



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

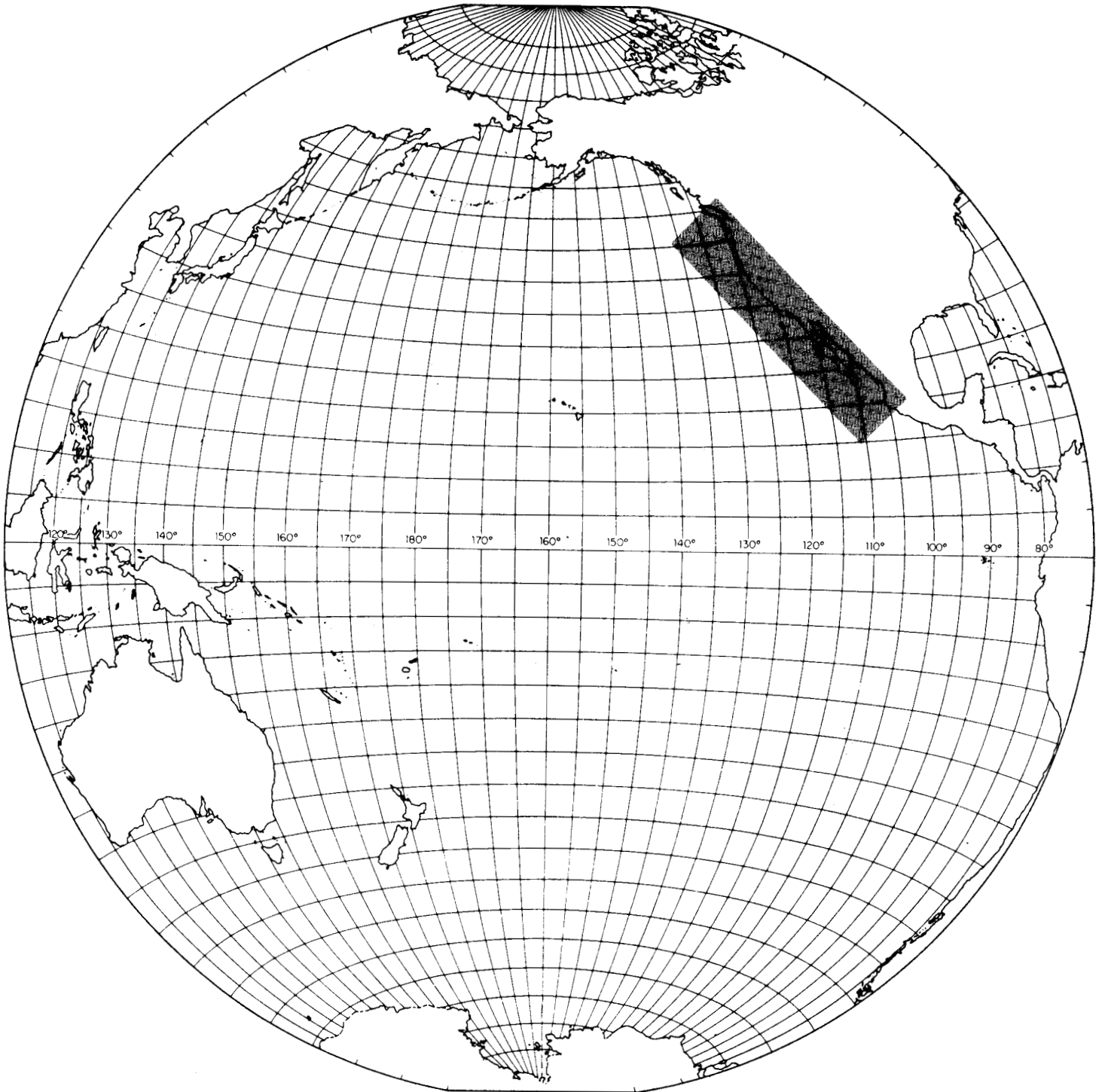
24 May 2007

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.

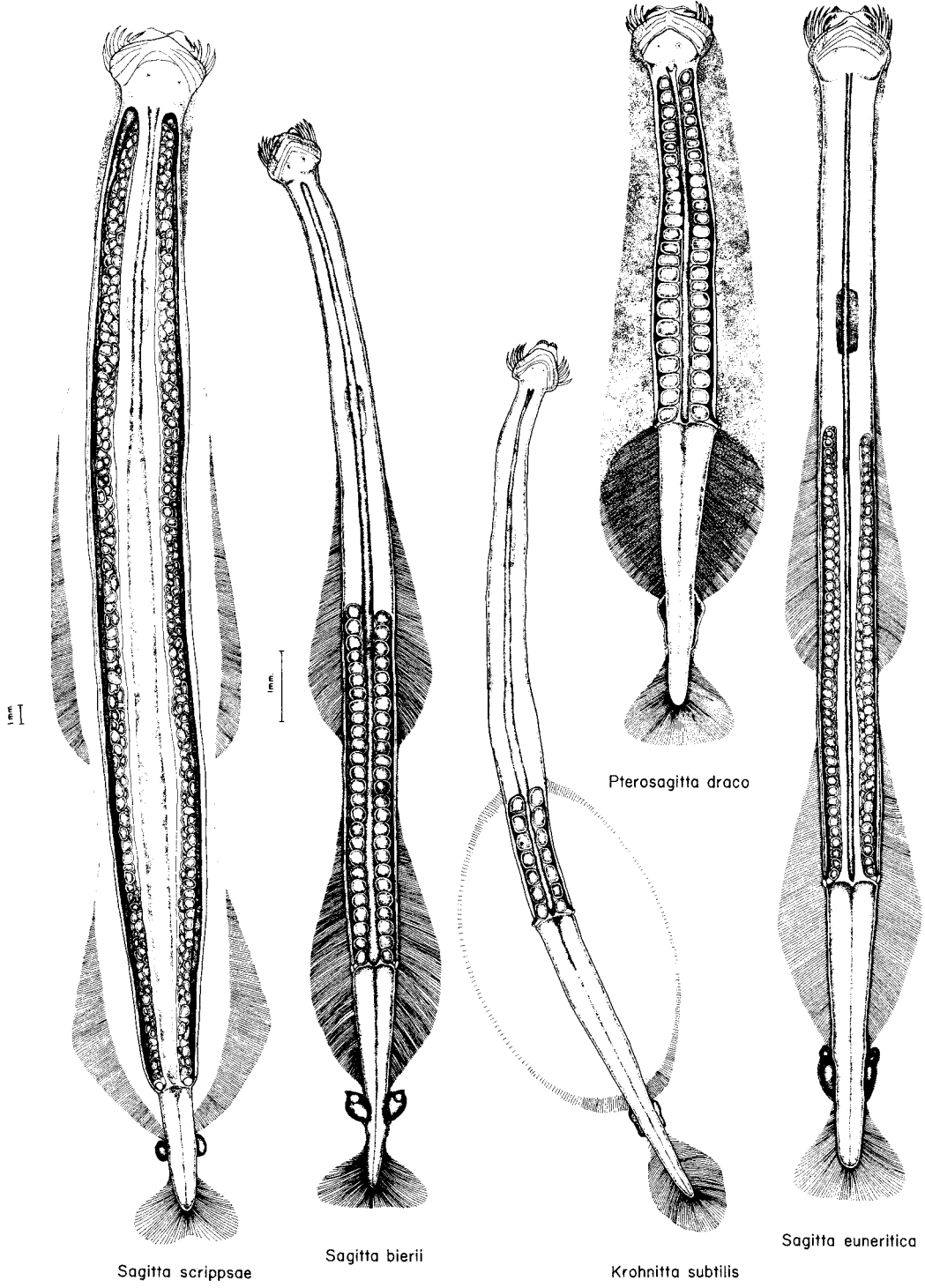
There is also information on the GBIF website: <http://nlbif.eti.uva.nl/bis/index.php> (go to projects and find Chaetognatha).

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:

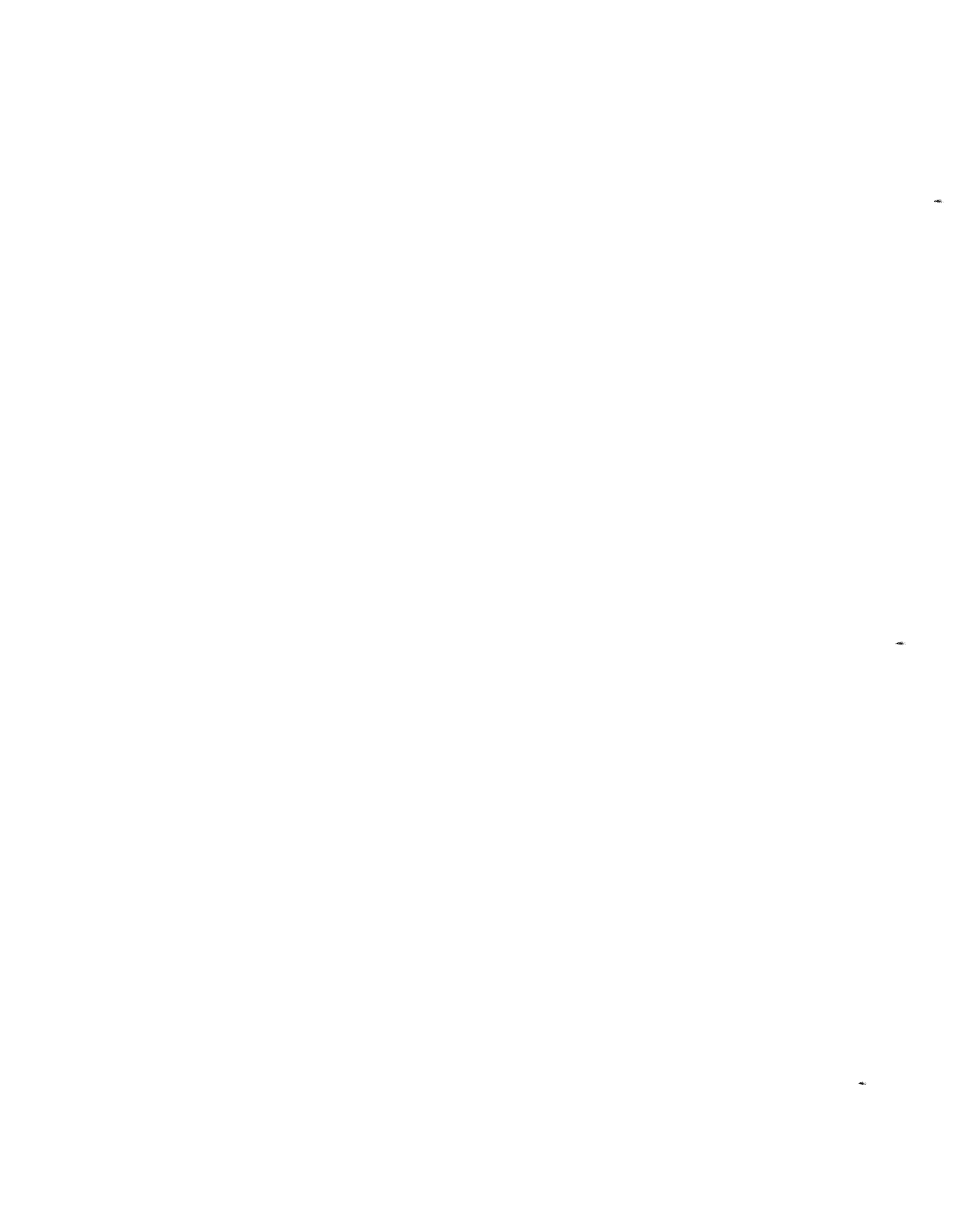
CALIFORNIA ACADEMY OF SCIENCES
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STANFORD UNIVERSITY, HOPKINS MARINE STATION
U. S. FISH AND WILDLIFE SERVICE, BUREAU OF COMMERCIAL FISHERIES
UNIVERSITY OF CALIFORNIA, SCRIPPS INSTITUTION OF OCEANOGRAPHY

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,¹ 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 atlases² 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.

¹ Usually abbreviated CalCOFI, sometimes CALCOFI or CCOFI.

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



DISTRIBUTIONAL ATLAS OF CHAETOGNATHA
IN THE CALIFORNIA CURRENT REGION¹

Angeles Alvarino²

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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.³

¹ 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.

² Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California.

³ 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 m³ of sea water filtered, according to the formula:

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

N = number of individuals in 1000 m³ of sea water filtered

n = number of individuals in the total sample

V = number of m³ 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).

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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 Béranec 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)									

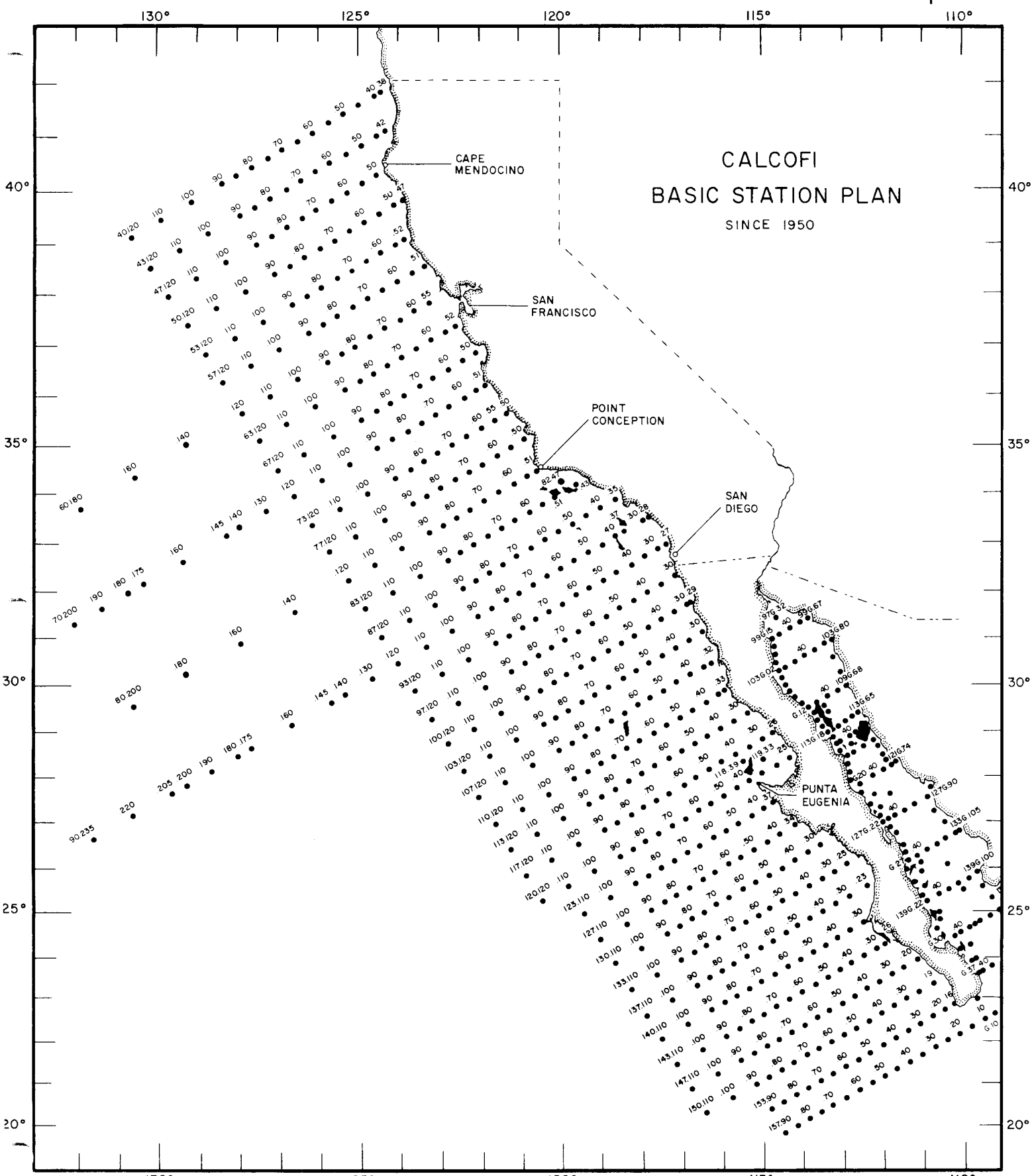
OF CHARTS

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.



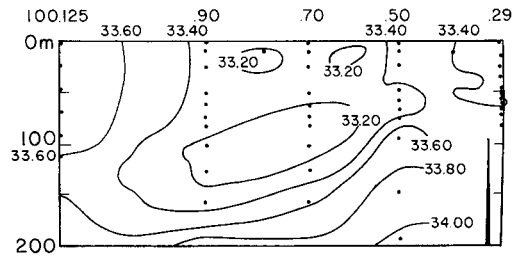
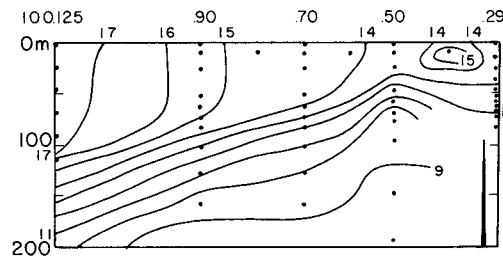
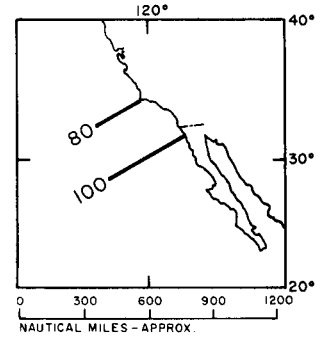
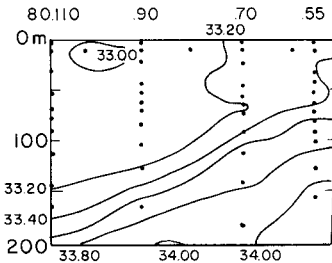
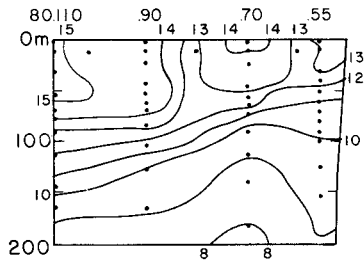
CALCOFI

BASIC STATION PLAN
SINCE 1950

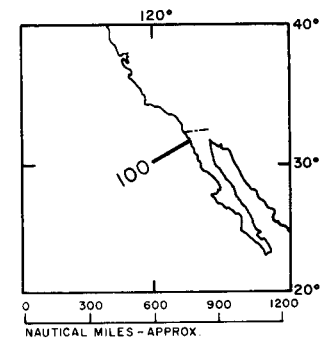
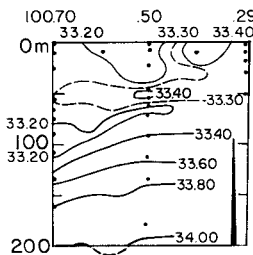
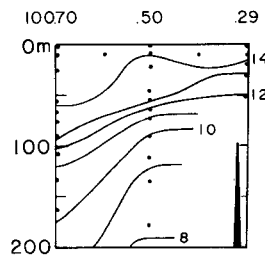
**CALCOFI CRUISE 5401
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5 JANUARY - 4 FEBRUARY 1954**

TEMPERATURE

SALINITY



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

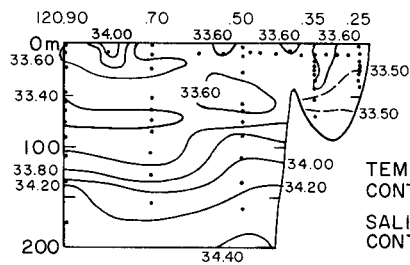
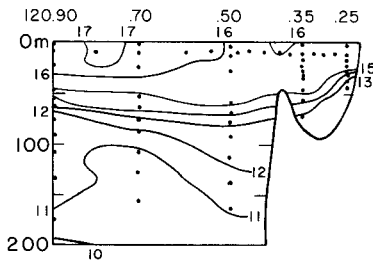
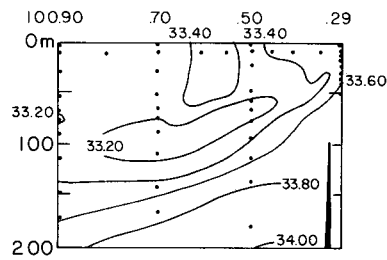
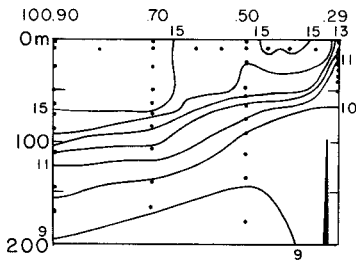
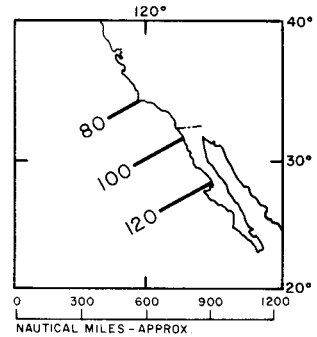
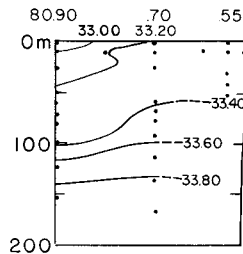
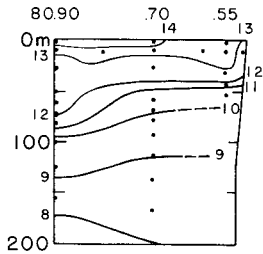


TEMPERATURE
CONTOUR INTERVAL 1.0°C
SALINITY
CONTOUR INTERVAL 0.20‰

CALCOFI CRUISE 5403
 VERTICAL SECTIONS
 3 MARCH - 5 APRIL 1954

TEMPERATURE

SALINITY

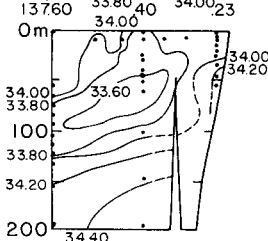
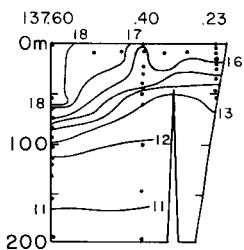
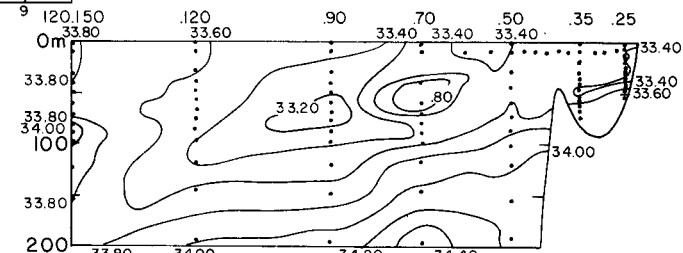
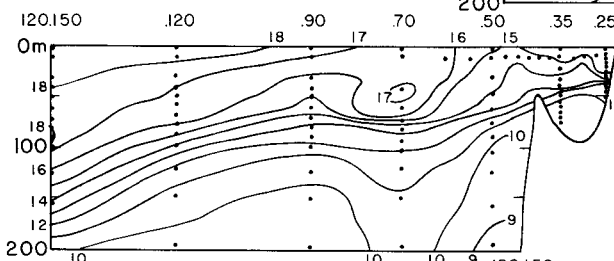
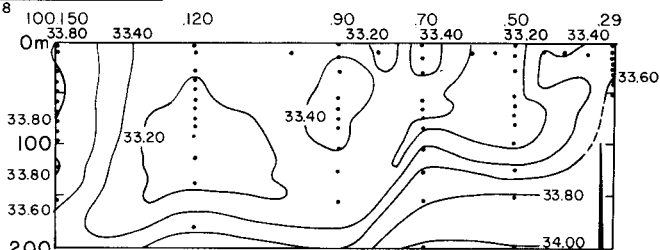
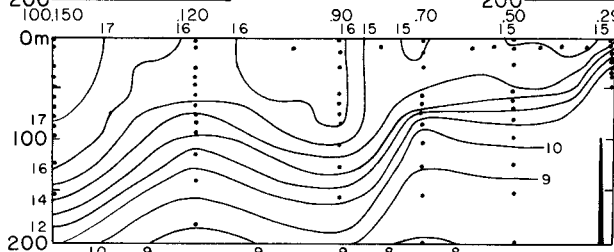
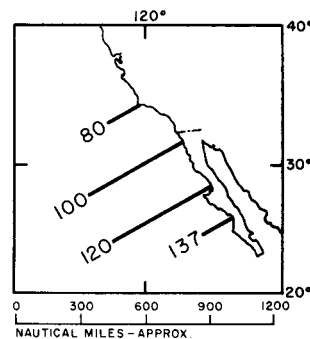
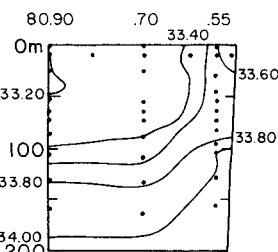
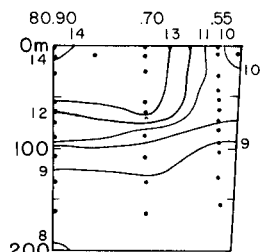


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CALCOFI CRUISE 5404
VERTICAL SECTIONS
7 APRIL - 13 MAY 1954

TEMPERATURE

SALINITY



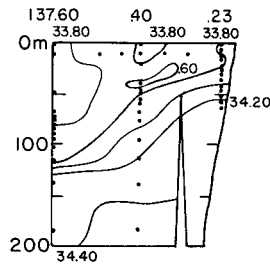
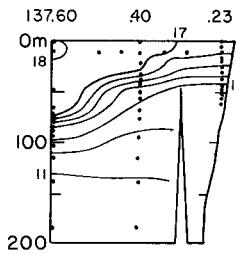
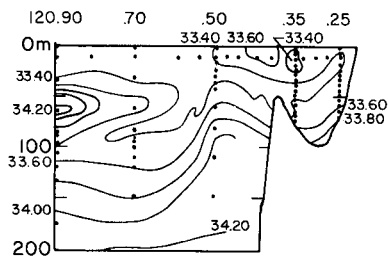
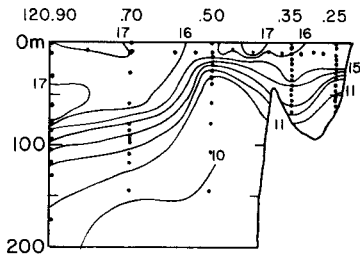
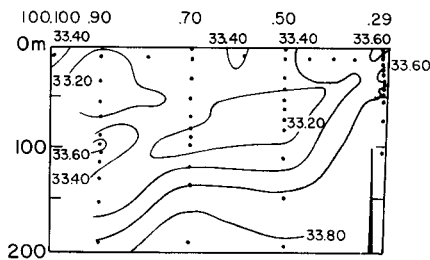
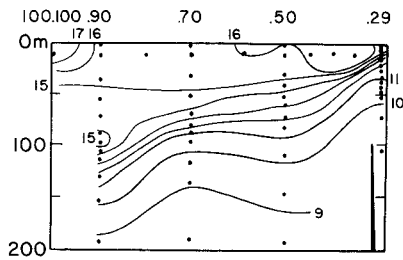
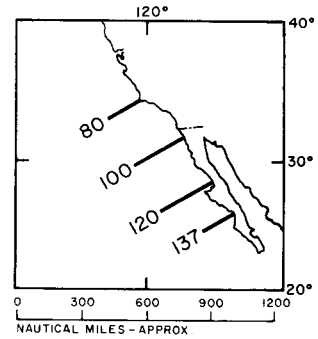
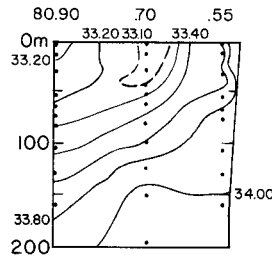
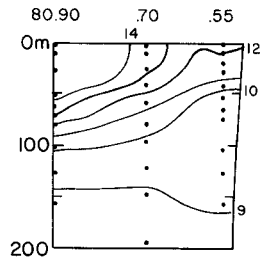
TEMPERATURE
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SALINITY
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CALCOFI CRUISE 5405
VERTICAL SECTIONS

5-24 MAY 1954

TEMPERATURE

SALINITY

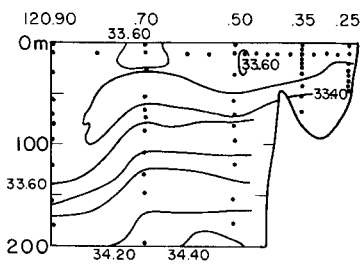
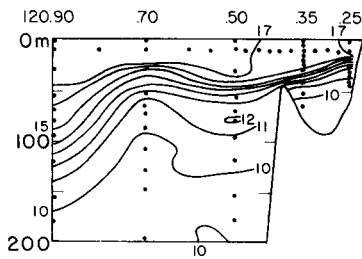
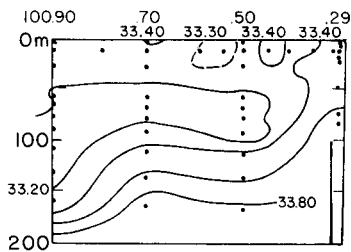
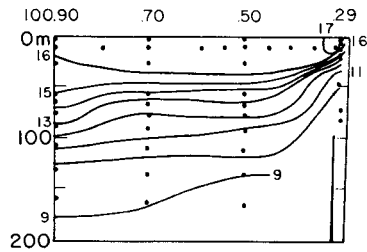
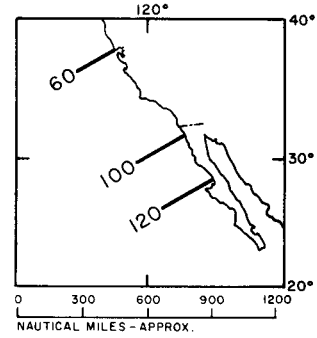
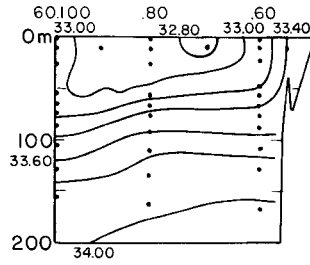
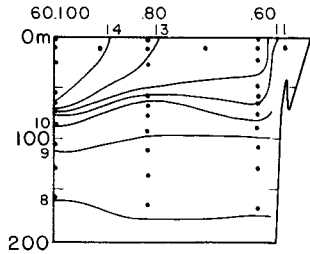


TEMPERATURE
CONTOUR INTERVAL 1.0 °C
SALINITY
CONTOUR INTERVAL 0.20 ‰

CALCOFI CRUISE 5406 VERTICAL SECTIONS 2 - 23 JUNE 1954

TEMPERATURE

SALINITY

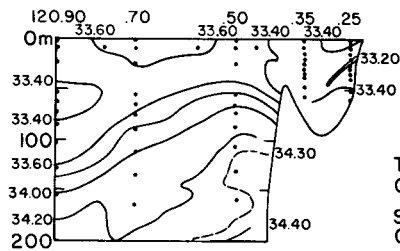
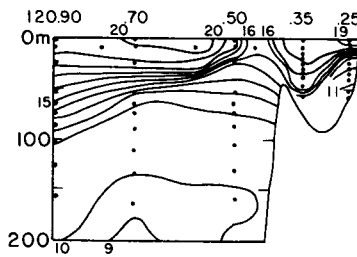
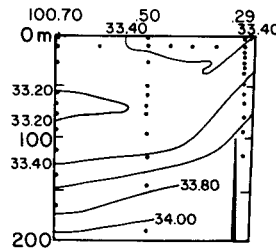
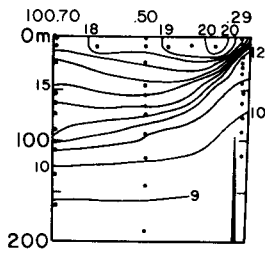
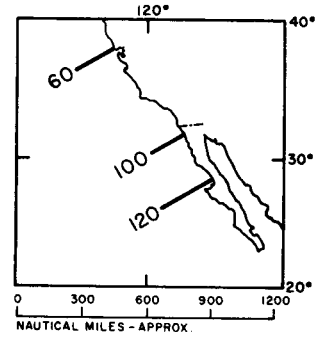
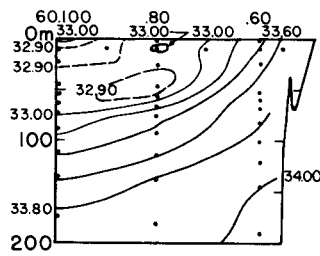
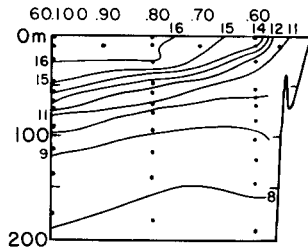


TEMPERATURE
CONTOUR INTERVAL 1.0°C
SALINITY
CONTOUR INTERVAL 0.20‰

CALCOFI CRUISE 5407
VERTICAL SECTIONS
7 - 23 JULY 1954

TEMPERATURE

SALINITY

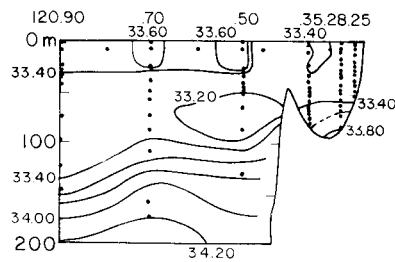
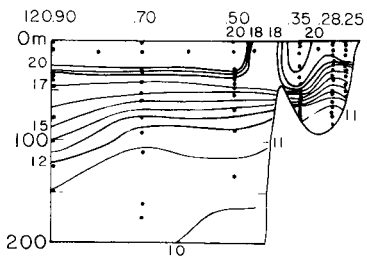
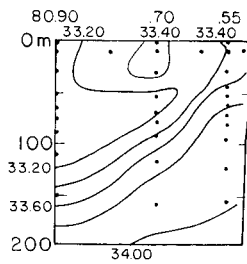
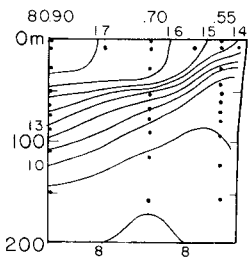
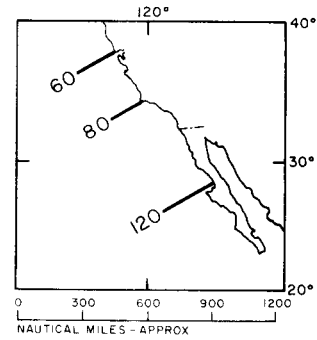
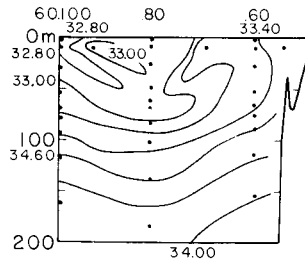
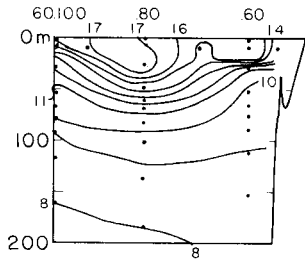


TEMPERATURE
CONTOUR INTERVAL 1.0°C
SALINITY
CONTOUR INTERVAL 0.20‰

CALCOFI CRUISE 5408
VERTICAL SECTIONS
18 AUGUST - 10 SEPTEMBER 1954

TEMPERATURE

SALINITY

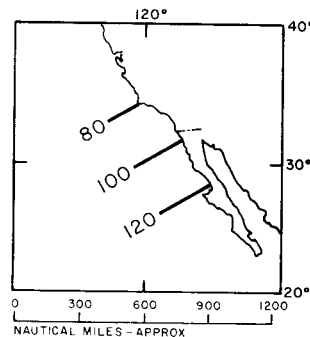
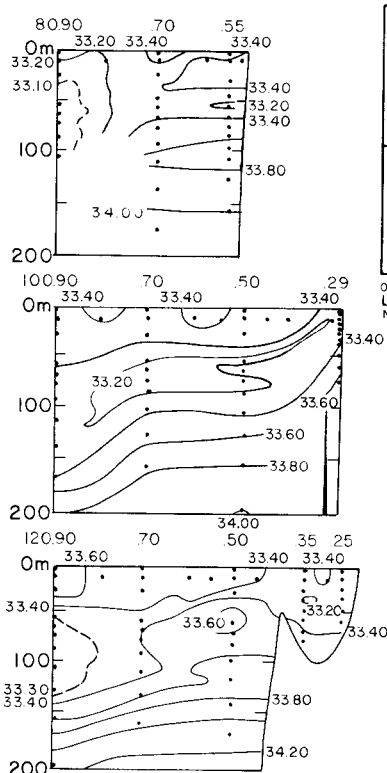
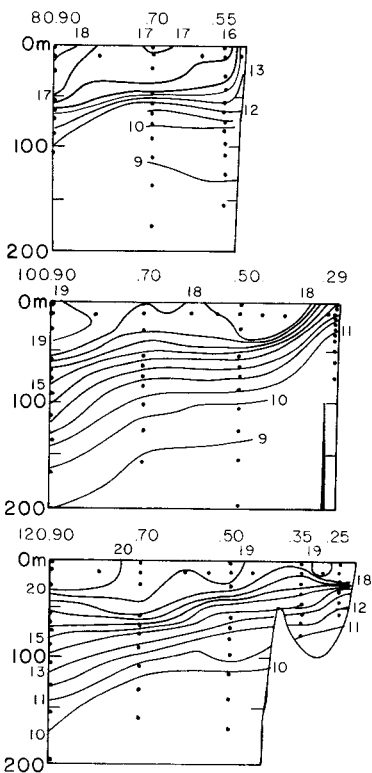


TEMPERATURE
CONTOUR INTERVAL 1.0°C
SALINITY
CONTOUR INTERVAL 0.20‰

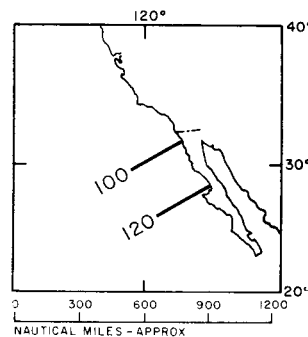
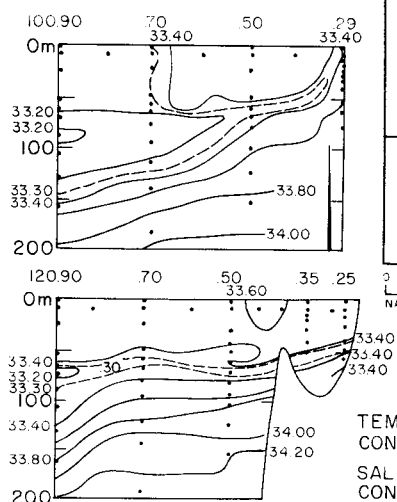
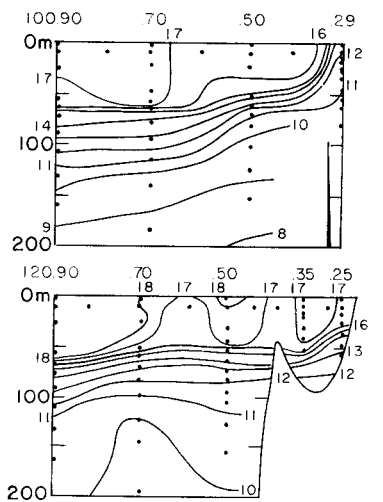
CALCOFI CRUISE 5410
 VERTICAL SECTIONS
 6 - 24 OCTOBER 1954

TEMPERATURE

SALINITY



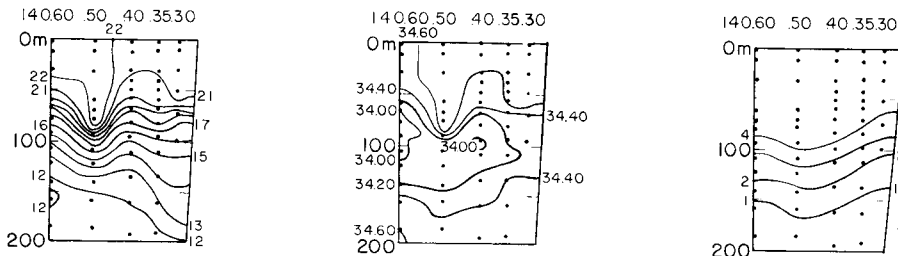
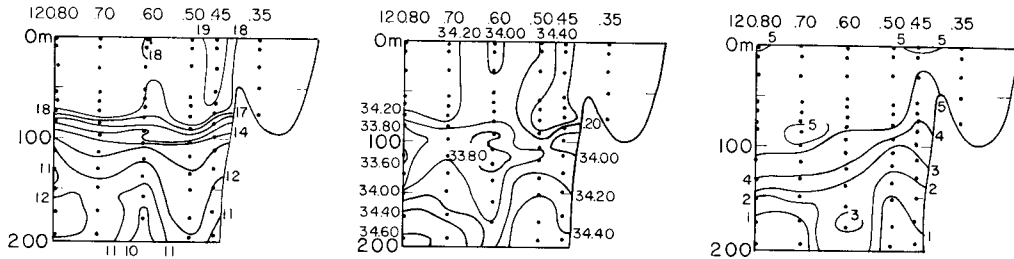
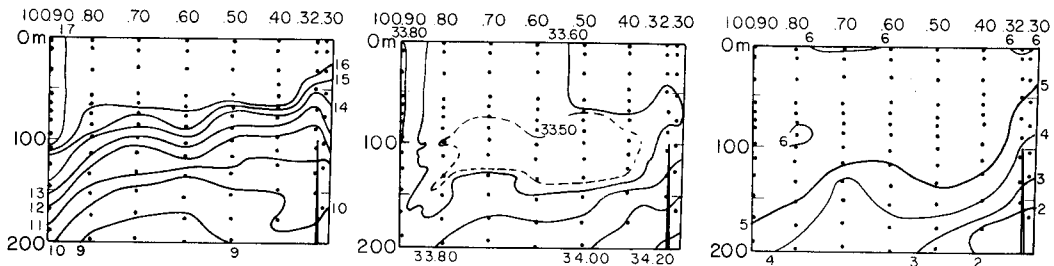
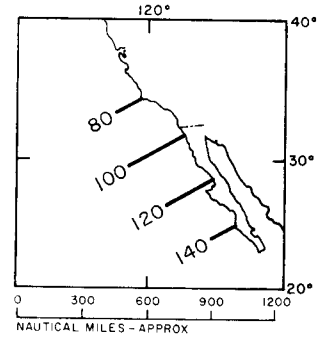
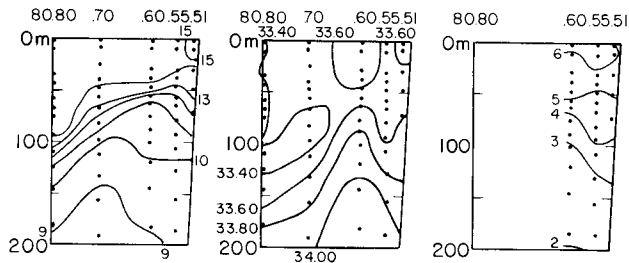
CALCOFI CRUISE 5412
 VERTICAL SECTIONS
 30 NOVEMBER - 16 DECEMBER 1954



TEMPERATURE
 CONTOUR INTERVAL 1.0°C
 SALINITY
 CONTOUR INTERVAL 0.20‰

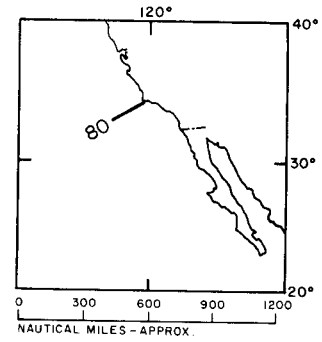
CALCOFI CRUISE 5801
 VERTICAL SECTIONS
 8 JANUARY — 2 FEBRUARY 1958

TEMPERATURE SALINITY OXYGEN

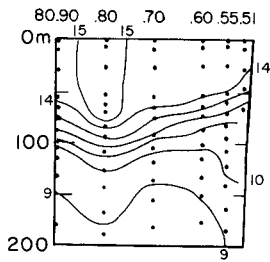


TEMPERATURE
 CONTOUR INTERVAL 1.0°C
 SALINITY
 CONTOUR INTERVAL 0.20‰
 OXYGEN
 CONTOUR INTERVAL 1.0ml/L

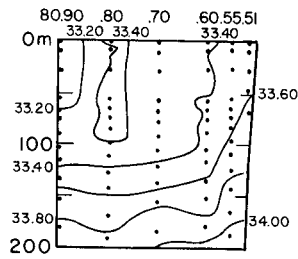
CALCOFI CRUISE 5803
 VERTICAL SECTIONS
 27 FEBRUARY - 21 MARCH 1958



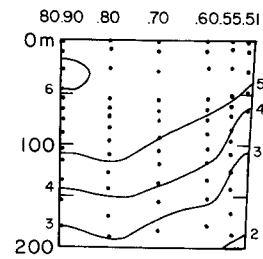
TEMPERATURE



SALINITY



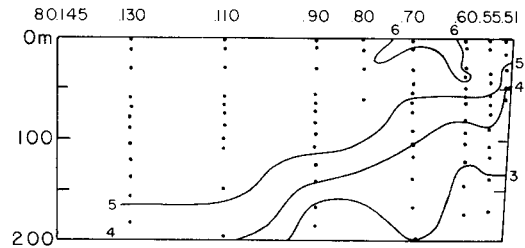
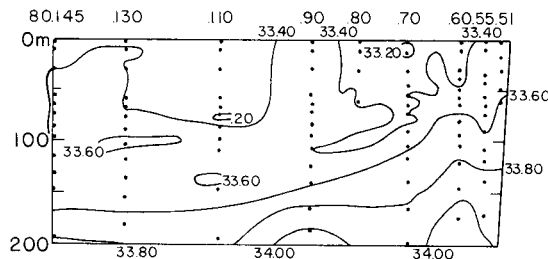
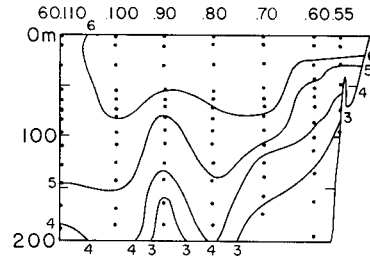
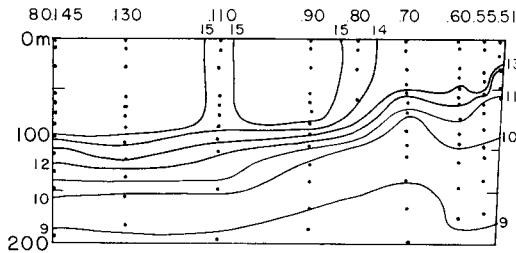
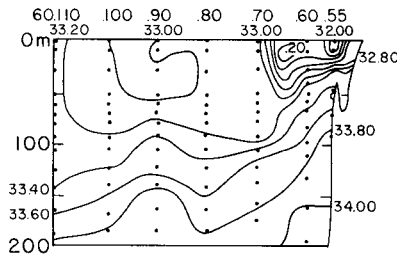
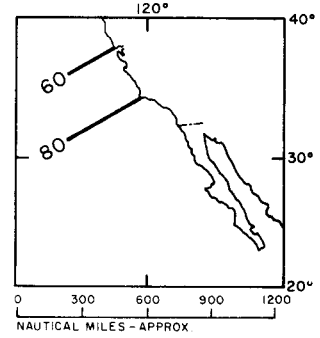
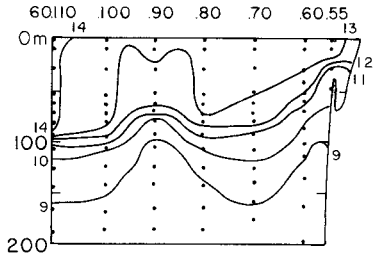
OXYGEN



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

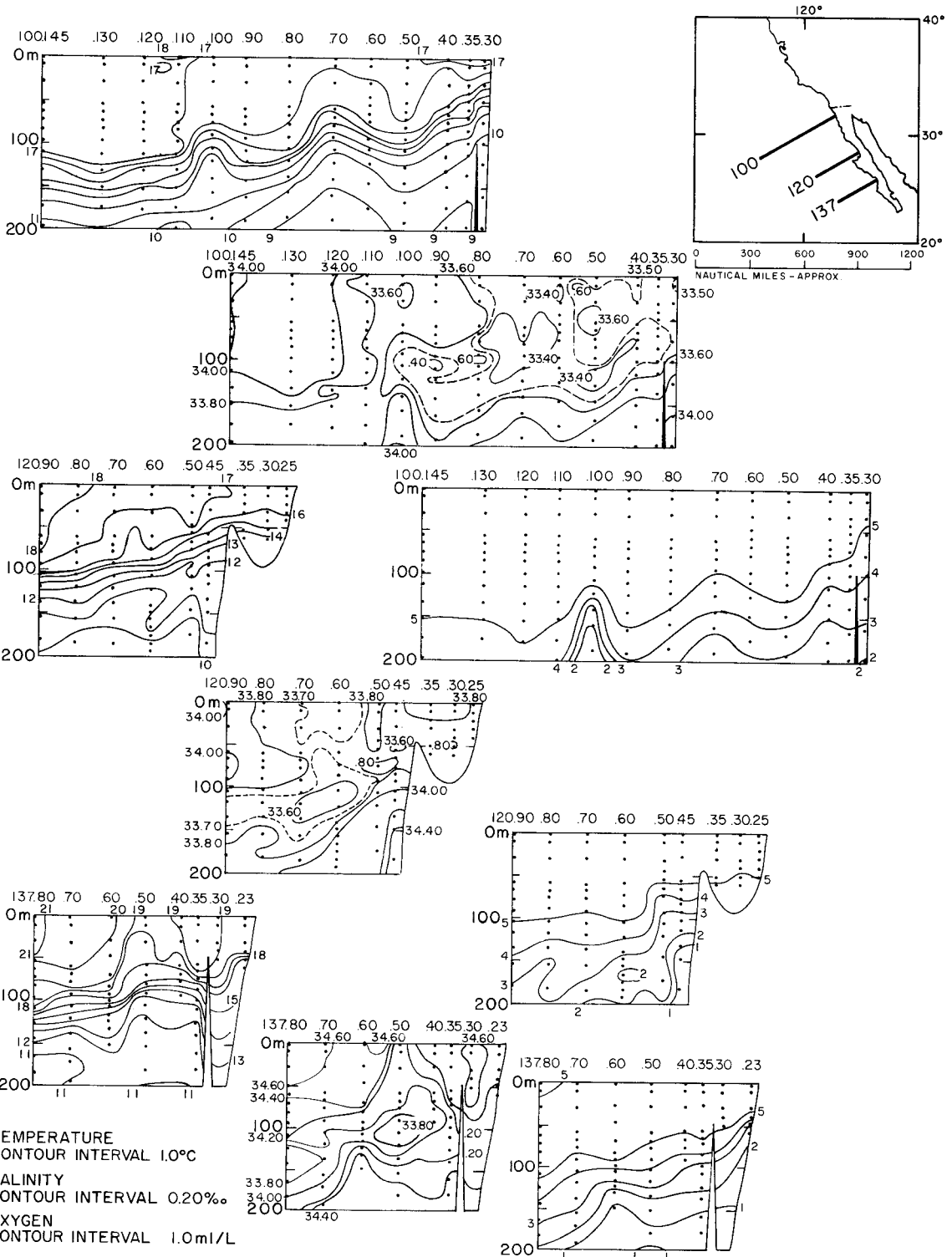


TEMPERATURE
 CONTOUR INTERVAL 1.0°C
 SALINITY
 CONTOUR INTERVAL 0.20‰
 OXYGEN
 CONTOUR INTERVAL 1.0 ml/L

SHEET 1 OF 2

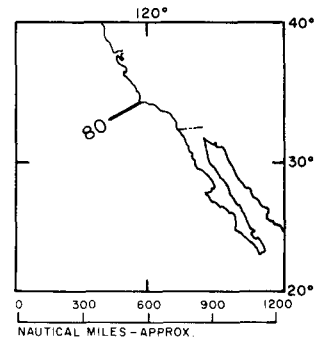
CALCOFI CRUISE 5804
VERTICAL SECTIONS
30 MARCH-27 APRIL 1958

TEMPERATURE SALINITY OXYGEN

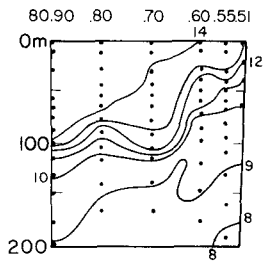


SHEET 2 OF 2

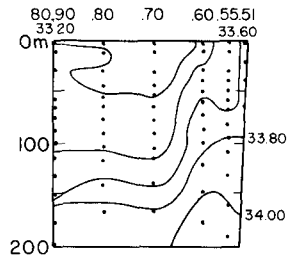
CALCOFI CRUISE 5805
 VERTICAL SECTIONS
 3 - 22 MAY 1958



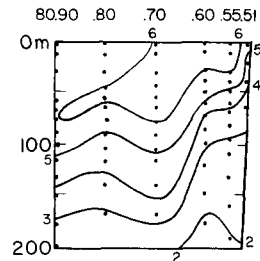
TEMPERATURE



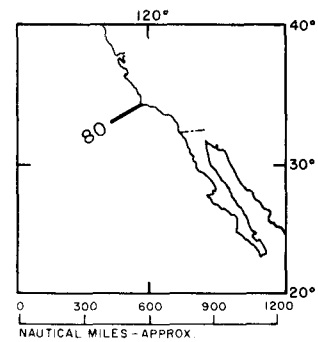
SALINITY



OXYGEN

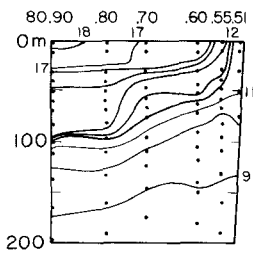


CALCOFI CRUISE 5806
 VERTICAL SECTIONS
 4 - 26 JUNE 1958

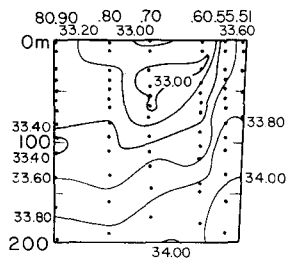


TEMPERATURE
 CONTOUR INTERVAL 1.0 °C
 SALINITY
 CONTOUR INTERVAL 0.20‰
 OXYGEN
 CONTOUR INTERVAL 1.0 ml/L

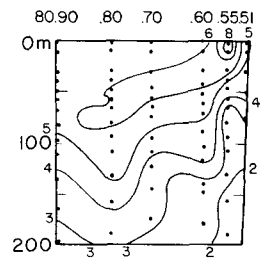
TEMPERATURE



SALINITY



OXYGEN

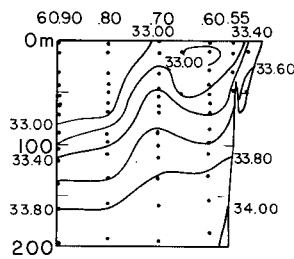
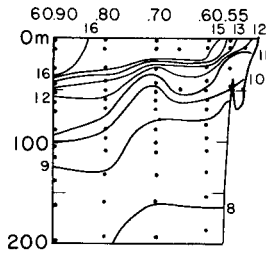
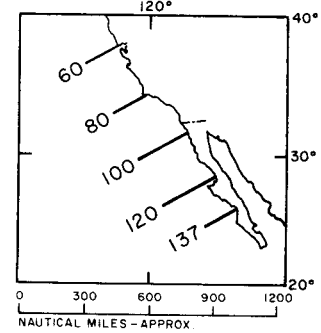


CALCOFI CRUISE 5807
VERTICAL SECTIONS

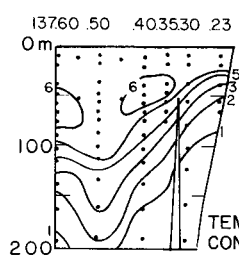
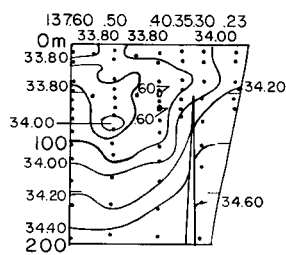
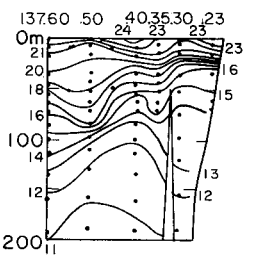
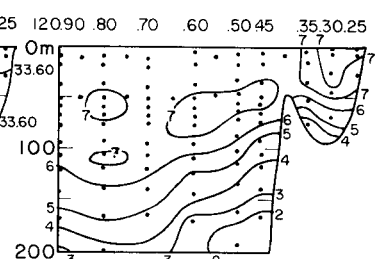
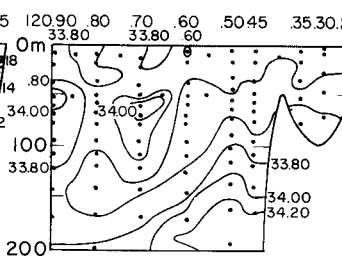
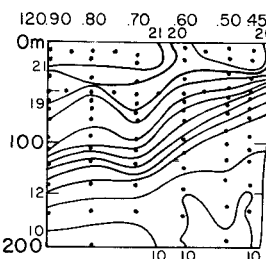
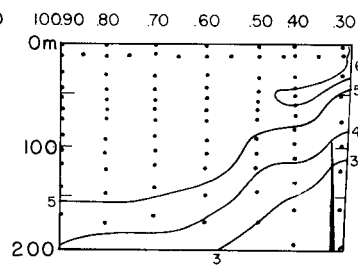
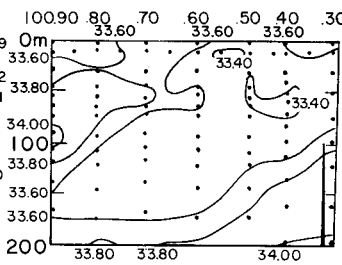
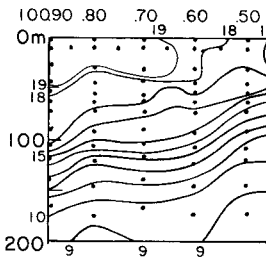
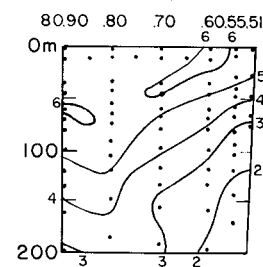
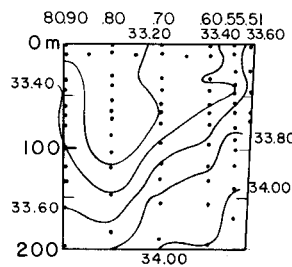
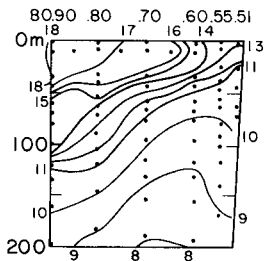
30 JUNE — 22 JULY 1958

TEMPERATURE

SALINITY



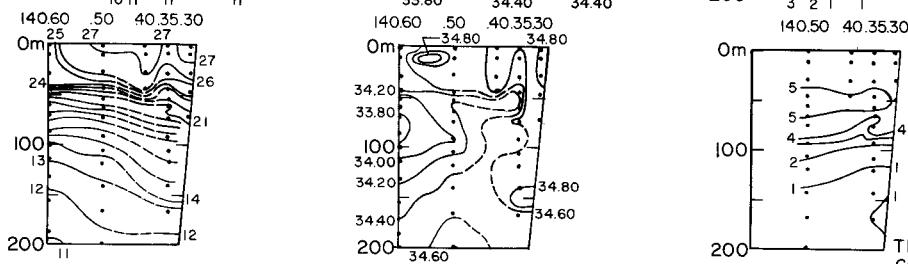
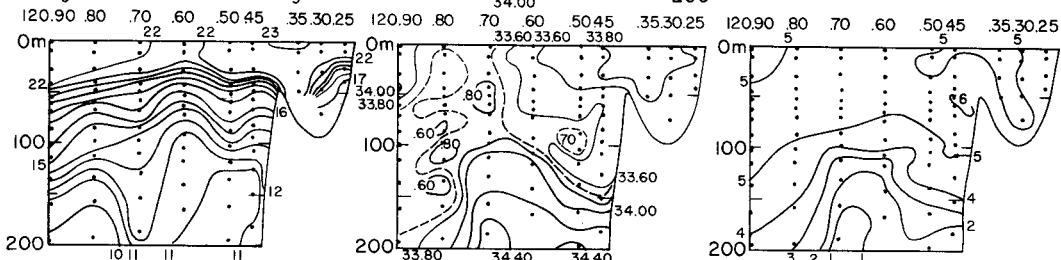
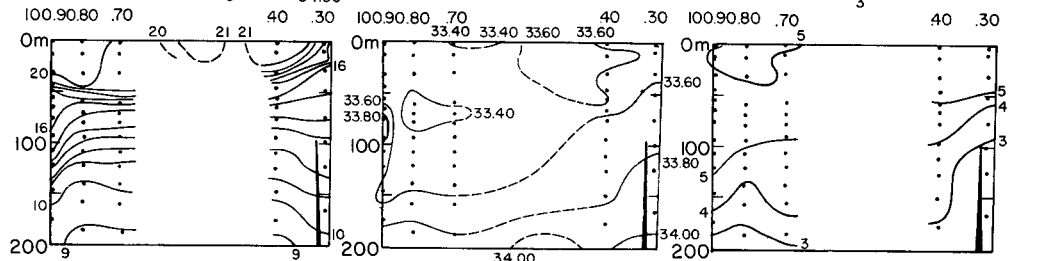
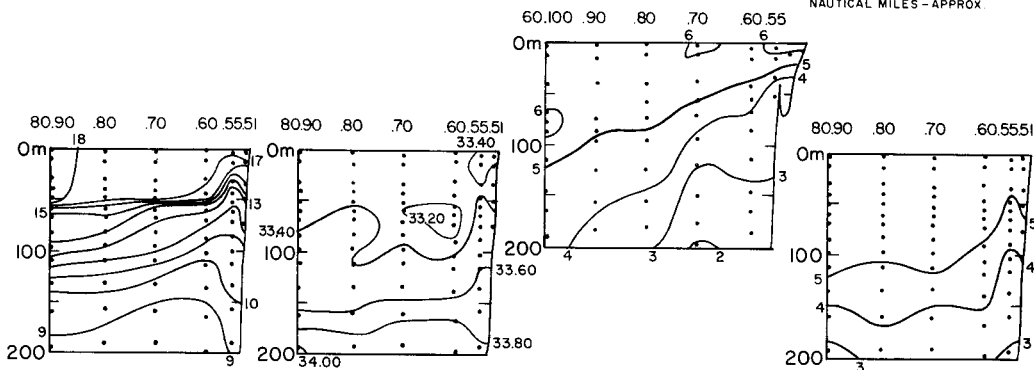
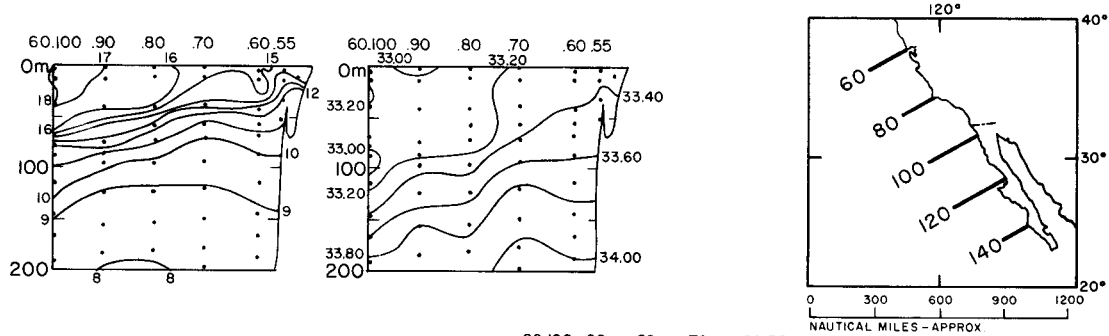
OXYGEN



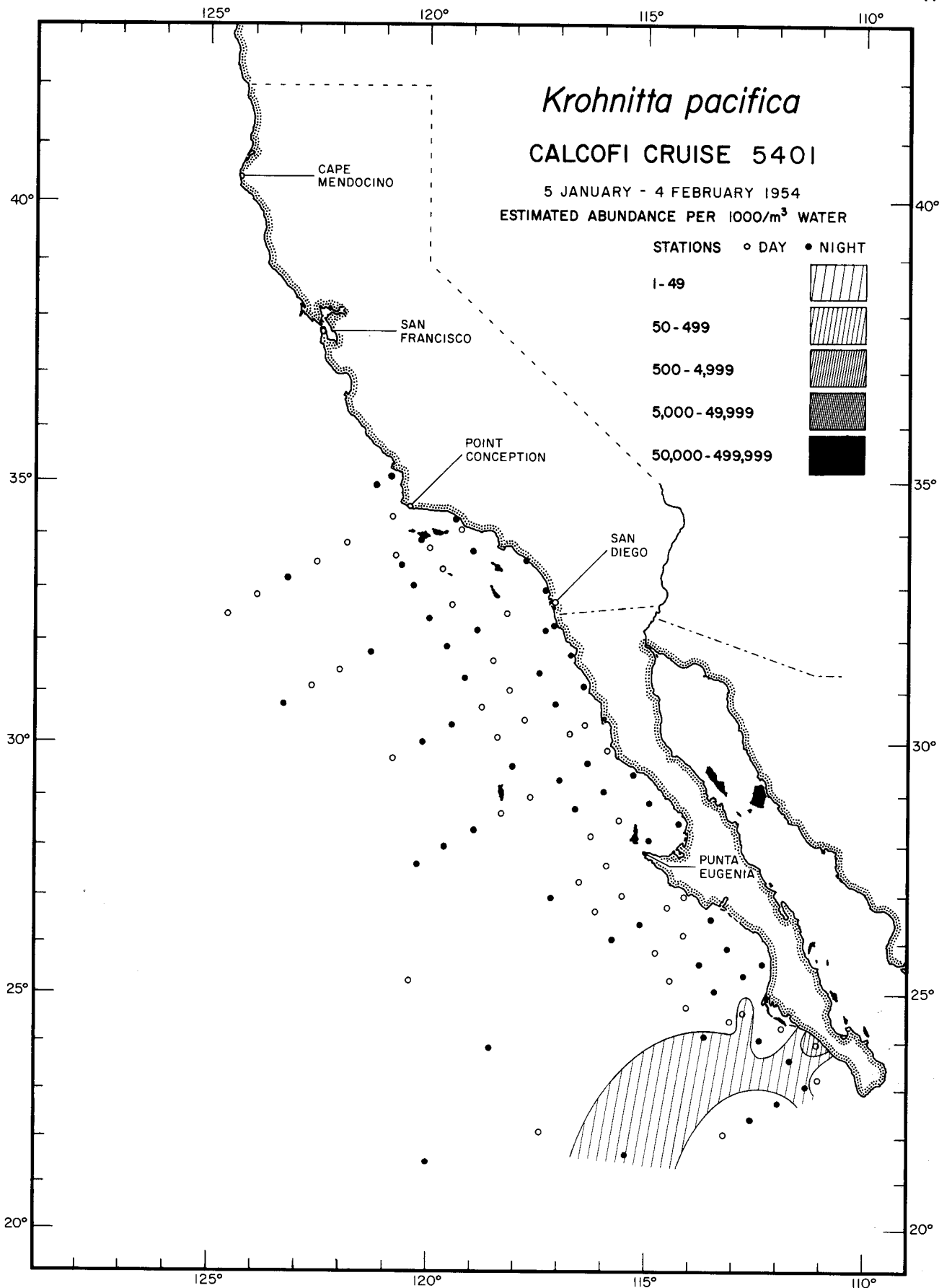
TEMPERATURE
 CONTOUR INTERVAL 1.0°C
 SALINITY
 CONTOUR INTERVAL 0.20‰
 OXYGEN
 CONTOUR INTERVAL 10ml/L

CALCOFI CRUISE 5810
VERTICAL SECTIONS
8 OCTOBER - 6 NOVEMBER 1958

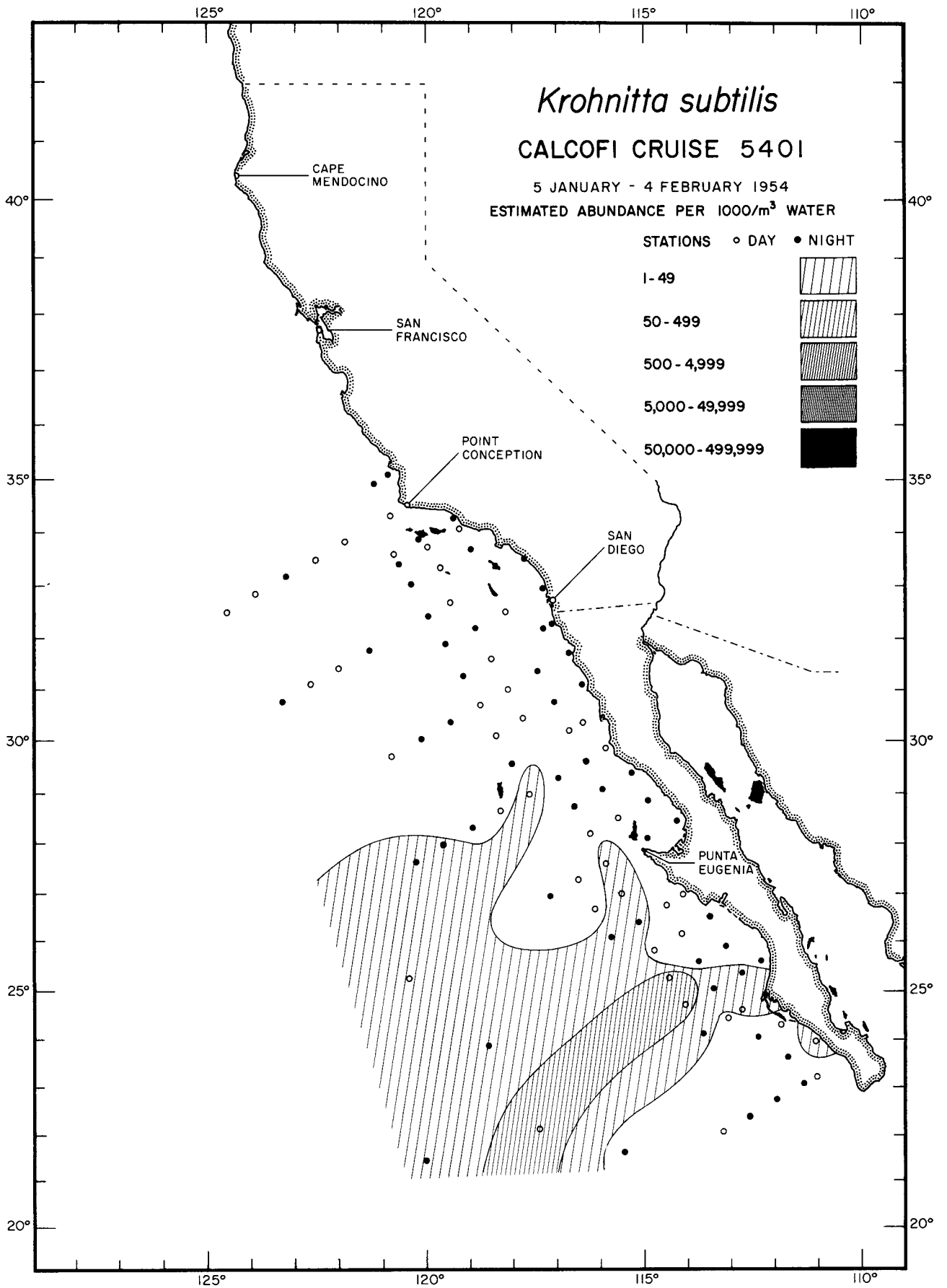
TEMPERATURE SALINITY OXYGEN



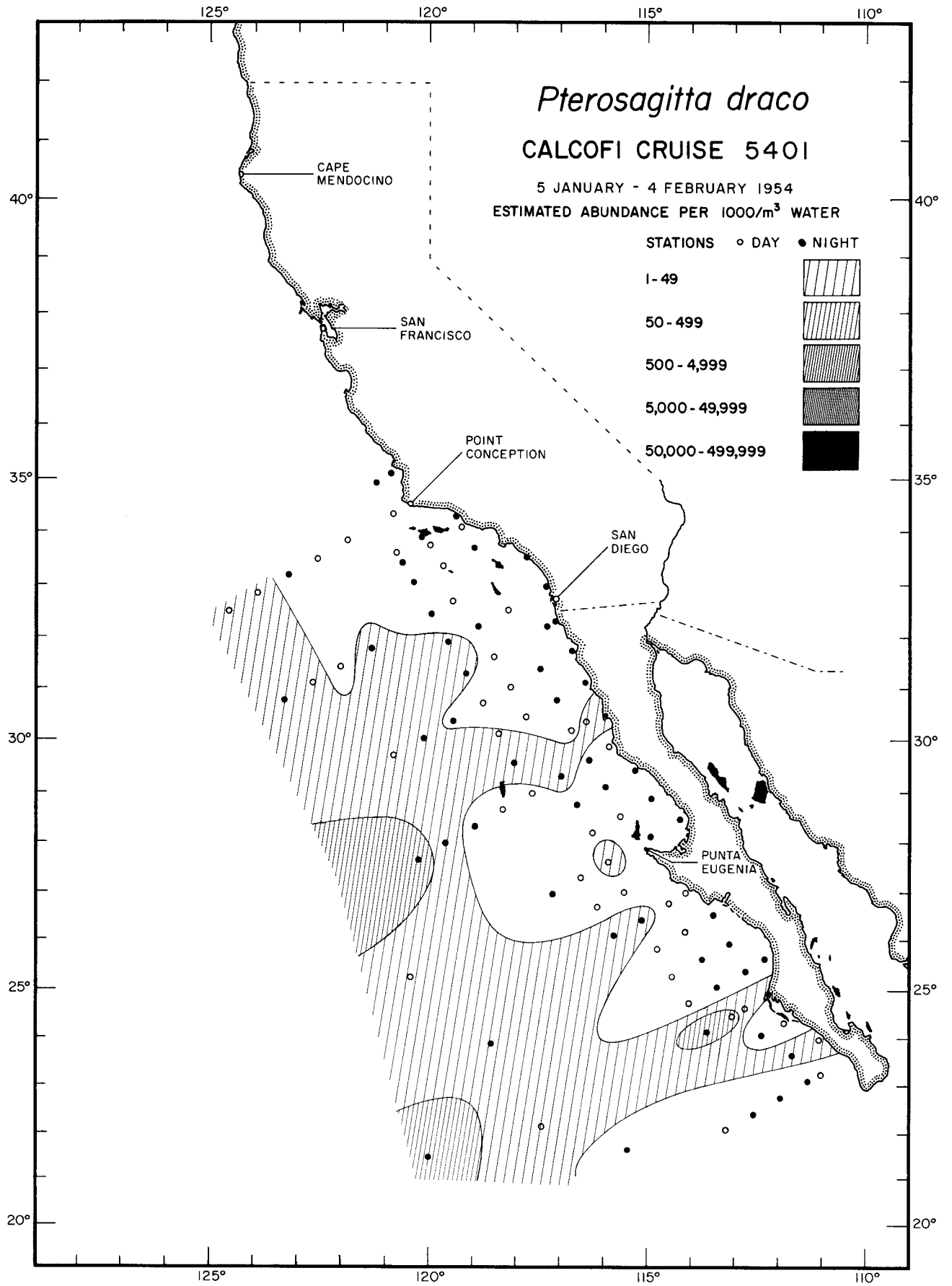
TEMPERATURE
CONTOUR INTERVAL 1.0°C
SALINITY
CONTOUR INTERVAL 0.20‰
OXYGEN
CONTOUR INTERVAL 1.0 ml/L

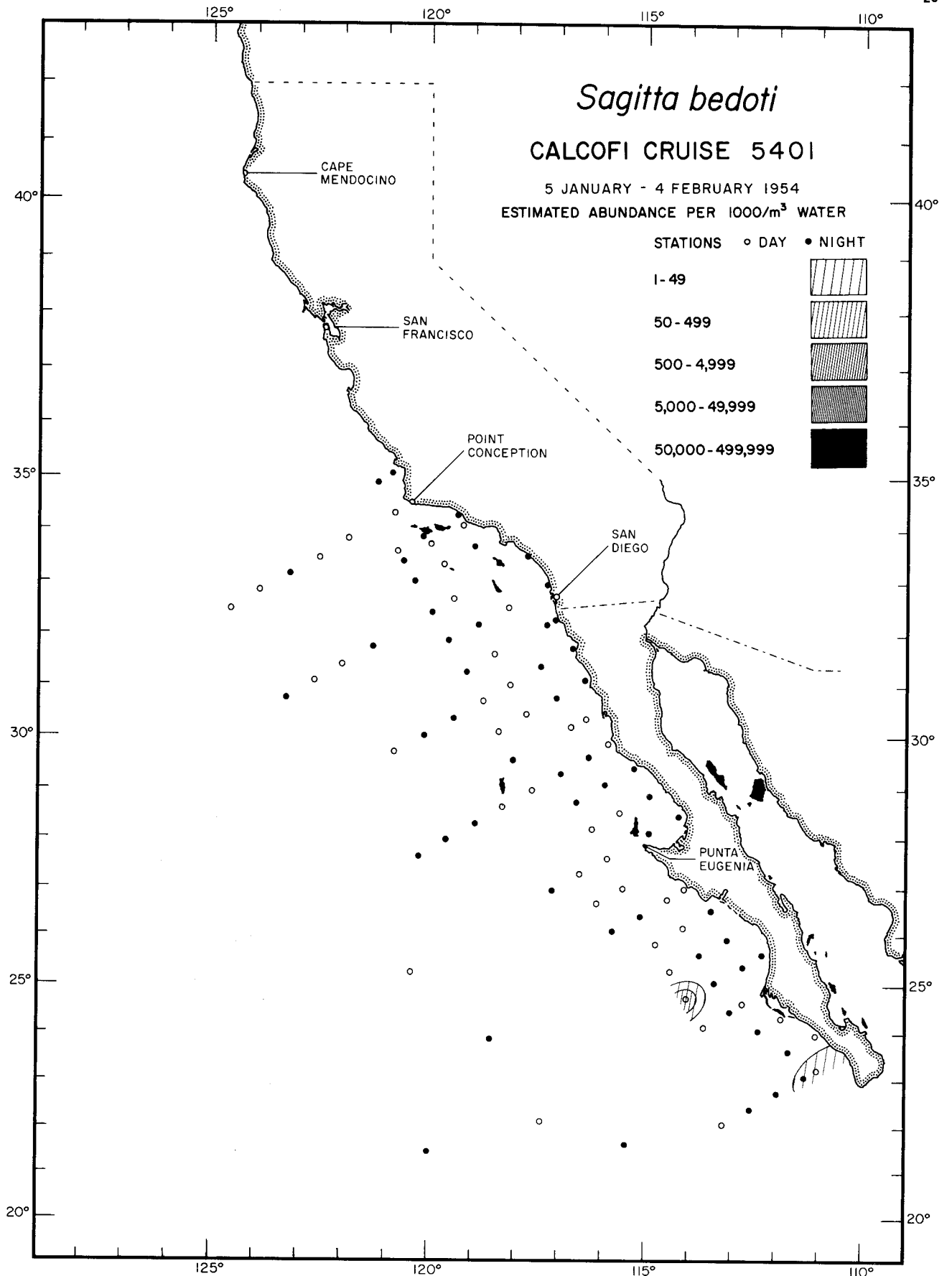


Chaetognatha
Krohnitta pacifica
5401

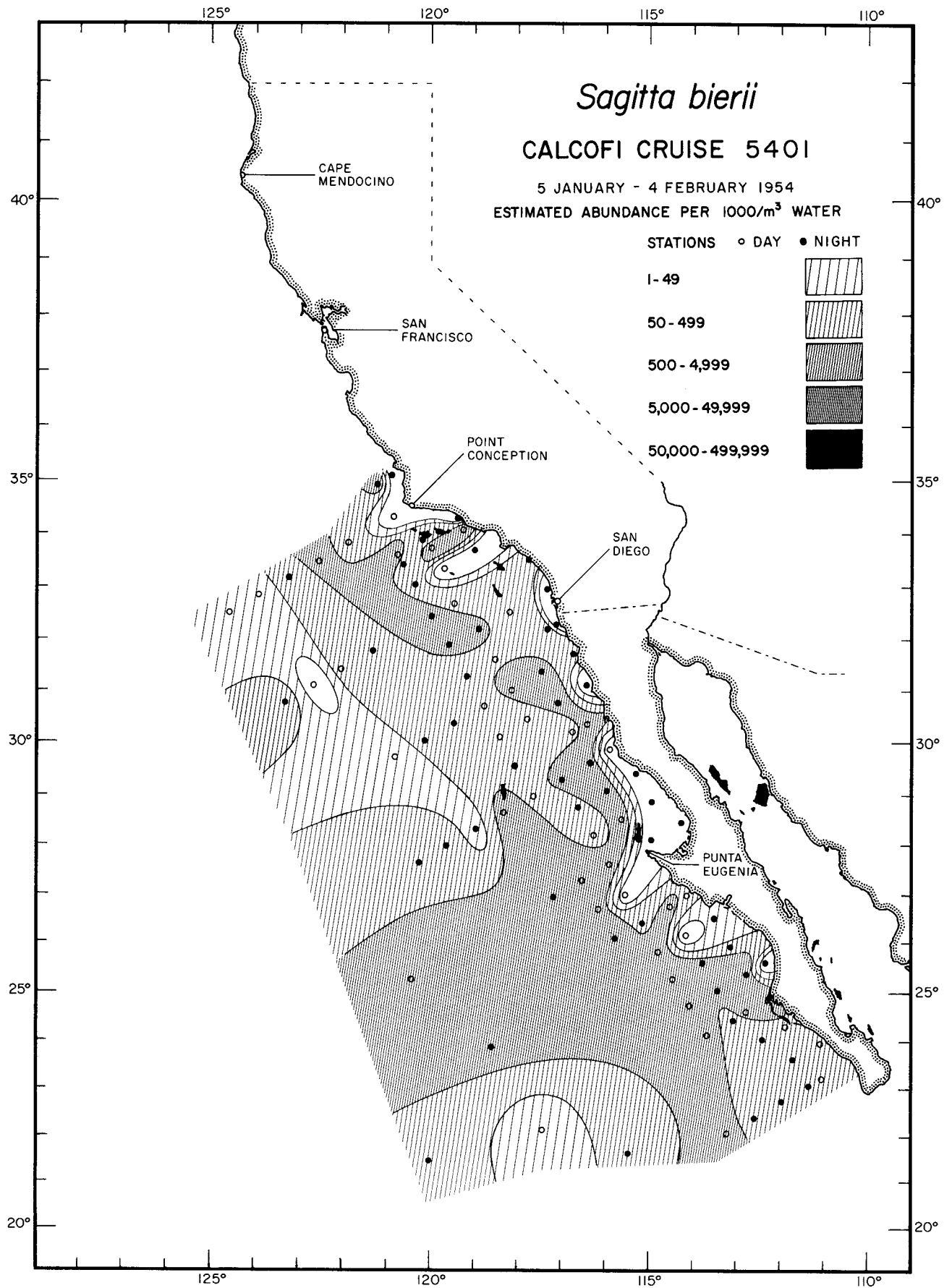


Chaetognatha
Krohnitta subtilis
5401

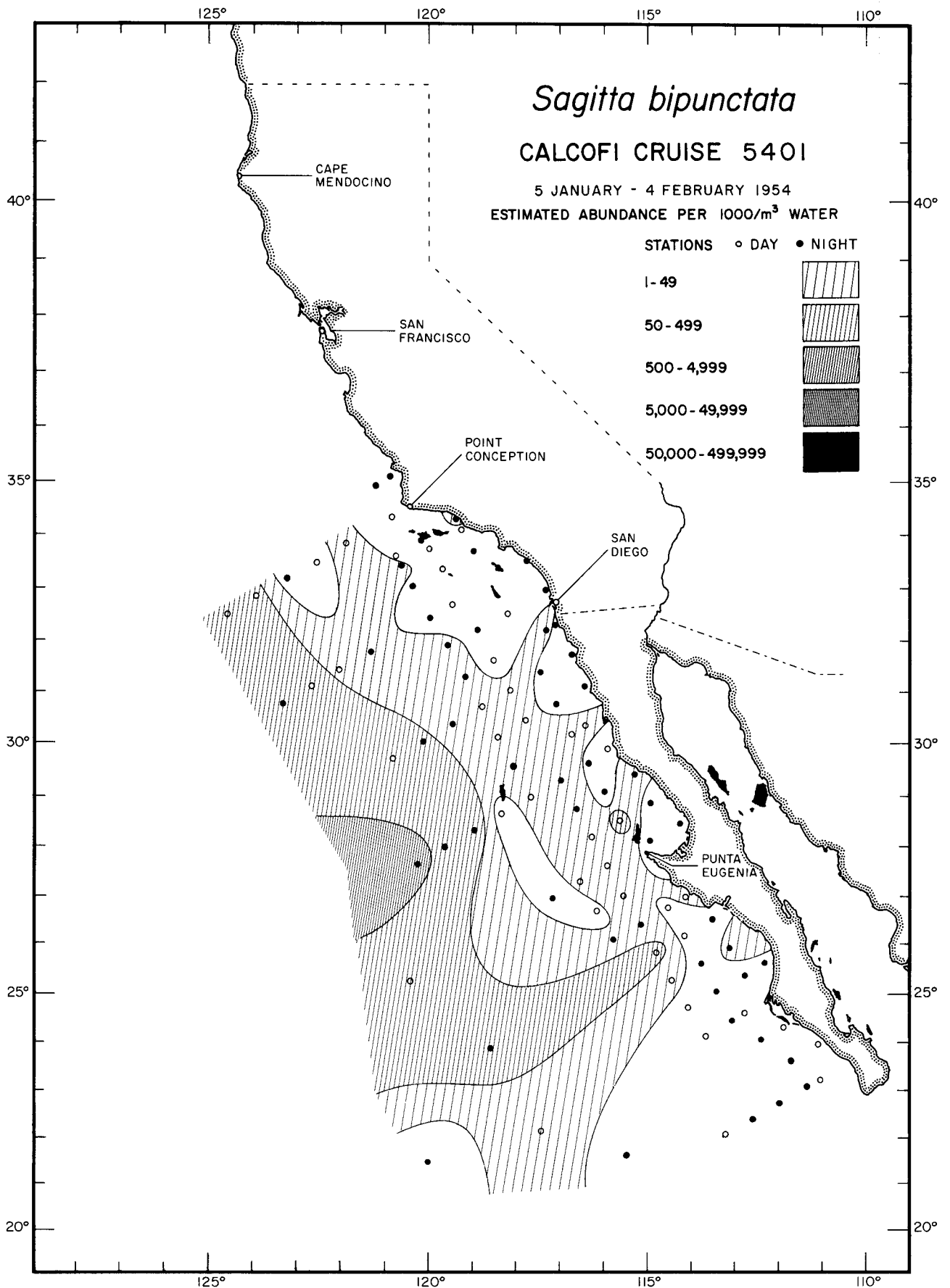




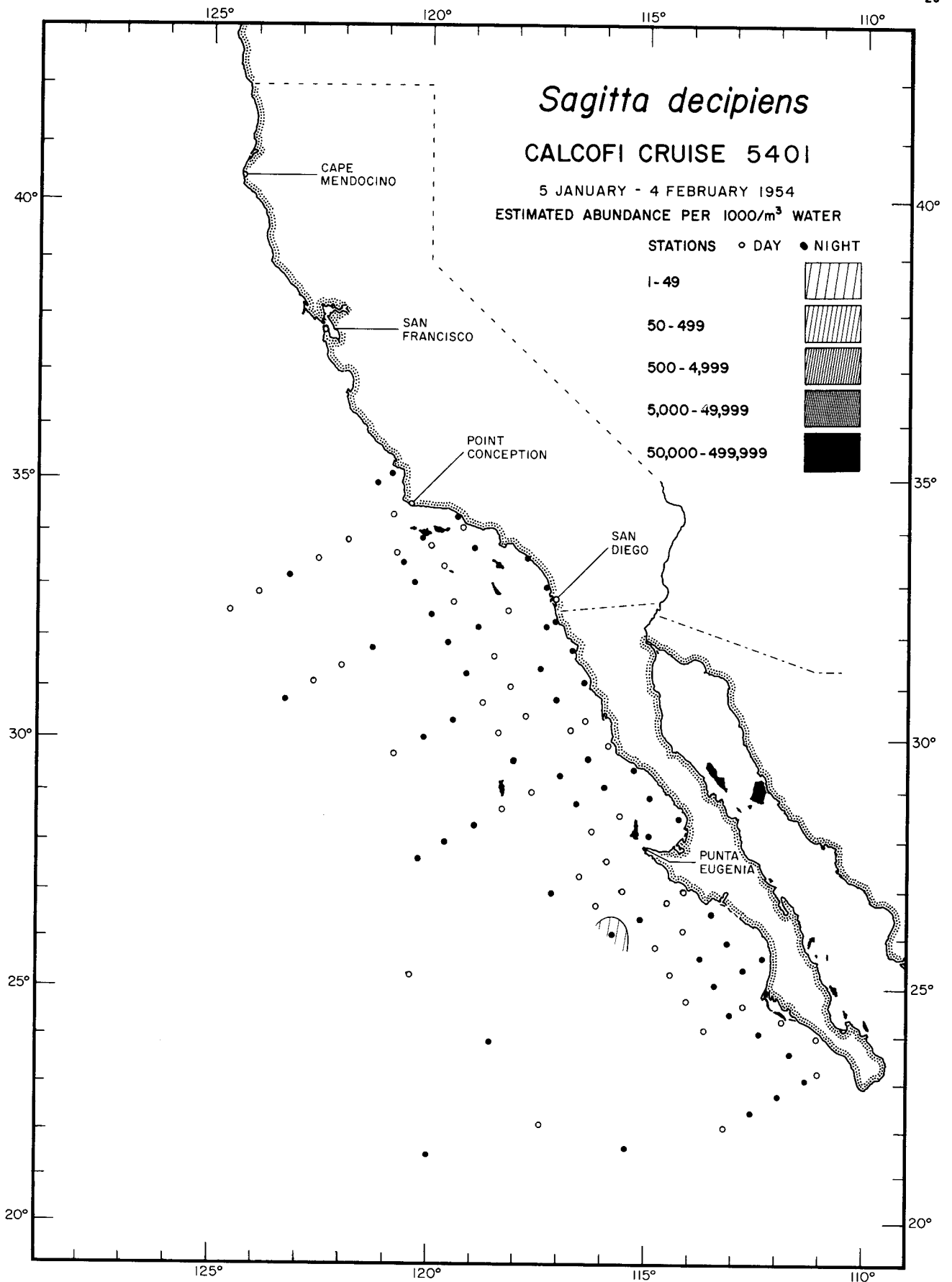
Chaetognatha
Sagitta bedoti
5401



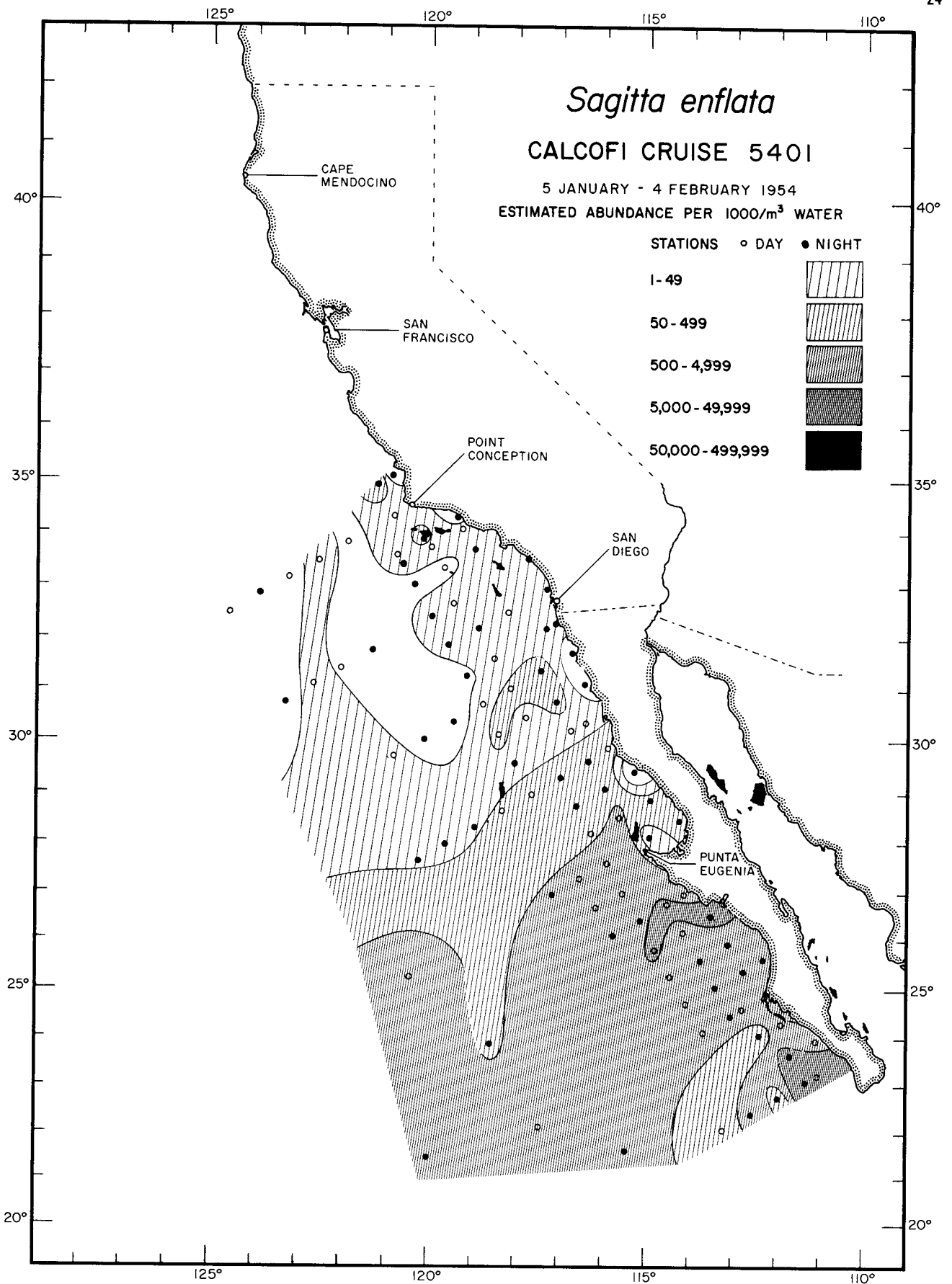
Chaetognatha
Sagitta bierii
5401



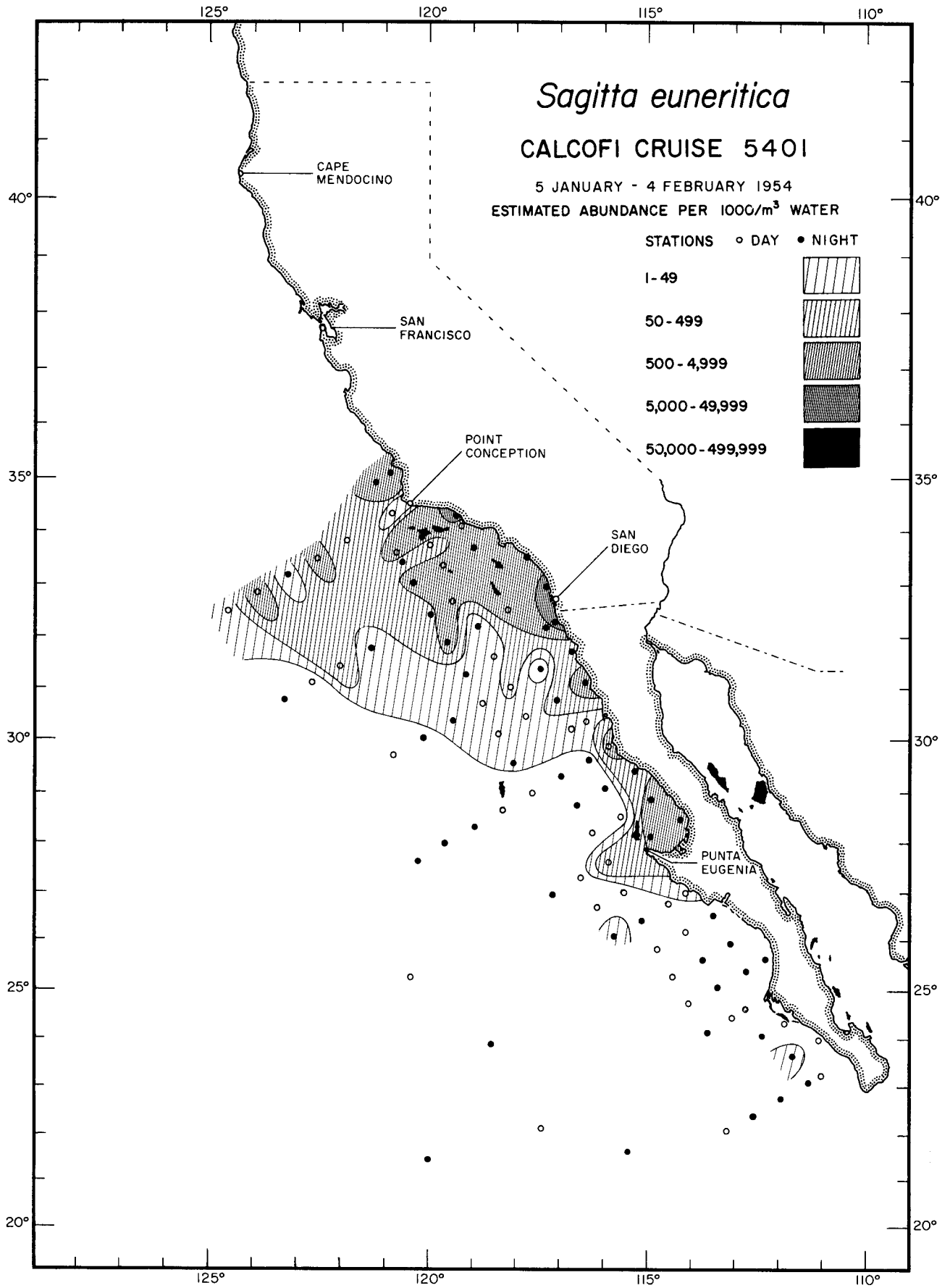
Chaetognatha
Sagitta bipunctata
5401



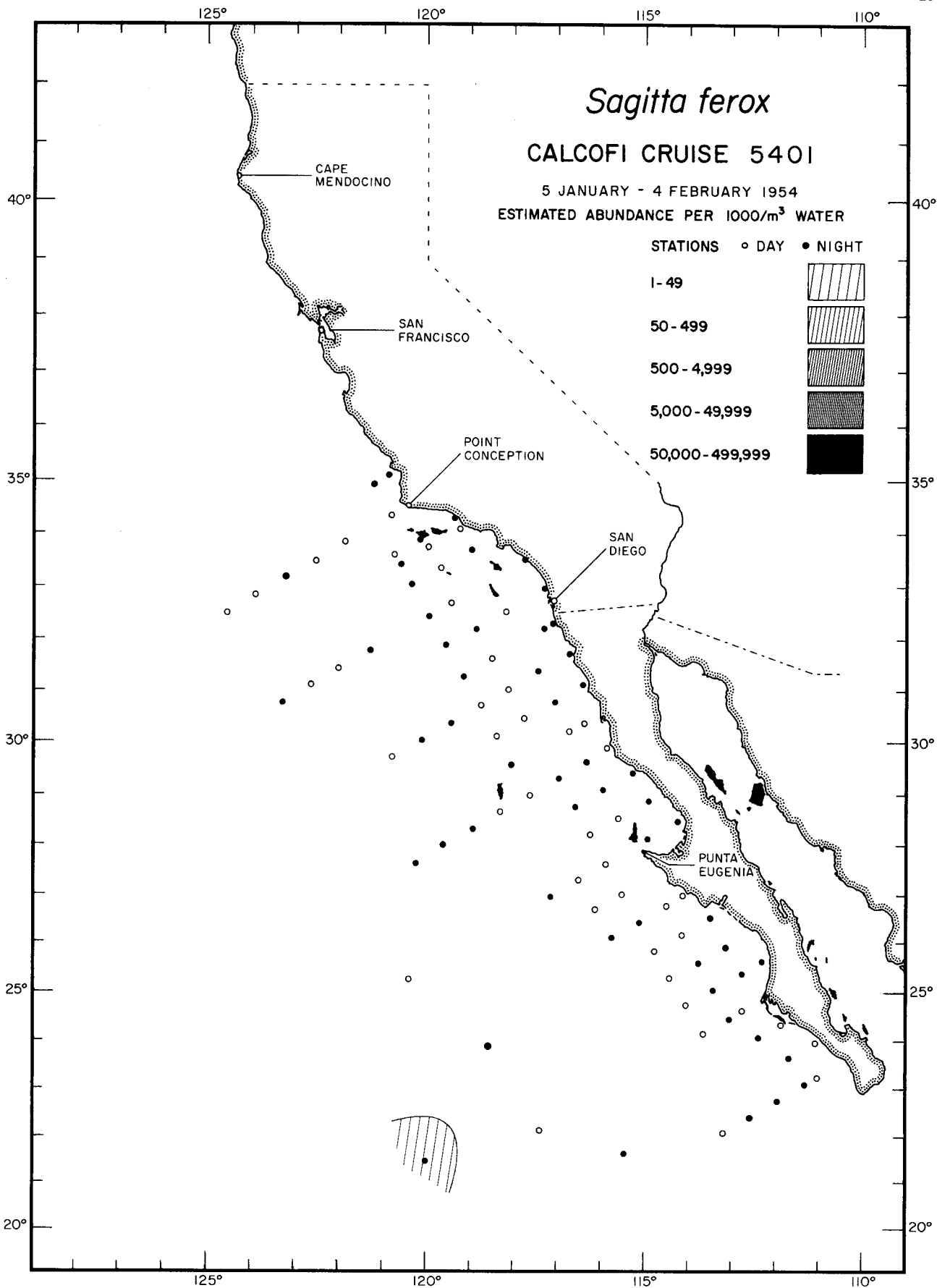
Chaetognatha
Sagitta decipiens
 5401



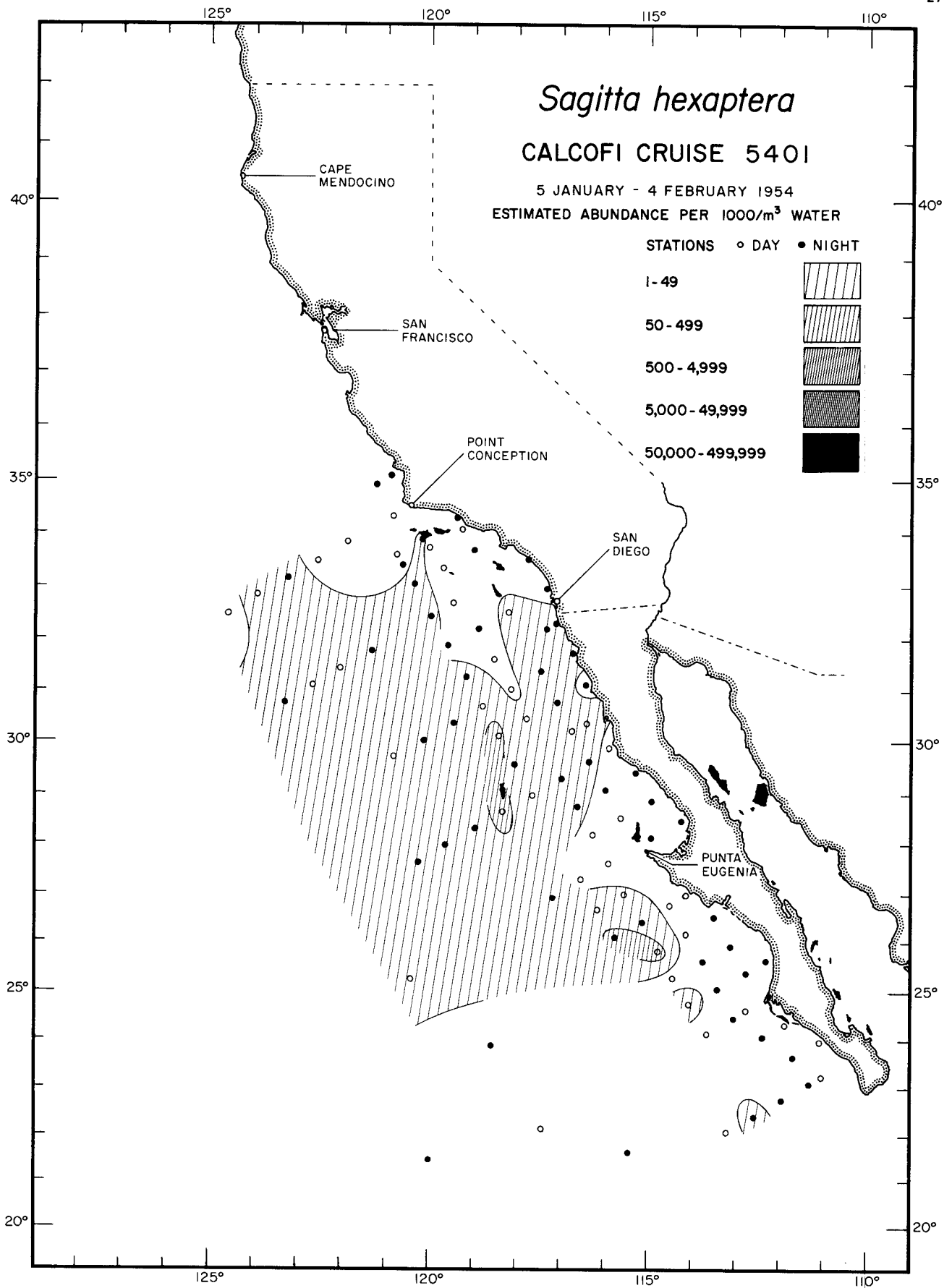
Chaetognatha
Sagitta enflata
5401



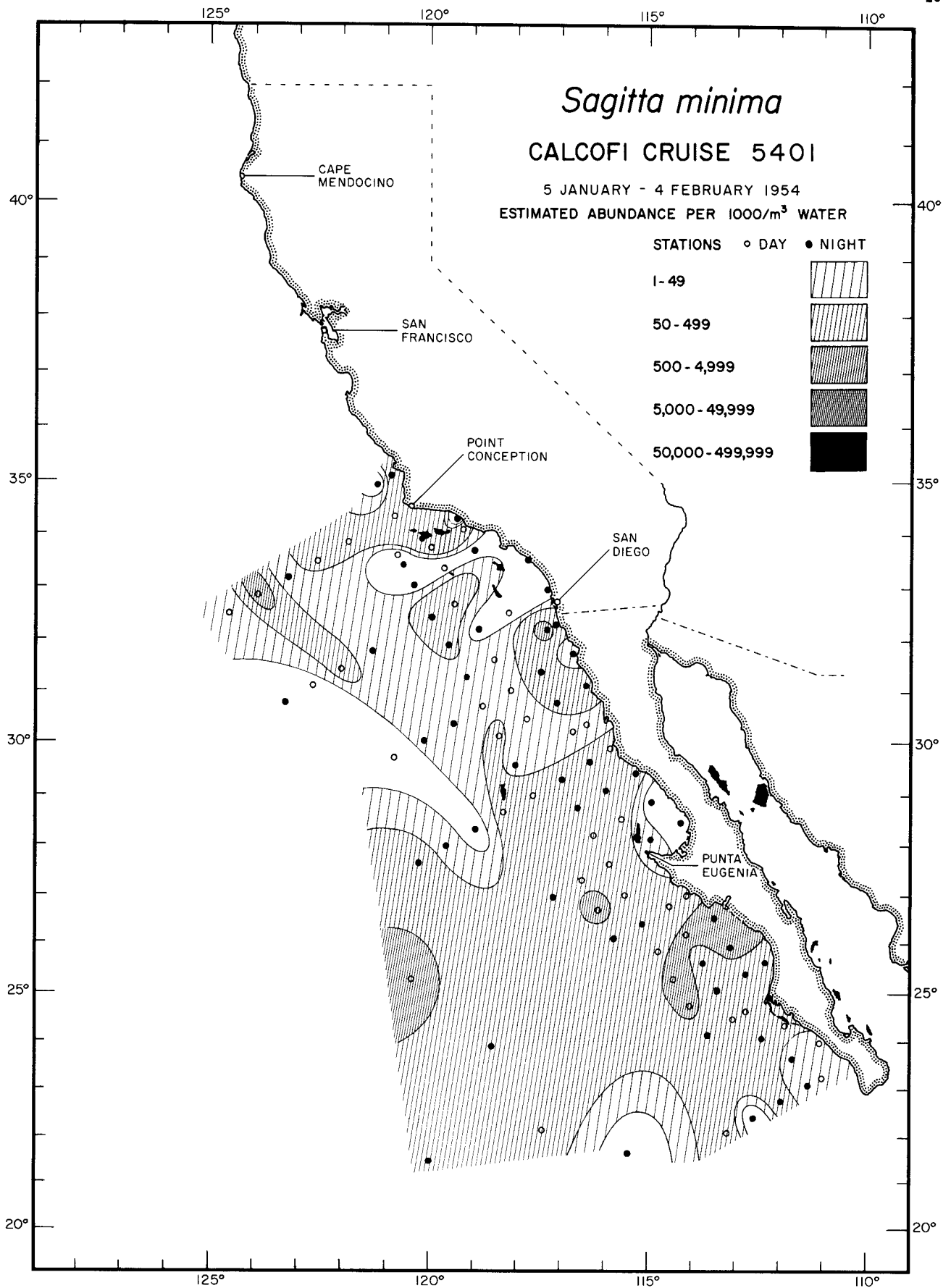
Chaetognatha
Sagitta euneritica
5401

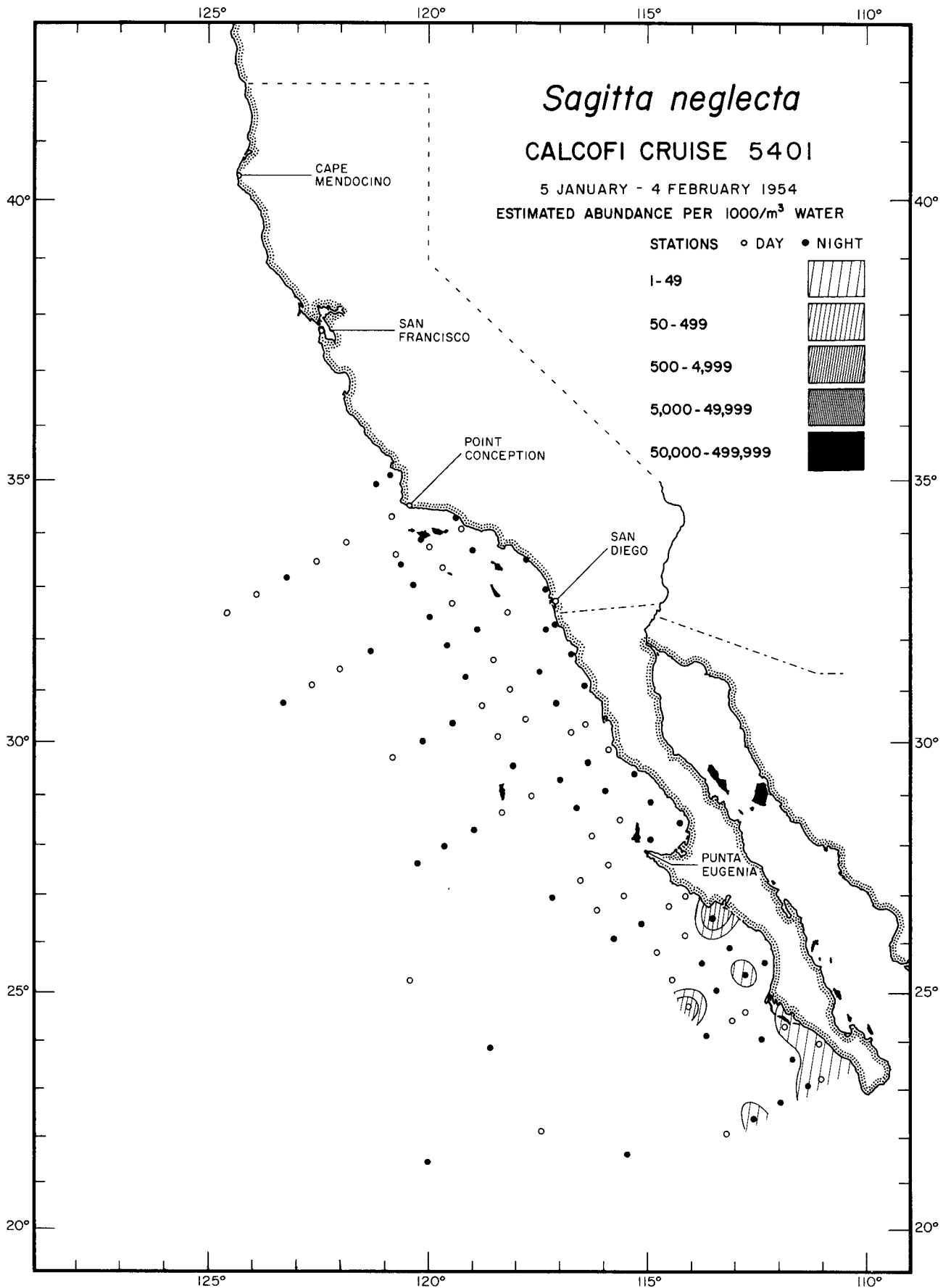


Chaetognatha
Sagitta ferox
5401

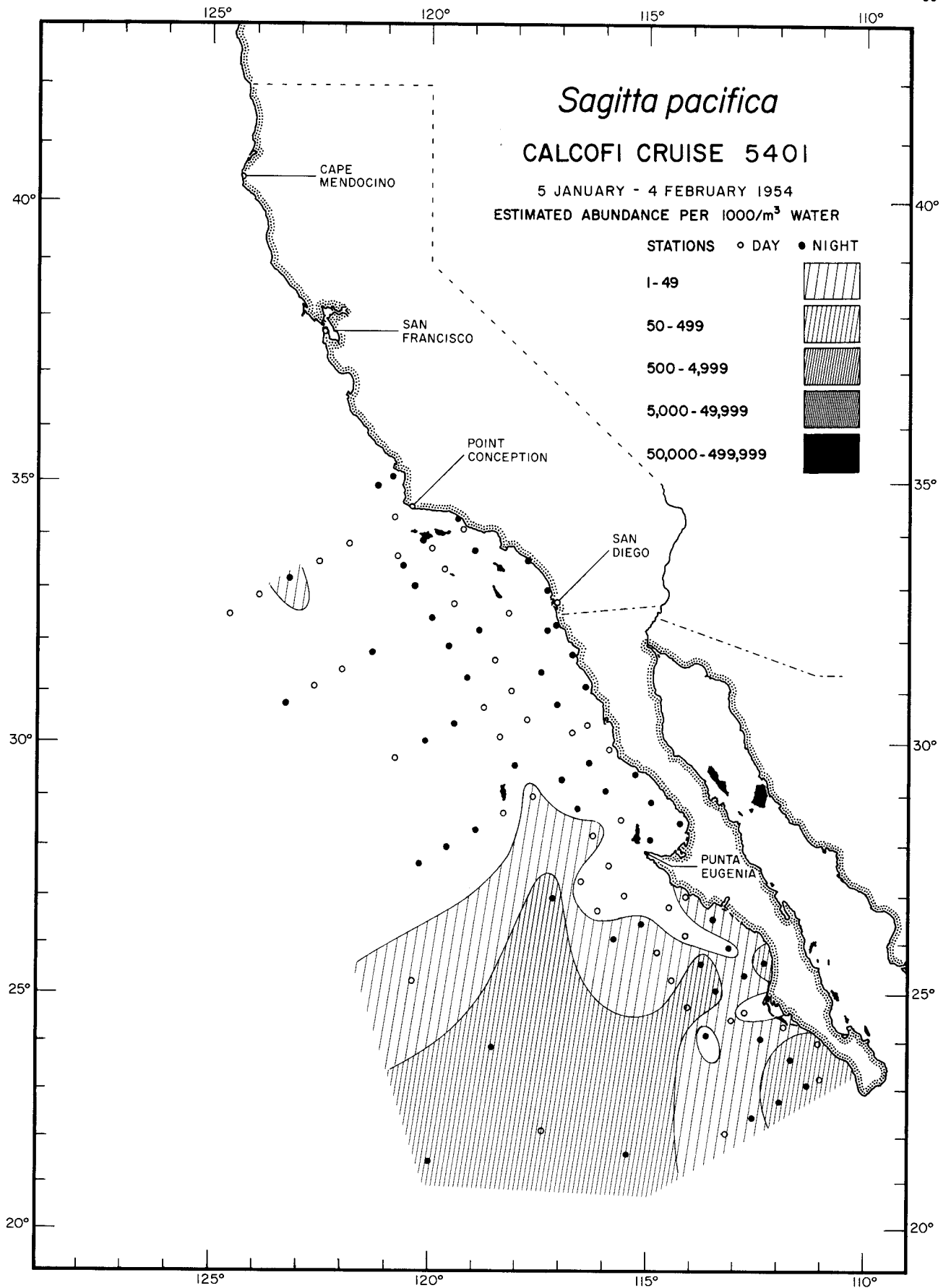


Chaetognatha
Sagitta hexaptera
 5401

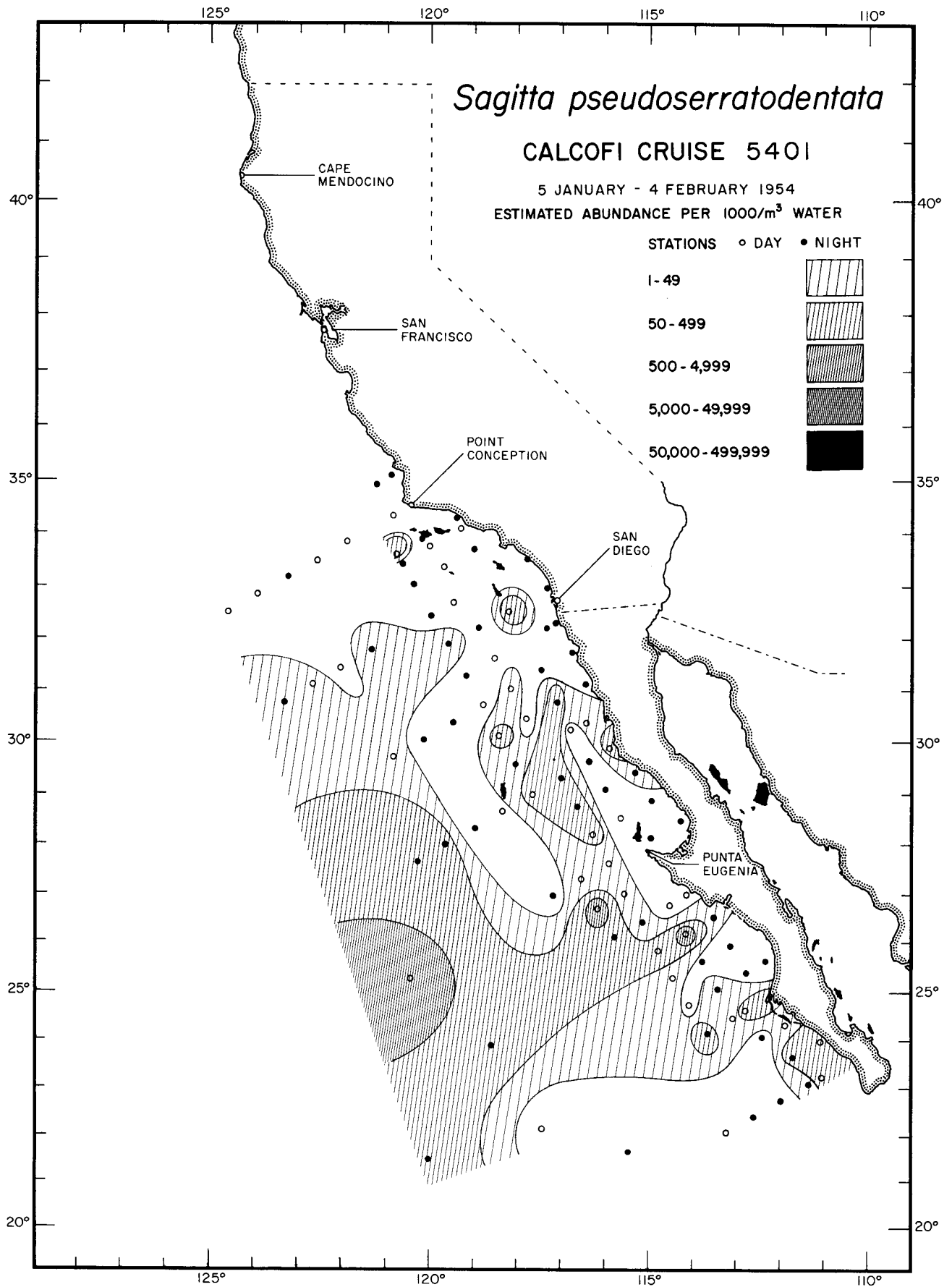




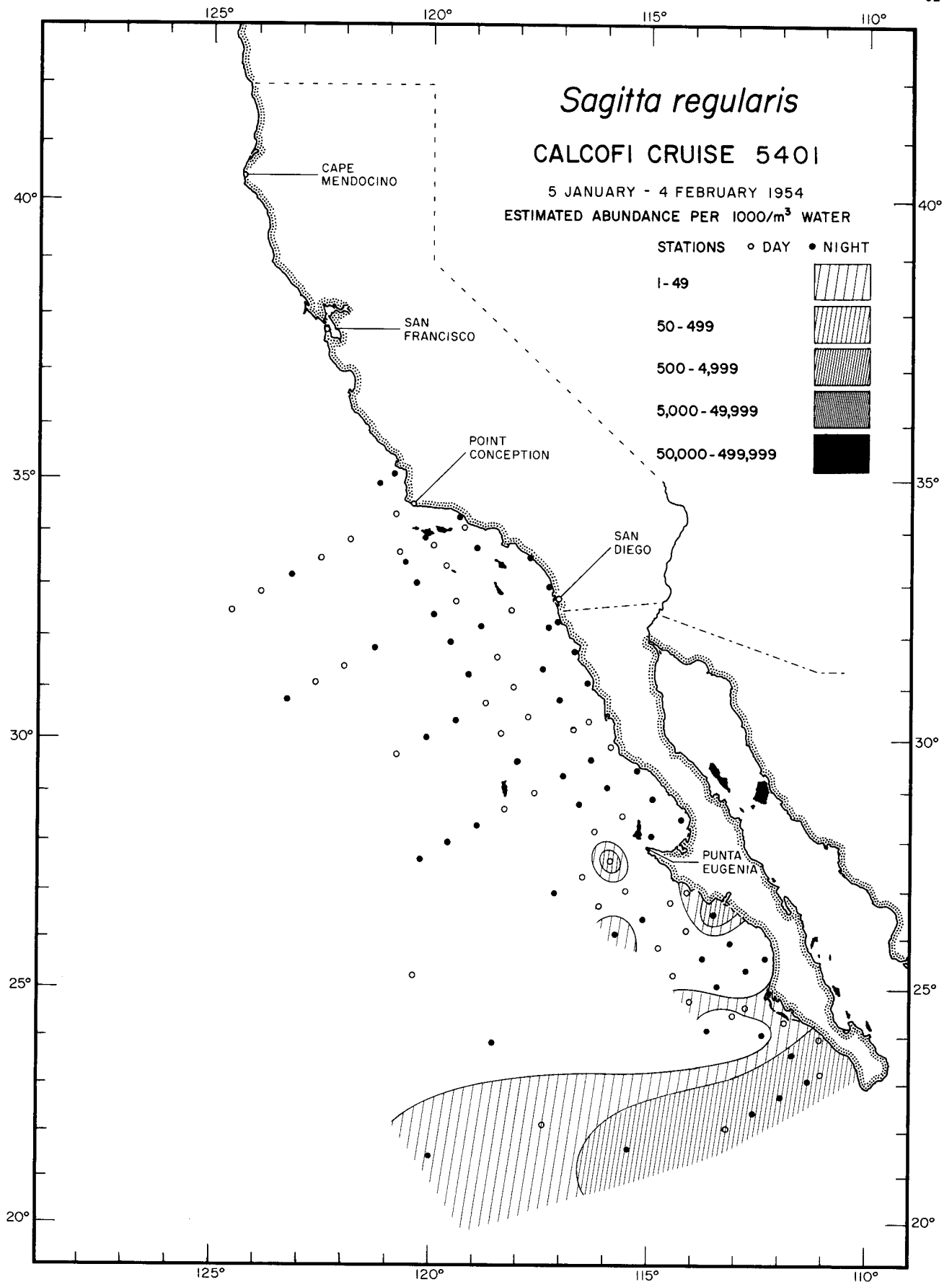
Chaetognatha
Sagitta neglecta
5401



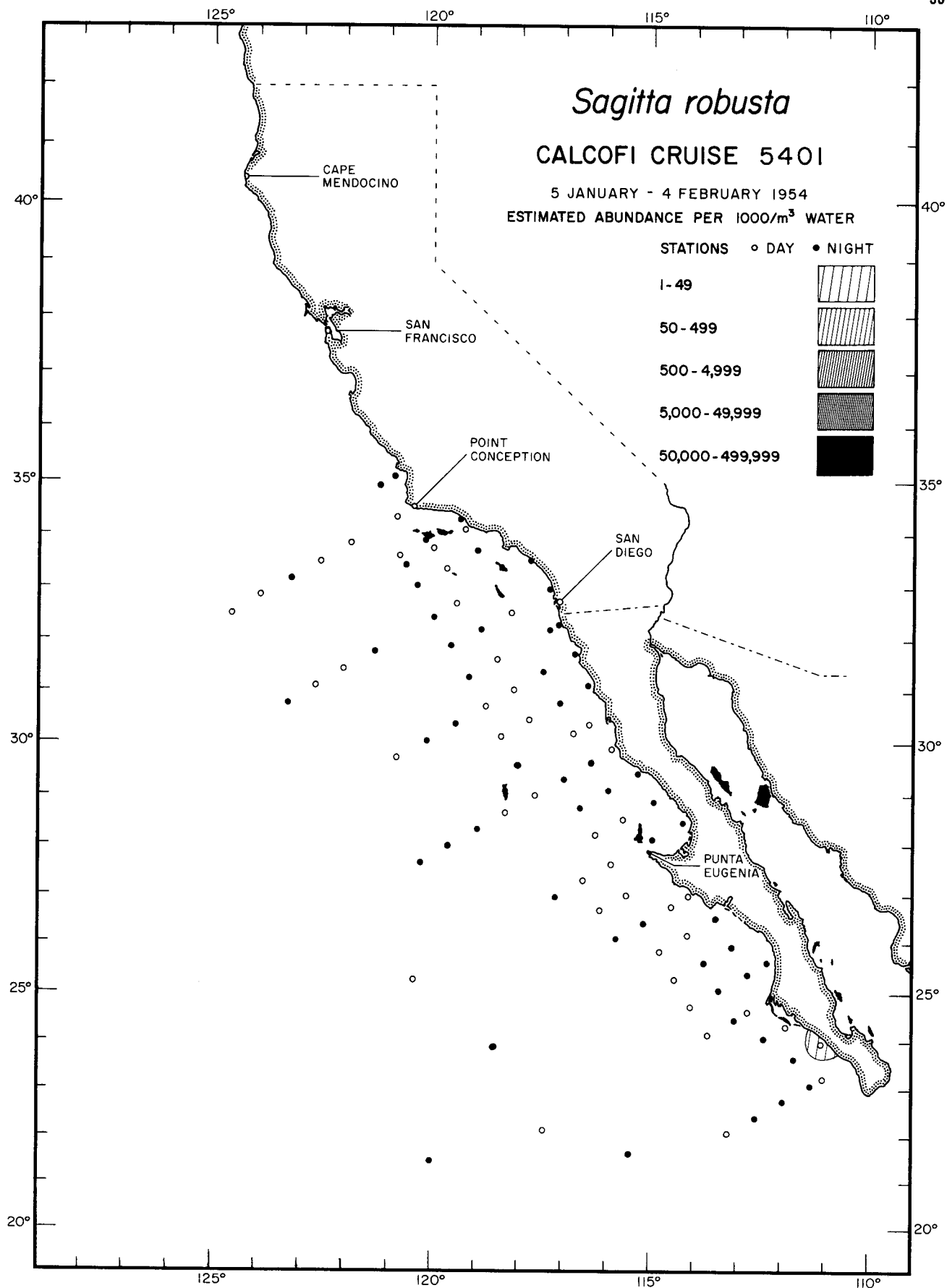
Chaetognatha
Sagitta pacifica
5401



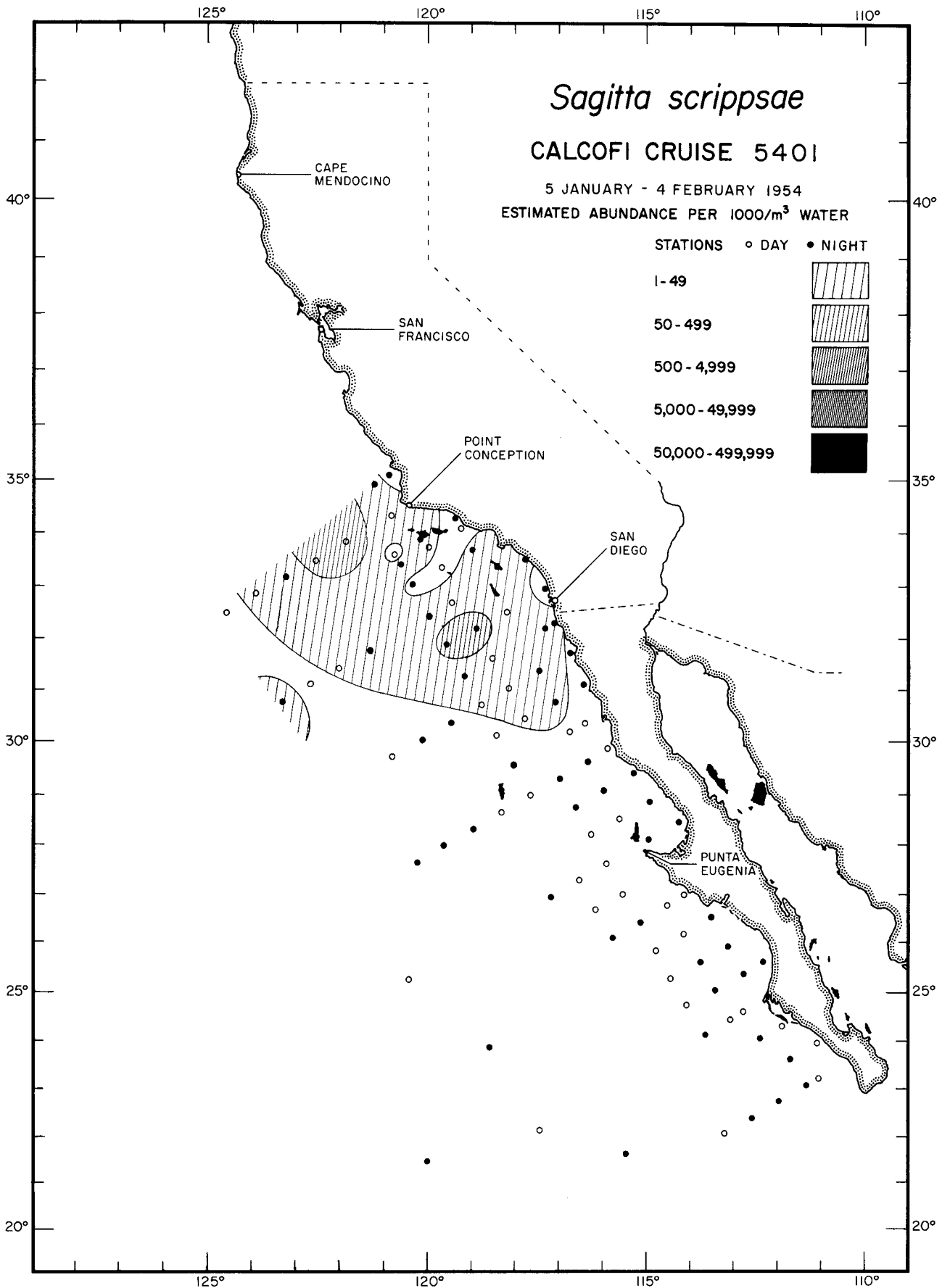
Chaetognatha
Sagitta pseudoserratodentata
5401



