# Comparative Study of the Reproductive Performance of Four Strains of *Artemia*

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Sea Grant
National Sea Grant College Program

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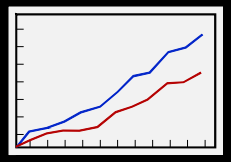
# This presentation evaluates important aspects of the ecological physiology of the genus *Artemia* in Puerto Rico

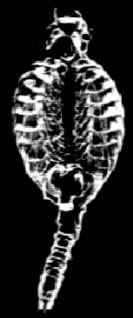
Background on the genus *Artemia* in Puerto Rico

International study on *Artemia*



Discussion of research data and conclusions

# *Artemia* are Anostracan Branchiopods that are well adapted to the extreme conditions of hypersaline environments



- Synthesis of hemoglobins
- Heat tolerance
- Flexibility in diet
- Production of resistant stages
- Efficient osmoregulation

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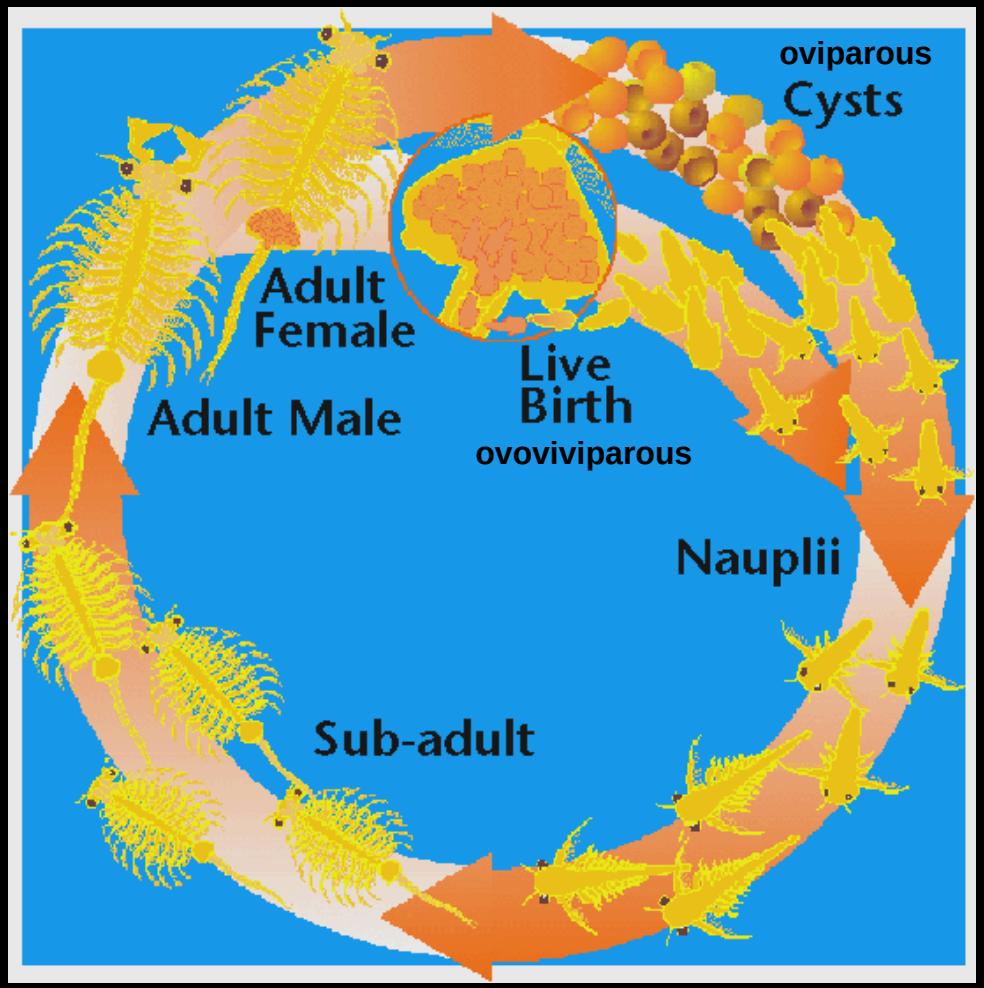
# Life cycle of *Artemia* is tightly coupled to the environment

There are sexual and parthenogenetic species

Continuous reproduction

Alternation of reproductive mode



# What is the importance of locating and characterizing populations of *Artemia?*

***Artemia* is a very important organism from an ecological and economic perspective:**

*Artemia* biomass is used in aquaculture (fish food)

