Vol. V
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Environmental Assessment of the Alaskan Continental Shelf

Annual Reports of Principal Investigators for the year ending March 1978

Volume V. Receptors — Fish, Littoral, Benthos

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration

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Outer Continental Shelf Environmental Assessment Program
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Bureau of Land Management

DISCLAIMER

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RECEPTORS -- FISH

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ANNUAL REPORT

RECONNAISSANCE CHARACTERIZATION OF LITTORAL BIOTA, BEAUFORT AND CHUKCHI SEAS

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I. Summary of Objectives, conclusions and implications with respect to OCS oil and gas development:

A. Objectives for 1977

1. To define further the benthic and epibenthic biota of the region between the shoreline and the 20m isobath of the Beaufort and Chukchi coasts.

   a. species present
   b. biomass
   c. diversity;

2. To complete descriptions and definitions of the vegetation of those portions of arctic Alaskan beaches likely to be inundated by periodic, wind-driven high water;

3. To describe ecological relationships, including trophic relationships and overall effects of perturbations (by oil and sand) in Arctic salt marshes;

4. To define the foods of the abundant, shallow-water marine invertebrate species and to describe food webs that include these species.

B. Conclusions

1. The fauna of the Beaufort littoral (2m depth to shoreline) region is poor in species and biomass and probably is depopulated annually by shore-fast ice. There are, however, resident populations of enchytraeid (Oligochaete) worms and chironomid (midge) larvae that must, somehow, be frozen in during the winter. The former, although numerous, account for very little total biomass. Their ecological role is unknown. The latter are fed upon by important anadromous fishes.

2. The Beaufort nearshore (+2m to 20m) is a refugium from which the littoral region is repopulated annually. The fauna of the nearshore region is intermediate in species diversity and biomass between the littoral and close offshore regions.

3. The principal forms of the Beaufort littoral/nearshore regions are gammarid amphipods (three species), isopods (one species), mysiids (mainly one species), oligochaete worms (unknown species), chironomid larvae (unknown species), polychaete worms (two species), bivalve mollusks (one species), priapulid worm (one species), and four-horned sculpin (one species).

4. The fauna of the Beaufort littoral/nearshore and the Chukchi littoral north of Point Hope are similar in species, diversity, and biomass.

5. South of Point Hope, the Chukchi littoral fauna is much richer in species and biomass than are comparable zones to the north. The fauna of the south Chukchi littoral includes bivalve mollusks (three principal species), mysiids (several species), chironomids (several species) and decopod shrimp (one species). Twenty-three genera found south of Point Hope were rare or absent from samples north of there.

6. Fewer than 35 species of macro-algae have been found in the Beaufort and Chukchi littoral and nearshore zones. In general, these species are not believed to be important ecologically except possibly in the south Chukchi or in rare boulder areas of the Beaufort.

7. Plant communities of Arctic Alaskan beaches may be categorized in eight major types. The most common lower beach communities (mainly combinations of the grass, Puccinellia phrygonodes and sedges of the genus Carex) may be called salt marshes. These marshes are important feeding areas for geese, brant, shorebirds, and to some extent caribou.

8. Carex species and other beach plants contribute significantly to soil stability and probably resist shoreline erosion.

9. Oil in quantities as low as 10ml m^{-2} adversely affects in a single season the growth of Carex in salt marshes.

10. Sand drift which may accompany beach erosion adversely affects growth of arctic salt marsh plants.

11. The amphipod, Gammarus setosa, ingests peat of terrestrial origin. It presently is unclear whether these animals derive energy or nutrients from the peat or, possibly, from the epifauna and epiflora on the peat. Gammarus and other amphipods are facultatively omnivorous in nature, but the also abundant Onisimus litoralis is primarily a carnivore.

12. Foods eaten in nature by amphipods include diatoms, peat, algal filaments, crustacean parts, oligochaetes, polychaetes, and foraminifera. In the laboratory, Gammarus has also ingested the kelp, Laminaria sp.

13. Polychaete worms (Terebellides stroemi) in nature eat diatoms, peat, and small amounts of crustacean fragments.

14. The isopod, Saduria entomon will feed in the laboratory on polychaete and oligochaete worms, crustaceans, kelp and peat.

15. Gammarus setosa and possibly Saduria entomon reduce the particle size of peat by ingesting and passing it through the digestive system.

C. Implications:

1. The fauna of the region soon to be developed (Beaufort lease zone) includes the organisms most commonly found in fish

stomachs and often used as food by shorebirds. The standing crops of these organisms are low as indicated by conventional sampling techniques. Data on effects of oil on these organisms are lacking as are data on growth and reproductive rates.

2. Salt marsh communities are sensitive to damage by oil in even small amounts. These communities contribute to shoreline stability and are important feeding areas for geese.

3. The benthic and epibenthic organisms of the Beaufort nearshore/littoral constitute a low diversity, low biomass (standing crop) community of evidently omnivores that feed on what is available. In this system detritus (peat) of terrestrial origin may represent a nutrient or energy source of considerable significance. The system may be quite sensitive to perturbation (as low-diversity ecosystems often are), or the vast amount of peat present may lend stability. Presently, it is not possible to say. If the peat already in the system will absorb oil, and if the system is detritus-dependent, it may be extremely vulnerable. These matters require additional research.

II. Introduction

RU356 began work in the summer of 1975 with the title "Littoral Survey of the Beaufort Sea" and the responsibility of describing habitats, biota, and ecological processes in the intertidal zone of the Beaufort Sea coast. Our approach to this was a combination of low altitude flights for habitat characterization and on-site sampling by ground crews for verification and data collection. What became immediately apparent from the distribution of driftwood observed on our first flights was that for the Beaufort Sea where lunisolar tides are negligible (on the order of six inches of tidal amplitude) the littoral or intertidal zone had a rather special meaning. The OCSEAP concern with prediction of effects on the environment of particular insults that may result from exploration for and development of oil and gas resources of the continental shelf, and the fact that--with some regularity--wind-driven tides carried flotsom (which could include oil) well onto coastal salt marshes and other, usually terrestrial plant communities--these seemed to us to require that the littoral zone we looked at include shoreward extensions of our beach and shallow aquatic transects.

In 1976 when OCSEAP interest was extended to the Chukchi coast, our program was renamed Reconnaissance Characterization of Littoral Biota, Beaufort and Chukchi Seas and we began on the Chukchi coast essentially the same sampling program we had carried out in the Beaufort the year before. Our 1975 Beaufort Sea marine samples had shown that the region between the shoreline and the 2m isobath was poor in both species and biomass (although including some unsuspected things), but that there was a marked increase in both diversity and biomass below 2 meters. Therefore, in 1976, we extended our Beaufort beach transects into deeper water by operating from a Zodiak or other small boat in the lagoons and by participating in the Beaufort Sea cruise of the RV ALUMIAK along with RU6.

By 1977 the reconnaissance phase of our work had been largely completed--although important gaps still remain--and our project had become a combination of monitoring beach stations to establish a population of sample means per station against which future--possibly post "insult"--samples might be measured and to look for seasonal variations in fauna and flora, studies aimed at defining food webs and ultimately, we might hope carbon or even energy flow in the shallow water, a study of ecological processes in coastal salt marshes that includes some first attempts at effects studies, and a continuation of what is still largely a reconnaissance of the benthic and epibenthic biota of the zone between our shore stations and Drew Carey's mostly deep-water benthos studies. The name of our project was changed again--this time to "Environmental Assessment of Selected Habitats in the Beaufort and Chukchi Littoral System."

III. Current State of Knowledge:

A. Beaufort Sea shallow water invertebrate fauna is poor in species, diversity, and biomass. Fish follow shorelines and, evidently, feed mainly on organisms that are common in littoral and nearshore areas. We have no knowledge of growth or reproductive activities of invertebrate animals in the beach, lagoon and nearshore system. There are indications of annual fluctuations in populations.

B. The food of the predominant shallow water invertebrate species is known only by inference.

C. Ecological processes, even phenological events in Beaufort Sea salt marshes have not been studied.

D. A "data gap" exists between our shoreline stations and the deeper stations sampled from icebreakers by RU6. The benthic and epibenthic organisms between depths of 2 and 20 meters are known primarily by inference from knowledge of littoral and offshore faunas.

IV. Study area:

The area of concern in this project remains the shoreline of the Beaufort and Chukchi Seas from Demarcation Point to Cape Prince of Wales. Through the summer of 1977 we continued to collect both reconnaissance and monitoring data derived from beach transects in both seas and from Beaufort Sea extensions of transects to 10m depth where our data interface with those collected in 1977 by RU7. Our concern with shoreline processes has always included the beach or marsh communities apt to be inundated by the late summer or fall storm-driven tides, and data on beach vegetation were taken in 1977 as in prior years. In addition to reconnaissance and monitoring, we initiated a study of ecological processes in salt marshes in 1977. The marshes studied were at the mouth of the Putuligayuk River at Prudhoe Bay on the Beaufort Coast and at Arctic Circle Landing Strip on the Baldwin Peninsula south of Kotzebue on the Chukchi shore. We also began, in 1977, studies of food webs in the littoral zone of the Arctic Ocean. These were carried out at the Naval Arctic Research Laboratory at Barrow.

V. Sources, methods and rationale of data collection:

Because the several parts of our research are treated separately below, we also have dealth with methods and rationale of data collection in section

VI. Methods and results obtained have been juxtaposed for clarity and ease of reading.

Benthic and Epibenthic Organisms of the Beaufort and Chukchi Littoral System

Our primary concern has been and remains the marine benthic and epibenthic flora and fauna of the region between the shoreline and the depth sampled by Carey (RU6) or others. Sampling from the shoreline to a depth of about 0.5m has been done by field personnel operating on foot with light equipment. When small boats were available, these beach transects were extended seaward to depths of about 2.0m (rarely deeper) with the same equipment. Deeper stations in the Beaufort Sea have been sampled with heavier equipment from R/V ALUMIAK. Many of these data are still being processed in our laboratory. Those reported here were collected in the 1975 and 1976 field seasons.

Methods: Methods used have been reported previously[1] and are summarized here for convenience.

Benthic samples have been made with pole-mounted, 0.231m^2 (152 x 152mm) Ekman grabs or with a 0.1m^2 Smith-McIntyre grab. All benthic samples are field screened to 0.516mm (all material except larger stones retained on a screen of that size is preserved in the field) and sorted in the laboratory. Wet weights of all species are taken, and all data are standardized to a per m^2 basis.

Epibenthic samples were made with a sea sled type dredge net (Wildco cat. 171) of 1.05mm mesh. Dredge tows were usually 50m long. Entire dredge samples were preserved for sorting in the laboratory. Data, including wet weights of animals, have been standardized to a 50m dredge tow.

Other samples have been made using a variety of techniques: seines, qualitative plankton nets, dip nets, shovels, scoops and hand collection from beach drift. Data from these collection techniques appear only in species lists.

Results: Our results are presented primarily in tabular form. Our data indicate that faunistic differences between the strictly littoral and nearshore regions of the Beaufort Sea and between the Beaufort and Chukchi Seas require reporting in four, regional categories. Here and elsewhere (1978 Synthesis report) we will refer to the region between the shoreline and the 2m isobath as littoral. Outside the 2m isobath and extending to the 20m isobath we call nearshore, but the nearshore data in this report were collected largely inside the 5m isobath. We refer to the Chukchi shore between Point Hope and Point Barrow as Chukchi North and to the Chukchi shore south of Point Hope and including Kotzebue Sound and Hotham Inlet as Chukchi South.

The number of species of various groups of organisms we have encountered (all sampling techniques) in these four regions is given in Table 1. The species are identified in appended tables 5 , 6 , 7 , and 8 .

The quantitative data obtained with benthic grabs and epibenthic dredges are presented in appended tables 9 through 18. Station locations have been given previously.[2] Beaufort Sea locations are arranged

TABLE 1 : NUMBER OF SPECIES OF VARIOUS CATEGORIES OF ORGANISMS TAKEN BY RU356 IN FOUR REGIONS OF ARCTIC ALASKA. BEAUFORT LITTORAL EXTENDS FROM THE SHORELINE TO 2m DEPTH BETWEEN POINT BARROW AND DEMARCATION POINT. BEAUFORT NEARSHORE IS FROM 2+m TO 5m DEPTH. CHUKCHI DATA ARE FOR THE LITTORAL REGION FROM POINT HOPE NORTH AND SOUTH OF POINT HOPE. TABULATED DATA ARE FROM VARIOUS BENTHIC AND EPIBENTHIC COLLECTING TECHNIQUES THAT USUALLY DO NOT CAPTURE FISH, PLANKTONIC FORMS OR ACTIVE SWIMMERS. THE DATA PRESENTED ARE FROM 1976 FIELD SEASONS. "OTHER INVERTEBRATE" TAXA USUALLY ARE FAMILIES OR HIGHER TAXA RATHER THAN SPECIES.

TAXON	BEAUFORT SEA		CHUKCHI SEA	
	LITTORAL	NEARSHORE	NORTH	SOUTH
ALGAE	11	2	8	20
SPONGES	0	0	0	1
HYDROZOA	7	7	3	7
POLYCHAETA	6	29	7	23
ENCHYTRAEIDAE	X	X	X	X
TUBIFICIDAE	0	X	0	X
GASTROPODA	4	5	12	7
PELECYPODA	13	15	4	18
CIRRIPEDIA	0	0	1	1
MYSIIDS	7	5	2	9
ISOPODS	2	1	1	1
AMPHIPODS	31	31	27	36
EUPHAUSIIDS	3	3	3	0
DECAPODS	3	2	2	6
CHIRONOMIDS	8	0	2	12
FISH	4	2	2	9
OTHER INVERTEBRATE	21	17	12	39
TOTAL	121	121	87	191

in the tables from east to west and Chukchi Sea locations from north to south. Each line of the tables gives the total number of animal species collected with the gear used; the calculated Shannon-Weaver diversity index, which is based on both number of species and number of individuals; the biomass in grams of wet weight corrected to a standard of $1m^2$ or one 50m long tow; the number of replicate samples at each station; where appropriate, the year in which the data were collected; and a somewhat subjective list of principal genera collected at each station. The principal genera are those that had a biomass in excess of 0.5 g/m^2 (or 150m tow) or were numerically predominant. Those genera followed by ! accounted for virtually all of the biomass of a pooled station sample.

Discussion: Table 2 presents sample variances and variance ratios for Beaufort Sea benthos and epibenthos of the littoral and nearshore regions.

TABLE 2 : Comparison of number of species, diversity indices, and biomass data for Beaufort Sea benthos and epibenthos of the nearshore and littoral regions. Data are from samples taken in 1975 and 1976 and presented in appended tables and

		Littoral	Nearshore	
No. Benthic species	S^2	18.984	84.217	F = 4.436**
	DF	62	14	p = 0.002
$\bar{H}$ Benthic samples	S^2	0.294	0.06	F = 4.9**
	DF	62	14	p = 0.002
Benthic biomass	S^2	22.438	1555.198	F = 69.311**
	DF	62	14	p = 0.002
No. Epibenthic species	S^2	41.274	44.183	F = 1.070
	DF	50	13	p = >0.4
$\bar{H}$ Epibenthic samples	S^2	0.308	0.436	F = 1.416
	DF	50	13	p = 0.4
Epibenthic biomass	S^2	47.088	63.860	F = 1.356
	DF	50	13	p = >0.4

Clearly, the littoral and nearshore benthic samples were not drawn from the same statistical populations; the epibenthic samples from the two regions may have been.

In most instances the genera cited as principal ones are represented by a single species or are predominantly of one species. Half of the sixteen principal genera of the Beaufort littoral benthos also occur as principals of the Beaufort nearshore benthos, and these eight genera that are common to both regions comprise 31 percent of all the principal forms of the Beaufort nearshore benthos. Examination of Table 5 shows that the principal species of the littoral benthos are enchytraeid worms (possibly more than a single species); the amphipods, Gammarus setosa and Onisimus litoralis; the isopod, Saduria entomon; and chironomid (midge) larvae. Table 6 shows that, of these, only the enchytraeids and chironomids are not also principal species of the nearshore benthos and that the polychaete worms, Scolecolepides arctius, Ampharete vega, Prionospio cirrifera, and Terrebellides stroemi, the amphipod Calliopus laeviusculus; two bivalve mollusks, Cyrtodaria kurriana and Liocyma fluctuosa, and the priapulid, Halicryptus spinulosus also are principal species of the nearshore region. Thus, three of the five species most characteristic of the littoral benthos are also among those most abundant in the nearshore benthos; and, of the eleven principal species of the nearshore region, seven are also found in the littoral benthos.

Table 5 shows that the principal species of the Beaufort littoral epibenthos are Mysis relicta; the four-horned sculpin, Myoxocephalus quadricornis; Gammarus setosa; Onisimus litoralis; and Saduria entomon. The principal species of the nearshore epibenthos are Mysis relicta and Saduria entomon. Of the eleven genera that are the principal ones of the littoral region, six also are principals of the nearshore samples, and only four principal genera of the nearshore region do not also occur as principals at the littoral.

The littoral and nearshore regions of the Beaufort Sea may be said to have a common fauna with some exceptions. Chironomid larvae and oligochaete (enchytraeid) worms occur only in the littoral where the polychaete worms and bivalve mollusks of the nearshore area are either non-existent or rare.

The littoral benthos may be characterized as poor in species (from 3 to 29 per station; 6.98 average ± 4.36); poor in biomass (2.99 g/m^2 ± 4.74); and lacking in diversity ($\bar{H}$ = 0.88 ± 0.54). Statistically, the nearshore benthos is quite different, although the species mix of animals is about the same. The lower limit of the region we have called littoral is the approximate lower limit of the seasonal, shore-fast ice, and this factor probably is responsible for population differences noted. The nearshore benthos has more species (23.07 ± 9.18), greater biomass (30.57 g/m^2 ± 39.44), and much higher diversity ($\bar{H}$ = 1.90 ± 0.24).

The epibenthos of the littoral and nearshore regions are not different. The species mix is the same and the population parameters measured indicate a common statistical population. Our samples gave from 0 to 42 species per littoral station (10.08 ± 6.42) and 6 to 31 species per nearshore station (15.79 ± 6.45). The biomass is low (0.00 to 34.13 g/50m net tow; average 4.94 ± 6.86) in the littoral and no higher (0.00 to 25.27 g/50m net tow; average 5.51 ± 7.99) in the nearshore stations. Species diversity is $\bar{H}$ = 0.00 to 2.13 (average 1.08 ± 0.56) in the littoral stations and $\bar{H}$ = 0.05 to 2.10 (1.12 ± 0.66) for the nearshore.

Except for those benthic species that occur only in the littoral, our data indicate that populations of non-mobile organisms are low in this region probably an effect of the annual ice. Mobile organisms move in from the nearshore as the shore-fast ice melts in the littoral. We do not know how chironomid larvae and enchytraeid worms survive the winter. Neither is mobile enough to move out of the littoral, yet neither seems to be an annual population.

The importance of the Beaufort littoral--nearshore benthic and epibenthic fauna is difficult to assess. Those species otherwise identified as critical[3] are not among the most abundant ones here. We have examined a few stomachs of fish caught in the littoral zone and find that the abundant species of the littoral-nearshore Beaufort are eaten by whitefish, sculpins and arctic char, but our data are too few to have statistical importance. The role of some of these species in Beaufort Sea food webs is the subject of a subsequent section of this report.

Table 3 gives sample variances, and variance ratios pertinent to the benthos and epibenthos of the littoral Chukchi Sea north and south of Point Hope.

TABLE 3 : Comparison of number of species, species diversity indices, and biomass data for littoral benthic and epibenthic fauna of the Chukchi Sea north and south of Point Hope. Data are from samples taken in 1976 and presented in appended tables and

		Chukchi North	Chukchi South	
No. Benthic	S^2	6.927	39.038	F = 5.636**
species	DF	15	25	p = 0.002
$\bar{H}$ Benthic	S^2	0.200	0.612	F = 3.060
samples	DF	15	25	p = 0.020
Benthic	S^2	15.705	89.473	F = 5.697**
biomass	DF	15	25	p = 0.002
No. Epibenthic	S^2	10.916	80.443	F = 7.369**
species	DF	17	22	p = 0.002
$\bar{H}$ Epibenthic	S^2	0.209	0.448	F = 2.144
samples	DF	17	22	p = 0.40
Epibenthic	S^2	209.757	257.074	F = 1.226
biomass	DF	17	22	p = >0.40

These variance ratios indicate, as do the Beaufort ratios, that the benthic samples were drawn from populations with different variances. A comparison of the principal genera found north and south of Point Hope also shows that the fauna south of Point Hope differs from that of the north Chukchi in the mix of species. One of the Chukchi principal benthic genera is found only north of Point Hope, but 13 are found only in the south Chukchi. There are 14 common genera, and ten of these also are common to the Beaufort littoral. There are three epibenthic genera of the north Chukchi that were not found as principals in our south Chukchi genera not found north of Point Hope, and seven principal genera that are common to the two regions. The Chukchi and Beaufort littoral epibenthos have six principal genera in common. The variance ratios given in Table 4 show it unlikely that the Beaufort littoral and north Chukchi samples were from different populations.

TABLE 4: Comparison of number of species, species diversity indices, and biomass data for littoral benthic and epibenthic fauna of the Beaufort Sea and the Chukchi Sea north of Point Hope. Data are from samples taken in 1975 (Beaufort) and 1976 and presented in appended tables and .

		Beaufort	Chukchi	
No. Benthic species	S^2	18.984	6.927	F = 2.741
	DF	50	15	p = 0.10
$\bar{H}$ Benthic samples	S^2	0.294	0.200	F = 1.470
	DF	50	15	p = >0.40
Benthic biomass	S^2	22.438	15.705	F = 15.705
	DF	50	15	p = 70.40
No. Epibenthic species	S^2	41.274	10.916	F = 3.781**
	DF	50	17	p = 0.002
$\bar{H}$ Epibenthic samples	S^2	0.308	0.209	F = 1.474
	DF	50	17	p = 0.40
Epibenthic biomass	S^2	47.088	209.757	F = 4.455
	DF	50	17	p = 0.02

The species of the principal genera common to the Beaufort and Chukchi are: *Cyrtodaria kurriana*, *Chironomus sp.*, Enchytraeid worms of unknown species; *Gammarus setosa*, *Halicryptus spinulosus*, *Mysis relicta*, *Myoxocephalus quadricornis*, *Onisimus litoralis*, *Saduria entomon*, *Scolecolepides arctius*, *Pygospio elegans*, and *Pontoporeia affinis*. South of Point Hope, we found 23 principal genera that were not abundant in or absent from the north Chukchi. Among these the bivalve mollusks, *Cryptomya sp.* *Mytilus edulis*, *Mysella sp.* (an undescribed species); the shrimp *Crangon septemspinosa*; several species of *Neomysis*; and several species of Chironomid larvae are particularly abundant in our samples and probably characteristic.

Conclusions:

1. The fauna of the Beaufort littoral region is poor in species and biomass and probably is largely depopulated annually by shore-fast ice. There are, however, resident populations of enchytraeid worms and chironomid larvae which probably are important in Beaufort Sea food webs.

2. The fauna of the Beaufort nearshore region is intermediate in species and biomass between the littoral and offshore regions. There

are resident populations of animals many of which have been identified in the stomachs of local fishes. The principal species are polychaete worms, gammaridean amphipods, an isopod, bivalve mollusks and a priapulid worm.

3. The fauna of the Beaufort littoral and that of the Chukchi littoral north of Point Hope are similar in species present, diversity and biomass.

4. South of Point Hope, the benthic and epibenthic littoral fauna of the Chukchi Sea is much richer in species than is the Beaufort-Chukchi North fauna. The benthic biomass is significantly greater, but our samples have not shown a corresponding difference in epibenthic biomass. The south Chukchi fauna includes bivalve mollusks, shrimp and other crustaceans, insect larvae, and many invertebrate groups not found or rarely found North of Point Hope.

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2. Broad, A. C., 1977. Environmental Assessment of Selected Habitation the Beaufort and Chukchi Sea Littoral System. Environmental Assessment of the Alaskan Continental Shelf. Principal Investigators' Reports October-December, 1977. U. S. Department of Commerce, National Oceanic and Atmospheric Administration/U. S. Department of Interior, Bureau of Land Management, Boulder, Colorado, in press.

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Benthic and Epibenthic Organisms of

the Beaufort and Chukchi Littoral System

appended tables

TABLE 5: SPECIES OF ORGANISMS TAKEN BY RU356 IN THE BEAUFORT SEA LITTORAL REGION (SHORELINE TO 2 METERS DEPTH) IN 1975 AND 1976. VARIOUS COLLECTION TECHNIQUES USED DO NOT NORMALLY SAMPLE PLANKTONIC FORMS, FISH, OR OTHER ACTIVELY SWIMMING SPECIES.

ALGAE
- LYNGBYA SP.
- ENTEROMORPHA SP.
- PERCURSARIA SP.
- SPHACELARIA RACEMOSA
- SPACELARIA SUBFUSCA
- STICTYOSIPHON TORTILIS
- PORPHYRA SP.
- RHODYMENIA SP.
- PHODYMENIA PALMATA F. MOLLIS
- DELESSERIACEAE
- PHYCODRYS

PROTOZOANS
- AMMOTIUM CASSIS

HYDROZOANS
- PERIGONIMUS YOLDIA-ARCTICAE
- BOUGAINVILLIA SP.
- CORYMORPHA FLAMMEA
- OBELIA BOREALIS
- TUBULARIA INDIVISA
- THUIARIA SP.
- AGLANTHA DIGITALE

SCYPHOZOANS
- CYANEA CAPILLATA

CESTODES

NEMERTEANS

NEMATODES

POLYCHAETES
- ETEONE LONGA
- AUTOLYTUS SP.
- GATTYANA CILIATA
- SCOLECOLEPIDES ARCTIUS
- SPIO FILICORNIS
- PYGOSPIO ELEGANS

OLIGOCHAETES
- ENCHYTRAEIDAE

GASTROPODS
- BITTIUM SP.
- AMAUROPSIS PURPUREA
- COLUS SP.
- LIMACINA HELICINA

BIVALVES
- NUCULA TENUIS
- PORTLANDIA ARCTICA
- YOLDIELLA SP.
- MONTACUTA SP.
- BOREACOLA VADOSA
- SILIQUA ALTA
- MACOMA SP.
- TELLINA LUTEA ALTERNIDENTATA
- LYOCYMA FLUCTUOSA
- MYA SP.
- MUSCULUS DISCORS
- ASTARTE MONTEGUI
- CYRTODARIA KURRIANA

MISC. CRUSTACEANS
- LEPIDURUS ARCTIUS
- PODOCOPA
- HARPACTICOIDA
- CALANOIDA
- THORACICA (NAUPLIUS)

TABLE 5, CONTINUED

MYSIIDS
- MYSIS RELICIA
- MYSIS OCULATA
- NEOMYSIS CZERNIAWSKII
- NEOMYSIS INTERMEDIA
- NEOMYSIS MERCEDIS
- NEOMYSIS MIRABILIS
- NEOMYSIS RAYII

CUMACEANS
- DIASTYLIS LUCIFERA
- DIASTYLIS SULCATA
- LAMPROPS SARSI

ISOPODS
- SADURIA ENTOMON
- AEGIDAE

AMPHIPODS
- (GAMMARIDS)
  - APHERUSA GLACIALIS
  - APHERUSA MAGALOPS
  - CALLIOPIUS LAEVIUSCULUS
  - HALIRAGES SP.
  - ROZIANANTE FRAGILIS
  - GAMMARACANTHUS LORICATUS
  - GAMMARUS LOCUSTA
  - GAMMARUS SETOSA
  - GAMMARUS ZADDACHI
  - WEYPRECHTIA PINGUIS
  - PONTOPOREIA FEMORATA
  - PONTOPOREIA AFFINIS
  - ISCHYROCERUS ANGUIPES
  - BOECKOSIMUS AFFINIS
  - BOECKOSIMUS BOTKINI
  - ONISIMUS GLACIALIS
  - ONISIMUS LITORALIS
  - ACANTHOSTEPHEIA BEHRINGIENSIS
  - ACANTHOSTEPHEIA INCARINATA
  - ACEROIDES LATIPES
  - MONOCULODES SP.
  - MONOCULOPSIS LONGICORNIS
  - DULICHIA ARCTICA
  - PAROEDICEROS LYNCEUS
  - PAROEDICEROS PROPINQUUS
  - OEDICEROS SAGINATUS
  - METOPA SP.
- (HYPERIDS)
  - PARATHEMISTO LIBELLULA
  - HYPEROCHE MEDUSARUM
- (CAPRELLIDS)
  - CAPRELLA CARINA
  - CAPRELLA DREPANOCHIR

EUPHAUSIIDS
- THYSANOESSA INERMIS
- THYSANOESSA LONGIPES
- THYSANOESSA RASCHI

DECAPODS
- PAGURIDAE
- CRANGON SEPTEMSPINOSA
- HYAS SP.

MISC. INSECTS
- COLLEMBOLA
- COLEOPTERA
- EMPIDIDAE
- EPHYDRIDAE

CHIRONOMIDS
- HYDROBAENUS SP.

TABLE 5, CONTINUED

CALOPSECTRA SP.
CHIRONOMUS SP.
DICROTENDIDES SP.
EUKIEFFERIELLA CORONATA
RHEOTANYTARSUS PHOTOPHILUS
CAMPTOCLADIUS STERCORARIUS
EUCRICOTOPUS SP.

PRIAPULIDS

HALICRIPTUS SPINULOSUS

BRYOZOANS

EUCRATEA LORICATA

ARROW WORMS

SAGITTA ELEGANS

STARFISH

PISASTER BREVISPINUS

FISH

BOREOGADUS SAIDA
PUNGITIUS PUNGITIUS
MYOXOCEPHALUS QUADRICORNIS
PLEURONECTIDAE

TABLE 6: SPECIES OF ORGANISMS TAKEN BY RU356 IN THE BEAUFORT SEA NEARSHORE REGION (FROM 2+ to 5m DEPTH) IN 1975 AND 1976. COLLECTIONS WERE WITH BOTTOM GRABS OR EPIBENTHIC DREDGE, TECHNIQUES THAT NORMALLY DO NOT TAKE FISH, PLANKTONIC FORMS OR ACTIVELY SWIMMING SPECIES OR SAMPLE ON BOULDERS OR ROCKY BOTTOM.

ALGAE

- STICTYOSIPHON TORTILIS
- DELESSERIACEAE

PROTOZOANS

- AMMOTIUM CASSIS

HYDROZOANS

- PERIGONIMUS YOLDIARCTICAE
- CORYMORPHA FLAMMAE
- OBELIA LONGISSIMA
- TUBULARIA INDIVISA
- GONIONEMUS VERTENS
- TRACHYNEMIDAE
- AGLANTHA DIGITALE

NEMERTEAN

NEMATODA

POLYCHAETES

- ANTINOELLA SARSI
- ETEONE LONGA
- NEREIMYRA APHRODITOIDES
- AUTOLYTUS SP.
- NEPHTYS LONGASETOSA
- SPHAERODOROPSIS MINUTA
- GLYCINDE ARMIGERA
- HAPLOSCOLOPLOS ELONGATUS
- SCOLOPLOS ARMIGER
- ORBINIA SP.
- ARICIDEA SUECICA
- PRIONOSPIO CIRRIFERA
- SCOLECOLEPIDES ARCTIUS
- SPIO FILICORNIS
- PYGOSPIO SP.
- THARYX SP.
- CHAETOZONE SETOSA
- BRADA VILLOSA
- SCALIBREGMA INFLATUM
- TRAVISIA FORBESII
- STERNASPIS SCUTATA
- CAPITELLA CAPITATA

AMPHARETE VEGA

- ARENICOLA GLACIALIS
- LEIOCHONE SP.
- AMPHARETE ACUTIFRONS
- AMPHARETE VEGA
- TEREBELLIDES STROEMII
- FABRICIA SP.
- SPIRORBIS SP.

OLIGOCHAETES

- ENCHYTRAEIDAE
- TUBIFICIDAE

GASTROPODS

- AMAUROPSIS PURPUREA
- NATICA CLAUSA
- PROPEBELA SP.
- CYLICHNA OCCULATA
- RETUSA SP.

BIVALVES

- PORTLANDIA ARCTICA
- PORTLANDIA INTERMEDIA
- MUSCULUS DISCORS

TABLE 6, CONTINUED

AXINOPSIDA SERRICATA
AXINOPSIDA ORBICULATA
THYASIRA SP.
MYSELLA SOVIALIKI
MONTACUTA PLANATA
BOREACOLA VADOSA
ASTARTE BOREALIS
ASTARTE MONTEGUI
MACOMA BALTHICA
LIOCYMA FLUCTUOSA
CYRTODARIA KURRIANA
PANDORA GLACIALIS

MISC. CRUSTACEANS
OSTRACODA
CALANOIDA

MYSIIDS
ACANTHOMYSIS PSEUDOMACROPSIS
MYSIS OCULATA
MYSIS RELICTA
NEOMYSIS INTERMEDIA
NEOMYSIS RAYII

CUMACEANS
LAMPROPS FUSCATA
DIASTYLIS LUCIFERA
DIASTYLIS RATHKEI
DIASTYLIS SULCATA
LEPTOSTYLIS SP.

ISOPOD
SADURIA ENTOMON

AMPHIPODS
(GAMMARIDS)
ATYLUS CARINATUS
ATYLUS COLLINGII
APHERUSA MEGALOPS
APHERUSA GLACIALIS
CALLIOPIUS LAEVIUSCULUS
CALLIOPIUS BEHRINGI
HALIRAGES SP.
ROZINANTE FRAGILIS
GAMMARACANTHUS LORICATUS
GAMMARUS SETOSA
GAMMARUS ZADDACHI
PONTOPOREIA FEMORATA
PONTOPOREIA AFFINIS
PRISCILLINA ARMATA
ANONYX NUGAX
BOECKOSIMUS AFFINIS
ONISIMUS GLACIALIS
ONISIMUS LITORALIS
ONISIMUS NANSENI
ACANTHOSTEPHEIA BEHRINGIENSIS
ACANTHOSTEPHIA INCARINATA
ACEROIDES LATIPES
MONOCULODES PACKARDI
MONOCULODES SCHNEIDERI
MONOCULOPSIS LONGICORNIS
PAROEDICEROS LYNCEUS
PAROEDOCEROS PROPINQUUS
PLEUSYMTES KARIANUS
STENOTHOIDAE
(HYPERIDS)
HYPEROCHE MEDUSARUM
PARATHEMISTO LIBELLULA

TABLE 6, CONTINUED

EUPHAUSIIDS

THYSANOESSA INERMIS

THYSANOESSA LONGIPES

THYSANOESSA RASCHII

DECAPODS

PAGURIDAE

HYAS SP.

PRIAPULIDS

PRIAPULUS CAUDATUS

HALICRYPTUS SPINULOSUS

BRYOZOANS

EUCRETIA LORICATA

ARROW WORM

SAGITTA ELEGANS

UROCHORDATES

MOLGULA GRIFFITHSII

OIKOPLEURA SP.

OIKOPLEURA VANHOEFFENI

FISH

MYOXOCEPHALUS QUADRICORNIS

LIPARIS SP.

TABLE 7: SPECIES OF ORGANISMS TAKEN BY RU356 IN THE CHUKCHI SEA LITTORAL REGION (SHORELINE TO 2m DEPTH) FROM POINT HOPE NORTHWARD IN 1976. COLLECTIONS WERE MADE WITH BOTTOM GRABS, EPIBENTHIC DREDGES AND OTHER TECHNIQUES THAT NORMALLY DO NOT SAMPLE FISH, PLANKTONIC FORMS OR ACTIVELY SWIMMING SPECIES.

ALGAE
- VAUCHERIA SP.
- ULOTRICHACEA
- ENTEROMORPHA SP.
- ULVA LACTUCA
- SPHACELARIA SP.
- FUCUS SP.
- PORPHYRA SP.
- IRIDAEA SP.

HYDROZOA
- PERIGONIMUS YOLDIARCTICAE
- CORYNE TUBULOSA
- AGLANTHA DIGITALE

CTENOPHORA

RHYNCHOCOELA (NEMERTEAN)

NEMATODA

POLYCHAETA
- ANAITADES GROENLANDICA
- ANTINOELLA SARSI
- AUTOLYTUS SP.
- EUSYLLIS MAGNIFICA
- NEREIS SP.
- SCOLECOLEPIDES ARCTIUS
- PYGOSPIO ELEGANS

OLIGOCHAETES
- ENCHYTRAEIDAE

GASTROPODS
- MARGARITES COSTALIS
- AMAUROPSIS PURPUREA
- NATICA CLAUSA
- BULBUS FRAGILIS
- POLINICES PALLIDA
- BUCCINUM ANGULOSUM
- SEARLESIA SP.
- NEPTUNEA HEROS
- PLICIFUSUS KROYERI
- CYLICHNA OCCULATA
- CLIONE LIMACINA
- DORIDIDAE (NUDIBRANCH)

BIVALVES
- MACOMA LAMA
- MACOMA BALTHICA
- CYRTODARIA KURRIANA
- HIATELLA ARCTICA

MISC. CRUSTACEANS
- OSTRACODA
- CALANOIDA
- HARPACTICOIDA
- BARNACLE

MYSIIDS
- MYSIS OCULATA
- MYSIS RELICTA

ISOPOD
- SADURIA ENTOMON

AMPHIPODS
(GAMMARIDS)
- ATYLUS COLLINGII

TABLE 7, CONTINUED

- APHERUSA MEGALOPS
- APHERUSA GLACIALIS
- CALLIOPIUS LAEVIUSCULUS
- HALIRAGES SP.
- ACCEDOMOERA SP.
- PARAMOERA SP.
- PONTOGENEIA SP.
- ANISOGAMMARUS SCHMIDTI
- GAMMARACANTHUS LORICATUS
- GAMMARUS SETOSA
- GAMMARUS ZADDACHI
- PONTOPOREIA FEMORATA
- PONTOPOREIA AFFINIS
- ISCHYROCERUS ANGUIPES
- ONISIMUS GLACIALIS
- ONISIMUS LITORALIS
- ACANTHOSTEPHEIA BEHRINGIENSIS
- ACANTHOSTEPHIA INCARINATA
- MONOCULODES BOREALIS
- MONOCULOPSIS LONGICORNIS
- PARAPLEUSTES PUGETTENSIS
- METOPELLOIDES STEPHENSENI
- STENULA SP.

(HYPERIDS)

- HYPERIA GALBA
- HYPERIA MEDUSARUM

(CAPRELLIDS)

- CAPRELLA DREPANOCHIR

EUPHAUSIIDS

- THYSANOESSA INERMIS
- THYSANOESSA LONGIPES
- THYSANOESSA RASCHII

DECAPODS

- PAGURUS TRIGONOCHEIRUS
- HYAS SP.

MISC. INSECTS

- CULICIDAE (MOSQUITO)

CHIRONOMIDS

- CHIRONOMUS SP.
- ICHNEUMONOIDEA

PRIAPULID

- HALICRYPTUS SPINULOSUS

BRYOZOAN (ECTOPROCTA)

HOLOTHUROIDAE

ARROW WORM

- SAGITTA ELEGANS

UROCHORDATES

- OIKOPLEURA SP.

FISH

- MYOXOCEPHALUS QUADRICORNIS
- HIPPOGLOSSOIDES SP.

TABLE 8: SPECIES OF ORGANISMS TAKEN BY RU356 IN THE CHUKCHI SEA LITTORAL REGION (SHORELINE TO 2m DEPTH) SOUTH OF POINT HOPE IN 1976. COLLECTIONS WERE MADE WITH BOTTOM GRABS, EPIBENTHIC DREDGES AND OTHER TECHNIQUES THAT NORMALLY DO NOT SAMPLE FISH, PLANKTONIC FORMS OR ACTIVELY SWIMMING SPECIES.

ALGAE

- LYNGBYA SP.
- SCYTONEMATACEAE
- ISTHMIA NERVOSA
- ENTEROMORPHA SP.
- ULVA SP.
- CLADOPHORA SP.
- ECTOCARPUS SP.
- PYLAIELLA SP.
- ISTHMOPLEA SP.
- STICTYOSIPHON TORTILIS
- SPHACELARIA RACEMOSA
- SPHACELARIA SUBFUSCA
- FUCUS SP.
- RHODOPHYLLIS SP.
- RHODYMENIA SP.
- HOLLENBERGIA SP.
- PHYCODRYS SP.
- POLYSIPHONIA HENDRYI
- PTEROSIPHONIA SP.
- ODONTHALIA SP.

SPONGE

- HALICLONA GRACILIS

HYDROZOANS

- PERIGONIMUS YOLDIARCTICAE
- CORYNE TUBULOSA
- OBELIA LONGISSIMA
- OBELIA BOREALIS
- BONNEVIELLA SP.
- ABIETINARIA SP.
- THUIARIA SP.

SCYPHOZOANS

- CYANEA CAPILLATA
- AURELIA LIMBATA

RHYNCHOCOELA (NEMERTEAN)

NEMATODA

POLYCHAETES

- ANTINOELLA SARSI
- HARMATHOE IMBRICATA
- PHOLOE MINUTA
- ANAITIDES GROENLANDICA
- ETEONE LONGA
- NEPHTYS CAECA
- NEPHTYS LONGASETOSA
- SPHAERODOROPSIS MINUTA
- GLYCINDE ARMIGERA
- SCOLOPLOS ARMIGER
- NERINE CIRRATULUS
- SCOLECOLEPIDES ARCTIUS
- SPIO FILICORNIS
- SPIOPHANES BOMBYX
- PYGOSPIO ELEGANS
- SCOLELEPIS SP.
- MAGELONA LONGICORNIS
- HETEROMASTUS FILIFORMIS
- ARENICOLA GLACIALIS
- MALDANIDAE
- PECTINARIA (CISTENIDES) GRANULATA

TABLE 8, CONTINUED

AMPHARETE VEGA
FABRICIA SP.

OLIGOCHAETES
ENCHYTRAEIDAE
TUBIFICIDAE

HIRUDINIDAE (LEECHES)

GASTROPODS
LITTORINA SITKANA
BITTIUM SP.
AMAUROPSIS PURPUREA
NEPTUNEA LYRATA
NEPTUNEA HEROS
CYLICHNA SP.
DORIDIDAE (NUDIBRANCH)

BIVALVES
MYTILUS EDULIS
MUSCULUS DISCORS
MODIOLUS MODIOLUS
MYSELLA?
ASTARTE BOREALIS
CLINOCARDIUM NUTTALLII
SPISULA POLYNYMA
SILIQUA ALTA
MACOMA CALCAREA
MACOMA LAMA
MACOMA BALTHICA
TELLINA LUTEA ALTERNIDENTATA
LIOCYMA FLUCTUOSA
CRYPTOMYA SP.
MYA SP.
CYRTODARIA KURRIANA
HIATELLA ARCTICA
ENTODESMA SP.

HALICARIDAE (MITES)

PYCNOGONID
NYMPHON GROSSIPES

CLADOCERANS
CYZICIDAE (=CAENESTHERIELLA) SP.
DAPHNIA SP.
LEPTODORA KINDTII

OSTRACODA

CALANOIDA

HARPACTICOIDA

BARNACLE
BALANUS CRENATUS

MYSIIDS
ACANTHOMYSIS PSEUDOMACROPSIS
MYSIS OCULATA
MYSIS RELICTA
NEOMYSIS CZERNIAWSKII
NEOMYSIS INTERMEDIA
NEOMYSIS KADIAKENSIS
NEOMYSIS MERCEDIS
NEOMYSIS MIRABILIS
NEOMYSIS RAYII

CUMACEANS
LAMPROPS FUSCATA
LAMPROPS FASCIATA
LAMPROPS SARSI
DIASTYLIS ALASKENSIS

TABLE 8, CONTINUED

DIASTYLIS LUCIFERA
LEPTOSTYLIS SP.

ISOPODS
SADURIA ENTOMON

AMPHIPODS
(GAMMARIDS)
ATYLUS CARINATUS
ATYLUS COLLINGII
APHERUSA MEGALOPS
CALLIOPIUS LAEVIUSCULUS
CALLIOPIUS BEHRINGI
ACCEDOMOERA SP.
PARAMOERA SP.
ROZINANTE FRAGILIS
ANISOGAMMARUS SP.
ANISOGAMMARUS SCHMIDTI
GAMMARACANTHUS LORICATUS
GAMMARUS LOCUSTA
GAMMARUS SETOSA
GAMMARUS ZADDACHI
PONTOPOREIA FEMORATA
PONTOPOREIA AFFINIS
PHOTIS SPASSKII
PROTOMEDEIA SP.
ISCHYROCERUS SP.
ONISIMUS GLACIALIS
ONISIMUS LITORALIS
ACANTHOSTEPHIA INCARINATA
ACEROIDES LATIPES
BATHYMEDON SP.
MONOCULODES LONGIROSTRIS
MONOCULOPSIS LONGICORNIS
PAROEDICEROS LYNCEUS
PAROEDICEROS PROPINQUUS
PLEUSYMTES SP.
DULICHIA ARCTICA
PARADULICHIA SPINIFERA
METOPA SP.
(HYPERIDS)
HYPERIA GALBA
HYPERIA MEDUSARUM
(CAPRELLIDS)
CAPRELLA CARINA
CAPRELLA DREPANOCHIR

DECAPODS
PANDALUS MONTAGUI TRIDENS
CRANGON SEPTEMSPINOSA
CRANGON COMMUNIS
CRANGON INTERMEDIA
PAGURUS TRIGONOCHEIRUS
BRACHYURA

MISC. INSECTS
HALIPLUS SP.
LEUCOTRICHIA SP.
TIPULIDAE
MYCETOPHILOIDEA
SYRPHIDAE
SCIOMYZIDAE
EPHYDRIDAE
HYMENOPTERA
ICHNEUMONOIDEA

CHIRONOMIDS
PROCLADIUS (PSILOTANYPUS) SP.
PARACLUNIO ALASKENSIS
CORYNONEURA SP.

TABLE 8, CONTINUED

METRIOCNEMUS MARCIDIS
EUCRICOTOPUS (=CRICOTOPUS) SP.
TANYTARSUS S.G. PARATANYTARSUS
CHIRONOMUS SP.
CRYPTOCHIRONOMUS SP.
TANYTARSUS S.W. CLADOTANYTARSUS SP.
DICROTENDIPES SP.
RHEOTANYTARSUS PHOTOPHILUS
EUKIEFFERIELLA CORONATA

ECHIDROID

ECHIURUS ECHIURIS ALASKANUS

PRIAPULID

HALICRYPTUS SPINULOSUS

TARDIGRADA

ECTOPROCTS

ALCYONIDIUM DISCIFORME
EUCRATEA LORICATA
FLUSTRA SERRULATA

ASTEROIDEA

OPHIUROIDAE

ECHINOID

ECHINARACHNIUS PARMA

ARROW WORM

SAGITTA ELEGANS

UROCHORDATE

MOLGULA GRIFFITHSII

FISH

SQUATINA CALIFORNICA
MYOXOCEPHALUS POLYACANTHOCEPHALUS
MYOXOCEPHALUS QUADRICORNIS
OCCELLA SP.
STICHAEIDAE
AMMODYTES HEXAPTERUS
HIPPOGLOSSOIDES SP.
HIPPOGLOSSOIDES ROBUSTUS
LIMANDA ASPERA

TABLE 9: Beaufort Sea littoral (0.0 to 2.0m) benthic fauna: data are summarized by location (station) and year (1975 or 1976); n is the number of Ekman grab samples taken and $\hat{H}$ is the Shannon-Weaver diversity index by station and year.

STATION NO.	NO. SPP.	$\hat{H}$	BIOMASS gm/m^2	PRINCIPAL GENERA	n	yr
BØ6	10	1.038	0.518	Enchytraeidae, Chironomidae	25	5
B17	4	0.067	0.067	Enchytraeidae, Gammarus, Onisimus	6	6
B18	17	1.770	8.222	Cyrtodaria! Saduria, Scolecolepides	30	5
B18	5	0.691	0.260	Enchytraeidae, Gammarus, Onisimus	9	6
B21	6	1.517	4.485	Saduria	18	5
B22	6	1.468	1.229	Saduria	11	5
C35	4	0.017	0.286	Enchytraeidae, Gammarus, Onisimus	5	6
C36	4	0.880	0.759	Gammarus	3	5
C36	3	0.637	0.729	Gammarus, Enchytraeidae	6	6
C37	9	1.201	1.417	Cyrtodaria	31	5
C37	7	0.804	1.540	Gammarus, Enchytraeidae	9	6
C38	14	0.705	18.539	Cyrtodaria! Halicriptus, Enchytraeidae, Tubularia, Pygiospio	26	5
C38	9	1.003	0.480	Enchytraeidae, Onisimus, Gammarus	9	6
C39	4	1.330	1.416	Saduria, Onisimus	6	5
C39	4	0.753	3.780	Gammarus, Onisimus	6	6
C40	8	0.374	11.020	Chironomidae! Enchytraeidae	18	5
C41	7	0.521	0.864	Enchytraeidae	36	5
C4E	14	2.026	0.733	(Polychaeta)	2	6
DØØ	9	1.390	6.736	Saduria! Pontoporeia	19	5
HØ8	8	0.929	1.239	Chironomidae	9	5
HØ8	9	0.854	2.276	Chironomidae	9	6
H12	9	0.219	2.271	Pontoporeia	12	5
H28	7	0.532	0.287	(Gammaracanthus)	6	5
H28	8	0.610	0.107	(Enchytraeidae)	9	6
H3F	9	1.089	12.451	Saduria! Gammarus, Onisimus	2	6
H32	7	1.013	0.998	Gammarus	5	5
H32	7	0.493	2.521	Saduria! Gastropoda	9	6

TABLE 9, continued

H39	12	0.784	0.981	Enchytraeidae	7	5
H4Ø	-	-	-	No Samples Taken	0	5
H4Ø	6	1.116	0.063	(Saduria)	9	6
I3Ø	6	0.854	3.596	Chironomidae!	7	5
I31	5	0.717	3.901	Chironomidae!	8	5
I3E	4	1.273	1.320	Gammarus!	1	6
I5Ø	4	0.693	0.076	(Enchytraeidae)	6	5
I5Ø	6	1.140	6.063	Saduria!	9	6
I58	7	1.667	2.015	Tubularia!	8	5
JØ6	9	1.099	1.166	Saduria, Pontoporeia	9	6
J22	7	1.052	0.362	(Saduria)	13	5
J22	2	0.683	0.735	Saduria	3	6
J24	4	1.234	0.405	(Scolecolepides)	7	5
MØ7	5	1.494	1.271	Onisimus	3	6
MØ8	-	-	-	No Samples Taken	0	5
MØ8	4	0.000	0.201	Enchytraeidae	6	6
M1Ø	7	1.858	0.101	(Onisimus)	6	5
M11	11	0.963	16.750	Chironomidae! Enchytraeidae	15	5
M14	4	0.237	1.768	Gammarus	6	5
M1B	29	2.311	6.513	Nemertean, Prionospio, Scolecol-epides	2	6
N42	3	0.030	2.392	Enchytraeidae	12	5
N43	8	1.458	5.274	Gammarus, Nucula	7	5
N44	4	0.416	1.743	Gammarus, Enchytraeidae	12	5
O39	6	1.513	0.670	(Onisimus)	12	5
O39	0	0.000	0	No Animals Found	3	6
O4Ø	8	0.676	0.599	(Onisimus, Sagitta, Enchytraei-dae)	15	5
O4Ø	2	0.451	0.022	(Enchytraeidae)	6	6
O42	7	0.632	0.900	(Onisimus, Enchytraeidae)	15	5
P2D	5	0.928	21.952	Onisimus, Gammarus	1	6
P28	5	0.426	2.388	Gammarus!	6	6
P3Ø	10	0.021	14.954	Enchytraeidae!	11	5
P3Ø	8	1.284	0.717	Gammarus, Enchytraeidae	6	6
P31	9	1.863	1.370	Onisimus	6	6

TABLE 9, continued

P33	4	0.088	0.217	Enchytraeidae!	8	6
P34	5	0.664	0.235	(Onisimus)	6	5
P34	4	1.277	0.203	(Onisimus)	5	6
N	63	63	63			
$\bar{X}$	6.984	0.884	2.986			
S^2	18.984	0.294	22.438			
S	4.357	0.542	4.736			

TABLE 10: Beaufort Sea littoral (0.0 to 2.0m) epibenthic fauna: data are summarized by location and year (1975 or 1976); n is the number of dredge tows made; $\bar{H}$ is the Shannon-Weaver diversity index by station and year.

STATION NO.	NO. SPP.	$\bar{H}$	BIOMASS gm/50m tow	PRINCIPAL GENERA	n	yr
BØ6	11	1.052	0.467	Mysis, Monocolodes, Onisimus, Myoxocephalus	4	5
B17	9	0.739	5.347	Gammarus, Onisimus, Myoxocephalus	1	6
B18	20	1.199	2.048	Mysis, Saduria	4	5
B18	5	0.698	7.120	Mysis, Onisimus, Gammarus	1	6
B21	10	0.781	0.449	Mysis	2	5
B22	14	2.133	1.543	Gammarus	2	5
C35	6	1.457	1.047	Gammarus, Onisimus	1	6
C36	-	-	-	No Sample Taken	0	5
C36	6	1.192	1.022	Gammarus, Myoxocephalus	1	6
C37	8	1.942	2.414	Gammarus, Myoxocephalus, Mysis	7	5
C37	8	0.795	21.445	Mysis! Gammarus	1	6
C38	13	1.338	0.593	Mysis	3	5
C38	0	0.000	0.000	No Animals Found	1	6
C39	5	1.468	0.732	Gammarus, Mysis	2	5
C39	4	0.840	34.125	Gammarus! Mysis, Onisimus	1	6
C40	9	1.606	0.272	(Mysis)	2	5
C41	10	0.798	4.636	Mysis, Onisimus	4	5
C4E	-	-	-	No Sample Taken	0	6
DØØ	13	1.192	0.737	Mysis	3	5
E59	7	1.246	2.180	Gammarus, Mysis, Onisimus	1	6
HØ8	7	0.675	2.779	Mysis	2	5
HØ8	-	-	-	No Sample Taken	0	6
H12	8	0.317	9.555	Mysis! Myoxocephalus	2	5
H28	11	1.196	4.027	Mysis, Gammaracanthus	2	5
H28	7	1.126	0.712	(Myoxocephalus, Mysis)	1	6
H3F	18	1.798	24.454	Saduria!	1	6
H32	8	0.484	0.311	(Saduria, Mysis)	3	5
H32	6	0.279	11.557	Mysis!	1	6
H39	-	-	-	No Sample Taken	0	5
H4Ø	8	0.672	1.774	Mysis!	1	5
H4Ø	7	0.541	5.748	Mysis!	1	6
I30	4	0.186	1.240	Mysis!	1	5
I31	-	-	-	No Sample Taken	0	5

TABLE 10, continued

I3E	17	2.069	13.068	Saduria!	1	6
I5Ø	19	1.673	2.583	Mysis	2	5
I5Ø	8	0.726	18.858	Saduria! Mysis, Gammaracanthus	1	5
I58	6	0.287	6.237	Mysis!	2	5
JØ6	13	1.697	3.145	Saduria, Mysis	1	6
J22	5	0.273	1.778	Saduria, Myoxocephalus	2	5
J22	3	1.082	0.042	(Mysis)	1	6
J24	-	-	-	No Sample Taken	0	5
MØ7	11	1.609	2.414	Gammaracanthus, Onisimus	1	6
MØ8	18	1.879	1.743	Mysis	3	5
MØ8	-	-	-	No Sample Taken	0	6
M1Ø	14	1.624	2.792	Sagitta	4	5
M11	-	-	-	No Sample Taken	0	5
M14	-	-	-	No Sample Taken	0	5
M1B	42	1.887	5.248	Saduria, Mysis, Acanthostepheia	1	6
N43	6	1.026	2.441	Gammarus	2	5
N44	-	-	-	No Sample Taken	0	5
039	4	1.254	0.166	(Onisimus)	2	5
039	13	1.049	8.970	Sagitta! Apherusa	1	6
04Ø	11	1.650	0.313	(Sagitta, Gammarus)	2	5
04Ø	9	1.453	1.023	(Gammarus, Aglantha, Onisimus)	1	6
042	12	1.557	1.051	Onisimus (Enchytraeidae)	2	5
P2D	-	-	-	No Sample Taken	0	6
P28	8	1.583	3.687	Myoxocephalus, Sagitta, Onisimus	1	6
P3Ø	-	-	-	No Sample Taken	0	5
P3Ø	18	1.455	5.929	Sagitta, Thysanoessa, Myoxocephalus	1	6
P31	15	1.187	9.277	Gammarus, Onisimus	1	6
P33	5	0.266	0.854	Enchytraeidae!	1	5
P33	8	0.310	1.395	Myoxocephalus, Enchytraeidae	1	6
P34	-	-	-	No Sample Taken	0	5
P34	7	0.583	10.581	Gammarus, Mysis	1	6
N	51	51	51			
$\bar{X}$	10.078	1.097	4.940			
S^2	41.274	0.308	47.088			
S	6.424	0.555	6.862			

TABLE 11: Beaufort Sea nearshore (>2.0 to 5.0m) benthic fauna: data are summarized by location (station) and year (1975 or 1976); n is the number of Ekman or Smith-McIntyre grab samples taken; and H̄ is the Shannon-Weaver diversity index by station and year.

STATION NO.	NO. SPP.	H̄	BIOMASS gm/m^2	PRINCIPAL GENERA	n	yr
C4F	20	1.806	5.381	Saduria, Scolecolepides, Ampharete	2	6
G3A	19	1.945	29.406	Gammarus, Onisimus, Scolecolepides, Calliopius	2	6
HØB	30	2.034	20.823	Gammarus, Onisimus, Calliopus, Ampharete, Prionospio, Liochyma	2	6
HØA	15	1.865	43.523	Cyrtodaria, Gammarus, Saduria, Onisimus, Pontoporeia, Scolecolepides, Calliopius, Eteone	1	6
H19	18	1.863	9.476	Scolecolepides, Halcriptus, Ampharete	6	5
H2Ø	10	1.847	0.996	Scolecolepides	6	5
H22	9	1.672	7.610	Astarte, Scolecolepides, Halcriptus	6	5
H3E	23	2.131	27.047	Gammarus, Onisimus, Calliopius, Prionospio, Ampharete, Scolecolepides	2	6
I3F	16	1.857	60.783	Saduria! Halicryptus, Ampharete, Arenicola, Prionospio, Scolecolepides	2	6
JØC	23	1.697	6.457	Scolecolepides, Tubificidae, Diastylis	2	6
J1A	29	1.820	160.636	Saduria! Prionospio, Portlandia Scolecolepides, Cyrtodaria, Ampharete, Fabricia, Terebellides, Onisimus	2	6
M1A	32	1.570	10.411	Liocyma, Propebela, Mysella Terebellides, Prionospio, Glycinde	2	6
N1A	43	2.116	31.008	Saduria, Liocyma, Sternapsis, Portlandia, Ampharete, Terebellides, Tharyx, Propebela	2	6
N1B	29	1.644	16.731	Liocyma, Molgola, Chaetozone	2	6
P2E	30	2.551	28.223	Saduria, Cyrtodaria, Gammarus, Nephtys, Anonyx, Onisimus, Pontoporeia	2	6

continued

TABLE 11, continued

N	15	15	15
$\bar{X}$	23.067	1.895	30.567
S^2	84.217	0.0595	1555.198
S	9.177	0.244	39.436

TABLE 12: Beaufort Sea nearshore (>2.0 to 5.0m) epibenthic fauna: data are summarized by location (station) and year (1975 or 1976); n is the number of dredge tows made; $\bar{H}$ is the Shannon-Weaver diversity index by station and year.

STATION NO.	NO. SPP.	$\bar{H}$	BIOMASS gm/50m tow	PRINCIPAL GENERA	n	yr
C4F	6	1.008	0.421	Copepods	1	6
G3A	15	1.915	0.001	Mysis	1	6
HØB	13	1.475	1.100	Saduria	1	6
HØA	12	1.715	2.745	Saduria	1	6
H19	13	1.174	9.449	Mysis, Saduria	2	5
H20	14	1.041	20.607	Mysis, Gammaracanthus, Monoculodes	2	5
H22	11	0.479	3.556	Mysis	2	5
H3E	19	0.748	8.631	Mysis, Saduria	1	6
I3F	14	0.269	1.253	Mysis!	1	6
JØC	-	-	-	No Sample Taken	0	6
J1A	28	0.051	25.273	Mysis! Saduria	1	6
M1A	18	2.087	1.157	Thysanoessa	1	6
N1A	31	2.097	1.232	Liocyma?, Mysis	1	6
N1B	16	0.728	1.128	Apherusa, Saduria	1	6
P2E	11	0.858	0.541	Onisimus, Neomysis	1	6
N	14	14	14			
$\bar{X}$	15.7857	1.1175	5.5067			
S^2	44.183	0.436	63.8596			
S	6.647	0.659	7.991			

TABLE 13: Chukchi Sea littoral (0.0 to 2.0m) benthic fauna between Point Hope and Barrow: data are summarized by location (station) for the year 1976; n is the number of Ekman grab samples; $\bar{H}$ is the Shannon-Weaver diversity index by station.

STATION NO.	NO. SPP.	$\bar{H}$	BIOMASS gm/m^2	PRINCIPAL GENERA	n
P52	9	0.136	2.193	Enchytraeidae!	6
P53	-	-	-	No Samples Taken	-
R19	4	0.000	0.224	Enchytraeidae	6
R20	5	0.127	0.492	Onisimus, Enchytraeidae	6
R28	10	0.189	5.801	Halicryptus, Macoma, Enchytraeidae	6
R40	6	0.466	0.564	Gammarus	6
S51	4	1.055	0.051	Apherusa	6
S56	5	0.000	0.087	Gammarus	6
T11	11	0.386	3.022	Enchytraeidae, Gammarus	6
T12	4	0.000	0.062	Onisimus	6
U51	5	0.615	7.313	Chironomus, Enchytraeidae	9
U55	10	1.371	5.019	Macoma, Cyrtodaria, Onisimus	9
U57	8	0.969	2.831	Onisimus, Macoma	6
Y5Ø	-	-	-	No Samples Taken	
ZØ9	4	0.673	0.248	(Anisogammarus)	6
Z44	3	0.213	5.660	Macoma! Enchytraeidae	6
Z45	6	1.116	0.480	(Enchytraeidae)	6
Z46	9	0.768	14.732	Diptera, Chironomus, Enchytraeidae	6

N	16	16	16
$\bar{X}$	6.438	0.505	3.049
s^2	6.927	0.200	15.705
s	2.632	0.447	3.963

TABLE 14: Chukchi Sea littoral (0.0 to 2.0m) epibenthic fauna between Point Hope and Point Barrow: data are summarized by location (station) for the year 1976; n is the number of dredge tows made; $\bar{H}$ is the Shannon-Weaver diversity index by station.

STATION NO.	NO. SPP.	$\bar{H}$	BIOMASS gm/50m tow	PRINCIPAL GENERA	n
P52	16	0.830	4.281	Gammarus, Enchytraeidae, Myoxocephaus	1
P53	8	0.277	59.0560	Onisimus, Gammarus	1
R19	5	0.937	0.780	Onisimus	1
R20	10	1.276	4.625	Myoxocephalus, Mysis, Onisimus	1
R28	12	1.235	4.213	Mysis, Gammarus	1
R40	7	1.497	25.897	Saduria! Mysis	1
S51	4	0.519	0.173	Onisimus	1
S56	10	1.340	18.335	Pagurus!	1
T11	8	1.117	3.212	Gammarus, Enchytraeidae	1
T12	4	0.317	1.396	Onisimus	1
U51	6	1.068	7.065	Mysis! Chironomus	1
U55	11	0.448	5.044	Onisimus	1
U57	6	0.340	1.781	Onisimus	1
Y5Ø	3	0.000	0.263	Gammarus	1
ZØ9	9	1.201	2.442	Gammarus, Calliopus	1
Z44	6	0.357	0.159	Enchytraeidae	1
Z45	5	1.310	0.186	Paramoera	1
Z46	9	0.759	0.772	Chironomus	1
N	18	18	18		
$\bar{X}$	7.722	0.824	7.760		
S^2	10.916	0.209	209.757		
S	3.304	0.458	14.483		

TABLE 15: Chukchi Sea littoral (0.0 to 2.0m) benthic fauna between Cape Prince of Wales and Point Hope: data are summarized by location (station) for the year 1976; n is the number of Ekman grab samples; $\bar{H}$ is the Shannon-Weaver diversity index by station.

STATION NO.	NO. SPP.	$\bar{H}$	BIOMASS gm/m^2	PRINCIPAL GENERA	n
46Y	4	0.302	2.813	Paramoera! Enchytraeidae	5
34X	6	0.814	21.120	Anisogammarus! Chironomus, Enchytraeidae	6
33X	7	2.958	14.002	Bryozoans! Ascidians, Anisogammarus	4
44W	5	1.011	0.173	Paramoera--only 0.0 depth!	1
27V	14	0.786	22.790	Macoma! Cyrtodaria (Enchytraeidae)	15
31T	8	1.055	0.016	(Enchytraeidae)	7
ØU3	15	1.603	4.550	Saduria, Scolecolepides, Caprella	6
2U1	23	2.200	9.729	Mysella? Macoma, Cryptomya	6
5U2	1	0.694	0.000	Mysella?	3
1V7	6	0.284	0.155	(Enchytraeidae)	5
1V8	3	0.337	0.812	Anisogammarus!	4
3V2	2	0.215	0.065	(Nemertean) - only 0.0 depth!	3
4V5	6	0.129	13.230	Saduria! Myoxocephalus	6
1WØ	6	1.550	0.054	(Onisimus)	6
1W2	3	0.083	0.056	(Enchytraeidae)	3
2WØ	8	0.419	5.082	Enchytraeidae, Gammarus	6
4W5	12	0.168	0.270	(Spio!)	12
5W3	7	1.287	15.768	Enchytraeidae, Hymenoptera, Diptera	2
4YØ	16	1.117	2.483	Chironomus, Procladius, (Chironomids)	8
4Y1	14	0.917	23.054	Chironomus! Scolecolepides, Pontoporeia	11
5Y2	22	2.003	5.825	Mytilus, Neomysis, Eucratia	8
ØZ7	9	1.527	0.092	(Saduria)	8
ØZ8	8	0.000	0.005	(Bivalve shells!)	9
75Ø	18	1.768	0.172	(Anisogammarus)	12
751	20	2.044	0.413	(Gammarus, Scolecolepides, Acanthostephia)	11
801	12	0.336	3.510	Saduria, Pygospio, Halicryptus	12
N	26	26	26		
$\bar{X}$	9.808	0.985	5.625		
S^2	39.038	0.612	89.473		
S	6.248	0.782	9.459		

TABLE 16: Chuchi Sea littoral (0.0 to 2.0m) epibenthic fauna between Cape Prince of Wales and Point Hope: data are summarized by location (station) for the year 1976; n is the number of dredge tows made; $\bar{H}$ is the Shannon-Weaver diversity index by station.

STATION NO.	NO. SPP.	$\bar{H}$	BIOMASS gm/50m tow	PRINCIPAL GENERA	n
46Y	5	0.703	0.266	Gammarus, Paramoera	1
34X	9	0.646	7.840	Anisogammarus, Myoxocephalus, Neomysis, Mysis	1
33X	26	2.203	7.164	Crangon, Ammodytes, Squatina, Neomysis	4
44W	5	0.451	14.390	Limanda! Asteroid	1
27V	10	0.139	28.255	Neomysis!	2
31T	6	0.491	6.854	Neomysis!	2
ØU3	-	-	-	No Sample Taken	0
2U1	22	1.768	5.731	Crangon!	2
5U2	3	0.937	0.078	Neomysis	1
1V7	-	-	-	No Sample Taken	0
1V8	9	1.104	0.462	(Neomysis)	2
3V2	10	1.057	0.293	(Neomysis)	2
4V5	9	1.869	8.350	Myoxocephalus, Gammarus	2
1WØ	11	0.207	18.059	Saduria, Crangon, Hippoglossoides	2
1W2	14	2.129	0.204	(Gammarus)	2
2WØ	12	0.765	2.372	Saduria, Myoxocephalus	2
4W5	25	1.242	14.340	Neomysis, Crangon, Haliclona	3
5W3	-	-	-	No Sample Taken	0
4YØ	25	1.047	8.637	Myoxocephalus, Neomysis, (Chironomids)	2
4Y1	24	1.625	1.476	Crangon, Hippoglossoides	2
5Y2	15	0.059	75.065	Neomysis!	2
ØZ7	8	1.683	1.245	Crangon!	2
ØZ8	14	1.535	0.764	Crangon, Pisaster	4
75Ø	38	1.335	13.828	Neptunea, Pagurus, Neomysis	3
751	25	1.889	1.395	Crangon, (Neomysis)	3
8Ø1	9	2.130	0.440	Neomysis, Mysis	3
N	23	23	23		
$\bar{X}$	14.522	1.175	9.457		
s^2	80.443	0.448	257.074		
s	8.969	0.669	16.03		

TABLE 17: Chukchi Sea nearshore (>2.0 to 5.0m) benthic fauna: data are summarized by location (station) for the year 1976; n is the number of Ekman grab samples; $\bar{H}$ is the Shannon-Weaver diversity index by station.

STATION NO.	NO SPP	$\bar{H}$	BIOMASS gm/m^2	PRINCIPAL GENERA	n
Hotham Inlet					
28V	2	0.000	10.2141	Macoma!	1
33X	45	(2.958)	46.393	Nephtys, Ammodytes, Arenicola, Echinarachnius, Alcyonidium, Magelone, Echiurus, Glycinde, Scolecolepides, Spio	17
5V4	-	-	-	No Samples Taken	
N	2	2	2		
$\bar{X}$	23.5	1.479	28.304		

TABLE 18: Chukchi Sea nearshore (>2.0 to 5.0m) epibenthic fauna: data are summarized by location (station) for the year 1976; n is the number of dredge tows made; $\bar{H}$ is the Shannon-Weaver diversity index by station.

STATION NO.	NO. SPP.	$\bar{H}$	BIOMASS gm/50m tow	PRINCIPAL GENERA	n
28V	13	1.061	0.382	Crangon, Neomysis	2
33X	32	(2.203)	7.780	Crangon, Limanda Monoculodes	2
5U4	30	1.240	7.682	Crangon, Molgula, Obelia, Caprella	2
N	3	3	3		
$\bar{X}$	25	1.501	5.281		

Marine Algae of the Alaskan Arctic

Lists of algal species collected at Beaufort and Chukchi stations are given in tables 5 through 8 . In addition, Dr. Maurice A. Dube visited selected Beaufort and Chukchi stations in 1977 specifically to collect and report on Macroalgae. The results of Dr. Dube's collections are given in Table 19.

TABLE 19: OCCURRENCE AND RELATIVE ABUNDANCE OF MACROALGAE IN THE LITTORAL ZONE OF THE BEAUFORT AND CHUKCHI SEAS DURING THE SUMMER OF 1977. SAMPLES WERE MADE AT FLAXMAN ISLAND (FL) NEAR STATION F59; CAPE LISBURNE (CL) NEAR ZØ9; CROWBILL POINT (CP) NEAR 48Y; CAPE BLOSSOM (CB) NEAR 2V5; RILEY'S WRECK (RW) NEAR 2V6; CHAMISSO ISLAND (CI) AND PUFFIN ISLAND (PI), BOTH NEAR 5U1; SOUTHWEST OF PUFFIN ISLAND (SP); AT CAPE DECEIT (DC) NEAR 4V5; AND AT WALES (WA) NEAR STATIONS 8Ø5 AND 8Ø6. COMPLETE STATION INFORMATION APPEARS IN OUR DECEMBER, 1977 QUARTERLY REPORT. SPECIES DESIGNATED "A" WERE ABUNDANT IN COLLECTIONS. THOSE IDENTIFIED AS "O" OCCURRED AND WERE MUCH LESS ABUNDANT. "Ad" OR "Od" IMPLY THAT THE SPECIES WAS ABUNDANT OR OCCURRED IN BEACH DRIFT ONLY.

GREEN ALGAE (CHLOROPHYTA)

SPECIES	LOCATION									
	FL	CL	CP	CB	RW	CI	PI	SP	CD	WA
CLADOPHORA GRACILIS		0					0	0	0	A
ENTEROMORPHA CLATHRATA			0			0	A		0	
ENTEROMORPHA INTESTINALIS							A		0	
ULVA LACTUCA							A		A	

BROWN ALGAE (PHAEOPHYTA)

SPECIES	LOCATION									
	FL	CL	CP	CB	RW	CI	PI	SP	CD	WA
ALARIA ESCULENTA		A								
CHORDA TOMENTOSA				0		A	A			
CHORDARIALES (ORDER)			A	A		A				
DICTYOSIPHON SP.		0	0	0	Ad	A	A	0	0	
ECTOCARPUS SP.		0			0d	A	A		0	
FUCUS EVANESCENS							A		A	A
LAMINARIA SP. 1		A								
LAMINARIA SACCHARINA	0	A								
LAMINARIA SP. 2	0				0d					
LAMINARIA SOLIDUNGULA	0	0								

TABLE 19, Continued

	FL	CL	CP	CB	RW	CI	PI	SP	CD	WA
PELVETIA CANALICULATA									A	
PETALONIA FASCIA										A
PILAYELLA LITTORALIS		0	0			0	A	0	A	0
SPHACELARIACEAE (FAMILY)		0			Od	0		A		

RED ALGAE (RHODOPHYTA)

SPECIES	LOCATION									
	FL	CL	CP	CB	RW	CI	PI	SP	CD	WA
AHNFELTIA PLICATA			0			A	0		A	0
ANTITHAMNION SP.		0		0			0	0	0	0
CERAMIUM RUBRUM							A		A	
GIGARTINACEAE (FAMILY)			A						A	
HALOSACCION GLANDIFORME										0
NEODILSEA INTEGRA (?)		Ad								
ODONTHALIA KAMTSCHATICA		Ad			Od	A				
PHYCODRIS RUBENS		Od								
PHYLOPHORA INTERUPTA		Ad								
POLYSIPHONIA SP.			0		Od		A	0		A
RHODOMELIA LYCOPODIOIDES		A	A	A	Ad	A	A	A	A	A

VEGETATION OF ARCTIC BEACHES

During 1977 we continued to sample terrestrial beach vegetation, especially in that sector of beaches inundated by storm tides and, hence, at least on a seasonal basis, intertidal. Data on cover and frequency were collected by field teams at the upper end of beach transects for Beaufort and Chukchi Sea stations. Dr. Ronald J. Taylor also visited selected Beaufort and Chukchi Sea sea stations and compiled the following report.

Plant Communities of Alaskan Arctic Beaches

Ronald J. Taylor

Arctic Alaskan shorelines can be divided into six very general habitat-types. Plant communities of each of these habitat-types are rather consistent in occurrence and similar in structure. It was noted that the major distinction between the shoreline communities of the Chukchi and Beaufort Seas resulted more from the ratio of habitat-types than from localized distribution of representative species. For example, wide gravelly beaches with *Elymus mollis* communities were especially common along the Chukchi Sea whereas mud flats with salt marsh vegetation were more frequent along the Beaufort Sea. The plant ecology and floristics of the six habitat-types are discussed below.

Mud Flats and Low Sandy Shorelines (broad, shallow beaches)

This habitat-type usually exists as a broad band along the shoreline, especially in protected lagoons, with a very slight incline. Such areas have been called salt marshes, even though they are seldom marshy in aspect. However, the vegetation either requires moist saline conditions or is salt tolerant.

A number of rather distinct plant communities differentiate-out with very subtle environmental variations. For example, an elevational gain of only a few cm may result in a community shift with a sharp ecotonal border. Very slight depressions also produce distinct plant communities.

This habitat-type was observed and quantitatively analyzed in four study sites as indicated in Table 28 of the Methodology Section. Plant communities and floristics are discussed below.

Puccinellia phryganodes community -- This community formed a band of variable width (depending on percent of incline) immediately adjacent to the water-line. This community was monospecific or nearly so except along the ecotone between this and the next community. Individual plants were seldom erect but crept along the shoreline by runners, forming extensive clones. Ironically, sexual reproduction by *Puccinellia phryganodes* was much less frequent in this community where it was the sole dominant than in the next (*Carex subspathacea*) community where it was often reduced to subordinate status. Individual plants were characteristically copper to reddish colored with anthocyanic pigmentation. Quantitative data for this community are presented in Table 20.

This community may be locally represented in marshy saline areas where bare area have recently formed with evaporation or drainage of water from shallow ponds. Here Puccinellia quickly invades.

TABLE 20: Mean Frequency, coverage, and prominence values of Puccinellia phryganodes communities (type a)

Species	Frequency	Coverage	Prominence Values
Puccinellia phryganodes	97.33	55.81	549.66
Carex ramenskii	33.33	6.13	35.39
Carex subspathacea	6.00	0.15	0.37

Carex subspathacea / Puccinellia phryganodes communities -- This community normally occurred a few centimeters above the previous community. The codominants were depressed, not more than a few cm, and coppery red in coloration. As was the case with the Puccinellia community, the width of this community depended on the percentage of incline. The upper ecotone was usually not sharp but consisted of a region of intergradation of two or more Carex dominated communities (see below). In most cases, coverage was complete or nearly so, the vegetation resembling a reddish mat. With competition with Carex subspathacea, Puccinellia phryganodes appeared to be reduced to a more subordinant position or status.

Quantitative data for this community are presented in Table 21.

TABLE 21: Mean Frequency, coverage, and prominence values of major species in the Carex subspathacea / Puccinellia phryganodes communities (type a)

Species	Frequency	Coverage	Prominence Values
Carex subspathacea	100	85.20	852.00
Puccinellia phryganodes	100	58.16	581.16
Stellaria humifusa	38	6.82	42.04
Carex ursinus	13	1.60	5.77

Carex ramenskii community -- With a slight increase in elevation and corresponding decrease in salinity. Carex subspathaceae tended to be replaced by C. ramenskii, a taller and more robust species. The distinction between these two sedges is difficult to make, especially when C. ramenskii is immature. When mature C. ramenskii is more robust, as mentioned above, and the reddish coloration is less pronounced. However, even when mature the characteristics overlap and hybridization of the two species may be suspected.

This community is more-or-less intermediate between the lowland "salt marsh" communities previously discussed and the upper shoreline or storm zone communities, containing significant numbers of plants from both regions. Quantitative data for this community are presented in Table 22.

TABLE 22: Mean frequency, coverage, and prominence values of major species in the Carex ramenskii community (type b).

Species	Frequency	Coverage	Prominence Values
Carex ramenskii[a]	100	85.88	858.80
Stellaria humifusa	68	21.04	173.50
Dupontia fisheri psilosantha	50	23.76	168.01
Puccinellia phryganodes	36	6.53	39.18
Carex ursinus	18	5.58	23.67

[a]Individuals of Carex subspathacea are undoubtedly grouped in this species.

Other communities -- Several other community-types occurred along mud flats and/or low sandy shorelines, mostly above the Carex subspathacea / Puccinellia phryganodes community. Occasionally Stellaria humifusa occurred as a sole or major dominant (e.g., at Barter Island). It seemed to become dominant in "upland" depressed areas where salt water runoff was restricted. Here it sometimes reflected salt-burn. Occasionally Puccinellia vaginata and/or P. andersonii formed distinct communities apart from or in association with other species. Such communities occurred at a similar elevation as Carex ramenskii and Stellaria humifusa communities with which the two Puccinellia species were often associated. Finally, Carex ursinus frequently achieved dominant status in association with Carex subspathacea and/or C. ramenskii.

All of these communities occurred below the driftwood or upper storm zone. In addition to the communities described above, features of occasional occurrence included apparent salt burns where standing salt water apparently killed most of the vegetation, and shallow ponds containing slightly saline water. In these ponds Hippuris tetraphylla and Potamogeton filiformis dominated.

Mosses were infrequent in occurrence along the low, muddy or sandy shorelines. This was probably because of their lack of ability to compete with the dominant sedges and grasses more than their lack of salt tolerance. In support of this assumption, in tire tracks or other disturbed areas, mosses had become established and were often conspicuous dominants.

Muddy to Sandy Upper Beaches (Including the Driftwood or Upper Storm Zone)

This zone or habitat-type usually consists of a rather broad band, beginning with the domination by Dupontia fisheri, Arctagrostis latifolia, Carex aquatilis, or other salt-tolerant, but not salt-requiring species or combination of species. The upper limit is less well defined, with a gradual transition into the arctic tundra typical for the region. Salinity appears to play only a minor role in determining the structures of plant communities, since species occurring here, especially the dominants, are frequently or usually found in moist to wet habitats well beyond the influence of the immediate coastal environment (except in terms of weather). It appears that the moisture and fine texture of the soil are at least equally important.

Plant communities within this zone are difficult to define because of an inconsistent mixing of salt-tolerant (not salt-requiring) species. However, the communities are generally similar in having the dominant species, Dupontia fisheri.

Dupontia fisheri community -- Dupontia is a medium-sized grass which exhibits extreme variation throughout its range. It is common over most of the arctic lowlands where the soil is heavy (not peaty) and moist to marshy. It is equally at home in soils of moderate and no salinity.

Associates of Dupontia are usually equally tall grasses and/or sedges and such low-growing willows as Salix ovalifolia and S. arctica. Although coverage by these taller species tends to be complete, mosses are an important understory species. Quantitative data for Dupontia communities are presented in Table 23.

TABLE 23: Mean frequency, coverage, and prominence values in Dupontia fisheri ssp. psilosantha communities (type b).

Species	Frequency	Coverage	Prominence Values
Dupontia fisheri psilosantha	99	68.38	680.37
Mosses	48	18.76	129.97
Carex aquatilis stans	47	18.27	125.25
Saxifraga cernua	30	7.74	42.39
Cochlearea officinalis	37	2.67	16.24
Eriophyllum angustifolium	18	1.55	6.58
Stellaria humifusa	7	0.90	2.38

Other locally important species of Dupontia communities were Poa arctica, Alopecurus alpinus, Saxifraga hirculus, Arctagrostis latifolia, Arctophila fulva, Eriophorum scheuchzeri, Carex rariflora, and Salix ovalifolia.

Gravelly to Sandy Beaches (narrow, steep beaches)

This habitat-type differs from the previous one in several important aspects: a) the beach is much narrower; b) the slope is much greater; c) the soil texture tends to be much coarser; d) the drainage is much better. Given these conditions, Elymus mollis (= E. arenarius of Hultin) is consistently the conspicuous dominant. This distinct habitat-type is especially common along the shoreline of the Chukchi Sea. The beaches are typically bare for the first 80 percent of their width followed by a rather narrow band dominated by Elymus and an upper zone (later described) of mixed vegetation. The upper zone includes the driftwood area.

Elymus mollis community -- Elymus is a tall, coarse grass that spreads over gravelly or sandy habitats by rootstalks as well as seeds. It forms a distinctive community in association with a relatively few, usually prostrati and succulent species. Coverage in this community varies from sparse to nearly complete and is usually somewhere between. Plants (Elymus) tend to be clumped because of clonal development.

Quantitative data of Elymus mollis communities are presented in Table 24.

TABLE 24: Mean frequency, coverage, and prominence values in Elymus mollis (E. arenarius communities (type c).

Species	Frequency	Coverage	Prominence Values
Elymus mollis	78	42.86	378.53
Mertensia maritima	16	1.93	7.71
Honckenya peploides	4	0.98	1.96
Lathyrus maritima	5	0.78	1.74
Cochlearea officinale	4	0.18	0.36

Other species of some importance in Elymus mollis communities were Senecio pseudoarnica (especially at Point Hope), Equisetum arvense, Poa arctica, and Artemisia spp. Mosses occurred where the substrate was firm and well stabilized.

Hard-packed Gravelly Coastal Bench

These benches were probably derived in most cases through stabilization of an earlier upper beach. The vegetation tended to be intermediate between the lower Elymus mollis community and adjacent tundra plains. However, because of the hard, rocky soil, many species occurring here are more frequently found on fell-fields or other rocky, montane habitats. Thus, there was a lack of consistency in vegetative structure from one station to another. At some stations Salix ovalifolia and/or S. arctica were the principle dominants. At other stations such grasses as Festuca brachyphylla and Poa arctica were of great importance. Artemisia species (especially A. tilesii and A. arctica) were often important, and various other species were locally dominant or had high prominence values. Finally, species from the Elymus mollis community were always present and sometimes dominant. Although the vascular plants are more conspicuous, the mosses as a group are very important ecologically.

These benches included the upper driftwood zone and because of this were undoubtedly subjected to rare or occasional salt water impregnation. Therefore, the species occurring here would either have to be salt tolerant or become established between major coastal storms.

Since the bench communities of various stations tended to be somewhat unique, any overall community classification would be artificial. Therefore, the important species have been listed in Table with no regard for the pattern of assocation. The structure of specific communities cannot be anticipated from the data presented in Table 25.

TABLE 25: Mean frequency, coverage, and prominence values of important species of Gravelly Coastal Benches (type d).

Species	Frequency	Coverage	Prominence Values
Salix ovalifolia	52	34.05	245.54
Mosses	63	22.19	176.13
Elymus mollis	63	20.19	160.25
Festuca brachyphylla	49	10.32	71.50
Androsace chamasjasme	38	4.37	26.94
Poa arctica	27	4.95	25.72
Potentilla villosa	23	4.94	23.69
Salix arctica	20	4.62	20.66
Conioselinum cnidifolium	40	3.05	19.29
Astrogalus alpinus	25	2.65	13.25
Oxytropis campestris	17	1.91	7.88
Artemisia arctica	14	1.48	5.54
Stellaria longipes	20	0.75	3.35

Several additional species were conspicuous associates of bench communities at one or more stations. These included the following: Artemisia tilesii, Epilobium latifolium, Equisetum arvense, Lathyrus maritimus, Myosotis alpestris, Oxytropis nigrescens, Pedicularis sudetica, Petasites frigidus, Papaver macounii, Polygonum bistorta, Polygonum viviparum, Saxifraga caespitosa, Saxifraga tricuspidata, and Senecio residifolius.

Coastal Bluffs With Solifluction

As was the case with coastal benches, the plant communities of coastal bluffs were not well defined. However, there were certain species of plants that occurred with some degree of regularity. The percent coverage varied with the amount of solifluction and correlated soil stability. In most cases, the soil was wet from the melting of permafrost (ice), sometimes to the point of oozing downward to the white beaches below.

In only one case--Wales--was a coastal bluff sampled. Here, vertical transects were run and 20 by 50 cm quadrats were sampled at regular intervals along the transects. For the results of that analysis see the appropriate entry in the "Summary of Field Notes" section. At several other stations, the vegetation was observed and descriptive notes were taken. These are also included in appropriate locations in the "Summary of Field Notes" section.

Salinity probably has little influence on bluff vegetation but as shown in the results of the Wales analysis, there was some zonation from the base of that bluff to mid elevations. This zonation was undoubtedly influenced by salt spray. This was especially indicated by the occurrence of the salt-indicator species, Stellaria humifusa and Phippsia algida, at the base of the bluff, near the water's edge.

Since Wales was the only station where quantitative data were obtained, to present frequency, coverage, and prominence values here would be to repeat those figures and there is nothing to be gained in doing that. Rather, in Table 26 there is a listing of the most common species recorded at various stations where coastal bluffs were observed. The order of listing is somewhat indicative of the general importance of the representative species. In some cases informative notes are provided.

TABLE 26: Important Coastal Bluff Species (listed in approximated order of importance) and Ecological Notes (type e).

Species	Notes
Artemisia telesii --	General distribution
Salix ovalifolia --	General distribution but in locations where the soil is well stabilized
Salix pulchra and/or S. glauca --	Crests of bluffs and sides of eroded ravines
Poa species (esp. P. eminens and P. arctica --	General to basal distribution
Saxifraga species (esp. S. bracteata, S. rivularis, and S. punctata) --	Moist to wet locations
Petasites frigidus --	Moist to wet, unstable areas
Equisetum arvense --	non-vegetated basal sites
Phippsia algida --	Rather stabilized basal locations
Artemisia arctica --	Mid to upper locations
various mustards (esp. Draba macrocarpa, D. lactea, Braya purpurescens, Eutrema edwordsii) --	
Papaver species --	Mid to upper locations
Puccinellia species --	Basal to mid elevations, in open areas
Primula species --	Moist sites, mid to upper locations
Luzula confusa --	General distribution
Oxyria digyna --	Mid to upper locations
Spiraea beauverdiana --	Crests of ("southern") bluffs
Stellaria and other "Caryophylls" --	General distribution (according to species)
Cochlearea officinalis --	Basal, open sites

Coastal Dunes

Two dune areas were observed and sampled, Prudhoe Bay and Colville River Delta. In both, the sand particles were very fine and the dunes were characterized by wind inundated, low-lying areas; wind-oriented channels of variable depth and width; and irregular profiles of alternately (temporarily) stabilized and wind-erroded surfaces. Cover varied from very sparce in unstable areas to high on stabilized mounds.

The principle plant species were grasses (especially *Elymus mollis*) and mat-forming species such as *Salix ovalifolia* and *Artemisia borealis*. More local mat-formers were *Oxytropis nigrescens bryophylla* (at Prudhoe and *Chrysanthemum bipinnatum* (in the Colville River Delta). *Elymus mollis* was the most important dune species, occurring in scattered tufts and general mats. Its success is due in large part to its ability to tolerate sand deposition and blow-outs.

Salinity undoubtedly has little influence on the structure of dune communities, in-as-much as similar communities occur on dunes along river bars far removed from the coast. Quantitative data of the two dune communities are presented in Table 27.

TABLE 27: Mean frequency, coverage, and prominence values of two dune communities, Prudhoe Bay and Colville River Delta (type f)

Species	Frequency	Coverage	Prominence Values
Elymus mollis	69	28.34	235.31
Salix ovalifolia	23	7.62	36.54
Chrysanthemum bipinnatum	29	3.65	19.66
Festuca rubra	20	3.65	16.32
Artemisia borealis comata	32	1.83	10.35
Stellaria lacta	19	1.59	6.58
Equisetum arvense	17	0.96	3.96
Oxytropis nigrescens bryophylla	5	1.15	2.57
Taraxacum ceratophorum	11	0.38	1.26
Poa arctica	10	0.34	1.08
Poa glauca	8	0.37	1.05
Androsace chamaejasme	5	0.24	0.54

TABLE 28: Plant community types of selected Arctic Alaskan beaches. See text for detailed descriptions of community types.

Station No.	Location	Community Types a	b	c	d	e	f	g	h
B2A	Nuvagapak Pt.		x			x		x	
C38	Barter Island	x	x						
F59	Flaxman Island	x	x						
	Prudhoe Bay						x		
	Colville River Delta	x	x				x		
	Cape Lisburne			x	x				
Z45	Point Hope			x	x				
48Y	Cape Thompson			x	x				
44W	Cape Krusenstern			x	x				
4V5	Deoring	x		x		x			
802	Wales			x	x	x			

type a - Puccinellia - Carex (salt marsh, muddy to sandy)
type b - Dupontia - Carex (upper beach, muddy to sandy)
type c - Elymus mollis (upper beach, gravelly)
type d - mixed community, Salix dominated (gravel bench above beach)
type e - mixed community (coastal bluffs with solifluction)
type f - Elymus dominated (coastal dunes)
type g - other (usually blending into tundra)

Ecology of Arctic Marshes

The primary results of our study of ecological relationships in Arctic salt marshes was reported in our December, 1978 Quarterly Report. Herein are presented in graphic form some observations on trophic interrelationships in marshes, permafrost depth, soil salinity, and vegetation distribution within marshes.