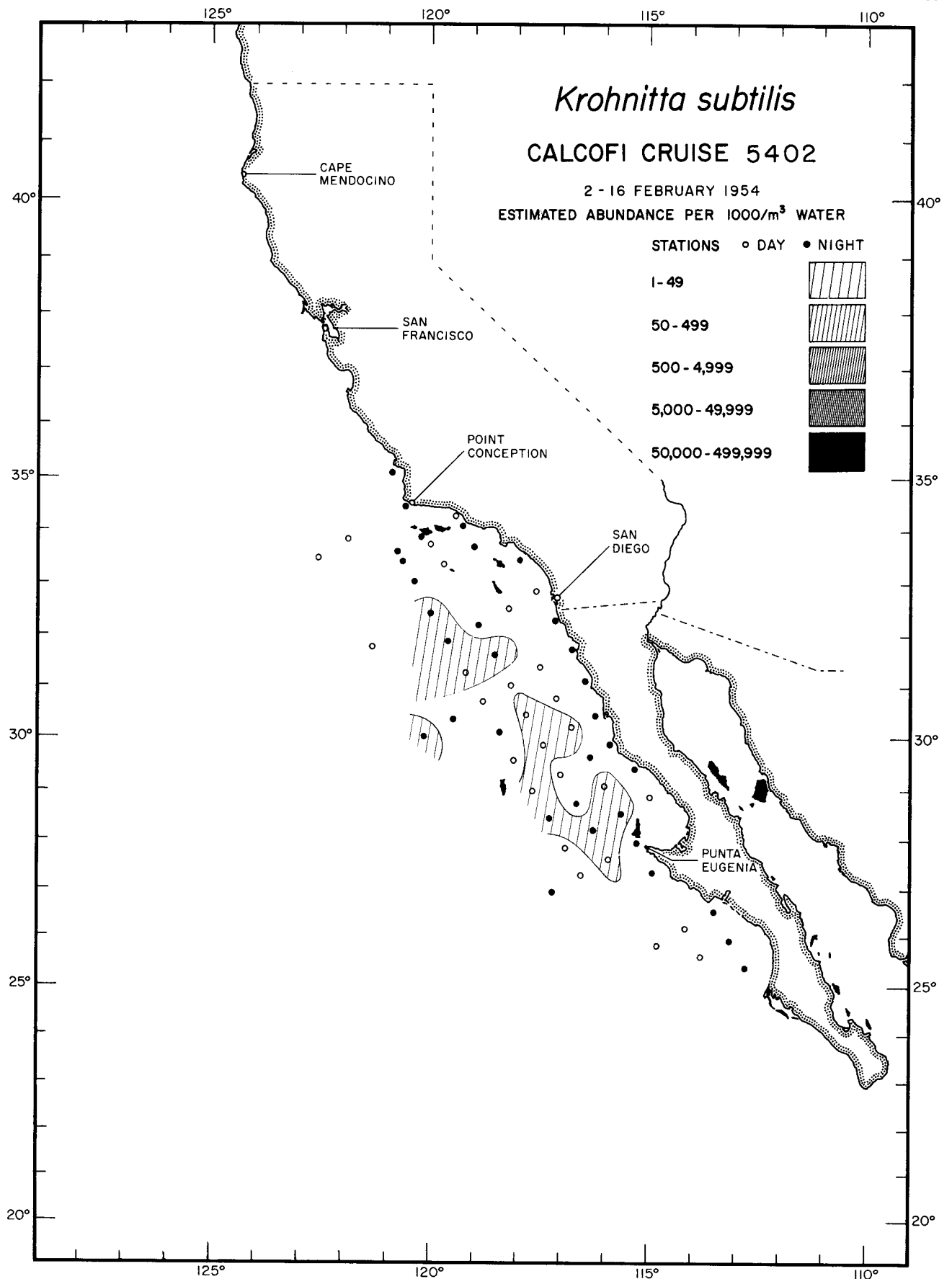
Chaetognatha
Sagitta regularis
5401



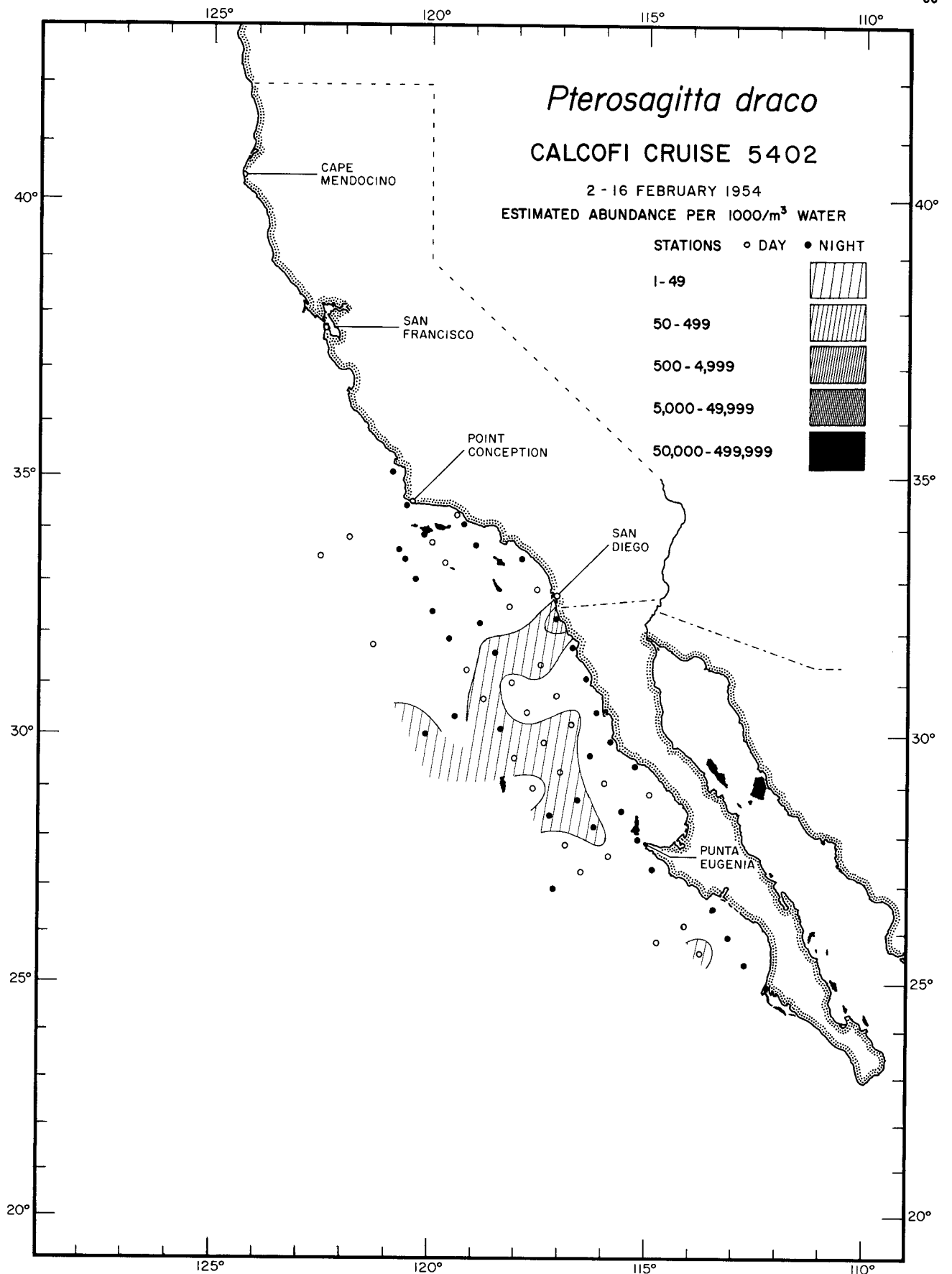
Chaetognatha
Sagitta robusta
 5401



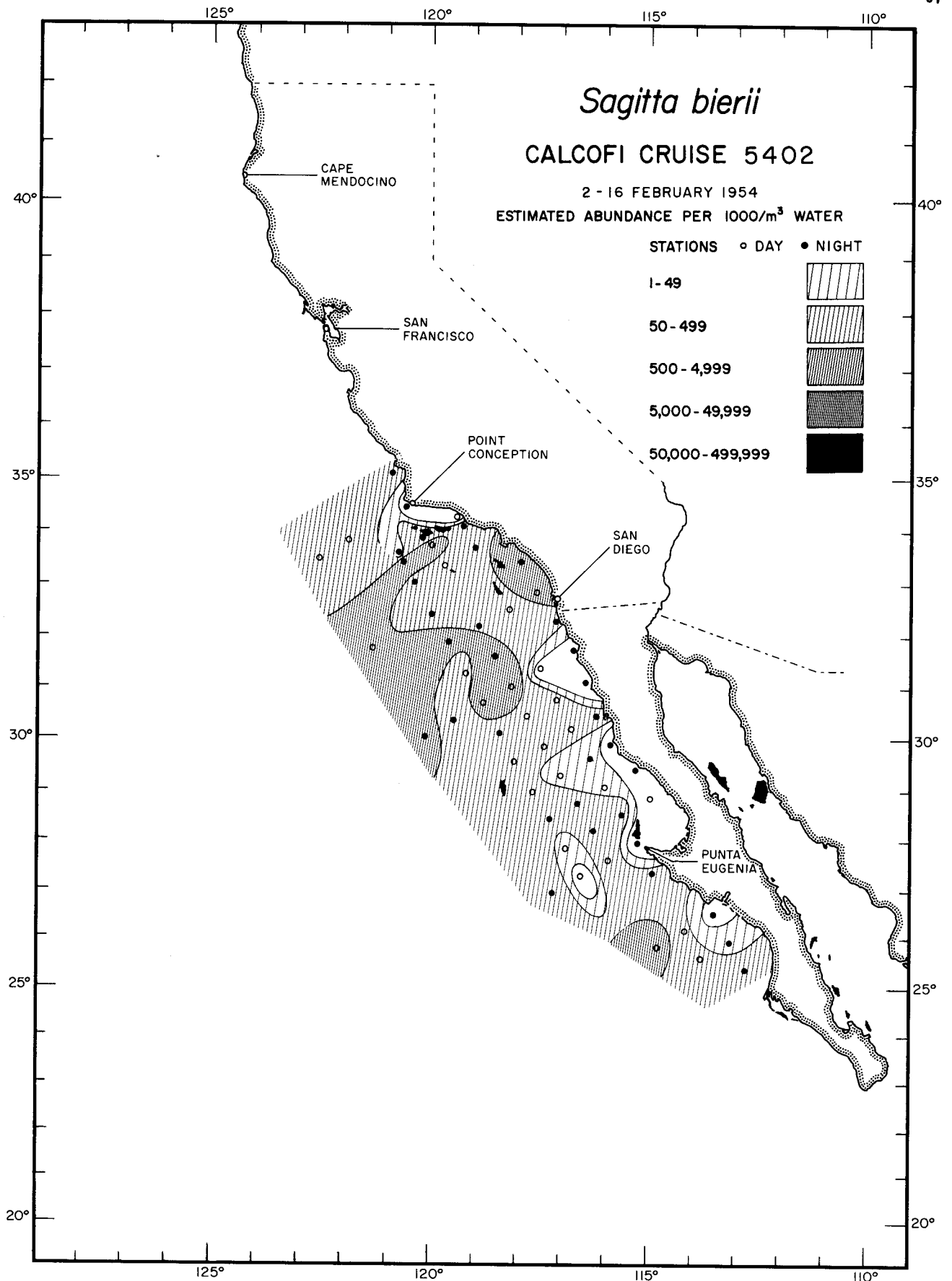
Chaetognatha
Sagitta scrippsae
5401



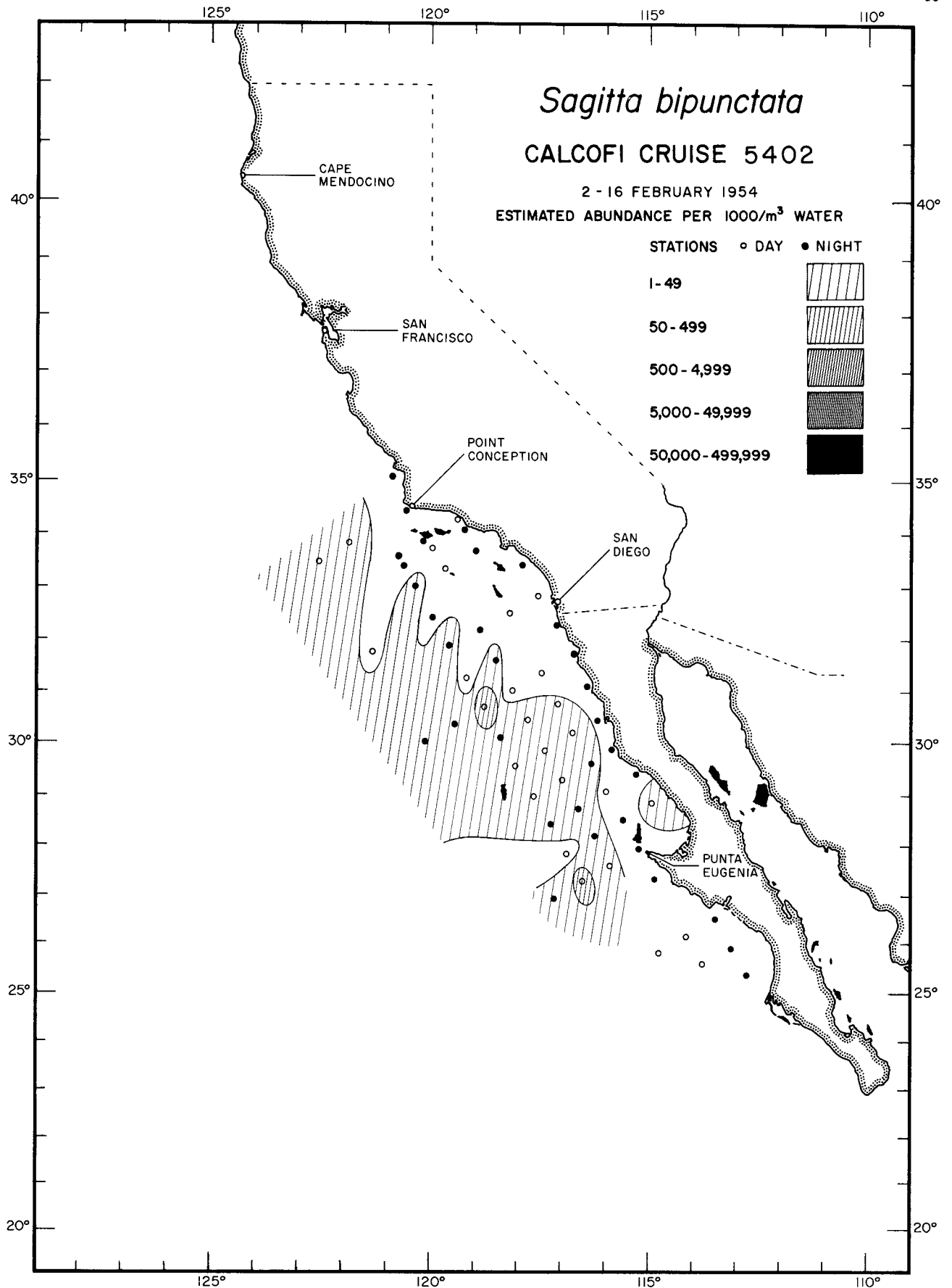
Chaetognatha
Krohnitta subtilis
5402



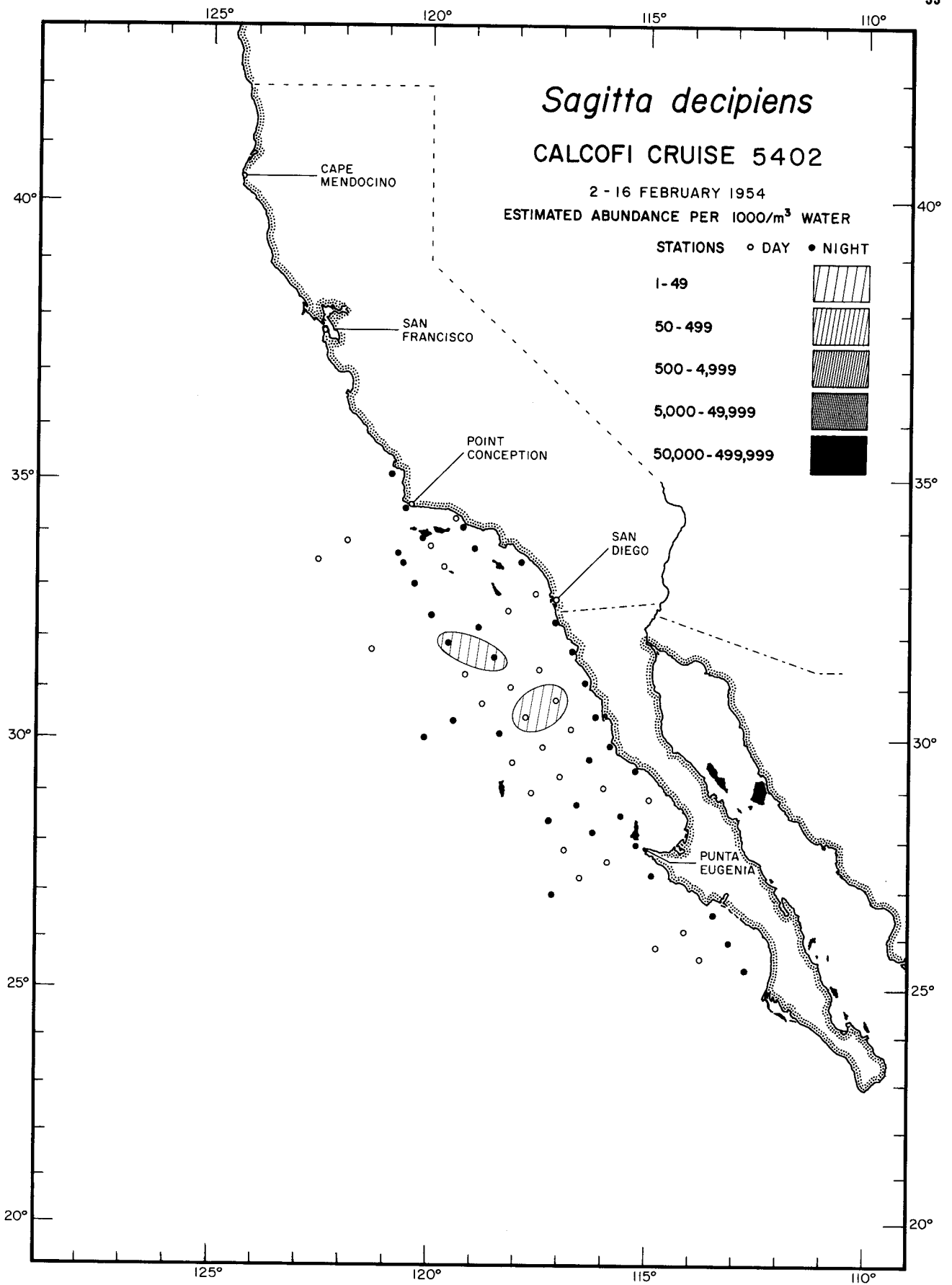
Chaetognatha
Pterosagitta draco
5402



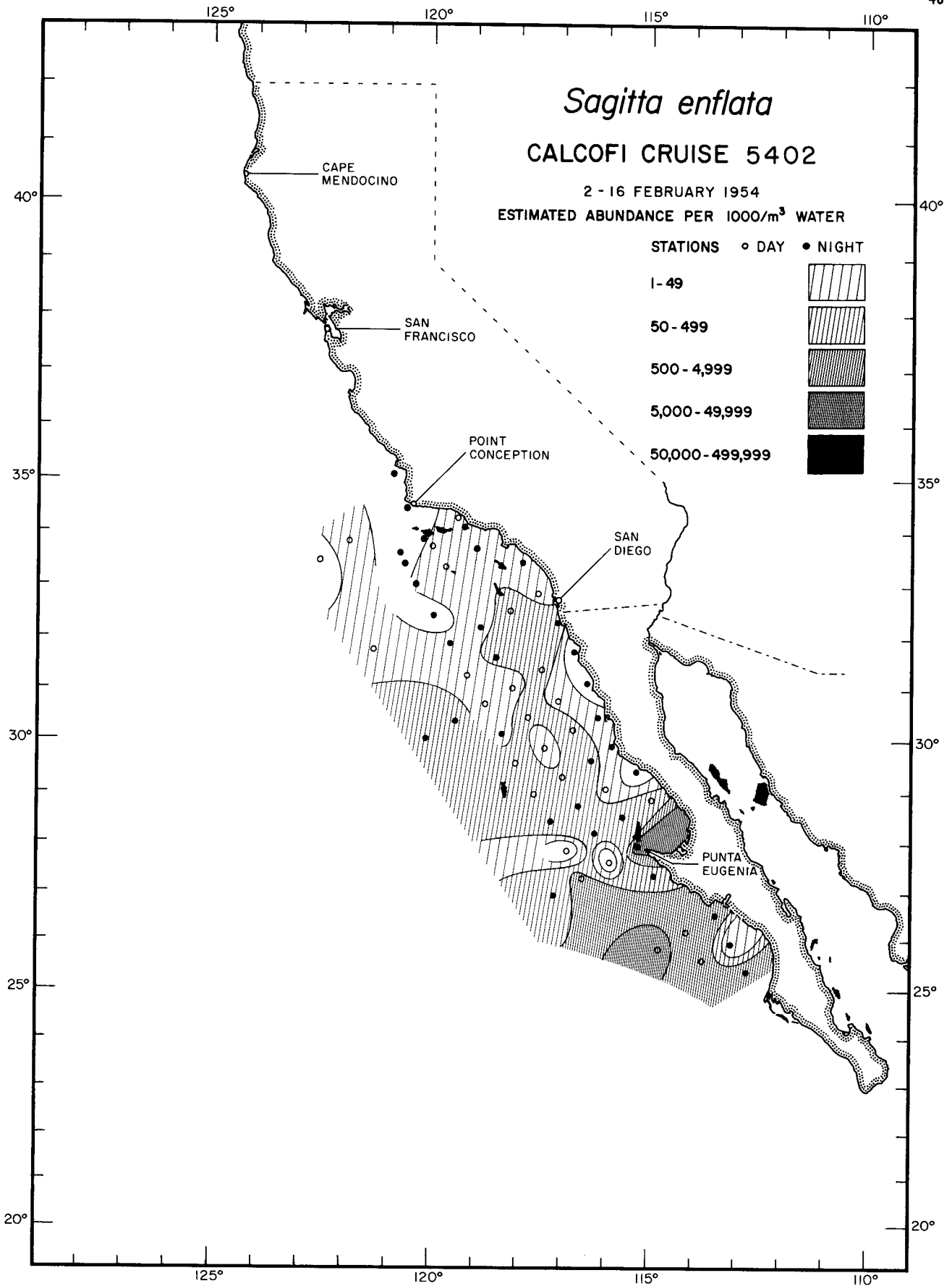
Chaetognatha
Sagitta bierii
5402



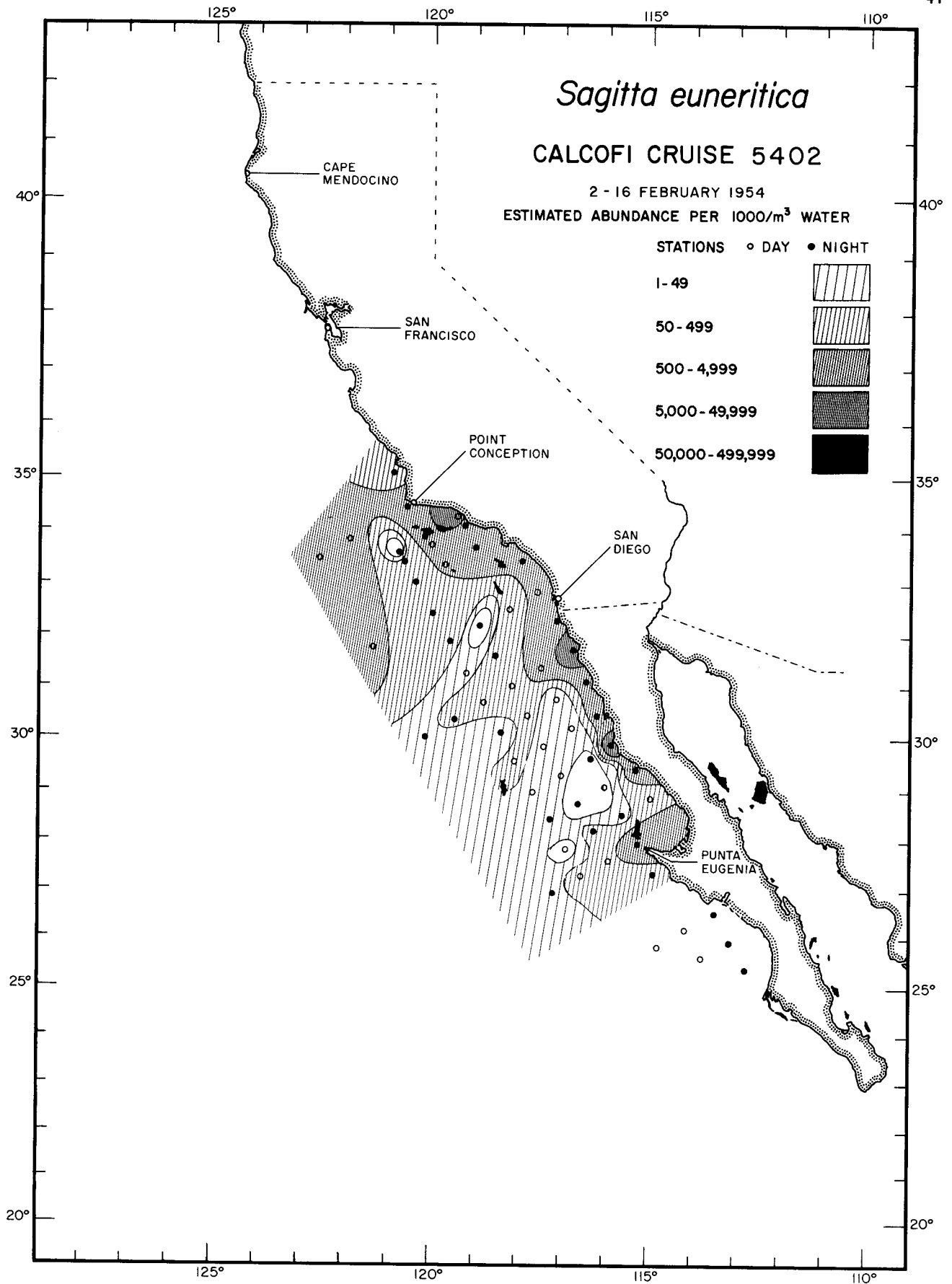
Chaetognatha
Sagitta bipunctata
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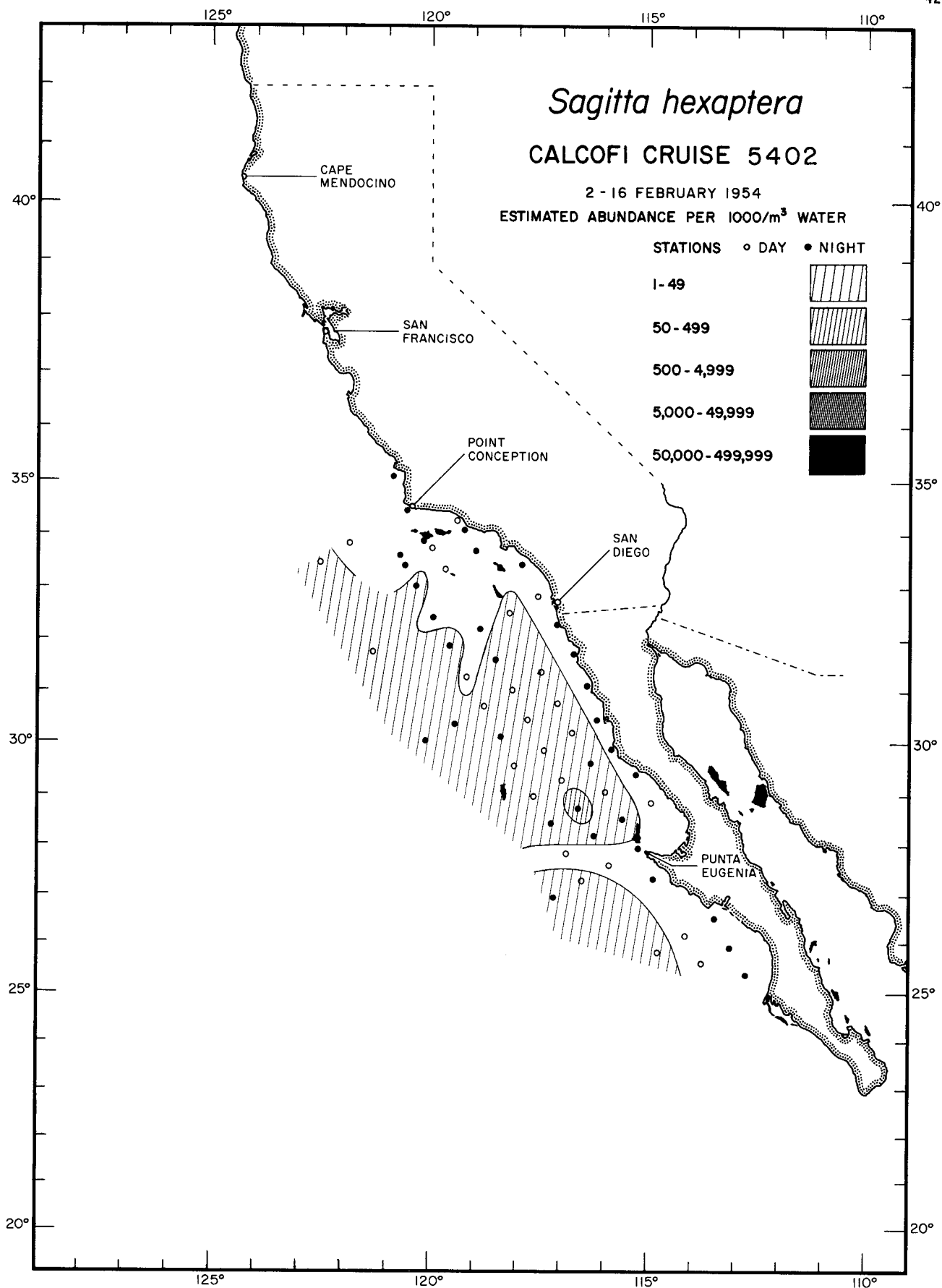
Chaetognatha
Sagitta decipiens
5402



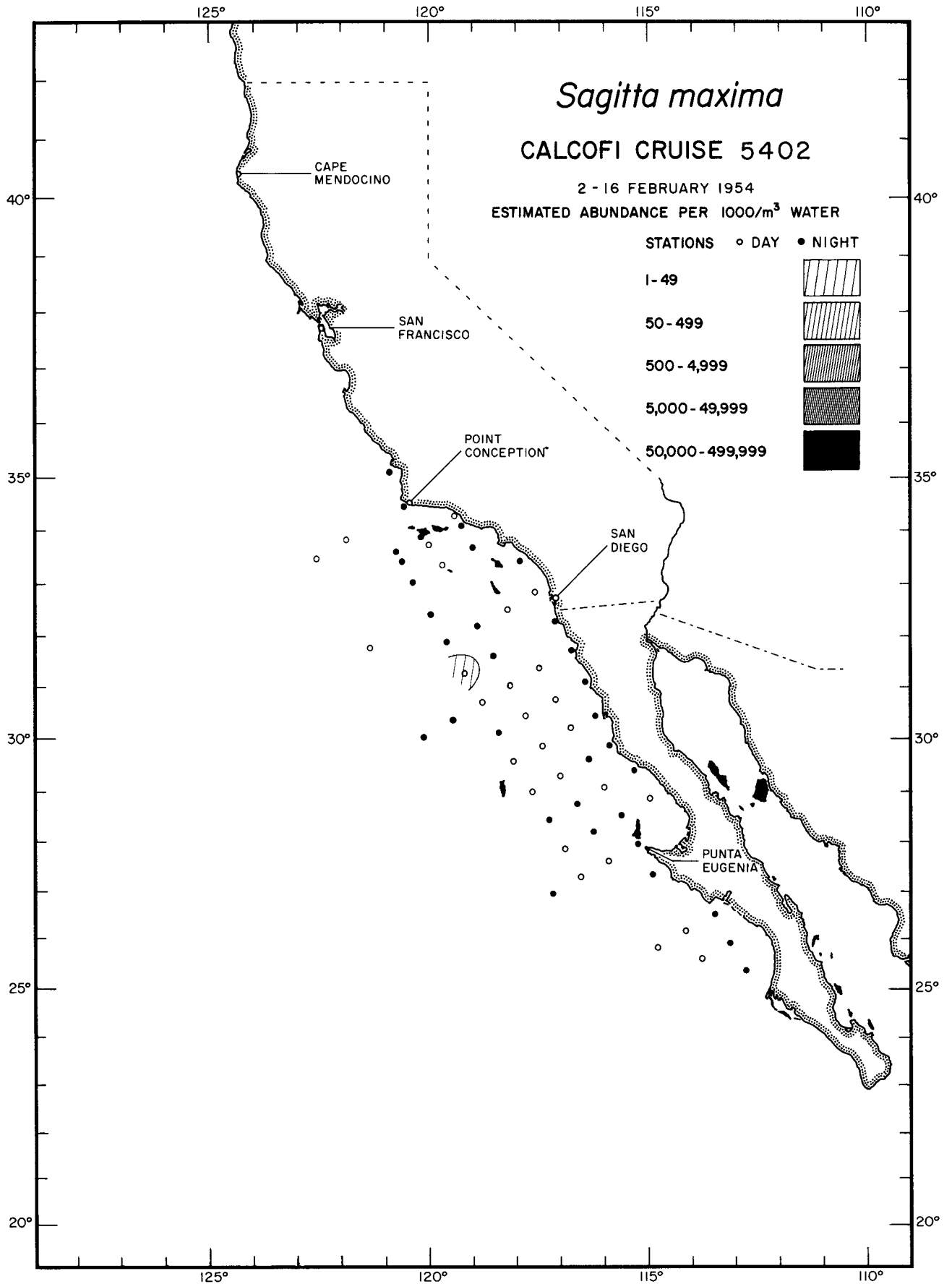
Chaetognatha
Sagitta enflata
 5402



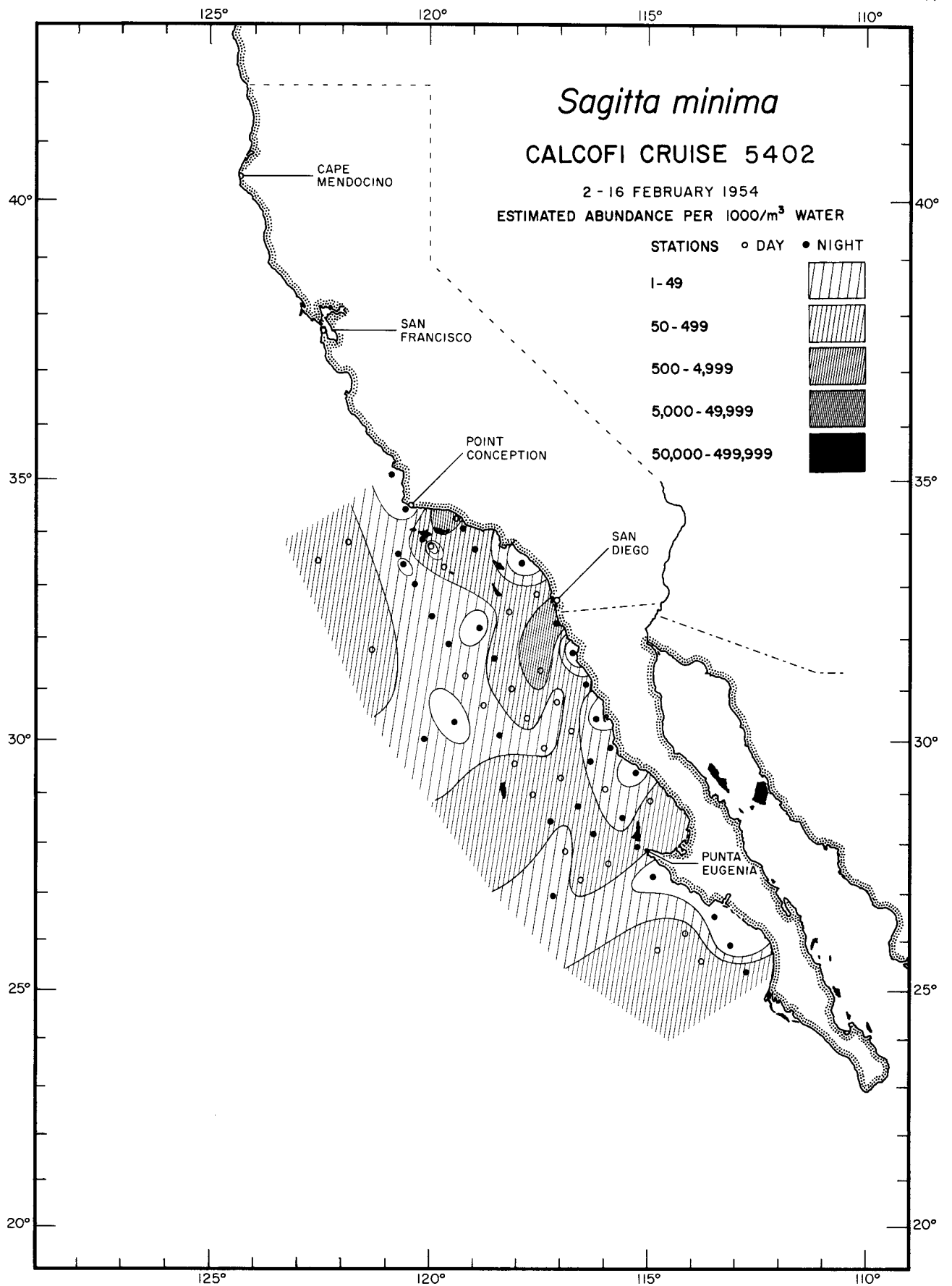
Chaetognatha
Sagitta euneritica
5402



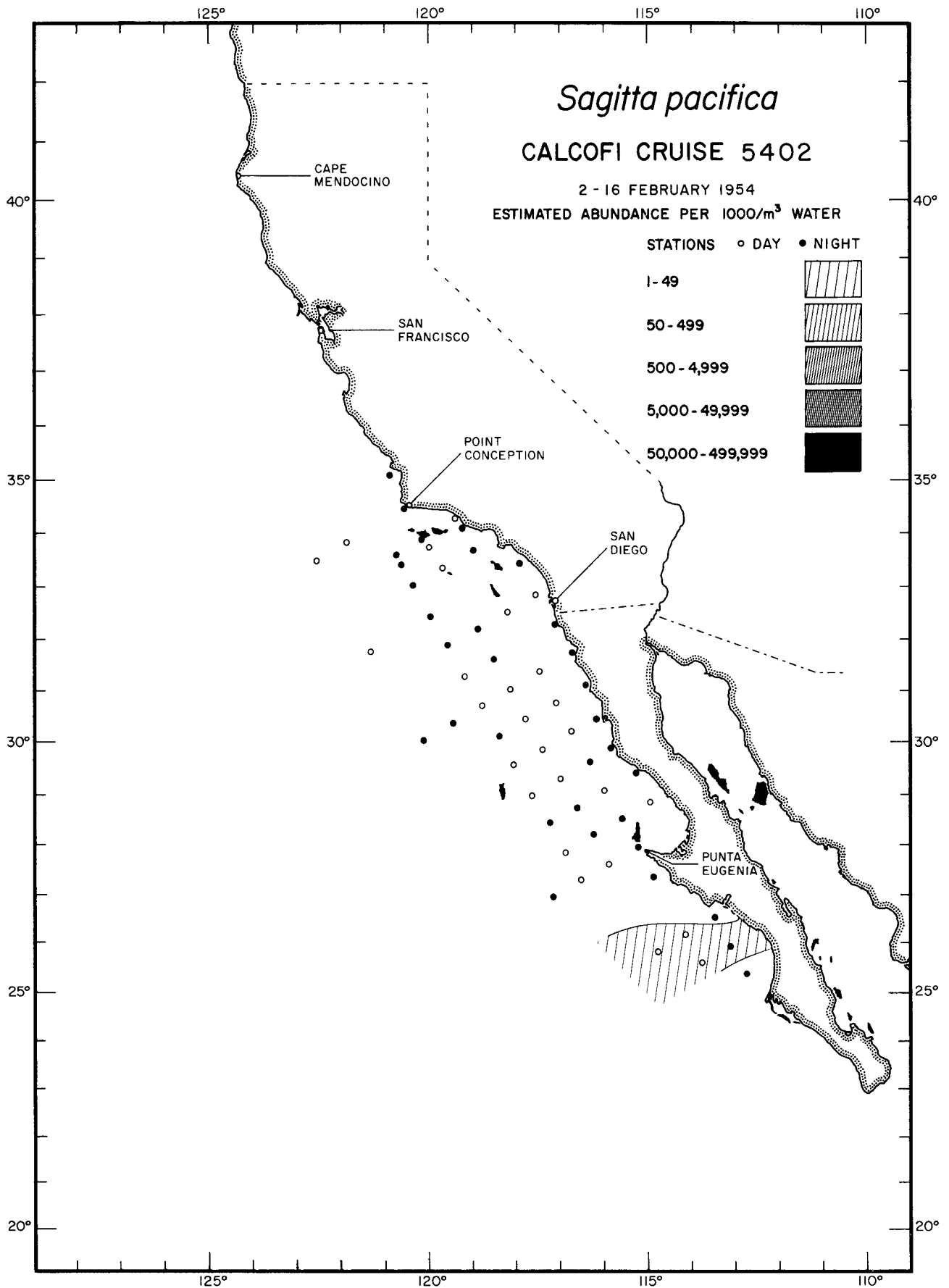
Chaetognatha
Sagitta hexaptera
5402



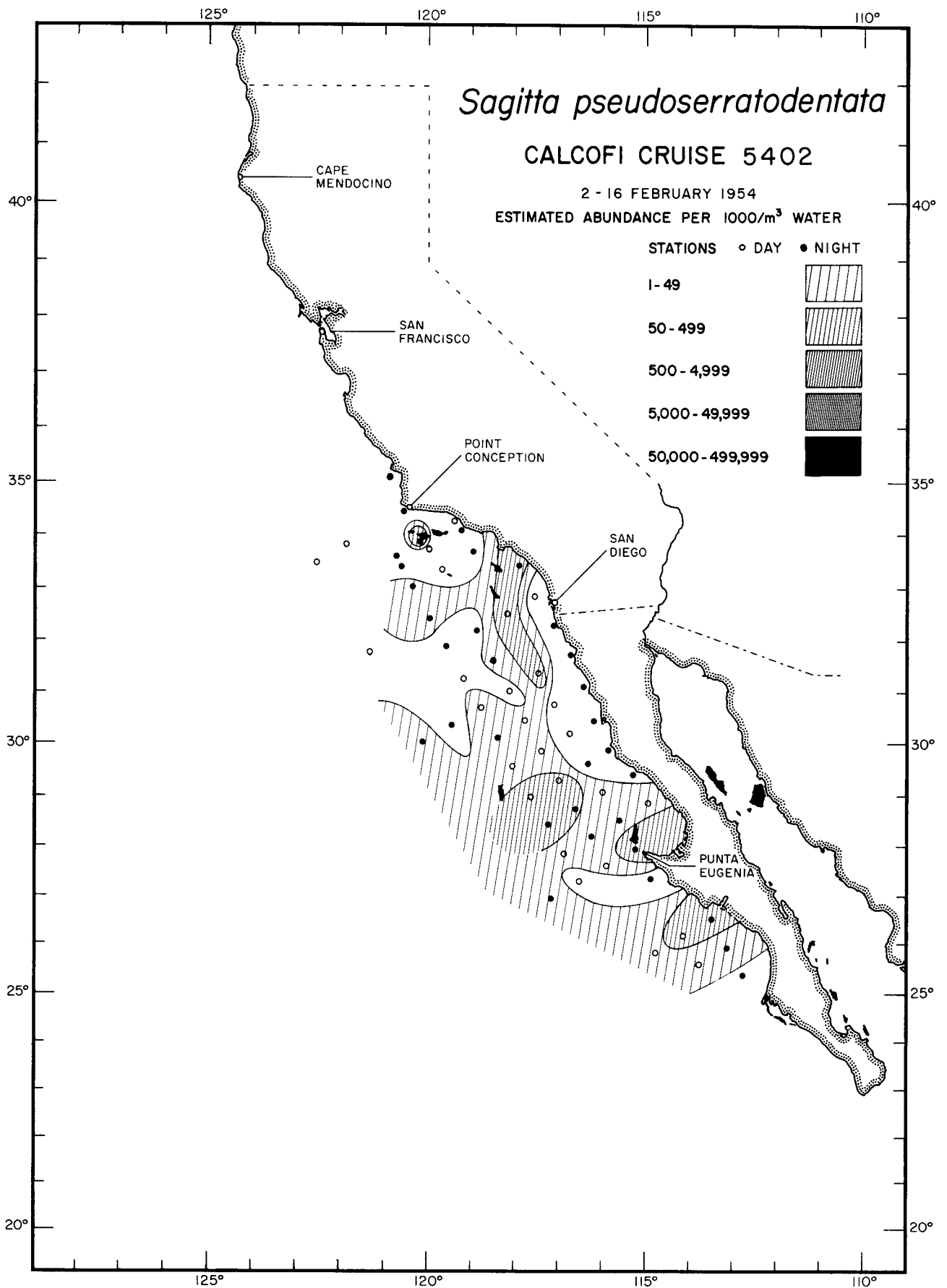
Chaetognatha
Sagitta maxima
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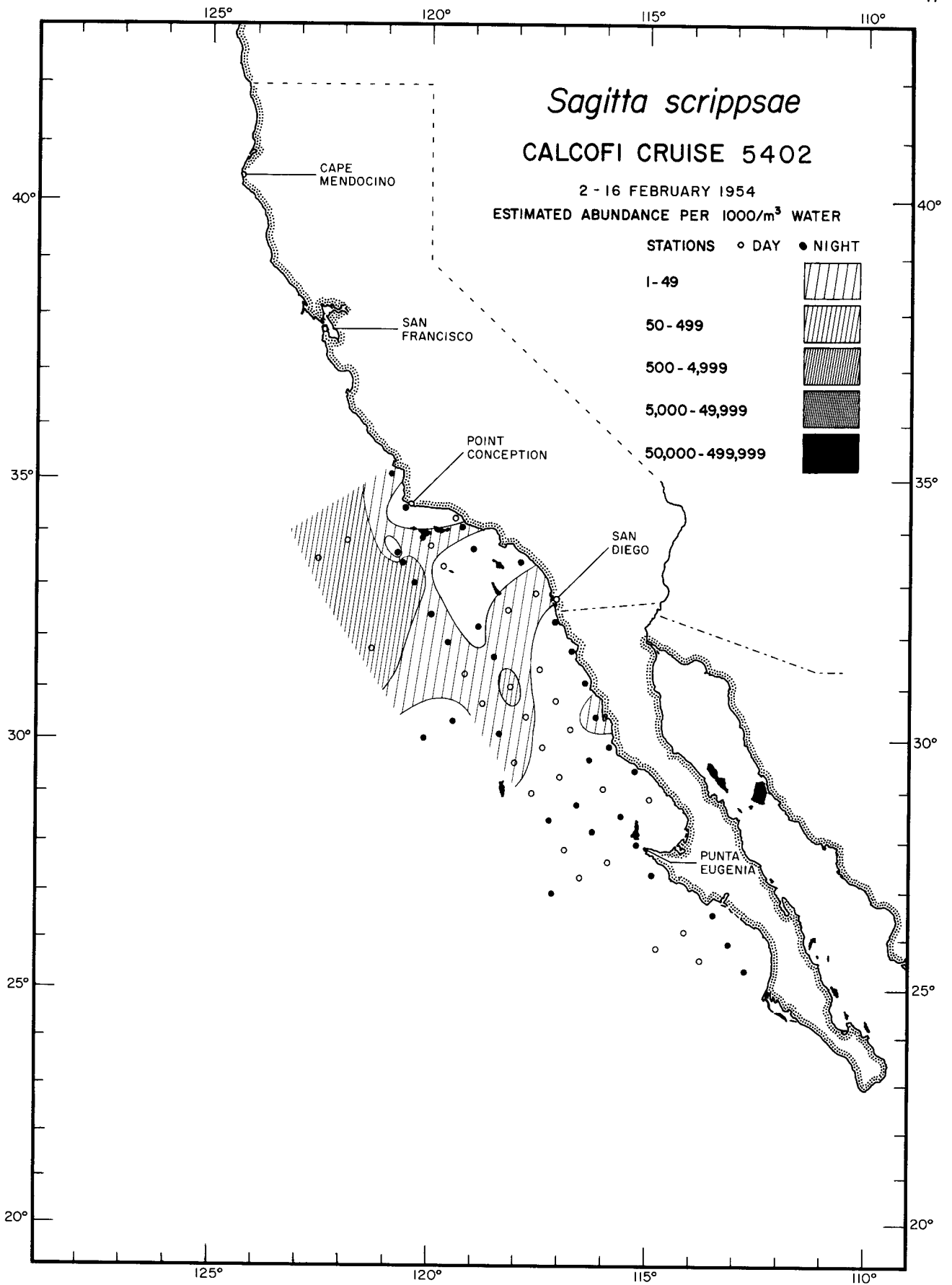
Chaetognatha
Sagitta minima
5402



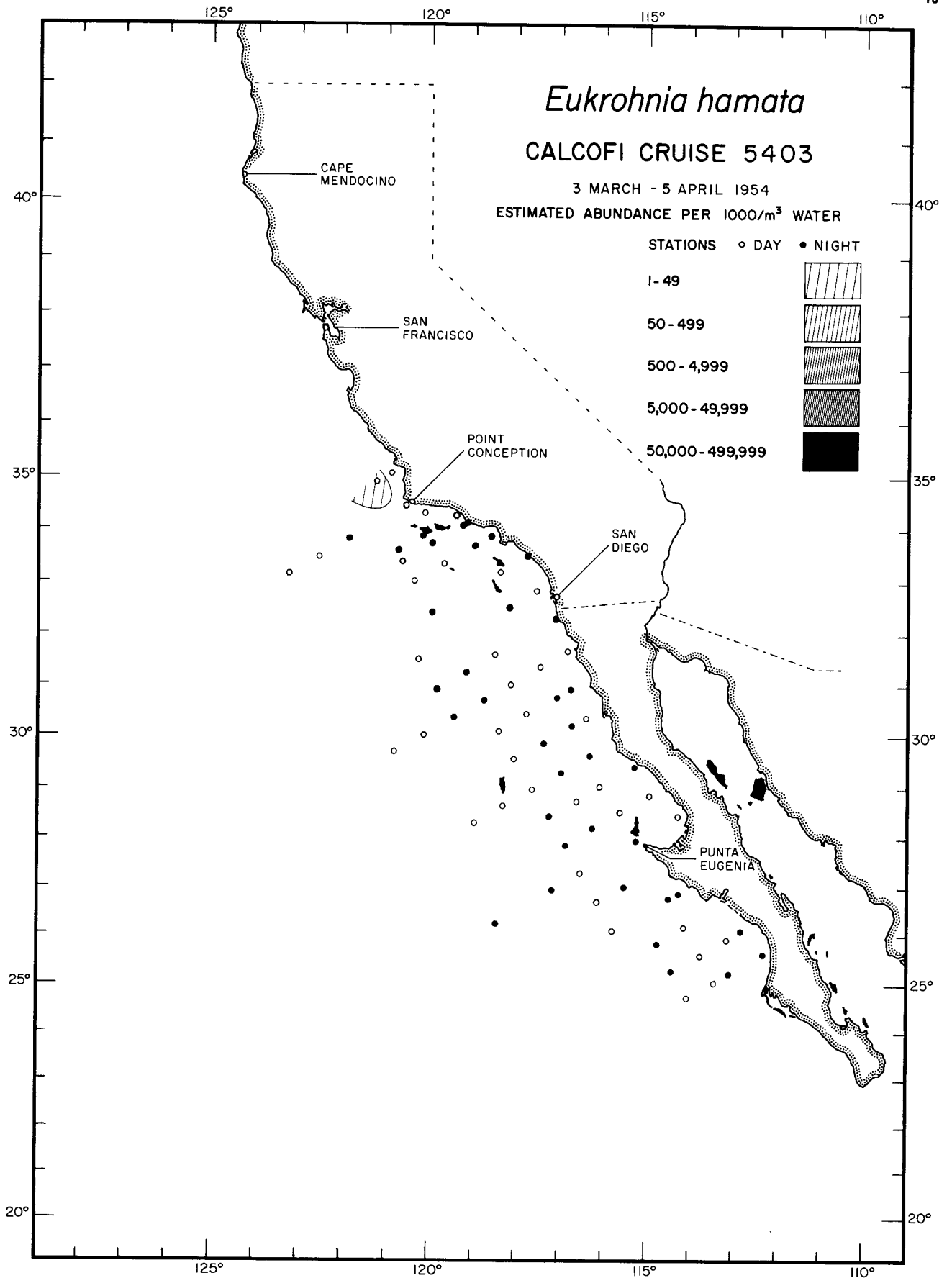
Chaetognatha
Sagitta pacifica
5402



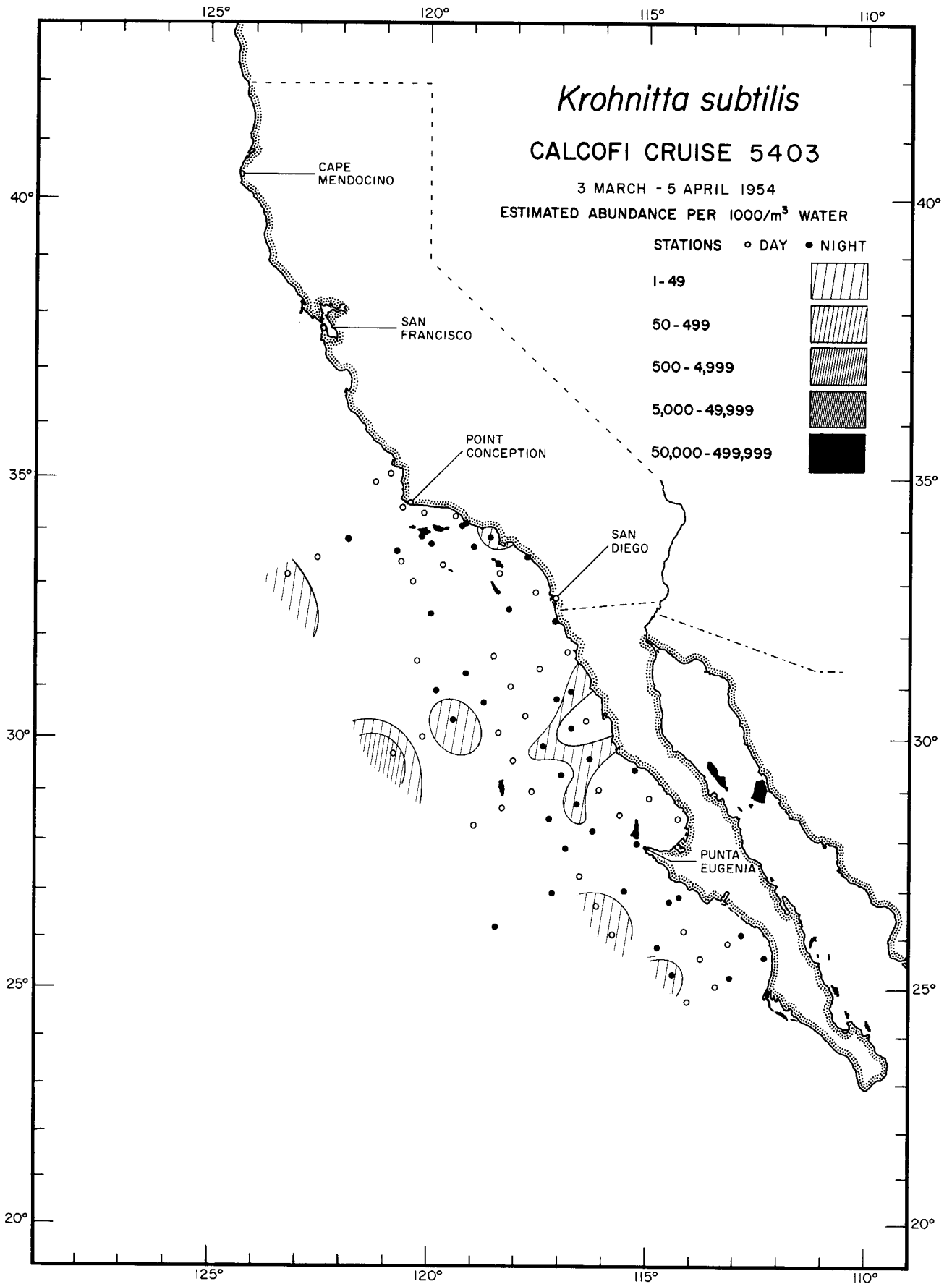
Chaetognatha
Sagitta pseudoserratodentata
5402



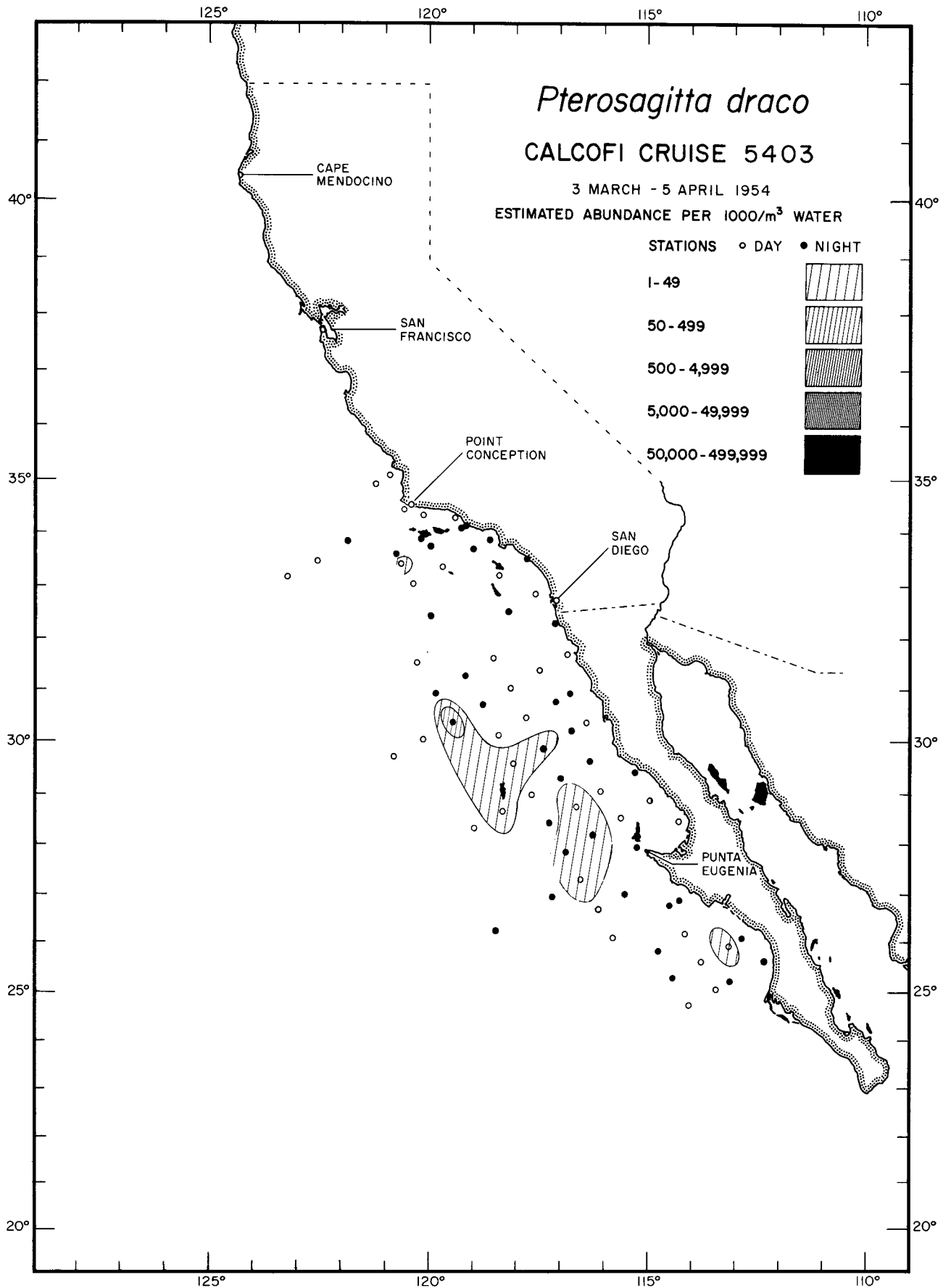
Chaetognatha
Sagitta scrippsae
5402



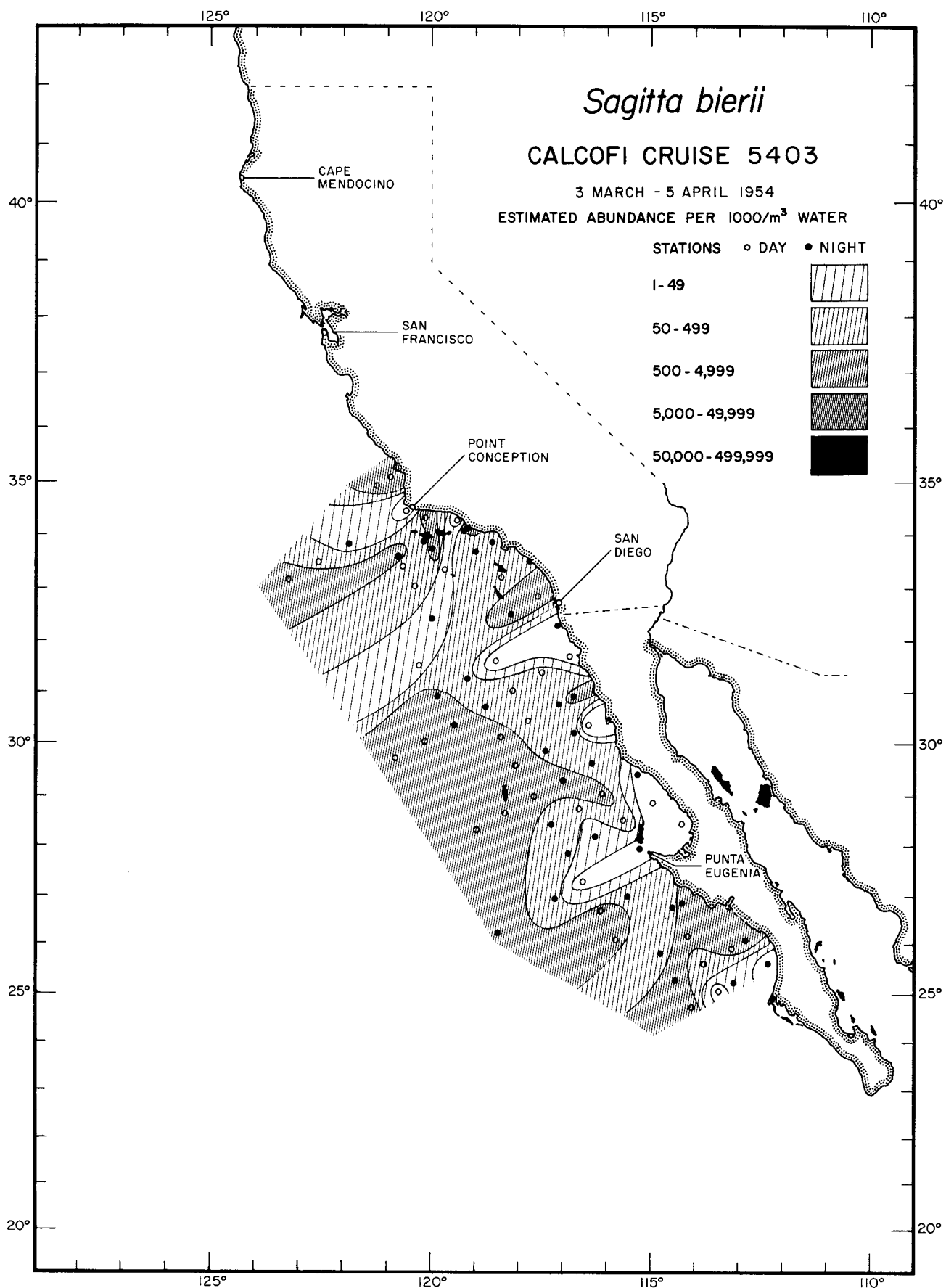
Chaetognatha
Eukrohnia hamata
5403



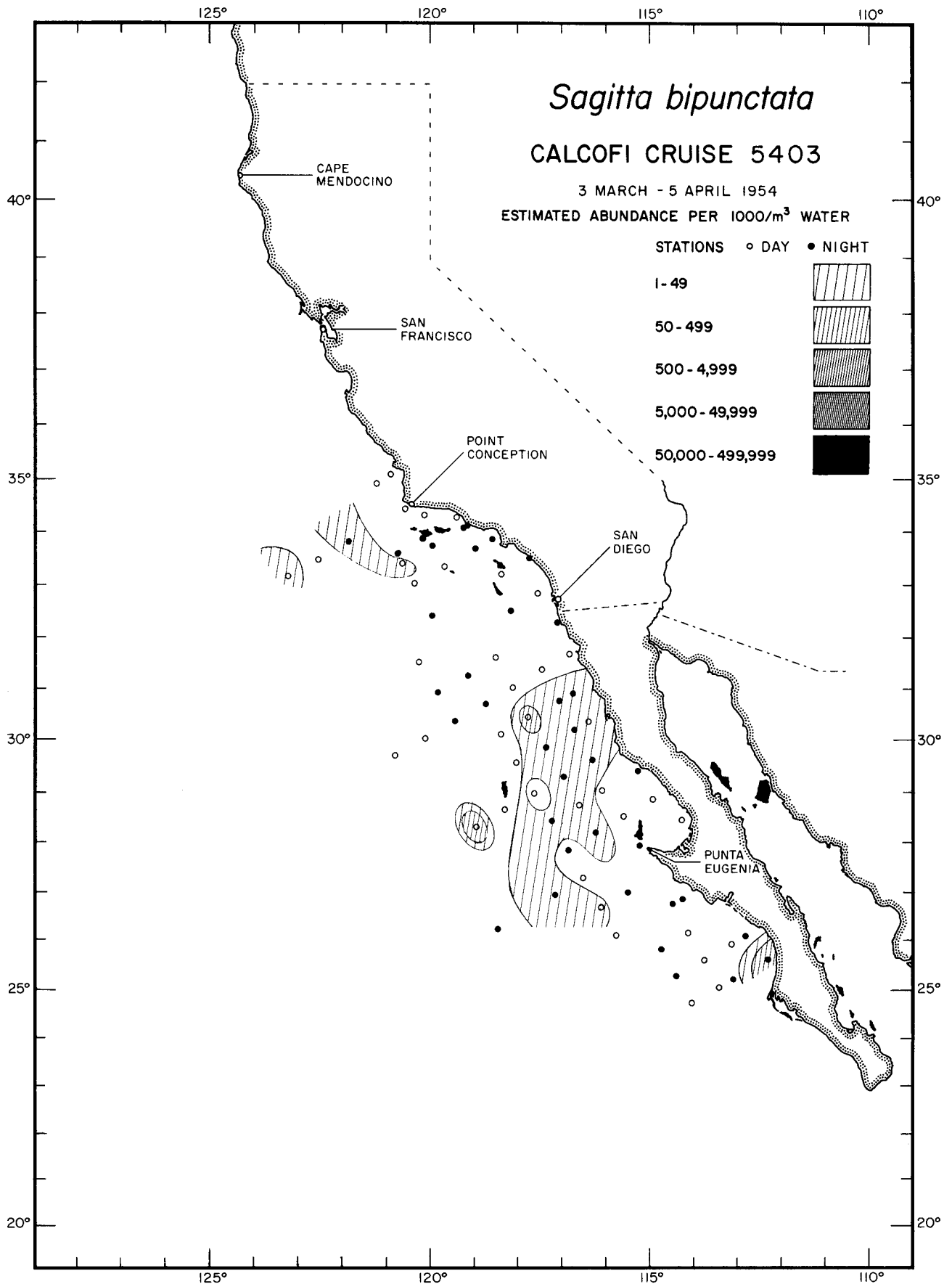
Chaetognatha
Krohnitta subtilis
5403



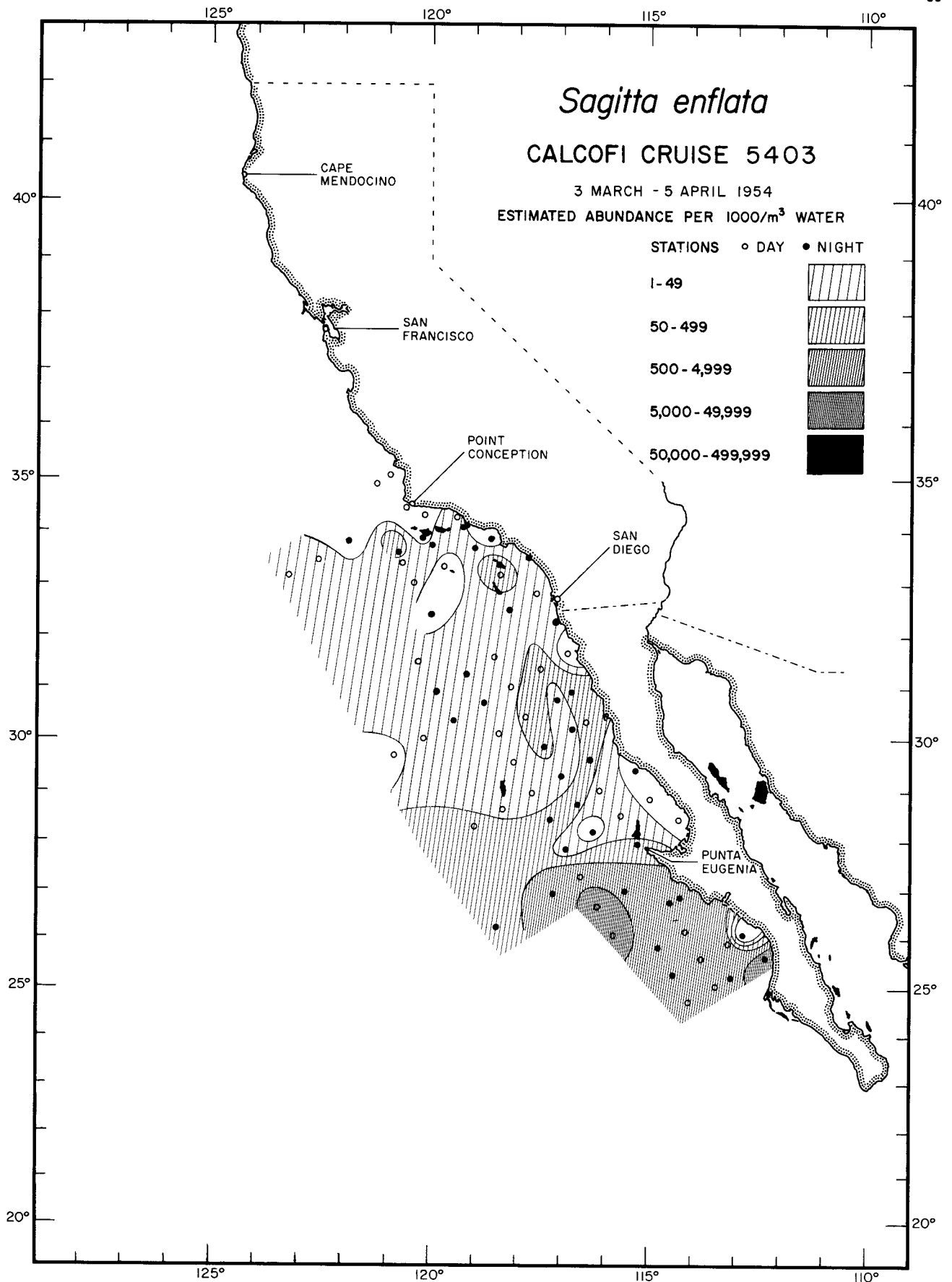
Chaetognatha
Pterosagitta draco
5403



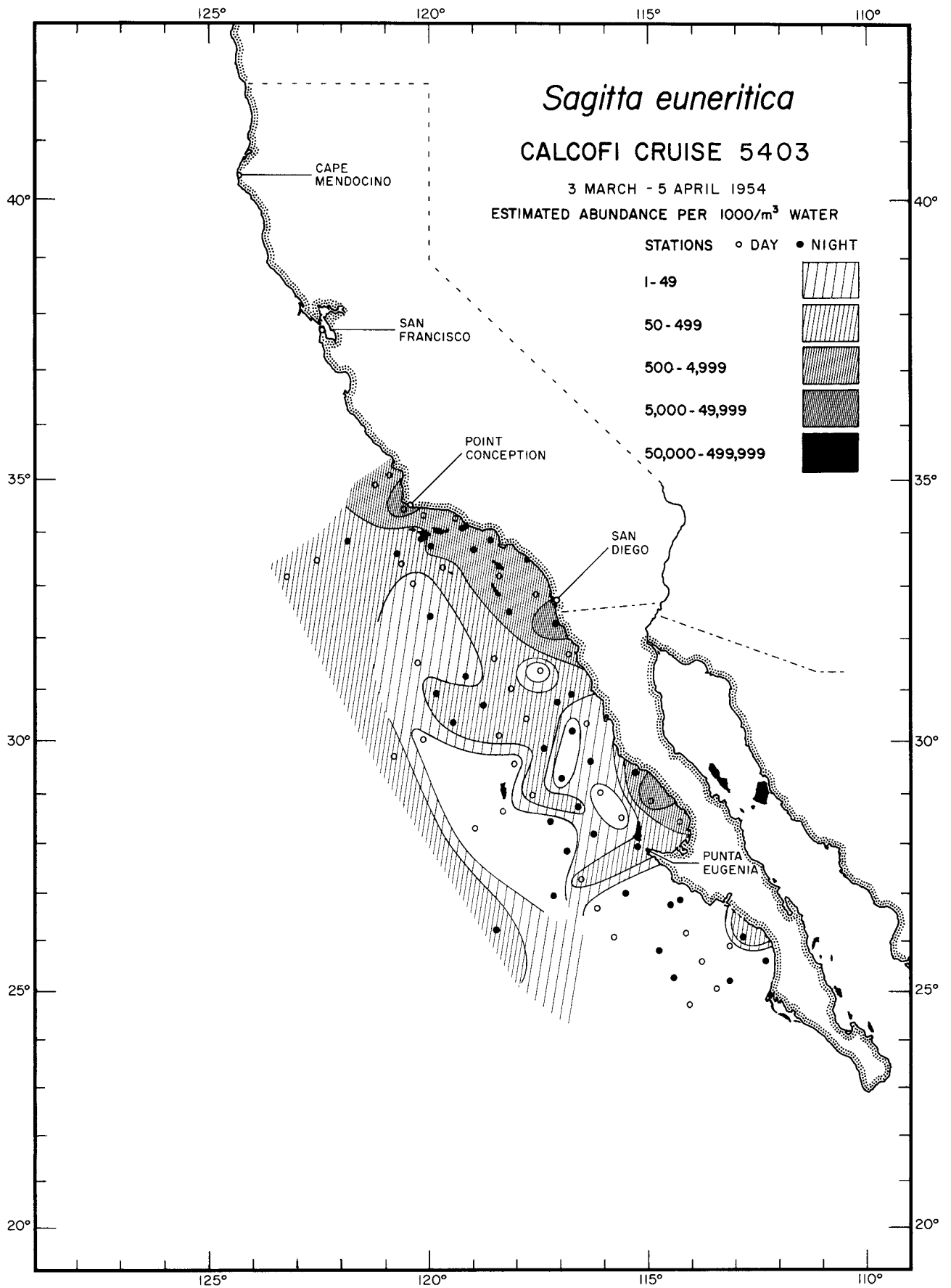
Chaetognatha
Sagitta bierii
5403



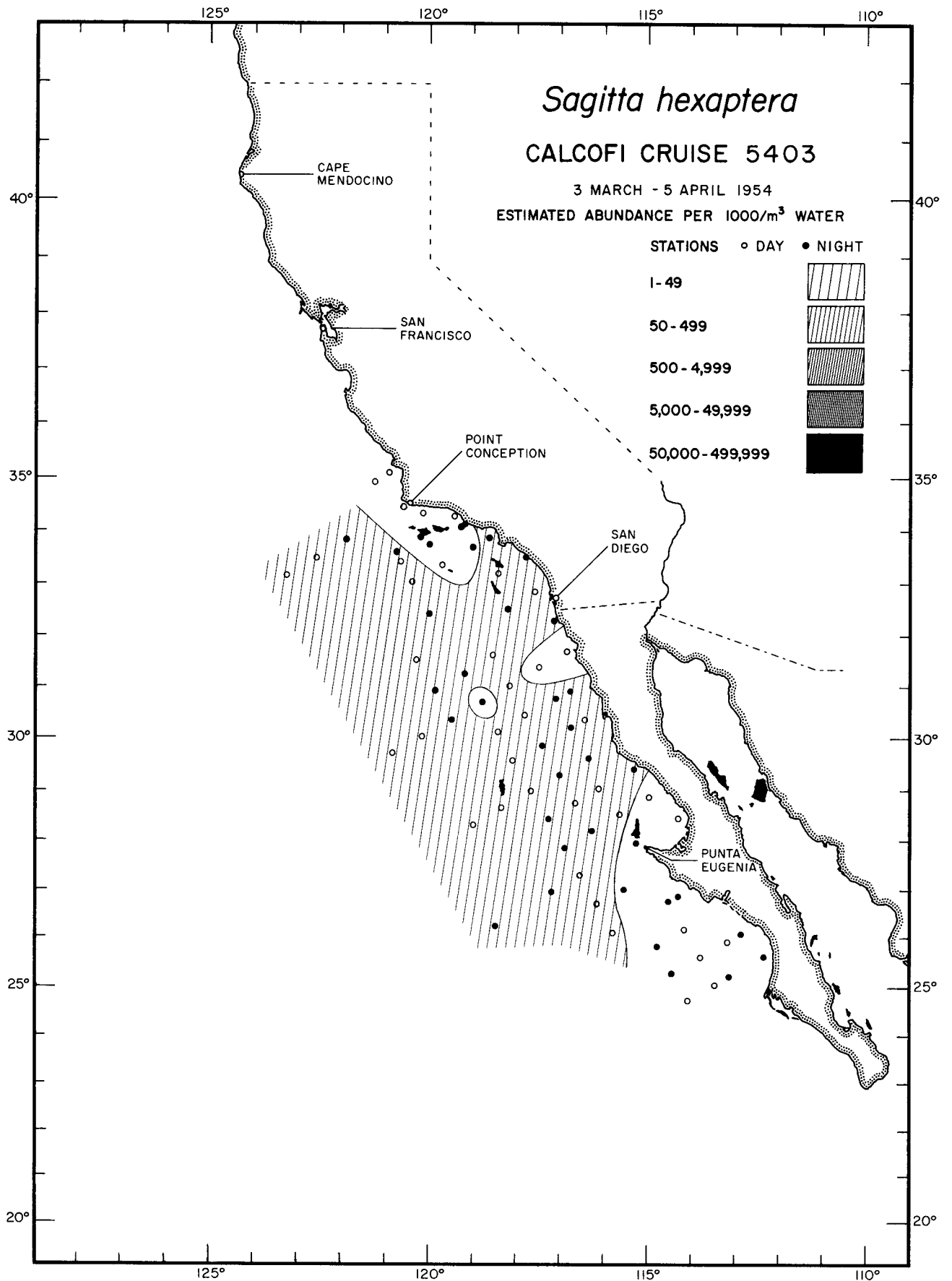
Chaetognatha
Sagitta bipunctata
5403



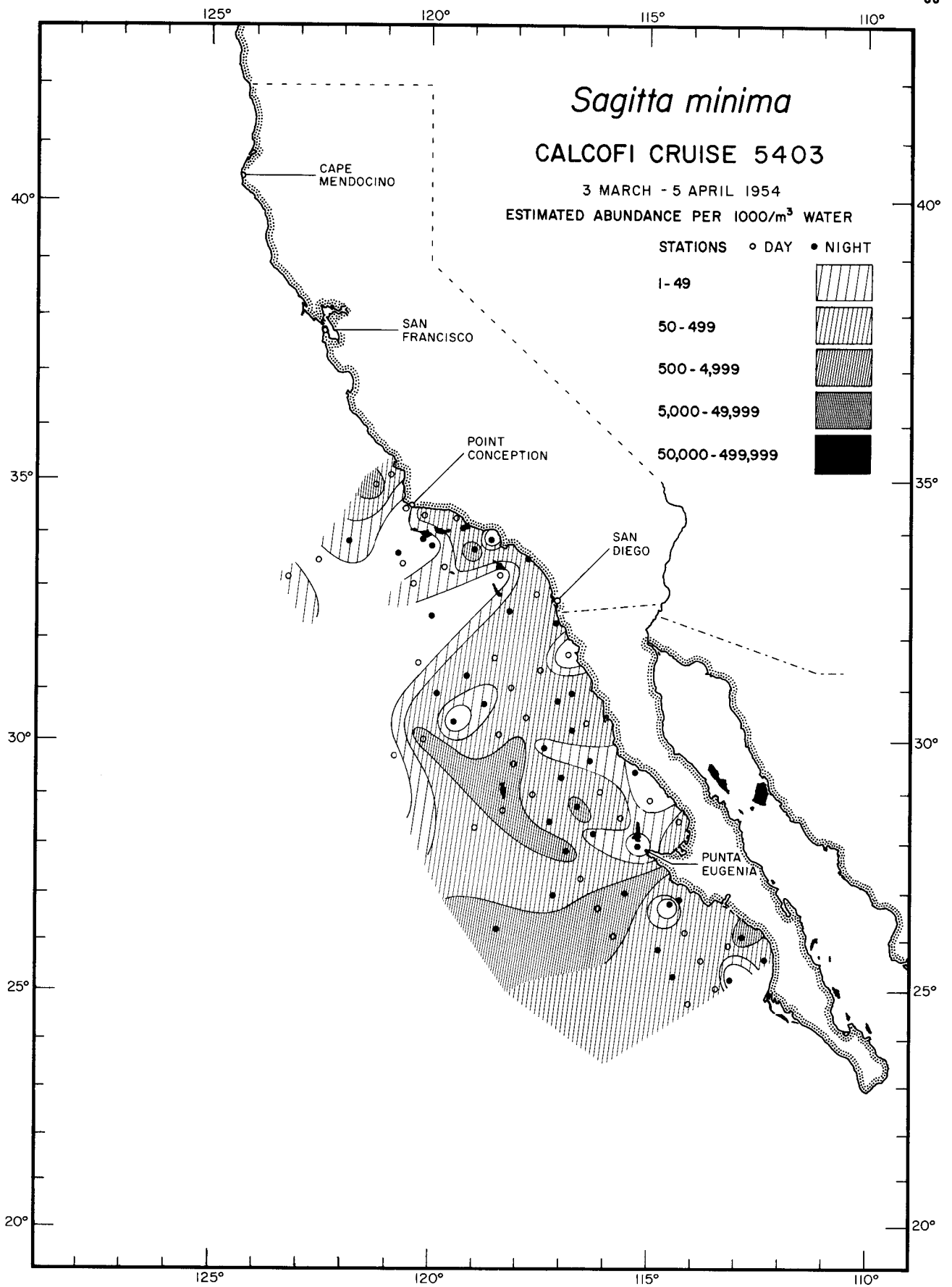
Chaetognatha
Sagitta enflata
5403

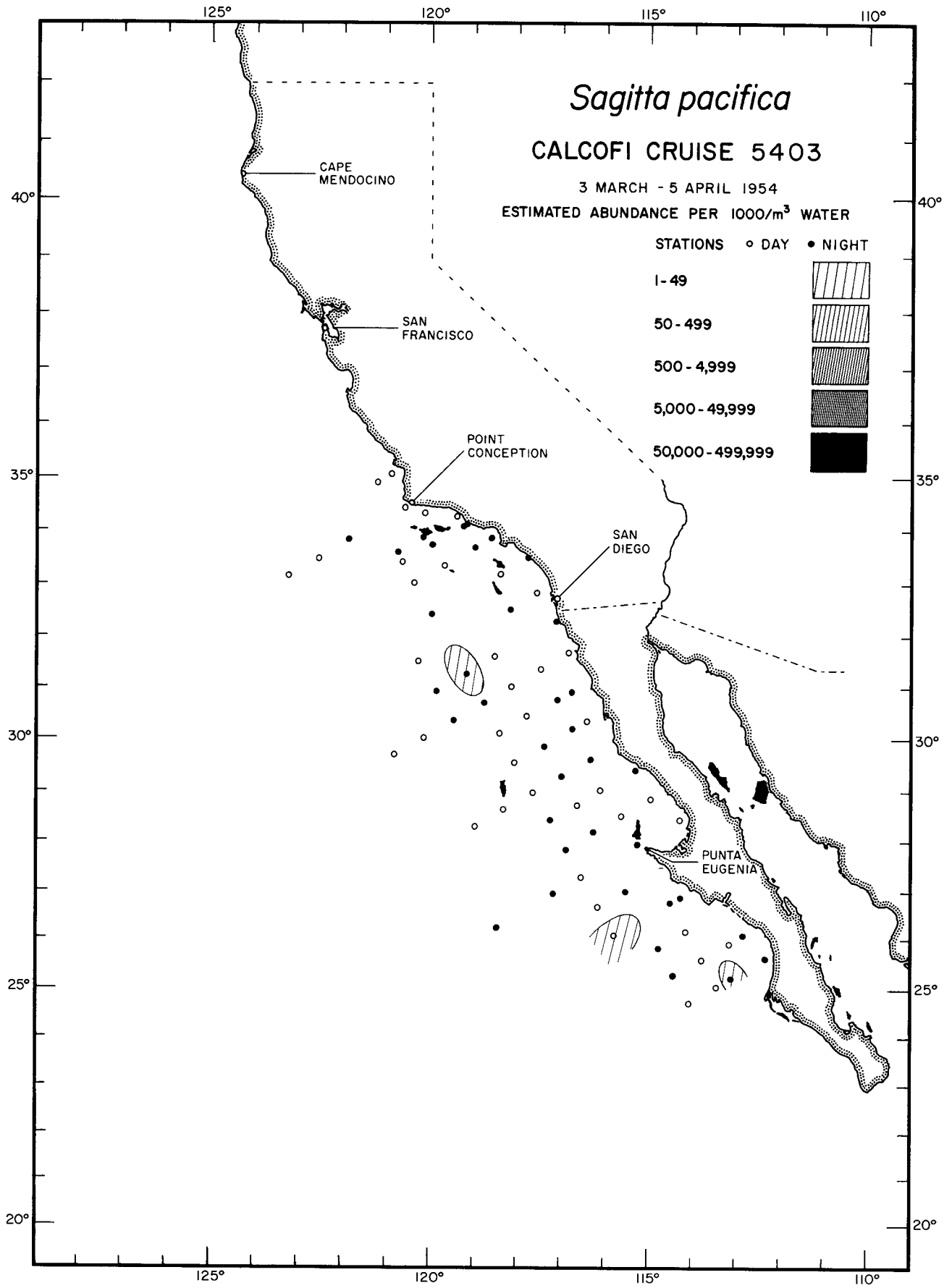


Chaetognatha
Sagitta euneritica
5403

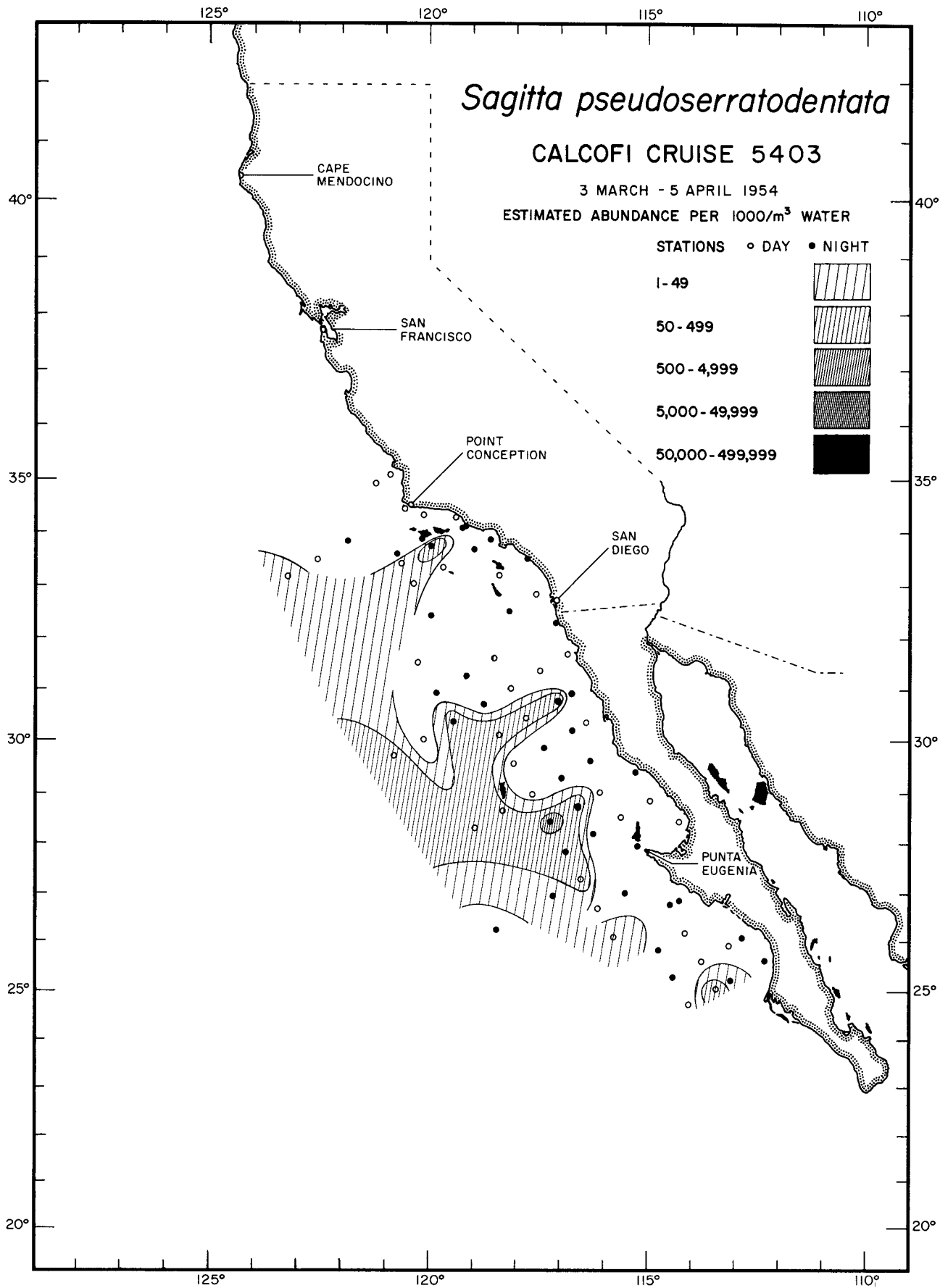


.Chaetognatha
Sagitta hexaptera
5403

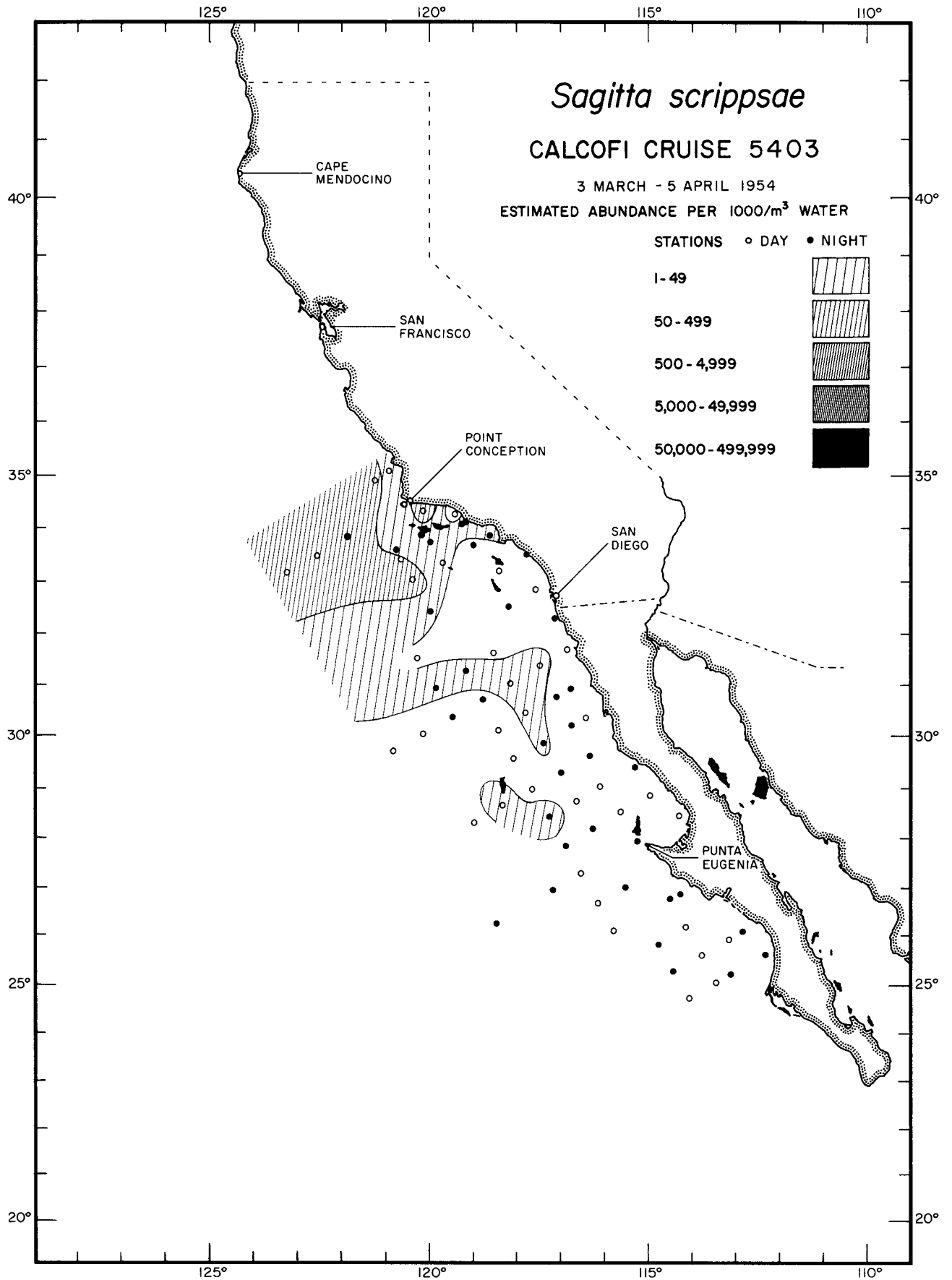




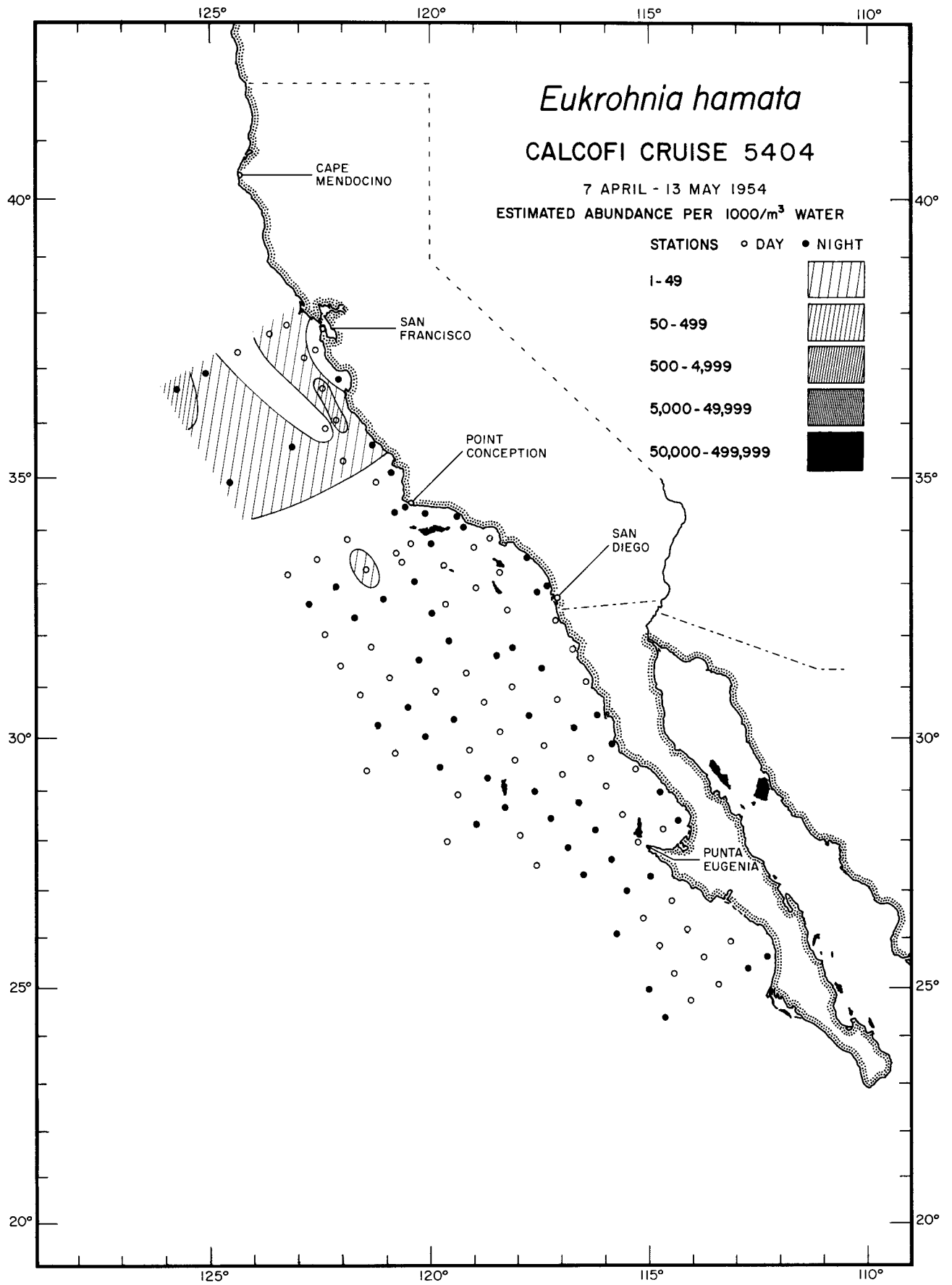
Chaetognatha
Sagitta pacifica
5403



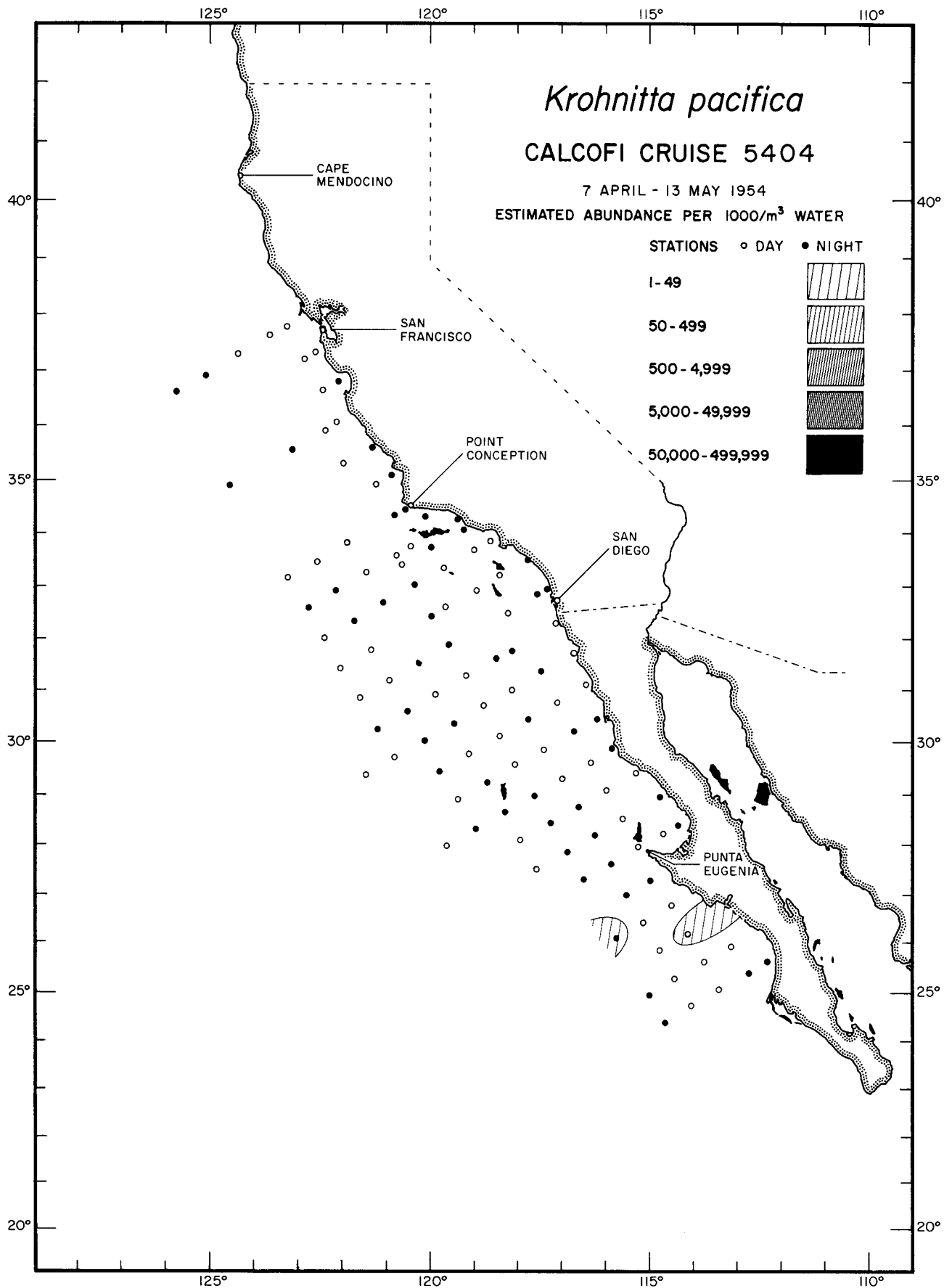
Chaetognatha
Sagitta pseudoserratodentata
 5403



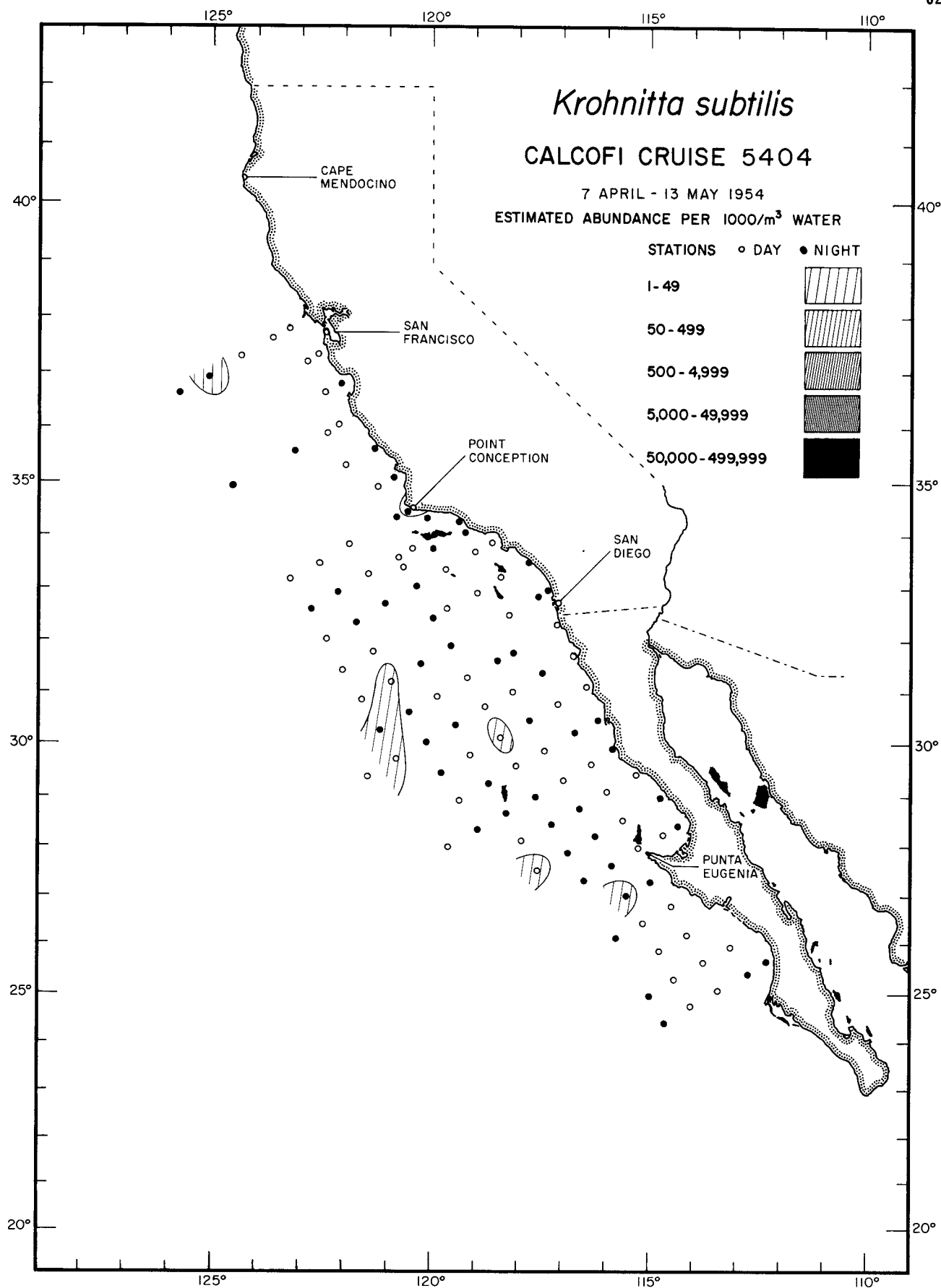
Chaetognatha
Sagitta scrippsae
5403



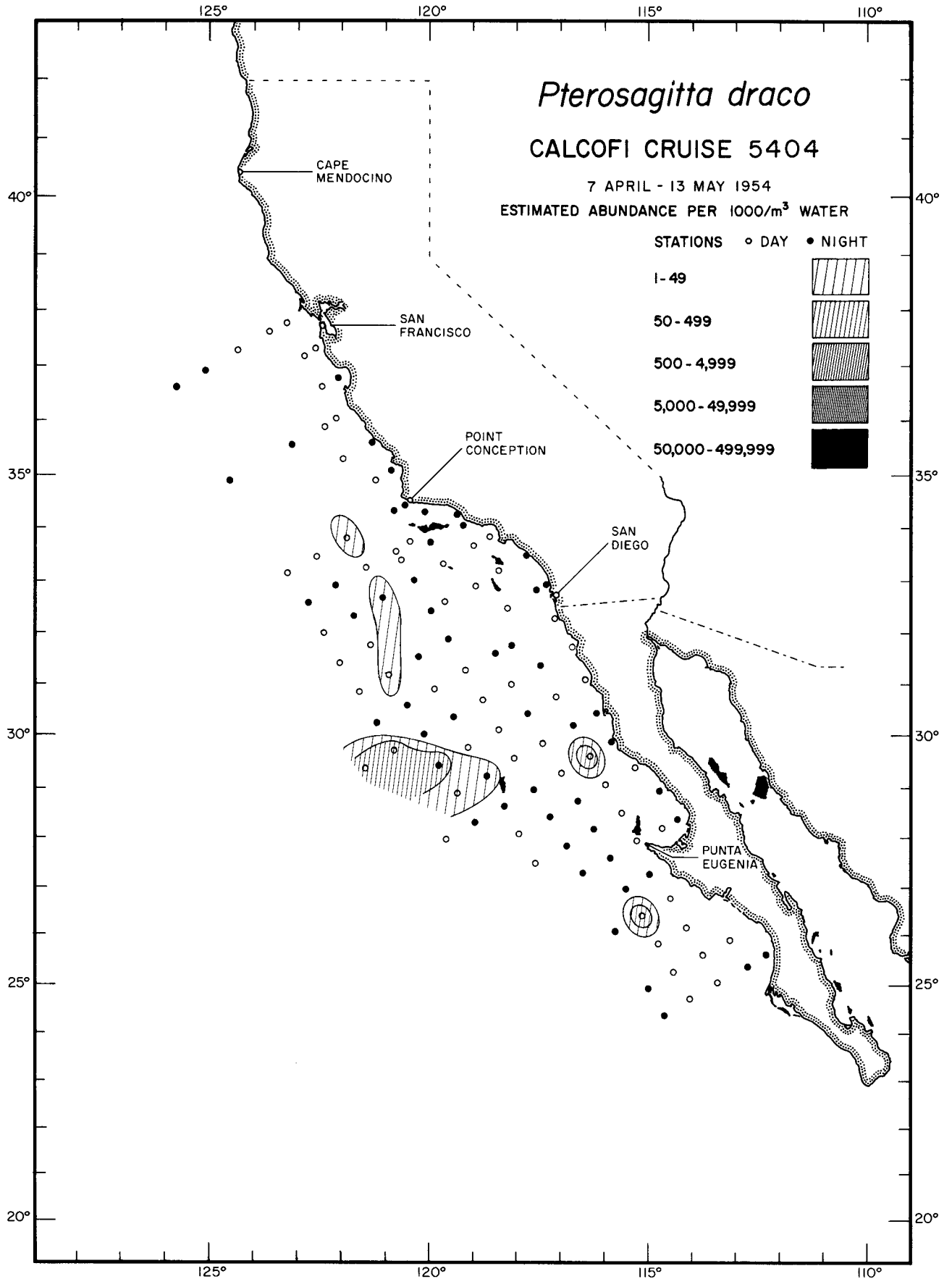
Chaetognatha
Eukrohnia hamata
5404



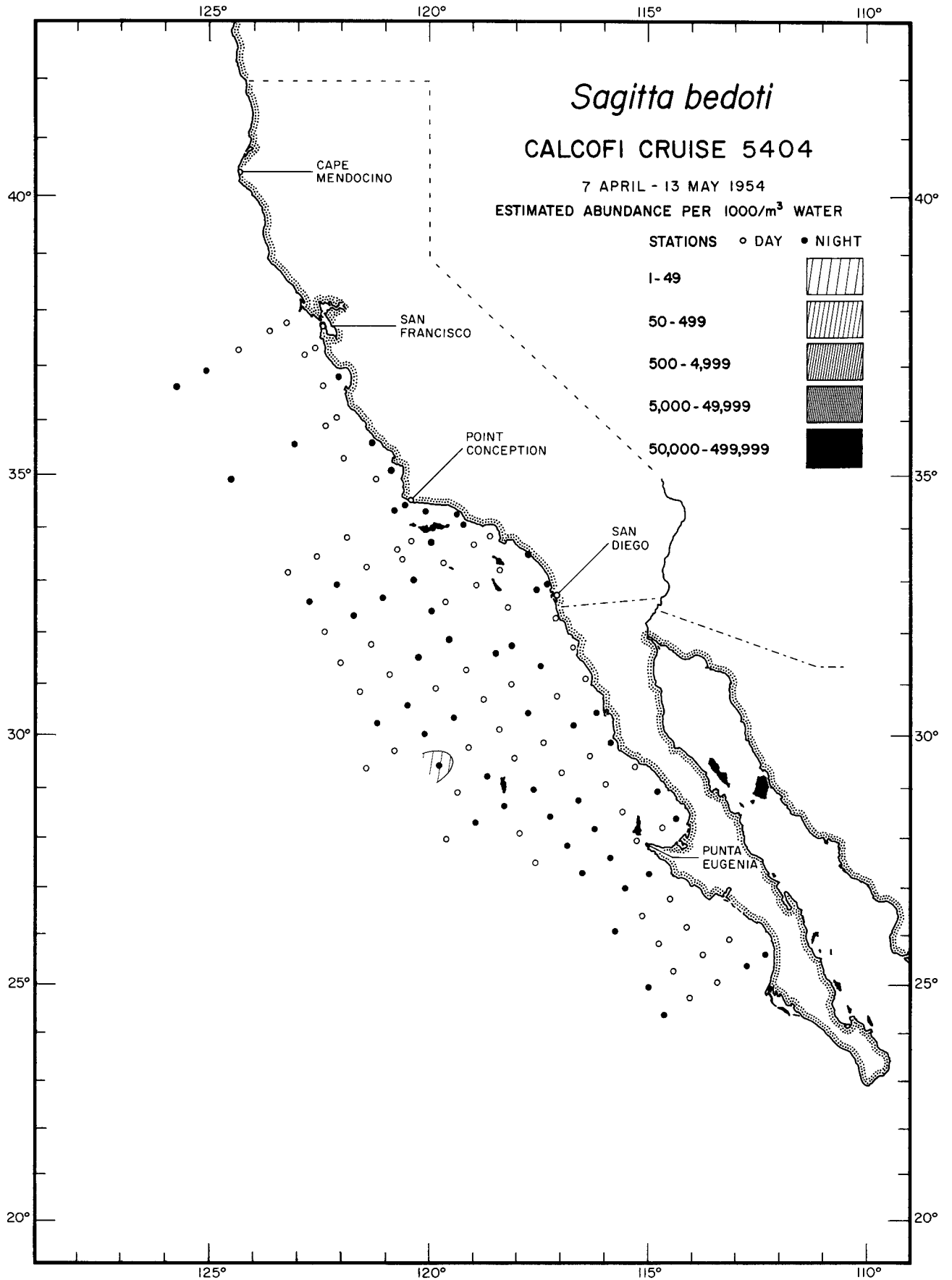
Chaetognatha
Krohnitta pacifica
5404



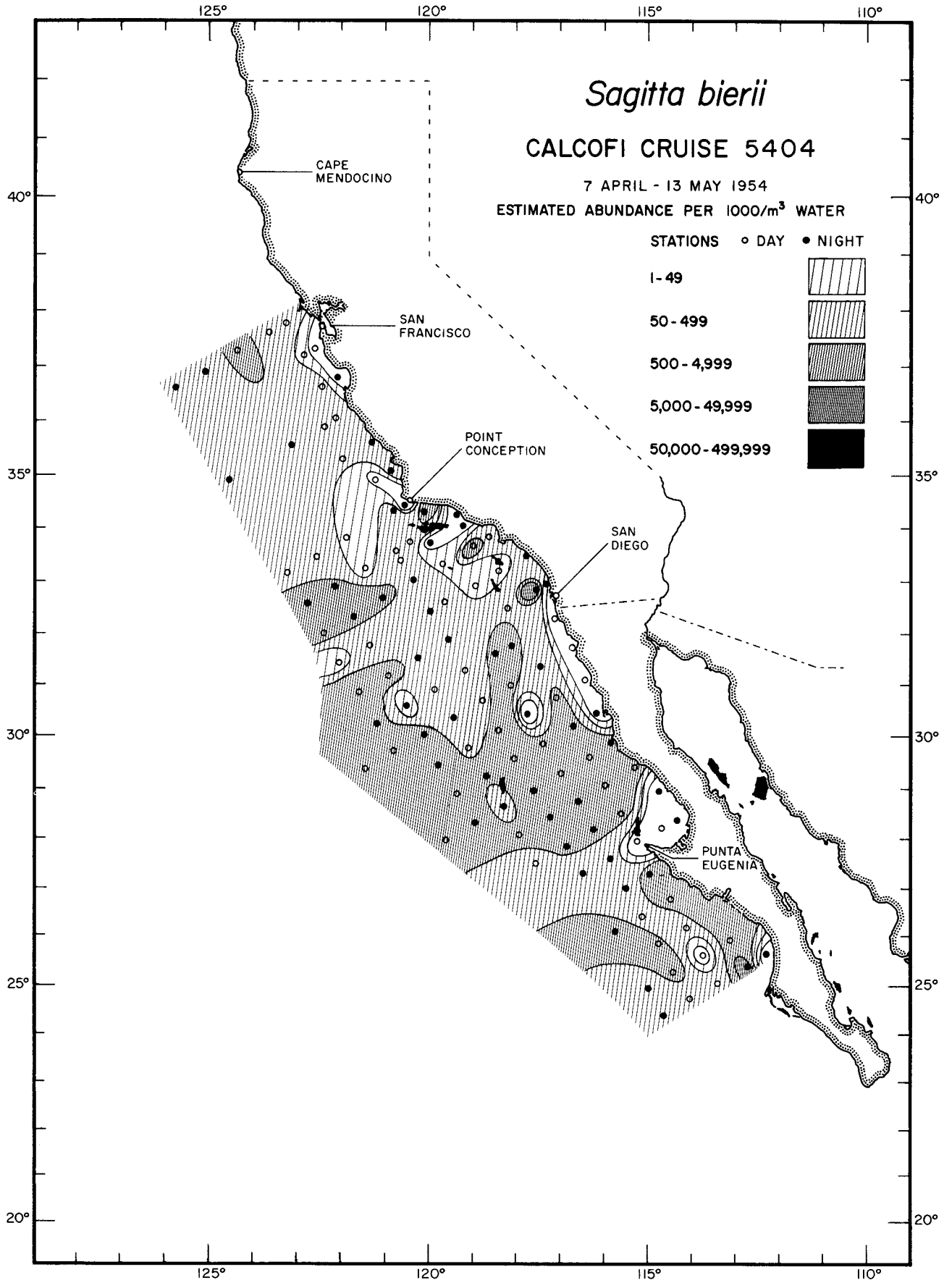
Chaetognatha
Krohnitta subtilis
5404



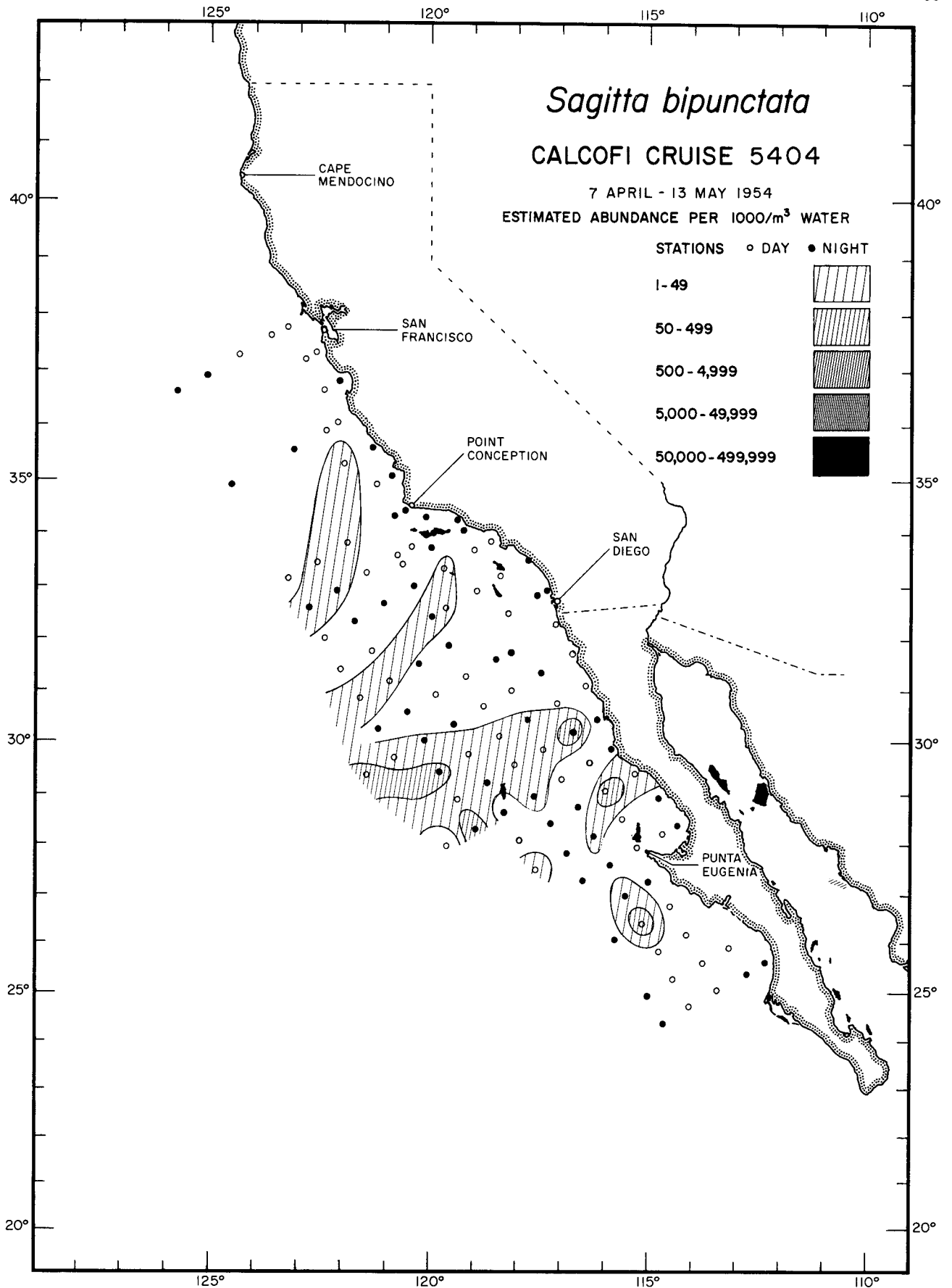
Chaetognatha
Pterosagitta draco
5404



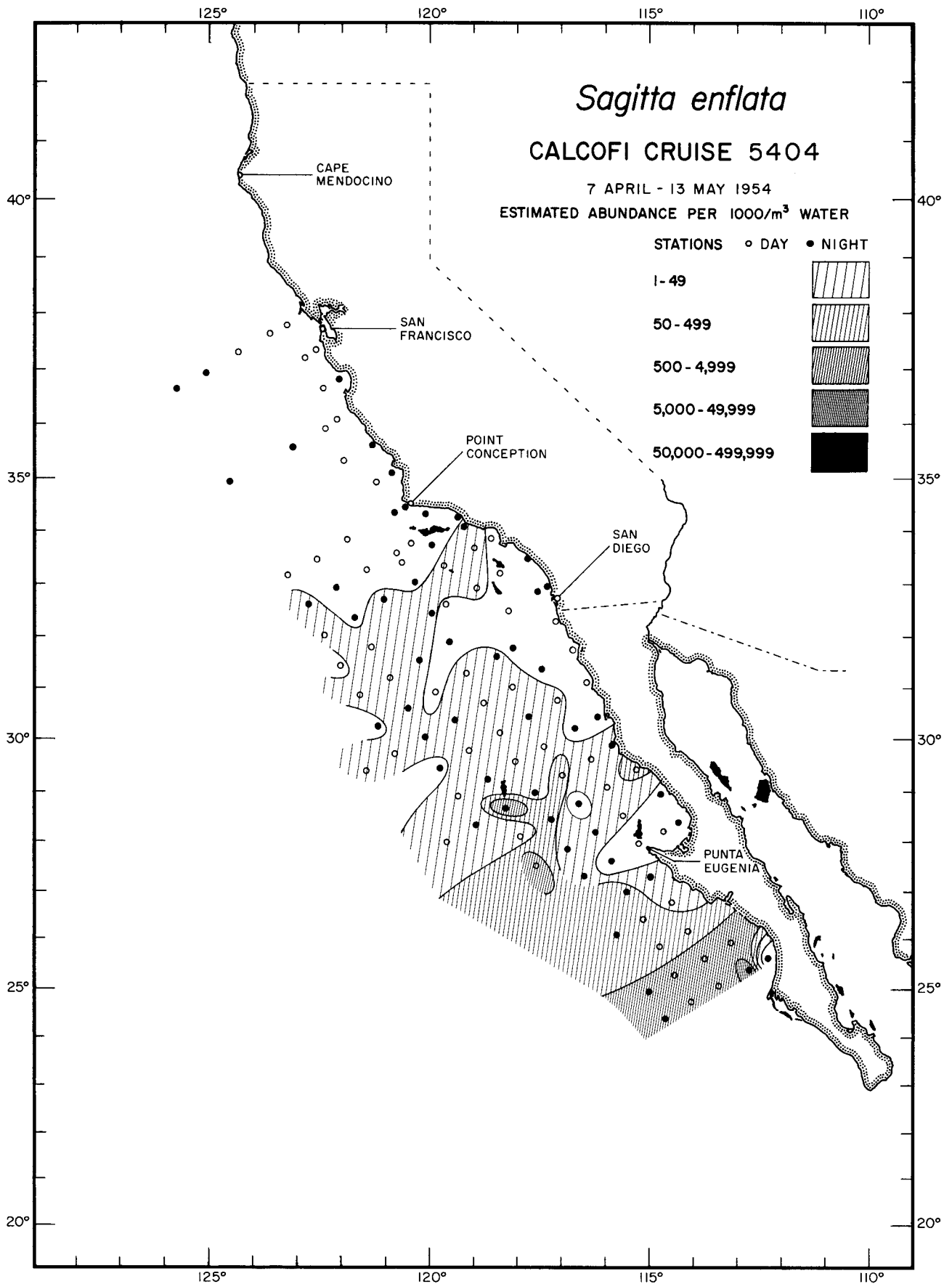
Chaetognatha
Sagitta bedoti
5404



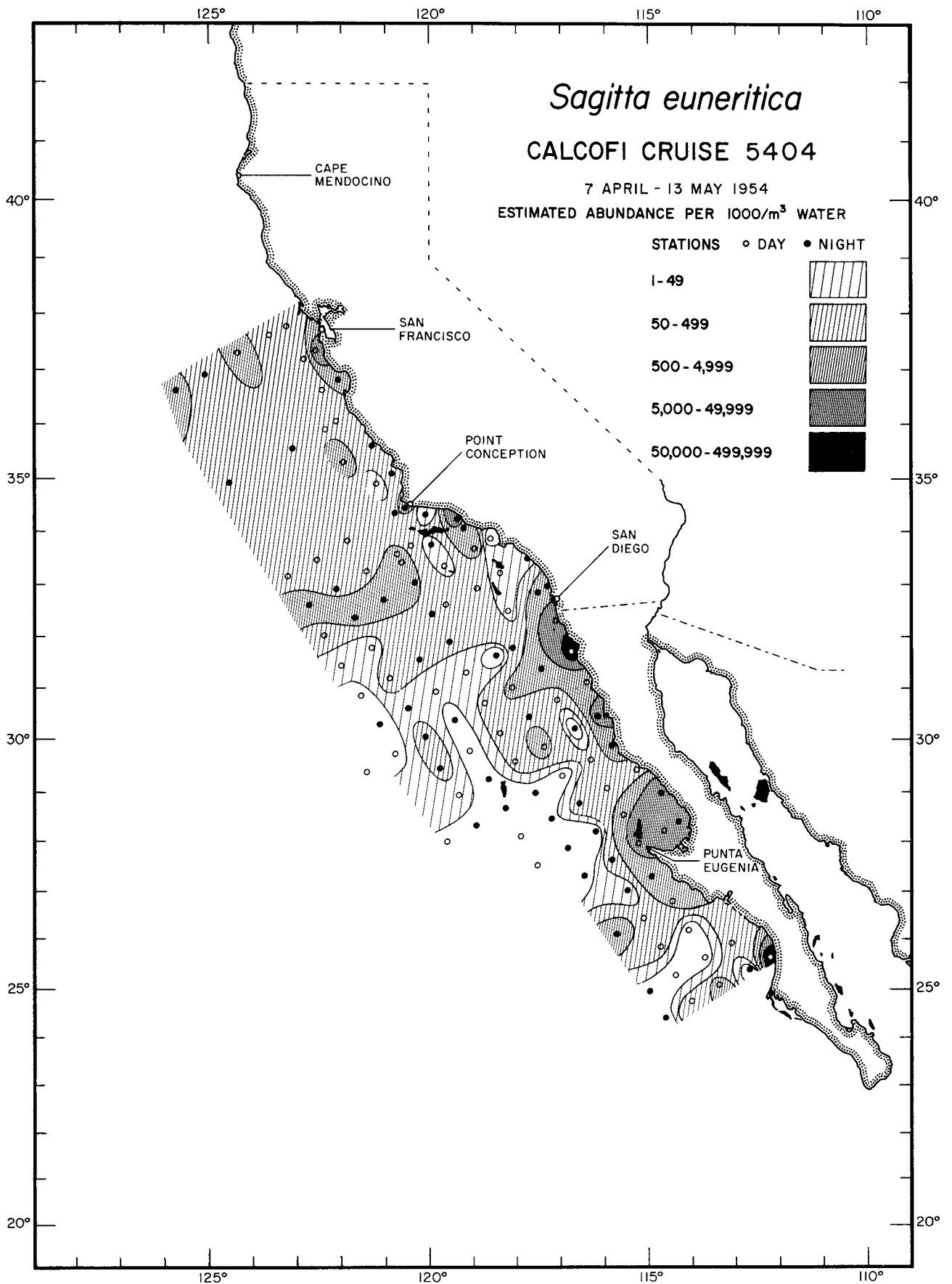
Chaetognatha
Sagitta bierii
5404

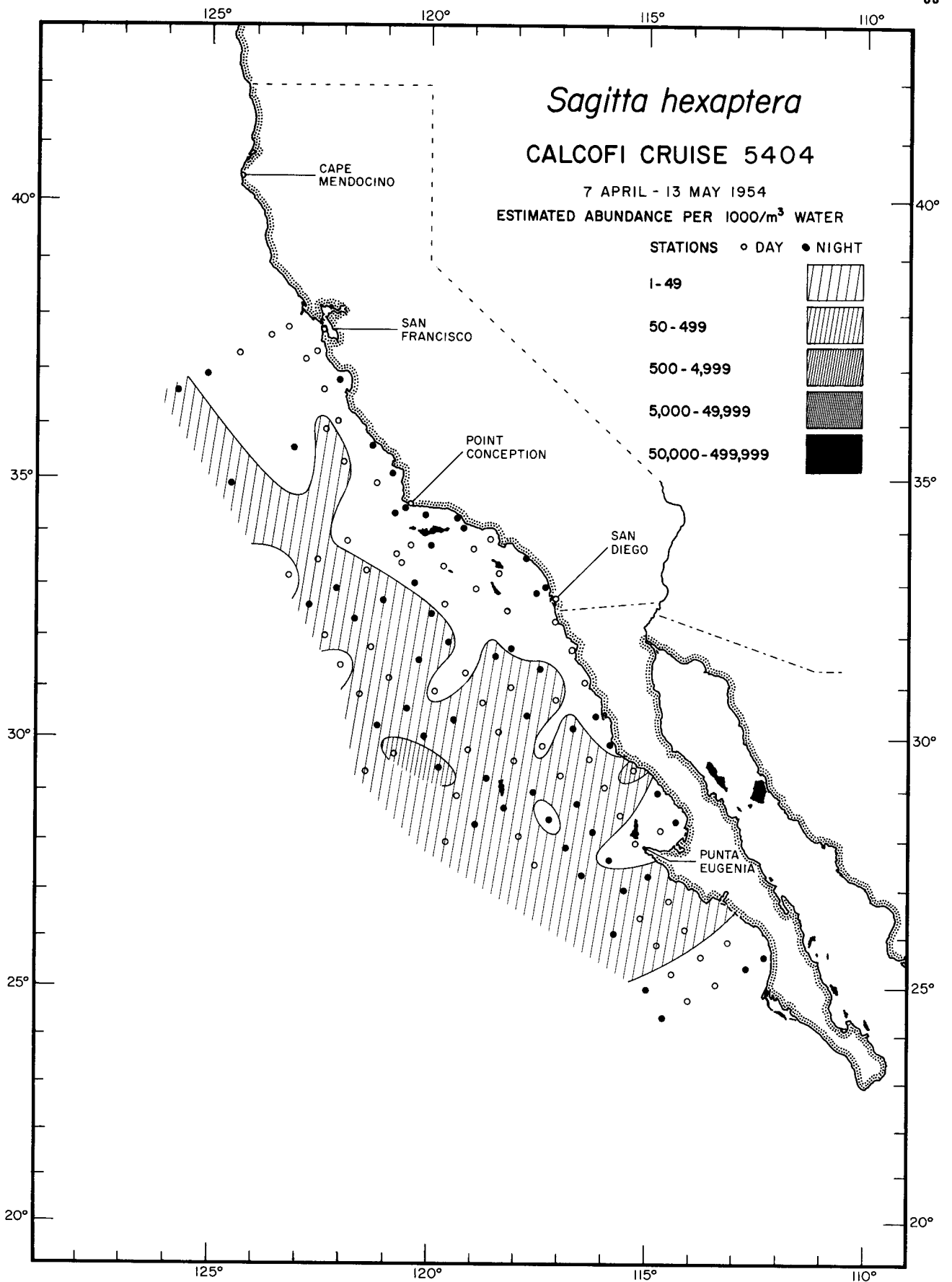


Chaetognatha
Sagitta bipunctata
5404

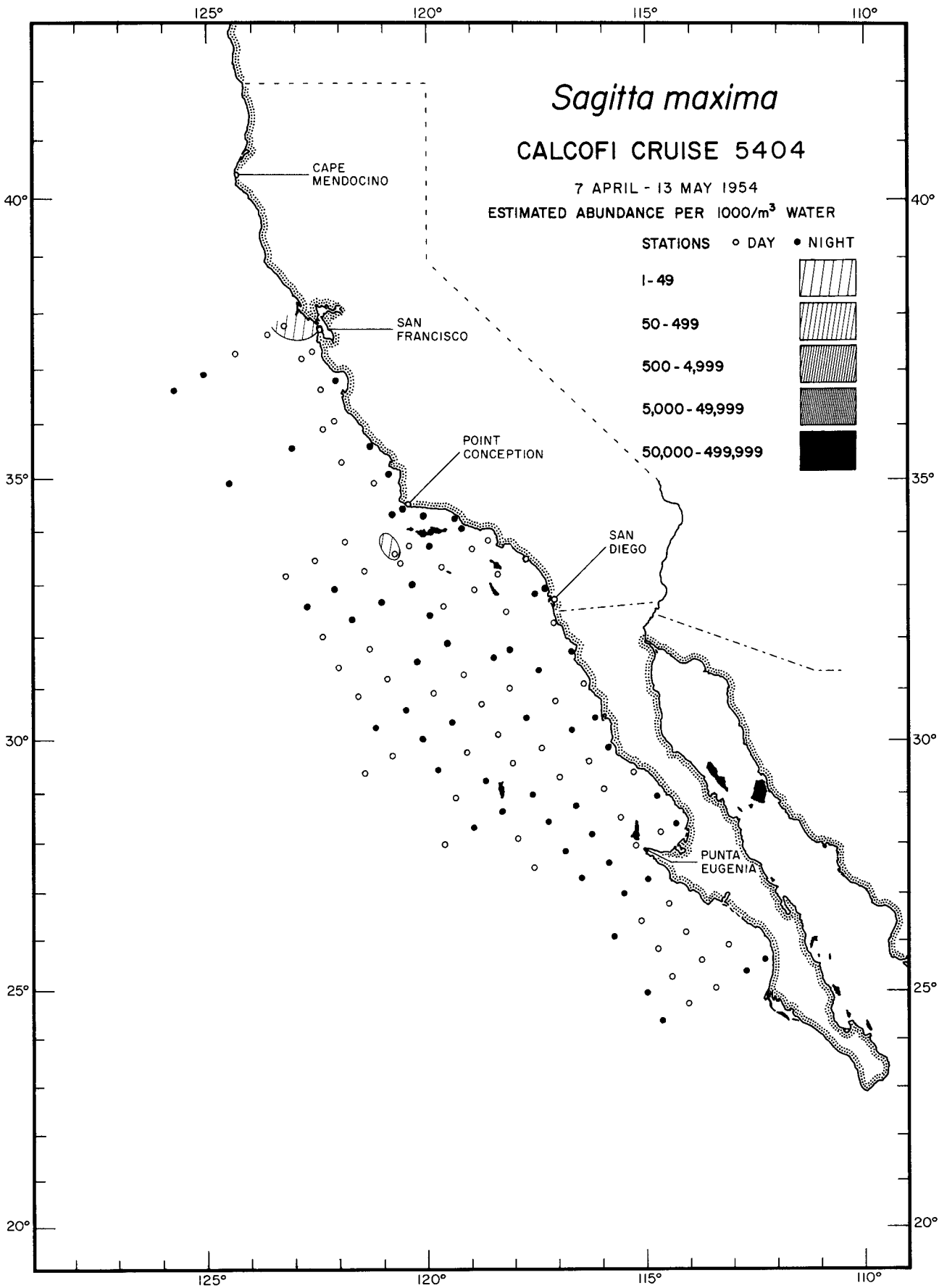


Chaetognatha
Sagitta enflata
5404

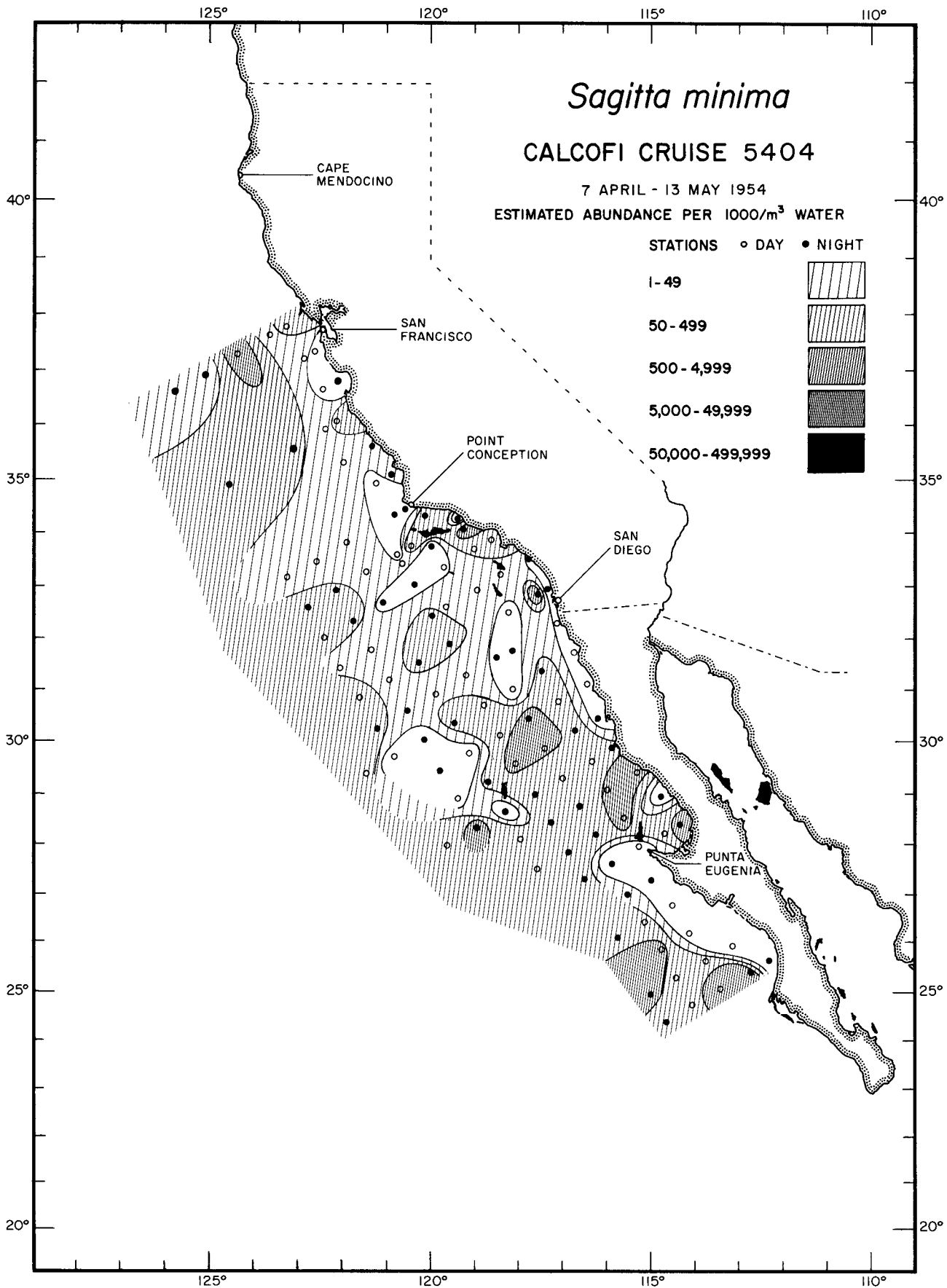




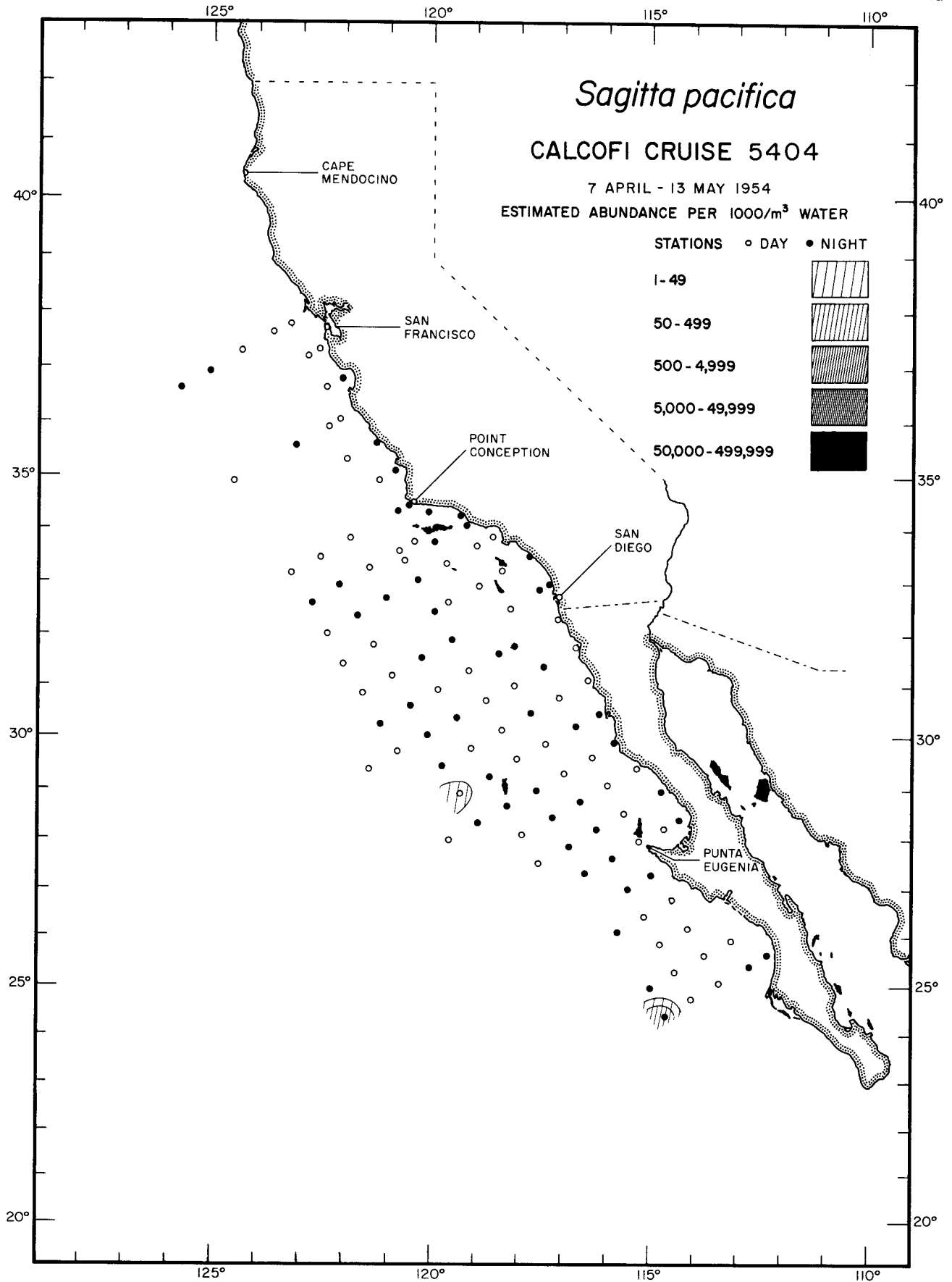
Chaetognatha
Sagitta hexaptera
5404



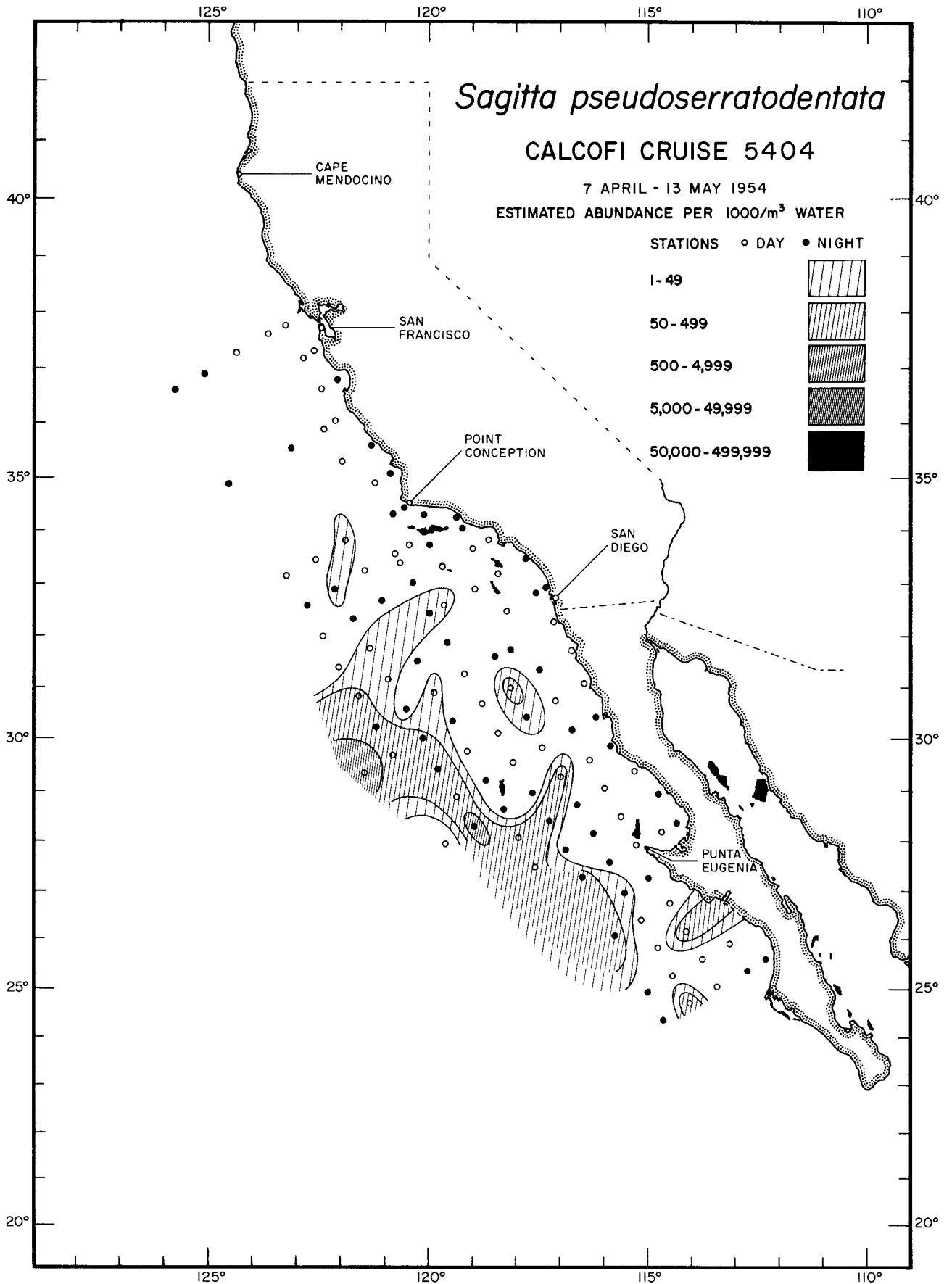
Chaetognatha
Sagitta maxima
5404



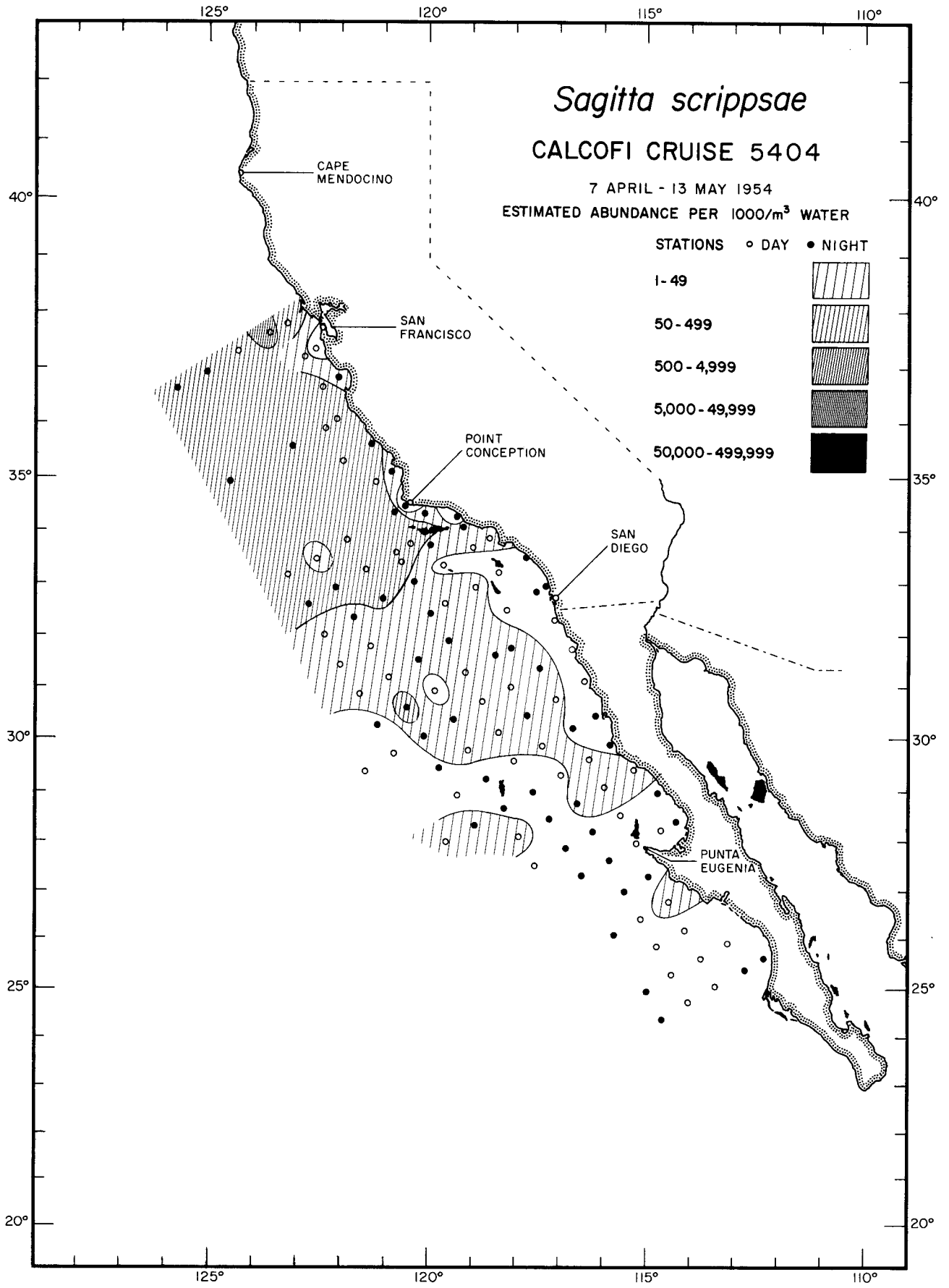
Chaetognatha
Sagitta minima
5404



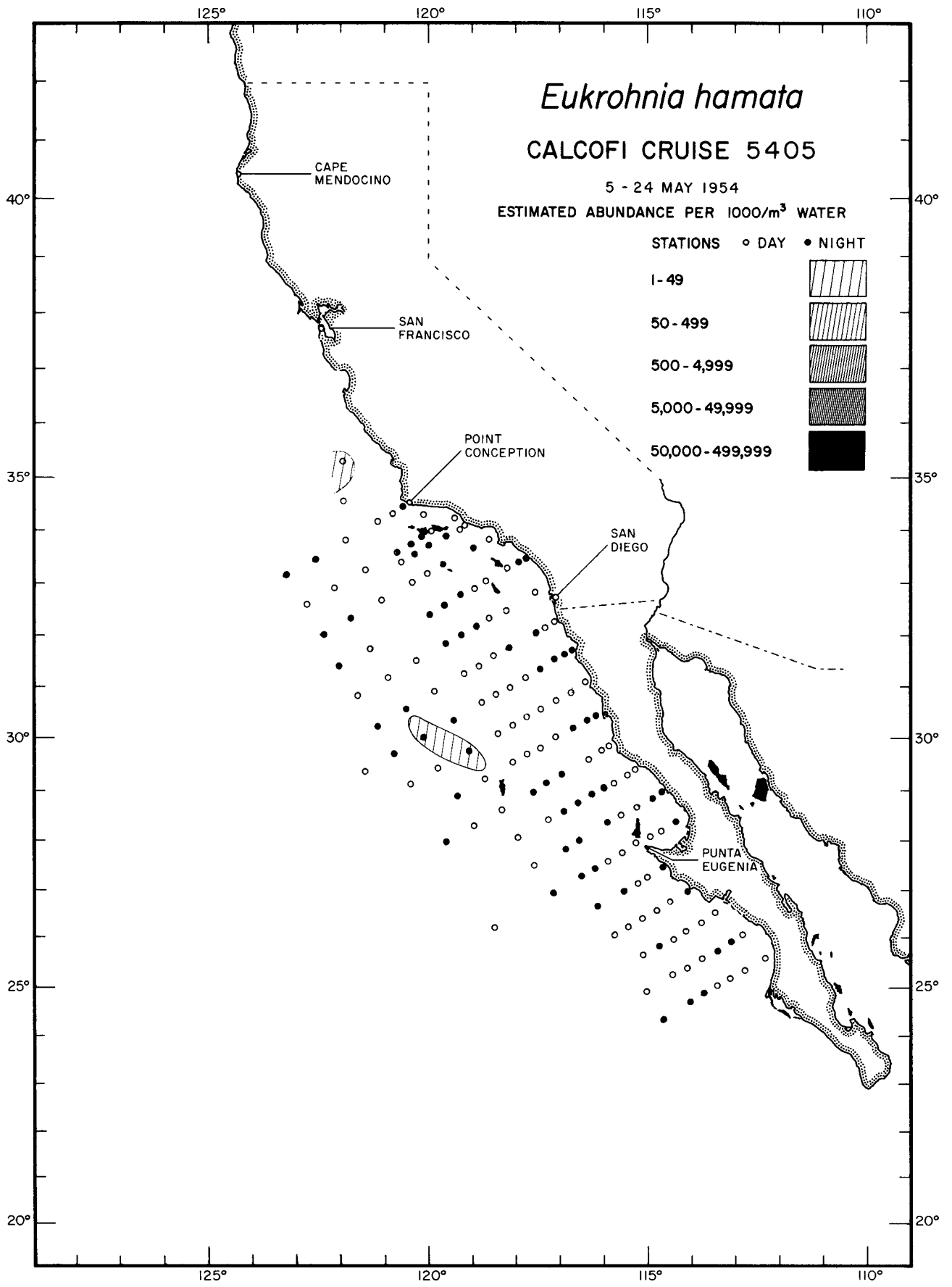
Chaetognatha
Sagitta pacifica
5404



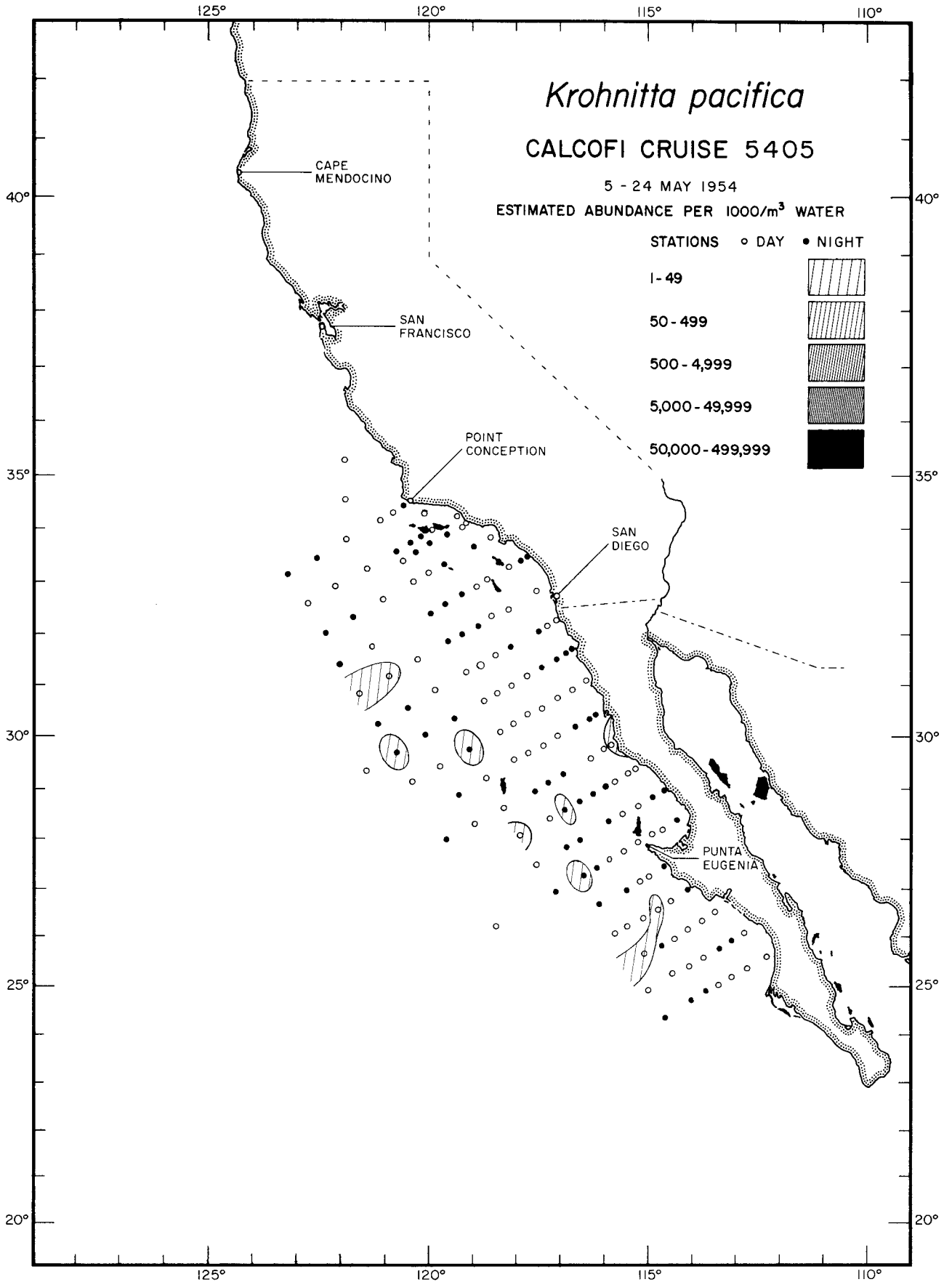
Chaetognatha
Sagitta pseudoserratodentata
5404