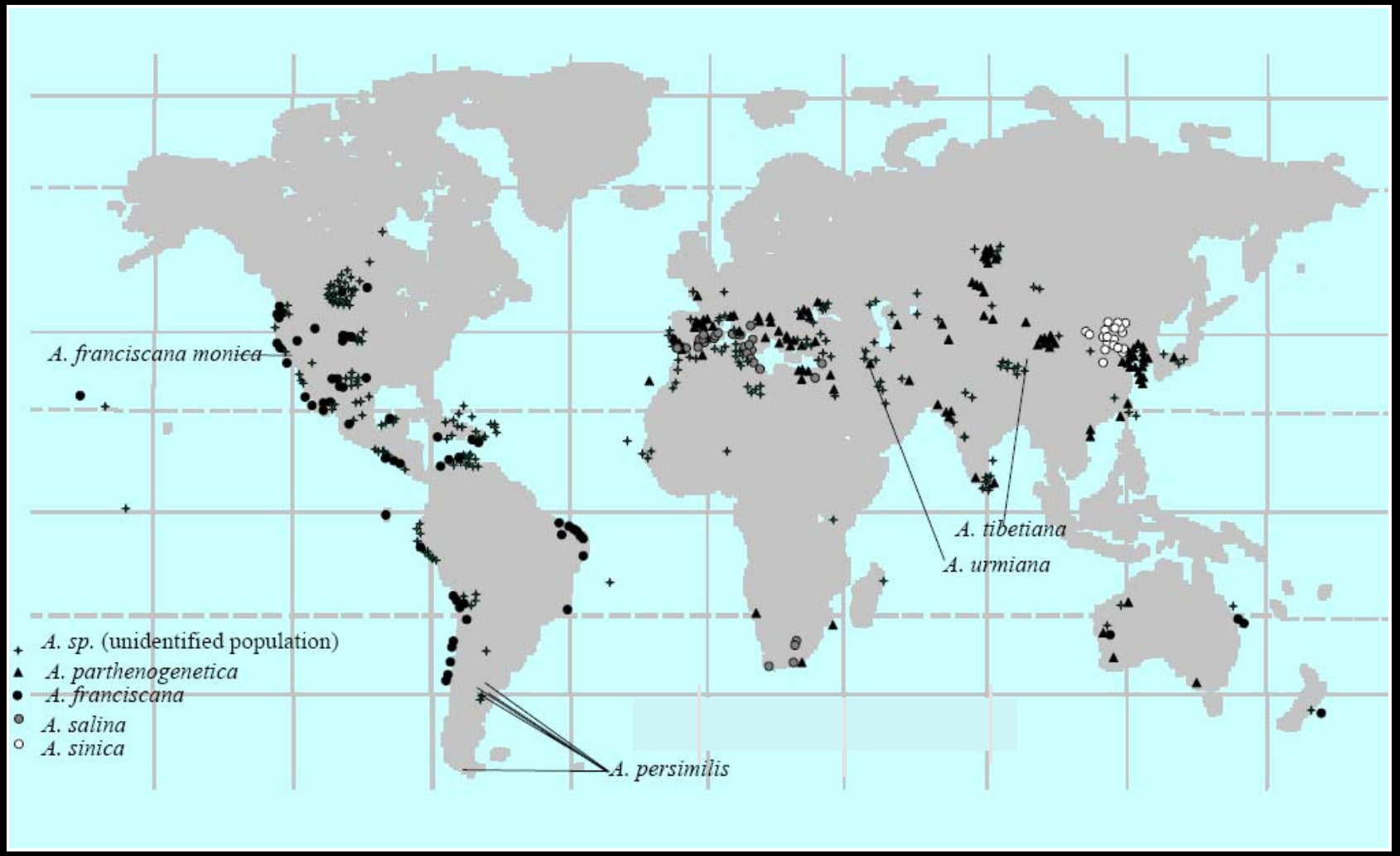
*Artemia* are important for the production of salt and for the survival of many species of birds in salt flat systems

# An eco-physiological characterization of local *Artemia* populations is very important

Development of management strategies for the Cabo Rojo salt flat system

Development of culture methods for the commercial production of *Artemia* biomass

# *Artemia* is widely distributed




Generated by Gilbert Van Stappen, *Artemia* Reference Center - Belgium

# The identification and characterization of *Artemia* species is part of an international initiative

A collaborative international effort is essential for the study of *Artemia* – urgent need for new sources = poor harvests in GSL

Interdisciplinary collaboration is very important

Uniformity of the methods

Dissemination of results

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# How do we characterize the different strains of *Artemia*?

Cross breeding tests

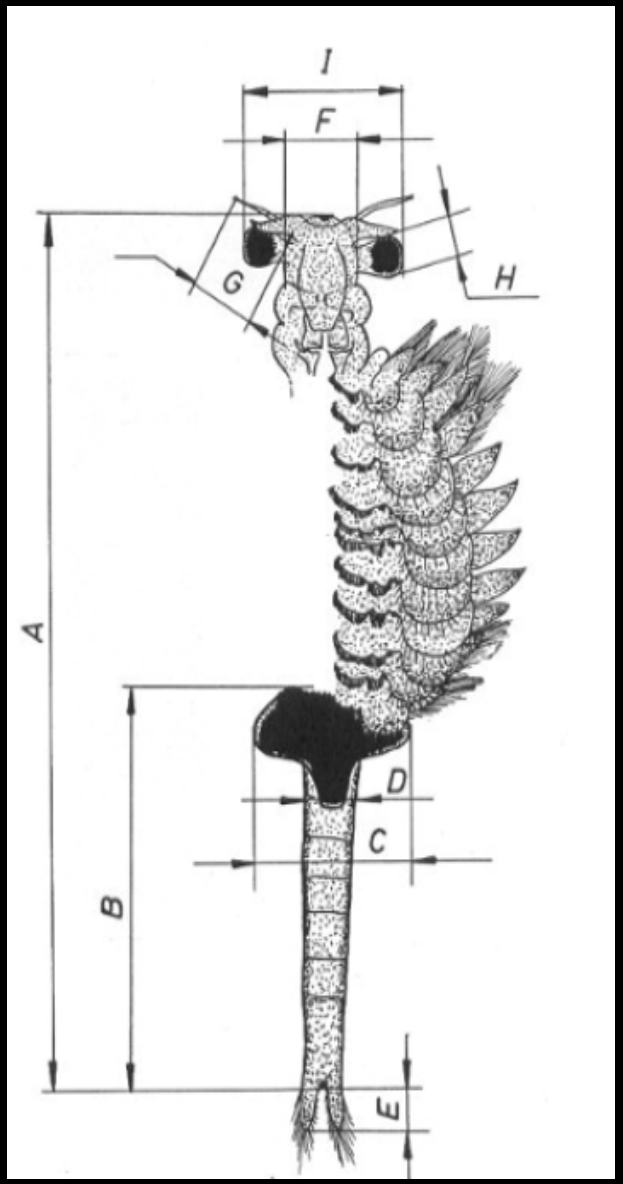
Biometrics (cysts and nauplii)