FIGURE 1

Food web in Alaskan arctic salt marshes. Data come primarily from Prudhoe Bay and south of Kotzebue on the Baldwin Penninsula. The important colloidal interface which concentrates organic matter and phosphorus is assumed to enrich the many small organisms in the precipitate habitat and increase their value to the insects which eat the precipitate. Many ponds may dry up in summer; planktonic crustaceans (copepods and cladocerans) may be trapped in large numbers and occasionally taken directly by shore birds.

The precipitate, which often forms (probably abiotically) at the pond undersurface and is pushed into cobwebby strands by wind, results from oxidation of ferrous iron by atmospheric (or dissolved) oxygen. The ferrous ion is brought in ground water to the surface from anaerobic sources of decay above in the adjacent meadows. These productive lawns (approximately 0.8 grams volatile matter per square meter per day) of Carex subspathacea, (and C. ramenskii), Puccinellia phryganodes, and Stellaria humifusa are important grazing turf for migratory brant and geese, especially on their critical fall flight southward. Caribou and reindeer will graze and escape insect pests in the marshes in mid-summer. Both of these animals are used by humans for food. The geese are important to hunters throughout their migratory range.

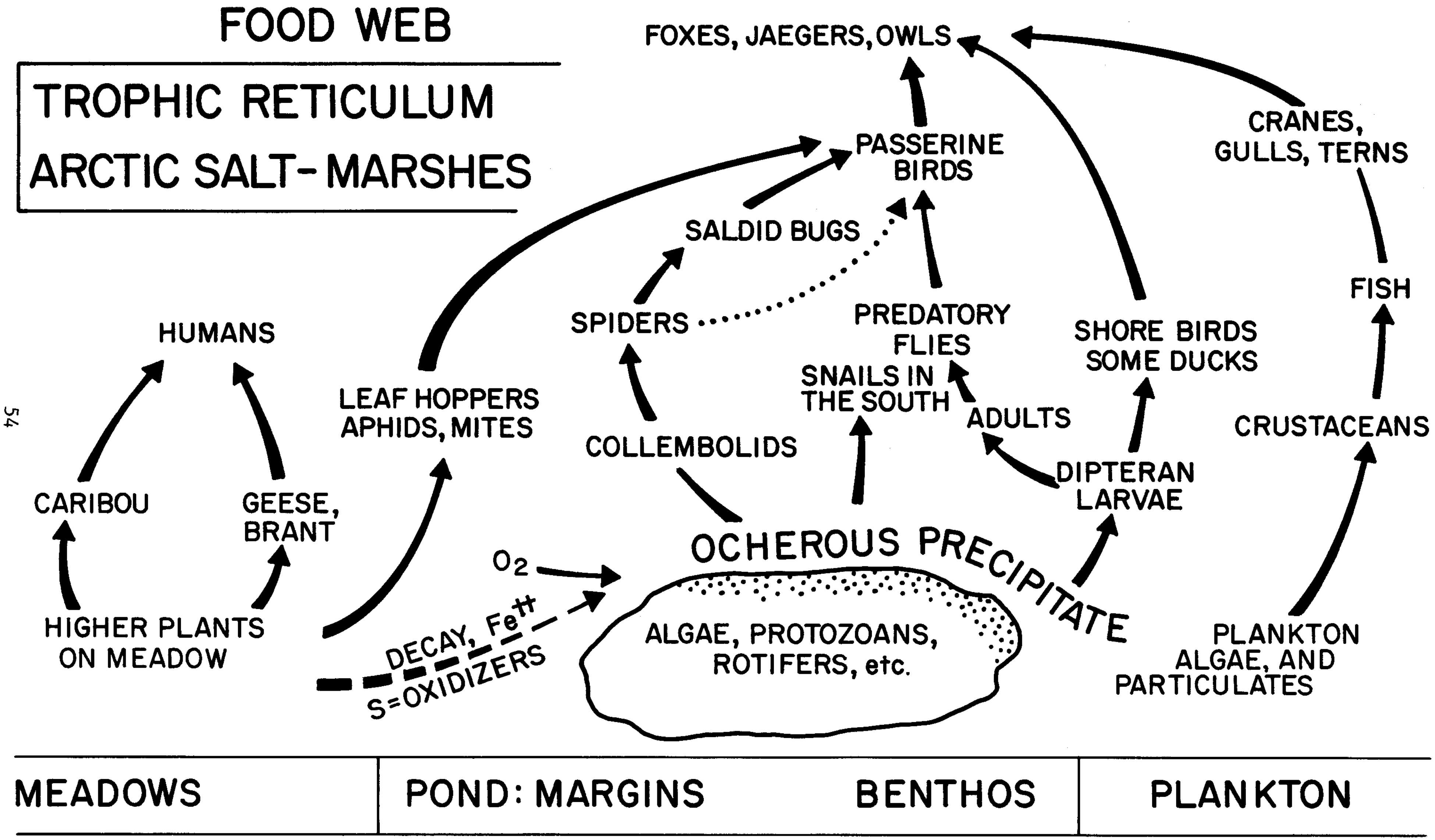
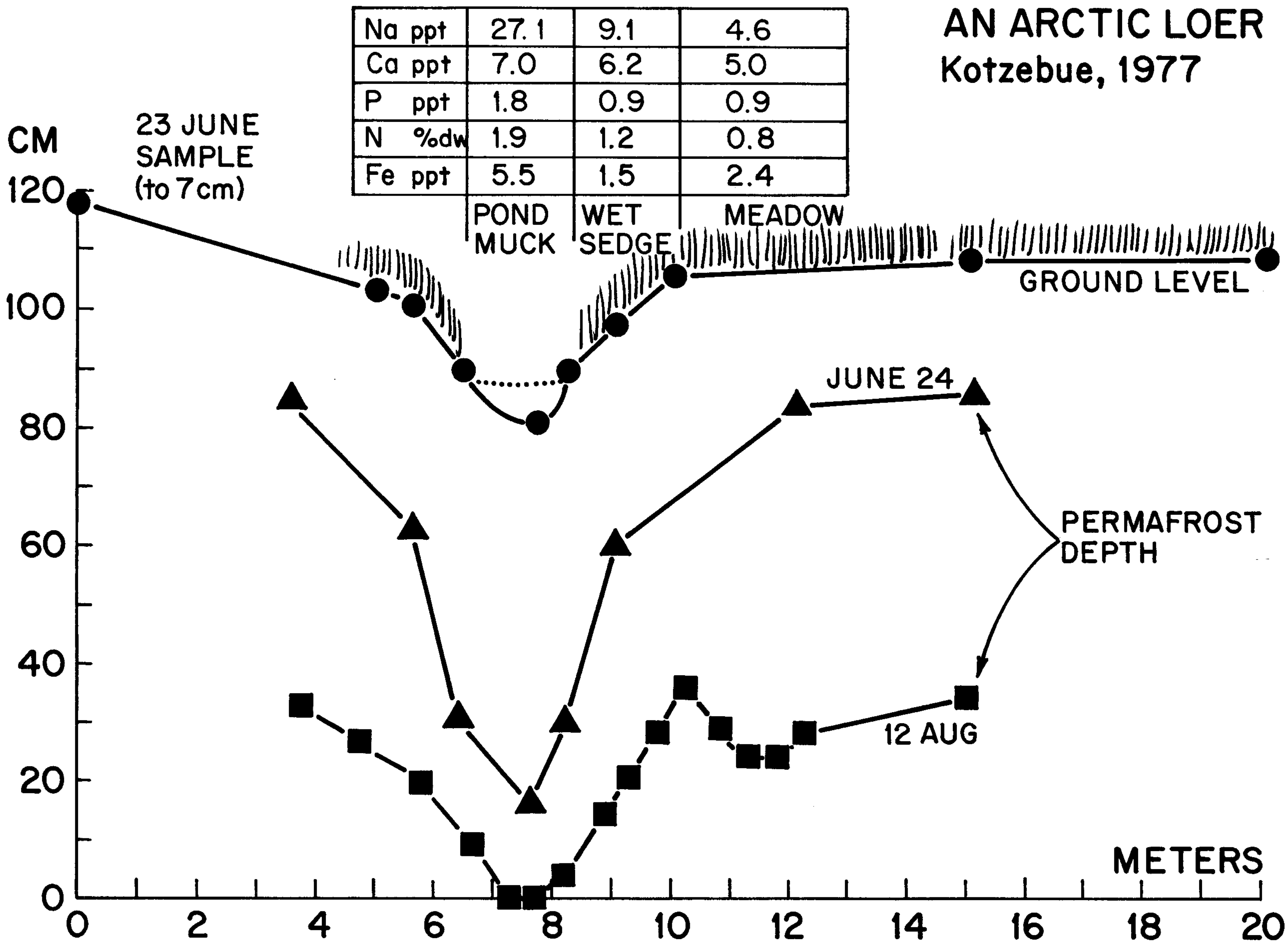

FOOD WEB
TROPHIC RETICULUM
ARCTIC SALT-MARSHES
FOXES, JAEGERS, OWLS
PASSERINE BIRDS
CRANES, GULLS, TERNS
SALDID BUGS
FISH
SPIDERS
PREDATORY FLIES
SHORE BIRDS SOME DUCKS
HUMANS
SNAILS IN THE SOUTH
ADULTS
LEAF HOPPERS APHIDS, MITES
COLLEMBOLIDS
CRUSTACEANS
DIPTERAN LARVAE
CARIBOU
GEESE, BRANT
OCHEROUS PRECIPITATE
O_2
DECAY, Fe^{++}
S=OXIDIZERS
HIGHER PLANTS ON MEADOW
ALGAE, PROTOZOANS, ROTIFERS, etc.
PLANKTON ALGAE, AND PARTICULATES
MEADOWS
POND: MARGINS
BENTHOS
PLANKTON

FIGURE 2

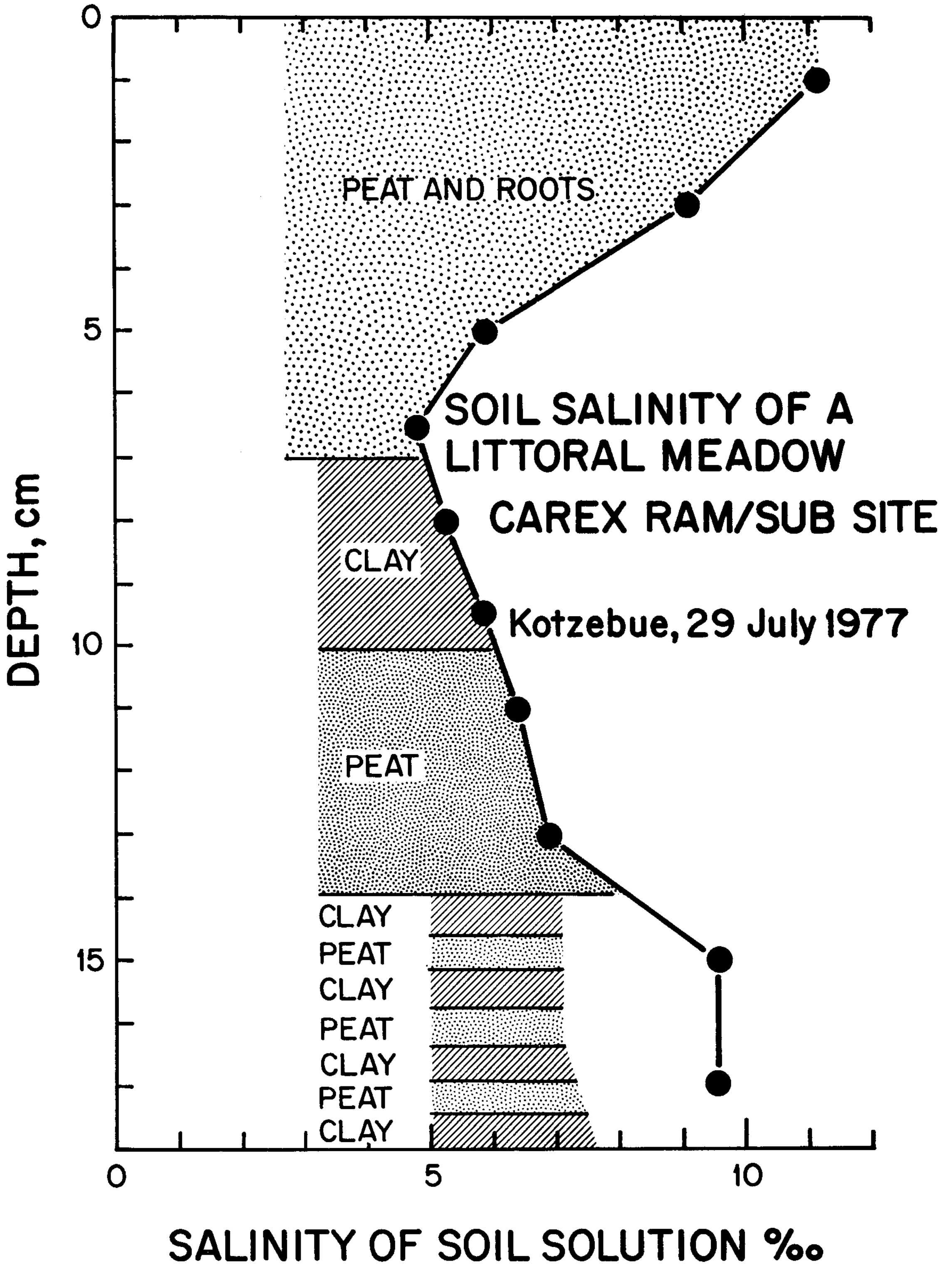
Altitude and summer permafrost depths at a small salt marsh pond (loer) on the Baldwin Penninsula, south of Kotzebue, Alaska. Note the dip of permafrost under the pond. Two factors contribute to this: the pond is of lower reflectance than the adjacent meadow turf and is not blanketed with a mat of grass; consequently it is warmer and begins melting earlier. Also, apparently because of the permafrost slope, salts are forced to migrate pond-ward by the freeze-out processes in autumn during the downward reach of ice into the ground. Soil analyses confirm increases in important minerals at the pond margin and center. The *Carex ramenskii/subspathacea* which surrounds the pond is greener and taller in the ring bordering the pond; it stops abruptly as the soil salinity rises. Some ponds may have a narrow ring of *Puccinellia phryganodes* within the *Carex*, thereby showing the same sequence found in the seaward hydrarch series.



Na ppt	27.1	9.1	4.6
Ca ppt	7.0	6.2	5.0
P ppt	1.8	0.9	0.9
N %dw	1.9	1.2	0.8
Fe ppt	5.5	1.5	2.4
	POND MUCK	WET SEDGE	MEADOW

FIGURE 3

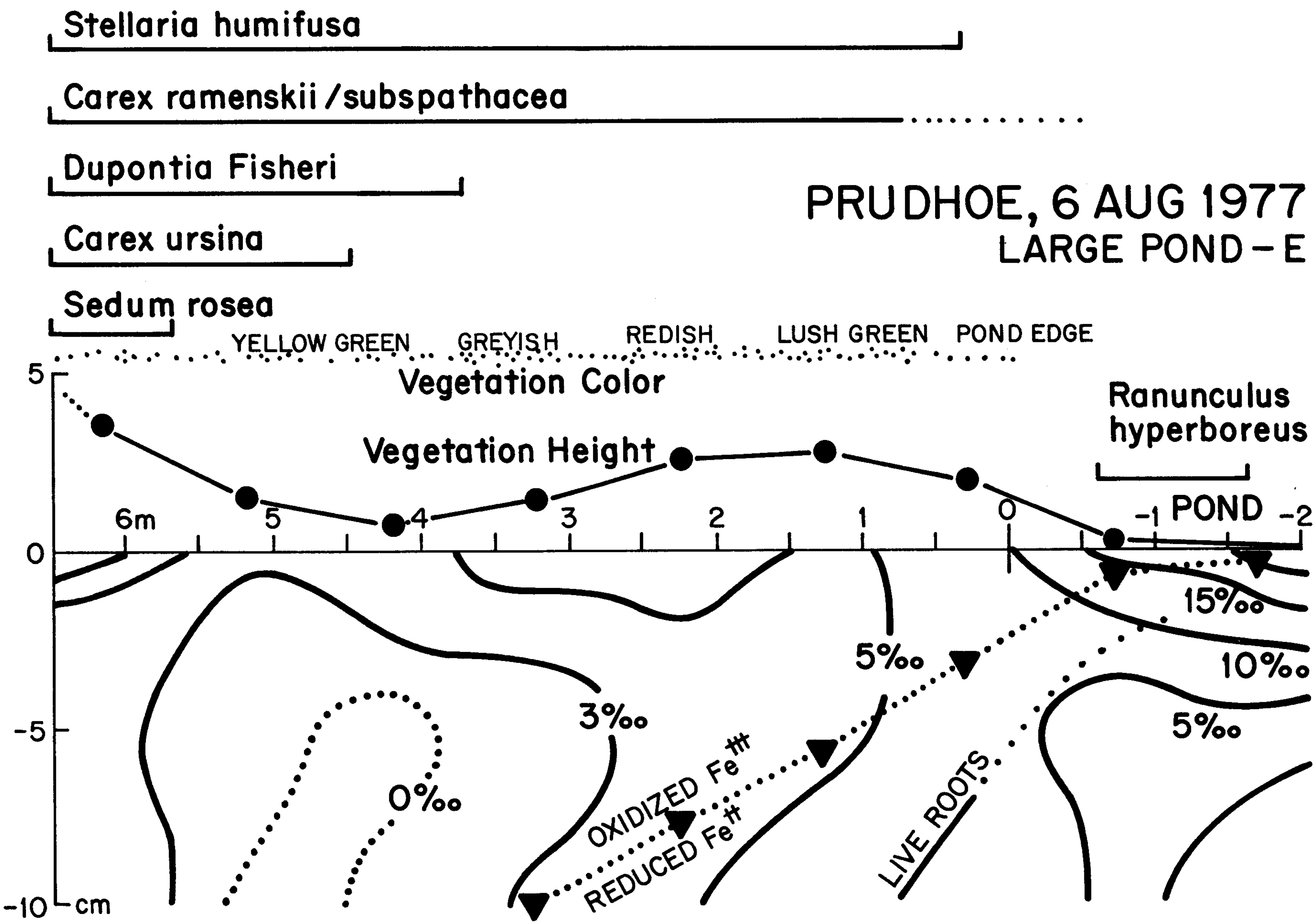
Salinity of soil solution and composition in a profile from a littoral meadow south of Kotzebue on the Baldwin Penninsula, Alaska. The decrease in salinity in the peaty upper layer may result from evapotranspiration in the active surface layer above the first clay stratum. The water below the uppermost clay layer is presumably less mobile.



SOIL SALINITY OF A LITTORAL MEADOW
CAREX RAM/SUB SITE
Kotzebue, 29 July 1977
PEAT AND ROOTS
CLAY
PEAT
CLAY
PEAT
CLAY
PEAT
CLAY
PEAT
CLAY
DEPTH, cm
0
5
10
15
0
5
10
SALINITY OF SOIL SOLUTION ‰

FIGURE 4

Soil solution salinity and vegetation between a drained ridge topped with Elymus arenarius and a pond; the marsh is at the mouth of the Put' River, Prudhoe Bay. Note the high salinity of the pond surface and the zone of reduced iron which rises to within a few millimeters of the surface. Live roots enter the reduced zone, sometimes showing characteristic ocherous coatings of local oxidation. Note also the high salinity at the ridge top to the left. The altitude difference from left to right is about 3.5 cm.


Stellaria humifusa
Carex ramenskii /subspathacea
Dupontia Fisheri
Carex ursina
Sedum rosea
PRUDHOE, 6 AUG 1977
LARGE POND - E
YELLOW GREEN
GREYISH
REDISH
LUSH GREEN
POND EDGE
Vegetation Color
Ranunculus hyperboreus
Vegetation Height
POND
6m
5
4
3
2
1
0
-1
-2
5
0
-5
-10
cm
15‰
10‰
5‰
5‰
3‰
0‰
OXIDIZED Fe+++
REDUCED Fe++
LIVE ROOTS

Preliminary Investigations of Trophic Relationships of the Arctic Shallow Water Marine Ecosystem

D. E. Schneider and Helmut Koch

Fecal Pellet and Gut Contents

One of our major approaches to investigating trophic relationships of the shallow water community was to examine the fecal pellets and gut contents of a number of the more common animals. Fifteen species were investigated by examining a total of 74 fecal pellets and 34 gut contents. The procedure followed in these observations was to place a single fecal pellet on a slide and to tease the contents apart as uniformly as possible. The preparation was then covered with a coverslip and examined with a compound microscope, usually at 400X. Thirty-eight of the fecal pellets were examined using a standardized procedure in which 4 complete non-overlapping traverses were made of the coverslip at 400X. Identifiable structures seen in these traverses were enumerated. Following this, the entire slide was examined at 100X to note any structures not seen in the traverses. For the remaining 36 fecal pellets, a complete qualitative examination of the preparation was made and the types of structures seen were described. However, only a subjective estimate of relative abundance was made for some of the more common items. Gut contents were examined by dissecting out the gut and spreading the contents on a slide as uniformly as possible. For many of the amphipods separate records were made of the contents of the fore-, mid-, and hindguts.

A summary of the qualitative results of the fecal pellet and gut content analysis is presented in Table 29. Results of the quantitative counts using the standard observation procedure are presented in Figs. 5 and 6.

It is evident from the above investigations that very few of the species examined are food specialists. Almost all of the amphipods and isopods examined appeared to be quite omnivorous, feeding on diatoms, filamentous algae, vascular plant (peat) fragments, and small crustaceans. The differences between species appear to be mainly quantitative in that a few species such as *Gammarus setosa* and *Acanthostepheia behringiensis* seem to concentrate heavily on diatoms, while *Onisimus glacialis* seemed to consume a high proportion of small crustaceans. Of the four polychaetes studied, only the data of *Terebellides stroemi* are extensive enough to permit some tentative conclusions. This species, which is very common at depths of around 2 meters in Elson Lagoon, is apparently a deposit feeder probably using its tentacles to entrap surface dwelling diatoms and recently settled detritus.

One striking feature of our observations was that there appear to be seasonal shifts in food preference. In early to mid July when we first began observations of fecal pellets, many of the diatoms that were being consumed by amphipods were planktonic forms such as *Thalassiosira nordenskioeldii* and *Chaetoceros sp.* Examination of plankton filtered from sea water taken off the NARL beach at this time indicated large numbers of these planktonic diatoms were present. During the last week

TABLE 29: TOTAL NUMBER OF FECAL PELLETS AND GUTS EXAMINED FOR EACH SPECIES. THE NUMBER IN PARENTHESES IS THE NUMBER OF QUANTITATIVE EXAMINATIONS MADE.

Species	Fecal Pellets		Gut Contents
Gammarus setosa	26	(18)	20
Onisimus littoralis (NARL beach)	4		
Onisimus glacialis (Elson Lagoon)	11	(10)	6
Acanthostepheia behringiensis	4		2
Gammaracanthus loricata	2		3
Apherusa glacialis	4	(4)	
Weyprechtia pinguis ?	1		
Saduria entomon	5	(1)	
Pagurus trigonochirus	5		
Terebellides stroemi	6	(5)	
Pectinaria granulosa			1
Anaitides groenlandica	1		
Harmothoe sp. ?	1		
Cylichna oculata	2		
Myoxocephalus quadricornis	2		2
Totals	74	(38)	34

TABLE 30: IDENTIFIABLE COMPONENTS OF GUT CONTENTS AND FECAL PELLETS OF SELECTED ANIMALS OF THE BEAUFORT SEA LITTORAL ZONE. X = PRESENT: XX = MAJOR IDENTIFIABLE COMPONENT: U = PRESENT BUT UNDIGESTED.

Species	(n) gut contents	(n) fecal pellets	Diatoms (mostly Centrales)	Amphipleura rutilans (Pennales)	Crustacean parts	Peat fragments	Wood fibers	Algal filaments	Polychaete setae	Oligochaete setae	Foraminifera	Blue-green algae
Gammarus setosa	20	26	XX	X	X	X	X	X	X	X	X	
Onisimus glacialis	6	11	X		XX	X	X	X	X	X		
Onisimus littoralis		4	X		X	X	X			X		
Acanthostepheia behringiensis	2	4	XX		X				X			
Gammaracanthus loricata	3	2	X	XX	X	X		U				
Apherusa glacialis		4	X		XX	X						
Saduria entomon		5	U	U	X	X	X	X				U
Pagurus trigonochirus		5	X		XX							
Terebellides stroemi		6	XX	X	X	X	X	X				
Cylichna oculate		2	X				X					
Myoxocephalus quadricornis	2	2	U		XX							

Figure 5 - Mean number and frequency of occurrence of identifiable component structures in three entire fecal pellets from *Gammarus setosa* individuals from the NARL beach (Chukchi shore). The pellets were 1.1mm x 0.28mm (mean length and diameter).

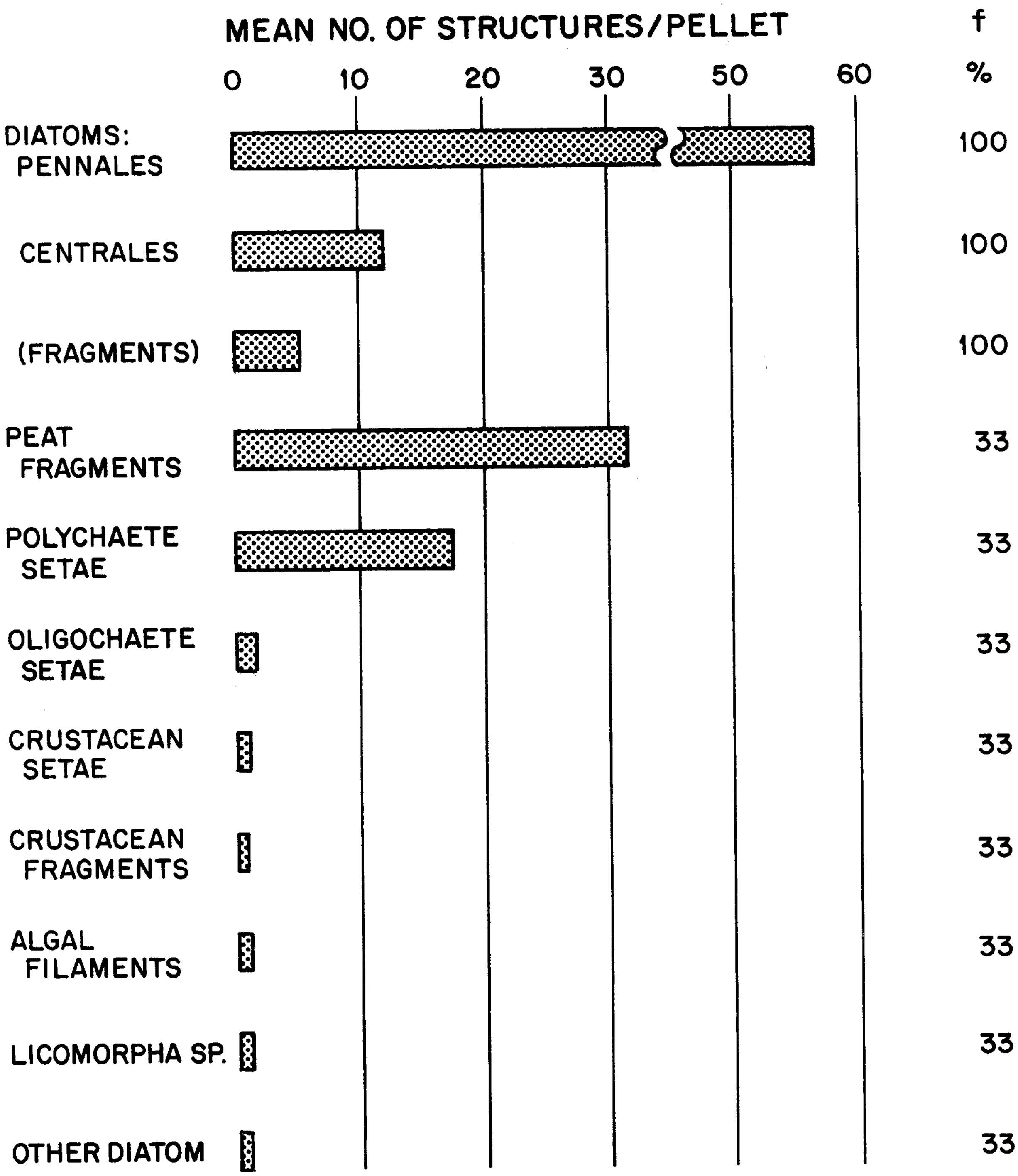
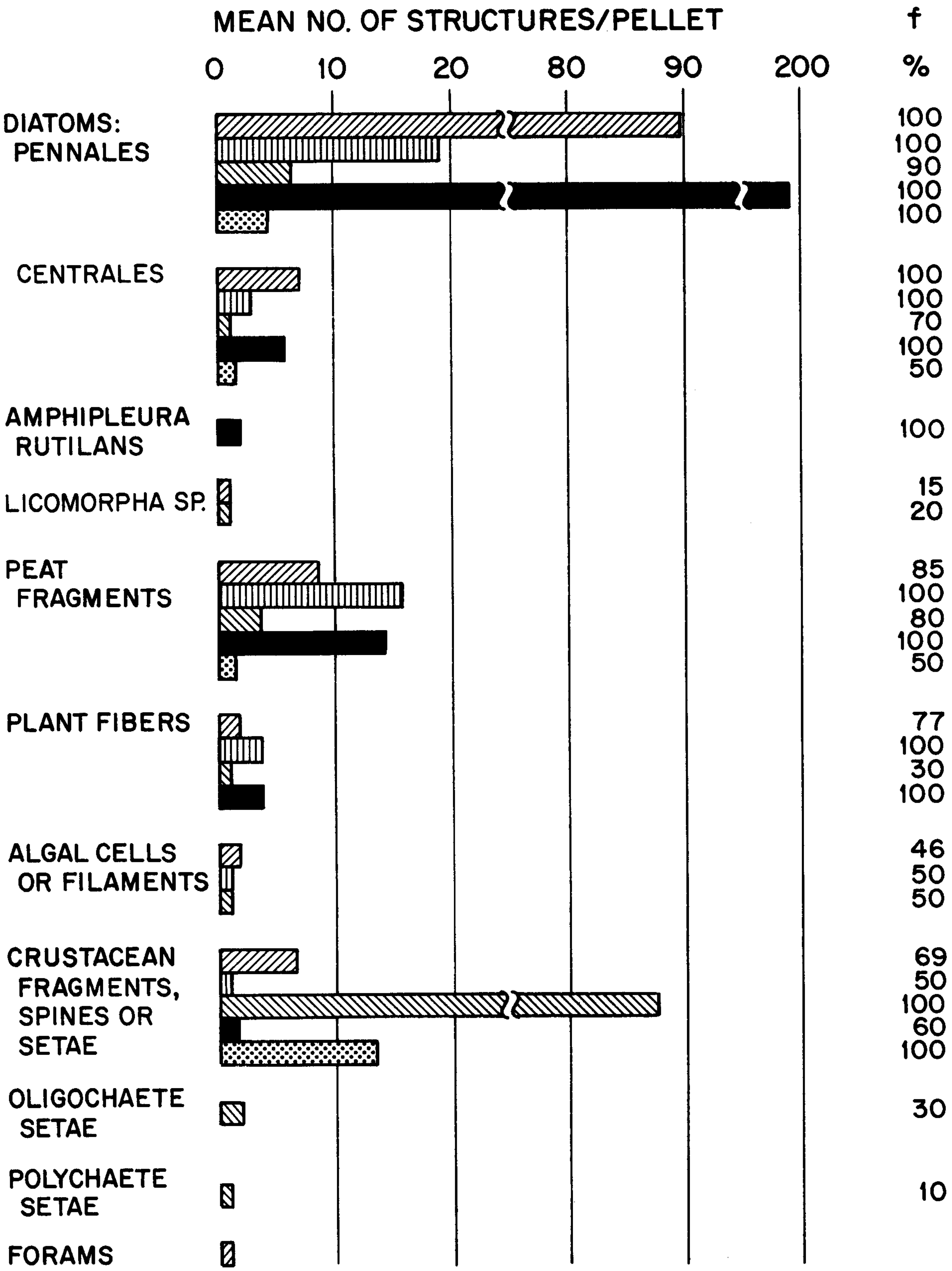

MEAN NO. OF STRUCTURES/PELLET
f
%
0
10
20
30
50
60
DIATOMS: PENNALES
100
CENTRALES
100
(FRAGMENTS)
100
PEAT FRAGMENTS
33
POLYCHAETE SETAE
33
OLIGOCHAETE SETAE
33
CRUSTACEAN SETAE
33
CRUSTACEAN FRAGMENTS
33
ALGAL FILAMENTS
33
LICOMORPHA SP.
33
OTHER DIATOM
33

FIGURE 6 : Occurrence of identifiable component structures in fecal pellets of selected animals from the Beaufort Sea littoral zone. Counts on which mean numbers are based were determined from four transects at 400X of slides on which pellets had been smeared (see text). Percent figures give the frequency (f) with which given component structures occur in fecal pellets of particular speices.

- (diagonal hatching) *Gammarus setosa* from the Chukchi Sea shore at NARL; N = 13
- (vertical lines) *Gammarus setosa* from Elson Lagoon (Whalebone Spit) north of NARL; N = 2
- (reverse diagonal hatching) *Onisimus litoralis* from Elson Lagoon (Whalebone Spit); N = 10
- (solid black) *Terebellides stroemi* from Elson Lagoon near Whalebone Spit; N = 5.
- (stippled) *Apherusa glacialis* from the Chukchi Sea shore at NARL; N = 4.



MEAN NO. OF STRUCTURES/PELLET
f
%
0
10
20
80
90
200
DIATOMS:
PENNALES
100
100
90
100
100
CENTRALES
100
100
70
100
50
AMPHIPLEURA
RUTILANS
100
LICOMORPHA SP.
15
20
PEAT
FRAGMENTS
85
100
80
100
50
PLANT FIBERS
77
100
30
100
ALGAL CELLS
OR FILAMENTS
46
50
50
CRUSTACEAN
FRAGMENTS,
SPINES OR
SETAE
69
50
100
60
100
OLIGOCHAETE
SETAE
30
POLYCHAETE
SETAE
10
FORAMS

of July we noted a striking decrease in the abundance of diatoms, particularly the planktonic forms, in the amphipod fecal pellets. Of the diatoms present, benthic forms such as *Amphipleura rutilans* and a number of solitary pennates seemed to increase in these later pellets. It is also our impression that the frequency of occurance of animal parts in the pellets increased later in the season. These apparent shifts in food preference are, of course, likely to reflect changes in availability of food items. Seasonal peaks of microalgae production are well documented in the Barrow vicinity. Matheke and Horner (1974) report an early bloom of ice algae in May followed by a plankton bloom just before breakup of the ice in early June, and then a rather substantial production peak of benthic microalgae in mid to late July. Although the timing of this sequence may have been different during 1977 from that in 1972 when their study was conducted, a similar pattern was probably operative during our study.

Feeding Experiments

A number of simple feeding experiments were set up by placing a predator along with a potential prey organism in a pint plastic freezer container filled with filtered sea water. A summary of these experiments along with their outcome is presented in Table 30. Most of the combinations listed represent only a single experiment therefore a negative result should not be taken as conclusive proof that the prey item is not consumed. It is evident that pieces of free floating *Laminaria* can be used by *Gammarus setosa* (both adults and juveniles were tested). Although *Saduria* and *Pagurus* did consume *Laminaria*, it is felt that due to the slow consumption of the sample offered, this is not an important food source. This is particularly true of *Pagurus*. Peat was only actively ingested by *Gammaracanthus* in this series of experiments; however, in other experiments we have shown that *Gammarus setosa*, juvenile *Saduria entomon* and perhaps mysids also consume substantial amounts of this material. *Nephtys* and oligochaetes are readily consumed by most of the predators tested. The failure of the sculpin to eat Nephtys is perhaps somewhat of an artifact as the refrigerator in which this experiment was set up malfunctioned and the sculpin died after about 24 hours. Considering the abundance of oligochaetes in peat rich sediments, these worms may be an important food source for a number of the shallow water animals. Mysids are probably fast enough in their escape maneuvers to avoid slower predators such as amphipods, but not sculpins.

Substrate Choice Experiment

Several experiments were set up in which *Gammarus setosa* was offered a choice of several food or substrate types. Behavioral association with the particular food type (usually some form of peat) could suggest its relative usefulness as a nutritional source.

A series of two-choice experiments was set up using fresh peat, autoclaved peat, and shreded Kimwipes. A small clear plastic box was partially divided into two chambers by cementing a piece of plastic ruler in the center of the box. Each box was filled with one liter of

TABLE 30: FOOD INGESTED BY SELECTED BEAUFORT SEA LITTORAL ANIMALS IN LABORATORY CULTURE. + = FOOD EATEN; 0 = FOOD NOT EATEN.

Predator \ Prey (food offered)	Peat	Laminaria	Nephtys (polychaete)	Oligochaete	Mysis	Mysis (dead)	Gammarus	Gammarus (dead)	Onisimus	Amphipod (dead)	Acanthostepheia
Gammarus setosa	+	+		+	0	+					
Onisimus sp.	+		+	+							
Gammaracanthus loricata	+		+	+							
Acanthostepheia behringiensis			+	+							
Saduria entomon		+	+	+			+		0	+	
Pagurus sp.		+					+				+
Harmothae sp. (polychaete)				0							
Myoxocephalus quadricornis	0		0	+	+		+	+			

millipore filtered sea water and two grams of peat or Kimwipes was introduced into each compartment. Ten Gammarus, five in each compartment, were introduced into each setup. A total of 30 readings of the distribution of amphipods was made over a four day period. The results are shown in Table 31 as the mean number of amphipods occupying each compartment. It is evident that the Kimwipes were preferred over the natural substrates. Unfortunately the Kimwipe shreds were larger than the peat fragments and this may have somehow influenced the distribution pattern. Of the two more natural substrates, fresh peat was preferred over autoclaved peat. Whether this indicates that fresh peat is a better food source is an open question. One cannot rule out the possibility that autoclaving has caused the release of some substance that is not attractive to the amphipods.

The second choice experiment allowed four choices: gravel, fresh peat, shreded Kimwipes, or neutral area. The setup is shown in Table 31. The gravel used was that retained on a 0.98mm screen, the fresh peat was screened to a fraction of 1 - 2mm size, and the box was filled with sea water filtered through Whatman #5 paper. Eight Gammarus setosa were introduced into the neutral area and a total of 20 readings were taken over a three day period. The results shown in Table 31 indicate the greatest preference for Kimwipes, fresh peat 2nd, gravel 3rd, and neutral area least favorable. Again, there is some suggestion for peat being favored as a natural substrate.

The third choice experiment allowed five choices among coarse or fine fractions of both autoclaved and fresh peat plus a neutral area. The setup and results are shown in Table 31. This experiment was not satisfactory in that the most favored resting location for amphipods was on the edges of the Petri dishes where they were scored as being in the neutral area. Even with this problem there is a slight indication that fresh peat is favored over autoclaved peat. The above experiments, although they do not prove much about the nutritive value of peat, suggest that fresh peat is not an unfavorable substrate for Gammarus setosa.

The Role of Peat as a Nutritional Source

Peat Particle Size Reduction Experiment

Several long-term culture experiments were set up in an attempt to assess the role of peat as a nutritional source for the shallow water community. The first question we dealt with was whether any of the common organisms are capable of ingesting and reducing the particle size of peat that enters the marine ecosystem from the tundra.

Methods. A series of cultures was set up in pint plastic freezer containers containing 300 ml of filtered sea water and 015 gm wet weight of peat. Peat was obtained in shallow water at Whalebone Spit on the Elson Lagoon side of the Barrow Spit. Before use in this experiment the peat was wet sieved and the fraction falling between 1-2.5mm was used for the cultures. Two peat treatments were used, autoclaved peat to insure that no organisms were initially associated with the peat, and fresh peat

TABLE 31: SUBSTRATE CHOICE EXPERIMENTS - <u>Gammarus setosa</u>

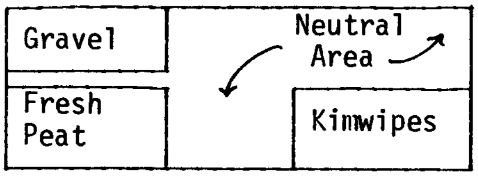
A

Choice	Auto-claved Peat : Fresh Peat	Kim-wipes : Fresh Peat	Kim-wipes : Auto-claved Peat	Fresh Peat : Fresh Peat	Auto-claved peat : Auto-claved peat
Mean no. per chamber	3.60 : 6.40	7.33 : 2.67	8.33 : 1.67	4.53 : 5.47	5.53 : 4.47

B

Choice	Gravel	Fresh Peat	Kimwipes	Neutral Area
Mean no. per area	1.40	2.25	4.25	0.10

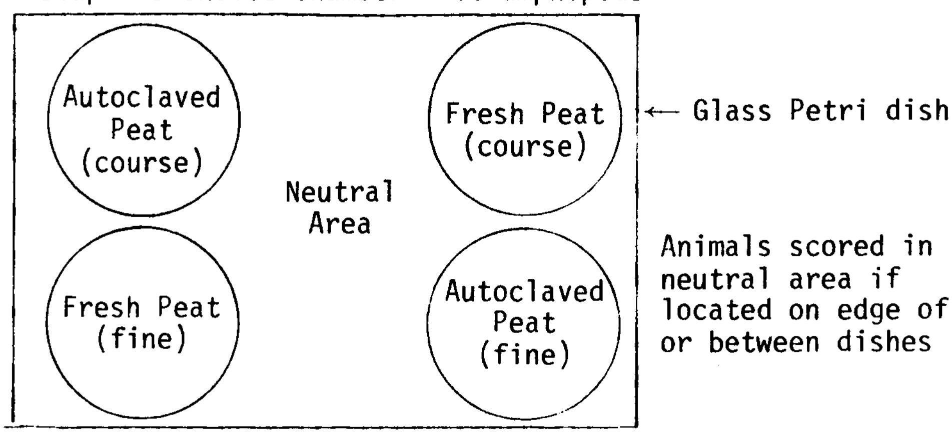
Setup - 4 Choice Chamber - 8 amphipods



C

Choice	Fresh Peat (1-2mm)	Autoclaved Peat (1-2mm)	Fresh Peat (>2.4mm)	Autoclaved Peat (>2.4mm)	Neutral Area
Mean no. per area	0.45	0.15	1.25	0.40	7.75

Setup - 5 Choice Chamber - 10 amphipods



that had the macroscopic animals removed. Four replicates of the following cultures were set up using each of these peat treatments:

1) No animals, Millipore filtered sea water, 10 μg/ml tetracycline
2) No animals, Whatman #5 filtered sea water
3) No animals, 0.2mm filtered sea water
4) Gammarus setosa, 0.2mm filtered sea water
5) Onisimus glacialis, 0.2mm filtered sea water
6) Saduria entomon, 0.2mm filtered sea water
7) Oligochaetes, 0.2mm filtered sea water
8) Mysids, 0.2mm filtered sea water

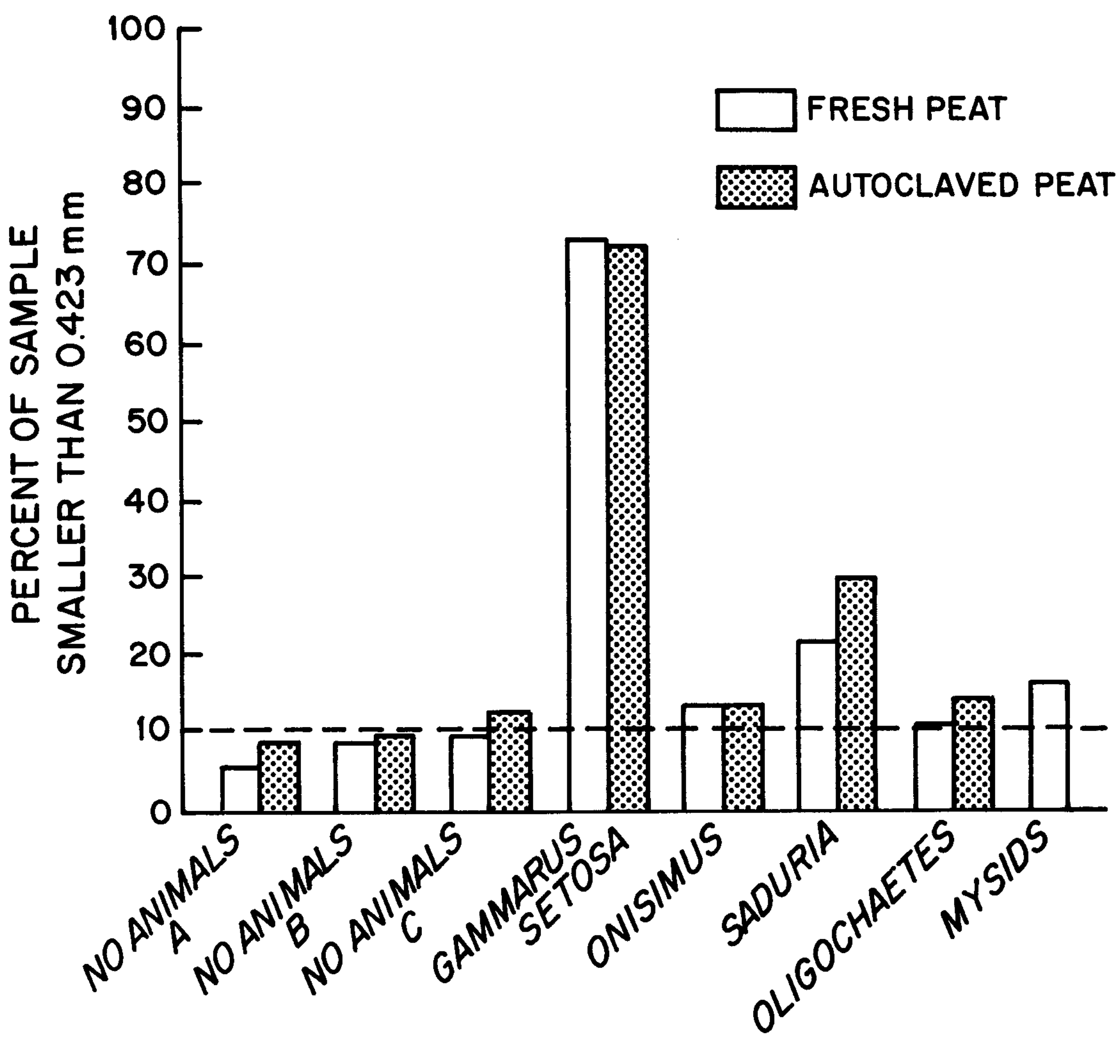
Treatment no. 1 using autoclaved peat should be devoid of all organisms and the antibiotic should prevent bacterial reinvasion. In the fresh peat version of treatment no. 1, bacteria would be supressed but fungi and algae would survive. Treatment no. 2 using autoclaved peat would initially destroy all organisms but would permit reinvasion by bacteria and perhaps fungi. The fresh peat version of treatment no. 2 would retain the normal assemblage of microorganisms associated with the peat. Treatment no. 3 using autoclaved peat would permit reinvasion of the sterilized peat by algae as well as bacteria and fungi. The fresh peat version of treatment no. 3 would retain the normal assemblage of microorganisms. These cultures that received animals were set up with the following number of individuals in each replicate: Gammarus and Onisimus, 5; Saduria, 1 large specimen in each of 3 replicates and 3 small individuals in the fourth replicate; Oligochaetes, 10; Mysids, 6.

The cultures were allowed to run for varying lengths of time due to problems with availability of some species. The cultures containing Gammarus, Onisimus, and mysids ran for 14 days. The Saduria and oligochaete cultures were terminated after 15 and 25 days respectively. The "no animal" cultures were terminated after 28 days. Upon termination of the cultures, the animals were removed and their wet weight was determined. The peat was then fractionated by a standardized sieving process into three fractions: A) >1.05mm, B) 1.05 - 0.423mm, and C) <0.423mm. The sieving was carried out in 2.5 inch diameter nitex sieves using 10 vertical strokes followed by about 5 horizontal strokes to disperse the peat across the screen. This sequence was repeated until a total of 50 vertical strokes had been made. The three fractions were collected on dried and preweighed filter paper using a Buchner funnel, rinsed with distilled water and dried at 100°C for 48 hours. Dry weight of each fraction was then determined.

Results and Discussion. The results of the above experiment are summarized in Fig. 7 which shows the percent of the peat samples that was contained in fraction C (<0.423mm). The treatments fall into two obvious categories, water treatments (1-3) and the type of animal present (3-8). For purposes of statistical analysis these two categories were considered separately.

The water treatments comprise a 2 x 3 factorial experiment with two levels of peat treatment (fresh vs. autoclaved) and three levels of water treatment (millipore filtered + 10μg/ml tetracycline, Whatman #5 filtered, and 0.2mm filtered). A two factor analysis of variance (ANOVA) indicates

Figure 7: Reduction of peat by selected Beaufort Sea littoral animals. The vertical bars represent the proportion of a peat sample that will pass through a 0.423mm filter after exposure to animals listed on the base line. Treatment A is millipore filtered sea water to which tetracycline has been added. Treatment B is Whatman No. 5 filtered sea water. Treatment C is sea water filtered through a 0.2mm screen.


PERCENT OF SAMPLE SMALLER THAN 0.423 mm
100
90
80
70
60
50
40
30
20
10
0
FRESH PEAT
AUTOCLAVED PEAT
NO ANIMALS A
NO ANIMALS B
NO ANIMALS C
GAMMARUS SETOSA
ONISIMUS
SADURIA
OLIGOCHAETES
MYSIDS

that the main effects for both treatments are significant ($p<.01$) but that the interaction is not significant ($p>.25$).

A Newman-Kuels test was run to determine the pattern of significance between means and the results are shown in Table 32.

Table 32: Mean percent of peat in fraction C. MF - Millipore filtered + 10μg/ml tetracycline, W#5 - Whatman #5 filtered, 0.2mm - screened through 0.2mm seive. Means that are not significantly different ($p>.05$) by a Newman-Kuels test are underlined.

	MF	W#5	0.2mm
Fresh	6.1	8.3	9.4
Autoclaved	9.2	9.3	12.5

Cultures receiving Millipore filtered sea water + tetracycline consistently had the smallest percent of the sample in fraction C and these values were always significantly different from those of the cultures receiving 0.2mm filtered sea water. Although statistical significance is shown in this experiment it is difficult to interpret these results as having ecological significance. First, the differences between all treatment groups is small and it is clear that rather little of the peat is broken down into this size fraction in the absence of larger animals. Second, the fresh peat cultured in Millipore filtered water has a suspiciously low percent of particles in fraction C. Other experiments suggest that the expected initial amount of the sample in fraction C ranges from 9-11 percent. As a result interpretation of the reduction in peat particle size in the absence of macroscopic animals should await further experimentation.

The animal treatments portion of the experiment was analyzed with a single factor ANOVA for each of the two peat treatment groups. For both fresh and autoclaved peat treatments there was a highly significant effect of animals on the appearance of peat particles in fraction C (p essentially 0 in each case). Newman-Kuels tests were run to determine the pattern of significance between means and these results are presented in Table 33. It is obvious that Gammarus setosa caused a striking reduction in peat particl

Table 33: Mean percent of peat in fraction C. Means that are shown not to be significantly different ($p>.05$) by a Newman-Kuels test are underlined.

Fresh Peat

Treatment	No Animals (0.2mm filt.)	Oligochaetes	Onisimus	Mysids	Saduria	Gammarus
Mean	9.4	11.3	13.1	16.2	21.1	71.6

Table 33, continued

Treatment	Autoclaved Peat No Animals (0.2mm filt.)	Onisimus	Oligochaetes	Saduria	Gammarus
Mean	12.5	13.5	13.9	29.6	70.6

size. In two weeks the amount falling into fraction C increased from about 9 to over 70 percent. This effect was obvious to even the casual observer as a fine flocculent material accumulated in these cultures and the larger pieces disappeared. Microscopic examination of the flocculent material indicated it was composed primarily of small pieces of vascular plant and moss tissue that had passed through the guts of the Gammarus. Of the other species tested, only Saduria entomon demonstrated an ability to reduce peat to smaller fragments. For both peat treatments, the Saduria cultures had a significantly higher proportion in fraction C than the "No Animal" controls. All other cultures were not significantly different from the control group, indicating that Onisimus, oligochaetes and mysids are not effective in breaking down peat into smaller particles. The mysids probably warrant further study though, as a fine flocculent sediment was beginning to form in their cultures when they were terminated.

A two factor ANOVA was run on the animal treatment portion of the experiment to see if autoclaving had an effect on the distribution of particles in fraction C. The mysids were omitted from this analysis since they were not tested with autoclaved peat. The analysis indicated that the main effect for peat treatment was not significant ($p>0.1$) and the interaction between peat and animal treatments was not significant ($p>.25$).

Effect of Autoclaving on Peat Particle Size

Autoclaving was shown to significantly influence peat particle size distribution in the water treatment portion of the preceeding experiment. In view of this, it is important to determine whether autoclaving directly alters the particle size distribution. The following experiment was set up to examine this question. Six samples, 0.5 gm wet weight, of fresh and autoclaved peat from the same source used in the above experiment were suspended in sea water and immediately fractionated by the standard sieving procedure described above. The dry weights were determined for each fraction and these are presented in Table 34 as the percent of the sample falling into each fraction.

Table 34: Effect of autoclaving on peat particle size distribution. The mean percent of the sample falling into each fraction is shown.

Treatment	A (>1.05mm)	B (1.05 - 0.423mm)	C (<0.423mm)
Fresh Peat	58.11	30.82	11.07
Autoclaved Peat	62.25	26.53	11.23

T-tests were run to compare the differences between the means for each fraction. Autoclaving significantly increases the percent of the sample falling into fraction A (p=.039), decreases that falling into fraction B (p=.013), and does not significantly alter the percent falling into fraction C (p=.752). This effect was noticable while working with the autoclaved peat cultures in that there was a tendency for the larger particles to stick together. Since our analyses have been confined to the fraction C data it is concluded that autoclaving is an acceptable procedure for sterilization of peat in these experiments.

Gammarus Growth Experiment

A second long-term experiment was set up to attempt to determine if *Gammarus setosa* is capable of growing with peat as its only food source. Two peat treatments and three water treatments were combined as follows to attempt to control the composition of living microorganisms in the peat offered to the amphipods:

1) Fresh peat, Whatman #5 filtered sea water
2) Fresh peat, Whatman #5 filtered sea water, 10 μg/ml tetracycline
3) Fresh peat, Millipore filtered sea water, 10 μg/ml tetracycline
4) Autoclaved peat, Whatman #5 filtered sea water
5) Autoclaved peat, Whatman #5 filtered sea water, 10 μg/ml tetracycline
6) Autoclaved peat, Millipore filtered sea water, 10 μg/ml tetracycline

Treatment no. 1 should have the normal complement of microorganisms while treatments nos. 2 and 3 should have the bacteria supressed but the fungi and algae normal. Treatment no. 4 should allow reinvasion of bacteria and fungi but have no living algae. Treatment no. 5 may allow reinvasion of fungi but not algae and treatment no. 6 should be completely devoid of living organisms.

The cultures were set up in pint plastic freezer boxes containg about 300 ml of the appropriate sea water. To each box 1.00 gm wet weight of the appropriate peat and five preweighed *Gammarus setosa* were added. Five replicates of each treatment were set up. The cultures were kept in a refrigerator set at about 7°C and under constant illumination from a small fluorescent light placed on the shelf above the culture boxes. The cultures were examined daily to record molt activity. After about two weeks, the amphipods had so thoroughly reduced the particle size of the peat that it was necessary to recharge the cultures with a fresh batch of peat. The fresh and autoclaved peat treatments were broken down on day 16 and 17 respectively. The animals were transferred to freshly prepared sea water solutions and peat. The original peat samples were fractionated for dry weight analysis using the standard procedure described in the first experiment. The recharged cultures were maintained for an additional 12 days before the experiment was terminated. At this time the animals were removed, rapidly blotted and weighed to the nearest 0.1 mg to determine the weight change over the experimental period. The second batch of peat samples were fractionated for dry weight analysis using the standard sieving procedure.

The results on growth rates for this experiment were disappointing as a considerable problem with cannibalism was experienced whenever an animal molted. Since only a single combined initial animal wet weight for each replicate was available, any losses meant that the replicate became unuseable. Clearly the experiment should have been set up with only one animal per culture dish. Almost all of the deaths recorded in each culture were probably associated with a molt. Frequently molt fragments were found when an animal was missing. If we assume that all deaths indicate that a molt had taken place, then the records give some idea of the molt activity in each treatment. These data are presented in Table35. Molt activity was not high in any of the treatments considering that there were 25 animals per treatment. The differences in apparent molt activity do not appear substantial enough to conclude that any of the treatments had a significant effect. In those cultures that did not experience any mortality, the weight changes can be used and these data appear in Table 35. In general the amphipods tended to lose weight, but the weight changes were smal. (2.5% maximum) compared to the average initial weight (0.462 gm). These changes are probably close to the limits of error for wet weights of amphipods as it is impossible to blot the animals in an identical manner each time. It should also be noted that these data include only one observed molt and if the other animals that had molted were included there would probably have been a small weight gain for each treatment. We tentatively conclude that although peat is vigorously consumed by Gammarus setosa, it is probably not a very adequate total diet for the amphipod. The natural diet of this species is much more diverse than this and other nutritional sources may be important for high growth rates.

The dry weight analyses for the peat fractions C obtained from the above experiment are also summarized in Table35. These data for the first 16-17 days of the experiment were subjected to a 2 factor ANOVA. The analysis indicated that the main effects of water treatment was not significant ($p>0.25$) but the main effect of peat treatment was significant ($p>0.01$). The interaction between peat treatments and water treatments was not significant ($p>0.25$). This indicates that the fresh peat was more vigorously attacked than the autoclaved peat. Whether this indicates that fresh peat is a more suitable source of nutrition than autoclaved peat cannot be determined from this experiment.

Rate of Peat Particle Size Reduction by Gammarus

The previous experiments, although they demonstrate the ability of Gammarus setosa to reduce the particle size of peat, may not give a good estimate of the rate of this process. The primary reason for this is that the cultures were allowed to run long enough that the availability of suitable fragments may have become limiting. To provide a more reliable estimate of the rate of this process, the following time-course study was set up. Sixteen pint plastic freezer boxes containing 300 ml of 0.2mm filtered sea water and approximately 0.5 gm wet weight of peat were set up. To 12 of these cultures five Gammarus setosa were added per box and the cultures were placed in a refrigerator set at about 7°C under constant illumination. The four replicates without Gammarus (day 0 or control group) were fractionated for dry weight analysis using the

TABLE 35 : GROWTH OF *Gammarus setosa* ON PEAT DIET AND RESULTANT REDUCTION IN PARTICLE SIZE OF PEAT.

Treatment		% of Peat in fract. C (<.423mm) First 16-17 days	% of Peat in fract. C (<.423mm) Last 12 Days	Mean Weight Change, gms. in replicates with no deaths	Apparent Number of Molts
Fresh Peat	Whatman #5 filtered SW	51.9	31.9	-0.0117	2
Fresh Peat	Whatman #5 filtered SW + Tetracycline	52.1	40.2	-0.0059	3
Fresh Peat	Millipore filtered SW + Tetracycline	60.6	42.0	-0.0110	2
Autoclaved Peat	Whatman #5 filtered SW	41.9	36.4	+0.0059	1
Autoclaved Peat	Whatman #5 filtered SW + Tetracycline	41.4	32.2	-0.0044	4
Autoclaved Peat	Millipore filtered SW + Tetracycline	41.1	36.1	-0.0053	1

standard procedure described previously. At days 2, 4, and 8 four boxes were removed and the peat fractionated for dry weight analysis. The change in dry weight from the control (day 0) value for each fraction was calculated for each time interval and expressed as the change per gram wet weight of animal in the culture dish. These weight changes are presented for fraction C in Fig. 8. The rate of production of small particles (fraction C) peaks between 2 and 4 days and declines fairly sharply after day 4. This may indicate that between 4 and 8 days the supply of suitable pieces of peat for ingestion was declining and becoming limiting. The actual rate of production of fraction C particles can be calculated from the values presented in Fig. 8 as the gm peat converted to fraction C/gm amphipod/day. Use of the day 4 value (0.0514 gm peat dry weight/gm animal wet weight) results in an estimated rate of 0.0129 gm peat dry weight/gm animal wet weight/day. This is probably a conservative estimate as the maximum rate appears to occur before day 4. This value can be converted to a wet weight value for the peat using the wet-dry weight conversion factor of 26.47% which was determined for the peat used in this experiment. Applying this conversion we get 0.0487 gm peat wet weight/gm amphipod wet weight/day. That is equivalent to saying that this species can convert nearly 5% of its body weight of peat to the finest fraction per day. Whether this rate is ever achieved in nature is an open question as *Gammarus setosa* is not normally restricted to peat as a food source.

Oxygen Uptake of Peat

Oxygen consumption has been found to be a useful index of aerobic microbial activity which may be presumed to be associated with decomposition processes (Hargrave, 1976). Several experiments were set up in an attempt to assess the microbial activity of peat. In addition to normal oxygen consumption measurements were also made on peat treated with antibiotics and sterilized by autoclaving.

Methods: Oxygen consumption of peat was measured with a Gilson differential respirometer. Peat samples of about 250 mg wet weight were rapidly weighed on a Roller-Smith torsion balance and transferred to 15 ml respirometer flasks. Three ml of Millipore filtered sea water (30°/oo), in some cases with tetracycline in solution, were added to the flasks and 0.2 ml of 20% KOH was added to the center well. The flasks were placed on the instrument and equilibrated in the water bath for at least 30 minutes before readings commenced. All experiments were run at 7°C and the bath was darkened with an aluminum foil cover to prevent algal photosynthesis. Readings were taken at hourly intervals for usually 5 hours. After terminating the run the peat was recoverd for dry weight determination.

Results and Discussion: The results of the oxygen consumption measurements are presented in Table 36. T-tests were run to compare the means of the tetracycline experiments with the fresh peat control. Only the 10μg/ml tetracycline group is significantly different from the control ($p<.003$). The 100μg/ml tetracycline group is not significantly different from either the control ($p=.21$), or the 10μg/ml group ($p=.26$).

The oxygen uptake of fresh peat is substantial suggesting that considerable biological activity is associated with this material. A rate

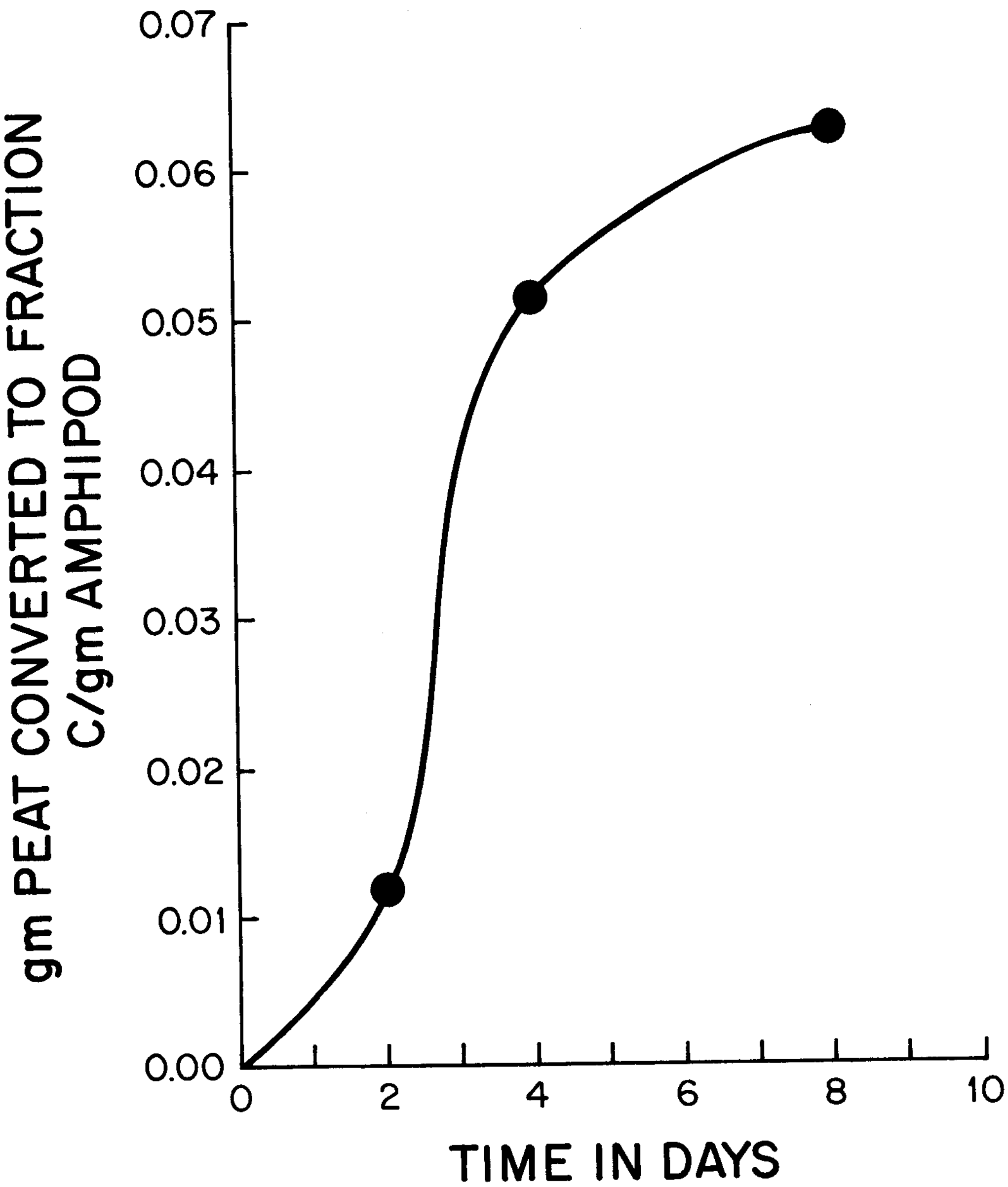


Figure 8: Calculated rate of peat particle reduction by *Gammarus setosa* in a closed system. Fraction C will pass through a 0.423mm screen.

TABLE 36: Oxygen consumption rates of peat expressed as μl O2/gm peat dry weight/hour.

Treatment	μl O_2/gm hr	n
Fresh Peat	99.59	24
10 μg/ml Tetracycline	77.92	9
10 μg/ml Tetracycline	89.62	13
Autoclaved	15.82	9

nearly 100 μl O_2/gm hr on a dry weight basis is perhaps 1/2 to 2/3 what would be expected for an invertebrate run at the same temperature considering that much of the dry weight of peat is composed of non-living material, the level of O_2 consumption is surprising. Tetracycline has only a slight effect on the respiration suggesting that organisms other than bacteria account for most of the respiration. Microscopic examination of the peat shows that there is a substantial population of diatoms and filamentous algae as well as ciliate protozoans. Presumably the bulk of the respiration is from these organisms. The residual respiration after autoclaving is low and may either represent chemical oxidative activity or perhaps contamination by airborne bacteria during transfer of the peat to the flasks. There is some indication in the data that prolonged exposure to tetracycline results in further inhibition of peat respiration. Peat exposed for 7 to 9 days to both 10 and 100 μg/ml tetracycline had a respiration rate approximately 63% that of the untreated peat. The number of replicates for these exposures is small though and further work needs to be done to evaluate this trend. It is not clear whether such a trend represents further inhibition of bacterial respiration or an influence on respiratory activity of other organisms associated with the peat.

Conclusions

Our preliminary work on trophic relationships has established that primary production by planktonic and benthic microalgae is an important energy input for the Arctic shallow water marine ecosystem. Presumably this input is most important during the late spring and summer months, however low populations of viable algal cells apparently remain available even through the winter months (Matheke and Horner, 1974). At least some of the animals in this ecosystem ingest vascular plant and moss fragments (peat) that enter the system from the tundra. Presumably this serves as a secondary energy input, but it is difficult at this time to evaluate the relative importance of primary production and detrital input. Substantial microbial activity is associated with the peat and it seems likely that the larger crustaceans and polychaete worms that ingest peat are actually feeding on these microorganisms. At least, that is the view that has emerged from studies of detritus based systems in temperate zone areas (see Fenchel and Harrison, 1976 and Hargrave, 1976 for reviews).

Literature Cited

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Matheke, G. E. M. and R. Horner, 1974. Primary productivity of the benthic microalgae in the Chukchi Sea near Barrow, Alaska. J. Fish. Res. Board Can. 31: 1779-1786.

IX. Summary of fourth quarter operations:

A. Ship or laboratory activities

1. no field work.

2. Scientific Party (all of Western Washington University)

   a. A. C. Broad, Principal Investigator (half-time)
   b. Helmut Koch, Laboratory Supervisor
   c. Gregg M. Petrie, Computer Programmer (hourly wages)
   d. Laboratory Assistants (hourly wages)
      1) Mark Childers
      2) Jan Chiavario
      3) James Hanes
      4) Scott Morrison
      5) Wendy Pounds
      6) Nancy Sherer
   e. Contract labor
      1) Patricia Jackson
      2) Ken Dunton
   f. Work-study students (provided by University)
      1) Dawn Christman
      2) Mark Rees
      3) John Zehr

3. Methods - see above.

4. Sample localities - none.

5. Data collected or analyzed:

   a. no samples taken
   b. analysis of 1977 Alumiak samples continued and is about 75% complete
   c. no miles of trackline

6. Milestone chart and update:

   a. sorting of samples continues to be a major problem due to the mass of material collected. We are probably six to nine months behind our anticipated reporting dates.

B. Problems encountered:

1. See 6a above. This is a continuing problem to which we have found no solution. Subsampling is not, in our minds, acceptable nor is partial reporting of any value.

2. The number of meetings that have involved the PI has seriously competed for available time.

ANNUAL REPORT

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Beaufort Sea Plankton Studies

Rita A. Horner

31 March 1978

I. Summary of objectives, conclusions and implications with respect to oil and gas development

The objectives of this project are to assess the density distribution and environmental requirements of zooplankton and ichthyoplankton in an array of samples of opportunity and to measure phytoplankton activity.

With some exceptions, the distribution of phytoplankton species is widespread in the Chukchi and Beaufort seas, while the distribution of zooplankton species is influenced by hydrography. Meroplankton are important in the western part of the Beaufort Sea and expatriate species are found when Bering Sea water occurs in the Beaufort Sea. Highest primary productivity occurs below the surface, but generally above 20 m; it is apparently light-limited when ice is present. These conclusions are reasonably firm, but are based only on samples collected in August and September.

Much of the information concerning the distribution and abundance of plankton in the Beaufort Sea in summer needed to assess the impact of oil development is now available, or will be following one more field season. Still needed however, and essentially not available at the present time, is information from other seasons, especially spring. Life history information is not available for many Arctic species and seasonal and annual variations and reasons for the variations are not known. Only a few studies have been done on the effects of oil on truly Arctic species and on species that contribute measureably to the Arctic marine ecosystem.

II. Introduction

A. General nature and scope of study

Phytoplankton and zooplankton are important in the Beaufort Sea ecosystem because they are primary producers and primary and secondary consumers. This project will provide basic information on species present, and the abundance and distribution of organisms recognized as important prey species for birds and mammals. In addition, this study will supply information on the primary productivity of the Beaufort Sea.

B. Specific objectives

The objectives of this project are to assess the density distribution and environmental requirements of zooplankton and ichthyoplankton, and to measure phytoplankton activity.

C. Relevance to problems of petroleum development

The potential for a major oil spill in the Arctic marine environment increases as exploration and drilling continue. The consequences of this kind of disaster to the Arctic marine ecosystem are unknown.

Potential dangers to the plankton community include reduced primary productivity and possible changes in species composition of the phytoplankton community (Fisher 1976, Lee and Takahashi 1977) that might cause changes in zooplankton diversity and therefore affect higher trophic levels. Slow growth and low reproductive rates in the Arctic mean slow recovery following an oil spill. Some life cycle stages, especially larvae, are more susceptible to pollutants than other stages. Thus, if both adults and larvae are destroyed and recruitment from adjacent areas is slow, reestablishment of a community may take considerably longer than in a temperate region.

Most of the discussions of effects of oil development on the Arctic marine ecosystem pertain only to the chemical effects of an oil spill. Physical changes in the environment will also affect the organisms living in the Beaufort Sea. Construction of causeways and artificial islands and dredging of channels will change circulation patterns which could affect nutrient supplies and migration and recruitment patterns. Whether these changes will be harmful or beneficial is not known.

The possible effects of oil on plankton communities in the Arctic have been reviewed in detail (Percy and Mullin 1975, Sanborn 1977, and Clark and Finley 1977). Most of the studies discussed have been in subarctic and temperate areas and on subarctic and temperate organisms. Laboratory studies on the effects of oil on organisms that actually live and reproduce in the Arctic and are important in the marine ecosystem have not been studied, with the exception of Percy and Mullin (1975). Basic background information on the productivity, species composition, distribution, abundances, life cycles, and migration patterns of planktonic organisms during all seasons is needed before changes caused by petroleum development can be assessed.

D. Achknowledgements

Tom Kaperak assisted in the field work and is analyzing the zooplankton samples with help from Marc Weinstein and Melanie Tyler. Leanne Stahl is identifying fish eggs and larvae. Marc Weinstein and Jerry Hornof are helping with the data processing. The officers and men of USCGC *Glacier* did a superb job of providing ship support during the cruise.

III. Current state of knowledge

The literature pertaining to plankton studies in the Beaufort Sea has been reviewed (English and Horner 1977). A summary of this literature is given in Table 1. With the exception of Adams (1975), Hsiao (1976), Busdosh and Atlas (1975), Percy and Mullin (1975) and Percy (1975, 1976, 1977), these studies have been concerned primarily with species composition, abundance and distribution.

Adams (1975) found that, although light levels were approximately 50% less below ice containing trapped oil, primary productivity was slightly enhanced for stations close to the oil. He also found a slight enhancement of total abundance and a greater variety of genera in the oil-contaminated samples. The higher abundance of phytoplankton under ice close to oil he thought might be caused by reduced zooplankton grazing due to chemical inhibition from the oil. This reduced grazing pressure was able to overcome any phytoplankton inhibition caused by reduced light. Adams suggested that in the Arctic the plankton component of the food chain is relatively stable when exposed to crude oil as compared with more vulnerable components at

Table 1. Summary of expeditions, publications, and subjects of marine biological studies in coastal waters of the Chukchi and Beaufort seas.

Expedition or Location	Reference	Subject
Canadian Arctic Expedition, 1913-1918 - Chukchi and Beaufort seas	Bigelow 1920	hydromedusae, ctenophores
	Shoemaker 1920	amphipods
	Willey 1920	copepods
	Schmitt 1919	schizopod crustaceans
	Mann 1925	diatoms
Chelan, 1934	Johnson 1936	zooplankton
	1953	zooplankton
Burton Island, 1950, 1951	Johnson 1956	copepods
LCM *Ripley*, 1954	Hand & Kan 1961	hydromedusae
	Mohr, Wilimovsky & Dawson, 1957	benthic algae, fish
Barrow - mainly Chukchi Sea	MacGinitie 1955	benthos, some plankton
	Shoemaker 1955	amphipods
	Johnson 1958	inshore zooplankton (summer)
	Bursa 1963	phytoplankton
	Horner 1969, 1972	phytoplankton
	Horner & Alexander 1972	ice algae, primary productivity
	Matheke 1973	benthic microalgae, primary productivity
	Matheke & Horner 1974	benthic microalgae, primary productivity
	Alexander, Horner & Clasby 1974	ice algae, phyto- phytoplankton, primary productivity
	Redburn 1974	zooplankton

Table 1. (continued)

Expedition or Location	Reference	Subject
Barrow - mainly Chukchi	Busdosh & Atlas 1975	amphipod ecology, physiology
Oliktok	Alexander 1974	phytoplankton, primary productivity
Prudhoe Bay	Horner, Coyle & Redburn 1974	phyto-, zooplankton, primary productivity
	Coyle 1974	phytoplankton, primary productivity
Glacier, WEBSEC cruises 1970, 1971, 1972, 1973	Quast	Arctic cod (Chukchi)
	Cobb & McConnell no date	zooplankton
	Wing 1974	zooplankton (Chukchi)
	Horner unpubl	phytoplankton
Staten Island 1974	Horner unpubl	phytoplankton
OCSEAP		
Prudhoe Bay 1975	English & Horner OCSEAP reports	phytoplankton, primary productivity
Glacier 1976 Icy Cape to Prudhoe Bay	English & Horner OCSEAP reports	phyto-, zoo-, ichthyo-plankton, primary productivity
Glacier 1977 Icy Cape to Demarcation Point	Horner OCSEAP reports	phyto-, zoo-, ichthyo-plankton, primary productivity
Southern Beaufort Sea Canadian Beaufort Sea Project	Percy & Mullin 1975	effects of oil on marine invertebrates
	Percy 1975	amphipod physiology
	Grainger & Grohe 1975	zooplankton
	Adams 1975	primary productivity, oil under ice
	Hsiao 1976	phytoplankton
	Percy 1976, 1977	amphipods, isopods, response to oil

higher trophic levels.

Hsiao (1976) reported standing stock and primary productivity to be higher in the southern Beaufort Sea than in the western Beaufort Sea, but lower than in other Arctic areas. Standing stock and primary productivity decreased with increasing depth and distance from shore. Diatoms and flagellates comprised most of the phytoplankton community, with diatoms more abundant at inshore stations and flagellates at offshore stations. Dinoflagellates were also present and blue-green algae occasionally occurred. The effect of oil on production rates depended on species composition of the sample, type and concentration of oil, duration of exposure, and method of preparing oil-seawater mixtures. Photosynthesis and growth of diatoms was inhibited more by crude oil-Corexit mixtures than by either crude oil or Corexit alone.

Busdosh and Atlas (1975) studied temperature and salinity tolerances in two Arctic amphipods, *Gammarus zaddachi* and *Boeckosimus affinus*. Both species were able to tolerate wide ranges of temperature and salinity, but *G. zaddachi* could survive lower salinities and higher temperatures than *B. affinis*. These authors suggested that the distribution of these species was at least partly determined by their temperature and salinity tolerances.

Percy and Mullin (1975) discussed the effects of crude oils on Arctic marine invertebrates and showed the complex nature of the potential interactions between crude oil and marine invertebrates. They point out the variability between species with regard to their responses to crude oil and suggest that this could cause a change in species diversity in the area of a spill. Elimination of some species could result in changes within the food web. Sublethal effects that cause changes in physiology and behavior are likely to be important because they are induced by low oil concentrations that occur over wide areas following a spill. These authors also point out that sub-ice and benthic species may be more seriously affected than neritic species because oil tends to accumulate on these surfaces. In addition, oil trapped in the ice would be released into the water during breakup, at a time when there is intense biological activity in the water column.

Percy (1976) reported the responses of two amphipods, *Onisimus* [*Boeckosimus*] *affinis* and *Gammarus oceanicus*, and the isopod, *Mesidotea entomon* to crude oil and oil-tainted food. The amphipods avoided an oil mass, although the response diminished when the oil was weathered or if the animals were previously exposed to crude oil emulsions. Untainted food was preferentially selected over oil-tainted food. *Mesidotea* was neutral to the oil masses and consumed oil-tainted as well as untainted food. Metabolism of *Onisimus affinis* was found to be depressed at low oil concentrations, but was reversed at increasing concentrations (Percy 1977).

IV. Study area

The study area and sampling stations are shown in Fig. 1. Station locations are given in Table 2.

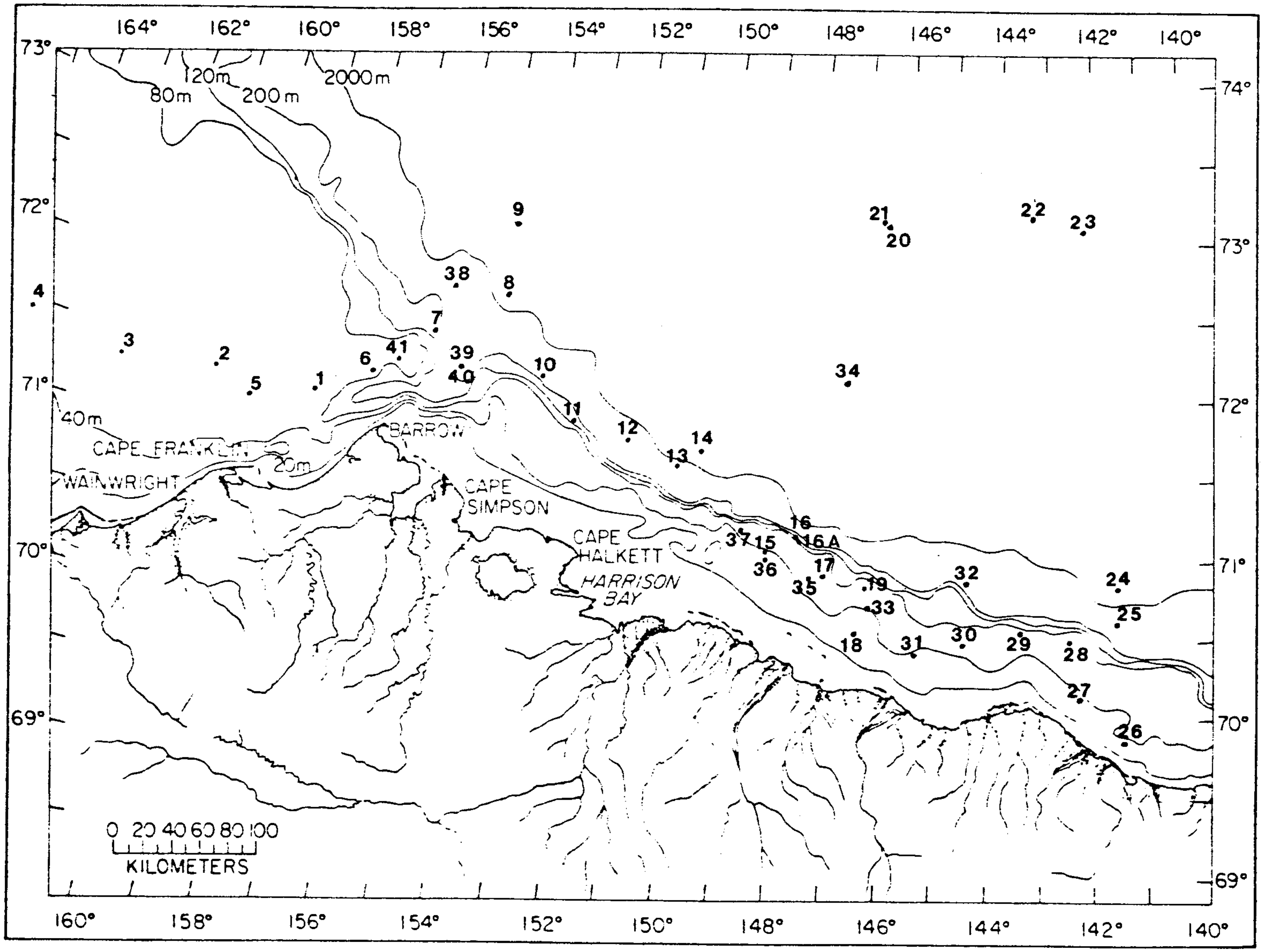

Fig. 1. Study area and station locations, USCGC *Glacier*, 01 Aug to 07 Sep 1977.

Table 2. Station locations, USCGC *Glacier*, 01 Aug to 07 Sep 1977.

Station	Latitude (N)	Longitude (W)	Sonic Depth (m)	Location
01	71°19'	157°59'	102	Chukchi Sea
02	71°22'	160°04'	48	Chukchi Sea
03	71°24'	162°00'	46	Chukchi Sea
04	71°25'	164°00'	42	Chukchi Sea
05	71°12'	158°22'	107	Chukchi Sea
06	71°25'	156°56'	112	Chukchi Sea
07	71°46'	155°51'	123	Beaufort Sea
08	71°57'	154°33'	183	Beaufort Sea
09	72°24'	154°37'	2196	Beaufort Sea
10	71°35'	153°29'	51	Beaufort Sea
11	71°18'	152°43'	55	Beaufort Sea
12	71°10'	151°30'	24	Beaufort Sea
13	71°05'	150°23'	29	Beaufort Sea
14	71°10'	150°04'	45	Beaufort Sea
15	70°38'	148°28'	21	Beaufort Sea
16	70°42'	147°59'	31	Beaufort Sea
16A	70°40'	147°48'	32	Beaufort Sea
17	70°33'	147°24'	28	Beaufort Sea
18	70°25'	146°41'	31	Beaufort Sea
19	70°32'	146°30'	3658	Beaufort Sea
20	72°46'	146°23'	3568	Beaufort Sea
21	72°47'	146°34'	3568	Beaufort Sea
22	72°57'	143°20'	3292	Beaufort Sea
23	72°54'	142°08'	3531	Beaufort Sea
24	70°45'	141°28'	1189	Beaufort Sea
25	70°32'	141°32'	406	Beaufort Sea
26	69°49'	141°31'	28	Beaufort Sea
27	70°04'	142°14'	35	Beaufort Sea
28	70°19'	142°32'	49	Beaufort Sea
29	70°21'	143°29'	38	Beaufort Sea
30	70°14'	144°28'	28	Beaufort Sea
31	70°10'	145°32'	20	Beaufort Sea
32	70°39'	145°34'	51	Beaufort Sea
33	70°23'	146°26'	28	Beaufort Sea
34	71°46'	147°02'	54	Beaufort Sea
35	70°32'	147°35'	18	Beaufort Sea
36	70°36'	148°26'	22	Beaufort Sea
37	70°45'	149°03'	27	Beaufort Sea
38	71°58'	155°43'	150	Beaufort Sea
39	71°30'	155°12'	26	Beaufort Sea
40	71°30'	155°13'	26	Beaufort Sea
41	71°32'	156°30'	160	Chukchi Sea

V. Sources, methods, and rationale of data collection

Phytoplankton samples were collected with 5-ℓ Niskin bottles. Subsamples of the water were taken for salinity, standing stock, primary productivity, and chlorophyll *a* and phaeopigment determinations. Standing stock samples were preserved with 5-10 ml of 4% formalin buffered with sodium acetate. Primary productivity measurements were made in 60 ml reagent bottles. Two light and one dark bottle were used for each depth. Two ml of $NaH^{14}CO_3$ solution were added to each bottle, aluminum foil was wrapped around the dark bottle, and the samples incubated in a laboratory sink under a bank of cool white fluorescent lamps. Light levels were measured at the beginning and end of the incubation period with a Gossen Super Pilot photographic light meter. Low temperature in the sink was maintained by running seawater and was monitored throughout the incubation period. Following a 3 to 4 hr incubation period, the samples were filtered onto 25 mm HA (0.45 μm) Millipore filters, rinsed with 5 ml filtered seawater and 5 ml 0.01 N HCl, and placed in liquid scintillation vials.

Water for chlorophyll *a* and phaeopigment determinations was filtered through 47 mm HA (0.45 μm) Millipore filters. A few drops of a saturated $MgCO_3$ solution were added near the end of the filtration and the filter tower was rinsed with filtered seawater. The filters were folded into quarters, placed in labelled coin envelopes and frozen.

Salinity was determined on board using a Bissett Berman Hytech induction salinometer, Model 6220. Temperatures, measured with reversing thermometers, were corrected using calibration factors provided by the Coast Guard and following the procedure outlined in U.S. Naval Oceanographic Office Publ. 607 (1968). Water transparency was measured with a Secchi disc.

Zooplankton samples were collected with bongo nets having mesh sizes of 333 and 505 μm, mouth openings of 60 cm, and areas of 0.2827 m^2. A TSK Model 313 flowmeter (InterOcean Systems, Inc.) was mounted in the mouth of each net and on the outside of the net frame to determine the amount of water filtered. After station 23, only one flowmeter was used and it was mounted in the mouth of the 505 μm net. A bathykymograph was attached to the center of the net frame to determine tow depth. Either two 50 lb cannon ball weights or one 100 lb rectangular weight was attached to the net frame. Tows were double oblique with the net lowered at *ca.* 40-50 m/min to a depth *ca.* 10 m from the bottom at shallow stations or to 200 m at deep stations, soaked for 30 sec, and retrieved at *ca.* 20 m/min.

A 2 m (4 m^2 mouth area) closing English umbrella net, mesh size *ca.* 220 μm, was used when the ship was in heavy concentrations of ice or stopped on station for long periods of time. This net, designed to fall open after it is in the water beneath the ice, was lowered to a depth near the bottom, allowed to stabilize for 30 sec, and hauled vertically to the surface. The net was closed *ca.* 2 m below the surface to facilitate handling.

The samples were concentrated by gently swirling in a net collection cup to remove excess water. The samples were poured into jars and preserved with 37% formalin and saturated sodium borate solution. The amount of formalin and buffer depended on the jar size. A label containing collection data was put in the jar, seawater added if necessary to fill the jar, and the jar was tightly capped for storage.

Acoustic surveys for layers of zooplankton were made with a Ross 200A Fine Line echosounder system operated at a frequency of 105 kHz. A 10° transducer mounted in a 0.6 m V-fin depressor was lowered to *ca.* 1 m when the ship was on station.

VI. Results

A. Hydrography

Hydrographic data for all stations taken in the Chukchi and Beaufort seas are given in Table 3.

B. Phytoplankton standing stock and primary productivity

Phytoplankton standing stock samples have been analyzed for 23 stations (Fig. 2), including all but three of the stations where primary productivity was measured. A list of phytoplankton species found in the Chukchi and Beaufort seas in 1976 and 1977 is given in Table 4.

The number of phytoplankton cells ranged from $< 1 \times 10^5$ to $> 12 \times 10^6$ cells per liter. *Chaetoceros* spp., mostly small cells *ca.* 6 to 10 μm along the apical axis, were the most abundant organisms at nearly all depths. *Nitzschia* spp. and *Thalassiosira* spp. were abundant at some stations. Small, unidentified flagellates were not as abundant as in 1976. The percentage of phytoplankton and the number of cells by major category, based on taxonomic affinities and abundance, are given in Table 5.

Primary productivity values ranged from 0.02 mg C $m^{-3} \cdot hr^{-1}$ at station 07-20 to 10.35 mg C $m^{-3} \cdot hr^{-1}$ at station 26-06. These values are somewhat higher than those found in 1976. High productivity generally occurred where cell numbers were high. *Chaetoceros* spp., *Thalassiosira* spp., *Bacterosira fragilis*, and unidentified flagellates 3 to 15 μm in diameter were the most abundant organisms at station 26-06. The depth of greatest productivity was usually greater than 20 m in the Chukchi Sea and, at station 5 extended from 30 to 100 m. In the Beaufort Sea, the depth of greatest productivity was usually < 20 m except at stations 29 and 30.

C. Zooplankton

Stations where zooplankton have been analyzed are shown in Fig. 3; Table 6 lists zooplankton species found in the Chukchi and Beaufort seas in 1976 and 1977.

Sixty-seven categories of zooplankton have been identified from 19 net hauls, representing 34 species and 30 other categories including larval stages and categories where identification was made to genus, family, sub-order, or order (Tables 7 and 8). In analyzing the zooplankton samples, greatest emphasis has been placed on those species known to be important prey species for birds and mammals. These include amphipods, euphausids, mysids, shrimp, and fish eggs and larvae. Copepods have not been identified

Table 3. Summary of sampling depths, temperature, salinity, Secchi disc depths, ice cover, and primary productivity for USCGC *Glacier* cruise, 01 Aug - 06 Sep 1977. When no number is present, no sample was taken.

