CLUES IN A MATCHMAKING MYSTERY:

LINKING THE SEXES OF GNATHIID ISOPODS

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Good Morning

Gnathiid isopods have been a difficult group for taxonomists since their discovery. In fact, the first male specimen was described as a cancer crab by Montagu in (1804). This is an extremely polymorphic group, not just between sexes but between adult and larval forms as well. Predominately species are known from described males. Currently, there have been no tested protocols for how to link females or larval forms to these described males. For this reason, non-males have typically been left at sp. in most ecological and taxonomic studies. This is an unfortunate loss of data but how to resolve this confusion has proved to be a mystery for some time. Perhaps today I can convince you though, that the mystery is beginning to unravel.

Smit and Davies, 2004

Gnathiid Isopods: What are they?

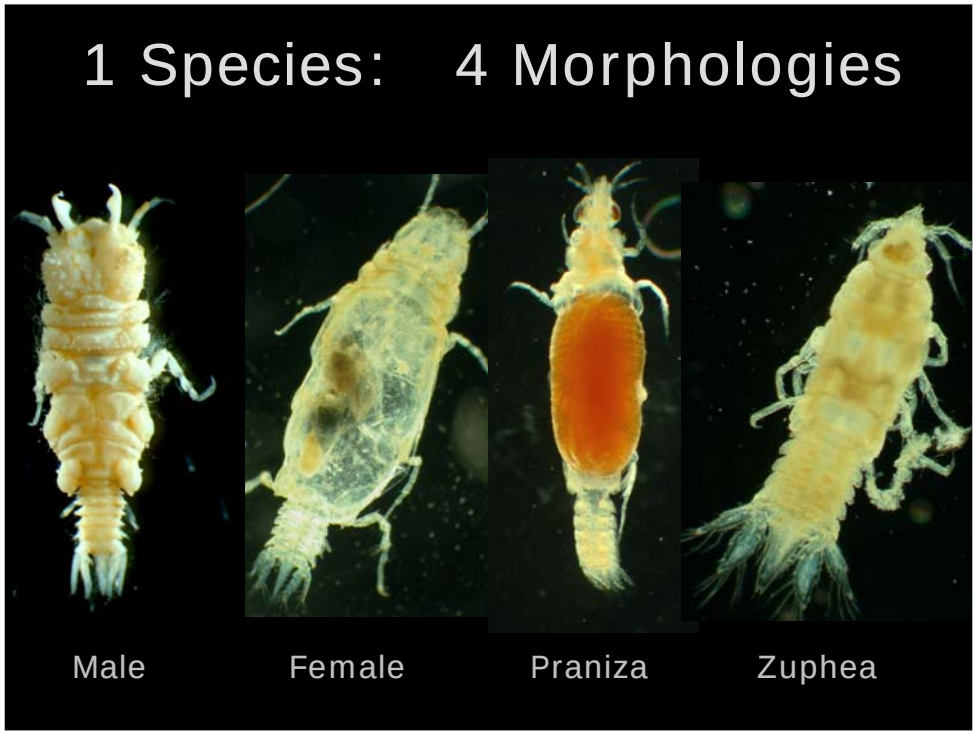
Adult Male

Unique group of cymothoid isopods. Relatively small (2.2 - 8.0 mm)

- Adults:
  - Non-feeding
  - Free-living
  - Benthic
- Juveniles:
  - Ectoparasites of fishes
  - Possible vector of blood protozoa
  - 2-stages
    - Zuphea
    - Praniza

