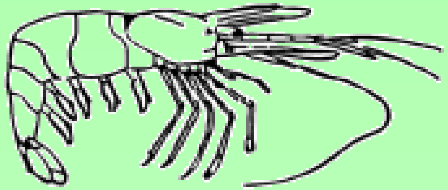
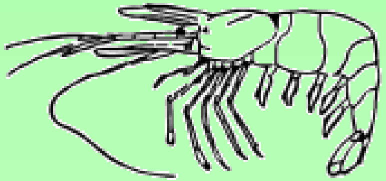


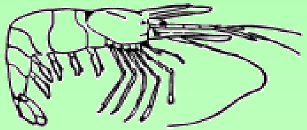


Consumption and digestion of suspended microalgal species common in biofloc culture systems by juvenile Pacific white shrimp *Litopenaeus vannamei*

Megan R. Kent[1], Craig L. Browdy[2], and John W. Leffler[3]

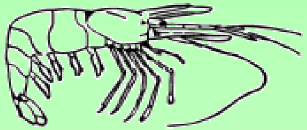
[1]College of Charleston [2]Novus International, Inc. [3]South Carolina Department of Natural Resources

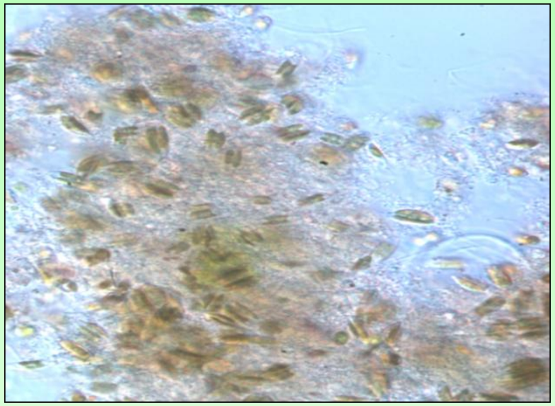
Understanding biofloc culture systems



- *L. vannamei* growth in microbial biofloc aquaculture systems is superior to that in clearwater
- Shrimp consume biofloc
- Growth rate fluctuates with community composition
- Filtration in the form of sand filters, foam fractionators (skimmers), or settling of pond particulates can be beneficial to shrimp growth

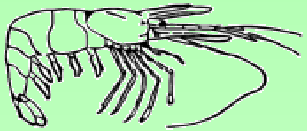
Filtration is beneficial?





- Turbidity and suspended solids
  - Increased biological oxygen demand
  - Potential gill fouling and stressing
- Filtration allows for development of a predominately photoautotrophic biofloc community
  - Capable of greater production, and lower FCR than a heterotrophic community
- Drawback: sludge production= possible fertilizer?

Understanding the ‘growth factor’



- Do *L. vannamei* have the ability to consume individual suspended cells from biofloc?
  - Determines what form of floc particle can be consumed by shrimp
- If consumed, do shrimp have the ability to digest these cells?
  - Determines if shrimp can thereby access nutrients within certain biofloc cells

