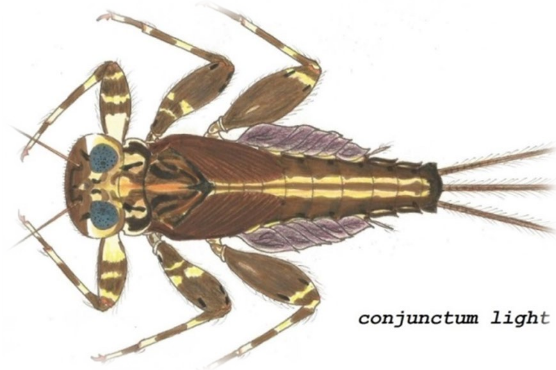
Traver 1935

First description

Notes; this description is based on many collected and reared samples that keyed out as adults to this form described in the Biology of a Mayfly Needham, Traver, and Hsu (1935). The larva exuvia of reared samples key to larva of this form. There currently are two distinct geological variations for this form. They are the same for the most part in the larva stage; However in the dark variation the abdominal submedial stripes a discontinuous. In the light type the stripes are continuous.

General appearance; dark cinnamon brown throughout with continuous dorsal median stripes. 8th and 9th lateral projections about equal in length.

Body size; 8-9 ♂ mm, 10-11 ♀ mm
Tails; 20 mm



conjunctum

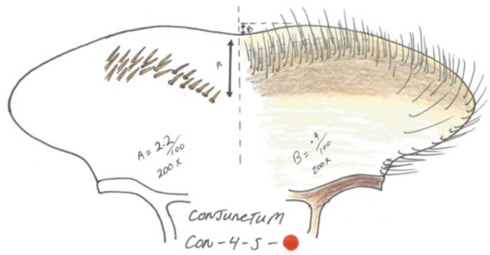
pale spot in front of median ocelli

conjunctum

Head capsule; dark cinnamon brown without a pale spot on frontal margin as in *frontale*. In many samples the entire frontal margin can have a very faint pale edge. Black-purple line from antenna base to antenna base in a U shape like a smile. Lateral to antenna on the forward margin 2 black spots preside with a pale spot in between. In front of each compound eye is a black streak that is like a smear heading towards the lateral edge. Spot in front of median ocelli is often ♥ shape with extensions as per illustration above with a midcrania spot forward of that. There are often very fine black lines at the cranium Suture, and black spots on the vertex behind the lateral ocelli.

Mouthparts; on the crown of the maxilla there are most often 10 heavy pectinate setae combs on the left and 11 on the right. Submedial row of setae has 30-37 setae in it and typically 29 of them are fimbriated in nature. The mandibles have 6 teeth on the interior side of the outer canine on both the left and right side. Regarding the inner canine, in most samples there is 1 tooth on the left and 2 teeth on the right on the inside. All other mouth parts coincide with and are reasonably

indistinguishable from all other species and forms in the genus except the labrum.



Labrum; both the light and dark type labrums are almost identical. There is a single row of 4, then a row of 2, then 5 rows of 3 robust setae, and the dorsal side fine hairs are forward of the robust setae.

Pronotum; similar to others in the group by having pale lateral edges and a crescent shaped pale spot in the submedial region. The remaining areas blackish-brown. Often having small black marks in the anterior submedial area that coincides with pronotum makings in the adult stages.

Mesonotum; Blackish-brown with small pale areas often having black lateral edges. Wing pads dark blackish with greenish-yellow hue from the fully formed adult wings encapsulated.

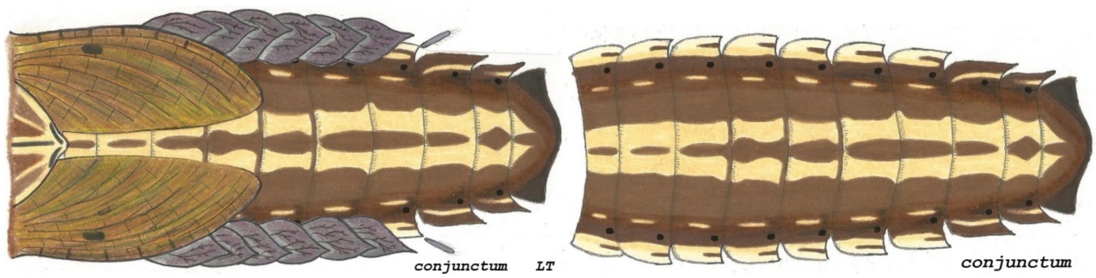
Mesosternum; Pale yellow, pleura marks are present at the lateral edges in front of the mid and rear legs.

Forelegs; There is commonly a faint black spot on the forecoxa. The femora in general having the appearance of banding. There is a darker longitude band in the median area, laterally followed by a light band and then a very dark band at the terminal end.

Often a large black area at the joint on the dorsal side. Tibia basil area very dark at the joint, followed by a pale area, another dark area and terminating at the tarsi joint as pale yellow-whitish. Tarsi marked as in tibia, fore claws not denticulate.

Middle leg; Coxa moderately marked in black, median longitudinal stripe restricted to the posterior edge followed by a pale stripe that is broken. Apex of femora very dark. Tibia marked as if fore tibia.

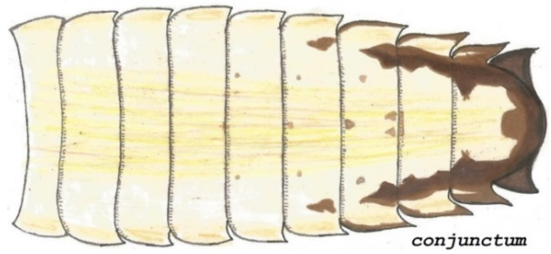
Rear leg; Femora almost entirely deep brownish. Pale median spots with a pale apex edge that has dark spots. The posterior edge often having large blackish spots that are restricted to the posterior edge.



Abdomen dorsum male light type;

Median line on tergites 1-3 fine and incomplete, 4-7 very irregular but forming a complete line for the most part. 8th often like *majus* and *frontale* having a median line that does not reach it posterior edge, 9th distinct ♦ diamond-ish shaped median spot as per Traver 1935, 10th with median spot. Submedial streaks are continuous and slightly intrude into the 10th.

There are a series of small pale spots from 1-7 near the gills but not covered by the gills 1-6. The terminal lateral edges of segments 1-7 are pale with very fine small pronounced spiracular spots.



Abdomen sternum; Female orange in color, male yellow pale whitish in general color. The female has sublateral cinnamon colored longitude maculation stains from the 1^{st} or 2^{nd} segment to the 9^{th}. From the 5^{th} to the 9^{th} often dark brownish and highlighted with black on the 8^{th} and 9^{th}. On the male these marks are darker and are present from the 6^{th} through the 9^{th}.

On the posterior edge of the 9^{th} the sublateral streaks wrap around the posterior edge to form a crescent shape facing posteriorly. There is often an indentured stain in the median area of the crescent shaped stain on the 9tthfacing anteriorly.

Posterior edge of the 9th and 10^{th} blackish. Ganglionic median stains from the 1st to the 8^{th} are often visible in the female. Sometimes looking very much like the shape of a boat anchor facing anteriorly.

Tails; brown with pale articulations.

frontale

Banks 1910

Re-described without synonymous forms

Notes; this description is based on; Banks (1910), Traver (1935) couplets, Spieth 1947, Burks (1953), and many collected, dissected, and reared samples from the Bronte creek watershed in southern Ontario.

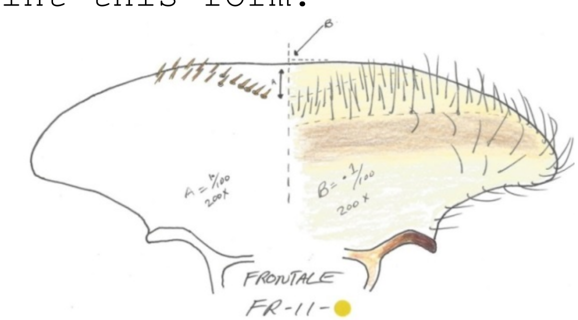
General appearance; medium brown-yellow with continuous submedial streaks, with lateral projections of the 8th and 9th being equal in length. Most samples have a pigment deletion in the median stripe on the 8th tergite.

Body size; 8 ♂ mm, 10-11 ♀ mm.

Tails; 18-22 ♂ mm 15-17 ♀ mm

Head capsule; ovate in shape and depressively flattened, shaped not as in *ohioense*, *candidum*, or *proximum*, but like all others in the genus. Typical samples will have a pale cream or pinkish spot on the median anterior edge or frontal margin. Heavy shading around the antenna bases and extending to the midcrania area, 1 small pale spot and 1 small dark spots under and lateral to the antenna bases, followed by a large lateral pale area from the compound eye to lateral edge as in all others in the genus. Black tear shaped black spot in front of compound eyes pointing to the median area. Pale spot in front of median ocelli commonly in the shape of a ♥ see below with a dark spot in front as to coincide with midcrania spot in the adults. There is commonly a purple-brown spot at the cranium suture and palmen body, with large black distinct spots on vertex often encapsulating the posterior areas of the lateral ocelli. Posterior edge shaded dark brown.

Mouthparts; on the crown of the maxilla there are normally 8-9 pectinate setae combs, 9L and 8R. In the submedial row of setae there are between 39-46 setae with 10-14 on each being none fimbriated in nature. On the mandibles there 6-7 teeth on the inner side of the outer canine with 0-2 teeth on the inner side of the inner canine, all other mouth parts coincide with others is the genus and are indistinguishable except for the labrum, we were able to blueprint this form.



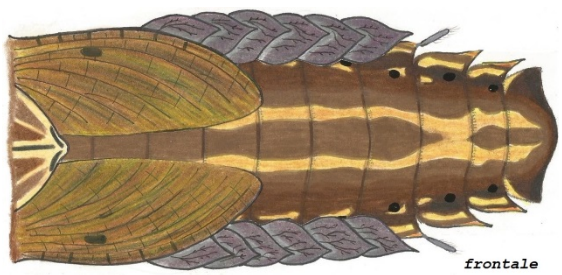
Labrum; very small forward indenture on anterior margin. Single row of 5, then 6 rows of 2, robust setae on the ventral side coming to the frontal edge. All fine dorsal setae are behind the robust setae.

Pronotum; Like others in the genus by having pale lateral edges followed inward by a blackish-gray (leaf) like coma type mark, with a fine pale stripe, followed by a large blackish spot as to coincide with pronotum oblique sublateral spots in the adult, with a large anterior-medial pale spot.

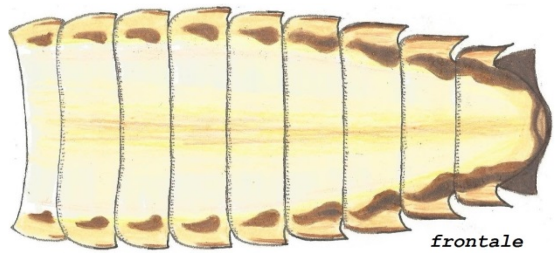
Pronotum

Mesonotum; very much like pronotum having small pale spots and dark lateral boarders. Wing pads typically reddish-brown with slight greenish hue in the female.

Forelegs; Femora banded with a median brownish band, followed by a pale yellow band, a pale area at the joint. Typical samples will normally have small black spots, one in the anterior-medial area, and two near the femora joint. Tibia dark brown at the apex followed by a pale band another larger dark band, and terminating at the tarsal joint with pale yellow. Tarsi same as tibia, fore claws not denticulate. Middle and rear legs following the same pattern but the dark areas are larger.



Abdomen; Lateral projections of the 8th and 9th segments are equal in length, brownish yellow in general coloring, with a wide median brown stripe that typically has a pigment deletion in the 8th tergite. This deletion can encapsulate all of the 8th part of the 7th, and also part of the 9th. Having narrow submedial pale stripes that are continuous from the 1-10 and expanding in width on the 8th due to medial stripe pigment deletion. These submedial stripes commonly deeply intrude into the 10th segment. The extreme lateral edges from 2-9 are dark with large pale areas followed by a very dark sublateral area where the spiracular spots are located, followed inward by a row of pale spots.



Sternum; Both the male and female have venter-lateral brown coma shaped spots. On the female they are normally from the 1-9 like above and on the males from the 6-9. The females are normally yellow-orange in ground color due to eggs present in the abdominal cavity. Males are typically whitish-yellow. Females will likely have small medial brownish spots from the 4th to the 8th. Both having the posterior margin of the 9th shaded in light brown staining. All of the 10th is normally darker brown sometimes blackish.

Tails; medium brownish with lighter articulations

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floridense

Lewis 1974

Based on his 1974 A&B descriptions

Notes: Reading both Lewis 1974 A, B, descriptions which appear to be the same description, it is clear that size is a issue. He has larva size 8-10 mm, and male imago 7-9 mm? We can rule out confusion with *interpunctatum* as *floridense* has 1-4 curved stout dorsal axial spines and no others in the genus has axial spines. We can rule out larva confusion as *floridense* tergite maculation is very distinct. The base line would likely be 8 mm for the male, 10 mm for the female. It is unfortunate that the samples at Bold Systems Museum larva photographed by Jeff Webb can't be used to clear this up. They are only in and around the 15-18 instars and are not full grown. From our studies and Ide 1935 Stenacron larva reach full body length at the 22nd instars when the wingpad reaches the posterior edge of the 2nd tergite, then the wingpad rapidly grows till it almost reach's the posterior edge of the 4th tergite by the 24th instars. We have also consulted The Mayflies of Florida and size is not covered.

Body size; ♂ 8 mm, ♀ 10 mm.

Tails; unknown likely ♂ 18 mm, ♀ 15 mm.

The only samples to work from for illustration are the 3 samples at Bold System that Jeff Webb photographed that are in the adult photo plate section. With the lack of details in Lewis's descriptions our illustration are based on the bold samples. Therefore head, pronotum and median ocelli spot illustrations were not done. We were unable to handle any larva so the labrum is also not blueprinted.

Head; shaped and marked as others in the genus, often a pale spot on the frontal margin, maxilla with 8 or 9 heavy setae combs on the crown of the maxilla with 20-25 setae in the submedial row, mandibles with 7 teeth on the inner side of the outer canine and 0 on the inner side of the inner canine.

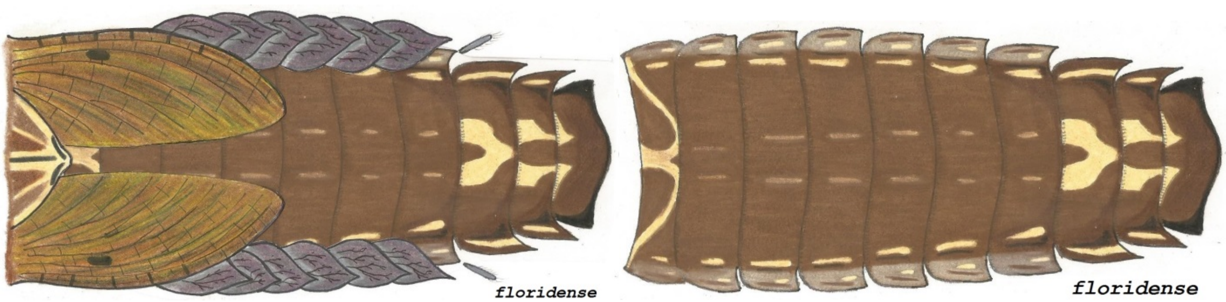
Pronotum; mostly brown with hyaline lateral edges.

Notum; median are with large pale spots, scutellum light yellow.

Legs; brown and whitish-yellow bandings.

Abdomen; mostly brownish-gray, lateral projections are unknown but likely equal in size. Lateral edges are pale, tergite 1 pale median spot with transverse pale line, with a series of pale sublateral spots from 2-7 as all in the genus, submedial pale spots on tergites 1-7 very small often hard to distinguish, tergite 8th large medial submedial **"V"** spot, 9th median brown spot breaking up median pale **"V"** spot. 10th tergite with pale anterior areas barely entering the 10th segment. Expect

variation in the size of submedial spots from 2-7 based on the color of the substrate.



<u>Ventral;</u> pale yellowish females having pale brown ventral-lateral spots becoming lines from the 7-9th on males from 7-9th

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Gildersleevei

Traver 1935

Notes; this description is based on Traver 1935, Burks 1953, Lewis 1974 a, and reared larva found in Bronte creek in southern Ontario in 2014. In the photo plate are the first publically seen photos of a female gildersleevei and a short video under the microscope was filmed. The only other known photo is Lewis 1974a figure 16 which is horrible but for the day wasn't to bad.

<u>General appearance;</u> pale cinnamon brown with very discontinuous submedial abdominal stripe, with equal lateral projection 8-9.

Body size; 10-11 ♂ mm, 13-14 ♀ mm

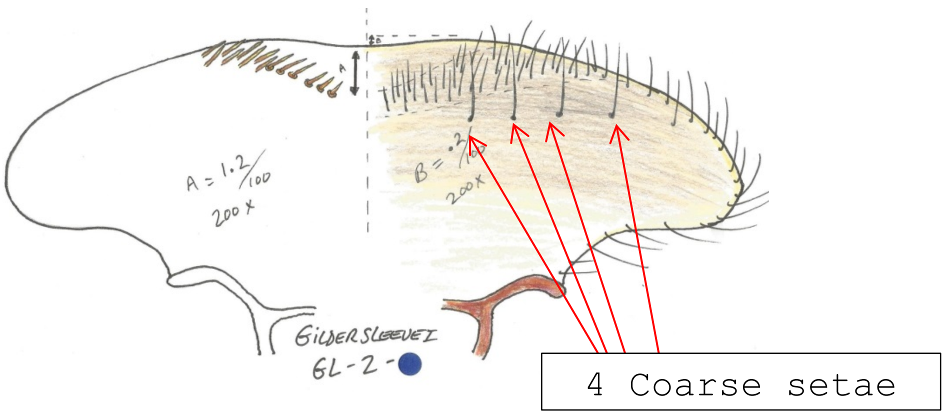
Tails; 24-26 ♂ mm, 18-22 ♀ mm

Head; median frontal area pale without a pale spot some samples having a small pale area lateral to each antenna base on the frontal margin, large pale areas from compound eye to lateral edge turning gray both forward and backward, generally a purple strip from antenna base to antenna base anterior to antennas to for a smile of sorts, typical samples with prominent median crania spot in front of elongated pale triangle ▼ shaped spot in front of median ocelli. Cranium suture pale white with prominent purple spot between and behind the lateral ocelli being the palmen body and trachea extension trunks. Very wide orange red stripe from mid-vertex to scutellum, with black spots behind the lateral ocelli.

Mouthparts; maxilla are highly diagnostic 11-13 pectinate setae combs on the crown of the maxilla, all samples from Bronte Ck all had 13, there are 30-45 setae in the submedial row, and our Bronte samples averaged 36, on the mandibles there are 7-9 teeth on the inner side of the outer canine, and 3-7 on the inner side of the inner canine, all other mouthparts generally are indistinguishable from all others in the genus except the labrum.

Labrum; very shallow indenture on the frontal margin, median robust setae .9 – 1.2/100th of a mm at 100X from the frontal margin forming a single row of 6 robust setae, followed by 4 rows of 2. Dorsal fine setae is placed right on top of ventral robust setae, there is one strange anomaly we only saw on

gildersleevei labrums, there are 4 very long specifically placed setae on the dorsal side they are almost robust in size they are marked below we refer to them as coarse setae that are more than double the length of standard setae.



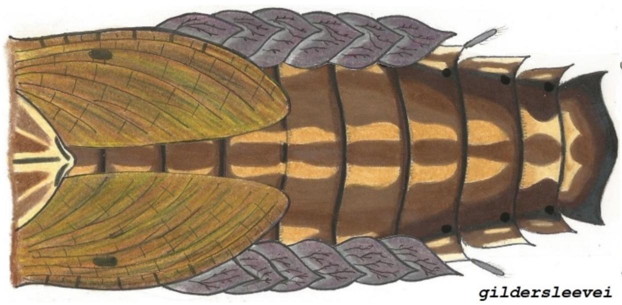
Pronotum; large pale yellow-hyaline lateral edges, followed inward by a blackish-brown stripe, then by a pale brown leaf shaped spot, a larger pale yellow are, 2 large submedial black spots that transcend into adulthood, prominent orange-red medial stripe.

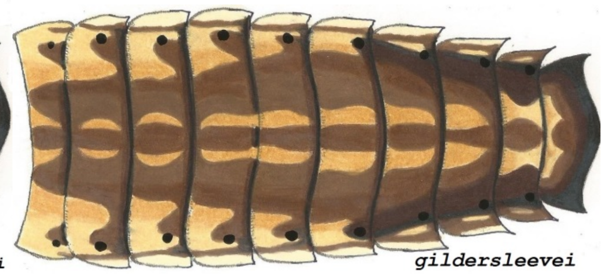
Notum; mostly brownish with pale spots and larger pale orange medial stripe scutellum is blackish-brown dividing the notum from the abdomen.

Legs; well banded with brown and pale transverse stripes.

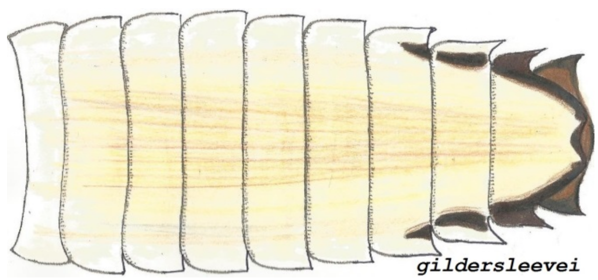
Abdomen; submedial pale stripe are discontinuous throughout often vase shaped. Lateral projection of the 8th and 9th are equal in length, medial stripe is a series of brown spot forming a moderately complete line from 1-10, sublateral pale areas from 1-7 decreasing in size from 1 through 7 these spots are often not evident due to gills and wing pads, they are easily seen samples younger than the 22 instars. All posterior edges with

transverse black bands, spiracular spots present on tergites 1-9, lateral areas of 7-10 blackish.





Ventral; pale yellow orange for females, whitish for males, at the lateral margins of 1-6 silvery white, both male and female only have ventral-lateral brownish-black lines from the 7th to the posterior area of the 9th, wrapping around the posterior area.



Tails; yellow-brown basely turning yellow-tan with very fine brown articulations.

Heterotarsale

McDunnough 1933

First pure description

Spieth 1947; larva undescribed SYN, Burks 1953 contains synonym forms.

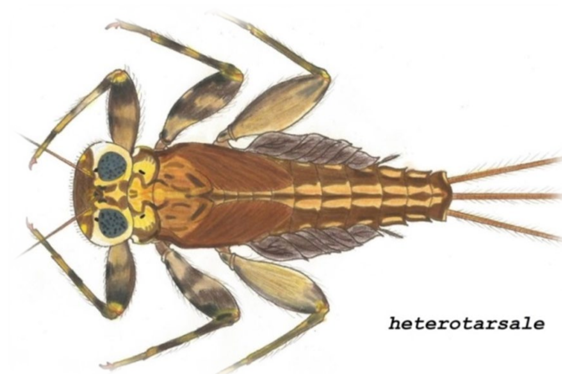
Notes; based on descriptions, reared adults and Traver 1935. *Heterotarsale* adults only have tiny spots near the compound eyes on the frontal margin,

and small blackish spots on the vertex and no other marking throughout the body in the adult stages. This description is pure to form.

General appearance; Cinnamon ruddy brownish, with continuous submedial dorsal stripes, lateral projections on the 8th & 9th are equal in length and somewhat squareish.

Body; 9 ♂ mm, 11 ♀ mm.

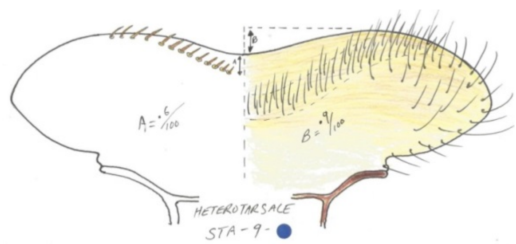
Tails; 18-24 ♂ mm, 15-17 ♀ mm.



Head capsule; oval in shape and depressed as in other forms and species in the genus. Typically having few black marks. No pale spot on the median frontal margin as in (*frontale*) and other forms, with rather large pale areas in front & lateral of the antenna base. Pale spot in front on median ocelli often shaped as mentioned by Traver 1935 as being in the shape of (fleur-de-lis). Very large pale areas on either side of the lateral ocelli, this spots extending to the lateral margin along the

cranium suture, and extending around the head capsule to the posterior area. There are very small black spots touching the anterior edge of the compound eyes. Lateral ocelli wide spread with very fine pale black spot right behind them.

Mouthparts; there are commonly 9 pectinate setae combs on the crown of the maxilla, and 30-35 setae in the submedial row, with 24-26 of them being fimbriated in nature. The mandibles have 5-7 teeth on the inner side of the outer canine and 3-4 on the inner sided of the inner canine, all the other mouthparts are indistinguishable from all others in the genus. We were able to blueprint the labrum and it is distinct.

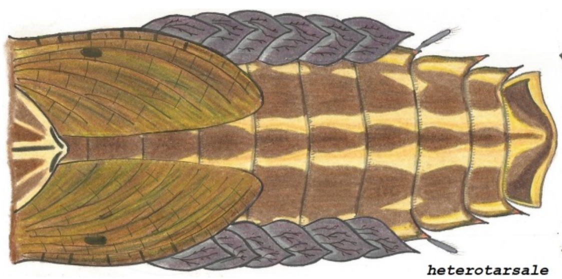


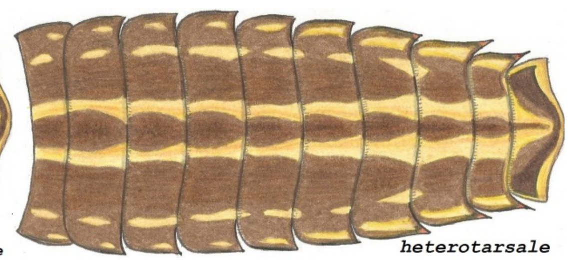
Labrum; Has a transverse median based row of spine setae just back from the anterior edge with the entire anterior edge without setae in front of this row, remaining areas sparsely covered in setae. All other mouthparts match others in the genus and are reasonably indistinguishable from each other.

Pronotum; much paler than others but similar to true *interpunctatum* (Say) the remaining notum pale yellowish background mottled with cinnamon spots. Wing pads are light brown with yellowish adult wing color coming through.

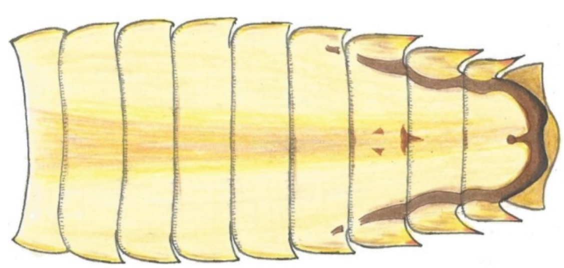
Legs; are marked as others in the genus. Fore femora mostly pale cinnamon and yellow with median and apical banding. Middle and hind leg similar to fore legs, however more brownish than pale yellow throughout.
Abdomen; 8th and 9th lateral projections are equal in size, and short in overall length, with the 9th having the shape of a bowie knife. The median line is light cinnamon with each section of each segment, being arrow shaped with the widest end on the anterior edge and the pointed end to the posterior edge, and intruding deeply into the 10th tergite, with 10th posterior edge being yellowish. Submedial streaks are continuous and uniformed with a moderate width as they travel from 1st to the 10th. These

streaks appear wider on the 6-9 as the median line diminishes. There are a series of small pale sublateral spots from the 1^{st} to the 7^{th} with a small pale spot in the anterior of the 8^{th} tergite, lateral to these spots is a darker area followed outward by another series of pale spots, with the terminal lateral edges being cinnamon in color.





Sternum; in the female the ground color is entirely orange, and the males are whitish-yellow with bases of the gills being hyaline. There are venter-lateral tan colored coma shaped marks from the 6^{th} through the 9^{th} in the female. In the male these marks commonly from the $8\text{-}9^{th}$. The 9^{th} segment having a transverse band rapping the lateral and posterior edge, with an indentured median area shape like the tip of a finial. Subanal plate is indentured in both the female and male.



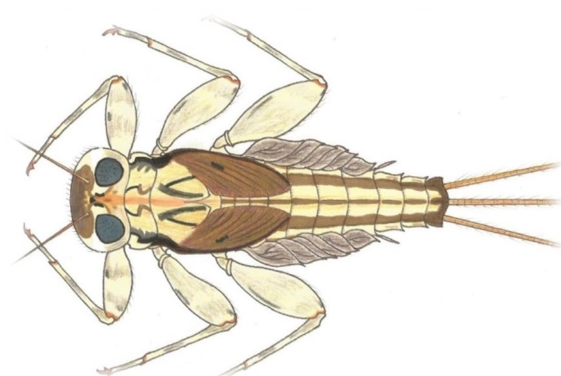
Tails; yellowish-orange with fine brownish articulations.

True ***interpunctatum*** Say 1839
Thomas Say
This is a synonym free description

Notes; Clemens 1924 clearly indicated the following. "The nymph is fully described (as species number 3) by Needham 1905". While we agree, there are aspects of that description that cause confusion. Dr Needham was using current wording that is now obsolete. It is also difficult to follow as it appears as though he is jumping from the head to the abdomen and back to the notum. We translated it to newer words and are utilizing that information. This is very much based on 4 reared males and 9 reared females from southern Ontario, as well as all comments from all previous authors 1839-2010. It is my pleasure to bring a modern and very clear description of Thomas Says original Stenacron *interpunctatum*.

General appearance; pale overall very small, with little markings on the legs, submedial and sublateral dorsal stripes continuous, 8^{th} and 9^{th} lateral projection equal.

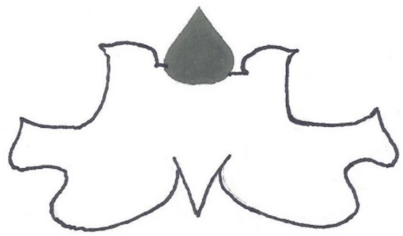
Body size; 7.5 ♂ mm, 9 ♀ mm Hagen 1861, 8 ♂ mm
Tails; 18-26 ♀♂ mm, Hagen 1861



Head; very pale overall with a brownish-tan-gray coloring, no pale spot on the frontal margin, large pale areas from the anterior of the compound eyes to lateral boarder wrapping around to the frontal margin somewhat, a small black dot in front compound eyes as in the adults, spot in front to median ocelli large and almost connecting to lateral pale areas near lateral ocelli, shape of this spot very much like a ♣ clover, there is sometimes a midcrania spot present, vertex has a small black spot on either side behind the lateral ocelli, remainder of head pale brownish.

interpunctatum Say

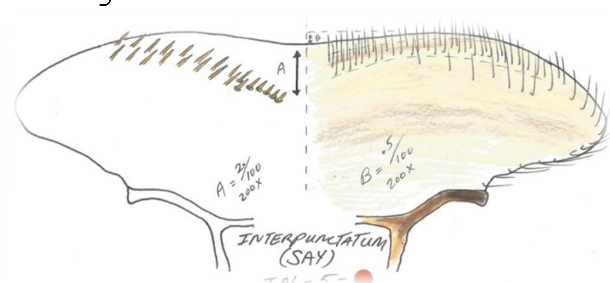
pale spot in front of median ocelli



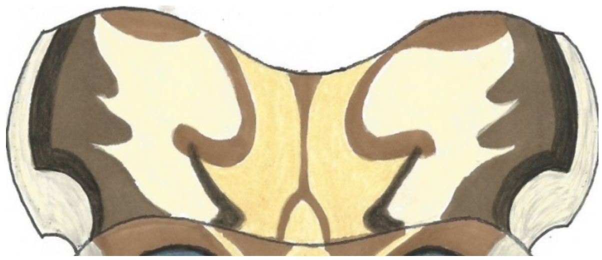
interpunctatum Say

Mouthparts; 9-10 pectinate setae combs on the crown of the maxilla, 25 or less setae in the submedial row, our sample indicated 20-23 as a average, with 7-9 being non fimbriated in nature, mandibles there are 7 teeth on the inner side of the outer canine, and 4 teeth on the inner side of the inner canine, all other mouthparts are indistinguishable from others in the genus except that labrum.

Labrum; shallow indenture on the forward margin, median robust setae set well back commonly 2.0/100th mm 200 X, there is a single row of 5 followed by 9 rows of 2 robust setae coming to the forward lateral margin.

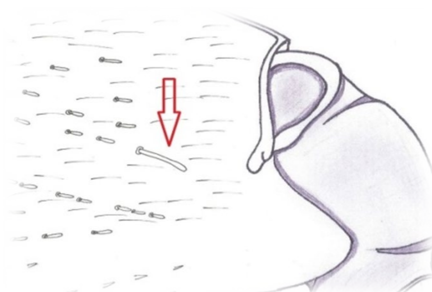


Pronotum; like the head very pale, large hyaline lateral edges followed inward by a narrow dark **S** shaped line, then by a pale brown spots shape like a Oak leaf, very large pale submedial areas with fine brown lines, very dark at the anterior margin becoming spots on the pronotum in the adults, median area yellowish.

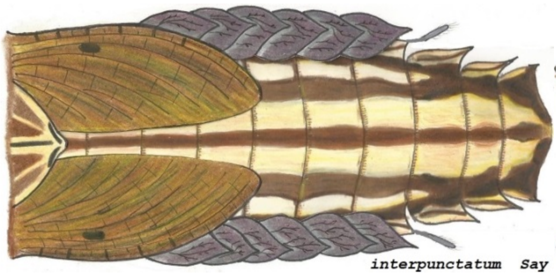


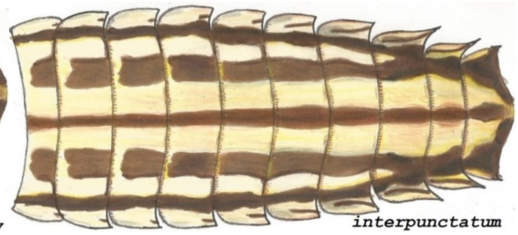
Notum; primarily yellow for male orangey for females, with longitudinal submedial and sublateral darker streaks, lateral boarder often blackish.

Legs; fore legs smoky hyaline background, with a fine median pale band followed by another darker area, with a yellowish-white spot at the femora joint, on the median anterior area of femora a purplish spot, and one at the femora joint. Middle leg mostly pale smoky gray with longer pale spots. Rear legs all gray with longitudinal posterial pale spot. All true *interpunctatum* Say we handled all had 1 long single paddle setae, without a group of small setae near it in the median-apical-dorsal area near the femora joint on the rear femora.

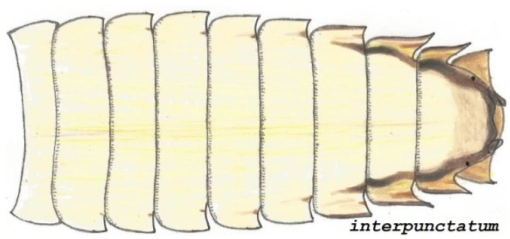


Abdomen; distinctly striped, the median line is thin and slightly darker than the other brownish areas, and deeply intrudes into the 10^{th} tergite, wide continuous pale submedial stripes that also deeply intrude into the 10^{th}, sublateral pale spots are near connected from 1-7 and just entering the 8^{th} in the anterior area, these lines are not obscured by the gills, but are by the fully grown wing pads, lateral margins pale hyaline with small brown longitudinal stripes on the spiracle ducts, no spiracular spots, very little dark shading, entire lateral areas of the $7\text{-}10^{th}$ slightly darker brown, females are yellow-orange do to eggs in the cavity.





Ventral; very pale yellow-white for males orangey yellow for females, on the males all the areas near the gills is silvery-white, on both male and female they tend to have very tiny brown stains sublateral to the edge from 3-6, sometimes absent, blackish-brown longitudinal-lateral lines from the middle of the 7^{th} to the posterior end of the 9^{th} with a small black spots at each side of the subanal plate. Our studies concur with Ide 1935 the male genitals can be examined earlier than the last instars; the earliest sample we could examine was about the 22^{nd} instars. The genitals are somewhat fully formed. However the spines are present as is the lobes but the lobe shape is hard to define; the penis is in a protective sheath and not yet full size. We used this to try to predetermine species concept when rearing what was looking to be a new species.



Tails; yellowish slight orange cast with pale articulations.

Reared male samples interpunctatum Say from Bronte Creek in southern Ontario from moderate color density substrate.

Majus

Traver 1935

First description

Notes; this species was created from Traver 1935 couplets, and larva table page 303 The Biology of a Mayfly. Her description of the adults allowed us to key reared adults to the historical profile 1935. The larvae were retraced using reared exuvia to ensure accuracy. This for majus is very district by it very large prominent spiracular spots especially on females. There are two different geological variations of this larva. However variation is little but we will comment when the information is usable.

Body size; 9.5-10.5 ♂ mm, 11-12 ♀ mm
Tail size; 18-22 ♂ mm, 18 ♀ mm

General appearance; pale cinnamon brown with prominent odd continuous submedial abdominal stripes, with a diamond ♦ shaped spot in the median area of the 9th tergite as per Traver 1935 lateral projection of 8th and 9th equal.

Head capsule; Deep brown in the frontal median area with a pale spot or stripe on the frontale margin, a moderate sized pale spot forward and lateral to each antenna base on the frontal margin, purple-black line from antenna base to antenna base like a faint smile, with a median crania spot in front of a median ocelli pale spot sort of a **T** and ▼ triangle shape combined, moderate pale areas lateral to compound eyes turning gray I to

the posterior margin, a black spot behind each lateral ocelli, vertex orangey in the median area.

majus

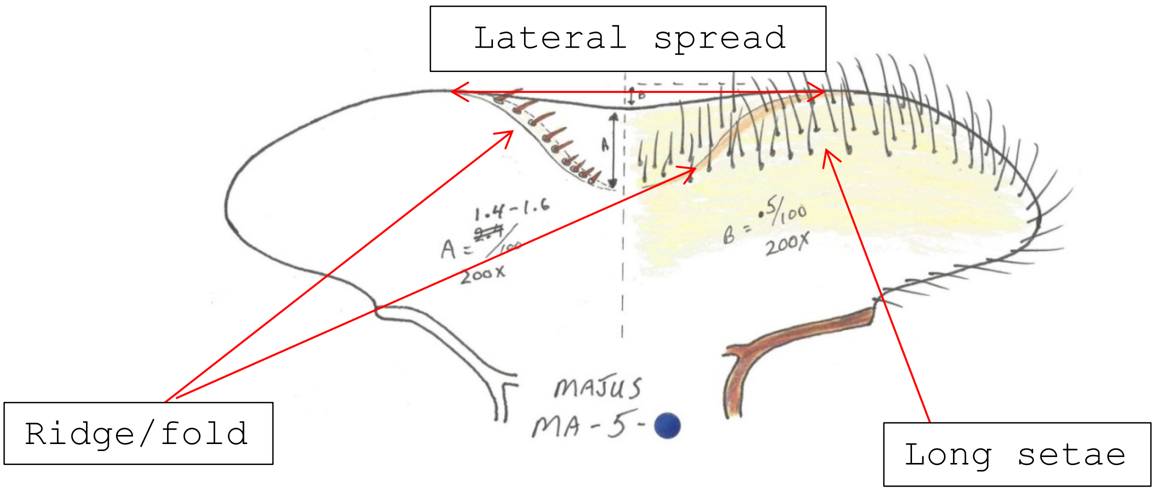
pale spot in front of median ocelli

majus

Mouthparts; on most samples there are 9 pectinate setae combs on the left maxilla and 10 on the right, and in the submedial row there are 34-35, rarely more rarely less. On the mandibles there are 6 teeth left and 7 teeth on the right inside of outer canine, and 0 on the inner side of the inner canine. All other mouthparts are indistinguishable from all others in the genus except the labrum.

Labrum; we slide mounted 5 labrum and all had this anomaly that is not on other forms, 3 were from exuvia, and 2 were from full larva, we cannot conclude for sure but all samples had a median like elliptical ridge see arrows indicating this. At first we thought it was a fold in the exoskeleton but the problem is the robust setae follow it with consistence.

The lateral spread from point to point is also short making the robust setae and ridge sort of **"U"** shaped but the frontal indenture is very shallow average sample .5/100th of a mm at 200X. There is a single row of 9 robust setae becoming twice the length of the median one at the frontal margin. The other interesting thing only seen on gildersleevei is the very long dorsal setae see below.



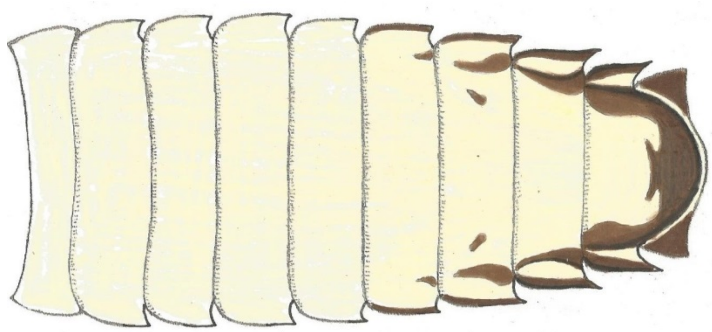
Pronotum; fine pale lateral area large in the forward area, followed inward by a large brownish-black leaf shape stripe, large pale submedial areas with black stripe to represent black lines in the adults, median area mostly orangey-brown.

Notum; mostly brown with pale spots and medial orange stripe.

Leg; very well banded rear femora brownish all with black spots especial at the femora joints.

Abdomen; incomplete medial brown stripe from 1-10. This stripe is typically a series of fine lens shaped spots thus (), in some sample not connecting to either the anterior or posterior edge of each tergite, that is a rule often broken. The submedial pale stripes are continuous from 1-10 but often uniquely expand on the posterior margins of tergites 4,7, and 9. This form can very much be confused with frontale as it also commonly has a deletion of pigment in the median line tergite 7 and 8, however distinction from frontale is the width of the median line it is very wide on frontale, and very thin here.

Ventral; brown ventral-lateral spots from 6-7, these spots turning into comma shaped and becoming a "U" shape as it wraps the posterior margin with a brown transverse line in the median area.



Tails; dark brown-yellow with fine brown articulations.

Minnetonka

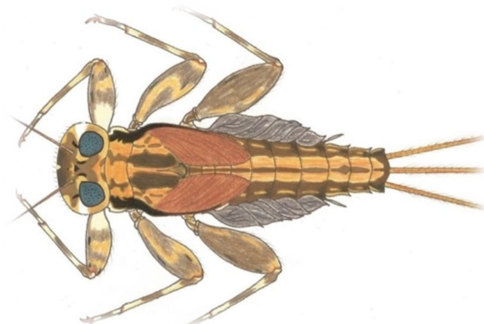
Daggy 1945

Notes; Lewis 1974 the Taxonomy and Ecology of Stenonema Mayflies description of the larva is so vague we could not make a full dorsal illustration but we wanted to. Because of what information is there it is likely very close to *canadense*. So for the opening full larva below the illustration is a *canadense* with a median frontal spot added to it. Making a very reasonable facsimile of the abdomen was not as hard, it was reversed engineered. We took the adult description combined it with our knowledge of transcending maculation in the genus specifically

the valid species, and were able to offer a likely representation. Description is basically Lewis 1974 combined with my genus knowledge and the complete adult morphology. My additional comments in parenthesis.

Body size; 9-10 ♂ mm, 11♀ mm.

Tail size; unknown



Head capsule; anterior to compound eyes uniformly brown,(will have pale dark marks at antenna bases that will coincide with lines on the clypeus of the adults, there will be a midcrania spot in front of pale spot that is in front of median ocelli).(there will also be a small black spots in front of the compound eyes and behind the lateral ocelli).

Mouthparts; there are 9-10 pectinate setae combs on the crown of maxilla, and 30-40 setae in the submedial row. Mandibles there are 6-7 teeth on the inner side of the outer canine, and 3-4 blunt teeth on the inner side of the inner canine. All other mouthparts are indistinguishable from all others in the genus. We did not hand *minnetonka* larva so we cannot comment on labrum but likely very distinct.

Pronotum; brown with a few pale areas, (would have hyaline lateral edges, and submedial black spots that coincide adult stage).

Notum; (likely darker brown with pale areas and likely a pale median longitudinal suture, and blackish lateral margins along wing bases).

Legs; alternating brown and white bands (with black spots near the femora joint as in the adults).

Abdomen; having a pair of continuous submedial stripes from 1-10, widest and the 8th and 9th tergite barely intruding into the 10th, (would have reducing sublateral areas under the gills as to coincide with very pale sublateral areas of the adults, with spiracular spots present from tergites 1-9).

Ventral; variable brown lateral spots from 4-9

Tails; light brown-yellow basil half alternating dark light band apical half.

Ohioense

Traver 1935

First description

Light types

Notes; in my 2014 rearing study of this form, the larva clearly indicate two separate types of larva that will rear out as adult *ohioense*. The two types are subject to specific substrates only. We are referring to these two types as light type and dark type. Both of these types possess sub-equal lateral spines on the 8th and 9th segment of the larva abdominal cavity. Because the light form aligns with Travers table and couplets in the Biology of a Mayfly, the lighter form should be considered the standard and the dark type the variant.

Lateral projection measurements 100X;

8th lateral projection average length; 7/100 mm

9th lateral projection average length; 11/100 mm

Female larva; 13 mm Tails; 17 mm

Male larva; 9 mm Tails; 15 mm

Light form;

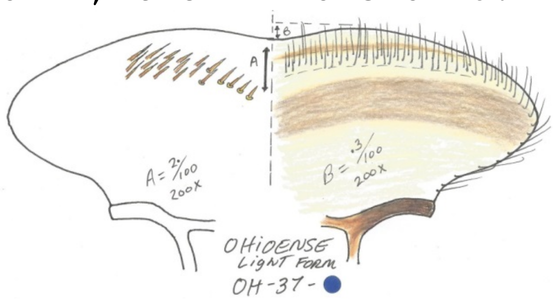
General appearance moderate brownish throughout with continuous submedial stripes.

Head capsule; in both the male and female the head capsule is highly depressed and oval in shape as in others in the genus, pale stripe frontal margin, pale spots in front of and lateral to the antenna bases, ♥ shaped pale spot in front of the median ocelli. Antenna bases heavily shaded in black, other than the extending pale stripe from the compound eyes to lateral edges. Very large black comas thus = **(** in front of each compound eye as in *candidum* but extending further than antenna bases and close to lateral edges, in the light type they are smaller and pointing towards the antenna bases. Very large black spots behind lateral ocelli, white cranium suture with large blackish-purple-red spot at the palmen body in both male and female, very dark blackish-brown posterior edge. Our median ocelli spot on the head capsule of light form is incorrect in shape.

Mouthparts; the female maxilla have 10 pectinate setae combs on both the left and right side, with 31L-29R setae in the submedial row with 10 in each row being none fimbriated in nature. The male maxillae have 10 pectinate setae combs on the

crown, and 27L-26R setae in the submedial row with 10 being none fimbriated in nature. Mandibles; on the female there are, 7 teeth on the inner side of the outer left canine, and 0 teeth on the inner side of the inner canine. On the right mandible there are 5 teeth on the inner side of the outer canine and 0 tooth on the inner side of the inner canine. On the male there are 6 teeth on the inner side of the outer left canine and 5 on the right. Regarding the inner canine there are 0 teeth left and 0 on the right.

Labrum; has a fairly shallow indenture in the frontal margin, fine dorsal setae all set forward of the ventral robust setae, robust setae set back well from frontal margin with, a row of 4, followed by 2 rows of 2, then 4 rows of 3.



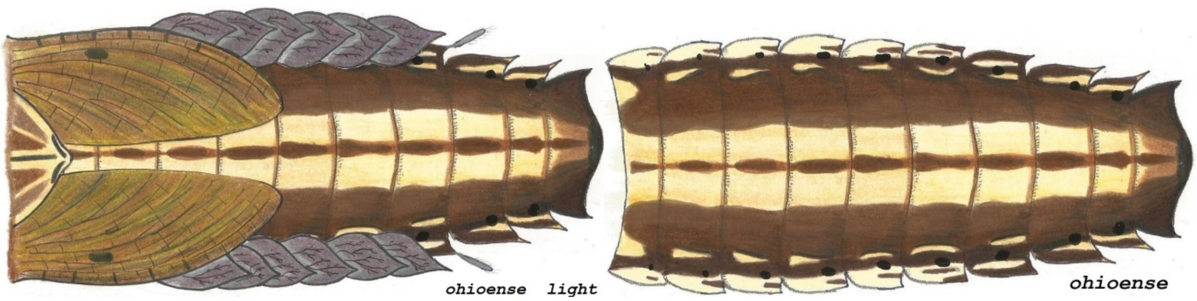
Pronotum; shaped as others in the genus, having a small brown coma spots on the anterior-lateral edge followed inward by large pale spot in the same shape, followed by a large brown-black spot in the same shape, a pale round spot in the submedial area, with another small brownish-black coma **(** spot. There are two submedial yellow spots and a small one in the median area, posterior edge brown.

mesothorax; pale pinkish median stripe with two large pinkish-brown coma shaped spots = **)** scutellum appears very dark black in color.

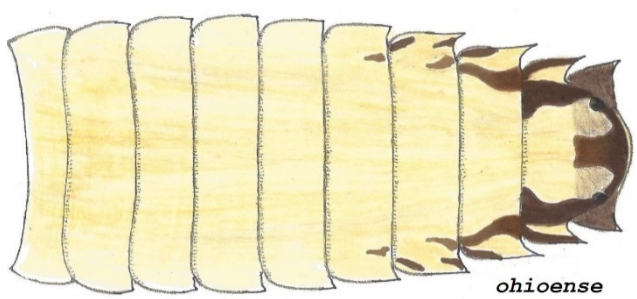
Mesosternum; pale white-yellow with many black markings, coxa all marked with blackish spots, pleura streaks present.

Legs; overall like all others in the genus but having distinct banding pattern from other forms.

Abdomen tergum; narrow median stripe being lighter that all other areas, often not connected to the posterior edge of each tergite, continuous submedial stripes on all tergites that fully intrude into the 10th which terminates with a black transverse rectangular spot on the posterior edge, lateral edges pale from 1-7 followed inward by a series of dark stripes 1-7, then with a pale sublateral streak with large black spiracular spots that transcend into the adult stage.



Abdominal venter; the female is orange-yellow and the male is yellow-white, both male and female have venter-lateral markings from the 5th-9th and are shaped as in a coma. The posterior 1/3rd of the 9th with a brown transverse band from lateral edge to lateral edge. There is a elevation in the median area of this band thus creating the appearance of a crescent shape marking rapping the 9th. There are (2) large prominent black spots on the sublateral area of the posterior edge of the 9th in both the male and female.



Tails; yellowish-brown with fine dark brown articulations.