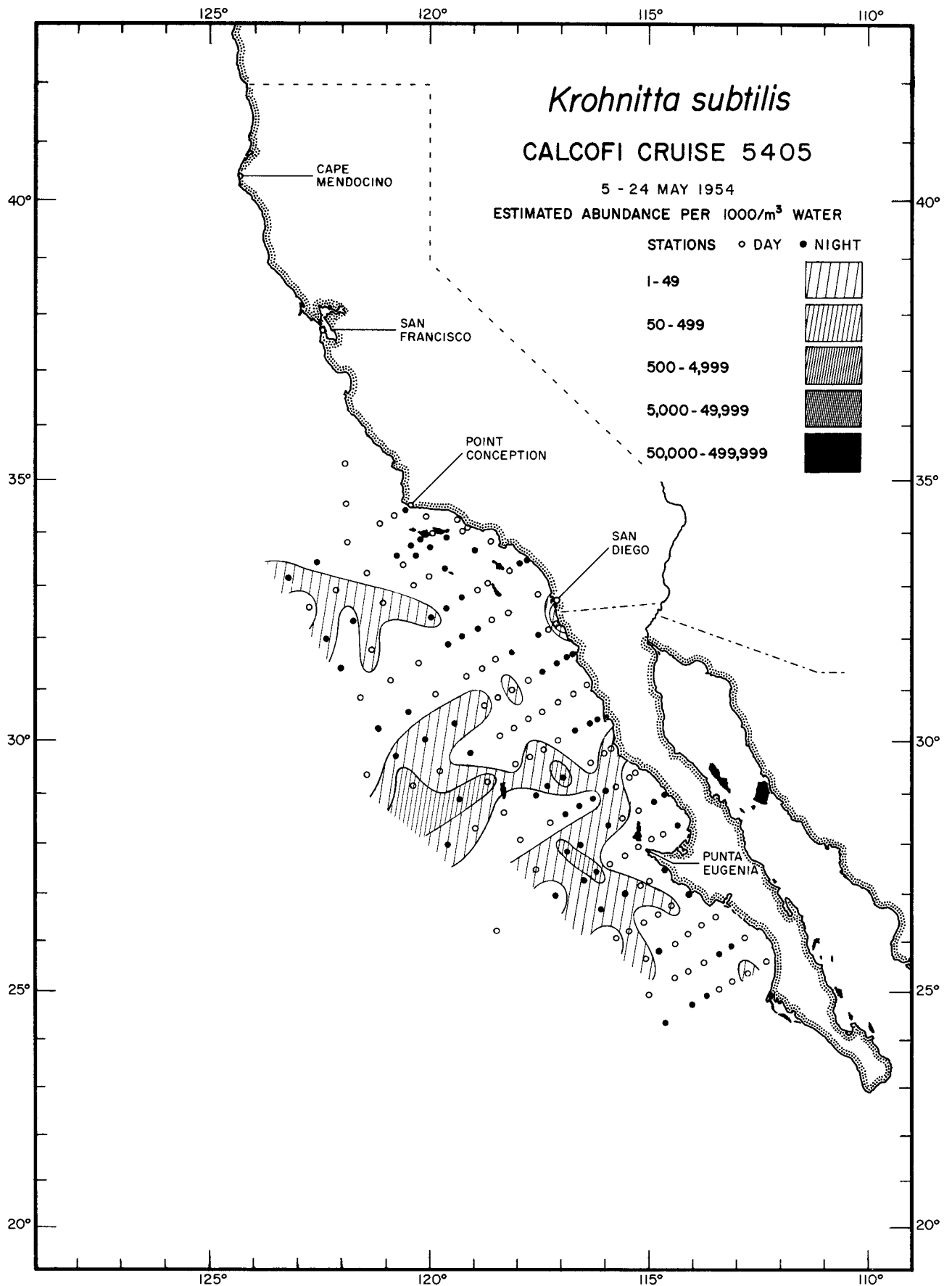
Chaetognatha
Sagitta scrippsae
5404



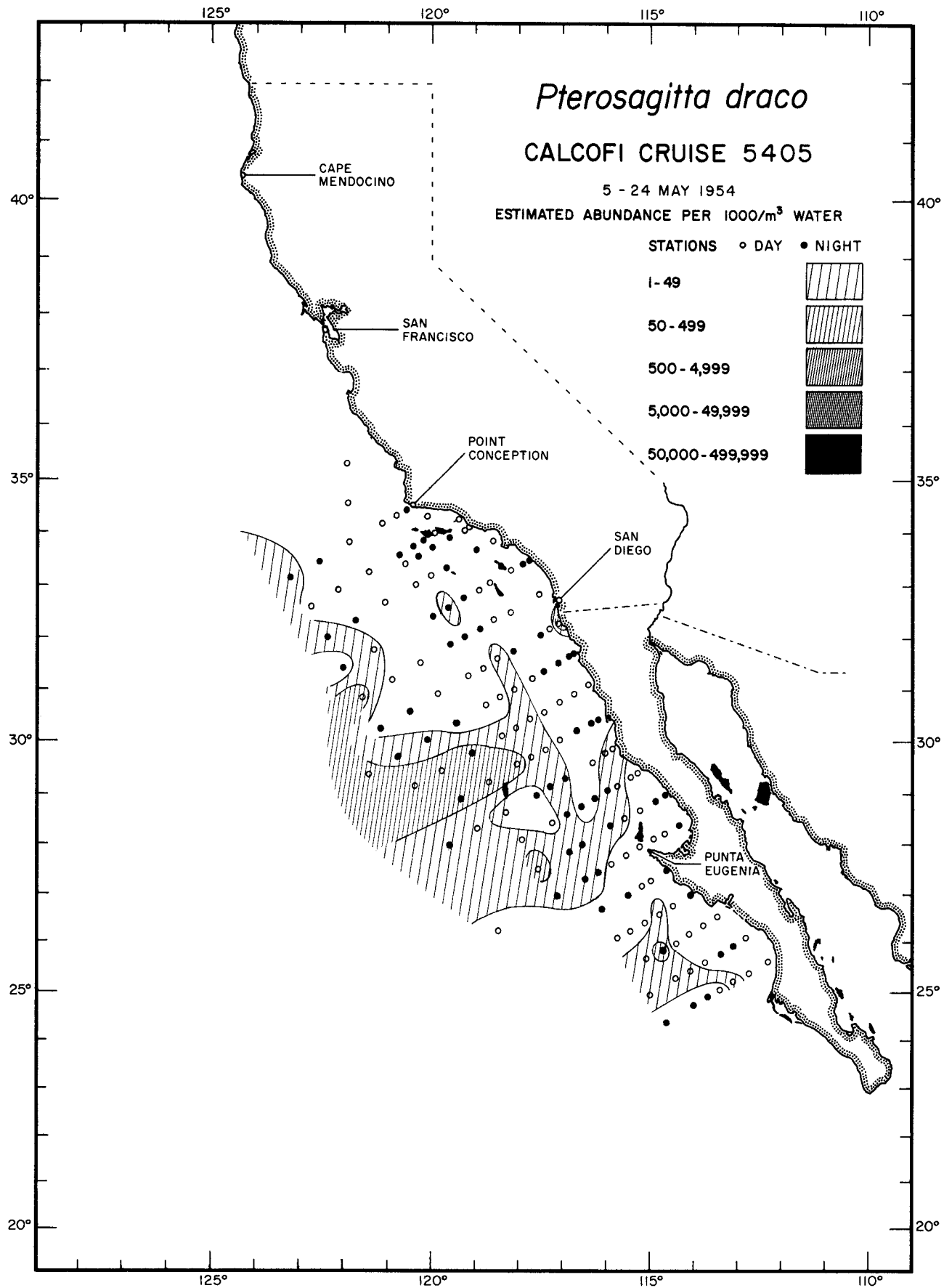
Chaetognatha
Eukrohnia hamata
5405



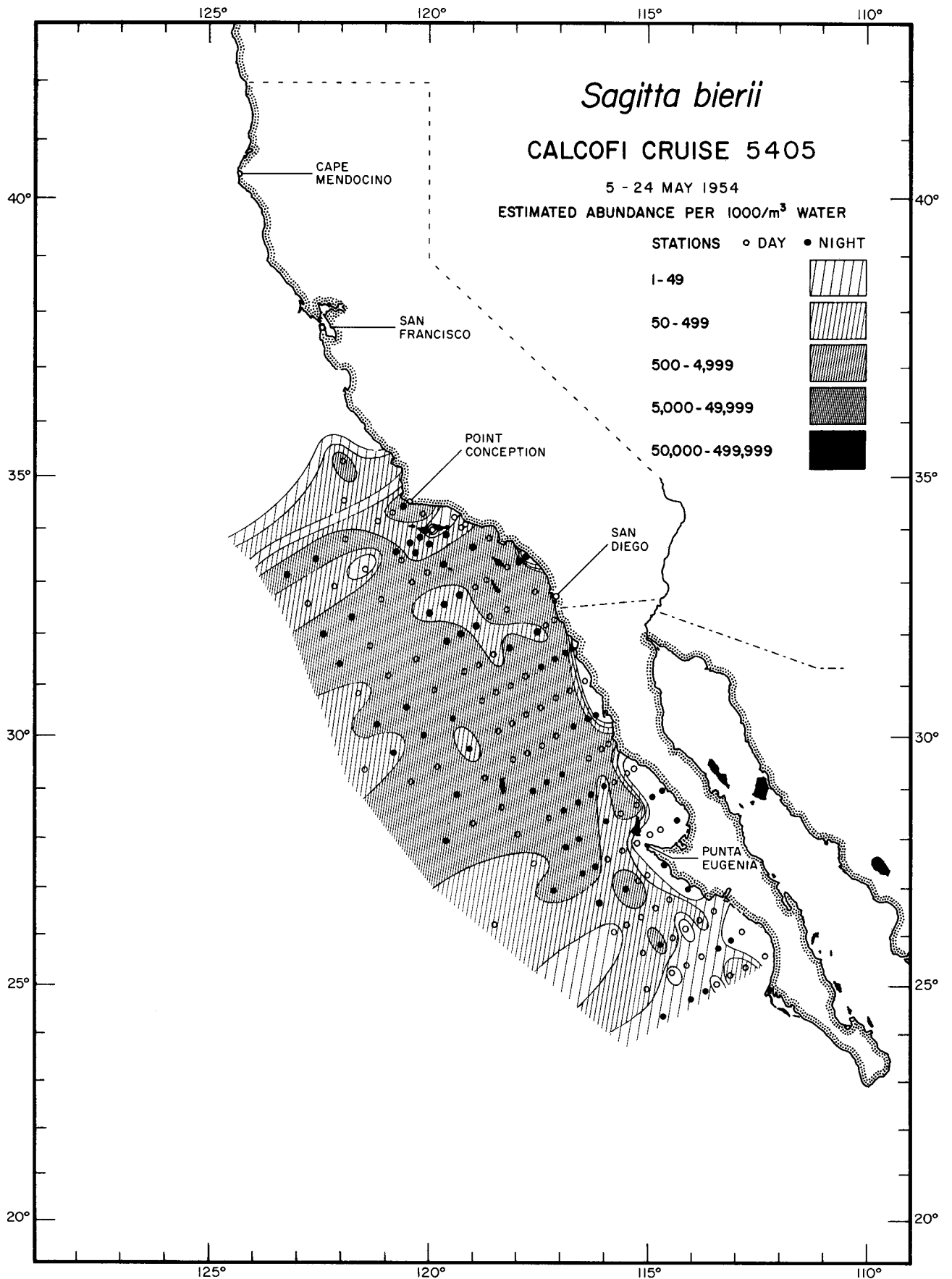
Chaetognatha
Krohnitta pacifica
5405

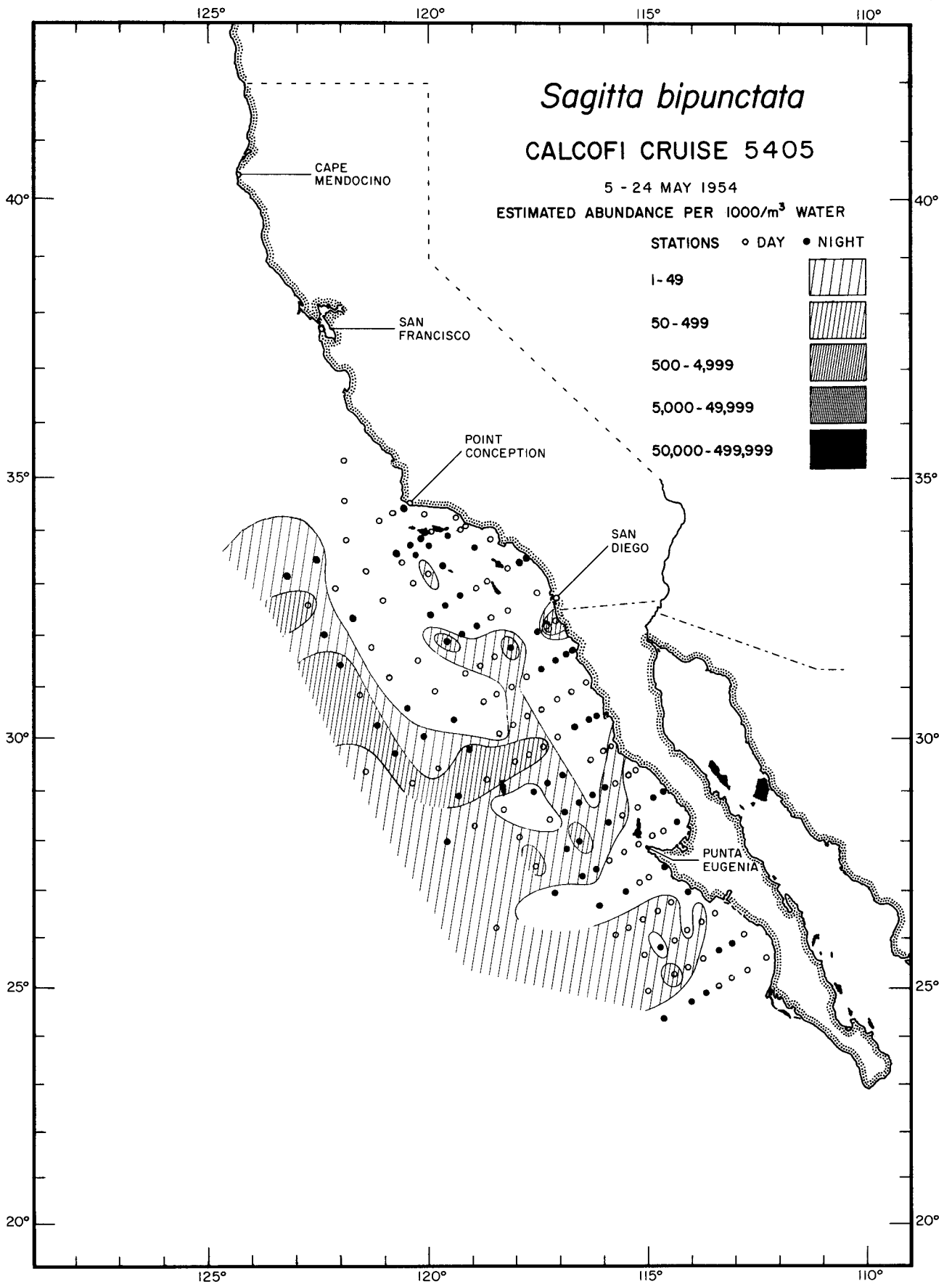


Chaetognatha
Krohnitta subtilis
5405



Chaetognatha
Pterosagitta draco
5405





Sagitta bipunctata

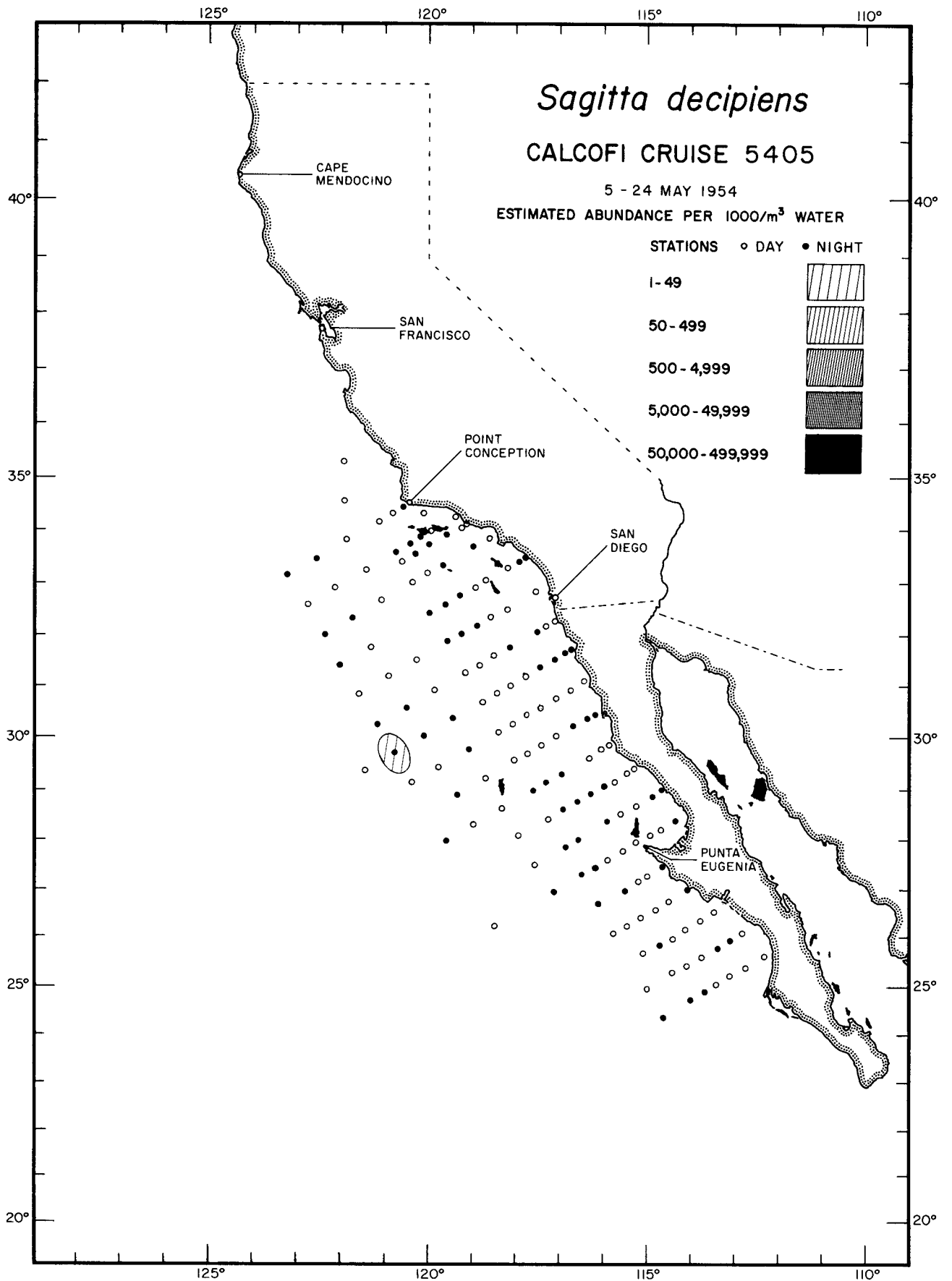
CALCOFI CRUISE 5405

5 - 24 MAY 1954

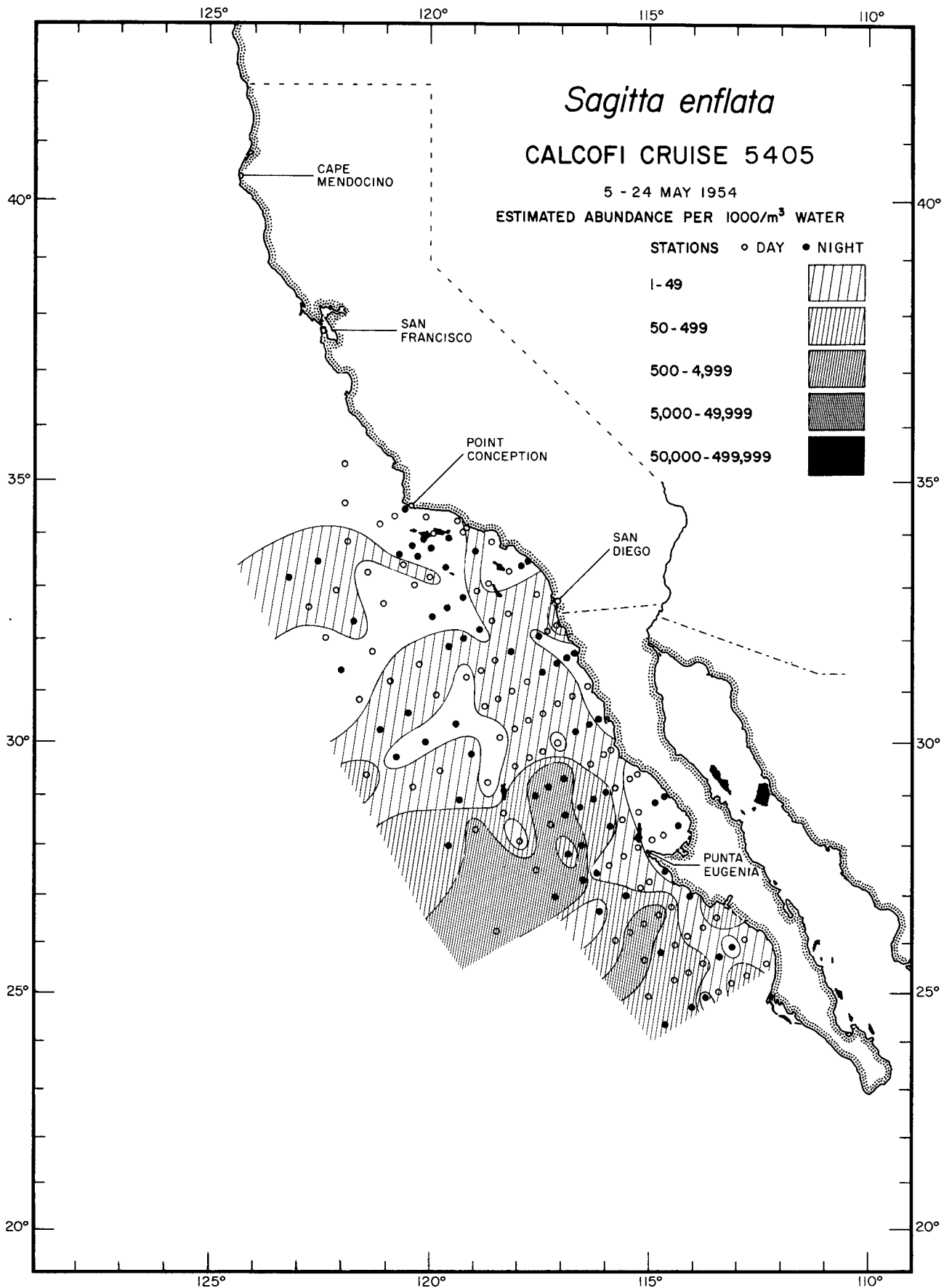
ESTIMATED ABUNDANCE PER 1000/m³ WATER

STATIONS ○ DAY ● NIGHT

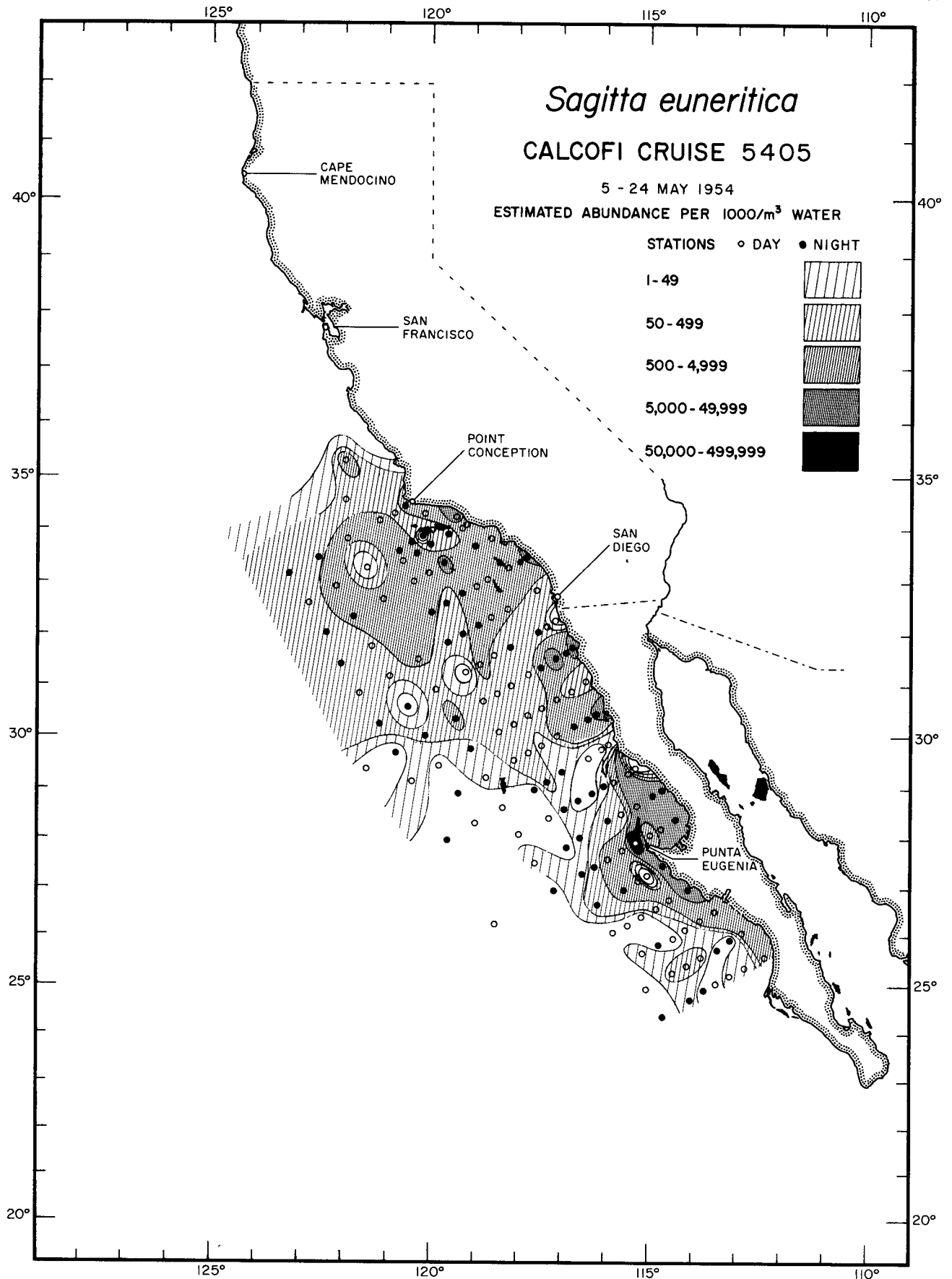
1 - 49	[Horizontal lines]
50 - 499	[Diagonal lines]
500 - 4,999	[Vertical lines]
5,000 - 49,999	[Cross-hatch]
50,000 - 499,999	[Solid black]



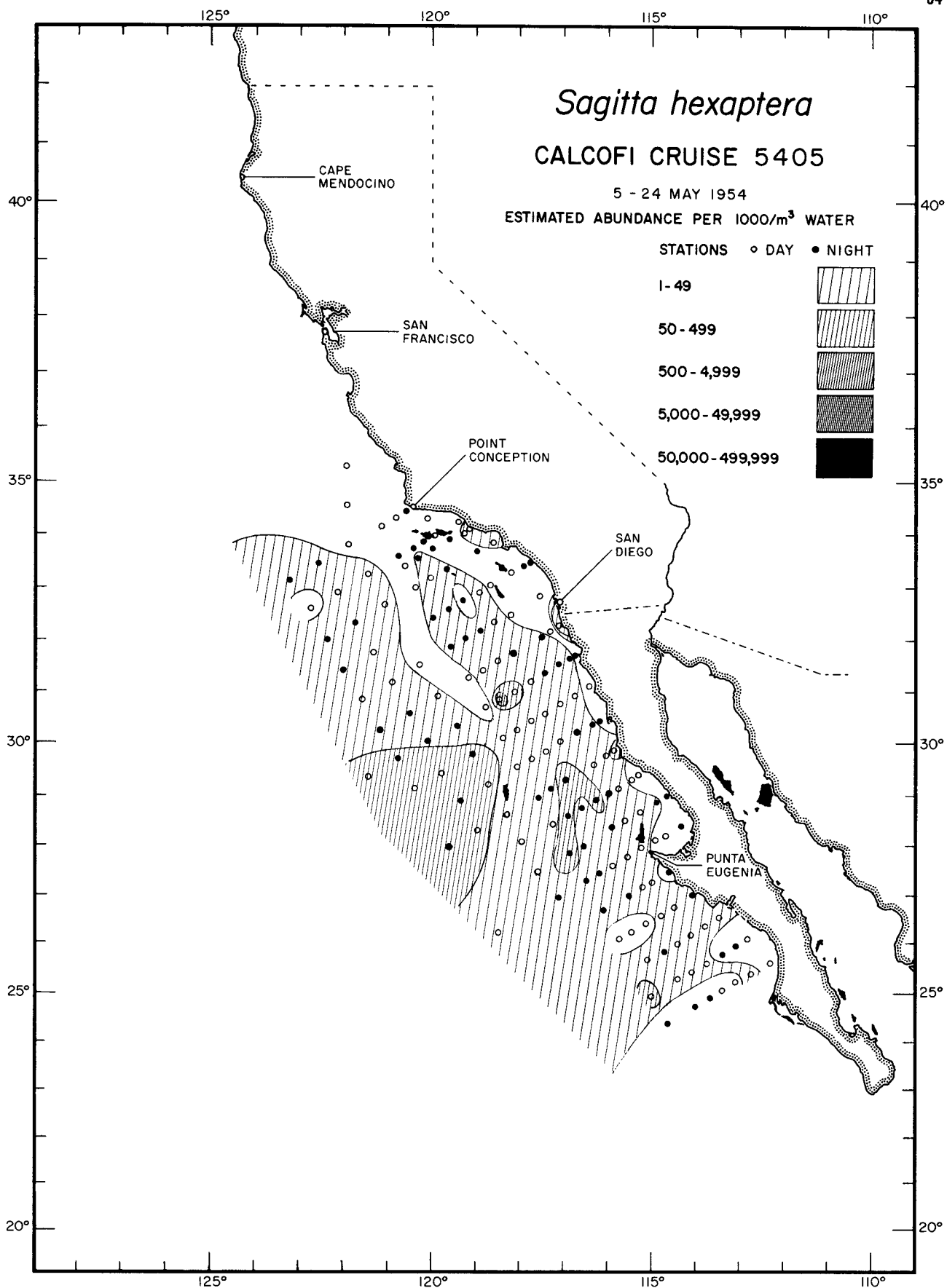
Chaetognatha
Sagitta decipiens
5405

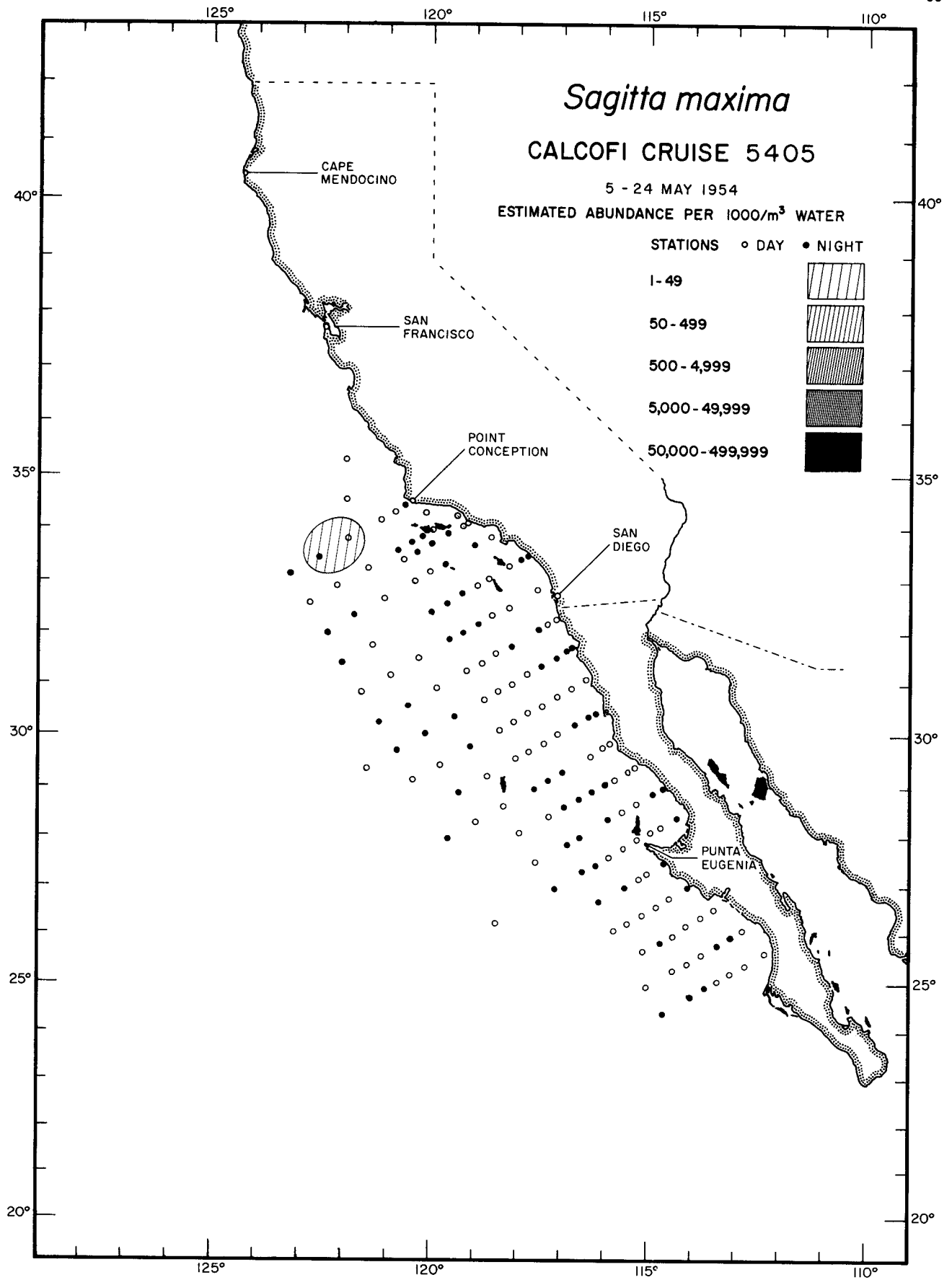


Chaetognatha
Sagitta enflata
 5405

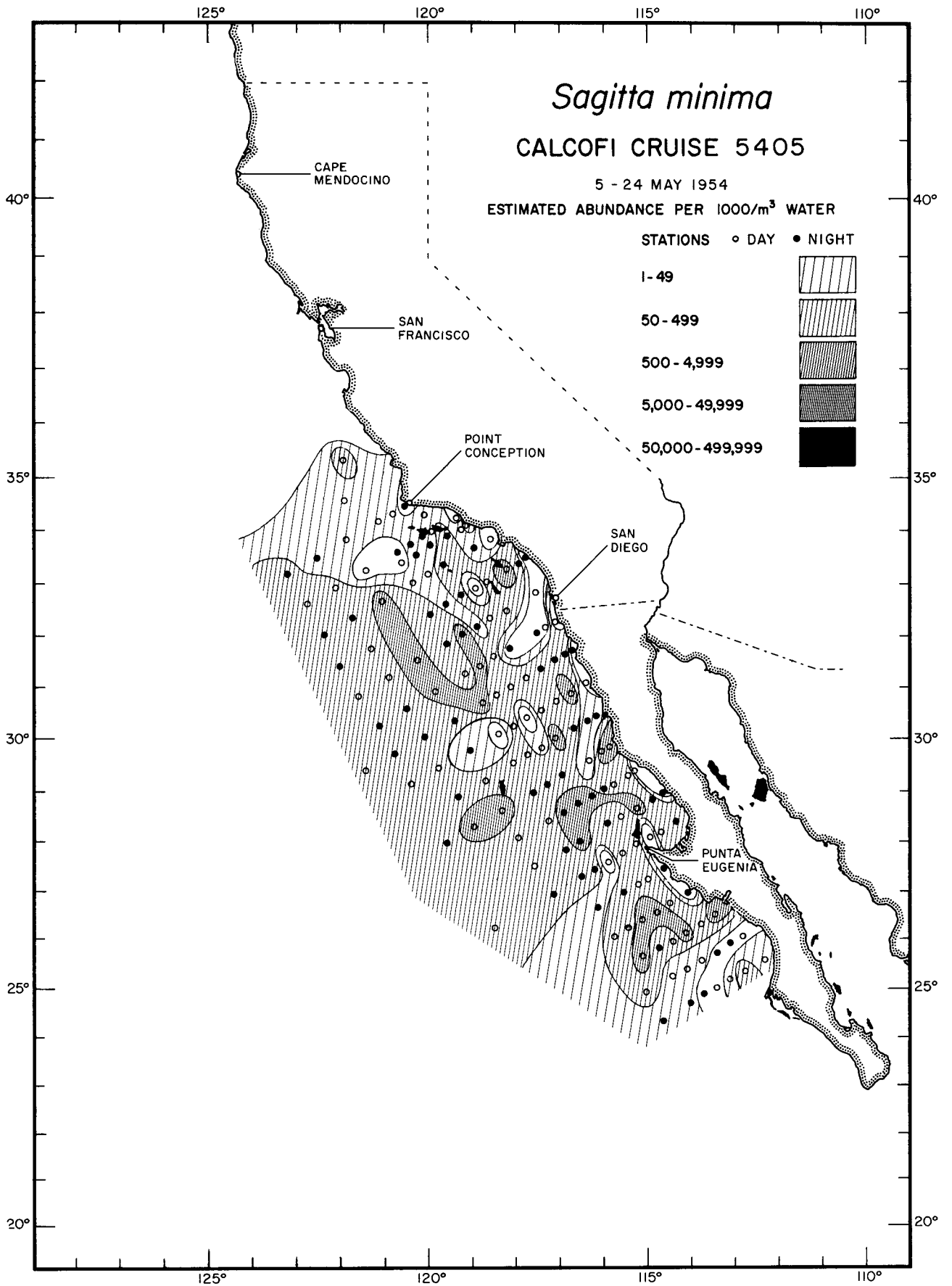


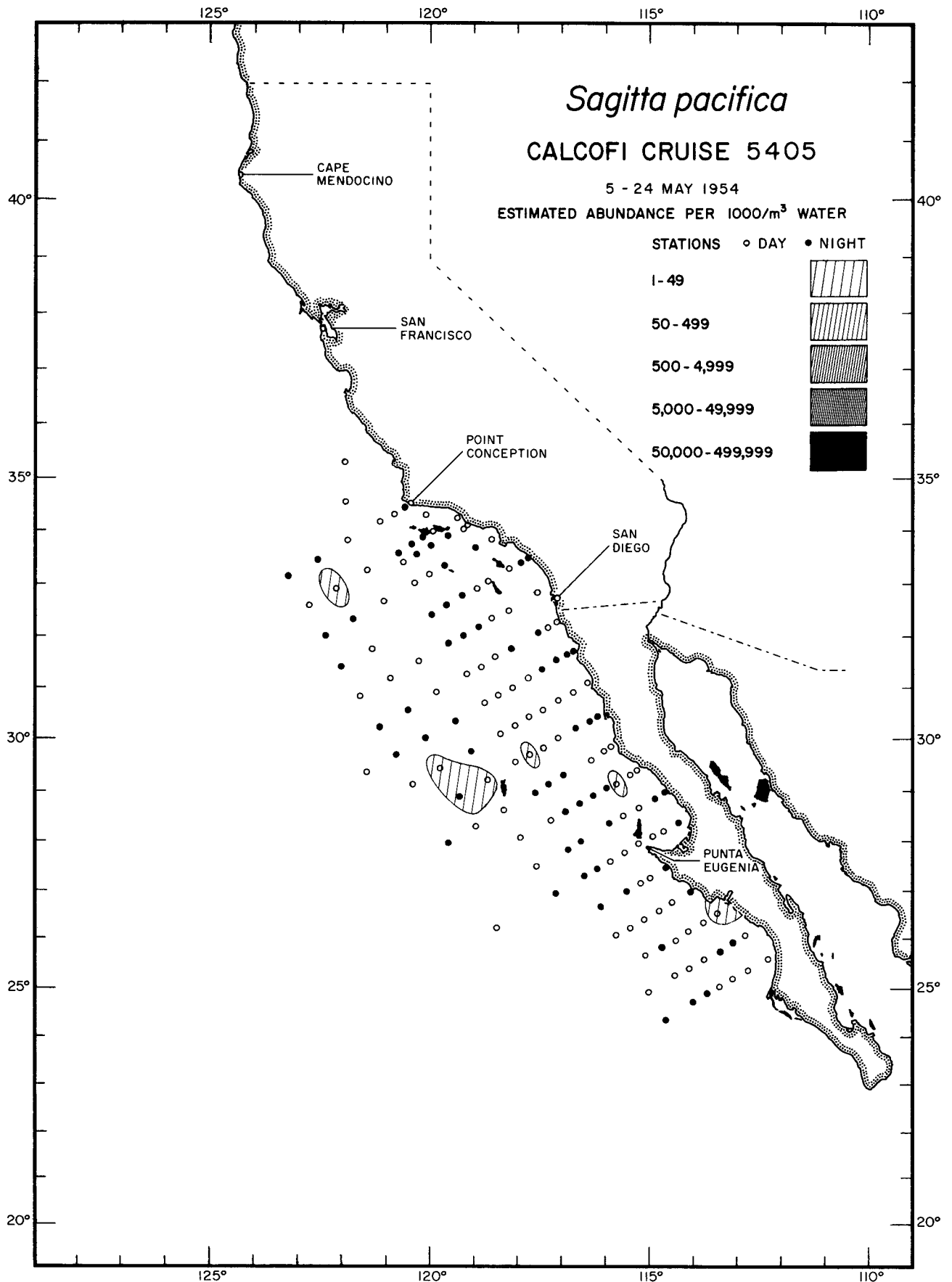
Chaetognatha
Sagitta euneritica
5405



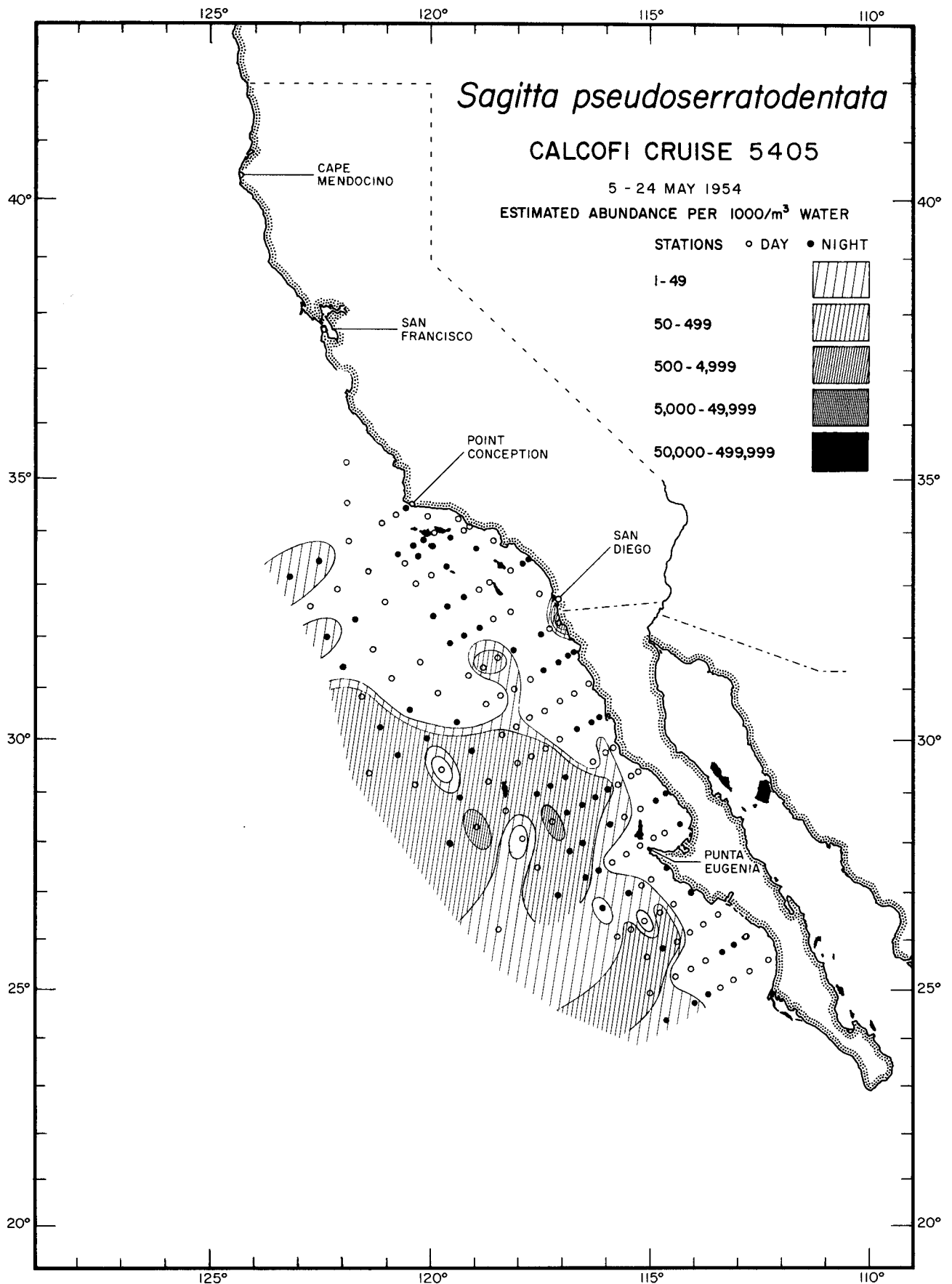


Chaetognatha
Sagitta maxima
5405

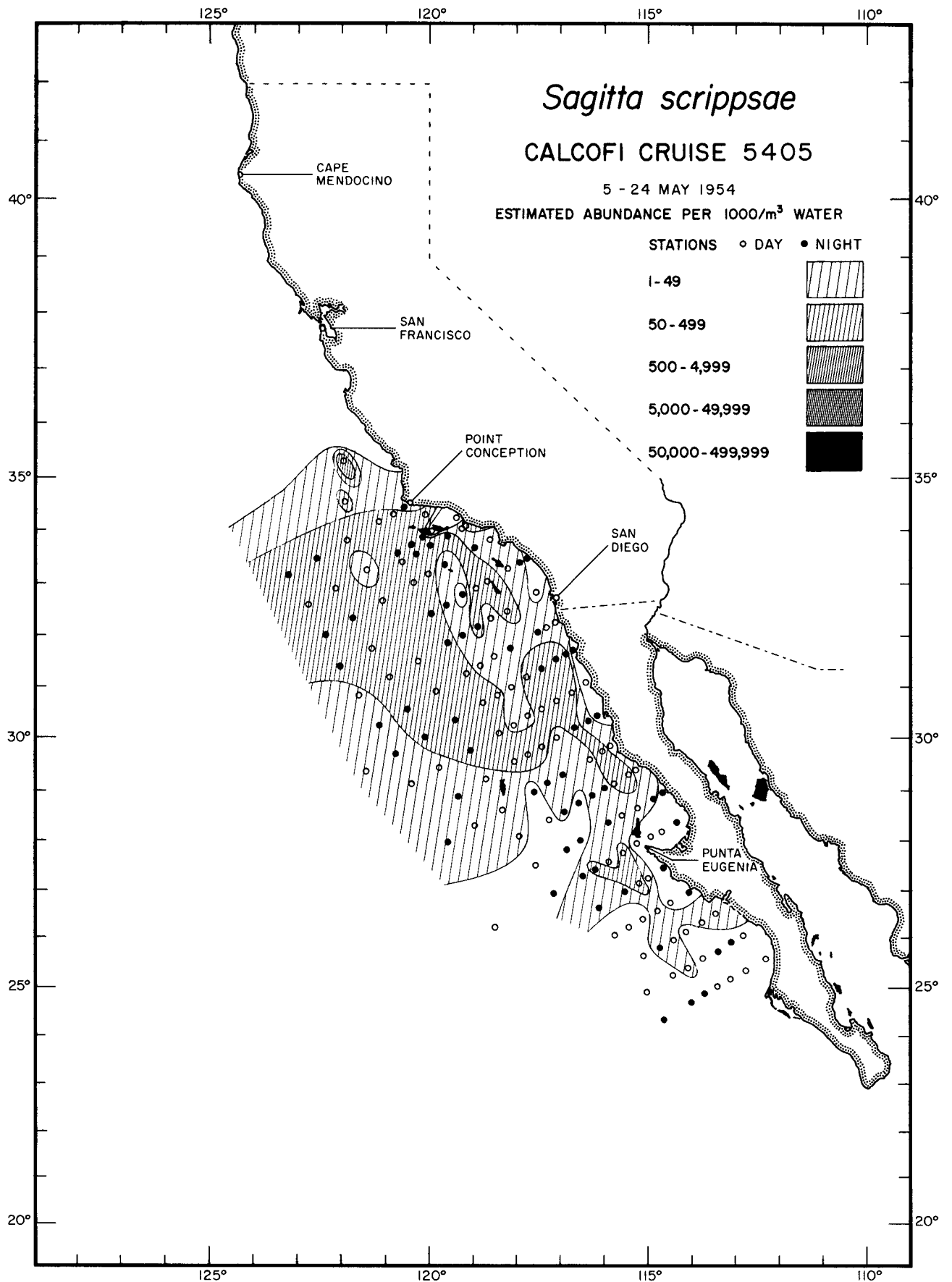


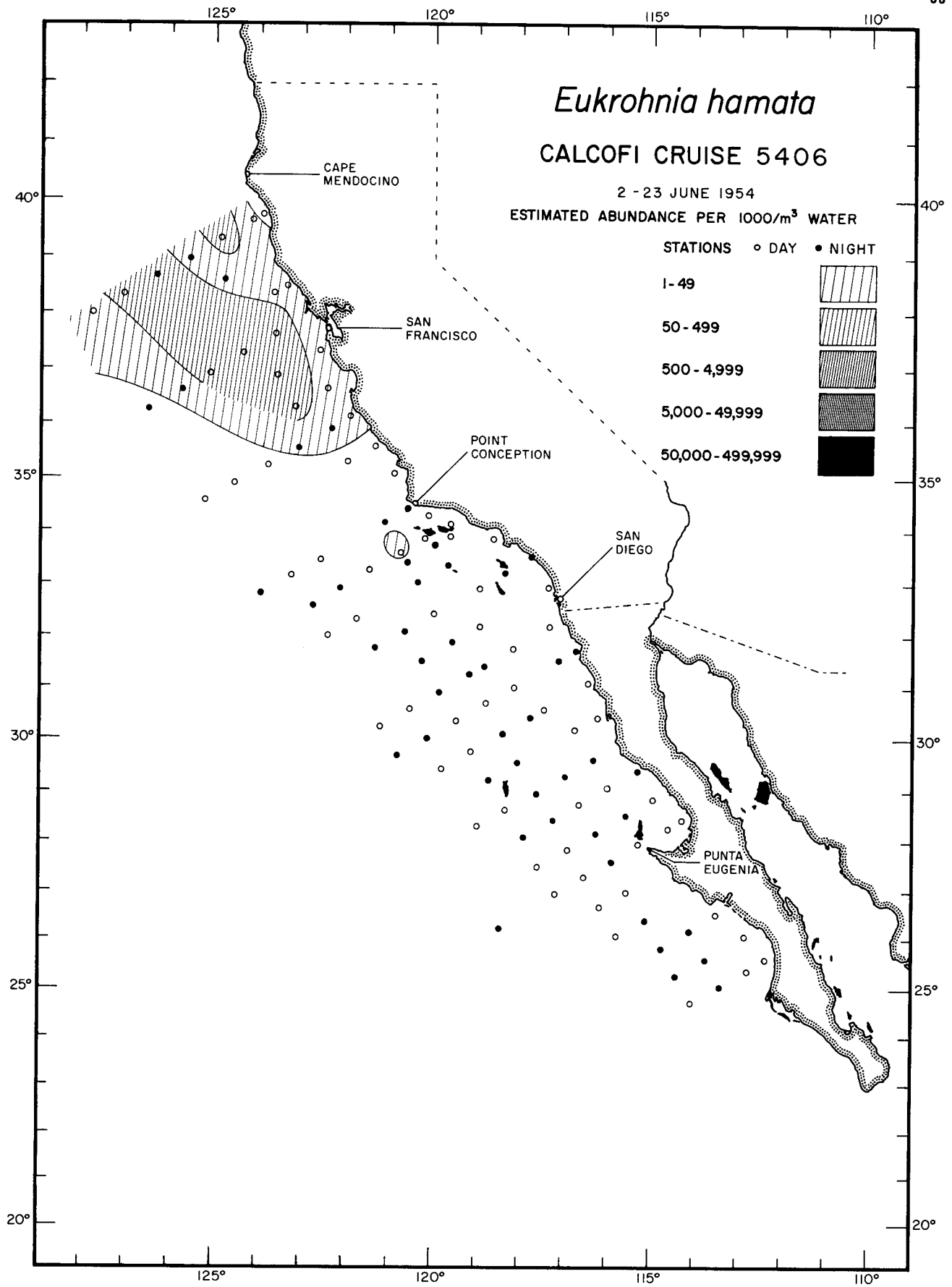


Chaetognatha
Sagitta pacifica
5405

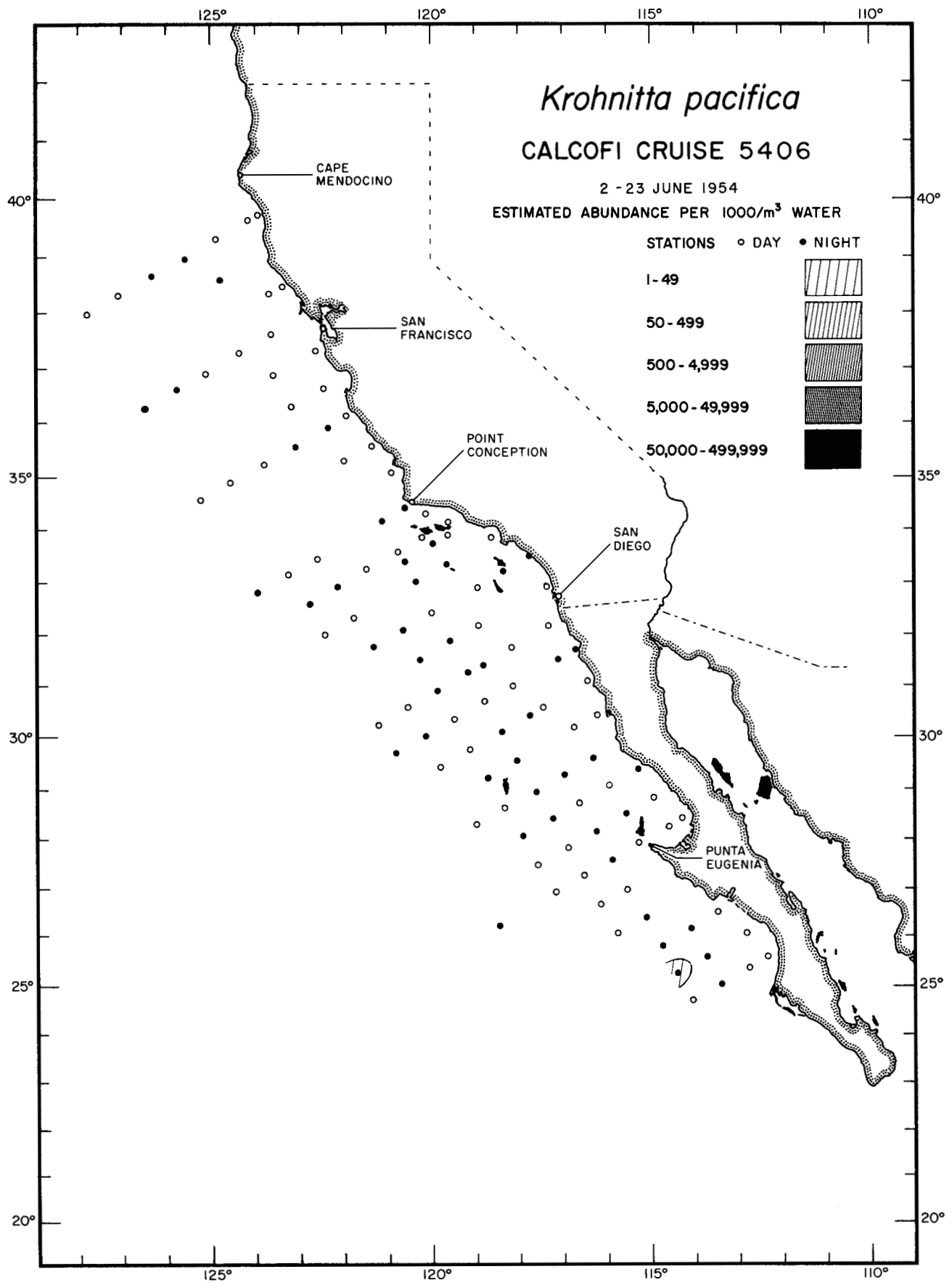


Chaetognatha
Sagitta pseudoserratodentata
5405

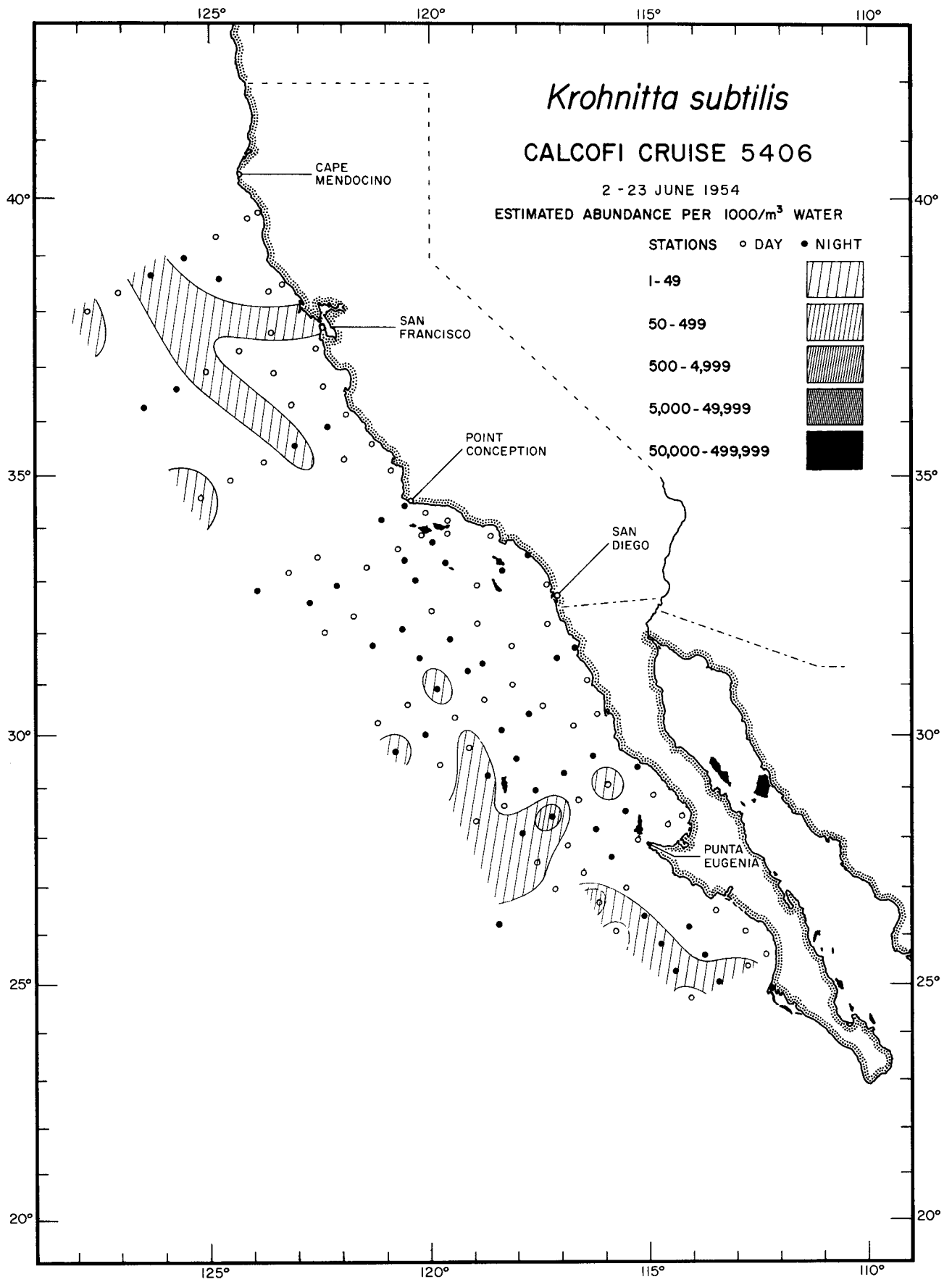




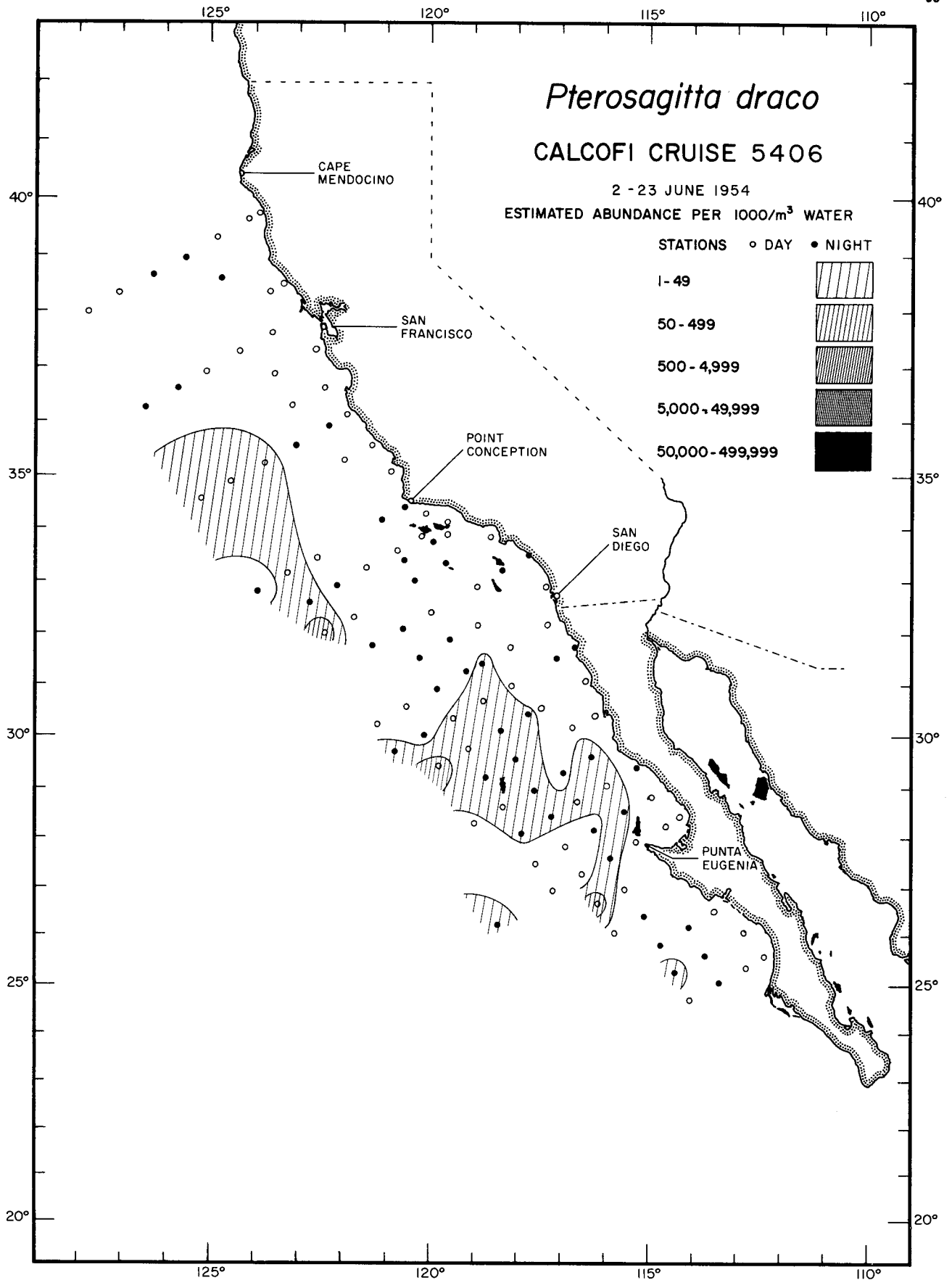
Chaetognatha
Eukrohnia hamata
5406



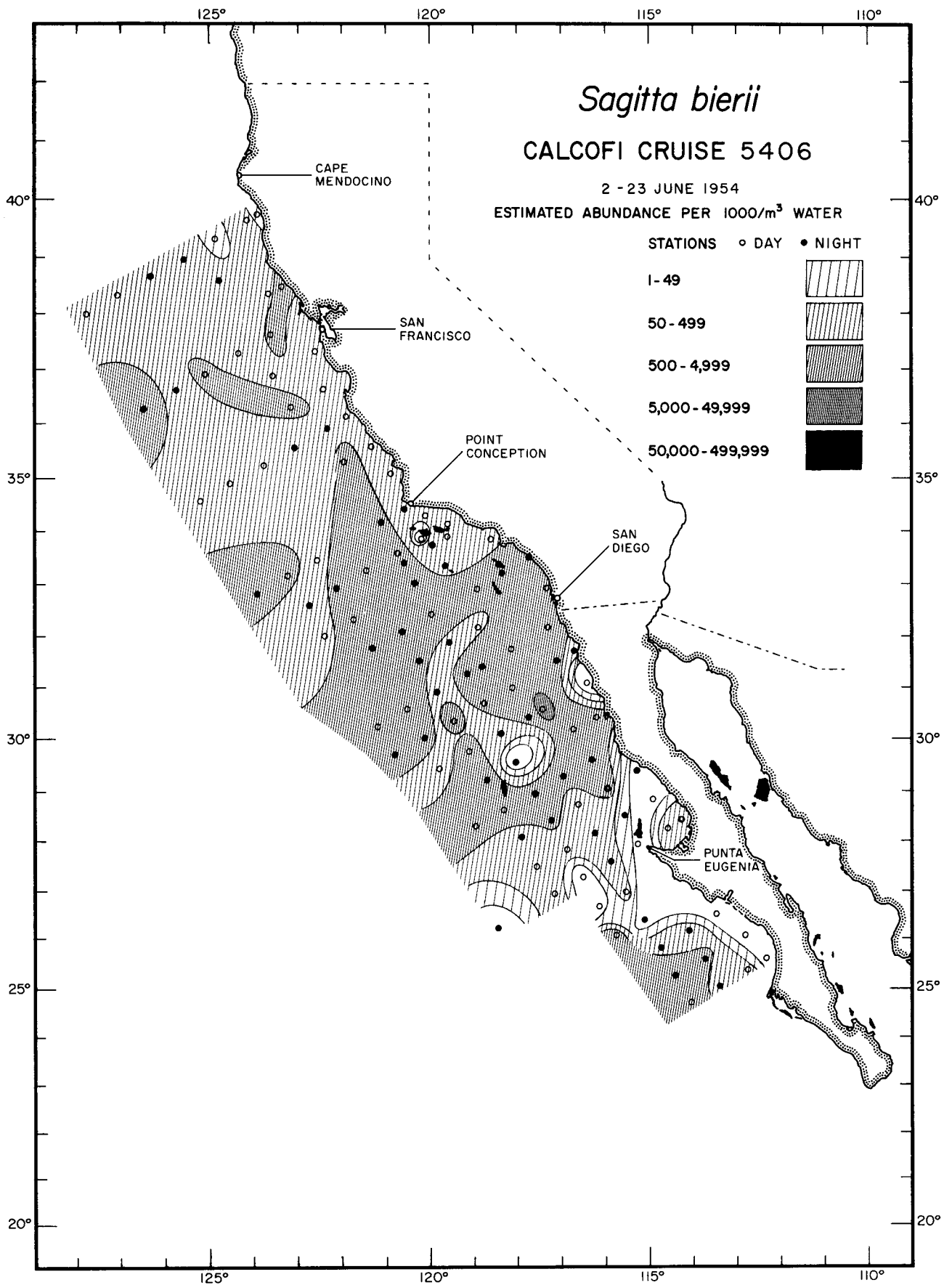
Chaetognatha
Krohnitta pacifica
5406



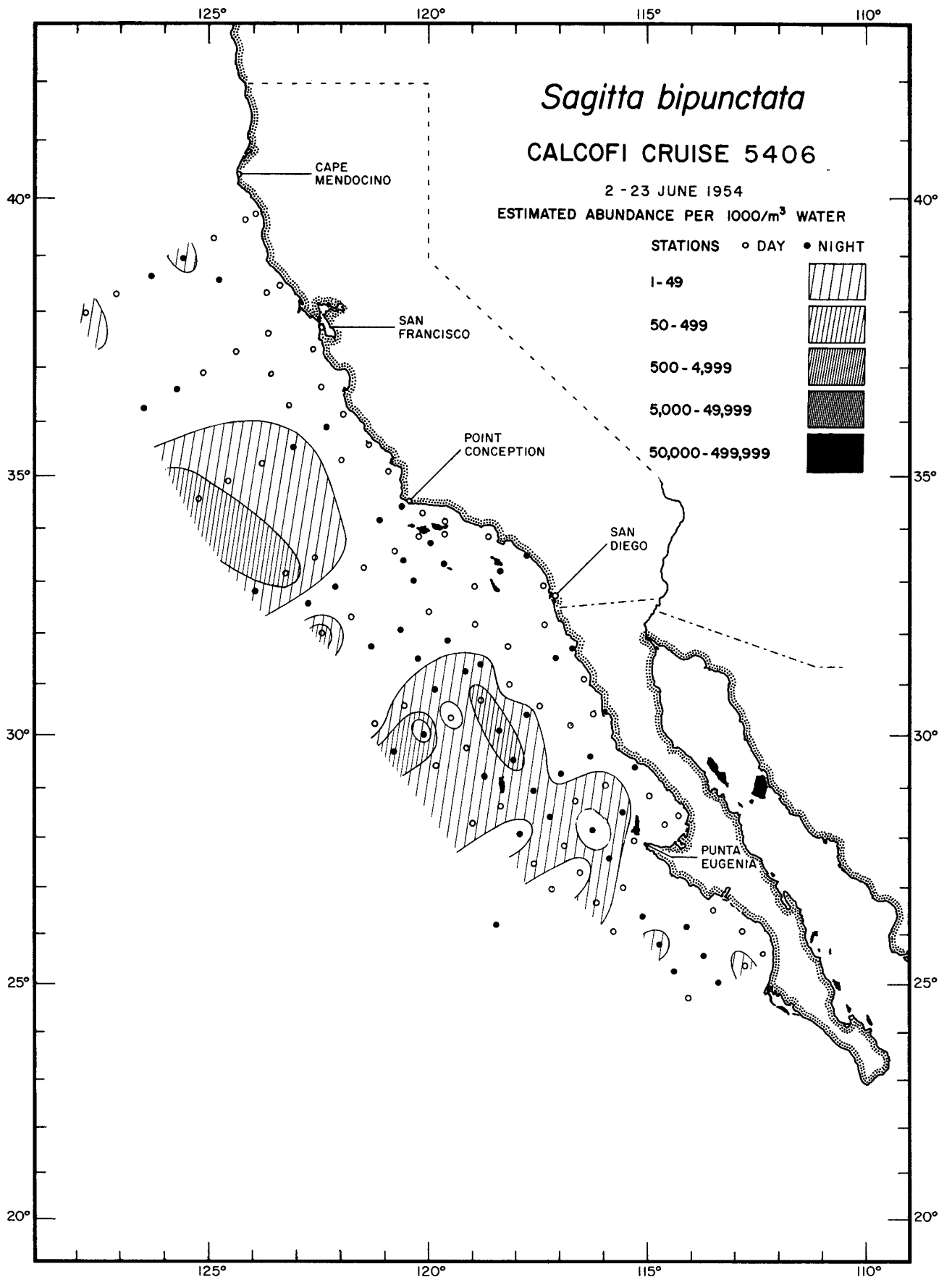
Chaetognatha
Krohnitta subtilis
5406



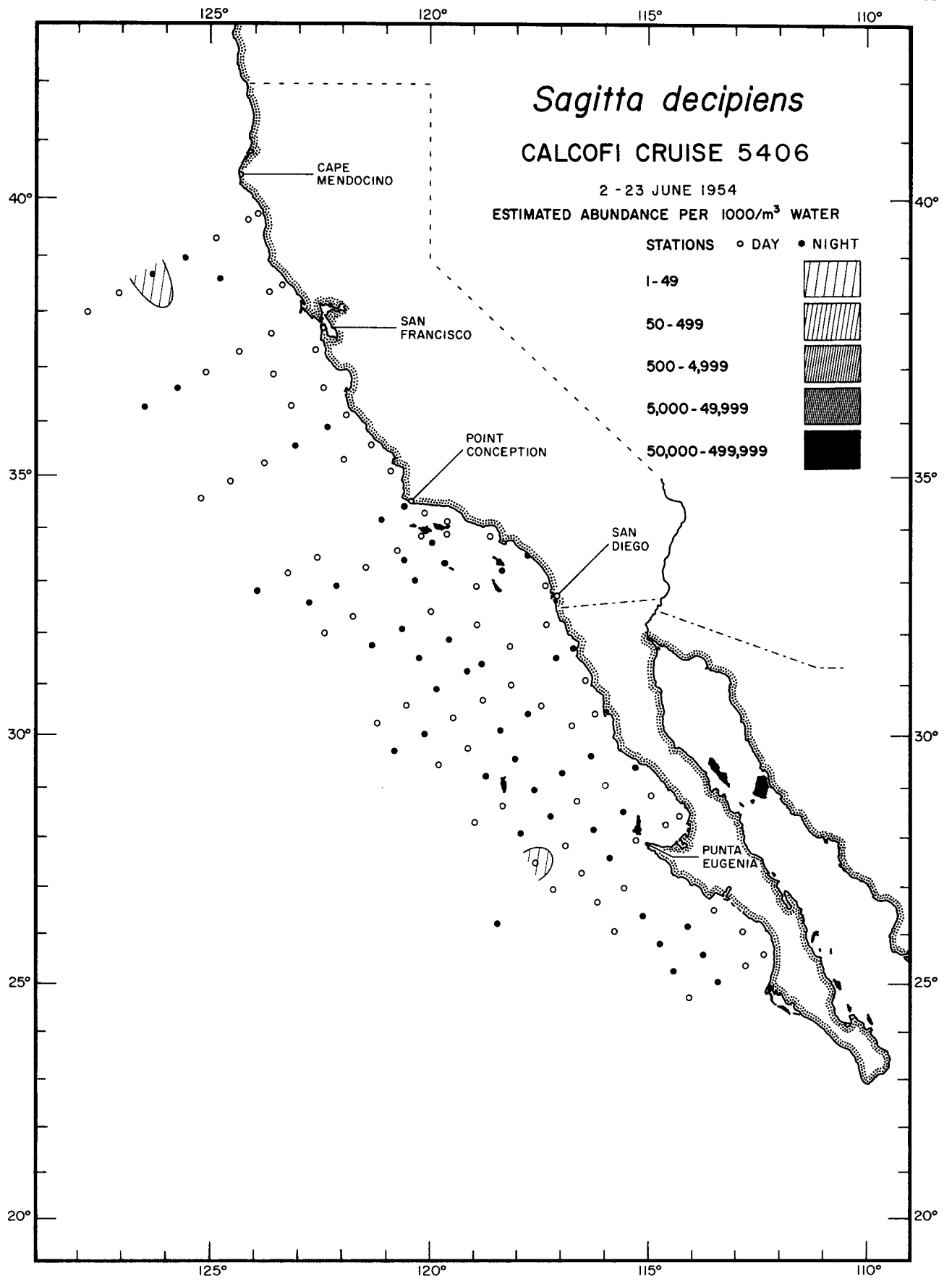
Chaetognatha
Pterosagitta draco
5406



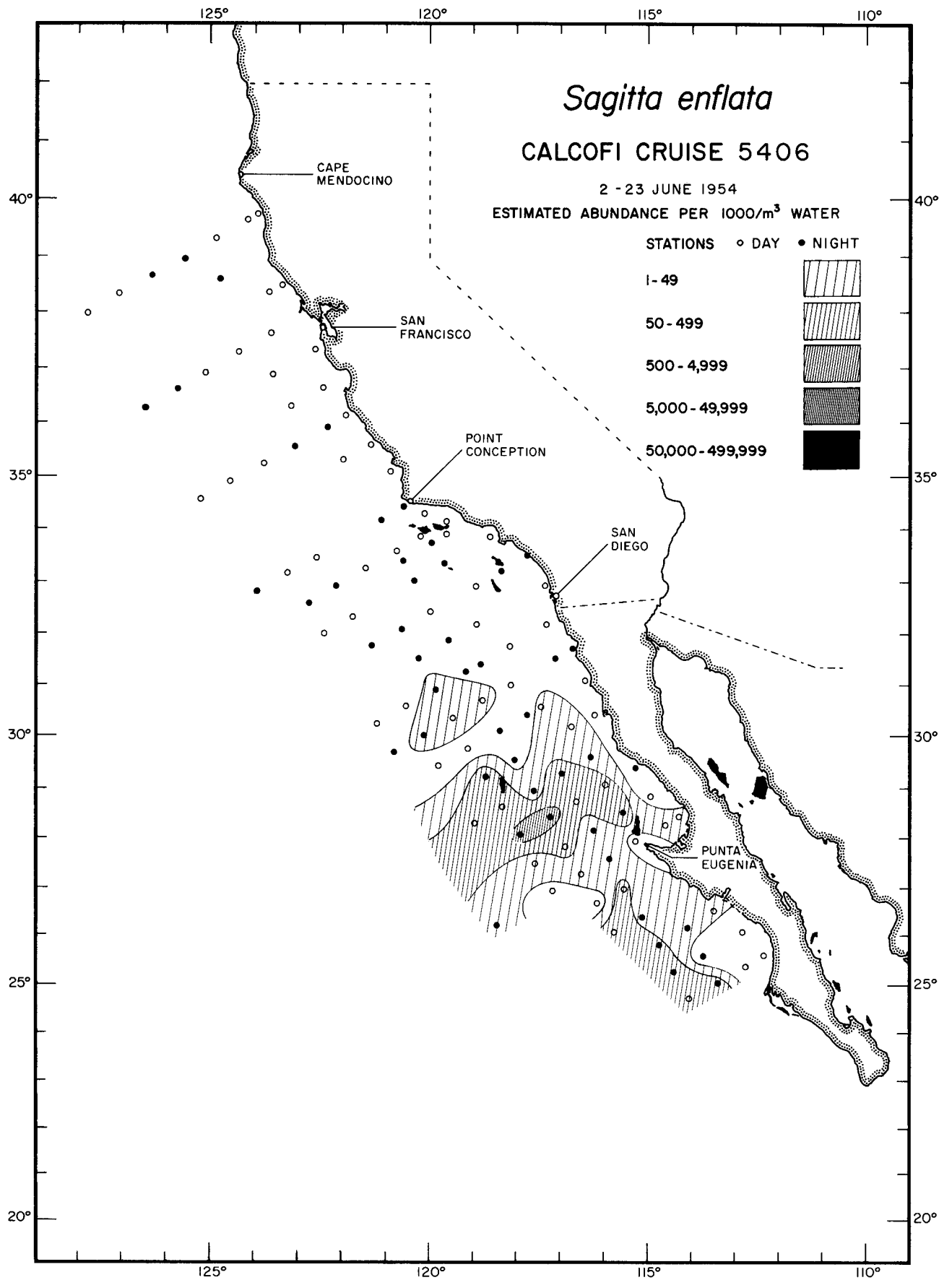
Chaetognatha
Sagitta bierii
5406



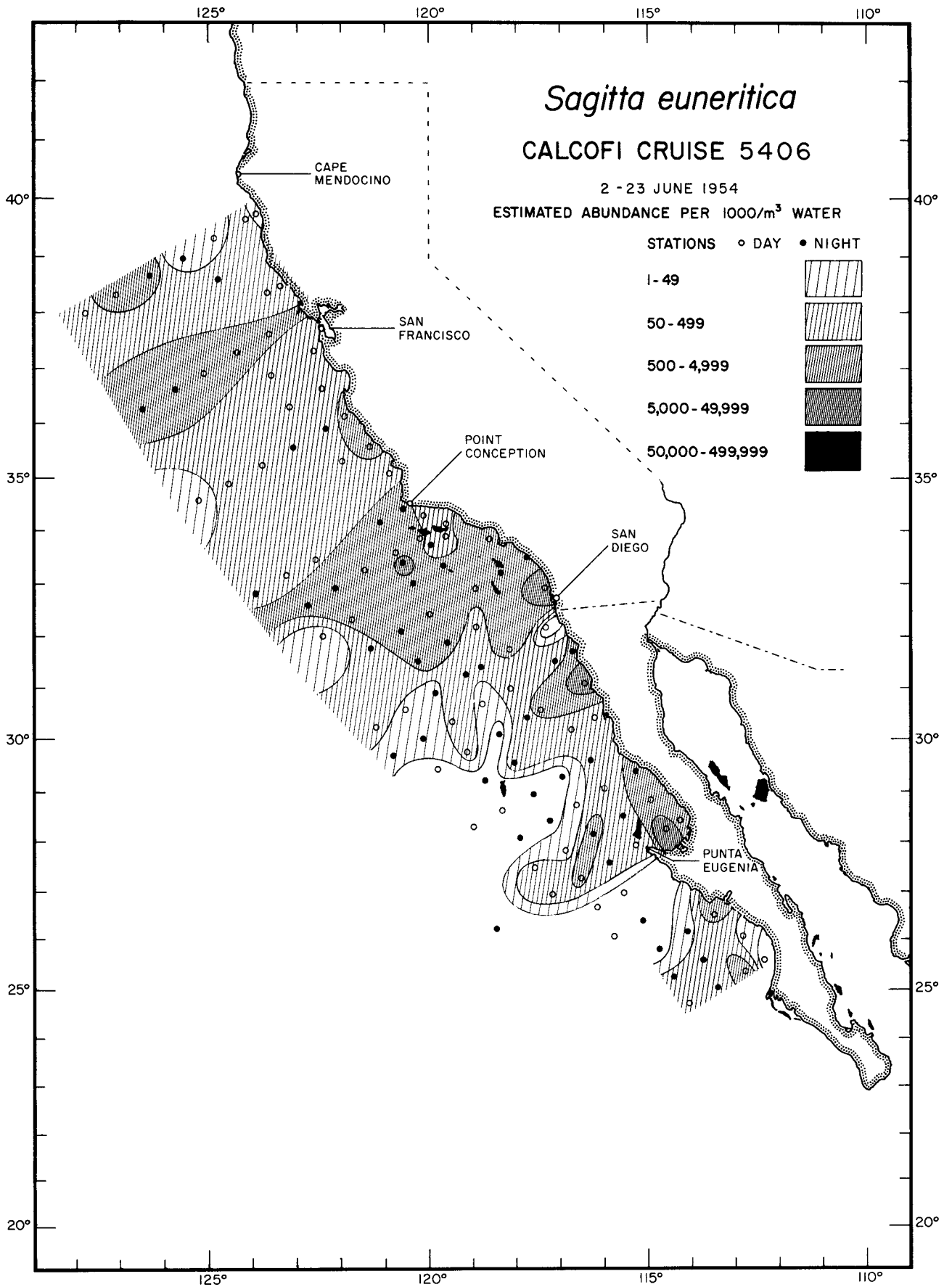
Chaetognatha
Sagitta bipunctata
5406



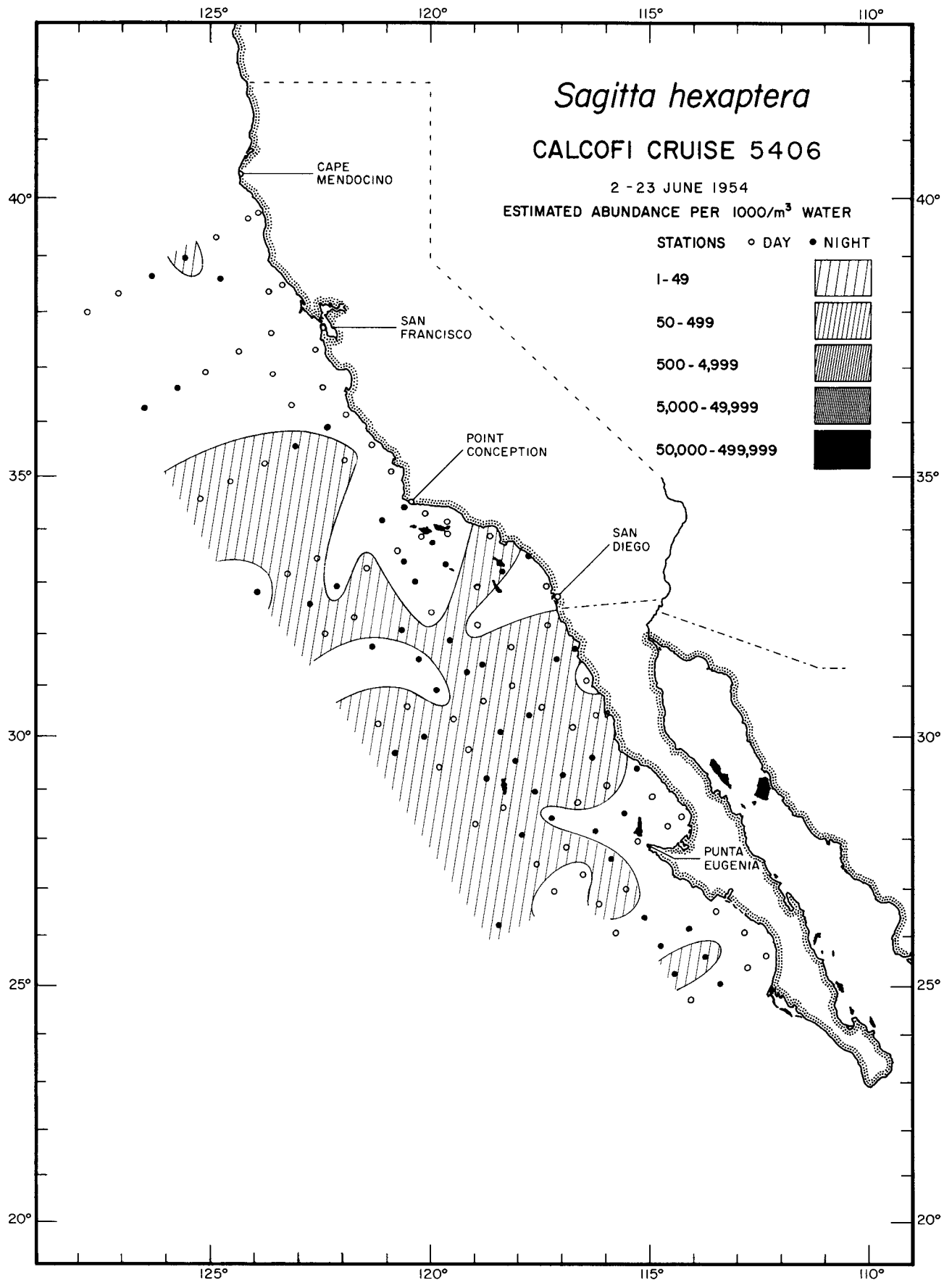
Chaetognatha
Sagitta decipiens
5406

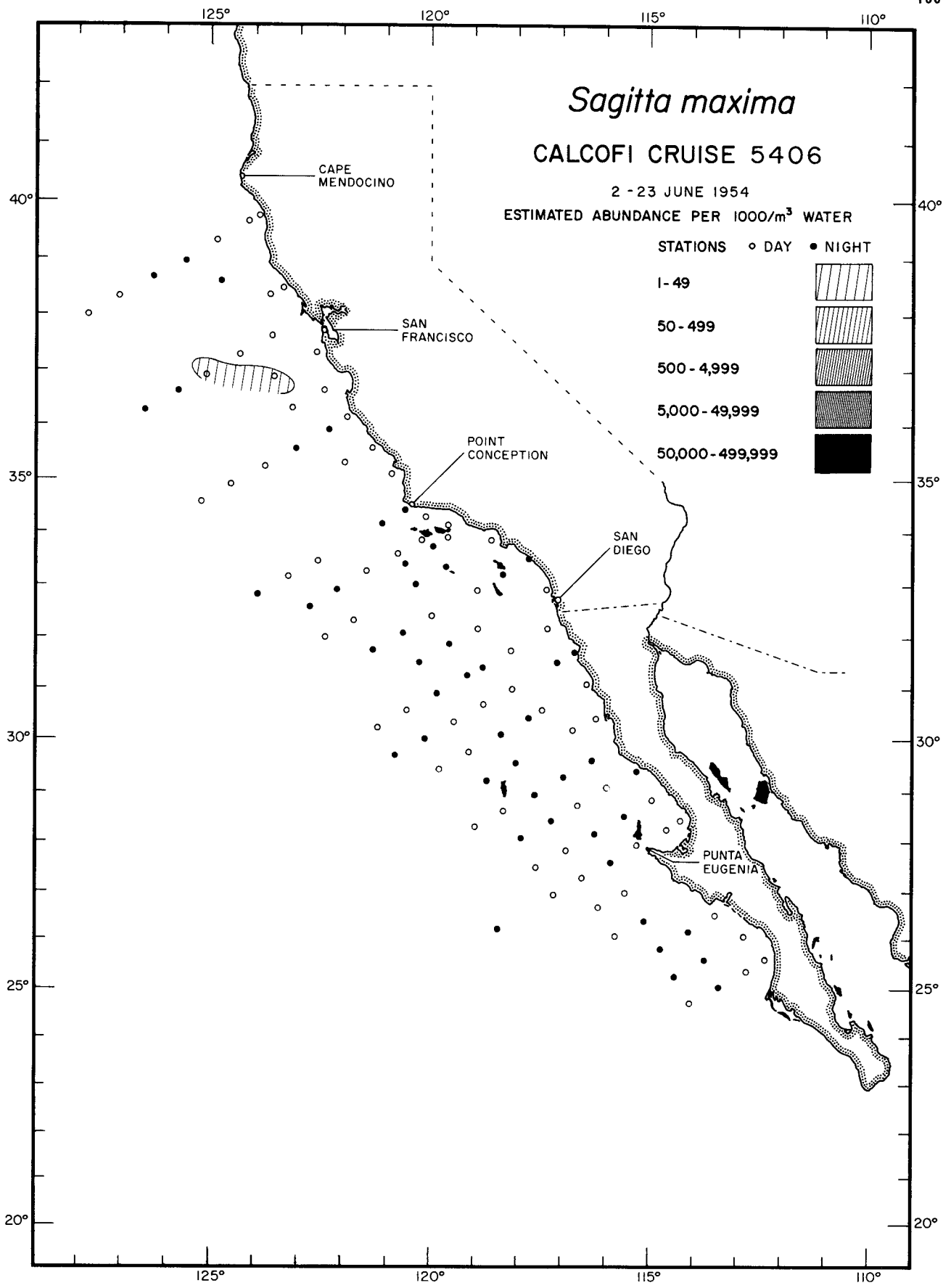


Chaetognatha
Sagitta enflata
5406

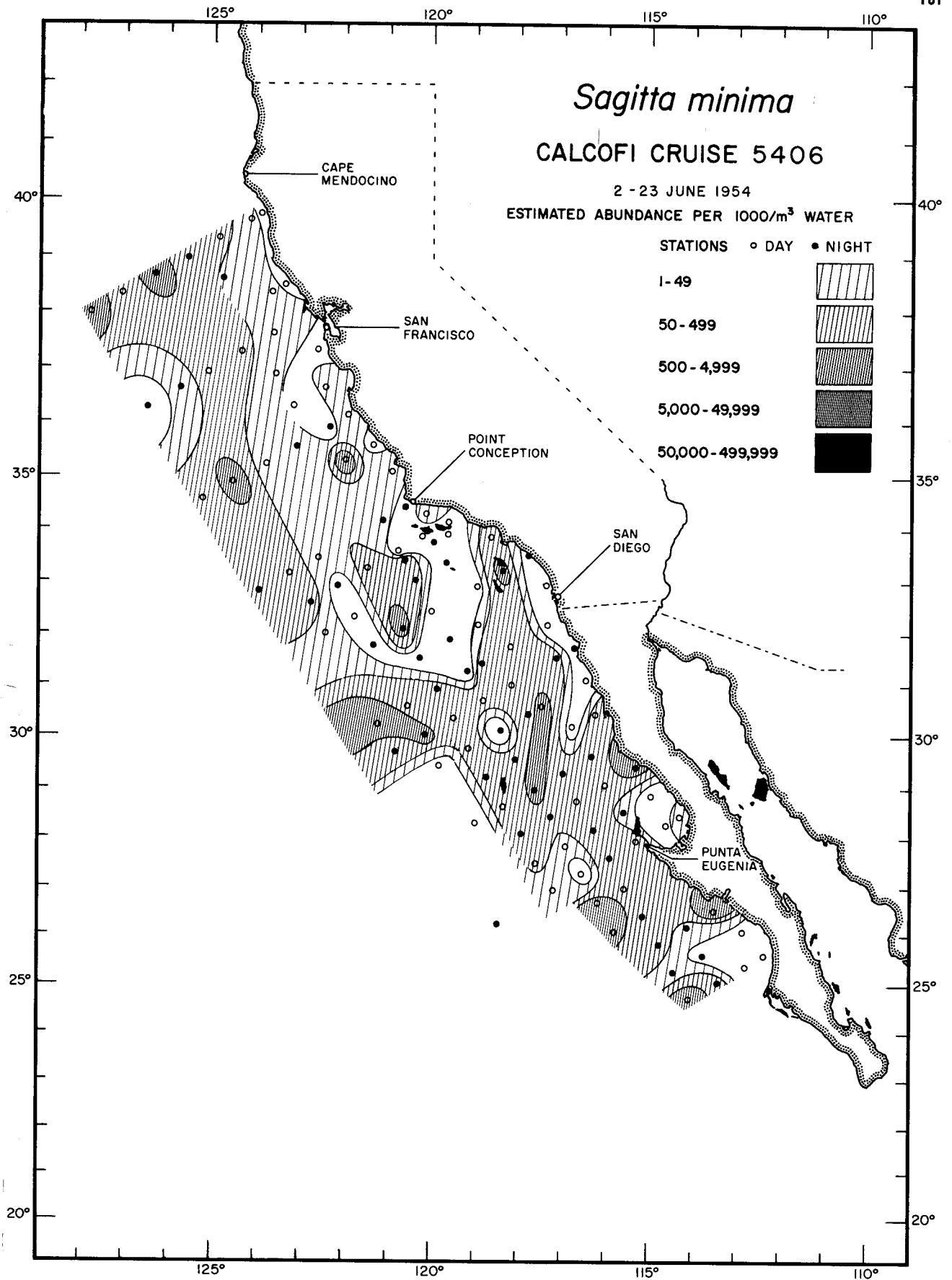


Chaetognatha
Sagitta euneritica
5406

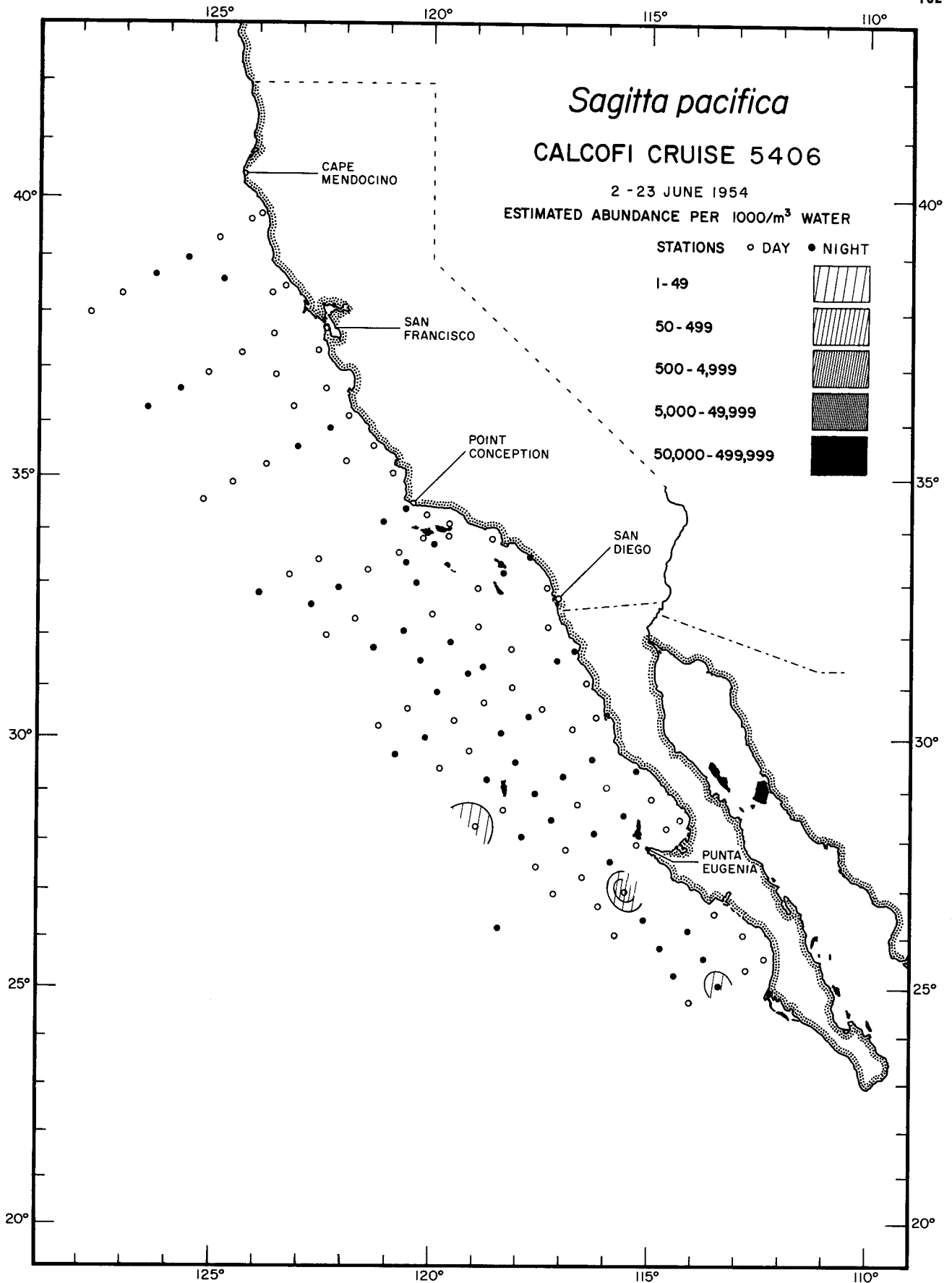




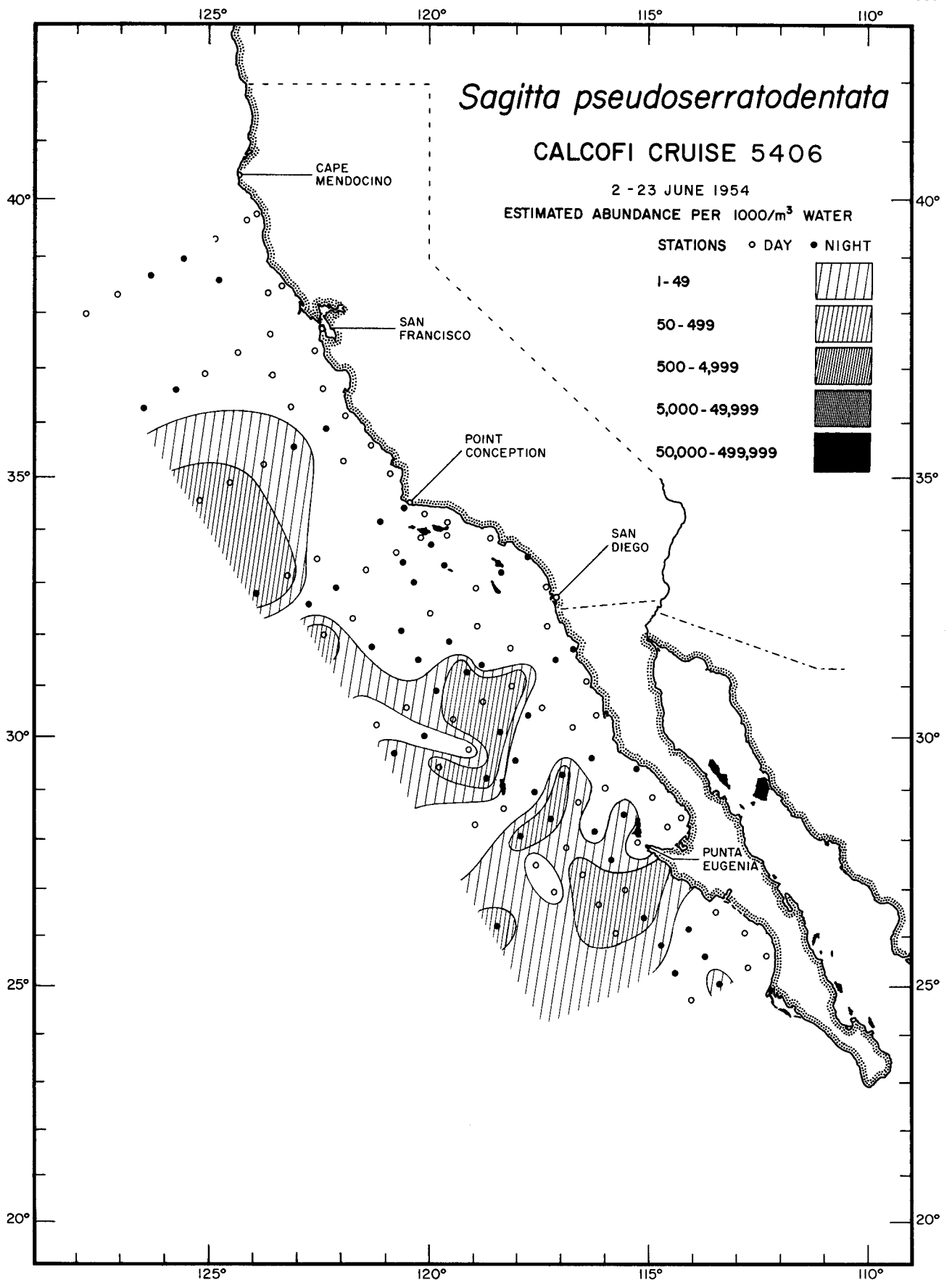
Chaetognatha
Sagitta maxima
5406



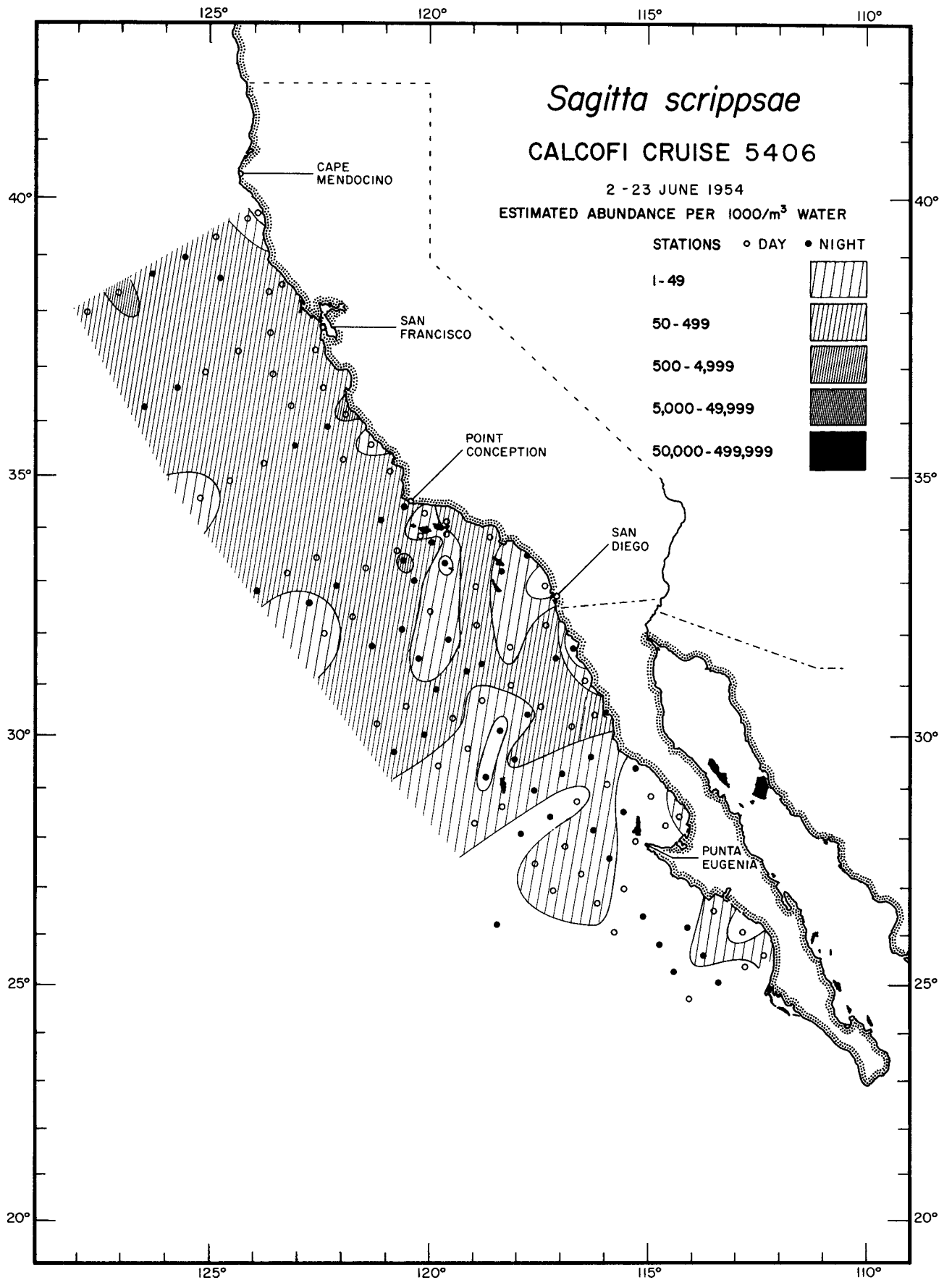
Chaetognatha
Sagitta minima
5406



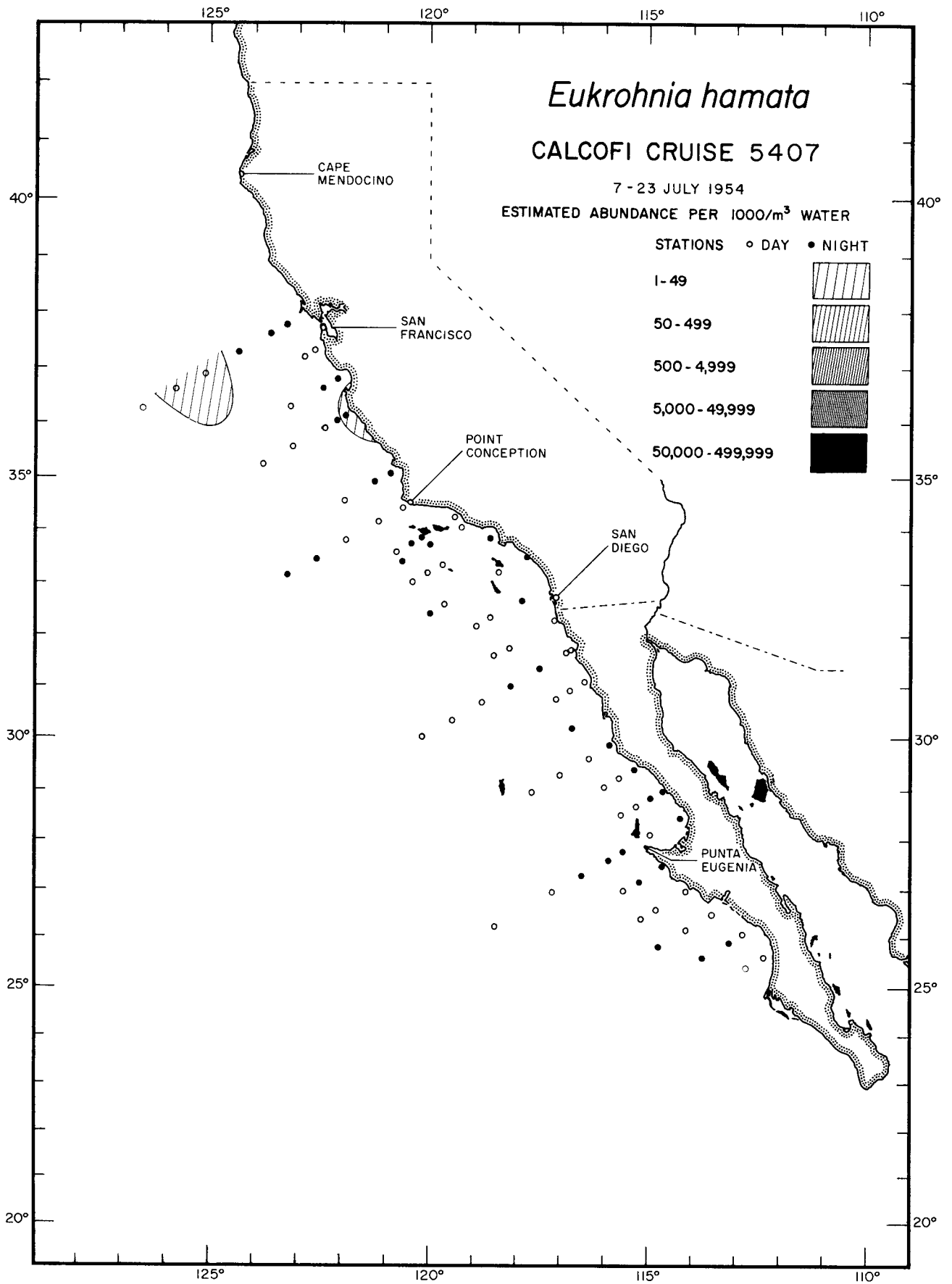
Chaetognatha
Sagitta pacifica
5406



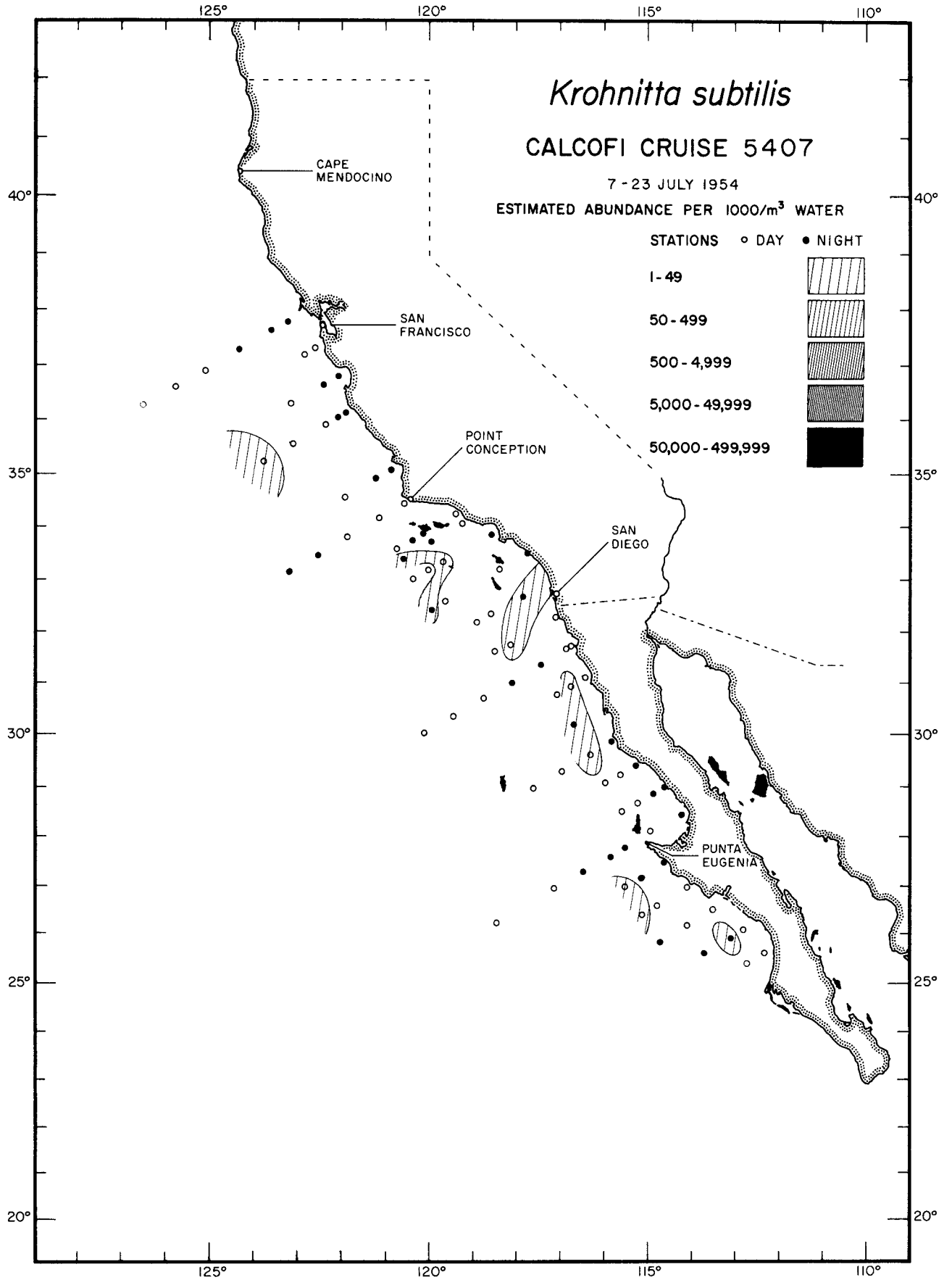
Chaetognatha
Sagitta pseudoserratodentata
 5406