L. vannamei digestion

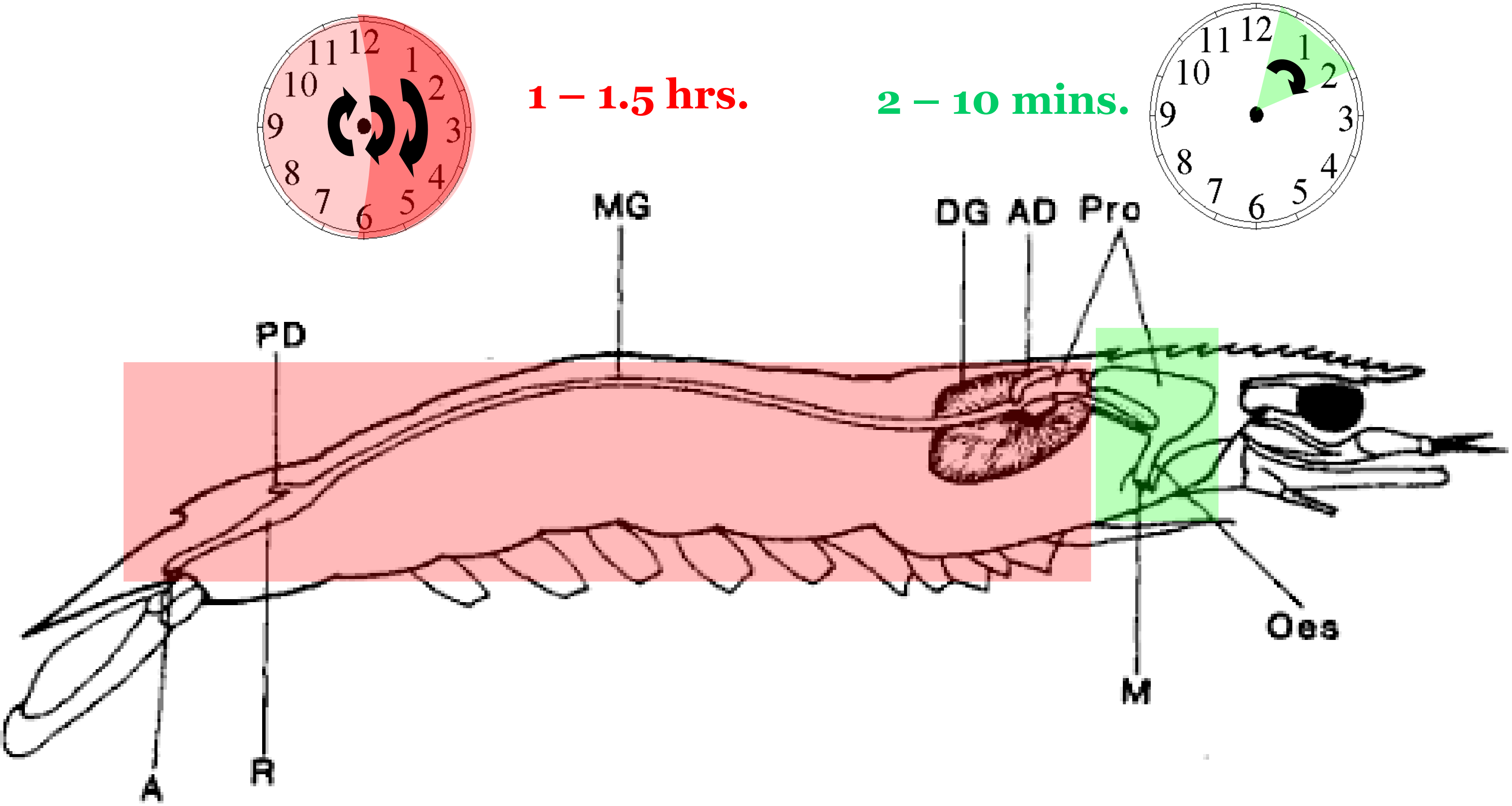
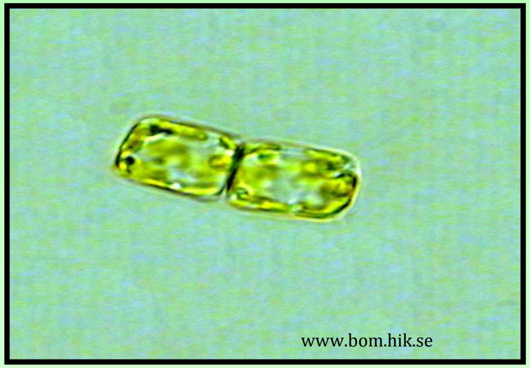
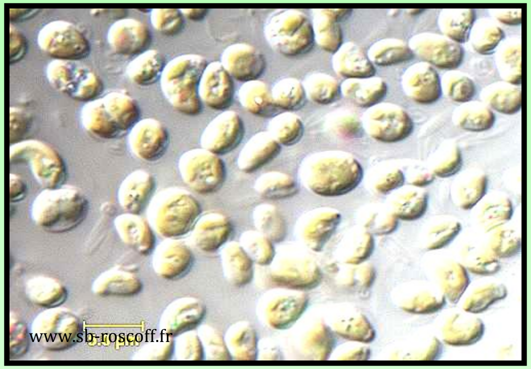


