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A COMPARISON OF THE MARINE ALGAE FROM THE GOLETA SLOUGH AND ADJACENT OPEN COAST OF GOLETA/SANTA BARBARA, CALIFORNIA WITH THOSE IN THE SOUTHERN GULF OF MAINE[1]

ARTHUR C. MATHIESON AND EDWARD J. HEHRE

ABSTRACT

The seaweed floras from the Goleta Slough and adjacent coastal sites near Santa Barbara, California are compared with several coastal and estuarine habitats within the southern Gulf of Maine. One hundred fifty-two taxa are described from the Goleta-Santa Barbara area, consisting of 104 Rhodophyta, 22 Phaeophyta and 26 Chlorophyta. Four of these taxa represent modest range extensions within the state (i.e., *Farlowia conferta, Giffordia hincksiae* var. *californica, Lomentaria caseae* and *Prionitis australis,* while two others found within the Slough (*Capsosiphon fulvescens* and *Microspora pachyderma*) are significant additions to the marine flora of the Pacific Coast. The patterns of species richness and composition at four contiguous southern California sites showed strong contrasts due to local environmental variability, with the highest numbers of taxa (117 taxa or ~77%) occurring at the sand-abraded nearshore Goleta Point site and the lowest within the shallow Slough (26 taxa or ~17%). The depauperate flora of this small arid salt marsh habitat is dominated by ephemeral green algae (16 species) and *Salicornia virginica,* with ten other seaweeds (i.e., 7 reds and 3 browns) only occurring just upstream from its mouth. By contrast, estuarine seaweed floras within New England usually have much higher numbers of red algal taxa, their "open coastal" floras often extend much farther inland (~2.0–8.5 miles) and seaweed standing stocks are usually dominated by fucoid brown algae. The similarity of the Slough's green algal flora to New England's estuarine vegetation is striking, with most of the latter sites exhibiting floristic affinities of 50% or more. The analogous distributional and abundance patterns of ephemeral green algae (*Cladophora sericea* and *Enteromorpha compressa*) and the California horn snail (*Cerithidea califor-*

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nica) suggest several important interactions between seaweeds and snails, plus several other invertebrates and birds.

Key Words: seaweeds, estuarine, coastal, Goleta Slough, southern California, New England

INTRODUCTION

Even though the marine flora of California has a long history of investigations (Papenfuss, 1976), there is a lack of information about seaweed communities at individual sites and man's effect on them (Murray, 1974; Murray and Littler, 1989). In southern California, Dawson (1959a, 1959b, 1965) conducted some of the earliest investigations of intertidal seaweeds during 1956–59, providing a "semi-quantitative baseline" of floras at 44 stations between Point Conception and the U.S.-Mexican border. He concluded that a major reduction of species richness had occurred at some sewage-impacted sites within Los Angeles County since the early 1900's, and an increase of selected articulated corallines. After resurveying 15 of Dawson's southern California sites between Point Dume and Dana Point during 1968–70, Widdowson (1971) found a further reduction in species richness. He suggested that sewage discharge, along with foot traffic and air pollution, were important factors causing an abundance of gelidioid turf algae (*Gelidium coulteri*/*G. pusillum*) and articulated corallines (Thom and Widdowson, 1978). Subsequent to the Santa Barbara oil spill in 1969, several investigators (e.g., Foster et al., 1971; Nicholson and Cimberg, 1971; Straughn, 1971) documented a further loss of some species and an increase of others (e.g., *Ulva, Corallina* and *Gelidium*) which were capable of uptaking dissolved amino acids (Murray, 1974; North et al., 1970). In discussing short-term plant loss immediately after the spill, Foster et al. (loc. cit.) noted a strong interaction between oil dispersal, storms and sand fluctuations. Three and one-half years later, Cimberg et al. (1973) re-investigated several intertidal beaches near Santa Barbara and stated that periodic inundations by sand were more important than oil in altering rocky epibenthic communities (Emerson and Zedler, 1978; Littler, 1980; Littler et al., 1991; Nicholson, 1972; Nicholson and Cimberg, 1971; Stewart, 1983; Thom and Widdowson, 1978; Widdowson, 1971). In ranking the effects of the Santa Barbara oil spill, Nicholson (loc. cit.) commented that is was only one of several abuses to these coastal waters, many of which dated back to the 1920's. In summarizing the effects of chronic long-term pollution near a natural oil seep in Goleta (i.e., Coal Oil or Devereaux Point), Littler et al. (1991) stated that several seaweeds either failed to recruit or recolonized very slowly, while Foster et al. (1971) and Nicholson and Cimberg (1971) noted diminutive and/or depauperate floras. In comparing the ecology of a sewage polluted site on San Clemente Island, Murray and Littler (1974) found pronounced changes in species richness and reduced spatial heterogeneity versus nearby controls.

Until recently, estuaries have been the least studied coastal environments in California (Josselyn, 1983; Macdonald, 1977; Macdonald and Barbour, 1974; Zedler, 1982b; Zedler and Nordby, 1986). In addition, most studies of estuarine seaweeds have emphasized productivity and ecological evaluations (Rudnicki, 1986; Shellem and Josselyn, 1982; Zedler, 1977, 1980, 1982a, 1982b), while there have been relatively few detailed assessments of species composition (Josselyn and West, 1985; Norris, 1970; Ripley, 1969; Silva, 1979). Several factors have contributed to the limited knowledge of estuarine seaweeds: (1) the more localized occurrence of estuarine versus rocky and sandy habitats (Chapman, 1977; Littler et al., 1991; Macdonald, 1977; Onuf, 1987; Reimold, 1977); (2) the muddy and often eutrophied conditions within estuaries versus the clean sand and pounding surf of the open coast (Silva, 1979); (3) the apparent dominance of flowering plants (Mason, 1957); (4) the perceived occurrence of a limited and/or cryptic algal flora and; (5) the massive destruction and alterations of such habitats, particularly within southern California (Macdonald, 1977; Zedler, 1982b). In describing the loss of coastal wetlands in southern California, Zedler (loc. cit.) states that there are about thirty wetlands within this geography with a total area of ~5000 ha (12,500 acres). She also emphasizes that this acreage is ~25% of what existed upon the arrival of European man (Speth 1969). In discussing the functional role of estuarine seaweeds, Mann (1972) states that they provide valuable habitats for a myriad of organisms; they also contribute to organic carbon and detrital cycling (Josselyn and Mathieson, 1978, 1980). With increased eutrophication, massive algal blooms may occur within these sheltered habitats (Bach and Josselyn, 1978; Johnson, 1971; McComb et al., 1981; Norton and Mathieson, 1983; Sawyer, 1965; Sewell, 1982; Silva, 1979; Wilce et al., 1982; Wilkinson, 1980).

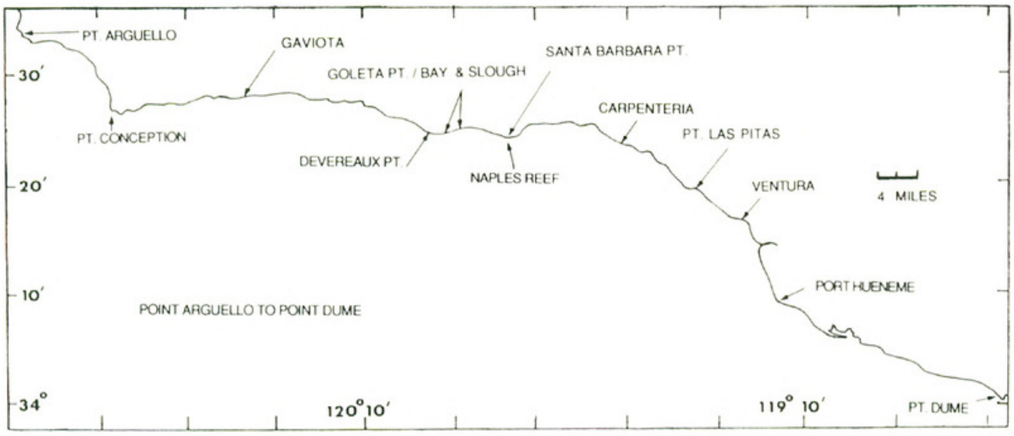


Figure 1. The southern California coastline between Point Arguello and Point Dume, showing the locations of the Goleta Point, Bay and Slough sites, plus Naples Reef.

The present study was initiated to document the open coastal and estuarine seaweeds near Goleta and Santa Barbara, California (Figure 1). We have attempted to summarize the species composition and distributional patterns of marine macrophytes within this arid, Mediterranean geography (Macdonald, 1977; Onuf, 1987; Onuf and Zedler, 1988; Zedler, 1982b; Zedler and Nordby, 1986), comparing them with thirteen New England coastal-estuarine habitats having diverse topographies and hydrographic conditions.

METHODS AND MATERIALS

Seasonal collections and observations of seaweed populations were made during 1979 at four coastal-estuarine habitats between Goleta and Santa Barbara, California (Figure 1 and Appendix). Estuarine collections were made within the Goleta Slough (Figure 2), while open coastal samples were obtained at Goleta Point and within Goleta Bay near the University of California, Santa Barbara Campus (UCSB), as well as at Naples Reef, offshore from Santa Barbara Point. A synopsis of each site's location, general topography and substrata is given in the Appendix. Overall, the most detailed spatial sampling was conducted within the shallow Goleta Slough, while the most comprehensive seasonal collections were made at Goleta Point. Twenty-seven Slough sites were evaluated during the spring and summer, while monthly collections (9 of 12 months) were made along an intertidal-shallow subtidal

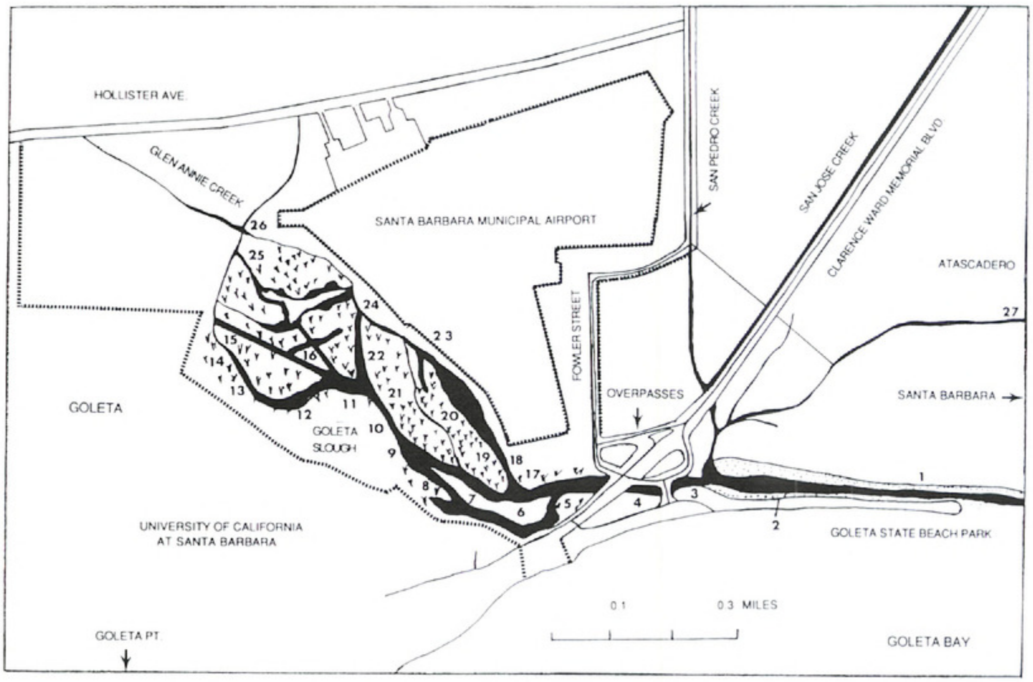


Figure 2. Twenty-seven study sites within the Goleta Slough and the adjacent open coast.

transect at Goleta Point. Periodic subtidal samples (−10 to −30 feet) were made near an experimental farm site in Goleta Bay (Wheeler et al., 1981), while analogous subtidal collections were made at Naples Reef (−15 to −40 feet). All conspicuous seaweeds were collected within the intertidal (on foot) and subtidal zones (by SCUBA) at each site when both habitats were present. The samples were sorted and identified using Abbott and Hollenberg (1976), Scagel et al. (1986) and Stewart (1991) as primary references. Several other synopses were also consulted, including some dealing with North Atlantic seaweeds (e.g., Bliding, 1963, 1968; Collins, 1909, 1912; Dawson, 1946; Scagel, 1966; Silva, 1979; Smith, 1969; South and Tittley, 1986; Sparling, 1971, 1977; Taylor, 1957; Webber and Wilce, 1971; Wilkinson, 1980). Approximately 550 herbarium voucher specimens are deposited in the Albion R. Hodgdon Herbarium (NHA) of the University of New Hampshire to document the region's flora.