Reproduction and life-span

Allozyme studies

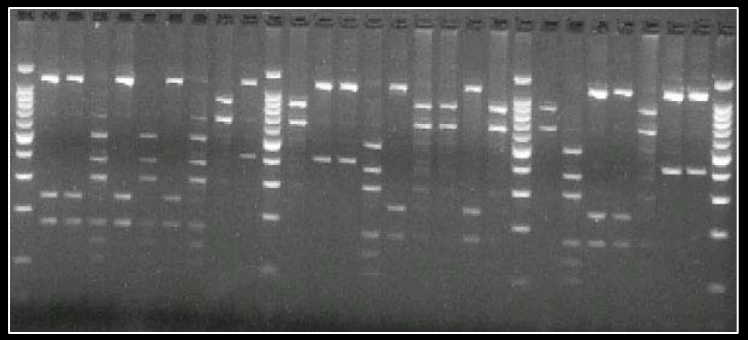
Cytogenetics

Molecular markers

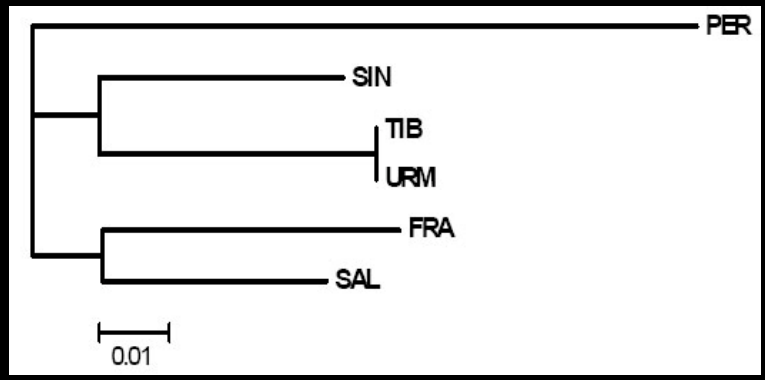


# Molecular methods

## Molecular markers



DNA polymorphism




Nuclear and mitochondrial DNA

- RFLP
- RAPD
- AFLP
- DNA sequencing

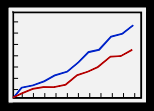
# What do we know about the biology of the populations of *Artemia* from Puerto Rico ?

Inhabit the waters of man made solar salterns

There are currently three populations of *Artemia* in Puerto Rico (Cabo Rojo Salterns, La Parda Saltern in Guánica and Papayo Salterns in La Parguera)

There is probably one population in Vieques

# What do we know about the biology of the populations of *Artemia* from Puerto Rico ?

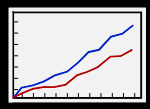


Mophometrically different from type population and among themselves

No indication of an intrinsic barrier to gene exchange between local and the type population

Differences in cyst eclosion profiles between the populations from PR and the type population

All the populations from Puerto Rico are sexual and diploid

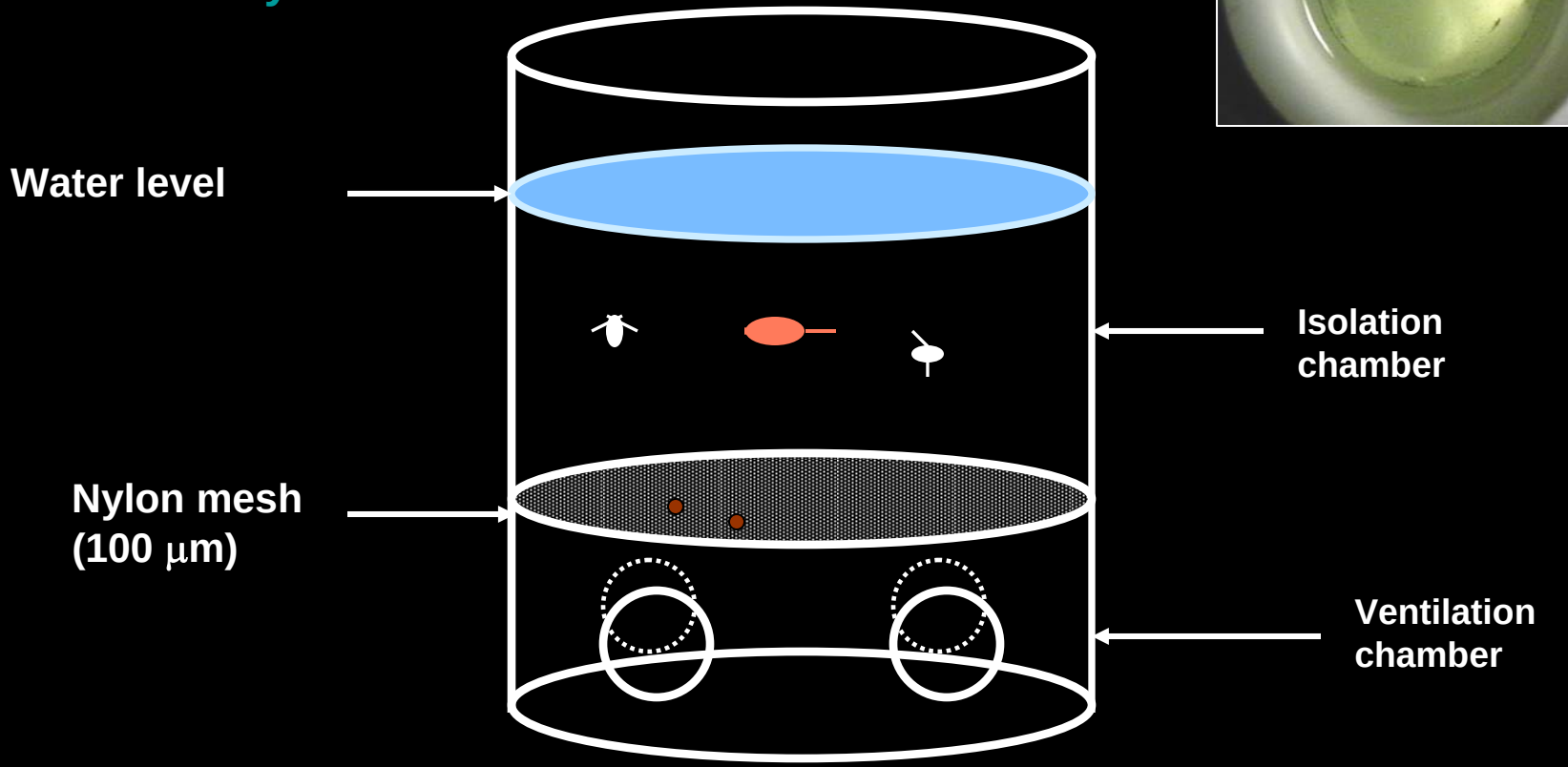


# Main question

- What are the effects of temperature, salinity and predator-derived chemical compounds on the reproductive performance of different strains of *Artemia?*

