



Atlas 3: Alvarino, A. Distributional atlas of Chaetognatha in the California Current region. Published December 1965.

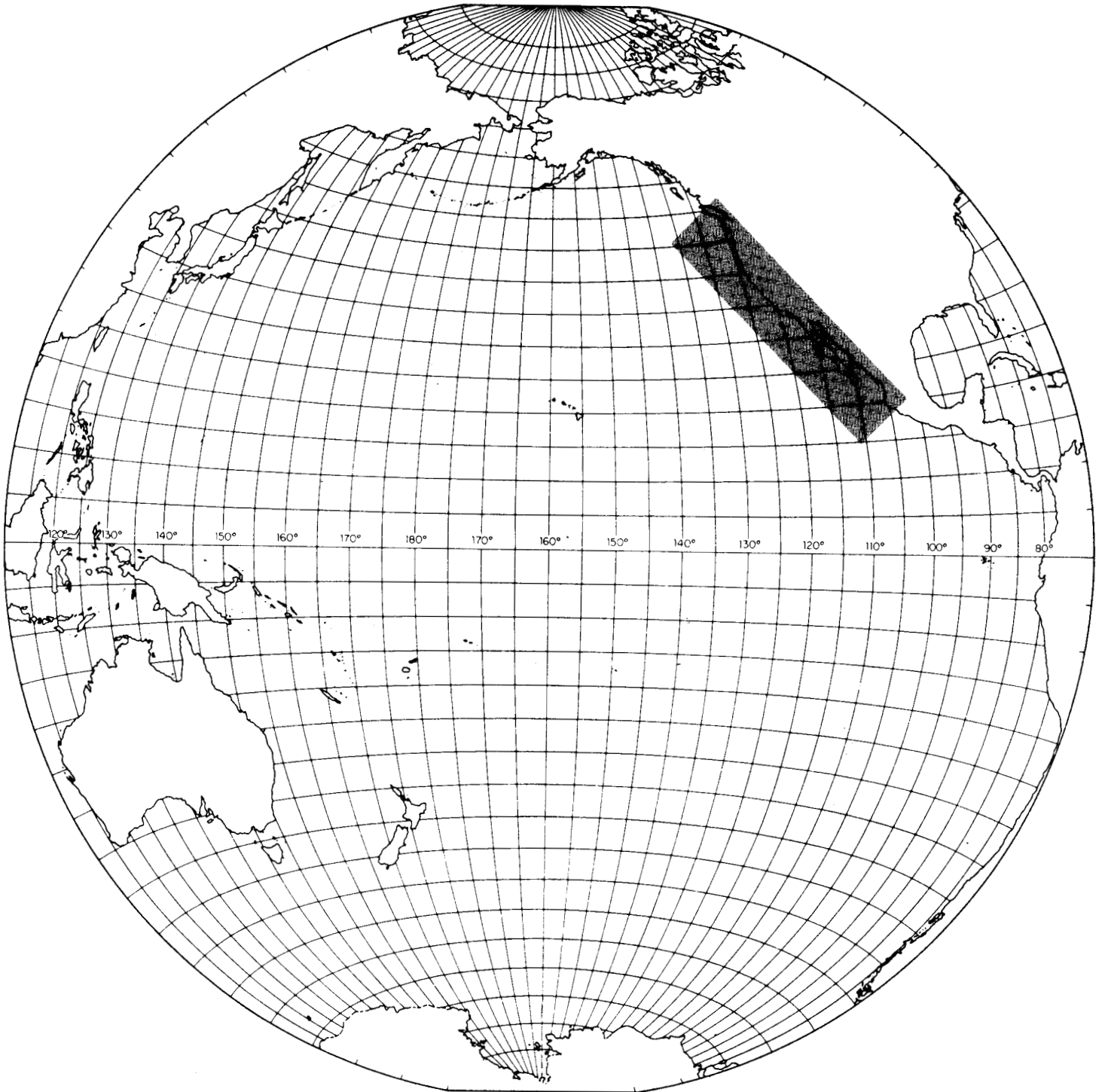
24 May 2007

The taxonomic nomenclature in the atlas is exactly as published, even though the chaetognaths have undergone taxonomic revision. A reference that may be useful in updating the species names is:

The Biology of Chaetognaths. 1991. Bone, O. Kapp, H. Pierrot-Bults, A. C. (eds). Oxford University Press.

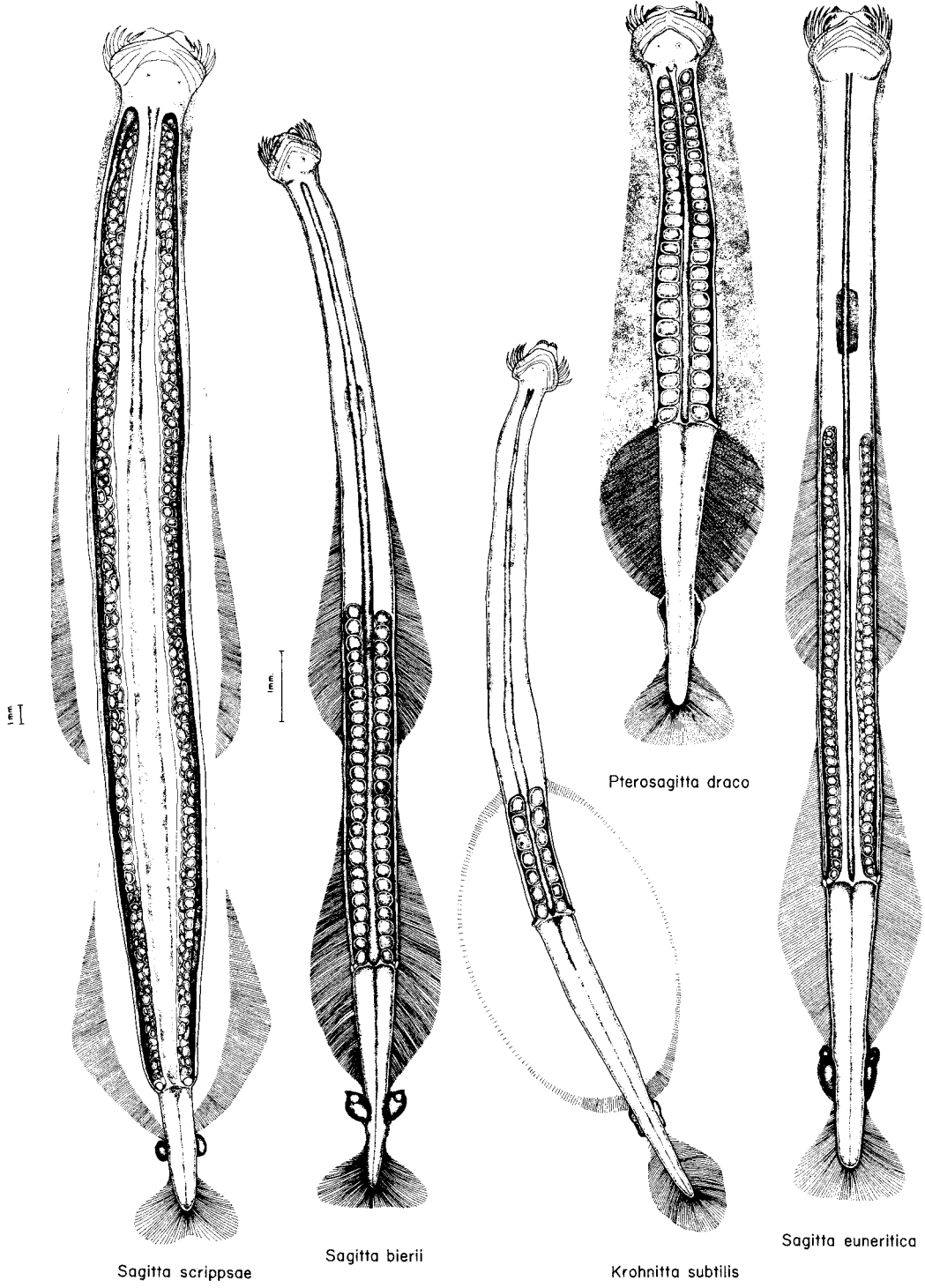
There is also information on the GBIF website: <http://nlbif.eti.uva.nl/bis/index.php> (go to projects and find Chaetognatha).

STATE OF CALIFORNIA  
MARINE RESEARCH COMMITTEE



# **CALIFORNIA COOPERATIVE OCEANIC FISHERIES INVESTIGATIONS**

ATLAS No. 3



*Sagitta scrippsae*

*Sagitta bierii*

*Pterosagitta draco*

*Krohnitta subtilis*

*Sagitta euneritica*

CALIFORNIA  
COOPERATIVE  
OCEANIC  
FISHERIES  
INVESTIGATIONS

*Atlas No. 3*

STATE OF CALIFORNIA  
MARINE RESEARCH COMMITTEE

*Cooperating Agencies:*

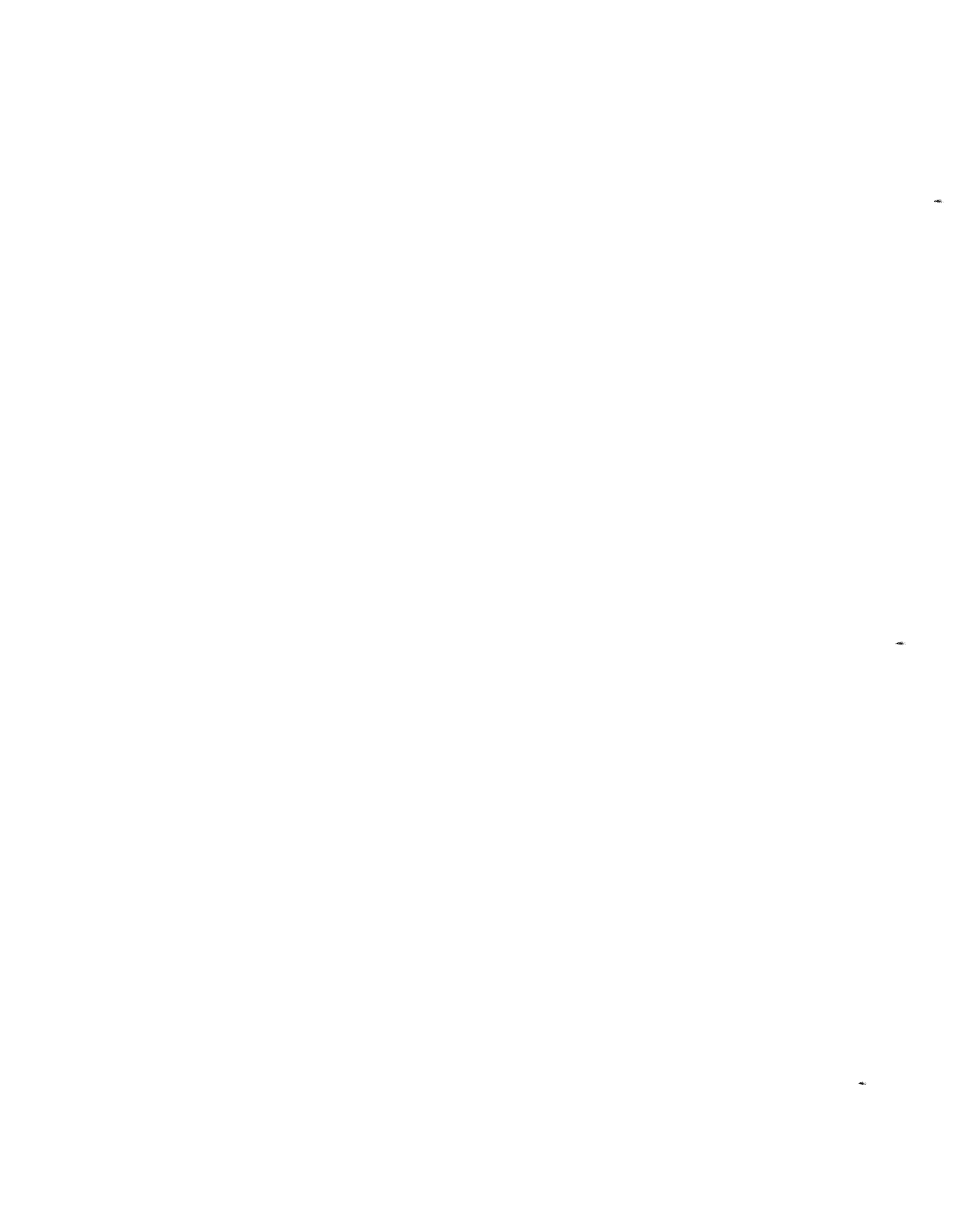
CALIFORNIA ACADEMY OF SCIENCES  
CALIFORNIA DEPARTMENT OF FISH AND GAME  
STANFORD UNIVERSITY, HOPKINS MARINE STATION  
U. S. FISH AND WILDLIFE SERVICE, BUREAU OF COMMERCIAL FISHERIES  
UNIVERSITY OF CALIFORNIA, SCRIPPS INSTITUTION OF OCEANOGRAPHY

December, 1965



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## THE CALCOFI ATLAS SERIES

This is the third in a series of atlases containing hydrographic and plankton data from the region of the California Current. The field work was carried out by the California Cooperative Oceanic Fisheries Investigations,<sup>1</sup> a program sponsored by the State of California under the direction of the State's Marine Research Committee. The co-operating agencies in the program are:

California Academy of Sciences  
California Department of Fish and Game  
Stanford University, Hopkins Marine Station  
U. S. Fish and Wildlife Service, Bureau of Commercial Fisheries  
University of California, Scripps Institution of Oceanography

CalCOFI atlases<sup>2</sup> are issued as individual units as they become available. They provide processed physical, chemical and biological measurements of the California Current region. Each number may contain one or more contributions. A general description of the CalCOFI program with its objectives appears in the preface of Atlas No. 2.

This atlas was prepared by the Data Collection and Processing Group of the Marine Life Research Program, Scripps Institution of Oceanography.

### CalCOFI Atlas Editorial Staff:

Abraham Fleminger and Hans T. Klein, Editors  
John G. Wyllie, Principal analyst, physical-chemical oceanographic data

### Previous atlases in this series are:

#### CalCOFI Atlas No. 1

Anonymous. CalCOFI Atlas of 10-meter temperatures and salinities 1949 through 1959.

#### CalCOFI Atlas No. 2

Fleminger, A. Distributional Atlas of calanoid copepods in the California Current region, Part 1.

<sup>1</sup> Usually abbreviated CalCOFI, sometimes CALCOFI or CCOFI.

<sup>2</sup> For citation this issue in the series should be referred to as CalCOFI Atlas No. 3.





DISTRIBUTIONAL ATLAS OF CHAETOGNATHA  
IN THE CALIFORNIA CURRENT REGION<sup>1</sup>

Angeles Alvarino<sup>2</sup>

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Introduction

The samples studied were collected on the monthly CalCOFI cruises for 1954 and 1958, which were chosen as representatives of cold and warm years respectively. The plankton samples were analyzed in order to define the seasonal abundance and distribution of the different species of chaetognaths within the area, and to present data pertinent to their relationship with water masses.<sup>3</sup>

<sup>1</sup> These studies have been conducted under the Marine Life Research Program, the Scripps Institution's component of the California Cooperative Oceanic Fisheries Investigations, and with partial support by the National Science Foundation (NSF G-19417, GB-2861) and the Office of Naval Research.

<sup>2</sup> Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California.

<sup>3</sup> More than 2000 additional samples were examined from the following expeditions in the Pacific: NORTHERN HOLIDAY, SHELLBACK, CAPRICORN, TRANSPAC, EAST TROPIC, NORPAC (CalCOFI), NORPAC (POFI), TROLL, CHINOOK, EQUAPAC (Horizon), EQUAPAC (Stranger), DOWNWIND, TETHYS, MONSOON, LEAPFROG. The results are reported by Alvarino (1962, 1964, and 1965).

To avoid duplication, pertinent hydrographic charts and hydrographic data for each of the stations corresponding to the monthly CalCOFI cruises analyzed for the Chaetognatha are not included here, for they are available in the CalCOFI Atlas No. 1; the Data Reports published by the Scripps Institution of Oceanography; or in the CalCOFI Atlas No. 2. Charts with profiles of temperature, salinity and oxygen for each of the monthly CalCOFI cruises studied here, have not appeared in either of the above-mentioned publications.

Hydrographic profiles show every second cardinal line where sufficient data are available. The analyses for these charts were made by Mr. John G. Wyllie, Data Collection and Processing Group, Scripps Institution of Oceanography.

No plankton data are presented for the months of September and November 1954 and 1958, and August and December 1958, because the cruises were restricted to neritic or small areas and not comparable with the other monthly cruises.

### Methods

The plankton nets used in the CalCOFI Program have already been described in other publications (Ahlstrom 1948, 1952; Fleminger, 1964).

The samples were collected in standard oblique quantitative plankton tows to a depth of 140 meters (200 m. of wire out), or less in shallow waters. In April 1958, a few net tows were taken at several greater depths (420 m., 418 m., 423 m., and 618 m.).

### Measurements and calculations

For each of the species of Chaetognatha in the plankton samples, the total number of individuals was usually directly counted. When species occurred in excess of 300 to 400 individuals, counts were made from aliquots. The aliquot was taken after the representatives of species appearing in smaller numbers had been removed. In every case the counting included all growth stages. In aliquoting, the sample was placed in a cylindrical jar, and formaldehyde (5%) was added to make up 1000 cc of total volume. When the sample had been uniformly mixed, a cylindrical glass container of 20 cc volume (attached to a thin wire or handle) was employed to obtain the sub-sample. This process was repeated about six times in order to obtain a more accurate number by means of the average resulting from the several aliquots sorted. The counts obtained were then adjusted to the total volume of the sample.

Counts were calculated for 1000 m<sup>3</sup> of sea water filtered, according to the formula:

$$N = \frac{1000 n}{V}$$

N = number of individuals in 1000 m<sup>3</sup> of sea water filtered

n = number of individuals in the total sample

V = number of m<sup>3</sup> of water filtered during the tow.

The biological charts of the quantitative distribution of the species show contours of the factor N at Briggs' logarithmic intervals.

### Sampling Limitations

It is important to notice that a "capture error" becomes apparent when studying the quality of the chaetognath populations. The large mature specimens of certain species of large size may escape capture by dodging, and the young of the species of small size go through the mesh. Therefore, it appears that there is an inadequate capture of large specimens of Sagitta hexaptera, S. maxima and S. scrippsae; and of immature specimens of Krohnitta pacifica, Pterosagitta draco, S. minima, S. pseudoserratodentata, S. neglecta, S. regularis, and S. robusta. This factor may sometimes produce striking features in the quantitative distributions, mainly during the reproductive seasons of the species. Irregularities in the sampling coverage of the California region from cruise to cruise, reduces the number of comparable observations.

### Faunistics

A short account of the faunistics of the Chaetognatha is presented below. (A detailed discussion on the Chaetognatha of the California waters, by the present author, is in press.)

This atlas includes all the species of Chaetognatha present in the samples studied. A total of 24 species was observed in the California region. An additional species, Eukrohnia bathypelagica Alvarriño, has been observed in net tows from depths greater than those systematically sampled in the CalCOFI Cruises.

The species of chaetognaths recorded in the California waters correspond to various categories; epi-, meso-, and bathypelagic; oceanic and neritic; as well as to the water masses adjacent and contributory to the California Current System.

The cold water northern species are *Sagitta scrippsae* in the upper layers, and *S. maxima*, *Eukrohnia hamata* below 100 meters. Warm-water southern and central species are *S. pacifica*, and the tropical species *Krohnitta pacifica*, *S. bedoti*, *S. ferox*, *S. neglecta*, *S. pulchra*, *S. regularis*, and *S. robusta*. *Sagitta euneritica* is a typical neritic species for the North American Pacific. Typical mesopelagic species are: *S. decipiens*, *S. macrocephala*, *S. maxima*, and *S. zetesios*. Meso- or bathypelagic species are *Eukrohnia hamata* and *E. fowleri*.

The distribution of *S. scrippsae*, a species typical of the Transition region in the North Pacific, shows a positive correlation to the California Current waters, being most abundant in the north and gradually decreasing in numbers as the California Current loses its distinctiveness to the south (Alvariño 1962, 1964, 1965).

## REFERENCES

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PAGINATION

Cruise Number	5401	5402	5403	5404	5405	5406	5407	5408	5410	5412
CalCOFI Basic Station Plan	1									
(Vertical Sections of Temperature and Salinity)	2	2	3	4	5	6	7	8	9	9
LIST OF SPECIES										
Eukrohnia fowleri Ritter-Zahony 1909	(No record for these cruises)									
Eukrohnia hamata (Möbius 1875)			48	60	75	90	105			144
Krohnitta pacifica (Aida 1897)	17			61	76	91		117	131	145
Krohnitta subtilis (Grassi 1881)	18	35	49	62	77	92	106	118	132	146
Pterosagitta draco (Krohn 1853)	19	36	50	63	78	93	107	119	133	147
Sagitta bedoti Béranek 1895	20			64				120		
Sagitta bierii Alvaríño 1961	21	37	51	65	79	94	108	121	134	148
Sagitta bipunctata Quoy-Gaimard 1827	22	38	52	66	80	95	109	122	135	149
Sagitta decipiens Fowler 1905	23	39			81	96		123		150
Sagitta enflata Grassi 1881	24	40	53	67	82	97	110	124	136	151
Sagitta euneritica Alvaríño 1961	25	41	54	68	83	98	111	125	137	152
Sagitta ferox Doncaster 1903	26									
Sagitta hexaptera d'Orbigny 1834	27	42	55	69	84	99	112	126	138	153
Sagitta macrocephala Fowler 1905	(No record for these cruises)									
Sagitta maxima (Conant 1896)		43		70	85	100			139	
Sagitta minima Grassi 1881	28	44	56	71	86	101	113	127	140	154
Sagitta neglecta Aida 1897	29									155
Sagitta pacifica Tokioka 1940	30	45	57	72	87	102	114	128	141	156
Sagitta pseudoserratodentata Tokioka 1939	31	46	58	73	88	103	115	129	142	157
Sagitta pulchra Doncaster 1903	(No record for these cruises)									
Sagitta regularis Aida 1897	32									158
Sagitta robusta Doncaster 1903	33									159
Sagitta scrippsae Alvaríño 1962	34	47	59	74	89	104	116	130	143	160
Sagitta zetesios Fowler 1905	(No record for these cruises)									

OF CHARTS

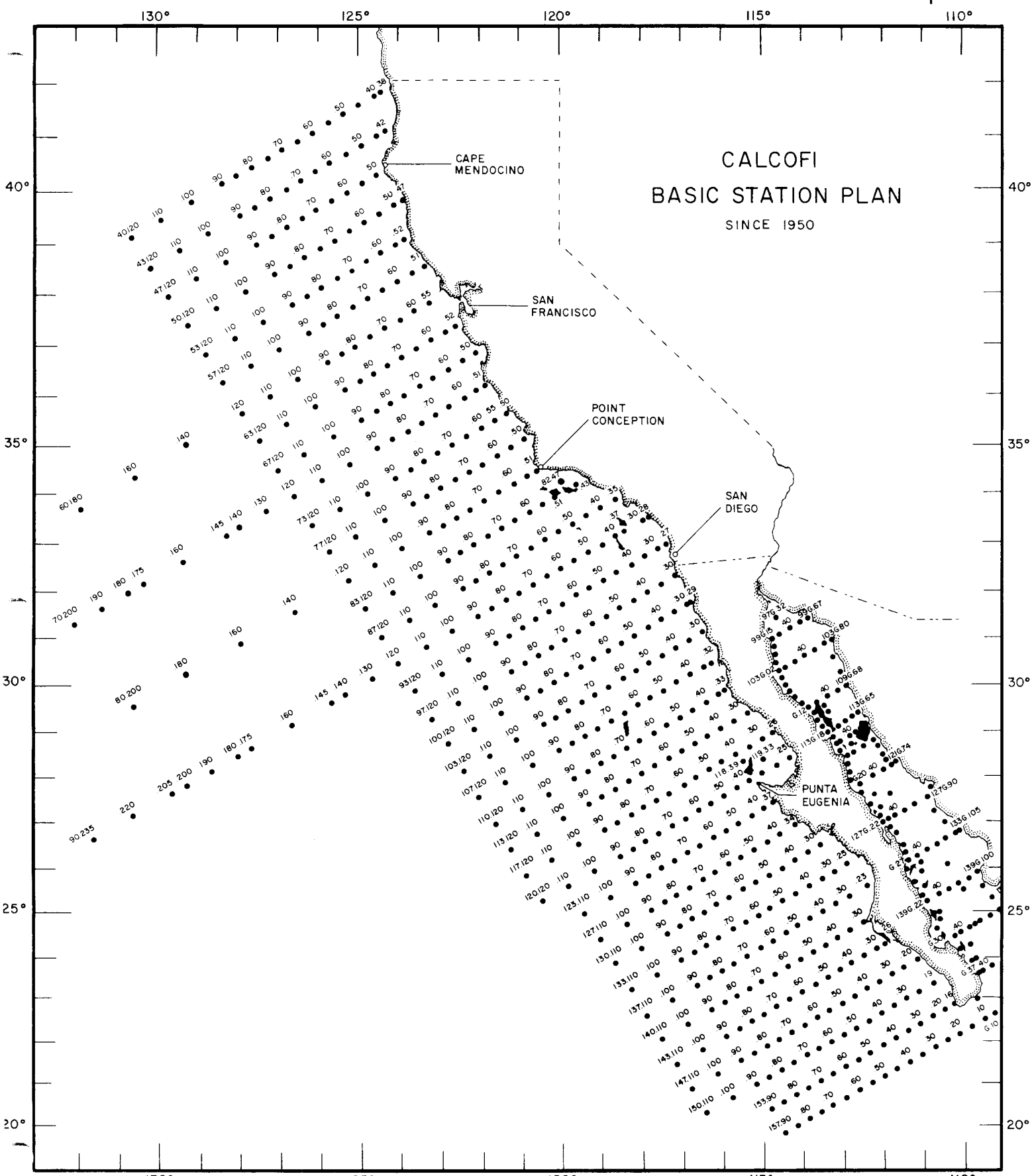
Cruise Number	5801	5802	5803	5804	5805	5806	5807	5810
(Vertical Sections of Temperature, Salinity and Oxygen)	10	None*	11	12,13	14	14	15	16

LIST OF SPECIES

Eukrohnia fowleri Ritter-Zahony 1909				209A				
Eukrohnia hamata (Möbius 1875)				210	228	245	260	
Krohnitta pacifica (Aida 1897)	161	178	195	211	229			274
Krohnitta subtilis (Grassi 1881)	162	179	196	212	230	246	261	275
Pterosagitta draco (Krohn 1853)	163	180	197	213	231	247	262	276
Sagitta bedoti Béranec 1895		181	198	214	232	248		277
Sagitta bierii Alvarino 1961	164	182	199	215	233	249	263	278
Sagitta bipunctata Quoy-Gaimard 1827	165	183	200	216	234	250	264	279
Sagitta decipiens Fowler 1905	166	184	201	217	235	251	265	280
Sagitta enflata Grassi 1881	167	185	202	218	236	252	266	281
Sagitta euneritica Alvarino 1961	168	186	203	219	237	253	267	282
Sagitta ferox Doncaster 1903								283
Sagitta hexaptera d'Orbigny 1834	169	187	204	220	238	254	268	284
Sagitta macrocephala Fowler 1905				220A				
Sagitta maxima (Conant 1896)				221	239		269	285
Sagitta minima Grassi 1881	170	188	205	222	240	255	270	286
Sagitta neglecta Aida 1897	171	189				256		287
Sagitta pacifica Tokioka 1940	172	190	206	223	241	257	271	288
Sagitta pseudoserratodentata Tokioka 1939	173	191	207	224	242	258	272	289
Sagitta pulchra Doncaster 1903	174							
Sagitta regularis Aida 1897	175	192	208					290
Sagitta robusta Doncaster 1903	176	193		225				
Sagitta scrippsae Alvarino 1962	177	194	209	226	243	259	273	291
Sagitta zetesios Fowler 1905				227	244			

\* Not enough hydrographic data to make up temperature, salinity and oxygen charts.



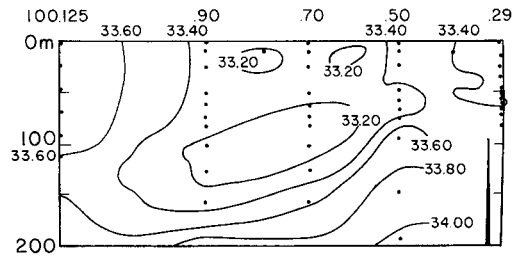
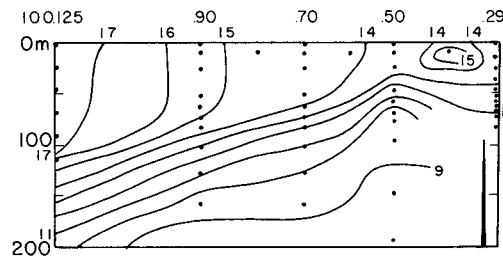
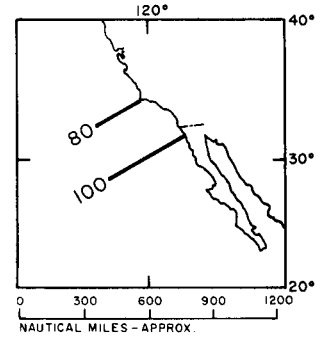
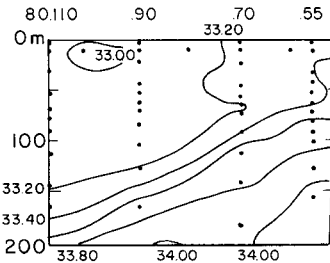
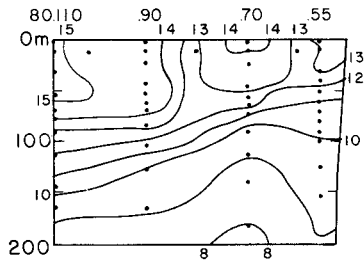


CALCOFI  
BASIC STATION PLAN  
SINCE 1950

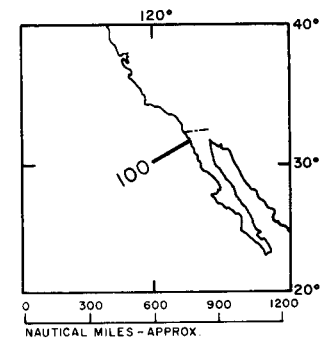
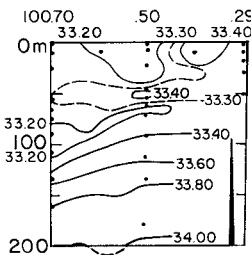
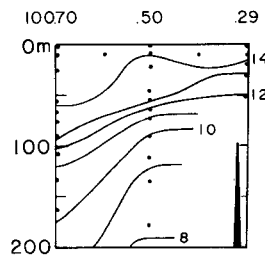
**CALCOFI CRUISE 5401  
VERTICAL SECTIONS  
5 JANUARY - 4 FEBRUARY 1954**

**TEMPERATURE**

**SALINITY**



**CALCOFI CRUISE 5402  
VERTICAL SECTIONS  
2 - 16 FEBRUARY 1954**

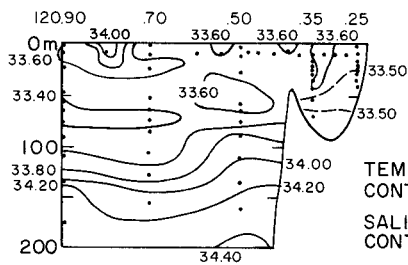
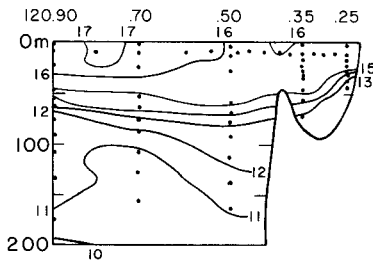
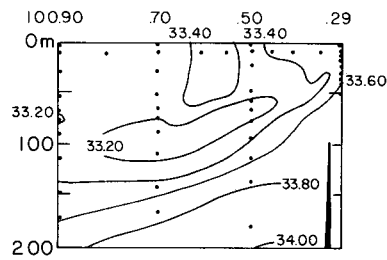
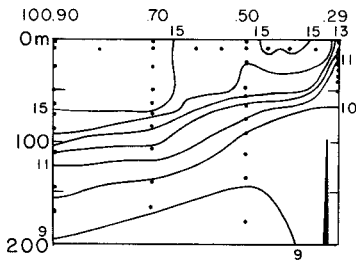
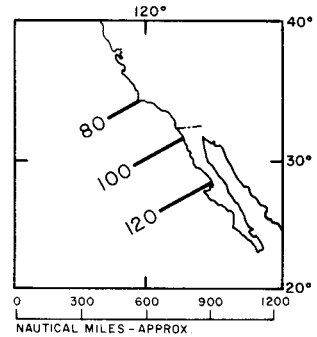
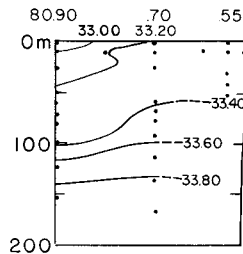
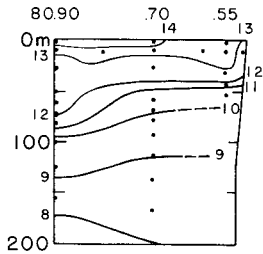


TEMPERATURE  
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SALINITY  
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CALCOFI CRUISE 5403  
VERTICAL SECTIONS  
3 MARCH - 5 APRIL 1954

TEMPERATURE

SALINITY

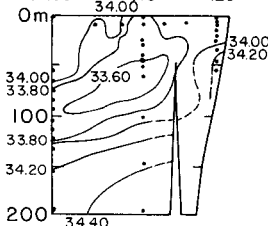
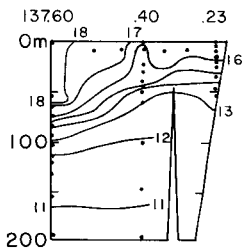
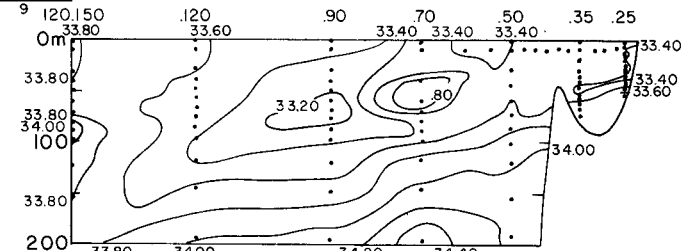
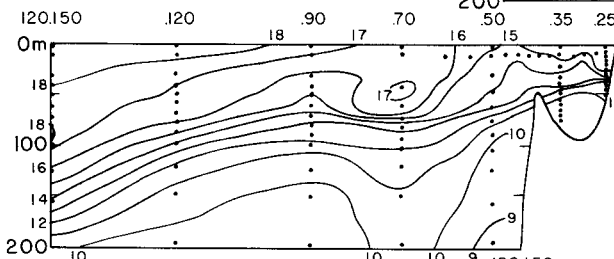
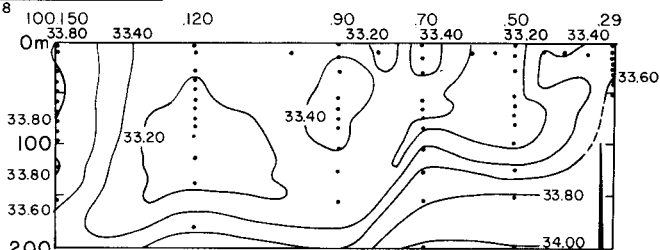
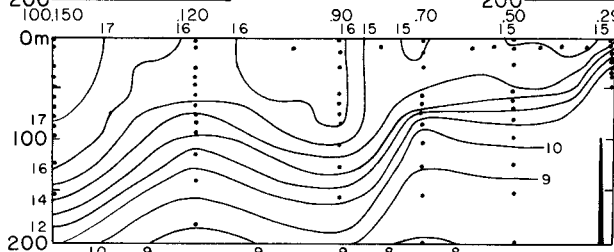
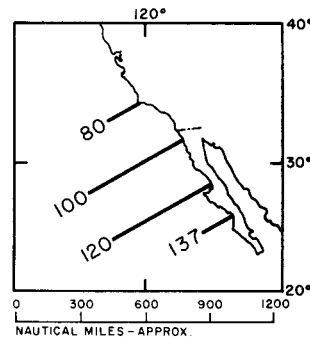
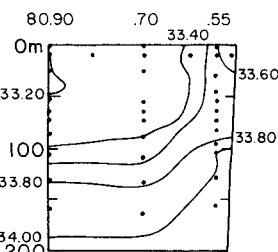
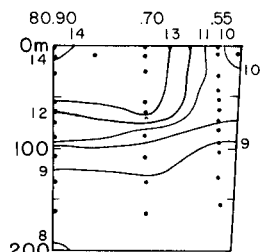


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CALCOFI CRUISE 5404  
VERTICAL SECTIONS  
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TEMPERATURE

SALINITY



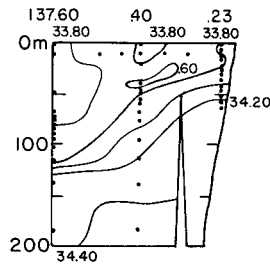
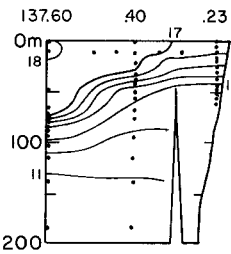
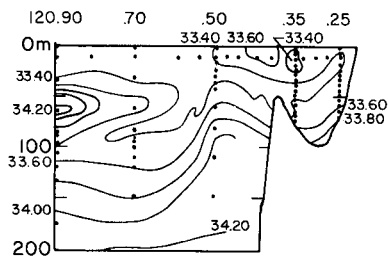
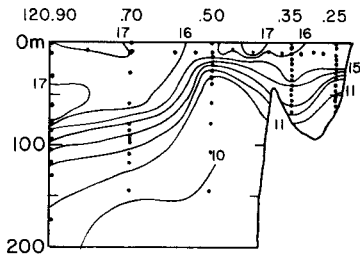
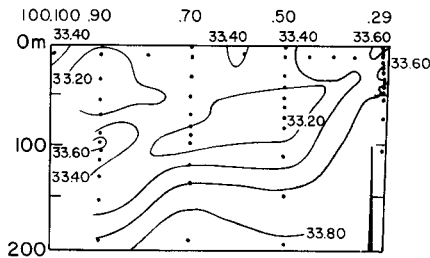
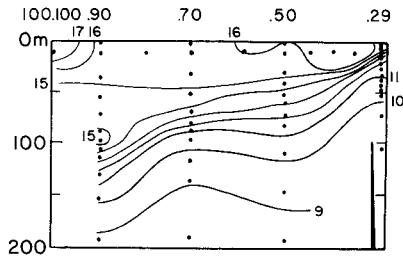
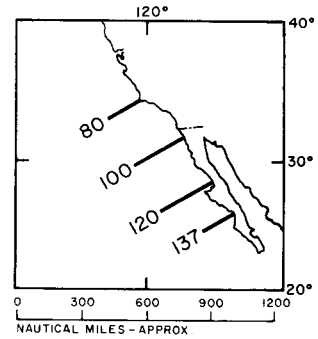
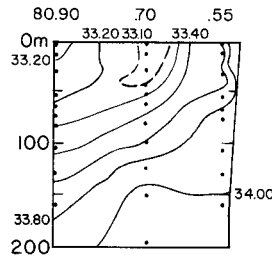
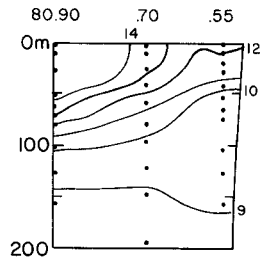
TEMPERATURE  
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CALCOFI CRUISE 5405  
VERTICAL SECTIONS

5-24 MAY 1954

TEMPERATURE

SALINITY

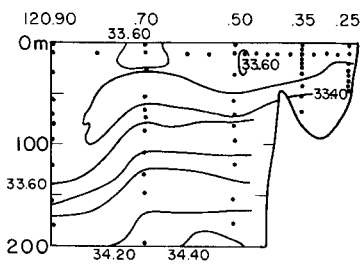
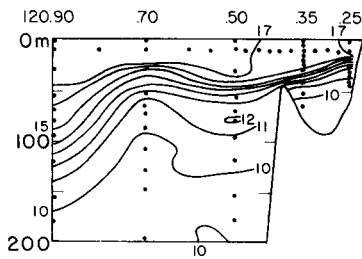
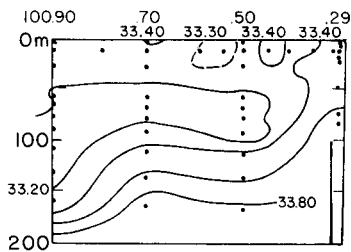
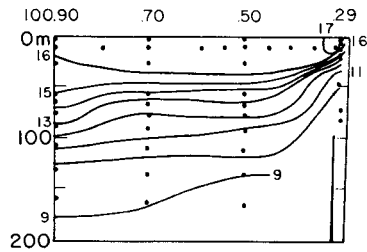
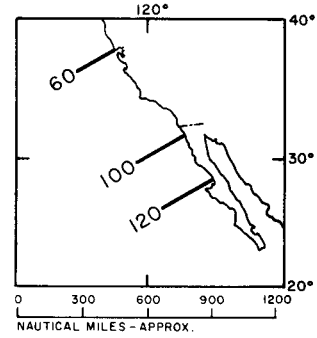
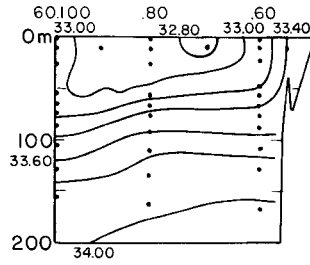
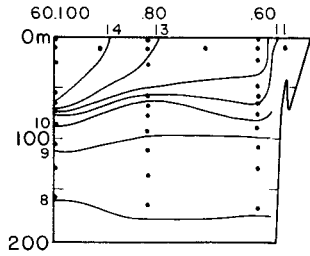


TEMPERATURE  
CONTOUR INTERVAL 1.0 °C  
SALINITY  
CONTOUR INTERVAL 0.20 ‰

CALCOFI CRUISE 5406  
 VERTICAL SECTIONS  
 2 - 23 JUNE 1954

TEMPERATURE

SALINITY

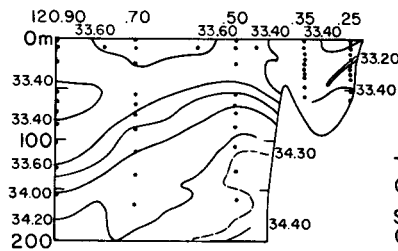
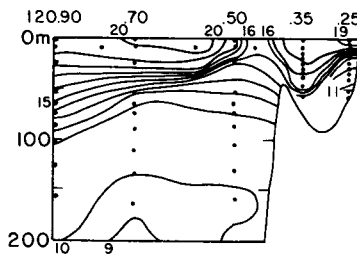
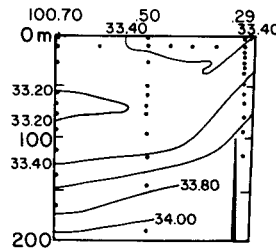
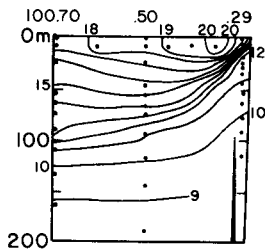
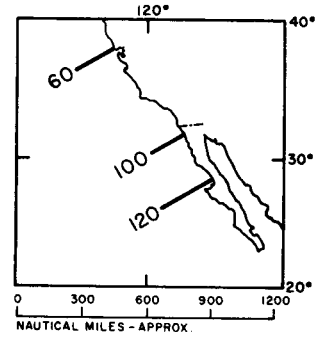
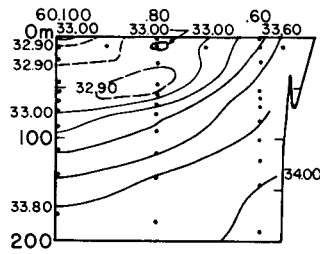
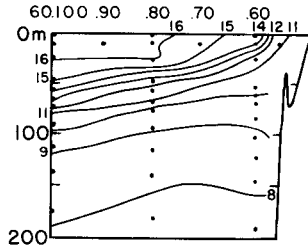


TEMPERATURE  
 CONTOUR INTERVAL 1.0°C  
 SALINITY  
 CONTOUR INTERVAL 0.20‰

CALCOFI CRUISE 5407  
 VERTICAL SECTIONS  
 7 - 23 JULY 1954

TEMPERATURE

SALINITY

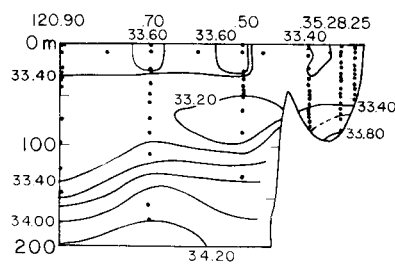
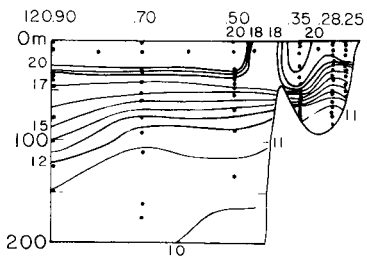
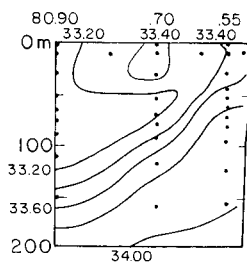
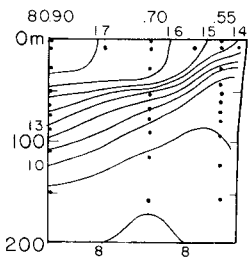
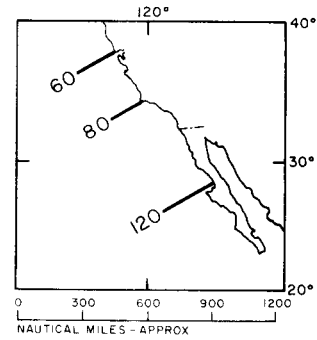
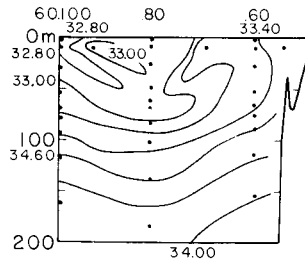
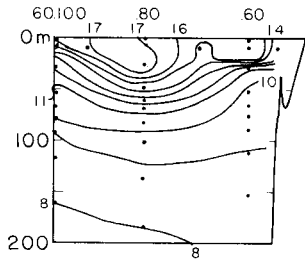


TEMPERATURE  
 CONTOUR INTERVAL 1.0°C  
 SALINITY  
 CONTOUR INTERVAL 0.20‰

CALCOFI CRUISE 5408  
VERTICAL SECTIONS  
18 AUGUST - 10 SEPTEMBER 1954

TEMPERATURE

SALINITY



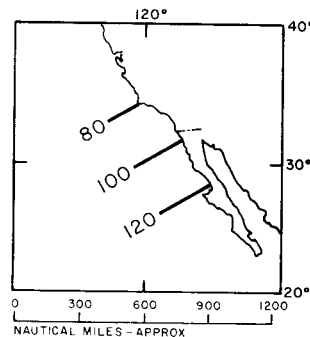
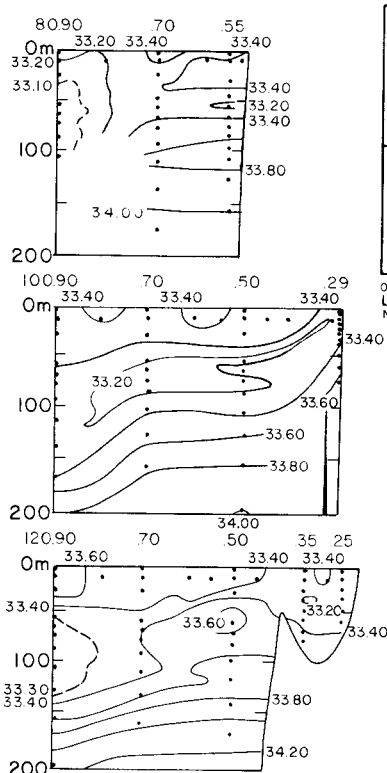
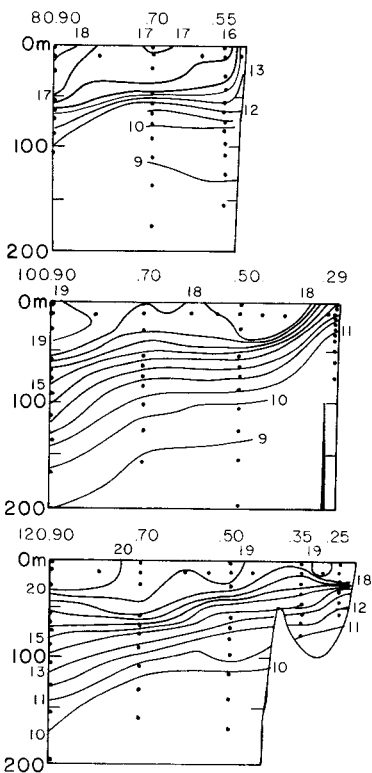
TEMPERATURE  
CONTOUR INTERVAL 1.0°C  
SALINITY  
CONTOUR INTERVAL 0.20‰



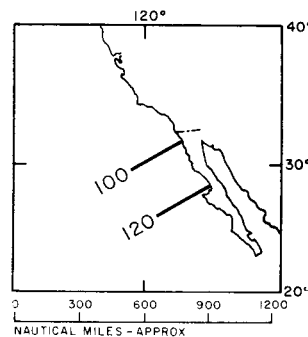
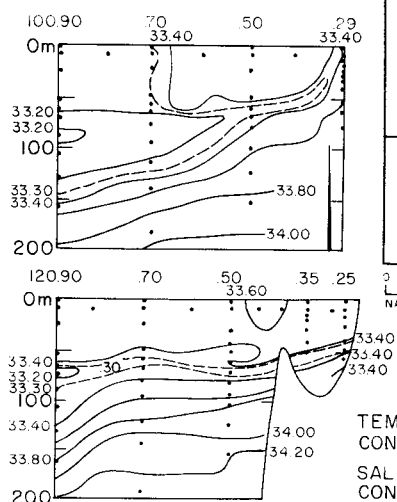
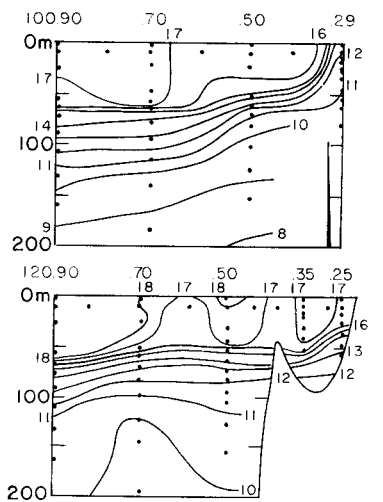
### CALCOFI CRUISE 5410 VERTICAL SECTIONS 6 - 24 OCTOBER 1954

#### TEMPERATURE

#### SALINITY



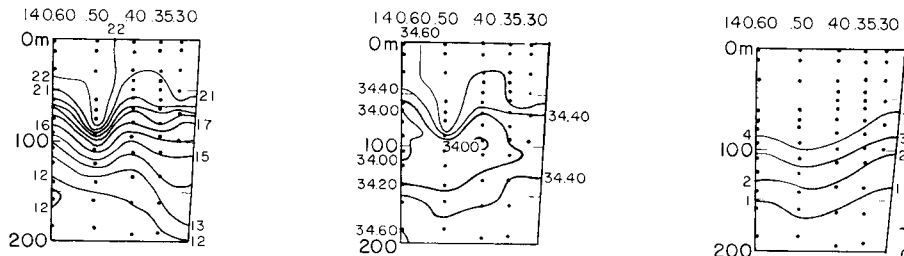
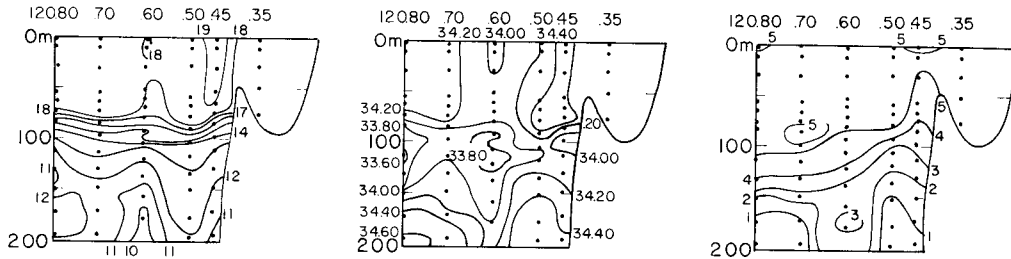
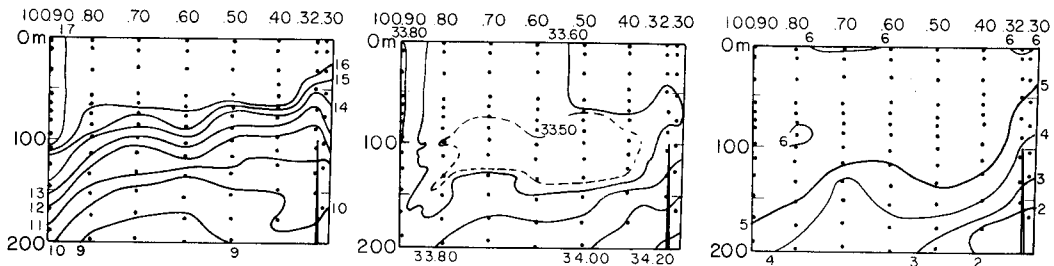
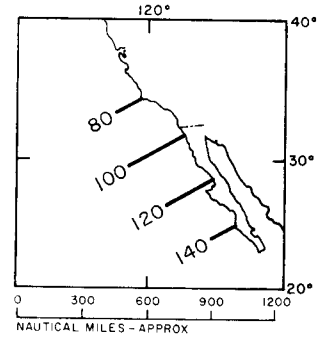
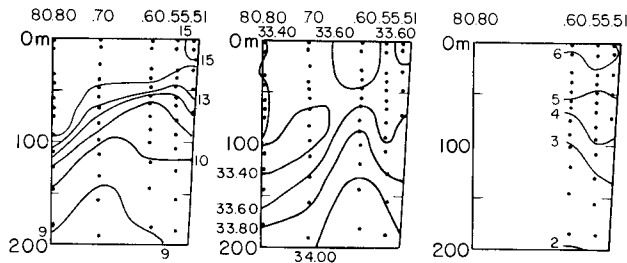
### CALCOFI CRUISE 5412 VERTICAL SECTIONS 30 NOVEMBER - 16 DECEMBER 1954



TEMPERATURE  
CONTOUR INTERVAL 1.0°C  
SALINITY  
CONTOUR INTERVAL 0.20‰

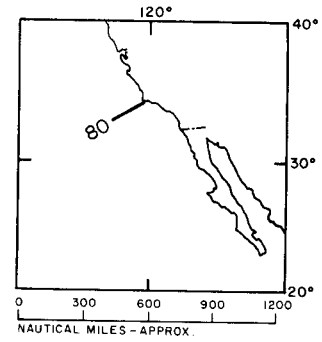
CALCOFI CRUISE 5801  
 VERTICAL SECTIONS  
 8 JANUARY — 2 FEBRUARY 1958

TEMPERATURE      SALINITY      OXYGEN

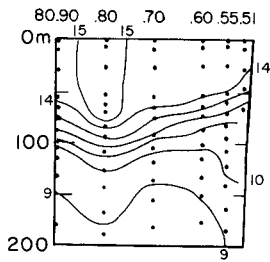


TEMPERATURE  
 CONTOUR INTERVAL 1.0°C  
 SALINITY  
 CONTOUR INTERVAL 0.20‰  
 OXYGEN  
 CONTOUR INTERVAL 1.0ml/L

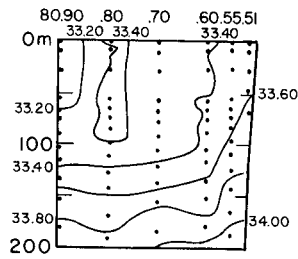
CALCOFI CRUISE 5803  
 VERTICAL SECTIONS  
 27 FEBRUARY - 21 MARCH 1958



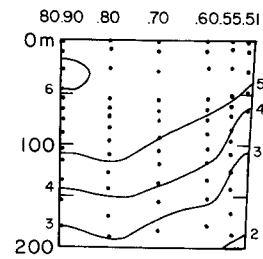
TEMPERATURE



SALINITY



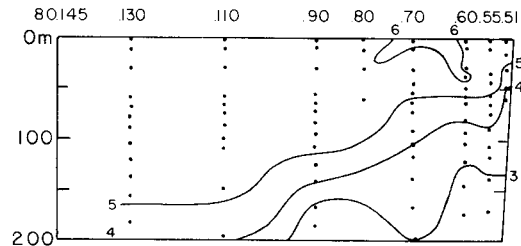
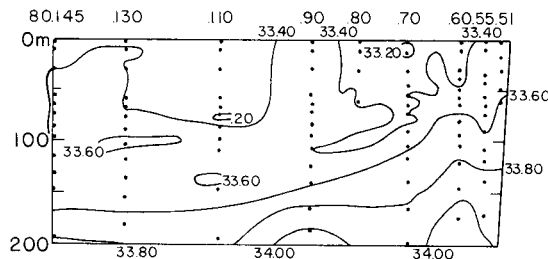
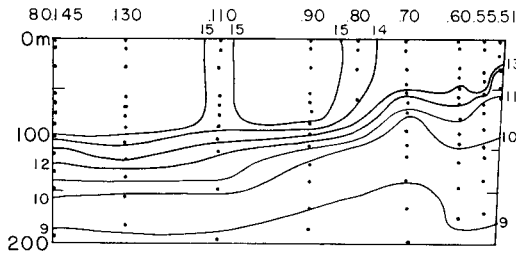
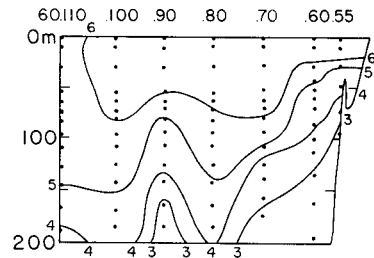
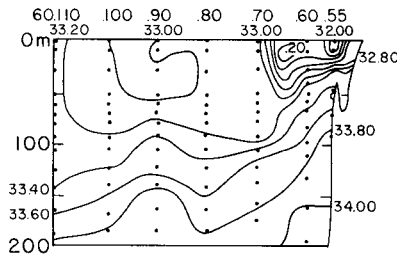
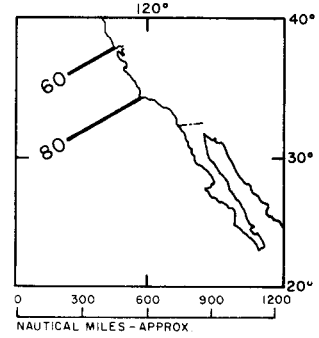
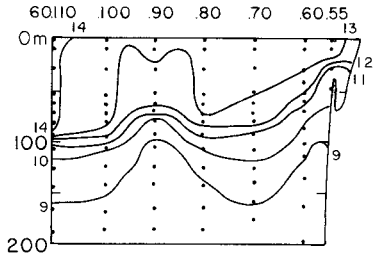
OXYGEN



TEMPERATURE  
 CONTOUR INTERVAL 1.0°C  
 SALINITY  
 CONTOUR INTERVAL 0.20‰  
 OXYGEN  
 CONTOUR INTERVAL 1.0 ml/L

CALCOFI CRUISE 5804  
 VERTICAL SECTIONS  
 30 MARCH - 27 APRIL 1958

TEMPERATURE SALINITY OXYGEN

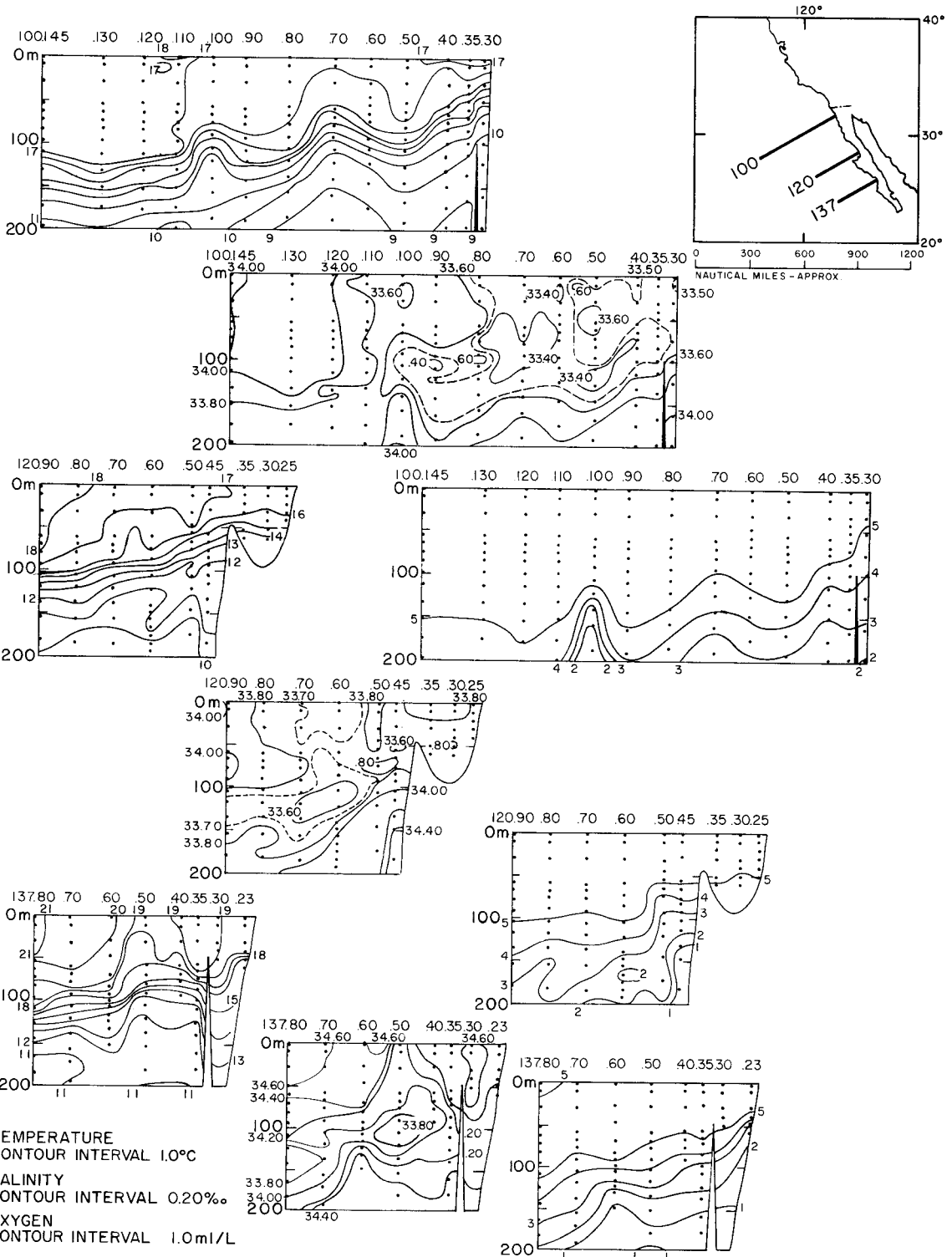


TEMPERATURE  
 CONTOUR INTERVAL 1.0°C  
 SALINITY  
 CONTOUR INTERVAL 0.20‰  
 OXYGEN  
 CONTOUR INTERVAL 1.0 ml/L

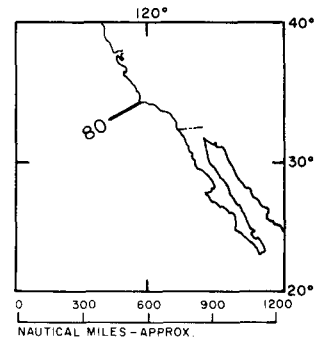
SHEET 1 OF 2

CALCOFI CRUISE 5804  
VERTICAL SECTIONS  
30 MARCH-27 APRIL 1958

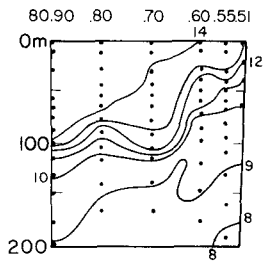
TEMPERATURE SALINITY OXYGEN



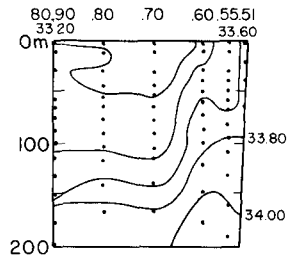
CALCOFI CRUISE 5805  
VERTICAL SECTIONS  
3 - 22 MAY 1958



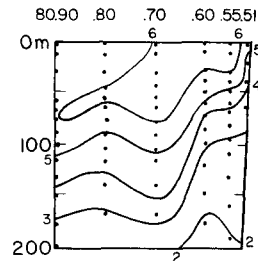
TEMPERATURE



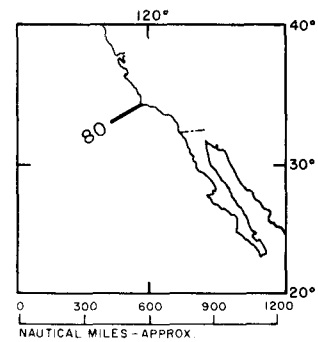
SALINITY



OXYGEN

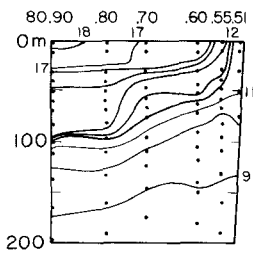


CALCOFI CRUISE 5806  
VERTICAL SECTIONS  
4 - 26 JUNE 1958

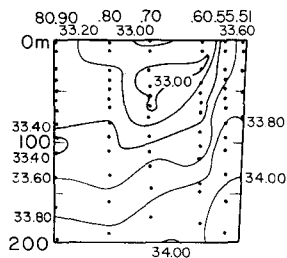


TEMPERATURE  
CONTOUR INTERVAL 1.0 °C  
SALINITY  
CONTOUR INTERVAL 0.20‰  
OXYGEN  
CONTOUR INTERVAL 1.0 ml/L

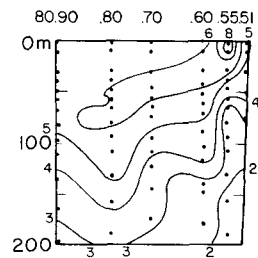
TEMPERATURE



SALINITY



OXYGEN

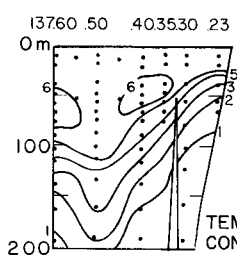
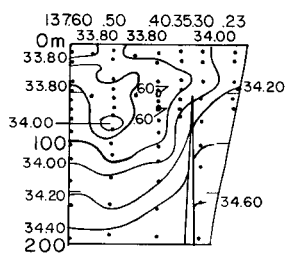
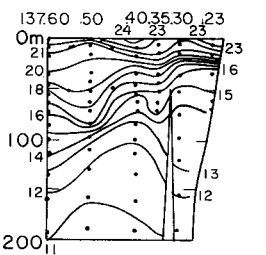
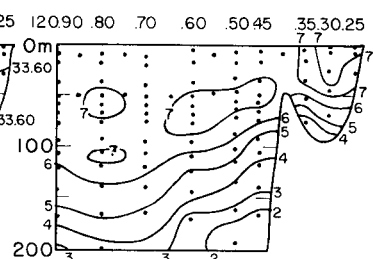
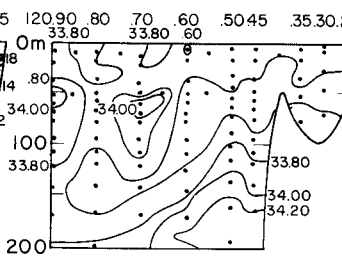
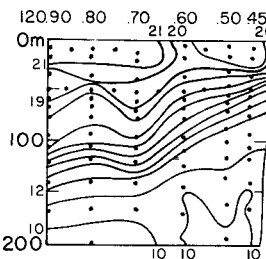
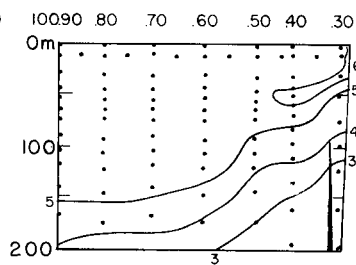
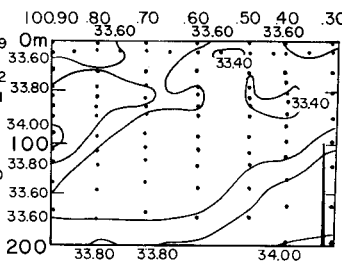
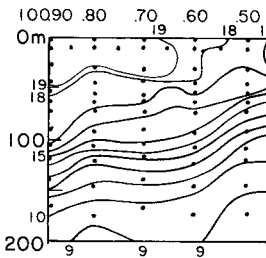
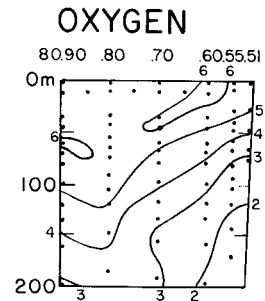
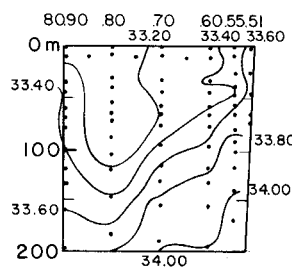
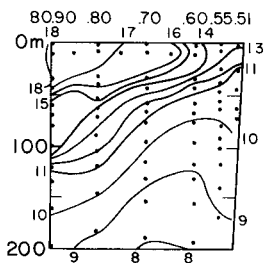
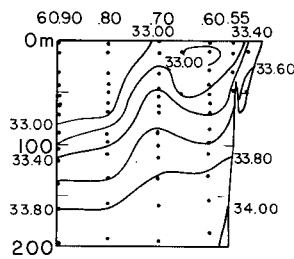
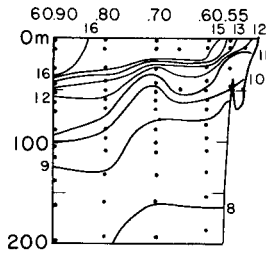
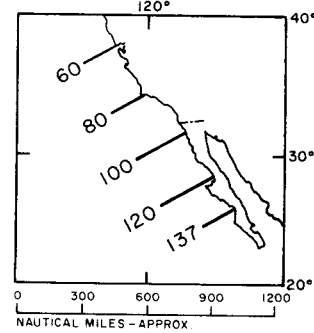


**CALCOFI CRUISE 5807**  
**VERTICAL SECTIONS**

30 JUNE — 22 JULY 1958

**TEMPERATURE**

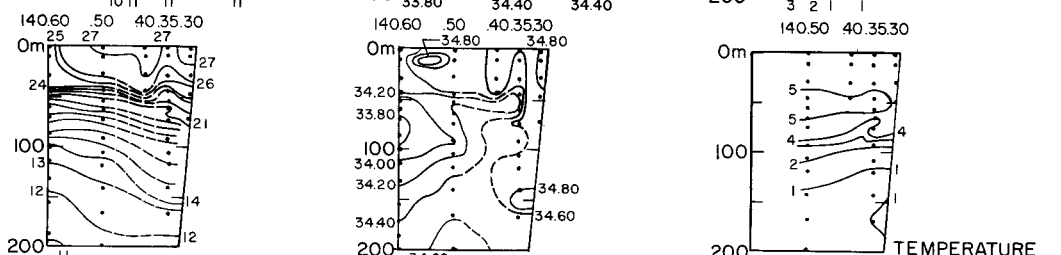
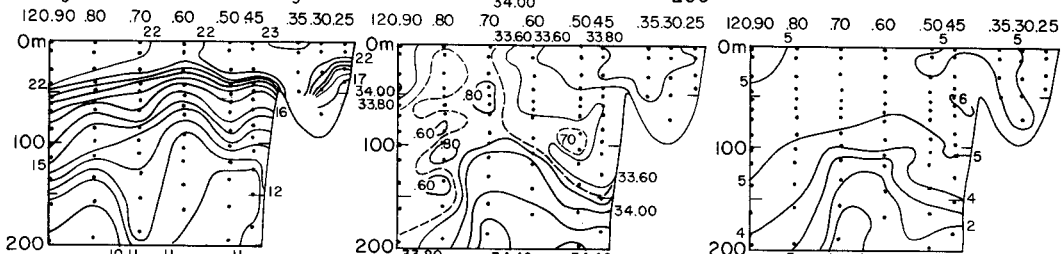
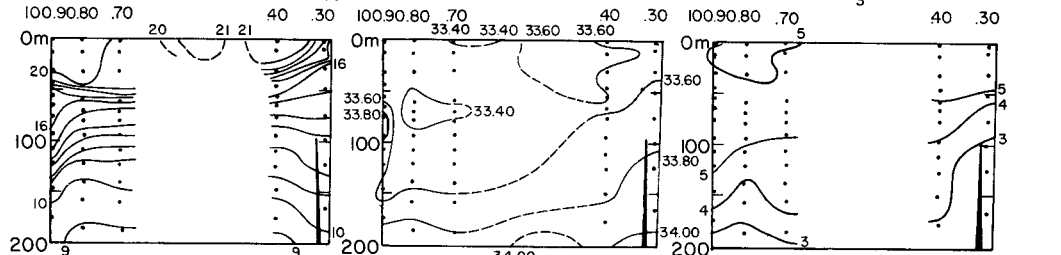
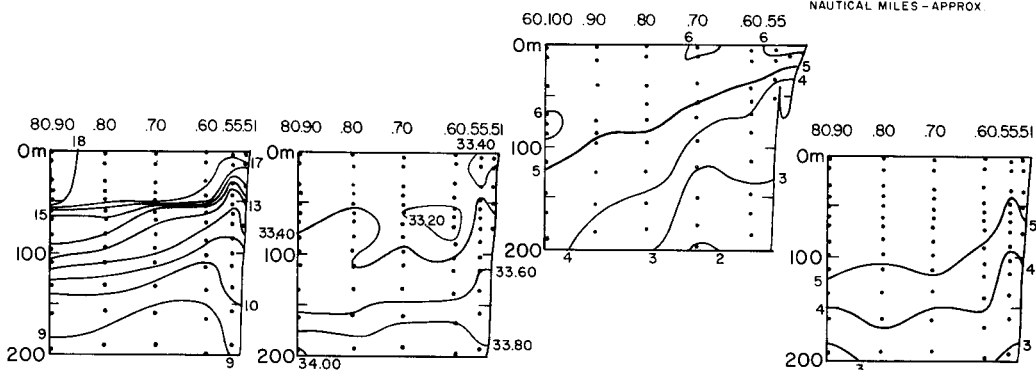
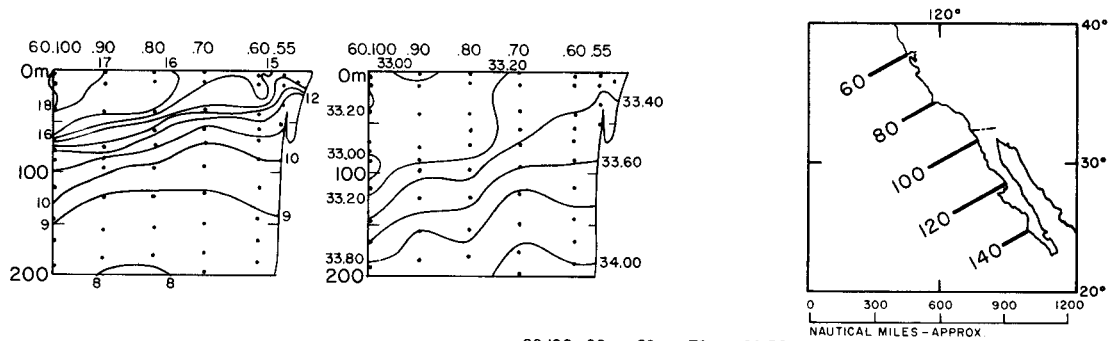
**SALINITY**



TEMPERATURE  
CONTOUR INTERVAL 1.0°C  
SALINITY  
CONTOUR INTERVAL 0.20‰  
OXYGEN  
CONTOUR INTERVAL 10ml/L

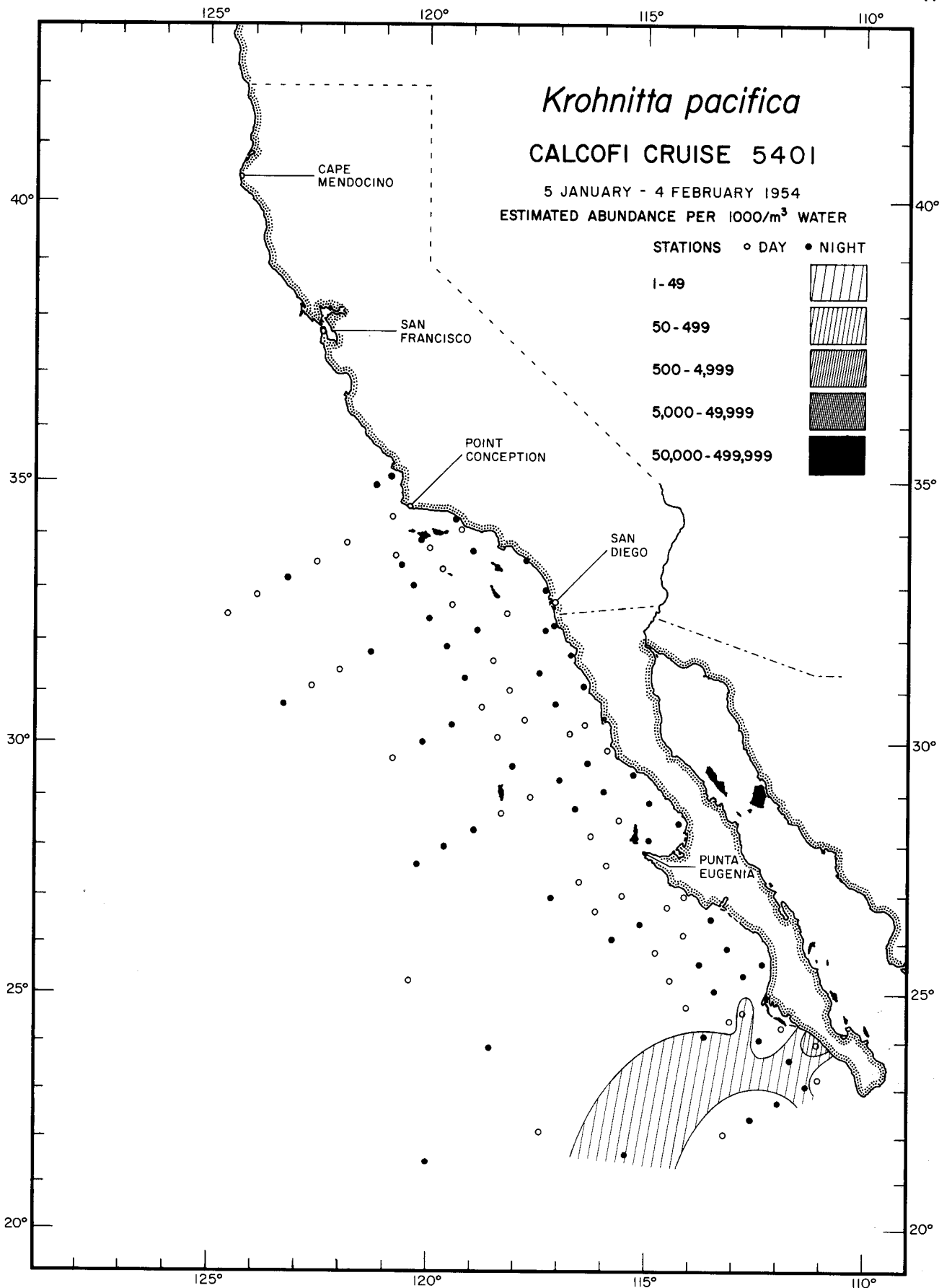
CALCOFI CRUISE 5810  
VERTICAL SECTIONS  
8 OCTOBER - 6 NOVEMBER 1958

TEMPERATURE SALINITY OXYGEN

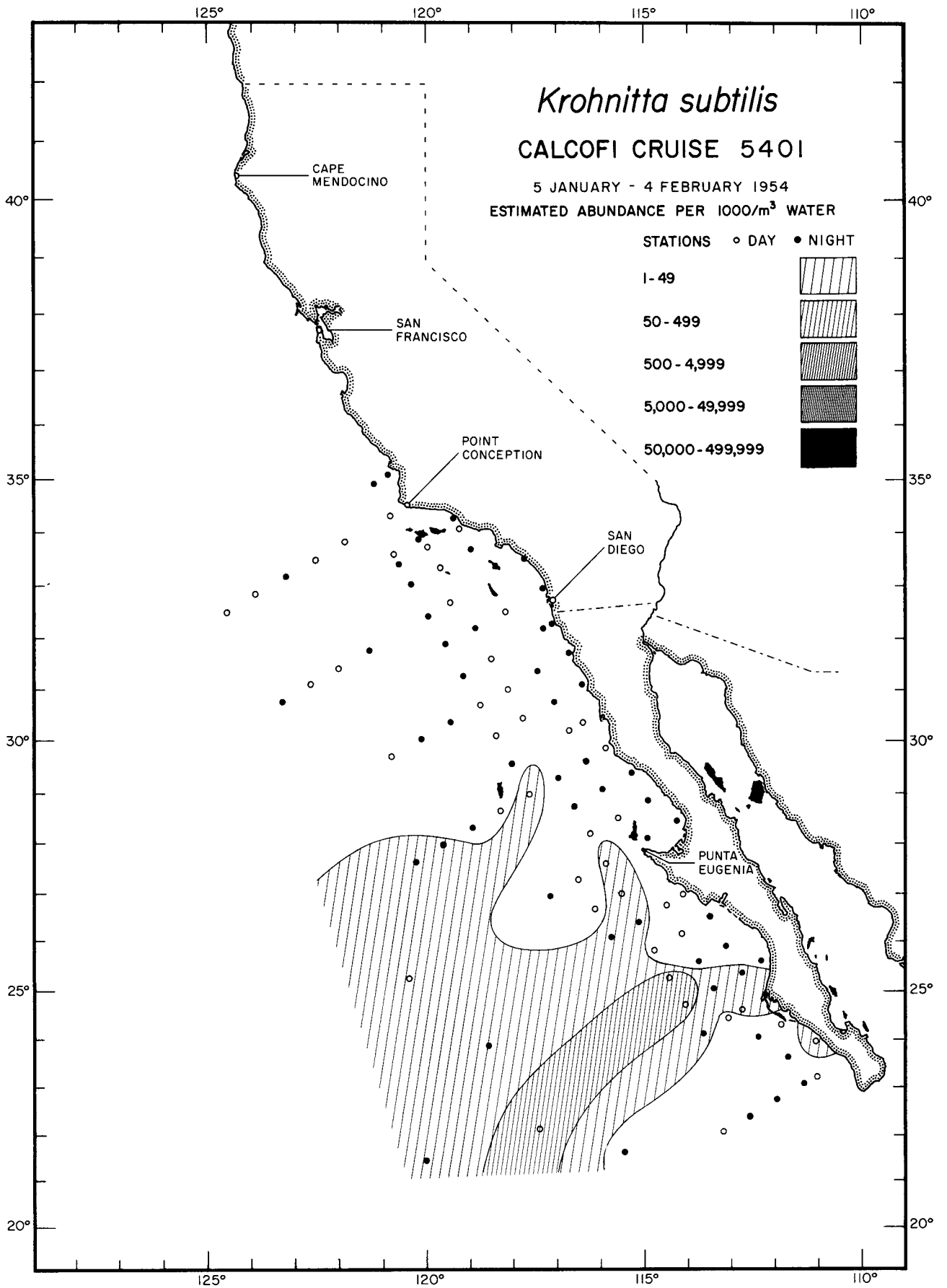


TEMPERATURE  
CONTOUR INTERVAL 1.0°C  
SALINITY  
CONTOUR INTERVAL 0.20‰  
OXYGEN  
CONTOUR INTERVAL 1.0 ml/L

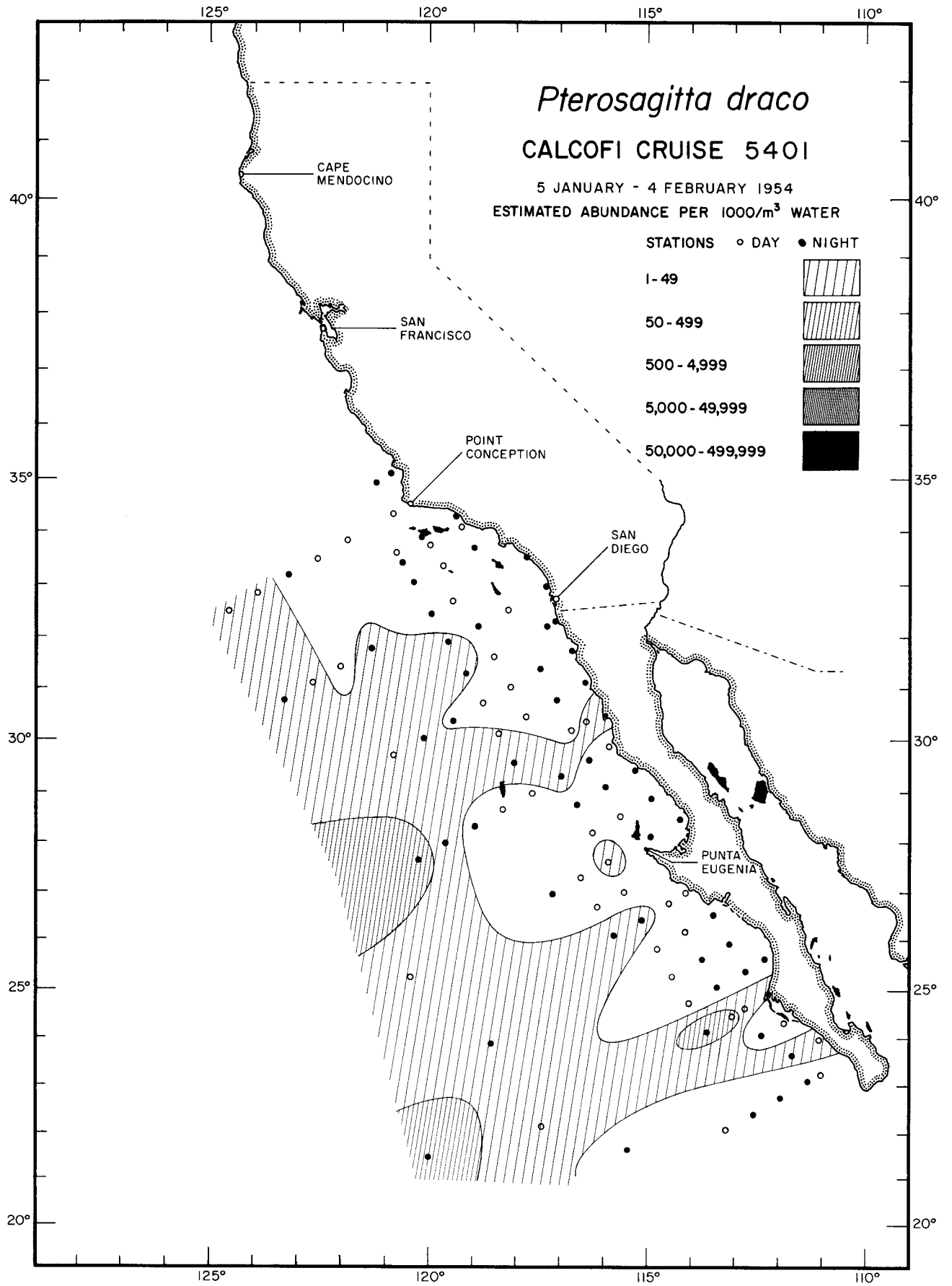




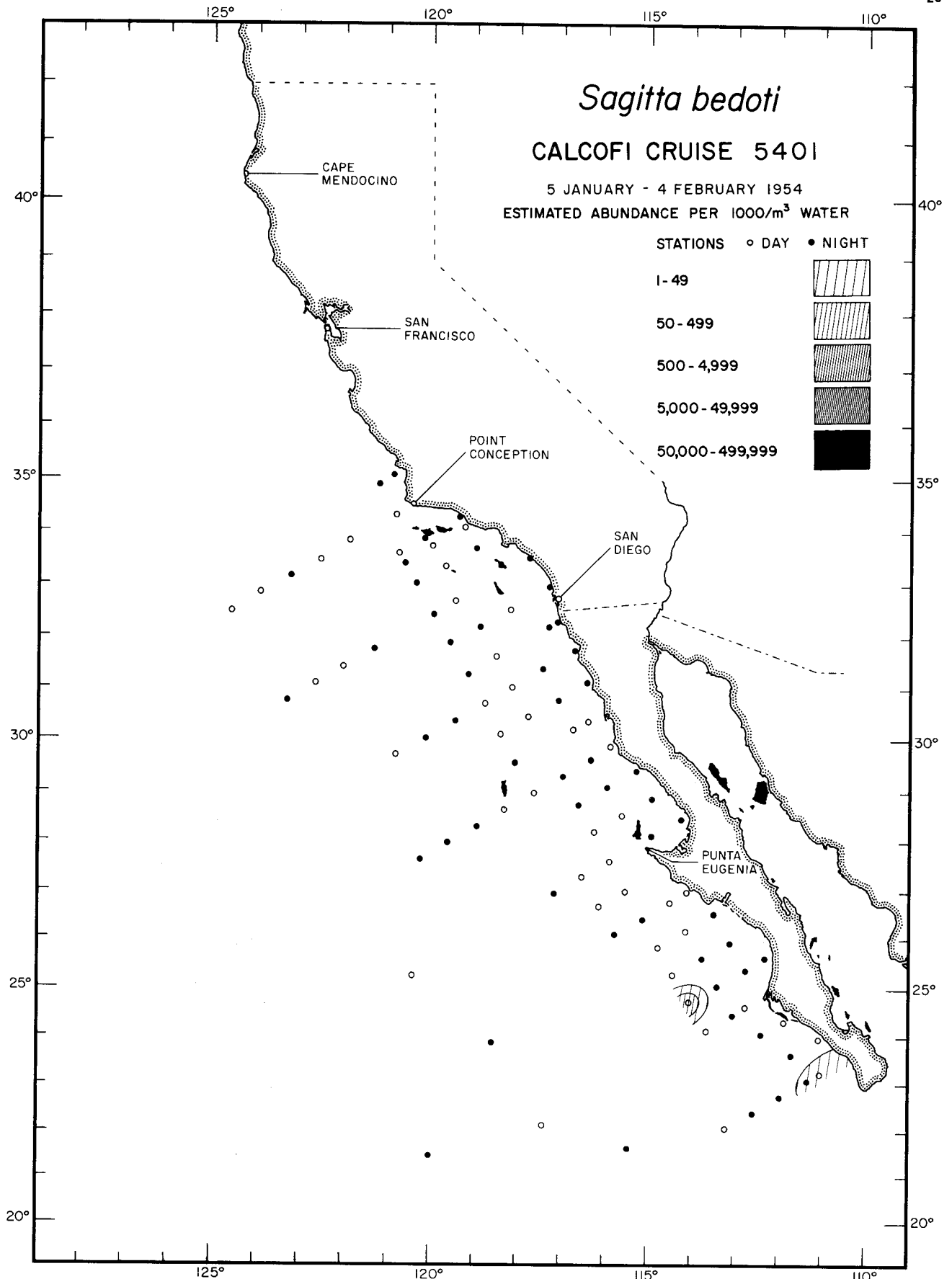
Chaetognatha  
*Krohnitta pacifica*  
5401



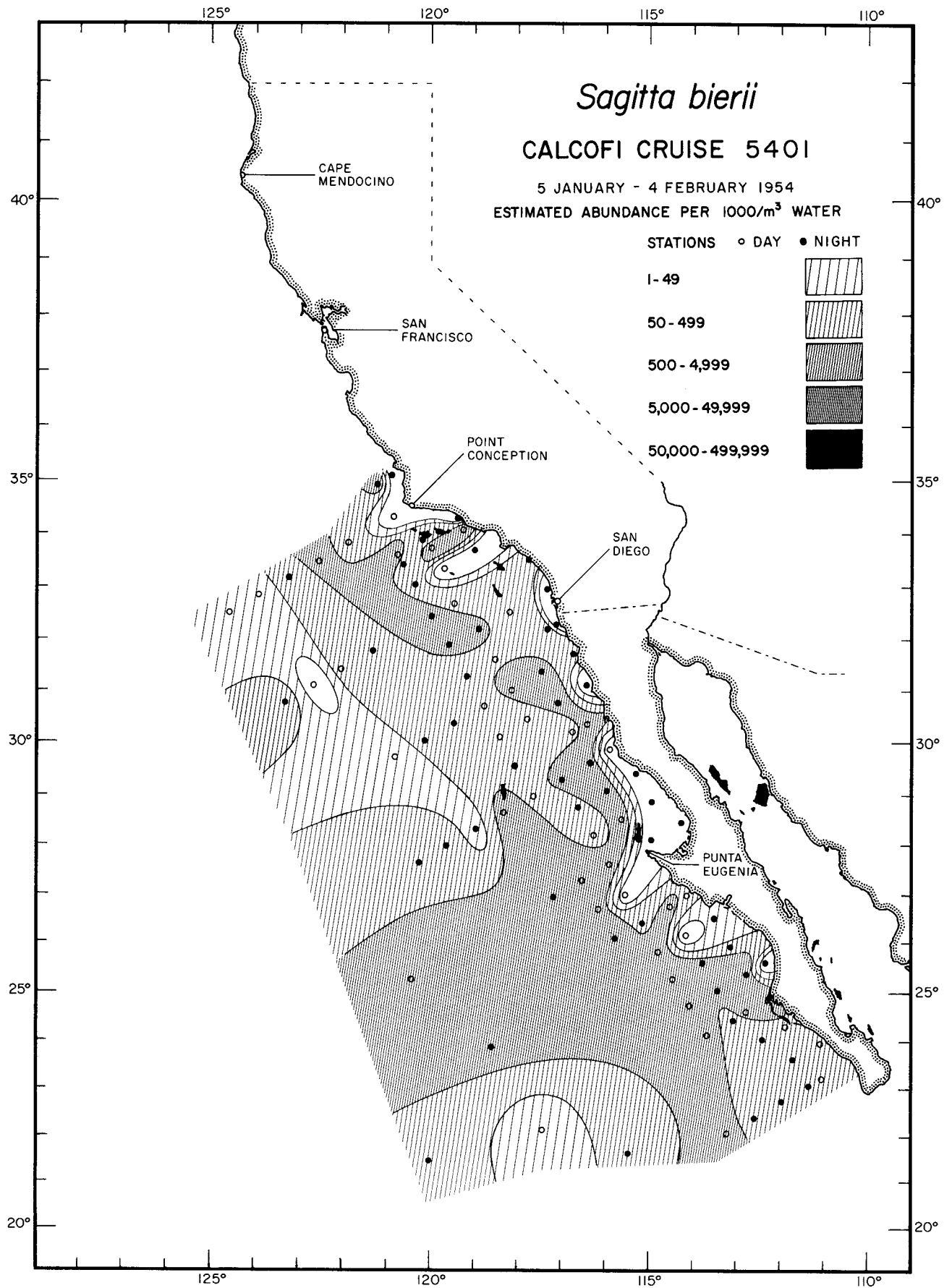
Chaetognatha  
*Krohnitta subtilis*  
5401



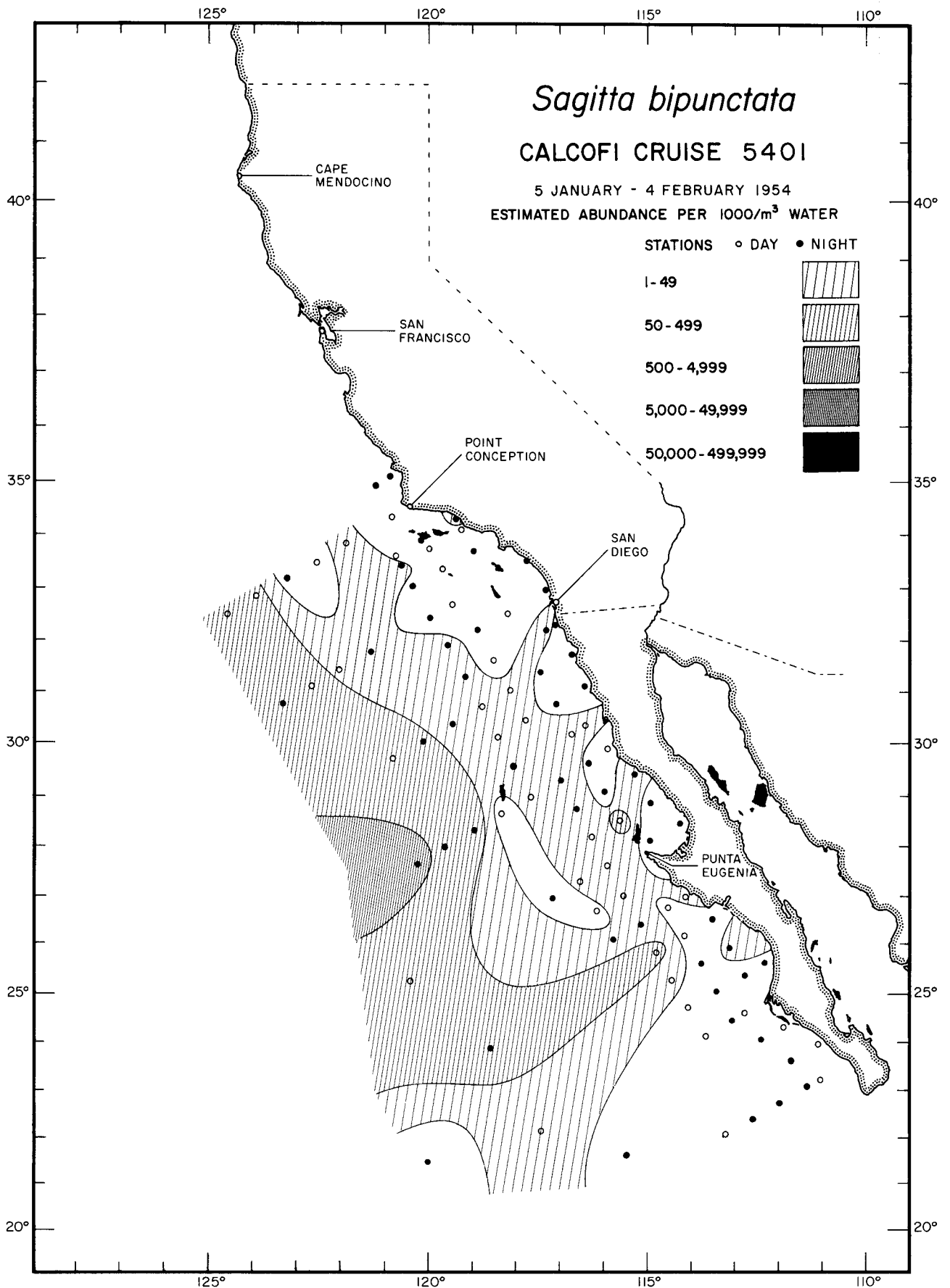
Chaetognatha  
*Pterosagitta draco*  
5401



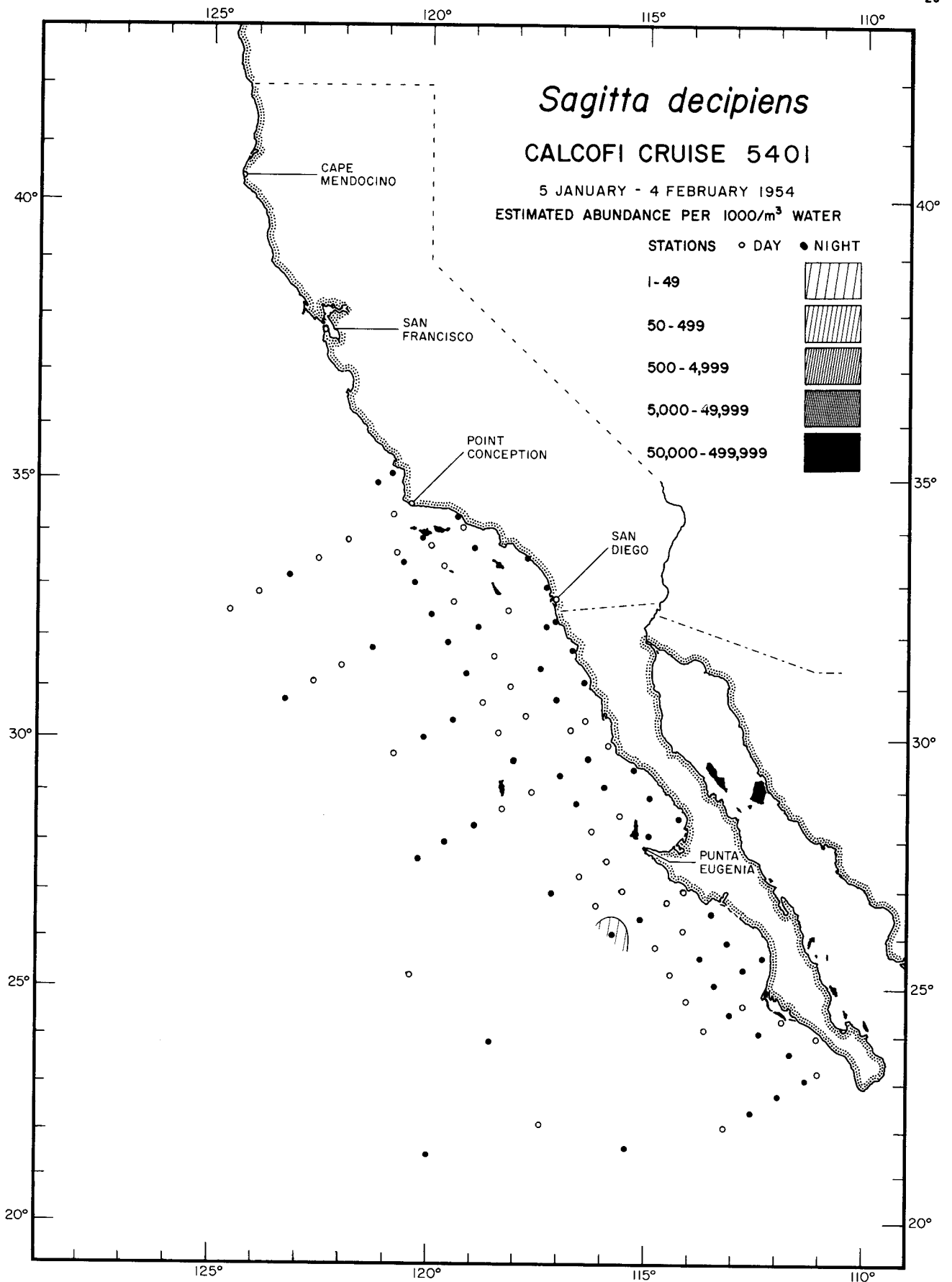
Chaetognatha  
*Sagitta bedoti*  
5401



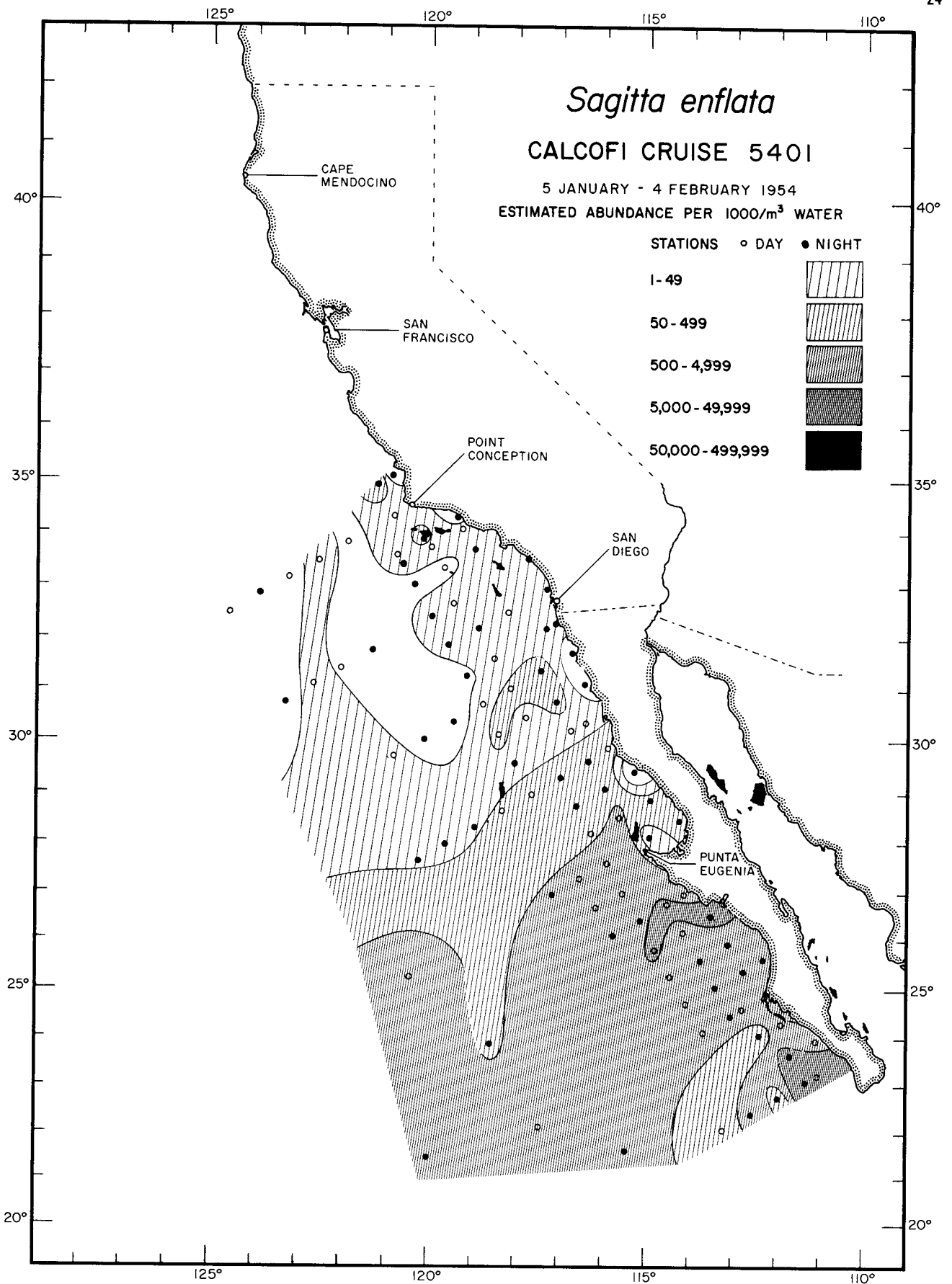
Chaetognatha  
*Sagitta bierii*  
5401



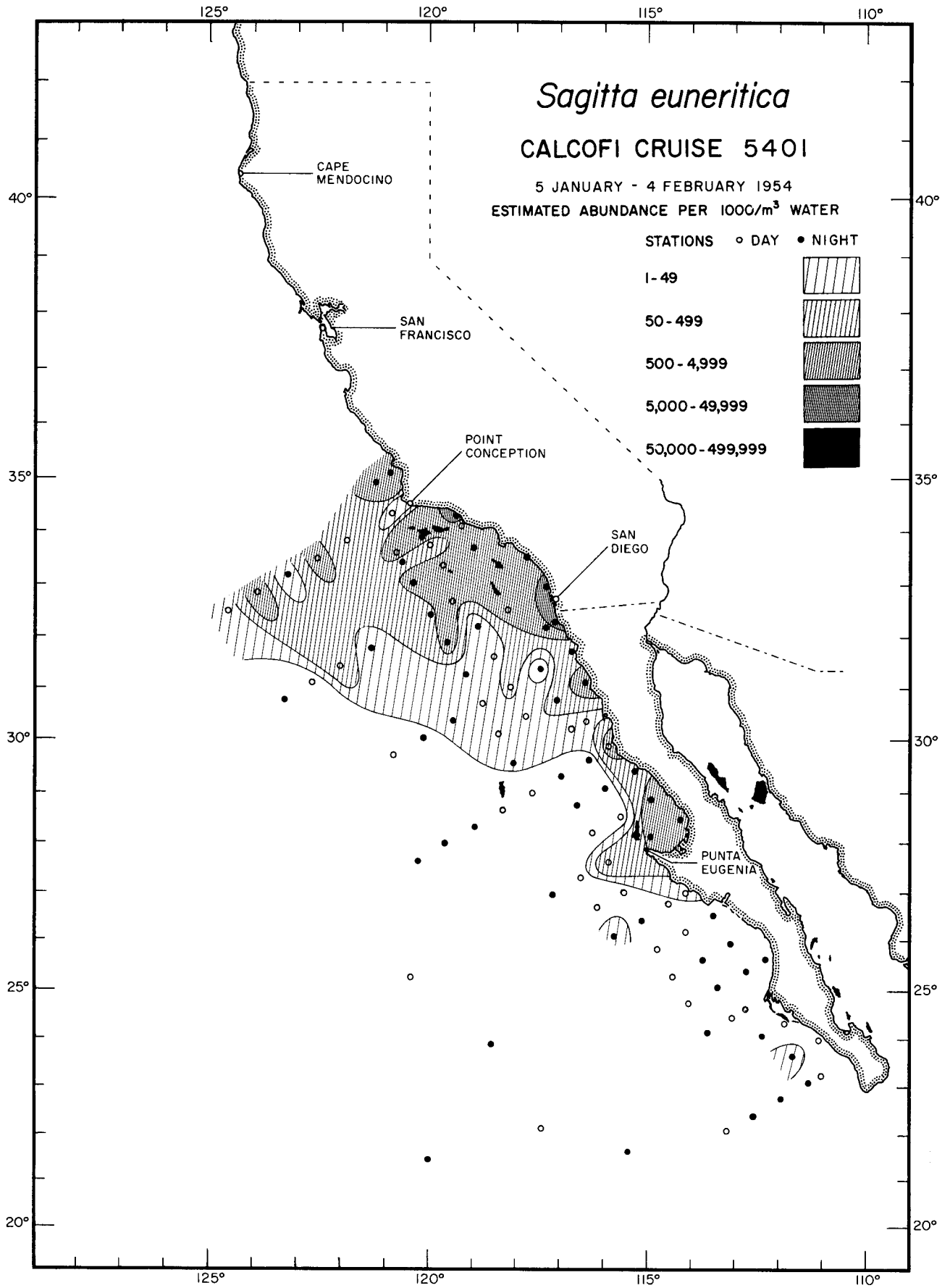
Chaetognatha  
*Sagitta bipunctata*  
5401



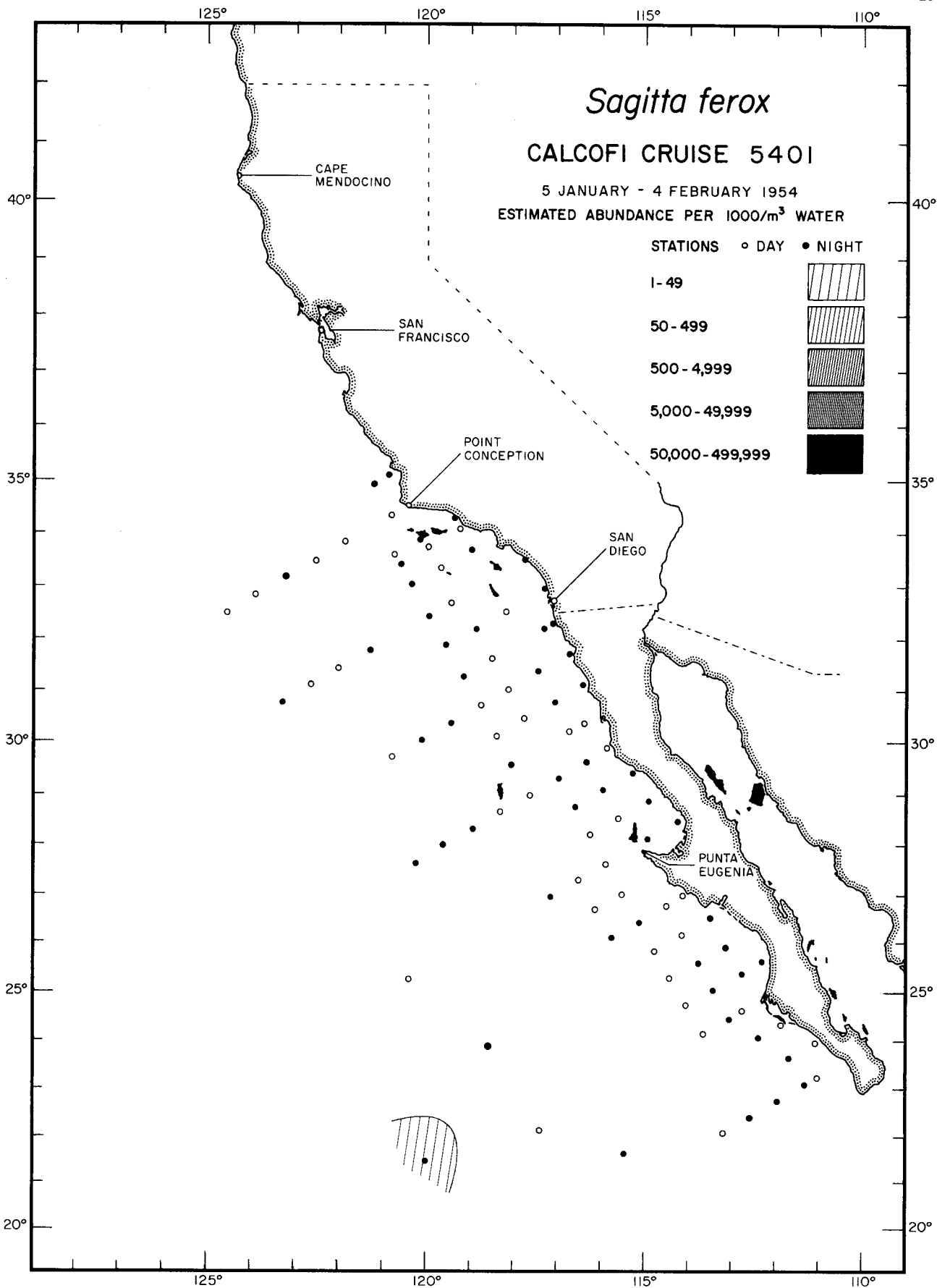
Chaetognatha  
*Sagitta decipiens*  
 5401



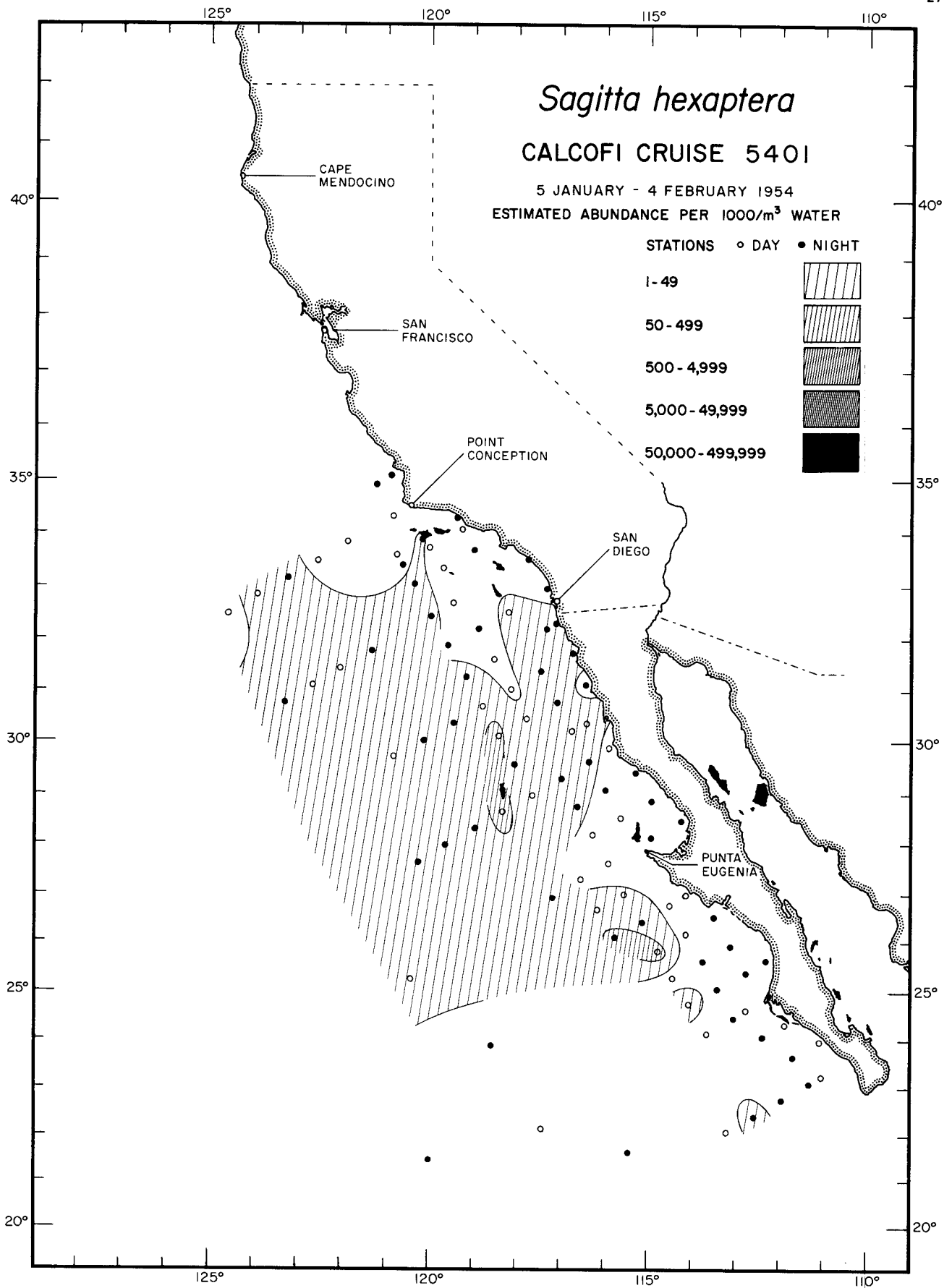




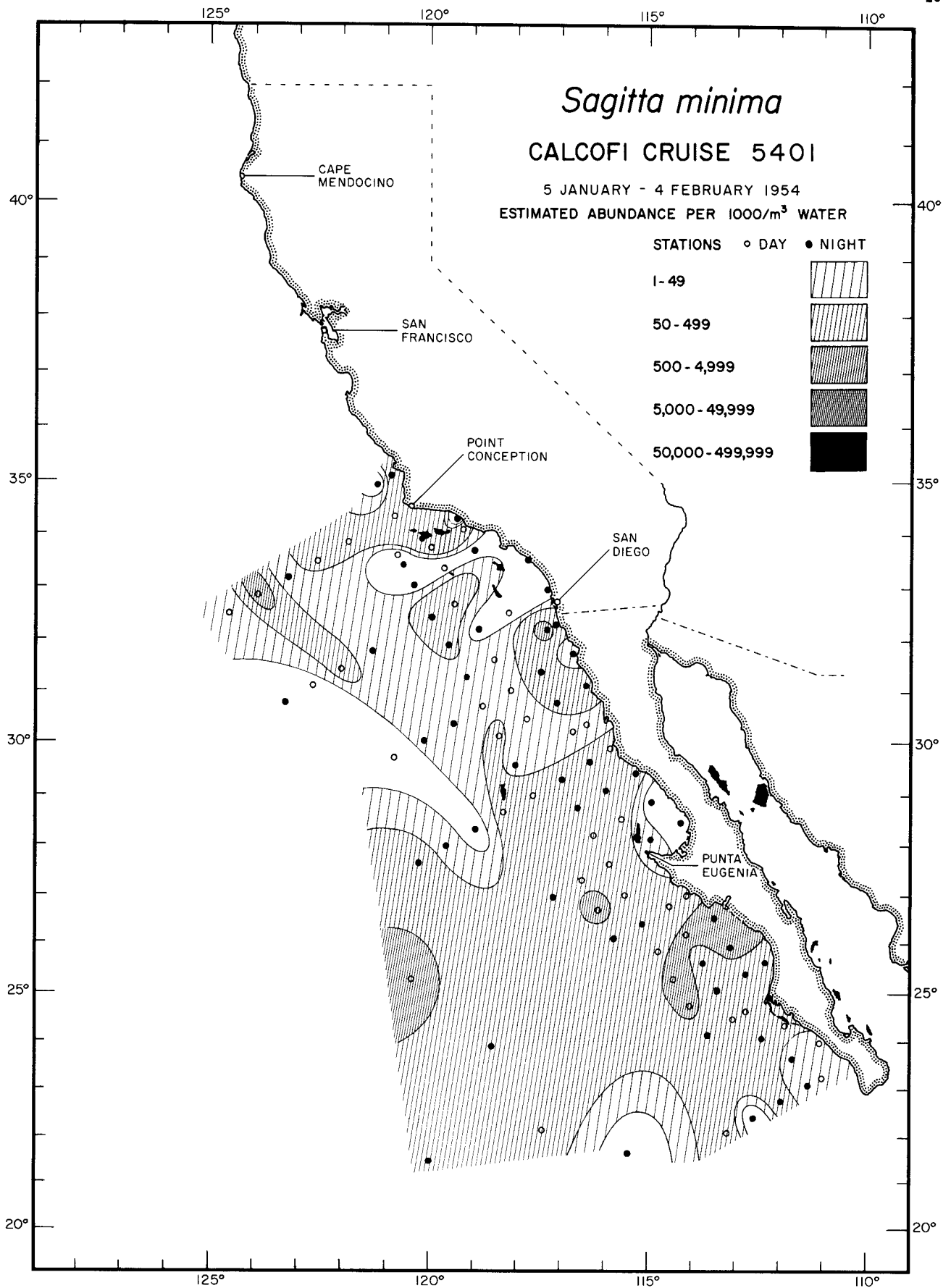
Chaetognatha  
*Sagitta euneritica*  
5401

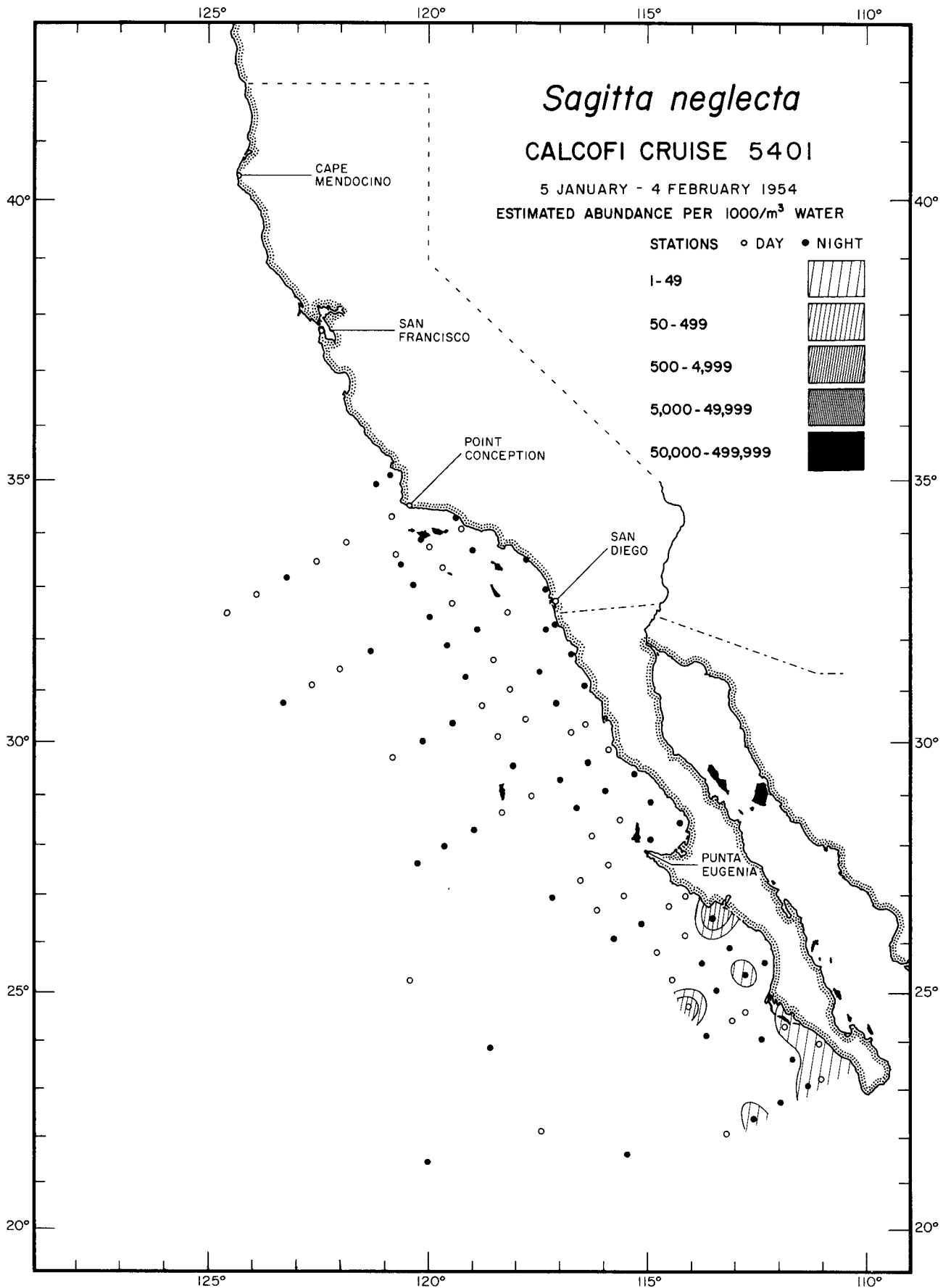


Chaetognatha  
*Sagitta ferox*  
5401

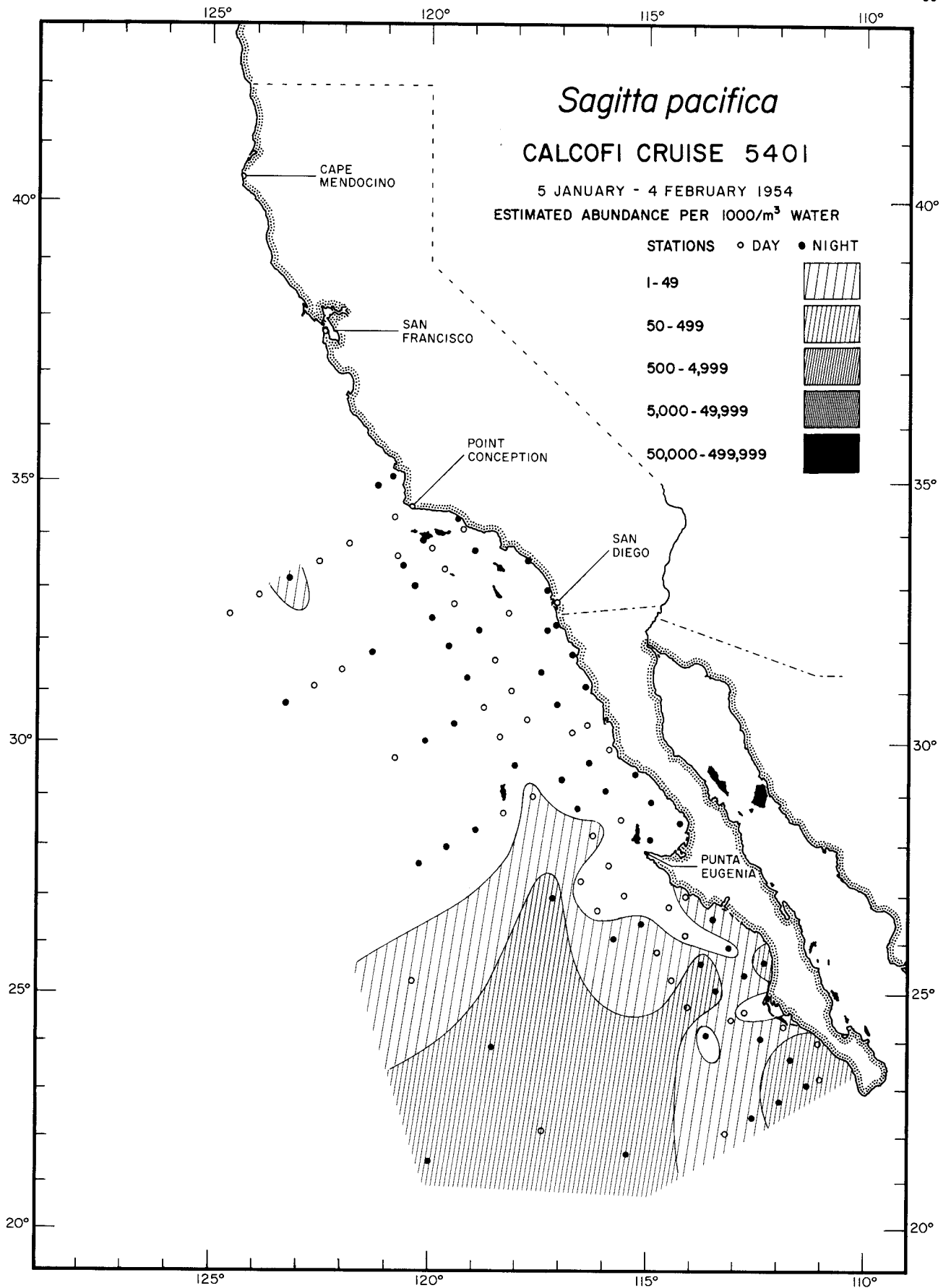


Chaetognatha  
*Sagitta hexaptera*  
 5401

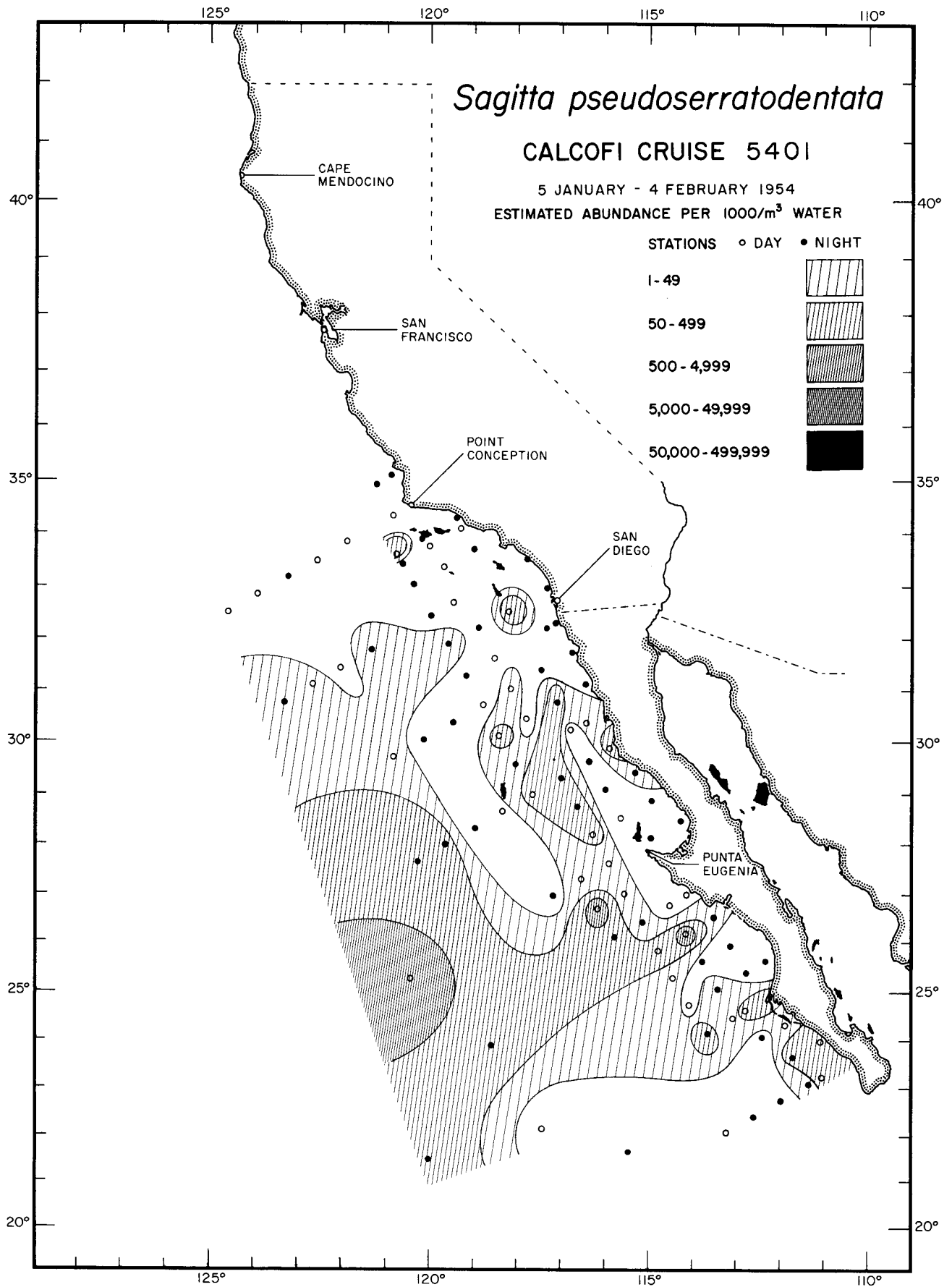




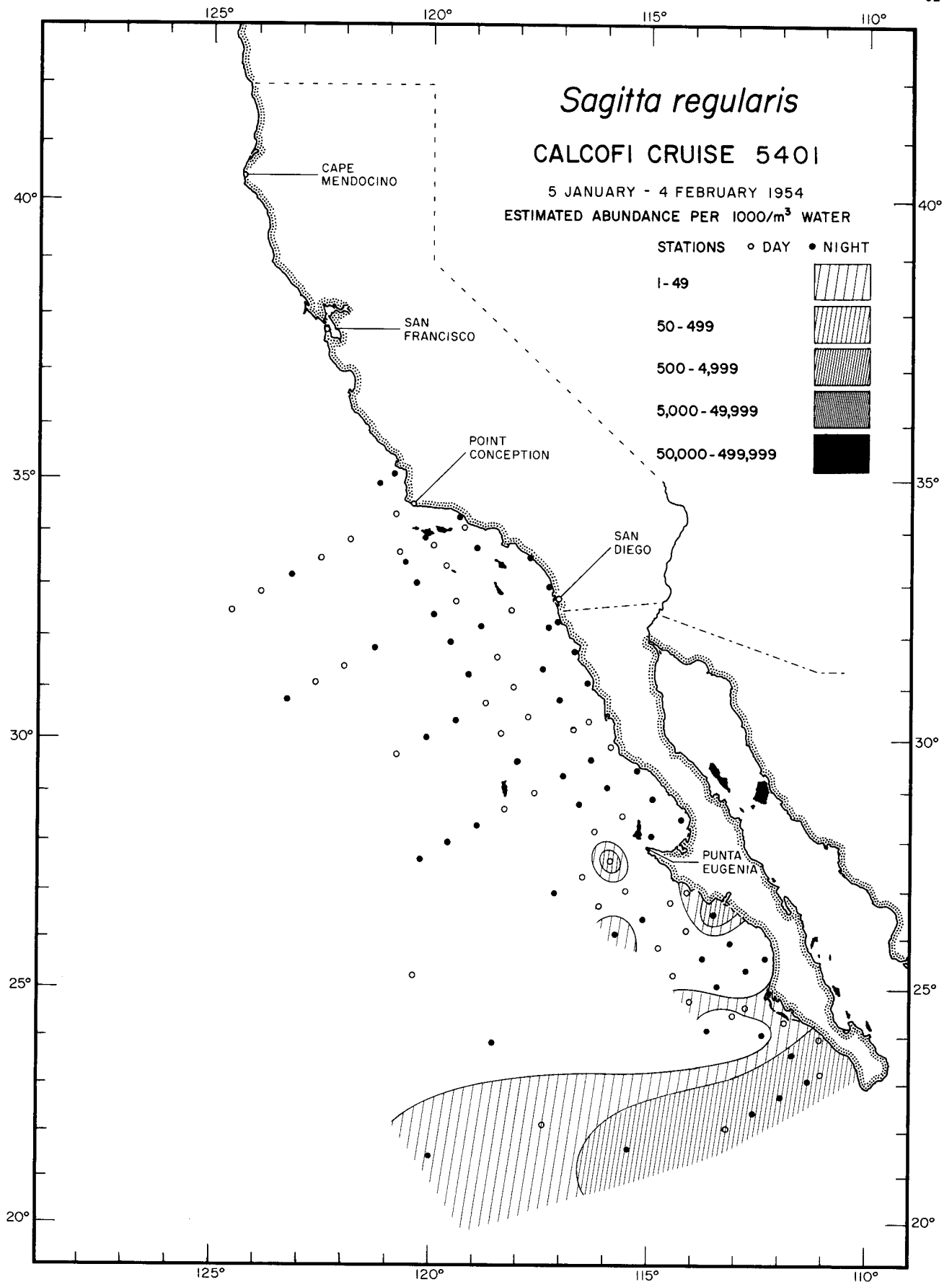
Chaetognatha  
*Sagitta neglecta*  
5401