A comparison of the number of species in common to the Goleta Slough and thirteen New England estuarine habitats is given, using a variety of published synopses (*see* Mathieson et al., 1993). The nature of these California and New England floras is compared using Cheney's (1977) floristic ratio, (R + C)/P:

$$\frac{\text{\# of Rhodophyta and Chlorophyta species}}{\text{\# of Phaeophyta species}}$$

With this calculation, a value of < 3.0 indicates a temperate or "cold-water" flora, while intermediate values and those > 6.0 indicate "mixed" and "warm-water" floras, respectively. The mean number of taxa/site from the Goleta Slough and thirteen New England estuarine habitats was also compared.

Monthly records of surface water temperatures and salinities were recorded at Goleta Point during 1979, while hydrographic surveys of the Slough were made during the spring and summer of the same year. A hand-held thermometer and refractometer were used for these measurements, having accuracies of 0.1°C and 0.5‰ (i.e., parts per thousand), respectively. Monthly records of sand levels within the intertidal zone at Goleta Point were documented by drawing out a metered line to a uniform distance between two rock outcrops with permanent bench marks (cement nails). Sand levels were determined by plumbing down to the sand/rock interface at ~1.0 m intervals along the transect line (Daly and Mathieson, 1977). All elevations were corrected to mean low water (MLW) after multiple measurements from these bench marks. Monthly comparisons of species richness and sand levels were made.

Abundance patterns of several green algae and the California horn snail, *Cerithidea californica* (Haldeman), were documented from three shallow pans within the Slough. A quadrat frame (1/16 m^2) was positioned at ~0.9 m intervals and the contents sampled. Individual seaweeds were dried (60°C for ~40 hours) and quantified as g dry weight/m^2; snail density was enumerated as #/m^2.

HABITAT DESCRIPTION

As outlined by Ricketts et al. (1985), most of the southern California coastline is exposed to moderate wave action due to an offshore archipelago—the Channel Islands. Even so, a strong gradient of water motion may exist (Wheeler et al., 1981), ranging from Naples Reef (most exposed) to Goleta Point, Bay and Slough (most sheltered). A pronounced gradient of rocky substrata occurs here, with Naples Reef having the most abundant rocky substrata and Goleta Slough the least. The broad sandy beaches at the

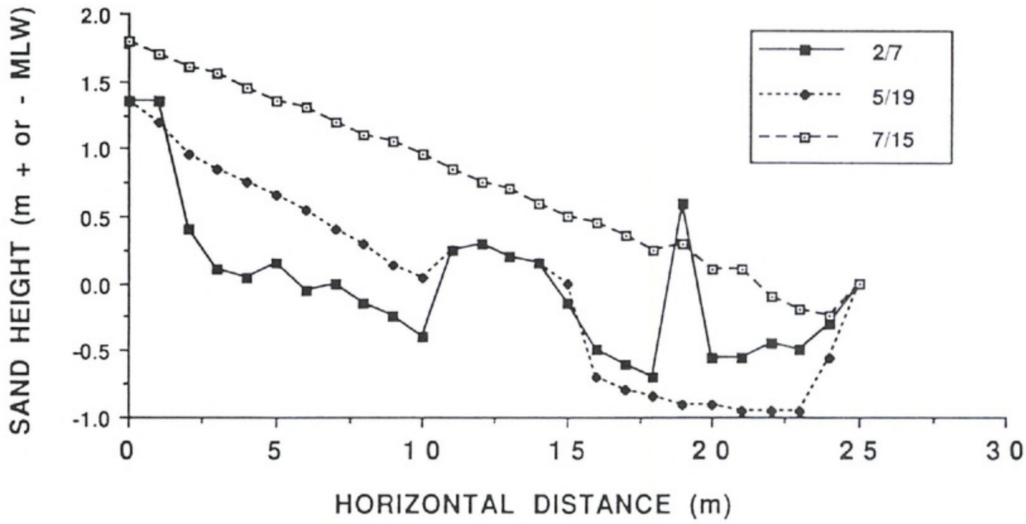


Figure 3. Variation of sand levels at Goleta Point between two major rock outcrops (i.e., at 0 and 10–15 m).

Goleta Point and Bay sites have scattered rock outcrops and boulders (i.e., Monterey shale/siltstone), which are often buried and extensively scoured (Littler et al., 1991). Figure 3 illustrates the variation of sand levels on the Goleta Point transect. Although rather irregular, sand elevations were usually highest during summer (July) and lowest in winter (February). *In situ* organisms growing in such habitats may be removed, scoured or buried by a meter or more of sand during mid-summer.

Goleta Point (Figure 1) is located downstream from a natural oil seep at Coal Oil (Devereaux) Point (Littler et al., 1991). In discussing the effects of the seep, Foster et al. (1971) noted that 30–60% of the rock surfaces at Goleta Point were covered by tar, causing a conspicuous reduction in abundance and stature of benthic organisms. Although we did not quantify the distribution and abundance of this "tar" on the intertidal transect, we concur with Foster et al. (loc. cit.) that it must, at the very least, reduce the availability of rocky substrata for benthic organisms.

Goleta Slough is a small, shallow, arid salt marsh habitat located at ~34°25′N and 119°50′W (Figure 2). As noted by Onuf and Zedler (1988), the average annual precipitation within this locale is < 40 cm (Baldwin, 1974) and the only substantial streamflow occurs just after a major storm. Because of such climatic extremes and the Slough's shallow topography, evaporation usually exceeds precipitation after March and monthly saturation deficits often exceed 10 cm. Tidal limits of the Slough extend ~1.0–1.2 miles inland from its mouth near Goleta State Beach Park. Like the Tijuana Estuary in San Diego, it is a wetland-dominated habitat, with no major embayment and a relatively narrow ocean connection (Zedler and Nordby, 1986). The Slough is located midway between Santa Barbara's Municipal Airport and the UCSB campus. Thus, it is an urbanized and highly modified estuary (Norris, 1970; Zedler and Nordby, 1986), with its northeastern perimeter drastically altered due to airport expansion, while the construction of overpasses (i.e., for gas pipelines and roads) and bike paths has changed its topography. In addition, a large part of the Slough is in the form of channels, which are artificially deepened for flood control and separated from the adjacent salt marsh by dikes (Onuf, 1987). Currently, the west-central part of the Slough is dominated by three major tidal channels, which bifurcate ~0.52 miles upstream from its mouth near the Clarence Ward Memorial Boulevard overpass. Further upstream (~0.94 miles inland), the source of these tidal channels is evident (i.e., Glen Annie Creek and an unnamed channel running parallel to Aero Camino Road). In the east-central portion of the Slough, three creeks converge between ~0.42–0.51 miles inland, with two originating from S and SW flowing flood channels (i.e., San Pedro and San Jose Creeks, respectively) and one arising from a tributary due east near Atascadero. Twenty-four study sites were established along the west central tidal channels, two near the Slough's mouth and one at the tidal dam near Atascadero (Figure 2 and the Appendix).

Most of the Goleta Slough consists of salt marshes, shallow pans and a series of channels (Appendix). Scattered boulders and artificial structures (i.e., bridge abutments, pilings, broken pieces of asphalt, etc.) are most abundant near the Slough's mouth and occur sporadically upstream. Sand periodically blocks the mouth, restricting tidal exchange and contributing to enhanced summer salinities (Figure 4; Macdonald, 1977; Onuf, 1987; Onuf and Zedler, 1988; Zedler, 1982b). As outlined by Onuf and Zedler (loc. cit.), *Salicornia virginica* L. is the dominant salt marsh plant within this tidally restricted habitat (94% frequency of occurrence), with only patchy amounts (1–2%) of *Cotula coronopifolia* L., *Frankenia grandifolia* Chamiso *et* Schlechtendal and *Lolium perenne* L. Zedler (1982b) lists eleven additional flowering plants from the Slough: *Atriplex watsonii* A. Nelson, *Cressa truxillensis,* H. B. K., *Cuscuta salina* Engelmann, *Distichlis spicata* (L.) Greene,

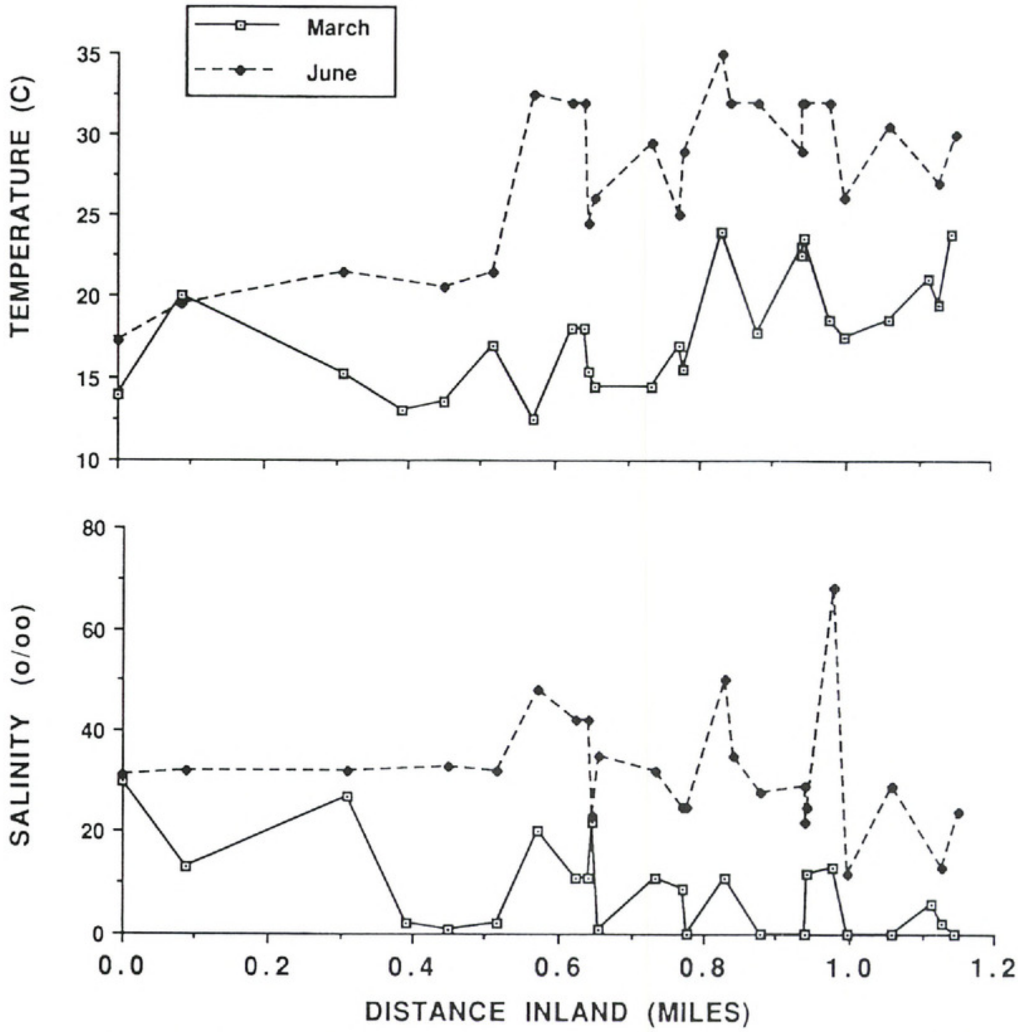


Figure 4. Surface water hydrographic conditions (i.e., temperature and salinity) at Goleta Point and adjacent Slough during March and June of 1979.

Jaumea carnosa (Lessing) Gray, *Lasthenia glabrata* Lindley, *Limonium californicum* Heller, *Monanthochloë littoralis* Engelmann, *Salicornia subterminalis* Parish, *Suaeda californica* Watson and *Triglochin concinnum* Davy. Although we primarily studied the macroalgal communities within the Slough, a variety of *Vaucheria* and microscopic algal mats (i.e., blue-green algae and diatoms) also occur on muddy surfaces (Onuf, 1987; Zedler, 1980, 1982a, 1982b). As outlined by Onuf (loc. cit.), the overall coverage of seaweeds is relatively small versus that of emergent vascular plants. Seaweeds, therefore, grow attached to widely scattered solid substrata, as entangled masses on the banks of tidal channels and as epiphytes upon salt marsh vegetation. The dominant macro-invertebrate within the Slough is *Cerithidea califor-*

nica, the California horn snail (Onuf, 1987; Zedler, 1982b; Zedler and Nordby, 1986).

Figure 4 illustrates surface water temperatures and salinities at Goleta Point and within the Slough during March and June of 1979. Temperatures tended to increase from outer (i.e., site 1) to inner estuarine sites (e.g., 21 and 22), ranging from ~14.0°–24.0°C during March to ~17.0°–35°C in June. Salinities at Goleta Point were relatively constant at 30–31‰, while those within the Slough varied from 0 to ~27 ‰ in March to ~12–68‰ in June. During March, twelve Slough sites had salinities of < 2‰. Three months later (June) the two lowest salinities were 10 and 13‰, while seven sites had salinities > 28‰. A maximum of 68‰ was recorded in one shallow pan with abundant green algae and horn snails (see ABUNDANCE PATTERNS).

