

# The life cycle of the symbiont-bearing larger foraminifera *Amphistegina lobifera*, a new arrival on the Israeli shelf, SE Mediterranean Sea

Limor Gruber<sup>1</sup>, Ahuva Almogi-Labin<sup>2\*</sup>, Dorit Sivan<sup>1</sup> and Barak Herut<sup>3</sup>

<sup>1</sup>Recanati Institute for Maritime Studies, Haifa University, Haifa 31905, Israel

<sup>2</sup>Israel Geological Survey of Israel, Jerusalem 95501, Israel, \*almogi@gsi.gov.il

<sup>3</sup>Israel Oceanographic & Limnological Research, Tel Shikmona, P.O.B. 8030 Haifa, Israel

The SE Mediterranean is the warmest and the most oligotrophic part of the entire Mediterranean



*Amphistegina lobifera*



750 µm in diameter

*Amphistegina lobifera*



350 µm in diameter

1. The opening of the Suez Canal 135 years ago opened the gates to a major faunal invasion from the Red Sea to the SE Mediterranean. *Amphistegina lobifera*, the most common symbiont-bearing larger foraminifera that invaded lately this area proliferates mainly on rocky environments, suppressing the native inhabitants.

2. In this study, we investigate the population dynamics of *Amphistegina lobifera*, as an example of an invader species living on the edge of its environmental tolerance and geographic distribution.