Chaetognatha  
*Sagitta pacifica*  
5401

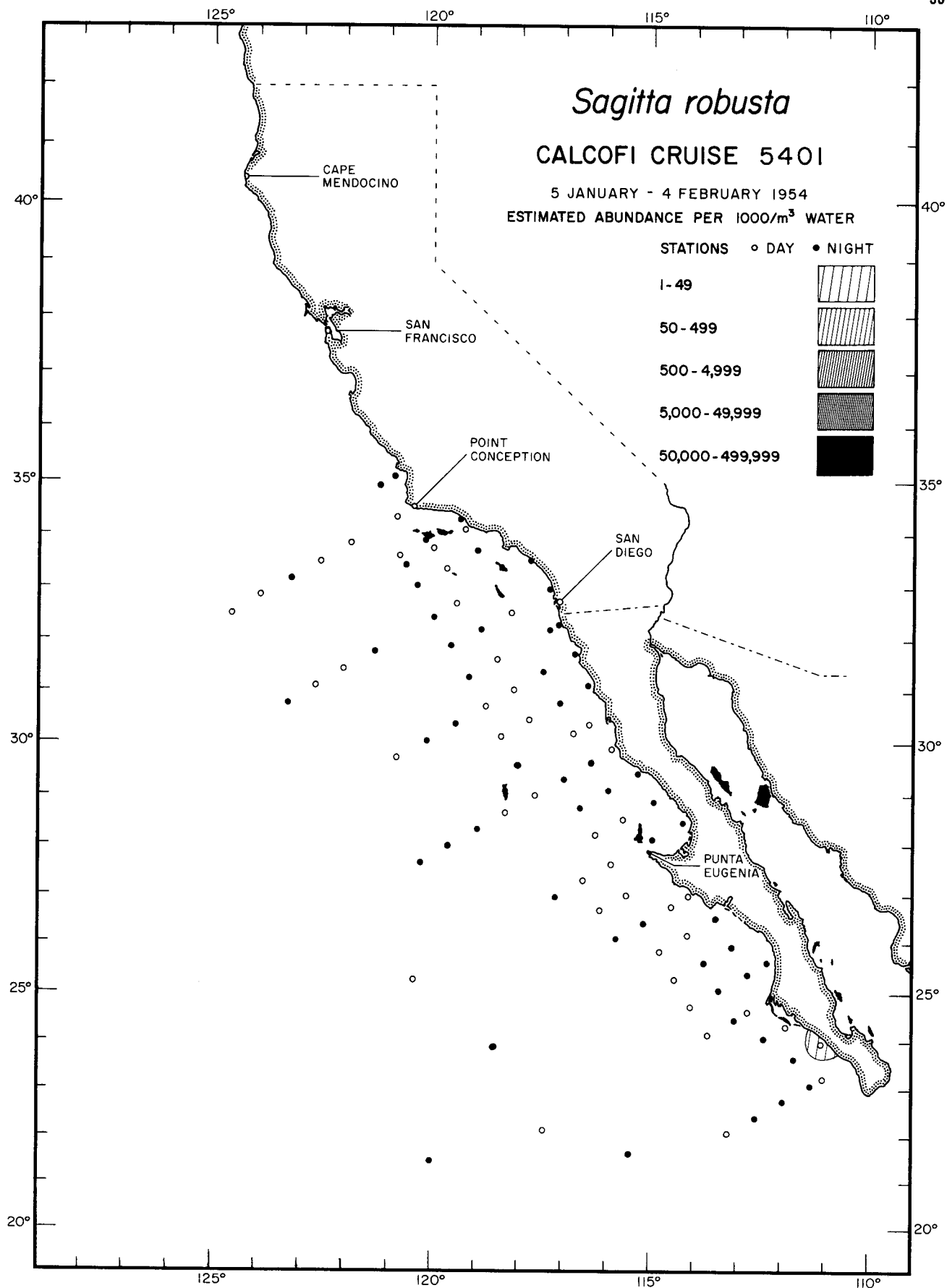


Chaetognatha  
*Sagitta pseudoserratodentata*  
5401

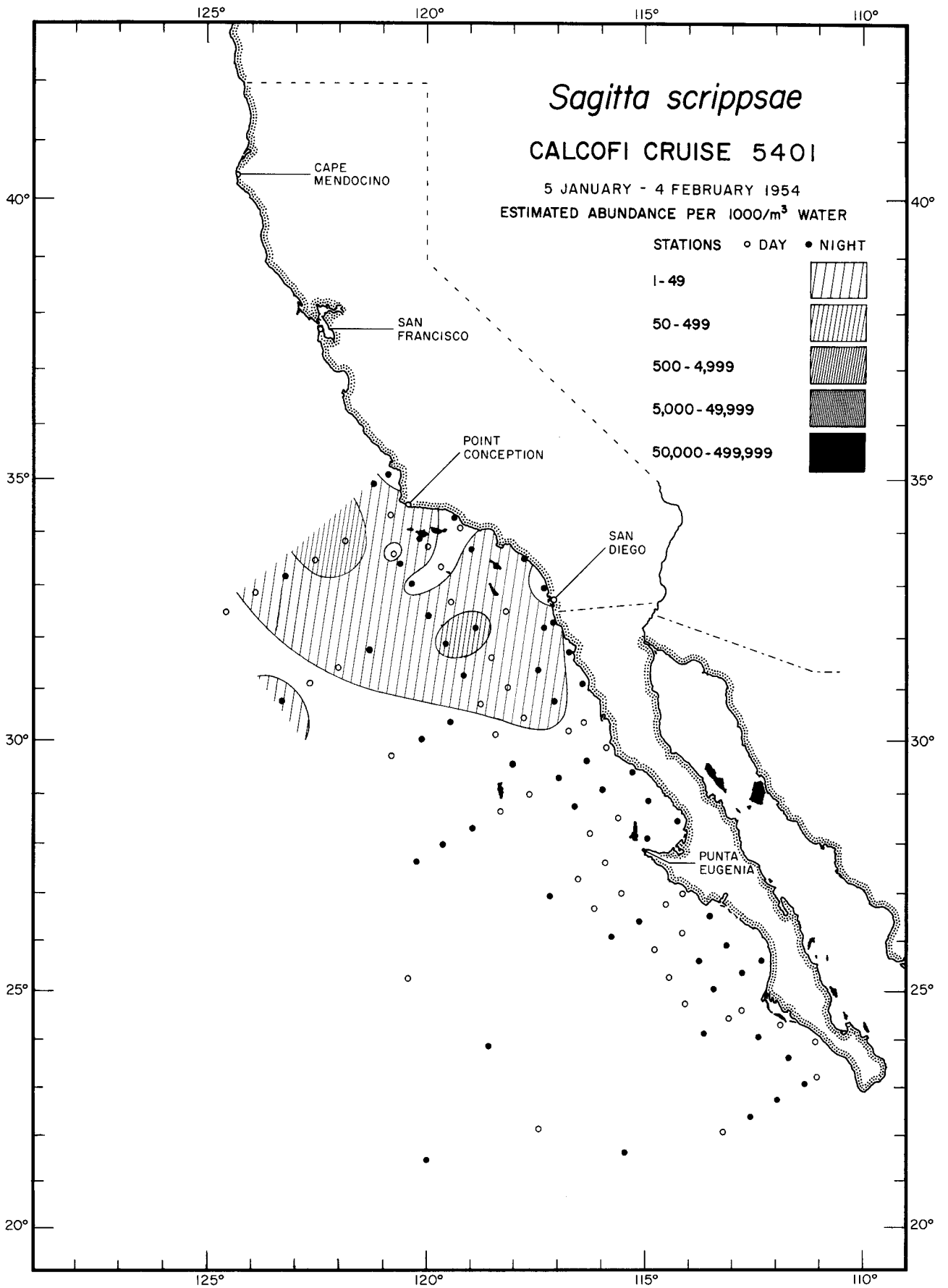


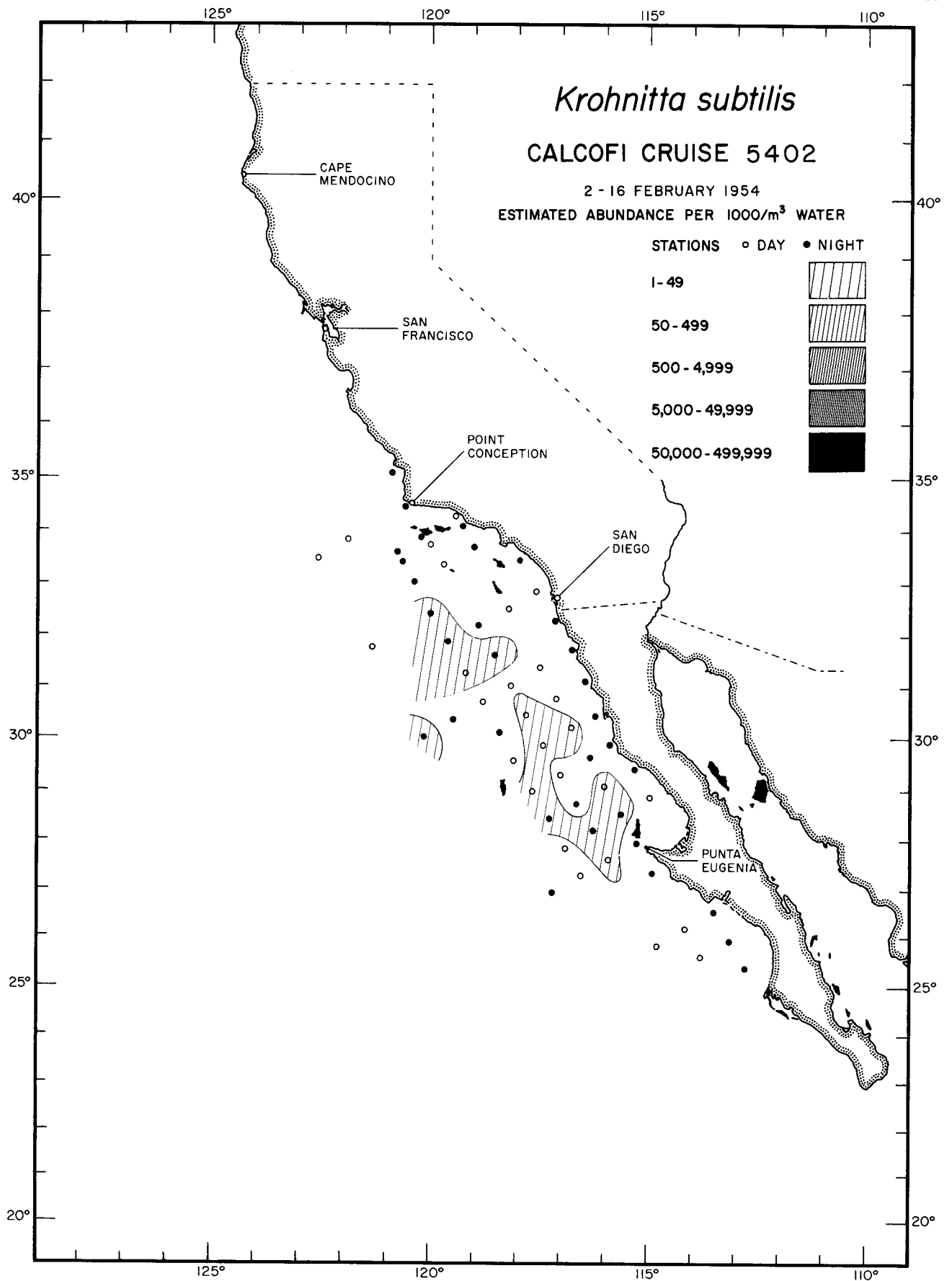
Chaetognatha  
*Sagitta regularis*  
5401



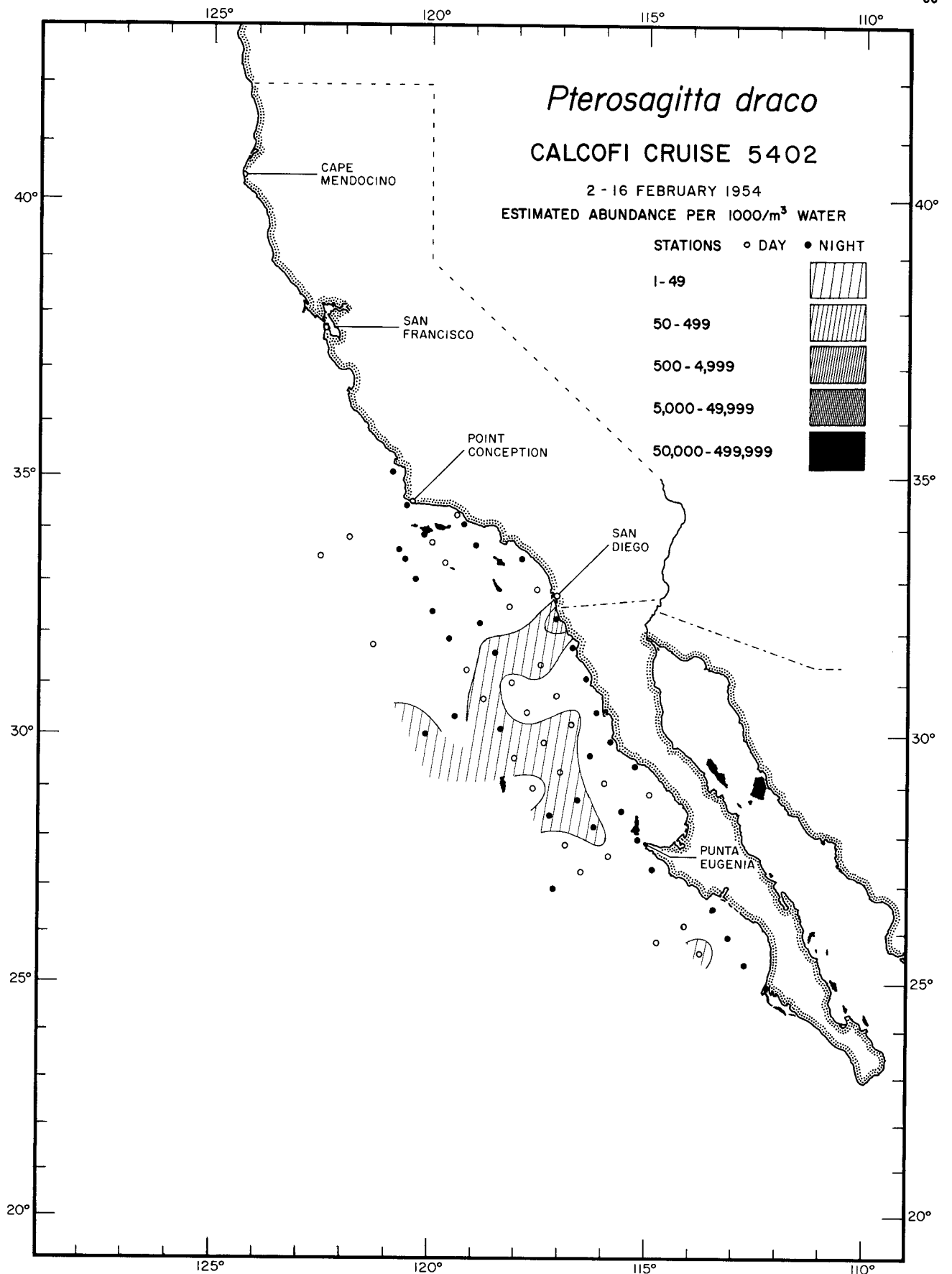


Chaetognatha  
*Sagitta robusta*  
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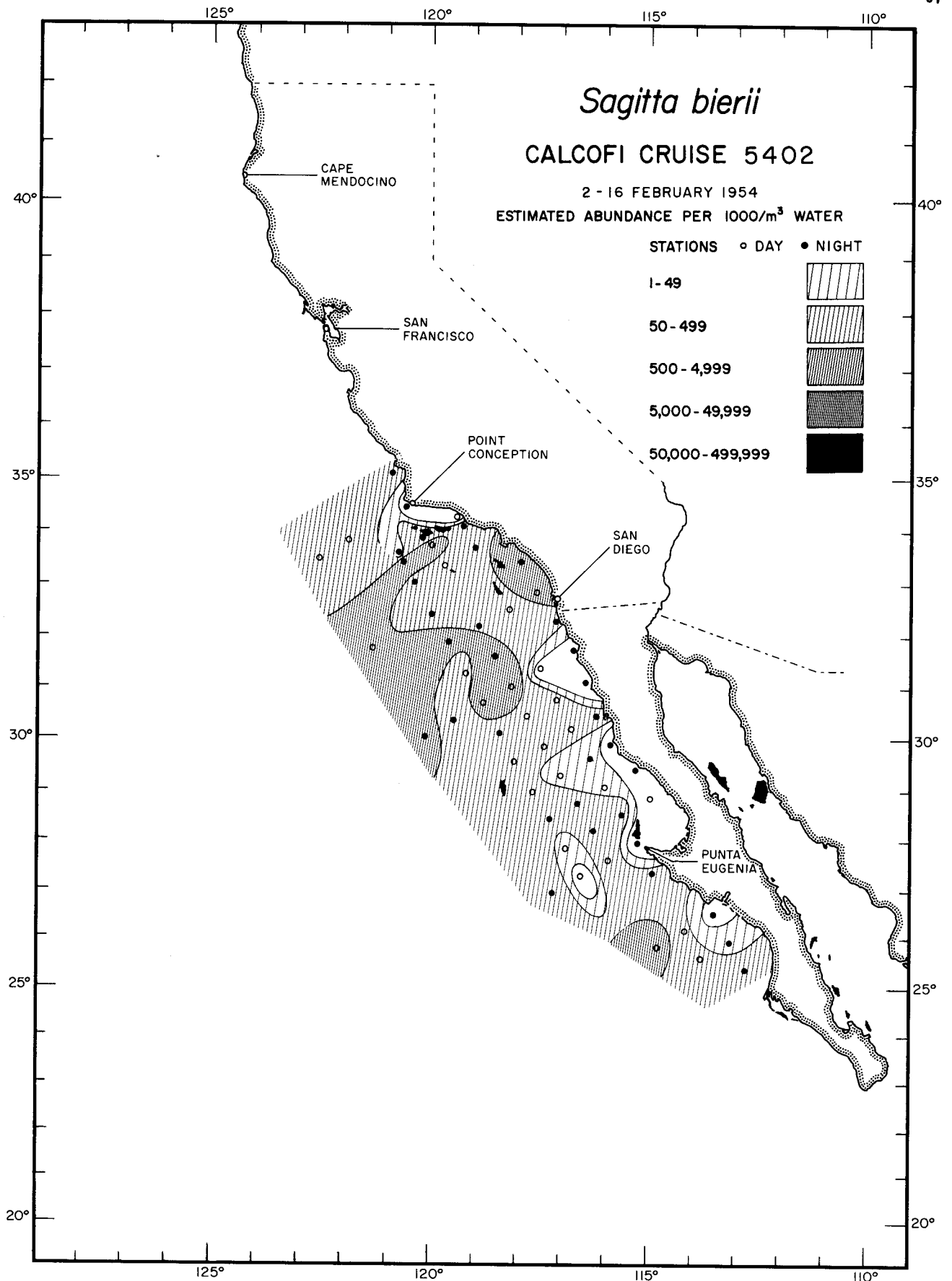




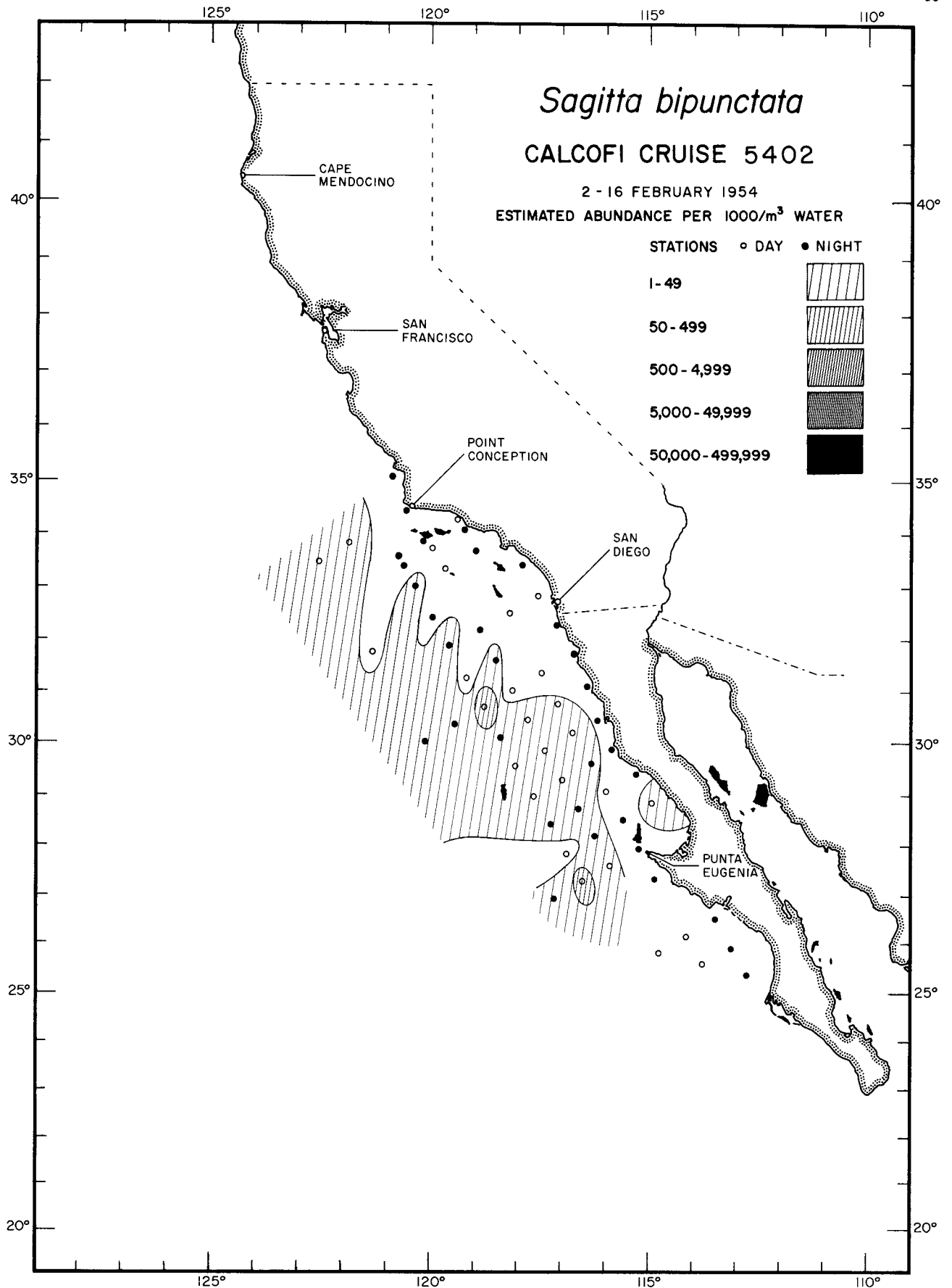
Chaetognatha  
*Krohnitta subtilis*  
5402



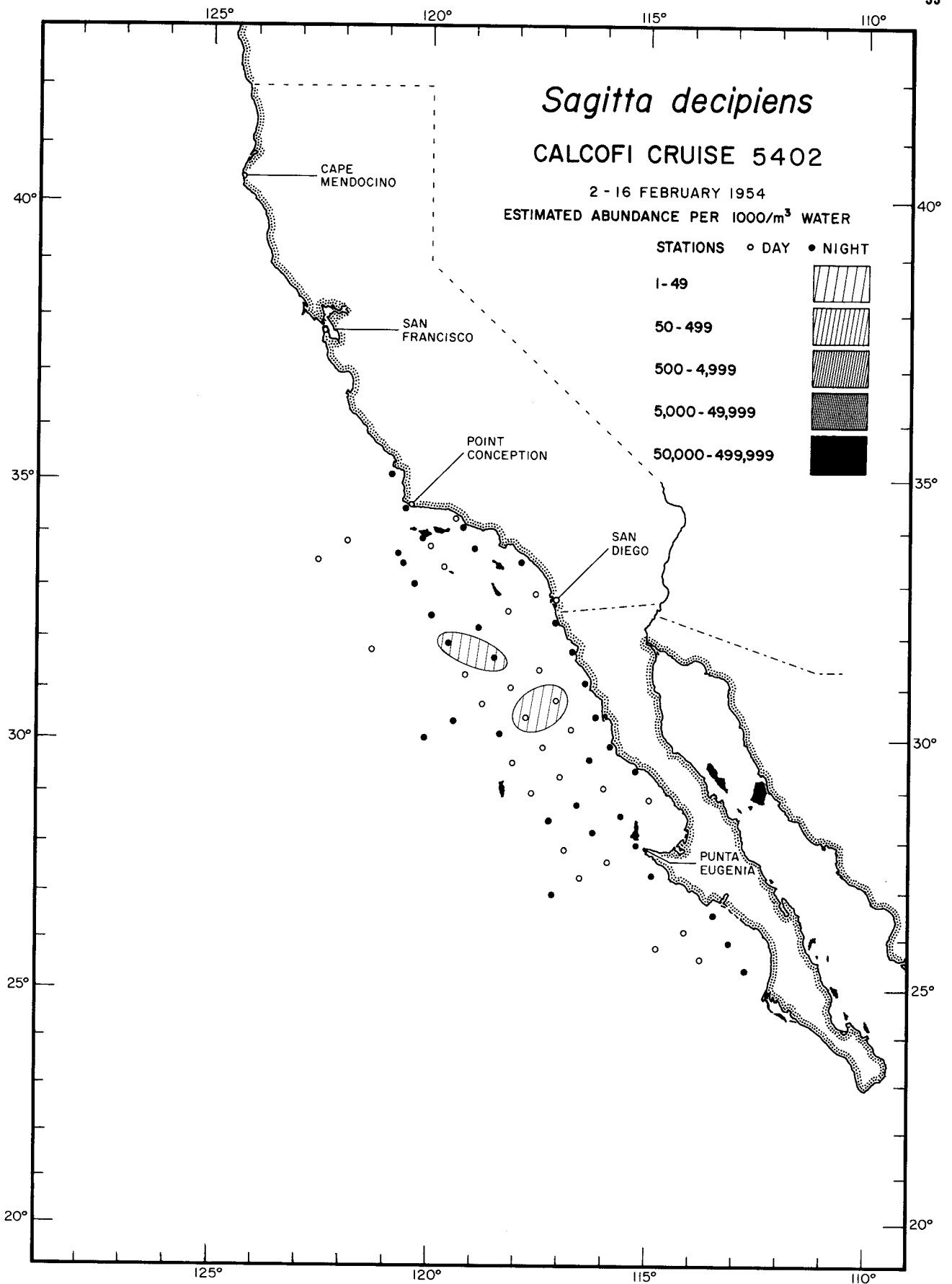
Chaetognatha  
*Pterosagitta draco*  
5402



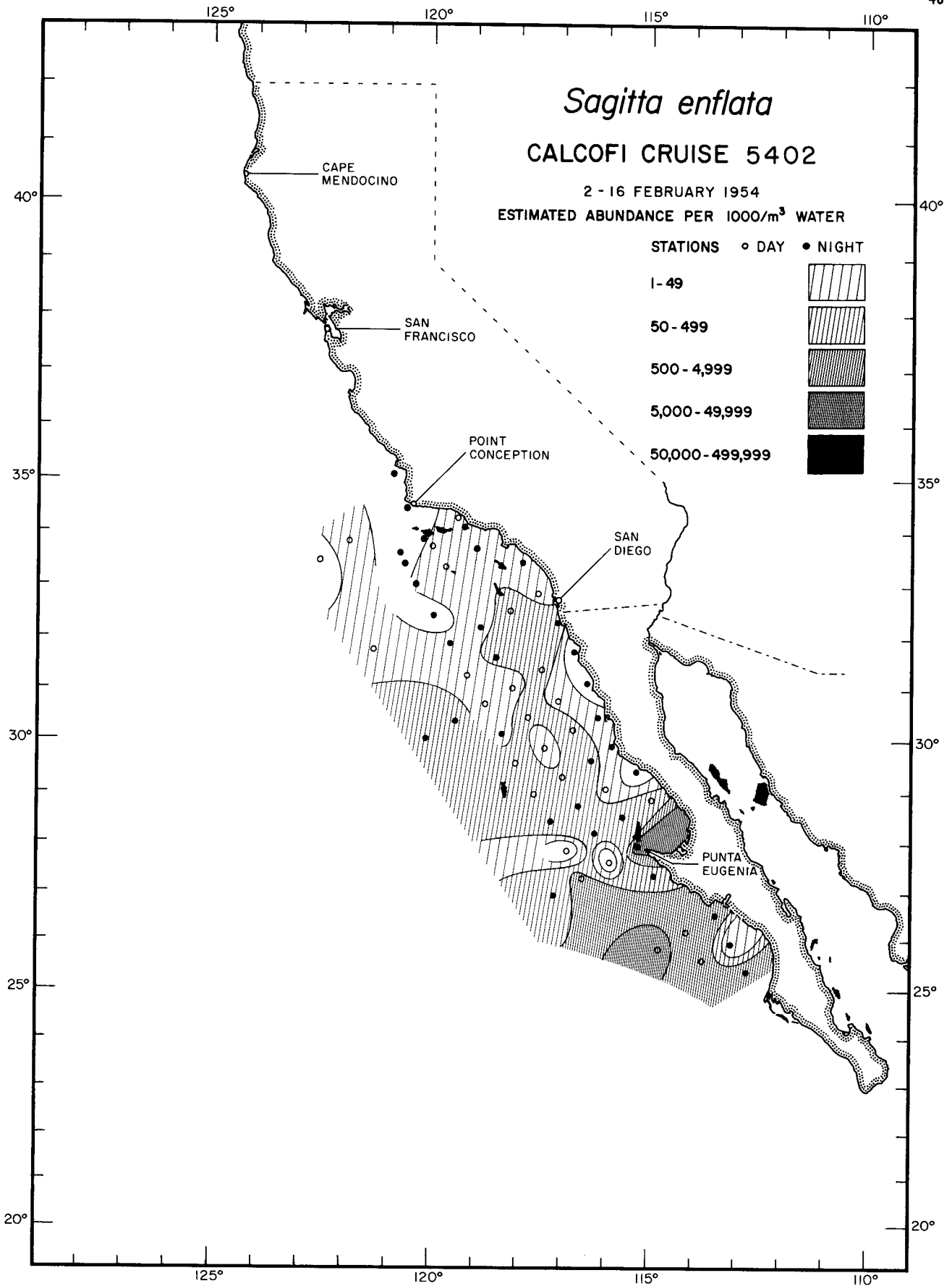
Chaetognatha  
*Sagitta bierii*  
5402



Chaetognatha  
*Sagitta bipunctata*  
5402

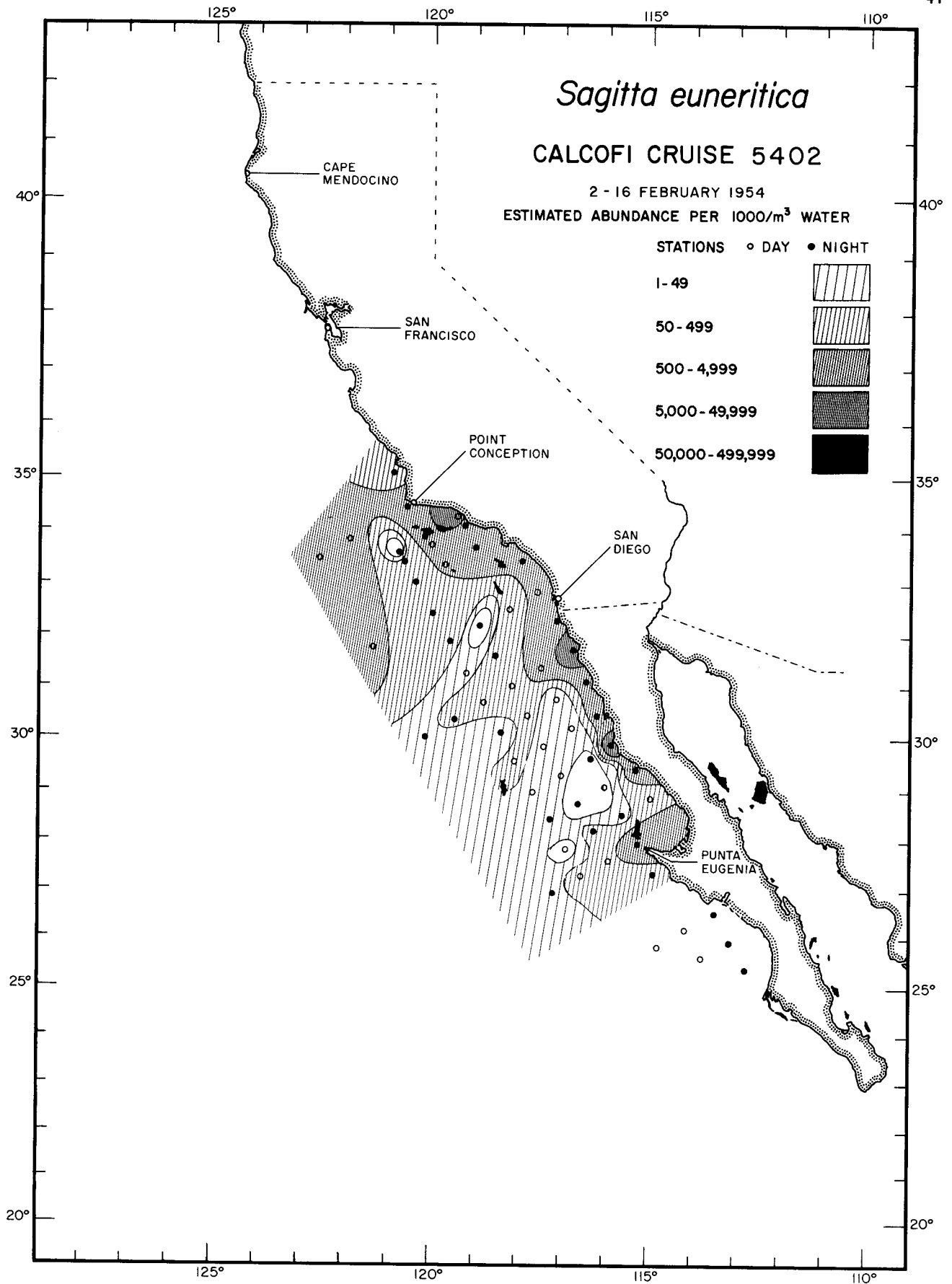


Chaetognatha  
*Sagitta decipiens*  
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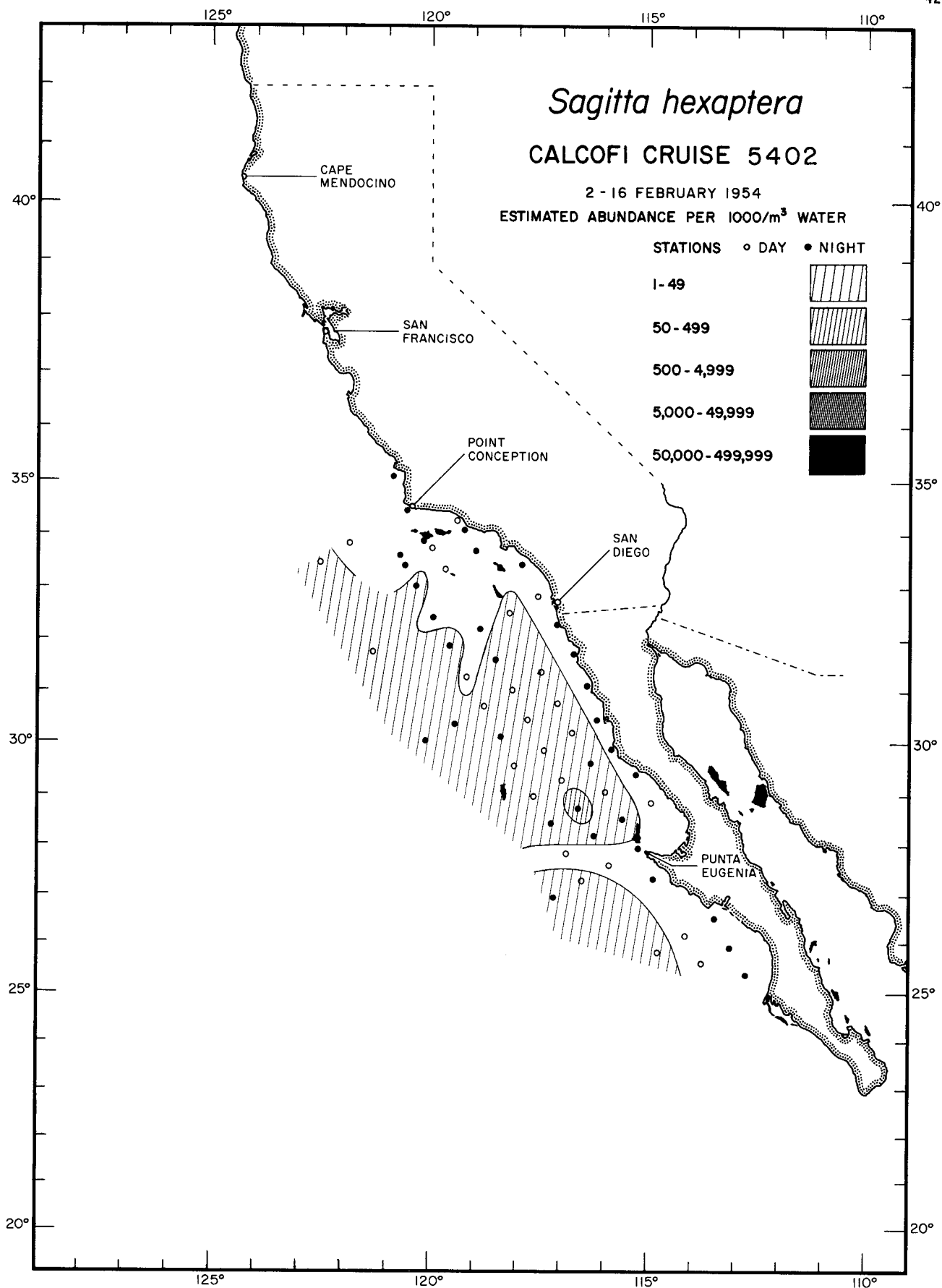


Chaetognatha  
*Sagitta enflata*  
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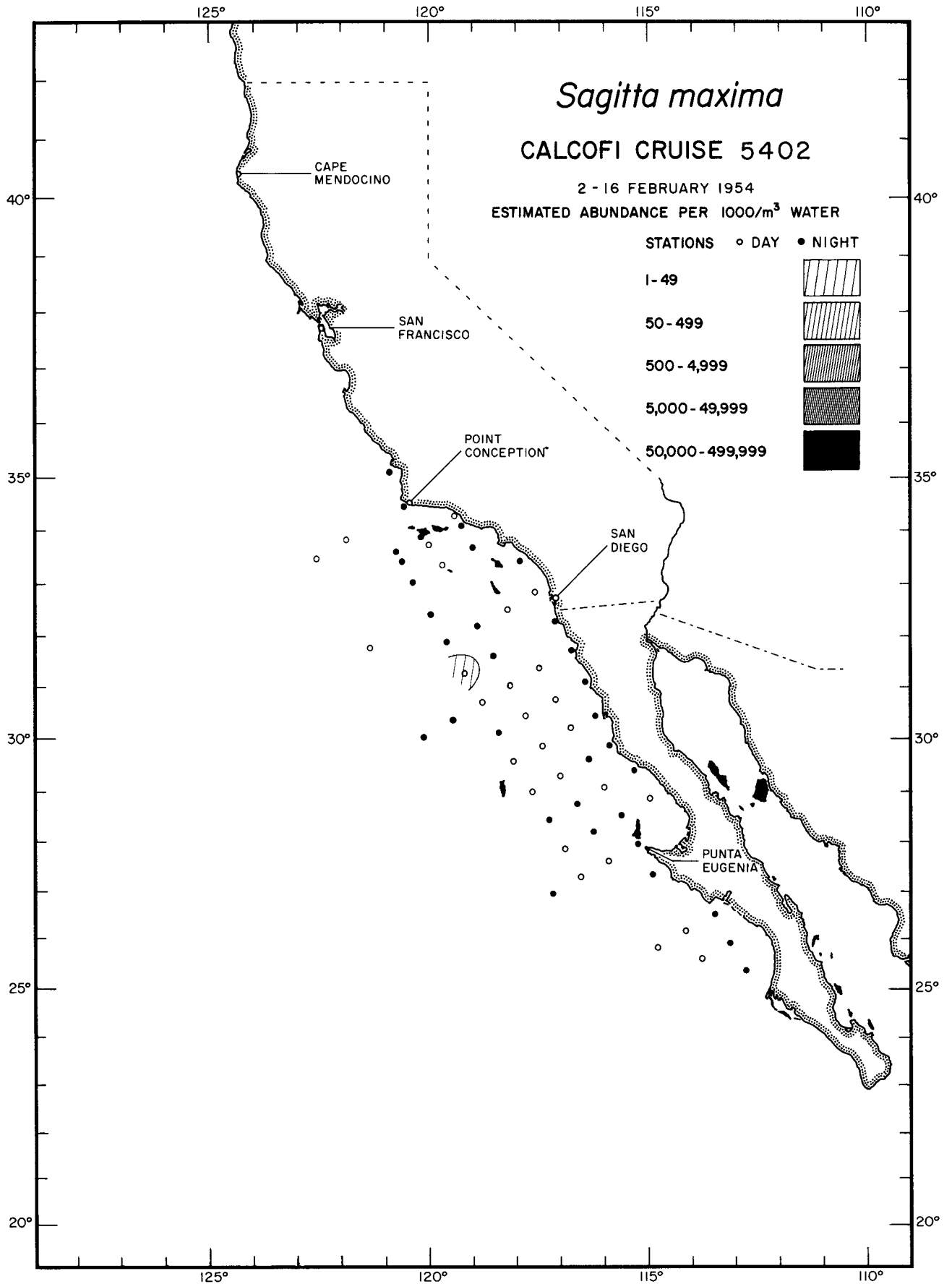




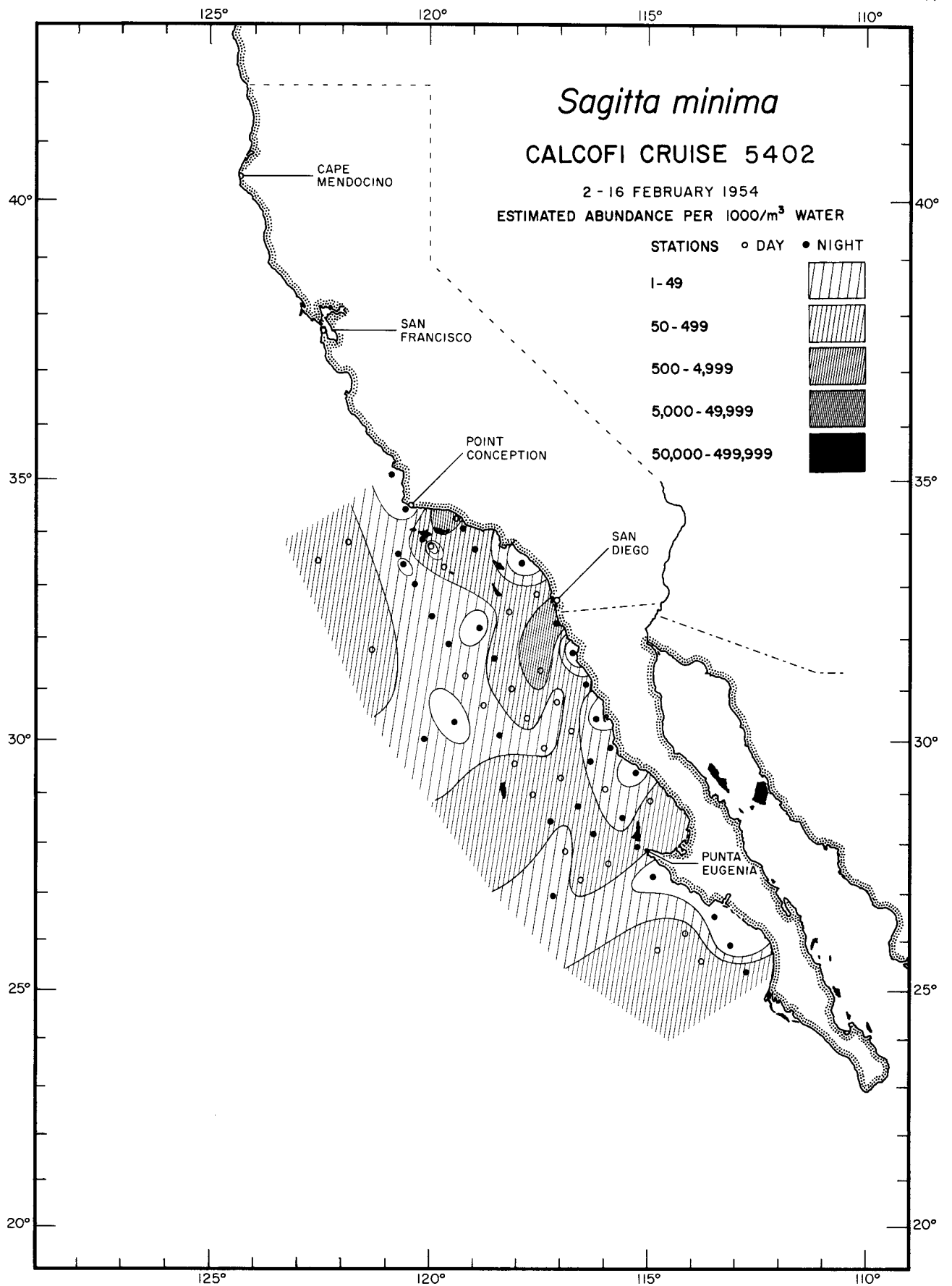
Chaetognatha  
*Sagitta euneritica*  
5402



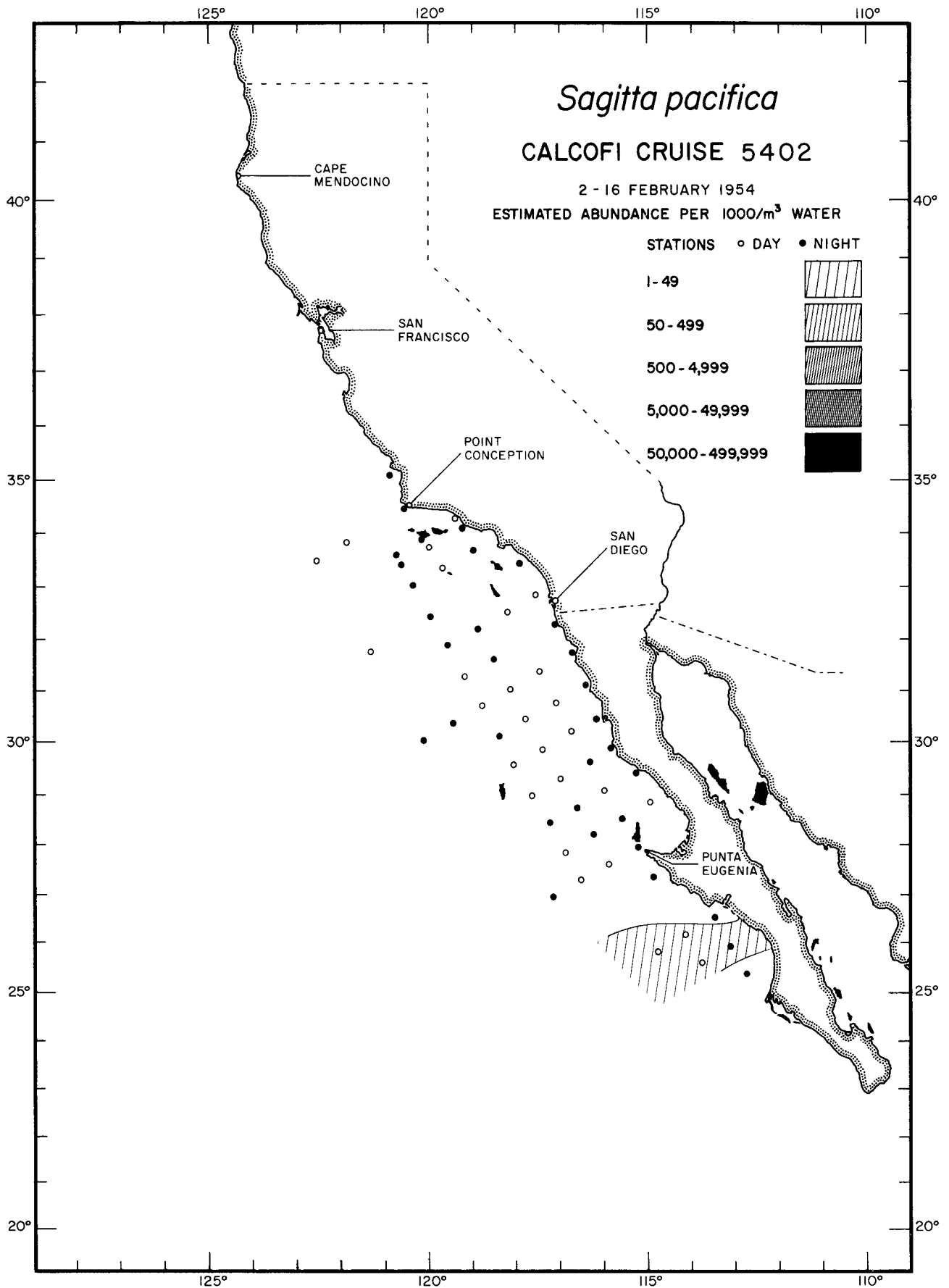
Chaetognatha  
*Sagitta hexaptera*  
5402



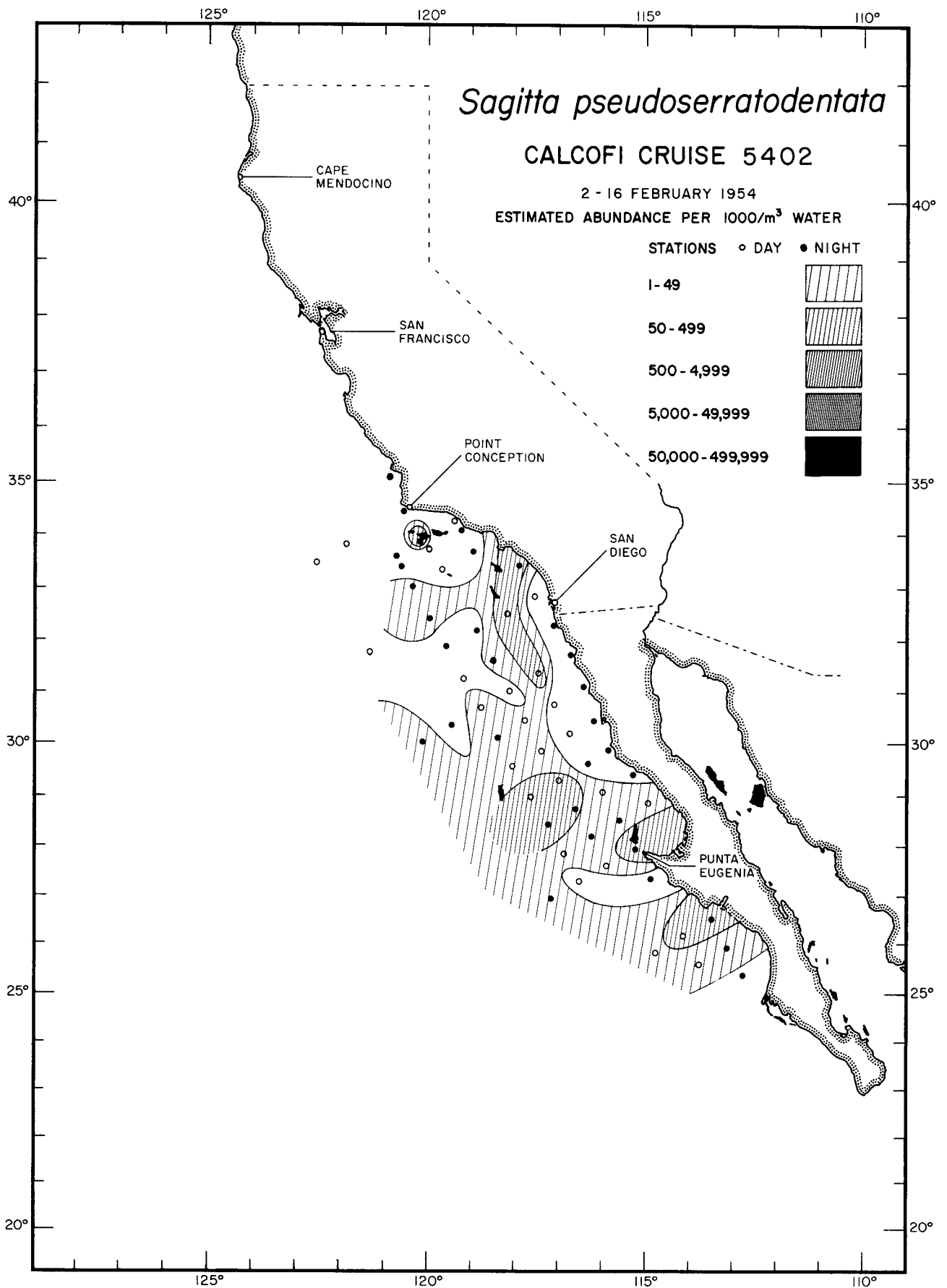
Chaetognatha  
*Sagitta maxima*  
5402



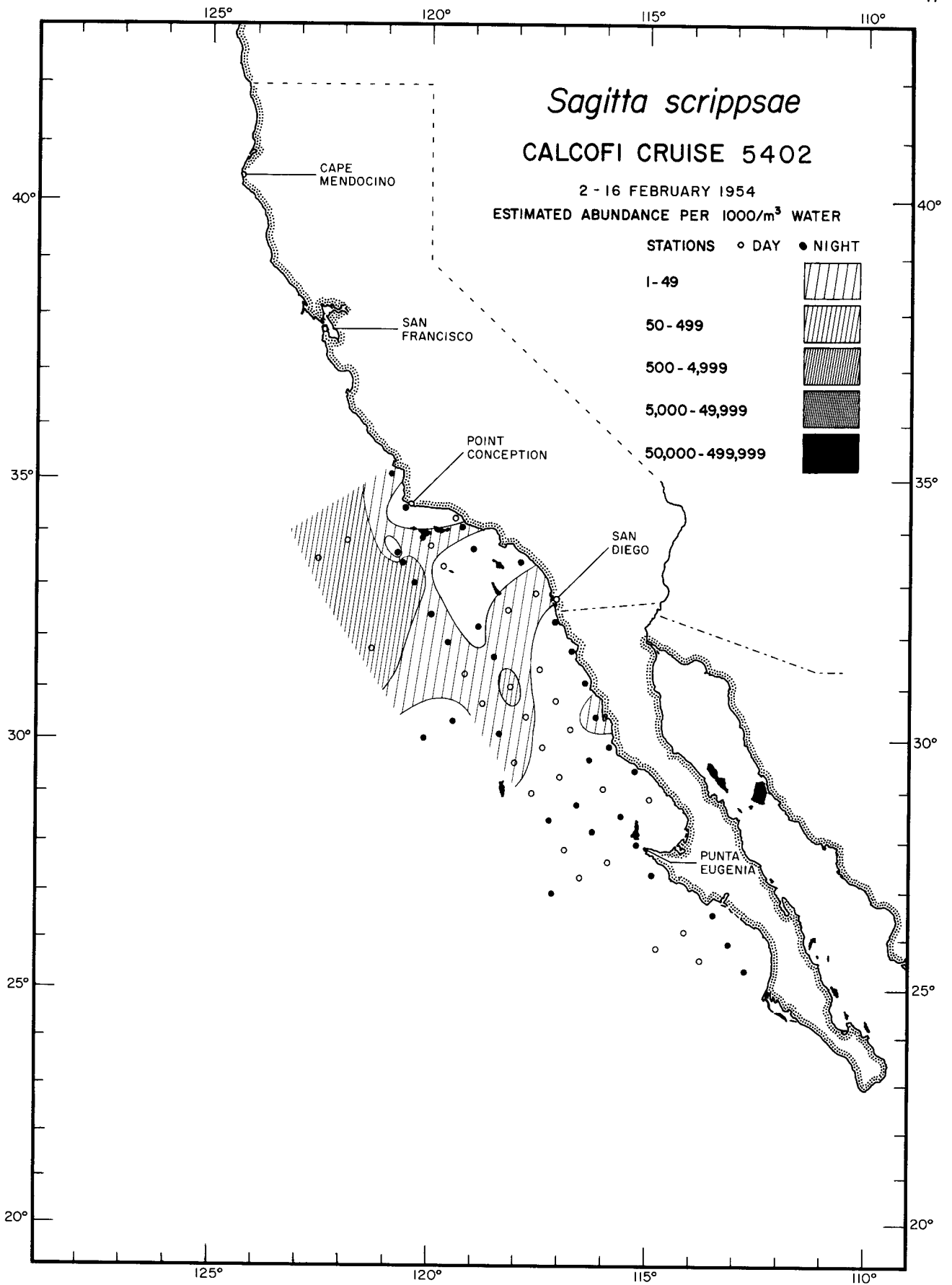
Chaetognatha  
*Sagitta minima*  
5402



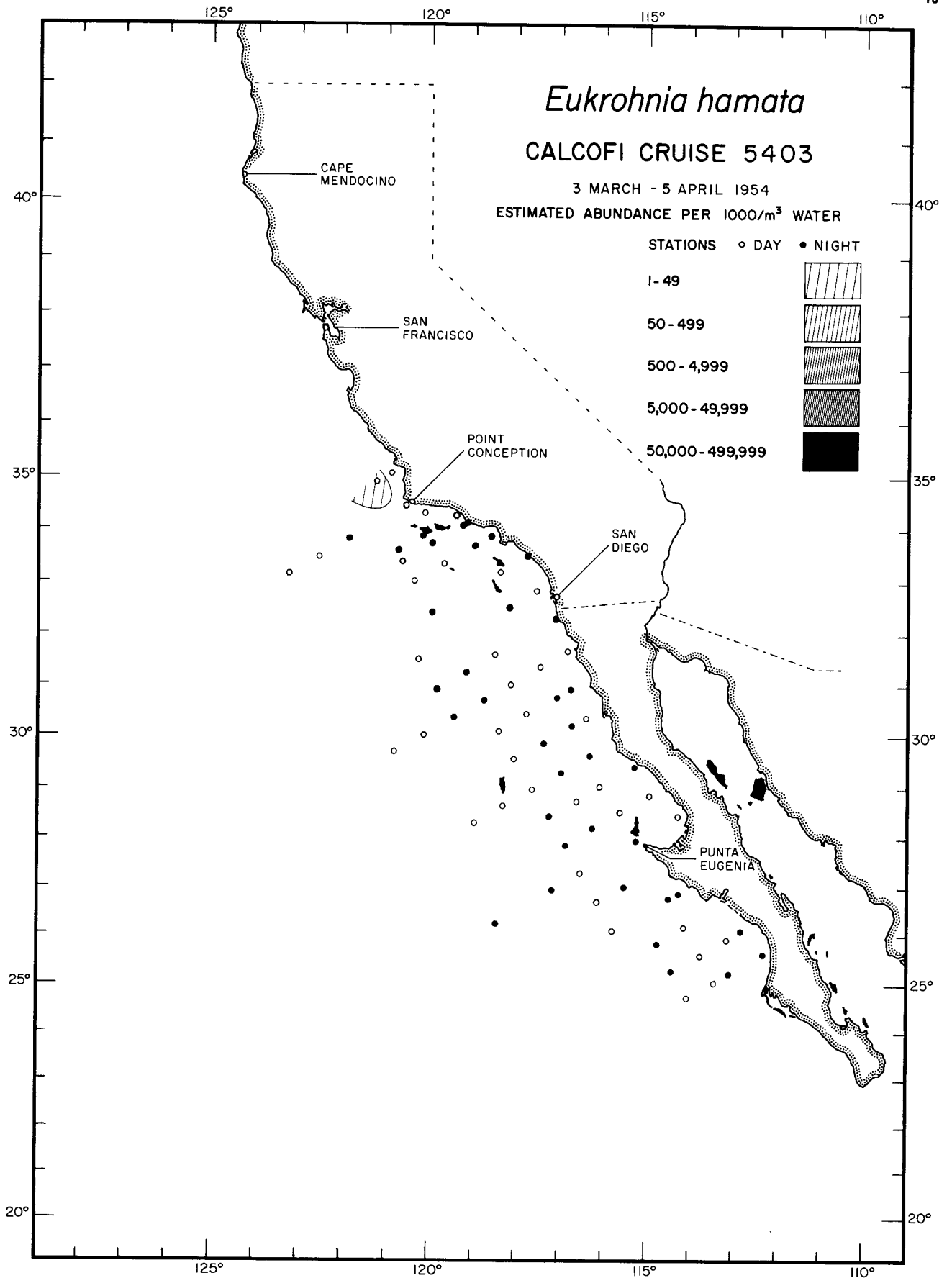
Chaetognatha  
*Sagitta pacifica*  
5402



Chaetognatha  
*Sagitta pseudoserratodentata*  
5402

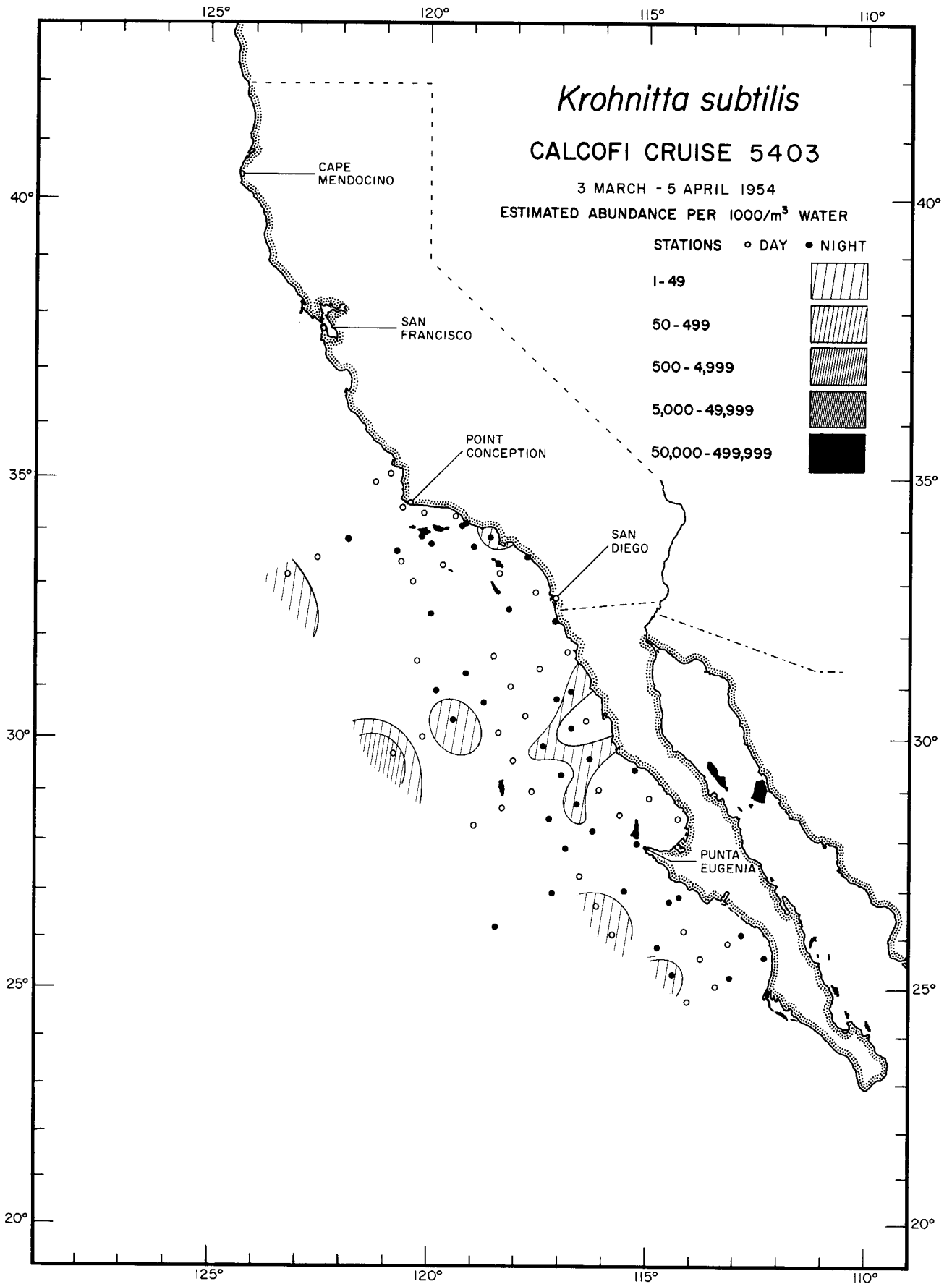


Chaetognatha  
*Sagitta scrippsae*  
5402

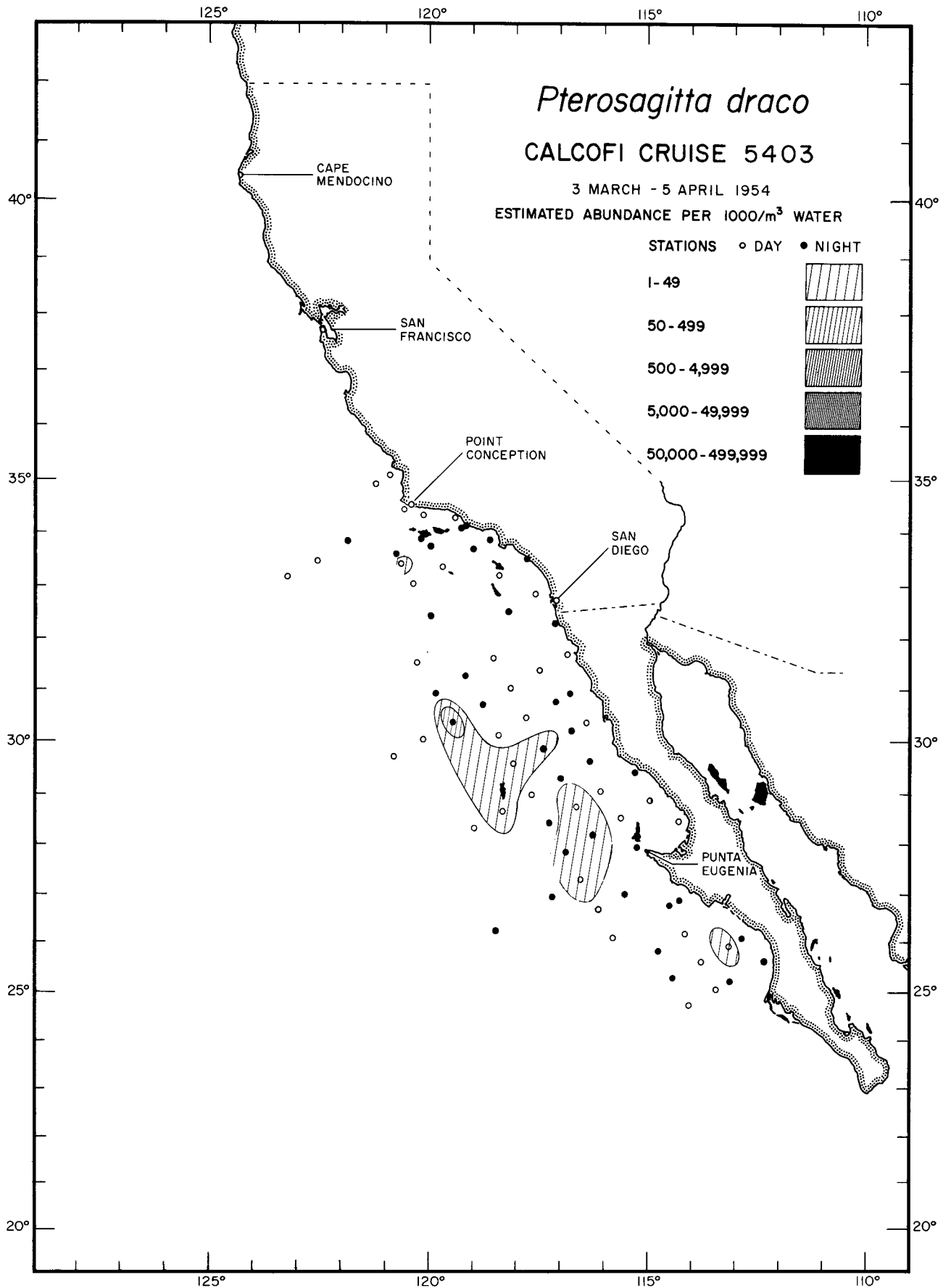


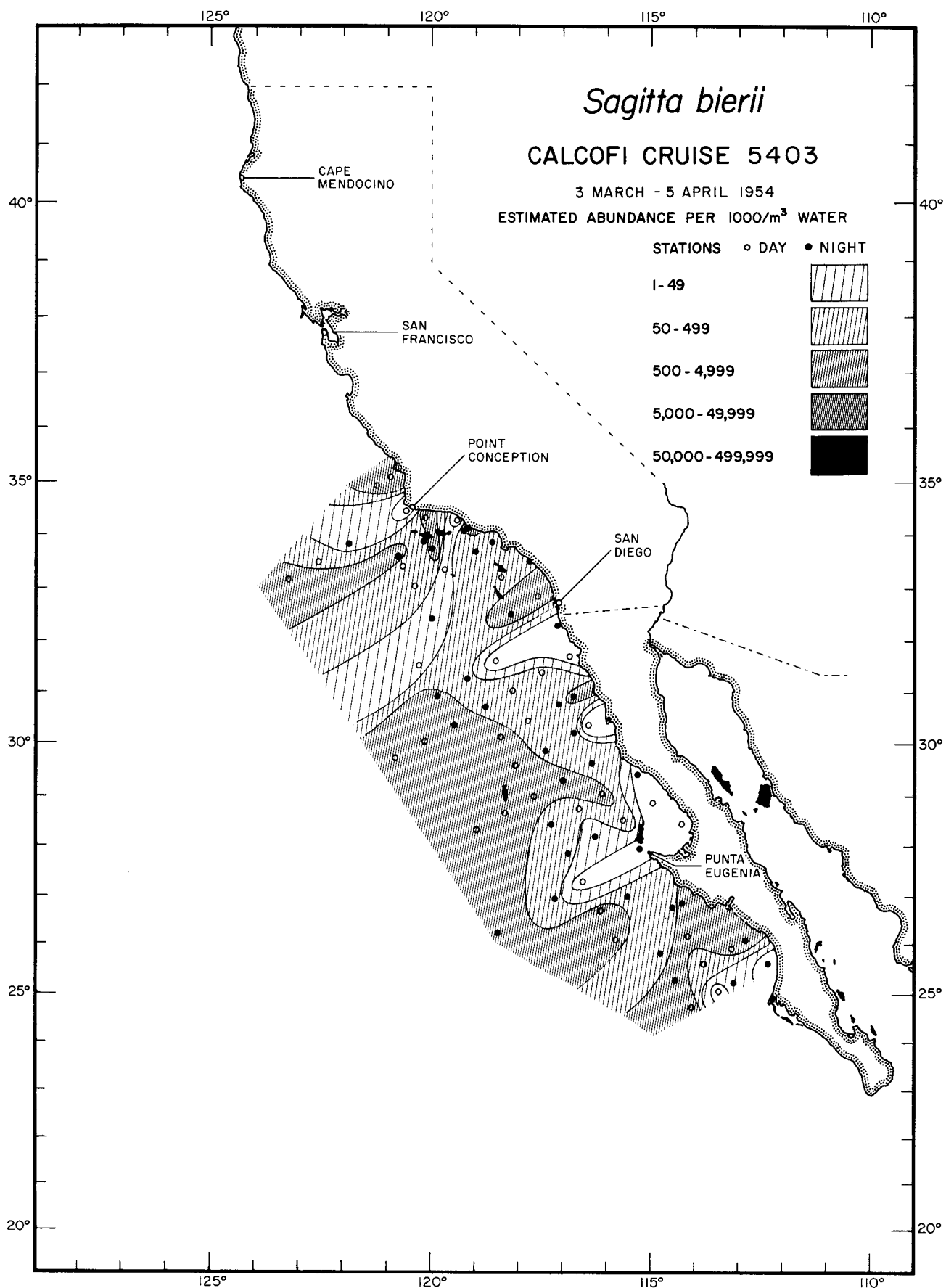
Chaetognatha  
*Eukrohnia hamata*  
5403



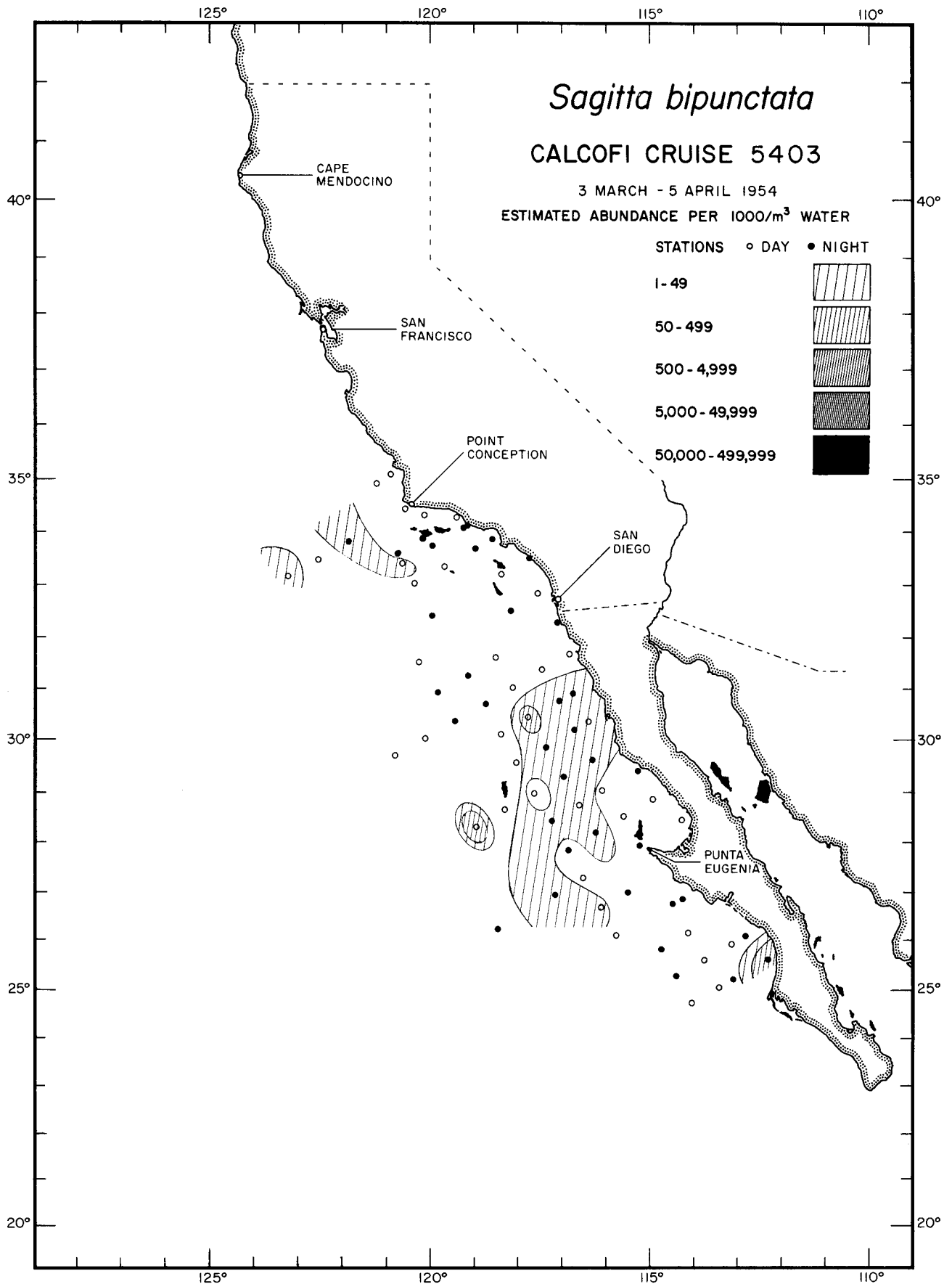


Chaetognatha  
*Krohnitta subtilis*  
5403

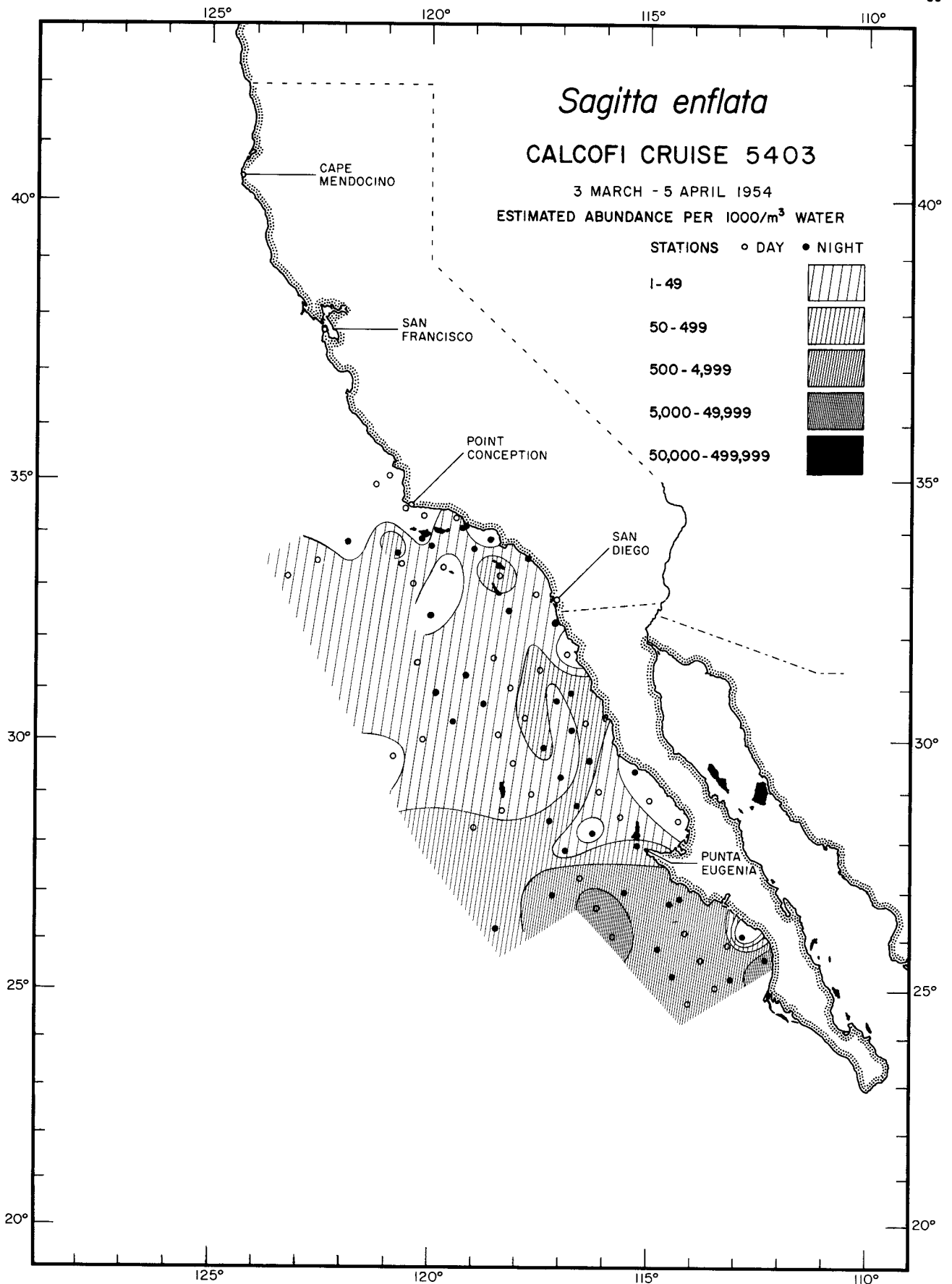




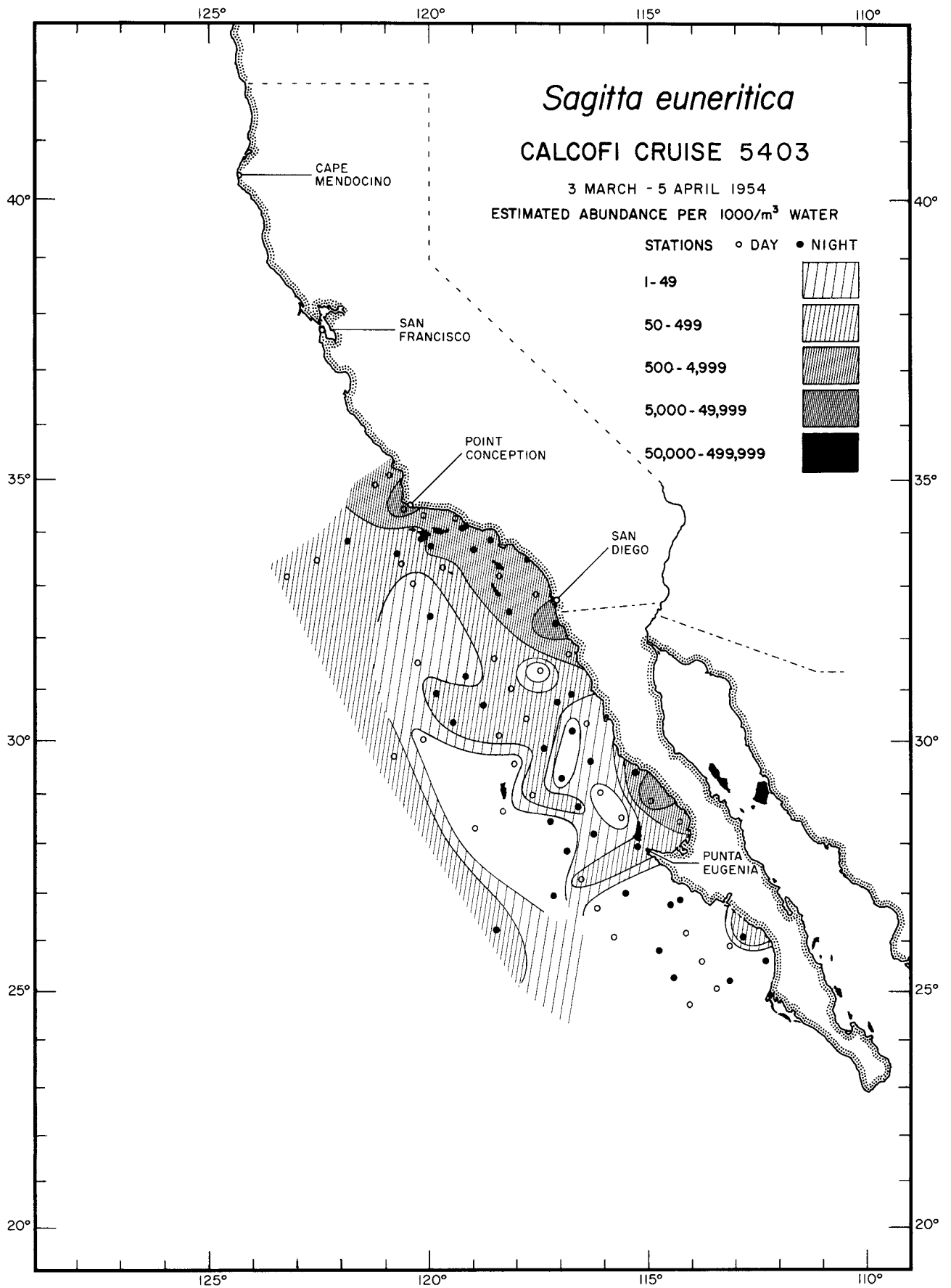
Chaetognatha  
*Sagitta bierii*  
5403



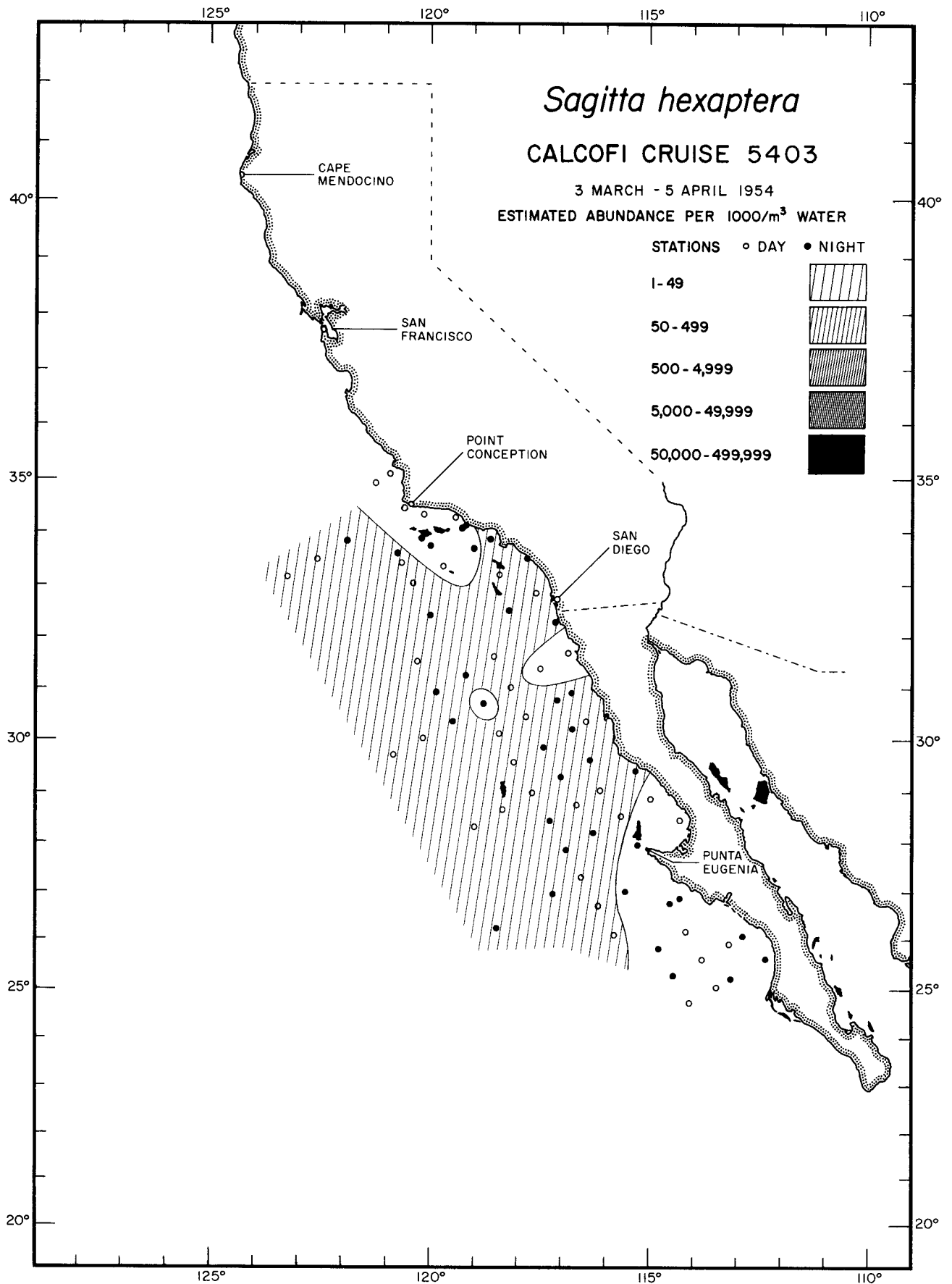
Chaetognatha  
*Sagitta bipunctata*  
5403



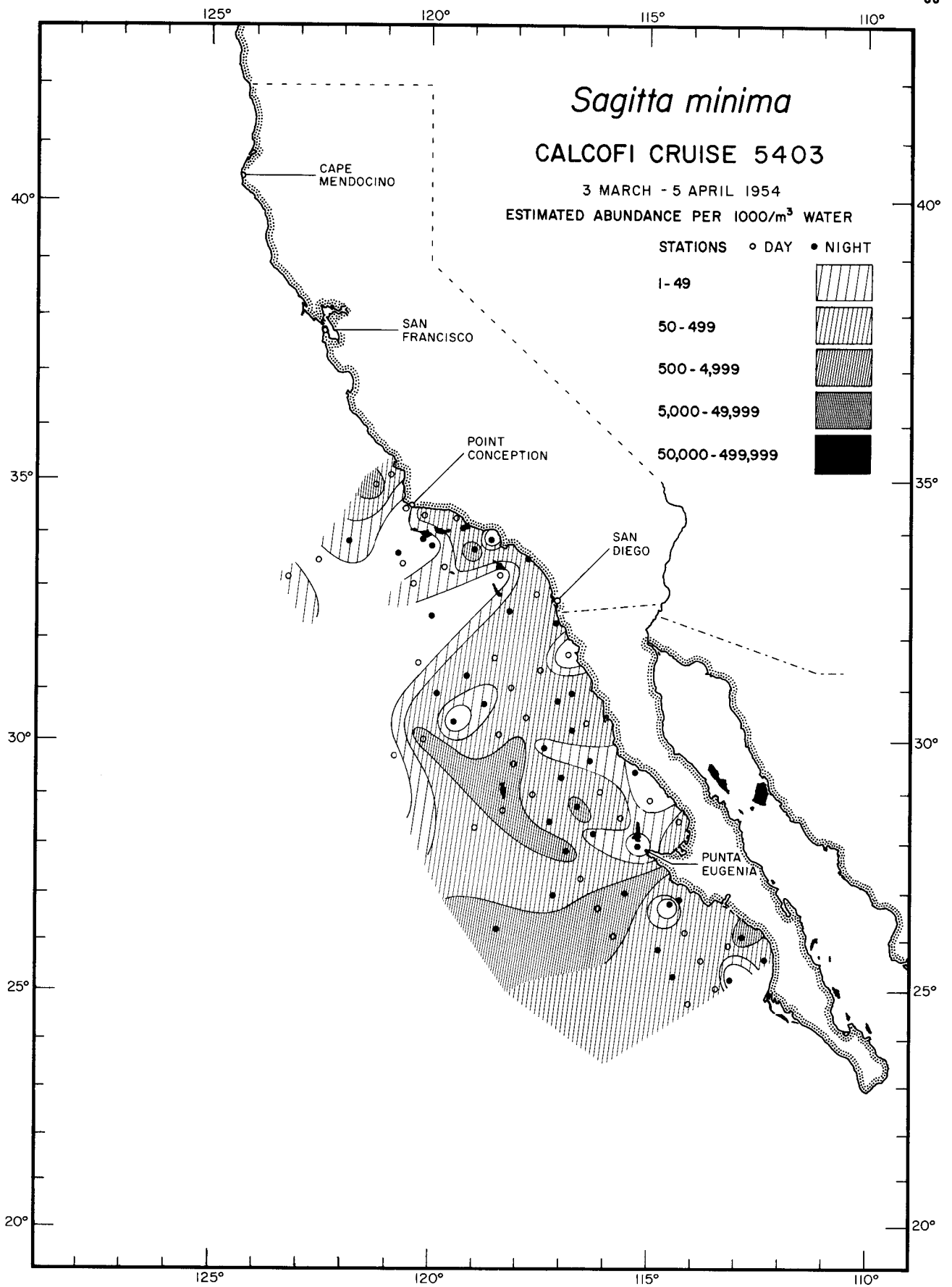
Chaetognatha  
*Sagitta enflata*  
5403



Chaetognatha  
*Sagitta euneritica*  
5403

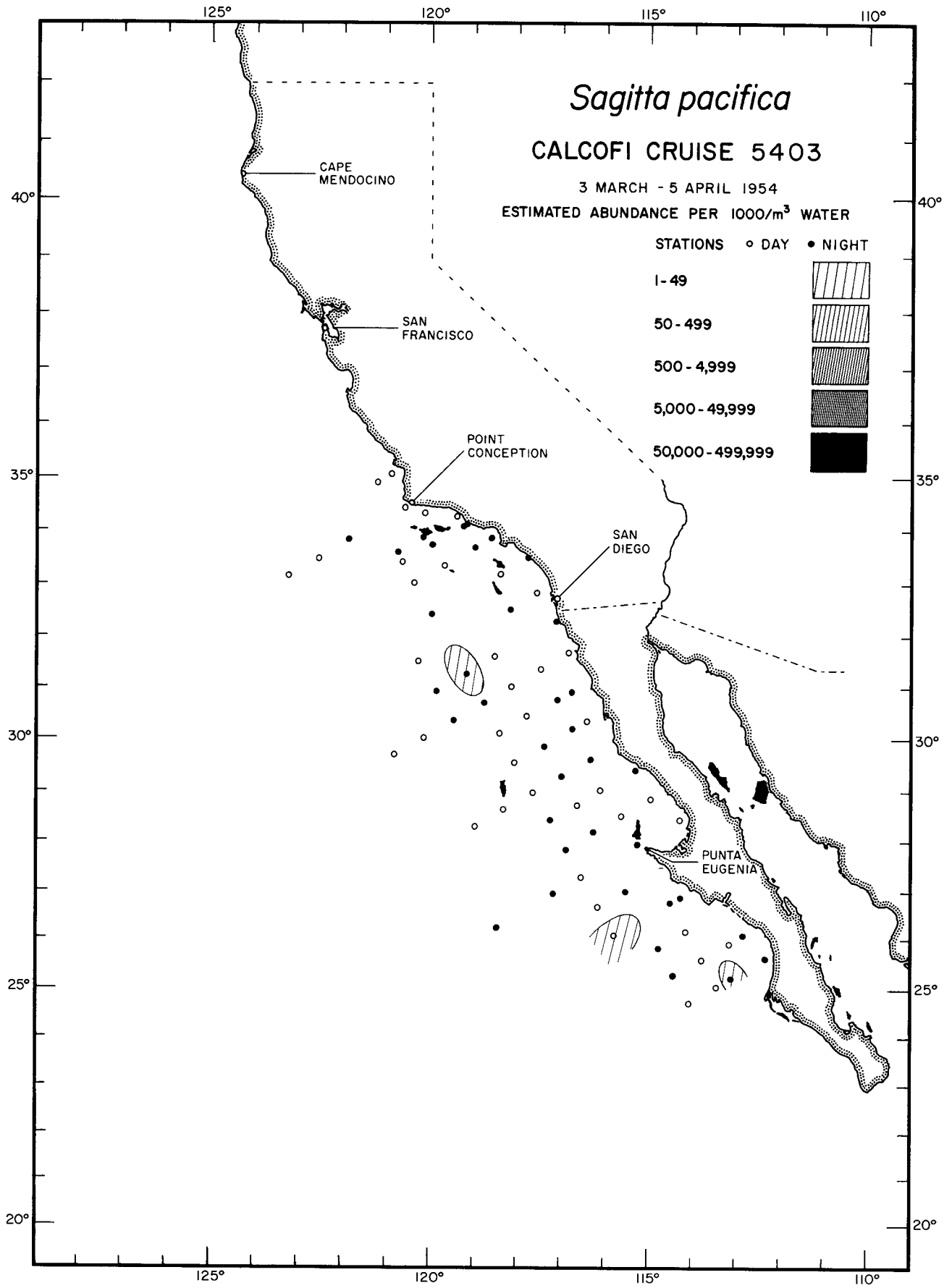


.Chaetognatha  
*Sagitta hexaptera*  
5403

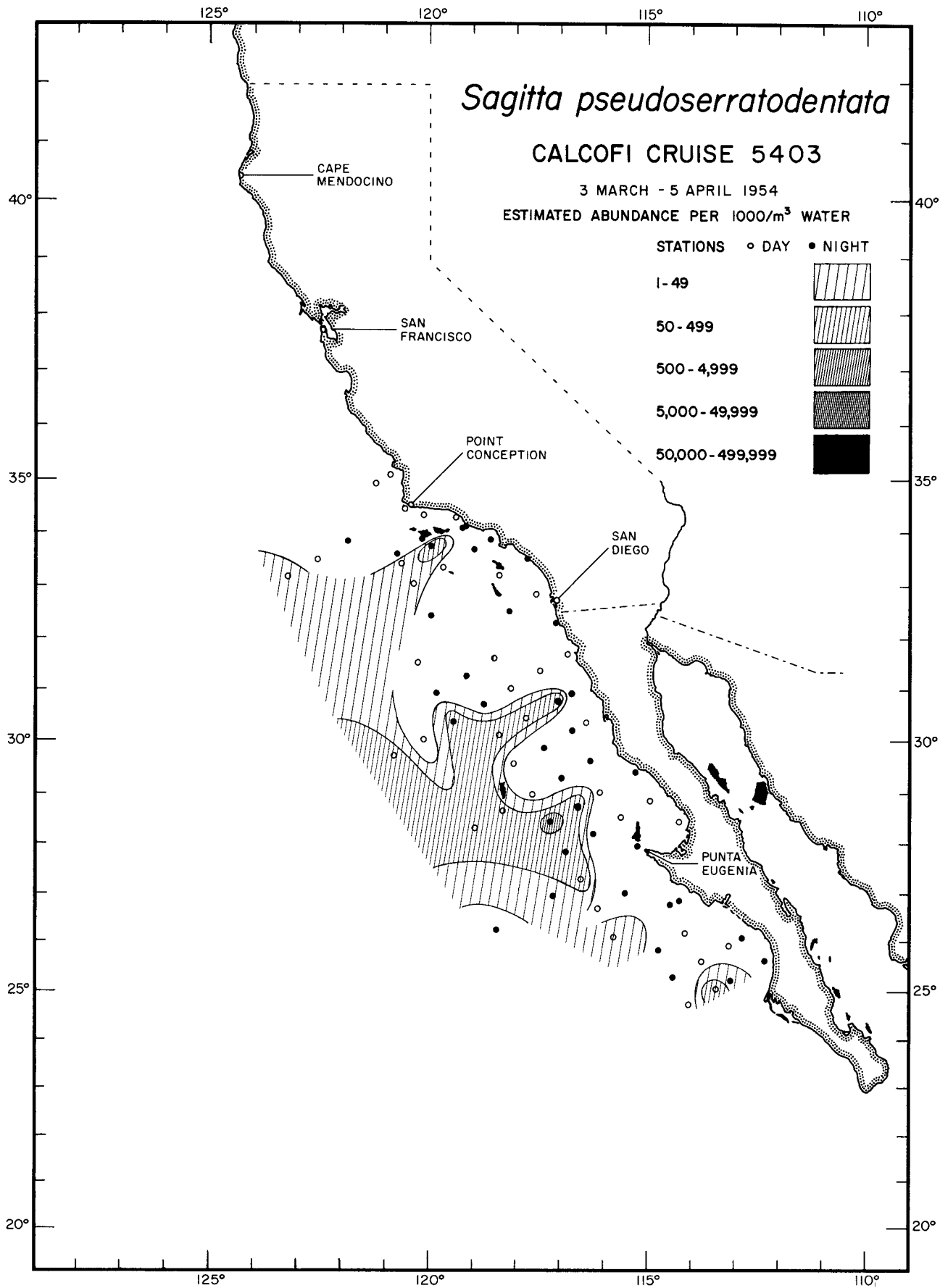


Chaetognatha  
*Sagitta minima*  
5403

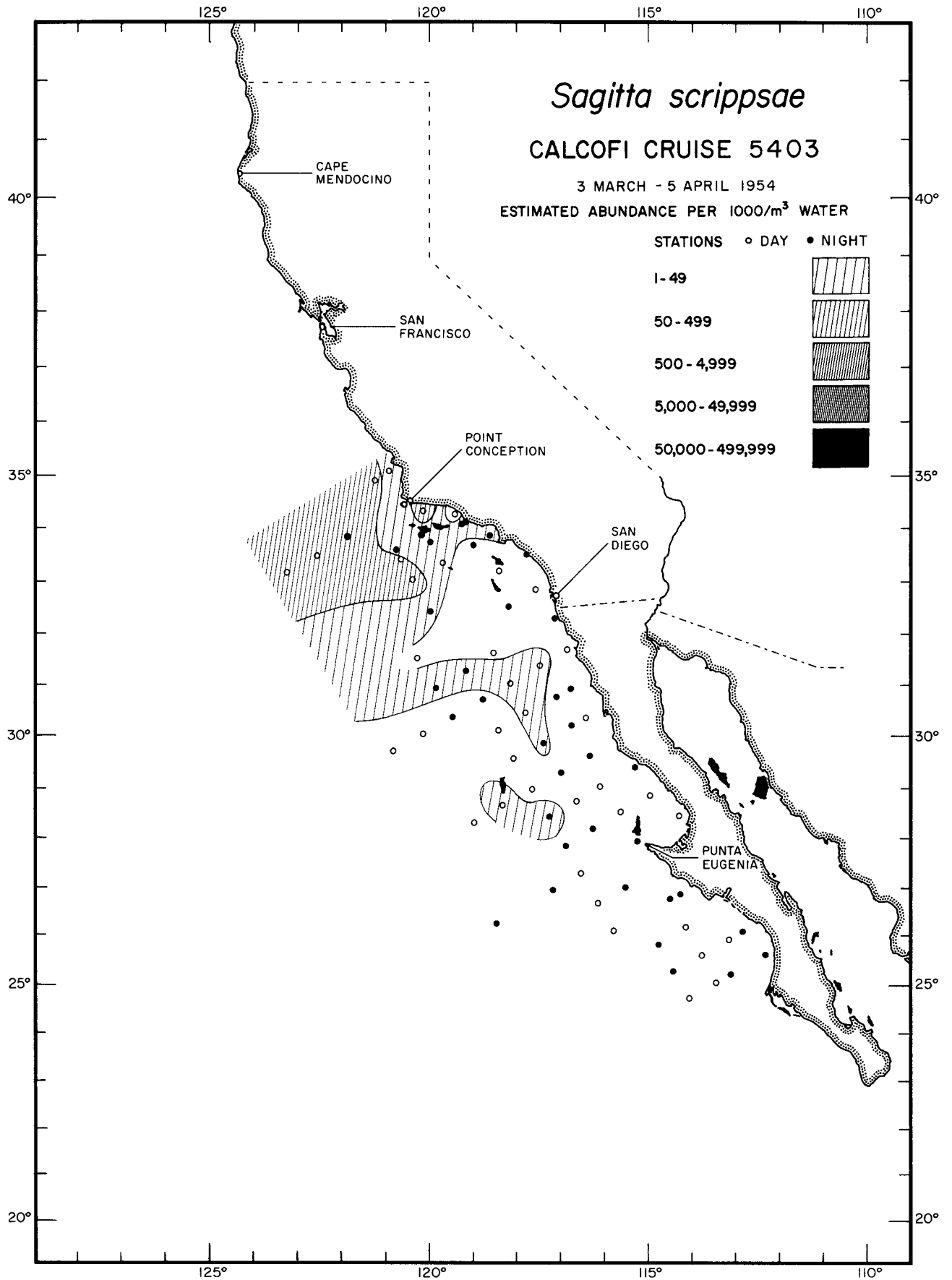




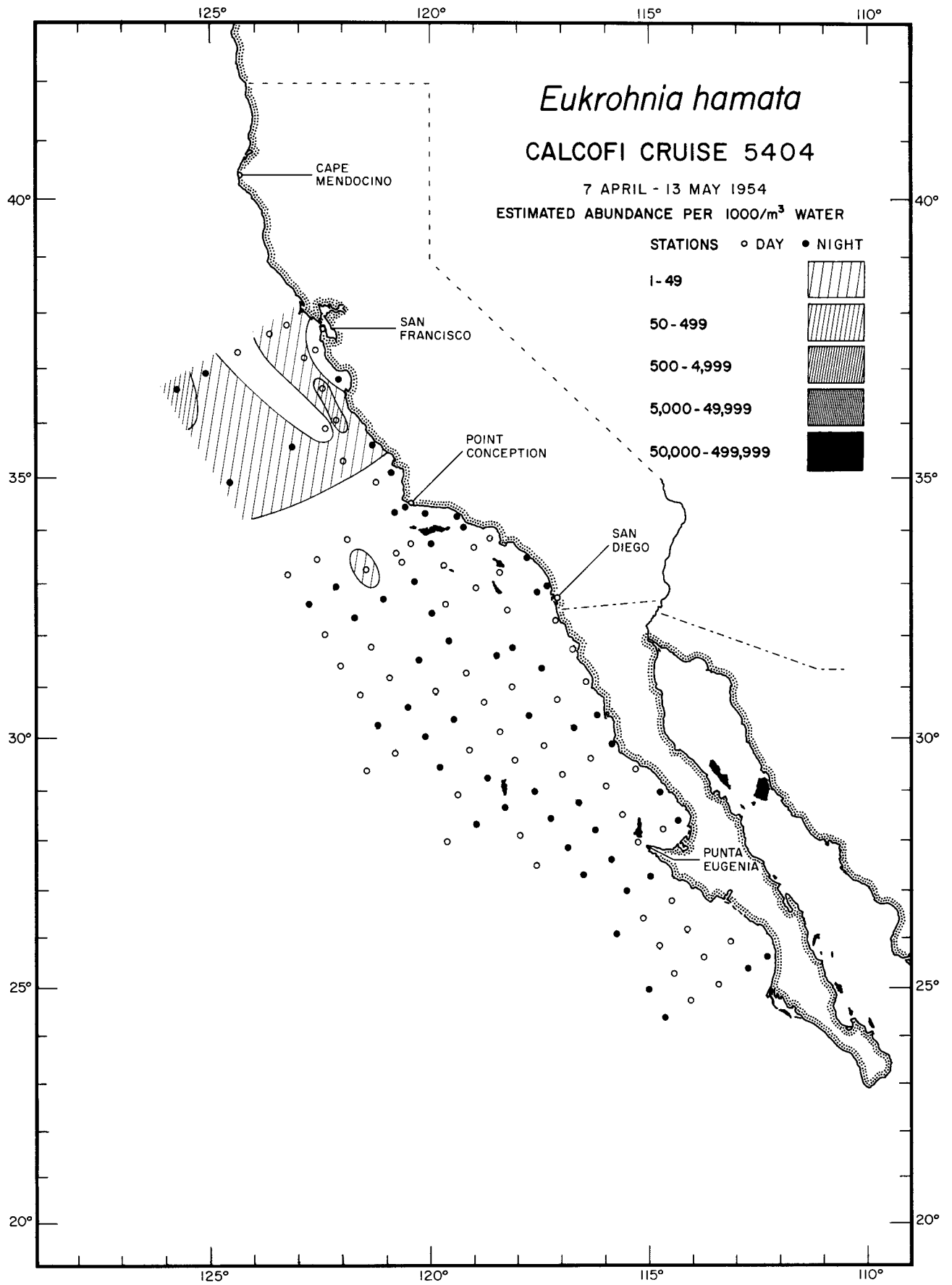
Chaetognatha  
*Sagitta pacifica*  
5403



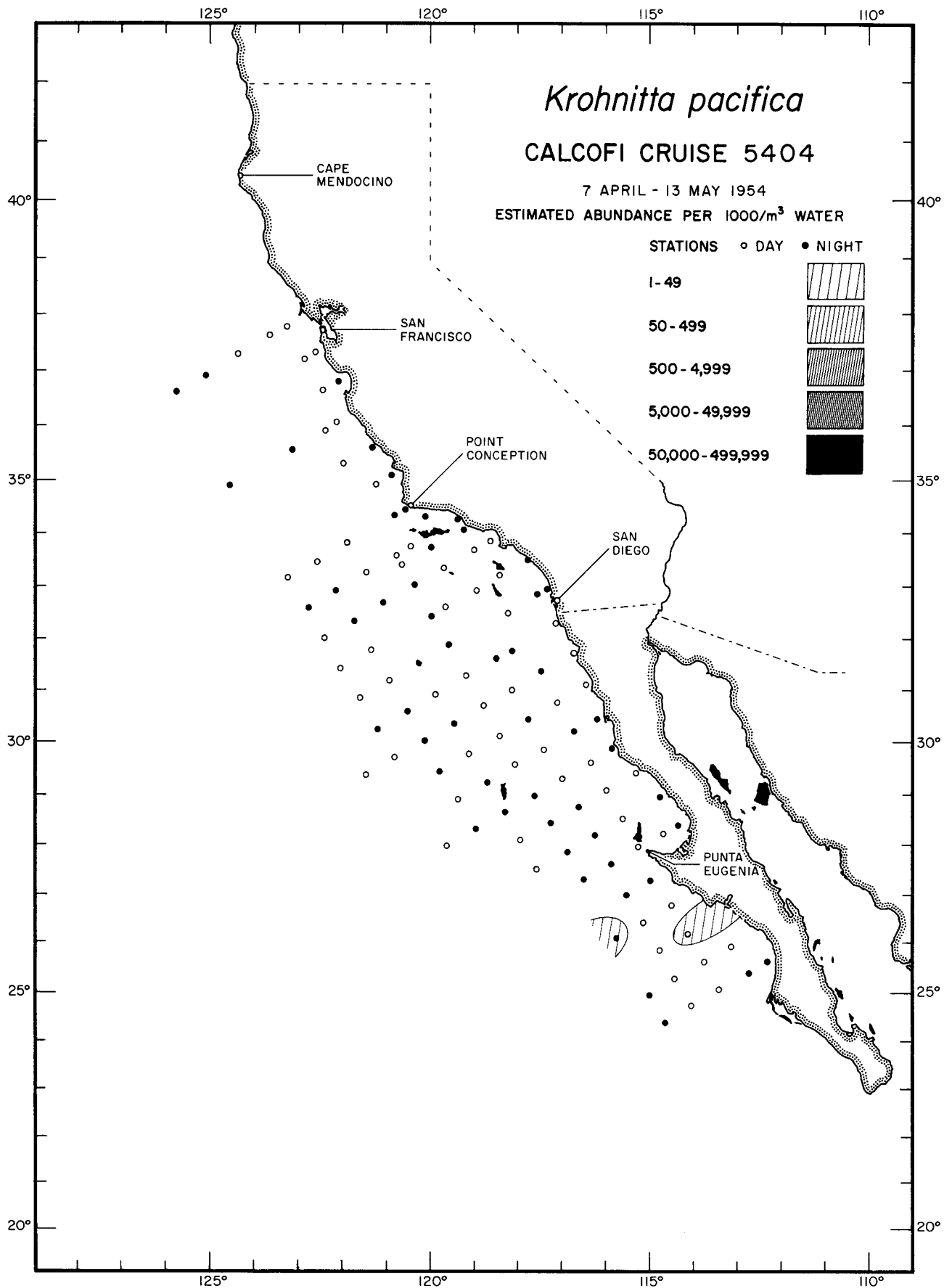
Chaetognatha  
*Sagitta pseudoserratodentata*  
 5403



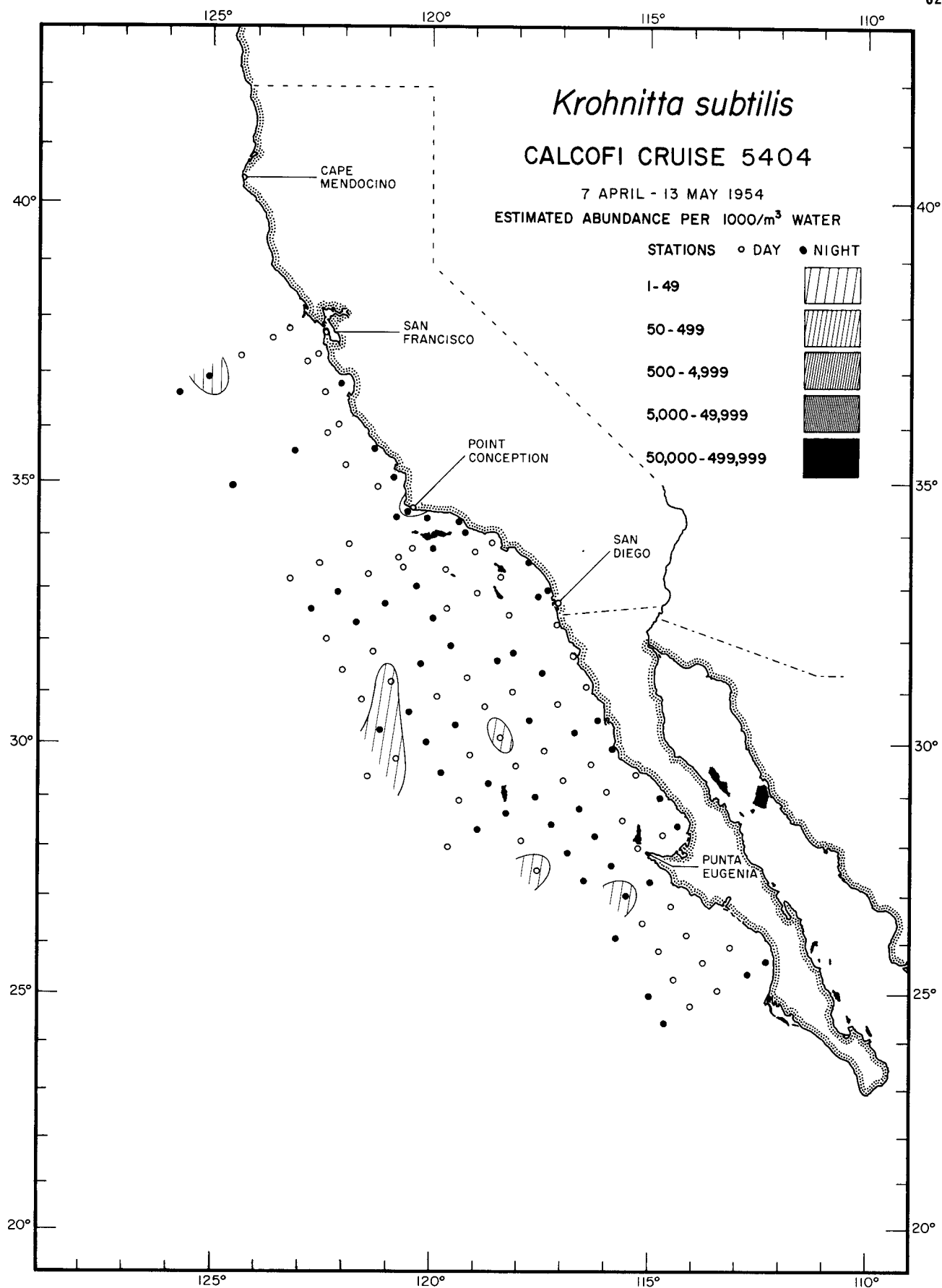
Chaetognatha  
*Sagitta scrippsae*  
5403



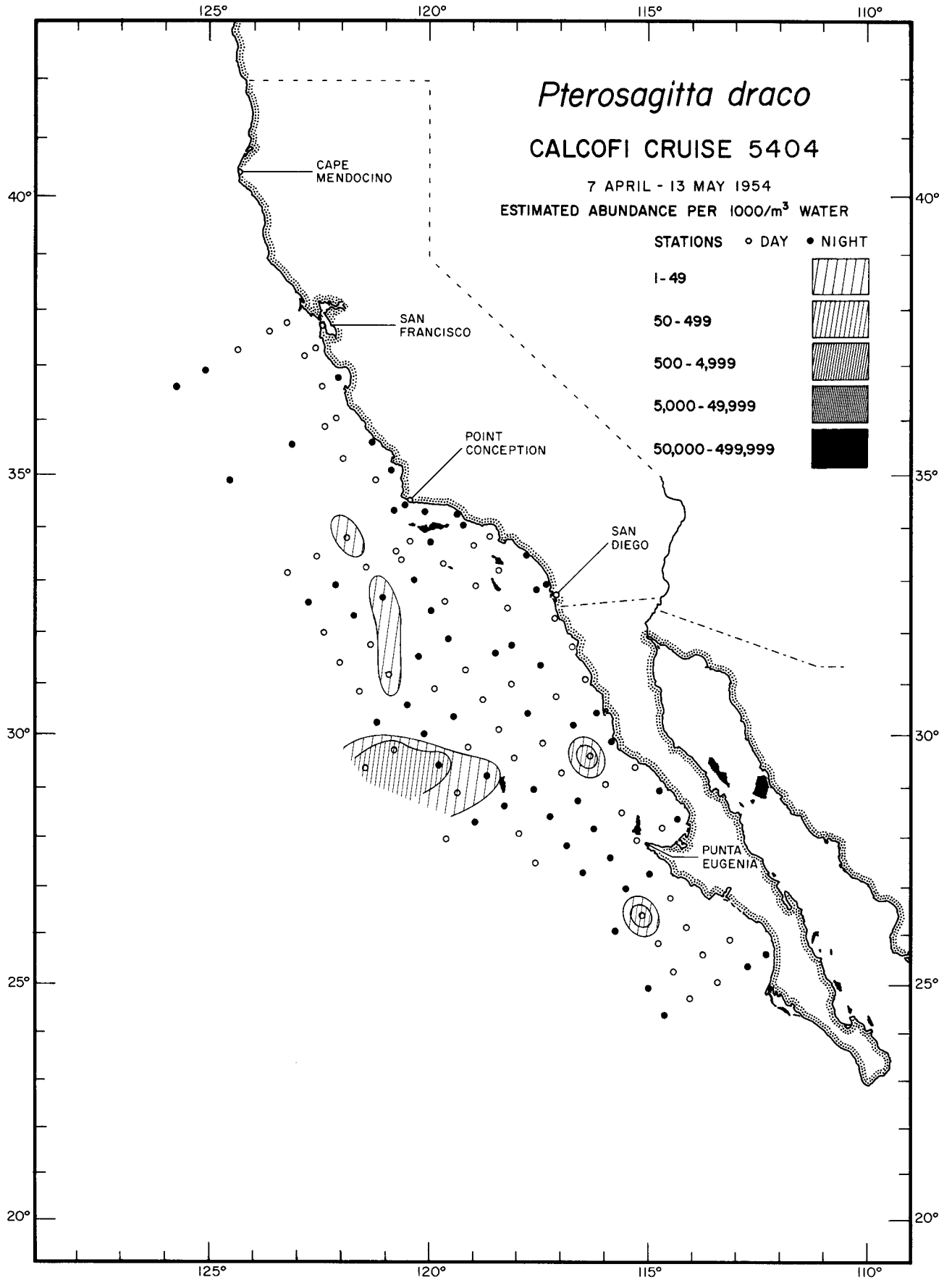
Chaetognatha  
*Eukrohnia hamata*  
5404



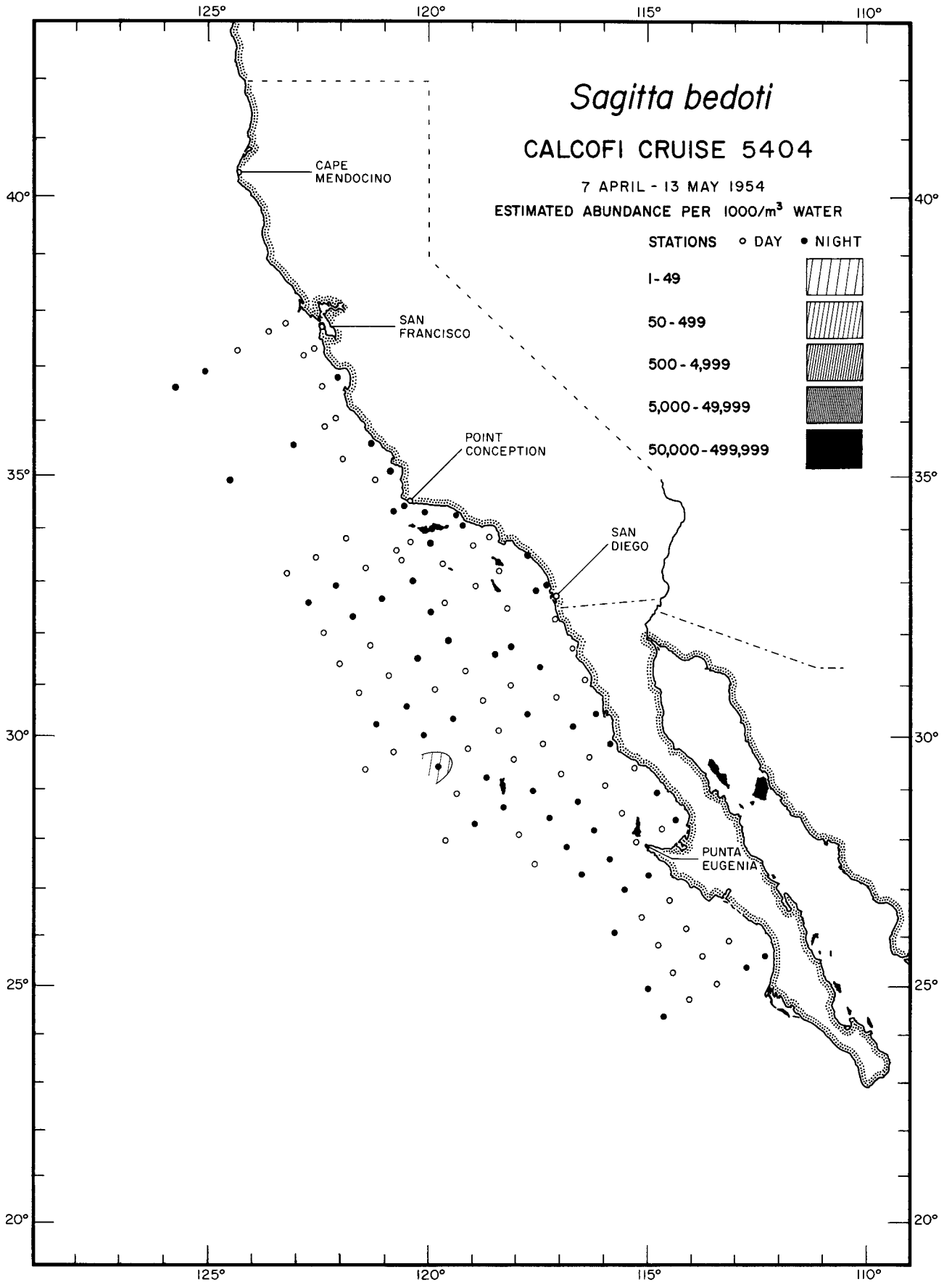
Chaetognatha  
*Krohnitta pacifica*  
5404



Chaetognatha  
*Krohnitta subtilis*  
5404

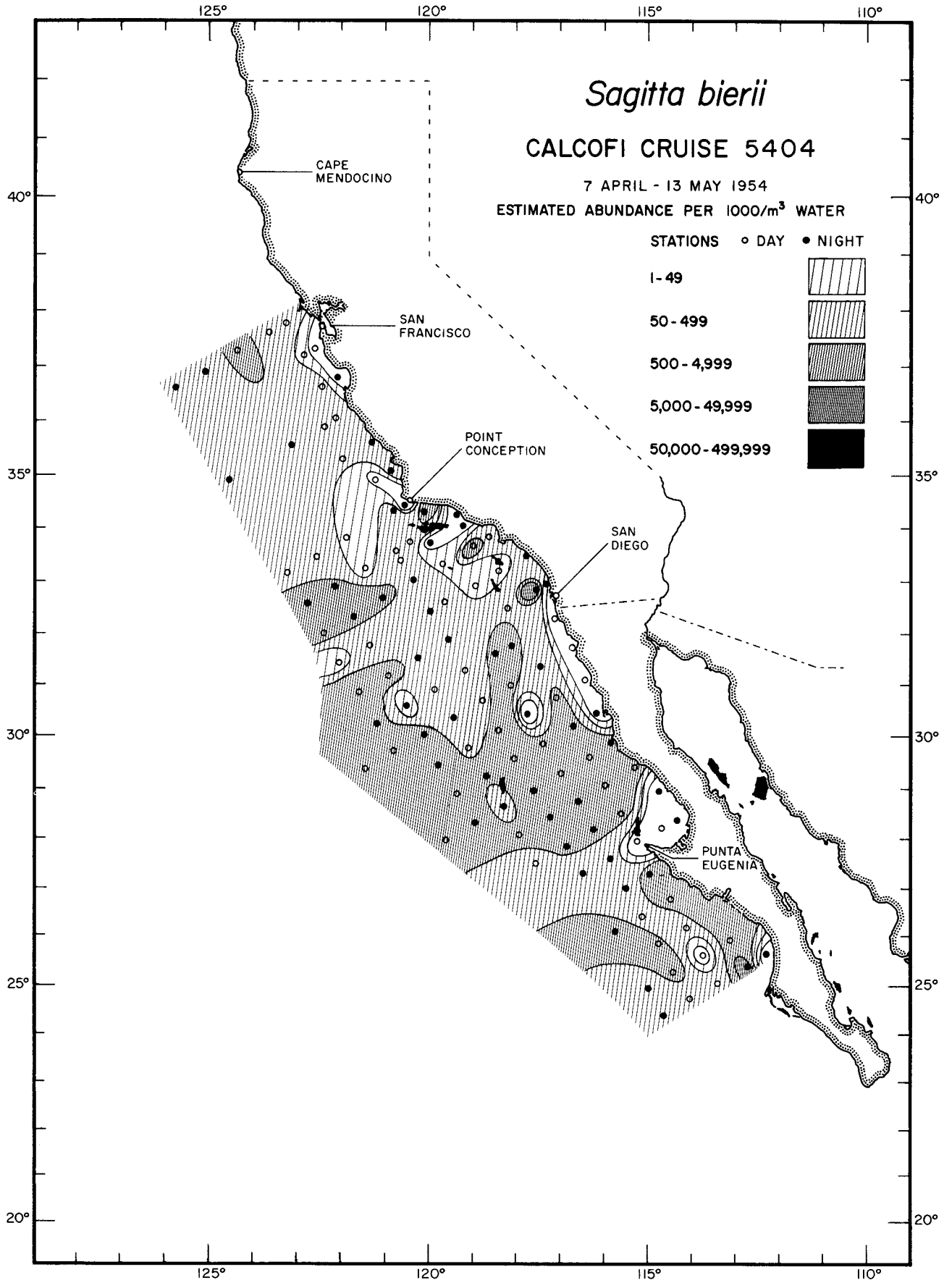


Chaetognatha  
*Pterosagitta draco*  
5404

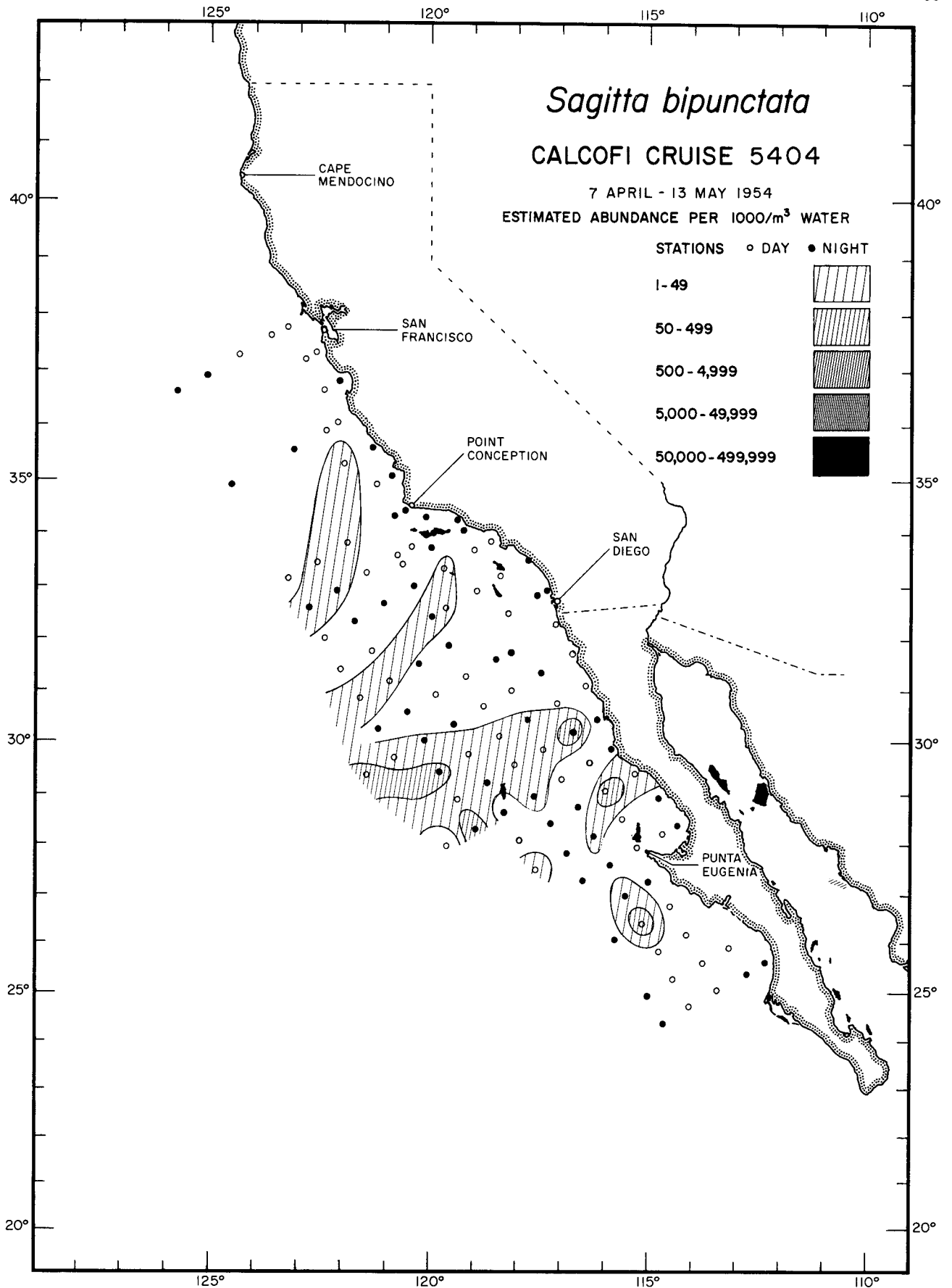


Chaetognatha  
*Sagitta bedoti*  
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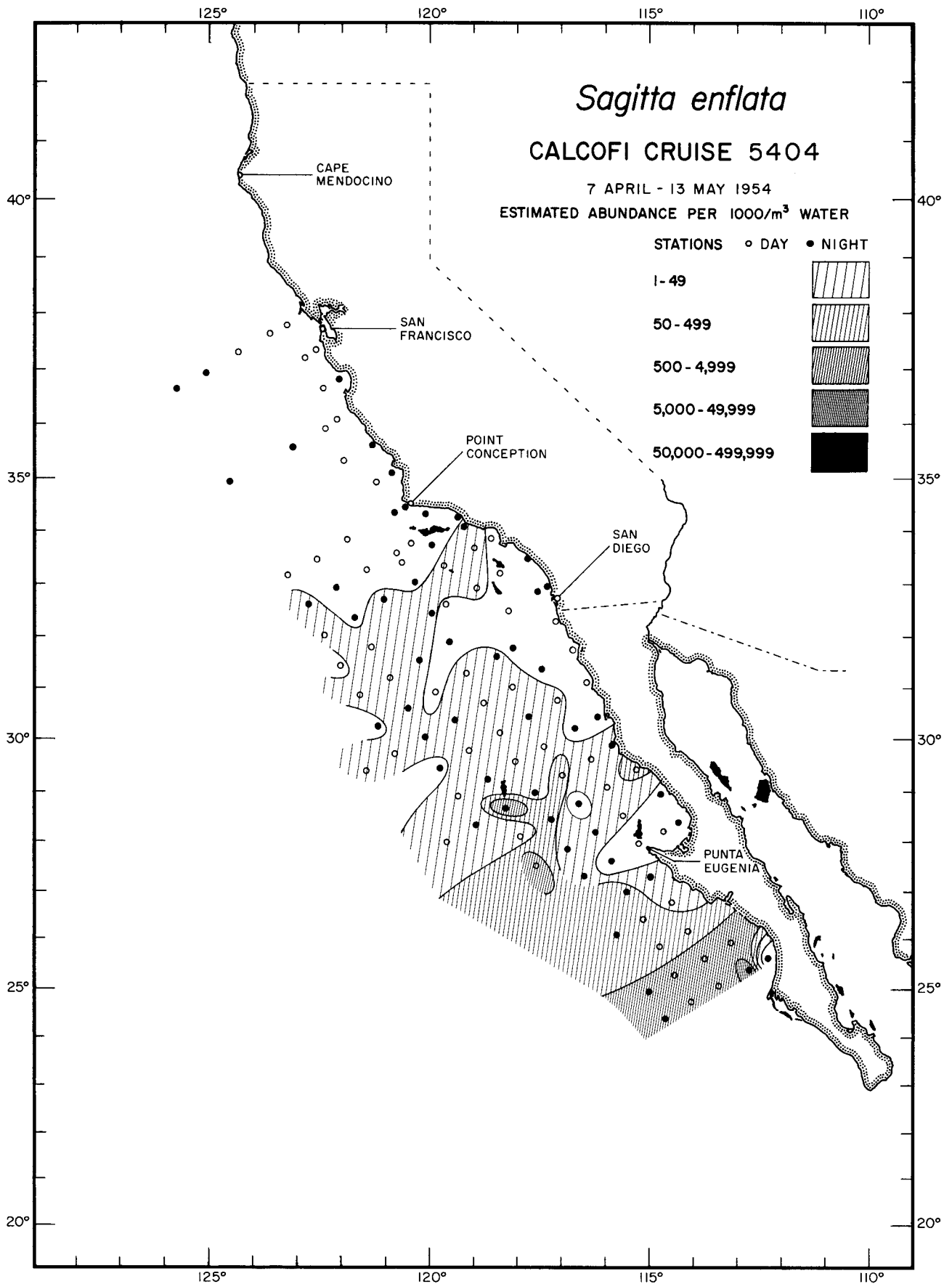




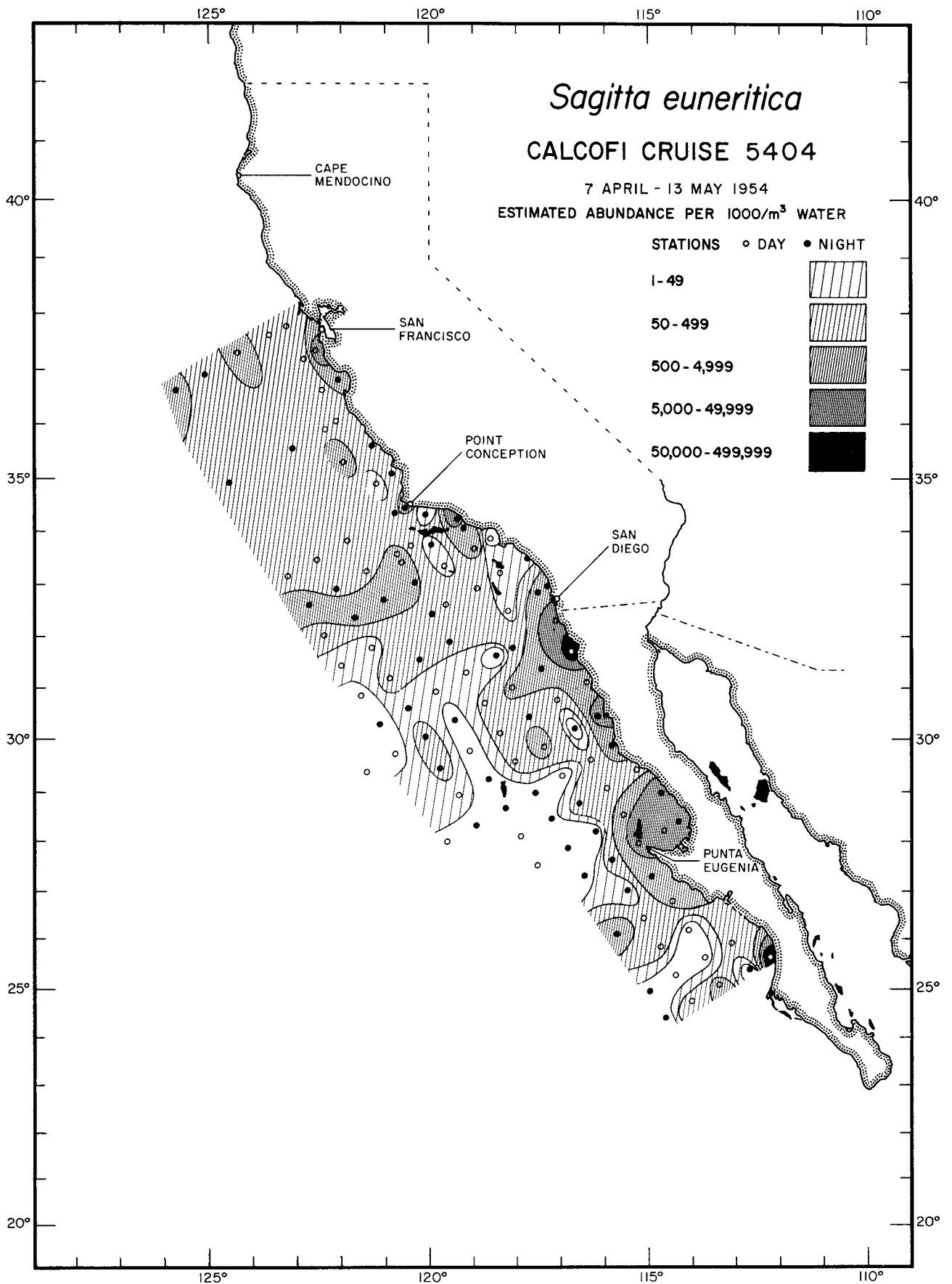
Chaetognatha  
*Sagitta bierii*  
5404

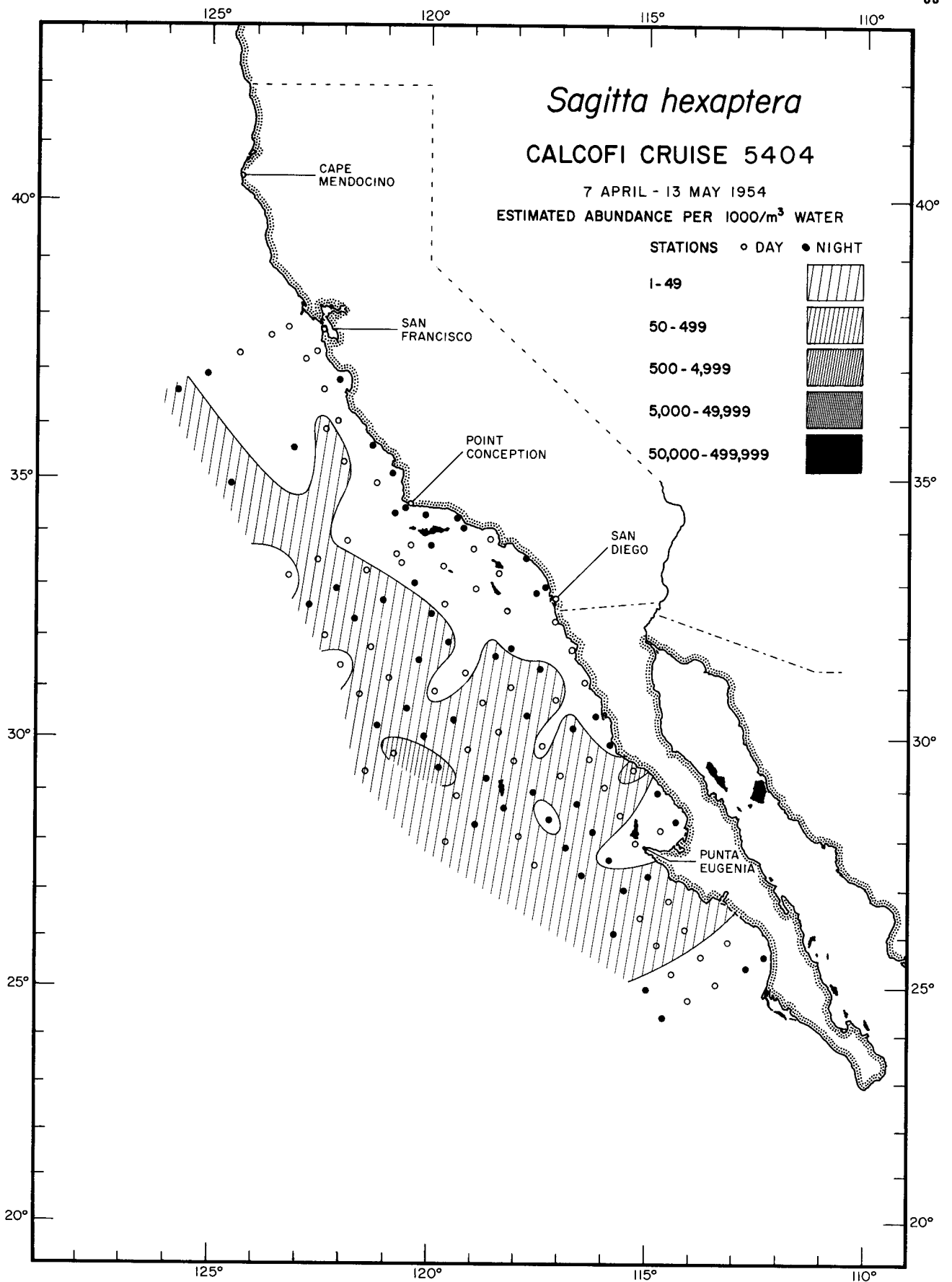


Chaetognatha  
*Sagitta bipunctata*  
5404

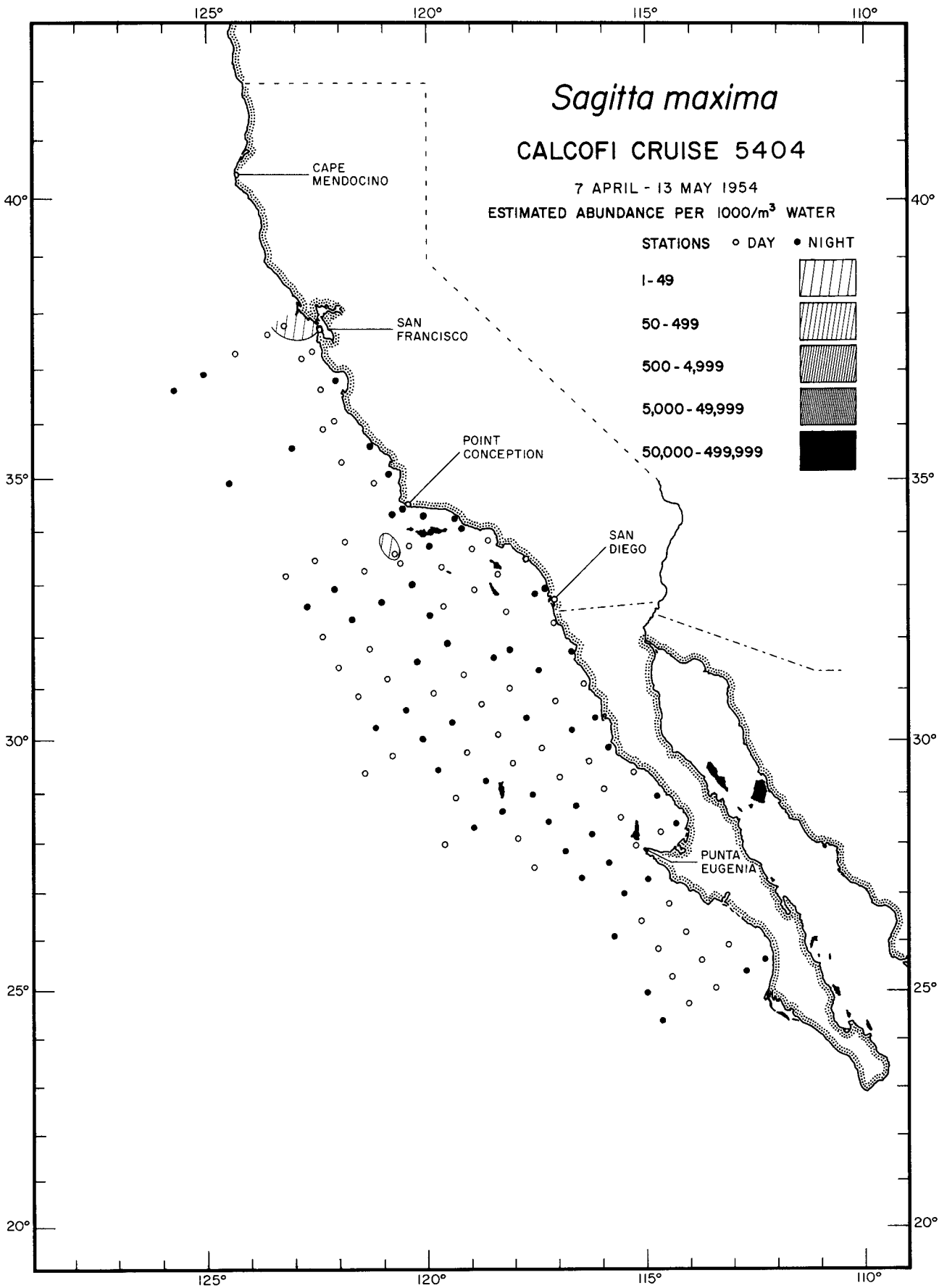


Chaetognatha  
*Sagitta enflata*  
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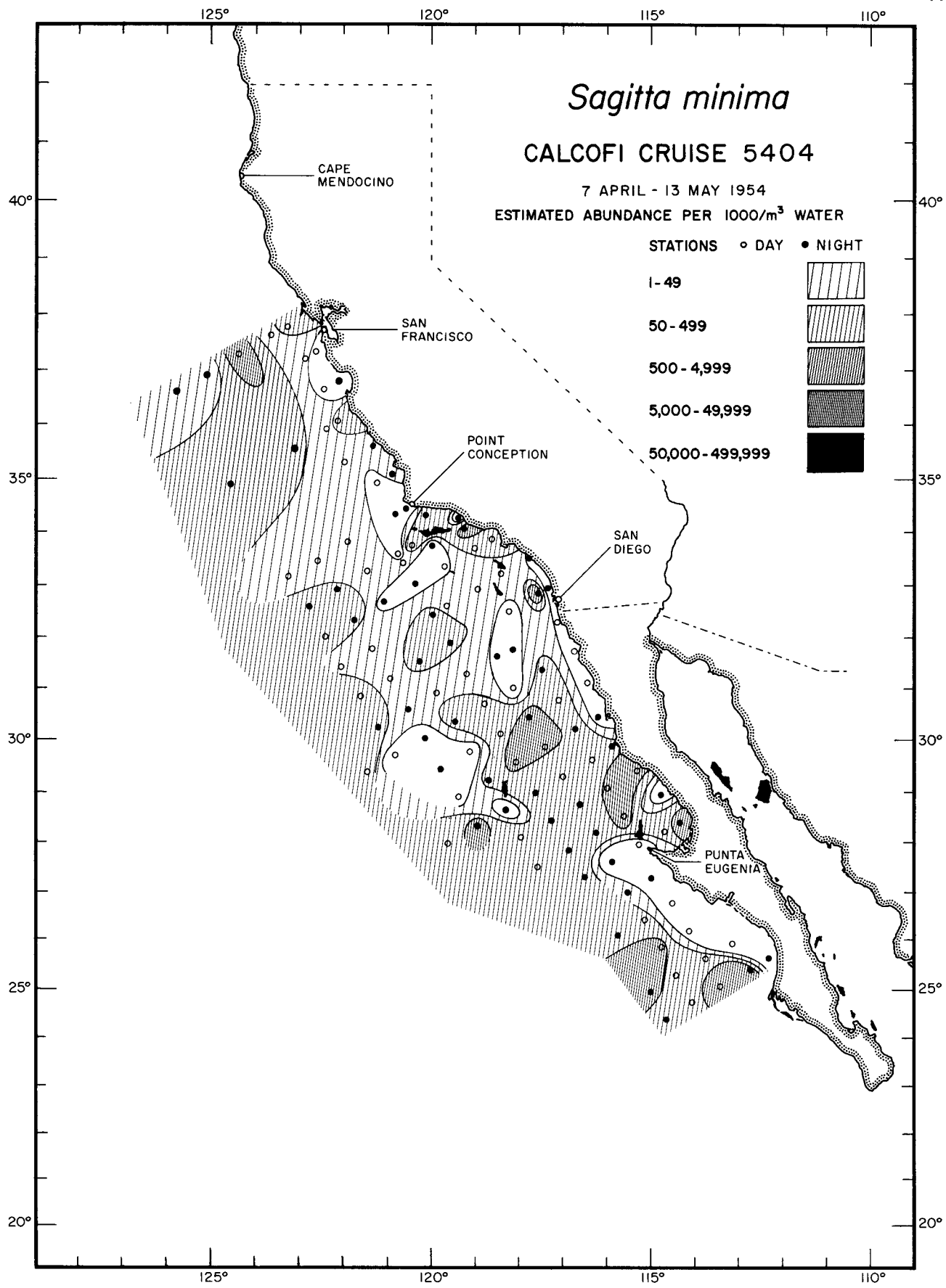