SPECIES COMPOSITION AND NEW DISTRIBUTIONAL RECORDS

One hundred fifty-two seaweed taxa were recorded from the four study sites, including 103 Rhodophyceae, 22 Phaeophyceae and 26 Chlorophyceae (Table 1). The highest numbers of taxa or percent contribution to species richness were recorded at Goleta Point (117 taxa or ~77%) and the lowest within the Slough (26 taxa or ~17%). Most taxa from Goleta Point occurred on the shallow transect (i.e., 94 taxa or ~62%), while the remainder were collected immediately offshore from the UCSB campus (i.e., 23 taxa or ~15%). Floristic patterns at Naples Reef and at the offshore Goleta Bay site were somewhat intermediate, with 52 taxa (~34%) occurring at the former and 39 (~26%) at the latter.

The numbers (%) of red, brown and green algal taxa/site were highly variable (Table 1). Green algae were maximal at Goleta Point (19) and within the Slough (16), while the lowest numbers occurred at the offshore Goleta Bay (2) and Naples Reef (1). Brown and red algae were highest at Goleta Point (17 and 81 taxa) and lowest within the Slough (3 and 7 taxa). Green algae dominated the Slough (~62%), were intermediate at Goleta Point (16%) and lowest at the offshore Naples Reef (2%) and Goleta Bay sites (5%). The percentage contribution of brown algae was minimal within the Slough with its depauperate flora (~12%), while it ranged from ~15–33% at the Goleta Point and Bay sites. Red algae dominated at Naples Reef (~85%), were intermediate at the Goleta Point and Bay sites (~62–69%) and lowest within the Slough (~27%).

Floristic diversity is further documented using Cheney's (R + C)/P ratio. The highest value was recorded for the Slough (~7.7), followed by the transect (~6.8) and total floras at Goleta Point (~5.9), Naples Reef (~7.7), and Goleta Bay (2.0). Thus, most of the floras would be interpreted as "warm-water," except for the offshore Goleta Bay site.

Six of the 152 taxa recorded here (Table 1) represent new geographical records. Two were collected from Goleta Slough (*Capsosiphon fulvescens* and *Microspora pachyderma*) and four from the open coast (*Farlowia conferta, Giffordia hincksiae* var. *californica, Lomentaria caseae* and *Prionitis australis*). *Capsosiphon fulvescens* was previously known from northern British Columbia and Vancouver Harbor (Garbary et al., 1982), while the only previous "marine" records for the freshwater green algae *M. pachyderma* (Collins, 1909; Prescott, 1962) were from several western North Atlantic estuaries (Mathieson and Hehre, 1986; Mathieson and Penniman, 1986a, 1991; Mathieson et al., 1993). The records of *G. hincksiae* var. *californica, F. conferta* and *P. australis* are modest extensions beyond San Luis Obispo County (i.e., Point Conception), while the occurrence of *Lomentaria caseae* is a northern expansion of its known range from Del Mar within San Diego County to Isla Guadalupe, Baja California (Abbott and Hollenberg, 1976; Scagel et al., 1986; Stewart, 1991).

DISTRIBUTIONAL PATTERNS AND FLORISTIC COMPARISONS

Seaweeds at the four study sites exhibited three local distributional patterns (Figure 5 and Table 1):

(1) Coastal—restricted to the nearshore open coast (126 taxa or ~83%).
(2) Cosmopolitan—present in estuarine and open coastal environments (20 taxa or ~13.0%).
(3) Estuarine—restricted to Goleta Slough (6 taxa or ~4.0%).

All six estuarine seaweeds were green algae, including *Capsosiphon fulvescens, Cladophora microcladioides, Enteromorpha intestinalis, Microspora pachyderma, Rhizoclonium riparium* and *Ulvaria oxysperma*. In contrast, coastal taxa consisted of 97 Rhodophyceae, 19 Phaeophyceae and 10 Chlorophyceae, while the

Table 1. Seaweed taxa from three open coastal sites and one estuarine habitat near Goleta, California.

	1a	1b	2	3	4
Chlorophyta					
Acrochaete viridis (Reinke) R. Nielsen	x	x			
Blidingia minima (Nägeli *ex* Kützing) Kylin	x	x		x	
Bryopsis corticulans Setchell	x	x			
Bryopsis hypnoides Lamouroux	x	x			
Capsosiphon fulvescens (C. Agardh) Setchell *et* Gardner				x	
Chaetomorpha aerea (Dillwyn) Kützing	x	x		x	
Cladophora columbiana Collins	x	x			
Cladophora graminea Collins	x	x			
Cladophora microcladioides Collins				x	
Cladophora sericea (Hudson) Kützing	x	x		x	
Codium sp. (basal filaments)	x	x			
Codium fragile (Suringar) Hariot					x
Enteromorpha clathrata (Roth) Greville	x	x		x	
Enteromorpha compressa (L.) Greville	x	x		x	
Enteromorpha flexuosa (Roth) J. Agardh ssp. *flexuosa*	x	x		x	
Enteromorpha intestinalis (L.) Link				x	
Enteromorpha linza (L.) J. Agardh	x	x	x	x	
Enteromorpha prolifera (Müller) J. Agardh	x	x		x	
Microspora pachyderma (Wille) Lagerheim				x	
Rhizoclonium implexum (Dillwyn) Kützing	x	x			
Rhizoclonium riparium (Roth) Harvey				x	
Ulva californica Wille	x	x			
Ulva costata (Howe) Hollenberg		x			
Ulva lactuca L.	x	x	x	x	

Table 1. Continued.

	1a	1b	2	3	4
Ulva taeniata (Setchell) Setchell *et* Gardner	x	x		x	
Ulvaria oxysperma (Kützing) Bliding				x	
Total green algal taxa/site	18	19	2	16	1
Total green algal taxa (26)	1a	1b	2	3	4
Phaeophyta					
Colpomenia sinuosa (Roth) Derbès *et* Solier	x	x			
Cylindrocarpus rugosus Okamura	x	x			
Cystoseira osmundacea (Turner) C. Agardh		x	x		x
Desmarestia ligulata (Lightfoot) Lamouroux var. *firma* (C. Agardh) J. Agardh					x
Desmarestia ligulata (Lightfoot) Lamouroux va. *ligulata*		x	x		x
Desmarestia viridis (Müller) Lamouroux			x		
Dictyota binghamiae J. Agardh					x
Ectocarpus parvus (Saunders) Hollenberg	x	x	x	x	x
Egregia menziesii (Turner) Areschoug	x	x	x		
Endarachne binghamiae J. Agardh	x	x	x	x	
Giffordia hincksiae (Harvey) Hamel var. *californica* Hollenberg et Abbott			x		
Giffordia sandriana (Zanardini) Hamel	x	x	x		
Haplogloia andersonii (Farlow) Levring			x		
Hincksia granulosa (J. E. Smith) Hamel	x	x	x		
Laminaria farlowii Setchell		x	x		x
Macrocystis pyrifera (L.) C. Agardh		x	x		
Pterygophora californica Ruprecht		x			x

Table 1. Continued.

	1a	1b	2	3	4
Scytosiphon dotyi Wynne	x	x			
Scytosiphon lomentaria (Lyngbye) J. Agardh	x	x	x		
Sphacelaria didichotoma Saunders	x	x			
Taonia lennebackerae J. Agardh	x	x		x	
Zonaria farlowii Setchell *et* Gardner	x	x			
Total brown algal taxa/site	12	17	13	3	7
Total brown algal taxa (22)					
Rhodophyta					
Acrosorium venulosum (Zanardini) Kylin			x		x
Ahnfeltia fastigiata (Postels *et* Ruprecht) Makienko	x	x			
Antithamnion defectum Kylin	x	x			
Asterocolax gardneri (Setchell) Feldmann *et* Feldmann	x	x			
Audouinella daviesii (Dillwyn) Woelkerling	x	x			
Bangia vermicularis Harvey	x	x			
Bossiella orbigniana (Decaisne) Silva ssp. *dichotoma* (Manza) Johansen	x	x			x
Bossiella orbigniana (Decaisne) Silva ssp. *orbigniana*	x	x			x
Botryocladia hancockii Dawson					x
Botryocladia neushulii Dawson		x	x		
Botryocladia pseudodichotoma (Farlow) Kylin					x
Calliarthron cheilosporioides Manza					x
Callithamnion biseriatum Kylin			x		
Callophyllis firma (Kylin) R. Norris					x

Table 1. Continued.

	1a	1b	2	3	4
Callophyllis flabellulata Harvey		x	x		
Callophyllis pinnata Setchell *et* Swezy		x			
Callophyllis violacea J. Agardh		x	x		
Centroceras clavulatum (C. Agardh) Montagne	x	x	x		
Ceramium californicum J. Agardh	x	x			
Ceramium eatonianum (Farlow) DeToni	x	x			
Ceramium sinicola Setchell *et* Gardner	x	x			
Ceramium zacae Setchell *et* Gardner					x
Chondria nidifica Harvey	x	x		x	x
Corallina officinalis L. var. *chilensis* (Decaisne) Kützing	x	x			x
Corallina vancouveriensis Yendo	x	x			
Cryptopleura corallinara (Nott) Gardner	x	x			
Cryptopleura crispa Kylin	x	x			
Cryptopleura ruprechtiana (J. Agardh) Kylin		x			
Cryptopleura violacea (J. Agardh) Kylin	x	x	x		x
Cumagloia andersonii (Farlow) Setchell *et* Gardner	x	x			
Erythrotrichia carnea (Dillwyn) J. Agardh	x	x			
Farlowia conferta (Setchell) Abbott					x
Fryeella gardneri (Setchell) Kylin		x			x
Gastroclonium subarticulum (Turner) Kützing	x	x			
Gelidiocolax microsphaerica Gardner	x	x			
Gelidium coulteri Harvey	x	x		x	
Gelidium purpurascens Gardner		x			
Gelidium pusillum (Stackhouse) Le Jolis	x	x			
Gelidium robustum (Gardner) Hollenberg *et* Abbott		x	x		x

Table 1. Continued.

	1a	1b	2	3	4
Gigartina canaliculata Harvey	x	x	x	x	
Gigartina exasperata Harvey *et* Bailey		x			x
Gigartina harveyana (Kützing) Setchell *et* Gardner			x		
Gigartina leptorhynchos J. Agardh	x	x		x	
Gigartina ornithorhynchos J. Agardh	x	x			
Gigartina volans (C. Agardh) J. Agardh	x	x			
Gracilaria papenfussii Abbott	x	x	x		x
Gracilaria textorii (Suringar) J. Agardh var. *cunninghamii* (Farlow) Dawson	x	x			
Gracilariophila oryzoides Setchell *et* Wilson	x	x			
Grateloupia doryphora (Montagne) Howe	x	x	x		x
Gymnogongrus chiton (Howe) Silva *et* DeCew	x	x	x		x
Gymnogongrus leptophyllus J. Agardh	x	x			
Halymenia californica Smith *et* Hollenberg			x		x
Halymenia hollenbergii Abbott					x
Herposiphonia plumula (J. Agardh) Hollenberg					x
Herposiphonia secunda (C. Agardh) Ambron forma *tenella* (C. Agardh) Wynne	x	x			
Herposiphonia verticillata (Harvey) Kylin	x	x			
Heterosiphonia japonica Yendo					x
Holmesia californica (Dawson) Dawson	x	x			x
Janczewksia lappacea Setchell	x	x			
Laurencia pacifica Kylin	x	x			x
Laurencia spectabilis Postels *et* Ruprecht	x	x			
Lomentaria caseae Dawson					x

Table 1. Continued.

	1a	1b	2	3	4
Mastocarpus papillatus (C. Agardh) Kützing	x	x			
Melobesia marginata Setchell *et* Foslie	x	x			
Melobesia mediocris (Foslie) Setchell *et* Mason	x	x			
Microcladia coulteri Harvey	x	x	x		x
Nemalion helminthoides (Velley) Batters	x	x			
Nienbergia andersoniana (J. Agardh) Kylin	x	x	x		x
Nitophyllum northii Hollenberg *et* Abbott			x		
Opuntiella californica (Farlow) Kylin			x		
Phycodrys isabelliae R. Norris *et* Wynne					x
Platythamnion heteromorphum (J. Agardh) J. Agardh					x
Platythamnion pectinatum Kylin					x
Platythamnion villosum Kylin		x	x		
Pogonophorella californica (J. Agardh) Silva	x	x			
Polyneura latissima (Harvey) Kylin		x	x		x
Polysiphonia hendryi Gardner	x	x		x	x
Polysiphonia pacifica Hollenberg	x	x	x		
Polysiphonia scopulorum Harvey var. *villum* (J. Agardh) Hollenberg	x	x			
Porphyra perforata J. Agardh	x	x			
Prionitis angusta (Harvey) Okamura		x			x
Prionitis australis (J. Agardh) J. Agardh		x			x
Prionitis lanceolata (Harvey) Harvey	x	x			
Pterochondria woodii (Harvey) Hollenberg	x	x			
Pterocladia capillacea (Gmelin) Bornet *et* Thuret		x			
Pterosiphonia baileyi (Harvey) Falkenberg	x	x			

Table 1. Continued.