Sta	Date (GMT)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	Salinity (°/°°)	Prim Prod (mg C $m^{-3} \cdot hr^{-1}$)
01	02 Aug		2	000	5.08	30.24	
				005	4.43	31.66	
				010	4.21	32.09	
				015	1.92	32.18	
				020	-1.31	32.67	
				025	-1.46	32.95	
				030	-1.20	32.89	
				045	-0.93	33.01	
02	02 Aug		2	000	1.77	30.20	0.06
				004	1.54		
				007	-0.62	30.90	0.05
				011	-1.15	31.29	0.08
				022	-1.41	32.27	0.31
				027	-1.48	32.40	1.58
				035	-1.66	32.80	1.44
				045	-1.72	33.64	1.15
03	03 Aug	10	0	000	-0.17	28.09	0.11
				004	2.10	30.12	0.06
				008	2.28	30.30	0.10
				014	4.25	31.60	0.11
				020	-1.51	32.57	0.19
				027	-1.71	33.09	2.20
				035	-1.71	33.16	0.88
				045	-1.72	33.17	0.98
04	04 Aug	8	1	000	-0.14	27.14	0.11
				005	1.36	30.50	0.09
				010	-0.47	31.77	0.29
				015	-1.43	32.32	0.06
				020	-1.53	32.49	4.52
				025	-1.70	32.82	7.96
				030	-1.70	33.18	1.84
				045	-1.74	33.45	0.49
05	06 Aug	9	1	000	1.20	24.26	0.08
				010	3.89	31.32	0.09
				020	-0.09	31.97	0.34
				030	-1.63	32.78	3.08
				045	-1.62	32.92	4.20
				060	-1.64	32.86	3.63
				075	-1.65	32.87	3.79
				100	-1.70	32.92	3.75

Table 3. (continued)

Sta	Date (GMT)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	Salinity (°/°°)	Prim Prod (mg C $m^{-3} \cdot hr^{-1}$)
06	06 Aug	11	1	000	2.81	29.38	0.16
				010	2.83	30.64	0.21
				020	0.13	32.36	0.48
				030	-0.21	32.46	0.51
				045	1.69	32.47	0.55
				060	-0.60	32.49	0.56
				075	-0.72	32.51	0.68
				100	-1.38	32.69	1.25
07	07 Aug	16	1	000	0.27	27.94	0.05
				010	-0.79	30.85	0.08
				020	-0.97	31.19	0.02
				030	-1.41	31.55	0.24
				045	-1.29	32.04	1.02
				060	-1.26	32.44	0.59
				075	-1.08	32.95	0.63
				100	-1.61	33.20	0.32
08	09 Aug	15	1	000	1.12	28.22	0.09
				010	1.12	28.27	0.11
				020	-0.33	30.27	0.25
				030	0.85	31.58	0.30
				045	-0.50	32.54	0.66
				060	-1.24	33.01	0.36
				075	-1.29	33.13	0.41
				100	-1.66	33.43	0.15
				125	-1.50	33.77	0.23
				150	-0.95	34.20	
				175	0.05	34.70	0.12
09	10 Aug		8	000	-0.73	25.20	0.14
				010	-0.63		
				020	0.95	31.80	0.23
				030	-1.38	32.29	0.04
				045	3.34	32.90	0.13
				060	2.34	32.86	0.16
				075	1.68	32.92	0.18
				100	0.16	33.01	0.22
10	10 Aug		1	000	1.24	29.45	0.25
				010	1.20	29.58	0.32
				020	3.90	31.95	0.56
				025	5.19	32.24	0.50
				030	5.06	32.33	0.63
				035	4.81	32.48	0.46
				040	5.02	32.58	0.36
				045	3.39	32.62	0.26

Table 3. (continued)

Sta	Date (GMT)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	Salinity (°/°°)	Prim Prod (mg C $m^{-3} \cdot hr^{-1}$)
11	11 Aug		0	000	1.39	29.39	0.74
				010	1.35	29.41	0.85
				015	1.33	29.45	1.37
				020	0.77	30.68	2.26
				025	0.83	31.99	0.82
				035	1.77	32.57	0.24
				045	2.57	32.77	0.08
				050	1.15	32.78	0.34
12	12 Aug		0	000	-0.71	28.80	1.89
				005	-0.81	29.35	1.75
				010	-1.23	31.18	2.65
				015	-1.30	32.84	1.03
				020	-1.28	32.87	1.07
13	13 Aug		1	000	-1.00	30.29	0.99
				005	-1.06	30.35	1.20
				010	-1.03	30.31	1.37
				015	-1.48	32.67	0.56
				020	-1.29	32.81	0.28
				025	-1.40	32.82	0.29
14	14 Aug	7	4	000	-0.85	30.95	1.22
				005	-1.00	31.32	1.83
				010	-0.97	31.71	3.21
				015	-1.13	31.96	1.78
				020	-1.45	32.24	0.41
				025	-1.49	32.33	0.11
				030	-1.49	32.54	0.07
				045	-1.53	32.86	0.20
15	16 Aug		0-1	000	0.05	31.25	2.75
				003	-0.69	31.80	2.97
				006	-0.74	31.83	4.12
				009	-0.94	31.90	3.81
				012	-0.84	32.13	2.57
				015	-1.23	32.13	1.51
				018	-1.24	32.13	1.43
16	17 Aug		3	000	0.19	31.03	
				005	-0.47	31.97	
				010	-0.98	32.31	
				015	-1.12	32.42	
				020	-0.98	32.47	
				025	-1.21	32.46	

Table 3. (continued

Sta	Date (GMT)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	Salinity (°/°°)	Prim Prod (mg C $m^{-3} \cdot hr^{-1}$)
16A	17 Aug	4	2	000	-0.39	30.44	
				005	-0.43	32.18	
				010	-0.65	32.39	
				015	-1.02	32.41	
				020	-1.09	32.43	
				025	-1.12	32.42	
				030	-1.17	32.42	
17	18 Aug	4	2-3	000	-0.15	31.48	4.13
				003	-0.16	31.51	3.94
				006	-0.28	31.55	5.82
				009	-0.47	31.61	4.99
				012	-0.50	31.65	7.08
				015	-0.64	31.85	7.35
				020	-0.78	31.98	6.42
				025	-0.97	32.09	5.12
18	18 Aug		0	000	0.90	32.06	2.19
				003	0.86	32.06	2.06
				006	0.88	32.06	2.18
				009	0.82	32.06	2.54
				012	0.90	32.06	2.57
				015	1.02	32.06	1.85
				020	-0.72	32.38	3.65
				025	-0.74	32.40	3.45
19	19 Aug	30	0	000	-0.97	26.66	
				010	-0.94	28.10	
				020	-1.24	30.98	
				030	-1.45	31.63	
				045	-1.33	31.91	
				060	-0.79	32.24	
				075	-1.42	32.52	
				100	-1.50	32.83	
				200	-0.77	34.27	
				400	0.47	34.88	
				500	0.45	34.90	
				600	-0.29	34.91	
				700	-0.23	34.91	
				800	0.03	34.92	
				900	-0.04	34.92	
				1000	-0.15	34.93	

Table 3. (continued)

Sta	Date (GMT)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	Salinity (°/°°)	Prim Prod (mg C $m^{-3} \cdot hr^{-1}$)
20	21 Aug	42	8	000	1.35	05.02	
				010	-0.85	29.76	
				020	-1.19	30.71	
				030	-1.43	31.45	
				045	-1.35	31.74	
				060	-1.48	32.10	
				075	-1.44	32.40	
				100	-1.47	32.76	
21	22 Aug	14	1	000	1.41	24.42	
				010	2.15	26.30	
				020	-1.14	30.60	
				030	-1.42	31.54	
				045	-1.50	31.88	
				060	-1.44	32.18	
				075	-1.42	32.37	
				100	-1.50	32.81	
22	23 Aug	21	4	000	2.13	17.72	
				010	-0.48	27.01	
				020	-0.87	30.93	
				030	-1.26	31.82	
				045	-1.17	31.82	
				060	-1.48	32.17	
				075	-1.47	32.42	
				100	-1.45	32.78	
23	23 Aug	21	5	000	3.34	21.22	
				010	1.16	29.20	
				020	-0.65	31.17	
				035	-1.45	31.71	
				050	-1.59	31.95	
				075	-1.59	32.43	
				100	-1.46	32.76	
				3400	-0.28	34.98	
24	25 Aug	12	0	000	2.59	30.50	
				010	2.39	30.54	
				020	-1.10	31.65	
				030	-1.49	31.92	
				045	-1.59	32.18	
				060	-1.56	32.43	
				075	-1.51	32.63	
				100	-1.50	32.95	

Table 3. (continued)

Sta	Date (GMT)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	Salinity (°/°°)	Prim Prod (mg C $m^{-3} \cdot hr^{-1}$)
25	25 Aug	20	0	000	2.02	30.92	
				010	-0.14	31.44	
				020	-0.73	31.96	
				030	-1.04	32.15	
				045	-0.85	32.40	
				060	-1.43	32.72	
				075	-1.48	32.81	
				100	-1.49	32.86	
26	26 Aug	5	0	000	2.38	32.52	8.20
				003	2.36	32.53	9.72
				006	2.41	32.52	10.35
				009	2.37	32.53	8.56
				012	2.33	32.52	8.30
				015	2.36	32.53	8.59
				020	0.36	32.76	1.71
				025	-0.18	32.79	1.40
27	26 Aug	4	0	000	1.27	32.34	2.82
				003	1.23	32.34	2.10
				006	1.26	32.34	2.93
				009	1.20	32.34	2.17
				012	1.19	32.34	2.53
				015	1.21	32.34	1.86
				020	0.20	32.45	1.98
				030	-0.33	32.50	1.85
28	27 Aug	13	0	000	1.47	31.22	
				005	1.45	31.21	
				010	1.47	31.21	
				015	0.93	32.09	
				020	0.55	32.35	
				025	-1.03	32.56	
				030	-1.08	32.56	
				045	-1.20	32.59	
29	28 Aug		0	000	1.47	31.71	0.25
				005	1.45	31.76	0.25
				010	1.38	32.03	0.80
				015	1.61	32.16	0.53
				020	1.15	32.19	1.05
				025	-0.64	32.46	5.17
				030	-0.61	32.46	4.52
				035	-0.62	32.46	4.58

Table 3. (continued)

Sta	Date (GMT)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	Salinity (°/₀₀)	Prim Prod (mg C $m^{-3} \cdot hr^{-1}$)
30	28 Aug	11	0	000	1.37	32.13	0.19
				003	1.36	32.13	0.36
				006	1.42	32.14	0.17
				009	1.36	32.14	0.25
				012	1.33	32.21	0.22
				015	1.35	32.14	0.18
				020	-0.76	32.37	4.86
				025	-0.80	32.38	3.94
31	29 Aug	5	0	000	1.04	31.39	0.31
				003	1.07	31.39	0.26
				006	1.09	31.42	0.28
				009	1.09	31.52	1.44
				012	1.07	31.61	0.25
				015	1.30	31.68	0.25
				018	1.36	31.71	0.37
32	30 Aug	10	0	000	2.08	29.62	
				005	2.08	29.62	
				010	2.08	29.65	
				015	1.28	31.67	
				020	0.56	31.89	
				025	-0.84	32.14	
				030	-0.83	32.29	
				045	-1.45	32.59	
33	30 Aug		2	000	-0.20	29.82	
				003	0.12	30.24	
				006	0.12	30.86	
				009	-0.07	31.40	
				012	-0.21	31.40	
				015	-0.46	31.55	
				020	-0.69	31.63	
				025	-0.73	31.64	
34	31 Aug	24	0	000	1.04	28.02	
				005	1.75	28.99	
				010	0.70	29.90	
				015	0.59	29.91	
				020	0.19	30.54	
				025	-1.08	31.36	
				030	-1.19	31.55	
				045	0.12	32.24	

Table 3. (continued)

Sta	Date (GMT)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	Salinity (°/∘∘)	Prim Prod (mg C $m^{-3} \cdot hr^{-1}$)
35	01 Sep	5	3-4	000	0.55	29.89	
				003	0.75	30.00	
				006	0.53	30.17	
				009	0.27	30.23	
				012	0.15	30.67	
				015	0.04	30.99	
36	01 Sep		1	000	0.66	28.78	0.15
				003	1.17	28.87	
				006	0.90	28.91	0.18
				009	0.40	30.07	0.20
				012	0.21	30.81	0.35
				015	-0.26	31.22	1.73
				018	-0.27	31.22	2.21
37	02 Sep	11	3	000	0.67	28.45	
				003	0.36	28.78	
				006	-0.13	29.79	
				009	-0.15	30.04	
				012	-0.50	30.47	
				015	-1.06	31.29	
				018	-1.43	31.83	
38	04 Sep		0	000	5.96	29.17	
				010	6.21	29.23	
				020	-1.16	31.70	
				030	-1.38	31.93	
				040	-1.40	32.10	
				050	-1.10	32.27	
				075	-1.06	32.68	
				100	-1.46	32.98	
39	04 Sep	9	0	000	7.97	28.62	
				003	8.07	28.63	
				006	8.47	28.98	
				009	8.54	28.97	
				012	8.37	29.03	
				015	8.42	29.15	
				018	8.35	29.21	
				021	7.83	29.37	

Table 3. (continued)

Sta	Depth (GMT)	Secchi Depth (m)	Ice Cover (oktas)	Sample Depth (m)	Temp (°C)	Salinity (°/oo)	Prim Prod (mg C $m^{-3} \cdot hr^{-1}$)
40	04 Sep	6	0	000	8.57	29.03	
				003	8.58	29.13	
				006	8.59	29.02	
				009	8.57	29.02	
				012	8.50	29.04	
				015	8.48	29.13	
				018	8.50	29.18	
				021	8.51	29.21	
41	05 Sep	9	0	000	3.56	27.67	
				010	4.39	31.26	
				020	3.01	31.52	
				030	1.22	31.98	
				040	0.83	32.06	
				050	0.63	32.10	
				075	0.51	32.13	
				100	-0.16	32.28	

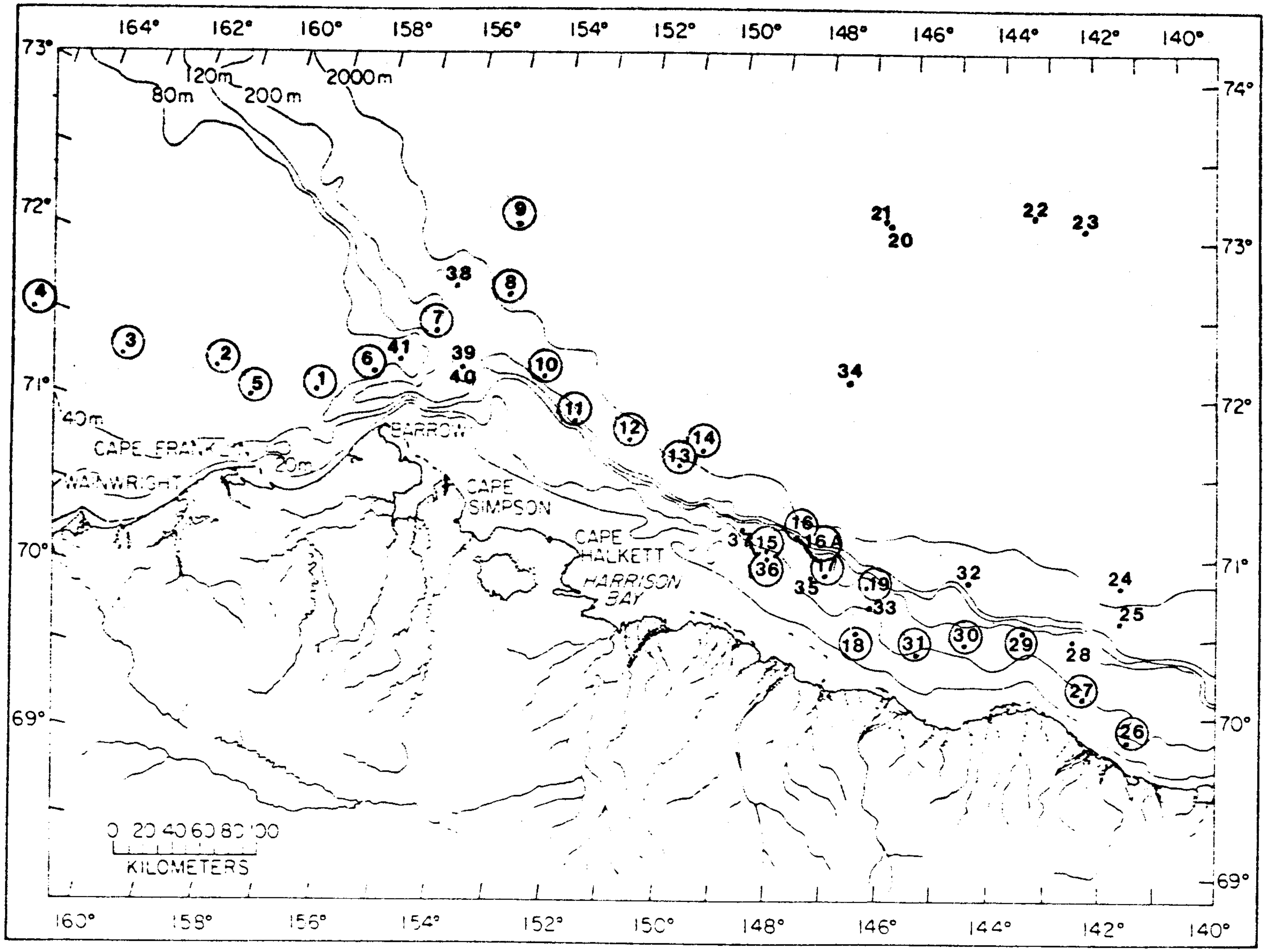

Fig. 2. Stations where primary productivity (0) was measured in Aug-Sep 1977. Phytoplankton standing stock has been determined at all primary productivity stations except 30, 31, and 36.

Table 4. Phytoplankton species present in the Chukchi and Beaufort seas, 1976-1977.

Bacillariophyta

Amphiprora hyperborea (Grunow) Gran

Bacterosira fragilis Gran

Chaetoceros atlanticus Cleve
Chaetoceros borealis Bailey
Chaetoceros ceratosporum Ostenfeld
Chaetoceros compressus Lauder
Chaetoceros concavicornis Mangin
Chaetoceros danicus Cleve
Chaetoceros debilis Cleve
Chaetoceros decipiens Cleve
Chaetoceros fragilis Meunier
Chaetoceros furcellatus Bailey
Chaetoceros gracilis Schütt
Chaetoceros karianus Grunow
Chaetoceros septentrionalis Østrup
Chaetoceros socialis Lauder
Chaetoceros subsecundus (Grunow) Hustedt
Chaetoceros subtilis Cleve
Chaetoceros teres Cleve
Chaetoceros wighami Brightwell

Coscinodiscus centralis Ehrenberg
Coscinodiscus curvatulus Grunow
Coscinodiscus excentricus Ehrenberg
Coscinodiscus oculus-iridis Ehrenberg
Coscinodiscus radiatus Ehrenberg

Cylindrotheca closterium (Ehrenberg) Reimann & Lewin

Detonula confervacea (Cleve) Gran

Eucampia zoodiacus Ehrenberg

Leptocylindrus danicus Cleve
Leptocylindrus minimus Gran

Melosira arctica (Ehrenberg) Dickie
Melosira juergensii Agardh
Melosira moniliformis (Müller) Agardh

Navicula pelagica Cleve
Navicula transitans Cleve
Navicula spp.

Table 4. (continued)

Bacillariophyta

Nitzschia delicatissima Cleve
Nitzschia frigida Grunow
Nitzschia grunowii Hasle
Nitzschia seriata Cleve
Nitzschia spp.

Porosira glacialis (Grunow) Jørgensen

Rhizosolenia alata Brightwell
Rhizosolenia hebatata (Bailey) Gran

Skeletonema costatum (Greville) Cleve

Stauroneis granii Jørgensen

Thalassionema nitzschioides Hustedt

Thalassiosira antarctica Comber
Thalassiosira decipiens (Grunow) Jørgensen
Thalassiosira gravida Cleve
Thalassiosira nordenskioeldii Cleve
Thalassiosira polychorda (Gran)
Thalassiosira spp.

Unidentified diatoms, mostly pennates

Pyrrophyta

Cladopyxis sp.

Dinophysis acuta Ehrenberg
Dinophysis norvegica Claparède & Lachmann

Gonyaulax catenata (Levander) Kofoid
Gonyaulax spinifera (Claparède & Lachmann) Diessing

Gymnodinium lohmanni Paulsen
Gymnodinium spp.

Oxytoxum spp.

Table 4. (continued)

Pyrrophyta

Peridinium belgicum Wulff
Peridinium brevipes Paulsen
Peridinium depressum Bailey
Peridinium minusculum Pavillard
Peridinium pallidum Ostenfeld
Peridinium pellucidum (Bergh) Schütt
Peridinium triquetrum (Ehrenberg) Lebour
Peridinium trochoideum (Stein) Lemmermann
Peridinium spp.

Unidentified dinoflagellates

Flagellates

Calycomonas gracilis Lohmann
Calycomonas ovalis Wulff

Craspedomonadaceae

Diaphanoeca grandis Ellis
Monosiga marina Grøntved
Parvicorbicula socialis (Meunier) Deflandre
Unidentified choanoflagellates

Euglenophyta

Dinema litorale Skuja

Cryptophyta

Chroomonas spp.
Cryptomonas spp.

Chrysophyta

Dinobryon balticum (Schütt) Lemmermann
Dinobryon petiolatum Willén

Silicoflagellatae

Distephanus (Dictyocha) speculum (Ehrenberg) Haeckel
Ebria tripartita (Schumann) Lemmermann

Organisms with unknown affinities

Piropsis polita Meunier
Radiospermum corbiferum Meunier

Table 5. Number of cells per liter and percentage of phytoplankton by major category by depth at each station. Where no number is given, the sample has not been counted; - indicates no cells found in the sample.

Sta	Depth (m)	*Chaetoceros* Number	*Chaetoceros* %	Other diatoms Number	Other diatoms %	Flagellates Number	Flagellates %	Dinoflagellates Number	Dinoflagellates %	Total Number of Cells
1	00									
	05	290000	61	126000	27	50000	11	6000	1	472000
	10	185000	53	104000	30	55000	16	2000	1	346000
	15	362000	72	80000	16	55000	11	4000	1	501000
	20	1516000	81	233000	13	102000	5	12000	1	1863000
	25	2531000	87	285000	10	59000	2	23000	1	2898000
	30	2899000	90	172000	5	105000	3	28000	1	3204000
	45	7866000	94	396000	5	110000	1	17000	< 1	8389000
2	00									
	07	1955200	93	48000	2	86400	4	6400	< 1	2096000
	11	2400000	93	59200	2	110400	4	6400	< 1	2576000
	22	636800	72	91200	10	145600	16	11200	1	884800
	27	2238400	78	507200	18	110400	4	3200	< 1	2859200
	35	1171200	54	971200	45	14400	1	22400	1	2179200
	45	2147200	60	1198400	34	209600	6	6400	< 1	3561600
3	00									
	04	299200	51	136000	23	14400	2	3200	1	582400
	08	265600	49	49600	9	220000	41	3200	1	538400
	14	262400	34	372800	48	126400	16	14400	2	776000
	20	235200	37	188800	29	212800	33	6400	1	643200
	27	158400	21	523200	69	65600	9	9600	1	756800
	35	147200	23	403200	62	73600	11	22400	3	646400
	45	177600	22	497600	63	83200	10	35200	4	793600

Table 5. (continued)

Sta	Depth (m)	*Chaetoceros* Number	%	Other diatoms Number	%	Flagellates Number	%	Dinoflagellates Number	%	Total Number of Cells
4	00									
	05	204800	25	504000	62	83200	10	17600	2	809000
	10	464000	43	457600	43	139200	13	12800	1	1073600
	15	152000	48	81600	26	80000	25	6400	2	320000
	20	675200	43	550400	35	328000	21	12800	1	1566400
	25	593600	20	2038400	67	360000	12	32000	1	3024000
	30	192000	20	622400	64	139200	14	19200	2	972800
	45	67200	16	193600	47	131200	32	17600	4	409600
5	00									
	10	352800	22	184000	16	707200	62	3200	< 1	1147200
	20	542400	51	336000	31	182400	17	8000	1	1068800
	30	5572800	85	288000	4	681600	10	12800	< 1	6555200
	45	7350000	88	628000	8	354000	4	22000	< 1	8354000
	60	7094000	92	412000	5	112000	1	24000	< 1	7642000
	75	8318000	93	518000	6	116000	1	32000	< 1	8984000
	100	7224000	94	358000	5	104000	1	34000	< 1	7720000
6	00									
	10	401600	58	214400	31	68800	10	4800	1	689600
	20	355200	42	419200	49	75200	9	4800	1	854400
	30	502400	50	417600	41	75200	7	11200	1	1006400
	45	672000	57	419200	36	73600	6	6400	1	1171200
	60	782400	62	387200	31	76800	6	17600	1	1264000
	75	942400	63	456000	31	76800	5	9600	1	1484800
	100	2502400	82	392000	13	144000	5	20800	1	3059200
7	00									
	10	320000	79	35200	9	33600	8	16000	4	404800
	20	41600	44	6400	7	36800	39	9600	10	94400
	30	353600	69	54400	11	102400	20	1600	< 1	512000
	45	2036800	83	284800	12	118400	5	-	-	2440000

Table 5. (continued)

Sta	Depth (m)	*Chaetoceros* Number	%	Other diatoms Number	%	Flagellates Number	%	Dinoflagellates Number	%	Total Number of Cells
10	40	336000	68	32000	6	123200	25	3200	1	494400
	45	249600	76	11200	3	67200	20	1600	< 1	329600
11	00									
	10	1059200	73	192000	13	187200	13	12800	1	1451200
	15	1073600	71	225600	15	219200	14	3200	< 1	1521600
	20	1603200	73	424000	19	156800	7	6400	< 1	2190400
	25	609600	68	62400	7	214400	24	4800	1	891200
	35	257600	43	41600	7	304000	50	1600	< 1	604800
	45	233600	57	32000	8	144000	35	1600	< 1	411200
	50	798400	62	158400	12	323200	25	8000	1	1288000
12	00									
	05	2244800	80	475200	17	84800	3	3200	< 1	2808000
	10	1171200	61	624000	33	116800	6	1600	< 1	1913600
	15	584000	61	312000	33	52800	6	9600	1	958400
	20	483200	54	348800	39	43200	5	14400	2	889600
13	00									
	05	1118400	81	118400	9	136000	10	6400	< 1	1379200
	10	1017600	73	236800	17	124800	9	8000	1	1387200
	15	208000	62	80000	24	44800	13	1600	< 1	334400
	20	129600	60	68800	32	14400	7	4800	2	217600
	25	177600	73	28800	12	38400	16	-	-	244800
14	00									
	05	1347200	67	592000	29	65600	3	3200	< 1	2008000
	10	1649600	65	828800	33	48000	2	6400	< 1	2532800
	15	1052800	72	345600	24	64000	4	6400	< 1	1468800
	20	107200	58	35200	19	32000	17	9600	5	184000
	25	3200	6	14400	28	25600	50	8000	16	51200

Table 5. (continued)

Sta	Depth (m)	*Chaetoceros* Number	%	Other diatoms Number	%	Flagellates Number	%	Dinoflagellates Number	%	Total Number of Cells
7	60	2614400	89	204800	7	124800	4	3200	< 1	2947200
	75	2931200	91	201600	6	91200	3	1600	< 1	3225600
	100	640000	71	184000	20	70400	8	8000	1	902400
8	00									
	10	344000	70	27200	6	118400	24	3200	1	492800
	20	387200	77	40000	8	72000	14	1600	< 1	500800
	30	827200	76	49600	5	212800	19	4800	< 1	1094400
	45	1561600	68	32000	1	683200	30	3200	< 1	2280000
	60	768000	82	59200	6	107200	11	–	–	934400
	75	681600	74	96000	10	124800	14	19200	2	921600
	100	627200	73	136000	16	84800	10	16000	2	864000
	125	992000	81	160000	13	67200	6	1600	< 1	1220800
	150	545600	91	17600	3	27200	5	8000	1	598400
	175	401600	90	22400	5	19200	4	4800	1	448000
9	00									
	10	No sample - bottle didn't trip								
	20	308800	29	68800	6	688000	65	–	–	1065600
	30	38400	51	1600	2	32000	43	3200	4	75200
	45	99200	44	11200	5	112000	50	3200	1	225600
	60	251200	50	36800	7	217600	43	1600	< 1	507200
	75	270400	55	49600	10	174400	35	1600	< 1	496000
	100	334400	51	57600	9	267200	41	–	–	659200
10	00									
	10	472000	70	67200	10	126400	19	4800	< 1	670400
	20	692800	81	27200	3	137600	16	–	–	857600
	25	513600	73	36800	5	153600	22	3200	< 1	707200
	30	392000	72	40000	7	107200	20	1600	< 1	540800
	35	521600	79	33600	5	104000	16	1600	< 1	660800

Table 5. (continued)

Sta	Depth (m)	*Chaetoceros* Number	%	Other diatoms Number	%	Flagellates Number	%	Dinoflagellates Number	%	Total Number of Cells
10	40	336000	68	32000	6	123200	25	3200	1	494400
	45	249600	76	11200	3	67200	20	1600	< 1	329600
11	00									
	10	1059200	73	192000	13	187200	13	12800	1	1451200
	15	1073600	71	225600	15	219200	14	3200	< 1	1521600
	20	1603200	73	424000	19	156800	7	6400	< 1	2190400
	25	609600	68	62400	7	214400	24	4800	1	891200
	35	257600	43	41600	7	304000	50	1600	< 1	604800
	45	233600	57	32000	8	144000	35	1600	< 1	411200
	50	798400	62	158400	12	323200	25	8000	1	1288000
12	00									
	05	2244800	80	475200	17	84800	3	3200	< 1	2808000
	10	1171200	61	624000	33	116800	6	1600	< 1	1913600
	15	584000	61	312000	33	52800	6	9600	1	958400
	20	483200	54	348800	39	43200	5	14400	2	889600
13	00									
	05	1118400	81	118400	9	136000	10	6400	< 1	1379200
	10	1017600	73	236800	17	124800	9	8000	1	1387200
	15	208000	62	80000	24	44800	13	1600	< 1	334400
	20	129600	60	68800	32	14400	7	4800	2	217600
	25	177600	73	28800	12	38400	16	-	-	244800
14	00									
	05	1347200	67	592000	29	65600	3	3200	< 1	2008000
	10	1649600	65	828800	33	48000	2	6400	< 1	2532800
	15	1052800	72	345600	24	64000	4	6400	< 1	1468800
	20	107200	58	35200	19	32000	17	9600	5	184000
	25	3200	6	14400	28	25600	50	8000	16	51200
	30	22400	44	8000	16	20800	41	-	-	51200
	40	80000	30	150400	57	27200	10	6400	2	264000

Table 5. (continued)

		Chaetoceros		Other diatoms		Flagellates		Dinoflagellates		Total Number
Sta	Depth (m)	Number	%	Number	%	Number	%	Number	%	of Cells
15	00									
	03	1891200	63	992000	33	123200	4	1600	< 1	3008000
	06	2072000	69	846400	28	70400	2	4800	< 1	2993600
	09	1884800	66	876800	31	107200	4	1600	< 1	2870400
	12	1592000	78	356800	18	80000	4	1600	< 1	2030400
	15	1091200	79	241600	17	43200	3	4800	< 1	1380800
	18	1150400	74	352000	23	49600	3	–	–	1552000
16	00	2402000	62	1412000	37	42000	1	6000	< 1	3862000
	05	3150400	82	636800	17	56000	1	8000	< 1	3851200
	10	620800	72	190400	22	46400	5	3200	< 1	860800
	15	889600	75	257600	22	43200	4	–	–	1190400
	20	848000	79	198400	19	20800	2	–	–	1067200
	25	772800	73	249600	24	36800	3	–	–	1059200
16A	00	3048000	86	436000	12	40000	1	2000	< 1	3526000
	05	7081600	86	1130400	14	59200	1	4800	< 1	8276000
	10	1625600	81	377600	19	6400	< 1	3200	< 1	2012800
	15	1798400	82	369600	17	19200	1	–	–	2187200
	20	1516800	86	219200	12	17600	1	3200	< 1	1756800
	25	1654400	84	292800	15	28800	1	1600	< 1	1977600
	30	1520000	83	283200	16	14400	< 1	4800	< 1	1822400
17	00	5036800	81	1121600	18	81600	1	4800	< 1	6244800
	03	4620800	76	1345600	22	80000	1	3200	< 1	6049600
	06	5270400	77	1512000	22	65600	1	–	–	6848000
	09	5225600	74	1785600	25	68800	1	4800	< 1	7084800
	12	5982000	80	1410000	19	64000	1	12000	< 1	7468000
	15	4876000	69	2089000	30	72000	1	8000	< 1	7045000
	20	3904000	74	1366000	26	32000	1	2000	< 1	5304000
	25	2272000	67	1076000	32	52000	2	6000	< 1	3406000

Table 5. (continued)

Sta	Depth (m)	*Chaetoceros* Number	%	Other diatoms Number	%	Flagellates Number	%	Dinoflagellates Number	%	Total Number of Cells
18	00	4254000	92	340000	7	34000	1	–	–	4628000
	03	3954000	93	240000	6	50000	1	14000	< 1	4258000
	06	4236000	95	194000	4	34000	1	12000	< 1	4476000
	09	3310000	90	304000	8	74000	2	10000	< 1	3698000
	12	3714000	89	390000	9	52000	1	2000	< 1	4158000
	15	3036000	92	208000	6	60000	2	12000	< 1	3316000
	20	4174000	90	404000	9	30000	1	6000	< 1	4614000
	25	6584000	86	1042000	14	34000	< 1	2000	< 1	7662000
19	00	–	–	4000	1	566000	99	4000	1	574000
	10	–	–	–	–	206000	100	–	–	206000
	20	–	–	4000	5	80000	91	4000	5	88000
	30	–	–	–	–	88000	100	–	–	88000
	45									
	60									
	75									
	100									
	200									
	400									
	500									
	600									
	700									
	800									
	900									
	1000									
26	00	6682000	83	890000	11	436000	5	4000	< 1	8012000
	03	6676000	83	948000	12	432000	5	36000	< 1	8092000
	06	6884000	84	916000	11	376000	5	38000	< 1	8214000
	09	7188000	84	1006000	12	340000	4	38000	< 1	8572000
	12	7818000	86	786000	9	418000	5	44000	< 1	9066000
	15	5610000	81	846000	12	490000	7	22000	< 1	6968000

Table 5. (continued)

Sta	Depth (m)	*Chaetoceros* Number	%	Other diatoms Number	%	Flagellates Number	%	Dinoflagellates Number	%	Total Number of Cells
26	20	2230000	88	136000	5	136000	5	24000	1	2526000
	25	1902000	92	50000	2	94000	5	18000	1	2064000
27	00	1342000	57	771000	33	210000	9	16000	1	2339000
	03	996000	47	818000	39	296000	14	14000	1	2124000
	06	1574000	55	866000	30	416000	14	18000	1	2874000
	09	1540000	59	704000	27	342000	13	8000	< 1	2594000
	12	1494000	55	918000	34	284000	10	16000	1	2712000
	15	1440000	59	668000	27	308000	13	14000	1	2430000
	20	1800000	72	556000	22	140000	6	14000	1	2510000
	30	2782000	73	850000	22	172000	5	10000	< 1	3814000
29	00	454000	76	64000	11	78000	13	4000	1	600000
	05	820000	76	114000	11	146000	13	4000	< 1	1084000
	10	782000	73	128000	12	158000	15	6000	1	1074000
	15	626000	63	196000	20	160000	16	8000	1	990000
	20	1274000	74	314000	18	134000	8	2000	< 1	1724000
	25	12028000	97	256000	2	140000	1	14000	< 1	12438000
	30	12030000	97	174000	1	158000	1	8000	< 1	12370000
	35	12232000	97	188000	1	114000	1	14000	< 1	12548000
30	00	800000	80	94000	9	104000	10	2000	< 1	1000000
	03	684000	81	66000	8	90000	11	2000	< 1	842000
	06	788000	85	68000	7	62000	7	4000	< 1	922000
	09	592000	73	178000	22	32000	4	4000	< 1	806000

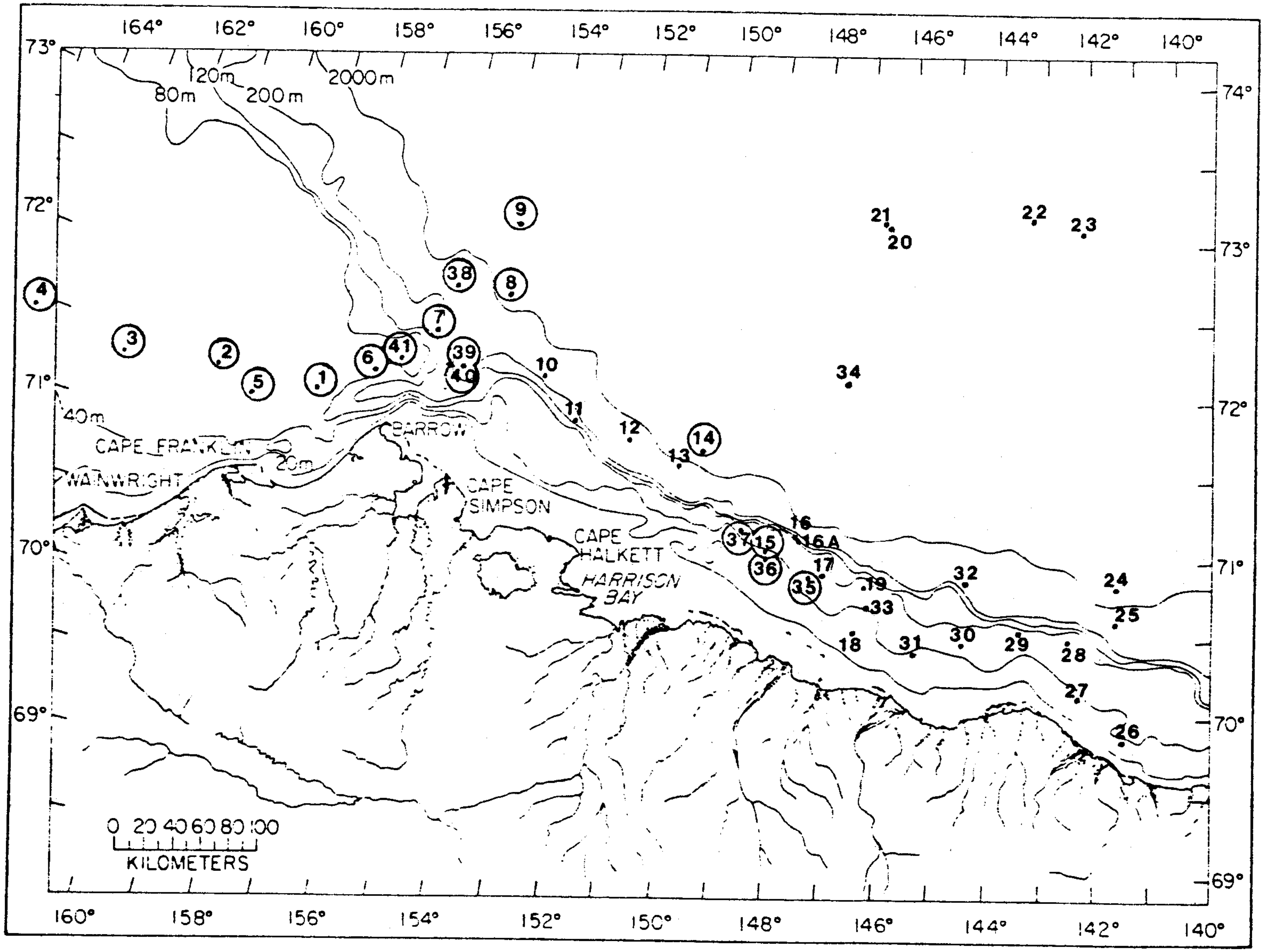

Fig. 3. Stations where zooplankton samples have been analyzed.

Table 6. Zooplankton species present in the Chukchi and Beaufort seas in 1976 and 1977.

Coelenterata (Cnidaria)

Hydrozoa

Aeginopsis laurentii Brandt
Aglantha digitale (Müller)
Bougainvillia superciliaris (L. Agassiz)
Calycopsis birulai (Linko)
Corymorpha flammea Linko
Perigonimus vesicarius (A. Agassiz)
Perigonimus yoldia-arcticae Birula
Perigonimus spp.
Plotocnide borealis Wagner
Rathkea octopunctata (M. Sars)
Unidentified Hydrozoa

Scyphozoa

Cyanea capillata (Linneaus)

Ctenophora

Beroë cucumis Fabricius
Pleurobrachia pileus (Vanhöffen)
Unidentified Ctenophora

Polychaeta

Unidentified pelagic larvae

Mollusca

Gastropoda - Pteropoda

Clione limacina Phipps
Spiratella helicina (Phipps)

Crustacea

Ostracoda

Conchoecia borealis maxima Brady & Norman
Philomedes globosus (Lilljeborg)

Table 6. (continued)

Copepoda

Calanoida

Acartia clausi Giesbrecht
Acartia longiremis (Lilljeborg)
Calanus cristatus Krøyer
Calanus glacialis Jaschnov
Calanus hyperboreus Krøyer
Calanus plumchrus Marukawa
Centropages abdominalis Sato
Derjuginia tolli (Linko)
Eucalanus bungii bungii Johnson
Euchaeta glacialis Hansen
Eurytemora richingsi Heron & Damkaer
Limnocalanus grimaldii (Guerne)
Metridia longa (Lubbock)
Microcalanus pygmaeus (G. O. Sars)
Pseudocalanus major G. O. Sars
Pseudocalanus minutus (Krøyer)
Pseudocalanus sp.
Scaphocalanus magnus (Scott)
Unidentified Calanoida

Cyclopoida

Oithona similis Claus
Oncaea borealis G. O. Sars
Unidentified Cyclopoida

Harpacticoida

Unidentified Harpacticoida

Unidentified copepod nauplii

Cirripedia

Balanus spp. nauplii
Balanus spp. cypris

Mysidacea

Mysis litoralis (Banner)
Mysis oculata (Fabricius)
Mysis spp.
Unidentified larvae

Cumacea

Unidentified cumacean

Table 6. (continued)

Cladocera

Unidentified Cladocera

Amphipoda

Gammaridea

Apherusa glacialis (Hansen)
Onisimus glacialis cf.
Unidentified Gammaridea

Hyperiidea

Hyperia galba (Montagu)
Hyperia medusarum (Müller)
Hyperoche medusarum (Krøyer)
Parathemisto abyssorum Boeck
Parathemisto libellula (Lichtenstein)
Parathemisto sp.
Unidentified Hyperiidea

Euphausiacea

Thysanoëssa inermis (Krøyer)
Thysanoëssa longipes Brandt
Thysanoëssa raschii (M. Sars)
Unidentified larvae

Decapoda

Anomura
Brachyura
Caridea - larvae
Hippolytidae
Pandalidae
Unidentified

Echinodermata

Unidentified larvae

Table 6. (continued)

Appendicularia (Larvacea)

Fritillaria borealis Lohmann
Fritillaria haplostoma Fol
Fritillaria spp.
Oikopleura labradoriensis Lohmann
Oikopleura vanhöffeni Lohmann
Oikopleura spp.

Chaetognatha

Eukrohnia hamata (Mobius)
Sagitta elegans Verrill
Sagitta maxima cf.
Sagitta spp.
Unidentified chaetognaths

Pisces

Eggs - unidentified

Pleuronectidae

Hippoglossoides robustus Gill & Townsend

Larvae - unidentified

Stichaeidae

Lumpenus fabricii cf.

Cottidae

Myoxocephalus quadricornis (Linnaeus)

Gadidae - unidentified

Boreogadus saida (Lepechin)

Other organisms

Nematoda - unidentified
Unknown organisms
Unknown invertebrate eggs

Table 7. Abundance (number per 1000 m^3) of zooplankton taxa found in net hauls from the Chukchi Sea. All samples were collected with bongo nets, mesh size 505 μm, unless otherwise indicated. Where no number is present, no animals were found.

Taxon	Station Numbers							
	1	2	3	4	4A	5	6	41*
Coelenterata								
Aeginopsis laurentii		90		20				
Aglantha digitale		180	160	20	110	110	50	
Calycopsis birulai								
Corymorpha flammea								
Perigonimus vesicarius								
Perigonimus yoldia-arcticae								
Perigonimus spp.								
Plotocnide borealis		90						
unidentified medusae		180	30					
Ctenophora								
Beroë cucumis			30			40	100	
Pleurobrachia pileus								
Polychaeta - unidentified larvae	210	360	740	170		150		
Mollusca								
Gastropoda - Pteropoda								
Clione limacina		550	50	20		40		
Spiratella helicina	410	2910	270	200	220	400	140	
Crustacea								
Ostracoda								
Conchoecia borealis maxima								
unidentified ostracods			30					

* Analysis of these samples is not complete.

Table 7. (continued)

Taxon	Station Numbers							
	1	2	3	4	4A	5	6	41
Copepoda								
Calanoida	71380	74730	16000	26540	98070	40690	14150	
Harpacticoida						40		
unidentified nauplii			50			150	50	
Cirripedia								
Nauplii	620	1270	30		740	470	290	
Cyprids	410							
Mysidacea								
Mysis litoralis								
Mysis oculata								
Mysis spp.		60					2	
unidentified *Mysis* larvae								
Cumacea								
unidentified cumacean					20			
Amphipoda								
Gammaridea								
Apherusa glacialis								
Onisimus glacialis cf.								
Other Gammaridea	720		150	60		590	150	90

Table 7. (continued)

Taxon	Station Numbers							
	1	2	3	4	4A	5	6	41
Hyperiidea								
Hyperia galba		10						
Hyperia medusarum								
Hyperoche medusarum								
Parathemisto abyssorum								
Parathemisto libellula		90			220	5	3	210
Parathemisto sp.		10				5		
Other Hyperiidea								
Euphausiacea								
Thysanoëssa inermis	30				40	10	2	
Thysanoëssa longipes		20					2	
Thysanoëssa raschii	10	10		10			5	
unidentified larvae							2	
Decapoda								
Anomura		30		60	20	20	10	
Brachyura		820	40	10	150	130	8	
Caridea - larvae								
Hippolytidae	20	160	40	20	110			
Pandalidae	10							
unidentified			10			10	80	240
Echinodermata								
unidentified larvae							50	

Table 7. (continued)

Taxon	Station Numbers							
	1	2	3	4	4A	5	6	41
Appendicularia (Larvacea)								
Fritillaria borealis		3270				330		
Fritillaria haplostoma								
Fritillaria spp.		2360	30			470		
Oikopleura labradoriensis		270						
Oikopleura vanhöffeni	1030						290	
Oikopleura spp.	2670	5910				180	670	
Chaetognatha								
Eukrohnia hamata								
Sagitta elegans	9440	10270	4490	3830	4520	15350	7960	
Sagitta maxima cf.	210							
Sagitta spp.		4000		70	520			
unidentified chaetognaths	1440		160	200	300	760		
Pisces								
Eggs - unidentified								
Pleuronectidae								
Hippoglossoides robustus		10				5		
Larvae - unidentified								20
Stichaeidae								
Lumpenus fabricii cf.		10					2	
Cottidae								
Myoxocephalus quadricornis								
Gadidae - unidentified	30	130			150	20	2	
Boreogadus saida								

Table 7. (continued)

Taxon	Station Numbers							
	1	2	3	4	4A	5	6	41
Other organisms								
Nematoda - unidentified			140	60				
Unknown organisms		180		10	70	40	530	
Unknown invertebrate eggs								

Table 8. Abundance (number per 1000 m^3) of zooplankton taxa found in net hauls from the Beaufort Sea. All samples were collected with bongo nets, mesh size 505 μm, unless otherwise indicated. Where no number is present no animals were found.

Taxon	Station Numbers											
	7*	8*†	9*	14	15E§	35	36	37E§	37	38	39	40
Coelenterata												
Aeginopsis laurentii	80					70	90	340	210			
Aglantha digitale	320	40			280	430	150	210	70	570	300970	47180
Calycopsis birulai						20	30					
Corymorpha flammea		2				140			10			
Perigonimus vesicarius		2				180		90				
Perigonimus yoldia-arcticae							30	180				
Perigonimus spp.						140			50			
Plotocnide borealis						50						
unidentified medusae					10				10	2	10	100
Ctenophora												
Beroë cucumis						110				70		
Pleurobrachia pileus					30							
Polychaeta - unidentified larvae	110					70				220		
Mollusca												
Gastropoda - Pteropoda												
Clione limacina				130	60		50		170		3027	200
Spiratella helicina	1090			4950	2640	5610	3830	8650	1390			

* Analysis of these samples is not complete.

† Volume of water filtered used to calculate abundances is from the flowmeter in the 333 μm net and is probably high due to wind.

§ E indicates the sample was collected with the English umbrella net, mesh size *ca.* 220 μm.

Table 8. (continued)

Taxon	Station Numbers											
	7*	8*†	9*	14	15E§	35	36	37E§	37	38	39	40
Crustacea												
Ostracoda												
Conchoecia borealis maxima					10	180	20		20			
unidentified ostracods												
Copepoda												
Calanoida	130			36320	8780	115640	16590	52700	96170	17510		360
Harpacticoida												
unidentified nauplii												
Cirripedia												
Nauplii					10	40	20	70		70		
Cyprids	80											
Mysidacea												
Mysis litoralis				80	10	20	120	90	40			
Mysis oculata				30		20	30		80			
Mysis spp.		2		30			20					
unidentified *Mysis* larvae						120						
Cumacea												
unidentified cumacean												
Amphipoda												
Gammaridea												
Apherusa glacialis							50	130				
Onisimus glacialis cf.					110		210	690				
Other Gammaridea	80	320	340	870		380			460	40	10	

Table 8. (continued)

Taxon	Station Numbers											
	7*	8*†	9*	14	15E§	35	36	37E§	37	38	39	40
Hyperiidea												
Hyperia galba	3			20			30	30	40		30	
Hyperia medusarum								10				
Hyperoche medusarum		2							10			
Parathemisto abyssorum	160	50	40	950			110	370	260	10	10	
Parathemisto libellula	40	110	160	1220			420	10	7970	110	510	
Parathemisto sp.	3	7	20	140					500	2	30	
Other Hyperiidea									20		30	
Euphausiacea												
Thysanoëssa inermis	3	20					50		10	7	40	
Thysanoëssa longipes												
Thysanoëssa raschii	20	5		20			50		40		120	
unidentified larvae										2		10
Decapoda												
Anomura	110									70		
Brachyura	90											100
Caridea - larvae												
Hippolytidae				160	100		50	100	80			
Pandalidae				20								
unidentified	30	7	3	20		340				90		10
Echinodermata												
unidentified larvae												

Table 8. (continued)

Taxon	7*	8*†	9*	14	15E§	35	36	37E§	37	38	39	40
	Station Numbers											
Appendicularia (Larvacea)												
Fritillaria borealis						960						
Fritillaria haplostoma							60					
Fritillaria spp.						2930	150	590		70		
Oikopleura labradoriensis	240			510	180	250	30	8000	520			
Oikopleura vanhöffeni	3680			1400	150	640	120	6240	4520	430		
Oikopleura spp.	11090			5210	210	570	850	13760	15300	3090		
Chaetognatha												
Eukrohnia hamata	240			130		40	50	10		70		
Sagitta elegans	6880			1140	430	1320	210	100	1040	9540		
Sagitta maxima cf.												
Sagitta spp.				130					700			
unidentified chaetognaths							30		170			
Pisces												
Eggs - unidentified	3											
Pleuronectidae												
Hippoglossoides robustus												
Larvae - unidentified	3									2	40	
Stichaeidae												
Lumpenus fabricii cf.												
Cottidae												
Myoxocephalus quadricornis							20			20		
Gadidae - unidentified					30	20	20			10		
Boreogadus saida							20			10		
Other organisms												
Nematoda - unidentified												50
Unknown organisms						40						
Unknown invertebrate eggs						20						

to species as they were in 1976 samples. Distribution and abundance of these and other organisms are discussed by taxonomic category.

Amphipoda

Of the gammarid amphipods, only *Apherusa glacialis* and *Onisimus glacialis* have been identified. They were collected at stations near the east end of Harrison Bay. Five species of hyperiid amphipods have been identified. *Parathemisto abyssorum* and *P. libellula* were the most common and were especially abundant off Harrison Bay.

Euphausiacea

Three species of the genus *Thysanoëssa*, *T. inermis*, *T. raschii*, and *T. longipes*, were collected, but never in large numbers.

Decapoda

The decapods have been divided into anomuran, brachyuran, and caridea larvae, with caridea further divided into hippolytid and pandalid shrimp larvae. Decapods, while not very abundant, were found at nearly all stations with the greatest numbers usually in the Chukchi Sea.

Mysidacea

Mysis litoralis and *M. oculata* were collected at stations off Harrison Bay.

Pisces

Few fish eggs and larvae were collected. A few *Hippoglossoides robustus* eggs were found at stations 2 and 5 in the Chukchi Sea and unidentified eggs were found at station 7 north of Point Barrow.

Larvae tentatively identified as *Lumpenus fabricii* were found at stations 2 and 6 in the Chukchi Sea. *Myoxocephalus quadricornis* larvae were found at stations 36 and 37 off Harrison Bay. Unidentified gadid larvae, probably *Boreogadus saida* were collected at stations in both the Chukchi and Beaufort seas, while larvae large enough to be definitely identified as *B. saida* were collected at stations 36 and 37.

Coelenterata

Seven species of medusae were identified in the samples with *Aglantha digitale* the most common and widespread species.

Ctenophora

Beroë cucumis and *Pleurobrachia pileus* were the only ctenophores identified; neither occurred in any abundance.

Polychaeta

Unidentified polychaete larvae were present at several stations especially in the Chukchi Sea.

Mollusca

Two species of pteropods were present, *Clione limacina* and *Spiratella helicina* with *Spiratella* being abundant at all stations, especially in the Beaufort Sea.

Copepoda

Copepods have been identified as Calanoida, Harpacticoida, and unidentified nauplii. Calanoid copepods were abundant and widespread throughout the sampling area. Harpacticoids were found only at station 5.

Cirripedia

Barnacle larvae were most abundant at stations in the Chukchi Sea.

Ostracoda

Conchoecia borealis maxima, the only species identified, was present in small numbers at stations off Harrison Bay. Unidentified ostracods were found at station 3 in the Chukchi Sea.

Cumacea

Unidentified cumaceans were found at station 4A.

Echinodermata

Unidentified echinoderm larvae were present at station 6 off Point Barrow.

Appendicularia

Appendicularia were present at most stations, being very abundant in the Beaufort Sea. Four species have been identified: *Fritillaria borealis, F. haplostoma, Oikopleura labradoriensis* and *O. vanhöffeni*.

Chaetognatha

Chaetognaths were widespread and abundant. Three species have been identified, with *Sagitta elegans* being the most common.

A few other organisms, including nematodes and unidentified organisms have been found at some stations.

VII. Discussion

A. Phytoplankton standing stock and primary productivity

With few exceptions, the same phytoplankton species (Table 4) were present in 1976 and 1977. The small species of *Chaetoceros*, including *Ch. ceratosporum, Ch. fragilis, Ch. furcellatus, Ch. gracilis, Ch. socialis*, and *Ch. wighami*, were the most abundant organisms at most stations both years.

Other abundant diatoms in 1977 were *Bacterosira fragilis*, *Thalassiosira gravida*, *Th. nordenskioeldii*, *Nitzschia delicatissima*, and *Nitzschia grunowii*. Small, unidentified flagellates were present both years, but were more abundant in 1976. Dinoflagellates were present, but not abundant, either year.

Some variability in species composition occurred between years. The centric diatom *Leptocylindrus minimus* that was present in Bering Sea water in 1976 has not been found in 1977 samples. The silicoflagellate *Distephanus (Dictyocha) speculum* was relatively common at some stations east of Barter Island in 1977. This species is common in deeper water of the Arctic Basin (Tibbs 1967), but is rarely seen in shallow water in the Beaufort Sea. Another silicoflagellate, *Ebria tripartita*, was more abundant in 1976 than in 1977. It is often found in coastal waters of the Beaufort Sea. *Thalassiosira antarctica* was present and common at many of the 1977 Beaufort Sea stations. *Eucampia zoodiacus* that occurred frequently in 1976 was also common in 1977, but its distribution was more widespread in 1977. The small changes in species composition, with the possible exception of *Leptocylindrus minimus*, are probably not important in the overall productivity of the Beaufort Sea. *Leptocylindrus* might be important because it apparently is an indicator of Bering Sea water. Other differences occurred because of sampling farther east than previously and some because of the absence of ice.

Cell numbers and primary productivity were generally higher in 1977 than in 1976. High values in the area near Barter Island ($\sim$ 143° W) where upwelling has been reported (Hufford 1974) could have been caused by nutrients being brought onto the shelf. Unfortunately, no nutrient data are available from the cruise. Most of the sampling area in the Beaufort Sea was ice-free in 1977, while in 1976, ice prevented sampling east of Prudhoe Bay ($\sim$ 148° W). Increased light probably caused higher numbers of diatoms and increased productivity in 1977.

B. Zooplankton

Based on 1976 samples, the zooplankton of the western Beaufort Sea were grouped into four categories (English and Horner 1977):

1. Species that are expatriates from the Bering and Chukchi seas;
2. Species that occur throughout the Arctic Basin;
3. Species that are usually found in neritic, less saline areas;
4. Species that contribute meroplanktonic life history stages.

Results from 1977 samples analyzed to date support these conclusions, although copepods, which were the major group of animals used to document the scheme, have not been identified to species. Thus, the presence or absence of Bering Sea water in the Beaufort Sea cannot be determined from 1977 zooplankton distributions, but this conclusion has been well-documented from 1976 and in earlier studies (Johnson 1956). Other organisms can be used to indicate the other categories however.

Species such as *Thysanoëssa* spp., *Fritillaria borealis*, *Oikopleura* spp., *Sagitta elegans*, and *Boreogadus saida* that occur throughout the Arctic Basin were present and sometimes abundant in 1976 and 1977 samples. The distribution of these species is probably affected more by biological processes than hydrography.

Neritic species found in 1977 samples include *Mysis litoralis* and *Onisimus glacialis*. They were found in shallower water at stations 36 and 37.

Meroplanktonic stages of barnacles, polychaetes, and echinoderms were more abundant in the Chukchi Sea than in the Beaufort Sea in 1977. Barnacle larvae were the most common component of the meroplankton. Meroplankton production may be greater in the Chukchi and western Beaufort seas than in the eastern Beaufort Sea because of the wider continental shelf area and shallower water in the western areas (Johnson 1956).

Of the hydromedusae identified, only *Aglantha digitale* was widespread. It was particularly abundant at stations 39 and 40, an area where currents converged and where the temperature was *ca.* 8 C and the salinity *ca.* 29°/°° throughout the water column. Hand and Kan (1961) have suggested that *Aglantha* in a downwelling current at a convergence would try to maintain itself in surface waters and thus occur in large numbers.

Amphipods in the 1977 samples are being identified to species. Distributions are widespread, although the hyperiids *Parathemisto libellula* and *P. abyssorum* were most abundant at stations where ice was relatively heavy and where they comprised 100% of the stomach contents of seals collected by Alaska Department of Fish and Game personnel (Frost pers. comm.). Hyperiid amphipods were not abundant in 1976 samples. MacGinitie (1955) reported *P. libellula* as very abundant in 1949, occurring in rows that stretched for miles along the beach, but it was not abundant in 1948.

VIII. Conclusions

A. Phytoplankton

1. With some exceptions, individual phytoplankton species have widespread distributions in the Chukchi and Beaufort seas, although standing stocks may be patchy.

2. Some species may be water mass indicators, *i. e.*, *Leptocylindrus minimus* apparently indicates the presence of Bering Sea water.

3. Primary productivity is variable and patchy. Highest production often occurs below 20 m in the northern Chukchi Sea and above 20 m in the Beaufort Sea and where diatoms are the most abundant organisms.

4. Standing stocks and primary productivity are apparently light-limited when ice is present during the growing season.

B. Zooplankton

1. Zooplankton species can be grouped into four categories:

a) Species that are expatriates from the Bering and Chukchi seas;
b) Species that occur throughout the Arctic Basin;
c) Species that are usually found in neritic, less saline areas;
d) Species that contribute meroplanktonic life history stages.

2. Distribution of many species is influenced by hydrography.

3. Meroplankton comprise a large fraction of the zooplankton in the western Beaufort Sea.

4. Birds and mammals are apparently opportunistic feeders, eating whatever prey species happen to be available at a given time.

These conclusions, based on samples collected in August and early September, are reasonably firm, but it must be emphasized that these conclusions are based only on samples collected in summer.

IX. Summary of fourth quarter operations

A. Ship or laboratory activities

1. There were no field activities this quarter.

2. Laboratory activities

Analysis of zooplankton and phytoplankton samples collected during the *Glacier* cruise, 1 Aug to 7 Sep 1977, is proceeding. Primary productivity samples have been analyzed and calculated (Table 3).

3. Methods

Phytoplankton standing stock samples are being analyzed using a Zeiss phase-contrast inverted microscope following the method of Utermöhl (1931). Five and 50 ml Zeiss settling chambers are set up for each sample. Rare organisms and cells larger than 75 μm are counted at 100 X magnification in the 50 ml chambers and small, abundant organisms are counted at 250 X magnification in the 5 ml chambers. One-fifth of the 50 ml chamber and 1/5, 1/8, or 1/10 of the 5 ml chamber is counted. References being used for species identification include Hustedt (1930, 1959) and Cupp (1943) for diatoms, and Schiller (1933, 1937) for dinoflagellates. Meunier (1910) and Brandt and Apstein (1908) are used for diatoms, dinoflagellates, and other organisms, including silicoflagellates.

Primary productivity samples have been analyzed using a Packard Tri-Carb Liquid Scintillation Spectrometer with Aquasol (New England Nuclear) as the scintillation cocktail. Productivity was calculated using the equation:

$$Ps\ (mg\ C\ m^{-3} \cdot hr^{-1} = \frac{(L-D) \times W \times 1.05}{R \times T}$$

where (L-D) = light-dark bottle disintegrations per min; W = carbonate carbon; 1.05 = ^{14}C isotope factor; R = activity of the ^{14}C used; and T = incubation time.

The zooplankton samples are first sorted for all specimens of Amphipoda, Caridea, Euphausiacea, Mysidacea, and Pisces. Each sample is then split in a Folsom plankton splitter until a subsample containing 100 specimens of the most abundant remaining species is obtained. The specimens are identified and counted using a dissecting microscope. Voucher specimens are being kept for some species. References used to identify zooplankton species are listed in Table 9.

4. Station locations are given in Fig. 1.

5. Data collected and analyzed

Parameter	Number Collected (Aug-Sep 77)	Number Analyzed (Oct 77-Mar 78)
Temperature	331	331
Salinity	334	334
Primary Productivity	186	186
Chlorophyll *a*, phaeopigments	334	0
Standing Stock		
Phytoplankton	334	163
Zooplankton		
Bongo net	37	14 (4)*
English net	8	2

* Number in parenthesis indicates partial analysis

6. Milestone chart and data submission schedules

a. A new milestone chart is given on page 52.

b. Slippages in data analysis have occurred because cash flow from NOAA has been slow and money has not been available to buy necessary supplies.

B. Problems encountered

The biggest problem has been in receipt of funds from NOAA. This has made paying salaries and purchasing supplies somewhat difficult and at times, impossible. NOAA contracting personnel have been extremely helpful in trying to remedy this problem.

Table 9. References used to identify zooplankton.

Taxon	References
Coelenterata - Hydrozoa	Naumov 1960 Shirley & Leung 1970
Ctenophora	Leung 1970b
Polychaeta	Pettibone 1954 Yingst 1972
Mollusca - Pteropoda	Leung 1971
Ostracoda	Leung 1972c
Copepoda	Vidal 1971
Mysidacea	Leung 1972b
Amphipoda	Sars 1895 Tencati 1970
Euphausiacea	Leung 1970a
Decapoda	Berkeley 1930 Hart 1971
Appendicularia	Leung 1972a
Chaetognatha	Dawson 1971
Pisces	Andriashev 1954 Musienko 1970

MILESTONE CHART

RU #: 359   PI: Rita A. Horner

Major Milestones: Reporting, data management and other significant contractual requirements; periods of field work; workshops; etc.

MAJOR MILESTONES	1977 O	N	D	1978 J	F	M	A	M	J	J	A	S	O	N	D
Reports: Quarterly	▲			▲						△					
Annual							▲								
Final													△		
Sample Analysis: Chlorophyll, phaeopigments	△														
Primary Productivity	△	△			▲	▲									
Zooplankton							△								
Phytoplankton							△								
Data Processing: Chlorophyll, phaeopigments			△												
Primary Productivity				△		▲									
Zooplankton								△	△						
Phytoplankton								△	△						
Data Submission: Primary Productivity, Chlorophyll					△					△					
Zooplankton										△					
Phytoplankton										△					
FY 78 Field Effort											△	△			

△ Planned Completion Date   ▲ Actual Completion Date

C. Estimate of funds expended

Approximately one-third of the funds have been expended as of 15 March 1978.

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QUARTERLY REPORT

Contract No.	:R7120824
Research Unit. No.	:RU-380
Reporting Period	:1 Jan - 31 Mar 1978
Number of Pages	:1
Attachments	:Final Report

ICHTHYOPLANKTON OF THE EASTERN BERING SEA

Co-Principal Investigators

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National Marine Fisheries Service
Northwest and Alaska Fisheries Center
Seattle, Washington
March 1978

PI QUARTERLY PROGRESS REPORT

Reporting period: 1 January-31 March 1978

Project title: Ichthyoplankton of the eastern Bering Sea (RU-380).

I. Highlights of the quarter's accomplishments:

No OCSEAP funds were allocated to this project this fiscal year. Work during the quarter consisted of the preparation of a Final Report for this project (copy attached).

II. Objectives:

Collect and analyze ichthyoplankton samples from a portion of the eastern Bering Sea during spring 1976 and 1977.

III. Field or laboratory activities:

A. Ship or field trip schedule:
None

B. Scientific party:

Kenneth D. Waldron	NMFS	Co-principal investigator (part-time)
Beverly M. Vinter	NMFS	Ichthyoplankton specialist (part-time)
Donald M. Fisk	NMFS	Technician (part-time)

C. Methods:
Fish larvae were identified by standard procedures used in larval fish taxonomy.

D. Samples collection localities:
None

E. Data collected and/or analyzed:
See Final Report

IV. Results:

The attached Final Report of this study includes a summary of objectives and conclusions, as well as implications with respect to potential oil and gas development.

The following was submitted as part of this report:

Waldron, Kenneth D. and Beverly M. Vinter (1978), "Ichthyoplankton of the Eastern Bering Sea", Northwest and Alaska Fisheries Center, NMFS, Seattle, Washington 98112, Processed Report, 88 pp.

ANNUAL REPORT

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Research Unit #: 424
Reporting Period: 1 Apr 1977 - 31 Mar 1978
Number of Pages:

Lower Cook Inlet Meroplankton

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1 April 1978

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REF: A78-9

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LIST OF APPENDICES

I. Summary

The objective was to obtain a reconnaissance level survey of eggs and larvae of fishes and shellfishes of economic importance in Lower Cook Inlet. The conclusions include the observations that the abundance of those early life history stages varies greatly in time and space because spawning is both seasonal and localized. Many organisms had their highest abundance of early life history stages in inner and outer Kachemak Bay. The implications with respect to OCS oil and gas development are that potential resource use conflicts with fisheries harvests are serious and that we lack quantitative ecosystem observations for model input to decide whether changes in harvests can best be attributed to oil and gas development or to fishing activities.

II. Introduction

A. General nature and scope of study

This study was planned as a reconnaissance level survey of early life history stages of fishes, shrimps, and crabs in Lower Cook Inlet. The study was intended to obtain preliminary quantitative observations in four seasons within one year.

B. Specific objectives

The specific objective of this study was to use MARMAP methods to obtain density distribution maps within seasons of eggs and larvae of fishes and shellfishes of major economic significance in Lower Cook Inlet.

C. Relevance to problems of petroleum development

Quantitative assessments of spatial and temporal distributions and abundance of economically important fishes and shellfishes are of relevance to problems of petroleum development in Lower Cook Inlet. A resource use conflict in Lower Cook Inlet exists between petroleum development and major fisheries harvests. Spawning areas are close to OCS lease areas; local fishermen and the State of Alaska are uneasy about potential damage to the harvests.

Studies of early life history stages are important fishery-independent observations: (1) the earliest life history stages allow an assessment of the magnitude of the spawning population, and (2) later, pre-recruit, life history stages allow an assessment of year class strength before exploitation by the fishery.

III. Current state of knowledge

The current state of knowledge has been compiled in an annotated review of the literature (Tables 1-3). These references are predominantly used for the identification of fish eggs and larvae (Table 1), crabs (Table 2), and shrimps (Table 3).

IV. Study area

Station locations in the Lower Cook Inlet region are shown in Figure 1. The geographic coordinates are shown in Table 4.

V. Sources, methods, and rationale of data collection

Ten routine sampling locations were established in the Lower Cook Inlet region (Figure 1 and Table 4). Seven cruises were made from April 1976 through February 1977; bad weather prevented sampling four stations (Table 5).

Plankton samples were obtained by using open bongo nets in double-oblique hauls using MARMAP[1] methods. The diameter of the nets was 60 cm and the mesh sizes were 333 and 505 μm. The volume of water filtered was estimated as the product of the area of the net opening and the distance of each haul measured by a calibrated flow meter in the mouth of each net. The assumption was implicit that the efficiency of filtration was 100%. If one flow meter failed, the other meter reading was used; in two instances when both meters failed, an estimate was made using the duration relative to other hauls.

The samples were sorted repeatedly to remove fish eggs, fish larvae and juveniles, shrimps, and crabs. In most cases the entire sample was examined; subsamples were taken when organisms in a group were relatively very abundant.

The organisms were identified to the lowest practicable taxonomic category and life history stage. The concentrations of the organisms were recorded, and reported in data submissions destined for the National Oceanographic Data Center, as abundance per cubic meter, with a minimum concentration of 0.001.

The concentrations of organisms taken with paired 333 and 505 μm meshes did not appear to differ as might occur with extrusion of small organisms or with escapement of large organisms (Figure 2). Therefore, the catches of the paired nets for each haul were combined as the geometric means of the two concentrations. Those mean concentrations per cubic meter were transformed, based on the depth of each sample, to abundance per 10 square meters for graphical and tabular presentations (Appendix A). The mean concentrations were also transformed to abundance per 1000 cubic meters (Appendix B). A rule for rounding was used throughout, such that any observation greater than 0 was rounded up to 1.

The abundance per 10 square meters was plotted at station locations for each cruise for the most abundant groups of fishes, shrimps, and crabs (Appendix C).

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[1] Smith, Paul E. and Sally L. Richardson. 1977. Manual of methods for resource survey and appraisal. Southwest Fisheries Center. Administrative Report No. LJ-77-11. 233 pp.

The geometric mean abundance per 10 square meters was plotted at station locations for each season for abundant groups of fishes, shrimps, and crabs (Appendix D). The appropriate life history stages were summed within each station and the geometric mean computed over cruises for the spring and summer seasons in which more than one cruise was made.

The annual abundance per 10 square meters was plotted at station locations for abundant groups of fishes, shrimps and crabs (Appendix E). The annual abundance was computed as the sum of organisms in specified categories within each station over seven cruises.

VI. Results

The results of this reconnaissance level survey include taxonomic lists and density distribution maps of planktonic eggs and larvae of fishes and shellfishes of major economic significance in Lower Cook Inlet. The taxonomic categories of fishes, pandalid shrimp, and commercially important species of crab larvae collected in the Lower Cook Inlet region from April 1976 through February 1977 have been tabulated (Tables 6, 7, and 8). In some cases the early life history stages could not be identified to species reliably and have been reported in more inclusive categories. The more abundant and important categories were selected for further analysis (Appendices A and B).

The quantitative density distributions of early life history stages of the selected categories for each of seven cruises are presented, as abundance per 10 square meters, on maps of the Lower Cook Inlet region (Appendix C).

The planktonic fish eggs are considered in four nominal size categories based on the diameter of the chorion: less than 1 mm, about 1 mm, about 2 mm, and about 3 mm (Table 9).

The fish eggs in the category less than 1 mm are between 0.74 and 0.88 mm in diameter. The fish eggs in this category are probably *Limanda aspera*, the yellowfin sole. The fish eggs in this category were caught from May through August. These fish eggs were most abundant in the July samples near Kachemak Bay and Kamishak Bay.

The fish eggs in the category about 1 mm are between 0.90 and 1.28 mm in diameter. The fish eggs in this category are probably a complex of four fishes: *Isopsetta isolepis*, the butter sole; *Parophrys vetulus*, the English sole; *Platichthys stellatus*, the starry flounder; and *Psettichthys melanostictus*, the sand sole. The fish eggs in this category were caught from April through August. These fish eggs were most abundant in the May samples near Kachemak Bay and Kamishak Bay.

The fish eggs in the category about 2 mm are between 1.30 and 2.54 mm in diameter. The fish eggs in this category are probably *Theragra* *chalcogramma*, the walleye pollock, and three flatfishes, *Atheresthes stomias*, the arrowtooth flounder, *Glyptocephalus zachirus*, the rex sole, and *Lyopsetta exilis*, the slender sole. The fish eggs in this category were caught from April through August. These fish eggs were most abundant in the May samples at scattered locations in the Lower Cook Inlet region.

The fish eggs in the category about 3 mm are 2.56 mm and larger in diameter. The fish eggs in this category are *Hippoglossoides* of an undetermined species, probably *H. elassodon*, the flathead sole. The fish eggs in this category were caught from May through August. These fish eggs were most abundant in the May samples at locations near the mouth of Cook Inlet.

The larvae of *Ammodytes hexapterus*, the Pacific sand lance, were caught from April through August and again in February. These larvae were most abundant in May in Kachemak Bay. No juvenile *Ammodytes* were observed.

The larvae of *Clupea harengus pallasi*, the Pacific herring, were caught in July and August. These larvae were most abundant in July at the most northern station location. One juvenile herring was taken in October at the same location.

The larvae of the Gadidae, the codfishes, are probably *Theragra chalcogramma*, the walleye pollock, and *Gadus macrocephalus*, the Pacific cod. The gadid larvae were caught from April through July. These larvae were most abundant in May toward the mouth of Cook Inlet. One gadid juvenile was taken in August near Kachemak Bay.

The larvae identified as *Hippoglossoides* sp. are probably one species, *H. elassodon*, the flathead sole. The larvae of *Hippoglossoides* were caught from May through August. One juvenile *Hippoglossoides* was taken in August near Kachemak Bay.

The larvae of *Mallotus villosus*, the capelin, were caught on every cruise except late May. The capelin larvae were most abundant in July and August near Kachemak Bay and Kamishak Bay, but were taken at all sampling locations. One juvenile capelin was taken in August and another in February.

The larvae of the family Osmeridae, the smelts, probably include *Thaleichthys pacificus*, the eulachon, *Spirinchus thaleichthys*, the longfin smelt, some small *Mallotus*, and other smelt. The larvae of Osmeridae were caught on five cruises, but not in April and late May. The osmerid larvae were most abundant in July and August and were widely scattered over the Lower Cook Inlet region. One juvenile osmerid was taken in February.

The early life history stages of *Pandalopsis dispar*, the sidestripe shrimp, were taken on all cruises except October. Stages I, II, III and IV were represented in the samples; stage V and juveniles were not represented.

The early life history stages of *Pandalus borealis*, the northern pink shrimp, were taken from April through August. Stages I, II, III, IV, V and juveniles were represented; stages VI and VII were not represented.

The early life history stages of the shrimp *Pandalus danae* were taken in July and August. Stages II and V were represented; stages I, III, IV, VI, and juveniles were not represented.

The early life history stages of *Pandalus goniurus*, the humpback shrimp, were taken from April through July. Stages I, II, III, IV, and juveniles were represented; stages V, VI, and VII were not represented.

The early life history stages of the *Pandalus hypsinotus*, the coonstripe shrimp, were taken in May. Stage I was represented; stages II, III, IV, V, VI, and juveniles were not represented.

The early life history stages of the shrimp *Pandalus platyceros* were taken in February. Stage II was represented; stages I, III, IV, and juveniles were not represented.

The early life history stages of the shrimp *Pandalus stenolepis* were taken from May through August. Stages I, II, III, IV, V, and VI were represented; the juveniles were not represented.

The early life history stages of the shrimp *Pandalus montagui tridens* were taken from April through July. Stages I, II, and III were represented; stage IV and juveniles were not represented.

The early life history stages of non-commercial crabs of the category Anomura were taken on all cruises. The zoea and megalopa stages were represented.

The early life history stages of non-commercial crabs of the category Brachyura, the true crabs, were taken from May through August and in February. The zoea and megalopa stages were represented.

The early life history stages of *Cancer magister*, the Dungeness crab, were taken from July through October. Stages I, II, V, and megalopa were represented; stages III and IV were not represented.

The early life history stages of *Cancer oregonensis*, the small non-commercial hairy cancer crab, were taken on all cruises except early May. Stages I, II, III, IV, V, and megalopa were represented.

The early life history stages of *Cancer productus*, the rock crab, were taken in May. Stage I was represented; stages II, III, IV, V, and megalopa were not represented.

The early life history stages of *Chionoecetes bairdi*, the tanner crab, were taken in May and July. Stages I and II were represented. The megalopa stage of *Chionoecetes* sp. is probably mostly *C. bairdi*, but that stage has not been described well enough to be certain. *Chionoecetes* sp. megalopa occurred in April and May, and again in August.

The early life history stages of *Paralithodes camtschatica*, the red king crab, were taken in April and May, and again in February. Stages I, II, and III were represented; stage IV and the megalopa were not represented.

The early life history stages of *Paralithodes platypus*, the blue king crab, were taken in July. The megalopa stage was represented; stages I, II, III, and IV were not represented.

The most abundant shrimp was *Pandalus goniurus*, with *Pandalus borealis* and *Pandalus montagui tridens* next most abundant. The non-commercial Anomura and Brachyura were very abundant, and the small *Cancer oregonensis* were the most abundant species of crab identified. *Paralithodes camtschatica* was the most abundant commercial crab, with *Chionoecetes bairdi* next in abundance.

The seasonal density distributions of early life history stages of selected categories are presented, as abundance per 10 square meters, on maps of the Lower Cook Inlet region (Appendix D).

The four categories of fish eggs are all present in spring and summer, but absent in fall and winter. The larvae of *Ammodytes* were present in winter and spring, but absent in summer and fall. The larvae of *Clupea harengus pallasi* were present only in summer. The larvae of the Gadidae were present in spring and summer, but absent in fall and winter. The larvae of *Hippoglossoides* sp. were present in spring and summer, but absent in fall and winter. The larvae of *Mallotus villosus* were present in all seasons, but appeared most abundant in summer. The larvae of Osmeridae were present in all seasons, but appeared most abundant in summer.

The zoea of *Pandalopsis dispar* were present in winter, spring, and summer, but absent in fall. The zoea of *Pandalus borealis* were present in spring and summer, but absent in fall and winter. The zoea of *Pandalus danae* were present only in summer. The zoea of *Pandalus goniurus*, *Pandalus montagui tridens*, and *Pandalus hypsinotus* were present only in spring. The zoea of *Pandalus platyceros* were present only in winter. The zoea of *Pandalus stenolepis* were present in spring and summer.

The zoea of Anomura were present in all seasons, but appeared least abundant in the fall and winter. The zoea of the Brachyura were present in all seasons, but appeared least abundant in fall. The zoea of *Cancer magister* were present in summer and fall, but absent in winter and spring. The zoea of *Cancer oregonensis* were present in all seasons, but appeared most abundant in summer. The zoea of *Cancer productus* were present only in spring. The zoea of *Chionoecetes bairdi* were present in spring and summer, but absent in fall and winter. The zoea of *Paralithodes camtschatica* were present in winter and spring, but absent in summer and fall.

The annual density distributions of early life history stages of selected categories are presented, as abundance per 10 square meters, on maps of the Lower Cook Inlet region (Appendix E).

The fish eggs about 1 mm in diameter appeared the most abundant size category. Most eggs appeared in Kachemak Bay and Kamishak Bay. The larvae of *Mallotus villosus* appeared more abundant than the larvae of other fishes. The larvae were widely distributed.

Stages I and II of *Pandalopsis dispar*, *Pandalus borealis*, and *Pandalus hypsinotus* appeared most abundant in Kachemak Bay. The early life history stages of *Pandalus danae* were few and scattered. The early stages of *Pandalus goniurus* were abundant in Kachemak Bay and Kamishak Bay. The distributions of *Pandalus montagui tridens* and *Pandalus stenolepis* were predominately toward the mouth of Cook Inlet, below Kachemak and Kamishak Bay. The early life history stages of *Pandalus platyceros* were relatively scarce.

The zoea and megalopa of the Anomura and Brachyura appeared most abundant in central Lower Cook Inlet and less abundant to the north and outside the inlet. The early stages of *Cancer magister* were in Kachemak Bay, but the later stages were taken toward the southwest. The early life history stages of *Cancer oregonensis* were abundant in central Lower Cook Inlet, but appeared less abundant toward the north and outside the inlet, as well as in Kamishak Bay.

Only stage I of *Cancer productus* was present, mostly toward the southwest.

Stage I of *Chionoecetes bairdi* appeared most abundant in Kachemak Bay, but stage II was taken only toward the south. The megalopa of *Chionoecetes* appeared widely distributed with most apparently in central Lower Cook Inlet.

Stages I and II of *Paralithodes camtschatica* appeared most abundant in Kachemak Bay and Kamishak Bay. Stage III appeared most abundant in Kamishak Bay; stage IV and the megalopa were not taken.

Only megalopa of *Paralithodes platypus* were taken. They occurred at one station toward the north.

A comparison of the annual density distributions of stage I zoea of the eight species of pandalid shrimps suggests spawning locations of four species in Kachemak Bay, one species in Kamishak Bay as well, and two species toward the south or outside of Cook Inlet (Figure 3). The late zoea of those same species appear somewhat more widespread, but have roughly the same distributions as the stage I zoea (Figure 4). The stage I zoea of the crabs suggest annual density distributions of several patterns (Figure 5). The commercially important species, *Cancer magister*, *Chionoecetes bairdi*, and *Paralithodes camtschatica*, appear most abundant in Kachemak Bay. The distributions of the late zoea of the commercially important crabs appear somewhat similar to the stage I in *Cancer magister* and *Paralithodes camtschatica*, but appear very different in *Chionoecetes bairdi* in which the late zoea occur only in the southwest and outside of Cook Inlet (Figure 6).

VII. Discussion

Quantitative density distributions have been prepared for a variety of early life history stages of representative planktonic fishes, shrimps, and crabs in the Lower Cook Inlet region. The overall impression is one of complex differences in abundance between seasons, between stations, and even between stations within seasons. Those differences in abundance in time and space seem to be caused by the interactions of both seasonal and localized spawning which are suggested in the results of this study.

The spawning seasons and areas can be delimited more clearly and quantified more precisely by further sampling. A new sampling program would provide for replication, a more balanced design, and the improvement of seasonal coverage by a more dense time series.

The early life history stages of the commercially important fishes, shrimps, and crabs repeatedly appear most abundant in inner and outer Kachemak Bay and secondarily in Kamishak Bay. In the year of sampling, some species are apparently characteristic of central Lower Cook Inlet and other species are more characteristic of the southern region and outside the inlet. The dispersion of older stages from spawning centers is suggested by the results, as is the increasing scarcity of older life history stages.

The extension and elaboration of this study will be useful when considering resource use conflicts between fisheries and oil and gas development. The results can provide independent assessments of the magnitudes of spawning populations and year class strength which are of critical importance in evaluating the status of harvested populations.

VIII. Conclusions

Early life history stages of many economically important fish and shellfish populations occur in the Lower Cook Inlet region.

The temporal and spatial variability of density distributions is large and complex because spawning is both seasonal and localized.

The time series sampling has been too diffuse to sample all life history stages of the several species.

Kachemak Bay, primarily, and Kamishak Bay, secondarily, are locations of spawning aggregations of fishes and shellfish.

IX. Needs for further study

The needs for further study are clear if there is a commitment to understand the resource use conflict between OCS oil and gas development and the commercial fish and shellfish harvests in Lower Cook Inlet, particularly in Kachemak Bay. The harvested fish and shellfish resources in the Lower Cook Inlet ecosystem should be documented by OCSEAP independently of fisheries management agencies, utilizing presently collected data insofar as appropriate. Fisheries catch statistics and market sampling can be used and supplemented. Fisheries-independent measures such as egg and larvae surveys, echo surveys, and experimental fishing will be essential.

An explicit commitment from BLM to obtain quantitative benchmark data and to monitor against those benchmarks should go far to meet local and state concerns in an emotional and poorly understood resource use conflict. An intensive study at the benchmark level may not be possible in many geographic regions, but Lower Cook Inlet appears to be economically the most important region per unit area within the Outer Continental Shelf program.

The data collected by fisheries management agencies should be assembled, analyzed, and described. Supplemental catch statistics and market sampling should be instituted. A time-series sampling of early life history stages of selected populations of fishes and shellfishes adequate to catch all stages should be undertaken. Consideration could be given to trophodynamic studies at least adequate to ascertain food web relationships of economically important fishes and shellfishes. Additional sampling adequate to detect major changes in food supplies probably approaches the limit of funding available for the study I envision.

This study is needed for informed management decisions in the managed ecosystem of Lower Cook Inlet. The levels of harvest of economically important fishes and shellfishes are likely to change primarily because of fishing effort--those changes can be documented and placed in perspective with the end products and deliverables from such a study.

X. Summary of 4th quarter operations

A. Laboratory activities were directed toward refining the analyses and graphic summaries of data for the annual report.

An updated milestone chart has been prepared (Figure 7).

B. No problems were encountered and no changes are recommended.

C. We estimate that 46 percent of the budgeted funds have been expended.

XI. References cited

(Computer printout)

XII. Acknowledgements

I would like to thank Kendra Daly, Leanne Legacie, Tom Kaperak, Mike Tomlinson, Clarence Pautzke, Marty Altemus, Phyllis Thoreson, and Doug Dey for collecting the samples, as well as the technicians, officers, and crew of the NOAA vessels who assisted. At the University of Washington, lab samples were sorted by Marc Weinstein, Jerry Hornof, Tom Kaperak, Kevin Wyman, Dave Murphy, Karen Peabody, Carla Stehr, Rich McKinney, Margaret Pfeil, and Harold Porath. Fish eggs and larvae were identified by Leanne Legacie and Anne Nguyen, crab larvae by Kendra Daly and Marc Weinstein, and shrimp by Dave Roetcisoender. Jerry Hornof worked far beyond his obligated commitment to assure that the computer programs and output were the best possible for this report. The report was compiled by Dave Roetcisoender, Leanne Legacie, Kendra Daly, and Marc Weinstein, with typing by Chris White.

Table 1. Annotated literature review; fish eggs and larvae

References	Area of Study	Nature of Study	Specific Features of Interest
Ahlstrom, 1972	California	Distribution of *Bathylagus stilbius*, *Stenobrachius leucopsarus*, and four non-Alaskan species in the California Current Region	Illustrations of planktonic larvae.
Ahlstrom and Moser, 1975	California	Distribution of flatfishes in the California Current Region	Brief descriptions of planktonic eggs and larvae, figures.
Bell and St. Pierre, 1970	North Pacific	Eggs and larvae of *Hippoglossus hippoglossus stenolepis*	Descriptions of eggs and larvae, figures, life history, and commercial fisheries.
Blackburn, 1973	Puget Sound, Washington	Ichthyoplankton survey of Skagit Bay	Species list, key to elongate fishes (Ammodytidae, Bathymasteridae, Clupeidae, Engraulidae, Osmeridae, Pholidae, and Stichaeidae), descriptions of larvae for elongate and non-elongate fishes (Cottidae, Hexagrammidae, and Pleuronectidae), figures.
Budd, 1940	Monterey Bay, California	Development of eggs and early larvae of *Parophrys vetulus*, *Pleuronichthys decurrens*, *Pleuronichthys coenosus*, and three non-Alaskan species	Descriptions of eggs and larvae, figures. Eggs and larvae from the plankton.

Table 1. (continued)

References	Area of Study	Nature of Study	Specific Features of Interest
Delacy, Hitz, and Dryfoos, 1964	Puget Sound, Washington coast	Reproduction of several *Sebastes* species	Descriptions of ovarian eggs, larval descriptions, figures of nine species, and life history. Eggs and larvae from the plankton.
Efremenko and Lisovenko, 1972	Gulf of Alaska	Intraovarian and pelagic larvae of some Alaskan *Sebastes* species	Descriptions of intraovarian and pelagic larvae, figures. Larvae from the plankton.
English, 1976	Alaskan waters	Pelagic fish eggs and larvae, shrimp and crab larvae	Keys in table form, figures.
Fraser and Hansen, eds., 1967	North Atlantic	Larvae of Ammodytidae	Keys and descriptions of larvae, figures.
Gorbunova, 1954	NW Pacific Ocean and Bering Sea	Reproduction and development of *Theragra chalcogramma*	Life history, descriptions of eggs, larvae, and juveniles; brief sections describing larvae and juveniles of *Gadus morhua macrocephalus*, *Eleginus gracilis*, and *Boreogadus saida*; figures.
Gorbunova, 1962	NW Pacific Ocean (?)	Spawning and development of Hexagrammidae	Text in Russian, English abstract; descriptions of embryonic and larval development for *Pleurogrammus monopterygius*, *Hexagrammos octogrammus*, *Hexagrammos lagocephalus*; descriptions of larvae for *Hexagrammos stelleri*, *Hexagrammos decagrammus* , and *Hexagrammos superciliosus*; larval key and figures.

Table 1. (continued)

References	Area of Study	Nature of Study	Specific Features of Interest
Hickman, 1959	Puget Sound, Washington	Larval development of *Psettichthys melanostictus*	Descriptions of larvae and early juveniles, figures. Larvae from the plankton.
Kobayashi, 1961	Okhotsk Sea, North Pacific	Larvae and young of *Ptilichthys goodei*	Text in Japanese, English summaries of descriptions of larvae and young, figures.
Miller, 1969	San Juan Is., Washington	Life history of *Hippoglossoides elassodon*	Life history, descriptions of egg and larval development, and photographs. Eggs artificially spawned and from the plankton, raised in the lab.
Morris, 1956	Monterey Bay, California	Early larvae of four *Sebastes* species: *S. goodei, S. jordani, S. paucispinus*, and *S. saxicola*	Descriptions of larvae and figures. Larvae raised in the lab.
Moser, 1967	Southern California	Reproduction and development of *Sebastes paucispinis* and comparison with other rockfishes	Descriptions of ovarian eggs and intraovarian and planktonic larvae, figures of larvae and early juveniles. Larvae from the plankton.
Moser, 1974	Southern California	Development and distribution of larvae and juveniles of *Sebastolobus*	Descriptions of larvae and juveniles, figures. Larvae from the plankton.

Table 1. (continued)

References	Area of Study	Nature of Study	Specific Features of Interest
Moser and Ahlstrom, 1974	World-wide	Systematic investigations of larval stages of Myctophidae	Descriptions of larvae, figures. Larvae from the plankton.
O'Connell, 1953	California	Life history of *Scorpaenichthys marmoratus*	Life history, descriptions of unfertilized egg, larvae, and young; figures. Artificially spawned eggs, larvae from the plankton.
Orcutt, 1950	Monterey Bay, California	Life history of *Platichthys stellatus*	Descriptions of eggs, larvae, and young; figures, life history and commercial fishery. Eggs artificially spawned and reared in the lab.
Quast and Hall, 1972	Alaska	List of fishes of Alaska	Species lists, distributions, and references.
Richardson and DeHart, 1975	Oregon coast	Larvae, young, and adults of *Ptilichthys goodei*	Descriptions of larvae, young, and adults; figure of larva. Larvae from the plankton.
Saville, 1964	North Atlantic	Eggs and larvae of Clupeoidae	Keys to eggs and larvae, descriptions and figures of larvae.
Templeman, 1948	Newfoundland	Life history of *Mallotus villosus*	Life history, descriptions of eggs and larvae; figures of larvae. Larvae from the plankton.