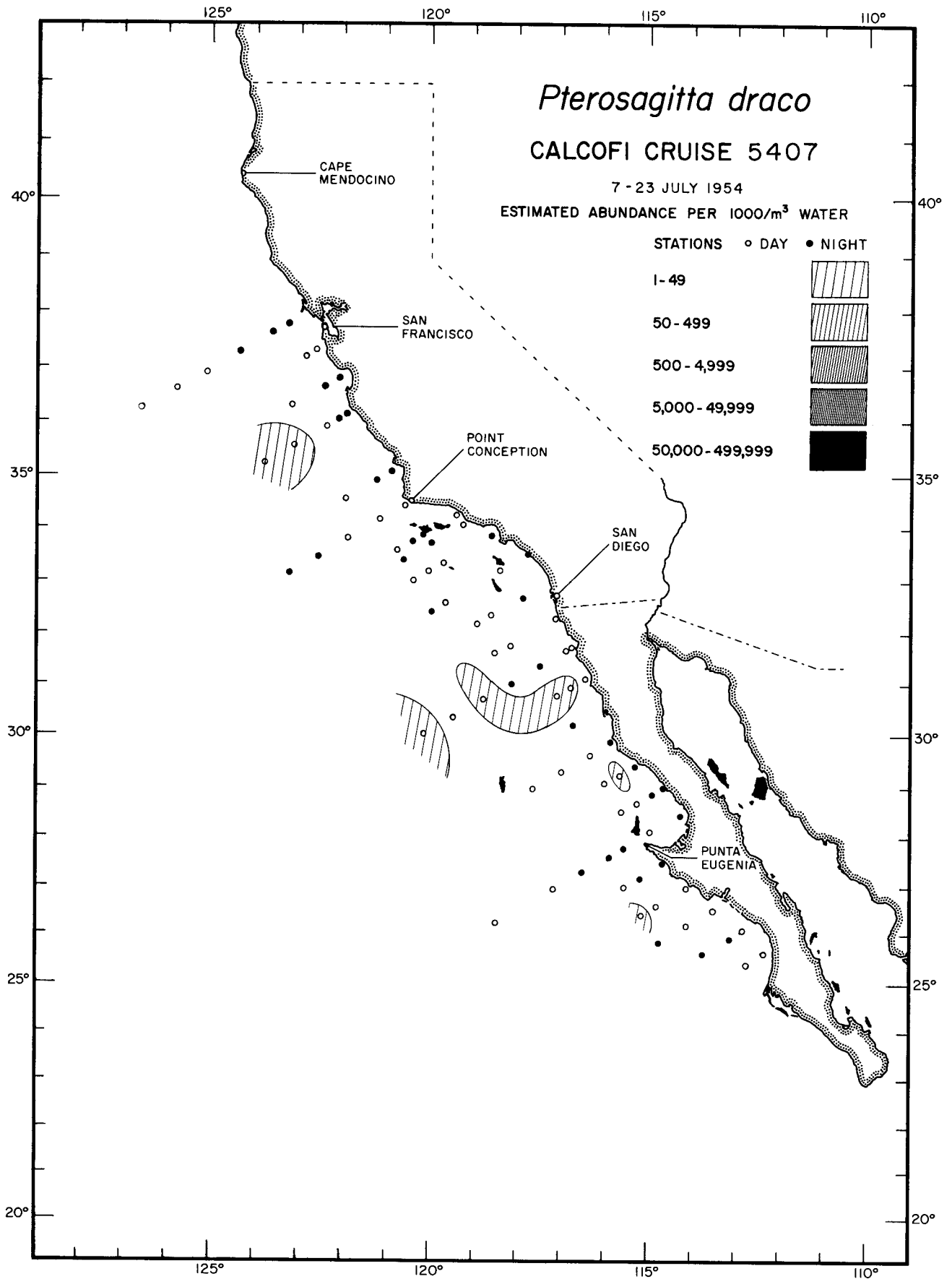
Chaetognatha
Sagitta scrippsae
5406



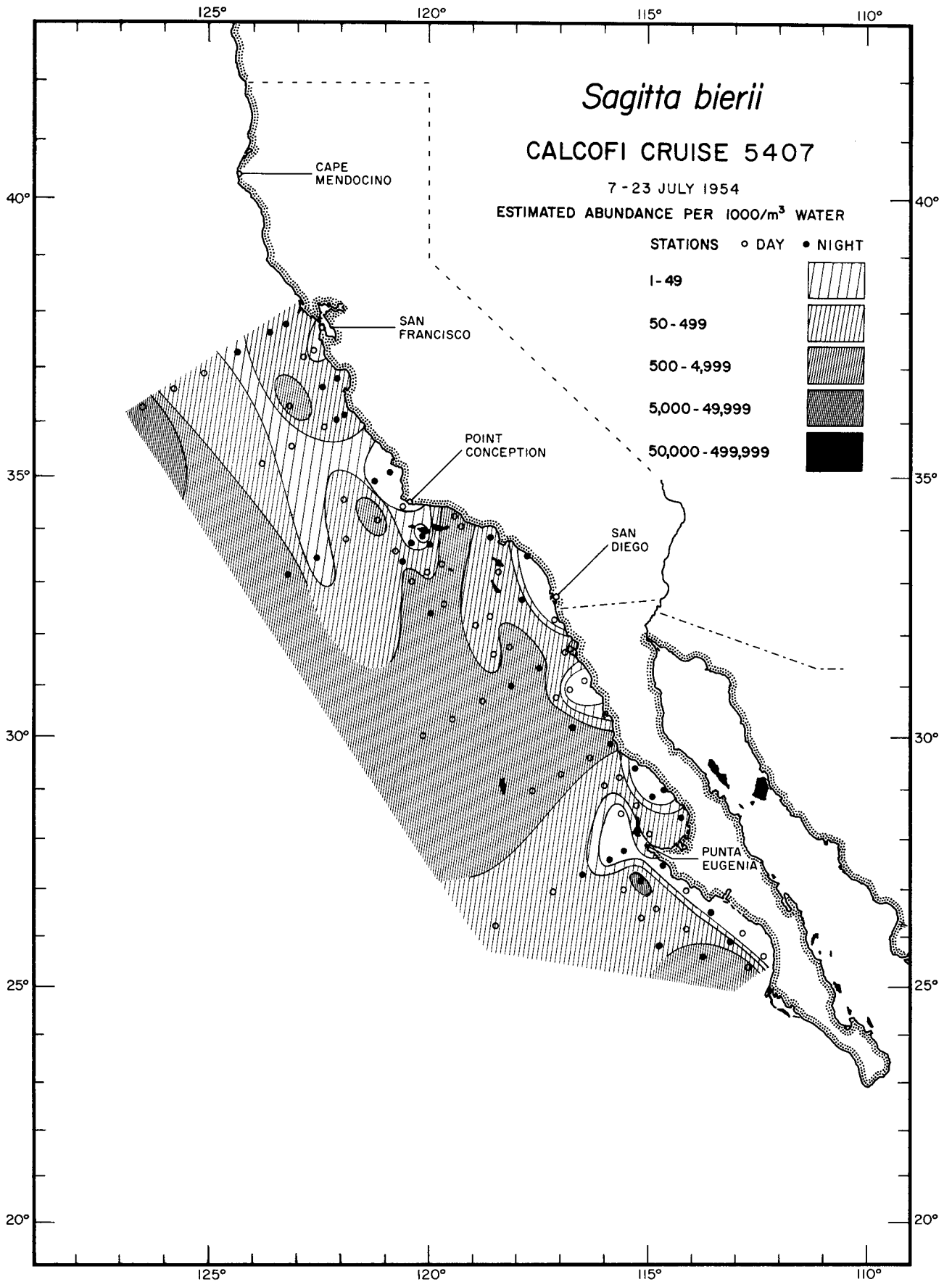
Chaetognatha
Eukrohnia hamata
5407



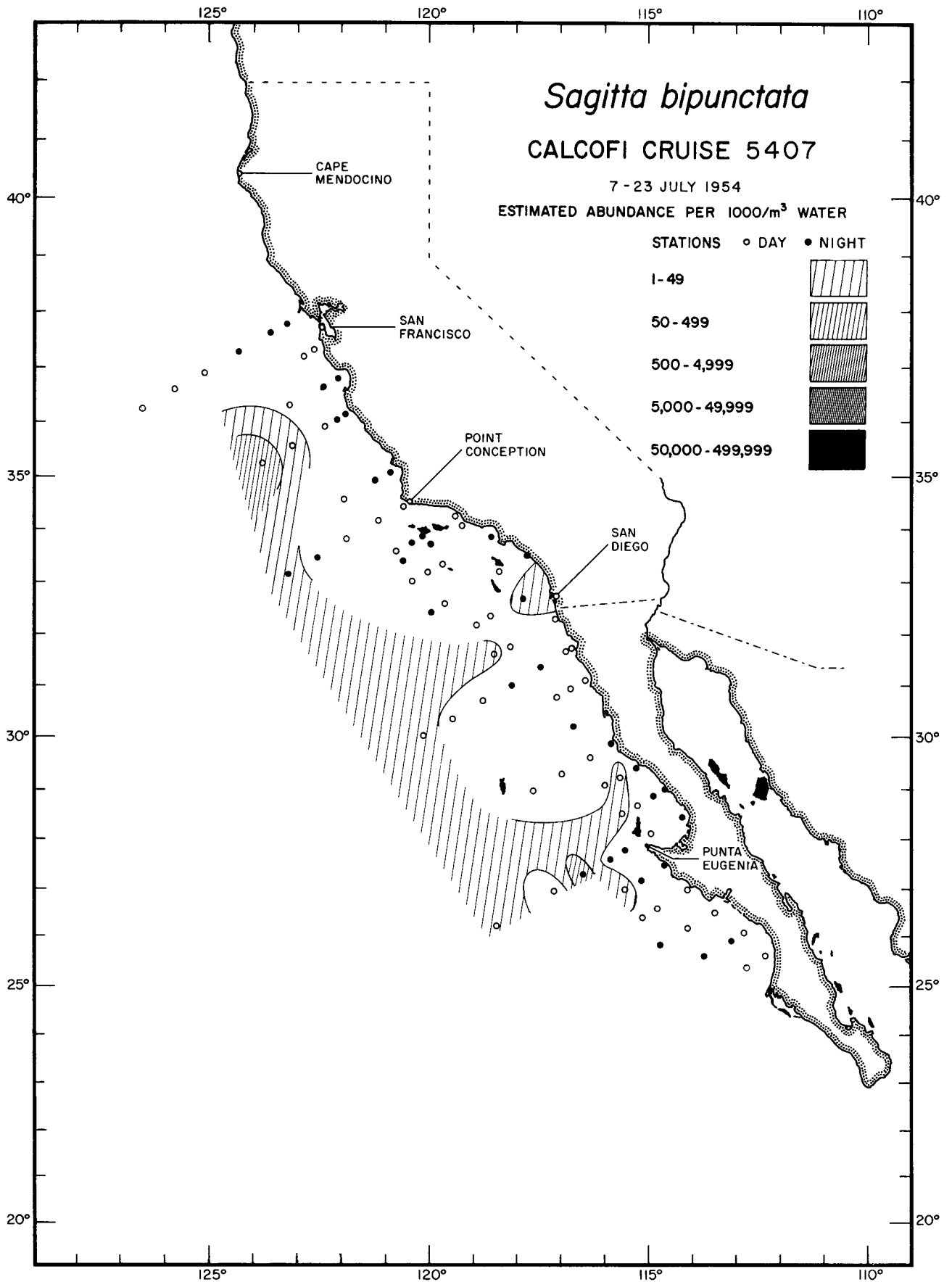
Chaetognatha
Krohnitta subtilis
5407



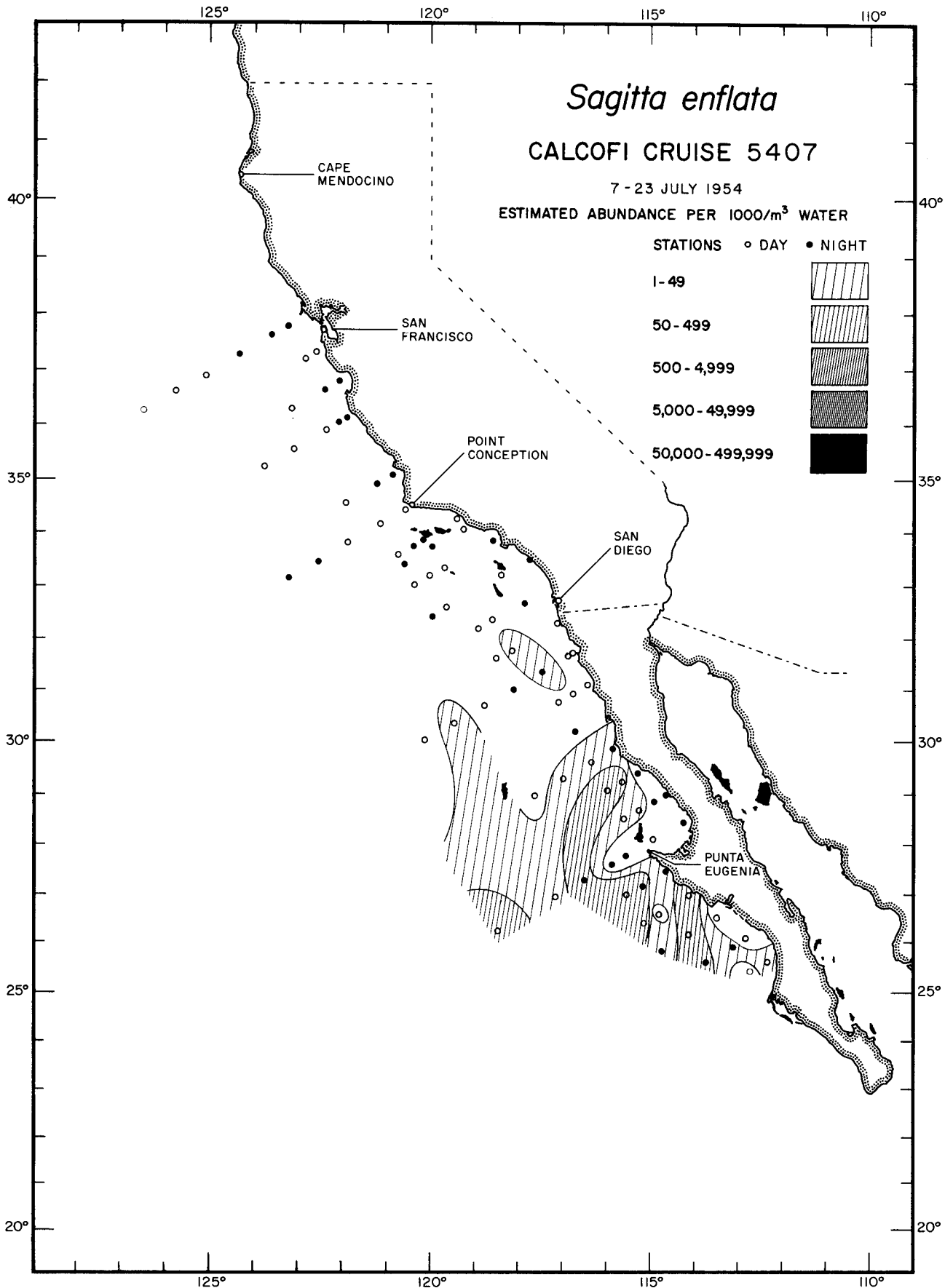
Chaetognatha
Pterosagitta draco
5407



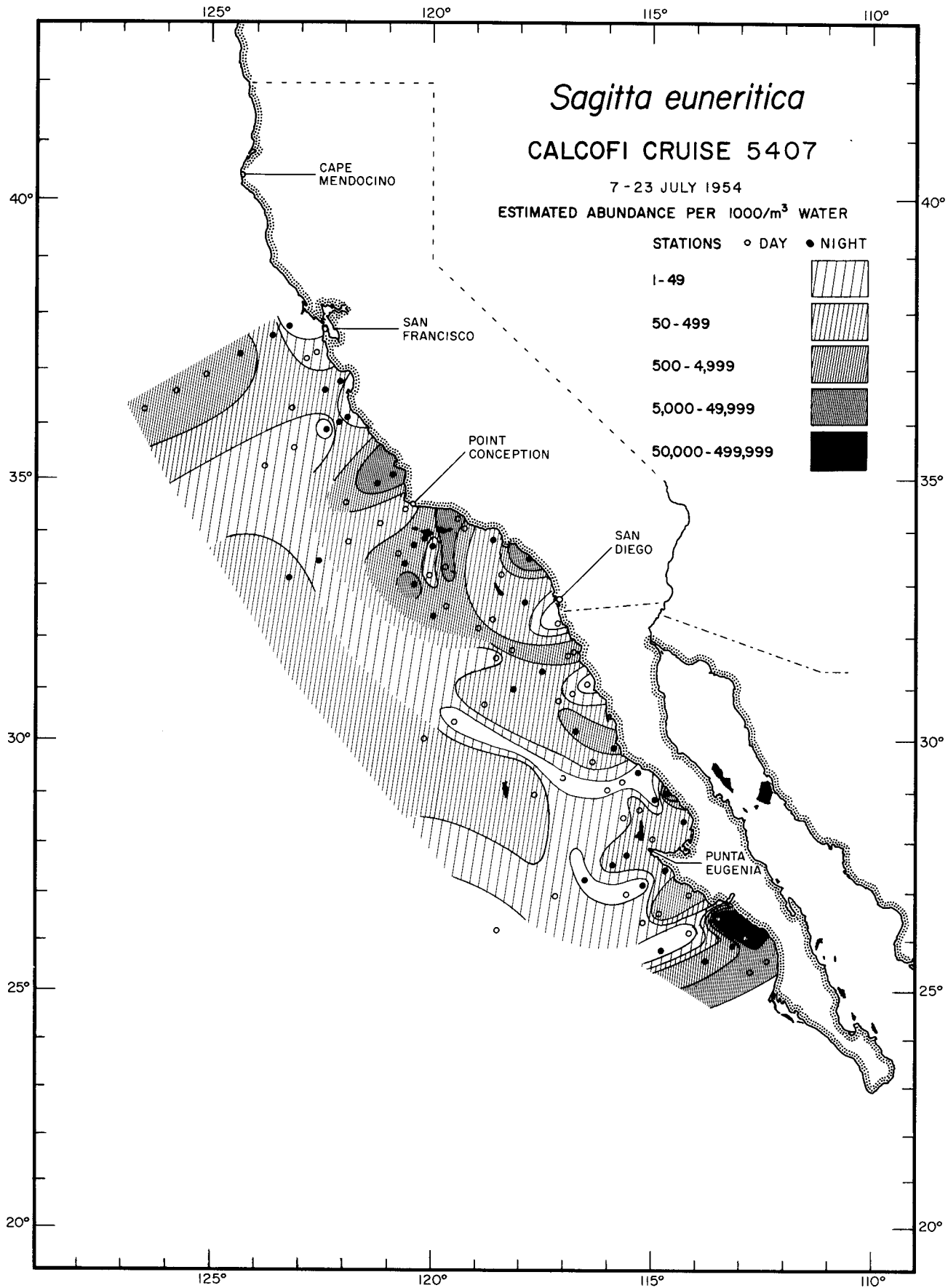
Chaetognatha
Sagitta bierii
5407



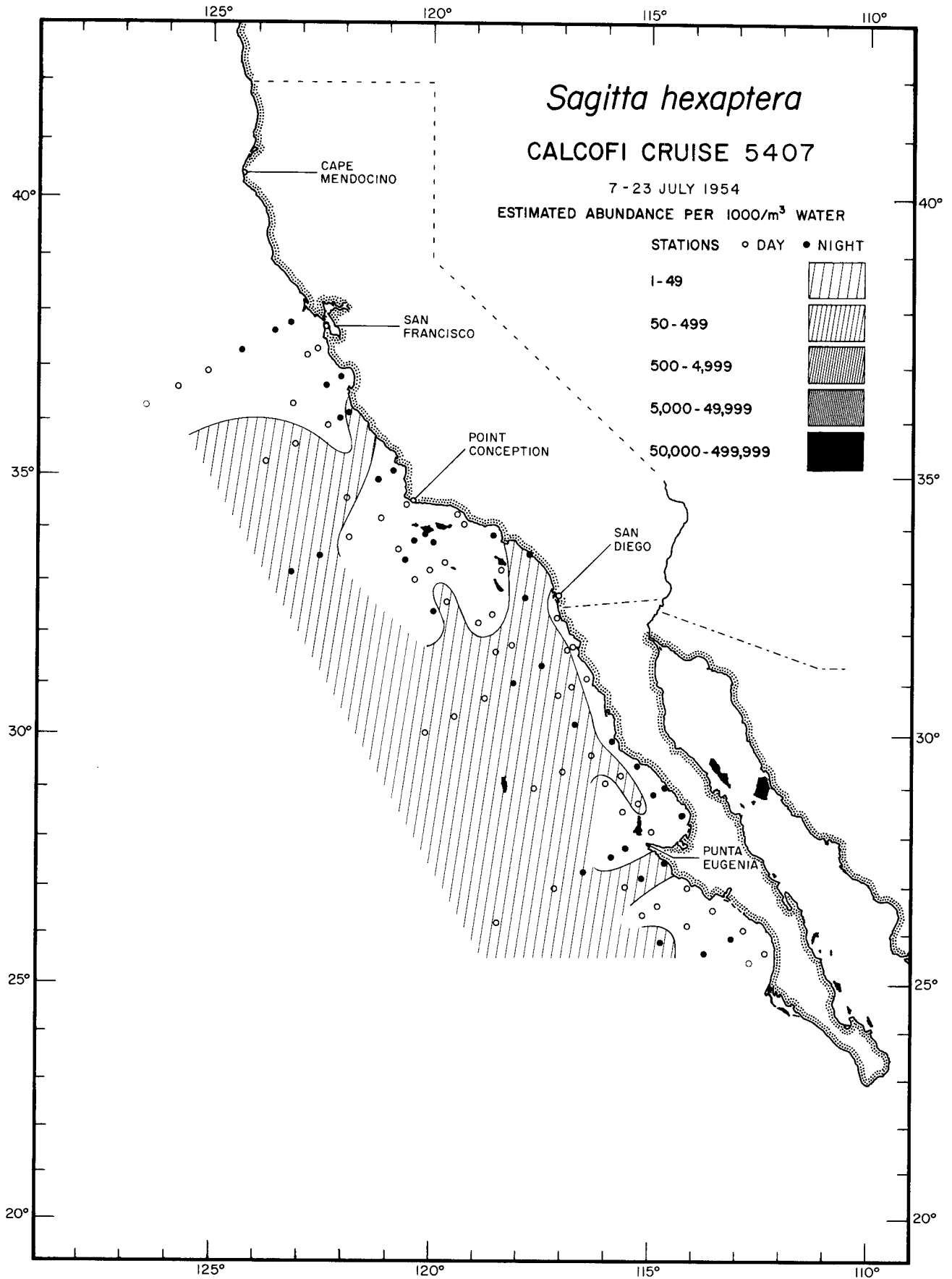
Chaetognatha
Sagitta bipunctata
 5407



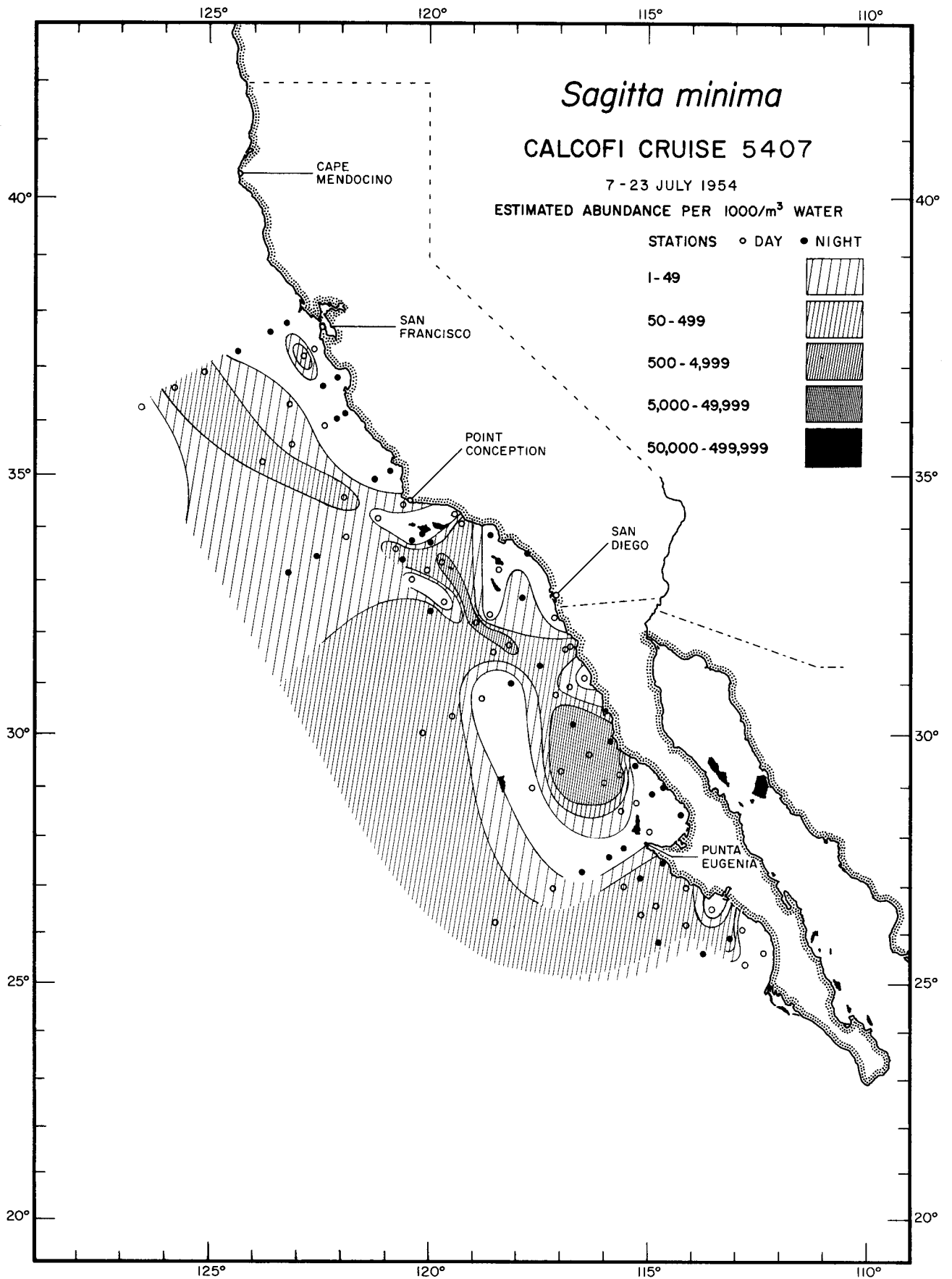
Chaetognatha
Sagitta enflata
 5407



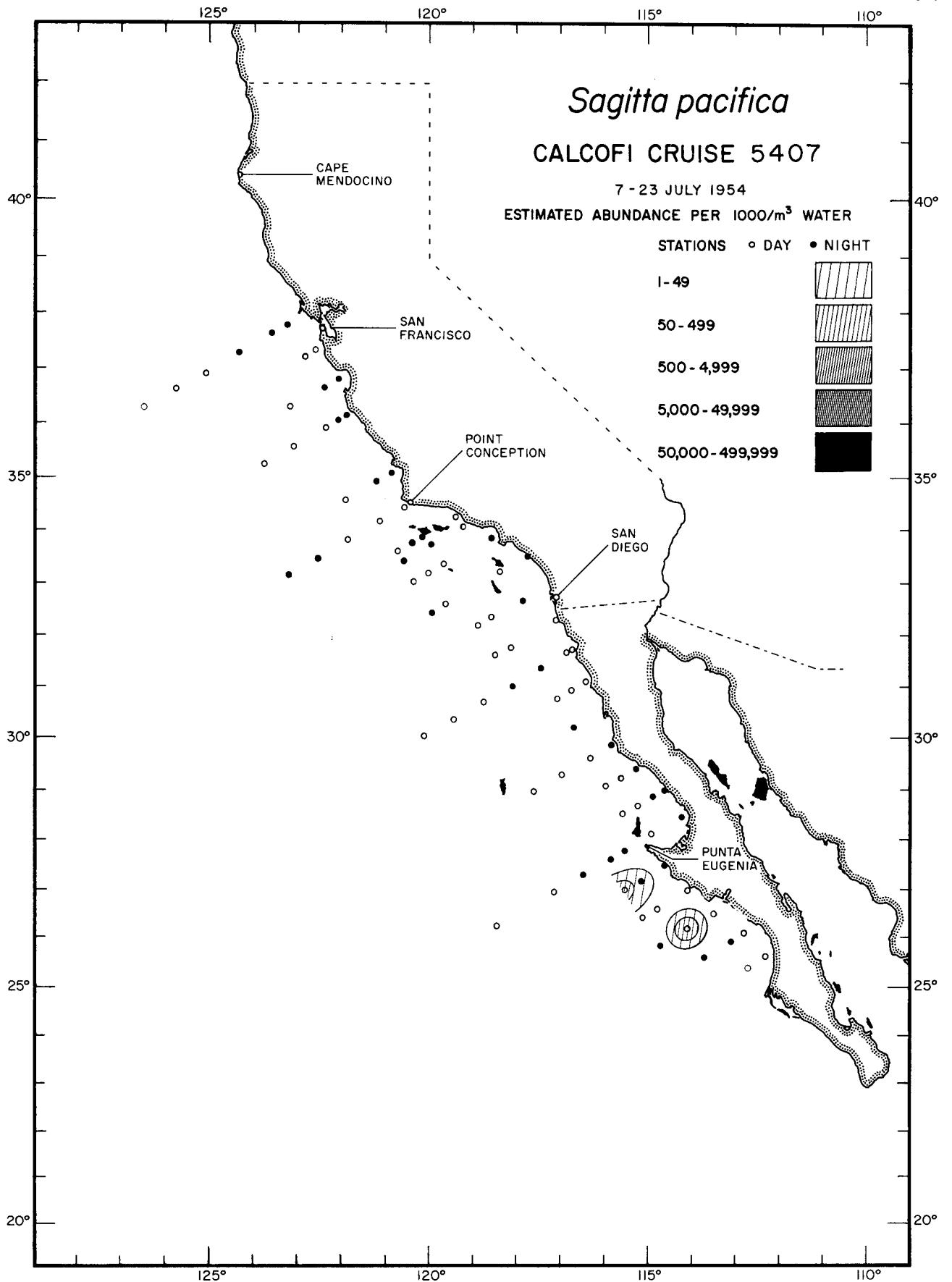
Chaetognatha
Sagitta euneritica
5407



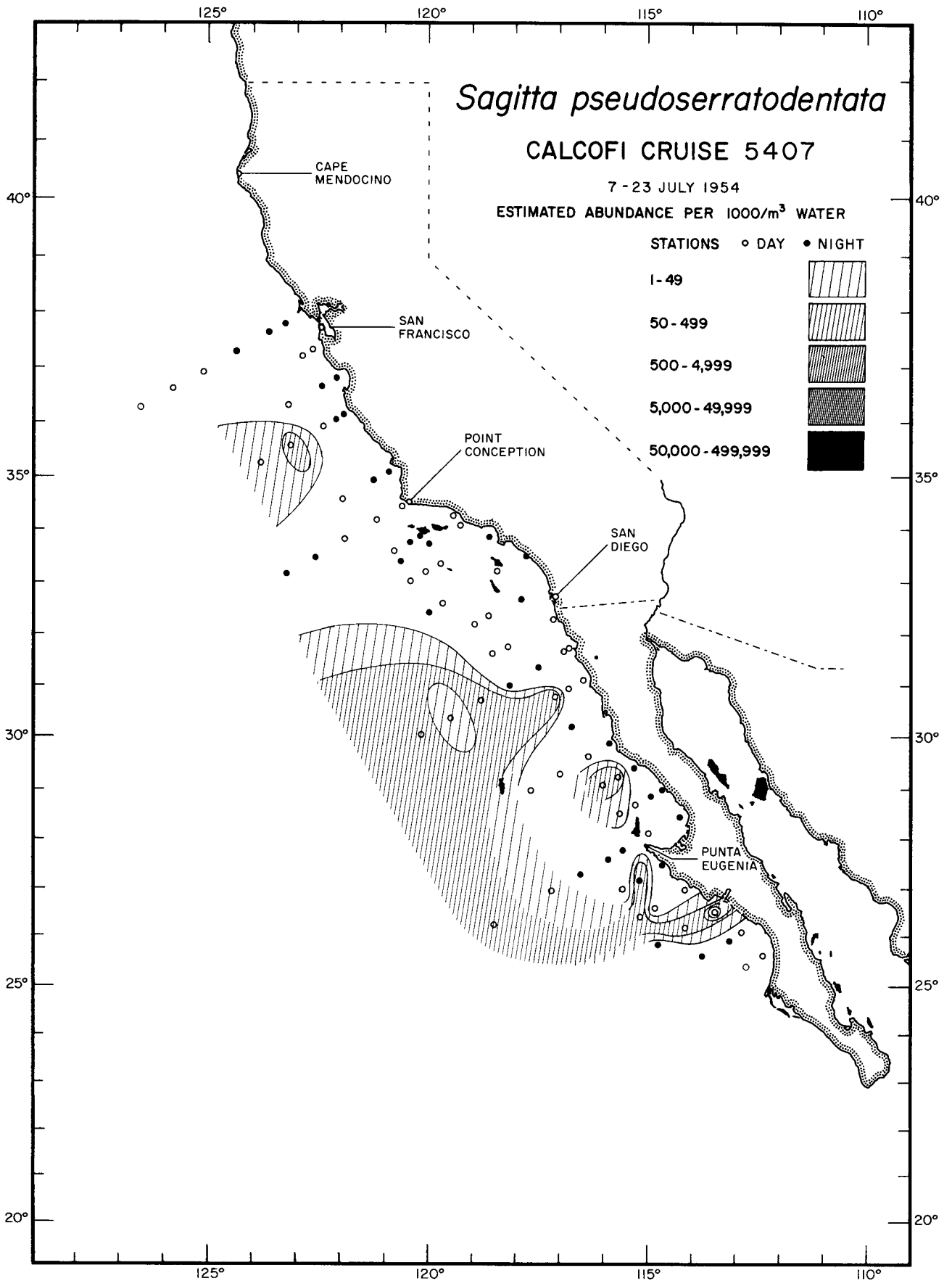
Chaetognatha
Sagitta hexaptera
5407



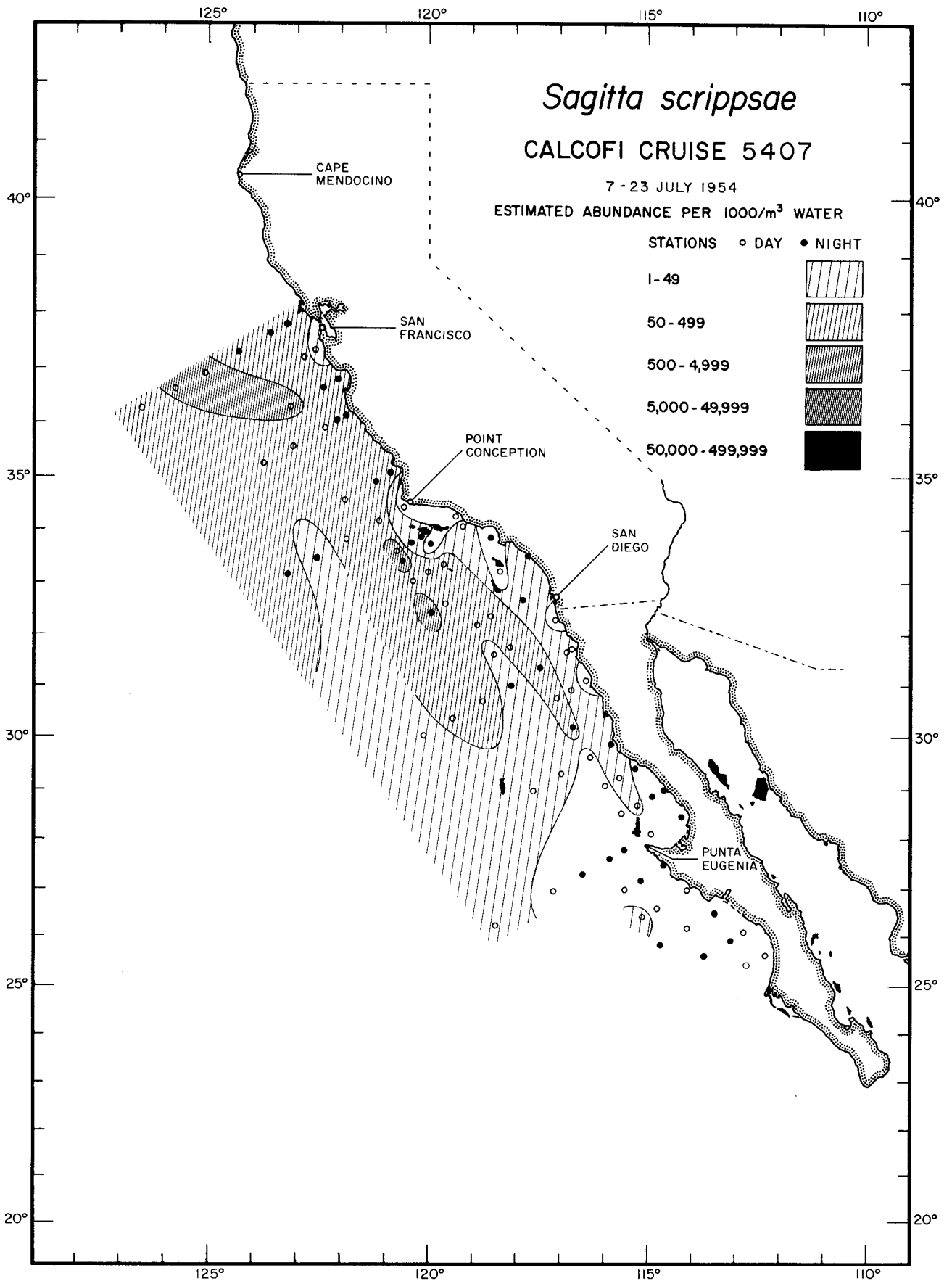
Chaetognatha
Sagitta minima
5407



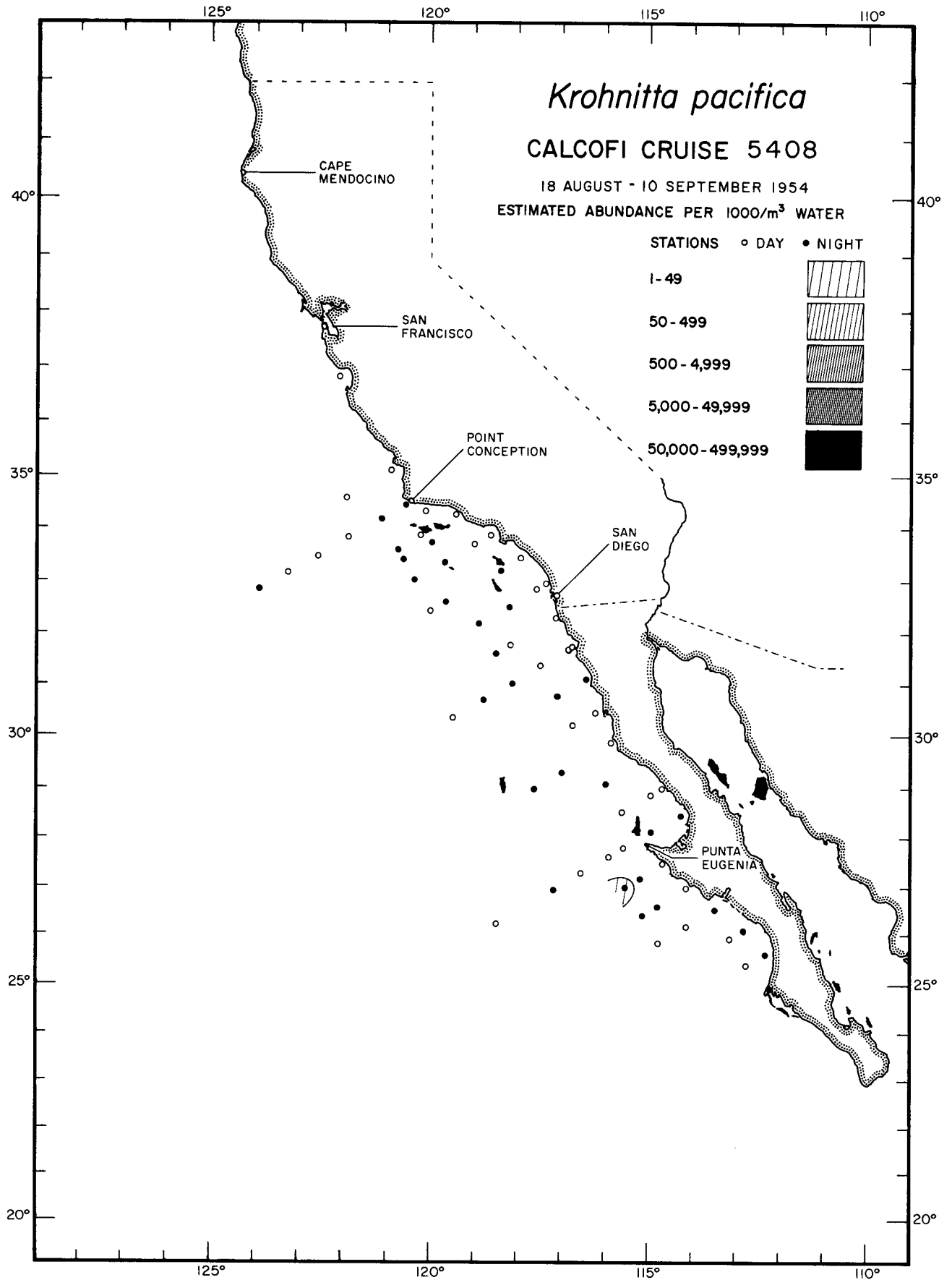
Chaetognatha
Sagitta pacifica
5407



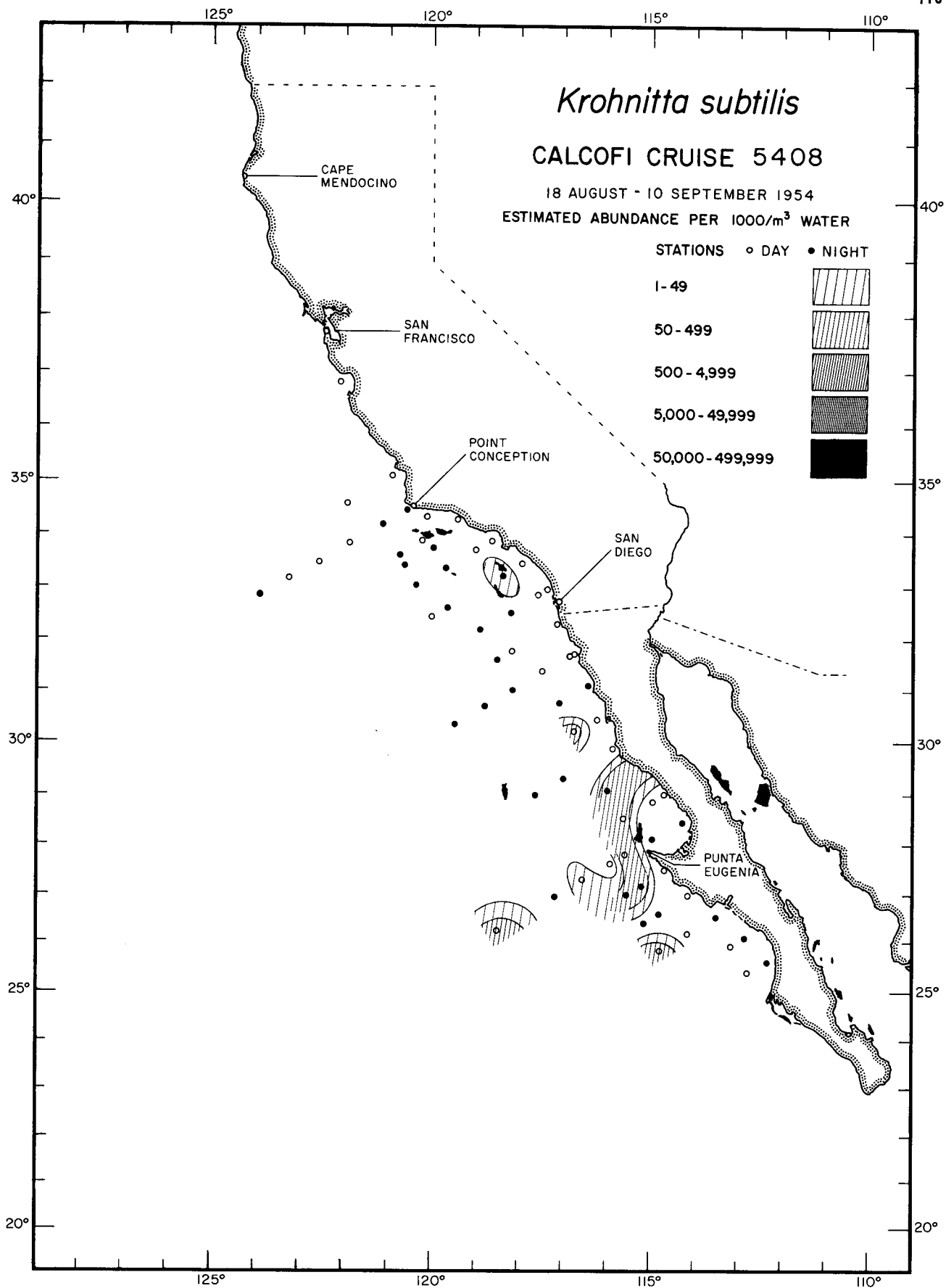
Chaetognatha
Sagitta pseudoserratodentata
5407



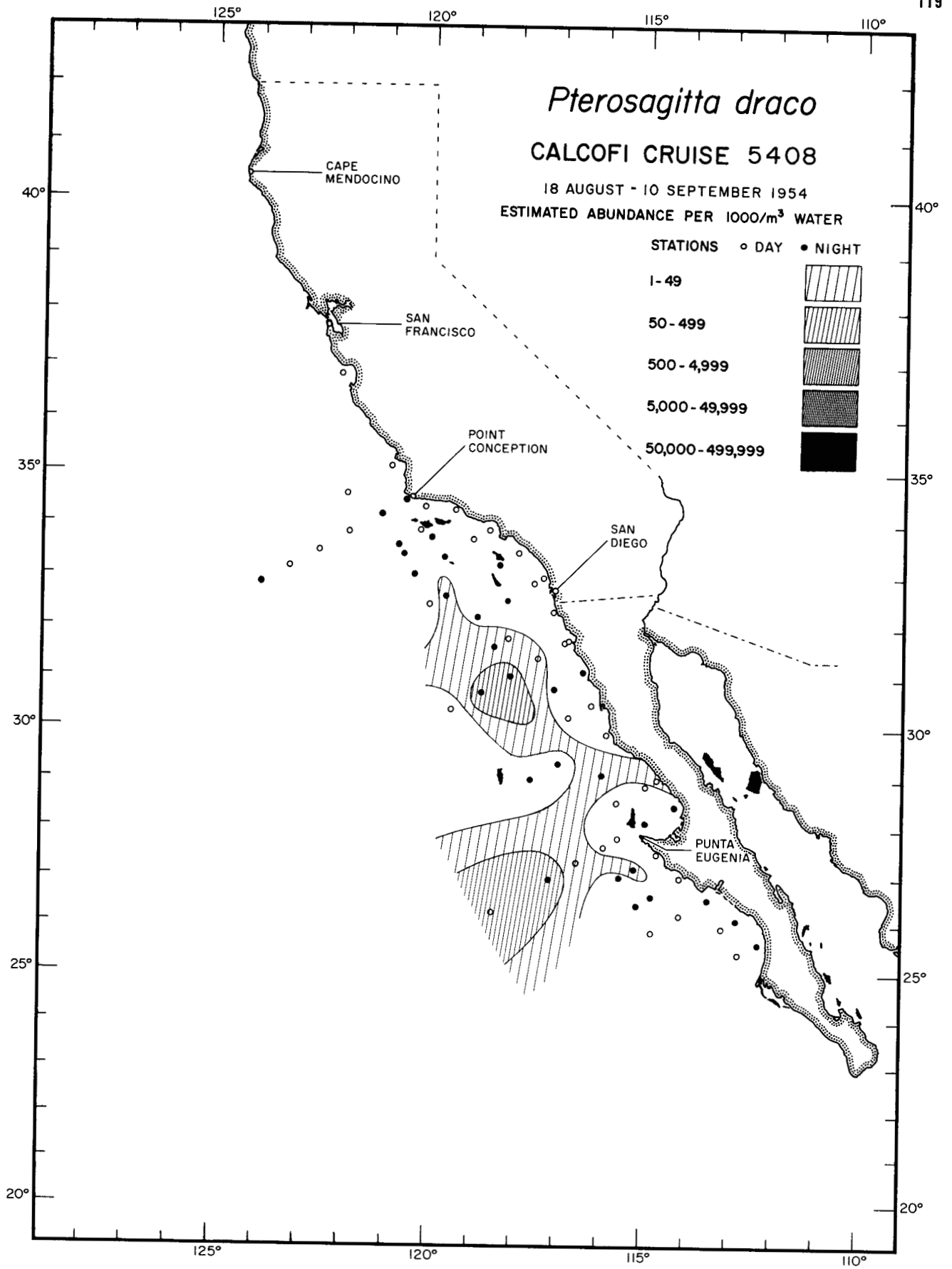
Chaetognatha
Sagitta scrippsae
5407



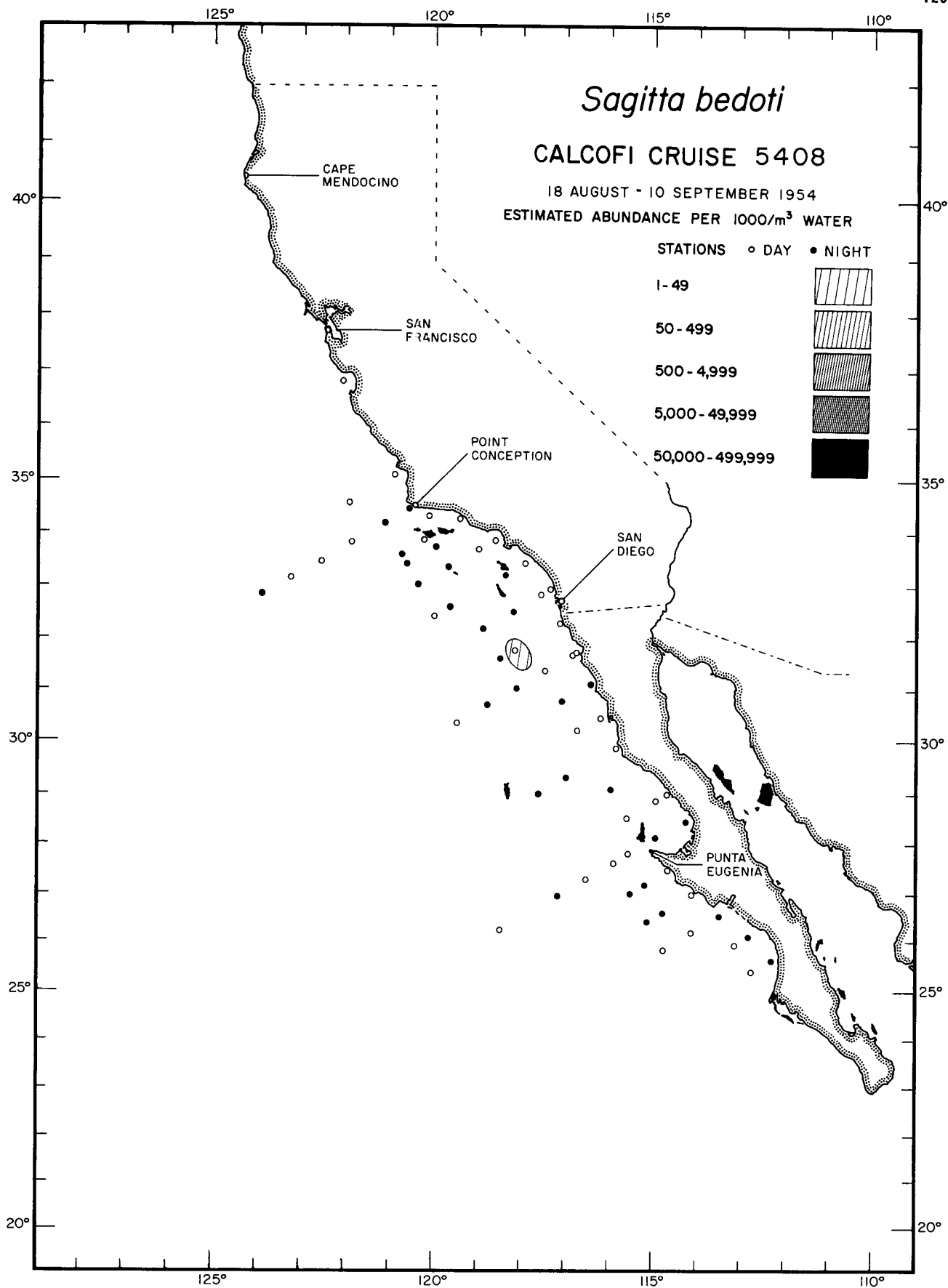
Chaetognatha
Krohnitta pacifica
5408



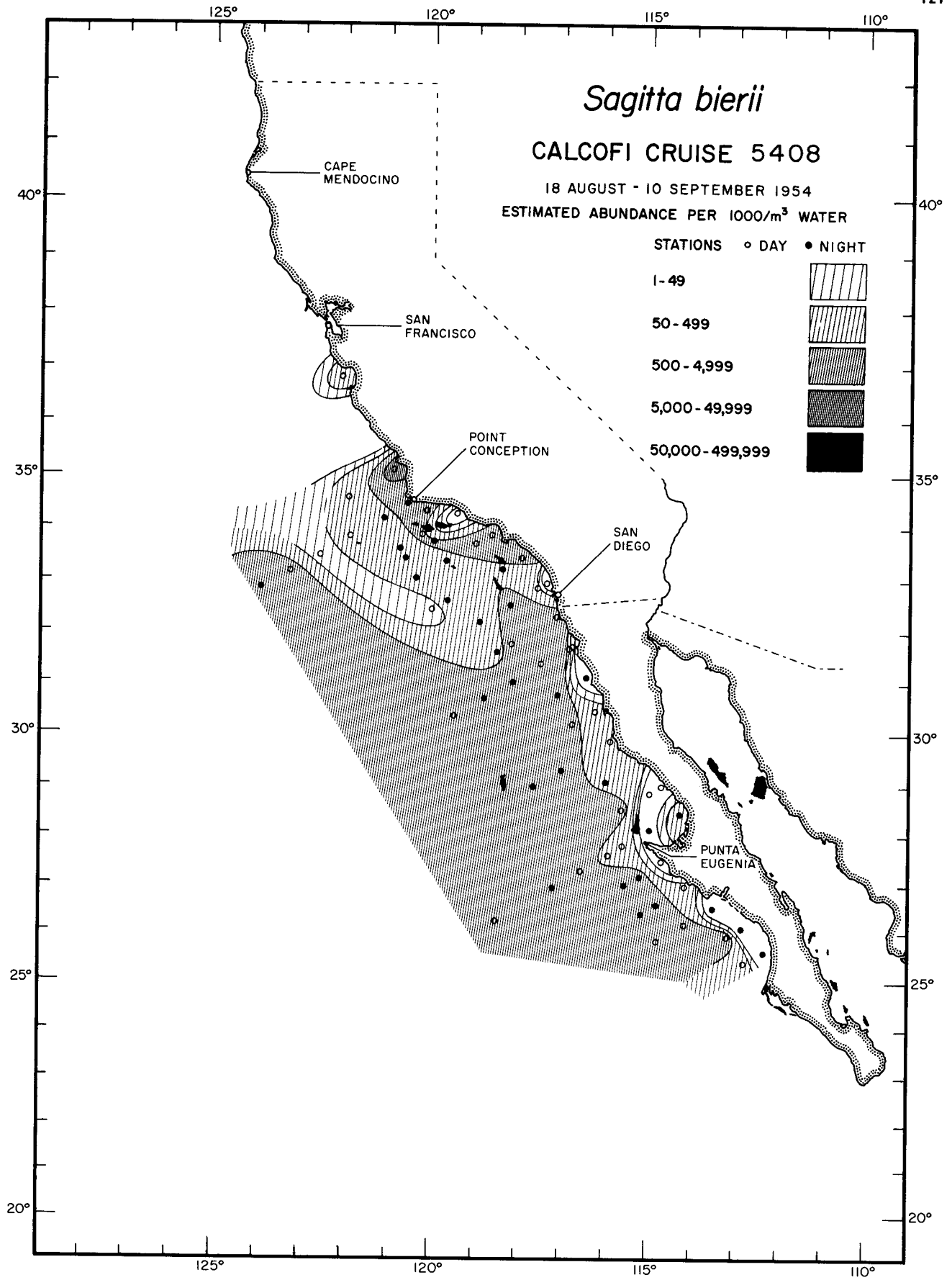
Chaetognatha
Krohnitta subtilis
 5408



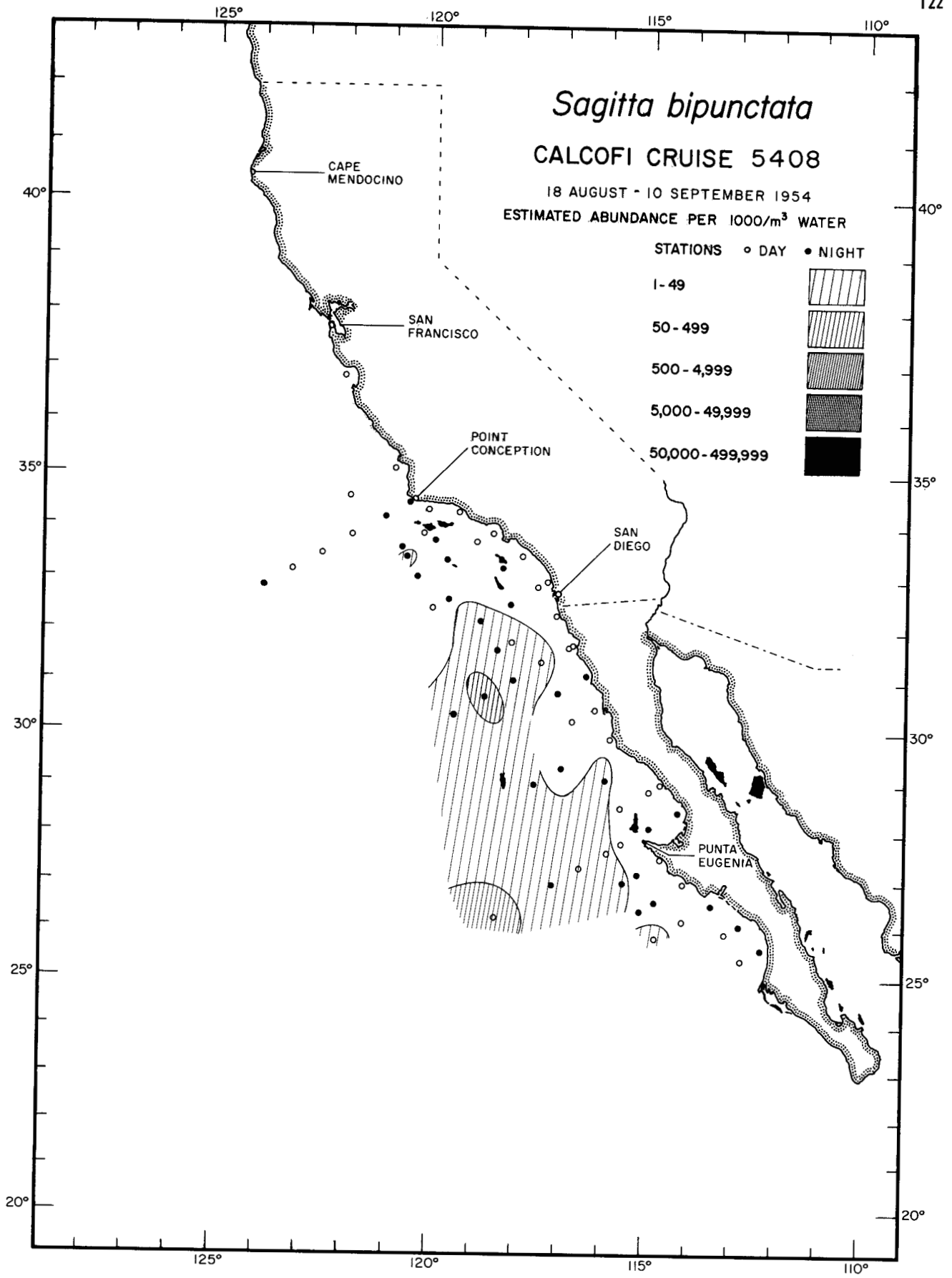
Chaetognatha
Pterosagitta draco
5408



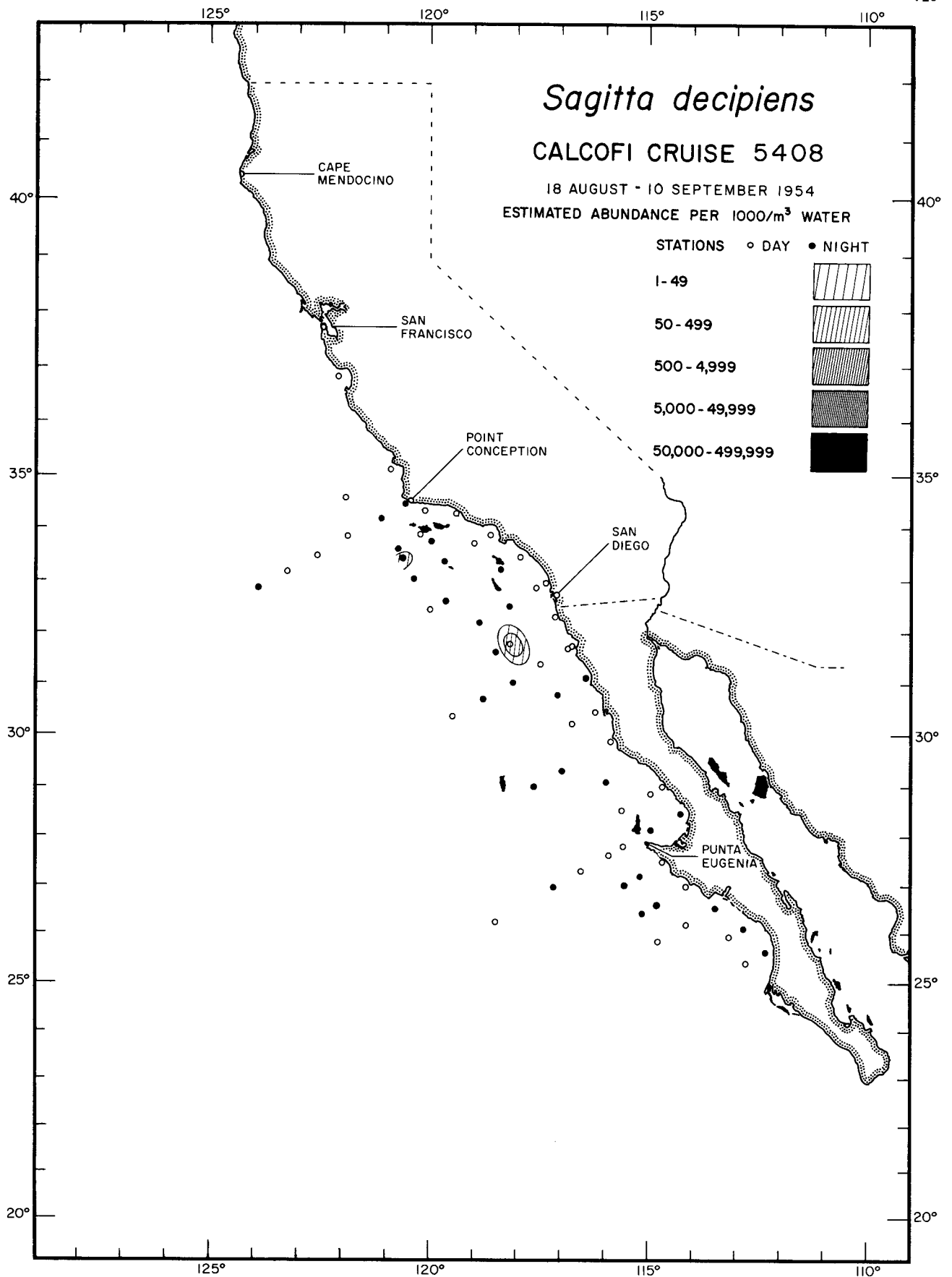
Chaetognatha
Sagitta bedoti
 5408



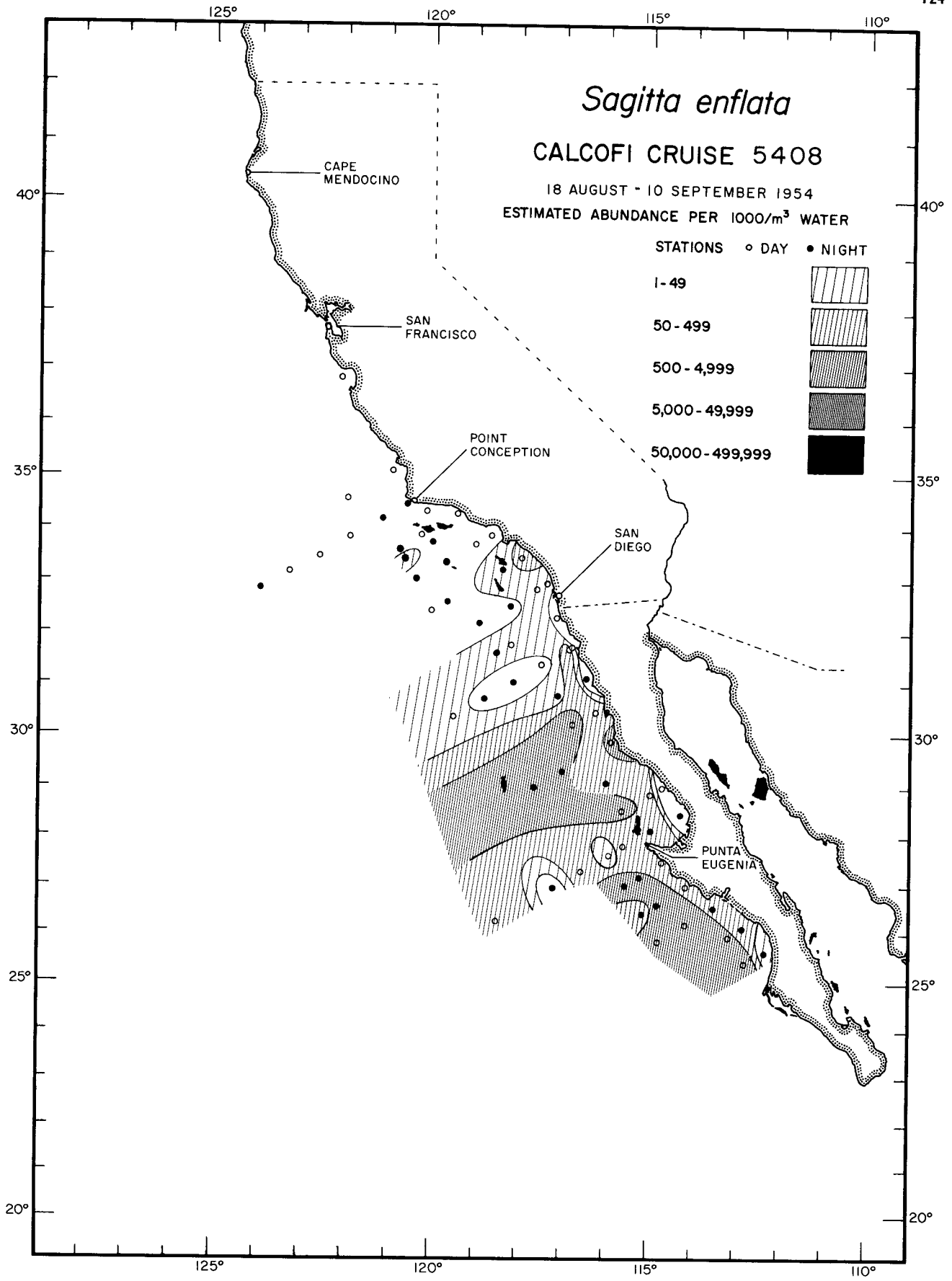
Chaetognatha
Sagitta bierii
 5408



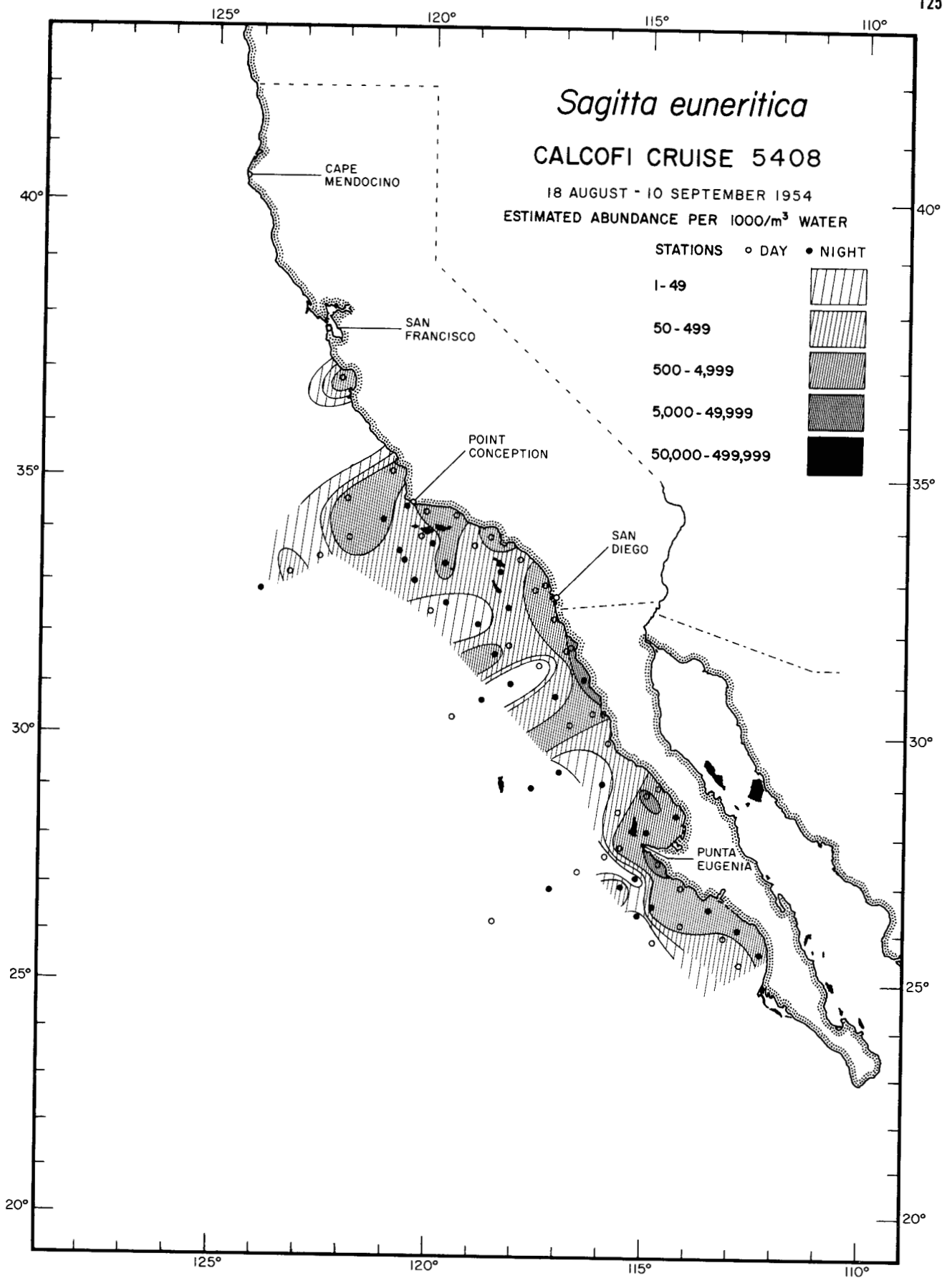
Chaetognatha
Sagitta bipunctata
 5408



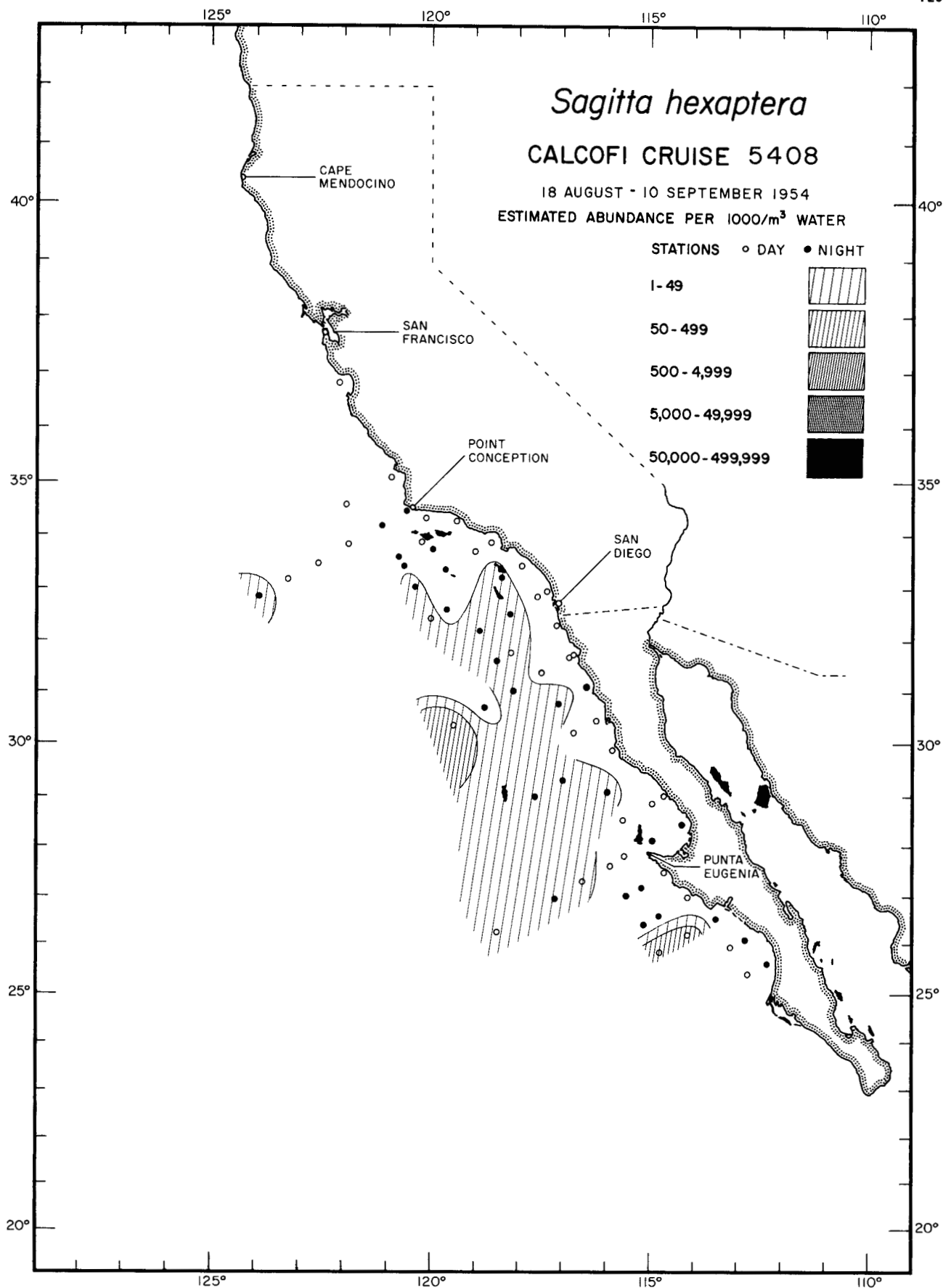
Chaetognatha
Sagitta decipiens
5408



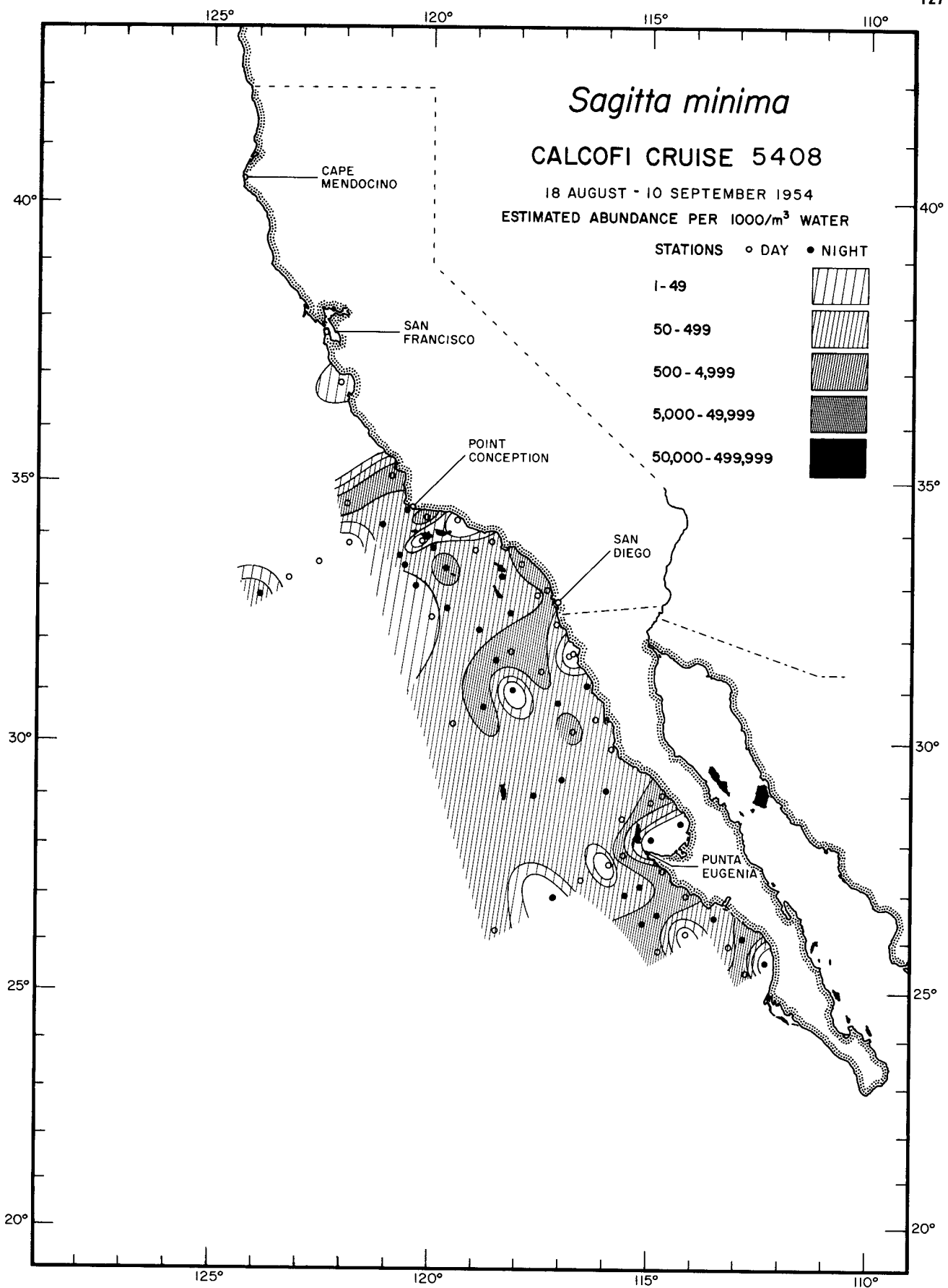
Chaetognatha
Sagitta enflata
5408



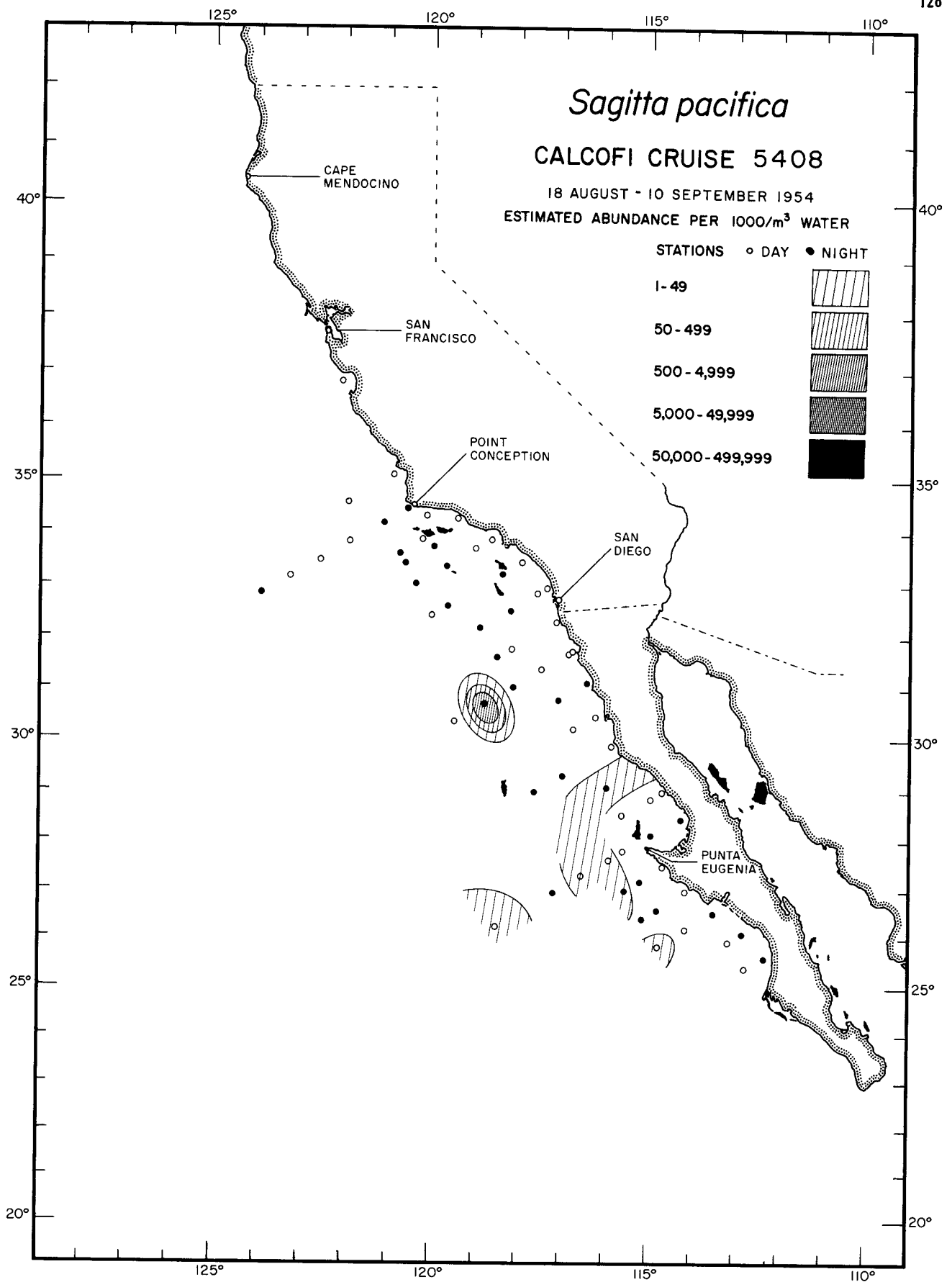
Chaetognatha
Sagitta euneritica
 5408



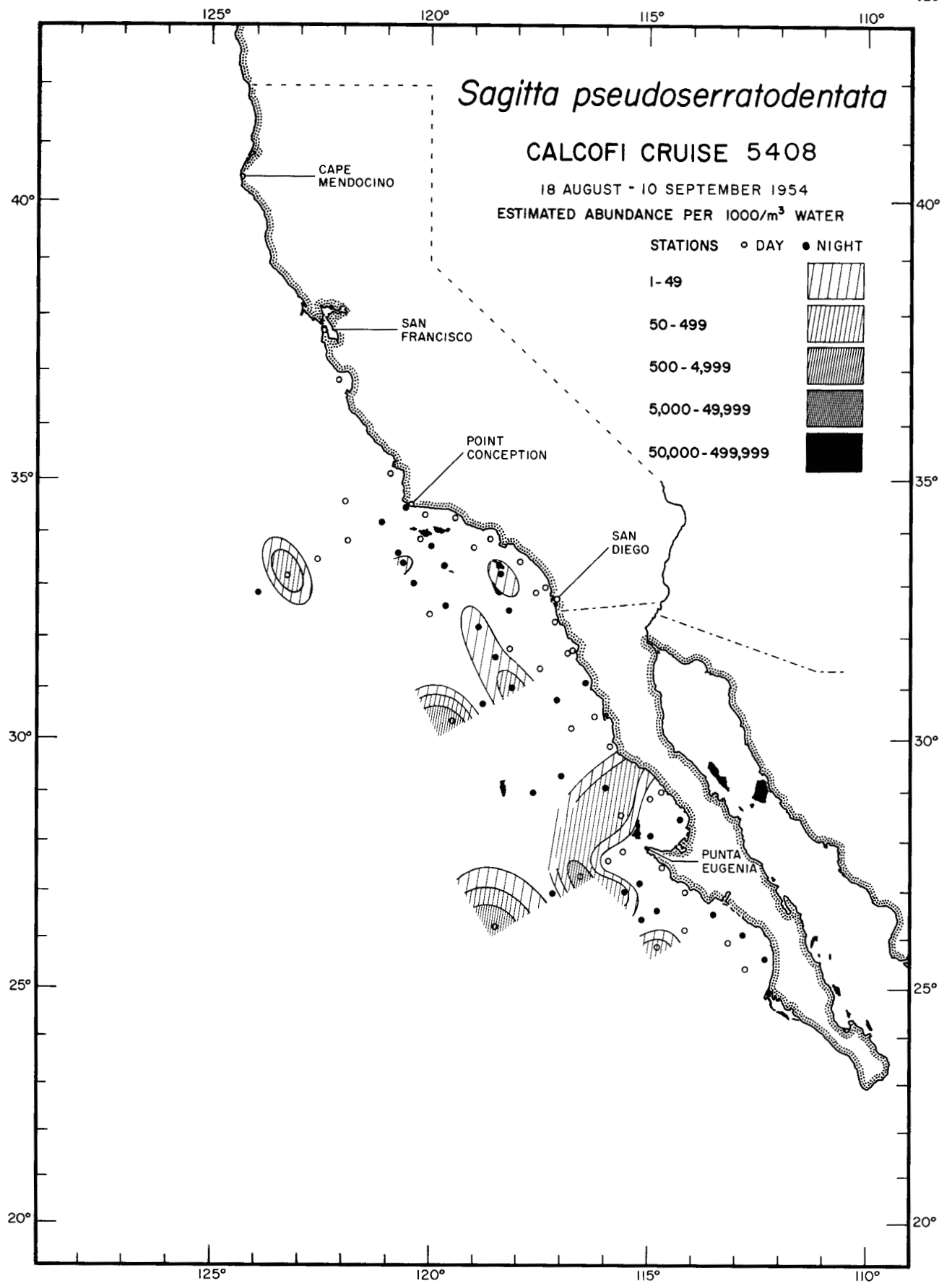
Chaetognatha
Sagitta hexaptera
5408



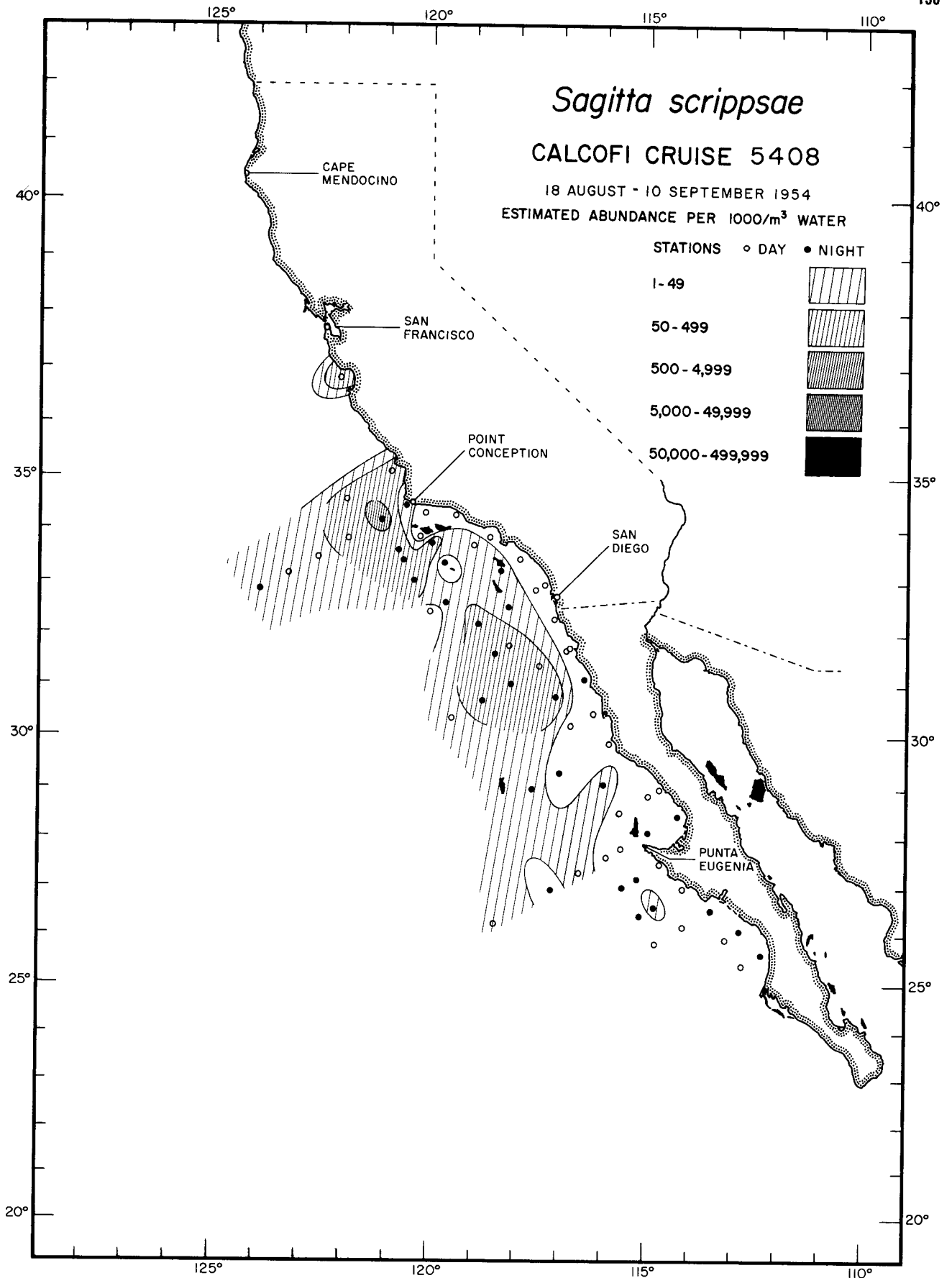
Chaetognatha
Sagitta minima
5408



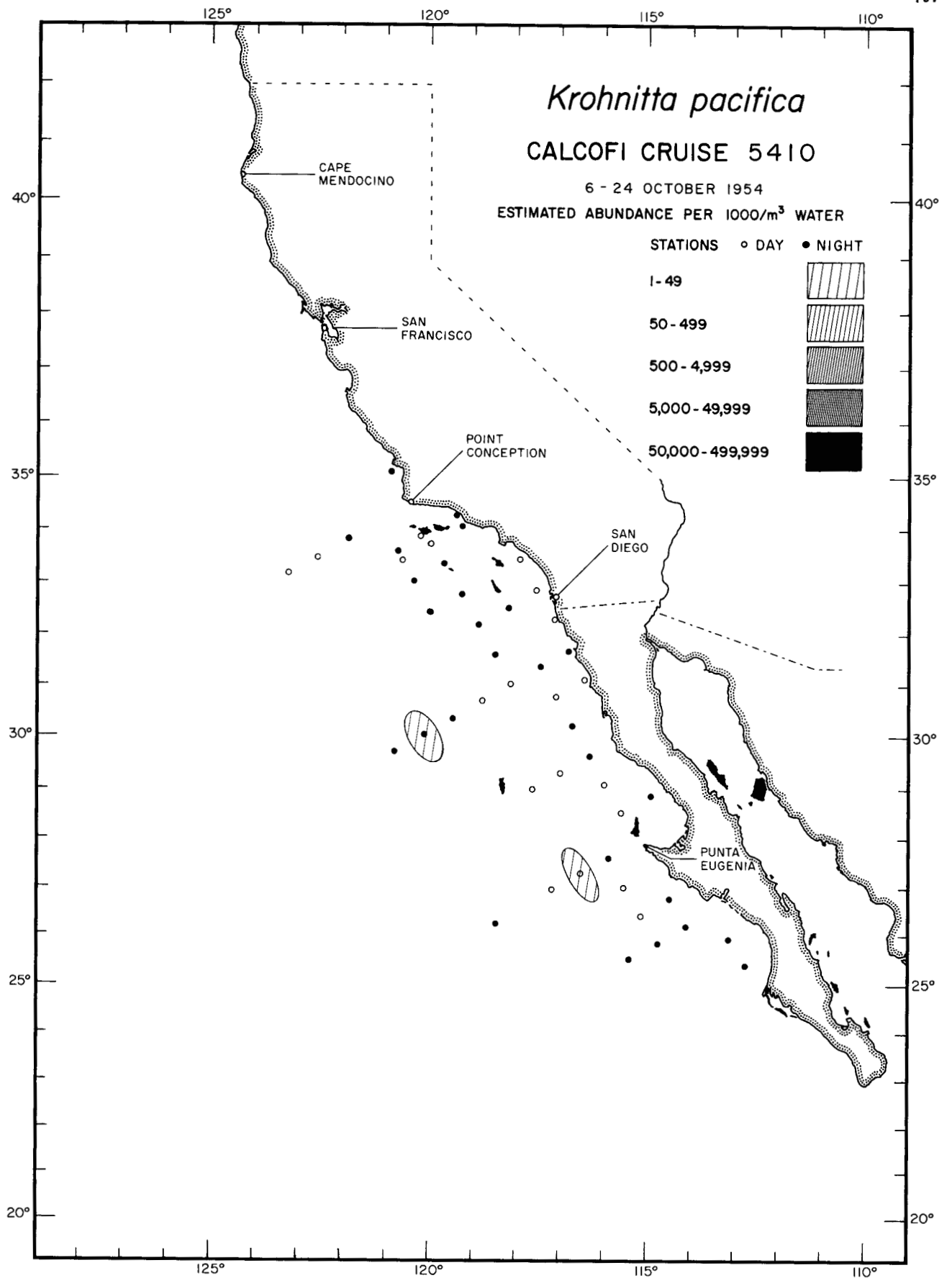
Chaetognatha
Sagitta pacifica
5408



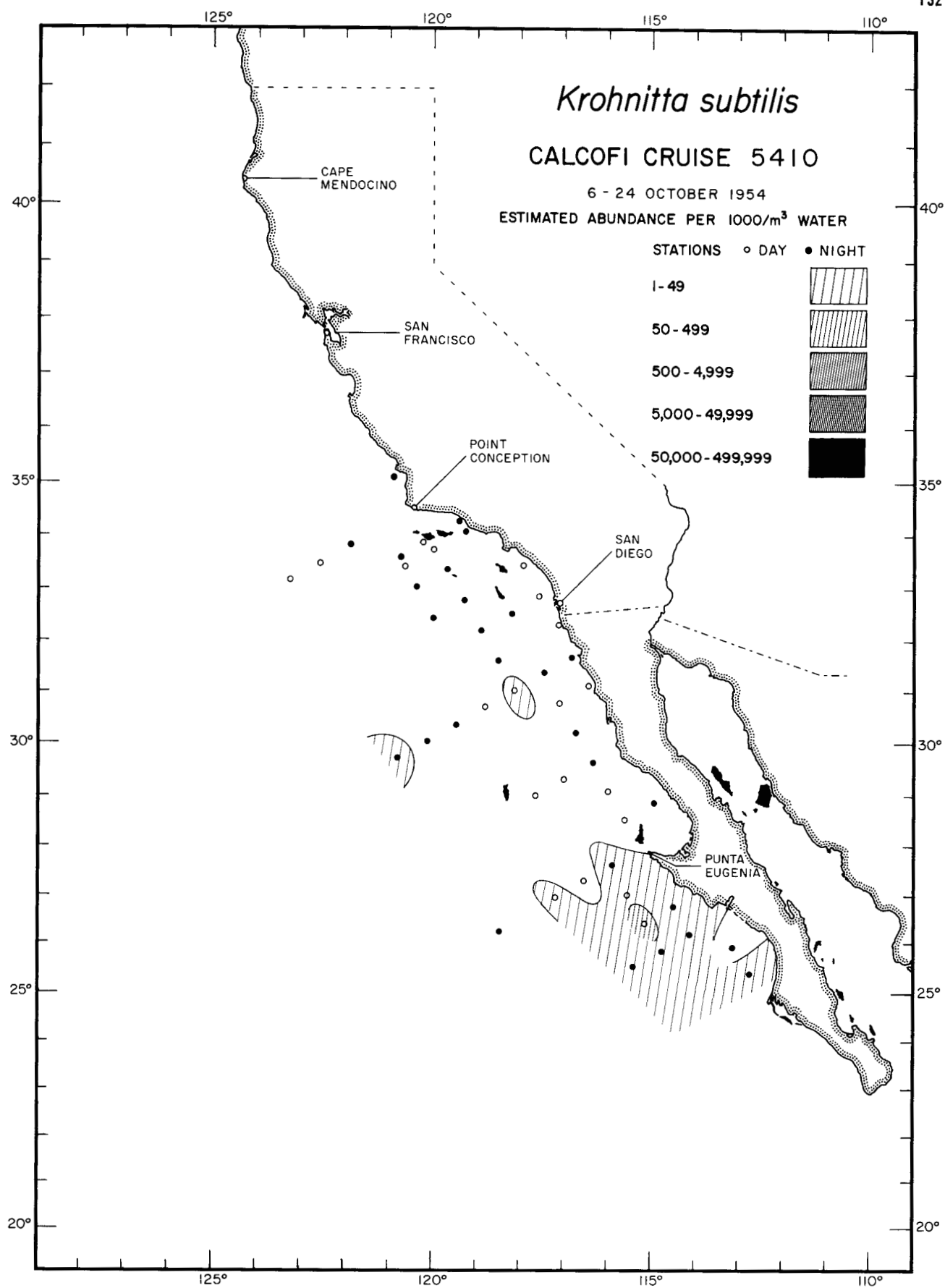
Chaetognatha
Sagitta pseudoserratodentata
5408



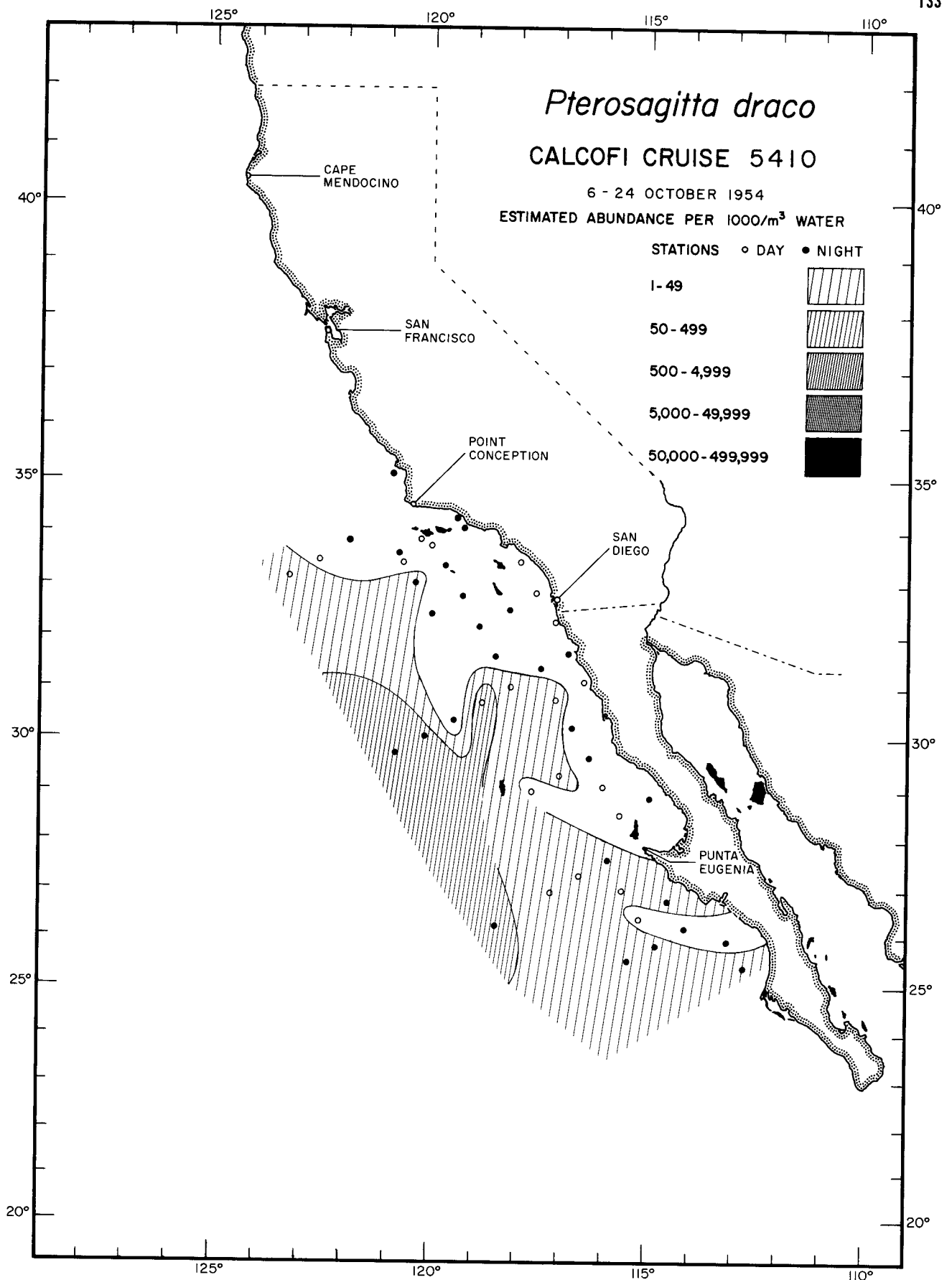
Chaetognatha
Sagitta scrippsae
5408



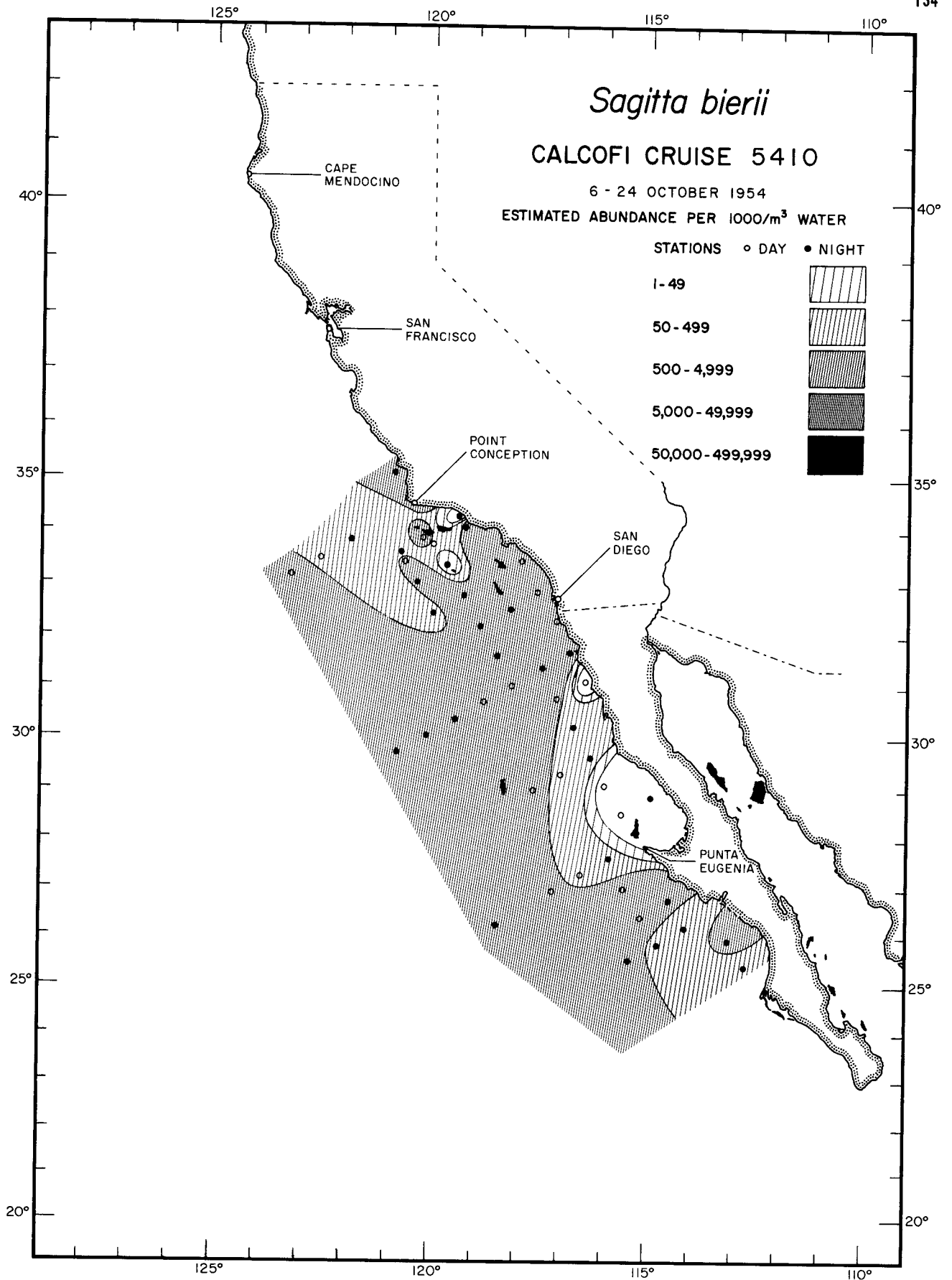
Chaetognatha
Krohnitta pacifica
5410



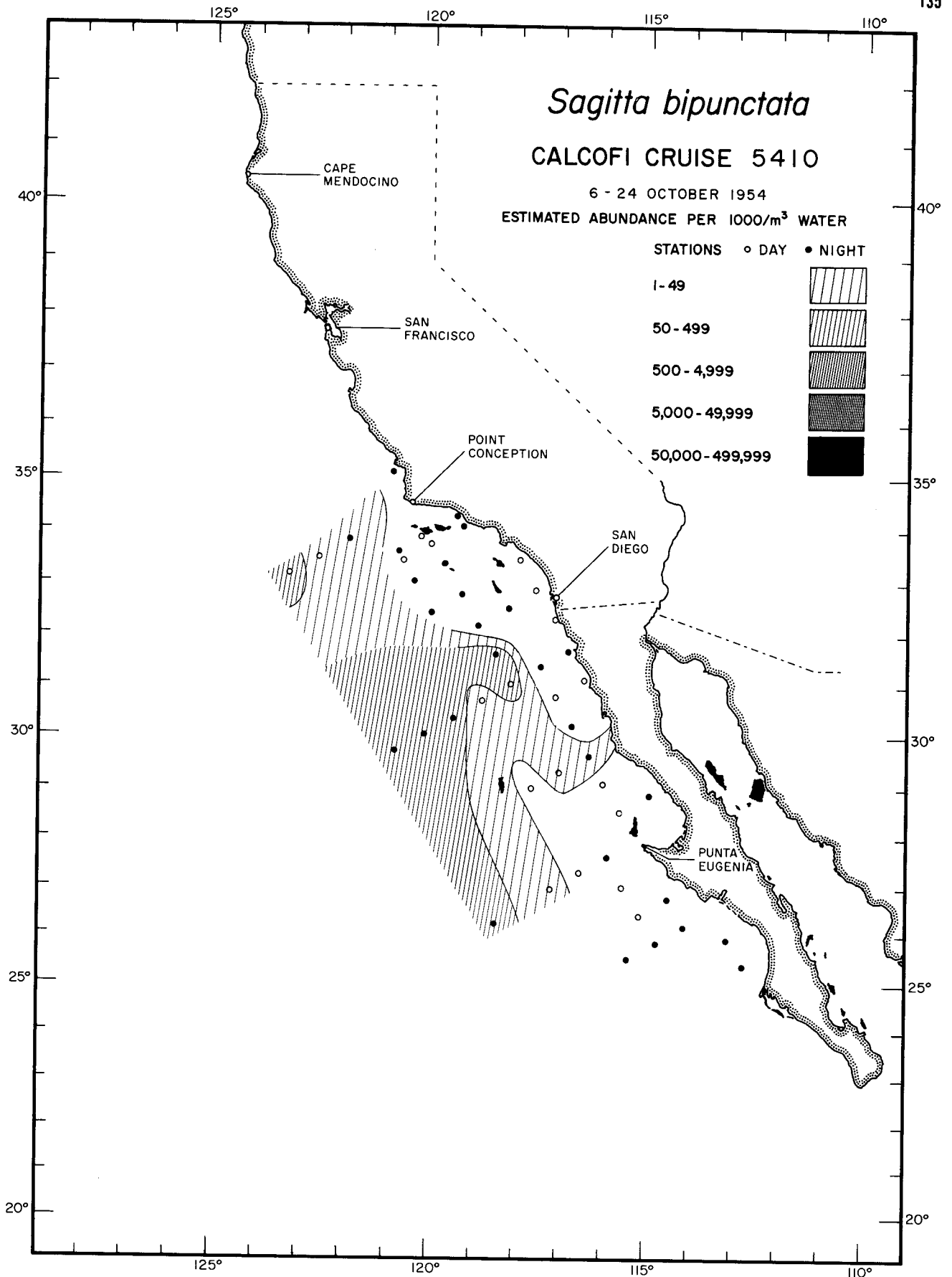
Chaetognatha
Krohnitta subtilis
5410



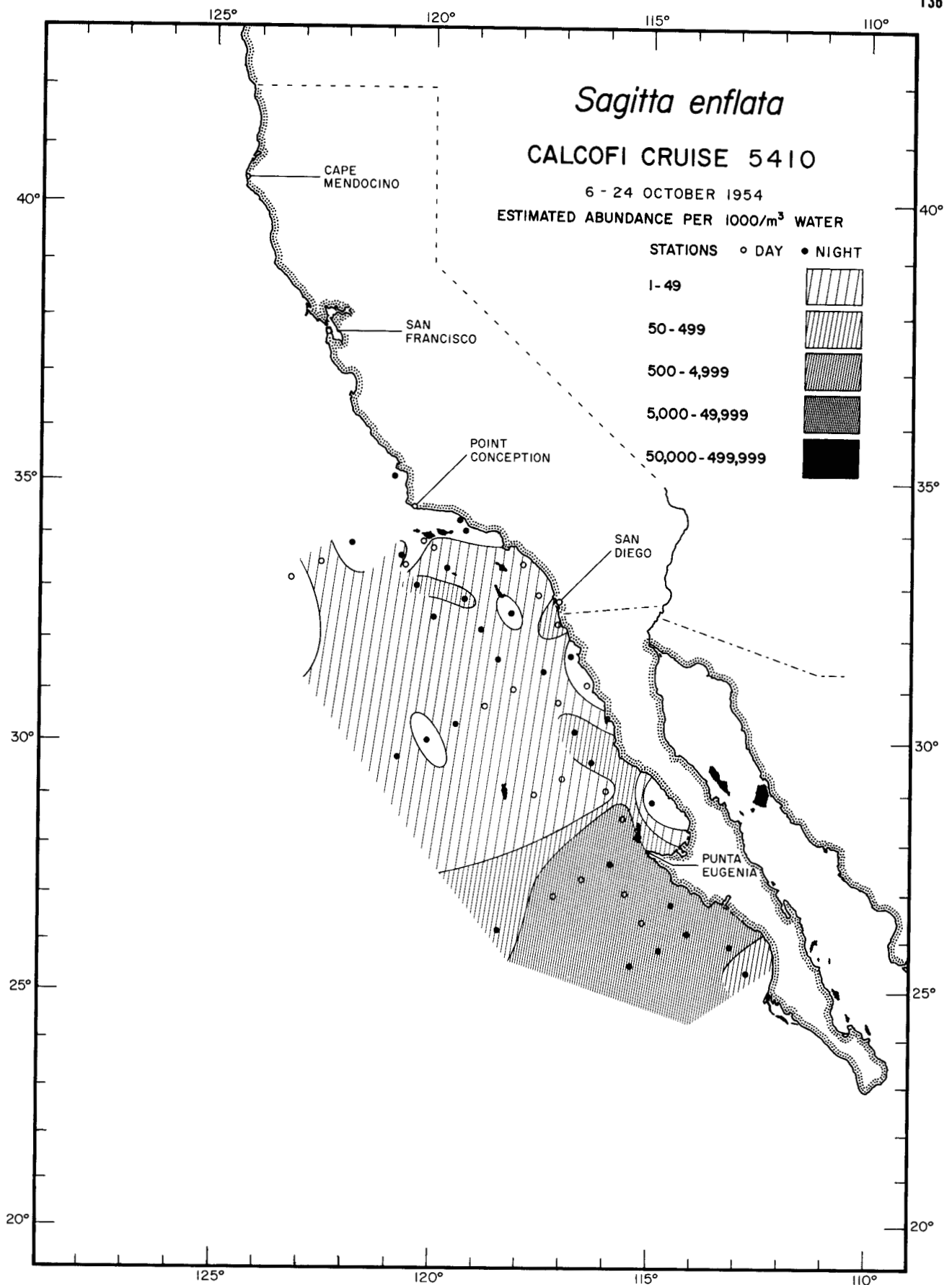
Chaetognatha
Pterosagitta draco
5410



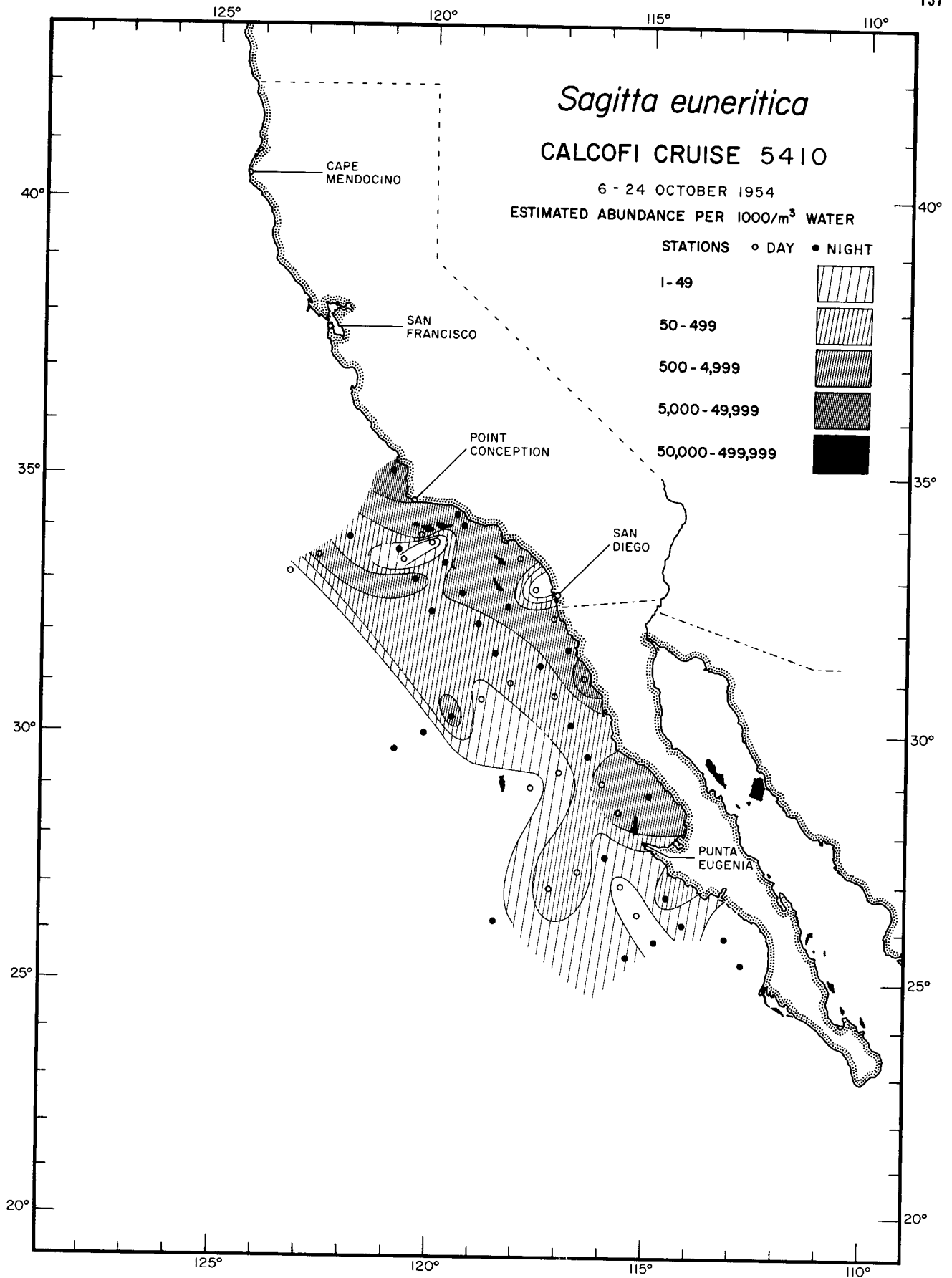
Chaetognatha
Sagitta bierii
5410



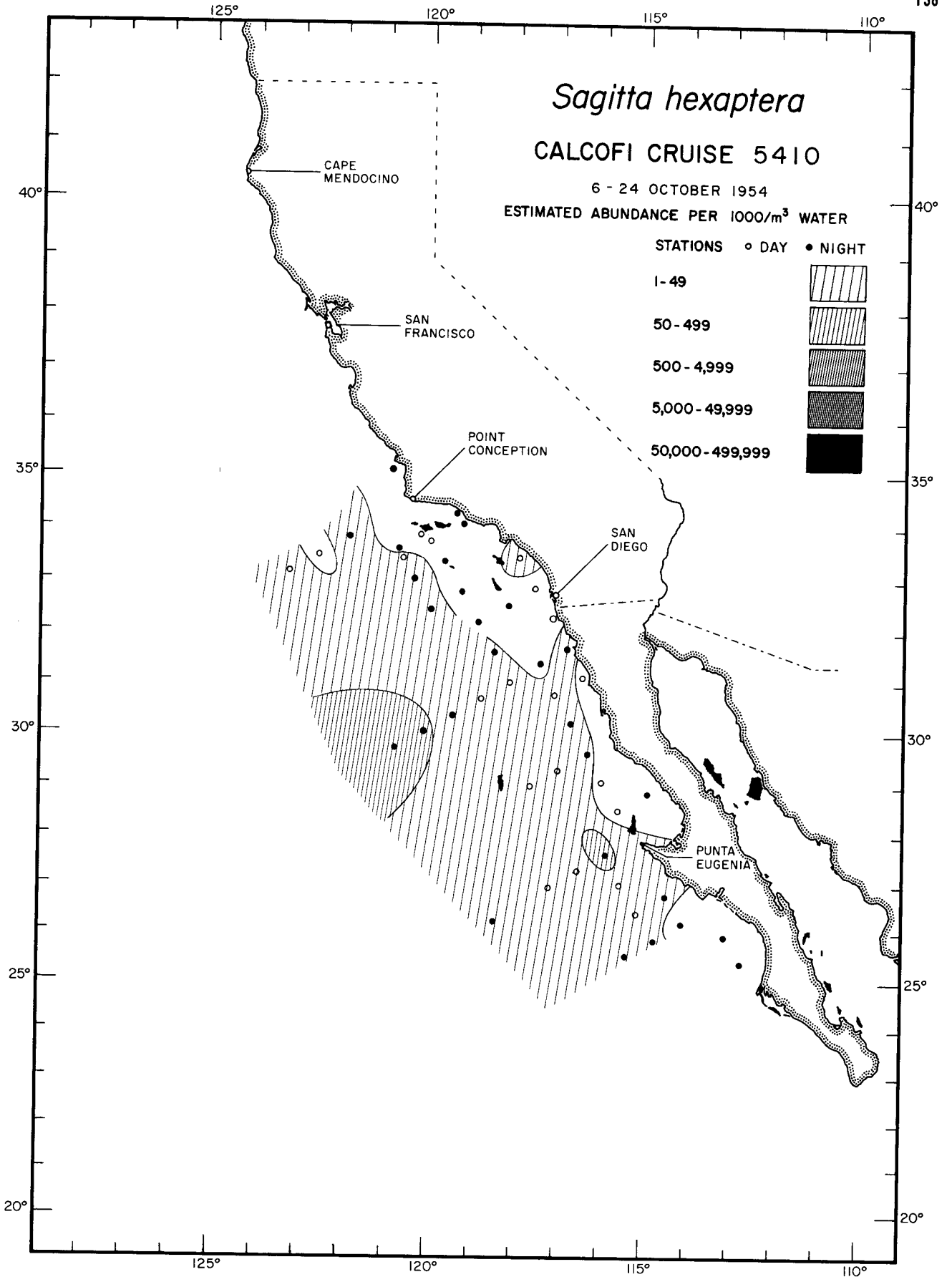
Chaetognatha
Sagitta bipunctata
5410



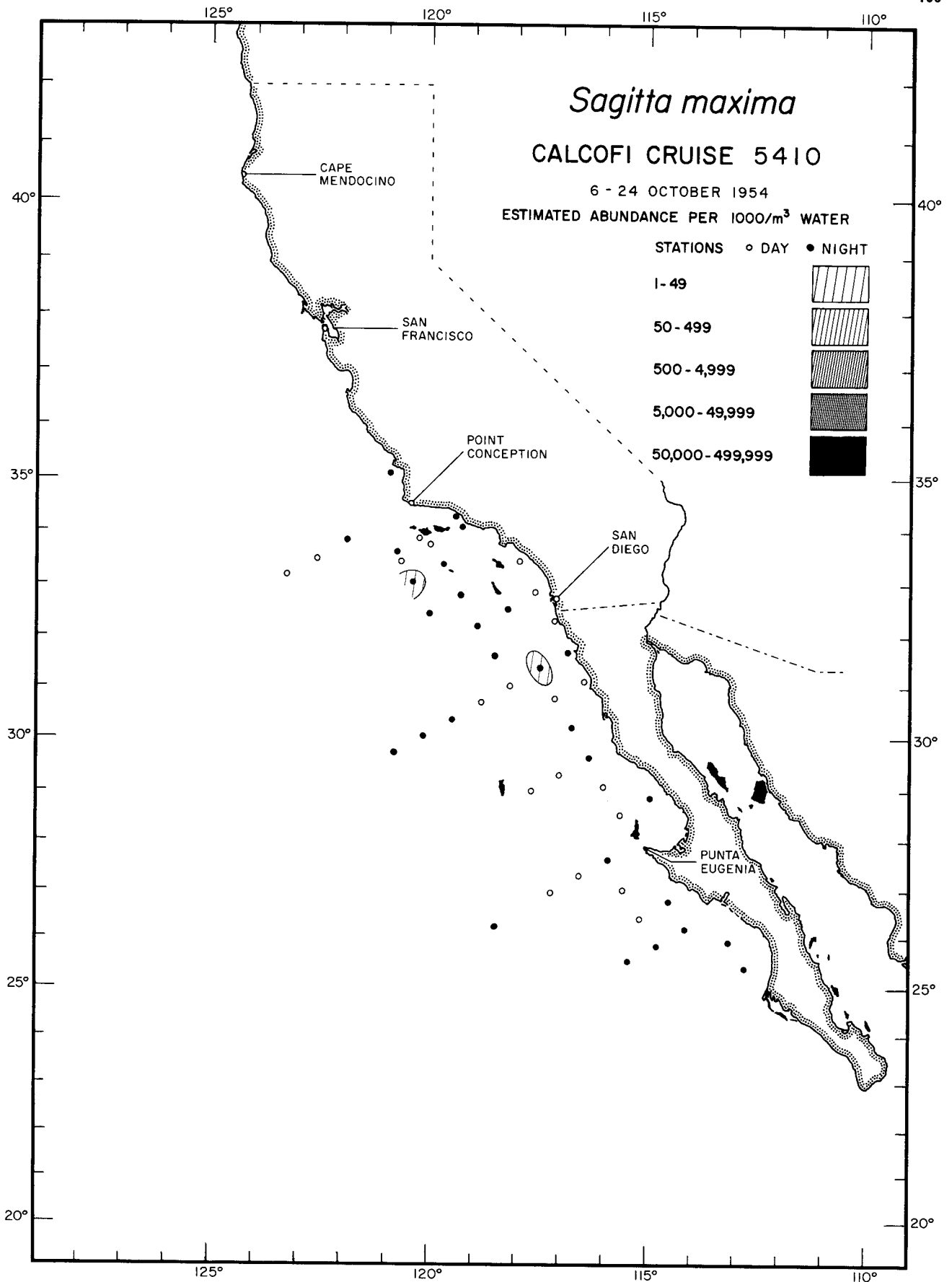
Chaetognatha
Sagitta enflata
5410



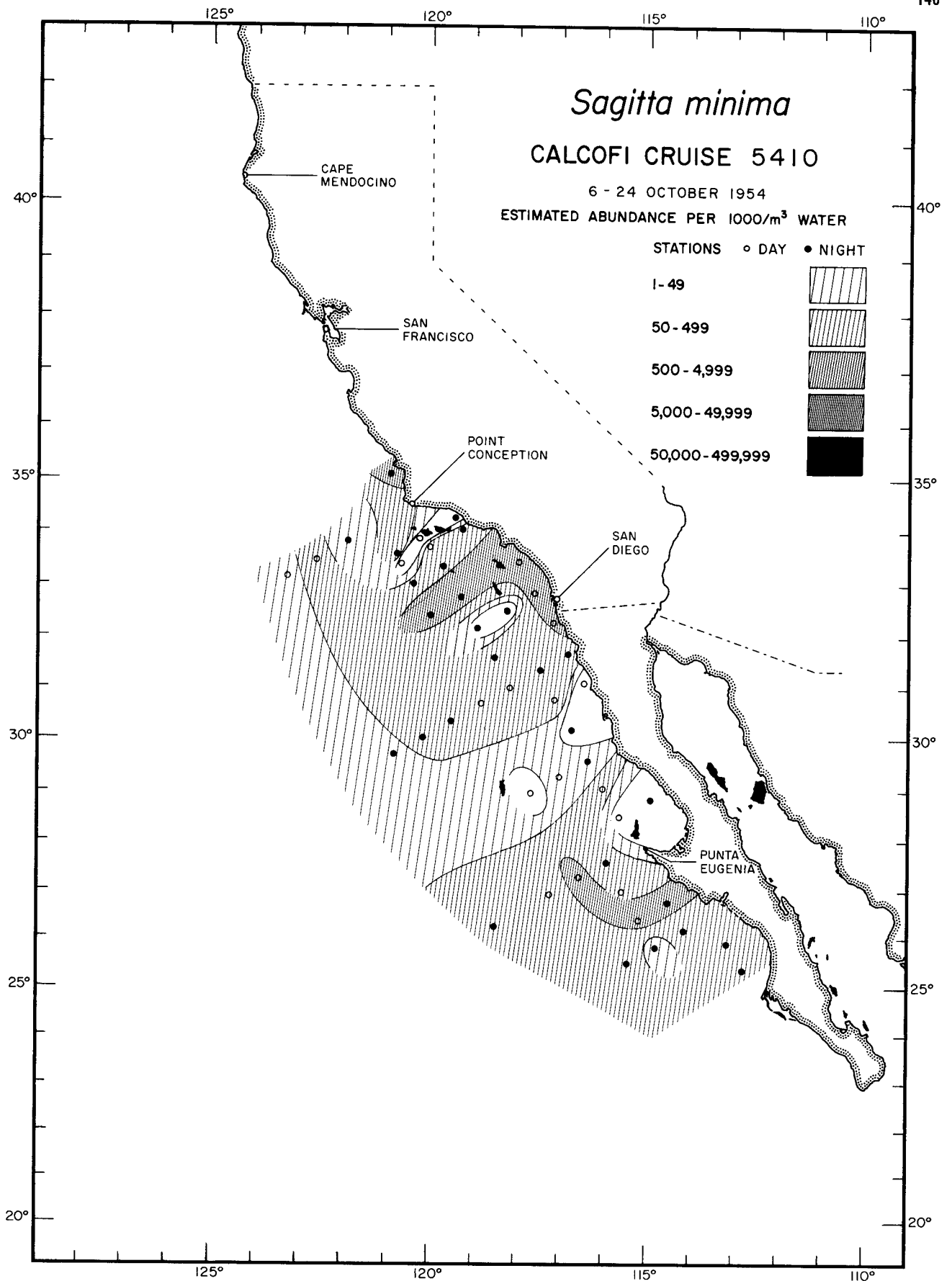
Chaetognatha
Sagitta euneritica
5410



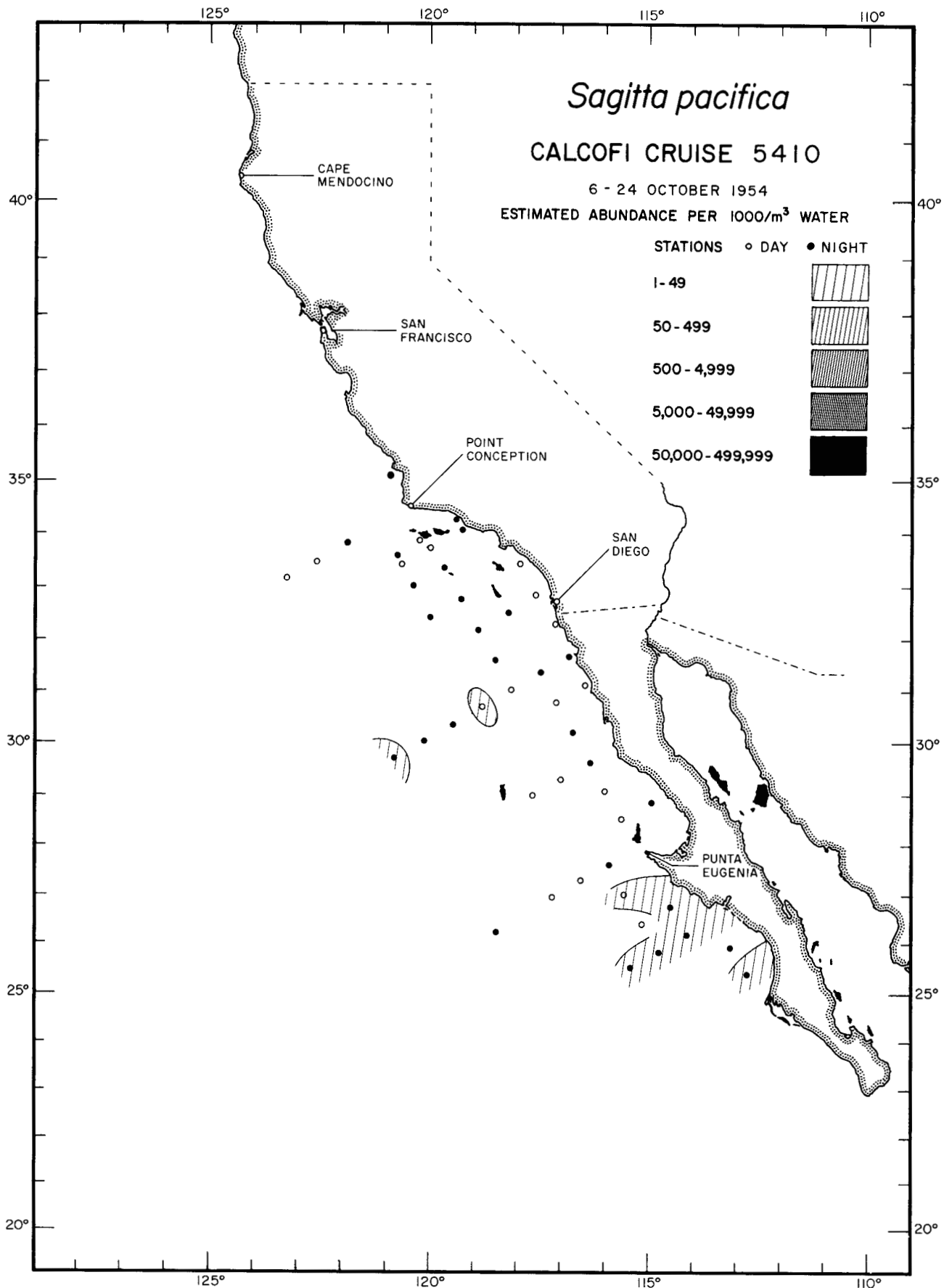
Chaetognatha
Sagitta hexaptera
5410

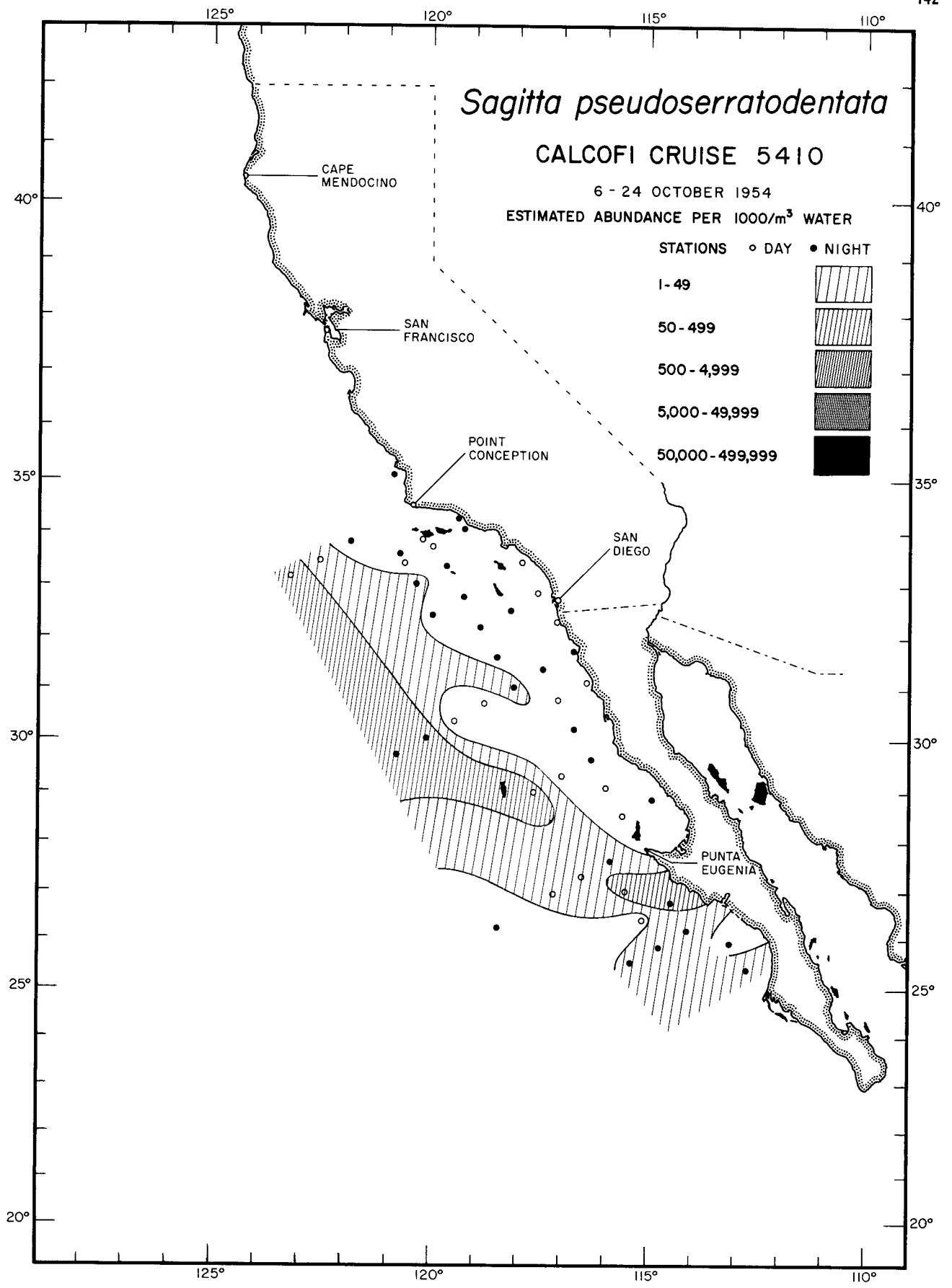


Chaetognatha
Sagitta maxima
5410

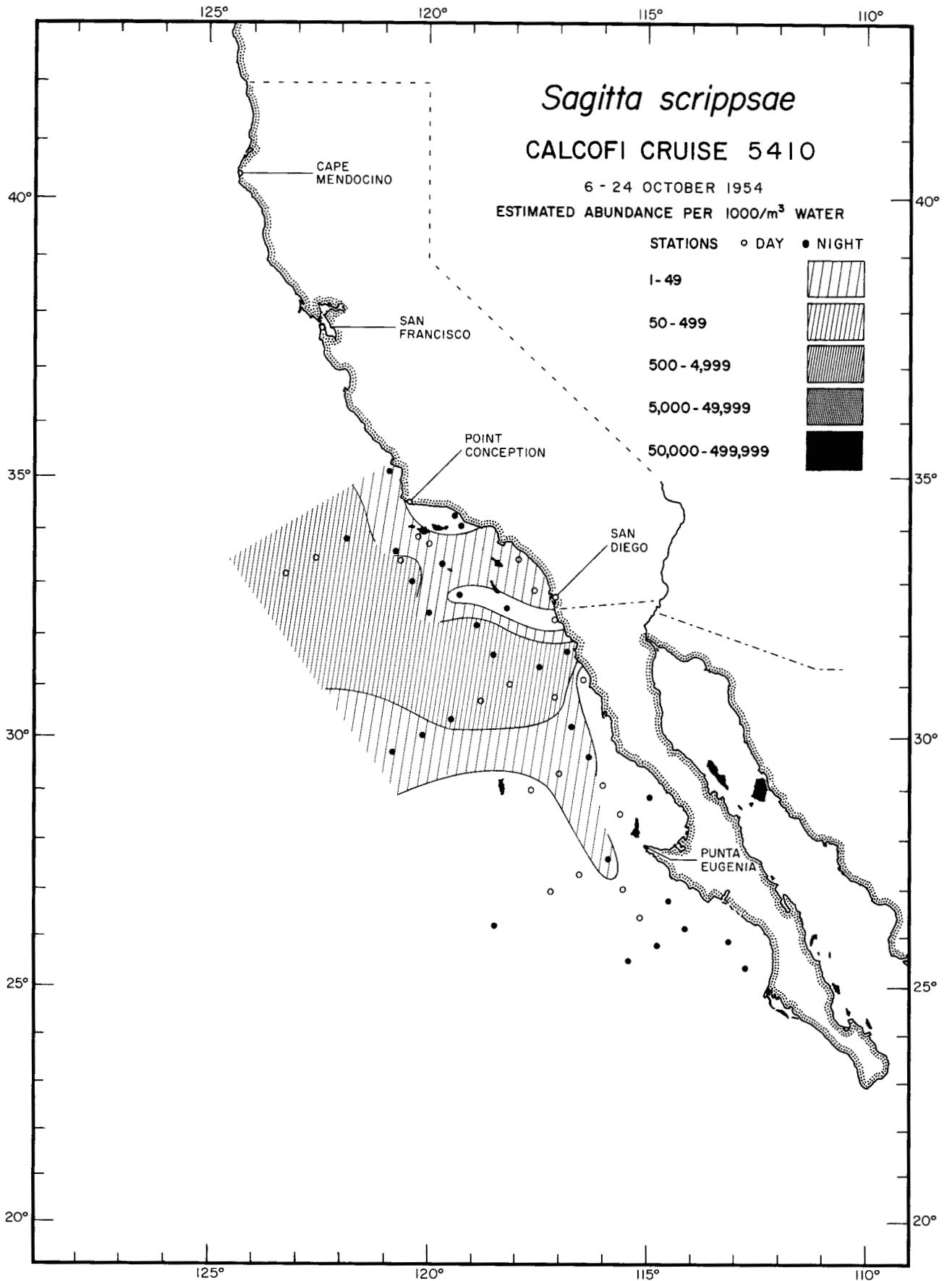


Chaetognatha
Sagitta minima
5410

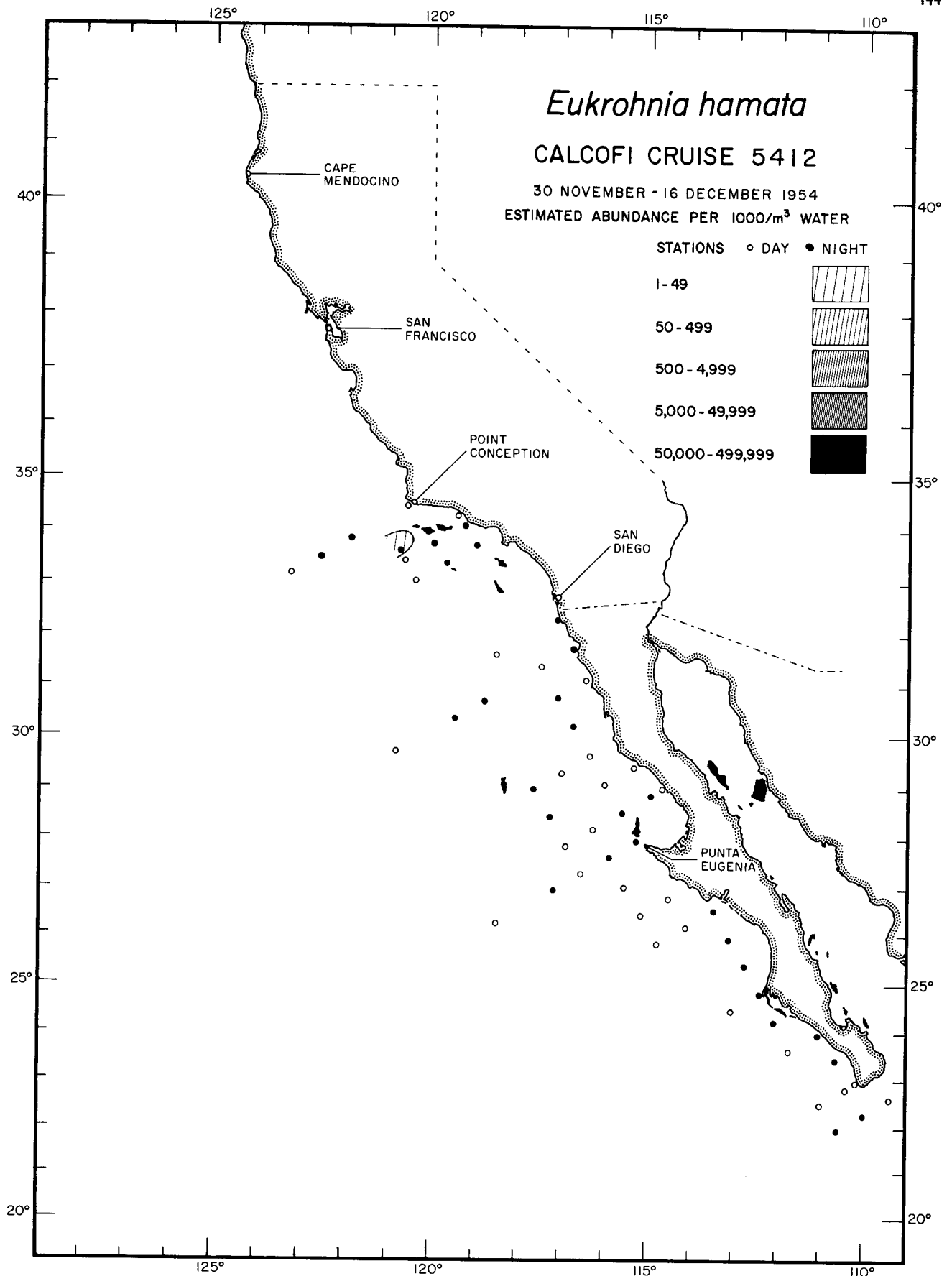




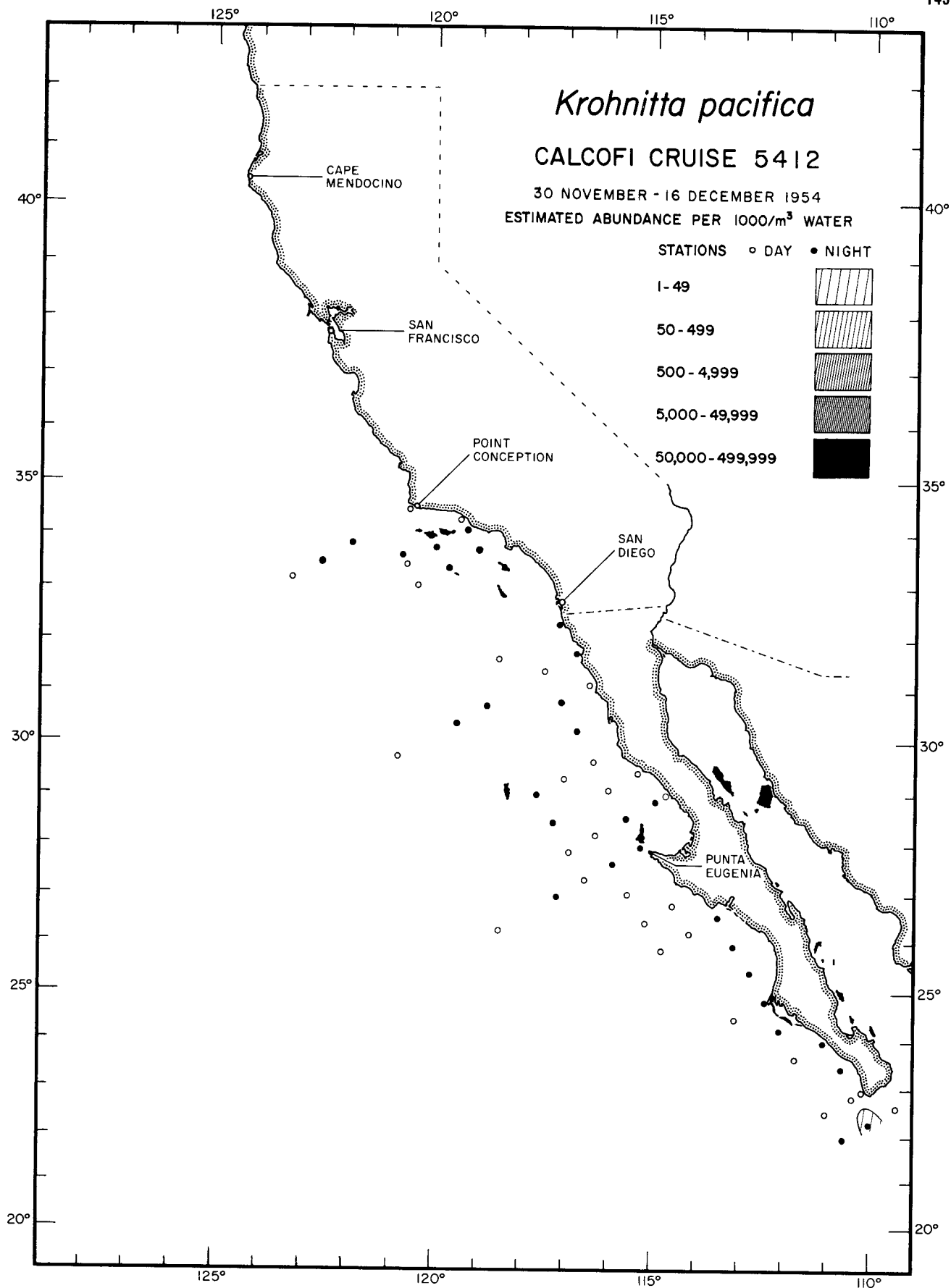
Chaetognatha
Sagitta pseudoserratodentata
5410