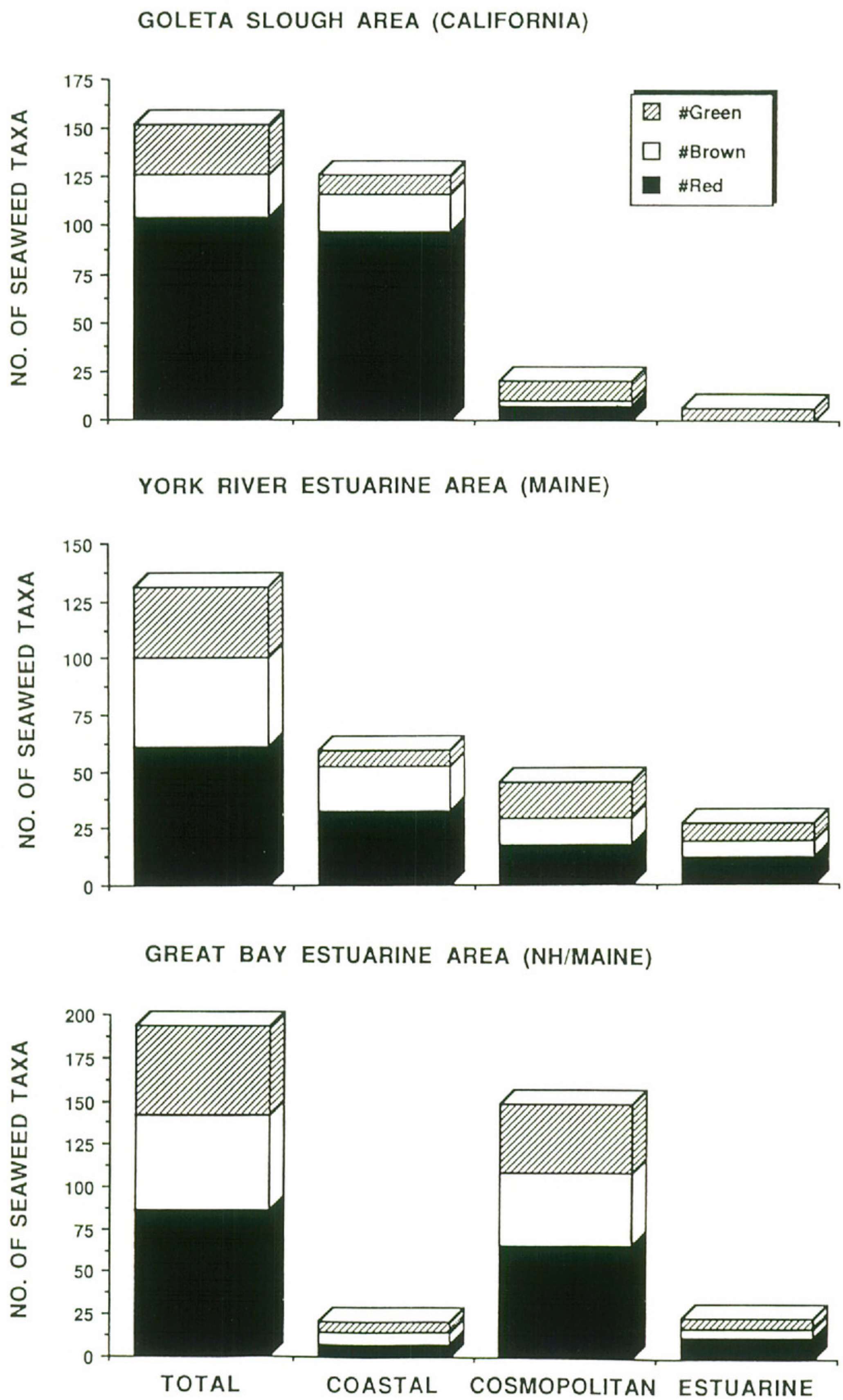
	1a	1b	2	3	4
Pterosiphonia dendroidea (Montagne) Falkenberg	x	x		x	x
Rhodoglossum affine (Harvey) Kylin	x	x			
Rhodoglossum californicum (J. Agardh) Abbott	x	x			
Rhodoglossum roseum (Kylin) G. M. Smith		x			
Rhodoptilum plumosum (Harvey *et* Bailey) Kylin					x
Rhodymenia arborescens Dawson					x
Rhodymenia californica Kylin var. *attenuata* (Dawson) Dawson					x
Rhodymenia californica Kylin var. *californica*			x		x
Rhodymenia pacifica Kylin	x	x	x		x
Sarcodiotheca furcata (Setchell *et* Gardner) Kylin		x			x
Sarcodiotheca gaudichaudii (Montagne) Gabrielson	x	x	x		x
Scinaia articulata Setchell	x	x			x
Scinaia confusa (Setchell) Huisman	x	x			
Schizmenia pacifica Kylin	x	x			x
Smithora naiadum (Anderson) Hollenberg	x	x			
Stenogramme interrupta (C. Agardh) Montagne	x	x			
Stylonema alsidii (Zanardini) Drew	x	x		x	
?*Tenarea dispar* (Foslie) Adey		x			
Total red algal taxa/site	64	81	24	7	44
Total red algal taxa (104)					
Total taxa/site	94	117	39	26	52
Total taxa (152)					

#1a = Goleta Point (transect, intertidal & shallow subtidal); #1b = Goleta Point (total flora, intertidal & subtidal); #2 = Goleta Bay (offshore-subtidal); #3 = Goleta Slough (intertidal & subtidal); #4 = Naples Reef (offshore-subtidal).

cosmopolitan component contained 7 Rhodophyceae, 3 Phaeophyceae and 10 Chlorophyceae. Approximately 31% of the coastal taxa occurred at two or more sites (39 taxa), while the remaining 87 were restricted to one of the following sites: (1) Goleta Point transect—9 Chlorophyceae, 4 Phaeophyceae and 45 Rhodophyceae; (2) Offshore Goleta Point—1 Chlorophyceae and 4 Rhodophyceae; (3) Goleta Bay—3 Phaeophyceae and 4 Rhodophyceae; (4) Naples Reef—1 Chlorophyceae, 2 Phaeophyceae and 17 Rhodophyceae. One cosmopolitan taxa occurred at all four sites (i.e., *Ectocarpus parvus*), while seven were found at three sites (i.e., *Enteromorpha linza, Ulva lactuca, Endarachne binghamiae, Chondria nidifica, Gigartina canaliculata, Polysiphonia hendryi* and *Rhodoglossum affine*). See Table 1 for specific details.

A comparison of the floras from Goleta Slough and the adjacent open coast with two analogous New England habitats (i.e., the York River and Great Bay Estuarine areas) shows varying patterns of local distribution (Figure 5). For example, 131 taxa occur within the York River Estuary and adjacent open coast of southern Maine, consisting of 59 coastal, 45 cosmopolitan and 27 estuarine (Mathieson, et al., 1993). The flora within the Great Bay Estuary and adjacent open coast is more diverse (i.e., 194 taxa), consisting of 21 coastal, 149 cosmopolitan and 24 estuarine taxa (Mathieson and Hehre, 1986). Thus, the estuarine reduction pattern is most conspicuous within Goleta Slough (i.e., 126 coastal, 20 cosmopolitan and 6 estuarine), intermediate within the York River Estuary, and least pronounced within the Great Bay Estuary. Floristic patterns within the Goleta Slough and York River are similar, except for differences in the numbers of total taxa and brown and red algae. The prevalence of cosmopolitan taxa within the Great Bay area (77%) should be emphasized, as it represents a very different pattern than that found within either the York River (34%) or Goleta Slough (13%).

The number of seaweed taxa/site within Goleta Slough is summarized in Figure 6 and Table 2. The highest number of taxa was recorded at site 1 (22), while reduced and irregular numbers occurred upstream (i.e., 1–13). Green algae dominated the Slough, with *Enteromorpha clathrata* and *Rhizoclonium riparium* exhibiting occurrences of 85.2 and 81.5%, respectively. All seven red algae and two of the three browns were restricted to site 1 (i.e., 3.7% occurrence), which is just 0.09 miles inland from the mouth. Only one brown alga (*Ectocarpus parvus*) extended upstream be-


GOLETA SLOUGH AREA (CALIFORNIA)
NO. OF SEAWEED TAXA
175
150
125
100
75
50
25
0
#Green
#Brown
#Red
YORK RIVER ESTUARINE AREA (MAINE)
NO. OF SEAWEED TAXA
150
125
100
75
50
25
0
GREAT BAY ESTUARINE AREA (NH/MAINE)
NO. OF SEAWEED TAXA
200
175
150
125
100
75
50
25
0
TOTAL
COASTAL
COSMOPOLITAN
ESTUARINE

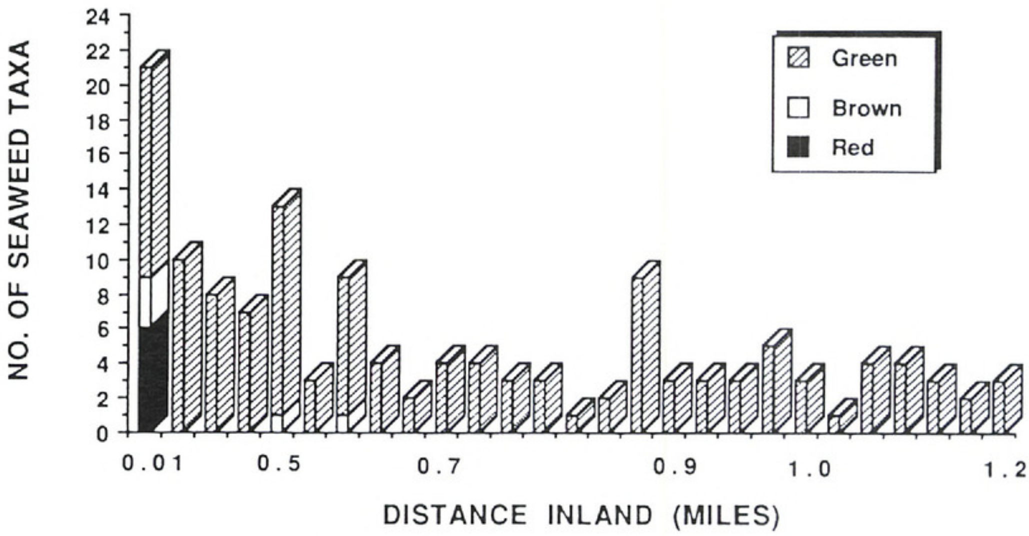


Figure 6. Number of seaweed taxa/site (green, brown and red) at twenty-seven Goleta Slough stations.

yond site 1, occurring also at sites 5 and 6 (i.e., 11.1% occurrence). See Table 2 for further details.

The paucity of seaweed taxa within Goleta Slough is further documented by comparing its species composition and mean number of taxa/site (Figure 7 and Table 2) with thirteen New England estuaries. Only 26 seaweeds were recorded from the Slough, with a mean of just 5.1 ± 4.3 taxa/site. Inner riverine habitats like the Winnicut River (4 taxa and 1.3 ± 1.6) have less diverse floras, while outer and mid-estuarine sites typically have greater number of species: e.g., Oyster (49 taxa and 12.6 ± 7.9), York (72 taxa and 21.4 ± 3.2) and Piscataqua Rivers (143 and 25.3 ± 24.9). Figure 8 compares the green algal taxa within the Slough (16 taxa) and thirteen New England estuaries. The number of taxa ranged from 24–37 within outer and mid-estuarine New England sites versus 12–20 for inner locations. The % of Slough greens within the same New England sites varied from 25–81%, with most habitats, other than the Winnicut and Merrimack Rivers, having floristic affinities of 50% or more. None of the browns

←

Figure 5. A comparison of species richness and local distribution of seaweed taxa from the Goleta Slough and adjacent open coast (California) with the York River (Maine) and the Great Bay Estuarine areas (Maine-New Hampshire).

Table 2. Summary of seaweed taxa at twenty-seven sites within the Goleta Slough.

	1	2	3	4	5	6	7	8	9	10	11
Chlorophyta											
Blidingia minima	x	x	x	x	x	x		x			
Capsosiphon fulvescens		x	x		x						
Chaetomorpha aerea	x										
Cladophora microcladioides	x										
Cladophora sericea	x	x	x		x	x					
Enteromorpha clathrata	x	x	x	x	x	x	x		x		x
Enteromorpha compressa	x			x	x			x			
Enteromorpha flexuosa ssp. *flexuosa*	x	x		x	x	x					
Enteromorpha intestinalis	x				x	x					
Enteromorpha linza		x									
Enteromorpha prolifera			x	x	x	x					x
Microspora pachyderma		x	x		x			x	x	x	
Rhizoclonium riparium	x	x	x	x	x	x	x		x		x
Ulva lactuca	x	x			x						
Ulva taeniata	x										
Ulvaria oxysperma	x	x	x	x	x	x					
# Green algal taxa/site	12	10	8	7	12	8	2	3	3	1	3
Mean # (± SD) green algal taxa/site (4.7 ± 3.1)											
Mean % occurrence (± SD) green algal taxa (28.9% ± 24.6%)											
Total # green algal taxa (16)											
Phaeophyta											
Ectocarpus parvus	x				x	x					

Table 2. Extended.