FIG. 2.13. The digestive system. A, anus; AD, anterior diverticulum of midgut; DG, digestive gland; M, mouth; MG, midgut; Oes, oesophagus; PD, posterior diverticulum of midgut; Prov, proventriculus; R, rectum. (Dall *et al*. 1990, The Biology of Penaeidae)

Common photosynthetic biofloc microbes

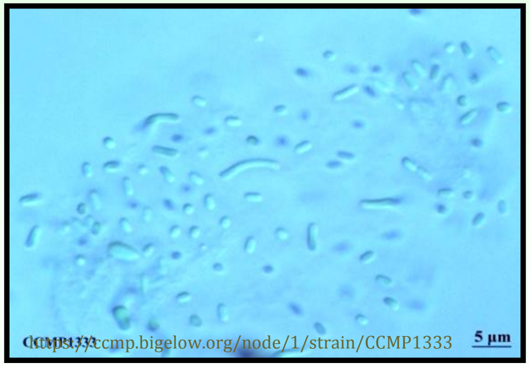


Thalassiosira weissflogii
Diatom, pelagic
(10-12 x 12-22 µm)



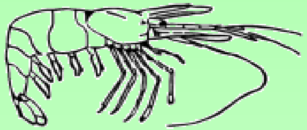
Nannochloropsis salina
Eustigmatophyceae
[thick cellulose cell wall]
(1-4 x 2-8 µm)

Amphiprora sp.
Diatom, benthic
(15-25 x 35-75 µm)



Synechococcus bacillaris
Cyanobacteria
(1-2 x <1 µm)