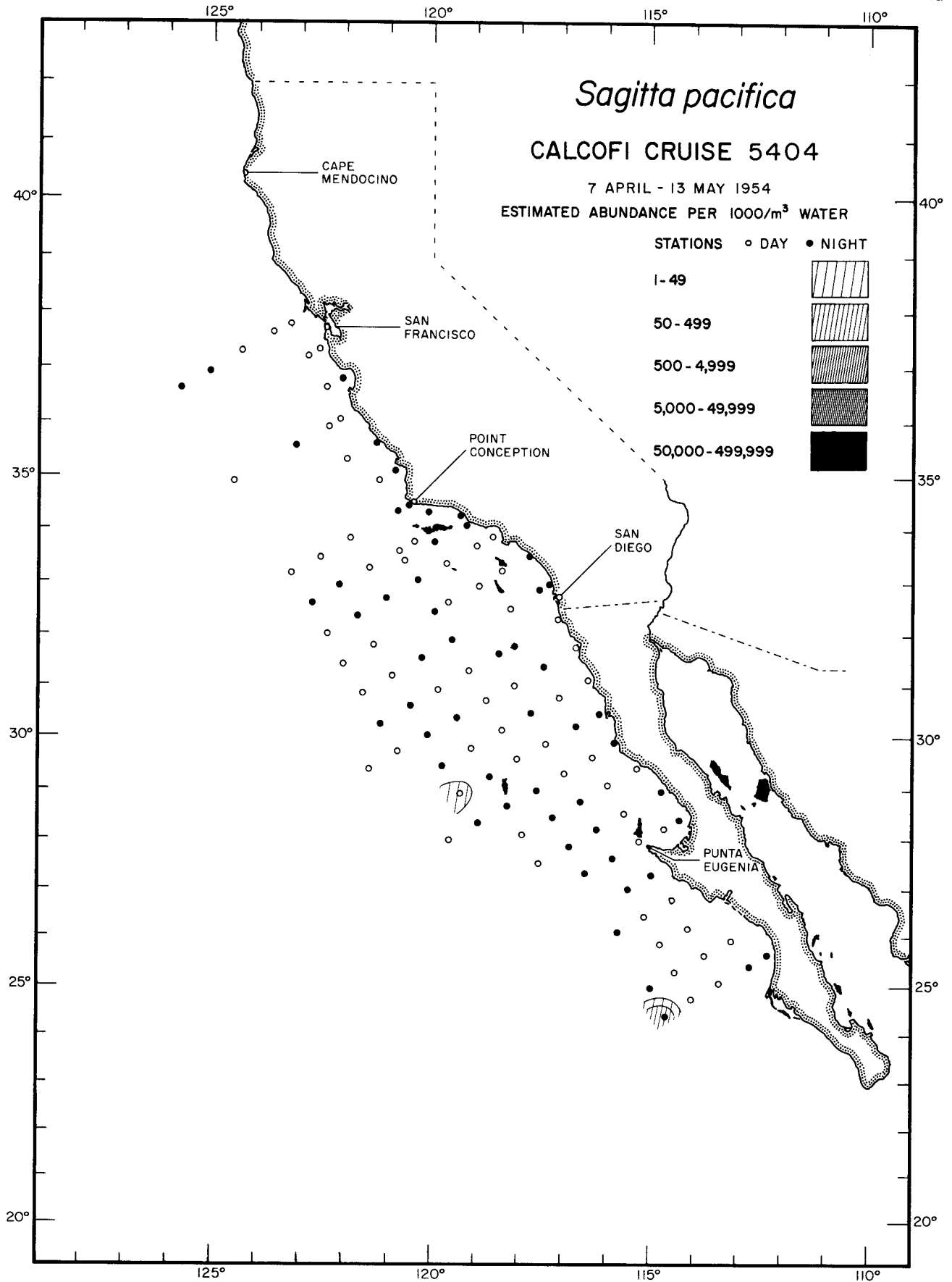
Chaetognatha  
*Sagitta hexaptera*  
5404



Chaetognatha  
*Sagitta maxima*  
5404

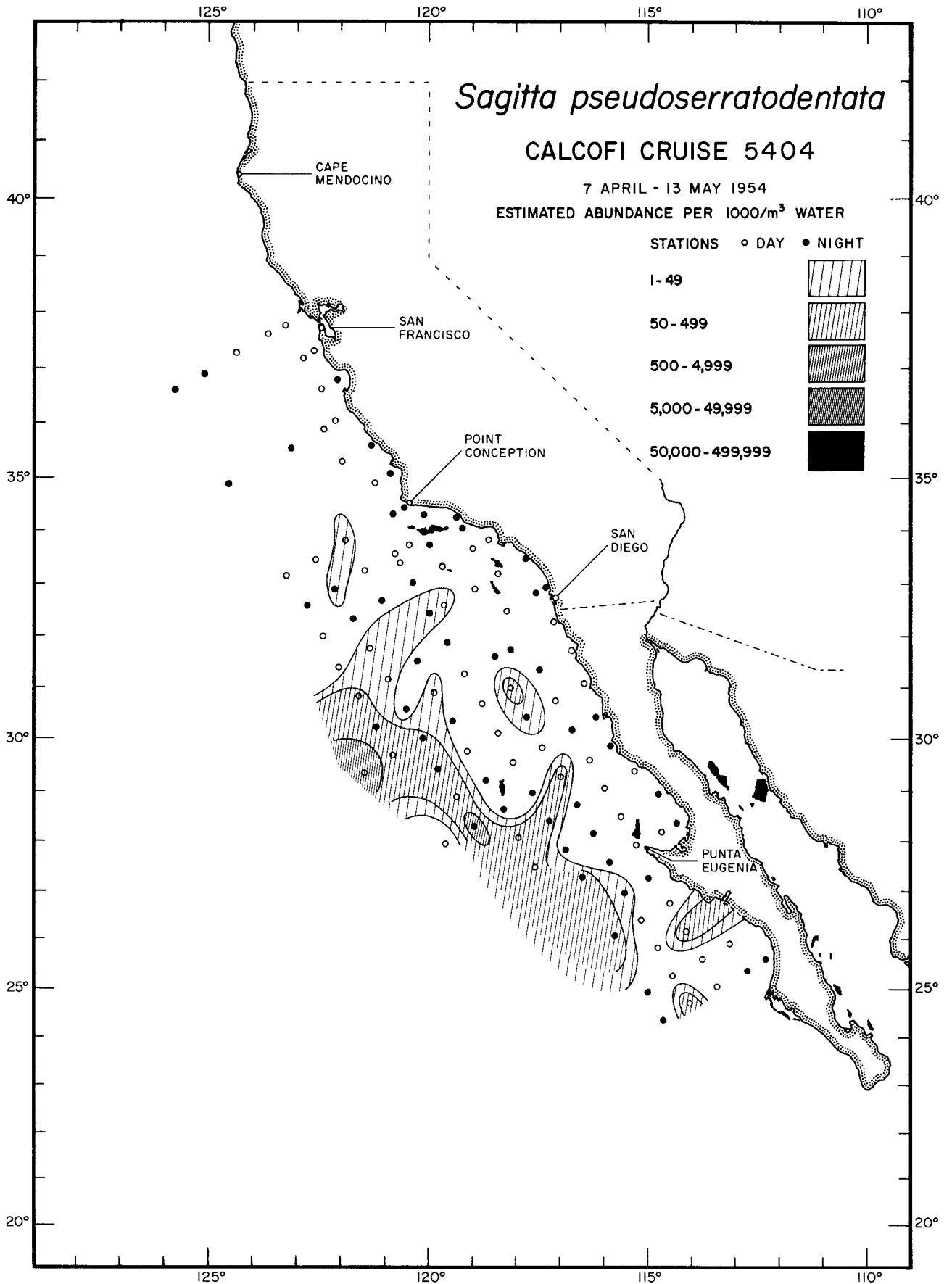


Chaetognatha  
*Sagitta minima*  
5404

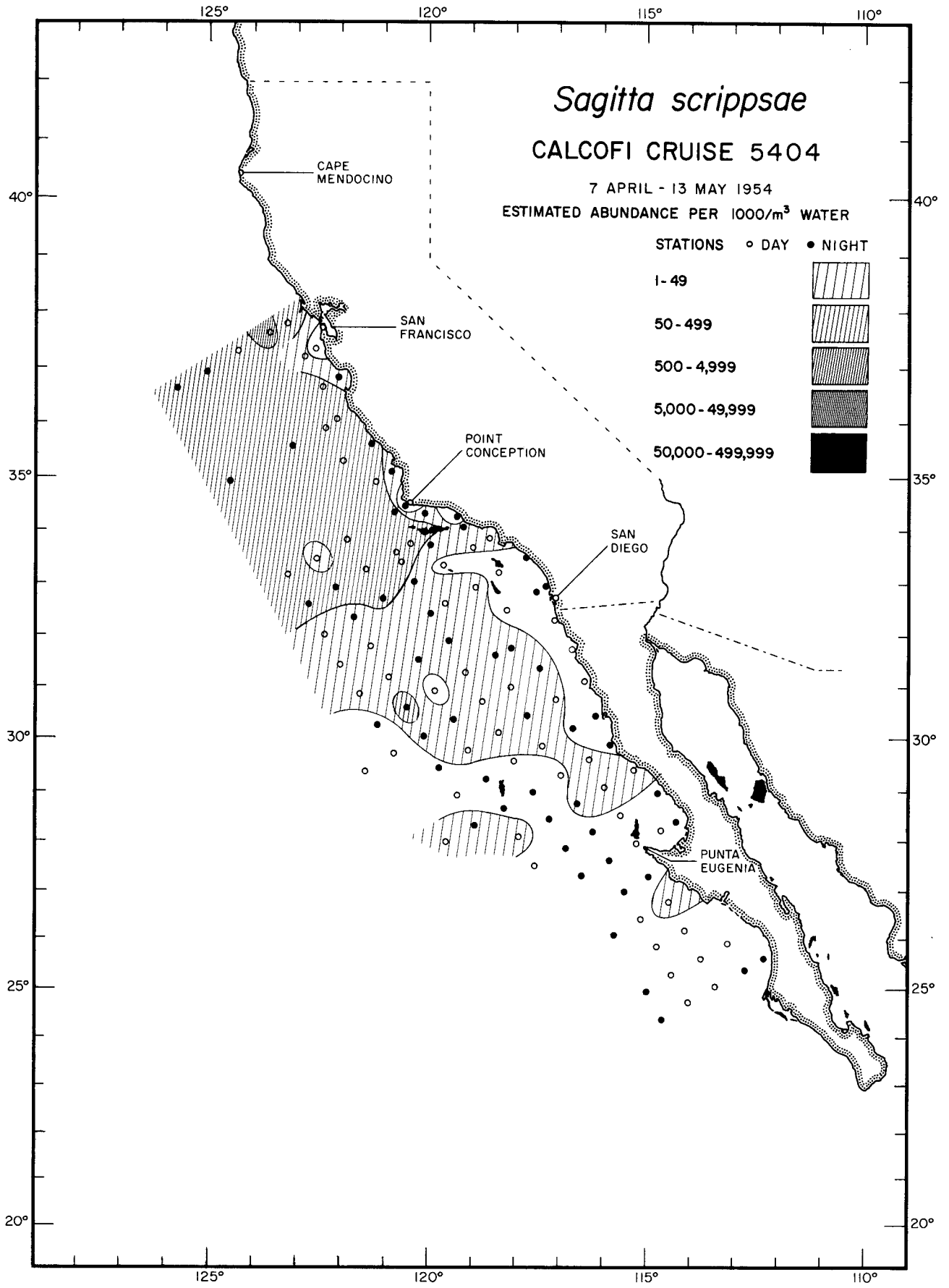


Chaetognatha  
*Sagitta pacifica*  
5404

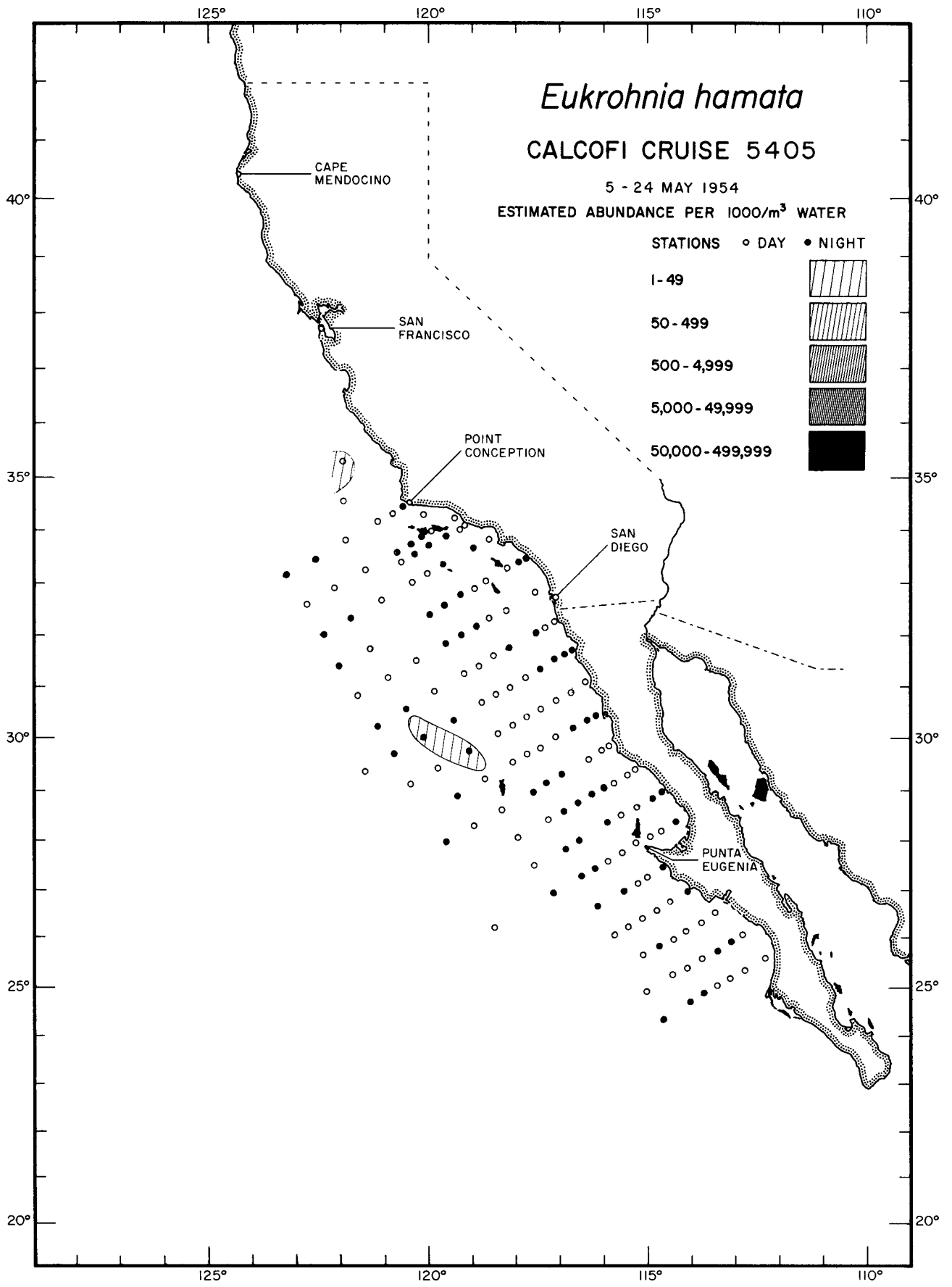




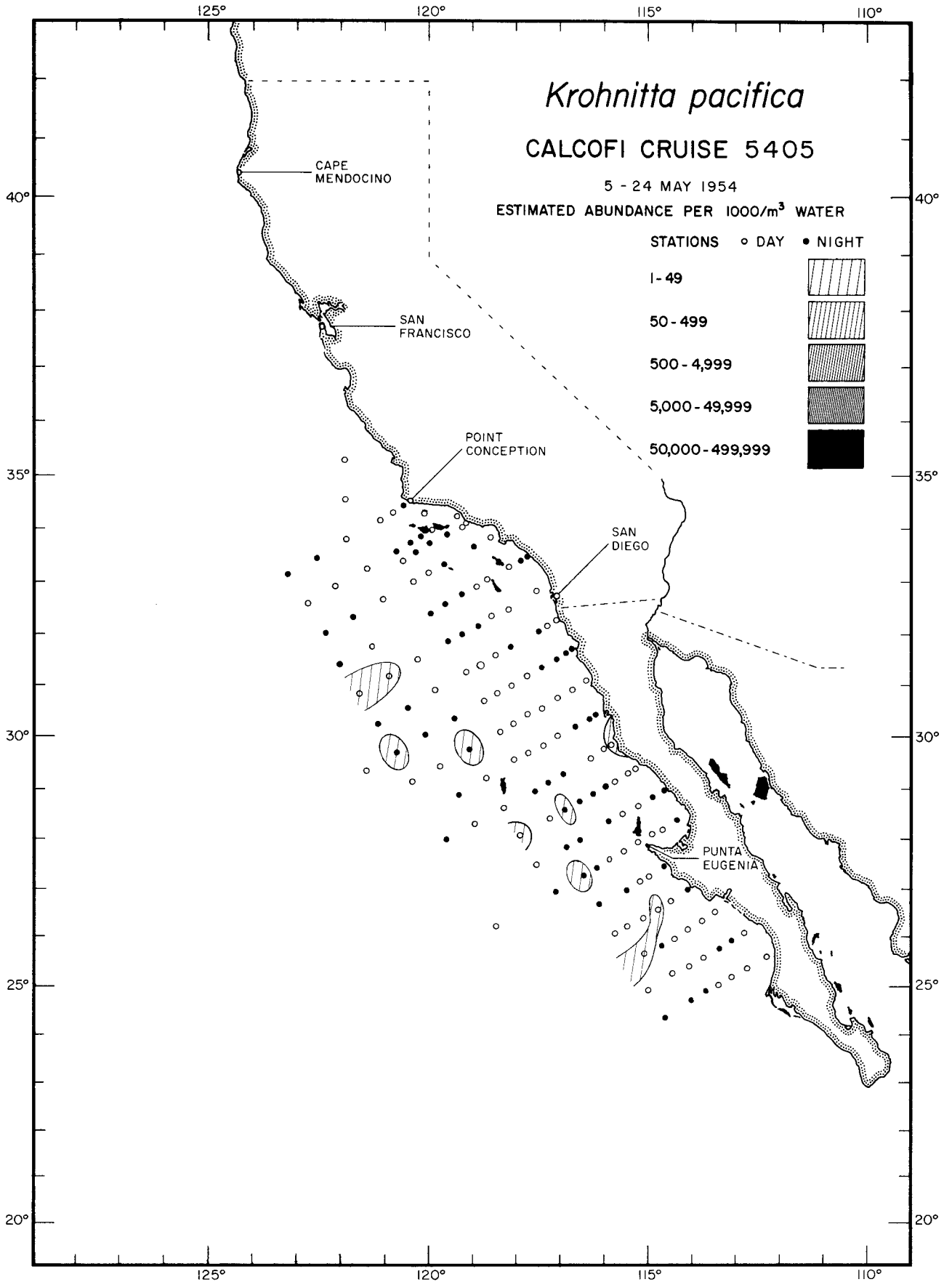
Chaetognatha  
*Sagitta pseudoserratodentata*  
5404



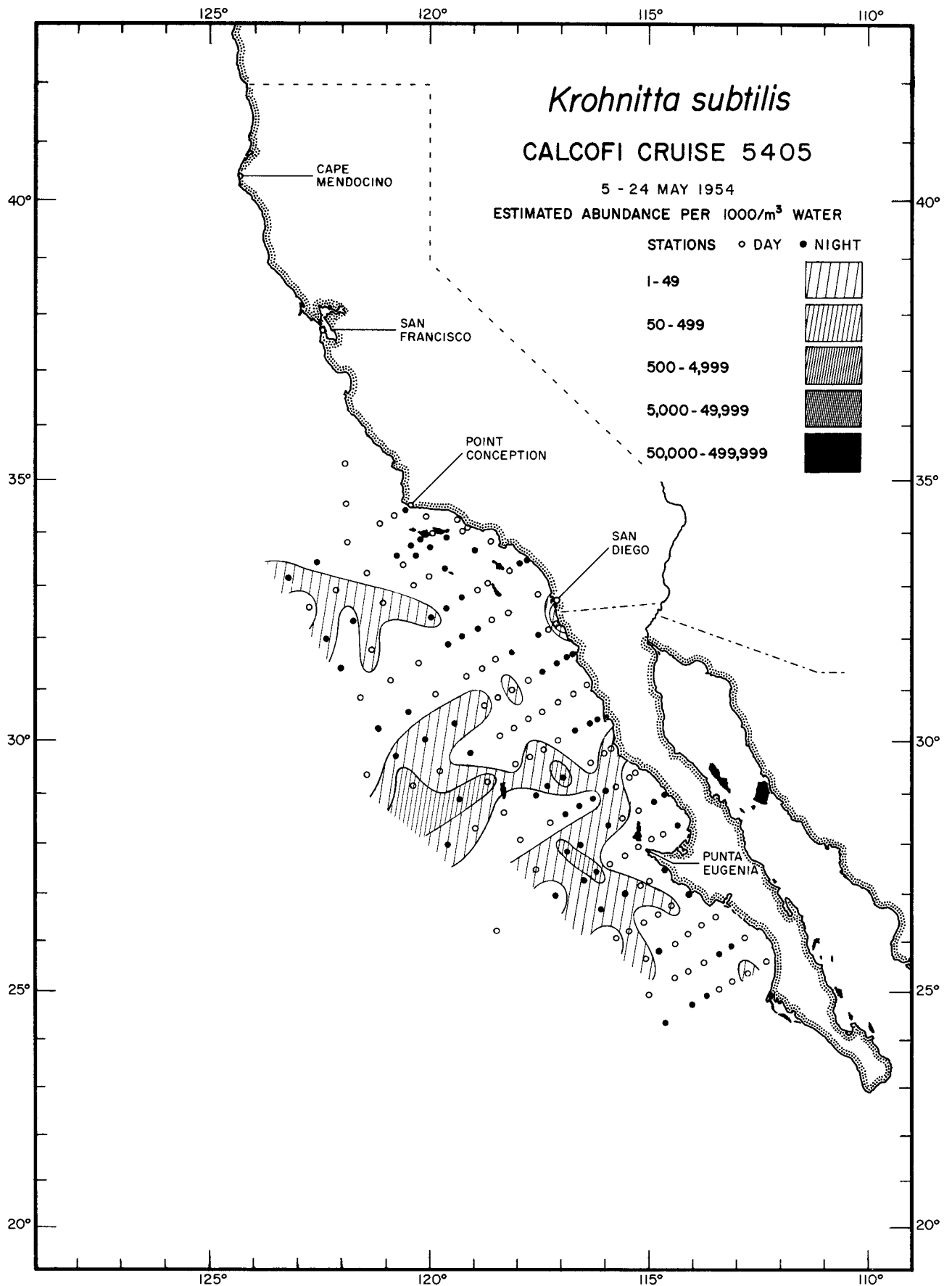
Chaetognatha  
*Sagitta scrippsae*  
5404



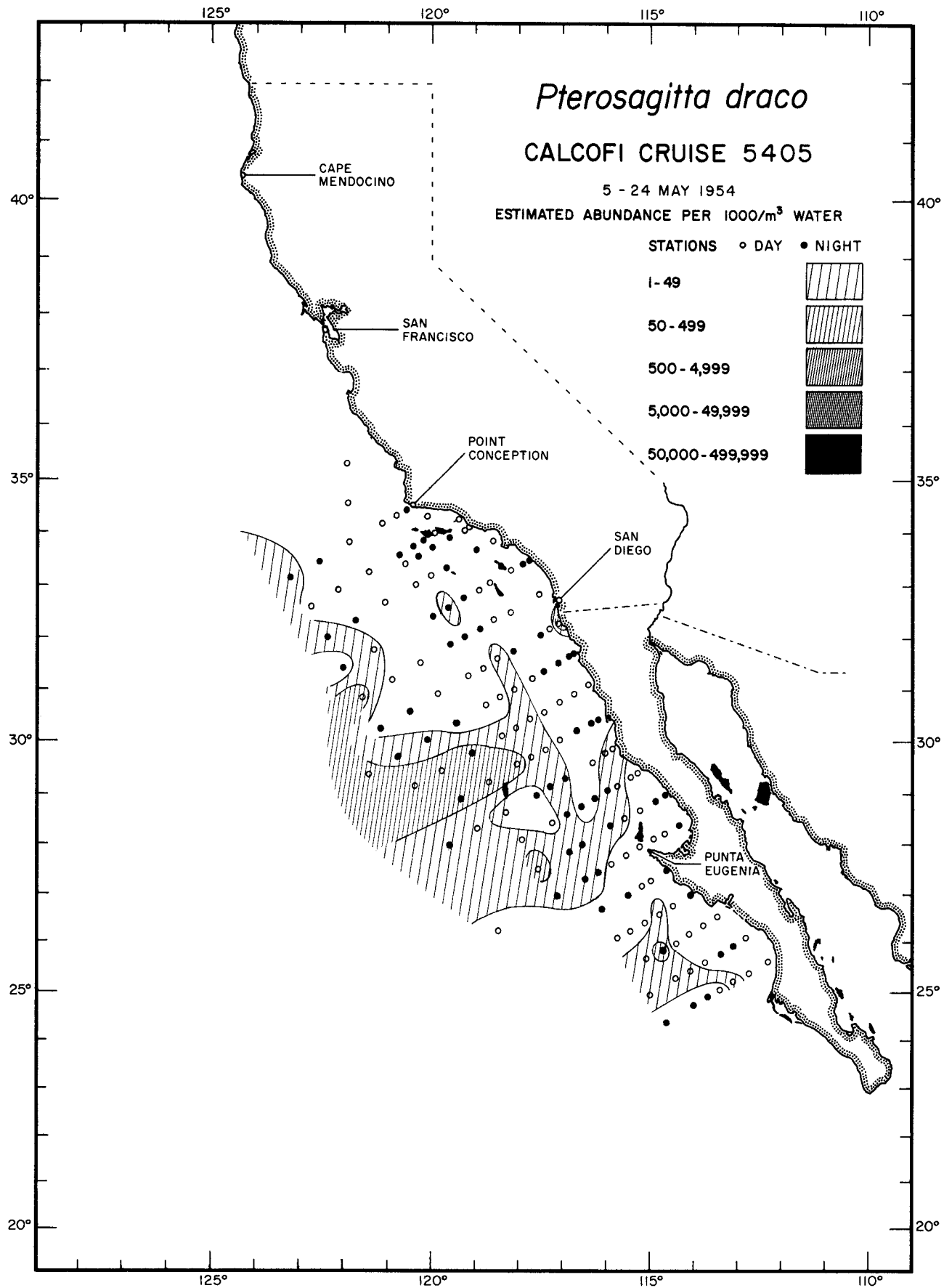
Chaetognatha  
*Eukrohnia hamata*  
5405



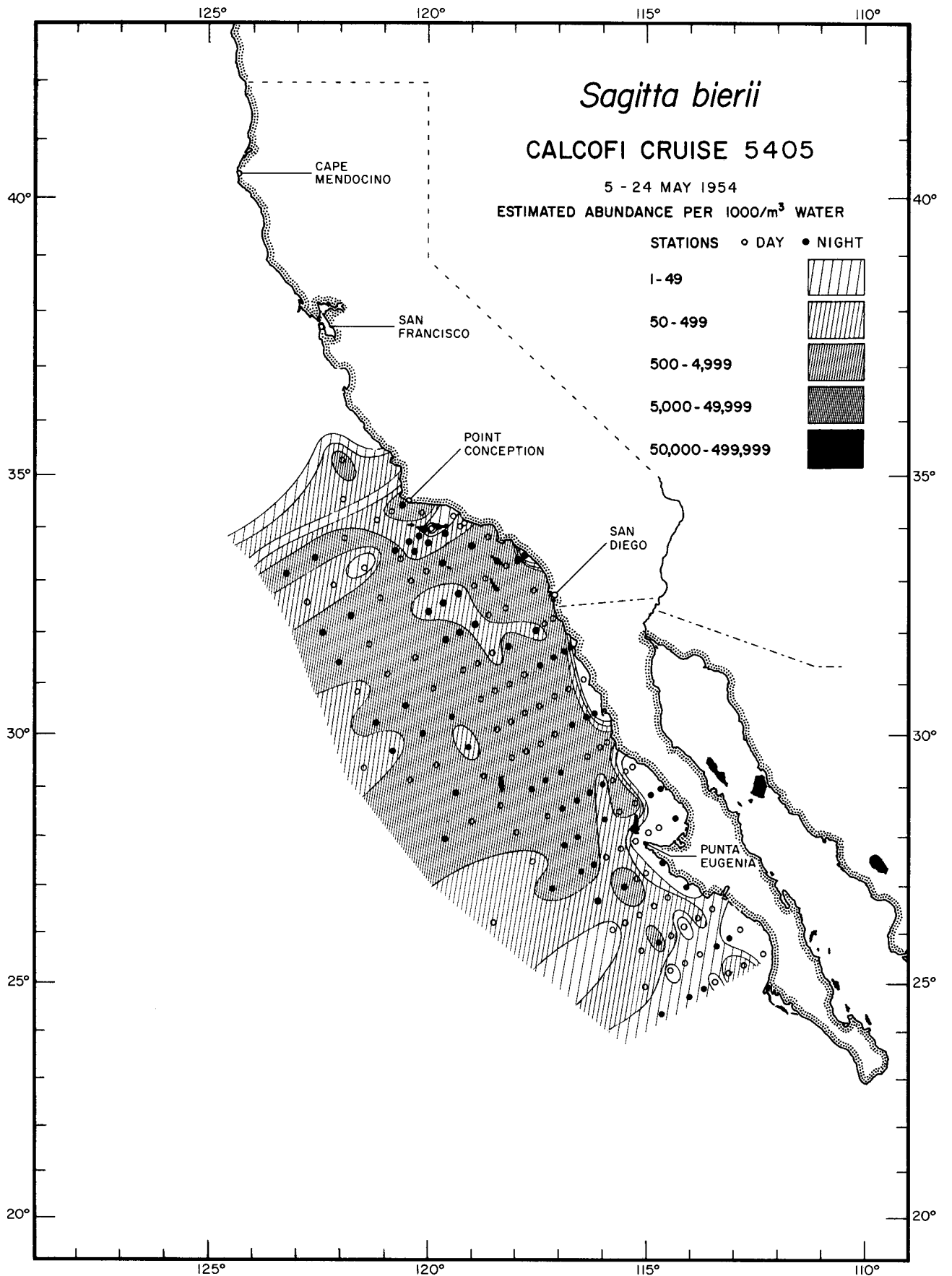
Chaetognatha  
*Krohnitta pacifica*  
5405

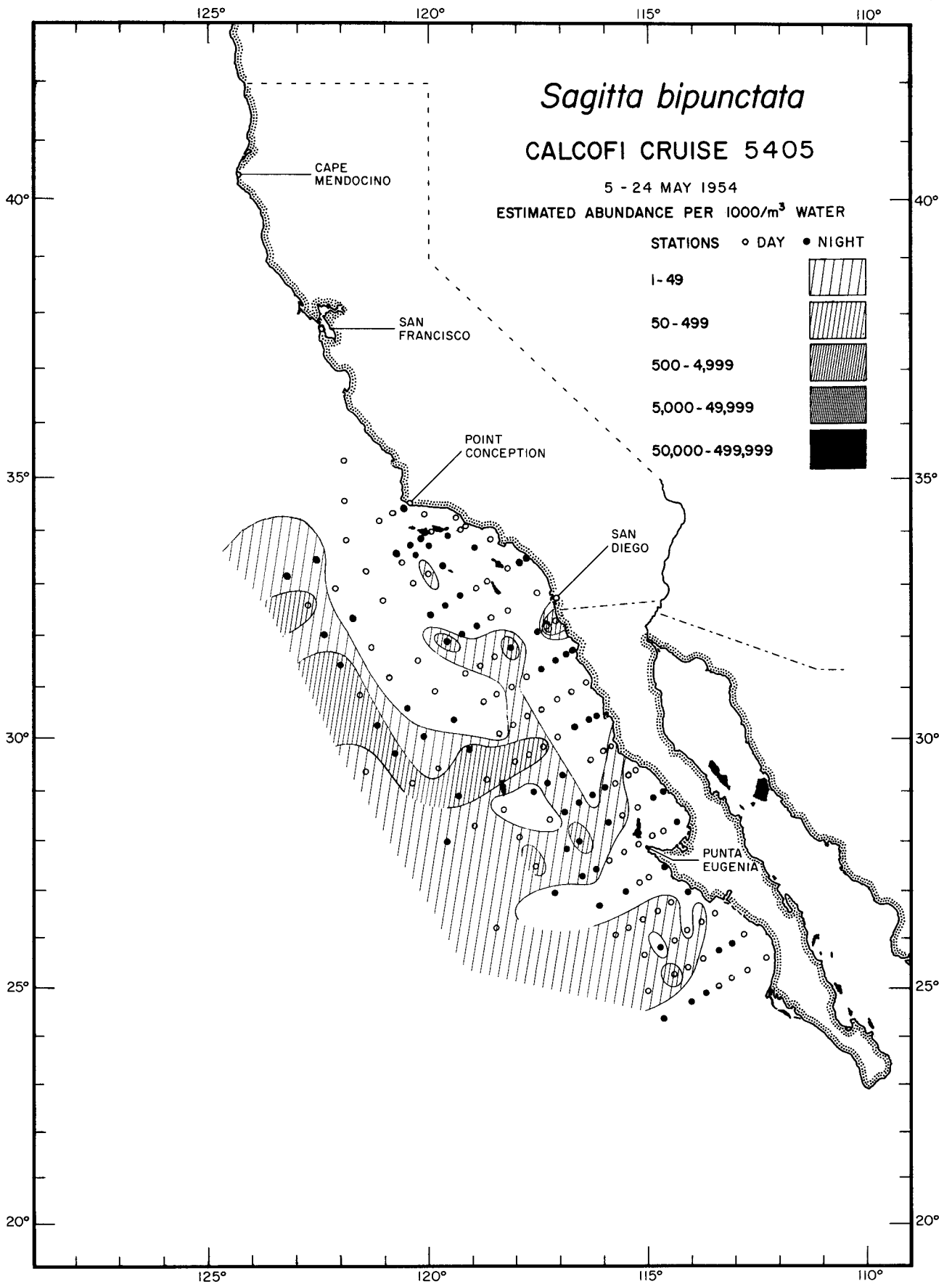


Chaetognatha  
*Krohnitta subtilis*  
5405



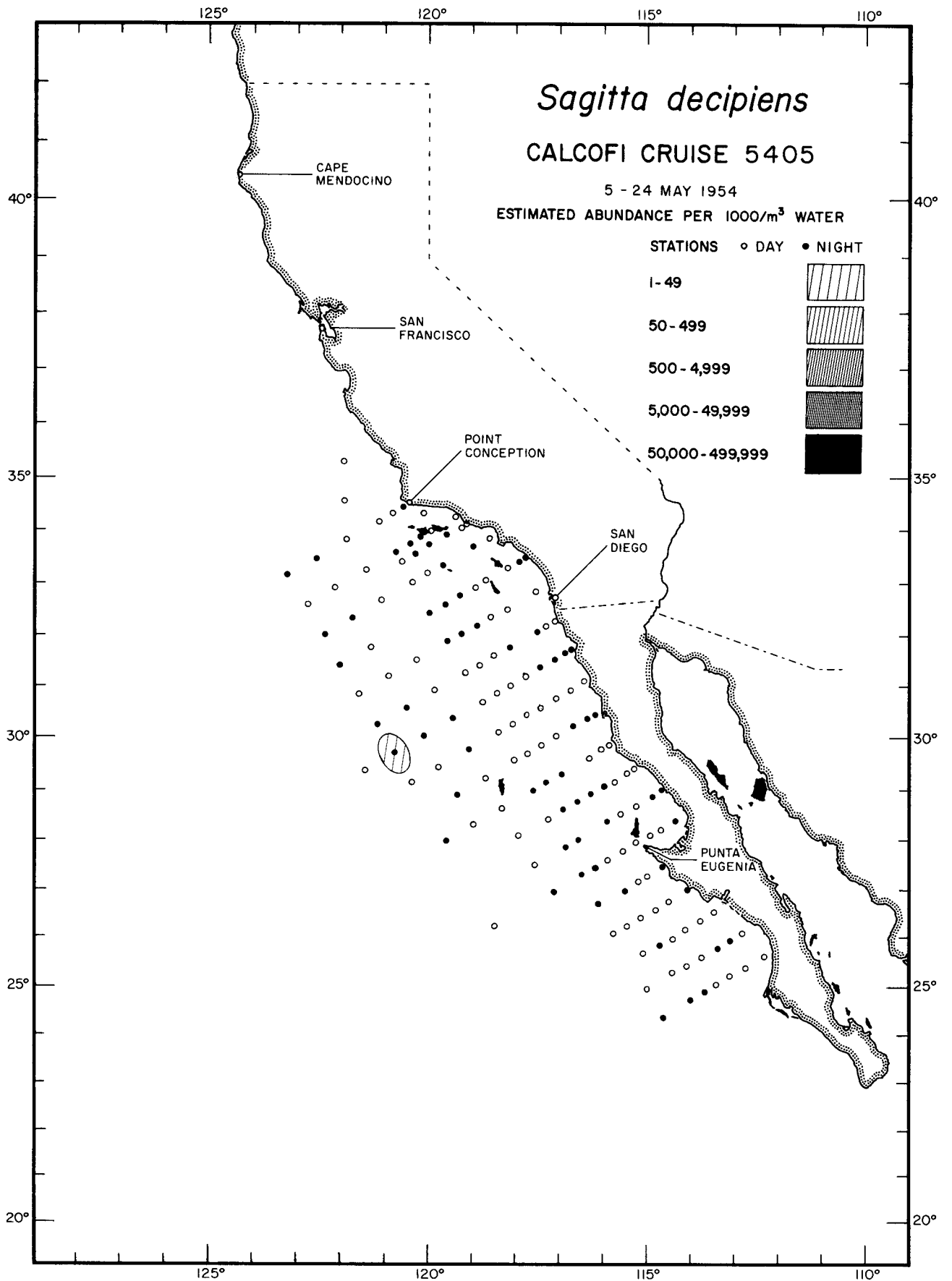
Chaetognatha  
*Pterosagitta draco*  
 5405



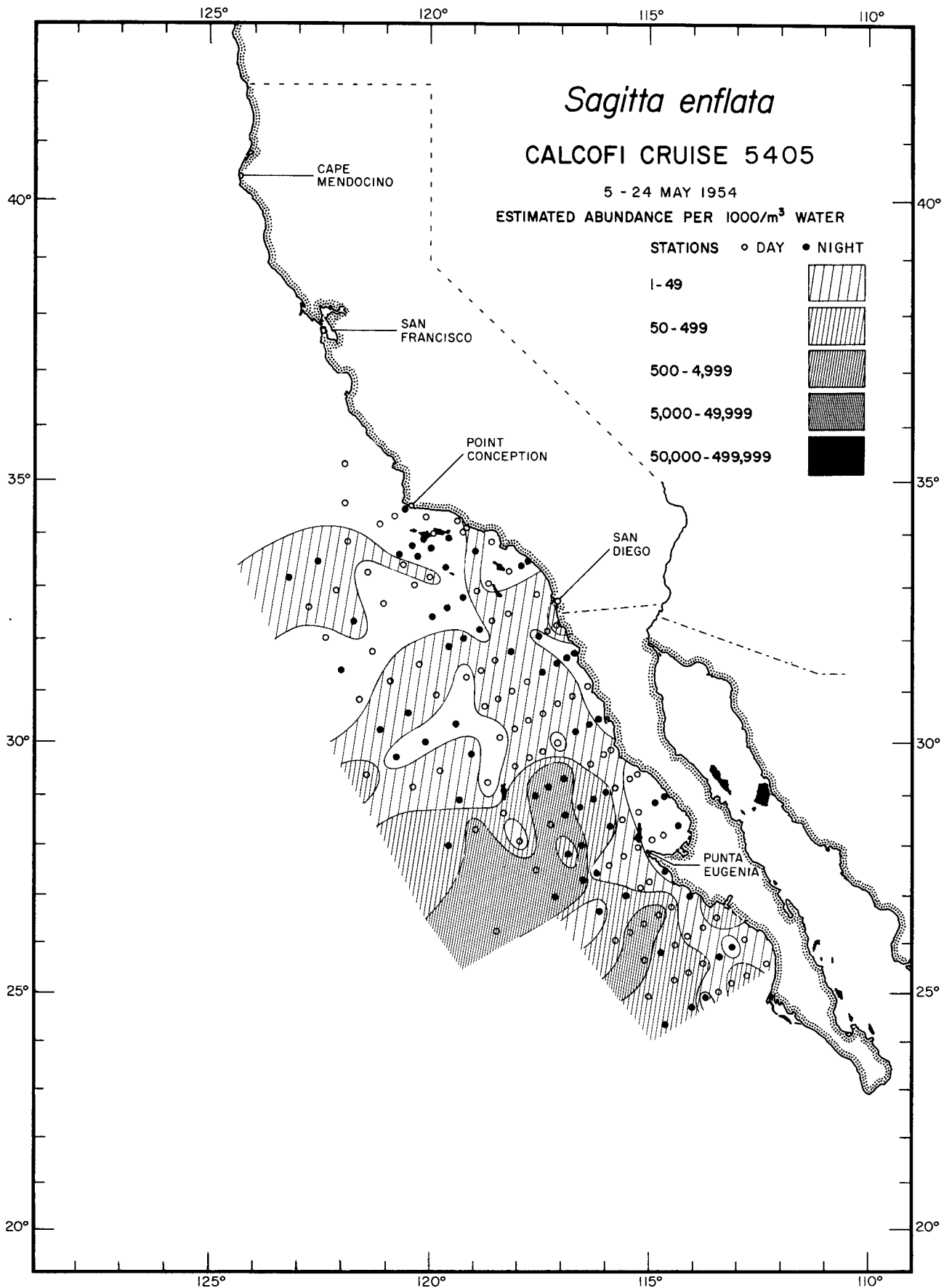


Chaetognatha  
*Sagitta bipunctata*  
5405

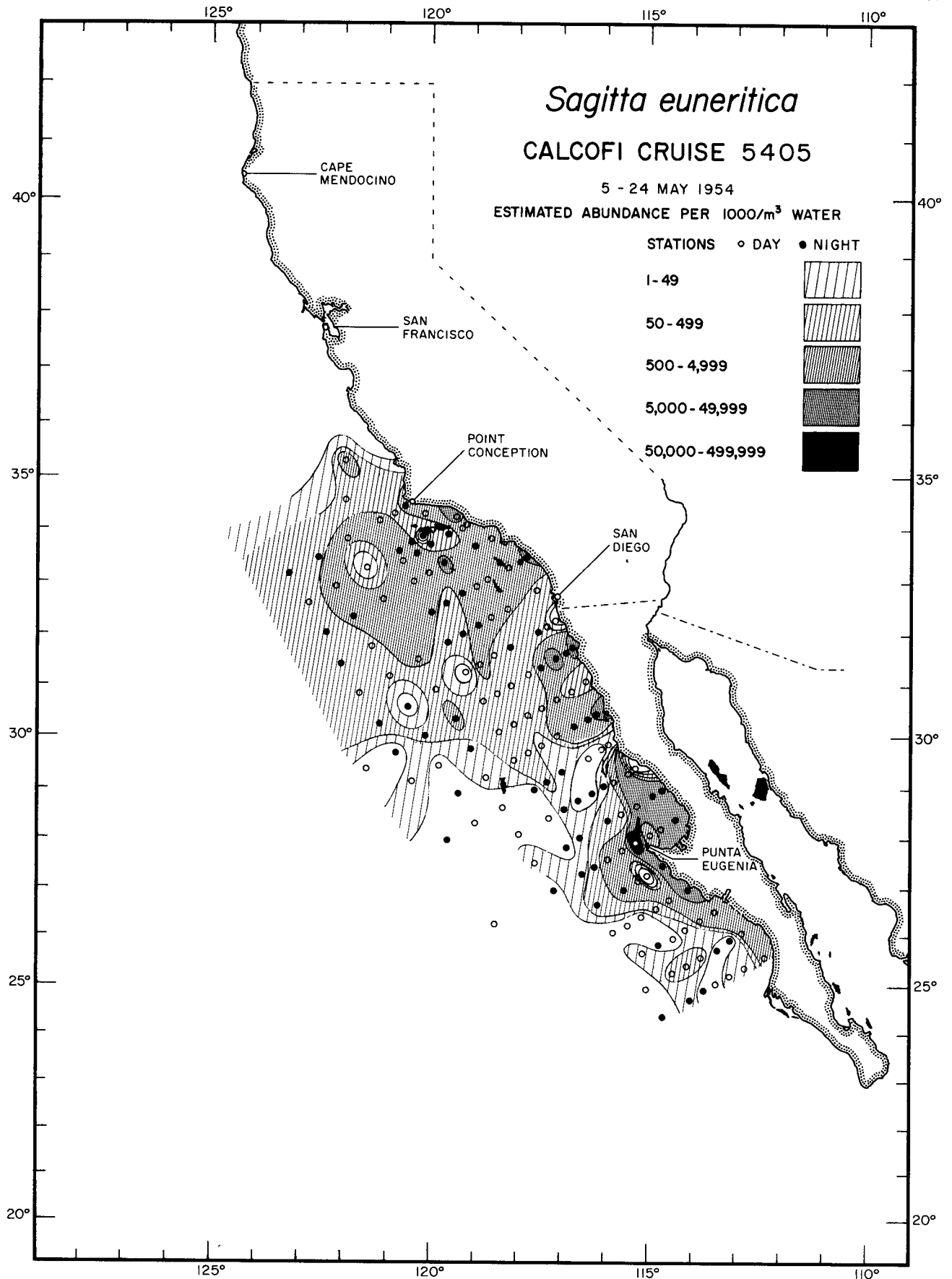




Chaetognatha  
*Sagitta decipiens*  
5405



Chaetognatha  
*Sagitta enflata*  
 5405



*Sagitta euneritica*

CALCOFI CRUISE 5405

5 - 24 MAY 1954

ESTIMATED ABUNDANCE PER 1000/m<sup>3</sup> WATER

STATIONS ○ DAY ● NIGHT

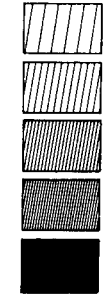
1 - 49

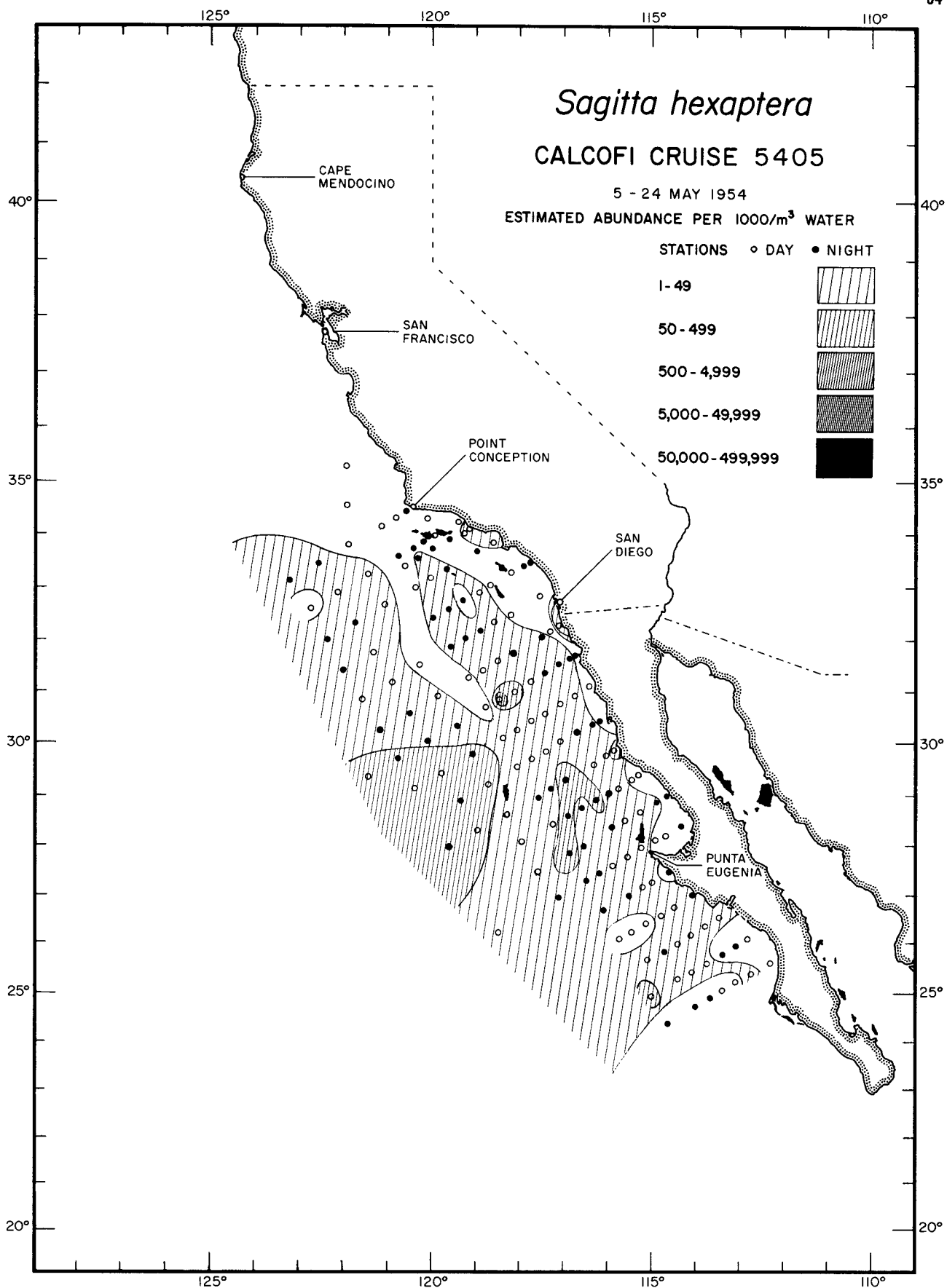
50 - 499

500 - 4,999

5,000 - 49,999

50,000 - 499,999





# *Sagitta hexaptera*

## CALCOFI CRUISE 5405

5 - 24 MAY 1954

ESTIMATED ABUNDANCE PER 1000/m<sup>3</sup> WATER

STATIONS ○ DAY ● NIGHT

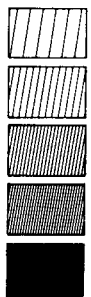
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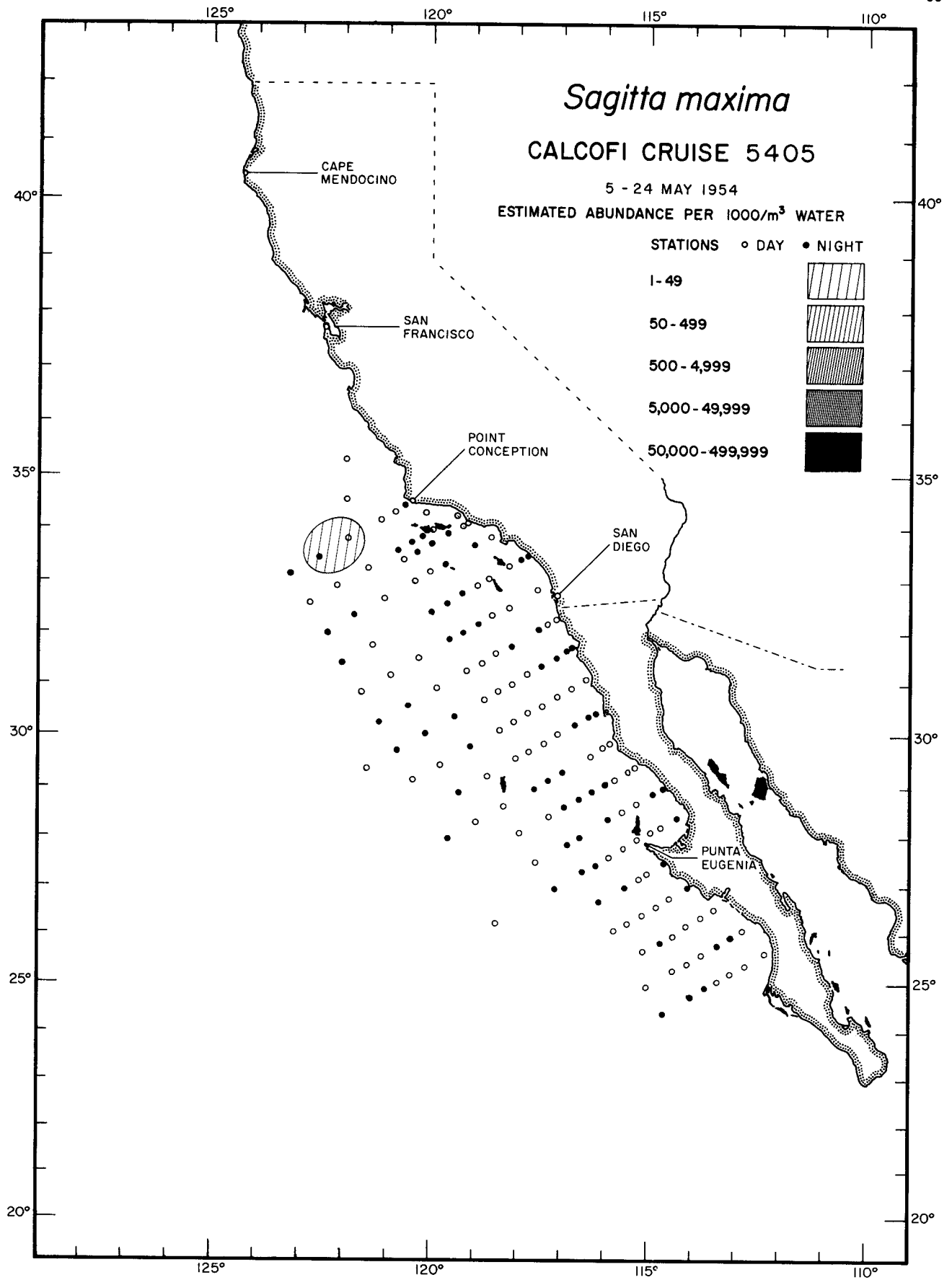
50-499

500-4,999

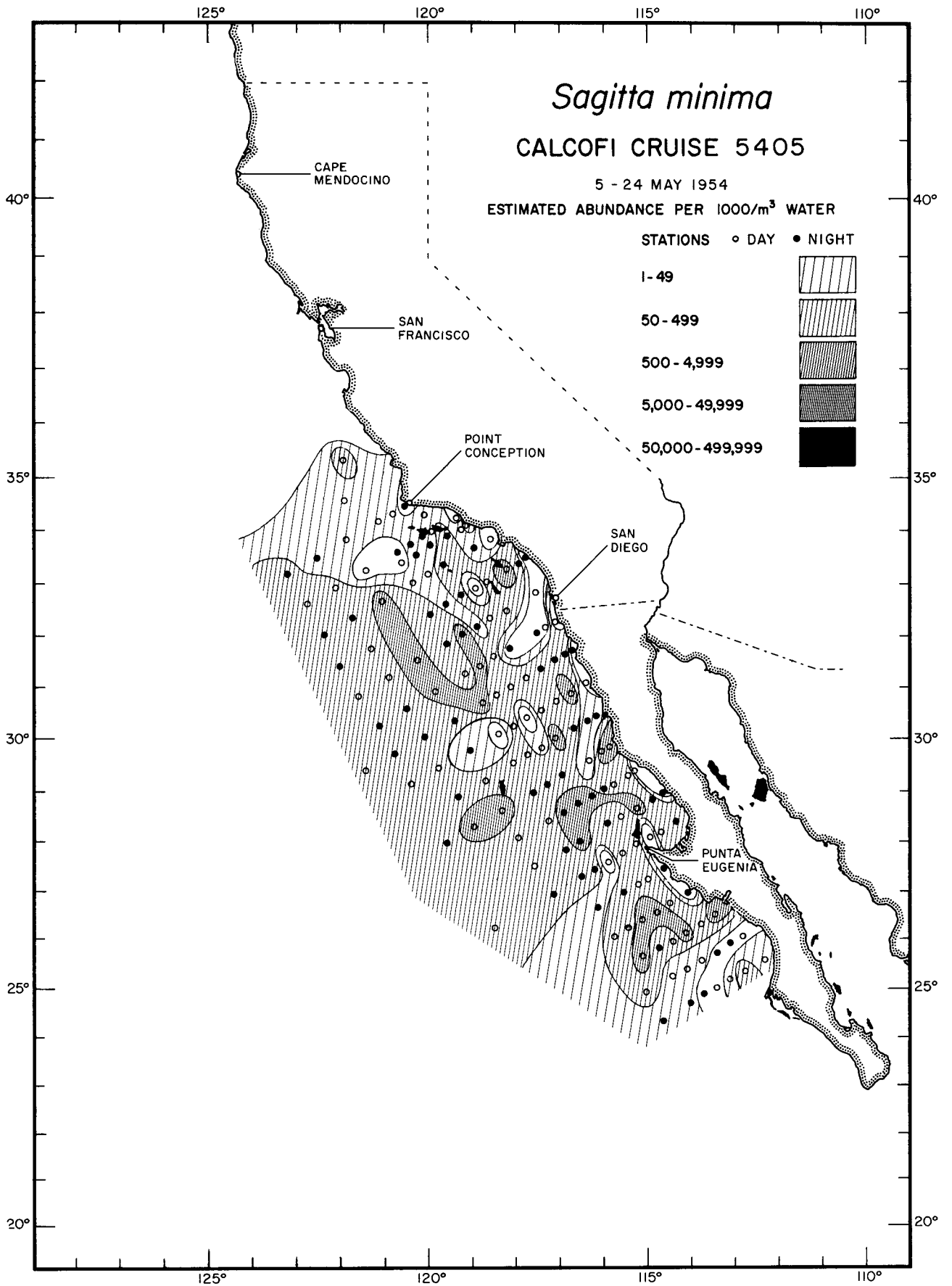
5,000-49,999

50,000-499,999

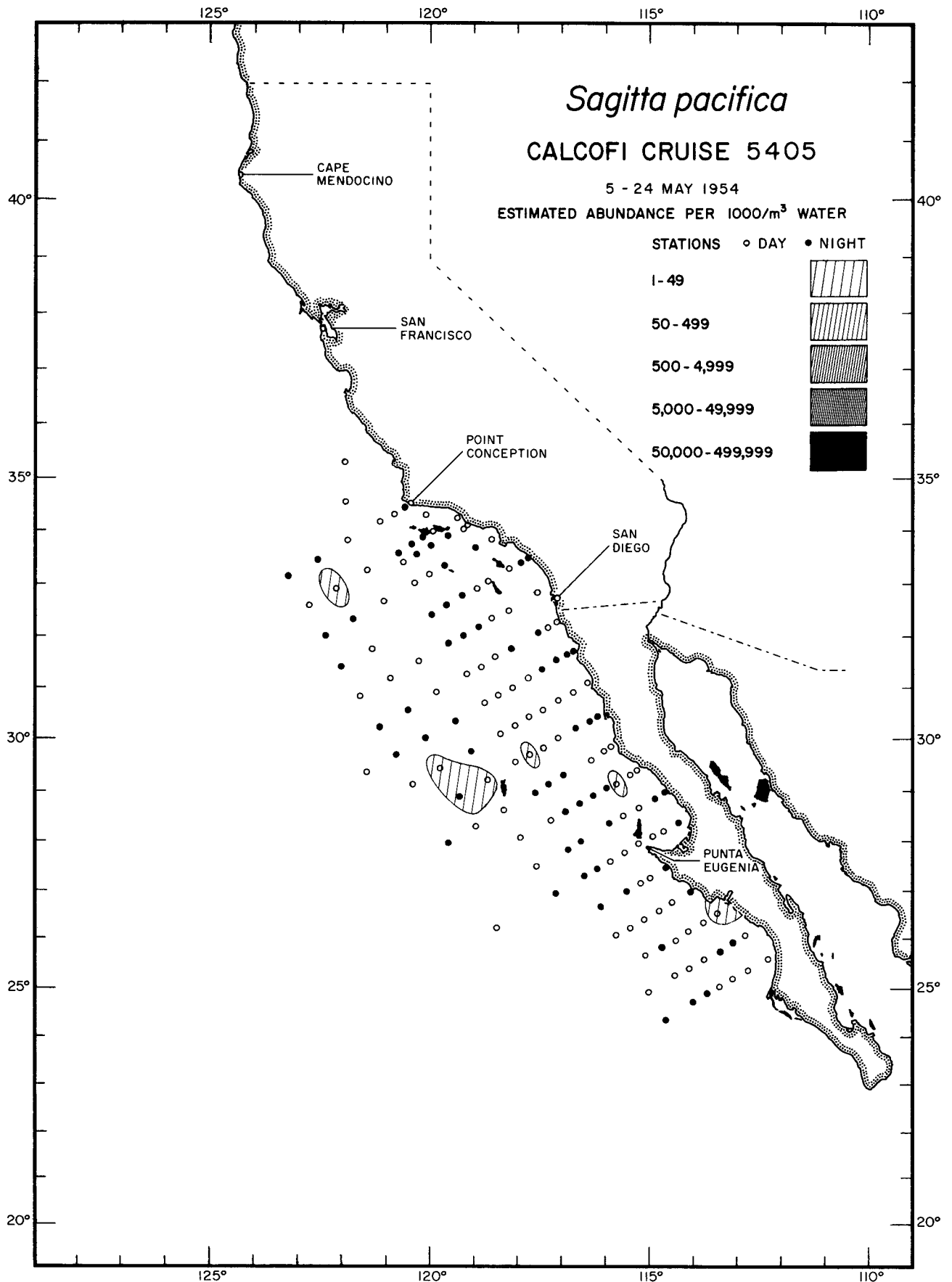




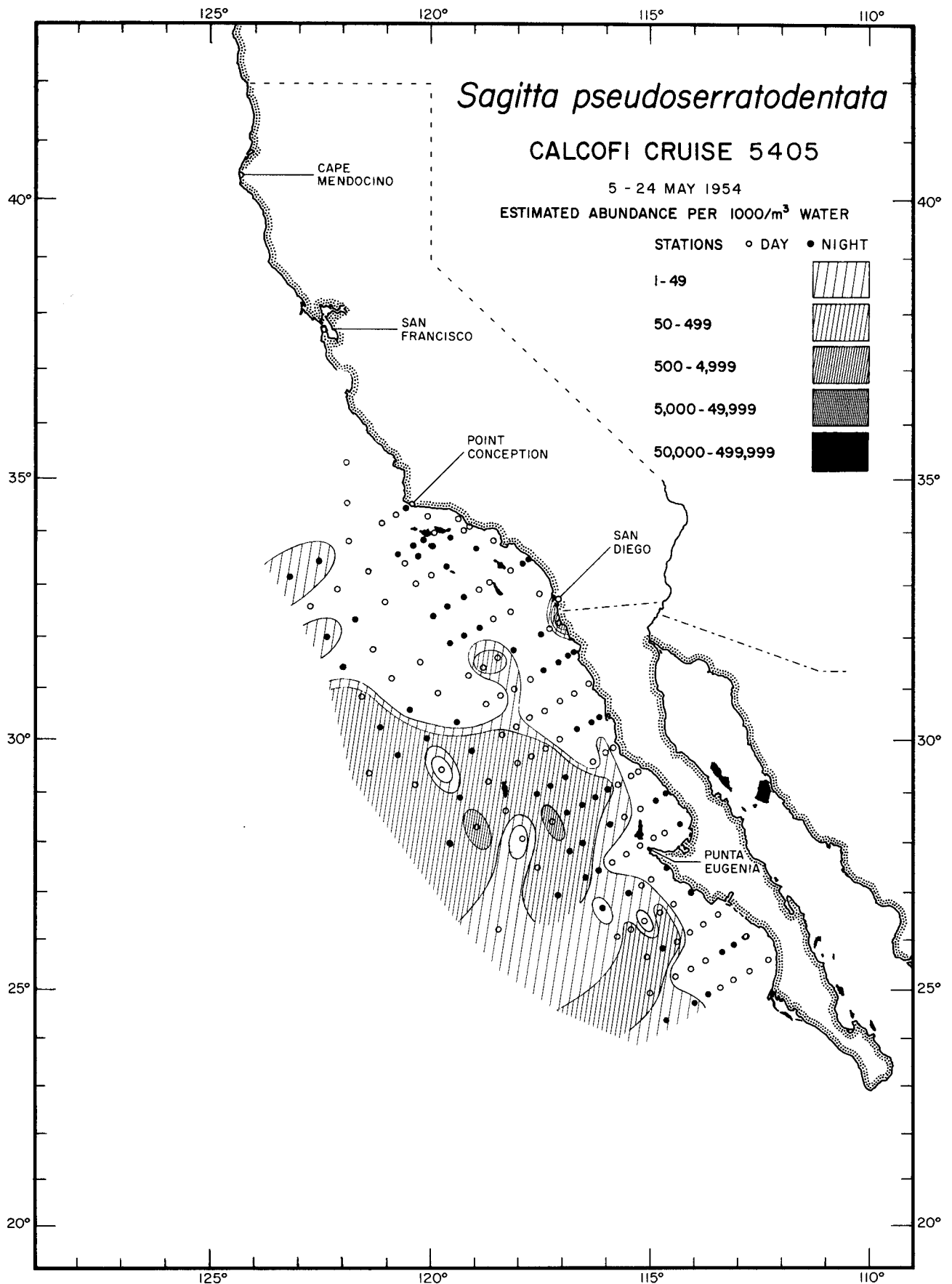
Chaetognatha  
*Sagitta maxima*  
5405



Chaetognatha  
*Sagitta minima*  
5405

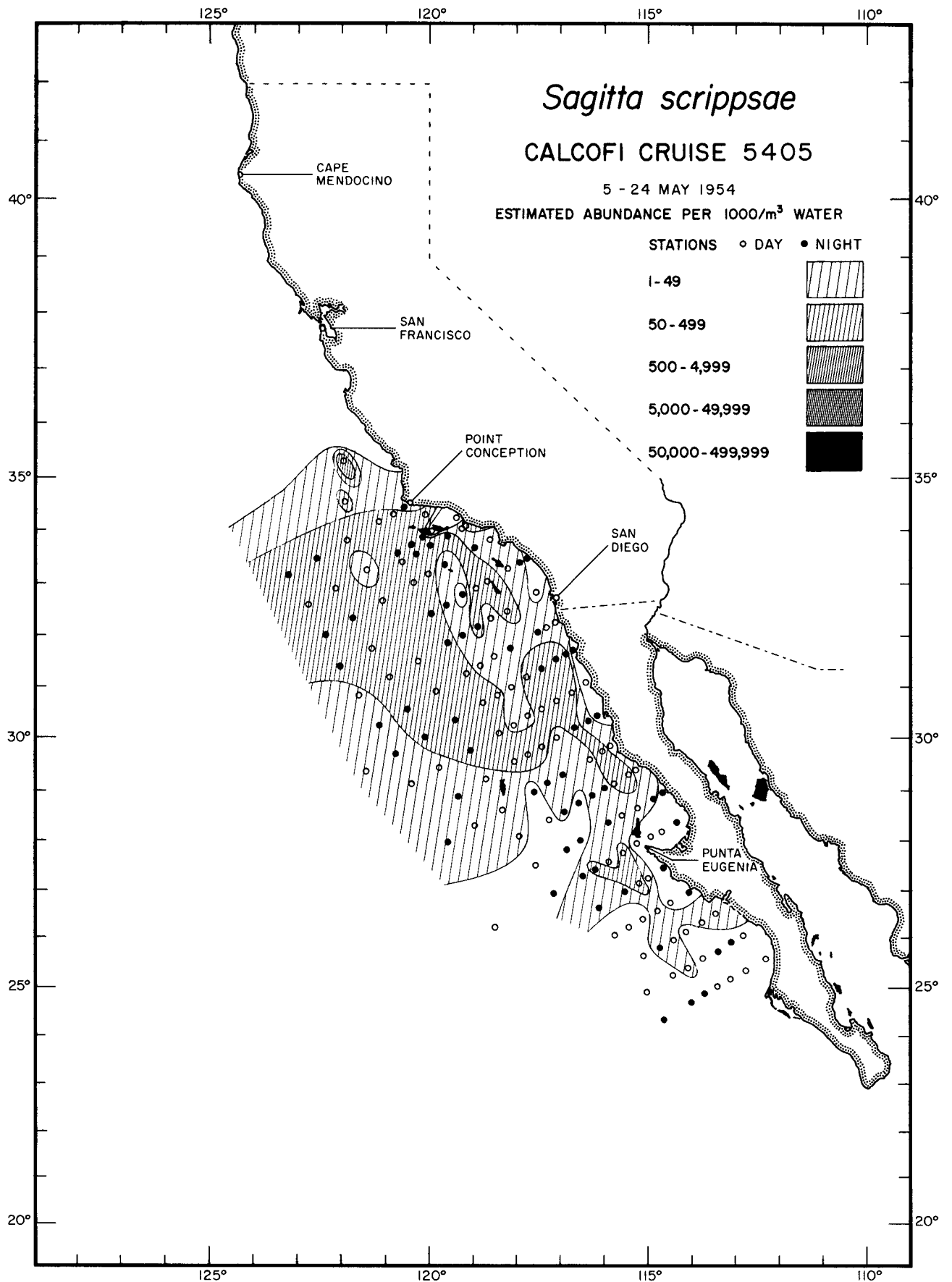


Chaetognatha  
*Sagitta pacifica*  
5405

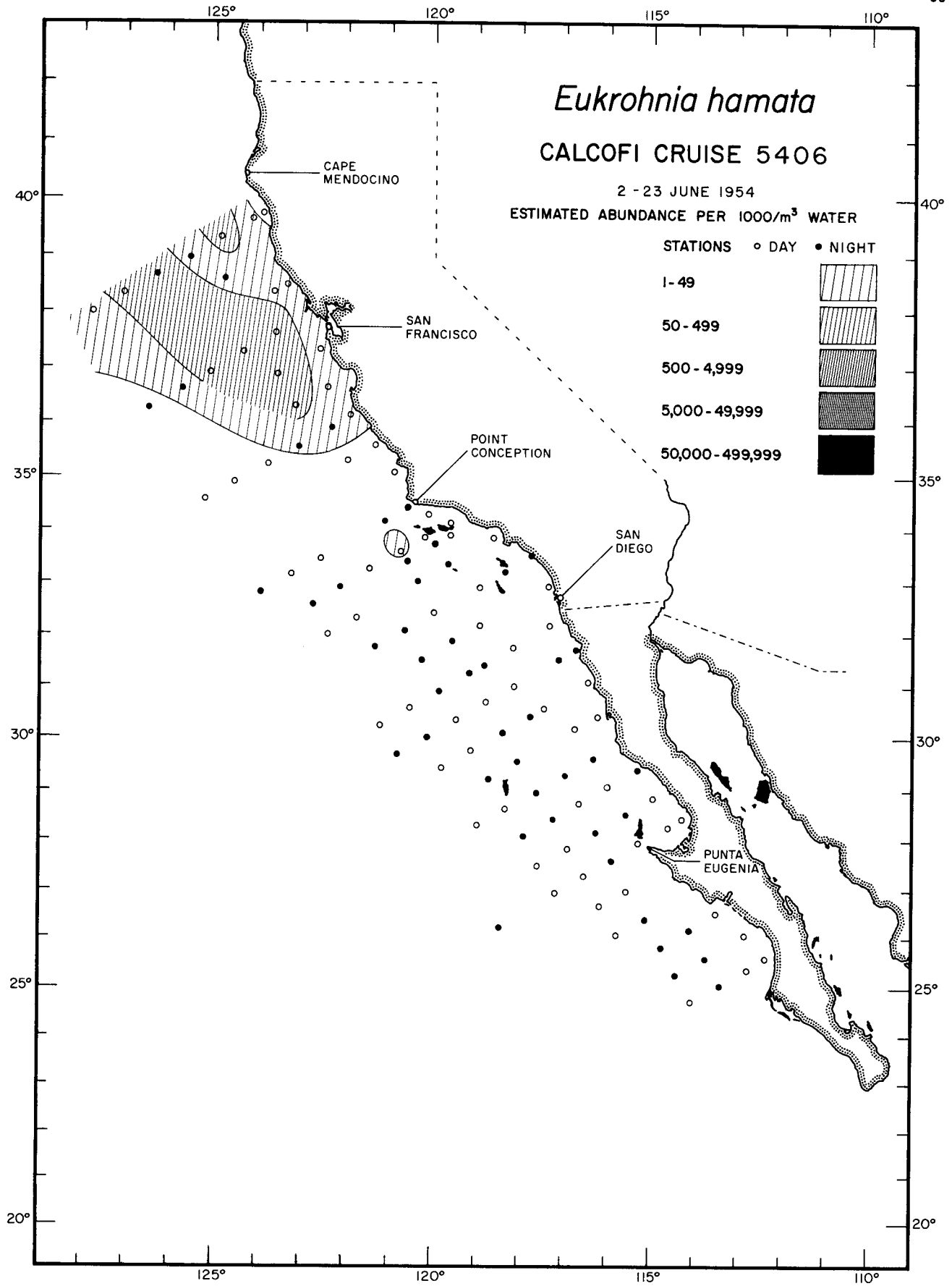


Chaetognatha  
*Sagitta pseudoserratodentata*  
5405

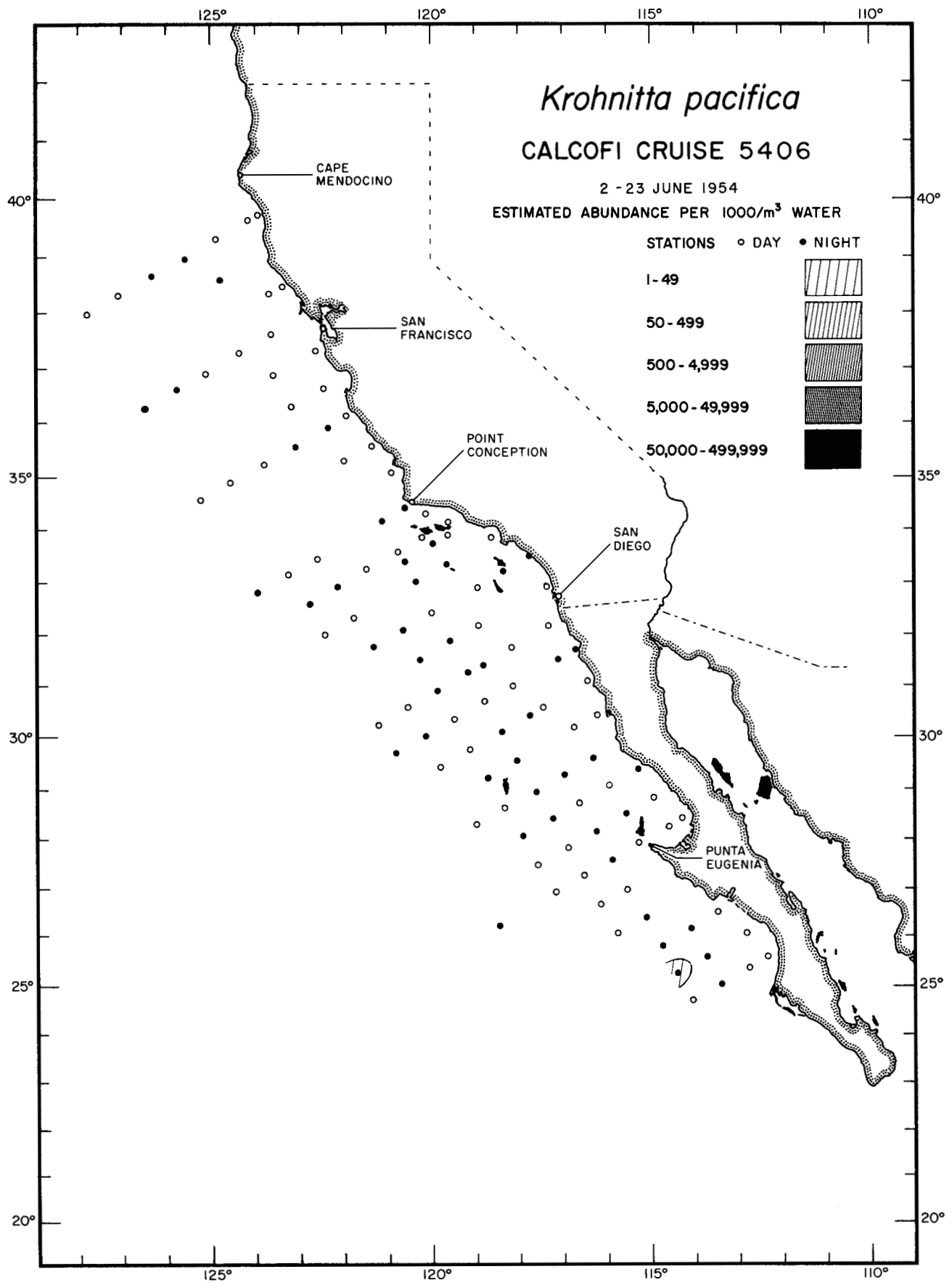




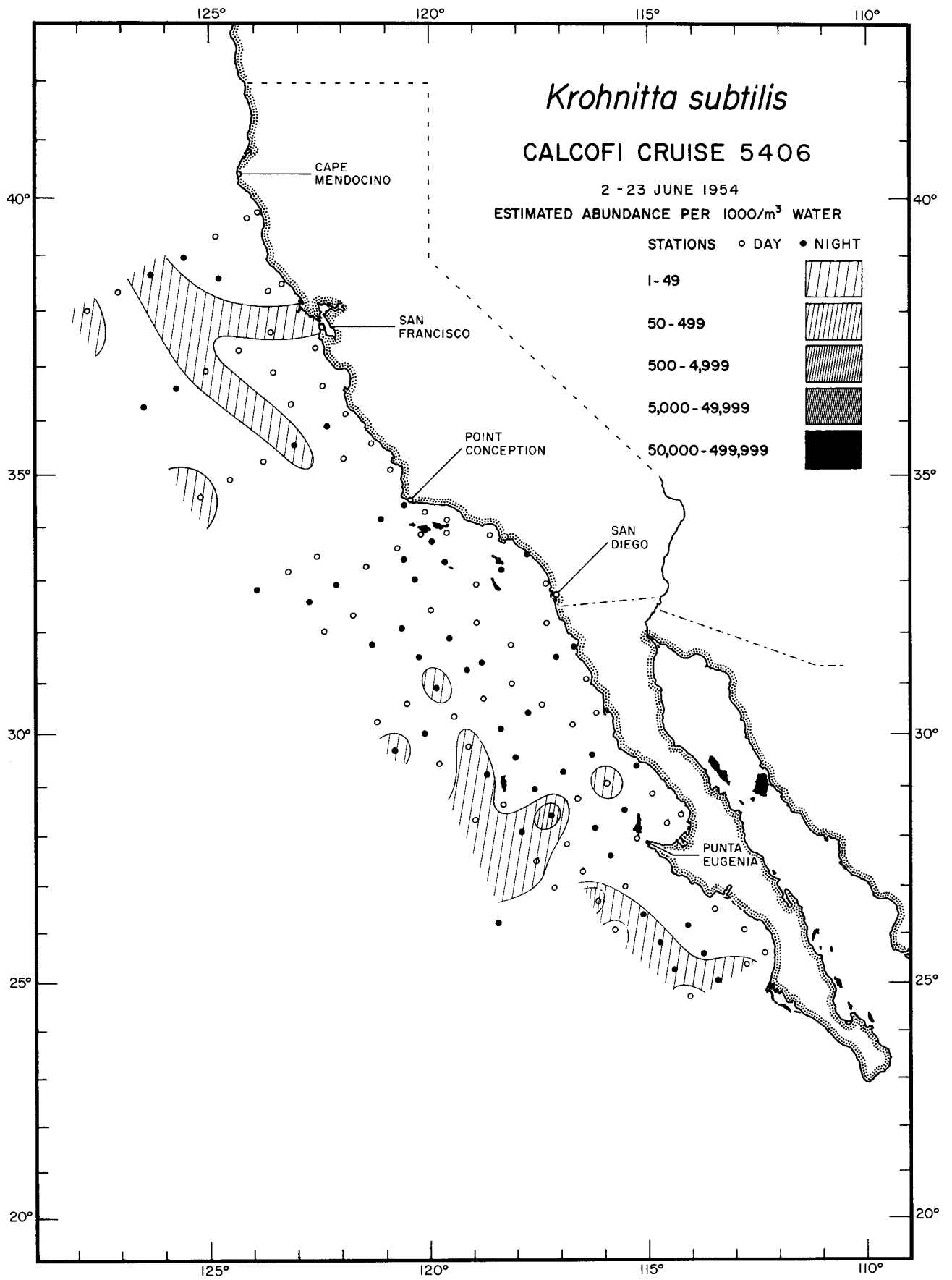
Chaetognatha  
*Sagitta scrippsae*  
5405



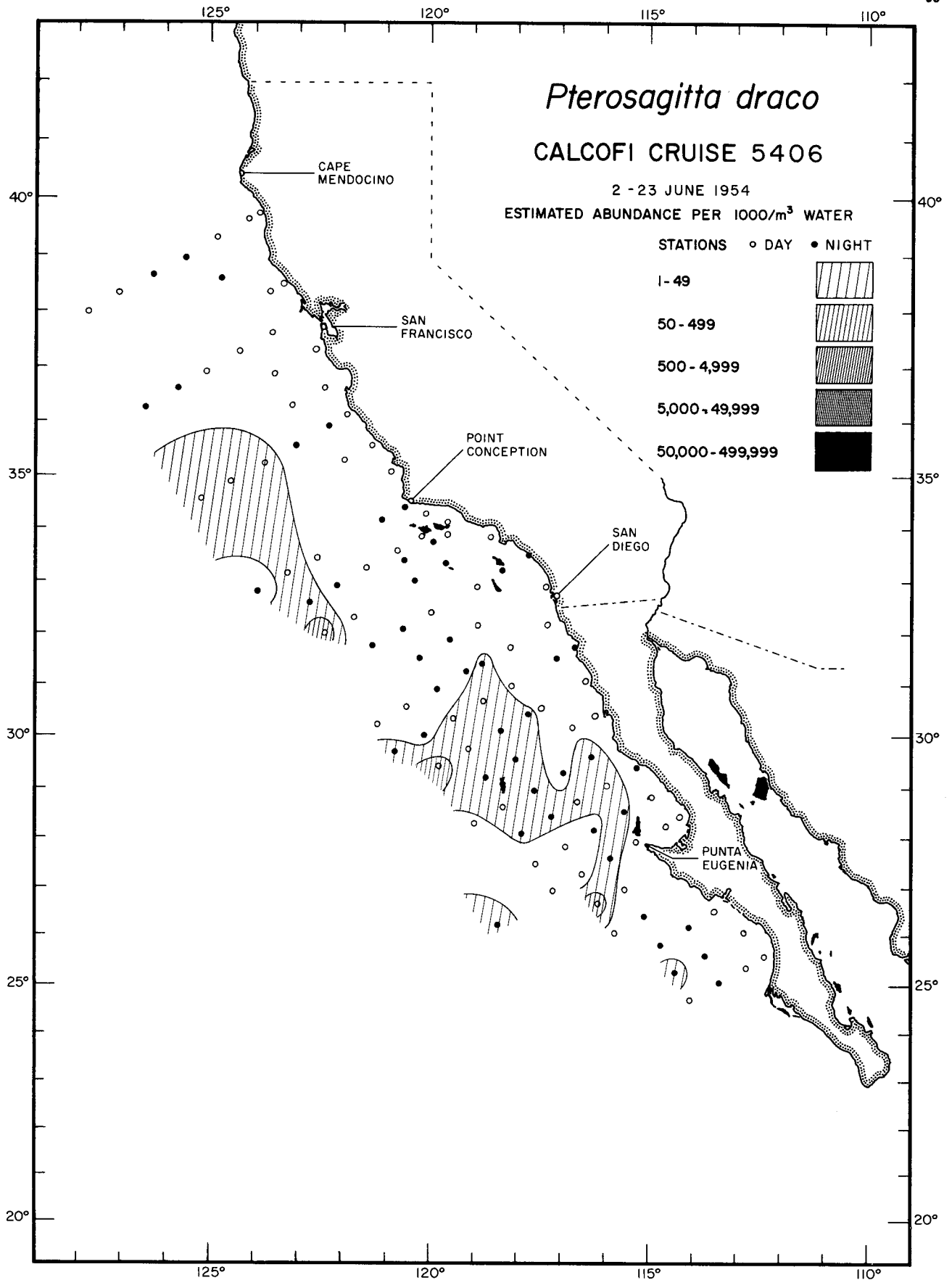
Chaetognatha  
*Eukrohnia hamata*  
5406



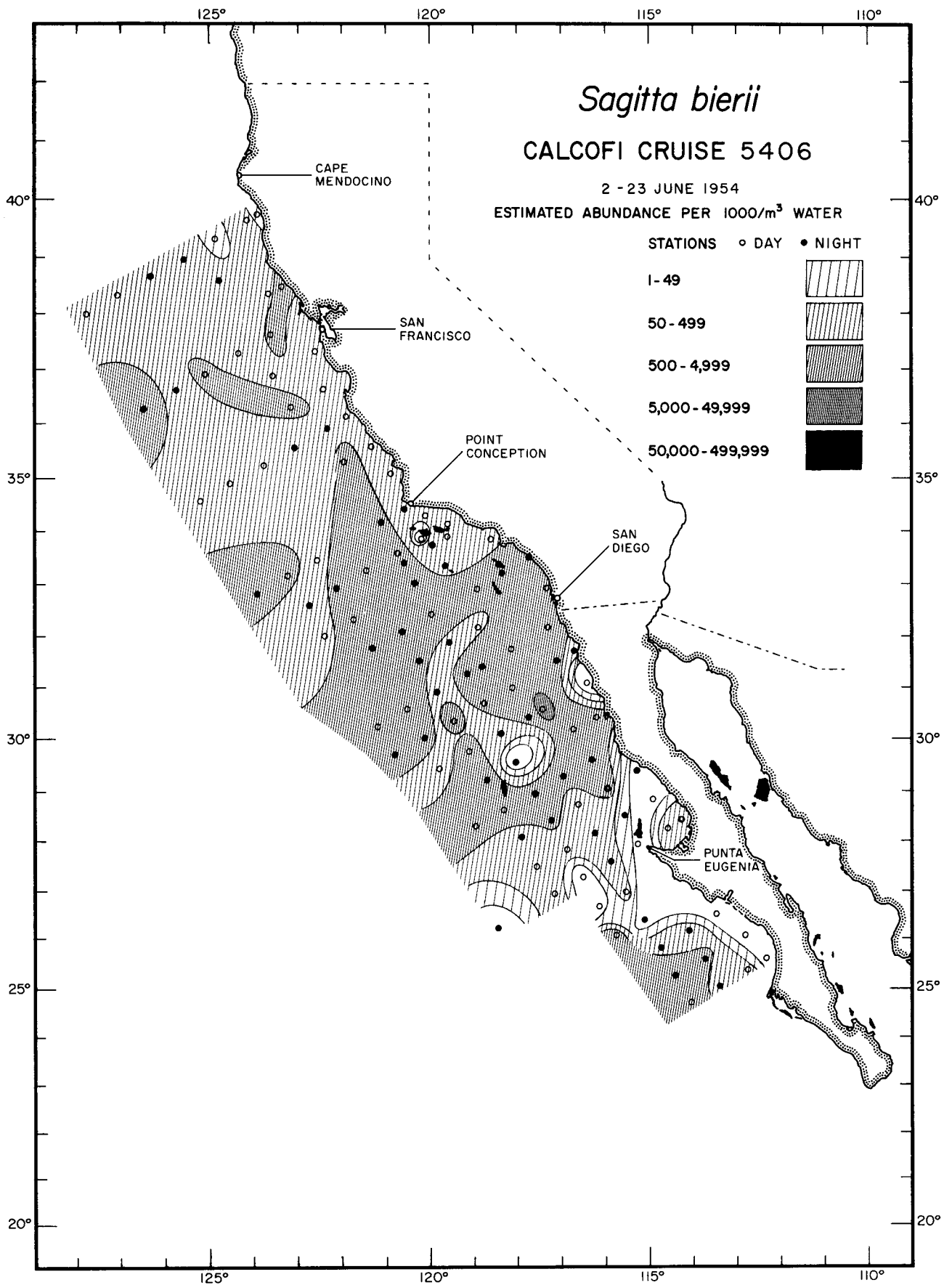
Chaetognatha  
*Krohnitta pacifica*  
5406



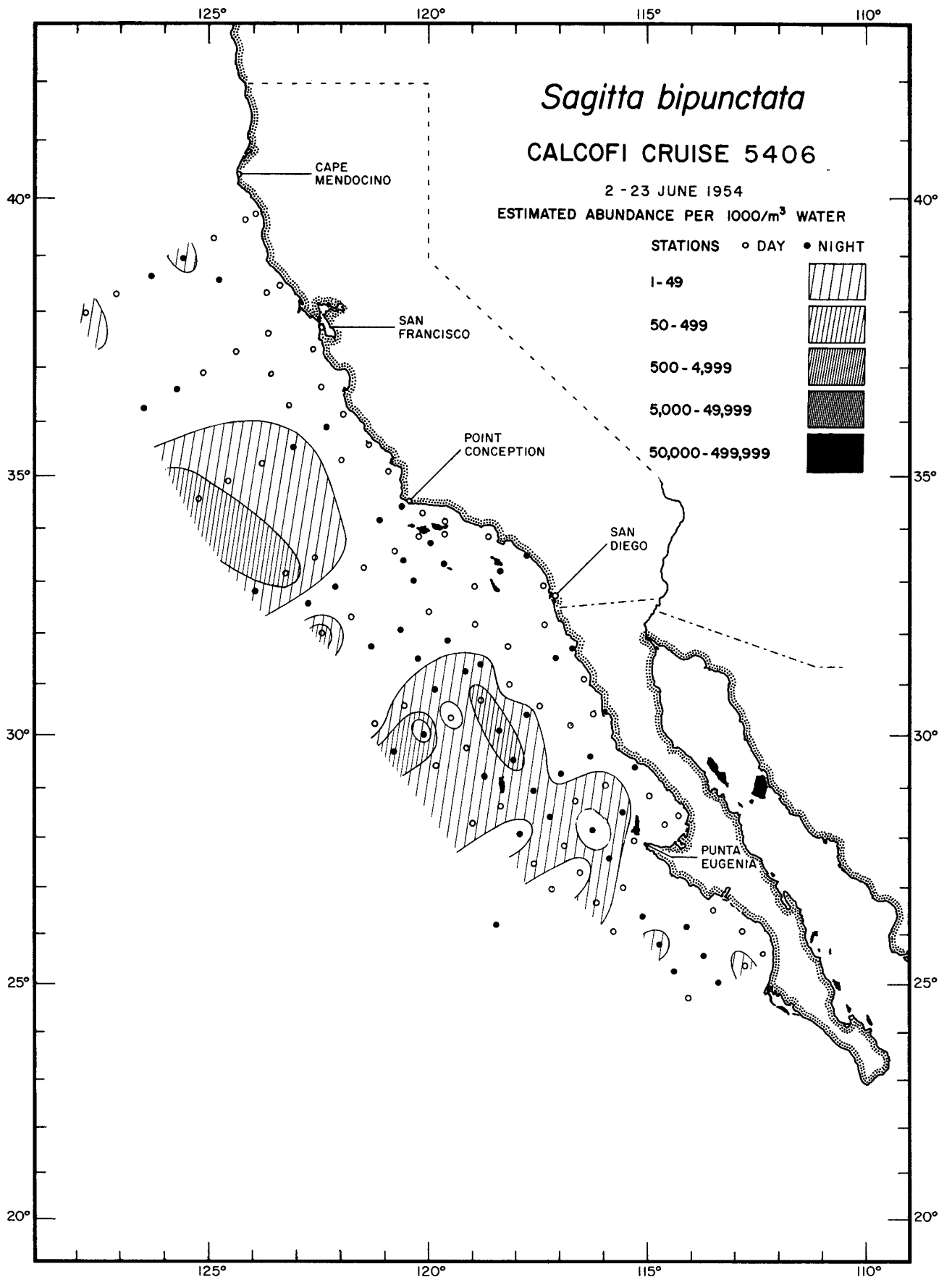
Chaetognatha  
*Krohnitta subtilis*  
5406



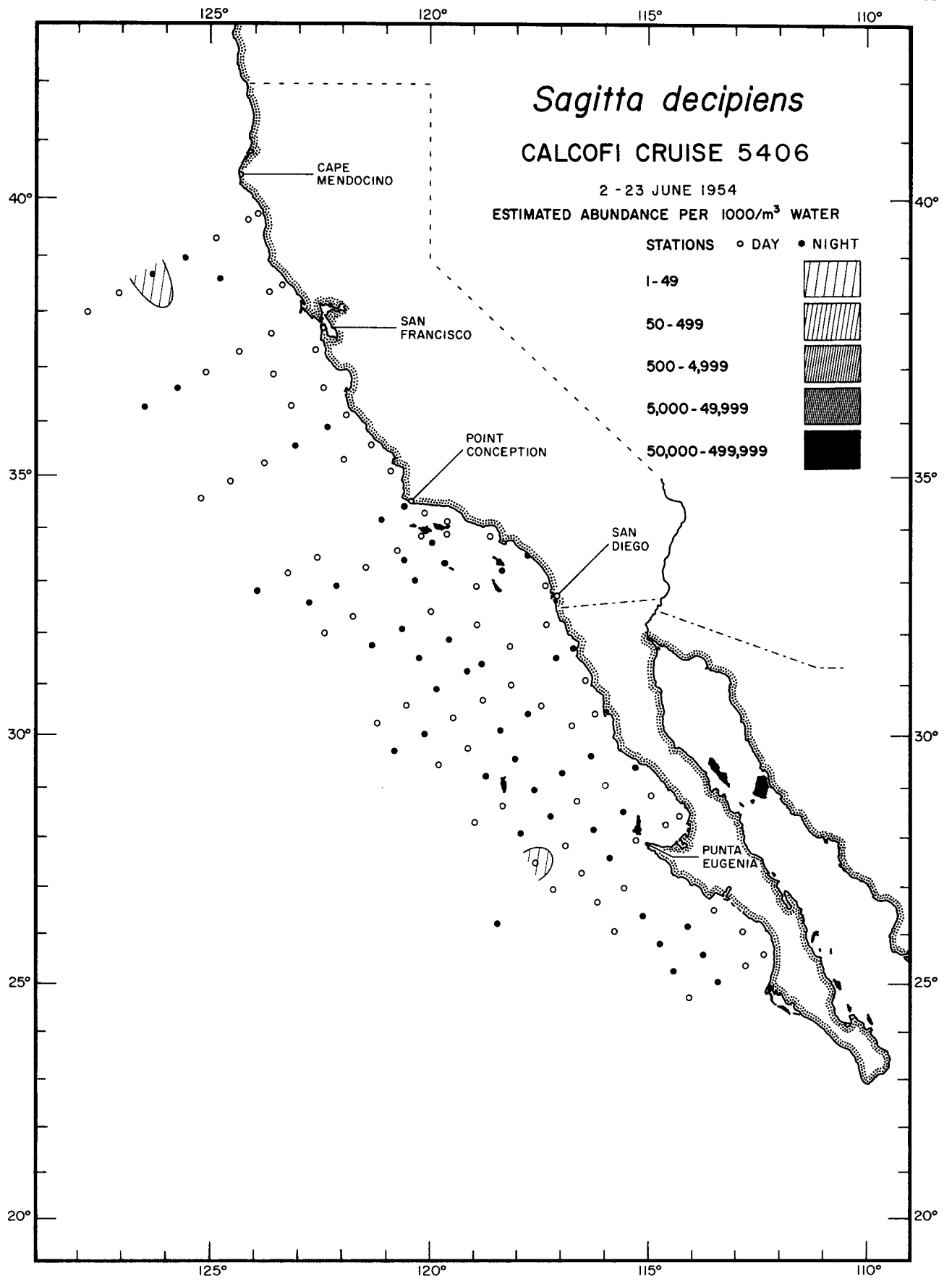
Chaetognatha  
*Pterosagitta draco*  
5406



Chaetognatha  
*Sagitta bierii*  
5406

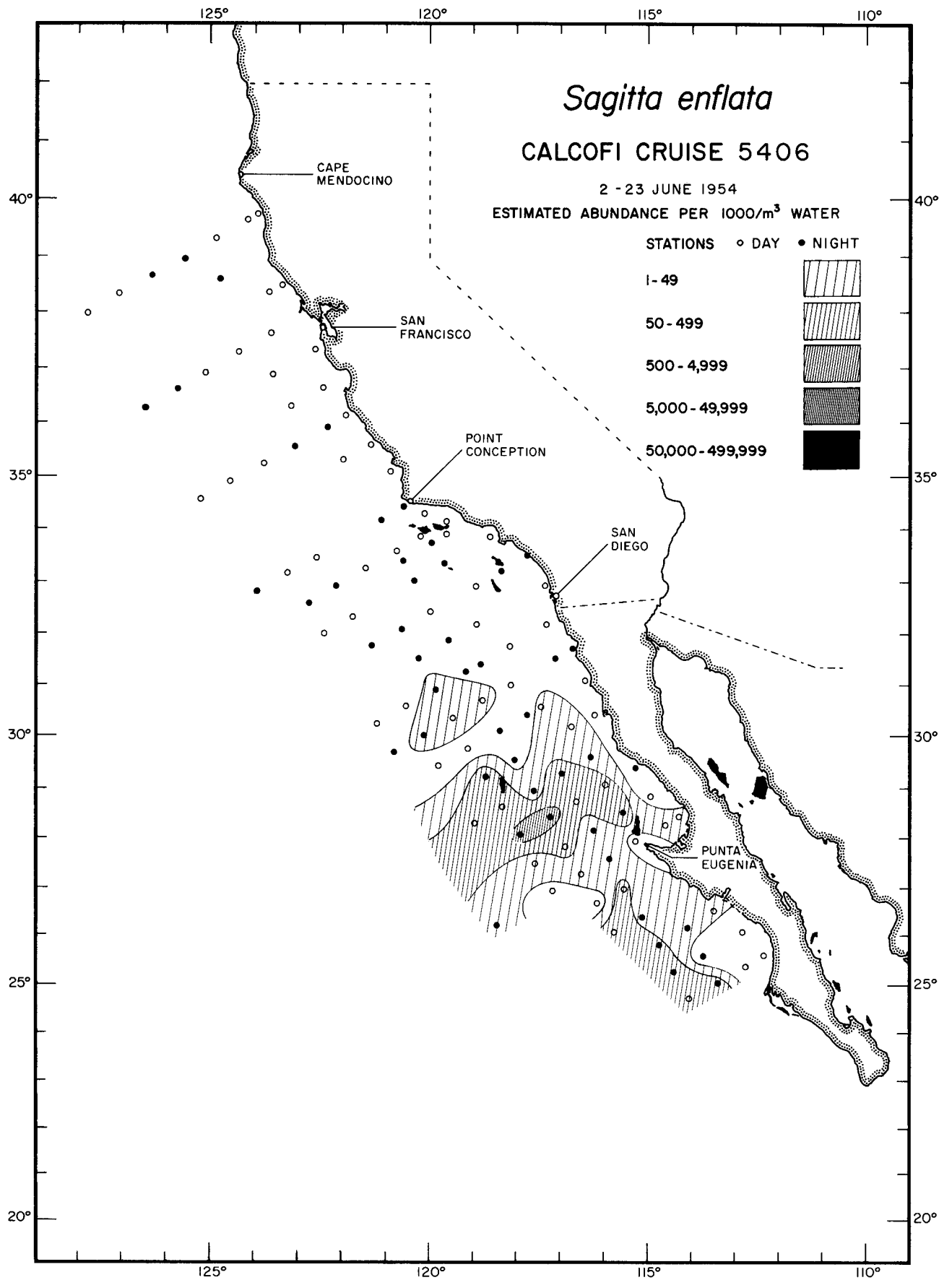


Chaetognatha  
*Sagitta bipunctata*  
5406

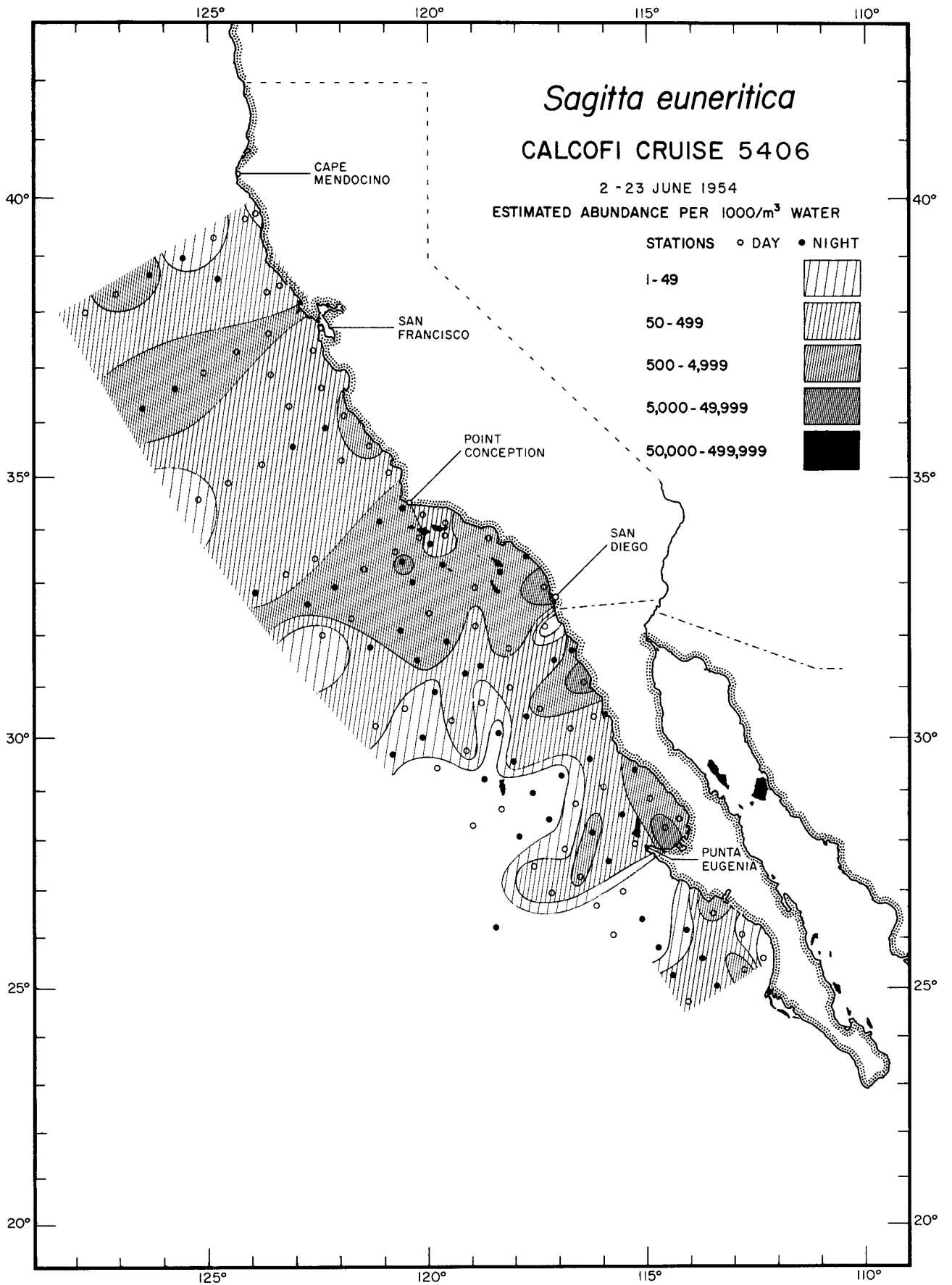


Chaetognatha  
*Sagitta decipiens*  
5406

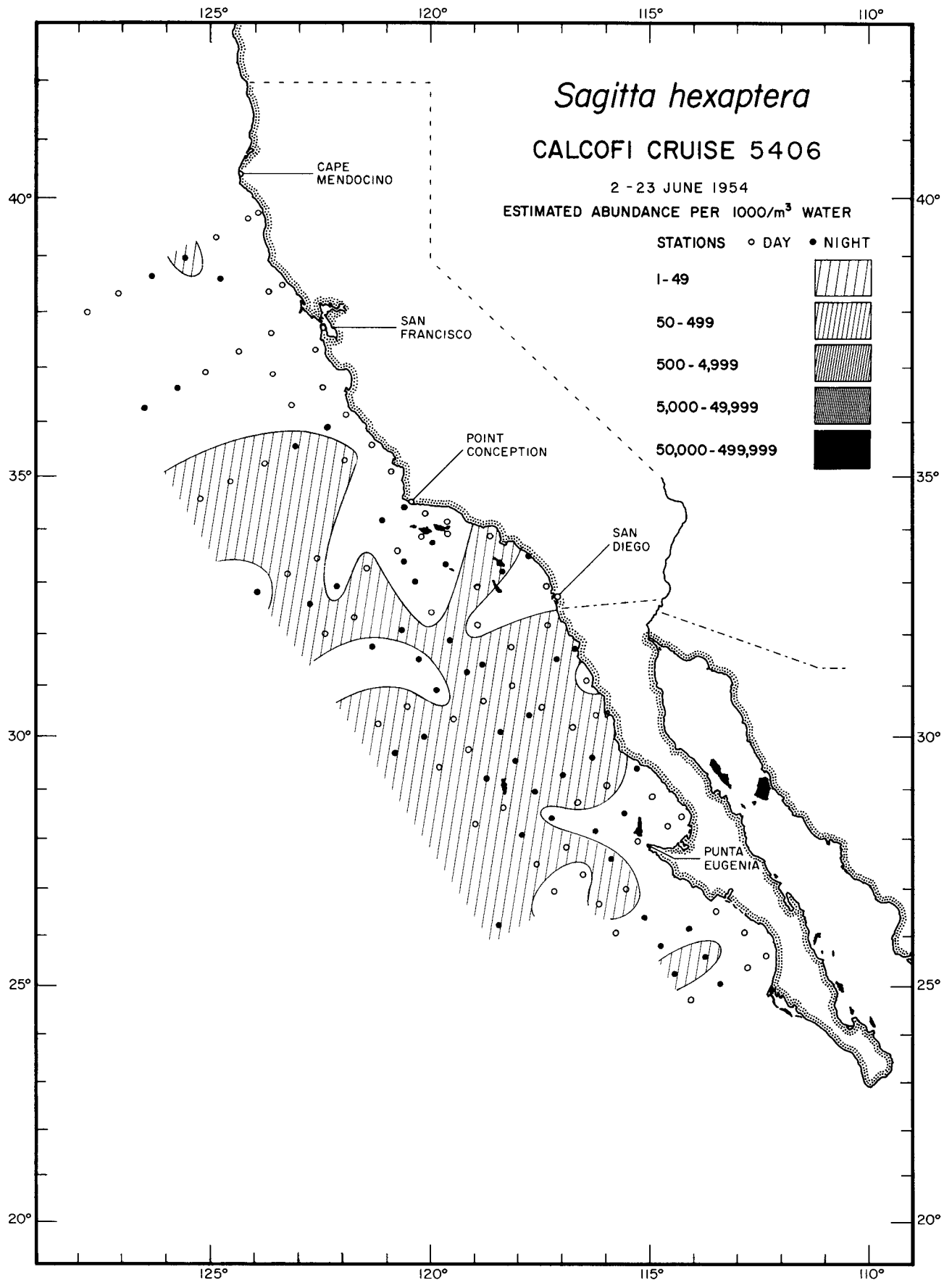


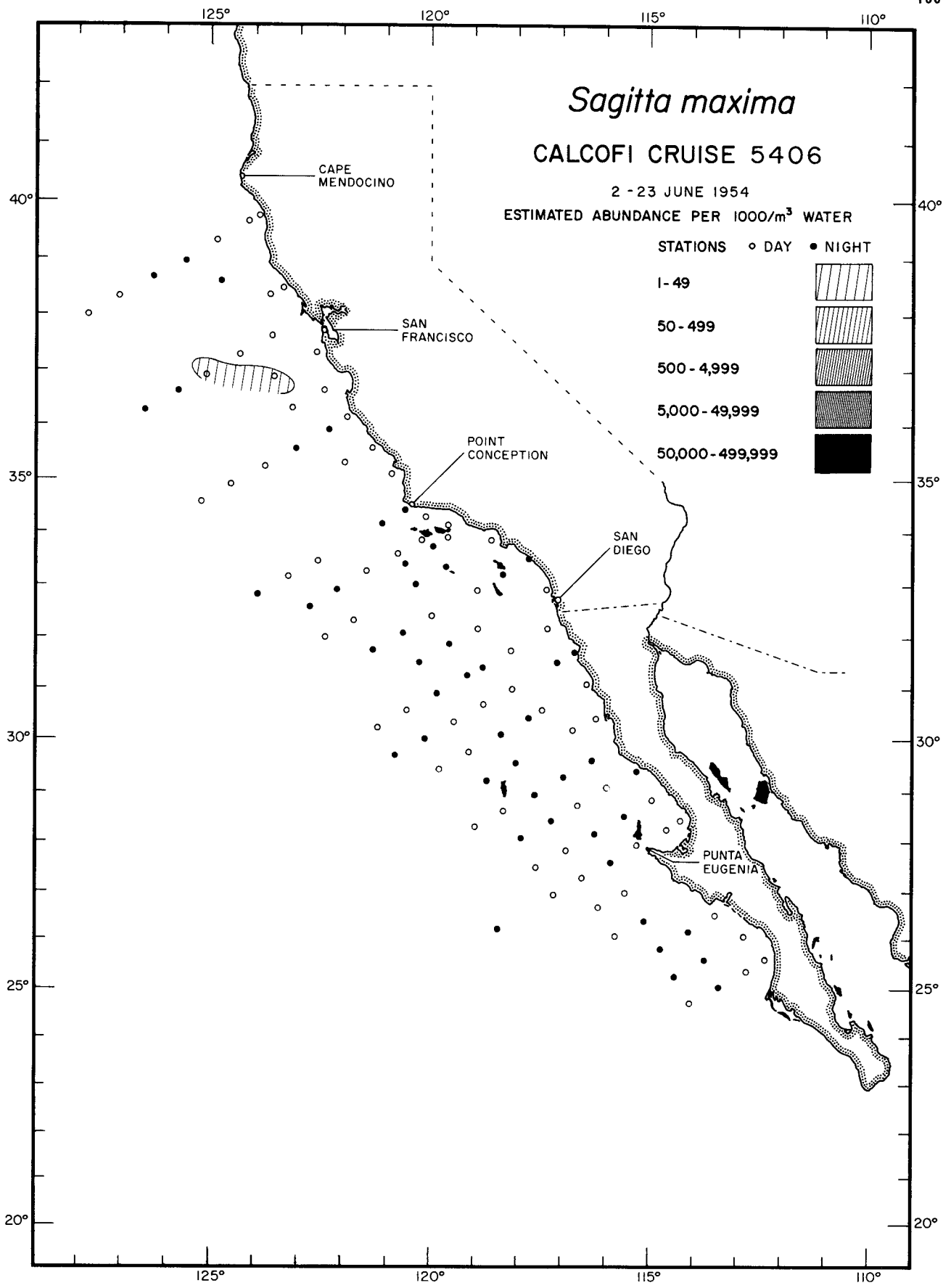


Chaetognatha  
*Sagitta enflata*  
5406

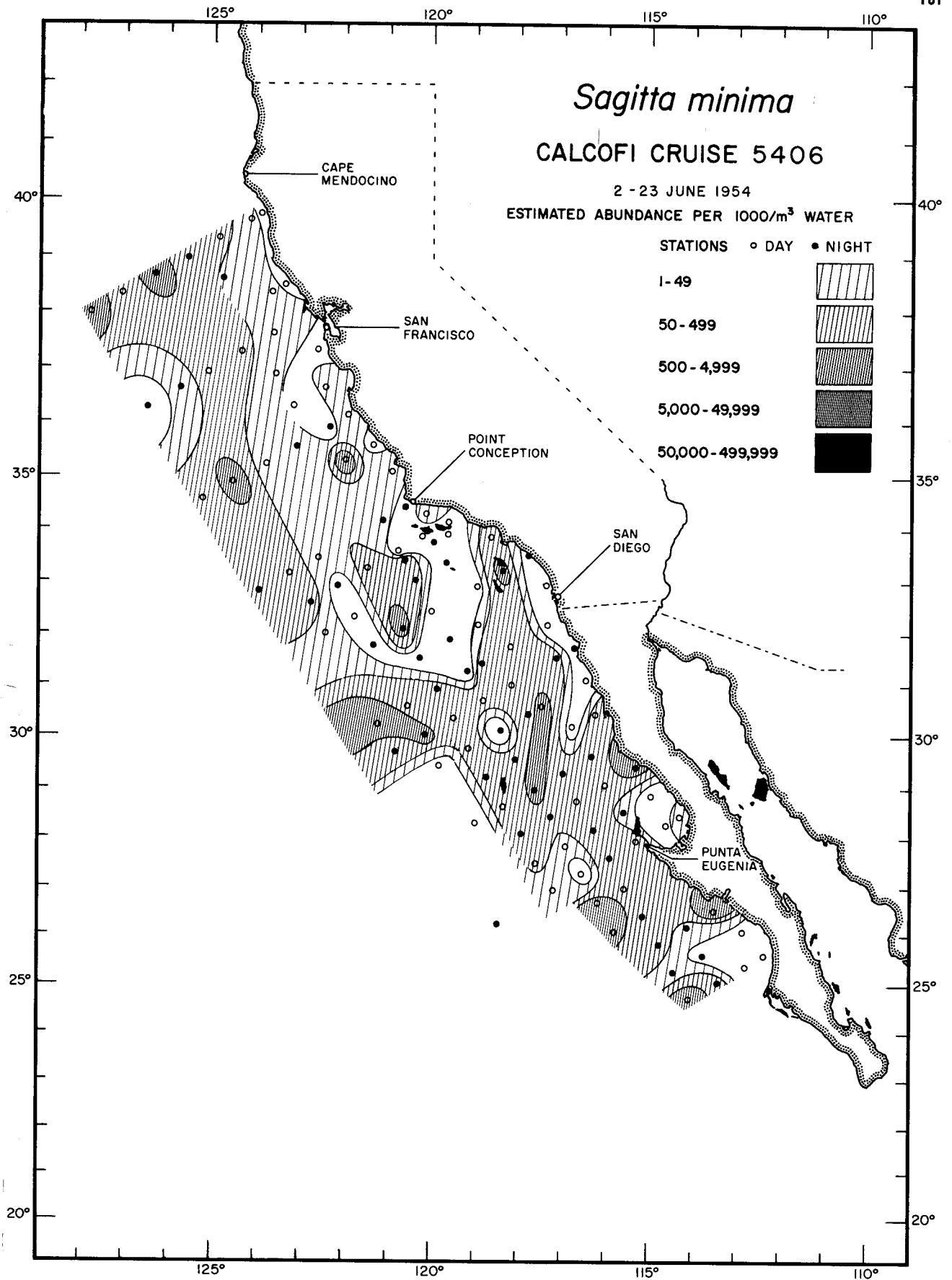


Chaetognatha  
*Sagitta euneritica*  
5406

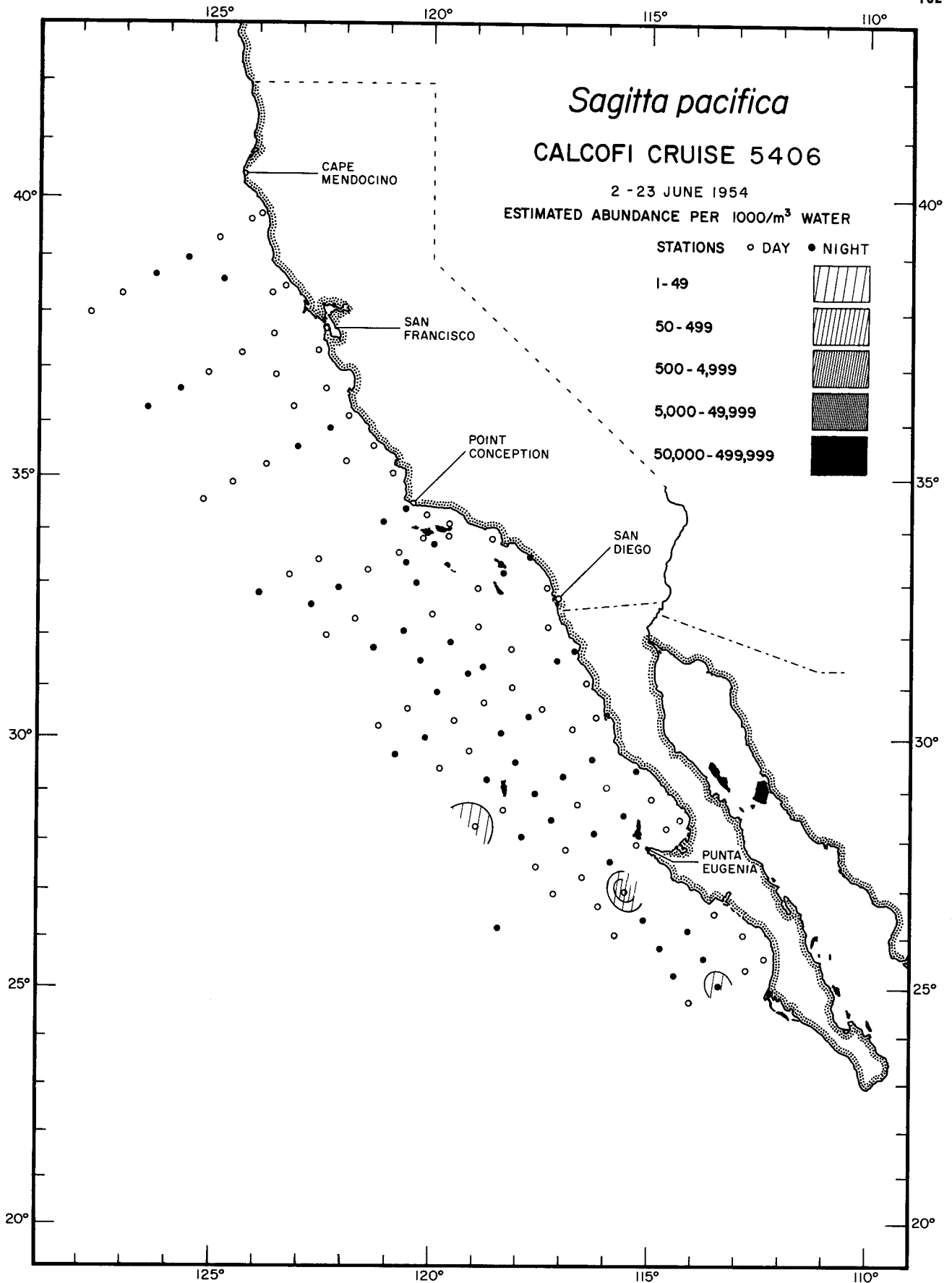




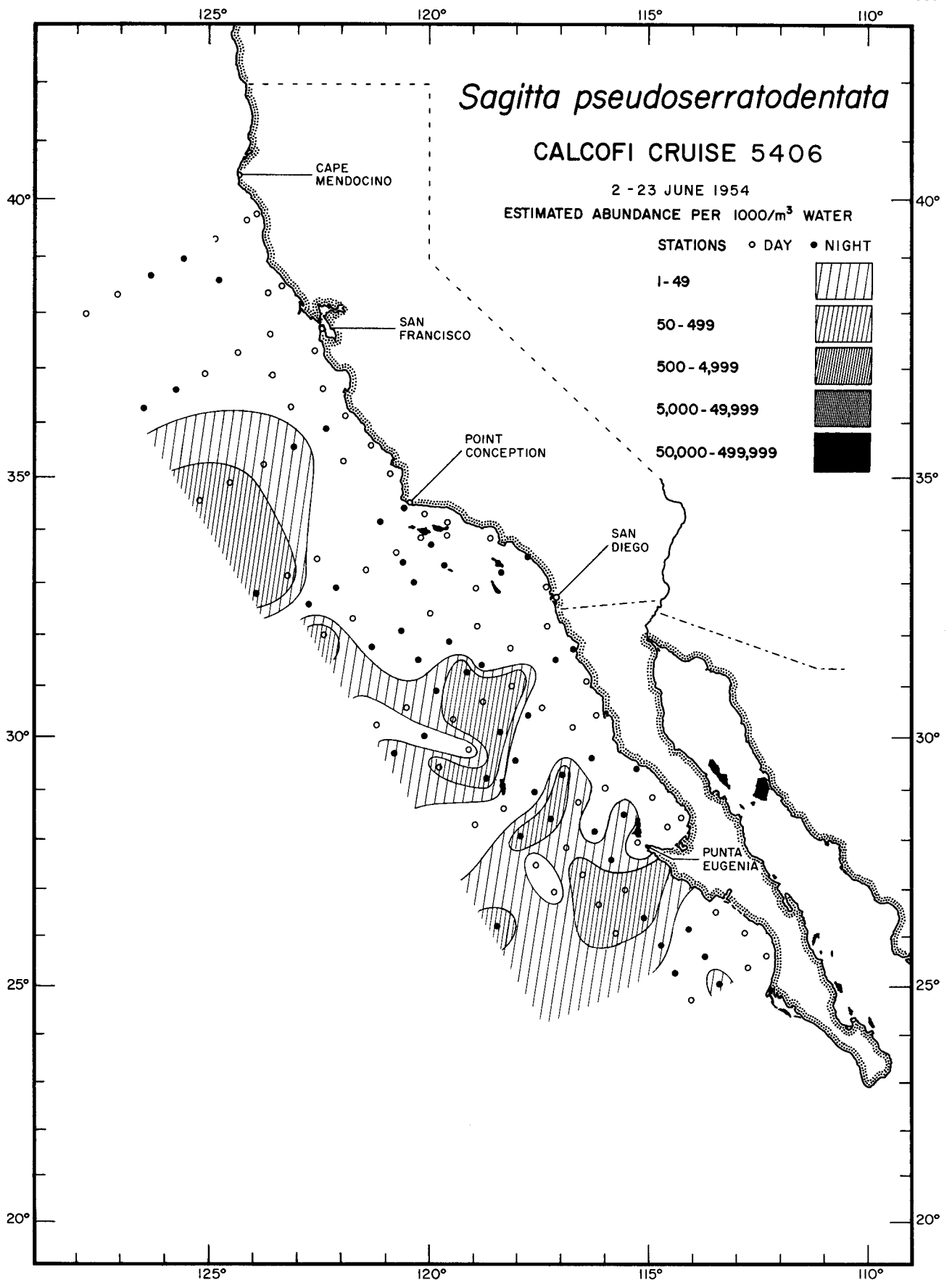
Chaetognatha  
*Sagitta maxima*  
5406



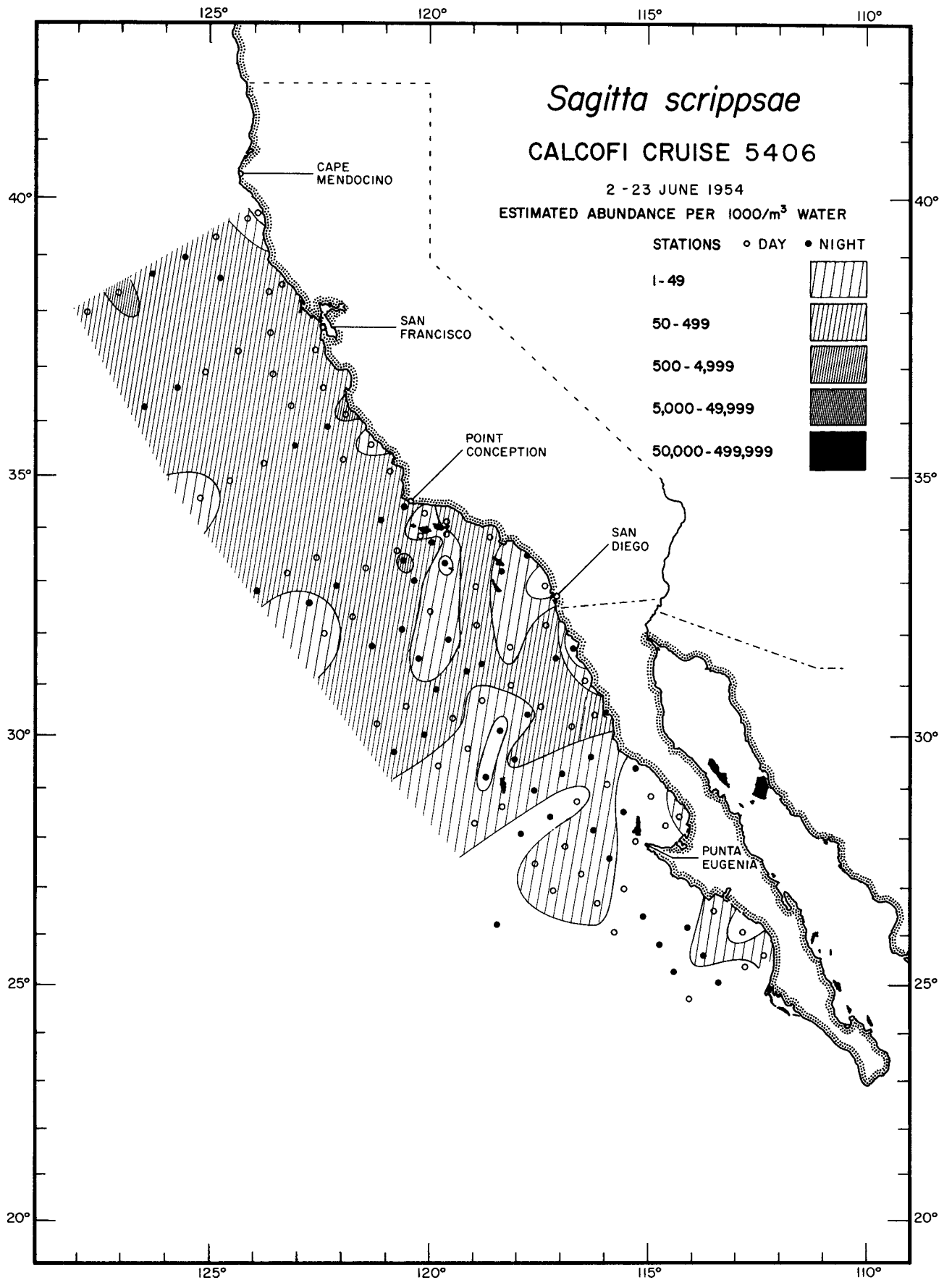
Chaetognatha  
*Sagitta minima*  
5406



Chaetognatha  
*Sagitta pacifica*  
5406

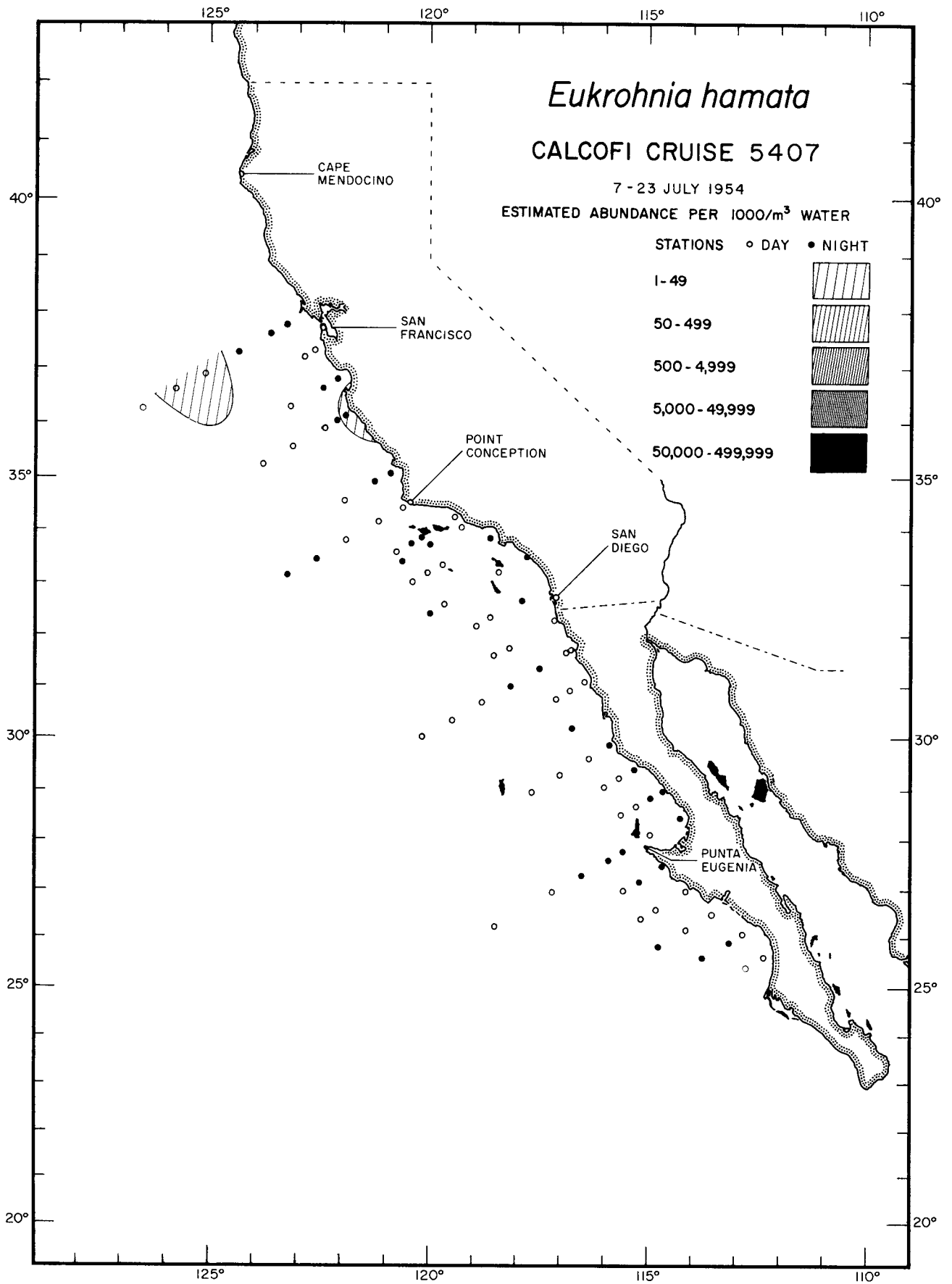


Chaetognatha  
*Sagitta pseudoserratodentata*  
5406

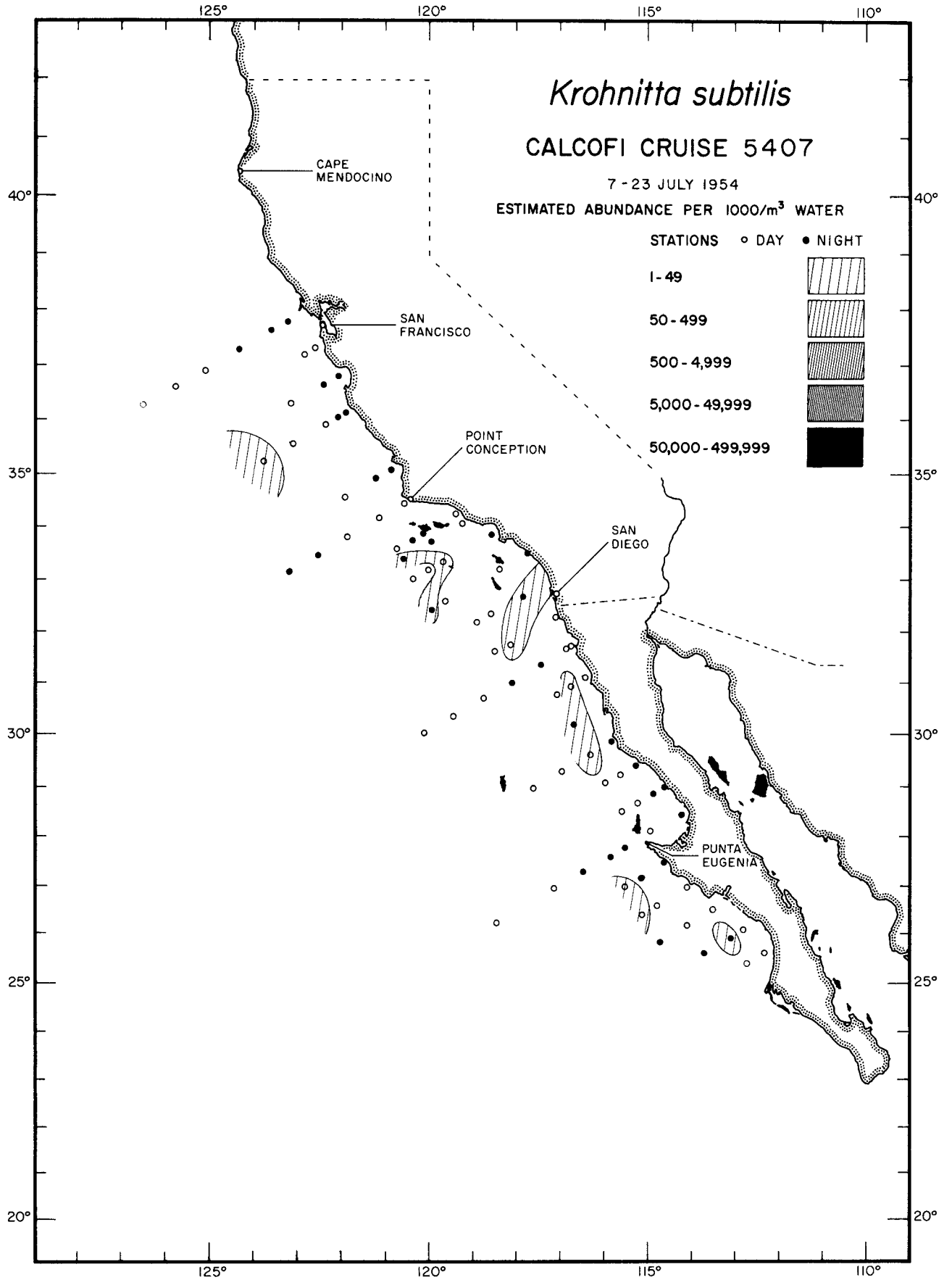


Chaetognatha  
*Sagitta scrippsae*  
5406

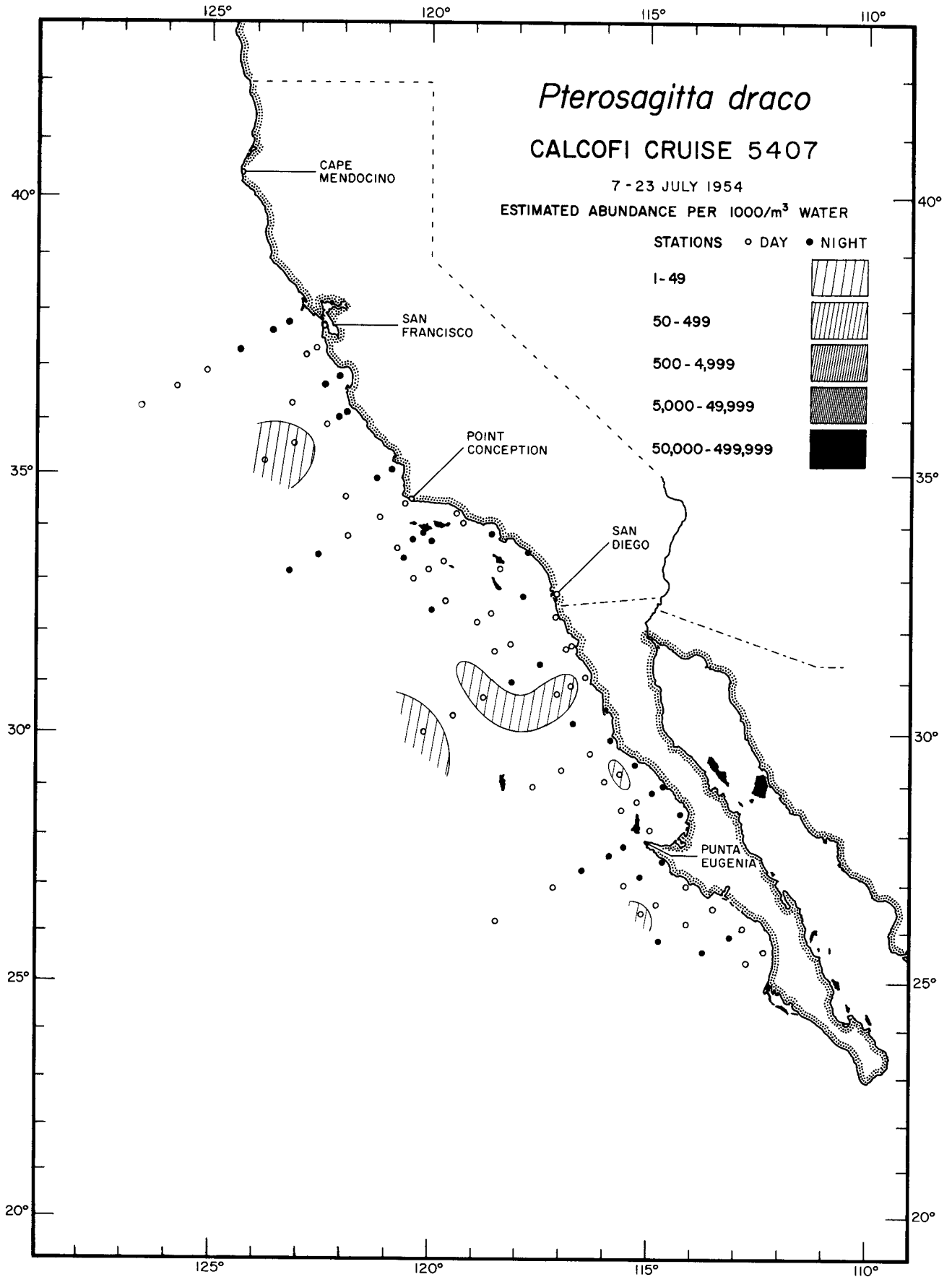




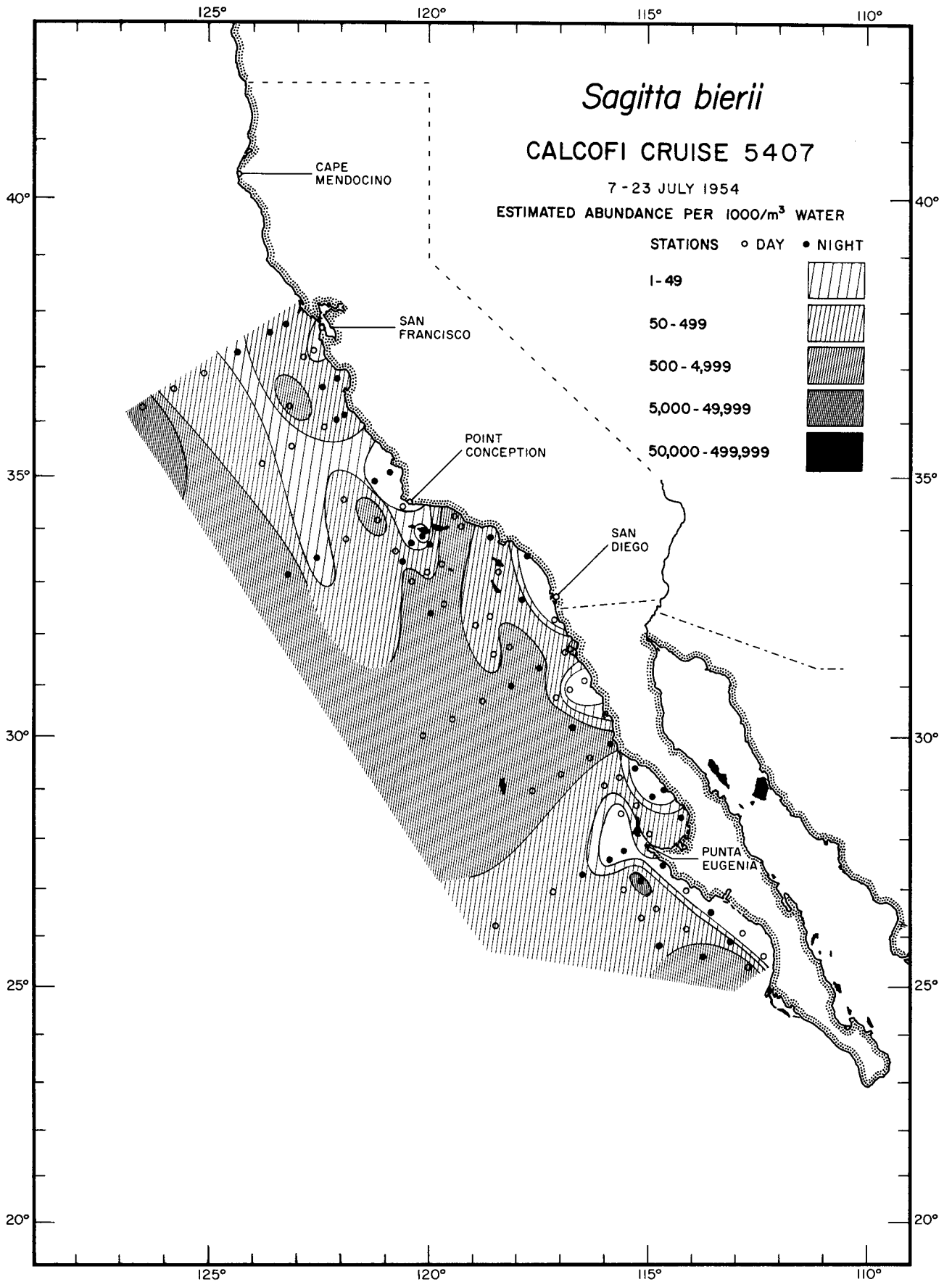
Chaetognatha  
*Eukrohnia hamata*  
5407