# Plankton isolation chambers were used to isolate reproductive couples

Animals grown in mass culture until sexual maturity




Introduced in isolation chamber upon reaching sexual maturity

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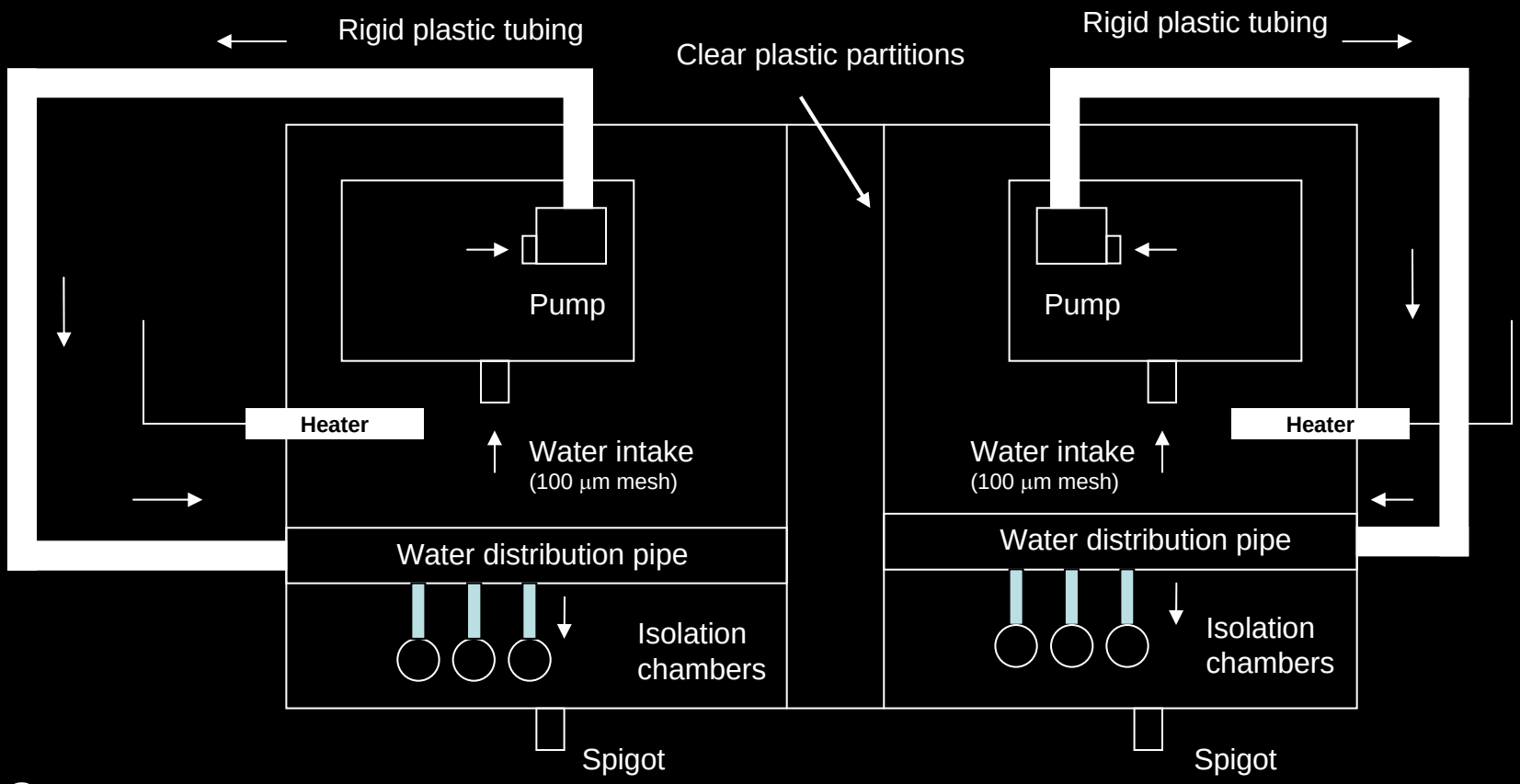
# A plankton recirculation apparatus was used in the life history experiments