12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	%*
x	x							x							x	40.7
										x					x	18.5
																3.7
																3.7
			x					x							x	29.6
x	x		x	x	x	x	x	x	x	x	x	x		x	x	85.2
															x	18.5
		x		x		x				x		x	x			40.7
					x											14.8
																3.7
						x	x			x		x		x	x	40.7
		x	x												x	33.3
x	x	x	x	x	x	x	x	x		x	x		x	x	x	81.5
																11.1
																3.7
	x						x								x	33.3
3	4	3	4	3	3	4	4	4	1	5	2	3	2	3	9	
																11.1

Table 2. Continued

	1	2	3	4	5	6	7	8	9	10	11
Endarachne binghamiae	x										
Taonia lennebackerae	x										
# Brown algal taxa/site	3	0	0	0	1	1	0	0	0	0	0
Mean # (± SD) brown algal taxa/site (0.19 ± 0.61)											
Mean % occurrence (± SD) brown algal taxa (6.2% ± 3.5%)											
Total # brown algal taxa (3)											
Rhodophyta											
Chondria nidifica	x										
Gelidium coulteri	x										
Gigartina canaliculata	x										
Gigartina leptorhynchos	x										
Polysiphonia hendryi	x										
Pterosiphonia dendroidea	x										
Stylonema alsidii	x										
# Red algal taxa/site	7	0	0	0	0	0	0	0	0	0	0
Mean # (± SD) red algal taxa/site (0.26 ± 1.32)											
Mean % occurrence (± SD) red algal taxa (3.7% ± 0%)											
Total # red algal taxa (7)											
Total seaweed taxa/site	22	10	8	7	13	9	2	3	3	1	3
Mean # (± SD) total seaweed taxa/site (5.1 ± 4.4)											
Total seaweed taxa (26)											

* The % values represent calculations based upon 27 Goleta Slough stations.

Table 2. Extended. Continued.

12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	%*
																3.7
																3.7
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
																3.7
																3.7
																3.7
																3.7
																3.7
																3.7
																3.7
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	4	3	4	3	3	4	4	4	1	5	2	3	2	3	9	

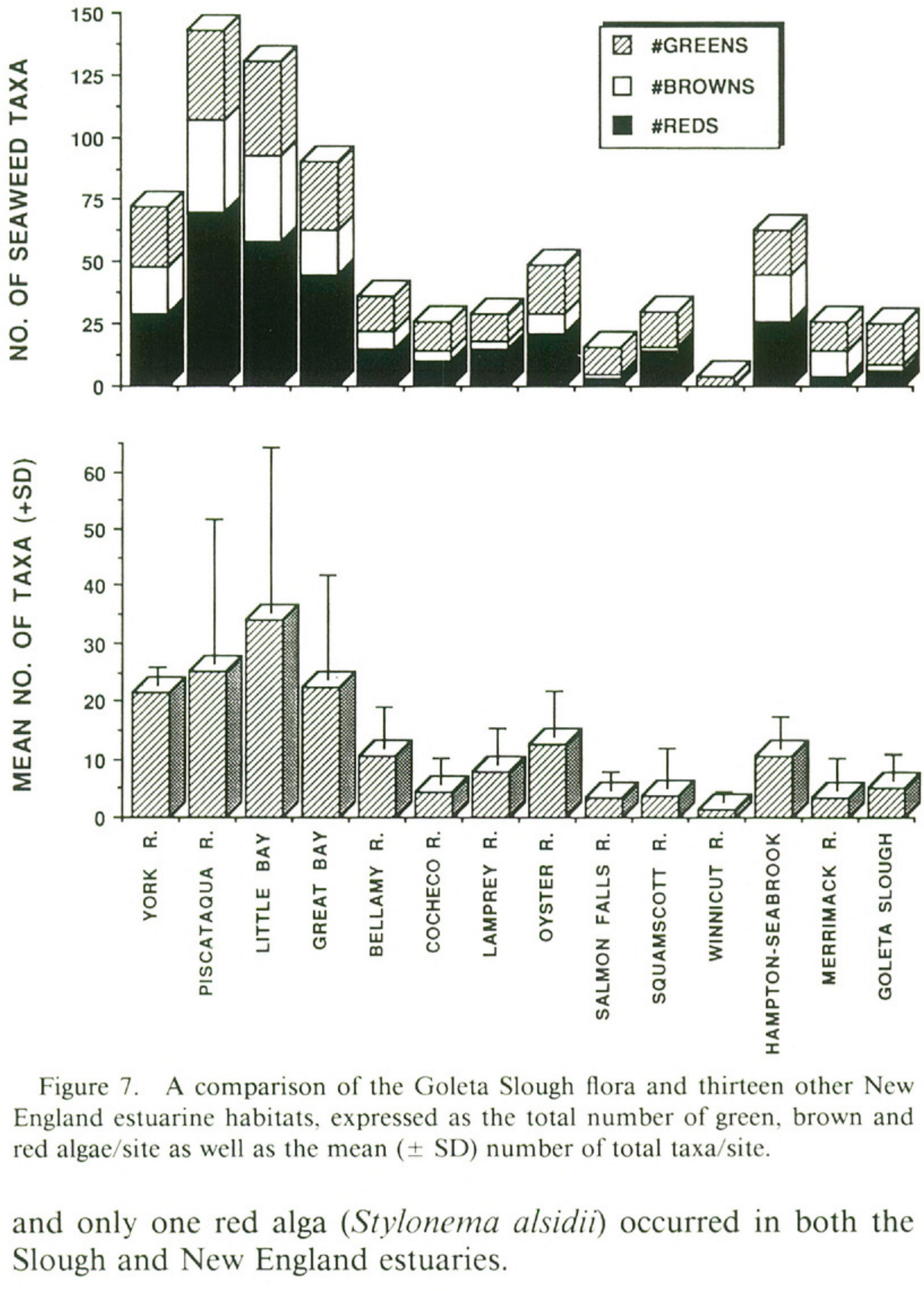


Figure 7. A comparison of the Goleta Slough flora and thirteen other New England estuarine habitats, expressed as the total number of green, brown and red algae/site as well as the mean (± SD) number of total taxa/site.

and only one red alga (*Stylonema alsidii*) occurred in both the Slough and New England estuaries.

PHENOLOGICAL PATTERNS AT GOLETA POINT

Table 3 summarizes monthly occurrences of seaweed taxa on the Goleta Point transect. No conspicuous pattern was evident, except that the minimum number of taxa occurred in April (27) and the highest in February and November (45). Green algae

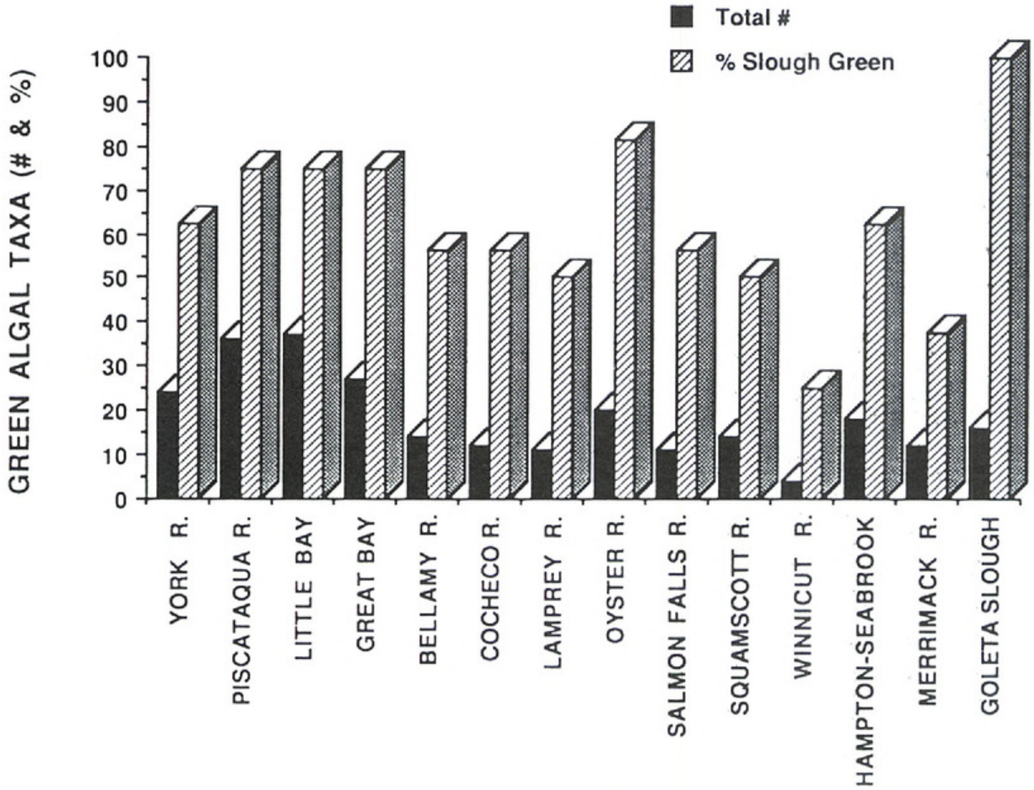


Figure 8. A comparison of the green algal floras of the Goleta Slough and thirteen other New England estuarine habitats, expressed as the total number of green algae as well as the % of Goleta Slough taxa.

varied from 5–12 taxa/month versus 3–9 for the browns and 23–29 for the reds. The mean number of taxa/month was 39.2 ± 6.0, with reds contributing 24.7 (± 2.8), greens 8.4 (± 2.1) and browns 6.1 (± 2.4). Four species were collected each month (i.e., *Gelidium coulteri, Gigartina canaliculata, G. leptorhynchos, Pterosiphonia dendroidea*). Thirteen others occurred during eight of nine months (90% occurrence), including *Chaetomorpha aerea, Cladophora columbiana, Ulva taeniata, Egregia menziesii, Endarachne binghamiae, Scytosiphon dotyi, Centroceras clavulatum, Ceramium eatonianum, Corallina vancouveriensis, Cryptopleura violacea, Gastroclonium subarcticulatum, Gigartina volans* and *Polysiphonia hendryi.* By contrast, 30 of the 94 taxa were only found once (~32% of total flora).

ABUNDANCE PATTERNS WITHIN GOLETA SLOUGH

Figure 9 illustrates the abundance of green algae and the California horn snail (*Cerithidea californica*) within three shallow

Table 3. Monthly records of seaweed taxa on Goleta Point transect.

	J	F	M	A	M	J	J	A	S	O	N	D	%*
Chlorophyta													
Acrochaete viridis							x						11.1
Blidingia minima			x	x			x	x					44.4
Bryopsis corticulans		x											11.1
Bryopsis hypnoides								x			x		22.2
Chaetomorpha aerea	x	x	x		x	x	x	x			x		88.9
Cladophora columbiana	x	x	x		x	x	x	x			x		88.9
Cladophora graminea								x					11.1
Cladophora sericea	x	x	x		x						x		55.6
Codium sp. (basal filaments)	x												11.1
Enteromorpha clathrata		x			x	x	x	x			x		66.7
Enteromorpha compressa	x			x	x	x	x	x			x		77.8
Enteromorpha flexuosa ssp. *flexuosa*		x			x			x					33.3
Enteromorpha linza	x	x		x			x	x			x		66.7
Enteromorpha prolifera		x	x	x		x	x	x					66.7
Rhizoclonium implexum		x											11.1
Ulva californica		x		x	x								33.3
Ulva lactuca			x			x	x	x			x		55.6
Ulva taeniata	x	x	x		x	x	x	x			x		88.9
# Green algal taxa/month	7	11	7	5	8	7	10	12			9		
Mean # (± SD) green algal taxa/month (8.4 ± 2.1)													
Total green algal taxa (18)													
Phaeophyta													
Colpomenia sinuosa	x		x										22.2

Table 3. Continued.

	J	F	M	A	M	J	J	A	S	O	N	D	%*
Cylindrocarpus rugosus	x	x			x			x					44.4
Ectocarpus parvus	x	x					x	x			x		55.6
Egregia menziesii	x		x	x	x	x	x	x			x		88.9
Endarachne binghamiae	x	x	x	x		x	x	x			x		88.9
Giffordia sandriana			x				x	x			x		44.4
Hincksia granulosa	x	x											22.2
Scytosiphon dotyi	x	x	x	x	x		x	x			x		88.9
Scytosiphon lomentaria			x		x								22.2
Sphacelaria didichotoma		x	x								x		33.3
Taonia lennebackerae	x	x	x								x		44.4
Zonaria farlowii	x	x	x		x						x		55.6
# Brown algal taxa/month	9	8	9	3	5	2	5	6			8		
Mean (# (± SD) brown algal taxa/month (6.1 ± 2.4)													
Total brown algal taxa (12)													
Rhodophyta													
Ahnfeltia fastigiata		x	x	x	x		x	x			x		77.8
Antithamnion defectum								x					11.1
Asterocolax gardneri		x											11.1
Audouinella daviesii		x											11.1
Bangia vermicularis			x										11.1
Bossiella orbigniana ssp. *dichotoma*		x				x	x						33.3
Bossiella orbigniana ssp. *orbigniana*				x									11.1
Centroceras clavulatum	x	x	x		x	x	x	x			x		88.9
Ceramium californicum											x		11.1

Table 3. Continued.