Ohioense
Traver 1935

First description

Dark types

Notes; In my 2014 rearing study of this form, the larva clearly indicate two separate types of larva that will rear out as adult *ohioense*. The two types are subject to specific substrates only. We are referring to these two types as light type and dark type. Both of these types possess sub-equal lateral spines on the 8th and 9th segment of the larva abdominal cavity. Because the light form aligns with Travers table and couplets in the Biology of a Mayfly, the lighter form should be considered the standard and the dark type the variant.

Lateral projection measurements 100X;

8th lateral projection average length; 7/100 mm
9th lateral projection average length; 11/100 mm

Female larva; 13 mm Tails; 17 mm
Male larva; 9 mm Tails; 15 mm

Dark form;

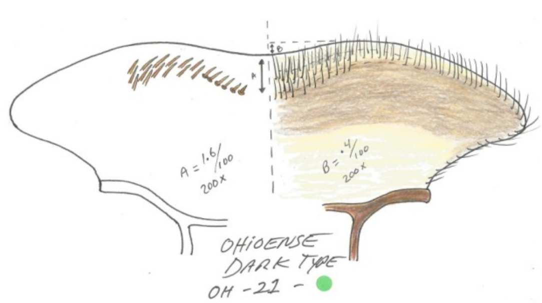
General appearance dark blackish brown throughout with **discontinues** submedial stripes, and is only found on dark substrates.

Head capsule; in both the male and female the head capsule is highly depressed and oval in shape as in others in the genus, no pale spot frontal margin, no pale spots in front of and lateral to the antenna bases, ♥ shaped pale spot in front of the median ocelli, with a large black spot in front representing a midcrania spot in the adults. Antenna bases heavily shaded in black, other than the extending pale stripe from the compound eyes to lateral edges the entire lateral edge is black much like

Heptagenia sp. Very large black comas thus = **(** in front of each compound eye as in *candidum* but extending further than antenna bases and close to lateral edges, in the light type they are smaller and pointing towards the antenna bases. Very large black spots behind lateral ocelli, white cranium suture with large blackish-purple-red spot at the pulmonary body in both male and female, very dark blackish-brown posterior edge.

<u>Mouthparts;</u> the female maxilla have 10 pectinate setae combs on both the left and right side, with 31L-29R setae in the submedial row with 10 in each row being none fimbriated in nature. The male maxillae have 10 pectinate setae combs on the crown, and 27L-26R setae in the submedial row with 10 being none fimbriated in nature. Mandibles; on the female there are, 7 teeth on the inner side of the outer left canine, and 2 teeth on the inner side of the inner canine. On the right mandible there are 5 teeth on the inner side of the outer canine and 1 tooth on the inner side of the inner canine. On the male there are 6 teeth on the inner side of the outer left canine and 5 on the right. Regarding the inner canine there are 2 teeth left and 0 on the right.

<u>Labrum;</u> has a fairly shallow indenture in the frontal margin, fine dorsal setae all set forward of the ventral robust setae, robust setae set back well from frontal margin with, a row of 4, followed by 2 rows of 2, then 4 rows of 3.



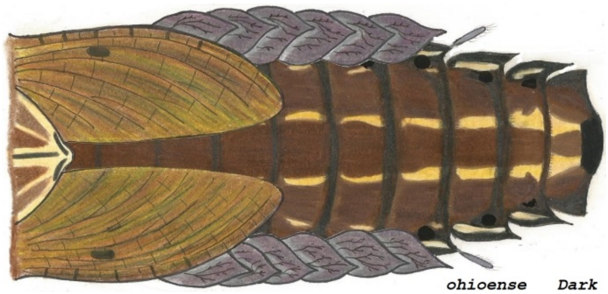
Pronotum; shaped as others in the genus, having a small gray coma spots thus = **(** on the anterior-lateral edge followed inward by large pale spot in the same shape, followed by a large black spot in the same shape, a pale round spot in the submedial area, with another large black coma **(** spot. There are two submedial pink spots and a small one in the median area, posterior edge very dark black-ish-brown.

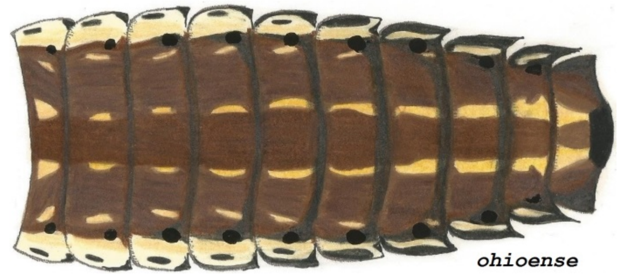
mesothorax; pale pinkish median stripe with two large pinkish-brown coma shaped spots = **)** scutellum appears very dark black in color.

Mesosternum; pale white-yellow with many black markings, coxa all marked with blackish spots.

Legs; overall like all others in the genus but having distinct banding pattern from other forms.

Abdomen tergum; large wide median brown stripe from the 1st through the 9th, with submedial pale discontinuous streaks throughout all tergites, thus looking like coma shaped spots as in *gildersleevei*, and *candidum*. These spots do not connect to ether the anterior or posterior edge of each tergite, with strong black shading on the posterior edges of the tergites as in *gildersleevei*, *pallidum*. Pale lateral areas with black spots from the 1st-6th, pale sublateral streaks shaped like a coma on 1st-6th, with a very small pale spots on tergum (7) in the posterior lateral area. In the female there are large prominent black spiracular spots on the 1st through the 9th. These spots not so prominent on the male and are from the 2nd through the 9th. Pale submedial streaks are deeply intruded into the 10th and the posterior edge is blackened by a transverse rectangular spot.





Abdominal venter; same as light type the female is orange-yellow and the male is yellow-white, both male and female have venter-lateral markings from the 5th-9th and are shaped as in a coma. The posterior 1/3rd of the 9th with a brown transverse band from lateral edge to lateral edge. There is an elevation in the median area of this band thus creating the appearance of a crescent shape marking rapping the 9th. There are (2) large prominent black spots on the sublateral area of the posterior edge of the 9th in both the male and female.

Tails; yellow-brown with pale brown articulations

Pallidum

Traver 1933

Notes; based on Traver 1933, Lewis 1974 and one photo that aligns with Dr Travers description and can only be *pallidum*. We have not handled *pallidum* as it is not in our geographical range. A maculation morphology study of the entire genus allows a very clear hypothesis. In the abdomen Traver says median spot thus =() what that means is this shape in the median area of each tergite.

General appearance; slender small light reddish-brown lateral projection equal in length.

Body size; 6-7 ♂ mm, 6-7.5 ♀ mm
Tail size; 10-11 mm

Head capsule; brighter reddish-brown especially anterior to ocelli meaning the area between the antenna bases, (very pale darker areas at antenna bases to reflect dashes below antenna bases on the clypeus in the adults). Pale areas from compound eyes to lateral margins, (with small black spots in front of compound eyes to coincide with adults), a pale spot in front of median ocelli (likely ▼ triangular in shape).

Mouthparts; maxilla with 11-13 pectinate setae combs on the crown, with approximately 25 setae in the sub medial row. Mandibles with 5-8 teeth on the inner side of the outer canine, and 2 blunt teeth on the inner side of the inner canine. All other mouthparts would be indistinguishable from all others in the genus. The labrum would be diagnostic as all other.

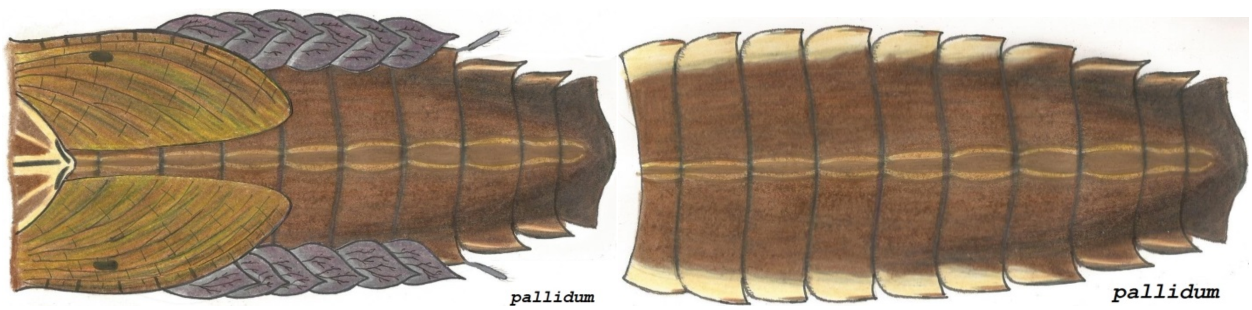
Pronotum; lateral areas hyaline brownish-red with pale areas (and very fine blackish spots that will become thin black stripes on adults).

Notum; similar to pronotum (likely with a paler median longitudinal suture, and a pale area at the scutellum as in the adults).

Legs; yellow-brown with alternating pale yellow and pale reddish-brown bandings, tibia smoky at the apex, tarsus dusky, (small black spots at the femora joint of all femora may be absent on rear).

Abdomen; reddish-brown with very thin and fine pale submedial stripes that do not stand out. Each median section of the median

line shaped and connected forming a median line, with very narrowly blackened posterior tergite margins, lateral edges of 1-7 pale but not seen with gills and wing pads present, no spiracular spots.



Ventral; pale yellow white with shaded brown lateral margins on sternites 7-9

Tails; pale yellow-brown at the base pale tan to gray tan throughout.

Proximum

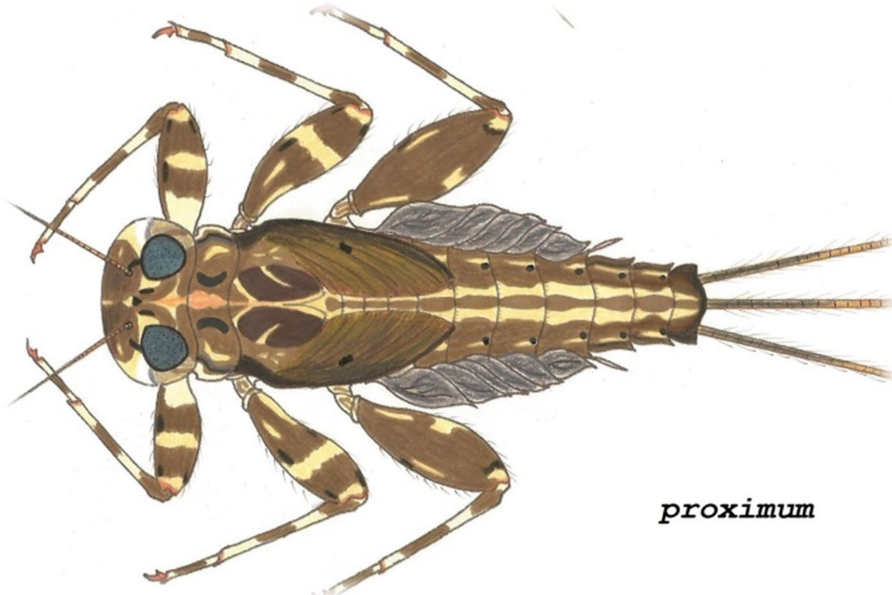
Traver 1935

First description

Notes; Traver (1935) establish some criteria that lead us to this form. This description is based on many collected and reared samples that keyed out as adults to this form described in the "Biology of a Mayfly" (1935). The genital were also distinct.

General appearance; Brownish-black throughout with continuous dorsal median stripes.

Body size; 9-9.5 ♂ mm, 11 ♀ mm,
Tails; 18 mm



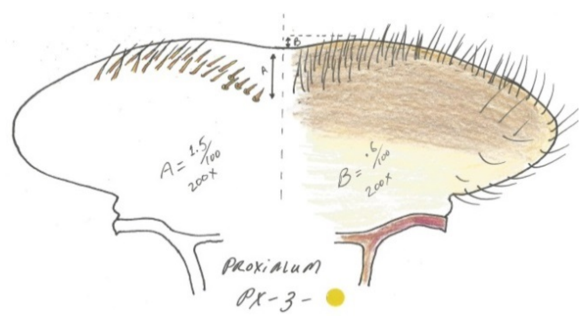
Head capsule; oval in shape and depressed as in other forms and species in the genus. Typically having many black marks. Often a pale spot on the median frontal margin as in (*frontale*) and other forms but not shaped like a spot rather shaped like a short longitudinal stripe. Pale spot in front on median ocelli often **T** or ♥ shaped.

Black spot sometimes present in front of this spot as to coincide with a midcrania shading. Very faint small pale spots present below and lateral to the antenna bases near the anterior margin. Triangular-ish pale spots on either side of the lateral ocelli, these spots extent to the lateral margin as in all forms in the genus in the general shape of a stripe and or triangle shape. Black markings in front of the compound eyes either tear or coma shaped pointing to antenna bases. There are two black spots on the vertex behind and close to the lateral ocelli.

Posterior edge of head capsule dark brownish-black. Posterior lateral area often grayish brown hyaline.

Mouthparts; On the crown of the maxilla there are most often 10-11 heavy pectinate setae combs on the left and right 10 being the average. Submedial row of setae has 28-32 setae and typically 21 of them are fimbriated in nature. The mandibles having 6 teeth on the interior side of the outer canine on both the left and right side. Regarding the inner canine, in most samples there are 2 teeth on the left and right. All other mouth parts coincide with and are reasonably indistinguishable from all other species and forms in the genus.

Labrum; the labrum of proximum is diagnostic to form. At 200X there is an frontal margin indenture of .6/100th, and the first or medial robust setae is 1.5/100th from the anterior edge, typically 3, then followed outward by 10 a rows of 2 to the anterior edge.



Pronotum; Similar to others in the group by having pale lateral edges and a crescent shaped pale spot in the submedial region. The remaining areas blackish-brown. Often having small black marks in the posterior submedial area that coincides with pronotum makings in the adult stages.

Mesonotum; Blackish-brown with small pale areas often having dark lateral edges. Wing pads dark brownish with greenish-yellow hue from the fully formed adult wings encapsulated.

Mesosternum; Pale yellow, pleura marks are present at the lateral edges between the rear and mid legs, and the mid leg and the foreleg.

Foreleg; The femora in general having the appearance of banding. There is a pale longitude band in the median area, laterally followed by a dark band and then a very pale band at the terminal end. Often a large black spot at the joint on the dorsal side. Tibia; basil area dark brown at the joint with black spots on the lateral edge, followed by a pale area, another pale brown area and terminating at the tarsi joint as pale yellow-whitish with a black spot. Tarsi marked as in tibia, fore claws not denticulate. Black spot at the terminal end of the tibia.

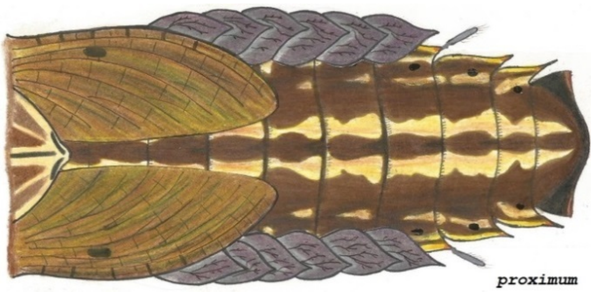
Middle leg; Median longitudinal stripe restricted to the posterior edge followed by a pale stripe that is broken. Apex of femora very dark. Tibia marked as in fore tibia with terminal black spots.

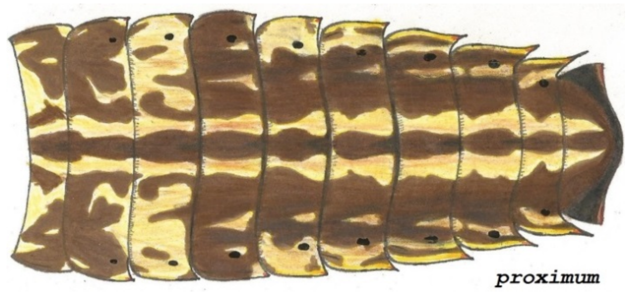
Rear leg; Femora almost entirely brownish-black. Pale median spots with a pale apex edge that has dark spots. The posterior edge often having large dark spots that are restricted to the posterior edge.

Abdomen dorsum; General appearance continuous medial stripes. Lateral spines on the 8th shorter than the 9th. Medial dark brown stripe generally equal in size from the 1st to the 10th. Slightly wider on segments 3-8, most often lens shaped thus; (). Pale submedial streaks somewhat uniformed slightly wider on the segments 5-8, slightly reduced on the 9th.

Streaks deeply intruded into the 10th. Lateral edges most often pale from 1-9. Sublateral areas having pale spots from the 4th through the 7th. These spots often covered by the gill plates giving the appearance of not having sublateral marks.

Small spiracular spots from the 2nd through the 9th. Tergum 3 often very pale from lateral edge to submedial streak binder edge. Tergum 10 posterior and lateral edges blackish and very dark.





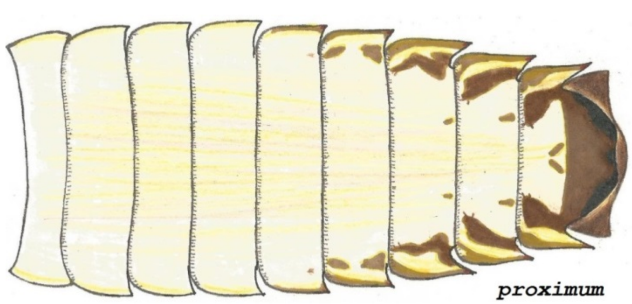
Abdomen Venter; Male and female both having venter-lateral markings. In females these marks are most often from the 1st or 2nd segment through the 9th.

In males these marks are typically seen on the 6th through the 9th as in most in this genus. In females the abdominal cavity is orange-yellow due to eggs present in the cavity.

In males most often yellow-white. These venter-lateral marks on the 7th-9th looking much like dark brown comas.

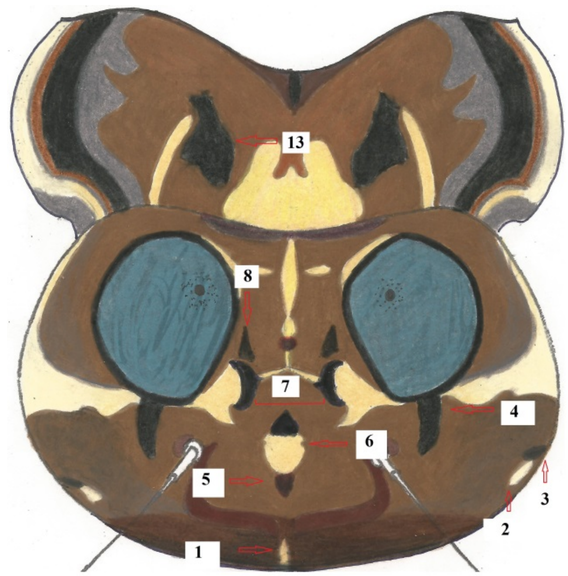
The entire posterial region being ½ of segment 9 dark cinnamon brown as a wide transverse band. May have slight anterior elevation in the medial area.

In the female there may be medial ganglionic markings present from the 3rd or 5th segment through to the 9th. The entire posterior edge of the 9th blackish. Male claspers are typically blackish-brown.



Tails; Blackish brown with pale articulations.

Now let’s start with the illustrations of the larva. All these markings are stated as they appear in the tables. Starting with the head then moving to the abdomen.



1; pale spot on the frontale shelf

2; pale spot lateral to antenna bases

3; black spot lateral to antenna bases

4; spot in front of compound eyes

5; median crania spot

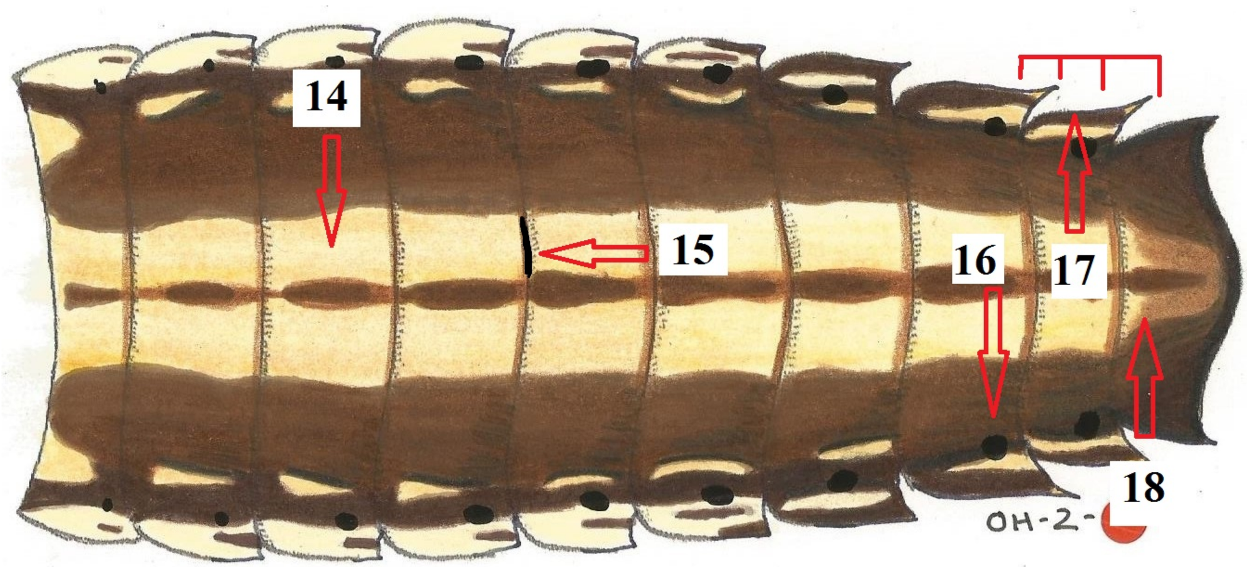
6; spot in front of median ocelli

7; spread of lateral ocelli

8; spots on the vertex of the head

9; black spots on the pronotum

All these marks do transcend into the adult stages. Not all the markings on the abdomen transcend into the adult stage.



14; submedial abdominal stripes

15; blackened posterior edge of tergite

16; spiracular spots

17; lateral projections, referring to equal size of the 8th and 9th

18; submedial stripes entering the 10th segment

Stenacron larva features and key

From darkest to lightest

	Anatomical Features	*canadense*	*gildersleevei*	dark form *ohioense*
1	pale spot frontale margin	no	no	no
2	pale spot ant bases	yes	yes	no
3	BLK spot ant bases	sometimes	yes	yes
4	spot in front of compound eyes	SM blk spot	LRG coma	large coma
5	median crania spot	yes blk	yes blk	yes blk
6	shape of spot in front ocelli	♣-ish	▼	♥-ish
7	spread of lateral ocelli	wide	very wide	wide
8	BLK spot vertex	SM black	LRG blk	LRG black
9	maxilla pect setae	10 - 11	11 - 13	10 - 11
10	setae submedial row	25 - 30	30 - 45	28 - 32
11	MAND outer canine	6	7 - 9	7 - 8
12	MAND inner canine	0	3 - 7	3 - 4
13	BLK spot pronotum	yes	LRG ◄	LRG coma blk
14	submedial streaks continuous	yes	no	no
15	tergites blackish	no	yes	yes
16	spiracular spots	no	yes prom	yes
17	8&9th spines =	equal	equal	sub-equal
18	streaks entering 10th	yes	minute	minute
19	tail color + ART	yellow	dark with art	blk-ish

Currently there is only (1) key to larva being the lateral projection on tergites 8-9. However the mouthparts being maxillae & mandibles are considered diagnostic Lewis 1974.

<u>Larva must be measured while alive abdomens expand at death</u>

Stenacron larva features and key

From darkest to lightest

	Anatomical Features	light form *ohioense*	*frontale*	*majus*
1	pale spot frontale margin	stripe pale	yes	yes
2	pale spot ant bases	LRG yellow	yes	yes
3	BLK spot ant bases	no	yes	yes
4	spot in front of compound eyes	tear drop	SM tear drop	small coma
5	median crania spot	sometimes	yes	yes
6	shape of spot in front ocelli	♥ - ish	▼-ish	**T - ish**
7	spread of lateral ocelli	wide	wide	wide
8	BLK spot vertex	LRG blk	LRG blk	LRG blk
9	maxilla pect setae	10	9 typical	9L - 10R
10	setae submedial row	25 - 30	39 - 46	34 - 35
11	MAND outer canine	6	6 - 7	6L - 7R
12	MAND inner canine	0	2 - 4	0
13	BLK spot pronotum	yes	small blk	yes
14	submedial streaks continuous	yes	yes	no
15	tergites blackish	no	no	no
16	spiracular spots	yes LRG	small	yes LRG
17	8&9th spines =	sub-equal	equal	equal
18	streaks entering 10th	deeply intruded	minute	deeply intruded
19	tail color + ART	yellow + art	dark + art	dark + art

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Stenacron larva features and key

From darkest to lightest

	Anatomical Features	*proximum*	*conjunctum*	*minnetonka*
1	pale spot frontale margin	pale stripe	no	yes
2	pale spot ant bases	yes	LRG yellow	unknown
3	BLK spot ant bases	yes	LRG blk X 2	unknown
4	spot in front of compound eyes	SM coma	smeared tear drop	unknown
5	median crania spot	faint	yes	unknown
6	shape of spot in front ocelli	**T - ish**	♥ - ish	unknown
7	spread of lateral ocelli	tight	tight	unknown
8	BLK spot vertex	yes sm blk	LRG blk	unknown
9	maxilla pect setae	10 - 11	10	9 - 10
10	setae submedial row	28 - 32	34 - 37	30 - 40
11	MAND outer canine	6	6 - 7	6 - 7
12	MAND inner canine	2	1 - 2	3 - 4
13	BLK spot pronotum	sm blk	sm blk	nk
14	submedial streaks continuous	yes	no	yes
15	tergites blackish	no	no	no
16	spiracular spots	small	moderate	LRG distinct
17	8&9th spines =	8th shorter	equal	unknown
18	streaks entering 10th	moderate	minute	short
19	tail color + ART	yellow + art	dark + art	lt brown + art

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Larva must be measured while alive abdomens expand at death

Stenacron larva features and key

From darkest to lightest

	Anatomical Features	*candidum*	*carolina*	*pallidum*
1	pale spot frontale margin	no	no	no
2	pale spot ant bases	sm yellow	no	no
3	BLK spot ant bases	blk shading	no	no
4	spot in front of compound eyes	coma	blk shading	sm slash
5	median crania spot	prominent	yellow	no
6	shape of spot in front ocelli	▼ - ish	**T** elongated	**T**-ish
7	spread of lateral ocelli	wide	wide	wide
8	BLK spot vertex	yes blk sm	yellow	yes
9	maxilla pect setae	7 - 8	10	11 - 13
10	setae submedial row	15 - 25	20 - 30	25
11	MAND outer canine	7 -8	7 - 8	5 - 8
12	MAND inner canine	0	2 P-Blunt	2
13	BLK spot pronotum	LRG coma blk	sm gray	pale gray
14	submedial streaks continuous	no	no	yes very fine
15	tergites blackish	no dark-ish	no	yes
16	spiracular spots	yes distinct	no	no
17	8&9th spines =	8th shorter	9th longer	8th shorter
18	streaks entering 10th	minute	moderate	minute
19	tail color + ART	dark + art	smoky = art	smoky brown

Currently there is only (1) key to larva being the lateral projection on tergites 8-9. However the mouthparts being maxillae & mandibles are considered diagnostic Lewis 1974.

Larva must be measured while alive abdomens expand at death

Stenacron larva features and key

From darkest to lightest

	Anatomical Features	*areion*	*affine*	*flaveola*
1	pale spot frontale margin	larva unknown	unknown	same as interpunctatum Say
2	pale spot ant bases		unknown	
3	BLK spot ant bases		unknown	
4	spot in front of compound eyes		minute blk	
5	median crania spot		no	
6	shape of spot in front ocelli		♣ - ish	
7	spread of lateral ocelli		unknown	
8	BLK spot vertex		very small	
9	maxilla pect setae		unknown	
10	setae submedial row		unknown	
11	MAND outer canine		unknown	
12	MAND inner canine		unknown	
13	BLK spot pronotum		no	
14	submedial streaks continuous		yes	
15	tergites blackish		no	
16	spiracular spots		no	
17	8&9th spines =		equal	
18	streaks entering 10th		unknown	
19	tail color + ART		brow-yellow	

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Larva must be measured while alive abdomens expand at death

Stenacron larva features and key

From darkest to lightest

	Anatomical Features	*heterotarsale*	*floridense*	*interpunctatum*
1	pale spot frontale margin	no	no	no
2	pale spot ant bases	yes LRG yell	no	LRG yellow
3	BLK spot ant bases	no	no	no
4	spot in front of compound eyes	minute	sm slash blk	very minute
5	median crania spot	no	no	no
6	shape of spot in front ocelli	fleur-de-lis ♣	▼ - ish	♣ - ish
7	spread of lateral ocelli	tight	very wide	moderate
8	BLK spot vertex	minute blk	sm blk	minute blk
9	maxilla pect setae	9	8 - 9	9 -10
10	setae submedial row	30 - 35	20 - 25	25 or less
11	MAND outer canine	5 - 7	7	7
12	MAND inner canine	3 - 4	4	4
13	BLK spot pronotum	minute tan	very small	slash minute
14	submedial streaks continuous	yes	no	yes + wide
15	tergites blackish	no	no	no
16	spiracular spots	no	no	no
17	8&9th spines =	equal	unknown	equal
18	streaks entering 10th	deeply intruded	minute	moderate
19	tail color + ART	pale yellow	pale brown	pale yellow

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Larva must be measured while alive abdomens expand at death

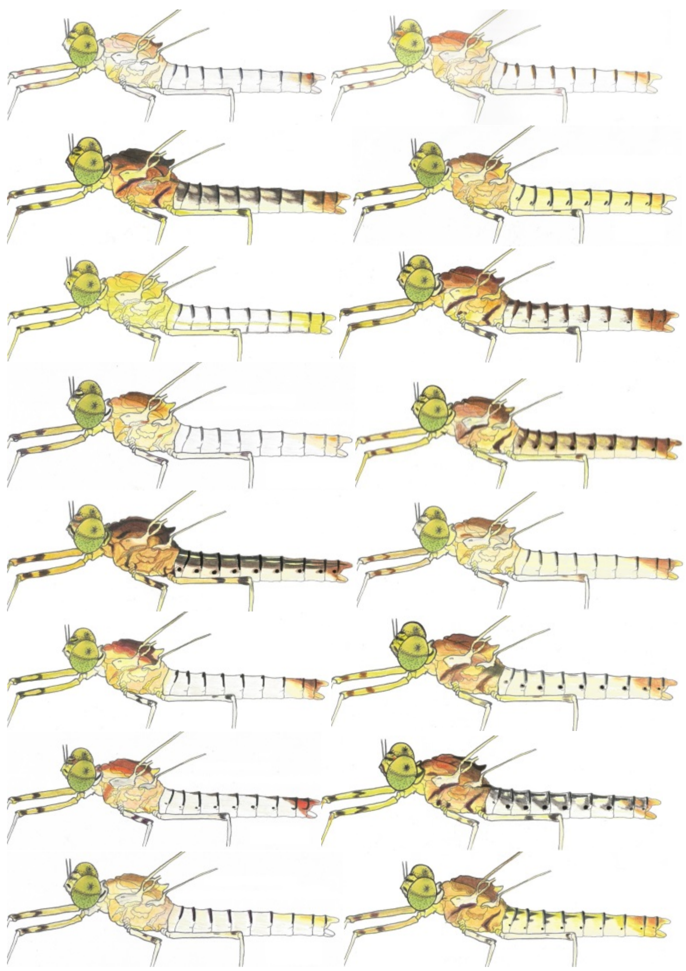
Stenacron

Mayflies

Adults 2020

Who is Who?

We bet you are having a hard time with who is who even in this larger than life test. Can you tell which is the real true to form *interpunctatum* Say 1839, not likely? By the time you finish with this book you will be able to see who is who. The samples you are looking at are nearly 3X the real size.

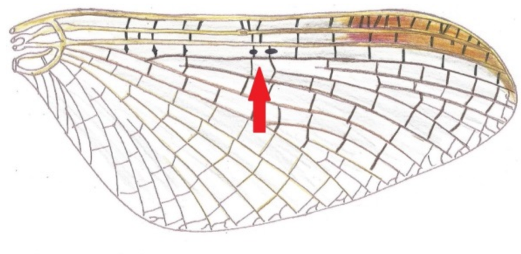


Adults

Table of contents

Characteristics of the adult in genus

All Stenacron in the adult stages have a signature genetic feature that is used to classify the adults. In the middle area of the forewing there is typically a black dash or spots as seen in the illustration below.



This dash can be just a single spot which is only found in one species in the genus being Stenacron *candidum*. In most samples it will be a black bar typically covering 2-3 cross-veins in the R_1&R_2 interspaces. By using this character you can establish that your sample is in fact a Stenacron.

Collecting adults

Collecting Stenacron adults is difficult for several reasons. First they typically hatch sporadically and in small numbers. So finding a spinner fall can be hard, unless you are collecting near a larger slower moving river. It will most always come down to you being in the right place at the right time.

Second the spinner fall often takes place after dark and over very shallow slow moving waters near the banks. They are often found resting on the underside of a leaf waiting mating time. Stenacron as a rule hatch with the greatest numbers being female.

In our rearing studies we have found that the ratio is about 9 females per 1 male. In captivity the females can survive up to 7 days, but the males expire often in less than 60 hours. Usually there is not a spinner fall every day; every third day is more likely.

Rearing the larva is not hard and is the best way to collect adults. Stenacron Mayflies part II; will cover this process in detail.

Male and female

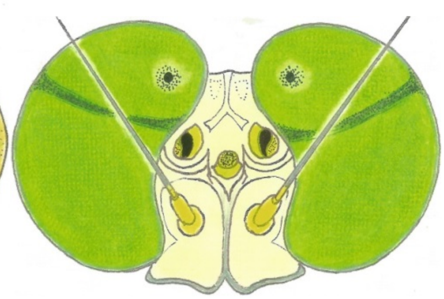
Here are some easy technics to tell if your samples are a male or female. Size is one way to tell the females are much larger than the males. Next most females have an orange colored abdomen because of the eggs they carry.

The most noticeable feature is the head shape and size. The first illustration is the head of the female. Right below that is the head of the male.

The males have very large compound eyes that are close together, while the females have small compound eyes spread very far from each other.

If you know how to identify by genitals you can also use the claspers at the posterior area of the 10^{th} to tell them apart.

Female



male

Interbreeding

From personal observations in both collecting and careful rearing interbreeding is inconclusive. None of the previous authors have given definitive proof of this. It is however a very reasonable concept.

Even with the newest morphological information one must still wonder if there really are any hybrids out there. So for a moment let’s assume that the hybrid possibly has merit, and could happen. We will need to have a hypothetical view point because there is no true evidence of the hybrids. Let’s first look at the life cycle or life history of the genus. Unlike many mayflies, Stenacron are more generally known for hatching in sporadic and smaller numbers. Reports do however indicate that they can hatch in greater numbers on some river systems. Those rivers that are generally slower and larger can support much bigger populations. So with less numbers on an average it seems not only plausible but sensible to conceive that interbreeding could take place. Most Stenacron male

Imagoes commonly expire within several days, and *ohioense* has shown itself to expire in less than (60) hours in captivity. So as a survival mechanism to the overall health of the genus the hybrid becomes more sensible. Life can be said as, “it just finds a way” and it often does just that. A hypothetical scenario would be. If inside a spinner fall there are 50 *frontale* males and 50 *frontale* females we could presume that all the females would copulate and deposit eggs as being the form *frontale*.

However if we change the female ratio to 25 of them are now *frontale*, 10 of them are now *gildersleevei*, 15 are *conjunctum*. Do we now presume that the *gildersleevei* will die, and not copulate with a *frontale* male?

For that part of the experiment DNA would likely be the only way to truly know, and it may not offer a true or clear answer. As a survival mechanism the females can hold a fertile position longer until copulation can be achieved. Many reared *ohioense* female can last up to 5 days in captivity, and in the real world they may last up to a week. The hatching ratio of male to female adults in my rearing of *ohioense*

clearly indicates 9 females to 1 male. So under sporadic hatching the female may have to wait even longer till a male is mature and able to mate.

As to the female *conjunctum* being what is already considered a hybrid form, I suspect that it is plausible that it could mate with the *frontale* male, if there were no others of that form available.

With smaller populations it does not seem likely they would allow themselves to expire, if they did it could put the entire genus at risk of survival as a whole in low percentage areas only. If there really are any hybrids out there that would just make this genus even more interesting and special. Why can they interbreed but yet no other genus is thought to have that ability?

Even with the Leopard larva changing its spots, the hybrid thinking will always remain a mystical mystery of this unique and special genus. It's like a great conspiracy theory.

With new evidence there are likely no true hybrids and the mystical legend of interbreeding will likely live in the legacy, of this amazing genus forever.

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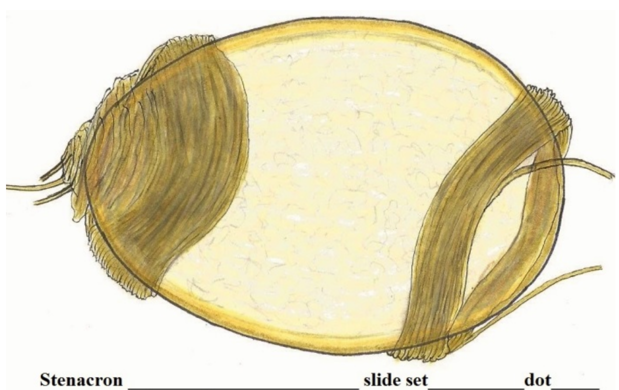
Eggs and eyes

One of the most fascinating things in nature is mate selection. In life many animals they are attracted to their mates by smells or pheromones. Because the male compound eyes are so sensitive to light definitions we felt that color definitions may be important. It is also unclear how much of their overall eyesight is based on the simple eyes or ocelli, or the larger compound eyes. First let’s take a look at the face and head of a male *interpunctatum* / *ohioense* dark type subimago under the microscope. Notice the full smile on the frontal margin.

As mentioned we did review of about 50 females eggs from 6 different forms. There is very slight variation in the color density and brightness in the dark form to the lighter forms. To the human eye the variation is not really high. There is quite a bit of color variation in the abdominal color of the egg carrying females. There is little question that the lighter species and forms have yellowish colored eggs. We were unable to locate S *carolina* that has yellow-cream colored eggs. So we worked with samples that were available in our geographical region to see if the males may use color definition in the mate selection process. Let's first take a close up look at an illustration we made of a typical female Stenacron egg.



Although there were slight differences in the eggs we had no way to describe the very slight differences and if what we saw was of any value. There was one primary difference that was notable. The size of the eggs from pole to pole or left to right and in the top to bottom in the above illustration.

There was slight variation in size in the different forms. However the size differential range was .2/100 to .5/100 @ 200X. We do feel that a true study of eggs would be worthwhile from someone like Dr Richard W Koss with great egg expertise. Now we will look at pictures of females we verified to males and larva exuvia to see the slight color difference.

Stenacron *interpunctatum / heterotarsale*

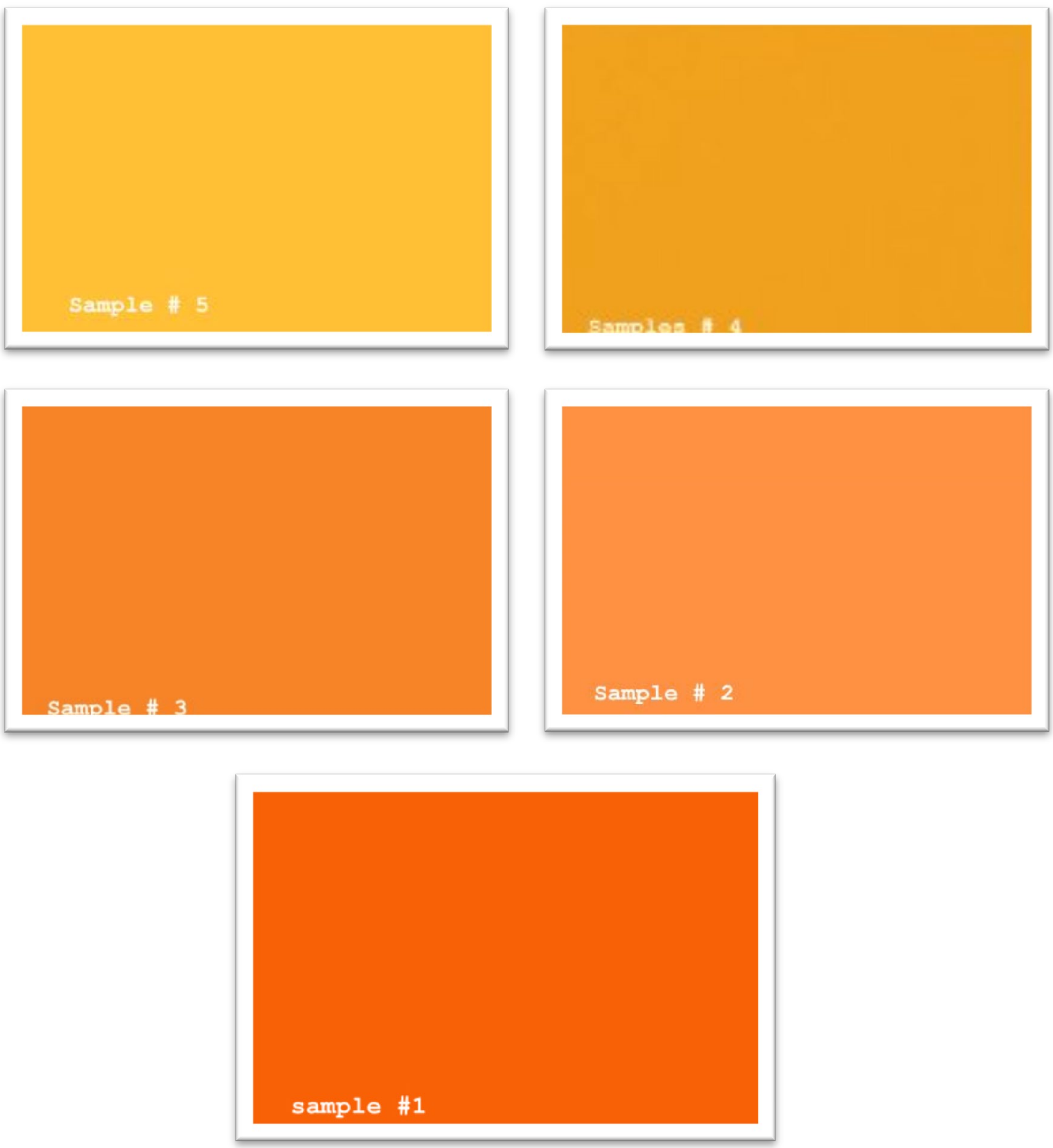
Stenacron *interpunctatum / conjunctum*

Stenacron *interpunctatum / proximum*

Stenacron *interpunctatum / ohioense*

It is pretty clear that the value of difference to our eyes is very little. We did perform a color range assessment on the male subimago and male imago’s and found they were more responsive and attacked to variable hues of orange. What we did was place two paint chip cards with two different hues of orange to their left and right to see if the males were more attracted to one

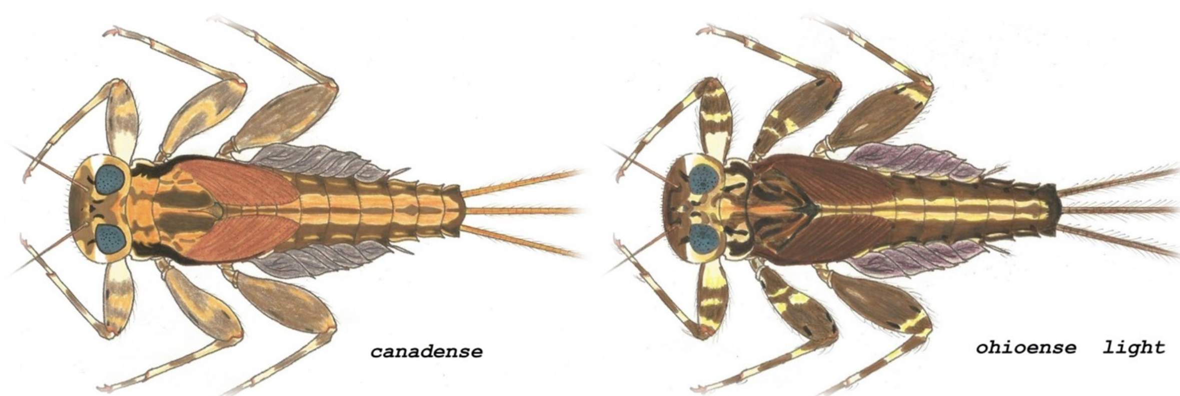
than the other, and it turns out that more than 70% of the time they picked the same color. We did this test with multiple cards inter mixing them. They showed the greatest attention to hues on the card sample# 3. If we picked card 1 and card 5 most times they were indecisive and wouldn't make a choice. If we picked 4 and 3 they sometimes had a difficult at times making a choice. Color # 3 was chosen the most, but number #4 was also chosen often. *Interpunctatum* Say did tend to prefer sample 5. We never data logged this little curiosity experiment we wanted to see what would happen. So is color part of the selection process it is tough to say but this is very suggestive.



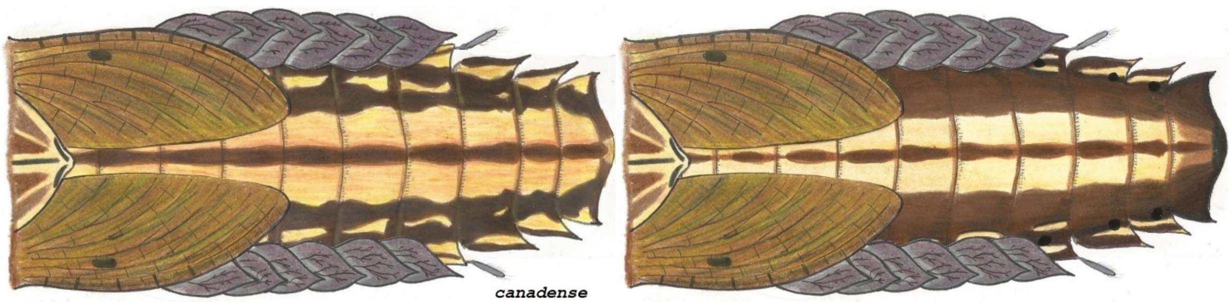
Taxonomic Confusion

Taxonomic confusion has plagued this genus most of its existence. There are two different time frames for confusion. Pre 1935 & post 1935. Why is the year 1935 so important to the understanding of this genus? In 1935 The Mayfly Bible was written, by Dr Needham, Dr Traver, Dr Hsu wrote The Biology of a Mayfly. As this book was being written Dr Needham requested that Dr Traver synonymize *affine* to *heterotarsale* and they have been together since. They have never been re-reviewed to this day even though there is a 2 mm size difference, and we believe the labrums of the larva are also likely different based on environmental needs. Quoting Dr Traver page 303 of my 1935 first addition of the Biology of a Mayfly under larva table. "Assuming *affine* equals *heterotarsale*". That sounds like she was skeptical of this new synonymy.

There was a fair amount of confusion prior to this like Clemens 1913 *canadense*, and the soon to be *ohioense* 1935, regarding spiracular spots on the abdomen of the larva. This is part of the reason we believe Dr Traver erected *ohioense* to bring clarity and isolation to it from *canadense.* Let's look at the larva that Clemens was looking at. Here is a sample of a female *canadense* that's why it has the orangey coloring in the abdomen as there are eggs present. On the right is *ohioense* the spiracular spot do not stand out that much at a distance. The size of the median line on the abdomen is the primary viewing difference *canadense* has a thin and tight line, with wide submedial stripes. *Ohioense* has a wider medial stripe, and narrower submedial stripes.



The key to separation without killing and dissecting is the lateral projections of the 8th vs 9th. On *canadense* the 8th and 9th lengths are equal. In *ohioense* they are sub-equal as per Traver 1935 meaning the 8th is slightly shorter. The difference is small but visible under a dissection microscope at a low power or by a 5X magnifier loop. The biggest difference is when we just view the abdomens. Here we have *canadense* on the left and *ohioense* light type on the right, matching Traver 1935 description or historical profile.

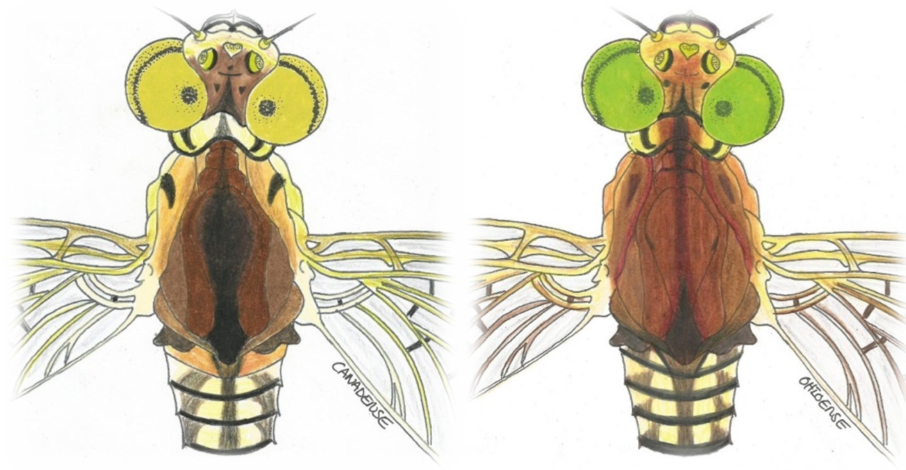


When you look close at the above illustrations you will see more differences than commonality. What is really striking is the sublateral stripes or series of pale spots on each segment near the gills. On *ohioense* they are often not seen, and on *canadense* they almost form a complete secondary stripe. Looking at this it is not hard to see why Clemens and others had a difficult time with the larva. Actually F P Ide 1935 did an excellent paper on development of postembryonic *canadense* larva. This was very helpful with larva understanding.

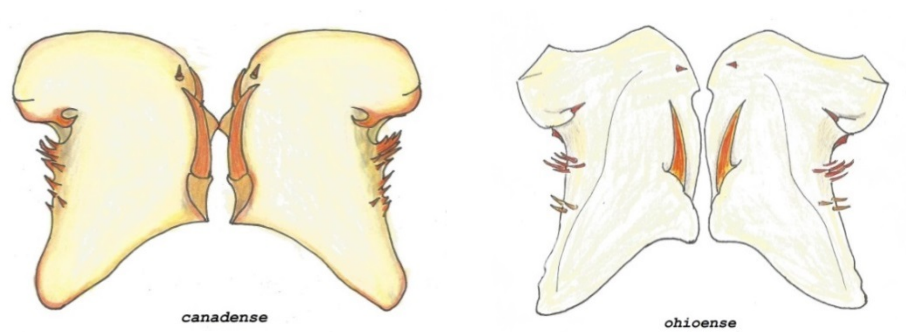
Now let’s move over to post 1935 taxonomic confusion. In 1947 Spieth did something radical and unjustifiable he synonymized *ohioense* into *canadense* and rewrote a new description for *canadense* to include *ohioense* and spiracular spots. Why is that so damaging to the genus. *Ohioense* has spiracular spots and *canadense* does not.