Methods

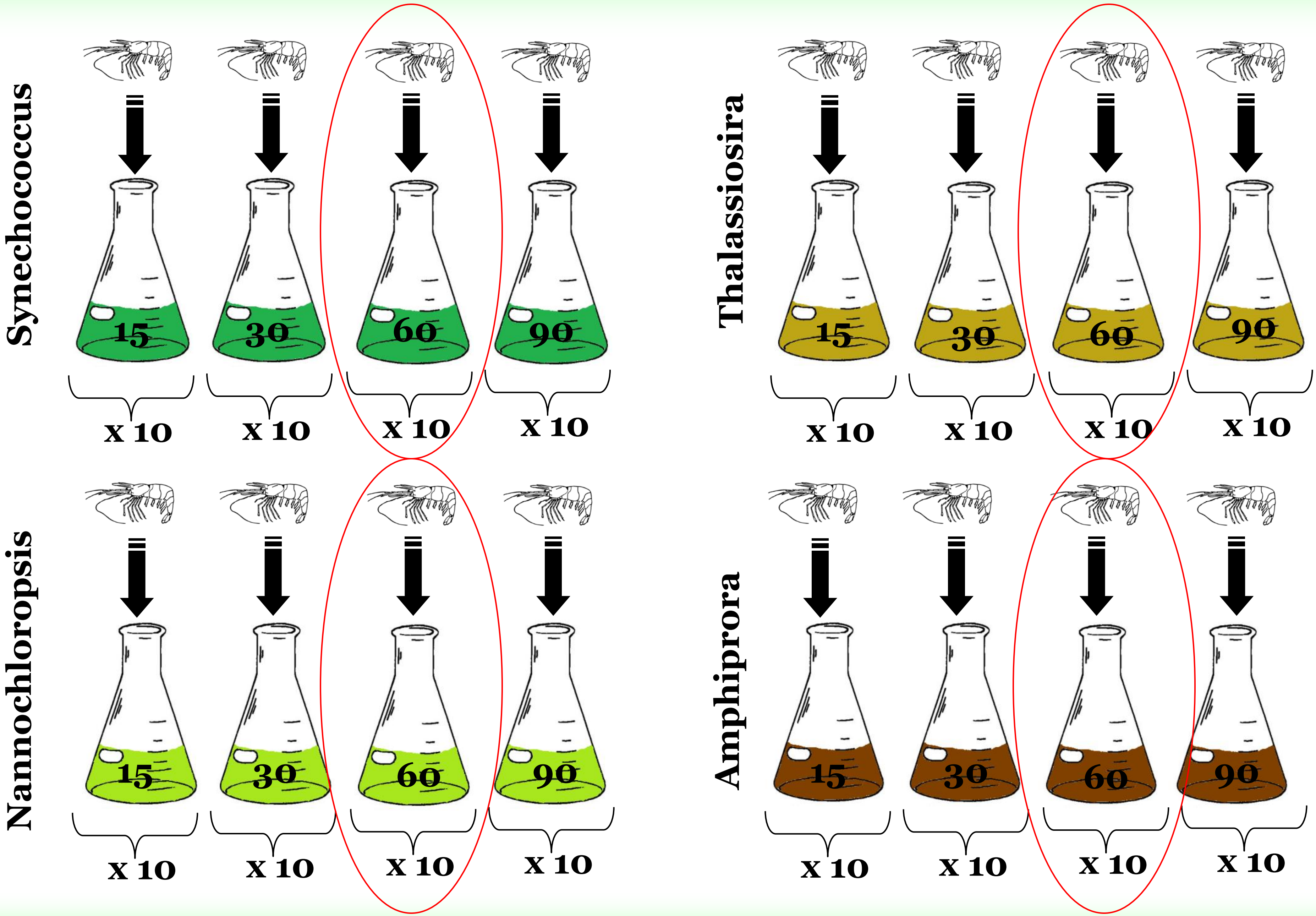


– Produced biofloc-typical monocultures of:

Amphiprora sp.
Thalassiosira weissflogii
Nannochloropsis salina
Synechococcus bacillaris

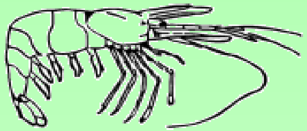
– Placed starved (24 h) shrimp (2g   0.2) in individual 1L Erlenmeyer flasks of aerated algal monocultures.

- Designated 40 shrimp for each treatment, 10 each for four immersion times (ITs): 15, 30, 60, and 90 minutes.



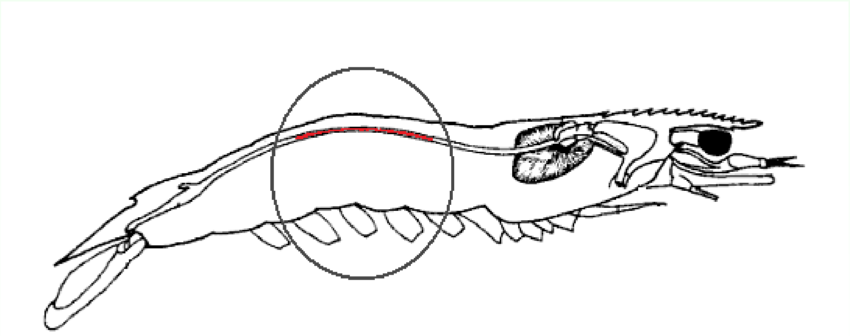
+ 10 per treatment (For epifluorescence cell counts)

Methods II



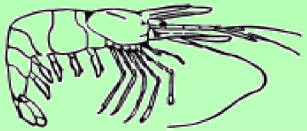
– Left shrimp for designated ITs, then euthanized and dissected them to remove the stomach (proventriculus) and intestine.

– Assessed samples from stomach and intestine for chlorophyll *a* concentration (at all ITs) using fluorometry and presence of whole microbe cells (at IT 60 min.) using epifluorescence.