	J	F	M	A	M	J	J	A	S	O	N	D	%*
Ceramium eatonianum	x		x	x	x	x	x	x			x		88.9
Ceramium sinicola		x											11.1
Chondria nidifica	x	x					x	x			x		55.6
Corallina officinalis var. *chilensis*		x											11.1
Corallina vancouveriensis	x	x	x	x	x	x	x	x			x		88.9
Cryptopleura corallinara											x		11.1
Cryptopleura crispa				x									11.1
Cryptopleura violacea	x		x	x	x	x	x	x			x		88.9
Cumagloia andersonii					x	x	x	x					44.4
Erythrotrichia carnea	x		x								x		33.3
Gastroclonium subarticulatum	x	x	x	x	x	x	x				x		88.9
Gelidiocolax microsphaerica	x												11.1
Gelidium coulteri	x	x	x	x	x	x	x	x			x		100
Gelidium pusillum	x	x					x						33.3
Gigartina canaliculata	x	x	x	x	x	x	x	x			x		100
Gigartina leptorhynchos	x	x	x	x	x	x	x	x			x		100
Gigartina ornithorhynchos					x		x	x					33.3
Gigartina volans		x	x	x	x	x	x	x			x		88.9
Gracilaria papenfussii	x		x	x	x		x				x		66.7
Gracilaria textorii var. *cunninghamii*	x		x		x			x			x		55.6
Gracilariophila oryzoides	x												11.1
Grateloupia doryphora				x	x	x	x	x					55.6
Gymnogongrus chiton											x		11.1
Gymnogongrus leptophyllus	x	x											22.2
Herposiphonia secunda forma *tenella*		x											11.1

Table 3. Continued.

	J	F	M	A	M	J	J	A	S	O	N	D	%*
Herposiphonia verticillata		x											11.1
Holmesia californica						x							11.1
Janczewskia lappacea	x						x	x					33.3
Laurencia pacifica						x		x					22.2
Laurencia spectabilis	x	x	x	x	x						x		66.7
Mastocarpus papillatus					x		x						22.2
Melobesia marginata											x		11.1
Melobesia mediocris						x							11.1
Microcladia coulteri				x			x						22.2
Nemalion helminthoides					x	x	x	x			x		55.6
Nienbergia andersoniana		x									x		22.2
Pogonophorella californica			x										11.1
Polysiphonia hendryi	x	x	x	x		x	x	x			x		88.9
Polysiphonia pacifica								x			x		22.2
Polysiphonia scopulorum var. *villum*	x												11.1
Porphyra perforata			x	x	x	x	x	x					66.7
Prionitis lanceolata				x									11.1
Pterochondria woodii	x					x							22.2
Pterosiphonia baileyi	x		x				x				x		44.4
Pterosiphonia dendroidea	x	x	x	x	x	x	x	x			x		100
Rhodoglossum affine					x	x	x	x			x		55.6
Rhodoglossum californicum							x						11.1
Rhodymenia pacifica		x	x										22.2
Sarcodiotheca gaudichaudii		x	x		x		x	x					55.6
Scinaia articulata						x							11.1

Table 3. Continued.

	J	F	M	A	M	J	J	A	S	O	N	D	%*
Scinaia confusa								x					11.1
Schizymenia pacifica			x		x								22.2
Smithora naiadum		x	x		x	x	x				x		66.7
Stenogramme interrupta													11.1
Stylonema alsidii		x						x			x		22.2
# Red algal taxa/month	23	26	24	19	24	23	29	26			28		
Mean # (± SD) red algal taxa/month (24.7 ± 2.8)													
Total red algal taxa (64)													
Total # taxa/month	39	45	40	27	37	32	44	44			45		
Mean # (± SD) total taxa/month (39.2 ± 6.0)													
Total seaweed taxa (94)													

* The % values represent calculations based upon a total of nine monthly samples.

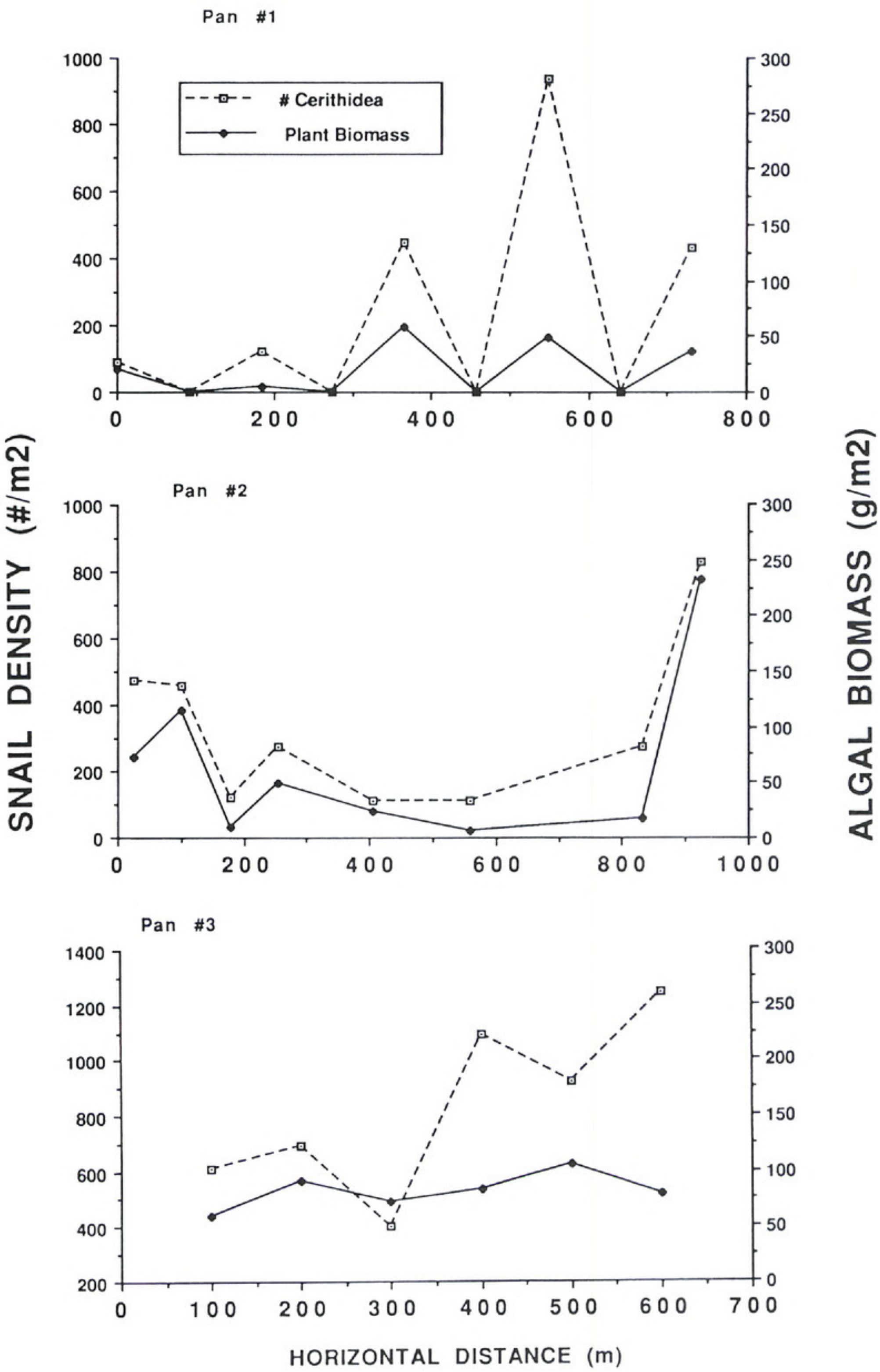


Figure 9. Spatial patterns of green algal biomass (g dry weigh/m^2) and horn snail densities (#/m^2) within three shallow Goleta Slough pans.

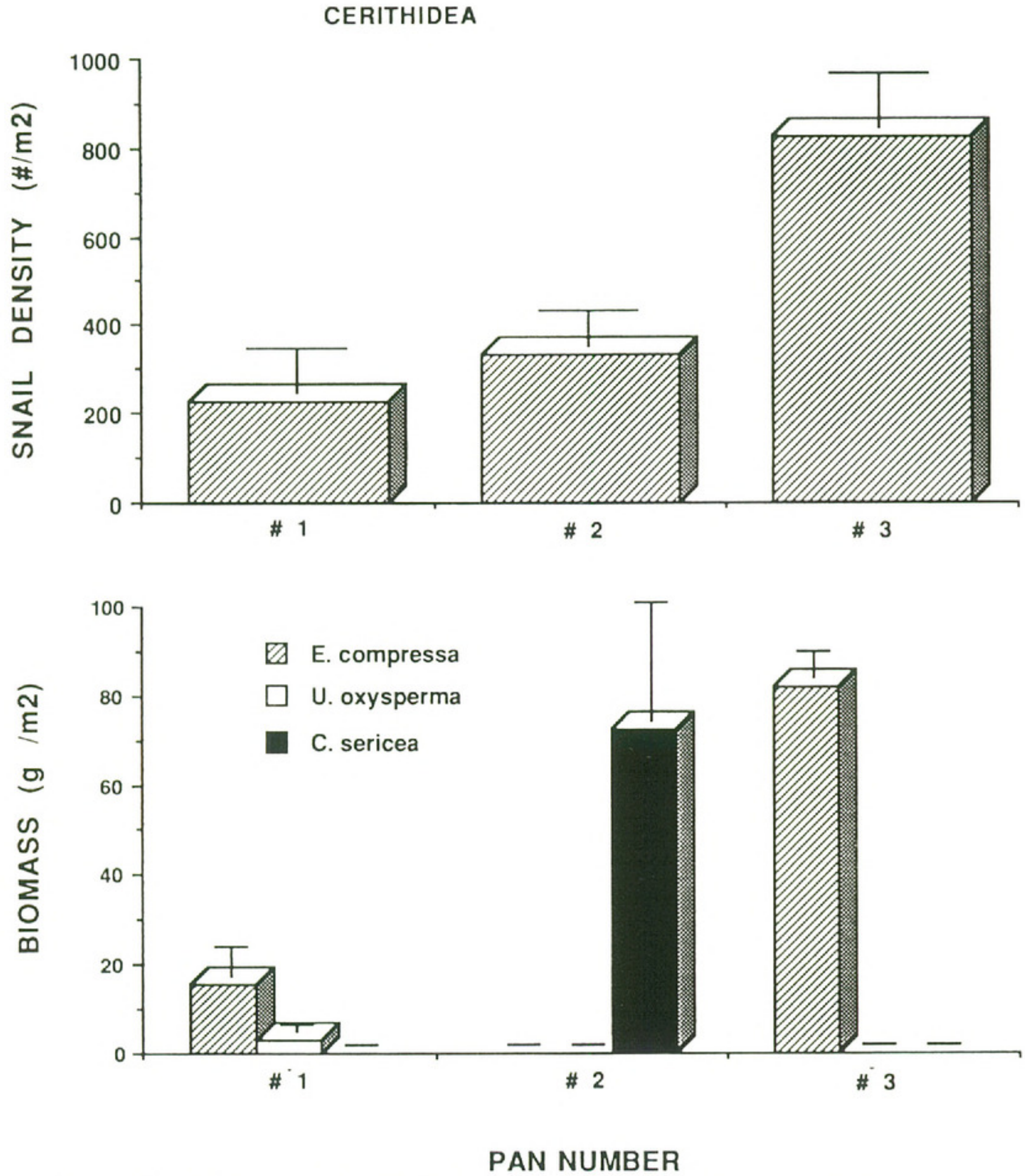


Figure 10. Mean (± SD) snail density (#/m²) and biomass of *Cladophora sericea*, *Enteromorpha compressa* and *Ulvaria oxysperma* (g dry weight/m²) within three shallow Goleta Slough pans.

pans. A strong similarity was evident between plant and snail abundances, except for one modest deviation within pan #3. Upwards of 800–1300 snails/m² were recorded, with maximum plant biomass ranging from ~50–250 g dry weight/m². *Cladophora sericea* and *Enteromorpha compressa* were the dominant seaweeds with mean biomass values of ~73 (± 26.4) and ~82 (± 5.8) g dry weight/m²; mean snail densities ranged from 225 (± 101) to 826 (± 82)/m² (Figure 10).