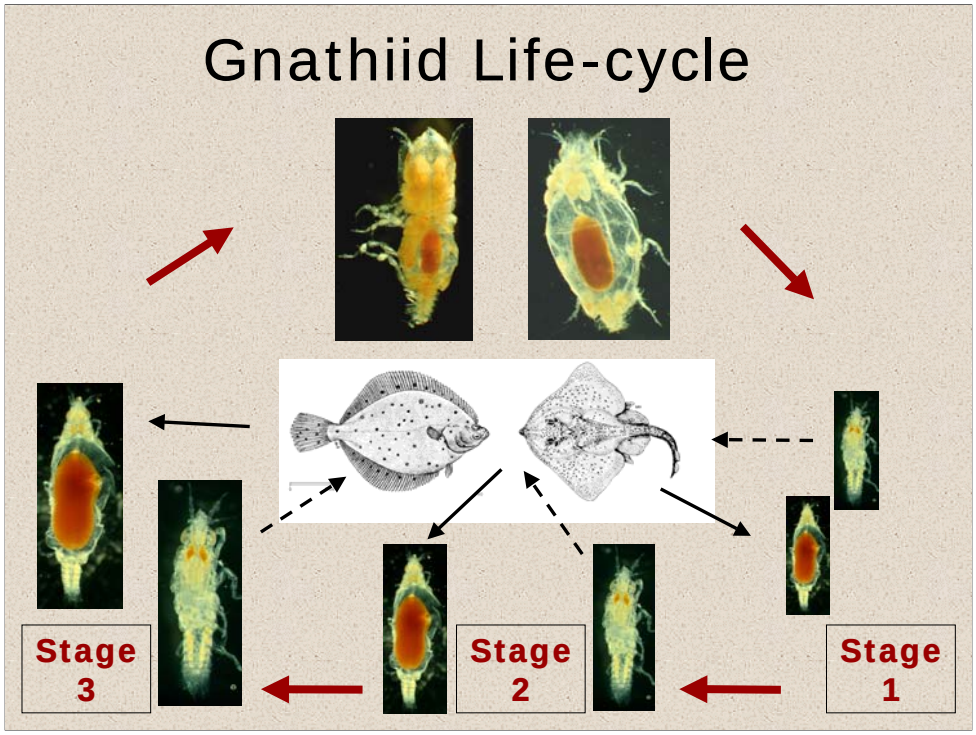
So what are Gnathiid isopods anyway? They are a fairly unusual group of cymothoid isopods that have an interesting bi-phasic lifecycle. The adults are non-feeding, free-living, benthic critters,that typically hang out in sponges, empty shells, sediment or burrows. The juvenile stages, however, are fish ectoparasites that attach to the gill filiments or fins of various fishes using their piercing mouthparts and partake of a blood meal. Juveniles are known to be common ecotoparasites on a wide variety of fishes. High infestations on a single fish have been demonstrated to be fatal for most hosts. Juveniles have also been cited as potential vectors of blood protozoa, typically from the phylum Apicomplexia. In the larval life-cycle there are two forms, the pre-feeding zuphea and the post fed praniza.

Smit and Davies, 2004



One species is represented by four distinct morphologies. As I mentioned in the last slide there is the pre-feeding zuphea, the post feeding praniza and the non feeding male and female. Initially four different genera were erected, mistakenly two genera were created to include both males and females while a third was created for pranizas and a fourth for zupheas. Such confusion over this group led to great controversy in the litterateur for some time. In the late eighteenth and early nineteenth century several researchers began rearing experiments (Wagner, 1866, Dohrn 1870, Haswell, 1885, Beddard 1886, Sars 1898, Smith 1904, Monod 1926) and started to recognize that these were all different morphologies of a single species increasing the taxonomic understanding of the group.