Table 2. Annotated literature review; crabs

References	Area of Study	Nature of Study	Specific Features of Interest
Hart, 1935	Nanaimo, British Columbia	Larvae of *Lophopanopeus bellus bellus*, *Hemigrapsis nudis* and *H. oregonensis*	Descriptions of larval stages, and figures of crabs with larvae similar to commercially important species.
Hart, 1960	Nanaimo, British Columbia	Larvae of *Oregonia gracilis* and *Hyas lyratus*	Descriptions of larval stages, and figures of crabs with larvae similar to commercially important species.
Hart, 1971	British Columbia	Key to planktonic larvae of families of decapod Crustacea	Figures.
Haynes, 1973	Bristol Bay, Alaska	Larvae of *Chionoecetes bairdi* and *C. opilio*	Descriptions of prezoeae and first stage, figures. Larvae raised at sea and preserved.
Hoffman, 1968	Auke Bay, Alaska	Larvae of *Paralithodes platypus*	Descriptions of larval stages and figures. Larvae raised in the lab.
Karinen and Rice, 1974	Auke Bay, Alaska	Effects of oil on Tanner crabs	Most significant effect of oil on crabs was the autotomy of limbs, or death in high concentrations.
Kurata, 1956	Hokkaido, Japan	Larvae of *Paralithodes brevipes*	Text in Japanese, brief English summaries of larval stages, figures. Larvae similar to commercially important species.

Table 2. (continued)

References	Area of Study	Nature of Study	Specific Features of Interest
Kurata, 1963a	Hokkaido, Japan	Larvae of *Erimacrus isenbeckii* and *Telmessus cheiragonus*	Text in Japanese, brief English summaries of larval stages, figures. Larvae similar to commercially important species.
Kurata, 1963b	Hokkaido, Japan	Larvae of *Chionoecetes opilio elongatus* and *Hyas Coaretatus alutaceus*	Text in Japanese, brief English summaries of larval stages, figures. Larvae similar to commercially important species.
Kurata, 1964	Hokkaido, Japan	Larvae of *Paralithodes camtschatica, P. brevipes* and *P. platypus*	Text in Japanese, brief English summaries of larval stages, figures.
Lough, 1975	Newport Bay, Oregon	Keys to larvae of *Cancer magister, C. productus* and *C. oregonensis*	Includes keys to families, and species of crabs with larvae similar to commercially important species.
Marukawa, 1933	Japanese waters	Descriptions of adult, biology and fishery	Illustrations of larval stages but no descriptions.
Motoh, 1973	Sea of Japan	Larvae of *Chionoecetes opilio*	Descriptions of larval stages, figures. Larvae raised in the lab.
Poole, 1966	Eureka, California	Larvae of *Cancer magister*	Descriptions of larval stages, figures. Larvae raised in the lab.
Sato and Tanaka, 1949	Hokkaido, Japan	Larvae of *Paralithodes camtschatica*	Descriptions of larval stages, figures. Larvae raised in the lab.

Table 2. (continued)

References	Area of Study	Nature of Study	Specific Features of Interest
Trask, 1970	Humboldt Bay, California	Larvae of *Cancer productus*	Descriptions of larval stages, figures and comparison with *Cancer magister* larvae. Larvae raised in the lab.

Table 3. Annotated literature review; shrimps

References	Area of Study	Nature of Study	Specific Features of Interest
Alaska Dept. of Fish and Game, 1975	Kachemak Bay, Alaska	Circulation, ecology, commercial fishing, potential impact of oil spill, conservation of renewable energy resources	*Pandalus borealis, P. goniurus, P: hypsinotus* and *Pandalopsis dispar* were the four species of shrimp caught commercially with the first two comprising 93% of trawl catches. *Pandalus hypsinotus* comprises 90% of pot catches. King crab, Tanner crab and Dungeness crab caught commercially.
Barr, 1970	Lower Cook Inlet Kenai Peninsula and Kodiak Is.	Commercial species of Alaskan shrimp	Key to species, life history, figures, domestic and foreign fisheries.
Berkeley, 1930	Nanaimo, British Columbia	Larvae of *Pandalopsis dispar, Pandalus borealis, P. danae, P. hypsinotus, P. platyceros*	Descriptions of larval stages, and adults, figures, key to species. First stage larva raised in the lab, later stages from plankton.
Greenwood, 1959	Lower Cook Inlet, Shelikof Strait, and Kodiak Is., Alaska	Exploratory research	*Pandalus borealis, Pandalopsis dispar* and *Pandalus hypsinotus* were 3 most abundant commercially important shrimp.
Haynes, 1976	Kasitsna Bay, Alaska	Larvae of *Pandalus hypsinotus*	Descriptions of larval stages, figures and comparison of zoeal stages by other authors. Larvae raised in the lab.

Table 3. (continued)

References	Area of Study	Nature of Study	Specific Features of Interest
Ivanov, 1965	Russian waters	Larvae of *Pandalus tridens*, *Eualus macilentus*, *E. barbatus*, *Spirontocaris spina*, *Lebbeus groenlandicus*	First stage illustrated, text in Russian.
Ivanov, 1971	Russian waters	Larva of *Pandalus goniurus*	First stage illustrated, text in Russian.
Kurata, 1964	Hokkaido, Japan	Larvae of *Pandalus borealis*, *P. hypsinotus* and *Pandalopsis coccinata*	Text in Japanese, brief English summaries of larval stages, figures.
Lee, 1969	Puget Sound, Washington	Larvae of *Pandalus jordani*	Descriptions of larval stages, figures and comparison of zoeal stages by Modin and Cox, 1967. Larvae raised in the lab.
Modin and Cox, 1967	Crescent City, California	Larvae of *Pandalus jordani*	Descriptions of larval stages and figures. Larvae raised in the lab.
Needler, 1938	Nanaimo, British Columbia	Larvae of *Pandalus stenolepis*	Descriptions of larval stages and figures. 1st and 2nd stages raised in the lab, 2nd to 7th from the plankton.

Table 3. (continued)

References	Area of Study	Nature of Study	Specific Features of Interest
Price and Chew, 1972	Dabob Bay, Washington	Larvae of *Pandalus platyceros*	Descriptions of larval stages and figures. Larvae raised in the lab.
Rathbun, 1904	Arctic Alaska to Southern California	Adult decapod crustaceans	Descriptions, figures, keys and distributions.
Ronholt, 1963	Southern Alaskan waters	Exploratory research	*Pandalus borealis, Pandalopsis dispar Pandalus hypsinotus* were the 3 most abundant commercially important shrimp in the Lower Cook Inlet area.

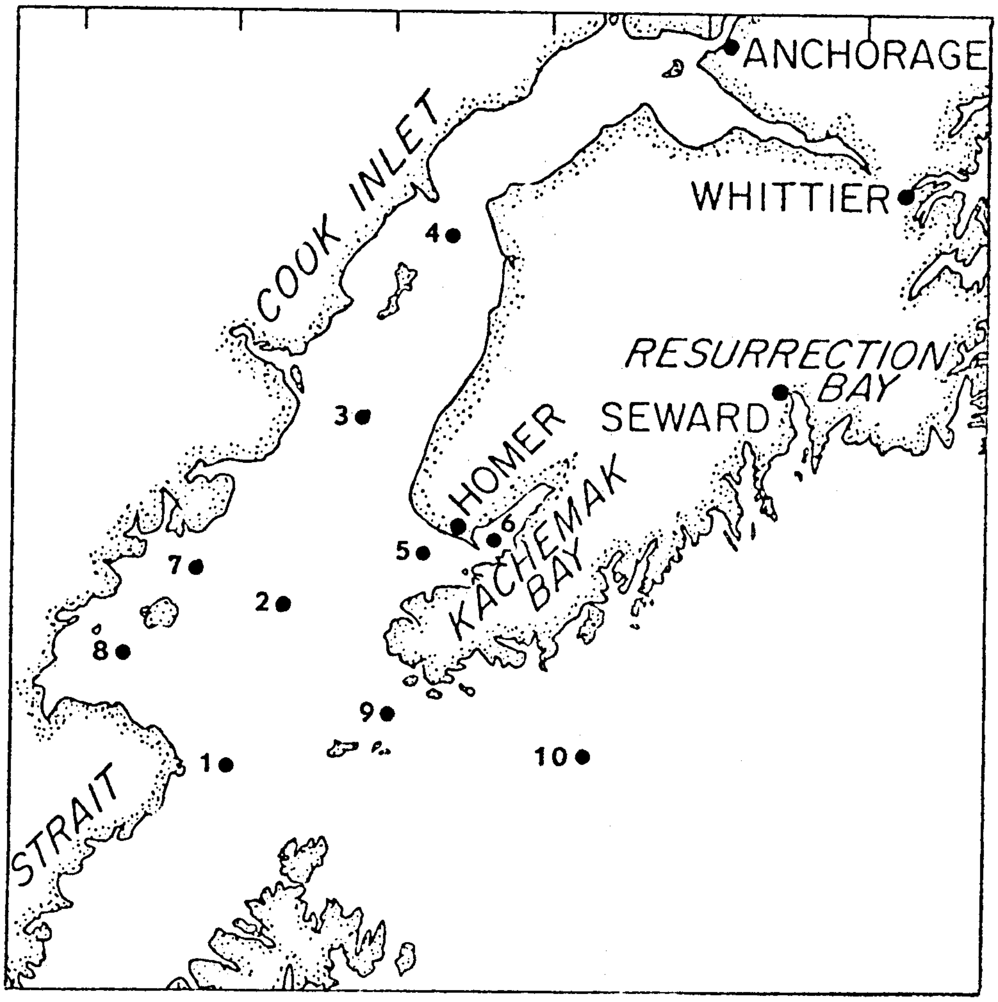

Figure 1. Station locations, Cook Inlet area

Table 4. Station Locations

Station	Latitude (N)	Longitude (W)	Chart Depth (m)	Location
1	58° 53.0'	152° 48.0'	174	Lower Cook Inlet
2	59° 22.0'	152° 40.0'	62	Lower Cook Inlet
3	60° 00.0'	152° 10.0'	58	Lower Cook Inlet
4	60° 40.0'	151° 40.0'	36	Cook Inlet
5	59° 31.0'	151° 45.0'	80	Outer Kachemak Bay
5a	59° 35.0'	151° 49.0'	36	Outer Kachemak Bay
6	59° 36.0'	151° 18.0'	77	Inner Kachemak Bay
7	59° 30.0'	153° 10.0'	35	Lower Cook Inlet
8	59° 14.0'	153° 40.0'	29	Kamishak Bay
9	59° 02.0'	151° 58.0'	196	Kennedy Entrance
10	58° 52.0'	150° 51.0'	210	Gulf of Alaska

Table 5. Samples taken at ten locations on seven cruises in four seasons in Lower Cook Inlet, April 1976 through February 1977.

	Spring			Summer		Fall	Winter
Station	6-13 Apr	6-9 May	22-30 May	8-15 Jul	24-31 Aug	17-29 Oct	21-26 Feb
1	X	X	X	X	X	X	X
2	X	X	X	X	X	X	X
3	X	X	X	X	X	X	X
4	X	X	X	X	X	X	X
5	X	X	X	X	X	X	X
6	X	X	X	X	X	X	X
7	X	X	X	X	X	X	X
8		X	X	X	X	X	X
9	X	X		X	X	X	X
10	X		X	X	X		X

Figure 2. Comparison of concentrations between 333 and 505 µm mesh nets

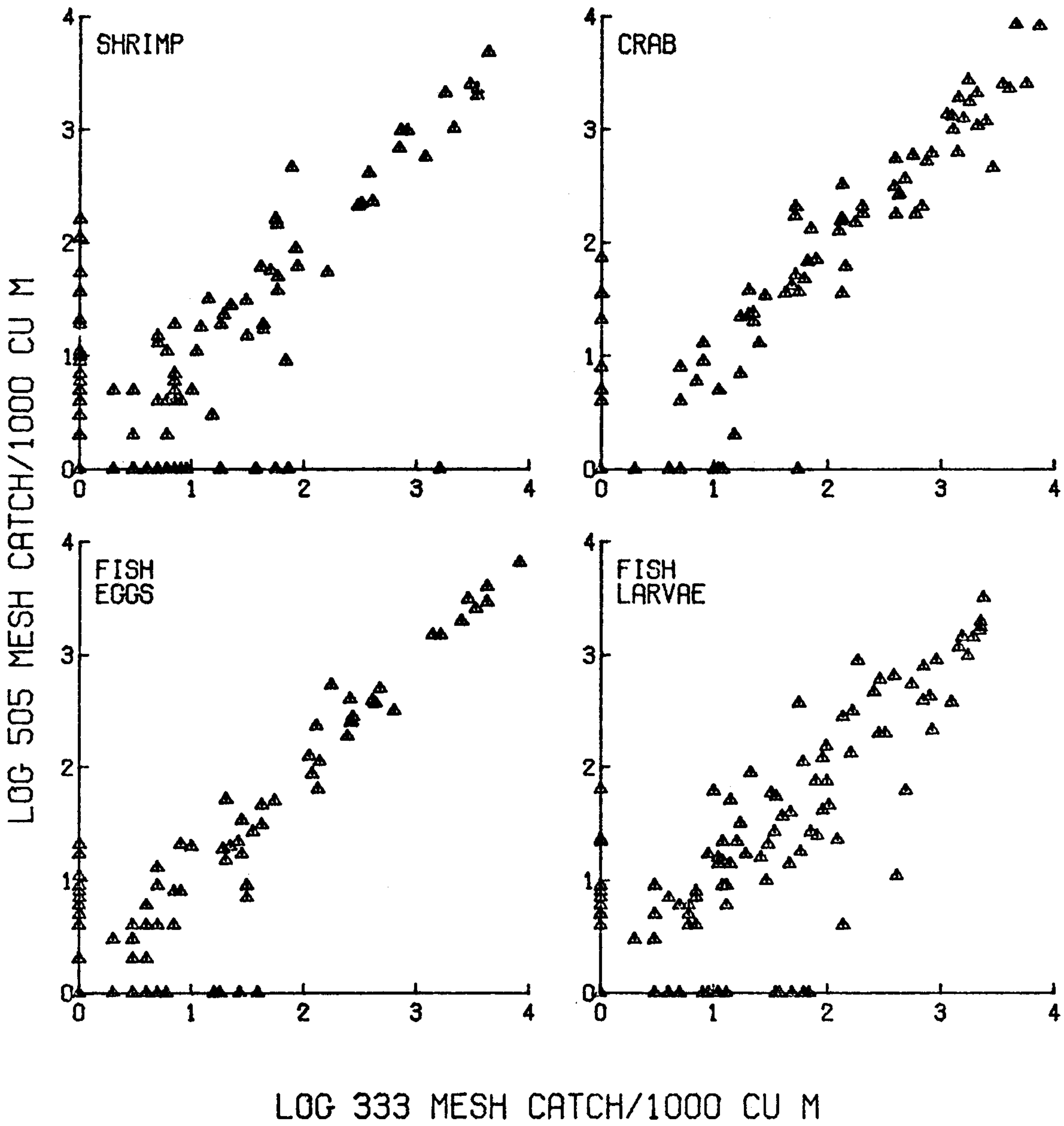

Table 6. Fishes collected in the Lower Cook Inlet region, April 1976 through February 1977.

Family Clupeidae - herrings

Clupea harengus pallasi Pacific herring

Family Salmonidae - trouts

Oncorhynchus sp. salmon

Family Osmeridae - smelts

Mallotus villosus capelin
Spirinchus thaleichthys longfin smelt
Thaleichthys pacificus eulachon

Family Bathylagidae - deepsea smelt

Bathylagus sp. blacksmelt
Leuroglossus schmidti northern smoothtongue

Family Myctophidae - lanternfishes

Stenobrachius leucopsarus northern lampfish

Family Gadidae - codfishes

Gadus sp. Pacific cod
Theragra chalcogramma walleye pollock

Family Gasterosteidae - sticklebacks

Gasterosteus aculeatus threespine stickleback
Pungitius pungitius ninespine stickleback

Family Bathymasteridae - ronquils

Family Stichaeidae - pricklebacks

Anoplarchus sp. cockscomb
Chirolophis sp. warbonnet
Lumpenus spp. prickleback
Xiphister atropurpureus black prickleback
Xiphister mucosus red prickleback

Family Pholidae - gunnels

Apodichthys flavidus penpoint gunnel
Pholis sp. gunnel

Table 6. (continued)

Family Ptilichthyidae - quillfishes

Ptilichthyidae goodei quillfish

Family Ammodytidae - sand lances

Ammodytes hexapterus Pacific sand lance

Family Tetragonuridae - squaretails

Family Scorpaenidae - scorpionfishes

Sebastes sp. rockfish
Sebastolobus thornyhead

Family Hexagrammidae - greenlings

Hexagrammos sp. greenling.

Family Cottidae - sculpins

Icelinus borealis northern sculpin
Myoxocephalus sculpin
Scorpaenichthys marmoratus cabezon

Family Agonidae - poachers

Agonus acipenserinus sturgeon poacher

Family Cyclopteridae - lumpfishes and snailfishes

Liparis sp. snailfish

Family Pleuronectidae - righteye flounders

Atheresthes stomias arrowtooth flounder
Glyptocephalus zachirus rex sole
Hippoglossoides sp. (probably flathead sole)
Isopsetta isolepis butter sole
Lepidopsetta bilineata rock sole
Limanda aspera yellowfin sole
Lyopsetta exilis slender sole
Platichthys stellatus starry flounder
Psettichthys melanostictus sand sole

Table 7. Pandalid shrimp collected in the Lower Cook Inlet region, April 1976 through February 1977.

Order Decapoda

Suborder Natantia

Section Caridea

Family Pandalidae

Pandalopsis dispar Rathbun side-stripe shrimp (larvae and adults)
Pandalus borealis Kröyer northern pink shrimp (larvae and adults)
Pandalus danae Stimpson dock shrimp (larvae)
Pandalus goniurus Stimpson humpy shrimp (larvae and adults)
Pandalus hypsinotus Brandt coonstripe shrimp (larvae)
Pandalus montagui tridens Rathbun no common name (larvae)
Pandalus platyceros Brandt spot shrimp (larvae)
Pandalus stenolepis Rathbun no common name (larvae)

Table 8. Commercially important species of crab larvae collected in Lower Cook Inlet region, April 1976 through February 1977.

Order Decapoda

Suborder Reptantia

Section Anomura

Family Lithodidae

Paralithodes camtschatica (Tilesius) king crab
Paralithodes platypus (Brandt) blue king crab

Section Brachyura

Superfamily Brachyrhyncha

Family Cancridae

Cancer magister Dana Dungeness crab

Superfamily Oxyrhyncha

Family Majidae

Subfamily Oregoniinae

Chionoecetes bairdi Rathbun tanner or snow crab

Table 9. List of Possible Fish for Egg Size Categories

< 1 mm category (0.74-0.88 mm)

Limanda aspera
Limanda proboscidea

∿ 1 mm category (0.90-1.28 mm)

Gadus macrocephalus
Isopsetta isolepis
Parophrys vetulus
Platichthys stellatus
Psettichthys melanostictus

∿ 2 mm category (1.30-2.54 mm)

Bathylagus stilbius
Eopsetta jordani
Glyptocephalus zachirus
Lyopsetta exilis
Microstomus pacificus
Pleuronectes quadrituberculatus
Pleuronichthys coenosus
Pleuronichthys decurrens
Theragra chalcogramma

∿ 3 mm category (2.56-3.90 mm)

Hippoglossoides elassodon
Hippoglossoides robustus
Hippoglossus stenolepis

Figure 3.
SHRIMP (STAGE I)
ANNUAL ABUNDANCE/10 SQ M

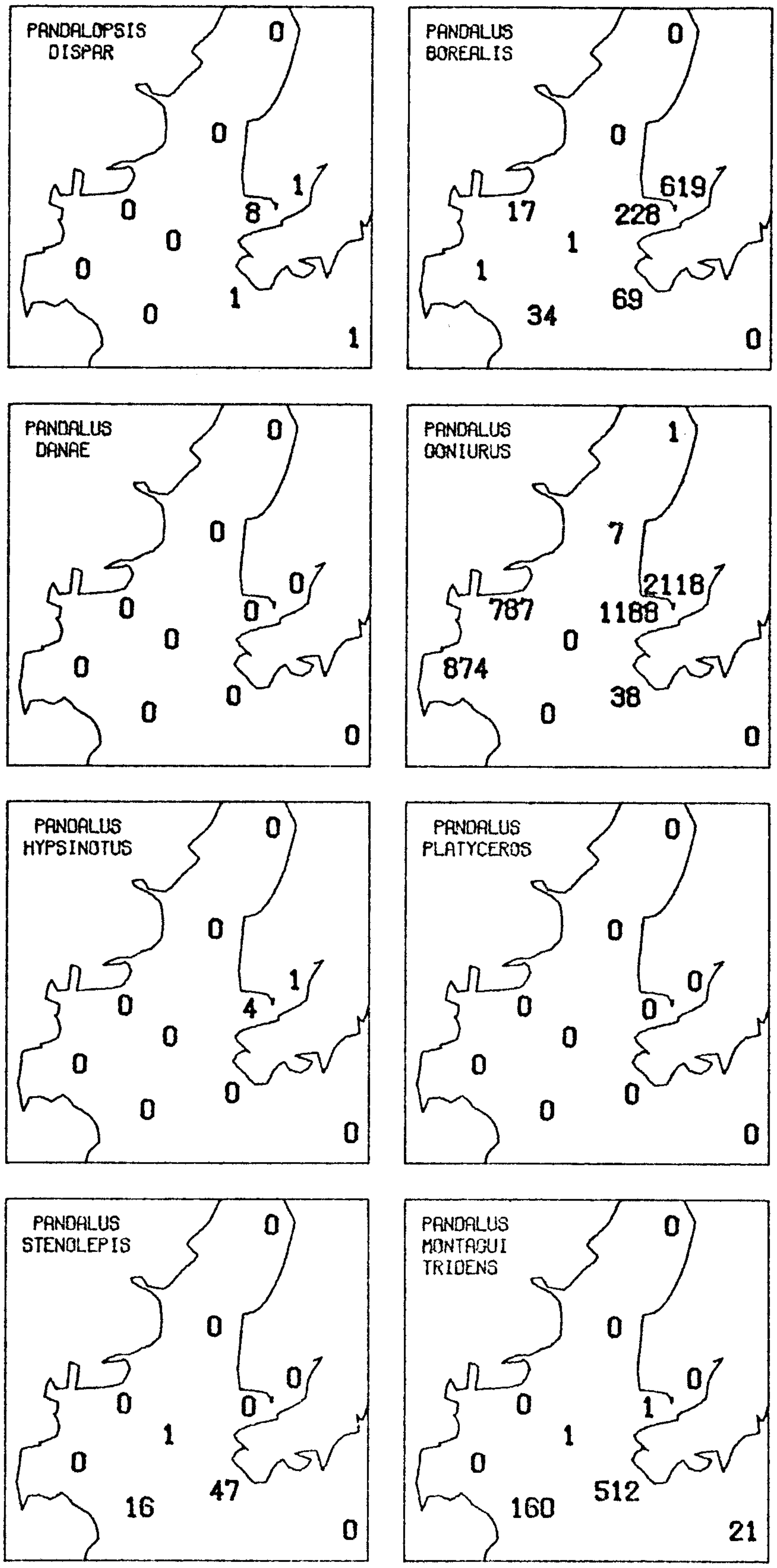

Figure 4.

SHRIMP (LATE ZOEA)

ANNUAL ABUNDANCE/10 SQ M

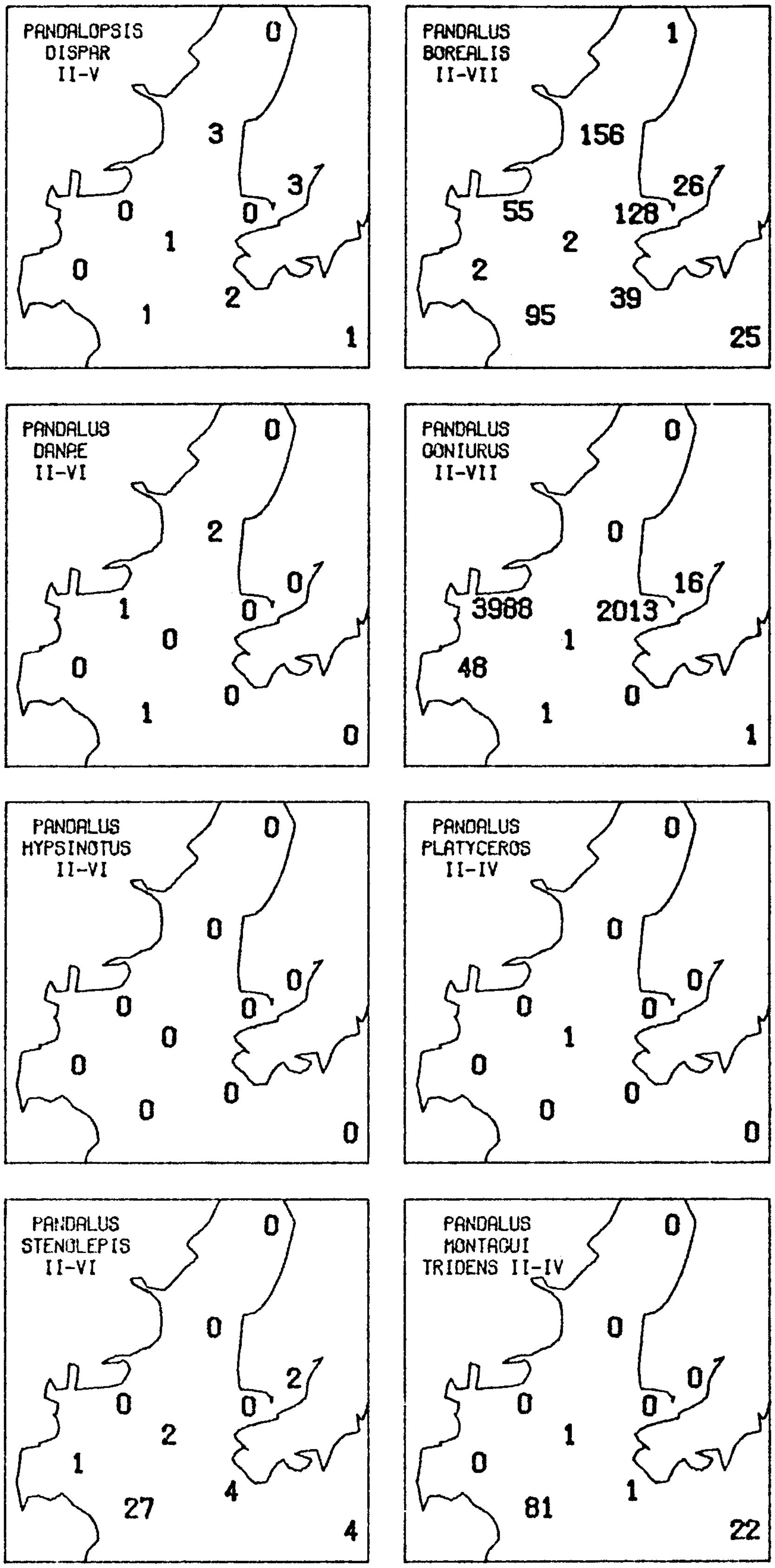

Figure 5.

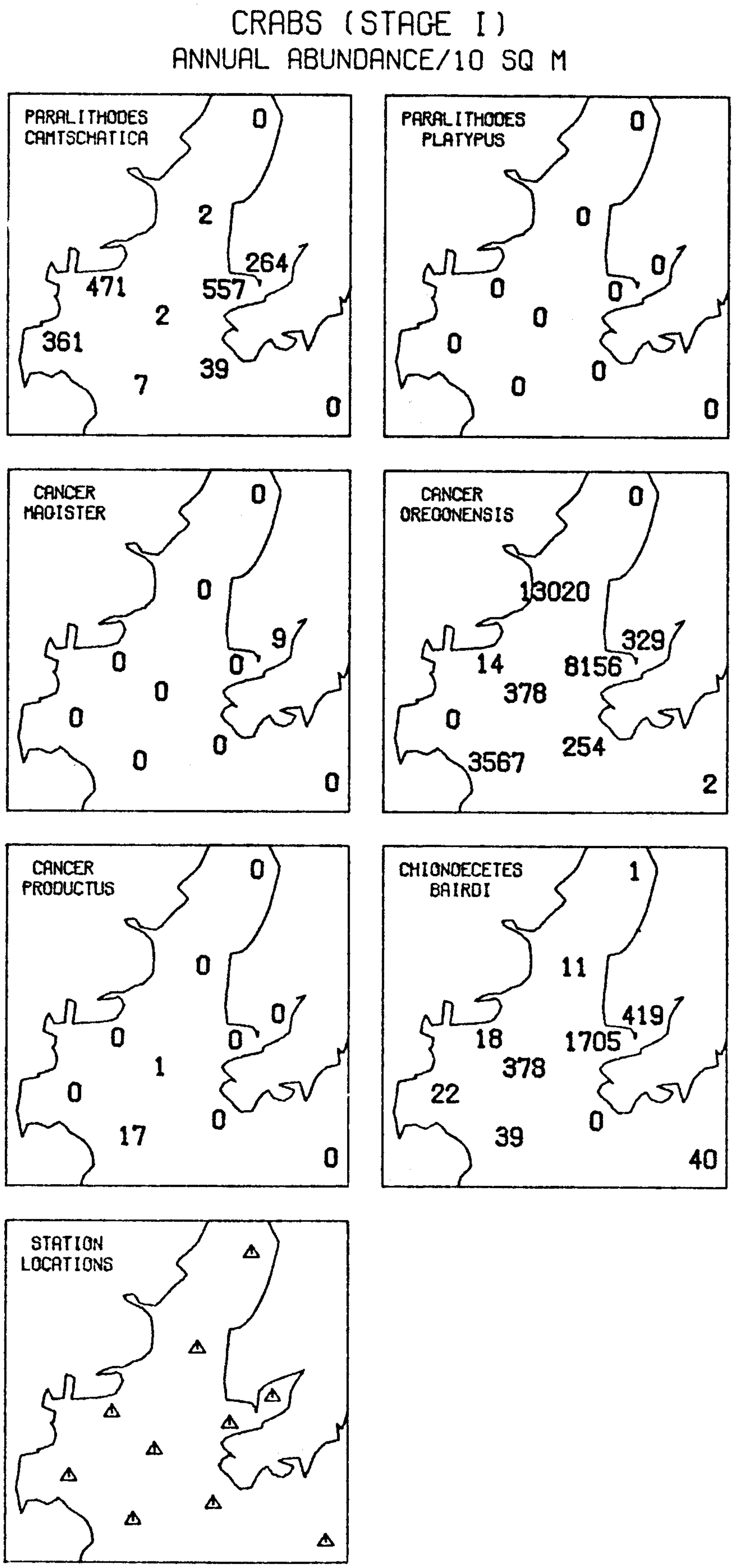
CRABS (STAGE I)
ANNUAL ABUNDANCE/10 SQ M
PARALITHODES CAMTSCHATICA
0
2
264
471
557
2
361
39
7
0
PARALITHODES PLATYPUS
0
0
0
0
0
0
0
0
0
0
CANCER MAGISTER
0
0
9
0
0
0
0
0
0
0
CANCER OREGONENSIS
0
13020
329
14
8156
378
0
254
3567
2
CANCER PRODUCTUS
0
0
0
0
0
1
0
0
17
0
CHIONOECETES BAIRDI
1
11
419
18
1705
378
22
0
39
40
STATION LOCATIONS

Figure 6.

CRABS (LATE ZOEA)
ANNUAL ABUNDANCE/10 SQ M

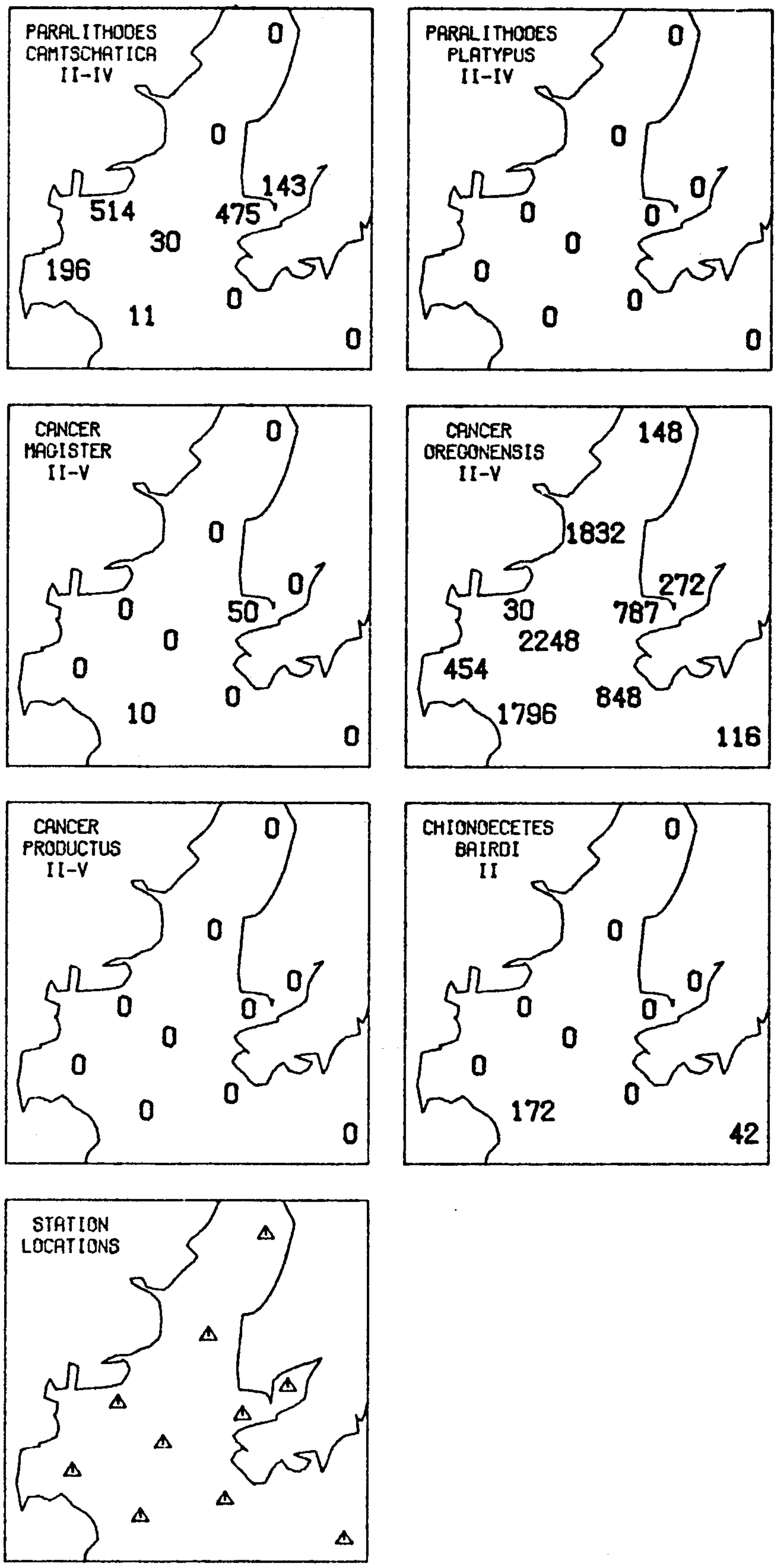

Figure 7.

MILESTONE CHART

RU #: 424 PI: T. Saunders English

Major Milestones: Reporting, data management and other significant contractual requirements; periods of field work; workshops; etc.

MAJOR MILESTONES	1977 O	1977 N	1977 D	1978 J	1978 F	1978 M	1978 A	1978 M	1978 J	1978 J	1978 A	1978 S	1978 O	1978 N	1978 D	1979 J	1979 F	1979 M	1979 A	
Plan - Coordinate for Field Program	├─	─	─	─	─	─	─	─┤												
Analysis - Interpretation of 1976-77 Data	├─	─	─	─	─	─┤														
Quarterly Report			▲																	
Annual Report						▲														
Spring Data Collection Period								├─	─┤											
Quarterly Report									△											
Spring Data Processing										├─	─	─	─	─	─┤					
Summer Data Collection Period										├─	─	─┤								
Quarterly Report												△								
Summer Data Processing													├─	─	─	─	─	─┤		
Quarterly Report															△					
Submit Spring Data															△					
Submit Summer Data																		△		
Final Report (if RU is terminated)																		△		
Synthesis Meeting				▲																
Program Review							△													

△ Planned Completion Date ▲ Actual Completion Date

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APPENDIX A

Density per 10 Square Meters

FISH EGGS/10 SQ M

STATION	SIZE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	<1 MM	0	0	0	4	0	0	0
	1 MM	0	2	0	1	0	0	0
	2 MM	1	2	2	0	0	0	0
	3 MM	0	87	96	0	0	0	0
2	<1 MM	0	1	0	2	0	0	0
	1 MM	0	0	12	35	0	0	0
	2 MM	0	1	1	1	0	0	0
	3 MM	0	0	1	0	0	0	0
3	<1 MM	0	0	0	2	0	0	0
	1 MM	11	80	281	0	0	0	0
	2 MM	0	11	8	1	0	0	0
	3 MM	0	0	0	0	0	0	0
4	<1 MM	0	0	0	3	0	0	0
	1 MM	0	0	3	0	0	0	0
	2 MM	0	0	1	0	0	0	0
	3 MM	0	0	0	0	0	0	0
5	<1 MM	0	0	1	438	30	0	0
	1 MM	1	100	138	90	2	0	0
	2 MM	0	5	5	0	0	0	0
	3 MM	0	0	3	0	0	0	0
6	<1 MM	0	0	16	291	21	0	0
	1 MM	21	5550	2701	3	1	0	0
	2 MM	2	0	0	0	0	0	0
	3 MM	0	0	0	0	0	0	0
7	<1 MM	0	0	62	290	0	0	0
	1 MM	101	96	1485	52	0	0	0
	2 MM	0	1	2	0	1	0	0
	3 MM	0	0	0	0	0	0	0
8	<1 MM		0	144	811	0	0	0
	1 MM		938	712	49	0	0	0
	2 MM		10	1	0	0	0	0
	3 MM		0	0	0	0	0	0

CONTINUATION-FISH EGGS/10 SQ M

9	<1 MM	0	0		3	0	0	0
	1 MM	1	30		3	0	0	0
	2 MM	1	3		1	0	0	0
	3 MM	0	26		1	1	0	0
10	<1 MM	0		4	0	1		0
	1 MM	3		4	2	0		0
	2 MM	0		27	1	0		0
	3 MM	0		14	2	0		0

HIPPOGLOSSOIDES SP./10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	LAR	0	0	45	7	0	0	0
	JUV	0	0	0	0	0	0	0
2	LAR	0	0	1	2	1	0	0
	JUV	0	0	0	0	0	0	0
3	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	LAR	0	0	0	0	1	0	0
	JUV	0	0	0	0	0	0	0
5	LAR	0	0	6	1	0	0	0
	JUV	0	0	0	0	0	0	0
6	LAR	0	0	0	2	0	0	0
	JUV	0	0	0	0	0	0	0
7	LAR	0	0	0	48	0	0	0
	JUV	0	0	0	0	1	0	0
8	LAR		0	0	15	0	0	0
	JUV		0	0	0	0	0	0
9	LAR	0	0		8	2	0	0
	JUV	0	0		0	0	0	0
10	LAR	0		0	12	0		0
	JUV	0		0	0	0		0

GADIDAE/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	LAR	0	26	5	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	LAR	0	13	2	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-GADIDAE/10 SQ M

3	LAR	0	0	1	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	LAR	0	1	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	LAR	0	0	0	1	0	0	0
	JUV	0	0	0	0	1	0	0
6	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
7	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	LAR		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	LAR	14	4		4	0	0	0
	JUV	0	0		0	0	0	0
10	LAR	0		0	0	0		0
	JUV	0		0	0	0		0

OSMERIDAE/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	LAR	0	0	0	752	659	2	0
	JUV	0	0	0	0	0	0	0
2	LAR	0	3	0	571	137	0	29
	JUV	0	0	0	0	0	0	0
3	LAR	0	0	0	21	29	0	0
	JUV	0	0	0	0	0	0	1
4	LAR	0	0	0	351	0	0	0
	JUV	0	0	0	0	0	0	0
5	LAR	0	0	0	368	224	0	1
	JUV	0	0	0	0	0	0	0
6	LAR	0	1	0	0	275	0	1
	JUV	0	0	0	0	0	0	0

CONTINUATION-OSMERIDAE/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
7	LAR	0	0	0	51	8	2	1
	JUV	0	0	0	0	0	0	0
8	LAR		0	0	2	2	0	0
	JUV		0	0	0	0	0	0
9	LAR	0	0		207	49	2	4
	JUV	0	0		0	0	0	0
10	LAR	0		0	238	17		0
	JUV	0		0	0	0		0

MALLOTUS VILLOSUS/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	LAR	5	11	0	2505	233	17	0
	JUV	0	0	0	0	0	0	0
2	LAR	0	0	0	633	85	9	0
	JUV	0	0	0	0	1	0	0
3	LAR	0	0	0	346	11	0	0
	JUV	0	0	0	0	0	0	0
4	LAR	0	0	0	412	2	0	0
	JUV	0	0	0	0	0	0	0
5	LAR	0	0	0	560	272	0	1
	JUV	0	0	0	0	0	0	0
6	LAR	0	0	0	14	1383	1	0
	JUV	0	0	0	0	0	0	1
7	LAR	0	0	0	299	21	0	0
	JUV	0	0	0	0	0	0	0
8	LAR		0	0	40	144	7	0
	JUV		0	0	0	0	0	0
9	LAR	7	0		170	49	0	0
	JUV	0	0		0	0	0	0
10	LAR	0		0	85	15		0
	JUV	0		0	0	0		0

CLUPEA HARENGUS PALLASI/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	LAR	0	0	0	31	4	0	0
	JUV	0	0	0	0	0	1	0
5	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
6	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
7	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	LAR		0	0	5	0	0	0
	JUV		0	0	0	0	0	0
9	LAR	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	LAR	0		0	0	0		0
	JUV	0		0	0	0		0

AMMODYTES HEXAPTERUS/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	LAR	5	0	8	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	LAR	0	2	30	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	LAR	13	28	3	0	0	0	13
	JUV	0	0	0	0	0	0	0

CONTINUATION-AMMODYTES HEXAPTERUS/10 SQ M

4	LAR	0	1	5	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	LAR	1	324	155	0	0	0	7
	JUV	0	0	0	0	0	0	0
6	LAR	10	394	1	0	0	0	22
	JUV	0	0	0	0	0	0	0
7	LAR	9	1	24	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	LAR		47	9	0	0	0	0
	JUV		0	0	0	0	0	0
9	LAR	1	2		0	0	0	0
	JUV	0	0		0	0	0	0
10	LAR	1		0	0	0		0
	JUV	0		0	0	0		0

PANDALOPSIS DISPAR/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	0	0	0	0
	II	0	0	1	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	1	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	3	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	I	0	0	0	0	0	0	8
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
6	I	1	0	0	0	0	0	0
	II	0	2	0	0	0	0	0
	III	0	0	0	0	1	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALOPSIS DISPAR/10 SQ M

7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	V		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	1	0		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		1	0	0	0
	IV	0	0		0	1	0	0
	V	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	I	0		1	0	0		0
	II	0		0	0	0		0
	III	0		1	0	0		0
	IV	0		0	0	0		0
	V	0		0	0	0		0
	JUV	0		0	0	0		0

PANDALUS BOREALIS/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	34	0	0	0	0	0
	II	0	23	10	0	0	0	0
	III	0	0	55	0	0	0	0
	IV	0	0	2	1	0	0	0
	V	0	0	0	2	1	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	5	0	0

CONTINUATION-PANDALUS BOREALIS/10 SQ M

2	I	0	1	1	0	0	0	0
	II	0	1	0	0	0	0	0
	III	0	0	1	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	156	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	1	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	1	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	1	0	0
5	I	0	211	18	0	0	0	0
	II	0	76	5	0	0	0	0
	III	0	0	42	0	0	0	0
	IV	0	0	5	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
6	I	1	618	0	0	0	0	0
	II	0	18	5	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	1	2	0	0
	V	0	0	0	1	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALUS BOREALIS/10 SQ M

7	I	0	17	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	1	0	0	0
	IV	0	0	0	53	0	0	0
	V	0	0	0	1	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	I		0	1	0	0	0	0
	II		0	1	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	1	0	0	0
	V		0	0	0	0	0	0
	VI		0	0	0	0	0	0
	VII		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	0	69		0	0	0	0
	II	0	34		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		5	0	0	0
	V	0	0		0	0	0	0
	VI	0	0		0	0	0	0
	VII	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	I	0		0	0	0		0
	II	0		1	0	0		0
	III	0		5	7	0		0
	IV	0		2	8	0		0
	V	0		0	2	0		0
	VI	0		0	0	0		0
	VII	0		0	0	0		0
	JUV	0		0	0	0		0

PANDALUS DANAE/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	1	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	2	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALUS DANAE/10 SQ M

6	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	1	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	V		0	0	0	0	0	0
	VI		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	0	0		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	V	0	0		0	0	0	0
	VI	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	V	0		0	0	0		0
	VI	0		0	0	0		0
	JUV	0		0	0	0		0

PANDALUS GONIURUS/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	0	0	0	0
	II	0	0	1	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	1	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	1	6	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	I	0	1	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	I	0	1146	42	0	0	0	0
	II	0	172	1176	0	0	0	0
	III	0	0	666	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALUS GONIURUS/10 SQ M

6	I	1	2109	9	0	0	0	0
	II	0	0	9	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	7	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	1	0	0	0
7	I	0	88	699	0	0	0	0
	II	0	0	3666	0	0	0	0
	III	0	0	322	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	I		874	1	0	0	0	0
	II		15	27	0	0	0	0
	III		0	6	0	0	0	0
	IV		0	0	0	0	0	0
	V		0	0	0	0	0	0
	VI		0	0	0	0	0	0
	VII		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	0	38		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	V	0	0		0	0	0	0
	VI	0	0		0	0	0	0
	VII	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	I	0		0	0	0		0
	II	0		1	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	V	0		0	0	0		0
	VI	0		0	0	0		0
	VII	0		0	0	0		0
	JUV	0		0	0	0		0

PANDALUS HYPSINOTUS/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	I	0	1	3	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALUS HYPSINOTUS/10 SC M

6	I	0	1	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	V		0	0	0	0	0	0
	VI		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	0	0		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	V	0	0		0	0	0	0
	VI	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	V	0		0	0	0		0
	VI	0		0	0	0		0
	JUV	0		0	0	0		0

PANDALUS PLATYCEROS/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	1
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
6	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALUS PLATYCEROS/10 SQ M

8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	0	0		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	JUV	0		0	0	0		0

PANDALUS STENOLEPIS/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	9	6	1	0	0	0
	II	0	0	3	5	0	0	0
	III	0	0	0	9	0	0	0
	IV	0	0	0	7	0	0	0
	V	0	0	0	2	0	0	0
	VI	0	0	0	1	0	0	0
	JUV	0	0	0	0	0	0	0
2	I	0	1	0	0	0	0	0
	II	0	0	1	0	0	0	0
	III	0	0	1	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	C	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALUS STENOLEPIS/10 SQ M

4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
6	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	2	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	I		0	0	0	0	0	0
	II		0	0	1	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	V		0	0	0	0	0	0
	VI		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	0	36		11	0	0	0
	II	0	2		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		1	0	0	0
	V	0	0		0	0	0	0
	VI	0	0		0	1	0	0
	JUV	0	0		0	0	0	0

CONTINUATION-PANDALUS STENOLEPIS/10 SQ M

10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	1	0		0
	IV	0		0	1	0		0
	V	0		0	1	0		0
	VI	0		0	0	1		0
	JUV	0		0	0	0		0

PANDALUS MONTAGUI TRIDENS/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	153	7	0	0	0	0
	II	0	0	76	0	0	0	0
	III	0	0	5	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	I	0	1	0	0	0	0	0
	II	0	0	1	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	I	0	1	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALUS MONTAGUI TRIDENS/10 SQ M

6	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	1	510		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		1	0	0	0
	IV	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	I	0		21	0	0		0
	II	0		18	0	0		0
	III	0		4	0	0		0
	IV	0		0	0	0		0
	JUV	0		0	0	0		0

ANOMURA/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	ZOE	12	346	438	534	854	0	0
	MEG	0	0	0	0	30	0	0
2	ZOE	0	199	3363	181	132	17	0
	MEG	0	0	0	16	14	0	0
3	ZOE	0	0	25	674	2	0	6
	MEG	0	0	0	0	4	1	0
4	ZOE	0	1	1	15	7	0	0
	MEG	0	0	0	1	4	0	0
5	ZOE	0	951	777	1084	1170	7	1
	MEG	0	0	0	0	3	8	0
6	ZOE	22	248	7	238	304	0	50
	MEG	0	0	0	9	4	0	0
7	ZOE	0	33	208	550	16	1	0
	MEG	0	0	0	0	4	1	0
8	ZOE		47	953	16	222	1	0
	MEG		0	0	0	10	1	0
9	ZOE	0	86		547	24	0	0
	MEG	0	0		24	1	0	0
10	ZOE	0		18	12	0		0
	MEG	0		0	0	0		0

BRACHYURA/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	ZOE	0	274	1479	1216	53	0	0
	MEG	0	0	0	365	7	0	0
2	ZOE	0	330	3767	402	231	0	0
	MEG	0	0	0	96	34	0	0

CONTINUATION-BRACHYURA/10 SQ M

3	ZOE	0	35	1030	773	73	0	1
	MEG	0	0	0	65	5	0	0
4	ZOE	0	0	83	16	199	0	0
	MEG	0	0	0	1	1	0	0
5	ZOE	0	286	3535	1529	1058	1	0
	MEG	0	0	0	46	9	0	0
6	ZOE	0	1131	5639	608	395	0	287
	MEG	0	0	0	0	10	0	0
7	ZOE	0	32	256	2446	9	2	0
	MEG	0	0	0	69	1	0	0
8	ZOE		9	3626	22	414	0	0
	MEG		0	0	2	10	0	0
9	ZOE	0	122		1310	5	0	1
	MEG	0	0		1554	1	0	0
10	ZOE	0		113	28	3		0
	MEG	0		0	102	1		0

PARALITHODES CAMTSCHATICA/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	7	0	0	0	0
	II	0	0	6	0	0	0	0
	III	0	0	5	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
2	I	0	0	2	0	0	0	0
	II	0	0	30	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
3	I	0	2	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0

CONTINUATION-PARALITHODES CAMTSCHATICA/10 SQ M

4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
5	I	0	546	0	0	0	0	10
	II	0	322	153	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
6	I	1	259	0	0	0	0	4
	II	1	143	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
7	I	0	434	37	0	0	0	0
	II	0	1	461	0	0	0	0
	III	0	0	51	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
8	I		361	0	0	0	0	0
	II		7	85	0	0	0	0
	III		0	104	0	0	0	0
	IV		0	0	0	0	0	0
	MEG		0	0	0	0	0	0
9	I	0	39		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	MEG	0	0		0	0	0	0
10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	MEG	0		0	0	0		0

PARALITHODES PLATYPUS/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
2	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	1	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	7	0	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
5	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
6	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	1	0	0	0

CONTINUATION-PARALITHODES PLATYPUS/10 SQ M

8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	MEG		0	0	0	0	0	0
9	I	0	0		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	MEG	0	0		0	0	0	0
10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	MEG	0		0	0	0		0

CANCER MAGISTER/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	0	0	0	0
	II	0	0	0	0	1	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	1	2	0
	MEG	0	0	0	0	1	63	0
2	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	1	0	0
	MEG	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0

CONTINUATION-CANCER MAGISTER/10 SQ M

4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
5	I	0	0	0	0	0	0	0
	II	0	0	0	3	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	1	0	0
6	I	0	0	0	2	0	0	0
	II	0	0	0	0	1	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	2	0	0
	IV		0	0	0	0	0	0
	V		0	0	0	0	0	0
	MEG		0	0	0	2	0	0
9	I	0	0		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	V	0	0		0	0	0	0
	MEG	0	0		0	1	0	0
10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	V	0		0	0	0		0
	MEG	0		0	0	0		0

CANCER OREGONENSIS/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	3112	0	0	0
	II	0	0	0	1093	0	0	0
	III	0	0	0	89	37	0	0
	IV	0	0	0	3	90	0	0
	V	0	0	0	0	122	0	0
	MEG	0	0	0	0	20	0	0
2	I	0	0	0	287	4	0	0
	II	0	0	0	369	11	0	0
	III	0	0	0	22	168	0	0
	IV	0	0	0	0	796	0	0
	V	0	0	0	0	318	0	0
	MEG	0	0	0	0	27	13	0
3	I	0	0	0	6426	1	0	1
	II	0	0	0	899	1	0	0
	III	0	0	0	37	12	0	0
	IV	0	0	0	0	36	0	0
	V	0	0	0	0	25	0	0
	MEG	0	0	0	0	1	0	0
4	I	0	0	0	10	0	0	0
	II	0	0	0	4	3	0	0
	III	0	0	0	0	6	0	0
	IV	0	0	0	0	39	0	0
	V	0	0	0	0	6	0	0
	MEG	0	0	0	0	1	0	0
5	I	0	0	0	6378	1	0	0
	II	0	0	0	359	1	0	0
	III	0	0	0	3	34	0	0
	IV	1	0	0	0	339	0	0
	V	0	0	3	0	113	0	0
	MEG	0	0	0	0	44	8	0
6	I	0	0	0	134	3	0	41
	II	0	0	0	9	7	0	0
	III	0	0	0	0	60	0	0
	IV	0	0	0	0	185	0	0
	V	0	0	0	0	130	0	0
	MEG	0	0	0	0	48	0	0

CONTINUATION-CANCER OREGONENSIS/10 SQ M

7	I	0	0	0	4	0	0	0
	II	0	0	0	1	2	0	0
	III	0	0	C	0	10	0	0
	IV	0	0	0	0	15	0	0
	V	0	0	0	0	7	0	0
	MEG	0	0	0	0	1	11	0
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	80	0	0
	IV		0	0	0	494	0	0
	V		0	0	0	288	0	0
	MEG		0	0	0	2	2	0
9	I	0	0		164	0	0	0
	II	0	0		87	0	0	0
	III	0	0		158	7	0	0
	IV	0	0		0	35	0	0
	V	0	0		0	181	1	0
	MEG	0	0		0	70	0	0
10	I	0		0	2	0		0
	II	0		0	63	0		0
	III	0		0	27	1		0
	IV	0		0	2	3		0
	V	0		0	0	14		0
	MEG	0		0	0	3		0

CANCER PRODUCTUS/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	9	8	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
2	I	0	1	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0

CONTINUATION-CANCER PRODUCTUS/10 SQ M

3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
5	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
6	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	V		0	0	0	0	0	0
	MEG		0	0	0	0	0	0
9	I	0	0		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	V	0	0		0	0	0	0
	MEG	0	0		0	0	0	0

CONTINUATION-CANCER PRODUCTUS/10 SQ M

10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	V	0		0	0	0		0
	MEG	0		0	0	0		0

CHIONOECETES BAIRDI/10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	1	23	3	0	0	0
	II	0	0	0	211	0	0	0
2	I	0	0	378	0	0	0	0
	II	0	0	0	1	0	0	0
3	I	0	1	10	3	0	0	0
	II	0	0	0	0	0	0	0
4	I	0	1	0	2	0	0	0
	II	0	0	0	0	0	0	0
5	I	0	763	942	0	0	0	0
	II	0	0	0	0	0	0	0
6	I	0	0	419	0	0	0	0
	II	0	0	0	0	0	0	0
7	I	0	0	18	0	0	0	0
	II	0	0	0	0	0	0	0
8	I		0	22	0	0	0	0
	II		0	0	0	0	0	0
9	I	0	0		0	0	0	0
	II	0	0		0	0	0	0
10	I	0		40	0	0		0
	II	0		0	6	0		0

CHIONOECETES SP./10 SQ M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	MEG	0	2	10	0	3	2	0
2	MEG	0	10	0	0	8	0	0
3	MEG	0	2	0	0	1	0	0
4	MEG	0	0	1	0	0	0	0
5	MEG	0	0	0	0	0	0	0
6	MEG	0	0	0	0	1	0	0
7	MEG	0	1	0	0	0	0	0
8	MEG		1	2	0	0	0	0
9	MEG	1	2		0	2	0	0
10	MEG	1		5	0	0		0

APPENDIX B

Density per 1000 Cubic Meters

FISH EGGS/1000 CU M

STATION	SIZE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	<1 MM	0	0	0	2	0	0	0
	1 MM	0	1	0	1	0	0	0
	2 MM	1	1	2	0	0	0	0
	3 MM	0	51	91	0	0	0	0
2	<1 MM	0	1	0	7	0	0	0
	1 MM	0	0	30	118	0	0	0
	2 MM	0	2	3	1	0	0	0
	3 MM	0	0	1	0	0	0	0
3	<1 MM	0	0	0	2	0	0	0
	1 MM	13	123	485	0	0	0	0
	2 MM	0	16	14	1	0	0	0
	3 MM	0	0	0	0	0	0	0
4	<1 MM	0	0	0	5	0	0	0
	1 MM	0	0	6	0	0	0	0
	2 MM	0	0	1	0	0	0	0
	3 MM	0	0	0	0	0	0	0
5	<1 MM	0	0	2	1566	100	0	0
	1 MM	3	399	306	320	6	0	0
	2 MM	0	21	12	0	0	0	0
	3 MM	0	0	7	0	0	0	0
6	<1 MM	0	0	18	399	43	0	0
	1 MM	35	7400	3001	3	1	0	0
	2 MM	3	0	0	0	0	0	0
	3 MM	0	0	0	0	0	0	0
7	<1 MM	0	0	172	1451	0	0	0
	1 MM	252	275	4125	258	0	0	0
	2 MM	0	4	4	0	1	0	0
	3 MM	0	0	0	0	0	0	0
8	<1 MM		0	449	3526	0	0	0
	1 MM		2931	2224	215	0	0	0
	2 MM		31	3	0	0	0	0
	3 MM		0	0	0	0	0	0

CONTINUATION-FISH EGGS/1000 CU M

9	<1 MM	0	0		1	0	0	0
	1 MM	1	23		2	0	0	0
	2 MM	1	2		1	0	0	0
	3 MM	0	20		1	1	0	0
10	<1 MM	0		4	0	1		0
	1 MM	3		4	1	0		0
	2 MM	0		30	1	0		0
	3 MM	0		16	2	0		0

HIPPOGLOSSOIDES SP./1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	LAR	0	0	43	5	0	0	0
	JUV	0	0	0	0	0	0	0
2	LAR	0	0	1	7	1	0	0
	JUV	0	0	0	0	0	0	0
3	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	LAR	0	0	0	0	1	0	0
	JUV	0	0	0	0	0	0	0
5	LAR	0	0	13	4	0	0	0
	JUV	0	0	0	0	0	0	0
6	LAR	0	0	0	3	0	0	0
	JUV	0	0	0	0	0	0	0
7	LAR	0	0	0	238	0	0	0
	JUV	0	0	0	0	1	0	0
8	LAR		0	0	66	0	0	0
	JUV		0	0	0	0	0	0
9	LAR	0	0		4	1	0	0
	JUV	0	0		0	0	0	0
10	LAR	0		0	11	0		0
	JUV	0		0	0	0		0

GADIDAE/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	LAR	0	15	4	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	LAR	0	24	4	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-GADIDAE/1000 CU M

3	LAR	0	0	2	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	LAR	0	1	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	LAR	0	0	0	4	0	0	0
	JUV	0	0	0	0	3	0	0
6	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
7	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	LAR		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	LAR	9	3		2	0	0	0
	JUV	0	0		0	0	0	0
10	LAR	0		0	0	0		0
	JUV	0		0	0	0		0

OSMERIDAE/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	LAR	0	0	0	501	404	1	0
	JUV	0	0	0	0	0	0	0
2	LAR	0	5	0	1904	195	0	42
	JUV	0	0	0	0	0	0	0
3	LAR	0	0	0	26	61	0	0
	JUV	0	0	0	0	0	0	1
4	LAR	0	0	0	586	0	0	0
	JUV	0	0	0	0	0	0	0
5	LAR	0	0	0	1315	746	0	2
	JUV	0	0	0	0	0	0	0
6	LAR	0	2	0	0	550	0	1
	JUV	0	0	0	0	0	0	0

CONTINUATION-OSMERIDAE/1000 CU M

7	LAR	0	0	0	254	17	6	2
	JUV	0	0	0	0	0	0	0
8	LAR		0	0	7	7	0	0
	JUV		0	0	0	0	0	0
9	LAR	0	0		103	42	1	2
	JUV	0	0		0	0	0	0
10	LAR	0		0	229	12		0
	JUV	0		0	0	0		0

MALLOTUS VILLOSUS/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	LAR	4	6	0	1670	143	10	0
	JUV	0	0	0	0	0	0	0
2	LAR	0	0	0	2110	121	13	0
	JUV	0	0	0	0	1	0	0
3	LAR	0	0	0	417	24	0	0
	JUV	0	0	0	0	0	0	0
4	LAR	0	0	0	687	2	0	0
	JUV	0	0	0	0	0	0	0
5	LAR	0	0	0	1999	907	0	2
	JUV	0	0	0	0	0	0	0
6	LAR	0	0	0	19	2766	2	0
	JUV	0	0	0	0	0	0	1
7	LAR	0	0	0	1495	44	0	0
	JUV	0	0	0	0	0	0	0
8	LAR		0	0	174	424	24	0
	JUV		0	0	0	0	0	0
9	LAR	5	0		85	42	0	0
	JUV	0	0		0	0	0	0
10	LAR	0		0	81	11		0
	JUV	0		0	0	0		0

CLUPEA HARENGUS PALLASI/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	LAR	0	0	0	52	4	0	0
	JUV	0	0	0	0	0	2	0
5	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
6	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
7	LAR	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	LAR		0	0	22	0	0	0
	JUV		0	0	0	0	0	0
9	LAR	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	LAR	0		0	0	0		0
	JUV	0		0	0	0		0

AMMODYTES HEXAPTERUS/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	LAR	4	0	8	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	LAR	0	4	76	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	LAR	16	43	6	0	0	0	37
	JUV	0	0	0	0	0	0	0

CONTINUATION-AMMODYTES HEXAPTERUS/1000 CU M

4	LAR	0	2	12	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	LAR	1	1296	344	0	0	0	18
	JUV	0	0	0	0	0	0	0
6	LAR	17	525	1	0	0	0	31
	JUV	0	0	0	0	0	0	0
7	LAR	22	2	68	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	LAR		145	29	0	0	0	0
	JUV		0	0	0	0	0	0
9	LAR	1	1		0	0	0	0
	JUV	0	0		0	0	0	0
10	LAR	1		0	0	0		0
	JUV	0		0	0	0		0

PANDALOPSIS DISPAR/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	0	0	0	0
	II	0	0	1	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	1	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	4	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	I	0	0	0	0	0	0	21
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
6	I	1	0	0	0	0	0	0
	II	0	3	0	0	0	0	0
	III	0	0	0	0	1	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALOPSIS DISPAR/1000 CU M

7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	V		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	1	0		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		1	0	0	0
	IV	0	0		0	1	0	0
	V	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	I	0		1	0	0		0
	II	0		0	0	0		0
	III	0		1	0	0		0
	IV	0		0	0	0		0
	V	0		0	0	0		0
	JUV	0		0	0	0		0

PANDALUS BOREALIS/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	20	0	0	0	0	0
	II	0	14	10	0	0	0	0
	III	0	0	52	0	0	0	0
	IV	0	0	2	1	0	0	0
	V	0	0	0	1	1	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	3	0	0

CONTINUATION-PANDALUS BOREALIS/1000 CU M

2	I	0	1	1	0	0	0	0
	II	0	1	0	0	0	0	0
	III	0	0	1	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	187	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	1	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	2	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	2	0	0
5	I	0	842	39	0	0	0	0
	II	0	302	12	0	0	0	0
	III	0	0	93	0	0	0	0
	IV	0	0	12	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
6	I	2	824	0	0	0	0	0
	II	0	24	5	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	1	4	0	0
	V	0	0	0	1	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALUS BOREALIS/1000 CU M

7	I	0	49	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	5	0	0	0
	IV	0	0	0	266	0	0	0
	V	0	0	0	5	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	I		0	2	0	0	0	0
	II		0	3	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	6	0	0	0
	V		0	0	0	0	0	0
	VI		0	0	0	0	0	0
	VII		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	0	53		0	0	0	0
	II	0	26		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		2	0	0	0
	V	0	0		0	0	0	0
	VI	0	0		0	0	0	0
	VII	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	I	0		0	0	0		0
	II	0		1	0	0		0
	III	0		5	7	0		0
	IV	0		2	8	0		0
	V	0		0	2	0		0
	VI	0		0	0	0		0
	VII	0		0	0	0		0
	JUV	0		0	0	0		0

PANDALUS DANAE/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	1	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	2	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-<u>PANDALUS DANAE/1000 CU M</u>

6	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	5	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	V		0	0	0	0	0	0
	VI		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	0	0		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	V	0	0		0	0	0	0
	VI	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	V	0		0	0	0		0
	VI	0		0	0	0		0
	JUV	0		0	0	0		0

PANDALUS GONIURUS/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	0	0	0	0
	II	0	0	1	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	1	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	2	11	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	I	0	1	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	I	0	4583	93	0	0	0	0
	II	0	687	2612	0	0	0	0
	III	0	0	1480	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALUS GONIURUS/1000 CU M

6	I	1	2812	10	0	0	0	0
	II	0	0	10	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	8	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	2	0	0	0
7	I	0	251	1942	0	0	0	0
	II	0	0	10182	0	0	0	0
	III	0	0	894	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	VII	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	I		2730	2	0	0	0	0
	II		46	85	0	0	0	0
	III		0	17	0	0	0	0
	IV		0	0	0	0	0	0
	V		0	0	0	0	0	0
	VI		0	0	0	0	0	0
	VII		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	0	29		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	V	0	0		0	0	0	0
	VI	0	0		0	0	0	0
	VII	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	I	0		0	0	0		0
	II	0		1	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	V	0		0	0	0		0
	VI	0		0	0	0		0
	VII	0		0	0	0		0
	JUV	0		0	0	0		0

PANDALUS HYPSINOTUS/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	I	0	5	6	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALUS HYPSINOTUS/1000 CU M

6	I	0	2	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	V		0	0	0	0	0	0
	VI		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	0	0		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	V	0	0		0	0	0	0
	VI	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	V	0		0	0	0		0
	VI	0		0	0	0		0
	JUV	0		0	0	0		0

PANDALUS PLATYCEROS/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	2
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
6	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALUS PLATYCEROS/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	0	0		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	JUV	0		0	0	0		0

PANDALUS STENOLEPIS/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	5	6	1	0	0	0
	II	0	0	3	3	0	0	0
	III	0	0	0	6	0	0	0
	IV	0	0	0	5	0	0	0
	V	0	0	0	1	0	0	0
	VI	0	0	0	1	0	0	0
	JUV	0	0	0	0	0	0	0
2	I	0	2	0	0	0	0	0
	II	0	0	1	0	0	0	0
	III	0	0	1	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALUS STENOLEPIS/1000 CU M

4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
6	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	3	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	VI	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	I		0	0	0	0	0	0
	II		0	0	1	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	V		0	0	0	0	0	0
	VI		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	0	28		6	0	0	0
	II	0	1		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		1	0	0	0
	V	0	0		0	0	0	0
	VI	0	0		0	1	0	0
	JUV	0	0		0	0	0	0

CONTINUATION-PANDALUS STENOLEPIS/1000 CU M

10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	1	0		0
	IV	0		0	1	0		0
	V	0		0	1	0		0
	VI	0		0	0	1		0
	JUV	0		0	0	0		0

PANDALUS MONTAGUI TRIDENS/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 6-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	90	7	0	0	0	0
	II	0	0	72	0	0	0	0
	III	0	0	5	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
2	I	0	1	0	0	0	0	0
	II	0	0	1	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
5	I	0	5	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0

CONTINUATION-PANDALUS MONTAGUI TRIDENS/1000 CU M

6	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	JUV	0	0	0	0	0	0	0
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	JUV		0	0	0	0	0	0
9	I	1	393		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		1	0	0	0
	IV	0	0		0	0	0	0
	JUV	0	0		0	0	0	0
10	I	0		24	0	0		0
	II	0		20	0	0		0
	III	0		4	0	0		0
	IV	0		0	0	0		0
	JUV	0		0	0	0		0

ANOMURA/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	ZOE	10	203	417	356	524	0	0
	MEG	0	0	0	0	19	0	0
2	ZOE	0	375	8408	602	189	26	0
	MEG	0	0	0	55	20	0	0
3	ZOE	0	0	44	811	4	0	18
	MEG	0	0	0	0	9	2	0
4	ZOE	0	1	2	25	8	0	0
	MEG	0	0	0	2	4	0	0
5	ZOE	0	3805	1726	3871	3899	21	2
	MEG	0	0	0	0	10	22	0
6	ZOE	38	330	8	326	609	0	71
	MEG	0	0	0	13	8	0	0
7	ZOE	0	95	577	2751	33	3	0
	MEG	0	0	0	0	7	3	0
8	ZOE		146	2980	69	653	2	0
	MEG		0	0	0	30	2	0
9	ZOE	0	66		273	21	0	0
	MEG	0	0		12	1	0	0
10	ZOE	0		20	12	0		0
	MEG	0		0	0	0		0

BRACHYURA/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	ZOE	0	161	1409	811	32	0	0
	MEG	0	0	0	244	4	0	0
2	ZOE	0	623	9418	1340	330	0	0
	MEG	0	0	0	322	48	0	0

CONTINUATION-BRACHYURA/1000 CU M

3	ZOE	0	54	1776	931	152	0	1
	MEG	0	0	0	78	10	0	0
4	ZOE	0	0	207	26	221	0	0
	MEG	0	0	0	1	1	0	0
5	ZOE	0	1144	7855	5462	3526	2	0
	MEG	0	0	0	165	29	0	0
6	ZOE	0	1508	6266	833	791	0	409
	MEG	0	0	0	0	20	0	0
7	ZOE	0	92	710	12228	19	6	0
	MEG	0	0	0	343	1	0	0
8	ZOE		27	11332	95	1219	0	0
	MEG		0	0	10	30	0	0
9	ZOE	0	93		655	4	0	1
	MEG	0	0		777	1	0	0
10	ZOE	0		125	27	2		0
	MEG	0		0	98	1		0

PARALITHODES CAMTSCHATICA/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	6	0	0	0	0
	II	0	0	5	0	0	0	0
	III	0	0	4	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
2	I	0	0	5	0	0	0	0
	II	0	0	74	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
3	I	0	3	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0

CONTINUATION-PARALITHODES CAMTSCHATICA/1000 CU M

4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
5	I	0	2183	0	0	0	0	25
	II	0	1287	339	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
6	I	2	345	0	0	0	0	5
	II	1	190	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
7	I	0	1240	102	0	0	0	0
	II	0	4	1282	0	0	0	0
	III	0	0	140	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
8	I		1129	0	0	0	0	0
	II		20	266	0	0	0	0
	III		0	326	0	0	0	0
	IV		0	0	0	0	0	0
	MEG		0	0	0	0	0	0
9	I	0	30		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	MEG	0	0		0	0	0	0
10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	MEG	0		0	0	0		0

PARALITHODES PLATYPUS/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
2	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	3	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	8	0	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
5	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
6	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	MEG	0	0	0	1	0	0	0

CONTINUATION-PARALITHODES PLATYPUS/1000 CU M

8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	MEG		0	0	0	0	0	0
9	I	0	0		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	MEG	0	0		0	0	0	0
10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	MEG	0		0	0	0		0

CANCER MAGISTER/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	0	0	0	0
	II	0	0	0	0	1	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	1	1	0
	MEG	0	0	0	0	1	37	0
2	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	2	0	0
	MEG	0	0	0	0	0	0	0
3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0

CONTINUATION-CANCER MAGISTER/1000 CU M

4	'I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
5	I	0	0	0	0	0	0	0
	II	0	0	0	12	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	4	0	0
6	I	0	0	0	3	0	0	0
	II	0	0	0	0	2	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	7	0	0
	IV		0	0	0	0	0	0
	V		0	0	0	0	0	0
	MEG		0	0	0	5	0	0
9	I	0	0		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	V	0	0		0	0	0	0
	MEG	0	0		0	1	0	0
10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	V	0		0	0	0		0
	MEG	0		0	0	0		0

CANCER OREGONENSIS/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	0	0	2075	0	0	0
	II	0	0	0	729	0	0	0
	III	0	0	0	60	23	0	0
	IV	0	0	0	2	55	0	0
	V	0	0	0	0	75	0	0
	MEG	0	0	0	0	12	0	0
2	I	0	0	0	956	6	0	0
	II	0	0	0	1230	16	0	0
	III	0	0	0	73	240	0	0
	IV	0	0	0	0	1137	0	0
	V	0	0	0	0	455	0	0
	MEG	0	0	0	0	39	20	0
3	I	0	0	0	7742	2	0	1
	II	0	0	0	1083	3	0	0
	III	0	0	0	45	26	0	0
	IV	0	0	0	0	76	0	0
	V	0	0	0	0	52	0	0
	MEG	0	0	0	0	2	0	0
4	I	0	0	0	17	0	0	0
	II	0	0	0	6	3	0	0
	III	0	0	0	0	7	0	0
	IV	0	0	0	0	43	0	0
	V	0	0	0	0	7	0	0
	MEG	0	0	0	0	1	0	0
5	I	0	0	0	22779	5	0	0
	II	0	0	0	1281	5	0	0
	III	0	0	0	9	115	0	0
	IV	1	0	0	0	1128	0	0
	V	0	0	6	0	376	0	0
	MEG	0	0	0	0	145	23	0
6	I	0	0	0	183	7	0	58
	II	0	0	0	12	13	0	0
	III	0	0	0	0	121	0	0
	IV	0	0	0	0	370	0	0
	V	0	0	0	0	260	0	0
	MEG	0	0	0	0	96	0	0

CONTINUATION-CANCER OREGONENSIS/1000 CU M

7	I	0	0	0	20	0	0	0
	II	0	0	0	1	5	0	0
	III	0	0	0	0	21	0	0
	IV	0	0	0	0	32	0	0
	V	0	0	0	0	14	0	0
	MEG	0	0	0	0	1	37	0
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	235	0	0
	IV		0	0	0	1454	0	0
	V		0	0	0	848	0	0
	MEG		0	0	0	7	6	0
9	I	0	0		82	0	0	0
	II	0	0		44	0	0	0
	III	0	0		79	6	0	0
	IV	0	0		0	30	0	0
	V	0	0		0	157	1	0
	MEG	0	0		0	61	0	0
10	I	0		0	1	0		0
	II	0		0	61	0		0
	III	0		0	26	1		0
	IV	0		0	1	2		0
	V	0		0	0	10		0
	MEG	0		0	0	2		0

CANCER PRODUCTUS/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	5	7	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
2	I	0	1	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0

CONTINUATION-CANCER PRODUCTUS/1000 CU M

3	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
4	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
5	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
6	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
7	I	0	0	0	0	0	0	0
	II	0	0	0	0	0	0	0
	III	0	0	0	0	0	0	0
	IV	0	0	0	0	0	0	0
	V	0	0	0	0	0	0	0
	MEG	0	0	0	0	0	0	0
8	I		0	0	0	0	0	0
	II		0	0	0	0	0	0
	III		0	0	0	0	0	0
	IV		0	0	0	0	0	0
	V		0	0	0	0	0	0
	MEG		0	0	0	0	0	0
9	I	0	0		0	0	0	0
	II	0	0		0	0	0	0
	III	0	0		0	0	0	0
	IV	0	0		0	0	0	0
	V	0	0		0	0	0	0
	MEG	0	0		0	0	0	0

CONTINUATION-CANCER PRODUCTUS/1000 CU M

10	I	0		0	0	0		0
	II	0		0	0	0		0
	III	0		0	0	0		0
	IV	0		0	0	0		0
	V	0		0	0	0		0
	MEG	0		0	0	0		0

CHIONOECETES BAIRDI/1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	I	0	1	22	2	0	0	0
	II	0	0	0	141	0	0	0
2	I	0	0	945	0	0	0	0
	II	0	0	0	3	0	0	0
3	I	0	1	17	4	0	0	0
	II	0	0	0	0	0	0	0
4	I	0	1	0	3	0	0	0
	II	0	0	0	0	0	0	0
5	I	0	3053	2094	0	0	0	0
	II	0	0	0	0	0	0	0
6	I	0	0	466	0	0	0	0
	II	0	0	0	0	0	0	0
7	I	0	0	51	0	0	0	0
	II	0	0	0	0	0	0	0
8	I		0	68	0	0	0	0
	II		0	0	0	0	0	0
9	I	0	0		0	0	0	0
	II	0	0		0	0	0	0
10	I	0		45	0	0		0
	II	0		0	5	0		0

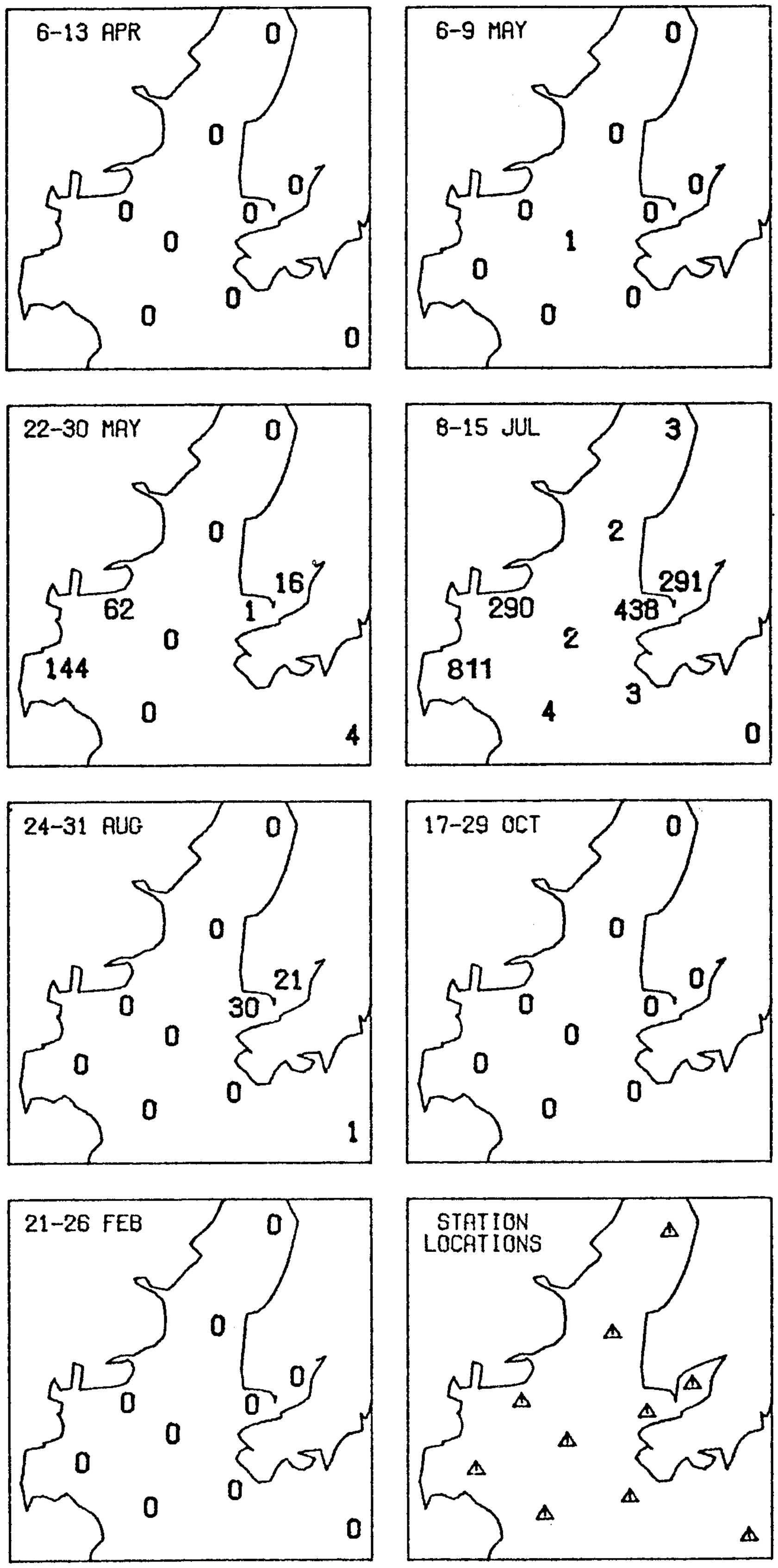
CHIONOECETES SP./1000 CU M

STATION	STAGE	APR 6-13	MAY 6-9	MAY 22-30	JUL 8-15	AUG 24-31	OCT 17-29	FEB 21-26
1	MEG	0	1	9	0	2	1	0
2	MEG	0	18	0	0	11	0	0
3	MEG	0	2	0	0	2	0	0
4	MEG	0	0	1	0	0	0	0
5	MEG	0	0	0	0	0	0	0
6	MEG	0	0	0	0	2	0	0
7	MEG	0	2	0	0	0	0	0
8	MEG		2	5	0	0	0	0
9	MEG	1	2		0	1	0	0
10	MEG	1		5	0	0		0