DISCUSSION

Patterns of species composition and richness of seaweeds at our study sites show strong contrasts (Figure 5), which may be associated with pronounced habitat and local environmental variability (Littler et al., 1991; Murray and Littler, 1989; Thom, 1976, 1980; Thom and Widdowson, 1978). Strong gradients of water motion, substratum availability and depth are evident from the offshore Naples reef site into the Goleta Slough, with deep water and abundant rocky substrata (former) versus muddy, shallow sedimented habitats (latter). The Goleta Point and Bay sites are exposed to contrasting (i.e., diminishing) patterns of water motion and sand fluctuation (Wheeler et al., 1981), with the latter often causing extensive erosion and burial at Goleta Point (Figure 3) and periodically blocking off the Slough (Macdonald, 1977; Onuf and Zedler, 1988). Contrasting patterns of light penetration are evident between Goleta Point and the Slough due to enhanced sedimentation (Wheeler et al., loc. cit.), while hydrographic differences between coastal and Slough habitats are most pronounced during summer (Figure 4). As would be expected, the most depauperate flora occurs within the Slough, a shallow, turbid and hydrographically variable environment (Zedler, 1982b). The most diverse flora was found at Goleta Point, which had a variety of intertidal and subtidal habitats, as well as intermediate conditions of light penetration, sediments and hydrographic variability. The Goleta Point transect was also the most extensively studied habitat (Table 3). The subtidal zone within the Slough is limited and shallow, while it is more expansive on the adjacent open coast. Typically, temperate subtidal habitats are dominated by a variety of red and brown algae, with ratios of greens to reds decreasing with depth (Dawson et al., 1960; Edelstein et al., 1969; Kain, 1960; Lamb and Zimmerman, 1964; Mathieson, 1979; Neushul, 1965; Sears and Wilce, 1974). By contrast, the Slough's flora is dominated by a few ephemeral green algae (Figure 6).

As noted previously, diversity of seaweeds near Goleta can be further documented using Cheney's (R + C)/P ratio. Three of the four study sites are interpreted as having "warm water" floras (~5.9–7.7), except for the offshore Goleta Bay site (2.0). Obviously, these floristic ratios are influenced by variability of habitat (see above) and species composition, with the highest value occurring within Goleta Slough (~7.7) where only three brown algae were recorded. In comparing these ratios for New England sites, eleven outer and mid-estuarine locations had values of < 6.0, indicating "mixed" or "cold-water" floras, while three inner riverine habitats (i.e., Lamprey, Salmon Falls and Squamscott Rivers), with reduced numbers of brown algal taxa, had ratios of 7–14 (cf. Mathieson and Penniman, 1986a, 1991). Adjacent open coastal sites in New England have much lower ratios (~1.72–3.0) and an overall mean value of ~2.5 (Mathieson and Penniman, 1986b). Such patterns confirm the usefulness of Cheney's ratio primarily for open coastal populations.

Based on a variety of detailed studies at 22 open coastal intertidal sites in southern California, Littler et al. (1991) recorded 224 taxa (i.e., 149 red, 47 brown and 23 green algae), while we recorded 152 at four primary sites (i.e., 104 red, 22 brown and 26 green algae). Our documentation of higher numbers of green algae and six new geographical records (see above) probably resulted from more extensive seasonal sampling of estuarine and subtidal habitats. In discussing distributional patterns of individual taxa, Littler et al. (loc. cit.) state that only 12 of the 224 seaweeds (i.e., exclusive of Cyanophyceae) occurred at all 22 sites, with these consisting of corallines, sheet-like species and small filamentous algae (Stewart, 1982, 1983). Most other taxa had restricted distributions, reflecting the high degree of local environmental variability between habitats (Murray and Littler, 1989). Both studies document a diverse warm-temperature flora dominated by red algae (Lüning, 1990; Thom, 1976, 1980) with restricted occurrences of several taxa. Littler and colleagues (loc. cit.) note that subclimax assemblages occur where there is a lack of environmental constancy (e.g., fluctuating sand) or some form of physiological stress (e.g., domestic pollution). In such habitats, opportunistic species readily occupy newly opened space (Emerson and Zedler, 1978; Murray and Littler, 1978; Wilson, 1925). If disturbance is periodic and not too severe, intertidal populations exhibit increased densities due to coexistence of both early and late successional species (Sousa, 1979). Such patterns probably occur at Goleta Point, where a large number of epiphytic and "turf" forms (Stewart, 1982, 1983), as well as the highest number of taxa/site, are found.

Our floristic records for open coastal taxa can be compared with several previous studies near Goleta and throughout southern California (e.g., Dawson, 1959a, 1959b, 1965; Murray and

Littler, 1989; Nicholson and Cimberg, 1971). For example, Dawson and Nicholson and Cimberg (loc. cit.) recorded intertidal species composition at three contiguous points near Goleta (Figure 1), with the former recording 38 and 47 seaweed taxa/site at Goleta and Santa Barbara Points, respectively and the latter, 49 taxa at Devereaux Point. Murray and Littler (loc. cit.) documented seasonal collections at 21 rocky intertidal sites between Government Point (Santa Barbara County) and Ocean Beach (San Diego County), finding a range of 51–107 taxa/site and a mean of 76.3 ± 15.5. In addition, they recorded 93 taxa at Devereaux Point, consisting of 69 red, 15 brown and 9 green algae. Dawson's collections of "dominant intertidal seaweeds" at Goleta Point (38 taxa) were based upon three seasonal collections (winter, spring and fall), while ours (i.e., 94 taxa) were made during nine monthly collections, which included all conspicuous taxa from an intertidal and shallow subtidal transect. Thirty of these 94 taxa (i.e., ~32%) were only collected once (Table 3), giving a mean value of 39.2 ± 6.0 taxa/month. The latter value is almost identical to Dawson's report. Overall, our records from Goleta Point are very similar to those of Murray and Littler (loc. cit.) from Devereaux Point (~93 taxa), while they are much higher than Dawson's from Goleta Point. Unfortunately, further comparisons are difficult because of varying collecting methods and sampling frequencies. Even so, eight of Dawson's "common intertidal" taxa from Goleta Point were never found by us at any of our four sites (i.e., *Anisocladella pacifica, Callophyllis obtusifolia, Chondria decipiens, Corallina pinnatifolia, Cryptopleura lobulifera, Gracilaria lemaneiformis, Laurencia splendens* and *Pleonosporium squarrulosum*), while Murray and Littler (loc. cit.) found half of these taxa at Devereaux Point. Thus, four of Dawson's common taxa may have become less so, while other specific changes may have occurred (Widdowson, 1971).

Estuarine reductional and compositional patterns observed within the Goleta Slough (Figure 6) are fairly typical (Coutinho and Seeliger, 1984; Josselyn and West, 1985; Ketchum, 1983; Mathieson and Penniman, 1986a; Wilkinson, 1980); even so, the rate of species loss upstream and dominance by ephemeral green algae are more pronounced within the Slough than in San Francisco Bay (Josselyn and West, loc. cit.; Silva, 1979) and most New England estuaries (Figure 7). For example, most open coastal red and brown algae within the Slough dropped out after ~0.09 miles.

By contrast, Silva (loc. cit.) found that 125 of the 156 total taxa recorded from San Francisco Bay penetrated the central Bay, while the remainder were protected water species (estuarine) that were more prevalent in the Bay than on the open coast. In New England open coastal taxa extend inland about one mile on the tidal portions of the Merrimack River in Massachusetts (Mathieson and Fralick, 1973), ~2–3 miles on the York River in Maine (Mathieson et al., 1993) and ~8.5 miles on the Piscataqua River in New Hampshire (Mathieson et al., 1983; Reynolds and Mathieson, 1975). Of the three New England sites, the Piscataqua River has the strongest currents (~5.0 knots) and most abundant rocky substrata, while industrial development and eutrophication are limited on the York, moderate on the Piscataqua, and maximal on the Merrimack (Mathieson et al., 1993). Several physical factors are probably responsible for the pronounced truncation of species within Goleta Slough. Both the range of salt content and maximum salinities are greater (i.e., ~0–68‰, Figure 4) than those found within the entire Great Bay Estuary (i.e., all ten subareas), which vary from ~0–34‰ (Mathieson and Hehre, 1986; Norall et al., 1982). Goleta's arid climate and the Slough's restricted tidal exchange (i.e., via sand deposition) no doubt contribute to these high salinities (Macdonald, 1977; Onuf, 1987; Onuf and Zedler, 1988; Zedler, 1982b). Maximum surface water temperatures within the Great Bay system are less than those in the Slough, but they exhibit a greater seasonal amplitude, varying from ~−2.0°–27.0°C in the former (Mathieson and Hehre, loc. cit.) to ~14°–35°C in the latter (Figure 4). The Slough's shallow topography and limited solid substrata also contribute to its reduced and patchy flora, as well as its dominance by loose-lying and epiphytic seaweeds (Josselyn and West, 1985; Norton and Mathieson, 1983).

In contrast to the depauperate flora of the Goleta Slough (i.e., 26 taxa and 5.1 ± 4.3 taxa/site), most New England habitats are more diverse, particularly outer- and mid-estuarine sites like the York (72 taxa and 21.4 ± 3.2) and Piscataqua Rivers (143 and 25.3 ± 24.9) and Little (130 and 34.1 ± 29) and Great Bays (90 and 22.5 ± 18.0). Depauperate floras dominated by green algae may also occur within inner riverine sites like the Cocheco, Salmon Falls and Winnicut Rivers (i.e., 1.3 ± 1.6 to 4.5 ± 4.3 taxa), as well as within the outer tidal portions of the Merrimack River (3.5 ± 5.2). The latter is badly polluted and one of the largest sources of freshwater discharge into the Gulf of Maine (Anon., 1984, 1987; Appolonio, 1979; Jerome et al., 1965; Lyons et al., 1982; Mathieson and Fralick, 1973; Miller et al., 1971). Comparing estuarine macroalgal communities within San Francisco Bay, Josselyn and West (1985) found a range of 28–61 taxa/site beyond its central portion, with lowest numbers occurring in South Bay. They noted that six of the eight most widely distributed species were green algae (*Enteromorpha clathrata, E. intestinalis, E. linza, Ulva angusta, U. lactuca* and *Cladophora sericea*) and two reds (*Antithamnion kylinii* and *Polysiphonia denudata*). Our studies of the Goleta Slough (Figure 8 and Table 2), plus those of Zedler (1982a, 1982b) from the Tijuana Estuary near San Diego and Norris (1970) from Elkhorn Slough near Carmel Bay, confirm a similar dominance of many of these same ephemeral green algae. Dawson (1962) found many of the same taxa (i.e., 9 green, 4 brown and 29 red algae) within the more saline Bahia de San Quintin. In summary, the Goleta Slough's flora is primarily dominated by ephemeral green algae and contains no perennial reds or browns; thus, it is analogous to several shallow embayments (estuaries) along the Pacific Coast of the U.S.A. and in New England (Figure 8).

As noted by several investigators (Anon., 1964; Clokie and Boney, 1980; Daly and Mathieson, 1977; Edwards, 1972; Littler, 1980; Littler et al., 1991; Patrick, 1963, 1964; Round, 1981; Wilkinson, 1980; Zedler, 1982b), patterns of low species richness are typical responses to stress, often allowing only a few tolerant species to dominate in both numbers and biomass. For example, the abundance of such ulotrichalean green algae as *Ulva lactuca, Enteromorpha* and *Ulvaria* (*Monostroma*) spp., typifies many eutrophied estuarine habitats, including the Goleta Slough (Cotton, 1910; Fritsch, 1956; Sawyer, 1965). The latter are tolerant of extremes of pollution and gross fluctuations in hydrographic conditions. Similar patterns are found in several estuaries having pronounced hydrographic variability and high sedimentation, including the Chesapeake Bay (Orris, 1980), the Merrimack River (Mathieson and Fralick, 1973) and many British and Dutch estuaries (Hartog, 1967; Nienhuis, 1975; Wilkinson, 1980). Within such turbid habitats, there is a relatively small pool of common (cosmopolitan) estuarine species, including *Cladophora, Enteromorpha,* and *Ulva* spp., together with several ceramialean red algae (Munda 1969, 1972; Orris, 1980; Wilkinson, 1980). The similarity of the Slough's green algal flora to New England estuarine vegetation is striking, with most sites exhibiting floristic affinities of 50% or more (Figure 8). In discussing salt marsh vegetation (i.e., angiosperms) within southern California, Zedler (1982b) describes a rather limited and highly stressed community from several hypersaline marshes, while Onuf and Zedler (1988) state that six of the seven species and all of the genera listed by Reimold (1977) from the eastern United States are in common. Thus, the estuarine chlorophycean and angiosperm floras of the two regions exhibit reduced numbers of taxa but strong floristic similarities. Only one other seaweed, the red alga *Stylonema alsidii,* occurred both within the Slough and in New England estuarine habitats, while 18 other cosmopolitan and coastal taxa from the Goleta and Santa Barbara area were in common to New England (~13.0% of 146 taxa). These include 13 green (*Acrochaete viridis, Blidingia minima, Chaetomorpha aerea, Cladophora sericea, Codium fragile, Enteromorpha clathrata, E. compressa, E. intestinalis, E. linza, E. prolifera, Rhizoclonium riparium, Ulva lactuca* and *Ulvaria oxysperma*), 2 brown (*Desmarestia viridis* and *Scytosiphon lomentaria*) and 3 red algae (*Audouinella daviesii, Erythrotrichia carnea* and *Nemalion helminthoides*).