Study area  
Tel Shiqmona, Haifa, Israel



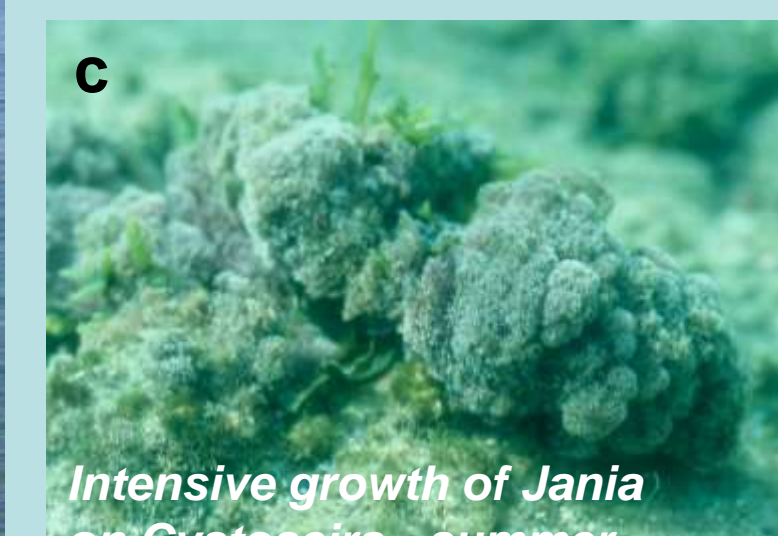
Haifa Bay



a Spring growth of *Cystoseira*



b *Cystoseira* & *Jania* - early summer



c Intensive growth of *Jania* on *Cystoseira* - summer