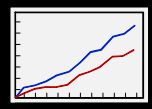


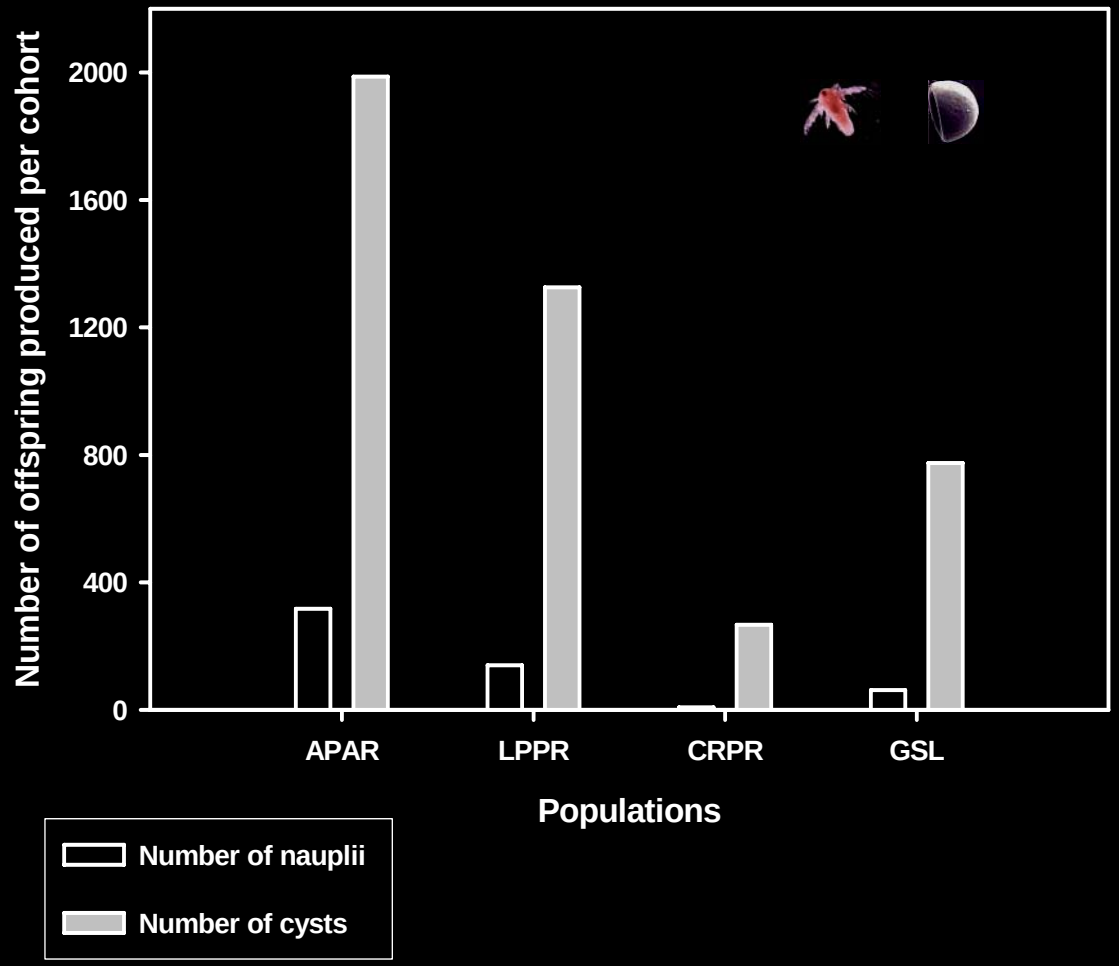

23° C

Salinity of 45

TOP VIEW

# Life history experiments showed that the total number of offspring produced was higher for APAR



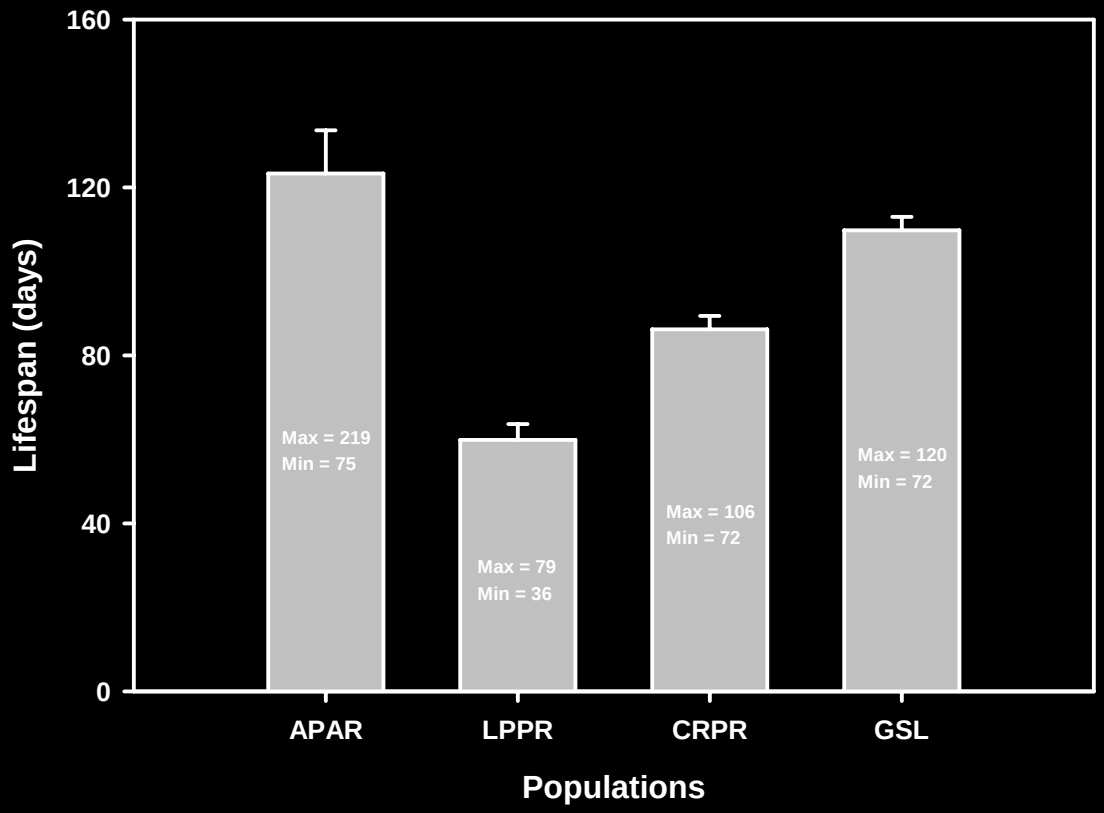


The production of nauplii was lower than that of cysts

Production of mixed broods

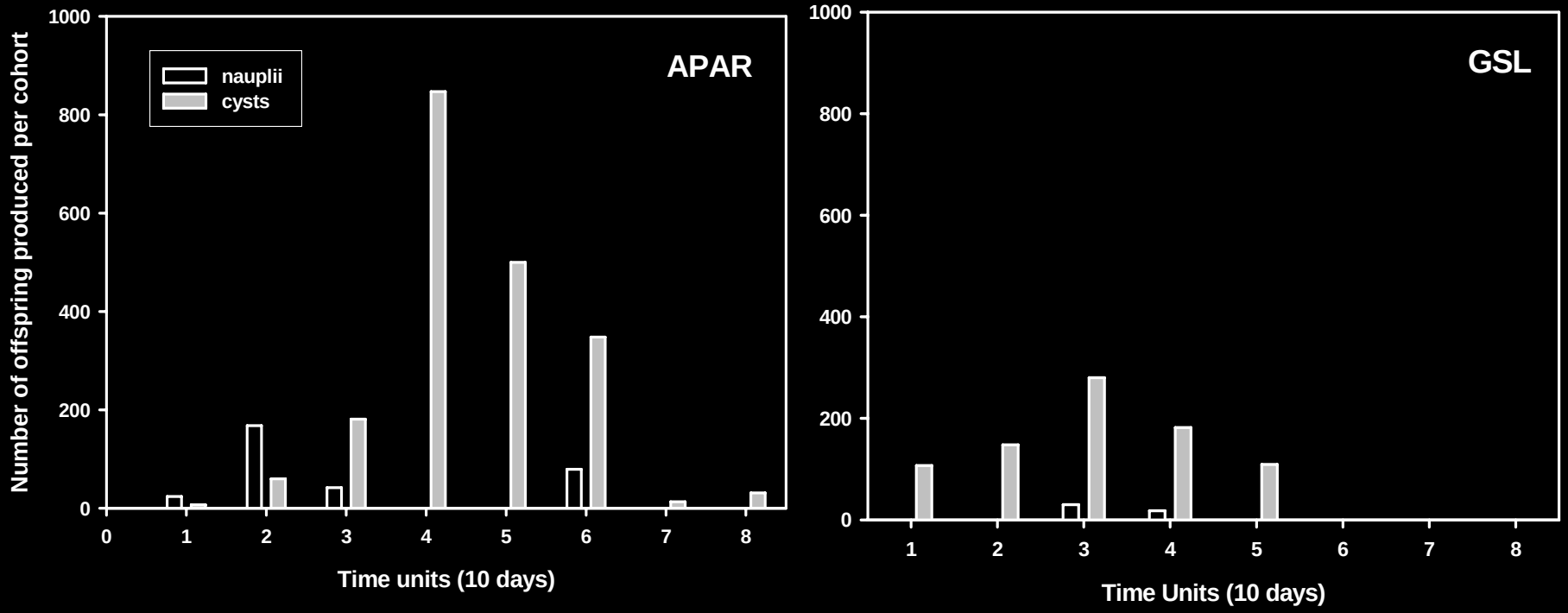
Random alternation between reproductive modes

# The lifespan of APAR individuals was higher than that of the other populations



Higher reproductive potential for APAR

# There was a significant time - dependent reduction in reproductive potential for all populations




Senescence?

Bet hedging strategy

## Effects of predator derived chemicals on the reproduction of *Artemia*

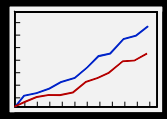
Mid-Mesozoic Marine Revolution (150 mya) evolutionary increase - intensity of predation of zooplankters by bony fishes (development of suction feeding)

Usually live in “predator-free” environments

Many of these habitats experience frequent predator invasions

Few studies in the literature on predator prey interactions involving *Artemia*

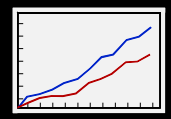