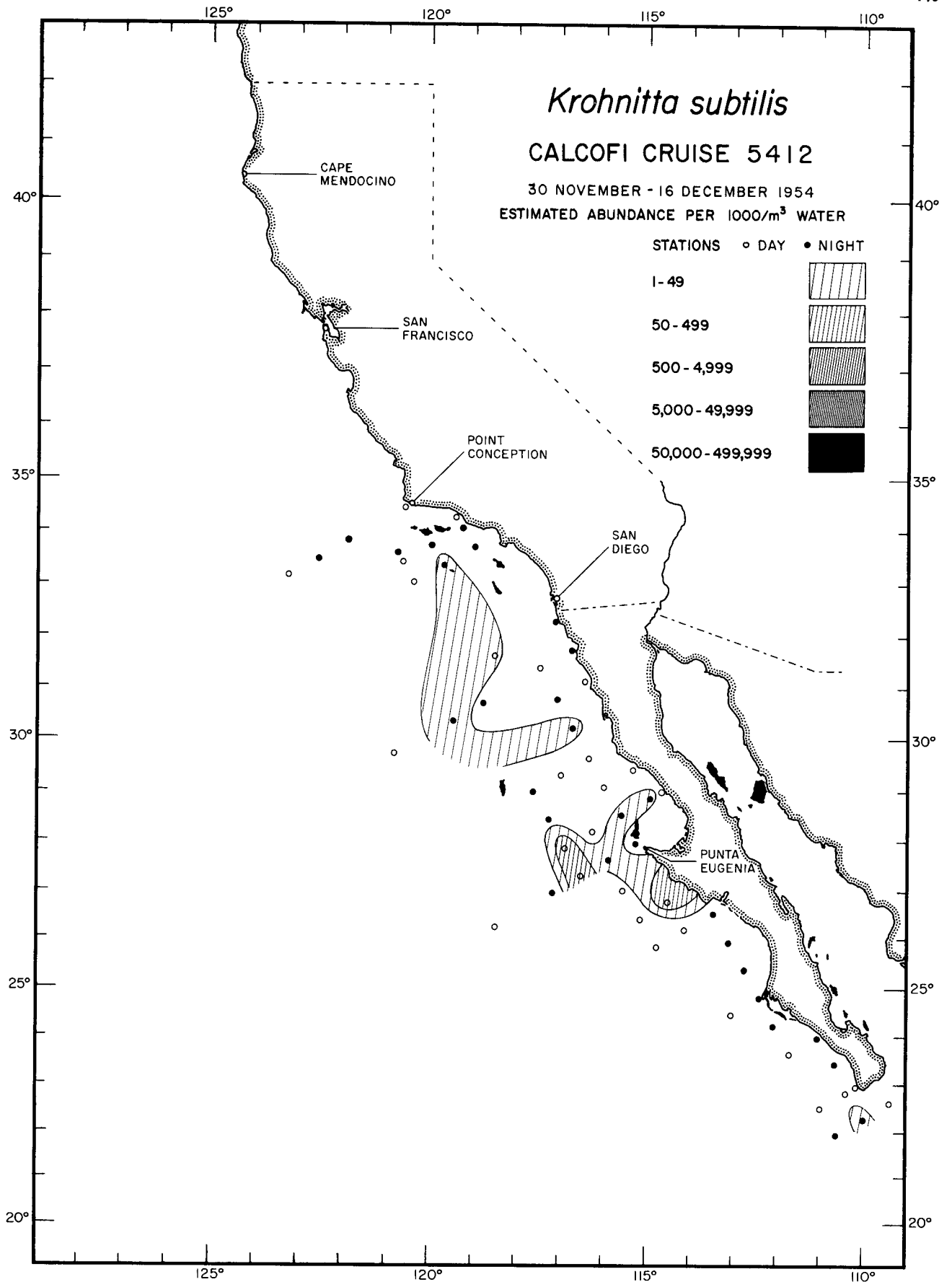
Chaetognatha
Sagitta scrippsae
5410



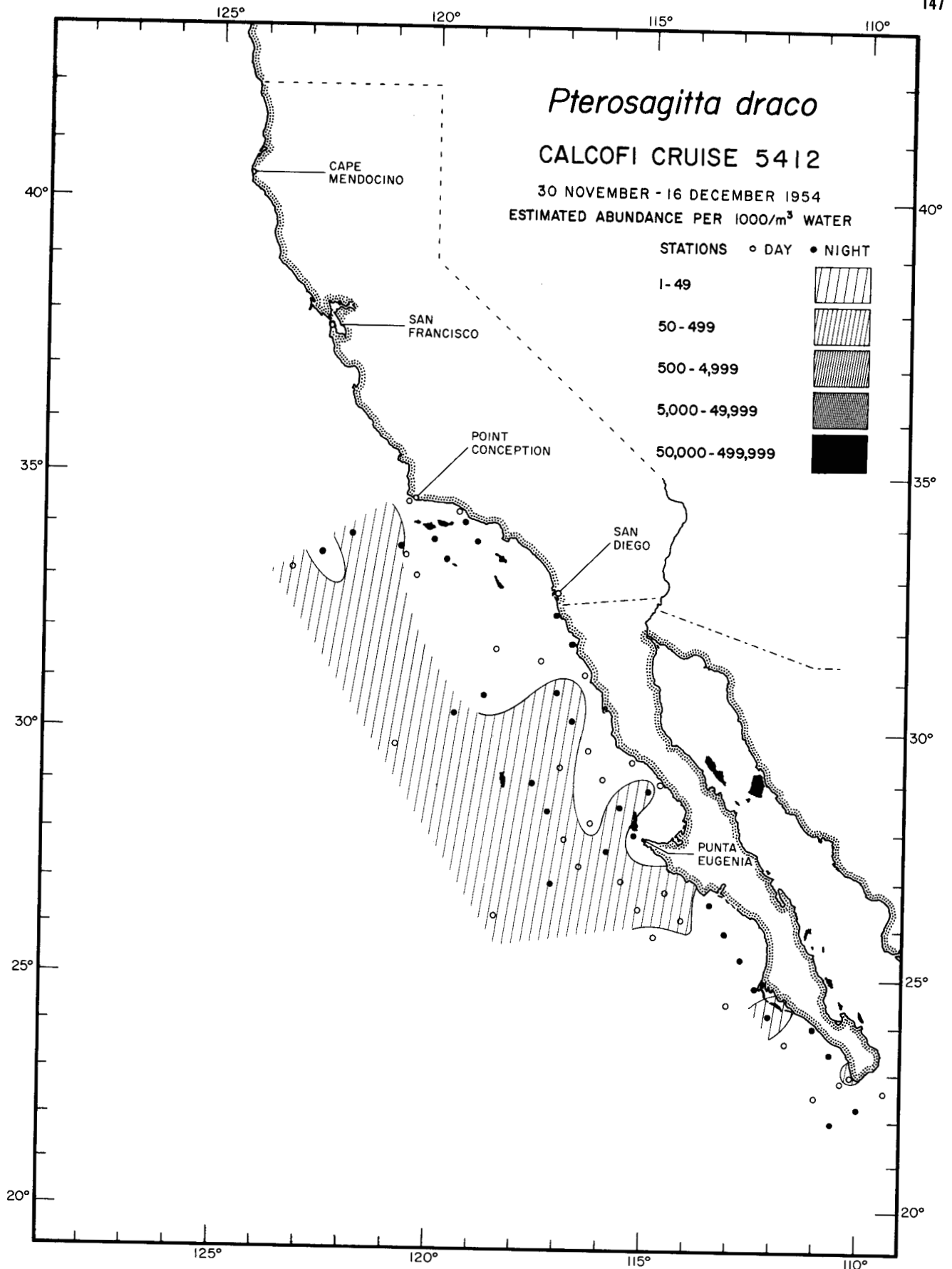
Chaetognatha
Eukrohnia hamata
 5412



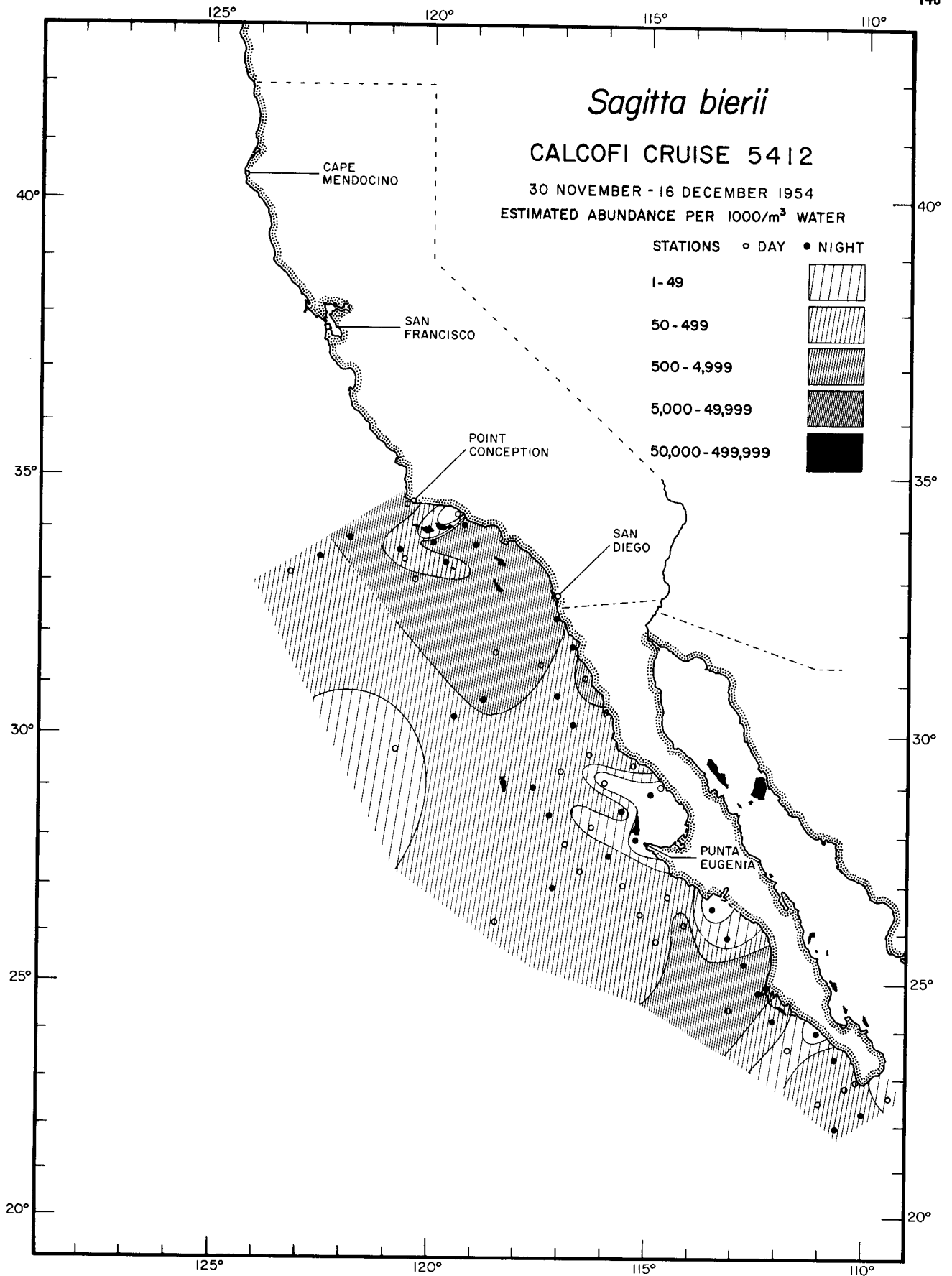
Chaetognatha
Krohnitta pacifica
5412



Chaetognatha
Krohnitta subtilis
5412



Chaetognatha
Pterosagitta draco
5412



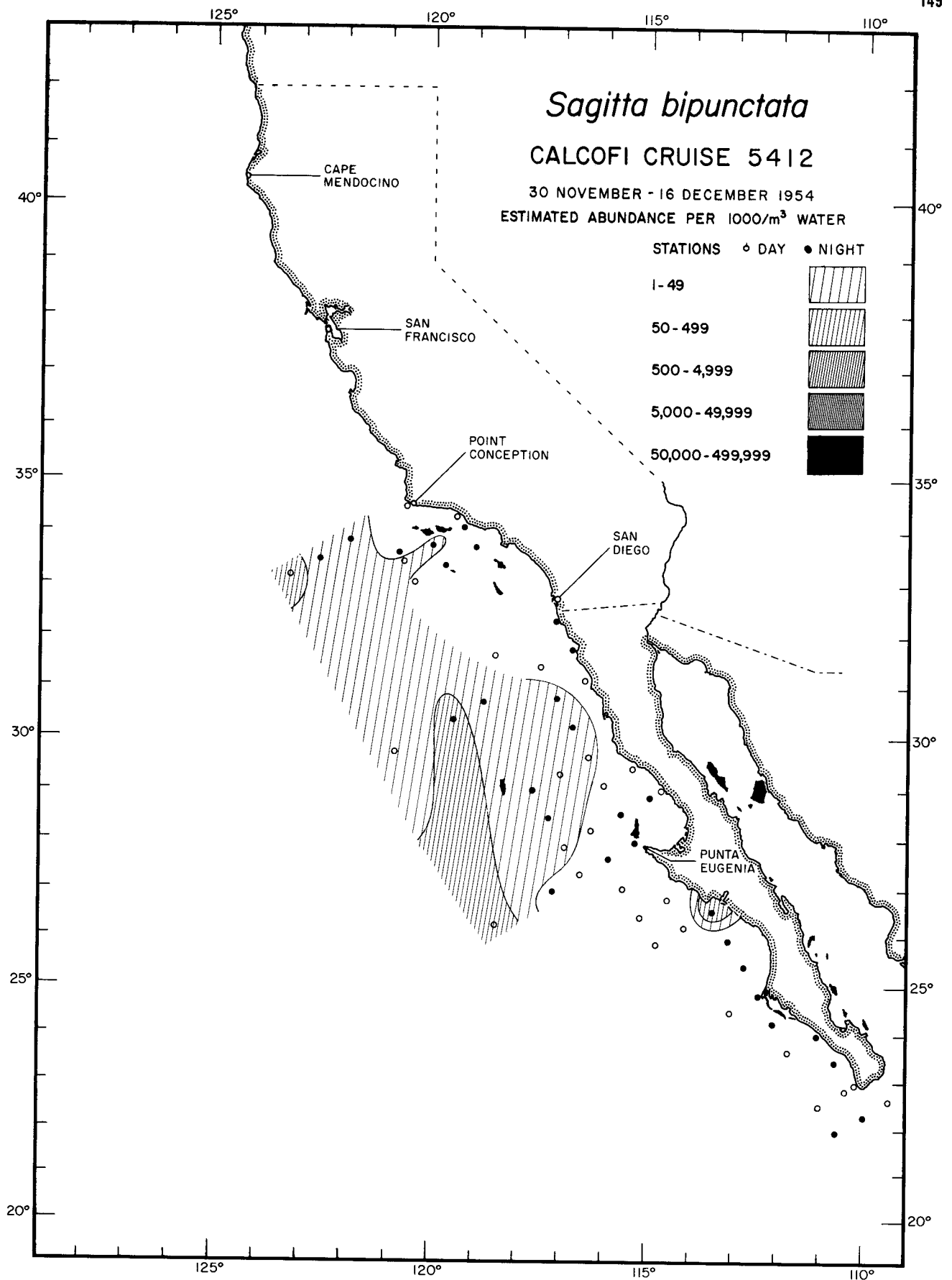
Sagitta bierii

CALCOFI CRUISE 5412

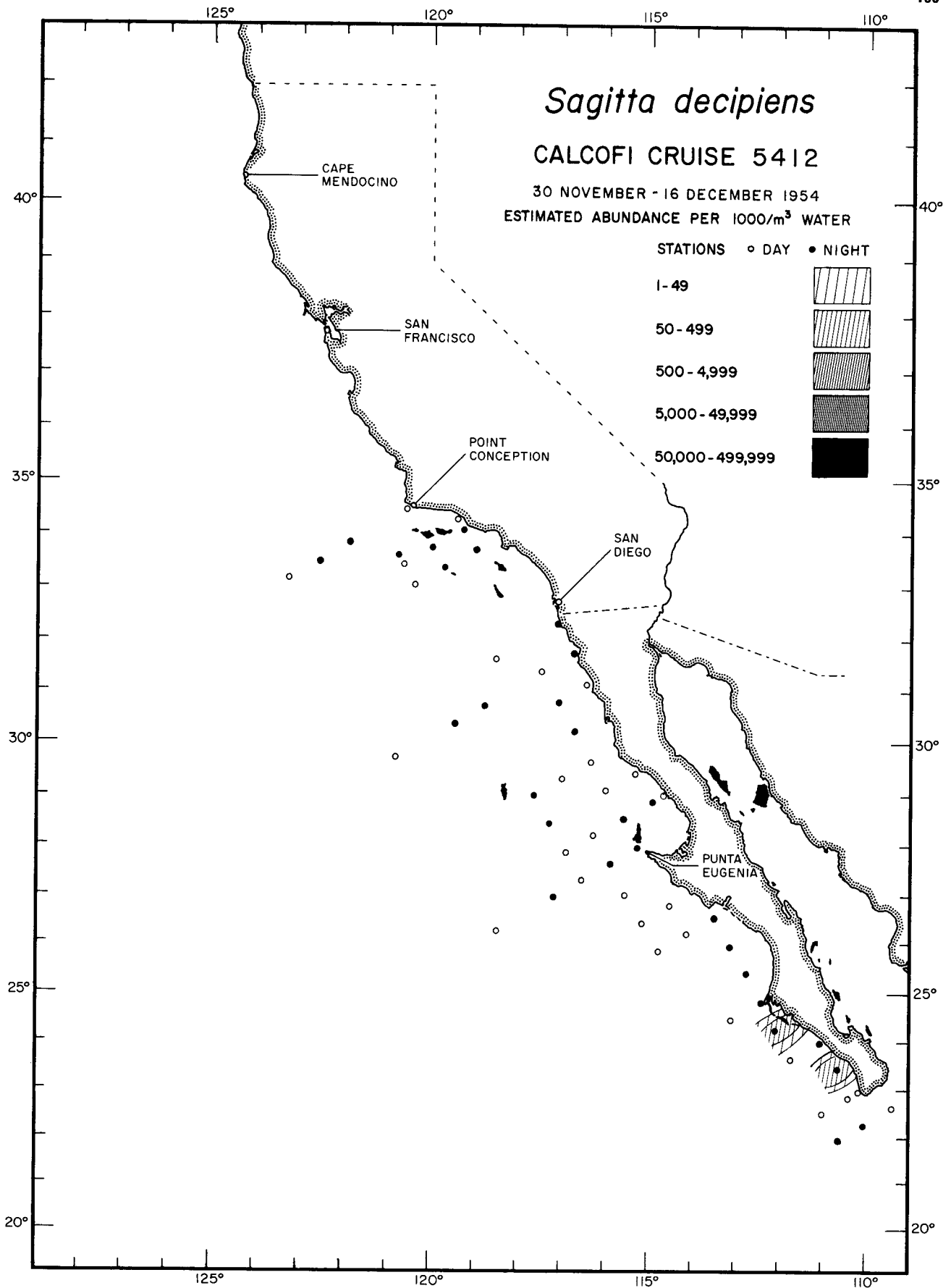
30 NOVEMBER - 16 DECEMBER 1954
ESTIMATED ABUNDANCE PER 1000/m³ WATER

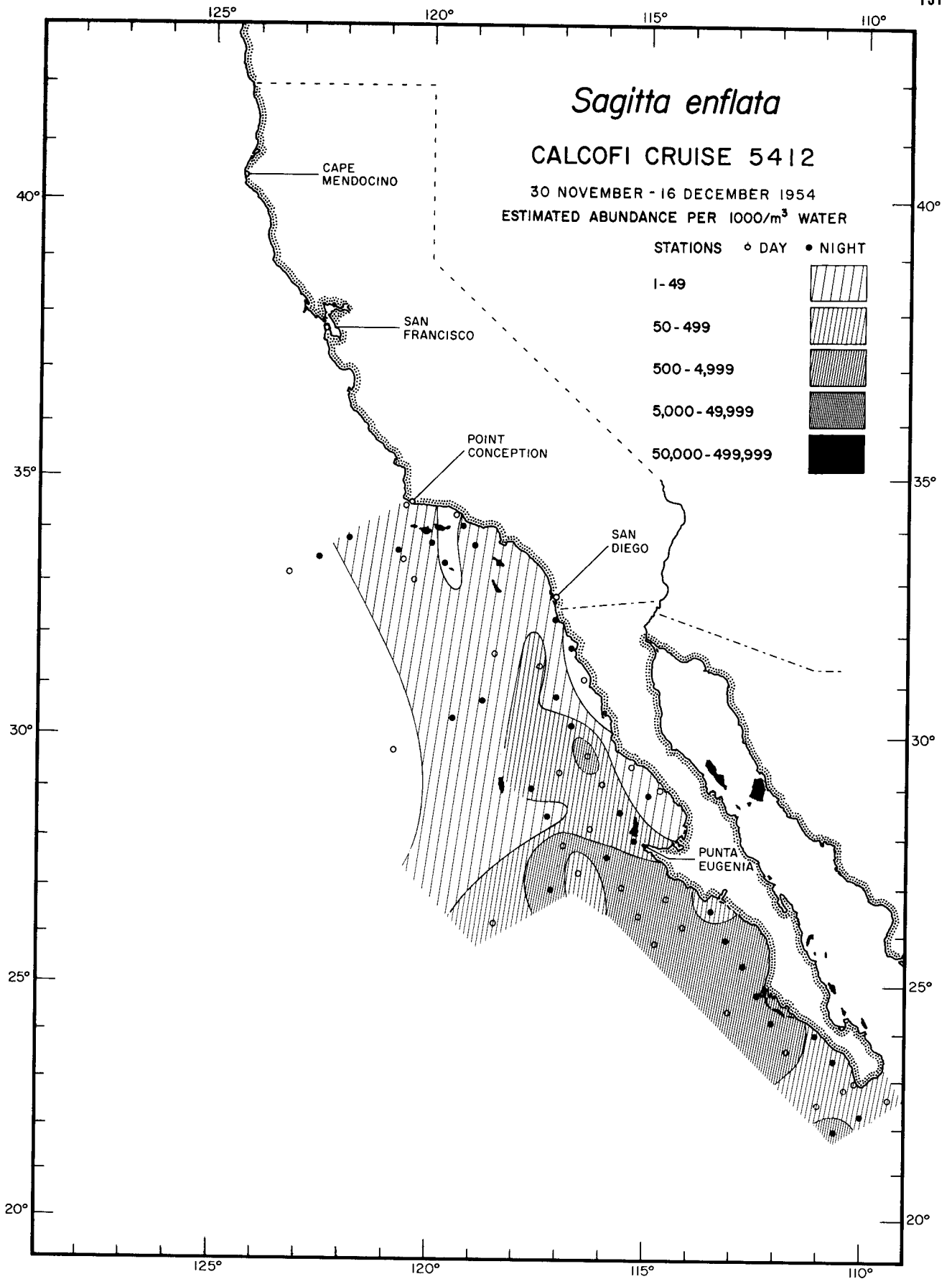
STATIONS ○ DAY ● NIGHT

1 - 49	[diagonal lines]
50 - 499	[horizontal lines]
500 - 4,999	[vertical lines]
5,000 - 49,999	[cross-hatch]
50,000 - 499,999	[solid black]

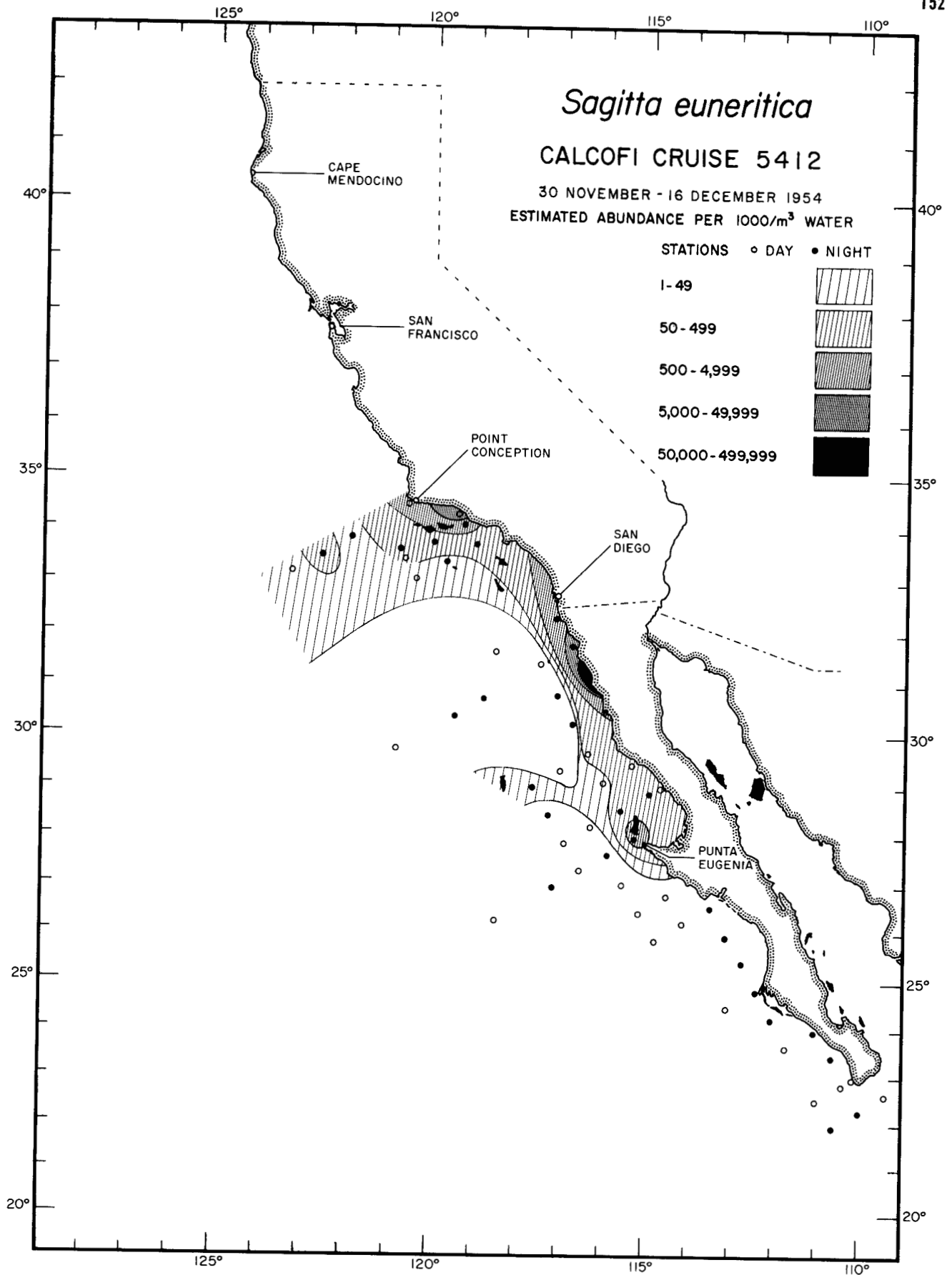


Chaetognatha
Sagitta bipunctata
 5412

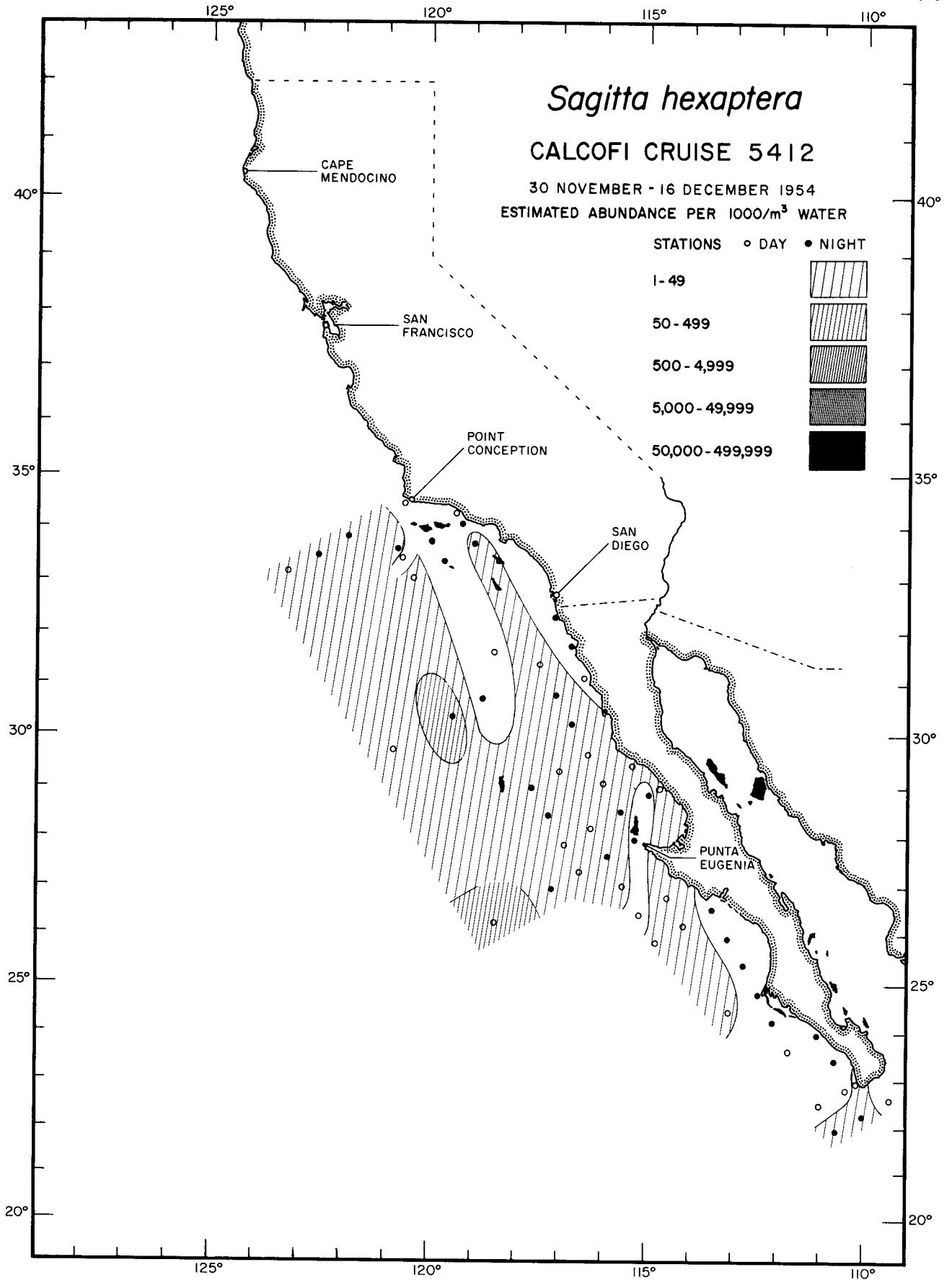




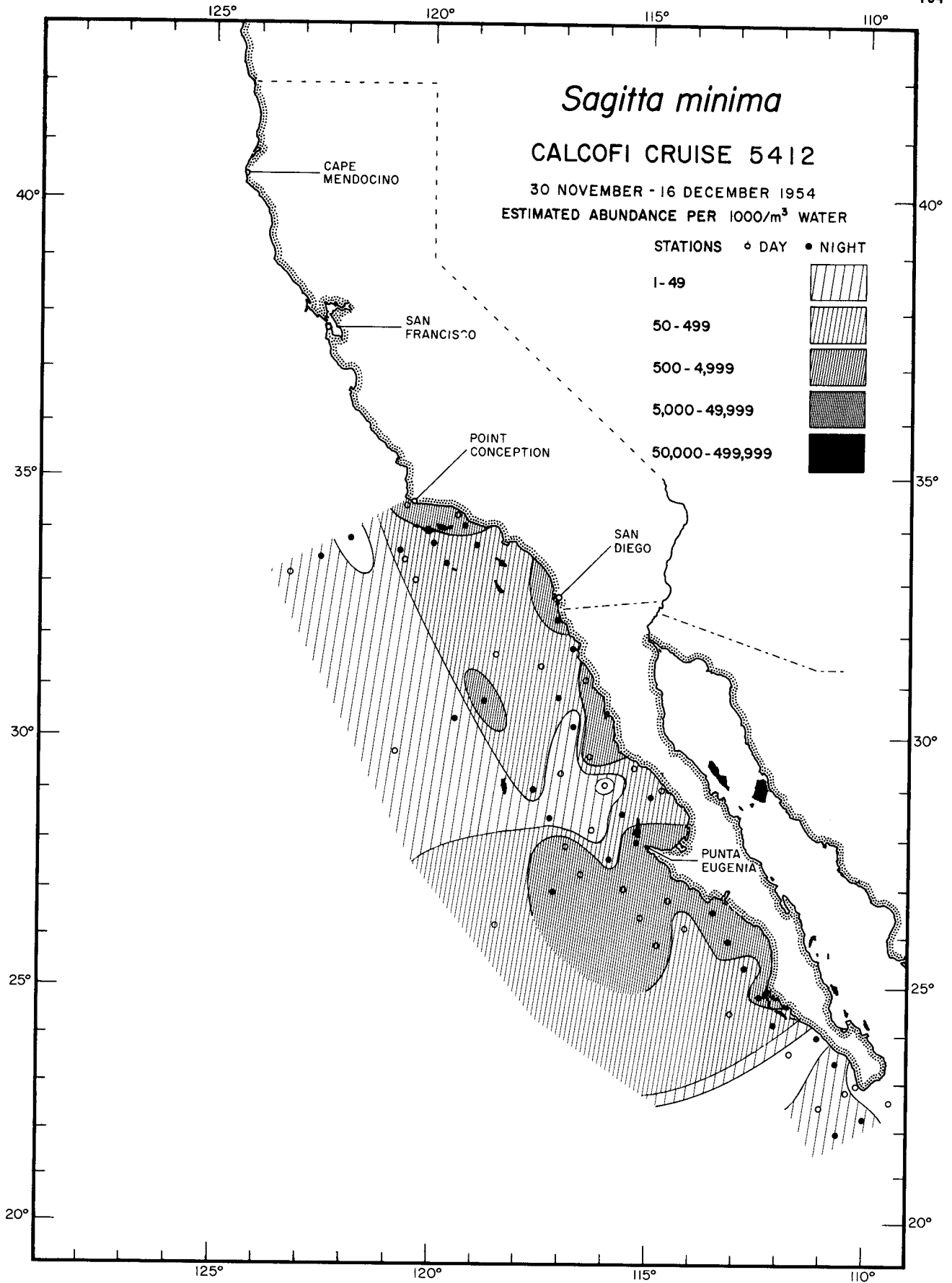
Chaetognatha
Sagitta enflata
5412



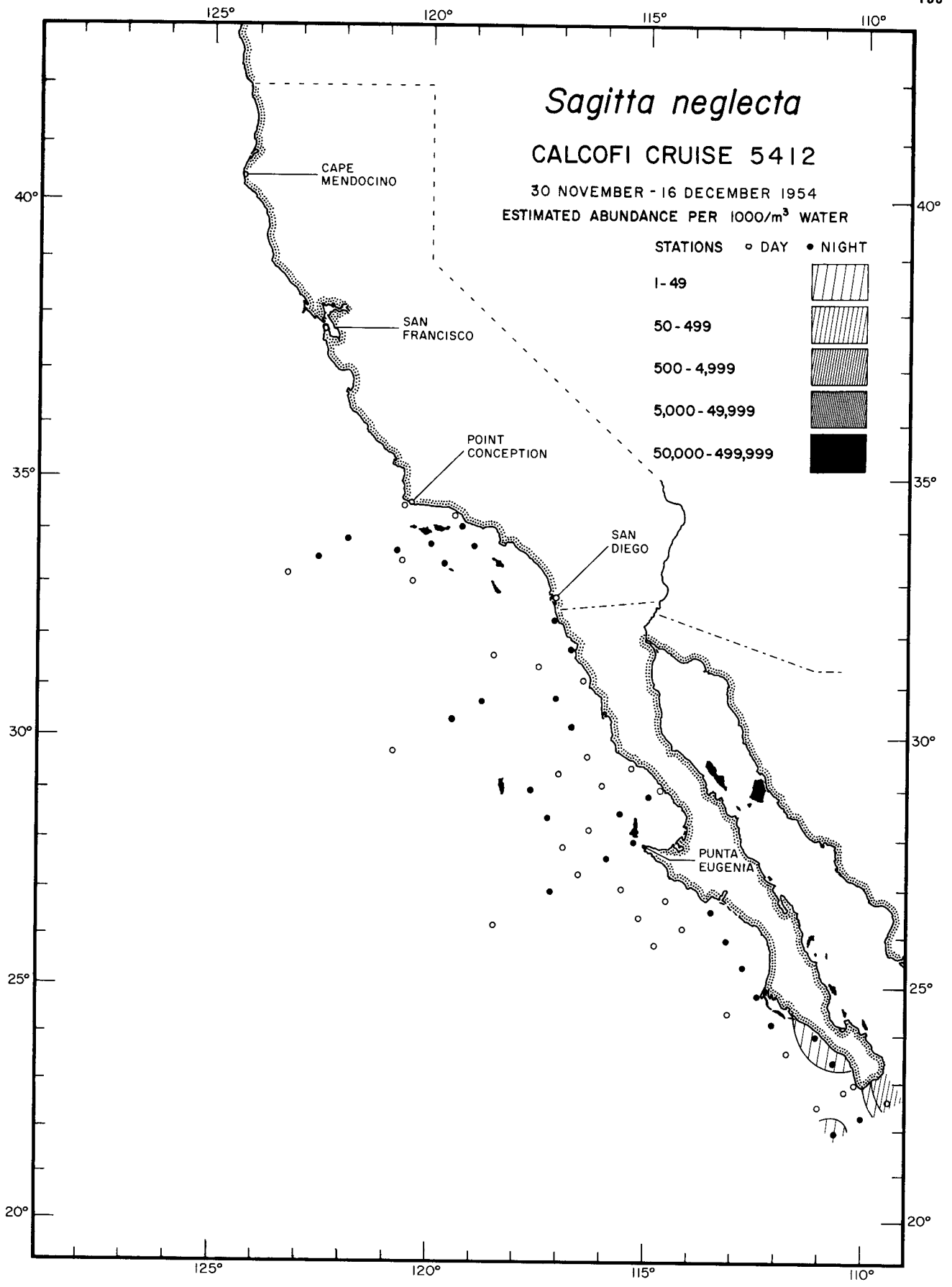
Chaetognatha
Sagitta euneritica
5412



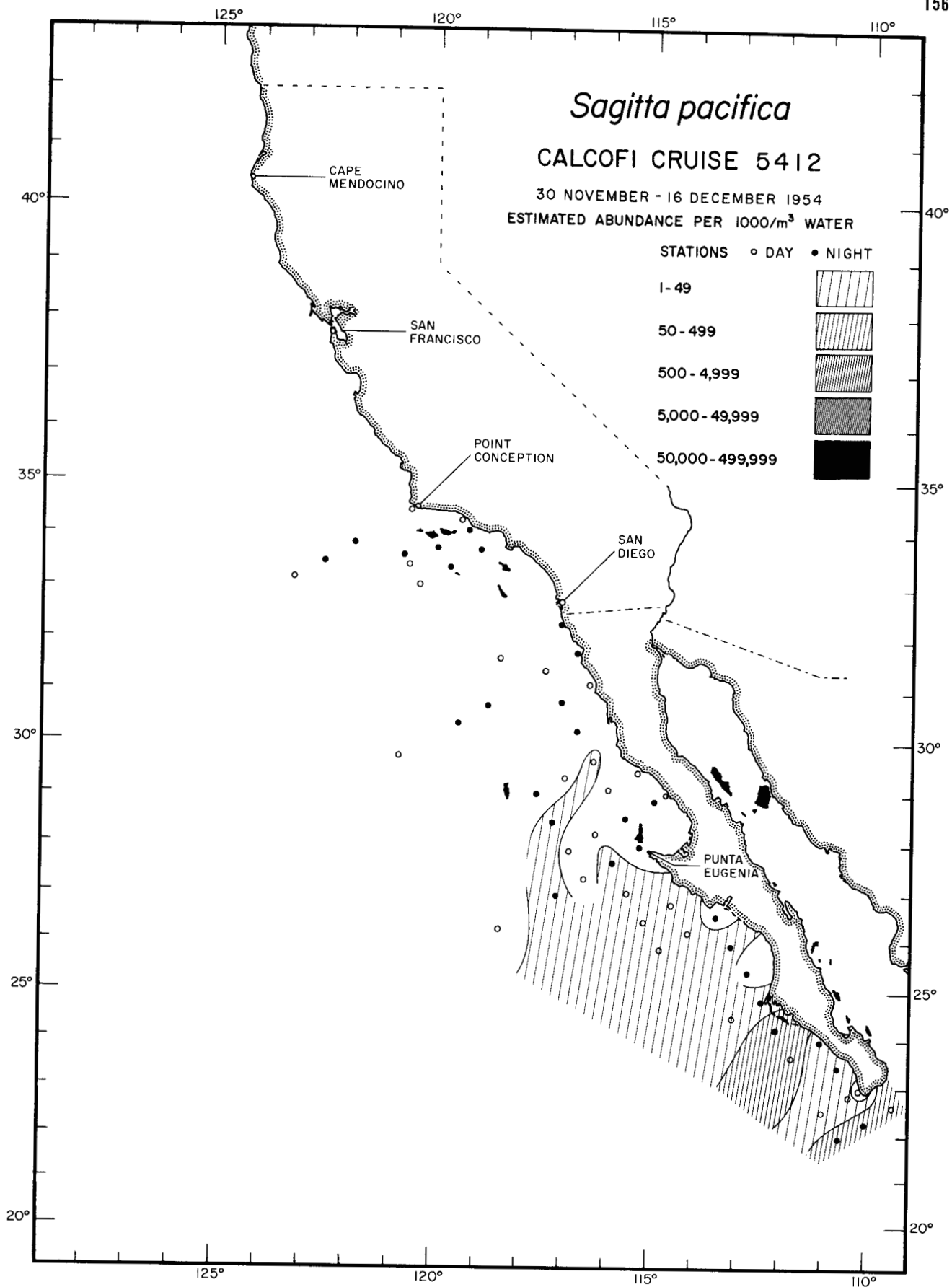
Chaetognatha
Sagitta hexaptera
5412



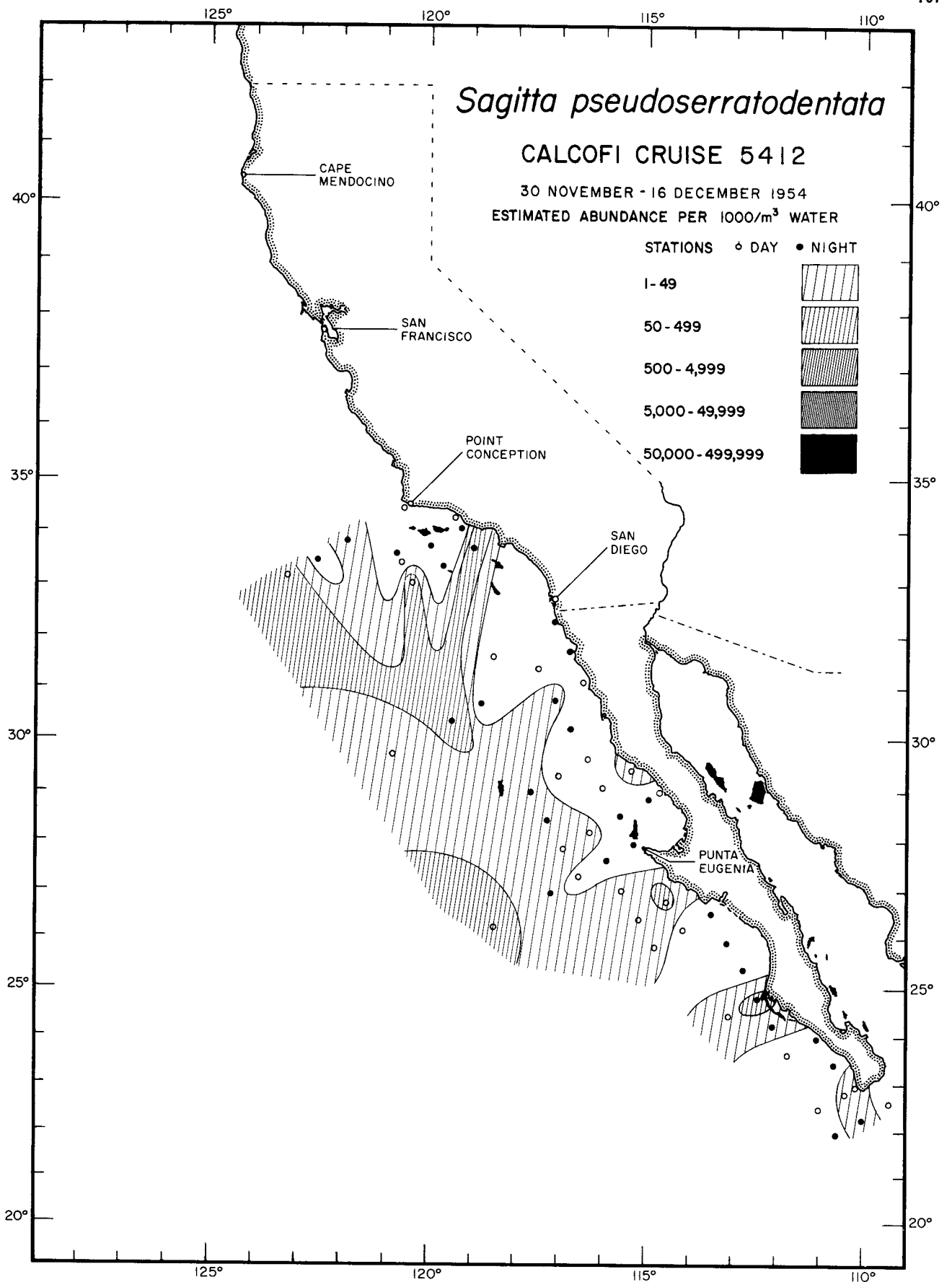
Chaetognatha
Sagitta minima
5412



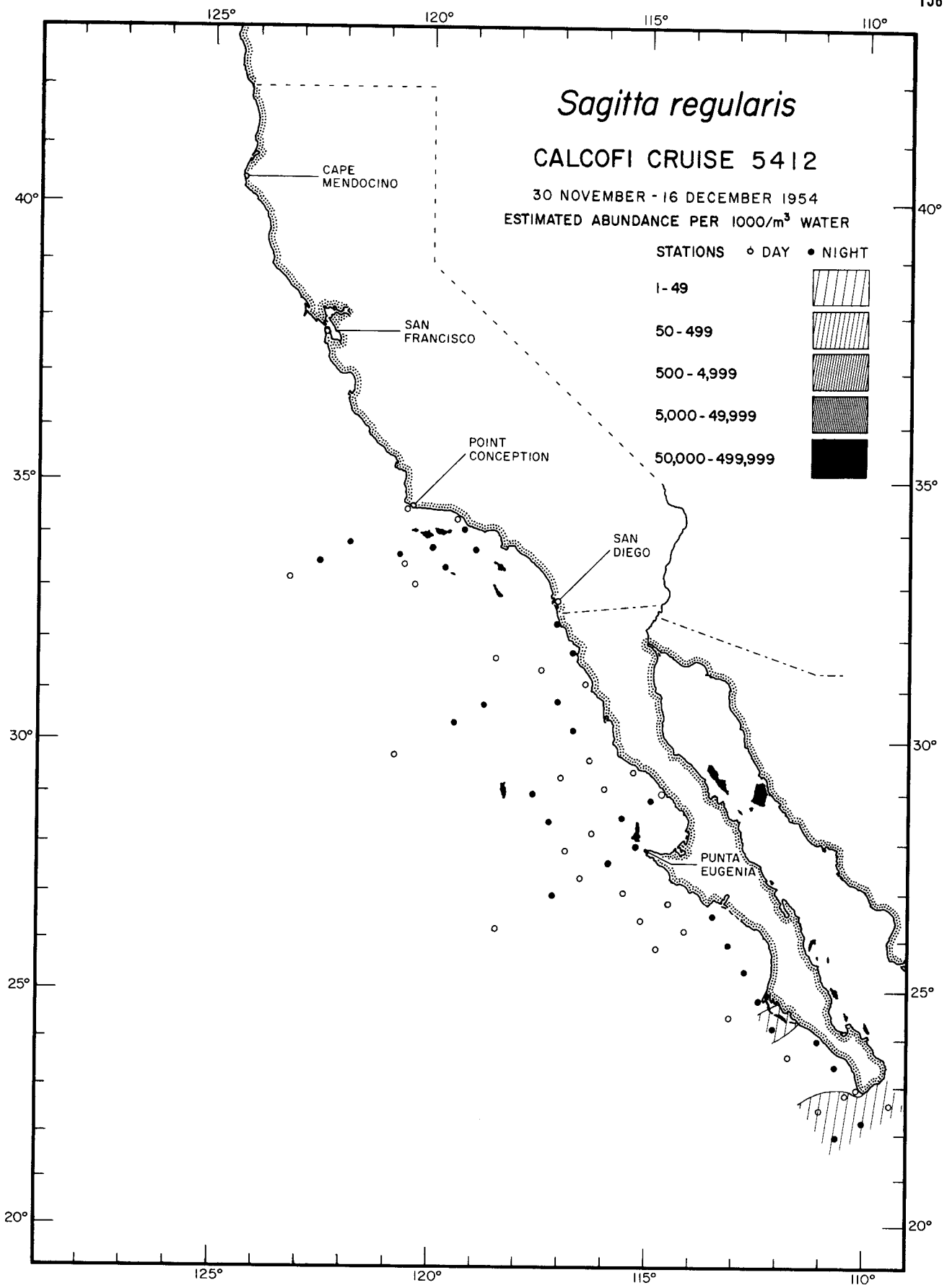
Chaetognatha
Sagitta neglecta
5412



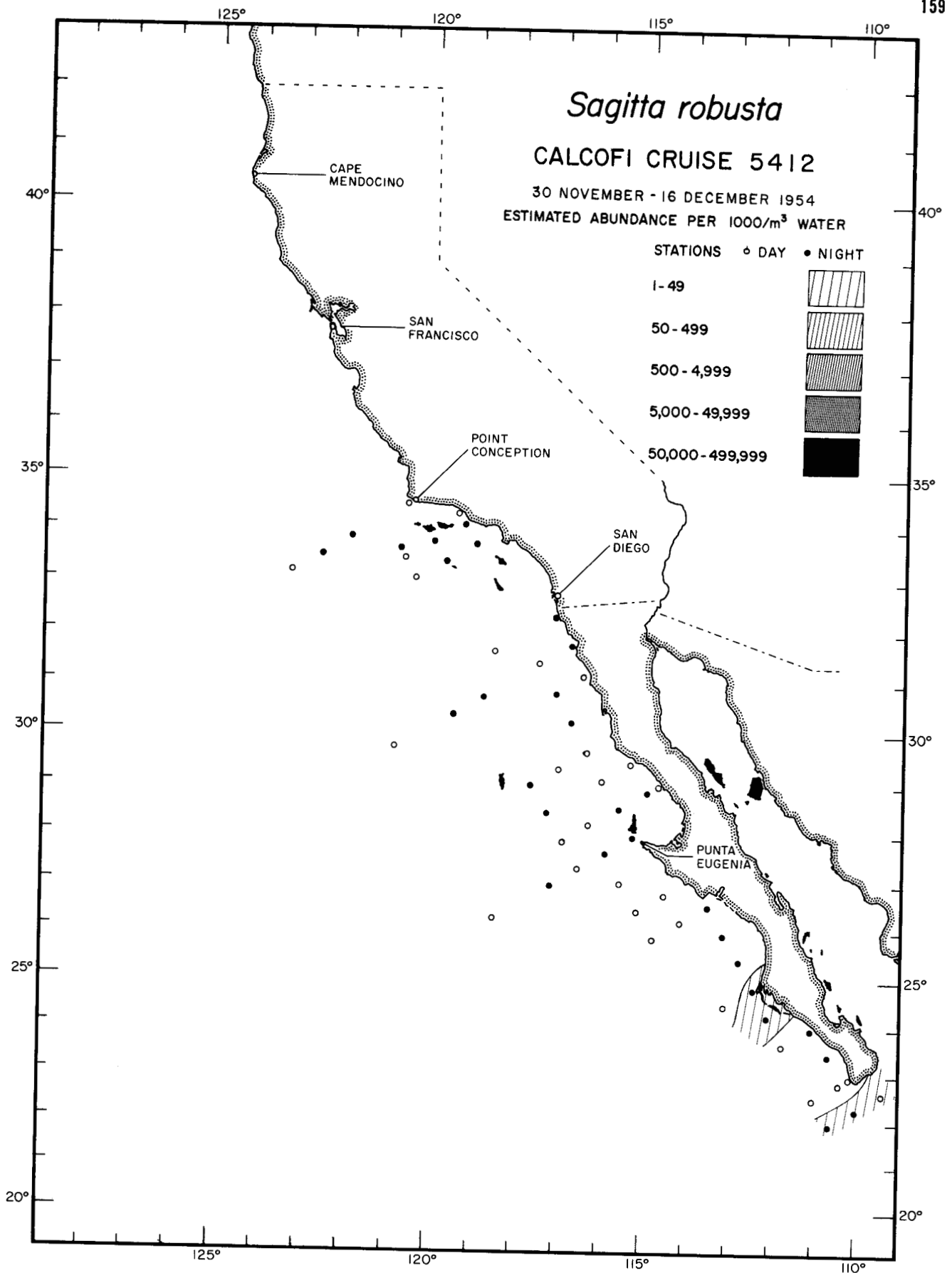
Chaetognatha
Sagitta pacifica
5412



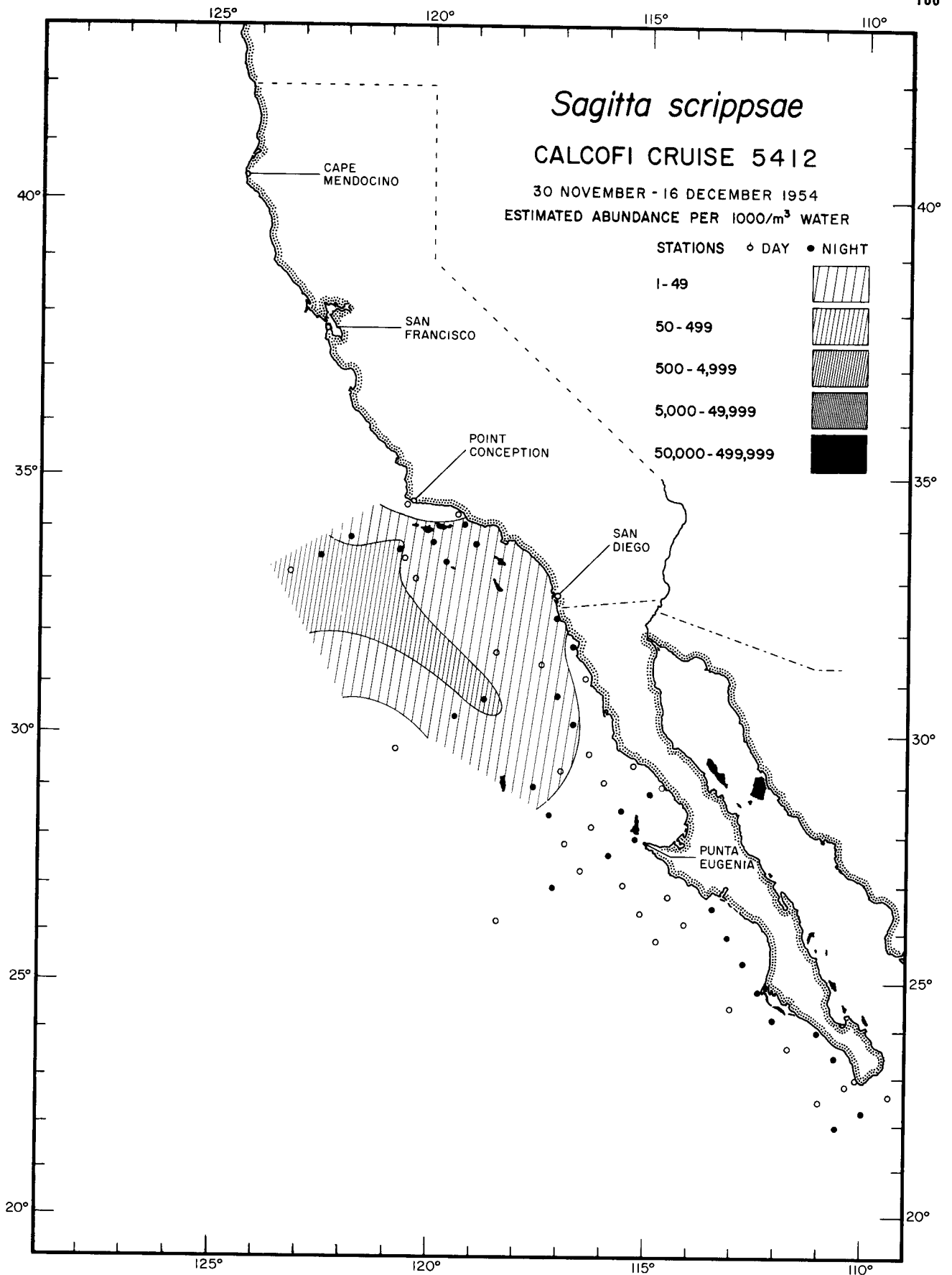
Chaetognatha
Sagitta pseudoserratodentata
5412



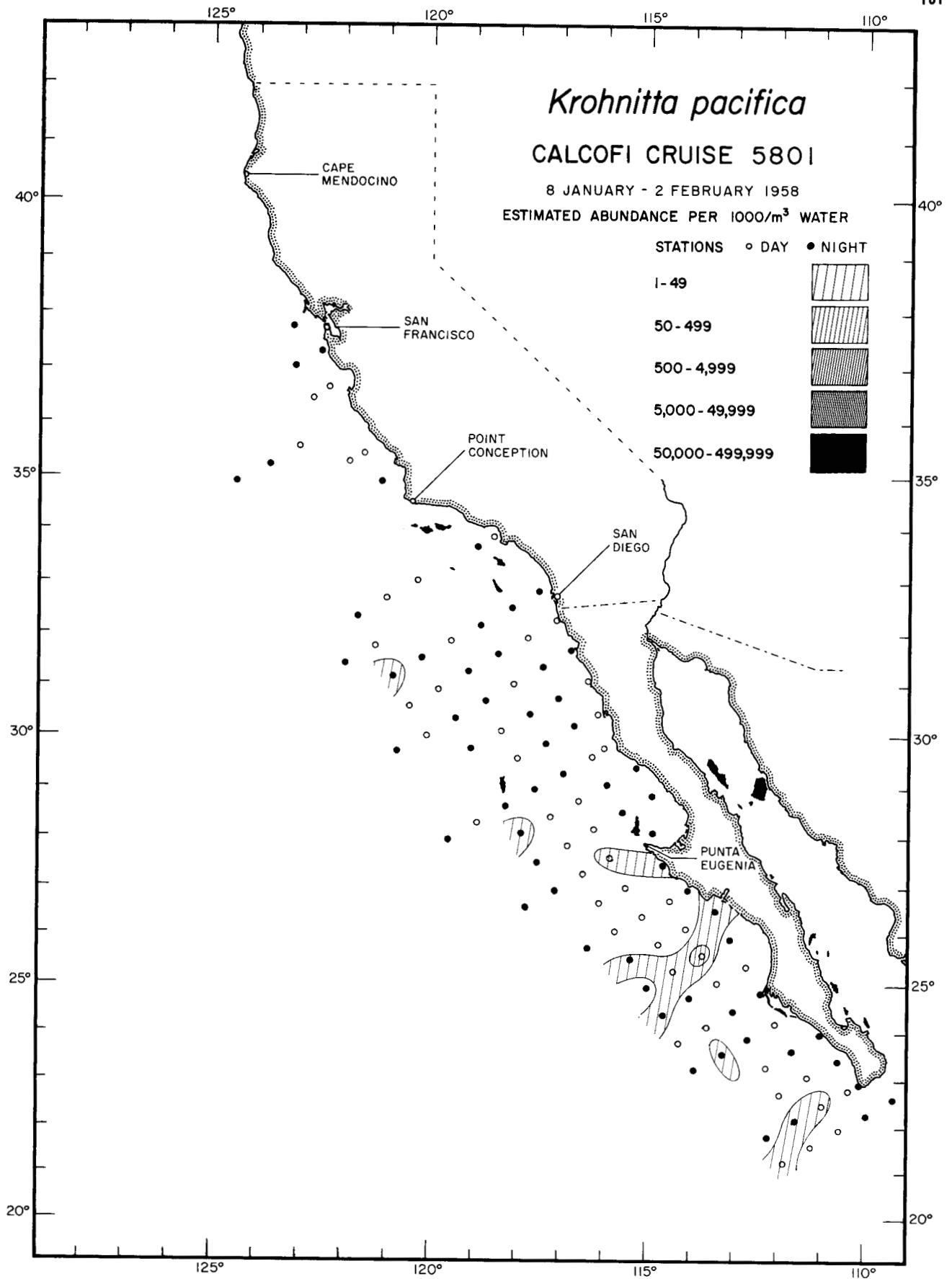
Chaetognatha
Sagitta regularis
5412



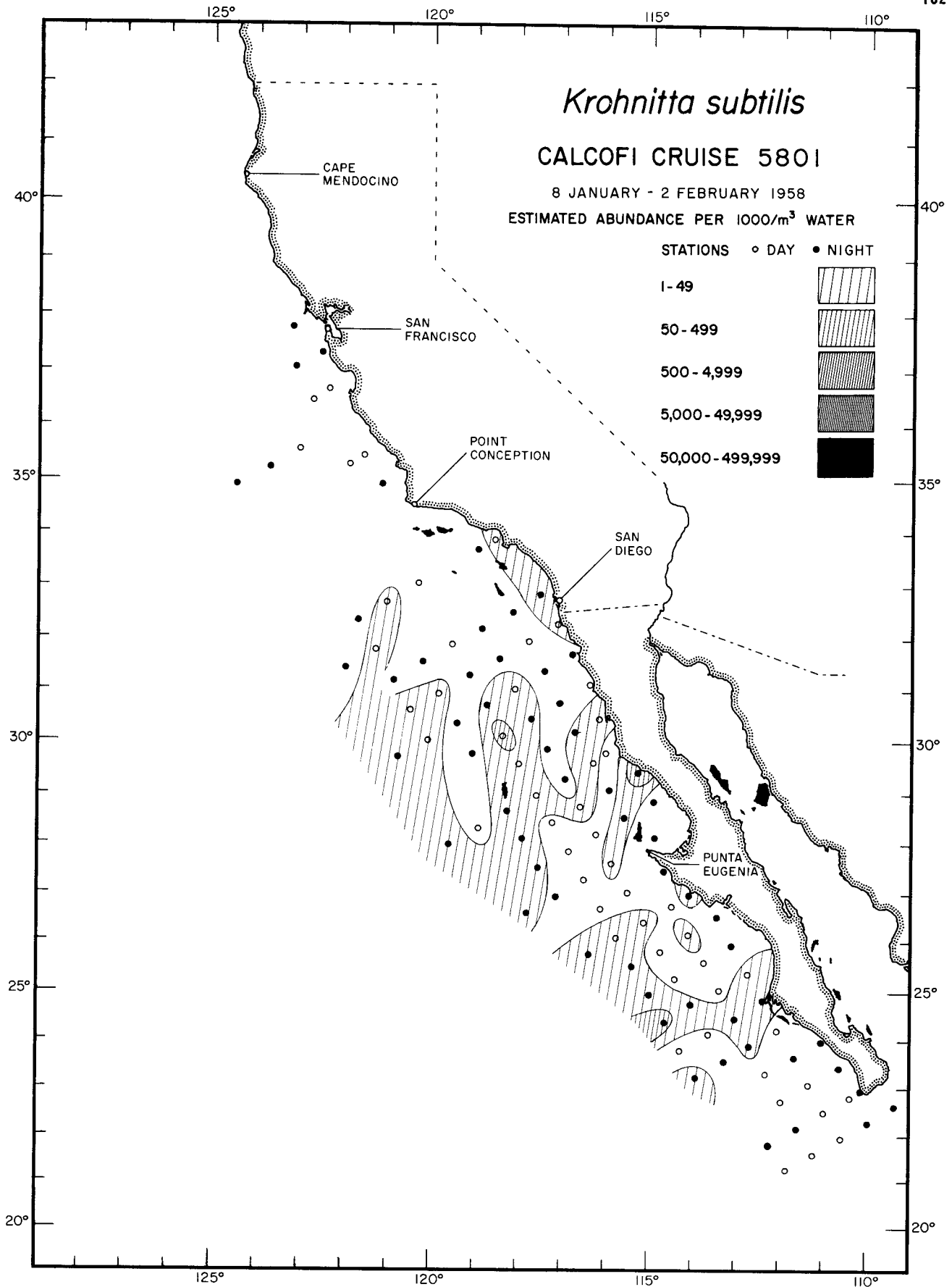
Chaetognatha
Sagitta robusta
 5412



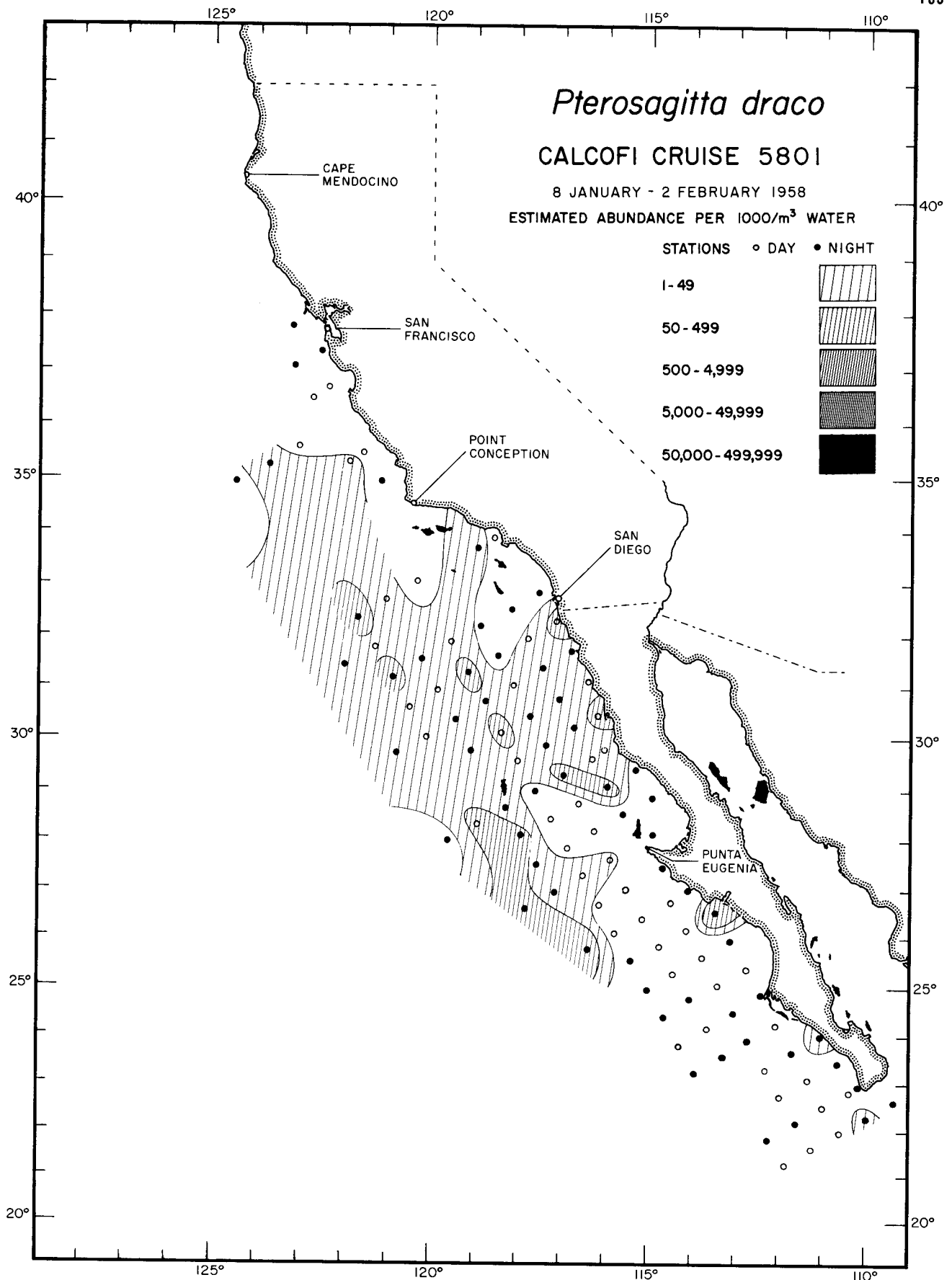
Chaetognatha
Sagitta scrippsae
5412

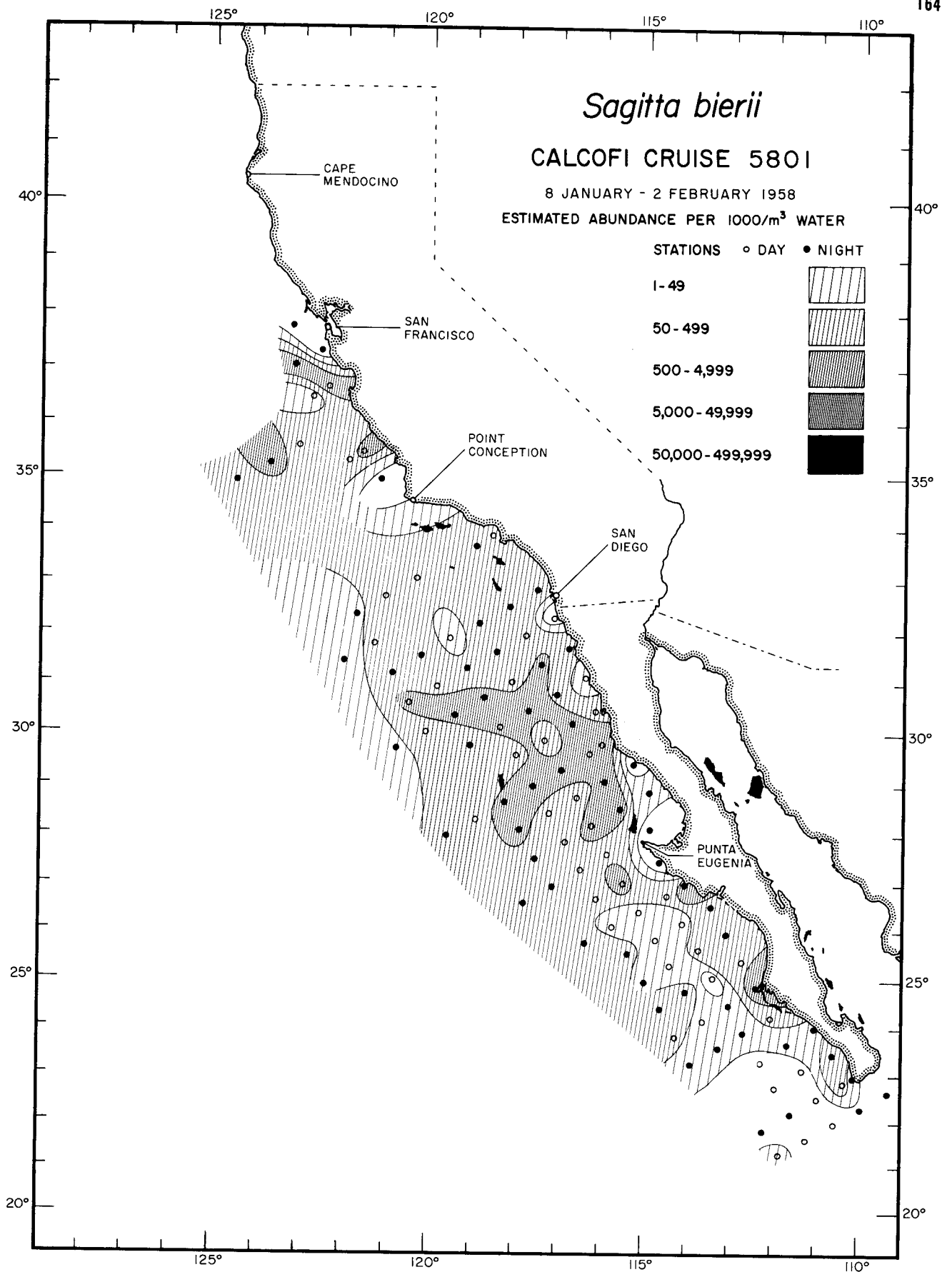


Chaetognatha
Krohnitta pacifica
5801

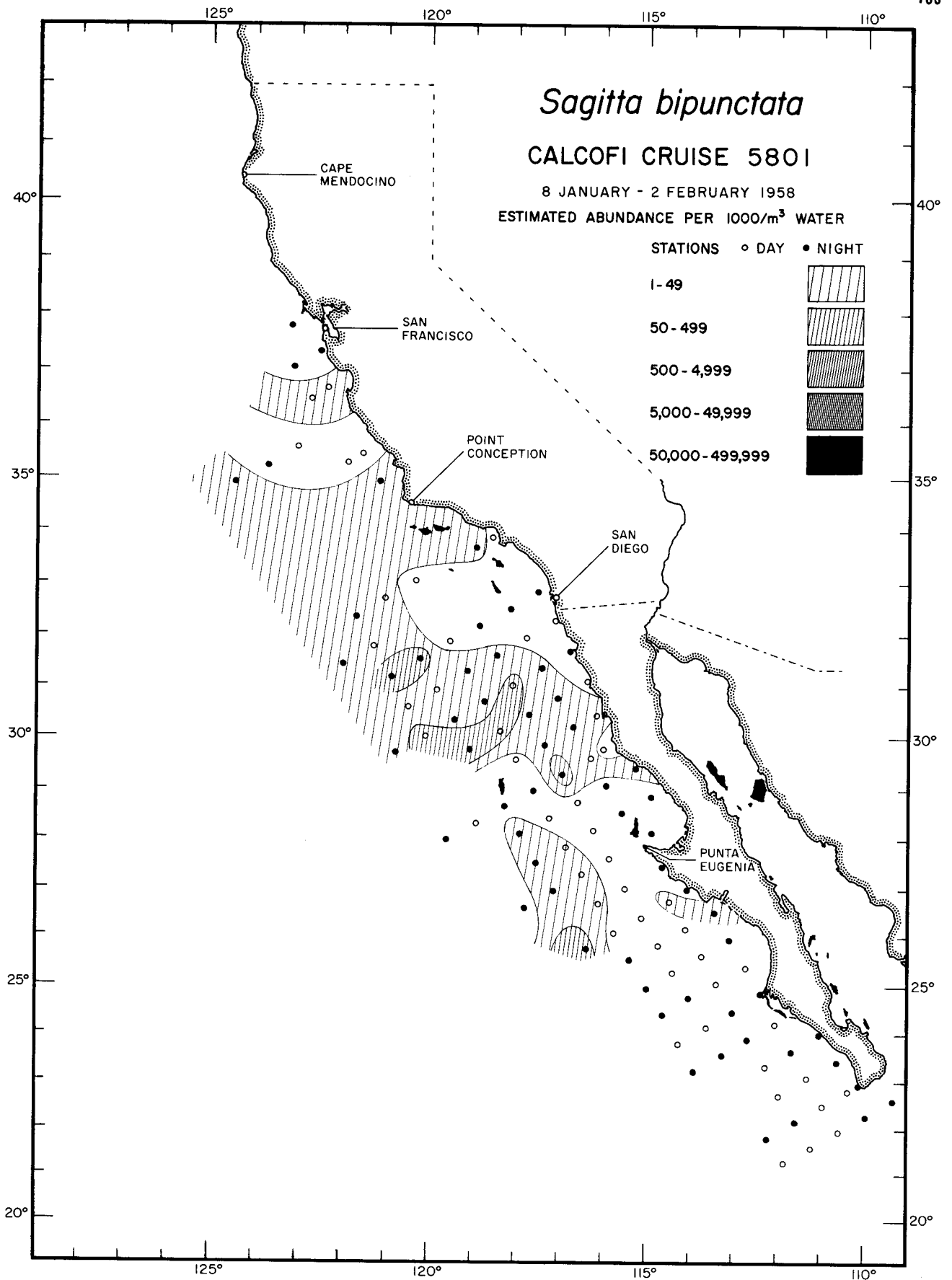


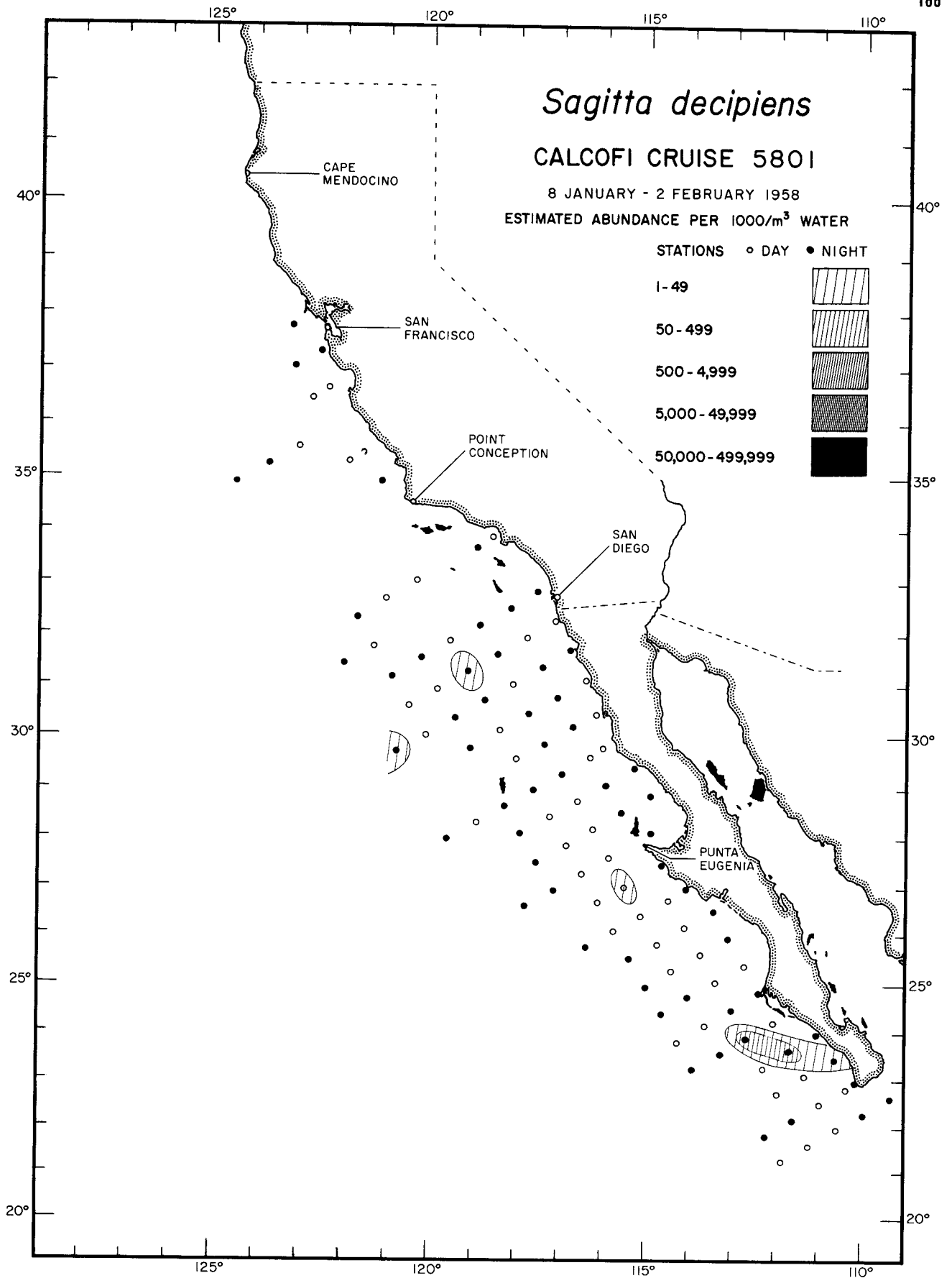
Chaetognatha
Krohnitta subtilis
5801



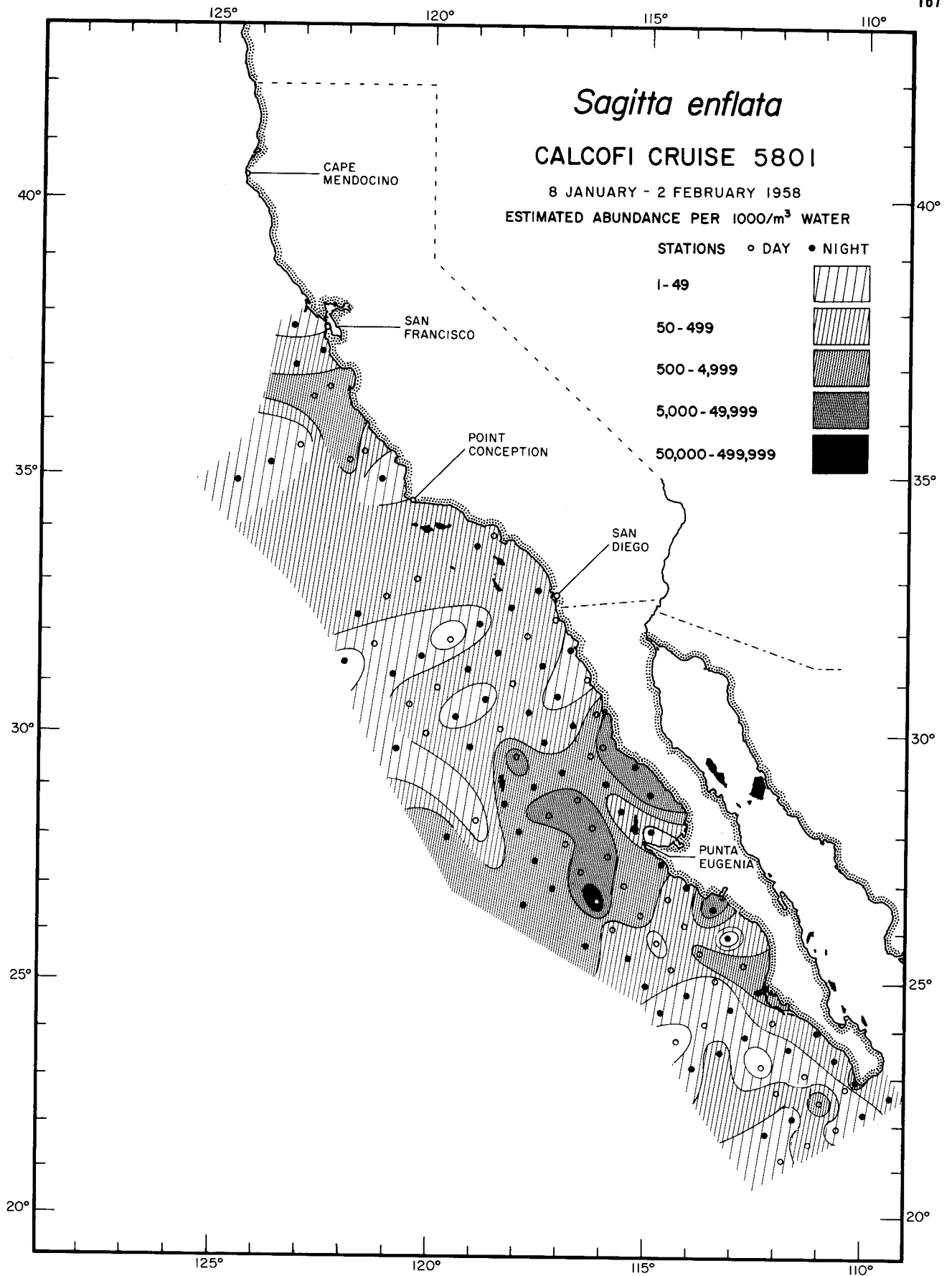


Chaetognatha
Sagitta bierii
5801

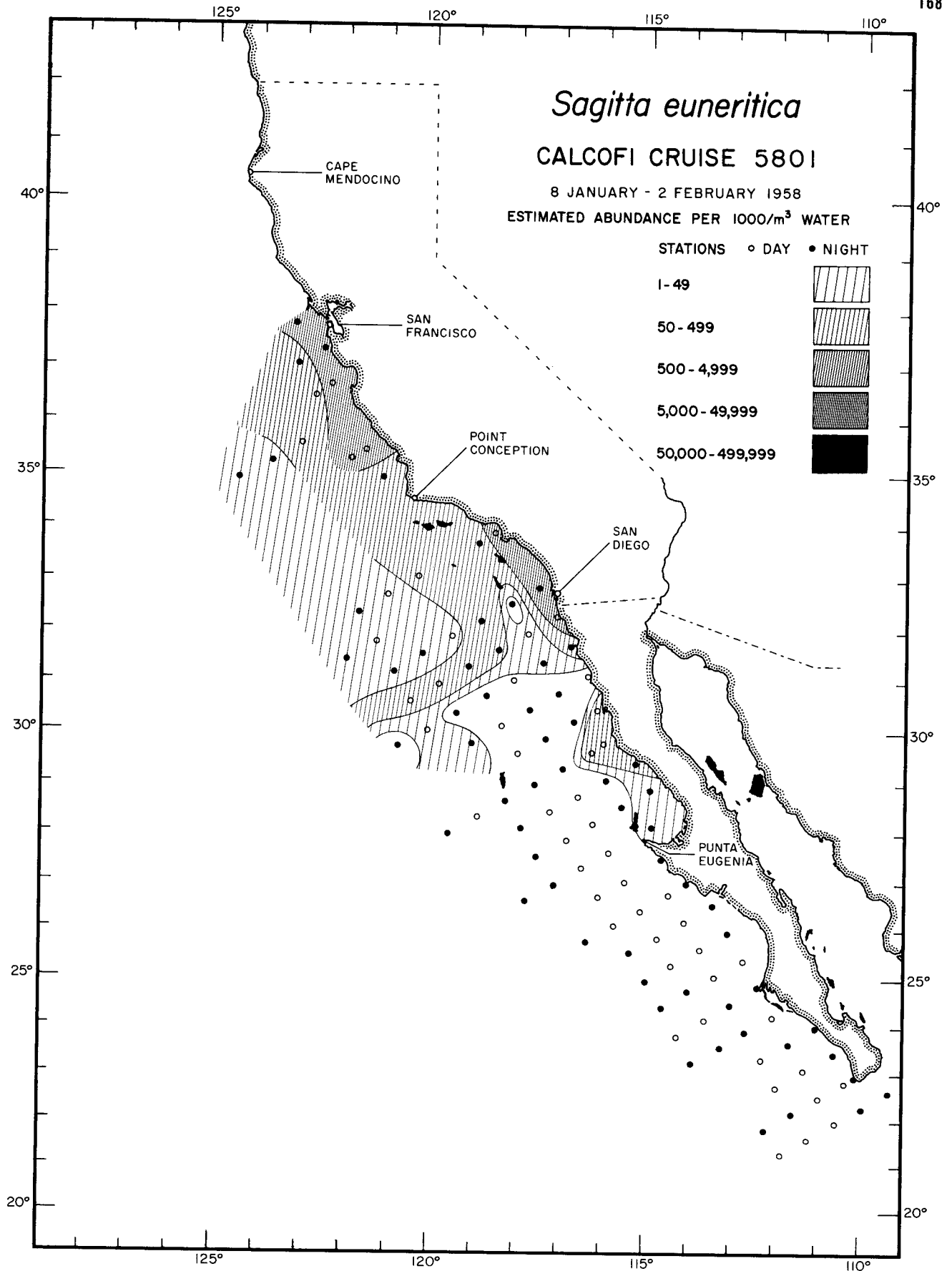




Chaetognatha
Sagitta decipiens
5801



Chaetognatha
Sagitta enflata
5801

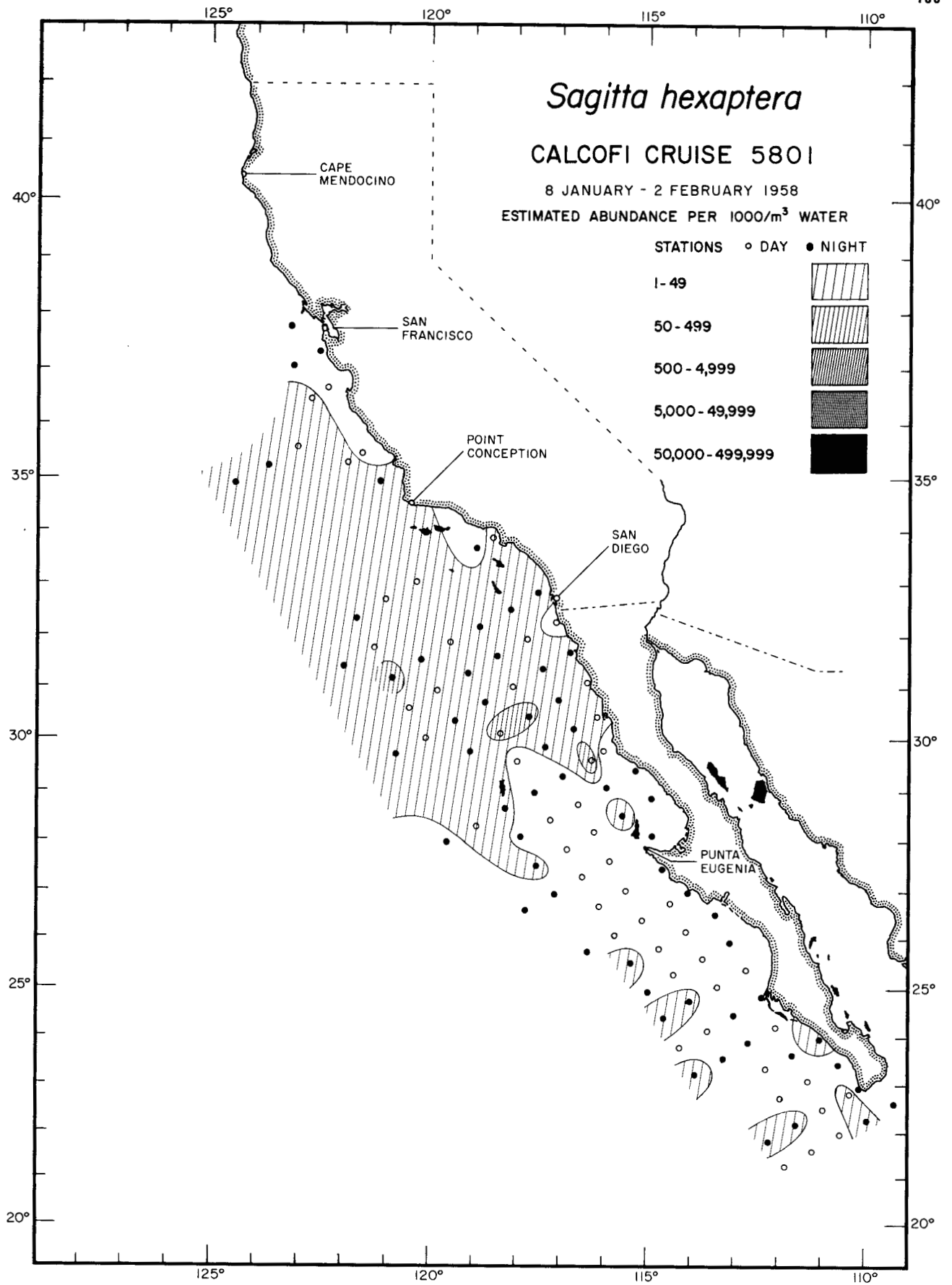


Sagitta euneritica
CALCOFI CRUISE 5801

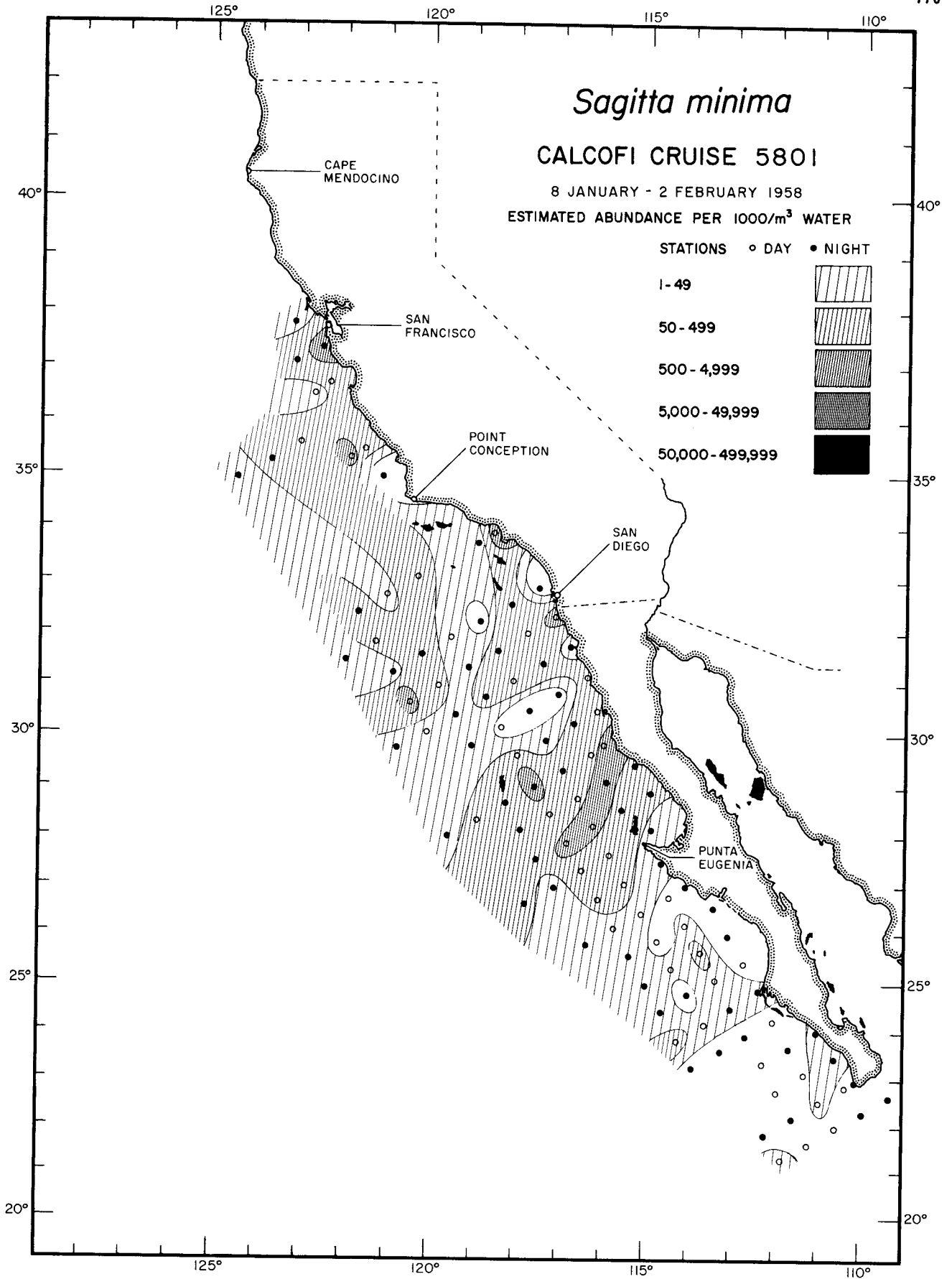
8 JANUARY - 2 FEBRUARY 1958
ESTIMATED ABUNDANCE PER 1000/m³ WATER

STATIONS ◯ DAY ● NIGHT

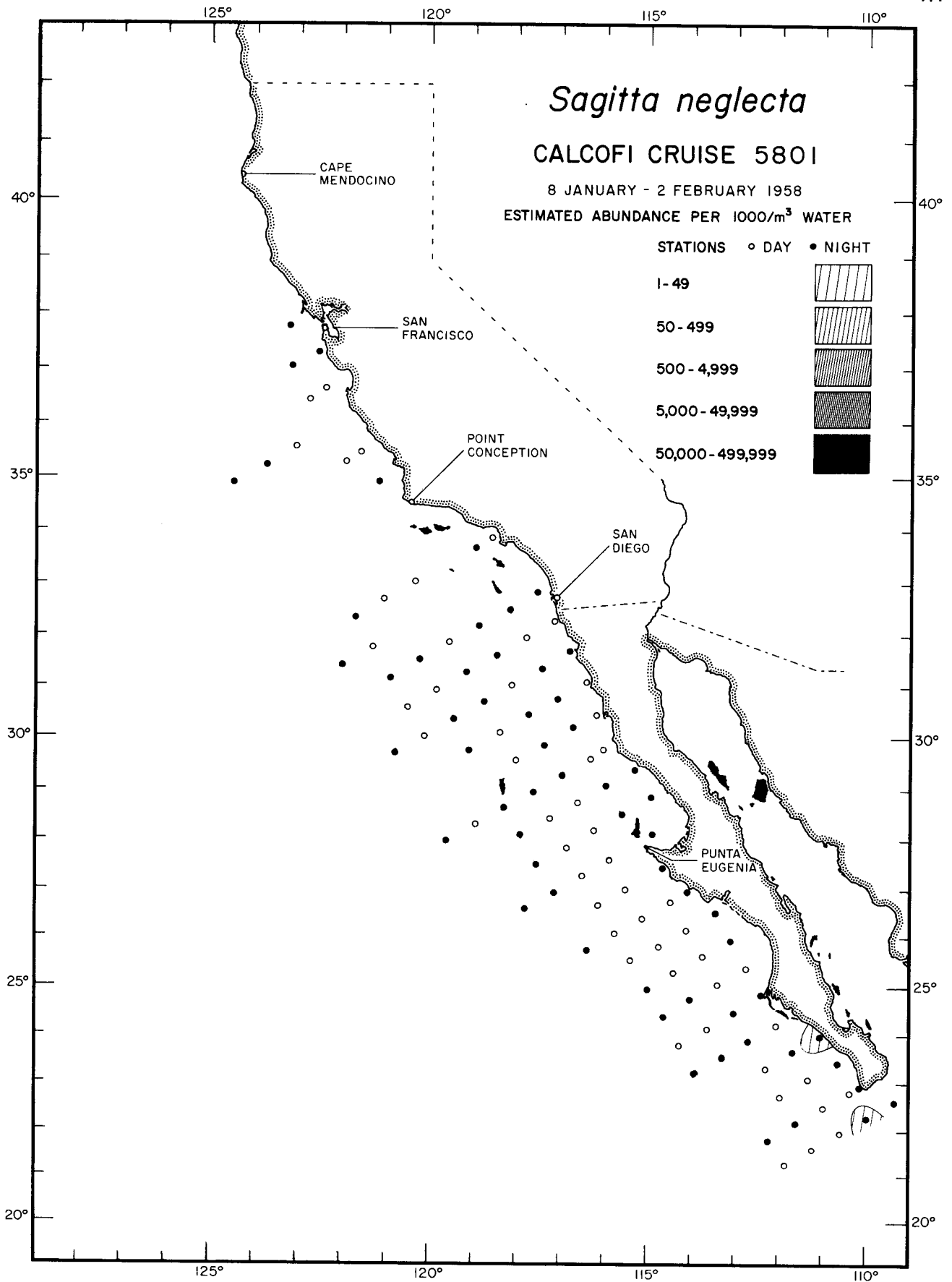
1-49	[diagonal lines]
50-499	[horizontal lines]
500-4,999	[vertical lines]
5,000-49,999	[cross-hatch]
50,000-499,999	[solid black]



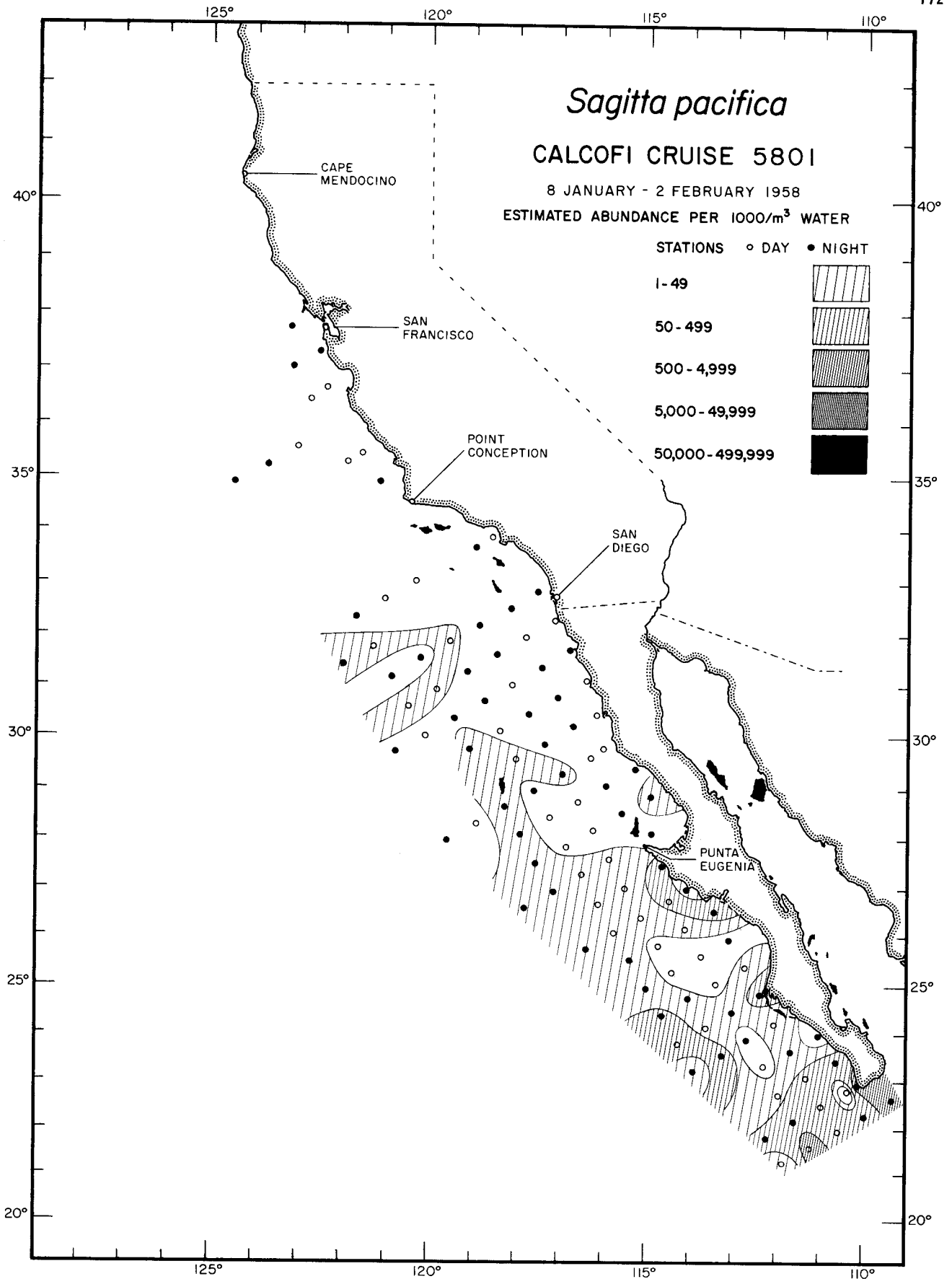
Chaetognatha
Sagitta hexaptera
5801



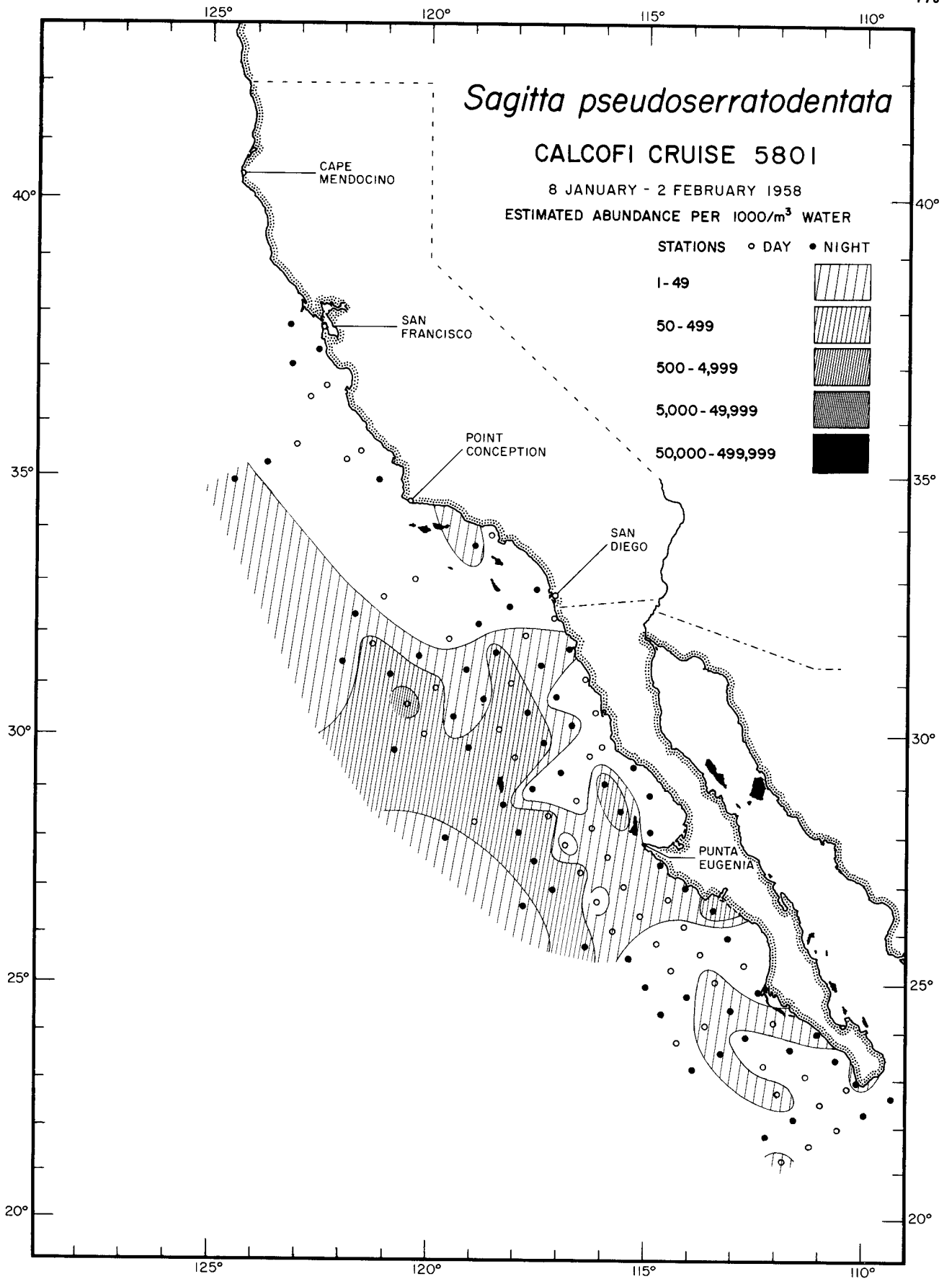
Chaetognatha
Sagitta minima
5801



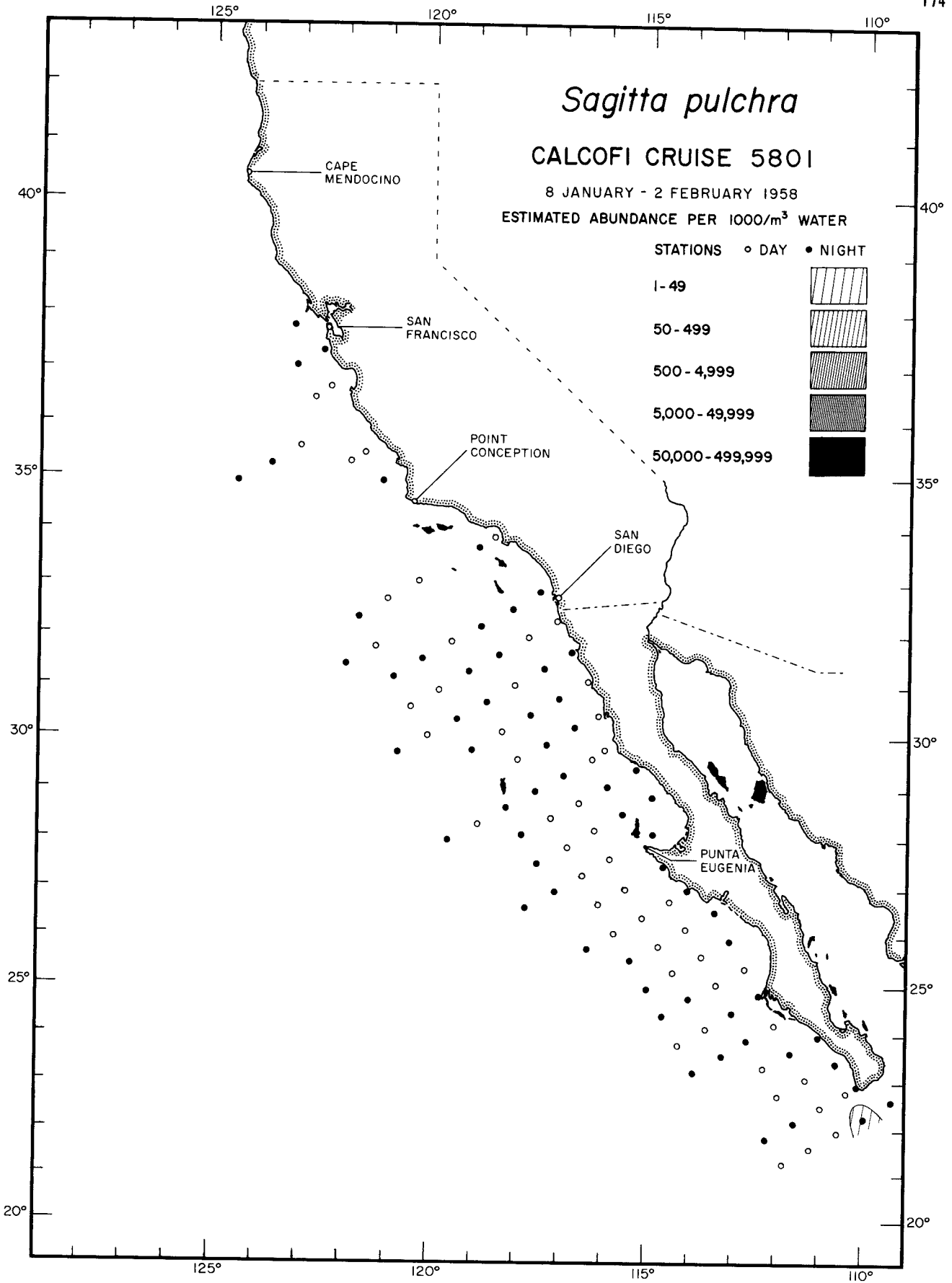
Chaetognatha
Sagitta neglecta
5801



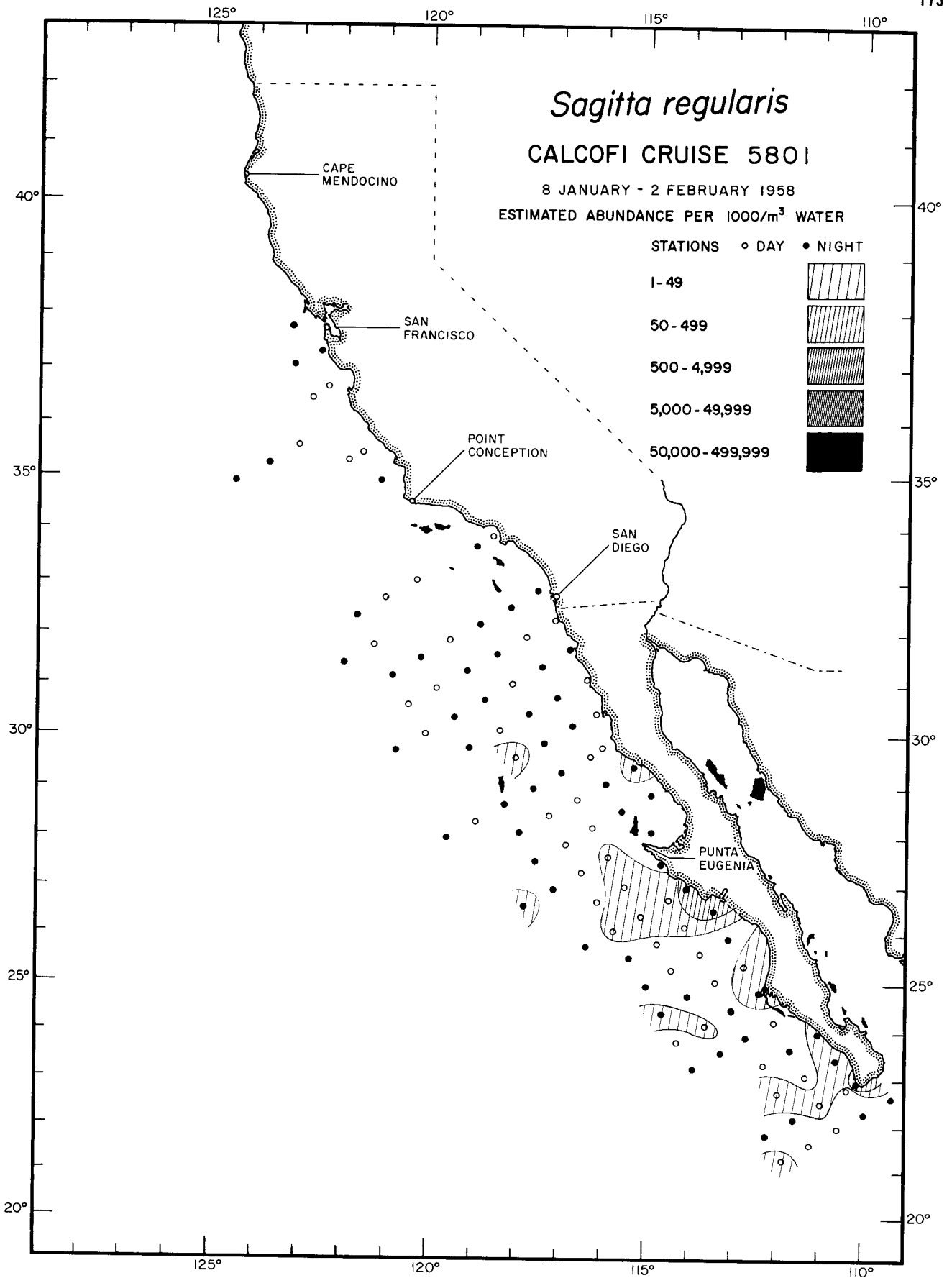
Chaetognatha
Sagitta pacifica
5801



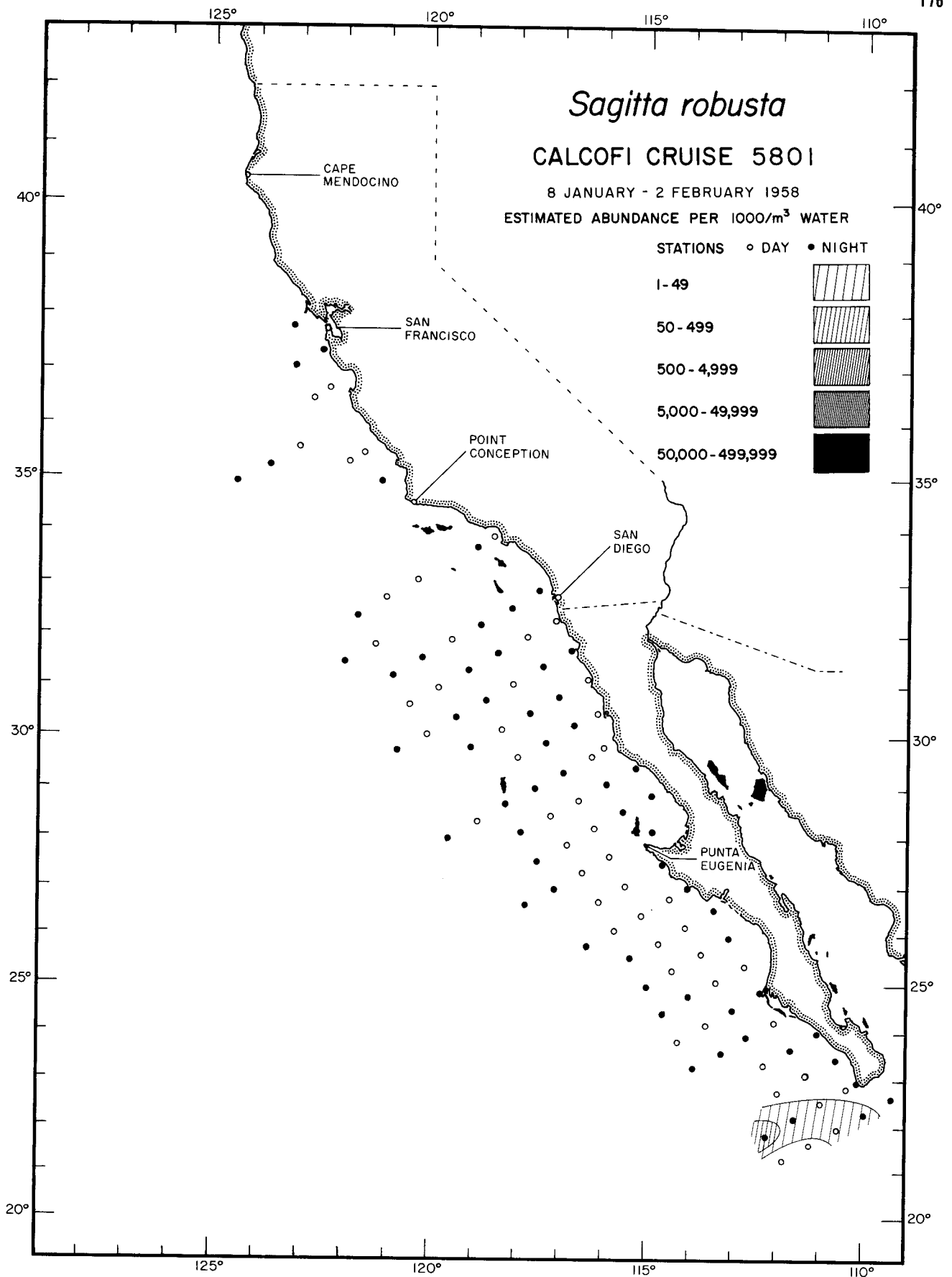
Chaetognatha
Sagitta pseudoserratodentata
5801