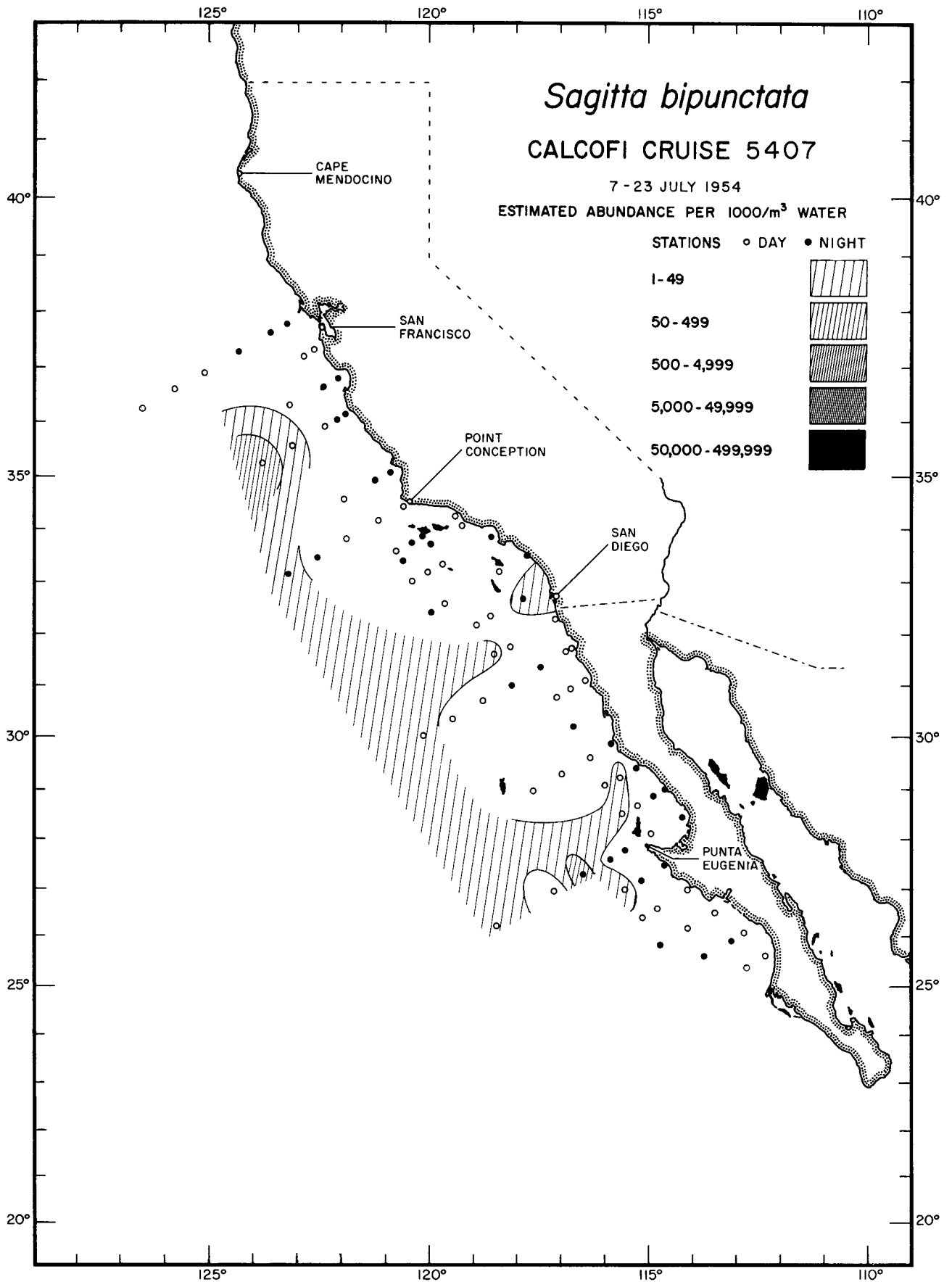
Chaetognatha  
*Krohnitta subtilis*  
5407

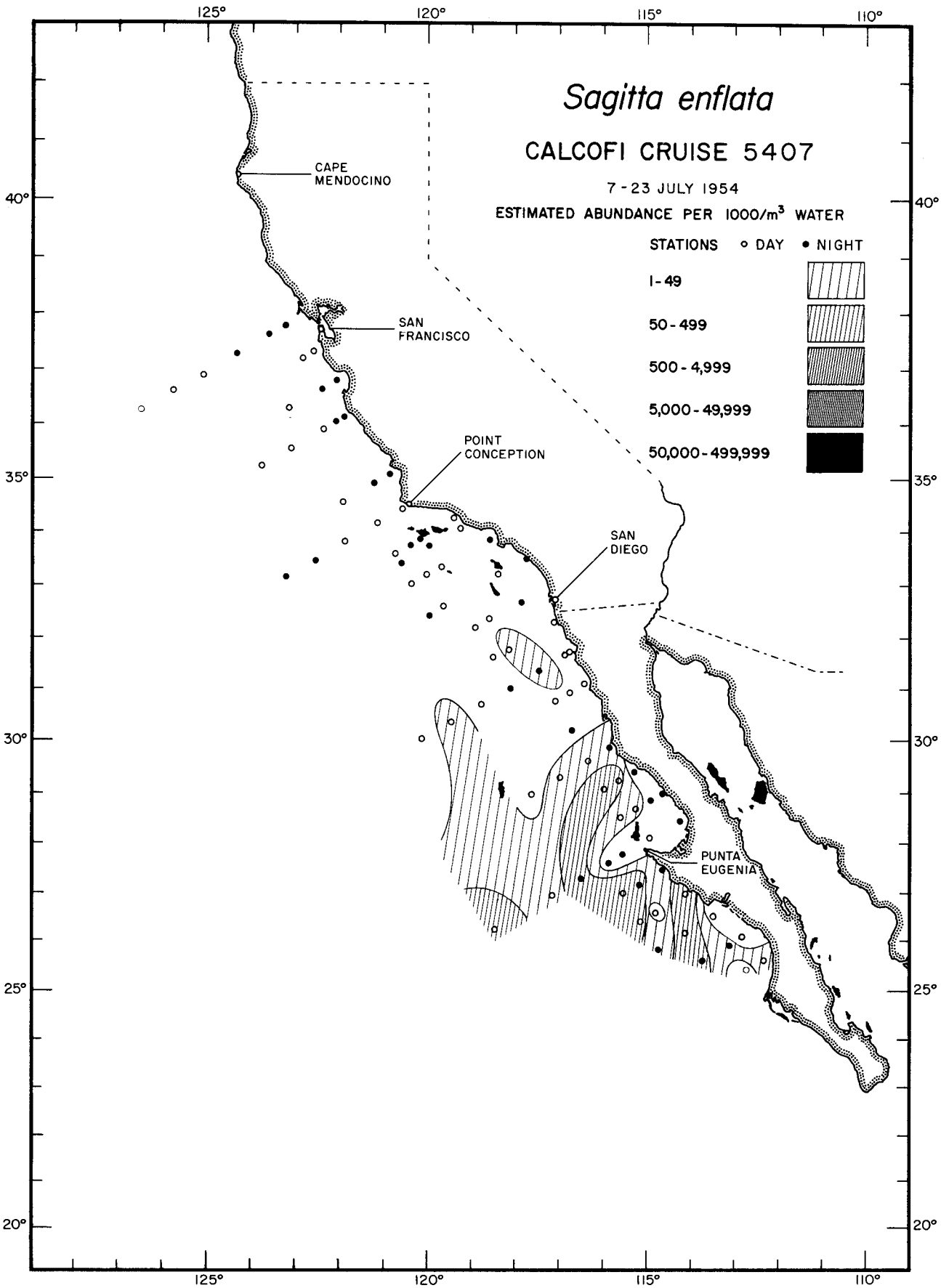


Chaetognatha  
*Pterosagitta draco*  
5407

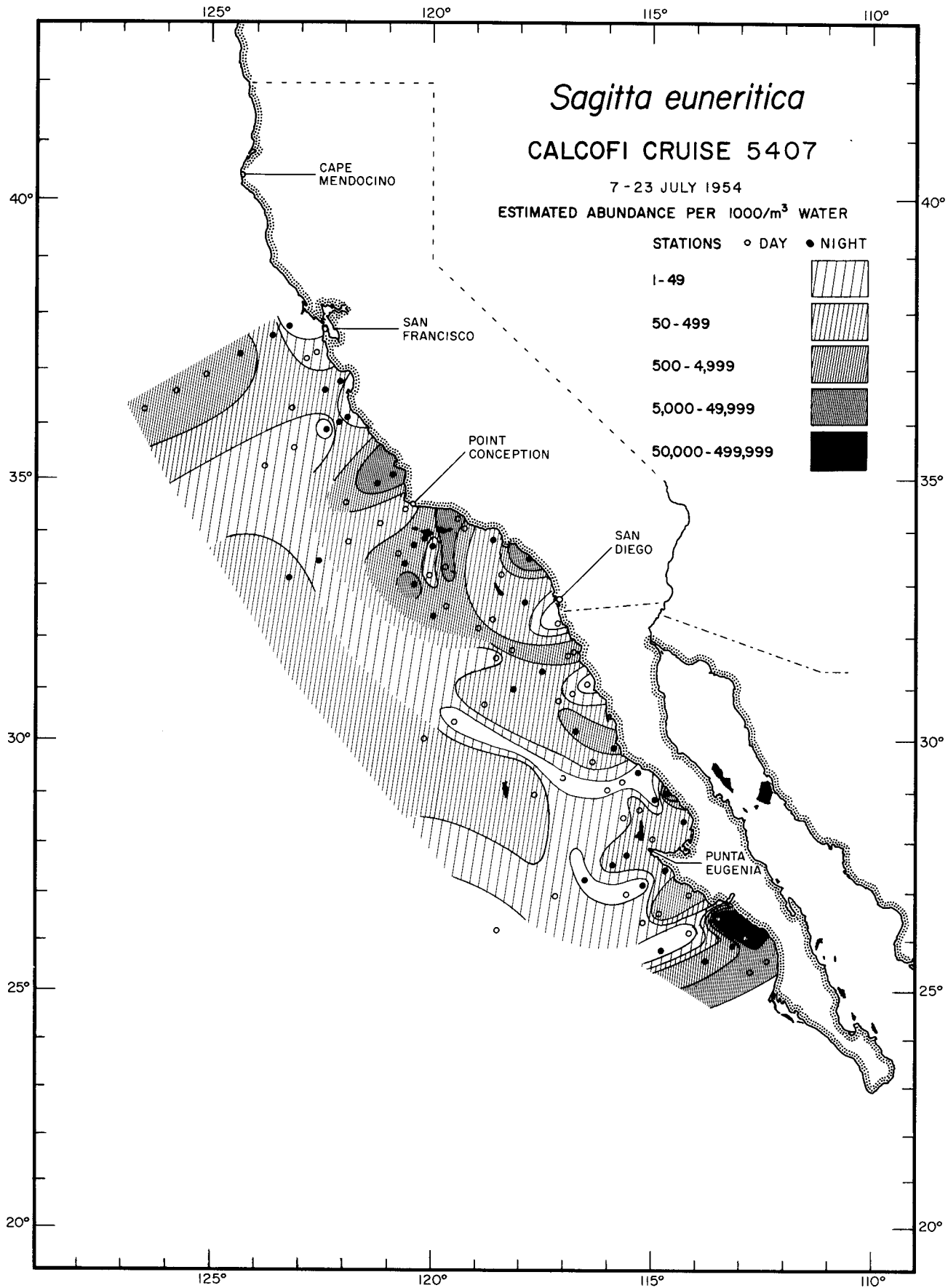


Chaetognatha  
*Sagitta bierii*  
5407

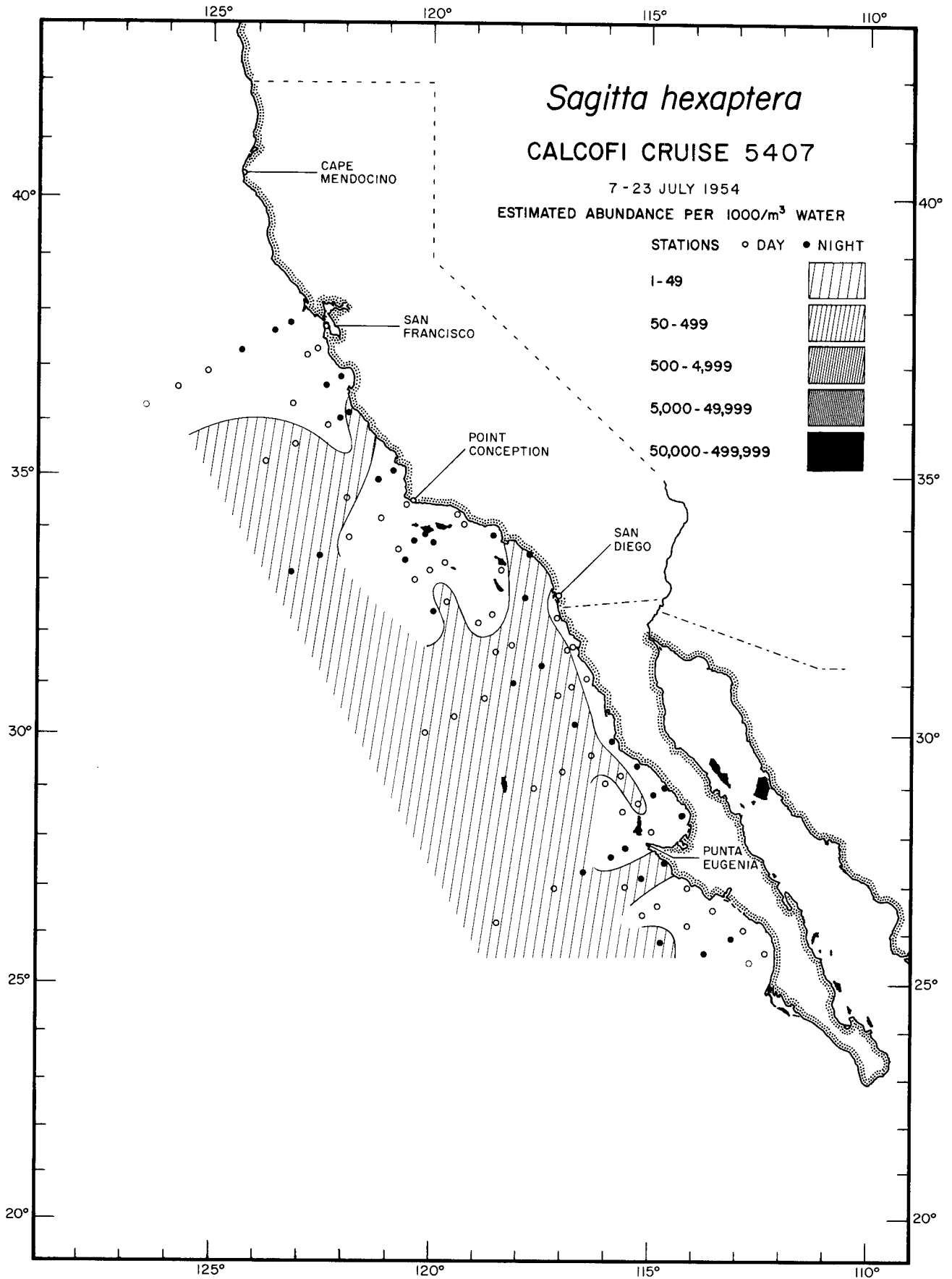




Chaetognatha  
*Sagitta enflata*  
5407

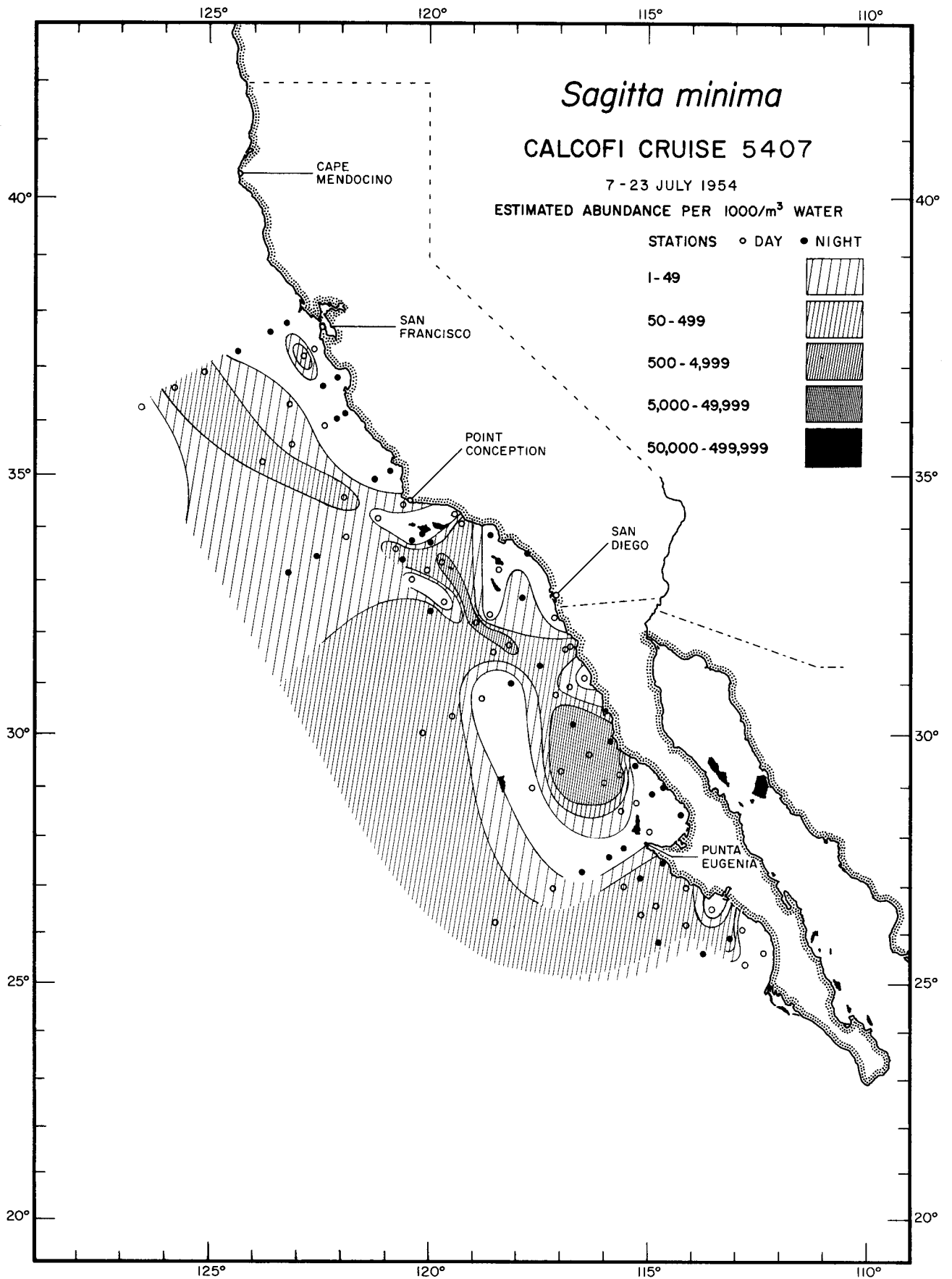


Chaetognatha  
*Sagitta euneritica*  
5407

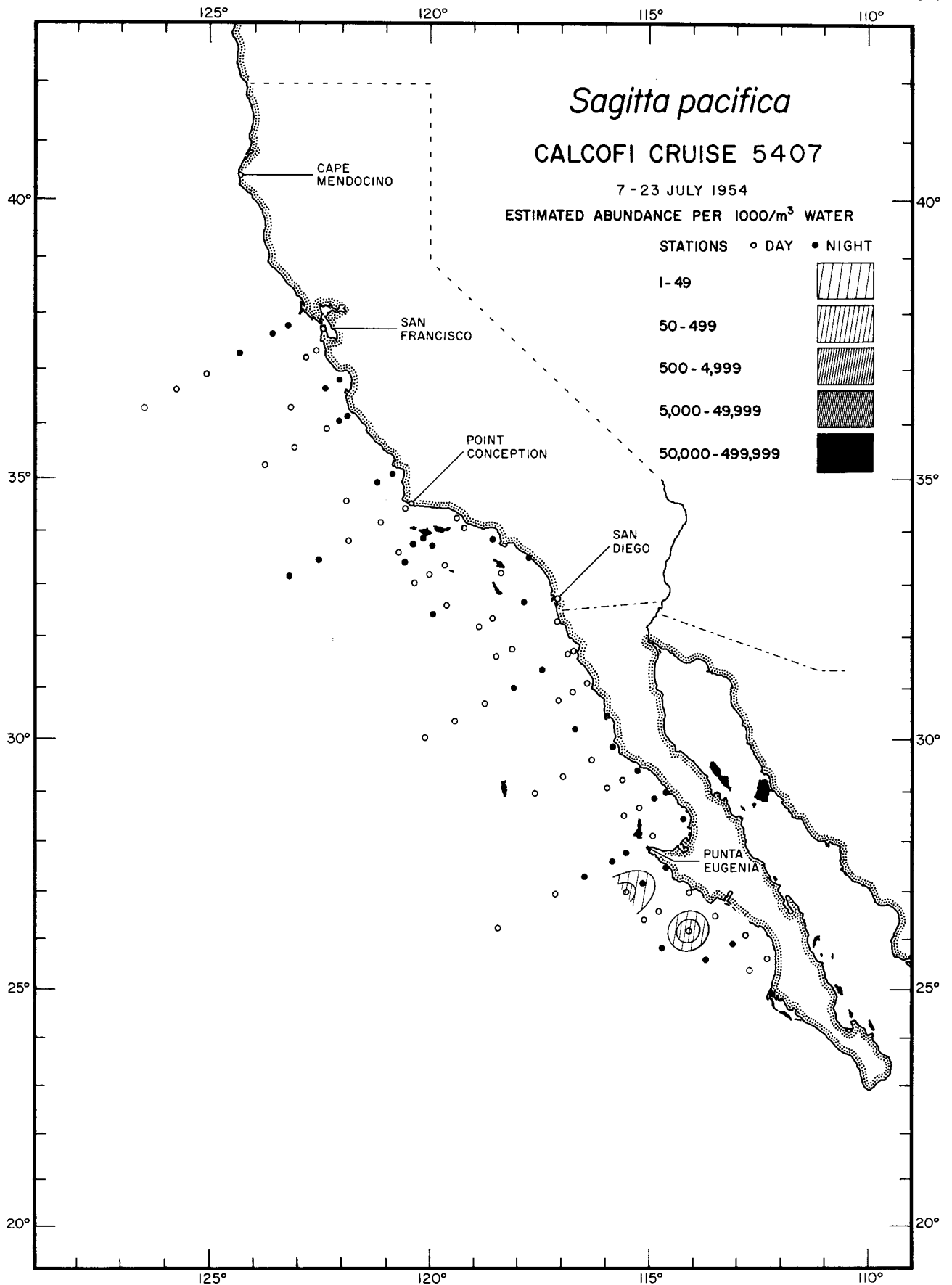


Chaetognatha  
*Sagitta hexaptera*  
5407

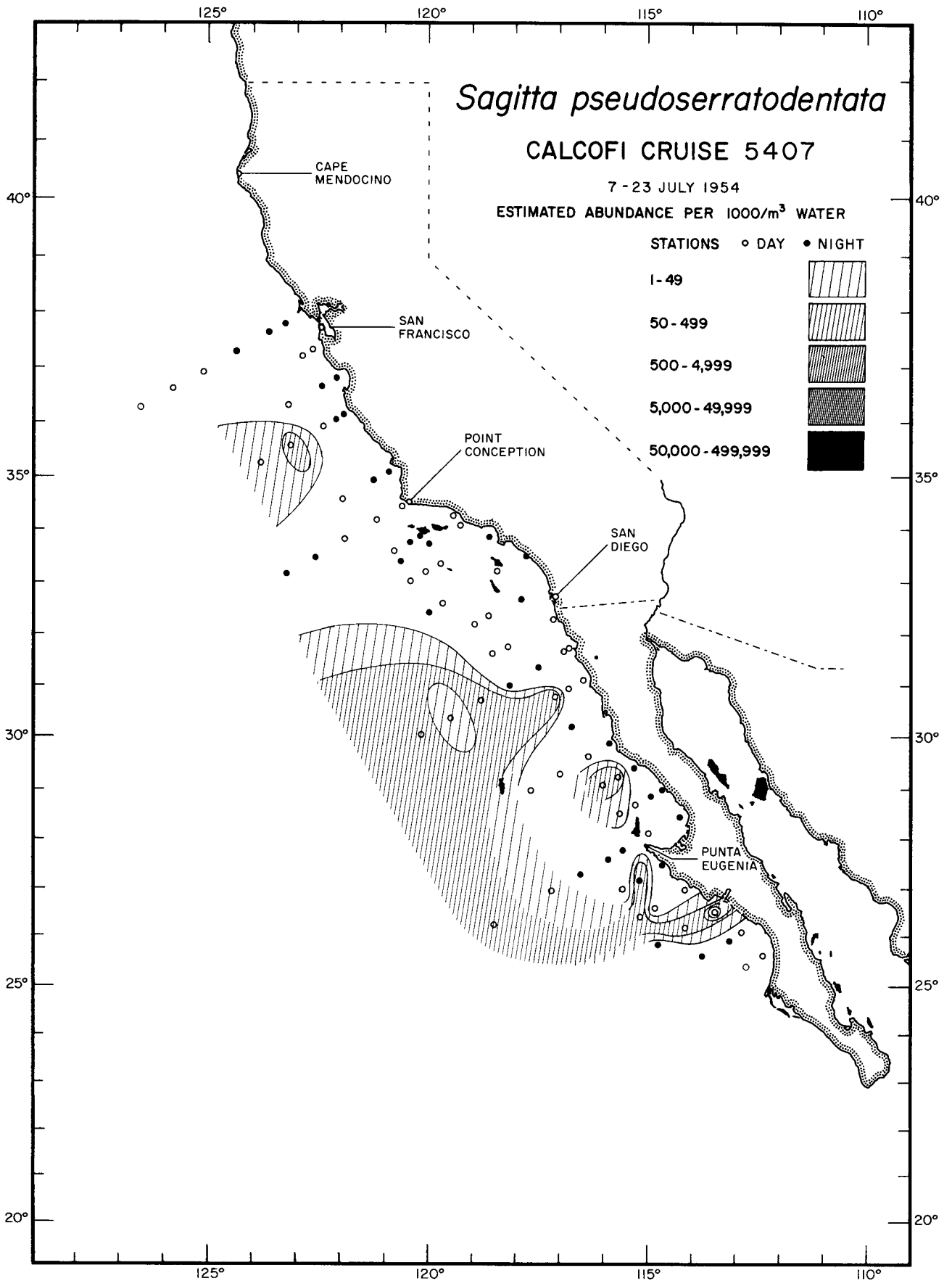




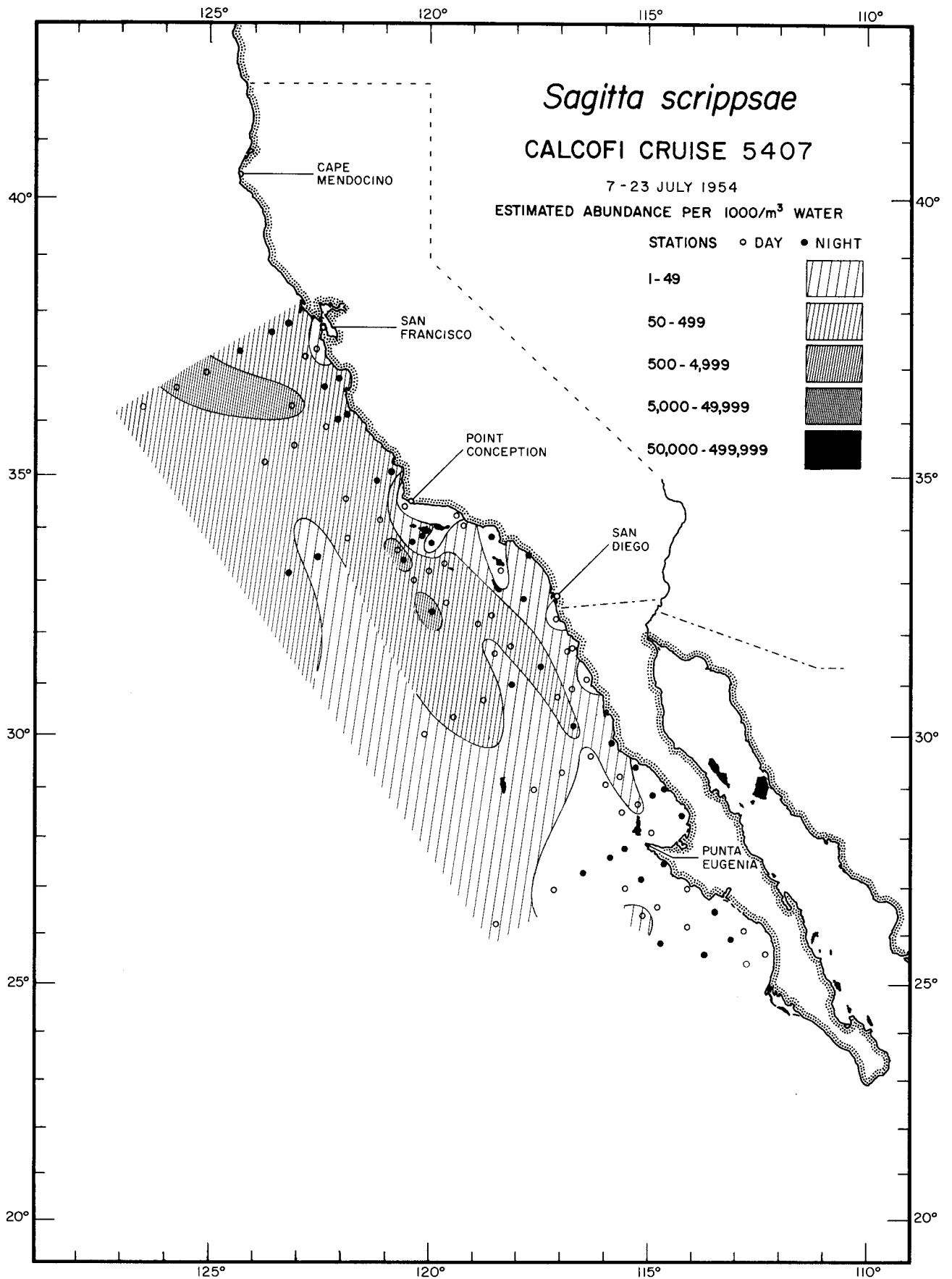
Chaetognatha  
*Sagitta minima*  
5407



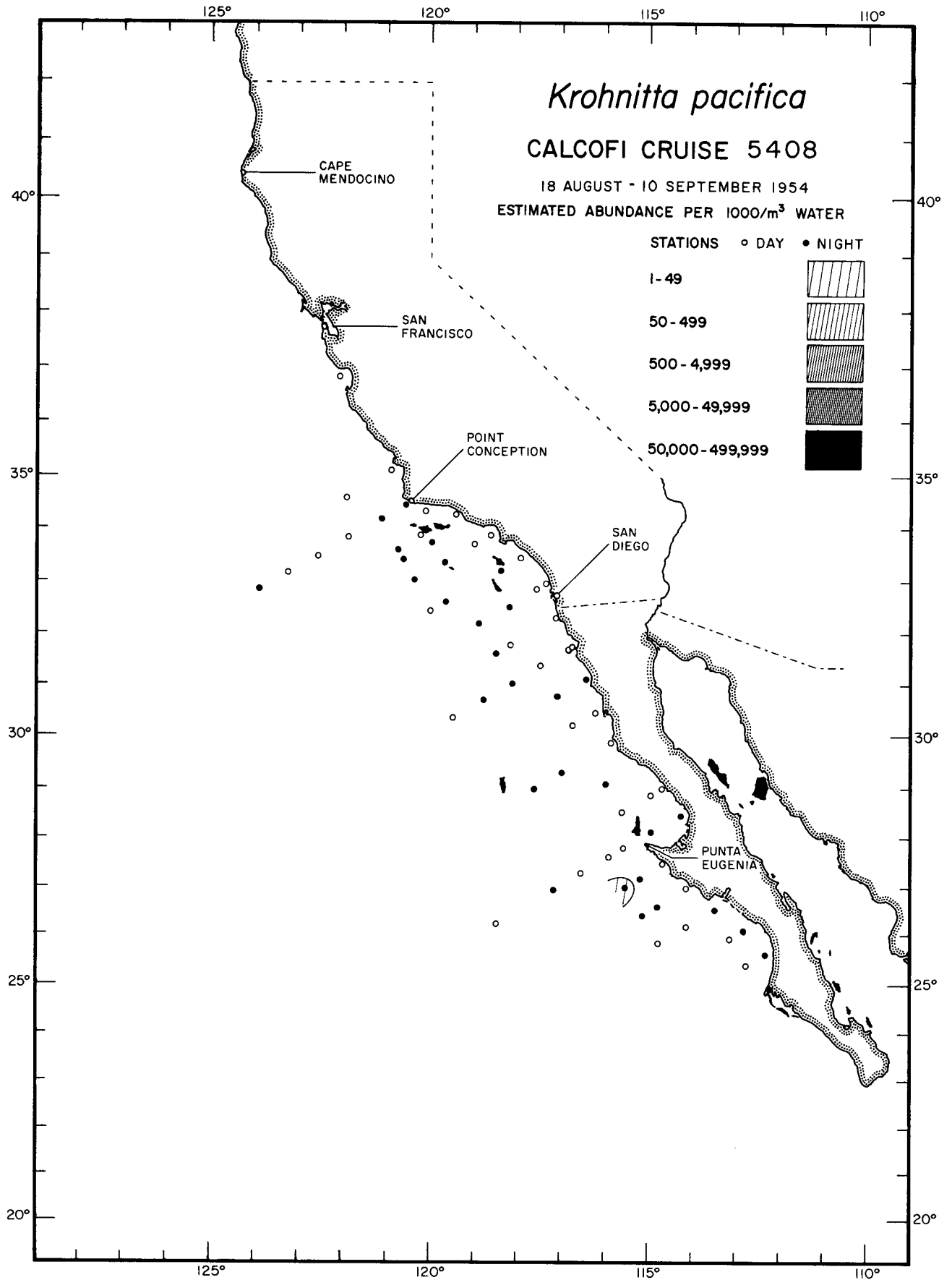
Chaetognatha  
*Sagitta pacifica*  
5407



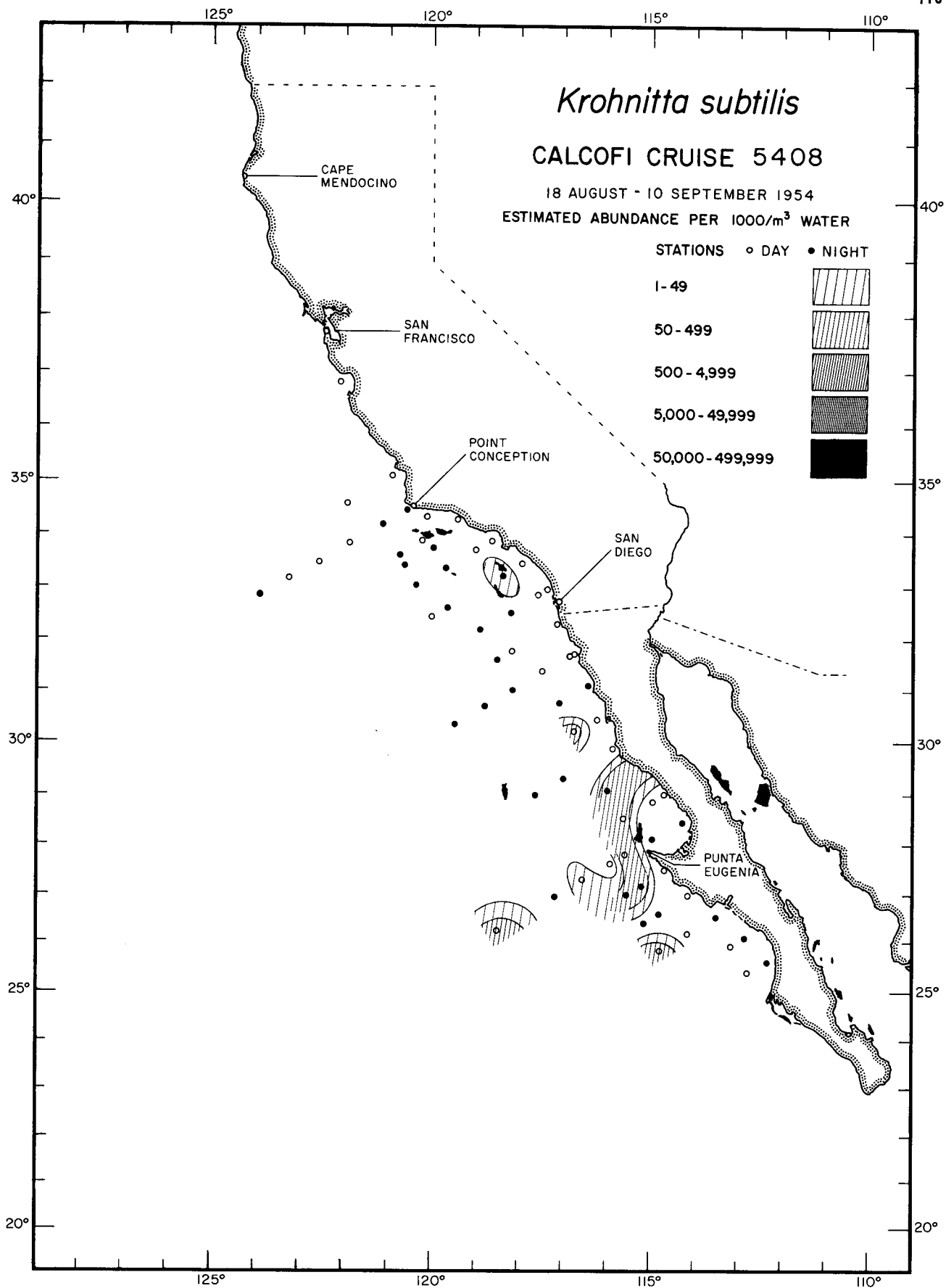
Chaetognatha  
*Sagitta pseudoserratodentata*  
5407



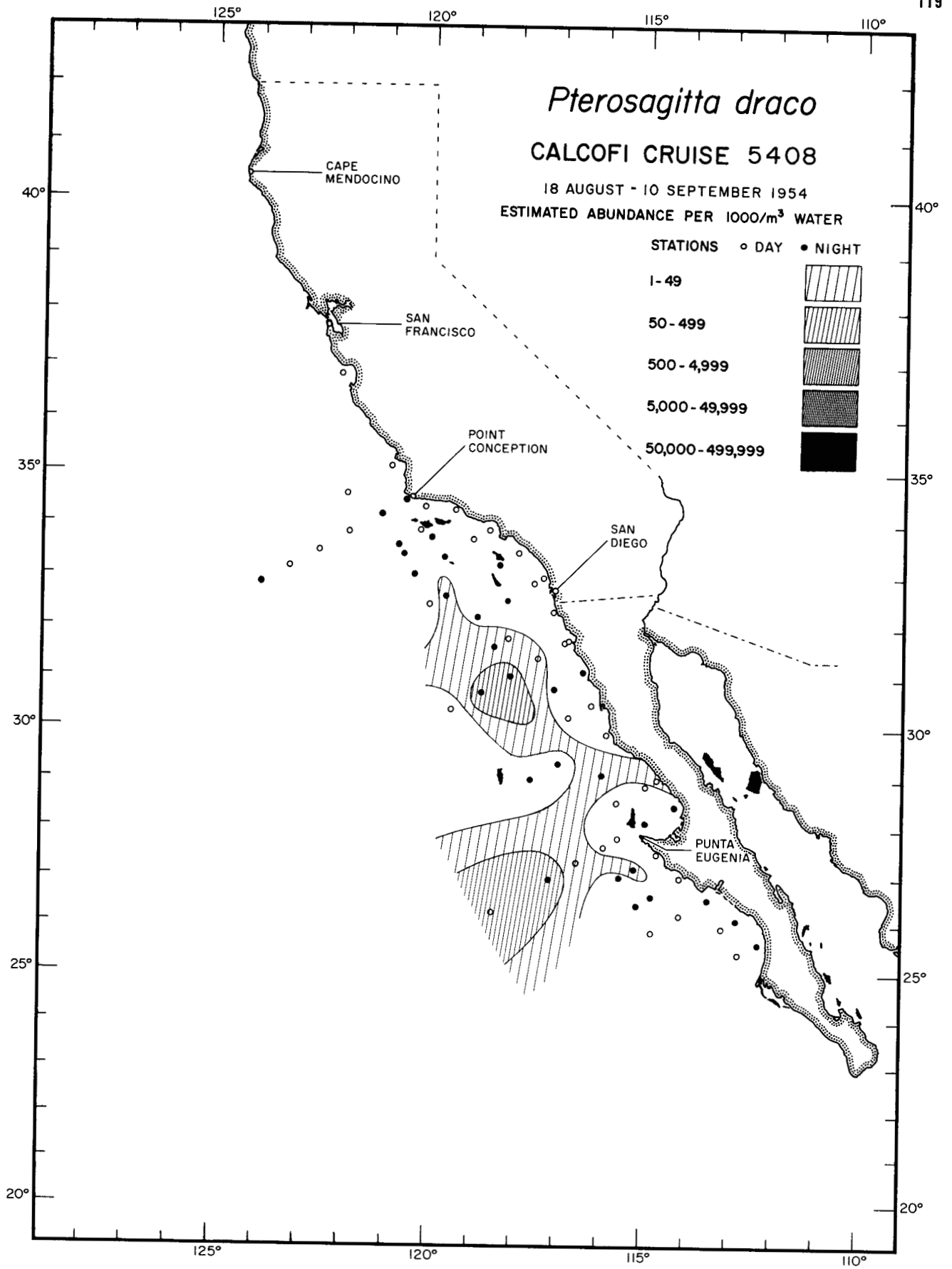
Chaetognatha  
*Sagitta scrippsae*  
5407



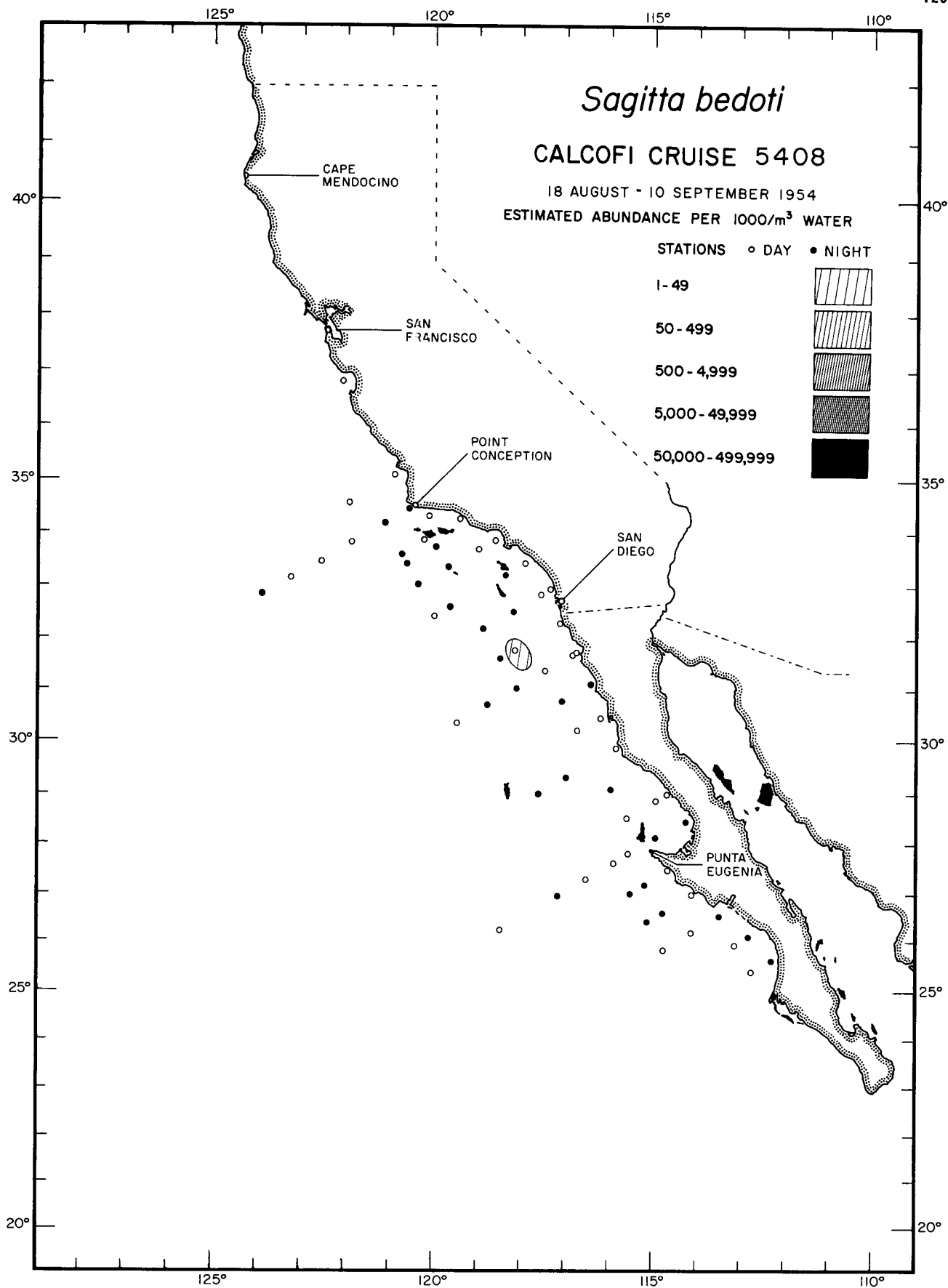
Chaetognatha  
*Krohnitta pacifica*  
5408



Chaetognatha  
*Krohnitta subtilis*  
 5408

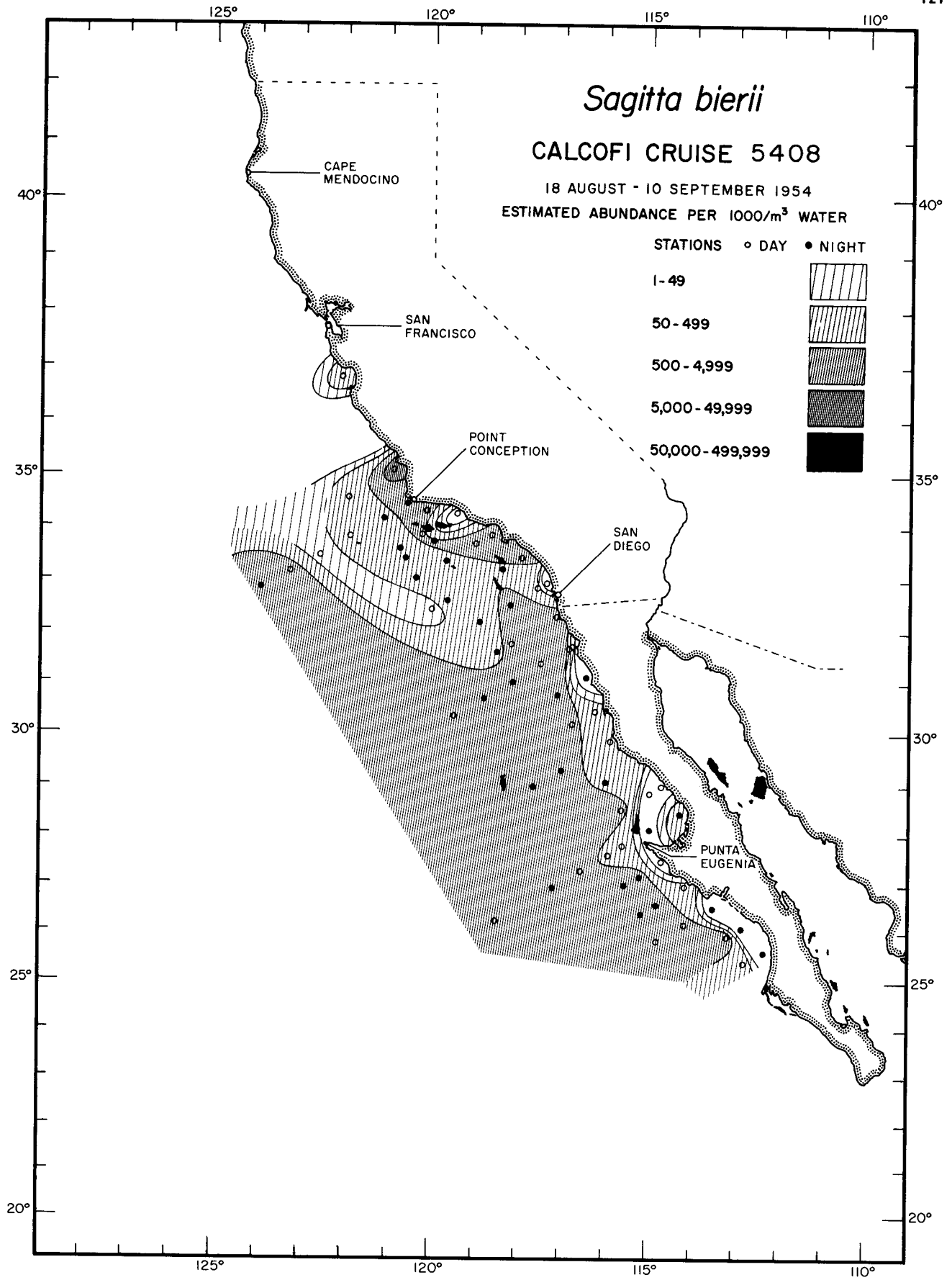


Chaetognatha  
*Pterosagitta draco*  
5408

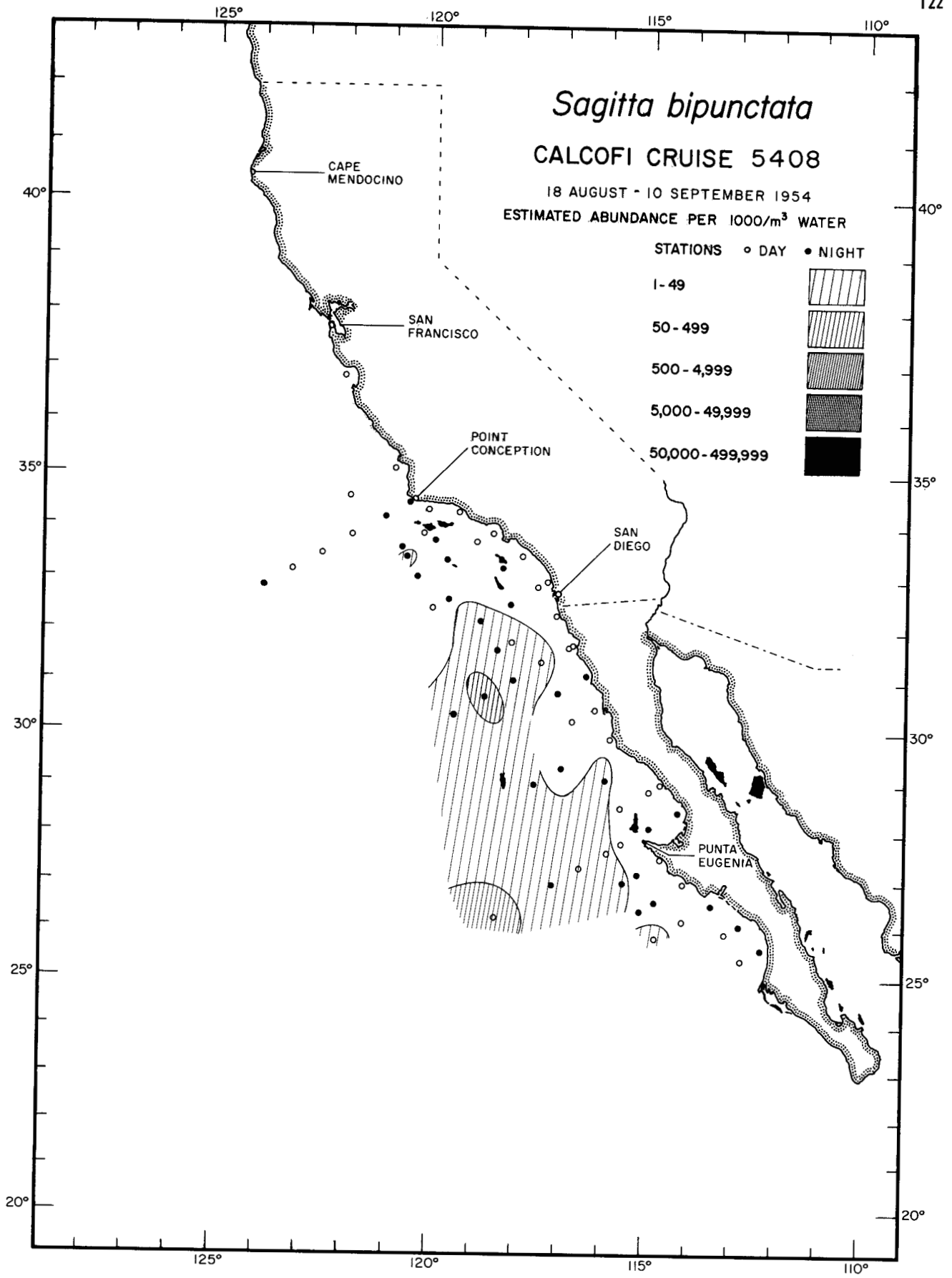


Chaetognatha  
*Sagitta bedoti*  
 5408

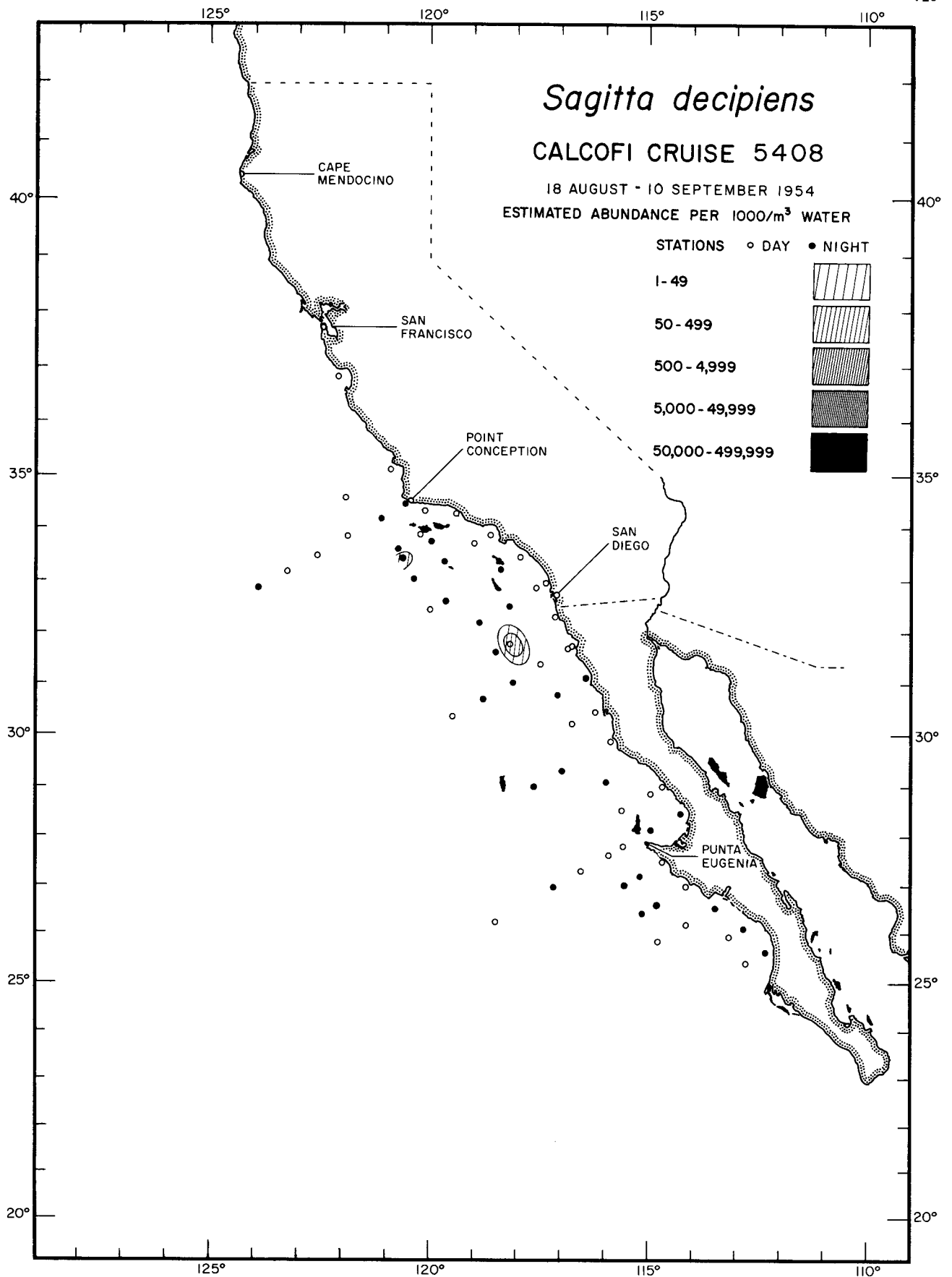




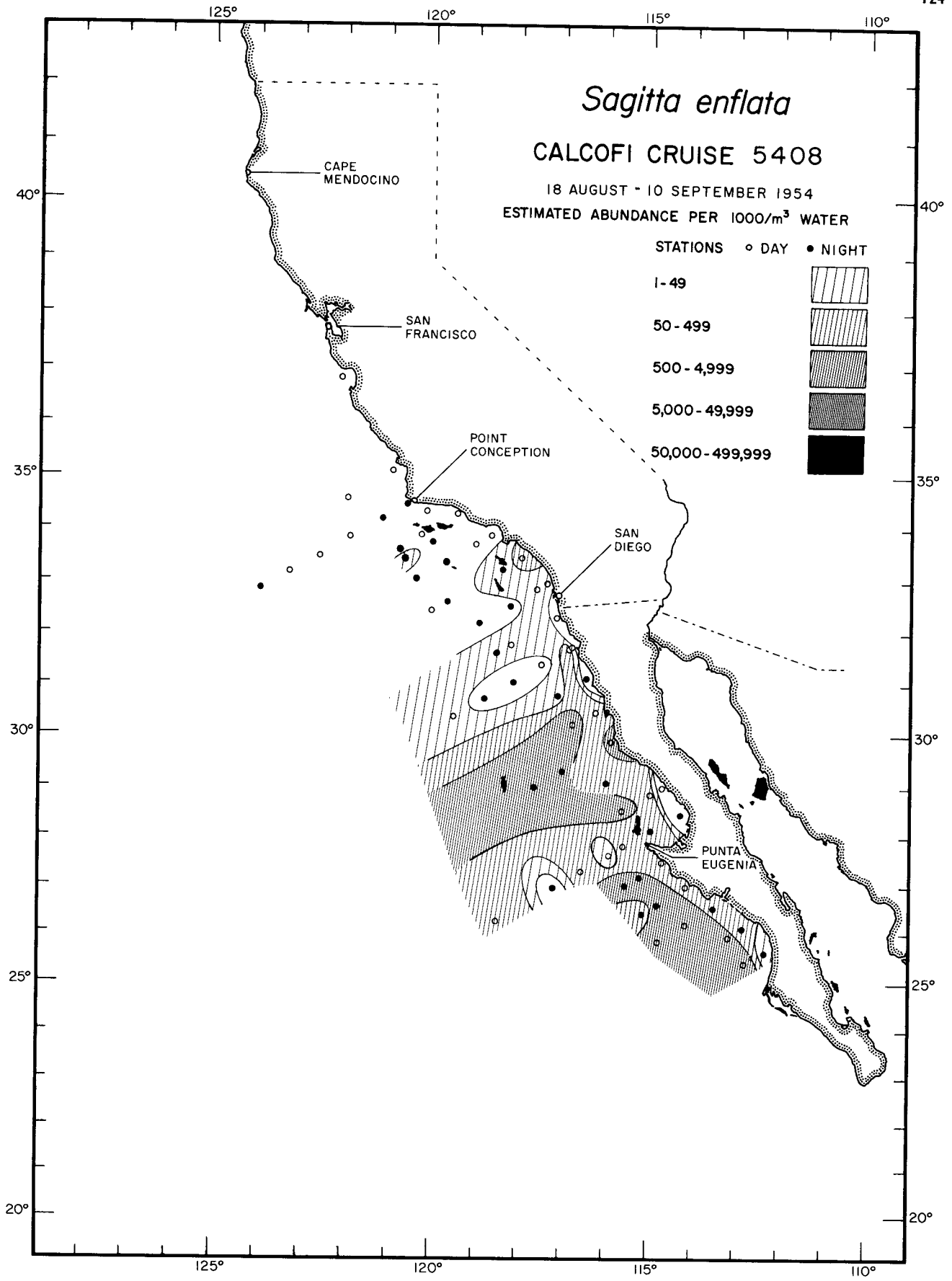
Chaetognatha  
*Sagitta bierii*  
 5408



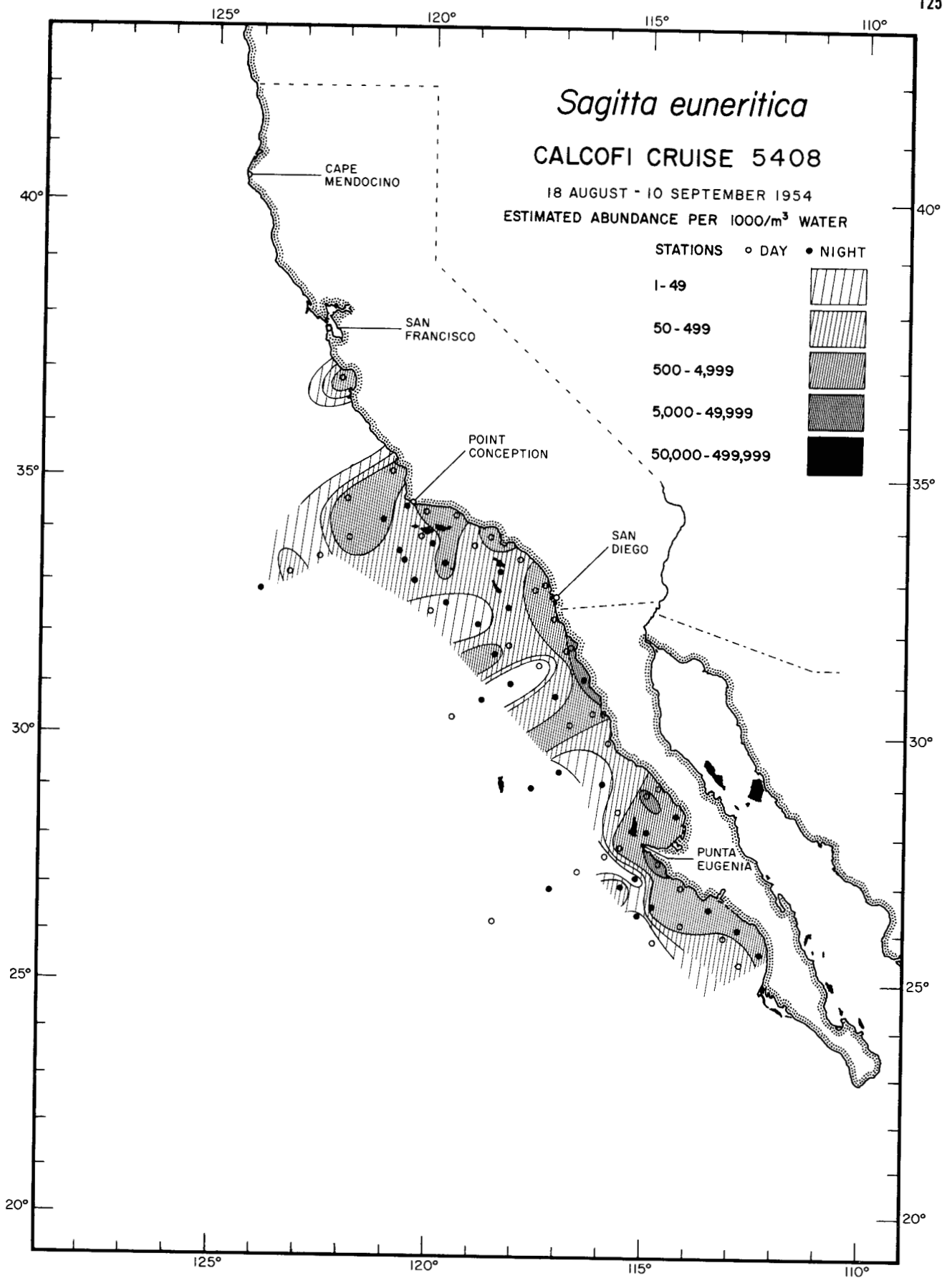
Chaetognatha  
*Sagitta bipunctata*  
 5408



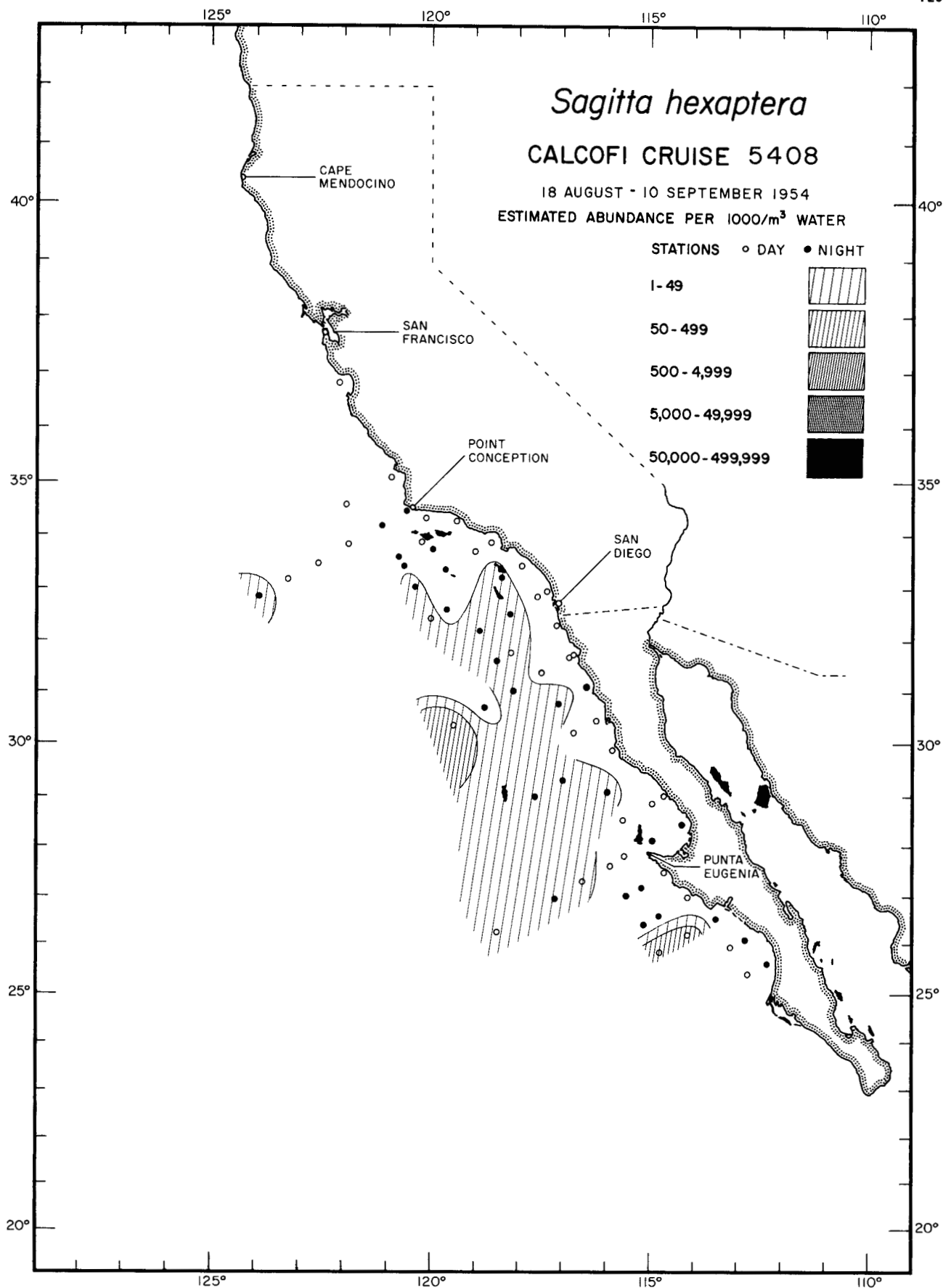
Chaetognatha  
*Sagitta decipiens*  
5408



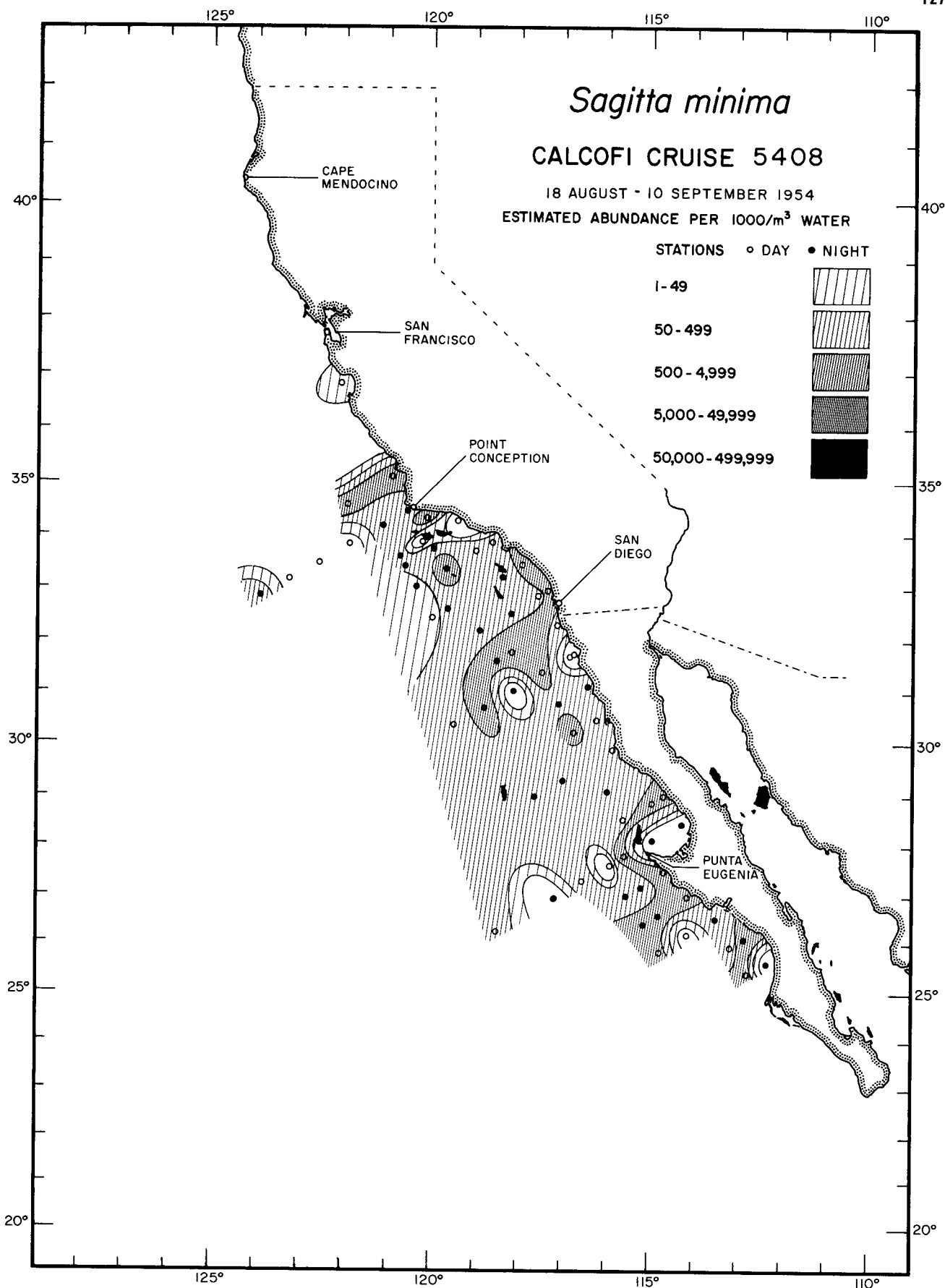
Chaetognatha  
*Sagitta enflata*  
5408



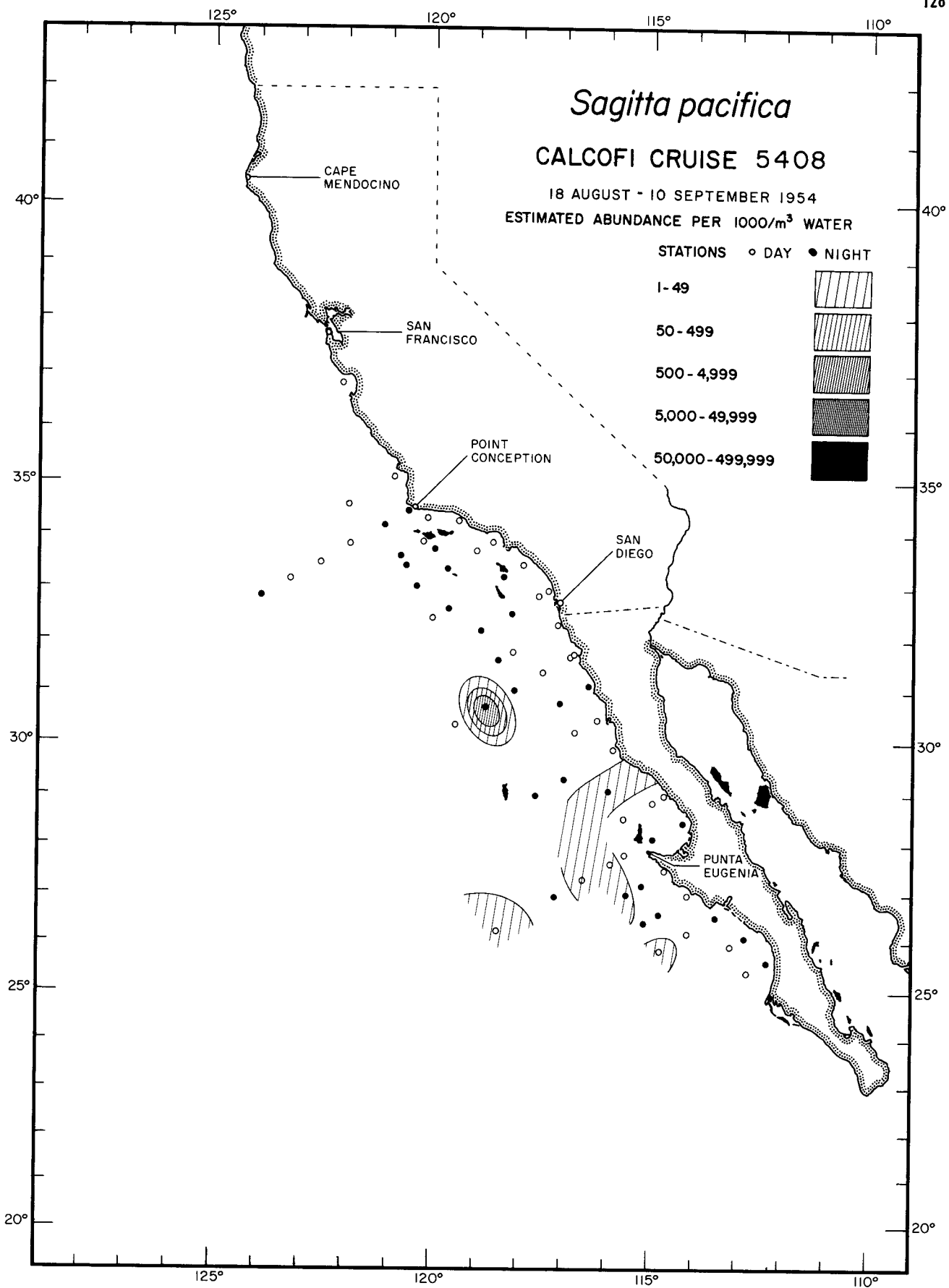
Chaetognatha  
*Sagitta euneritica*  
 5408



Chaetognatha  
*Sagitta hexaptera*  
5408

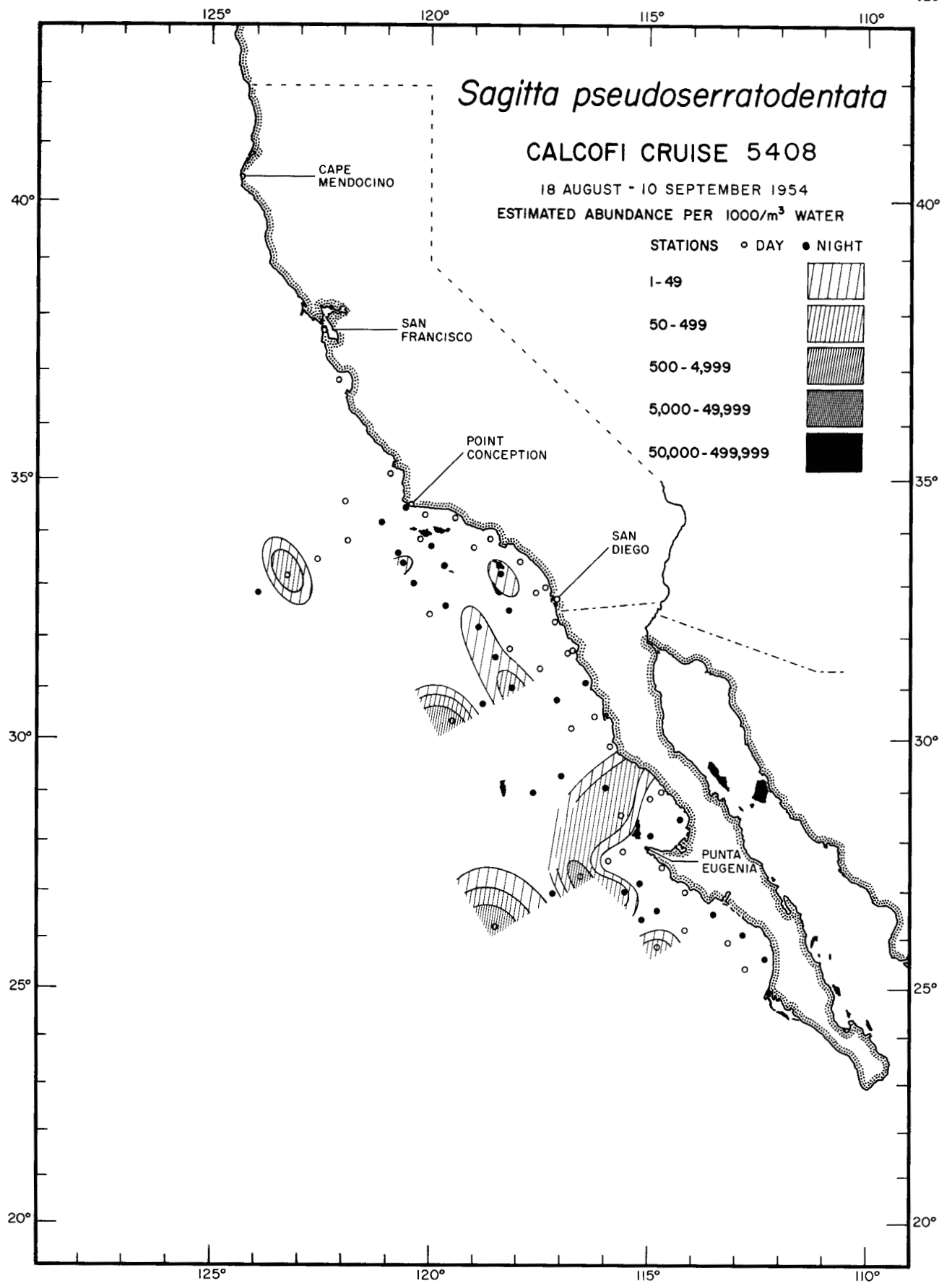


Chaetognatha  
*Sagitta minima*  
5408

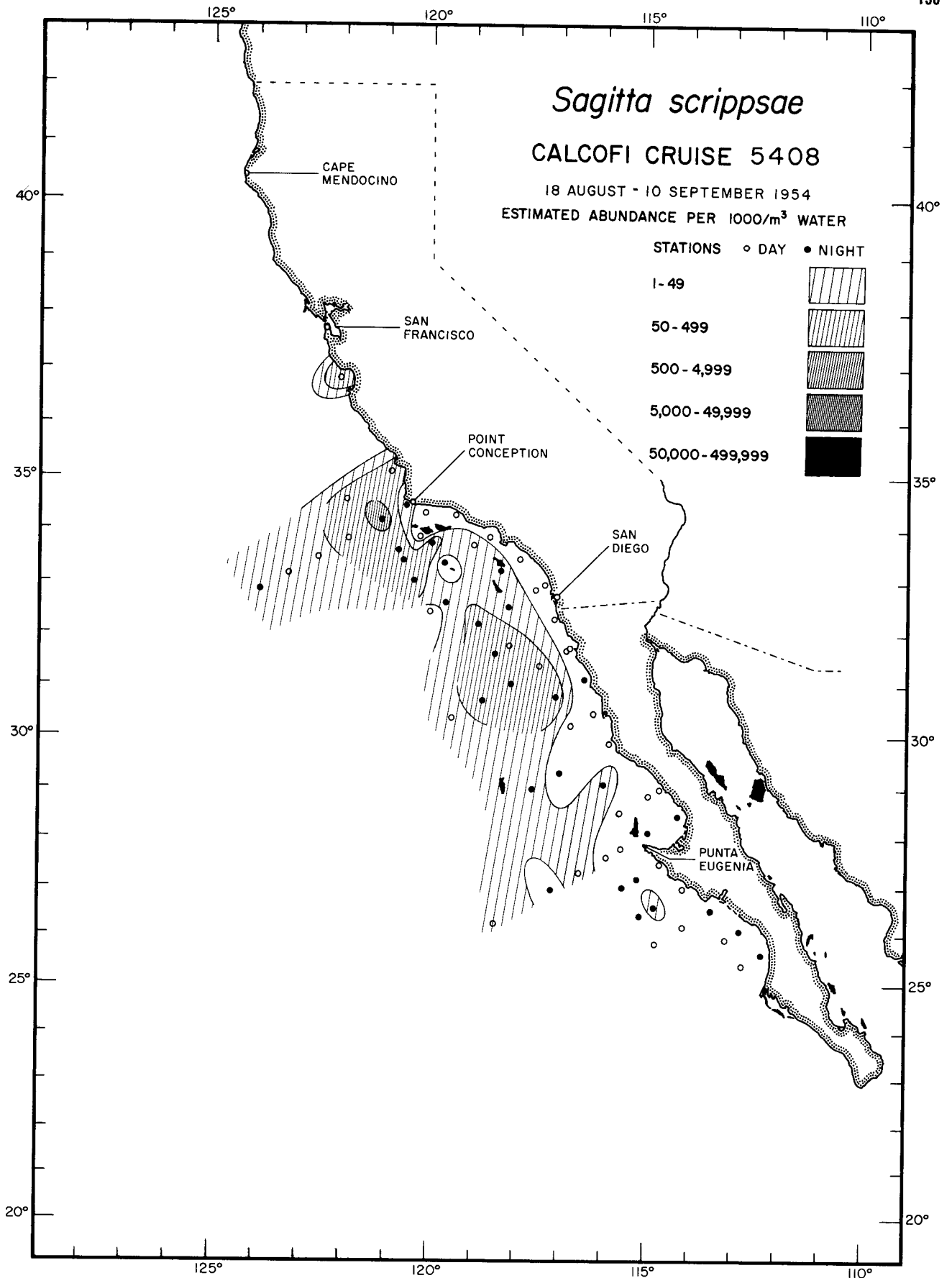


Chaetognatha  
*Sagitta pacifica*  
5408

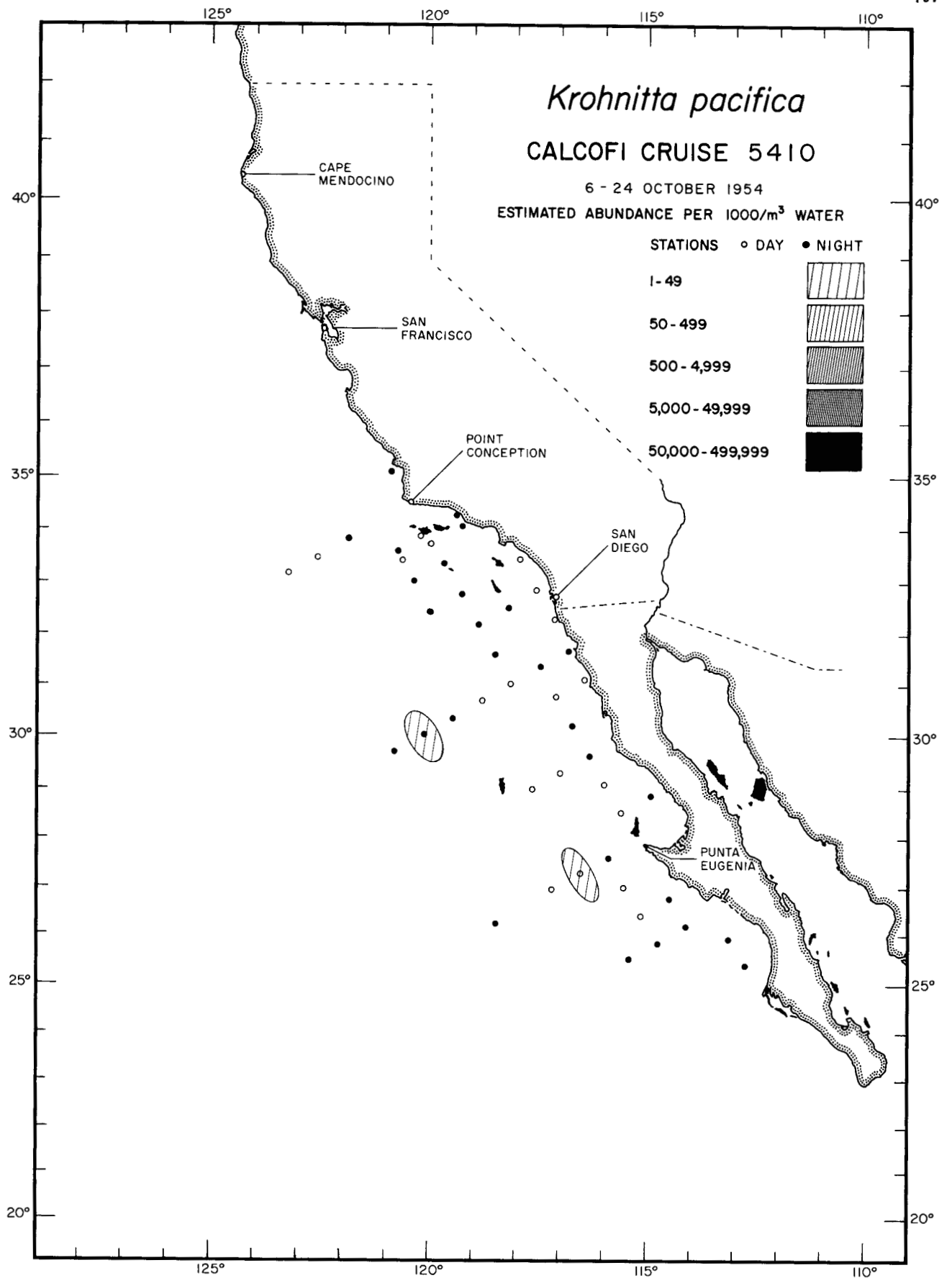




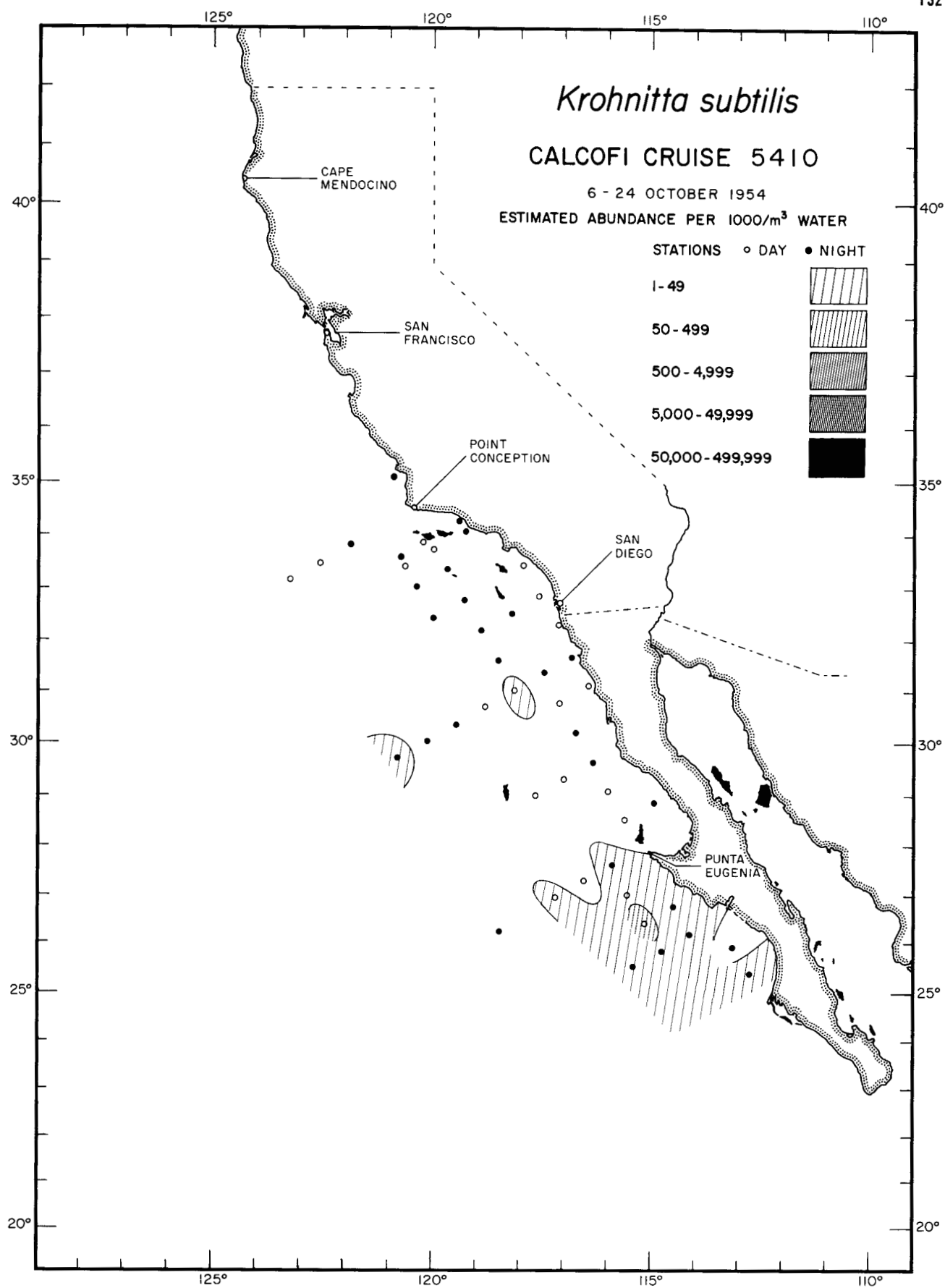
Chaetognatha  
*Sagitta pseudoserratodentata*  
5408



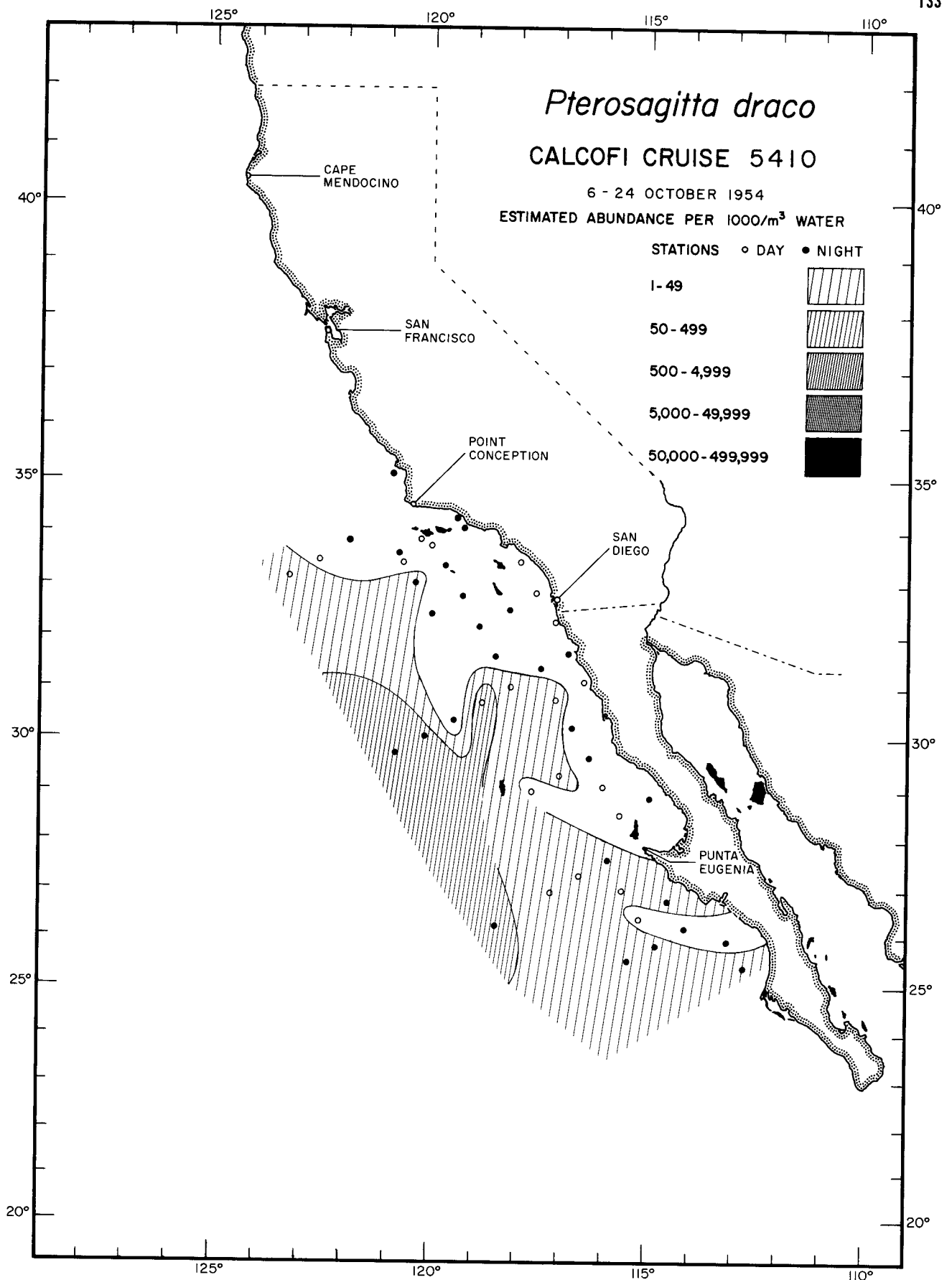
Chaetognatha  
*Sagitta scrippsae*  
5408



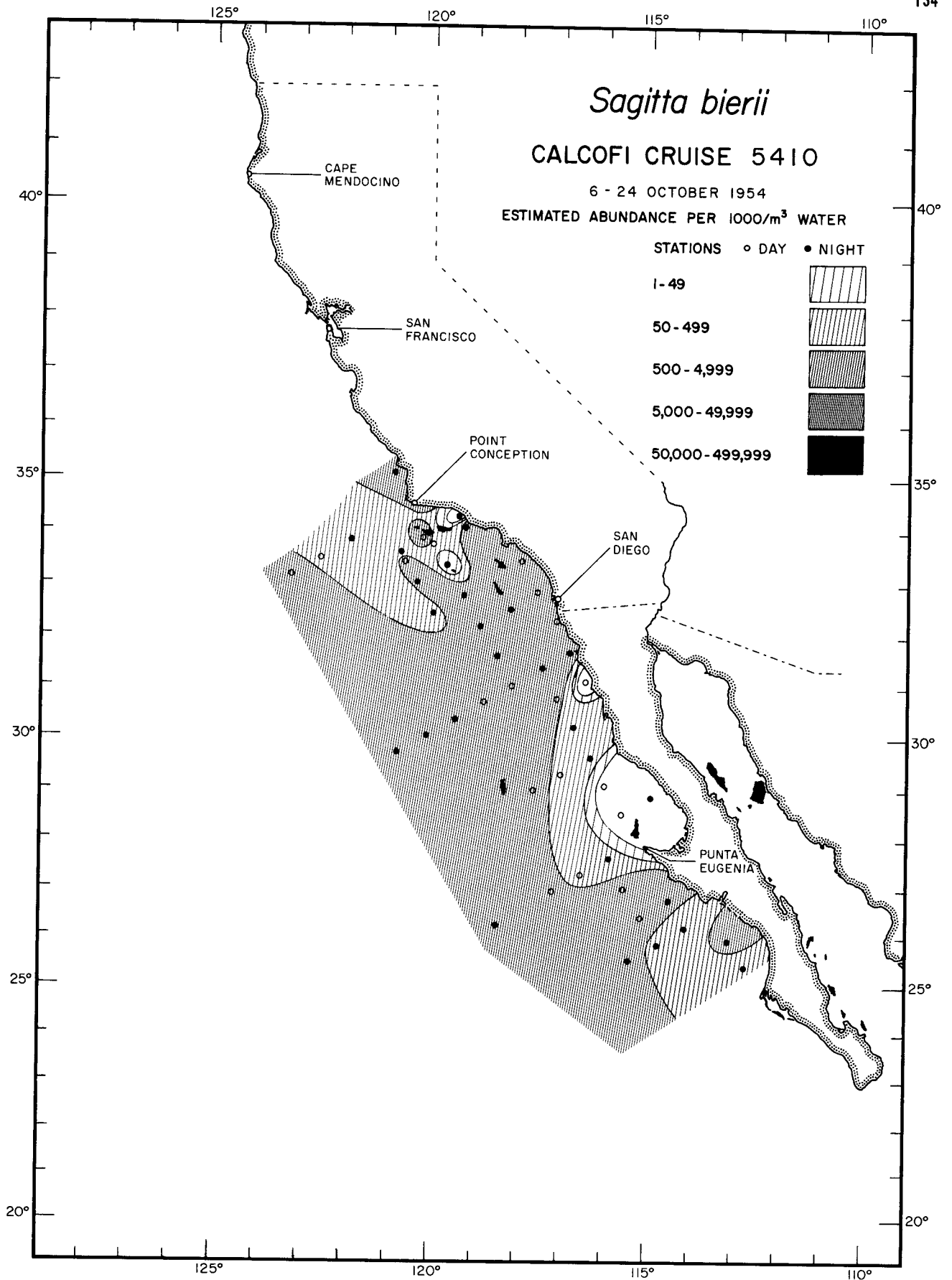
Chaetognatha  
*Krohnitta pacifica*  
5410



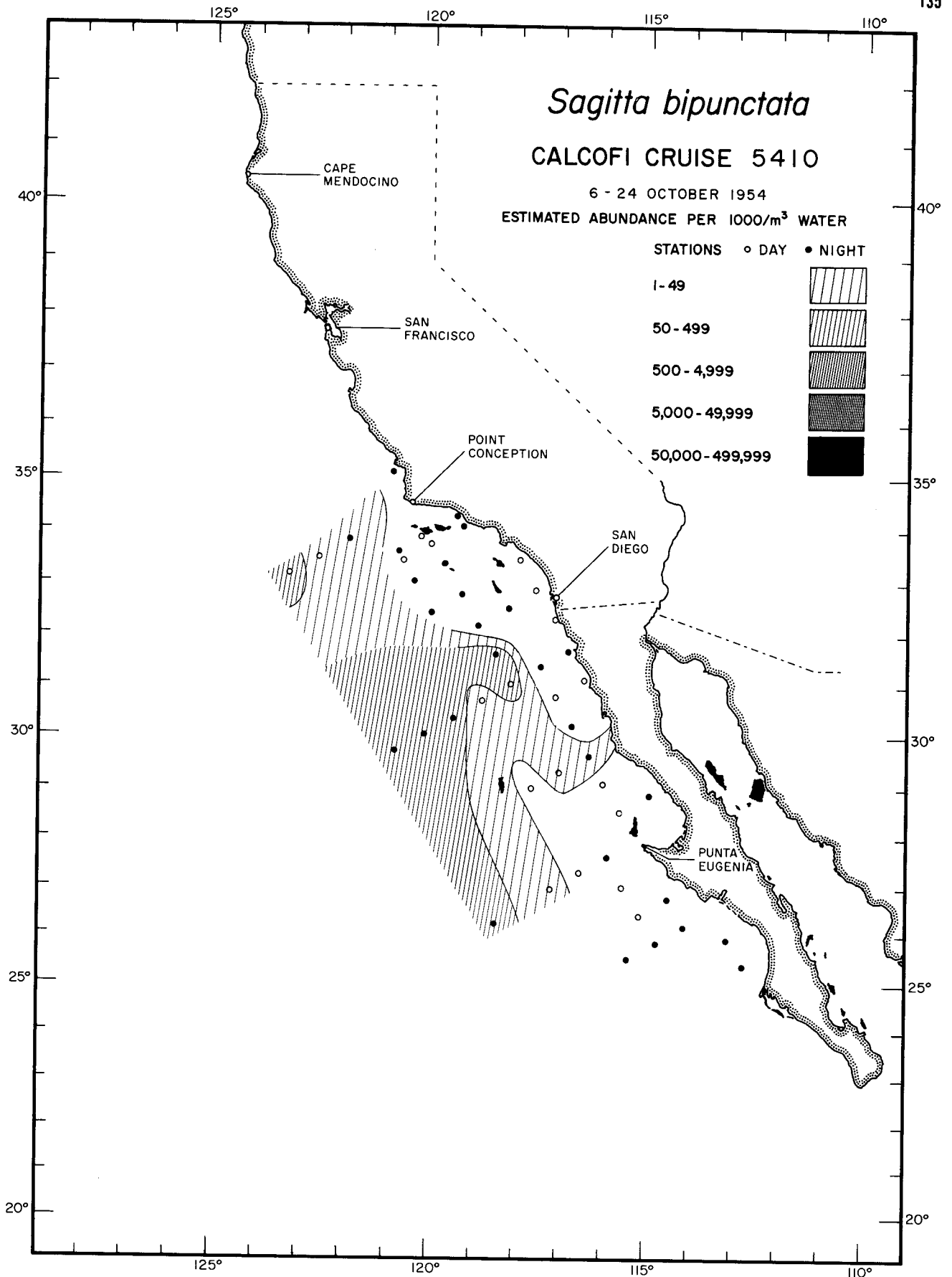
Chaetognatha  
*Krohnitta subtilis*  
 5410



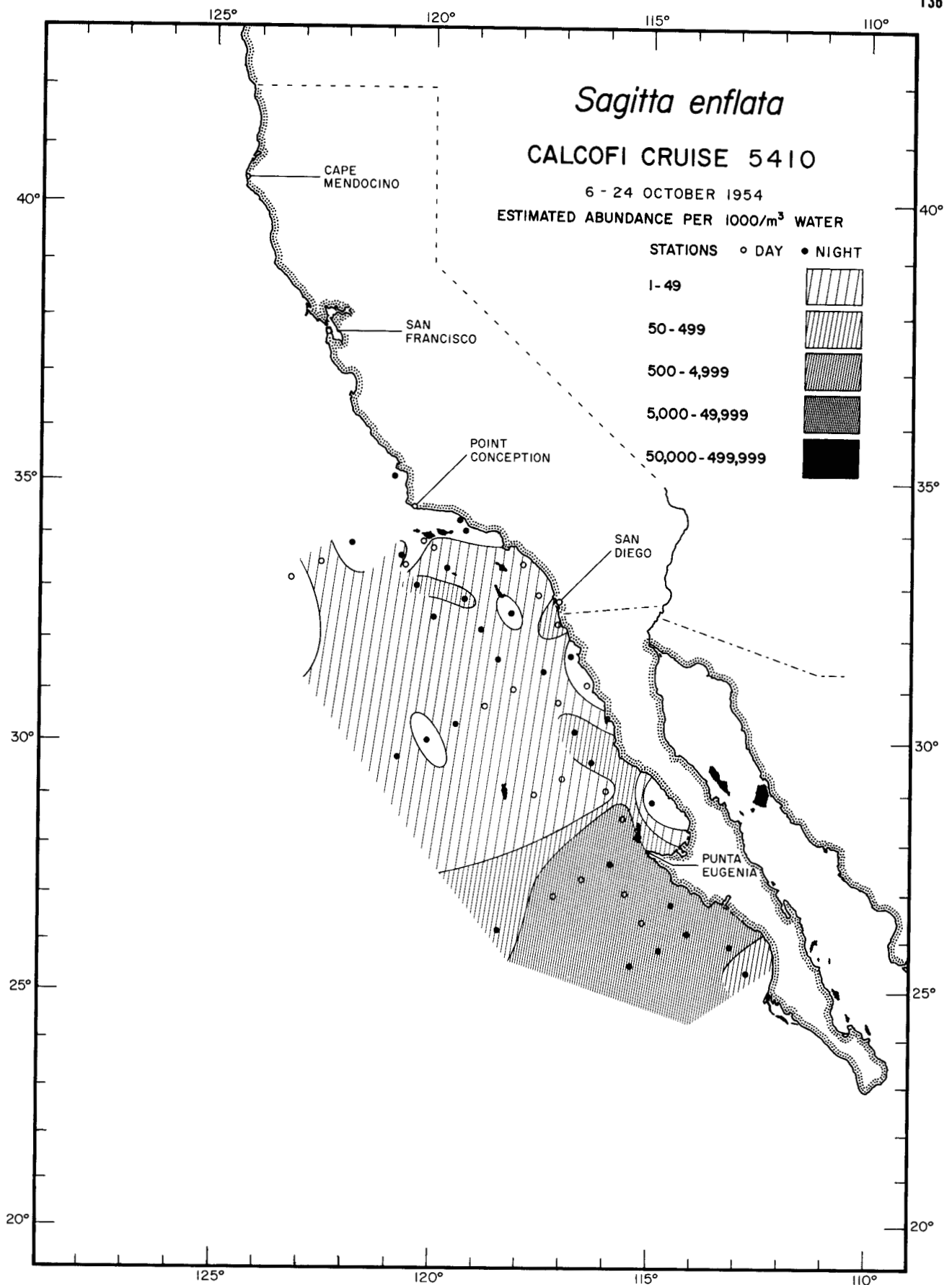
Chaetognatha  
*Pterosagitta draco*  
5410



Chaetognatha  
*Sagitta bierii*  
5410

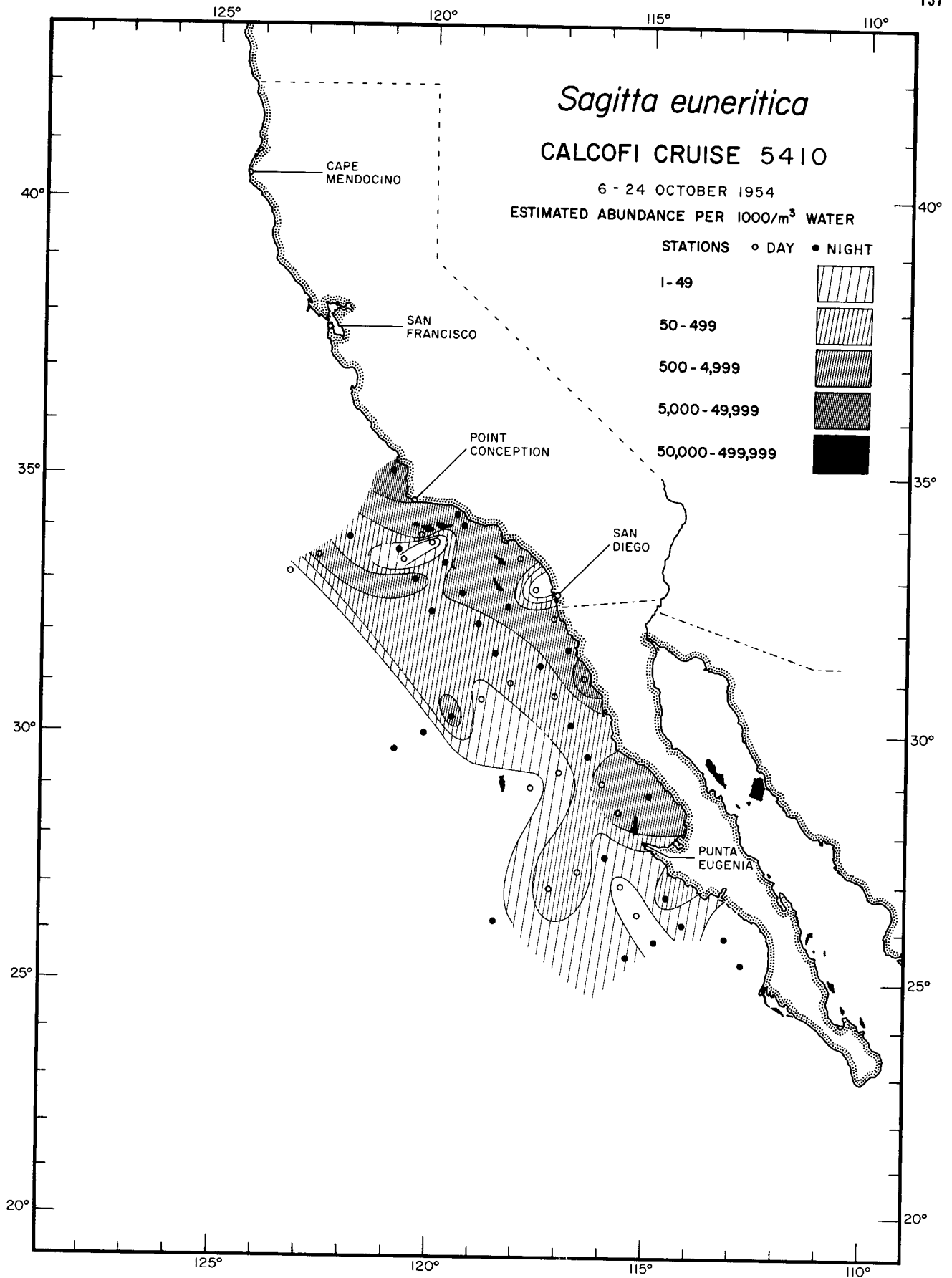


Chaetognatha  
*Sagitta bipunctata*  
5410

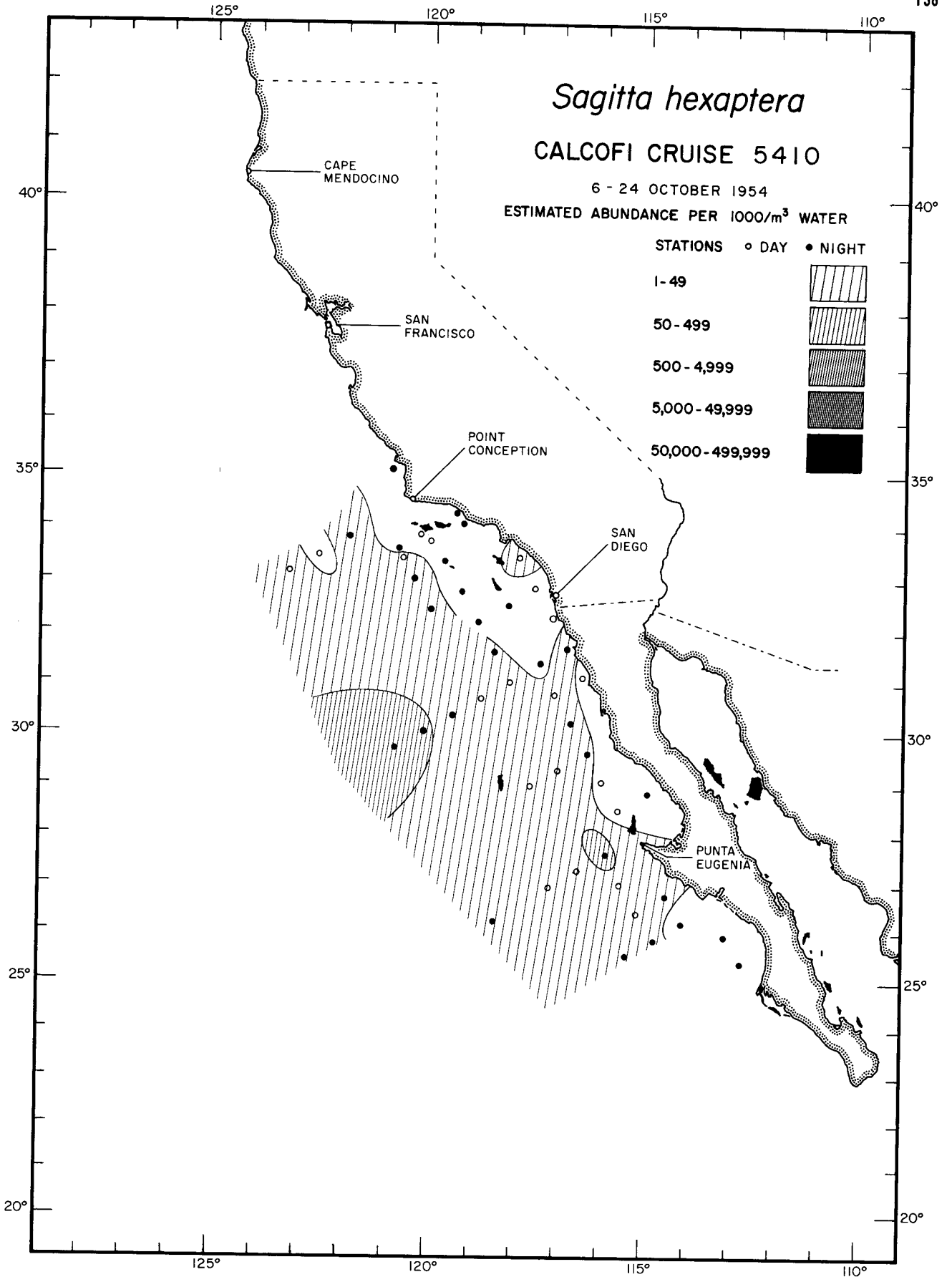


Chaetognatha  
*Sagitta enflata*  
5410

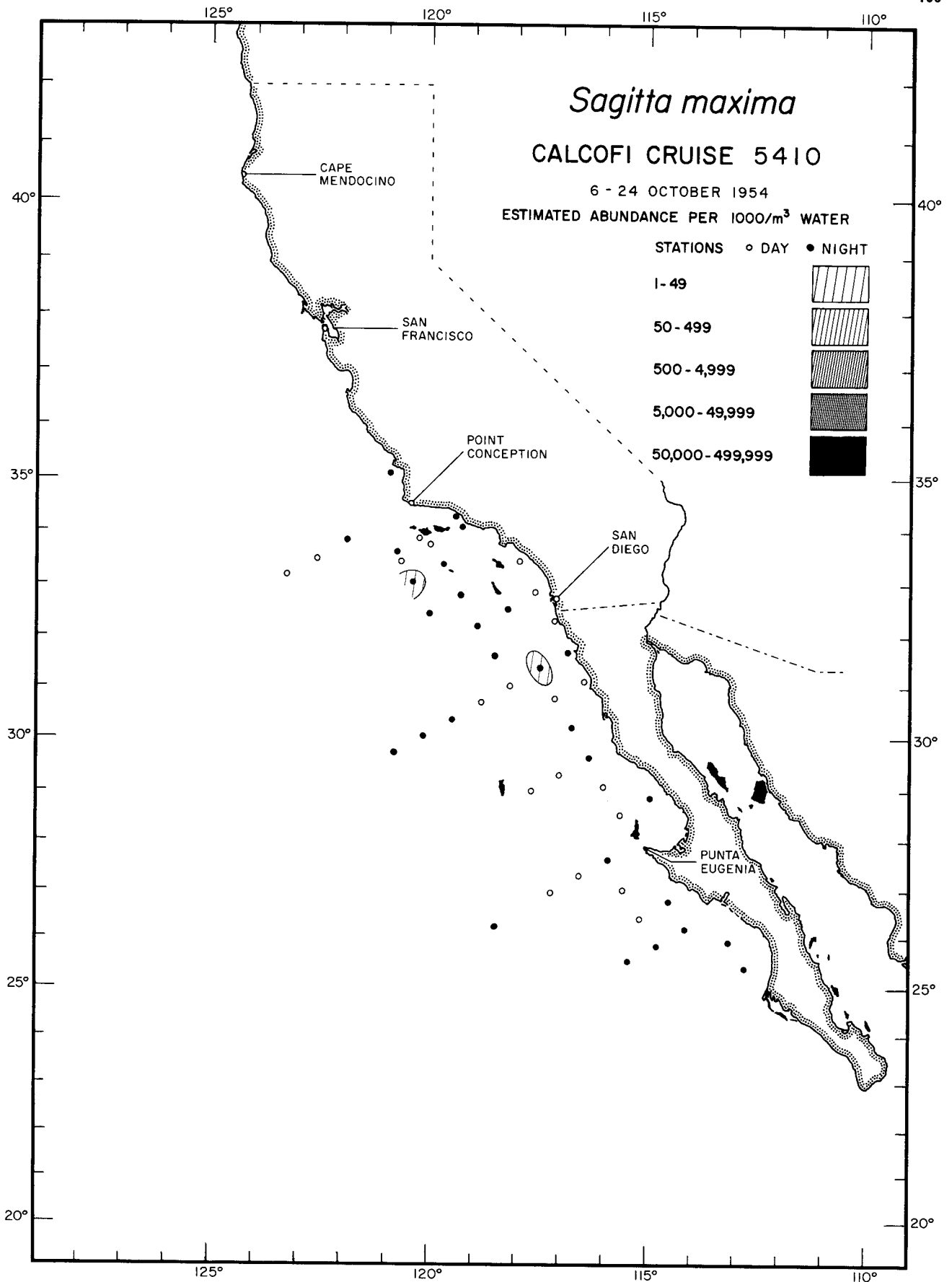




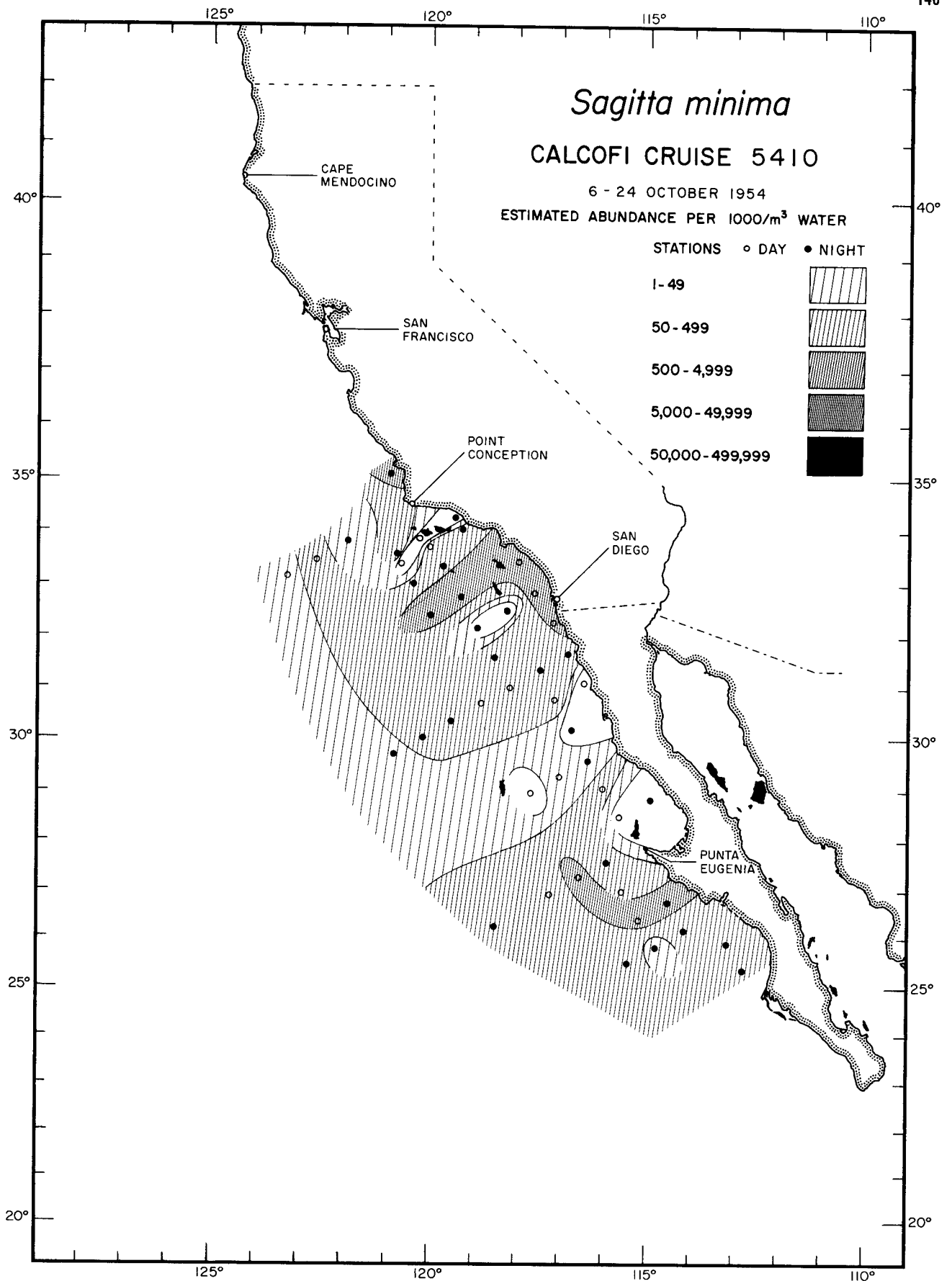
Chaetognatha  
*Sagitta euneritica*  
5410



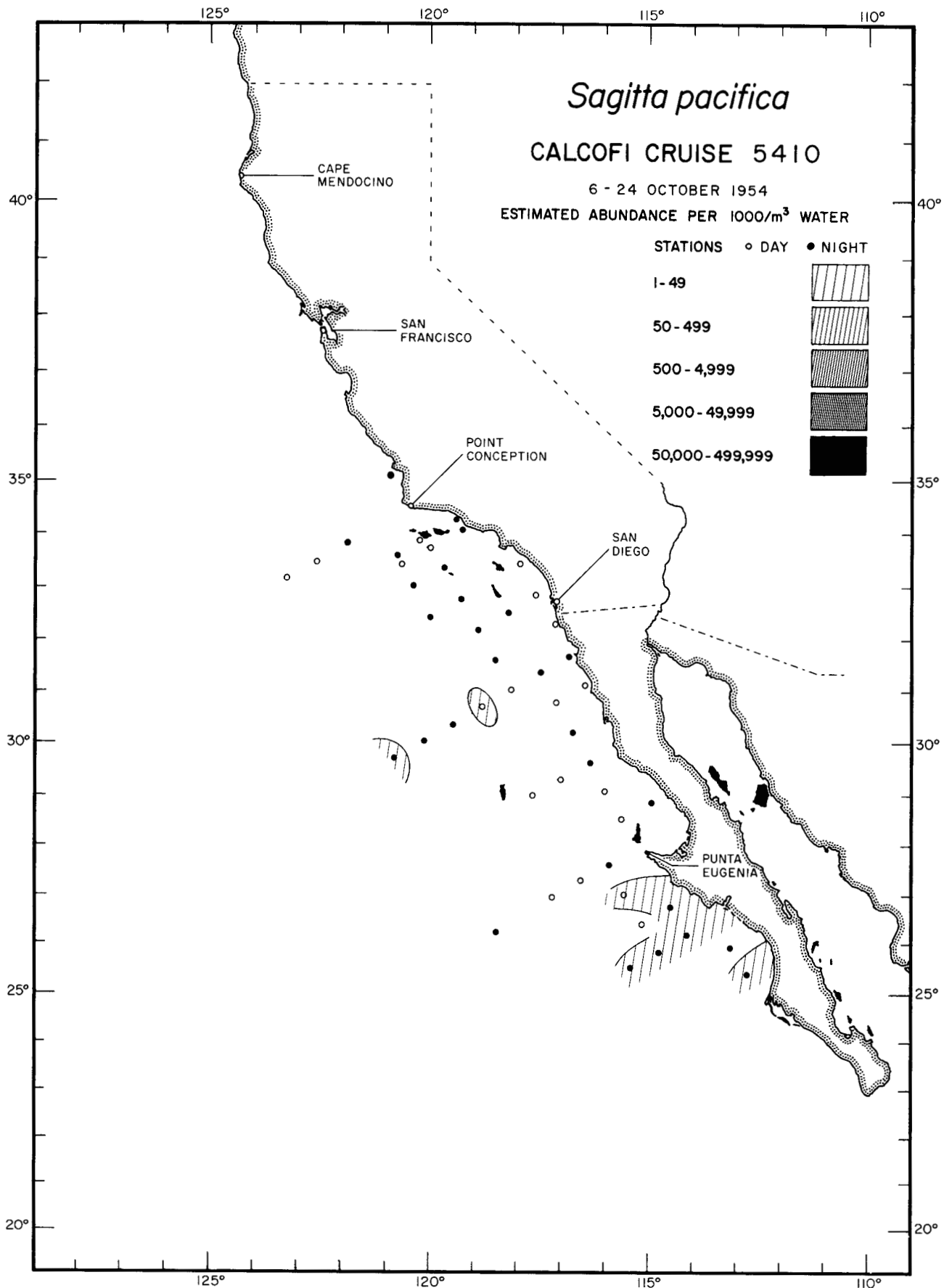
Chaetognatha  
*Sagitta hexaptera*  
5410



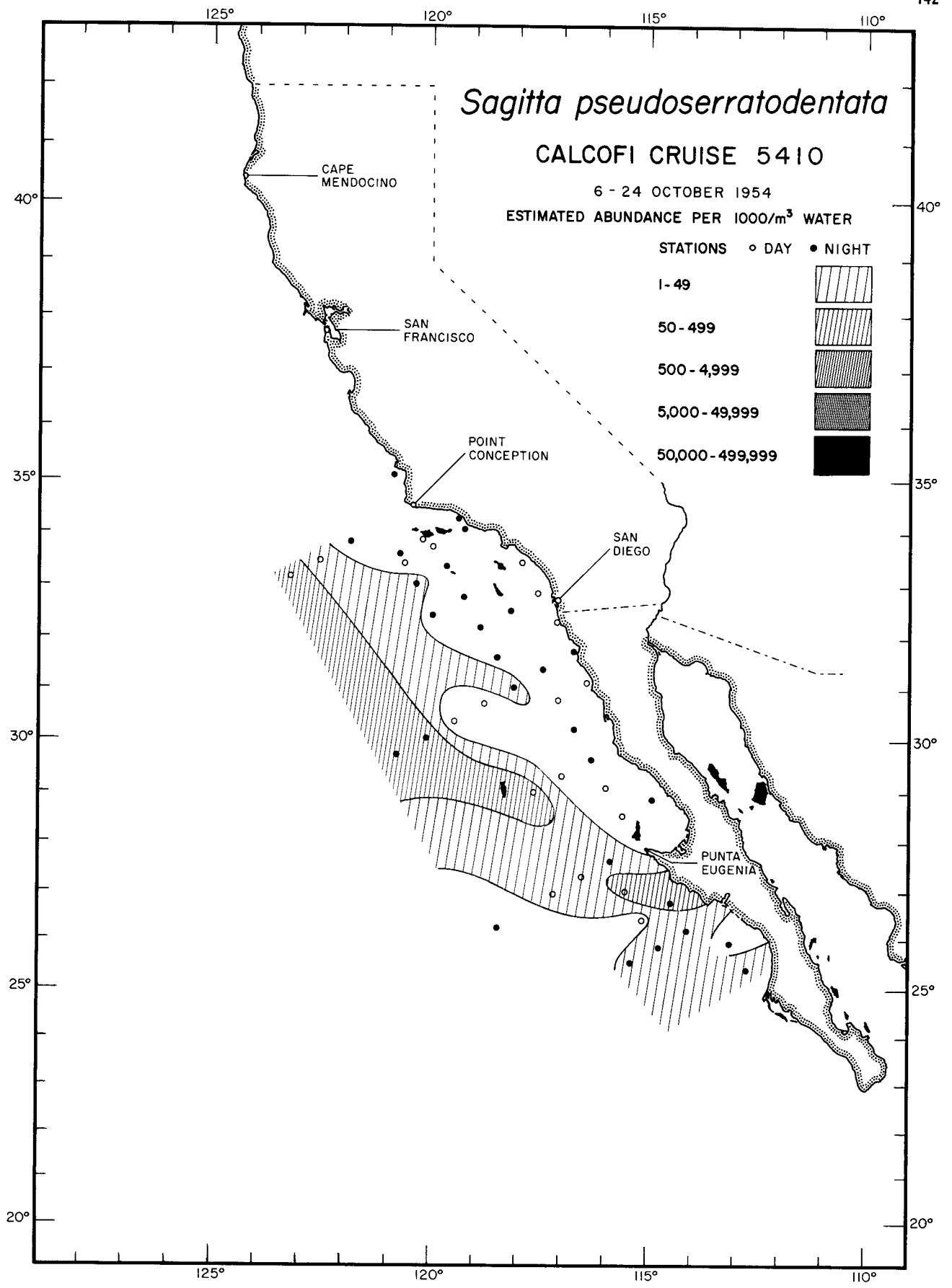
Chaetognatha  
*Sagitta maxima*  
5410



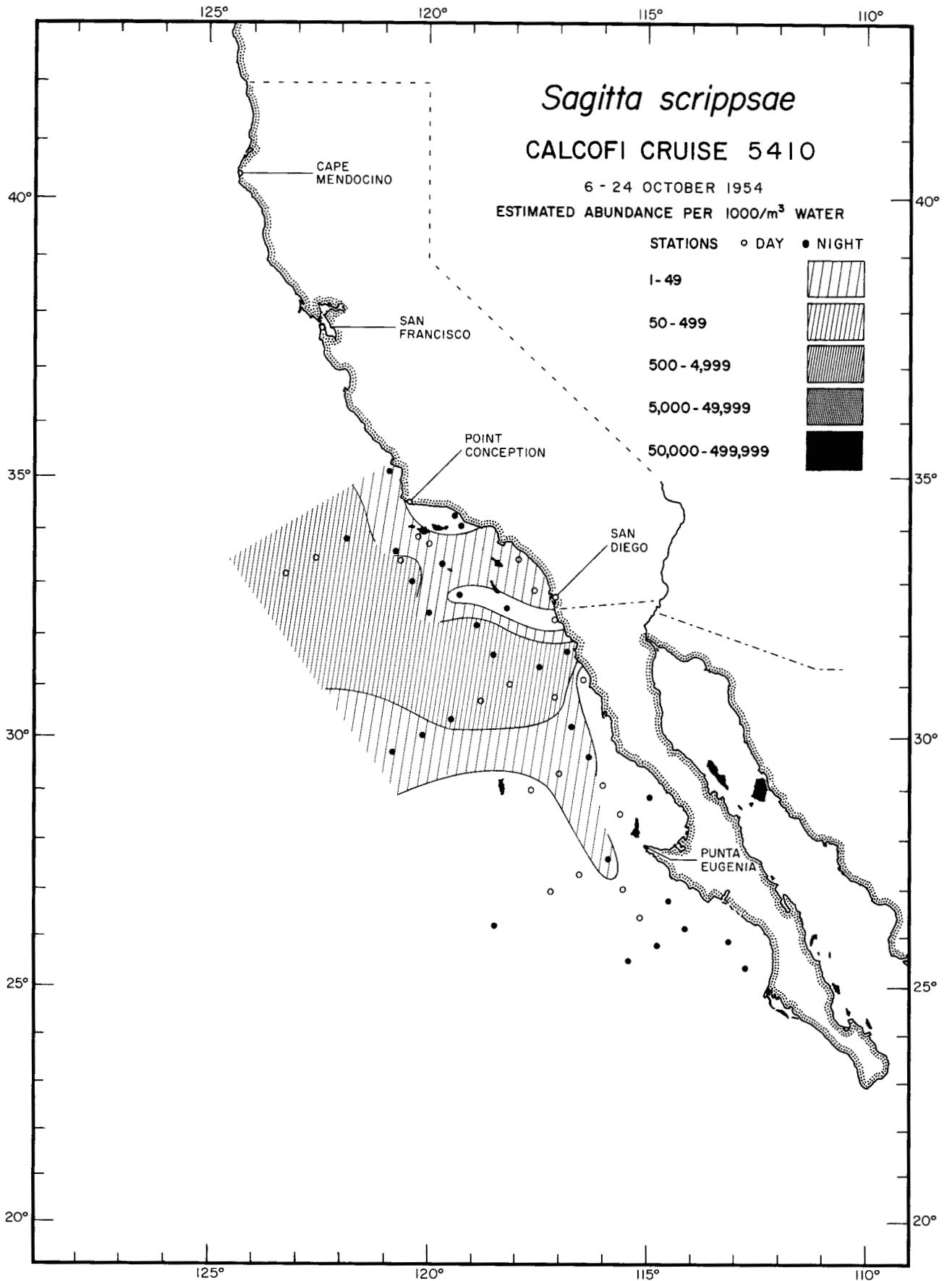
Chaetognatha  
*Sagitta minima*  
5410



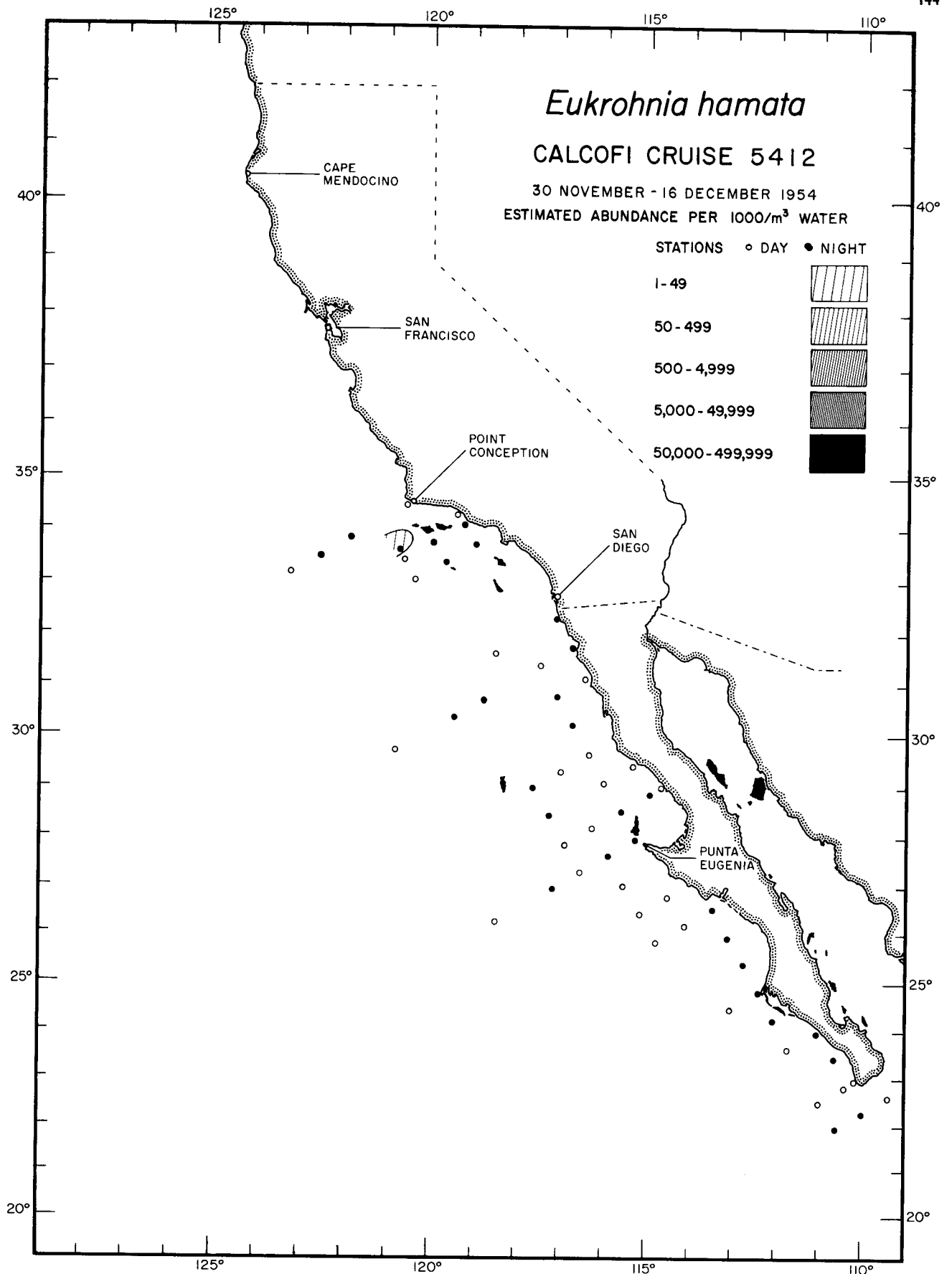
Chaetognatha  
*Sagitta pacifica*  
5410