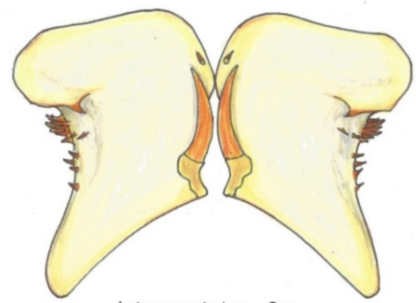
To further complicate things he also synonymized his new *canadense* profile to the *frontale* complex now inside *interpunctatum* Say. Looking at a typical *canadense* male adult left, then a typical *ohioense* male adult on the right although very similar there are distinct differences.

Other than the spiracular spots distinction is moderately difficult. The first thing besides the spots that stands out is the very dark notum or top of the thorax. *Canadense* is typically very dark chocolate brown and *ohioense* is more reddish with a dark germinate or incomplete median notum stripe. Here is a dorsal view of the notum's to clarify this.



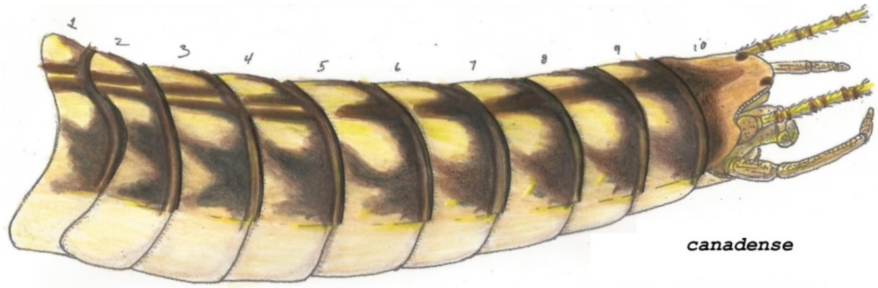
However the adult male genitals are very far from each other. From the overall shape, to the spine cluster size, and shape of the lateral-dorsal spine cluster. The basal or sublateral spines on *ohioense* are 3 or less, and on *canadense* there typically 4-6 often making a small basal sublateral spine cluster looking like *interpunctatum* Say. Most true *canadense* samples will have 2 sets of dorsal mesal spines plus apical spines.



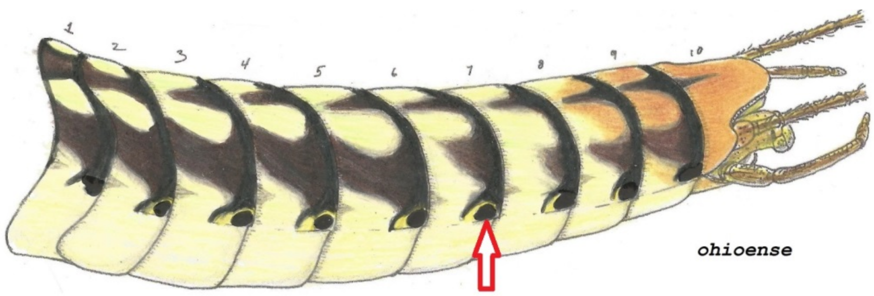


Historically every description for *canadense* true to form being Walker 1853 *canadense* through Traver 1935 descriptions do not have spiracular spots on the lateral areas of each abdominal segments. This first illustration for *canadense* shows the lack of spots. The illustration below is for true to form *ohioense* with a red arrow pointing to the spiracular spots.

canadense Walker 1853



ohioense Traver 1935



In 1935 Dr Traver erected *ohioense*, *proximum*, *majus*, *conjunctum*, *gildersleevei*, and *candidum*. Without a doubt this was the largest contribution to the genus. Since that time *gildersleevei* and *candidum* have continued to be considered valid species concepts as they are very distinct from all others in the genus.

There is no question that looking at it from Spieth's view in 1947 the following can look very similar. *Frontale*, *proximum*, *conjunctum*, *majus*, and even *ohioense* in the light type of the form. We can see his reasoning for creating a *frontale* complex, but Spieth's error was synonymizing this dark group into *interpunctatum* Say 1839.

If he had have worked with more than fore tarsal ratio, forewing size, the age of the species in priority of name he could have made a valid species concept for Banks *frontale* 1910 including; *frontale*, *ohioense*, *proximum*, *conjunctum*, and *majus*, and left Walker 1853 *canadense* as a valid species. If he had of done that there would be no misunderstandings or taxonomic confusion from 1947 till 2017 and his hybrid concept would have looked even more legitimate. All of the following disagreed with Spieth 1947 and so do we.

- G F Edmonds
- L Berner
- B D Burks
- P A Lewis
- S L Jensen (genus)

That is a big group of very important taxonomist that disagreed with Spieth's conclusions. Lewis 1974 The Taxonomy and Ecology of Stenonema Mayflies made a big effort to break apart some of Spieth's work. It was Lewis that made larva diagnosis more possible by stating mouthpart tooth counts for many of the forms and species. Berner paved the way in 1950 with the publication and first usage of mouthparts in the genus in the book The Mayflies of Florida. What was missing now was forms like *ohioense*, *proximum*. *conjunctum*, and *majus*. From close isolation rearing, Traver 1935 descriptions, Spieth's synonymy study, Burk 1953, and Lewis 1974, cataloguing the larva was not too hard. Filling in the blanks was easily done by rearing larva, identifying the male adults, and then retracing and documenting the form back to the larva from the exuvia. From that point doing a large mouthpart morphology study was easily done. On average there were about 30 of each form dissected and

catalogued per form. This gave us a solid average tooth, pectinate setae comb, and setae in the submedial row count to work with. All this information was placed in the tables in the back of the larva book. There are also tables in the adult book that reflect the features and keys to them. Breaking down the *interpunctatum* complex into 3 basic groups as per Needham 1935, Spieth 1947, and Lewis 1974 this is what it basically looks like from very simple view.

Group A *interpunctatum* Say; Lewis 1974 new Syn

- *interpunctatum* Say + *areion*

Group B *heterotarsale;* Needham 1935 new Syn

- *heterotarsale* + *affine*

Group C *frontale*; Spieth 1947 new Syn

- *frontale*
- *canadense* + *ohioense*
- *proximum*
- *conjunctum*
- *majus*

Now let's compare true *interpunctatum* Say 1839, against *proximum*, and *ohioense* so you will quickly see why most people do not have any idea what the (true *interpunctatum* Say 1839) looks like. As you can see they have nothing in common but fore tarsal ratio as per Spieth 1947. Between our studies, Traver 1935, Burks 1953, Lewis 1974, and current DNA, we see many reasons for this complex to be completely restructured.

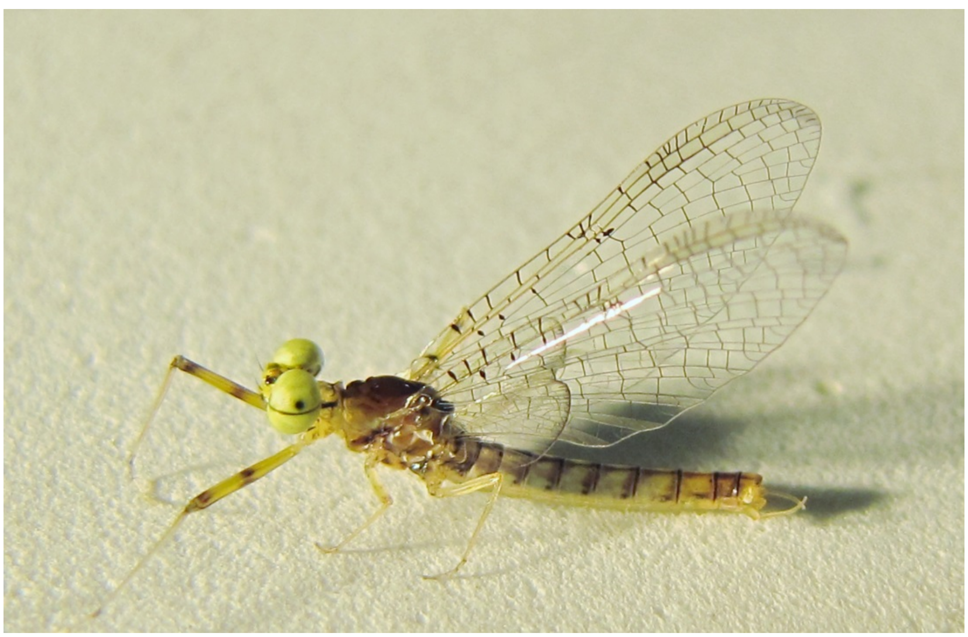
Photo Plate

Photo of a male and female when available

Female imago *Interpunctatum / canadense*

Female imago *Interpunctatum / canadense*

Female imago *Interpunctatum / frontale*

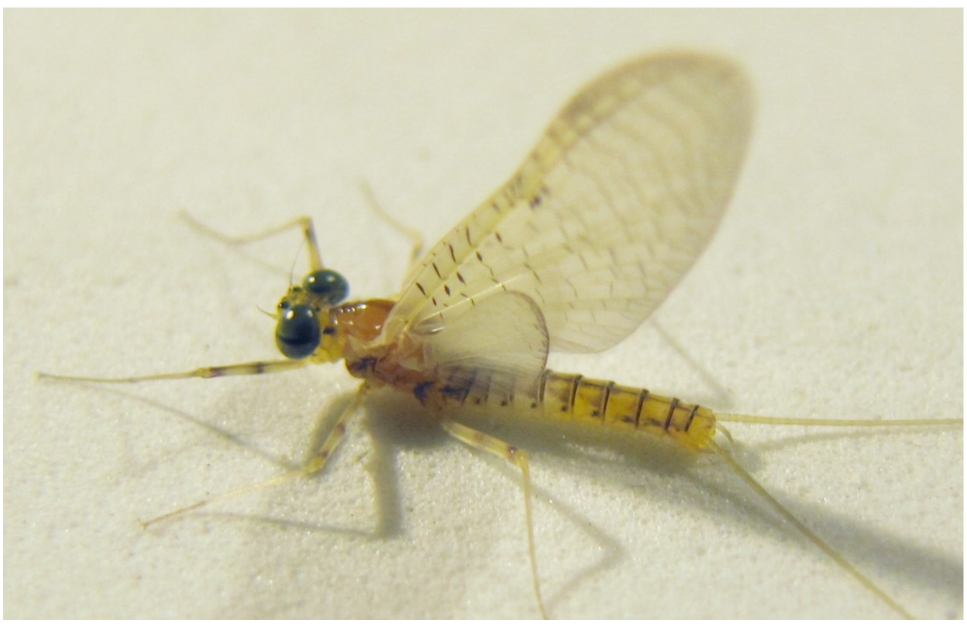


Male imago *Interpunctatum / frontale*

Female subimago *Interpunctatum / proximum*

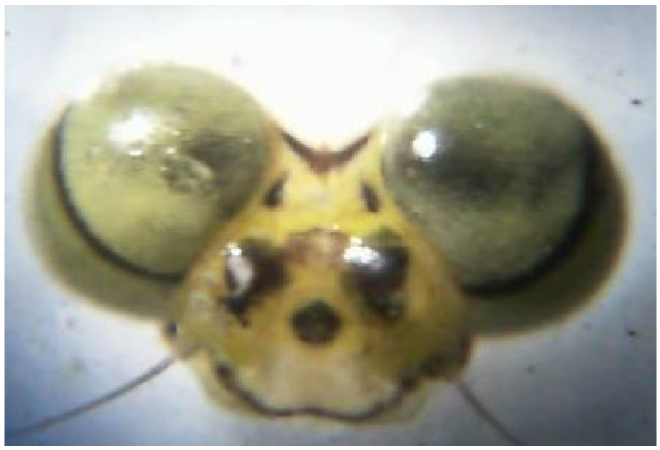
Male subimago *Interpunctatum / proximum*

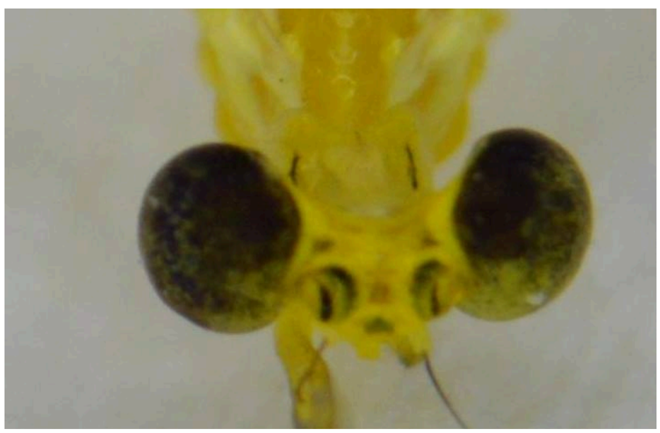
Female subimago *Interpunctatum / ohioense*



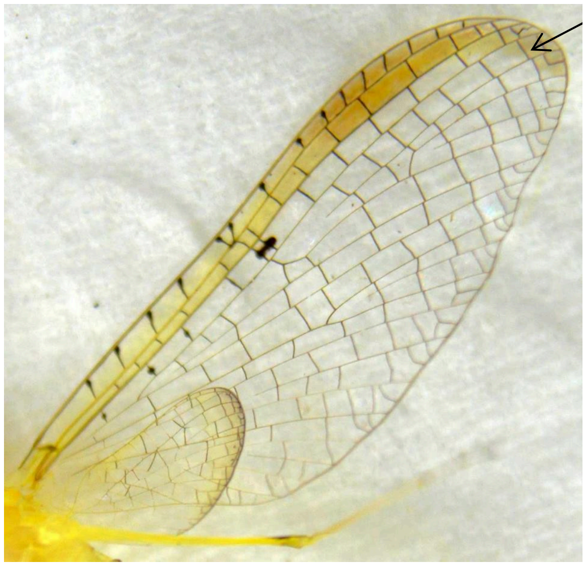
Male subimago *Interpunctatum / ohioense*

The following *carolina* photos are by Sharon Moorman and are without question Stenacron *carolina* male imago. To show how to quickly identifying this male is we must look at the head. First is a photo *interpunctatum* / *ohioense* dark type, all others in the genus have this head shape. In the head shape of *carolina* notice how wide spread the compound eyes are from each other.





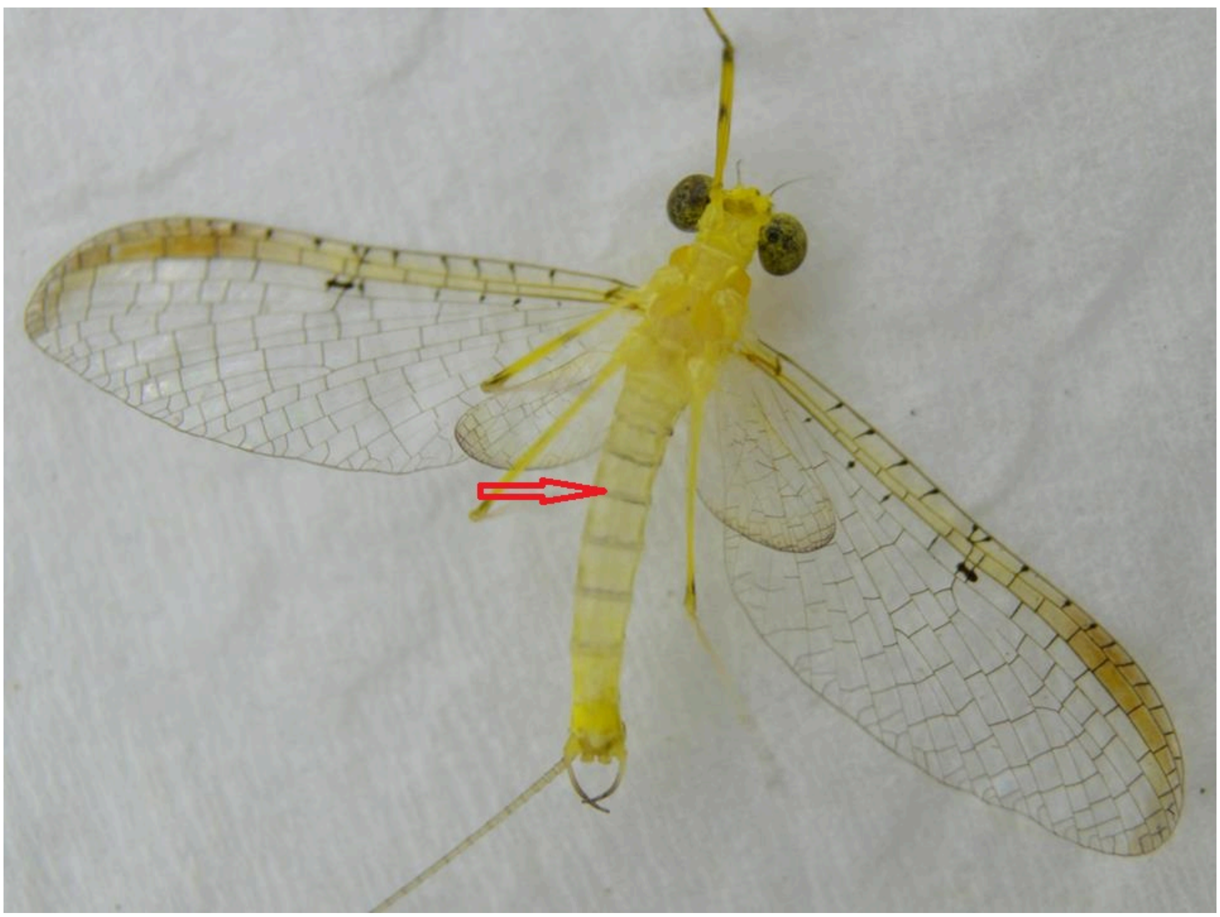
This can cause confusion with Maccaffertium, Heptagenia, and Luecrocuta as many samples of *carolina* may have very little to no pigmentation in the R1&R2 interspaces of the forewings. Moreover all Stenacron have less pigmentation in the left wing than the right. If markings are faint use the right wing for genus conformations. Another thing to note very fine pronotum streaks and black ringed at the bases of lateral ocelli as in *interpunctatum* Say 1839.



Over apex

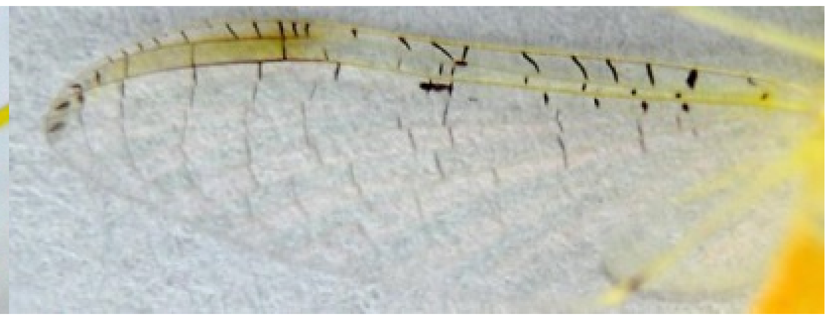
Left forewing male carolina stigma stain over apex

Other identification descriptive factors are by Traver 1935. All Sternites are banded in smoky gray tones that wrap from the terga bands breaking at the spiracles then reforming and continuing around from lateral edge to lateral edge see ventral photo below on the posterial margins see red arrow. This is often more prominent on sternites 2-5. In this photo you can see the right wing is more pigmented in the R1&R2 interspaces. There is also commonly faint yellow shading on the posterior and apex areas of the hindwings with light smoky edge. The stigma stain clearly continues over the apex of the forewing as in most forms and species in the genus.



100% positive identification of females is hard in person let alone from a photo. The credibility of the source must be considered as part of the equation. Sharon Moorman has proven reliable in many identifications. With that said she stated several times that this sample was digitally measured to be 7.5 mm. There is only one Stenacron female that size in the genus being Stenacron *pallidum*. We have read and re-read Traver 1933, 1935, 1937 and find these photos align with great confidence. We can even see the dumbbell shaped black spot in the forewing as per Traver 1933 and stigma stain going over the apex of the forewing.

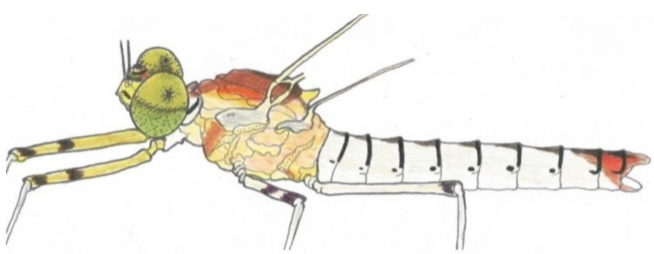
Source Sharon Moorman; Lewis 1974 is the only proper description of this species. Berner 1986 mayflies of Florida did cover it but more on ecology. *Floridense* is the only species or form in this genus with a reddish elongated spot on the vertex of the head. No measurements were taken. However based on Lewis regarding this spot, pale or no spots on the frontal margin, and black ringed ocelli the likely hood of this being *floridense* is very high. If we could with assurance place this as *floridense* it would go to range extension as this is from; La Follette/ Norris Lake, Campbell County, Tennessee, USA. This is a moderate sea level elevation.

Here we wish to present two photos that are close representations of two forms in the genus. Photo one is from Charley Eiseman Black River, Wisconsin, USA. The first sample we are very sure could only be *minnetonka*, for several reasons.

The most important is there is no sign of even potential pleura streaks, and the spiracular spots are very prominent. The next is the reddish tinge on the 8^{th}-10^{th} tergites on the dorsal side and surrounding the notum.

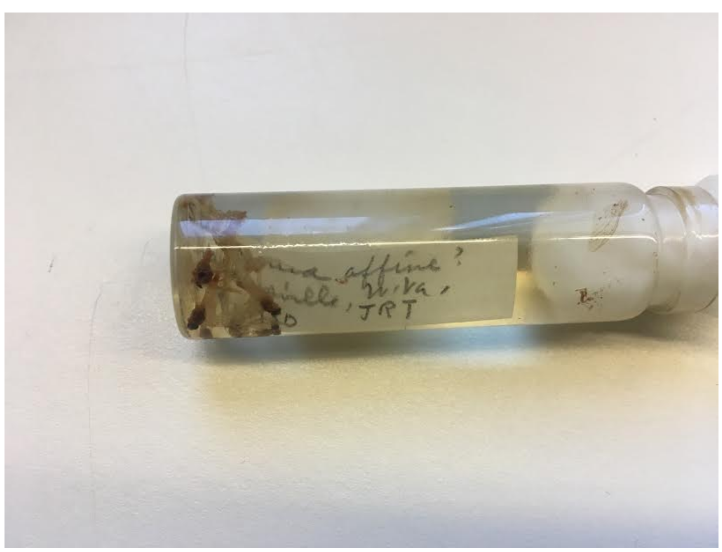
We will compare to our illustration made from Daggy 1945, Burks 1953, Lewis 1974. Most important is the collection location is within 150 mile of Daggy’s holotype.



Also from Charley Eiseman is a sample he photographed in Nashville, Tennessee, this is only about 250 miles from Oakwood IL where Burks collected *areion*. This sample is a reasonable variation that aligns with Burks 1953 with a high degree. Looking very close at the rear tergites 6-9 there is a very slight orange hue in front of the transverse dark bands. We are

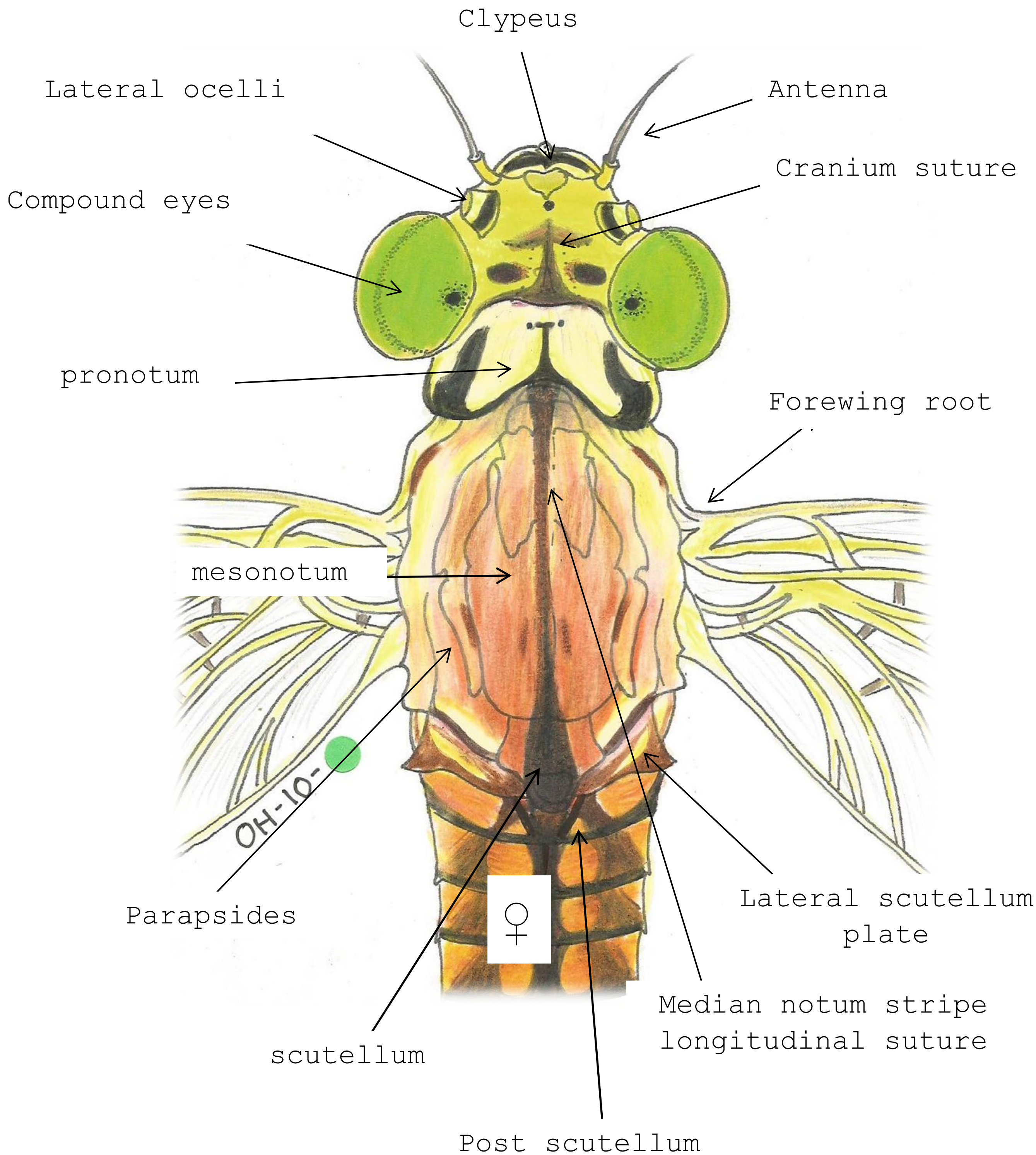
not saying this is *areion* but the photo is very suggestive. We are also showing our illustration made based on Burks 1953, and Lewis 1974 discussions. We have also seen on sites many that are very bright orange. I personally believe Burk's *areion* is a real and heavily over looked form.

The only photo of Travers affine taken by Brando Woo at the Cornell collection.

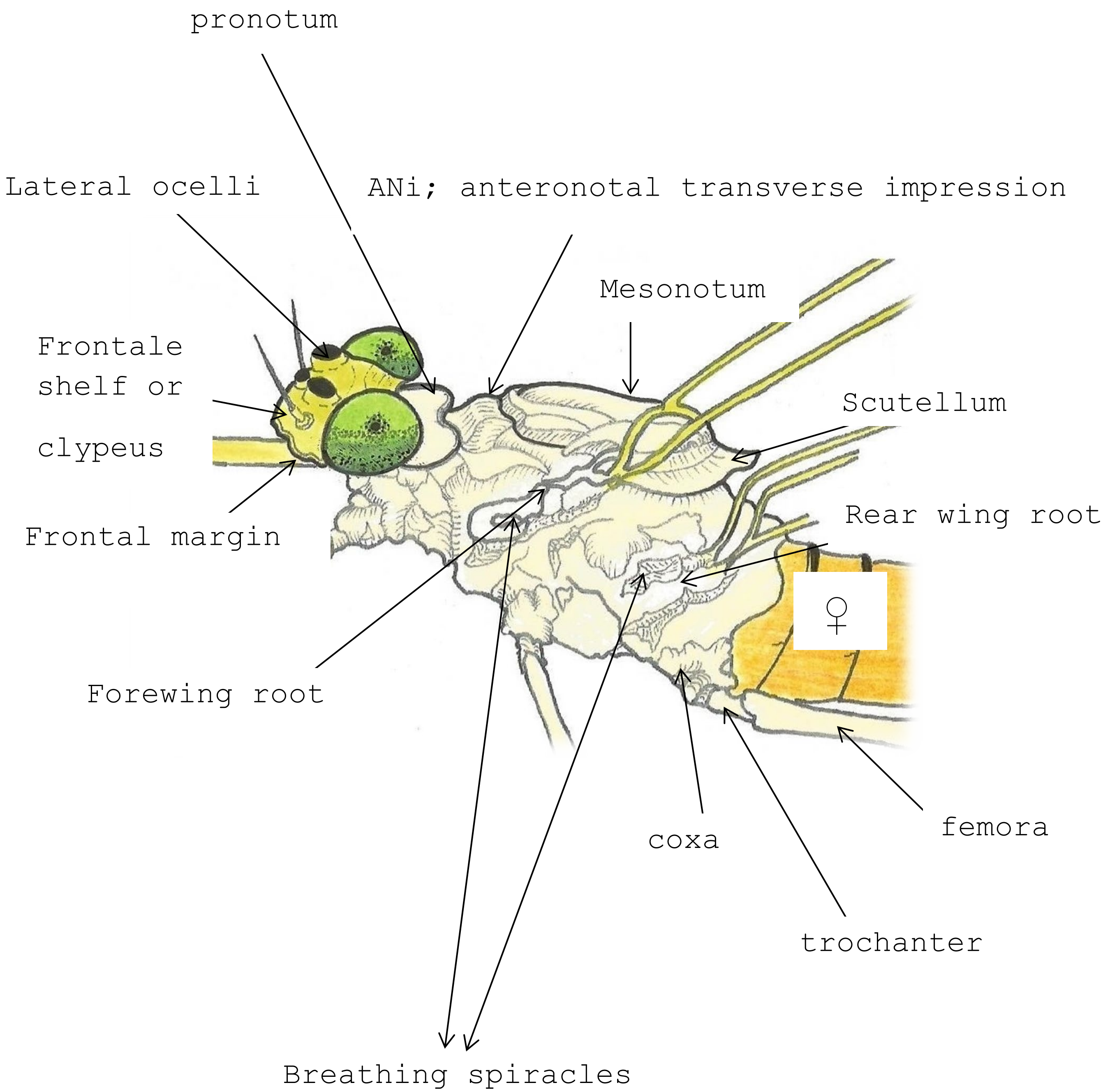


Adult Anatomy

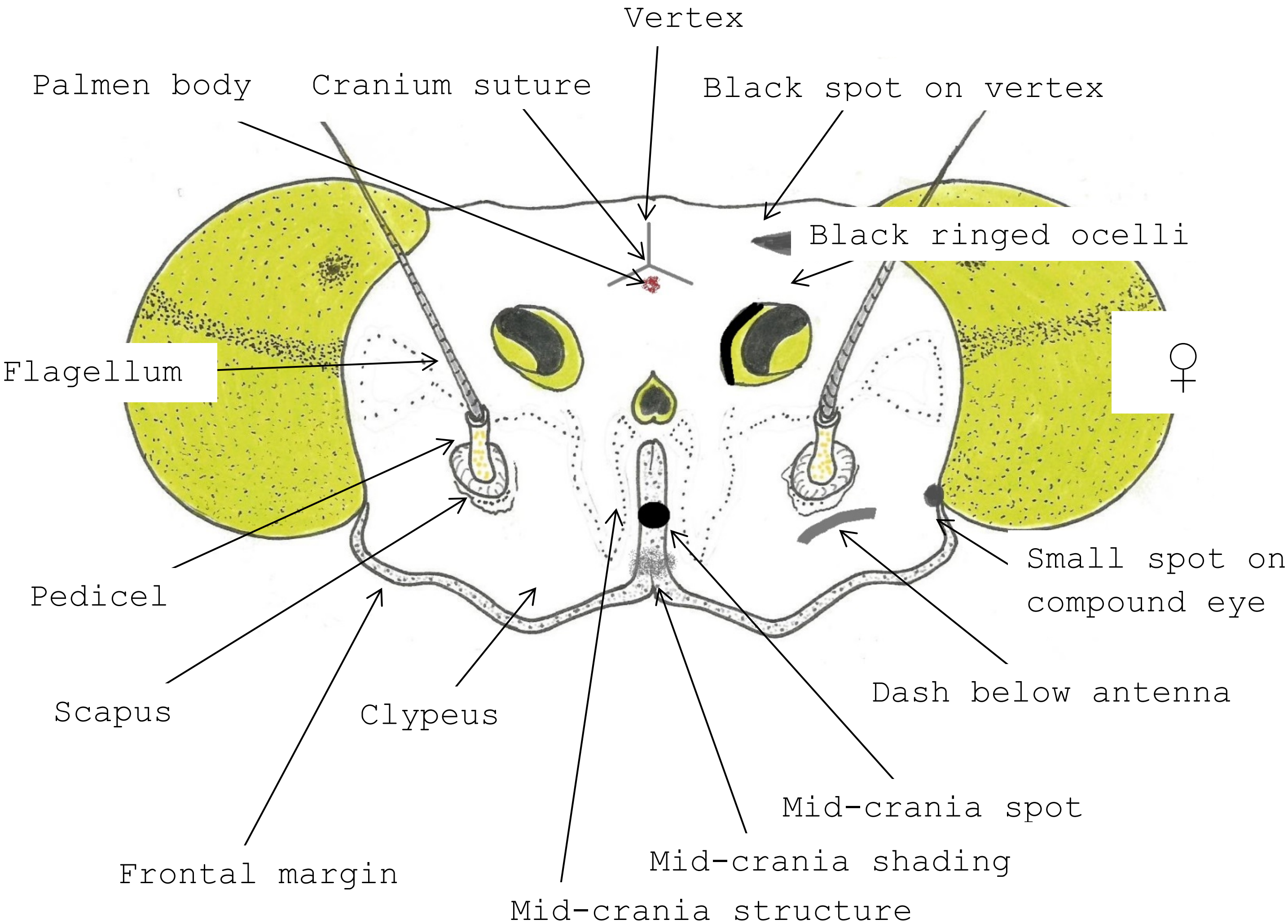
Top view of thorax to head, notum view

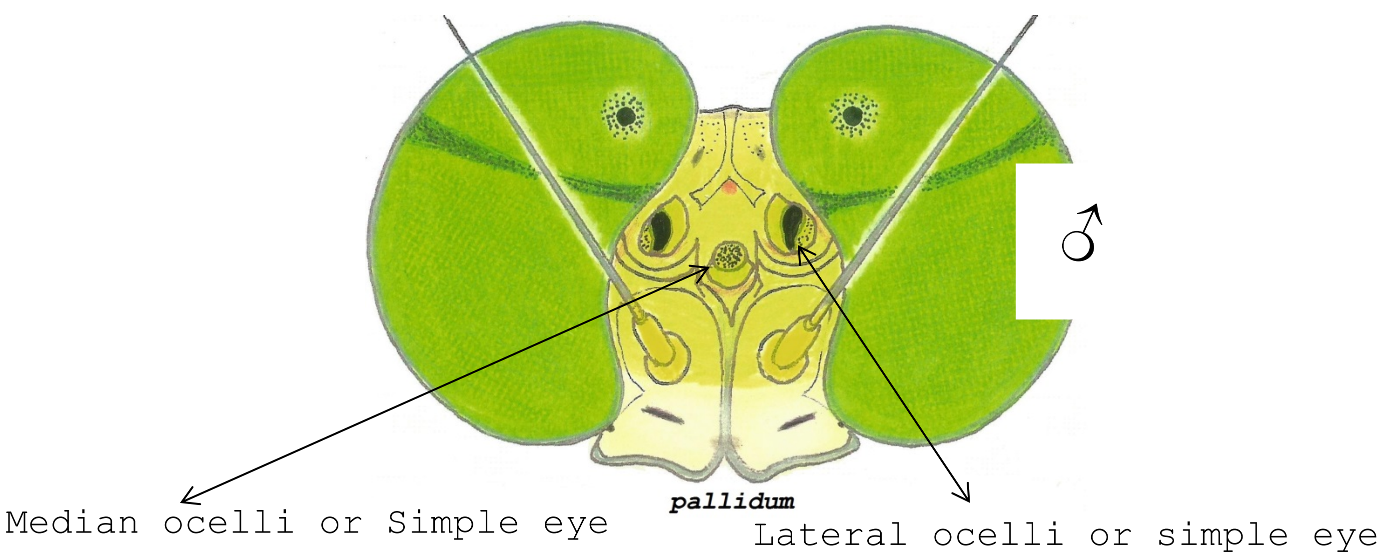


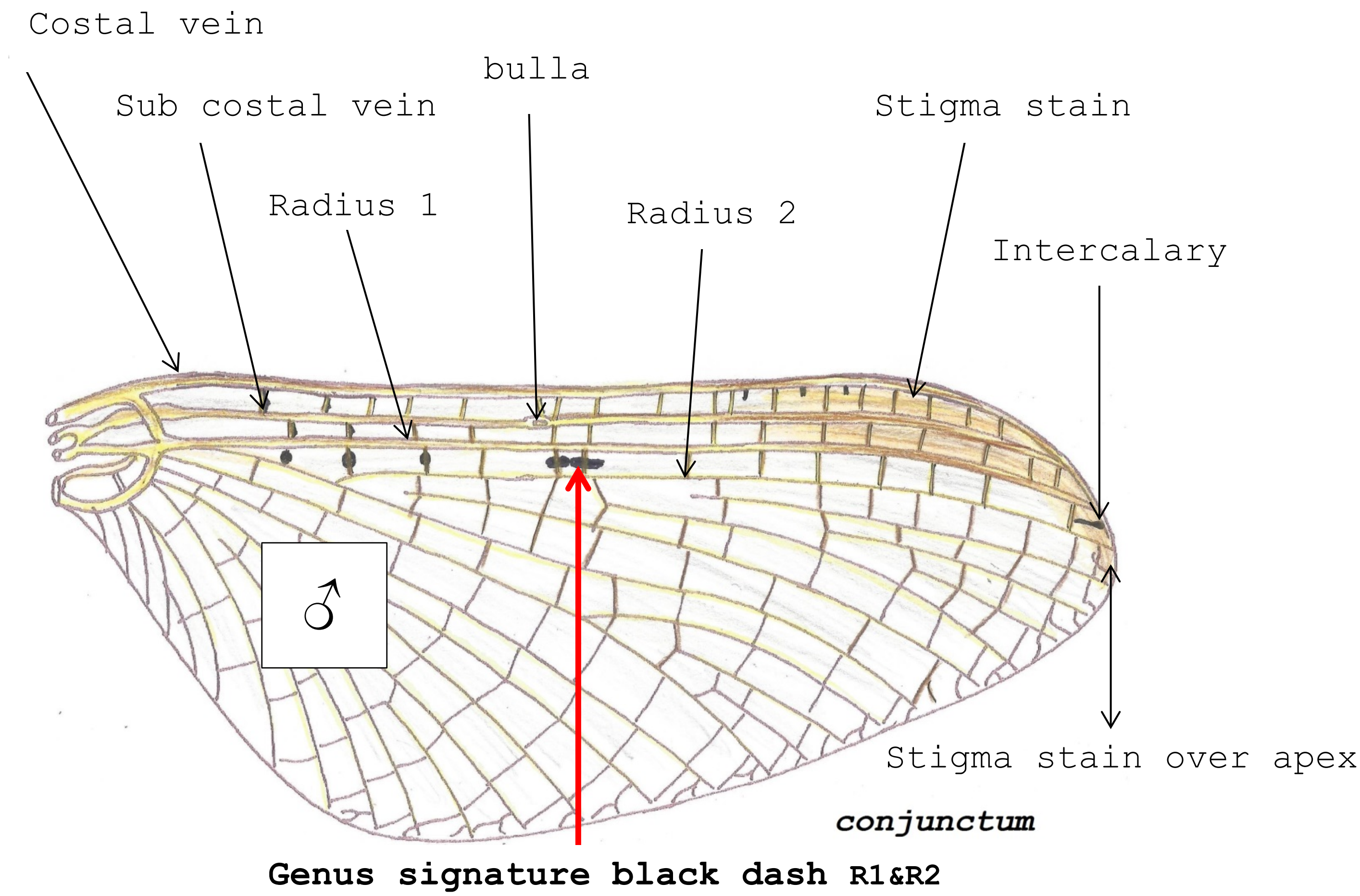
Side view of thorax or pleura



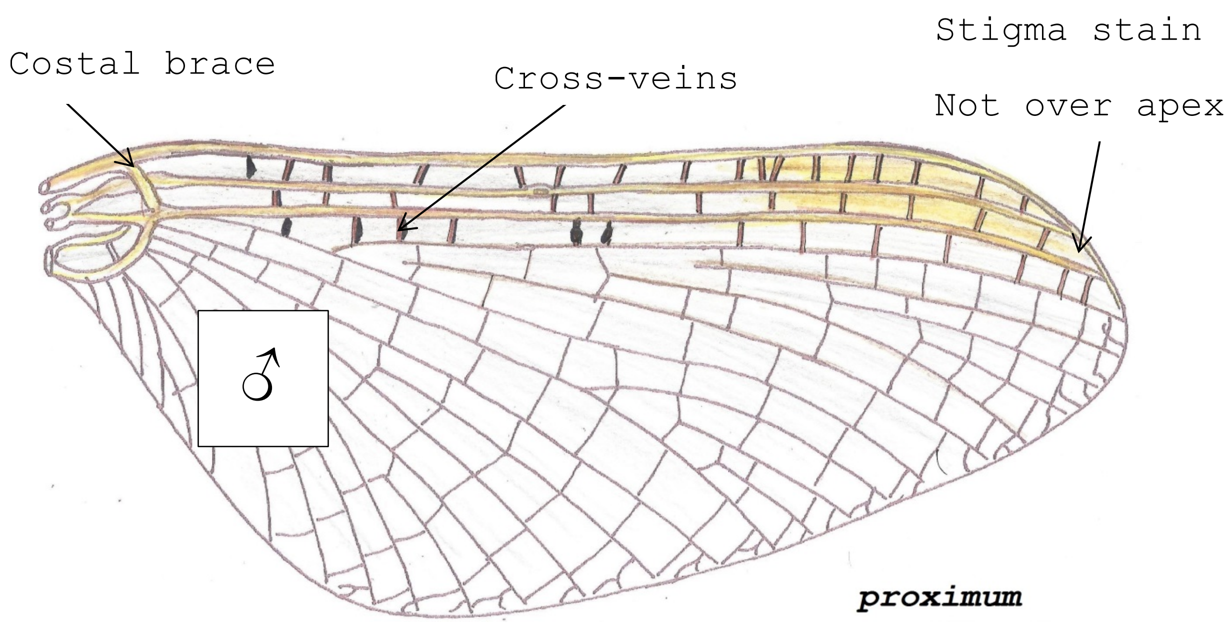
Female and male heads





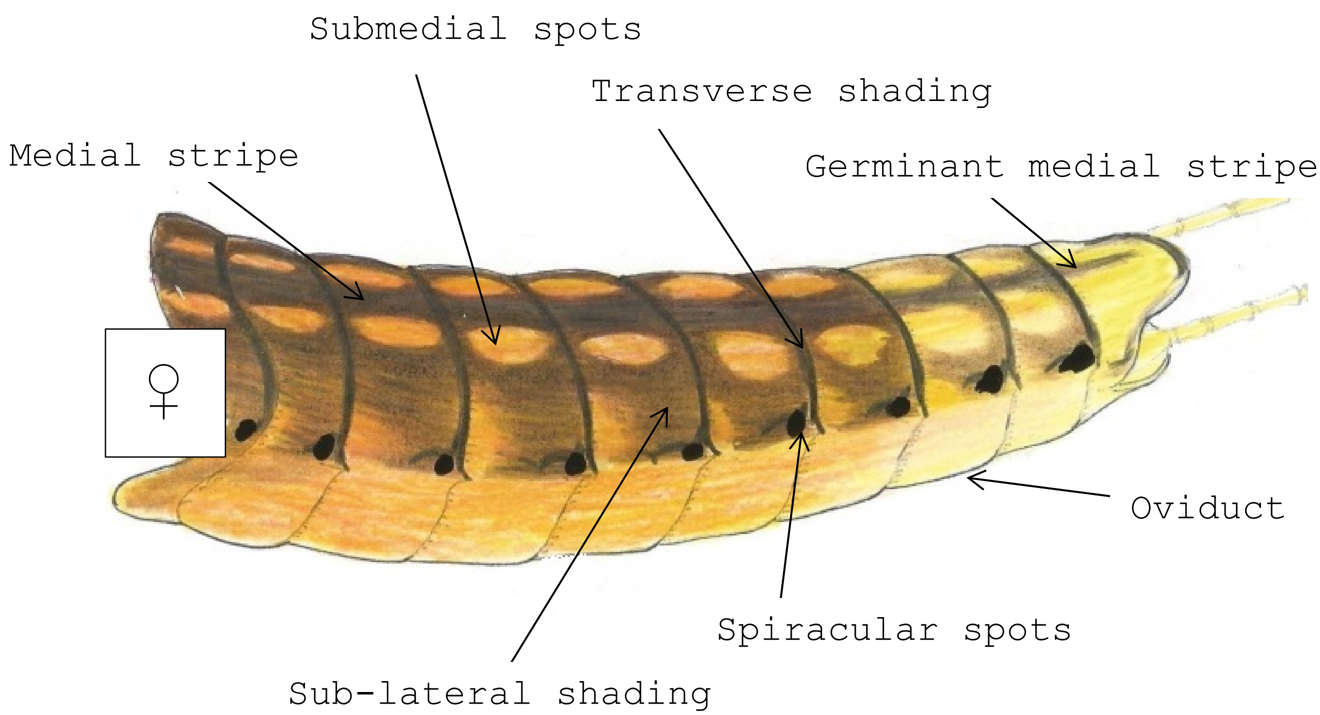


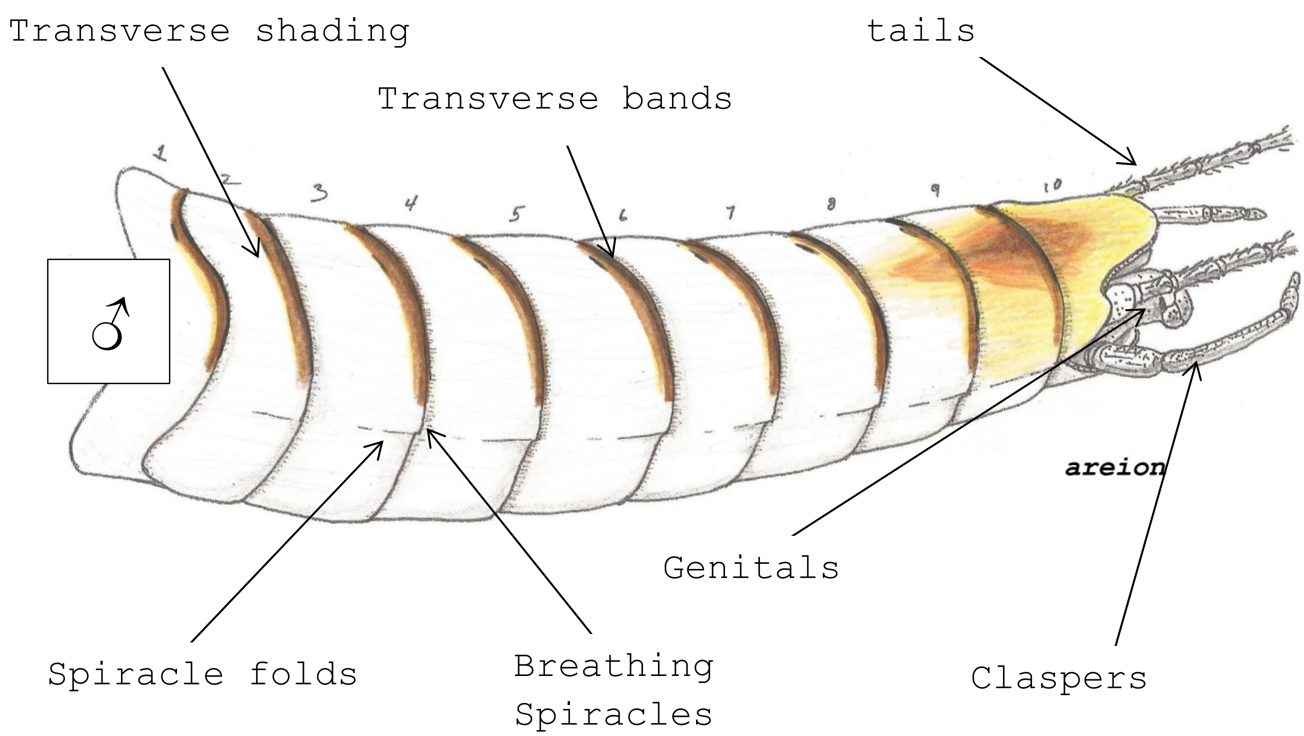
conjunctum



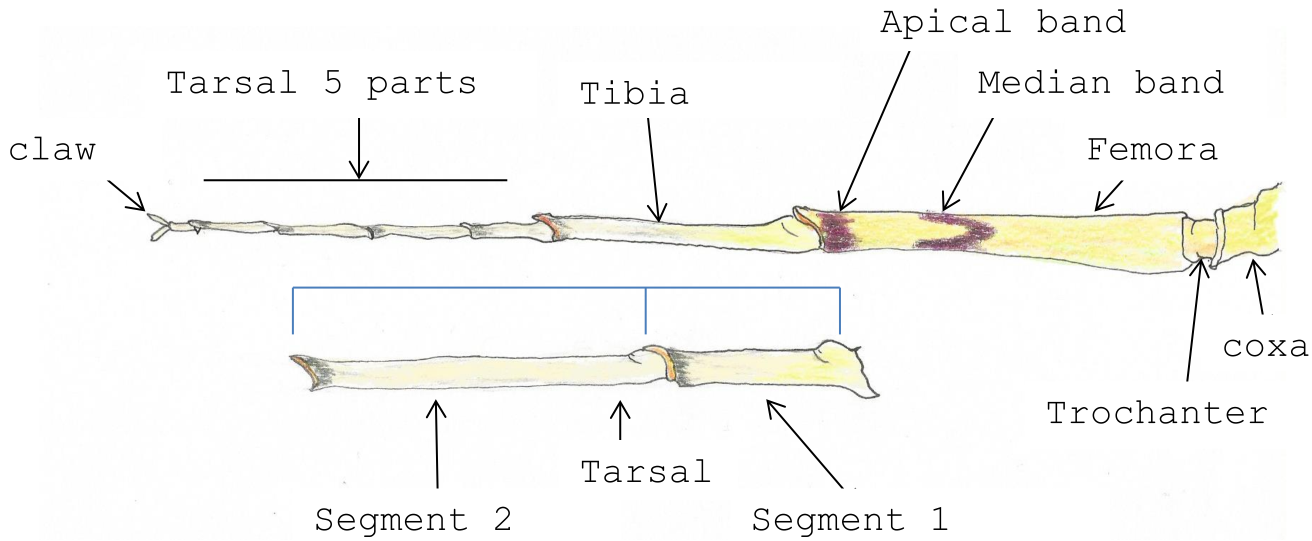
proximum

Female and male abdomens





Foreleg described with fore tarsal ratio



The foreleg is made up of the following components. The coxa is technically part of the thorax and the leg is connected to the thorax by it. The trochanter is like an elbow that rotates and it connects the coxa to the femora. The femora is connected to the tibia, the tibia is connected to a multipart tarsal section, finally with a small foot like claw. The tarsal area is divided into 5 sections. Historically and in many geneses the measurement of section 1 compared to section 2 of the tarsal is very valuable in species concepts. A fore tarsal ratio is how big the 1st section is compared to the 2nd. We are using a simple percentage because everybody can see it, and use it. It’s like cutting a pie in pieces.

