GLOBEC: Abundance, Distribution, and Feeding Ecology of Large Medusae in the California Current Upwelling System

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RATIONALE

Here we present preliminary data describing the distribution and abundance of three scyphomedusae (Chrysaora fuscescens, Aurelia labiata, and Phacellophora camtschatica) and one hydromedusa (Aequorea sp.) in the California Current between Newport OR and Crescent City CA. Although many gelatinous zooplankton taxa are conspicuous in the ecosystem, very little quantitative data have been presented to estimate how many are present and what their impact – both in terms of predation and competition – may be. This study focuses on large medusae because they can be quantified from trawls designed to catch juvenile salmon as part of the GLOBEC NEP program. Although a single previous study in 1981 did quantify large medusae in the region using purse seine transects (Shenker 1984), it has not been repeated since. Almost no data have been published on the diet of the scyphomedusae found in the California Current, and thus this study also will ultimately provide new information on prey selection and predation potential.

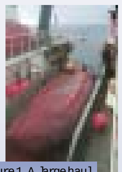


Figure 1. A large haul of medusae coming aboard the FV Frosti

Figure 2. Preparing to measure the bell diameter of Phacellophora camtschatica

APPROACH

Abundance and distribution data were obtained during trawls deployed from chartered fishing vessels (FV Sea Eagle, FV Frosti) during four cruises (June and August 2000 and June and August 2002). The Nordic 264 rope trawl fished surface waters (to ~18 m depth). Trawl stations formed onshore-offshore transects (E-W) bounded to the North and South by Newport, OR and Crescent City, CA. Volume sampled was approximated from ship position during deployment (start) and retrieval (end) of each trawl (distance, corrected for the curvature of the Earth) multiplied by the open area of the net (540 m²).

Large medusae caught in each trawl were identified to species, counted, weighed, and measured (Fig 1). When trawls captured a large number of medusae, only the bell diameters of 30 randomly chosen individuals were measured. In the case of extremely large catches (Fig 2), only a subsample of the catch was weighed and counted and total counts were derived from total weight data.

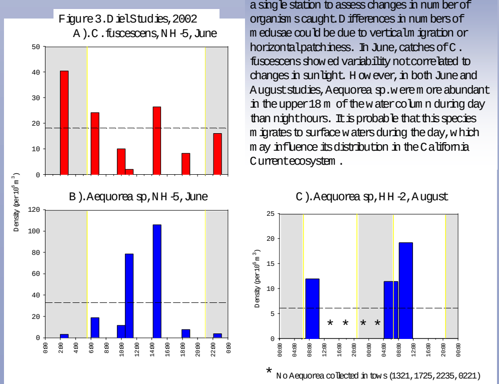
During each cruise of 2002, trawls were deployed on the same station over 24+ hours to assess whether organisms vertically migrate past 18 m, the depth fished by the trawl.

Medusae were collected for **diet analysis** during cruises on the RV Elakha (23 July 2002) and RV New Horizon (31 July-19 August 2002). Individual medusae were collected from surface waters using a long-handled dip net, and immediately transferred to sample jars (1 medusa per jar) and preserved in 5% formalin. In the laboratory, medusan oral arms and gastric cavities were dissected to count and identify all prey ingested. Vertical hauls of a 202um-mesh ½-meter net were performed at each station where medusae were sampled. The zooplankton prey field was assessed by counting replicate 1-ml subsamples of each tow.

RESULTS: Diel Study (Fig 3)

Diel studies were performed by repeating trawls at a single station to assess changes in number of organisms caught. Differences in numbers of medusae could be due to vertical migration or horizontal patchiness. In June, catches of C. fuscescens showed variability not correlated to changes in sunlight. However, in both June and August studies, Aequorea sp. were more abundant in the upper 18 m of the water column during day than night hours. It is probable that this species migrates to surface waters during the day, which may influence its distribution in the California Current ecosystem.

Figure 3. Diel Studies, 2002



* No Aequorea collected in tows (1321, 1725, 2235, 0221)

RESULTS: Abundance and Distribution

Figure 4 and Table 1 summarize the data for the four large medusa species collected during four cruises. Distribution, defined as proportion of trawls catching medusae, varied markedly between the two study years, with wider distribution during 2002 for all species. C. fuscescens and Aequorea sp. were most abundant and most widely distributed over the study area relative to the other two species. Abundance of medusae was higher later in the season (August).

Figure 5 presents the data for each species and each cruise. All are found on the shelf or near the shelf break; the upwelling front is probably an important mechanism keeping these plankton close to shore. In general, more widespread distribution in June is followed by focused distribution in August, with different patterns seen in August between species and between years. For example, by August, C. fuscescens is found farther north than A. labiata and P. camtschatica. Population separation may be a result of preference for different depth strata. In 2000 all species except C. fuscescens seem to have population maxima centered around Cape Blanco. In 2002, populations are more dispersed.