Smith 1904

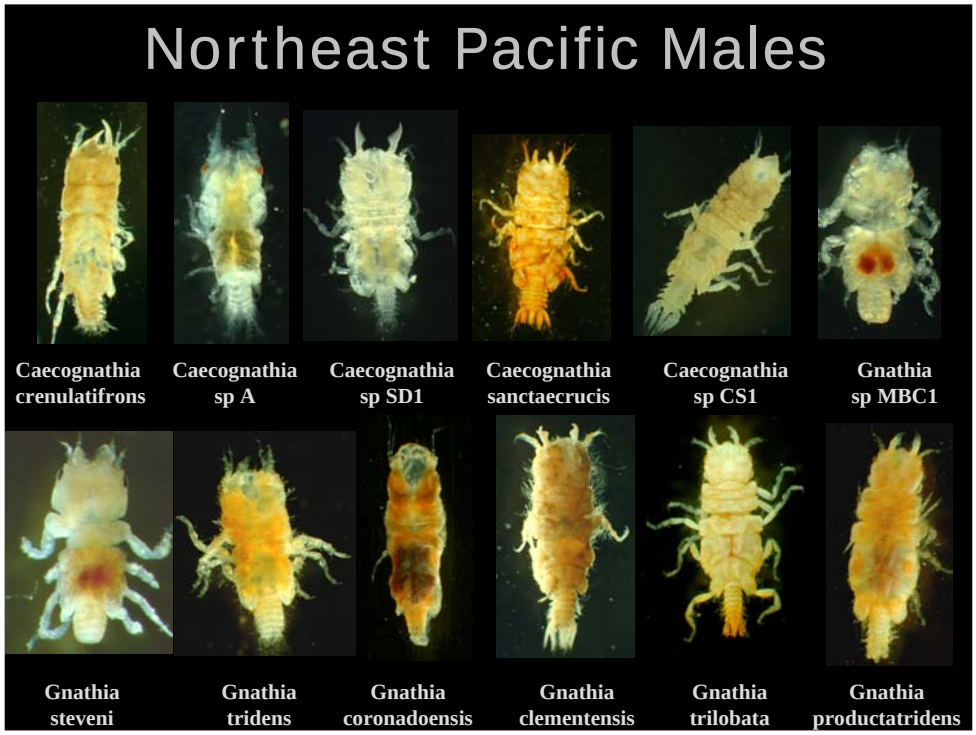


Mouchet in 1928, was the first to provide evidence of the bi-phasic life-cycle of the group. His work has since been confirmed by many authors. The basic life-cycle is as follows: the brood is released from the female all as prefeeding zupheas who quickly look for a host off which to feed. They are known to parasitize a wide range of both teleost and elasmobranch fishes. Since larval forms have not traditionally been identified to species in many parasitological studies, it is unclear if they are completely opportunistic at each stage or exhibit host preferences. Once they find a host they feed for minutes or hours, as long as it takes for them to become fully engorged, at which point they are referred to as a post feeding praniza. They then drop off, settle out, and seek shelter where they can process their meal and then molt. This would be the first larval stage. After molting they become a stage two zuphea and begin another host cycle. The morphologies of the zupheas and pranizas remain exactly the same in each stage, the only difference is an increase in body size. After the third stage the post feeding praniza again returns to the benthos to look for shelter and will then molt into the first adult stage as either a male or female. This last blood meal will be all they have to nourish them from that point on.

Gnathiidae: Diversity

- Distributed Worldwide
  - 10 genera
  - ~172 species
- Habitats
  - Marine
  - Brackish
  - Possibly Fresh Water
  - 0 – 3800 meters
  - Wide variety of fish hosts
  - Plankton trawls
  - Sediment

Read the slide



In the NEP there are 2 genera and 12 species. 8 are described and four are new to science. Again, typically only the males have been identified.