For tarsal ratio in this genus went through all kinds of changes from the late 1800’s to the 1970’s. As science became more detailed and more complex ratios replaced simplicity. Things started out as simple as (first segment slightly shorter than second) to having a range of (first = 40% the length of second) to (3-5th the length of the second) and finally (1.6-3.3).

This can be very complicated for someone learning. Dr Traver set a excellent understandable ratio by stating simply 40% the length of the second. With fore tarsal ratio being variable in

Stenacron we will go with Dr Traver simple method of percentages Everybody can then understand with ease. The table below shows just how close the size is in the entire genus being 40-50% range. This does not make it useless it is just another tool to aid the diagnostic process.

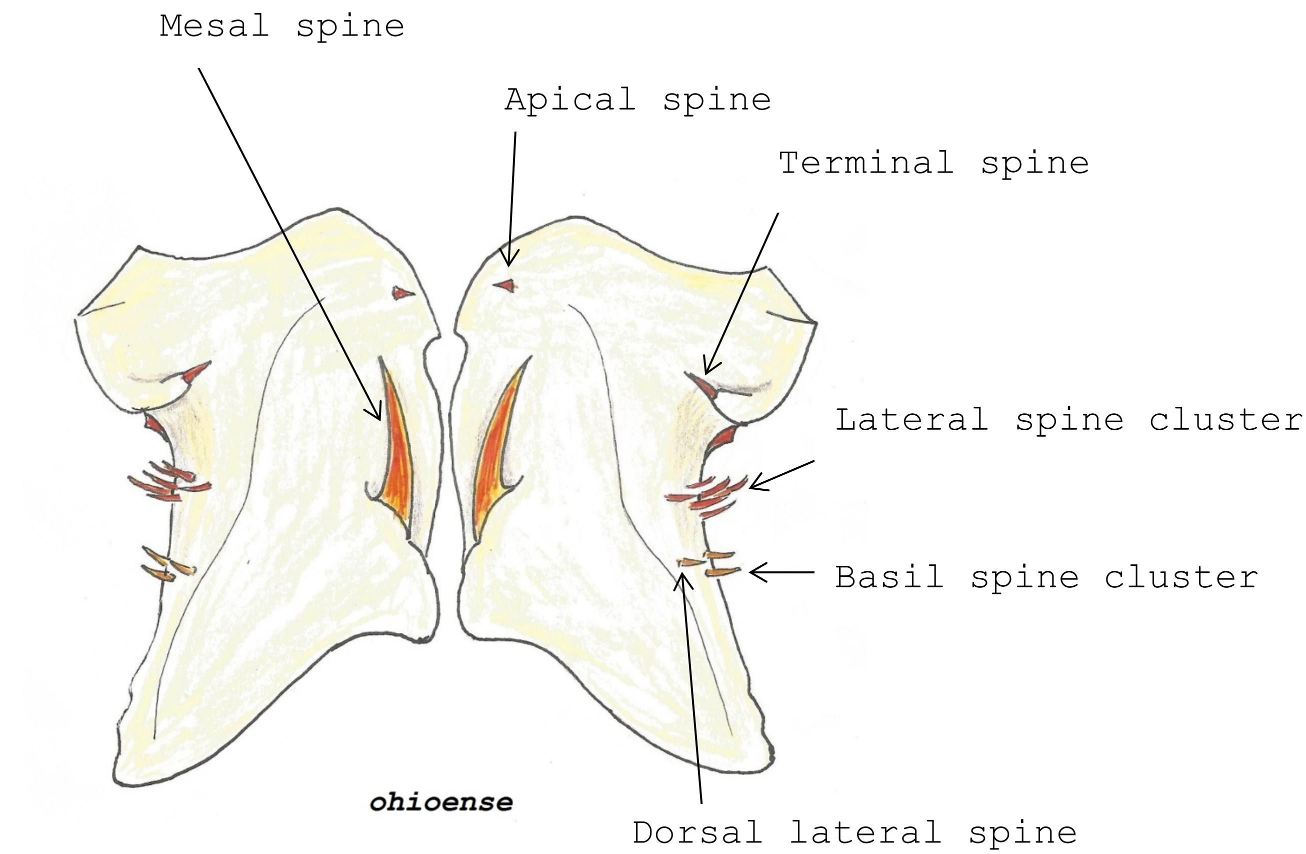
Moreover she described all but, *affine*, *minnetonka*, *areion*, and *floridense* to work with. All percentages given are from original historical profile Lewis 1974 *minnetonka*, and floridense we reversed engineered the numbers to a percentage, and did the same forward to give ratios to older forms that didn't have a real ratio.

Stenacron fore tarsal ratio and percentage conversion table;

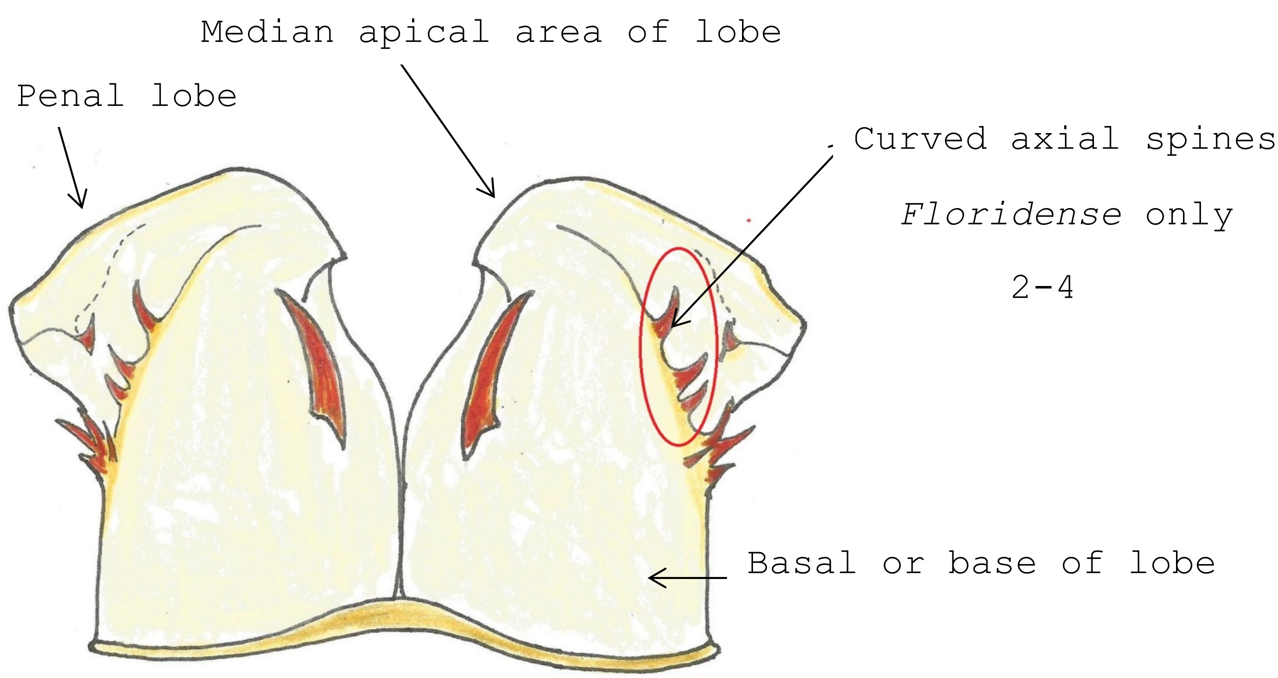
Form	Max	Min	Mean	length of 1st %
Affine unknown	-----	-------	------	Likely 45%
Areion	3-5th	-------	2.630	35-40%
Canadense	3.0	2.0	2.340	40%
Candidum	-----	-------	2.4	50%
Carolina	-----	-------	2.5	50-55%
Conjunctum	-----	-------	2.6	35-40%
Floridense	2.4	2.0	2.2	40-45%
Frontale	3.2	1.6	2.370	50-55%
Gildersleevei	2.3	1.7	1.992	45%
Heterotarsale	1.9	1.1	1.570	45%
Interpunctatum	3.5	2.2	2.630	35-40%
Majus	-----	------	2.4	50%
Minnetonka	------	------	2.4	50%
Ohioense	------	------	2.0	45%
Pallidum	------	------	2.4	50%
proximum	------	------	2.4	50%

So you could say for *floridense* that the 1st segment equals about 40-45% the length of segment 2.

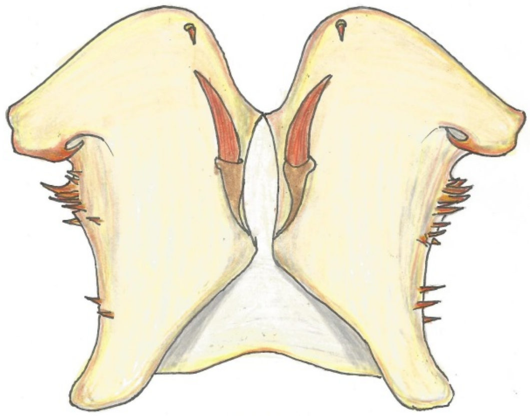
Male Genitals Spines Explained



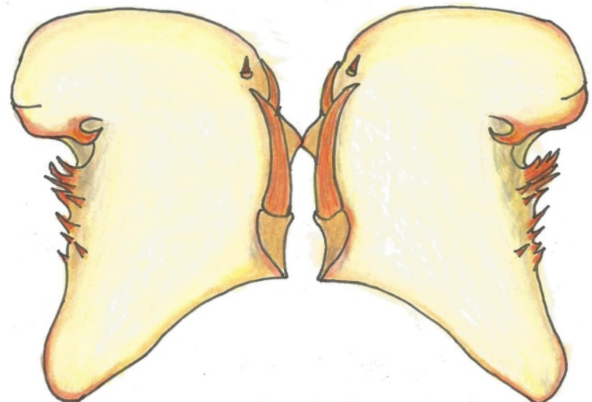
ohioense



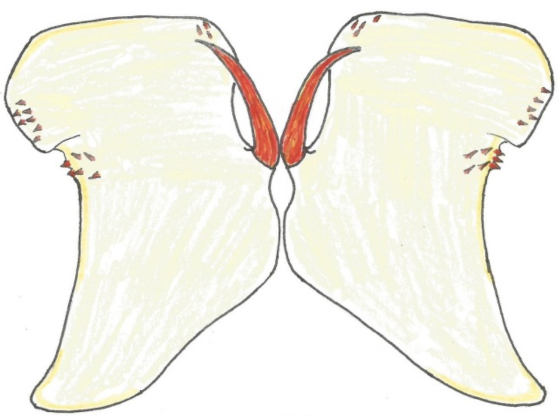
floridense



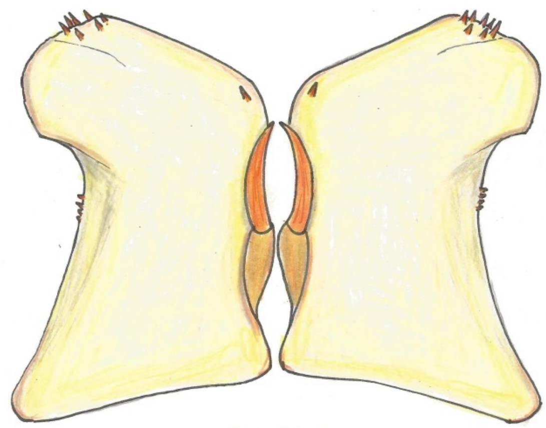
areion



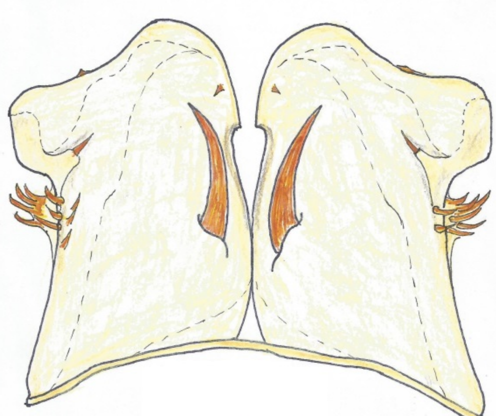
canadense



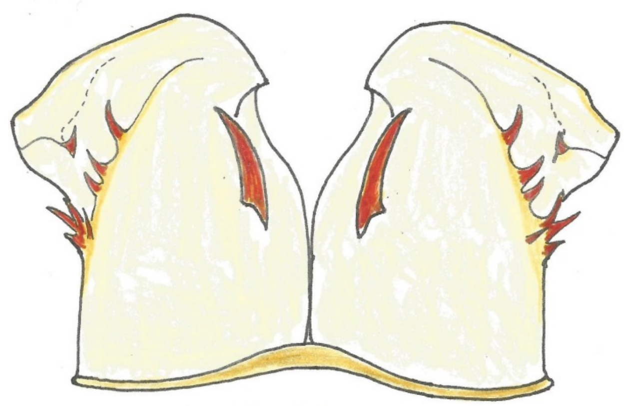
candidum



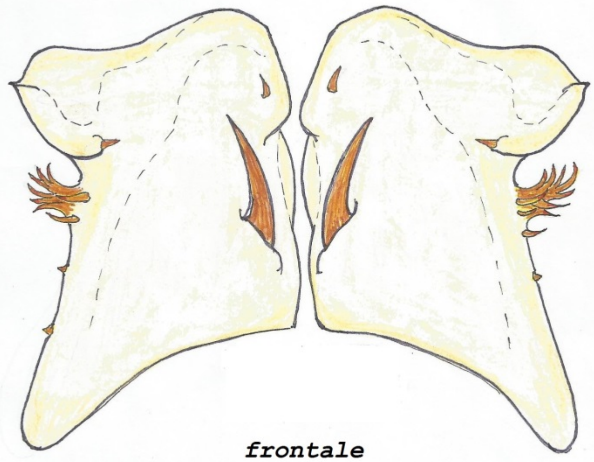
carolina



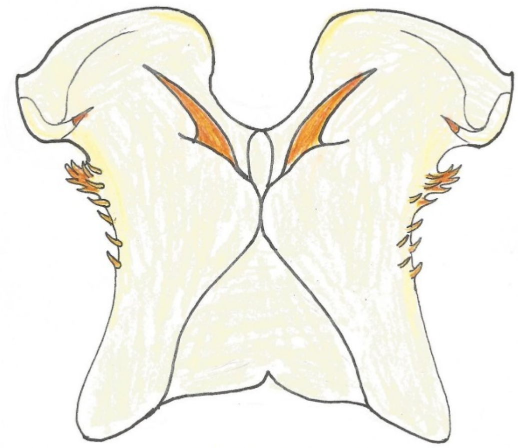
conjunctum



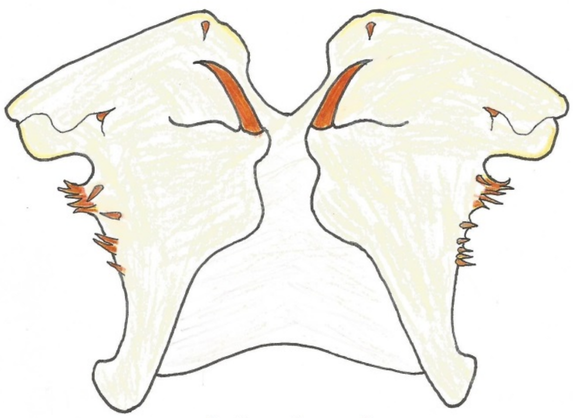
floridense



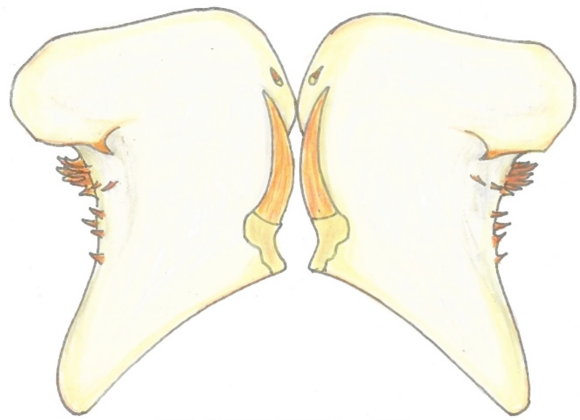
frontale



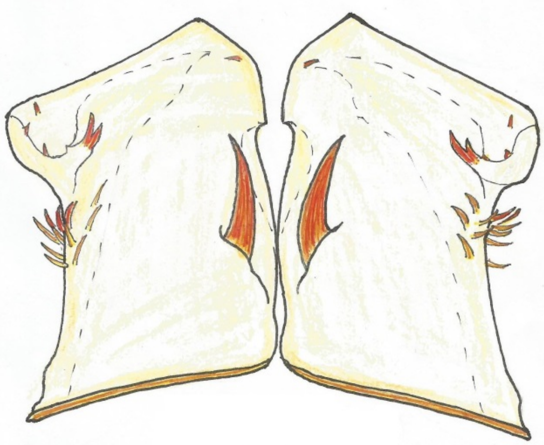
gildersleevei



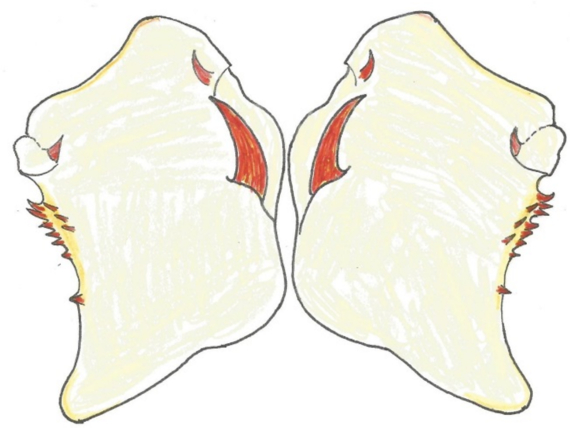
heterotarsale



***interpunctatum* Say**

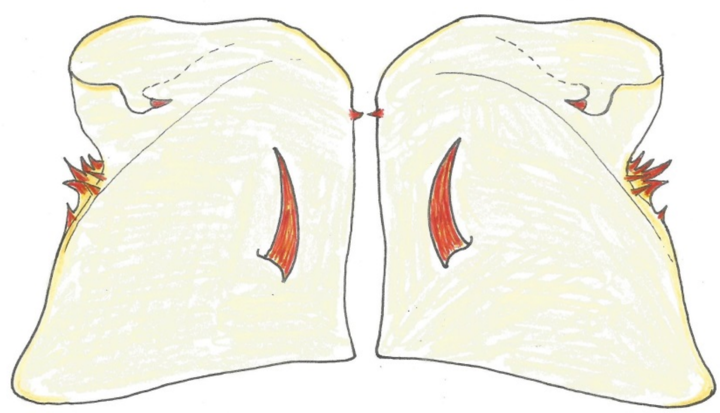


majus

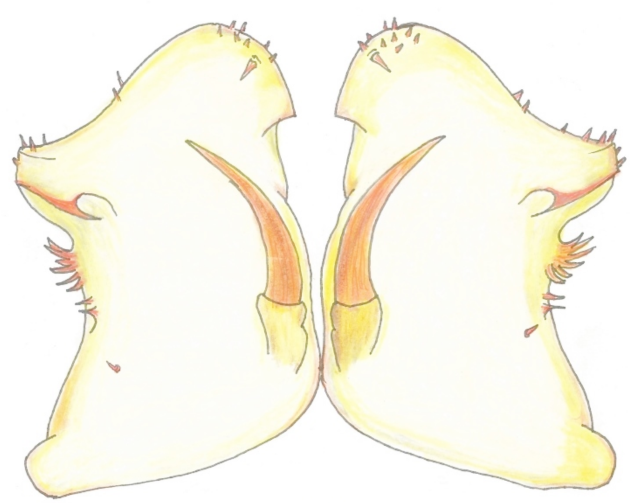


minnetonka

ohioense



pallidum



proximum

Comparative Discussions

Having a section on comparative discussions is very helpful in many ways. First is it the best opportunity to get to know them all and what makes one different from the other.

In the past this has only to a degree been accomplished in a lab with a large series of samples. However without a very clear picture of what all the forms looked like under their historical profile, being the original description, the range of variation is very high and easily misunderstood.

This section is all about putting the two most difficult side by side and seeing and discussing the differences. Although they may at first glance look almost identical there is why more to separate them than there is making them look the same.

Some samples we didn't even include the opening of what they have in common cause the list was too long. It was more effective to focus on what the differences are in more detail.

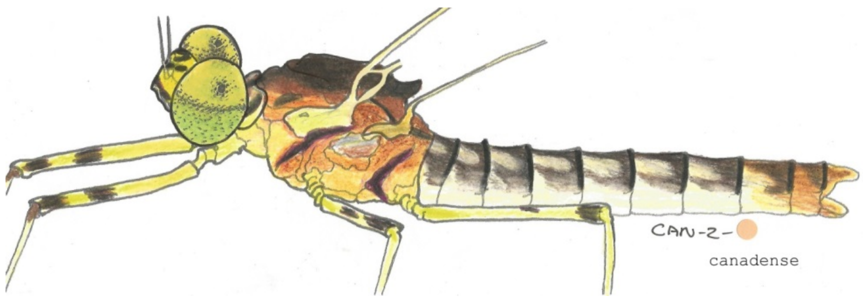
Try to view all Stenacron to a specific form rather than species you will find species from finding form. Keep the substrate in mind, the darker the sample the darker the substrate and the higher the altitude was. High variation in form is not from hybrids it caused by their specific ecology.

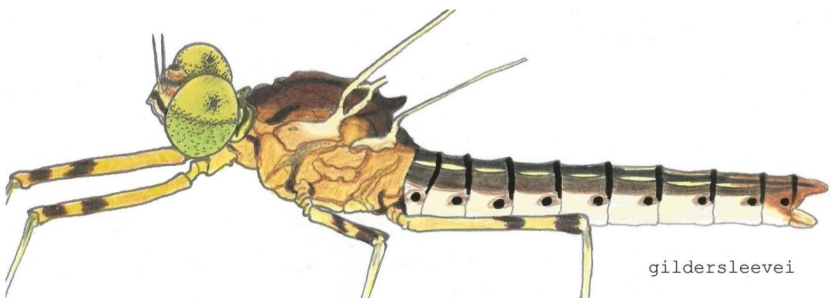
Remember the adult is a mere temporary reflection of the yearlong larva stage and the pigmentational maculation platform does transcend from the larva to the adult stages.

(Stenacron *interpunctatum / canadense*)

(Stenacron *gildersleevei*)

These two adults can be very similar especially the females and have a lot in common. The male of *canadense* is much lighter in the abdomen than the *gildersleevei* and the male *canadense* is not as likely to be confused. In the female *canadense* the abdomen is commonly very dark in maculation.





Features commonly shared in the two are;

larger overall size, transverse black band on the frontal shelf from compound eye to compound eye forming a somewhat complete smile, black spots on the vertex of the head, large black spots on the pronotum, black triangle spots on the mesonotum right behind the pronotum, longitudinal median stripe on the entire notum area, black marked scutellum, black spots on the fore-coxa area, heavily banded hind femur and a strong median band present. Abdomen, Median black stripe on the dorsum of each tergite 1 through 9, heavy submedial, sublateral, and transverse band shading often blackish in color.

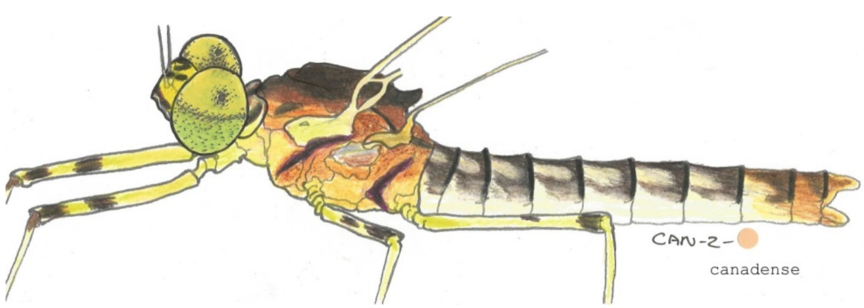
Defining features to separate are;

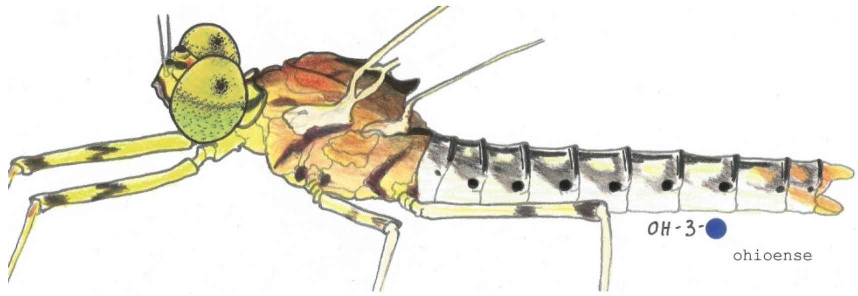
Size, *gildersleevei* is larger, with no pleura streaks, stigma stain is darker and going over the apex of the forewing on *gildersleevei*, fine and smaller pale spots on submedial and sublateral areas of all tergites, *gildersleevei* having large fine defused spiracular spots that can be very hard to see and are often encapsulated inside sublateral and transverse abdominal shading. *Canadense* has no spiracular spots present, and has pleura streaks; the notum area is mostly dark brown with germinate medial stripe, the stigma stain on the forewing of *canadense* is paler.

(*Stenacron interpunctatum / canadense*)

(*Stenacron interpunctatum / ohioense*)

These two forms are confused because of historical taxonomic issues. *Canadense* from an historical profile aspect does not have spiracular spots on the sides of the abdomen but *ohioense* does. Herman T Spieth in 1947 synonymized *ohioense* with *canadense* and wrote a new description for *canadense* which included *ohioense* and spiracular spots.





Features commonly shared in the two are;

Both have a line on the frontal shelf that is most often not connected under the antenna bases going from compound eye to compound eye, black spots on the vertex of the head, large black oblique pronotum streaks with germinate medial stripe.

Notum is striped and very dark with a black scutellum; both also have pleural streaks with prominent dorsal median stripe on tergites 1-9 with heavy blackish shading in the sublateral and transverse banding areas. The stigma stain in the apex of the forewing wraps over the apex both.

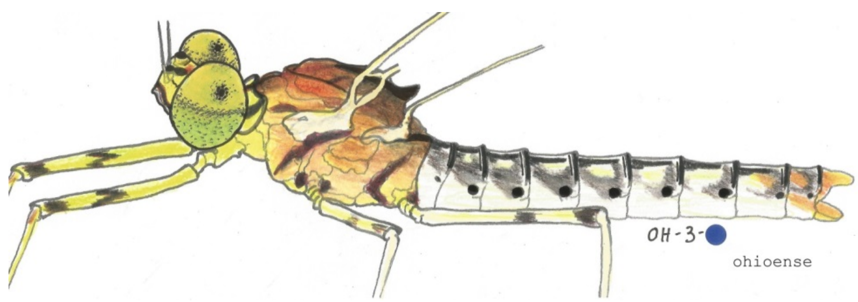
Defining features to separate are;

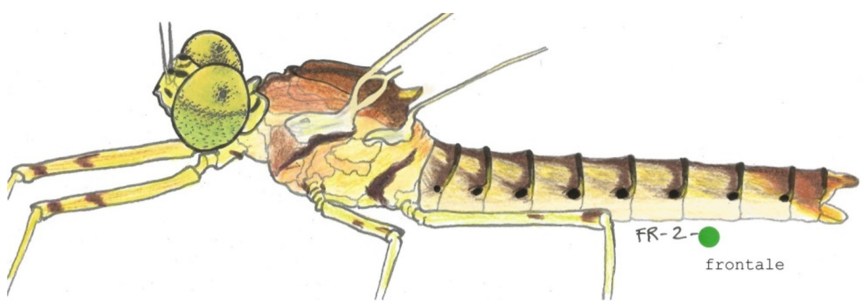
Size is the biggest factor, *ohioense* male is 9 mm and the female is 11 mm. In *canadense* the male is typically 10 mm and the female is 13 mm, *ohioense* commonly has reddish shading in the lateral areas of the notum, and *canadense* is tawny brownish yellow, *ohioense* has large spiracular spots and *canadense* has black shading in the spiracle area, but no spiracular spots present.

(*Stenacron interpunctatum / ohioense*)

(*Stenacron interpunctatum / frontale*)

These two are very likely to be confused in both male and females. There are geological variations of both forms. To date there are 2 geological variations of *ohioense* and 2 for *frontale*. The lightest of the *ohioense* matches the standard form of *frontale* and can only be separated by genital comparisons. However they can be separated superficially by a couple features.





<u>Features commonly shared in the two are</u>;

Black marks on face and top of the head, black oblique streak on the lateral area of the pronotum, dark notum with germinate medial stripe, pleura streaks, germinate dorsal median stripe on tergites 1-9, sublateral tergite shading, with spiracular spots.

Defining features to separate are*;*

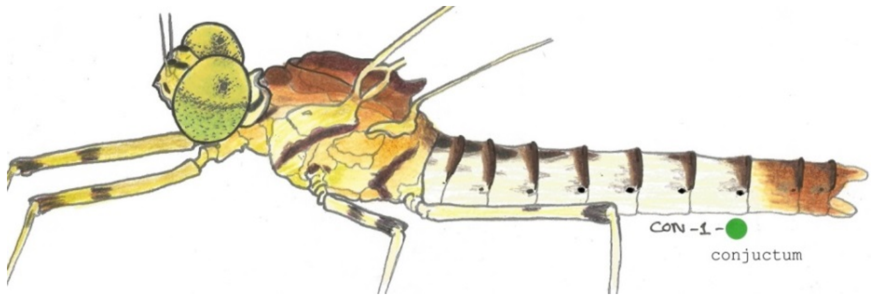
Frontale has a median crania spot and dashes below the antenna bases, *ohioense* has a frontal shelf line that is very near complete from compound eye to compound eye, with a median dark area on the pronotum, *ohioense* has a dark triangle shaped spot in front of the forewing root and *frontale* does not, *frontale* has a brownish notum with yellowish lateral shading and in *ohioense* the lateral shading is most often reddish.

The background colors of all tergites in *frontale* are yellowish-cream and *ohioense* is commonly hyaline with slight yellow-green tinge. The tails of *frontale* are whitish with reddish-brown articulations; in *ohioense* they are yellowish with no articulations.

(*Stenacron interpunctatum / proximum*)

(*Stenacron interpunctatum / conjunctum*)

These two forms are so close that they are very difficult to separate. But they can be separated by genitals and very fine defining features. As well as seasonal variation there are 2 types for the *conjunctum* form the darker variation looking very much like *proximum* and the lighter variation looking very much like *majus*.



Features commonly shared in the two are;

Black marks on face and vertex of head, oblique pronotum streaks, pleural streaks, germinate dorsal medial stripe on abdomen, small diffused spiracular spots.

Defining features to separate are;

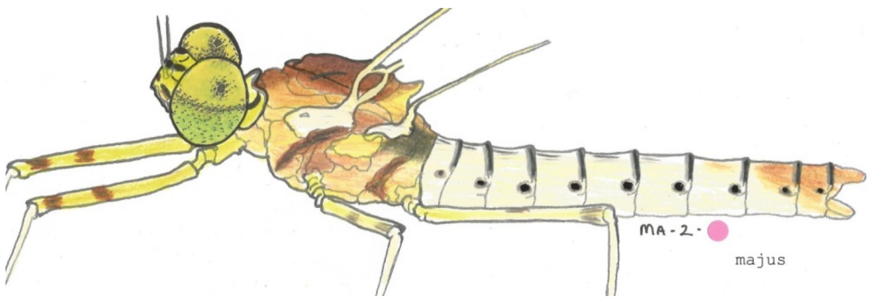
Conjunctum has a midcrania spot and *proximum* does not, on *conjunctum* the stigma stain goes over the apex of the forewing and this does not occur in *proximum*. The germinate dorsal stripe on the abdomen of *proximum* is present on tergites 1-8 and is present on tergites 1-5 on *conjunctum*. The tails on *proximum* are yellowish without any articulations, and on *conjunctum* the tails are whitish with articulations.

The genitals of both differ by the type and size of the spines. *Conjunctum* only has a lateral cluster of spines with minute spines covering the apical portion of each lobe. In the apical portion on *proximum* these spines are stouter and the lateral cluster has independent sublateral spines. However both have terminal, lateral cluster, and median apical spines.

(*Stenacron interpunctatum / majus*)

(*Stenacron interpunctatum / conjunctum*)

Currently there are 2 geological variations of the form *conjunctum* and 2 variations for the form *majus*. Both are very similar to each other but can be separated by the fine detailed features and genitals of the males.



<u>**Features commonly shared in the two are**</u>;

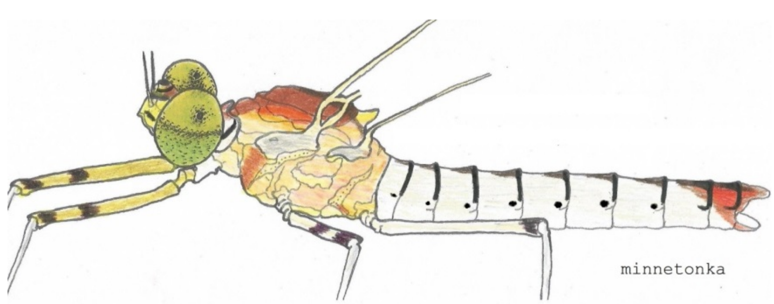
Both have a median crania spot, dashes below antenna bases, small black spots at the corners of the compound eyes, small reddish spot at the cranium suture on the vertex, with black spots on either side of the vertex, posterior edge shaded blackish. Both have pronotum lateral streaks, darker brownish notum, pleural streaks are present; germinate median line on tergites 1-5 with black spiracular spots. Both have white tails with articulations.

Defining features to separate are*;*

Overall size *majus* is slightly larger than *conjunctum*, *majus* has median crania shading and a slight hyaline frontal shelf. Most of the upper area of the head in *conjunctum* is brownish and in majus it is only slight orangey shading. *Majus* has black ringed ocelli and *conjunctum* does not have this feature as in true *interpunctatum* Say. In *majus* on the notum there are sublateral black streaks that *conjunctum* does not have, the scutellum of *majus* is brownish tipped with yellow and on *conjunctum* it is brown. The forewing root of *majus* is hyaline fleshy colored and *conjunctum* is yellow. The germinate median line on the abdomen of *majus* is a very fine grayish line restricted to the median area of tergites 1-5 and the spiracular spot on *majus* are prominent large and black.

(*Stenacron candidum*)

(*Stenacron minnetonka*)



Features commonly shared in the two are;

Both of these forms have a black spot at the median crania area, black marks below antenna bases, small black spots at the corner of the compound eyes, black spots on the vertex on either side near the compound eyes. Both have lateral streaks on the pronotum, brownish notum with a yellow scutellum, and no pleural streaks. Both have a minor geminate median line restricted to the posterior edge of each tergite, and black spiracular spots.

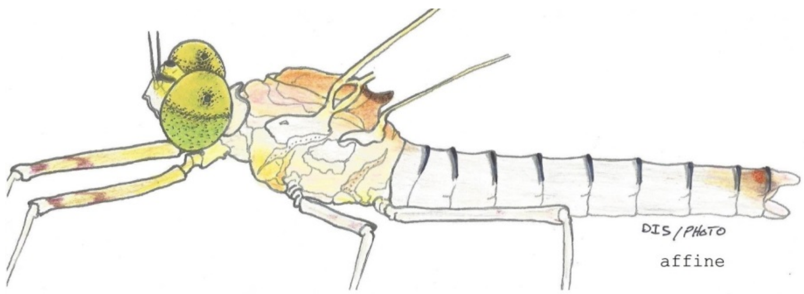
Defining features to separate are;

Size is very important when separating as *minnetonka* is large by several millimeters. On *candidum* the dashes below the antenna bases is in fact an elliptical spot and not a true dash as in all others, *minnetonka* also has deep prominent orange shading on the lateral areas of the notum above and forward of the forewing root and one in front of the middle coxa. On *minnetonka* the median spot on the rear femora is absent on most samples and this spot is present on *candidum*. The spiracular spots on *candidum* are aslant meaning elongated and on an angle and they are small and round on *minnetonka*. The tails are also different on *minnetonka* they are very pale yellow with articulations, and on *candidum* they are white without articulations.

(*Stenacron interpunctatum / heterotarsale*)

(*Stenacron interpunctatum / affine*)

Doctor Traver synonymized these two in 1935. We can surmise that they are synonyms and are very likely geological and or sessional variations of each other. However based on very fine difference we can separate them. Because there is so much in common we will only discuss the defining features to separate them.



Defining features to separate are;

The principle features are the size *affine* is smaller than *heterotarsale*, *affine* has pinkish shading on the lateral areas of the notum and on the pleura, *heterotarsale* commonly but not always has a brownish triangle stain above and forward of the forewing root.

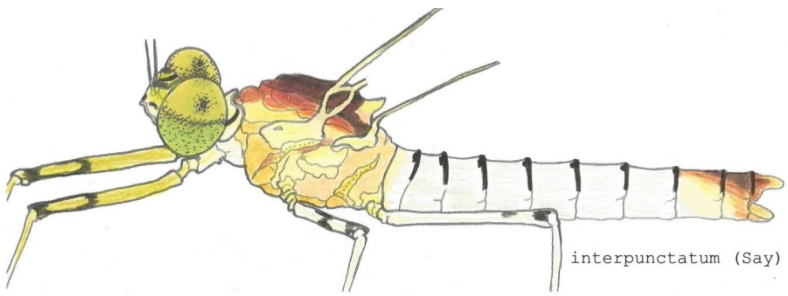
The abdomen of *affine* is stated as being hyaline, and *heterotarsale* has a pale creamy-yellow abdomen. In the tails of *affine* the tails are white without articulations and the tails of *heterotarsale* are hyaline with articulations.

Dr Traver also noted the genitals of *affine* differ slightly from the coastal plain variation being *heterotarsale*.

(***Stenacron interpunctatum***) Say 1839

(*Stenacron floridense*)

In this selection we will compare the true *interpunctatum* (Say) 1839 to a newer less known species *floridense* Lewis (1974).



<u>Features commonly shared in the two are</u>;

Both have black ringed ocelli with spots on the vertex, pale hyaline pronotum with fine black oblique lateral streaks, both having brownish shading in two areas below the forewing root, yellowish-white scutellum, stigma stain going over the apex of the forewing, hyaline abdomen with fine blackish transverse bands.

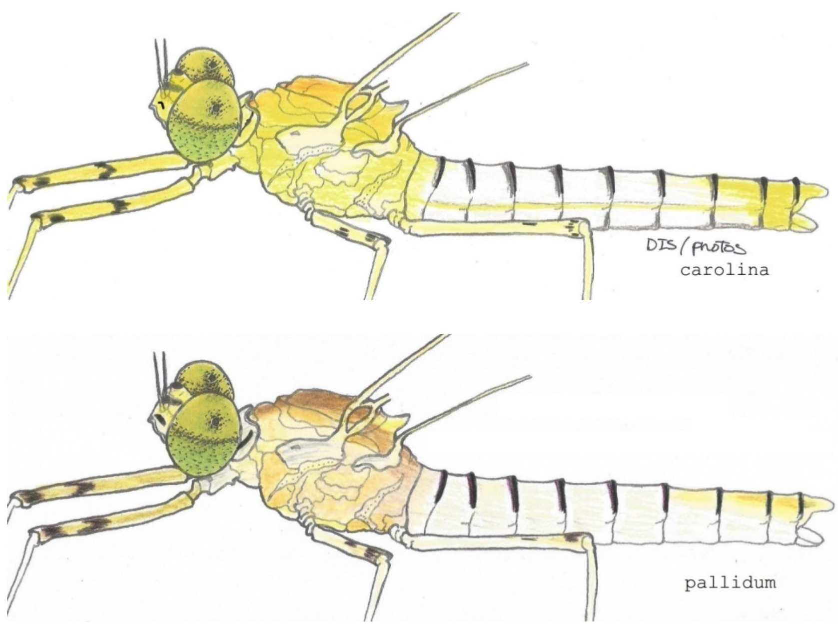
<u>Defining features to separate are</u>;

True *interpunctatum* Say has black marks on the face and *floridense* does not. Note; according to Lewis (1974) *floridense* may have marks on the face; if so typically very faint or almost nonexistent. The head of *interpunctatum* Say is very bright green throughout the entire head, whereas *floridense* is very pale

yellow. *Floridense* has a distinct red triangle stain on the vertex and *interpunctatum* Say does not. The median area of the notum on *interpunctatum* Say is typically very dark brown with lateral reddish-orange shading. The notum on *floridense* is pale clay-brown colored with fleshy-yellow-pink lateral areas. The transverse bands on true *interpunctatum* Say have a blackish rectangle in the median area of each tergite and this does not occur in *floridense*. The genitals of *floridense* are very distinct an not likely to be confused with any other in the genus. *Floridense* has 1-3 very large dorsal axial spines.

(***Stenacron carolina***)

(*Stenacron pallidum*)



Features commonly shared in the two are;

Both of these species have black marks of the face and vertex of the head, oblique pronotum streaks at the lateral areas of their pronotum, no pleura streaks present, stigma stain going the apex of the forewing, blackish tergite transverse bands, and no spiracular spots.

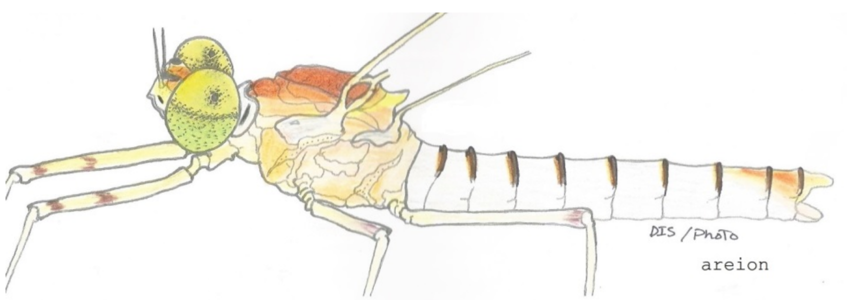
Defining features to separate are;

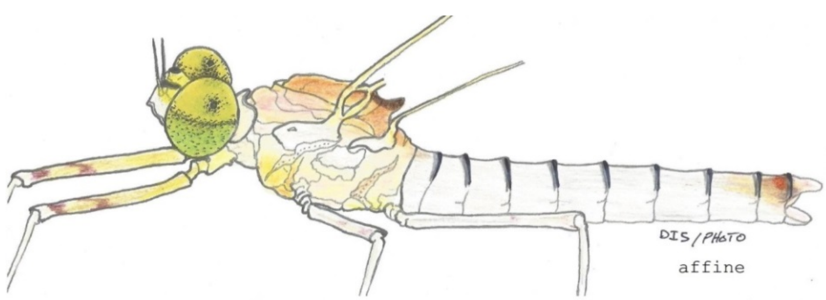
The compound eyes spacing in *carolina* is unlike any other in the genus. The eye spread is typically 1.5 X the width of the compound eye itself. In descriptions the eye spacing is commonly referred to as being remote. Size is the biggest facture *carolina* is most typically seen as 10 mm and the male *pallidum* is 7.5 mm. *Carolina* is very bright yellow throughout and *pallidum* is more of a tawny color with a hyaline abdomen.

The transverse banding of *carolina* is also like no others in the genus it bands wrap the ventral side of the abdomen as gray shading. *Pallidum* also has wide purplish-black transverse banding. The tails of *carolina* are dark smoky gray without articulations and *pallidum* has hyaline tails that are also unarticulated.

(***Stenacron interpunctatum / areion***)

(*Stenacron interpunctatum / affine*)





Features commonly shared in the two are;

Both of these are very pale and very similar in size, spots on the vertex of the head, no pleura streaks, stigma stain going over the apex of the forewing, hyaline white abdomens without spiracular spots, and hyaline-white tails without articulations.

Defining features to separate are;

Areion has black dashes below the antenna bases and *affine* may have very faint grayish markings. There are black oblique pronotum streaks on *areion* and these are absent on *affine*. The scutellum on *areion* is bright yellowish-white, and on *affine* it is medium brownish-yellow. The entire notum of *areion* is deep tawny orange with brighter lateral edges, and on *affine* it is a very pale tawny color with pinkish lateral areas. The transverse tergal bandings on *areion* are brownish with tawny orange transverse shading on each tergite, and on *affine* they are very fine blackish shaded with a somewhat metallic look.

(***Stenacron pallidum***)

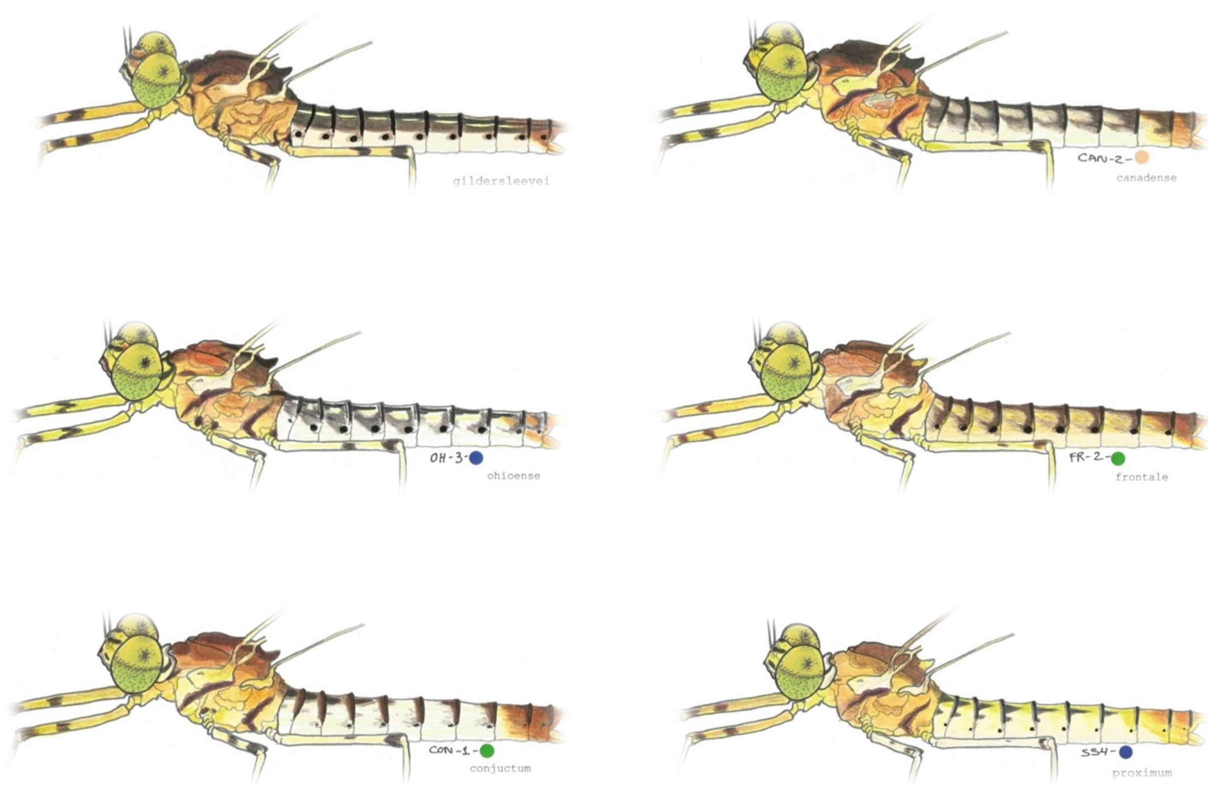
(*Stenacron interpunctatum / heterotarsale*)

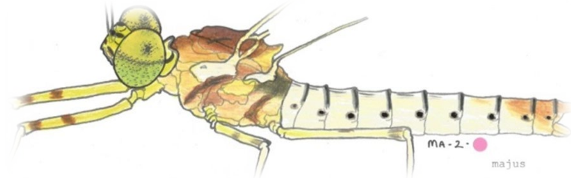
<u>Defining features to separate are</u>;

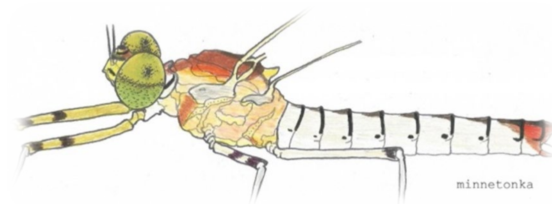
Size is the biggest facture is *heterotarsale* is 9 mm and *pallidum* is 7 mm. *Pallidum* has black marks on the face and *heterotarsale* only has small black spots at the corners of the compound eyes and *pallidum* has dashes bellow the antenna bases.

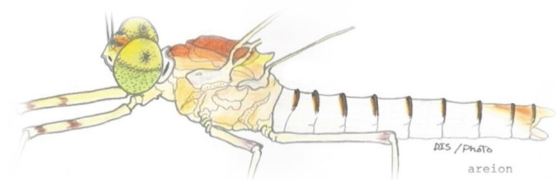
There are pronotum streaks on the lateral areas of *pallidum* and *heterotarsale* is void of any pronotum markings. The abdomen on *pallidum* is hyaline white and on *heterotarsale* it is creamy-yellow. The tails of *pallidum* are hyaline without articulations, and on *heterotarsale* they are hyaline with articulations.