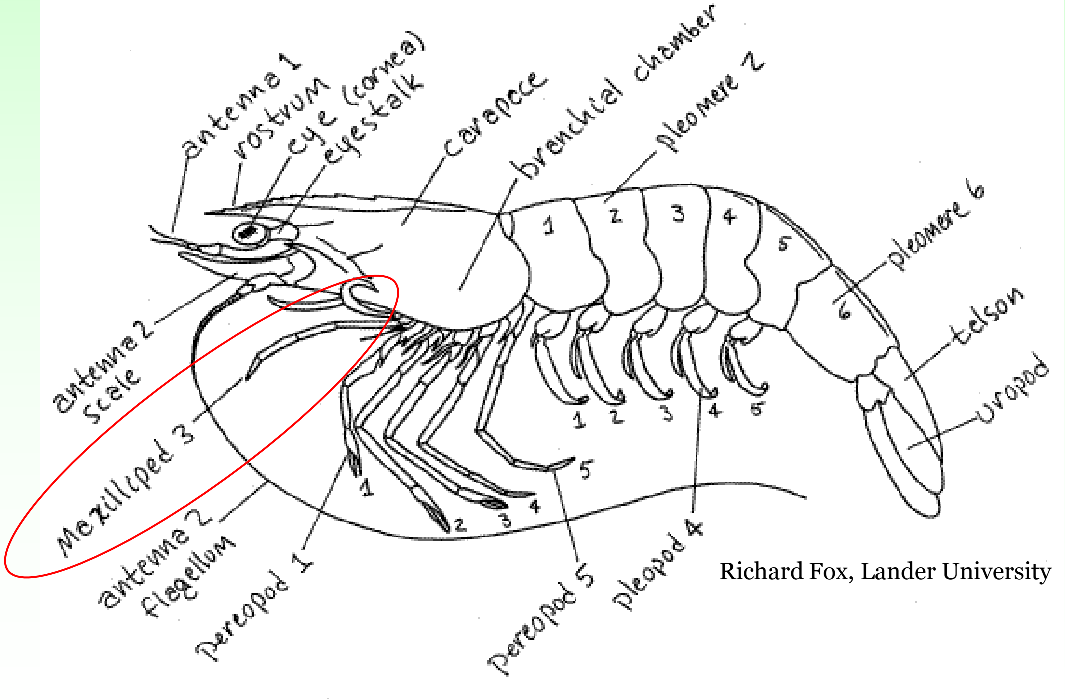


Modified from Dall *et al.* 1990 "The Biology of Penaeidae"