Identifying Males

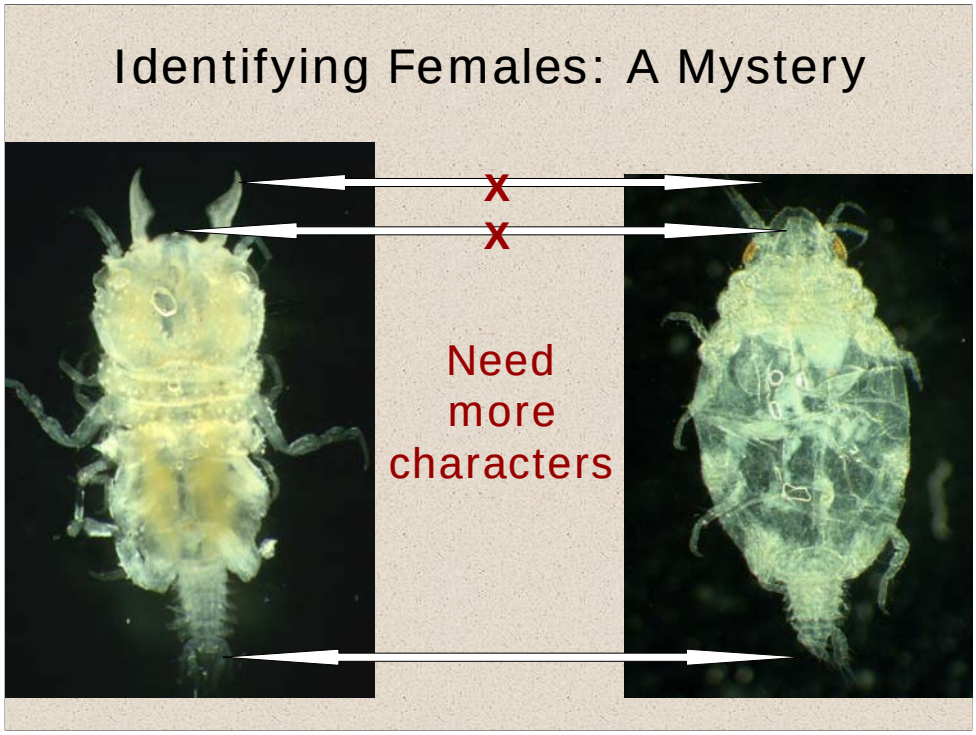
Mandibles

Frons

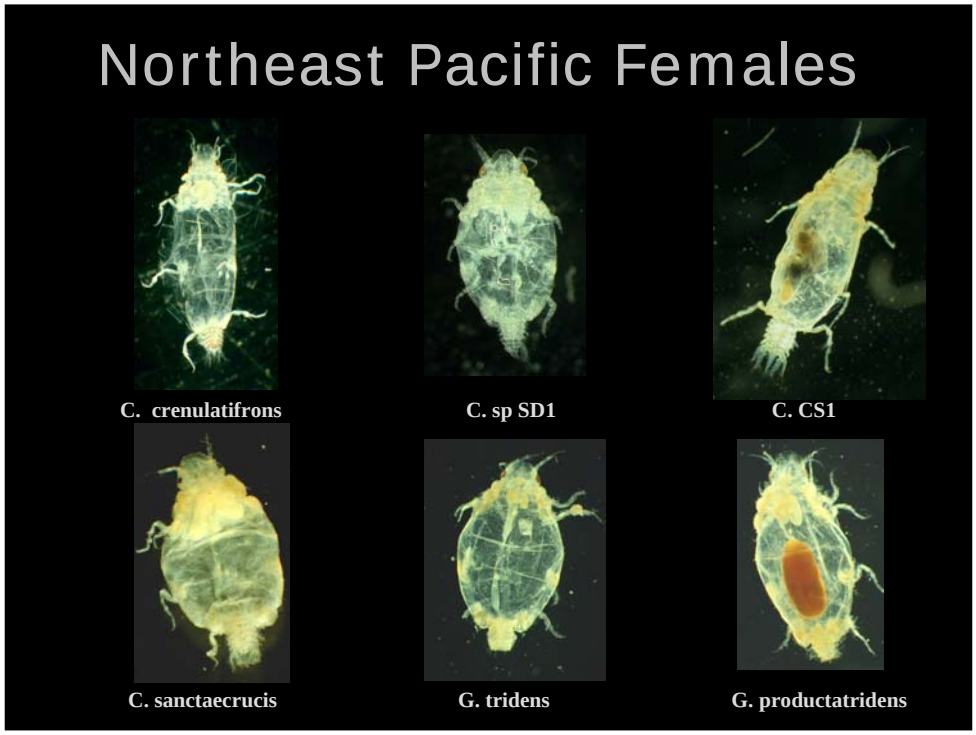
Three Main Characters

Pleotelson

Three main characters help separate gnathiid males. The structure of the mandible, pattern of the frontal margin or frons, and the shape of the pleotelson.



When trying to link females to males, however, it becomes clear pretty quick that two of three characters are specific only to males, making it extremely difficult to link the sexes. Obviously we need to find other morphological characters that show high fidelity between these two genders and test them to see if they used as a reliable method for making species level identifications.



In an attempt to do that, I began going through material from various agencies here in Southern California and found six distinct females. In each case the female was collected with a male that could be identified. The question still remained however, how can one reliable determine if the female is indeed the same species as the male?

Character Clues for Matchmaking

Body Size & Shape

Pigment Patterns

Body setosity

Eyes (present/absent)