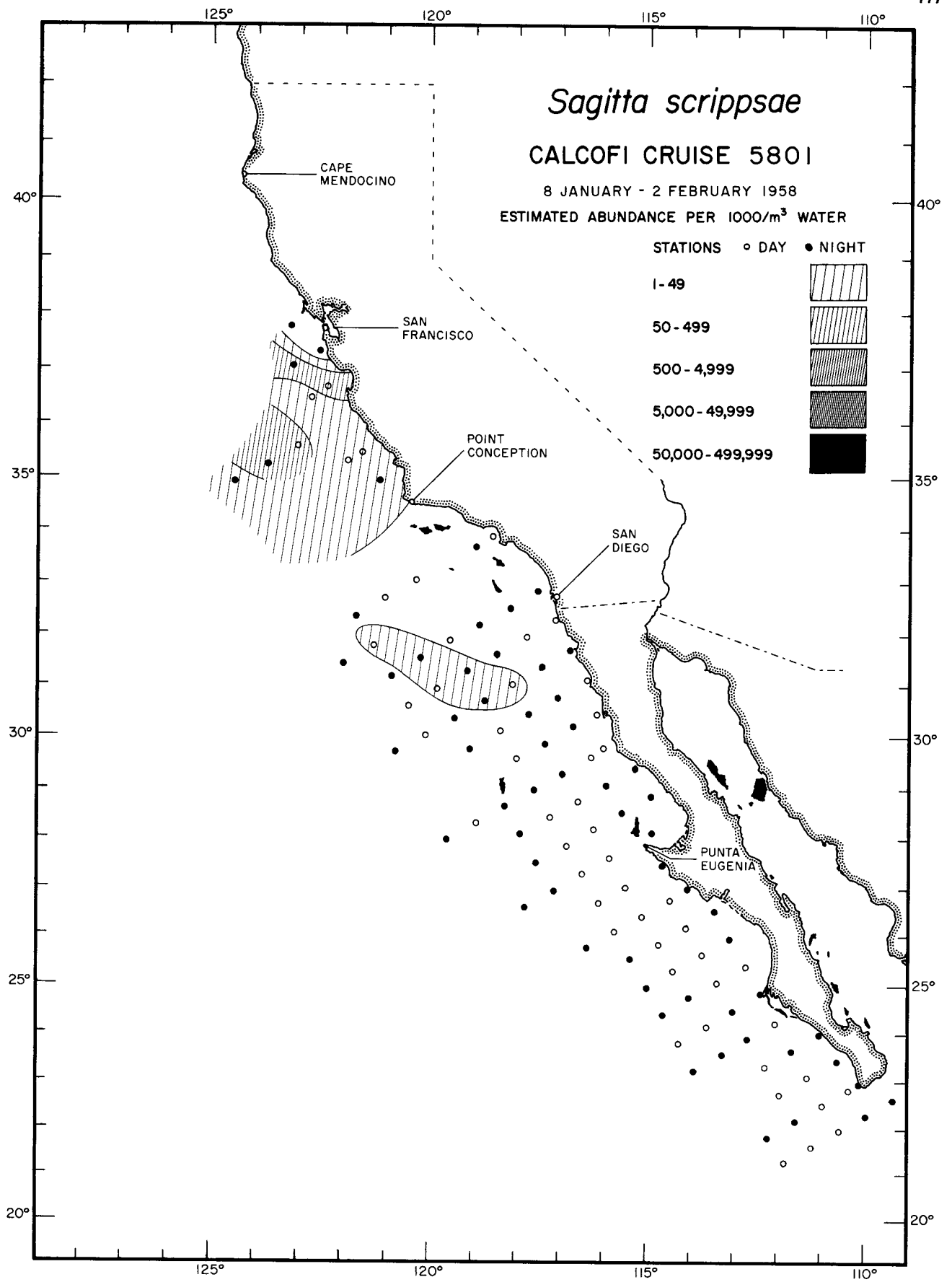
Chaetognatha
Sagitta pulchra
5801



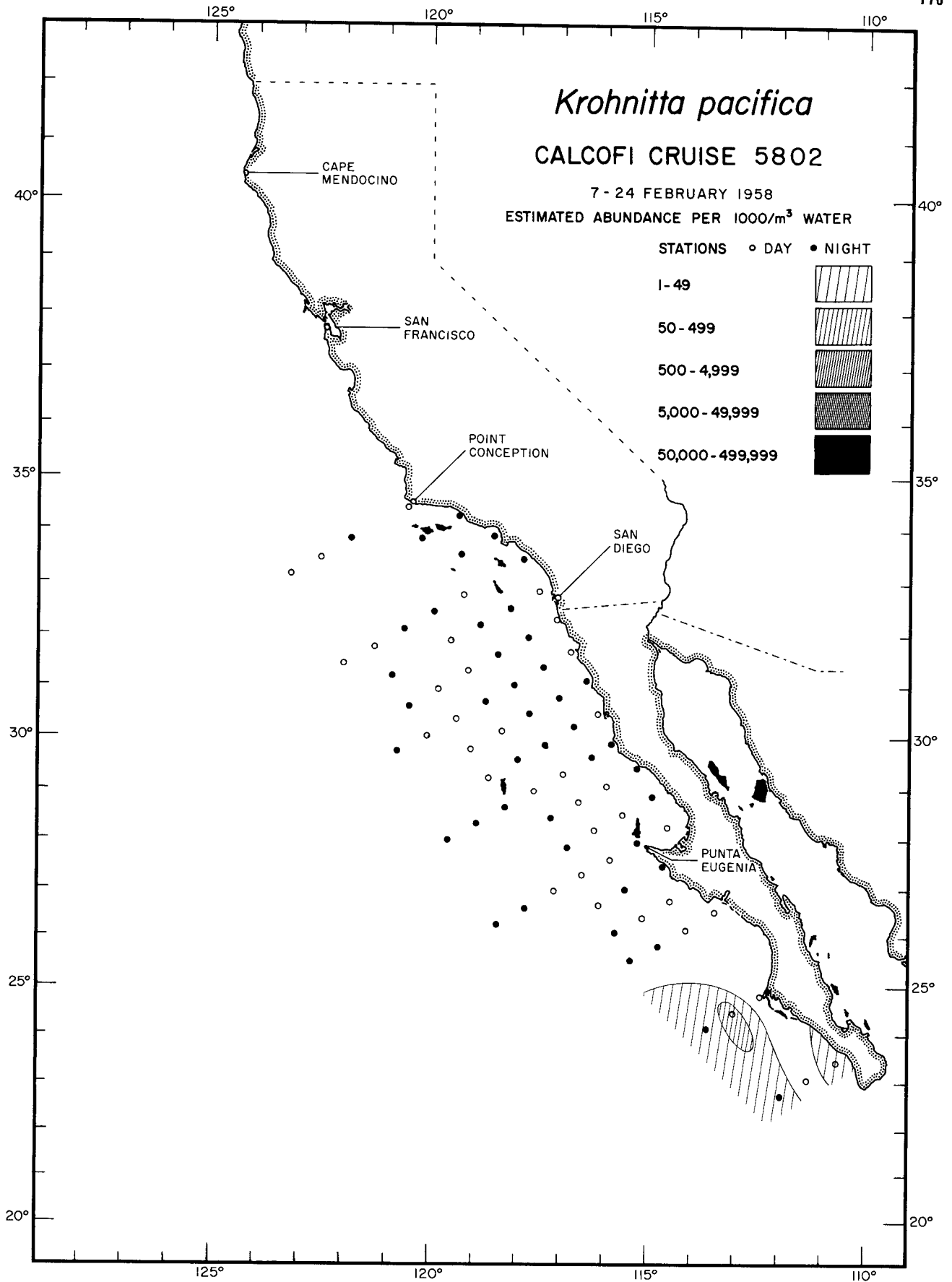
Chaetognatha
Sagitta regularis
5801



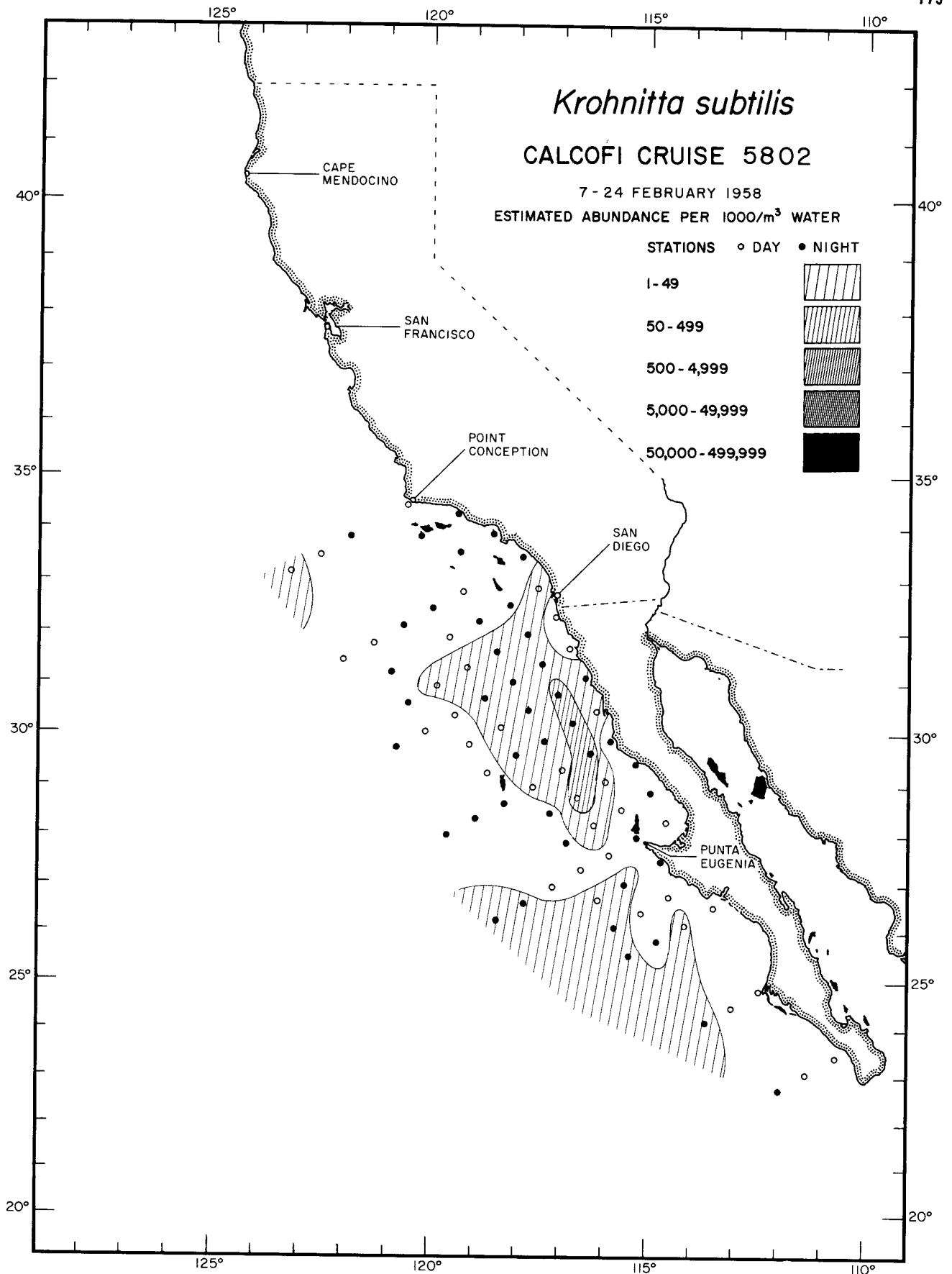
Chaetognatha
Sagitta robusta
5801



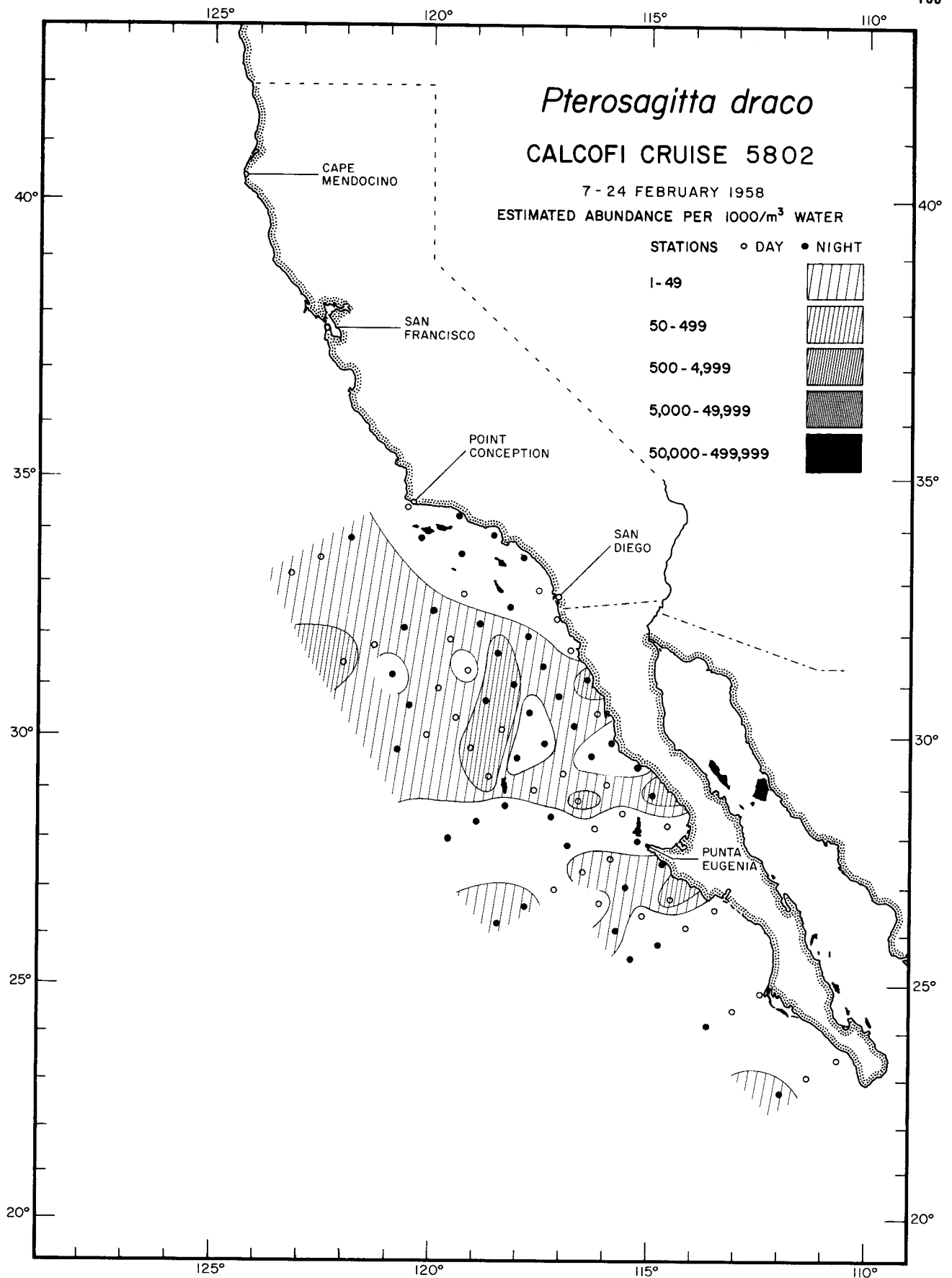
Chaetognatha
Sagitta scrippsae
5801



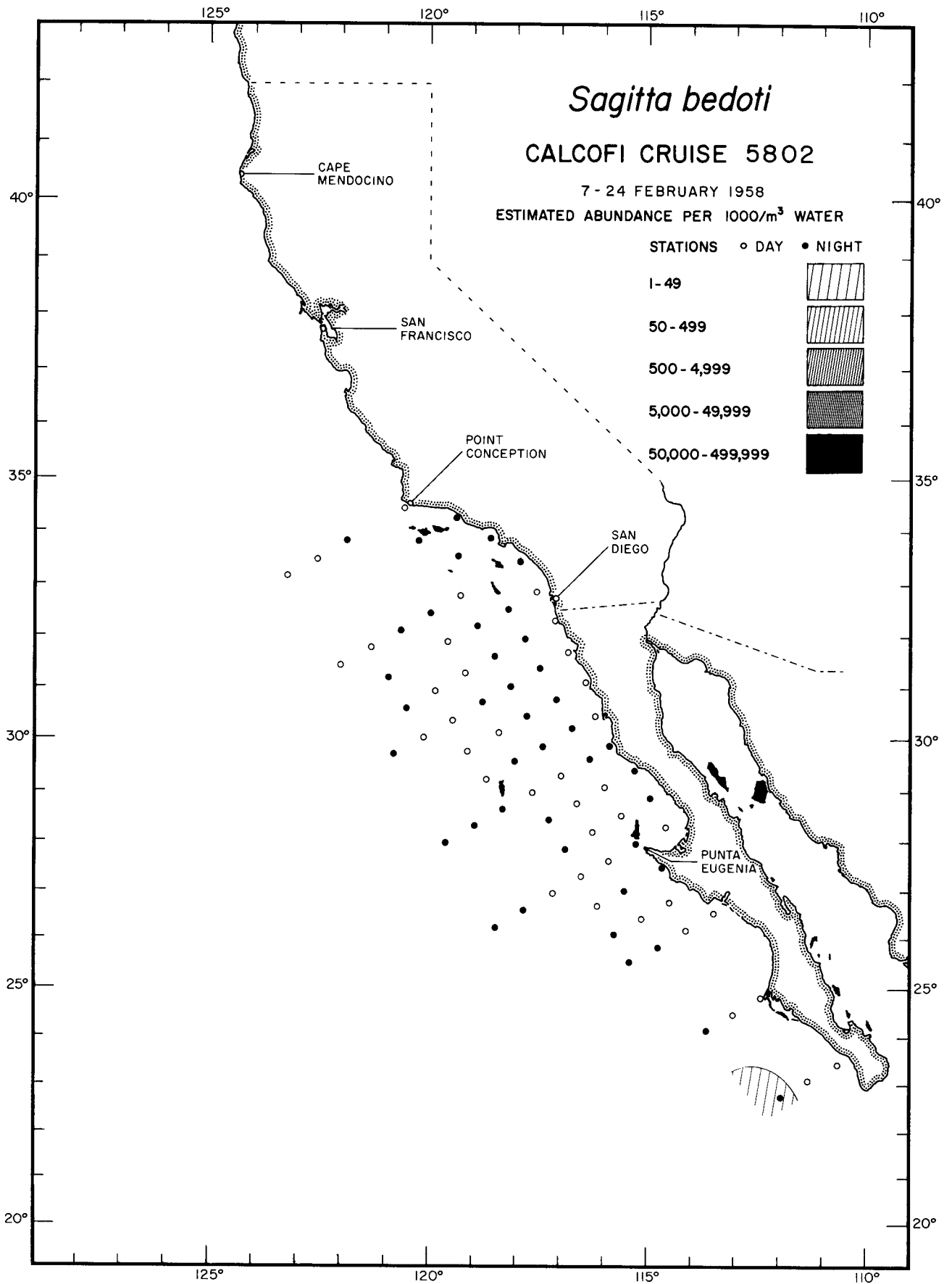
Chaetognatha
Krohnitta pacifica
5802



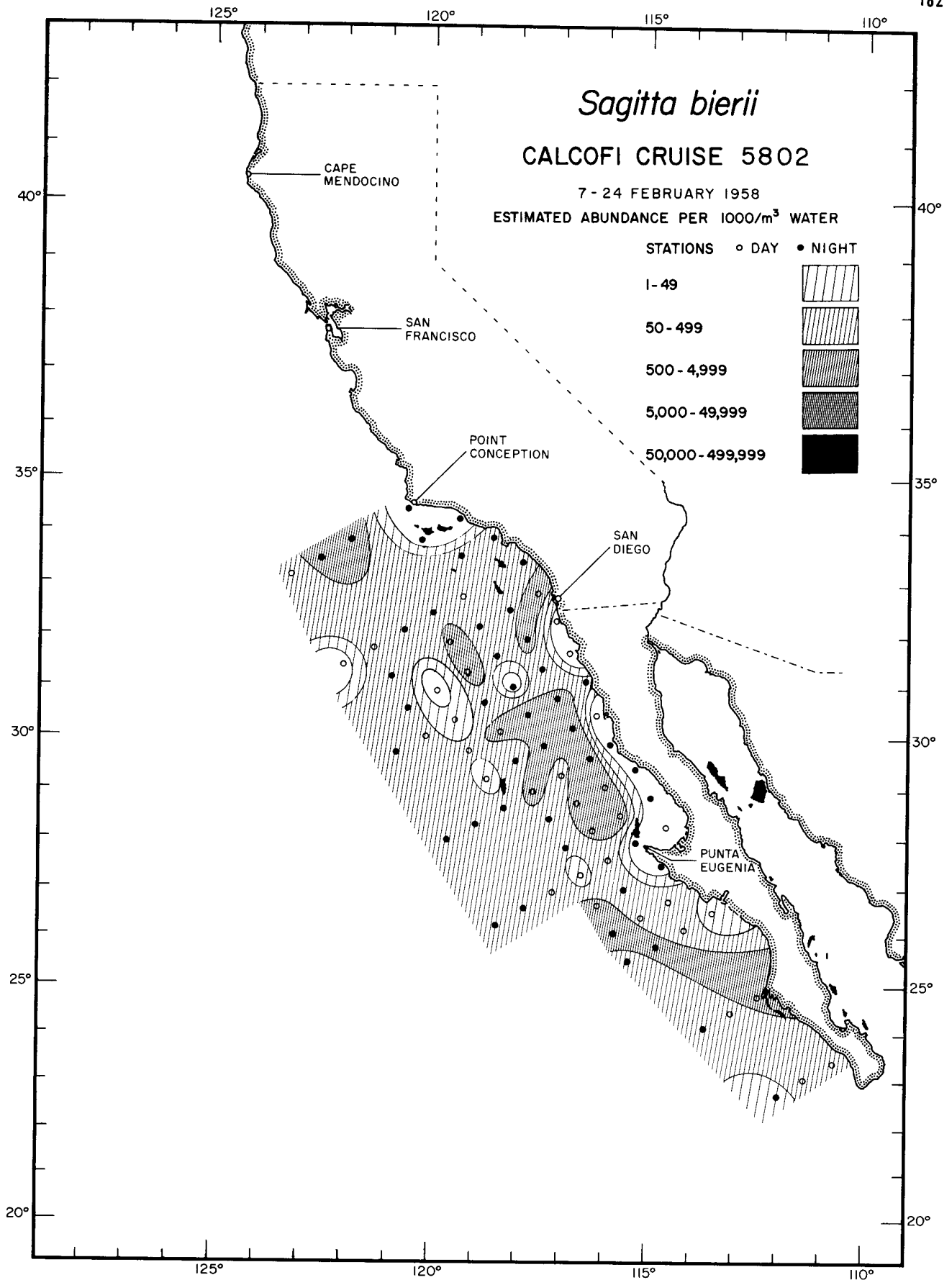
Chaetognatha
Krohnitta subtilis
5802



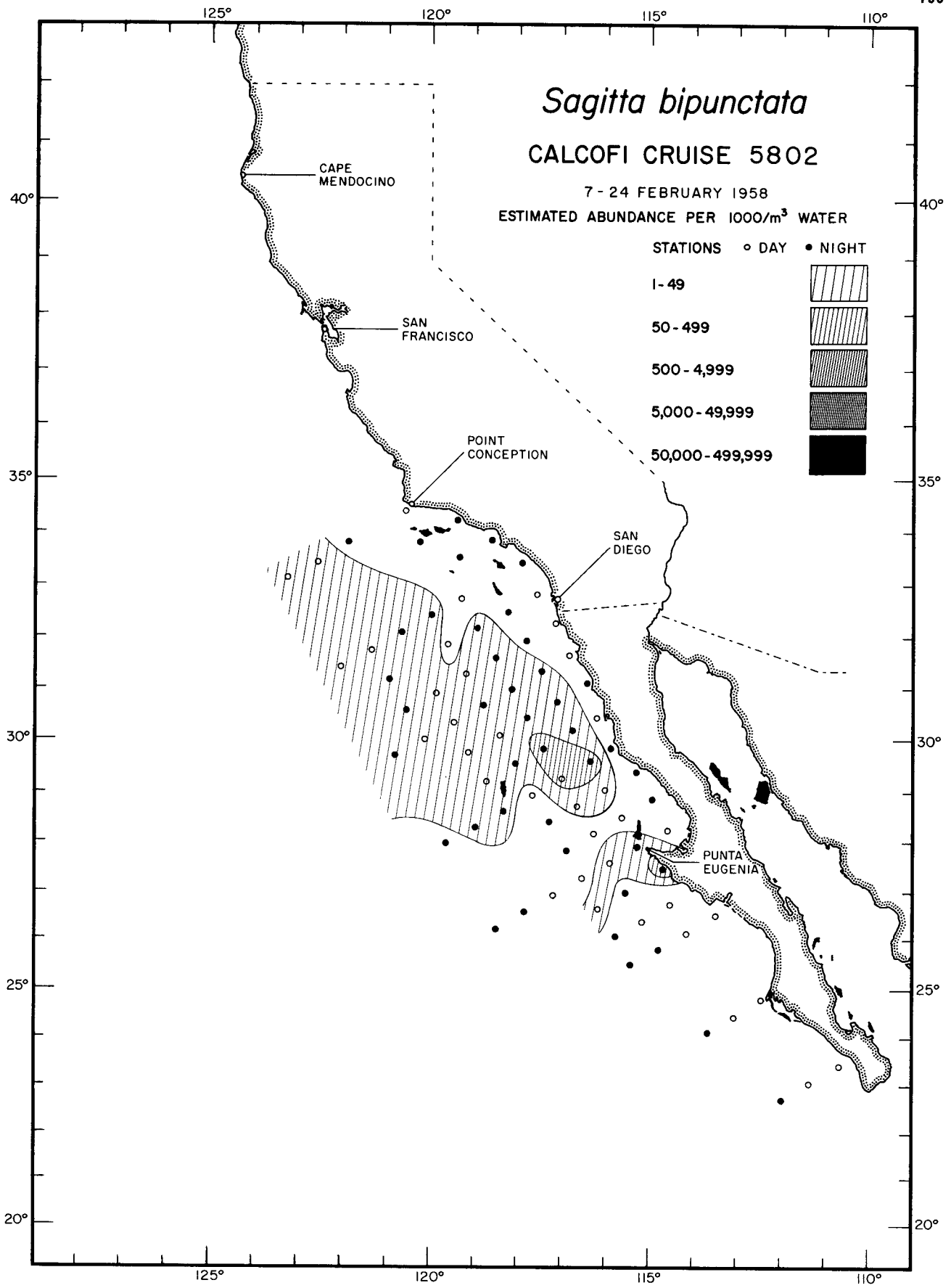
Chaetognatha
Pterosagitta draco
5802



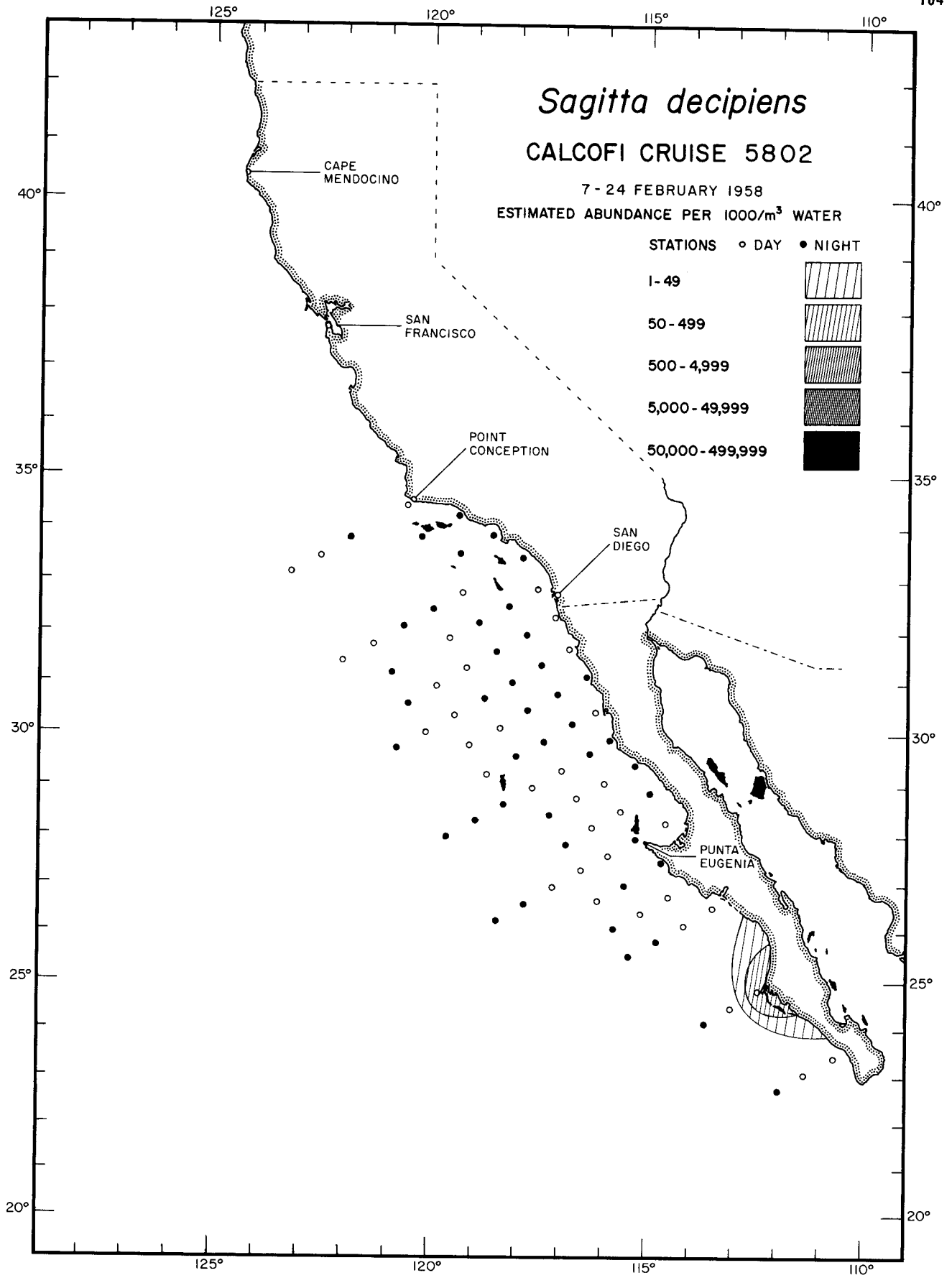
Chaetognatha
Sagitta bedoti
5802



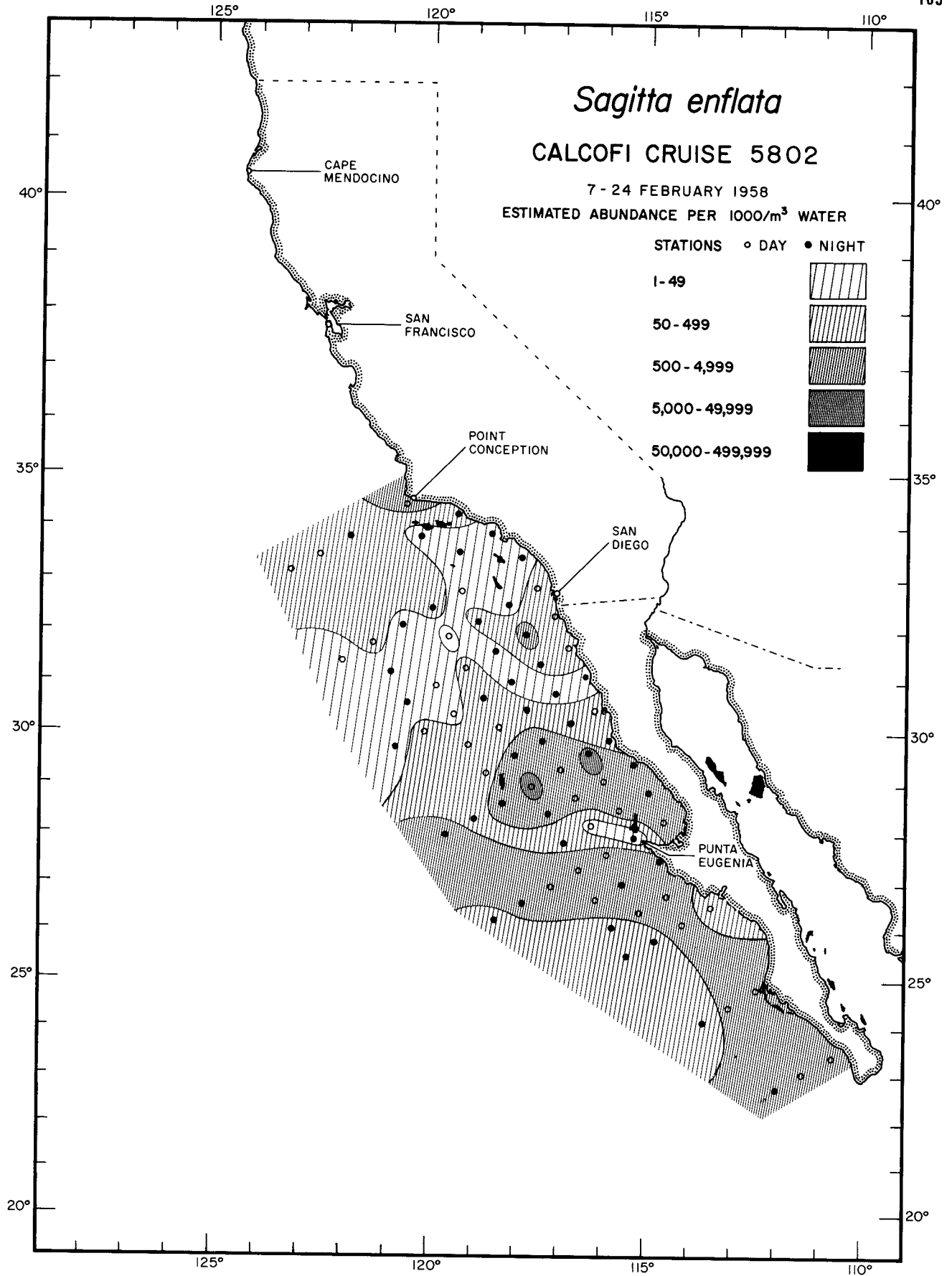
Chaetognatha
Sagitta bierii
5802



Chaetognatha
Sagitta bipunctata
5802



Chaetognatha
Sagitta decipiens
5802

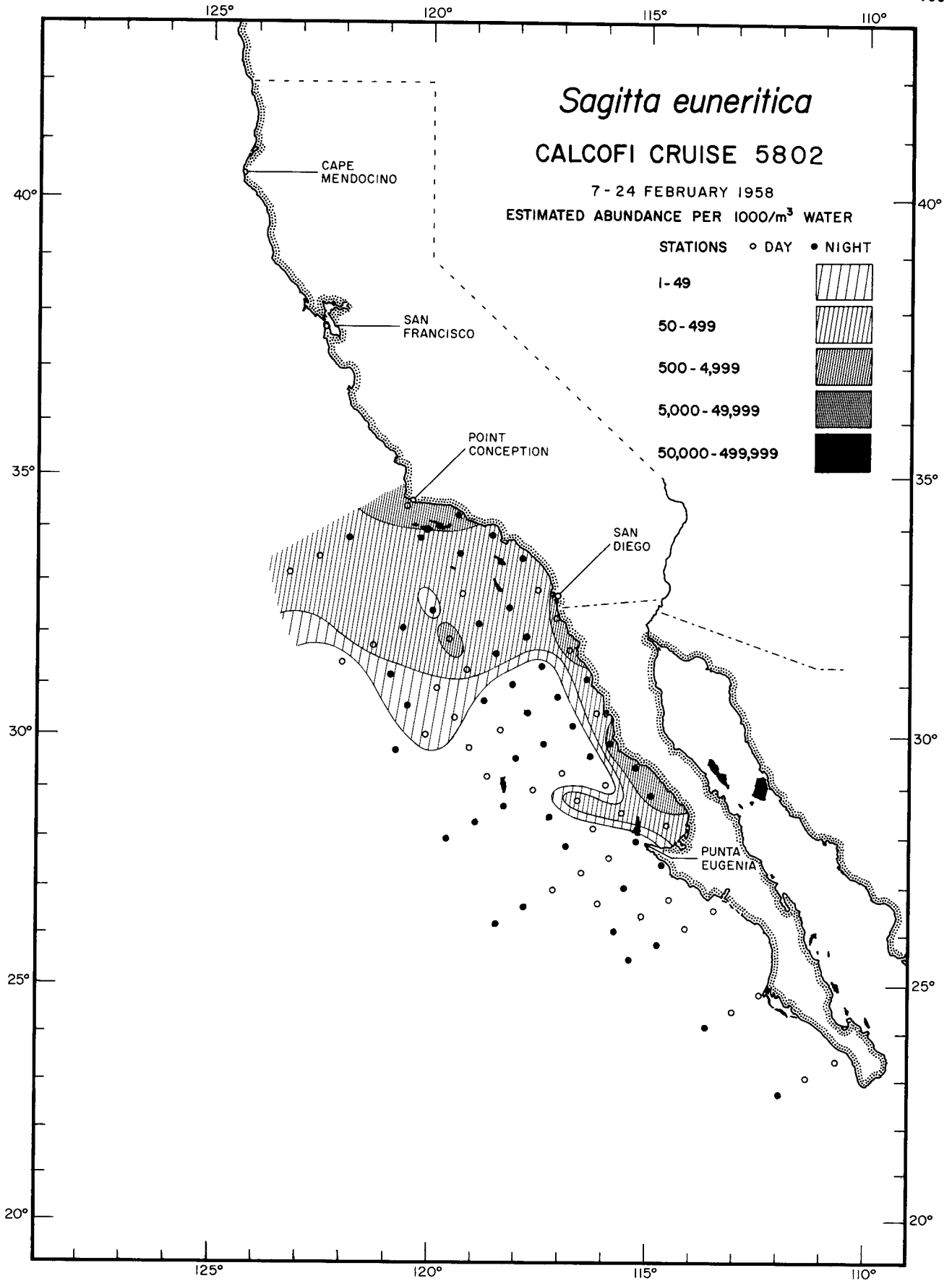


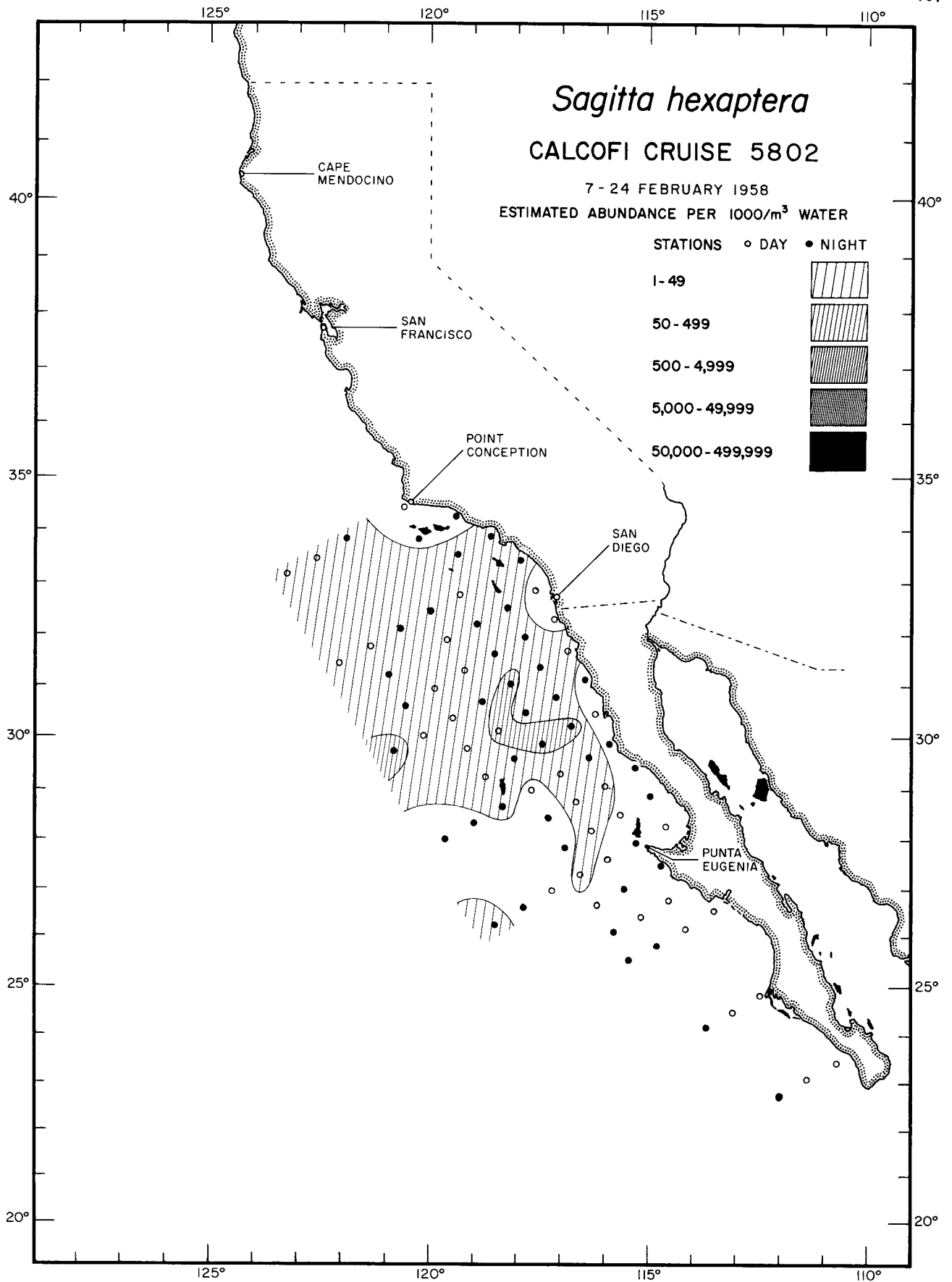
Sagitta enflata
CALCOFI CRUISE 5802

7 - 24 FEBRUARY 1958
ESTIMATED ABUNDANCE PER 1000/m³ WATER

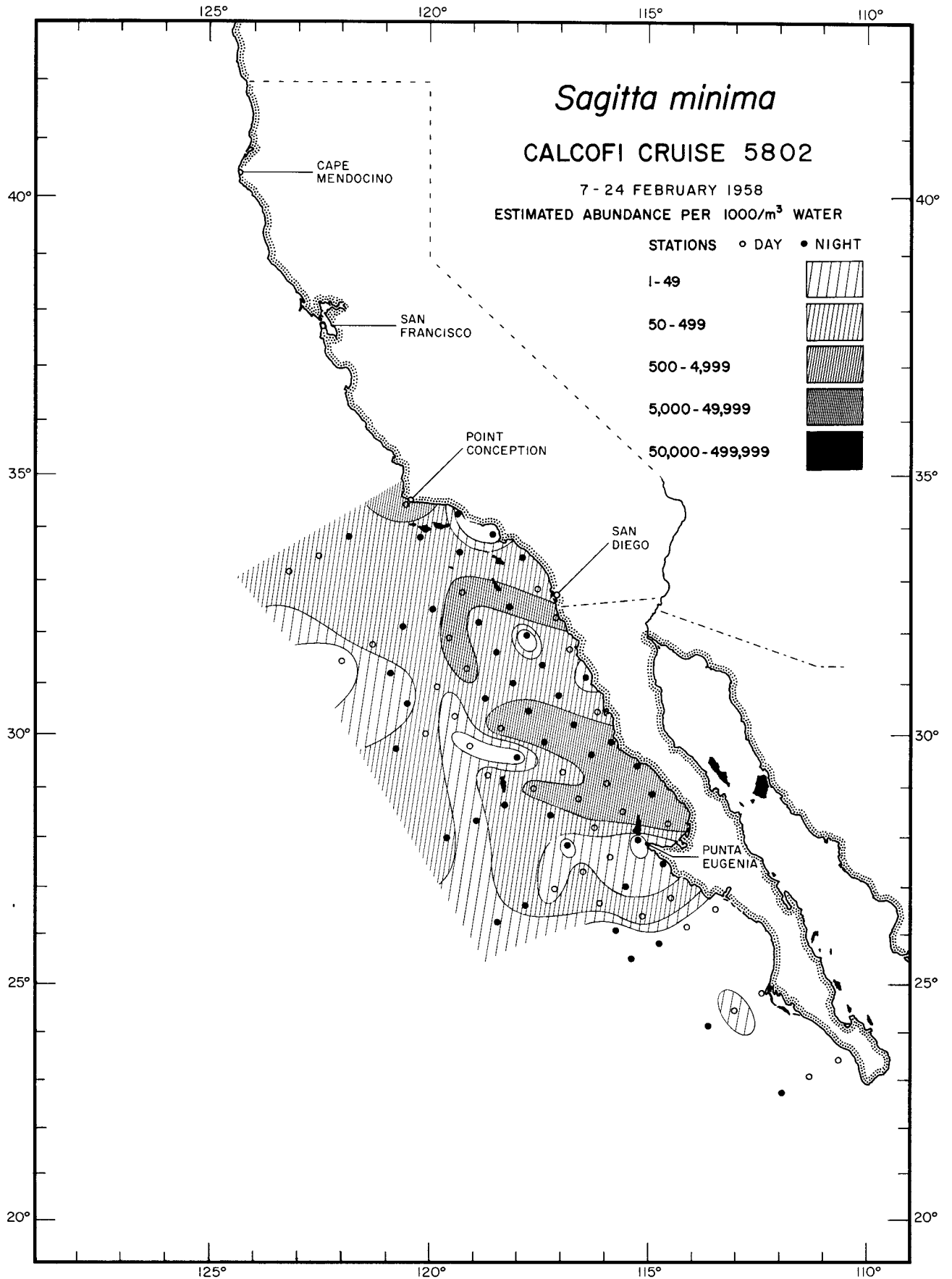
STATIONS ○ DAY ● NIGHT

1-49	[diagonal lines]
50-499	[cross-hatch]
500-4,999	[vertical lines]
5,000-49,999	[horizontal lines]
50,000-499,999	[solid black]

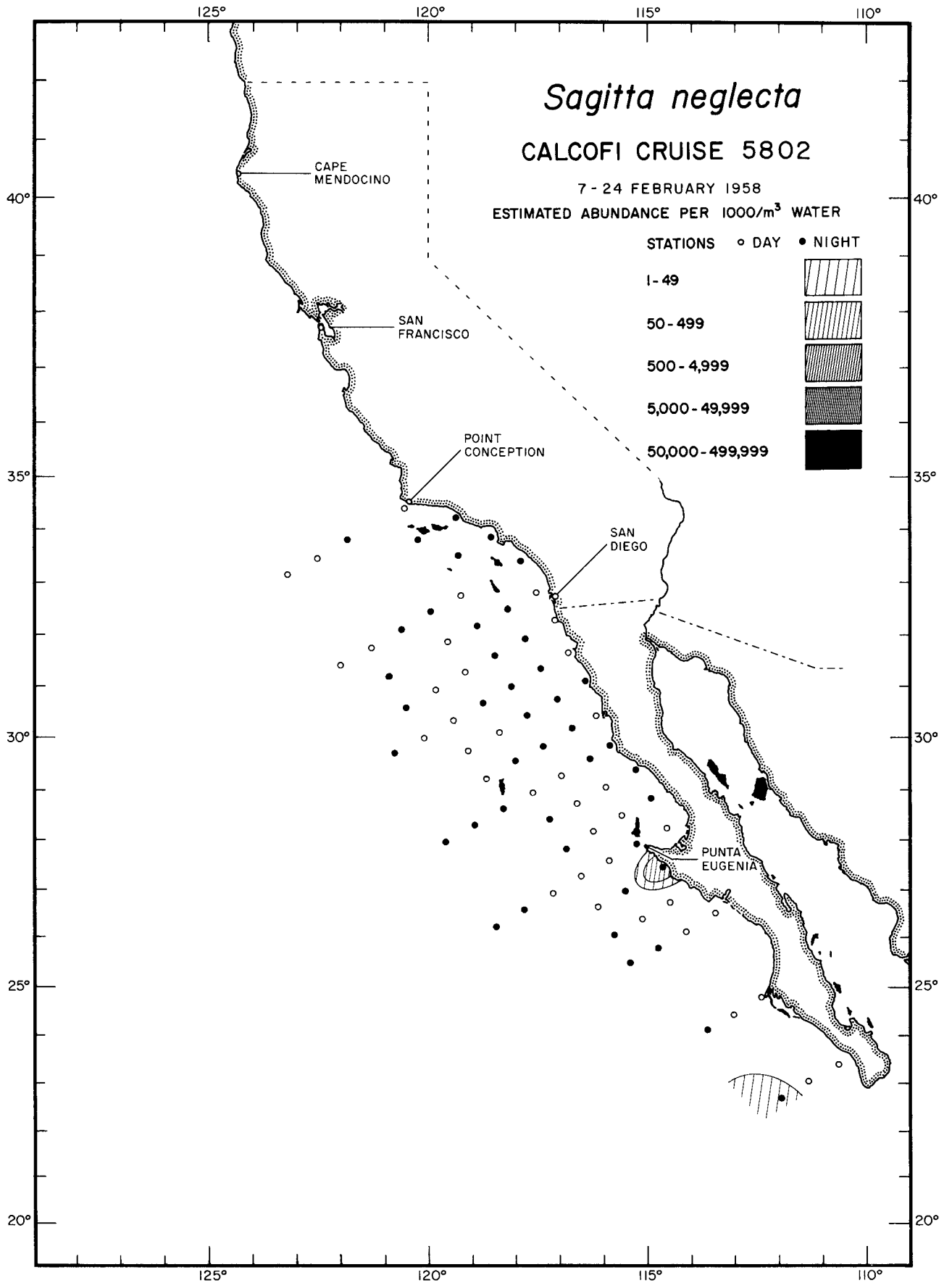




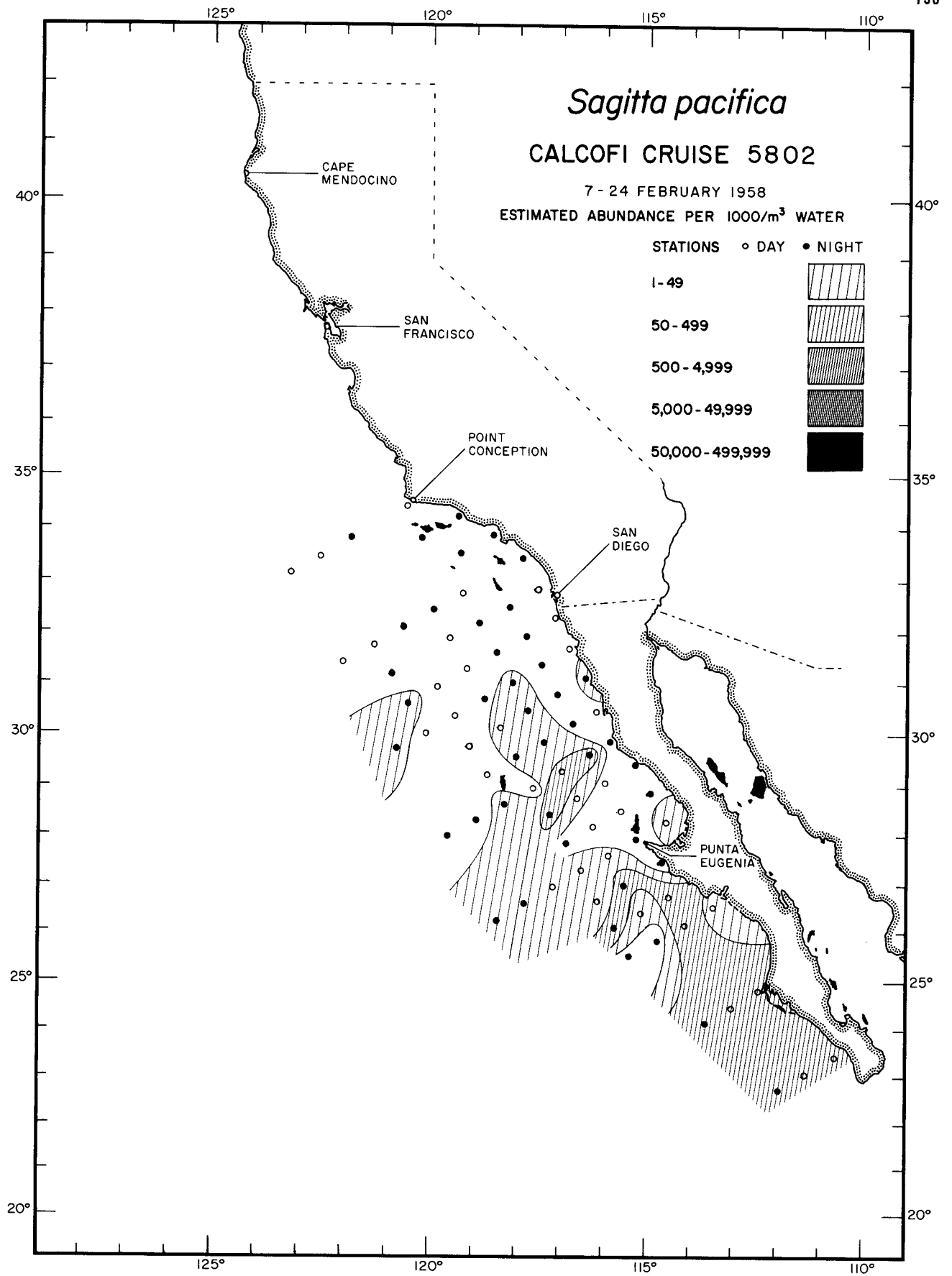
Chaetognatha
Sagitta hexaptera
5802



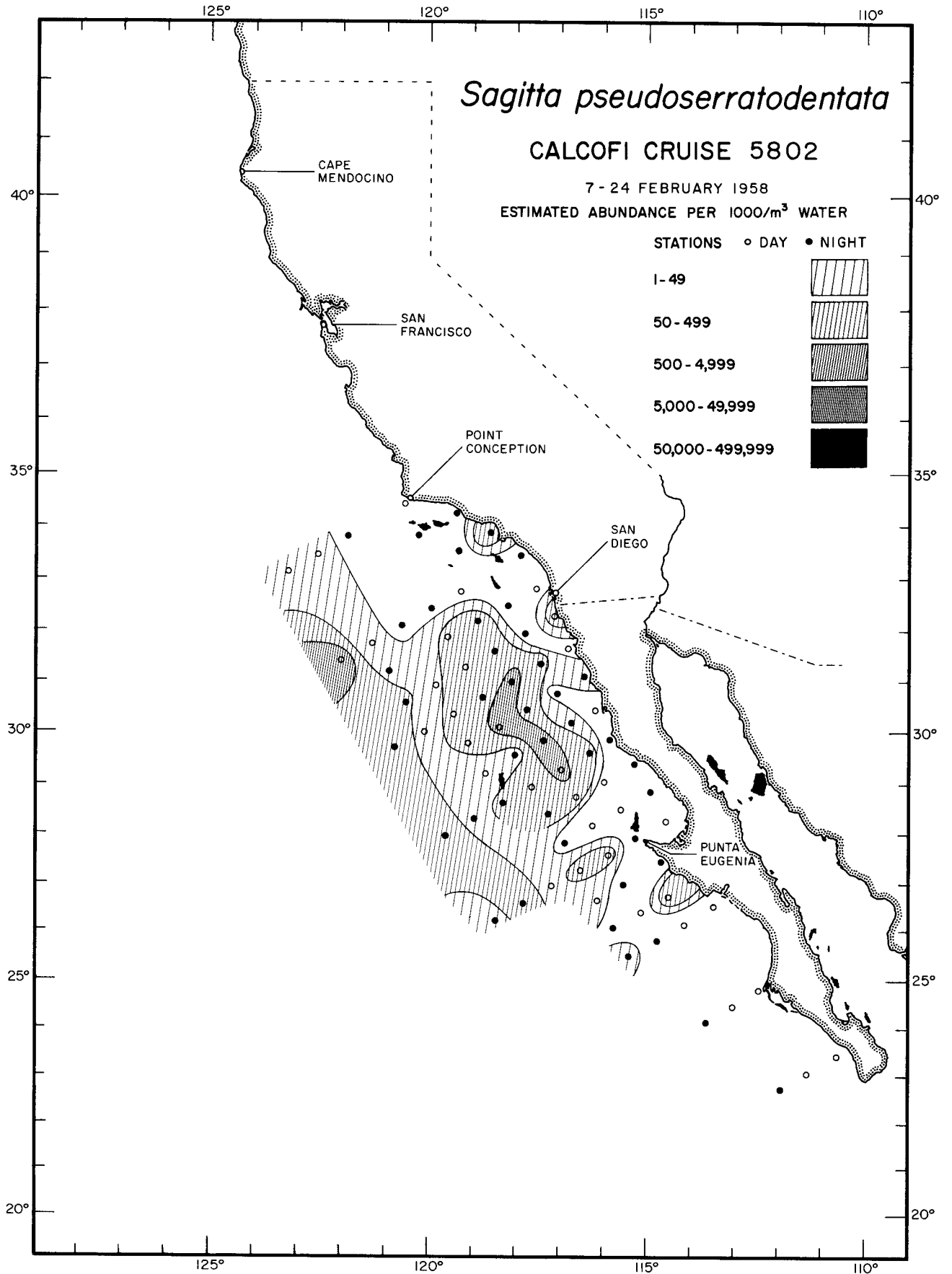
Chaetognatha
Sagitta minima
5802



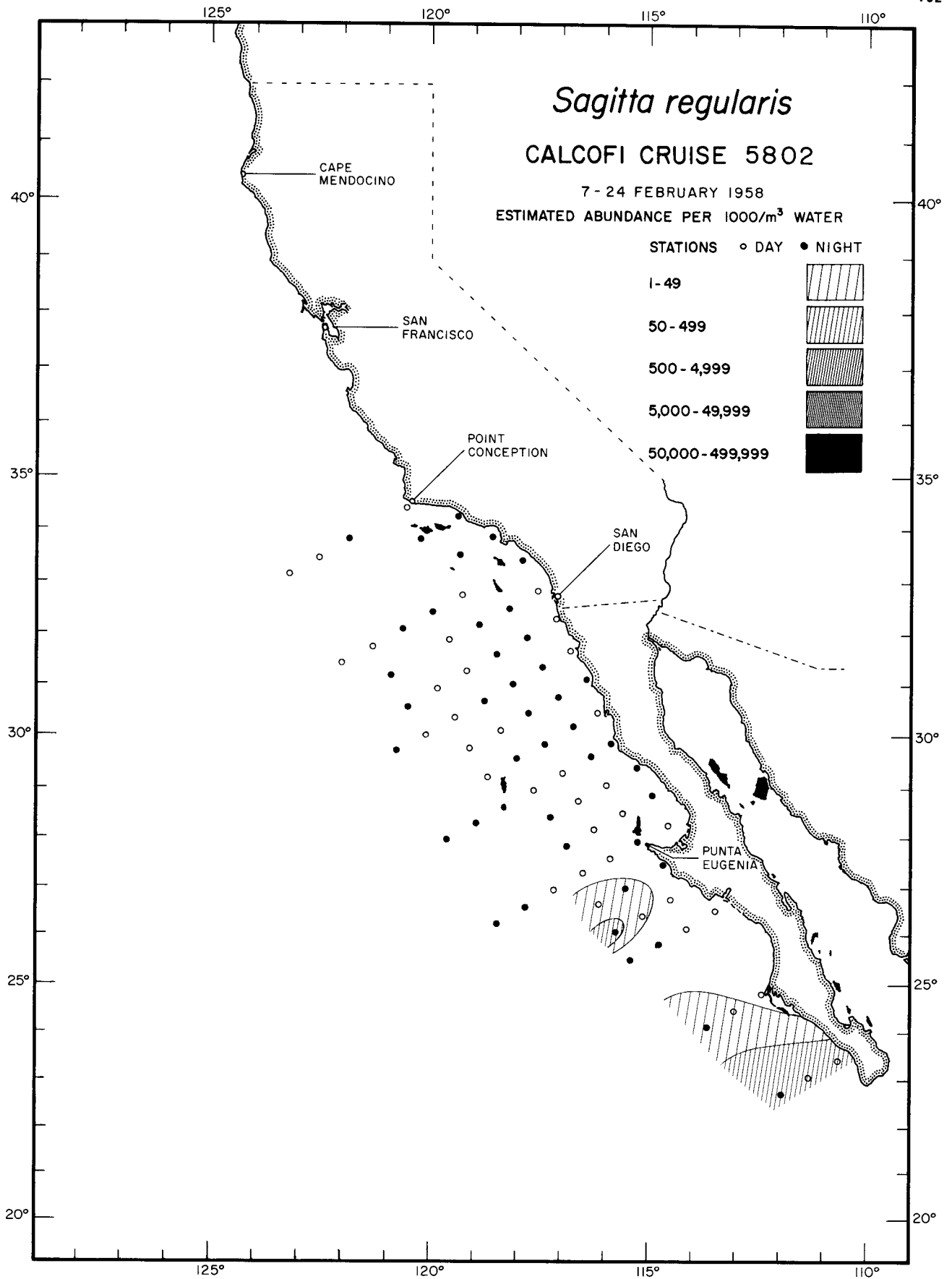
Chaetognatha
Sagitta neglecta
5802



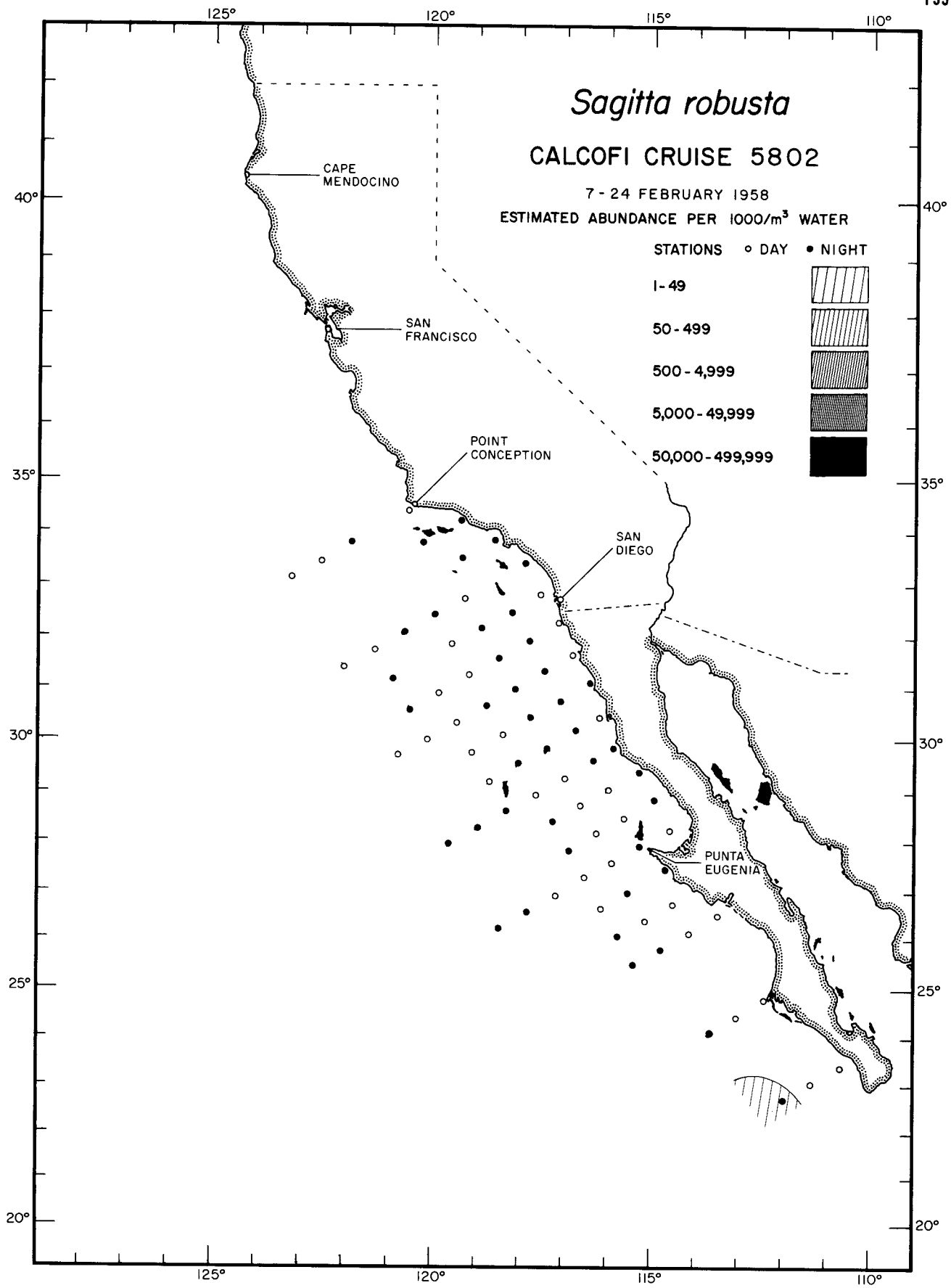
Chaetognatha
Sagitta pacifica
5802



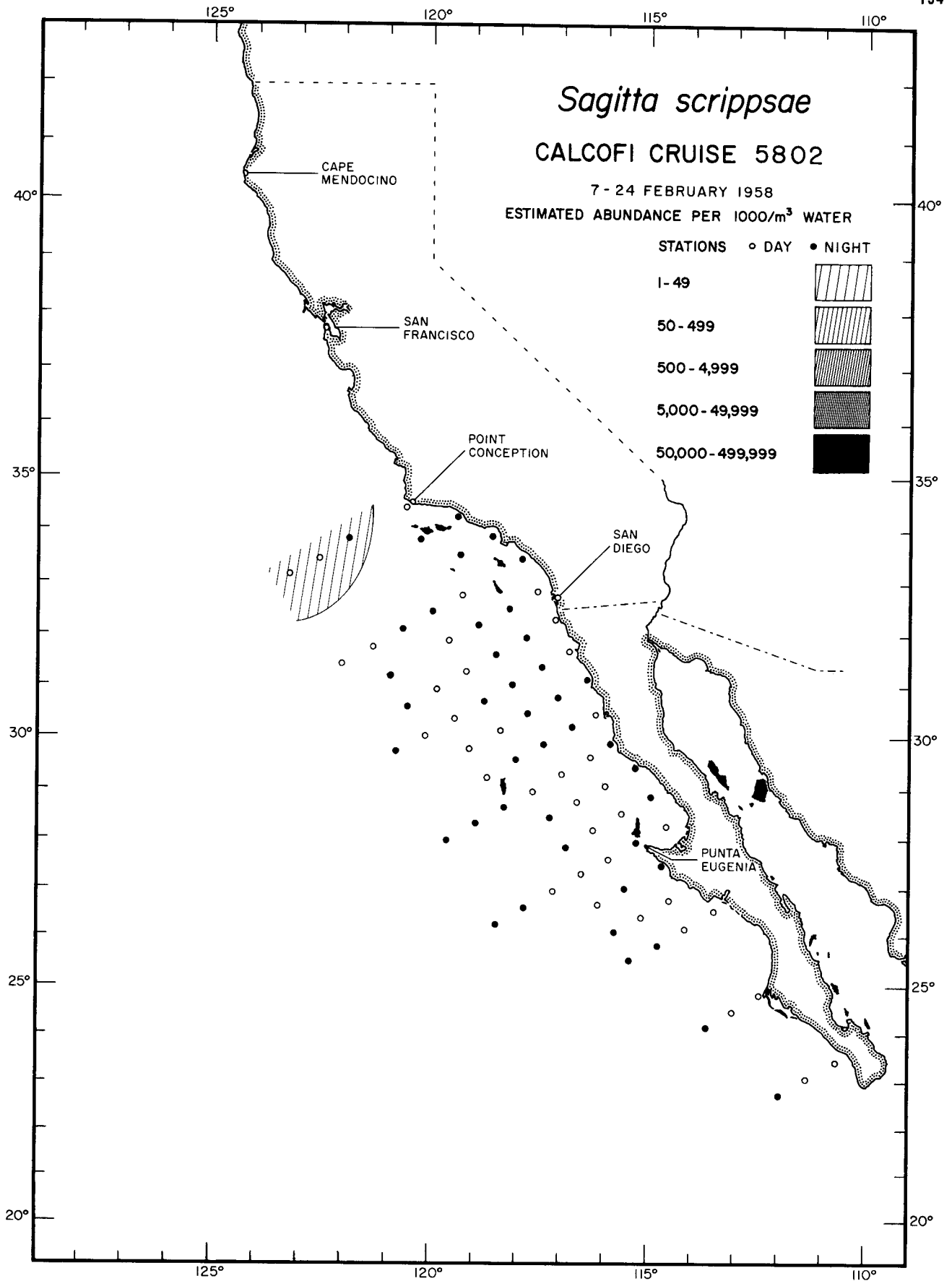
Chaetognatha
Sagitta pseudoserratodentata
5802



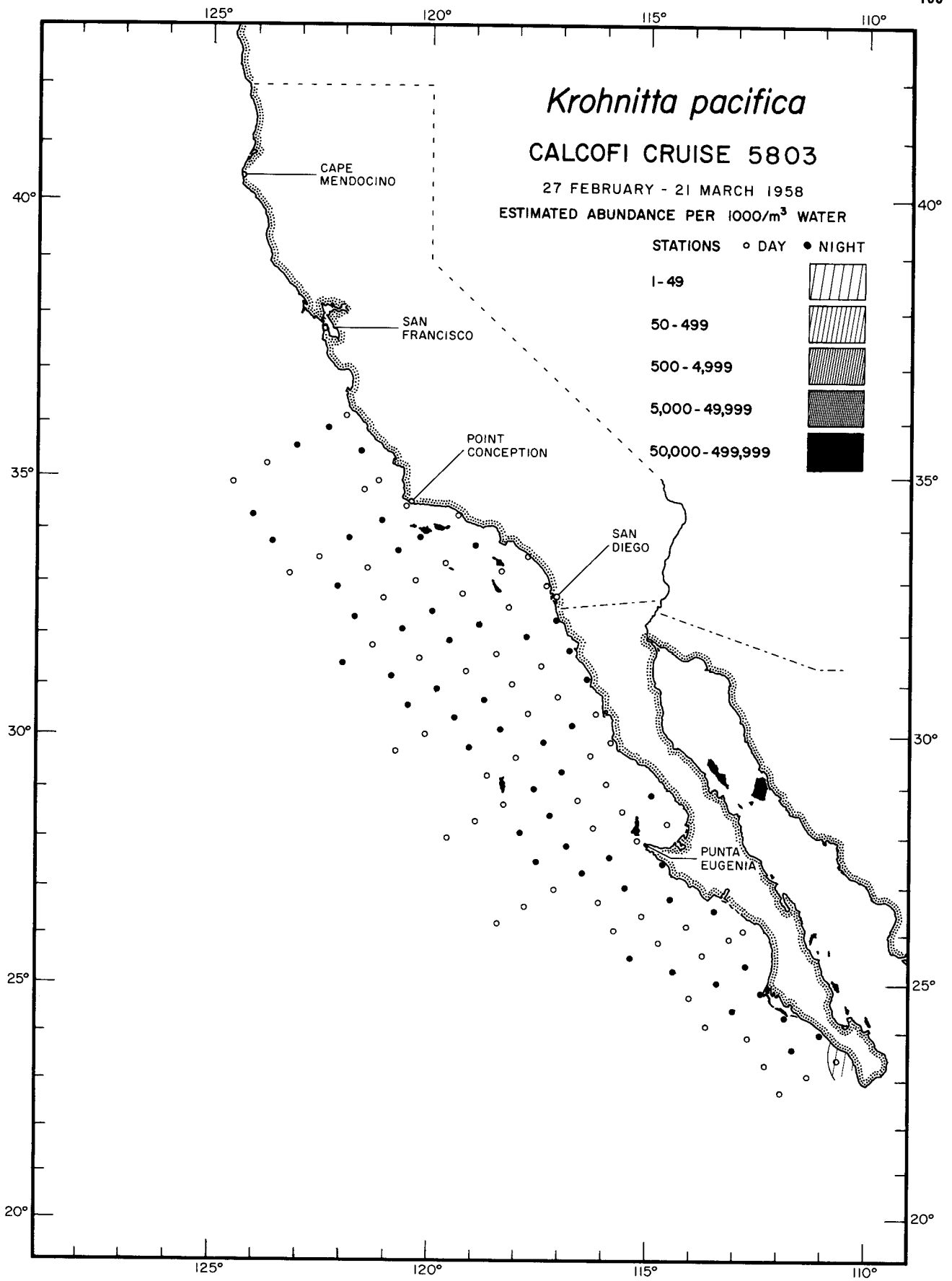
Chaetognatha
Sagitta regularis
5802



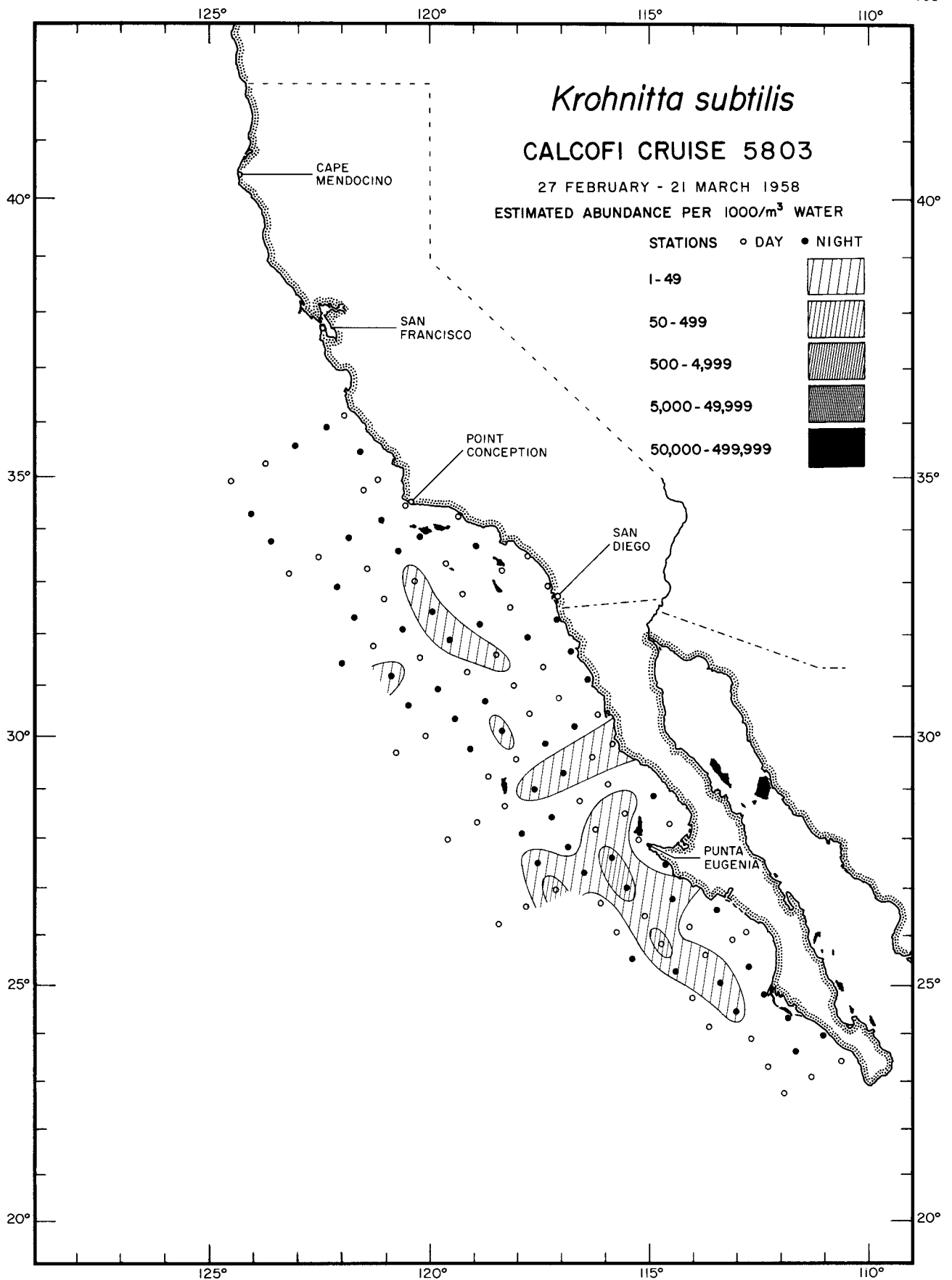
Chaetognatha
Sagitta robusta
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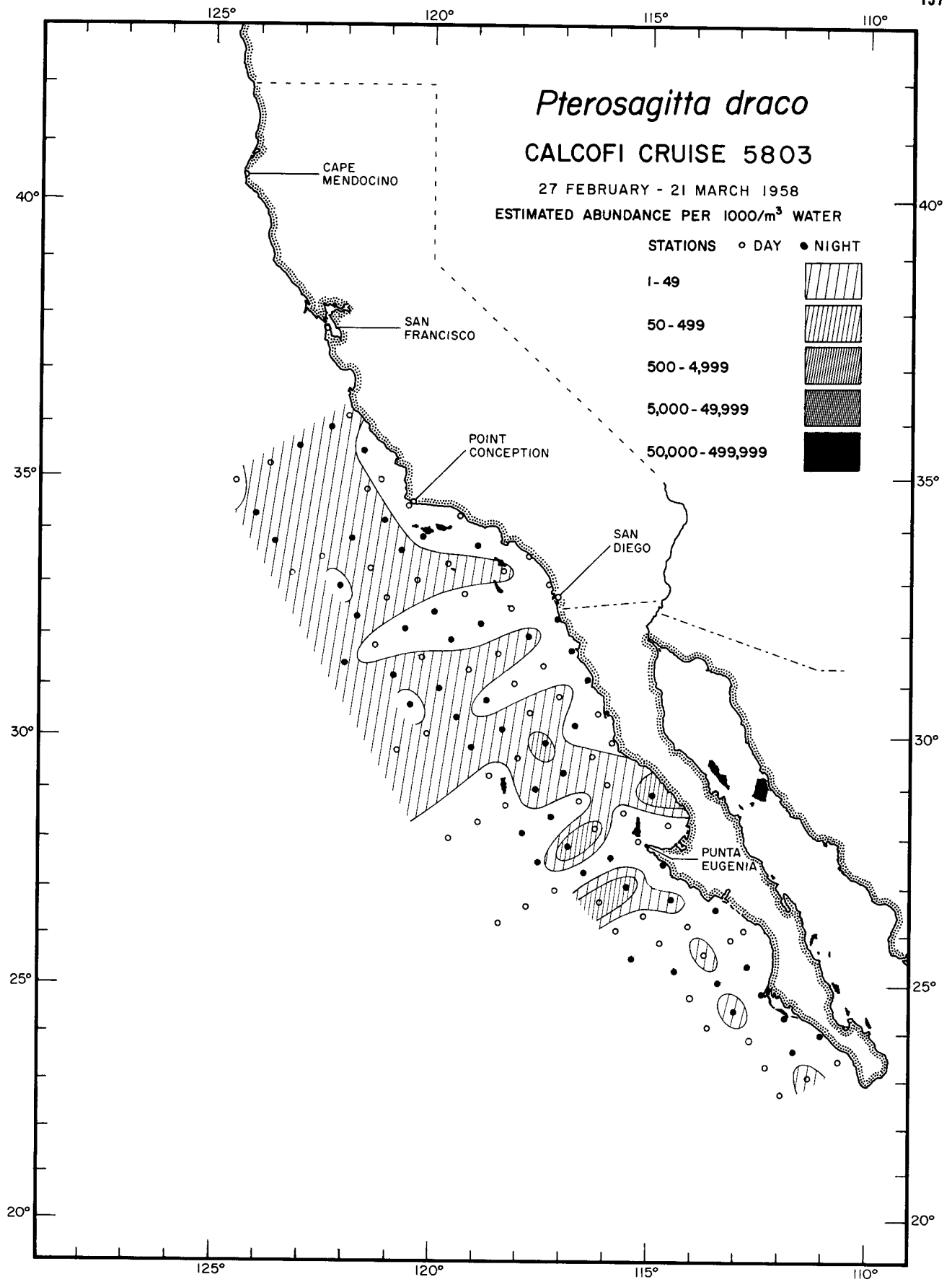


Chaetognatha
Sagitta scrippsae
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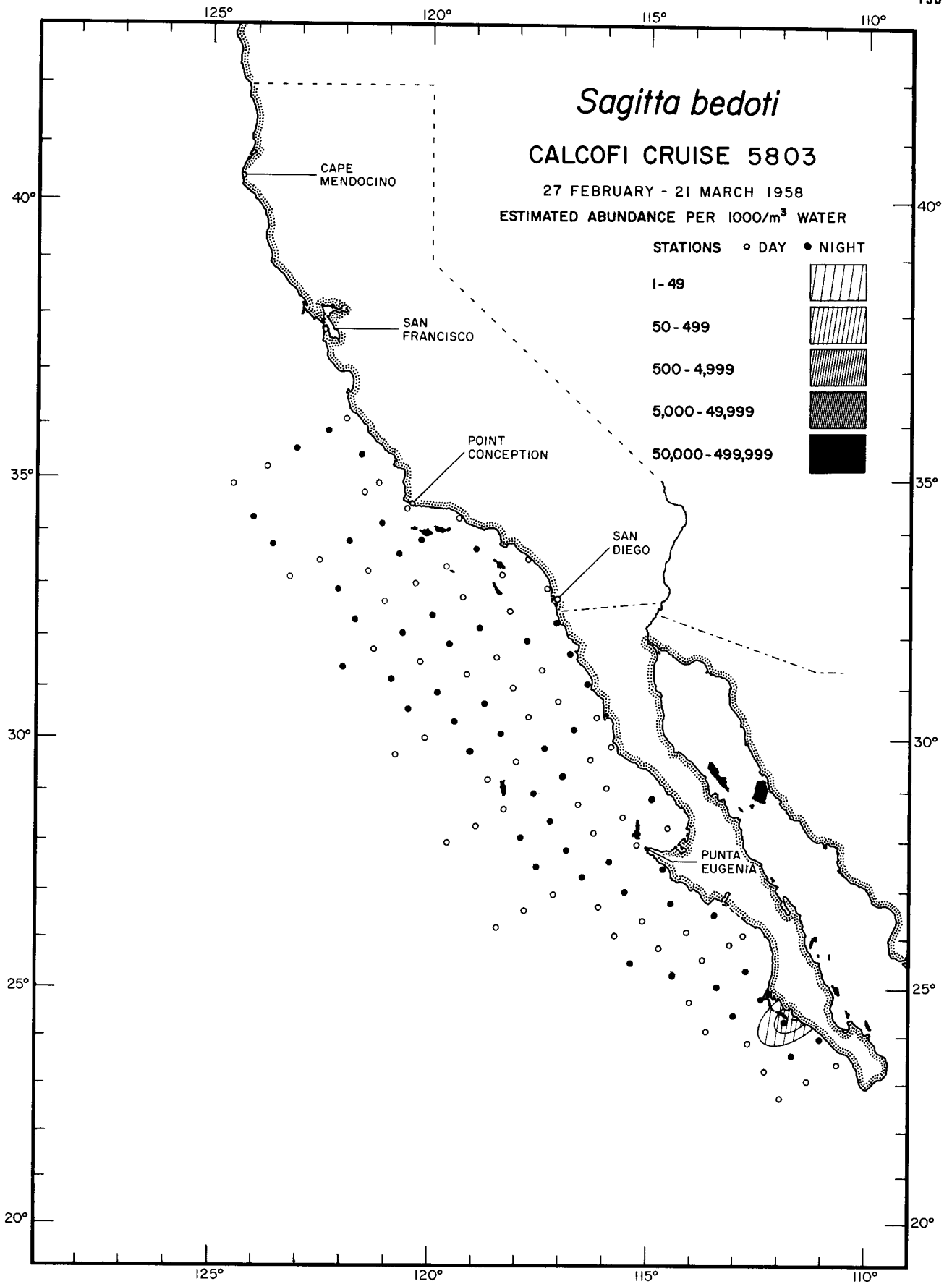


Chaetognatha
Krohnitta pacifica
5803

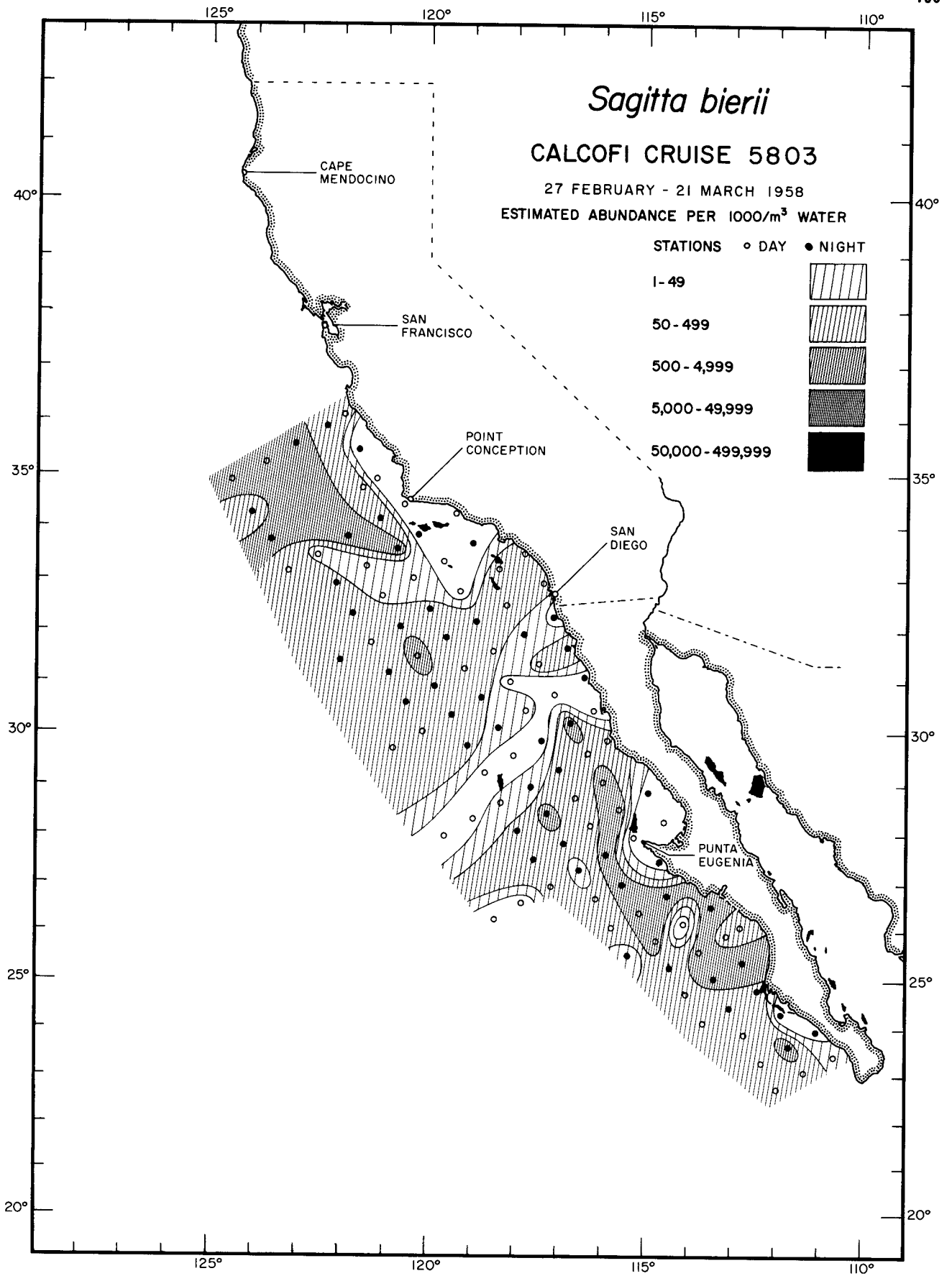


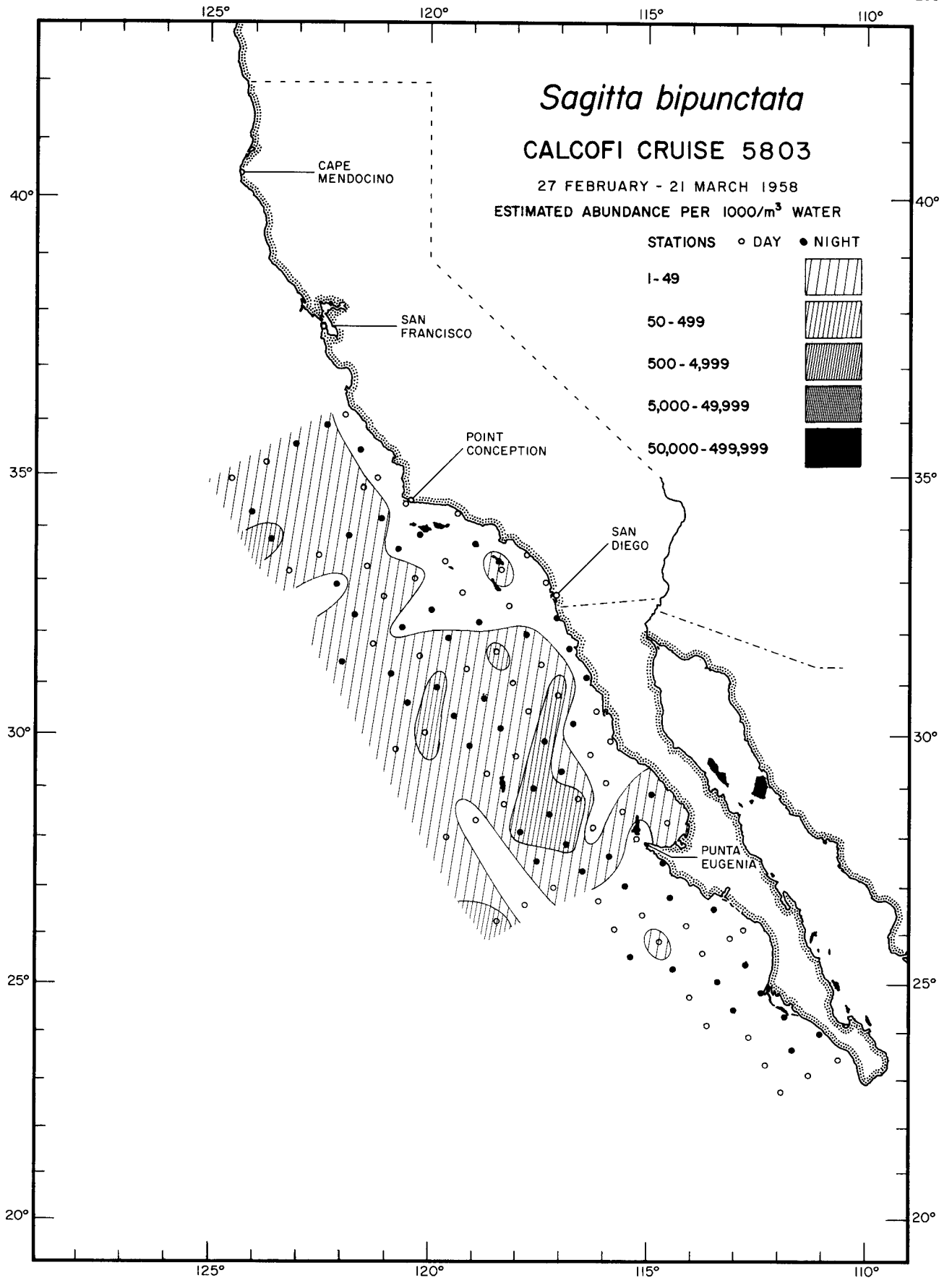


Chaetognatha
Pterosagitta draco
5803

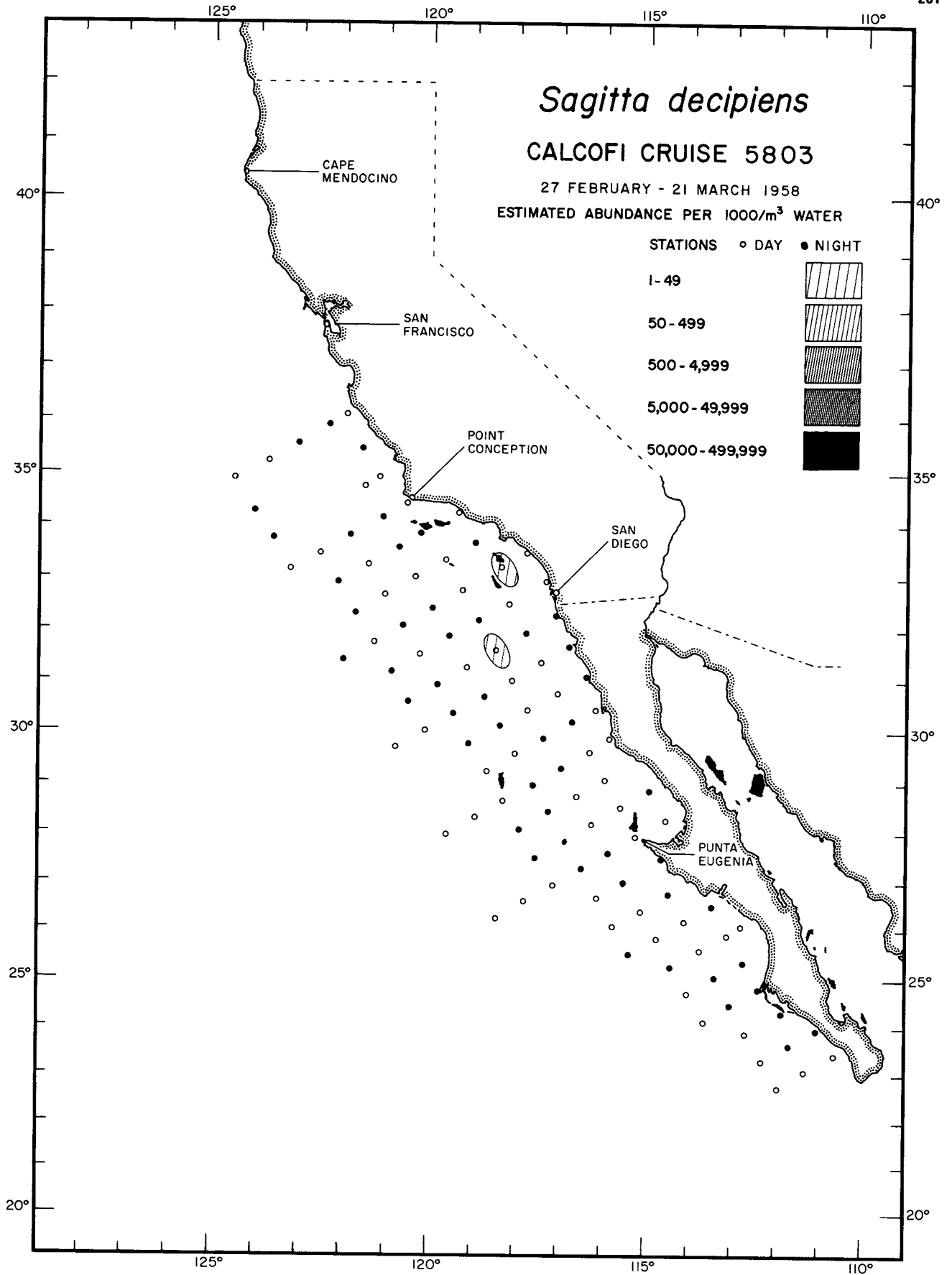


Chaetognatha
Sagitta bedoti
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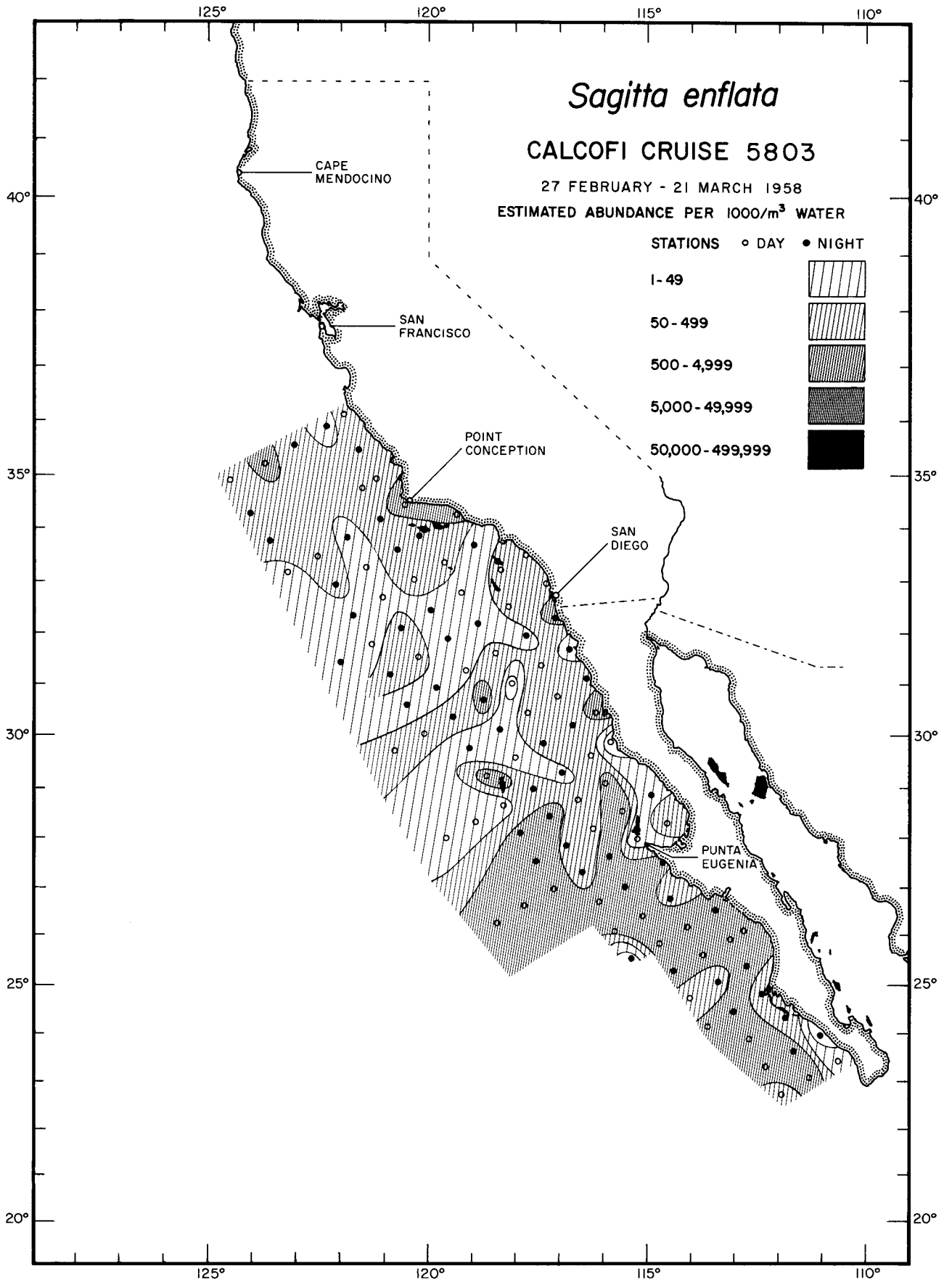




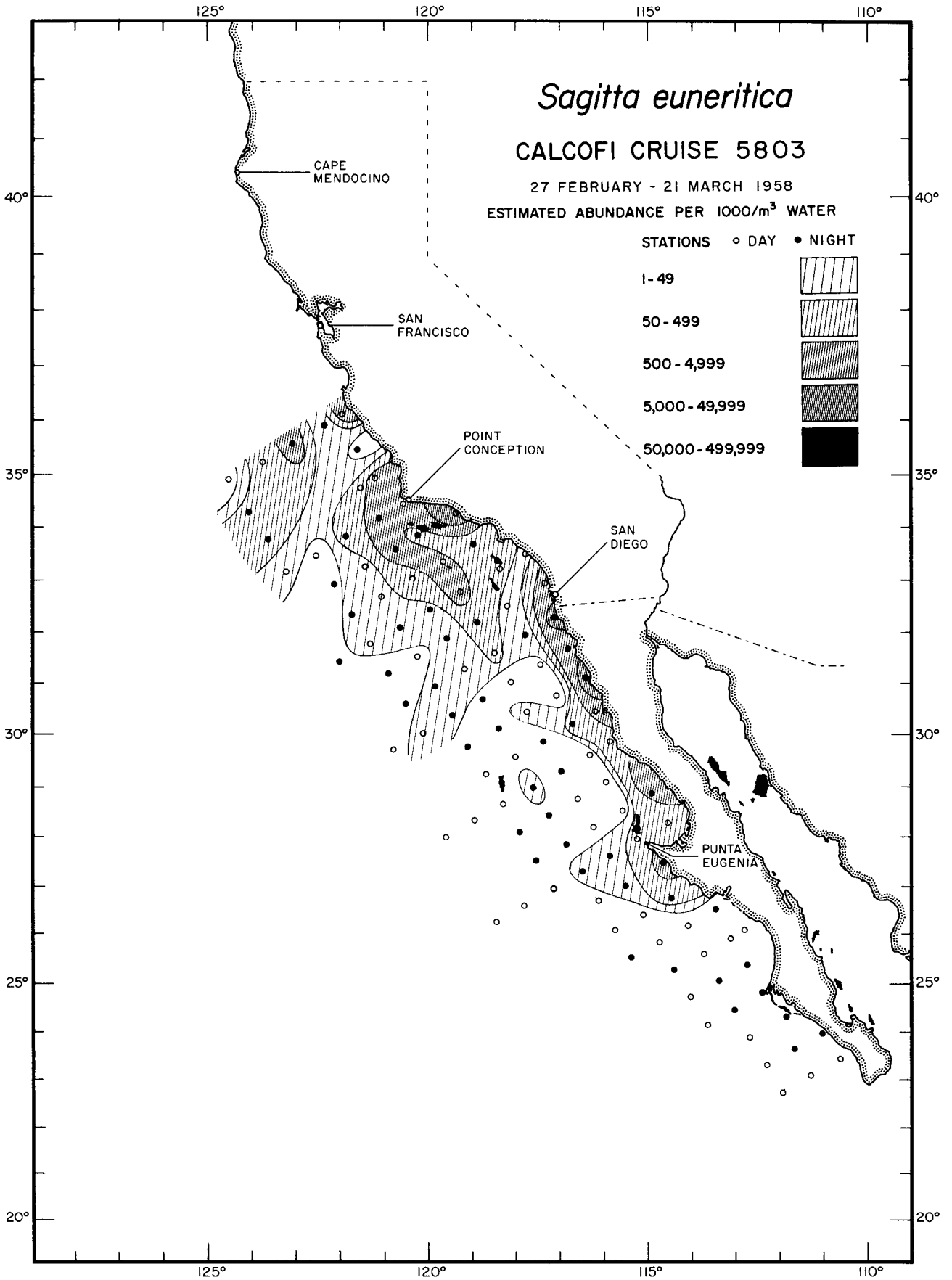
Chaetognatha
Sagitta bipunctata
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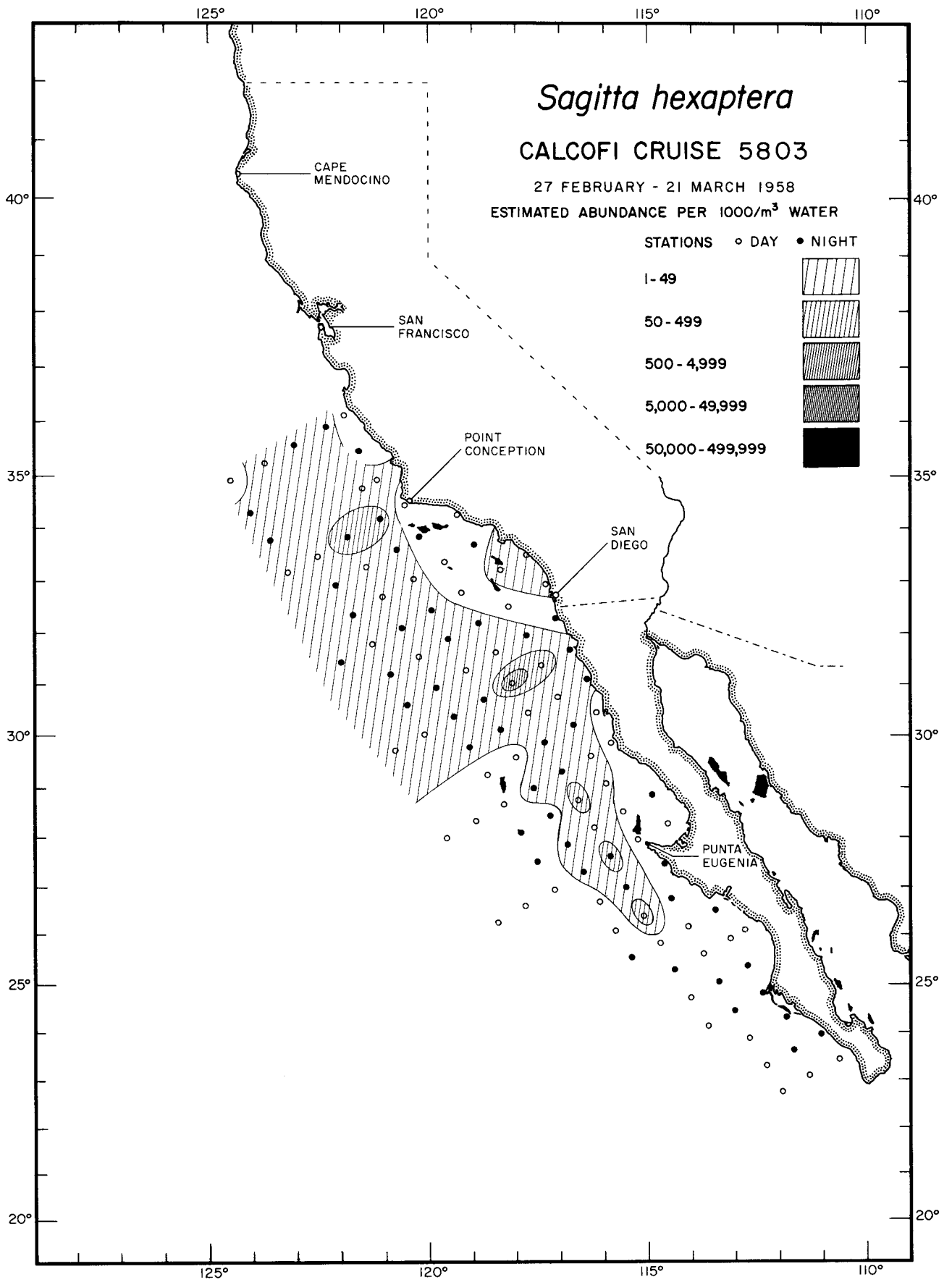
Chaetognatha
Sagitta decipiens
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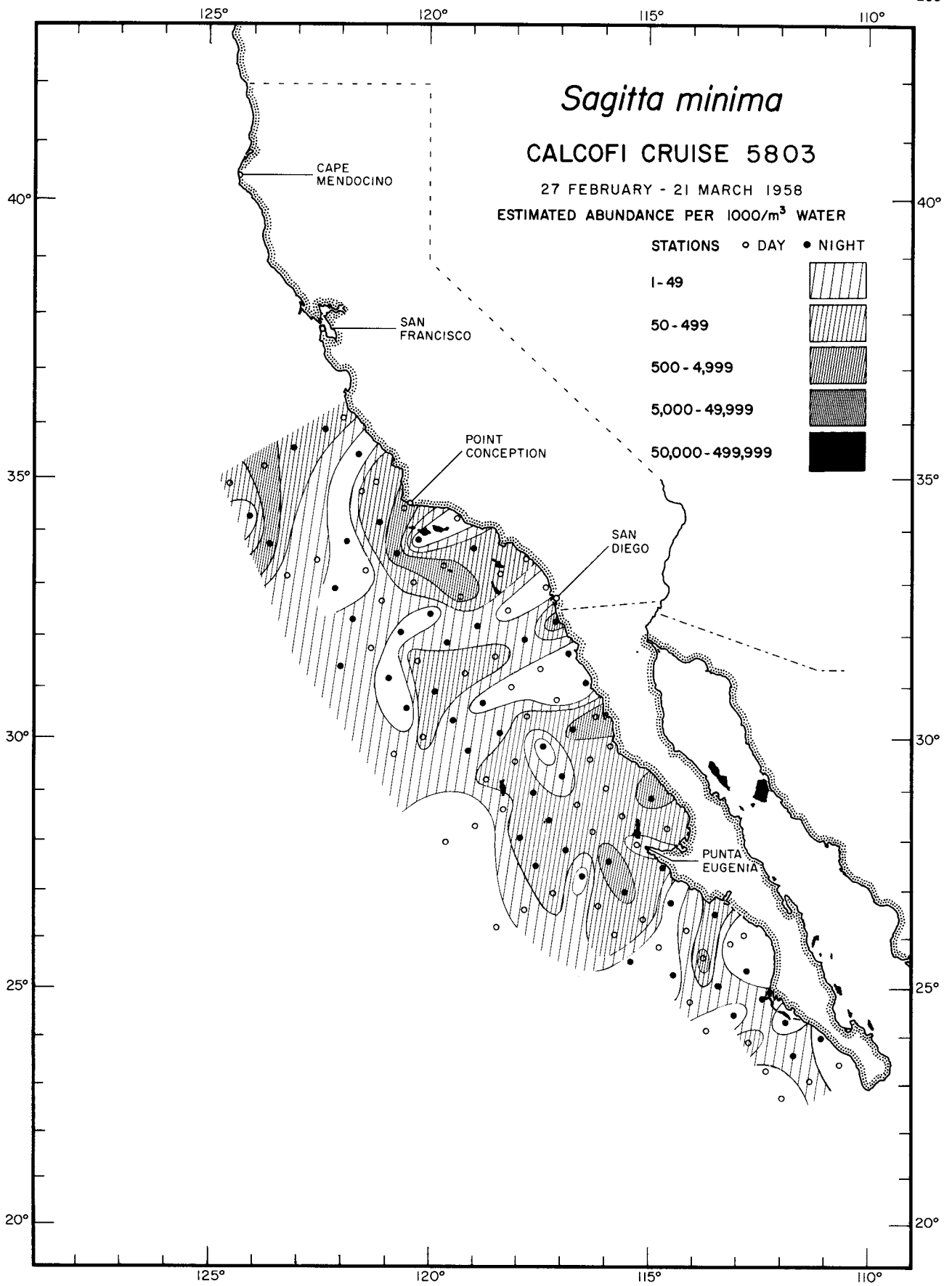
Chaetognatha
Sagitta enflata
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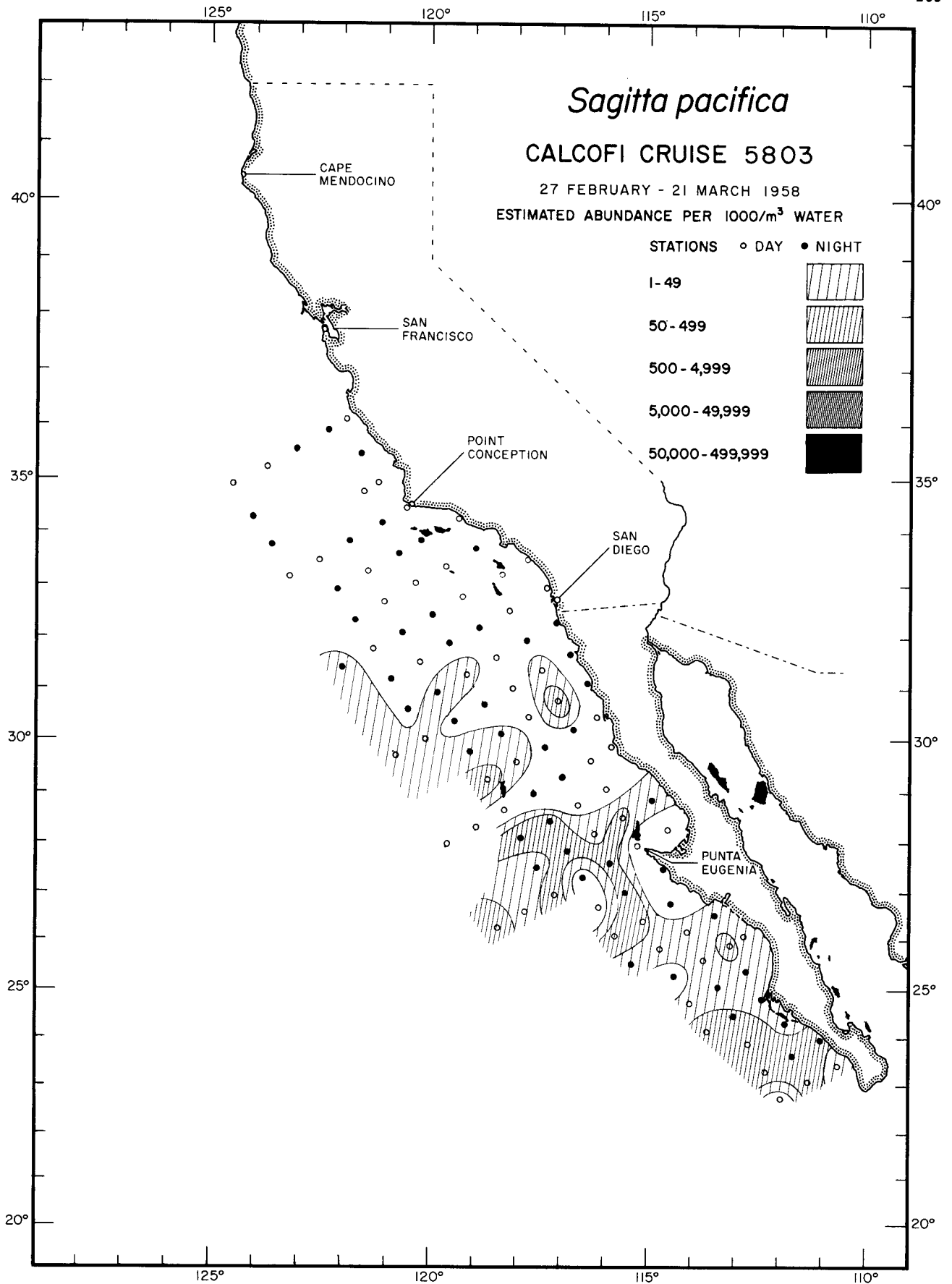
Chaetognatha
Sagitta euneritica
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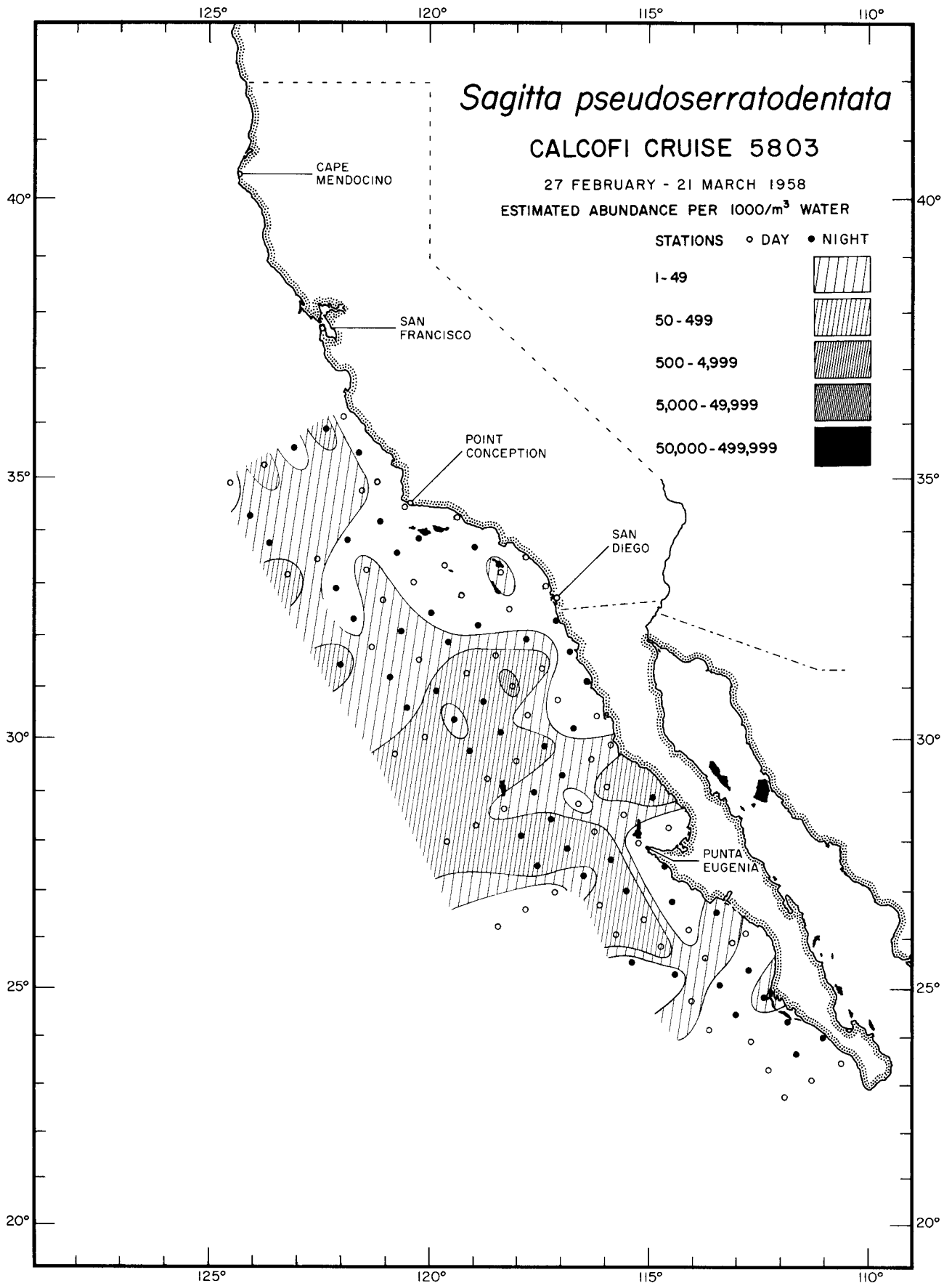
Chaetognatha
Sagitta hexaptera
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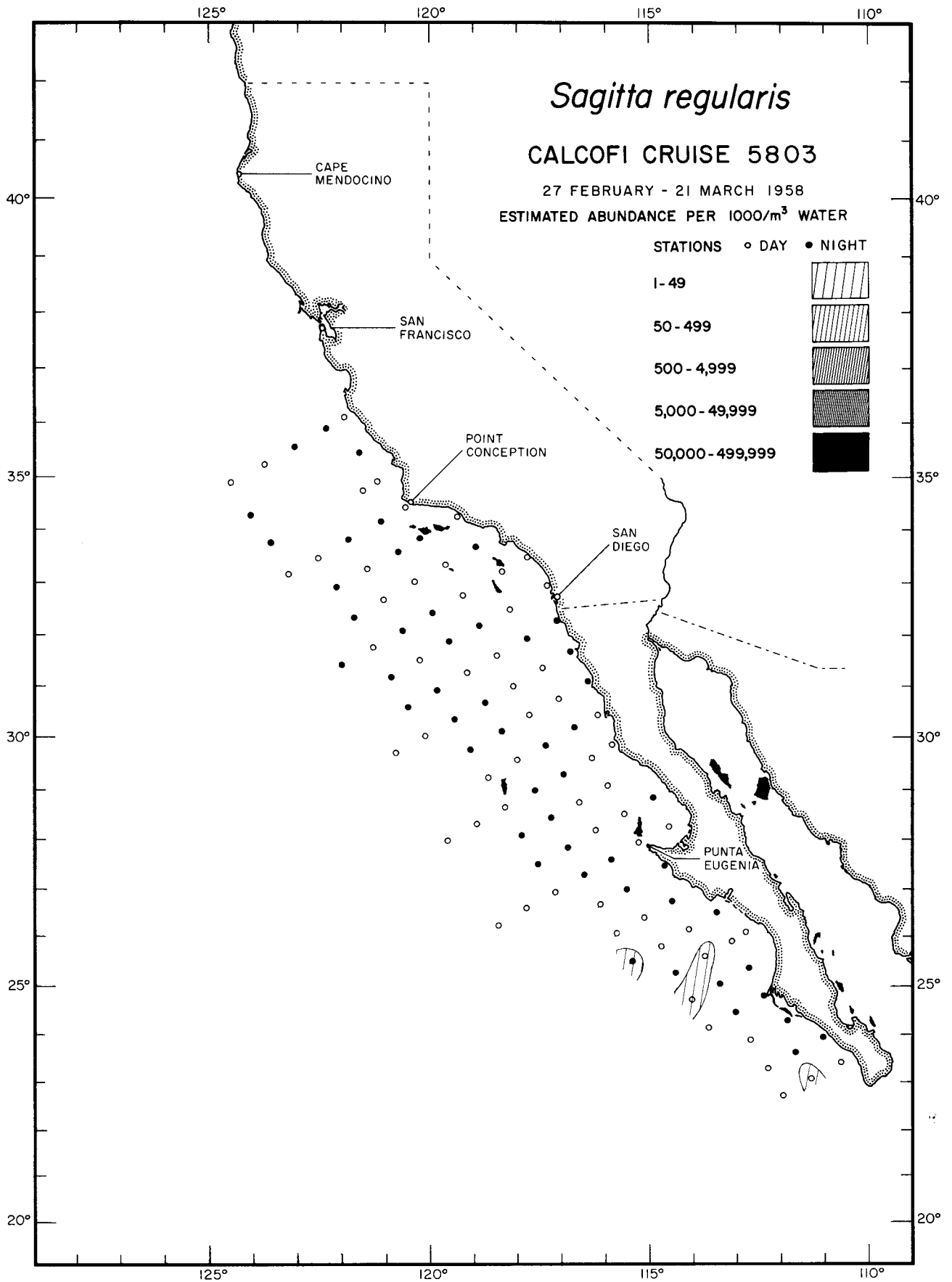
Chaetognatha
Sagitta minima
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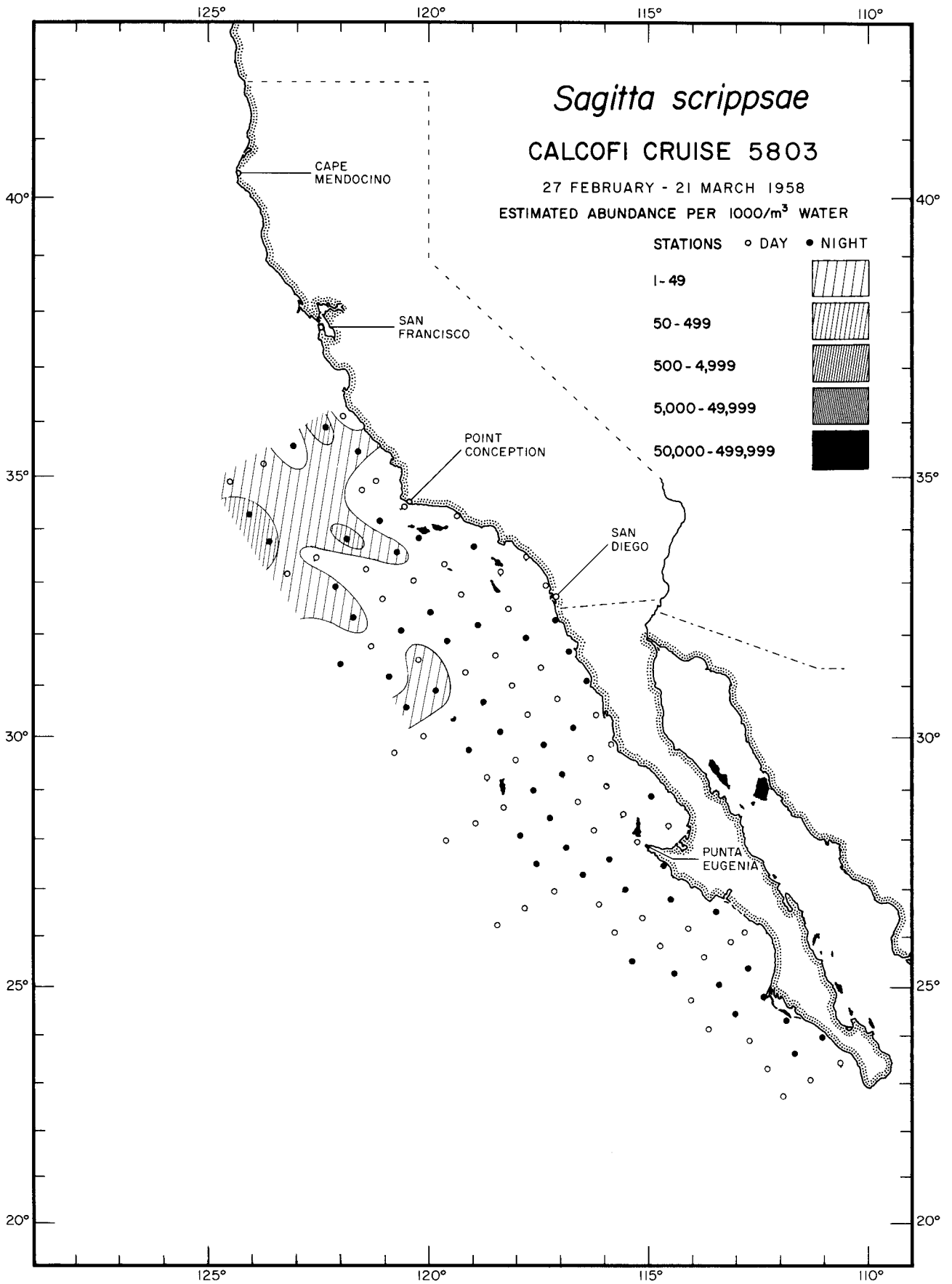
Chaetognatha
Sagitta pacifica
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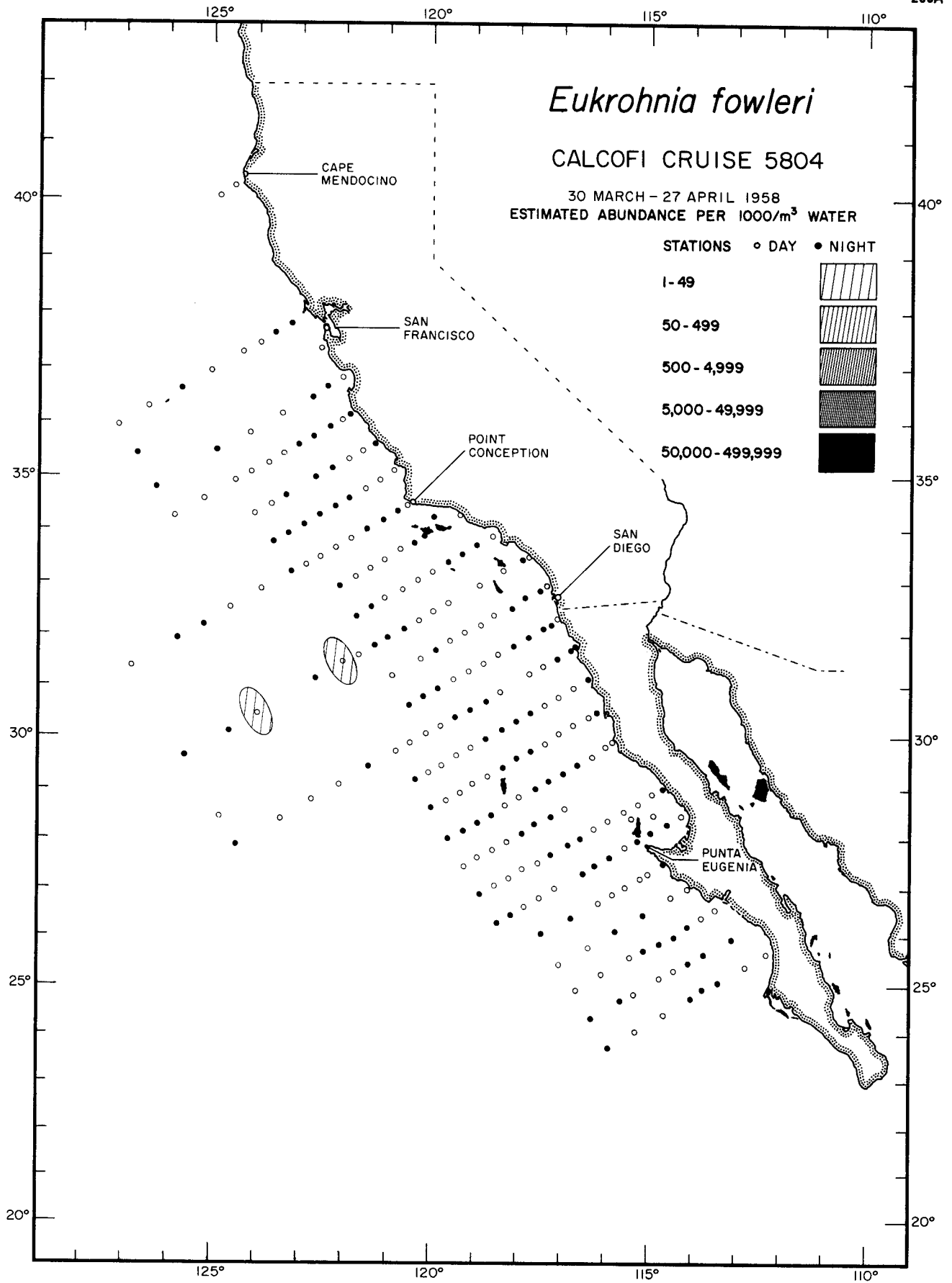
Chaetognatha
Sagitta pseudoserratodentata
5803

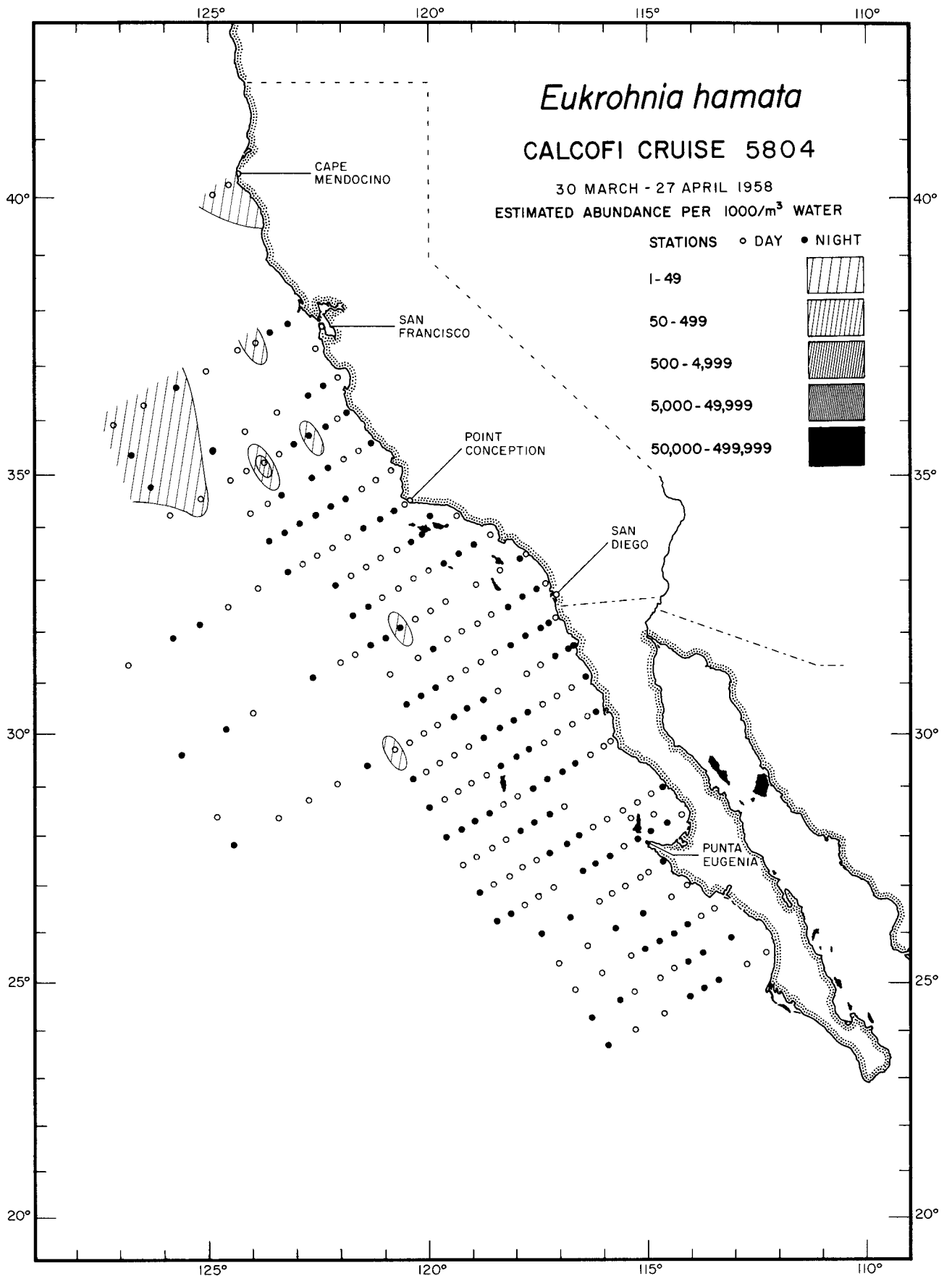


Chaetognatha
Sagitta regularis
5803

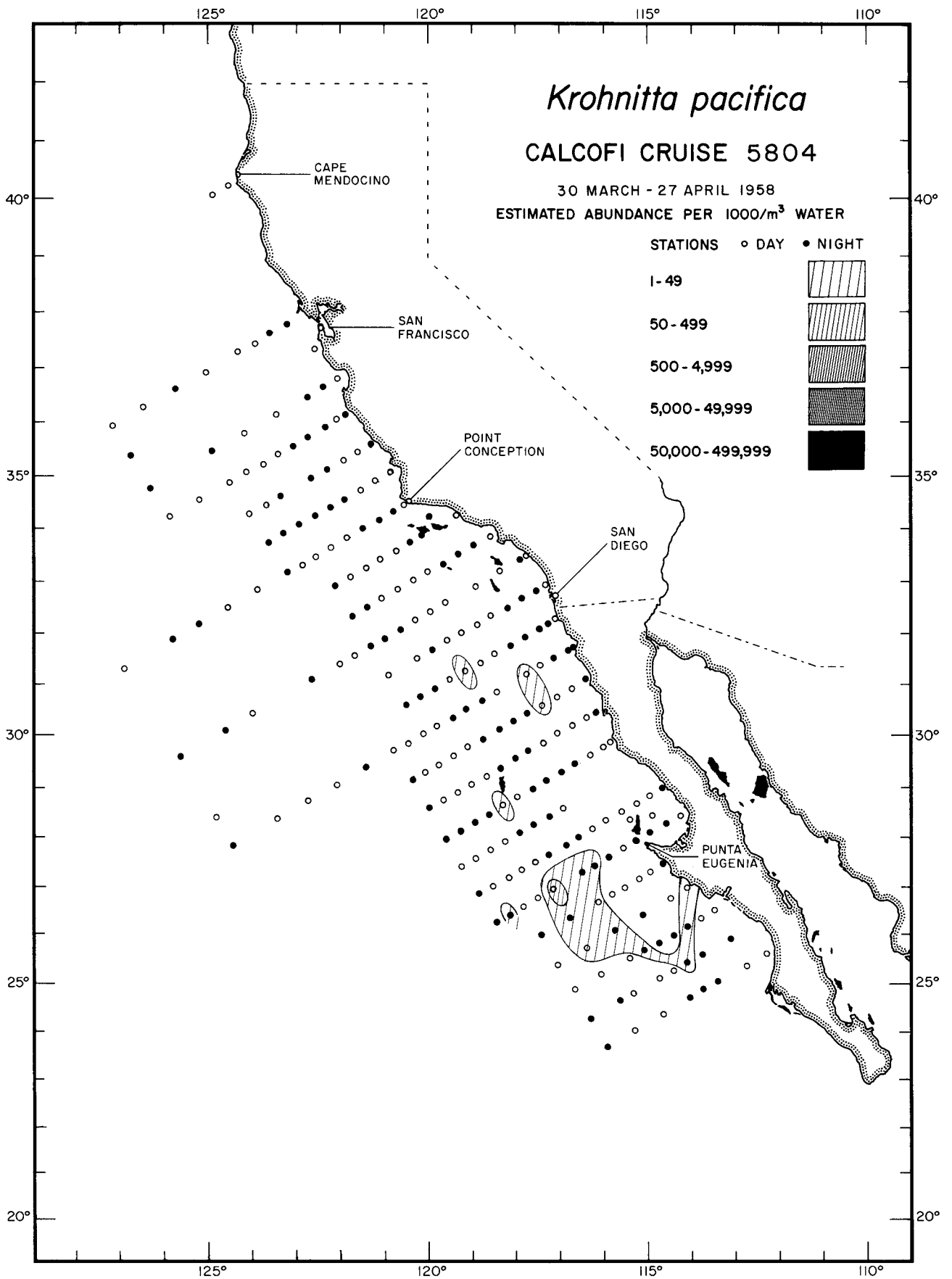


Chaetognatha
Sagitta scrippsae
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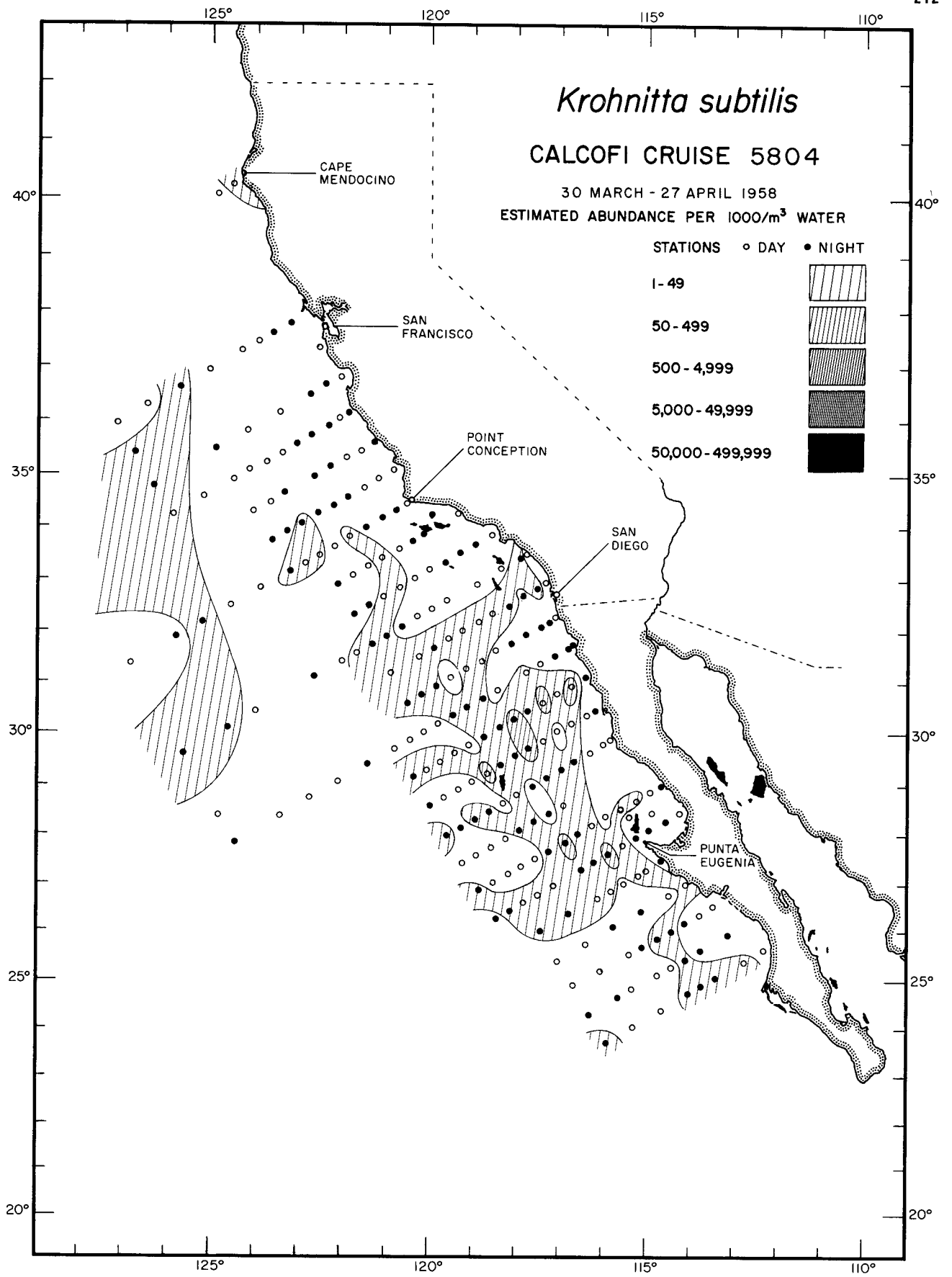




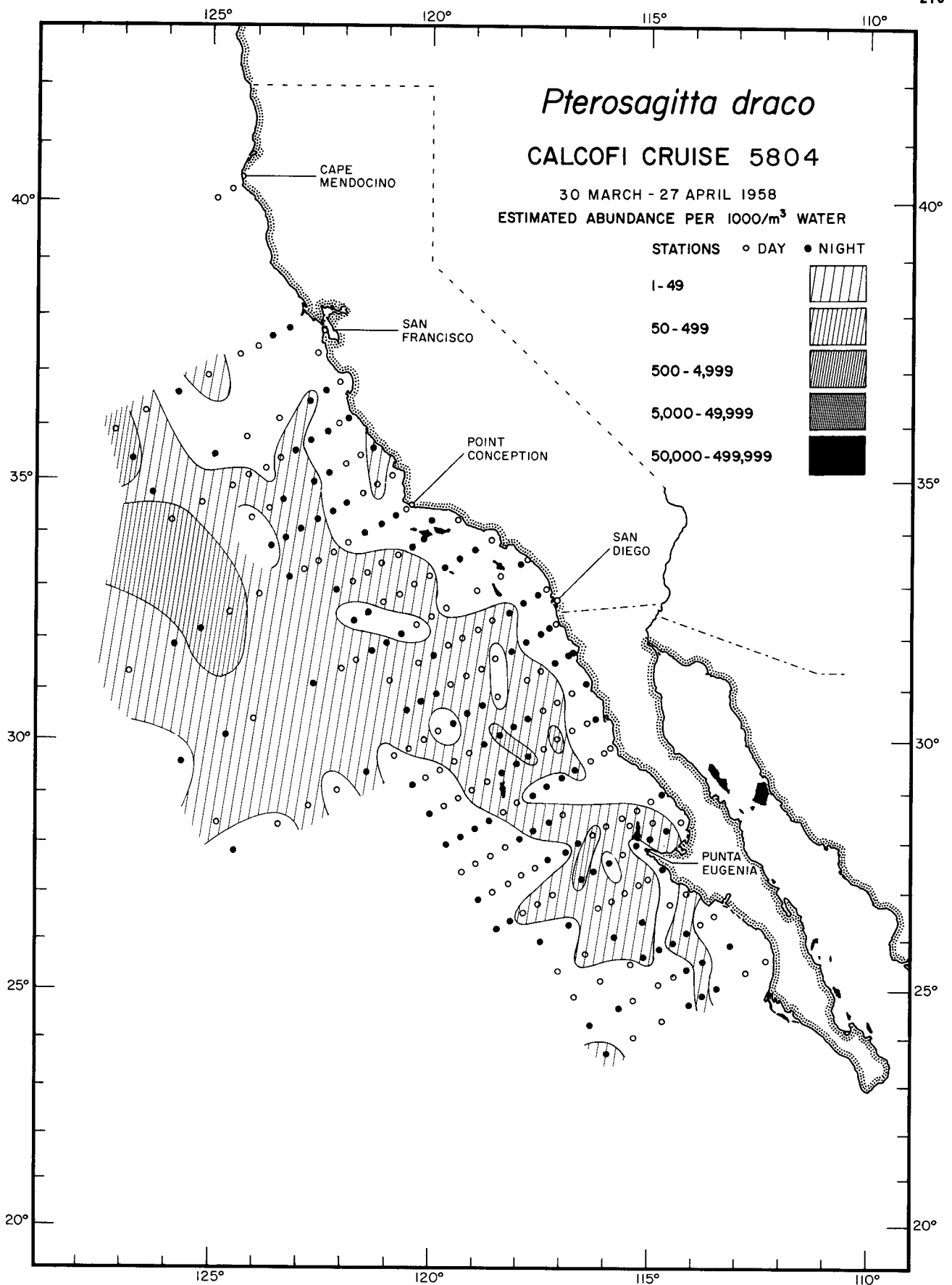
Chaetognatha
Eukrohnia hamata
5804



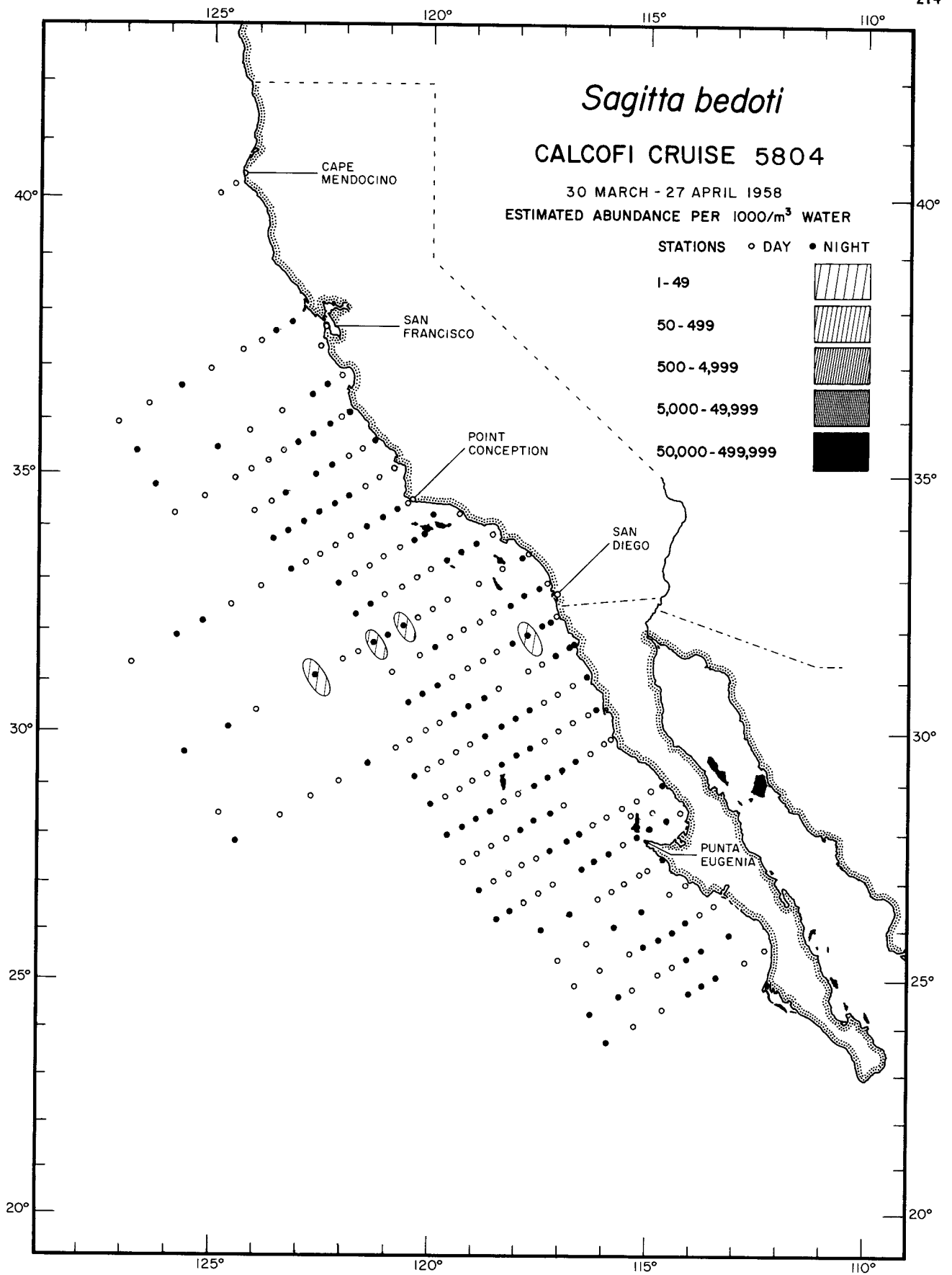
Chaetognatha
Krohnitta pacifica
5804



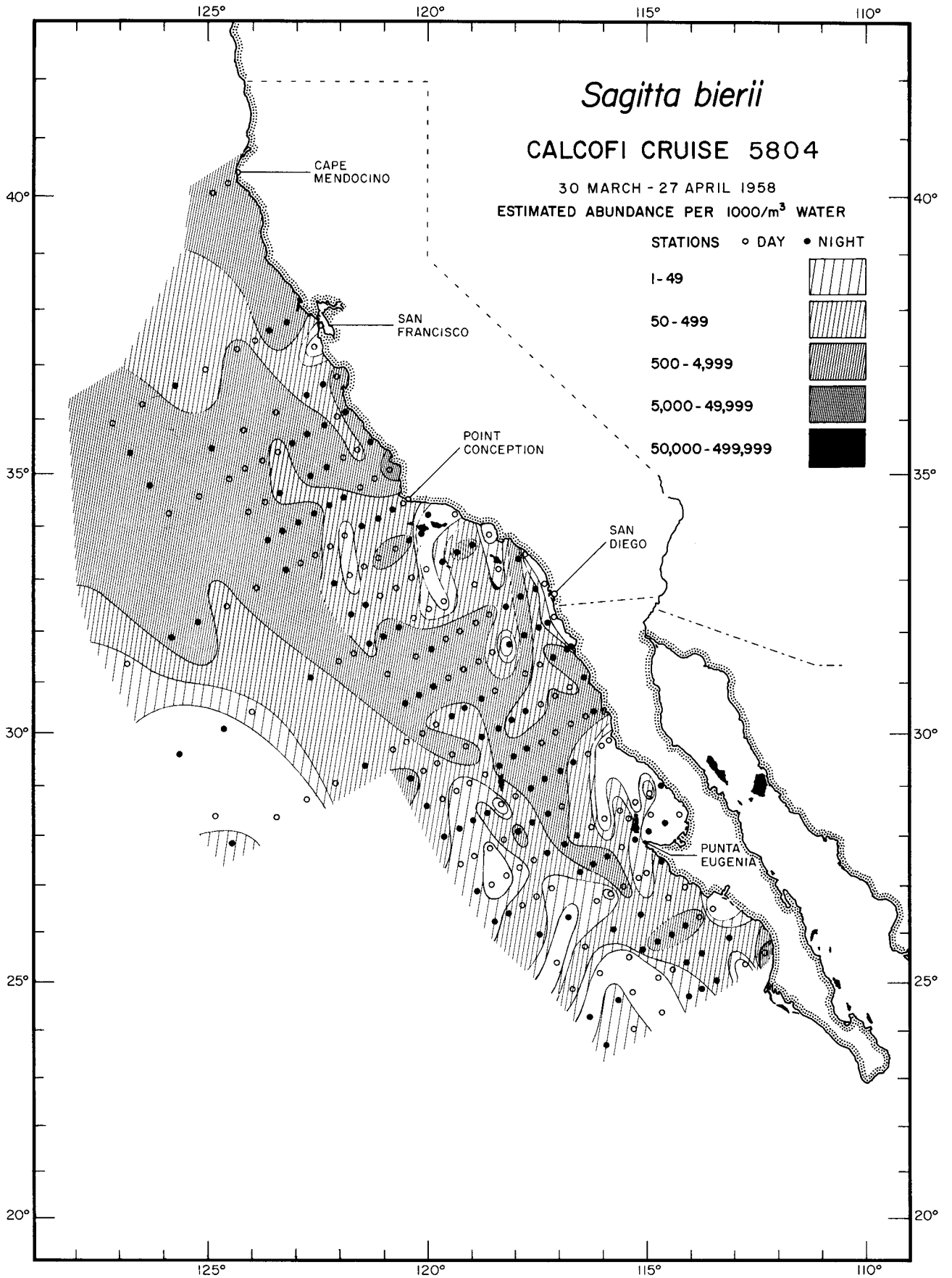
Chaetognatha
Krohnitta subtilis
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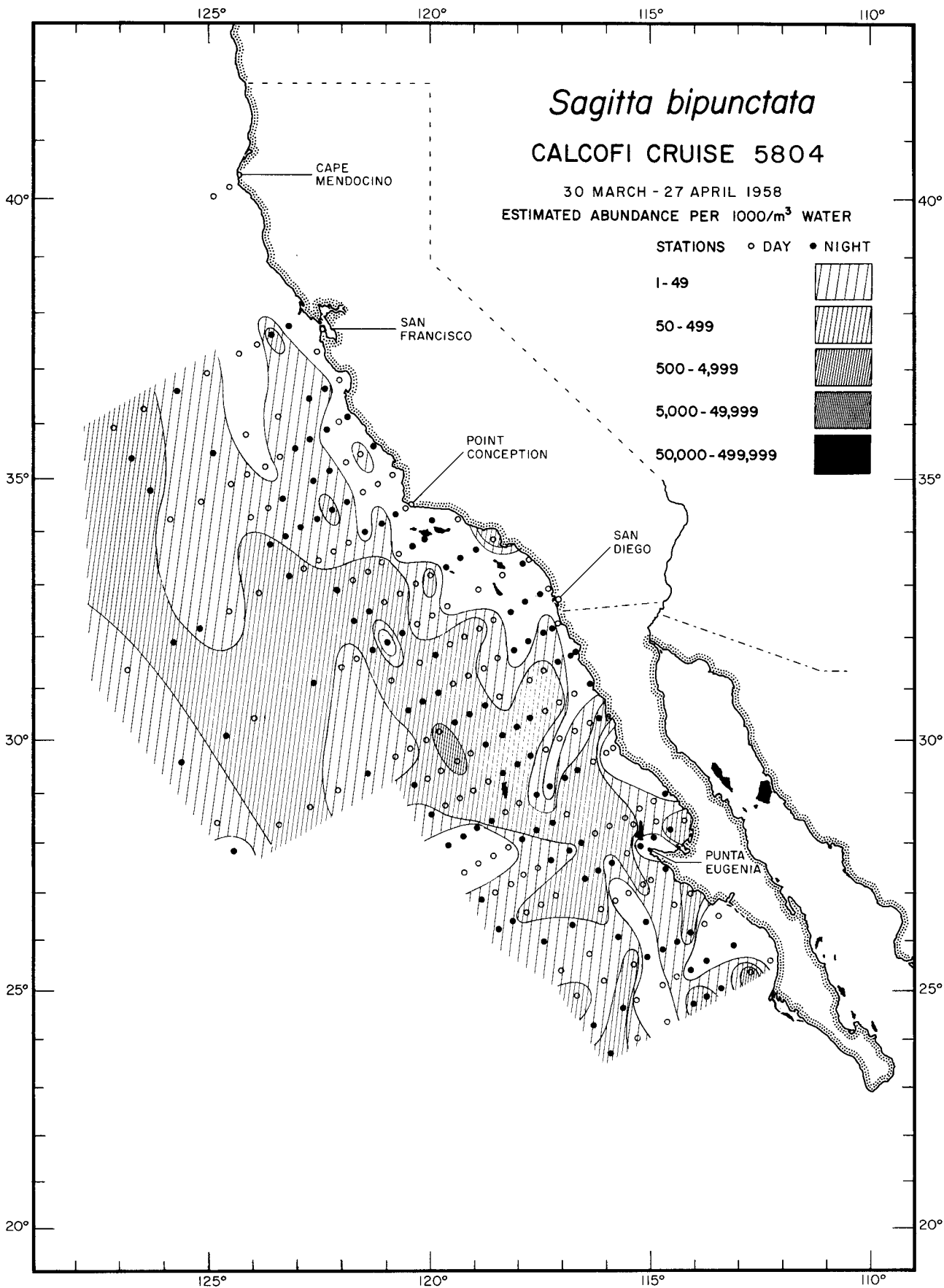
Chaetognatha
Pterosagitta draco
 5804