Describing seasonal variability of southern California seaweeds, Widdowson (1971) notes a conspicuous maximum in March–June and a minimum during August–September, due to changes of individual species that are present year-round. We found a rather irregular pattern on the Goleta Point transect (Table 3), which may have resulted from pronounced sand fluctuations (Figure 3). Dawson (1965) states that no conspicuous seasonal differences in quantity and quality of southern California seaweeds occur. Littler et al. (1991) emphasize that local-scale or even site-specific conditions predominate and they often obscure broad climatic effects. Thus, major stochastic abiotic disturbances may be more important than subtle seasonal patterns, including heavy precipitation and flooding, extreme atmospheric conditions during daylight tidal emersions, storm generated waves and sand burial/scouring (see above). More pronounced seasonal patterns are often evident within cold-temperate areas like New England (Mathieson, 1989; Mathieson and Penniman, 1986a).

As noted by Zedler (1980, 1982a, 1982b), algal mats are often conspicuous and productive components of southern California tidal marshes, owing to the open canopies and short stature of their vascular plants. Two green algae (i.e., *Enteromorpha clathrata* and *Rhizoclonium riparium*), plus a variety of microscopic diatoms and blue greens, dominate the Tijuana Estuary near San Diego (Zedler, loc. cit.), while an analogous benthic microflora plus *Enteromorpha* and *Ulva* are abundant within the Mugu Lagoon near Port Hueneme (Onuf, 1987). According to Rudnicki (1986), maximum standing crops of dominant green algae within the Tijuana Estuary average 15 g dry wt./m^2, which is much less than the above ground biomass ($\sim$100–1100 g) of associated vascular plants (Zedler, 1982b). Green algal mats within the Goleta Slough were primarily composed of *Cladophora sericea* and *E. clathrata,* with mean biomass values of $\sim$73 and 82 g dry wt./m^2, respectively (Figure 10). Such values are $\sim$5.0–5.5 times greater than equivalent green algal mats within the Tijuana Estuary (Rudnicki, loc. cit.), and those of *E. clathrata* from San Francisco Bay (Shellem and Josselyn, 1982); they are also $\sim$20–60 times greater than mid-estuarine *Enteromorpha* spp. and *Ulva lactuca* populations from New England (Chock and Mathieseon, 1983). By contrast, standing crop values for Goleta Slough macroalgae are approximately the same as those found within New England inner riverine sites such as the Oyster River (Mathieson, unpubl. data). Fucoid algae typically dominate New England mid-estuarine habitats, with *Ascophyllum nodosum* ecad *scorpioides* and *A. nodosum* having mean biomass values of $\sim$300 and 500 g dry wt./m^2, respectively (Chock and Mathieson, loc. cit.). Thus, green algal standing stocks within the Slough are substantial but less than those of southern California vascular plants and New England estuarine fucoid algae.

The high densities of the California horn snail *Cerithidea californica* within the Goleta Slough ($\sim$225–826 snails/m^2) should be emphasized as well as the similarity of distributional patterns to *Cladophora sericea* and *Enteromorpha clathrata* (Figure 9). Among others, McCloy (1979) and Macdonald (1969) record high densities of horn snails (250 to > 1000/m^2) from southern California marshes, while Morris et al. (1980) state that it is probably the most common estuarine snail within this geography, often forming dense aggregations under debris and amongst plants on high lagoonal mudflats. Several investigators (e.g., Morris et al., loc. cit.; Onuf, 1987; Whitlatch and Obrebski, 1980) suggest that *C. californica* primarily feeds upon microorganisms and fine organic detritus. By contrast, Dawson (1962) states that *Enteromorpha* and other green algae serve in considerable part as food for this extremely abundant snail, while Zedler (1982b) describes an enhancement of macroalgal biomass within the Tijuana Estuary after the exclusion of horn snails (i.e., via cages). She further states that the removal of horn snails by shore birds results in increased algal mats, while *in situ* patchiness of snails and intertidal algal mats may be due to feeding by birds and other carnivores. The distributional patterns of *C. californica* are analogous to those of the common mud snail *Ilyanassa obsoleta,* which occurs in aggregated masses on mudflats and other estuarine habitats on the east coast of North America (Morris, 1947; Smith, 1964). Similarly, the removal of *I. obsoleta* from intertidal mudflats in Georgia resulted in enhanced algal and microbial biomass (Pace et al., 1979). Whether the abundance of *C. californica* within Baja and southern California marshes (Barnard, 1962; Dawson, 1962; Morris et al., 1980; Zedler and Nordby, 1986) indicates a consistent and similar interaction with seaweeds like that of *I. obsoleta* and *Littorina* spp. on the east coast (Mathieson et al., 1991; Pace et al., loc. cit.), should be better clarified by exclusion and manipulative experiments. In a discussion of the shore crab *Hemigrapsus oregonensis,* Onuf (1987) states that it is capable of shredding live macrophytes and will grow well in the laboratory provided solely with *Enteromorpha* (Kuris and Mager, 1975). However, in nature it feeds on diatoms (Morris et al., 1980) and is a scavenger and predator (Chapman et al., 1982). Lastly, the interrelationship between green algae and some surface-feeding shorebirds (e.g., coots) within Mugu Lagoon should be noted, as they primarily feed on thick mats of *Enteromorpha* (Onuf, 1987).

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DEPARTMENT OF PLANT BIOLOGY
JACKSON ESTUARINE LABORATORY
UNIVERSITY OF NEW HAMPSHIRE
DURHAM, NEW HAMPSHIRE, 03824

APPENDIX: STUDY SITES

Open Coast

GP: Goleta Point: A semi-exposed sandy habitat also called Campus Point located at the west end of Goleta Bay (Dawson, 1959a, 1959b). Scattered rock outcrops (Monterey shale/siltstone) and boulders occur on a broad sandy beach, many of which are extensively scoured. The point is exposed to greater longshore currents and wave action than within Goleta Bay (Wheeler et al., 1981). Subtidal collections (−10 to −30 feet) were made just offshore from the Point (= 0 miles inland; 30–32‰, 14.0°–18.0°C).

GB: Goleta Bay: A coastal site having limited wave action and currents (see above). Substratum primarily consists of sand with scattered boulders; sand often covers *in situ* benthic populations. Collections were made from −5 to −50 feet near two experimental farm sites (cf. Wheeler et al., 1981) (= just offshore from Goleta; 30–32‰, 14.0°–18.0°C).

NR: Naples Reef: An offshore reef site having abundant rocky substrata (Monterey shale/siltstone) and reduced levels of sediment and sand. Collections were made from −15 to −40 feet (= ~2.0 miles offshore from Santa Barbara Point).

Goleta Slough

1: Near the mouth of the Goleta Slough, just downstream from Goleta Beach State Pier; a sandy berm-like area on the northern bank of the channel. Collections were made from an old pier piling as well as on cliff facings with scattered mussel populations. The mouth of the slough is periodically blocked off by sand deposition during the summer, restricting tidal exchange (= 0.087 miles inland; 13–32‰, 15.0°–20.0°C).

2: A muddy area upstream from the mouth of the slough and near the entrance (i.e., bridge) to Goleta Beach State Park. Collections were made on the south bank of the channel, next to the park ranger's house. The substrata consists of muddy surfaces, as well as scattered and broken pieces of asphalt (= 0.311 miles inland, 27–30‰, 15.2°–21.5°C).

3: A muddy area on the south bank of the channel adjacent to the entrance to Goleta Beach State Park. Plants were collected from bridge pilings, scattered boulders, and as entangled masses on extensive muddy shorelines (= 0.392 miles inland; 2–25.5‰, 13.0°–15.3°C).

4: A muddy area near the Clarence Memorial Boulevard overpass (~0.125

miles) and upstream from the entrance to Goleta Beach State Park (~0.0623 miles). Collections were made on the south bank of the channel (= 0.448 miles inland; 1–33‰, 13.5°–20.5°C).

5: A muddy area on the south bank of a channel, ~0.075 miles from the Clarence Ward Memorial Boulevard overpass and near a bicycle overpass. A series of gas pipelines were also present. Collections were made of entangled masses of seaweeds on muddy surfaces, while epiphytic and entangled masses of algae also occurred within a small shallow pan (= 0.517 miles inland; 2–32‰, 15.2°–28.5°C).

6: Two shallow pans near station 7. Collections were made of free-floating and entangled masses of plants within the pans and on muddy surfaces around the periphery of the pan (= 0.622 miles inland; 11–42‰, 18.0°–32.0°C).

7: The south bank of a narrow muddy channel at the end of a large shallow pan, ~0.150 miles upstream from the Clarence Ward Memorial Boulevard overpass. Collections were made from entangled masses of seaweeds growing on muddy surfaces, epiphytic populations on *Salicornia virginica* and attached plants on drift wood (= 0.647 miles inland; 22‰, 15.4°–24.5°C).

8: A narrow tidal channel located approximately 0.3 miles upstream from the Clarence Ward Memorial Boulevard overpass on the south bank of the channel. The site is located at the end of an auxilliary road and just SW from the end of Santa Barbara's Municipal Airport runway 33L. Collections were made of epiphytic plants and entangled masses on muddy substrata (= 0.772 miles inland; 9–25‰, 17.0°–25.0°C).

9: A muddy channel approximately 0.375 miles upstream from the Clarence Ward Memorial Boulevard overpass on the south bank of the channel. The site is next to a pipe crossing. Collections were made on muddy vertical bankings (= 0.778 miles inland; 0–25‰, 15.5°–29.0°C).

10: One end of a large pan just downstream from the junction of two channels. Collections were made from emergent and tangled masses of seaweeds, which grew amongst vascular plants (= 0.996 miles inland; 0–12‰, 17.5°–26.0°C).

11: Junction of two tidal channels ~0.48 miles upstream from the Clarence Ward Memorial Boulevard overpass. Collections were made from entangled muddy plants (= 0.878 miles inland; 0–28‰, 17.8°–32.0°C).

12: A narrow muddy tidal channel, ~0.555 miles upstream from the Clarence Ward Memorial Boulevard overpass. Collections were made from entangled masses amongst *Salicornia virginica*, etc. (= 0.94 miles inland; 0–29‰, 23.0°–29.0°C).

13: A tidal channel ~0.2 miles downstream from a spill gate; considerable freshwater runoff was evident, particularly during spring. Collections were made along an embankment area lined with *Salicornia virginica* (= 1.058 miles inland; 0–29‰, 18.5°–30.5°C).

14: A large shallow pan next to the Goleta Water District facility. Stations 10 and 14 represent the extremities of the same pan. Collections were made from free-floating and entangled masses of seaweeds growing amongst vascular plants, as well as from entangled masses on muddy surfaces on the periphery of the pan (= 1.27 miles inland; 2–13‰, 19.5°–27.0°C).

15: A small pan area located just north of the spill gate adjacent to the Goleta Water District facility. Collections were made from free-floating and entangled masses of seaweeds, growing amongst vascular plants and on muddy marginal surfaces around the pans (= 1.114 miles inland; 6–>32‰, 21.0°–>30.0°C).

16: A shallow pan area, partially dried up during summer and forming cracked pavement-like masses of blue-green algae. Entangled masses of green algae were also present around the margin of the pan, growing amongst *Salicornia virginica*; many dead bivalve and periwinkle shells were found near these pans (= 0.977 miles inland; 13–68‰, 18.5°–32.0°C).

17: A shallow pan just upstream from station 5. Collections were made from entangled and free-floating masses of seaweeds growing in and around the pan (= 0.572 miles inland; 20–48‰).

18: A shallow pan area just upstream from station 17. Collections were similar to those at 17 (= 0.641 miles inland; 11–42‰, 18.0°–32.0°C).

19: A muddy channel bank next to station 18. Collections were made from entangled masses on muddy surfaces and around the bases of vascular plants (= 0.654 miles inland; 1–35‰, 14.5°–16.0°C).

20: A muddy channel bank that was artificially dredged and widened. Collections were made from entangled masses and carpets on the muddy channel surfaces and bankings (= 0.734 miles inland; 11–32‰, 14.5°–29.5°C).

21: A variety of shallow pans similar to station 16, although of a more extensive area (= 0.828 miles inland; 11–50‰, 24.0°–35.0°C).

22: A small channel downstream from station 23, approximately 15 feet wide with conspicuous freshwater drainage at low tide. Collections were made from small sticks and from entangled and tufted masses of seaweeds growing on muddy surfaces (= 0.942 miles inland; 12–25‰, 23.5°–32.0°C).

23: A muddy channel with abundant masses of green algae and vascular plants (= 0.840 miles inland; 35‰, 32.0°C).

24: The south bank of a wide, artificially dug channel near station 16, having limited seaweed populations (= 0.840 miles inland; 0–22‰, 22.5°–32.0°C).

25: A shallow pan area just north of and parallel to a bridge carrying pipes over a channel. Collections consisted mostly of entangled masses of seaweeds, growing on and amongst *Salicornia virginica* (= 0.940 miles; 0–>32‰, 23.8°–>30.0°C).

26: The northern bank of Glen Annie Creek, opposite station 24 and adjacent to a pipe crossing. A channel 25–30 feet wide with muddy surfaces covered with *Vaucheria* (= 1.145 miles inland; 24‰, 30.0°C).

27: Headwaters of the easternmost tidal channel in the Goleta Slough (Atascadero). It originates from San Pedro Creek and adjacent to the Clarence Ward Memorial Boulevard Highway. Collections were made near a concrete dam, and on adjacent scattered rocks and muddy bankings (= 0.846 miles inland; 0–10‰, 12.0°–28.5°C).

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