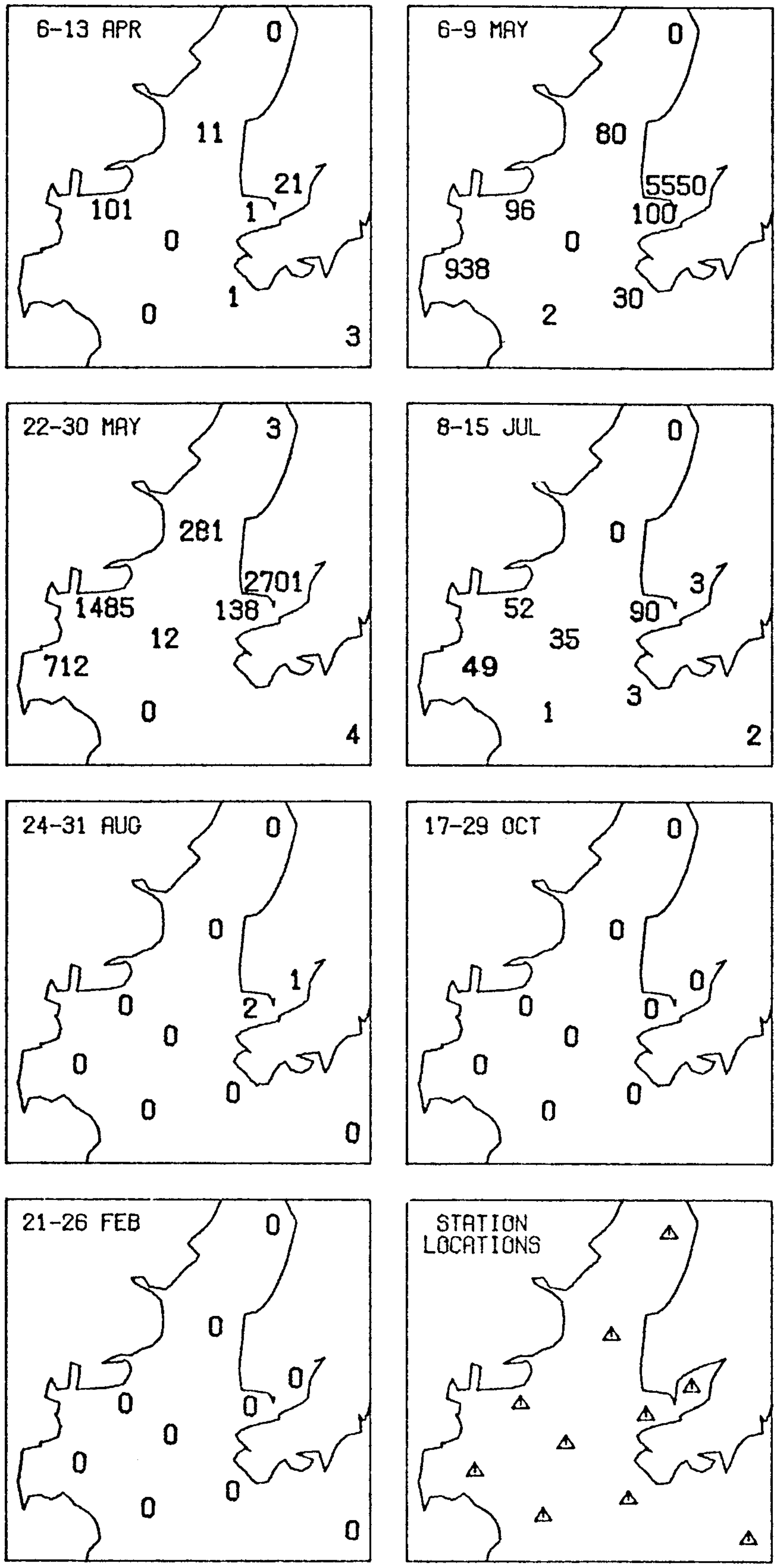
APPENDIX C

Density Distributions per 10 Square Meters for Seven Cruises

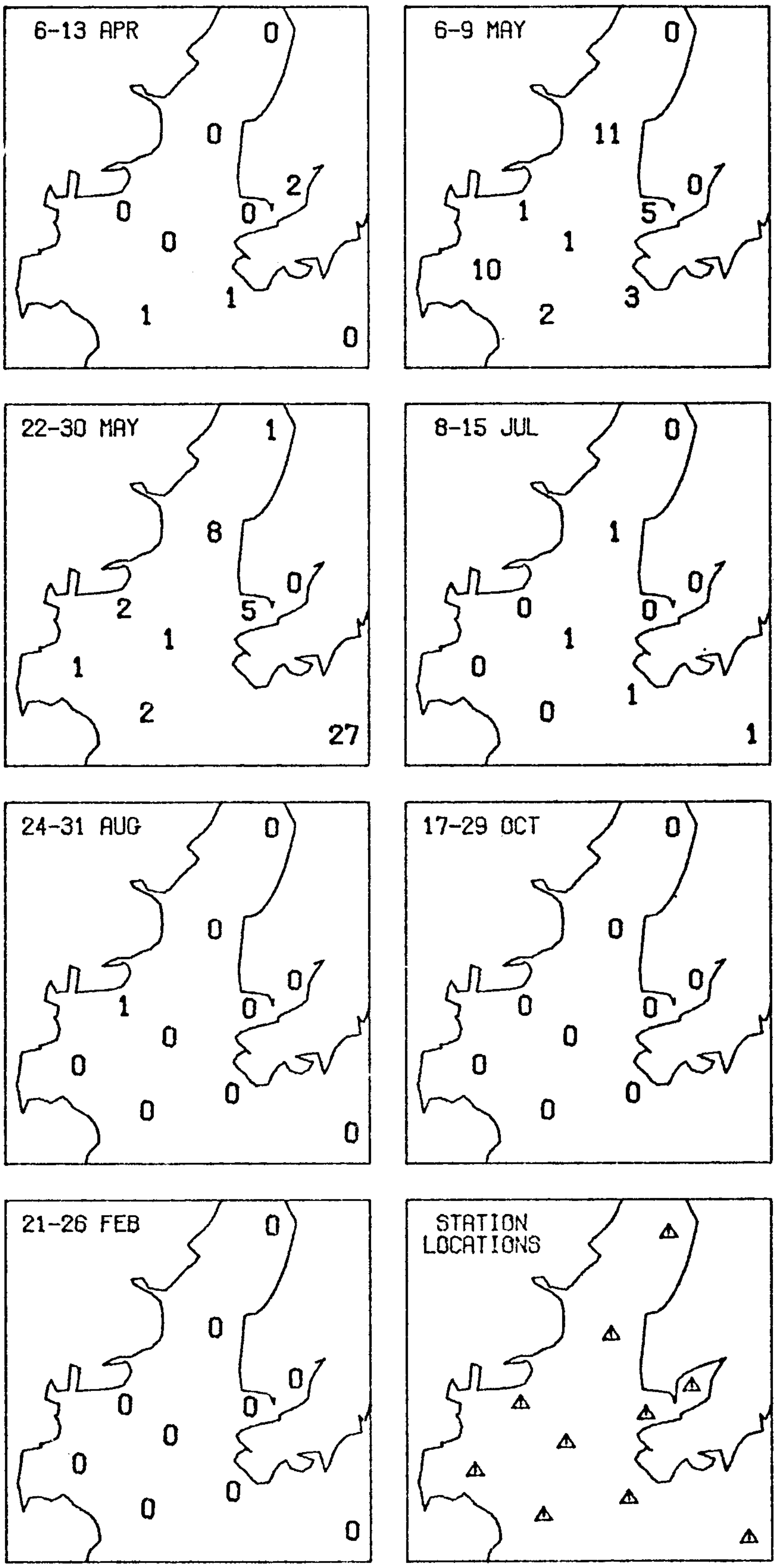
FISH EGGS
<1MM DIAM/10 SQ M



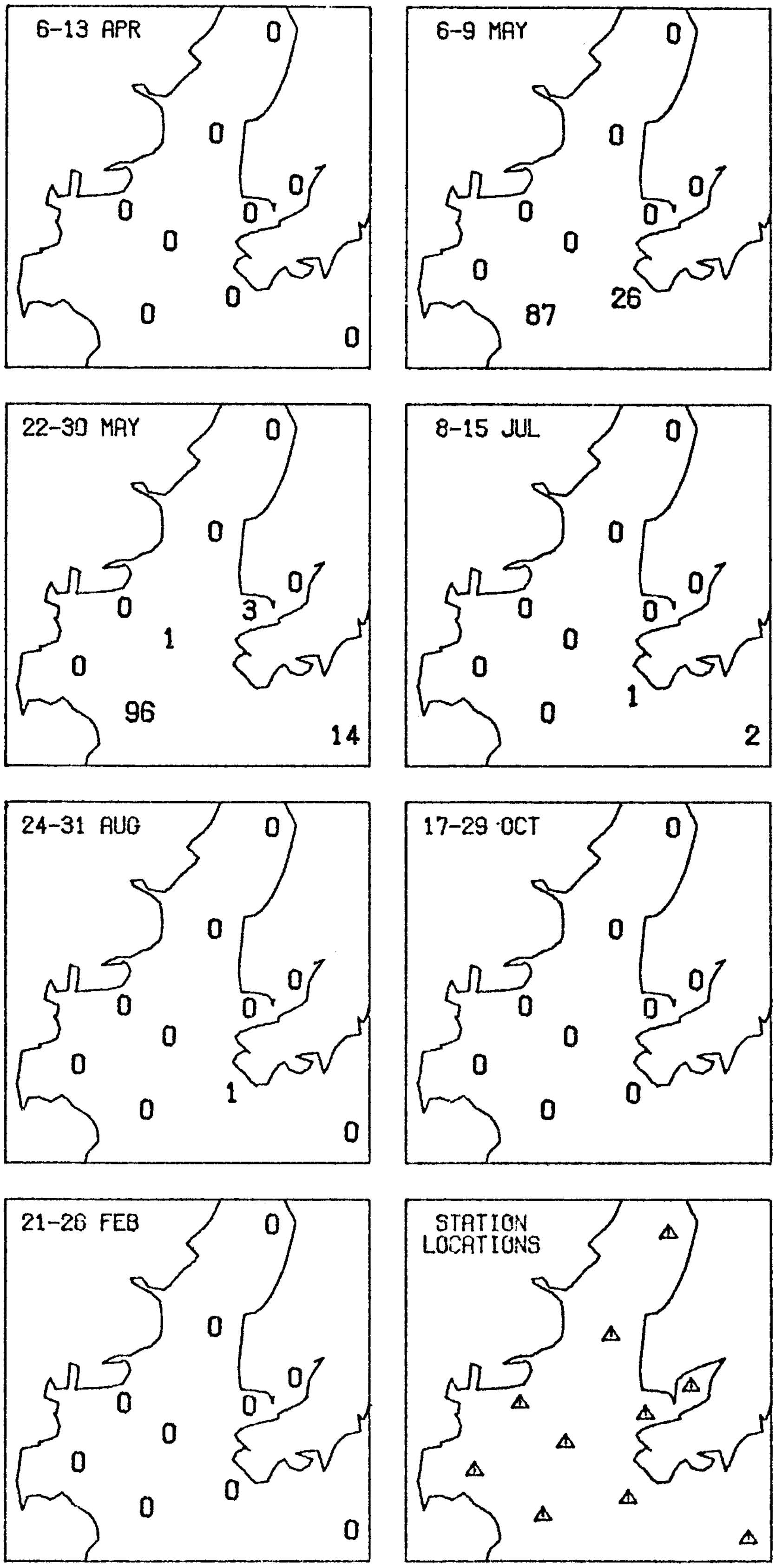
FISH EGGS
~1MM DIAM/10 SQ M



FISH EGGS
~2MM DIAM/10 SQ M

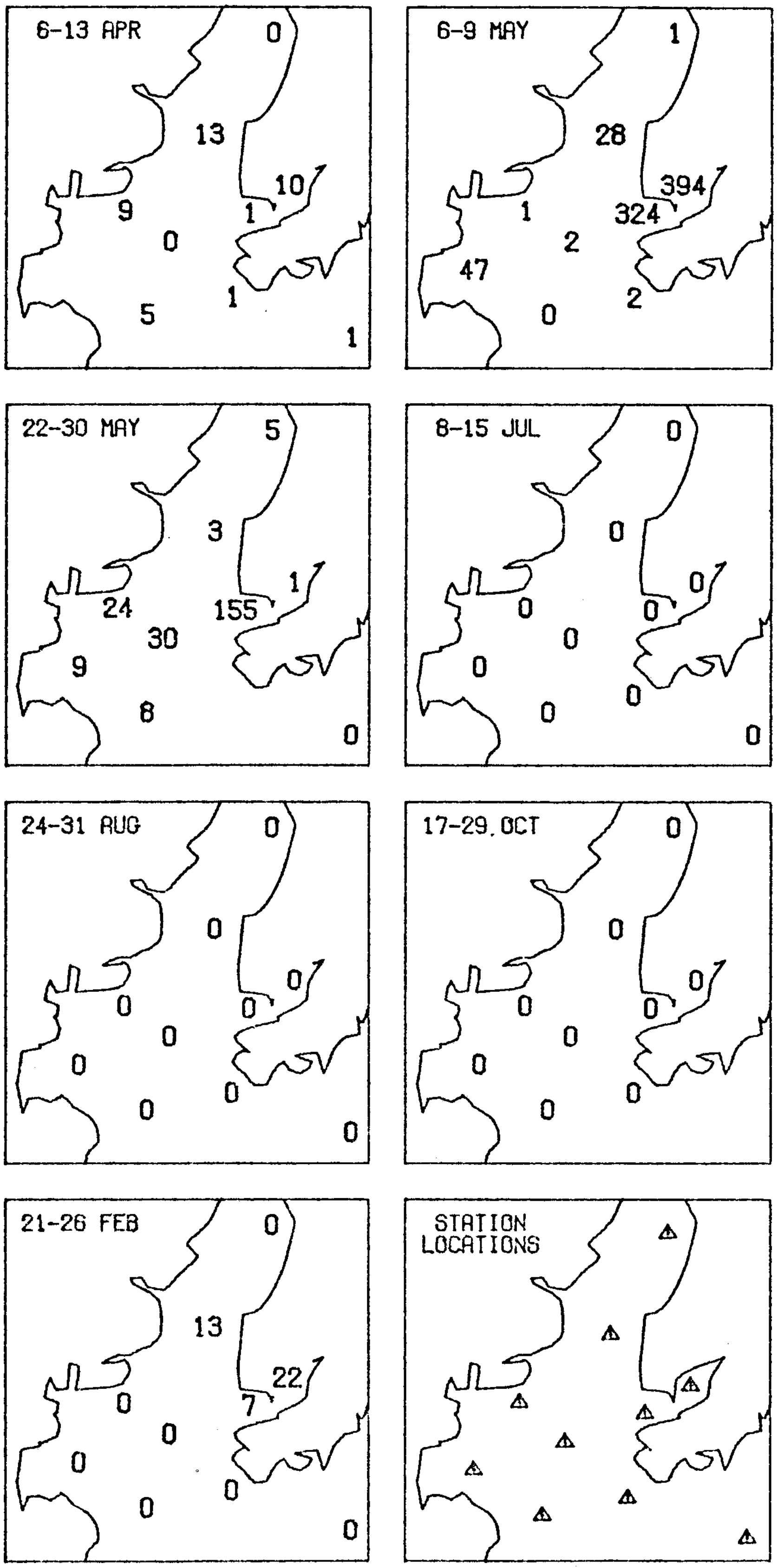


FISH EGGS
~3MM DIAM/10 SQ M

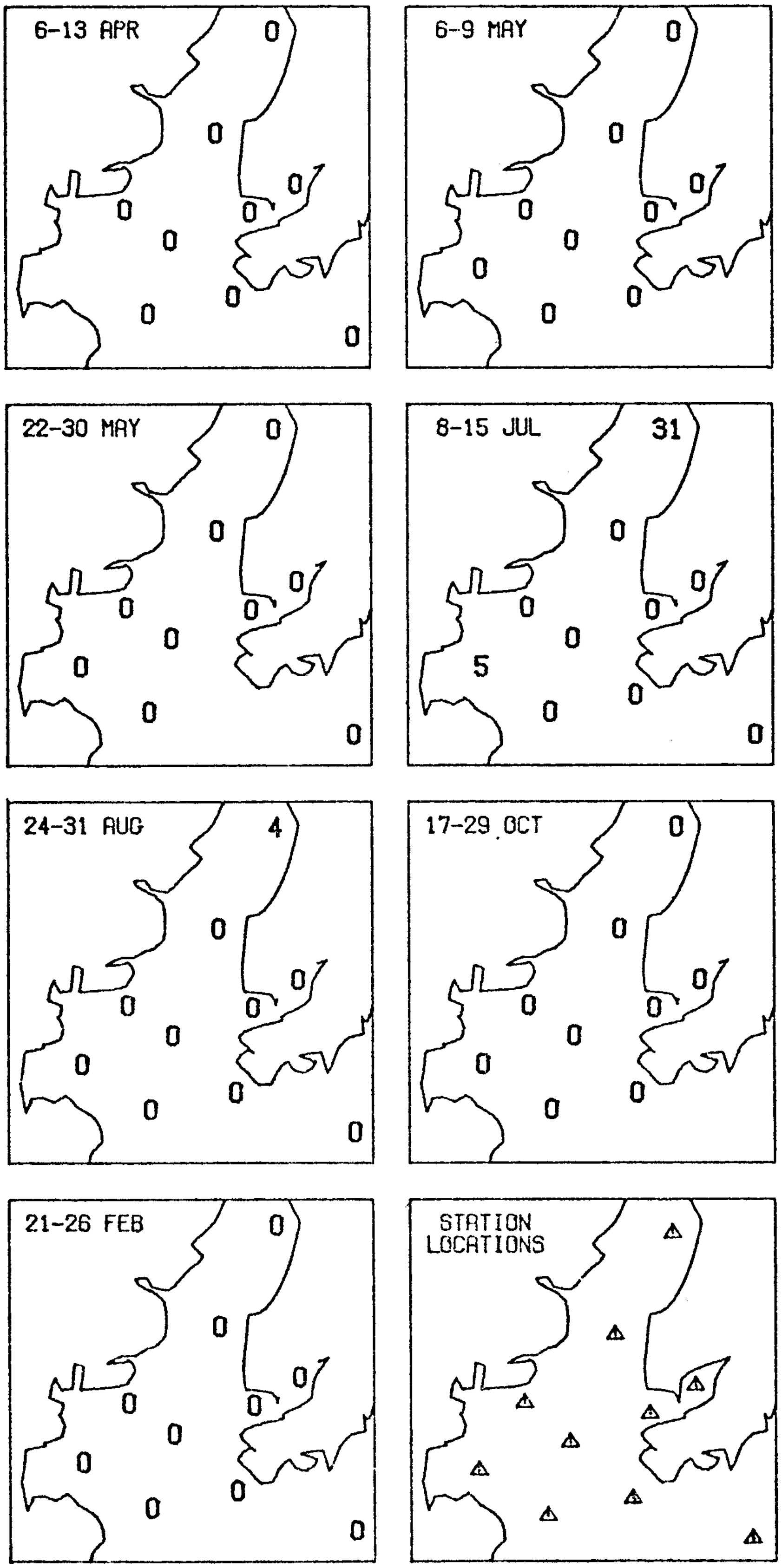


AMMODYTES HEXAPTERUS

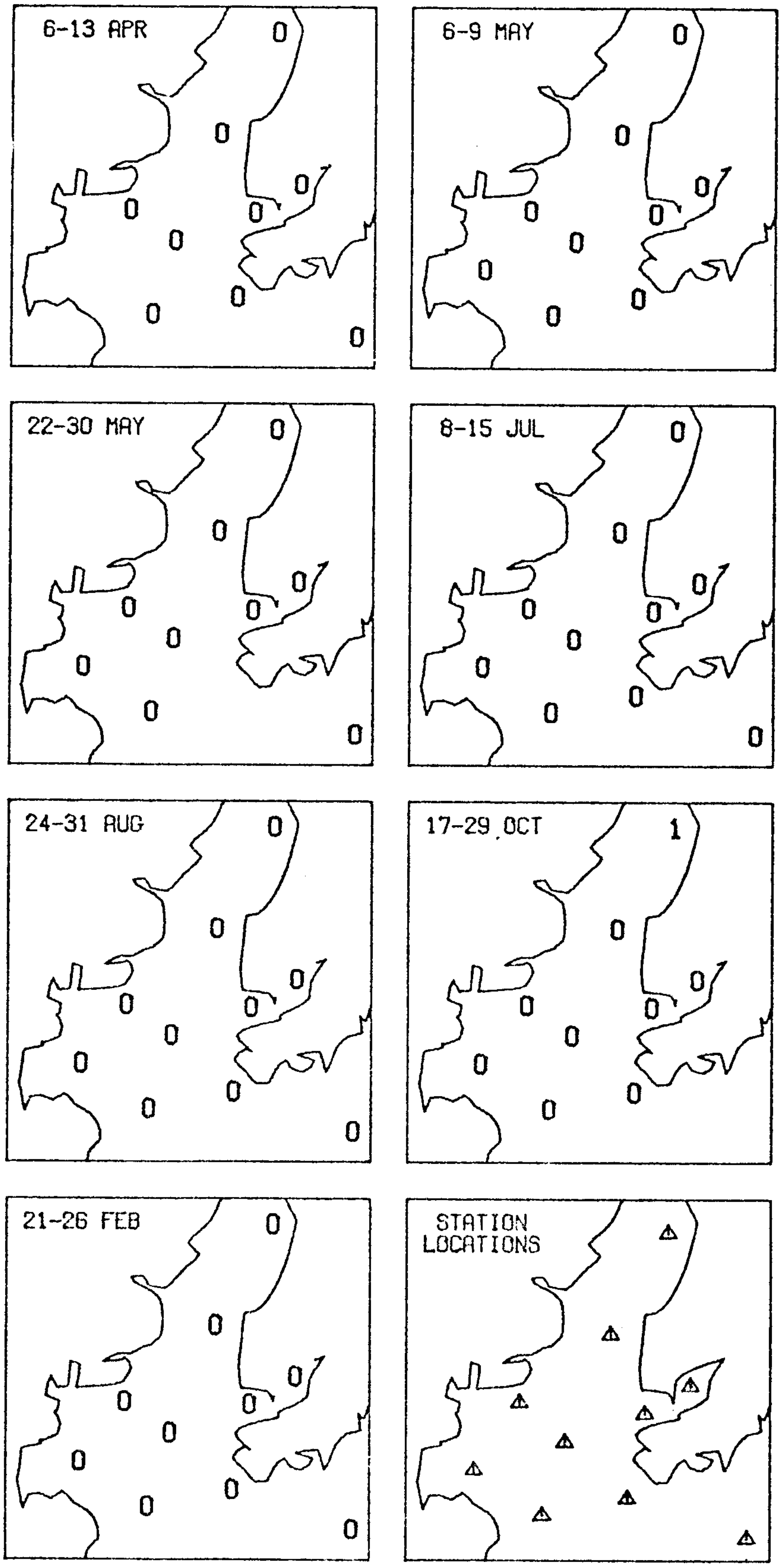
LARVA/10 SQ M



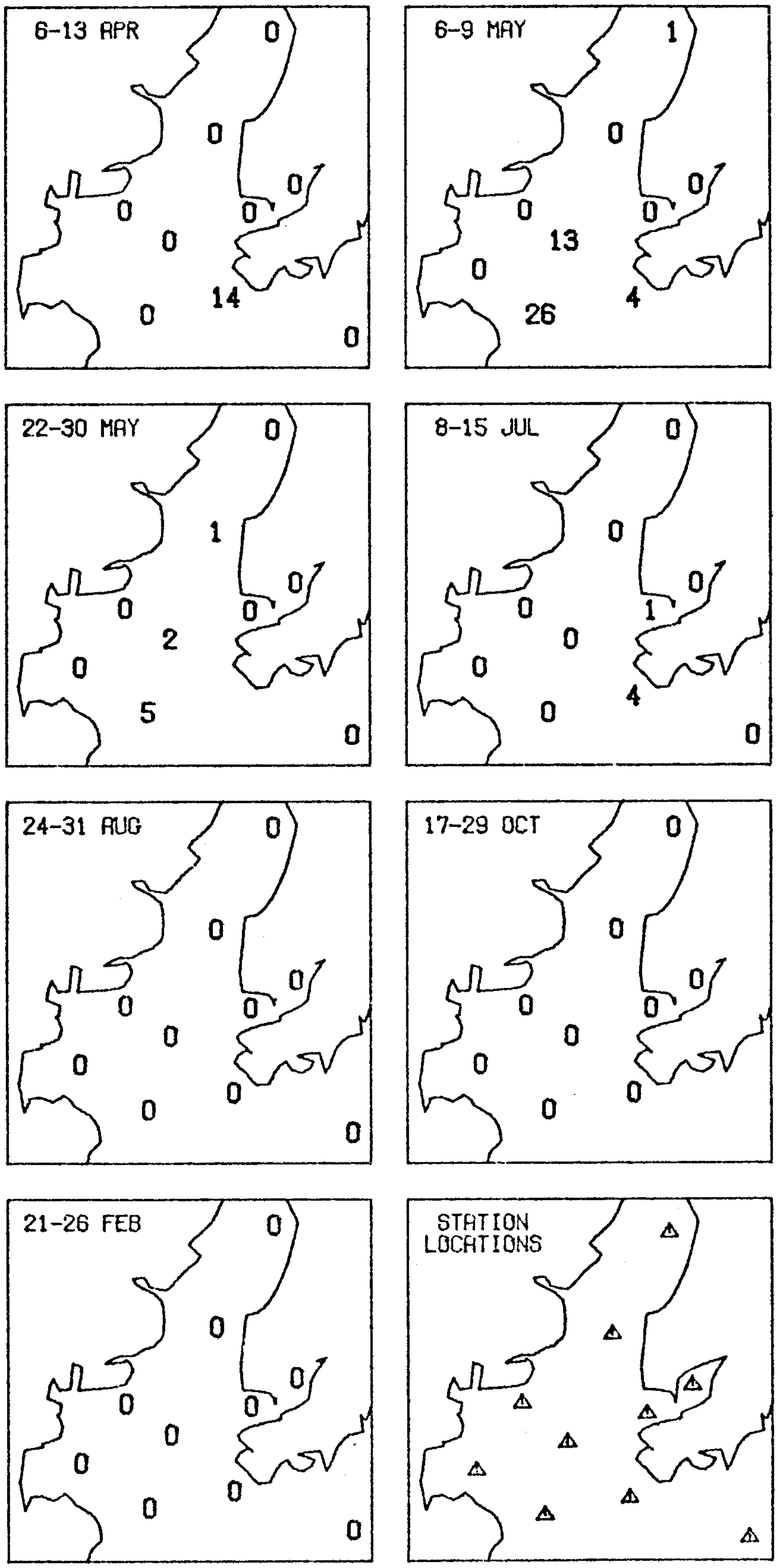
CLUPEA HARENGUS PALLASI
LARVA/10 SQ M



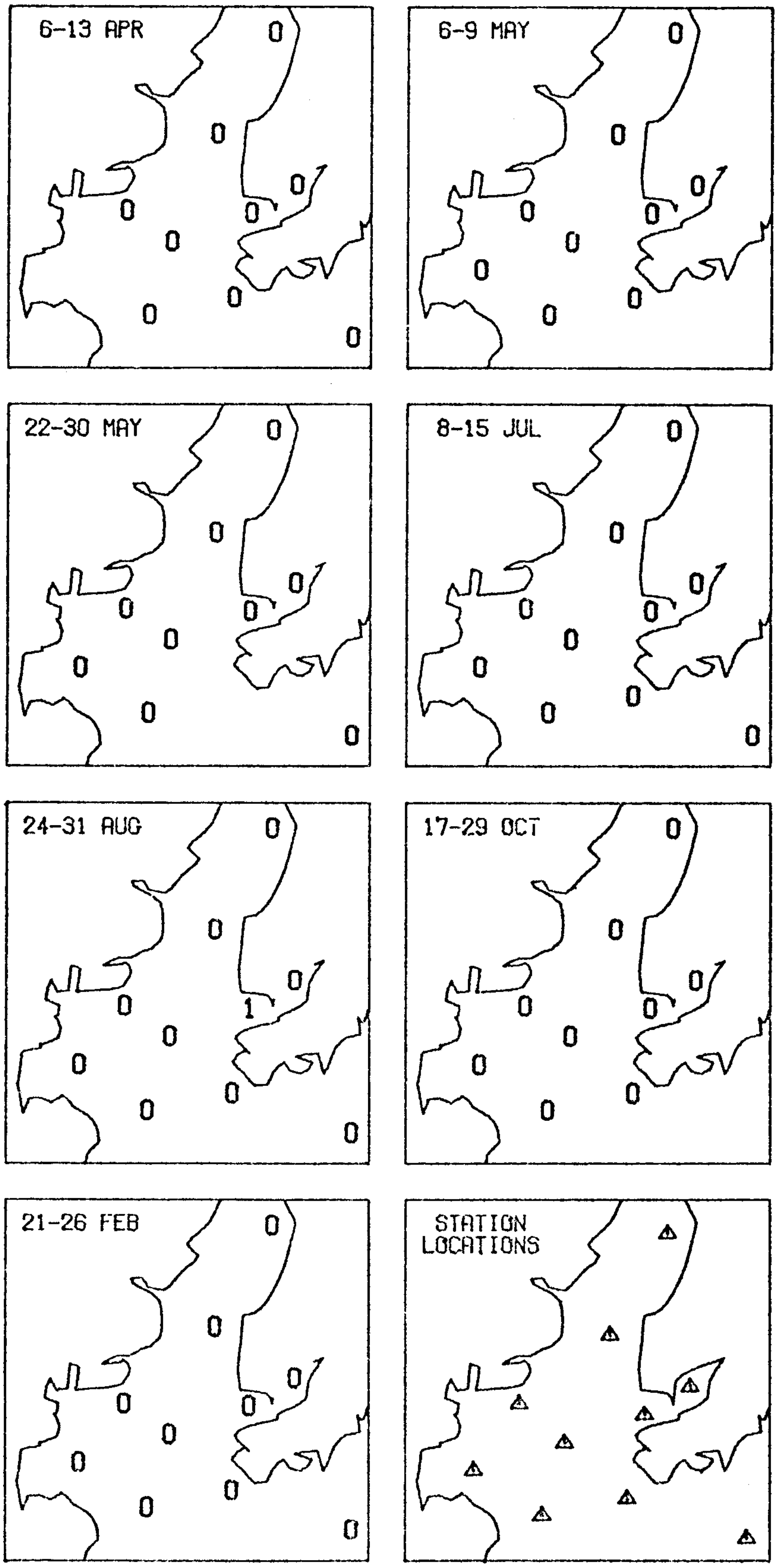
CLUPEA HARENGUS PALLASI
JUVENILE/10 SQ M



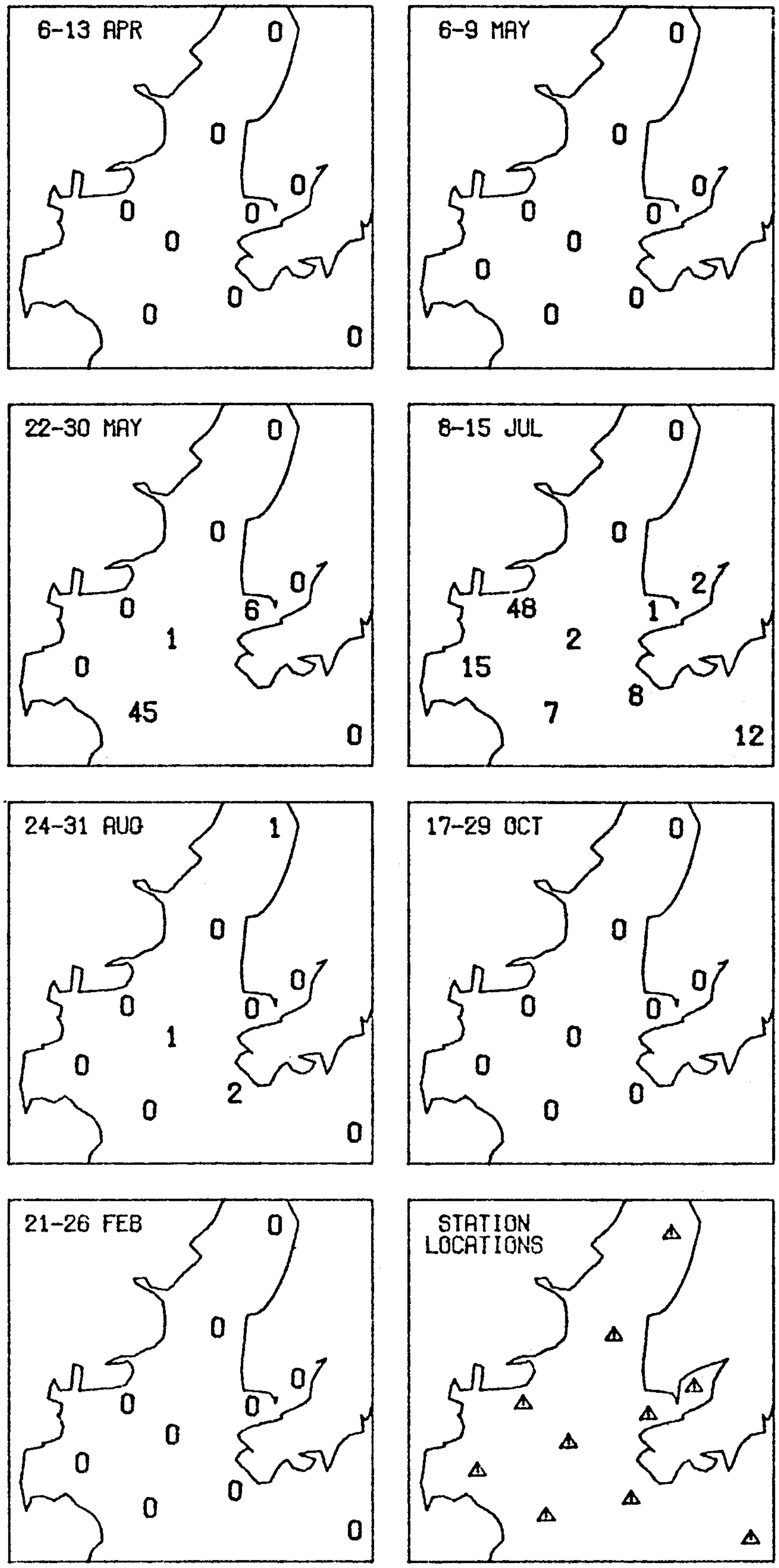
GADIDAE
LARVA/10 SQ M



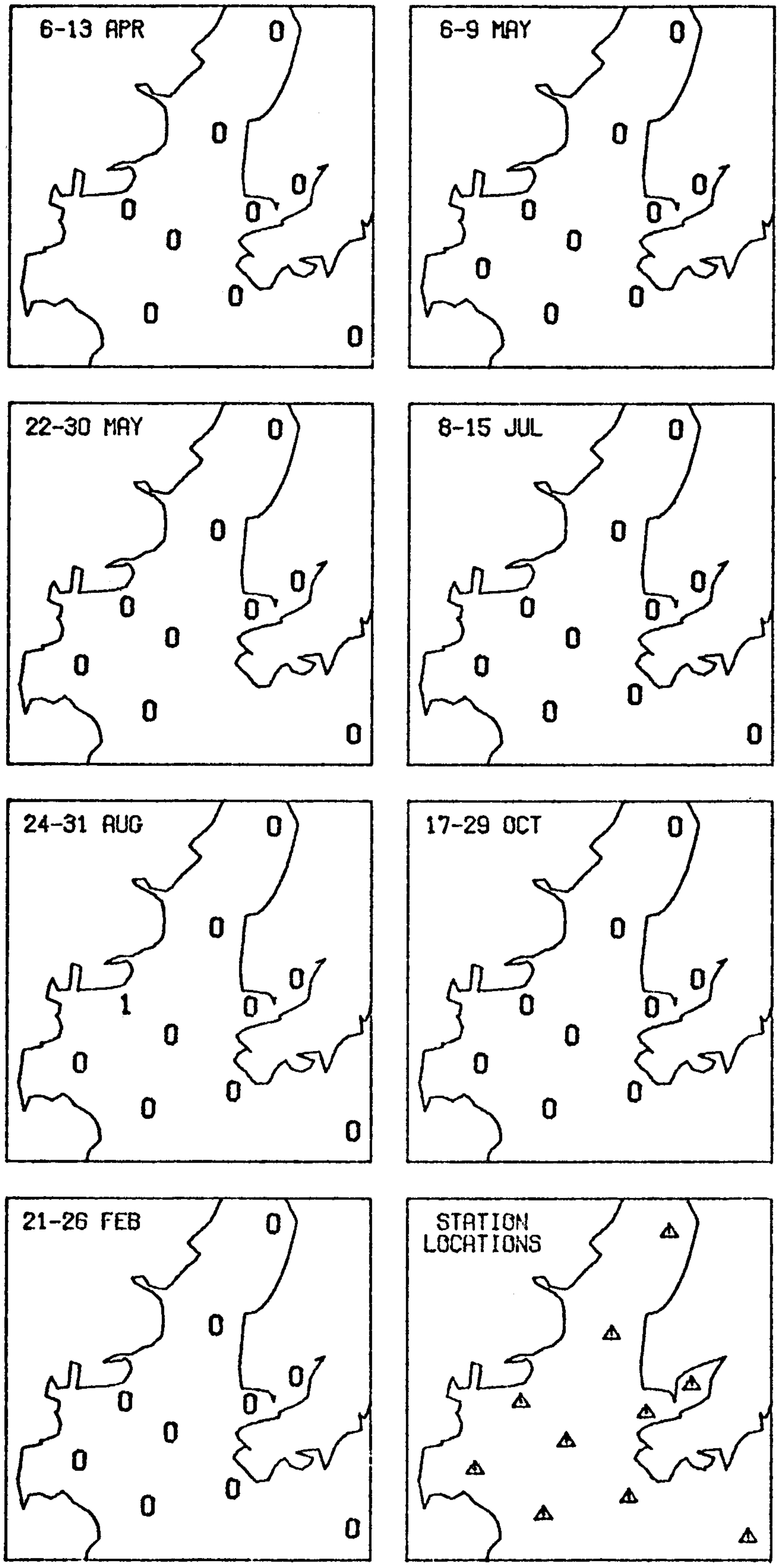
GADIDAE
JUVENILE/10 SQ M



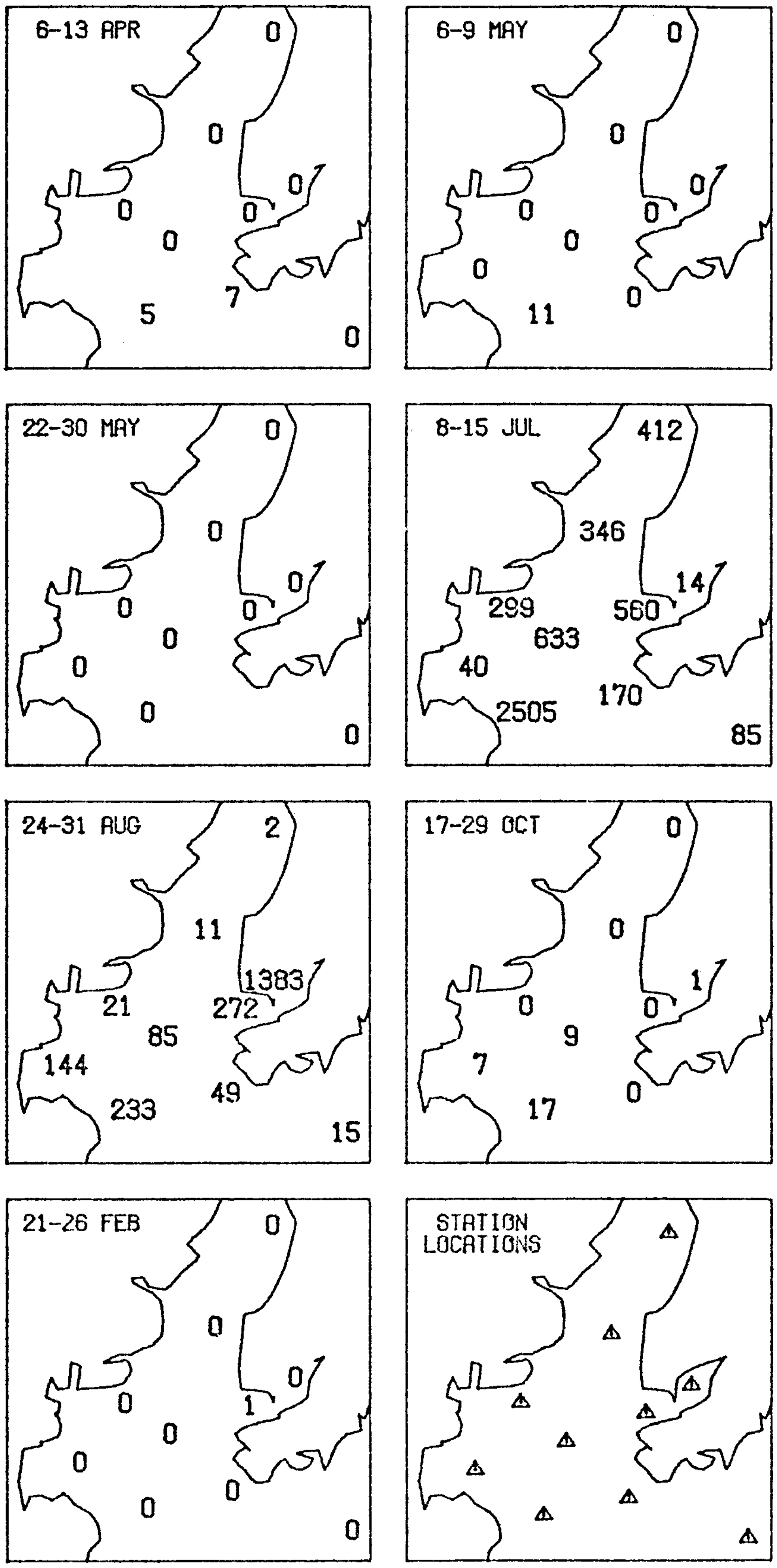
HIPPOGLOSSOIDES SP.
LARVA/10 SQ M



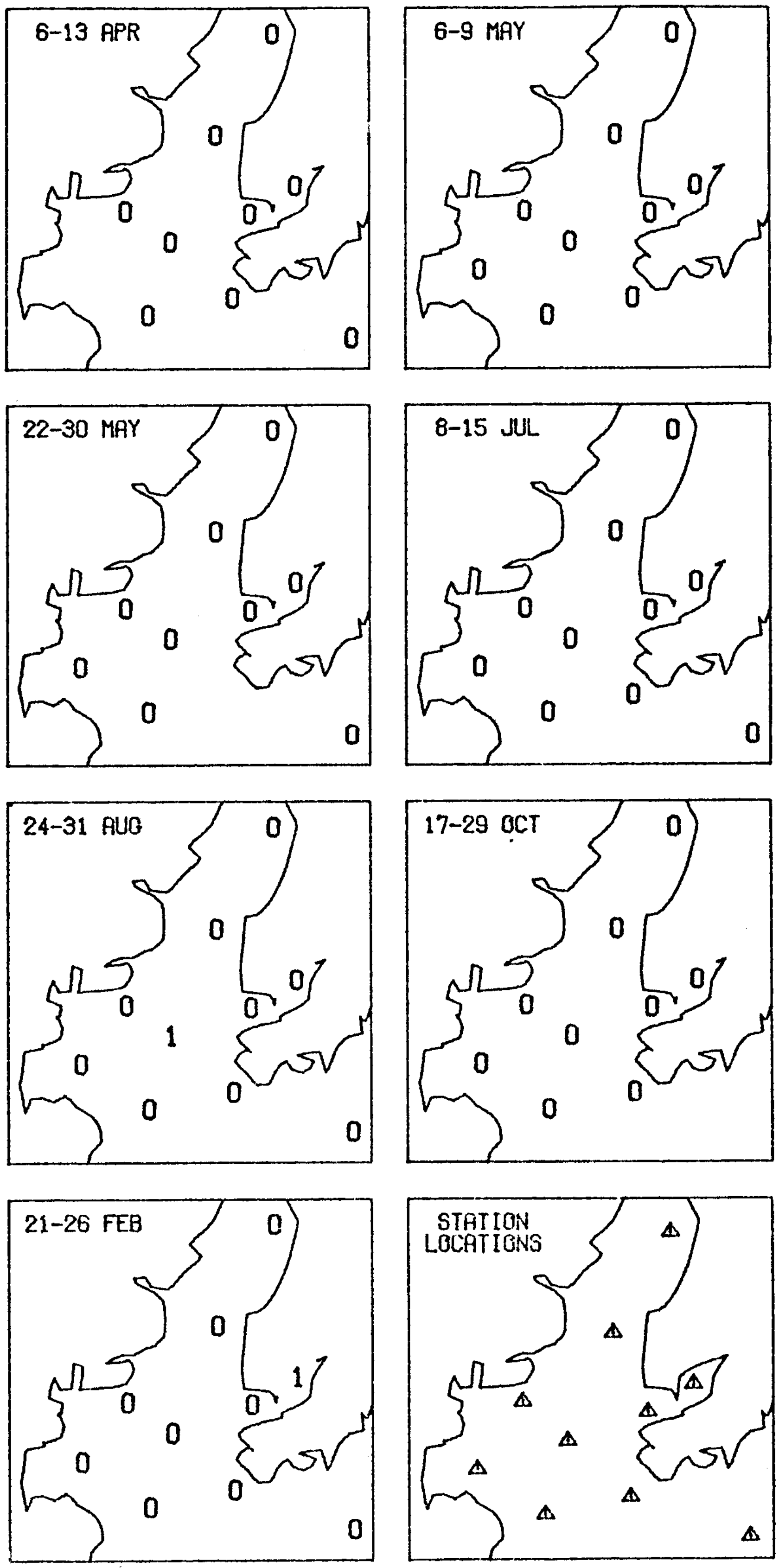
HIPPOGLOSSOIDES SP
JUVENILE/10 SQ M



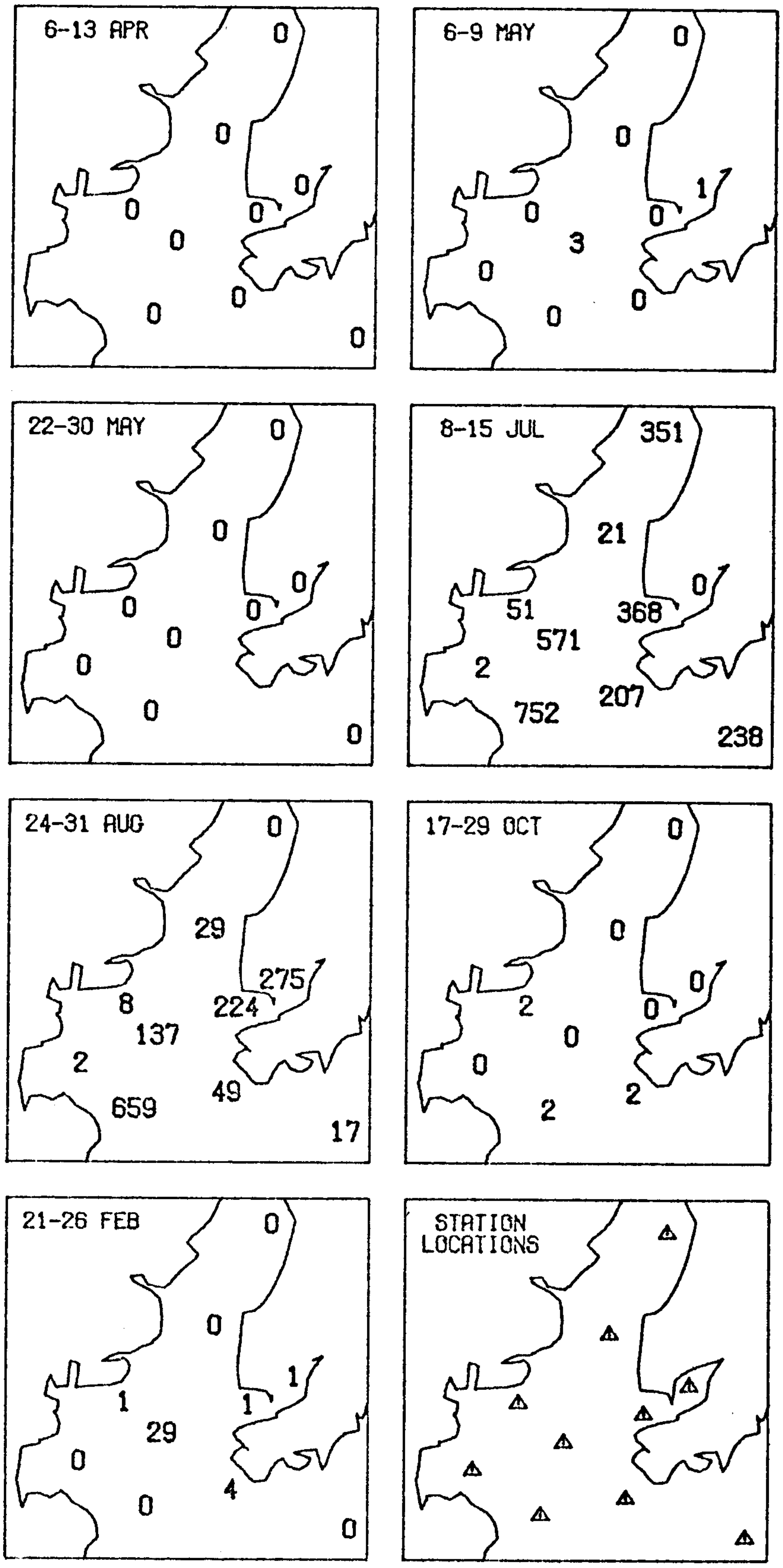
MALLOTUS VILLOSUS
LARVA/10 SQ M



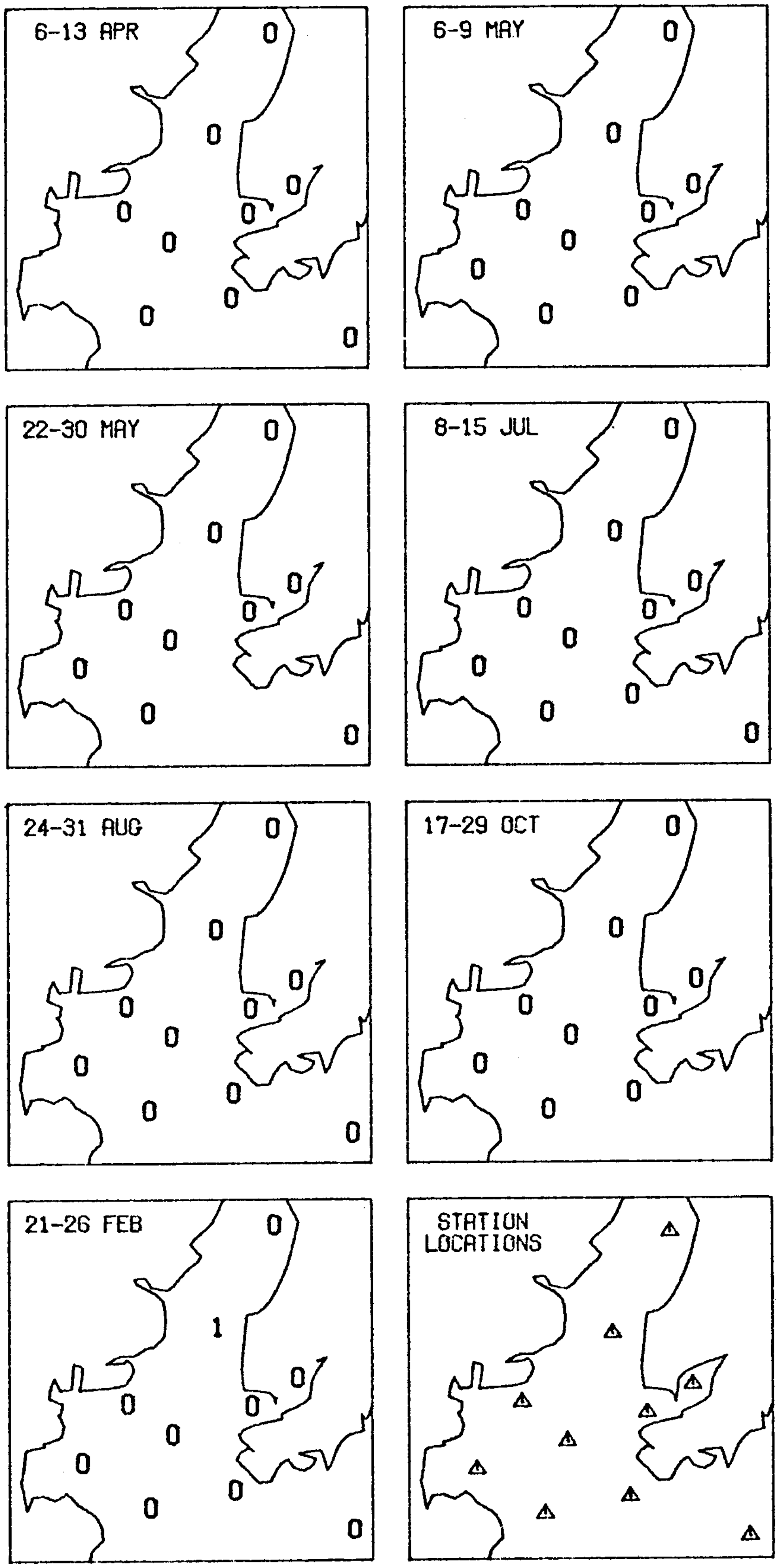
MALLOTUS VILLOSUS
JUVENILE/10 SQ M



OSMERIDAE
LARVA/10 SQ M

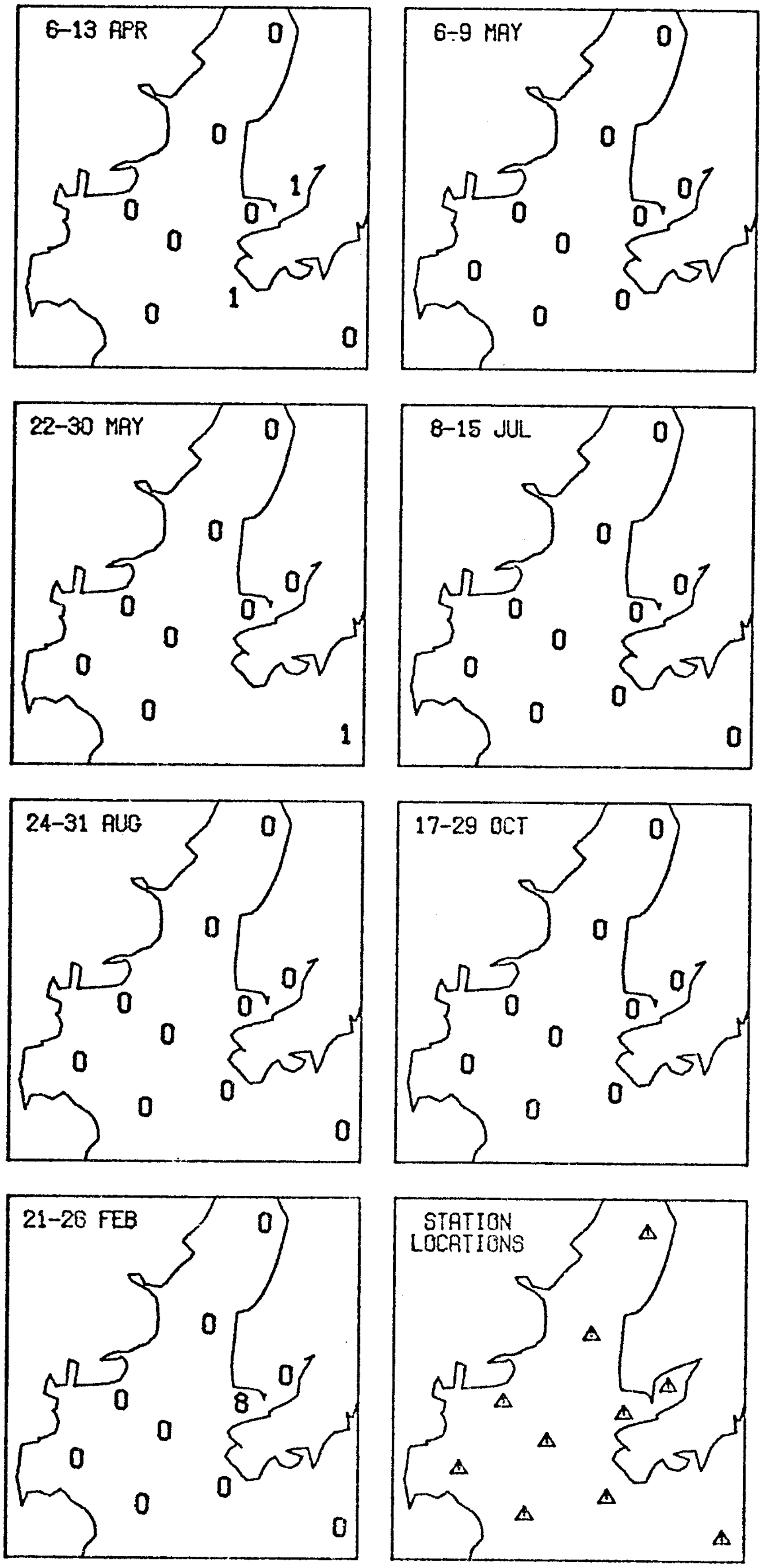


OSMERIDAE
JUVENILE/10 SQ M

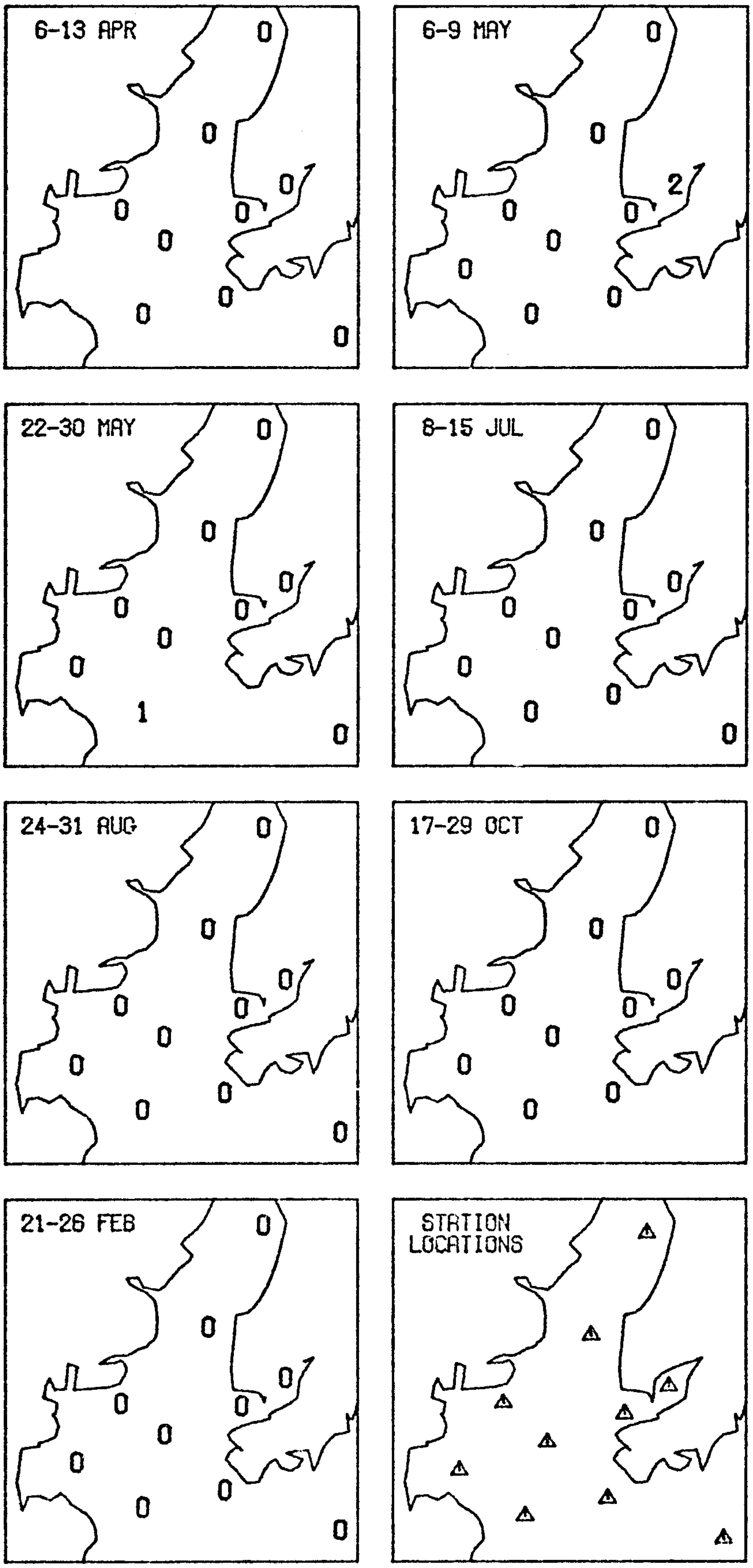


PANDALOPSIS DISPAR

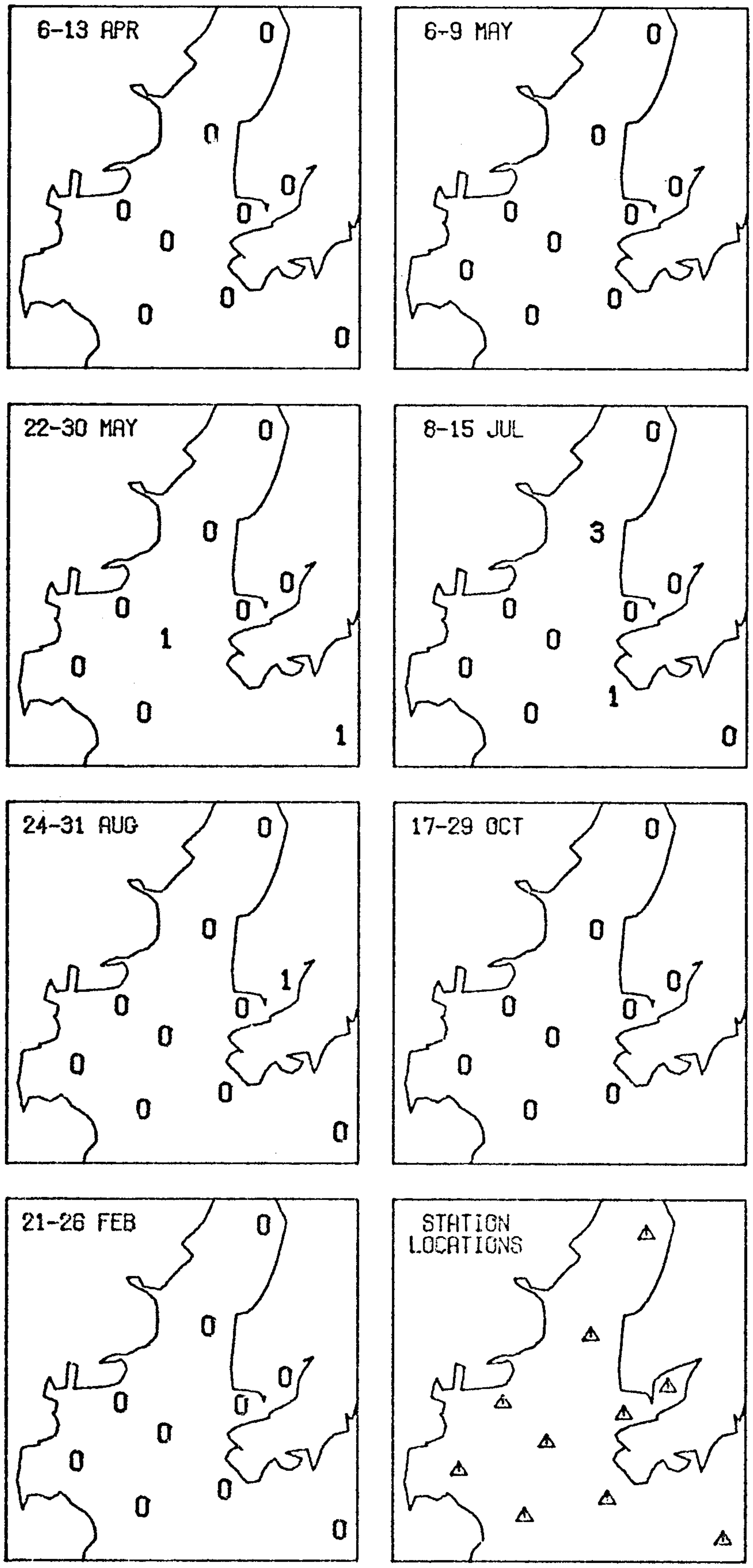
STAGE I/10 SQ M



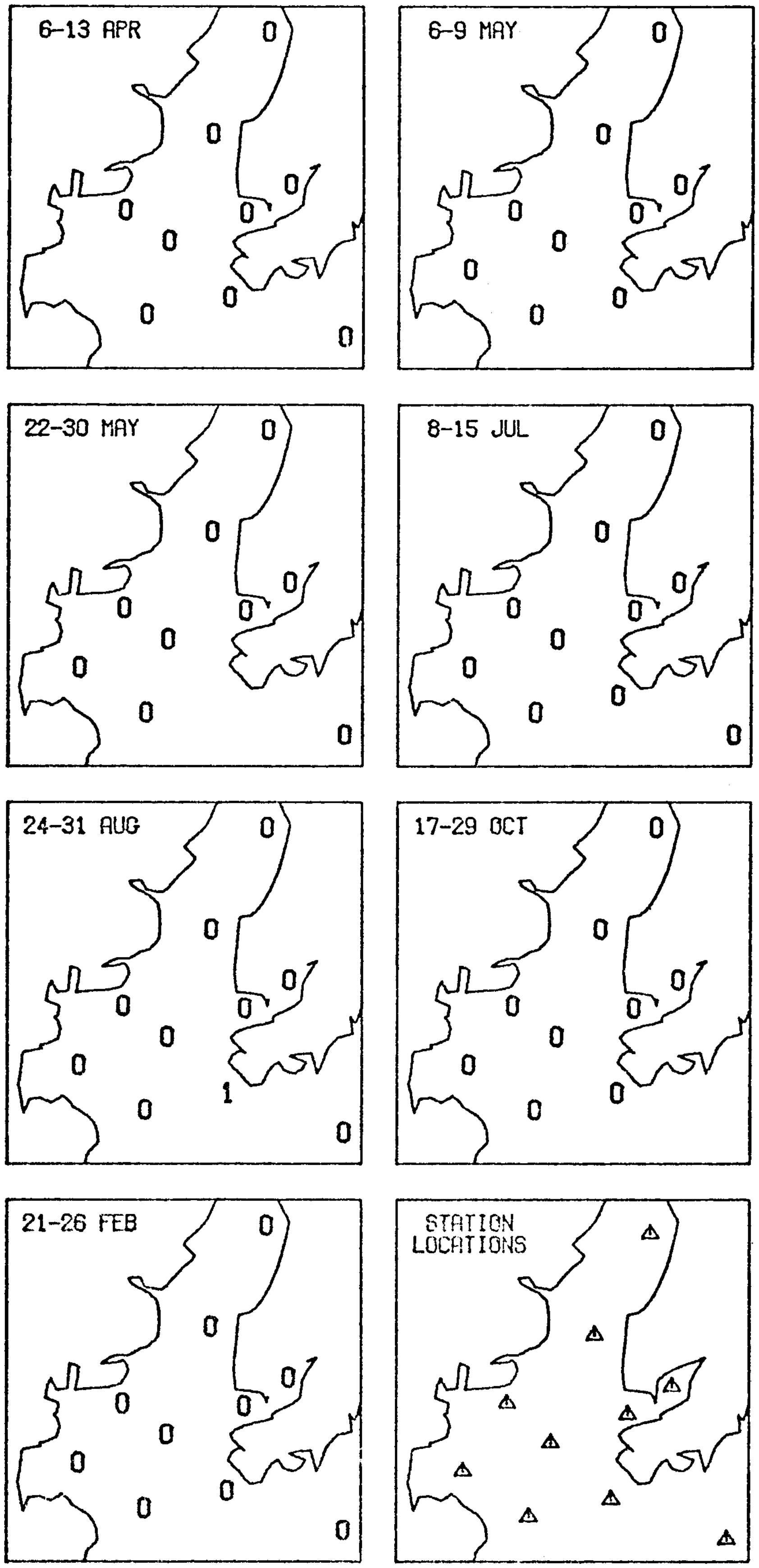
PANDALOPSIS DISPAR
STAGE II/10 SQ M



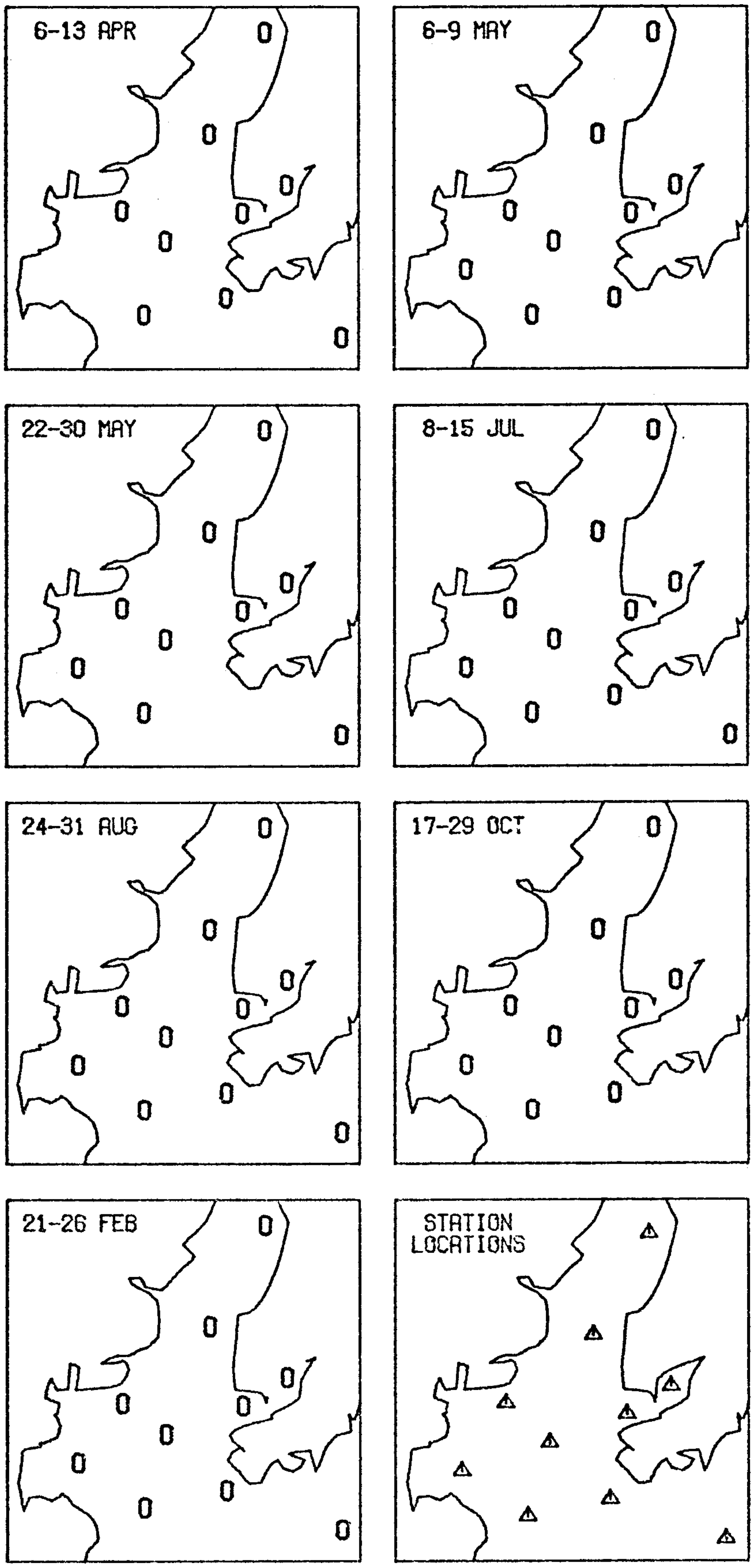
PANDALOPSIS DISPAR
STAGE III/10 SQ M



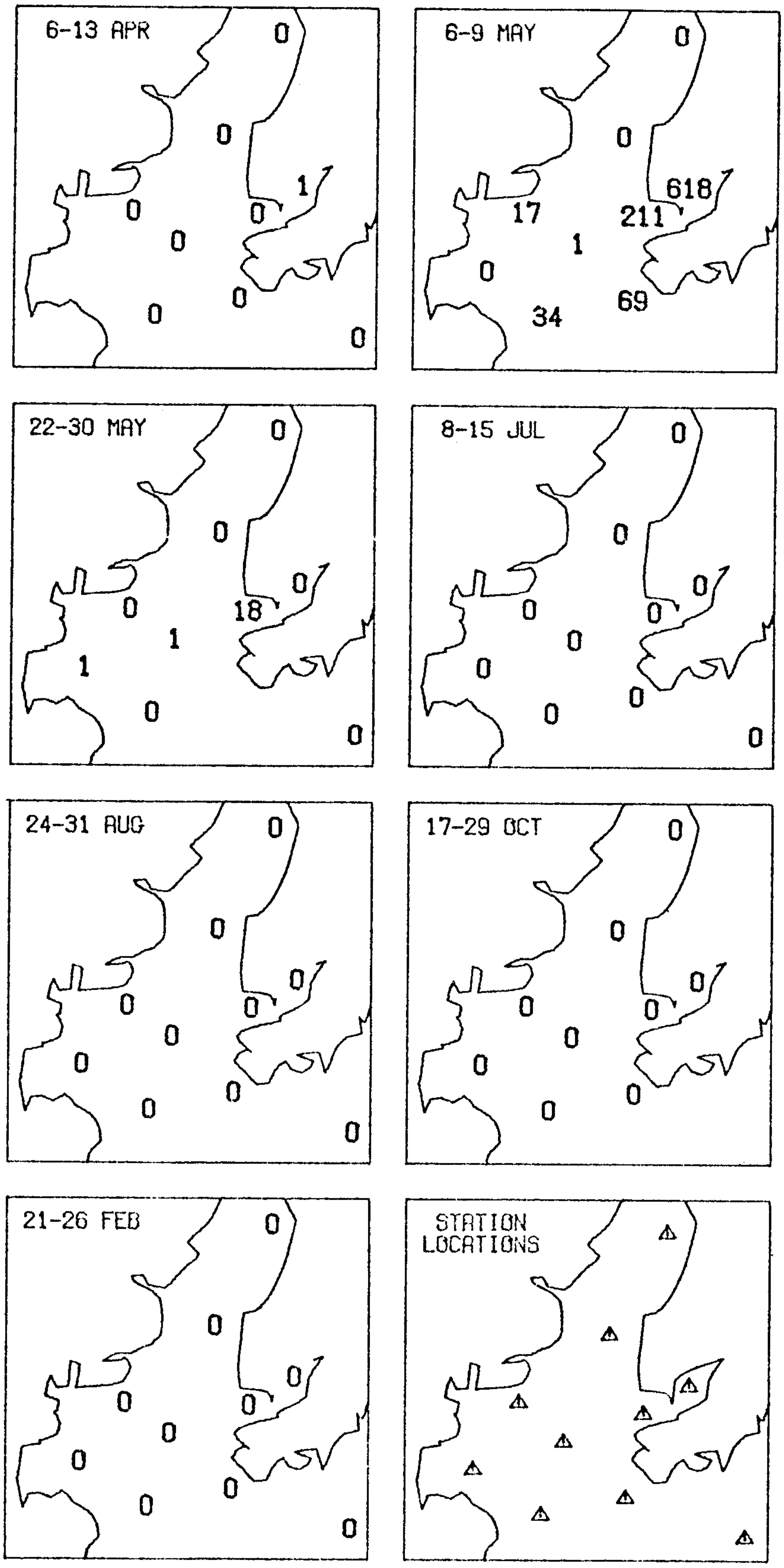
PANDALOPSIS DISPAR
STAGE IV/10 SQ M



PANDALOPSIS DISPAR
JUVENILE/10 SQ M



PANDALUS BOREALIS
STAGE I/10 SQ M



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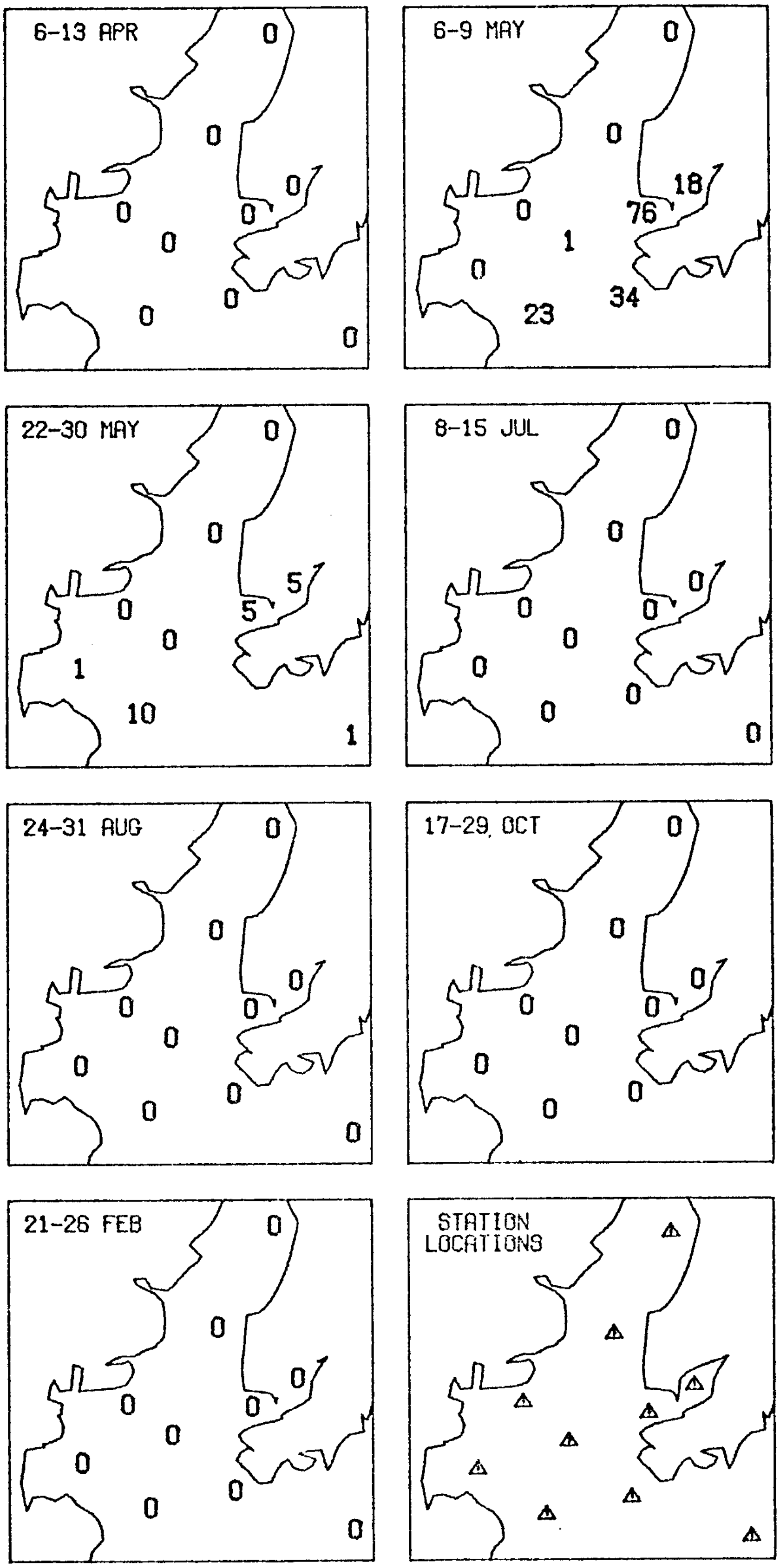
STAGE II/10 SQ M



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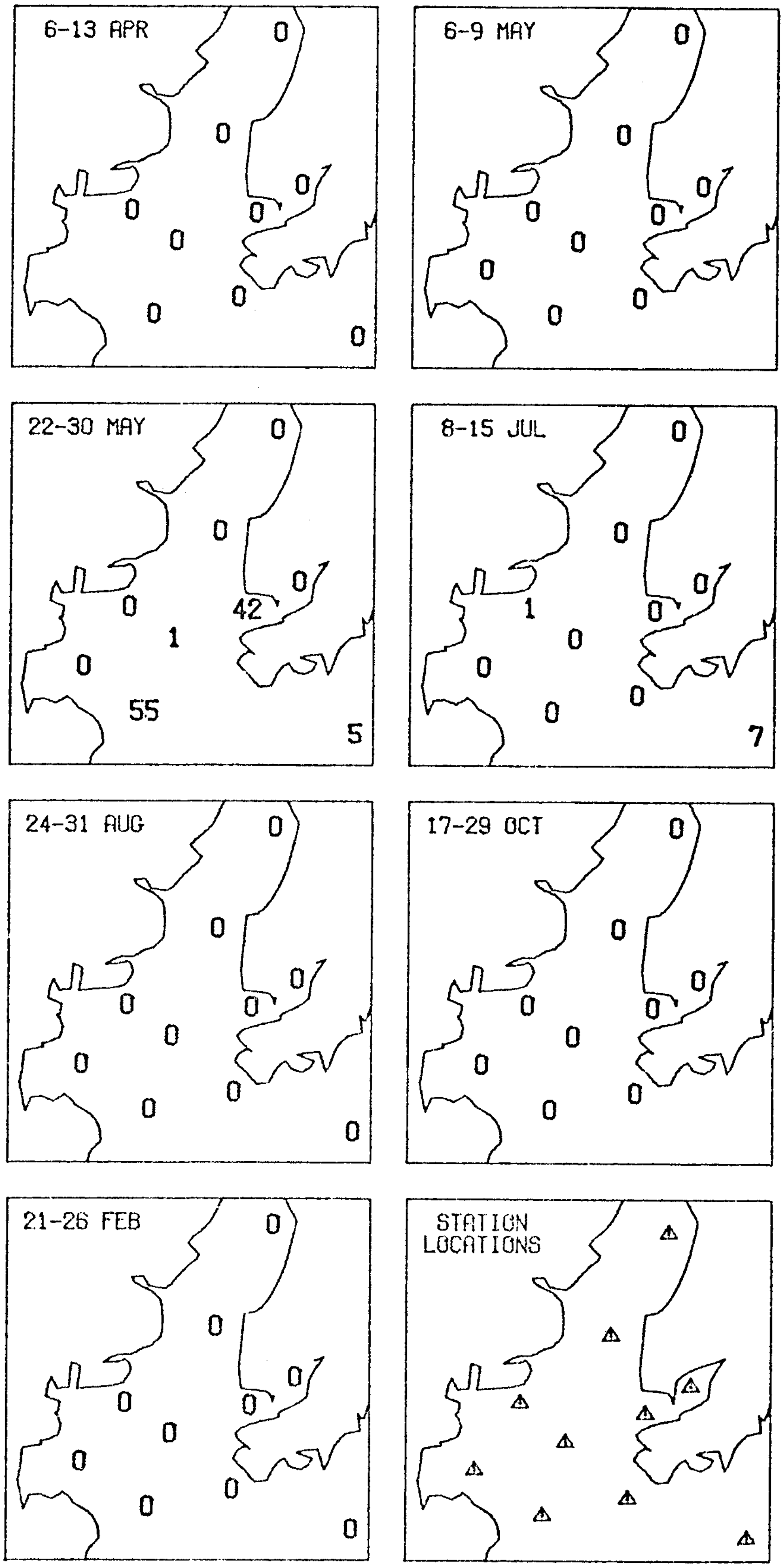
STAGE III/10 SQ M



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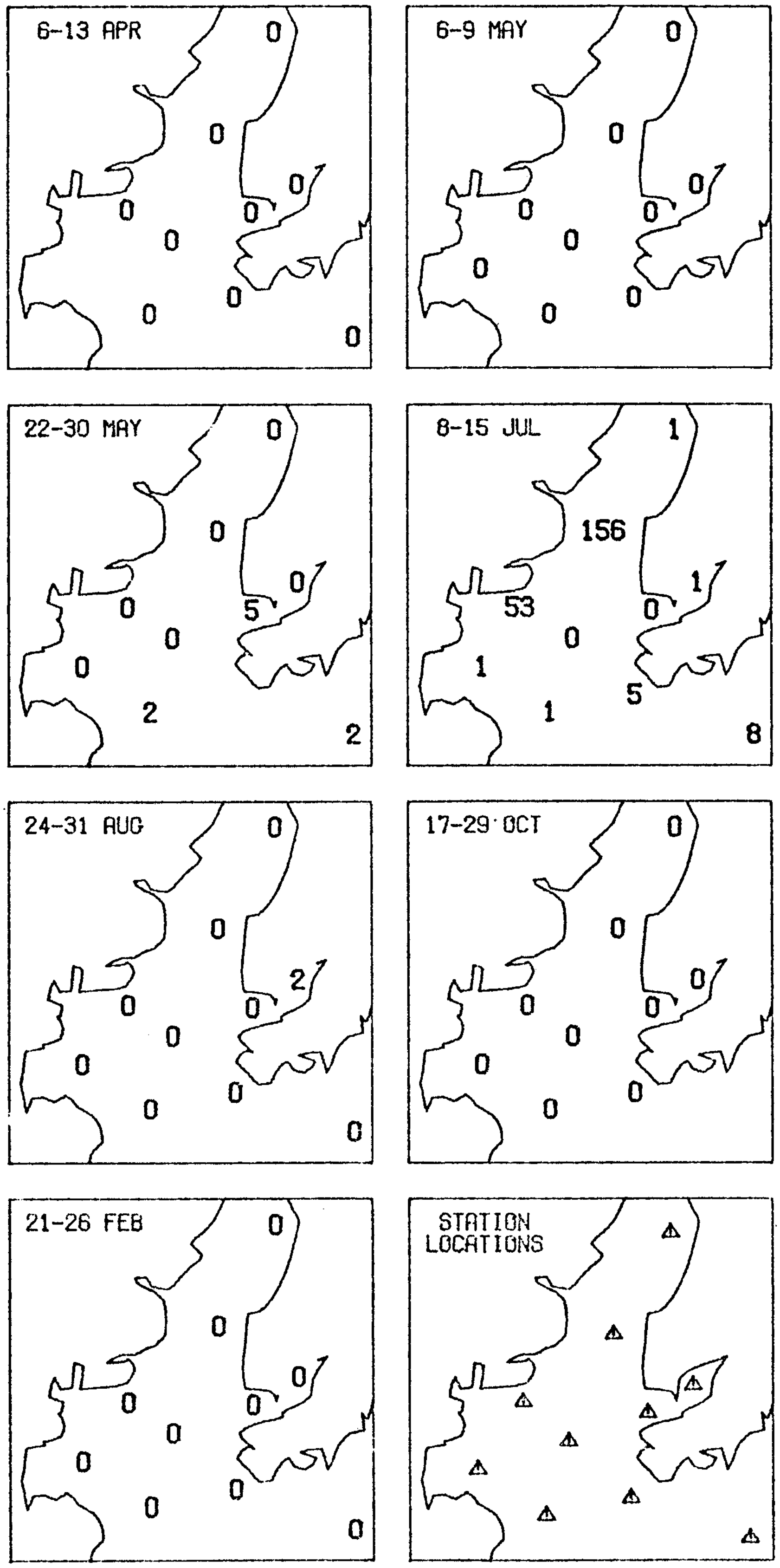
STAGE IV/10 SQ M



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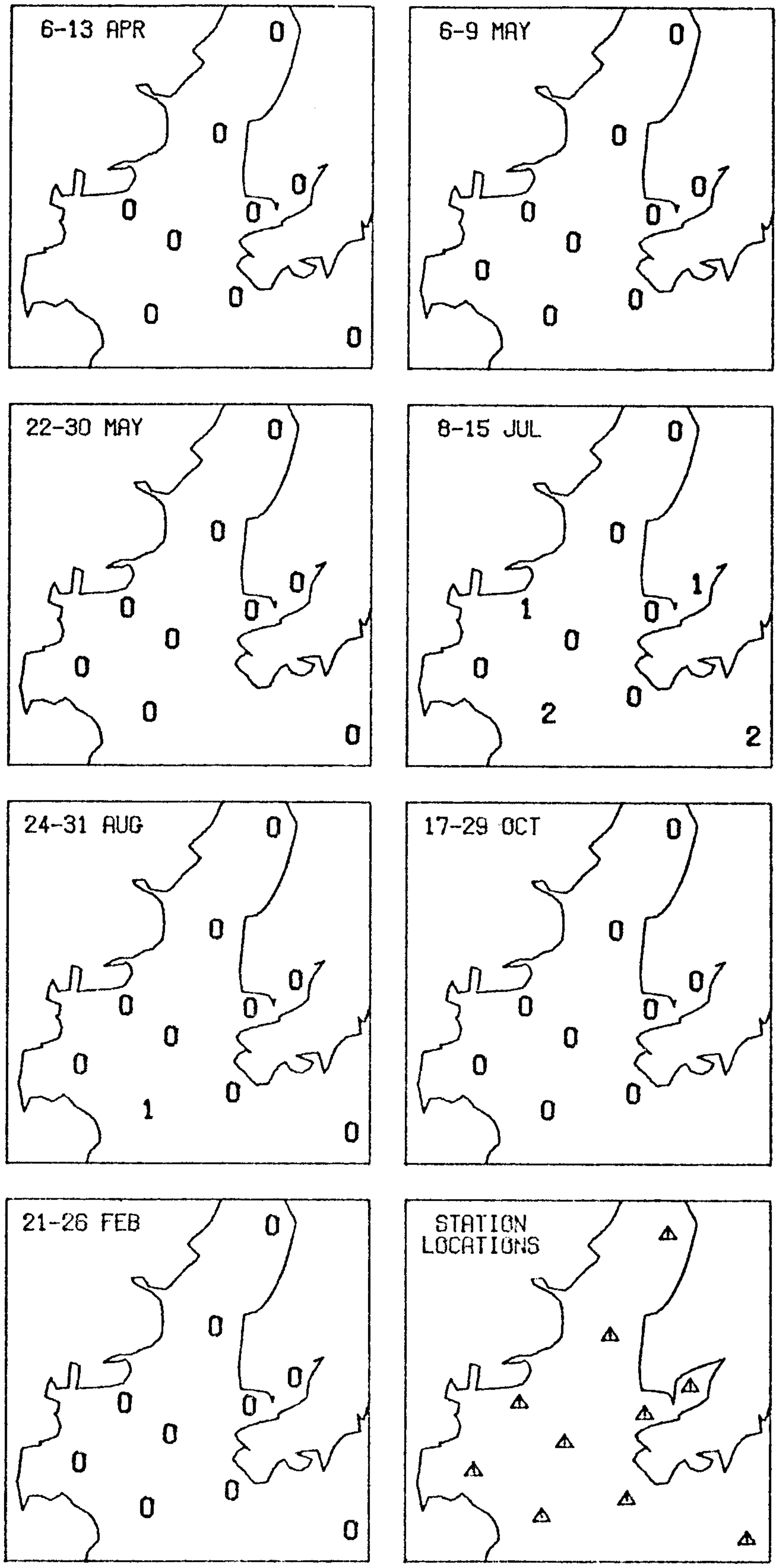
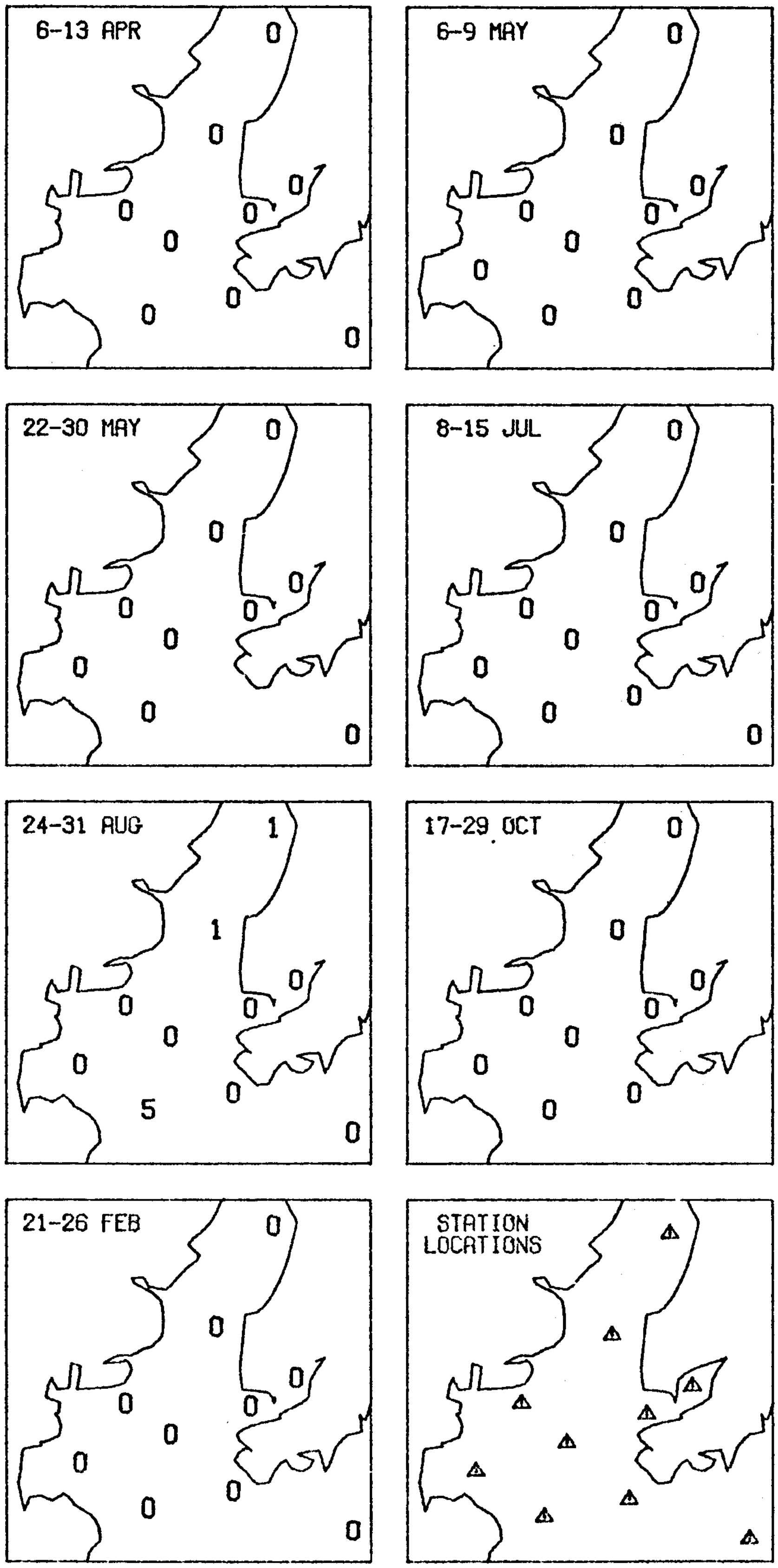
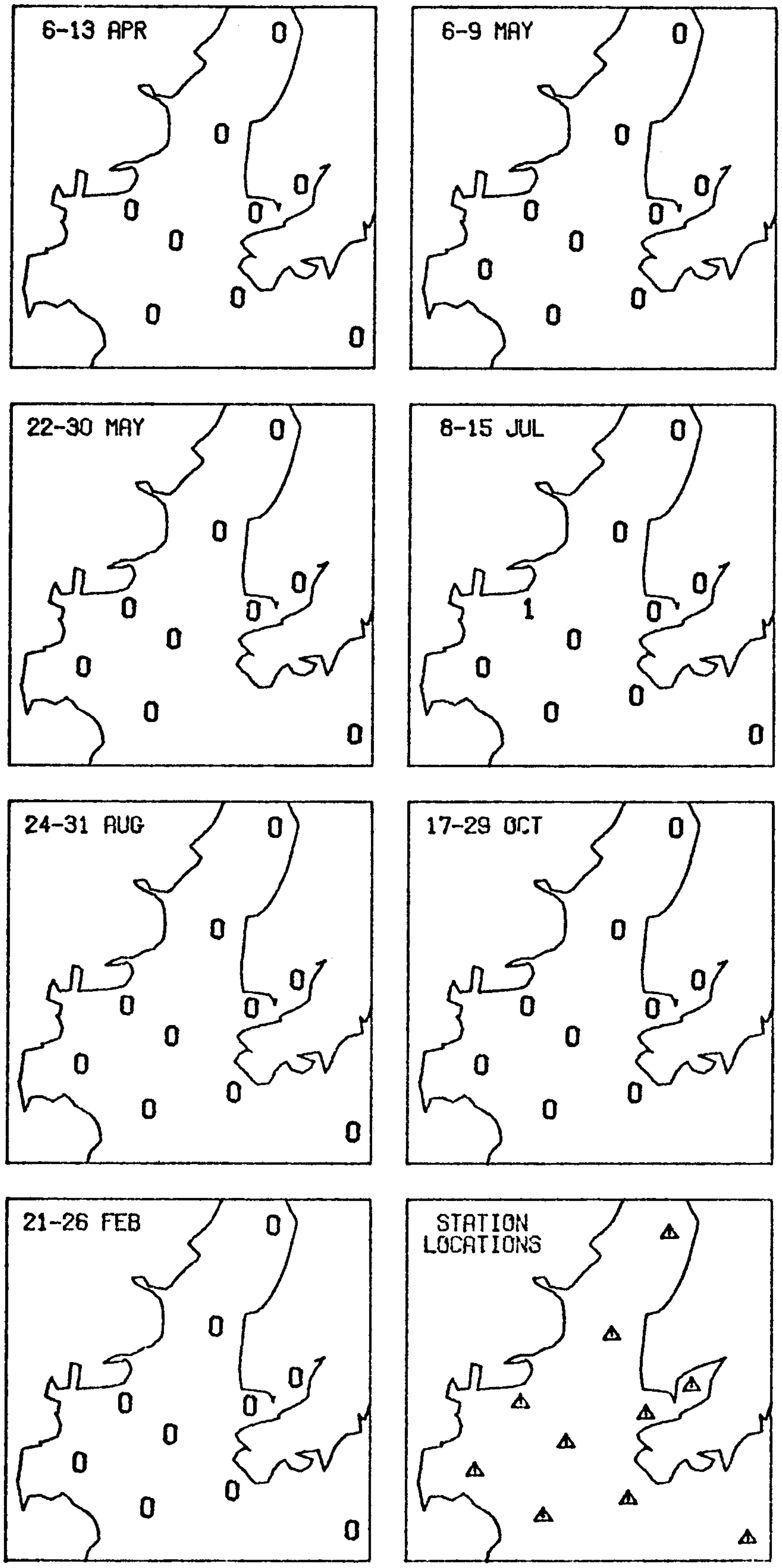
STAGE V/10 SQ M