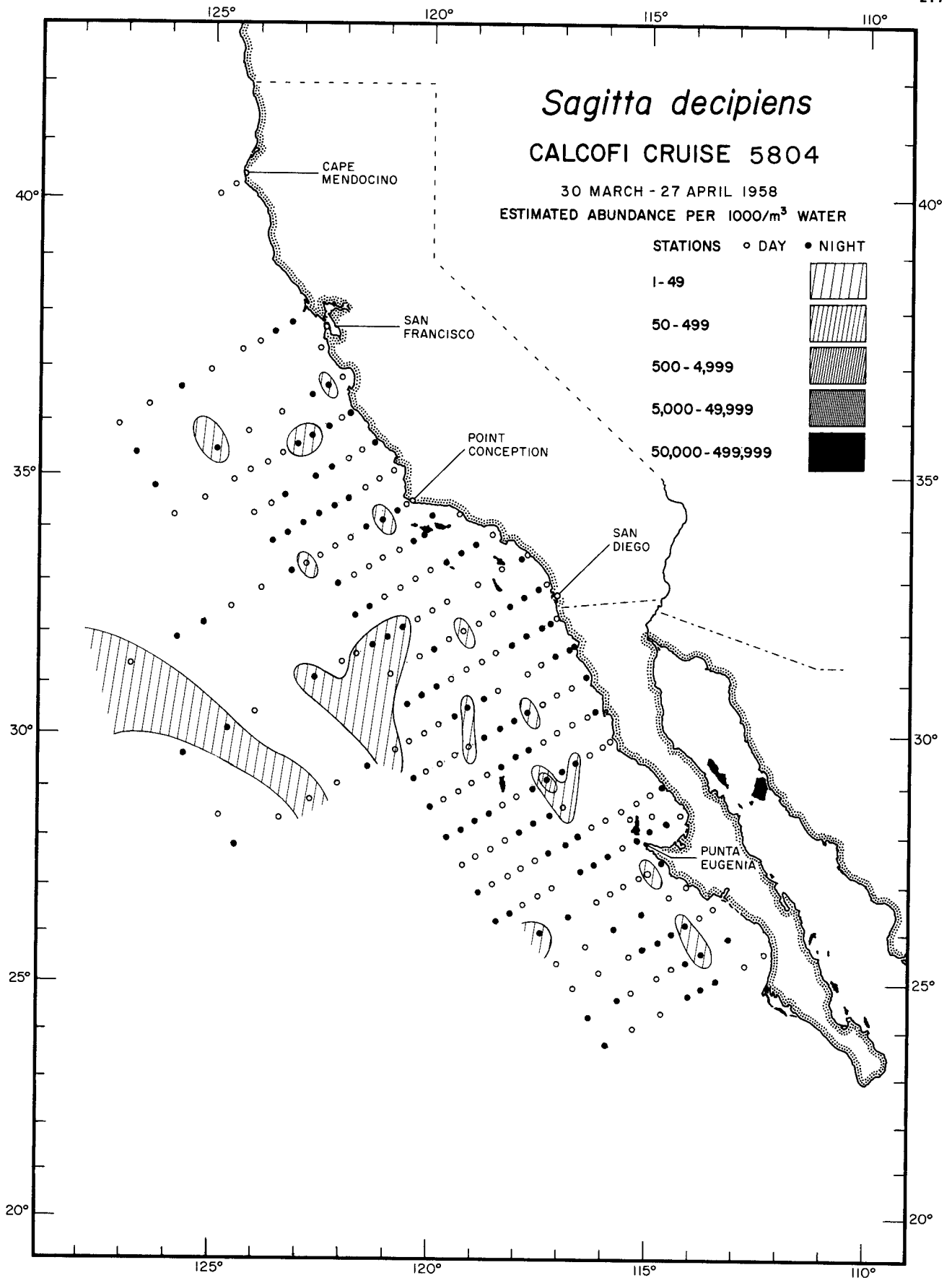
Chaetognatha
Sagitta bedoti
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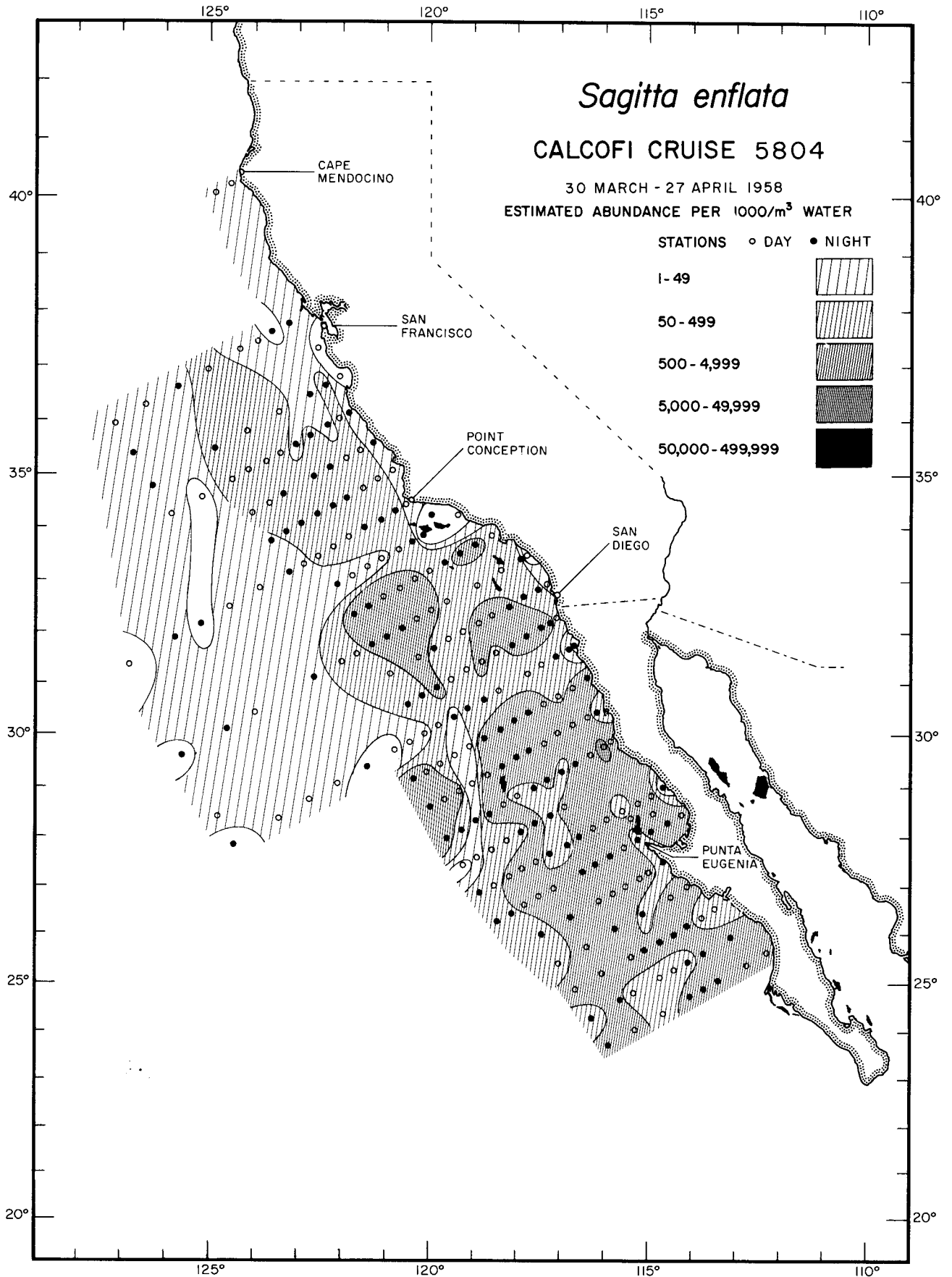
Chaetognatha
Sagitta bierii
5804



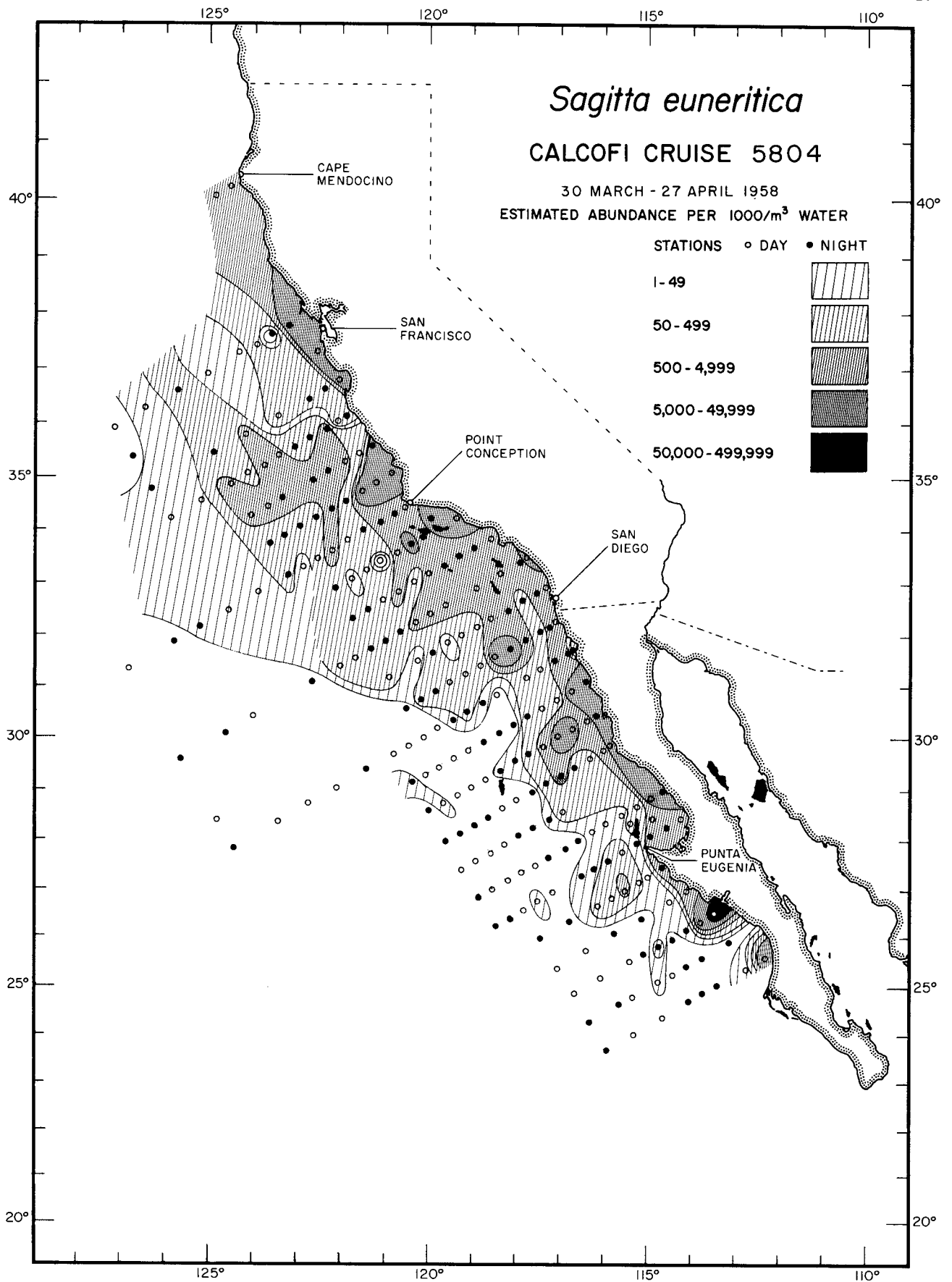
Chaetognatha
Sagitta bipunctata
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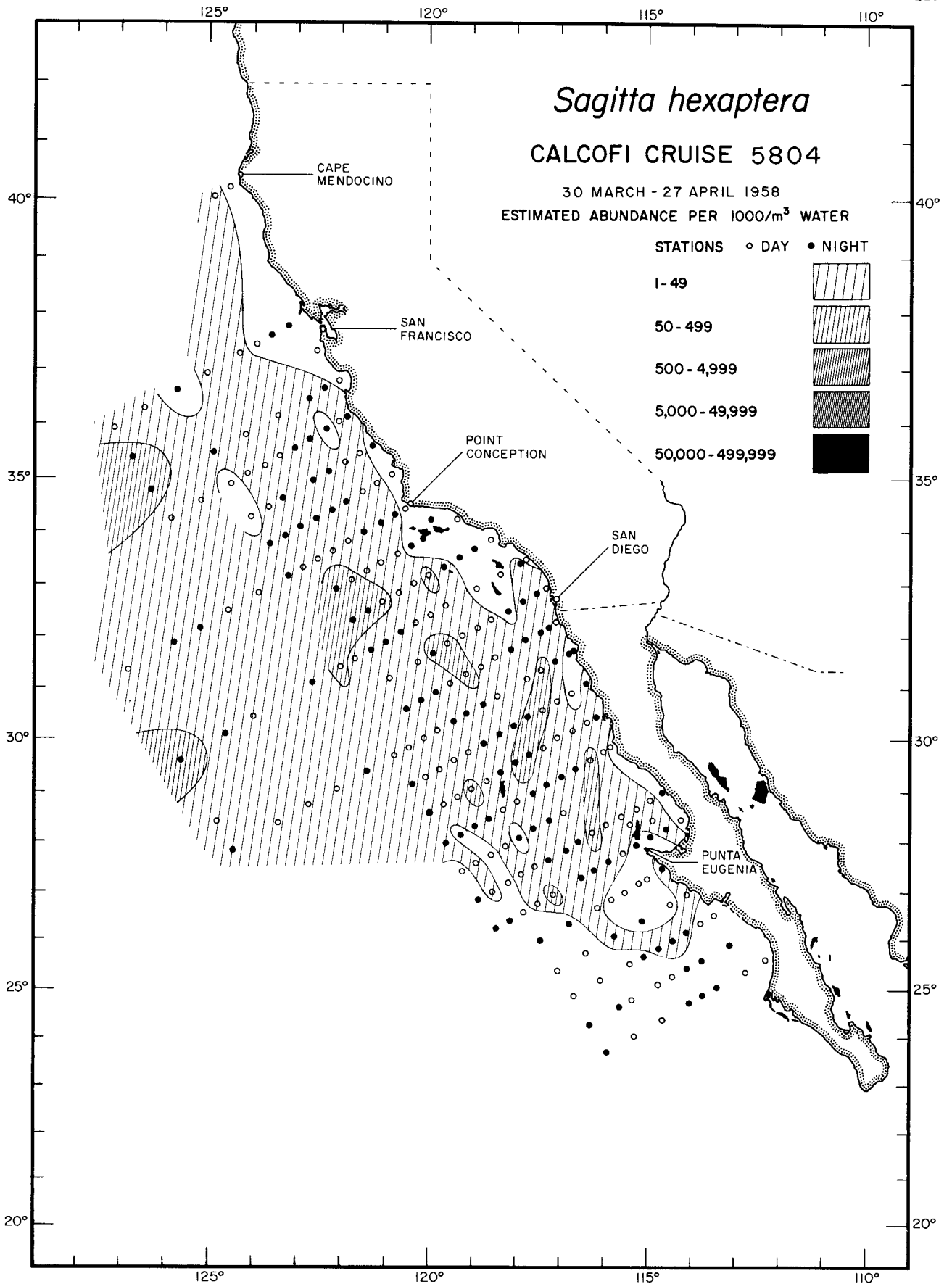


Chaetognatha
Sagitta decipiens
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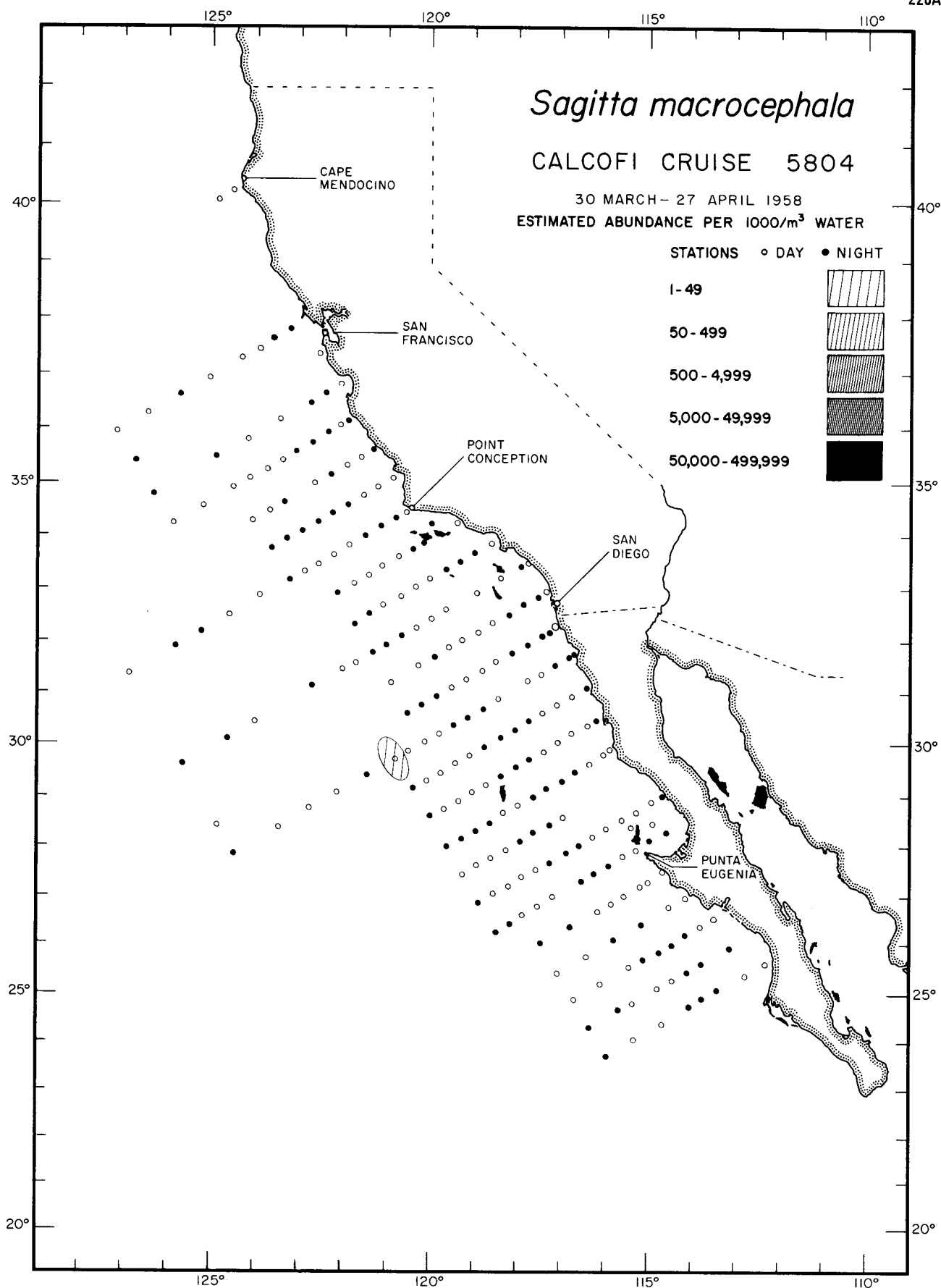


Chaetognatha
Sagitta enflata
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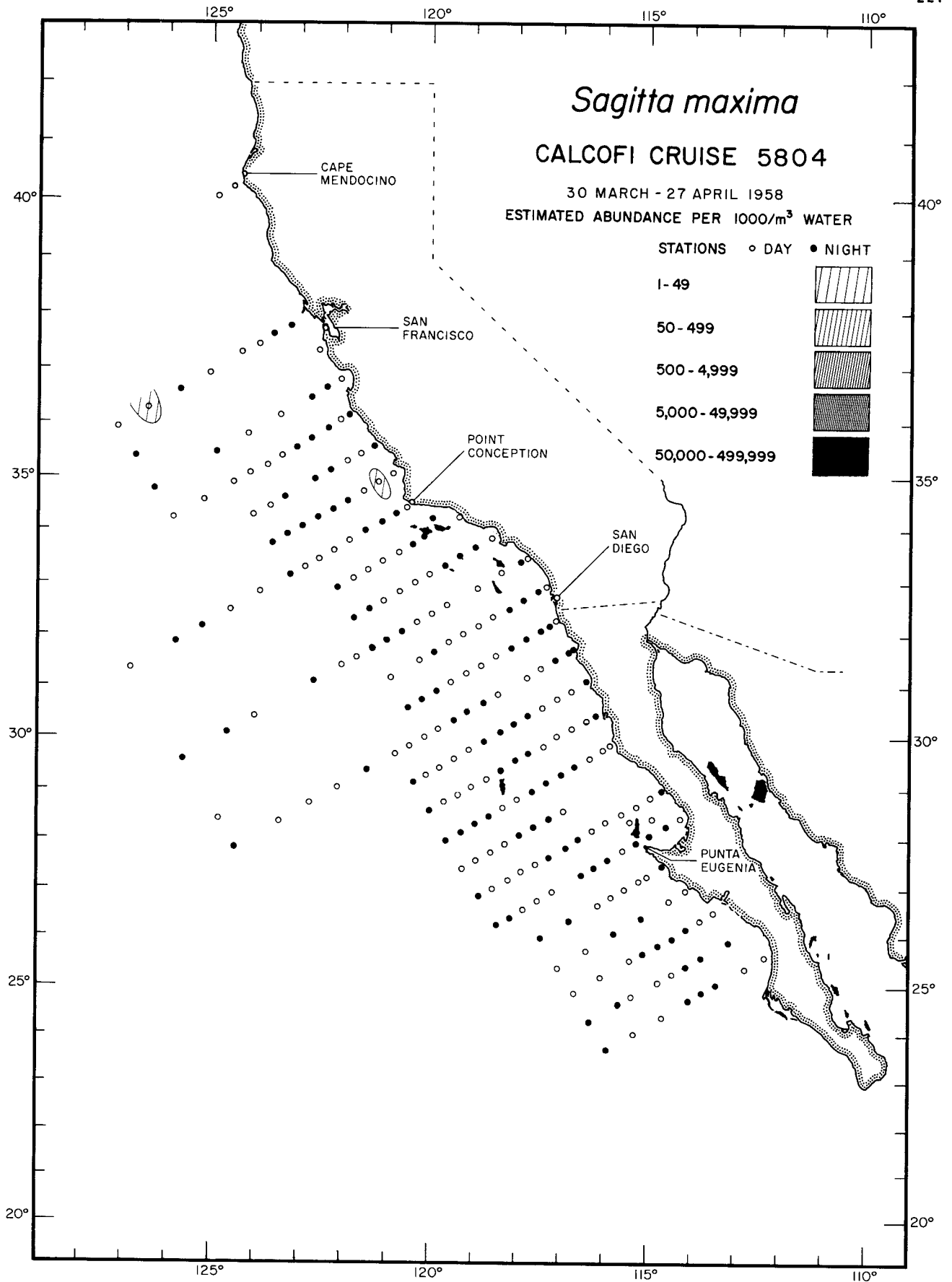




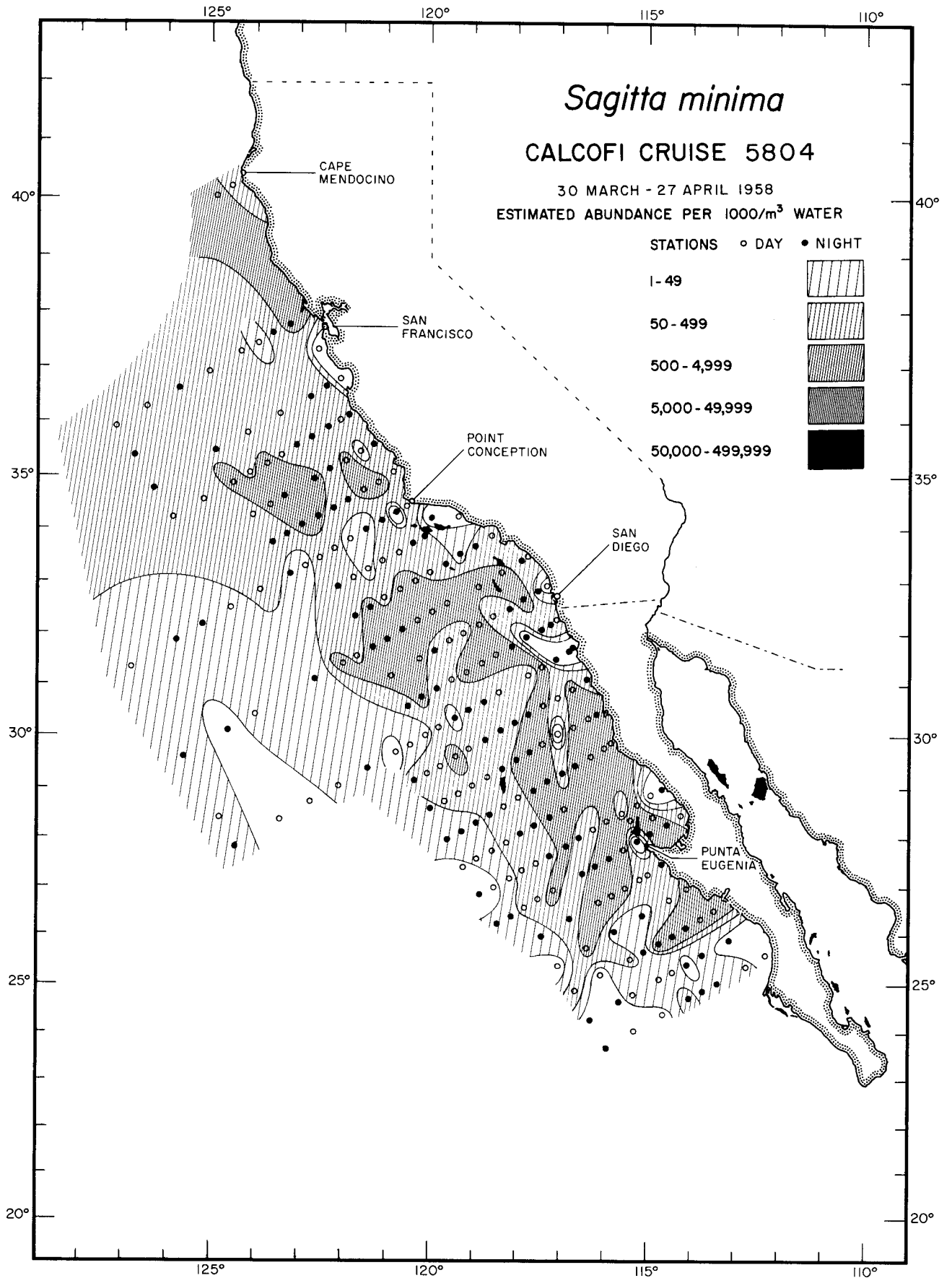
Chaetognatha
Sagitta hexaptera
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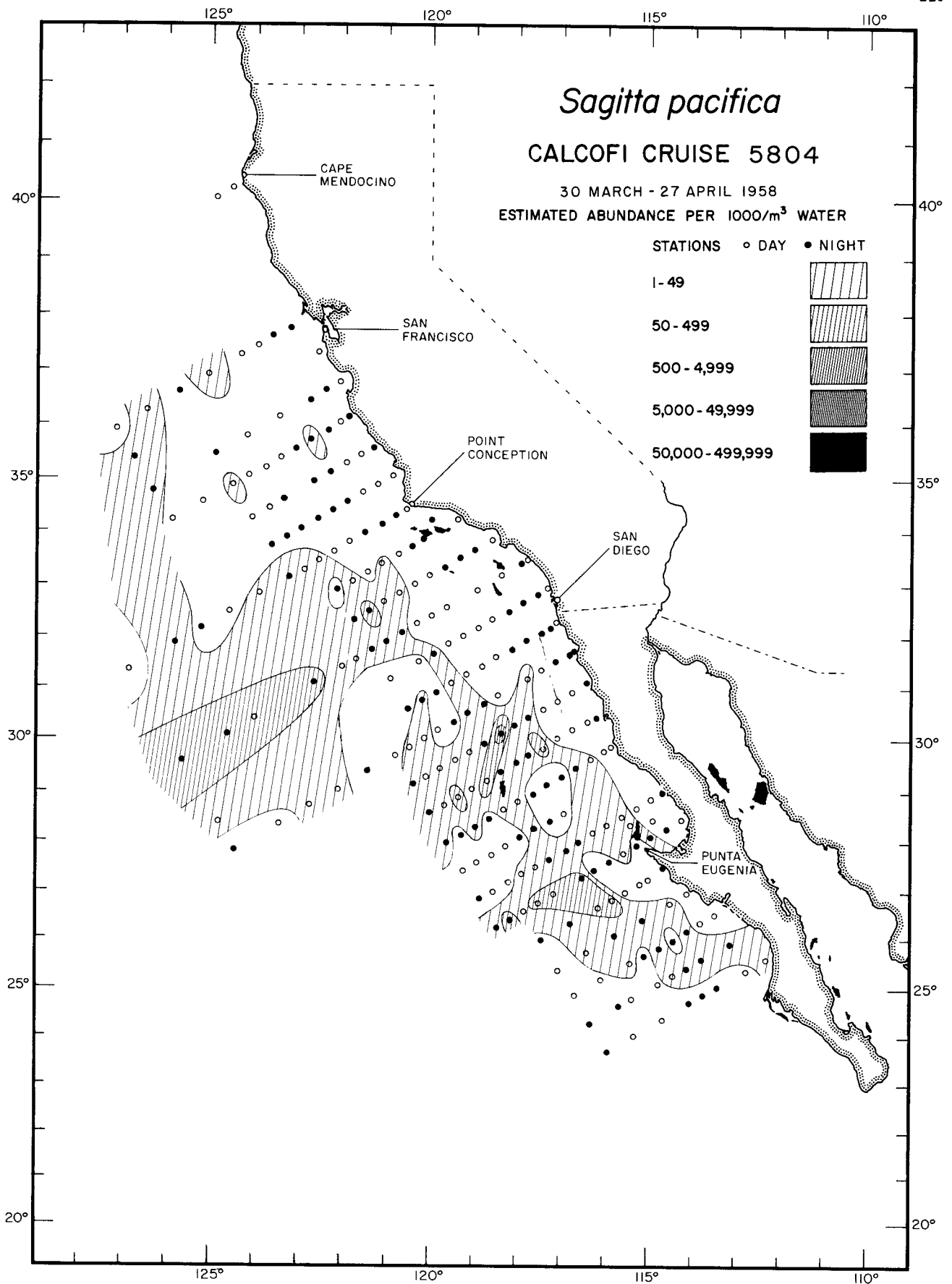
Chaetognatha
Sagitta macrocephala
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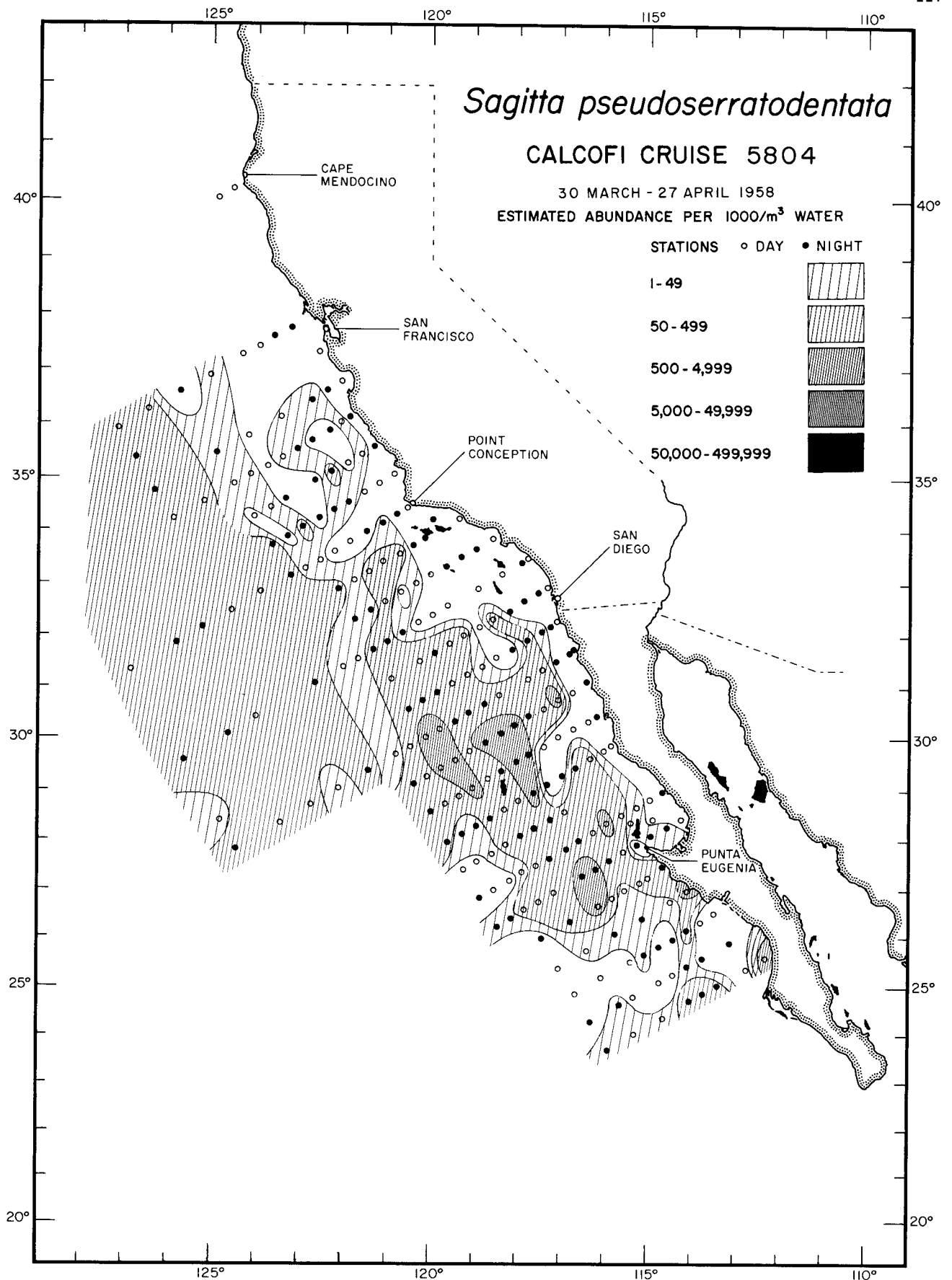
Chaetognatha
Sagitta maxima
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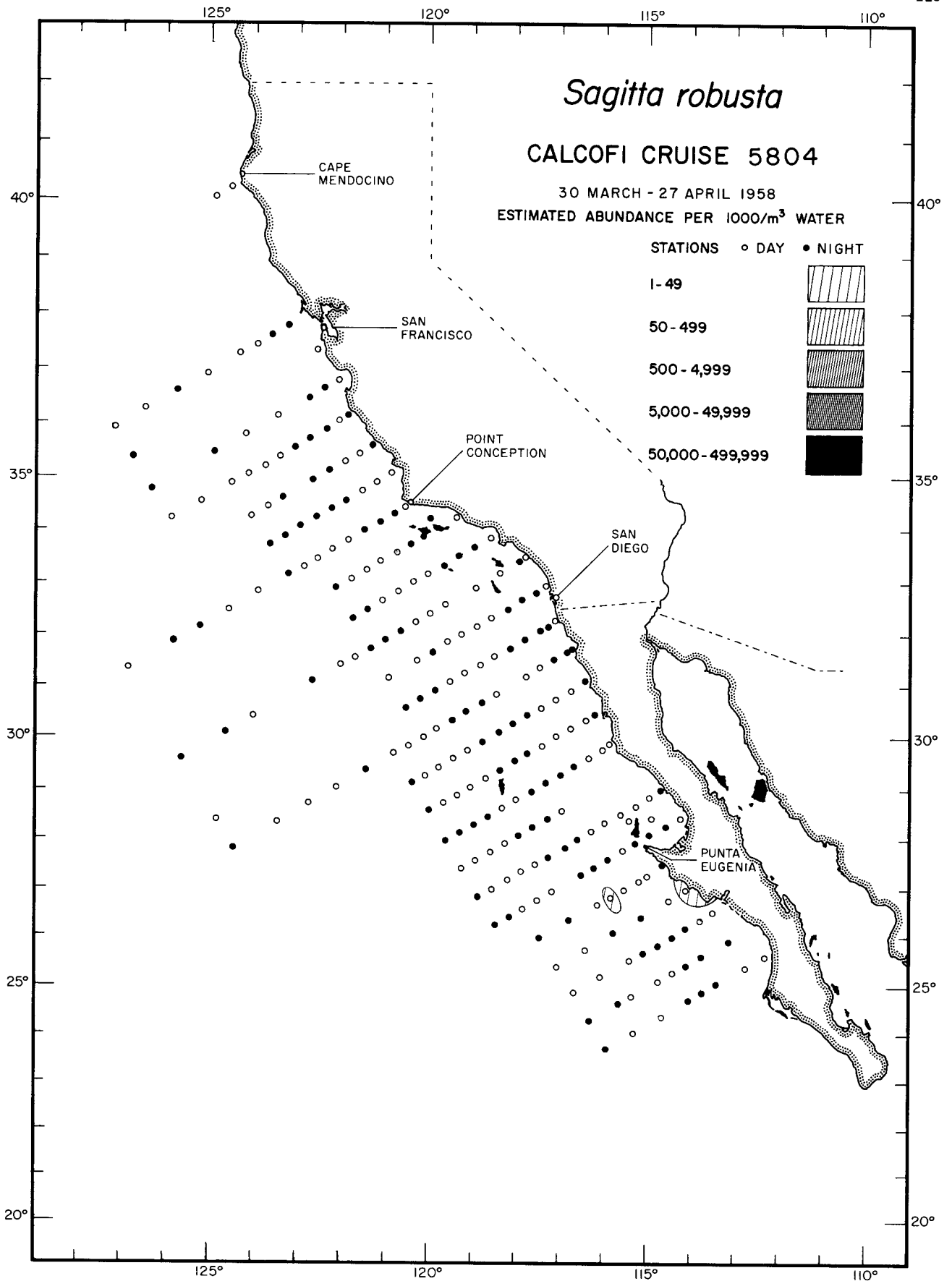


Chaetognatha
Sagitta minima
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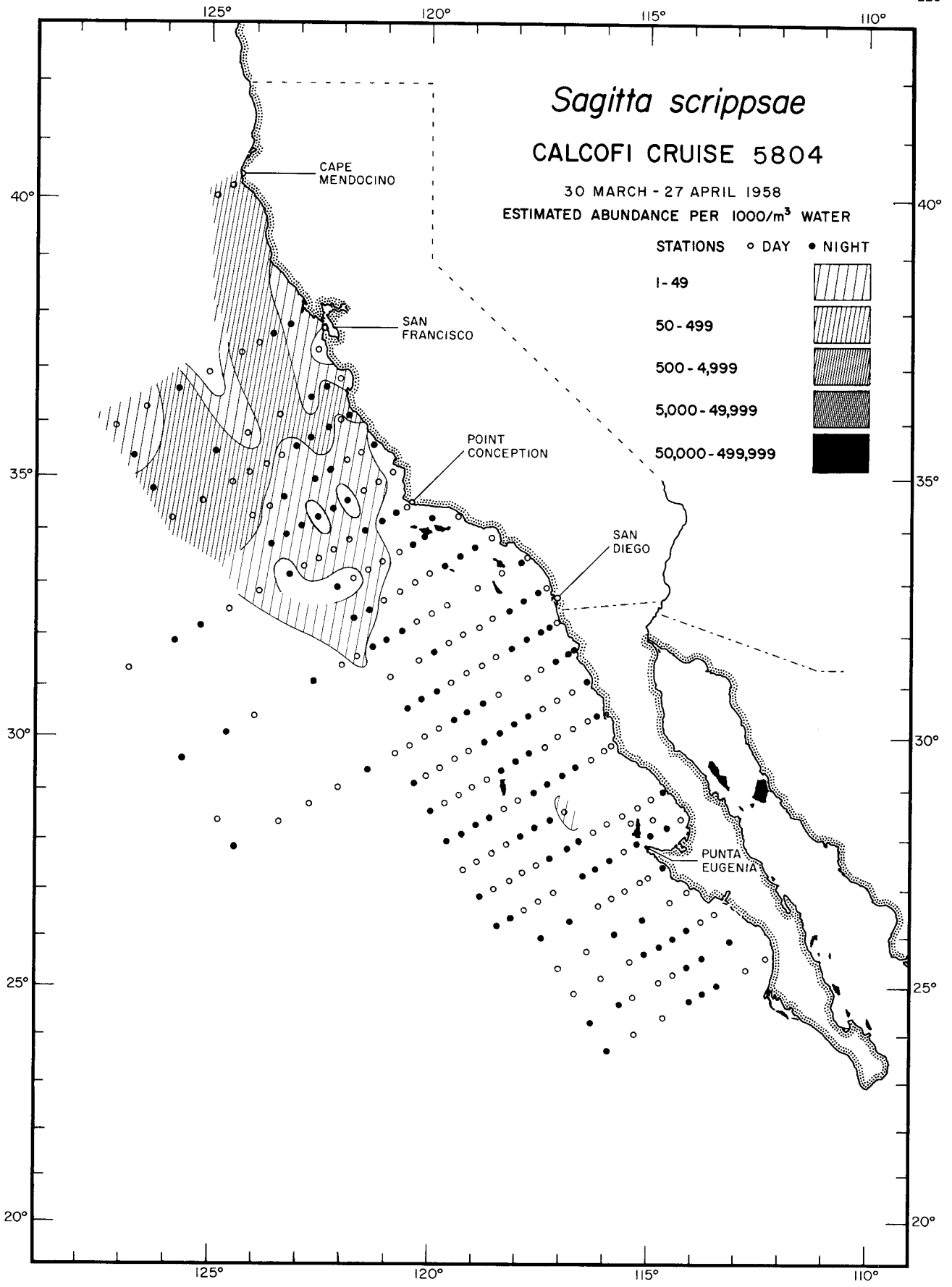


Chaetognatha
Sagitta pacifica
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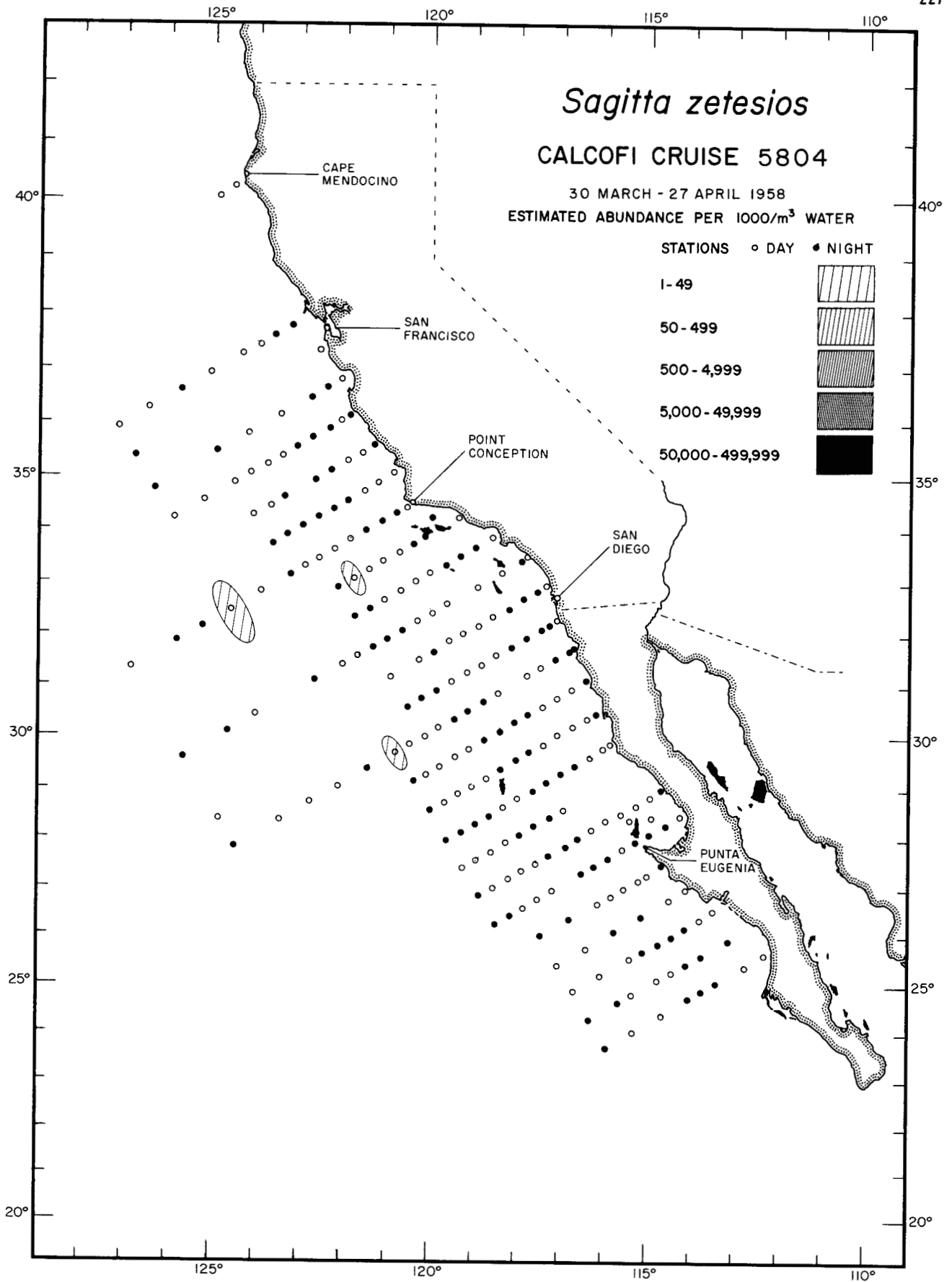




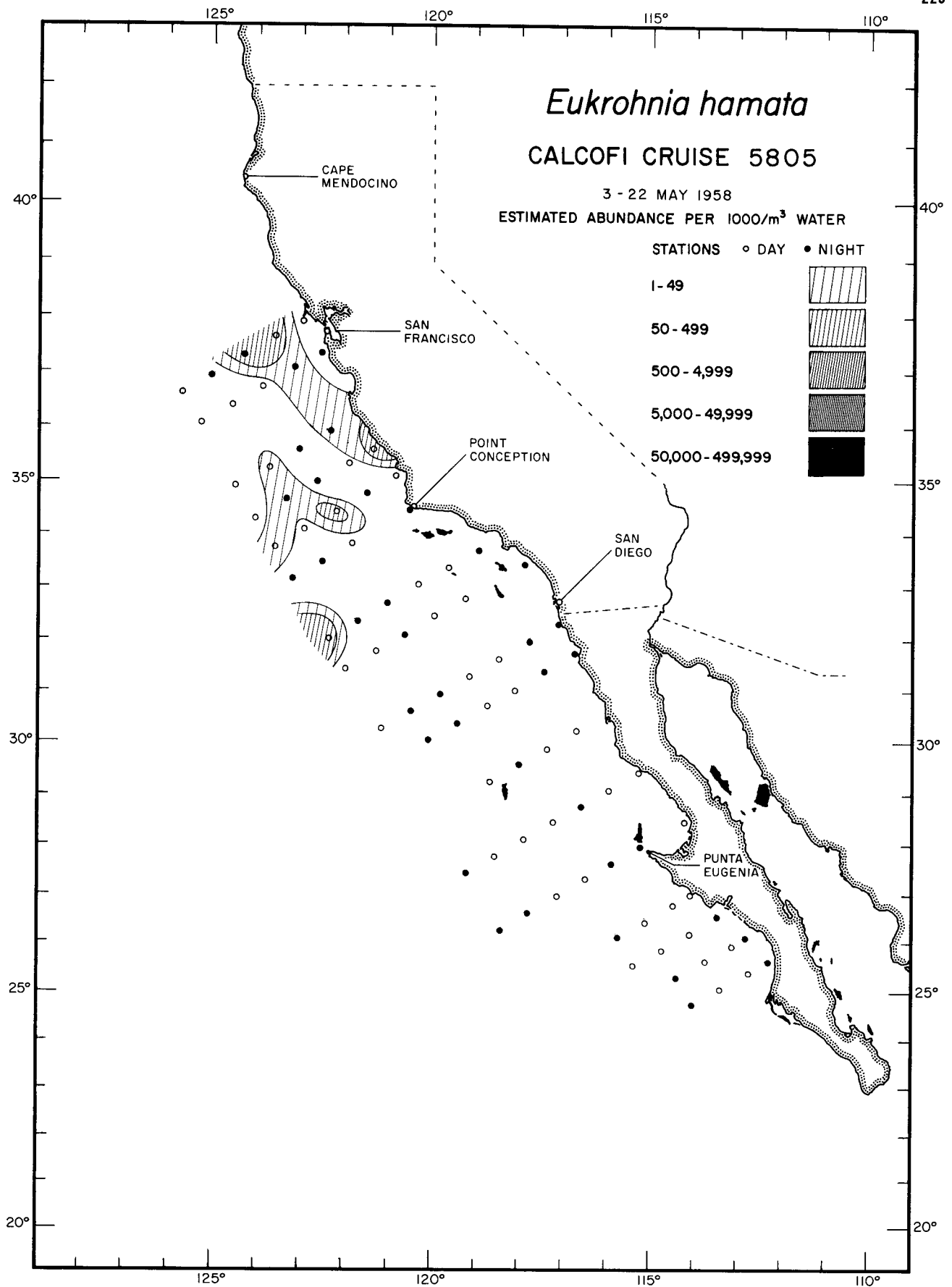
Chaetognatha
Sagitta robusta
5804



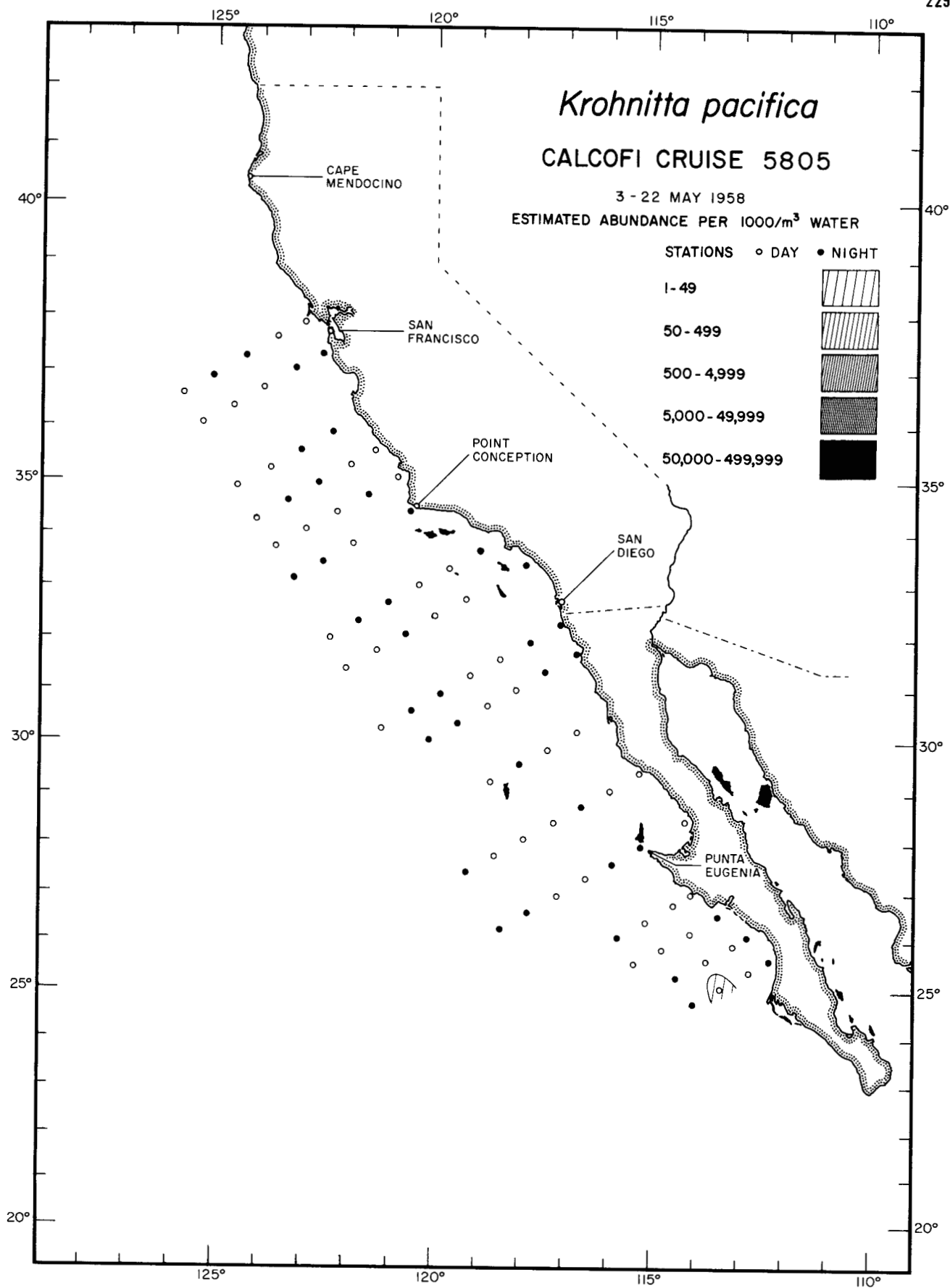
Chaetognatha
Sagitta scrippsae
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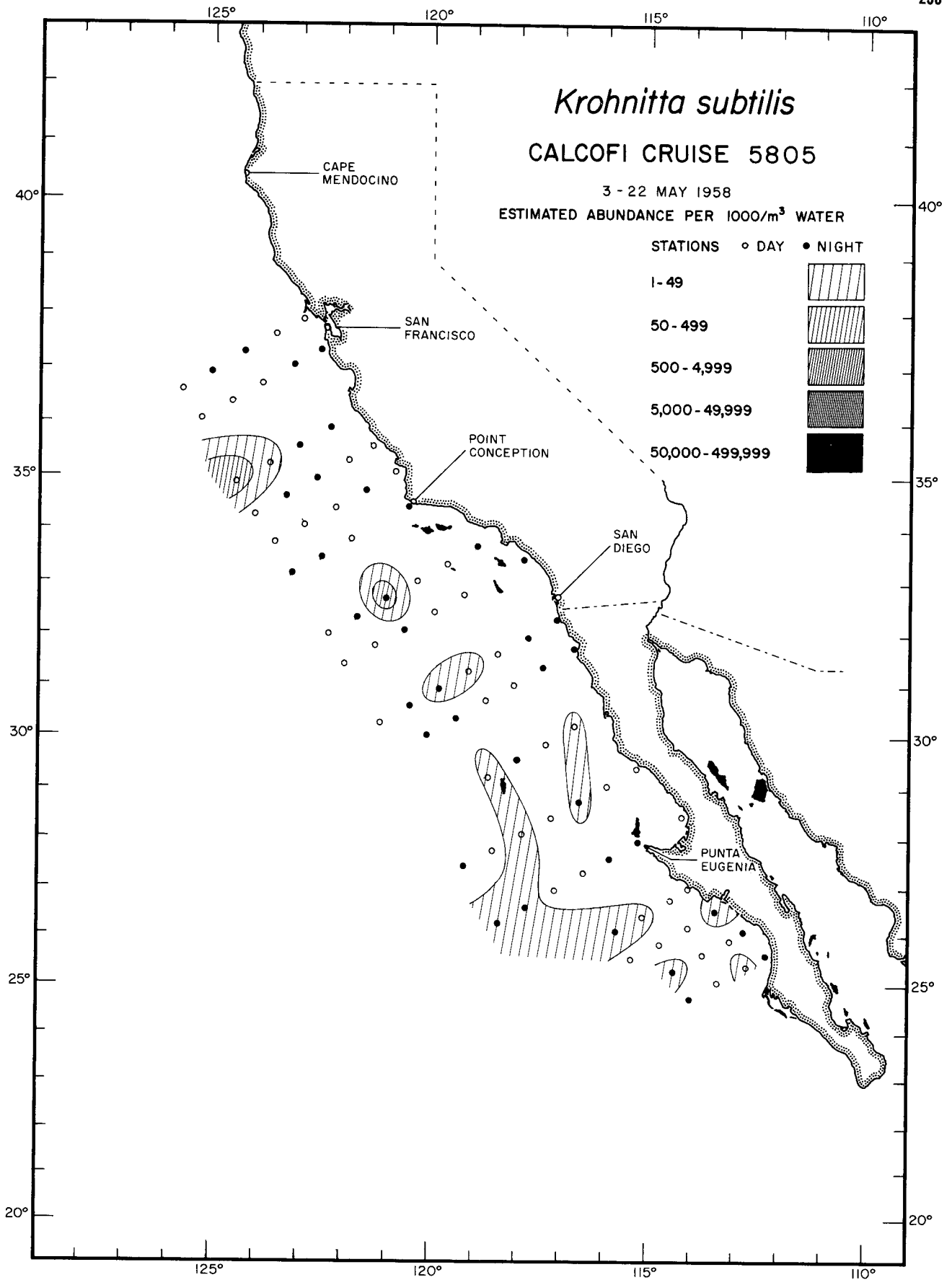
Chaetognatha
Sagitta zetesios
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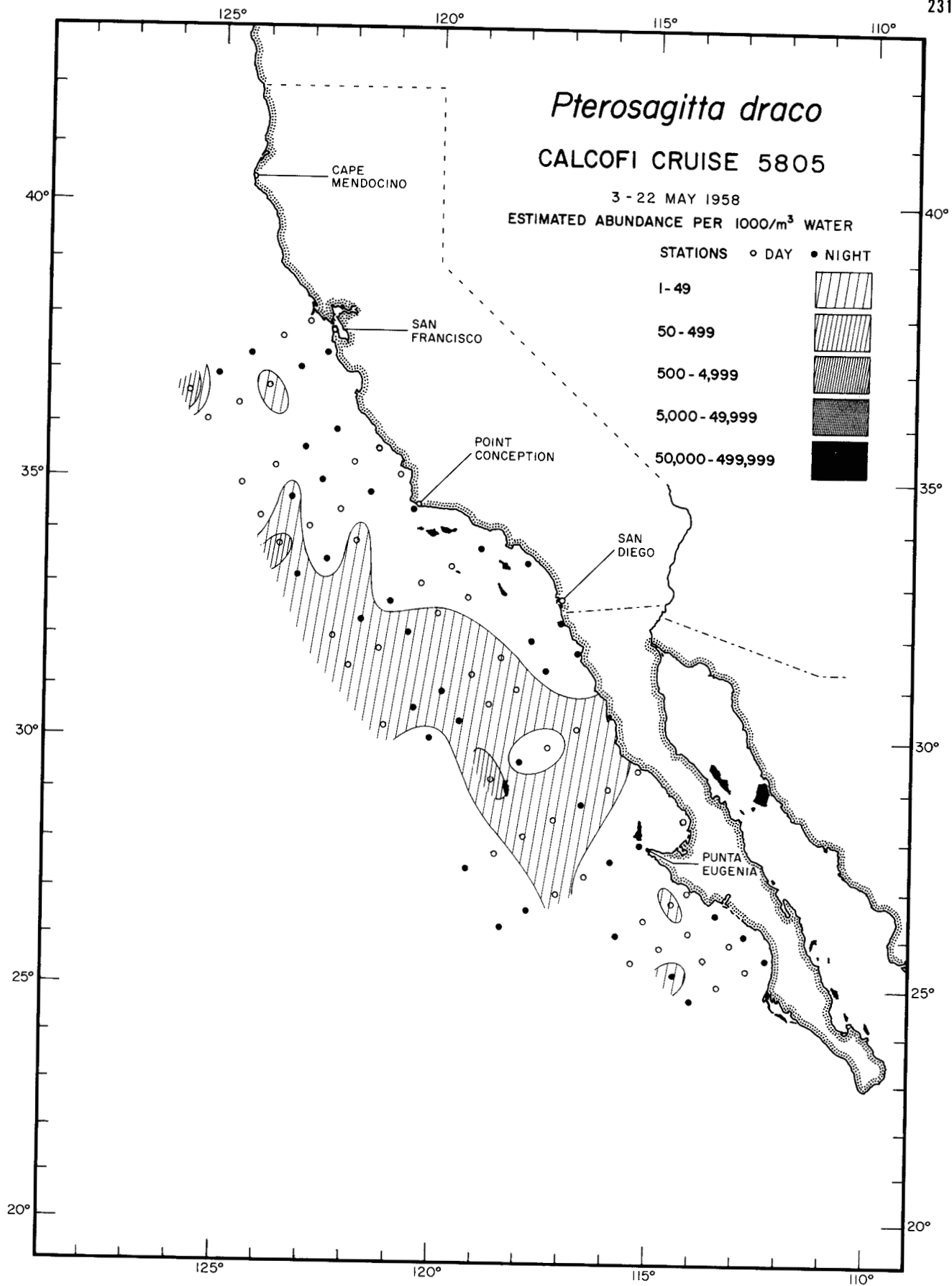
Chaetognatha
Eukrohnia hamata
5805



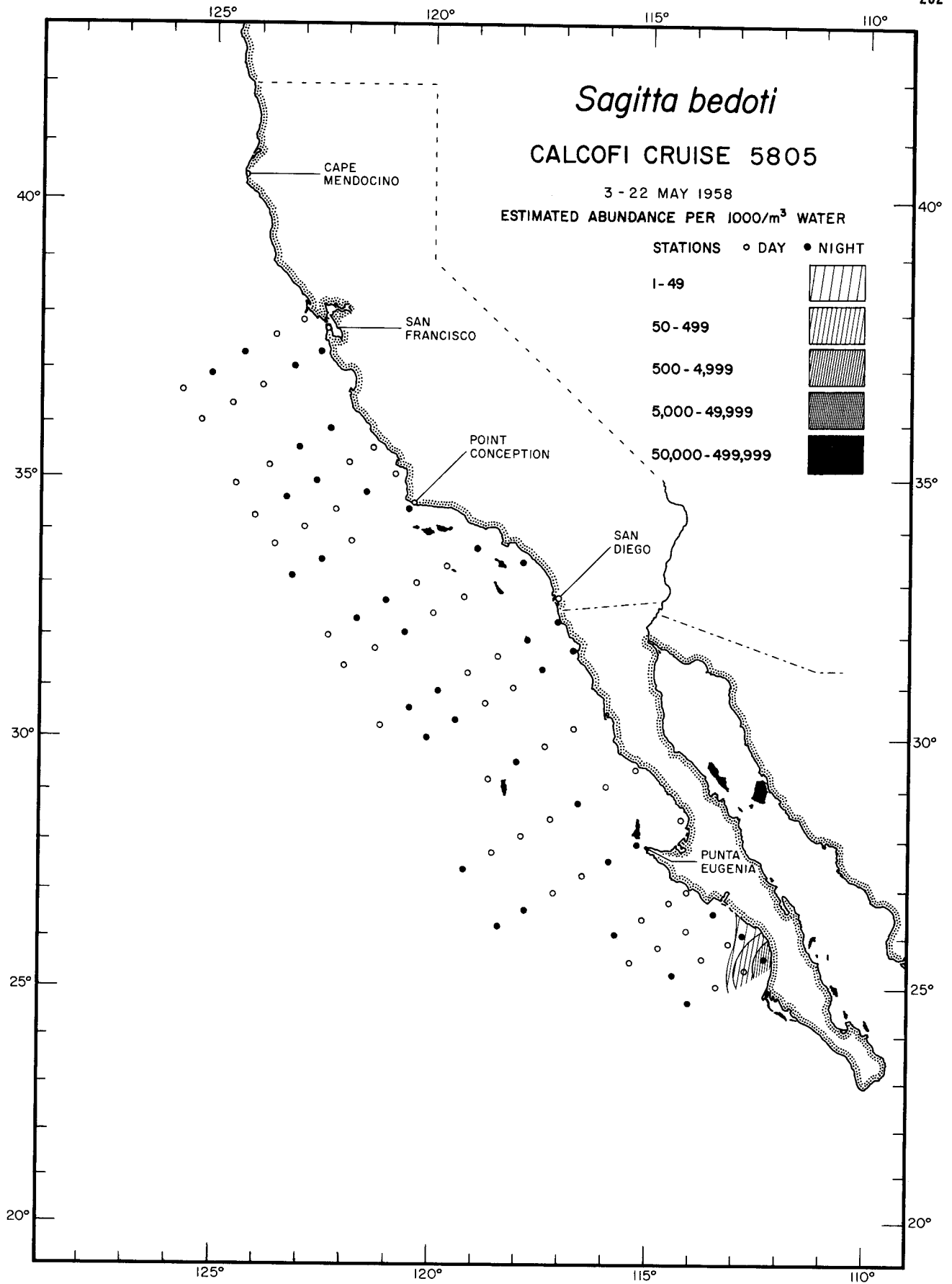
Chaetognatha
Krohnitta pacifica
5805



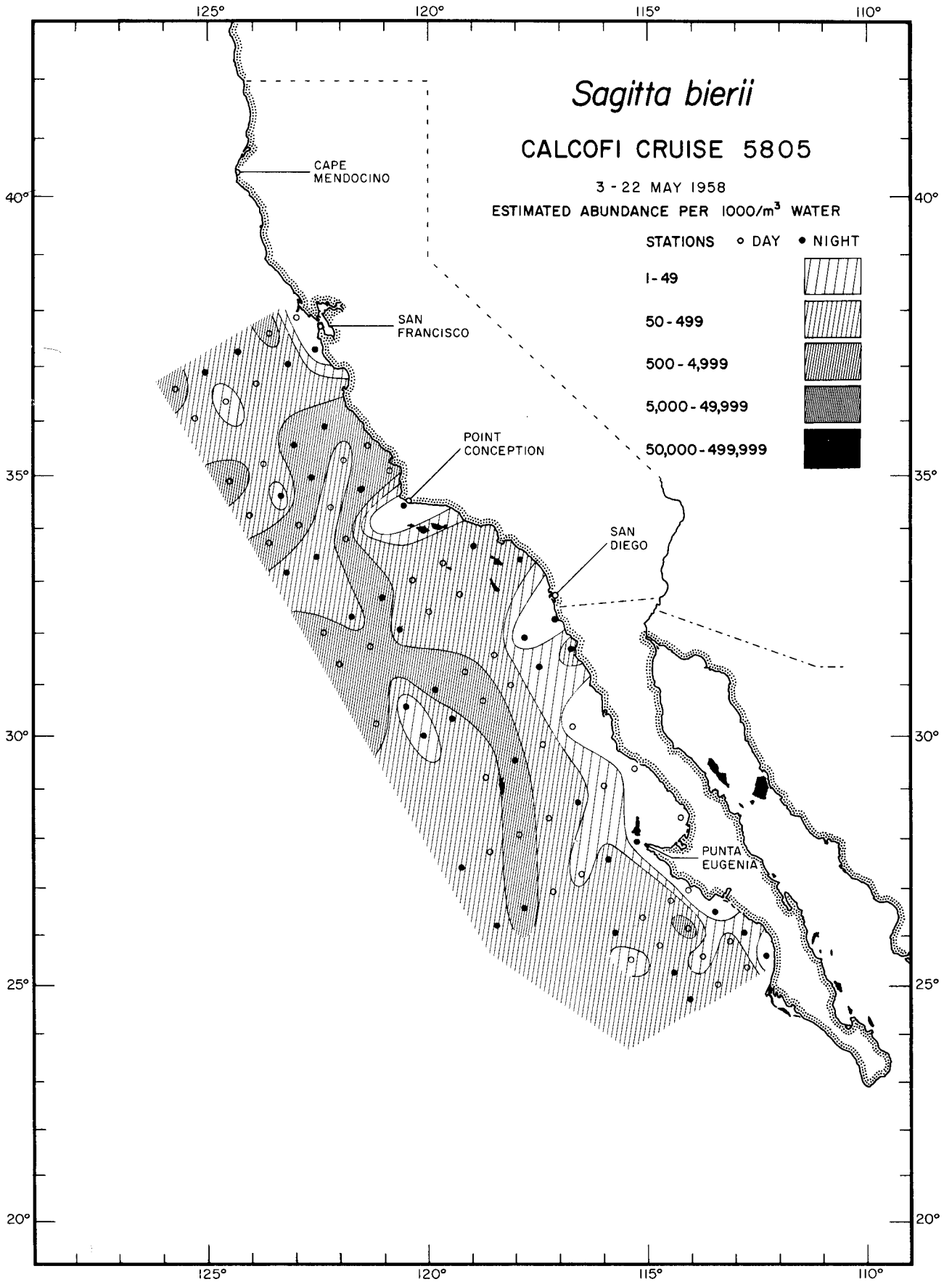
Chaetognatha
Krohnitta subtilis
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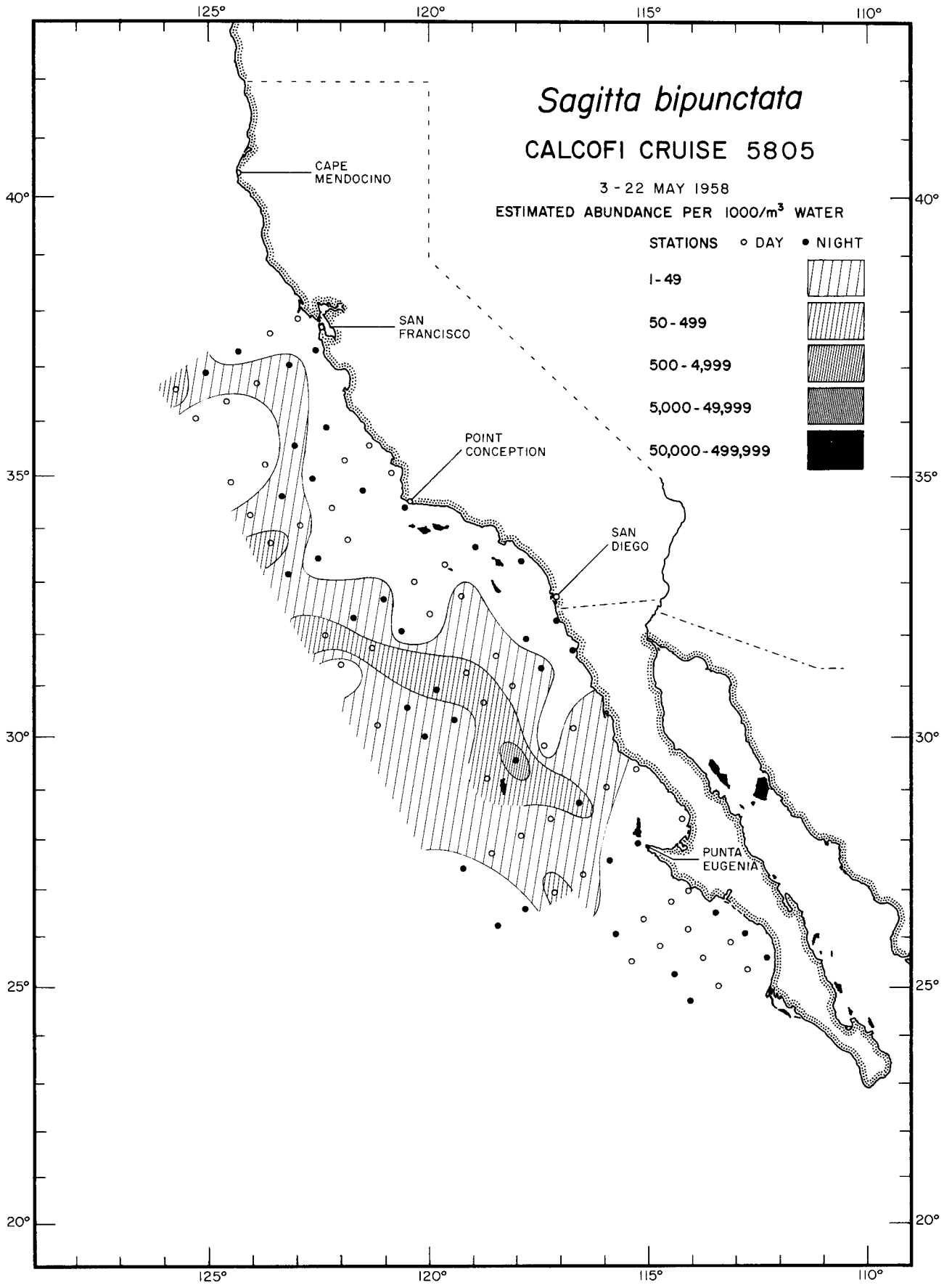
Chaetognatha
Pterosagitta draco
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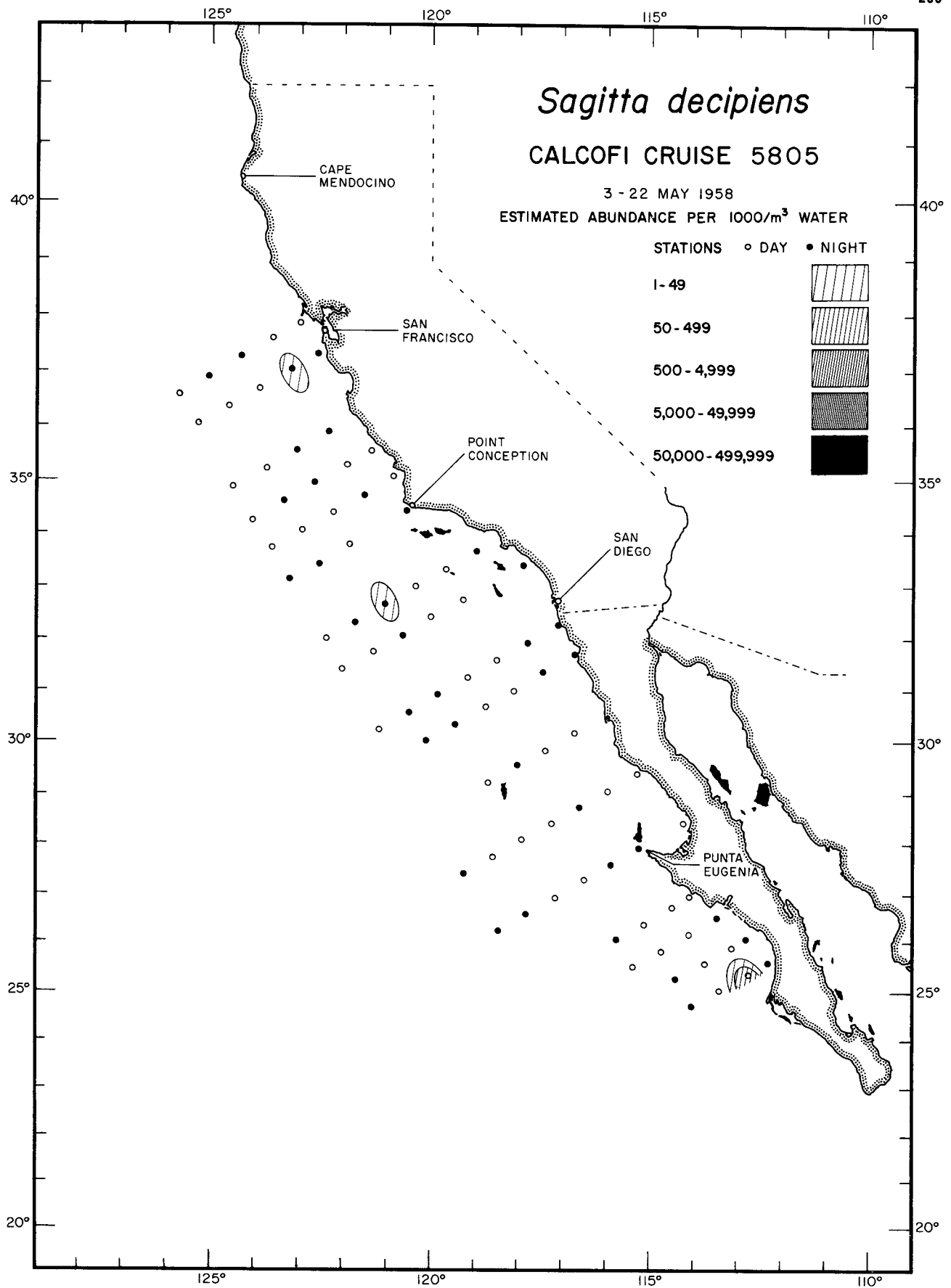
Chaetognatha
Sagitta bedoti
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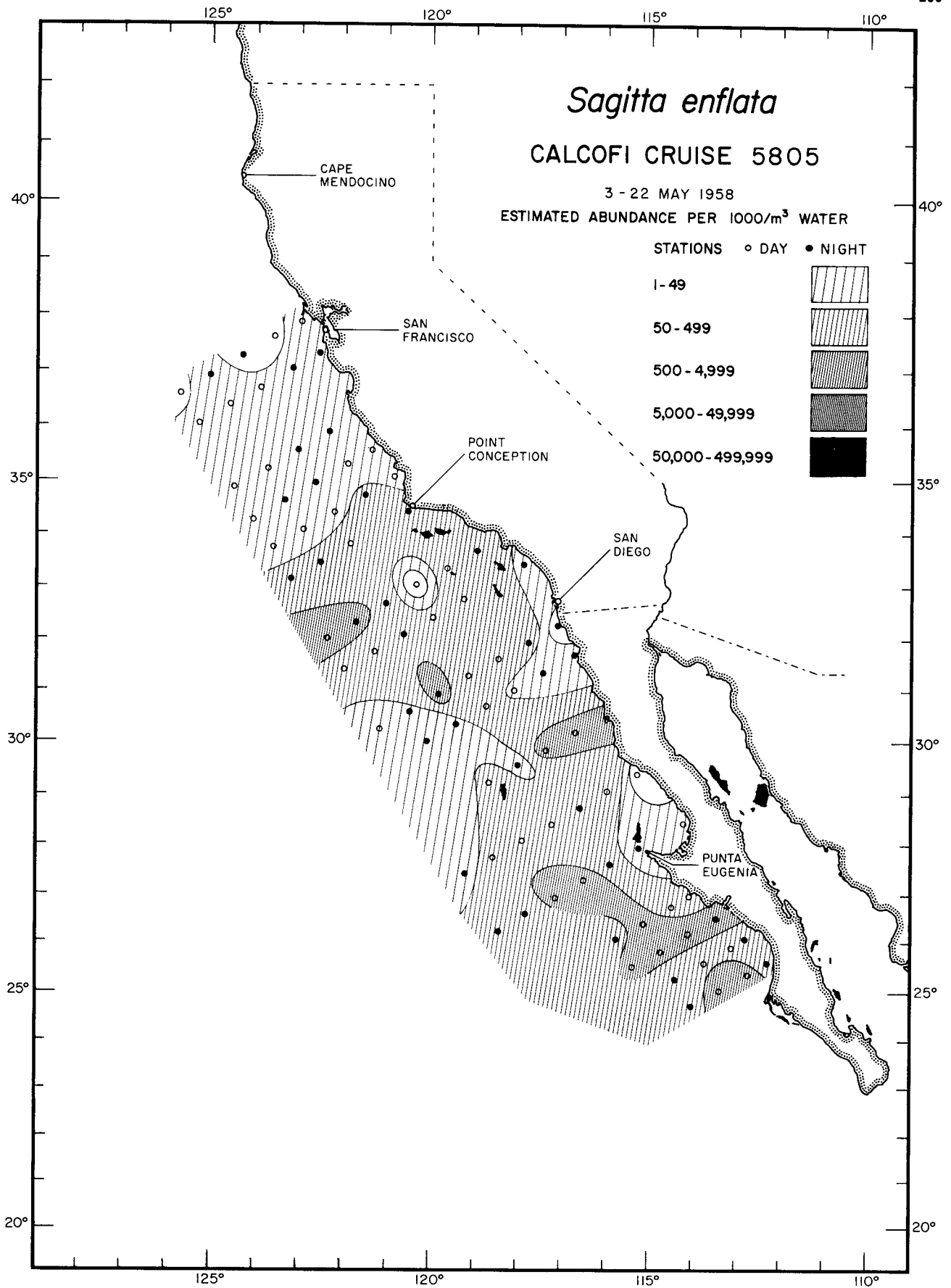
Chaetognatha
Sagitta bierii
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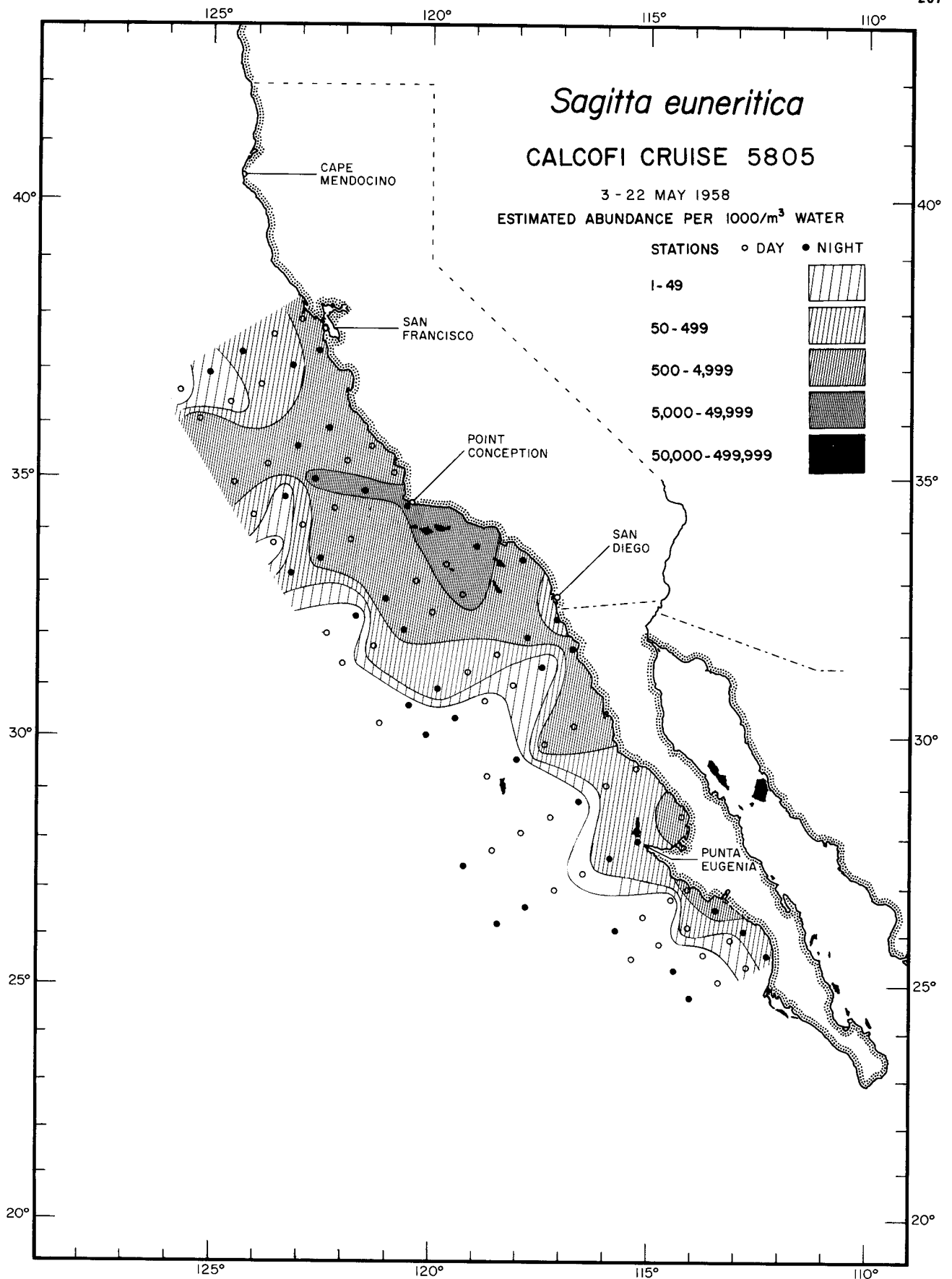
Chaetognatha
Sagitta bipunctata
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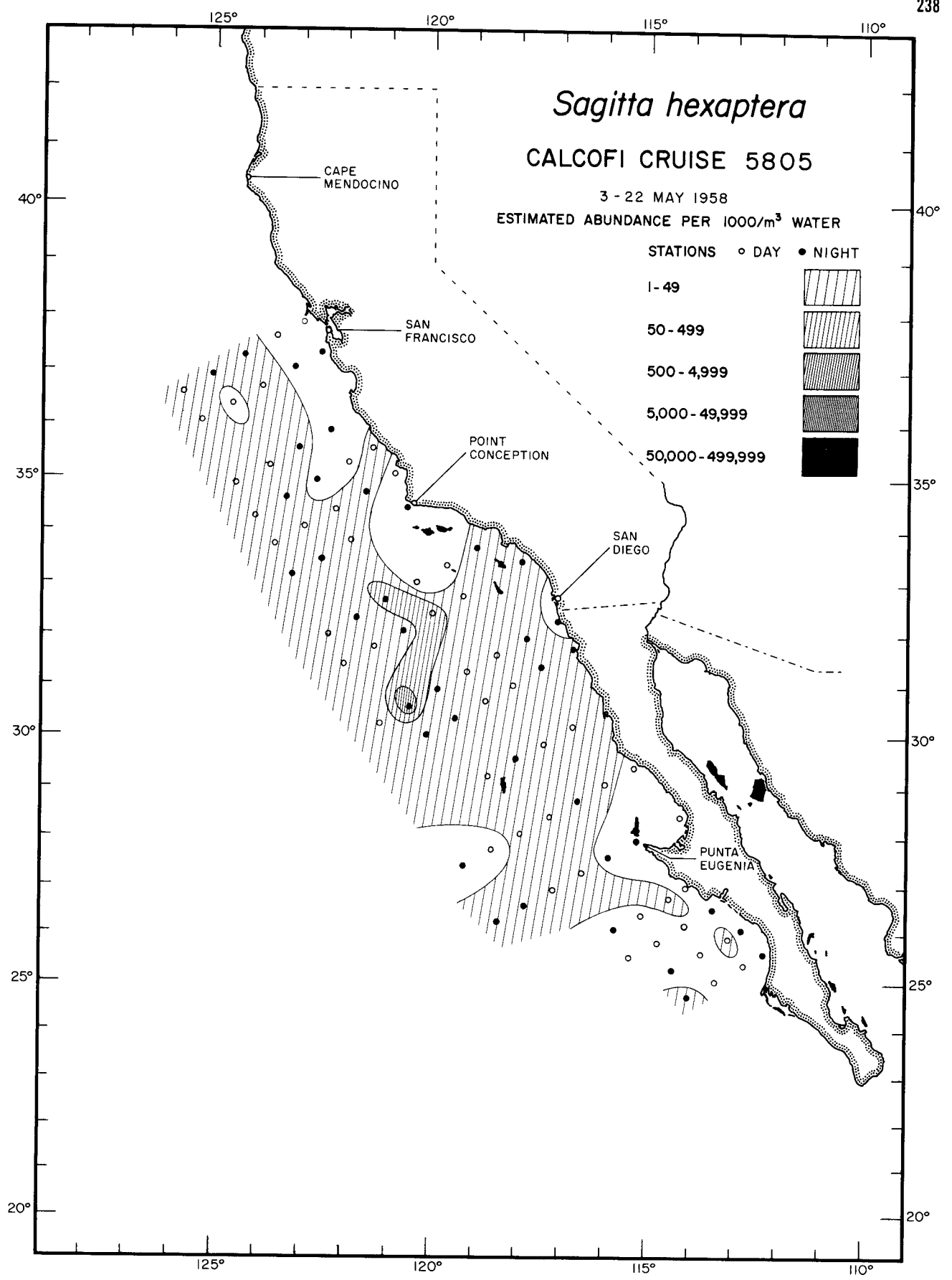
Chaetognatha
Sagitta decipiens
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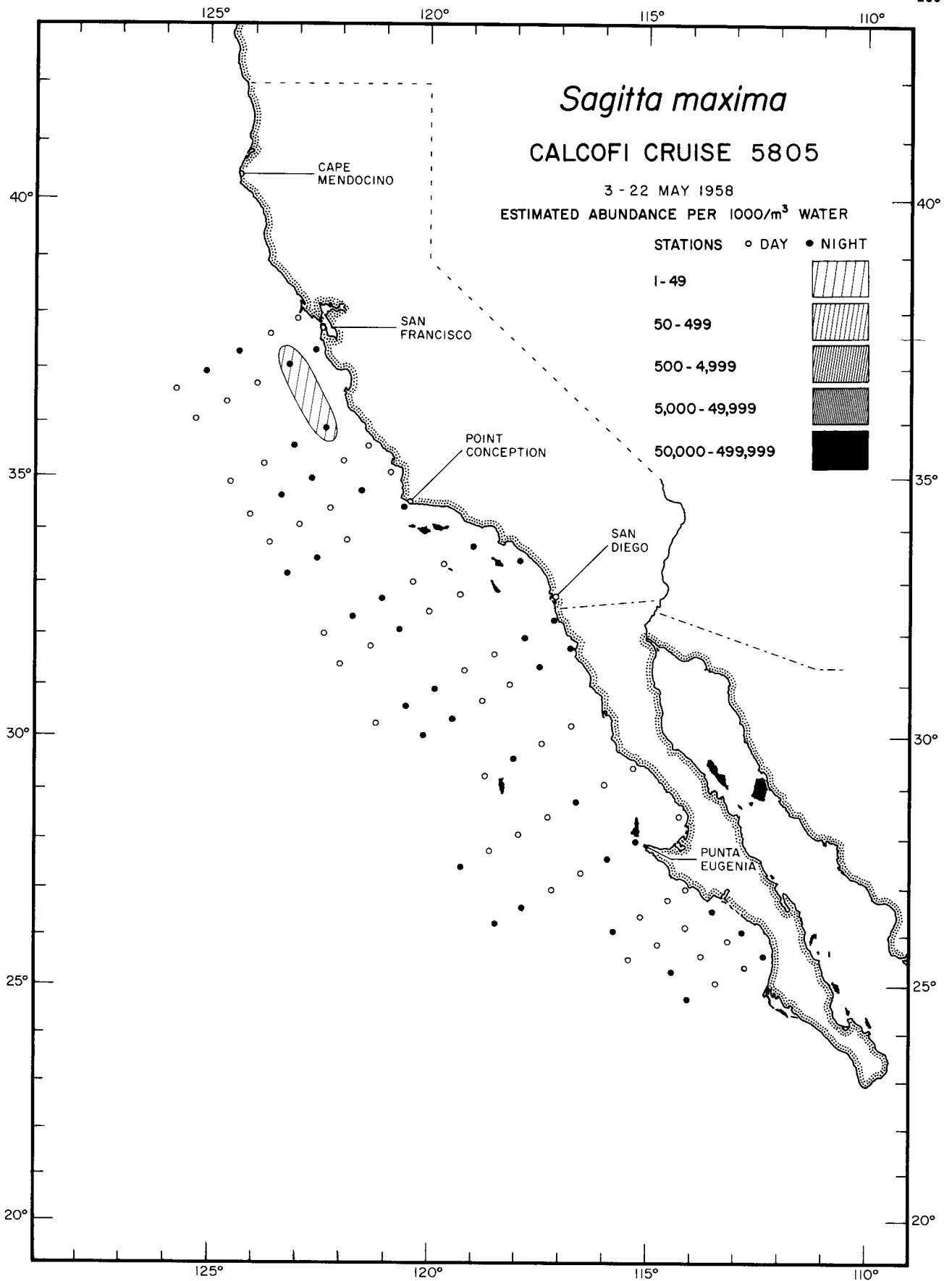
Chaetognatha
Sagitta enflata
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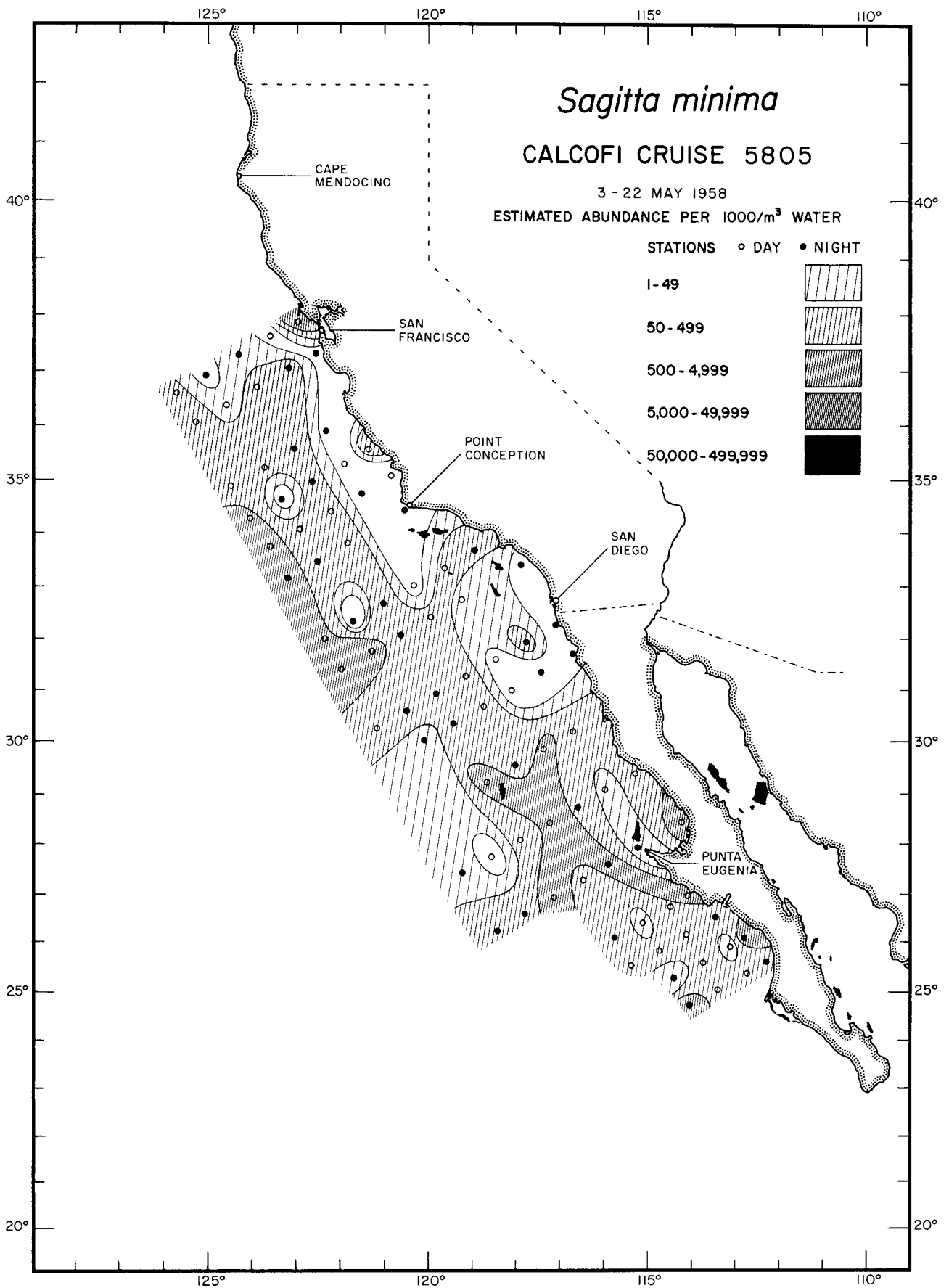
Chaetognatha
Sagitta euneritica
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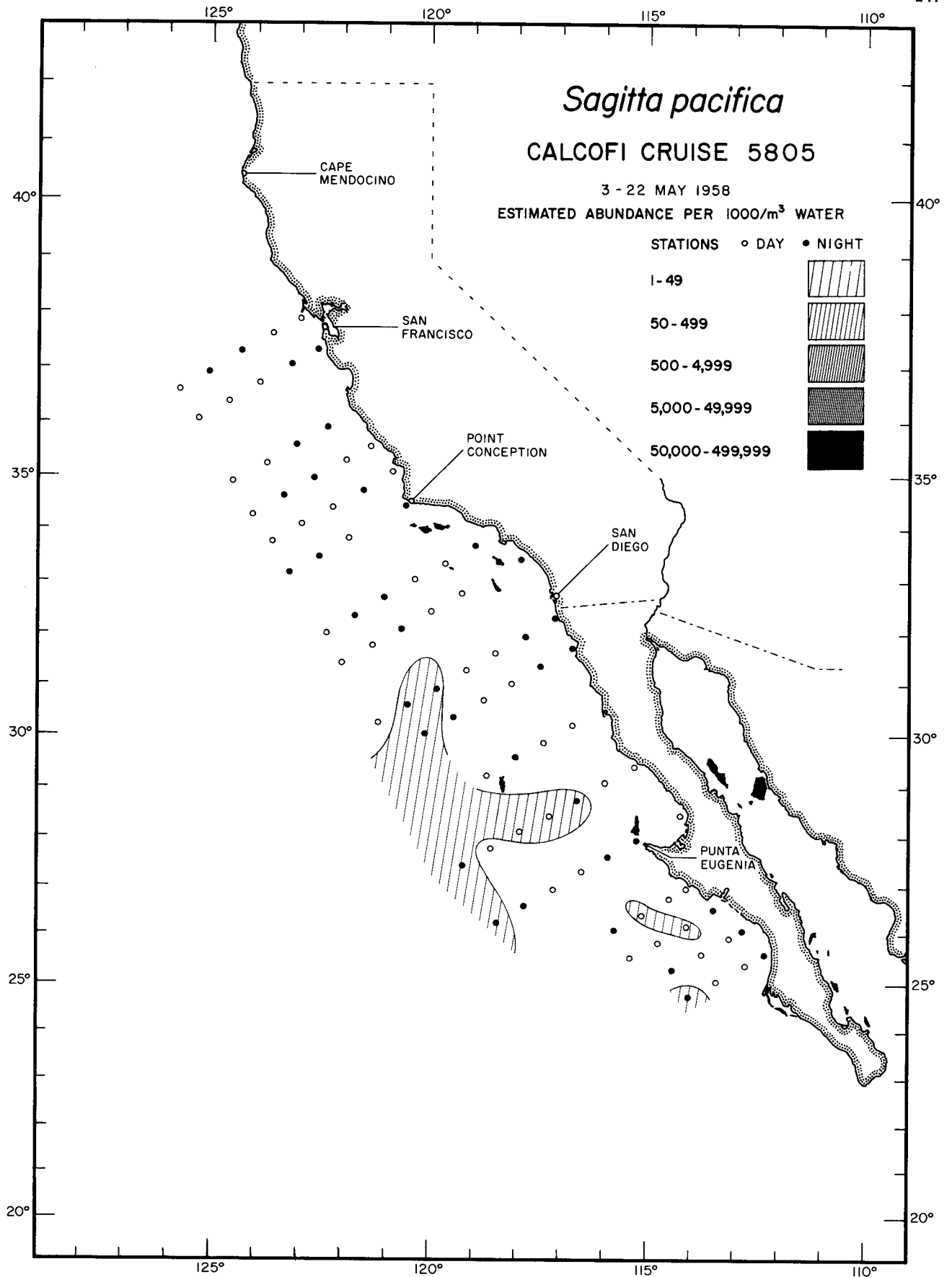
Chaetognatha
Sagitta hexaptera
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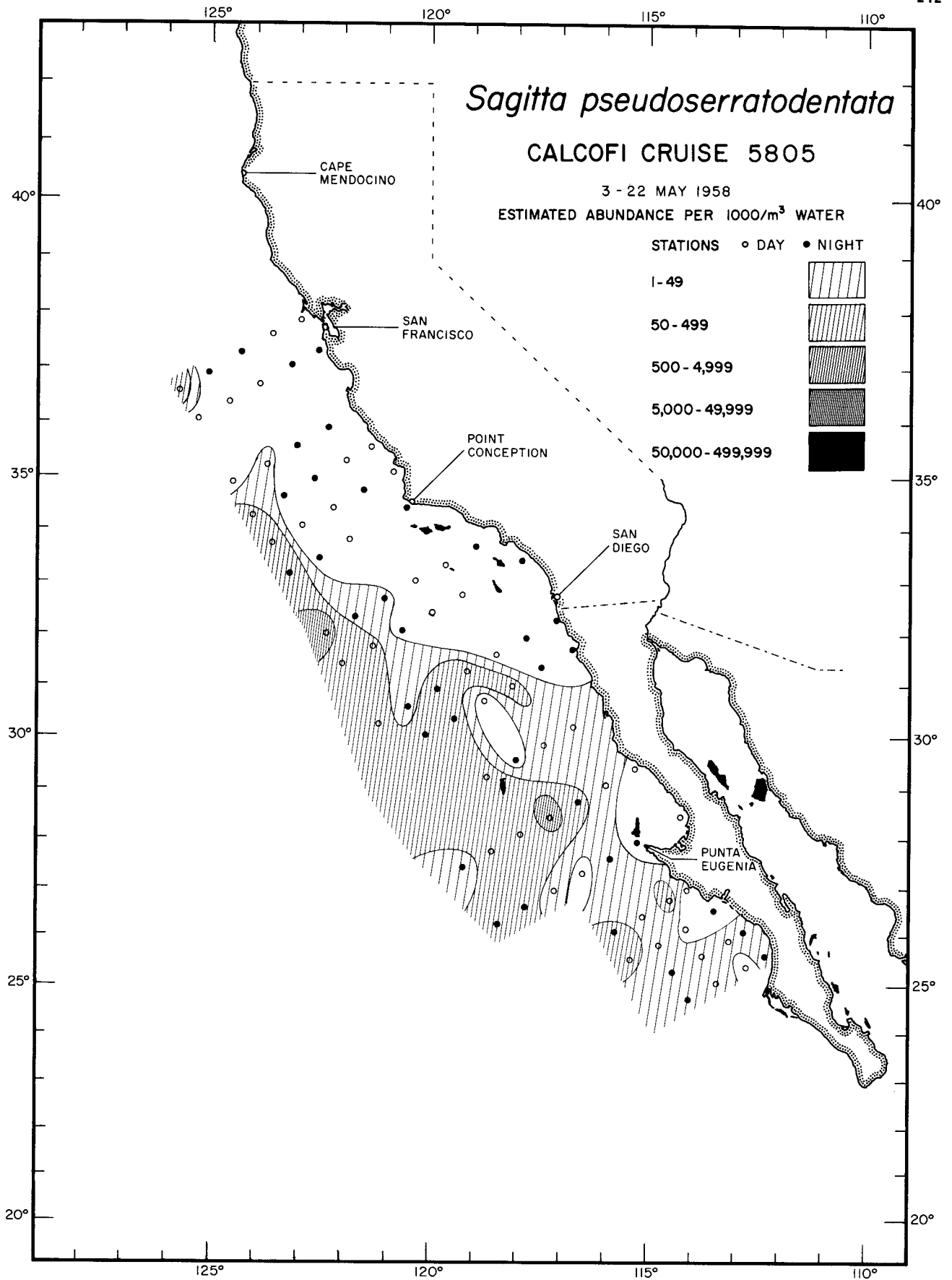
Chaetognatha
Sagitta maxima
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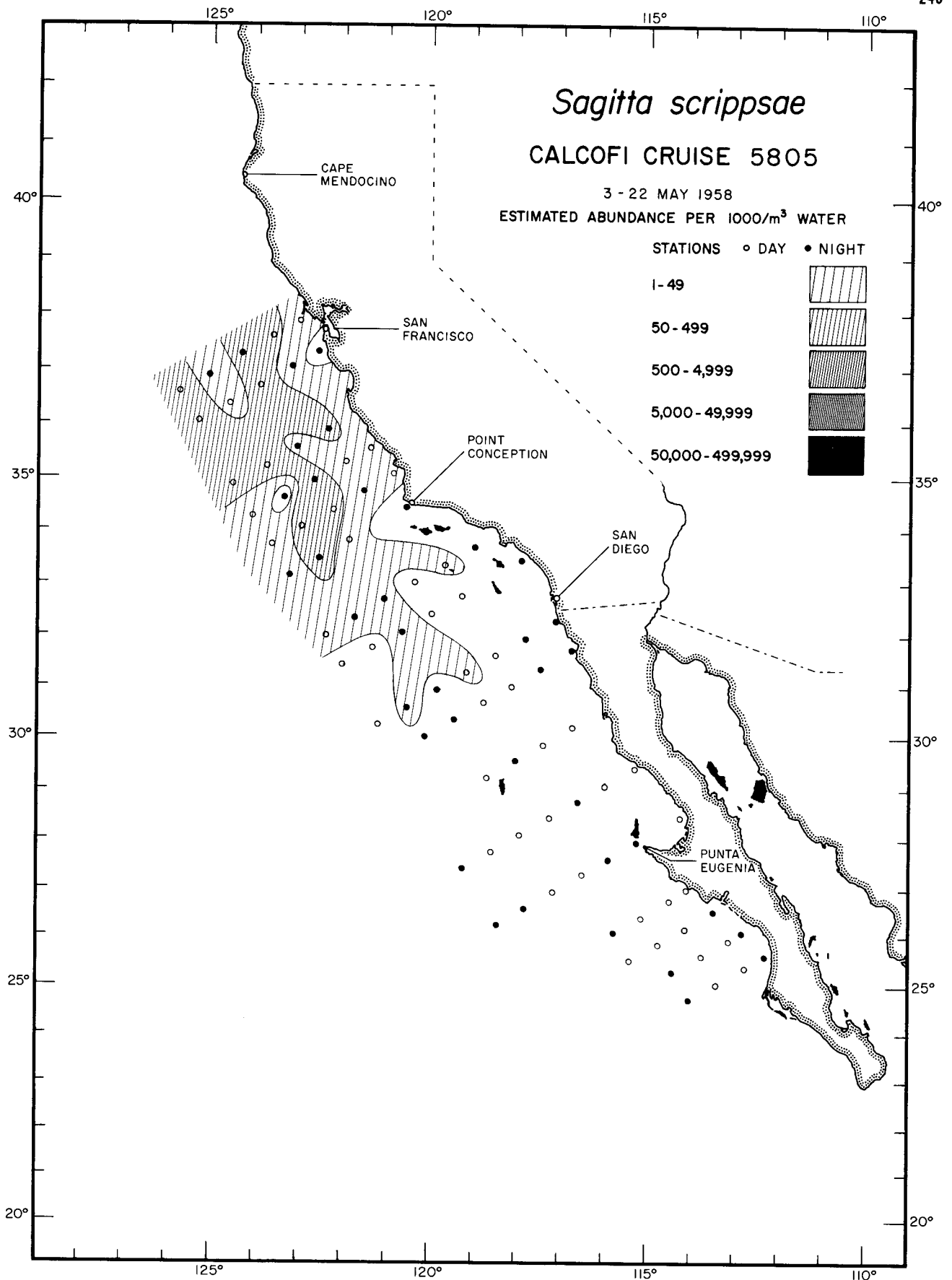
Chaetognatha
Sagitta minima
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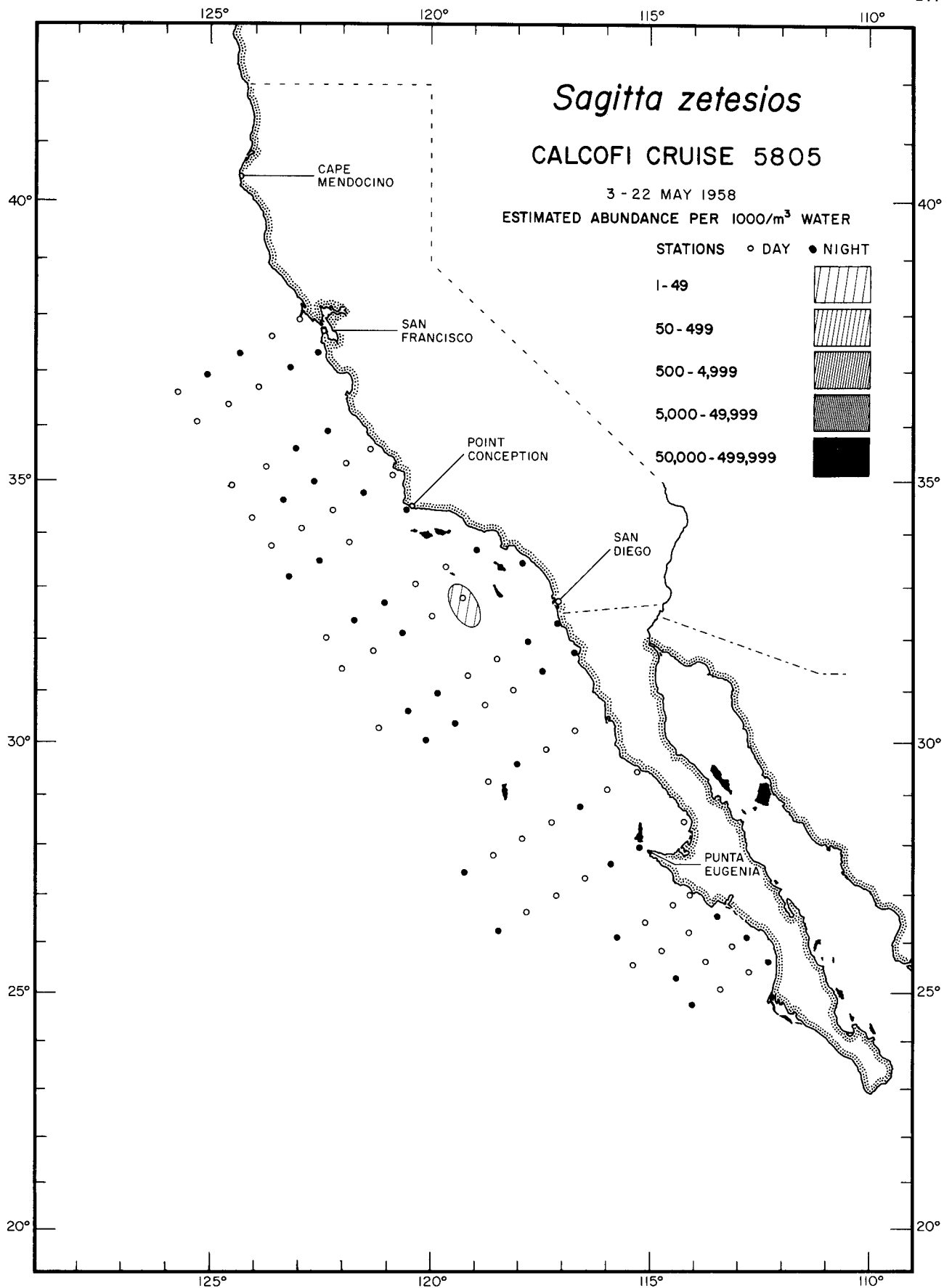
Chaetognatha
Sagitta pacifica
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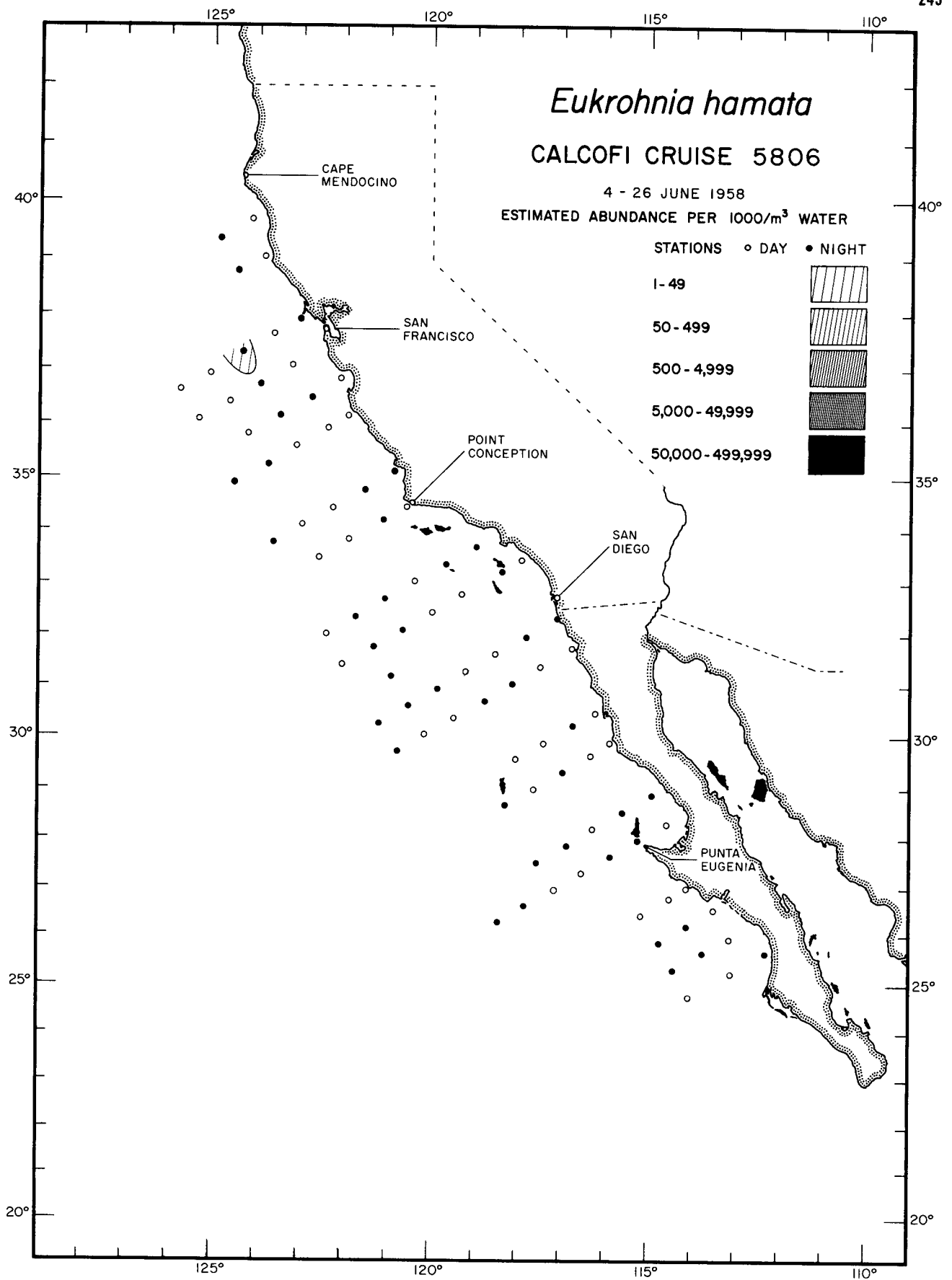


Chaetognatha
Sagitta pseudoserratodentata
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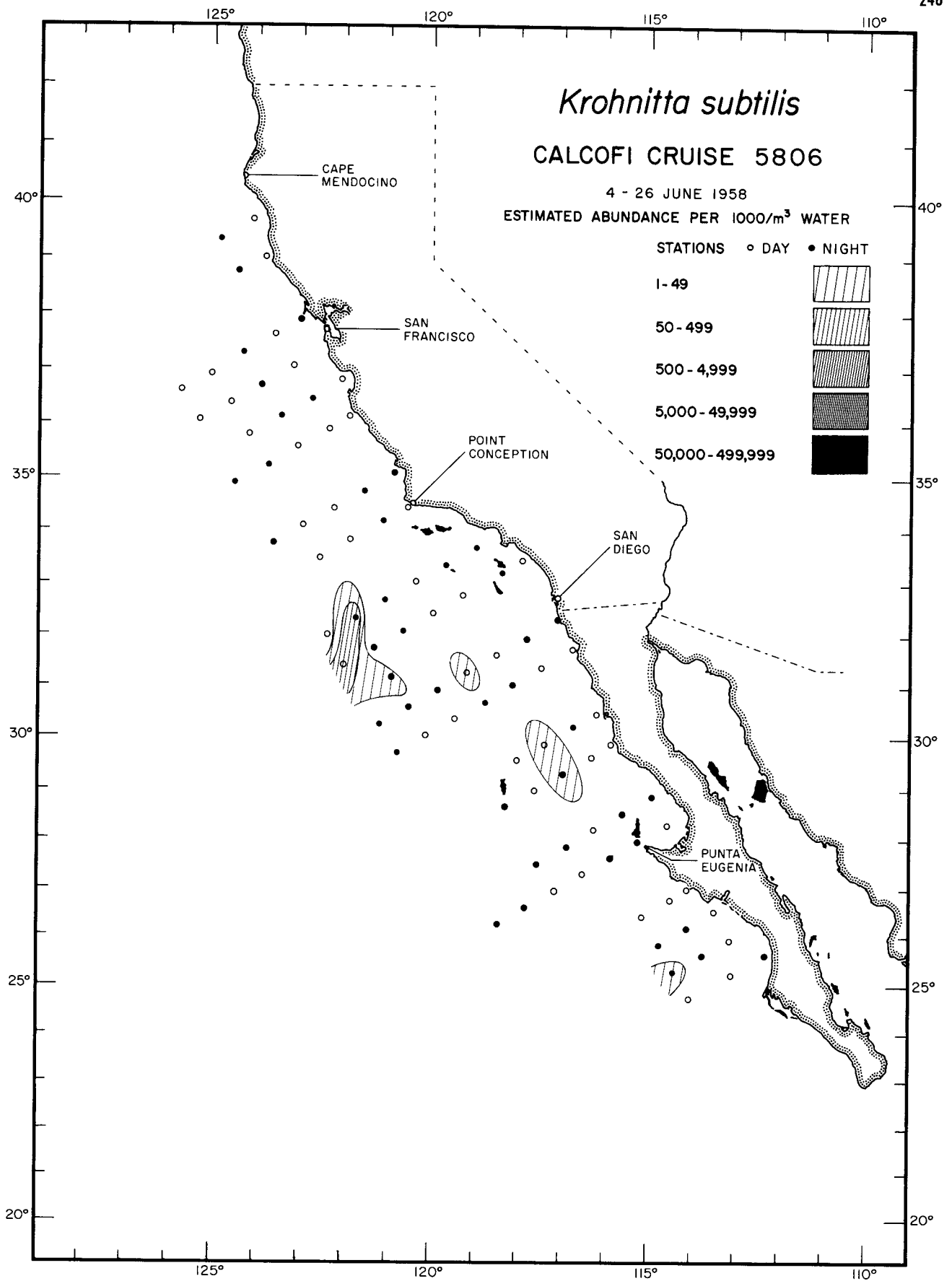


Chaetognatha
Sagitta scrippsae
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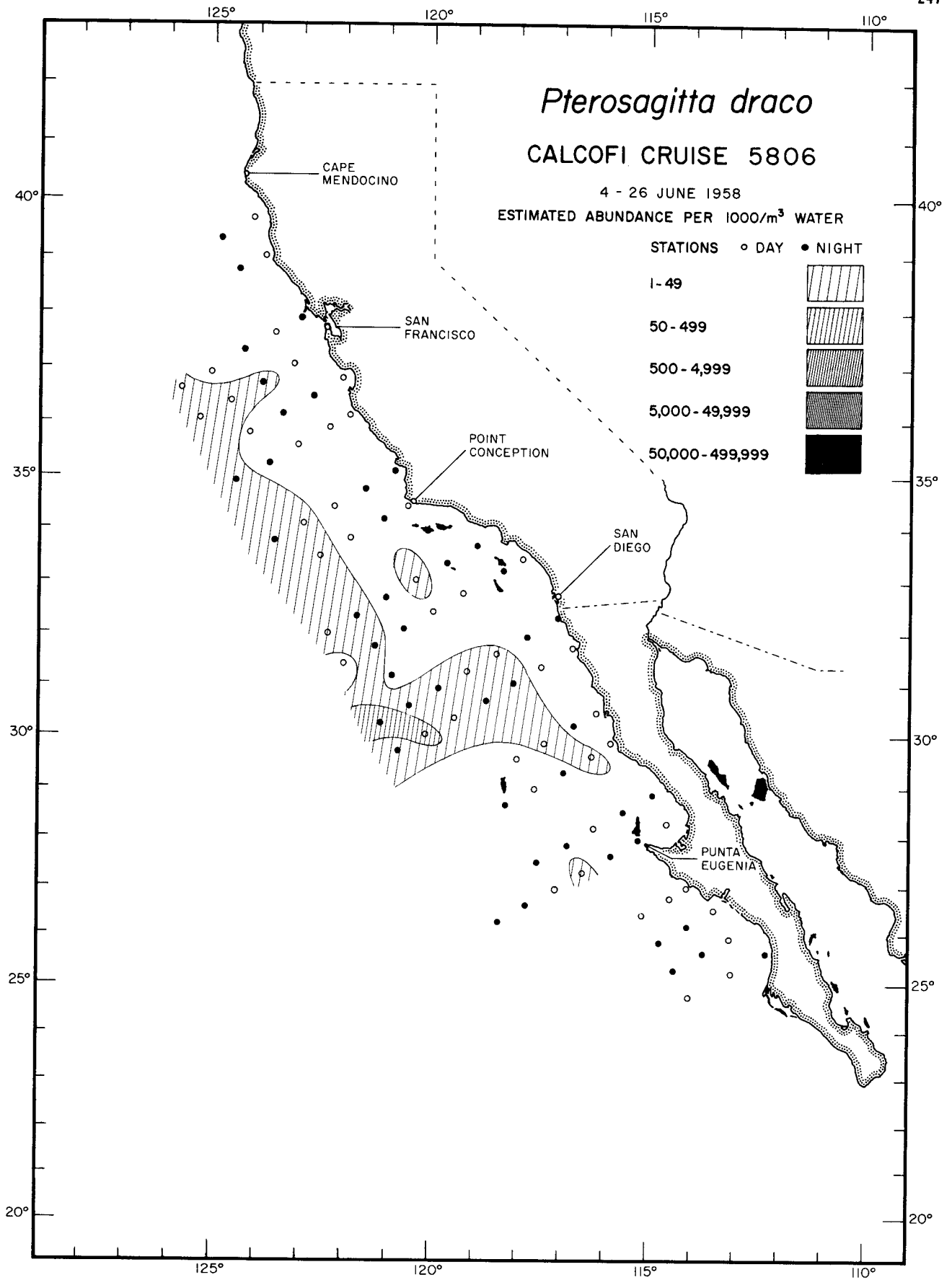