Methods III



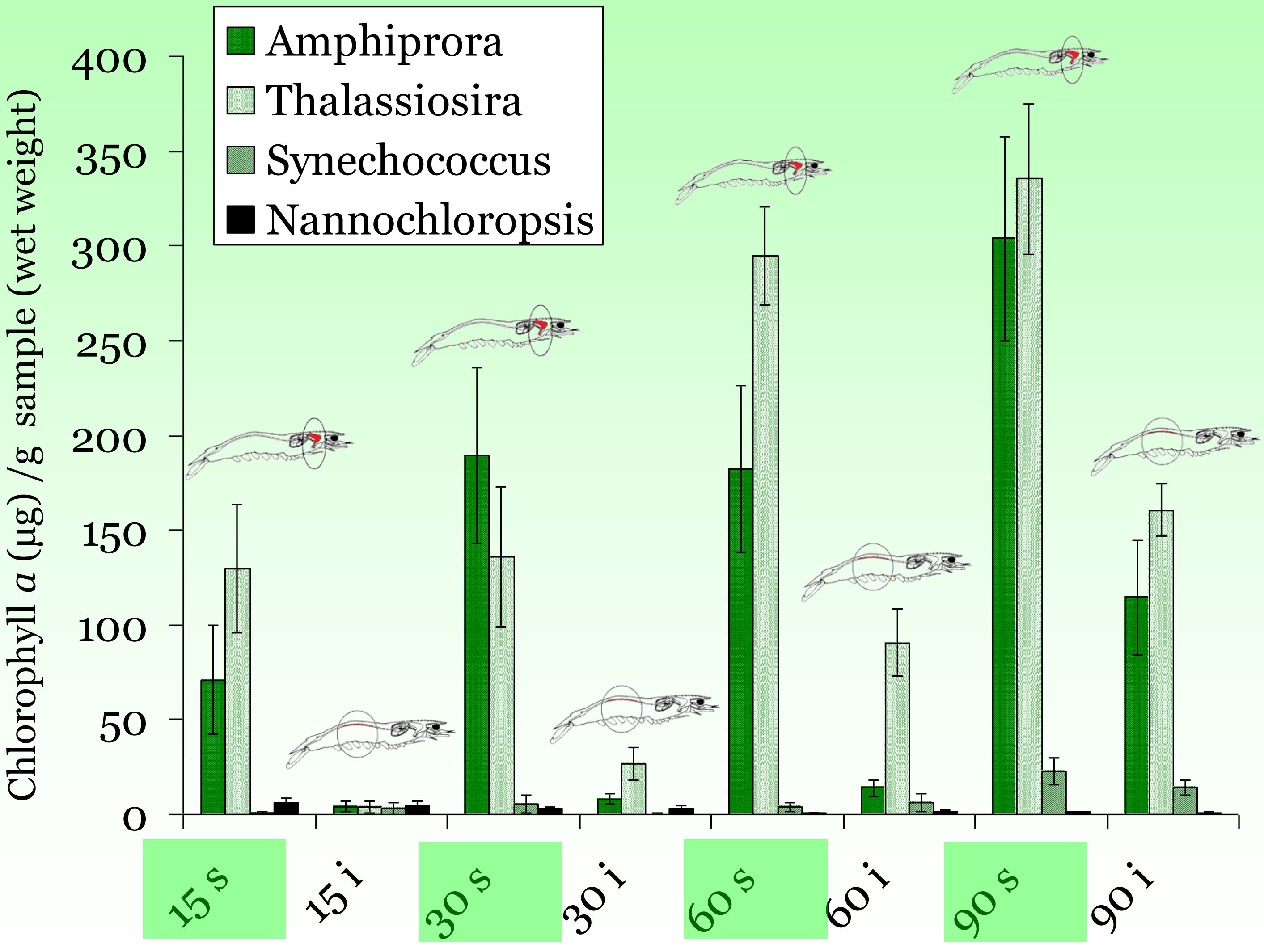
- Observed ‘sweeping’ movement of shrimp 3rd maxillipeds, a possible feeding behavior. Collected 3rd maxillipeds and examined them under scanning electron microscope.