d "Mixture" of *Jania* & *Cystoseira* - fall

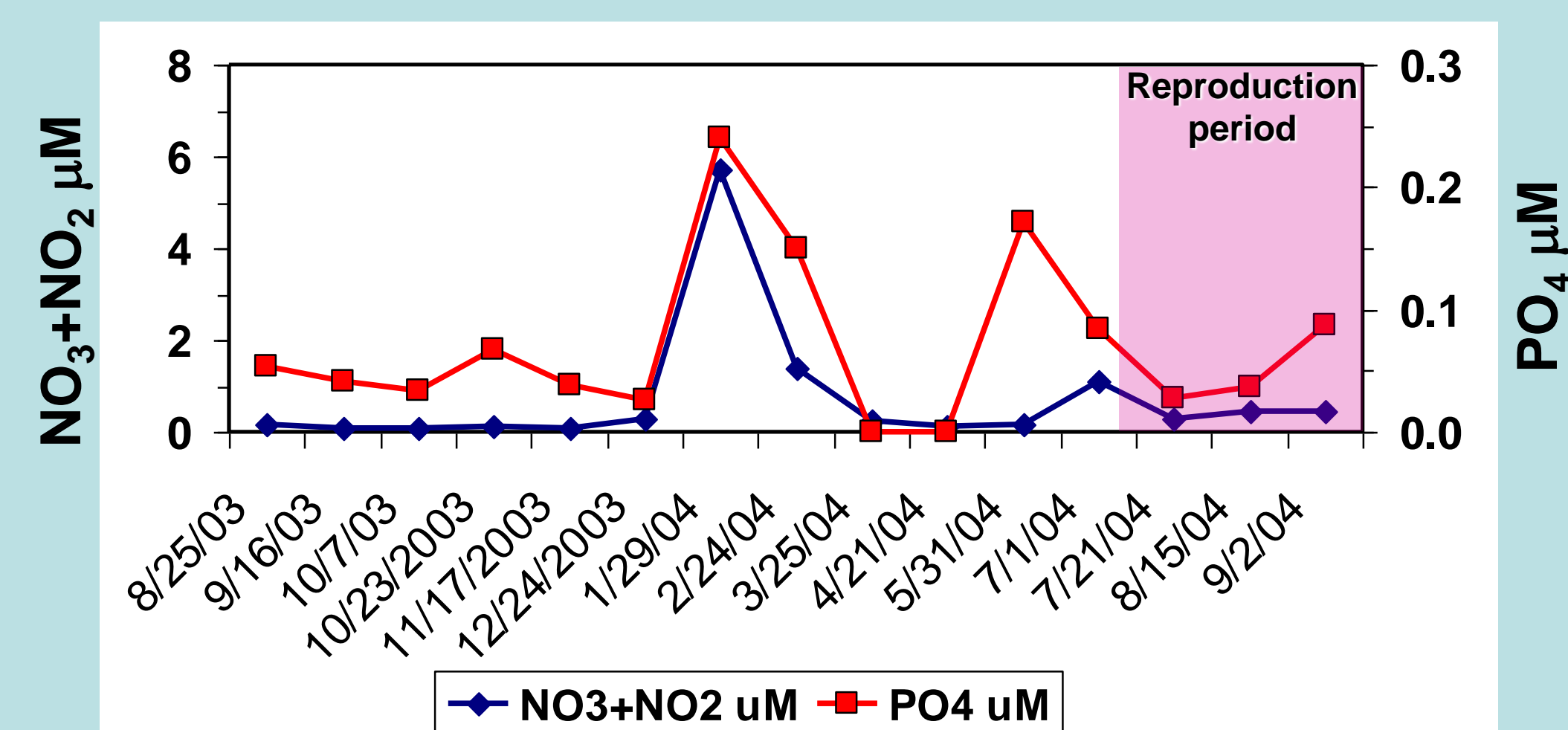
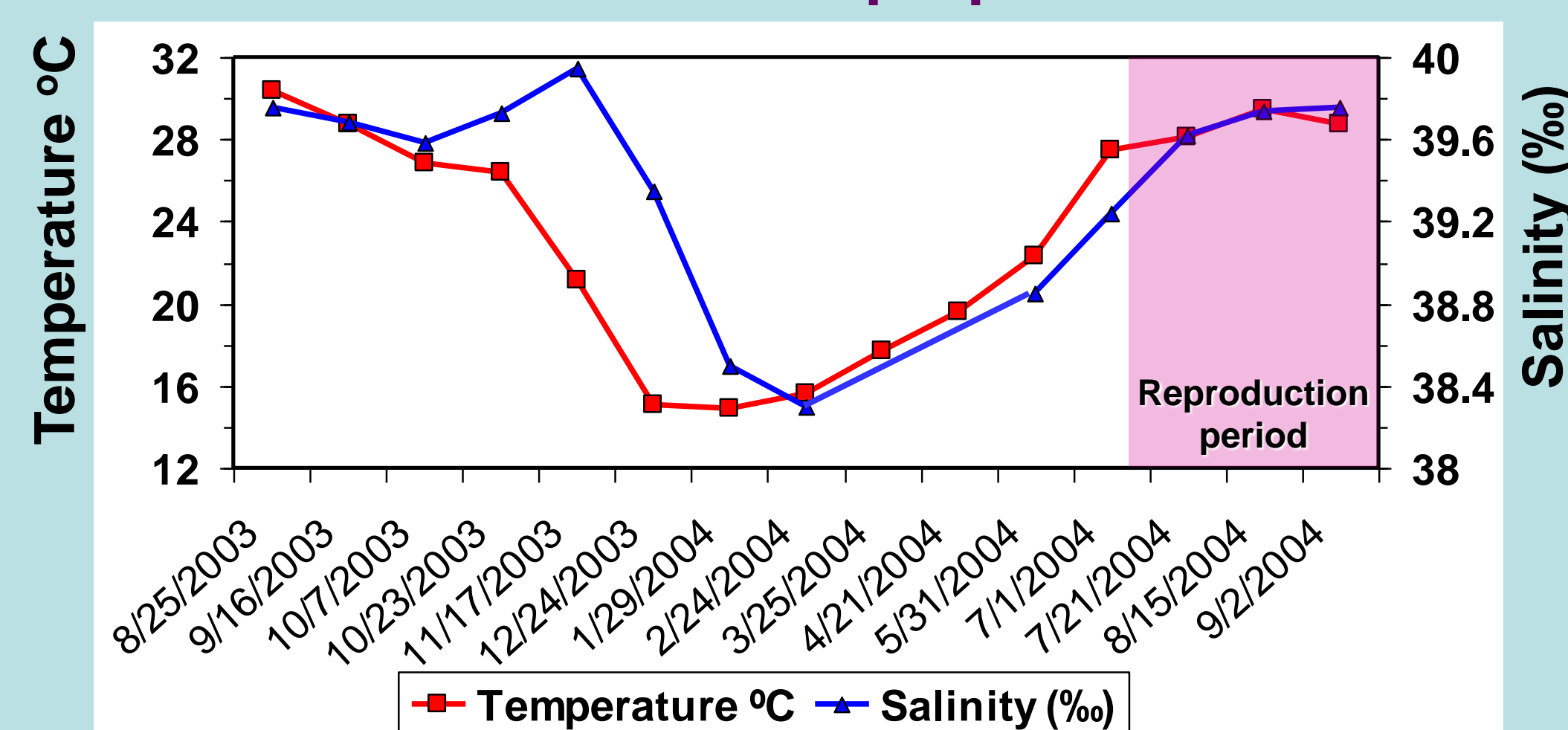
4. In the algal complex of *Cystoseira* & *Jania rubens* *Amphistegina lobifera* clings using its pseudopodia.