Male Adults Lateral views

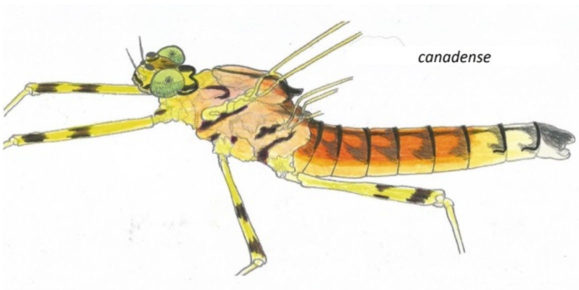






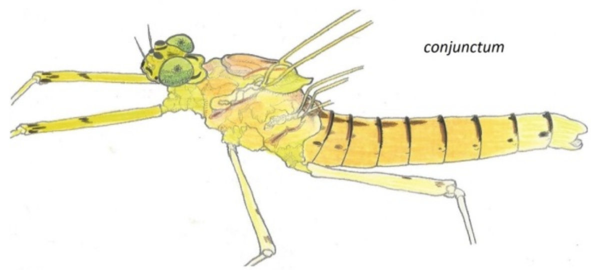


Female's Lateral views

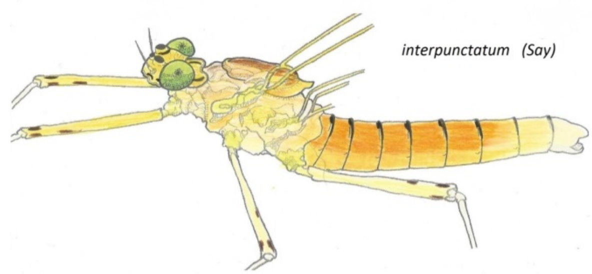

canadense


frontale


proximum

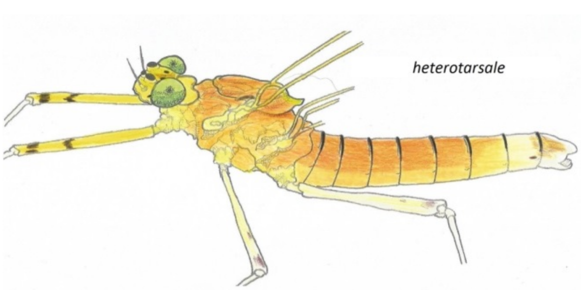

conjunctum


majus


interpunctatum (Say)

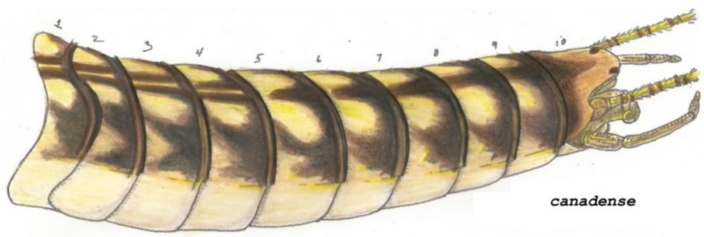

carolina


floridense

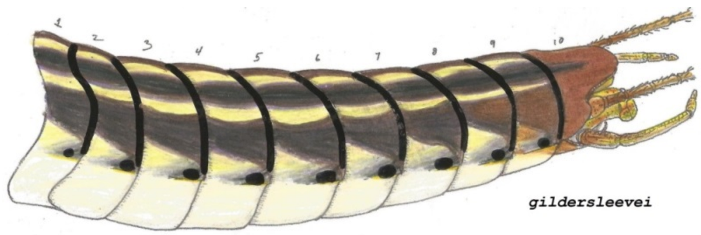

heterotarsale


pallidum

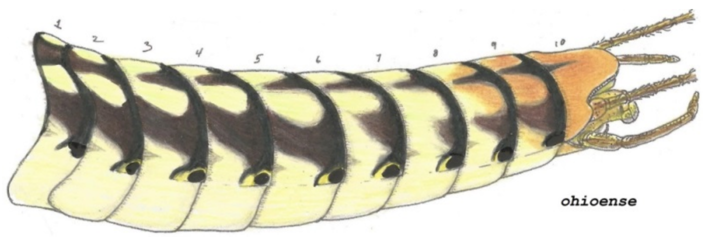
Male Abdomens lateral View



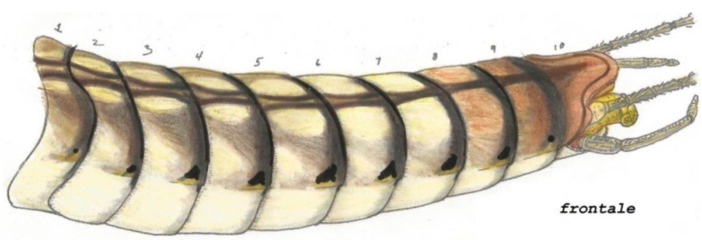
canadense



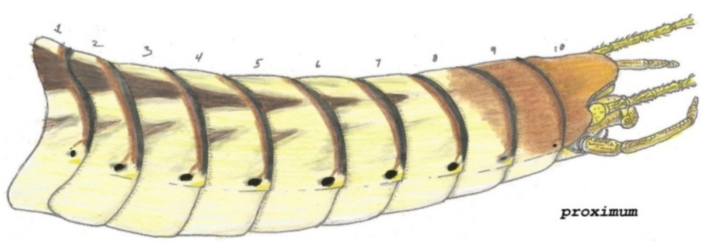
gildersleevei



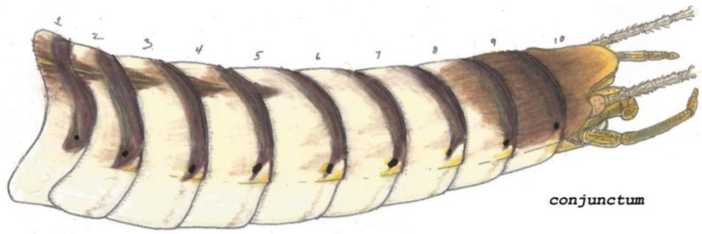
ohioense



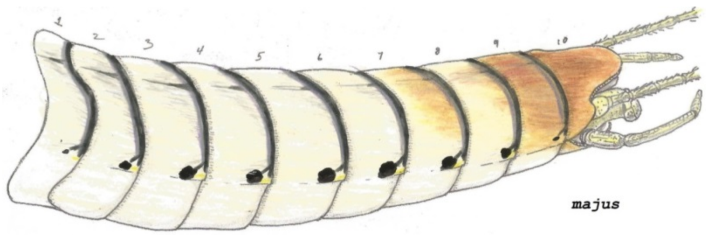
frontale



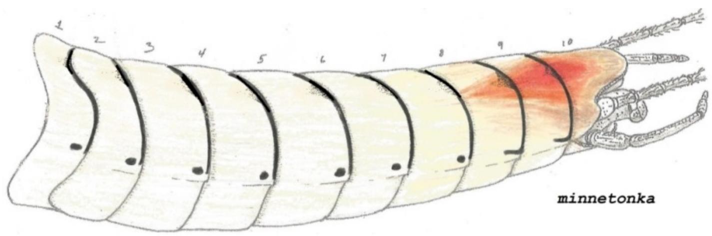
proximum



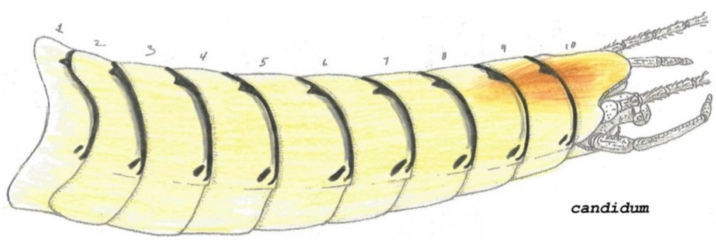
conjunctum



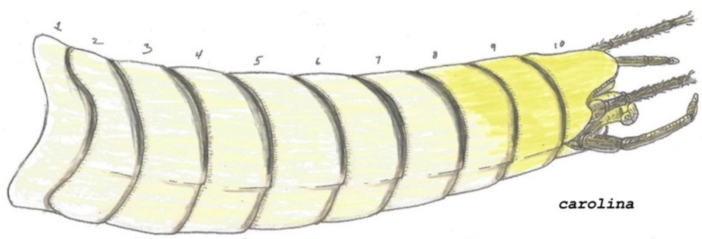
majus



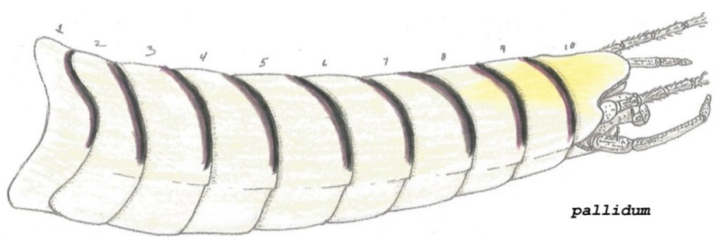
minnetonka



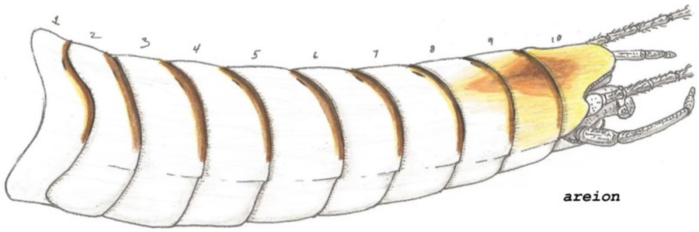
candidum



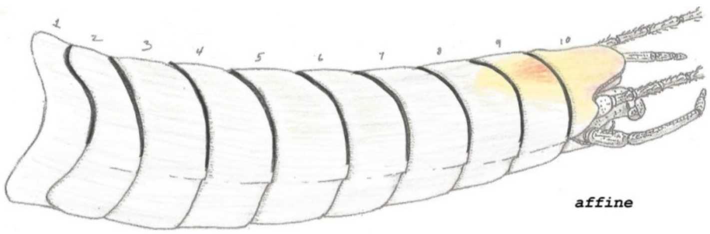
carolina



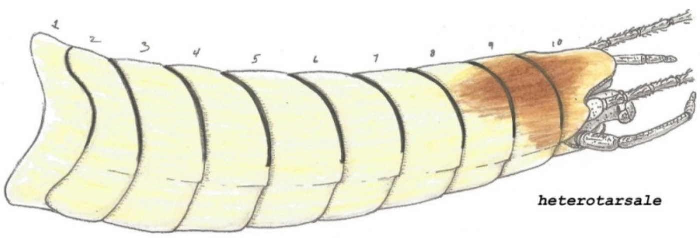
pallidum



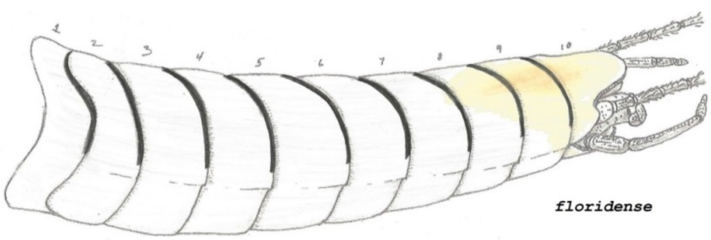
areion



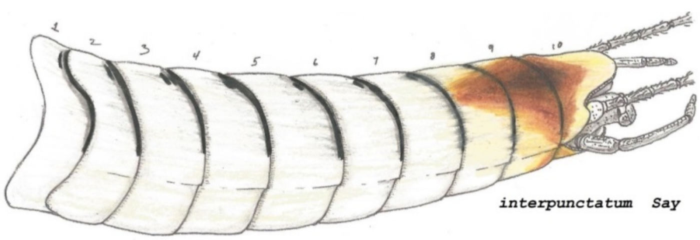
affine



heterotarsale



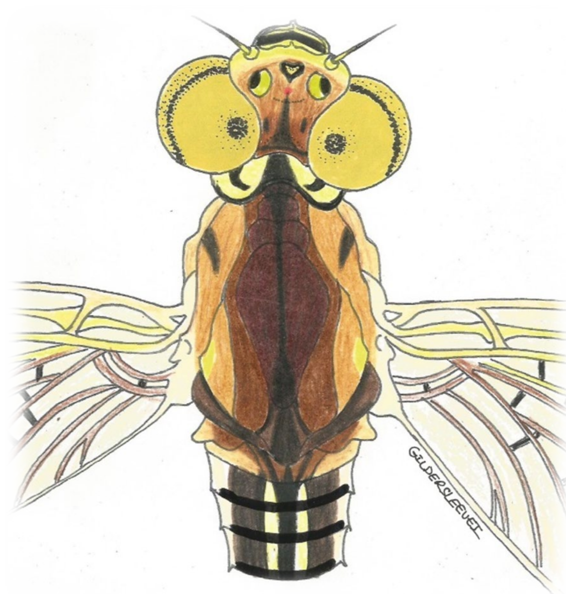
floridense



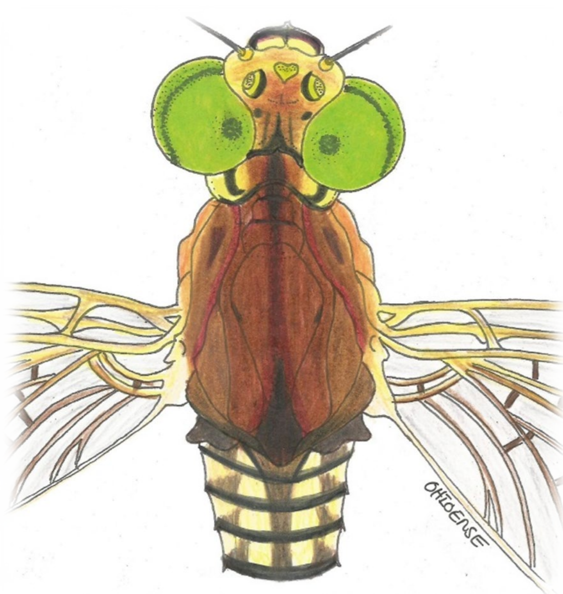
interpunctatum Say

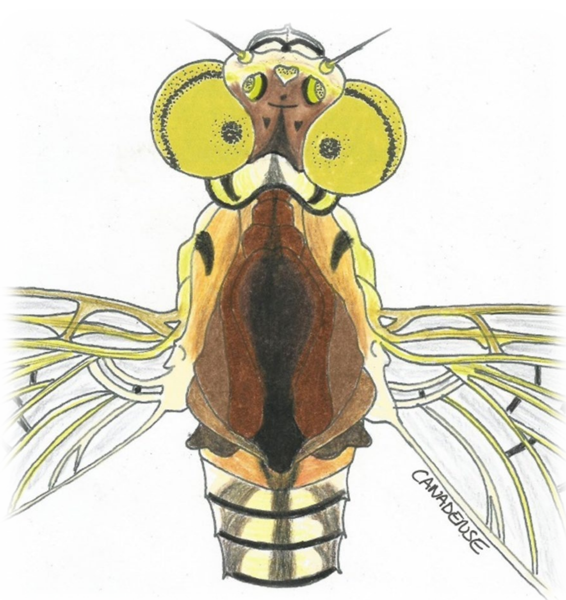
Master dorsal notum and Pleura Views

gildersleevei



ohioense





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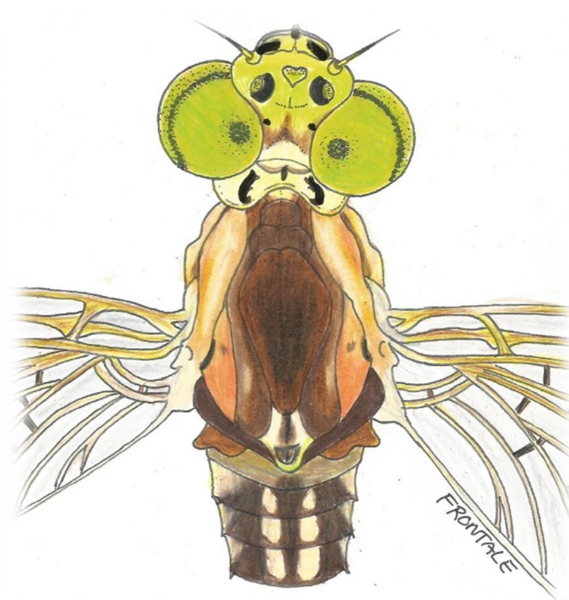
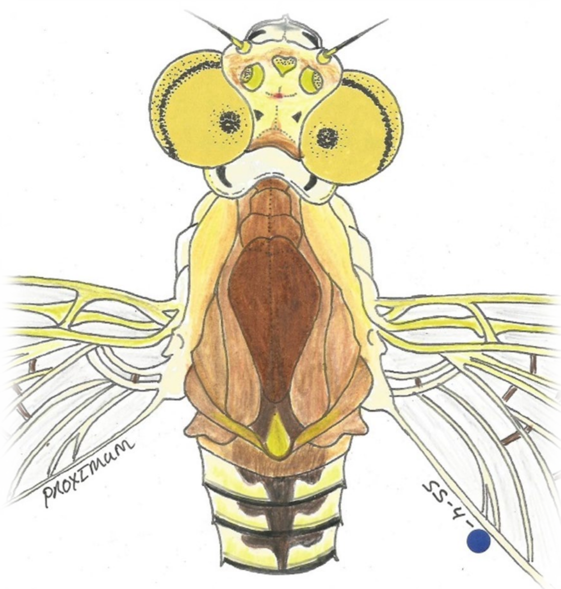


frontale

proximum



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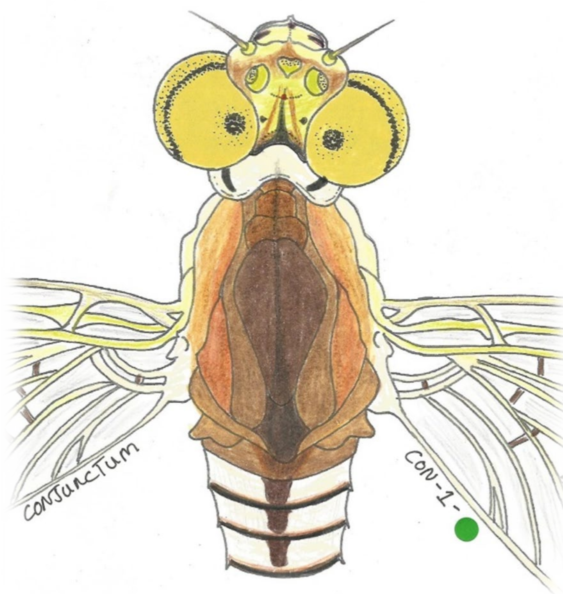
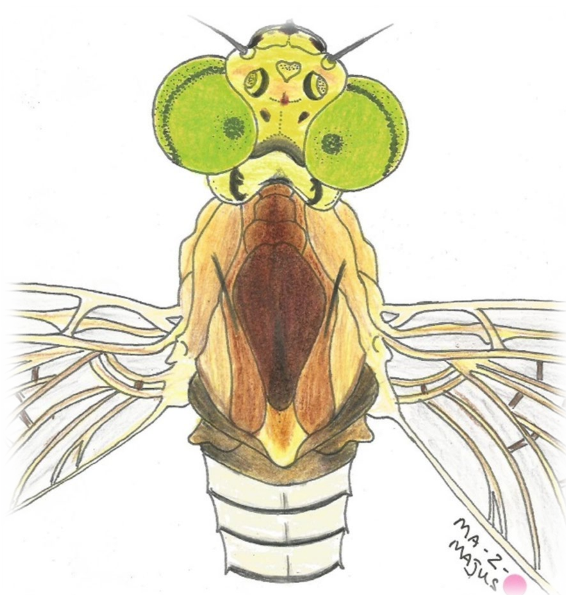
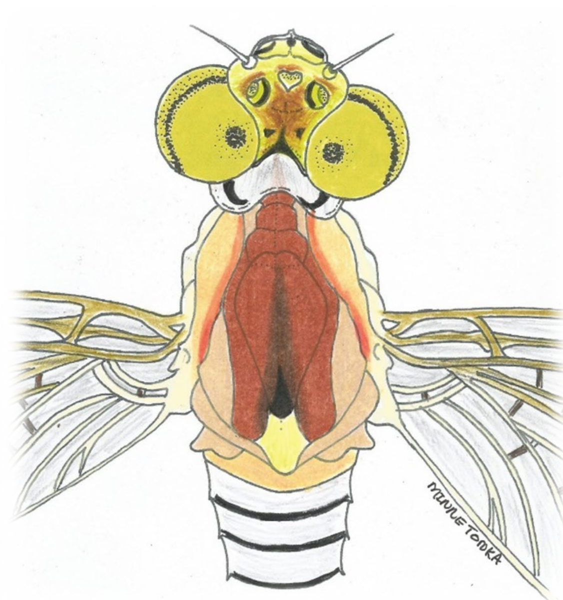


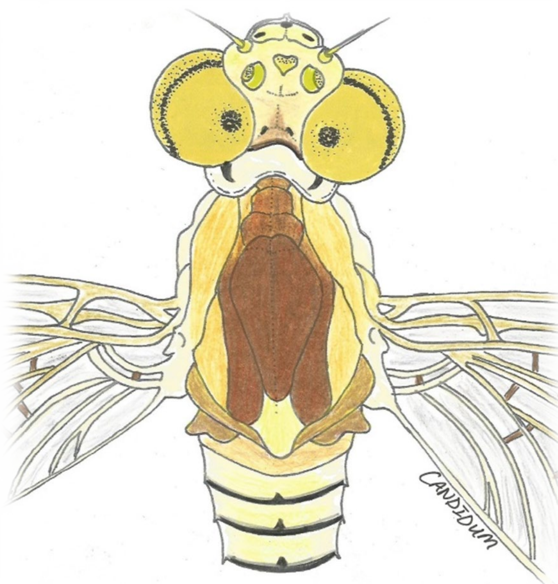


majus



minnetonka

candidum



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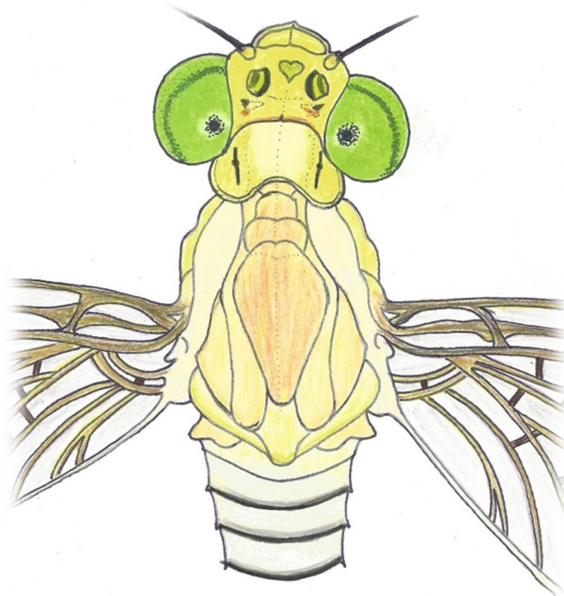

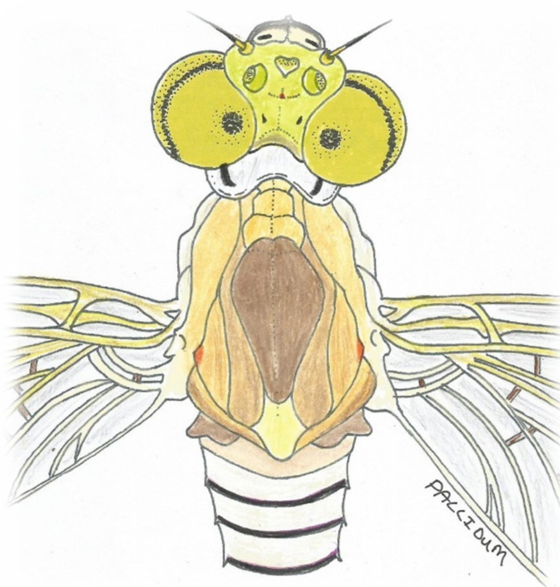

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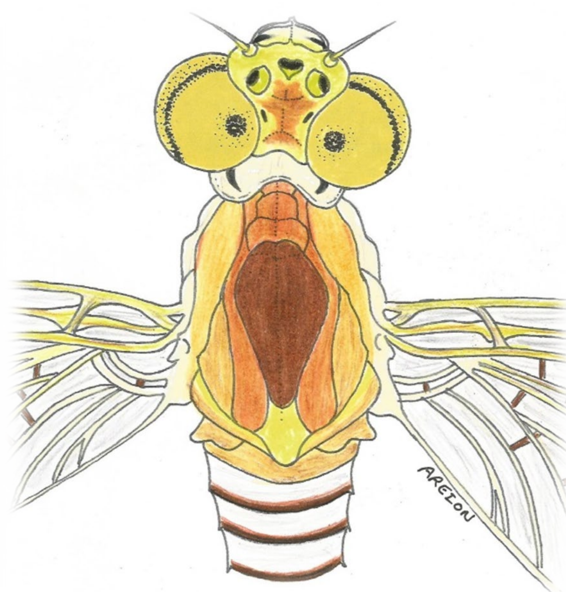
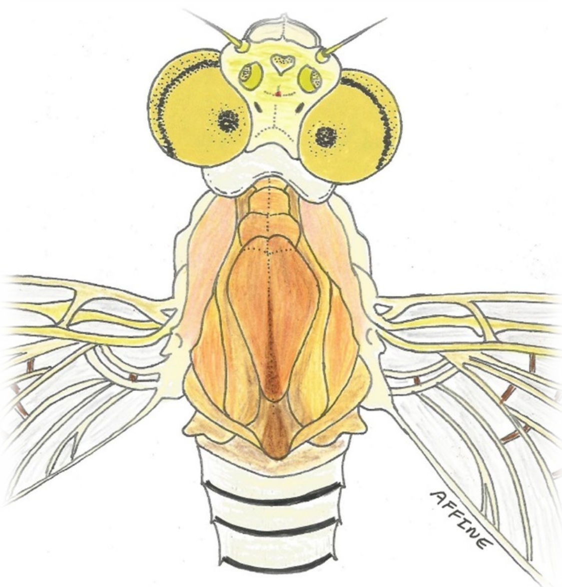


areion

affine



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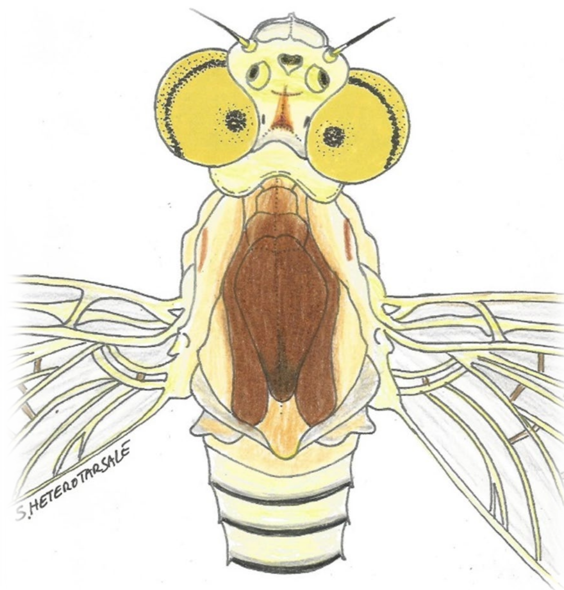

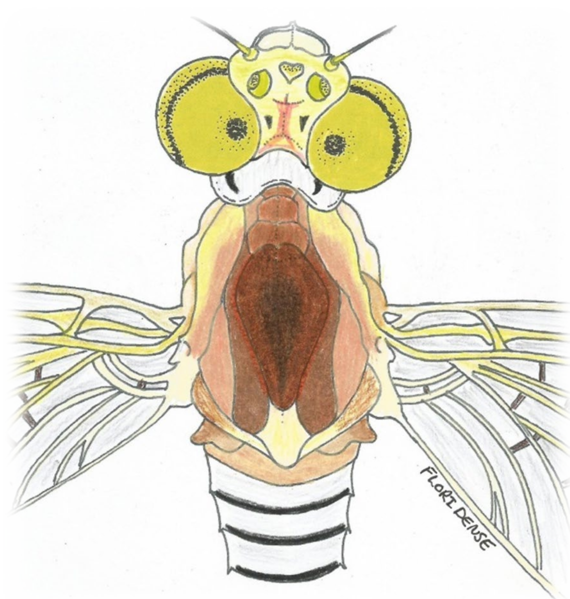

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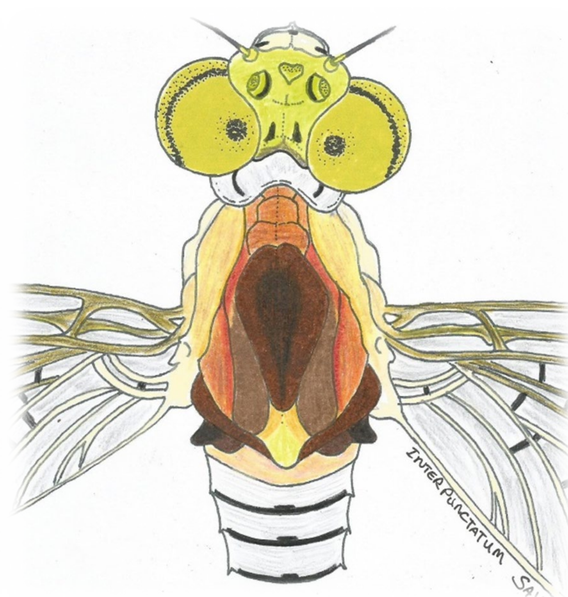
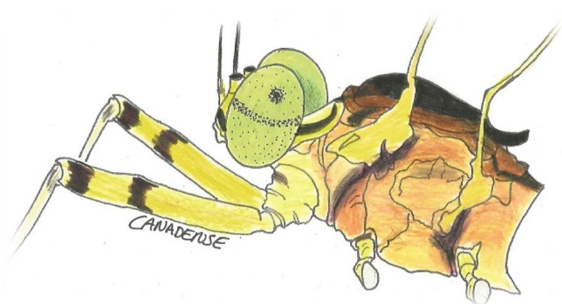


interpunctatum Say

gildersleevei

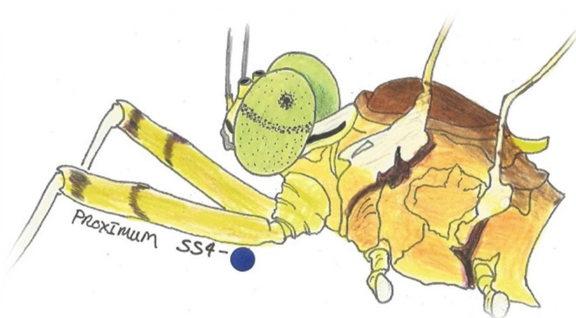
ohioense

canadense



frontale

proximum



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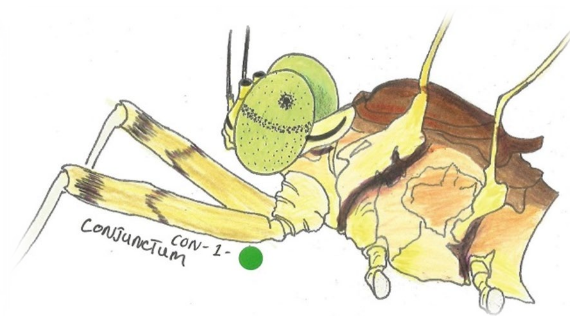

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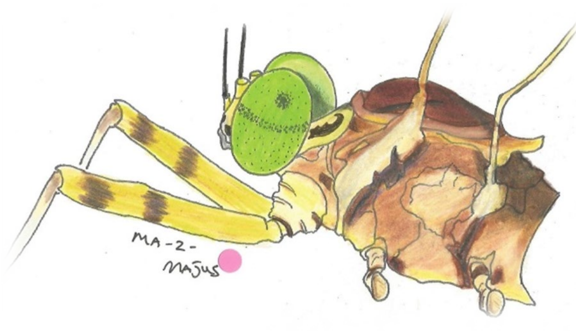
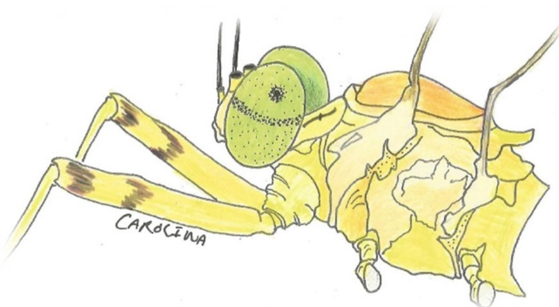


minnetonka

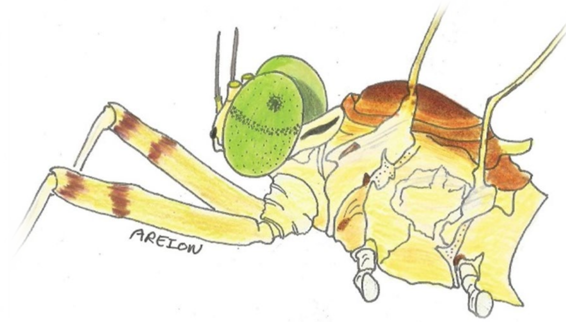
candidum

carolina



pallidum

areion



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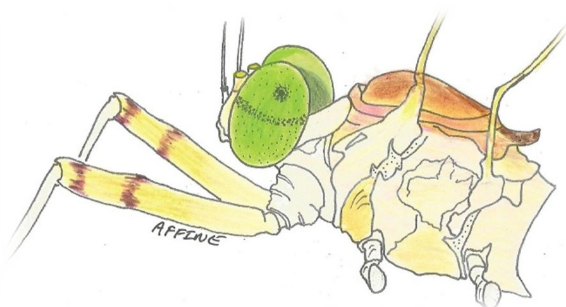

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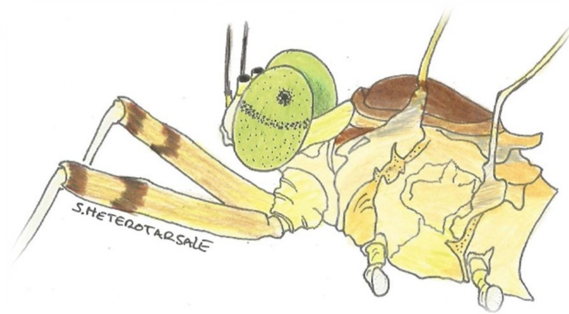
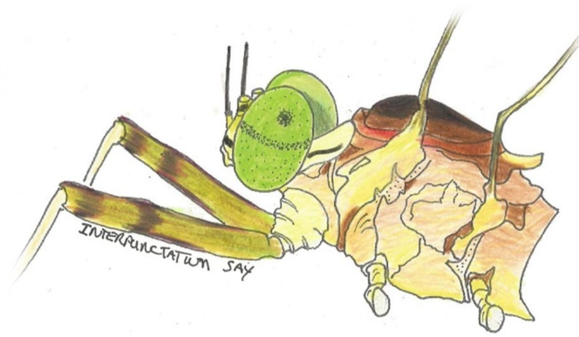
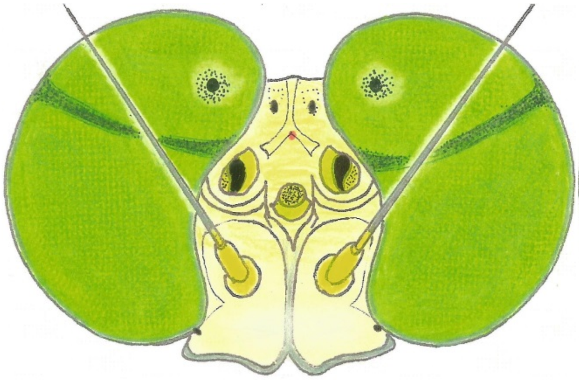


floridense

interpunctatum Say



Male heads anterior View



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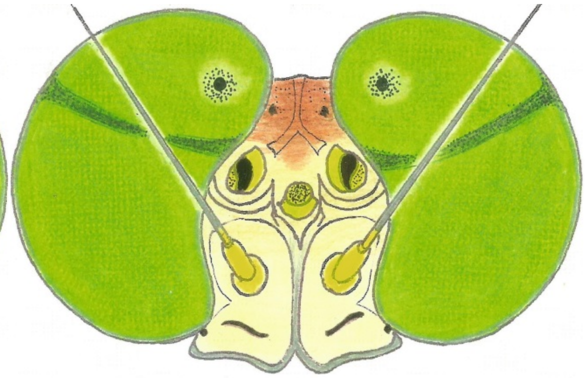

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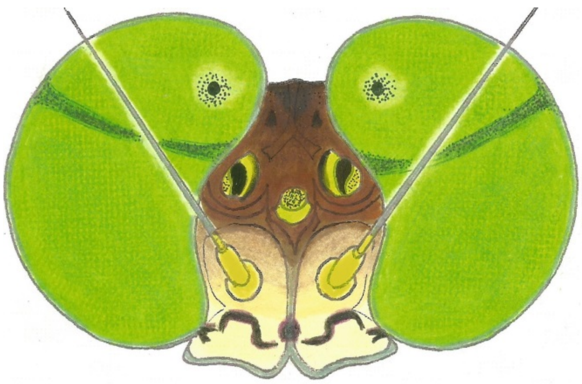

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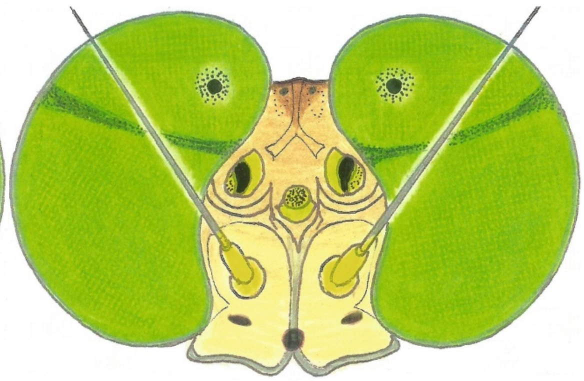

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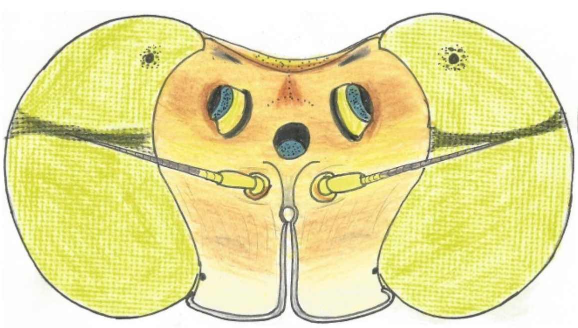

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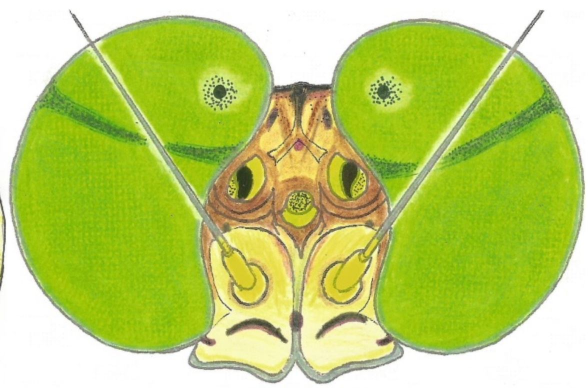

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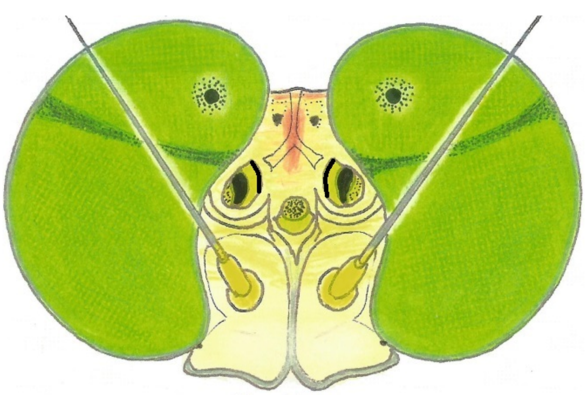

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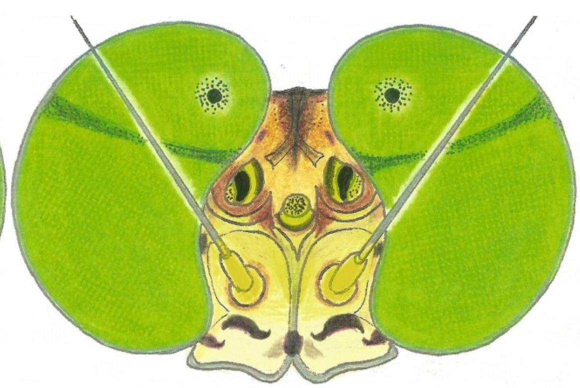

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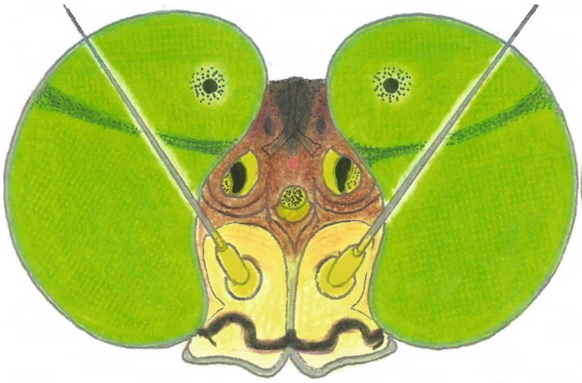
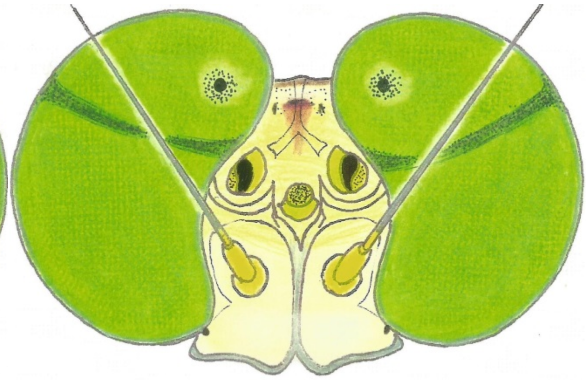


gildersleevei



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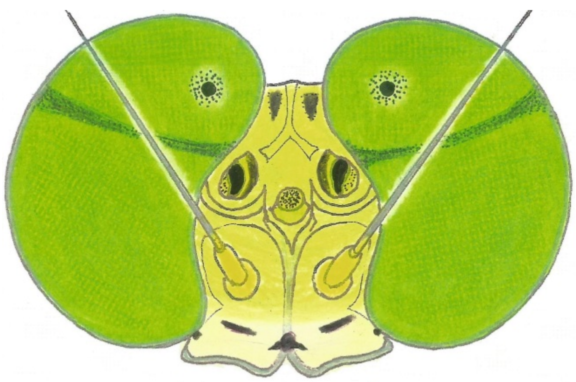
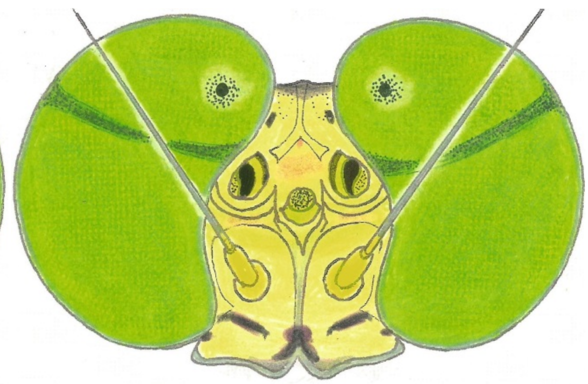


interpunctatum Say



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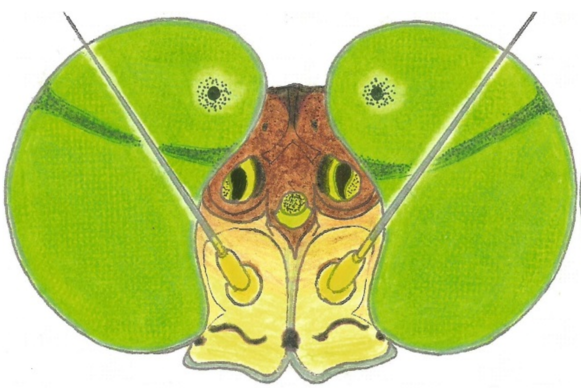

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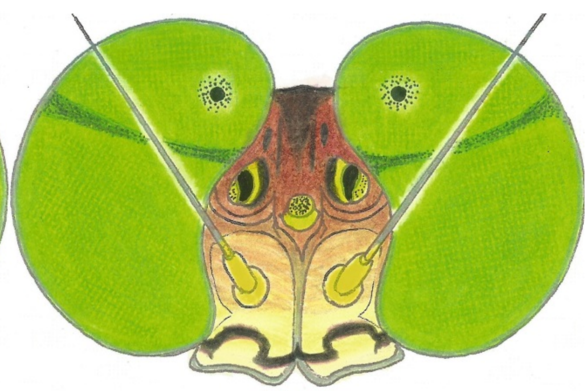

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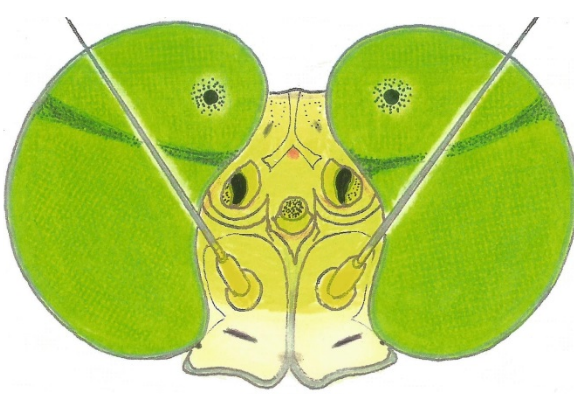

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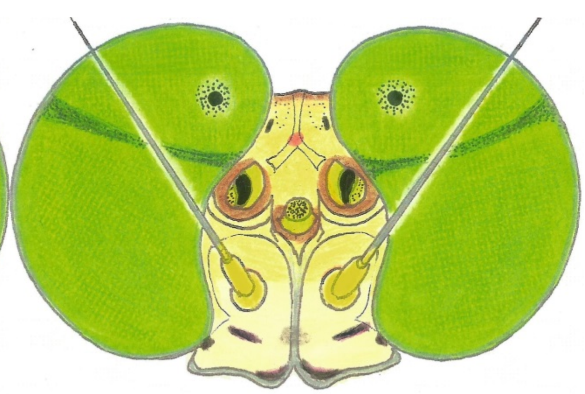
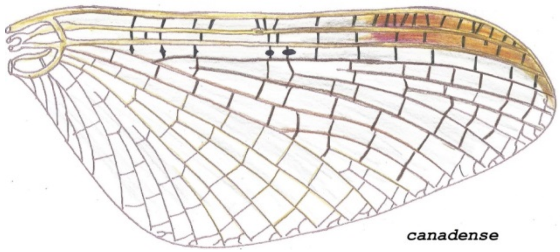


proximum

Forewings



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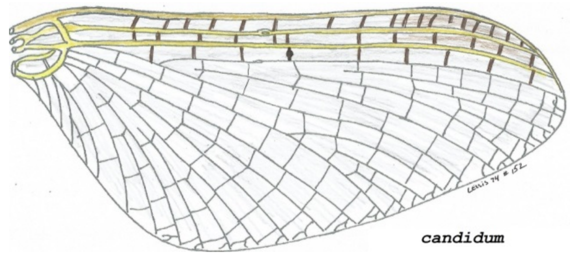

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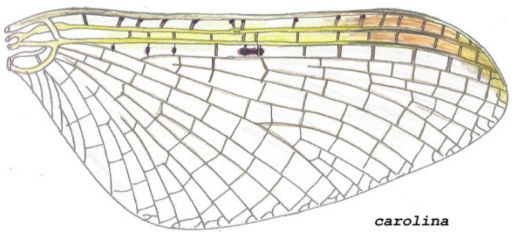

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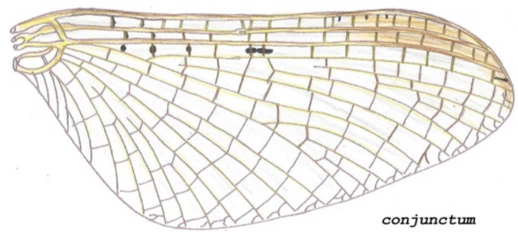

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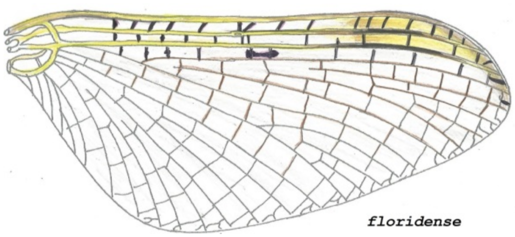

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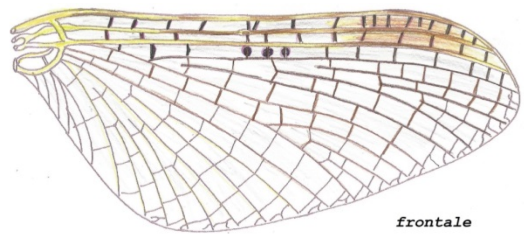

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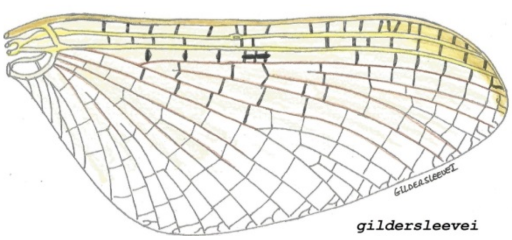
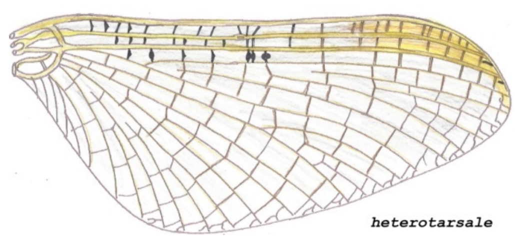


gildersleevei



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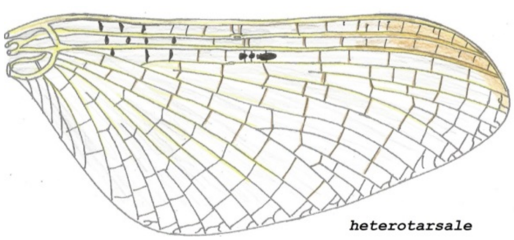

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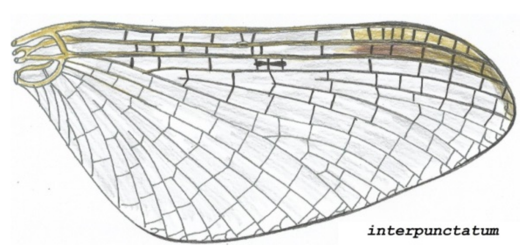
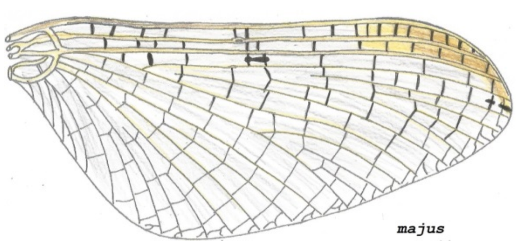


interpunctatum



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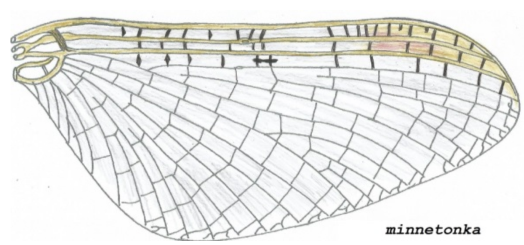
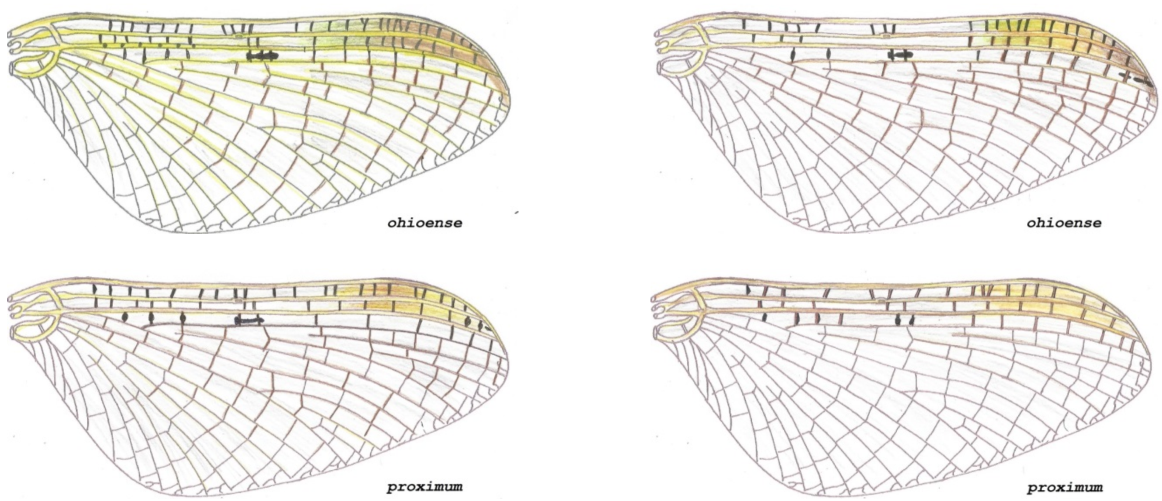


minnetonka



Adult Couplets

Note: All past authors on all species indicate variation in maculation from holotypes, Paratypes, and haplotypes as to their species concepts. Some samples missing maculation some having it when it shouldn't be there. Line up your sample to the nearest form keeping the geology of the substrate in mind, then lookup current species status by the form name.