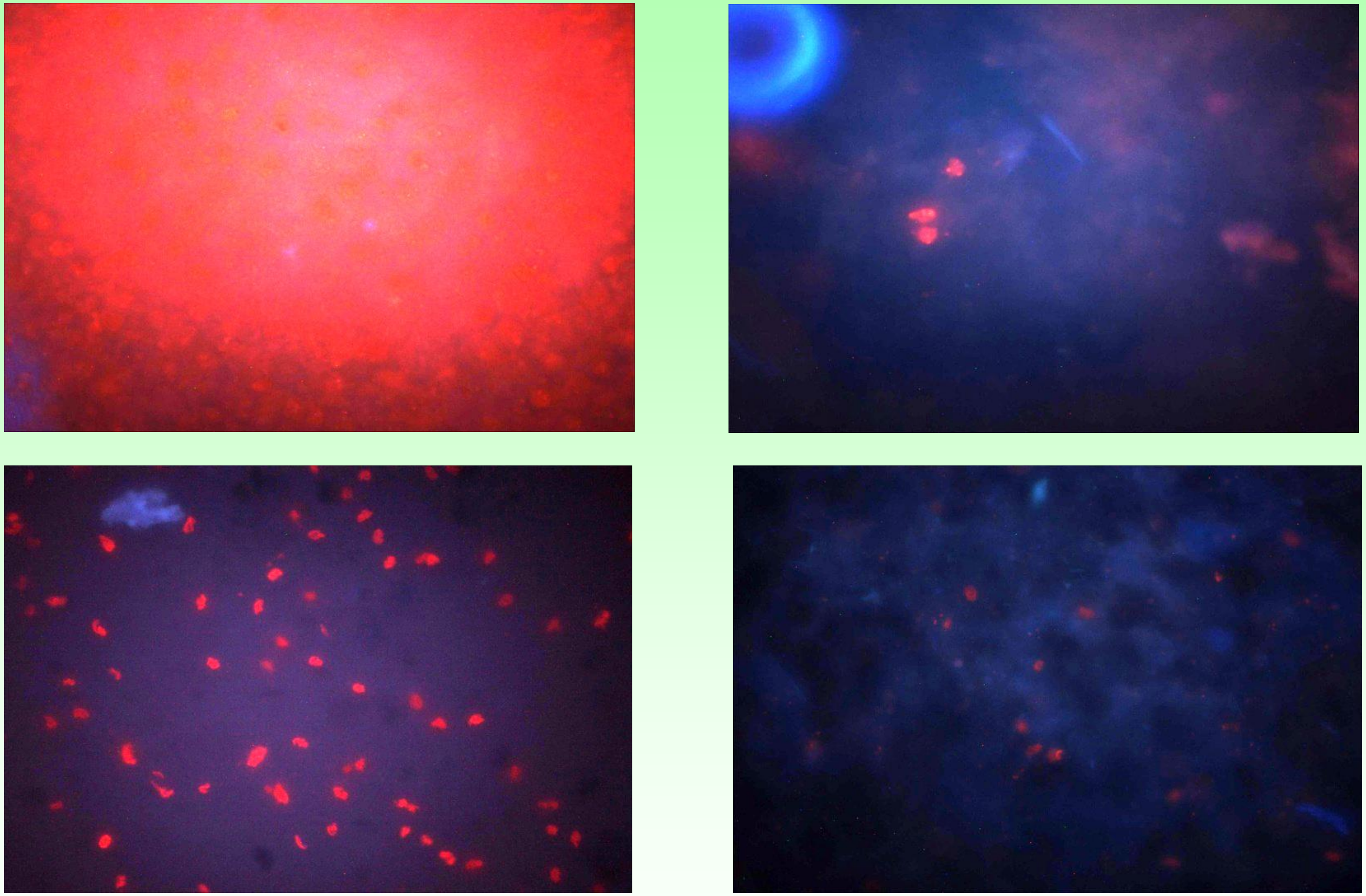
Richard Fox, Lander University

Results

Consumption and digestion (via fluorometry)

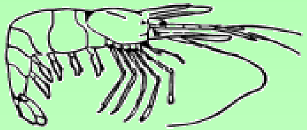


Results II



Clockwise from top: *Thalassiosira* in stomach, *Thalassiosira* in intestine, *Amphiprora* in intestine, *Amphiprora* in stomach