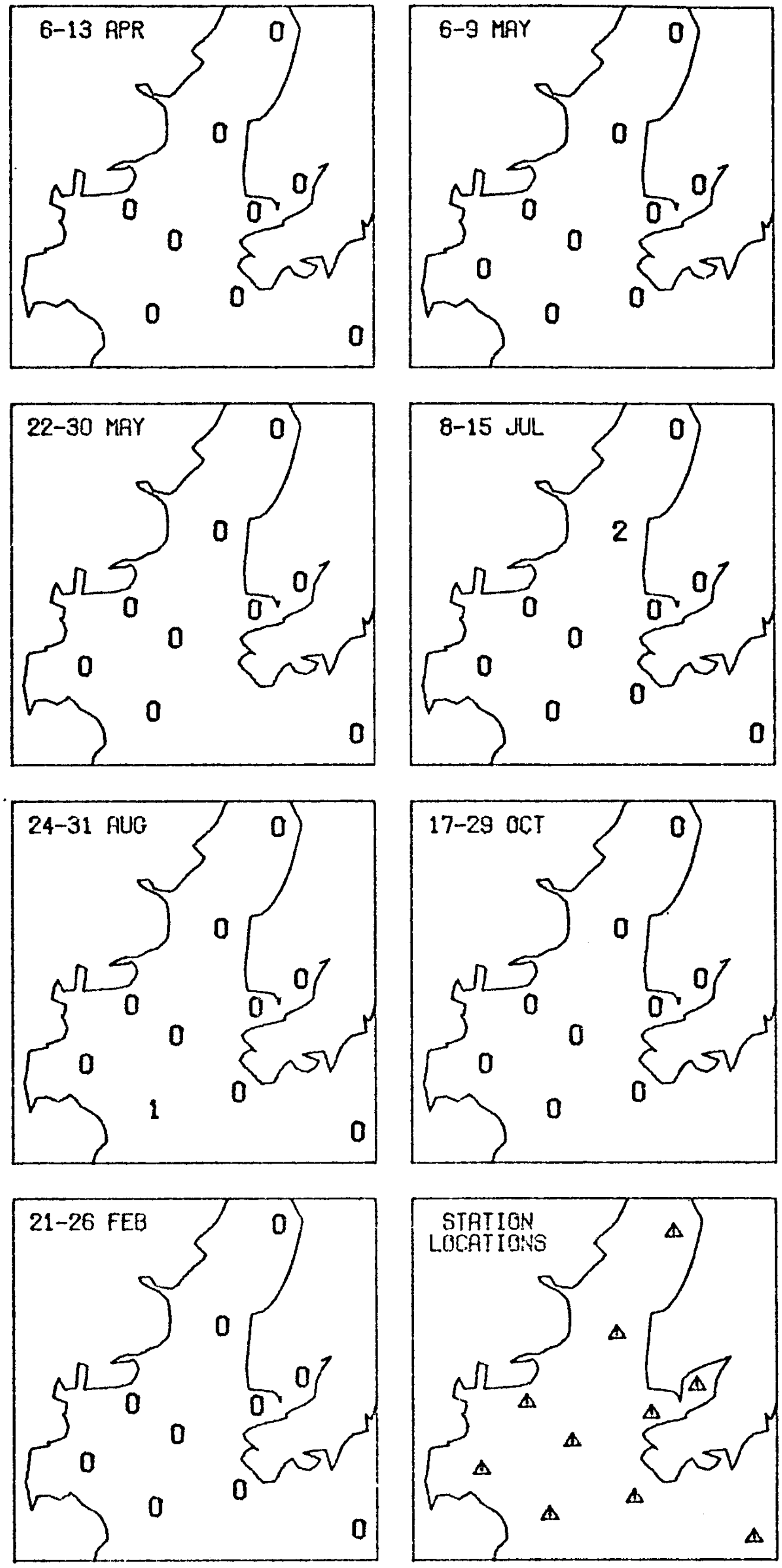
PANDALUS BOREALIS
JUVENILE/10 SQ M



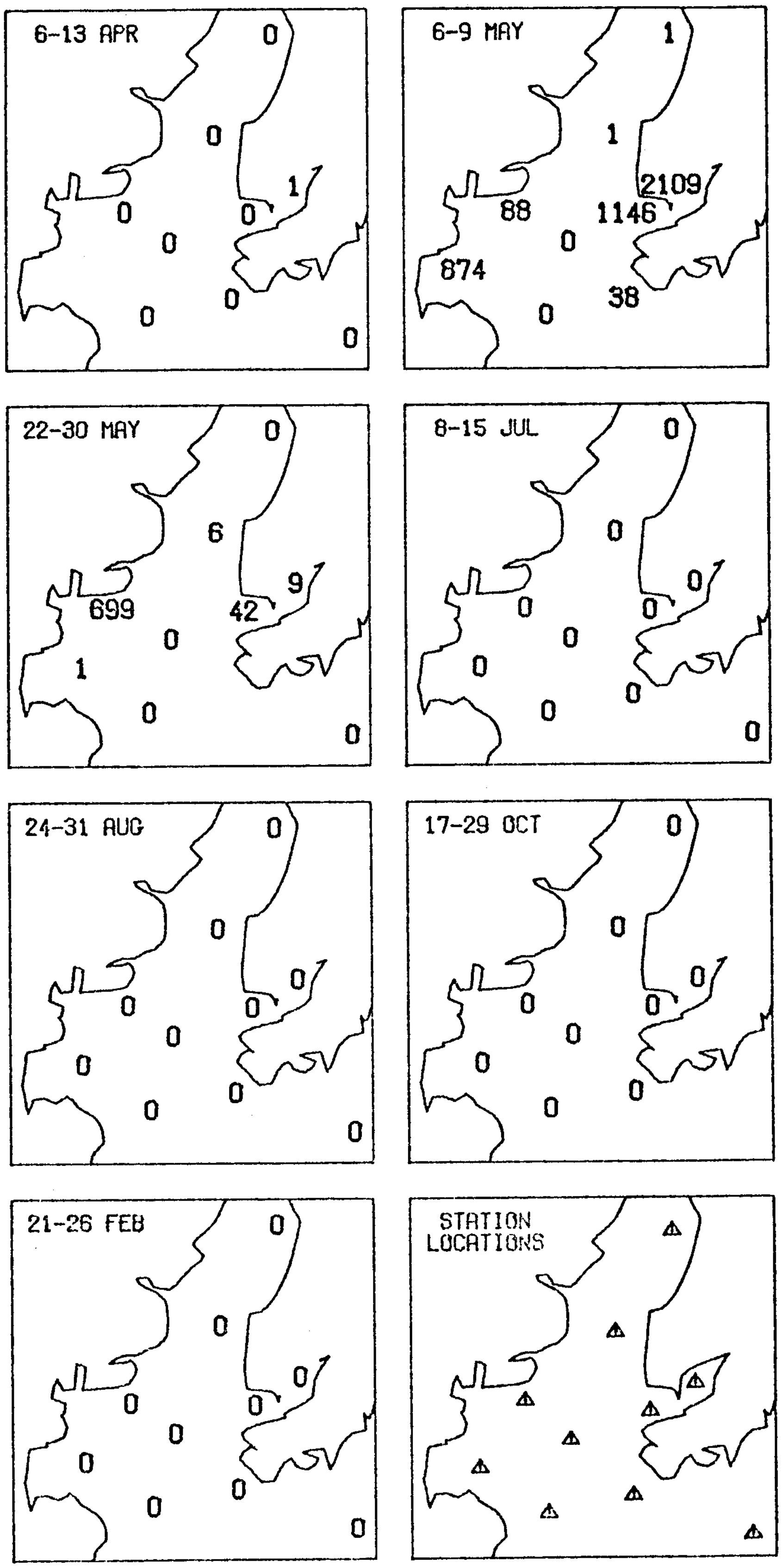
PANDALUS DANAE
STAGE II/10 SQ M



PANDALUS DANAE
STAGE V/10 SQ M



PANDALUS GONIURUS
STAGE I/10 SQ M



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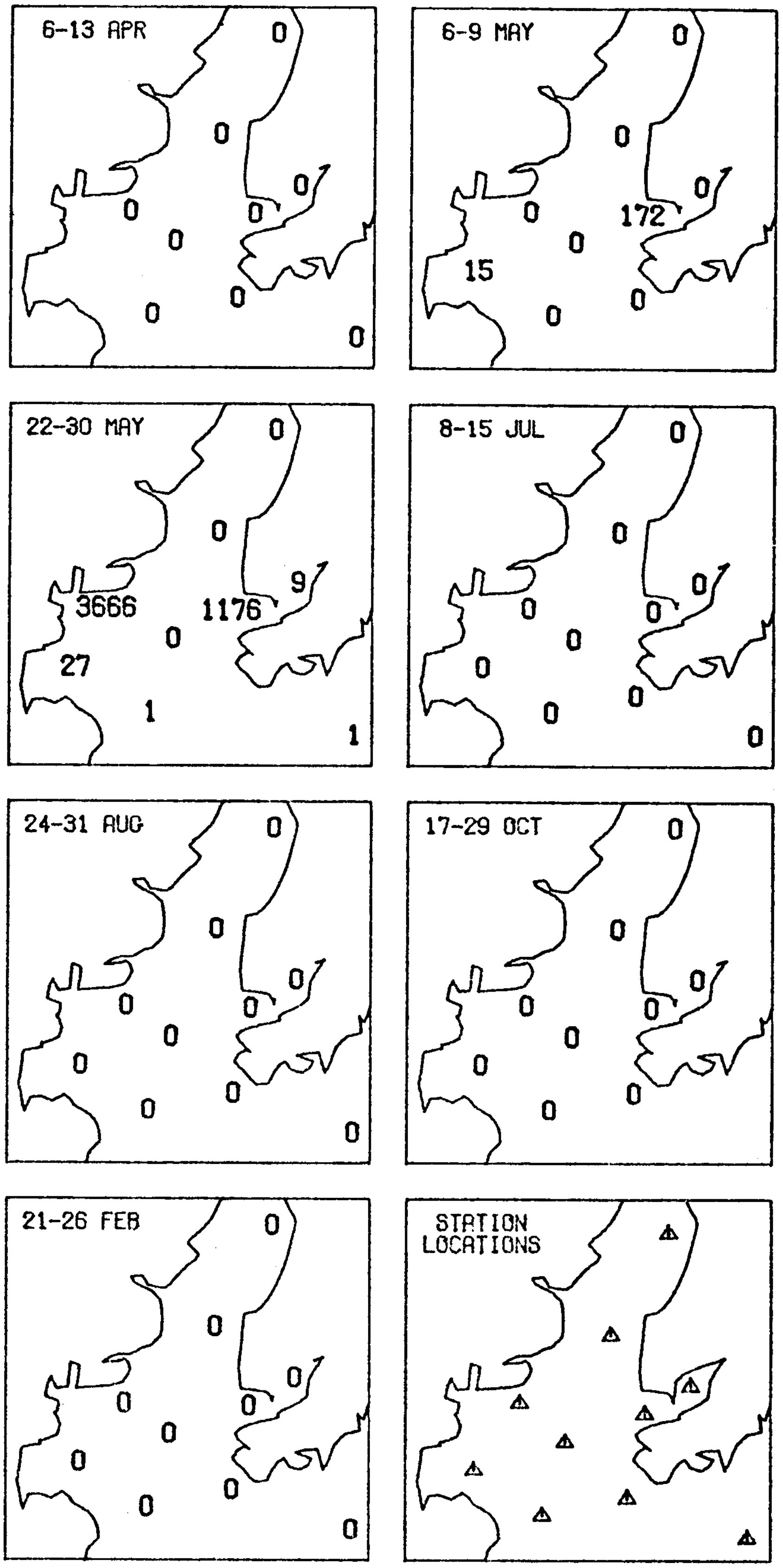
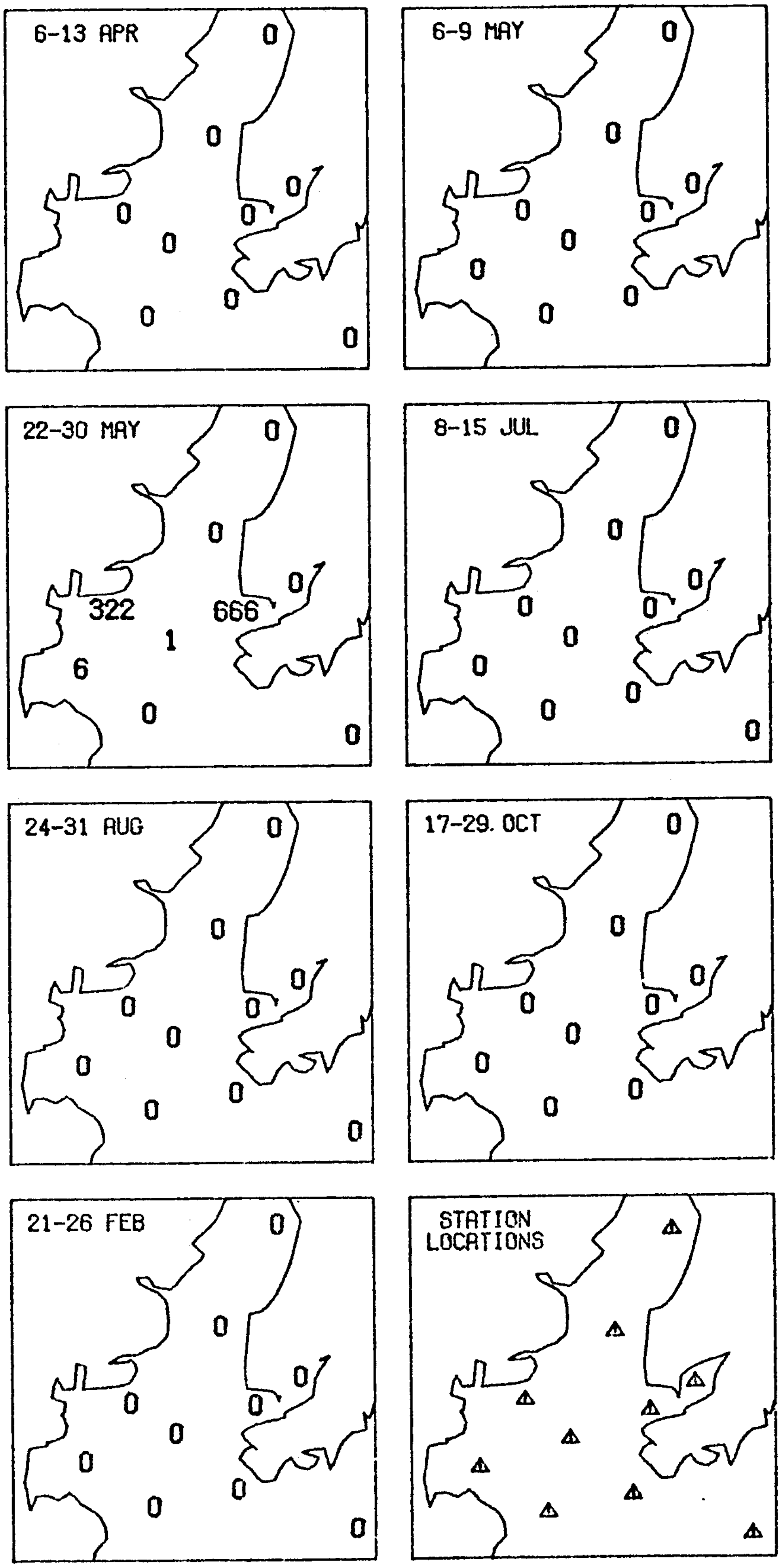
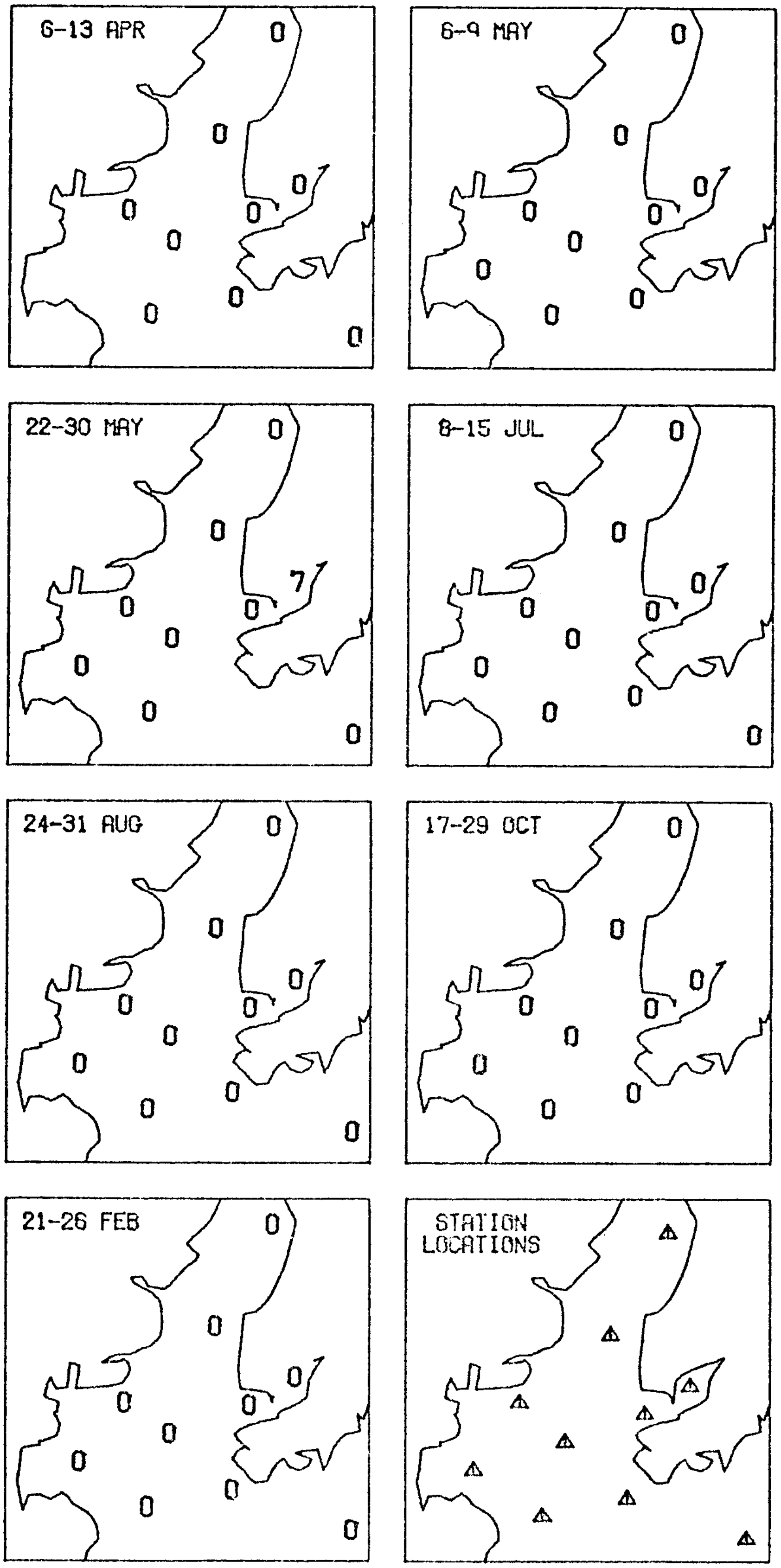
STAGE II/10 SQ M



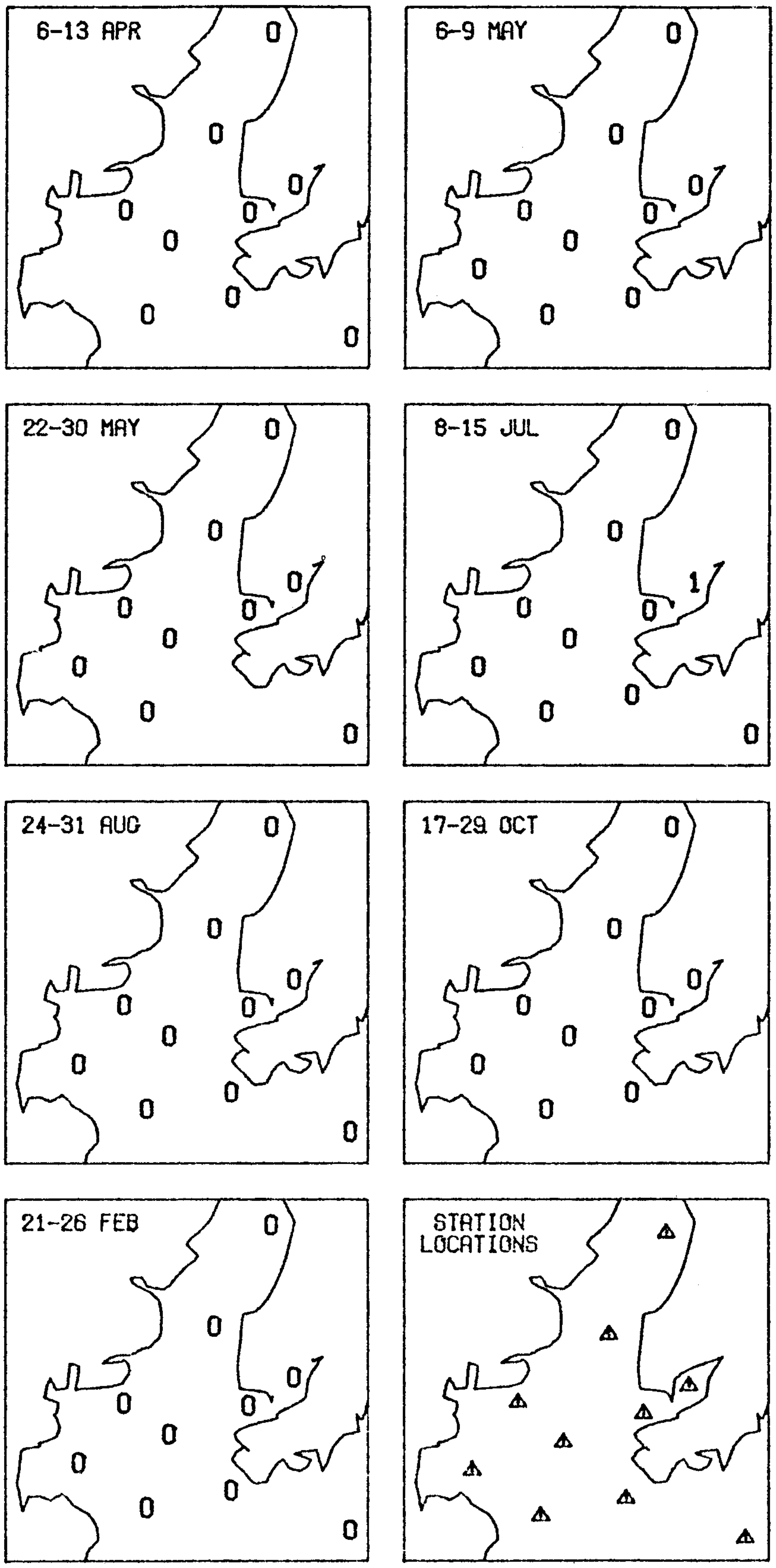
PANDALUS GONIURUS
STAGE III/10 SQ M



PANDALUS GONIURUS
STAGE IV/10 SQ M

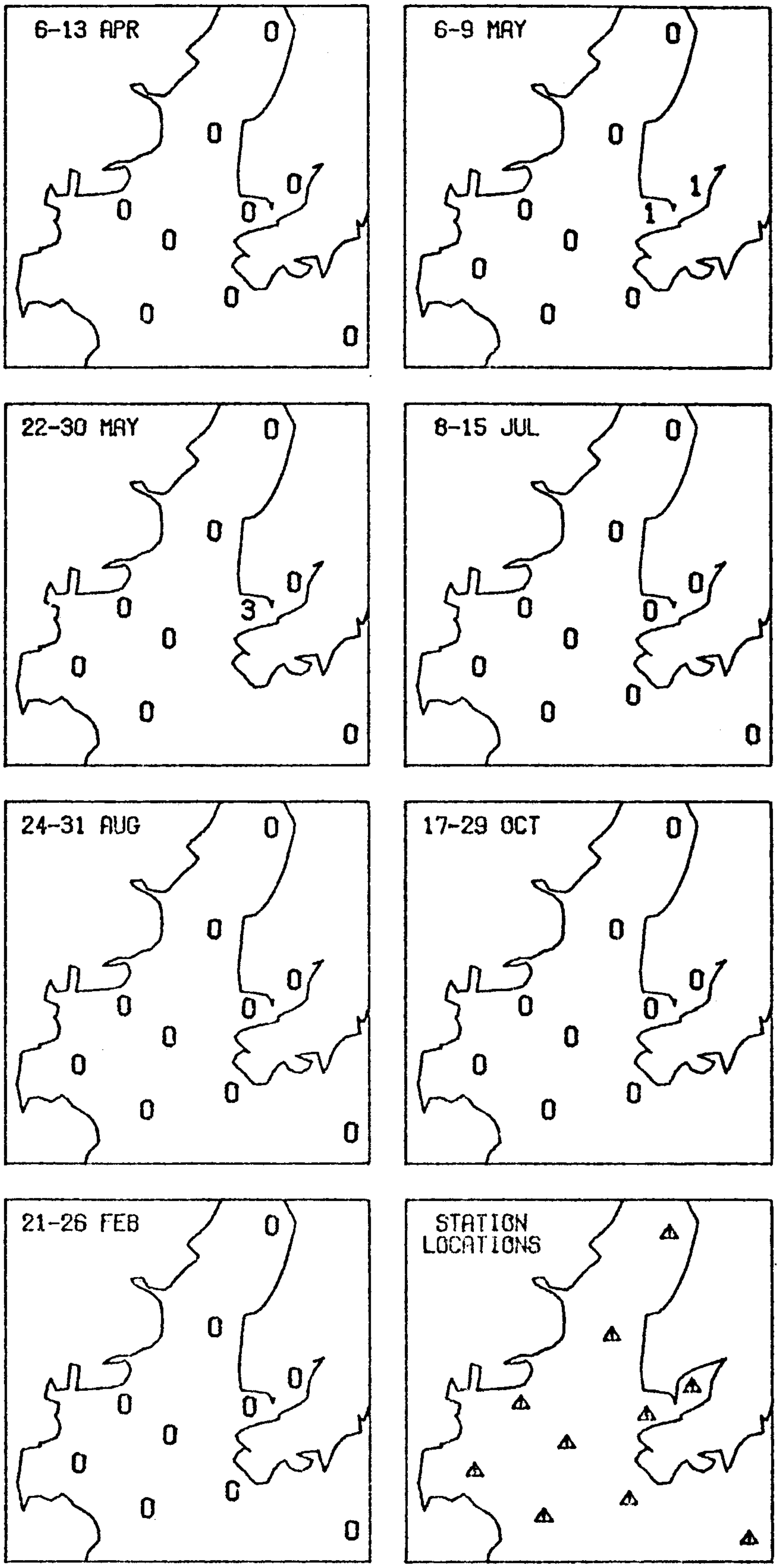


PANDALUS GONIURUS
JUVENILE/10 SQ M

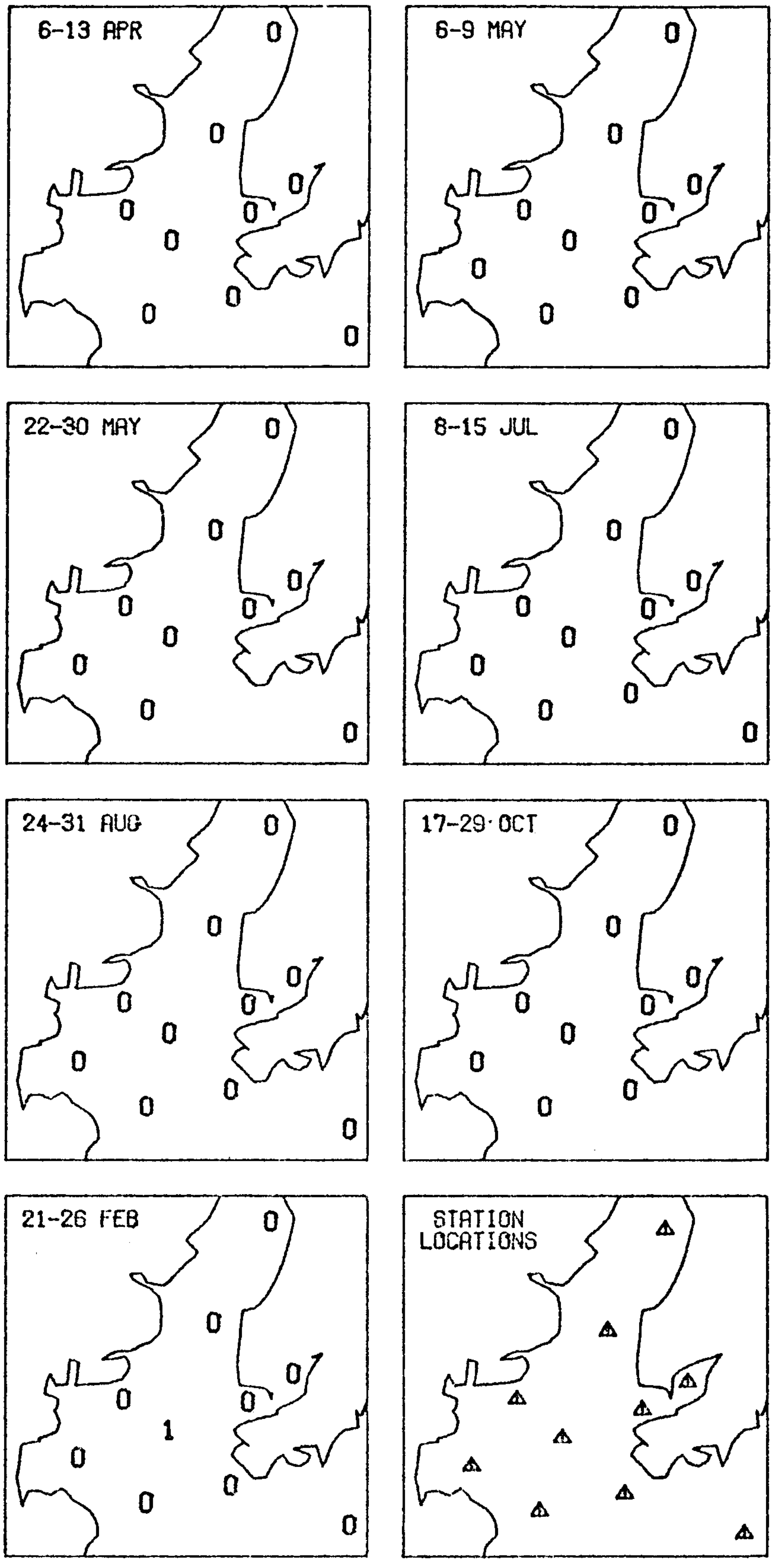


PANDALUS HYPSINOTUS

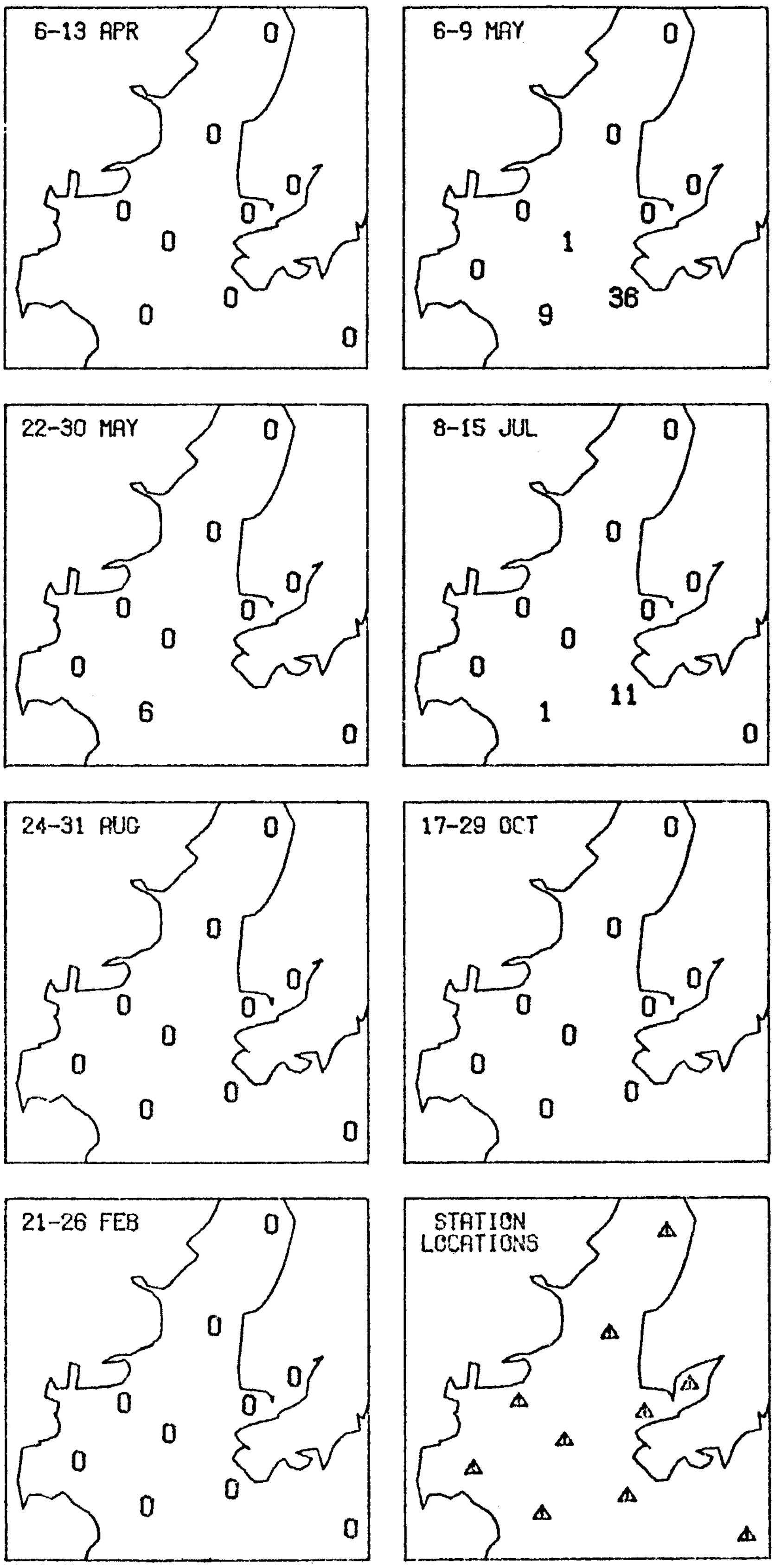
STAGE I/10 SQ M



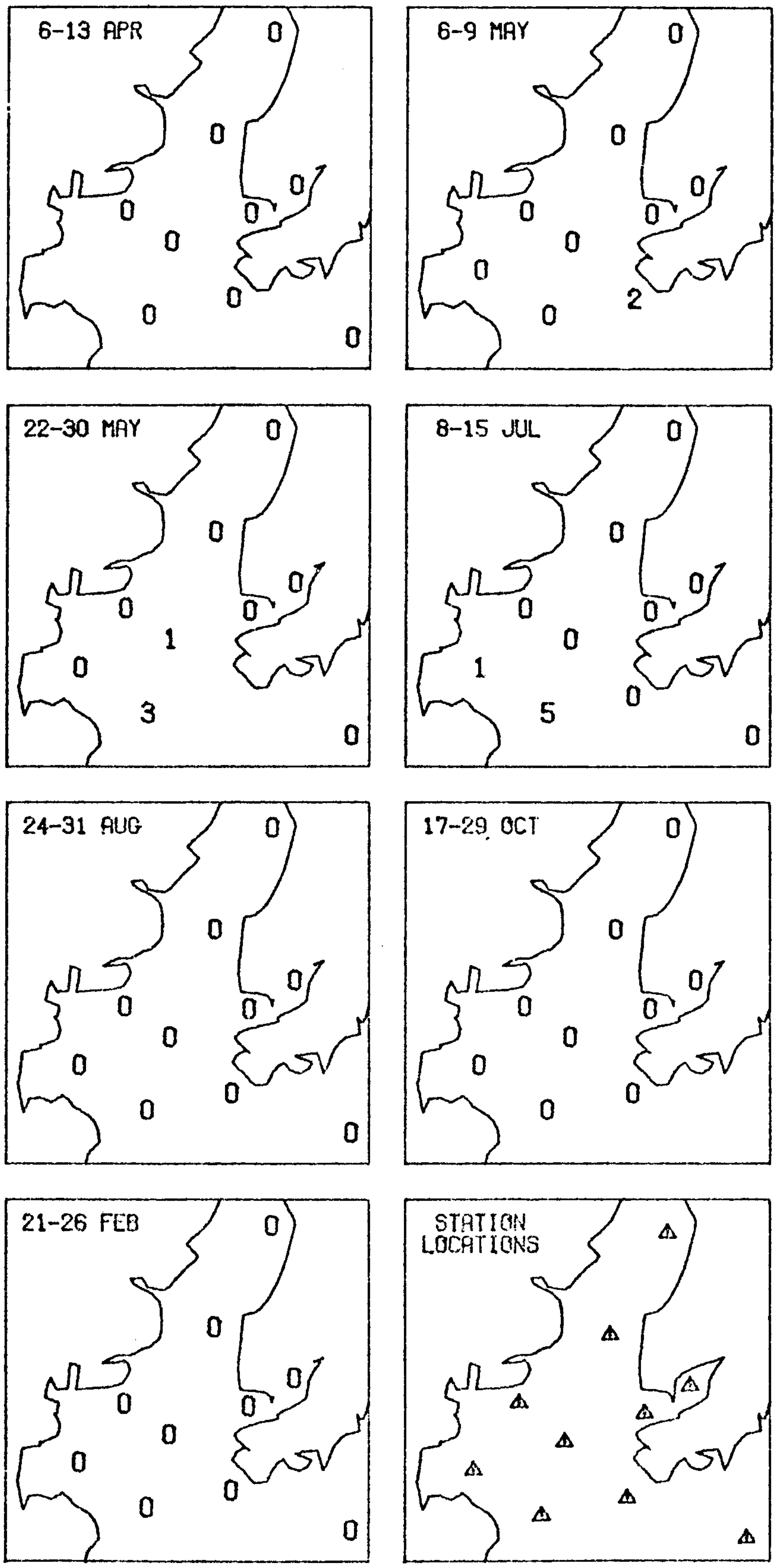
PANDALUS PLATYCEROS
STAGE II/10 SQ M



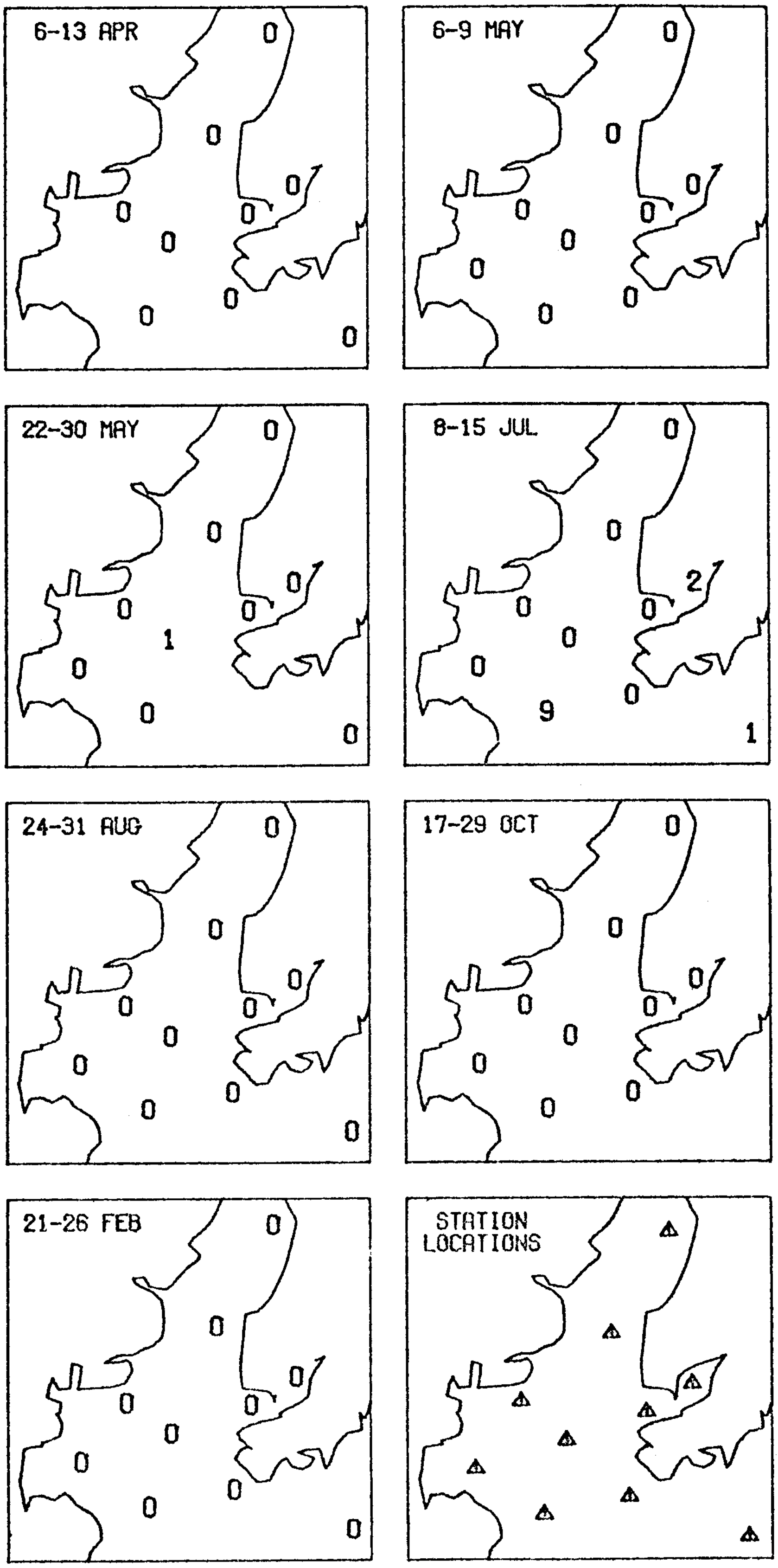
PANDALUS STENOLEPIS
STAGE I/10 SQ M



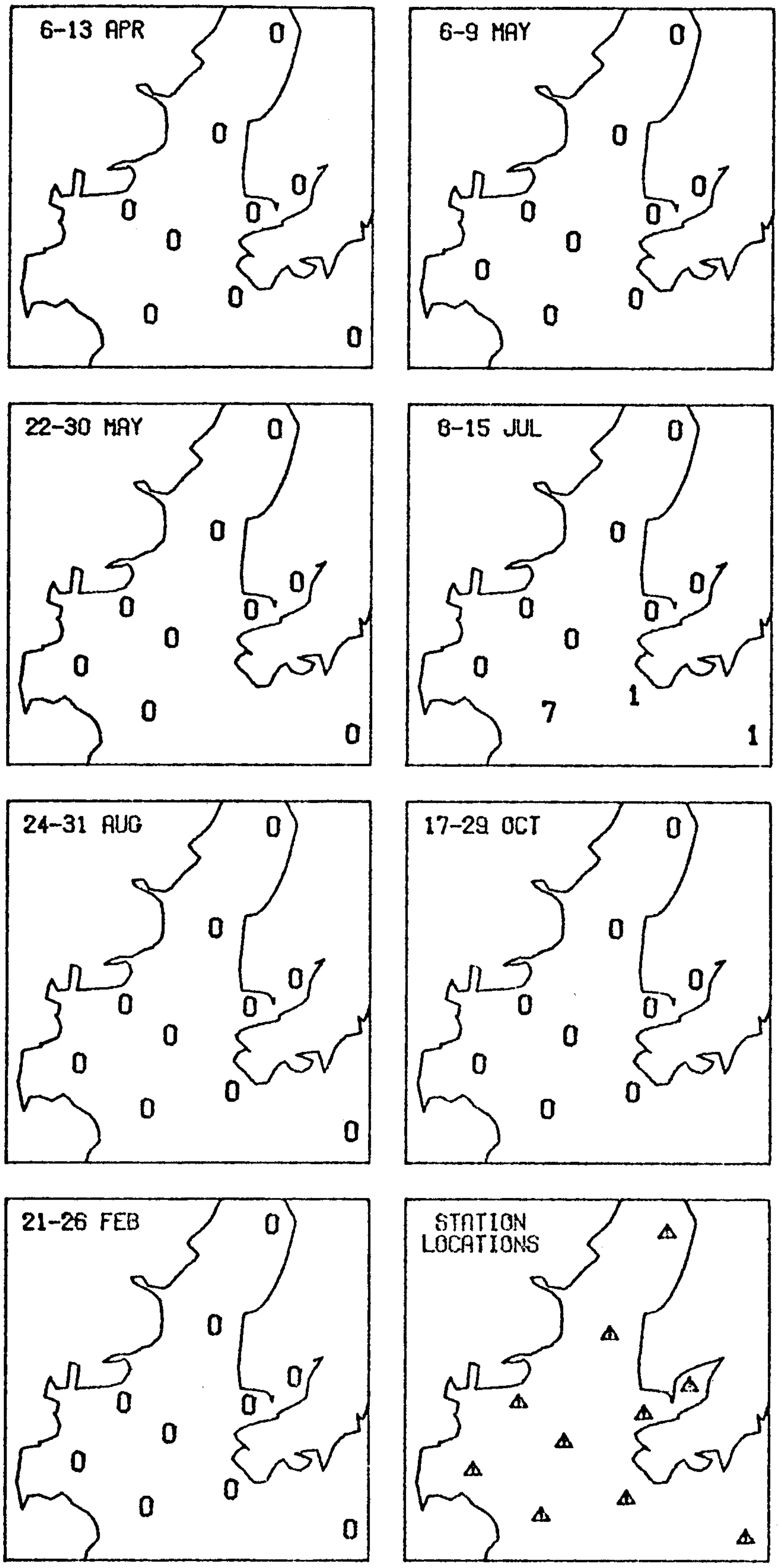
PANDALUS STENOLEPIS
STAGE II/10 SQ M



PANDALUS STENOLEPIS
STAGE III/10 SQ M



PANDALUS STENOLEPIS
STAGE IV/10 SQ M



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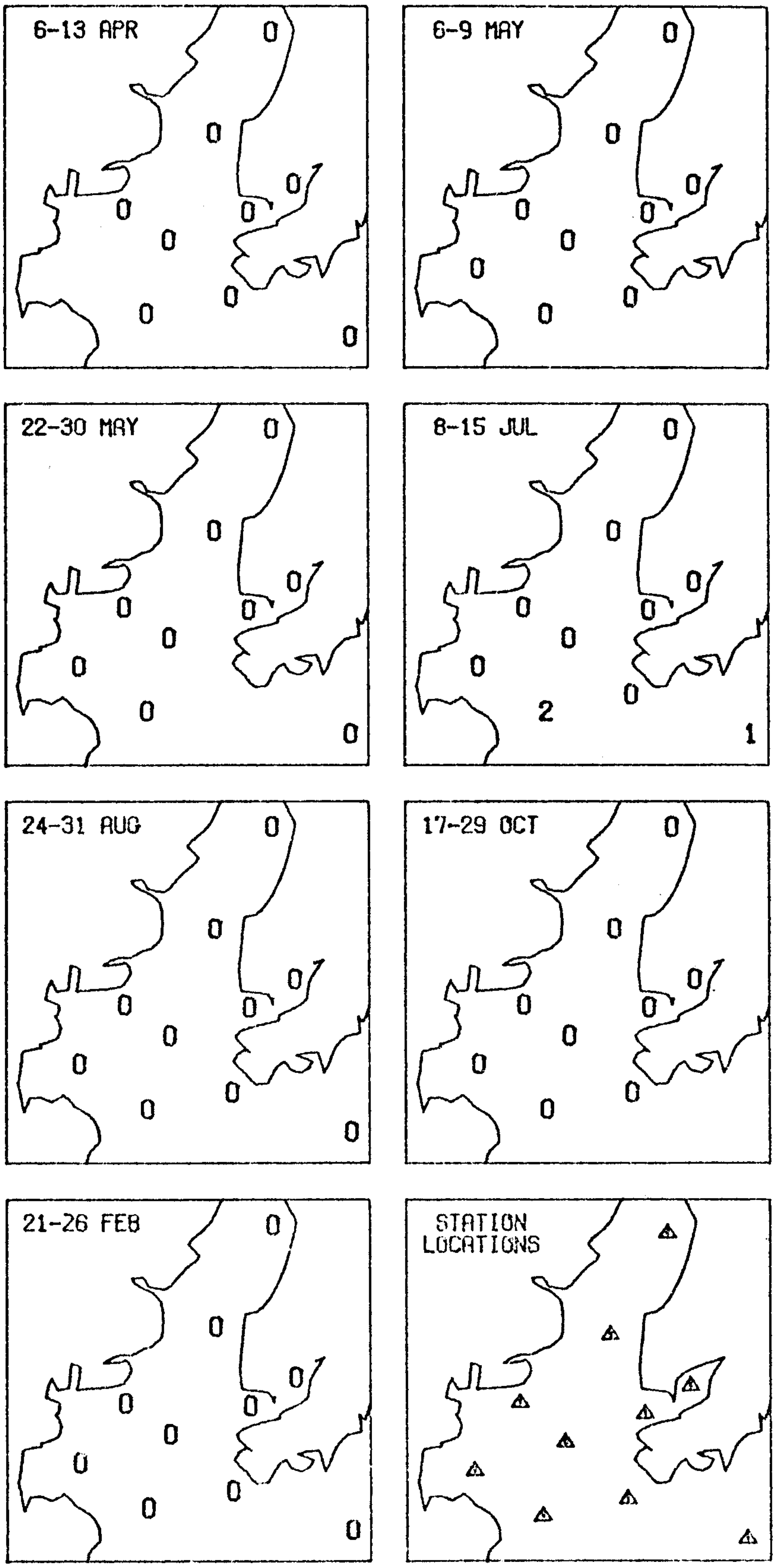
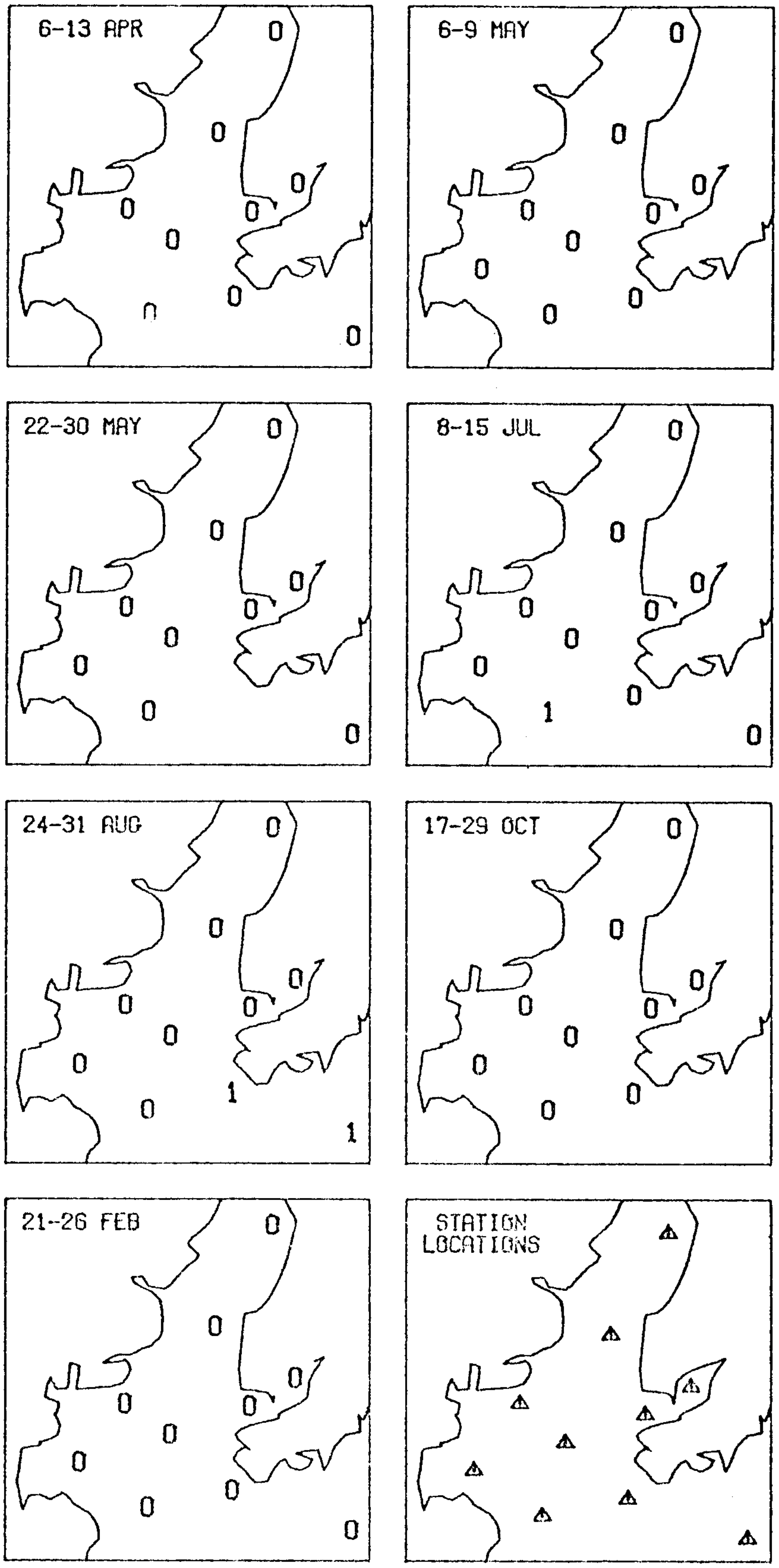
STAGE V/10 SQ M

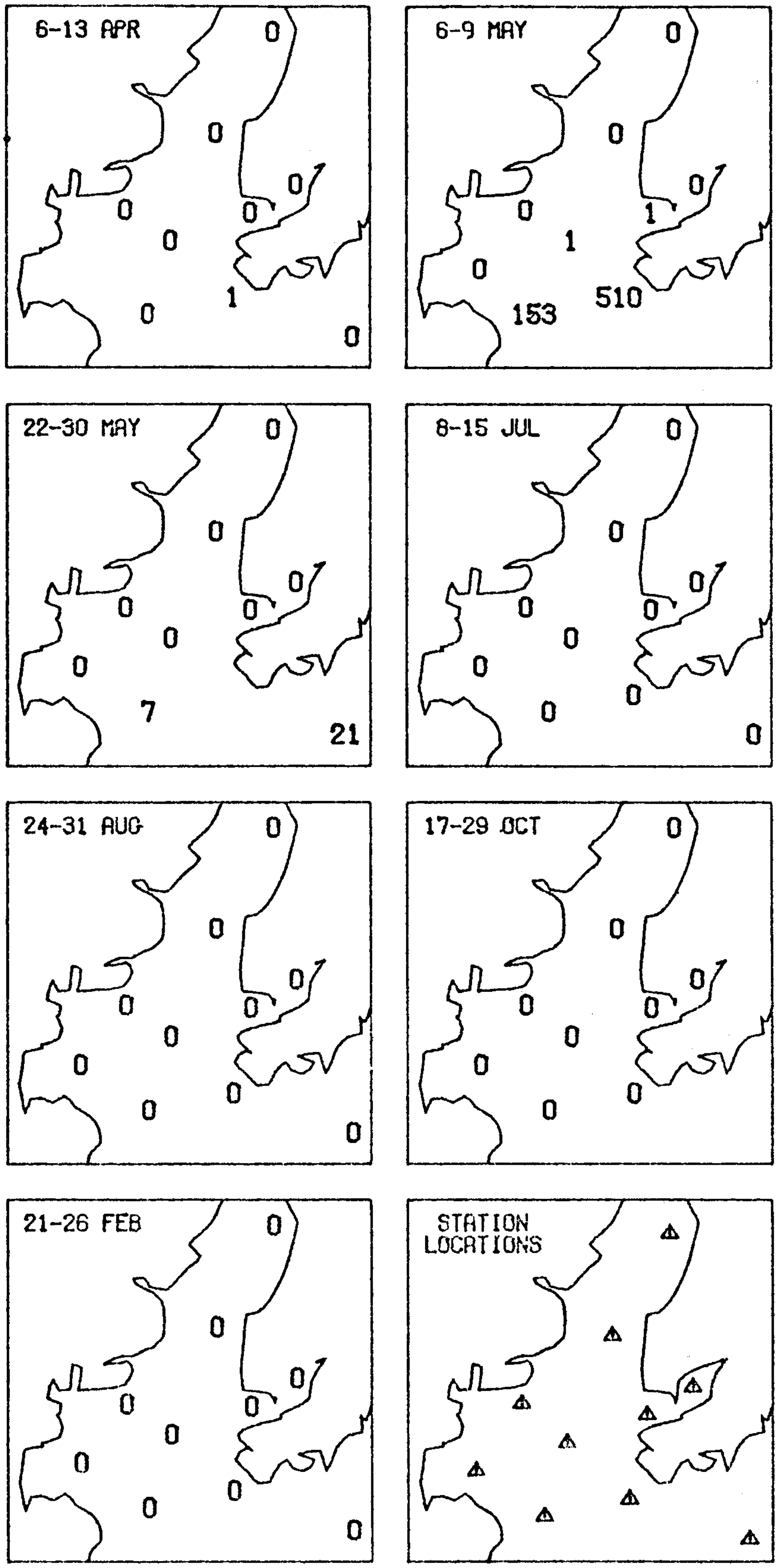


PANDALUS STENOLEPIS
STAGE VI/10 SQ M

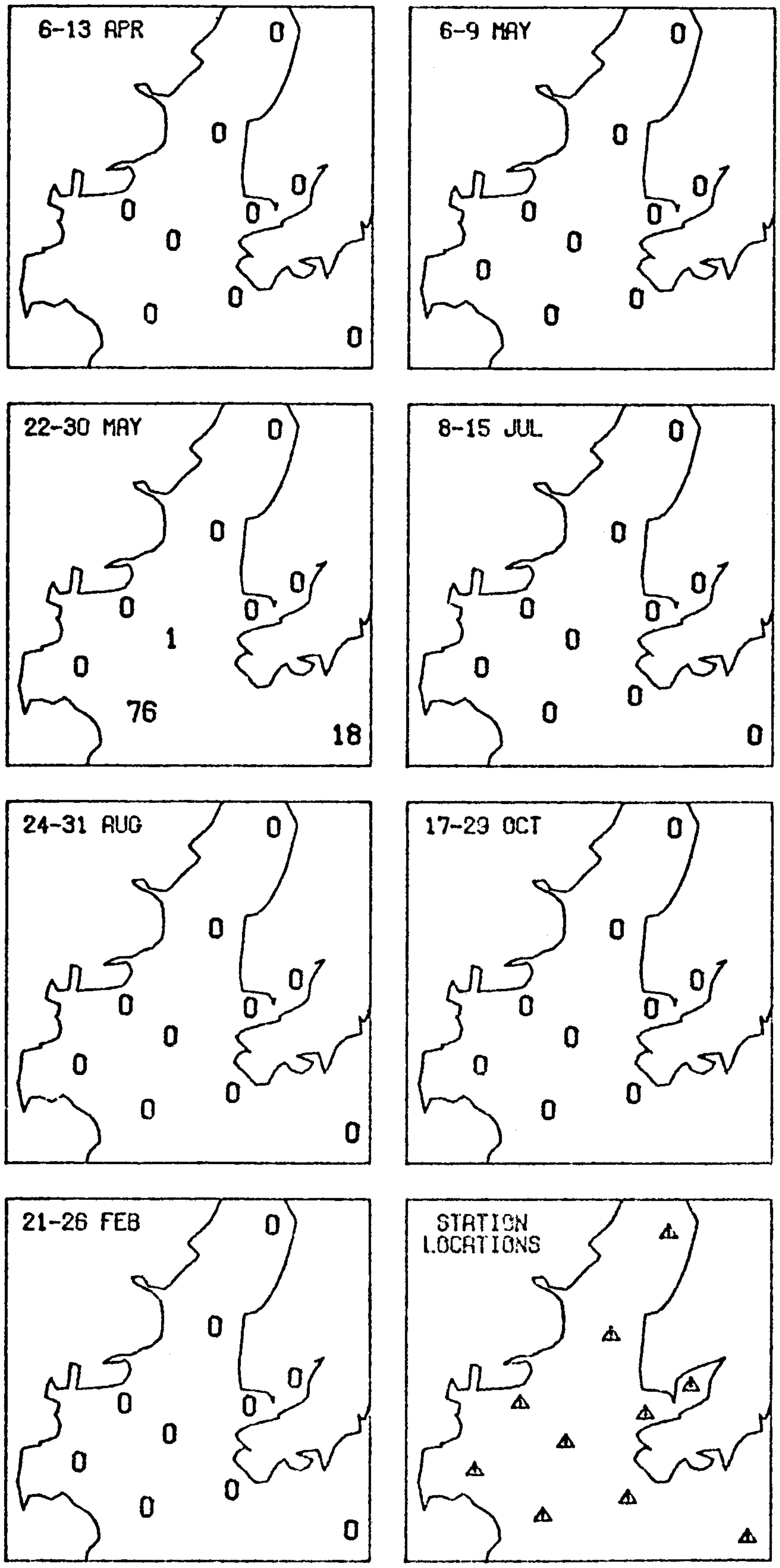


PANDALUS MONTAGUI TRIDENS

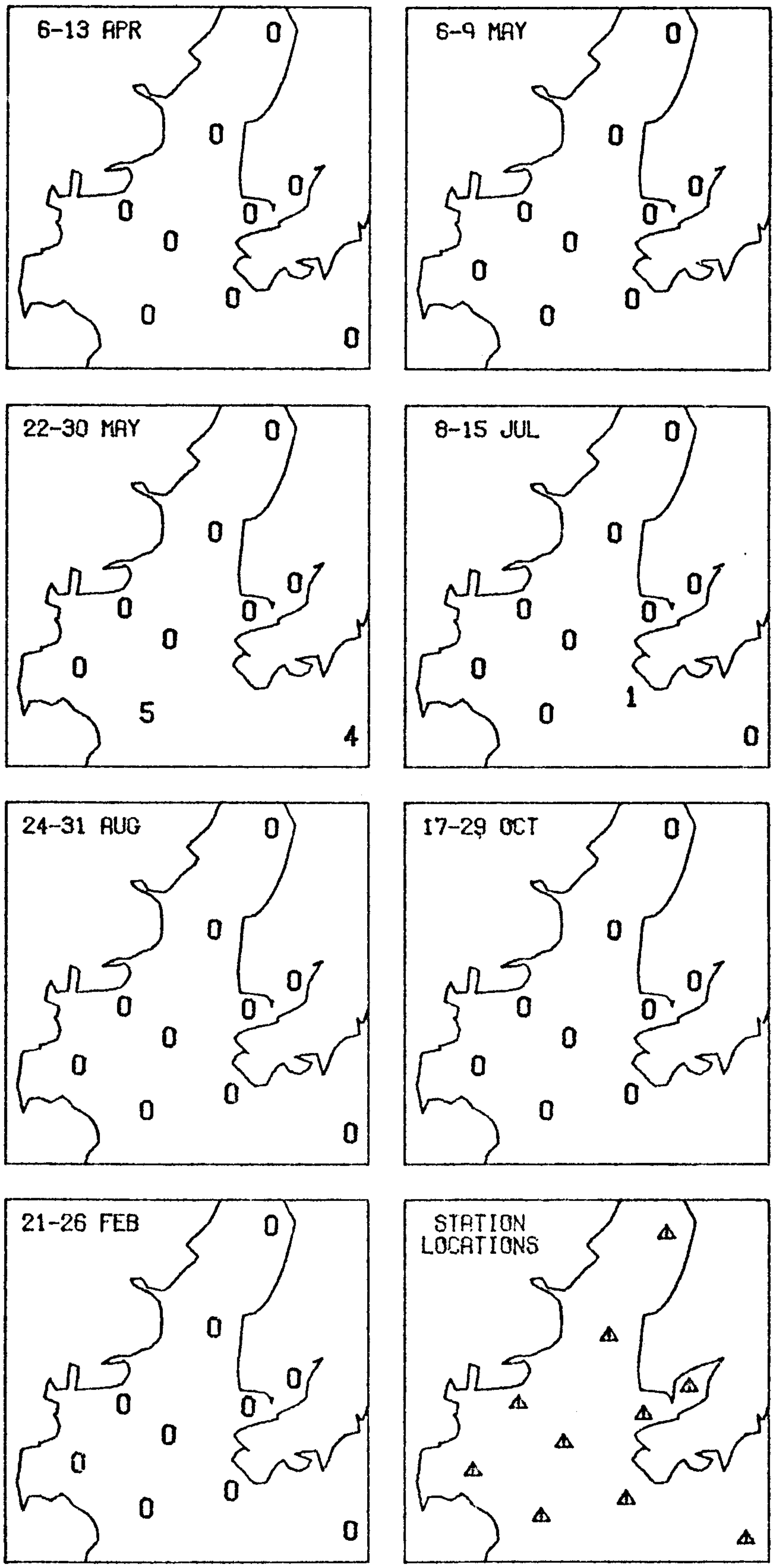
STAGE I/10 SQ M



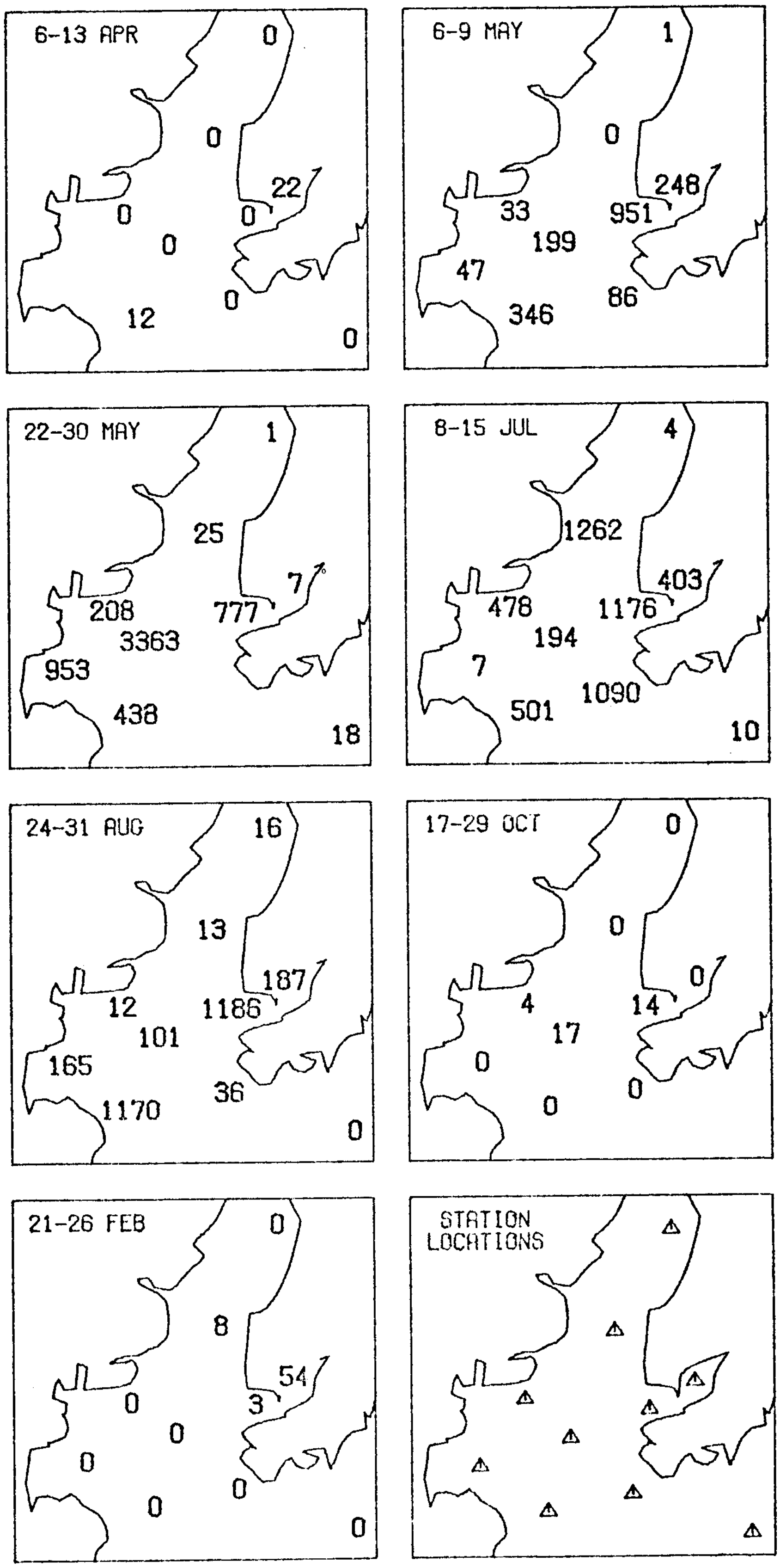
PANDALUS MONTAGUI TRIDENS
STAGE II/10 SQ M



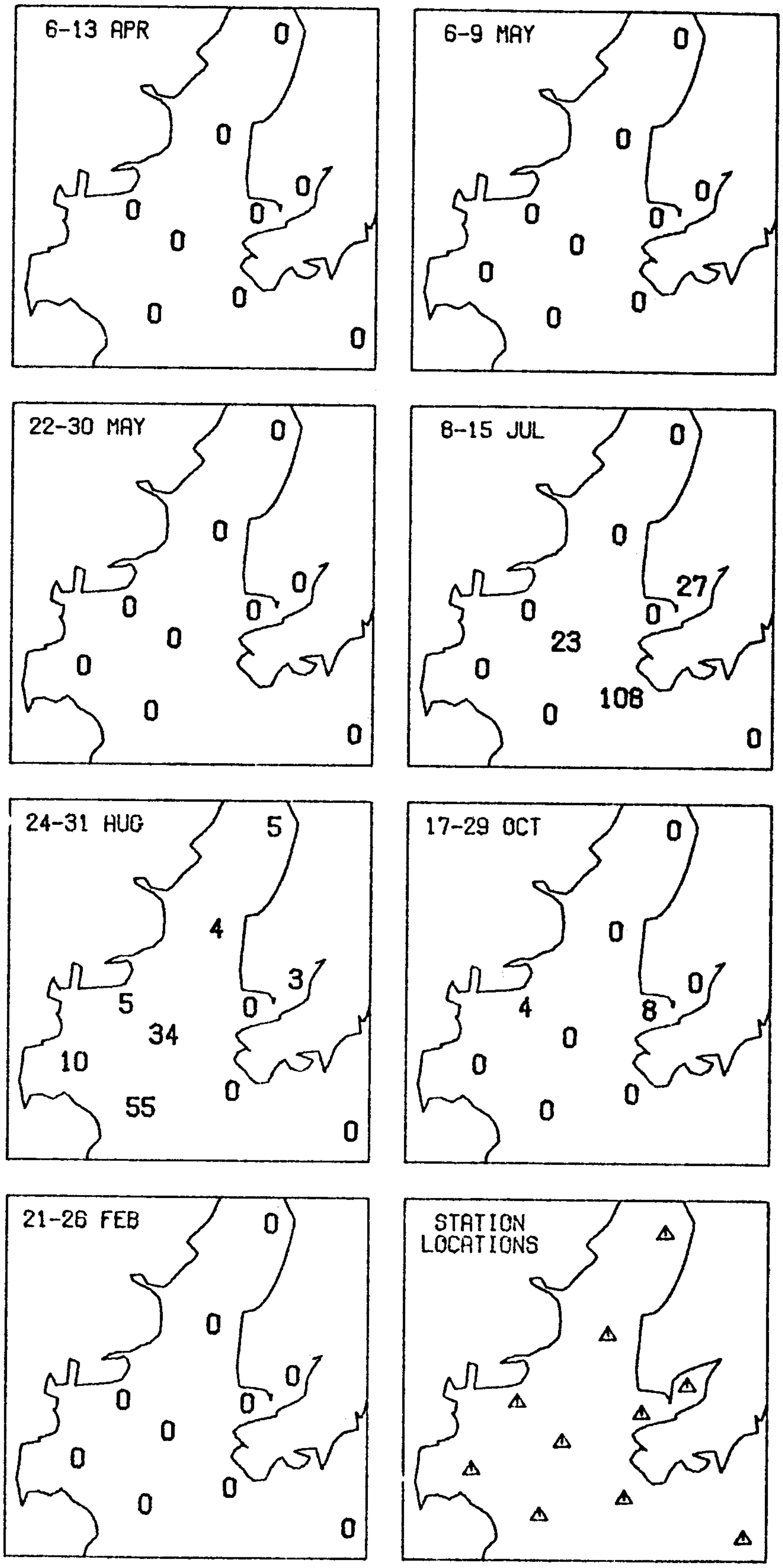
PANDALUS MONTAGUI TRIDENS
STAGE III/10 SQ M