Chaetognatha  
*Sagitta pseudoserratodentata*  
5410

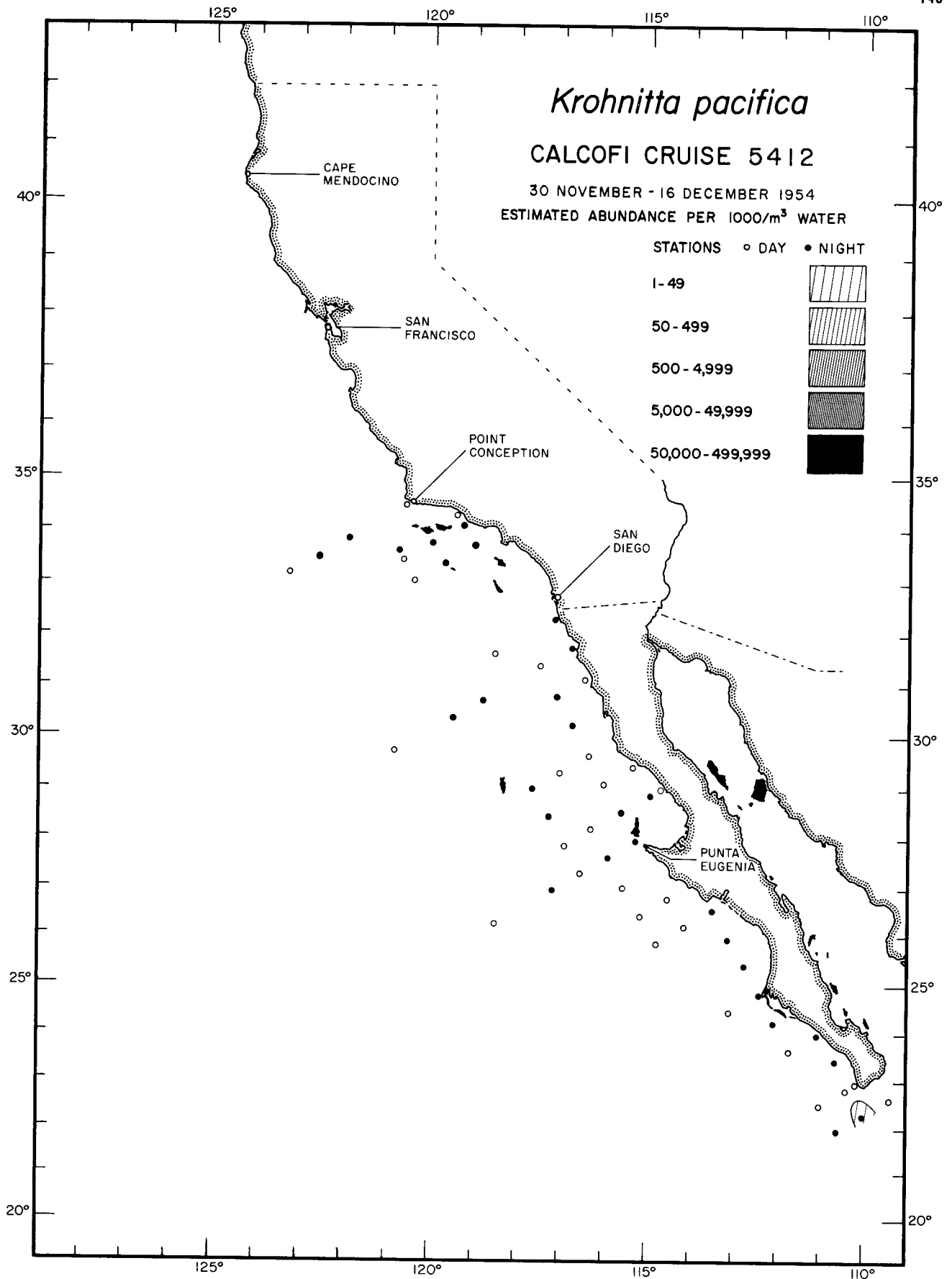


Chaetognatha  
*Sagitta scrippsae*  
5410

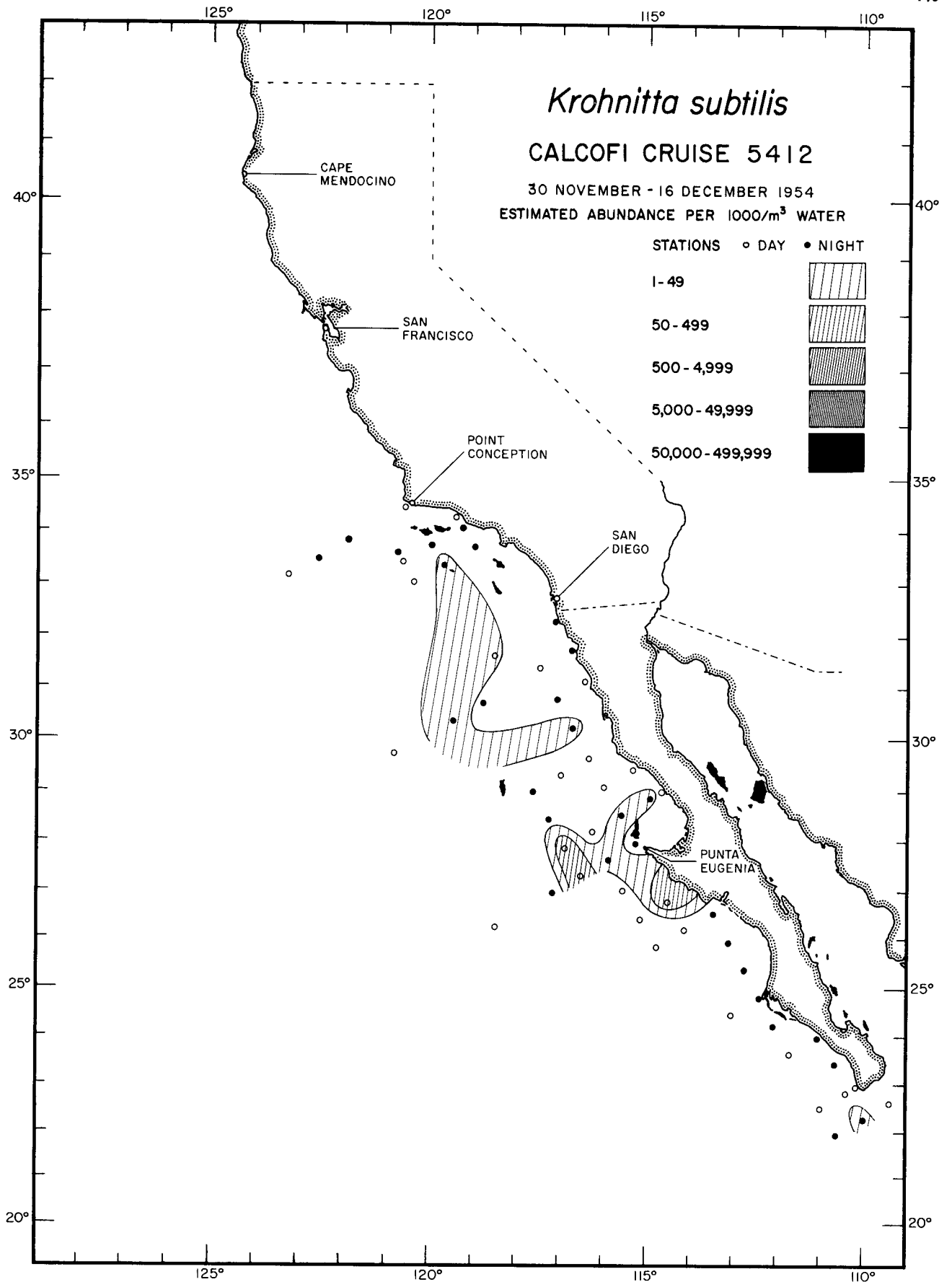


Chaetognatha  
*Eukrohnia hamata*  
5412

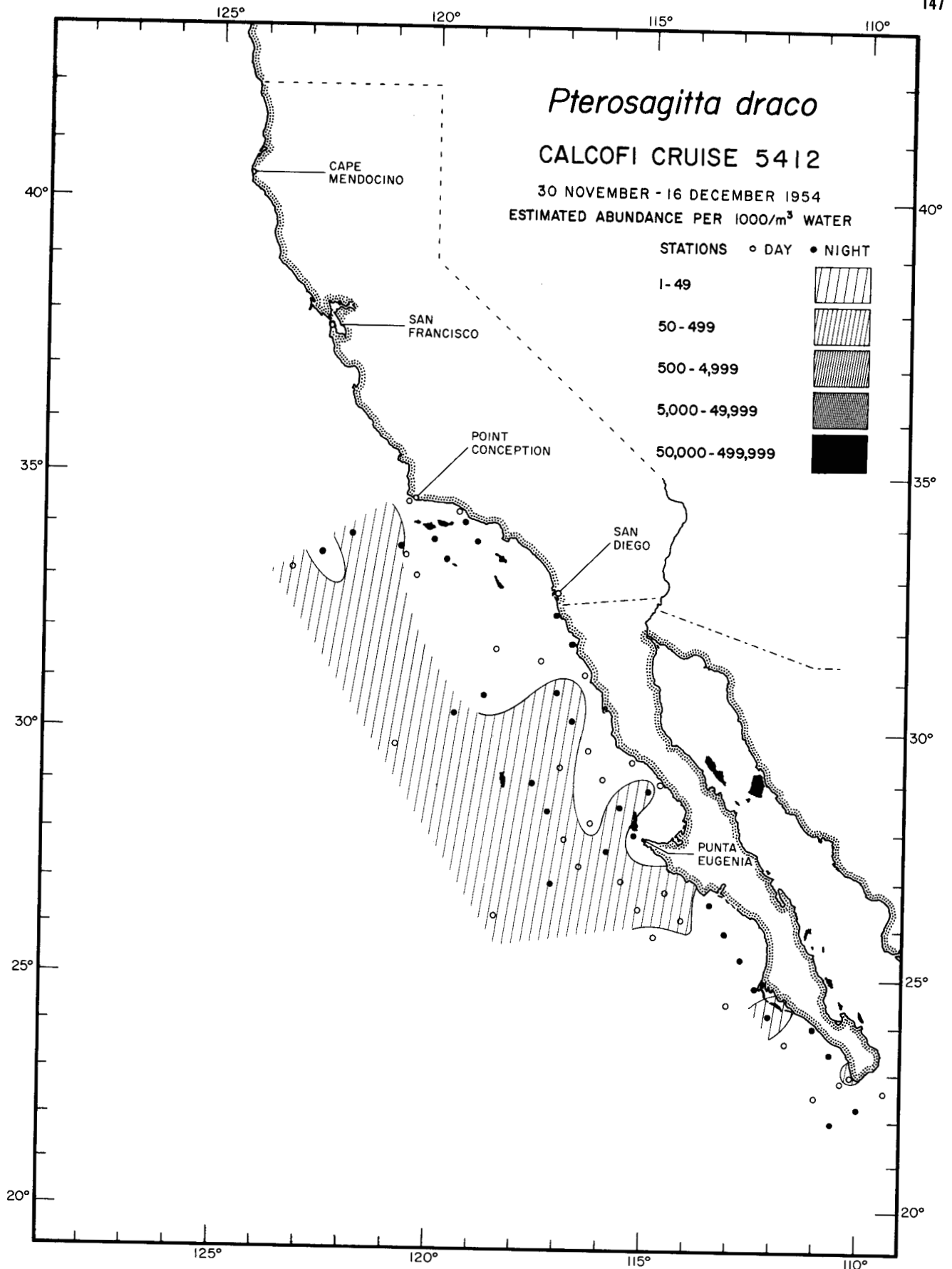




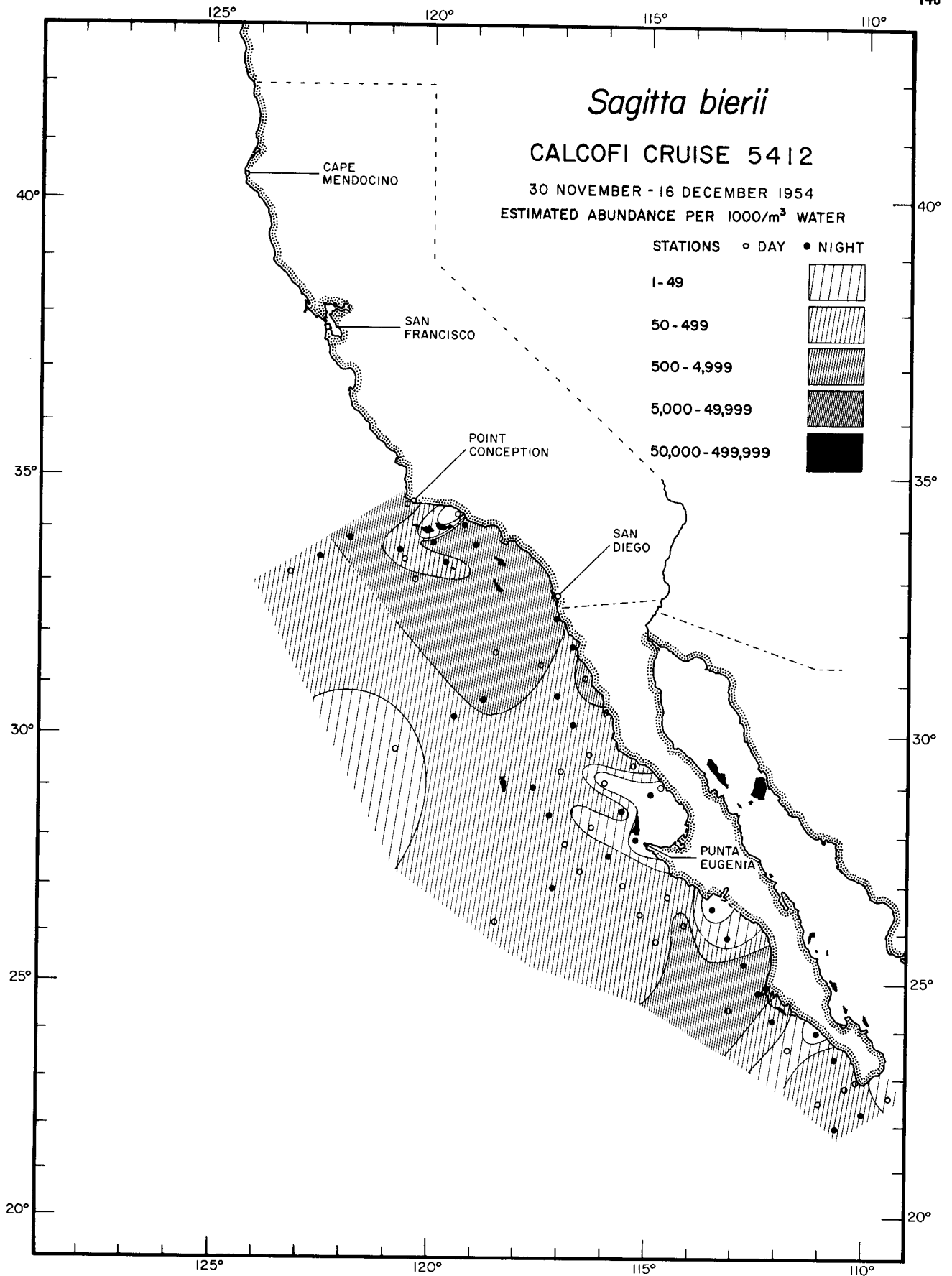
Chaetognatha  
*Krohnitta pacifica*  
5412



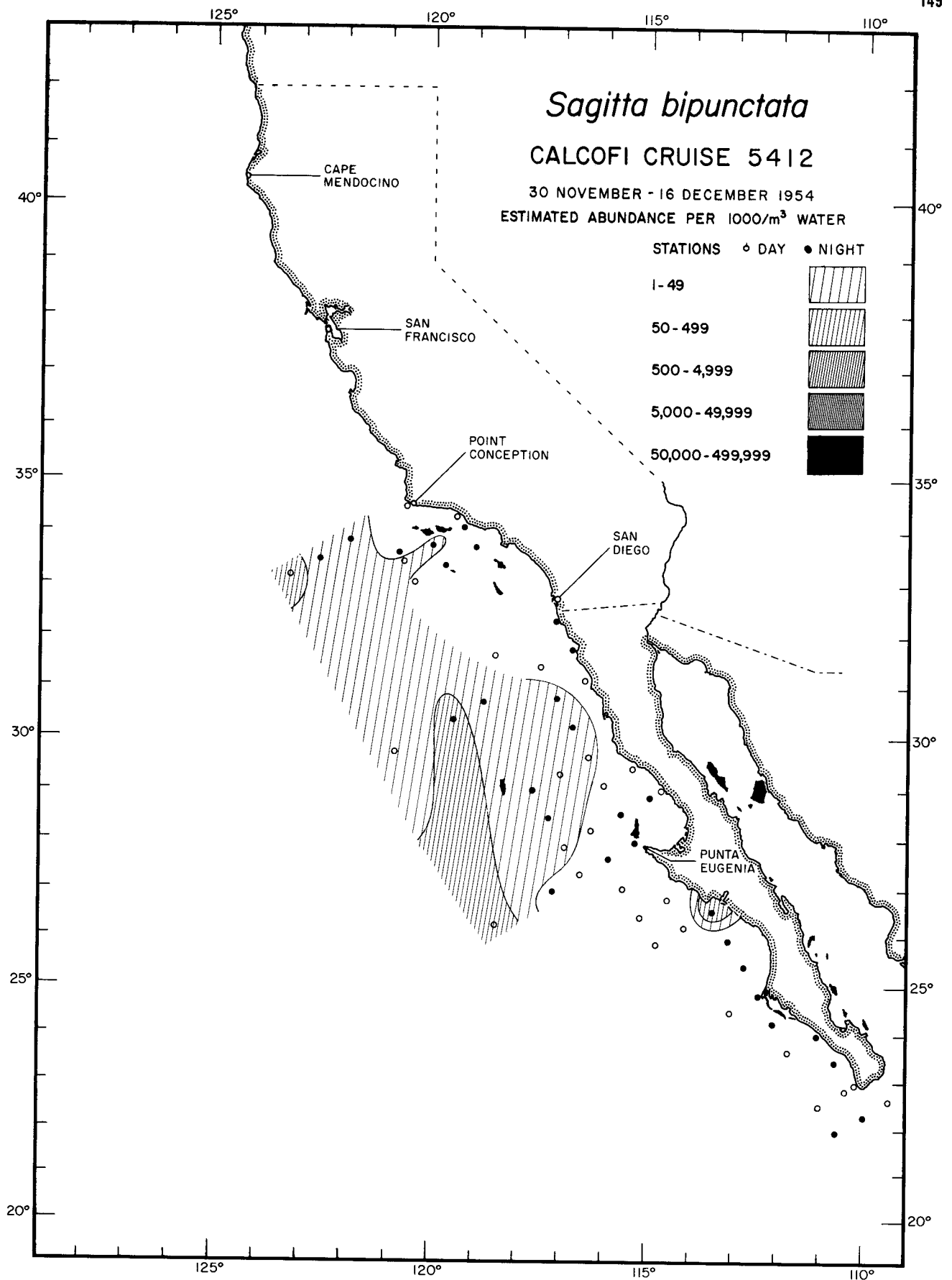
Chaetognatha  
*Krohnitta subtilis*  
5412



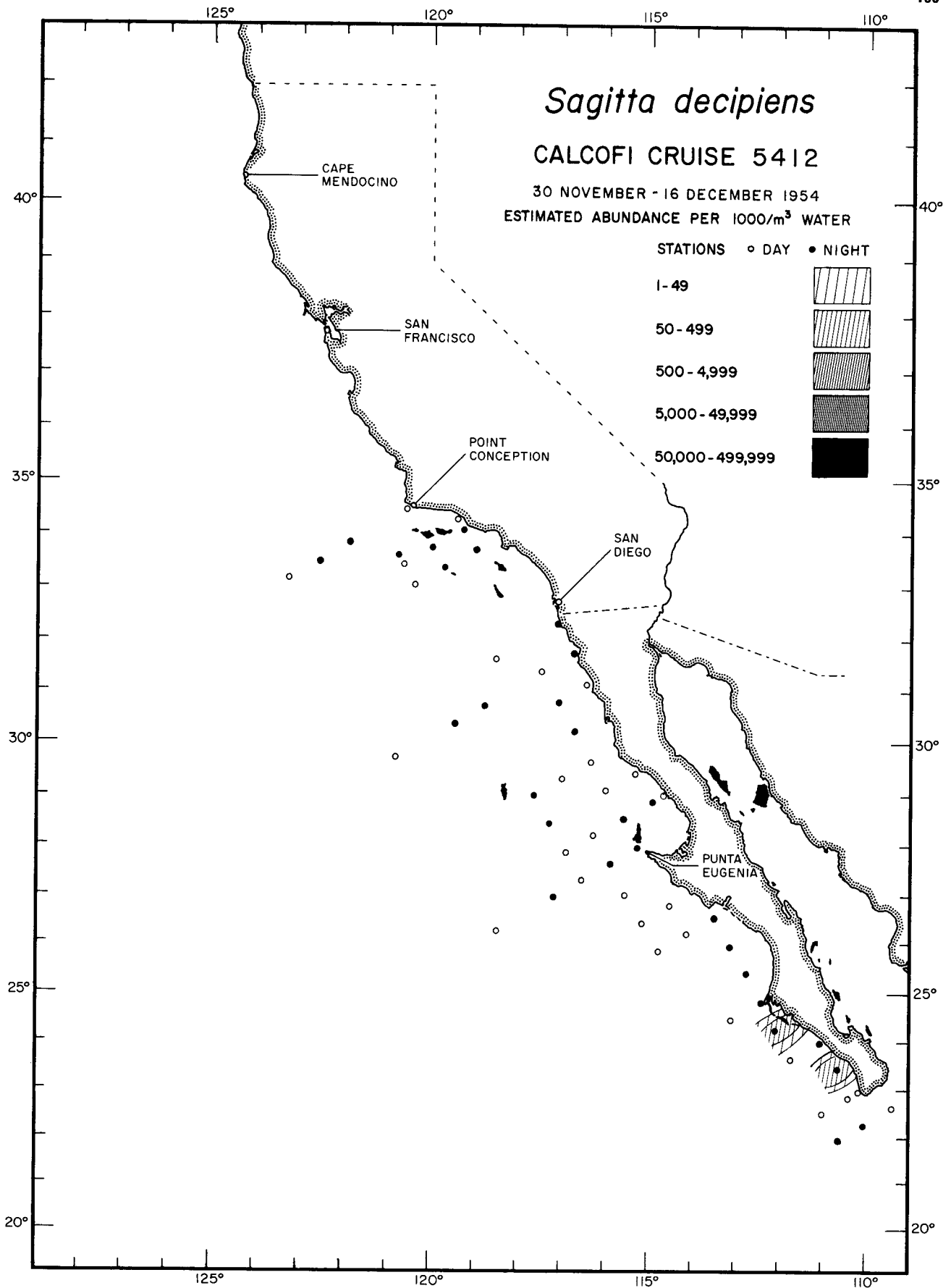
Chaetognatha  
*Pterosagitta draco*  
5412



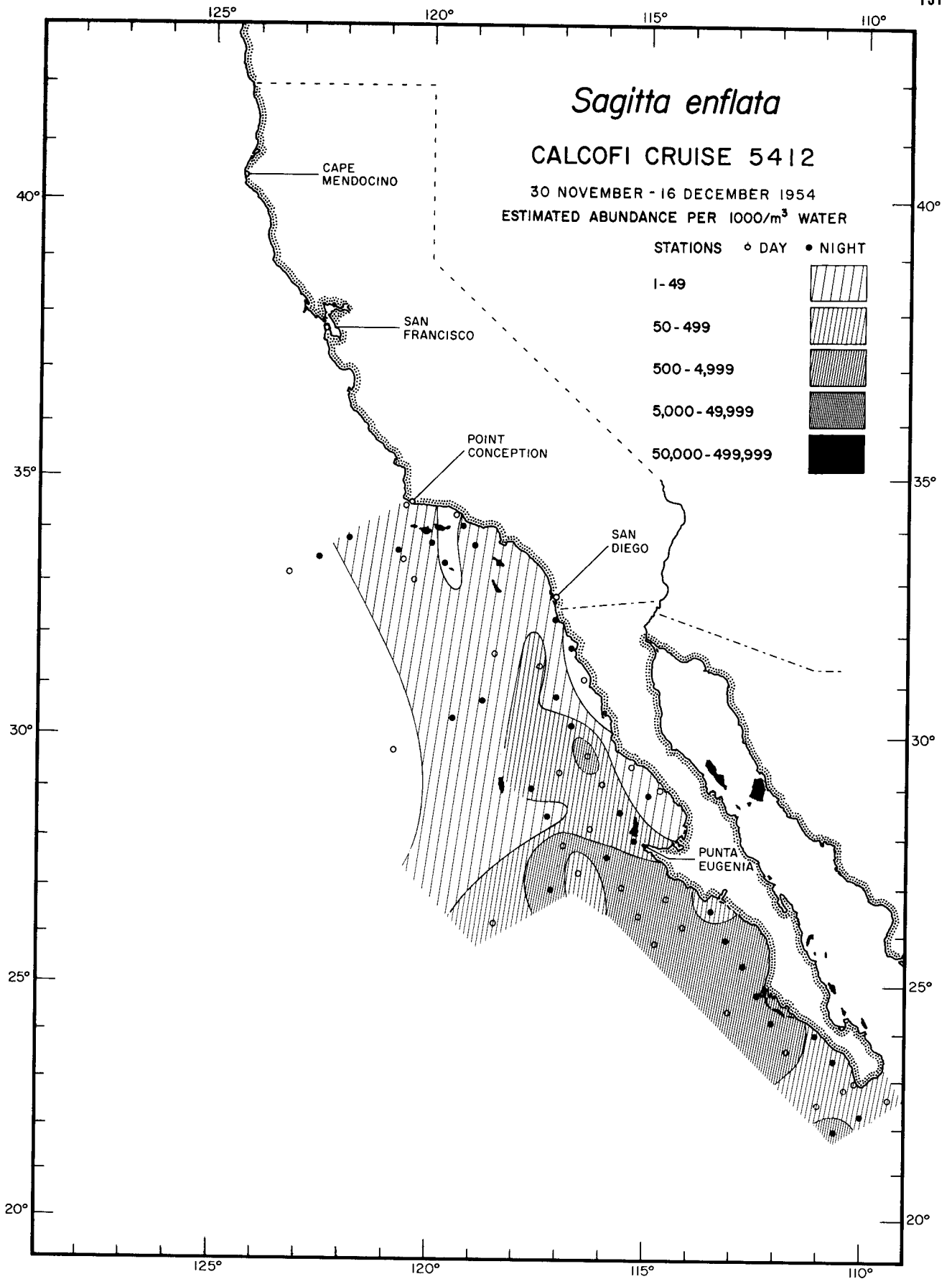
Chaetognatha  
*Sagitta bierii*  
5412

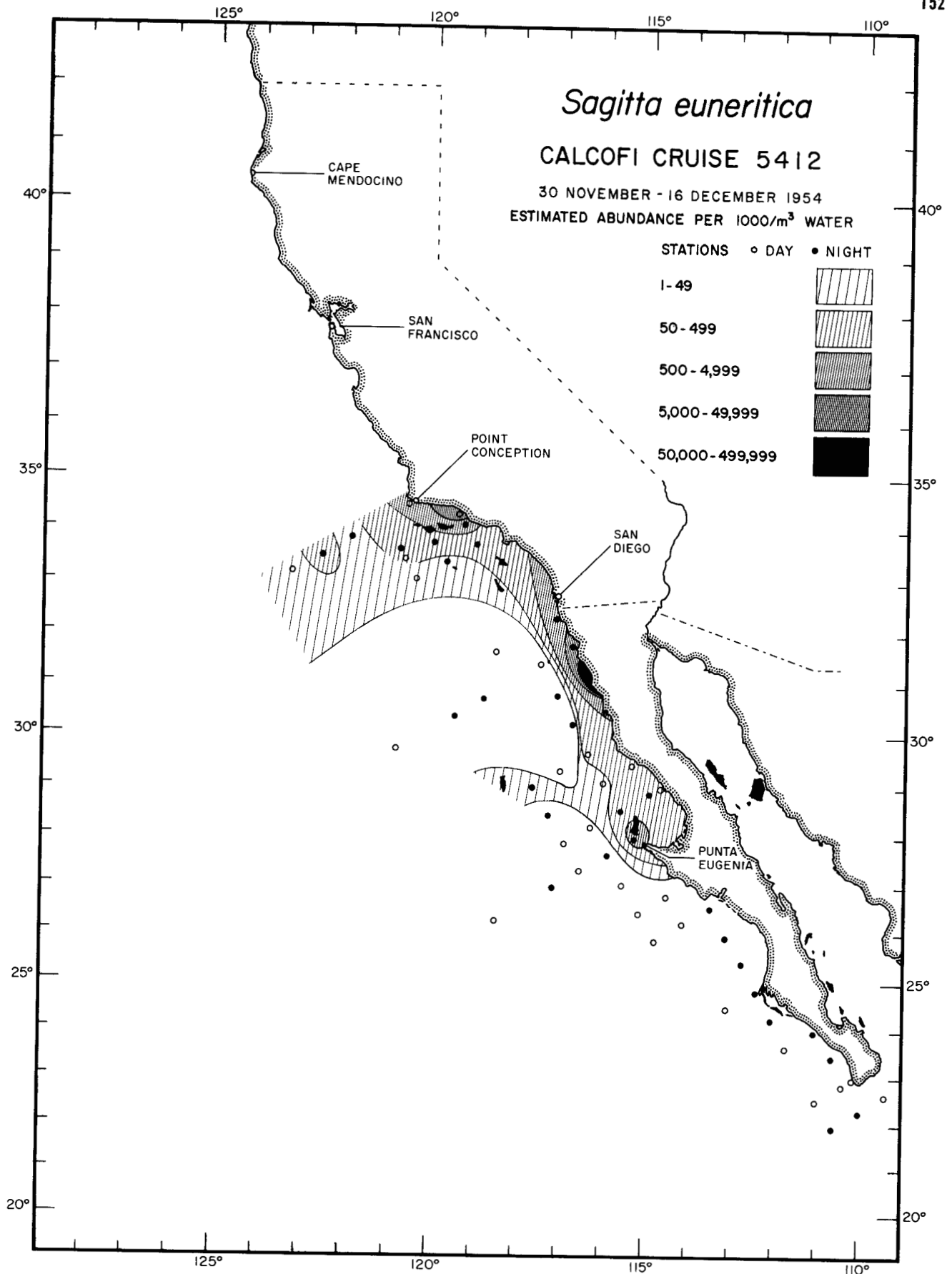


Chaetognatha  
*Sagitta bipunctata*  
 5412



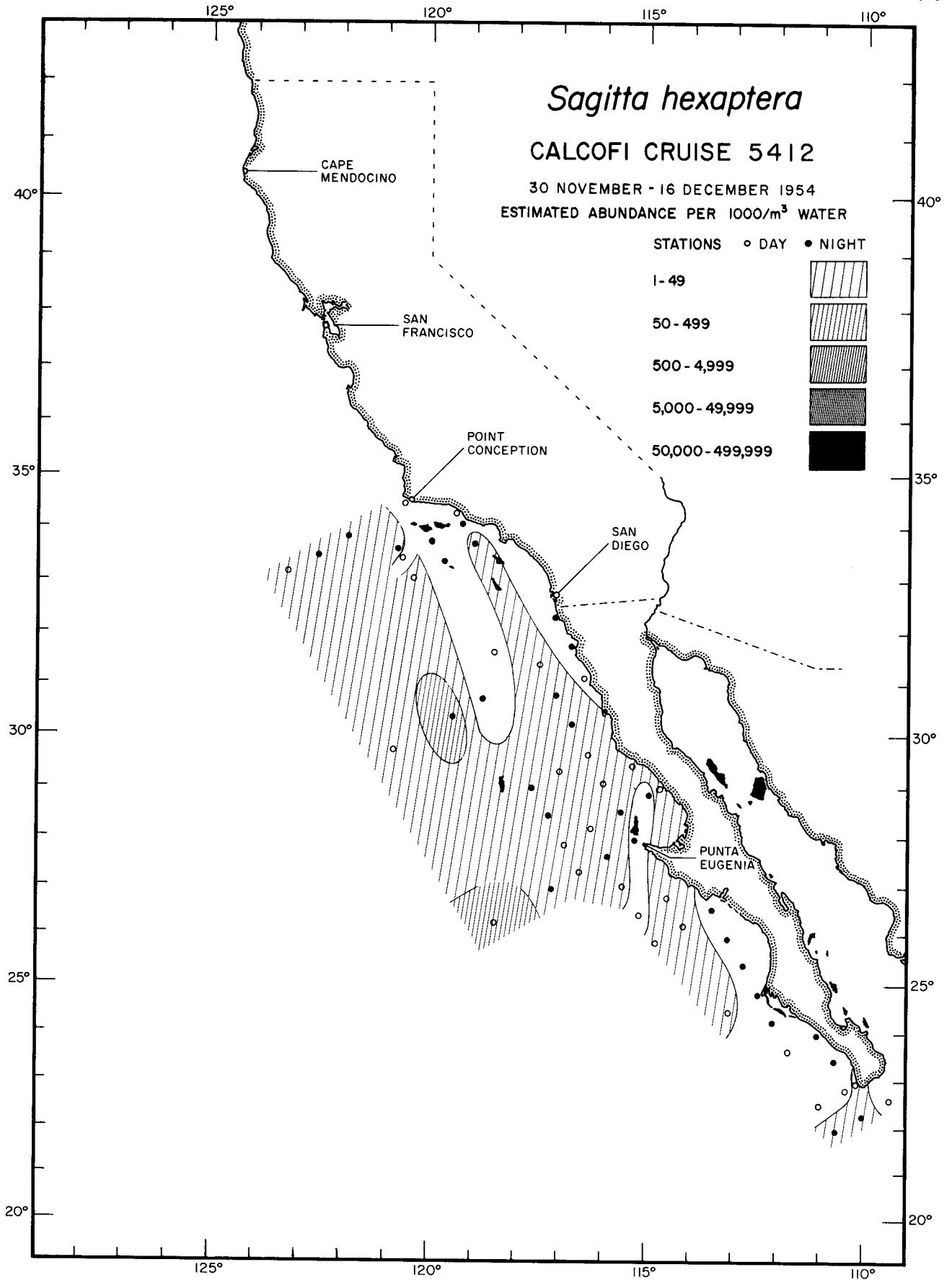
Chaetognatha  
*Sagitta decipiens*  
 5412



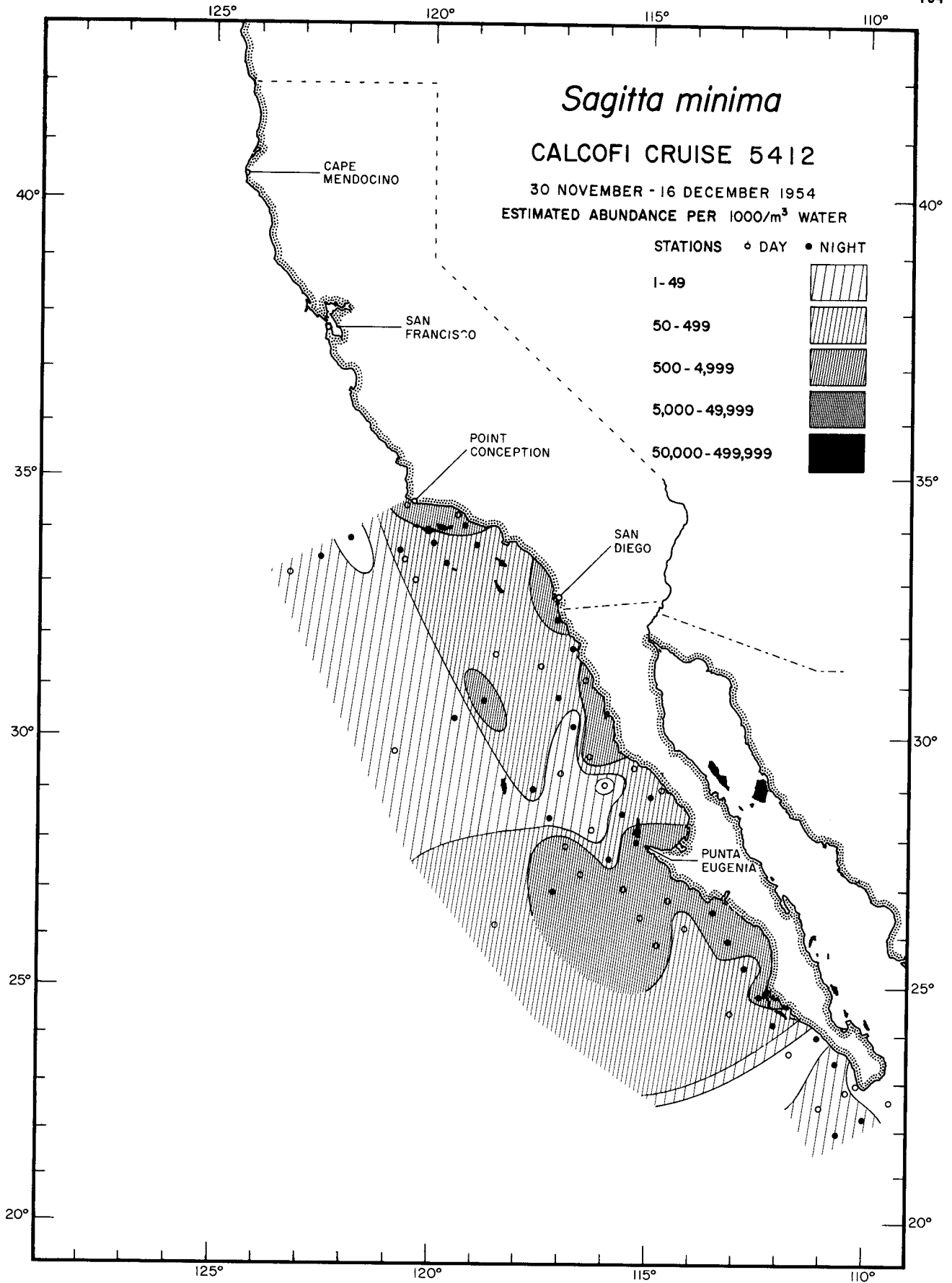


Chaetognatha  
*Sagitta euneritica*  
5412

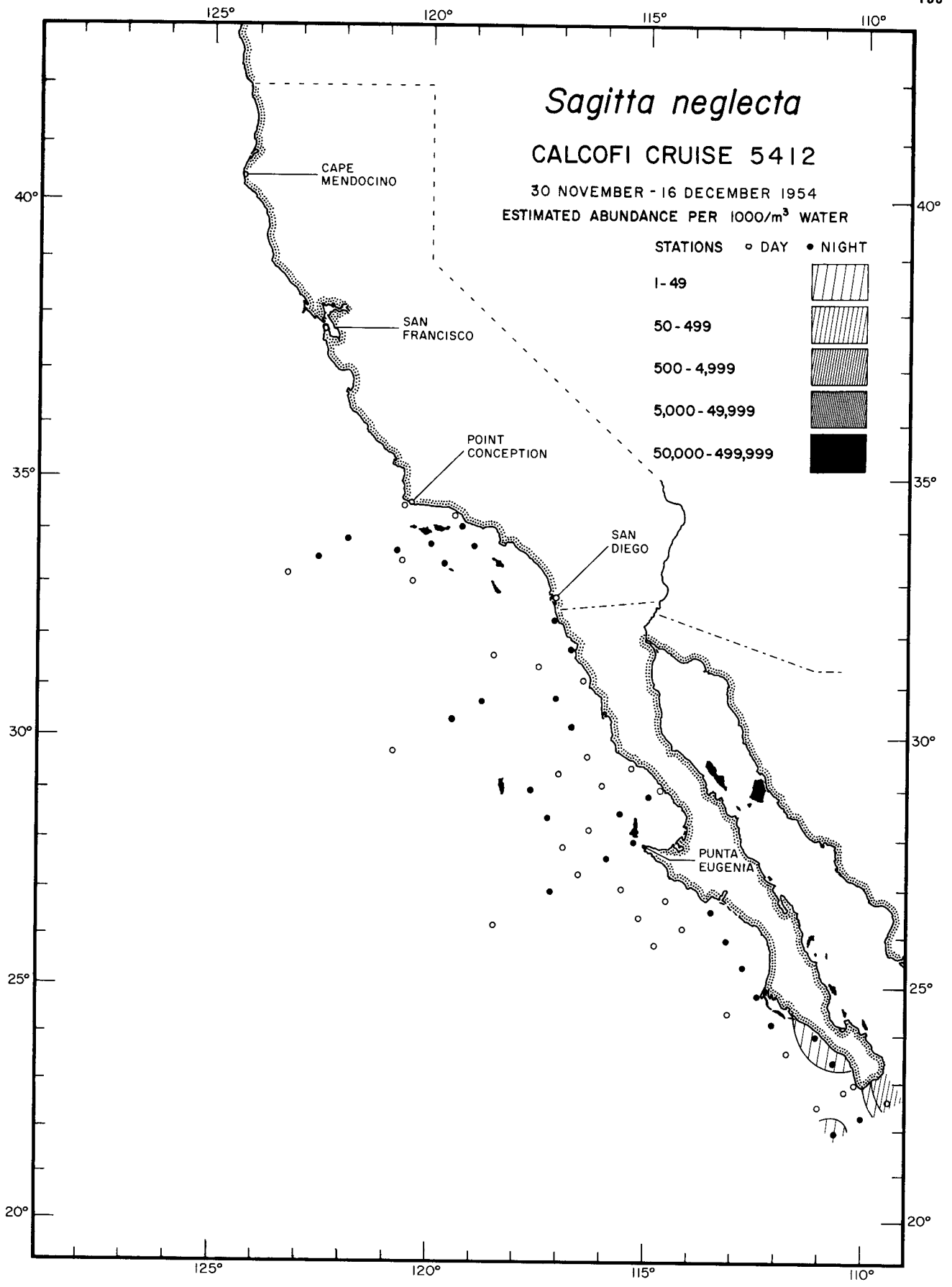




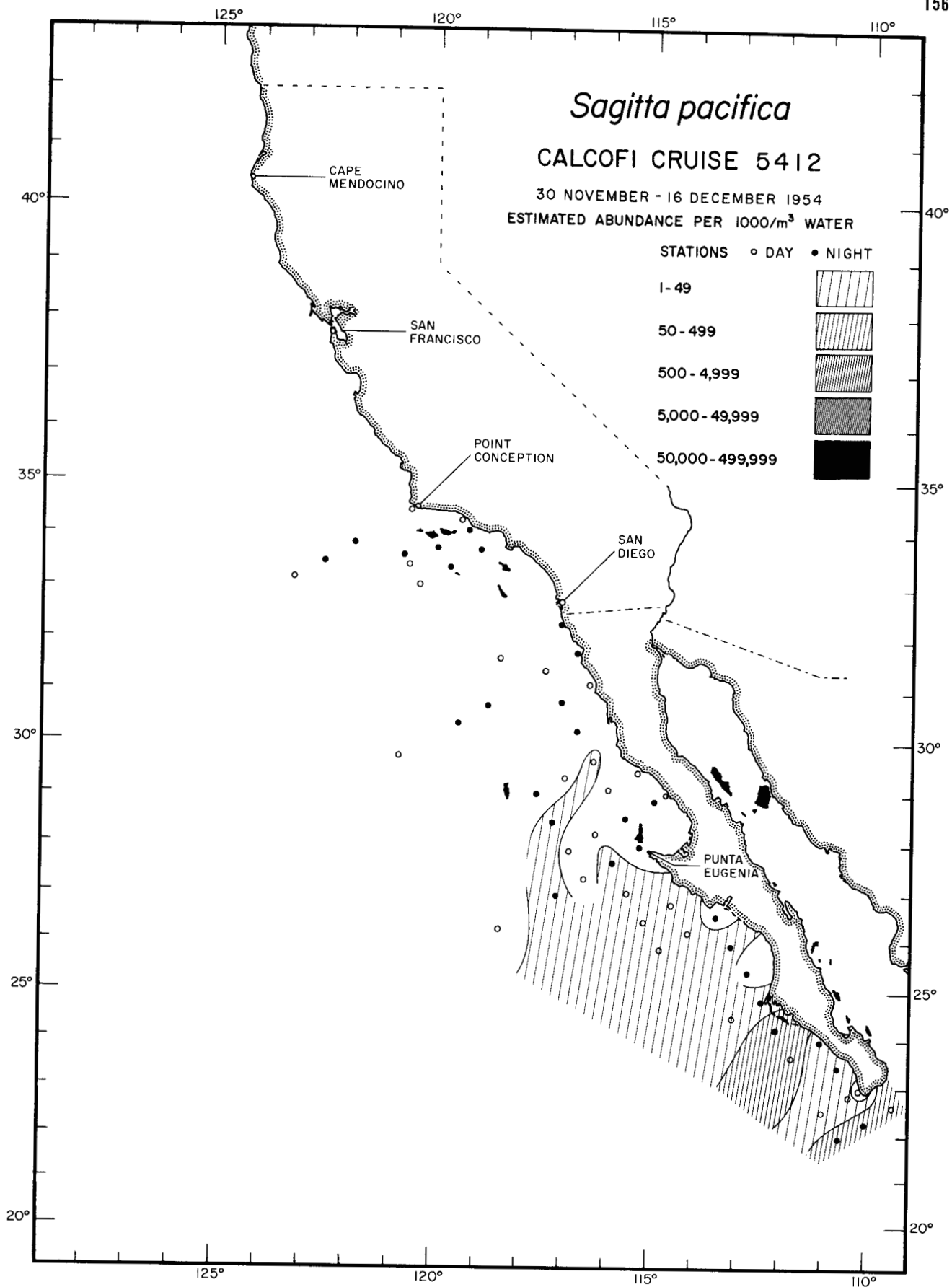
Chaetognatha  
*Sagitta hexaptera*  
5412



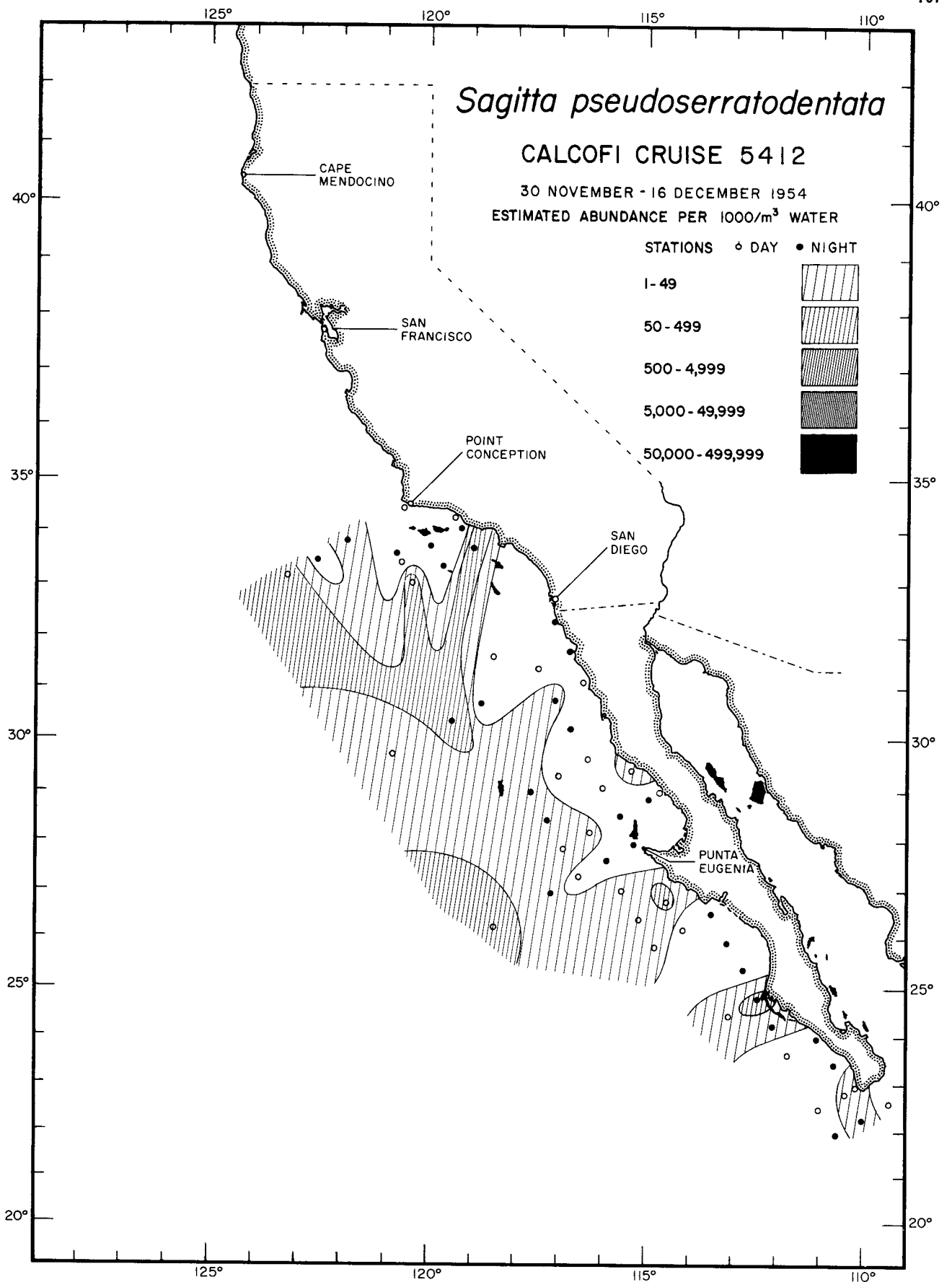
Chaetognatha  
*Sagitta minima*  
5412



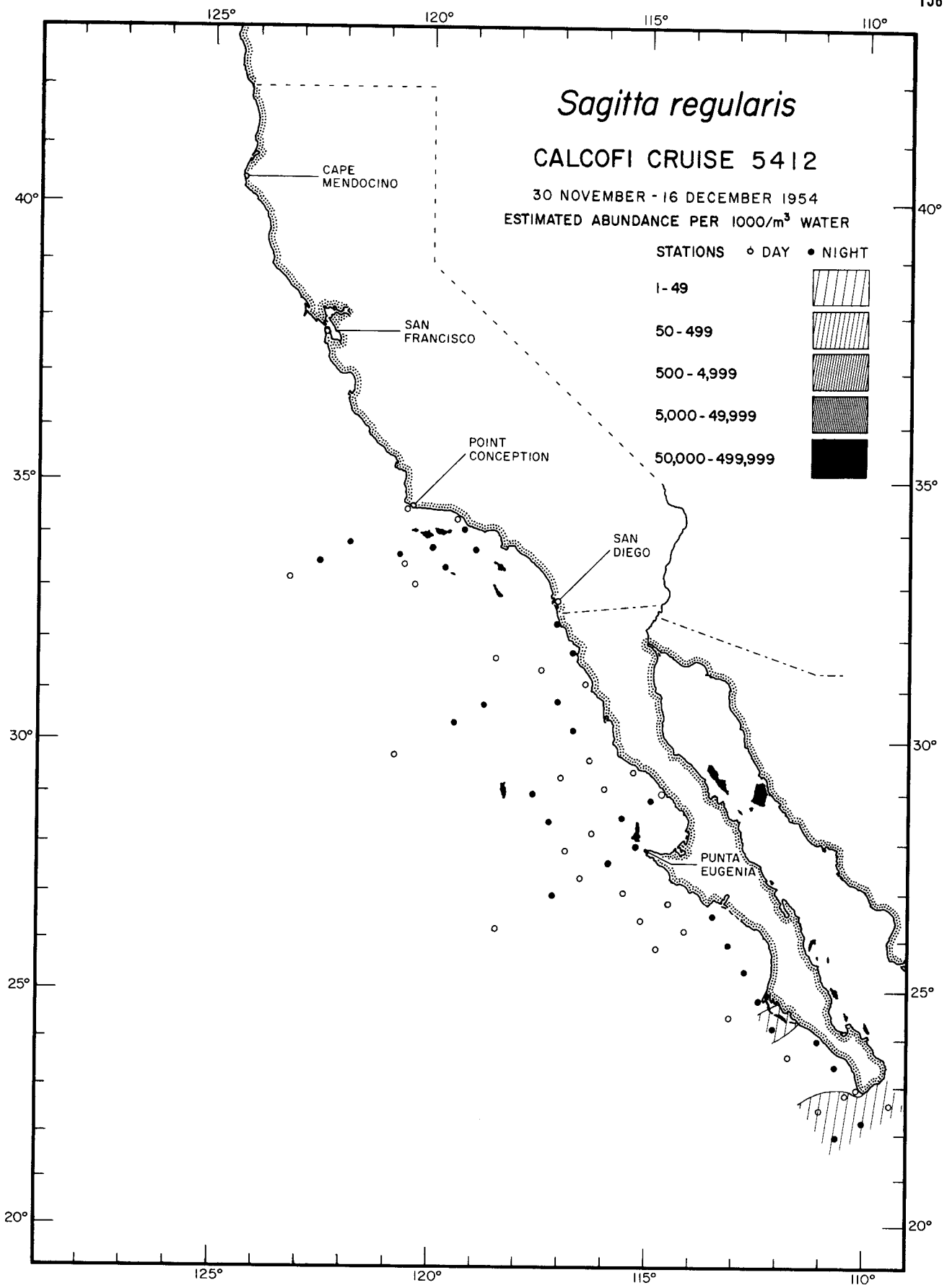
Chaetognatha  
*Sagitta neglecta*  
5412



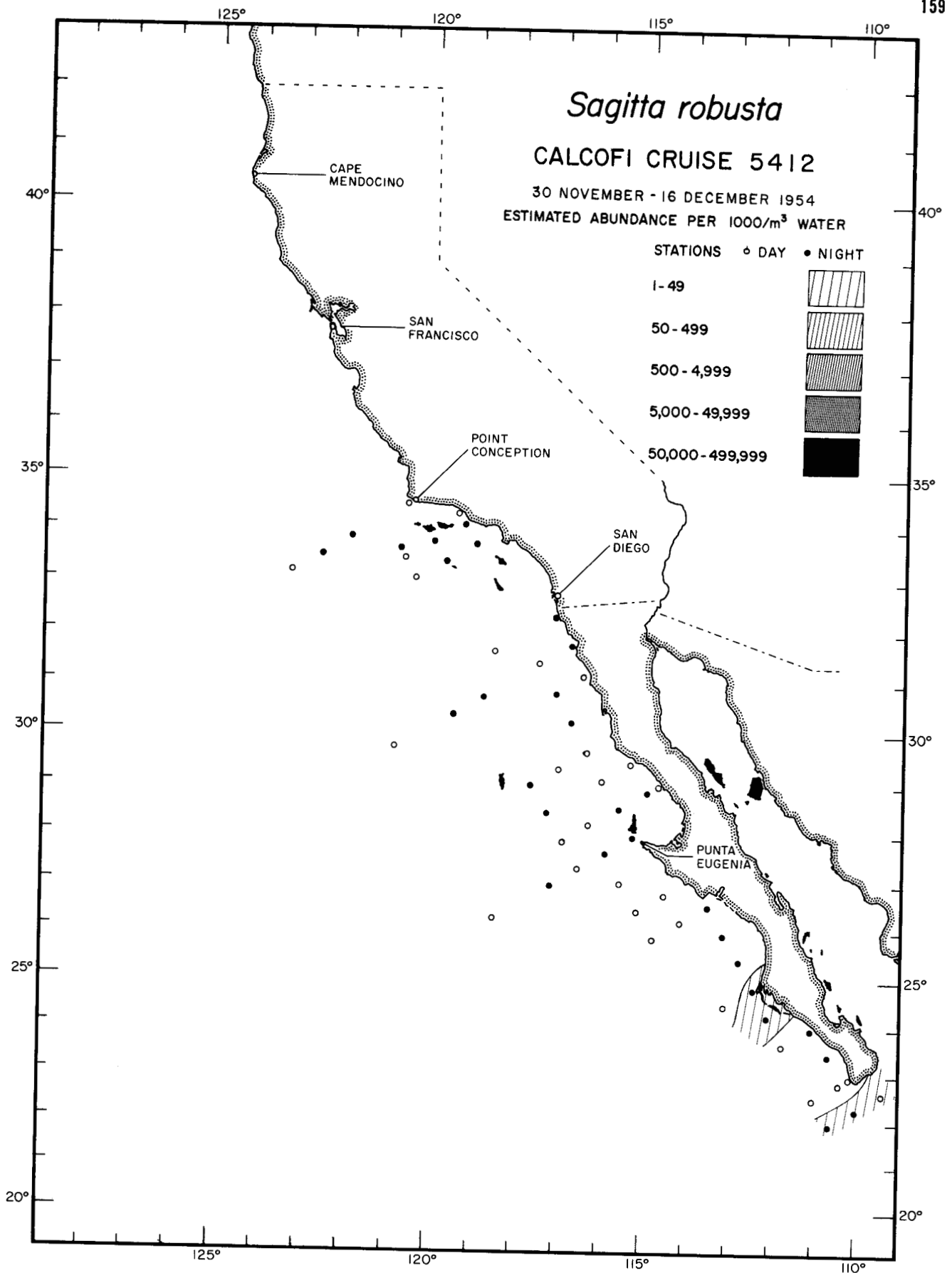
Chaetognatha  
*Sagitta pacifica*  
5412



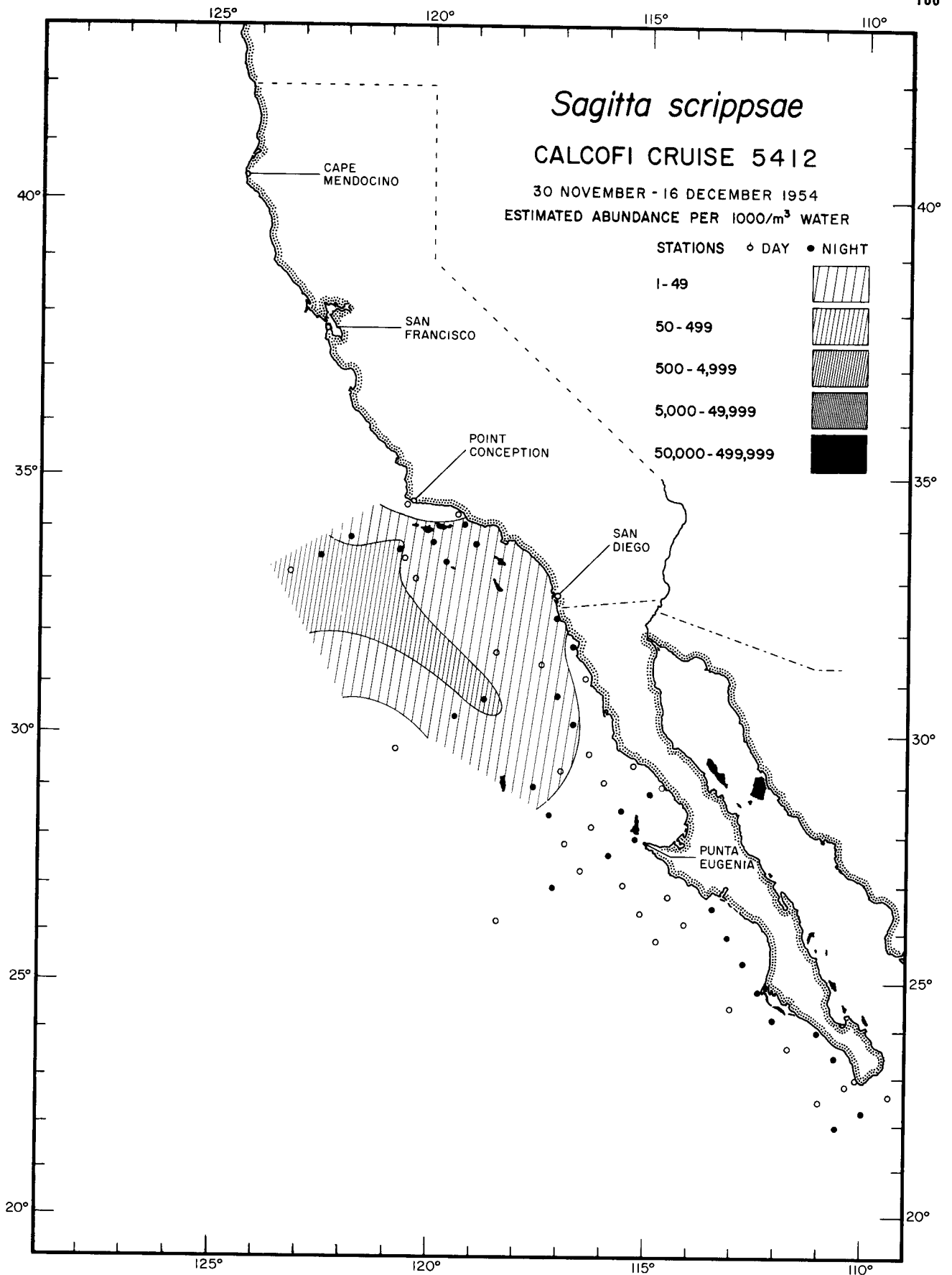
Chaetognatha  
*Sagitta pseudoserratodentata*  
5412



Chaetognatha  
*Sagitta regularis*  
5412

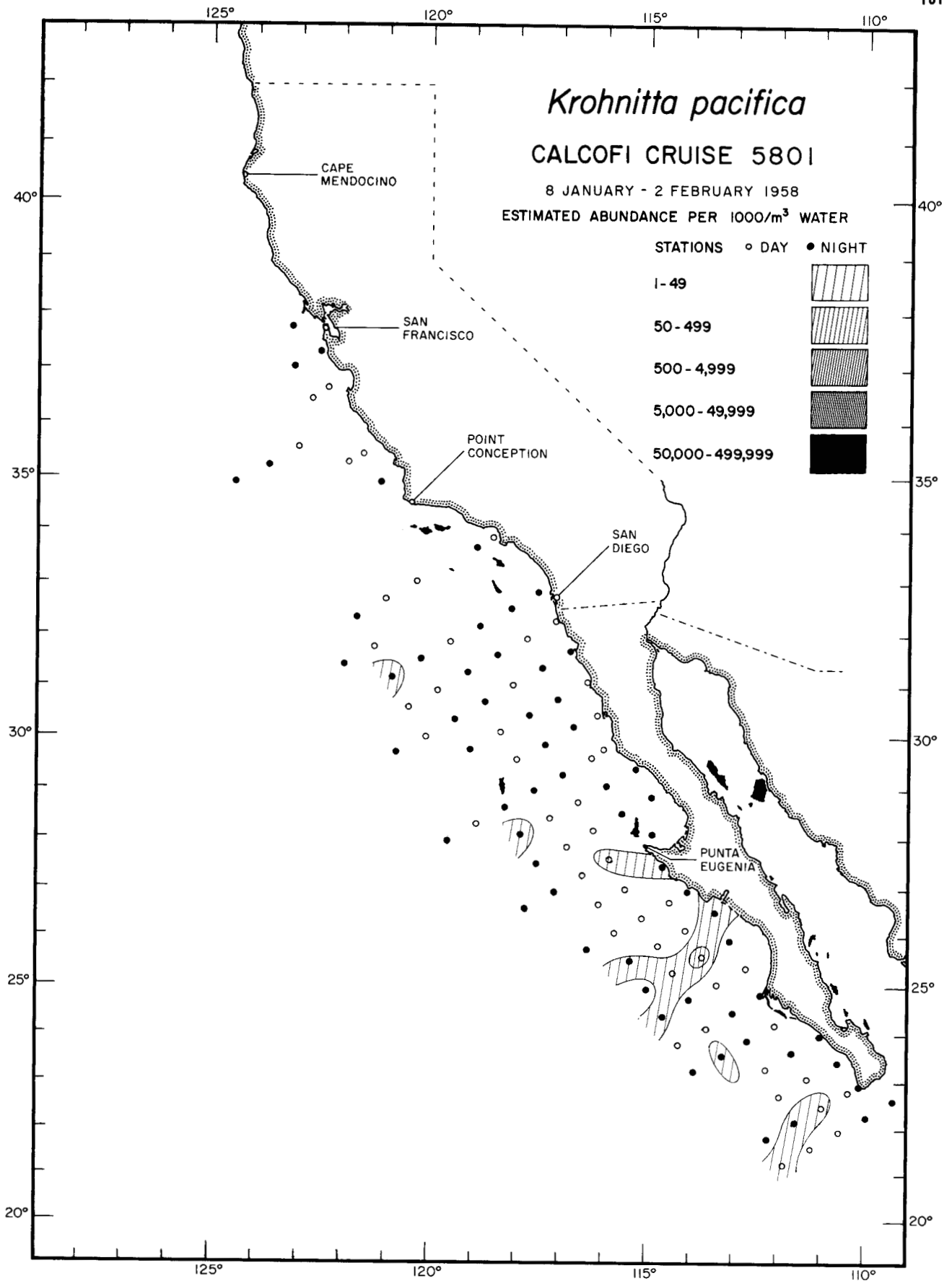


Chaetognatha  
*Sagitta robusta*  
 5412

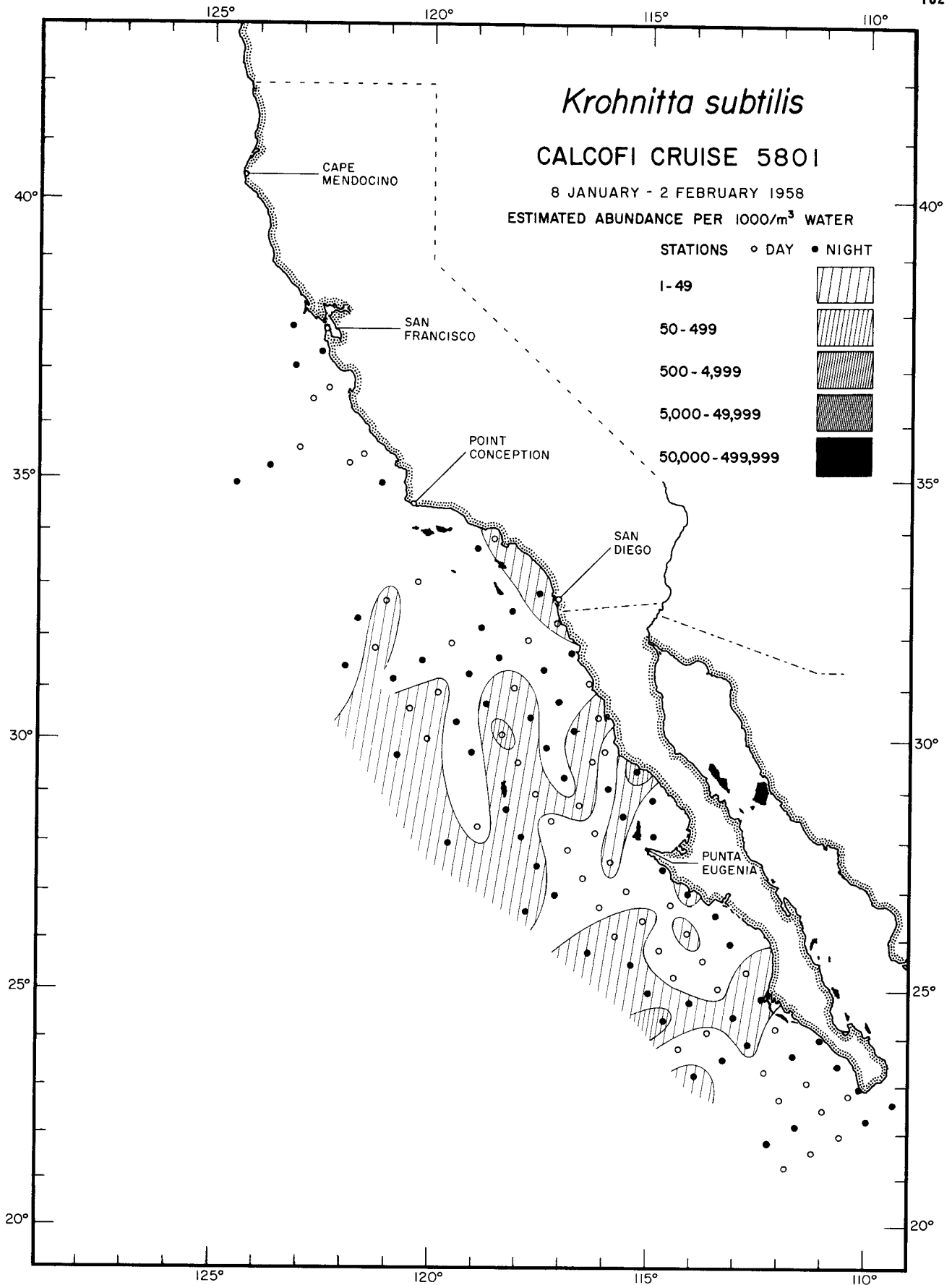


Chaetognatha  
*Sagitta scrippsae*  
5412

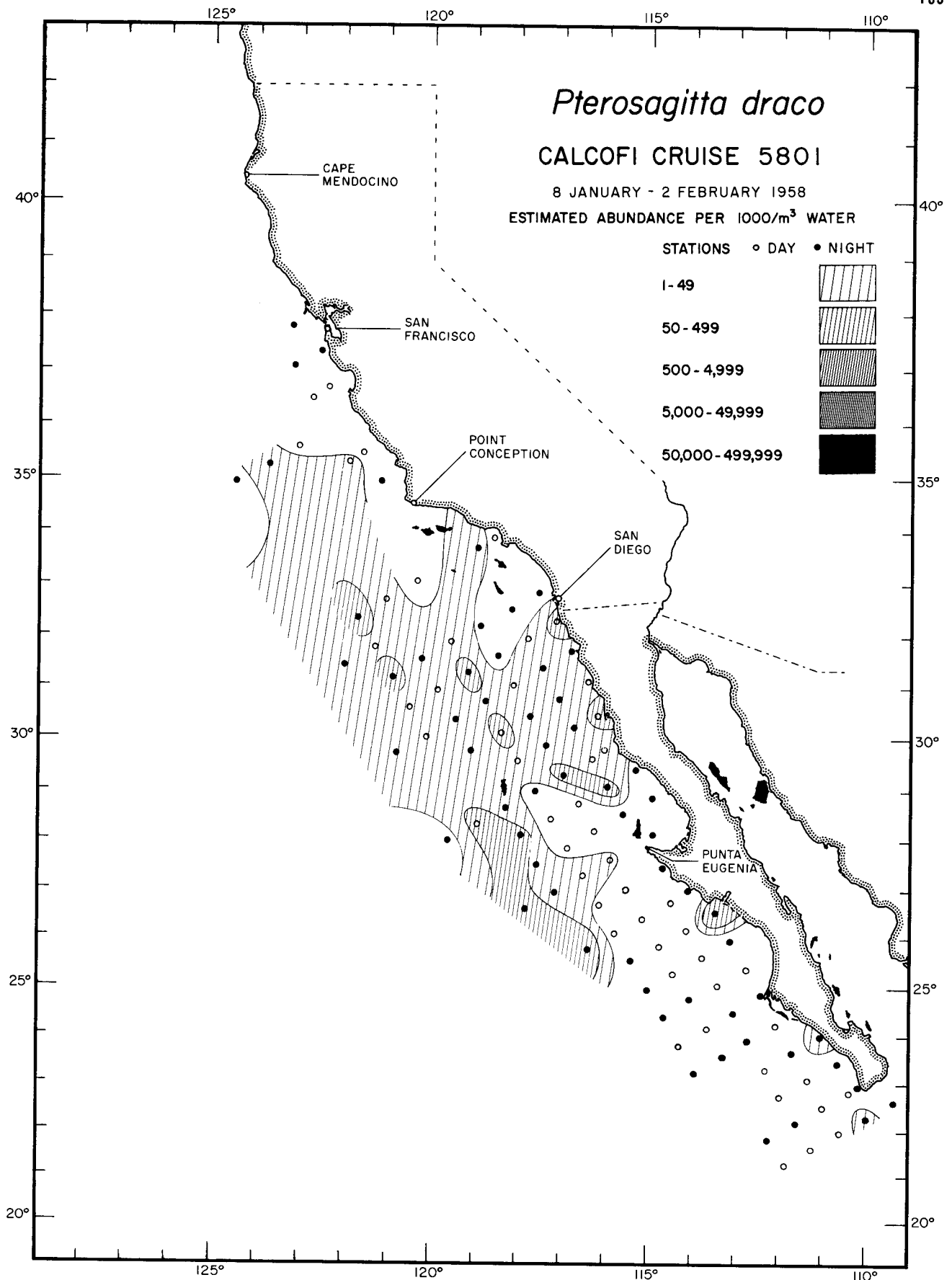


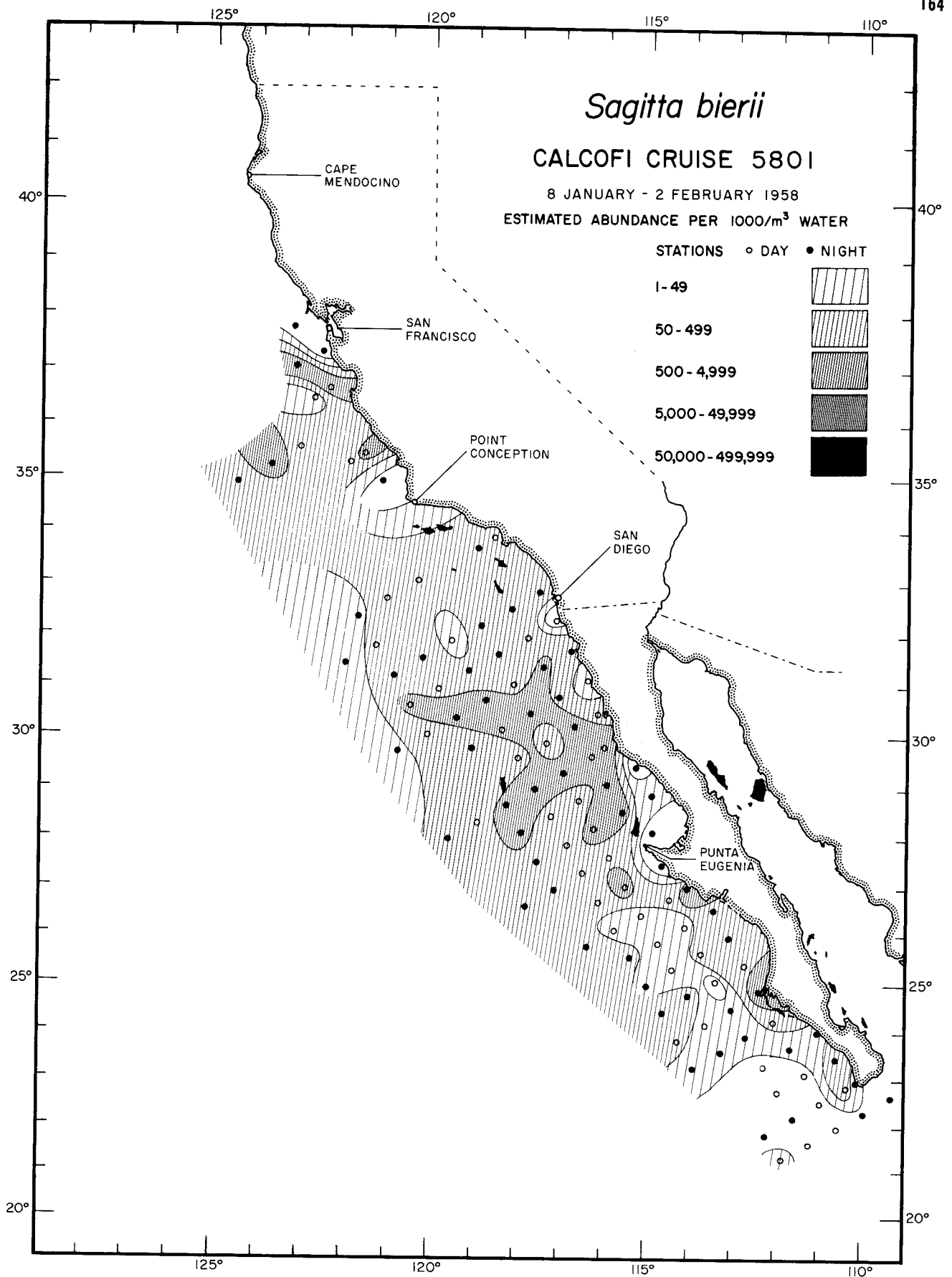


Chaetognatha  
*Krohnitta pacifica*  
5801

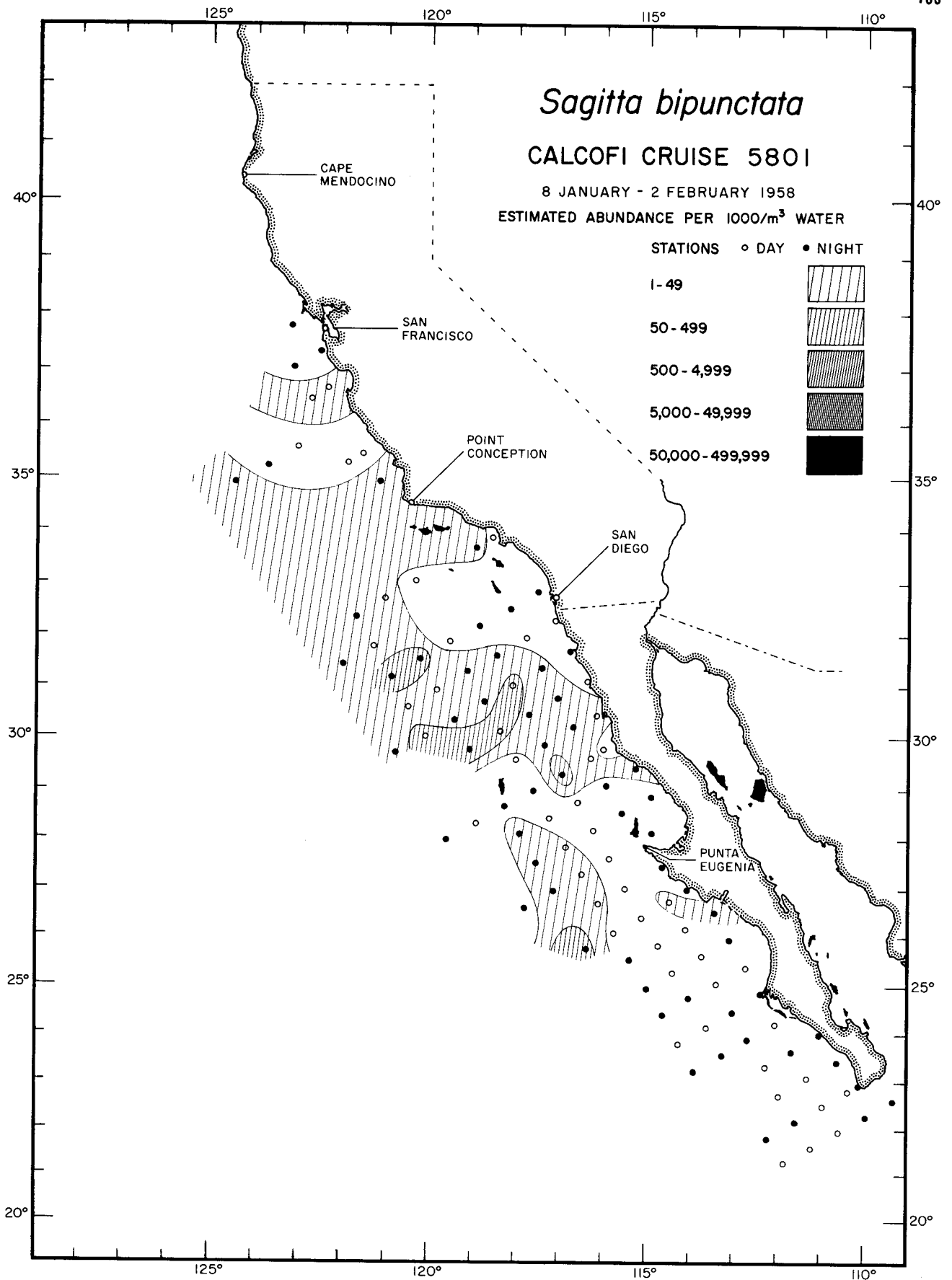


Chaetognatha  
*Krohnitta subtilis*  
5801

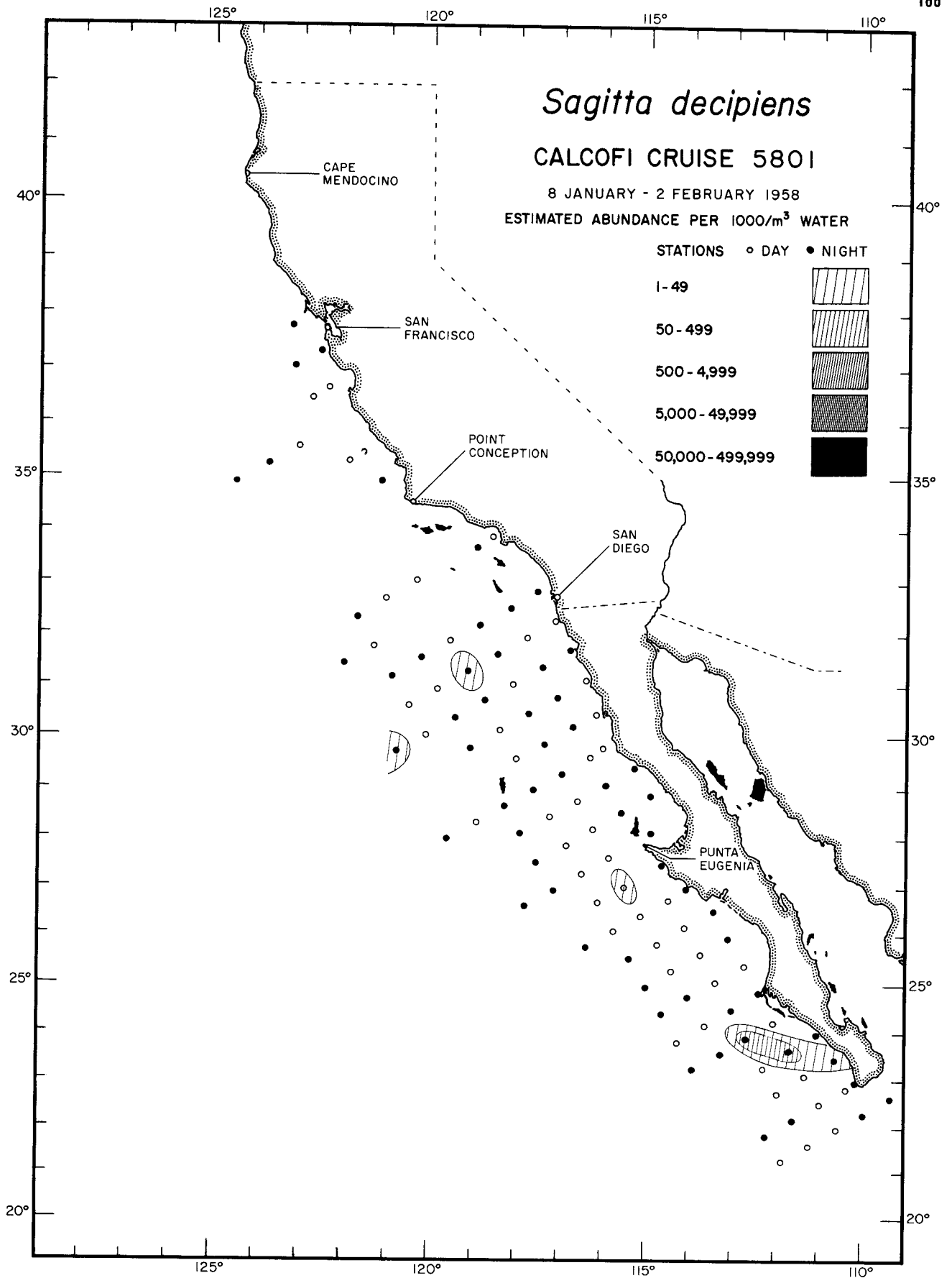




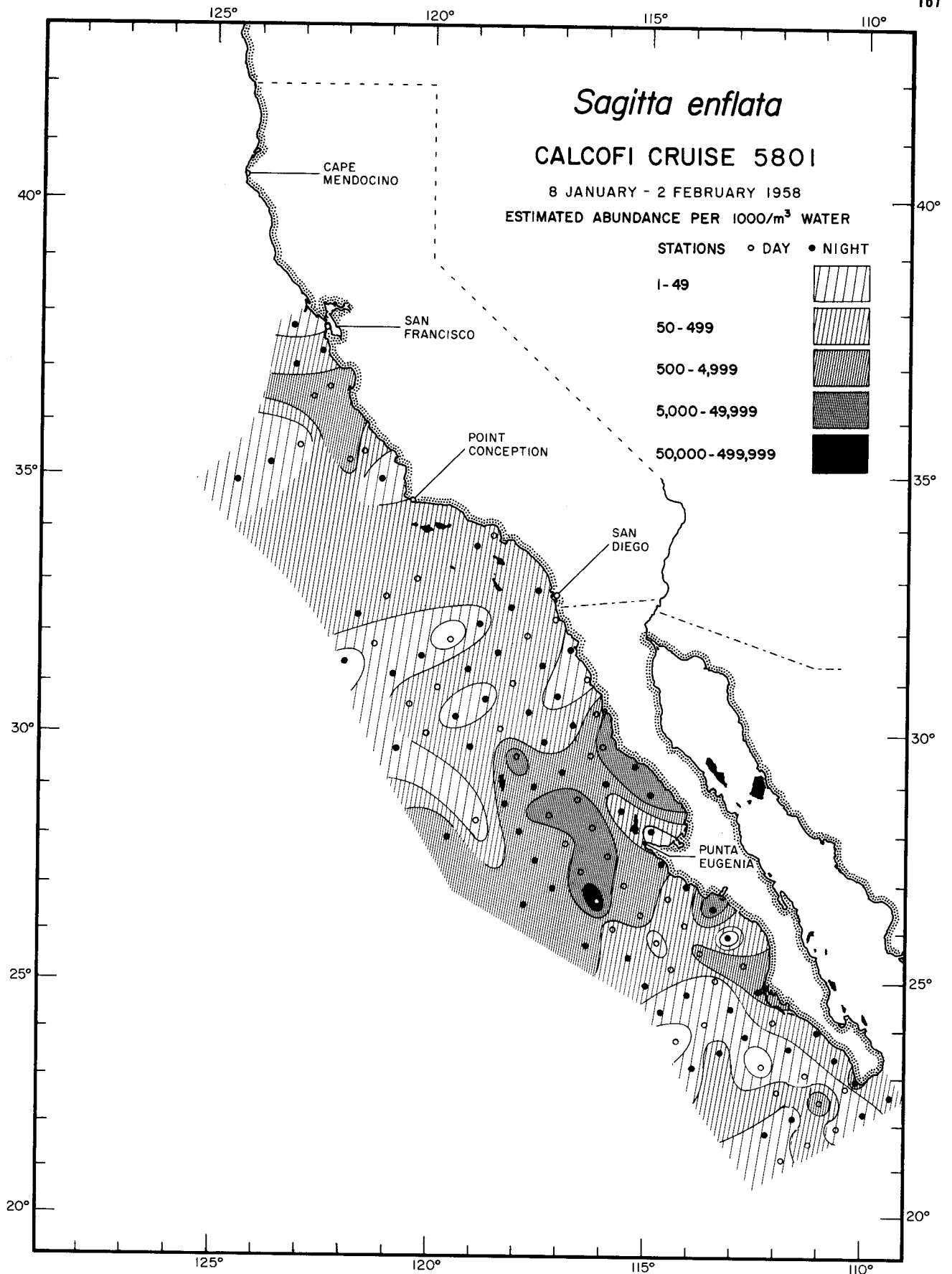
Chaetognatha  
*Sagitta bierii*  
5801



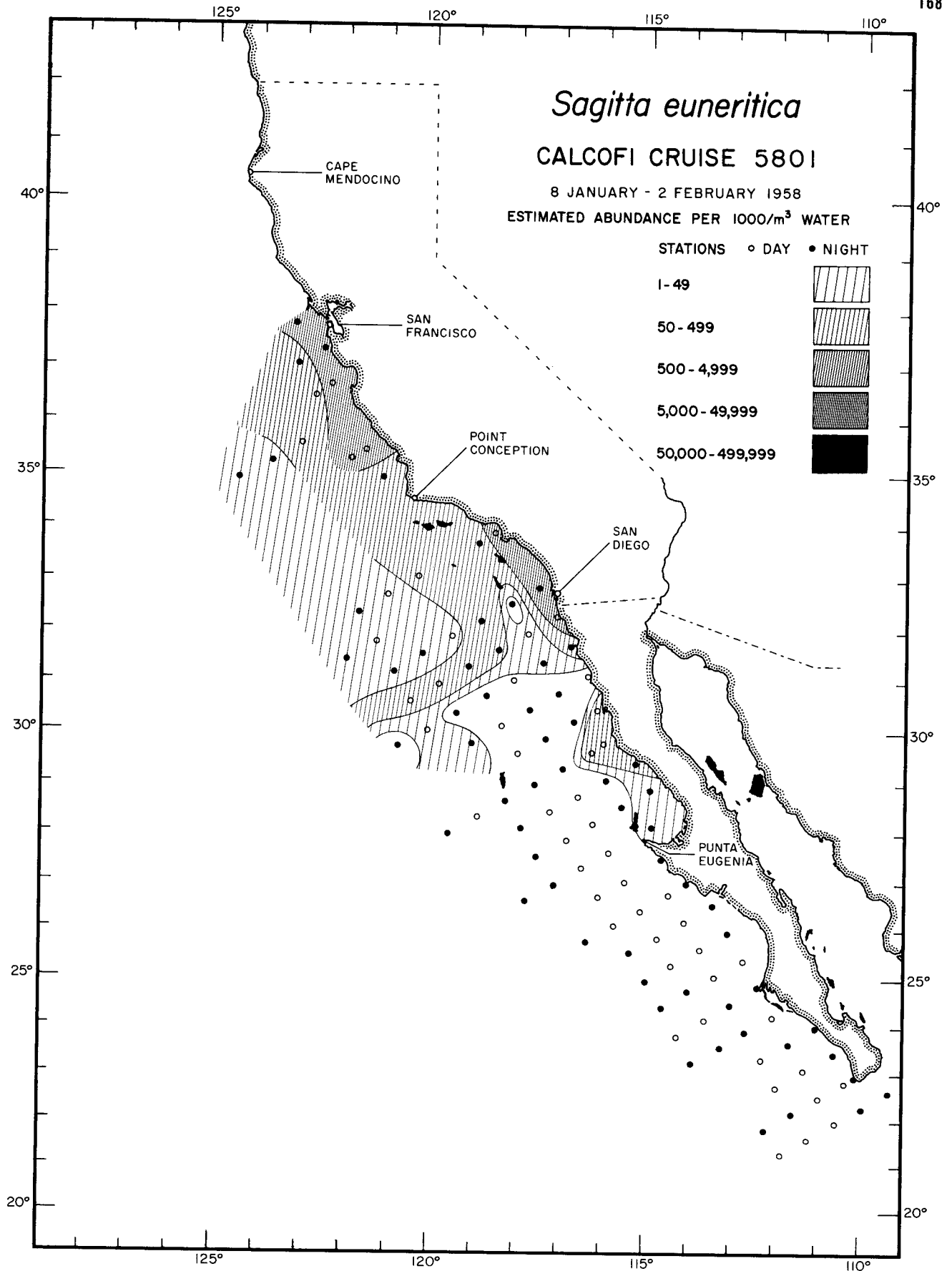
Chaetognatha  
*Sagitta bipunctata*  
 5801



Chaetognatha  
*Sagitta decipiens*  
5801



Chaetognatha  
*Sagitta enflata*  
5801



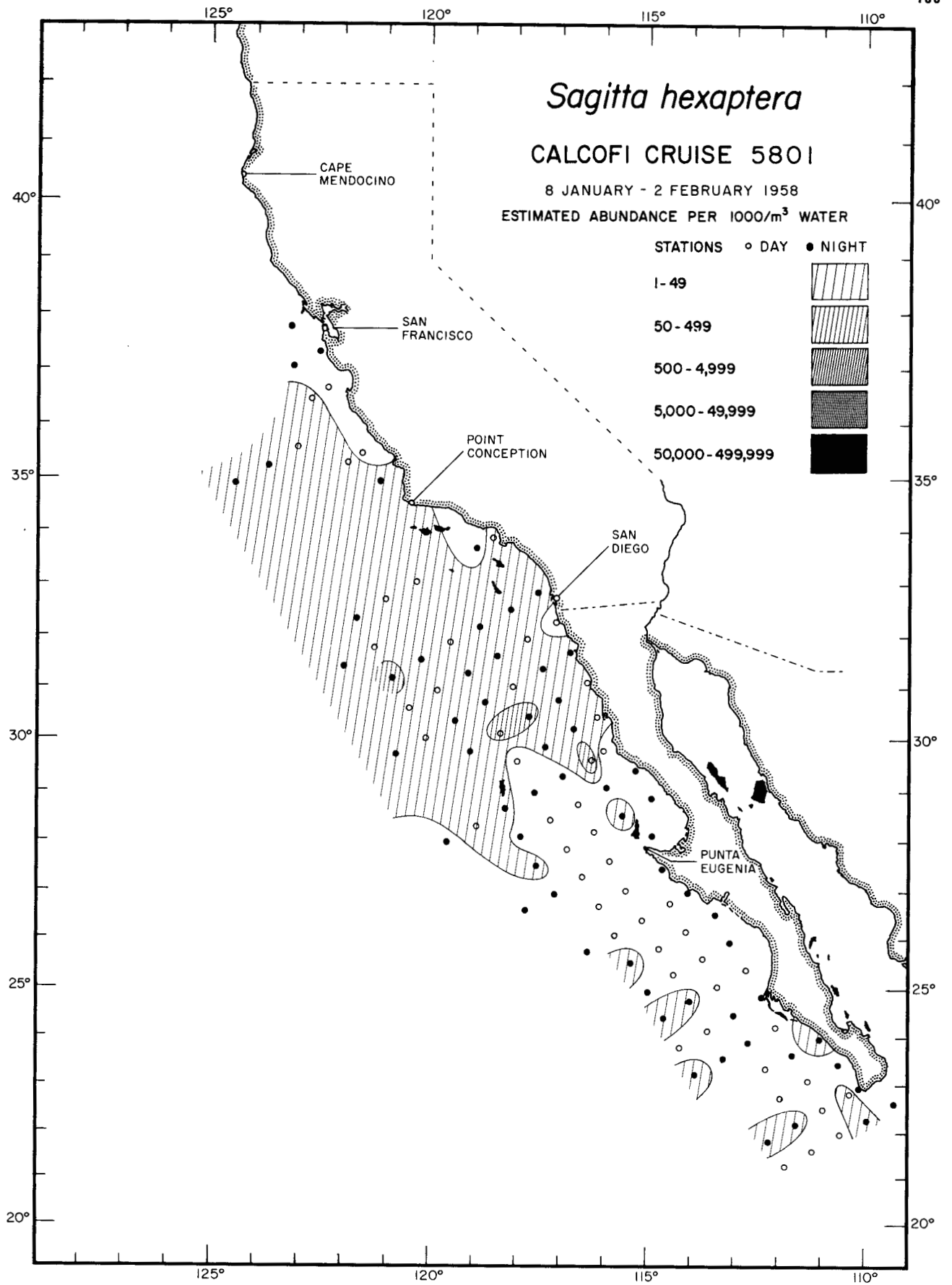
*Sagitta euneritica*  
CALCOFI CRUISE 5801

8 JANUARY - 2 FEBRUARY 1958  
ESTIMATED ABUNDANCE PER 1000/m<sup>3</sup> WATER

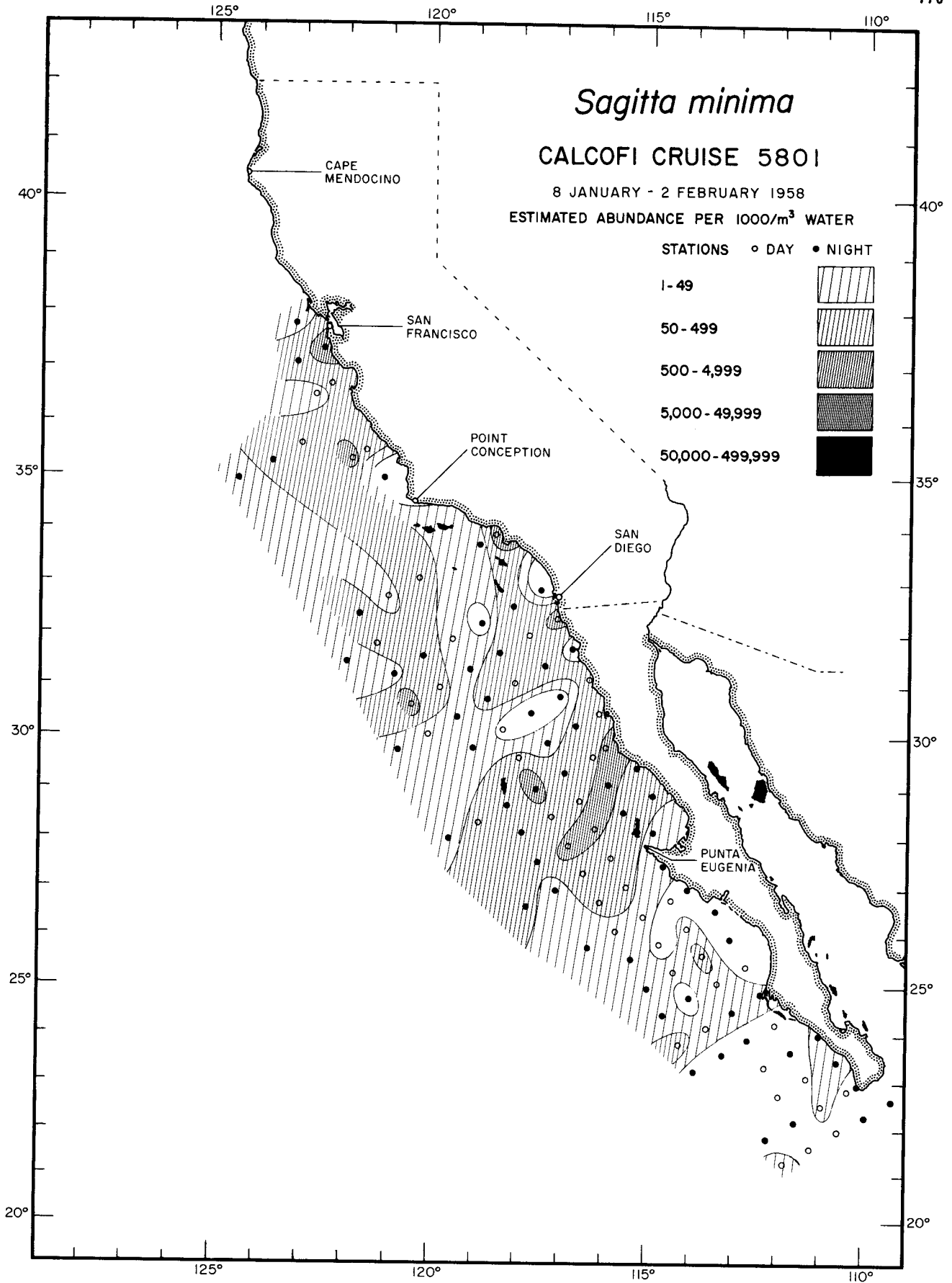
STATIONS    ◯ DAY    ● NIGHT

1-49	[Diagonal lines]
50-499	[Cross-hatch]
500-4,999	[Dense cross-hatch]
5,000-49,999	[Solid grey]
50,000-499,999	[Solid black]

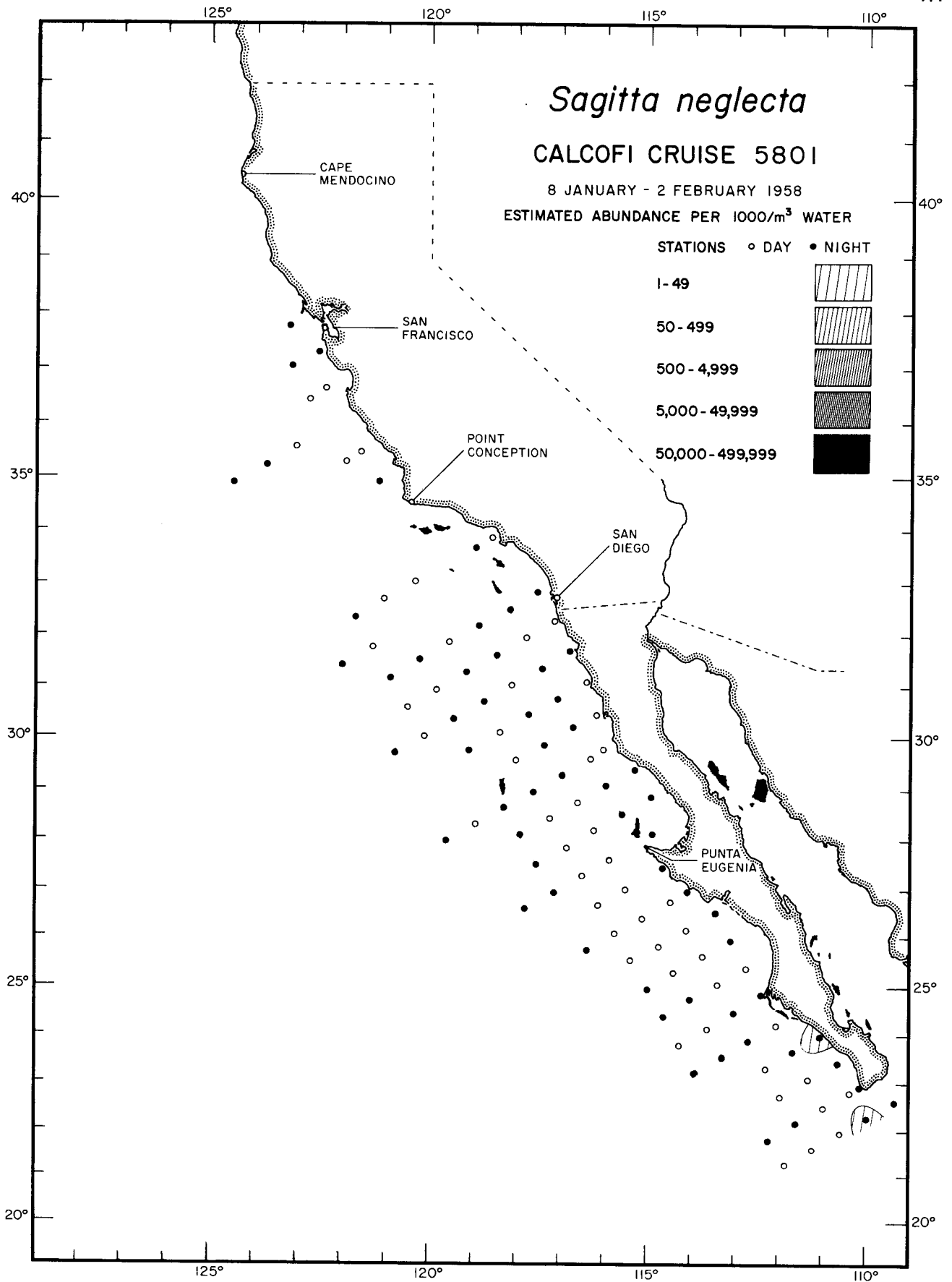




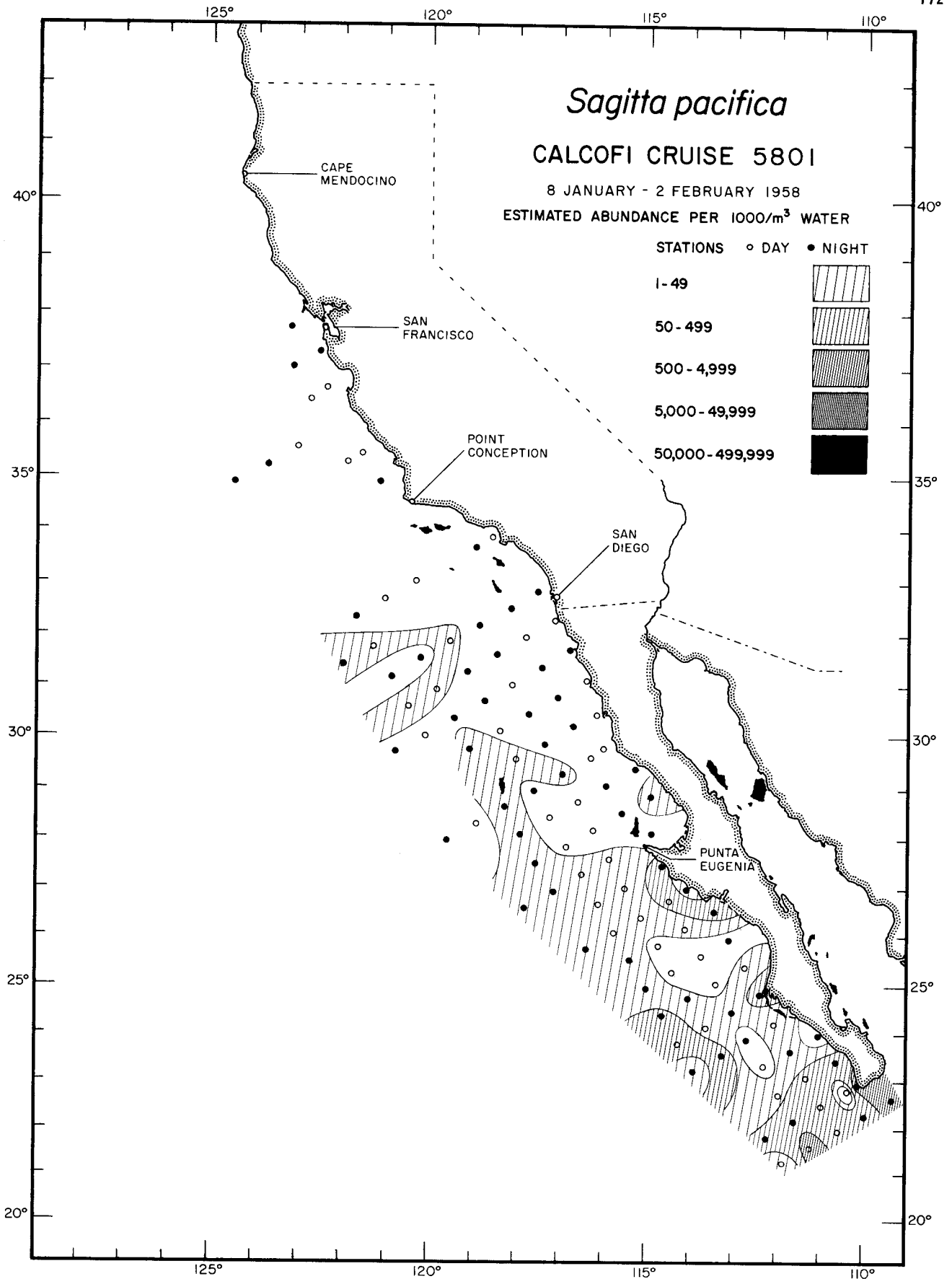
Chaetognatha  
*Sagitta hexaptera*  
5801

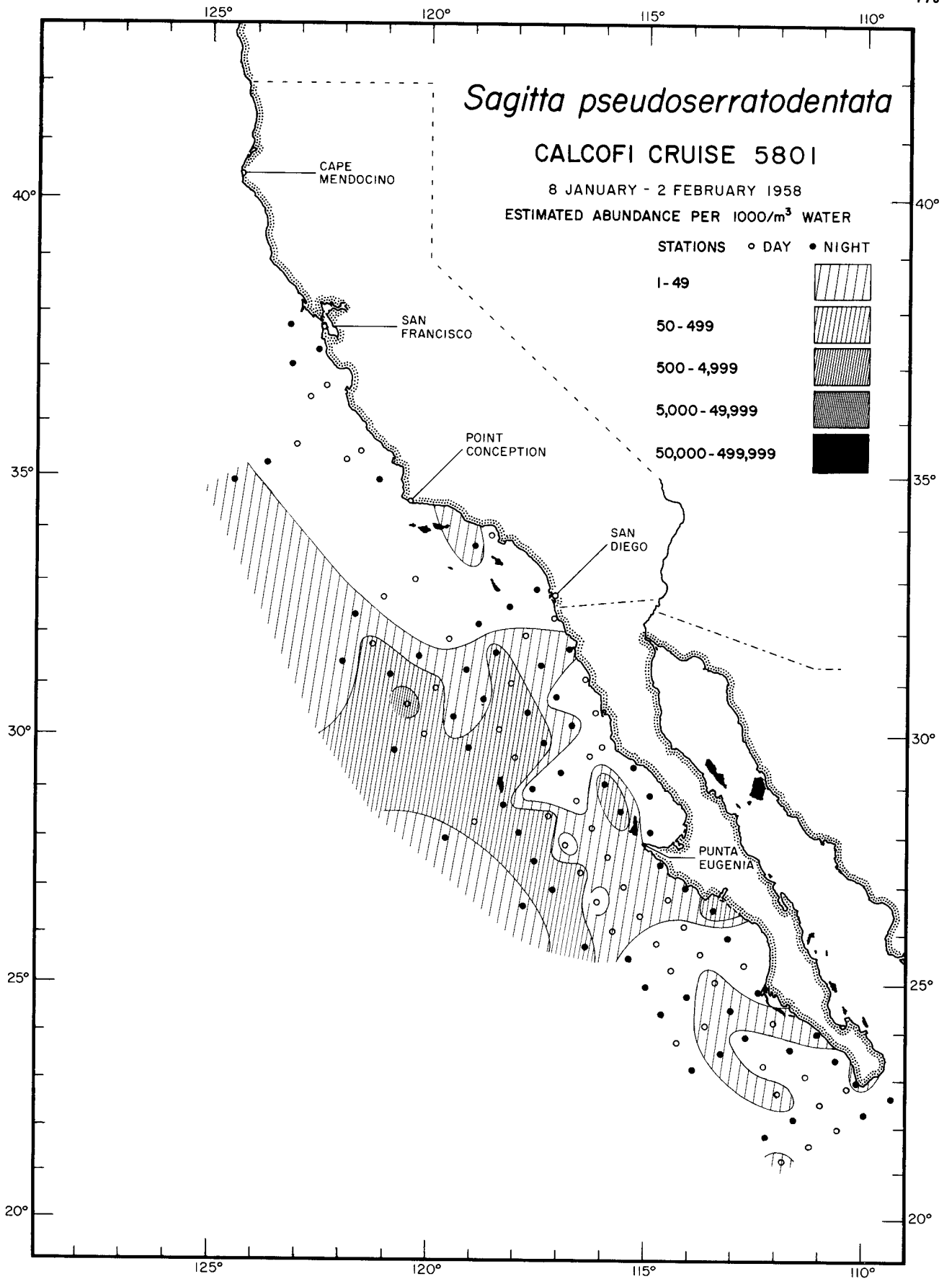


Chaetognatha  
*Sagitta minima*  
5801

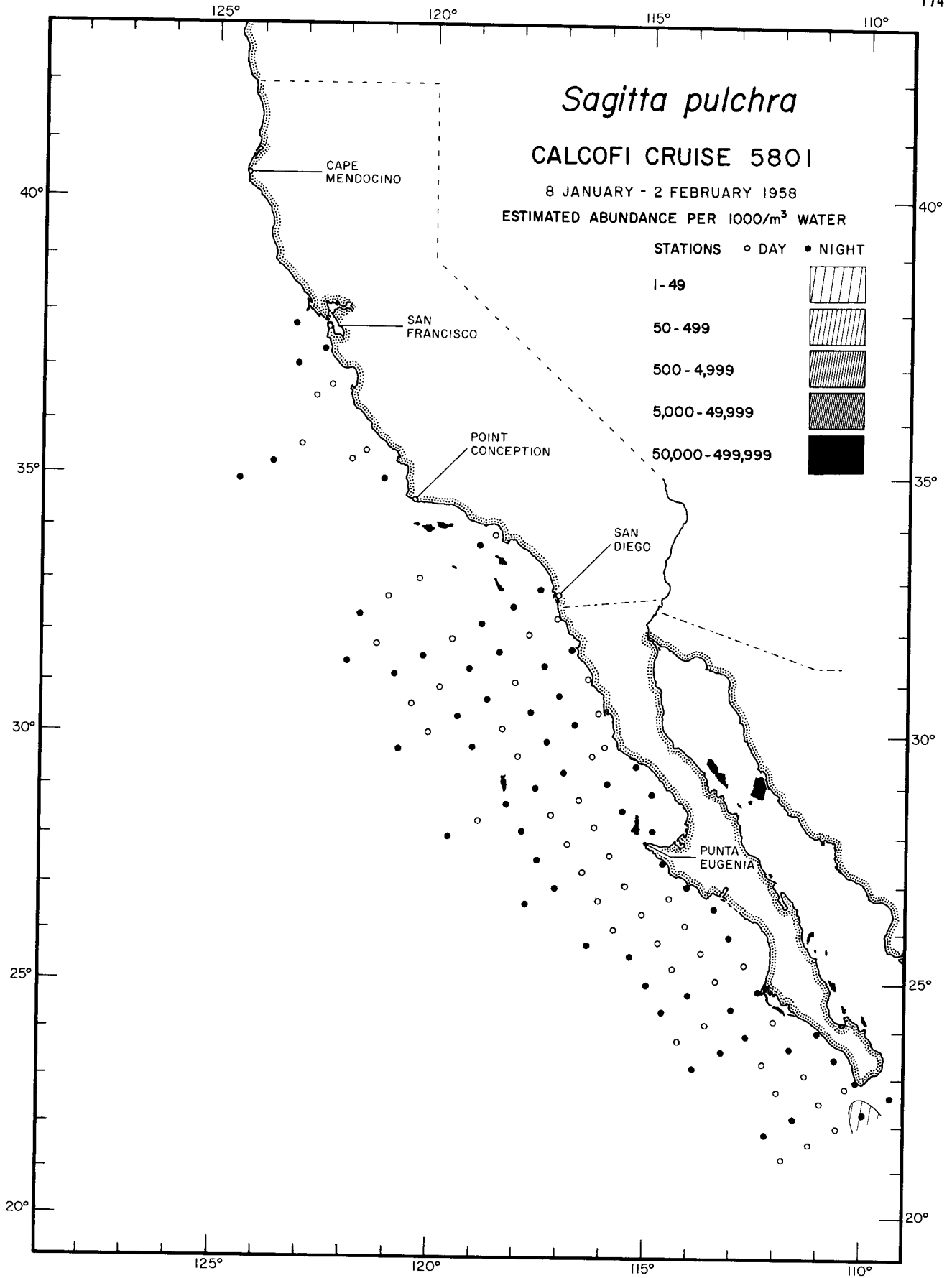


Chaetognatha  
*Sagitta neglecta*  
5801

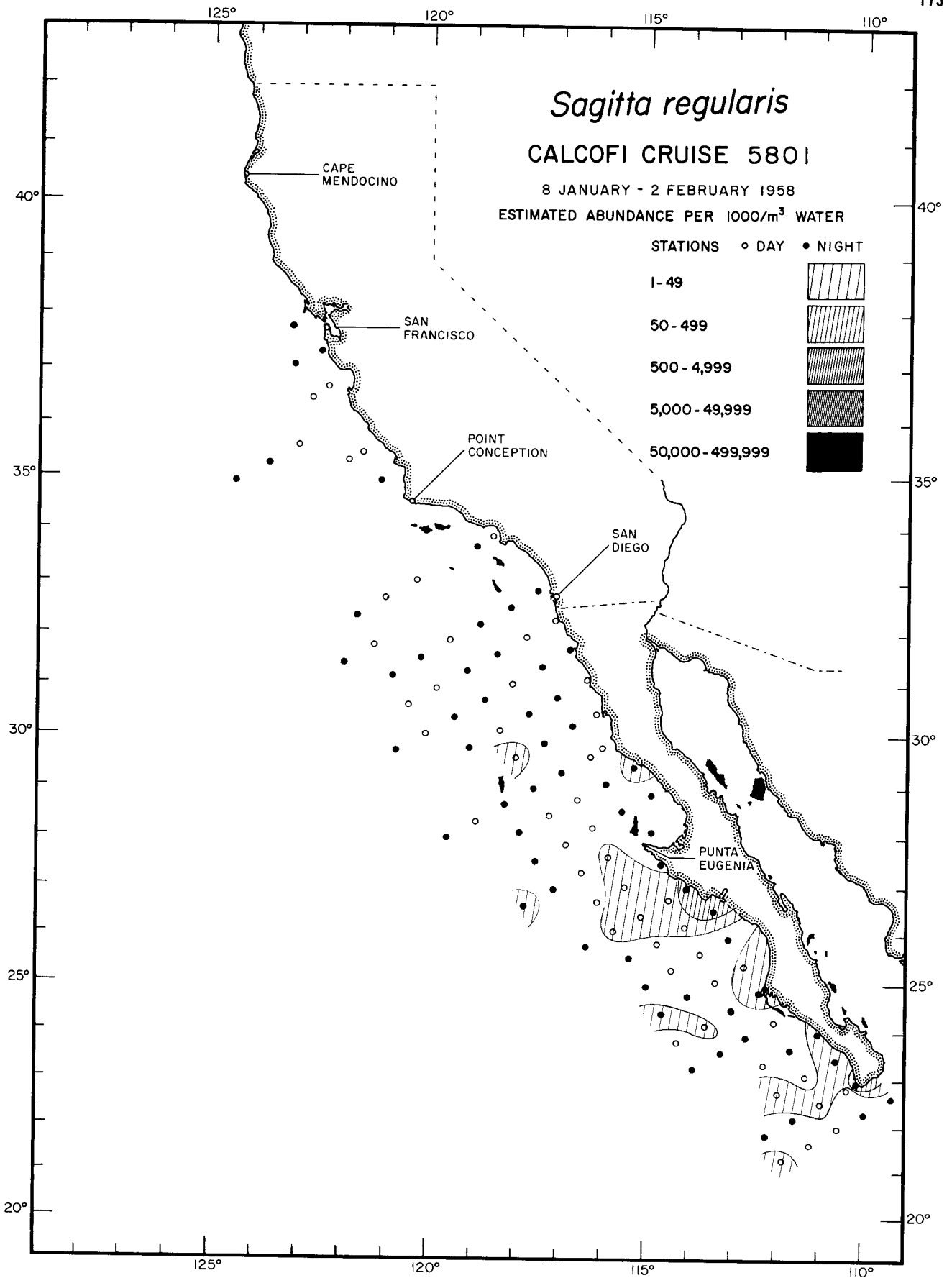




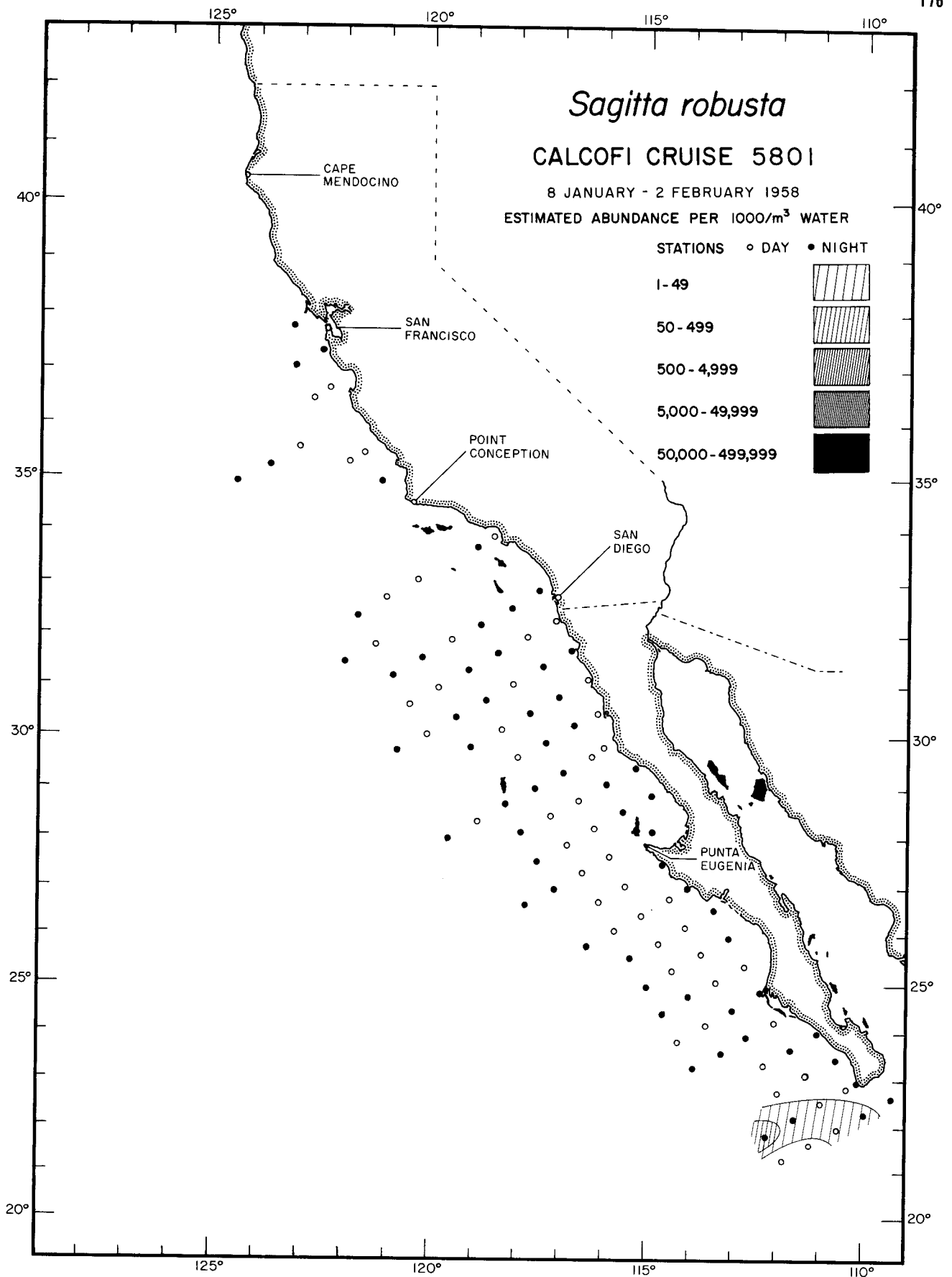
Chaetognatha  
*Sagitta pseudoserratodentata*  
5801



Chaetognatha  
*Sagitta pulchra*  
5801

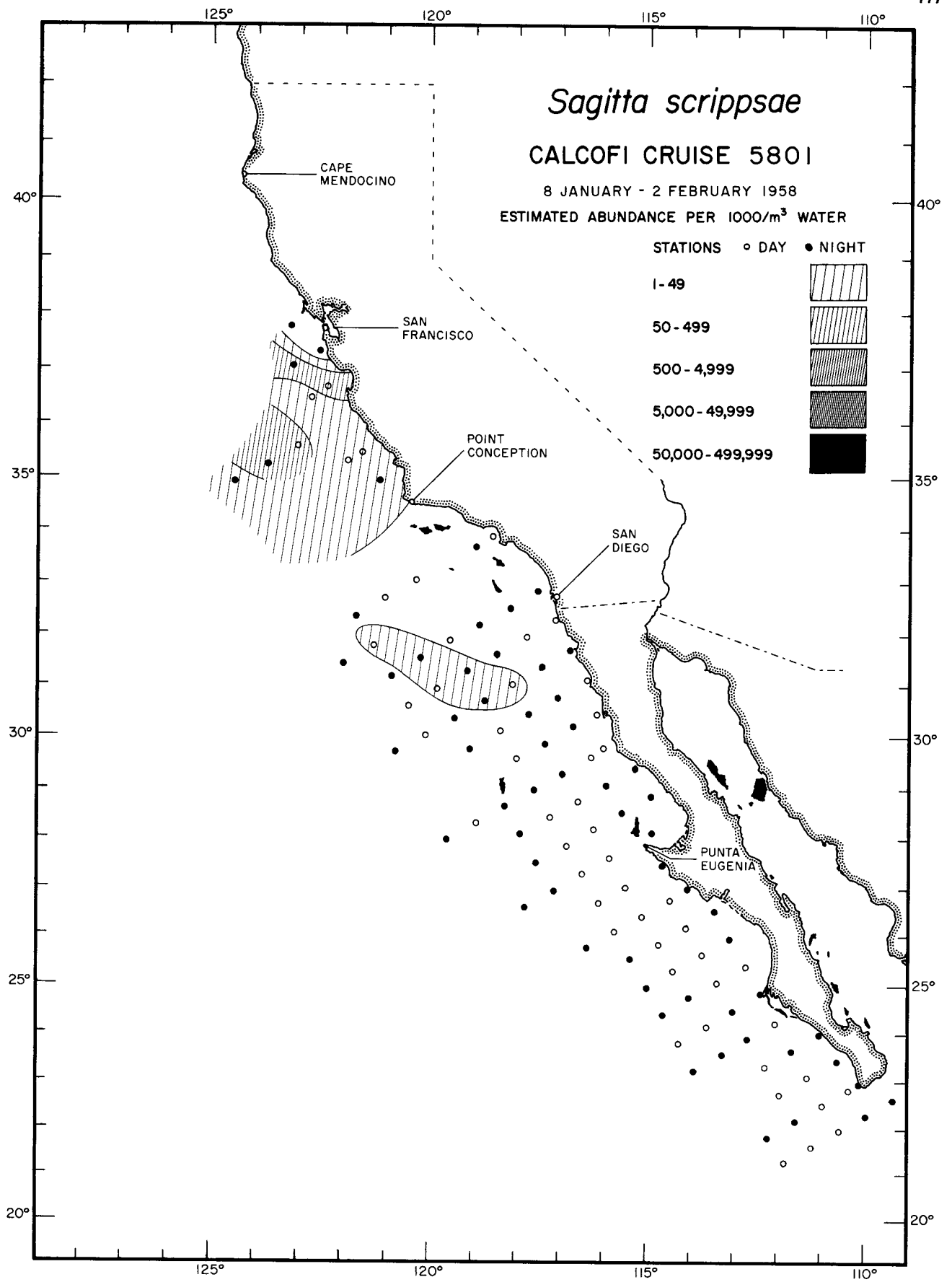


Chaetognatha  
*Sagitta regularis*  
5801

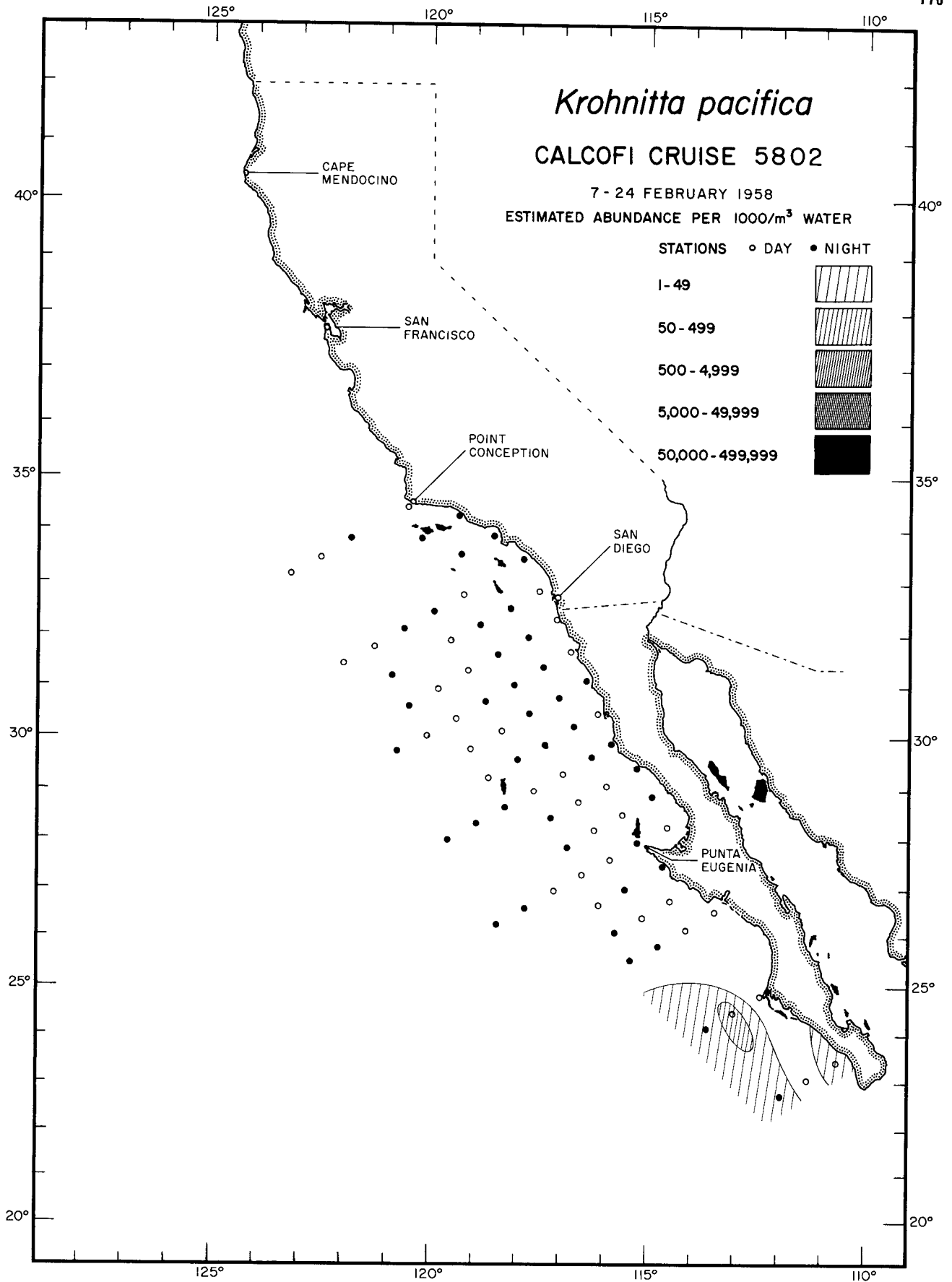


Chaetognatha  
*Sagitta robusta*  
5801

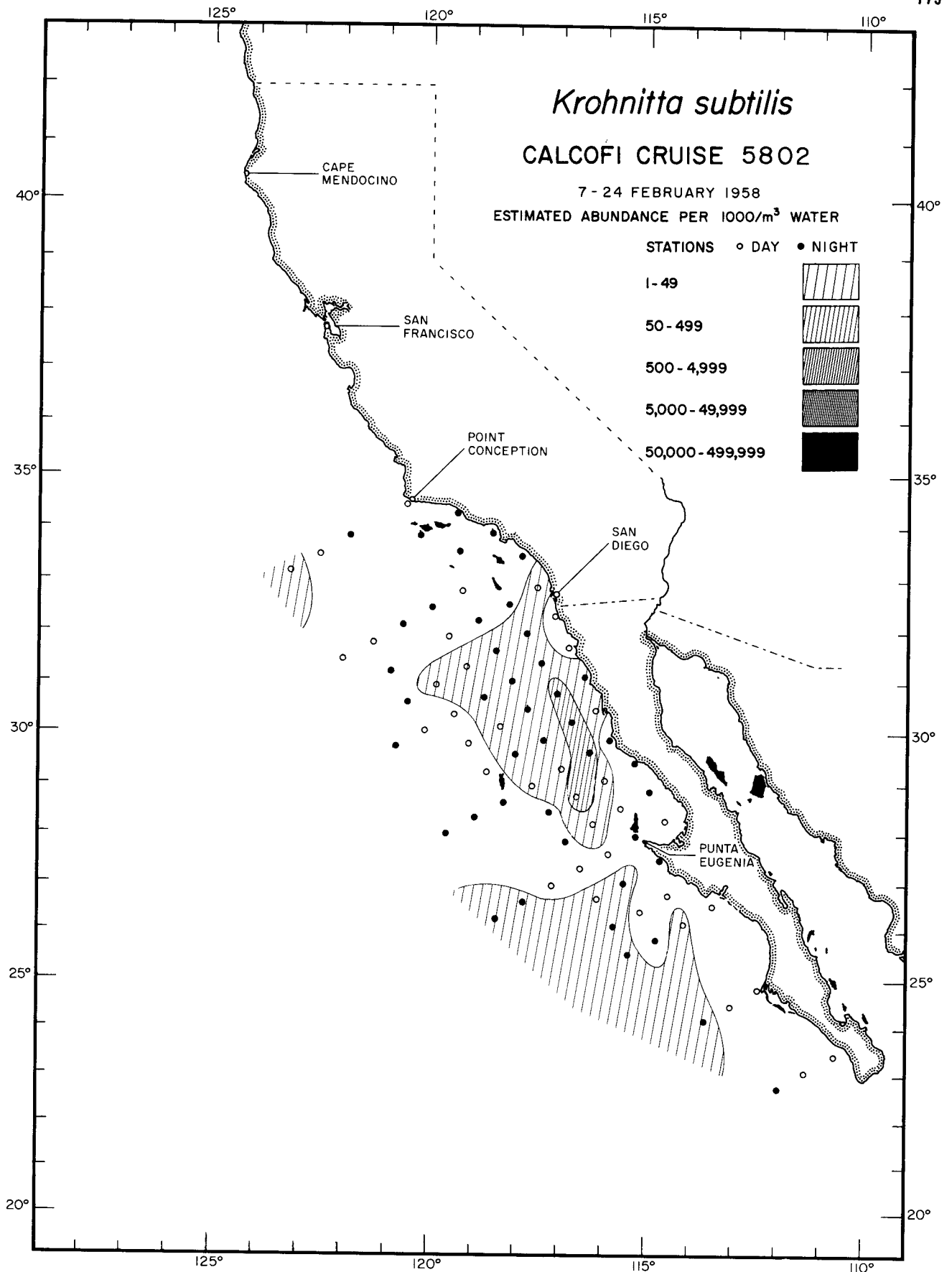




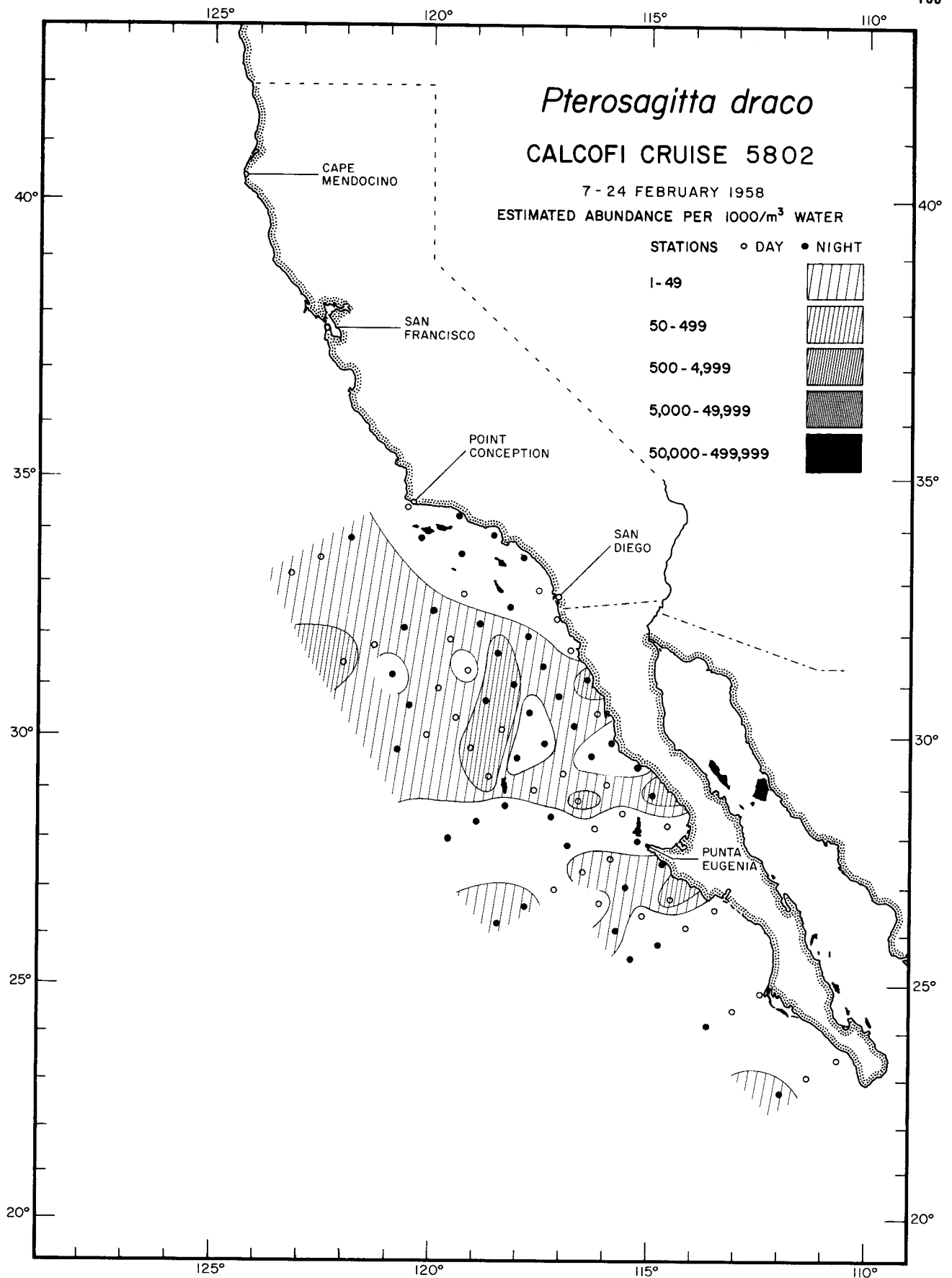
Chaetognatha  
*Sagitta scrippsae*  
5801



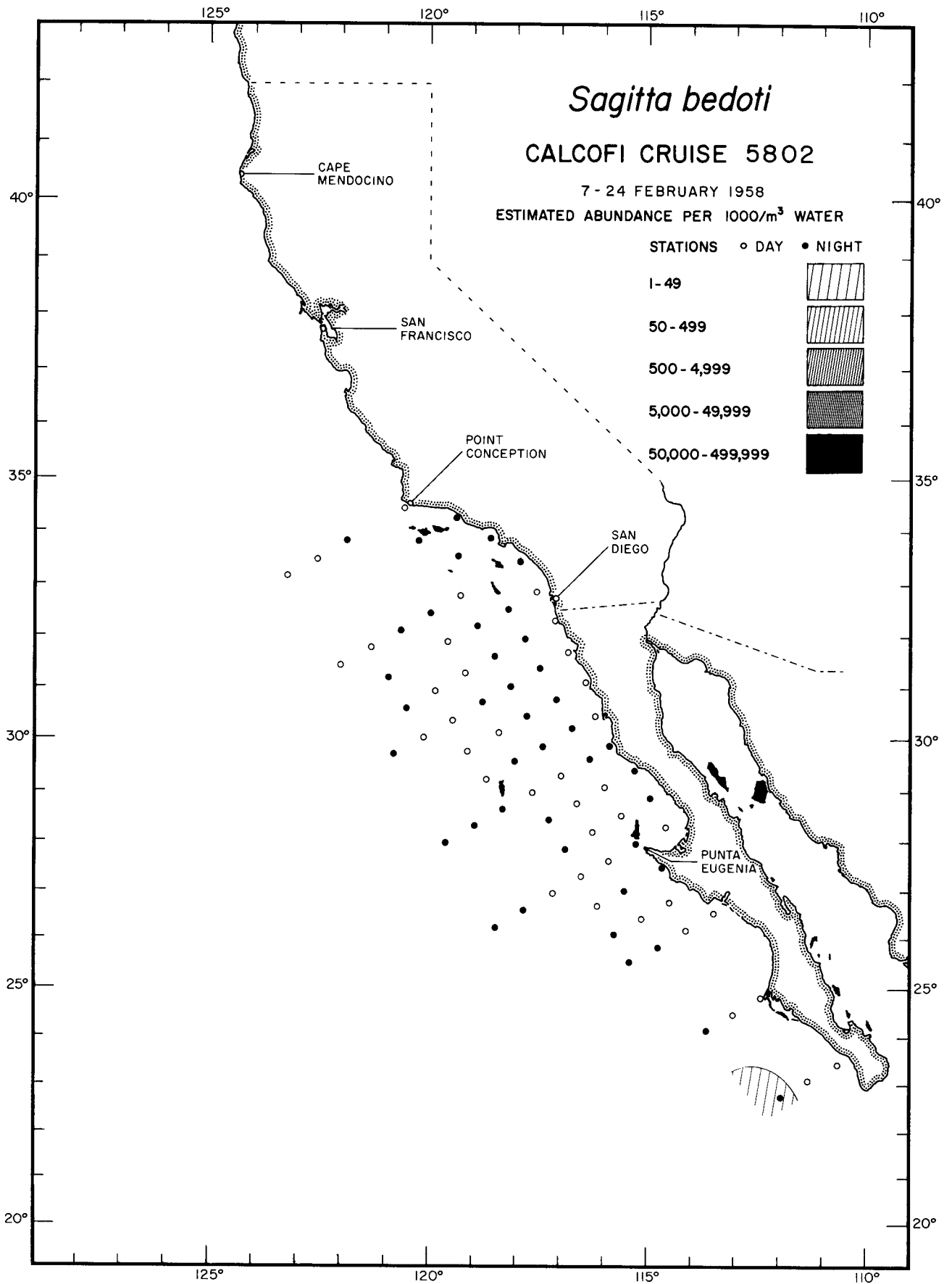
Chaetognatha  
*Krohnitta pacifica*  
5802



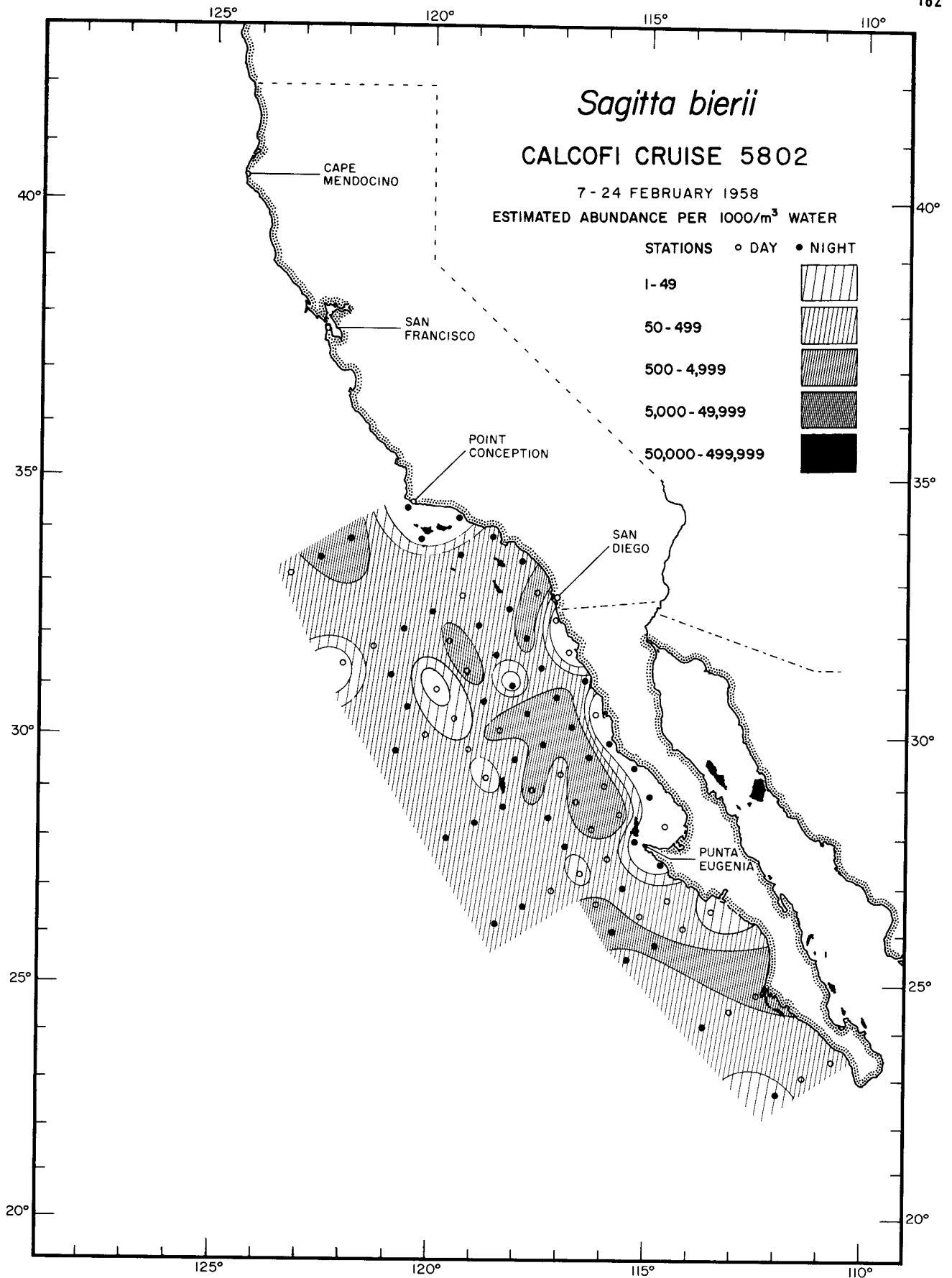
Chaetognatha  
*Krohnitta subtilis*  
5802