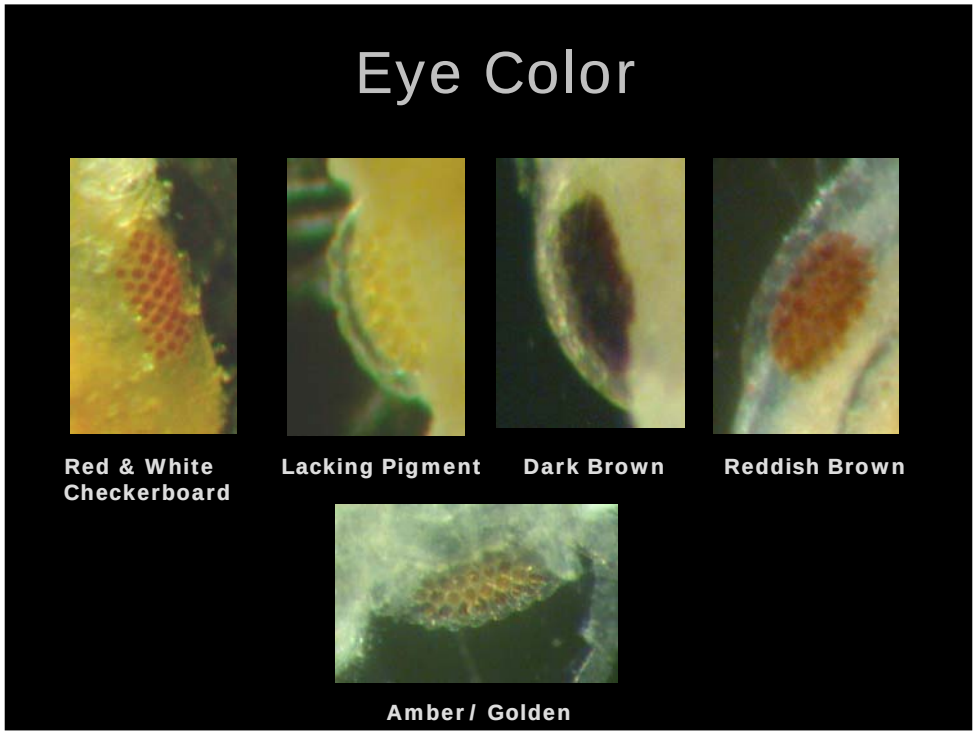
Eye Color & Shape

Epimere Condition

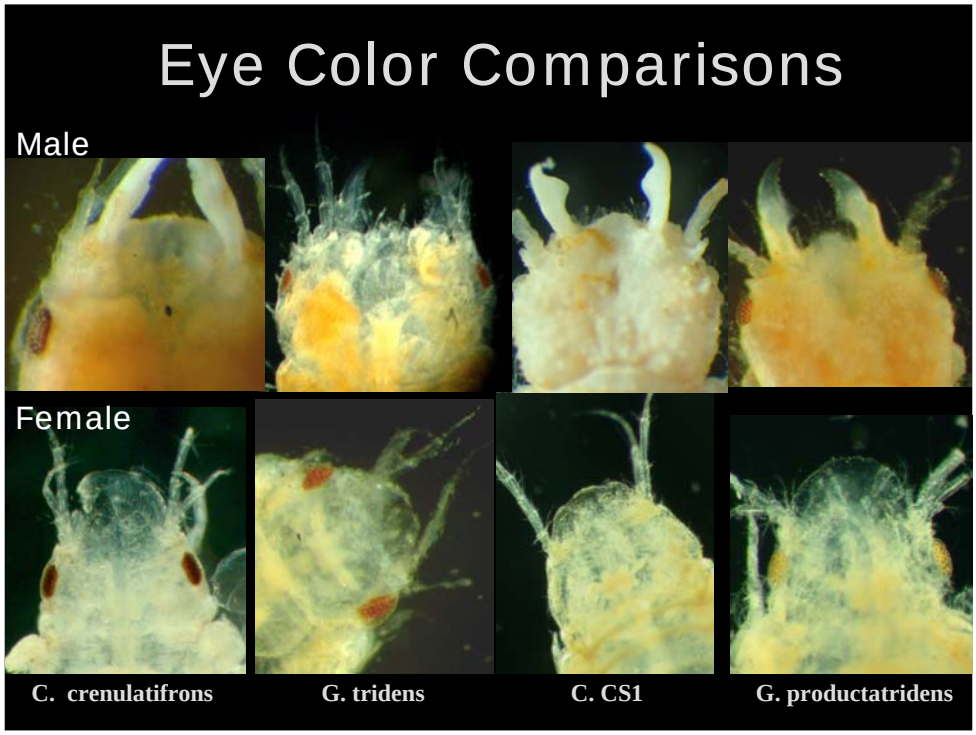
Pleopod Shape

Pleotelson Size & Shape

In an attempt to resolve that question, I began to review the literature for clues as to which characters may prove most beneficial. Cohen and Poore 1994 did a lengthy review of the family and performed a cladistic analysis using 72 morphological characters. I used their character list as a starting point for comparing and contrasting the morphology of the two sexes. In addition, I used characters that Dr. Smit mentioned in various publications as being potentially useful in distinguishing females. In all, the characters listed here showed the highest fidelity and were the most practical and least subjective. In comparing and contrasting these characters, it became clear though, that no single character would work to identify a female to species but one would need to use a combination of these characters to make an accurate identification. To demonstrate the usefulness of these characters, I'm picking a few for this presentation to show you the male female comparisons that I think make the case for using these characters pretty compelling.