The strongest maculation on Stenacron are; spots below antenna bases, Black ringed ocelli, black spots on top of head, pronotum streaks, pleura streaks, stigma stain over apex of forewing, and spiracular spots.

Secondary maculation markings; spots and shading on median crania center structure of clypeus margin, median stripe on notum and pronotum, spots in the R1&R2 interspaces, transverse shading on tergites, median abdomen stripe, transverse bands.

Fore tarsal ratios can be helpful but often are all over the map in size. Reading Spieth 1947 will give you insight into that. It's not useless it is just not to be trusted that much.

1. ***affine;*** head pale yellow only small black spots near the compound eyes on clypeus, small black spots on vertex with reddish spot at cranium suture, no pronotum streaks, no pleura streaks, stigma stain over apex of forewing unknown, tawny notum with pinkish tinge, narrow purple-black transverse bands, with no spiracular spots.
2. ***areion;*** small spots under antenna bases, small black spot near compound eyes on the clypeus, orange vertex with black spots on either side, pronotum marked with fine black streaks, mars orange notum brighter on the sides with red-brown shading on parapsides, scutellum yellow in the center, no pleura streaks, stigma stain over apex is unknown, white abdomen with or without mars orange-brownish transverse bands.

3. ***canadense;*** clypeus yellow-hyaline, median crania spots, blacks spots below antenna bases, small black spots corner of compound eyes, black ringed ocelli, brown vertex with blackish triangle in median area with two small black spot, pronotum large black lateral streaks, black triangle spots in front and above forewing roots on the lateral side of notum, deep brownish-black notum, scutellum black, strong pleura streaks, stigma stain going over the apex of the forewing, heavy black shading on at tergites lateral and median, with submedial pale spots, ***no spiracular spots***.

4. ***candidum;*** yellowish head vertex sight orangey toned, clypeus median crania spot, elliptical black spot below antenna bases, small black spots at the corners of the compound eyes, ocelli not black ringed, brownish triangle on vertex with small black spots, posterior edge grayish, pronotum, with lateral streaks, notum brown, no pleura streaks, stigma stain not over apex of forewing, yellow abdomen, black transverse bands pointed in the median area of each tergite, prominent can be aslant spiracular spots.

5. ***carolina;*** compound eyes wide spread, clypeus small spot at the corners of the compound eyes, vertex two grayish black sots brownish shading, pronotum with very fine lateral streaks, pleura bright yellow no pleura streaks, stigma stain over the apex of the forewing, tergites with black transverse bands wrapping the sternum as faint gray bands.

6. ***conjunctum;*** clypeus pale yellow with a midcrania spot, a long fine dash below antenna bases, moderately sized black streak at the corner of the compound eyes, ocelli not black ringed but heavily shaded in brownish orange, red spot at the palmen body, median black triangle spot, with two small black spots, pronotum with moderate black lateral streaks, pleura streaks present, stigma stain going over the apex of forewing, germinant median stripe on tergites 1-4 some 1-5, black transverse band with heavy brown transverse shading, small defused spiracular spots.

7. ***floridense;*** head pale yellow with small black spot at the corner of compound eyes, faint gray spots rarely on face, distinct reddish spot on vertex with two small black spots, ocelli black ringed, pronotum hyaline with lateral fine black streaks, notum dark chocolate brown, mesoscutellum whitish-cream, no pleura streaks, stigma stain over the apex of the forewing likely, very fine blackish transverse bands.

8. ***frontale;*** hyaline-yellow clypeus, prominent median crania spot with shading, black dash's below antenna bases, larger black streaks at the corners of the compound eyes, green below ocelli, ocelli black ringed, brown around lateral ocelli, vertex yellowish with brown-black triangle spot with two small blackish spots, pronotum yellow with prominent lateral black spots, pleura streaks present, faint germinant median notum stripe with yellow scutellum, stigma stain not over apex of forewing, abdomen with median stripe on all tergites, with pale submedial spots, heavy brownish transverse shading, with black transverse bands, large infused prominent spiracular spots.

9. ***gildersleevei;*** clypeus yellow turning green, transverse black band across face from compound eye to compound eye forming a complete smile, some males have a broken band, brownish around all ocelli, palmen body red spot, medial black triangle on vertex with two small spots, pronotum yellow with median black stripe, and lateral black spots, scutellum brown tipped with black, remaining notum deep tawny-brown, with large blackish triangles in front and above forewing roots, no pleura streaks all coxa with blackish marking, abdomen solid black median stripe on all tergites, with sublateral pale spots that are thin and not touching the anterior or posterior for all

tergites, black sublateral shading with prominent spiracular spots separated from sublateral shading.

10. ***heterotarsale;*** faint yellow hyaline clypeus with a light gray margin, small black spots at the corner of the compound eyes, brighter yellow around ocelli, ocelli not black ringed, brownish triangle stain on vertex with black spots on each side, posterior margin smoky, pronotum yellowish without any makings, notum largely brown, scutellum tipped with ocher yellowish, tawny pale yellow notum lateral sides, pleura yellowish some samples not all have a pale brownish streak on the pleura anterior to the forewing roots, slight deeper brown-orange right in front of mid-coxa, stigma stain going over the apex of the forewing, black transverse bands on all tergites, with no spiracular spots,

11. ***True interpunctatum Say 1839***;
Head bright yellow turning bright green on vertex, many sample may have a median crania spot, all samples will have black dash's under the antenna bases, with small black spots near compound eyes, antenna usually black not gray, ocelli prominently black ringed at the bases, vertex with a pair of black spot, some samples black triangle spot, pronotum hyaline yellow tinged at lateral areas with fine lateral stripes, dark chocolate notum, scutellum yellow or yellow tipped, pleura yellow-tawny with slight orange cast in front of mid-coxa, coastal margin of forewing generally completely black tinged, all longitudinal veins yellow at base turning yellow-green-black as they enter the stigma stain, stigma stain greenish-amber going over apex, commonly with strong intercalaries in the right wing, abdomen hyaline, black transverse bands with an median posterial spot on the band often shaped like a rectangle, no spiracular spots.

12. majus; head pale yellow green clypeus grayish, black lines below antenna bases, small spots at the corner of the compound eyes, slight orange shading forward of cranium suture, red spot palmen body, black ringed ocelli, small black spots on either side of the vertex, pale grayish posterior edge, pronotum yellow with slight median spots having lateral

streaks, notum largely reddish brown in the meson area paler at lateral areas, commonly very fine black stripes in front and above forewing roots, scutellum brownish tipped with yellow, lateral areas of scutellum tannish with dark gray staining in post scutellum areas, pleura bubble gum pink-orange with brown over tones, pleura streaks, with coxa markings, forewings stigma stain going over the apex of the wing, abdomen, often a faint gray very fine medial line on tergites 1-4 or 1-5, black transverse bands with a metallic silvery gray shading, often very large spiracular spots, large than everything in the genus.

13. ***minnetonka;*** pale yellow clypeus with mid crania spot, long thin dash's below antenna bases, small black spots corners of the compound eyes, slight orange shading between antenna bases and lateral ocelli, ocelli black ringed, ocelli to the rear of vertex chocolate brown, two small black spots on vertex, with blackish posterior margin some samples having a blackish medial triangle spot, pronotum largely hyaline slight yellow on the lateral areas, with lateral black streaks, notum reddish-orange, brownish germinant medial stripe dark near scutellum, scutellum yellow with pale lateral areas, lateral areas of notum tawny with orange tones, pleura unmarked yellowish-brown with slight orange area in front of mi-coxa, stigma stain is unclear but likely over the apex, abdomen with clearly black transverse bands with elevation in median area of each tergite somewhat forming a arrow pointing forward, small but prominent spiracular spots.

14. ***ohioense;*** clypeus yellow green with a black line going for compound eye to compound eye forming what looks like a complete smile not always complete, orangey-brown around antenna bases, from ocelli back brownish red, ocelli black ringed, black spots on vertex with median triangle black stain, posterior margin black, pronotum deep yellow with strong black median line with reddish surrounds lateral black spots large often connected to posterior edge, notum largely deep reddish-brown, with germinant medial stripe on transverse suture, dark brown spots forward and above forewings, pleura largely yellow with fore-coxa spots, pleura streaks, forewings stigma stain going over the apex, abdomen largely blackish or infuscated gray shading, having a strong medial stripe, with variable submedial pale spots, with infuscated sublateral

areas, heavy transverse dark shading with black transverse lines on all tergites, large spiracular spots, in fused with lateral area of tergite transverse shading.

15. ***pallidum;*** clypeus very pale yellow very pale or absent median crania spot, fine dash’s below antenna bases, small black spots in the corners of the compound eyes, brighter green-yellow from antenna bases to posterior margin, black spots on vertex, red spot at palmen body, pronotum pale yellow-hyaline with fine black streaks near lateral edges, notum pale tawny-amber-yellow with paler lateral areas, scutellum yellowish with tan sides, pleura no streaks with pale tawny yellow all over, stigma stain based on sample in photo plate stain likely over apex, abdomen moderately wide purple-black transverse bandings, without spiracular spots.

16. ***proximum;*** clypeus very pale yellow-hyaline, dark medial shading on the frontal margin, with pale median crania spot, small black dash’s below the antenna bases, small black dah’s at the corner of the compound eyes, ocelli not black ringed but ringed with brownish-red shading, red spot at palmen body, two very small black spots on vertex, with posterior margin brownish-red shading, pronotum hyaline-yellow with lateral black streaks, notum in the median area deep brown darker near scutellum, scutellum yellow with a touch of green, pale yellow tan lateral areas, pleura medium yellow with areas of orangey-brown with pleura streaks, forewing stigma stain not over apex, germinant medial stripe 1-7, with germinant submedial shading on 1-4, black transverse bans with forward transverse shading, moderate spiracular spots infused with transverse bands.

Adult Male Full Descriptions

All descriptions are free of synonym forms, based on original descriptions, and reared samples that align with the proper original historical profiles. Every attempt was made to base our descriptions on the original description combined with other matching ones with reared samples from Southern Ontario that meet the criteria of the original descriptions. If new information can make a concept more concise we are commenting in a manner that is easily recognized with parenthesis. We will not write a description that was affected by a synonym. These are as original and as clear as historical documentation and current information can allow. Pure clarity to original form combined with new study information clearly indicates all the original concepts. All are listed in their form names, not species.

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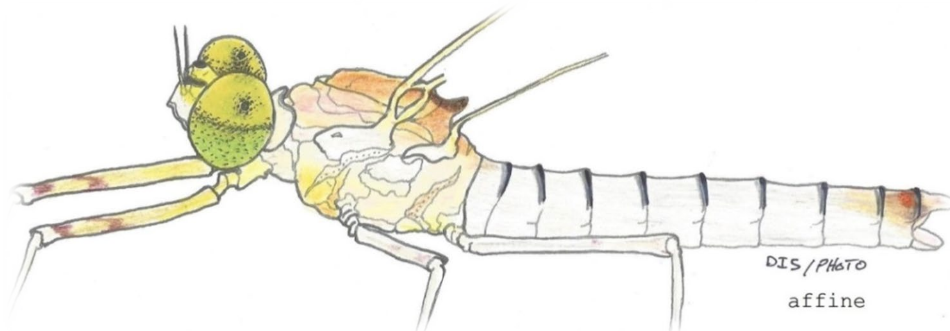
affine

Traver 1933

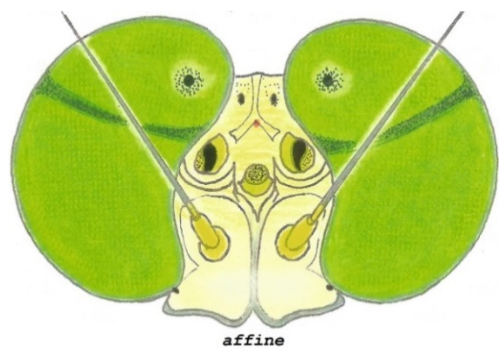
Synonymized to *heterotarsale* 1935

Notes; Based on Travers description and our illustration facsimiles. To the best of our knowledge *affine* has never been seen outside the Cornell collection and was never reviewed, not even for DNA according to Jeff Webb. This description follows Traver 1933 very close. (However from our full genus morphology studies, altitude, and ecology affect it can be clarified).

Body size; 7-8 ♂ mm, 9 ♀ mm
Forewing size; 8-9 ♂ mm
Tails; 18 ♂ mm

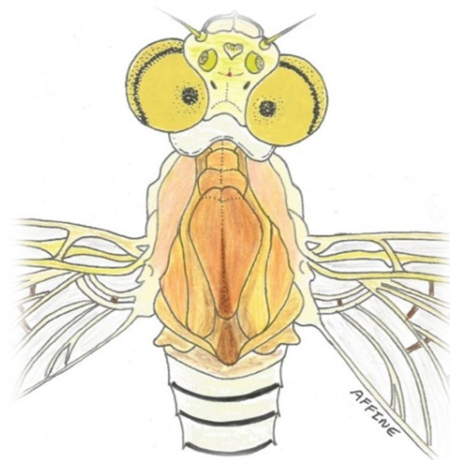


Head; Pale yellowish with very pale clypeus (likely almost hyaline). Two very small dark dots by the corners of the compound eyes on the lateral areas of the clypeus. Traver does not remark that the ocelli are black ringed at the base as in true *interpunctatum* Say. Traver remarks very small red spot in the area of the cranium suture at the palmen body. On the vertex of the head two very small black spots, the posterior margin may be slightly dusky.

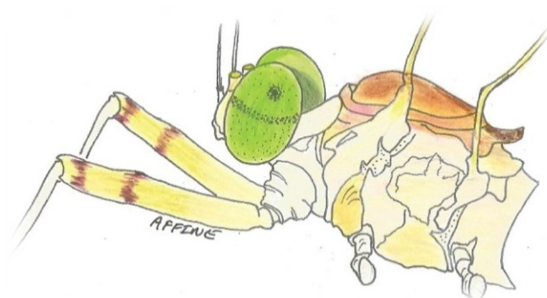


Pronotum;
As in all the pale forms having a hyaline pronotum that is unmarked as in *heterotarsale* may have slight yellowish tinge at the lateral areas.

Notum; entirely pale yellow with tinge of pink without any dark markings, some structures of the notum and pleura very narrowly darker. (Likely darkening tones typical to the genus in the scutellum area).



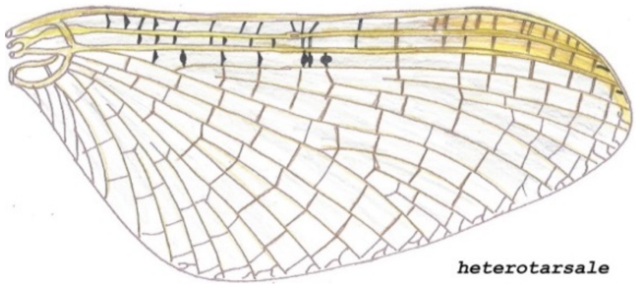
Pleura; very pale whitish-yellow with a slightly brighter yellowish area in front of middle leg as all forms in the genus have, (may be even slightly orange).

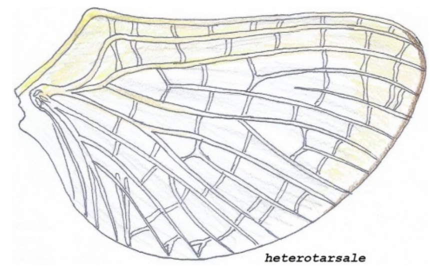


Forelegs; faintly tinged in pale yellow with an apical and median femora bands. (Tarsi and tibia would likely be hyaline with smoky-brown tipping's). Traver never included a fore tarsal ratio, if truly like *heterotarsale* about ½ the length of the second.

Middle and rear legs; (would be hyaline with very faint femora bands), Traver comments both legs are missing median bands, and apical spot is very faint.

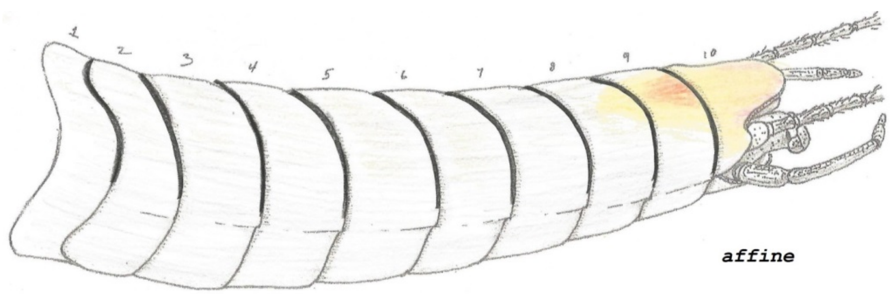
Forewing; because Traver synonymized *affine* to *heterotarsale* in 1935 as per Dr Needham, and her notes showing a very close resemblance, we are using a *heterotarsale* forewing here. This is a female forewing so there are more crossveins than in a male. We can also surmise that like as in most in the genus, and like *heterotarsale,* that the stigma stain in the apex of the forewing wraps over the apex, (we suspect a very pale stigma stain much lighter than *heterotarsale*).





Hindwing; again using *heterotarsale* the hindwing is likely very pale yellow in the basal area, and apical margin with very fine faint brownish shading.

Abdomen; semi-hyaline or yellow-cream throughout with narrowly purplish-black transverse banding on tergites 1-9 (that would stop short of the spiracles) with no spiracular spots, posterior of 8th tergite narrowly tinged in yellow, 9th – 10th pale yellow (likely having a faint slight brownish-red stain) at the posterior area of tergite 9.



Tails; whitish at the basal area turning very faintly smoky without articulations.
Genitals; Traver 1933 "differ but just slightly from coastal plain species" meaning *heterotarsale*: Based on her comment we suspect this is the difference; samples likely lacked sublateral basal spines from about 4-6 as in *heterotarsale* to about 1-4, the general shape would still be blocky like in shape, and the terminal spines likely pointed to the median posterial lobe, more than to the middle like *heterotarsale*. What we just explained is very common in Stenacron. Like changes to mouthparts, environmental shifts do take place, and my statement is based on *affine* actually being a true geological variant, which we doubt. It also seems that the higher the altitude the

fewer the lateral spines *carolina* has almost none only 4 minute spines.

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areion

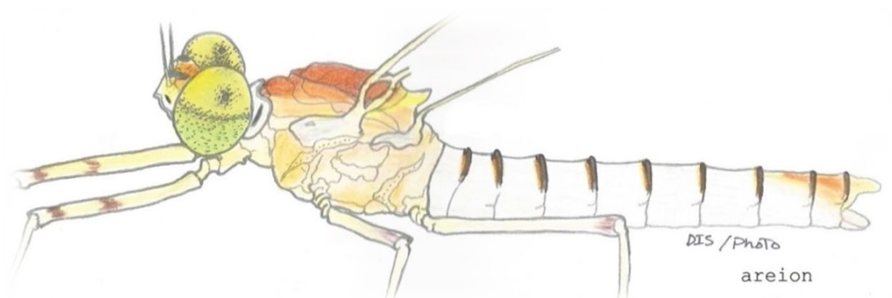
Burks 1953

Synonymized to *interpunctatum* 1974

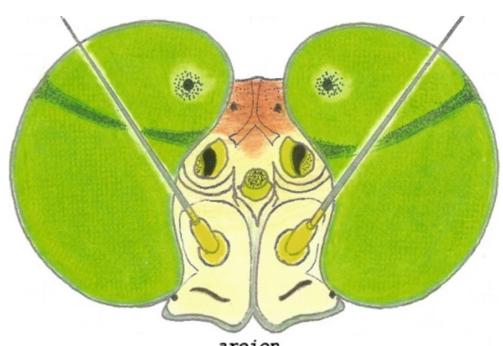
Original description modified

Notes; the greatest confusion was Burks stating “Bright” mars orange on the crossbands of the tergites. If he had of said mars orange his species concept would have made more sense. Both *majus*, and *conjunctum* can have orangey-brown transverse bands in their lightest variations. If Spieth 1947 had not synonymized *majus* to *interpunctatum*, Lewis would likely have picked the pale *majus* form, over the hybrid theory.

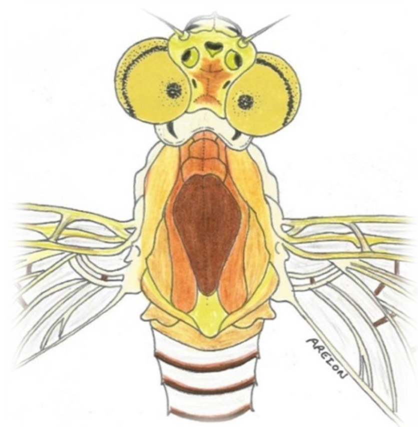
body size; 7 ♂ mm, 8-9 ♀ mm
Forewing size; 8 ♂ mm, 10 ♀ mm
Tails; 18 ♂ mm



Head; Face below antennal sockets light yellow, a small black mark on margin of frontal shelf below each antenna base, each antenna pedicel yellow, flagellum slightly grayed near base, area of face between antennal sockets and lateral ocelli deep yellow, vertex Mars orange. Burks does not state black ringed ocelli.

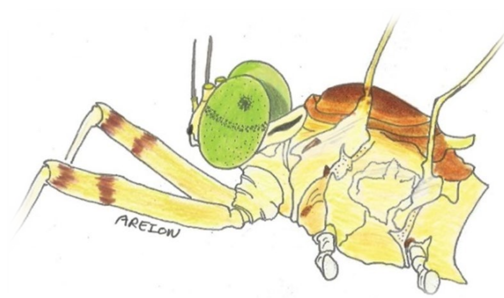


Pronotum; pale yellow, black streak on either side, mesonotum amber-brown, with red-brown shading at posterior ends of outer parapsides and on lateral margins anterior to forewing bases.

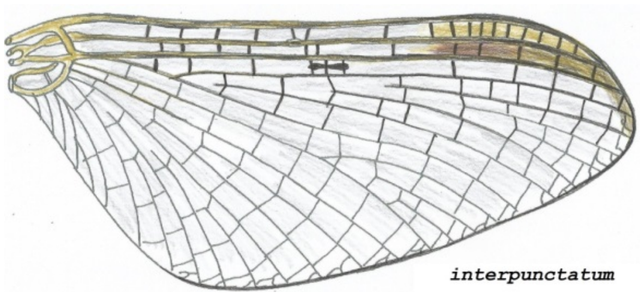


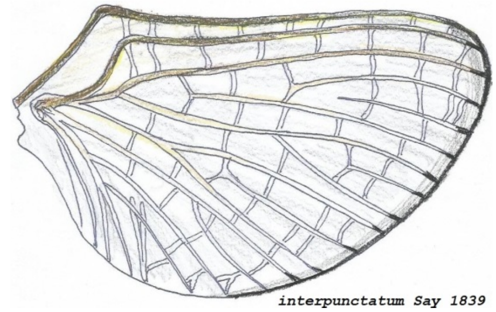
Mesoscutellum; yellow in the center, Mars orange at margins. Mars orange shading also present on lateral margins of mesonotum posterior to forewing bases.

Pleura; bright yellow, minute dark brown point on each middle and hind coxa suture, thorax sternum bright yellow.



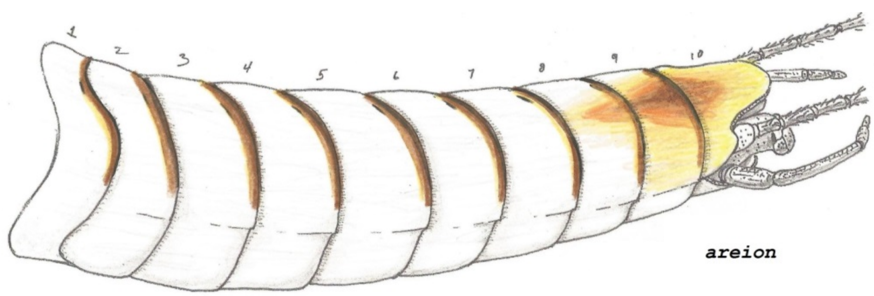
Forewings; hyaline, (It is very likely that Burks samples had the same forewings of *interpunctatum*). Stigmatic areas stained with brown, veins light yellow-brown, crossveins black, two crossveins below bulla connected by black dash, veins and crossveins of each hindwing pale yellow, but crossveins and intercalaries at outer margin black.





Legs; deep yellow, median and apical dark brown crossbands present, tibia pale yellow, apex black, tarsus white, apexes of segments slightly darkened, first segment 55% as long as second segment, middle and hind legs white, each femur with a faint, dark brown shading in middle and a well-marked, brown band at apex.

Abdomen; white, posterior margin of each tergite 1-7 with Mars orange crossbands, spiracular dots absent, apical three tergites yellow-orange, with overlying Mars orange shading.



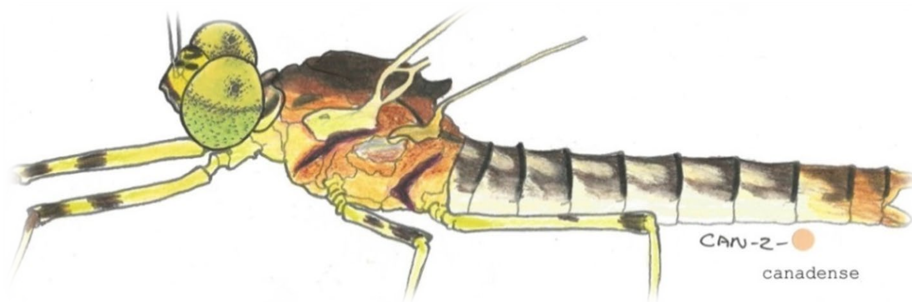
Tails; white, articulations not darkened.

canadense

Walker 1853

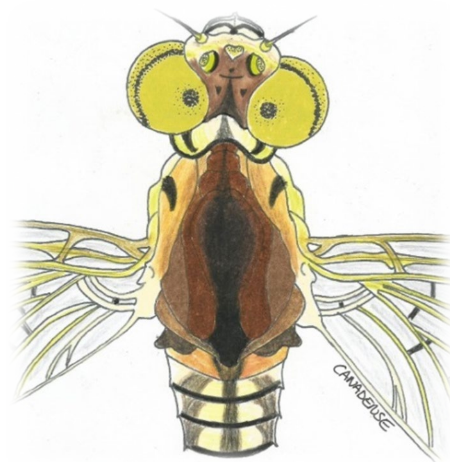
Notes; This description is based on many historical descriptions and records. But, more so on reared samples from southern Ontario that key out to this form in the larva exuvia and the adults of male and females. Important notes; Spieth 1947 included *ohioense* in his new description for *canadense* which caused great taxonomic confusion in understanding *canadense*, in its true to form state. See taxonomic confusion for a clear understanding between *canadense* and *ohioense*.

Body size; 8-9 ♂ mm, 13 ♀ mm
forewing size; 9 ♂ mm. 14 ♀ mm
Tails; 22-24 ♂ mm



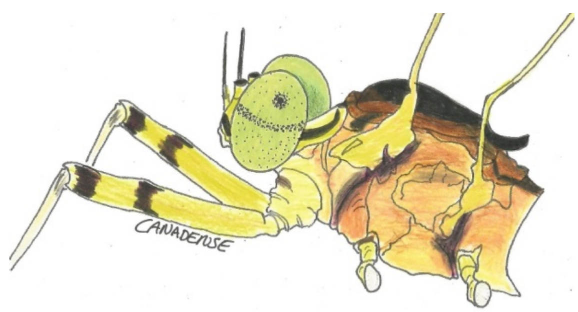
Head; yellowish-hyaline on the clypeus, dark brownish-black on the vertex. Frontal shelf slightly hyaline with median crania spot large streaks under antenna bases extending to median spot, larger spots near corners of compound eyes but not connected. All these markings make the general appearance of a transverse band across the face. In some of the darkest females these spots can connect forming a complete smile. Vertex dark chocolate brown some samples having very small black spots near the compound eyes blackish at the posterior margin. Our Ontario samples have black ringed ocelli.

Pronotum; brownish-black in the median area with hyaline yellow lateral edges, median stripe present with large lateral pronotum spots connected to posterior margin and often adjoining the median stripe.



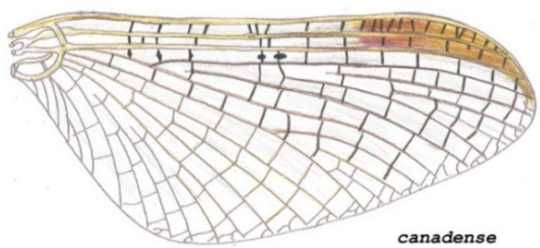
Mesonotum; deep brown with triangle dark reddish-purple spots anterior and lateral to the base of forewings, germinate median line from anterior area to middle mesonotum region, scutellum can be narrowly tipped with pale yellow but generally black.

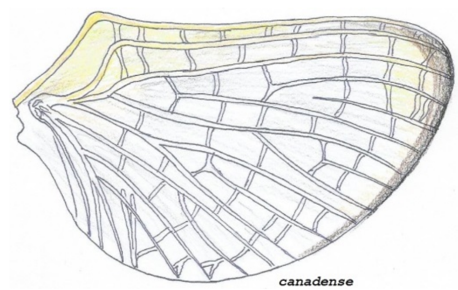
Pleura; yellowish-golden background coloring with structural areas darker reddish-brown, oblique and prominent purplish-brown pleural streaks extending from wing roots to the sternum, forecoxa with two brown spots per coxa.



Forelegs; fore femora deep greenish-yellow with prominent brownish-purple apical and median bands on all femora, fore tibia yellowish-brown with blackish-brown shading at the apex, fore tarsi smoky yellow-whitish with the first segment being about 40% of the length of the second. Mid and rear legs much like forelegs but paler.

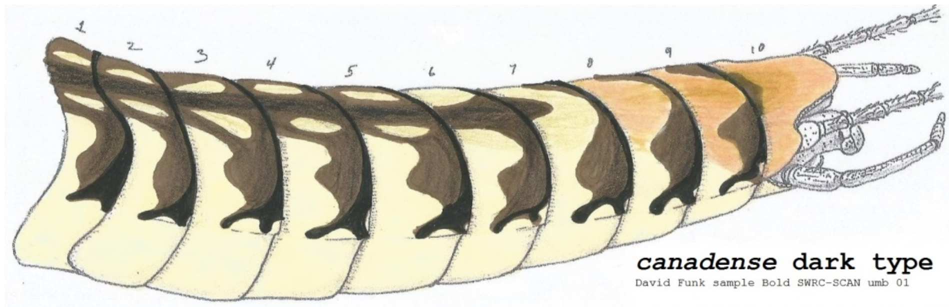
Forewings; costal vein yellowish-gray, subcostal and R1&R2 veins yellow in basil area turning brownish in apical area. Stigma stain reddish-brown turning smoky-yellowish in the apex region with stain extending over the apex of the wing. Crossveins dark brown blackish in coastal areas, typically in the costa and subcosta interspaces there are 4-6 aslant crossveins below the bulla and 12-17 above the bulla. In the subcosta and R1 interspaces there are normally 3-6 crossveins below the bulla and 8-12 from the bulla to the apex. In the R1&R2 interspaces there are typically 2-3 crossveins that are commonly connected by a black dash in the bulla area.

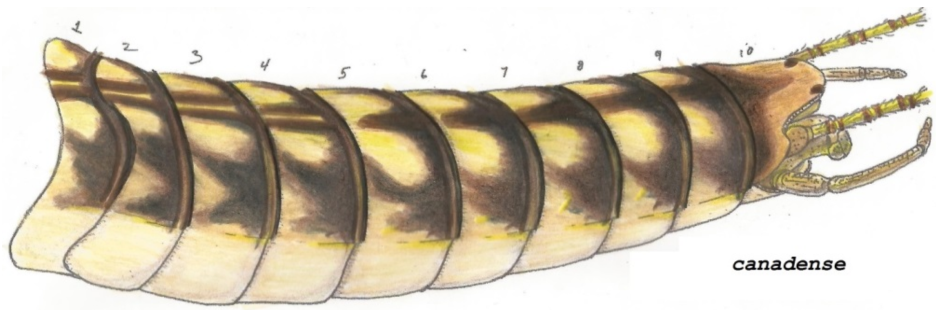


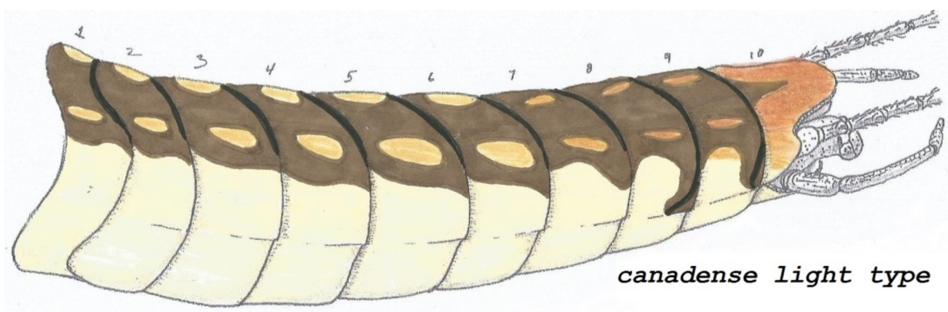


Hindwing; longitudinal veins in the basil area often yellow turning hyaline in the apical area with the posterior edge being dusky brown black terminal edge.

Abdomen; important note; *canadense* true to form does not have spiracular spots but often has dark lateral markings that can appear to be spots infused with the transverse bands. If your sample looks like *canadense* but has spots see the *ohioense* description. Background coloring most often yellow-hyaline-whitish, strong piceous coloring on all tergites occupying the median and sublateral areas infused with wide transverse banding. Median longitudinal stripe on all tergites with submedial pale areas that form discontinuous stripes, wide pronounced transverse bands on tergites 1-9 with an incomplete paler band on the 10^{th}. Background coloring of 8-10 orange-rusty-clay terminating in yellowish-orange coloring on the 10th.







Tails; whitish-yellow turning smoky at the apical ends, with pale reddish-brown articulations.

Genitals; pale brown yellow similar to *interpunctatum* (Say) and not like *frontale*, many samples having two sets of meson spines with apical spines. Lateral spine cluster often like *frontale* with more than 6 spines combined as one cluster, basil spines are smaller more spread out but still as a group. In the basil cluster there is often 1 spine coming around to the dorsal side.

Candidum

Traver 1935

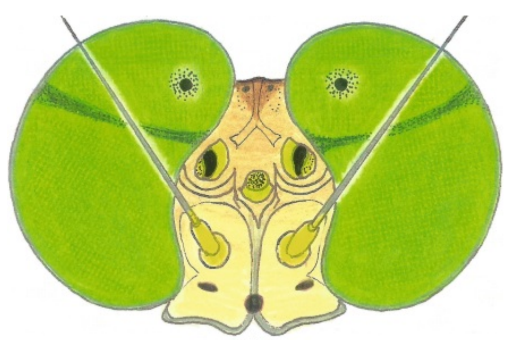
Notes; Based on Traver 1935, Burks 1953, Lewis 1974 and many reared and collected samples from southern Ontario.

Body size; 7.5 ♂ mm, 9.5 ♀ mm

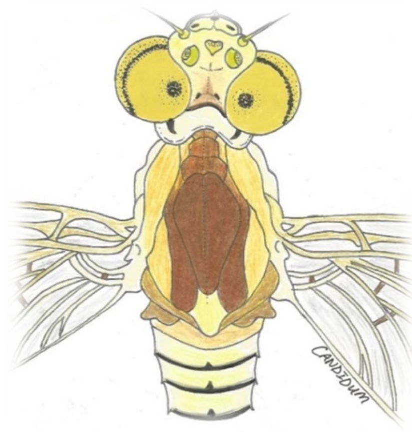
Forewing size; 8.5 ♂ mm, 10 ♀ mm

Tails; 18-22 ♂ mm

Head; yellow-orangey-brown, yellow on the frontal margin, dark spot on the median crania, **elliptical black spots** below each antenna base, small black spots in the corner of each compound eye, slight orangey shading in the ocelli area, ocelli not black ringed as in *interpunctatum* Say. Vertex largely yellow-brown with a brownish triangle in the median area, with black spots on either side of the triangle, posterior edge darkened.

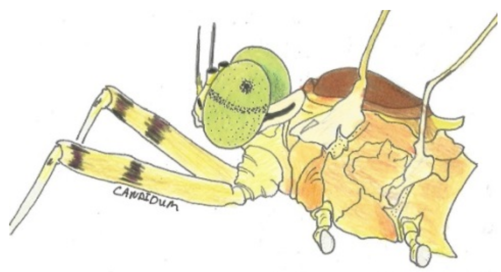


Pronotum; creamy-yellowish with oblique black spots in the lateral area, no median markings, no lateral shading, posterior may have slight grayish shading.



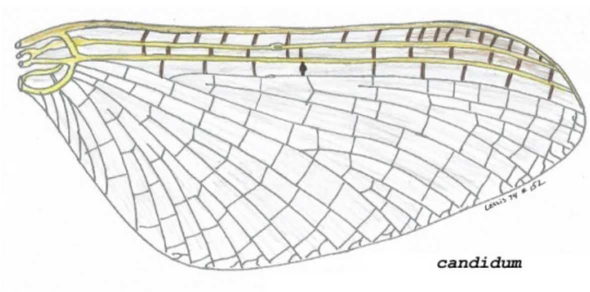
Notum; brownish-amber colored in the posterial central area, slight reddish-tan shading in the median area, with surrounding areas being pale tawny-yellow, scutellum bright yellow with tannish areas surroundings in the metanotum.

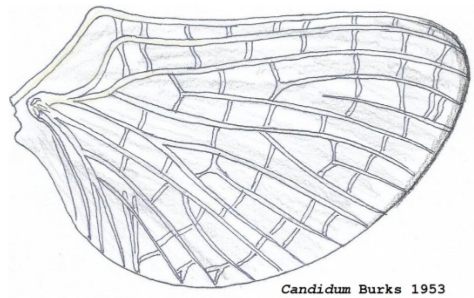
Pleura; principally yellow-tawny without any markings other than faint gray stain above rear coxa, slightly orangey just in front the middle and hind legs. No pleura streaks, bright yellow fore-coxa, sternum yellow.



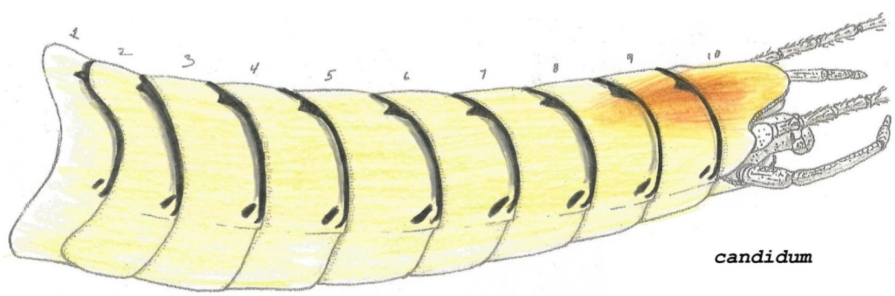
Legs; fore femora deep bright yellow with apical and median bands that are prominent, fore tarsal ratio 45-50% the length of the second section. Middle leg pale yellowish with apical and median bands lacking the hyaline of other pale species. Rear femora pale yellow slight hyaline strong apical band, one slight dark dash as a median band on dorsal side only.

Forewing; *candidum* is noted as typically only having 1 small back spot in the R_1&R_2 interspaces see Lewis 1974 figure (152) and sample below, when diagnosing all Stenacron it is most advisable to utilize the right wing. All Stenacron we observed have a deletion of pigment in the R_1&R_2 interspaces of the left wing. So *candidum* samples may have no pigment in the left wing. The stigma stain does not go over the apex of the forewing.





Abdomen; background color yellowish-white, creamy on the ventral side, transverse black tergite bandings on 2-9 having a slightly metallic silvery sheen on the front of the bands. In the medial area of each band there is an enlargement commonly in the shape of a point facing forward. Prominent spiracular spot that can be elongated and slightly aslant, 8-10 slight orangey-reddish coloring.



Tails; entirely white

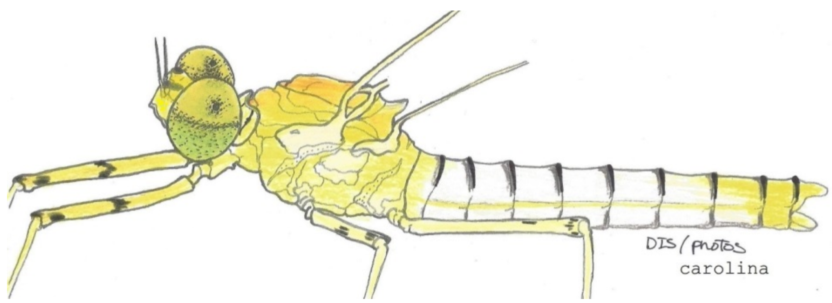
Genitals; boot shaped with 2-4 apical spines, no terminal spines but 4-6 minute spines on lateral lobe, with 4-6 lateral minute spines.

carolina

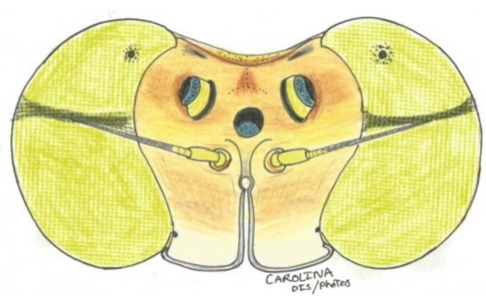
Banks 1914

Notes; Defining features compound eyes very wide spread 1.5 X compound eye size only form in genus with this feature, orange amber stigma stain over wing apex, terga banding wrapping around the sternum as gray shading, bright yellow overall, smoky gray tails.

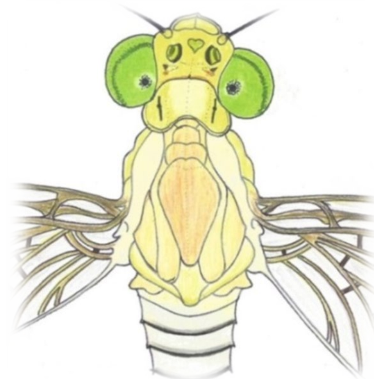
Body size; 10 ♂ mm, 12 ♀ mm.
Forewing size; 10.5-11.5 ♂ mm, 12.5 ♀ **mm.**
Tails; variable 24-30 ♂ mm



Head; Deep bright ocher yellowish, no black dash below antenna bases, small black spots at the corner of the compound eyes, slight reddish-brown shading below and at the ocelli area. Ocelli black ringed as in *interpunctatum* Say, cranium suture shading reddish-brown, fine gray spots on vertex, posterior edge slightly dusky hyaline.



Pronotum; in some samples the pronotum maybe be whitish in the median area otherwise yellow throughout, with very fine black sublateral streaks.



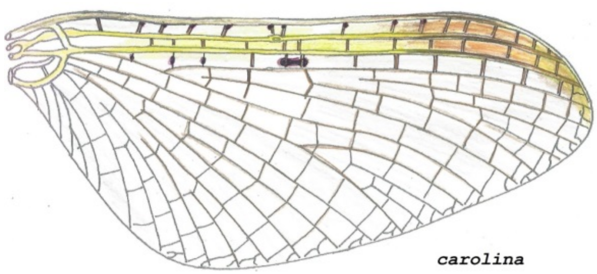
Mesonotum; mango-orange-ocher without any markings, surrounding areas pale-yellowish-creamy, scutellum pale yellow somewhat bright. Notum of samples from darker substrates can be brownish in the notum but much lighter that *interpunctatum* Say.

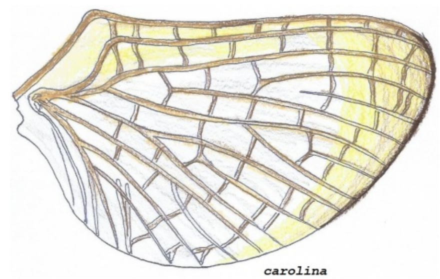
Pleura; bright ocher yellowish with large pale cream colored areas at the root of both wings, these areas connecting to each other in the median pleura region behind forward spiracle.

Legs; all femora yellowish with fore femora being darker that the others. Apical and median bands present on all femora, median band faded out on rear femora. Fore tarsal ratio, first segment about 55-60% the size of the second segment so longer.

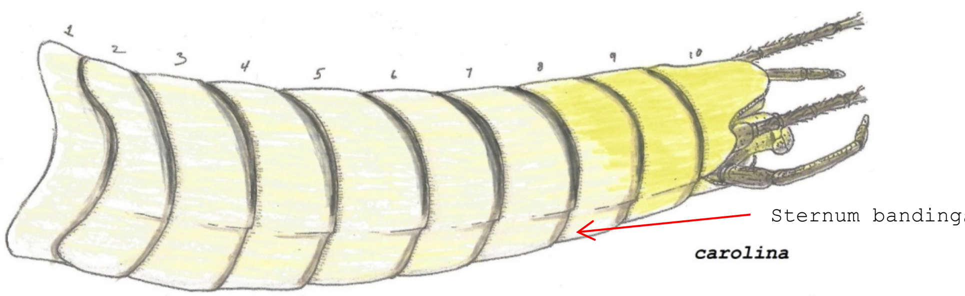
Forewing; NOTE; *often a creamy-yellow tinge in the costa-subcosta interspaces near the bulla region*. Costa longitudinal vein yellow smoky gray, subcosta and R_1 veins bright yellow, all others yellowish-gray-brown, in the interspaces between the costa and subcosta veins there are 5-6 aslant crossveins below the bulla, 2-3 in the bulla, 8-14 beyond to the wing tip. Most samples in the R_1&R_2 interspaces in the bulla area have 2 crossveins connected by black dash.

Rare samples may not have a dash and only 1 cross vein. Stigma stain orangey yellow turning gray-yellow and going over the apex of the wing, some samples have a greenish tinge to the stain. Hindwing; similar to forewing with yellow then black shading on the posterior edge.





Abdomen; NOTE; *posterior edges of tergites are blackish grayish and wrap around the sternum as sternum bandings.* Ground coloring hyaline-creamy with moderate transverse black terga banding from 1-9, 10th void of markings. These bands wrap around the abdomen as gray shading. Lateral edges may be yellowish-gray in some samples in the spiracular area. No spiracular spots, 8-10 bright yellowish.



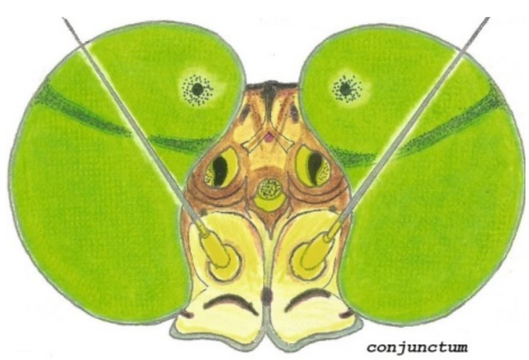
Tails; in some samples from dark substrates can have very long and dark gray tails, others are hyaline smoky with dark gray articulations.

conjunctum
Traver 1935

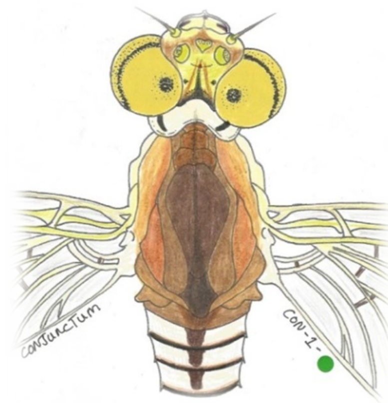
Notes; this description is based on Traver (1935) and many reared and keyed samples from our collection in southern Ontario. There are two geological variations of this form, the most common one being mostly hyaline white in the abdomen, the second one yellowish like *heterotarsale*.