Results III



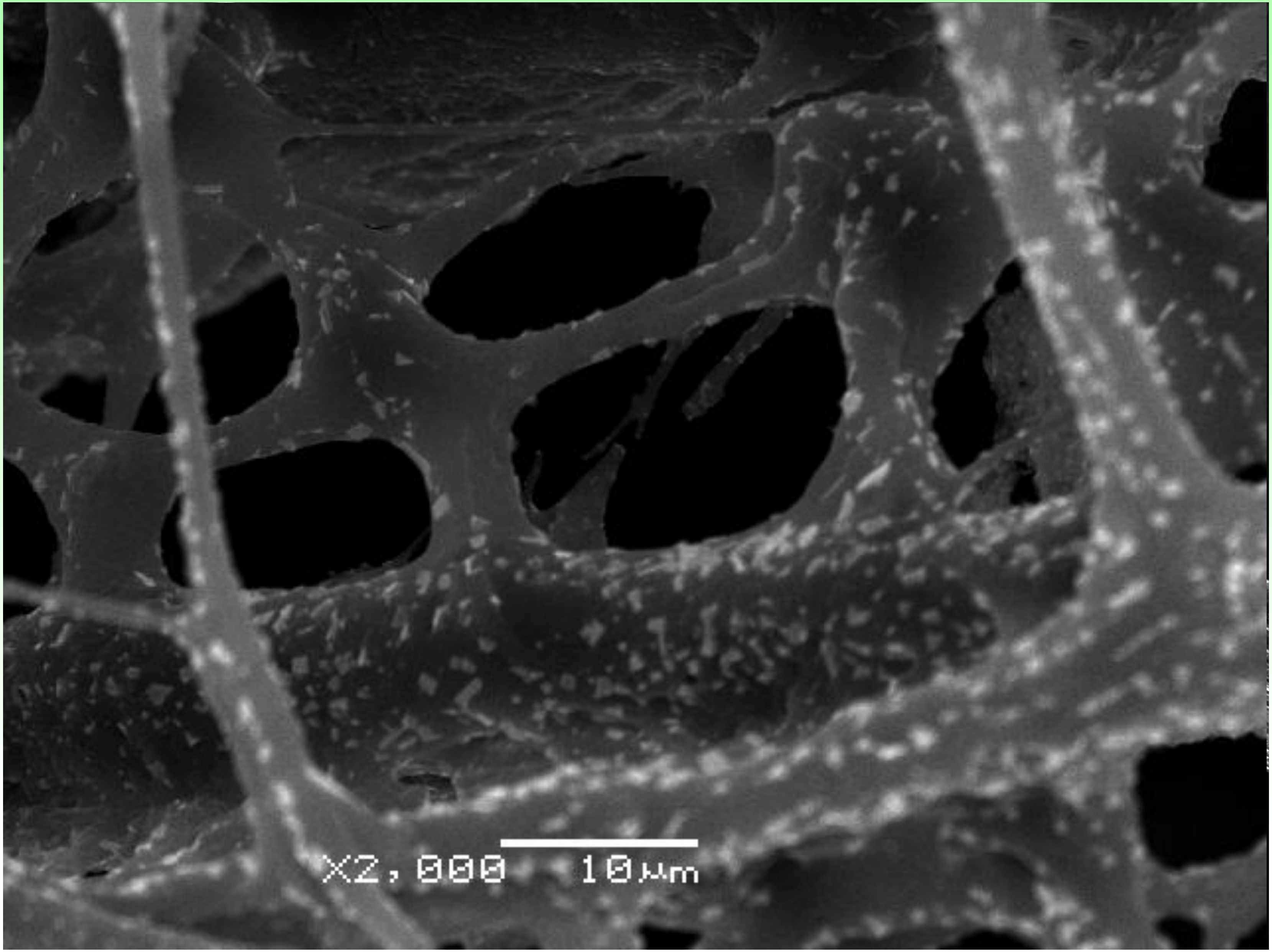
- **Shrimp were able to ingest both *Amphiprora* sp. and *T. weissflogii* readily.** *N. salina* and *S. bacillaris* were only ingested to a very limited degree.

- Shrimp submerged in the two diatom treatments contained significantly higher (ANOVA, $p<0.05$) concentrations of chlorophyll *a* in stomach samples than in intestine samples across ITs. Epifluorescence counts also yielded higher numbers of intact cells in stomach samples than in intestine samples (ANOVA, $p<0.05$) . These data signify **digestion of both diatoms**.

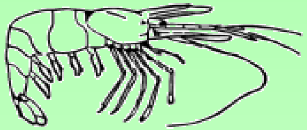
- Digestibility of *S. bacillaris* and *N. salina* could not be determined due to low consumption rates and data variability.

Results IV

Results V



Conclusions and implications



- Since *L. vannamei* can consume and digest ***Thalassiosira* and *Amphiprora***, they **may potentially provide nutritional benefit**.

- Furthermore, behavioral observations and microscopy suggest that selective uptake of microbes from the water may be related to a sweeping behavior of the **3rd maxillipeds**, which could potentially form a type of **filtering** net.

- May signify that improved shrimp growth in filtered biofloc may be due to **better access to** these easily consumable, nutritious, **photoautotrophic algae** (in addition to improved water quality)

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