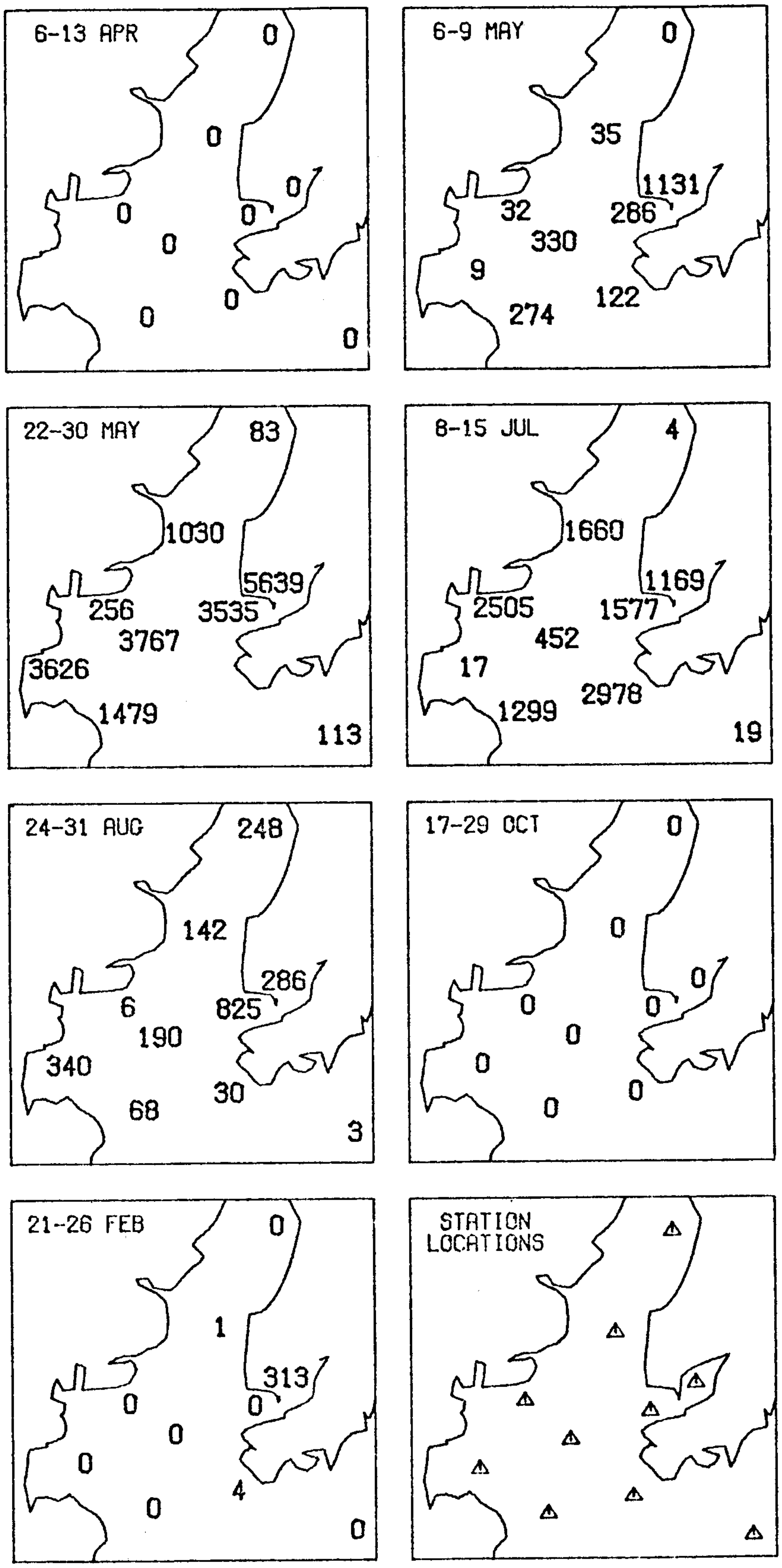
ANOMURA
ZOEA/10 SQ M



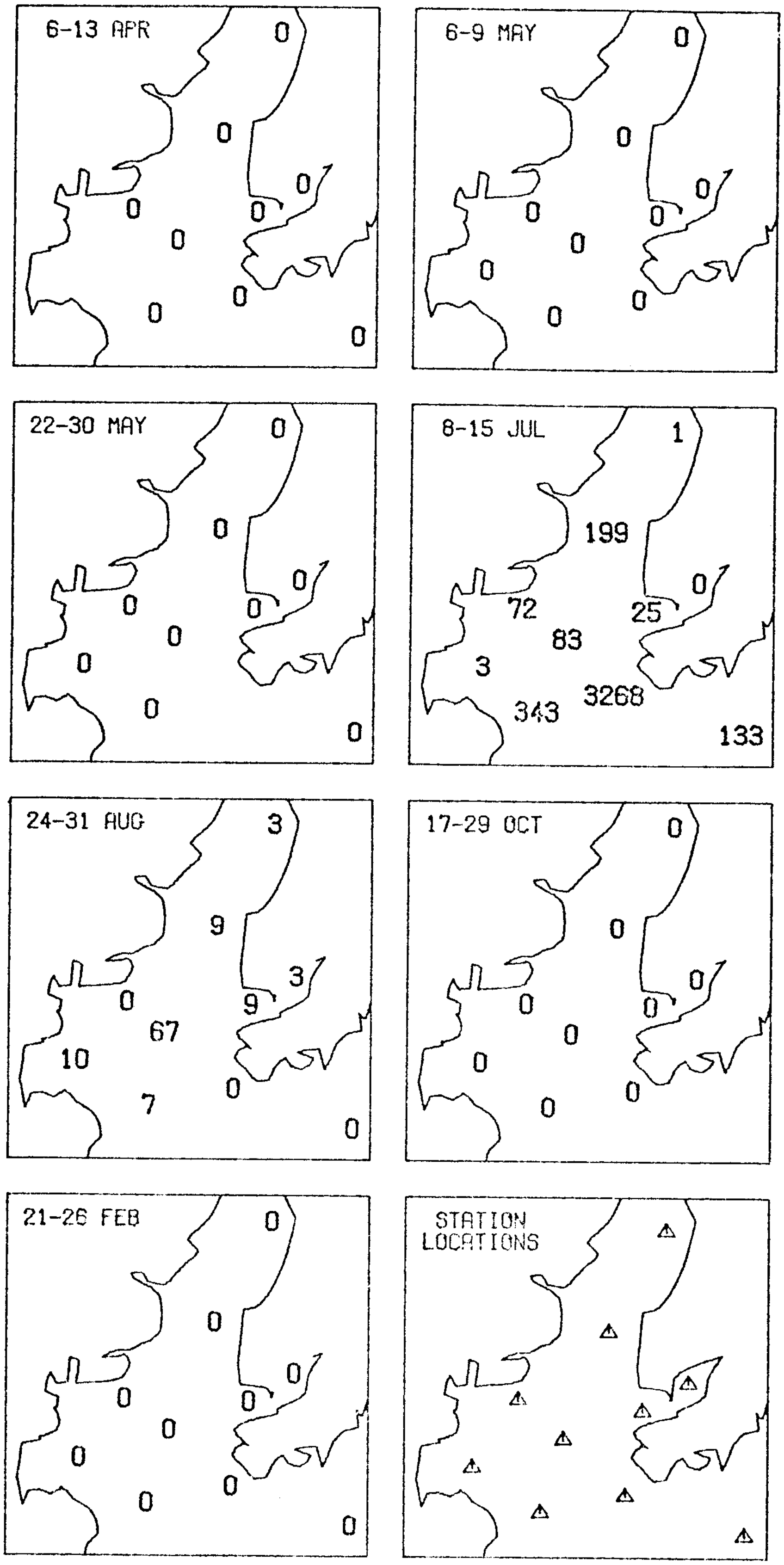
ANOMURA
MEGALOPA/10 SQ M



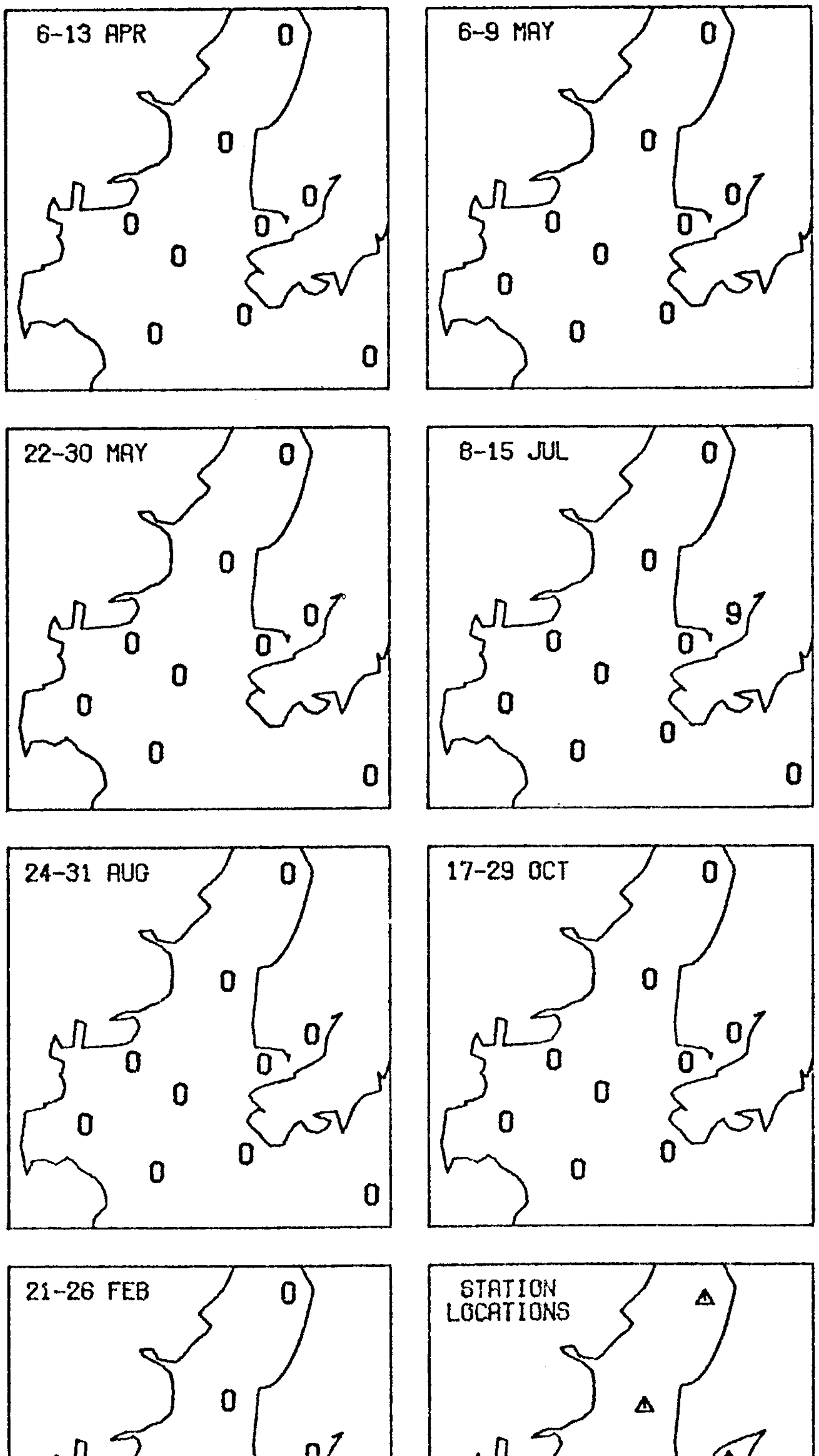
BRACHYURA
ZOEA/10 SQ M



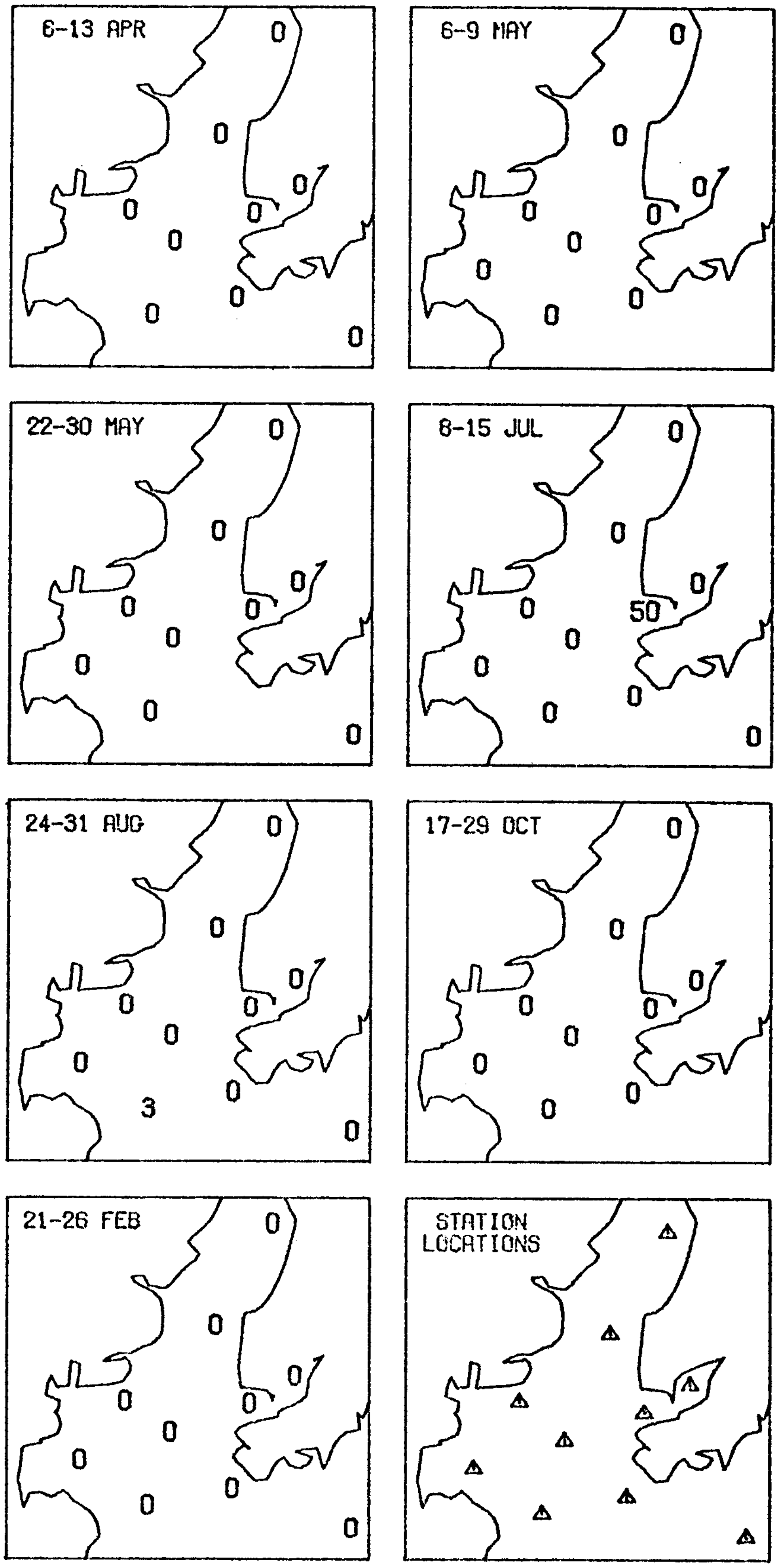
BRACHYURA
MEGALOPA/10 SQ M



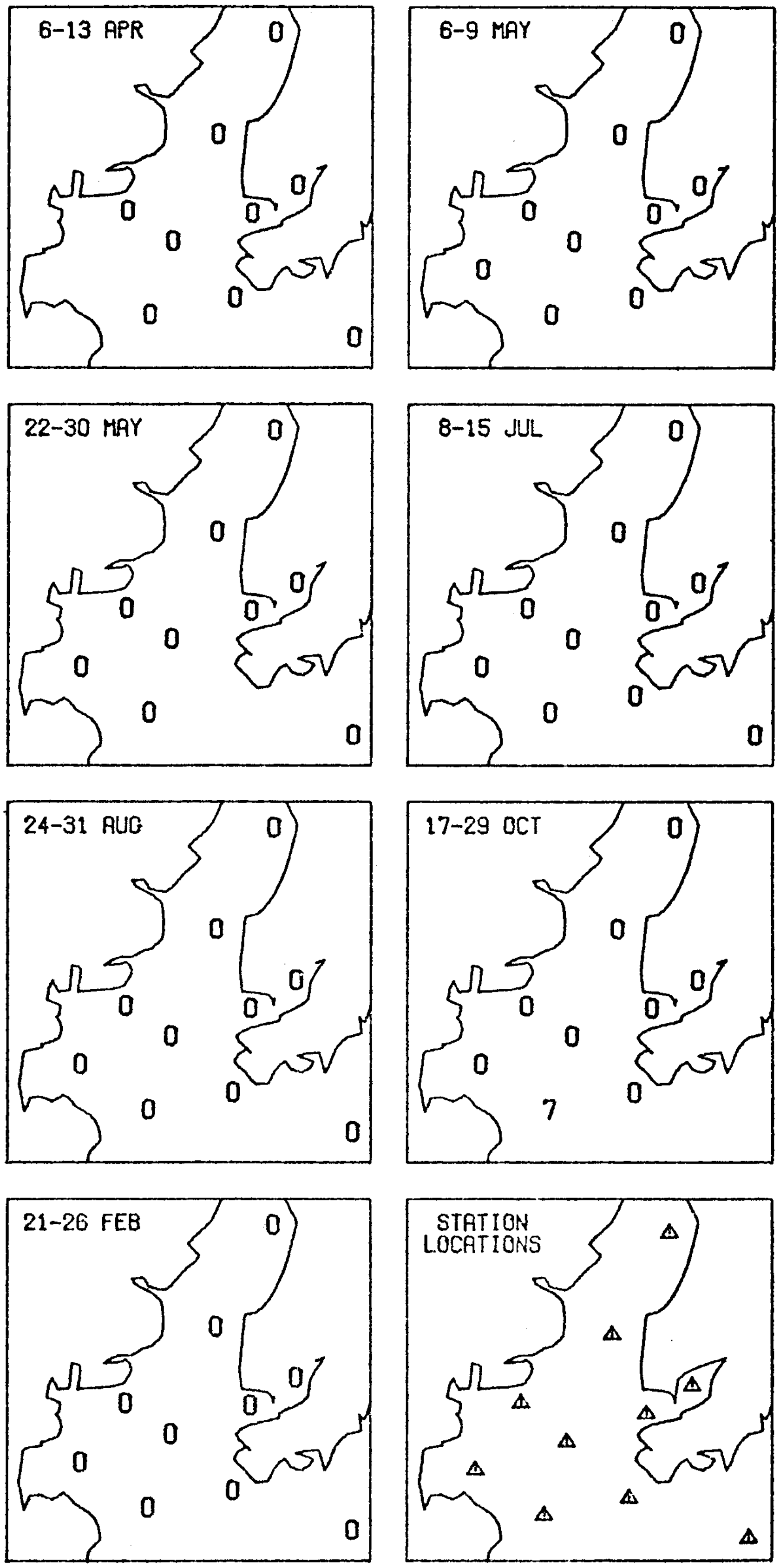
CANCER MAGISTER
STAGE I/10 SQ M



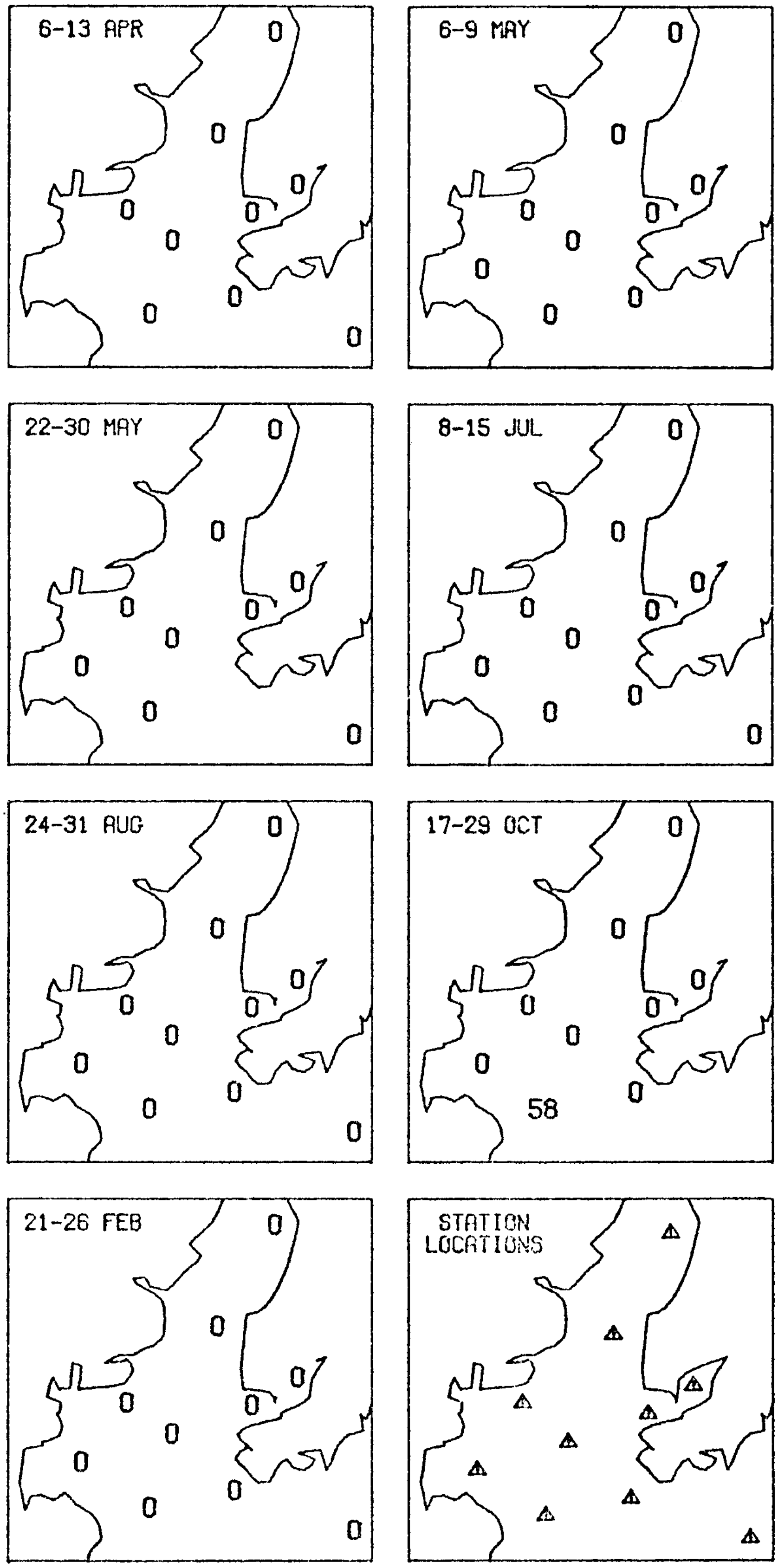
CANCER MAGISTER
STAGE II/10 SQ M



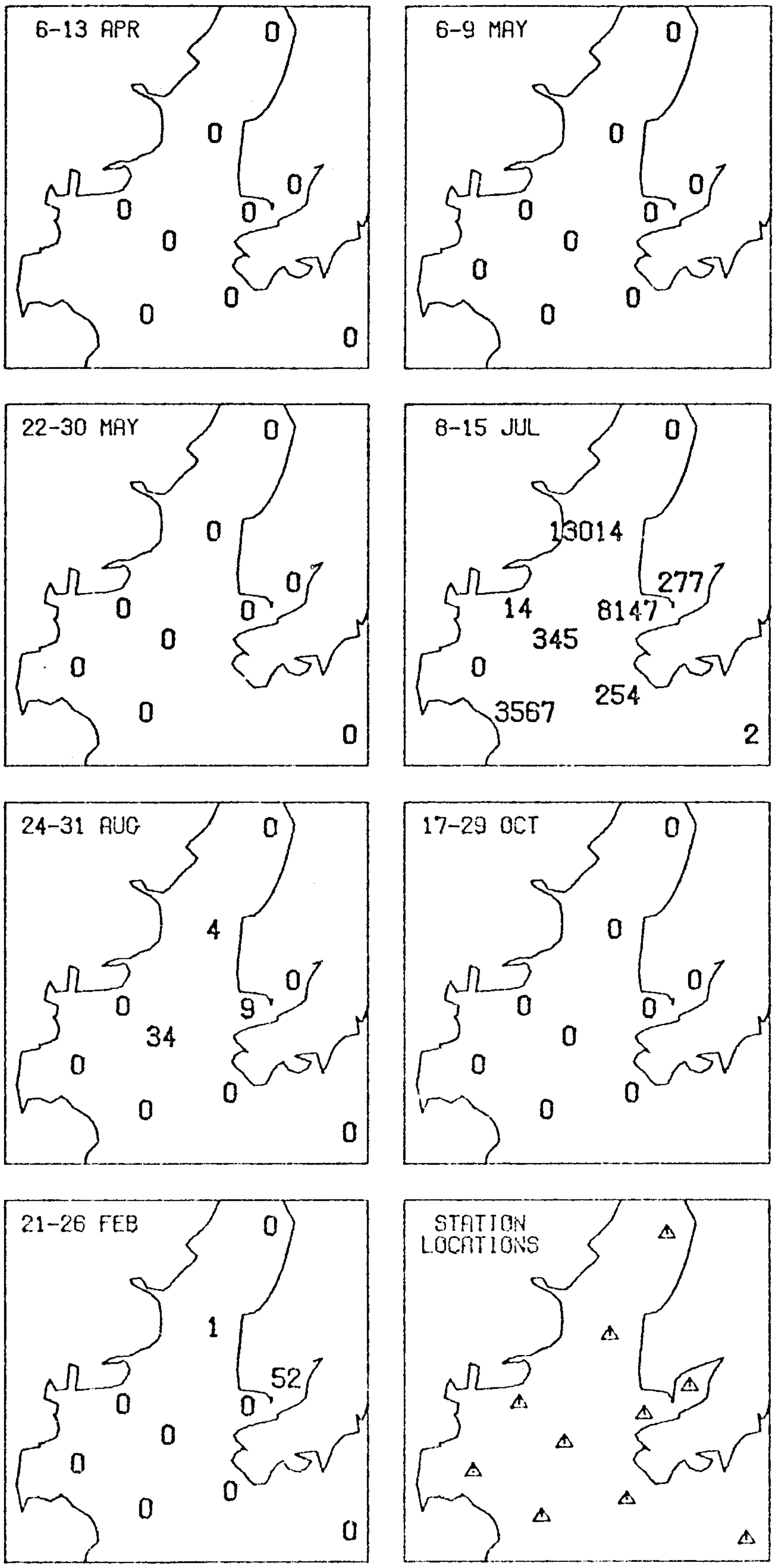
CANCER MAGISTER
STAGE V/10 SQ M



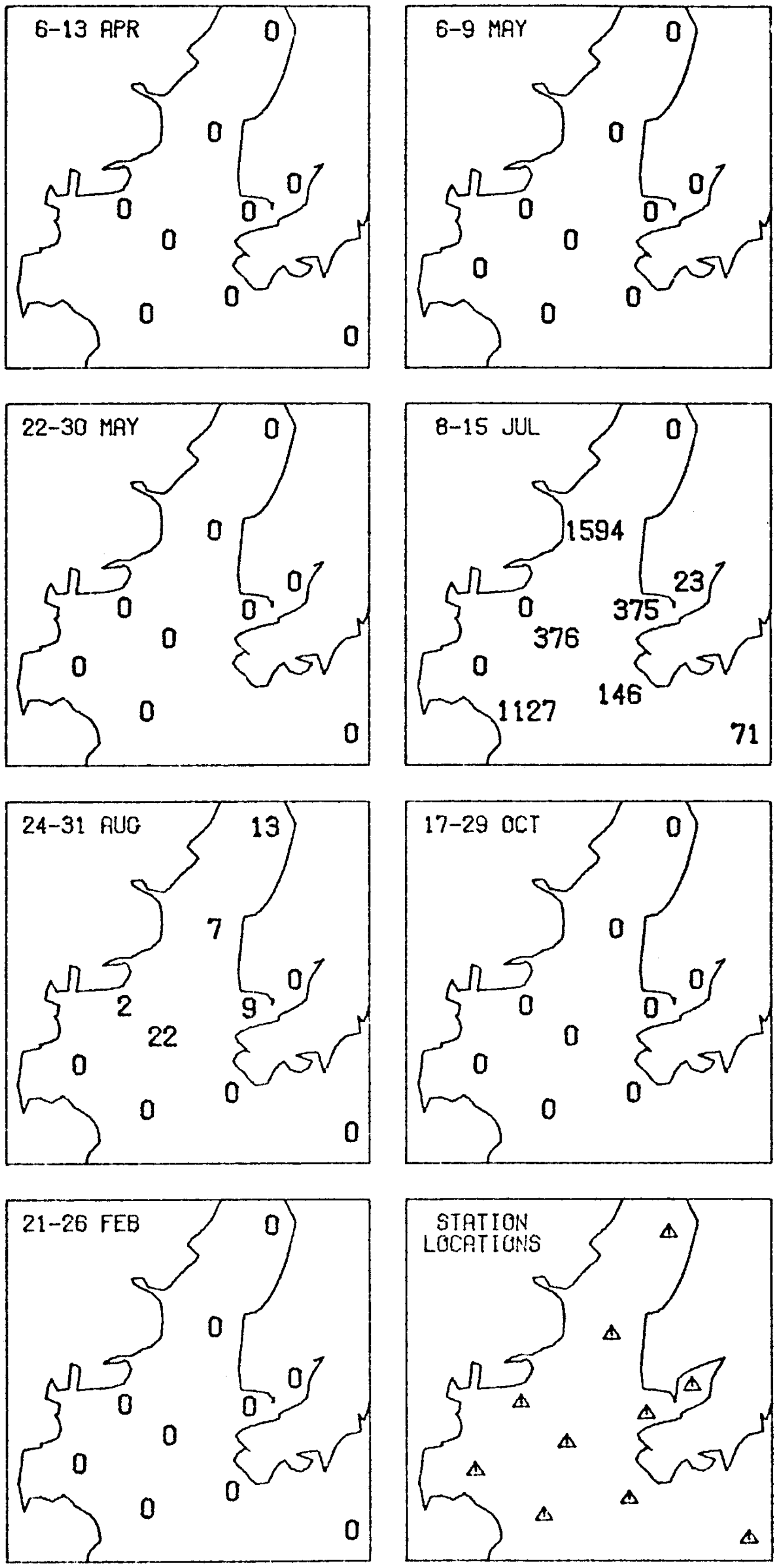
CANCER MAGISTER
MEGALOPA/10 SQ M



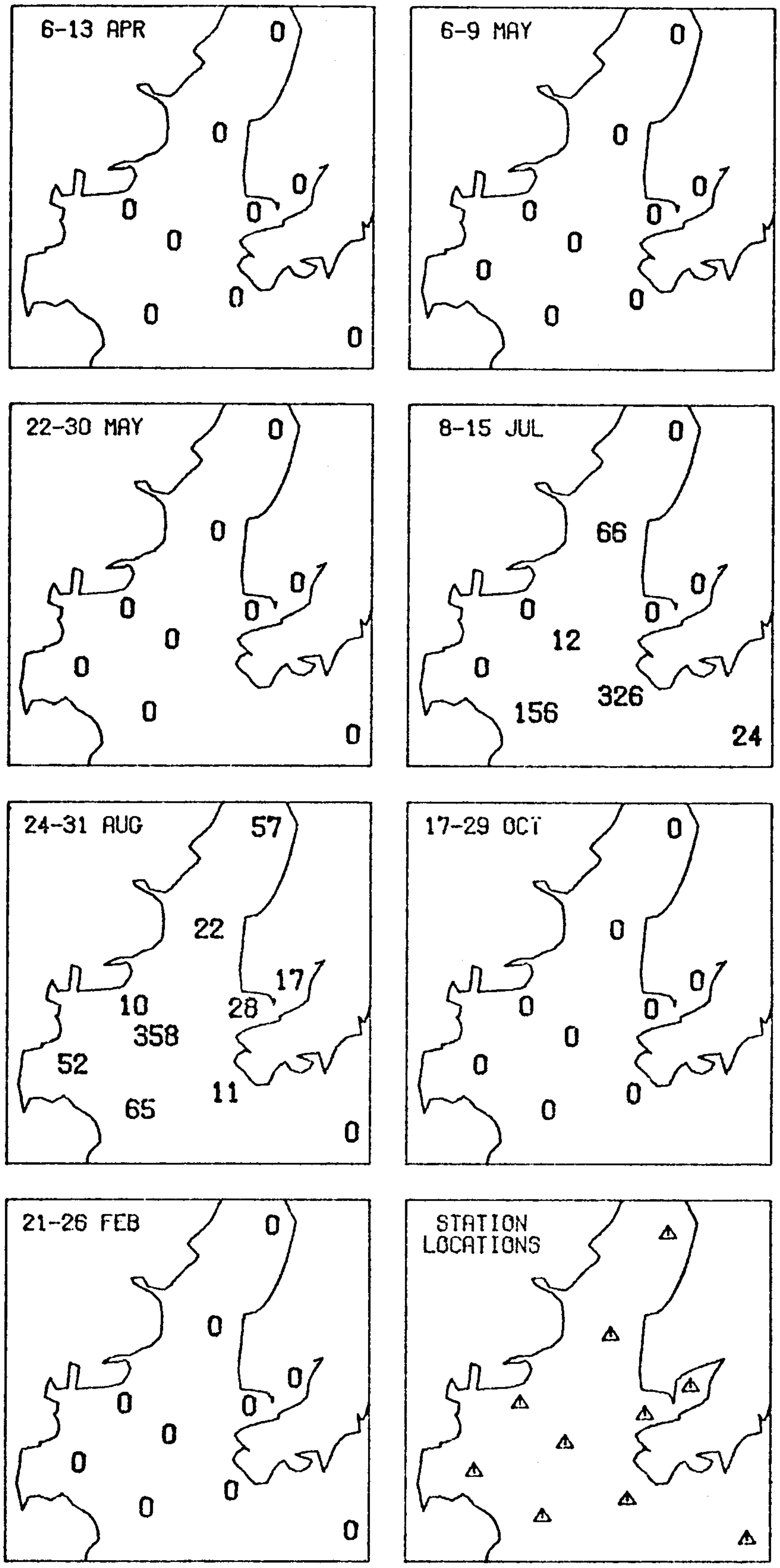
CANCER OREGONENSIS
STAGE I/10 SQ M

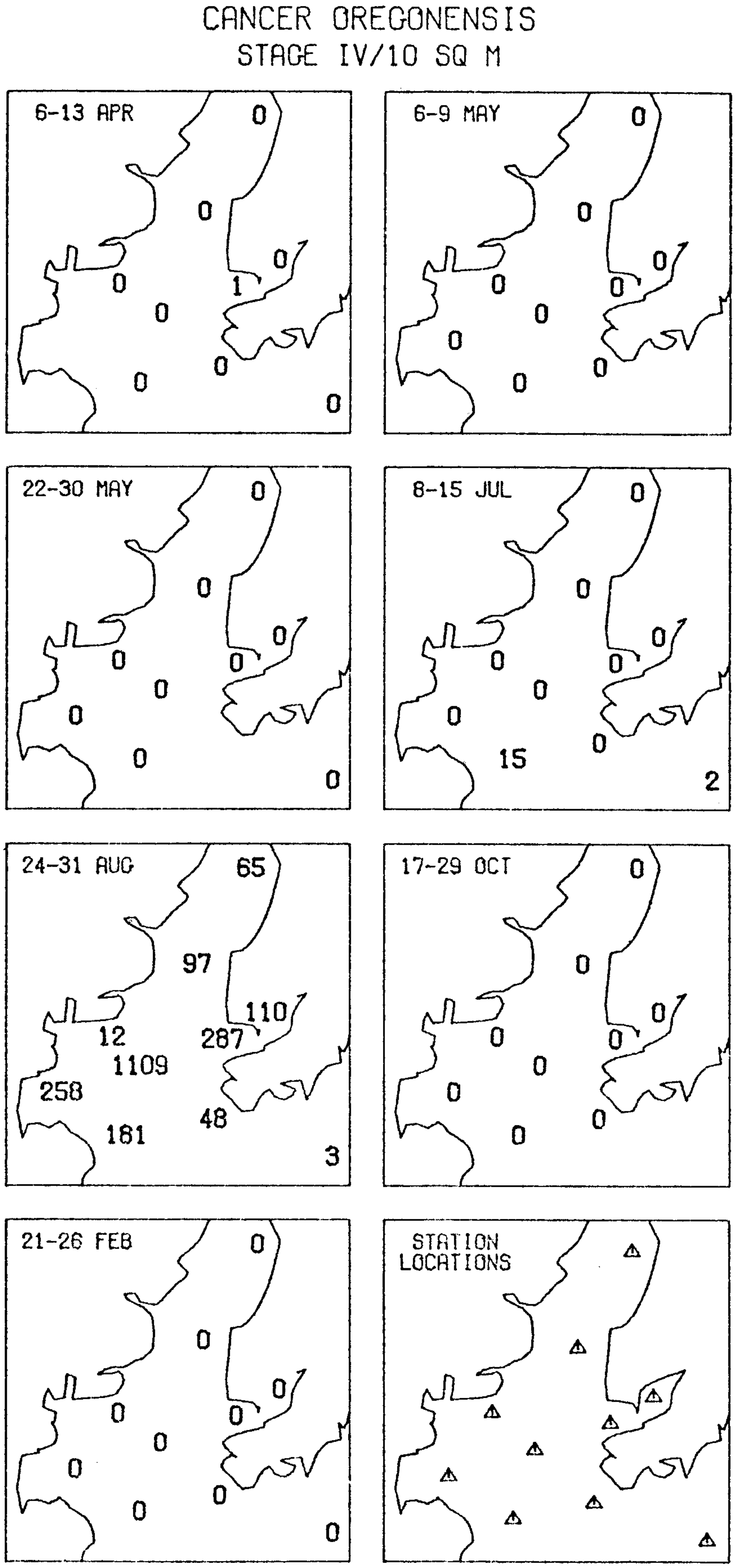


CANCER OREGONENSIS
STAGE II/10 SQ M



CANCER OREGONENSIS
STAGE III/10 SQ M




CANCER OREGONENSIS
STAGE IV/10 SQ M
6-13 APR
0
0
0
1
0
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0
0
6-9 MAY
0
0
0
0
0
0
0
0
0
22-30 MAY
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8-15 JUL
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24-31 AUG
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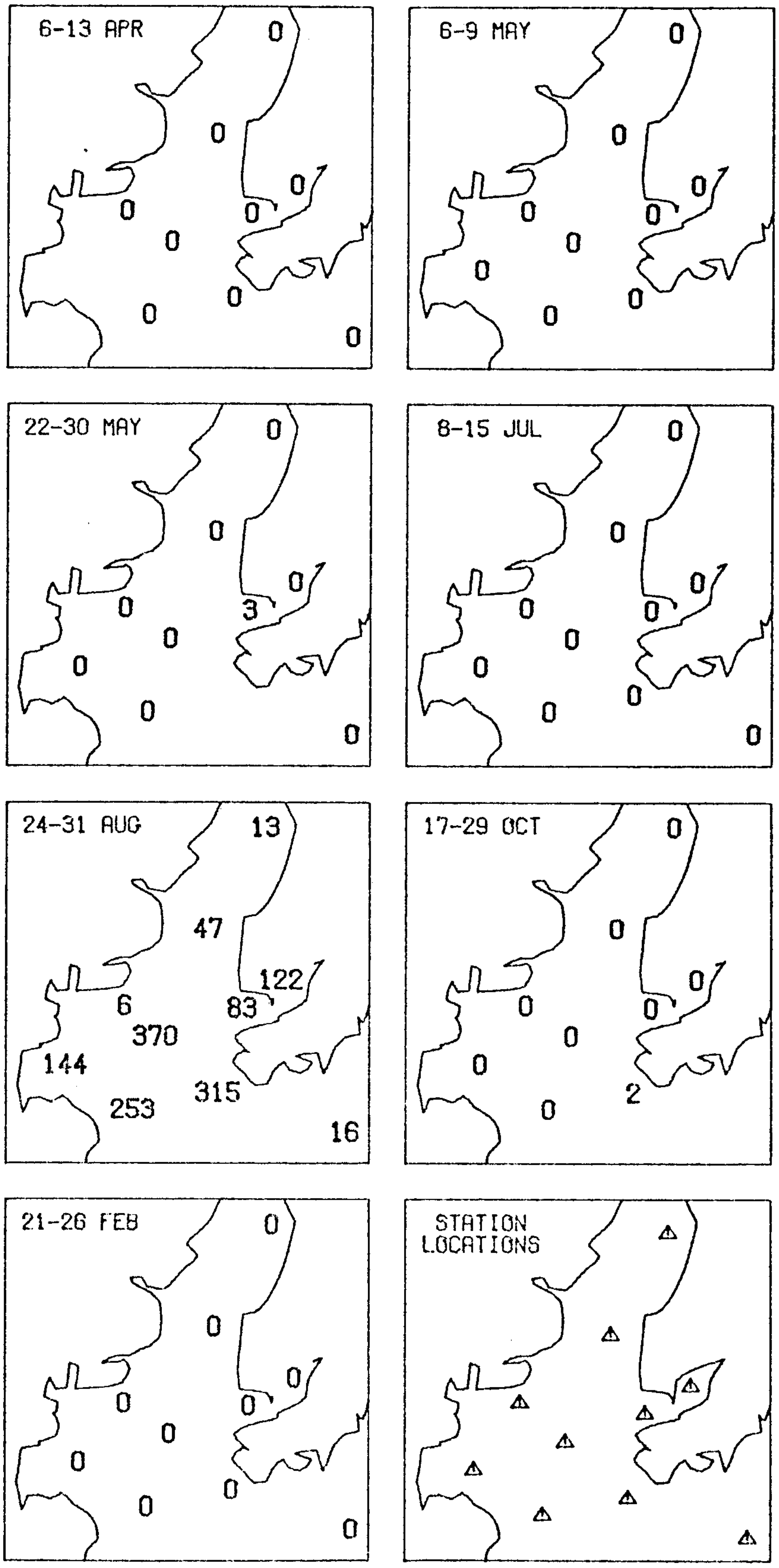
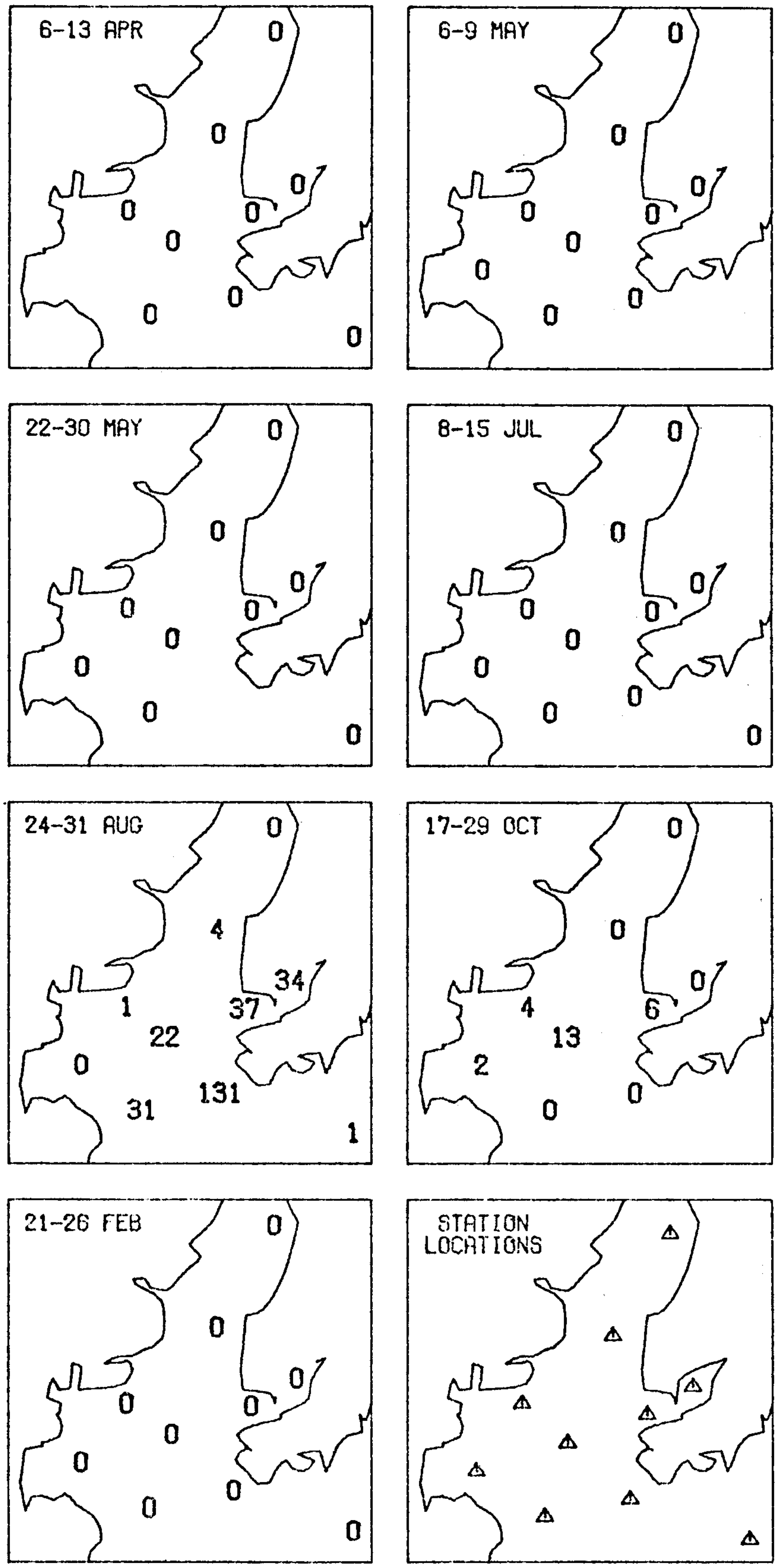
97
110
12
287
1109
258
48
161
3
17-29 OCT
0
0
0
0
0
0
0
0
0
21-26 FEB
0
0
0
0
0
0
0
0
0
STATION
LOCATIONS

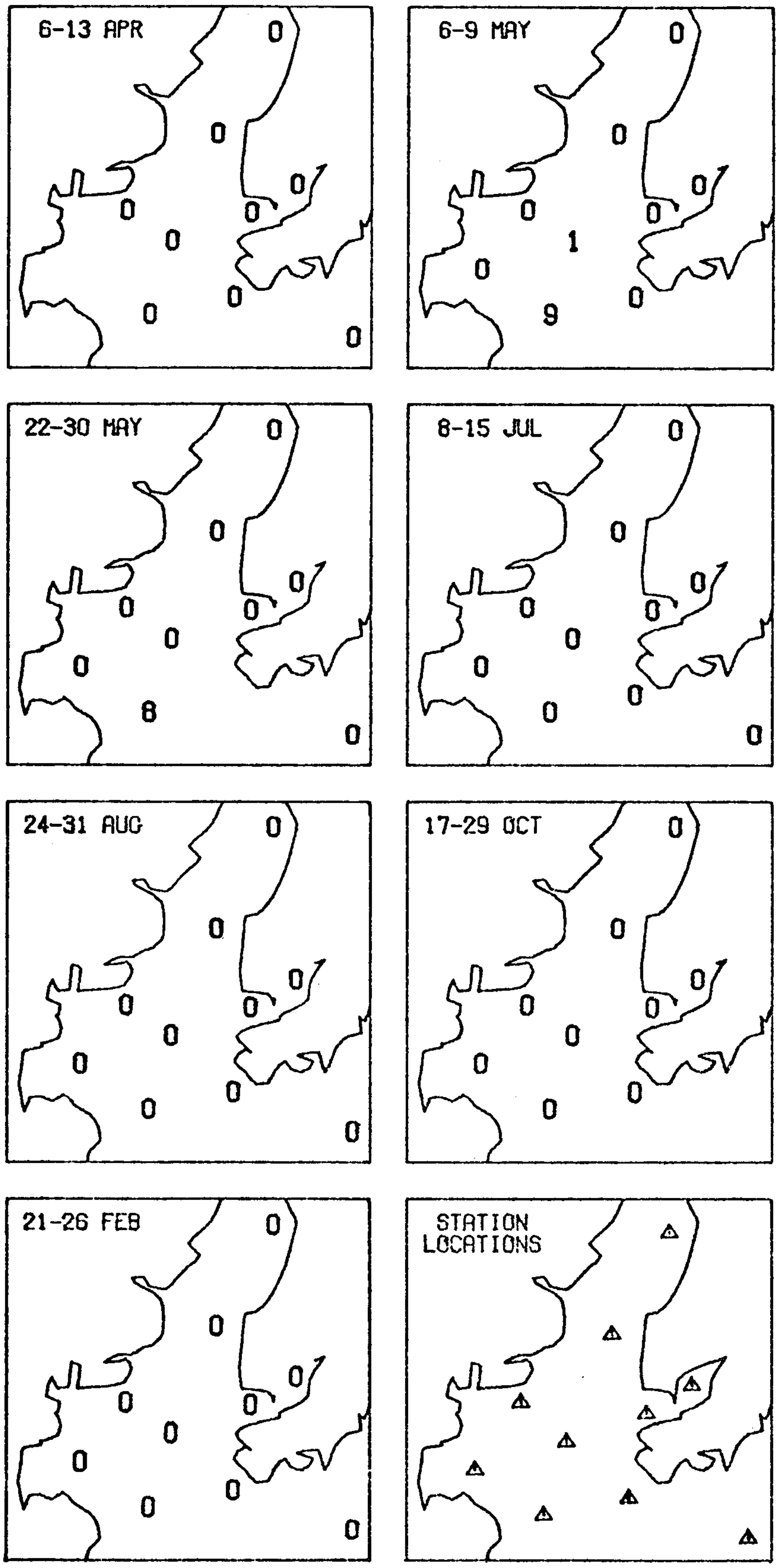
CANCER OREGONENSIS
STAGE V/10 SQ M



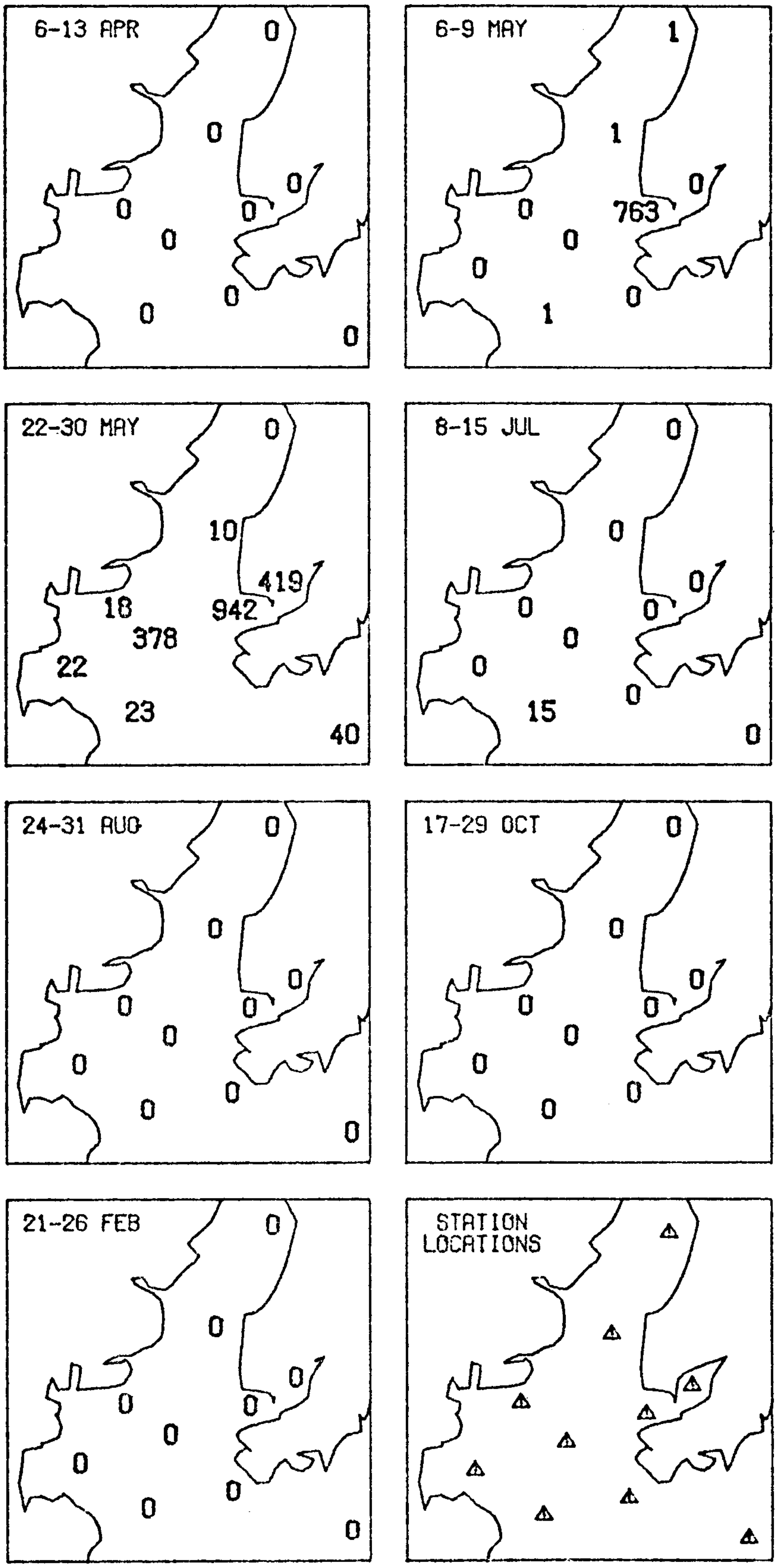
CANCER OREGONENSIS
MEGALOPA/10 SQ M



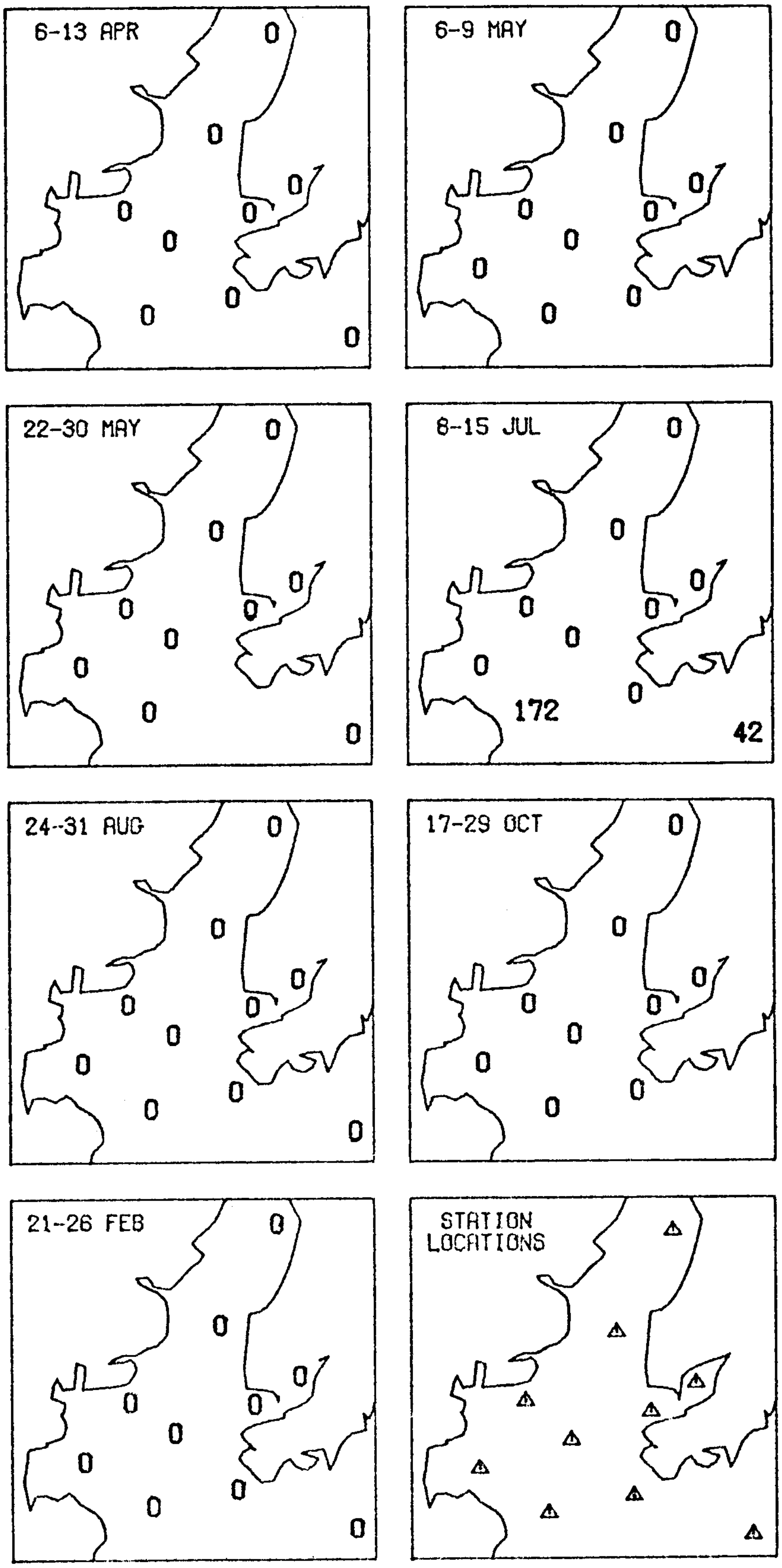
CANCER PRODUCTUS
STAGE I/10 SQ M



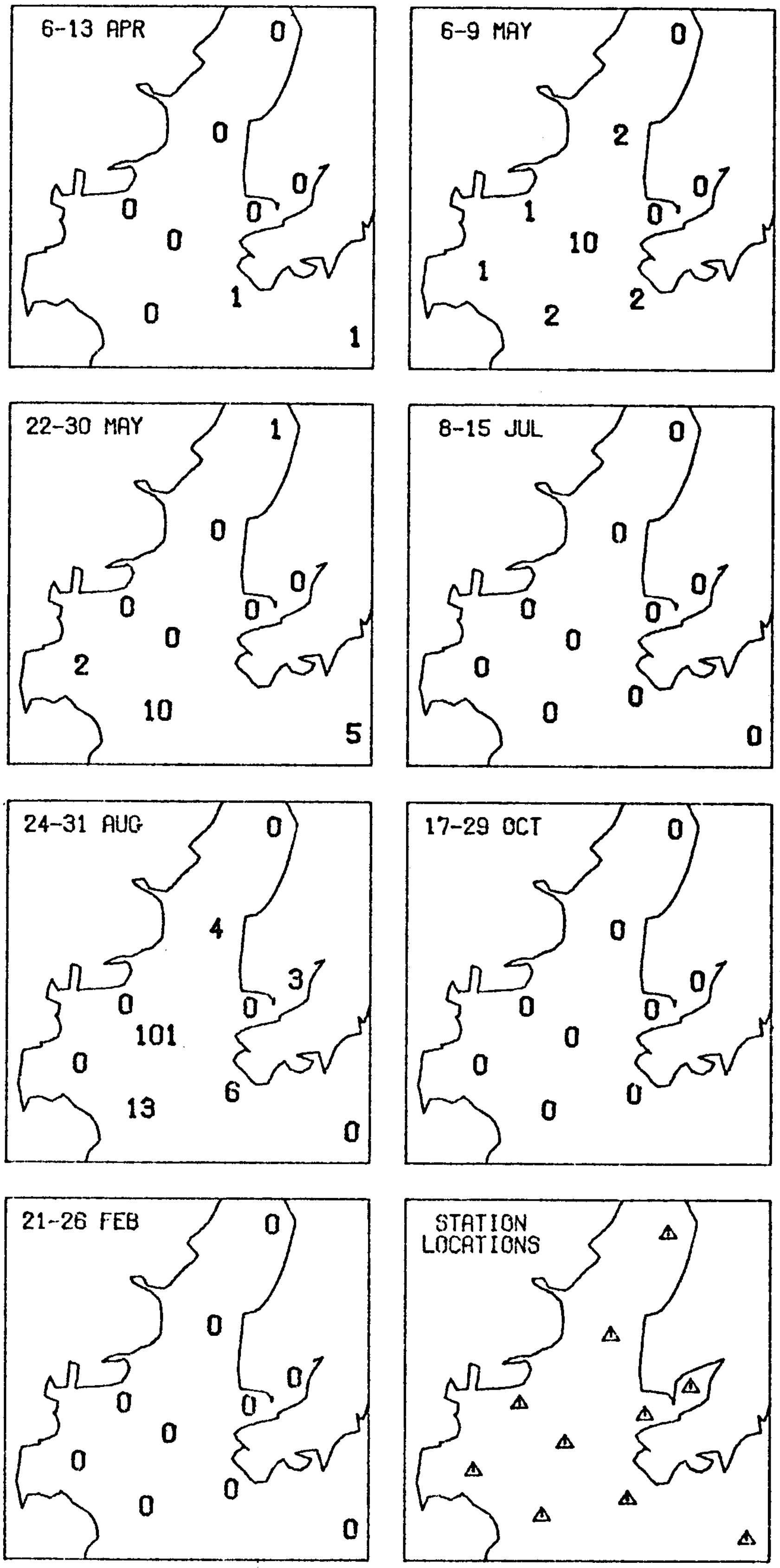
CHIONOECETES BAIRDI
STAGE I/10 SQ M



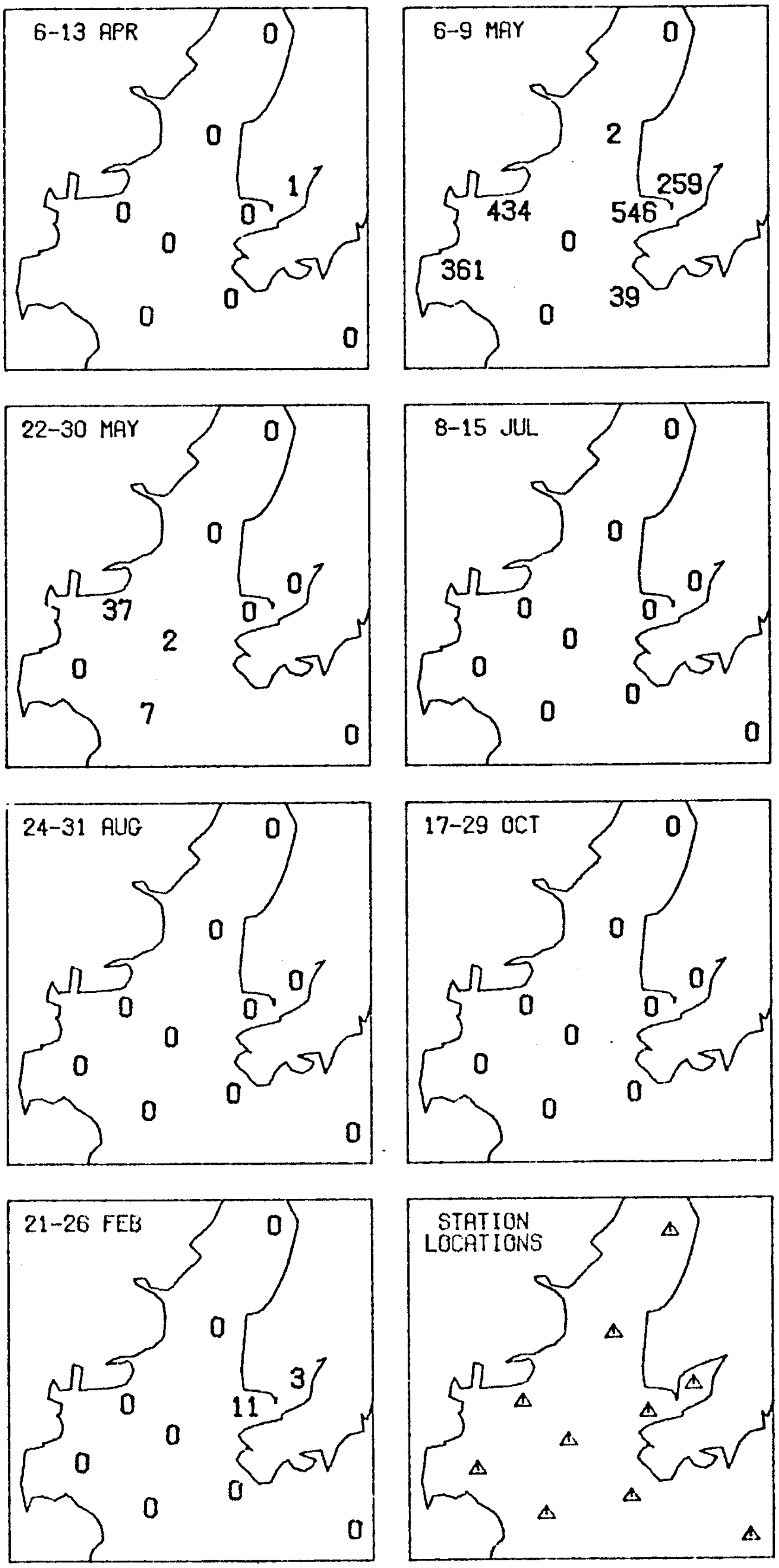
CHIONOECETES BAIRDI
STAGE II/10 SQ M



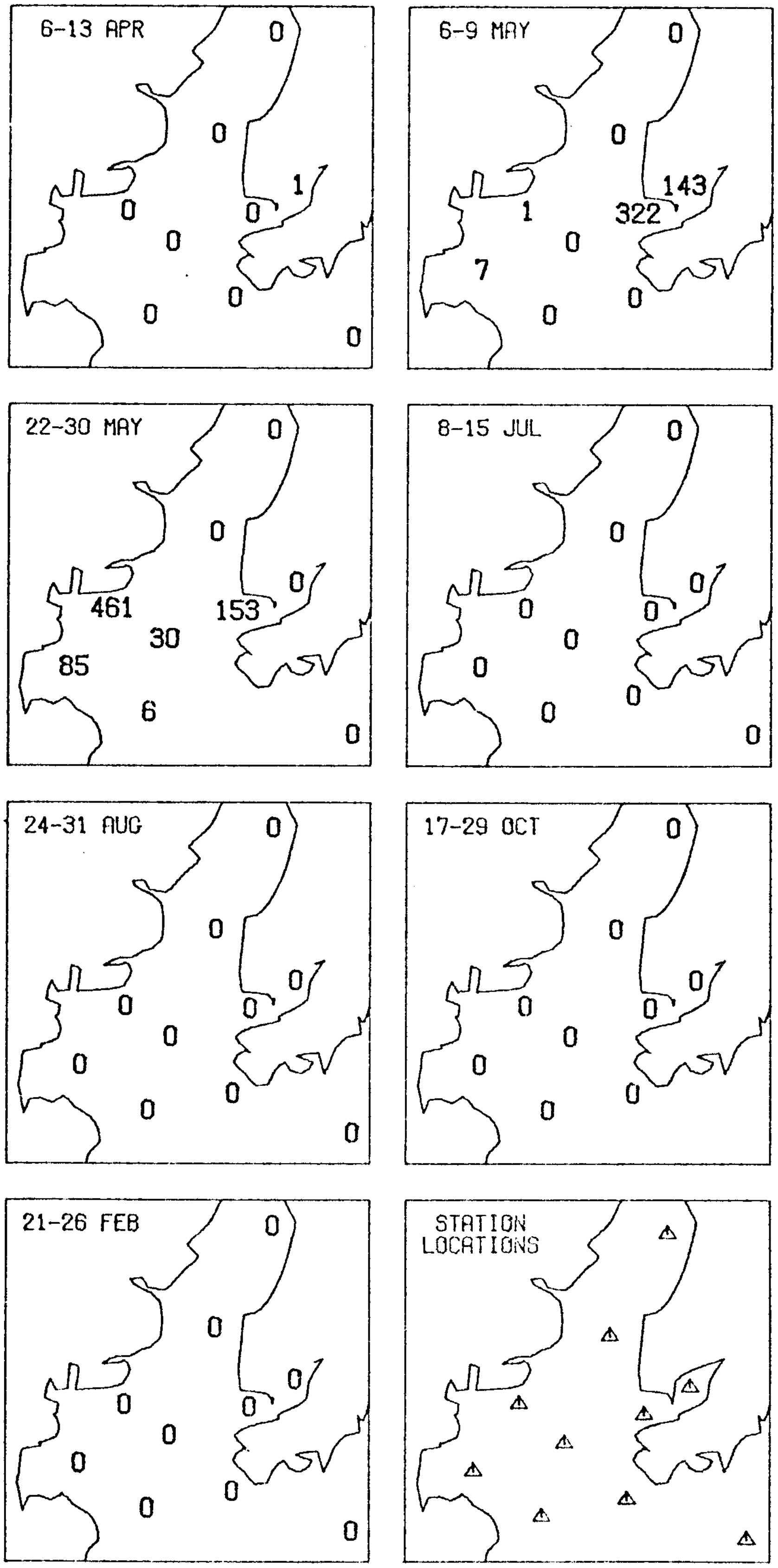
CHIONOECETES SP.
MEGALOPA/10 SQ M



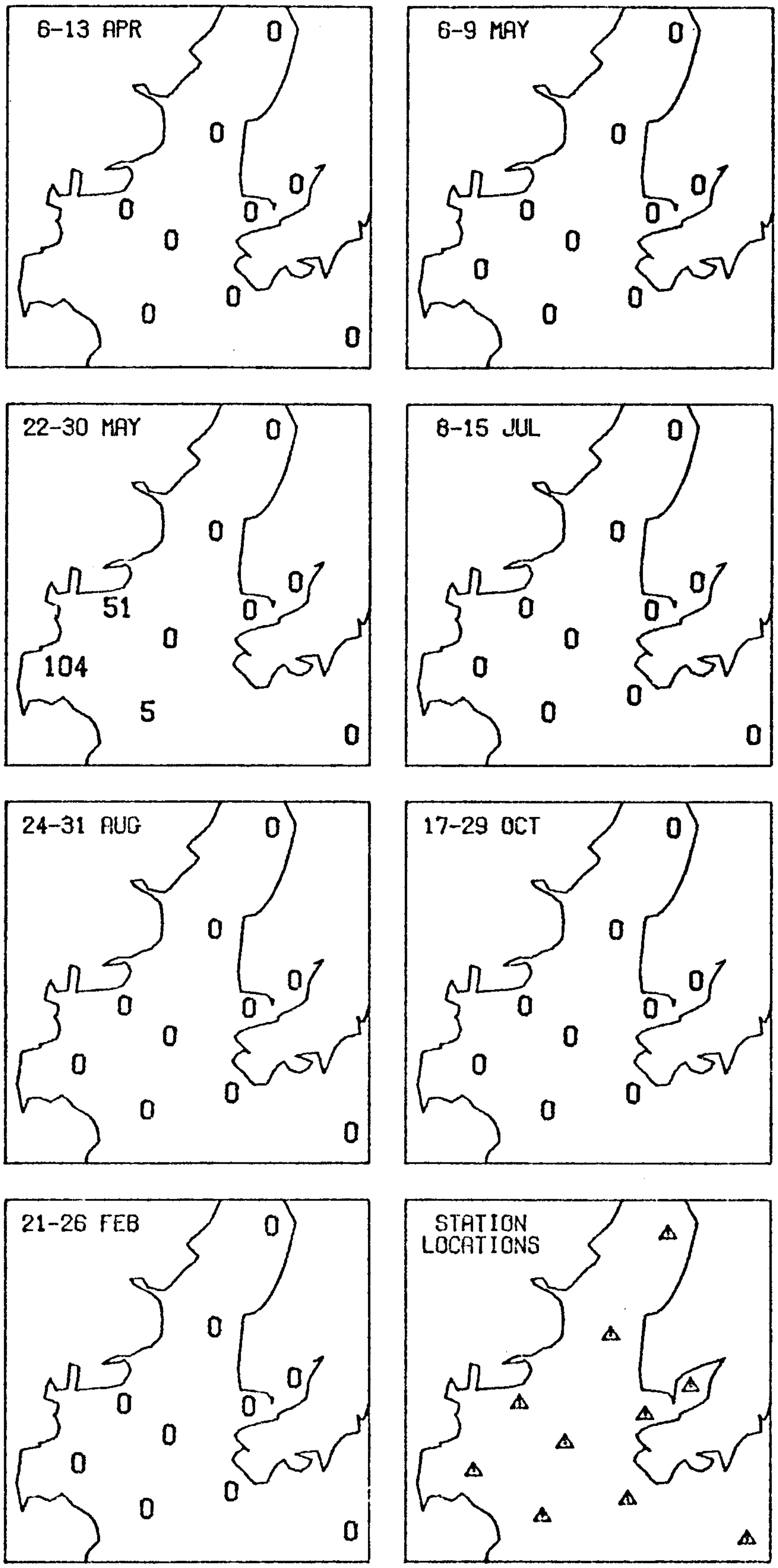
PARALITHODES CAMTSCHATICA
STAGE I/10 SQ M



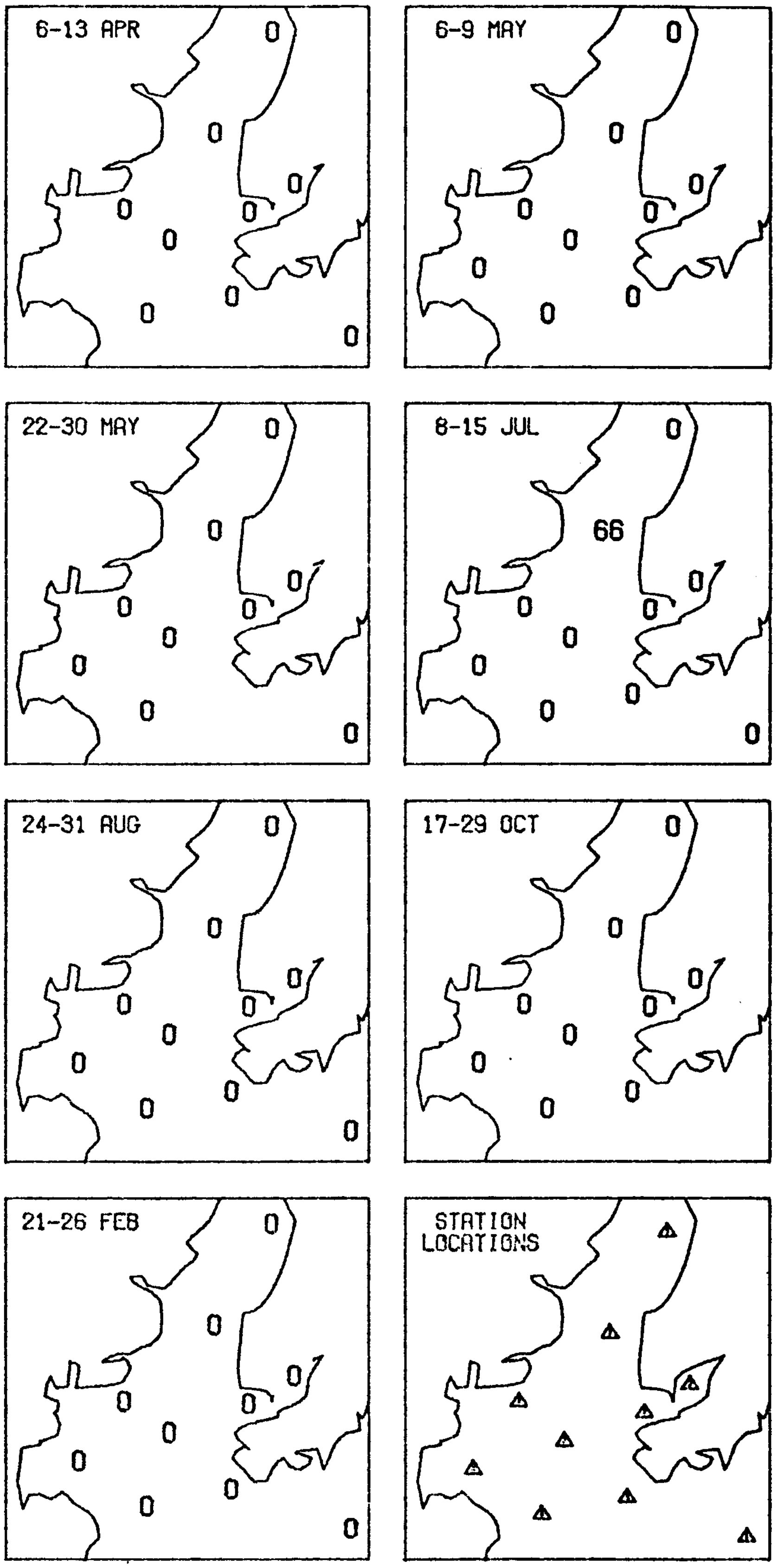
PARALITHODES CAMTSCHATICA
STAGE II/10 SQ M



PARALITHODES CAMTSCHATICA
STAGE III/10 SQ M



PARALITHODES PLATYPUS
MEGALOPA/10 SQ M

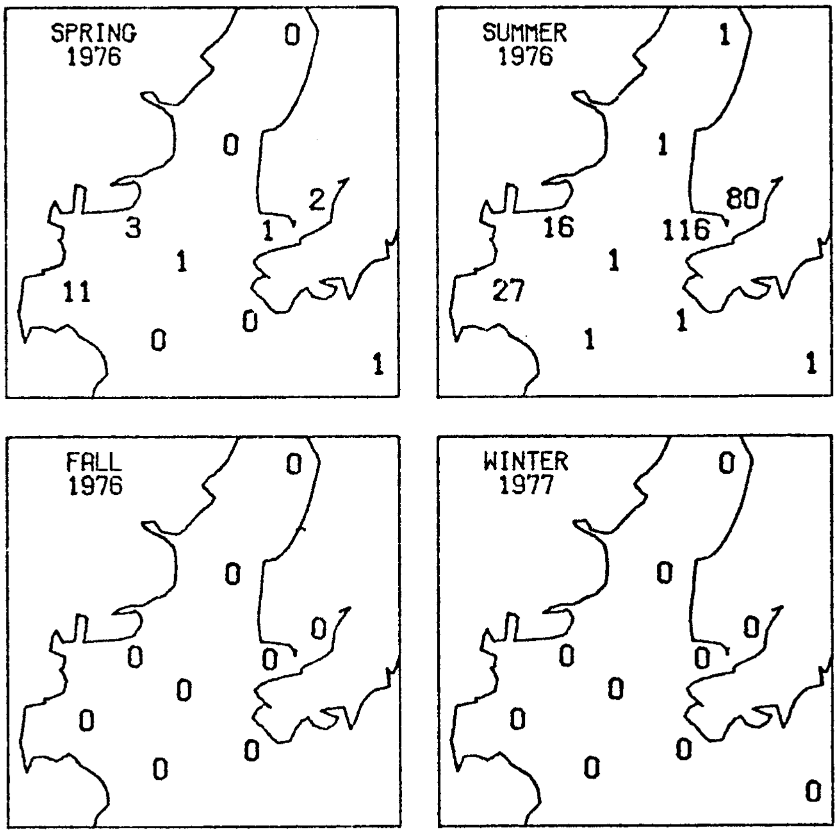


APPENDIX D

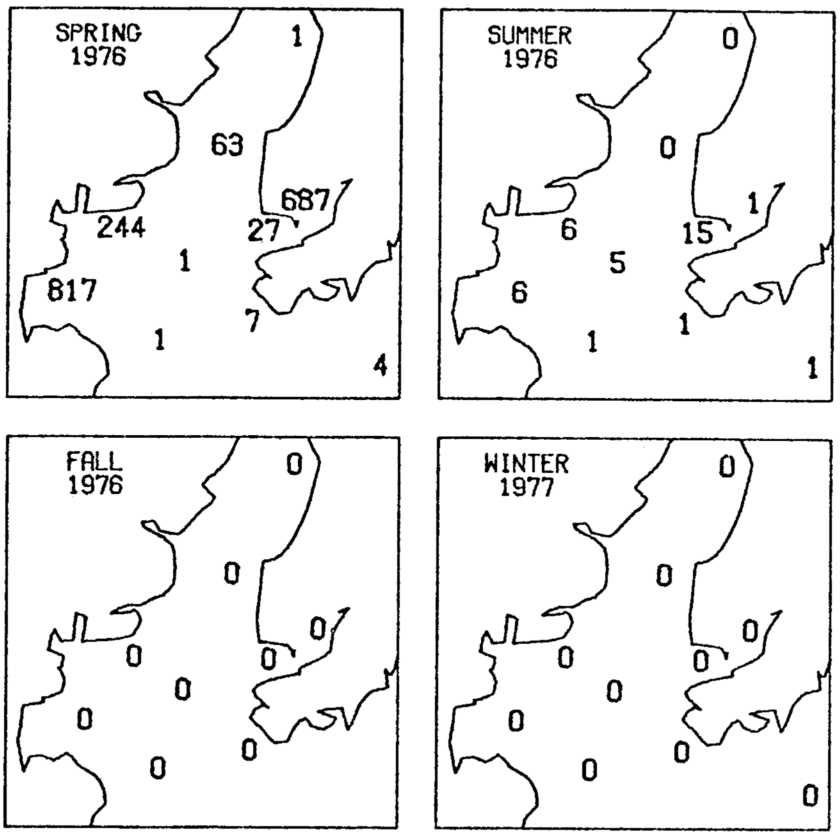
Density Distributions per 10 Square Meters

for Four Seasons

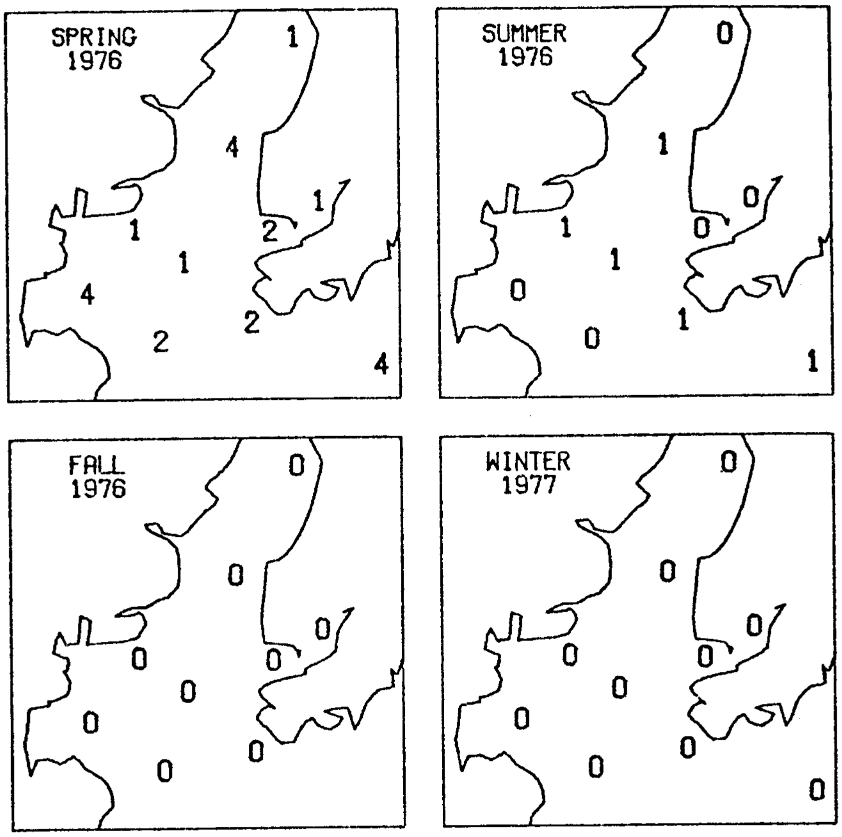
FISH EGGS
<1MM DIAM/10 SQ M



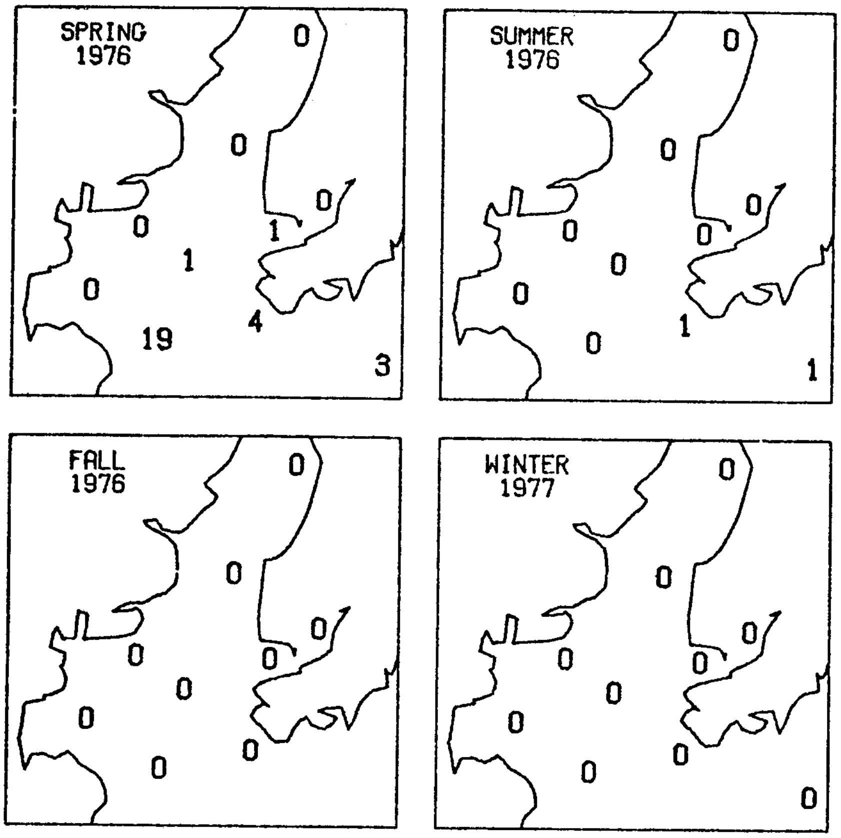
FISH EGGS
~ 1MM DIAM/10 SQ M

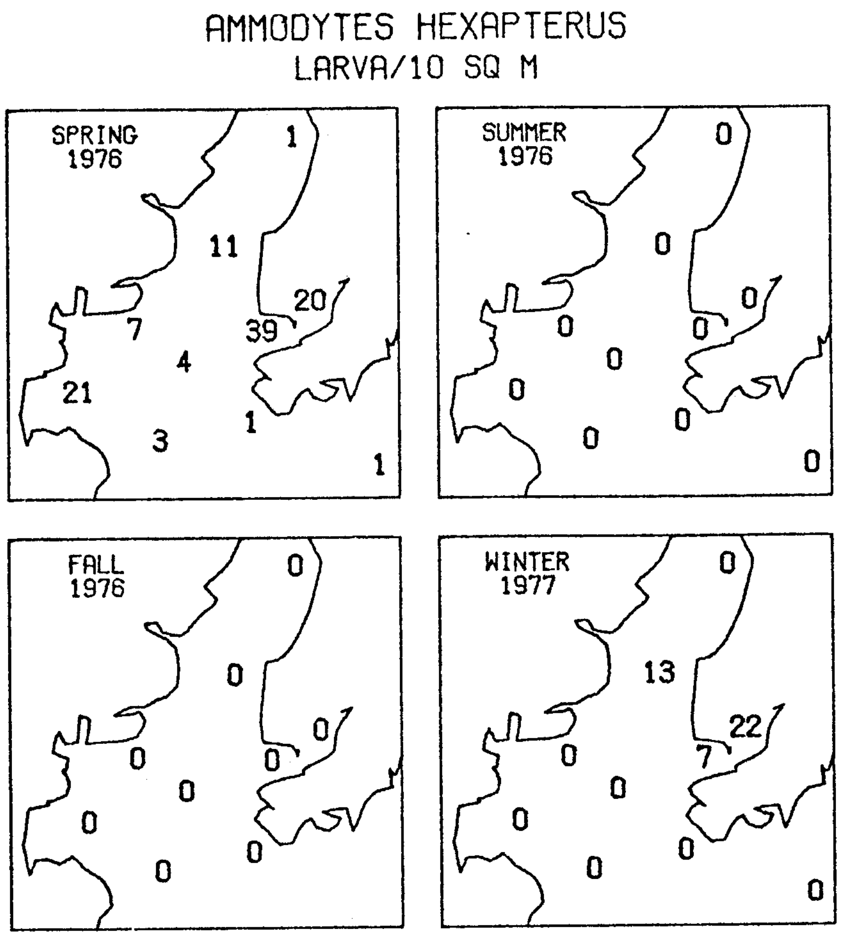


FISH EGGS
~2MM DIAM/10 SQ M



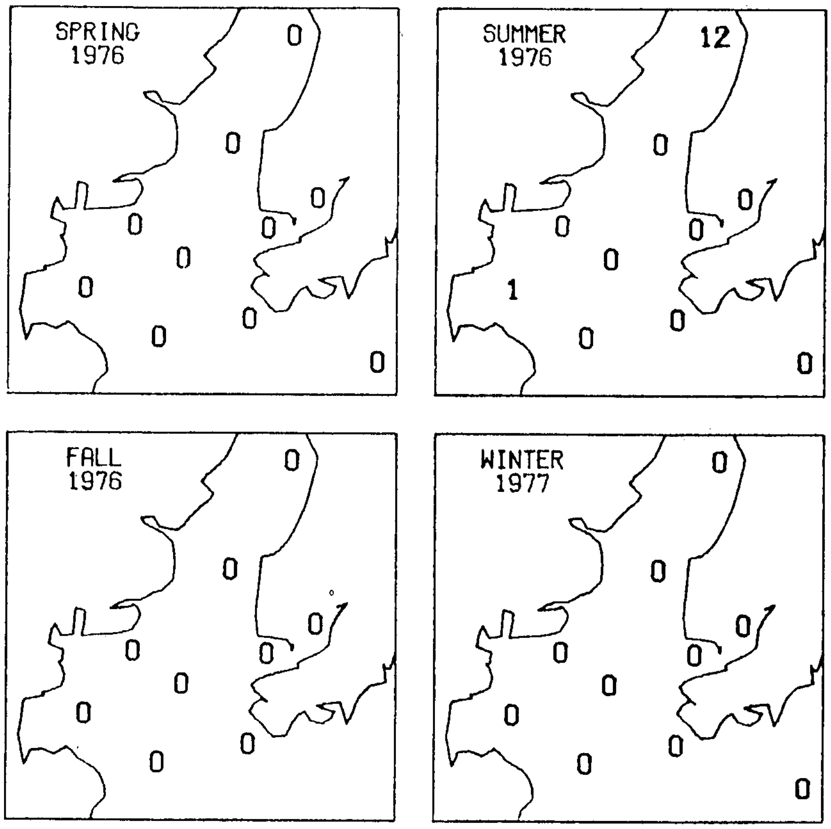
FISH EGGS
~3MM DIAM/10 SQ M



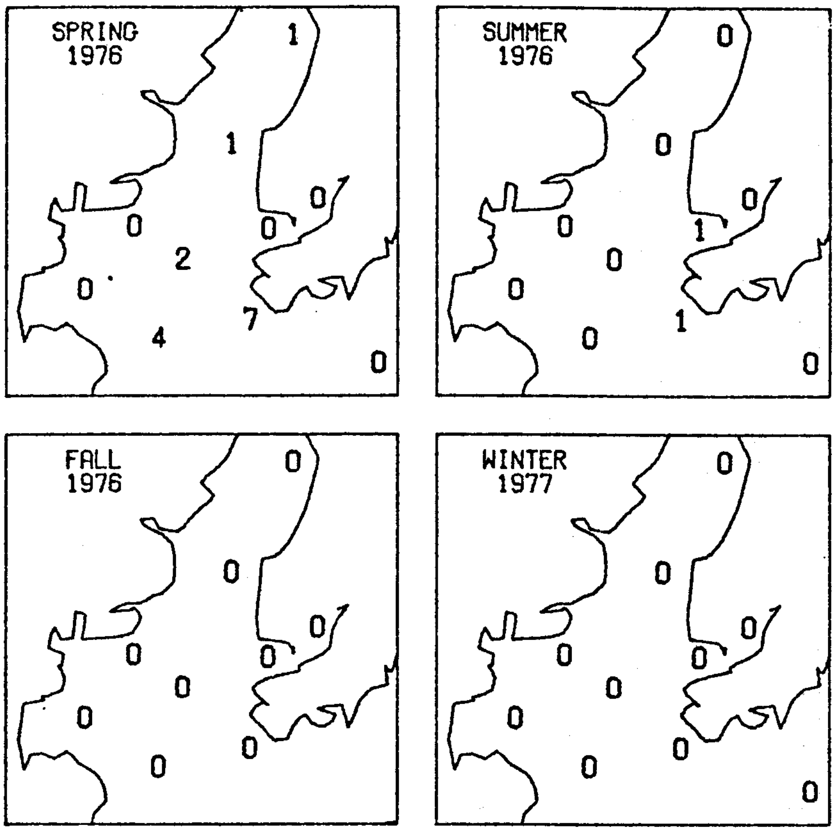

AMMODYTES HEXAPTERUS
LARVA/10 SQ M
SPRING 1976
1
11
20
7
39
4
21
1
3
1
SUMMER 1976
0
0
0
0
0
0
0
0
0
0
FALL 1976
0
0
0
0
0
0
0
0
0
WINTER 1977
0
13
22
0
7
0
0
0
0
0

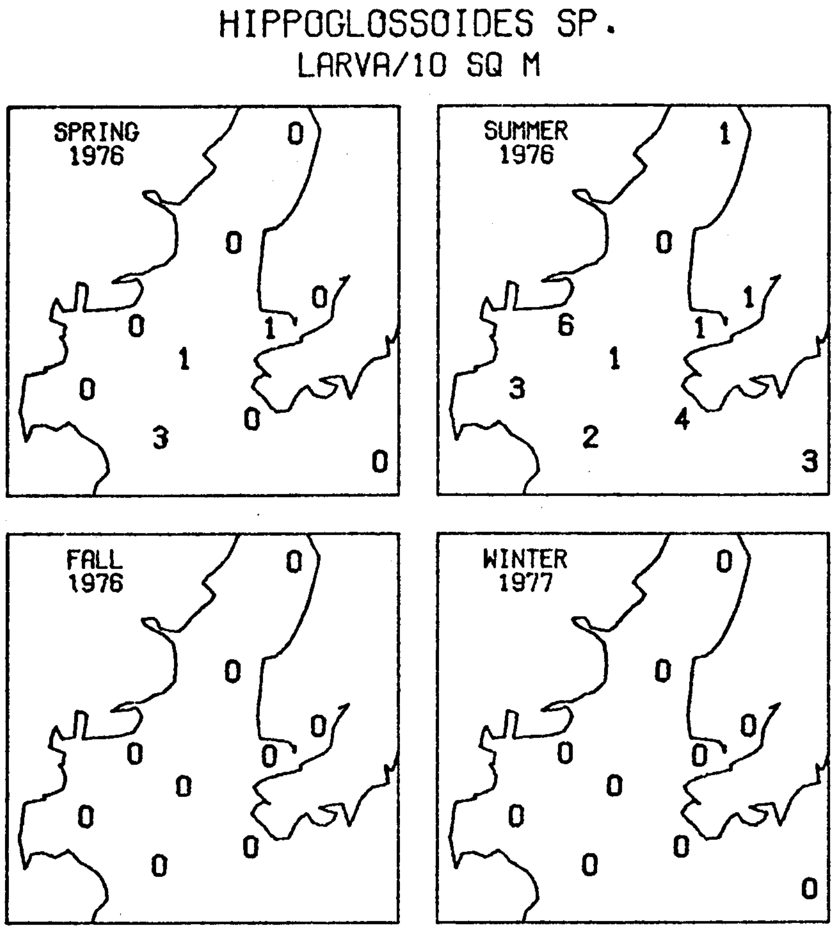
CLUPEA HARENGUS PALLASI

LARVA/10 SQ M

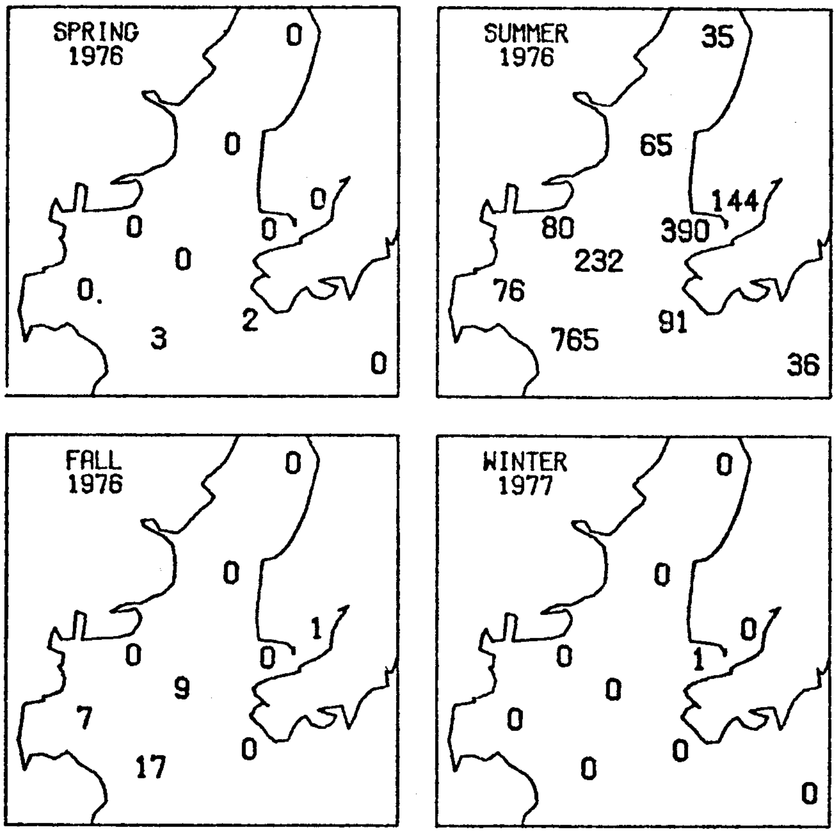


GADIDAE
LARVA/10 SQ M

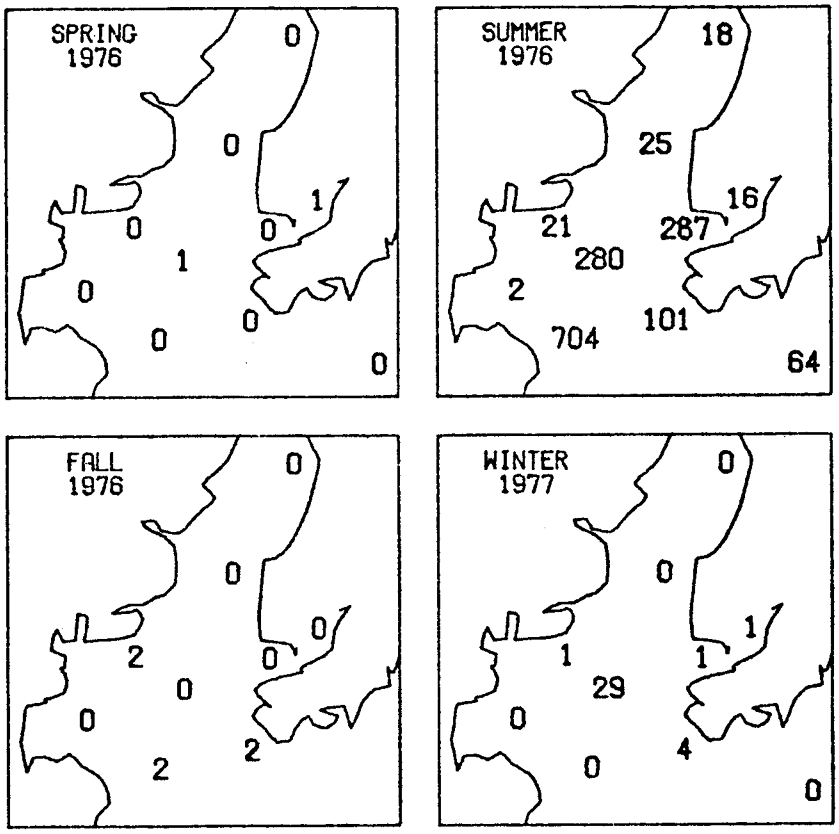



HIPPOGLOSSOIDES SP.
LARVA/10 SQ M
SPRING 1976
0
0
0
0
1
1
0
0
3
0
SUMMER 1976
1
0
1
6
1
1
3
4
2
3
FALL 1976
0
0
0
0
0
0
0
0
0
WINTER 1977
0
0
0
0
0
0
0
0
0
0