Limor Gruber during sampling

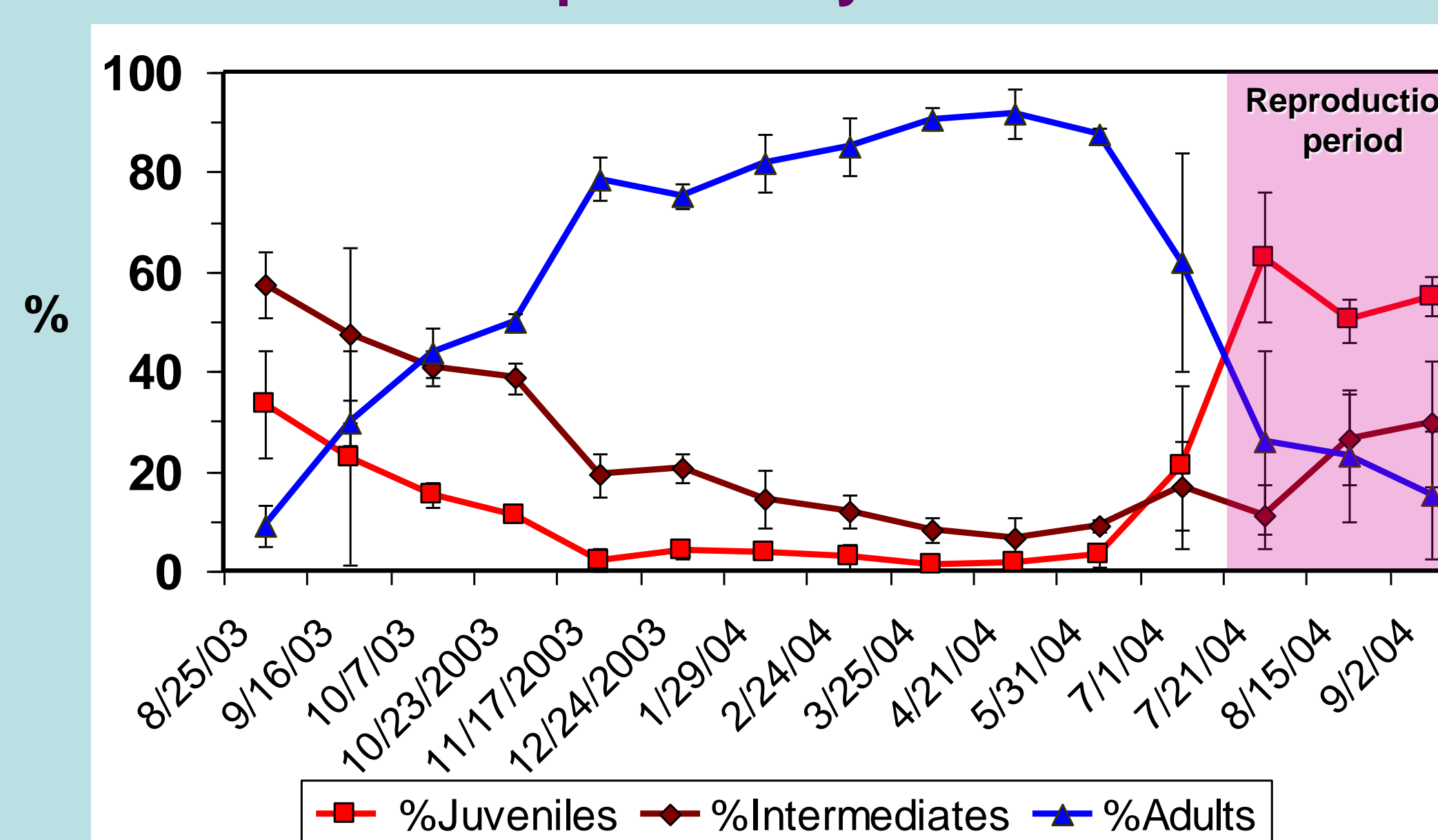
3. The annual population dynamics of *A. lobifera* was studied off Tel Shiqmona, Haifa, Israel in a rocky area densely covered by macroalgae. Sampling was carried out by scuba diving at ~1.5 m water depth, every 3-5 weeks from August 2003 to September 2004, in triplicate samples of intergrowing brown algae *Cystoseira* sp. and the red coralline *Jania rubens*. Living specimens, recognized by the presence of chloroplasts were identified, counted and weighed. The abundance of the entire foraminiferal population was normalized against the total dry algal weight in 4 different size categories.

## Water column properties



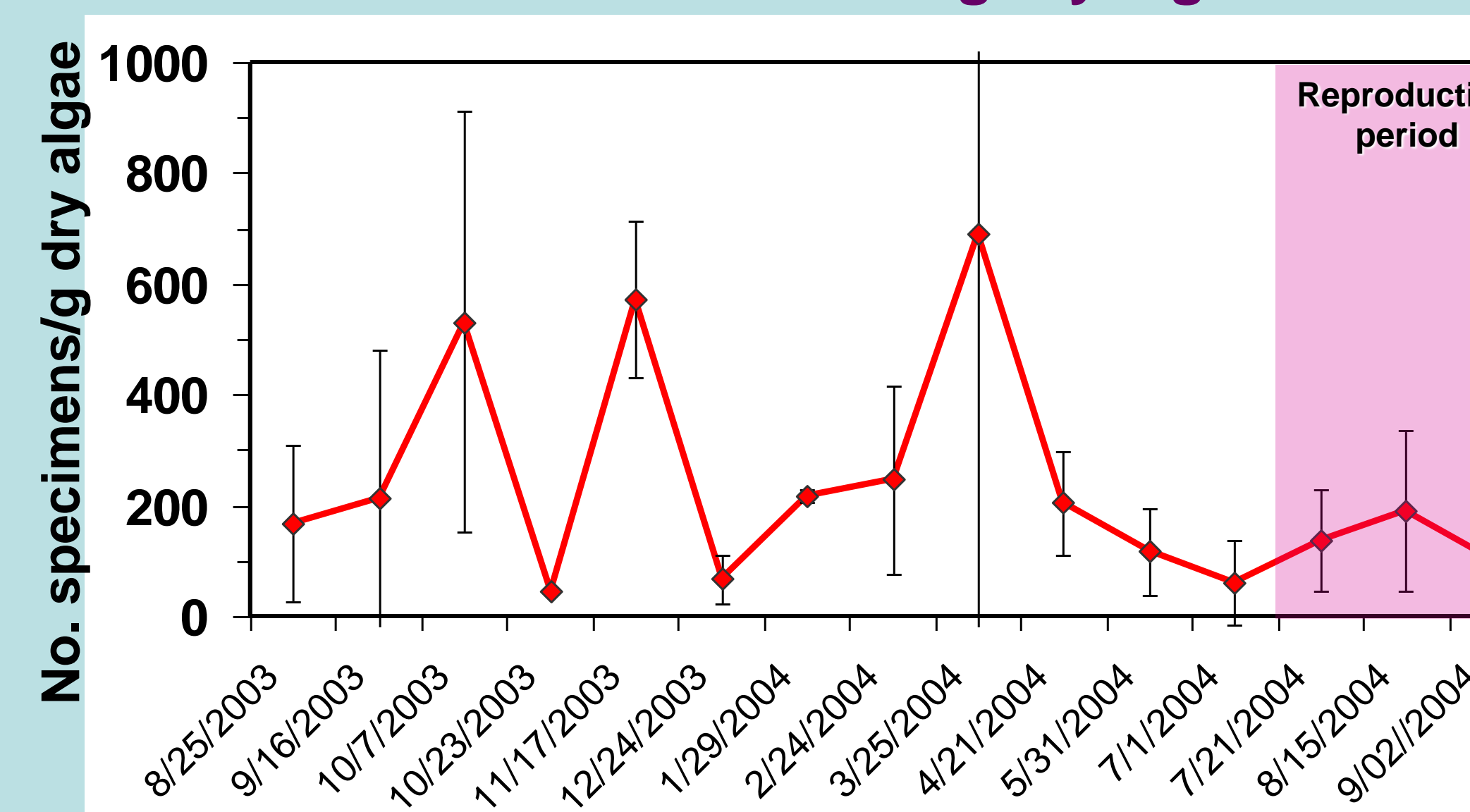
5. Sea surface temperatures vary between 14.88 °C and 30.35 °C and salinity between 38.3 and 39.95 ‰. Nutrient concentrations are raised in winter but much lower in summer and are similar to values known to be typical for the oligotrophic SE Mediterranean Sea.