# Previous work involving inducible defenses



Most of the work involving inducible defenses involving zooplankton has been done on freshwater cladocerans and has received a lot of attention in zooplankton ecology in the past two decades

Predation can have effects on : functional morphology, behavior, life history, and distribution of zooplankton

**Stanley I. Dodson**



# Studies on *Artemia* photoresponses

Enzymatic degradation products of sulfated and acetylated external mucus of fish can increase the photosensitivity of first instar *Artemia* nauplii

Lower photoresponse thresholds causing larvae to remain deeper in the water column where low light levels reduce the effectiveness of visual predators

***Defenseless??***

**Forward and Rittschof, 1999**

**Kairomones** - interspecific signal chemicals which only benefit the receiving organism in the context of the signal transmission

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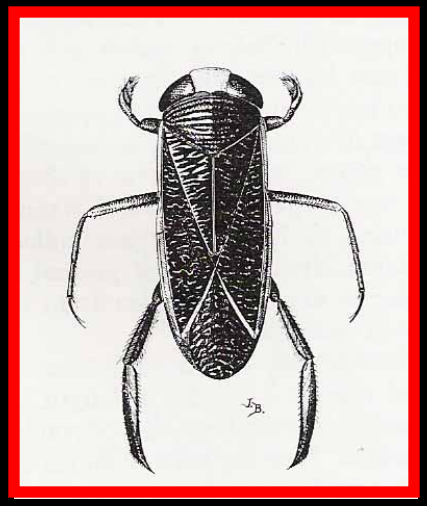
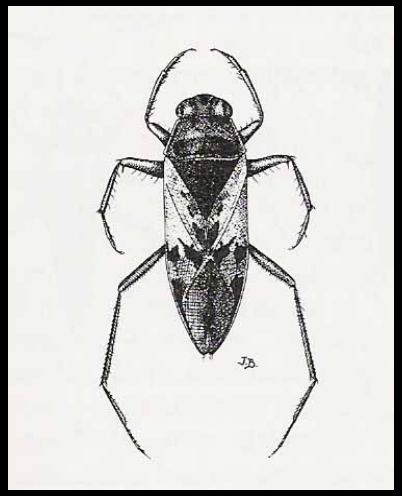
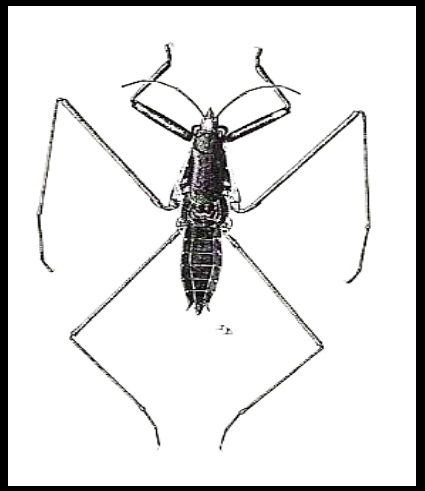
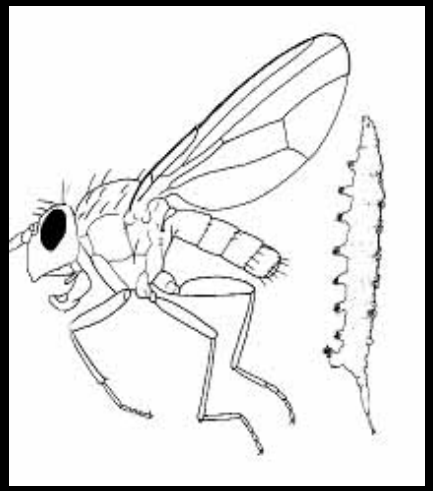
# Aquatic insects found in the saltern ponds