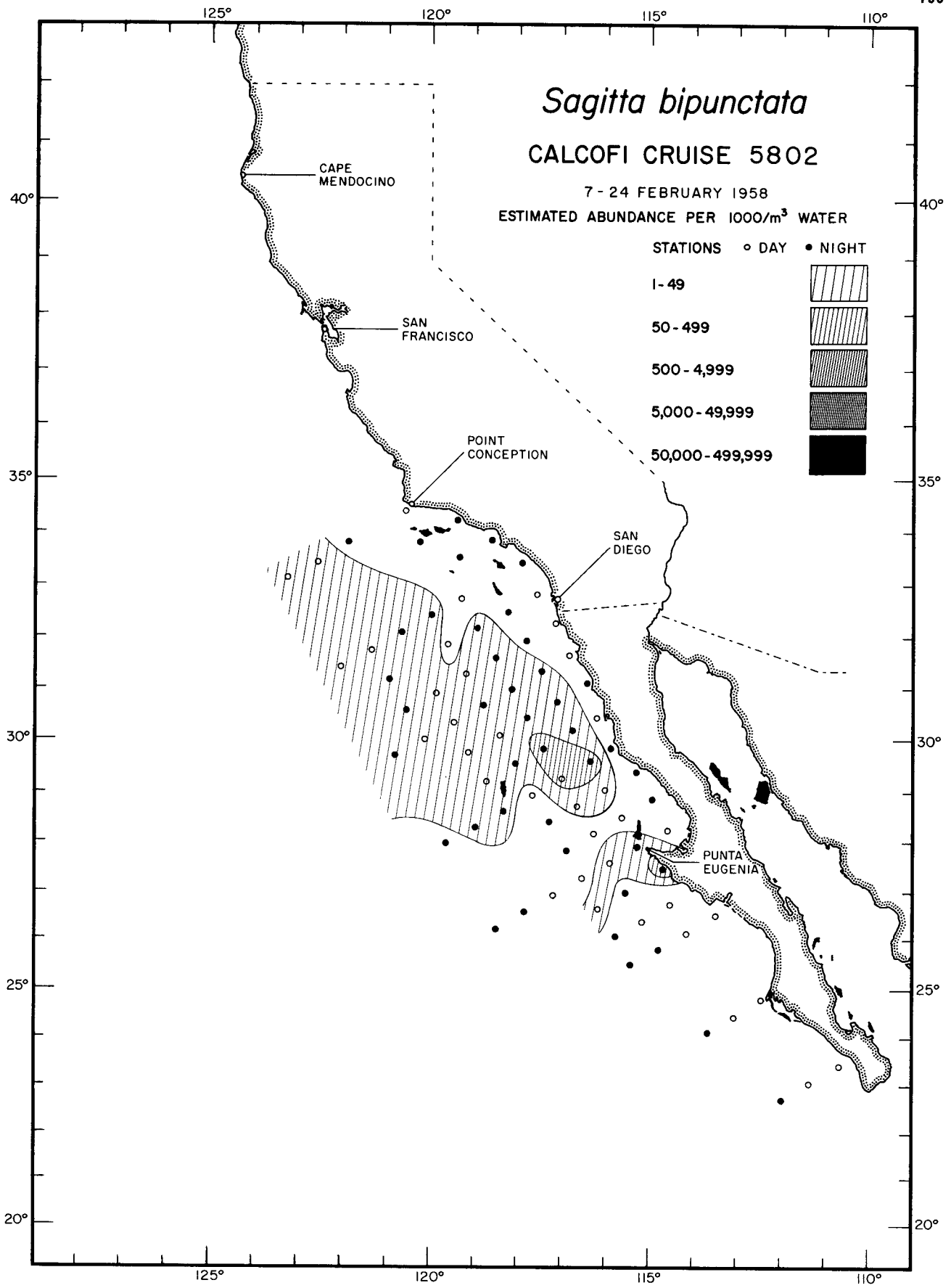
Chaetognatha  
*Pterosagitta draco*  
5802



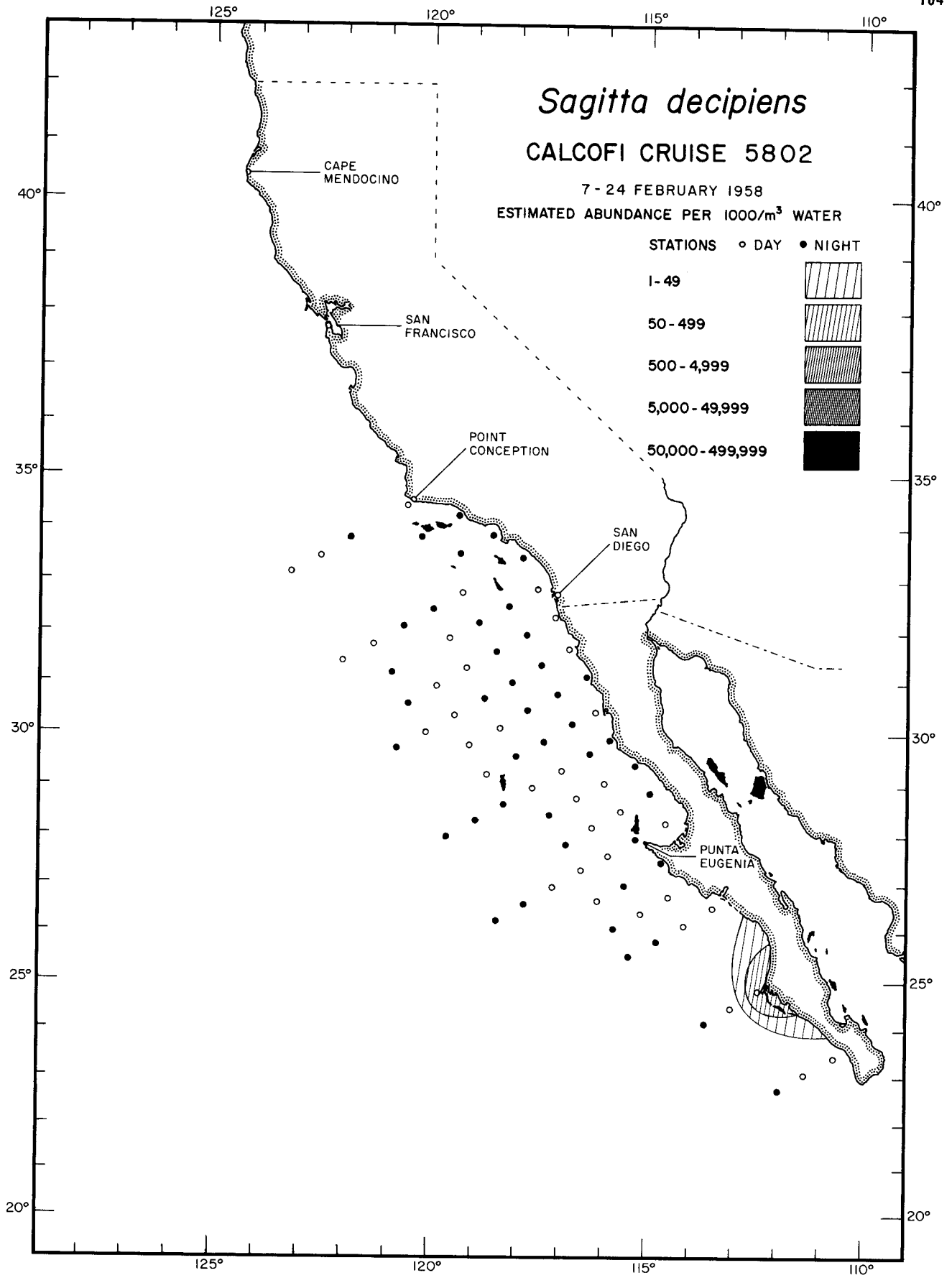
Chaetognatha  
*Sagitta bedoti*  
5802



Chaetognatha  
*Sagitta bierii*  
5802

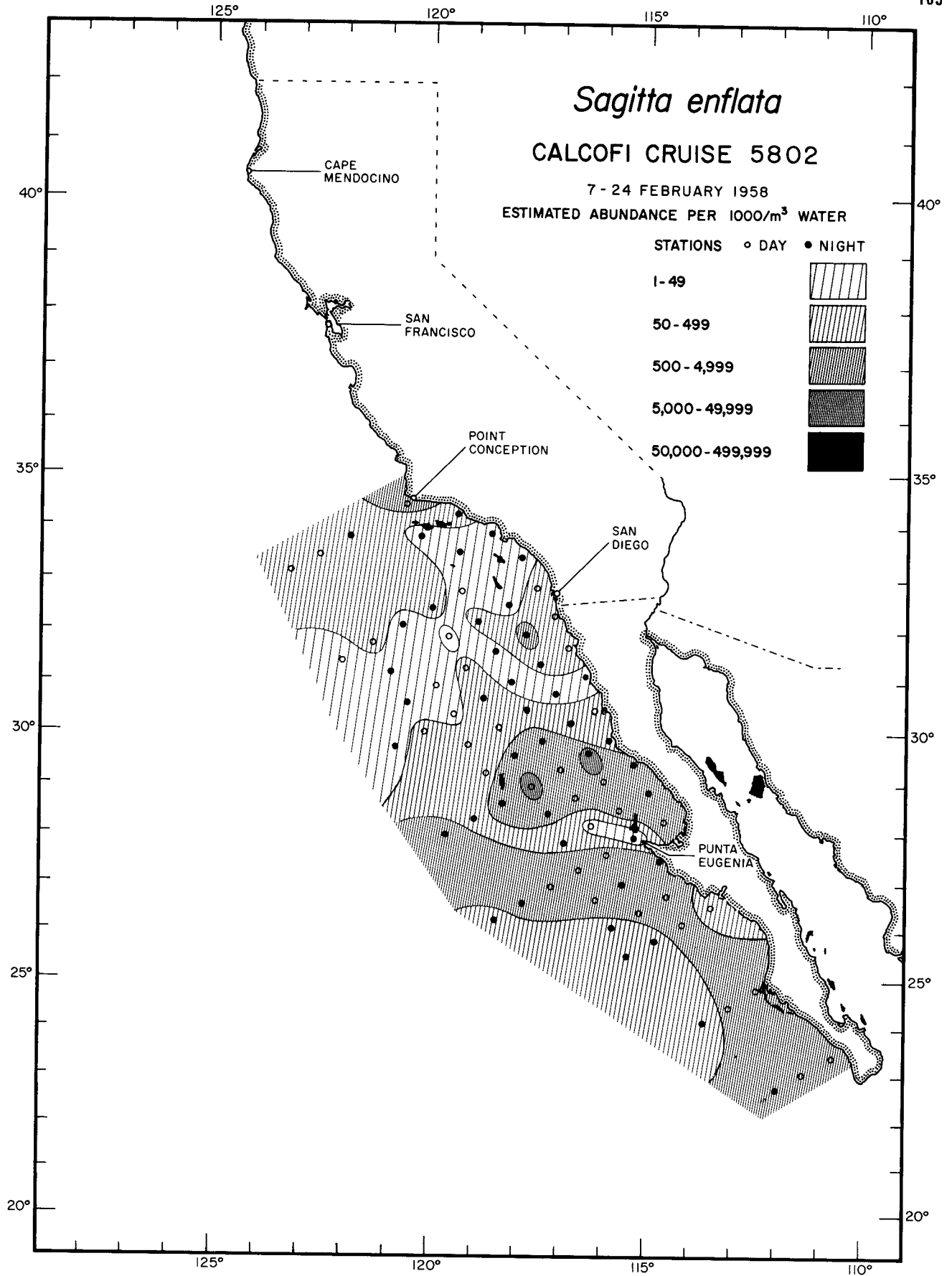


Chaetognatha  
*Sagitta bipunctata*  
5802

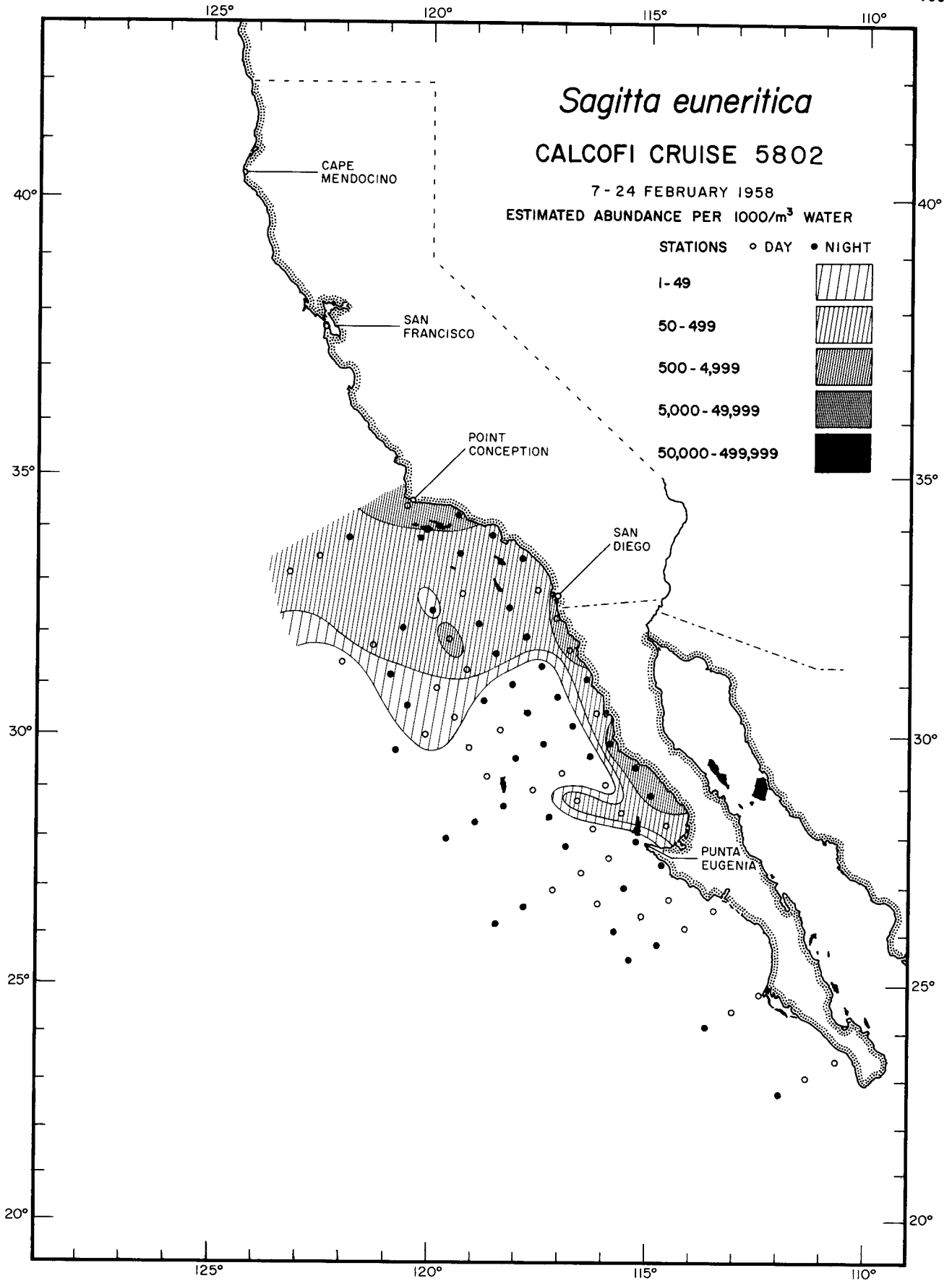


Chaetognatha  
*Sagitta decipiens*  
5802

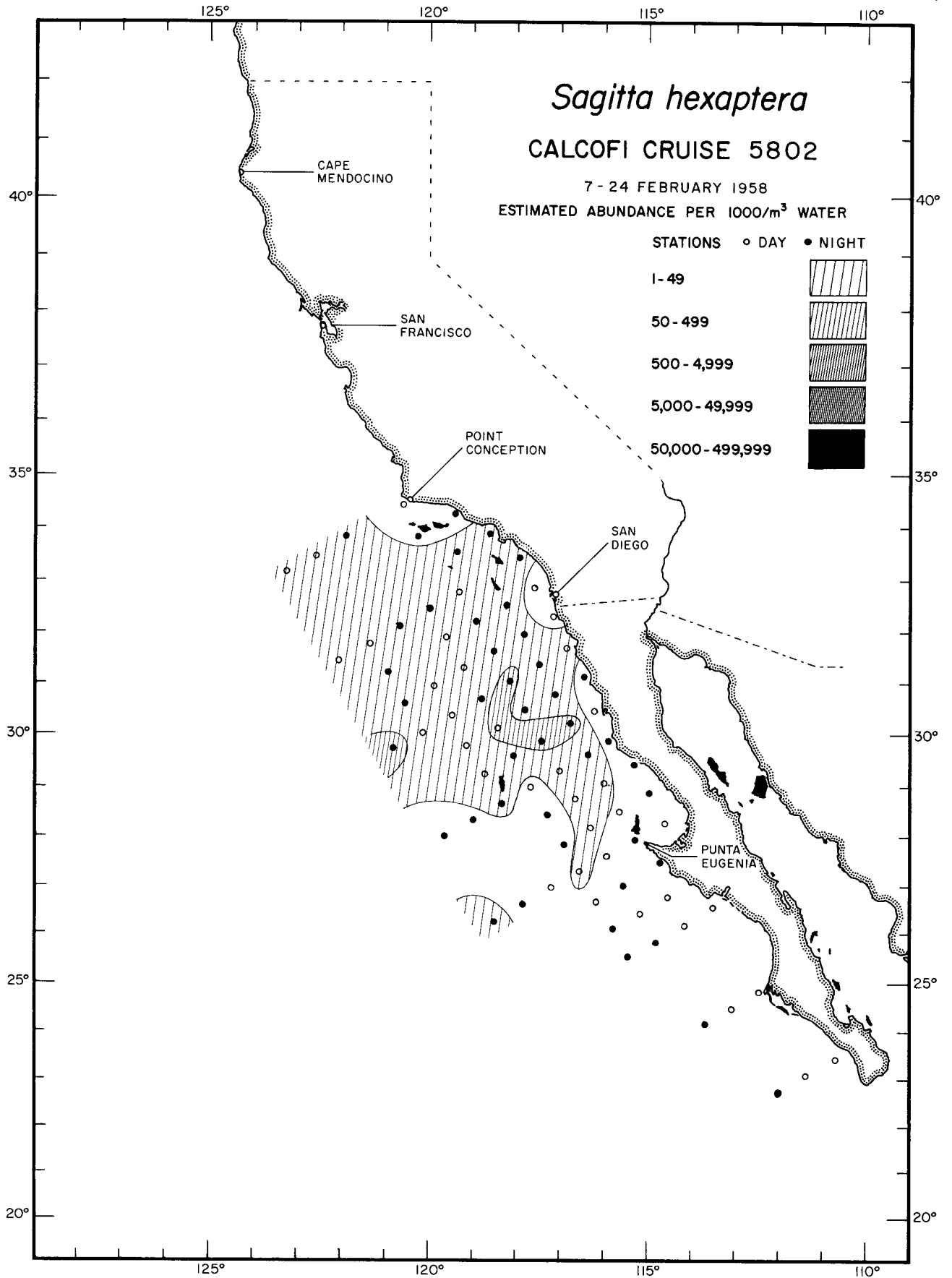




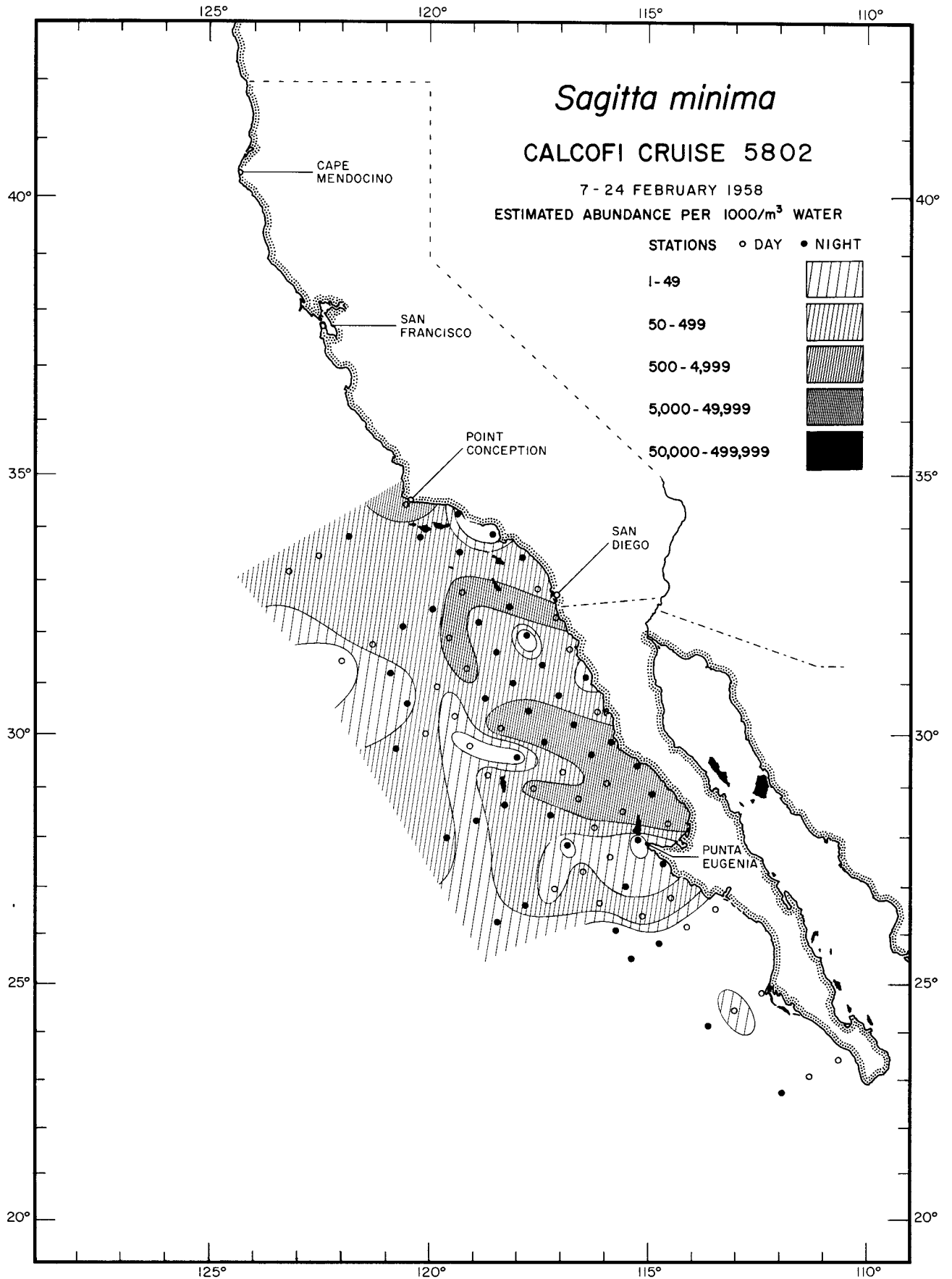
Chaetognatha  
*Sagitta enflata*  
5802



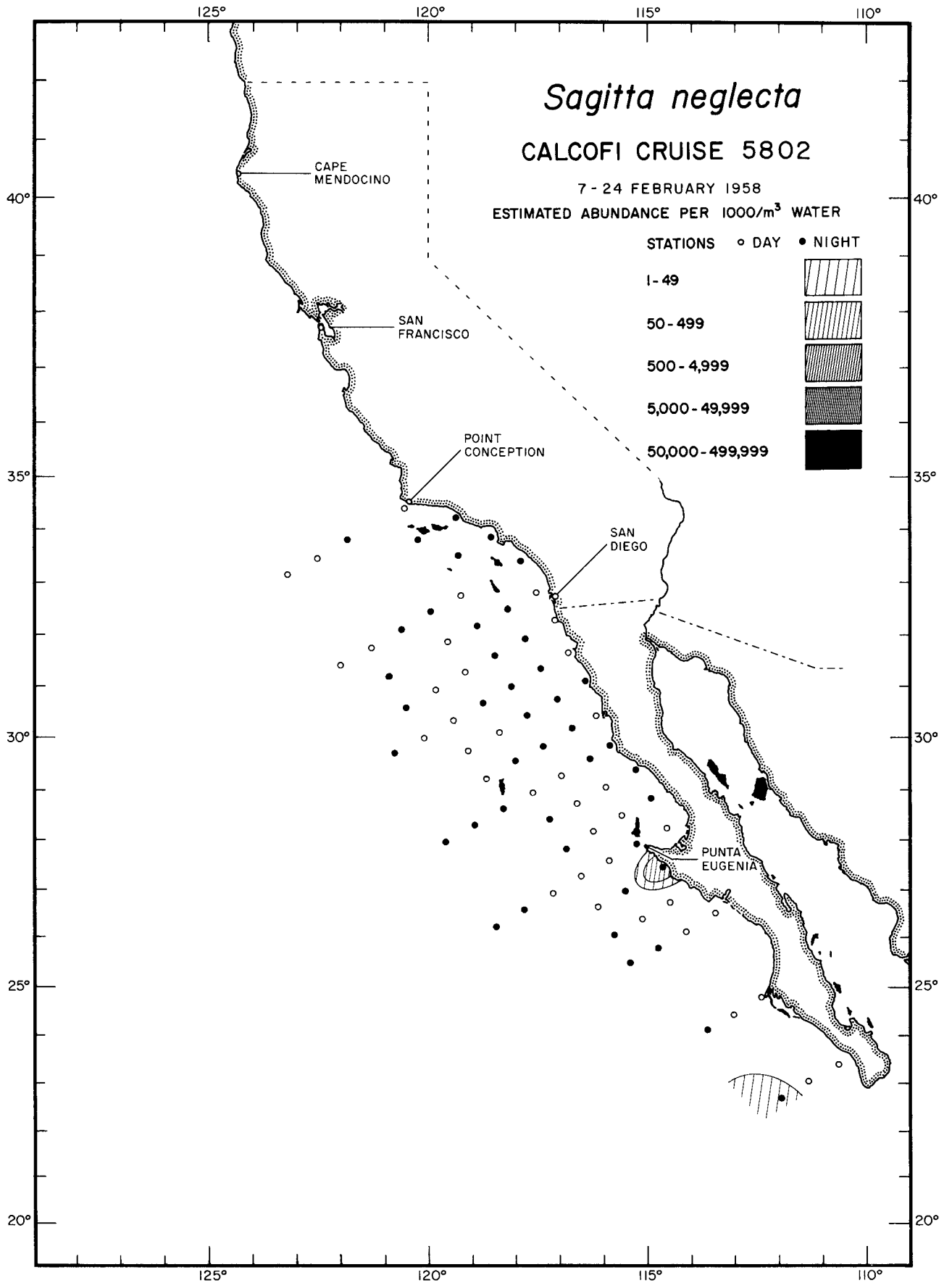
Chaetognatha  
*Sagitta euneritica*  
5802



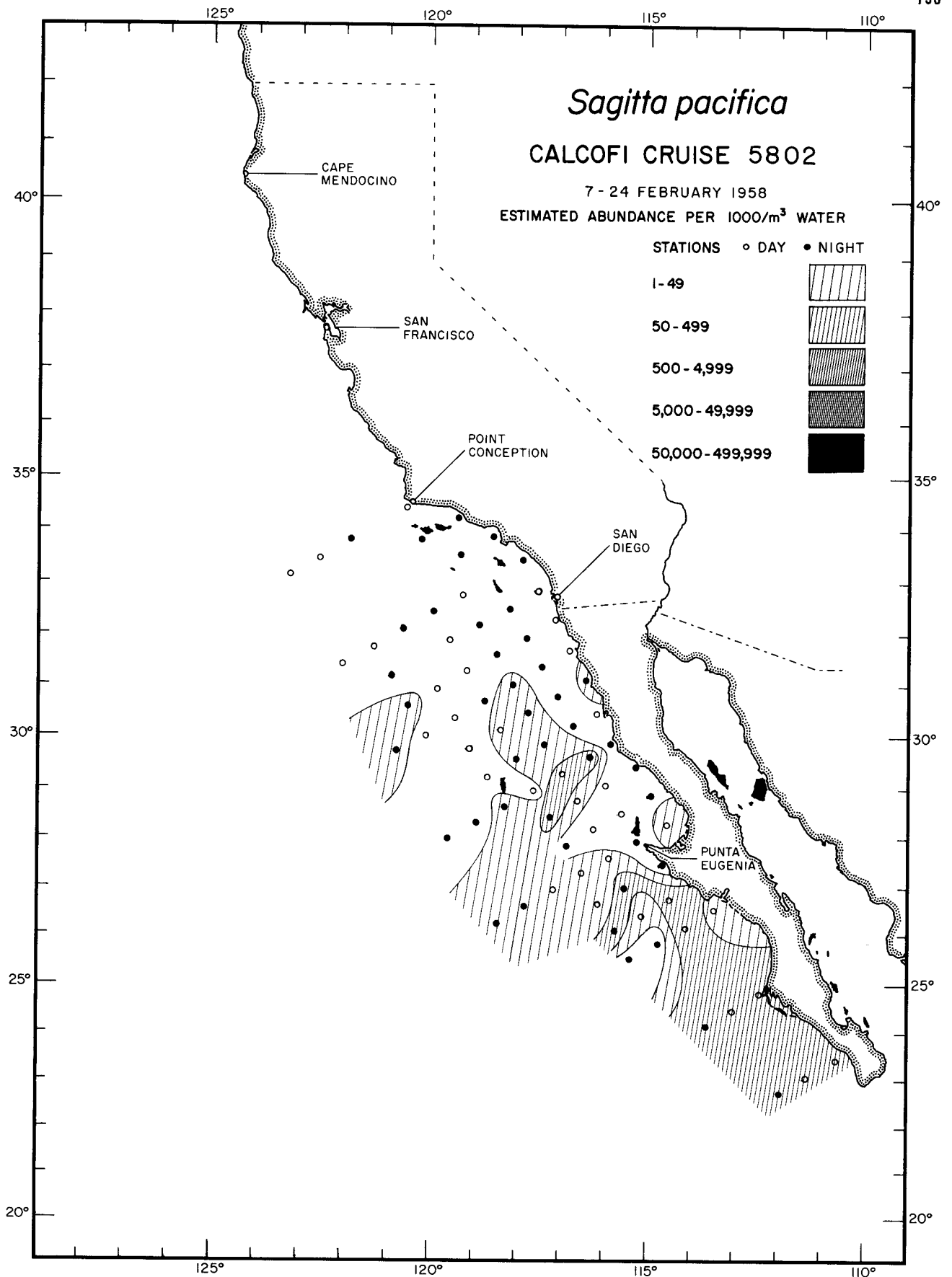
Chaetognatha  
*Sagitta hexaptera*  
5802

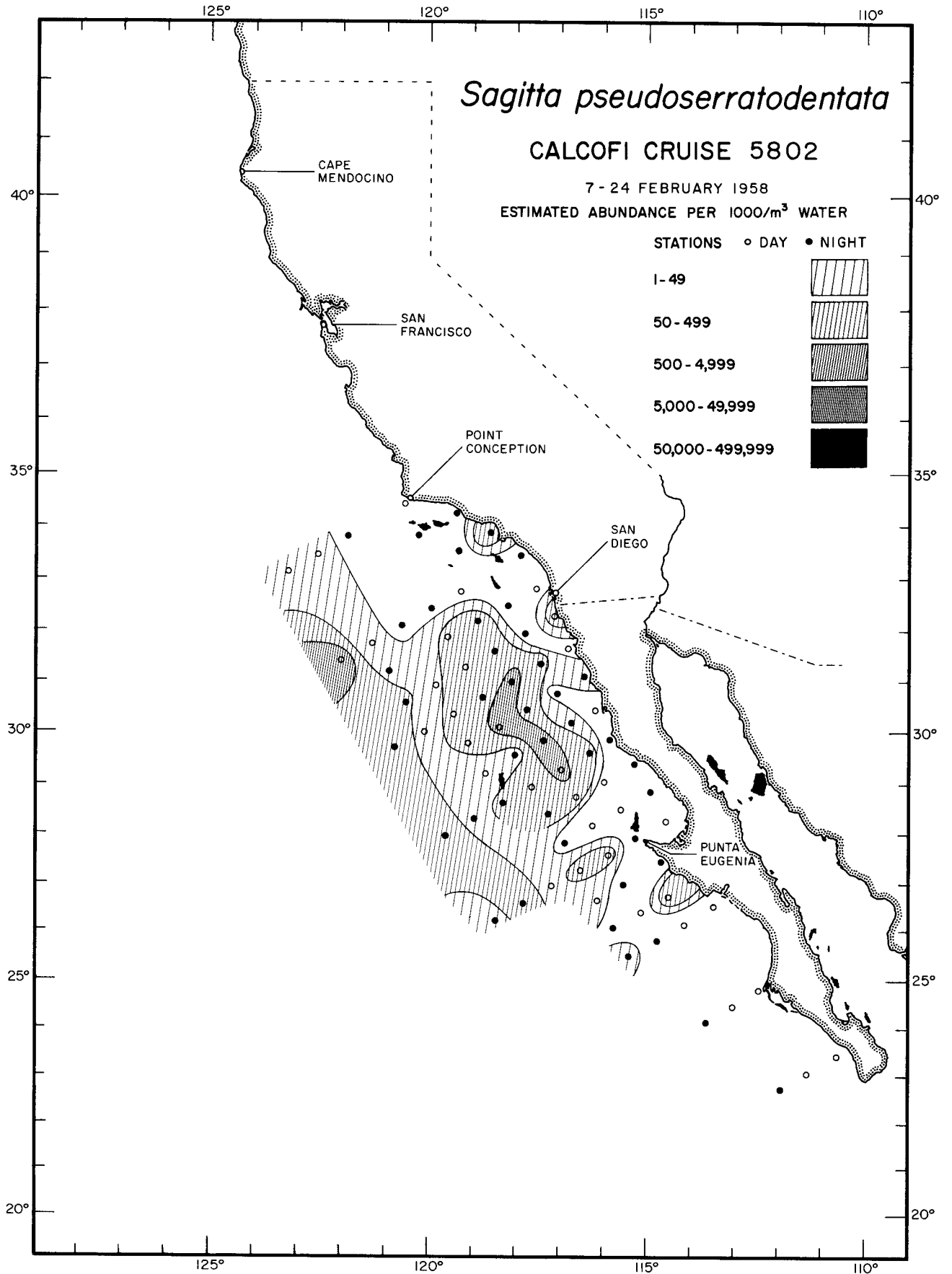


Chaetognatha  
*Sagitta minima*  
5802

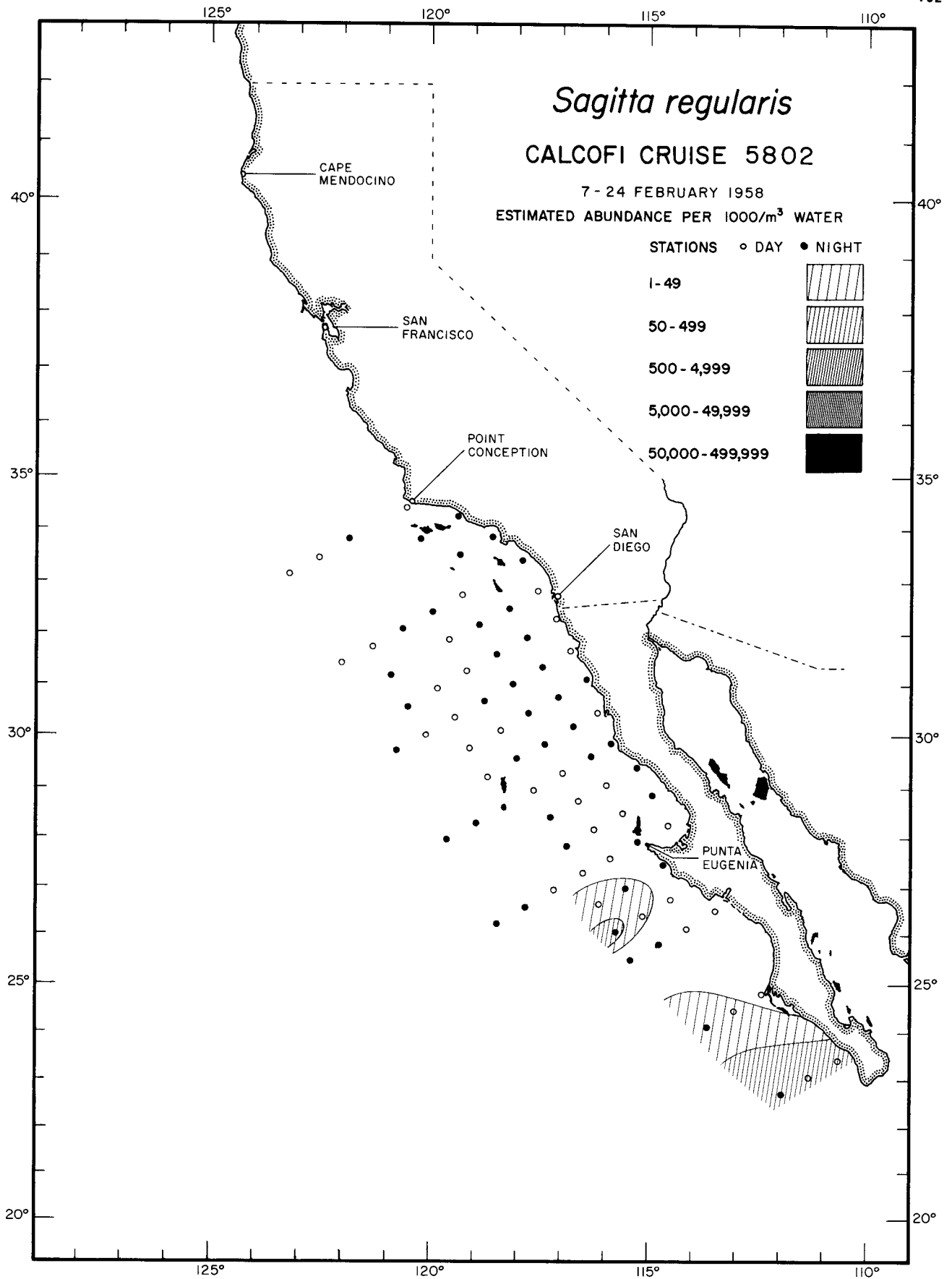


Chaetognatha  
*Sagitta neglecta*  
5802



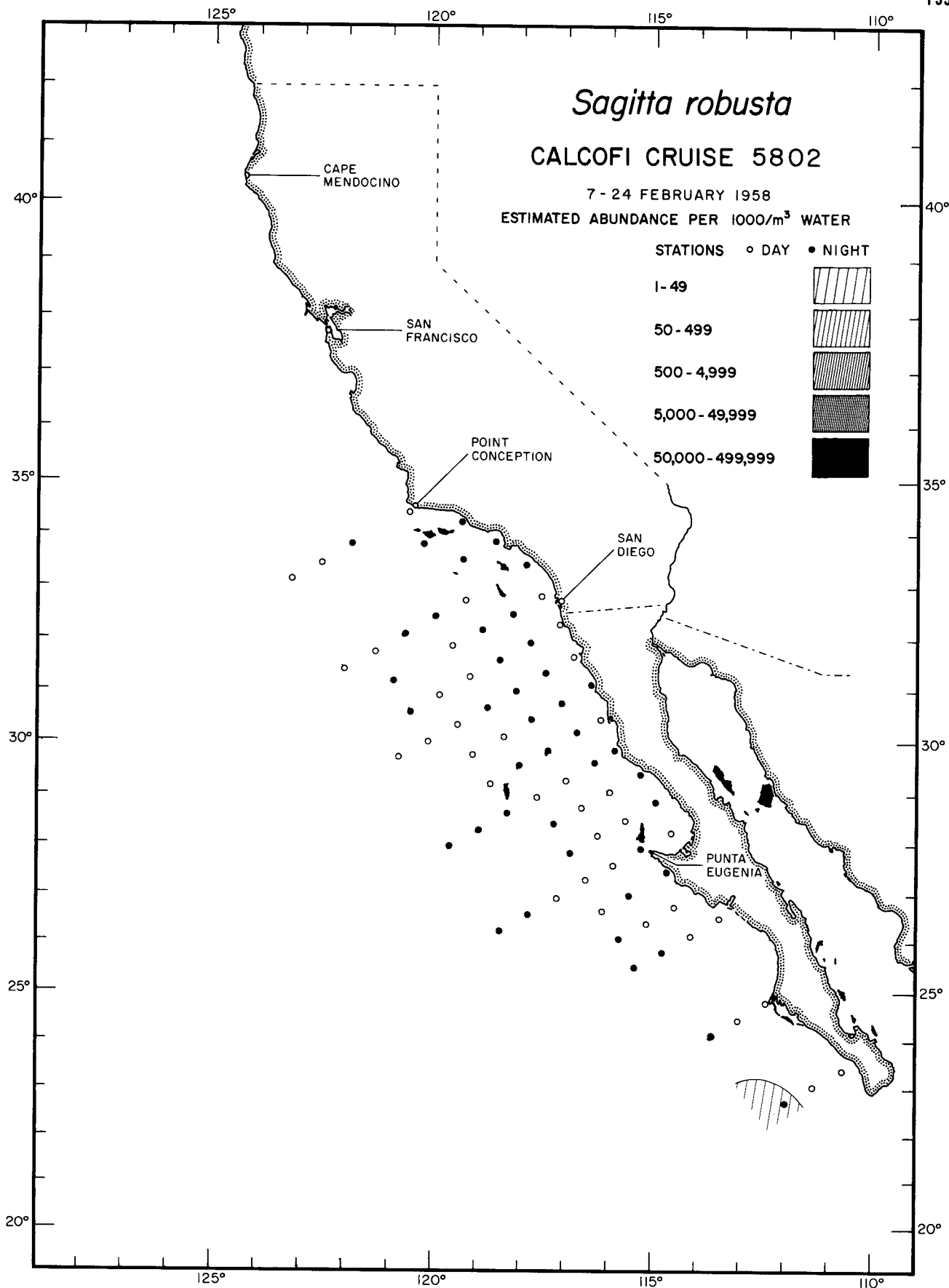


Chaetognatha  
*Sagitta pseudoserratodentata*  
5802

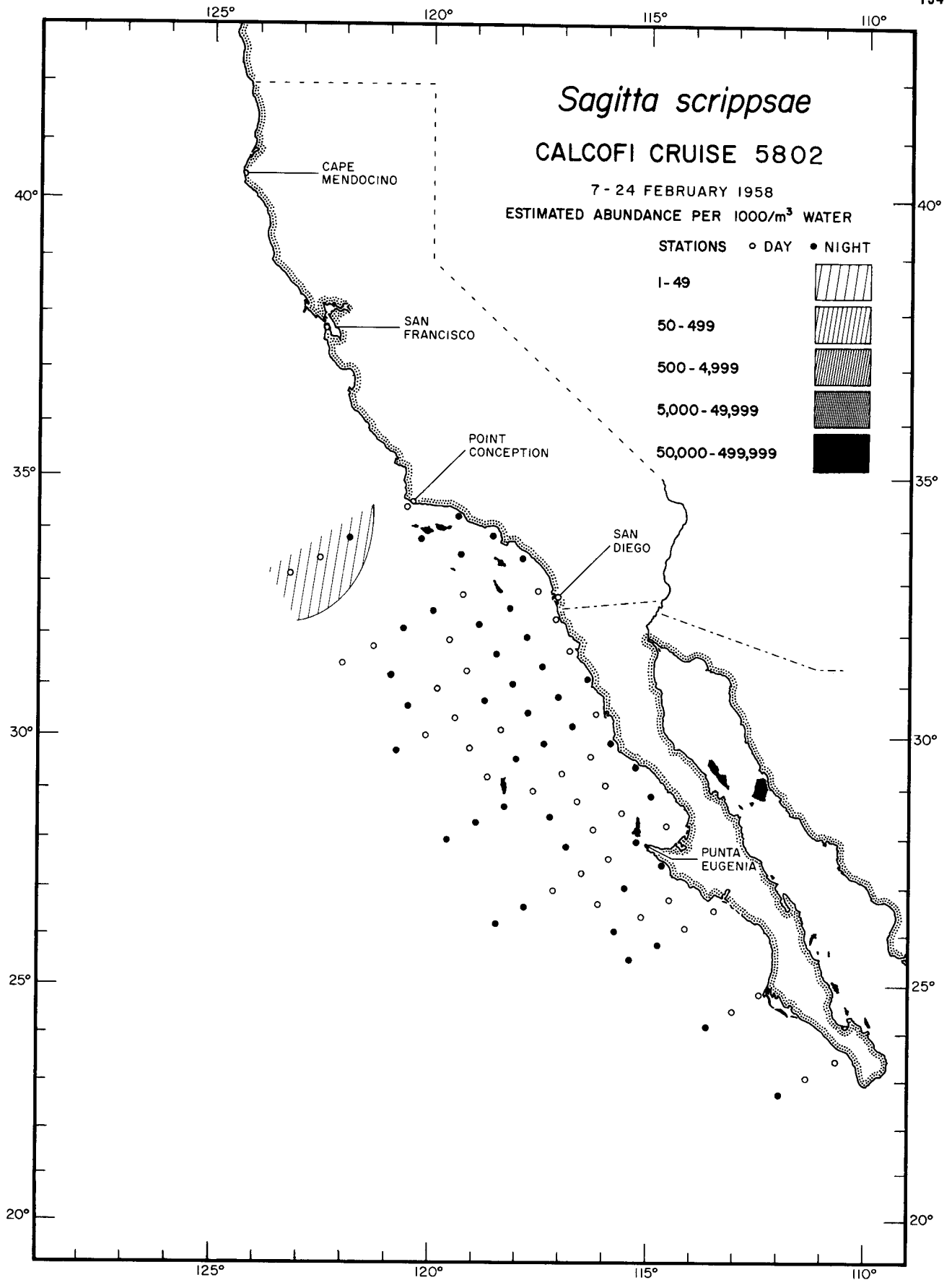


Chaetognatha  
*Sagitta regularis*  
5802

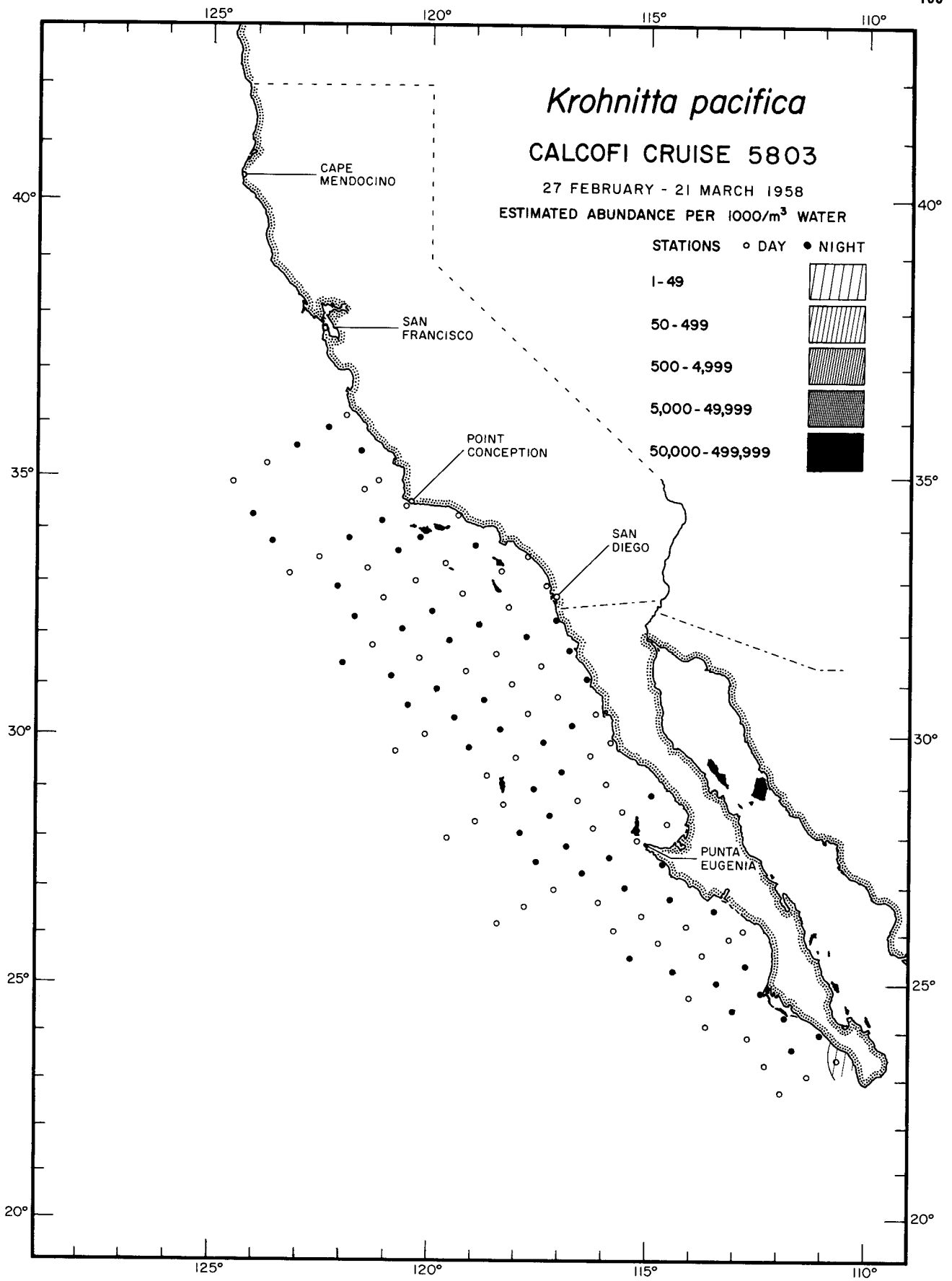




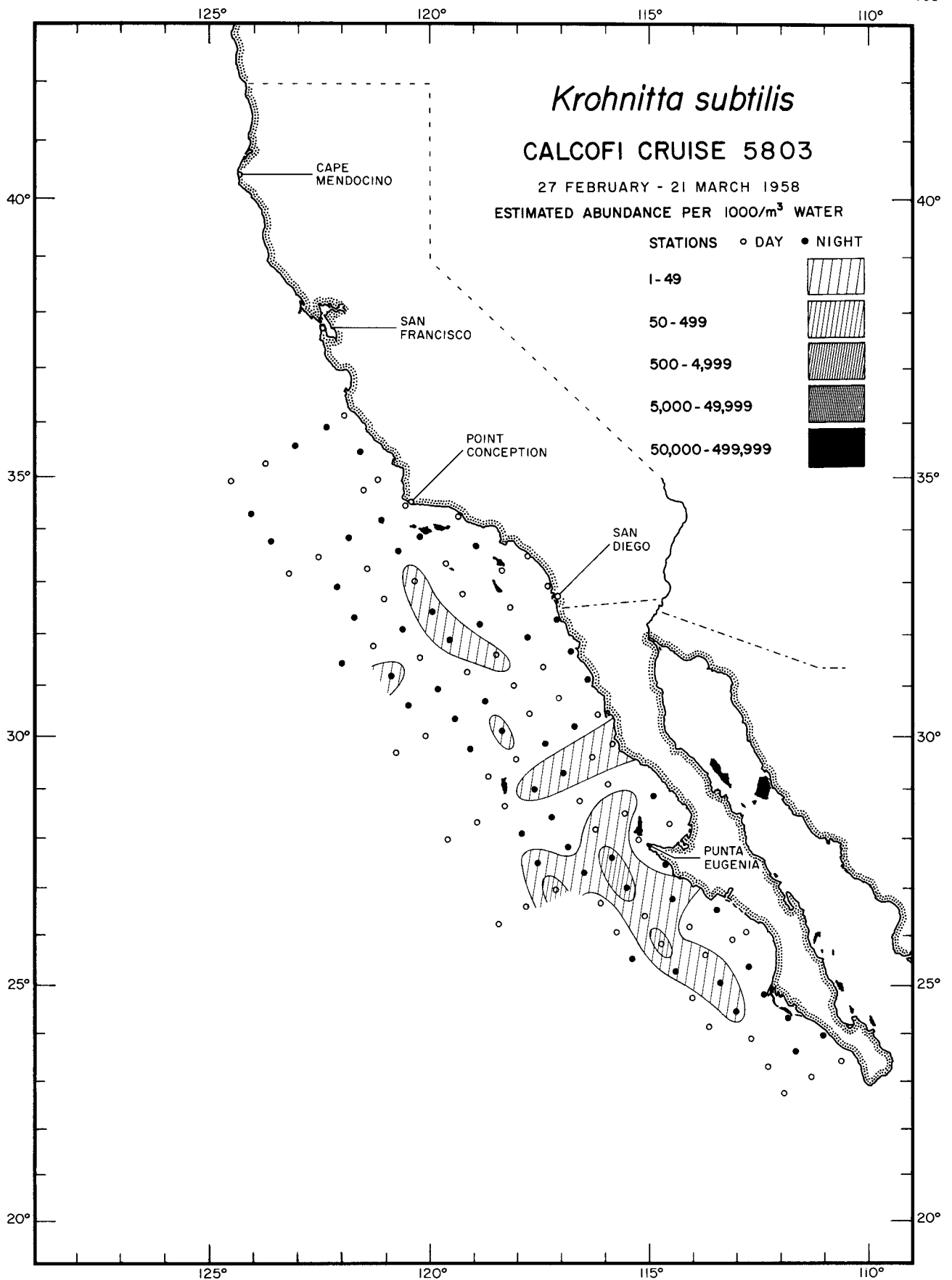
Chaetognatha  
*Sagitta robusta*  
5802

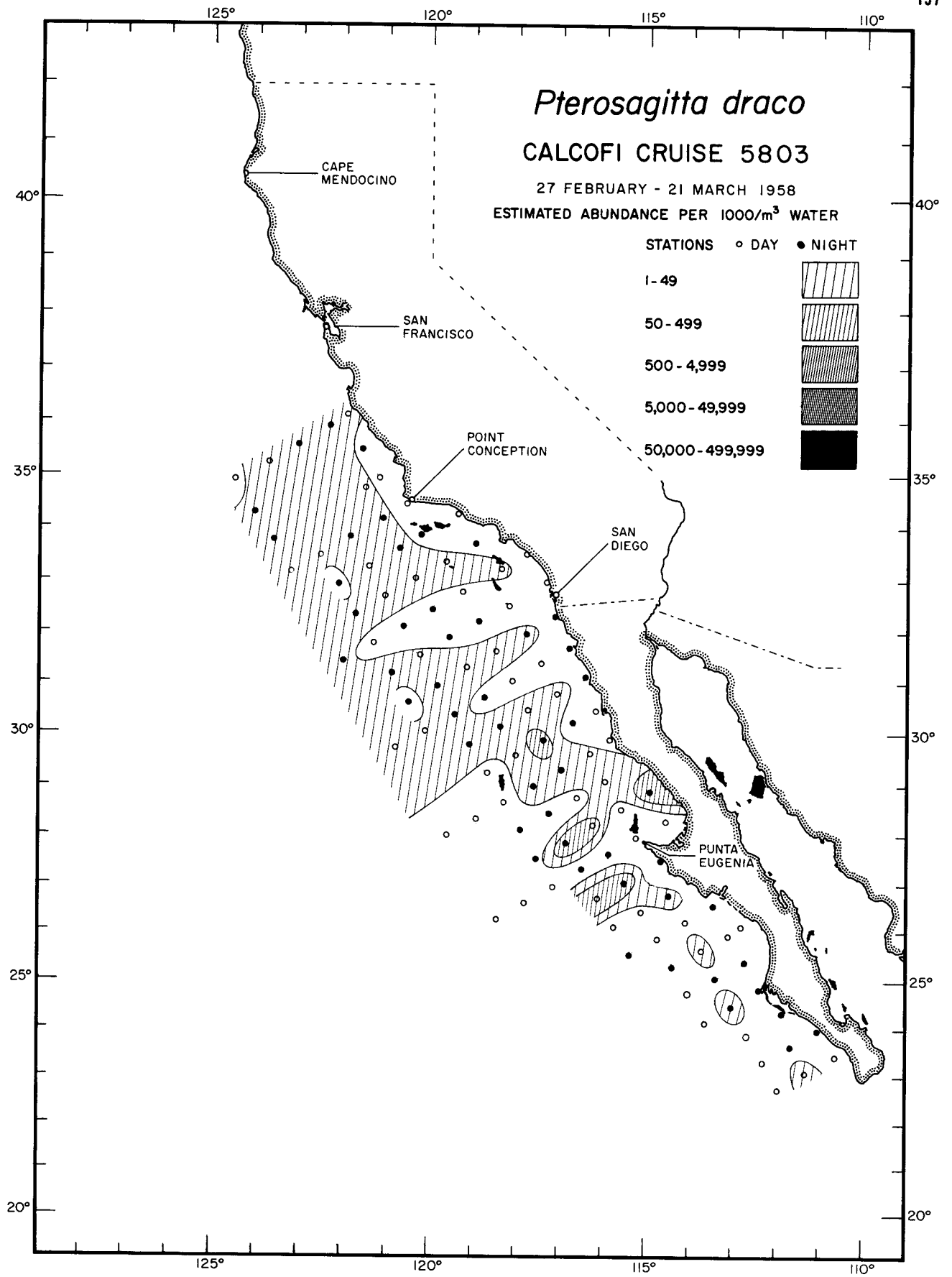


Chaetognatha  
*Sagitta scrippsae*  
5802

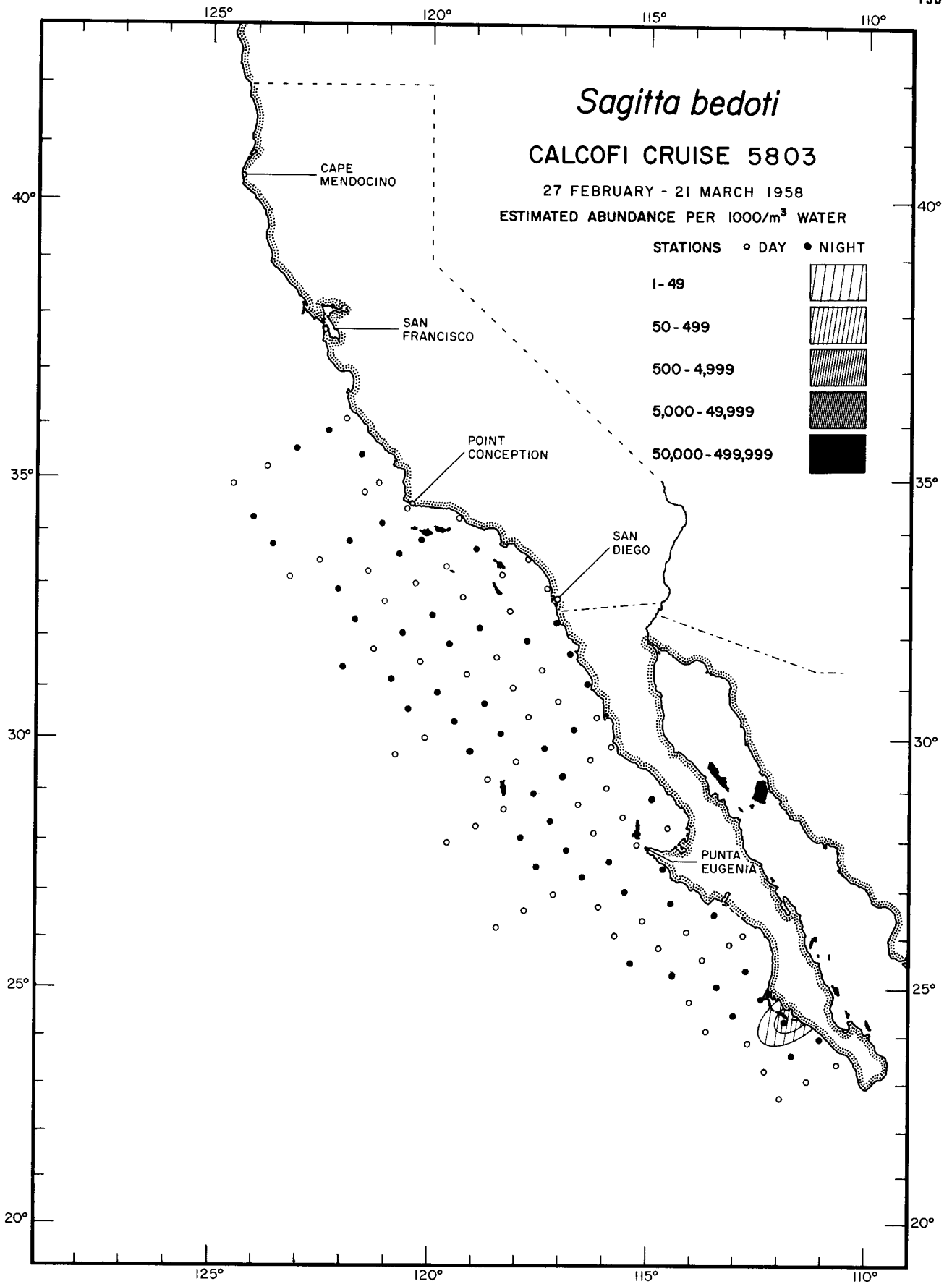


Chaetognatha  
*Krohnitta pacifica*  
5803

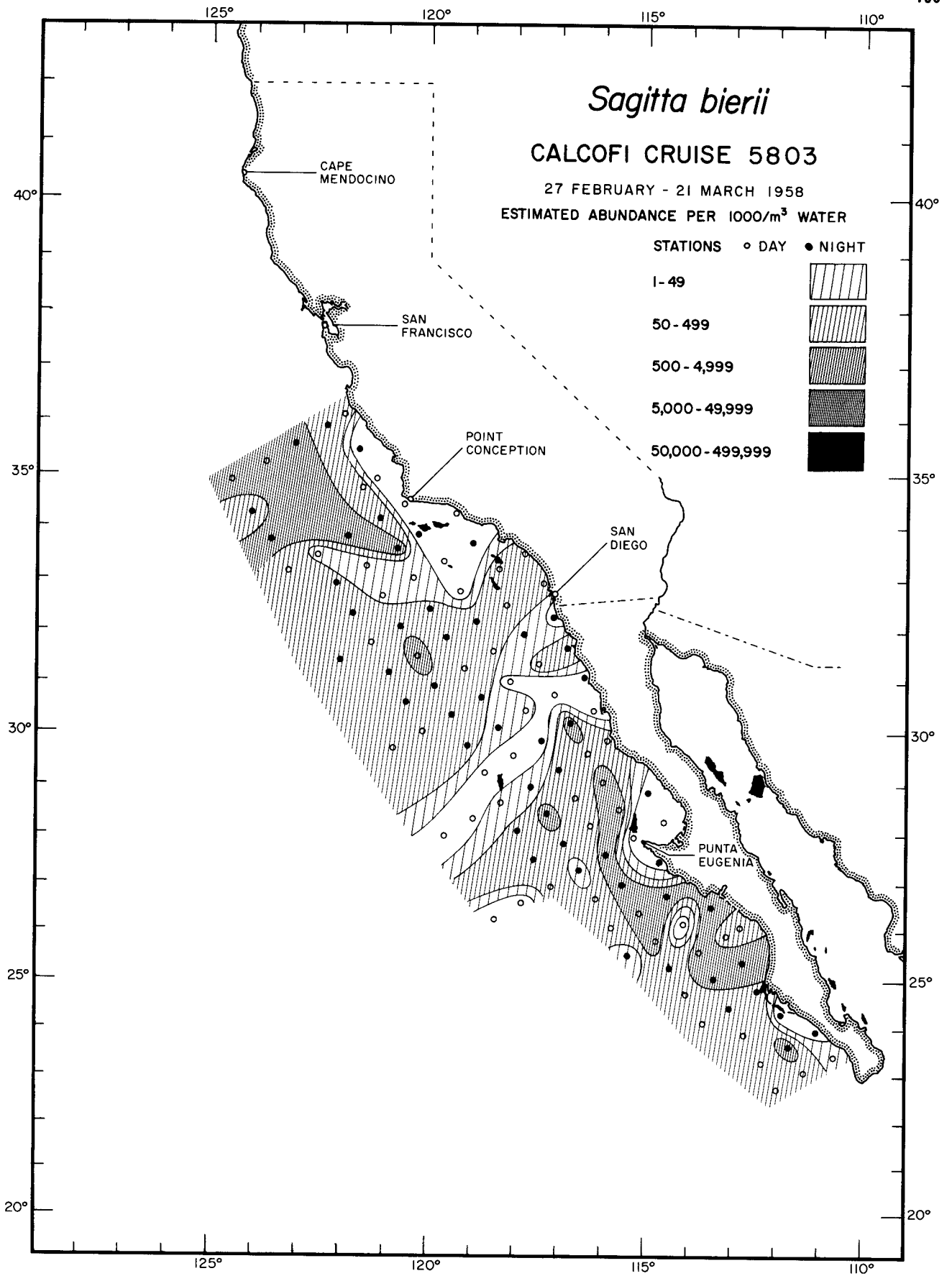


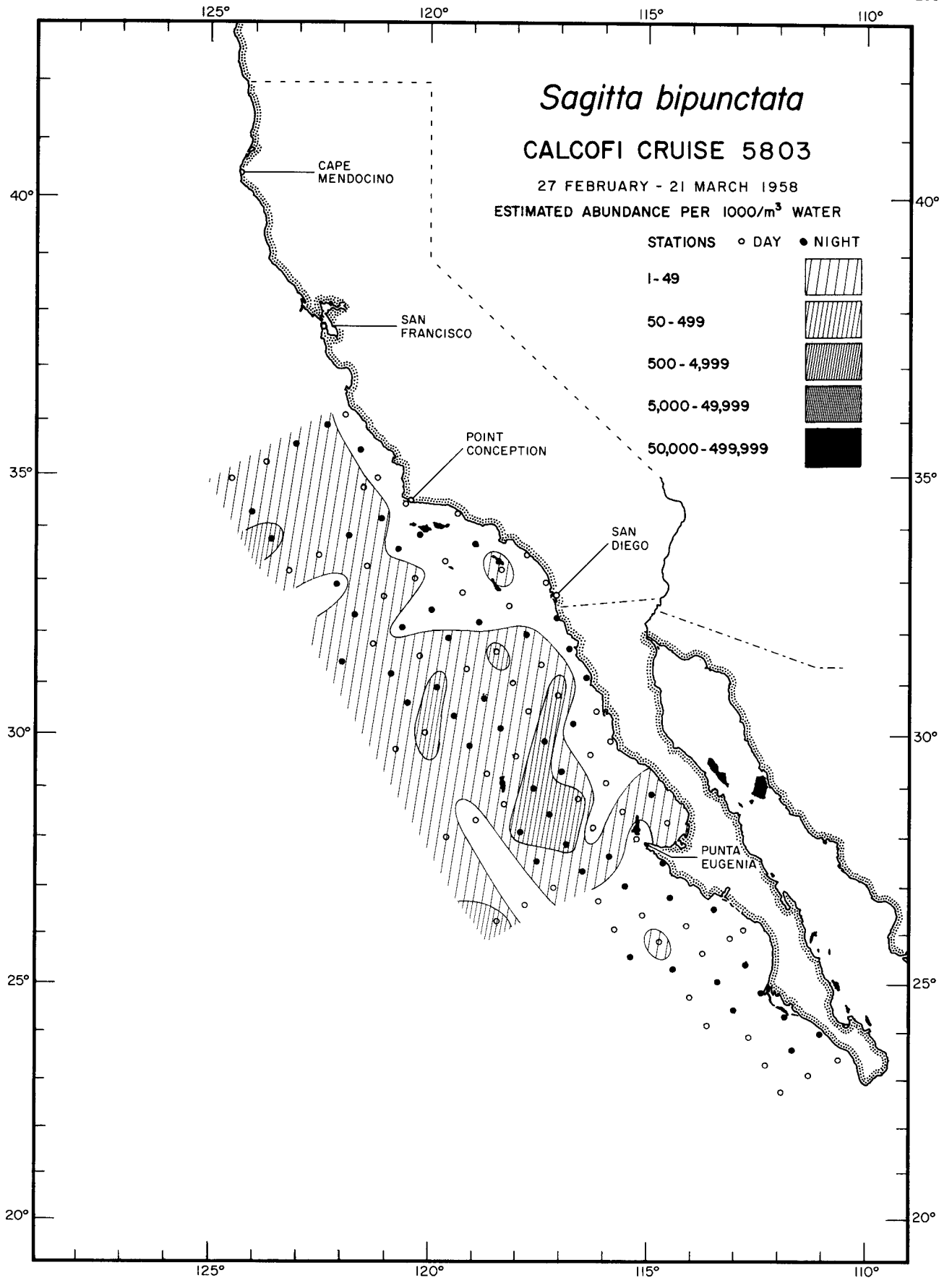


Chaetognatha  
*Pterosagitta draco*  
5803



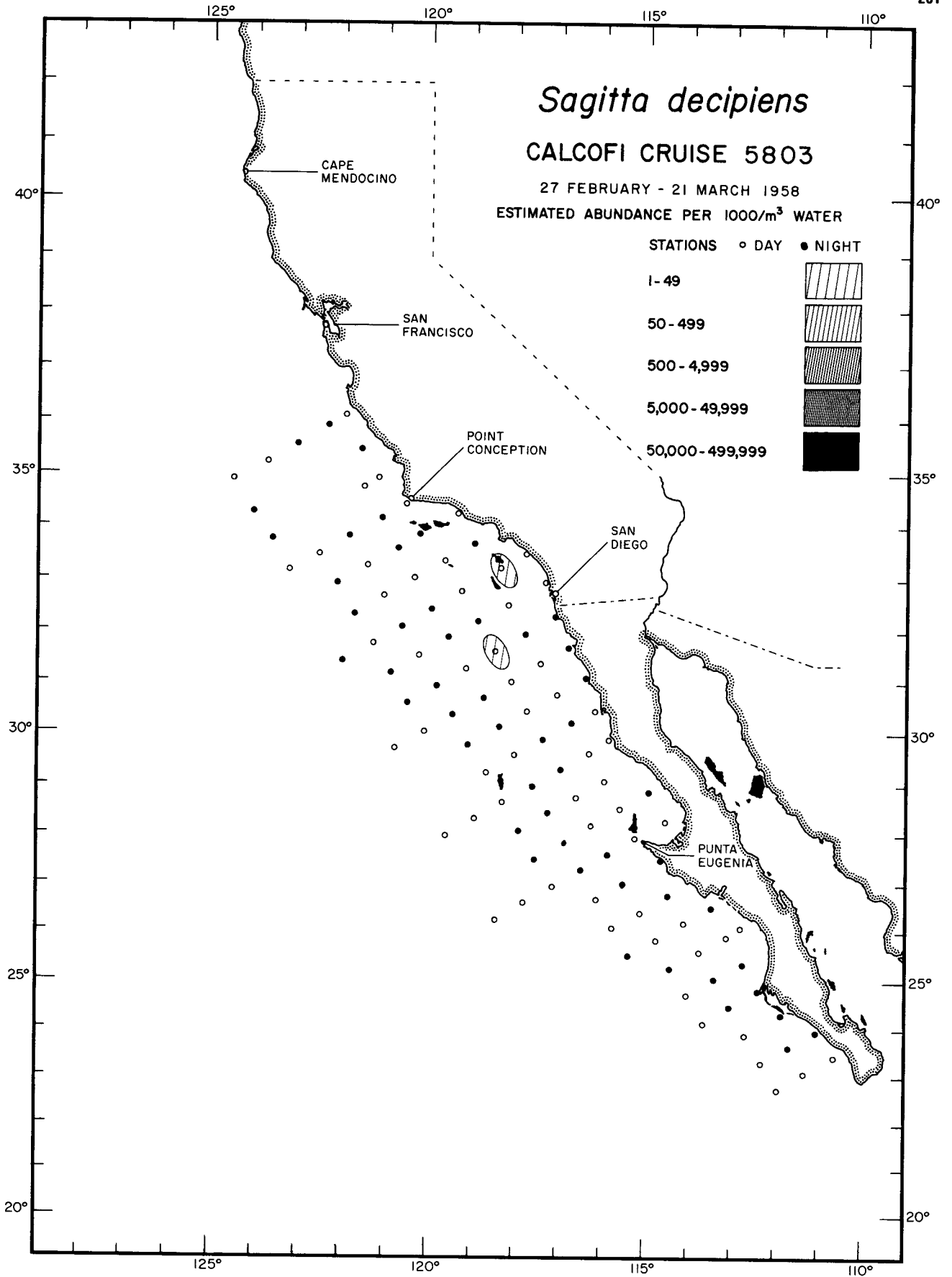
Chaetognatha  
*Sagitta bedoti*  
5803



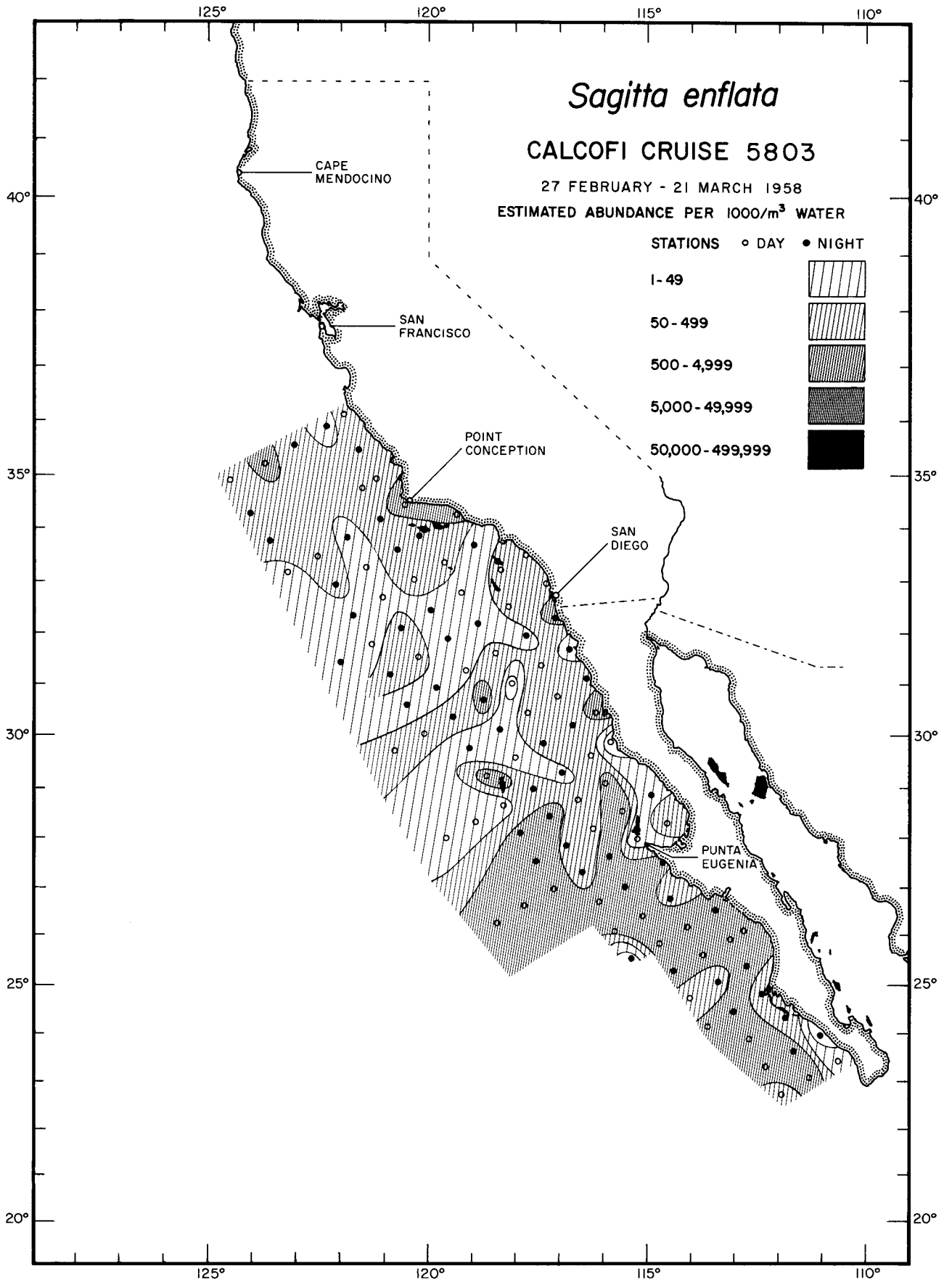


Chaetognatha  
*Sagitta bipunctata*  
5803

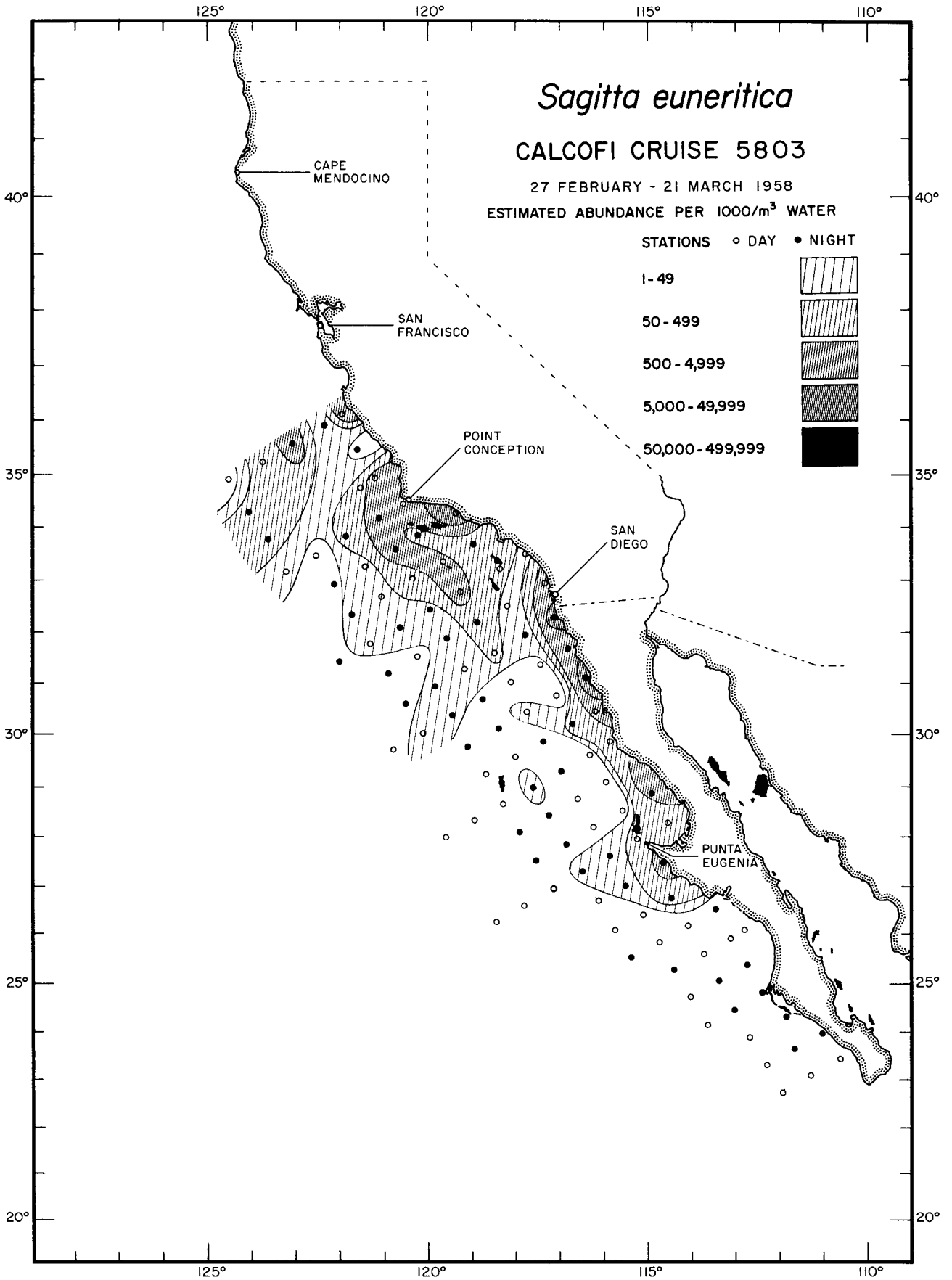




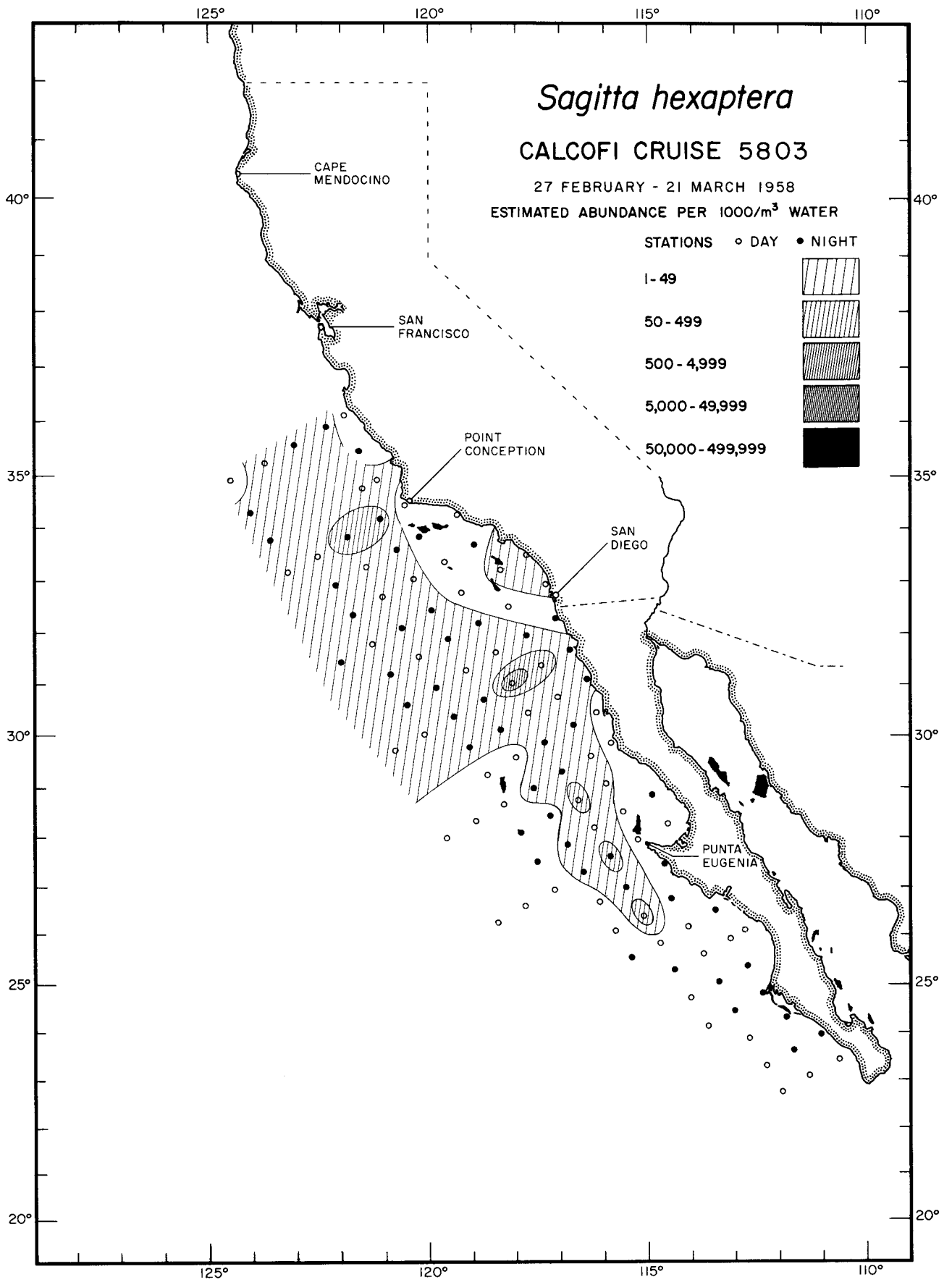
Chaetognatha  
*Sagitta decipiens*  
5803



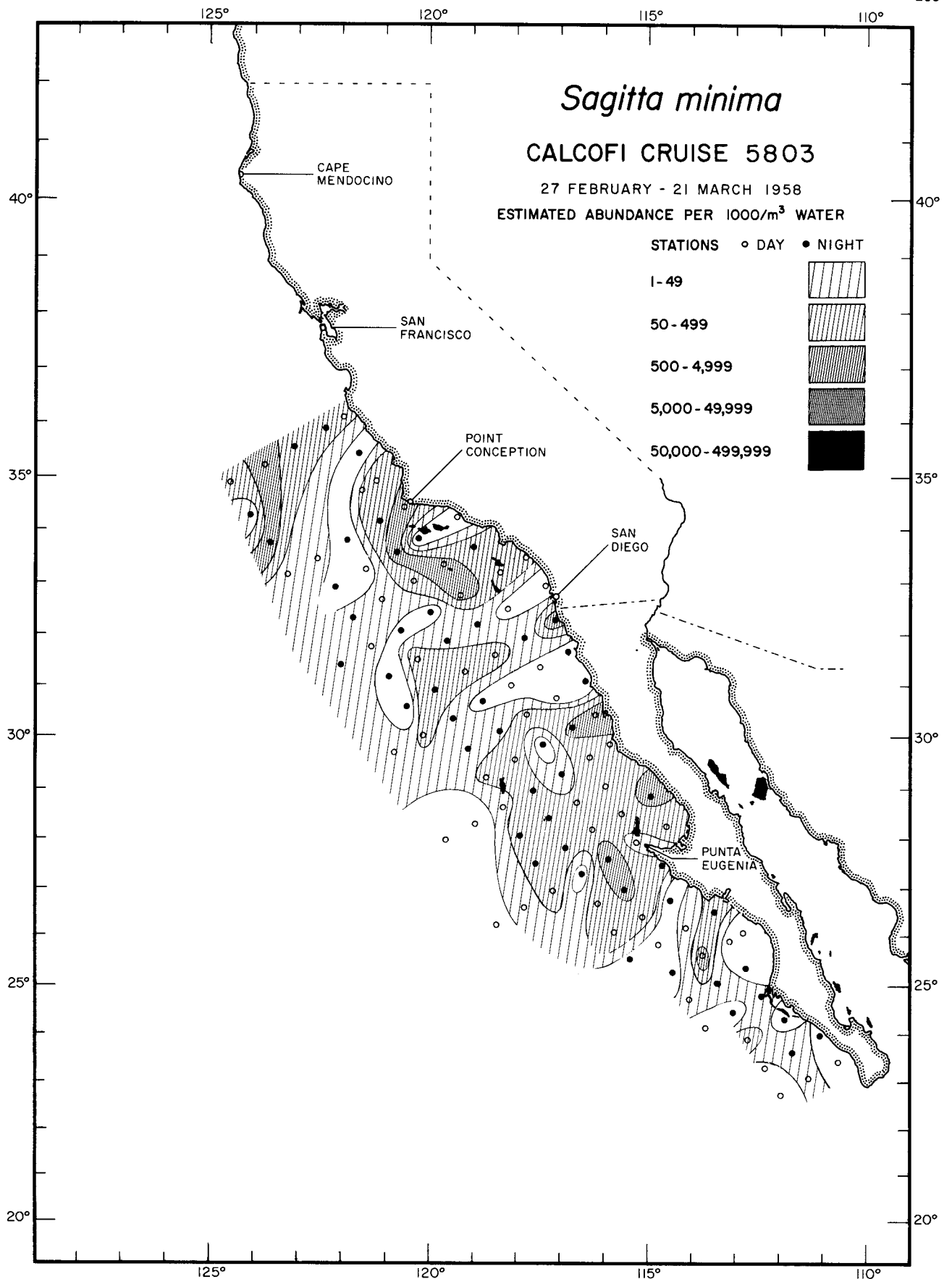
Chaetognatha  
*Sagitta enflata*  
5803



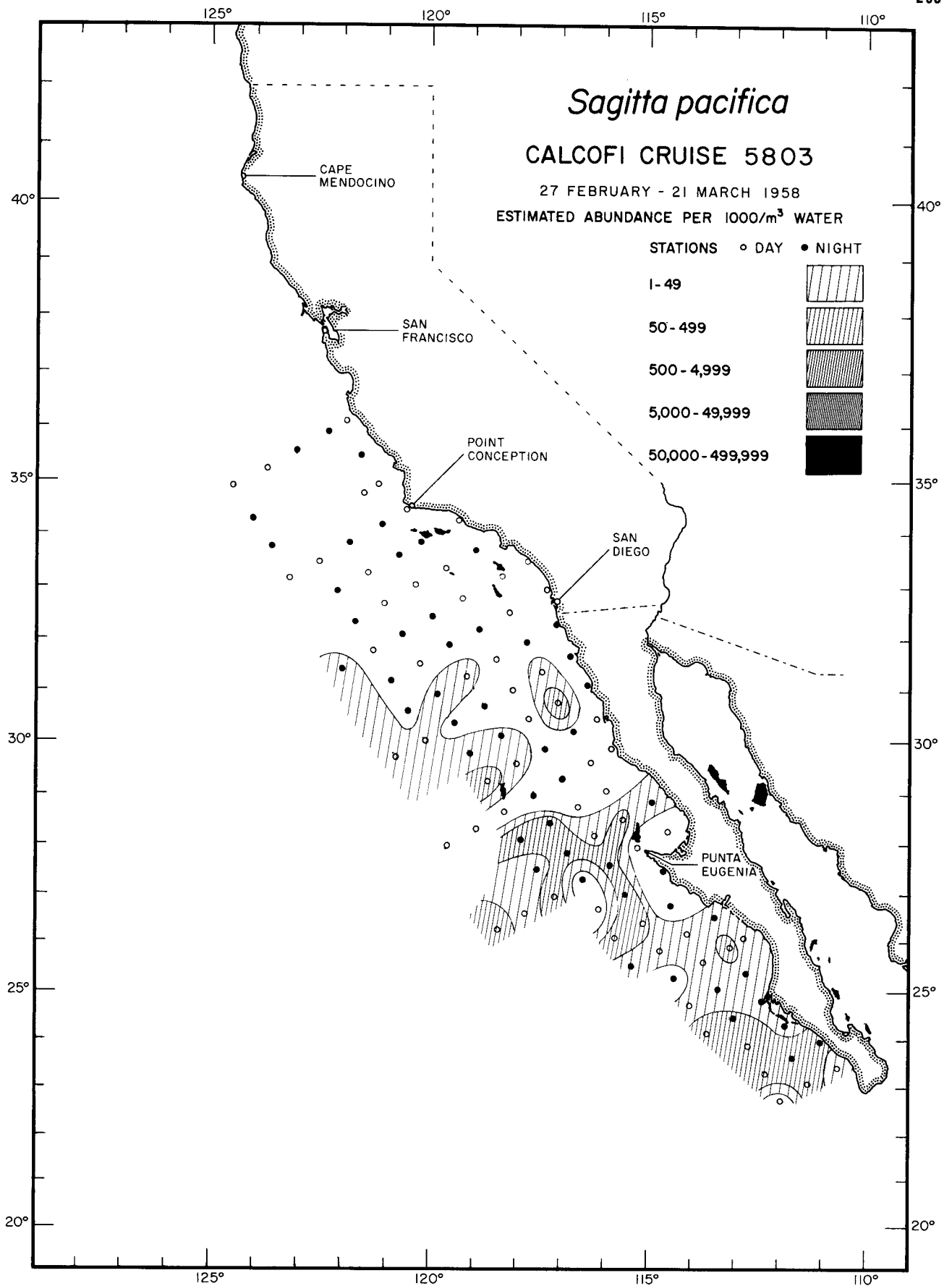
Chaetognatha  
*Sagitta euneritica*  
5803



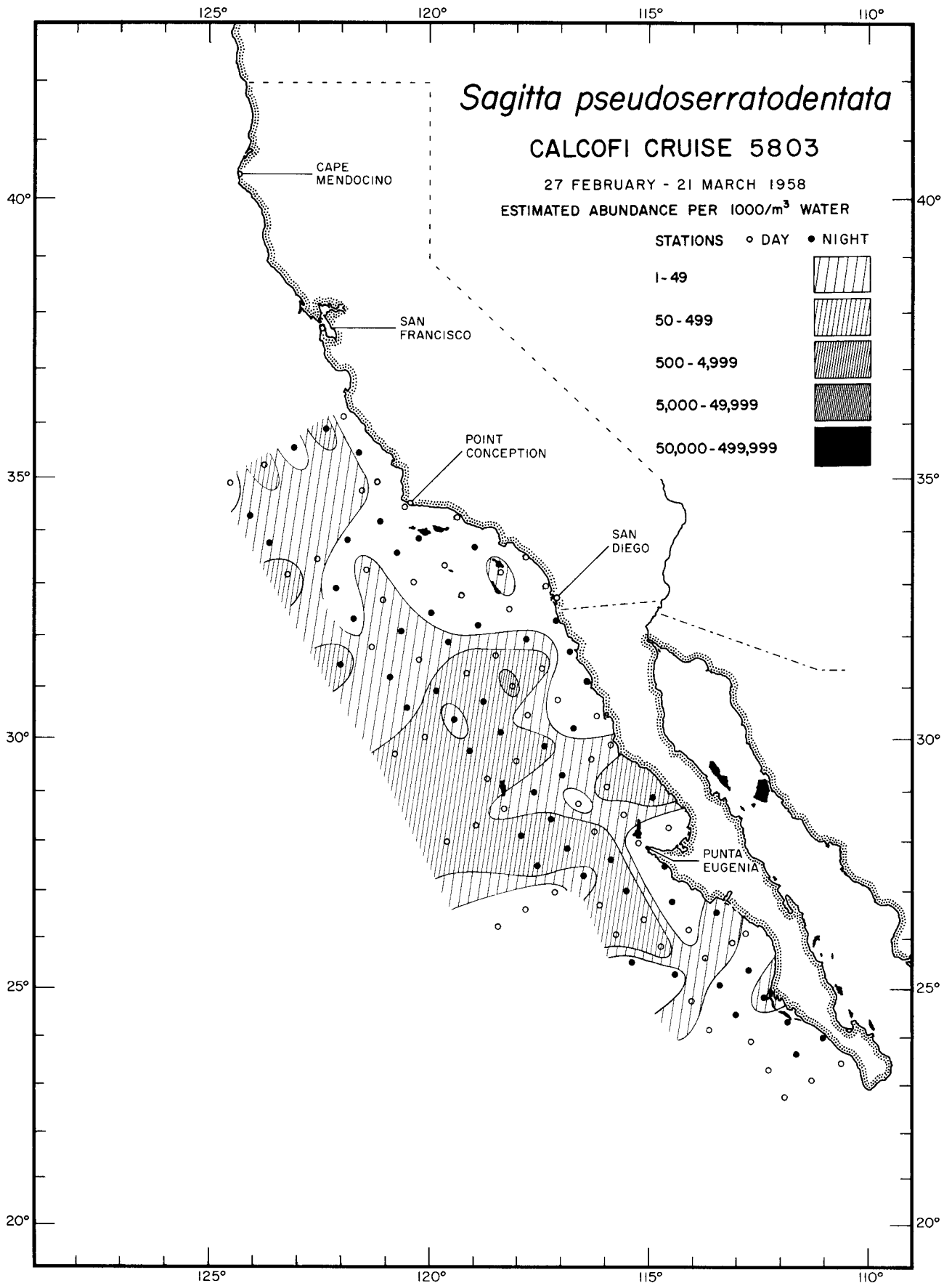
Chaetognatha  
*Sagitta hexaptera*  
5803



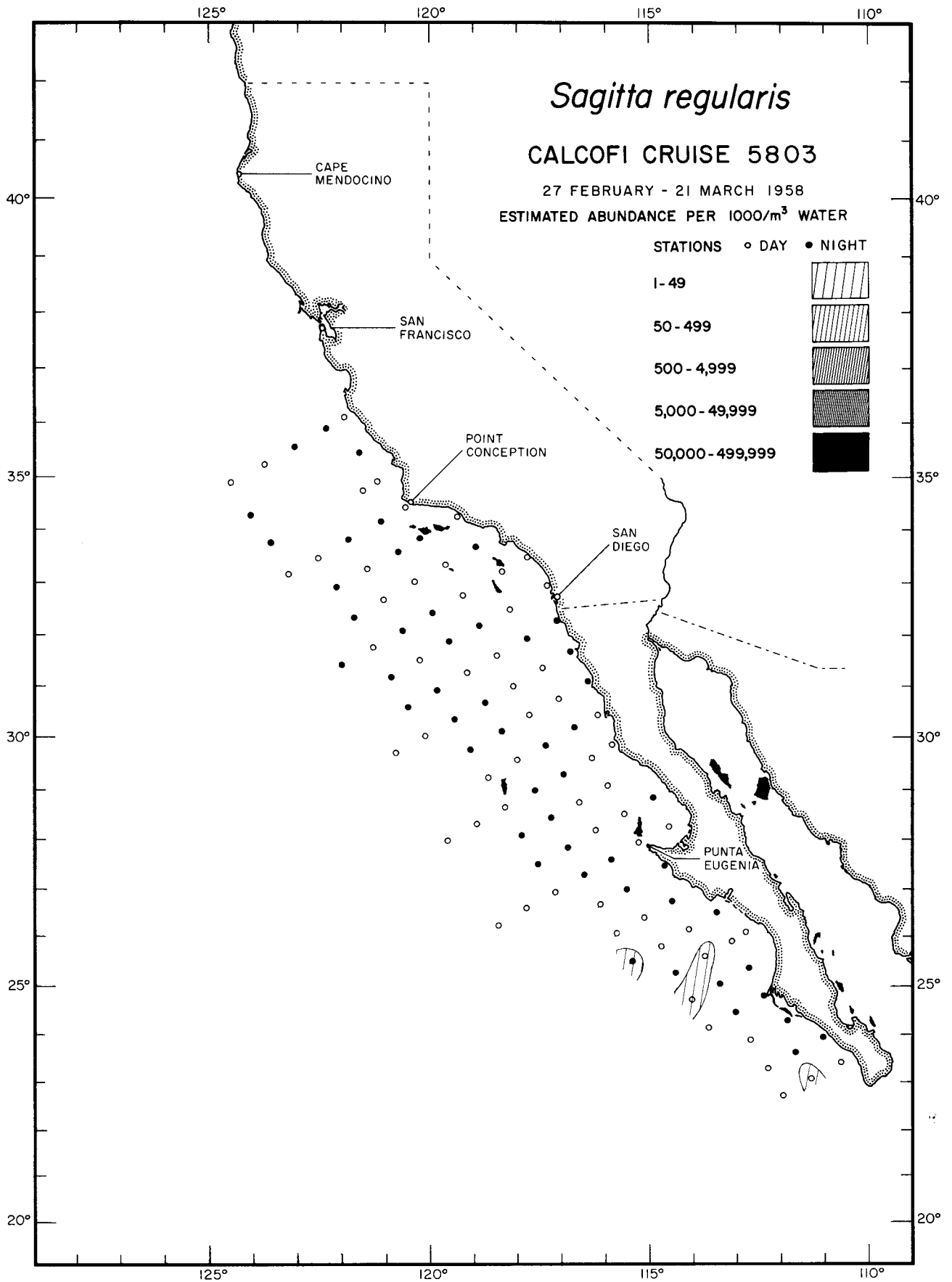
Chaetognatha  
*Sagitta minima*  
5803



Chaetognatha  
*Sagitta pacifica*  
5803

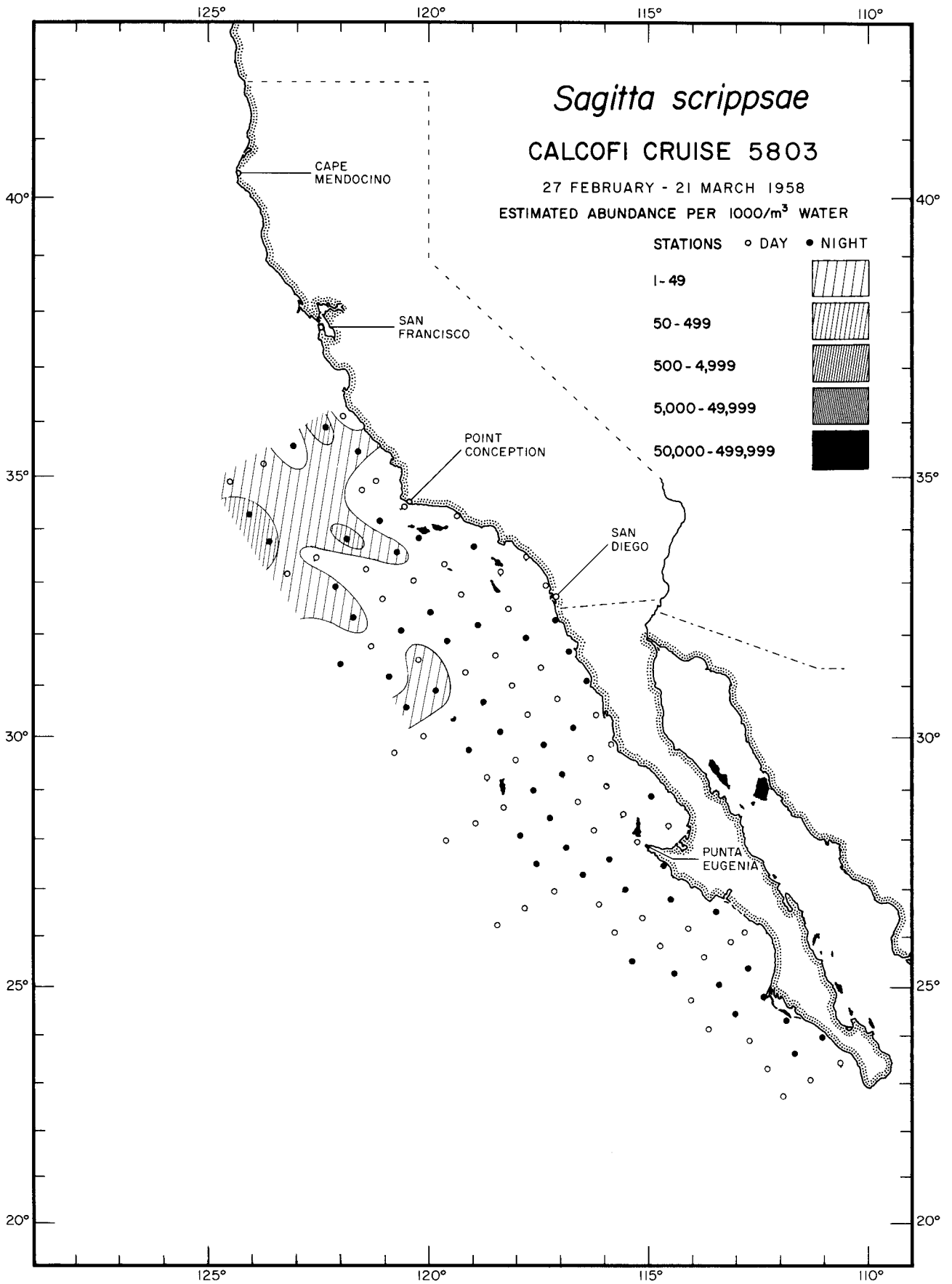


Chaetognatha  
*Sagitta pseudoserratodentata*  
5803

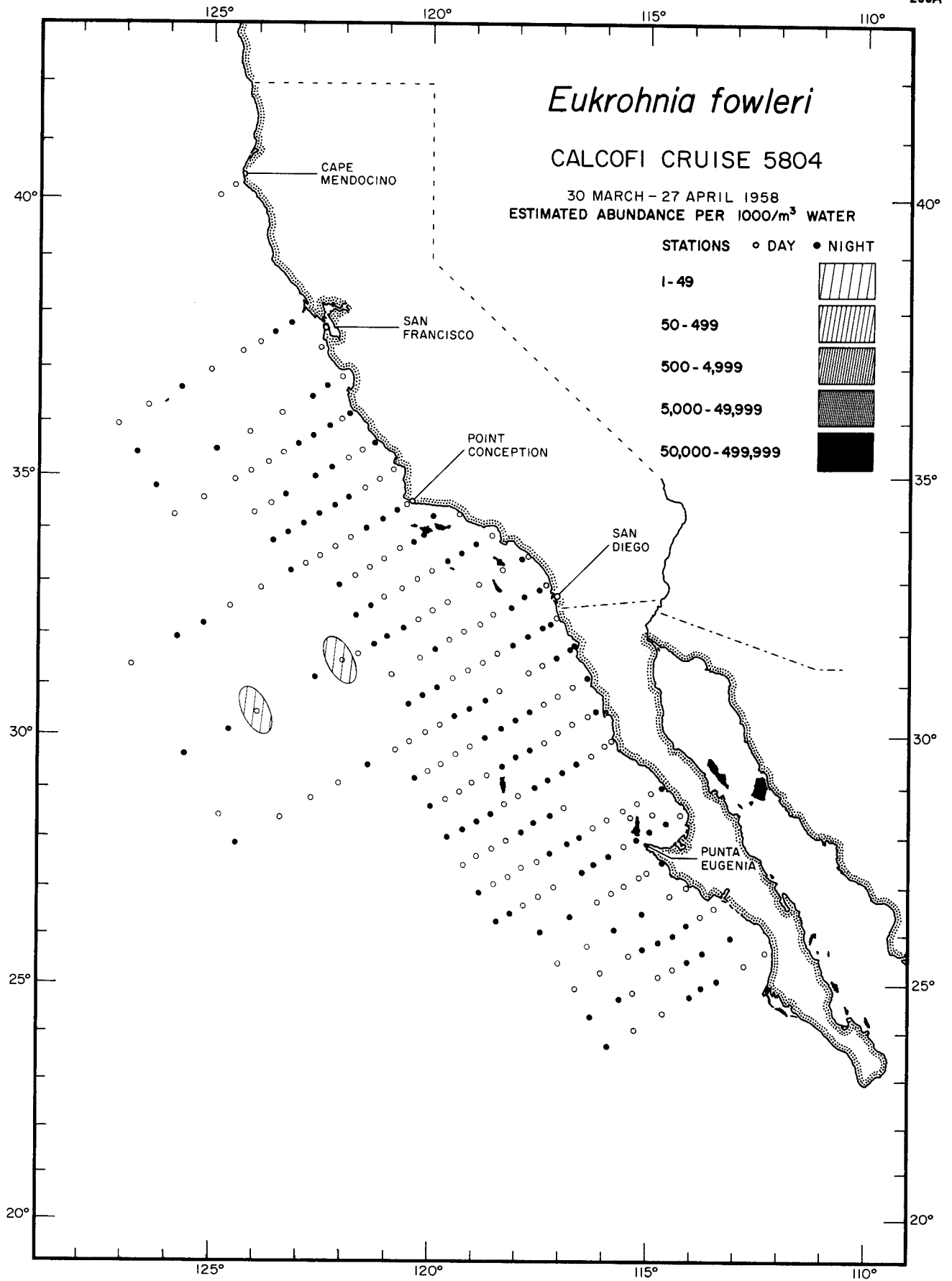


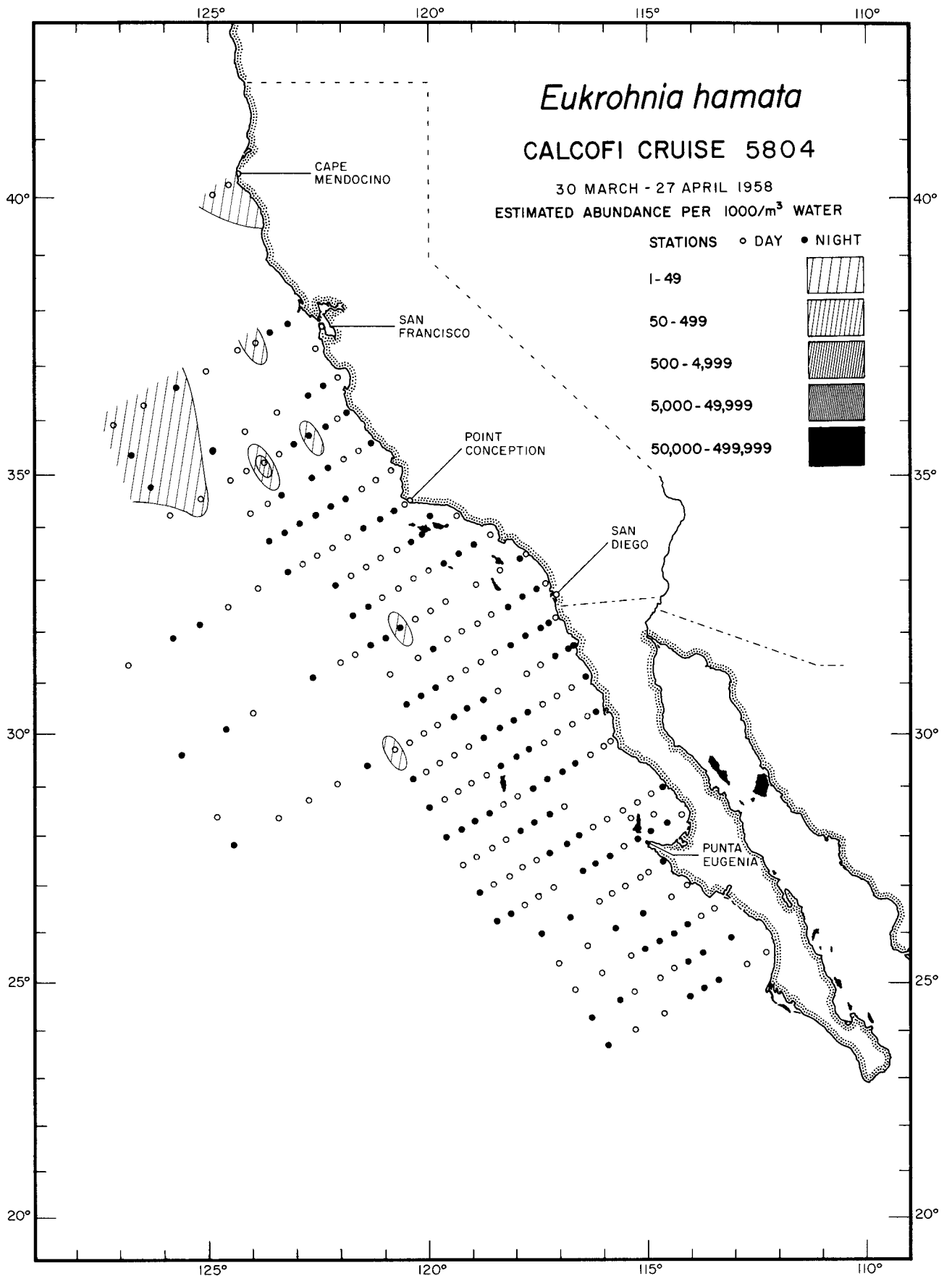
Chaetognatha  
*Sagitta regularis*  
5803



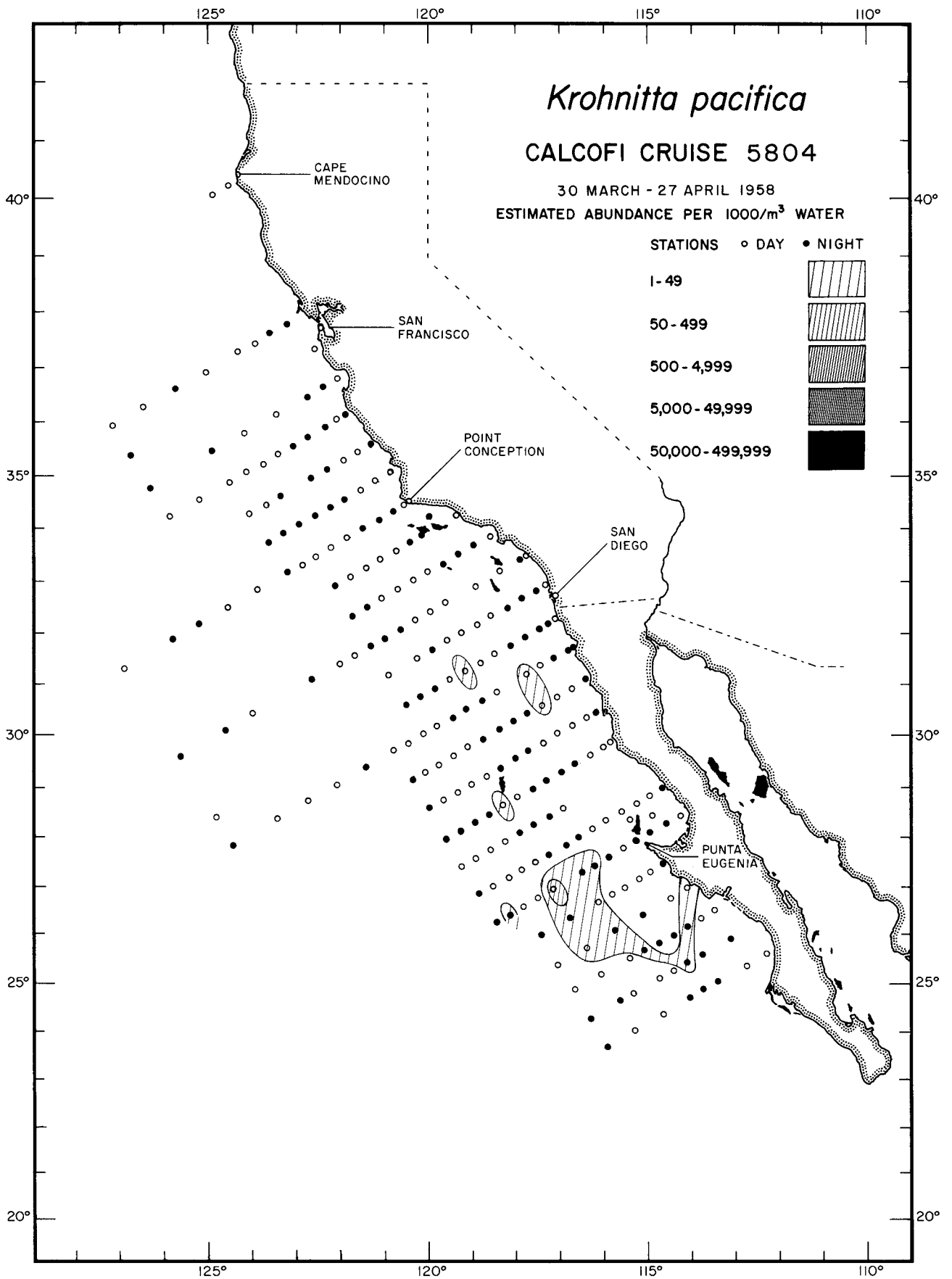


Chaetognatha  
*Sagitta scrippsae*  
5803

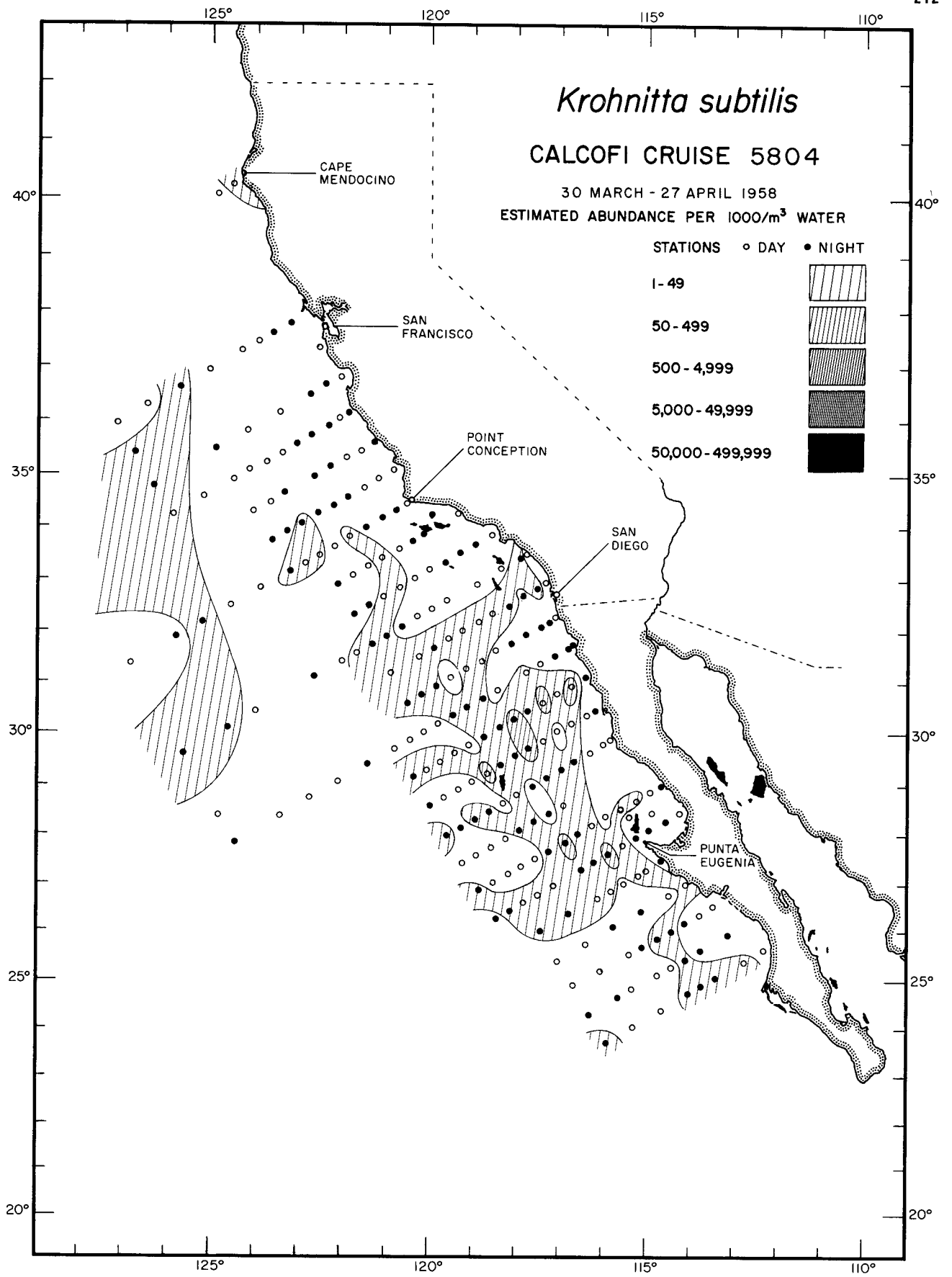




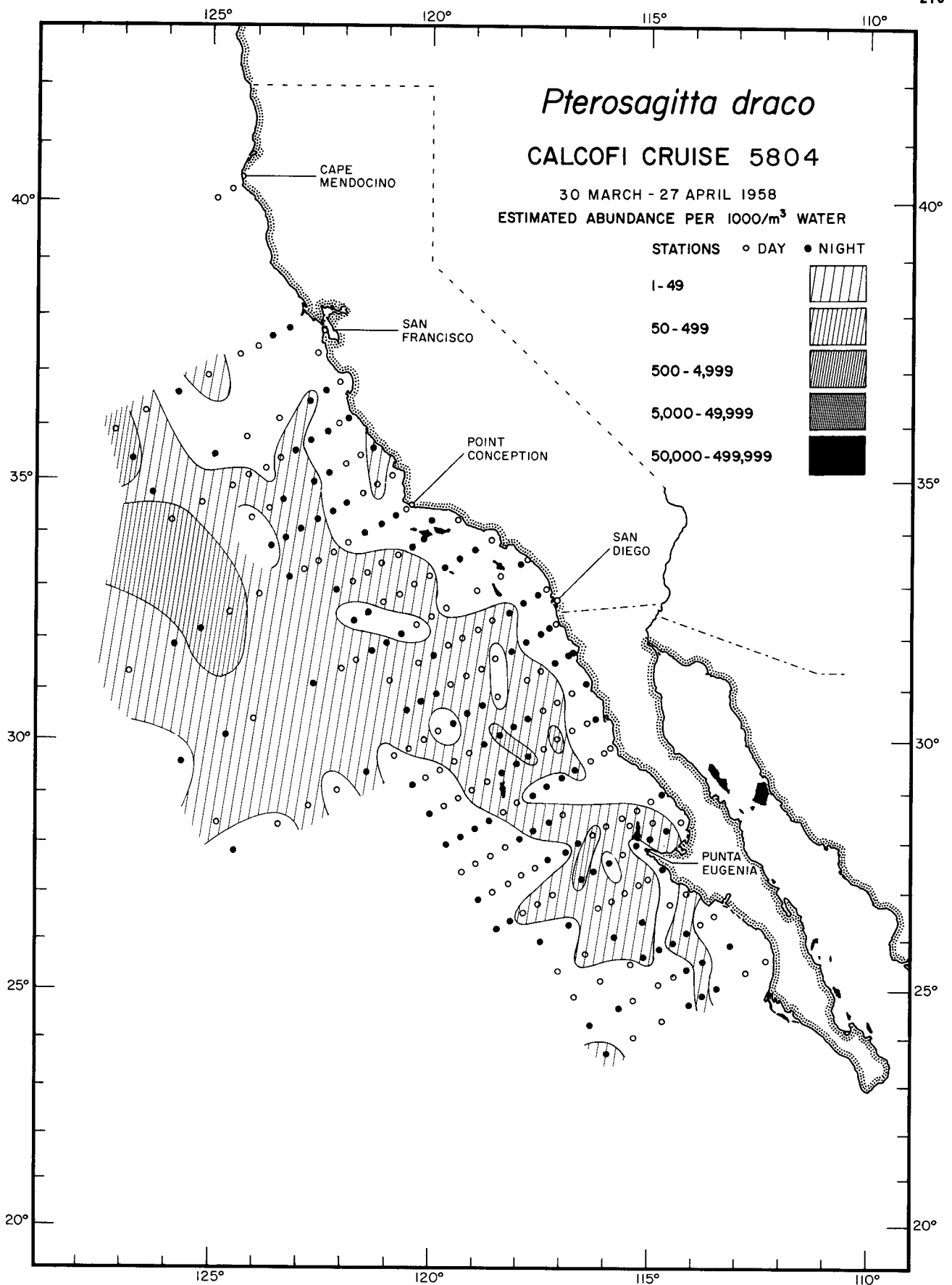
Chaetognatha  
*Eukrohnia hamata*  
5804



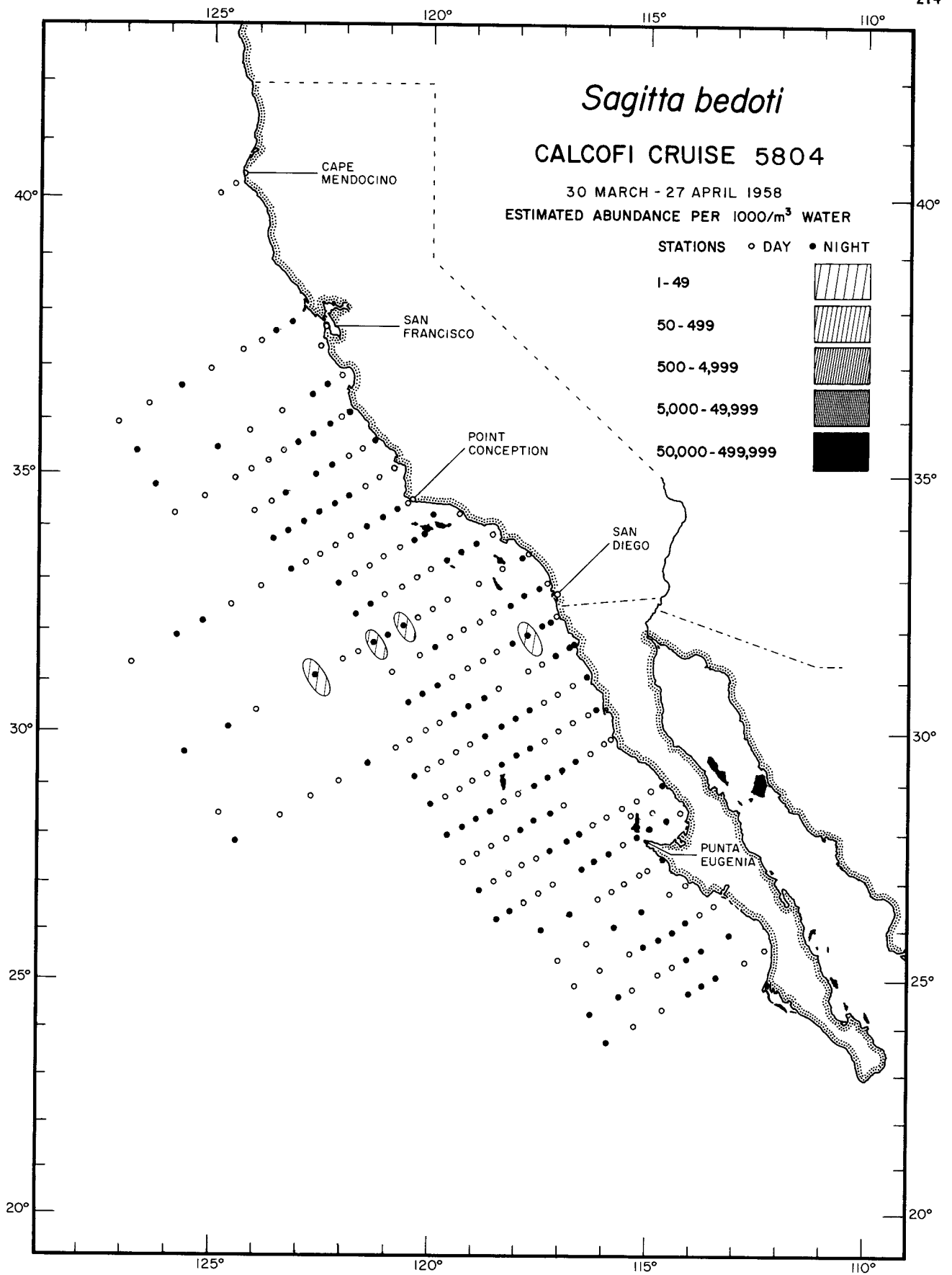
Chaetognatha  
*Krohnitta pacifica*  
5804



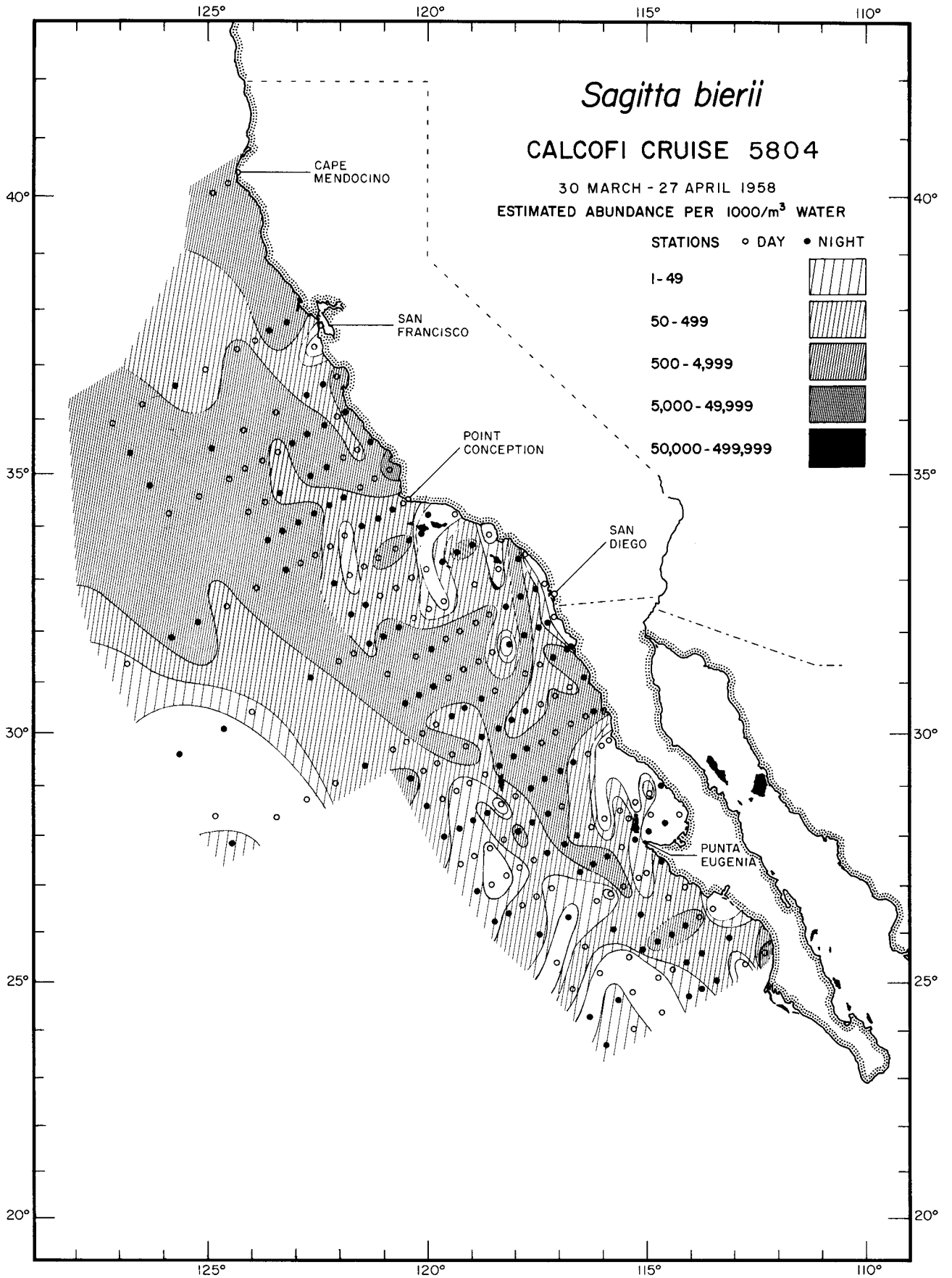
Chaetognatha  
*Krohnitta subtilis*  
5804



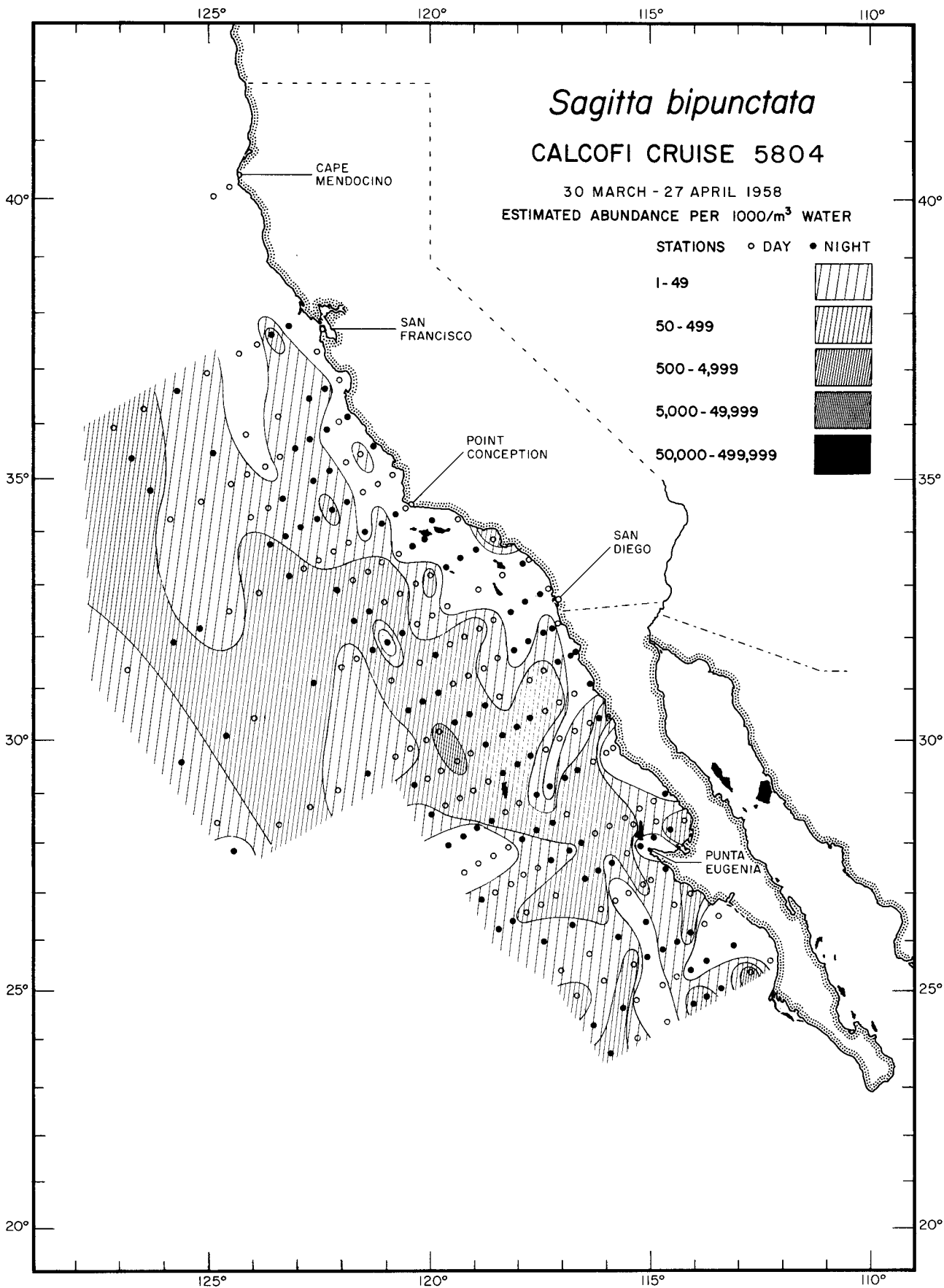
Chaetognatha  
*Pterosagitta draco*  
 5804



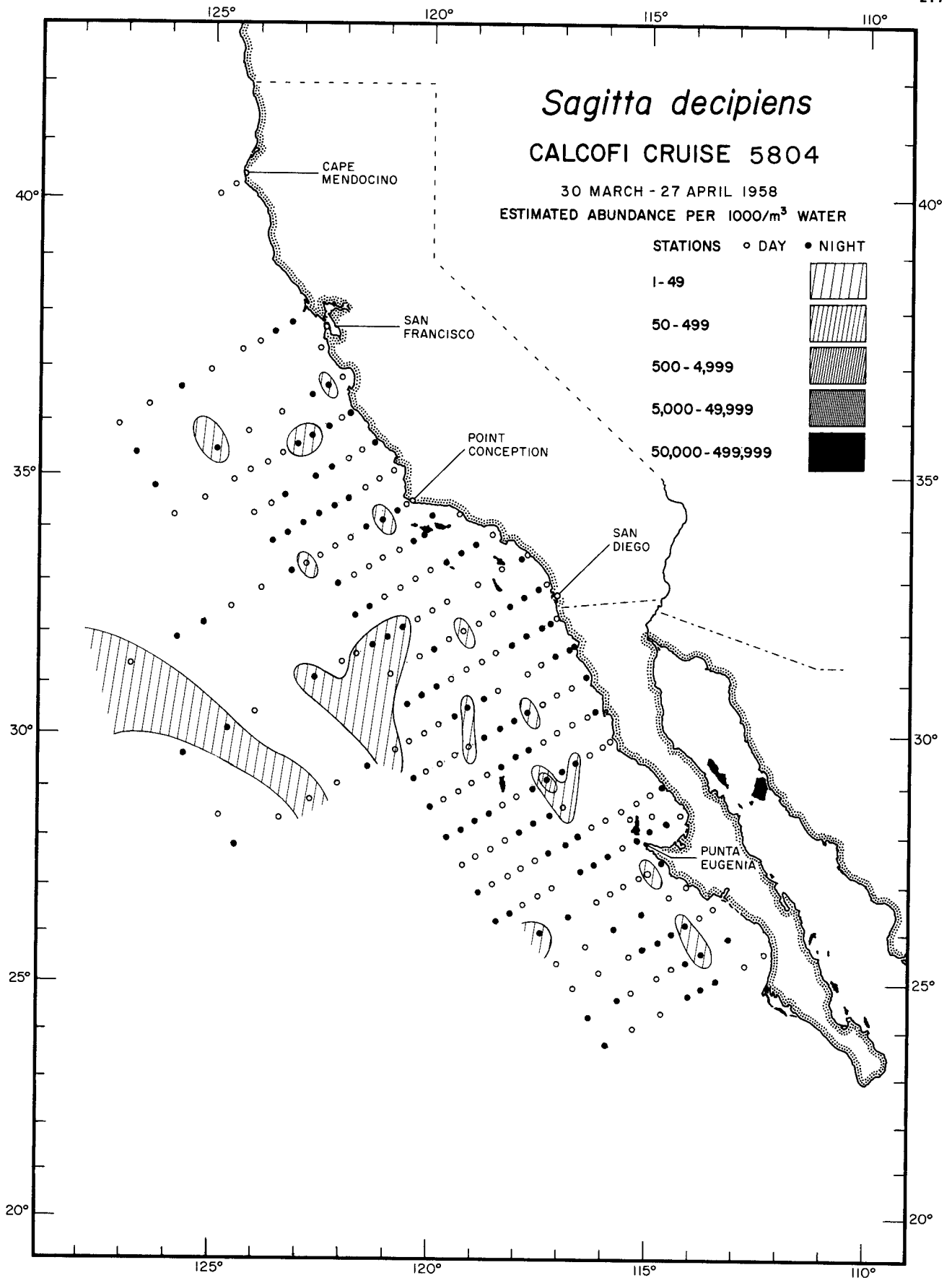
Chaetognatha  
*Sagitta bedoti*  
5804



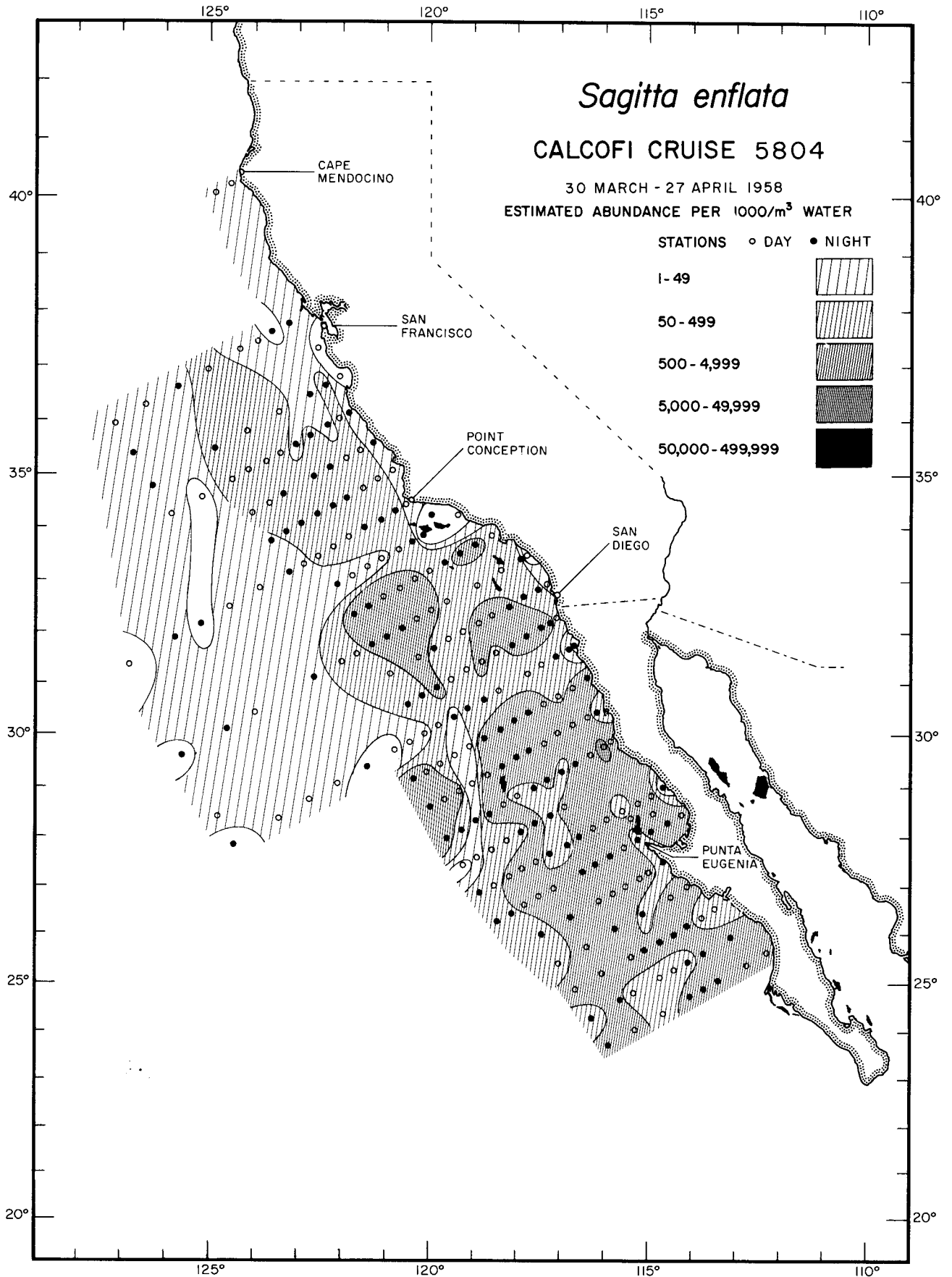




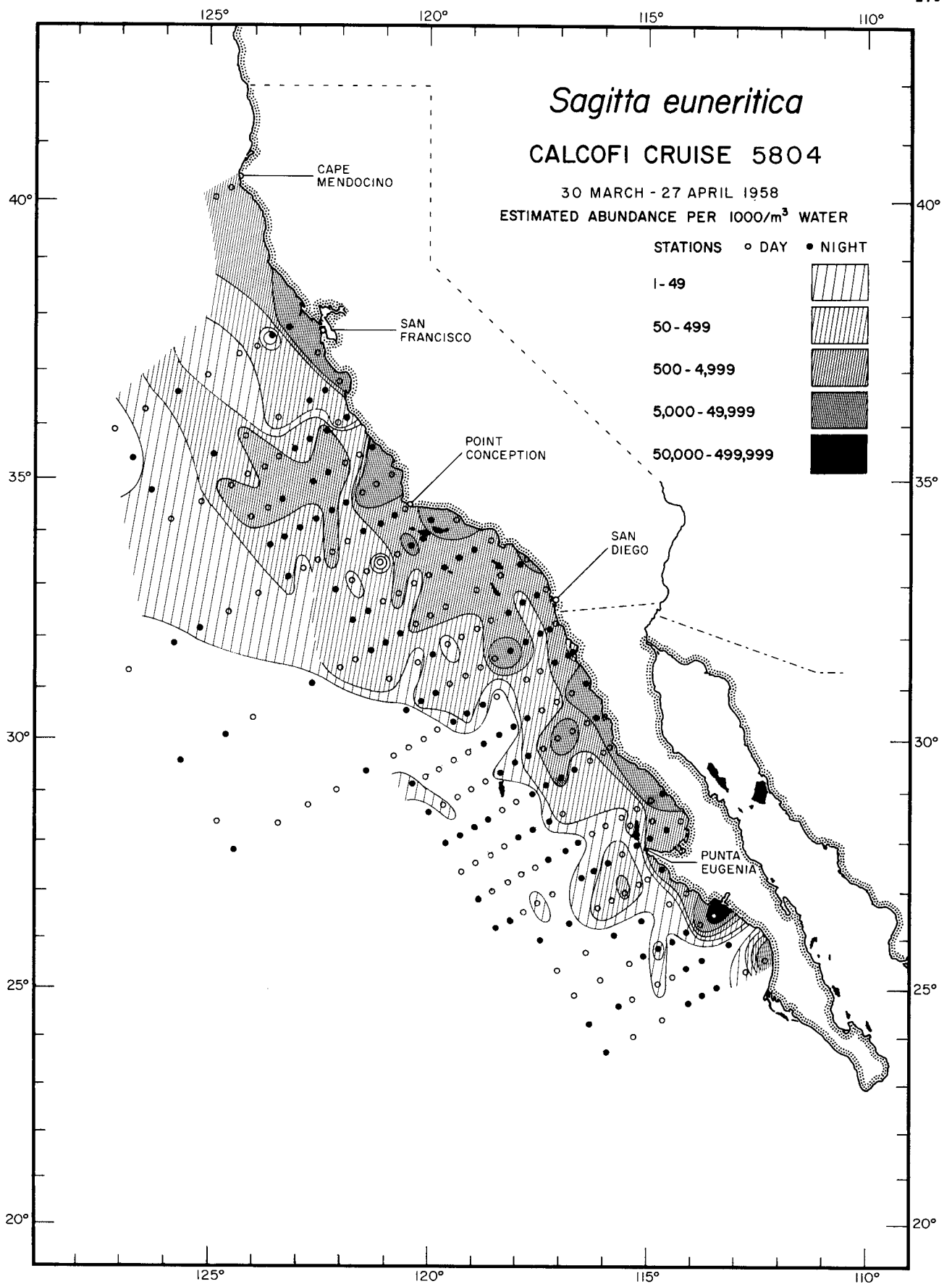
Chaetognatha  
*Sagitta bipunctata*  
5804