Body; 8 ♂ mm, 10 ♀ mm.
Forewings; 9 ♂ mm, 11 ♀ mm.
Tails; 18-24 ♂ mm.

Head; yellow, black spot median crania region, black dash below antenna rather long but not connected to either the midcrania spot or spots in the corner of compound eyes, hyaline frontal shelf, small black spot corner of the compound eyes, brownish-red shading around ocelli, and not black ringed as in *interpunctatum* (Say). Reddish-brown dark shading rear margin of vertex, two very fine black spots behind lateral ocelli and one small red-brown spot at the palmen body, often two submedial longitudinal pale yellowish streaks on either side in between the black spots.

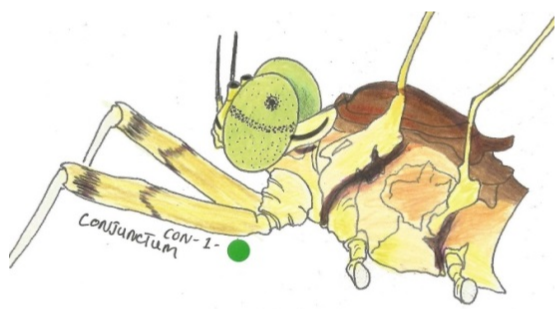


Pronotum; pale white-hyaline-yellow, oblique black streaks in sublateral areas with very faint median blackish spot.



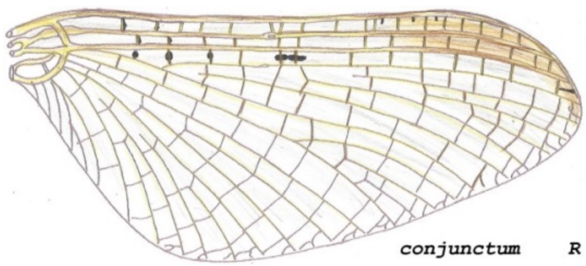
Mesonotum; dark brown in median area, geminate medial stripe paler in the median area of the thoracic notum, lateral areas paler yellow-orange, scutellum brownish with paler tawny areas anterior-lateral to it very pale samples may have slight yellow tinge to scutellum.

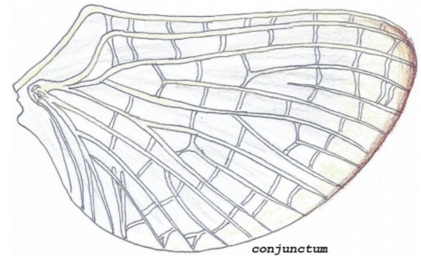
Pleura; ocher yellowish with hyaline areas at the base of both wings, oblique purplish-brown pleura streaks, sometimes with brown spot on middle coxa, with pale yellow forecoxa.



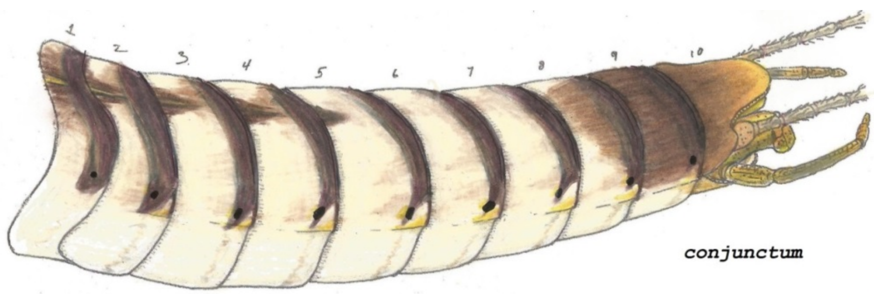
Foreleg; femora ocher yellowish-green with median and apical purplish-brown bands. Fore tibia paler in color blackish at apex, fore tarsi approximately 40% on average the length of the second. Middle and hind leg; like foreleg put much paler overall hind leg having a fainter median band.

Forewing; costal and subcostal longitudinal veins yellow-brown, all crossveins brownish-black, typically 2 crossveins in the bulla area that have blackish pigment connecting them, 7-10 crossveins from bulla stain to wing tip in the R_1&R_2 space. Stigma stain moderately pale reddish-brown-yellow wrapping over the apex of the wing and most often having 1 intercalary spots at the tip between the R_1&R_2. Hindwing; dusky brown shaded posterior margin.





Abdomen; terga 1-8 semi-hyaline white, some samples can be almost yellowish in their ground coloring, tergites posterior margins brown, slight black transverse bands. (Important notes) germinate median line starting at the anterior median area of tergites 1-4 or 1-5, these lines often not touching the posterior edge of the terga. Some samples having pale anterior sublateral gray shading on 1-4 as in *proximum*. 8-10 opaque dark red, brownish over rusty-orange with the (terminal end of the 10th yellowish). Spiracular dots small defused hard to define not like *frontale*, and very faint on tergites 3-7, slight gray-brown sublateral shading infusing the dots but not connected. Medial and lateral faint grayish-brown shading on tergites 4-7.



Tails; Whitish-hyaline with brownish-red articulations.

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floridense

Lewis 1974

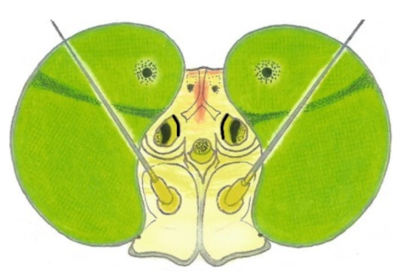
Original description Lewis 1974

Notes: as with all forms and species in the genus reported range is questionable since being able to tell the difference on site can be difficult with many forms. In this book we are showing in the photos plates one larva and one adult female that align with this species from Tennessee near the Kentucky boarder. Reading both Lewis 1974 A,B, descriptions which appear to be the same description, it is clear that size is a issue. He has larva size 8-10 mm, and male imago 7-9 mm? We can rule out confusion with *interpunctatum* as *floridense* has 1-4 curved stout dorsal axial spines and no others in the genus have axial spines. We can rule out larva confusion

as *floridense* tergite maculation is very distinct. The base line would likely be 8 mm for the male, 10 mm for the female. It is unfortunate that the samples at Bold Systems Museum larva photographed by Jeff Webb can't be used to clear this up. They are only in and around the 15-18 instars and are not full grown. From our studies and Ide 1935 Stenacron larva reach full body length at the 22nd instars when the wingpad reaches the posterior edge of the 2nd tergite, then the wingpad rapidly grows till it almost reach's the posterior edge of the 4th tergite by the 24th instars. We have also consulted The Mayflies of Florida and size is not covered.

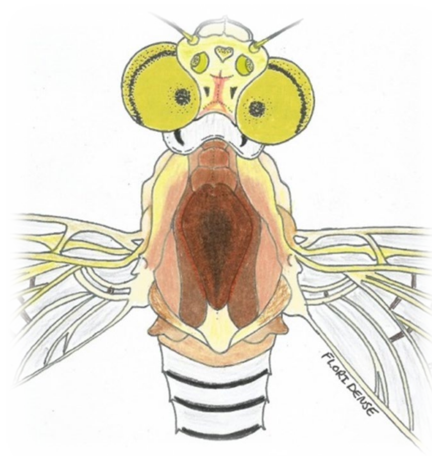
Body size; 8 mm ♂, 10 mm ♀
Forewing; 9 mm ♂, 11-12♀
Tails; 15-22 mm

Head; clypeus pale yellow (likely having slight hyaline in the median area), some samples pale grayish stains on the clypeus but not like others; (not having dash's below antenna bases or black spot at median crania), deeper yellow with a cast of green from ocelli to posterior areas, ocelli black ringed as in *interpunctatum* Say, vertex reddish-brown median stain, (vertex stains are elongated in this genus unless it is a palmen body spot), black or gray spots on either side of the cranium suture slight brownish black shading at the posterior margin.



Pronotum; ligth yellow (likely hyaline in median area) with a black streaks in the lateral areas.

Mesonotum; light yellow brown, scutellum and surronding whiteish, (slight darkening lateral to scutellum common to the genus) yellow-tan laterally.

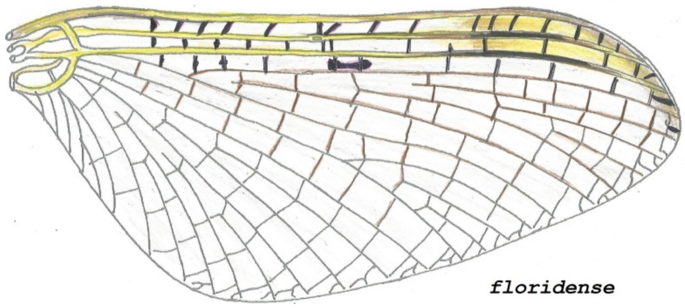


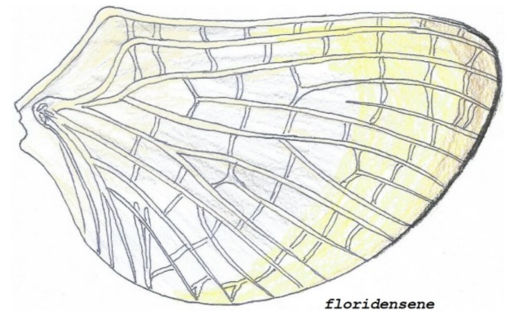
Pleura; pale yellow with slight amber area in front of middle leg forewing roots (likely pale hyaline).

Forelegs; greenish-yellow with median and apical brown-black bands, fore tarsal ratio is 2.0-2.4; or the first segment being 40-45% the length of the second, middle and hind legs pale whitish both with apical bands, the middle leg has a median spot the rear femora median spot is absent.

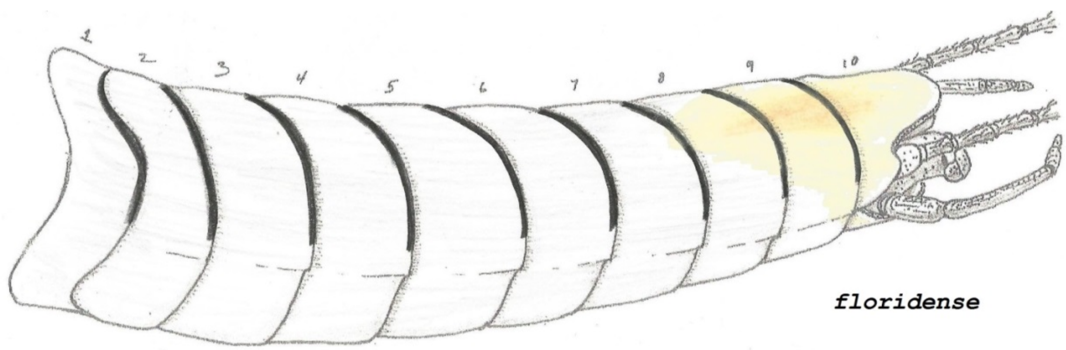
Forewings; forewing information is sparse, (based on the high possibility of new sightings in TN we will use illustrated wings from that sample as they would likely accurately reflect this

species). Lewis states black dash present with 2 or 3 crossveins in the bulla, stigma stain likely going over apex as most do in the genus. Hindwings with darkened apical margin.



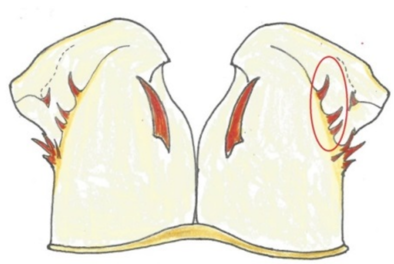


Abdomen; hyaline with faint black posterior margins that end above the spiracles, no spiracular spots, dorsal area of tergites 8-10 alabaster white, (likely a fine touch of very pale yellow).



Tails; light gray throughout without articulations.

Genitals; very distinct from the entire genus; having large later spines, 2-4 stout dorsal axial spines, (no others in the genus has axial spines), with terminal spines, apical spine may be present but often without.



frontale

Banks 1910

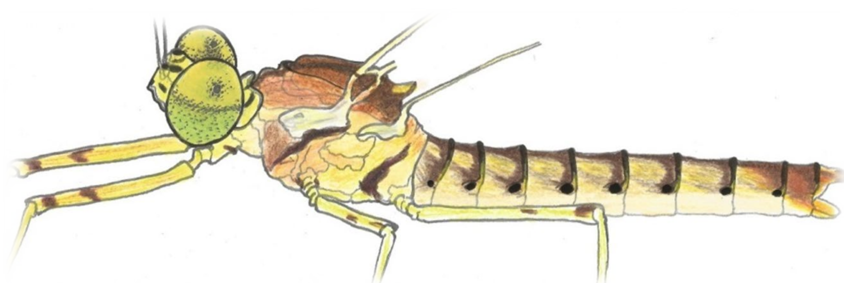
Synonymized to interpunctatum 1947

Notes; this is based on Banks 1910, Traver 1935, Burks 1953, and reared samples from southern Ontario that match this historic profile. There are currently two geological types a dark type and a light type. The dark type more aligns with the historical profile so this description is a historical composition of the dark type.

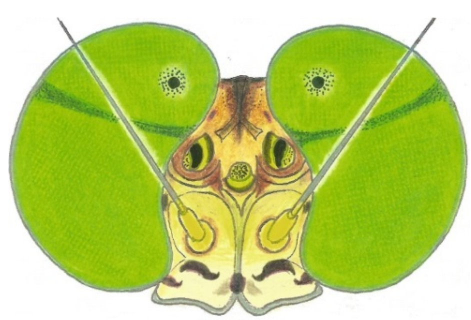
Body size; 9 ♂ mm, 11 ♀ mm

Forewing; 10 ♂ mm, 13 ♀ mm

Tails; 22-26 mm ♂

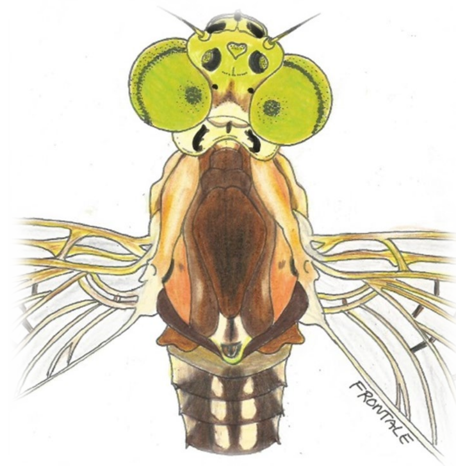


Head; very pale hyaline yellow at the frontal margin darkening at celli, median crania spot and shading, black dashes below antenna bases, with moderate spots at the corners of the compound eyes, very dark samples may have an almost complete line from compound eye to compound eye. Slight orange-brown shading around the base of antenna scape, ocelli black ringed, with deep brownish red around the ocelli, vertex principally yellow brown two small black-brown spots posterior margin often blackish.



frontale

Pronotum; hyaline-yellow often with a median spot and having lateral black streak like stains.

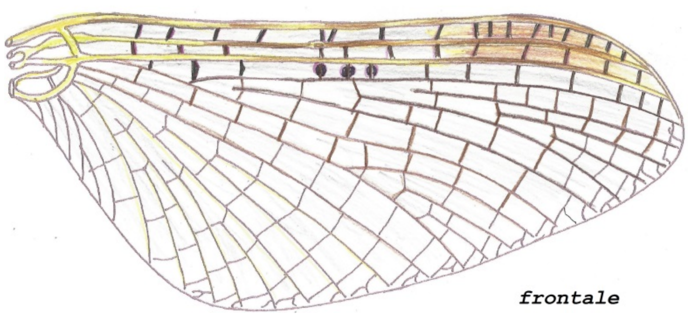


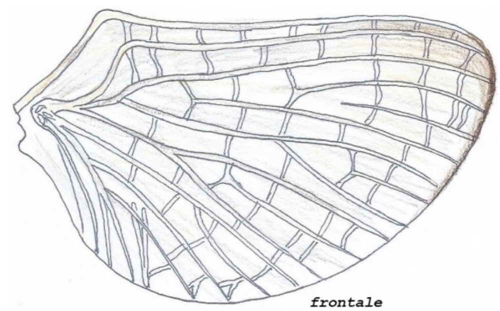
Notum; dark brown with tawny-yellow lateral areas with orange casts, scutellum brownish most often tipped with yellow, lateral scutellum dark brown, post scutellum tannish lateral areas can be shaded in gray no median notum stripe orangey-yellow lateral areas.

Pleura; forward area and coxa brighter yellow-brown, wing roots hyaline-yellow, median coxa to rear area brownish-yellow, with pronounced pleura streaks that are normal more brownish then blackish, Brown stain at mid-coxa root, hyaline area between the wing roots.

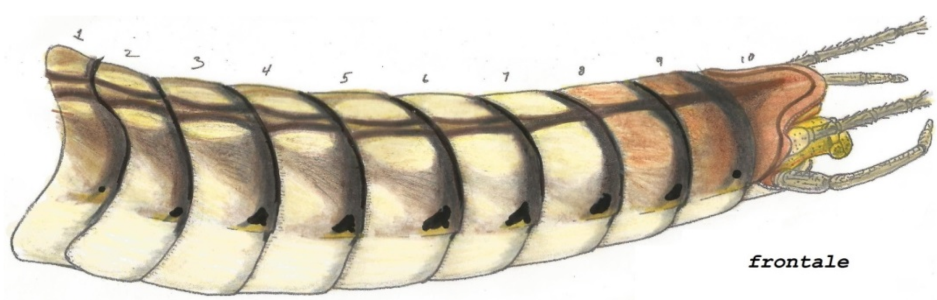
Legs; Fore femora ruddy yellow-brown-gray with median and apical bands that are fainter than most forms in the genus, fore tarsal ratio is the first segment is 50-55% the size of the second, so just slightly larger. Median and hind legs yellow-hyaline-gray with median and apical bands.

Forewings; costal, subcostal, R_1 veins yellow basil turning brownish in the bulla area, generally 4 or less aslant black crossveins in the costal-subcostal interspaces below the bulla, 2 at the bulla, 9-12 beyond, in the R_1&R_2 interspaces below the bulla there are normally 3 crossveins typical samples will have a black dash some only 3 spots as seen in illustration. Stigma stain fairly prominent reddish-brown and not going over the apex key to form. Hindwing if there is any yellow basely it will be very faint, slight yellow brown, with the posterior margin narrowly brown.





Abdomen; creamy-yellow background most samples have a median stripe on all tergites, typical samples have a double median line on tergites 1-6 but not always, Variable sized submedial pale spots often very small from the 1-5, then continuously getting larger till the 9th. Typical samples have moderately prominent sublateral shading that connects to the transverse bands, more prominent it segments 1-5 brown-black transverse bands on all tergites, moderately prominent spiracular spots, 8-10th dorsally ruddy-clay-red.

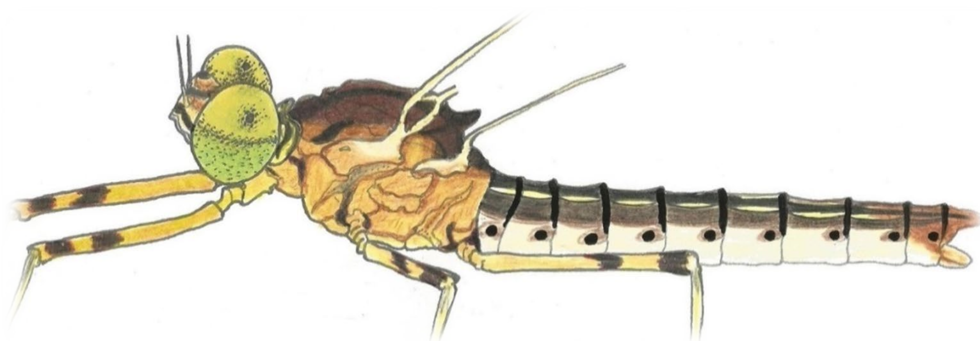


Tails; pale white-yellowish with articulations

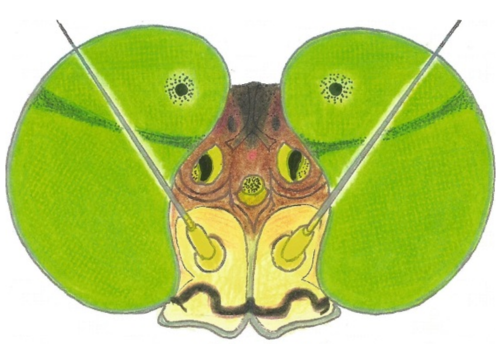
gildersleevei
Traver 1935

Notes; based on Travers original description with male and female samples from Bronte creek southern Ontario.

Body size; 10-11 ♂ mm, 13-14 ♀ mm
Forewing length; 10.5-11 ♂ mm, 14 ♀ mm
Tails; 24-28 ♂ mm

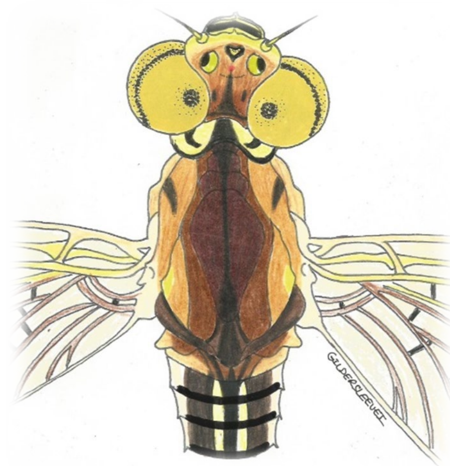


Head; (Very rare sample may have incomplete transverse line across clypeus Traver 1935), clypeus pale yellow slight greenish tinge transverse line from compound eye to compound eye often looking like a complete smile, turning brownish in ocelli area, ocelli not black ringed, vertex principle brownish-red with a small red spot at the palmen body at cranium suture, larger median blackish triangle stain pointing forward, with small black spots on either side.



gildersleevei

Pronotum; largely yellow with distinct black median triangle line pointing forward, with prominent black lateral streaks that commonly connect to the posterior edge, the lateral and median terminal edge blackish.

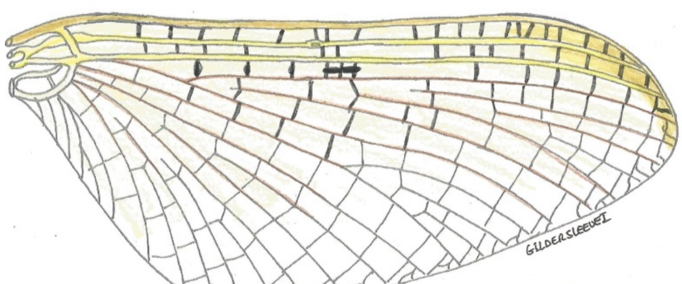


Notum; median notum area very dark brown slightly lighter lateral areas, black median stripe from pronotum to tip of scutellum, lateral areas of scutellum very dark if not black, post-scutellum distinct median triangle outline with pale lateral areas, forward of forewing roots, blackish triangle stain like *canadense*, with orangey-yellow background.

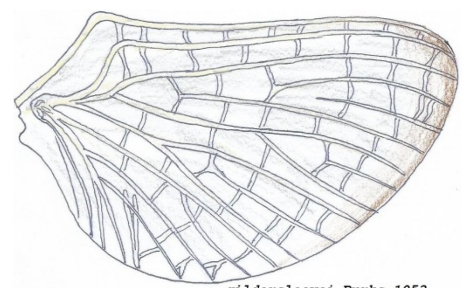
Pleura; prominently yellow with an overcast of reddish-brown staining, fore coxa brighter yellow, above fore coxa on [pronotum-pleura] dark blackish streak, fore coxa may have small dark spot, black spots on either side of the middle and hind coxa, on in front of middle leg often extending to breathing spiracle, rarely but can have black spot at the top of the rear wing root, wing roots hyaline-yellow.

Legs; fore femora deep yellow with orangey-brown cast, with median and apical band very dark and prominent, tarsi tinged with smoke stain fore tarsi ratio first segment 45% the length of the second, middle and hind legs yellow-hyaline, with median and apical bands often median band on hind femora paler.

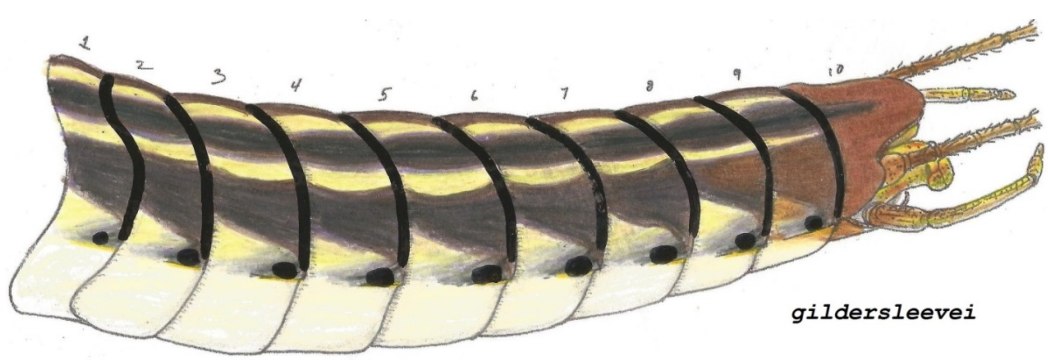
Forewings; (some sample may have milky tinge in the costal and subcostal interspaces from the bulla area to the tip) Costal, subcostal, and R1 bright yellow with a touch of brown, in the costal-subcostal interspace normally 4-6 crossveins from costal brace to bulla, 2-3 in the bulla, 12-15 beyond, Stigma stain brighter yellow slightly ruddy and going over the apex of the wing, R_1&R_2 interspaces at the bulla 3 crossveins connected by customary black dash, other crossveins brownish black. Hindwings very pale yellow at the base hyaline throughout with slight brown stain at the apex and posterior areas.



gildersleevei


gildersleevei Burks 1953

Abdomen; background coloring can vary from yellow to creamy whitish, typical samples are yellowish dorsally and whitish ventrally, strong wide predominant median line from 1-9, reduced to germinant medial stripe on the 10^{th}, all tergites but 10^{th} long thin pale submedial spots almost forming a discontinuous submedial stripe on either side of median line, very dark sublateral shading nearly forming a lateral stripe with strong spiracular spots often encapsulated with this shading, some samples dark gray shading with spiracular spot sometimes making them hard to see, parts of the 8^{th} and 9^{th} tergite ruddy dark red clay coloring, 10^{th} very dark reddish-clay coloring.



gildersleevei

Ventral; (The sample is a female making it orange) Both male and female may have black markings near the posterial boarders, in some cases as seen here forming the shape of a boat anchor, this stains are not typically seen in the larva at any point in development and they are not ganglionic created as far as we can distinguish. This staining is for unknown reasons and does not appear on all samples principally it has more to do with the females.

Tails; yellowish at the bases turning dusky in the middle and apical portions, with light brown articulations.

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heterotarsale

McDunnough 1933

affine synonym 1935

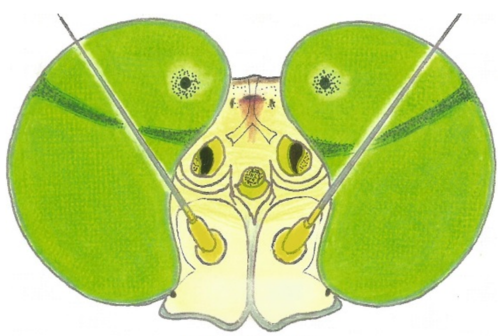
Notes; this description was without the inclusion of *affine*. We believe that Dr Traver felt it was too soon to make this synonym we find her comments indicate this. This is based on McDunnough 1933, reared samples from southern Ontario, and also Traver 1935 for details. Size greatly impacted in the concept as *affine* was 2 mm smaller than true *heterotarsale* from Burks 1953 forward.

Body size; 9 ♂ mm, 11 ♀ mm

Forewing length; 11 ♂ mm, 13 ♀ mm

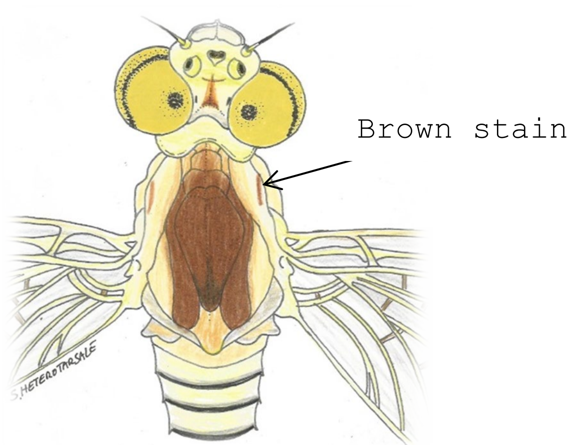
Tails 22-26 ♂ mm

Head; both the lower clypeus area and the posterior margin hyaline slight gray shading posterior edge. Light yellow a little deeper in the ocelli area, brighter on the vertex, clypeus free of all black markings except tiny black dots at the corner of the compound eyes, ocelli not black ringed as in true interpunctatum Say, pale to dark brownish triangle stain pointing forward in the cranium suture area on the vertex, small to moderate blackish-gray spots on either side of this triangle stain.

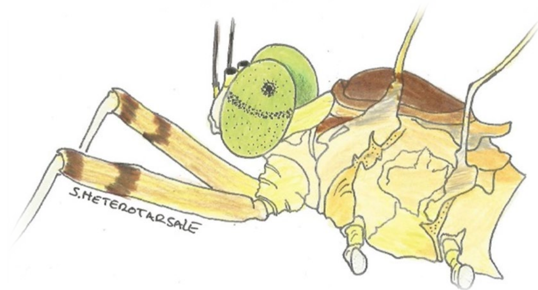


heterotarsale

Pronotum; geological variation can shift pronotum to hyaline, but typical samples are pale yellow without any black marking, we have one female sample with very slight wanting of black lateral marks but in our opinion should not qualify as black markings, may have slight gray shading on posterior edge in median area but rarely.



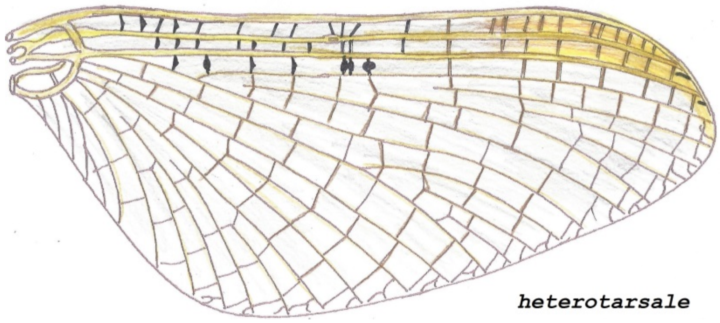
Notum; pale brownish in the median area turning yellow laterally, scutellum yellow-ocher some with a touch of orange, often pale faint gray staining lateral to scutellum, post scutellum slight orangey-tan, in the forward area lateral near forewing roots commonly but not always a brown stripe like stain. This stain often absent on females.

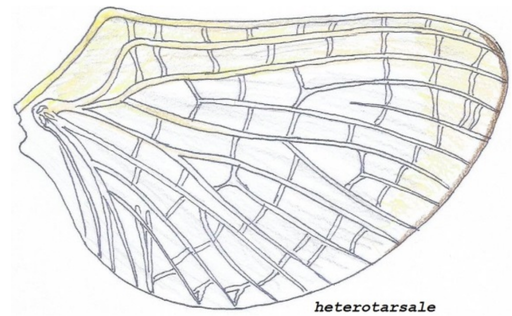


Pleura; free of any markings yellow-ocher can be brighter yellow in some samples, typical to the genus slightly orange-mango coloring right in front of the middle coxa, forewing roots often hyaline-yellow fore coxa brighter yellow.

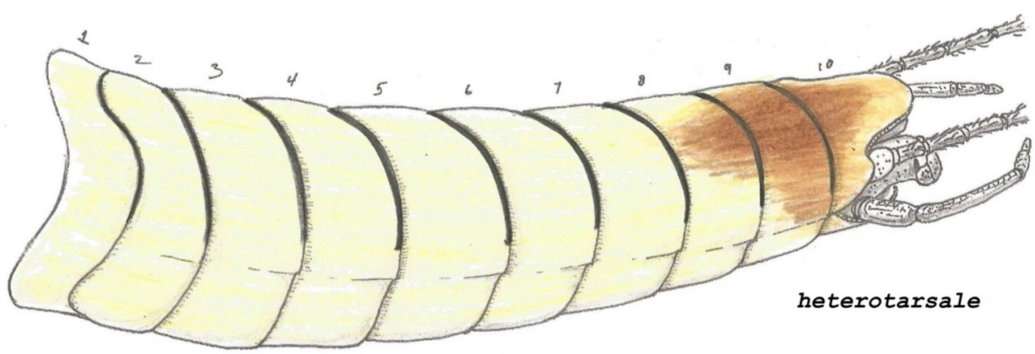
Legs; fore femora deep yellow not too bright with slight cast of brownish hues, median and apical bands brownish-purple fairly prominent, tibia and tarsi hyaline with smoky tipping's, for tarsal ratio the first segment is about 45% the length of the second segment, McDunnough states highly variable. Middle and rear legs hyaline slight yellow with apical and median bands, rear median bands faint may be reduced to fine line on dorsal side.

Forewings; The sample below is a female so there are more crossveins in the forward areas for the wing than in the male, most males having longitudinal veins yellow in the basil area turning brownish in the bulla region and continuing to the apex, in the interspace of the costal vein and the subcostal veins from the costal brace to the bulla area normally less than 6 black margined crossveins, 2 in the bulla area and 8-13 beyond into the stigma area, in the R_1&R_2 interspace at the bulla there are 2 or 3 crossveins black margined but not always connected to for a black dash, left wing may only have 1 crossveins with a larger black spot. Stigma stain ruddy yellow and going over the apex of the wing. Hindwings pale yellow costal and subcostal veins yellow with interspaces being pale yellow, posterior margin pale yellow terminating with a very narrowly brownish edge.





Abdomen; typical samples are pale yellow, but hyaline- creamy-white samples are common, posterior margins of tergites 1-9 with blackish transverse bands often ending short of the spiracle area, no spiracular spots on any samples throughout history, can have mild silvery metallic transverse shading in front of the black bands, 8th on dorsal area slight infusion of ruddy-brown-reddish-clay coloring, this coloring occupying the dorsal areas of tergites 9-10, with the 10th terminating in yellow.



Tails; tails pale being whitish-yellow, males are more hyaline, female are more yellow, all have very fine faint reddish-brown articulations. In some samples tails are smoky very pale gray, in this genus the substrate coloration and geology composition has an enormous impact on color deviation from historical profile.

Genitals; very blocky shaped but similar to interpunctatum Say.

Ture ***interpunctatum*** Say 1839
Thomas Say
Free of synonym forms

Notes; to the memories of the Godfather of American Entomology Thomas Say who died in 1834, this description is based on Say 1839, Walker 1853, LeConte 1858, Hagen 1861, Walsh 1863, Banks 1910, Traver 1935, this also included the reading of all *flaveola* notes and descriptions as it is a true synonym of *interpunctatum* Say. Moreover from reared Ontario samples by us.

Before we start this is a great time to mention somethings. First Stenacron did not start out with the name Stenacron. It started with the genus name Baetis *interpunctata*. The genus name was changed to Heptagenia then Stenonema, and then finally in 1974 the name Stenacron appears. Researching this very old species is highly complex for many reasons. First is wording. In 1853 new words were being used, by the 1880's some of those words were no longer in use. By 1900 we have word changes and about every 5 years new words replaced old words till the 1980's.

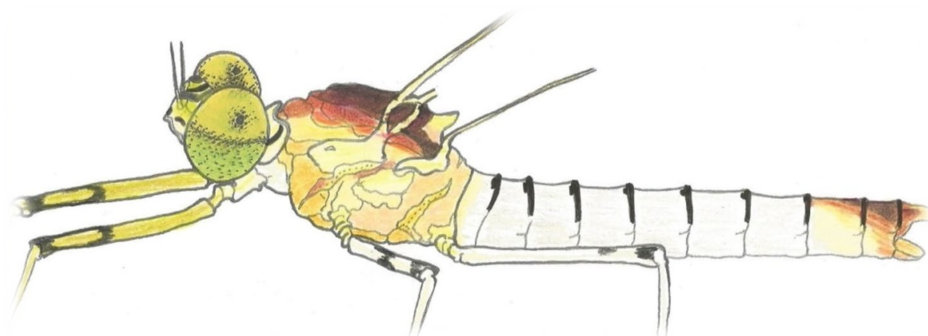
In order to dissect an old description too truly understands what was being said required they usage of my very large 1912 dictionaries nearing 4000 pages. Every word ever written by that time was in these books. Reading Needham 1905 for *interpunctatum* larva is very hard to read and understand. There are some vintage documents that have been mentioned in many text that are currently unavailable like Walsh 1862, some are in foreign languages and we could not make use of them.

We have read every document availably that has any relativity to *interpunctatum* to insure that this description is a modern but accurate to original description. Ture *interpunctatum* is very distinct from every other in the genus. We will put forth the most clarity possible including new insight that clarifies old words and descriptions.

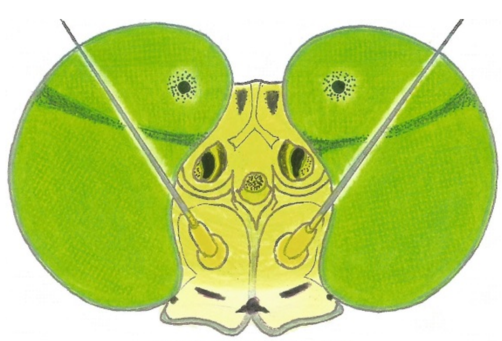
It is my honor and privilege on behalf of Thomas Say to resurrect and put forth clarity to his species concept of Ture *interpunctatum* Say 1839

Body size; 7.5 ♂ mm, 9 ♀ mm Hagen 1861 8 ♂ mm
Fore wing size; 7.5-8.5 ♂ mm, 10 ♀ mm
Tails; 18-26 ♂ mm, Hagen 1861

(very district from all others by very a green head and black antenna all in genus antenna grayish).

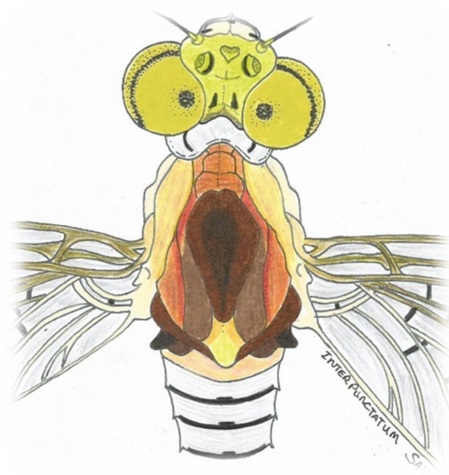


Head; very distinctly greenish throughout, clypeus pale yellow can be almost hyaline at the lower frontal margin, not all but often having a median crania spot, a clear black dash below each antenna base, small black spot corners of the compound eyes, from the lower scape or antenna bases to the posterior of the head rapidly turning bright green, scape bright yellow-green, pedicel bright yellow, flagellum or segmented part of antenna blackish in most samples turning pale then terminating hyaline, all others flagellum is gray, ocelli black ringed at the bases, cranium suture is unmarked, a black spot of variable size on each side of the vertex, uncommon but may have slight gray shading at posterior margin of head.



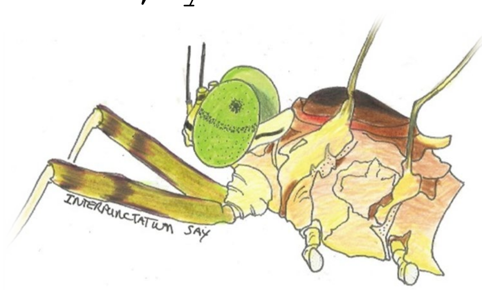
interpunctatum Say

Pronotum; hyaline without any median marking, crisp clear pronotum black lines in the lateral areas.



Notum; variability in notum intensity due to geological pigmentation shifts. Most samples very deep chocolate brown in the absolute center, getting paler as you move both forward and backward as well as laterally, scutellum commonly yellowish-white or just white, post scutellum peachy toned with darker areas laterally, upper terminal lateral areas tawny-yellow overcast with a mango tone, turning more yellow towards the pronotum.

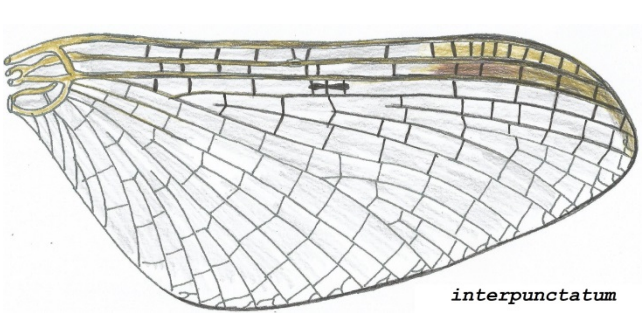
Pleura; yellow with a mango-brownish over tone but not everywhere, forewing roots slight yellow or completely hyaline, slight brown stain at the bottom of forward breathing spiracle, with a mango tone in front of middle coxa, some sample have a brown stain on the rear coxa, yellow sternum.



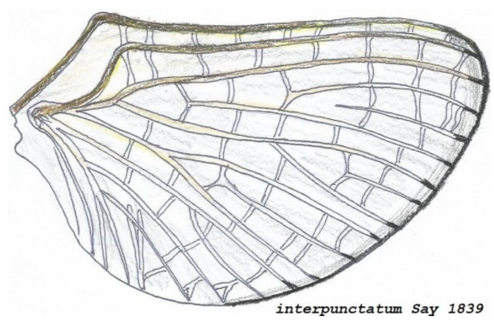
Legs; fore femora very distinct from all others in the genus, strong bright green with a cast of yellow, powerful black distinct apical and median bands, tibia rapidly shifting in tones from deep yellow-green to almost hyaline, tarsi hyaline all joints commonly tipped with smoky tinge, fore tarsal ratio

the first segment is commonly 35-40% the length of the second, middle and hind legs yellow-hyaline with median and apical bands, some rear femora may have fainter median mark as to geological conditions.

Forewings; without a doubt commonly very distinct by blackish coloring. Costal, subcostal, and R_1 veins yellowish at the costal brace rapidly turning a blackish yellow all the way around the posterior of the wing, all crossveins black, stigma stain yellow-black slight cast of green going over the apex of the forewing, interspaces between the costal and subcostal typical samples less than 5 crossveins below the bulla 2 in the bulla, and 9-11 beyond, R_1&R_2 interspaces typically 3 crossveins with strong customary black dash, intercalaries often it the top of right wing. Hindwings; costal and subcostal veins yellow-black without any yellow staining in the membrane, posterior blackish with intercalaries veins black.

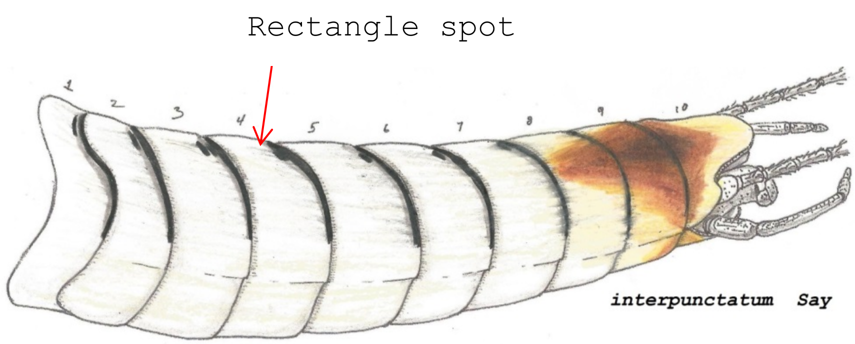


interpunctatum



interpunctatum Say 1839

Abdomen; white-hyaline some samples may have a faint creamy-yellow background coloring, fine black tergite transverse bands stopping short of the spiracle folds, these bands on 1-9 often having a fine gray transverse shading, rarely sample may have a median line in the 9^{th} tergite or on the 1-5 tergites, this is rare in both cases, the lines on 1-5 if present very fines gray not black, median stripe in 9^{th} sometimes arrow shaped pointing forward see Lewis 1974 A Figure 122 for *areion* to see 9^{th} median line, in the median area of each transverse band there is commonly a black █ rectangle shaped spot on tergites 1-7 larger getting smaller as you move back to the 7^{th}, 8^{th} dorsally rusty-orangey-brown some samples may have a cast of red, 9^{th} and 10^{th} very similar with this opaque staining also commonly on the ventral side, the terminal end and lateral sides of 10^{th} pale yellow.



Tails; immaculate according to Say, pale whitish without any form of articulation.

What an honor that was. Thomas Say died in 1834 it was 186 years to bring his species concept back to its original condition.

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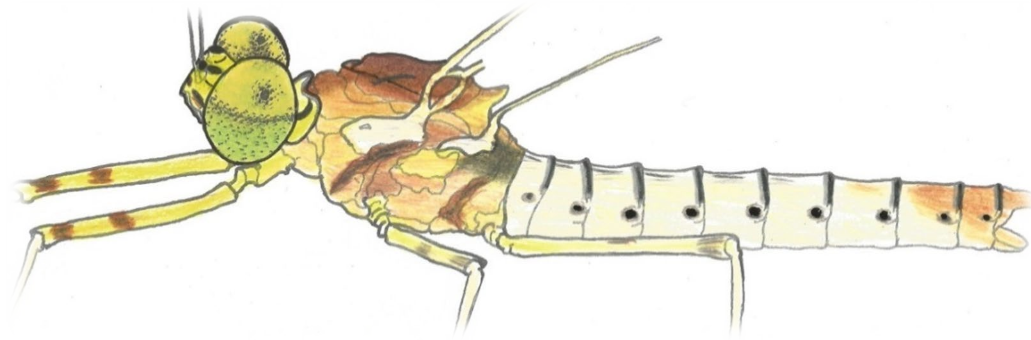
majus

Traver 1935

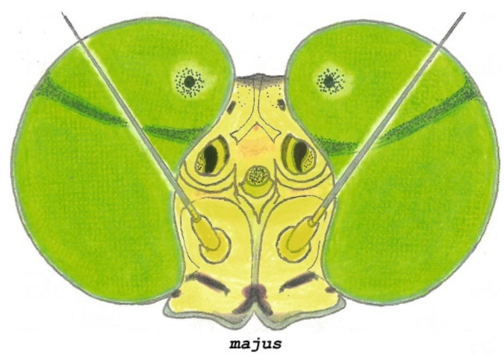
Synonym of frontale 1947

Notes; majus has very distinct features that we believe are the reason the Traver gave it species status. This description is based on Traver 1935 and reared samples from Sothern Ontario. There are currently two distinct larva types dark and light.

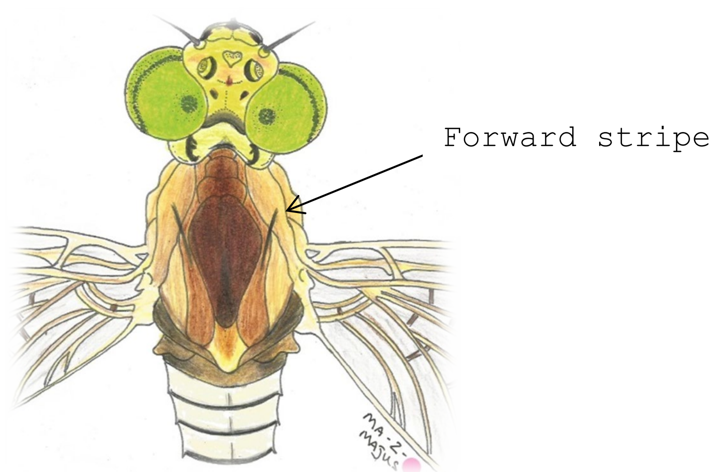
Body size; 9.5-10.5 ♂ mm, 12-13 ♀ mm, ♂ Average 10 mm
Forewing size; 11 ♂ mm, 13 ♀ mm,
Tails; 24-28 ♂ mm,



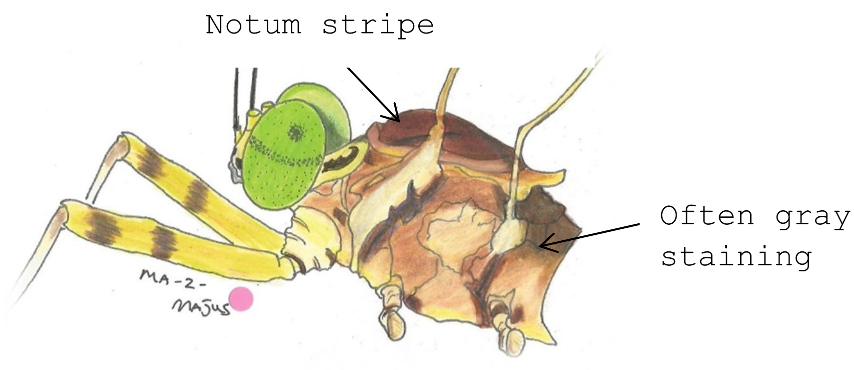
Head; yellow throughout often rather bright, gray shading on the frontal margin is common, median crania spot with shading, long black dash below antenna bases, with small black spot at the corners of the compound eyes, ocelli black ringed, slight reddish-orange shading on forward vertex in front of the cranium suture, red spot on the palmen body, small black spot on either side of the vertex, with gray shading on the posterior margin.



Pronotum; largely pale yellow but often principally hyaline, small blackish patch median posterior edge, with prominent black streaks in the lateral areas.



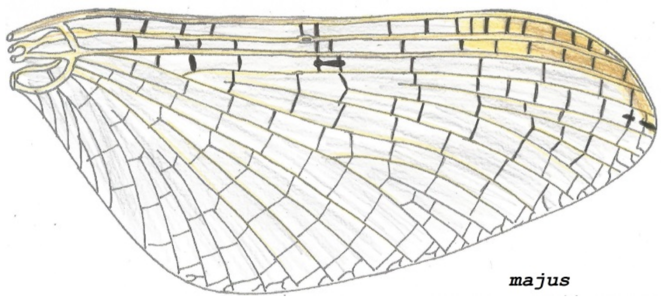
Notum; from bubble-gum-mango to deep chocolate brown, becoming paler in the lateral areas, most sample will have a distinct forward notum stripe, scutellum yellow shaded in brown, post scutellum tan median area with grayish staining on the lateral areas, sometimes right behind rear wing roots.

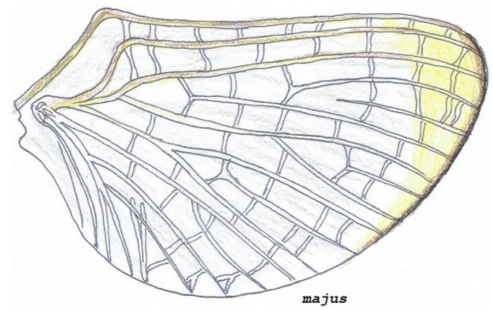


Pleura; yellow toward the sternum, often bubble-gum-yellow-brown, for coxa often bright yellow and marked with small brown stains, brownish-black spots behind the middle and hind coxa, forewing and rear wing roots often hyaline slight yellow, prominent pleura streaks that are blackish-brown-purplish.