## Population dynamics



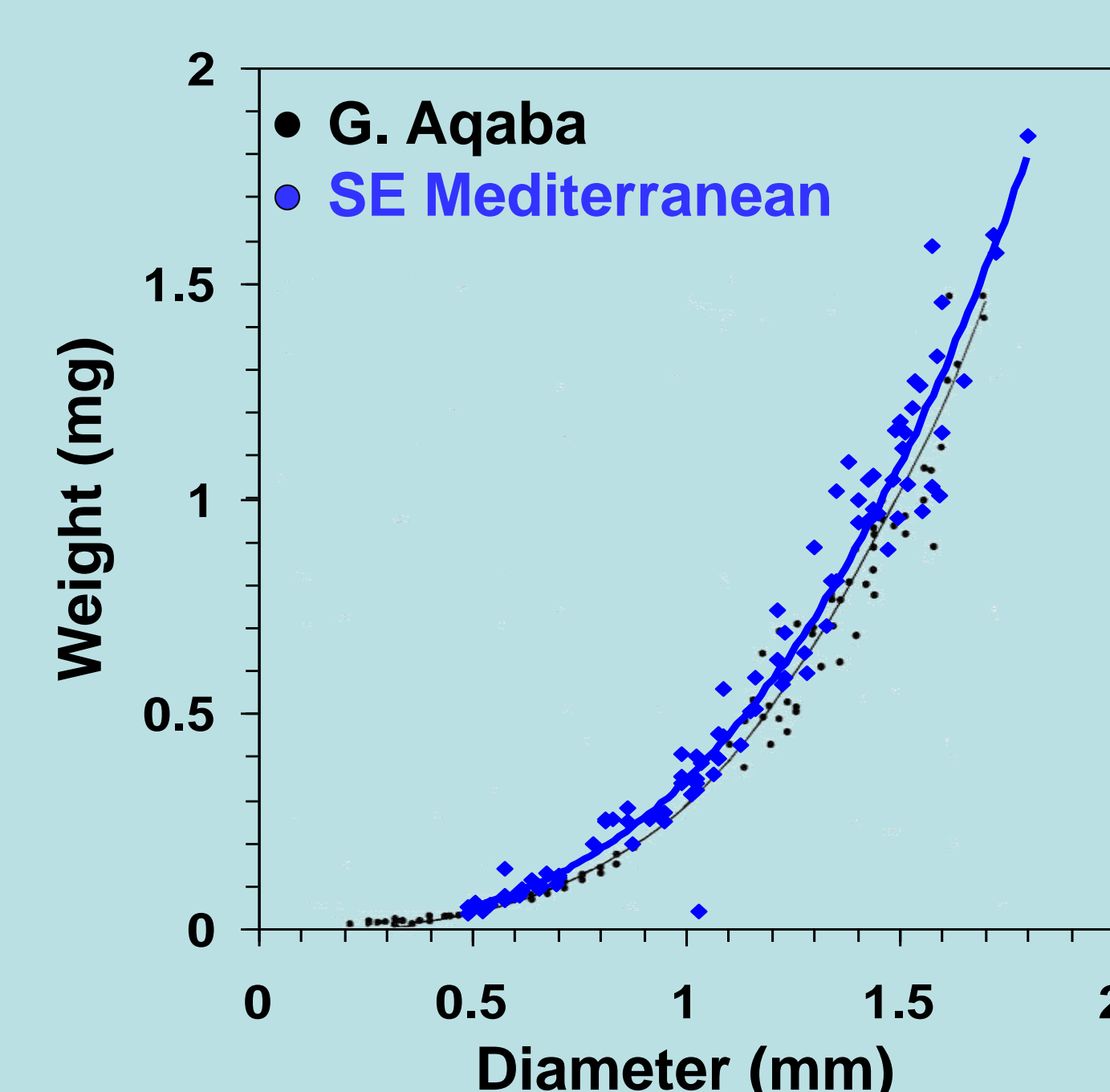
6. *A. lobifera* is reproducing once a year during peak summer season, unlike its counterpart in the G. Aqaba which reproduces twice a year during June and January (ter Kuile & Erez, 1984). The reproduction in the SE Mediterranean is a-sexual, as evident by the large average size of the proloculus of  $61.3 \pm 6.1 \mu\text{m}$ .