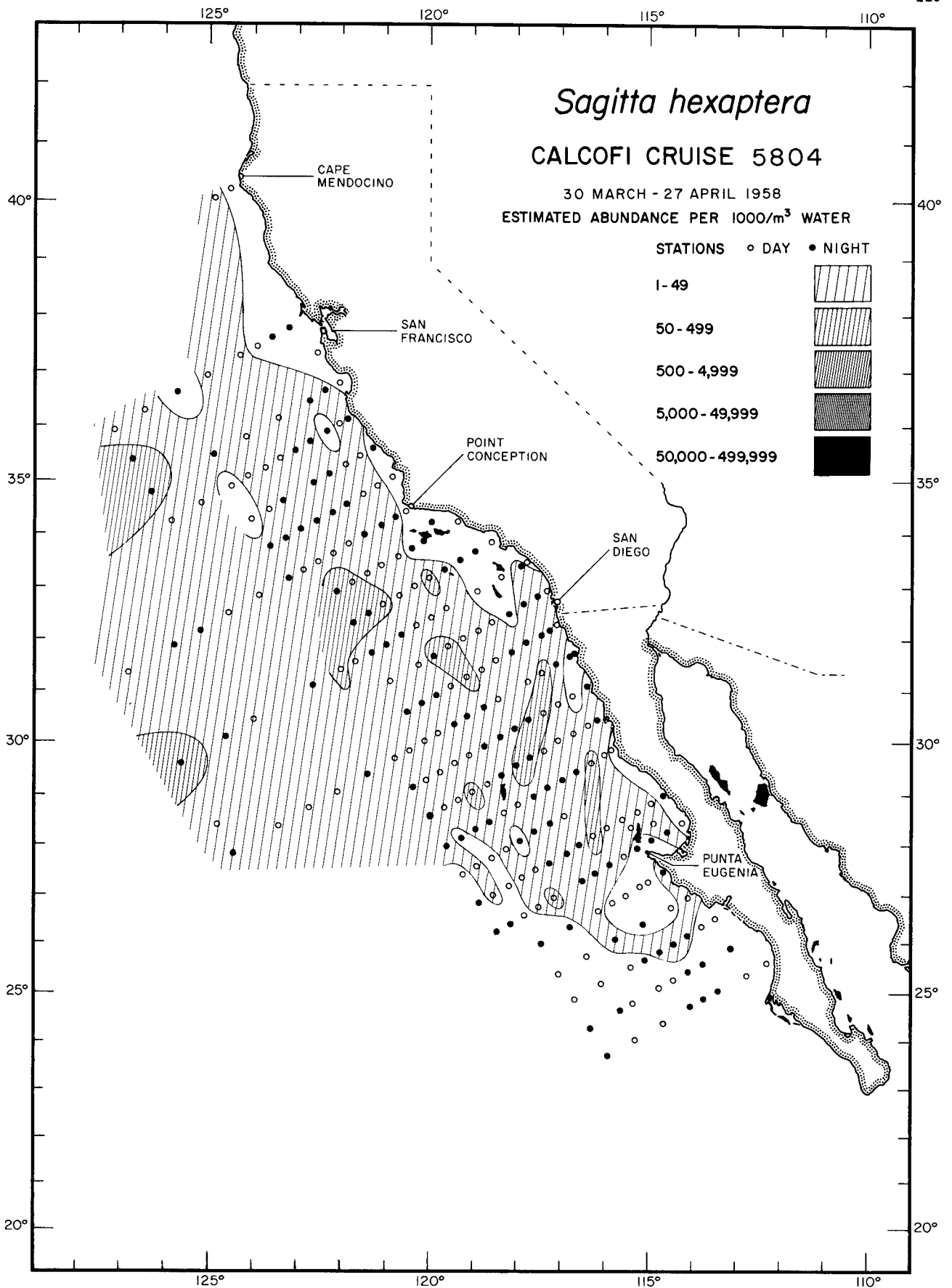


Chaetognatha  
*Sagitta decipiens*  
5804

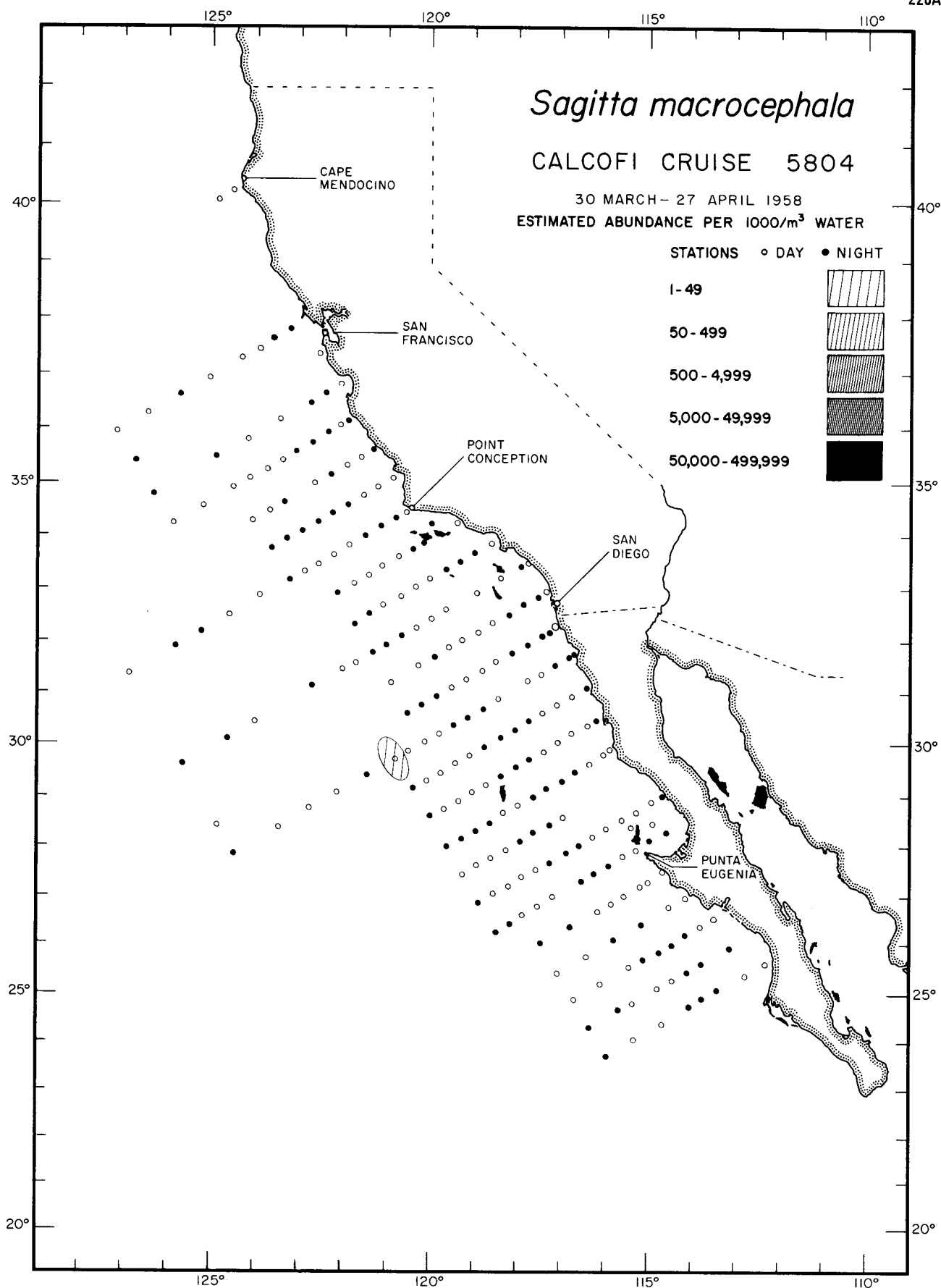


Chaetognatha  
*Sagitta enflata*  
5804

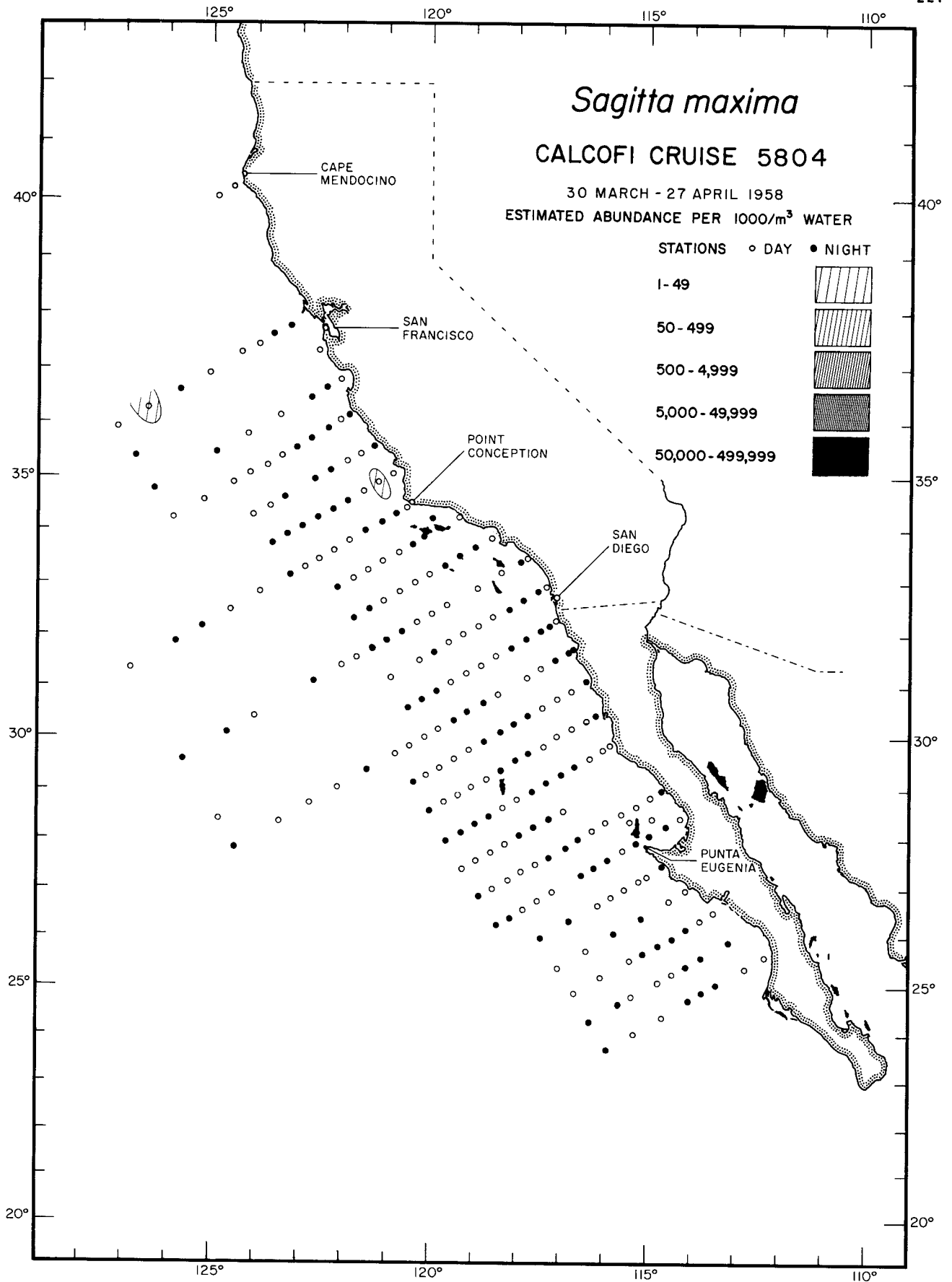




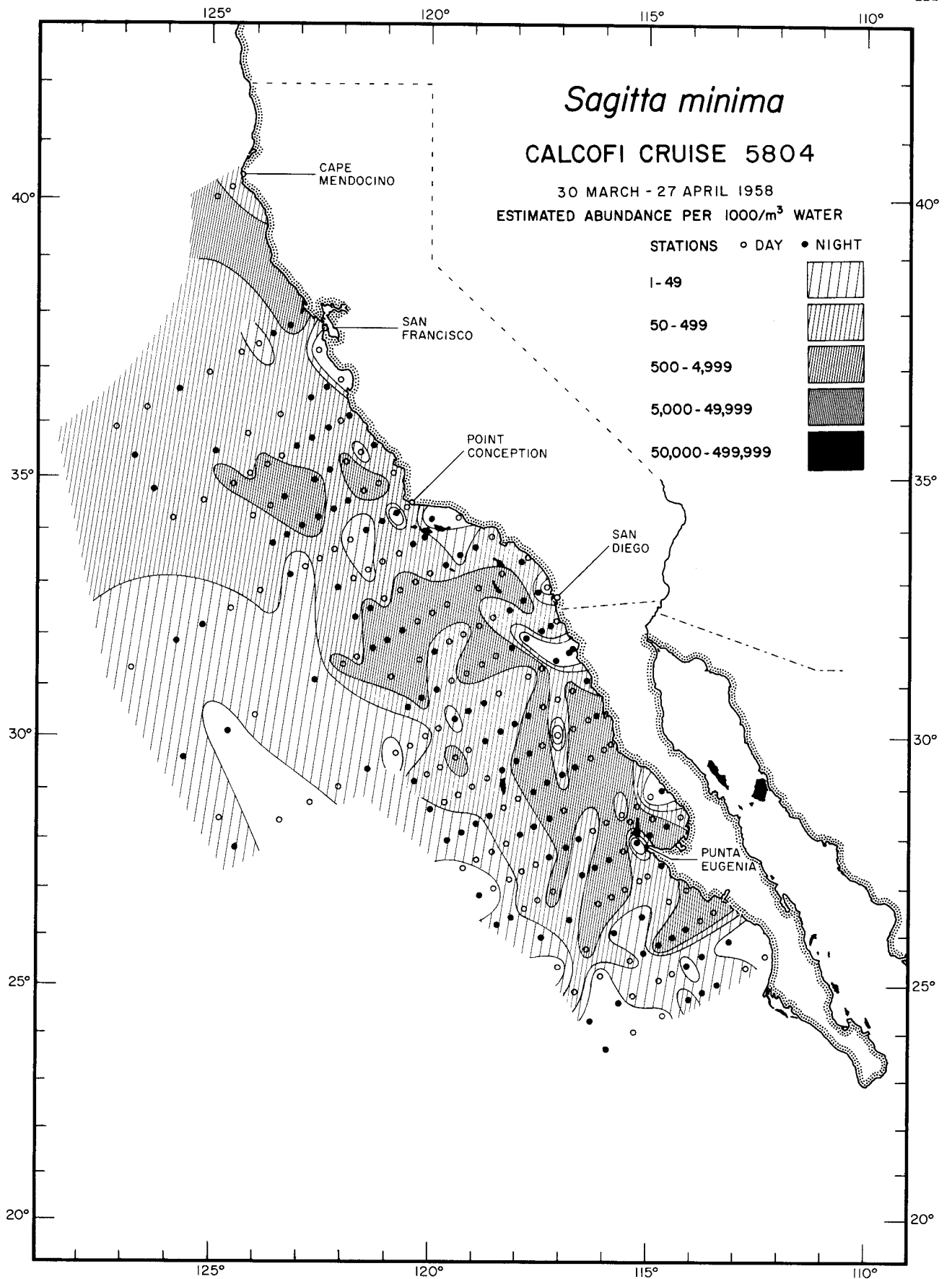
Chaetognatha  
*Sagitta hexaptera*  
5804



Chaetognatha  
*Sagitta macrocephala*  
5804

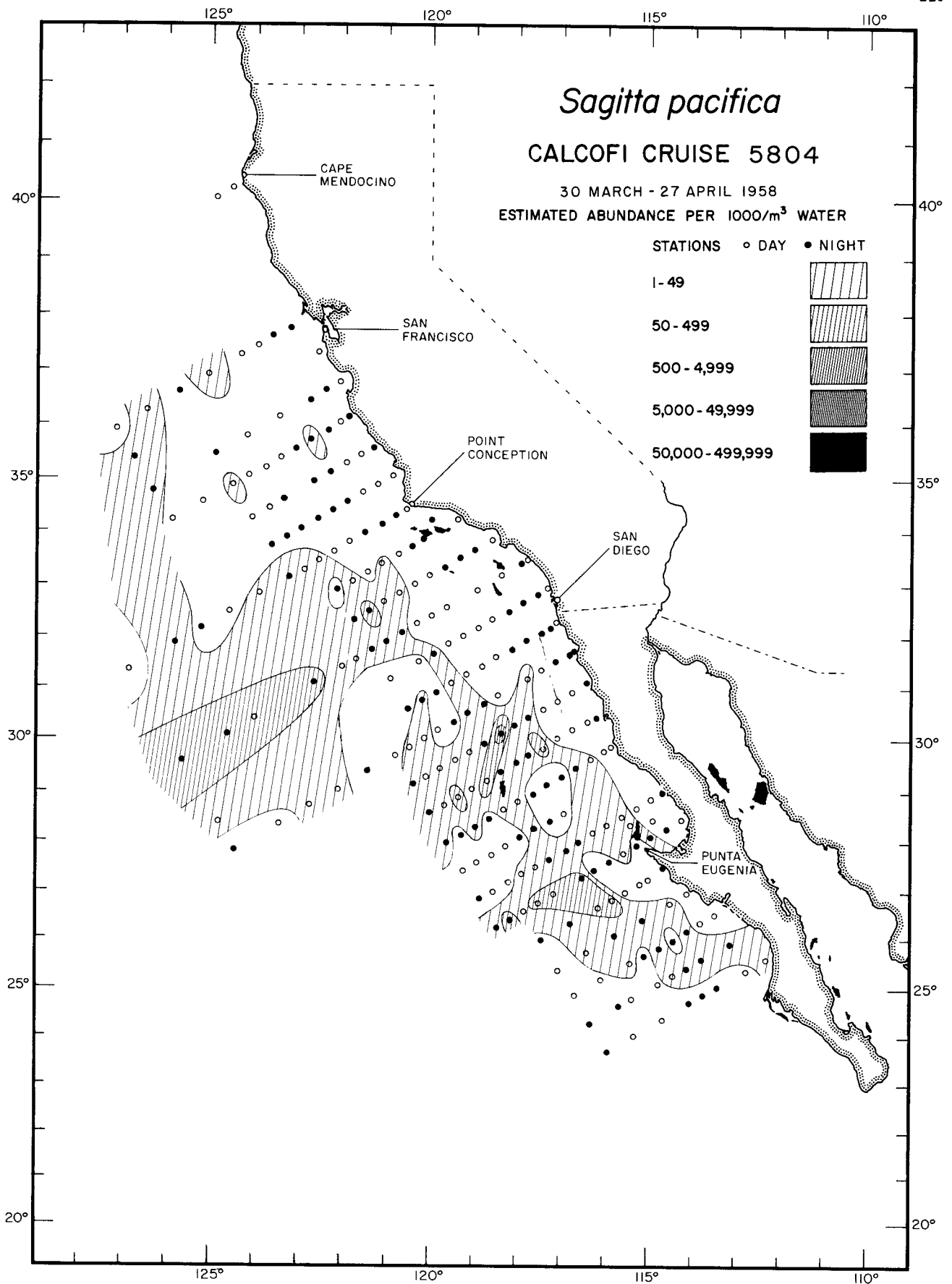


Chaetognatha  
*Sagitta maxima*  
5804

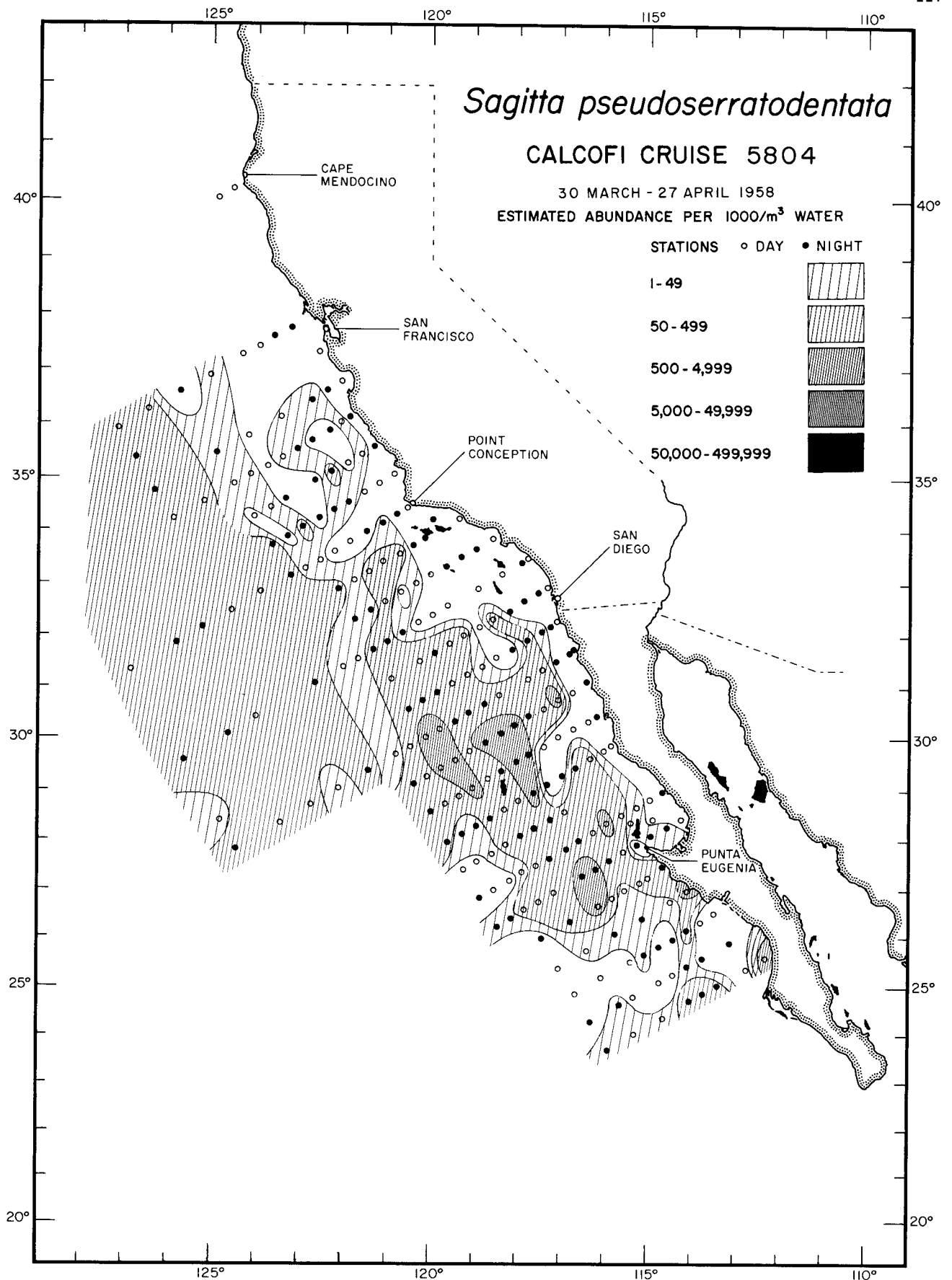


Chaetognatha  
*Sagitta minima*  
5804

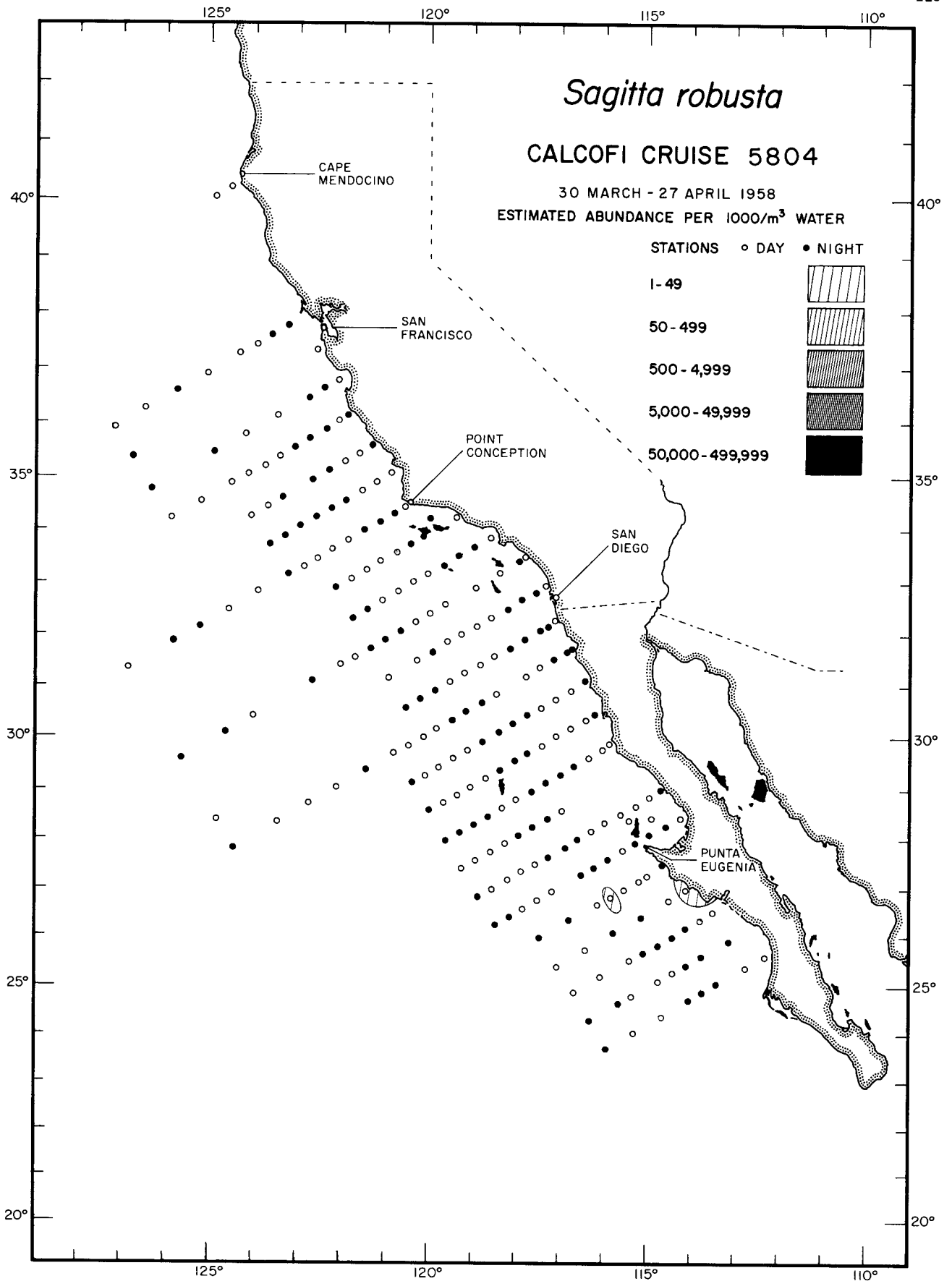




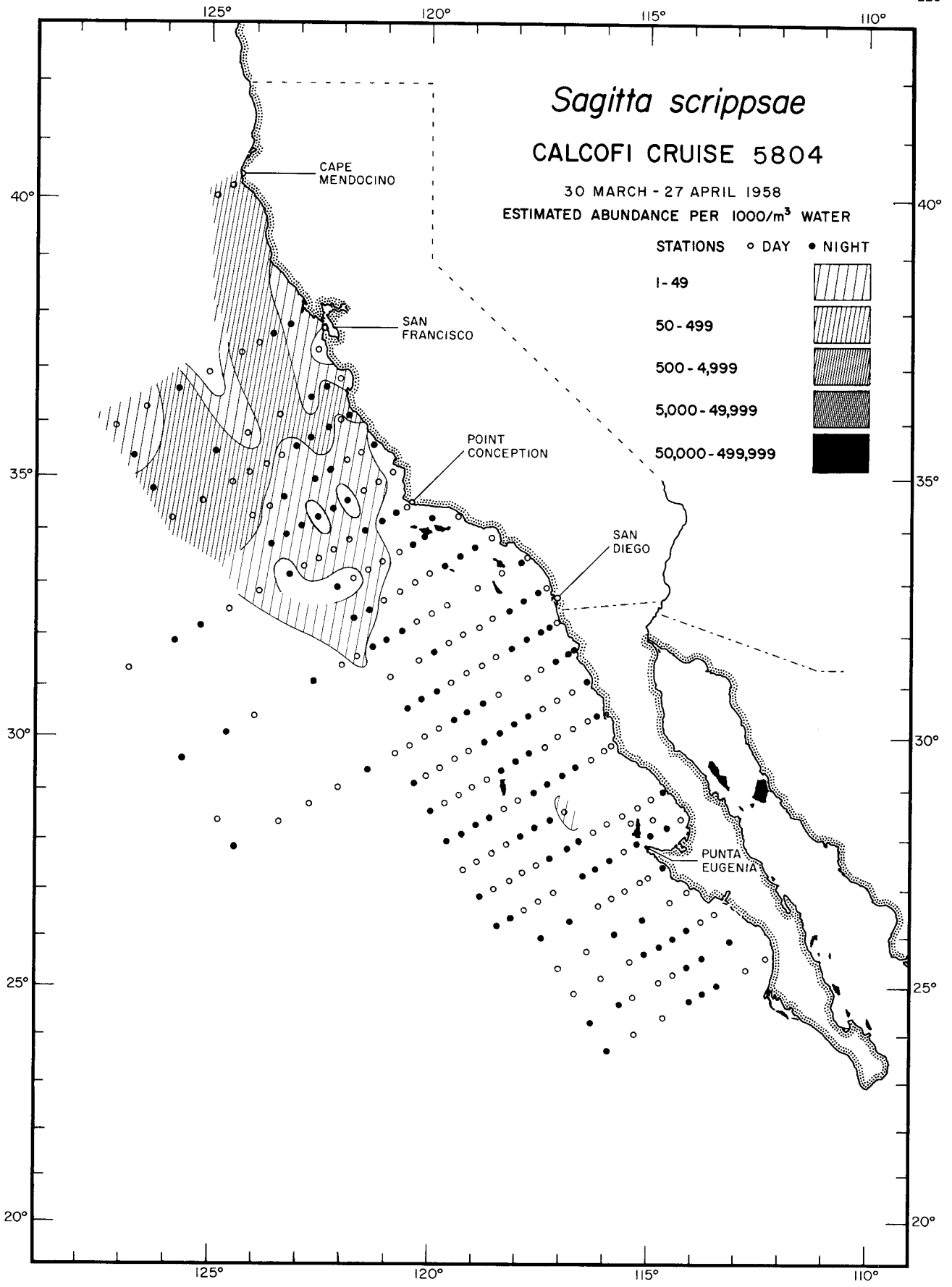
Chaetognatha  
*Sagitta pacifica*  
5804



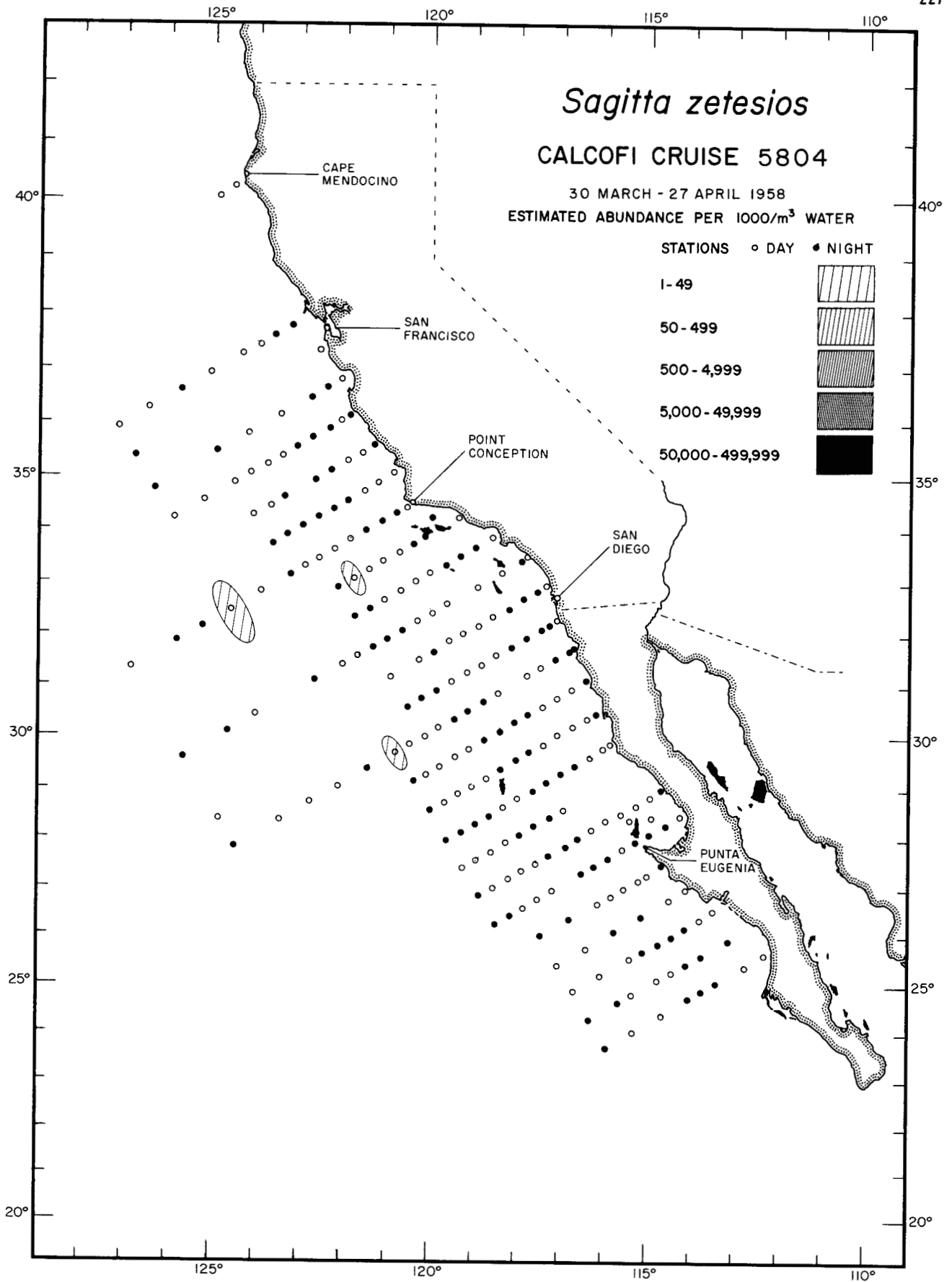
Chaetognatha  
*Sagitta pseudoserratodentata*  
5804



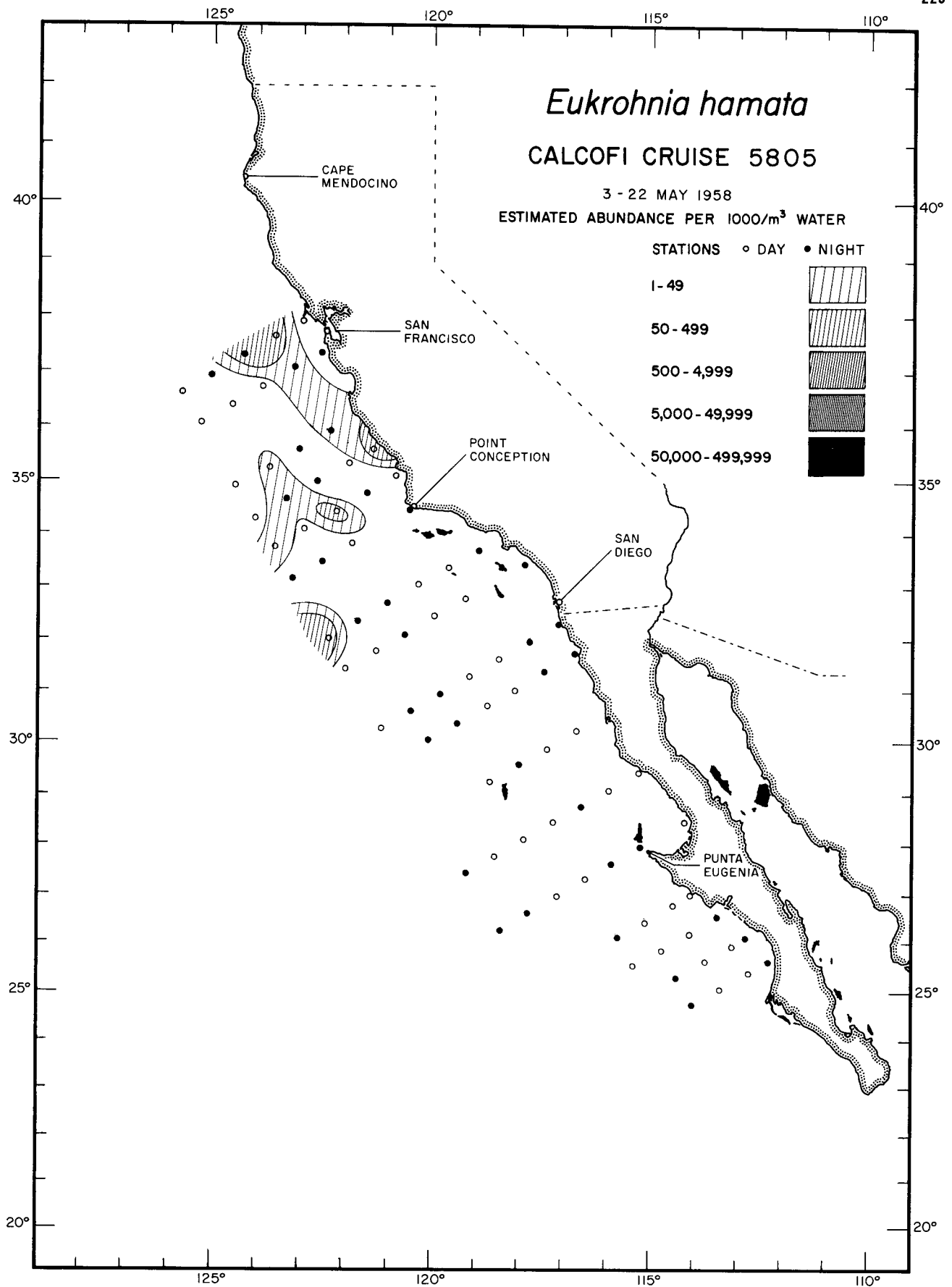
Chaetognatha  
*Sagitta robusta*  
5804



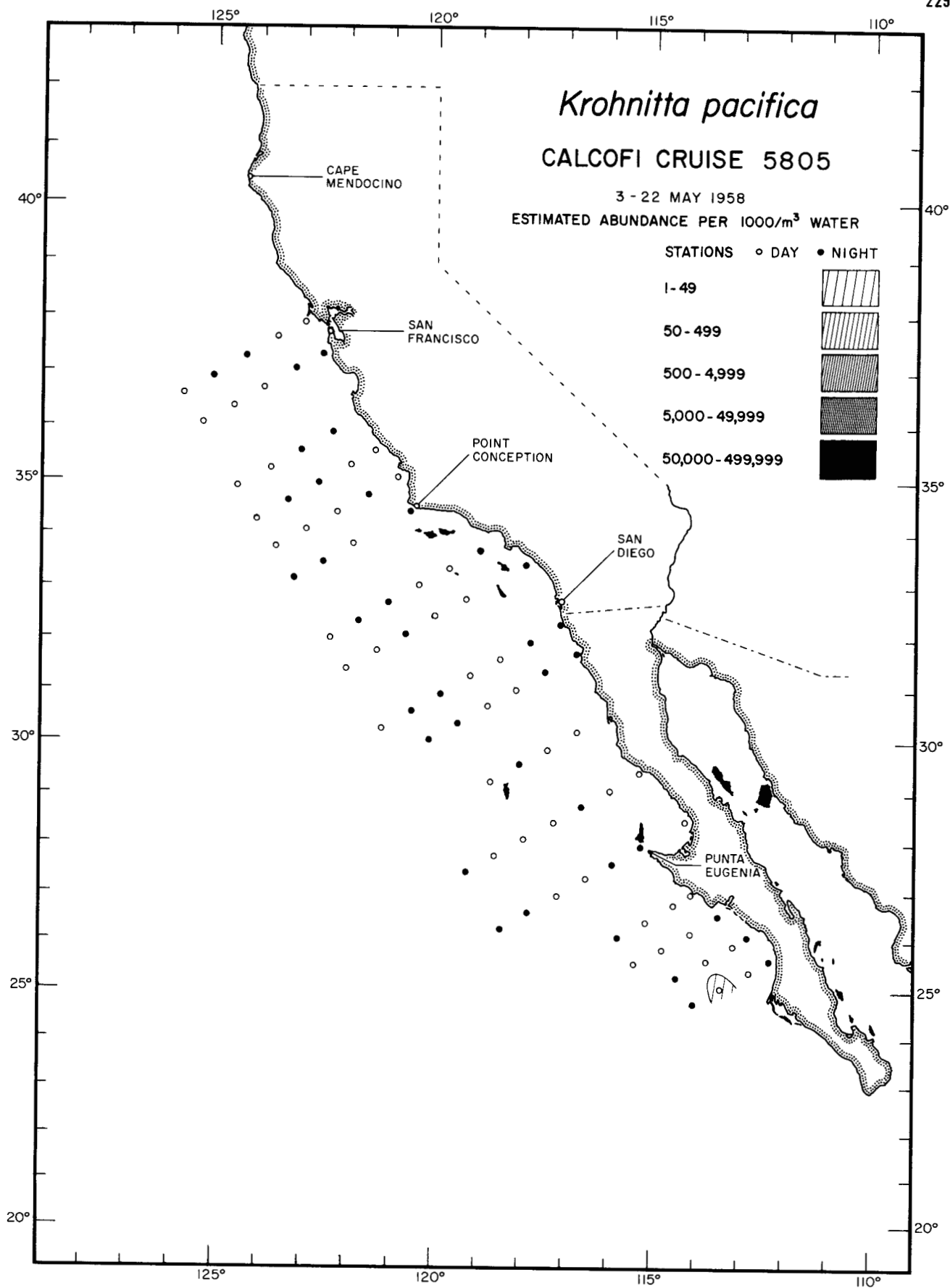
Chaetognatha  
*Sagitta scrippsae*  
5804



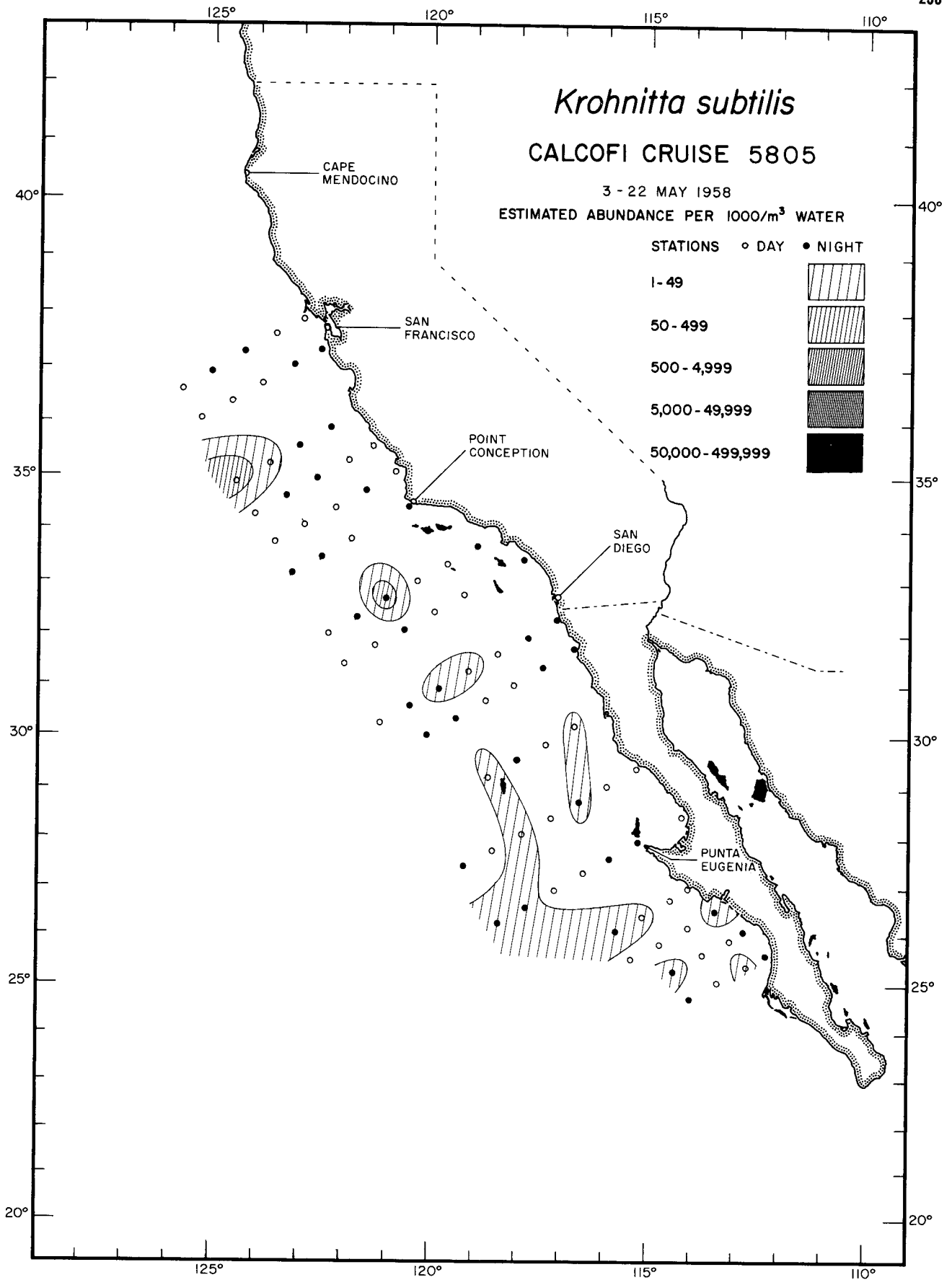
Chaetognatha  
*Sagitta zetesios*  
5804



Chaetognatha  
*Eukrohnia hamata*  
5805

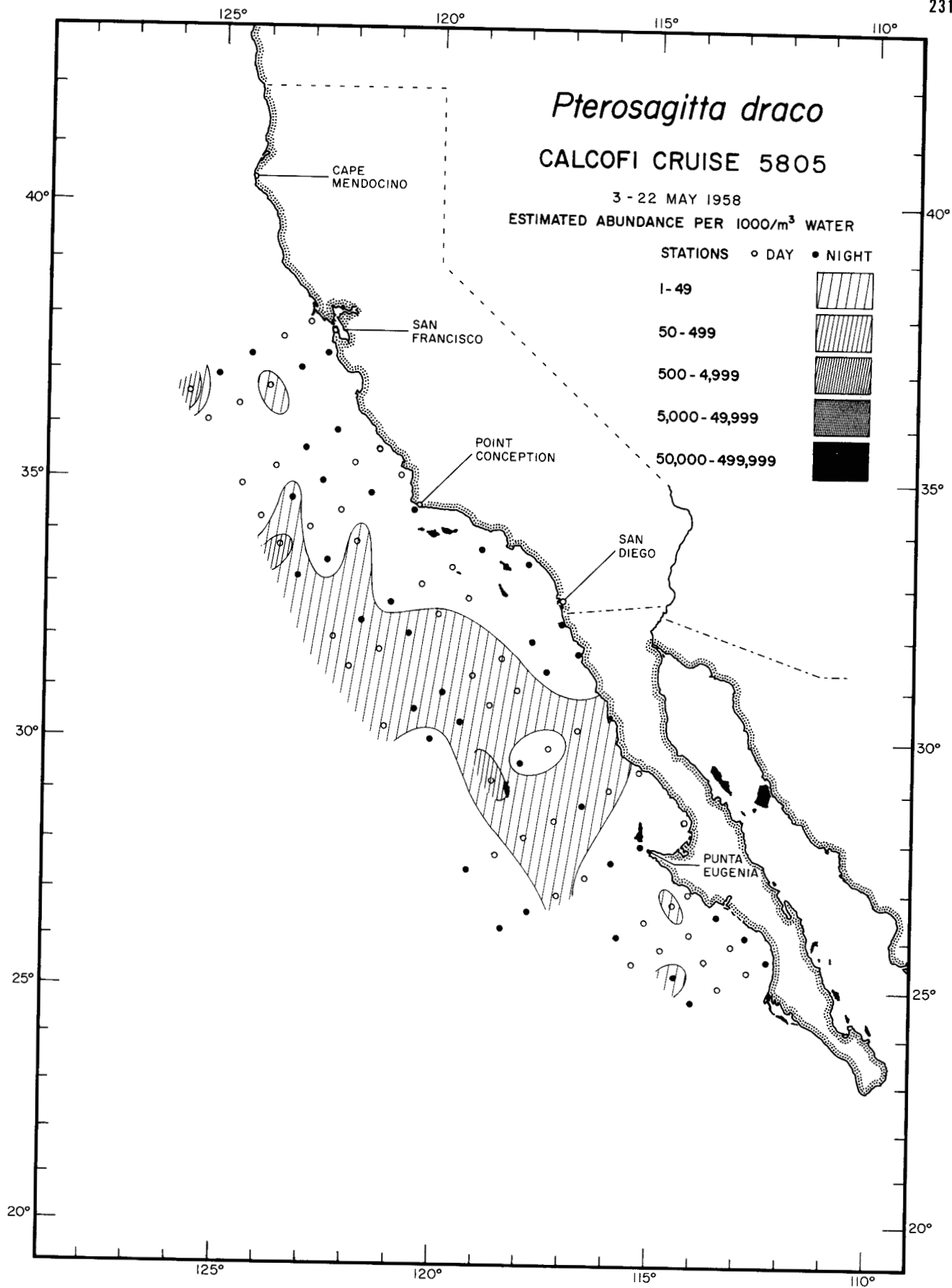


Chaetognatha  
*Krohnitta pacifica*  
5805

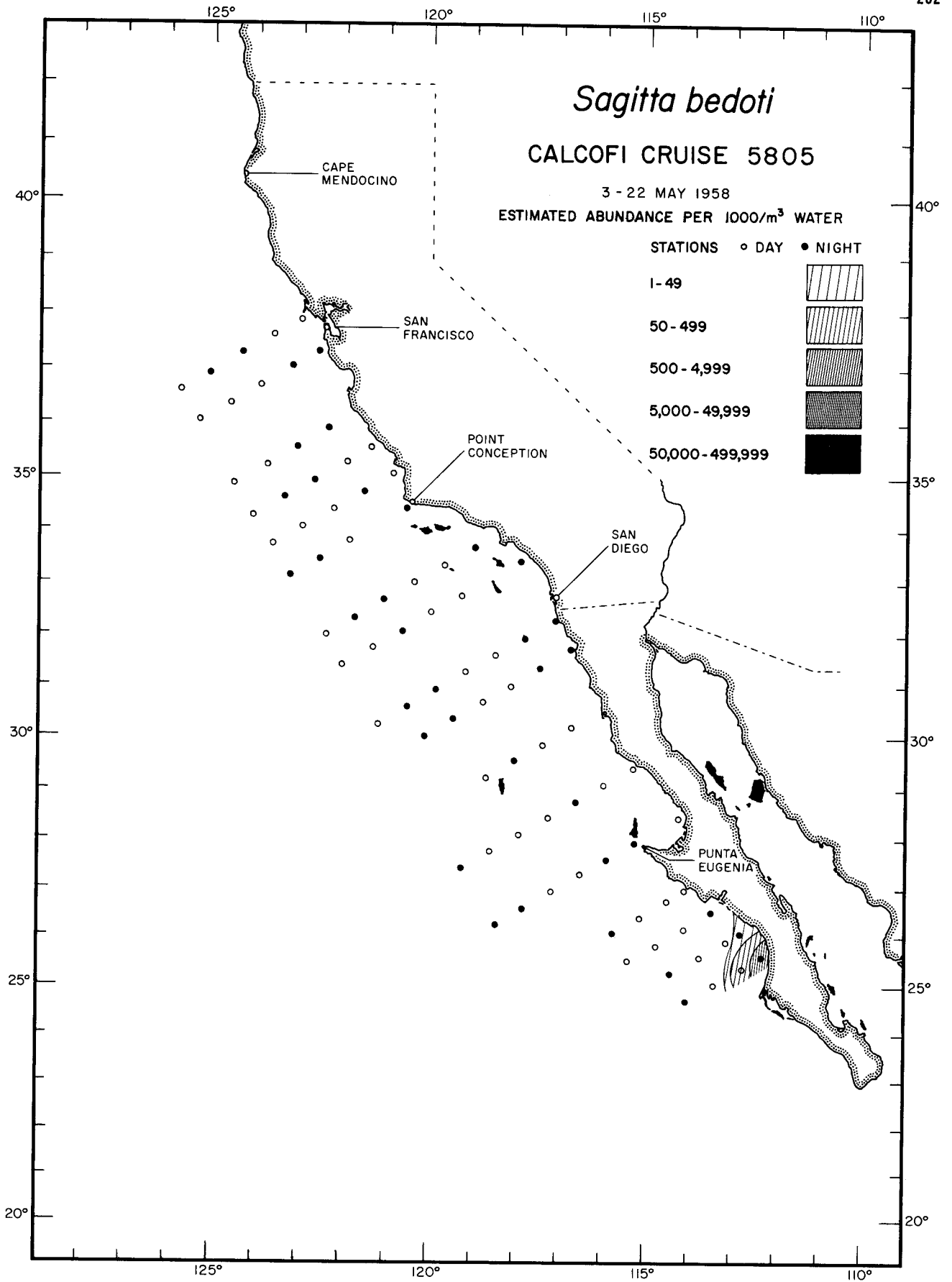


Chaetognatha  
*Krohnitta subtilis*  
5805

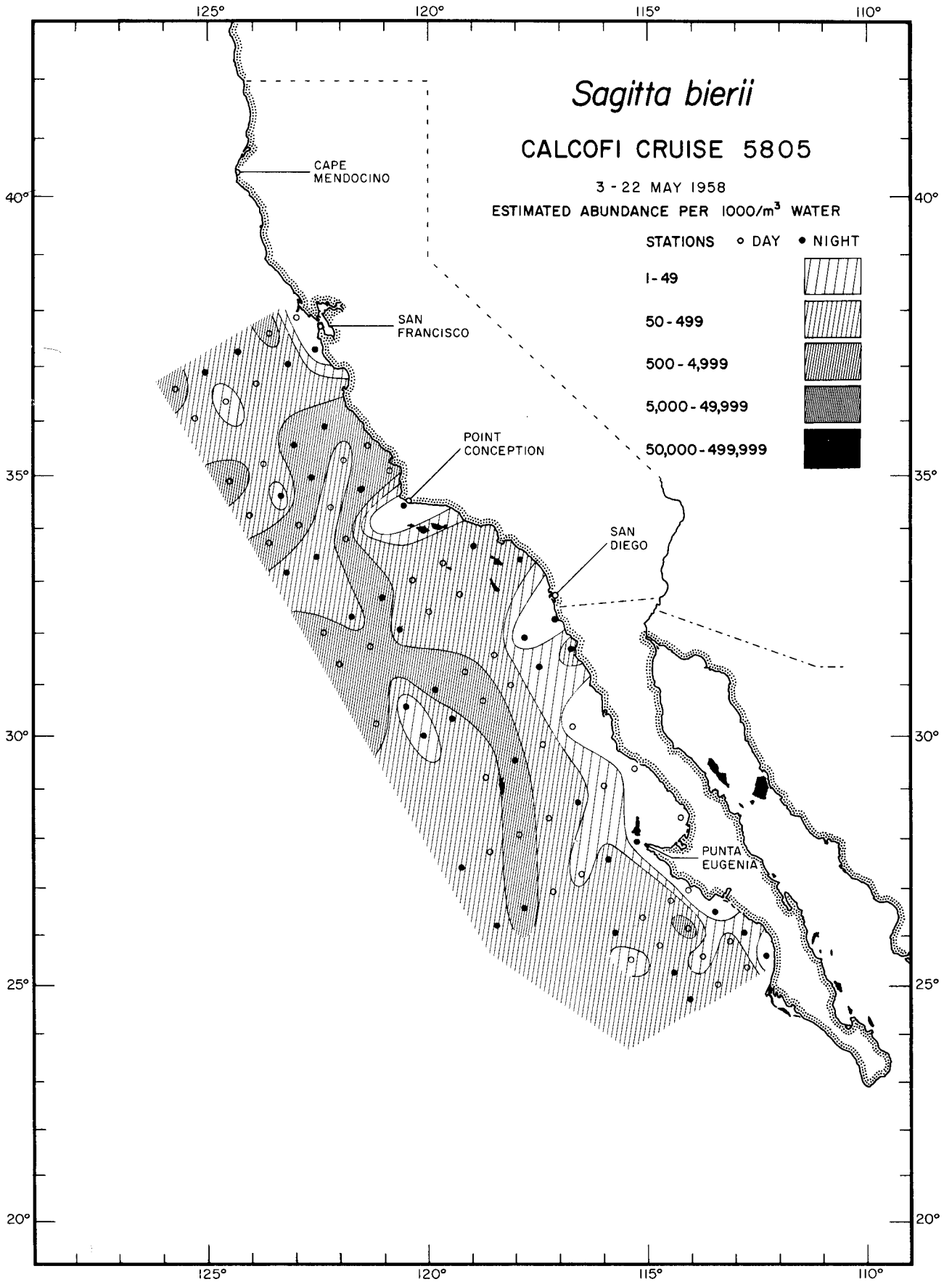




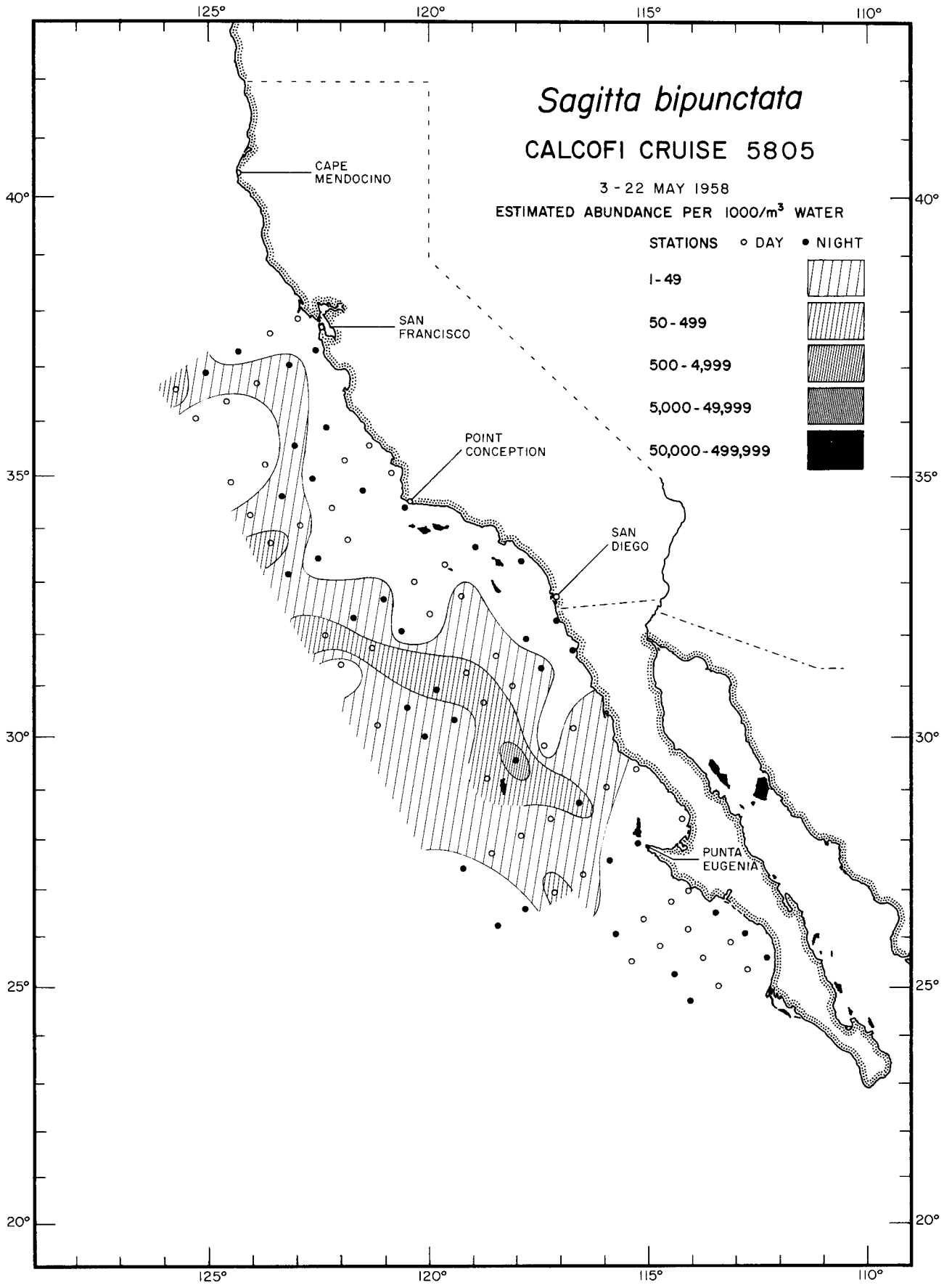
Chaetognatha  
*Pterosagitta draco*  
5805



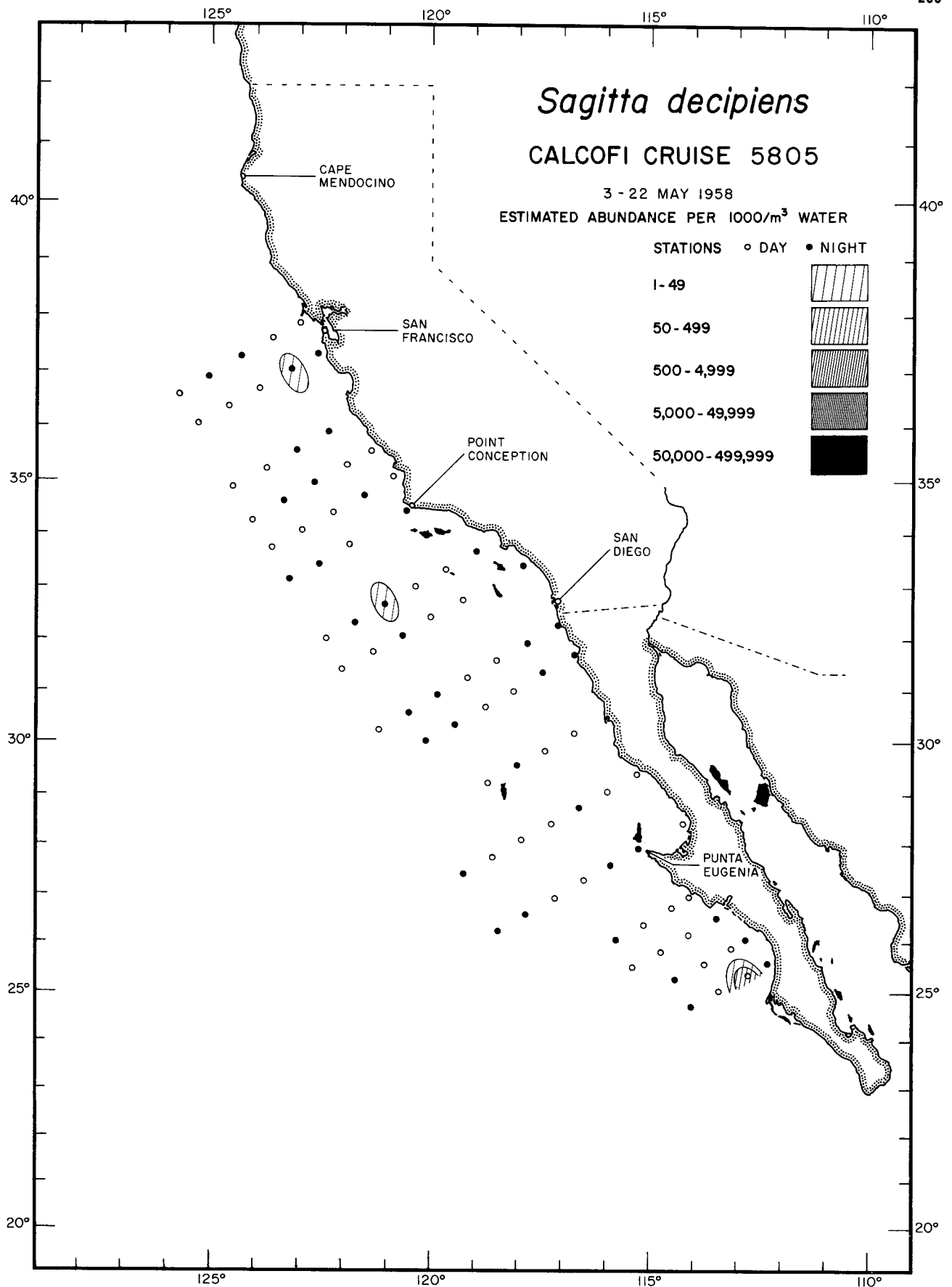
Chaetognatha  
*Sagitta bedoti*  
5805



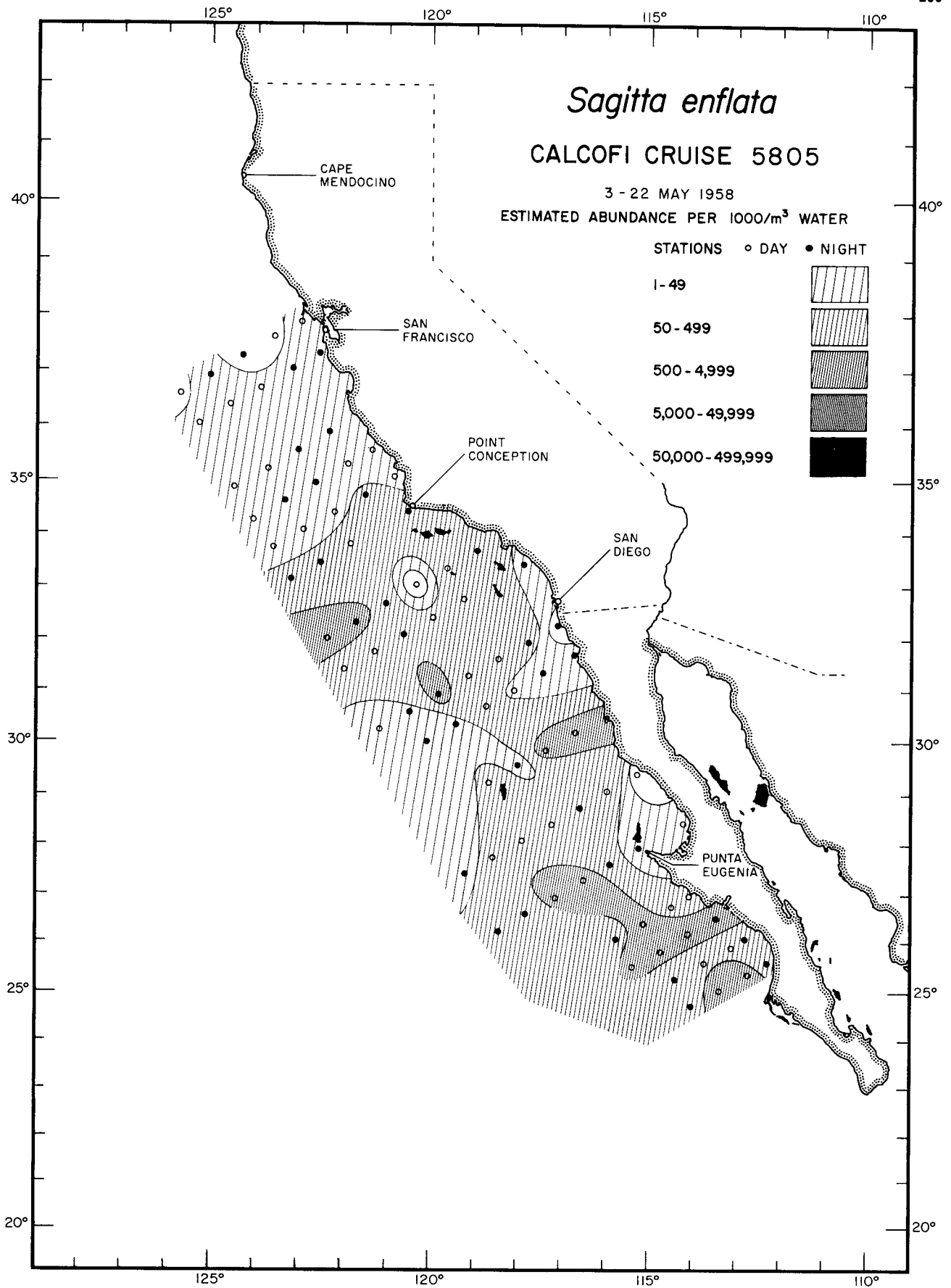
Chaetognatha  
*Sagitta bierii*  
5805



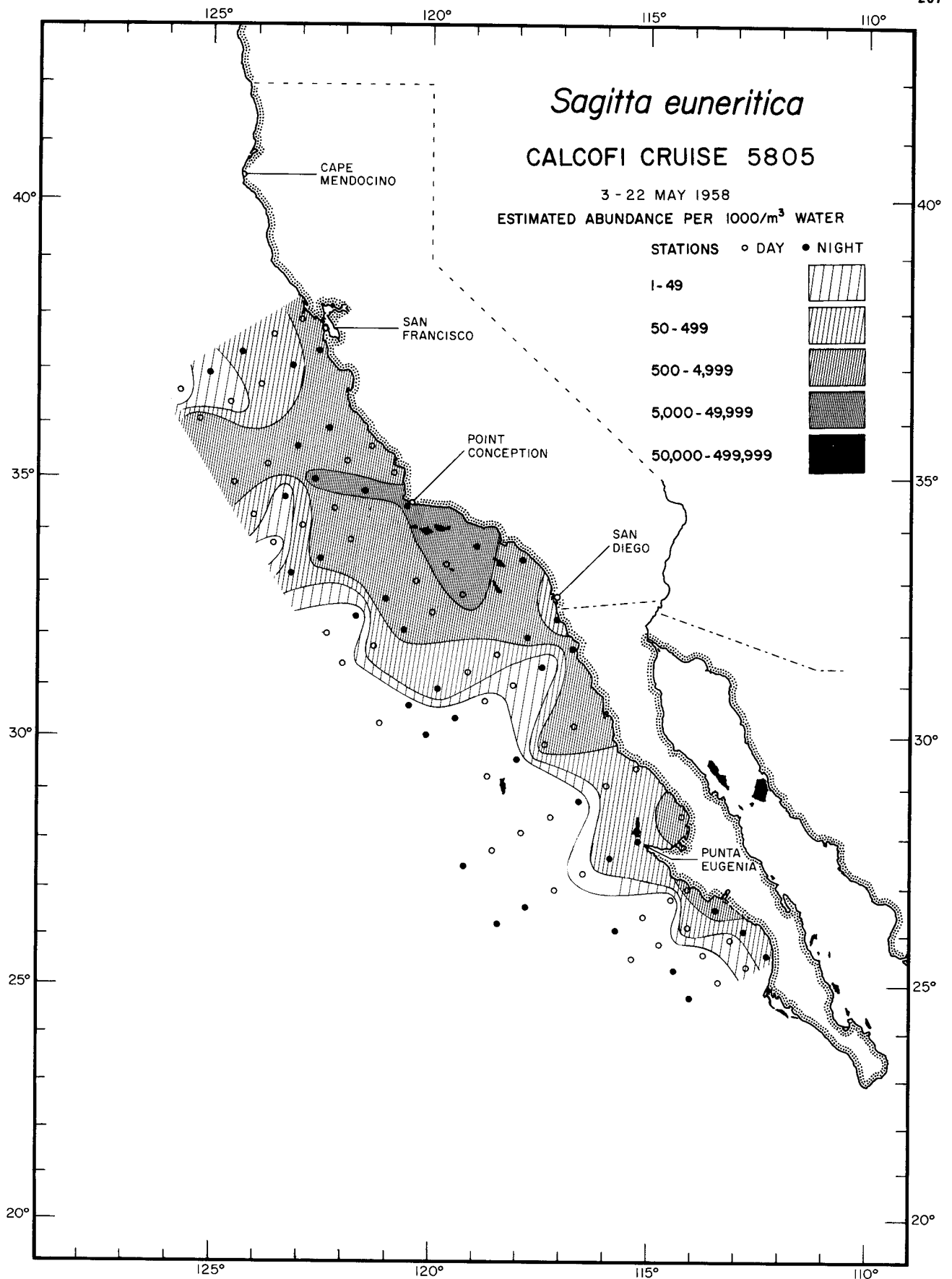
Chaetognatha  
*Sagitta bipunctata*  
5805

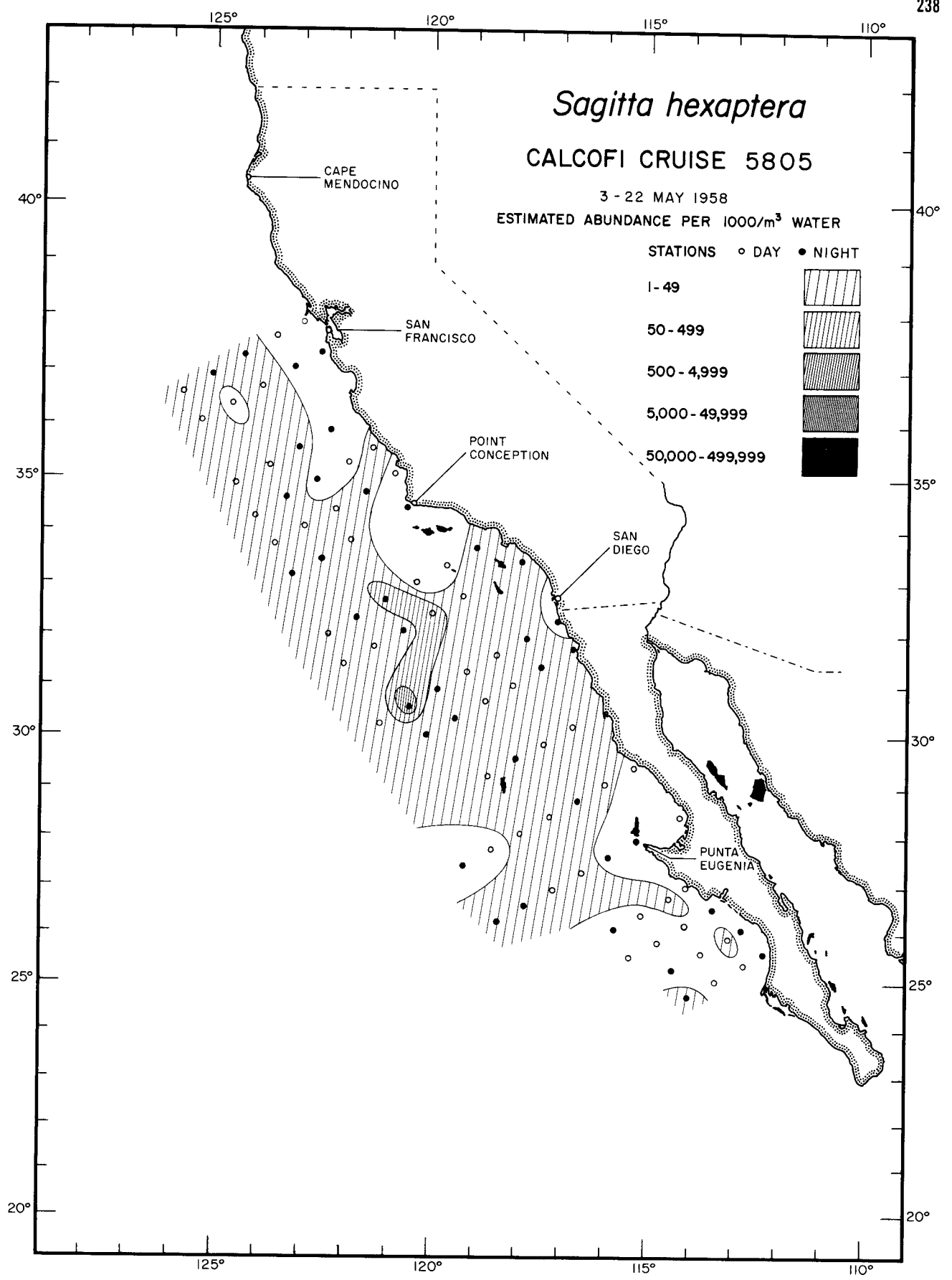


Chaetognatha  
*Sagitta decipiens*  
5805



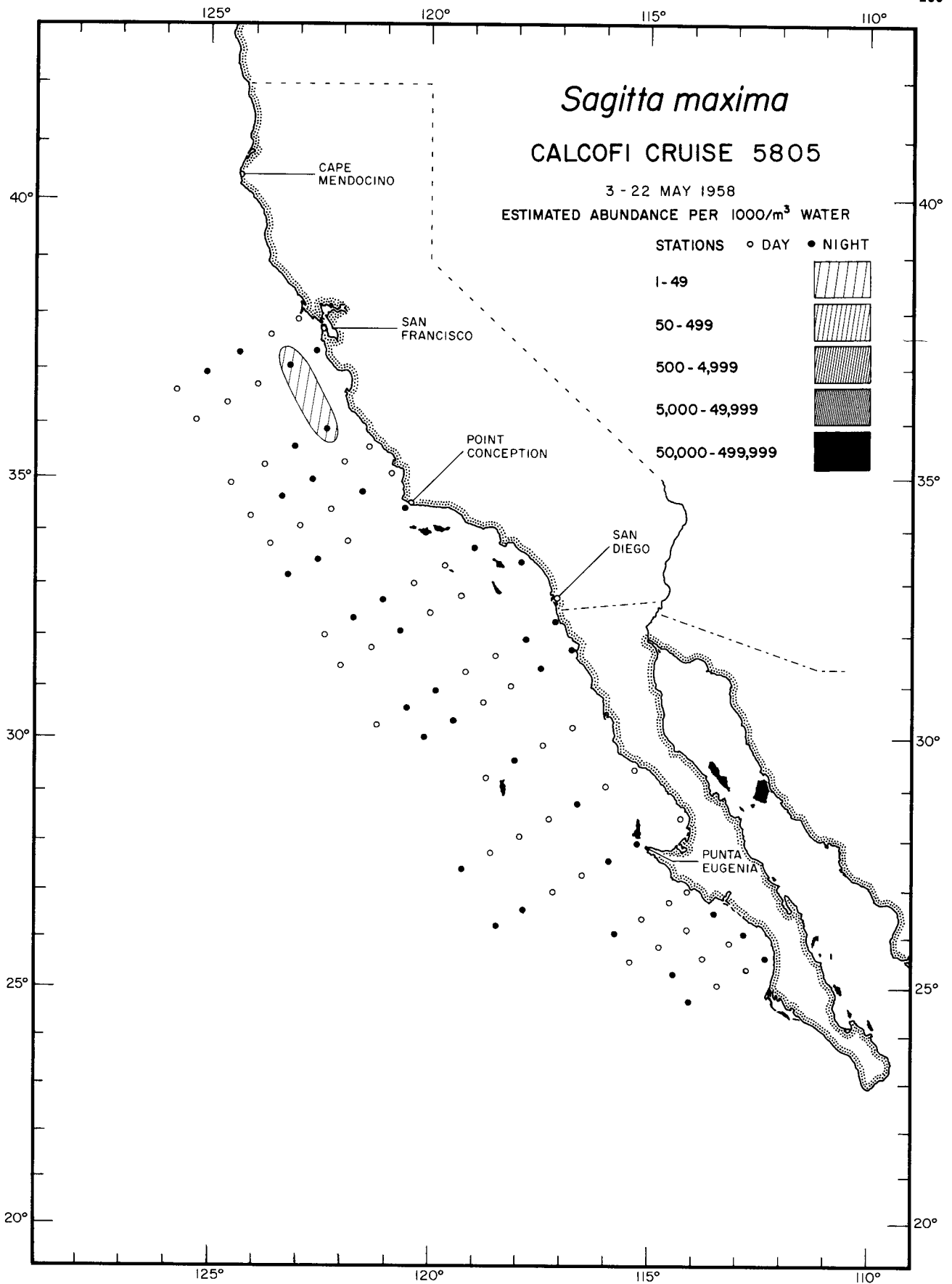
Chaetognatha  
*Sagitta enflata*  
5805



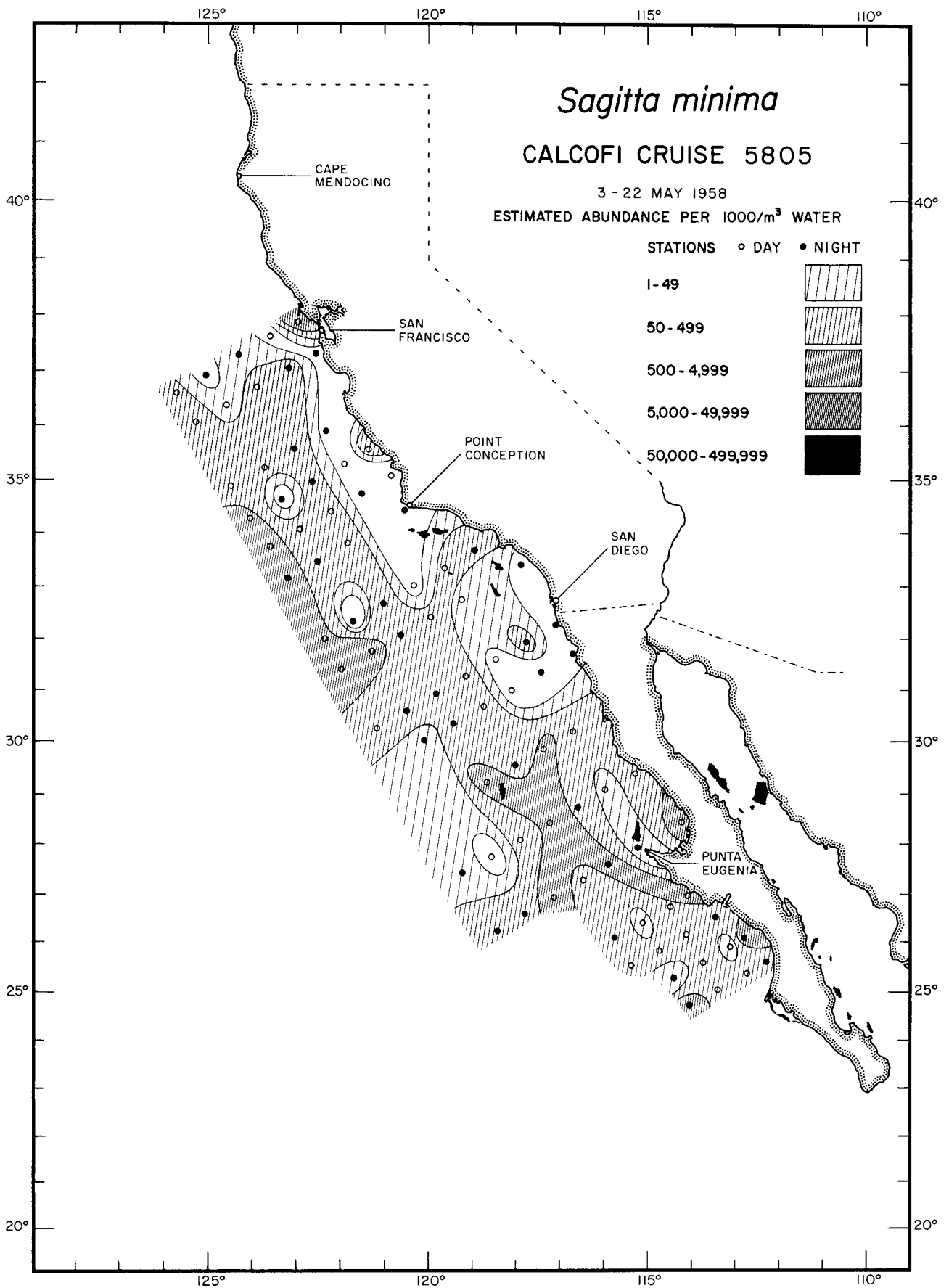


Chaetognatha  
*Sagitta hexaptera*  
5805

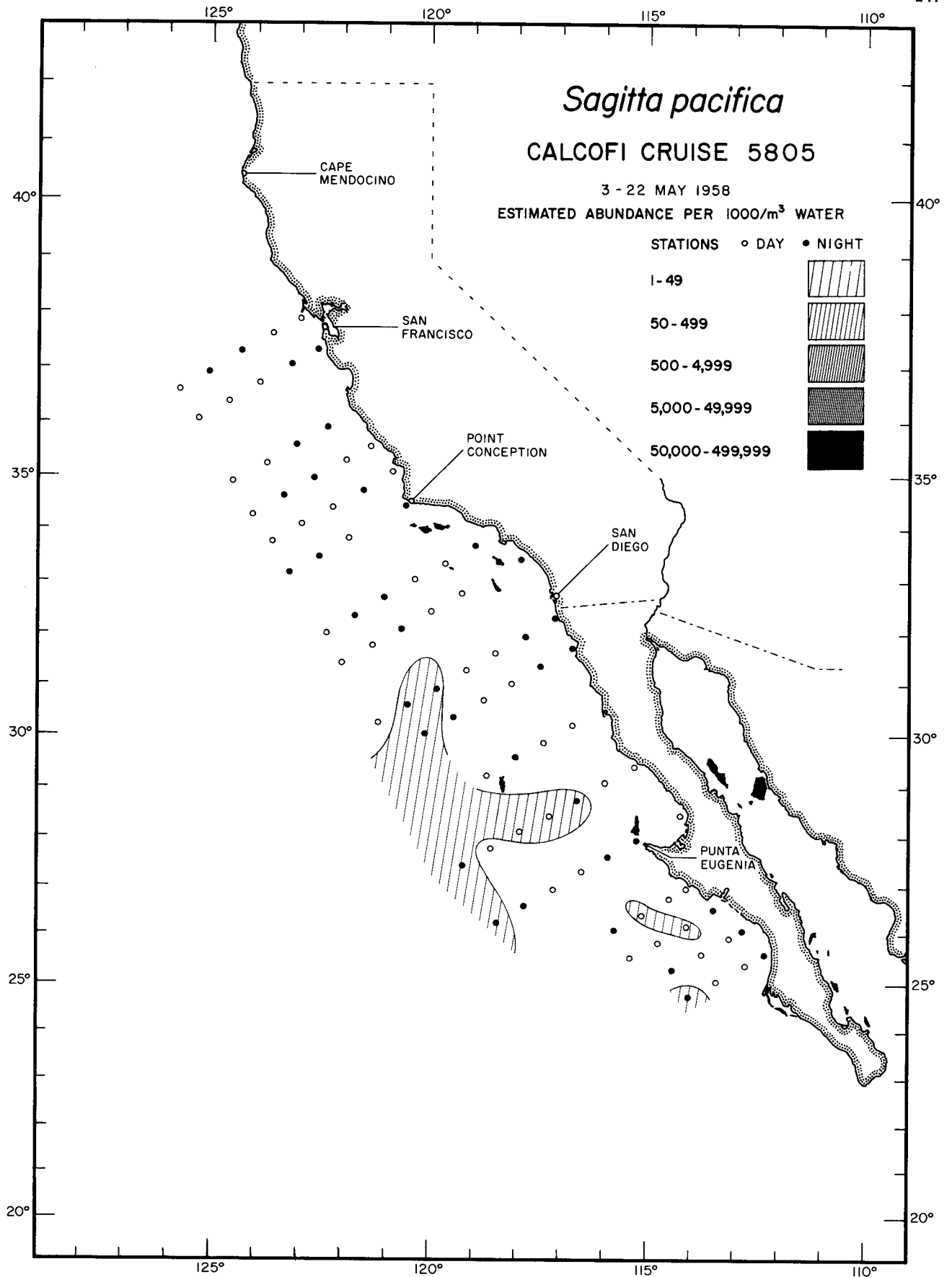




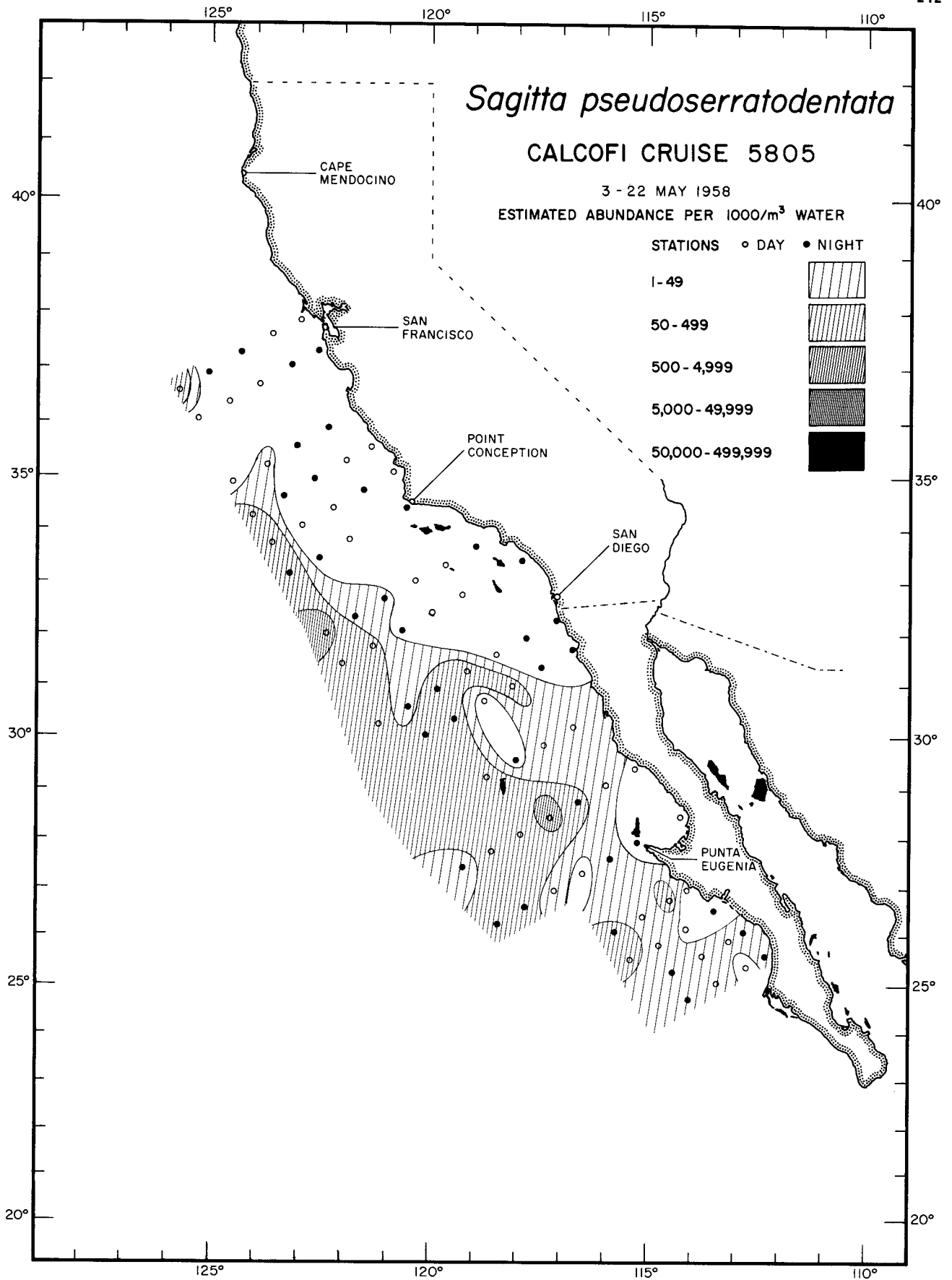
Chaetognatha  
*Sagitta maxima*  
5805



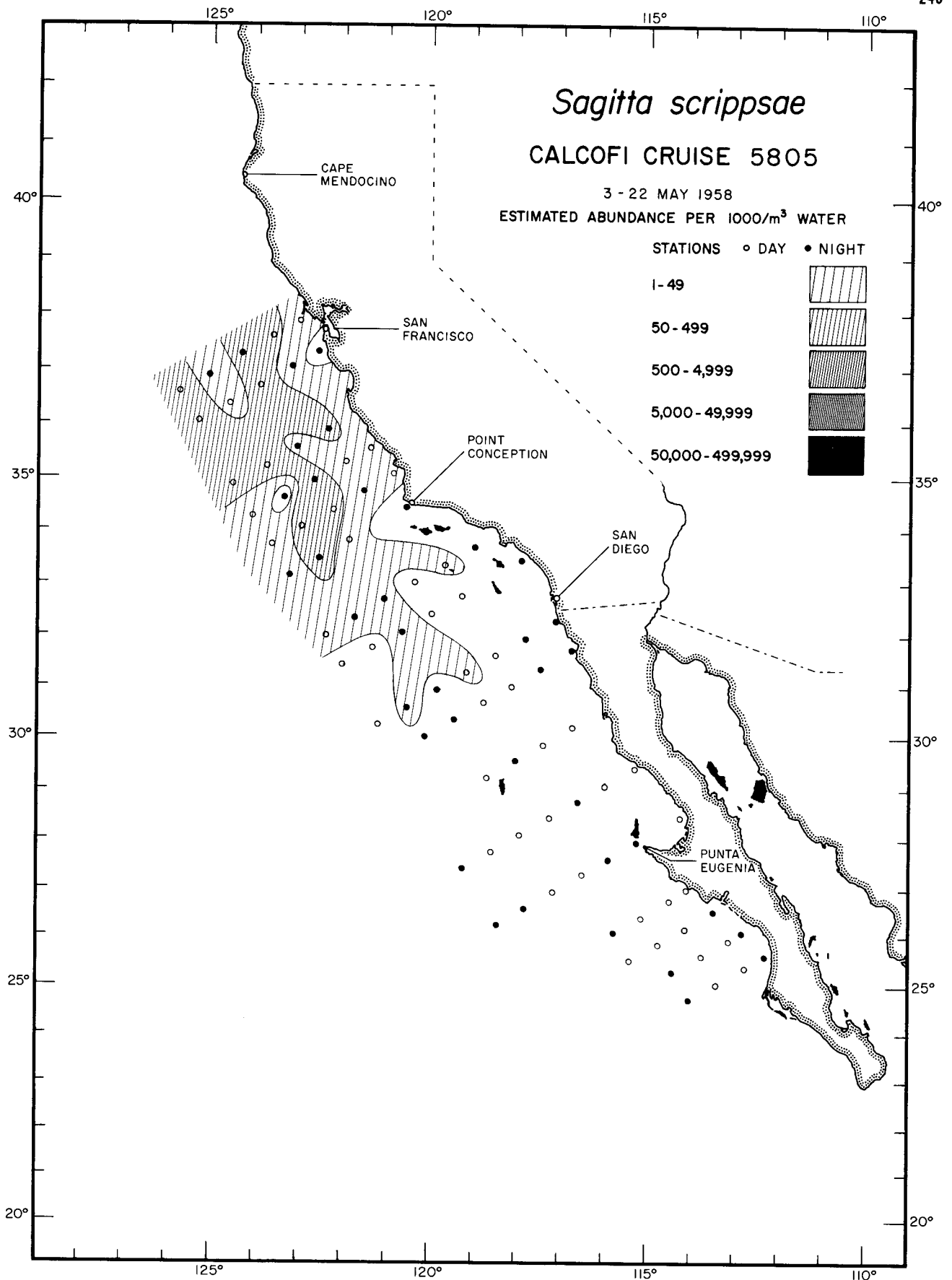
Chaetognatha  
*Sagitta minima*  
5805



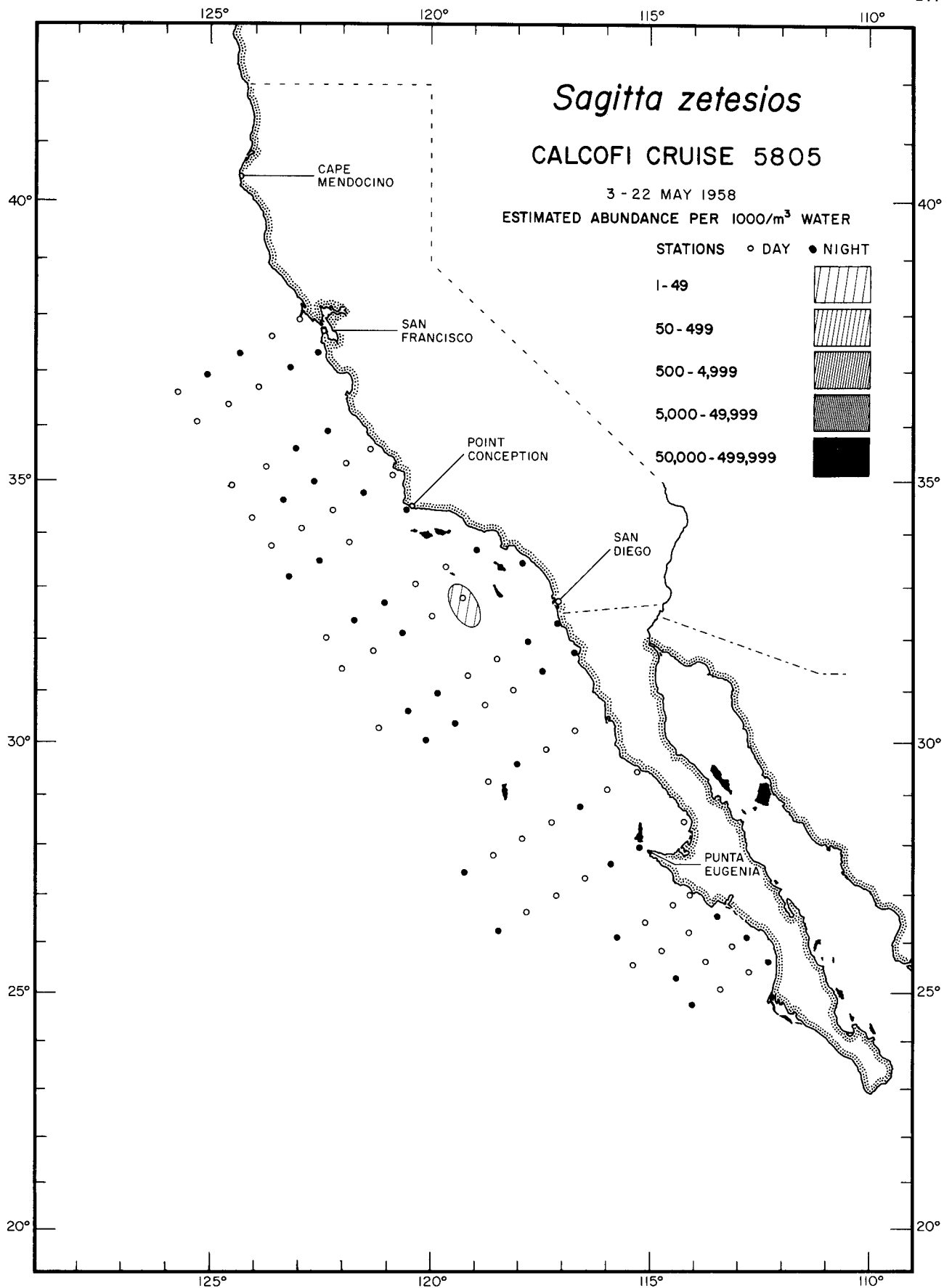
Chaetognatha  
*Sagitta pacifica*  
5805



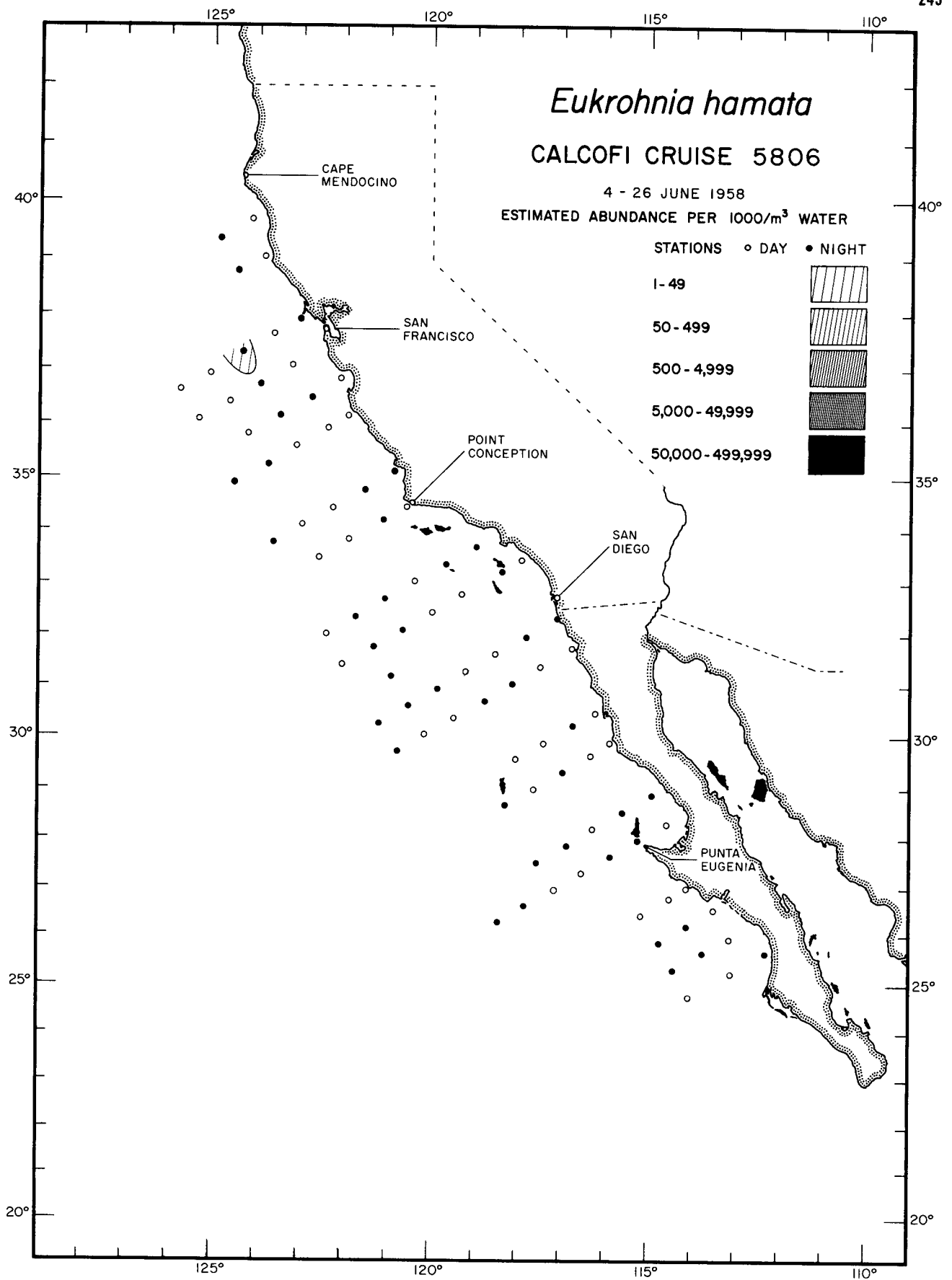
Chaetognatha  
*Sagitta pseudoserratodentata*  
5805



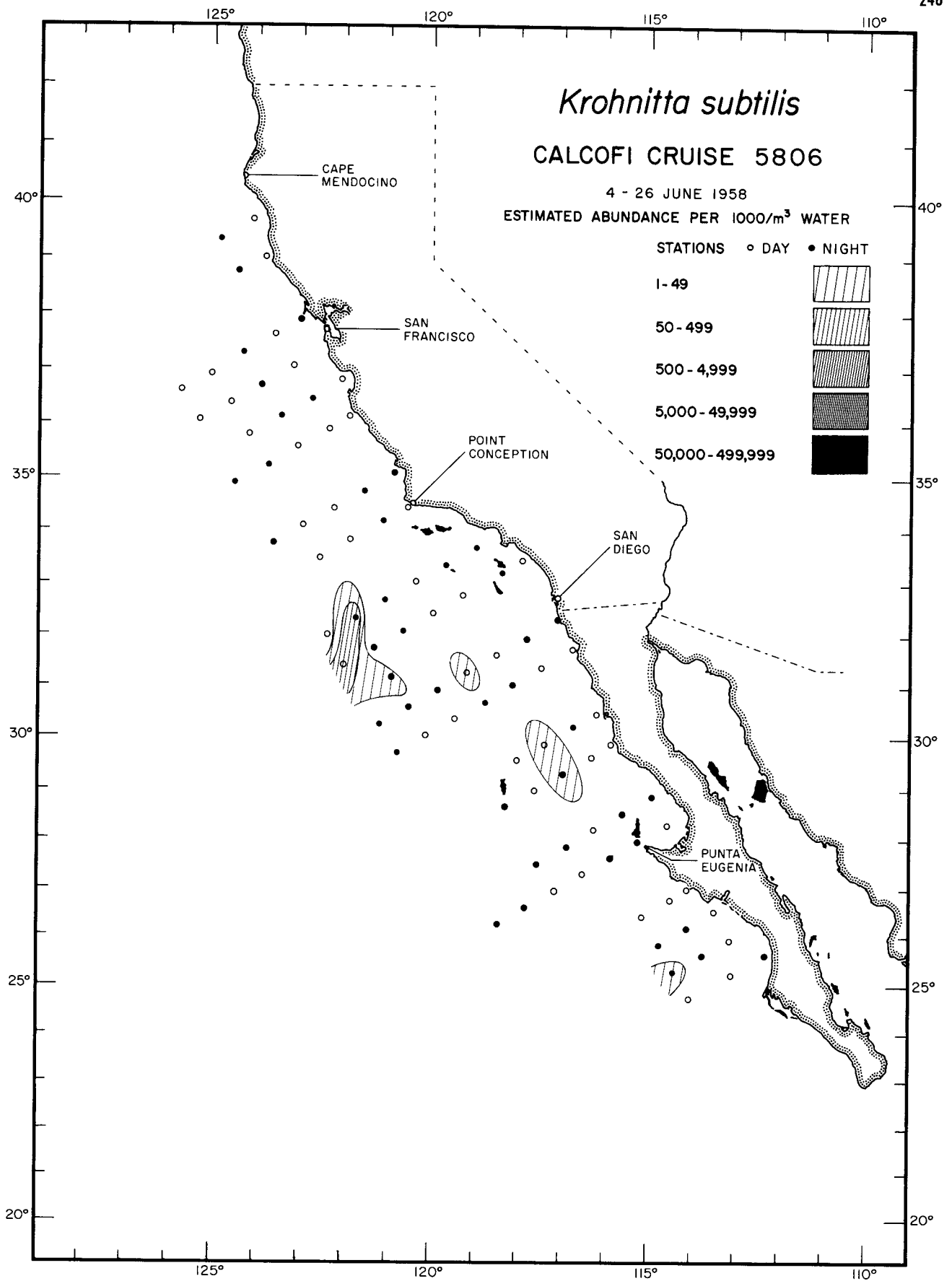
Chaetognatha  
*Sagitta scrippsae*  
5805



Chaetognatha  
*Sagitta zetesios*  
5805

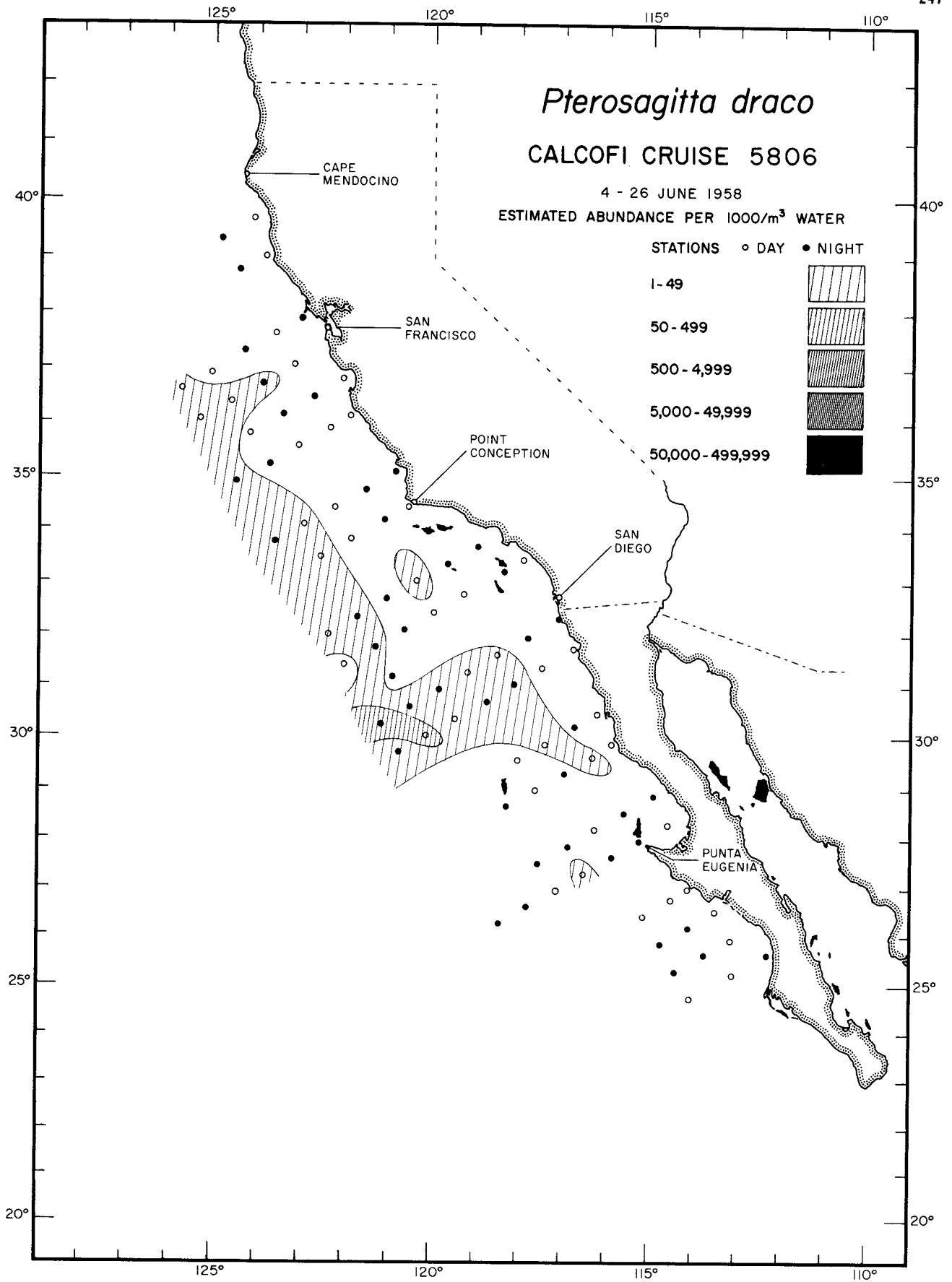


Chaetognatha  
*Eukrohnia hamata*  
5806

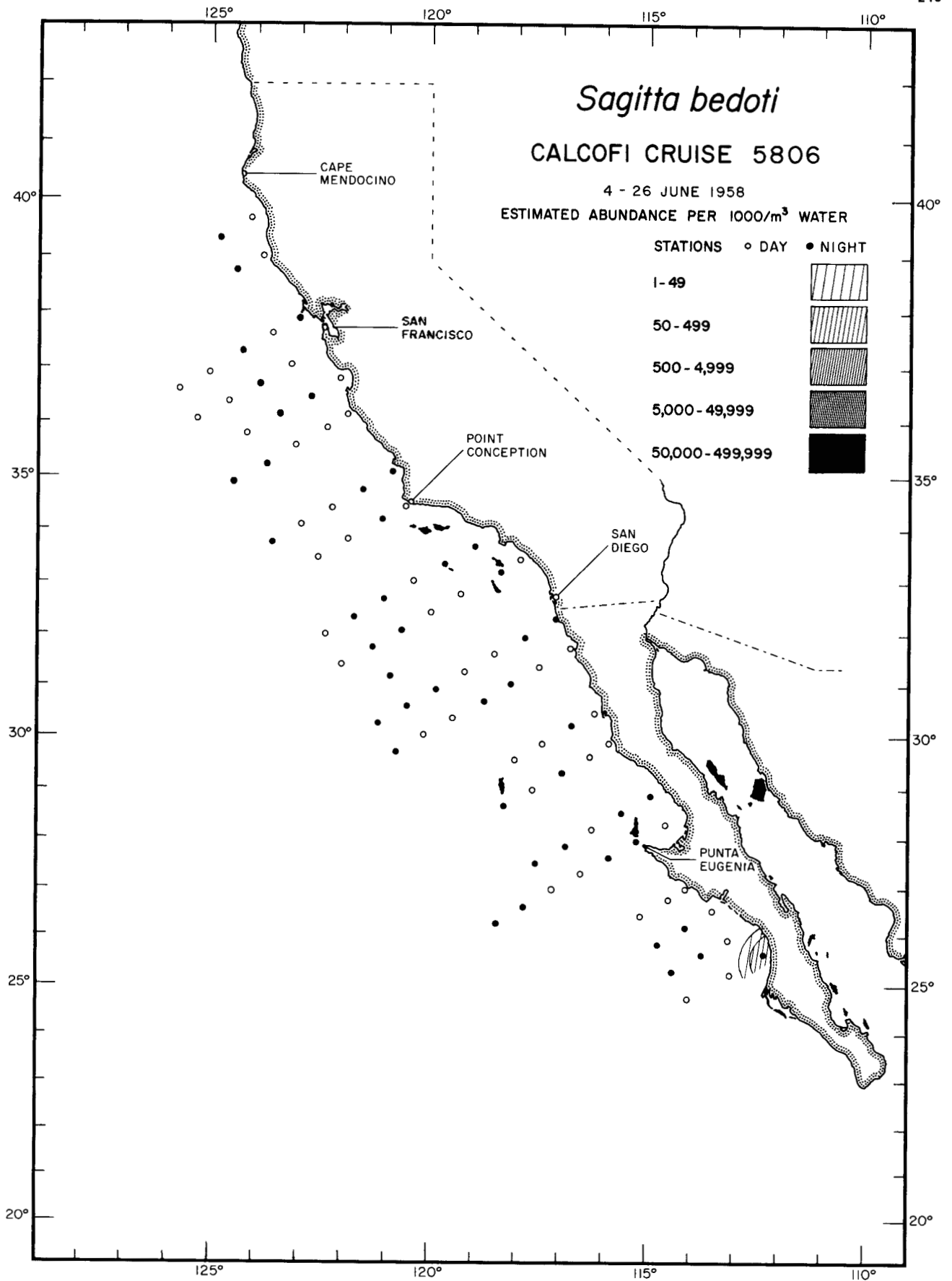


Chaetognatha  
*Krohnitta subtilis*  
5806

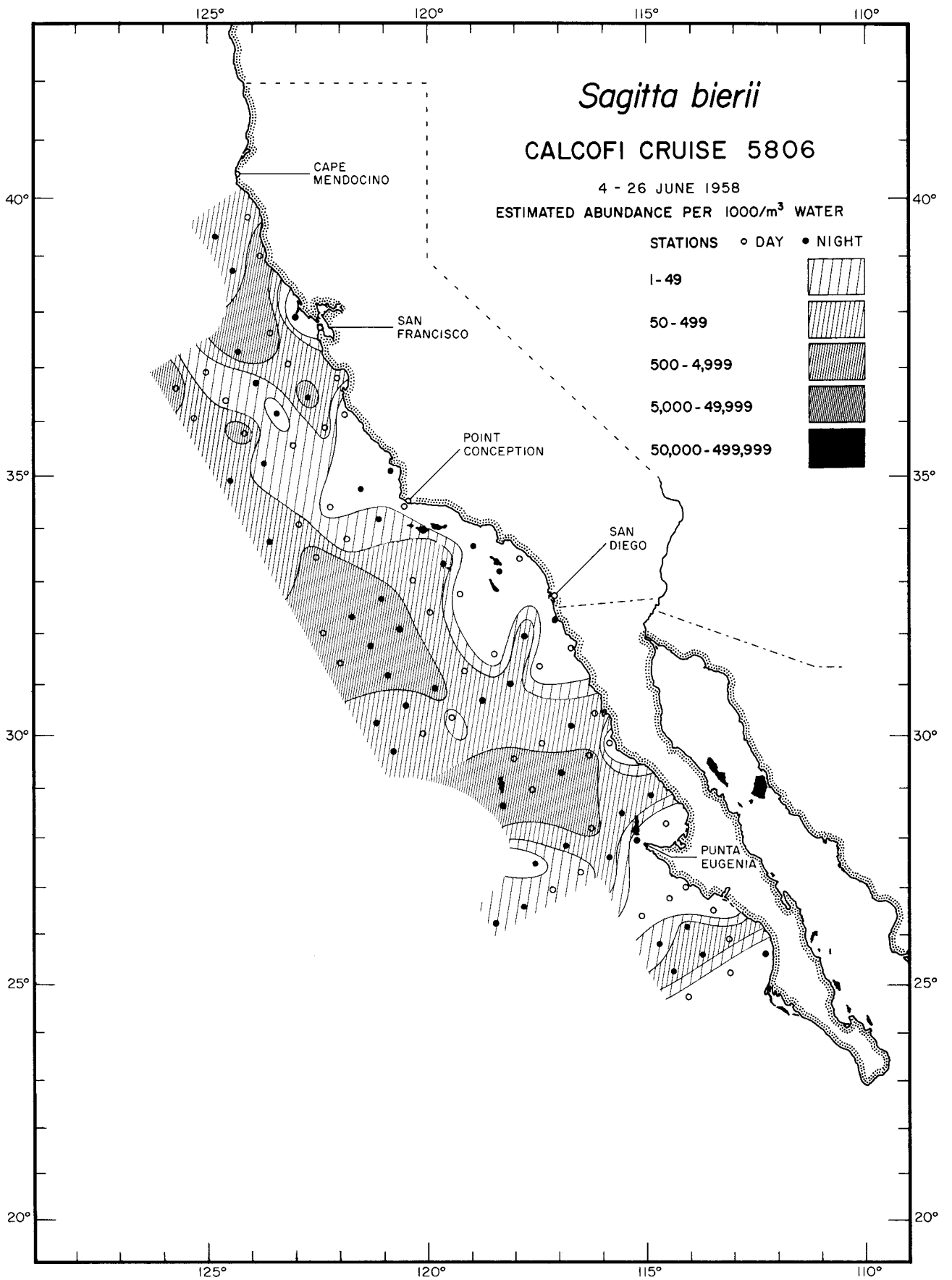




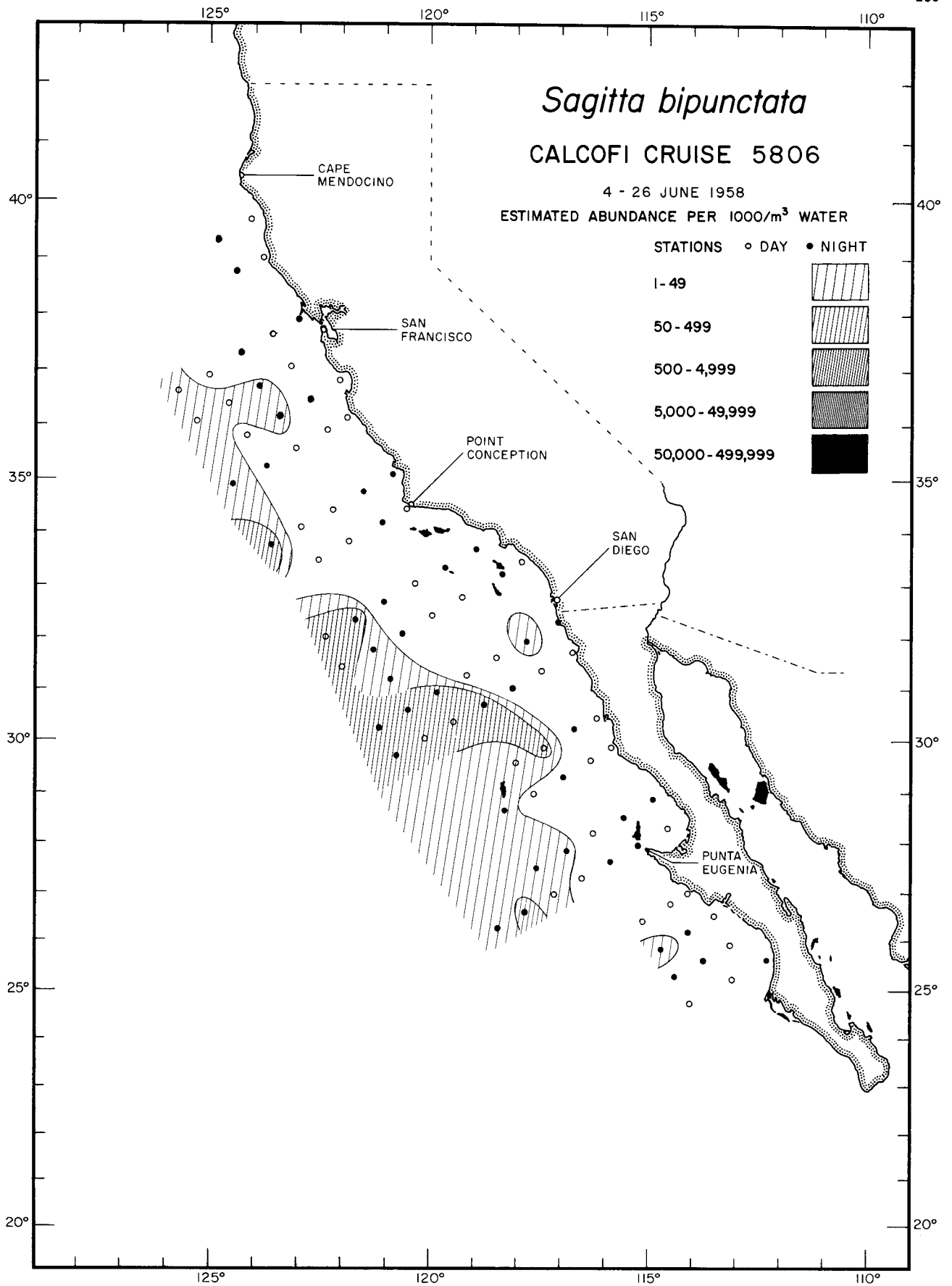
Chaetognatha  
*Pterosagitta draco*  
5806

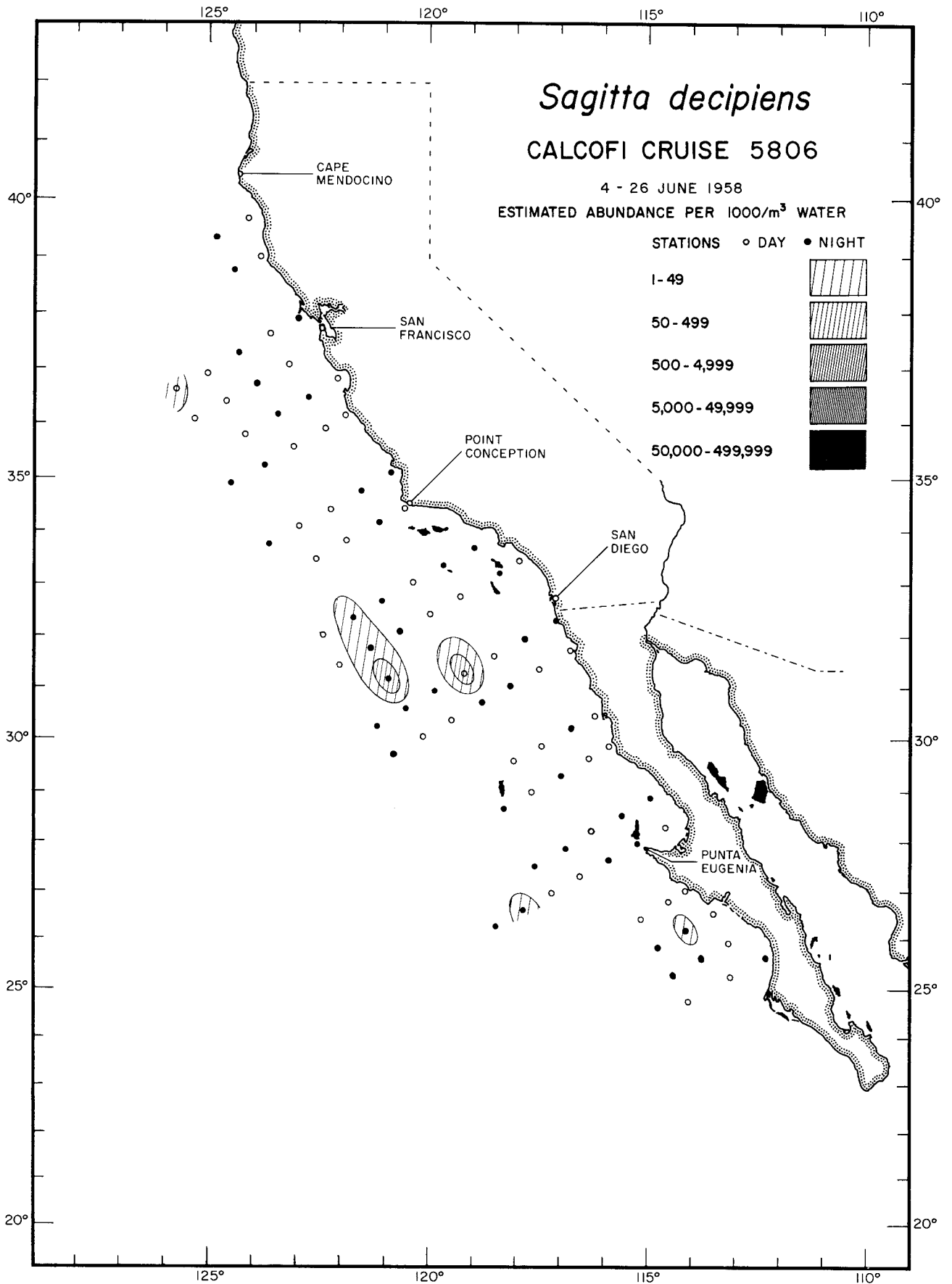


Chaetognatha  
*Sagitta bedoti*  
5806

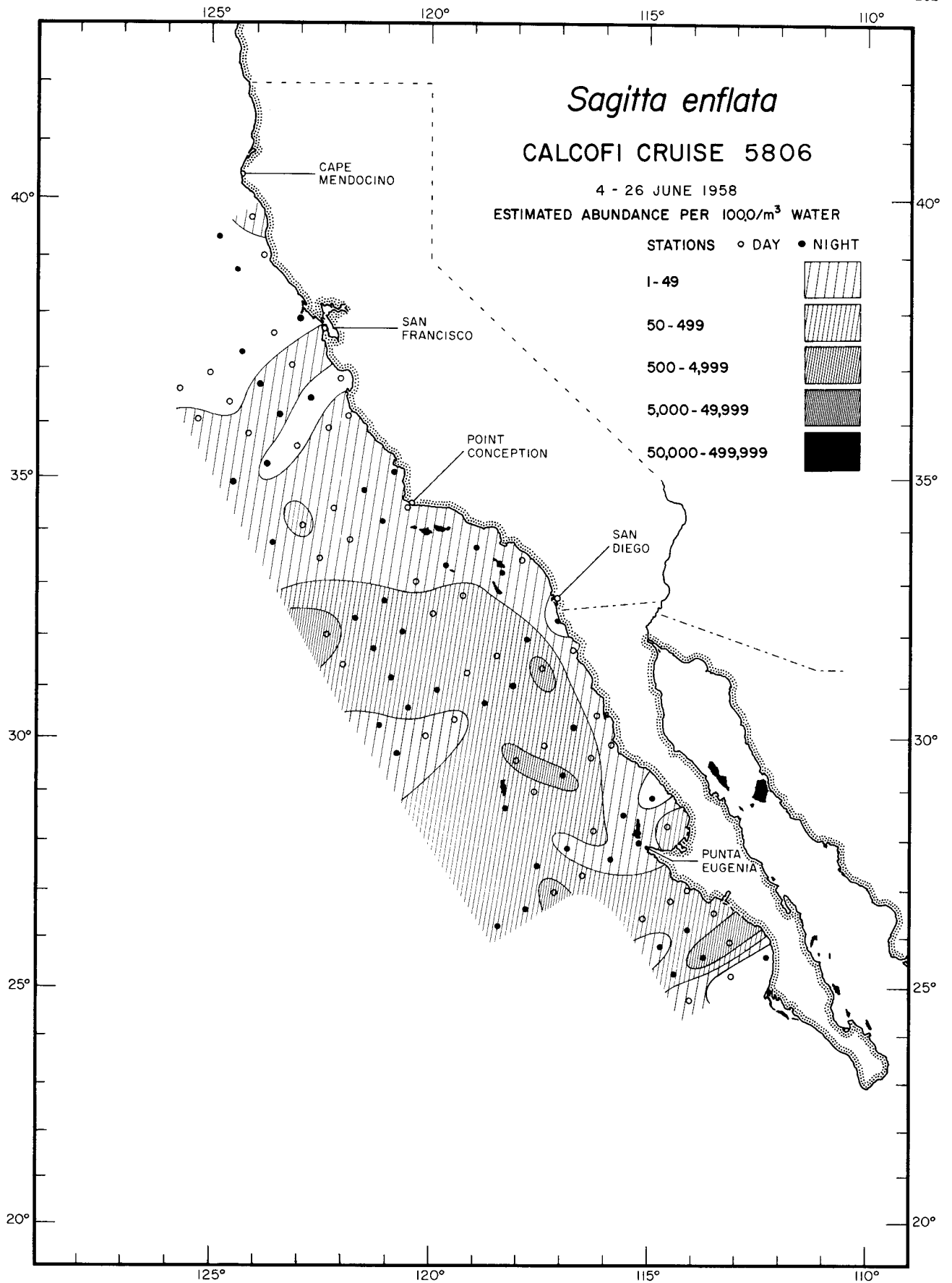


Chaetognatha  
*Sagitta bierii*  
5806

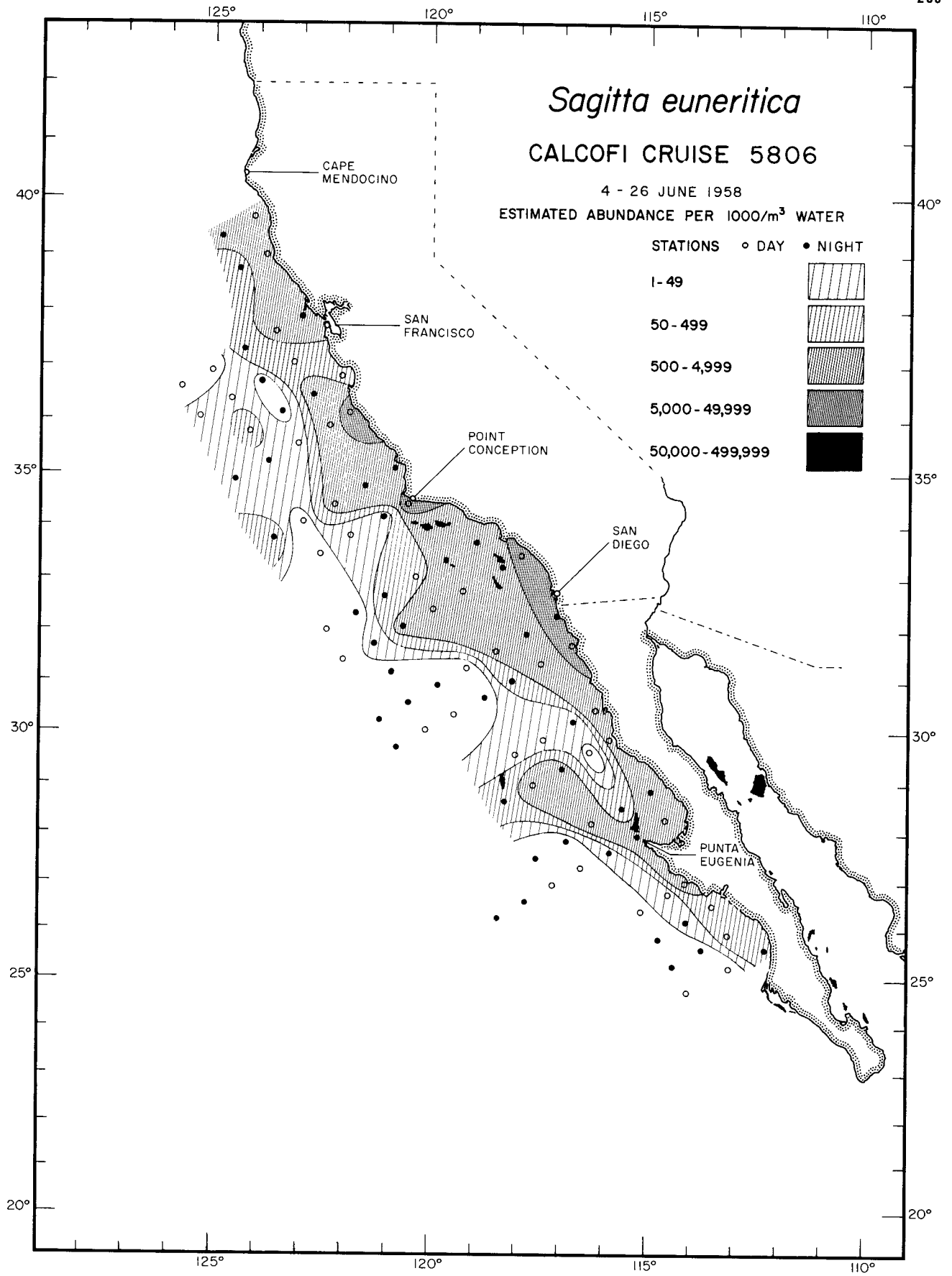




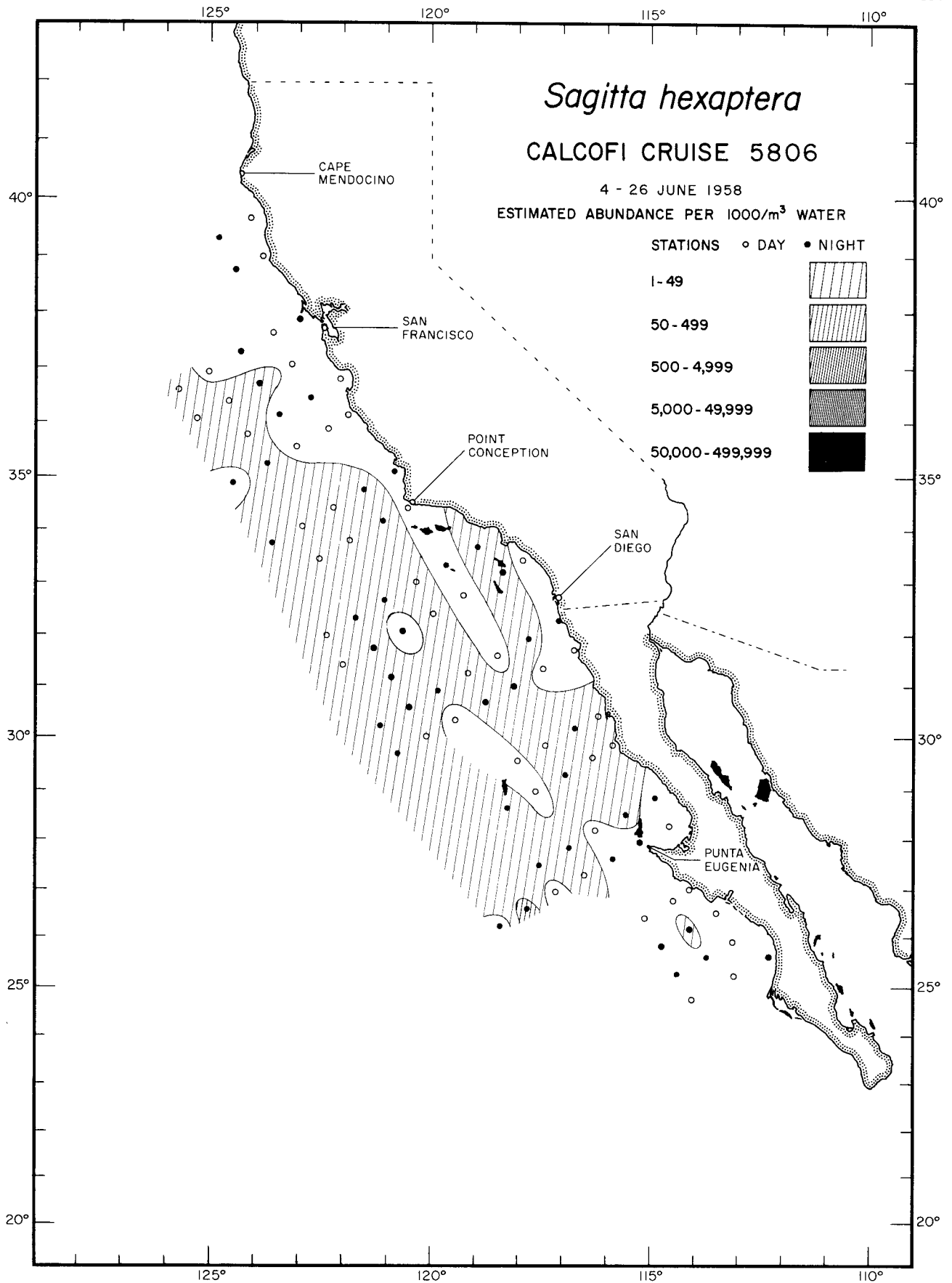
Chaetognatha  
*Sagitta decipiens*  
5806



Chaetognatha  
*Sagitta enflata*  
5806

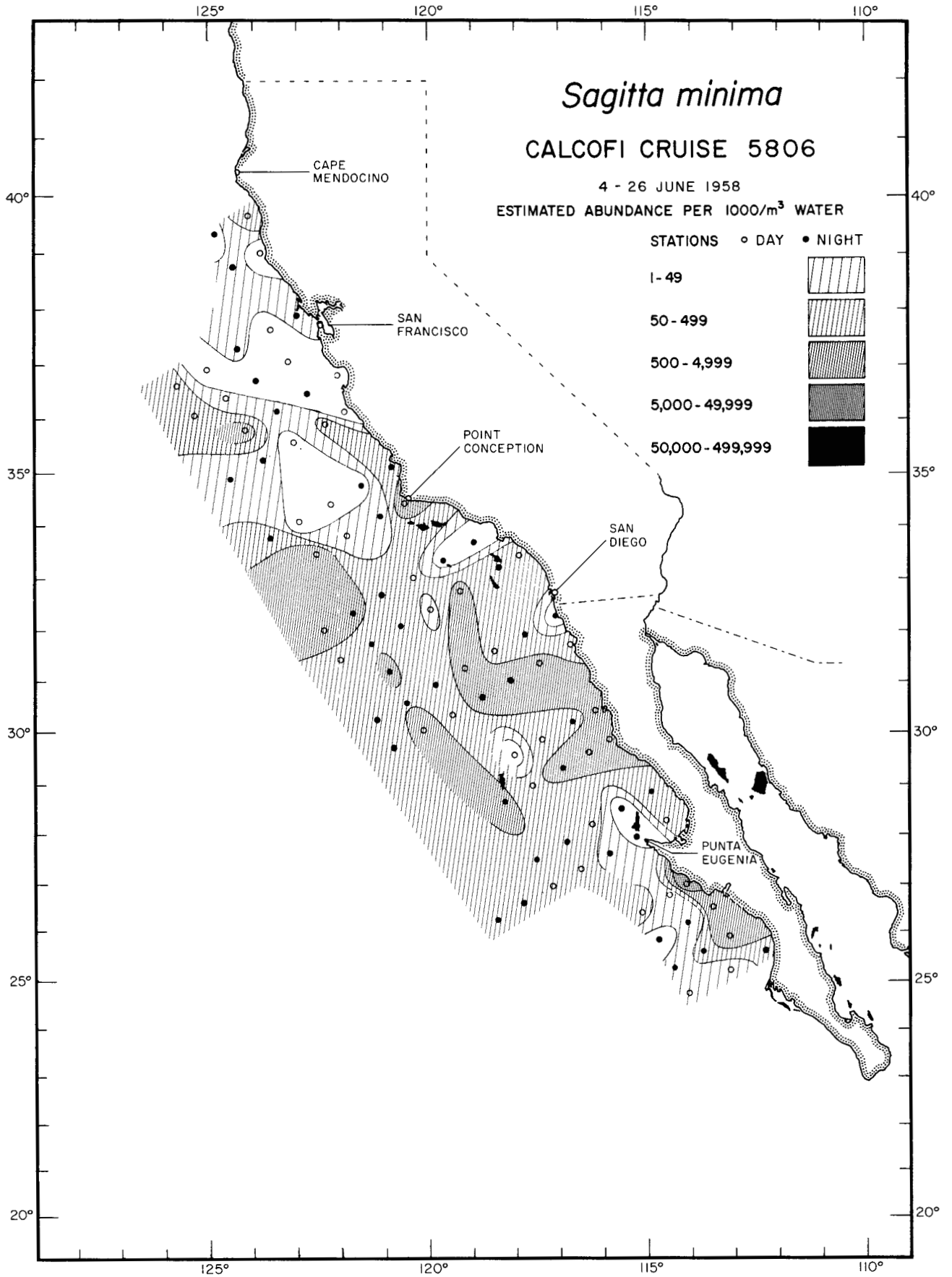


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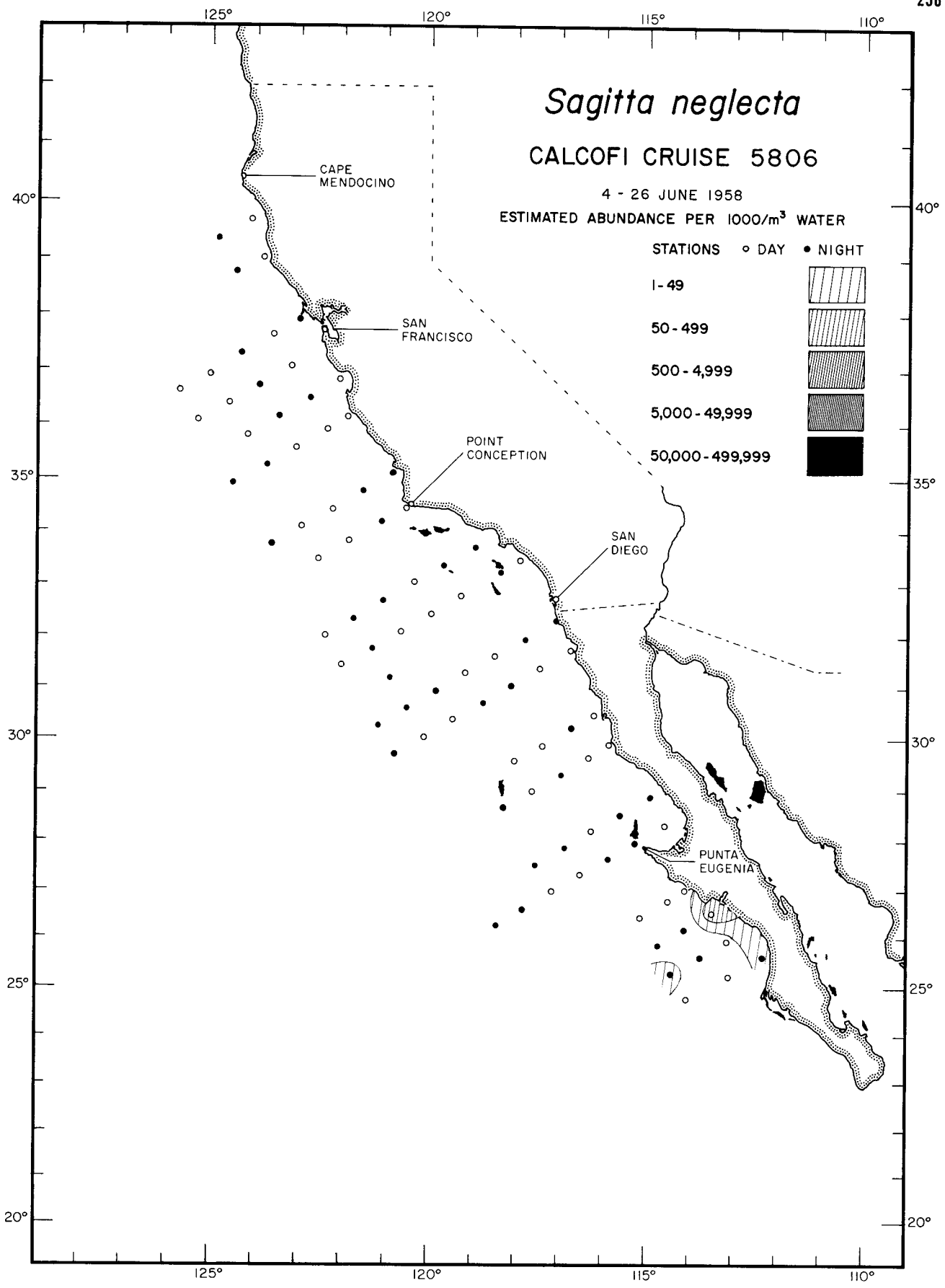