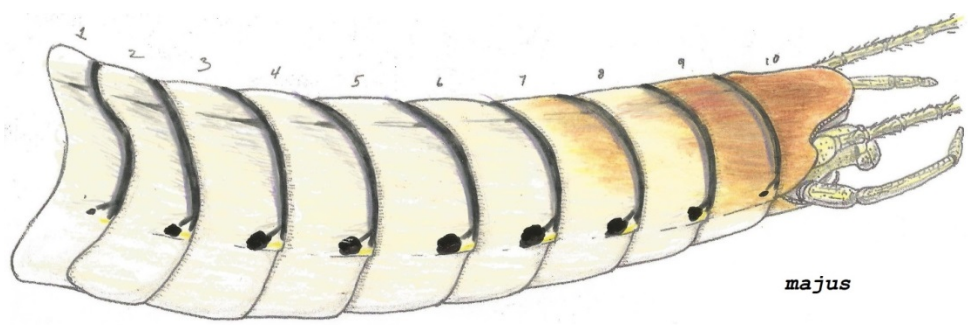
Legs; fore femora bright yellow slight cast for gray-brown with strong prominent median and apical bands, hyaline-pale-yellow tibia apically tipped with smoky gray, for tarsi hyaline with a ratio of the first section being the same length as the second, middle and hind legs, hyaline-white both having median and apical bands.

Forewings; costal vein basally gray turning yellow in the bull area till the tip, subcostal and R1 yellow basally yellow turning brownish gray in the bulla returning to yellow to the tip, crossveins in the interspaces of costal and subcostal veins below the bulla, typical samples have 4 some samples 3 broad black crossveins, 2 in the bulla area 9-11 above, left wing in the R1&R2 interspaces in the bulla area, often one vein with long spot, right wing 2-3 veins with a black elongated stain, stigma stain yellow-brown going over the apex of the forewing, intercalaries black at the tip on the right wing common. Hindwing costal, subcostal, and R1 veins basely gray yellow turning yellow-hyaline, membrane in the posterial area yellowish, then tipped with brown then black staining.





Abdomen; geographical variations in background coloring from yellow-creamy to whitish-hyaline, strong black transverse bands on tergites 1-9 the 10th unmarked, most samples will have silvery metallic transverse shading in front of black bands, most samples with have a broken germinant medial line that is very fine gray on tergites 1-4, in some samples this line can go from 1-8, if it is pronounced it will only be on 1-4, prominent spiracular spots, spots are highly variable in size, in females the ay are commonly twice the size of the one pointed to, in males often smaller abdomen below shows average spot sizes, spot can be connected to the black transverse lines but not as a rule, often having a cast of orangey-brown on the dorsal area of tergite 7 this is rare in the genus, slight orangey-brown stain in dorsal side at the posterior area of tergite 8, 9-10 fully orangey-brown-rusty-clay colored.



Tails; pale- yellow-tan, narrowly brown at the joining's so slight articulations.

Genitals; as in frontale, however highly elevated in the median apical area of each lobe but very blocky shaped like *heterotarsale*.

minnetonka

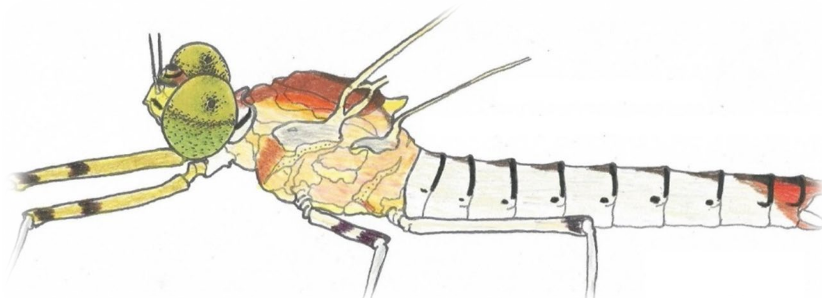
Daggy 1945

Notes; currently there are only two known complete descriptions of *minnetonka* Daggy 1945, and Burks 1953. Although very similar they are also different. Example Daggy 1945 indicates median crania spot, this is absent in Burks. Daggy states rear wings distinctly margined, Burks distinct by all veins been yellow. Burk was very descriptive on all of his descriptions, actually over descriptive. This description is a combination of both, combined with our morphology, and geological habit studies. There are no known photos of this species. There is one sample we are presenting in the photo plates that is highly suggestive of it and is within 200 miles of holotype. Burk's description includes new collections from Illinois. This would describe differences likely caused be geological and dietary morphology.

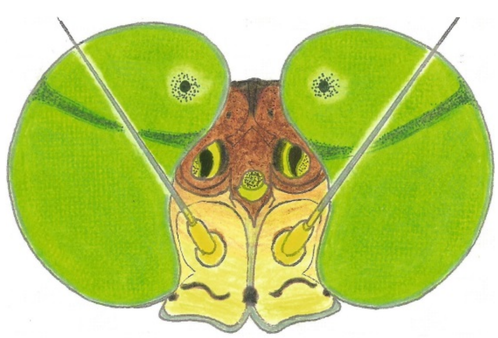
Body size; 9 ♂ mm, 11 ♀ mm,

Forewing length; 10 ♂ mm, 12 ♀ mm,

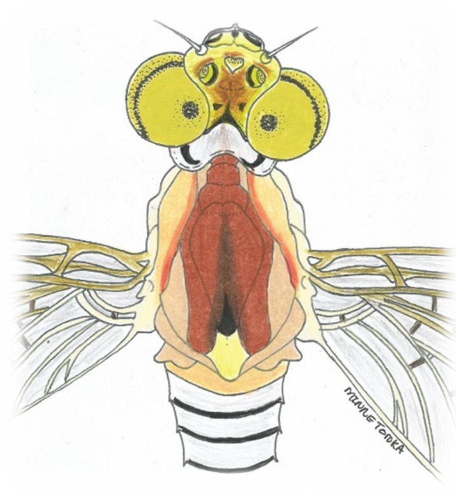
Tails; 24-28 ♂ mm,



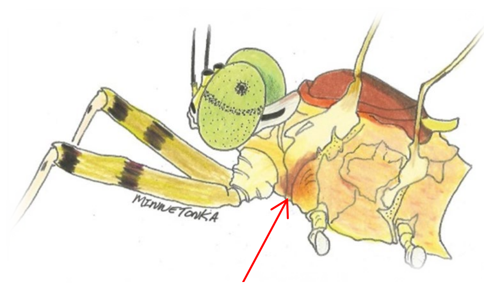
Head; principally yellow samples may have a black median crania spot, dashes below antenna bases, small black dots at the corners of the compound eyes as all in the genus do, vertex reddish-brown with small black spots on either side, blackish in the median area and posterial margin, ocelli black ringed.



Pronotum; hyaline-yellow, may have sight brownish shading in the median area, lateral black streak.



Notum; slight dark median line, most of notum reddish-brown paler laterally like most in the genus, may or may not have anterior-lateral black lines, scutellum yellow, with tan areas surrounding.

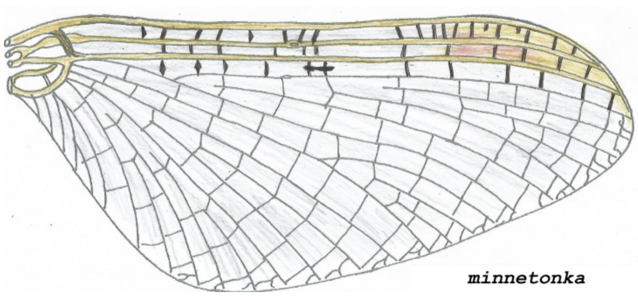


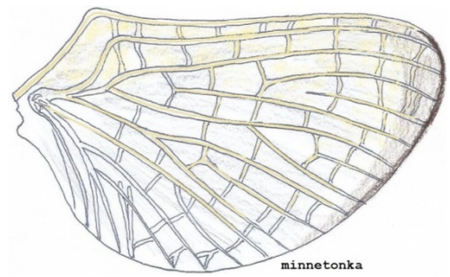
Raised area

Pleura; largely yellow (likely slight cast of brownish) very common to the genus, raised brownish red area between the fore and mid coxa see above (also common to the genus) no other marks notes by Daggy 1945, sternum yellow.

Legs; fore femora darker yellow with median and apical blackish band, fore tarsal ratio is about 40% the length of the second section. Middle femora with median and apical black bands, hind femora median band absent apical present both median and hind rather hyaline-yellow.

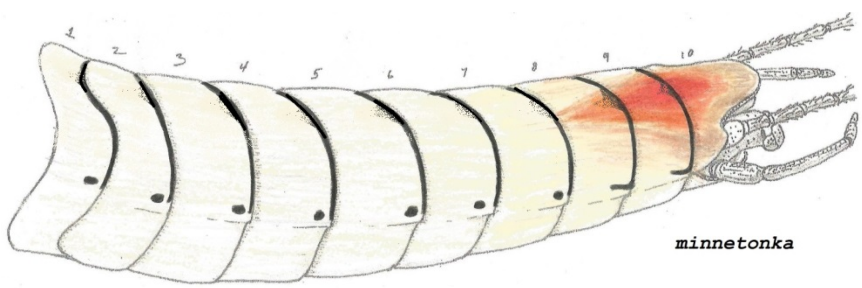
Forewings; (from Daggy, Burks and potential sample) like most in this genus having yellow brown longitudinal veins, stigma stain slight reddish-yellow, and going over apex as per Daggy, customary black dash in bulla area. Hindwing Burks, all veins yellow the membrane would also be yellow dusky brown posterior edge.





Abdomen; background color pale yellowish-hyaline posterior margins of tergites 1-9 narrowly blackish, with pronounced spiracular spots, tergites 8-10 dorsally infused with reddish-brown tergum 9 darkest, (Daggy v Burks) in the median area Burks says black median tergite 1-8 with black cross line, meaning median line, Daggy somewhat suffused with black dorsally, meaning blackish transverse shading in the median area, sternum white.

Transcribed; may have either median black shading or slight median black line could have either or both.



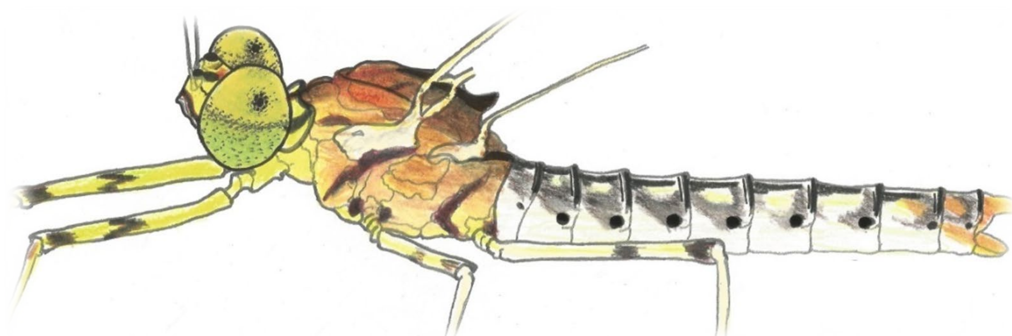
Tails; gray-yellow articulations brown

ohioense

Traver 1935
Synonym free
Includes light and dark type

Notes; based on Traver 1935. There are currently two types for this form a dark type and a light type. The dark type is the more commonly seen and photographed, therefore this description is principally on the dark type, but we will comment on variation of light types. Further information on types can be found in the leopard larva changed its spots in the larva book.

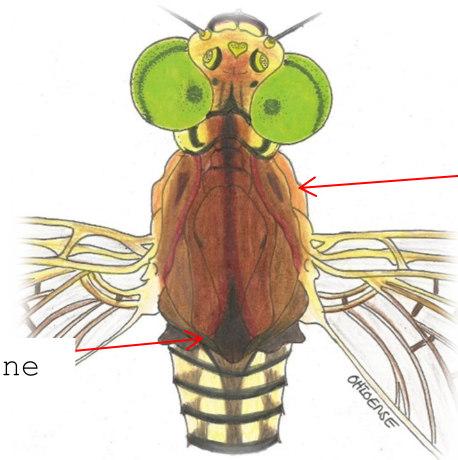
Body size; 9 ♂ mm, 11 ♀ mm.
Forewing size; 10 ♂ mm, 12-13 ♀ mm.
Tails; 22-26 ♂ mm.



Head; yellow turning brownish-red, clypeus yellow with a strong black band going for compound eye to compound eye forming a complete smile, rarely line is broken in the median crania area and near the compound eyes, face turning orangey-brown between the antenna bases and ocelli, ocelli black ringed at the bases, vertex reddish-brown, black spots lateral of cranium suture, median black triangle stain pointing forward and connected to the posterior margin.

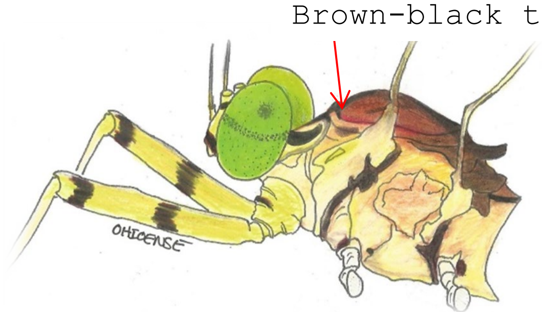
ohioense

Pronotum; in the median area reddish-brown staining with blackish median stripe, laterally yellow with predominant black lateral stripes.



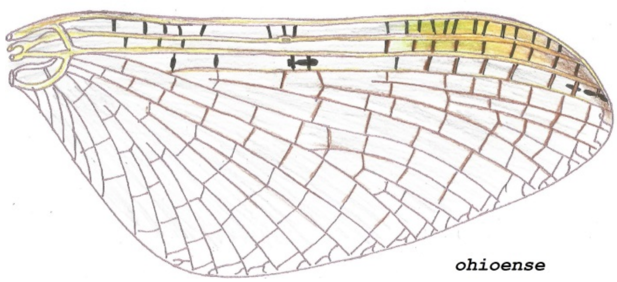
Notum; Largely reddish-brown, pronounced median blackish germinant medial stipe, stripe can be just purplish, often reddish above forewing roots anterior-lateral of notum often with black or very dark chocolate brown triangle stains in this area see above, scutellum black lateral to that very dark or black, post scutellum often a black triangle outline in median area see above, light types can be very bubble-gum brown in the notum area.

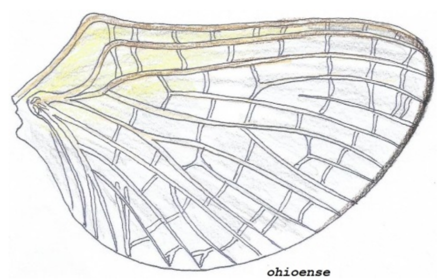
Pleura; yellow with orangey-brown casting, typical samples have middle and rear coxa spots, prominent pleura streaks that are very dark but not always blackish-purple, fore coxa brighter yellow with dorsal coxa brown stain, common samples have a brown or black triangle stain right behind the pronotum near forewing roots see below.



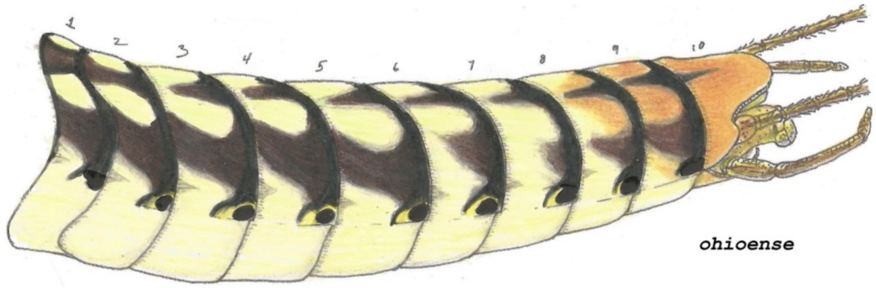
Legs; most sample all yellow, fore femora very deep yellow-green, very dark prominent black-purple median and apical bands, these bands are also promenent on the middle and hind legs, median fainter on rear, tips of tibia blackish, for tarsl ration the first section is 45% the length of the second.

Forewings; (some sample may have black longitudinal viens), costal, subcostal, R1 veins yellow turning brown in bulla area till stigma, R2 and all other logituninal veins brownish and same with crossveins, in the costal subcostal interspaces from costalbrace to bulla less than 5 heavliy blackend crossveins then a blank area, 3 in the bulla, then blank again, from the base of stigma stain to tip ofet 9-13, stigmac stain yellow turning brown-gray-green and going over the apex of the wing, black intercalaries spots in the right wing, 2-3 crossveins in the bulla area with costomary black dash. Hindwing costal, subcostal, and R1 brown with yellow colored membraine, out margin black shaded.





Abdomen; (background coloring highly variable do to geological substrate composition). Often hyaline-white but many sample yellow-cream, median germinant line rarely, but it may connect to the posterior edge of forward tergite like *canadense*, in light types this median line can be completely absent see the leopard larva changed its spots in larva book for adult male with no median line at all, making it look like *frontale*, moderate to large submedial pale spots that are not arranged to form a submedial line, heavy piceous sublateral shading from tergites 1-5, on 6-9 may not connect to forward tergites, moderate to very large spiracular spots, often infused or in capsulated within the transverse bands, tergites 1-9 black-purple transverse bands wide and often turning black in spiracle area, median line on tergite 10 short if present, tergites 8-10 commonly orangey-brown sometimes with cast of reddish stain.



Tails; pale yellow turning smoky brown in apical area, with darker articulations.

Genitals; without question allied to *frontale*, distinguished from *frontale* by the sublateral basal spines. *Frontale* has a lateral cluster, with rarely 1 or 2 basal spines; *ohioense* has 3-6 basal lateral spines often like a small cluster. *Ohioense* also does not have a true lateral spine cluster they are broken apart see anatomy section.

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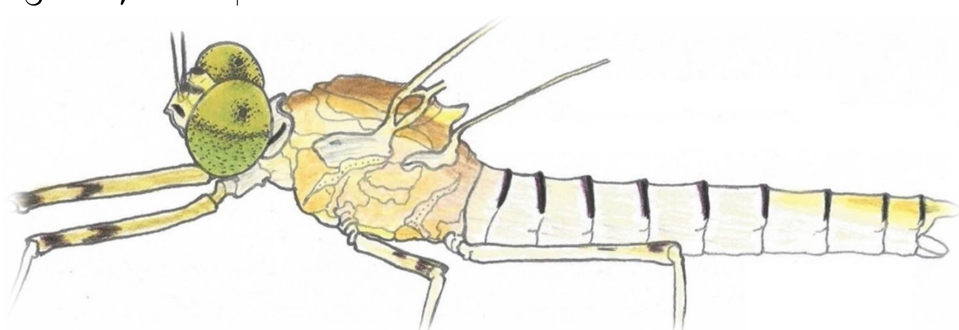
pallidum

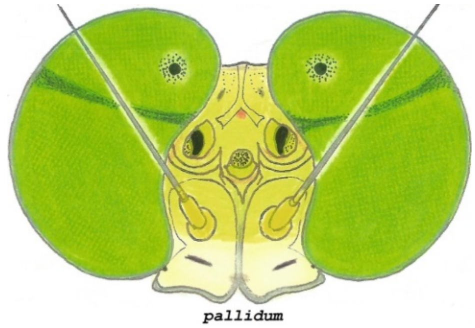
Traver 1933 / 1935
Synonym free

Notes; based more on Traver 1933 than 1935. She was more descriptive in 1933, so this is a combination of both. In the photo plate section of this book there is a female sample that aligns with this species from Lake Norris TN 2014. Although not yet reported in that state the size eliminates all others in the genus as this female sample was 7.5 mm.

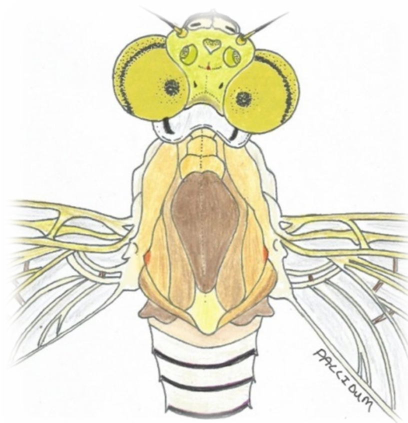
Body size; 6.5-7 ♂ mm, 6-7.5 ♀ mm
Forewing size; 7.5-8 ♂ mm, 9-10 ♀ mm
Tails; 20-22 ♂ mm, 17 ♀ mm



Head; pale yellow to darker yellow on the vertex that is standard for the genus, maybe even hyaline on the lower area of the clypeus, a fine dash underneath each antenna scape, a small black spot near the compound eyes, a red spot on the vertex, in this genus that represents the palmen body at the cranium suture, although not stated all Stenacron have some form of black or very pale gray spots on the vertex on either side of cranium suture, she did not comment on black ringed ocelli.



Pronotum; hyaline as most light forms are in the genus with fine dark gray or black streaks in the lateral areas of the pronotum.

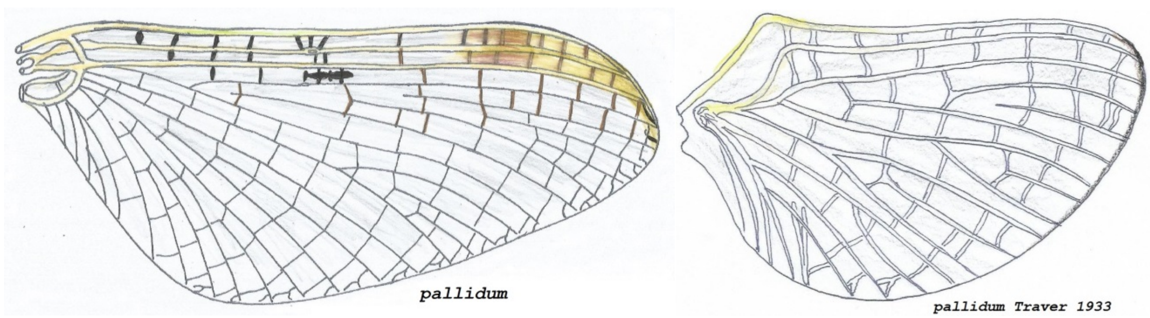


Notum; pale yellow to yellow tan unmarked, not stated but typically Stenacron of very pale forms have either a yellow or a white scutellum.

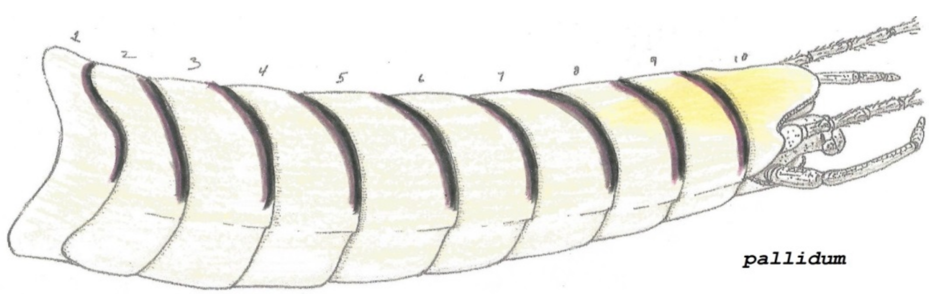
Pleura; slightly deeper yellowish, with a deeper orange spot on either side of the rear coxa, maybe slightly orange in front of the middle coxa as in many forms in the genus.

Legs; yellowish-white, fore femora deep yellowish with a cast of brown, conspicuous purplish-black median and apical bands, fore tibia purplish-black at the apical area, joining of fore tarsi faintly brown, fore tarsal ration the first segment is basically equal to the second, middle and hind femora pale yellow-hyaline with median and apical band just fainter, hind median band my be restricted to a dorsal line.

Forewings; (illustrations based on descriptions a sample that aligns with this species). Costal, subcostal, R_1 veins yellow-brown, stigma stain pale (she does not comment on over apex but most in the genus do) as does aligning sample, 2 or 3 crossveins in the bulla area with dumbbell shaped black dash. Hindwing may have slight basal tinge with darkened hind margin.



Abdomen; whitish 1-7 semi-hyaline, 8-10 opaque faintly yellowish dorsally, each tergite with rather widely margined posteriorly with purple black, meaning moderately wide purplish-black transverse bands, without spiracular spots.



Tails; pale, so whitish-hyaline without articulations

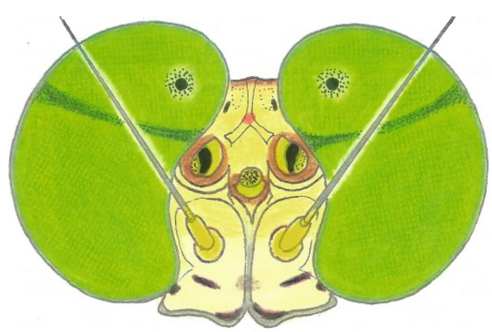
proximum

Traver 1935

Notes; only one description exists for this form in the Biology of Mayfly 1935. This description in based on that description but more so on reared adults from Southern Ontario that align with the historical profile. The form *conjunctum* is almost inseparable from *proximum* but in comparative discussions, variation and maculation we clarify the two forms from each other.

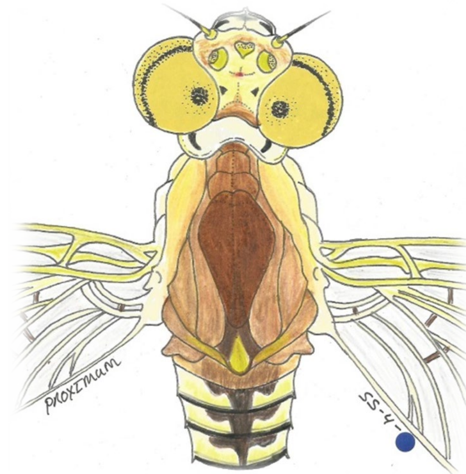
Body sized; 9-9.5 ♂ mm, 11 ♀ mm
Forewing size; 10 ♂ mm 12 ♀ mm
Tails; 22-26 ♂ mm

Head; pale yellow with a very slight median crania shading, below on the frontal margin a blackish spot on either side of the median cranium structure, dash below each antenna bases, small black spots at the corners of the compound eyes, brownish-orange shading around the ocelli, and ocelli not black ringed, Strong red spot at the palmen body, small black spots on the vertex, posterior margin brownish terminating in black shading.



proximum

Pronotum; hyaline with slight yellow lateral edges, black streaks in the lateral areas no other markings.

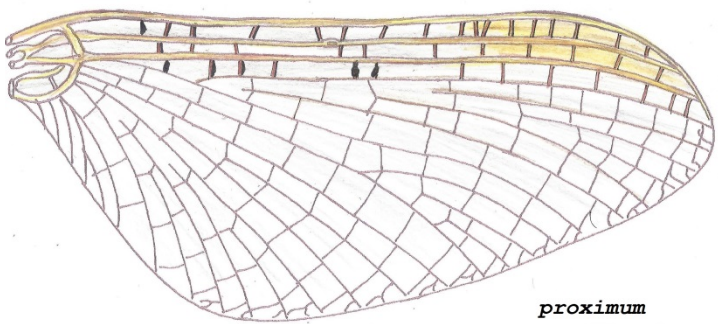


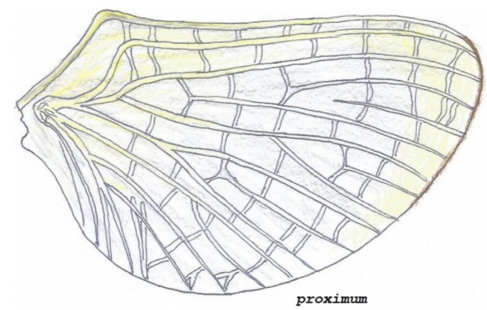
Notum; deep reddish-chocolate brown in the upper most median area, paler laterally with a bubble-gum-tan coloring, scutellum often tipped with yellow.

Pleura; principally yellow with cast of orangey-brown, moderately pronounced blackish-brown pleura streaks, fore coxa bright yellow, fore and hind wing roots hyaline.

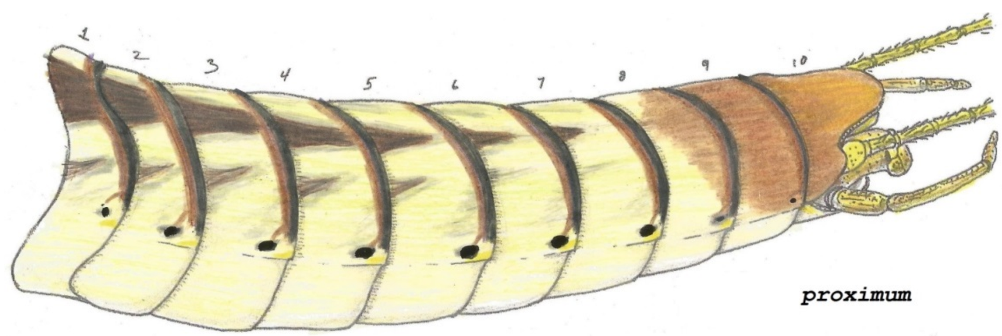
Legs; yellow with middle and hind being paler almost whitish on the rear, fore femora, deeper yellow with moderate to prominent median and apical bands, fore tarsal ratio first segment is basically equal to the second.

Forewings; costal, subcostal, R_1 veins yellow brown throughout with pale yellowish-red stigma stain not going over the apex this is rare in the genus, wings spares of crossveins throughout, typically 2 in the R_1&R_2 area below the bulla with two black spots seldom a black bar.



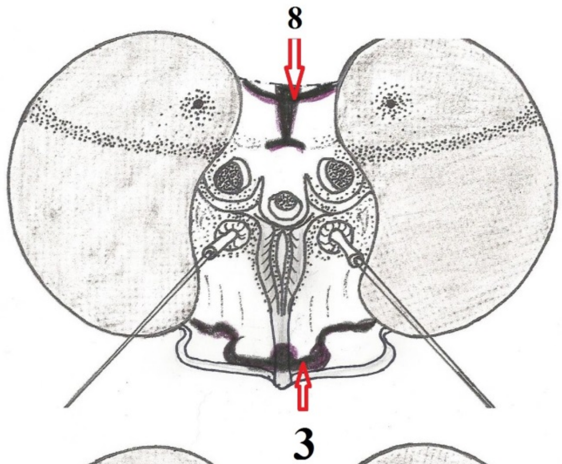


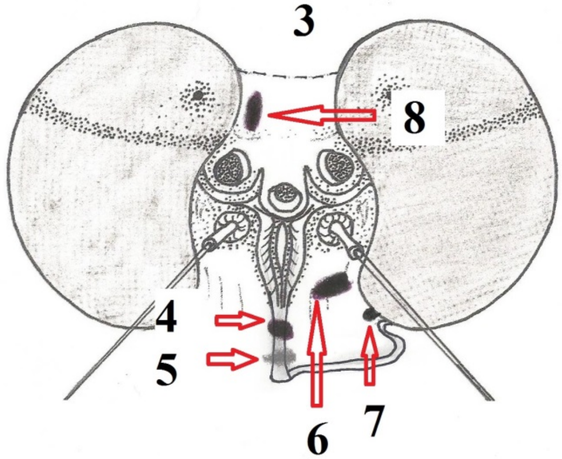
Abdomen; most samples yellow-white, summer sample whitish-pale-yellow, germinant medial stripe from 1-7 sometimes only 1-5, often sublateral anterior shaded points see arrow, blackish tergite banding 1-9, 10th un marked, 1-9 brown transverse shading fine black or gray spiracular spots often incorporated with the black transverse bands, 8-10 rusty-reddish-brown with the 10th ending with a orangey tone but muted.

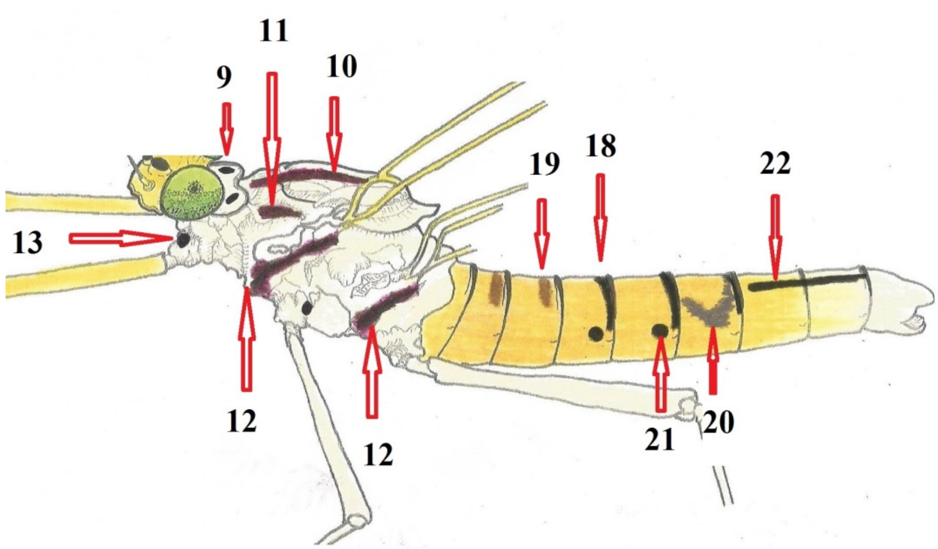


Tails; yellowish basally turning dusky with alternating fine articulations, so one thin one fat and so on.

Table of key features







Pronotum spots, pleural streaks, and spiracular all are good for a reasonable diagnosis. Male genitals are the best proof of form. Always keep in mind geological variations should be considered the nearest form.

1; full body length from head to the beginning of the tails

2; forewing length from the base to the tip

3; complete line across frontal shelf

4; median crania spot

5; median crania shading

6; dashes or spots below antenna bases

7; spot in the corner of the compound eyes on the face

8; spots on the vertex or top of the head

9; oblique lateral black streaks on the pronotum

10; median stripe on the notum or top side of thorax

11; spots forward and above forewing root

12; pleura streaks, stripes in front of middle hind legs

13; spots on the coxa either F front, M middle, R rear legs

14; stigma stain going over the apex of the forewing

15; longitudinal vein color in the forewings

16; shading on the posterior edge of the hind wings

17; abdomen background color

18; transverse bands at the posterior margin of tergites

19; shading on the anterior area of the transverse bands

20; sublateral shading on the sides of the abdomen

21; spiracular spots on the side of the abdomen often black

22; median stripe on the top of the abdomen

23; color of the tails + articulations or banding

Stenacron adult Male features and key

From darkest to lightest

	Anatomical Features	*canadense*	*gildersleevei*	dark form *ohioense*
1	body length	8-9 mm	10-11 mm	9 mm
2	forewing length	9-10 mm	10.5-11 mm	10 mm
3	frontale shelf line	full smile on female	full smile connected	yes not connected
4	midcrania spot	infused	infused	infused
5	midcrania shading	infused	infused	infused
6	marks below ANT	line	line	no
7	spots comp-eye	yes	LRG	LRG
8	vertex marks	black spots	yes	red shading
9	pronotum marks	LRG black	LRG black	LRG black
10	notum mid-streak	germinate	purp-black	germinate
11	marks ant-forewing	yes- ▶	yes- ▶	yes- ▶
12	pleura streaks	yes-BLK	no	yes-BLK
13	coxa marks F M R	F-M	F-M-R	F
14	stigma stain / over apex	brown-red yes	pale brown yes	brown-yell yes
15	long-vein color	yell-brown	yellow milky	yellow
16	hindwing shading	NAR-black	NAR dusky	black
17	AB ground color	yellowish	hya-yellow	hyaline
18	transverse bands	yes	heavy black	heavy black
19	trans-V-shading	heavy gray	heavy black	heavy black
20	sub-lat-shading	heavy gray	heavy black	heavy black
21	spiracular spots	no /with BLK shading	LRG distinct	LRG distinct
22	medial stripe	yes wide	heavy black	yes wide
23	tail color + ART	pale smoky + ART	yellow-brown no ART	yellow no ART

Females can be identified by all characters but are larger

Stenacron adult Male features and key

From darkest to lightest

	Anatomical Features	light form *ohioense*	*frontale*	*majus*
1	body length	9 mm	8 mm	9.5-10.5 mm
2	forewing length	10 mm	9 mm	11 mm
3	frontale shelf line	somewhat	somewhat	no
4	midcrania spot	infused	yes	yes
5	midcrania shading	infused	yes	no
6	marks below ANT	line	line	line
7	spots comp-eye	LRG	small	small
8	vertex marks	blk stripes	blk spots	yes
9	pronotum marks	LRG black	sm blk	sm blk
10	notum mid-streak	yes	germinate	yes
11	marks ant-forewing	yes- ▶	no	no
12	pleura streaks	yes prom	yes prom	yes moderate
13	coxa marks F M R	F-M-R	M	M
14	stigma stain / over apex	green-brown yes	LT brown not over	amber not over apex
15	long-vein color	green-brown	yell-brown	amber-yell
16	hindwing shading	purp-blk	NAR brown	dusky
17	AB ground color	yellow-green	yell-brown	creamy-yell
18	transverse bands	moderate blk	fine blk	fine blk
19	trans-V-shading	pale-gray	fine gray	pale gray
20	sub-lat-shading	moderate-blk	pale gray	no
21	spiracular spots	prominent infused	moderate distinct	LRG distinct
22	medial stripe	germinate	germinate	germ 1-4
23	tail color + ART	smoky-brown	pale + ART	white + ART

Females can be identified by all characters but are larger

Stenacron adult male features and key

From darkest to lightest

	Anatomical Features	*proximum*	*conjunctum*	*minnetonka*
1	body length	9-9.5 mm	8 mm	9-10 mm
2	forewing length	10 mm	9 mm	10-11 mm
3	frontale shelf line	no	broken line	full smile
4	midcrania spot	no	yes	yes-Daggy
5	midcrania shading	yes	no	no
6	marks below ANT	line	line	line
7	spots comp-eye	small	small	small
8	vertex marks	yes	yes	yes
9	pronotum marks	sm black	yes	yes
10	notum mid-streak	germinate	germinate	no
11	marks ant-forewing	no	no	no
12	pleura streaks	moderate	moderate	no
13	coxa marks F M R	M	no	M-R
14	stigma stain / over apex	yell-green not over	yell-brown over apex	yell-brown over apex
15	long-vein color	yell-brown	yell-brown	yell-brown
16	hindwing shading	dusky	pale brown	purp-brown
17	AB ground color	pale yellow	hyaline	yell-white
18	transverse bands	fine blk	fine brown	yes
19	trans-V-shading	pale brown	pale brown	faint gray
20	sub-lat-shading	1-5 gray	1-3 brown	no
21	spiracular spots	fine defused	fine defused	LRG distinct
22	medial stripe	1-7 germ	1-4 germ	no
23	tail color + ART	yell dusky	white + ART	pale + ART

Females can be identified by all characters but are larger

Stenacron adult Male features and key

From darkest to lightest

	Anatomical Features	*candidum*	*carolina*	*pallidum*
1	body length	7.5 mm	10 mm	6.5-7 mm
2	forewing length	8.5 mm	10.5-11.5 mm	7.5-8.5 mm
3	frontale shelf line	no	no	no
4	midcrania spot	very dark	no	no
5	midcrania shading	no	no	pale Y/N
6	marks below ANT	spots	line	dash
7	spots comp-eye	small	tiny	tiny
8	vertex marks	mid stripe	reddish-line	red spot
9	pronotum marks	yes	fine blk	distinct
10	notum mid-streak	no	no	no
11	marks ant-forewing	no	no	orange spot
12	pleura streaks	no	no	no
13	coxa marks F M R	faint gray	no	no
14	stigma stain / over apex	pale reddish over apex	yell-brown over apex	red-brown over apex
15	long-vein color	yell-brown	amber-brown	pale amber
16	hindwing shading	NAR black	pale gray	dark brown
17	AB ground color	yell-white	hyaline	hyaline
18	transverse bands	blk	fine black	yes
19	trans-V-shading	no	GRY rapping sternum	pale brownish
20	sub-lat-shading	no	no	no
21	spiracular spots	distinct	no	no
22	medial stripe	no	no	no
23	tail color + ART	white no art	dark-smoky	hyaline

Females can be identified by all characters but are larger

Stenacron adult Male features and key

From darkest to lightest

	Anatomical Features	*areion*	*affine*	*flaveola*
1	body length	7 mm	7-8 mm	same as
2	forewing length	8 mm	8-9	interpunc-
3	frontale shelf line	fine dash	no	tatum Say
4	midcrania spot	no	no	
5	midcrania shading	no	no	
6	marks below ANT	no	faint dots	
7	spots comp-eye	not known	minute	
8	vertex marks	no	spots	
9	pronotum marks	yes	no	
10	notum mid-streak	not known	no	
11	marks ant-forewing	not known	no	
12	pleura streaks	no	no	
13	coxa marks F M R	M	no	
14	stigma stain / over apex	brown over apex unknown	yell-brown over apex	
15	long-vein color	unknown	hya-amber	
16	hindwing shading	unknown	NAR brown	
17	AB ground color	hyaline-white	hyaline	
18	transverse bands	blk-brown	purp-black	
19	trans-V-shading	brown	pale gray	
20	sub-lat-shading	no	no	
21	spiracular spots	no	no	
22	medial stripe	9th germ	no	
23	tail color + ART	white no art	white no art	

Females can be identified by all characters but are larger

Stenacron adult Male features and key

From darkest to lightest

	Anatomical Features	*heterotarsale*	*floridense*	*interpunctatum*
1	body length	9 mm	7-9 mm	7.5 mm
2	forewing length	11 mm	not known	7.5-8.5 mm
3	frontale shelf line	no	no	no
4	midcrania spot	no	no	no
5	midcrania shading	no	no	no
6	marks below ANT	no	no	line
7	spots comp-eye	minute	sm gray	minute
8	vertex marks	blk-spots	gray spots	blk spots
9	pronotum marks	no	yes	fine
10	notum mid-streak	no	no	no
11	marks ant-forewing	no	no	no
12	pleura streaks	no	no	no
13	coxa marks F M R	no	no	no
14	stigma stain / over apex	amber over apex	yellow over apex	yell-brown over apex
15	long-vein color	yellow	yell-gray	yell-brown
16	hindwing shading	NAR dusky	dusky	blackish
17	AB ground color	hya-yellow	hyaline	hyaline
18	transverse bands	blk fine	fine black	fine black
19	trans-V-shading	no	no	fine gray
20	sub-lat-shading	no	no	no
21	spiracular spots	no	no	no
22	medial stripe	no	no	sm ▯ medial 1-4
23	tail color + ART	hya + art	lt gray	yell-hyaline

Females can be identified by all characters but are larger

Credit for usage of photos

- The Centre for Biodiversity Genomics; 2 photos by Jeff Webb of ♀ larva *floridense*.
- Sharon Moorman; complete photo series of *carolina* ♂ sample imago, samples we believe to be *pallidum* ♀ imago, *frontale* ♀ larva, ♂ larva that align with *floridense*, and adult ♀ imago that also align with *floridense*, ♂ carolina larva, all samples from Norris lake TN.
- Brandon Woo; Norway Maine for his perfect sample of a ♂ *interpunctatum / majus*.
- Brandon Woo; affine photos from the Cornell collection.
- Charley Eiseman Black River Wisconsin; one ♂ sample that aligns with *minnetonka*, and a rare photo of what aligns very well with Burk’s 1953 *areion* ♂.
- Tom Murry for his picture of what we believe to be the larva of *pallidum*
- Joshua Doby for photos of S *carolina* larva from Ashville NC.

Pronouncing names and words

Saying the name right or pronouncing complex words make this very hard for everybody. However the correct Latin and biological terms are the best to use. Remembering a few years back trying to learn this stuff and it is not easy. But, once you got it you got it.

So this is the place and time to learn how to talk the talk shall we say. First let's look at pronouncing all the names mentioned in this genus.

STENACRON = [sten-ah-cron]

AFFINE = [a-fine]

AREION = [air-e-on]

CANADENSE = [can-ah-dense]

CANDIDUM = [can-did-um]

CAROLINA = [car-o-line-a]

CONJUNCTUM = [con-junk-tum]

FLAVEOLA * = [fla-vee-o-la] *

FLORIDENSE = [flor-ah-dense]

FRONTALE = [fron-tull]

GLIDERSLEEVEI = [gil-der-slee-vah]

HETEROTARSALE = [he-ter-o-tar-sal-ly]

INTERPUNCTATUM = [in-ter-punk-ta-tum]

MAJUS = [may-jus]

MINNETONKA = [min-knee-tonk-ah]

OHIOENSE = [o-hi-o-ense]

PALLIDUM = [pal-li-dumb]

PROXIMUM = [prox-e-mum]

There that is all the names you need to be able to say. One of the names in that list is no longer in usage, but it will be inside the text. It is marked with a star *****. From here out any words that are typed in red are very important and used in the text of these guides.

This section is the technical terms used when a description is made. As stated these are the correct words and best ones used. So if you take the time to know them now, it will make your reading that much easier.

Abdomen; [ab-duh-mun-n] This is the rear section of the insect regardless of its stage in the life cycle. It will have 10 sections.

Abdominal; [ab-dom-muh-nl] Referring to the entire abdomen cavity.

Adult; [uh-duhlt] The fully grown stage of the mayflies life. Having only 2 tails and 4 wings. Two large wings and two small wings.

Antenna; [an-ten-uh] Meaning, there are two single small antenna or segmented like hairs on the head of the insect. On the larva they are on the front top of the head, and in the adults they are on the lower face area.

Antennae; [an-ten-ae] Meaning, more than one antenna referring to the pair.

Anterior; [an-teer-ee-er] the very front of something, or anteriorly; in front of something.

Apex; [ey-peks] The very furthest end, or at the end. At the very top of the forewing the rounded over area. Opposite of basal or base of something.

Apical;[ah-pick-al] referring to the apex of something.

Basal & base; [bey-sul] the base of something typical usage, the basal end of the abdomen meaning; the beginning of the abdomen segment #1.

Crania; [krey-nee-ia] Meaning; in the adult insect in the center area just above the very bottom of the face. Elevated keel like edge.

Cranium; [krey-nee-uh-m] the upper part of the head near the vertex between the compound eyes.

Cranium suture; typically **Y** shaped area that joins the 3 primary areas of the head capsule.

Clypeus; [klip-ee-uh-s] in the larva this is the very front leading edge just above the labrum. In the adult is where it is used the most and it pertains to the lowest area of the face.

Costa or costal vein; [kos-ta] & [kos-tl] rib like vein in the further most anterior edge the wings. In the forewing it is typically yellowish-gray in color.

Denticle; [den·ti·cle] a small tooth or tooth-shaped projection typically on the claw.

Depressed; [de-press-ed] biology flattened, as if from downward pressure

Dorsal; [dor-sal] the upper area or top of the insect.

Elliptical; [el-lip-ti-cal] elongated oval shape

femora; [fem-o-ra] A plural of femur.

Femur; [fe-mur] zoology a bone equivalent to the human thighbone in other vertebrates

fimbriated; [fim-bri-ated] describes parts of organisms that have a fringed border.

Frontal; [fron-tul] pertaining to the front edge.

Fuliginous; [fu·lig·i·nous] having the color or consistency of soot or smoke.

Fulvous-tawny; [ful·vous]-[taw·ny] color of the common deer.

Fuscous; [fus·cous] dark brown approaching black.

Humeral; [hum-er-al] the first and lowest cross vein in the forewing near the wing root.

Hyaline; [hy·a·line] resembling glass, as in translucence or transparency; glassy.

Imago; [im-a-go] an insect in its sexually mature adult stage after final metamorphosis.

Infuscated; [In-fus-ca-ted] (Zoology) darkened with a blackish tinge.

Interrupted; [in-ter-rupt-ed] to break the continuity or uniformity.

Labium; [ley-bee-uh] the lower lip of an insect.

Labrum; [la-brum] the upper lip of an insect.

Larva; [lahr-va] Entomology. the immature, wingless, feeding stage of an insect that undergoes complete metamorphosis.

Larvae; plural mean more than one larva

Lateral; [la-ter-al] relating to the sides of the insect.

Laterally; [la-ter-al-ly] sideways; moving towards the sides of the insect.

Mandibles; [man-duh-buh-l] the bone of the lower jaw having teeth and molars.

Maxilla; [mak-sil-uh] the upper part of the jaw on the insect having comb like teeth.

Maxillae; [mak-sil-ee] plural mean two maxilla.

Mesonotum; [me-so]-[noh-tuh-m] the middle area of a dorsal plate or sclerite of the thorax of an insect. The middle of the upper area of the thorax.

Metanotum; [mee-tuh]- [noh-tuh-m] the rear area of the notum. Rear upper area of thorax.

Notum; [noh-tuh m] the upper dorsal plate or thorax of the insect.

Ocelli; [oh-sel-ahy] a type of simple eye common to invertebrates, consisting of retinal cells, pigments, and nerve fibers.

Piceous; [pis-ee-uh-s] color of pitch or very close to black-brown color.

Pectinate; [pek-tuh-neyt] formed into or having closely parallel, tooth-like projections; comb-like.

Pectinate setae comb; A type of comb-tooth on the crown or anterior edge of the maxillae.

Pleura; [ploo r-uh] the side of the thorax.

Pronotum; [proh-noh-tuh m] same as prothorax the most forward part of the thorax right behind the head and forward of the notum.

Scutellum; [skyoo-tel-uh m] Zoology. a small plate, or other shield-like part, as on the thorax of insects.

Setae; [see-tuh] very fine hair like appendage.

Subimago; [sub-im-a-go] the first winged stage of the mayfly, with dull opaque wings, known to anglers as a dun, before it metamorphoses into the shiny glassy imago or spinner See also dun.

Sublateral;[sub]-[la-ter-al] less than lateral towards the median area.

Submedial; [sub]- [mee-dee-uh-l] less than the middle, slightly off center.

Thorax; [thawr-aks] Anatomy. the part of the trunk in humans and higher vertebrates between the neck and the abdomen, containing the cavity, enclosed by the ribs, sternum, and certain vertebrae, in which the heart, lungs, etc., are situated; chest.

Tawny; [taw-nee] of a dark yellowish or dull yellowish-brown color or orangey brown.

Tibia; [tib-ee-uh] (in insects) the fourth segment of the leg, between the femur and tarsus.

Tarsus; [tahr-suh-s] the distal part of the leg of an insect, usually subdivided in the adult into two to five segments.

Venter; [ven-ter] underside of the abdomen or belly.

Ventral; [ven-truh-l] of or relating to the venter or belly; abdominal. Anatomy, Zoology. situated on or toward the lower, abdominal plane of the body; equivalent to the front, or anterior, in humans.

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The End
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