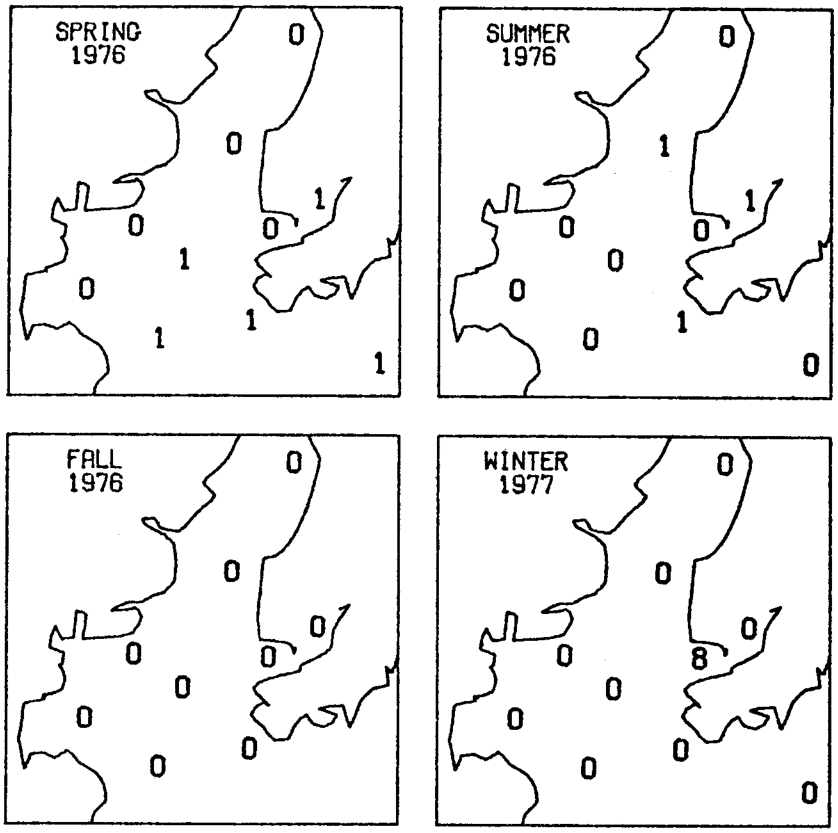
MALLOTUS VILLOSUS
LARVA/10 SQ M



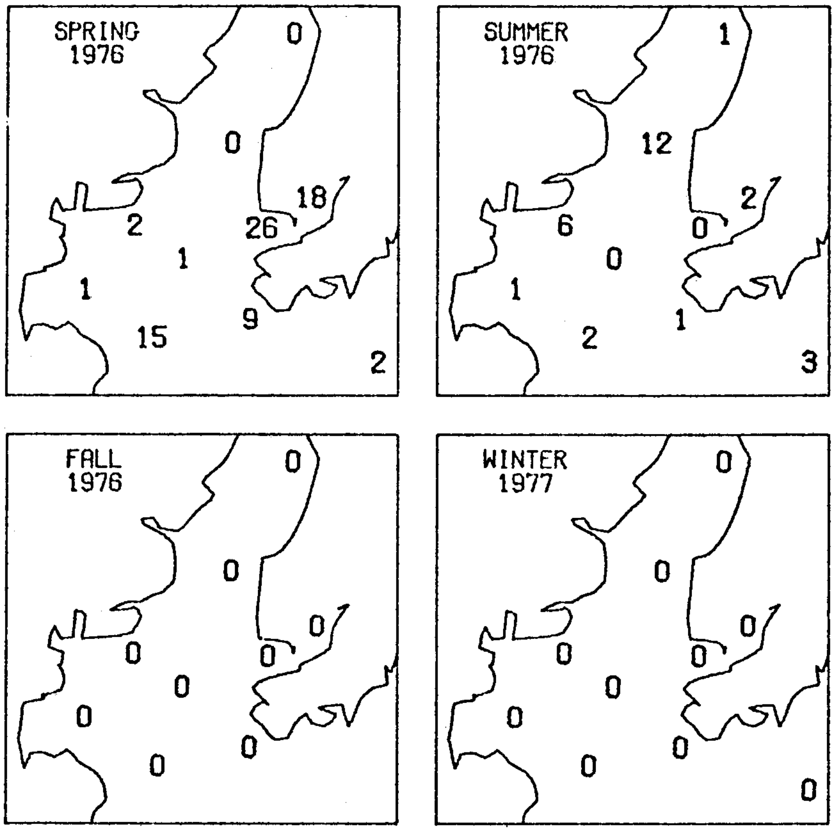
OSMERIDAE
LARVA/10 SQ M



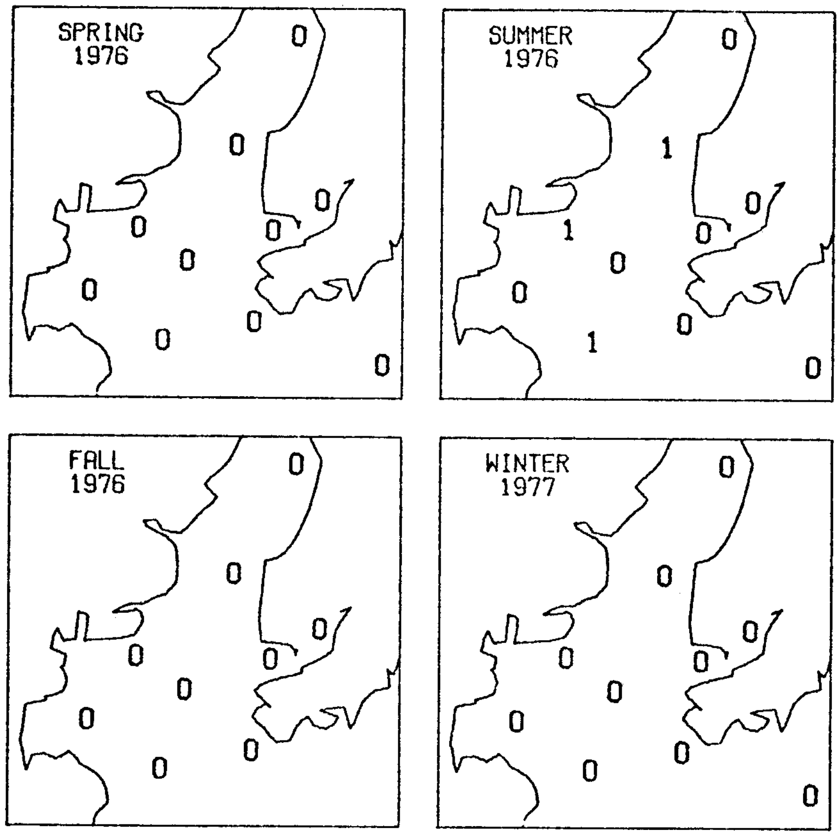
PANDALOPSIS DISPAR
ZOEA/10 SQ M



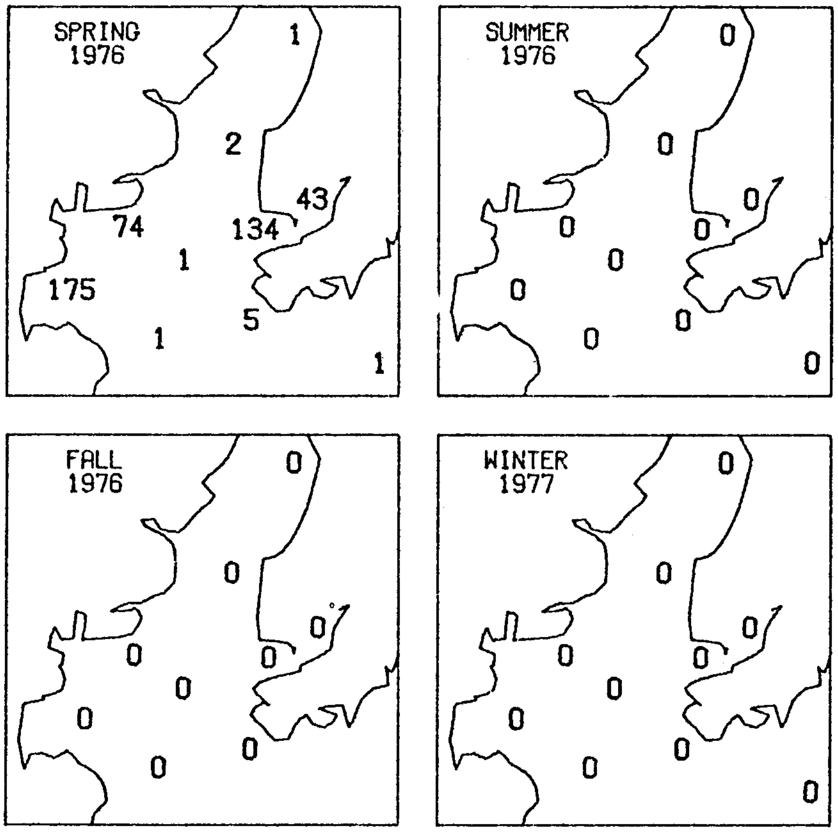
PANDALUS BOREALIS
ZOEA/10 SQ M



PANDALUS DANAE
ZOEA/10 SQ M

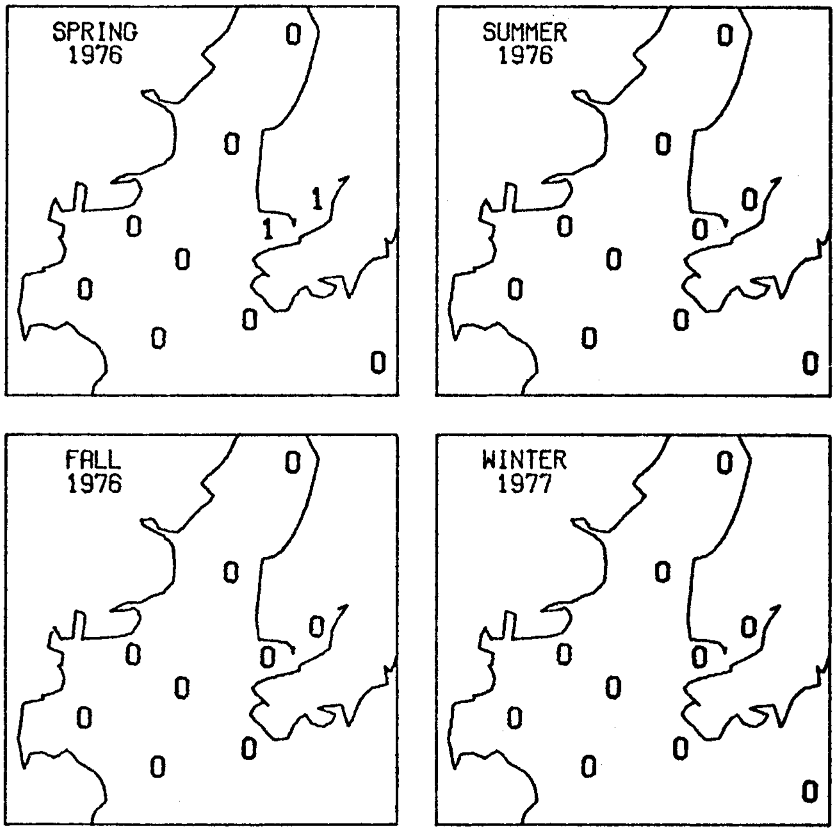


PANDALUS GONIURUS
ZOEA/10 SQ M

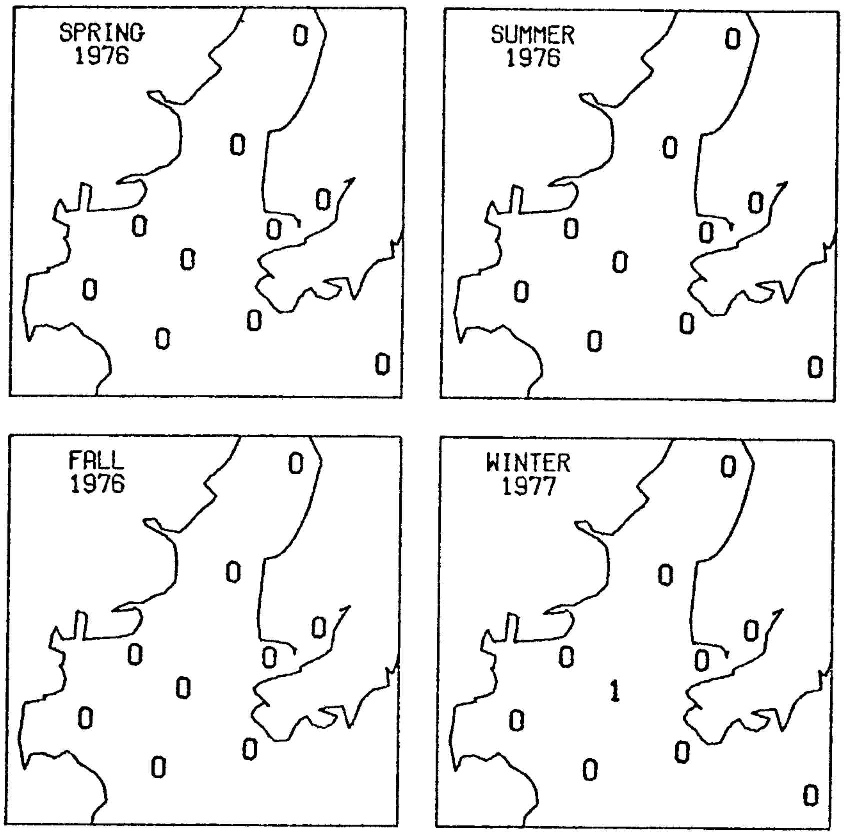


PANDALUS HYPSINOTUS

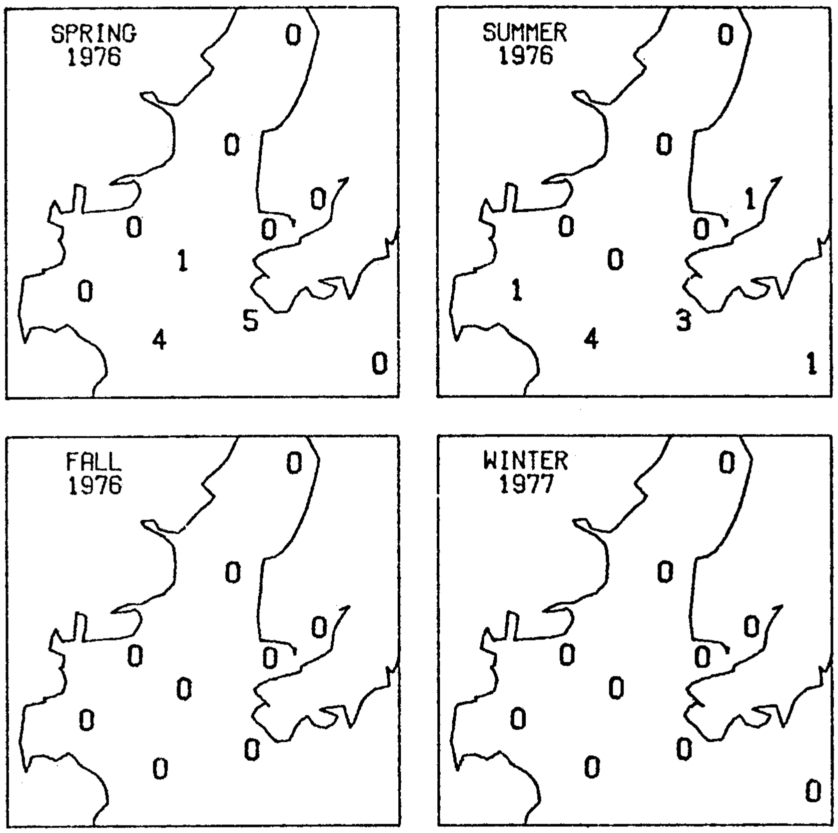
ZOEA/10 SQ M



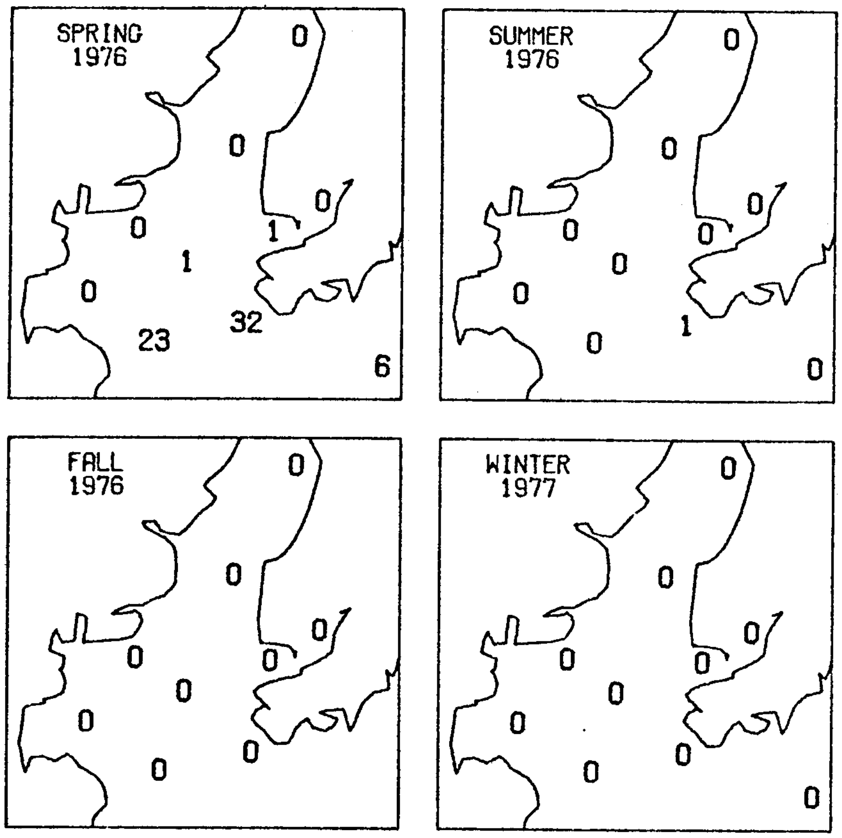
PANDALUS PLATYCEROS
ZOEA/10 SQ M



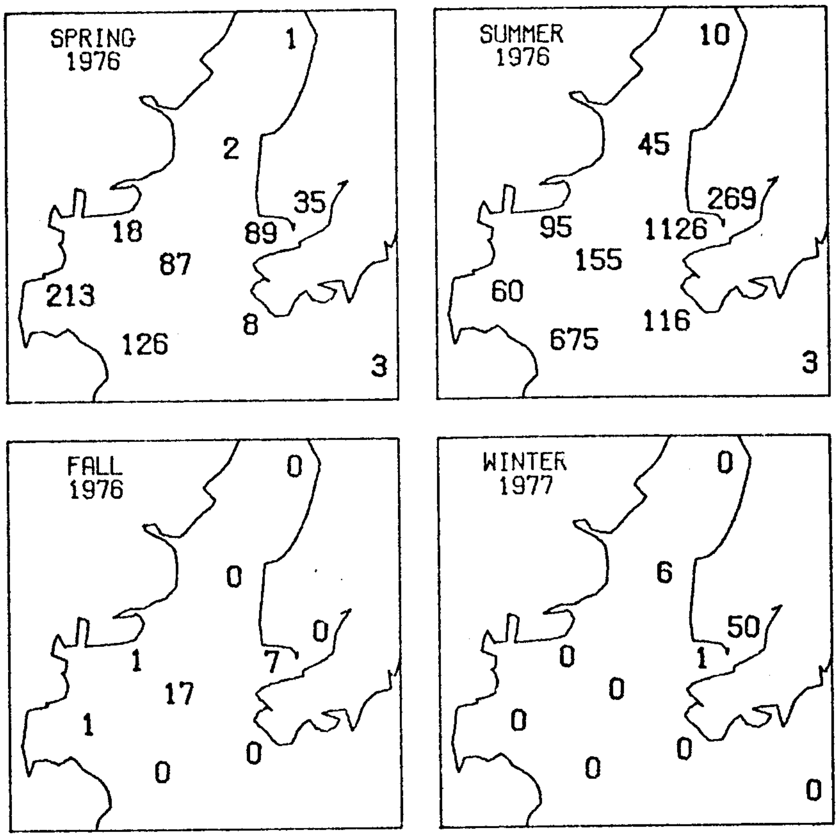
PANDALUS STENOLEPIS
ZOEA/10 SQ M

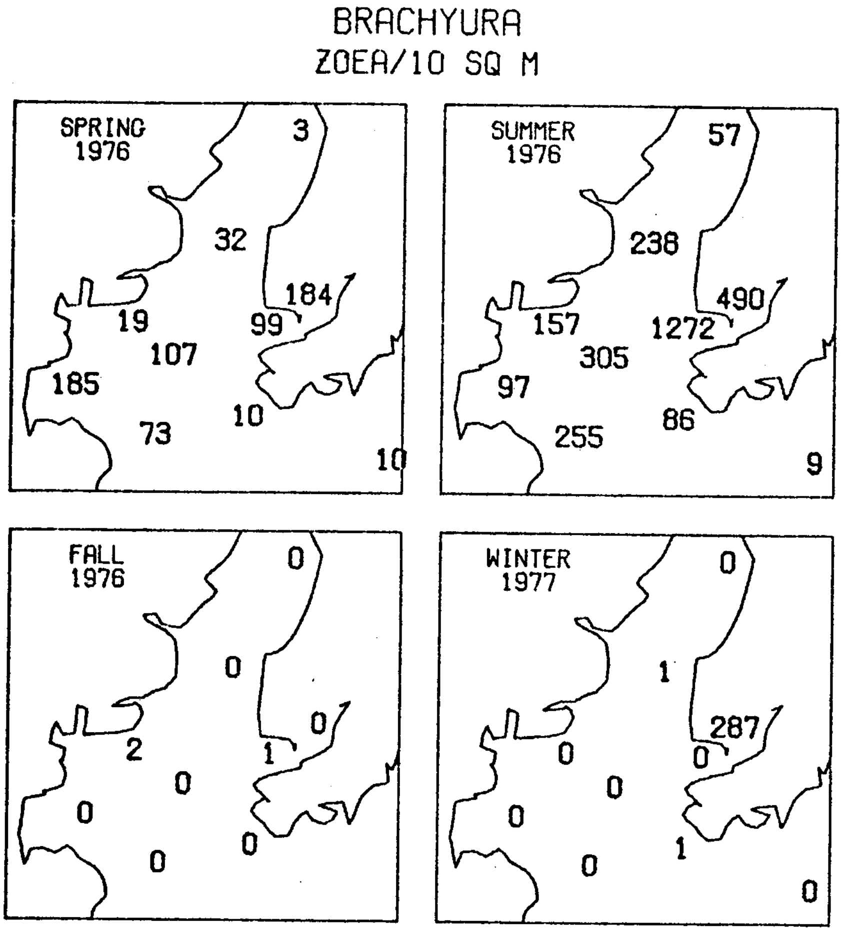


PANDALUS MONTAGUI TRIDENS
ZOEA/10 SQ M



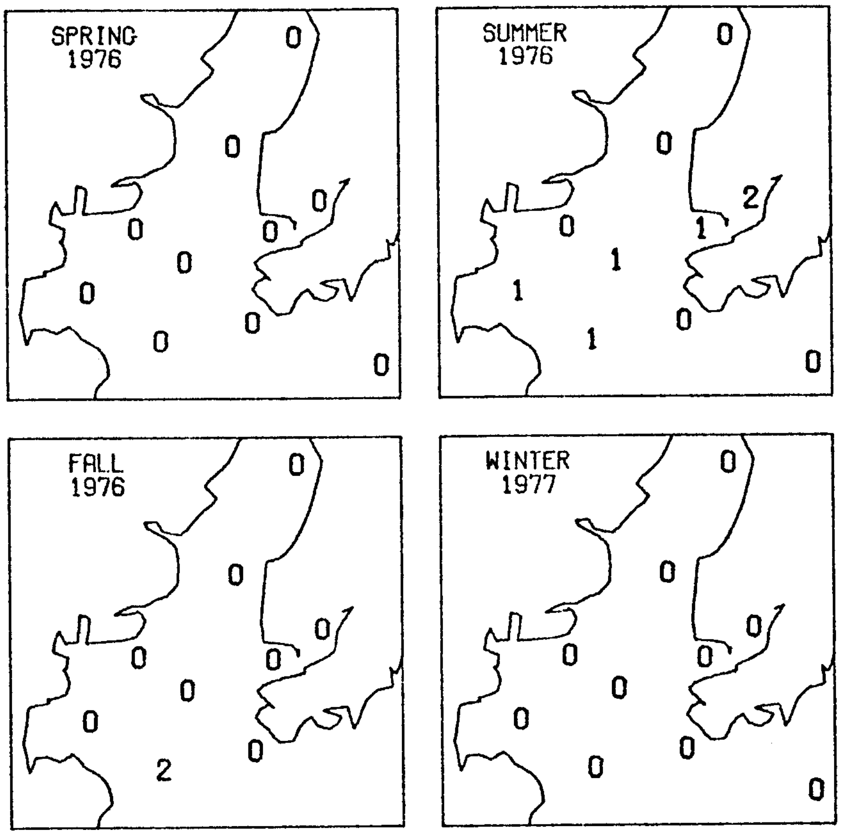
ANOMURA
ZOEA/10 SQ M



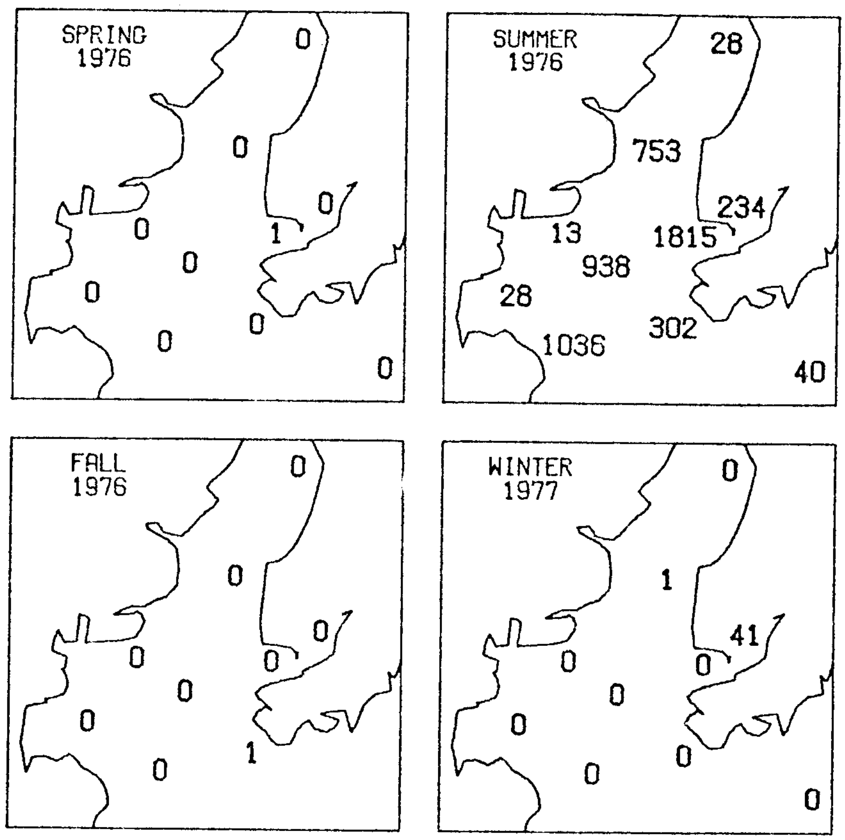

BRACHYURA
ZOEA/10 SQ M
SPRING
1976
3
32
184
19
99
107
185
10
73
10
SUMMER
1976
57
238
490
157
1272
305
97
86
255
9
FALL
1976
0
0
0
2
1
0
0
0
0
WINTER
1977
0
1
287
0
0
0
0
1
0
0

CANCER MAGISTER

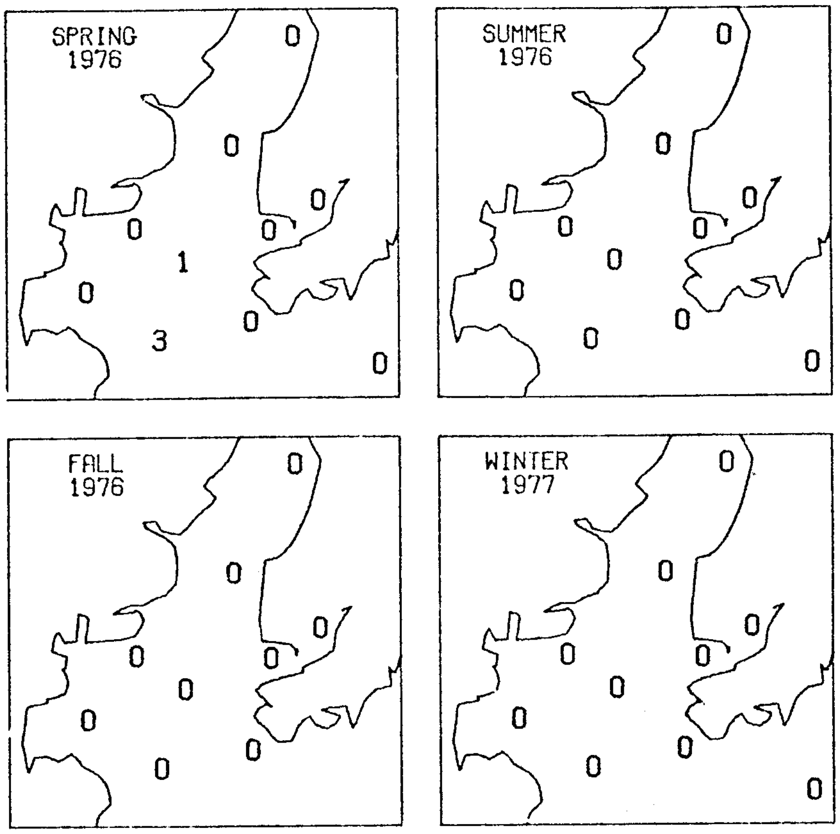
ZOEA/10 SQ M



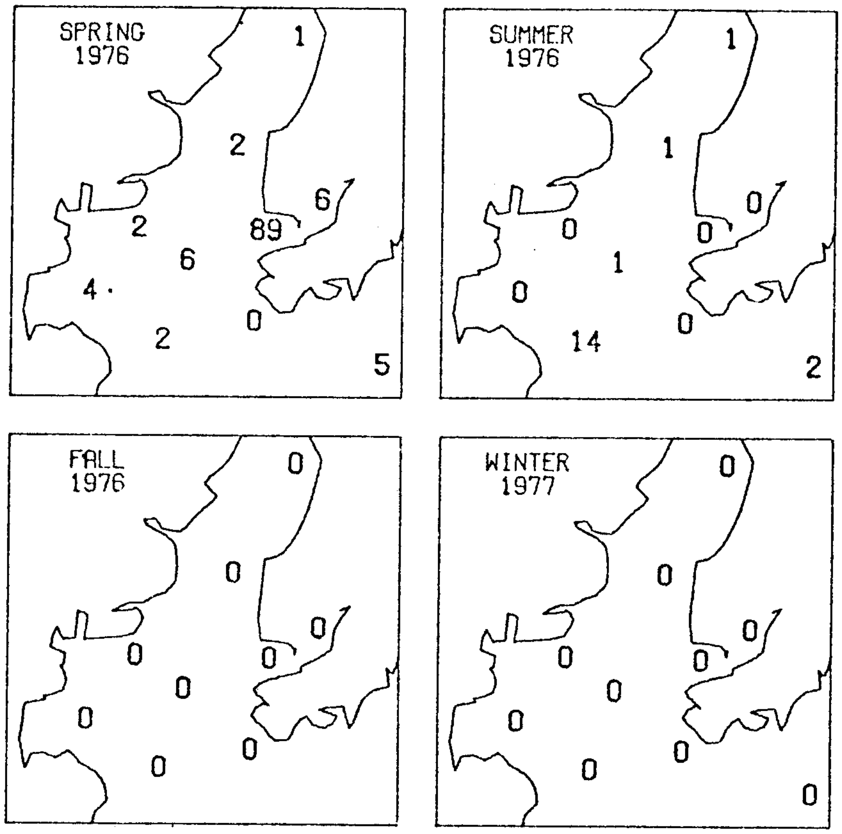
CANCER OREGONENSIS
ZOEA/10 SQ M



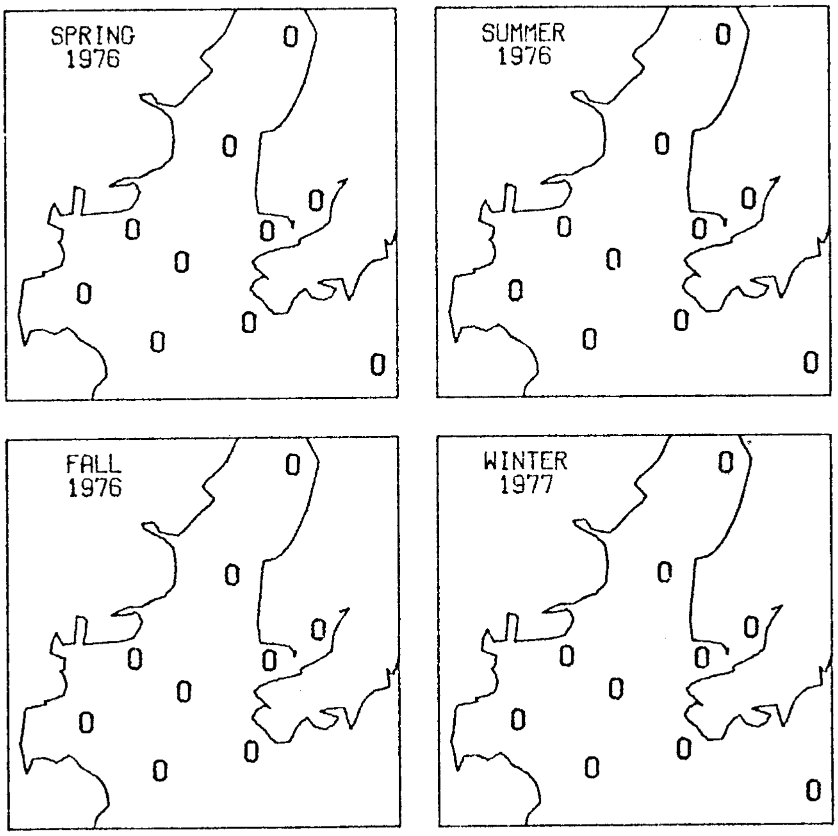
CANCER PRODUCTUS
ZOEA/10 SQ M



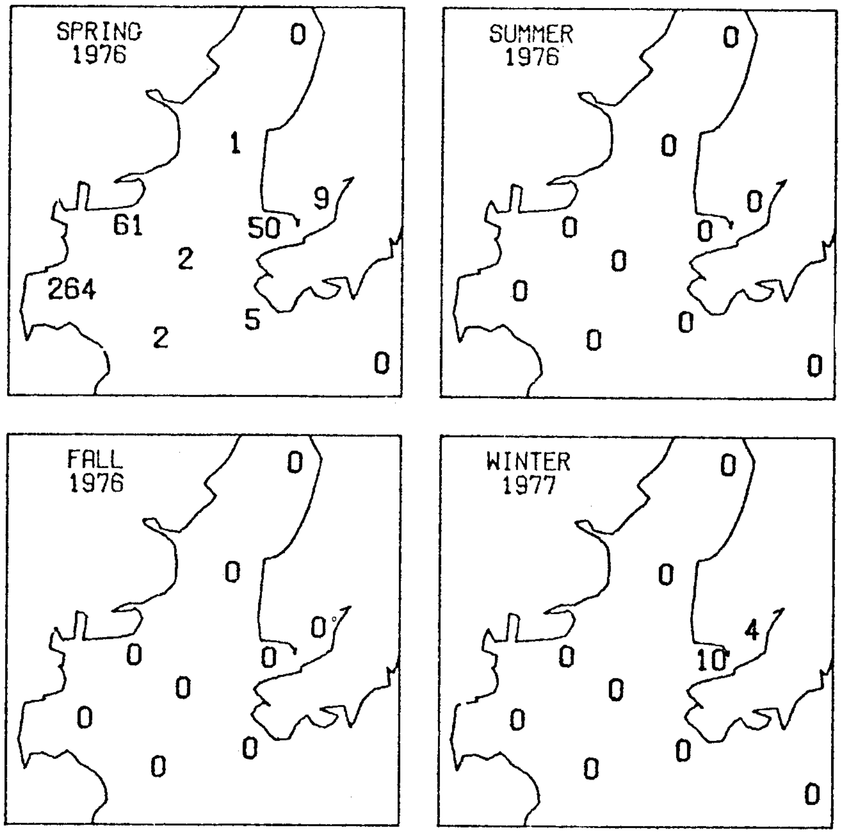
CHIONOECETES BAIRDI
ZOEA/10 SQ M



CHIONOECETES SP.
ZOEA/10 SQ M



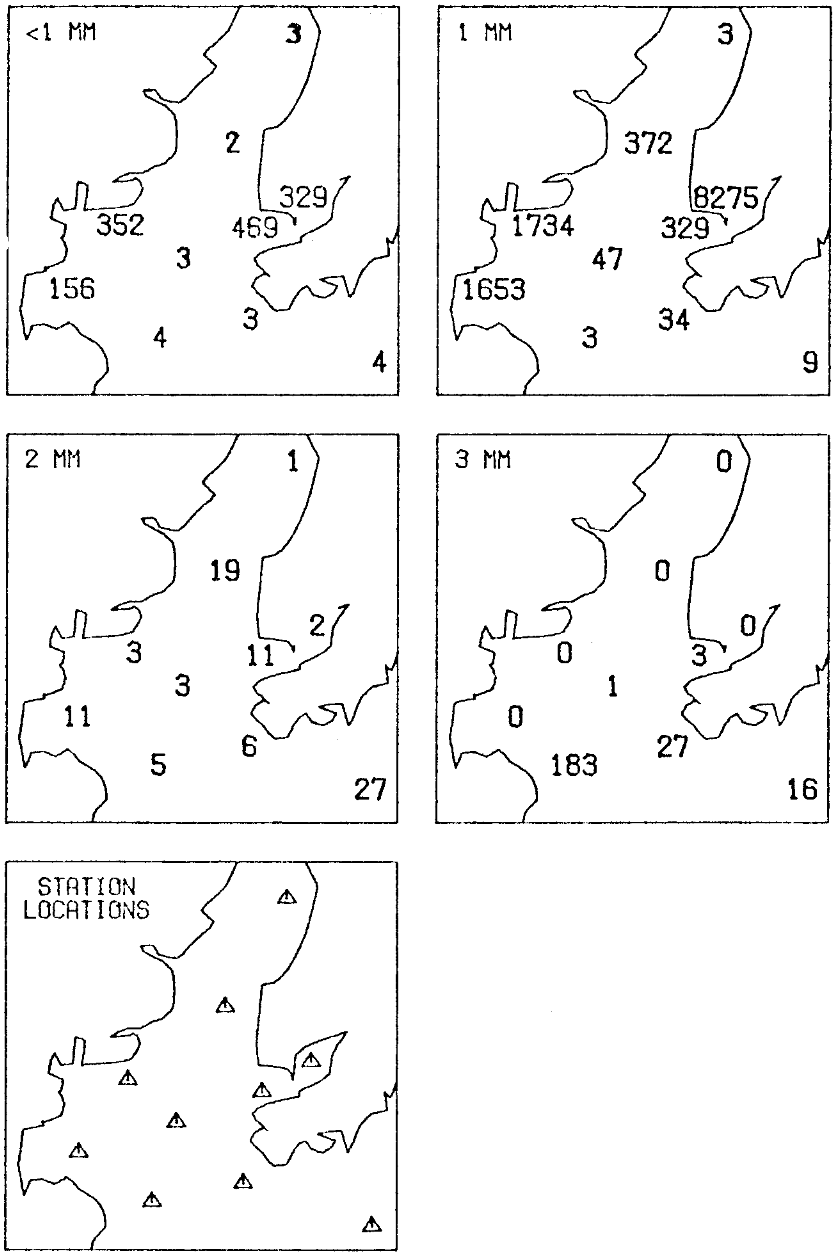
PARALITHODES CAMTSCHATICA
ZOEA/10 SQ M



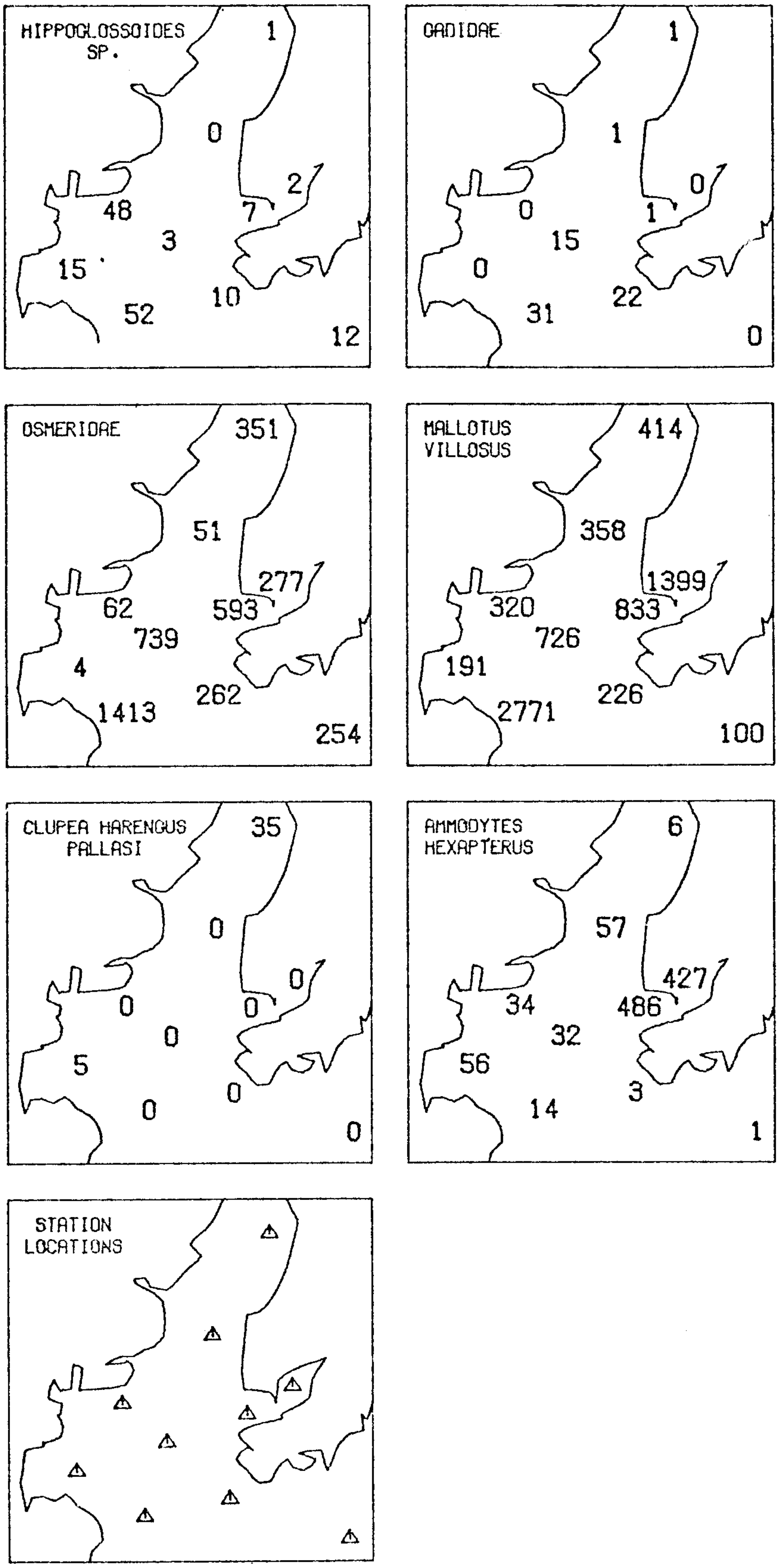
APPENDIX E

Density Distributions per 10 Square Meters for One Year

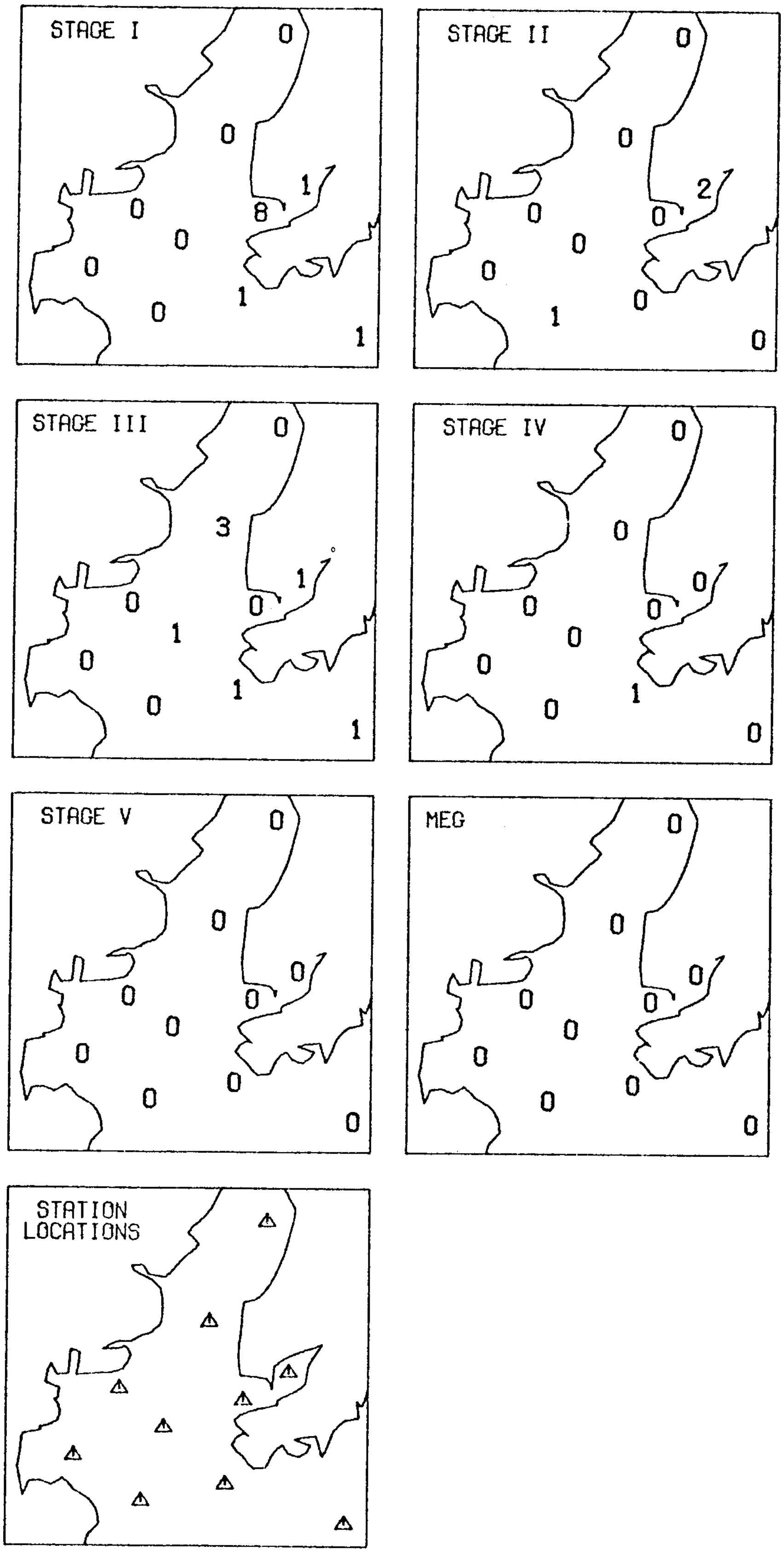
FISH EGGS
ANNUAL ABUNDANCE/10 SQ M



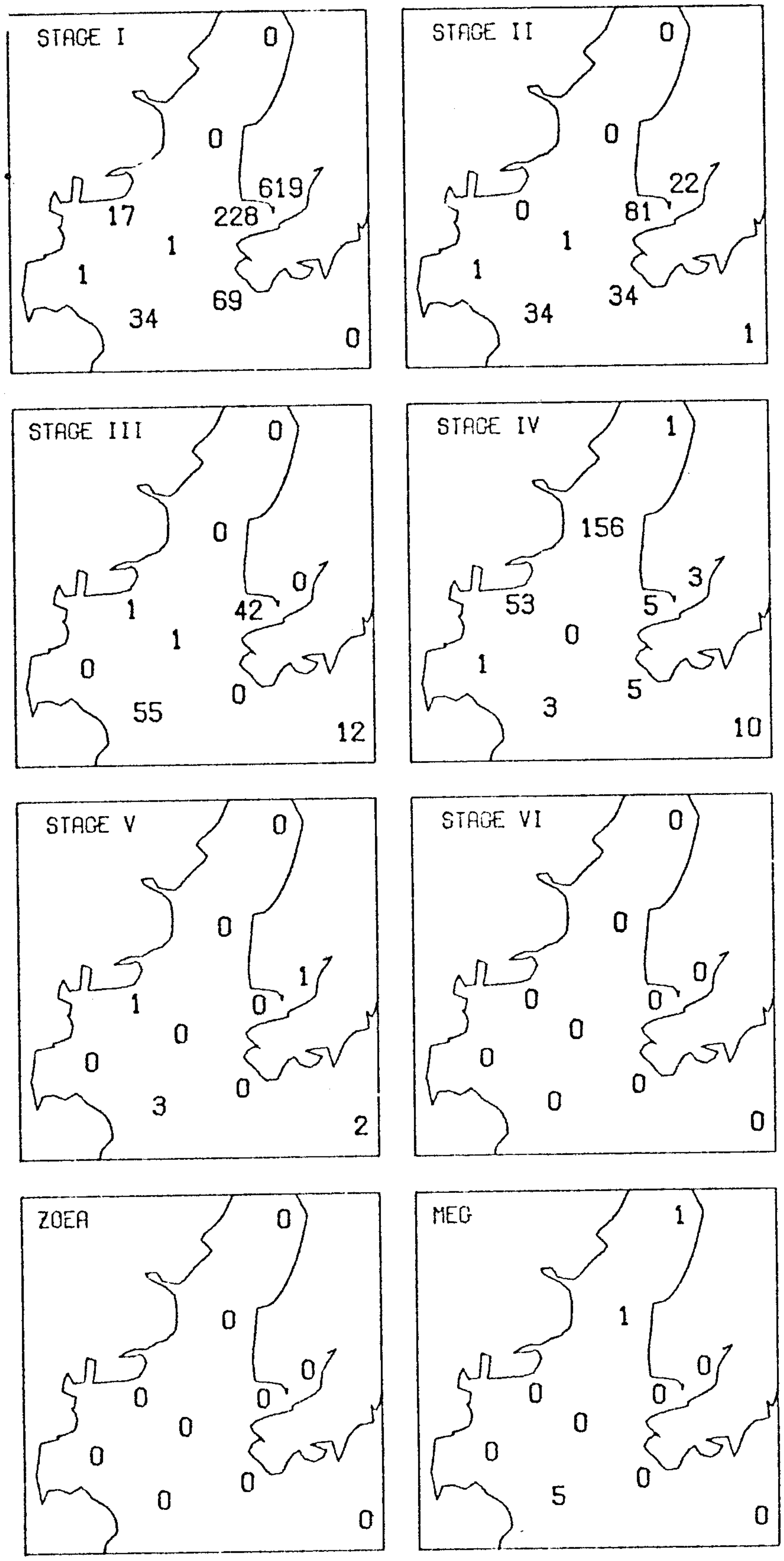
FISH LARVAE
ANNUAL ABUNDANCE/10 SQ M



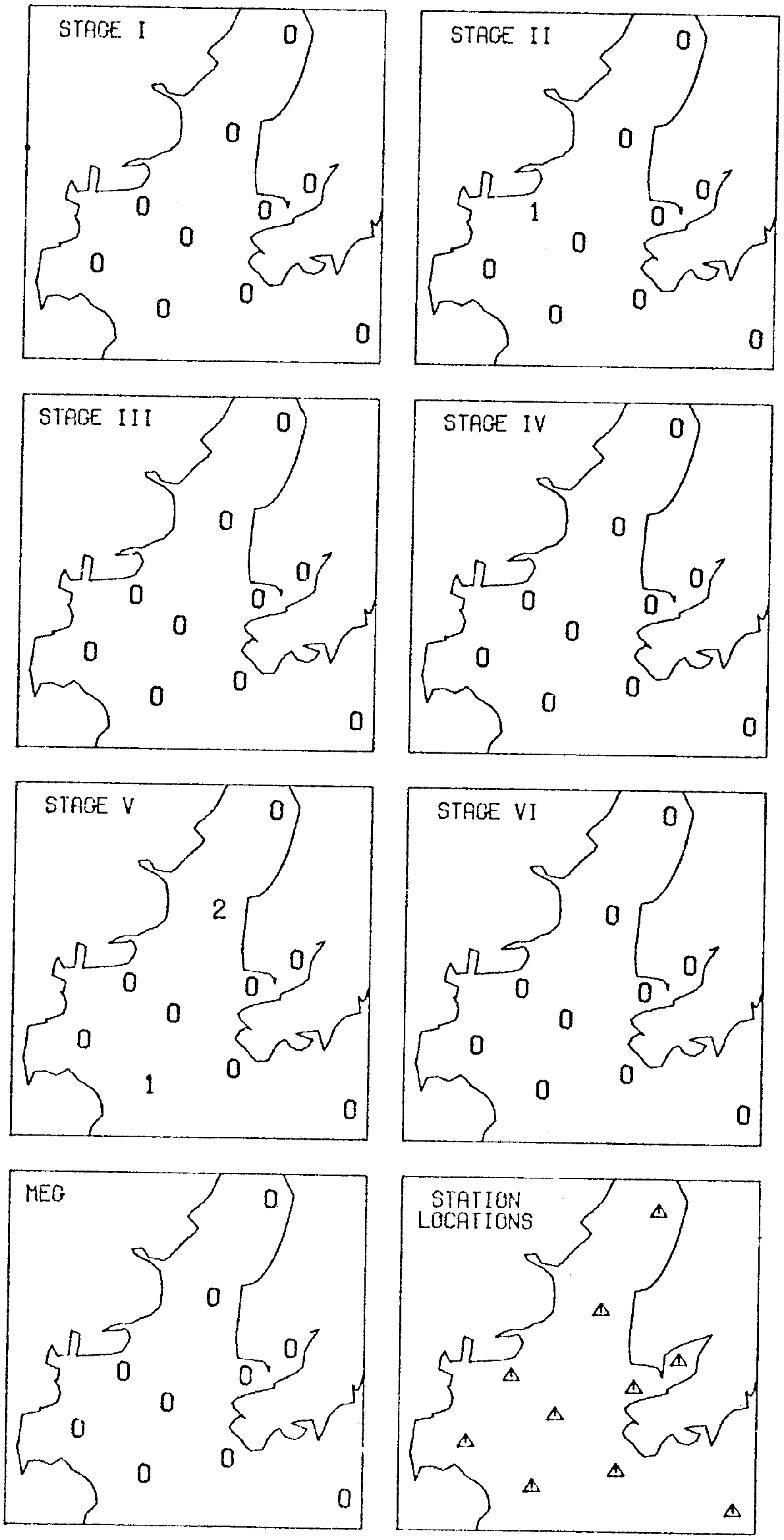
PANDALOPSIS DISPAR
ANNUAL ABUNDANCE/10 SQ M



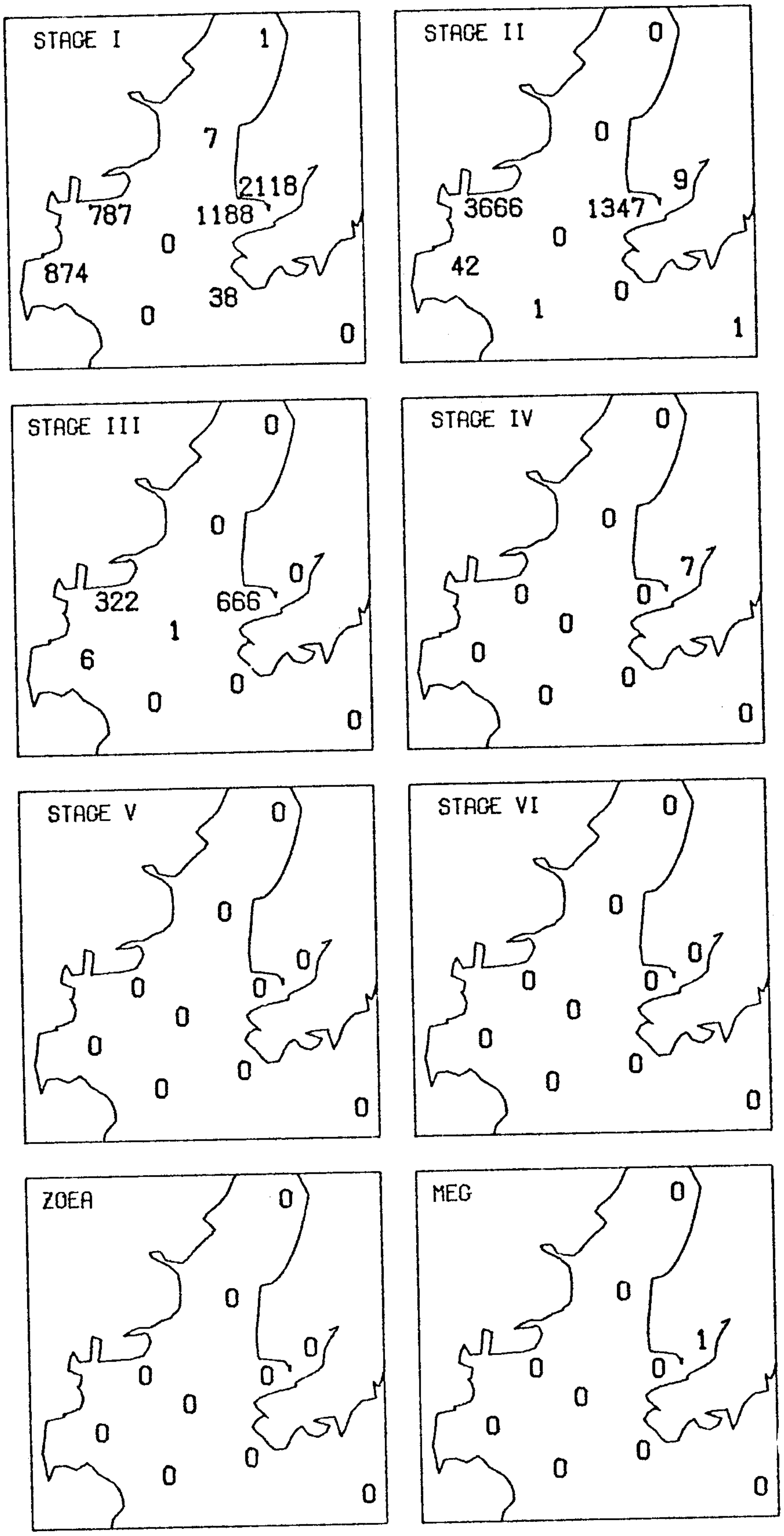
PANDALUS BOREALIS
ANNUAL ABUNDANCE/10 SQ M



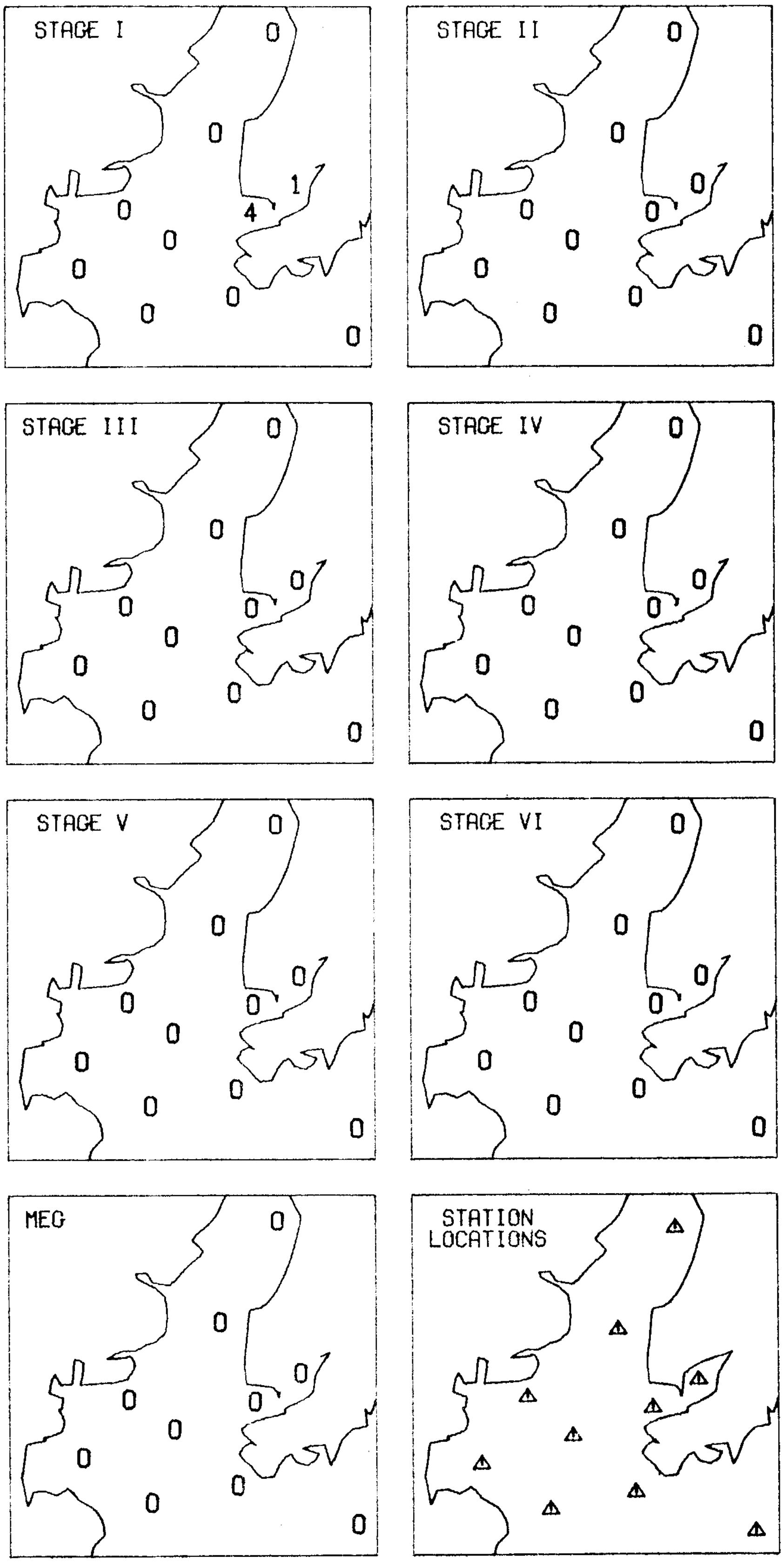
PANDALUS DANAE
ANNUAL ABUNDANCE/10 SQ M

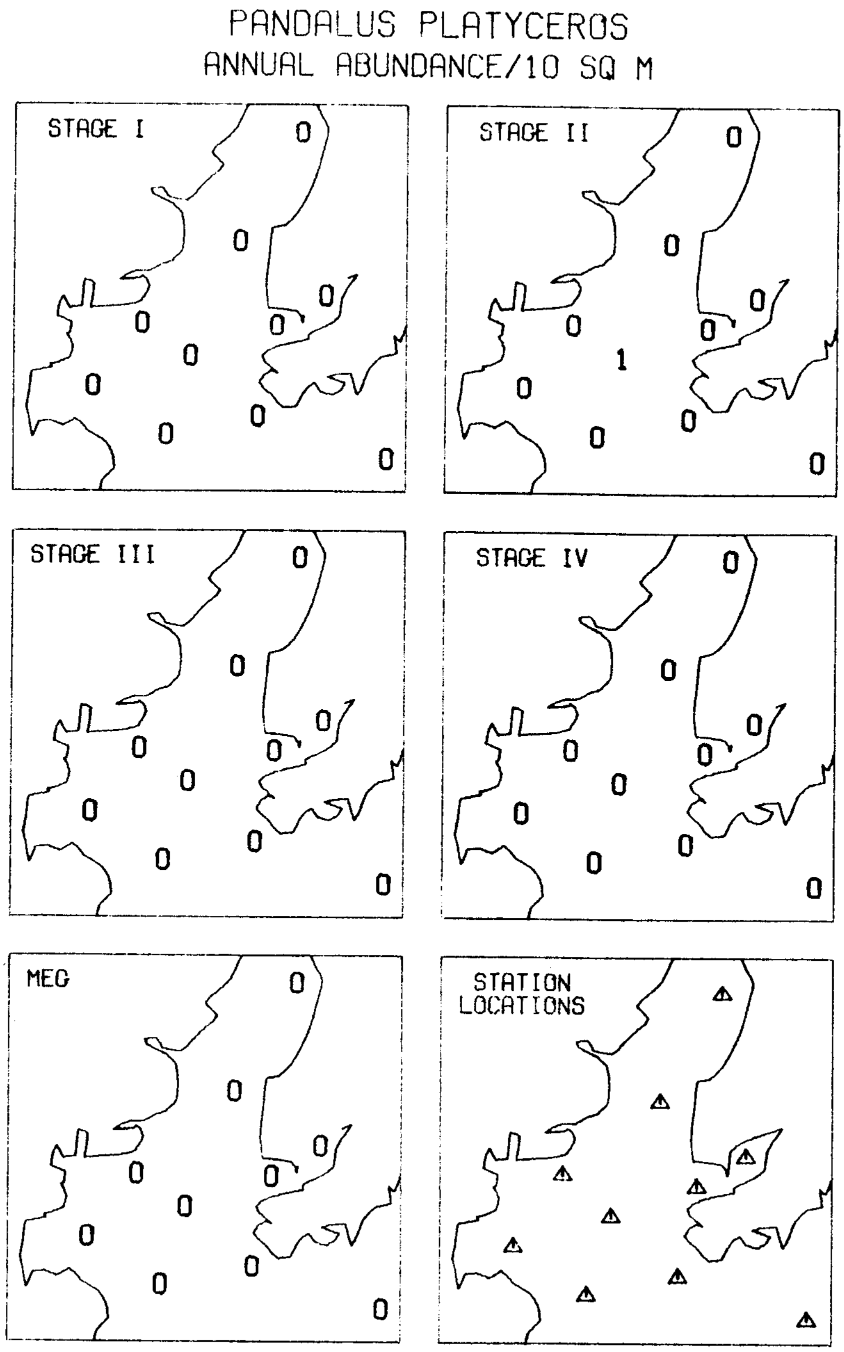


PANDALUS GONIURUS
ANNUAL ABUNDANCE/10 SQ M

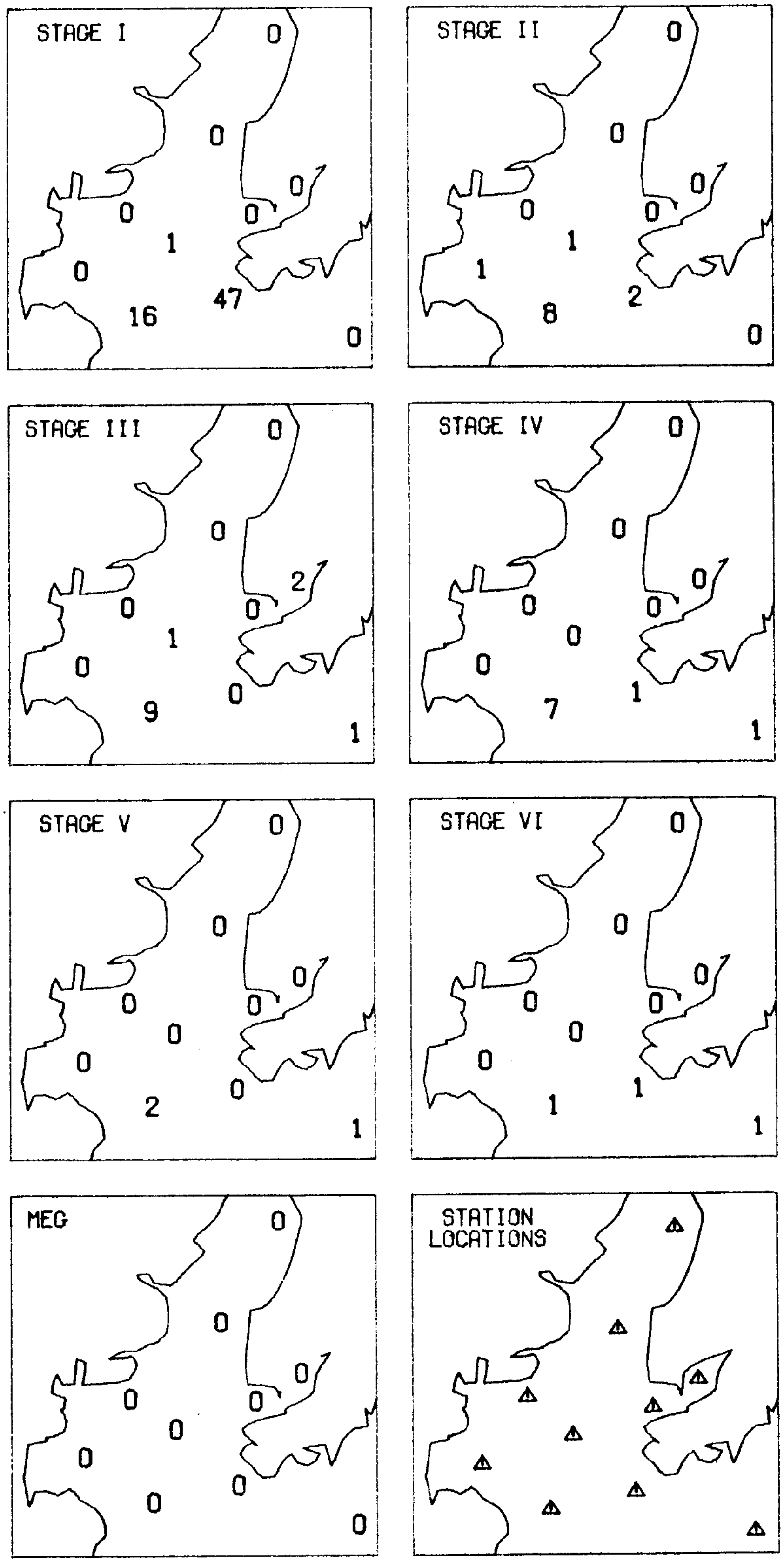


PANDALUS HYPSINOTUS
ANNUAL ABUNDANCE/10 SQ M

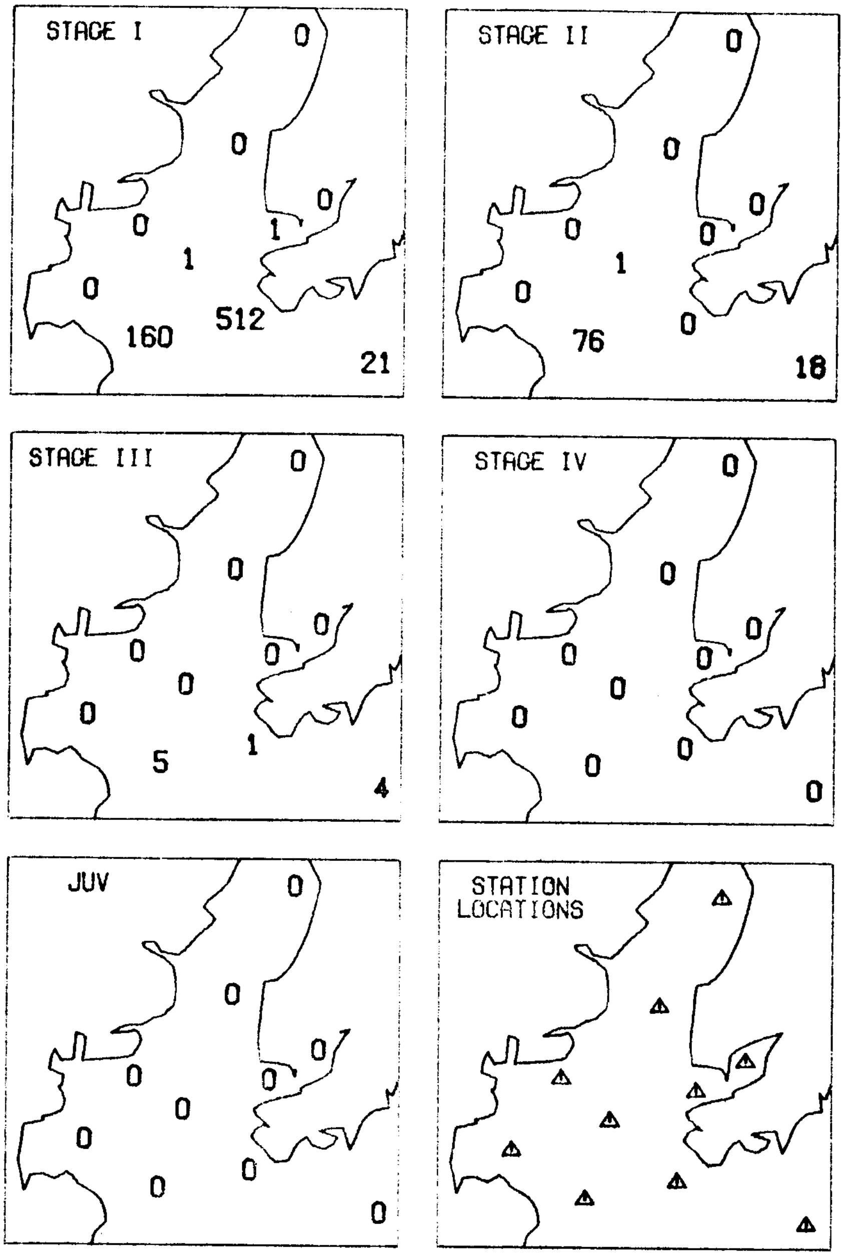



PANDALUS PLATYCEROS
ANNUAL ABUNDANCE/10 SQ M
STAGE I
0
0
0
0
0
0
0
0
0
0
STAGE II
0
0
0
0
0
1
0
0
0
0
STAGE III
0
0
0
0
0
0
0
0
0
0
STAGE IV
0
0
0
0
0
0
0
0
0
0
MEG
0
0
0
0
0
0
0
0
0
0
STATION
LOCATIONS

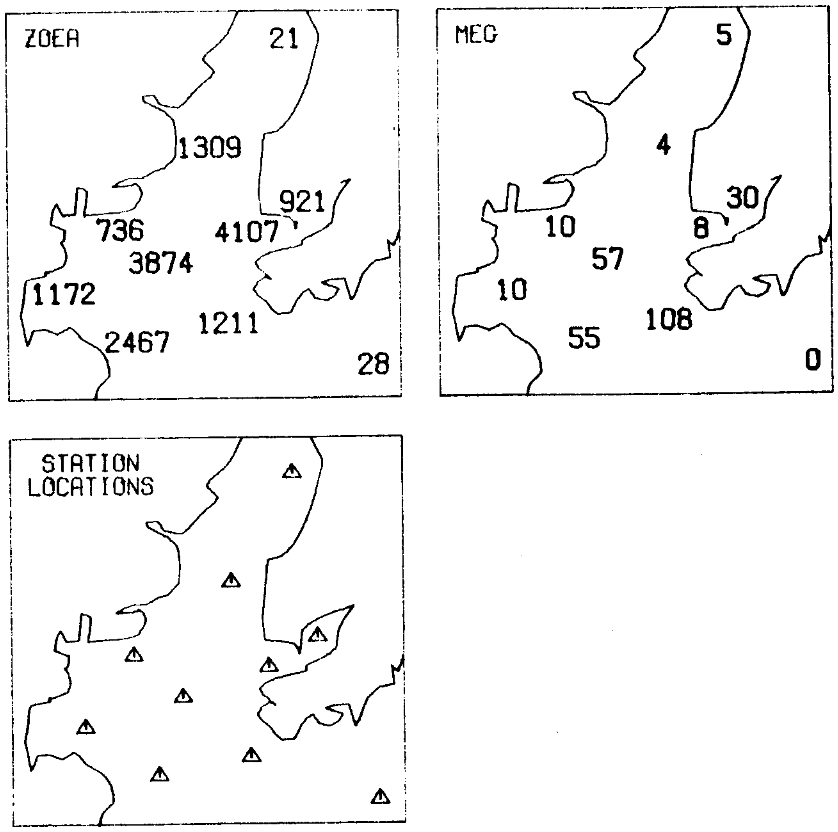
PANDALUS STENOLEPIS
ANNUAL ABUNDANCE/10 SQ M



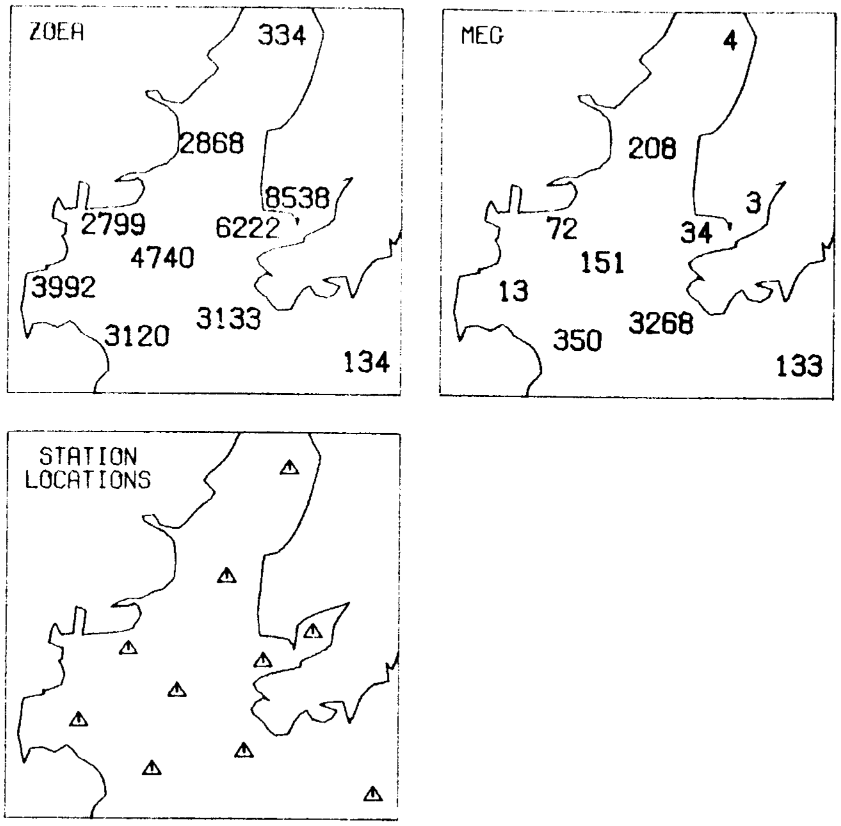
PANDALUS MONTAGUI TRIDENS
ANNUAL ABUNDANCE/10 SQ M



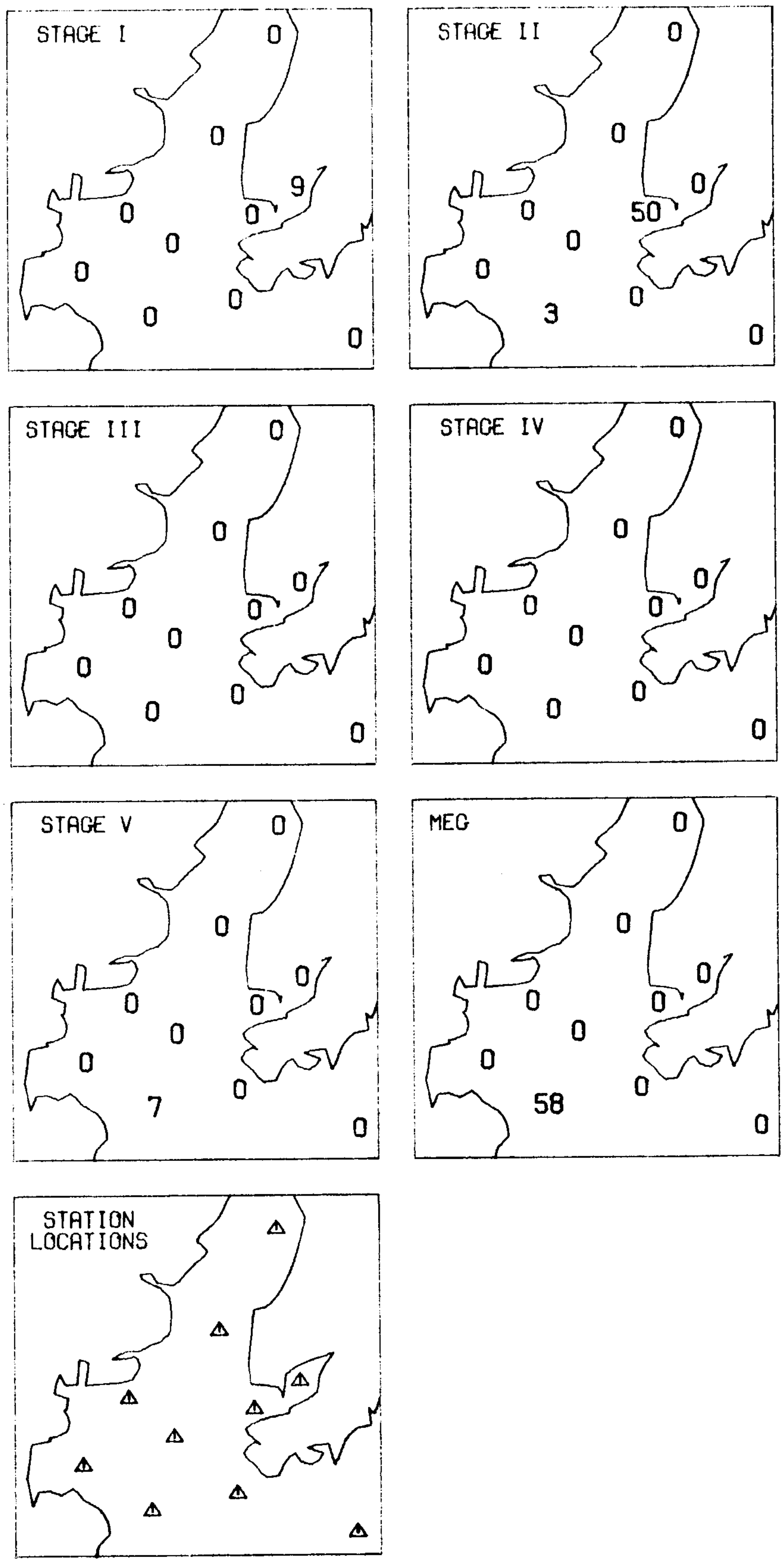
ANOMURA
ANNUAL ABUNDANCE/10 SQ M



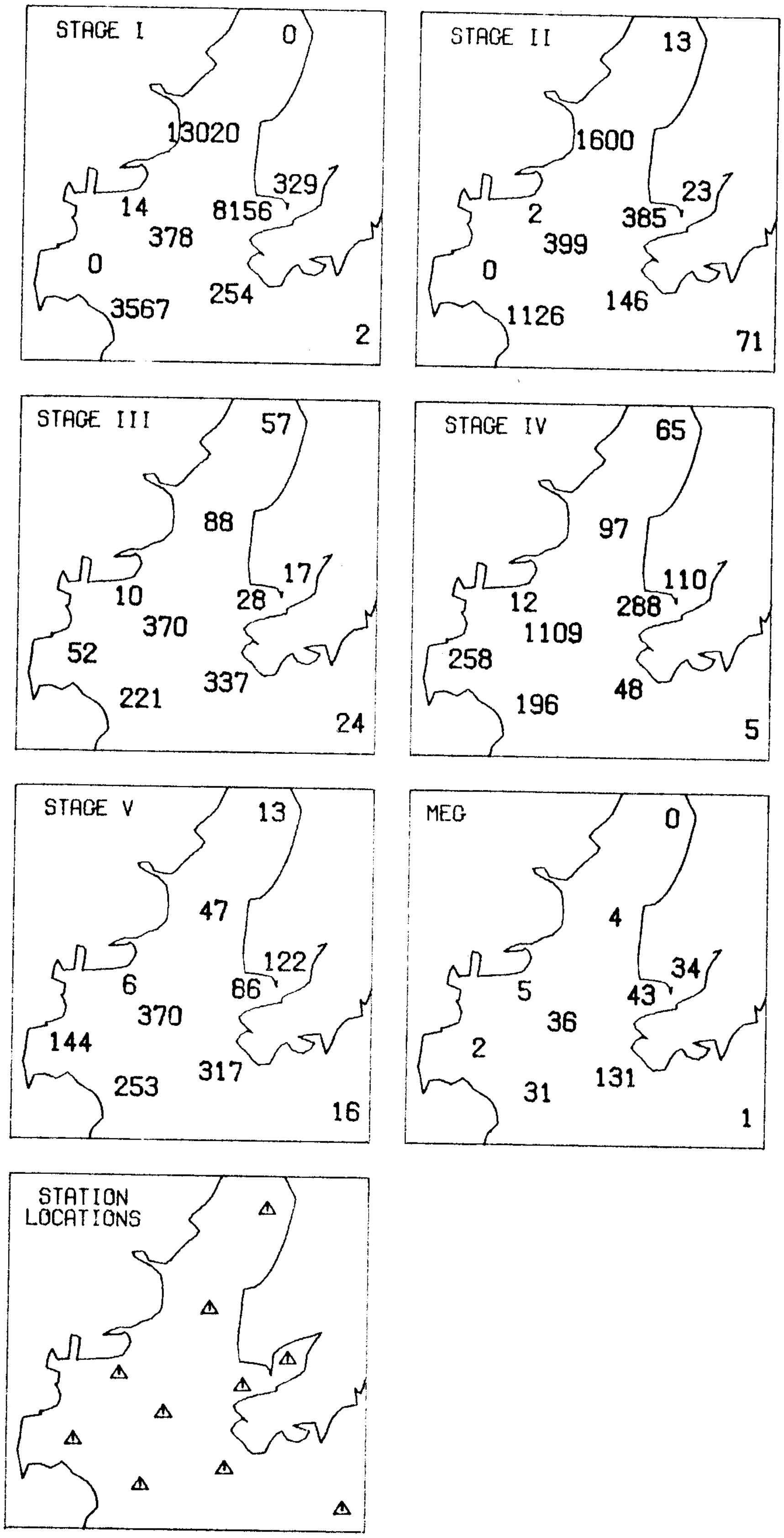
BRACHYURA
ANNUAL ABUNDANCE/10 SQ M



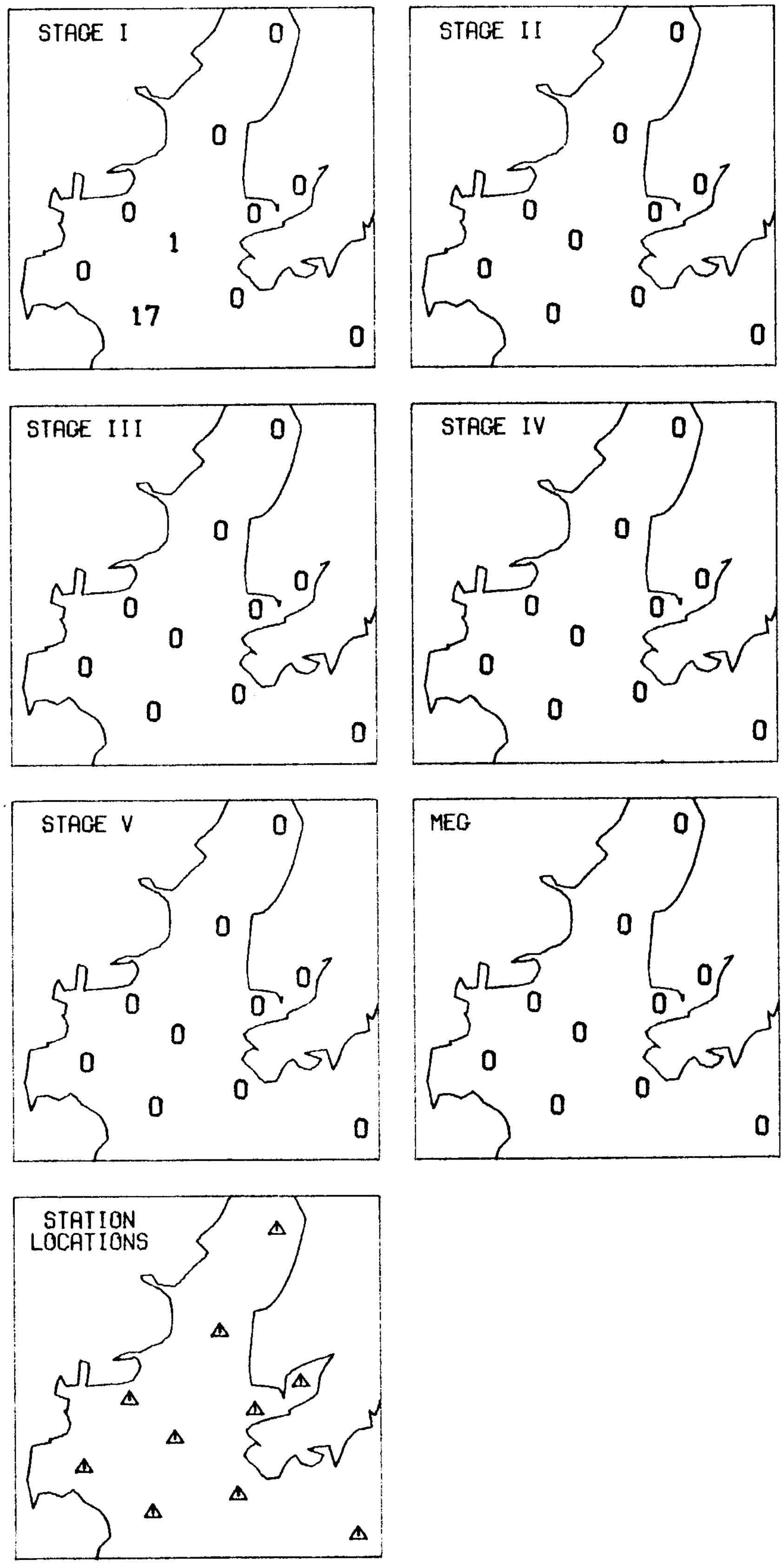
CANCER MAGISTER
ANNUAL ABUNDANCE/10 SQ M



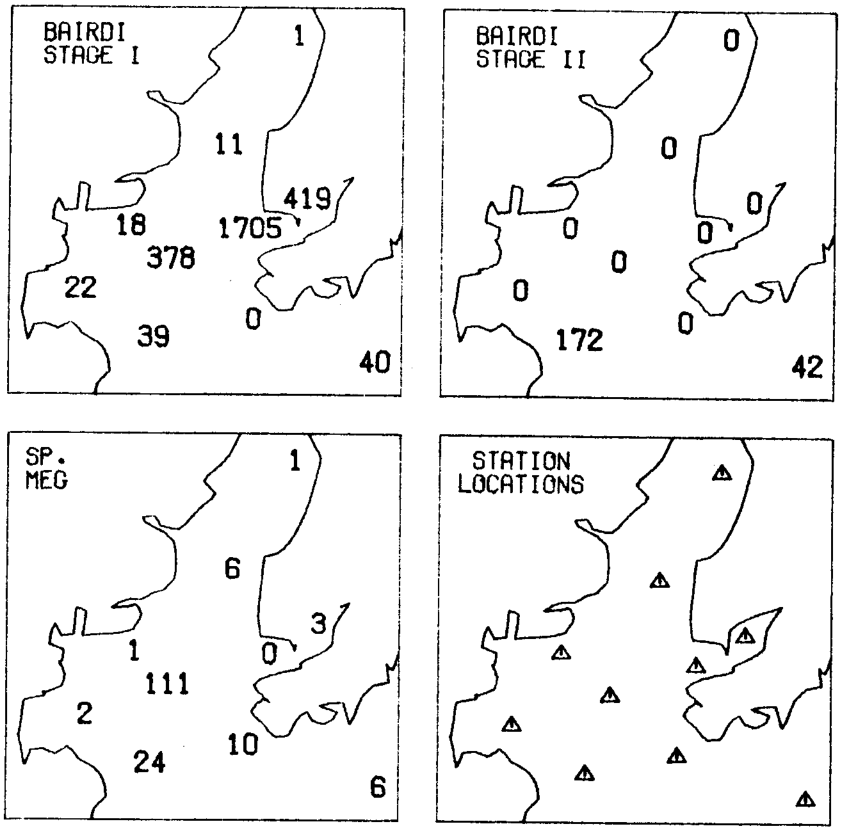
CANCER OREGONENSIS
ANNUAL ABUNDANCE/10 SQ M



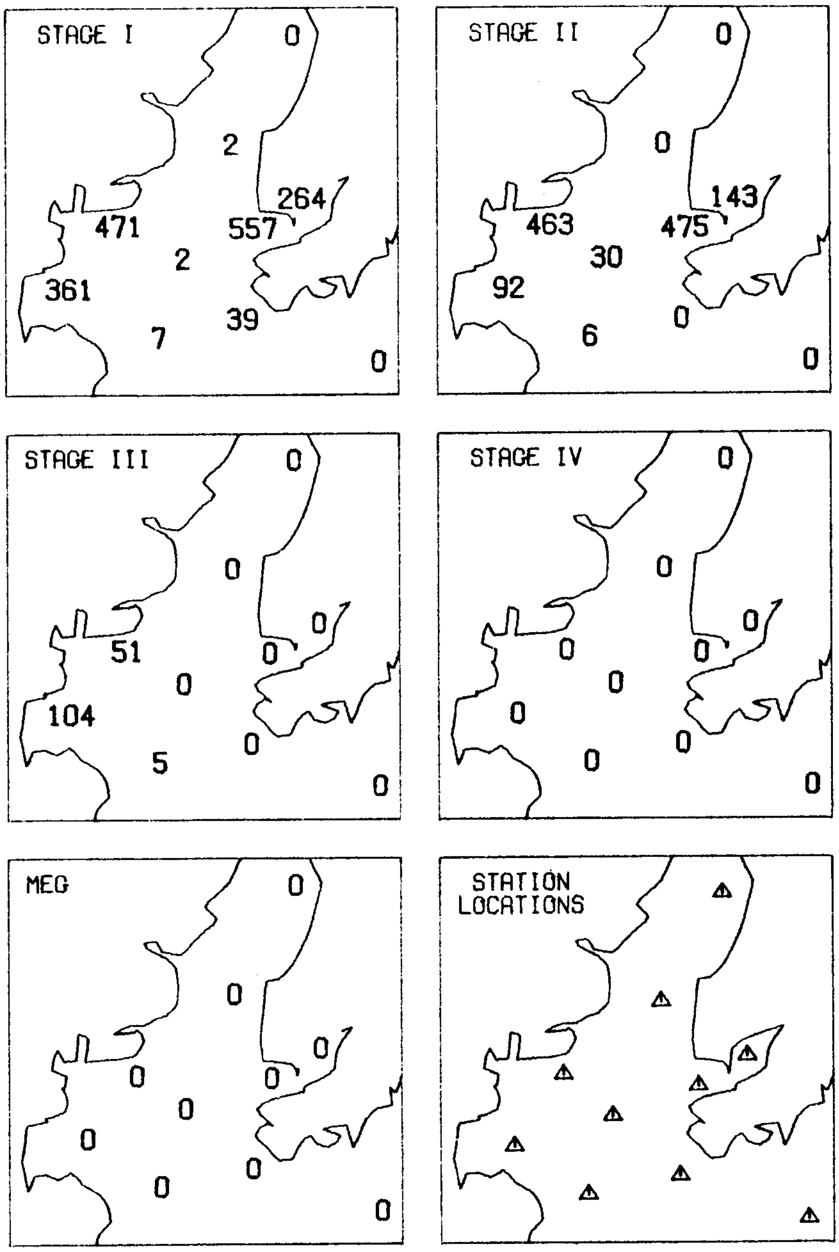
CANCER PRODUCTUS
ANNUAL ABUNDANCE/10 SQ M



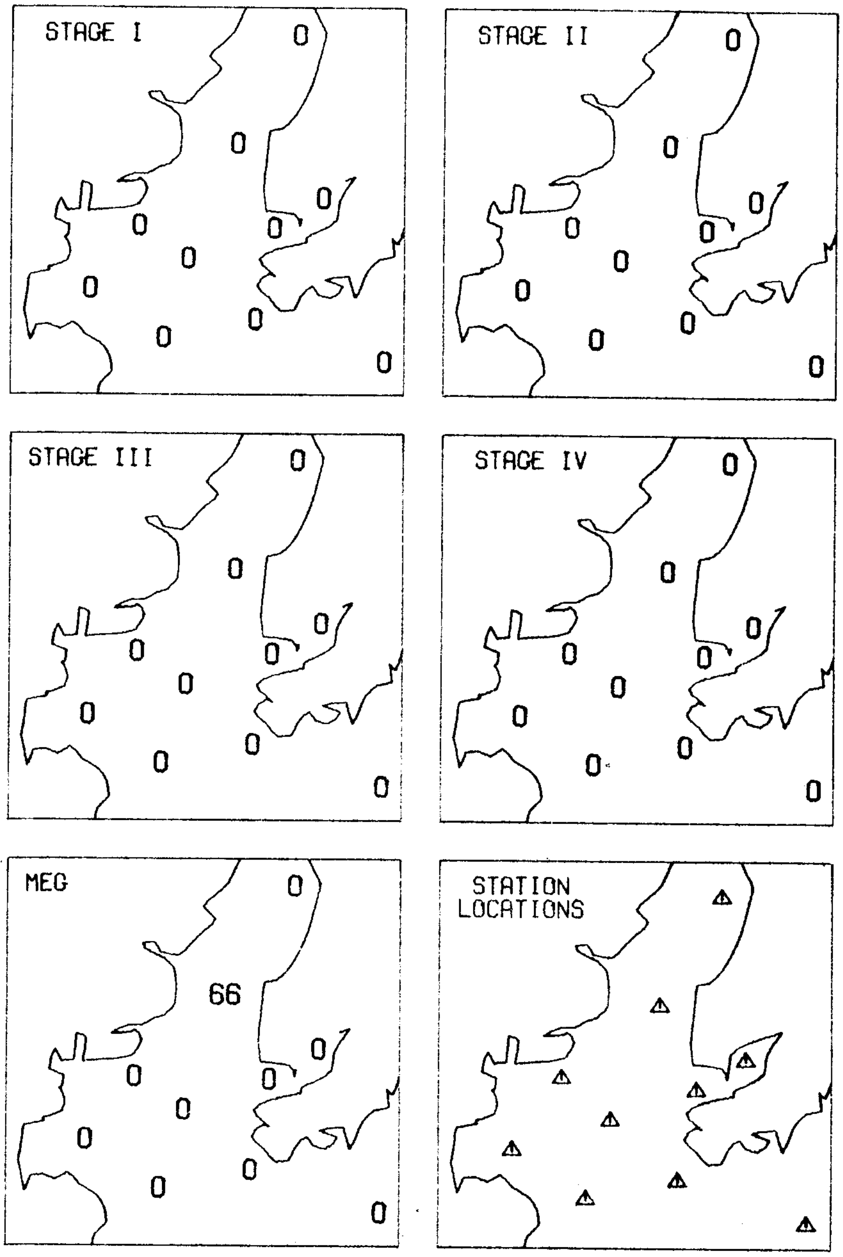
CHIONOECETES
ANNUAL ABUNDANCE/10 SQ M



PARALITHODES CAMTSCHATICA
ANNUAL ABUNDANCE/10 SQ M



PARALITHODES PLATYPUS
ANNUAL ABUNDANCE/10 SQ M



QUARTERLY REPORT

Contract No: R7120825
Research Unit No: RU-551
Reporting Period: January 1-March 31, 1977
Number of Pages: 2

SEASONAL COMPOSITION AND FOOD WEB RELATIONSHIPS OF MARINE ORGANISMS IN THE NEARSHORE ZONE--INCLUDING ICHTHYOPLANKTON, MEROPLANKTON, AND NEARSHORE FISHES

Co-Principal Investigators

Jean R. Dunn and Felix Favorite

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northwest and Alaska Fisheries Center
2725 Montlake Boulevard East
Seattle, Washington 98112

March 1978

QUARTERLY PROGRESS REPORT

Reporting Period: January 1 - March 31, 1978

Project Title: Seasonal Composition and Food Web Relationships of Marine Organisms in the Nearshore Zone--Including Ichthyoplankton, Meroplankton, and Nearshore Fishes

I. Highlights of Quarters Accomplished

Ichthyoplankton samples collected on cruise 4MF77 (October 30 - November 15, 1977) have been sorted and returned to NWAFC by the contractor. Identification of ichthyoplankton has begun. Co-principal investigator participated in an OCSEAP coordination meeting in Anchorage. Preparations made for a spring cruise initiated aboard *Discoverer*.

II. Objectives

To determine the seasonal composition, distribution, and abundance of marine organisms in waters contiguous to Kodiak Island, and to relate these to oceanographic conditions, with emphasis on ichthyoplankton, meroplankton, and macroplankton.

III. Field or Laboratory Activities

A. Ship schedule

Discoverer cruise, Leg II, initiated March 28 (will be reported on in next quarterly report).

B. Laboratory activities

1. Scientific party

   Jean R. Dunn, NWAFC, Co-Principal Investigator

   Beverly M. Vinter, NWAFC, Ichthyoplankton Specialist (part-time)

   Kevin Bailey, NWAFC, Fishery Biologist

   Donald M. Fisk, NWAFC, Technician

2. Methods

Fish eggs and larvae were identified by microscopic examination and standard procedures used in larval fish taxonomy. Fish larvae were measured by means of a calibrated ocular micrometer.

3. Sample collection localities

Collection localities for the fall 1977 cruise are shown in Figure 1.

4. Data collected or analyzed

a. Number of samples identified:

To date, 206 samples of fish eggs and larvae have been processed. These samples consisted of 51 Neuston tows, 51 bongo tows and 94 Tucker trawl samples. Remaining to be identified are 32 Neuston, 6 bongo and 64 Tucker trawl samples.

b. Number of types of analyses

The 206 samples identified to date contained 6,059 fish larvae, of which 59% came from the Neuston samples. Only 157 fish eggs were captured.

c. Sorting of the zooplankton has not been completed.

IV. Preliminary Results

Cottids of the genus *Hemilepidotus* accounted for 70%, by number, of the fish larvae captured followed by hexagrammids (*Pleurogrammos monopterygius*), 13%; and *Hexagrammos* spp., 12%).

Of the fish eggs captured, most were *Leuroglossus schmidti*, a bathylogid smelt.

V. Prelminary Interpretation of Results

None

VI. Auxiliary Material

None

VII. Problems Encountered and Recommended Changes

None

VIII. Estimate of Funds Expended

Approximately $50K was expended this quarter.

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