## Numerical abundance/g dry algae



7. *A. lobifera*, the most common larger foraminifera off Shiqmona, occurs throughout the year. Its numbers vary considerably indicating patchy distribution (of adults) with variable numbers from fall to spring and low and even numbers (of juveniles) during summer. Water temperature and light intensity seems to regulate the reproduction cycle of *A. lobifera* in the eastern Mediterranean.

## The relation between size & weight



8. Growth rate of individuals in the SE Mediterranean (blue dots) is relatively fast, and juveniles can reach a size of ~700 µm within 46 days, similarly to rates determined elsewhere in the tropics (Hallock, 1985) including the Gulf of Aqaba (black dots) (ter Kuile & Erez, 1984) with a growth of 3.8% a day. During winter growth rate of the adult stage is slowing to 0.3%/day. The sharp decrease in shell growth rate seems to be connected to winter temperature values which were close to the minimum that this species can tolerate.



9. *Amphistegina lobifera* is considered to be a major carbonate producer off Tel Shiqmona. This species precipitate ~ 260g CaCO<sub>3</sub> m<sup>-2</sup> yr<sup>-1</sup>. This conservative value is based on an average individual test weight of 1.3 mg, the assumption that each individual reach maturity and an average numerical abundance of 200 specimens/g dry algae.

## 10. Summary

The SE Mediterranean, the warmest and the most oligotrophic region in the entire Mediterranean, was invaded lately by *Amphistegina lobifera*. This symbiont-bearing larger foraminifera proliferates along the Israeli coast mainly on rocky substrate. *A. lobifera* reproduces a-sexually once a year, during summer (July-August), unlike its counterparts in the Gulf of Aqaba which reproduce twice a year (June and January). It therefore can survive the low winter temperatures of 15°-17°C of the eastern Mediterranean, but it fails to reproduce in the winter. *A. lobifera* is a major carbonate producer, with a contribution of about 260 g CaCO<sub>3</sub> m<sup>-2</sup> yr<sup>-1</sup> on rocky coasts of Israel.

## References

Hallock, P., 1985. Why are larger foraminifera large? *Paleobiology*, 11: 195-208.  
ter Kuile, B., Erez, J. 1984. In situ growth rate experiments on the symbiont bearing foraminifera *Amphistegina lobifera* and *Amphisorus hemprichii*. *Journal of Foraminiferal Research*, 14: 262-276.