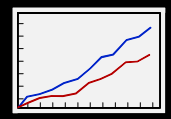


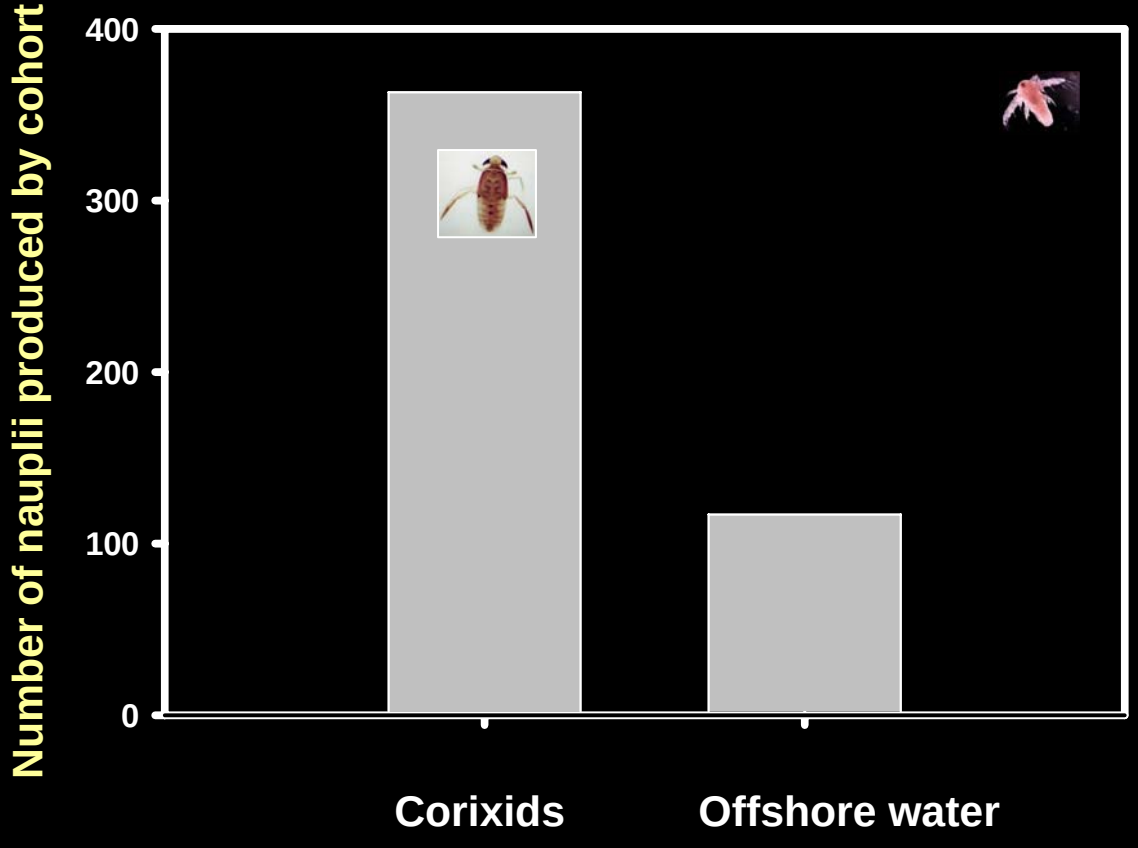


*Trichorixa reticulata*

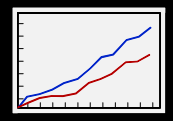
From Borror, Triplehorn, Johnson's INSECTS (sixth edition)

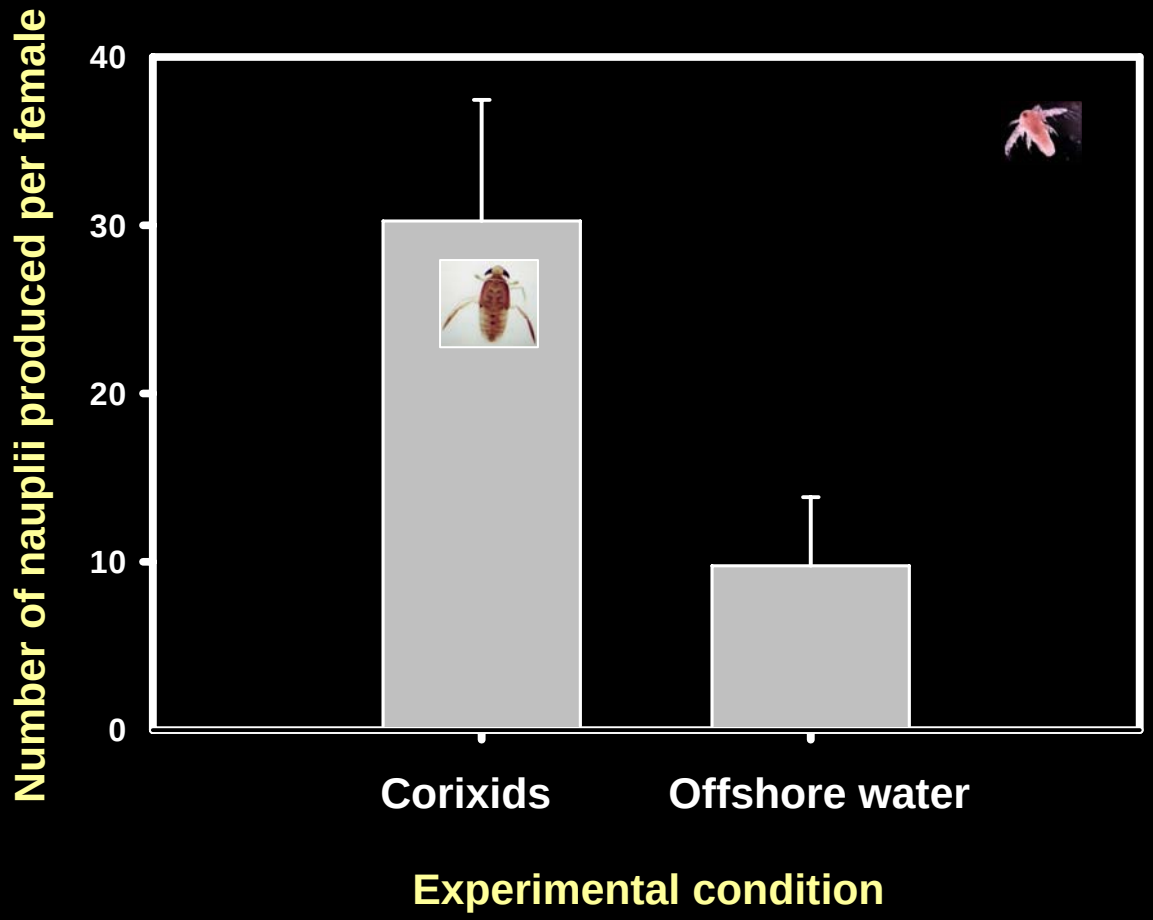
# The presence of *T. reticulata* increases total number of nauplii produced by cohort