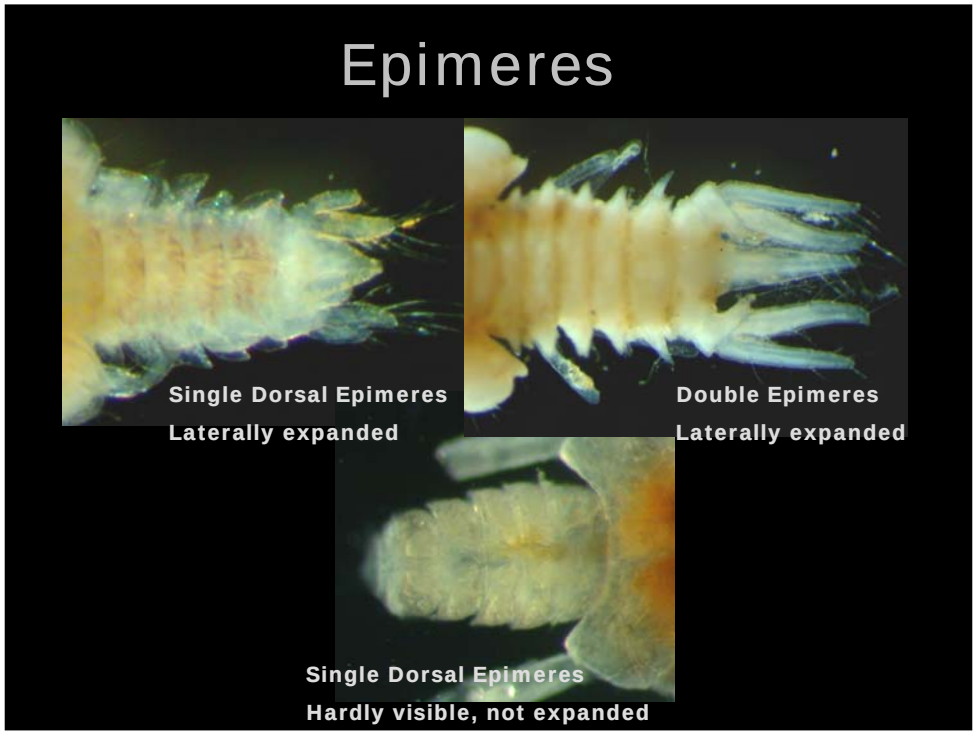


When I first started looking at specimens, the most noticeable character to me, was the eye color. Eye color had not been mentioned in the literature but I decided to include in my list of characters anyway. In looking through all the male material that I had for the NEP, I found five distinct character states for eye color. List the following.

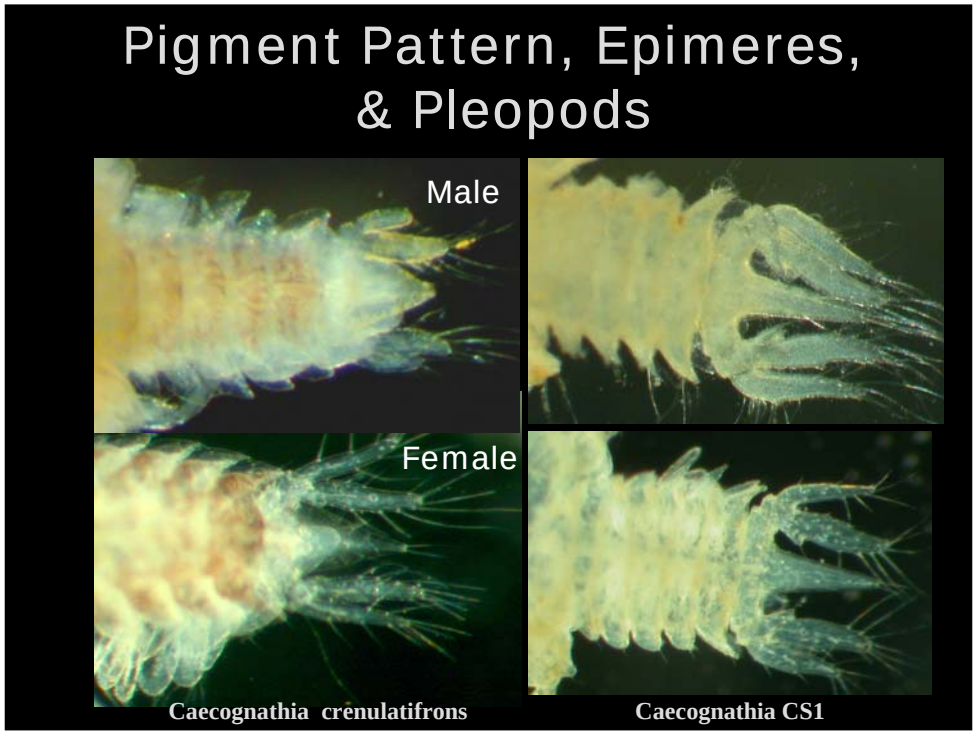


In each case, the female I found with the associated males, had the exact same eye color. This was true for both live and recently preserved material. Review pictures.

