Competition and niche segregation following the arrival of Hemigrapsus in the formally Carcinus maenas dominated delta


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Introduction

- Invasions change things
  - Environment
    - Substrate
    - Spatial heterogeneity
  - Communities
    - New predators
    - Parasites/diseases
    - Fouling
    - Competitors
      - Food
      - shelter
Invasions change things

- Facilitate other invaders
  - Open niches
  - Provide microhabitats
  - Provide food source
A CRAB INVASION

- Carcinus maenas has been dominant for a long time in the Delta on both hard and soft substrates
- Hemigrapsus (takanoi and sanguineus) arrived in the late 1990s
  - Possibly with oyster transport
  - Spread rapidly

Both

What effect did the arrival of Hemigrapsus have on the resident population of Carcinus maenas?
Methods

- Long term sampling in the Delta
  - Monitoring task group NIOO (NIOZ) 1990-2010
  - Core sampling throughout Delta waters
    - Technique validity is limited for crabs but still useful for
      - Distribution
      - Large scale (time and space) ideas
      - Large individuals likely to be underestimated
  - Sediment type recorded (soft or with hard elements)
  - Crab size classes
  - Data separated into
    - 1990-1998 = pre *Hemigrapsus*
    - 1999-2004 = early *Hemigrapsus*
    - 2005-2010 = established *Hemigrapsus*
Methods

- Snapshot of crab community
  - May – June 2011
  - 10 locations in Oosterschele
  - Hard substrate (dyke edges)
    - Rocks + sand/mud
    - Rocks + Oyster shells
  - 1hr search with two people – collect all crabs
  - Crab species identified
  - Crab size classes recorded
Results: long term survey

- Data set: 13600 samples (small % included crabs)
- *Carcinus* densities fluctuating but declining pre *Hemigrapsus*
  - Significant decrease over 20 year period
  - Encounter rate 2.9% of samples in 1997-2003 to 1.8% in 2004-2010
- *Hemigrapsus* first observed in samples from spring 2004
  - From that time on *Hemigrapsus* was more abundant than *C. maenas* (until 2009)
Results: long term survey

A. Grevelingen
- Carcinus maenas
- Littorina sp.
- Portunus latipes

B. Oesterschelde
- Cancer pagurus
- Carcinus maenas
- Hemigrapsus takanoi
- Littorina sp.
- Nucella lapillus
- Nucella lapillus
- Pecten maximus
- Pleuronectes platessa
- Thais clavigera

C. Veerse Meer
- Carcinus maenas
- Hemigrapsus takanoi
- Littorina sp.
- Nucella lapillus
- Nucella lapillus
- Pleuronectes platessa

D. Westerschelde
- Carcinus maenas
- Hemigrapsus takanoi
- Littorina sp.
- Nucella lapillus
- Nucella lapillus
- Pleuronectes platessa
- Portunus latipes
- Rhithropanopeus harrisii
Results: long term survey

- Size classes
  - Minor change in size distribution of *C. maenas* between three time periods, but:
    - Decrease in proportion of smaller (0-10mm CW) crabs
    - The same size classes *Hemigrapsus* fills!
Results: long term survey

Oosterschelde 1990-1998

Proportion total population

C. maenas

Oosterschelde 1999-2004

Proportion total population

C. maenas

Oosterschelde 2005-2010

Proportion total population

C. maenas

H. takanoi
Results: long term survey

- Both crabs more abundant with hard elements in substrate
- With *Hemigrapsus*, total abundance is similar, but two species instead of one
Case Study: The Veerse Meer

- Fresh until 2006
- Both crabs could invade at the same time
- Small *C. maenas* less abundant than expected with local reproduction
- Small *Hemigrapsus* present in high numbers
Results: snapshot survey

- **Hemigrapsus** always most dominant
  - 81-98% of the sampled population
- **H. sanguineus** most abundant outside barrier
  - Proportion decreased further in Oosterschelde
- **H. takanoi** most abundant inside barrier
  - Differences in habitat preferences - energy
- **C. maenas** present in all locations in small proportions
  - 0.7-17.8%
Results: snapshot survey
Results: snapshot survey

- **Hemigrapsus**
  - size classes <30 mm CW
  - Peak for both species 10-15mm

- **Carcinus maenas**
  - None smaller than 10mm
  - No obvious peak
  - Juvs should be 16-30mm
Although *C. maenas* was always abundant and widespread, it was on the decrease pre *Hemigrapsus*

The arrival of *Hemigrapsus* may not have caused this decline, but has certainly taken advantage of it.
**Discussion**

- *Hemigrapsus* dominates habitats where *C. maenas* used to flourish
  - Size dependent competition of hard substrate?
- Small *C. maenas* forced into more vulnerable soft habitat?
  - No increase of small individuals on soft sediment
    - Soft sediment sink? = predation?
  - Decrease of small individuals
    - result of overall population decrease
    - Missed in sampling?
- Size refuge back on hard substrate?
**Discussion**

- **Jensen *et al.* (2002):** two *Hemigrapsus* species overwhelmingly outcompeted similar size *C. maenas* for shelter in the field and lab.
  - With *Hemigrapsus*: 20% juvenile *C. maenas* under rocks
  - Without *Hemigrapsus*: >97%

- **Lohrer and Witlatch (2001):**
  - Field: 40-90% decline in abundance of *C. maenas* with 10x increase in *H. sanguineus*
  - Lab: significant predation risk for small juvenile *C. maenas* with larger *H. sanguineus* and conspecifics, but not vice versa
Conclusion

Through probable size dependent competition for space with juvenile *C. maenas*, *Hemigrapsus* has taken over some niches previously occupied by *C. maenas*.

- Possibly also occupying previously unoccupied niches
Thank you

Any Questions?