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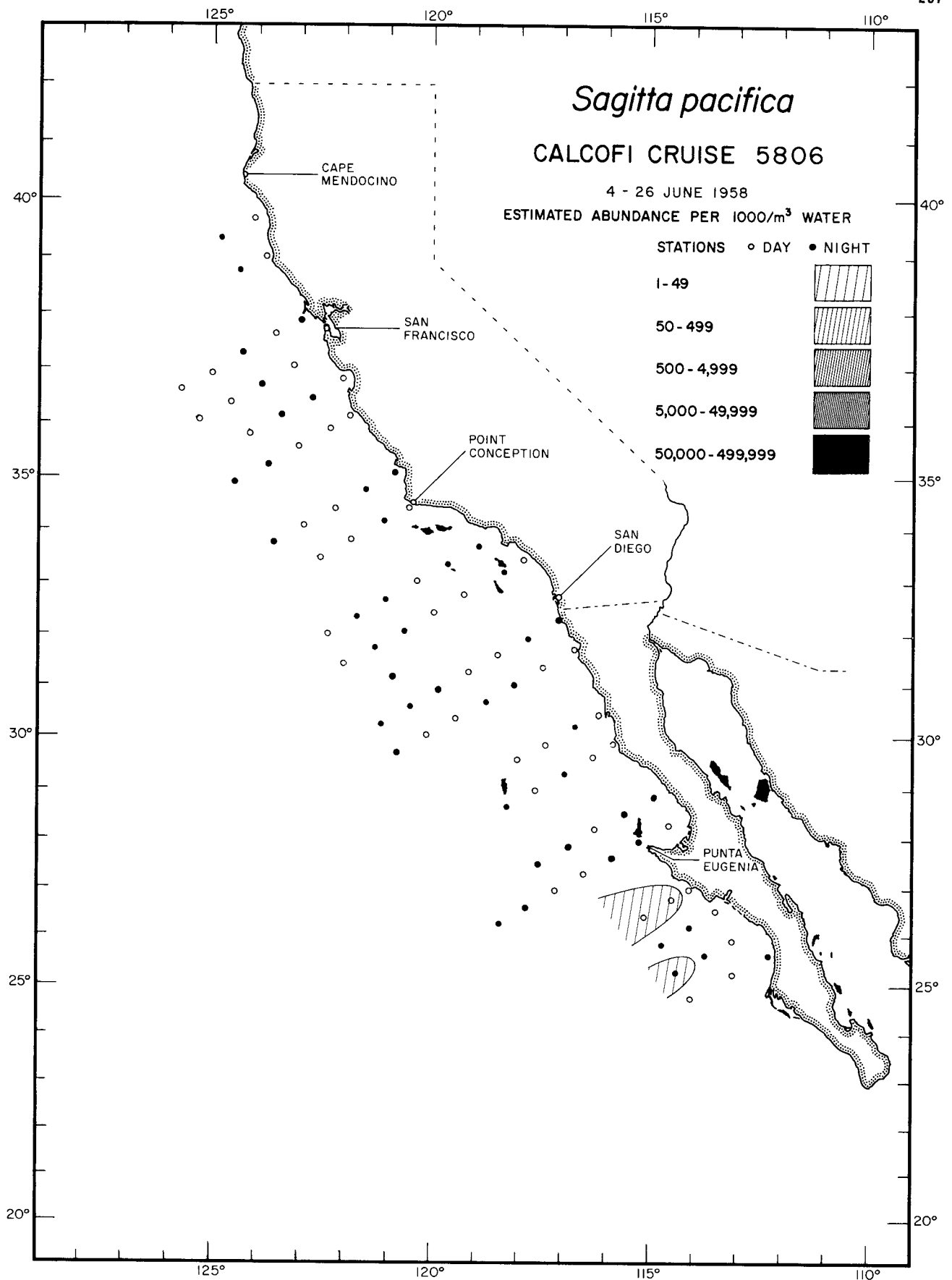




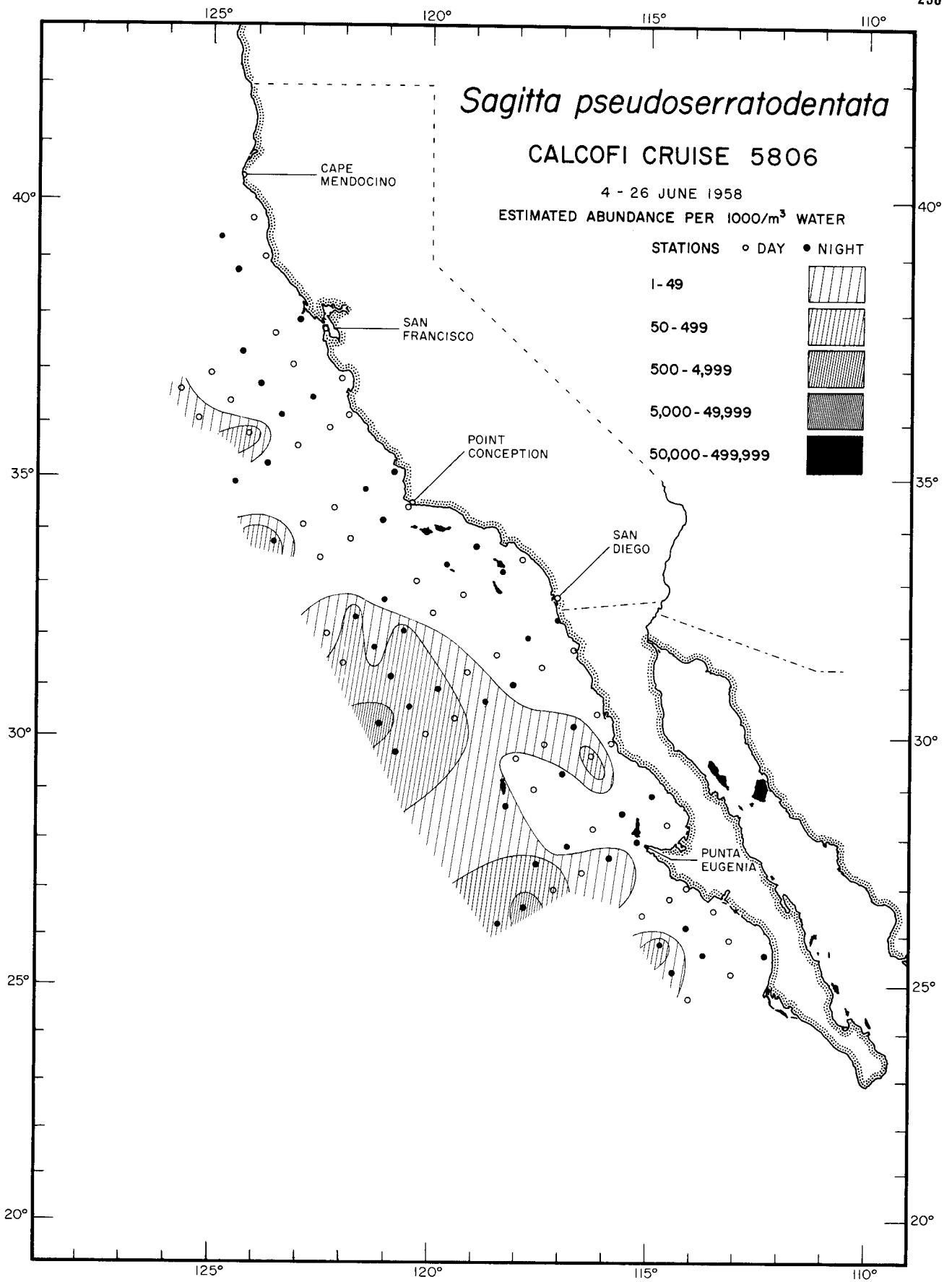
Chaetognatha  
*Sagitta minima*  
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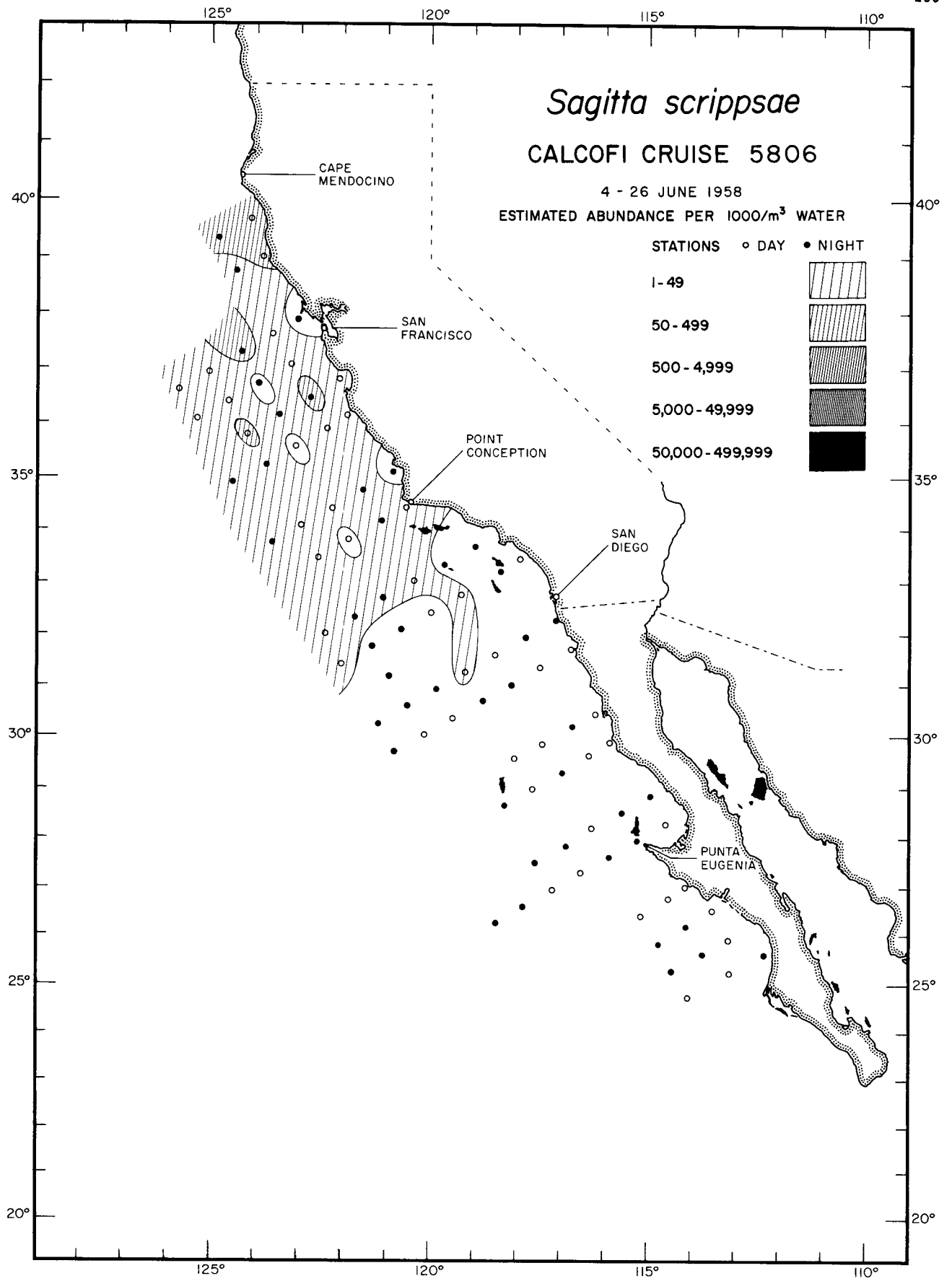
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*Sagitta neglecta*  
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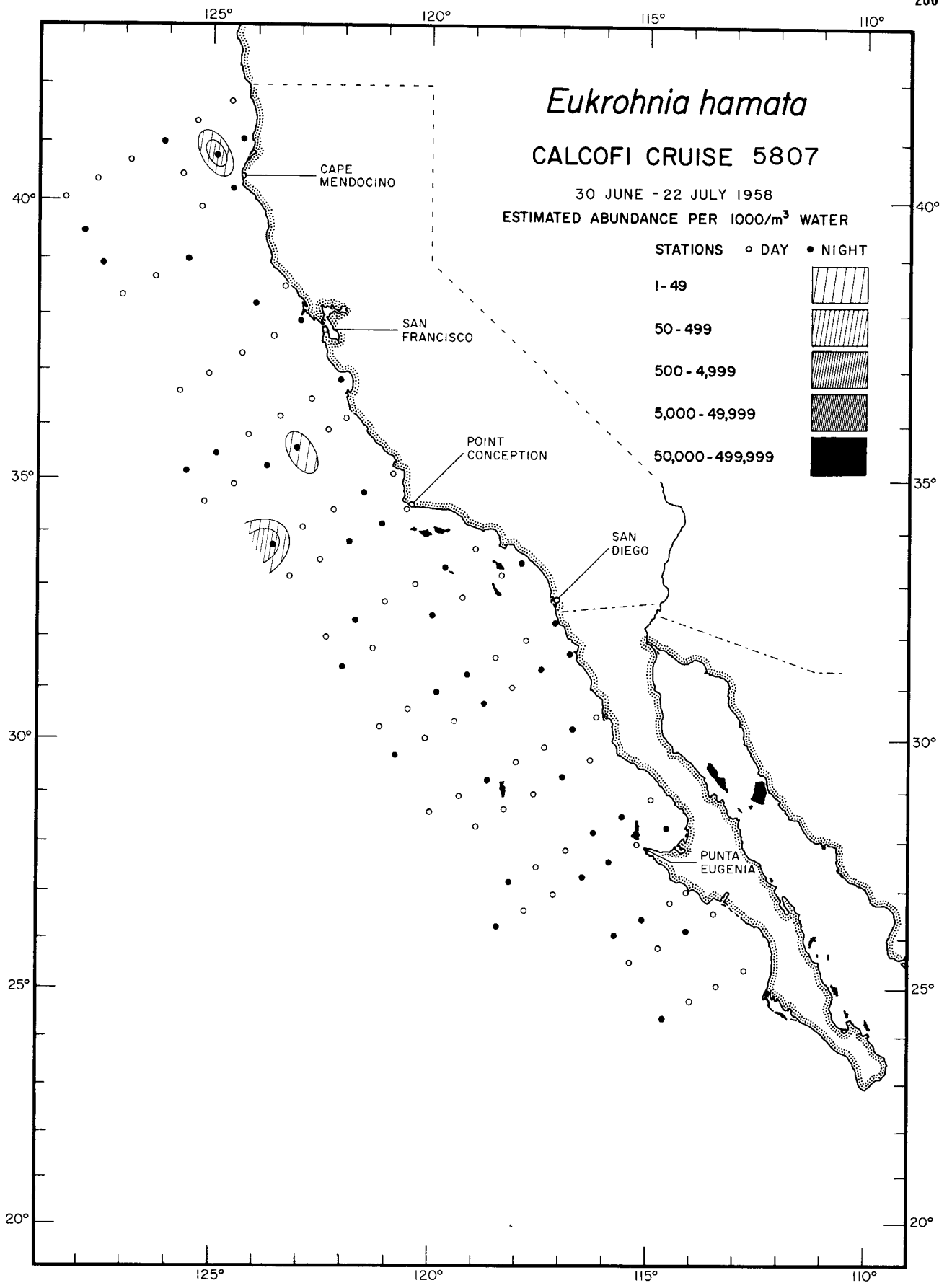
Chaetognatha  
*Sagitta pacifica*  
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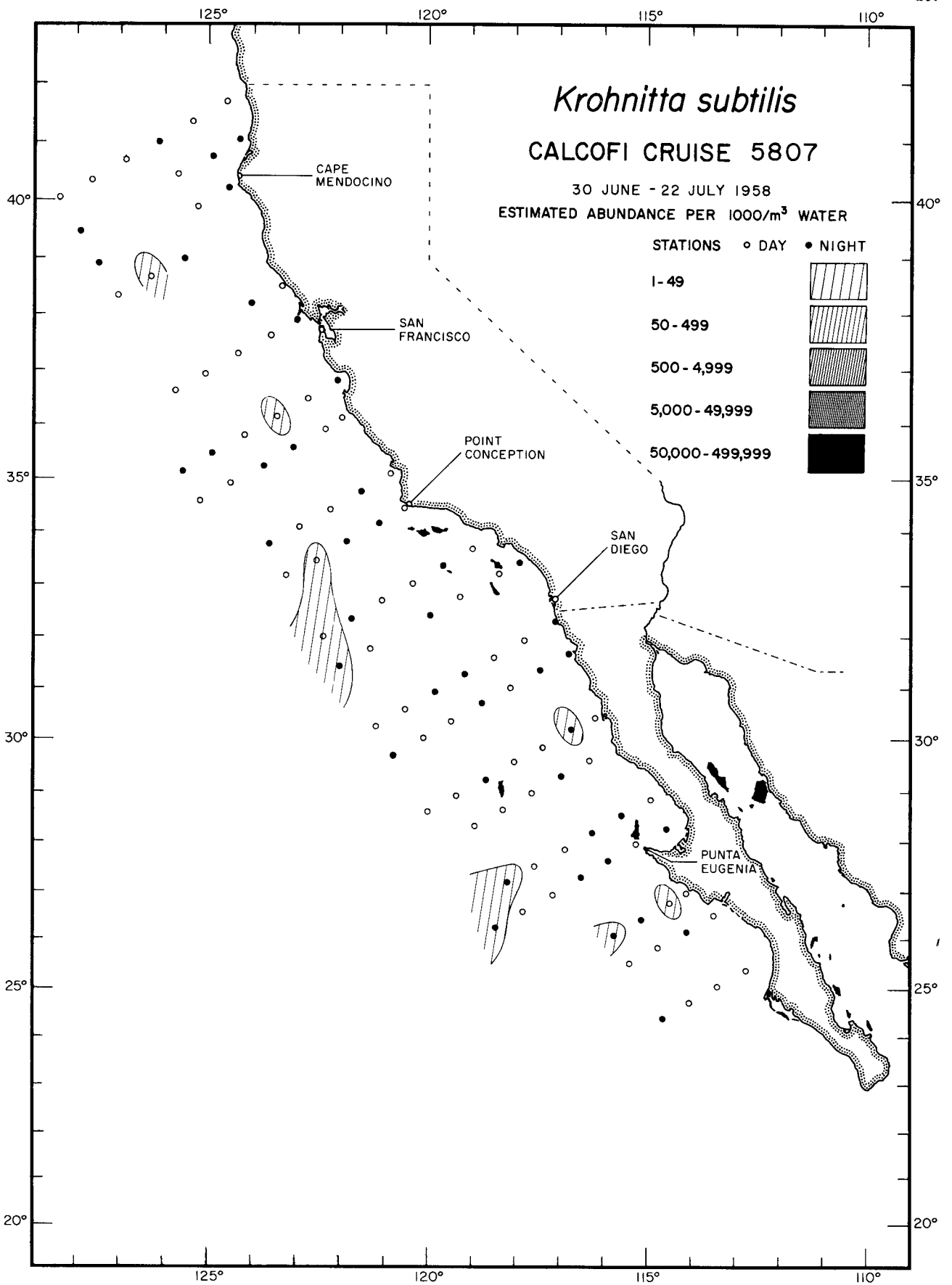
Chaetognatha  
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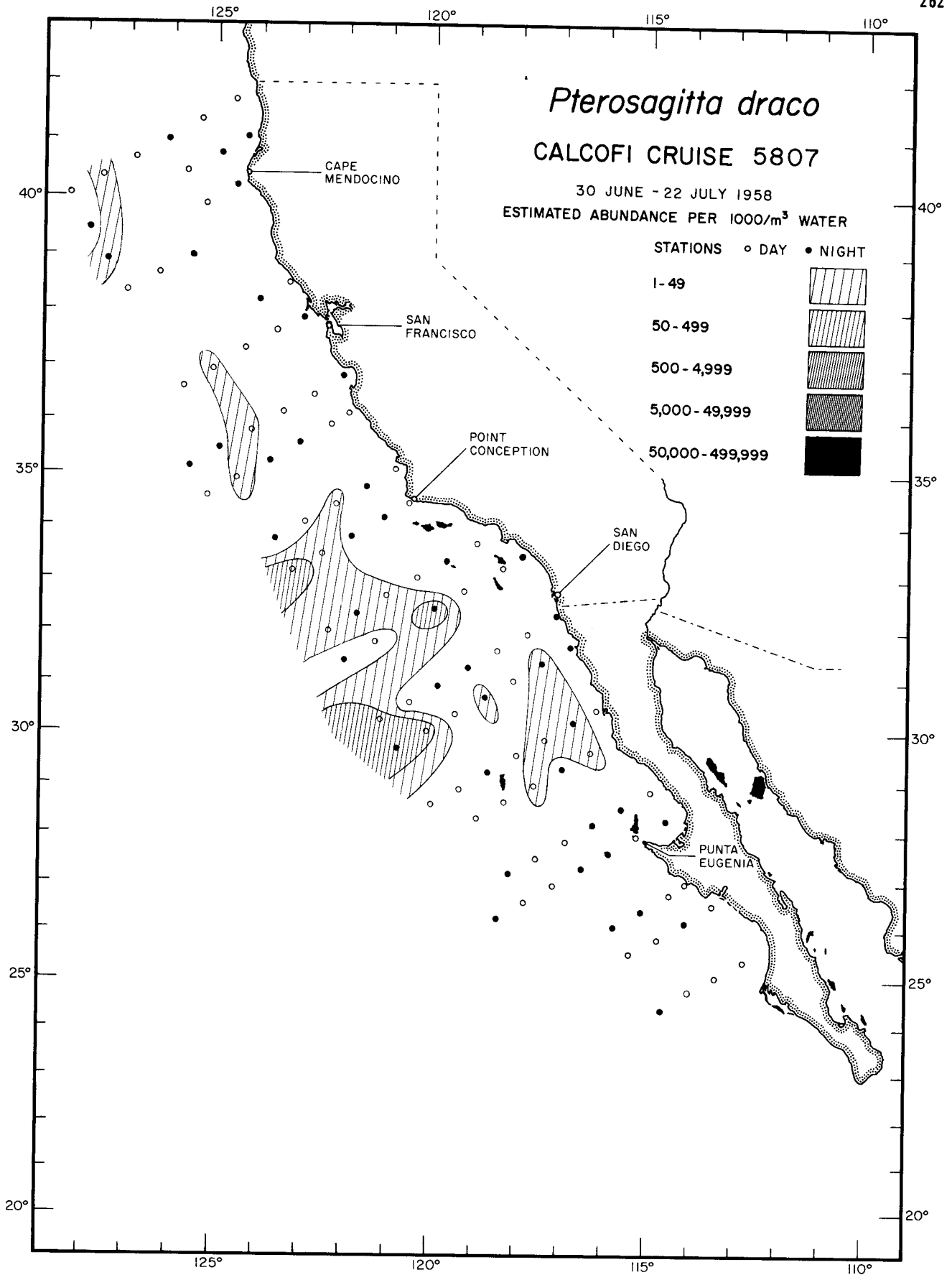
Chaetognatha  
*Sagitta scrippsae*  
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Chaetognatha  
*Eukrohnia hamata*  
5807

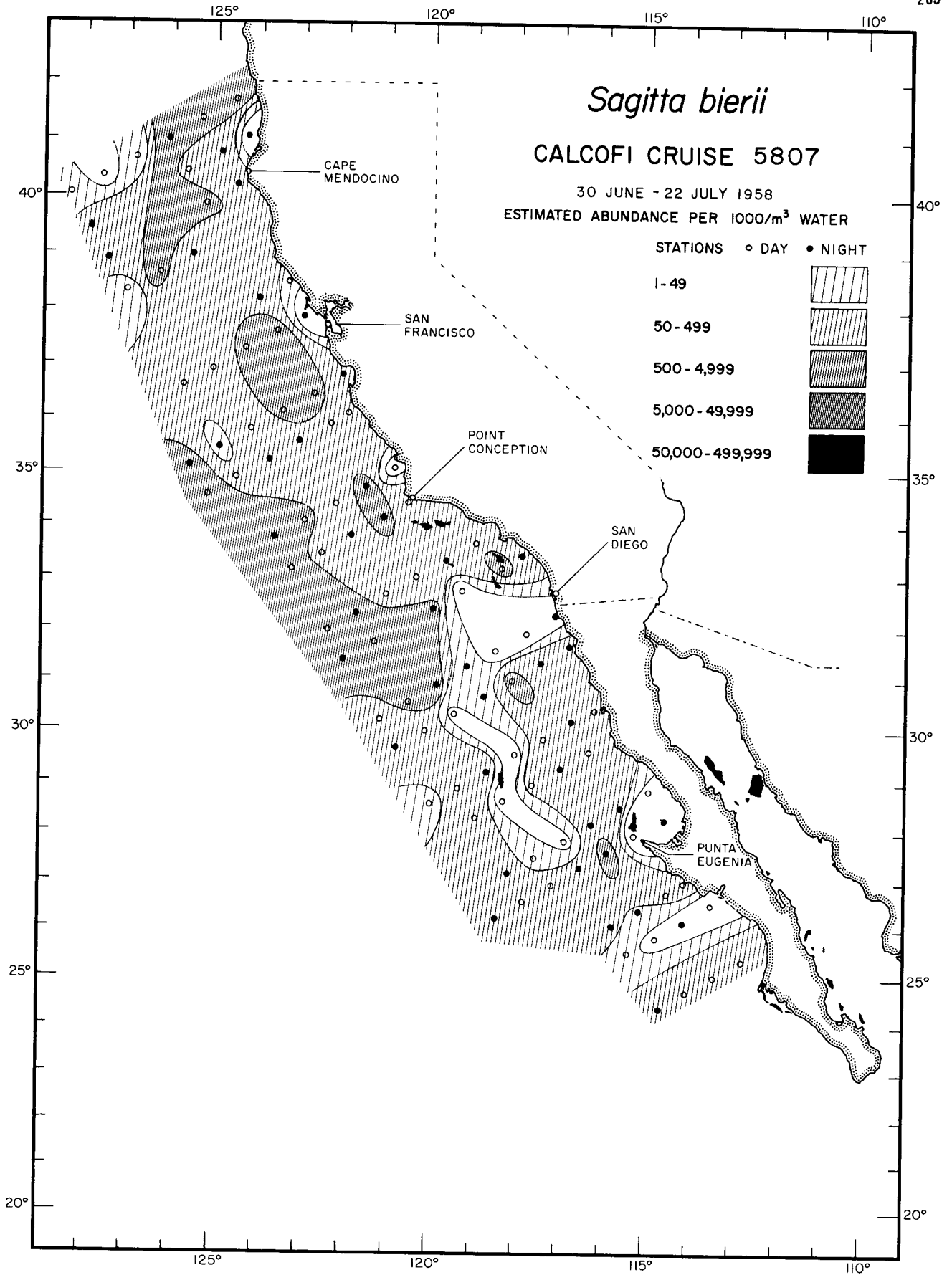


Chaetognatha  
*Krohnitta subtilis*  
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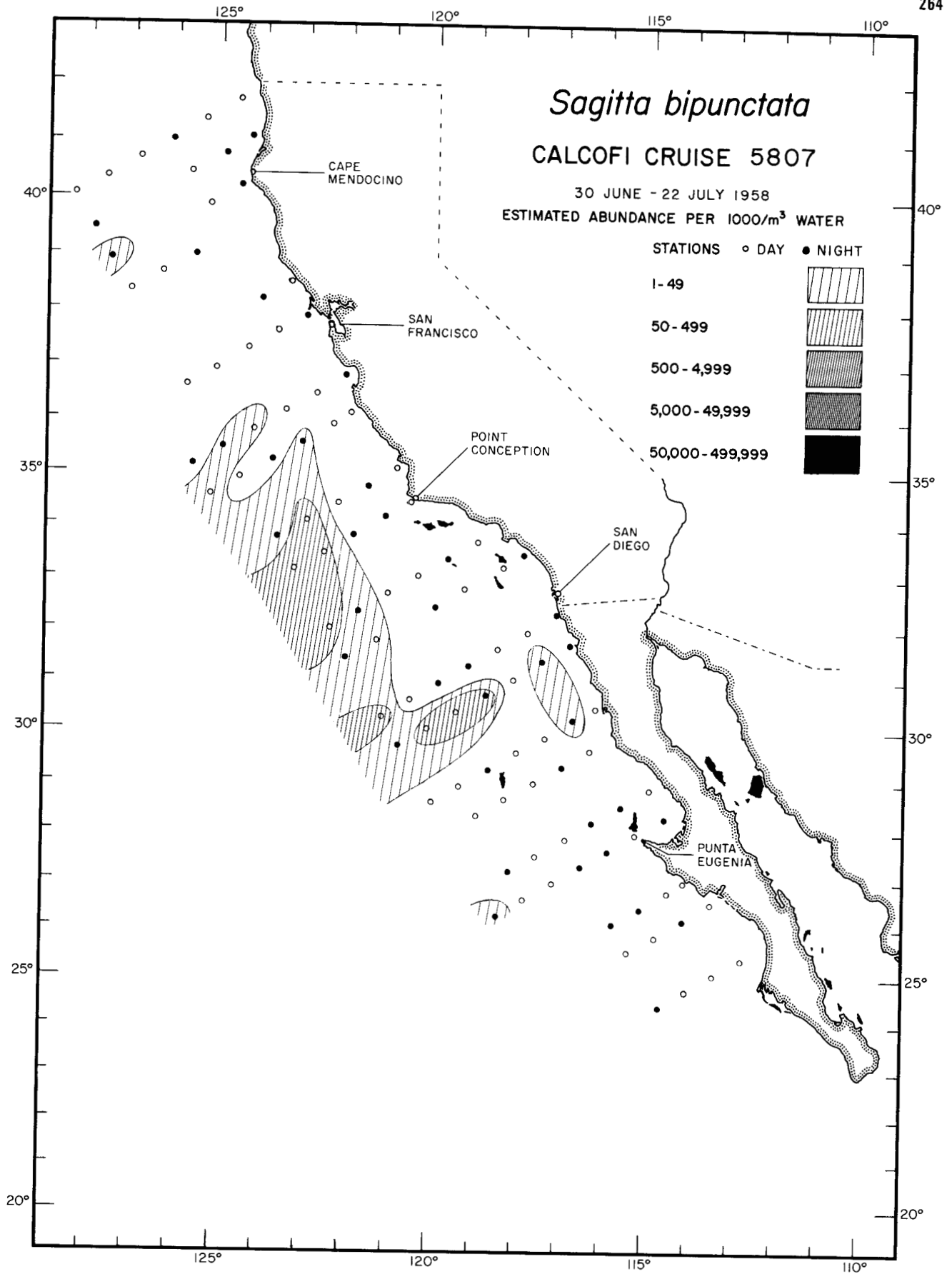


Chaetognatha  
*Pterosagitta draco*  
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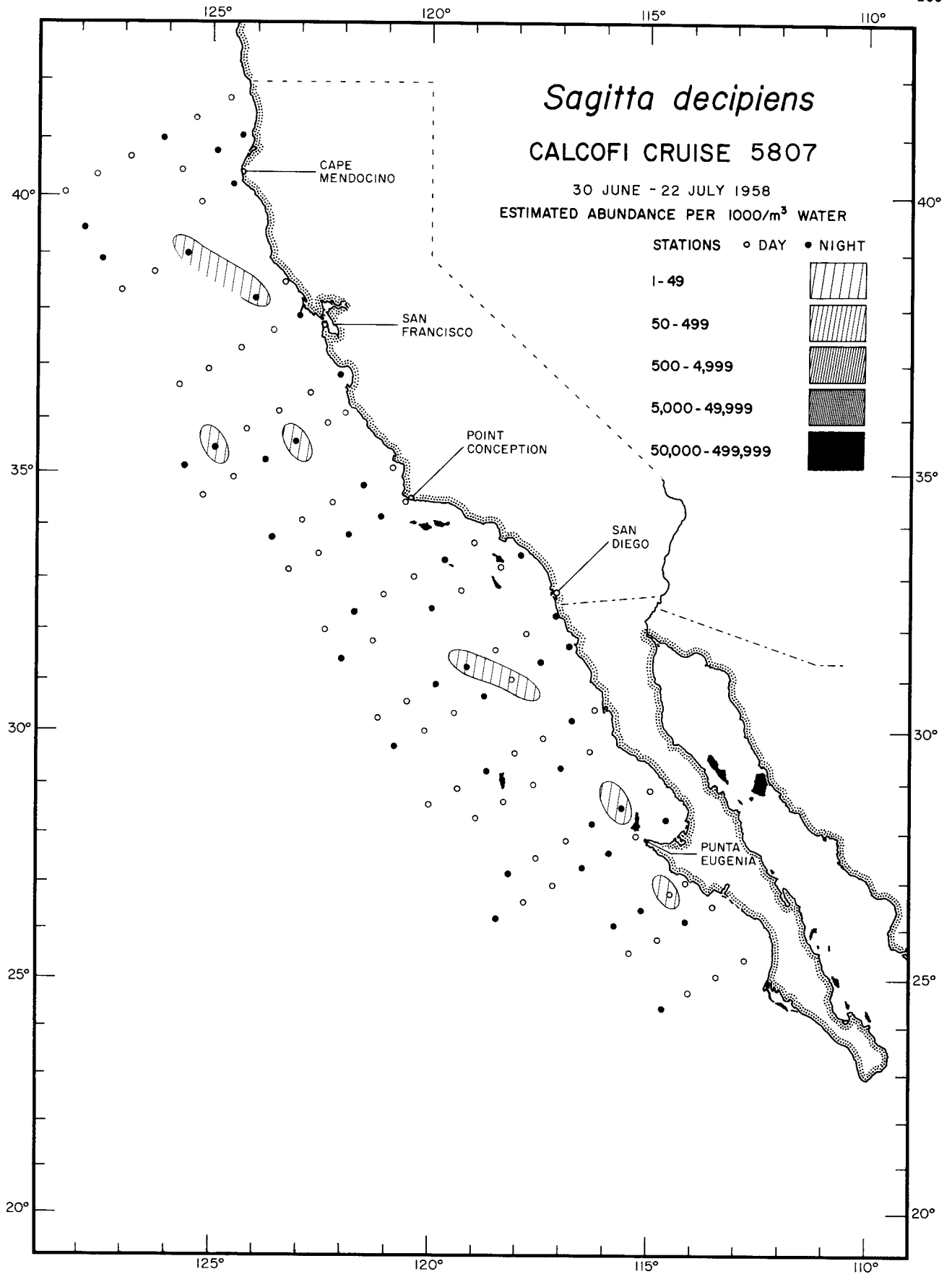




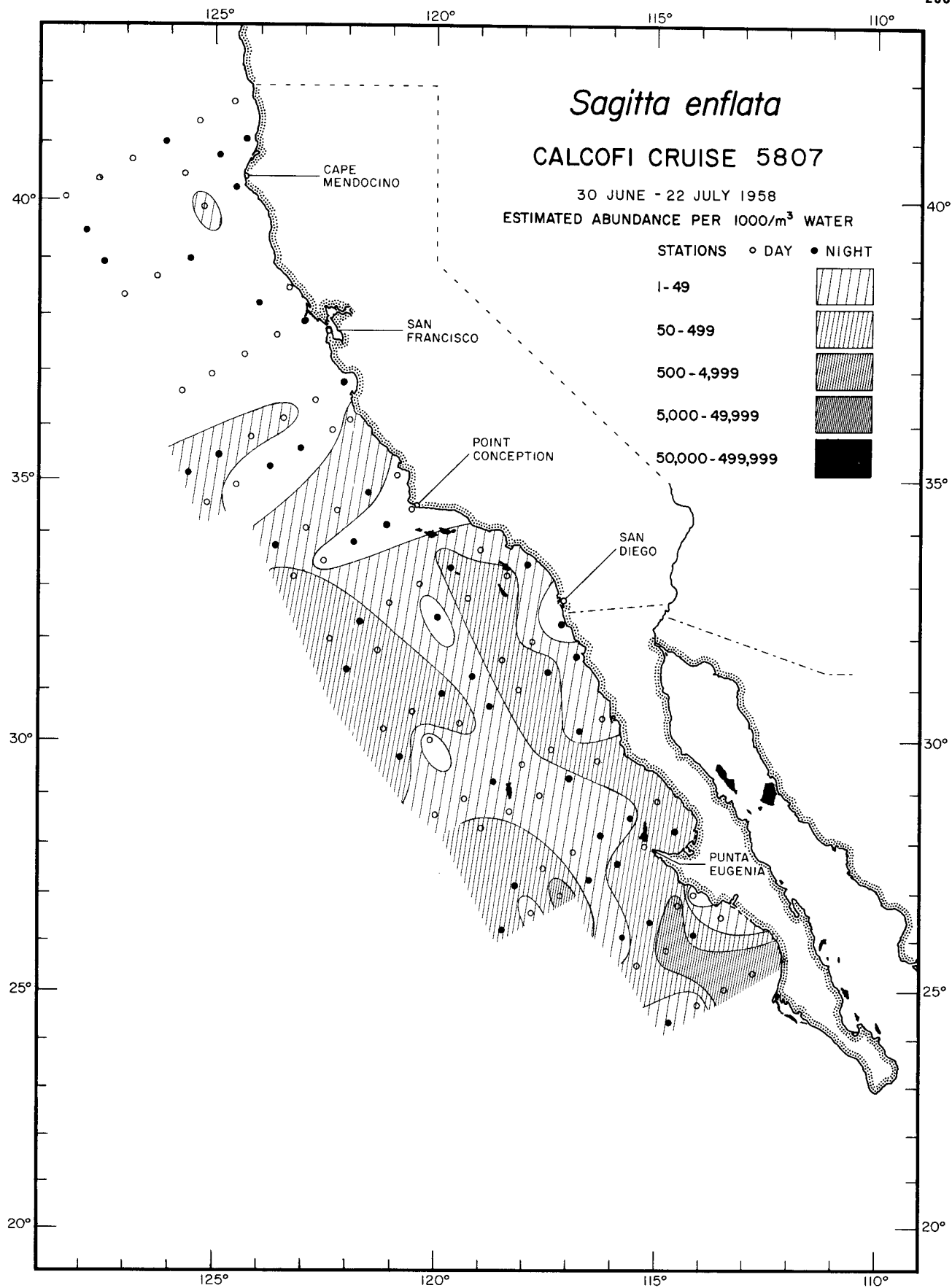
Chaetognatha  
*Sagitta bierii*  
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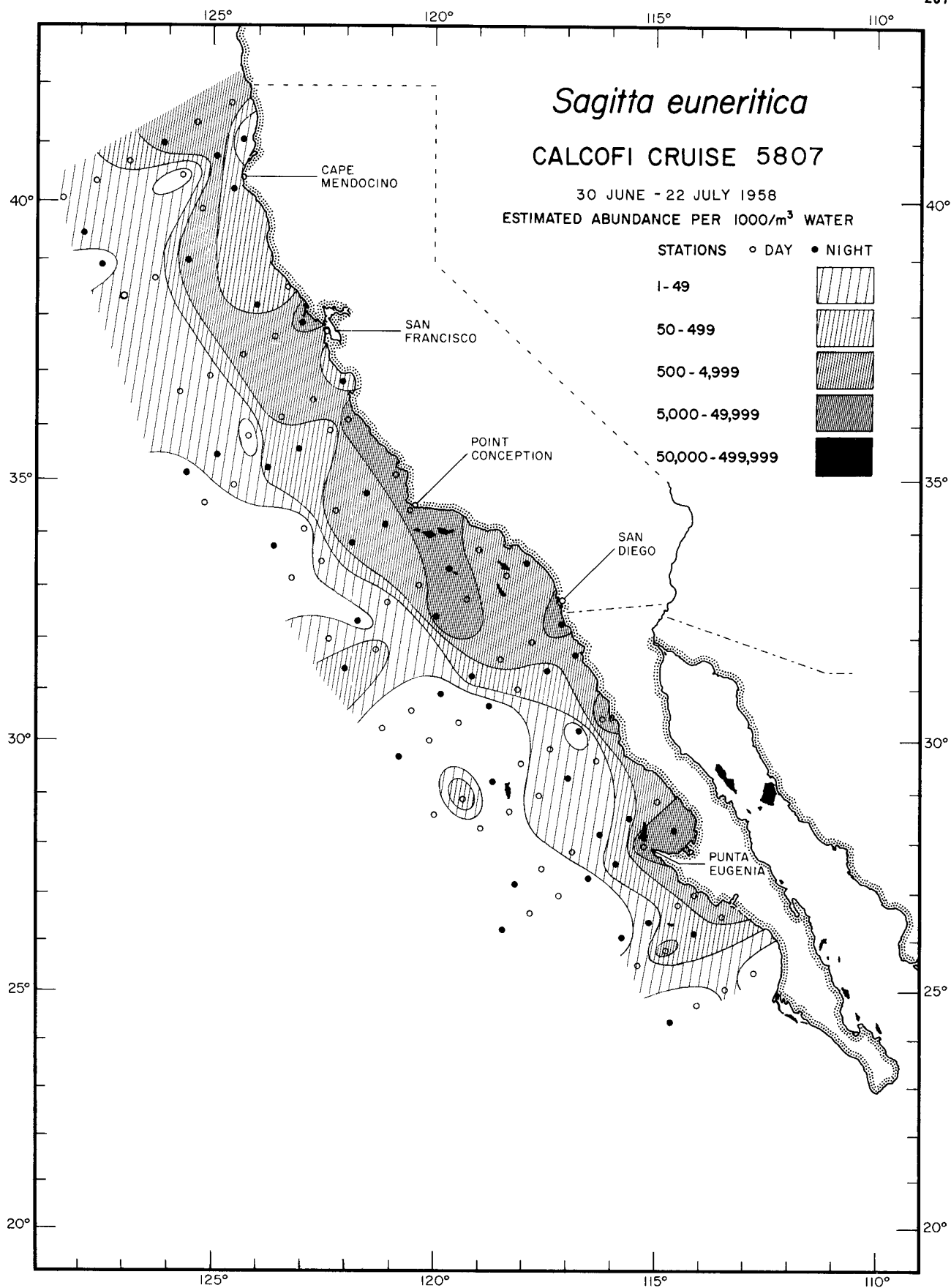
Chaetognatha  
*Sagitta bipunctata*  
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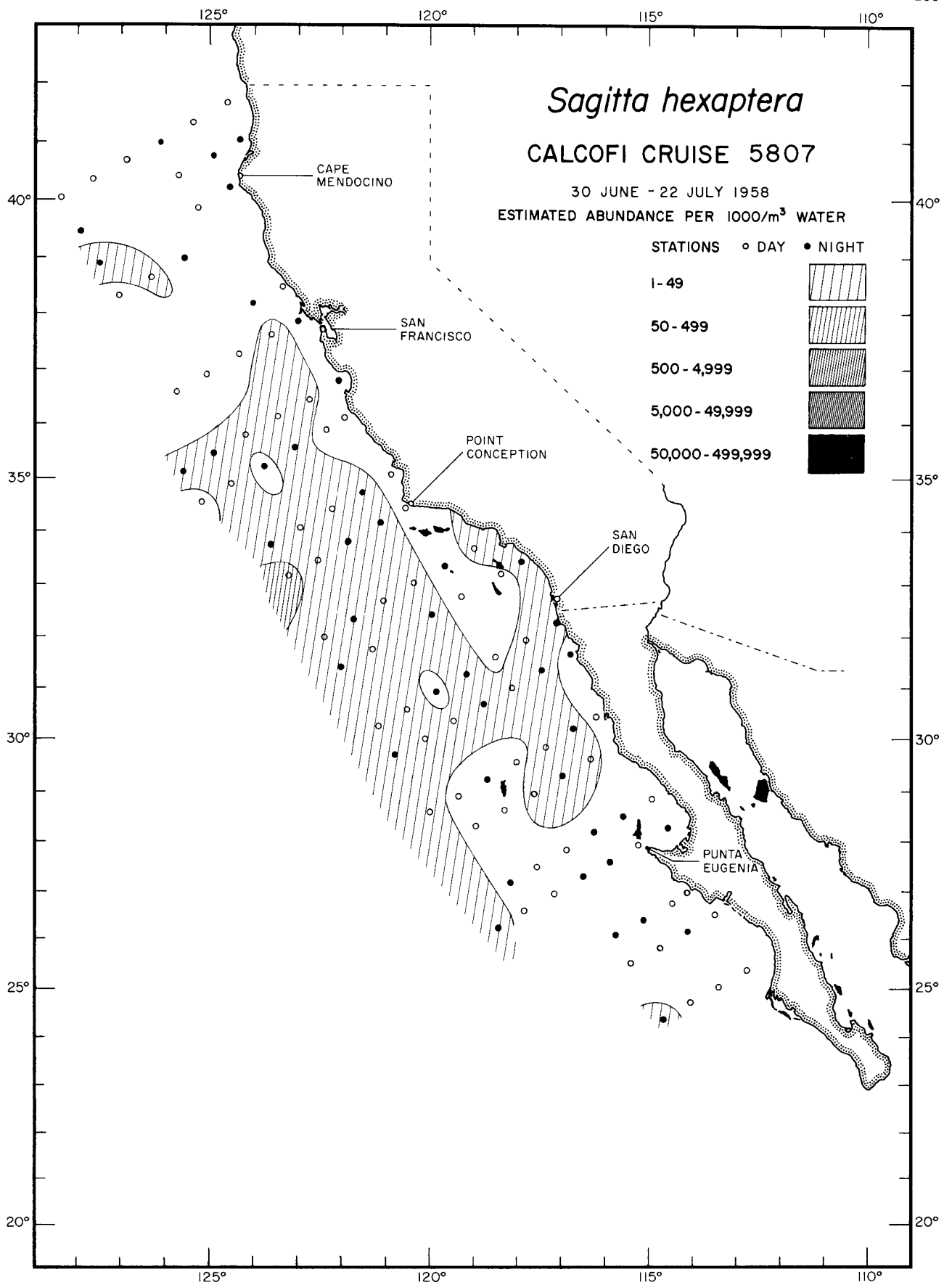
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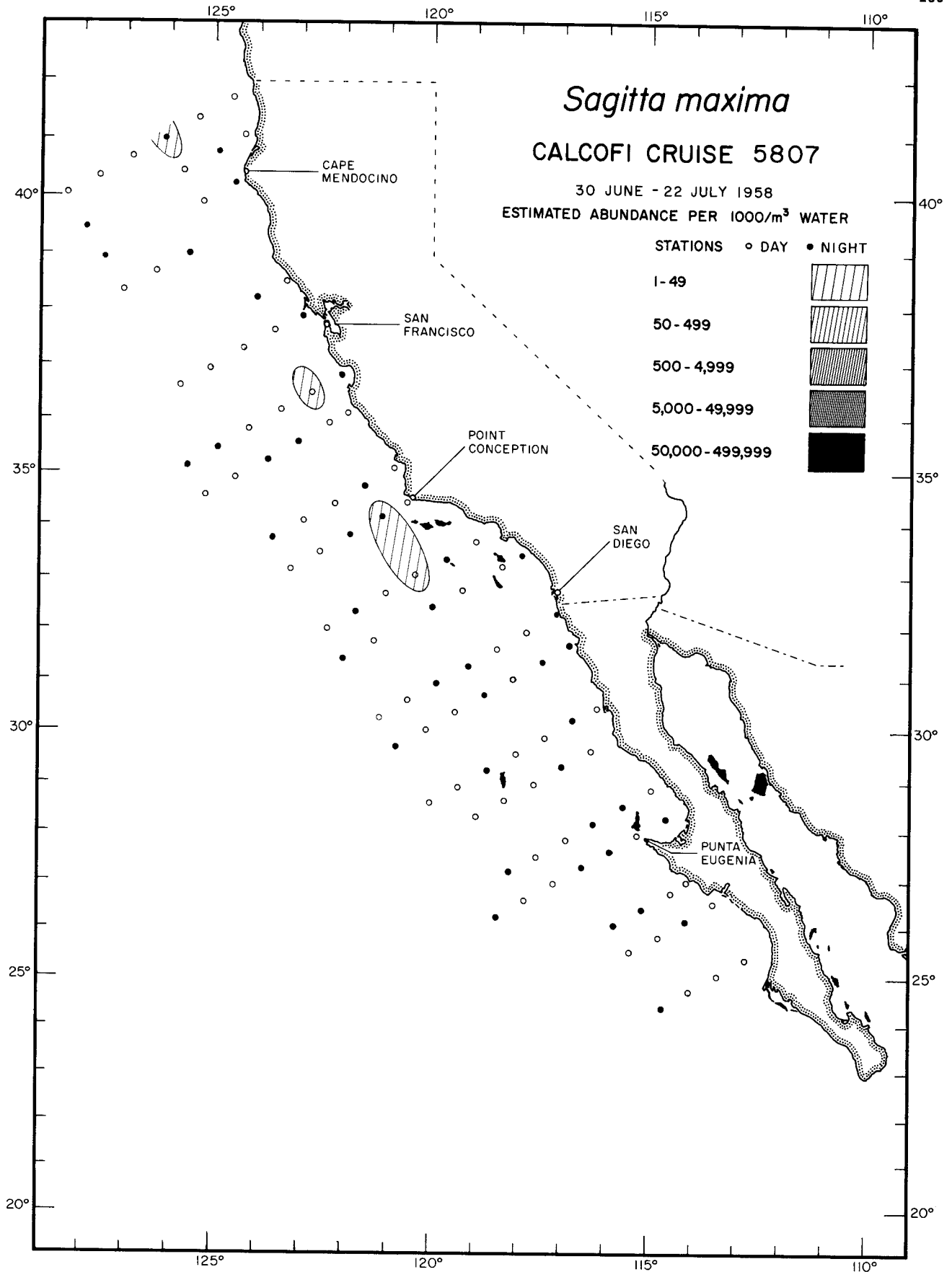
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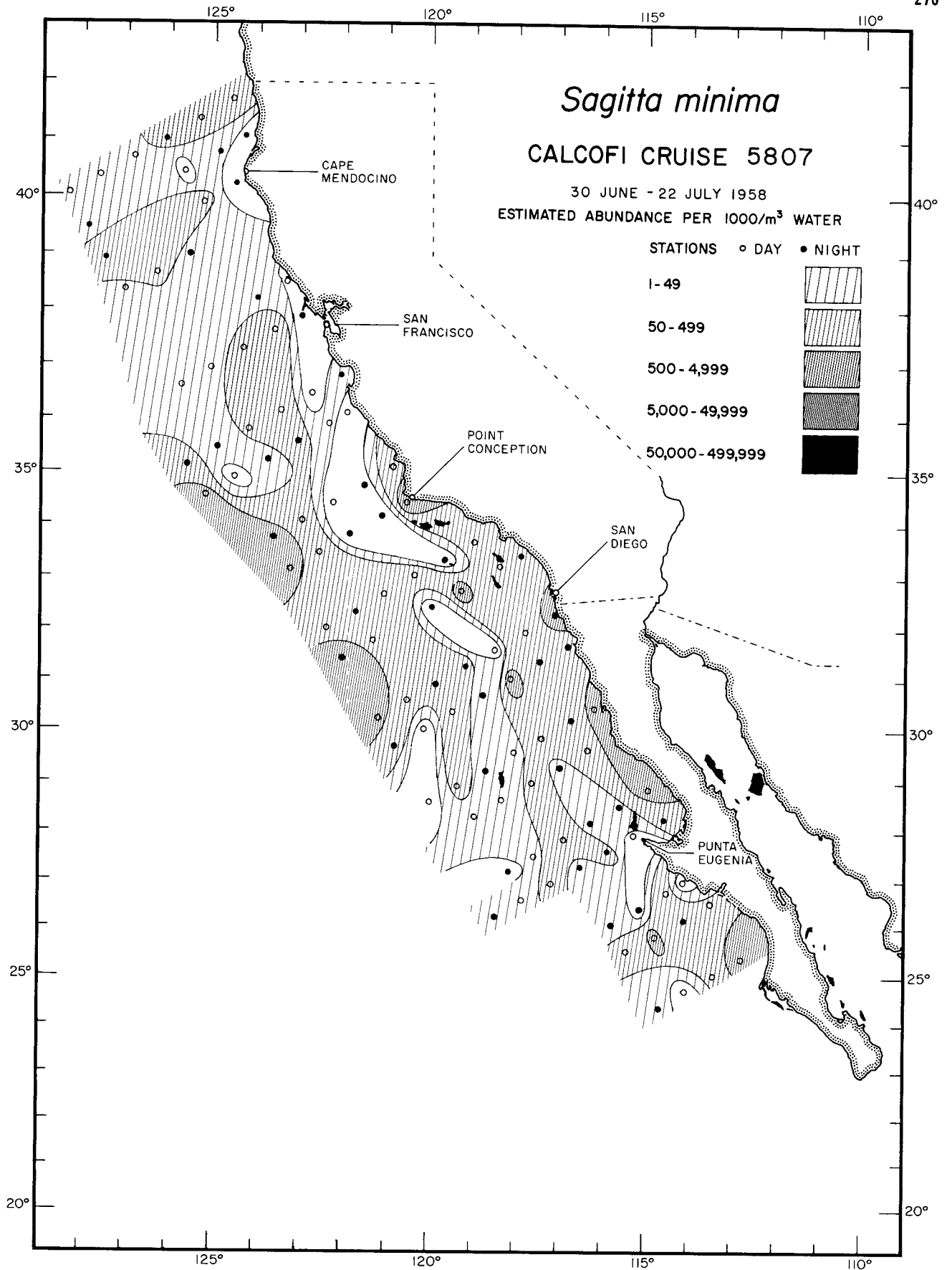
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Chaetognatha  
*Sagitta hexaptera*  
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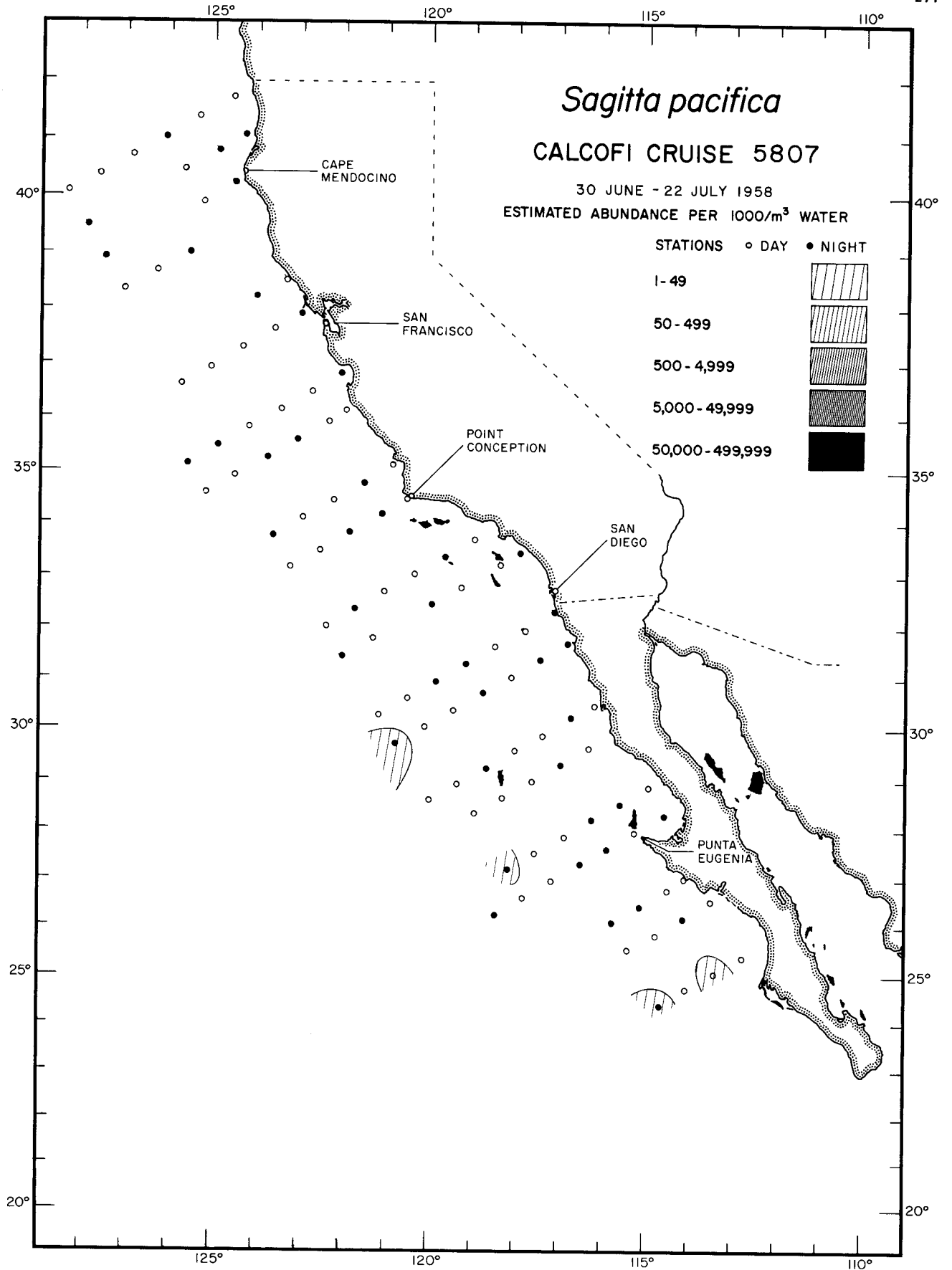


Chaetognatha  
*Sagitta maxima*  
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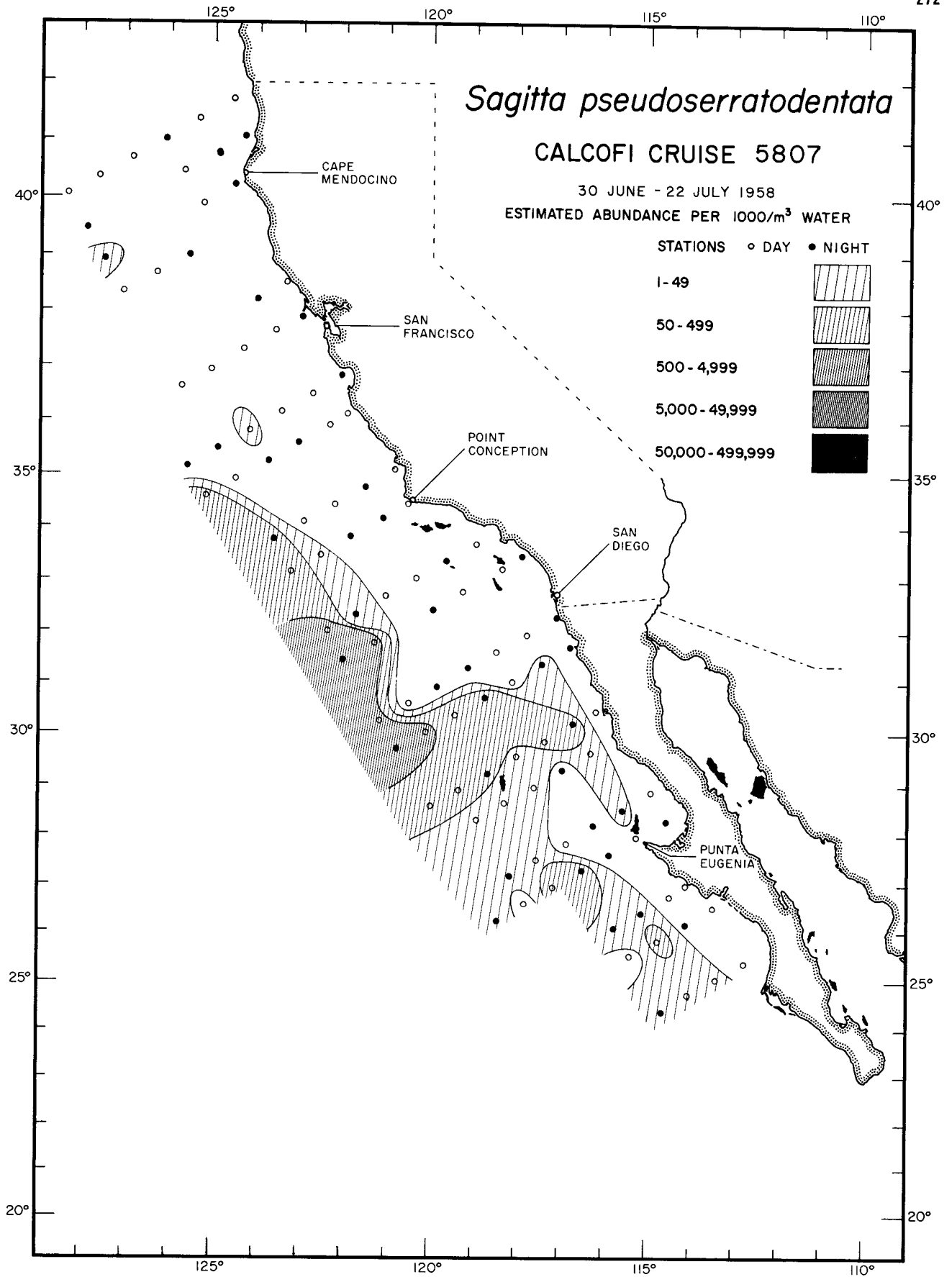


Chaetognatha  
*Sagitta minima*  
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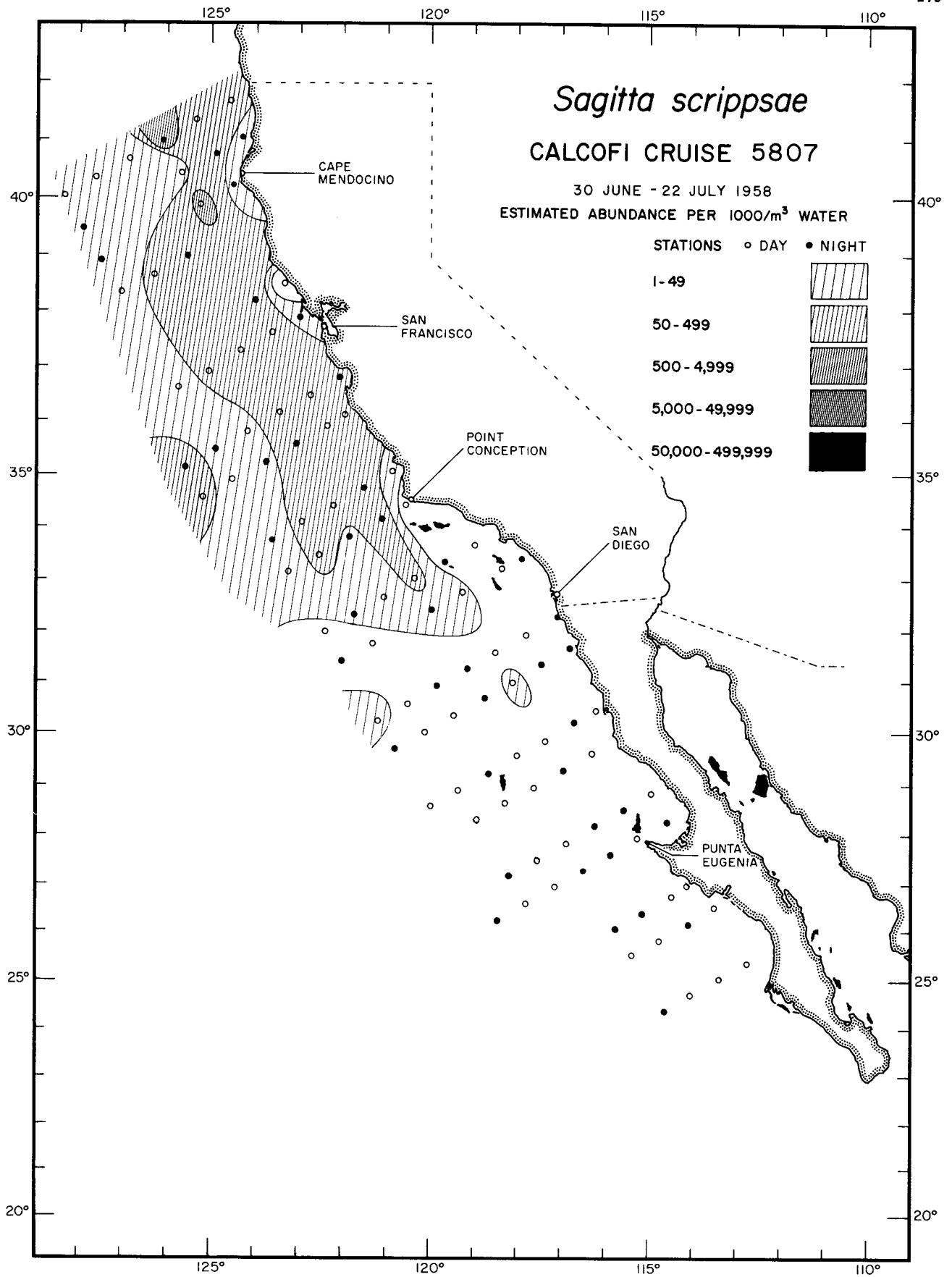




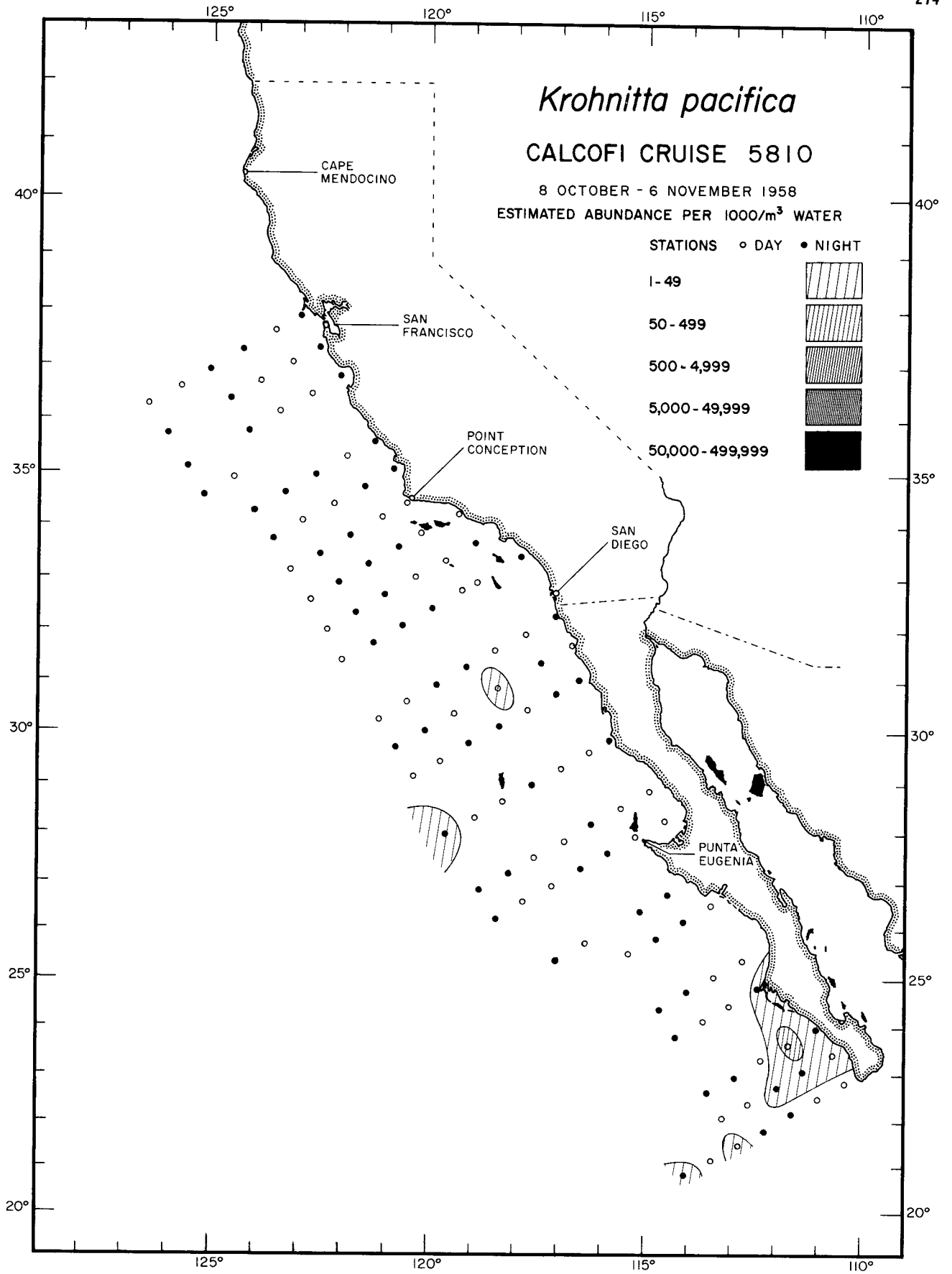
Chaetognatha  
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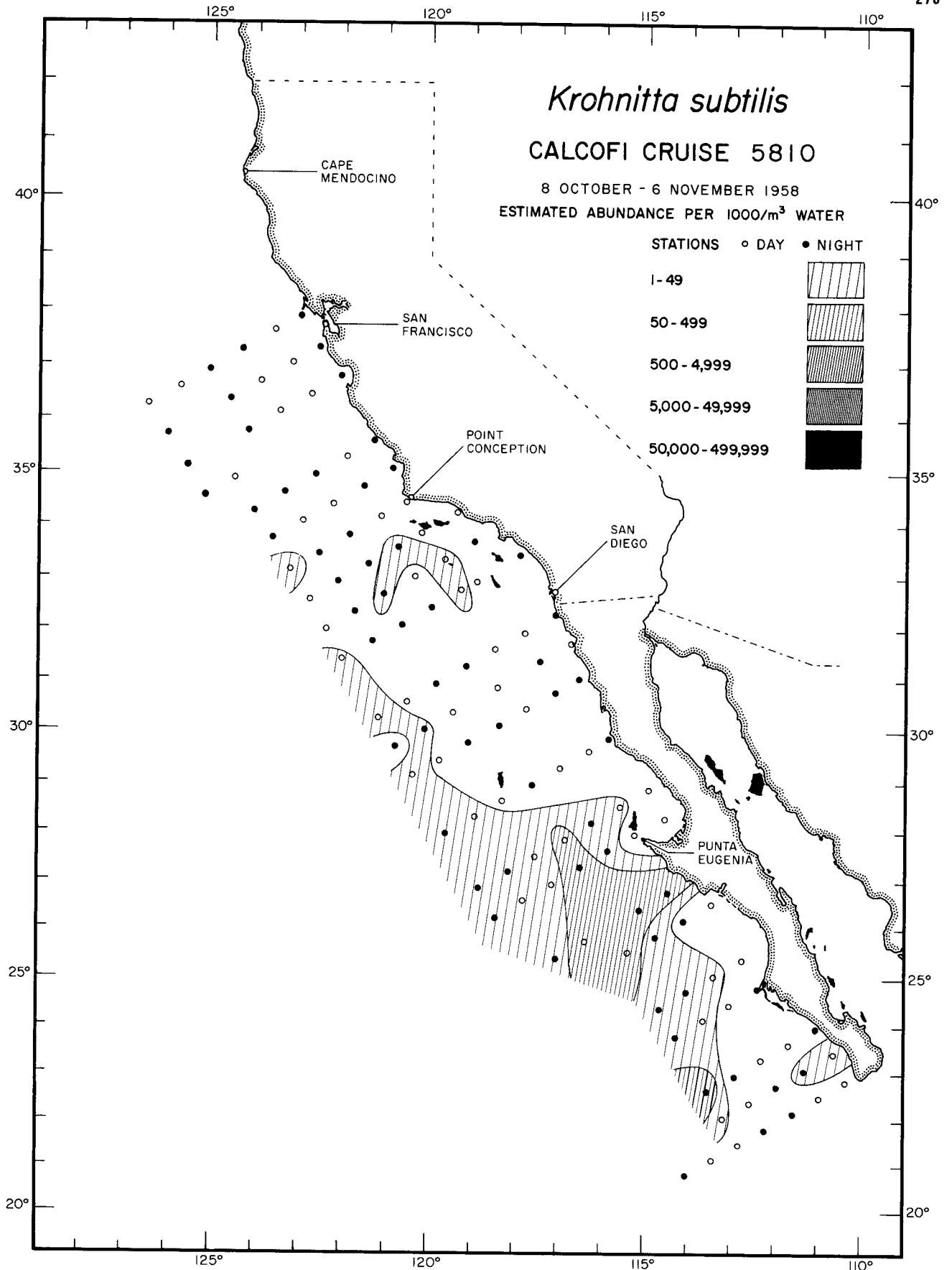
Chaetognatha  
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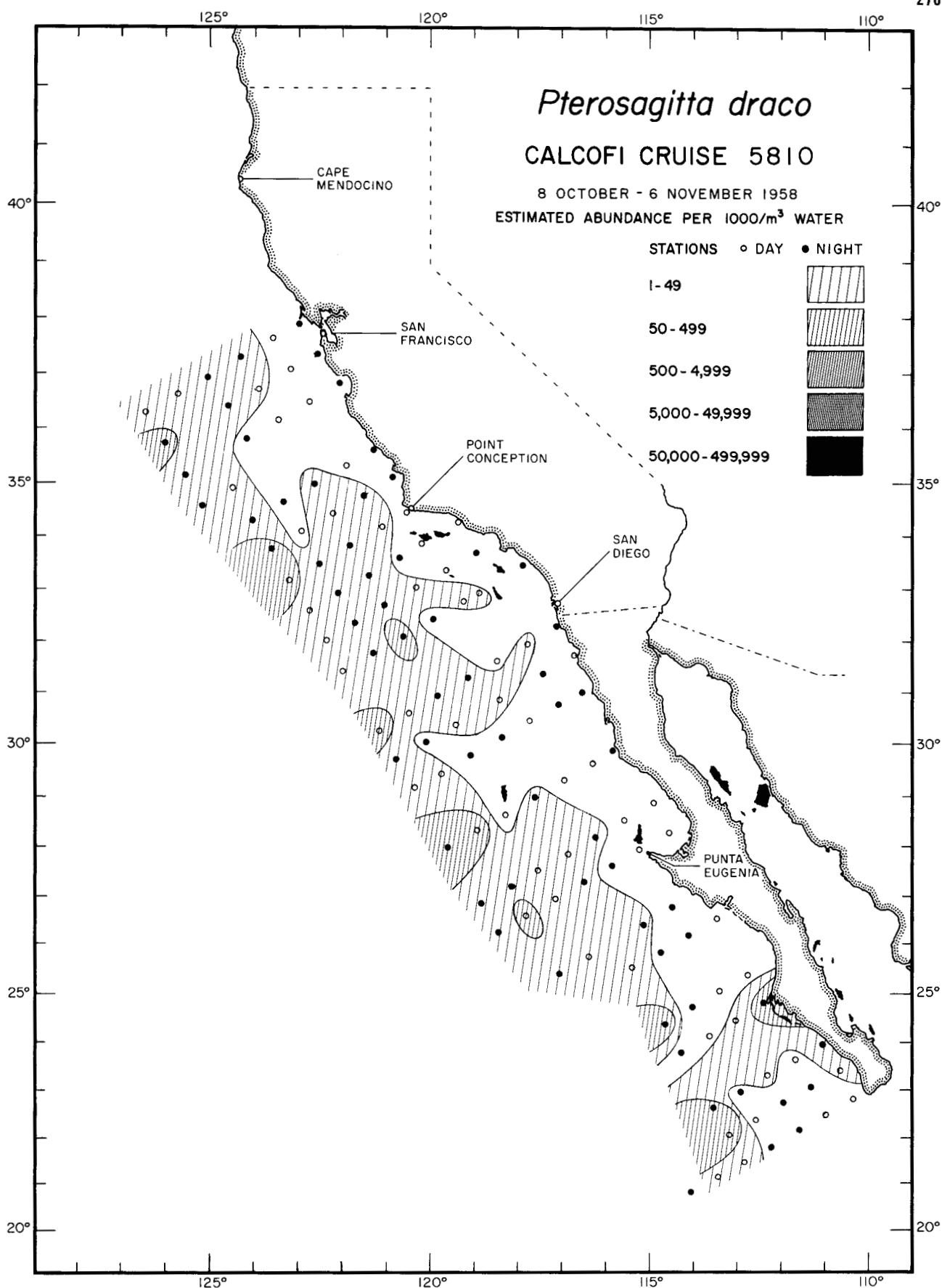
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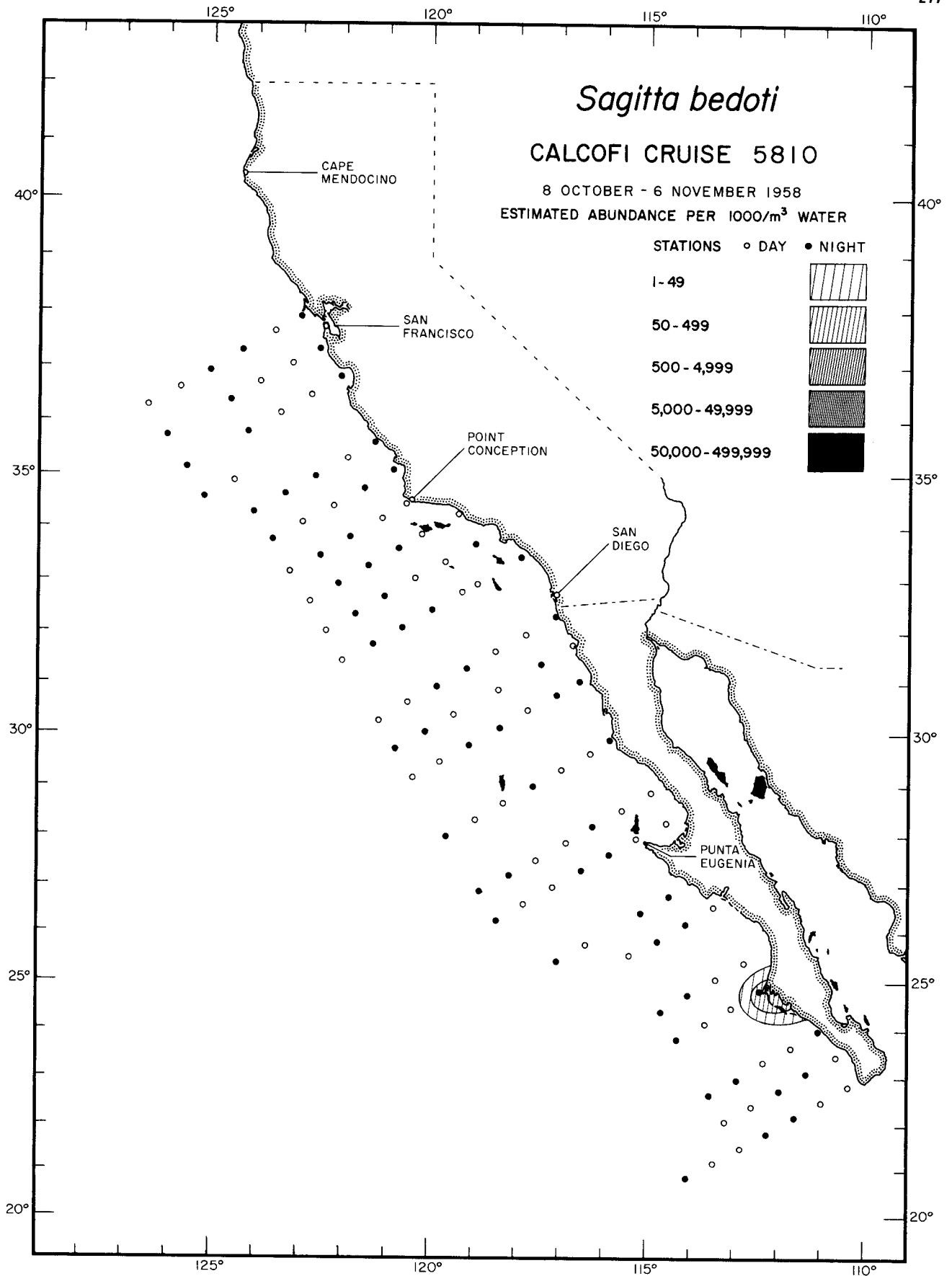
Chaetognatha  
*Krohnitta pacifica*  
5810



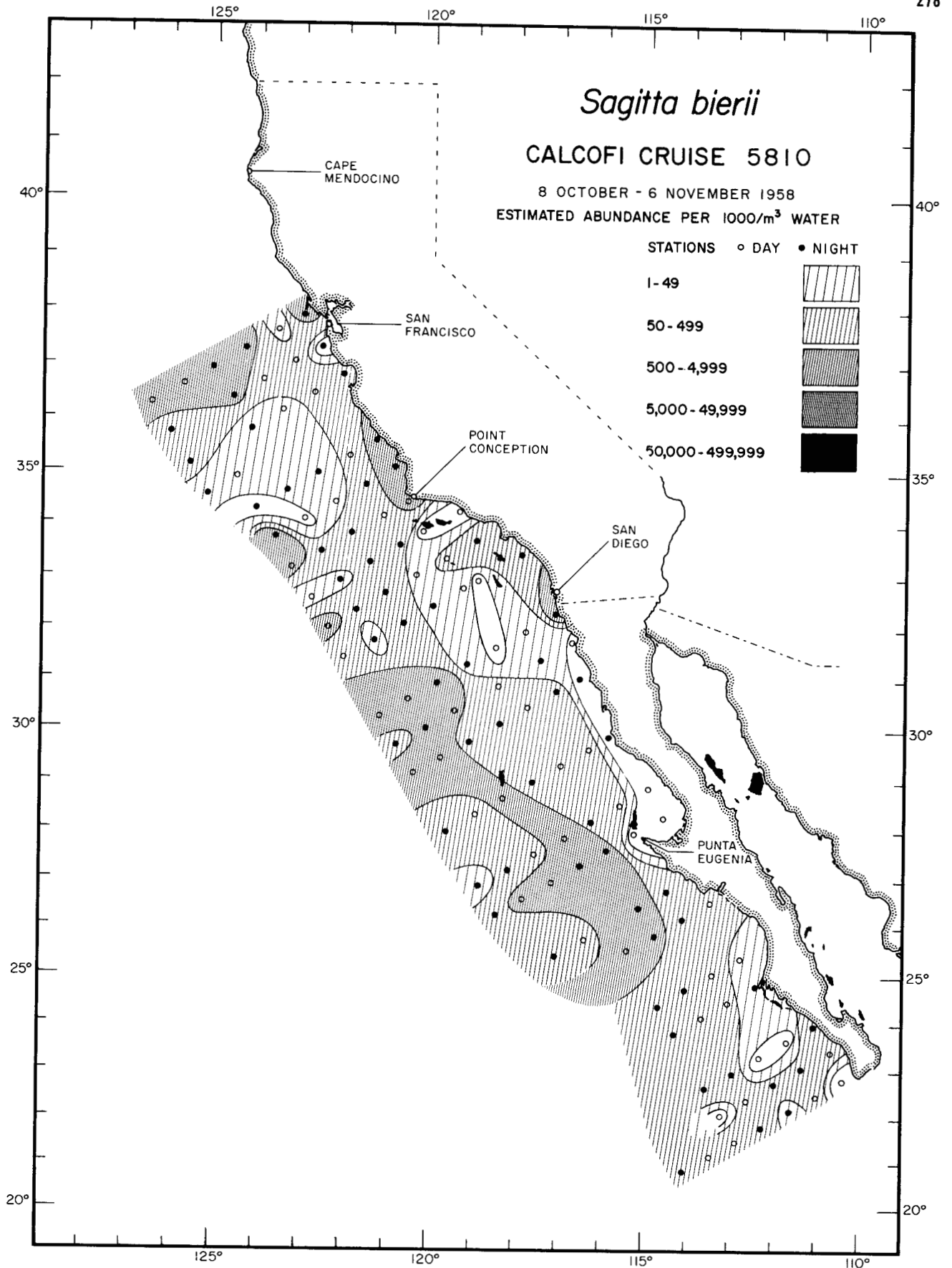
Chaetognatha  
*Krohnitta subtilis*  
5810



Chaetognatha  
*Pterosagitta draco*  
5810

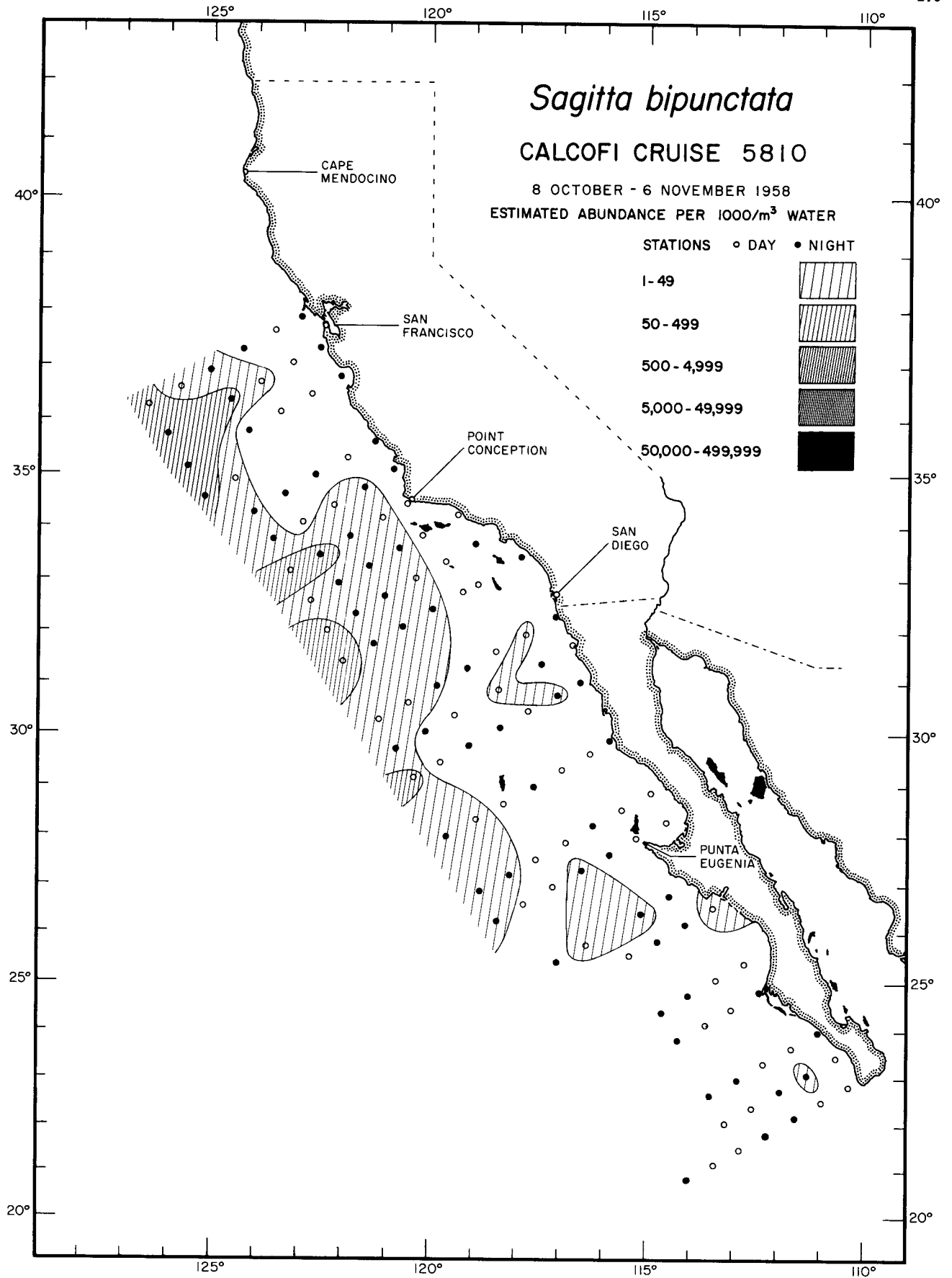


Chaetognatha  
*Sagitta bedoti*  
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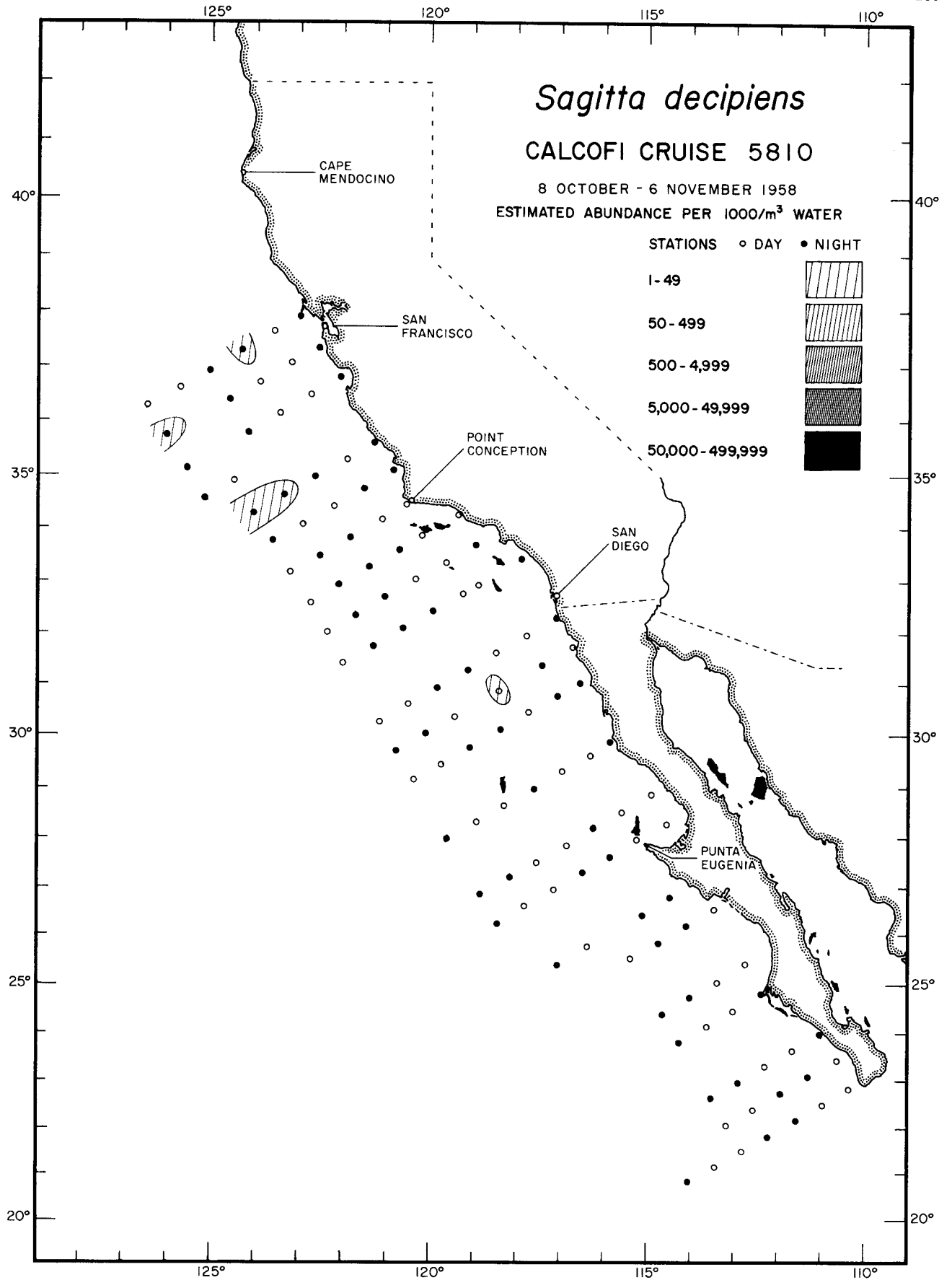


Chaetognatha  
*Sagitta bierii*  
5810

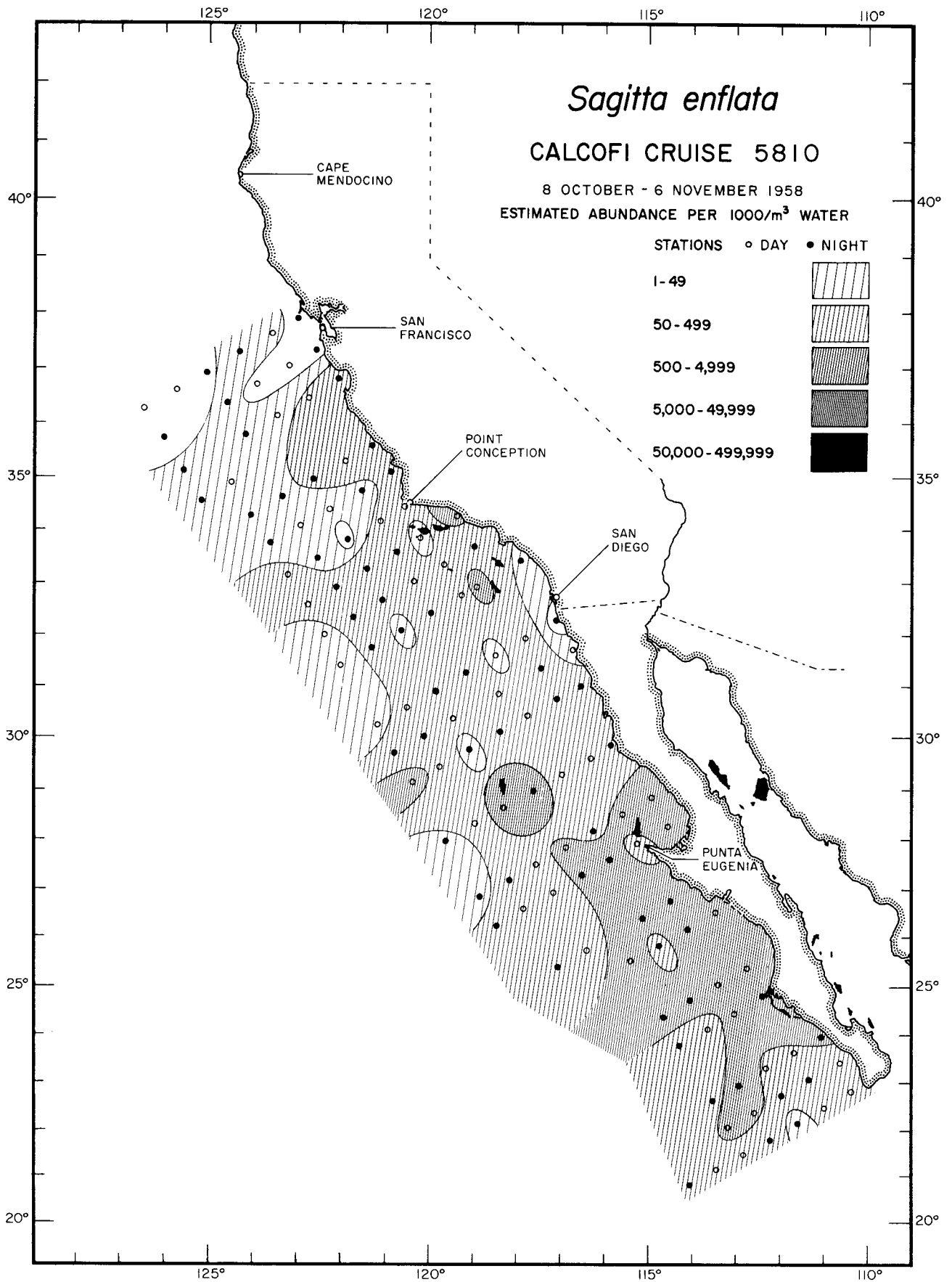




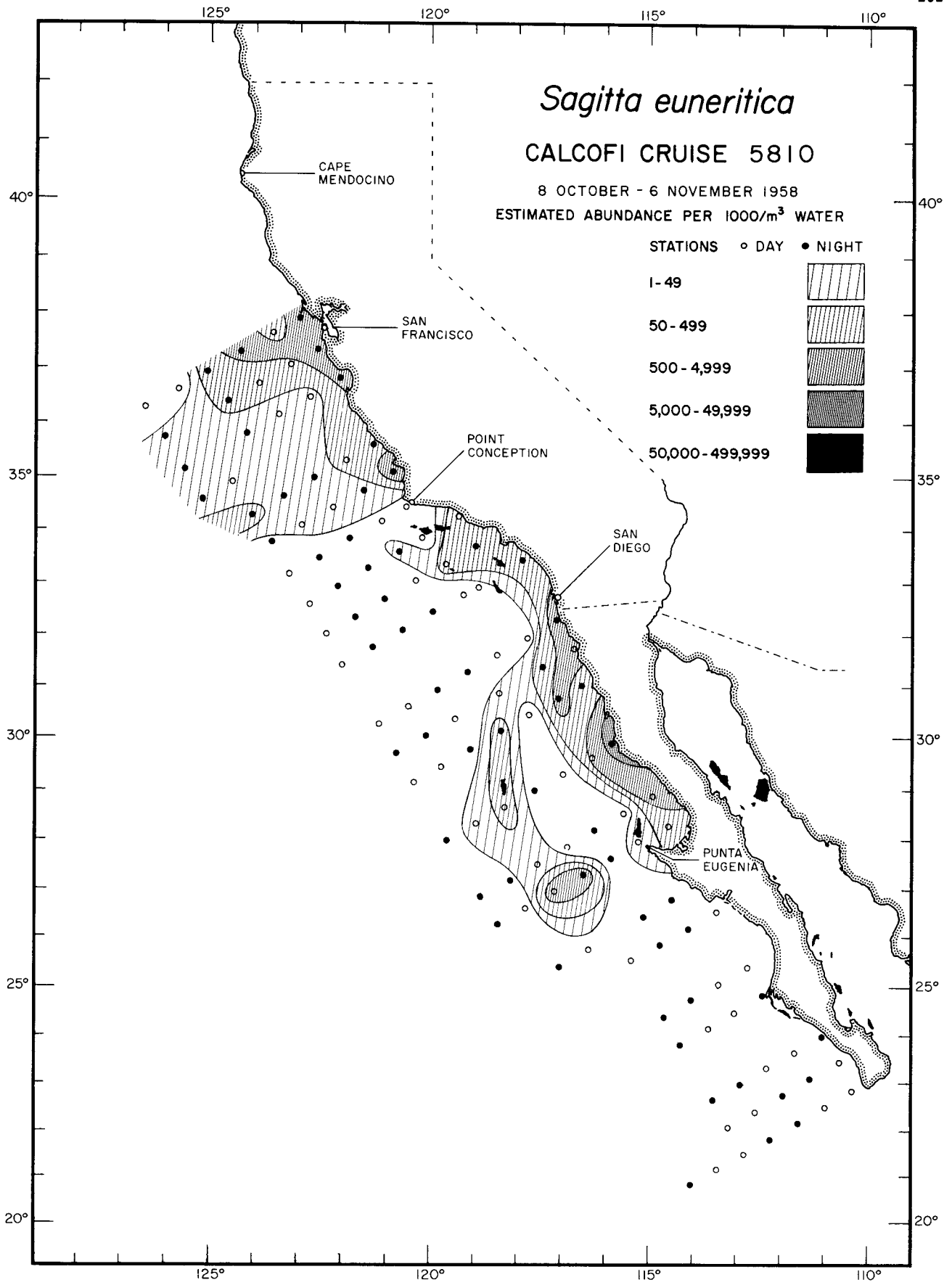
Chaetognatha  
*Sagitta bipunctata*  
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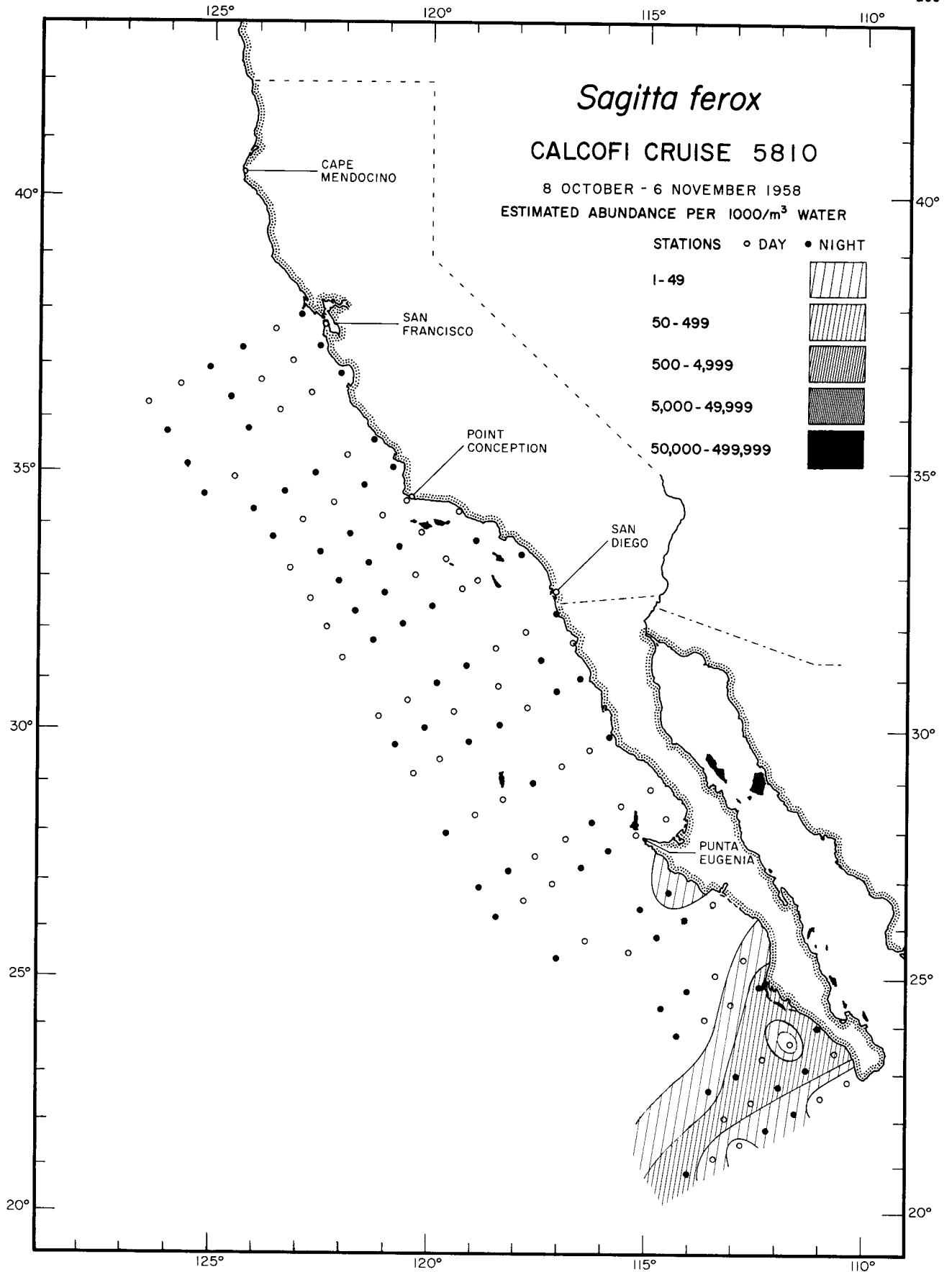


Chaetognatha  
*Sagitta decipiens*  
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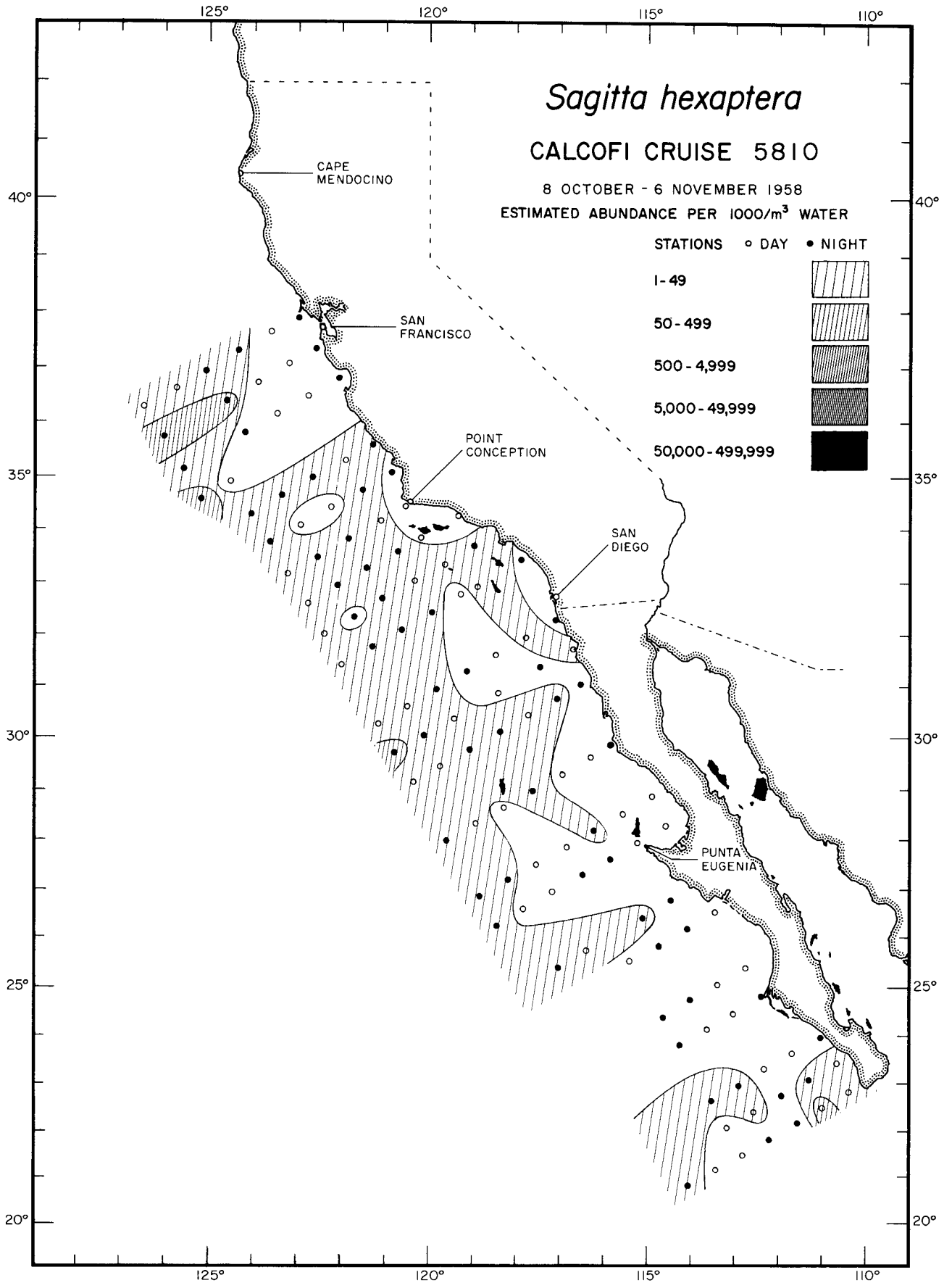


Chaetognatha  
*Sagitta enflata*  
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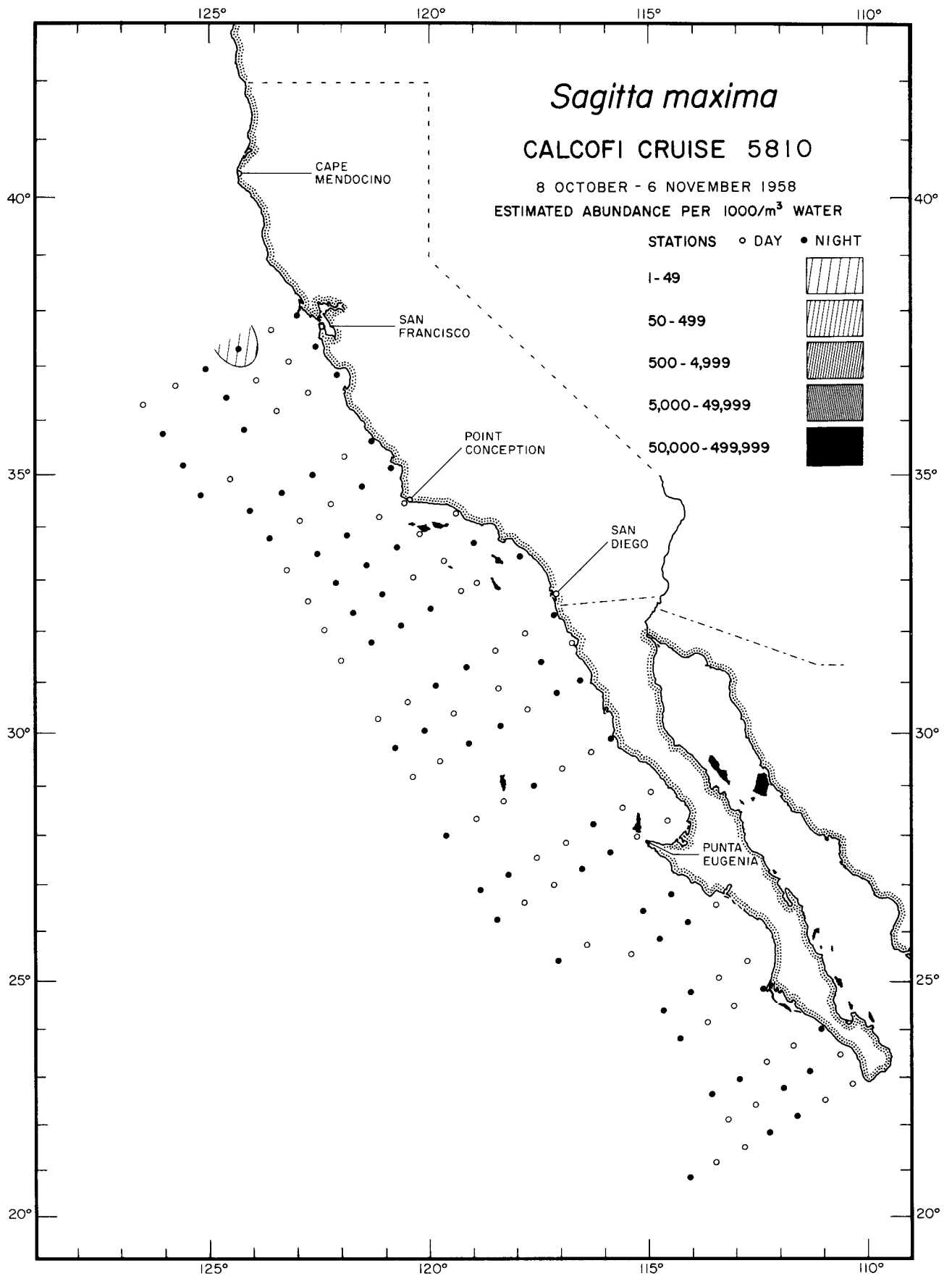




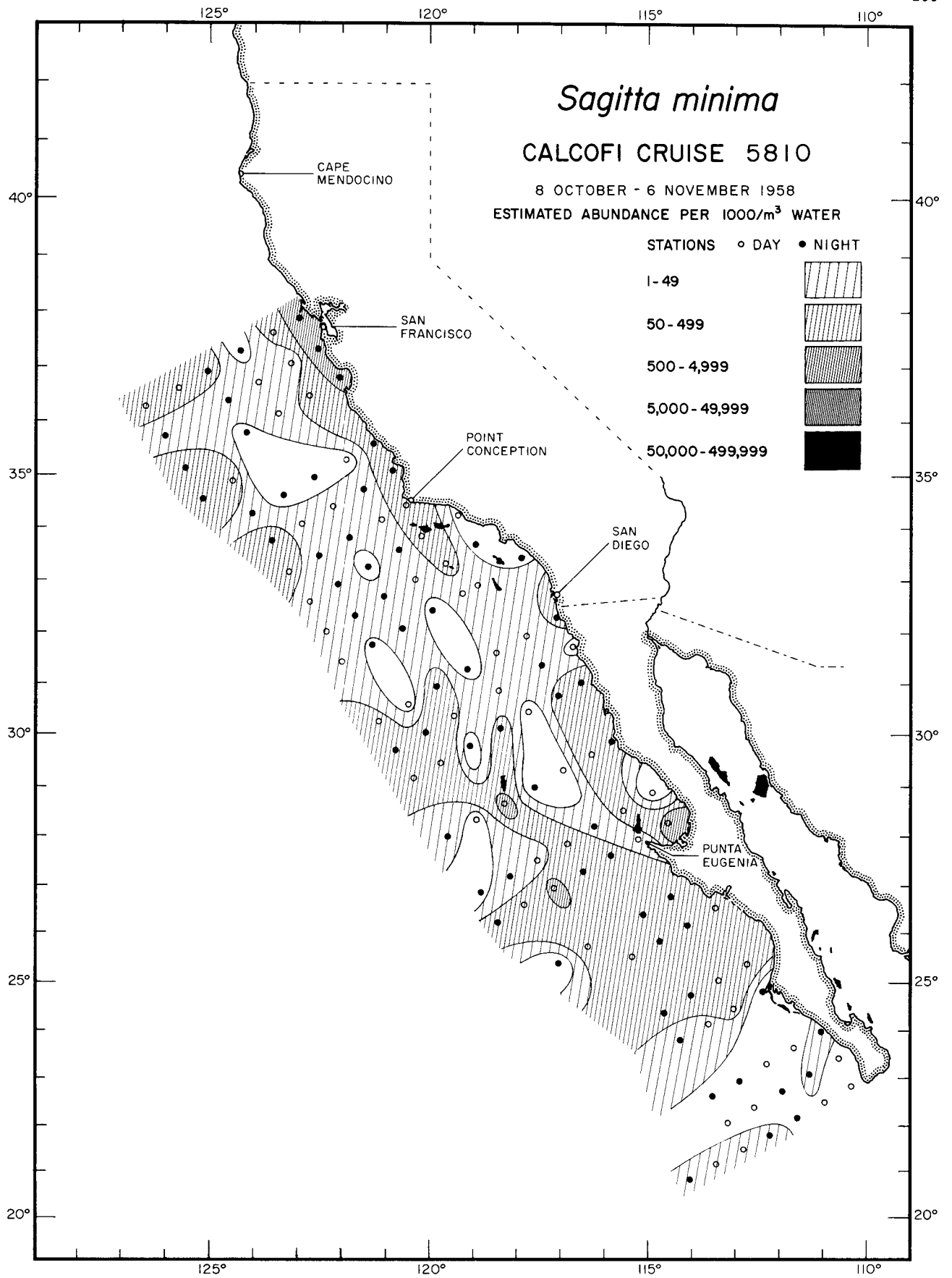
Chaetognatha  
*Sagitta ferox*  
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Chaetognatha  
*Sagitta hexaptera*  
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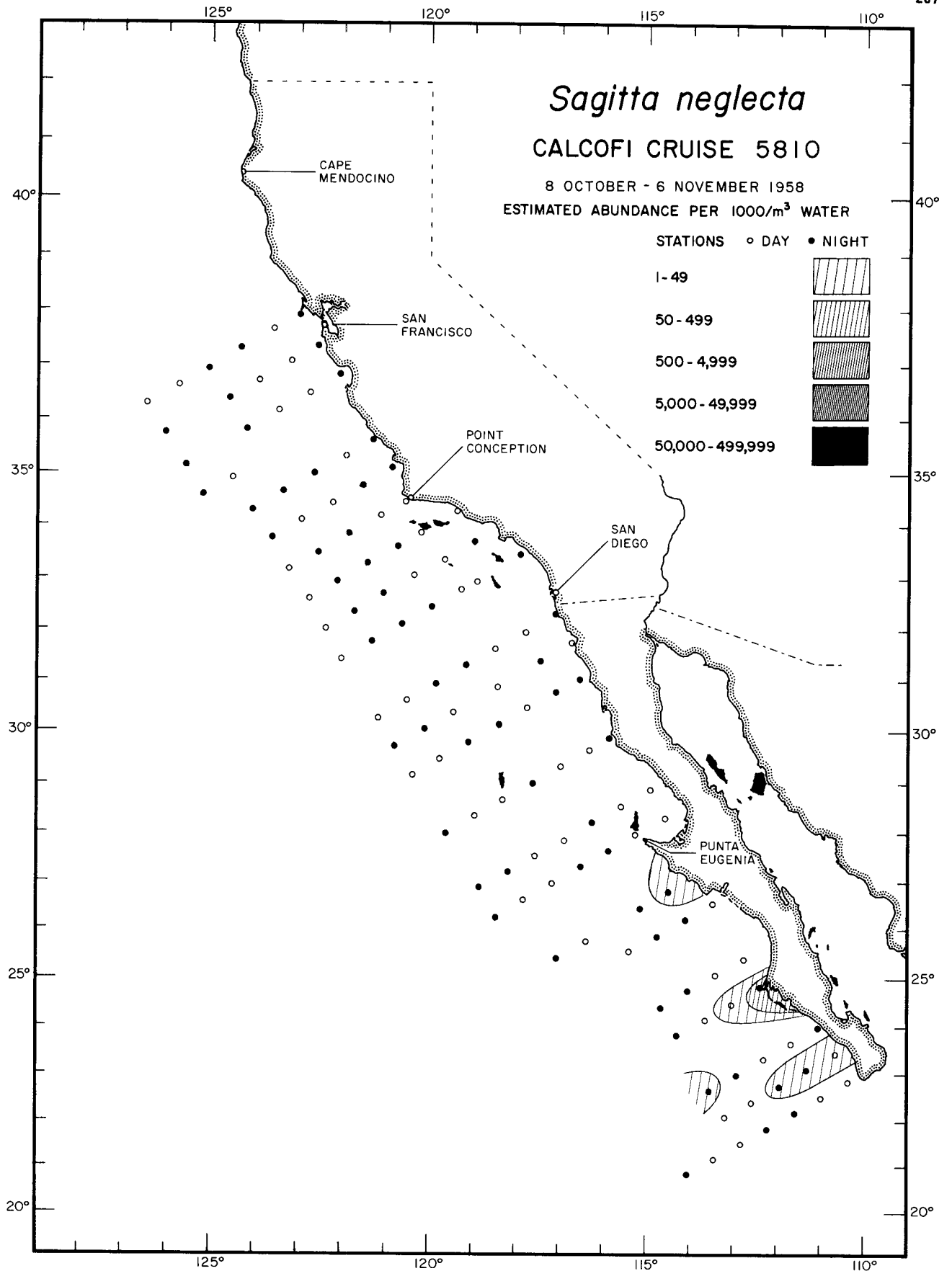


Chaetognatha  
*Sagitta maxima*  
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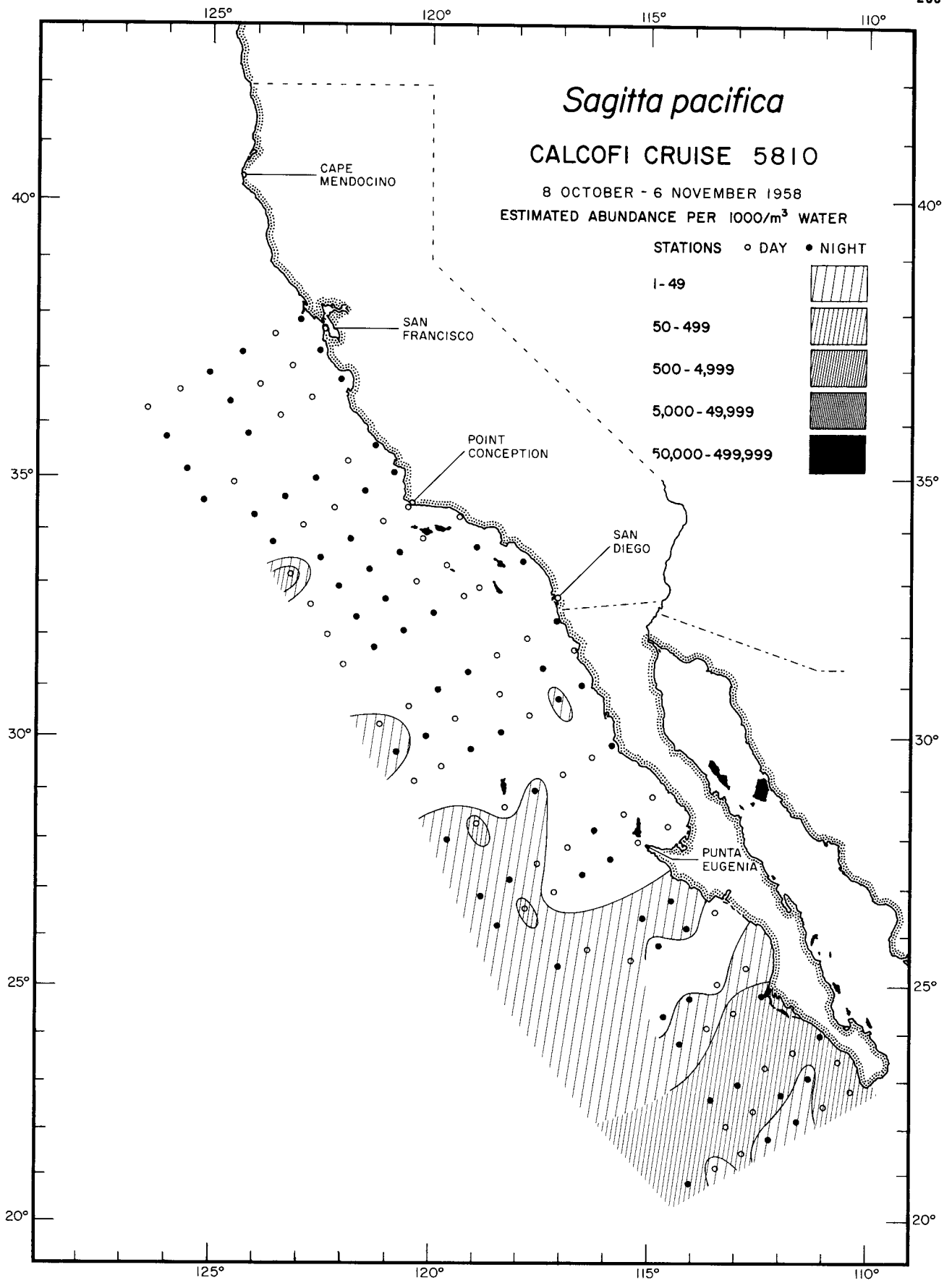


Chaetognatha  
*Sagitta minima*  
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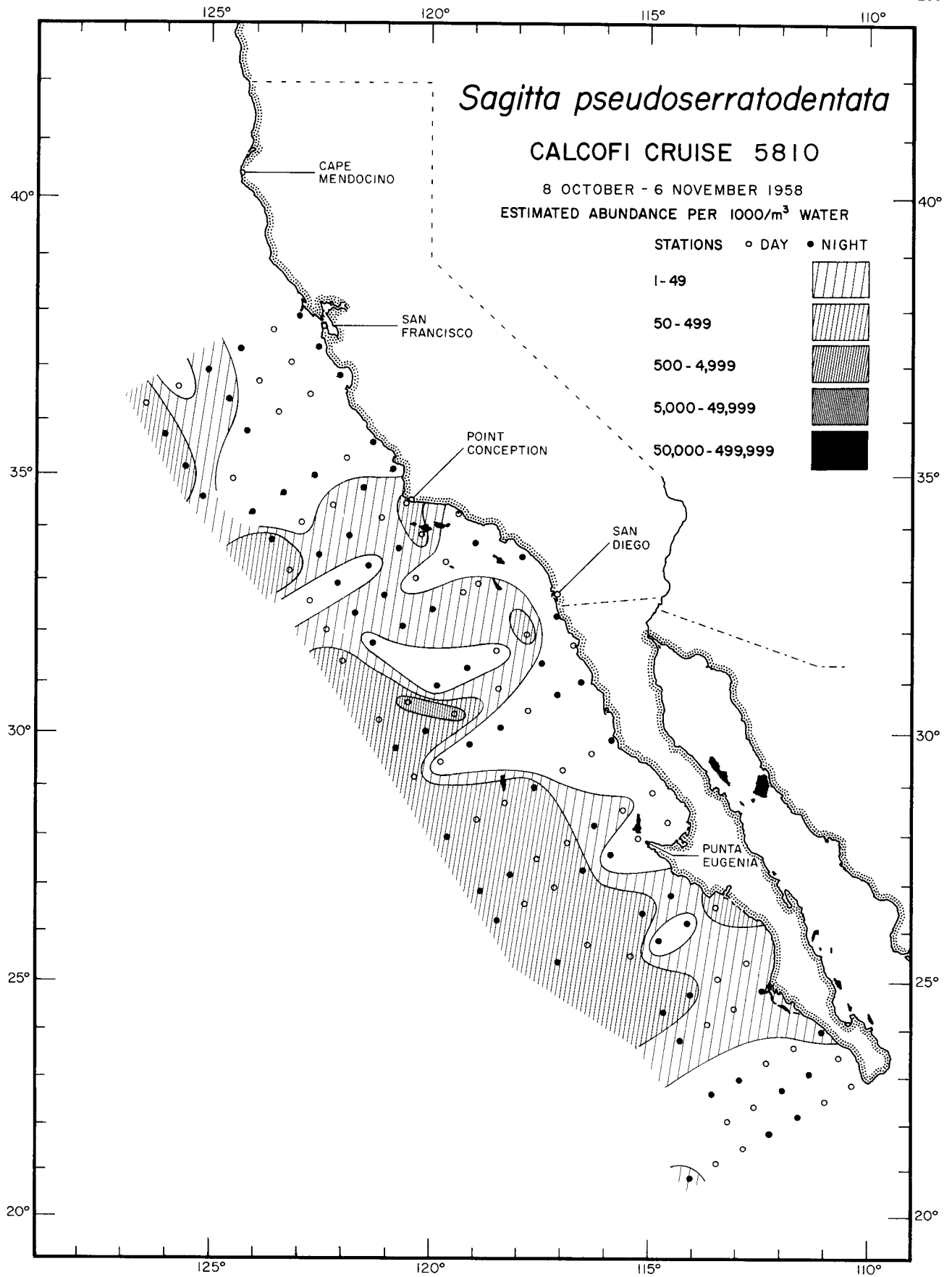




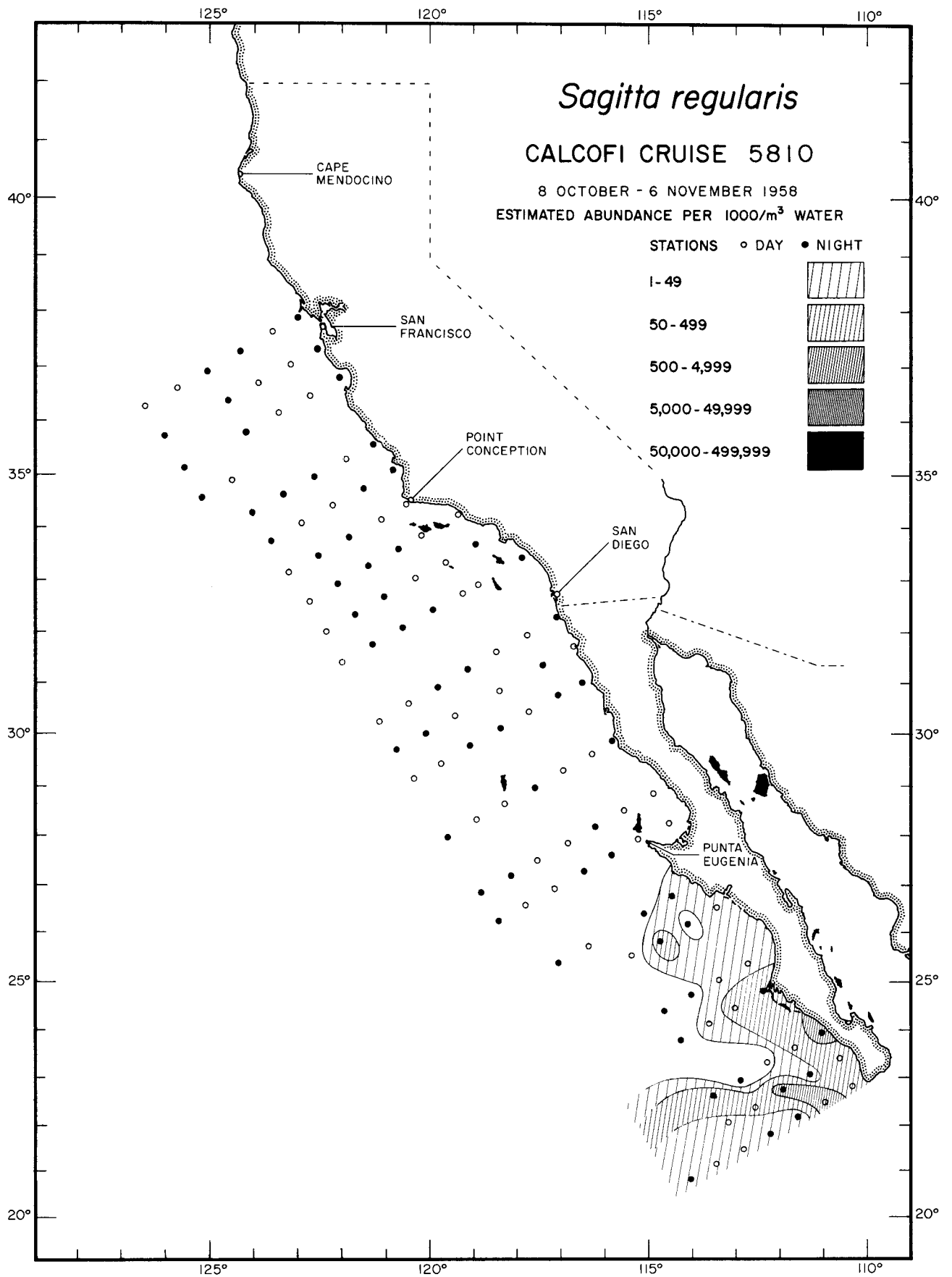
Chaetognatha  
*Sagitta neglecta*  
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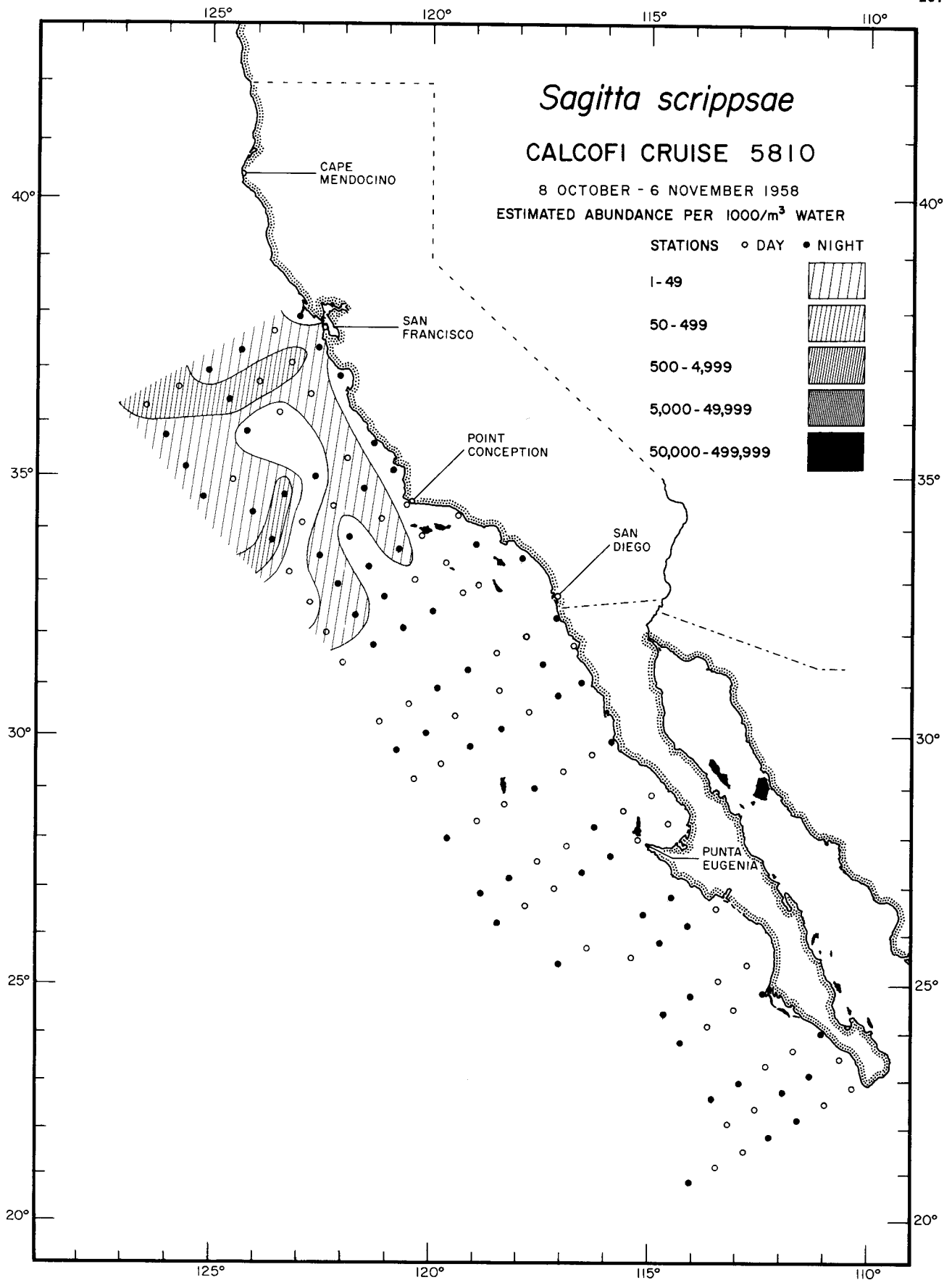
Chaetognatha  
*Sagitta pacifica*  
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Chaetognatha  
*Sagitta pseudoserratodentata*  
5810

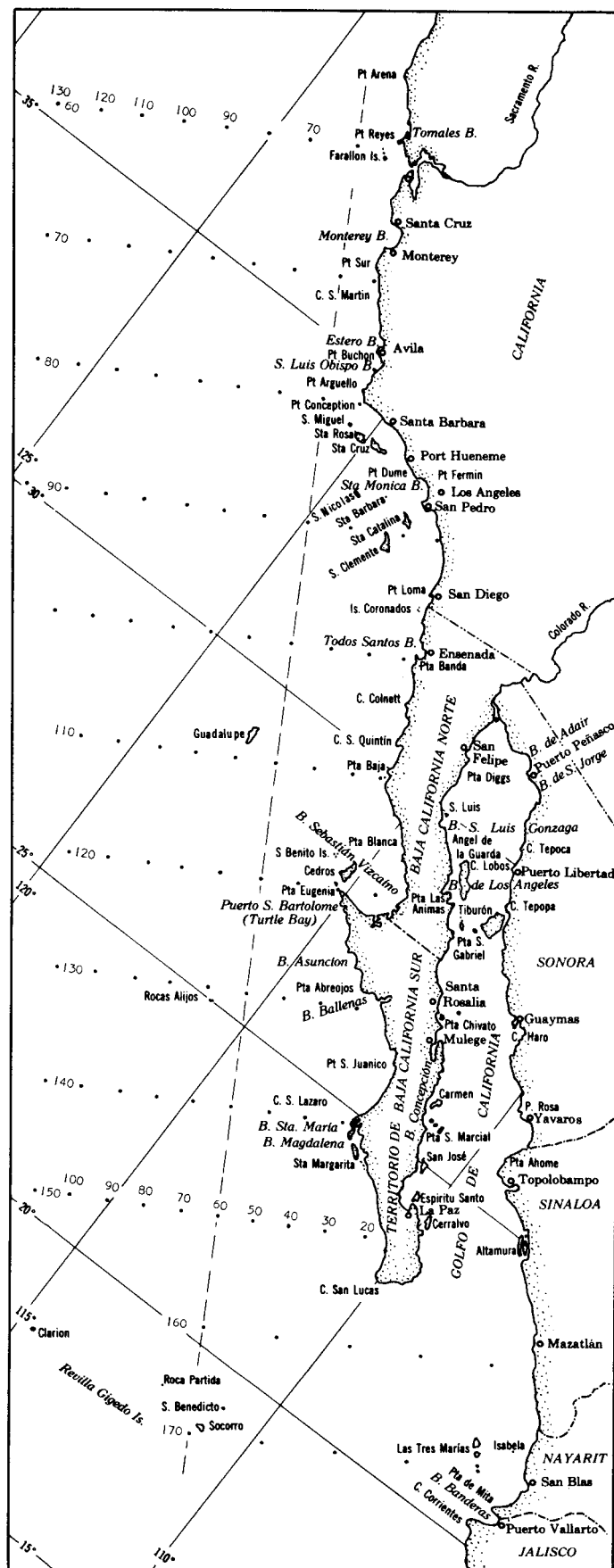
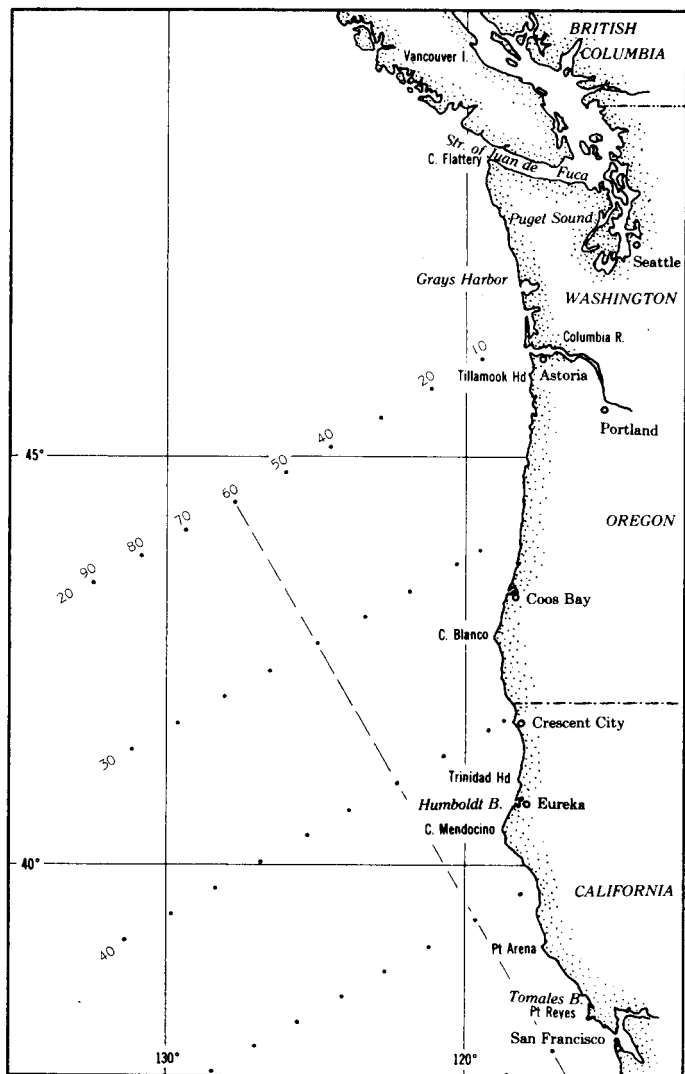


Chaetognatha  
*Sagitta regularis*  
5810



Chaetognatha  
*Sagitta scrippsae*  
5810





These maps are designed to show essential details of the area most intensively studied by the California Cooperative Oceanic Fisheries Investigations. This is approximately the same area as is shown in color on the front cover. Geographical place names are those most commonly used in the various publications emerging from the research. The cardinal station lines extending southwestward from the coast are shown. They are 120 miles apart. Additional lines are utilized as needed and can be as closely spaced as 12 miles apart and still have individual numbers. The stations along the lines are numbered with respect to the station 60 line, the numbers increasing to the west and decreasing to the east. Most of them are 40 miles apart, and are numbered in groups of 10. This permits adding stations as close as 4 miles apart as needed. An example of the usual identification is 120.65. This station is on line 120, 20 nautical miles southwest of station 60.

The projection of the front cover is Lambert's Azimuthal Equal Area Projection. The detail maps are a Mercator projection.

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