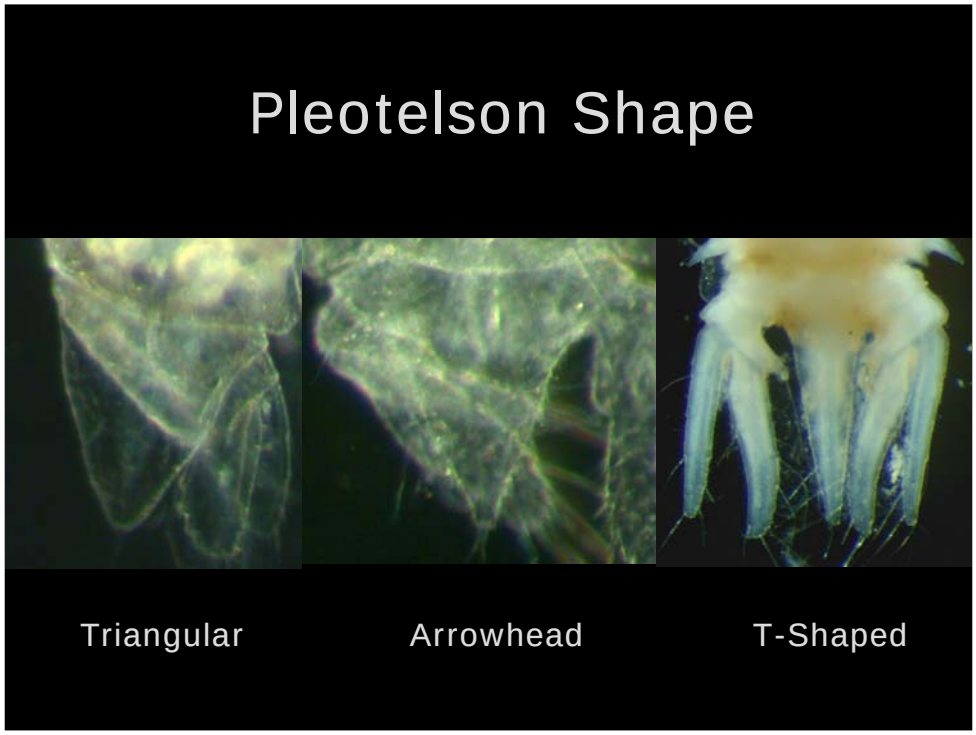
As I mentioned, this was probably the most obvious character, because the eyes are large and the colors states were easily distinguishable. Unfortunately eye color in some of the species seemed to fade after five or more years in preservative. In other species though the pigment remained even after thirty years or more in preservative. So all though I think this is a great character, it is probably best used within the first five years of collection.



Another strong character on the list is the condition of the epimeres. In reviewing the male material, I found basically three conditions, go over them.



In each case, the female demonstrated the same character state as the male on the abdomen. If the male had a pigment pattern, the female did as well and in most cases was even more prominent. If the male did not have pigment patterns, neither did the female. Compare and contrast epimeres and pleopods.



And finally, Telson shape was also a distinctive character that was shared between sexes. Again in the male material I found three specific states:

Pleotelson shape was similar between the males and females. The structures were more calcified and thus more defined in the males. In the females the pleotelsons were less calcified and more transparent making them a little more difficult to see but in the end the expressed the same morphology.

Character Clues for Matchmaking

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Eyes (present/absent)