# The presence of *T. reticulata* increases the number of nauplii produced per BOTPR female

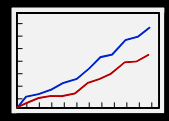


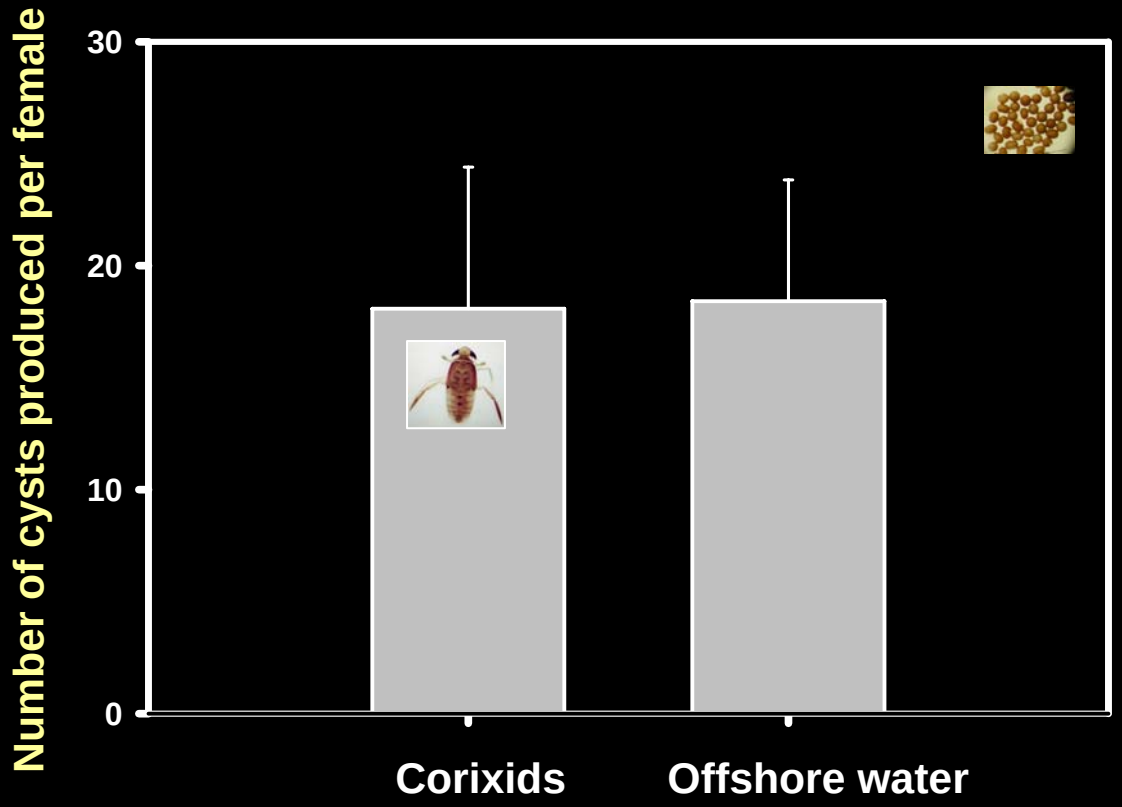



Stunning mechanism ?

Increase the probability that some animals survive to a reproductive age ?

# The presence of *T. reticulata* has no effect on number of cysts produced per BOTPR female





# Conclusions

The reproductive performance of *Artemia* varies between strains and is affected by environmental conditions

*A. parthenogenetica* had the highest reproductive performance of all the populations tested

*Artemia* can modify its reproductive performance and behavior in response to waterborne chemical compounds (practical applications?)

# Future direction of the research

Completion of the reproductive characterization of PR populations (assessment of potential use in aquaculture)

Determination of the degree of genetic variation among the PR populations and GSL using the Restriction Fragment Length Polymorphism (RFLP) fingerprinting technique

**SDS-PAGE** analysis of heat shock protein patterns in the cysts of *Artemia* from local strains

Effect of other chemical compounds on the reproduction and genetics of local strains

# This interdisciplinary project involves undergraduate students from UPR-Aguadilla

*Helping revitalize our nation's talent pool in STEM*

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# Acknowledgements

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Duke University Marine Laboratory

US Fish and Wildlife Service – Caribbean Islands NWR

# Development of a pilot plant for the small scale production of *Artemia* biomass in Cabo Rojo, Puerto Rico

Great outreach and educational opportunity

Pilot project to study the possibility of the development of a production operation of a larger scale

Good way to raise funds for conservation projects and maintenance of the “Centro Interpretativo de las Salinas de Cabo Rojo”

Great training for undergraduate and graduate students