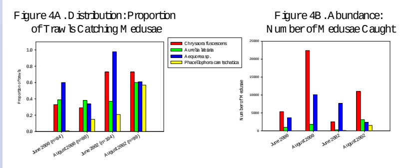


Table 1. Summary: Ranks by Medusa Species and Ranks by Cruise Date

Most Widely Distributed	1. Aequorea sp	1. August 2002
	2. C. fuscescens	2. June 2002
	3. A. labiata	3. June 2000
	4. P. camtschatica	4. August 2000
Most Abundant	1. C. fuscescens	1. August 2000
	2. Aequorea sp.	2. August 2002
	3. A. labiata	3. June 2002
	4. P. camtschatica	4. June 2000

Figure 5. Matrix of medusa catch data

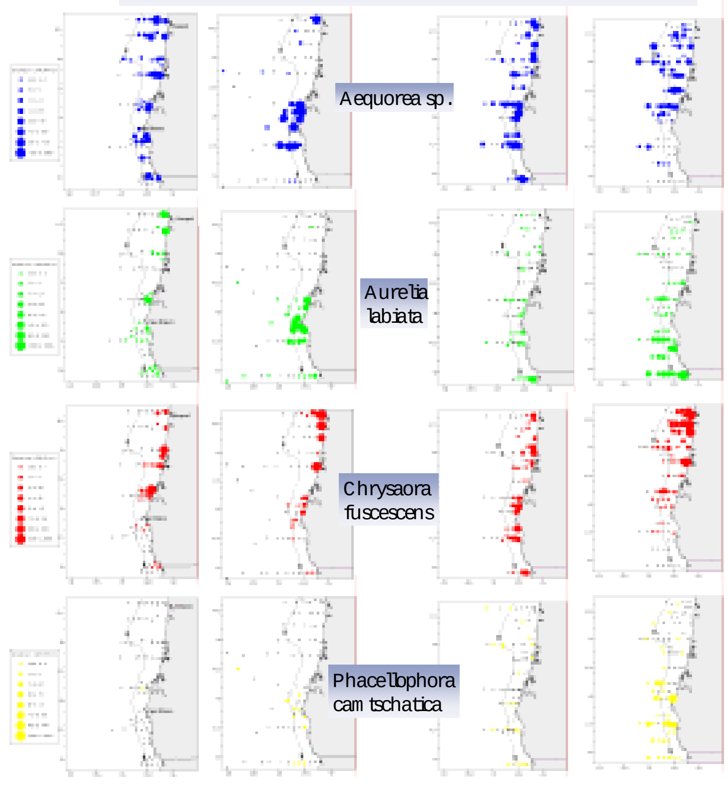


Table 2. Feeding habits of medusae of interest.

Species	Dominant Prey	Reference
C. fuscescens	euphausiid eggs, euphausiid nauplii, calanoid copepods	this study
Aurelia labiata	copepods, cladocerans, bivalve veligers	Purcell in press, Purcell and Sturdevant 2001
Aequorea sp.	gelatinous zooplankton (larvaceans, hydromedusae), invert. eggs	e.g. Costello and Colin 2002, Purcell in press
P. camtschatica	gelatinous zooplankton (medusae, ctenophores)	Strand and Hamner 1988

Figure 7. Euphausiid eggs (~400 μm)

Figure 6A-D. C. fuscescens Diet vs. Environment at NH-5 (44° 38.9 N, 124° 10.7' W), 23 July 2002

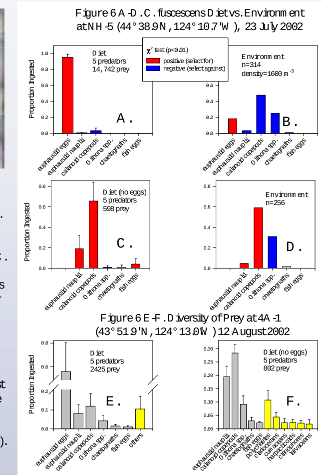


Figure 6 E-F. Diversity of Prey at 4A-1 (43° 51.9' N, 124° 13.0' W) 12 August 2002

RESULTS: Feeding by Chrysaora fuscescens

Minimal information is available on the diet, predatory impact, and prey selection of these medusae, in particular C. fuscescens (the most abundant medusa in the California Current ecosystem) (Table 2). Preliminary analysis from NH-5 shows that euphausiid eggs can dominate the diet of C. fuscescens (Fig 6A, 7) disproportionate to this prey type's occurrence in the plankton (Fig 6B). Prey selection analyses run if euphausiid eggs are removed show relatively stronger preference for calanoid copepods, euphausiid nauplii, and fish eggs – compared to negative selection for Oithona sp. copepods (Fig 6C, D). Initial gastric analysis from another station, 4A-1, reveal a strikingly similar pattern – dominance of euphausiid eggs in the diet, with calanoid copepods and euphausiid nauplii the second and third largest components (Fig 6E). C. fuscescens collected from 4A-1 ate a wider variety of prey types than those from NH-5, however, including polychaetes, cladocerans, cumaceans, harpacticoid copepods, ctenophores, and larvaceans (Fig 6F). Future comparison with zooplankton counts from vertical hauls will determine which of these prey are preferentially ingested by the medusae.

FUTURE WORK AND INTERESTING QUESTIONS

❖ We hope to link abundance and distribution data to other biological and environmental data (e.g. current patterns, temperature/upwelling, and chlorophyll, zooplankton, and fish distributions). In particular, distributions in August 2000 and 2002 were markedly different. Is there a corresponding change in the physical oceanography that could explain the change, particularly the shift from aggregation of Aurelia labiata and Aequorea sp. around Cape Blanco in August 2000 to more widespread distributions in August 2002?

❖ All populations appear more widespread latitudinally in June than August (probably reflecting widespread distribution of the benthic polyp stage and subsequent seasonal release of ephyrae). By August, the Chrysaora fuscescens population is most dense at the northern end of the sampling grid, while Aurelia labiata and Phacellophora camtschatica are farther south. What differences in behavior or vertical distribution cause this separation?

❖ We will continue to assess prey selection and feeding rates for the three scyphomedusan species. Calculations of density of medusae must be refined to reflect the trawl mesh size, and experiments to determine digestion times of prey must be completed. The goal is to determine the impact on zooplankton populations, particularly euphausiid eggs and nauplii, calanoid copepods, and fish eggs.

References

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Acknowledgements

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