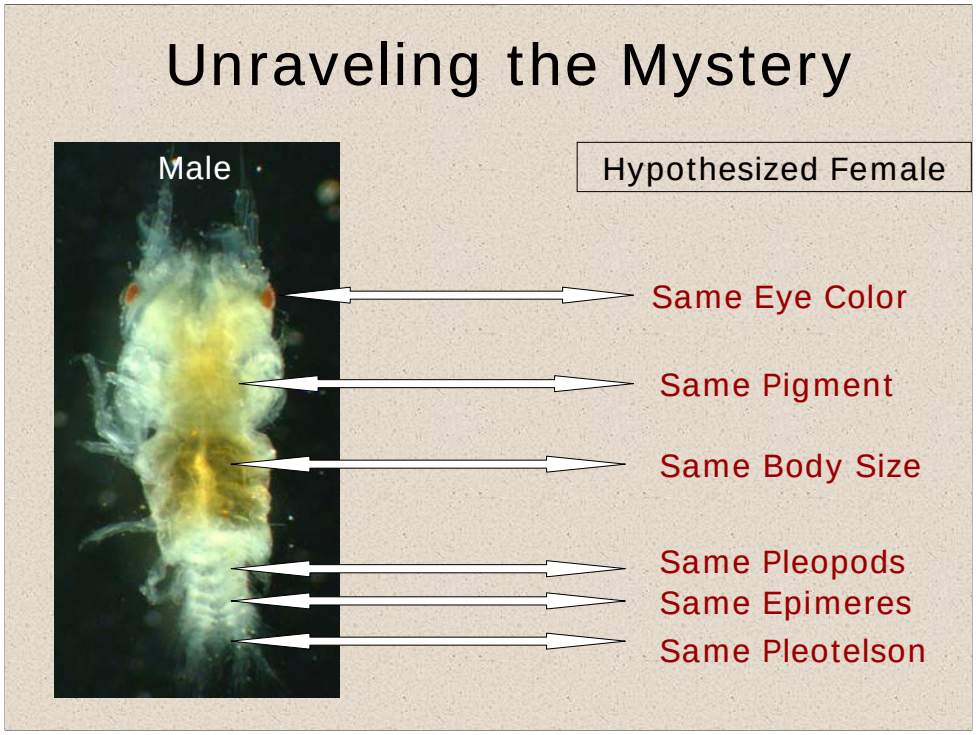
Eye Color & Shape

Epimere Condition

Pleopod Shape

Pleotelson Size & Shape

So although no single character will enable one to assign the female to a particular species, this combination of characters does provide a mechanism of finally identifying females to the species level. Because these characters worked so well for all six male-female pairs that I observed, and I expect now, based on the trends I showed here, that we could predict what the females for the remaining male species might look like.



So I'm putting forward the concept of the hypothesized female. Here I have a male, for which the female has not yet been encountered, but I hypothesize that the female will have certain expressed character states based on what I see here in the male. Review slide. I expect this would also work in the reverse as well, meaning these characters are the ones best used to differentiate individual species.

The field of taxonomy has received some criticism and has been described as more of a descriptive discipline rather than one that creates testable hypotheses. I believe taxonomy still serves an important purpose in resolving and understanding difficult groups. And in many cases, there are opportunities such as this to propose taxonomic hypotheses. It is my hope that people working with this group of isopods will test the hypothesis I put forward here.

Further Investigation

- Look at larval forms, develop similar taxonomic tools
- Perform cladistic analysis for NEP taxa and determine if current generic characters are valid
- Collaboration on host specificity

Further work is needed to link larval forms adults. Providing a method to identify these to species is certain to be of interest to fish parasitologists. I will be pursuing this in the next year and hope to return to SCAS next year with those results.

Once I have a good handle on all the characters and what works well for linking all the stages together, I plan to run a series of cladistic analyses on the limited NEP fauna. I'm hopeful that this may provide clues for better characters to separate the two genera found locally, Caecognathia and Gnathia. As currently diagnosed there is only one definitive character separating the two and this character is of course based only the male morphology and is not applicable to non-males and is completely subjective in nature leaving most taxonomists who study this group uncertain of their validity. The two genera were synonymized in the past but were probably correctly separated out again in Cohen and Poore's revision of the family in 1994. The current diagnoses provide no mechanism to place females or larval forms though and it would be beneficial to rediagnose these genera based on characters that were applicable to all life-stages of a particular species.

Lastly, I'll be collaborating with Juli Kalman from Cal State Long Beach on a study of larval host specificity. Are species purely opportunistic or do they show an affinity for particular species of fish?

www.SCAMIT.org

- Southern California Association of Marine Invertebrate Taxonomists
  - Taxonomic Tools
    - Key to NEP Gnathiid males
    - Key to NEP known & hypothesized females
    - Character Chart (males)
    - Character Chart (females)
    - Numerous Photos documenting characters
      - Male comparisons
      - Female comparisons
      - By individual species

In the process of developing methods of linking males with females, I developed a series of taxonomic tools that I hope prove to be useful to folks working with this group. I will be posting them online at www.SCAMIT.org.

You should be able to find the following tools posted on the website, under taxonomic tools by June 1, 2006.

Acknowledgements

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