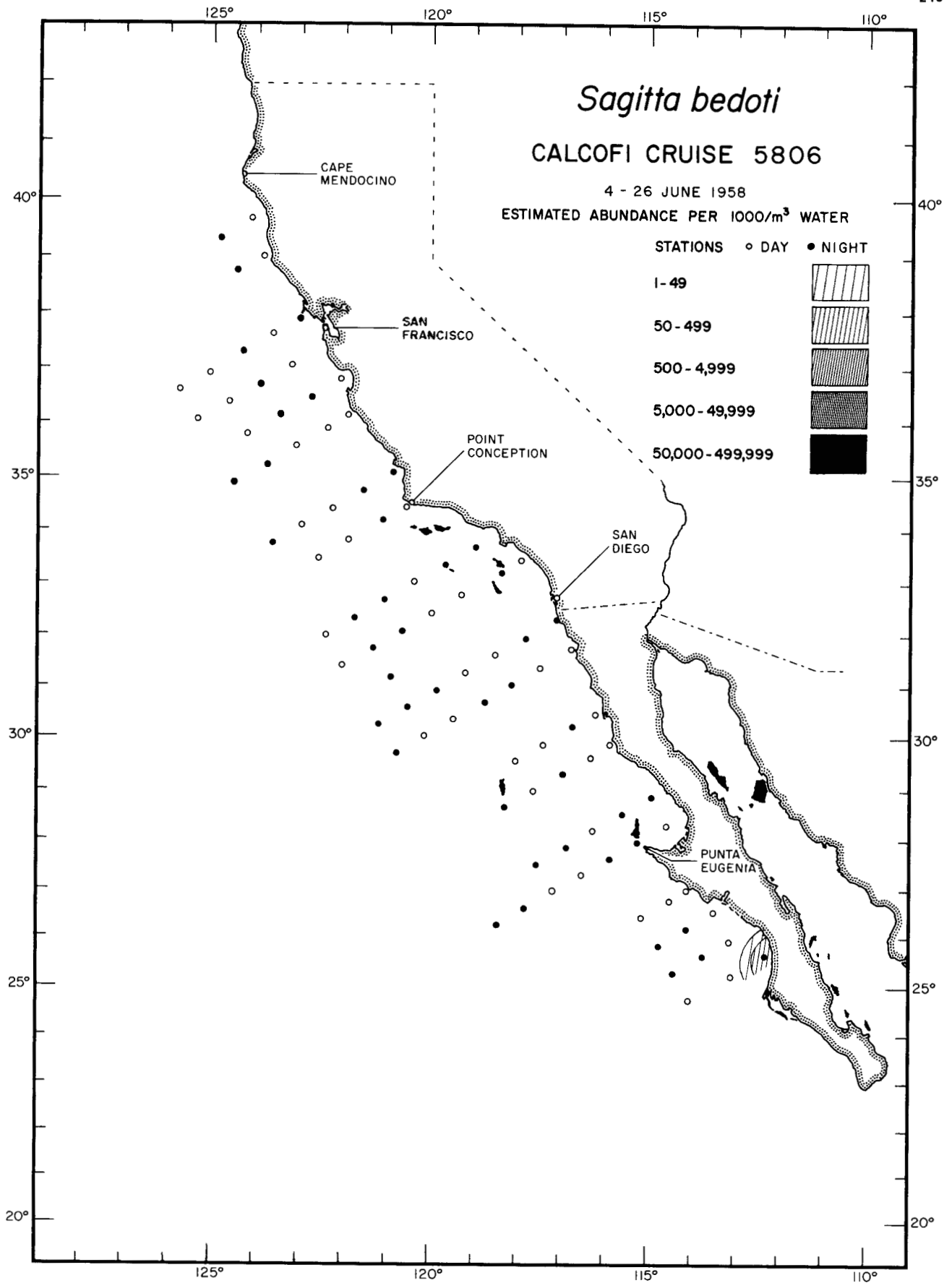
Chaetognatha
Eukrohnia hamata
5806



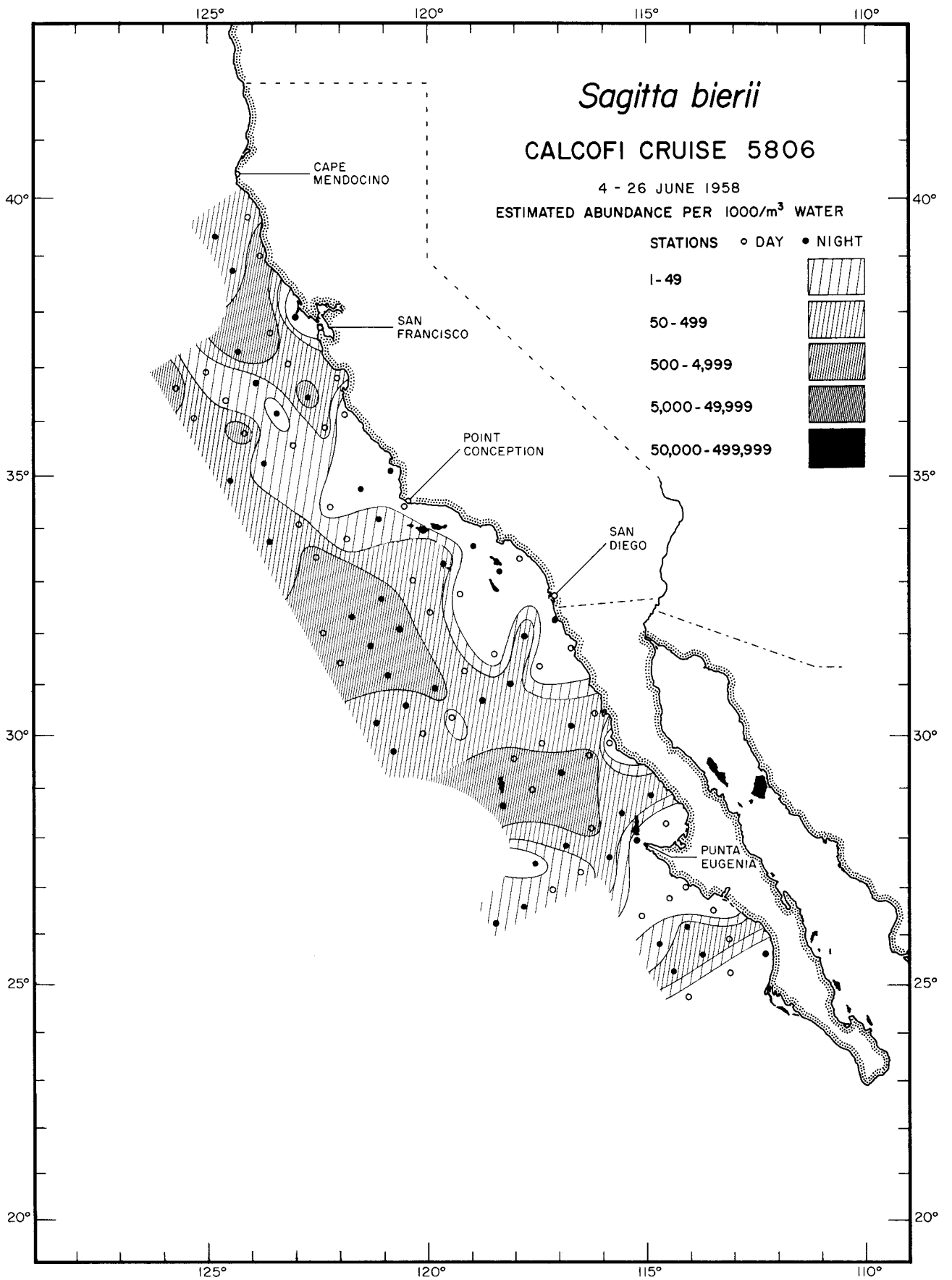
Chaetognatha
Krohnitta subtilis
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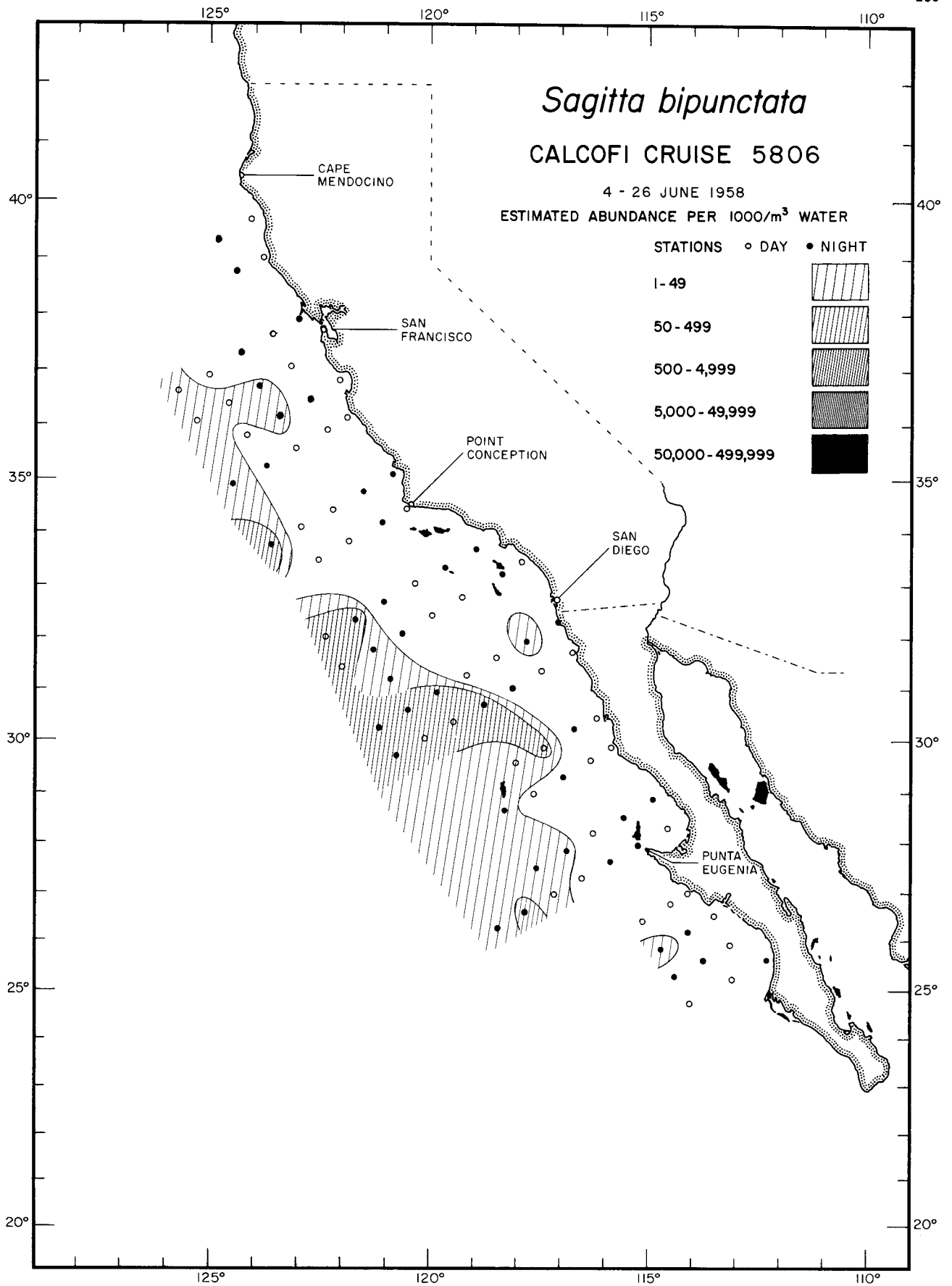
Chaetognatha
Pterosagitta draco
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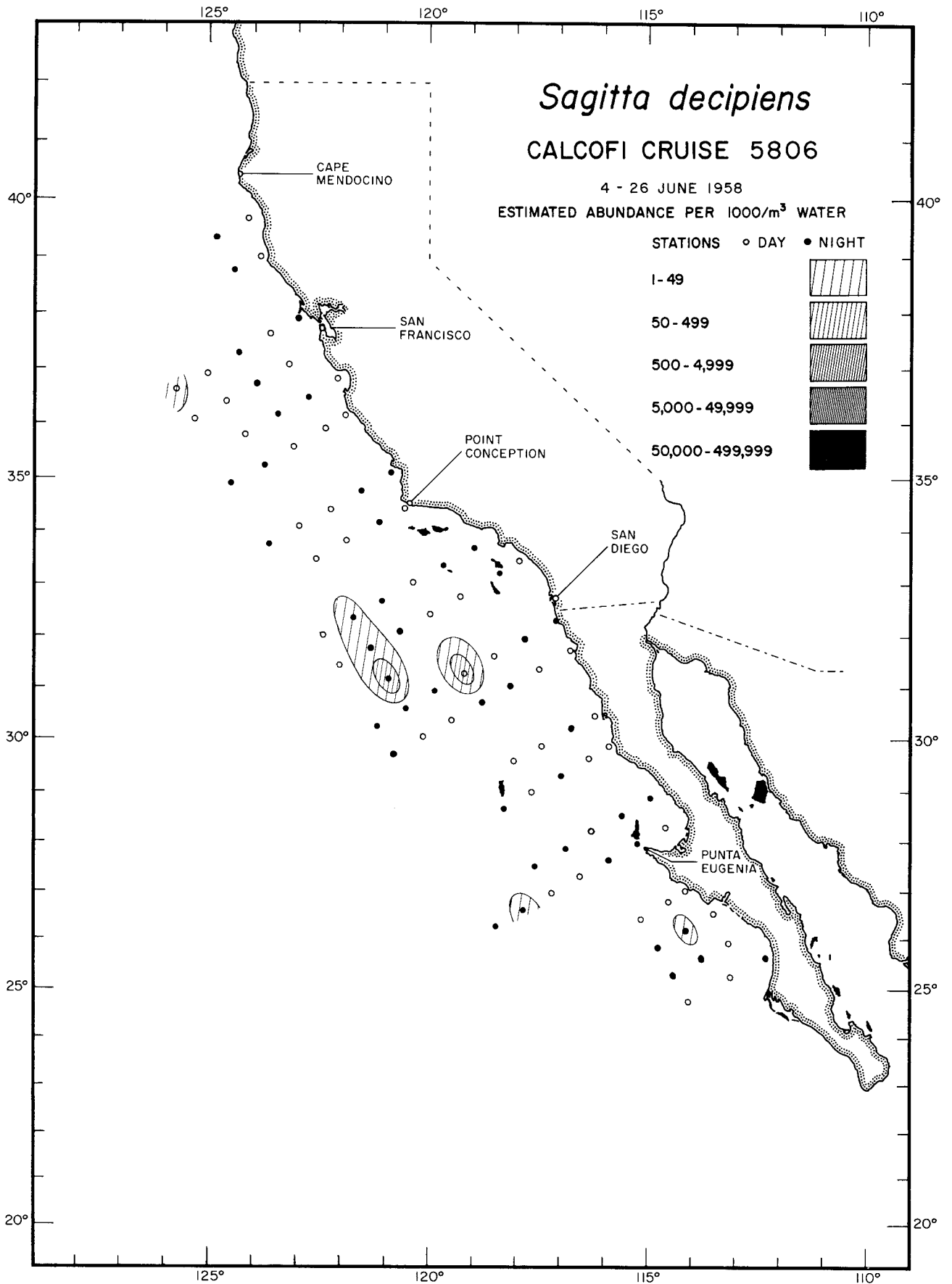
Chaetognatha
Sagitta bedoti
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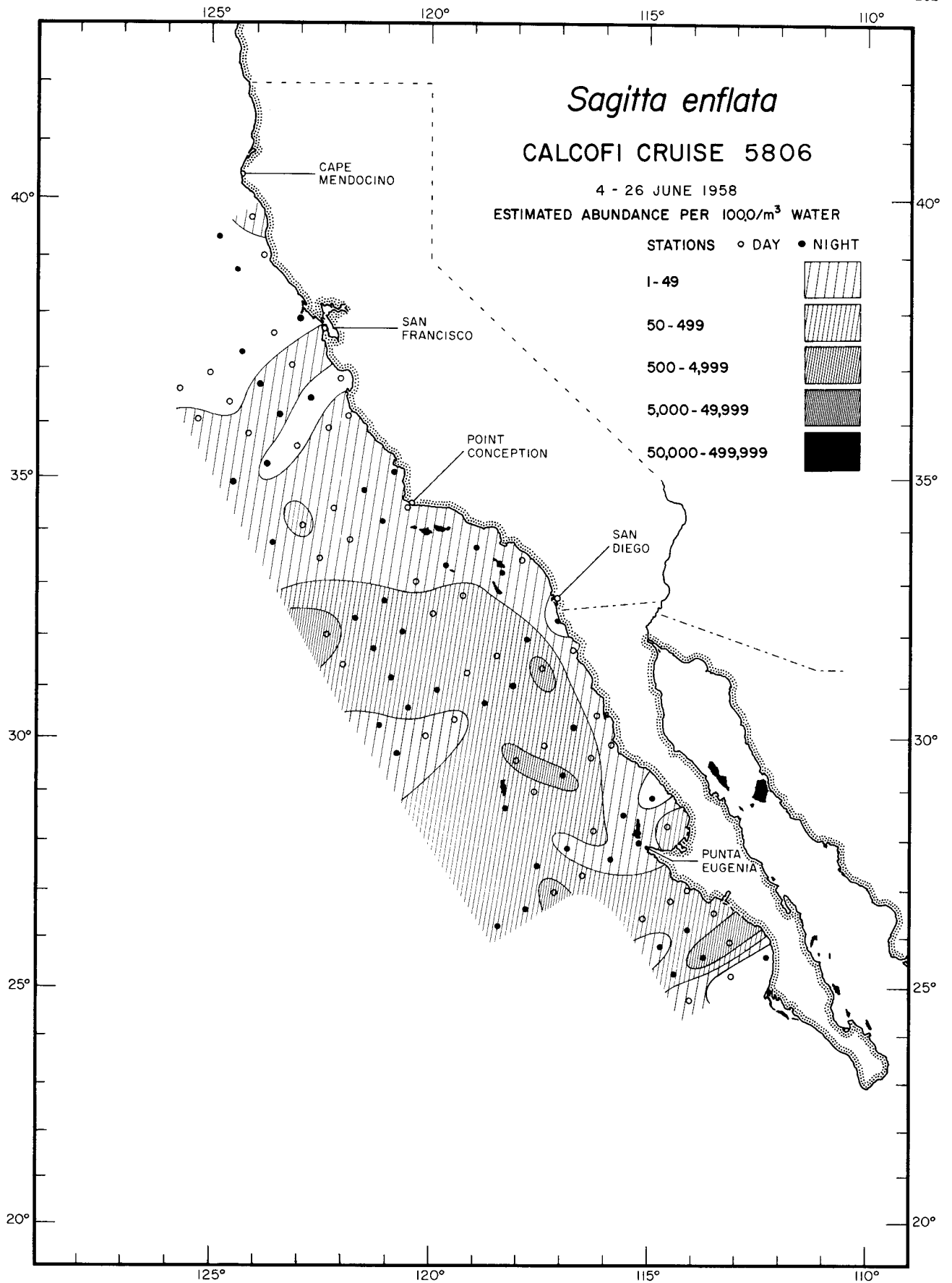
Chaetognatha
Sagitta bierii
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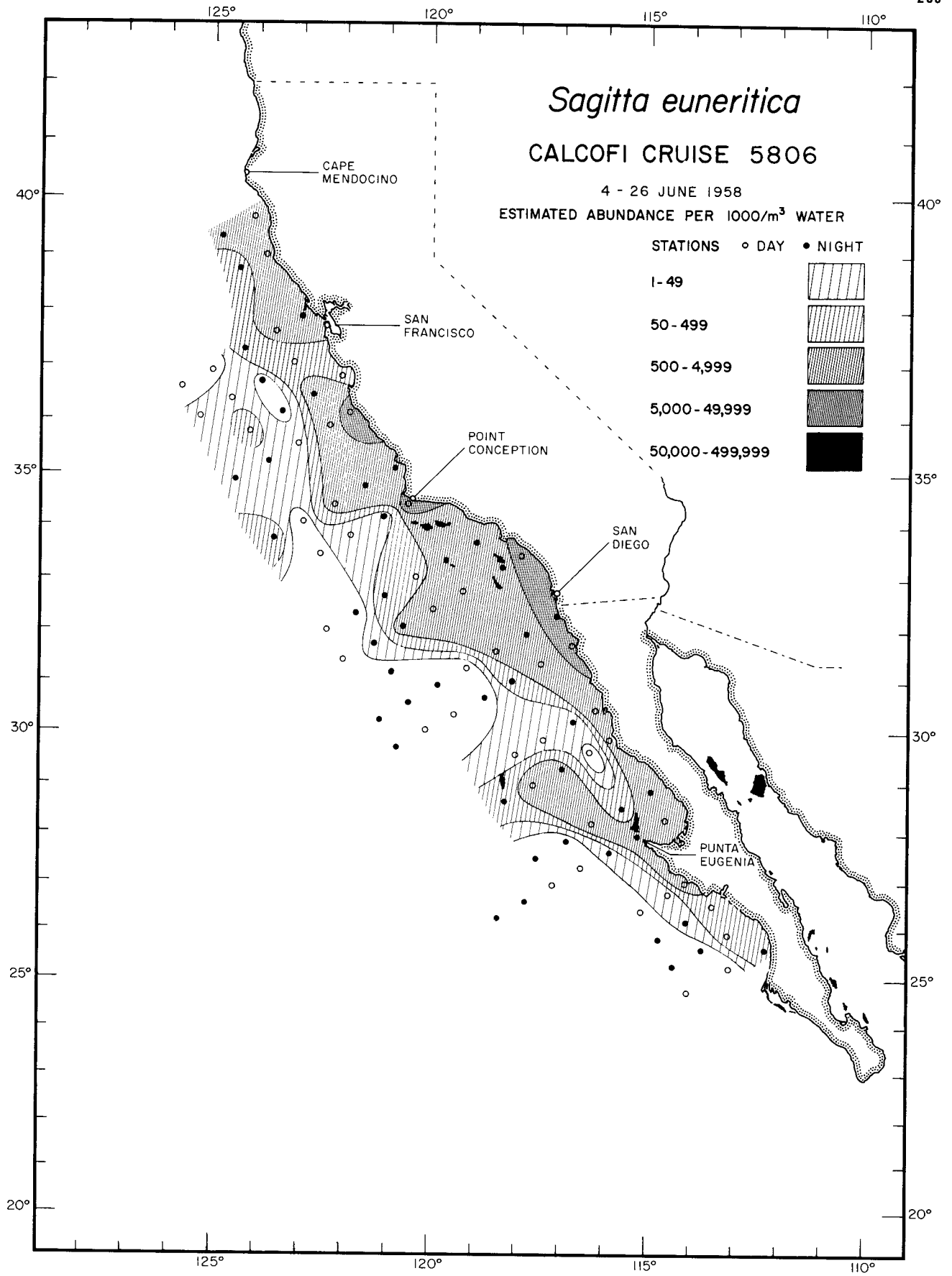
Chaetognatha
Sagitta bipunctata
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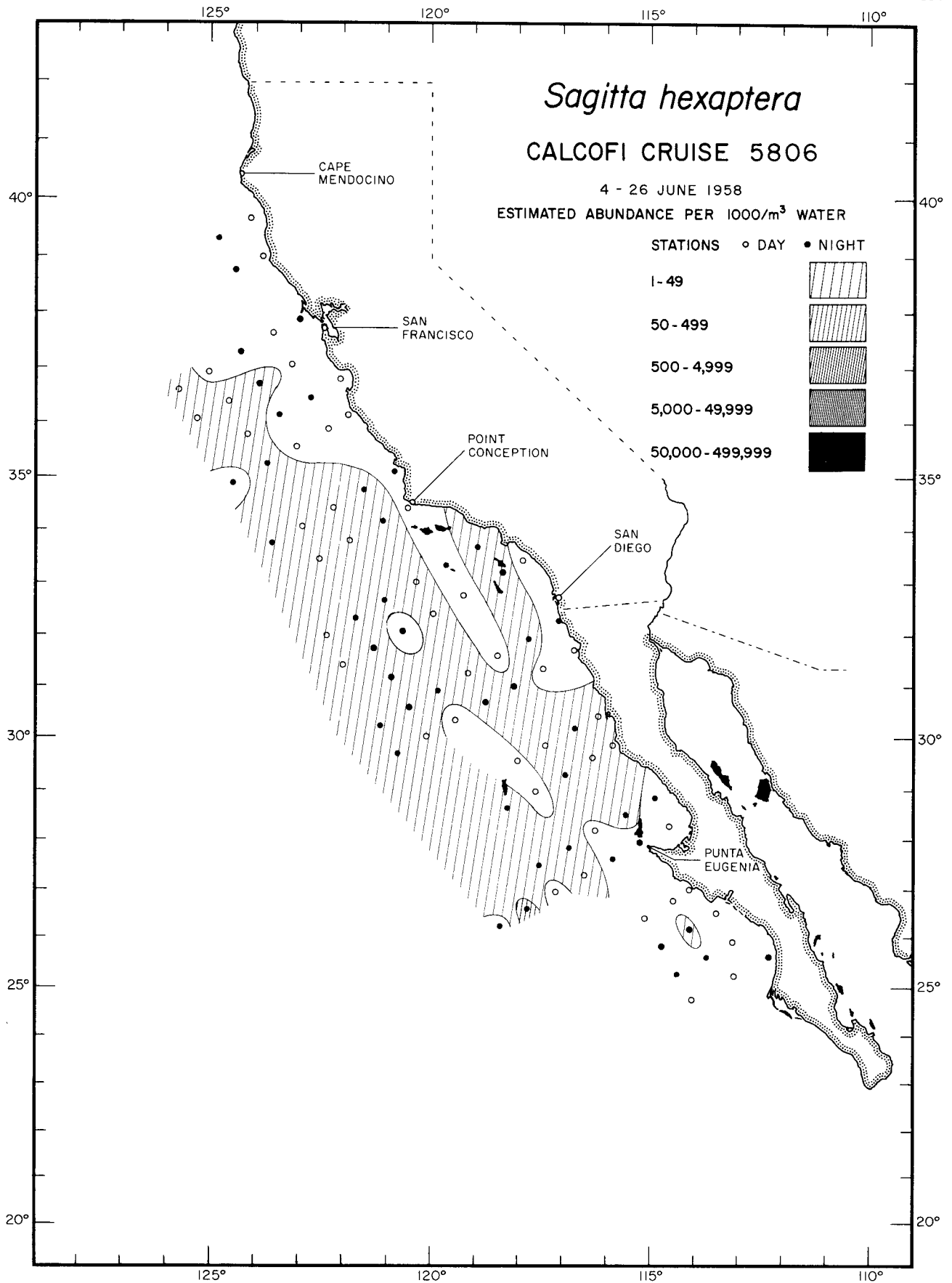
Chaetognatha
Sagitta decipiens
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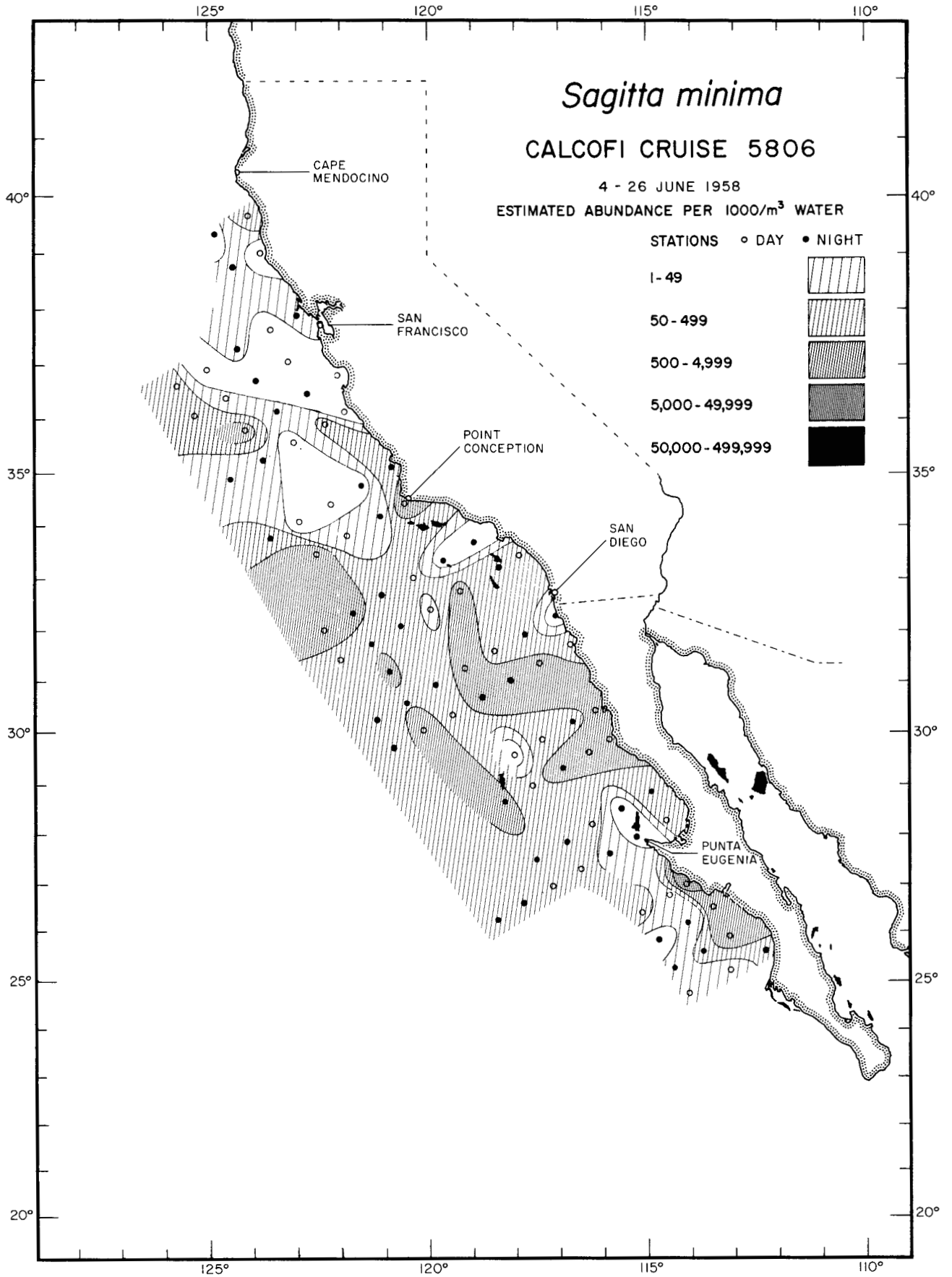
Chaetognatha
Sagitta enflata
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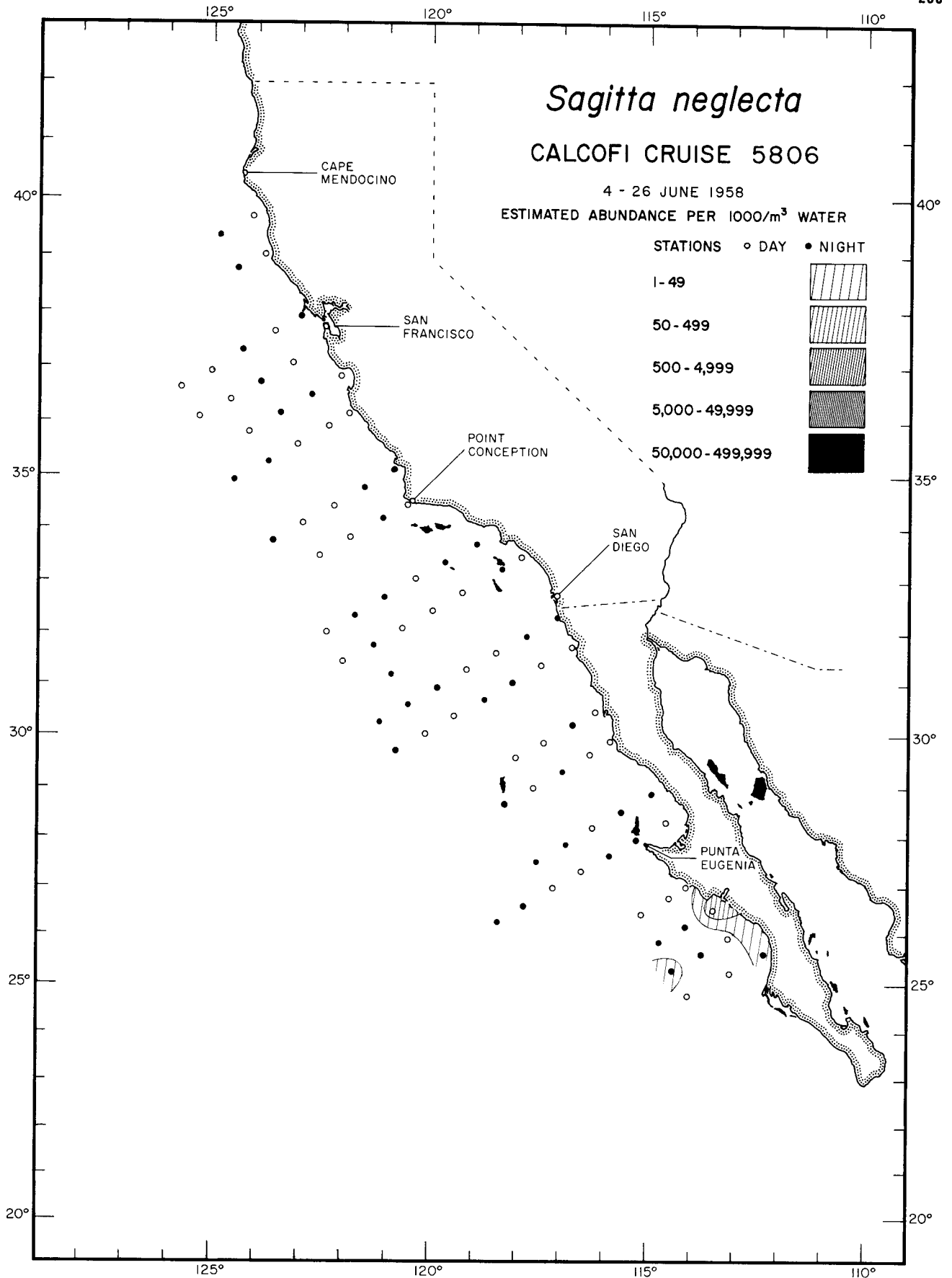
Chaetognatha
Sagitta euneritica
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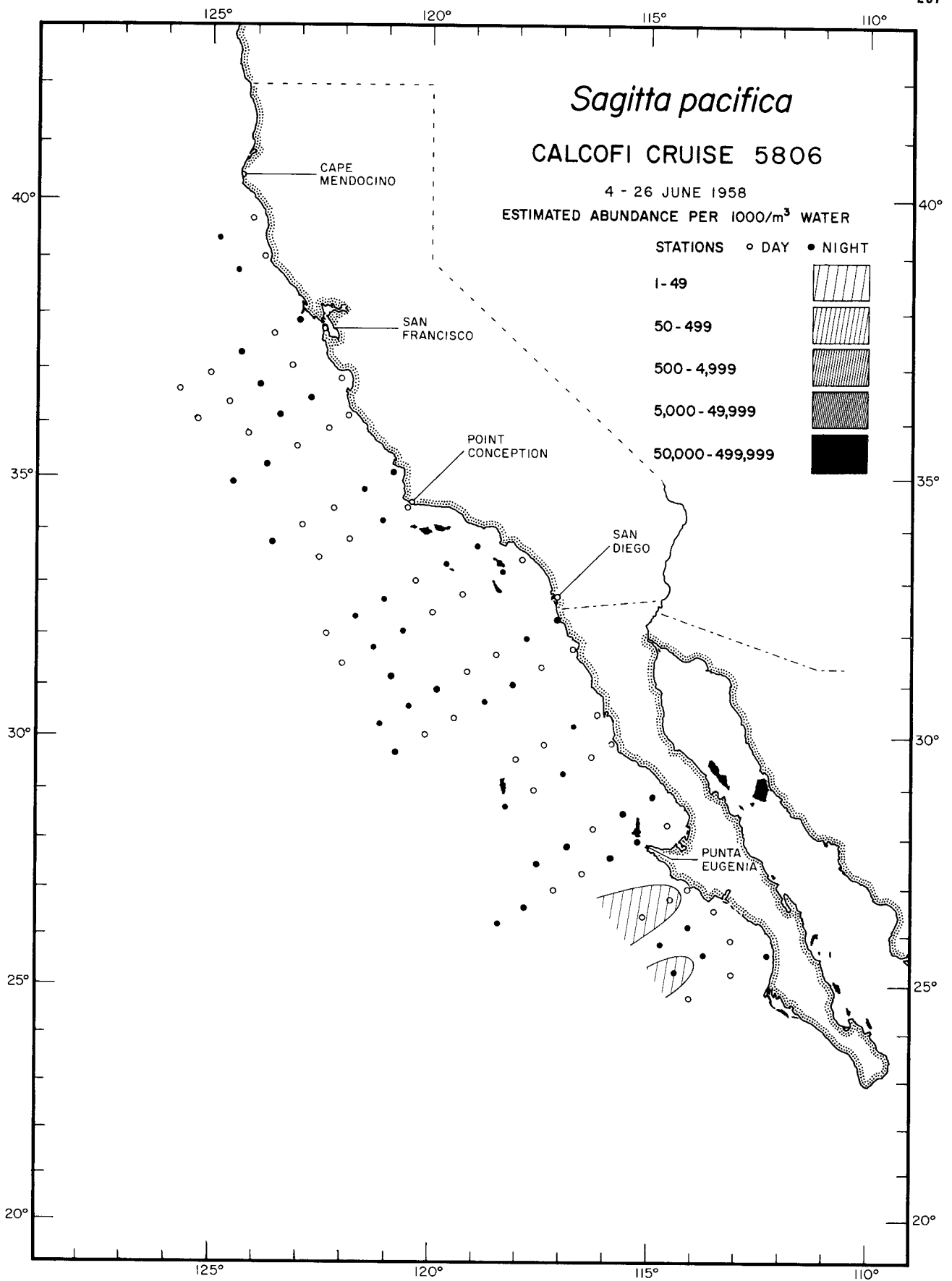
Chaetognatha
Sagitta hexaptera
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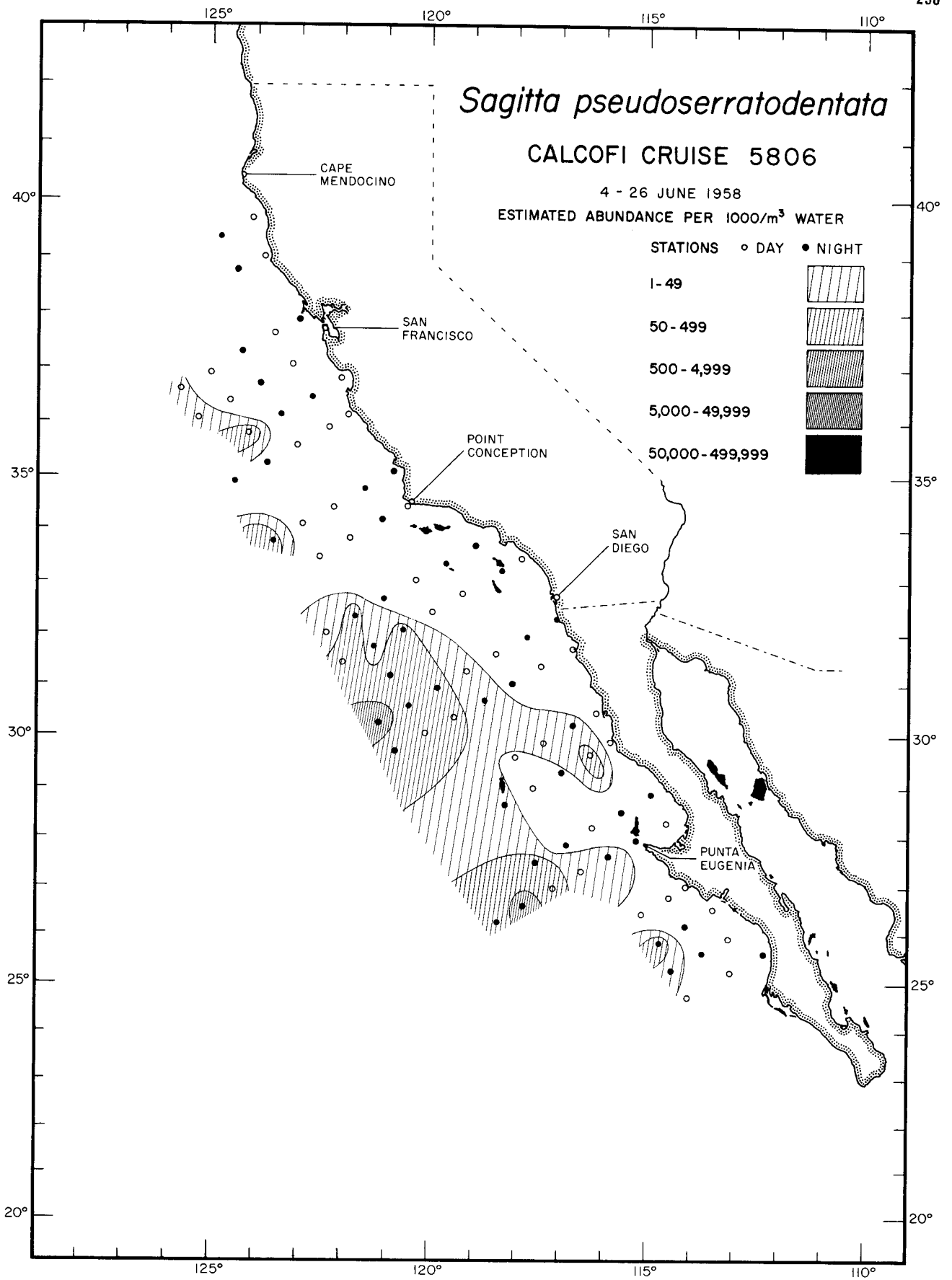
Chaetognatha
Sagitta minima
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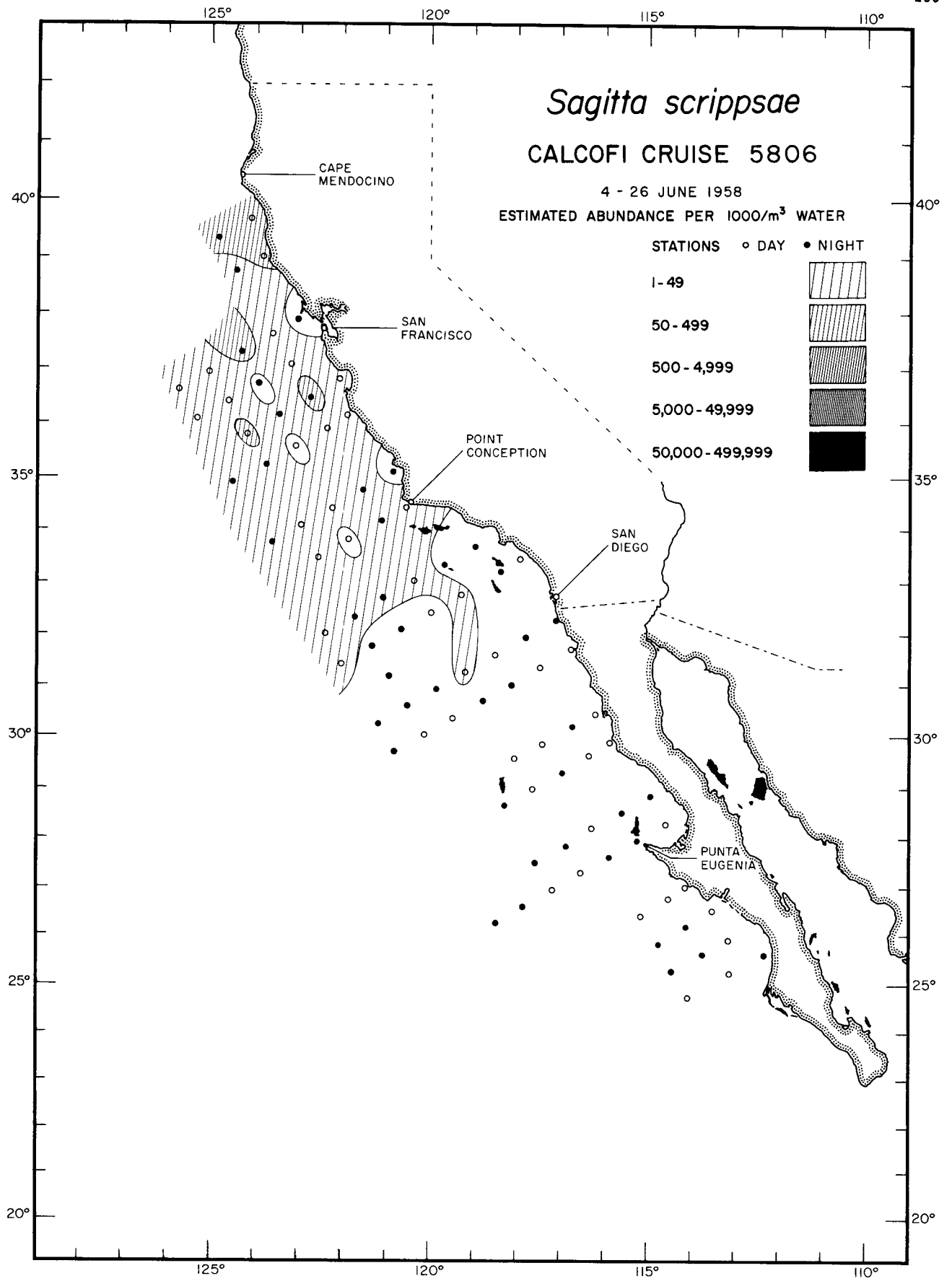
Chaetognatha
Sagitta neglecta
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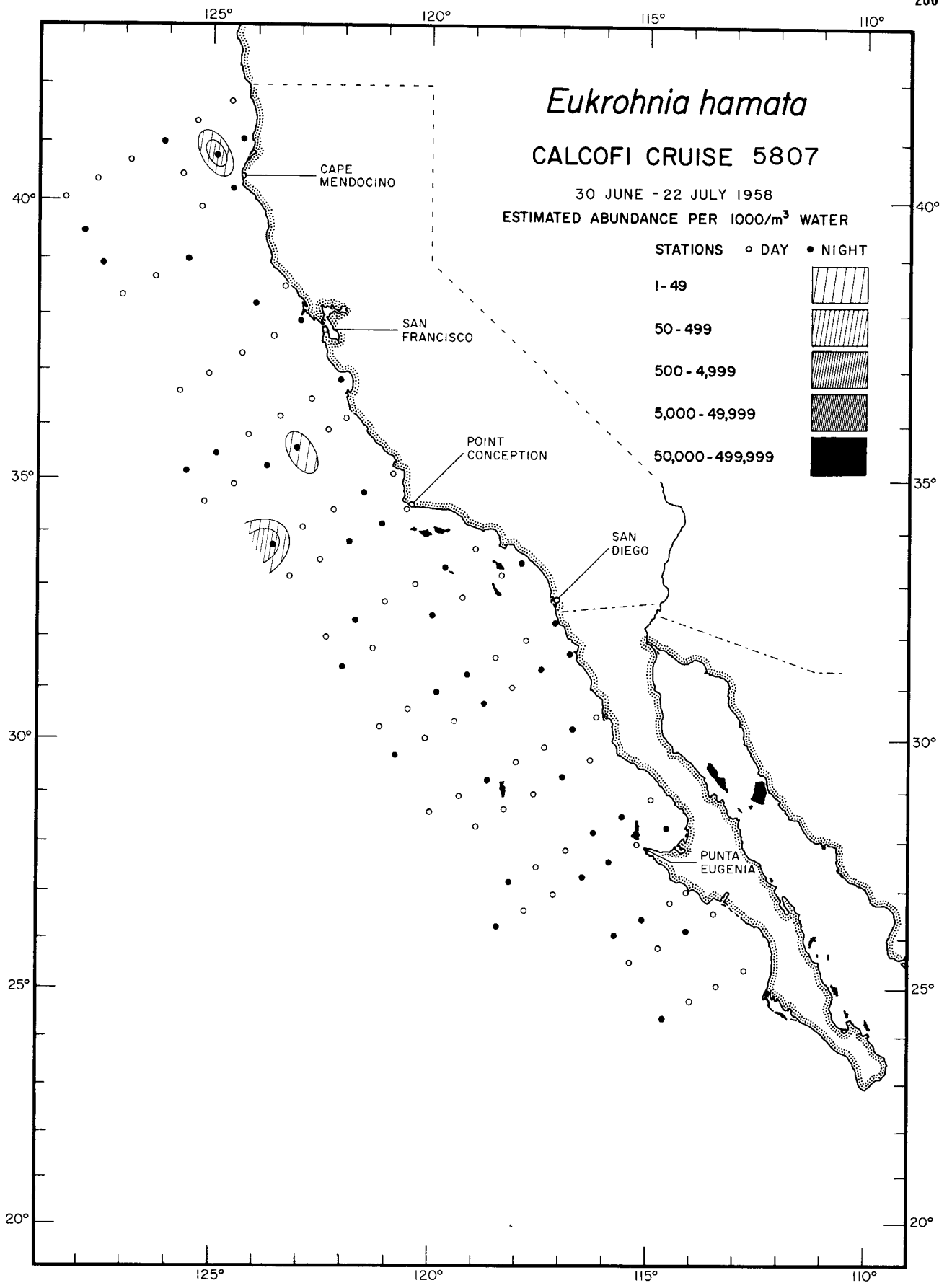
Chaetognatha
Sagitta pacifica
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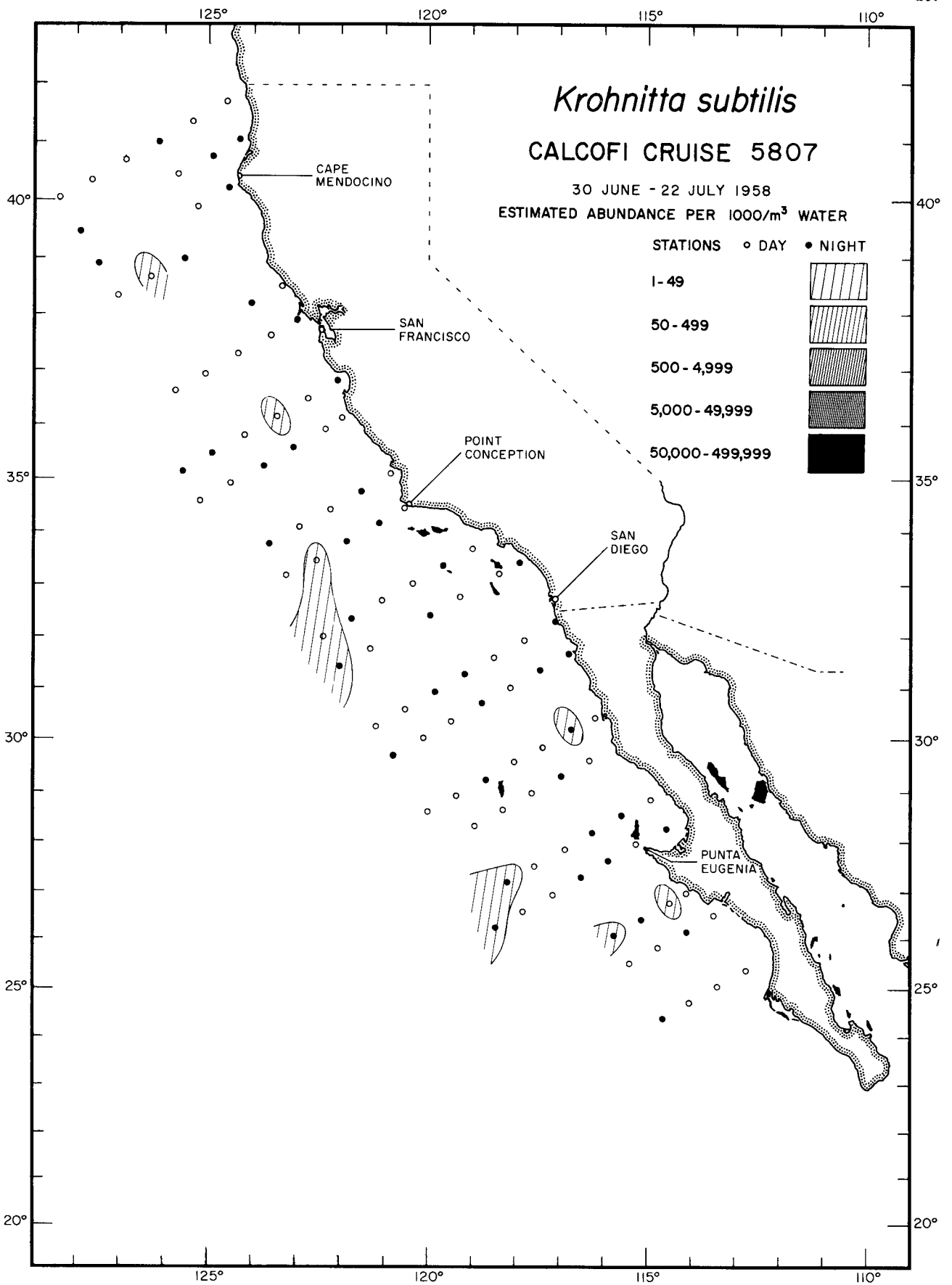
Chaetognatha
Sagitta pseudoserratodentata
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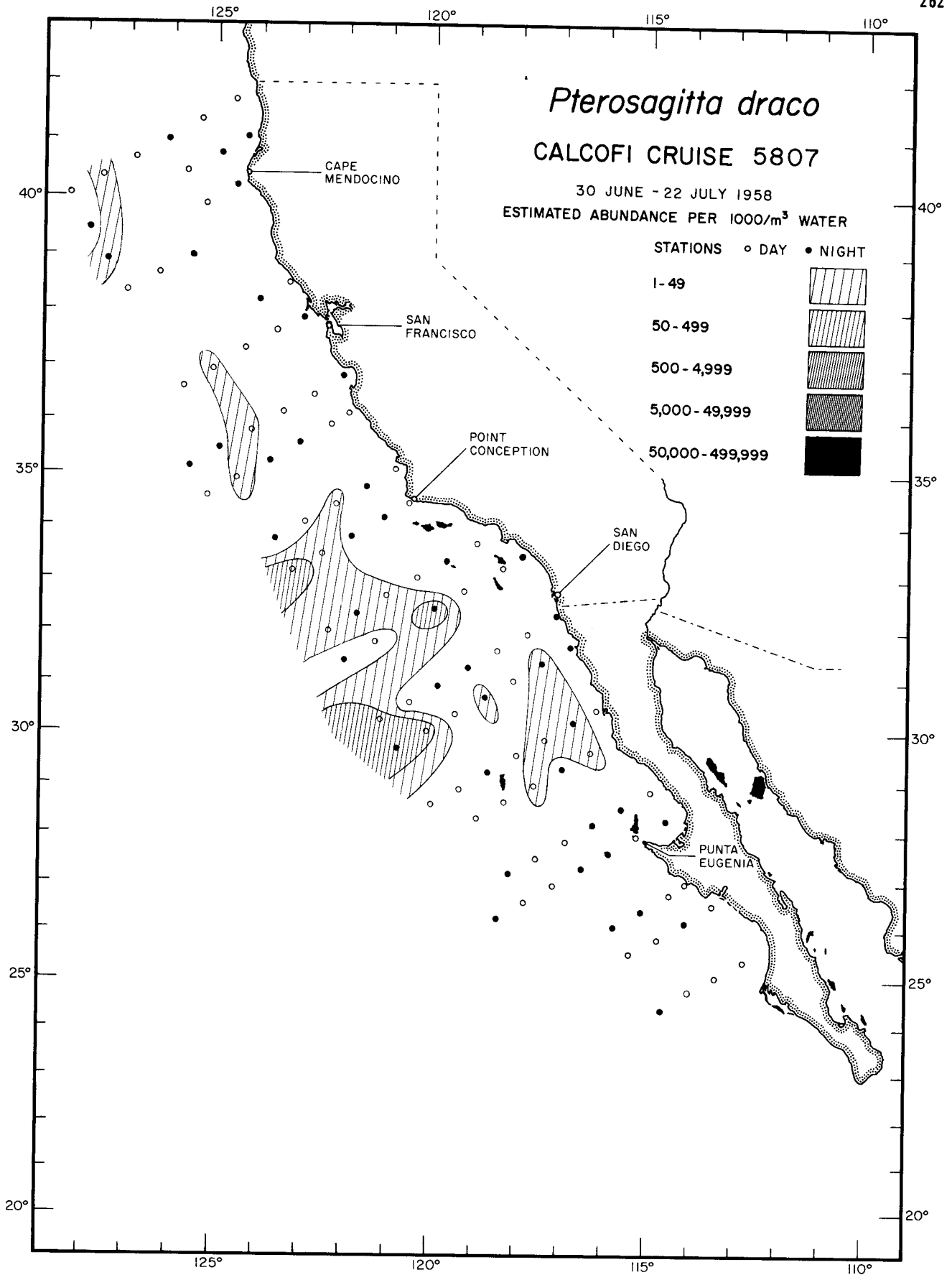
Chaetognatha
Sagitta scrippsae
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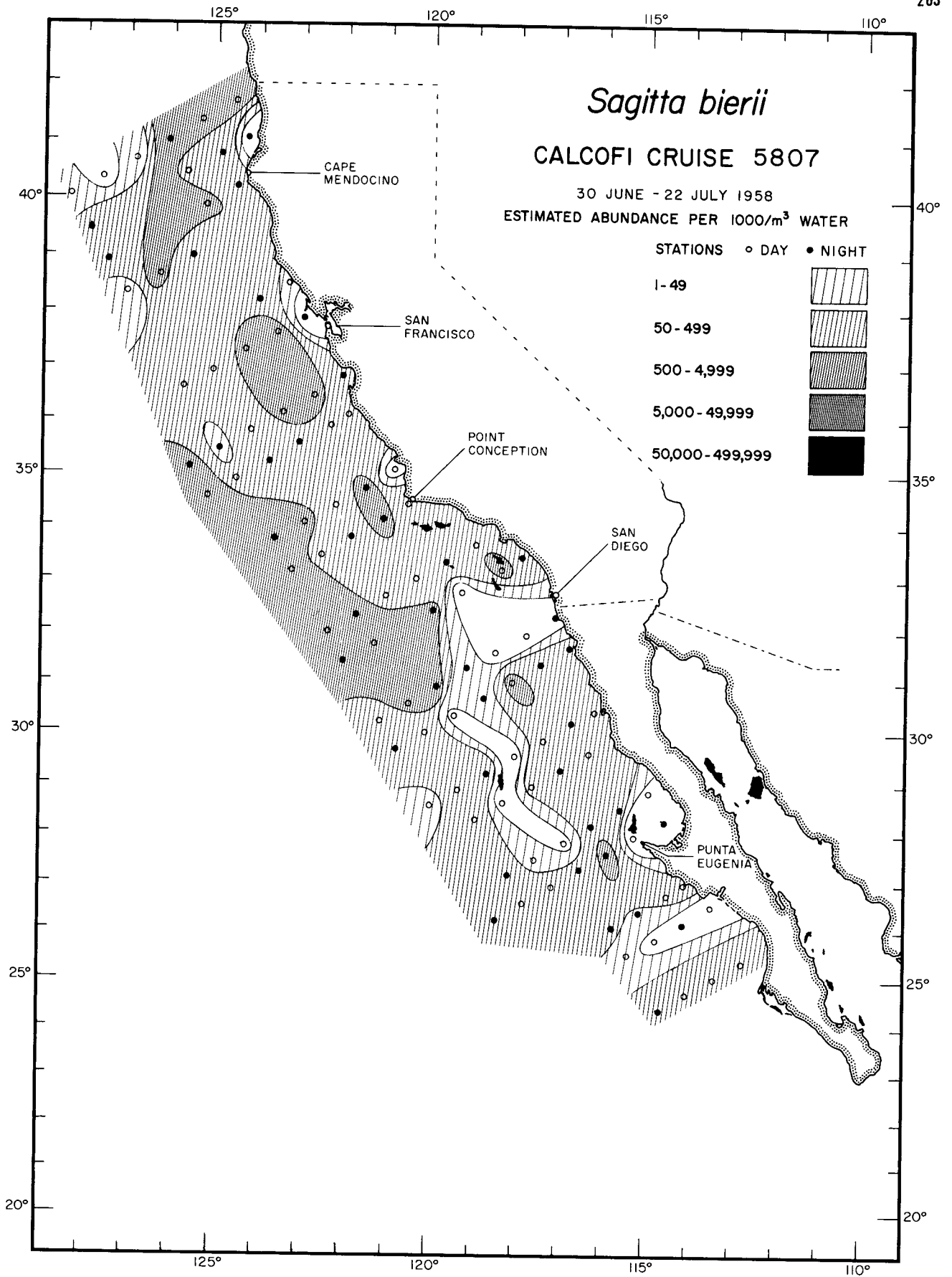
Chaetognatha
Eukrohnia hamata
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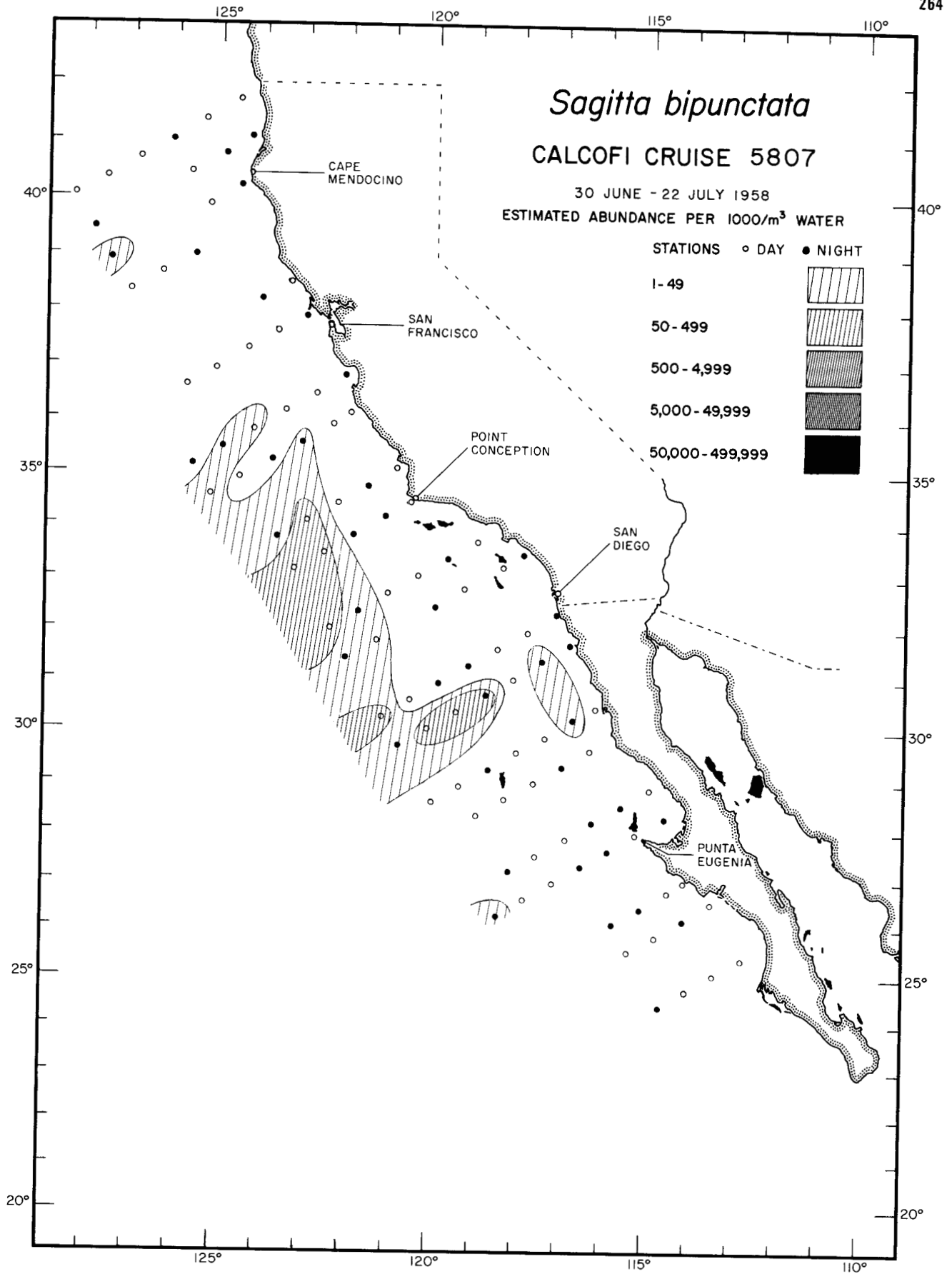
Chaetognatha
Krohnitta subtilis
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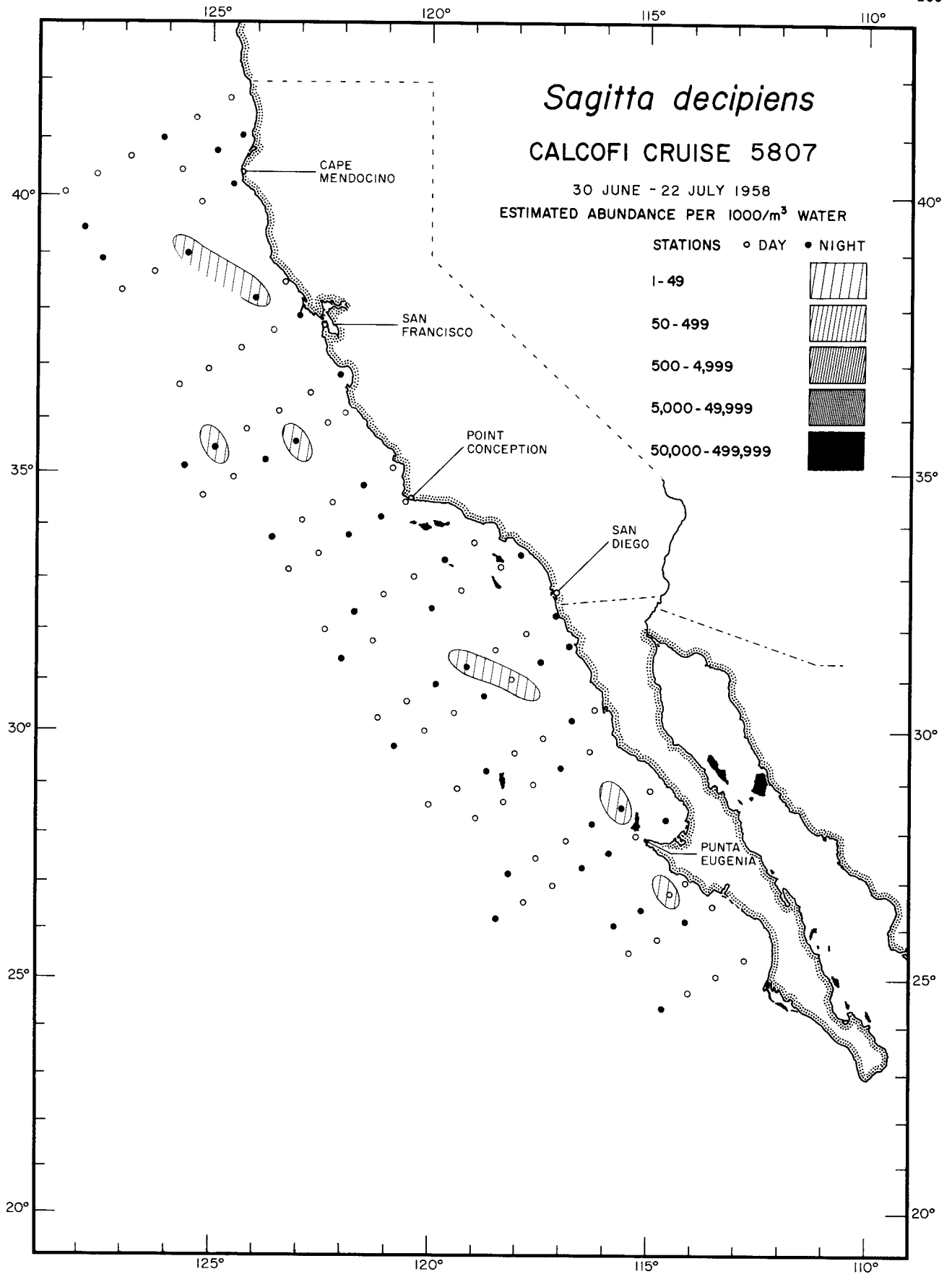
Chaetognatha
Pterosagitta draco
 5807



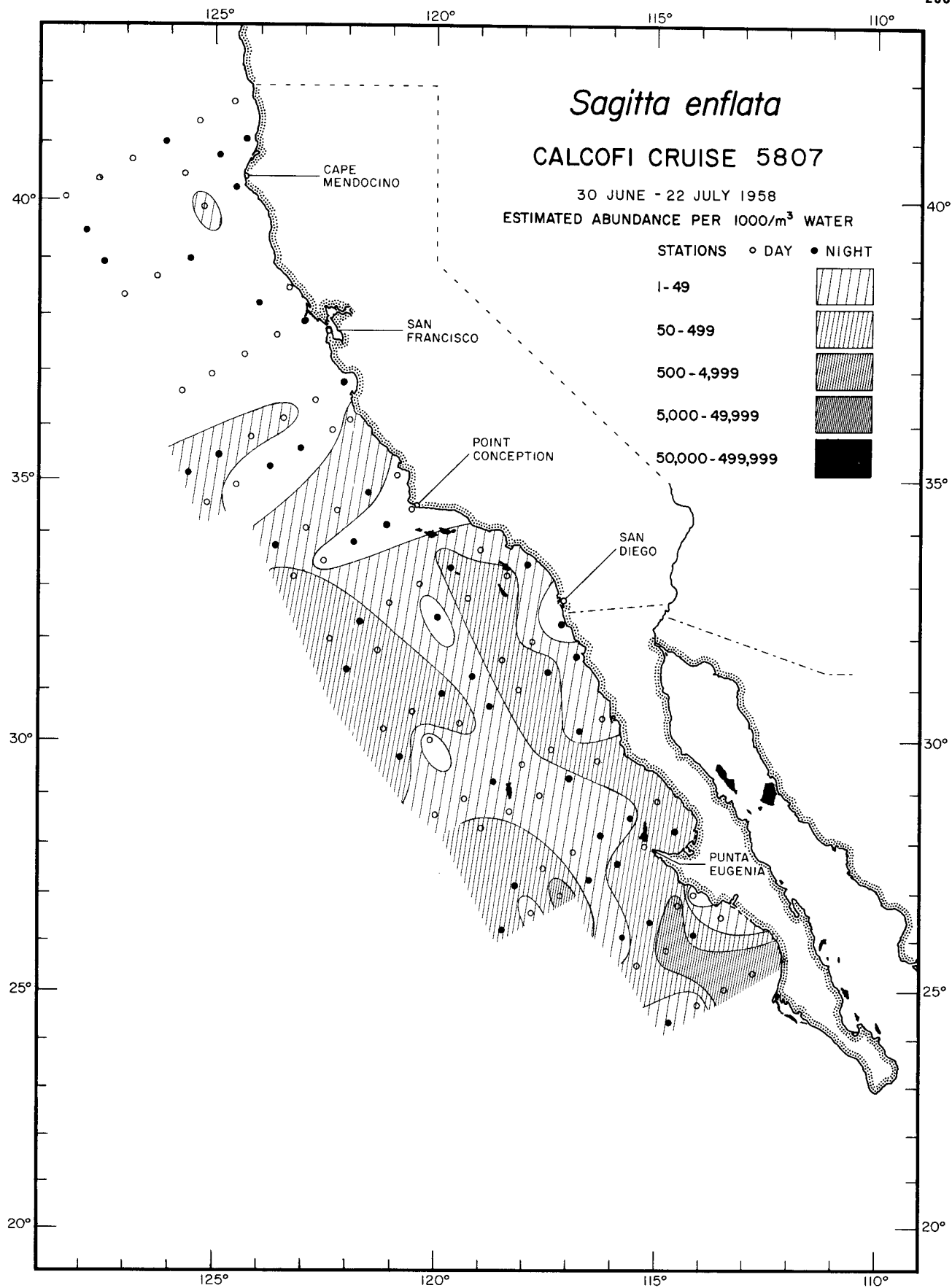
Chaetognatha
Sagitta bierii
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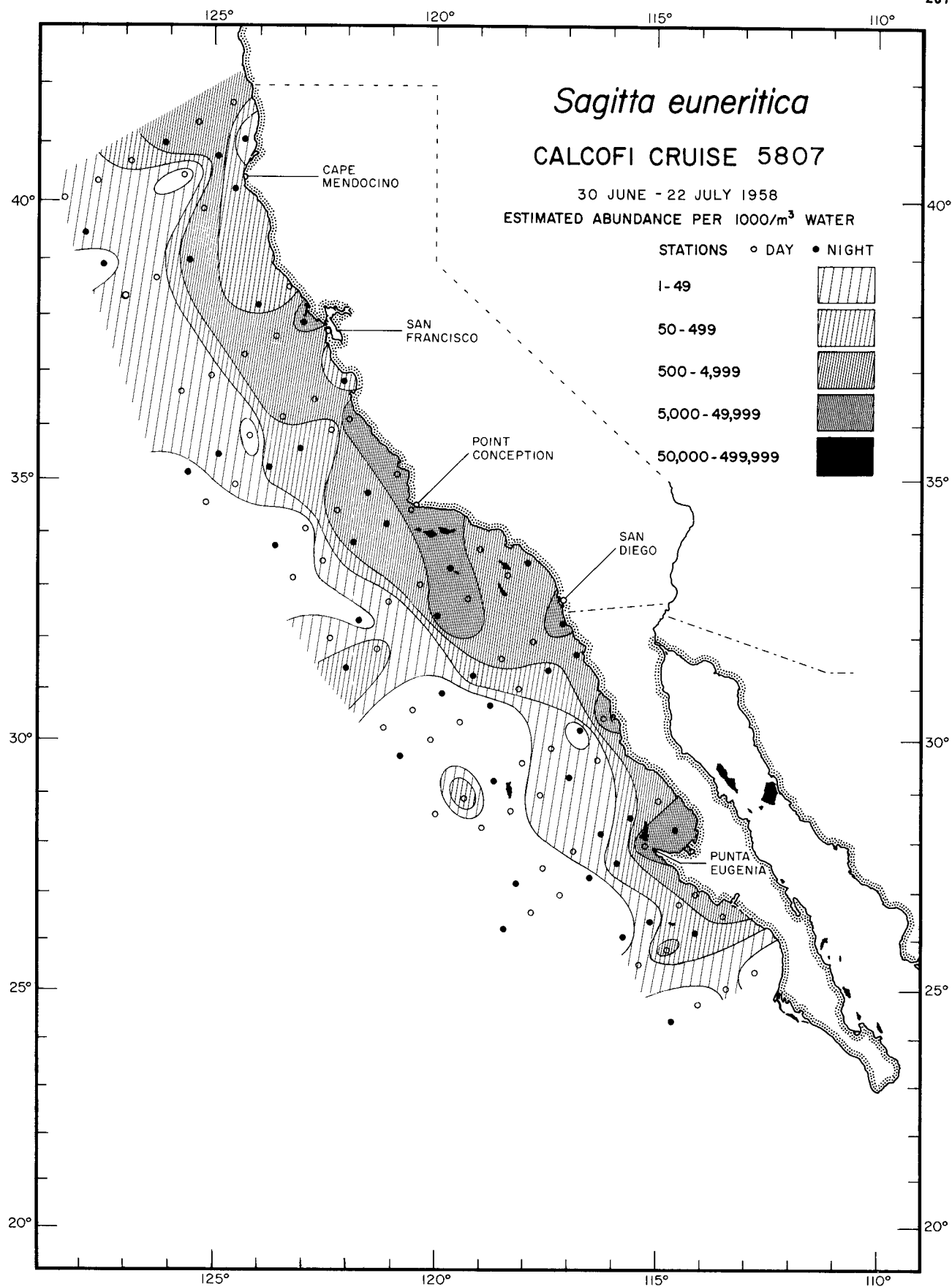
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Sagitta bipunctata
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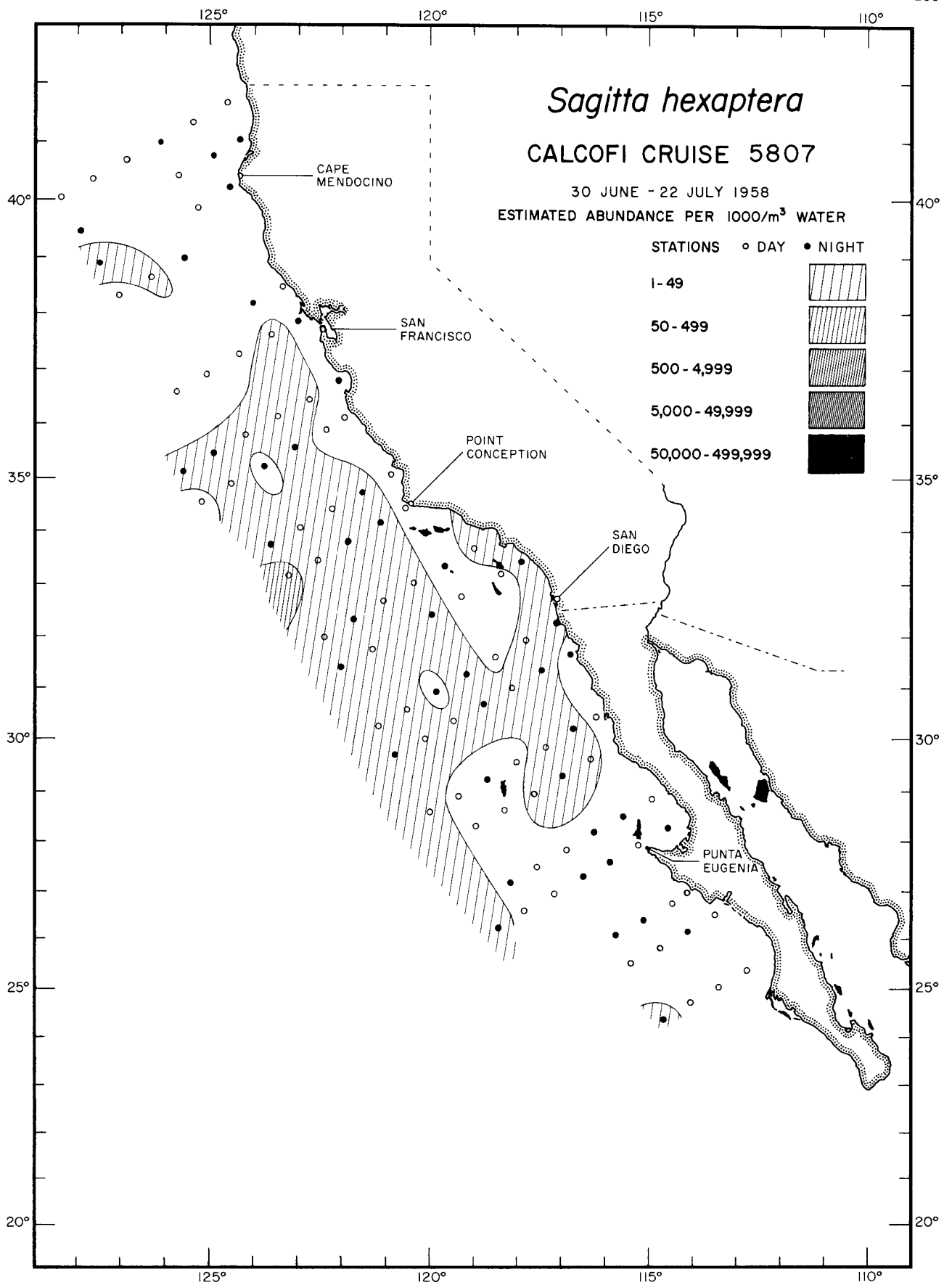
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Sagitta decipiens
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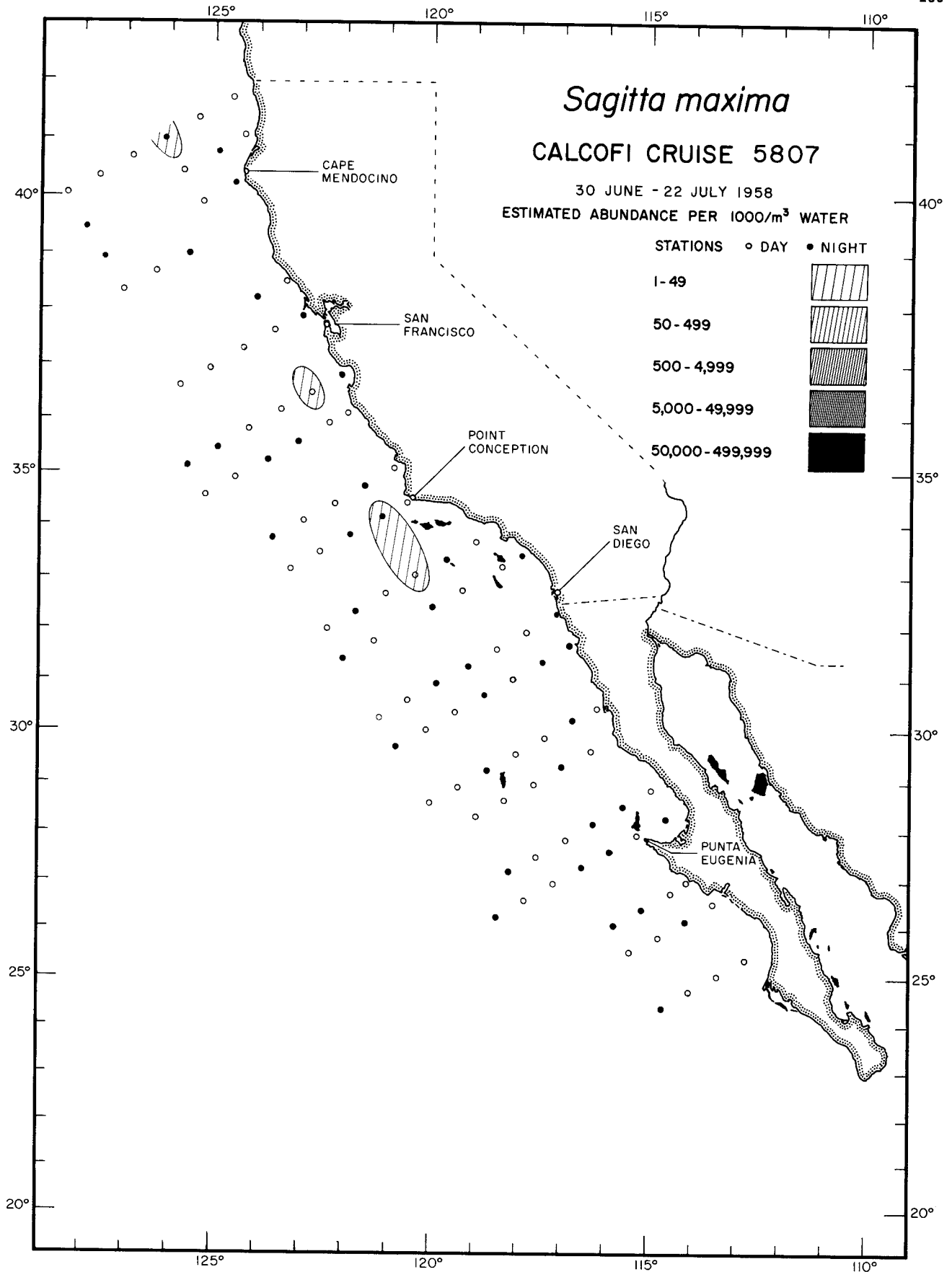
Chaetognatha
Sagitta enflata
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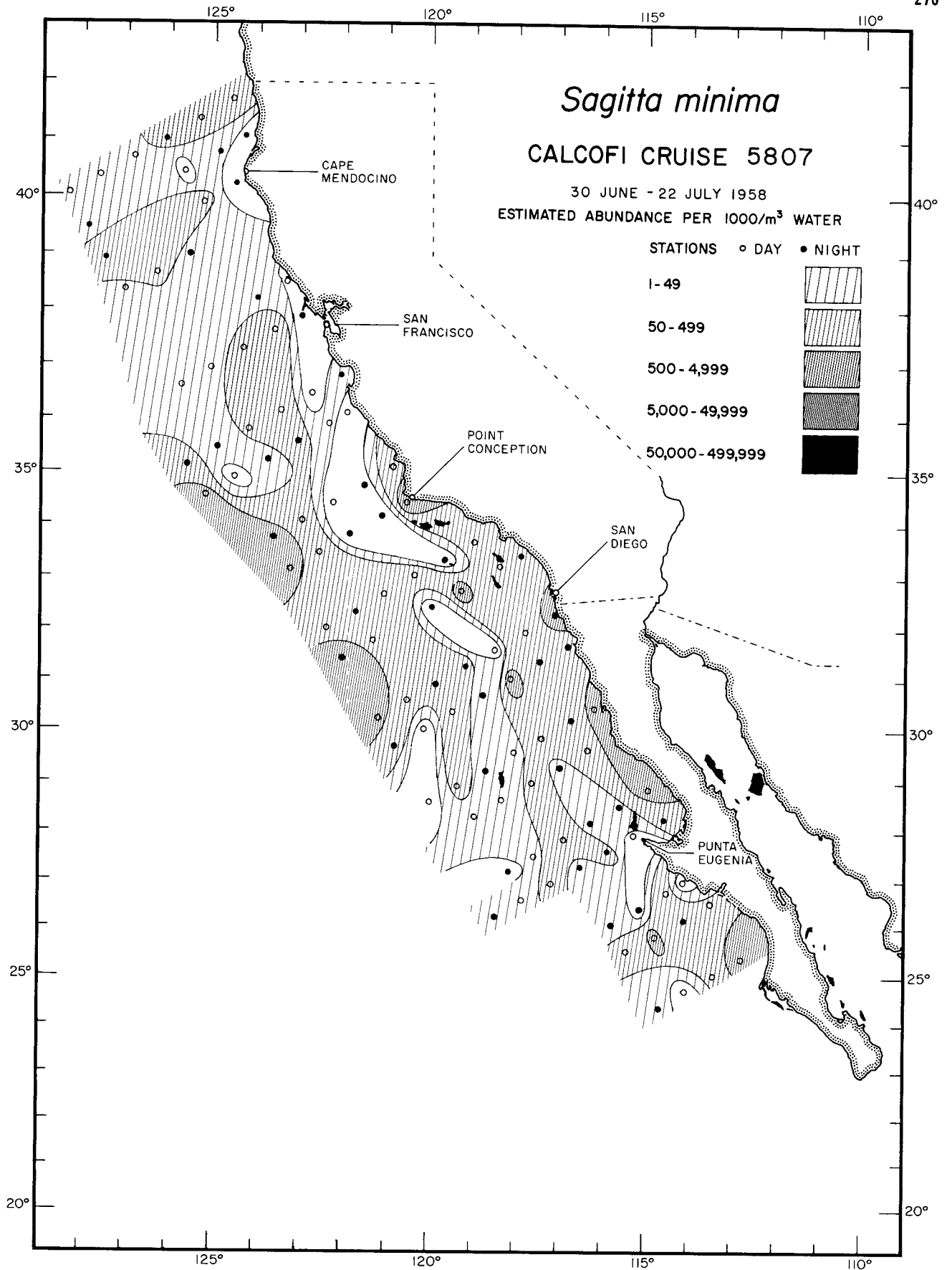
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Sagitta euneritica
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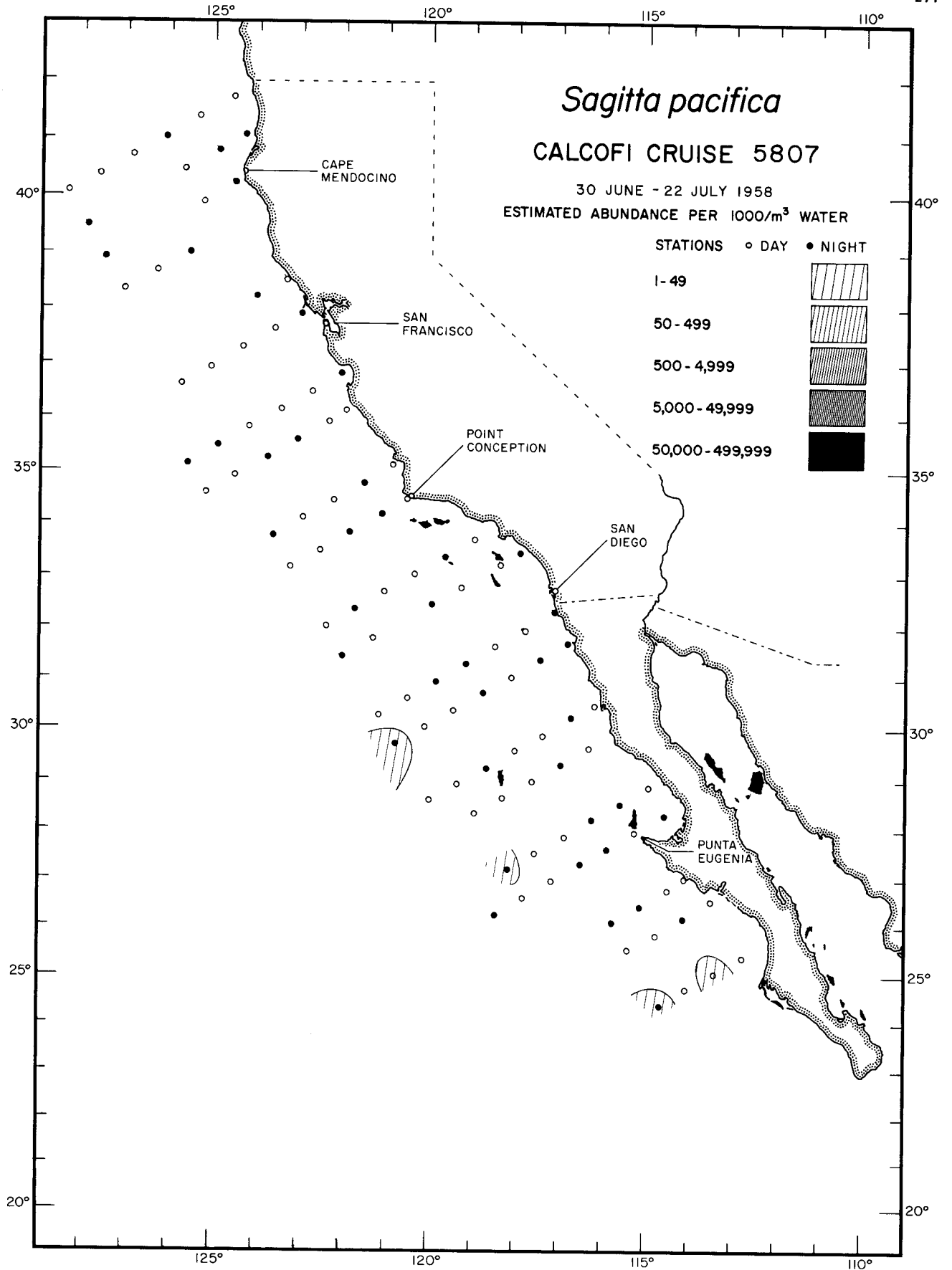
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Sagitta hexaptera
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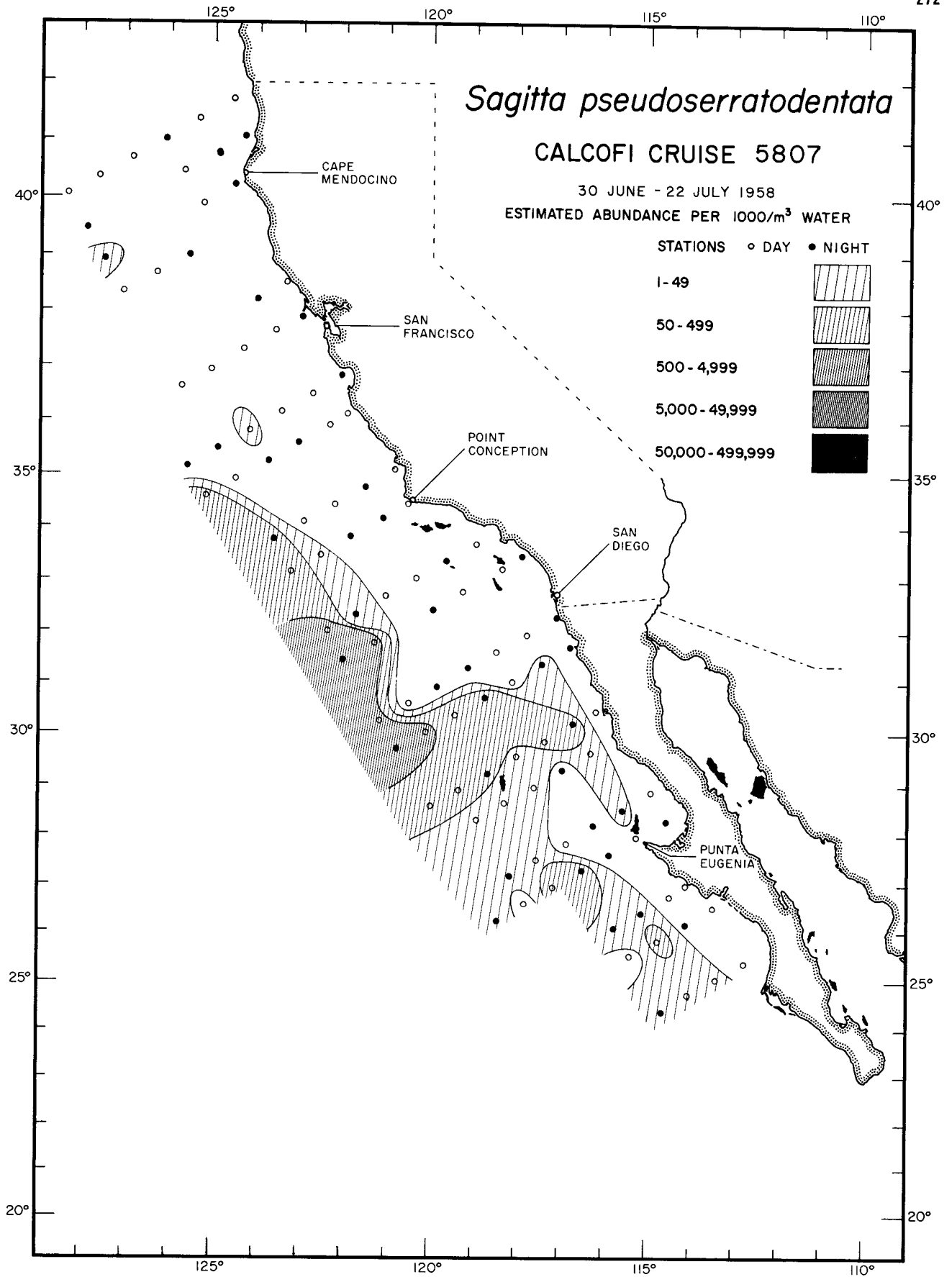
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Sagitta maxima
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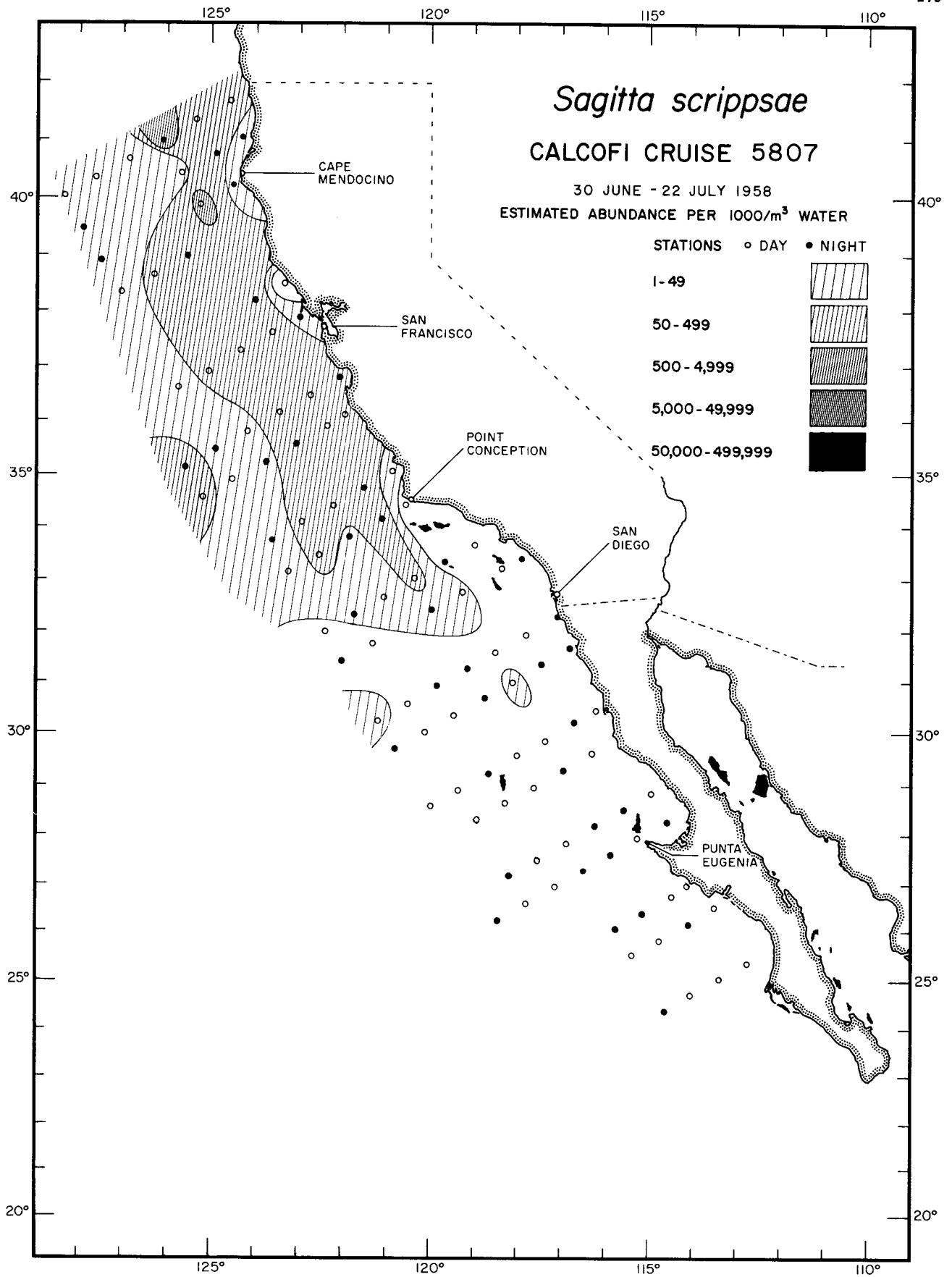
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Sagitta minima
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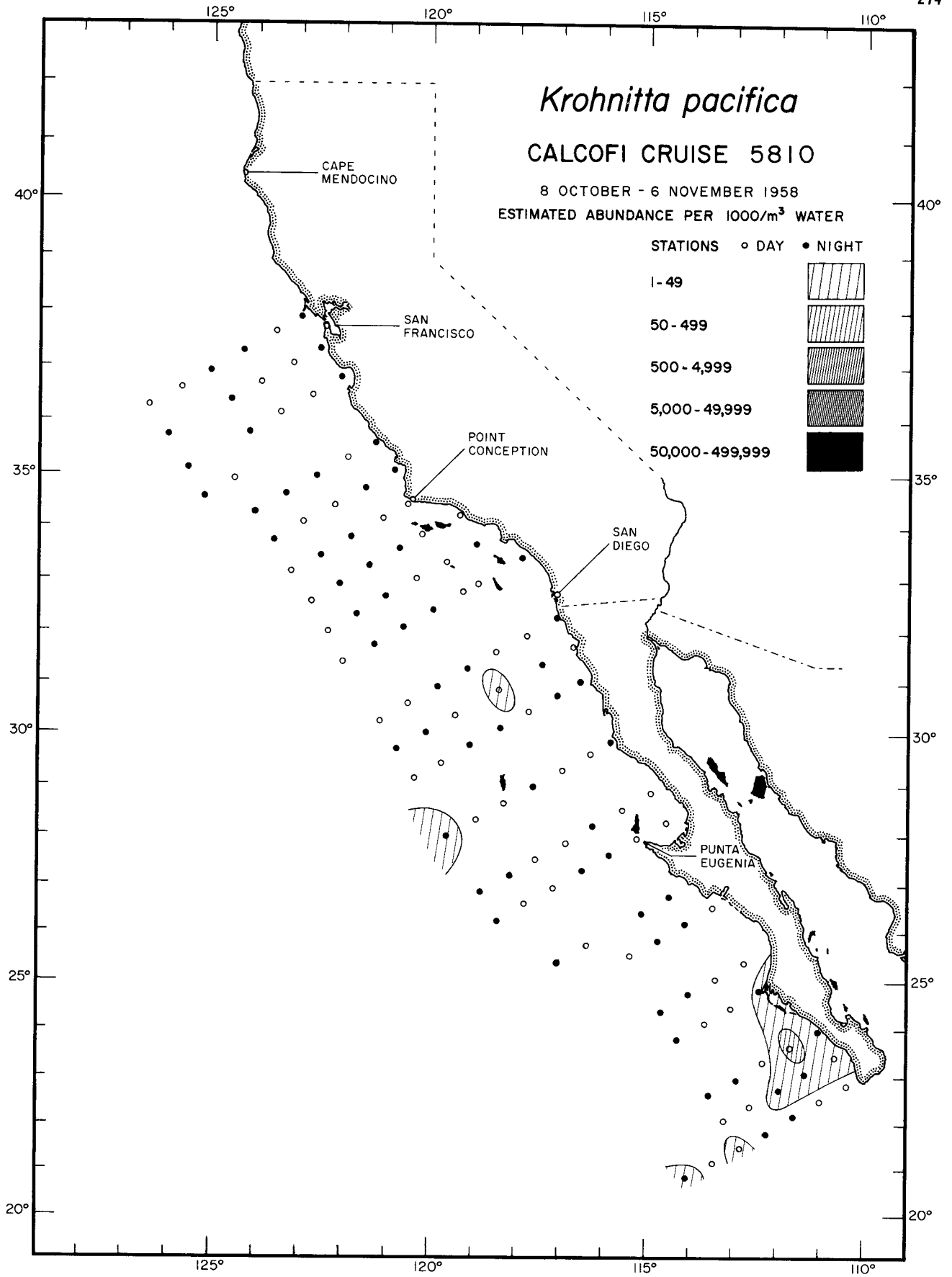
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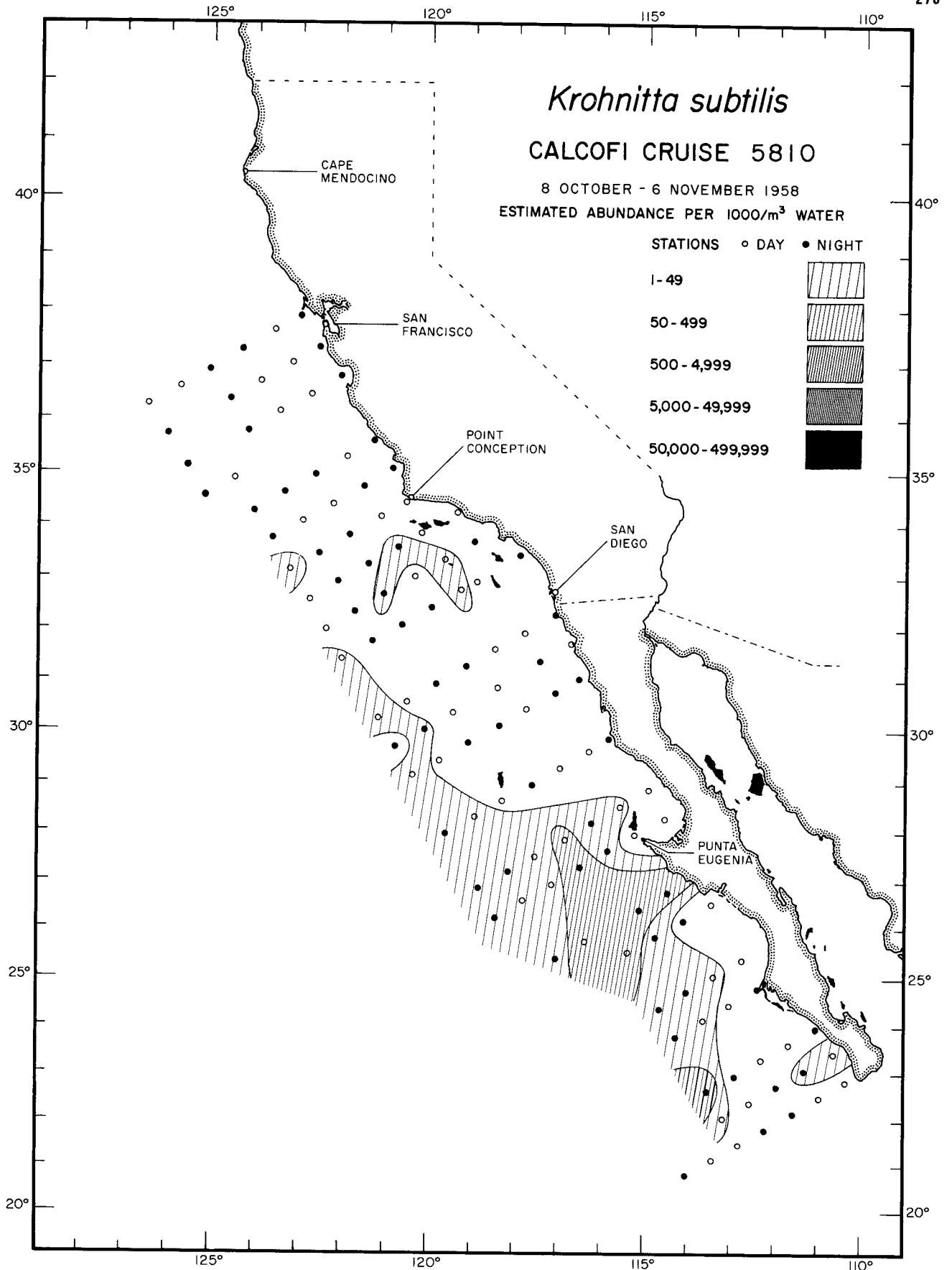
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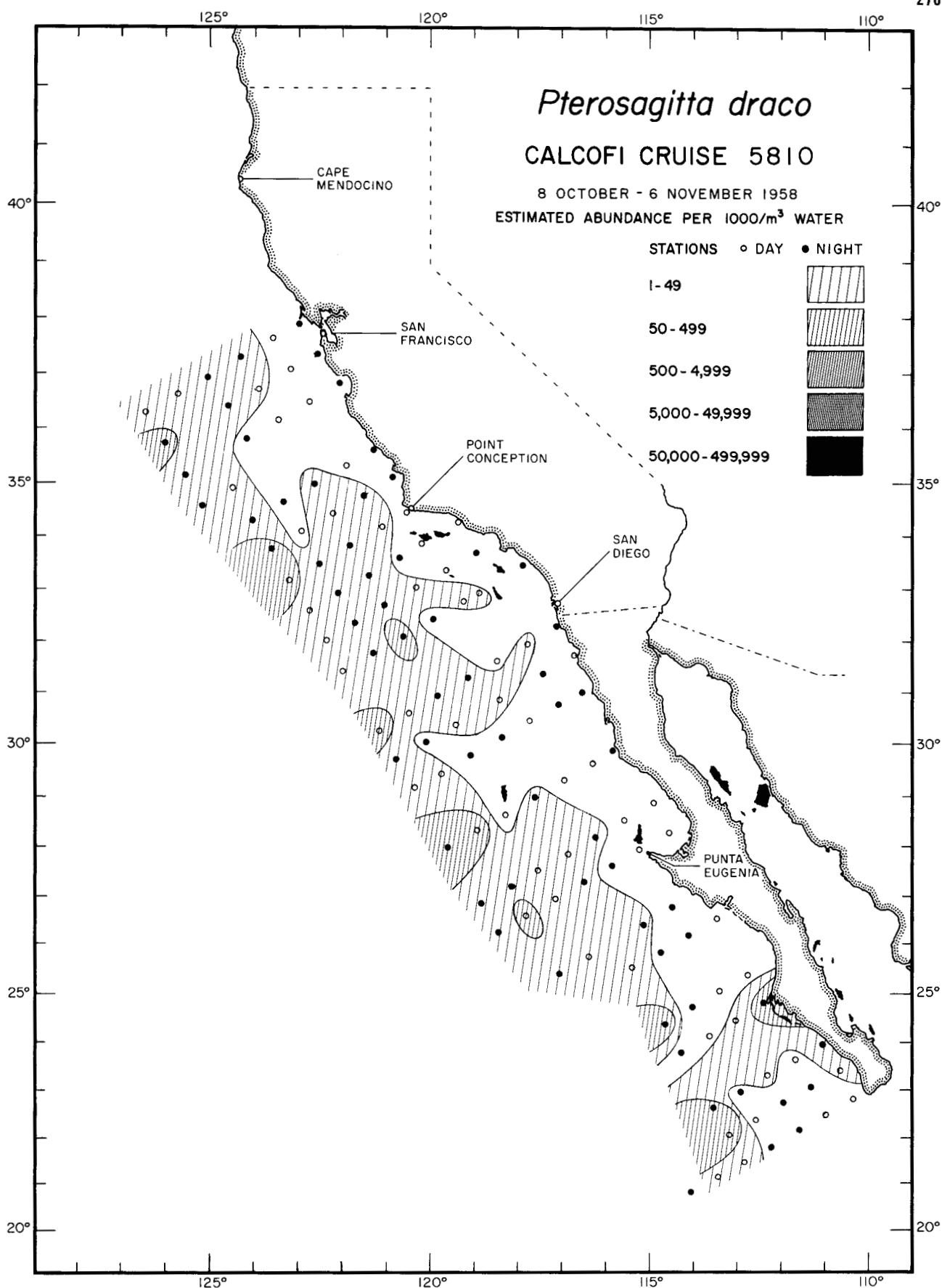
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Sagitta scrippsae
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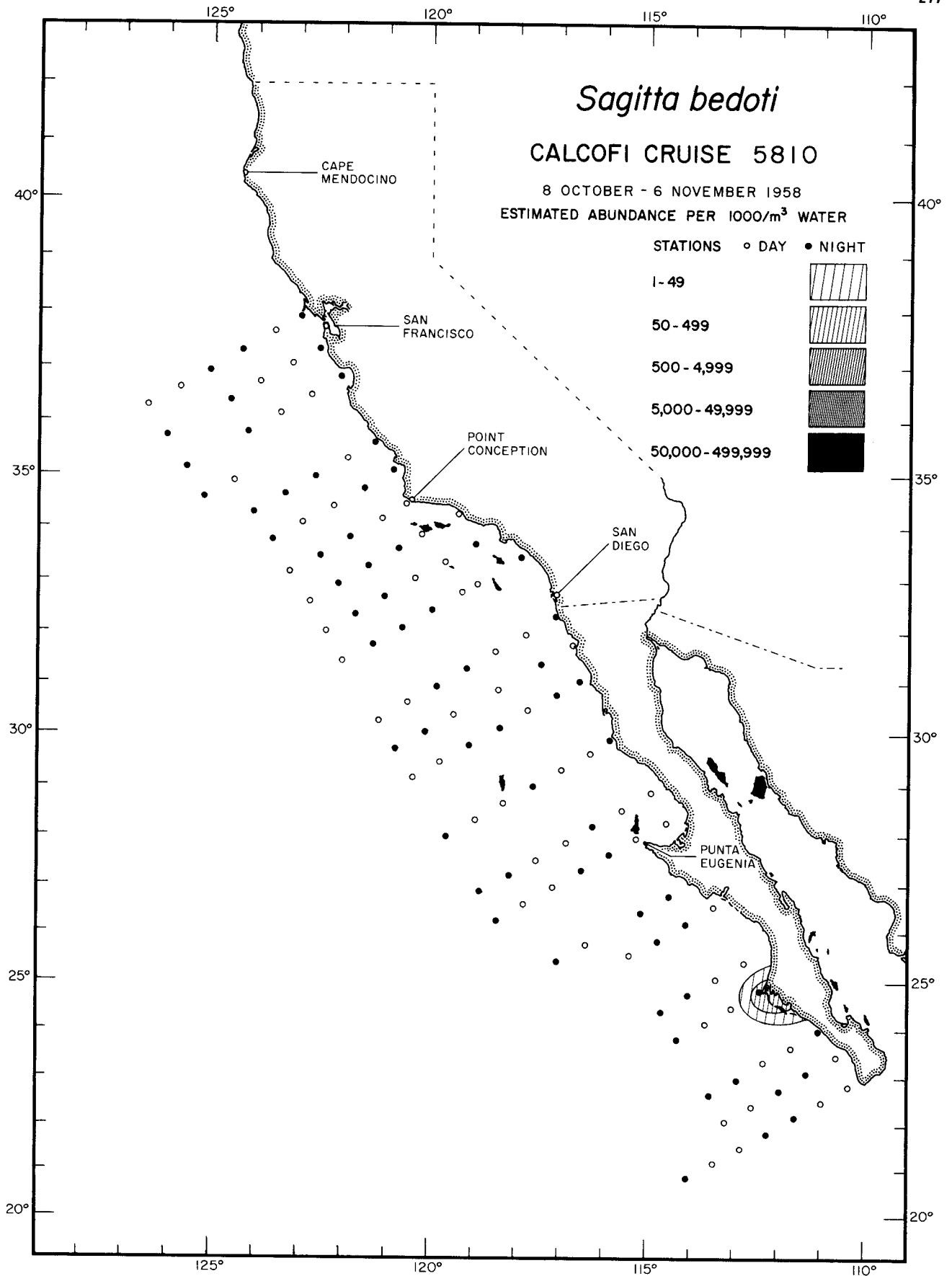
Chaetognatha
Krohnitta pacifica
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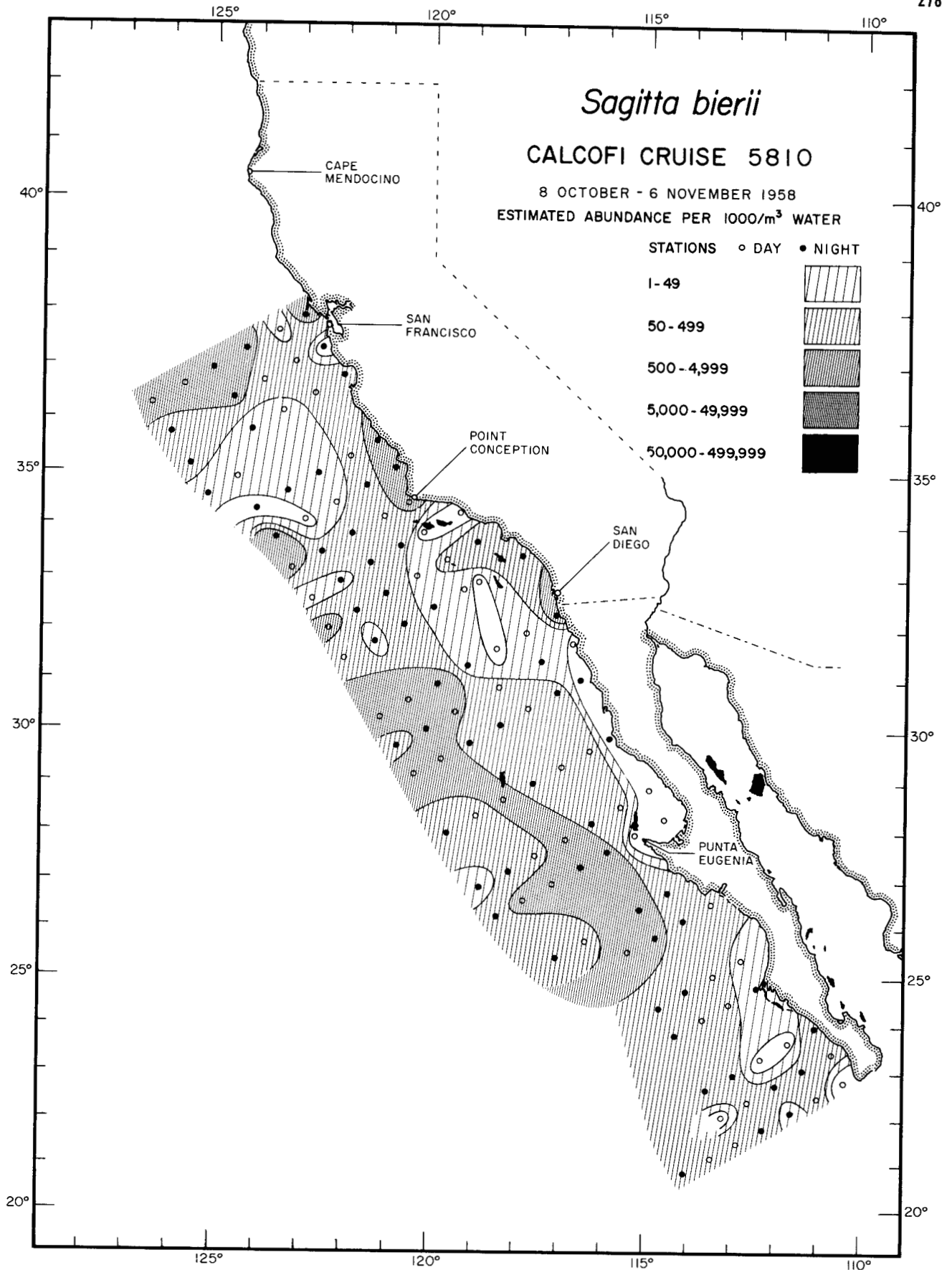
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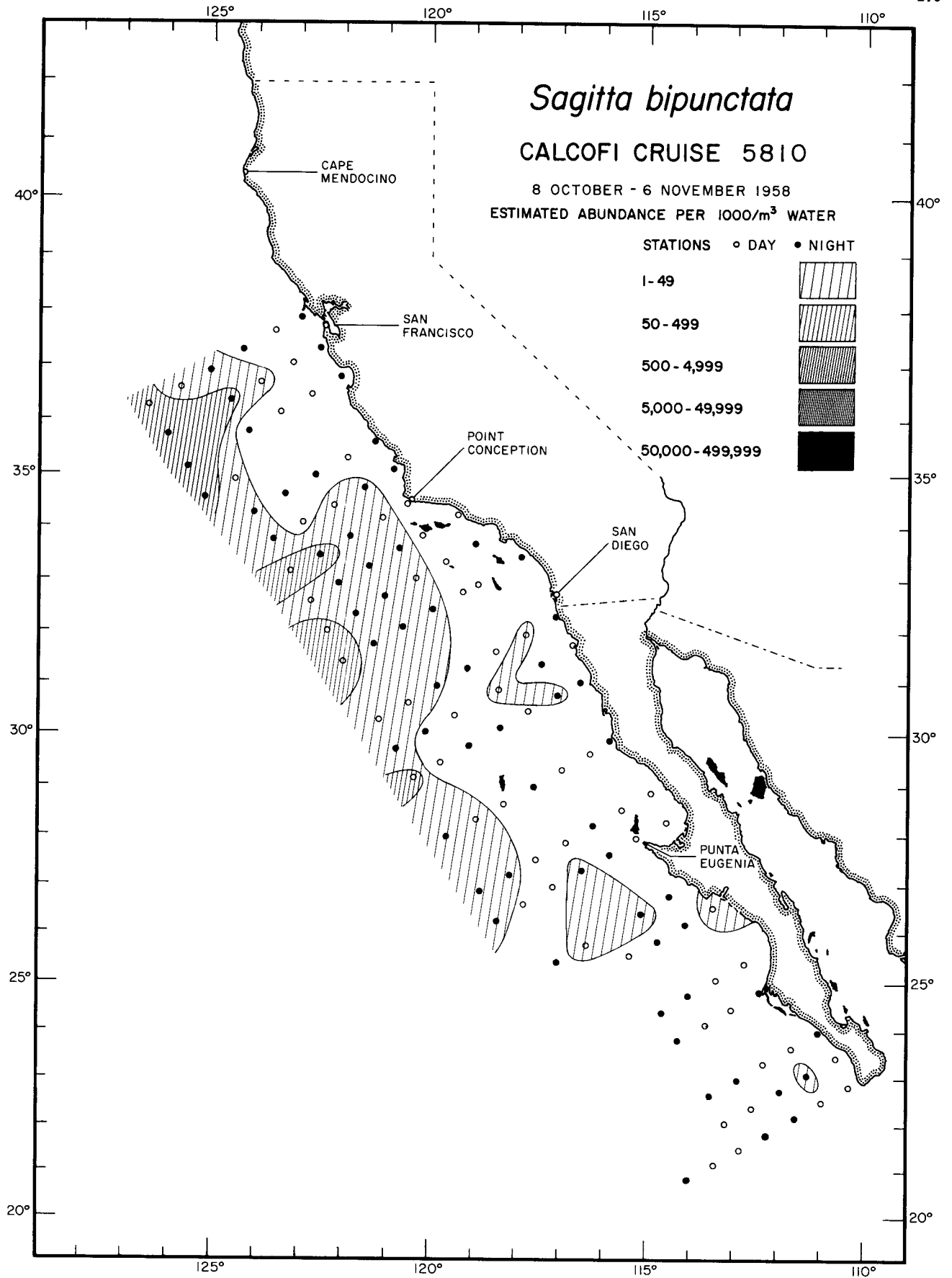
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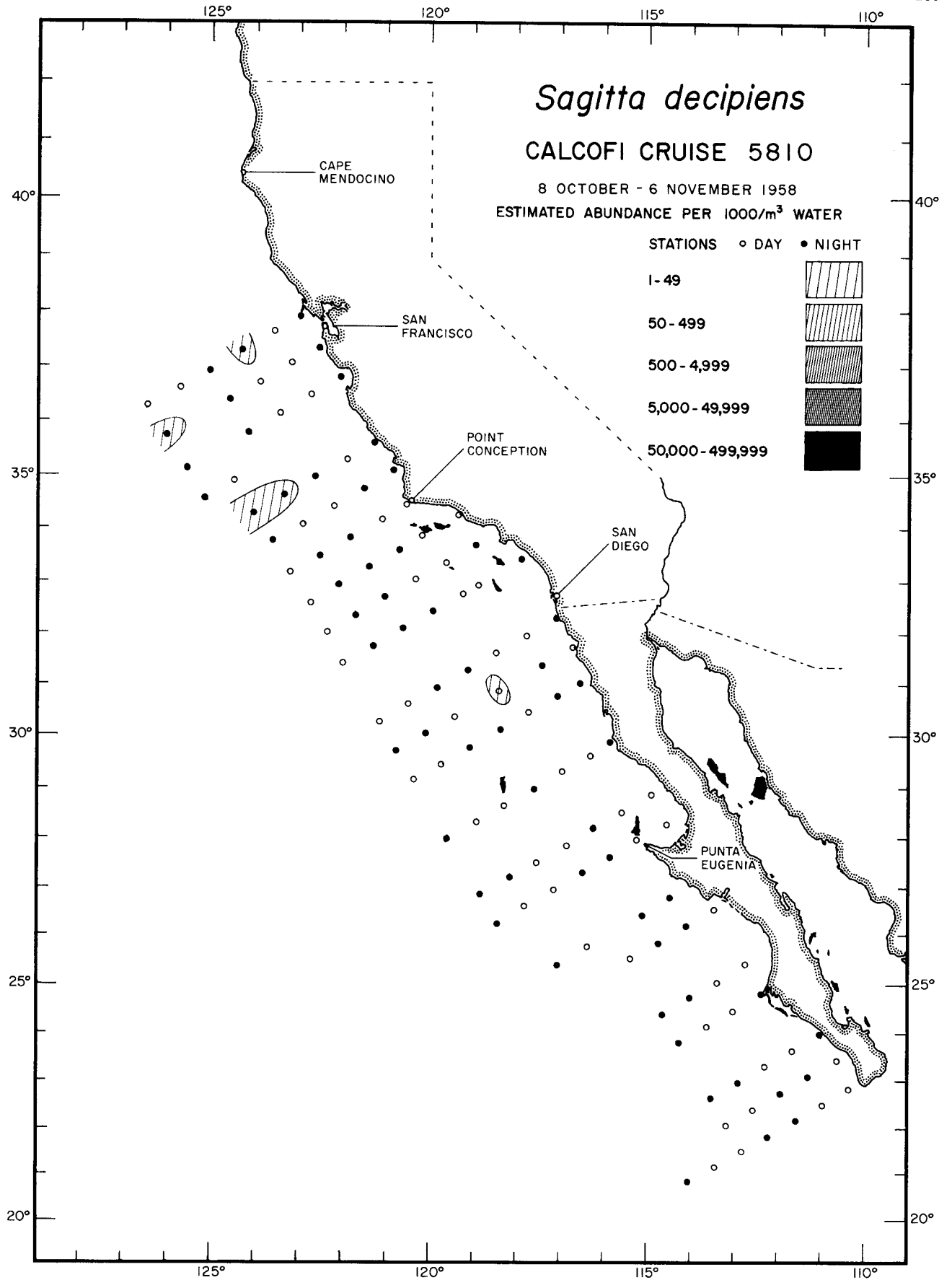
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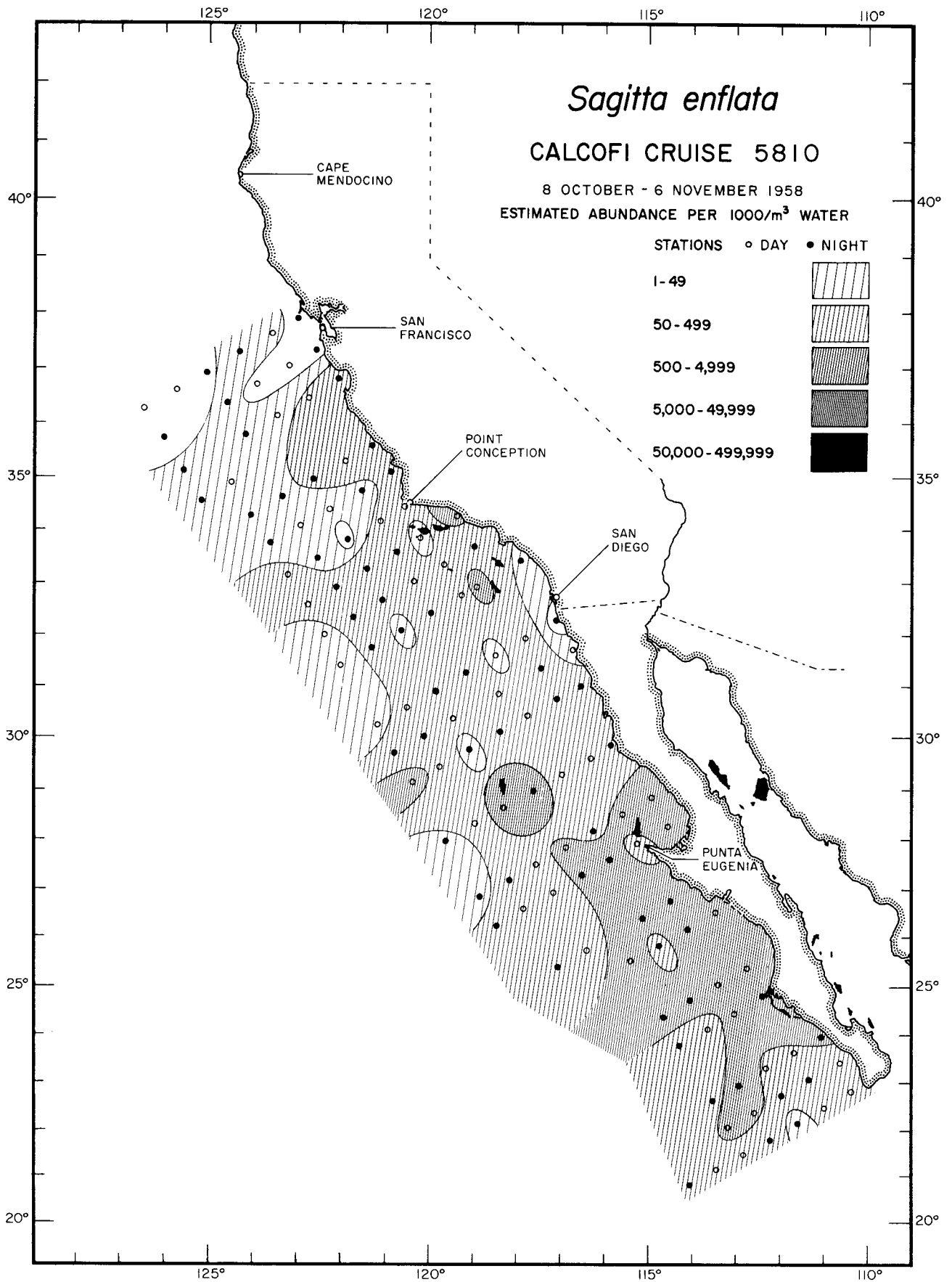
Chaetognatha
Sagitta bierii
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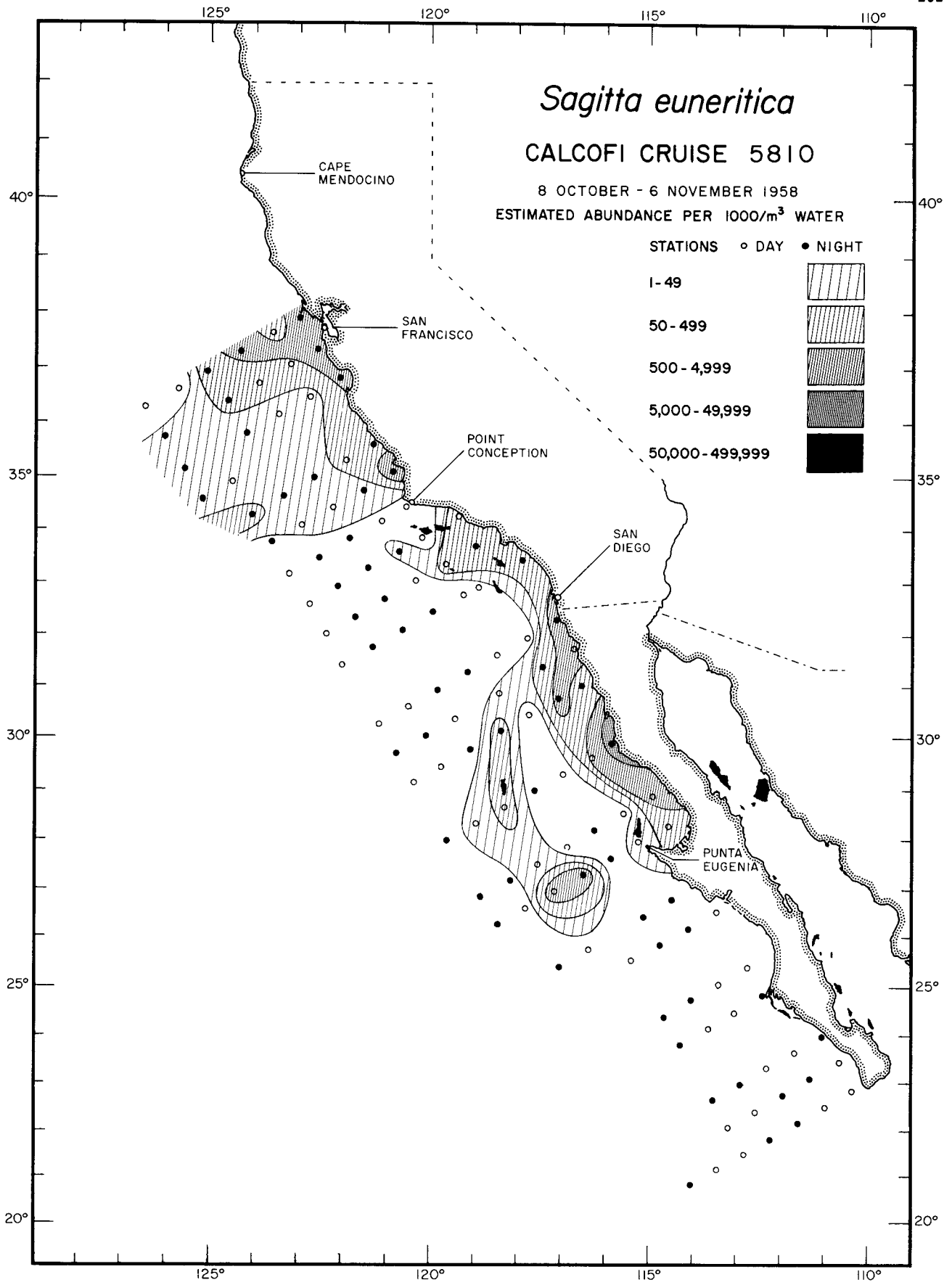
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Sagitta bipunctata
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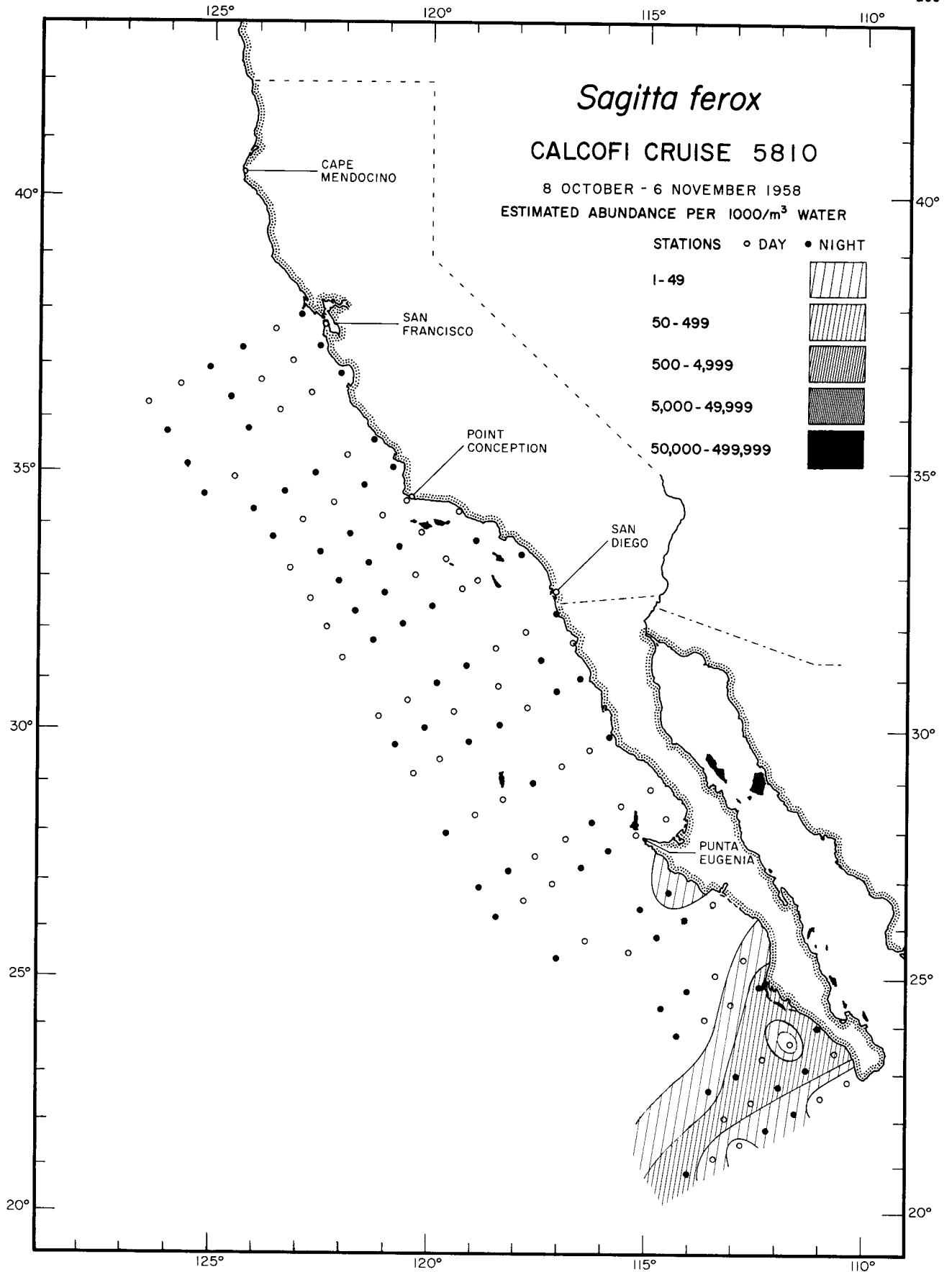
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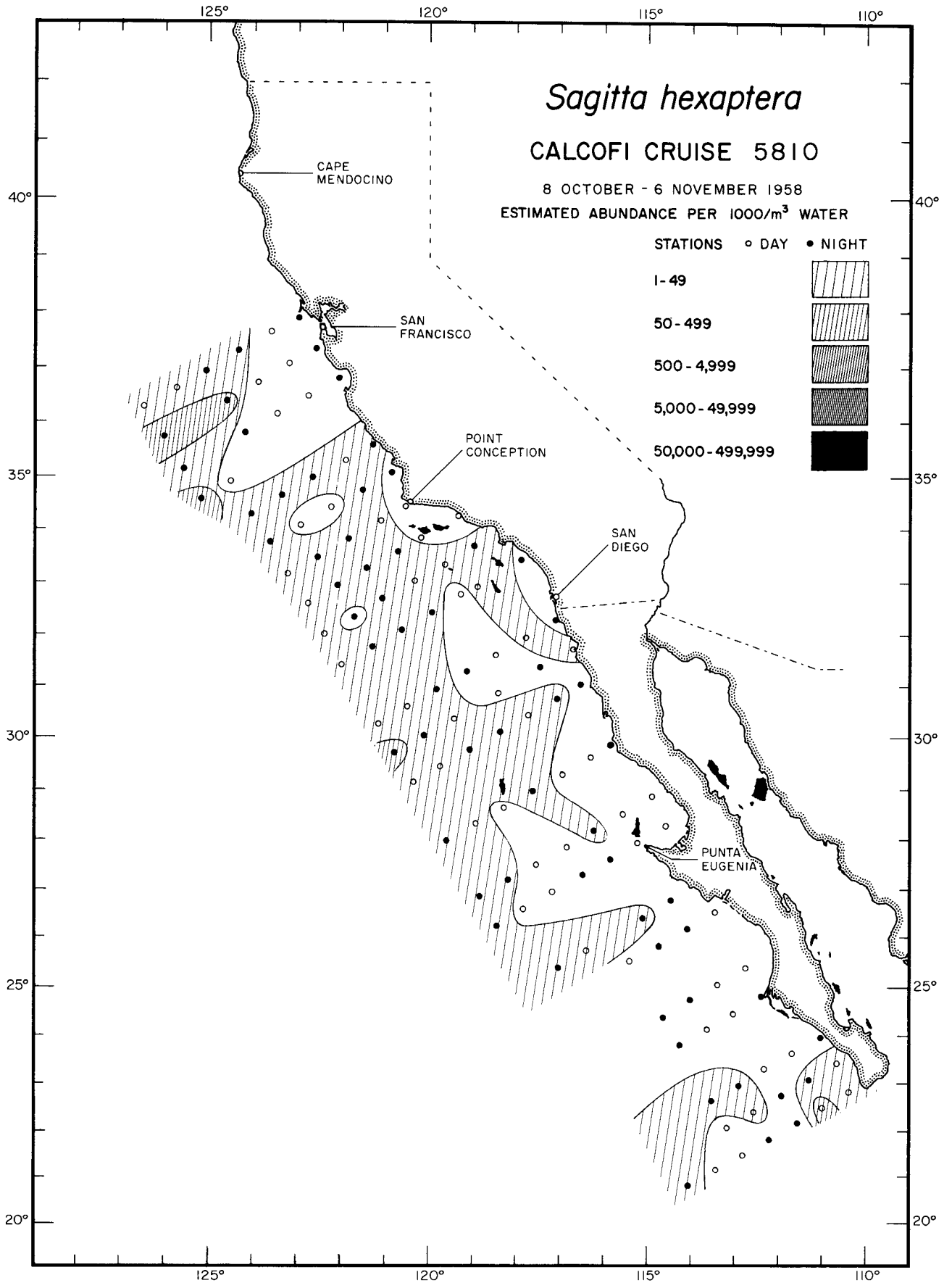
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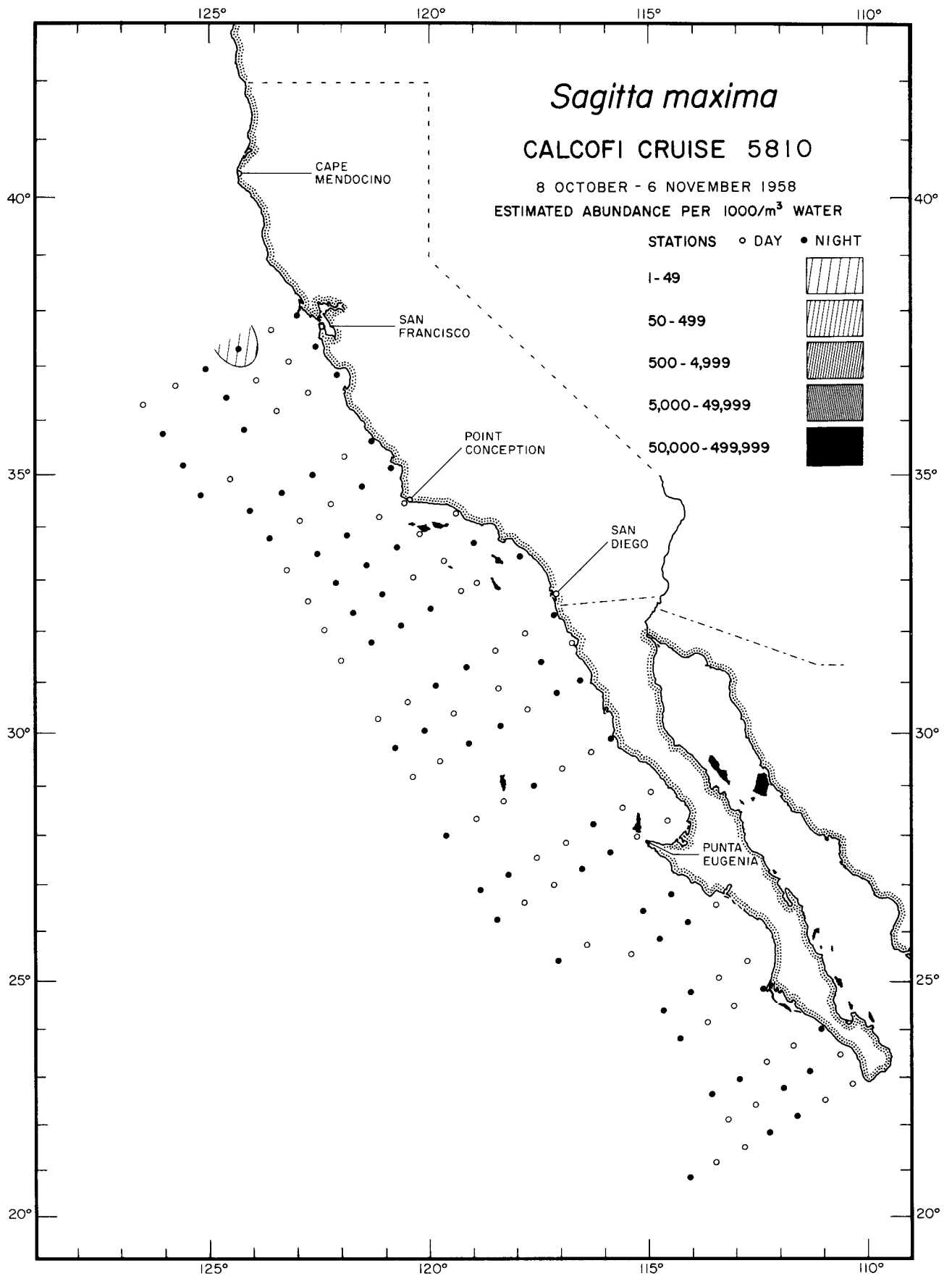
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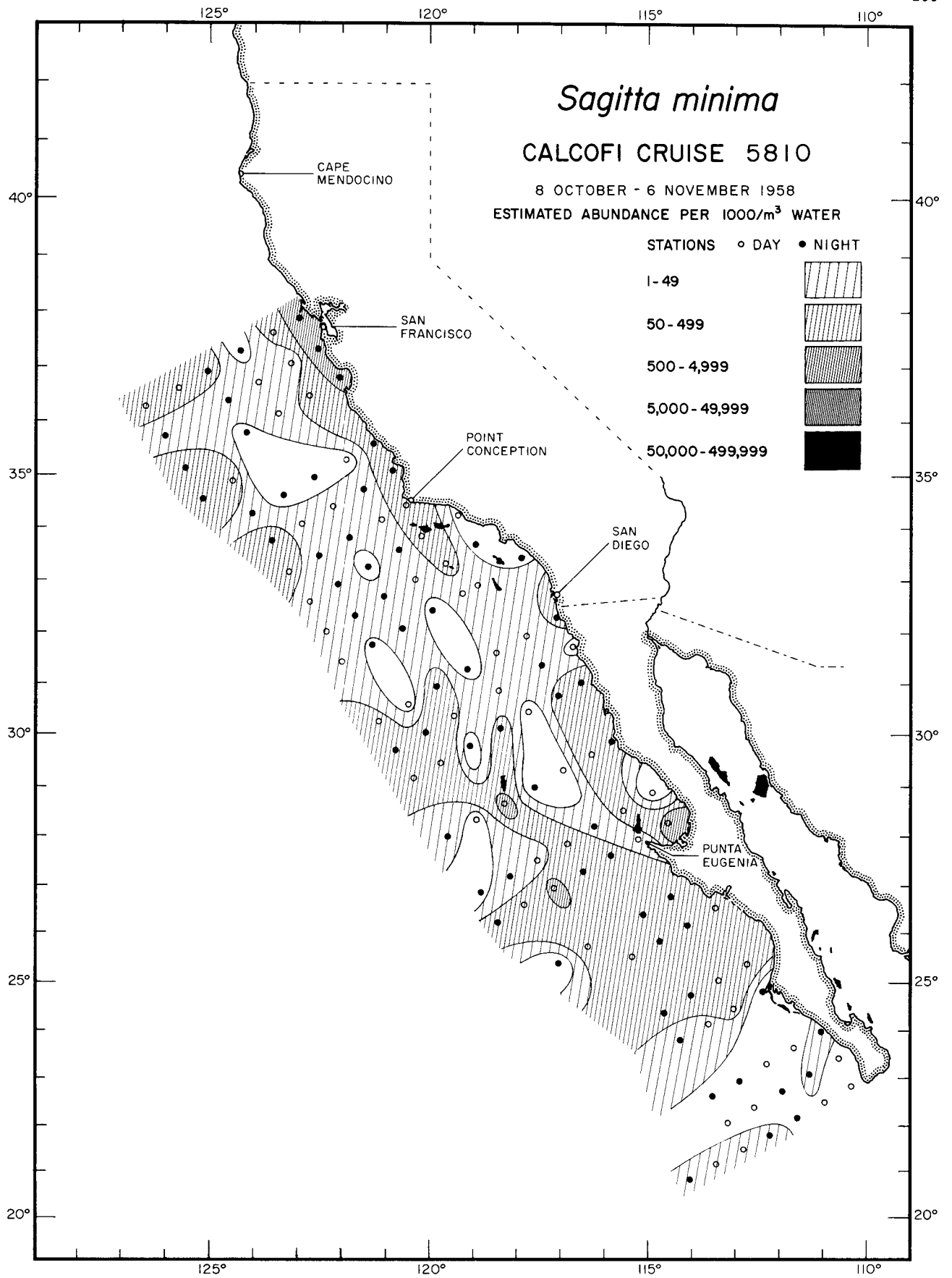
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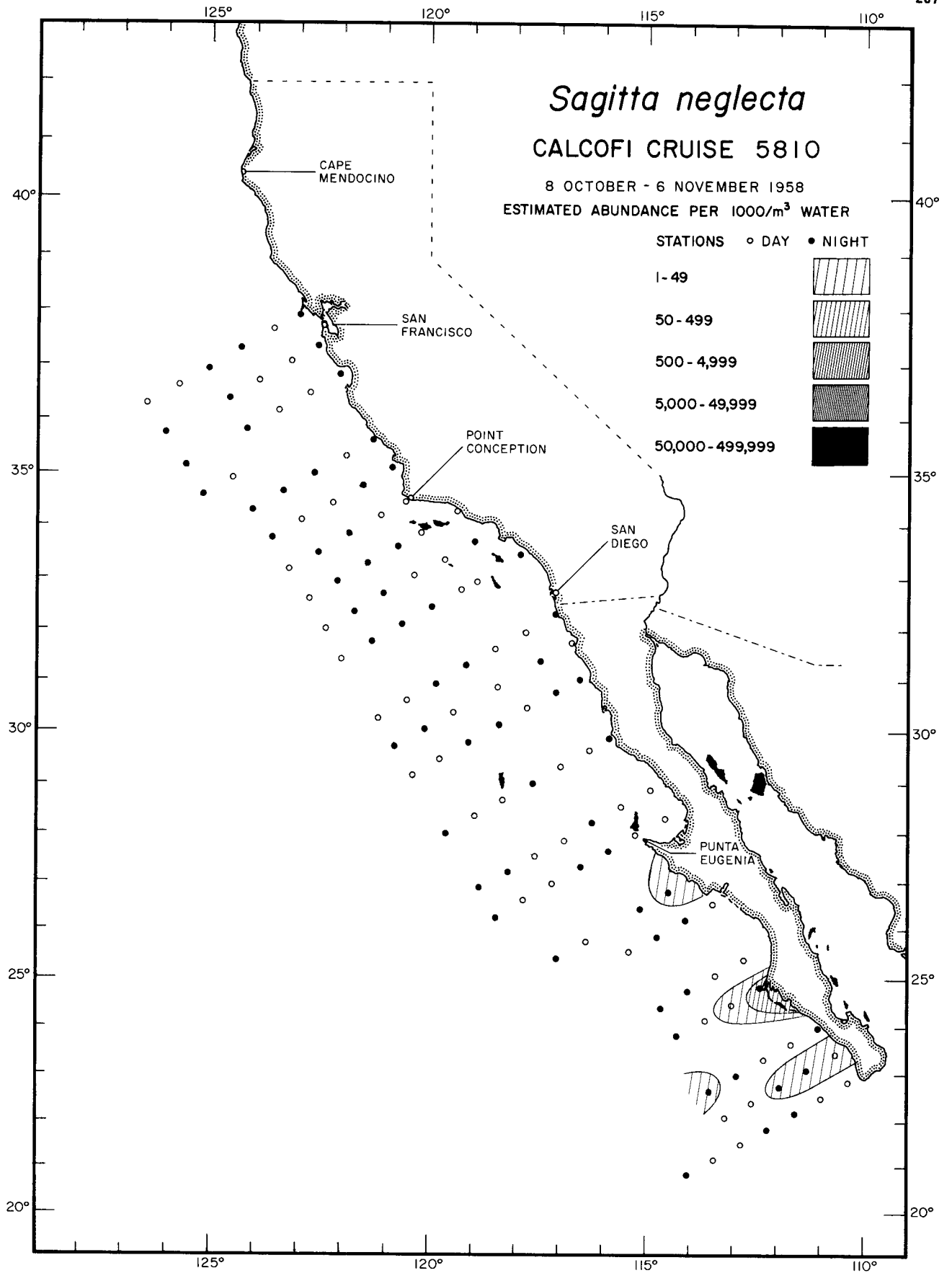
Chaetognatha
Sagitta hexaptera
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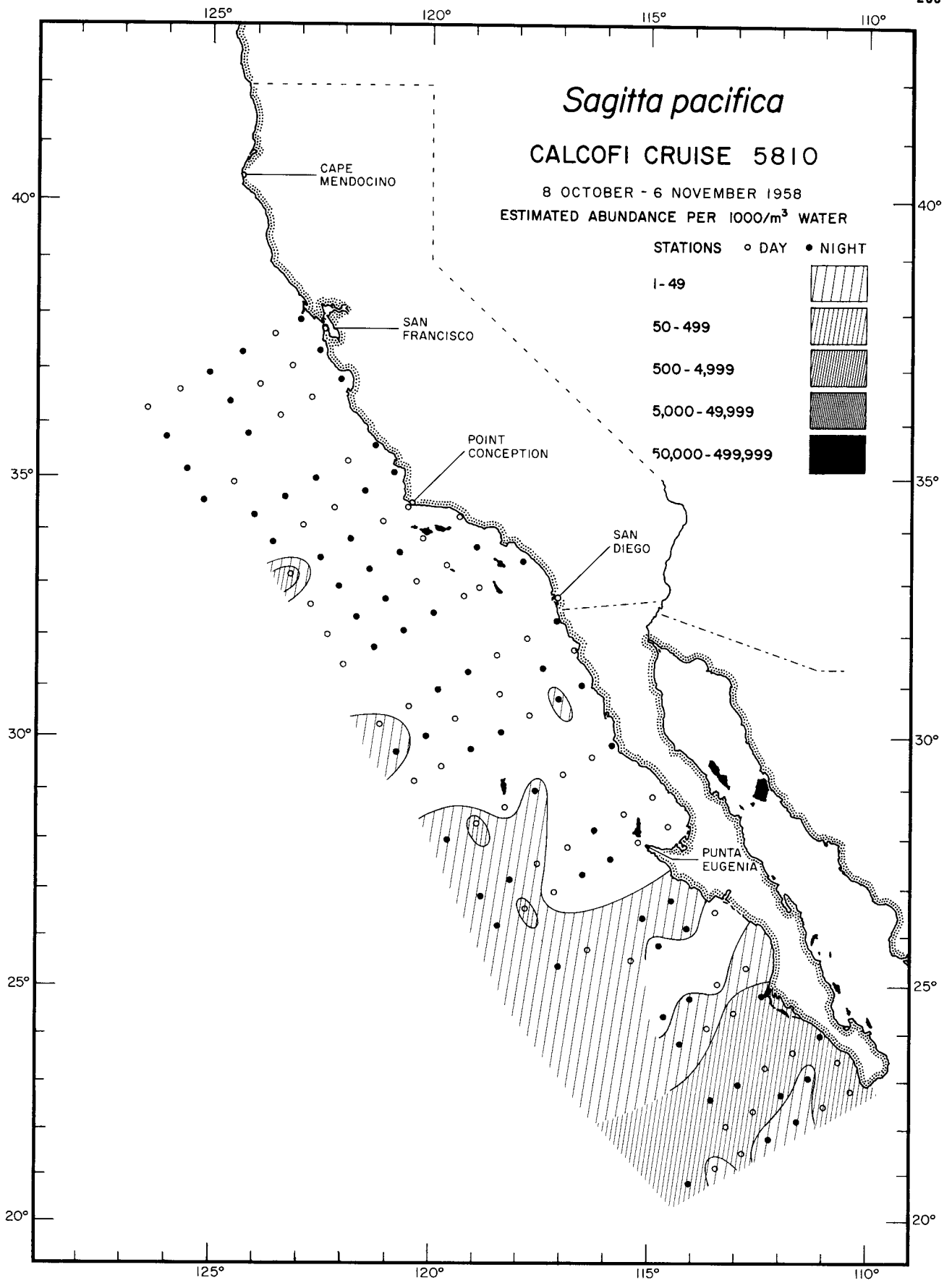
Chaetognatha
Sagitta maxima
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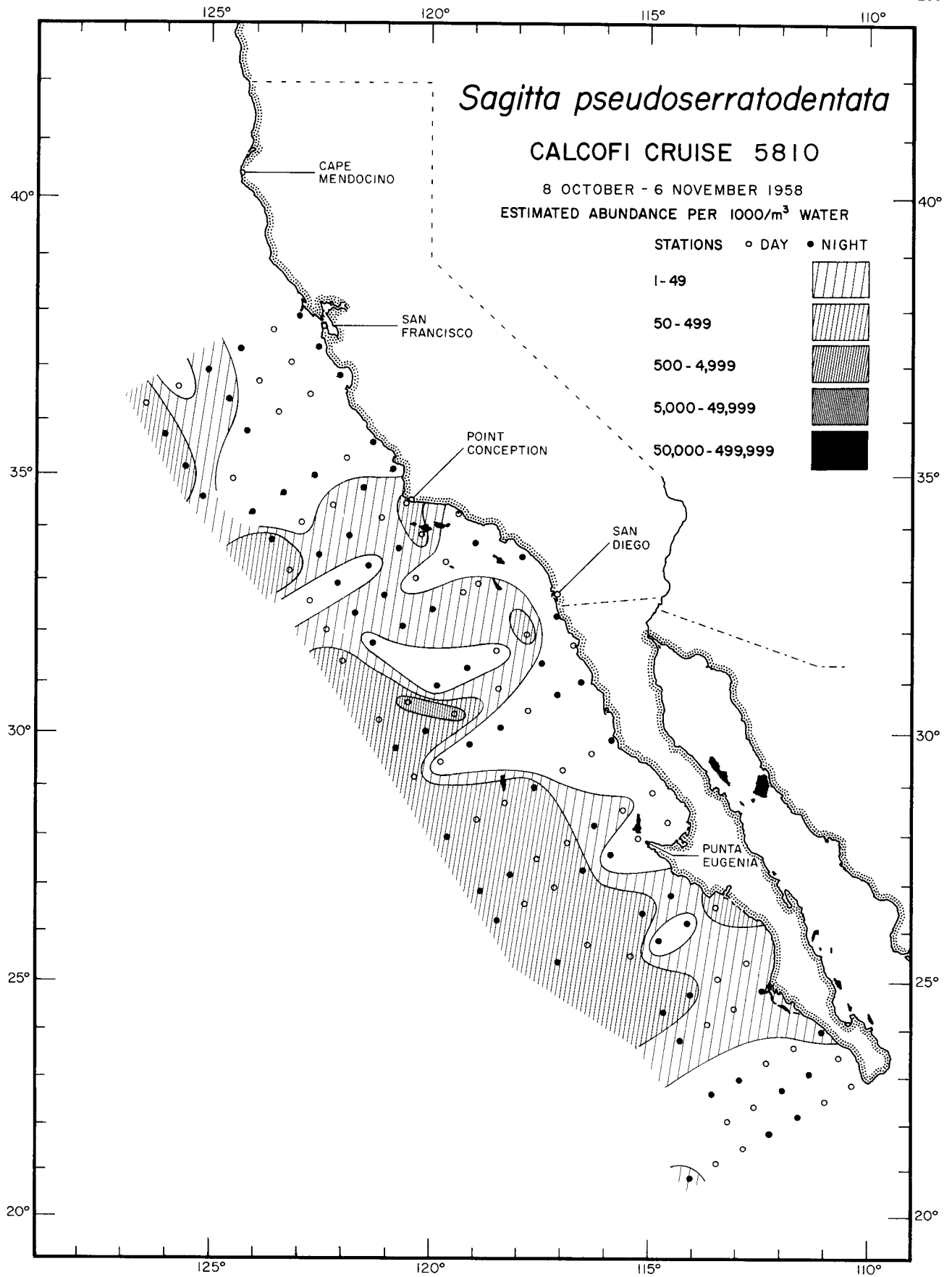
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Sagitta minima
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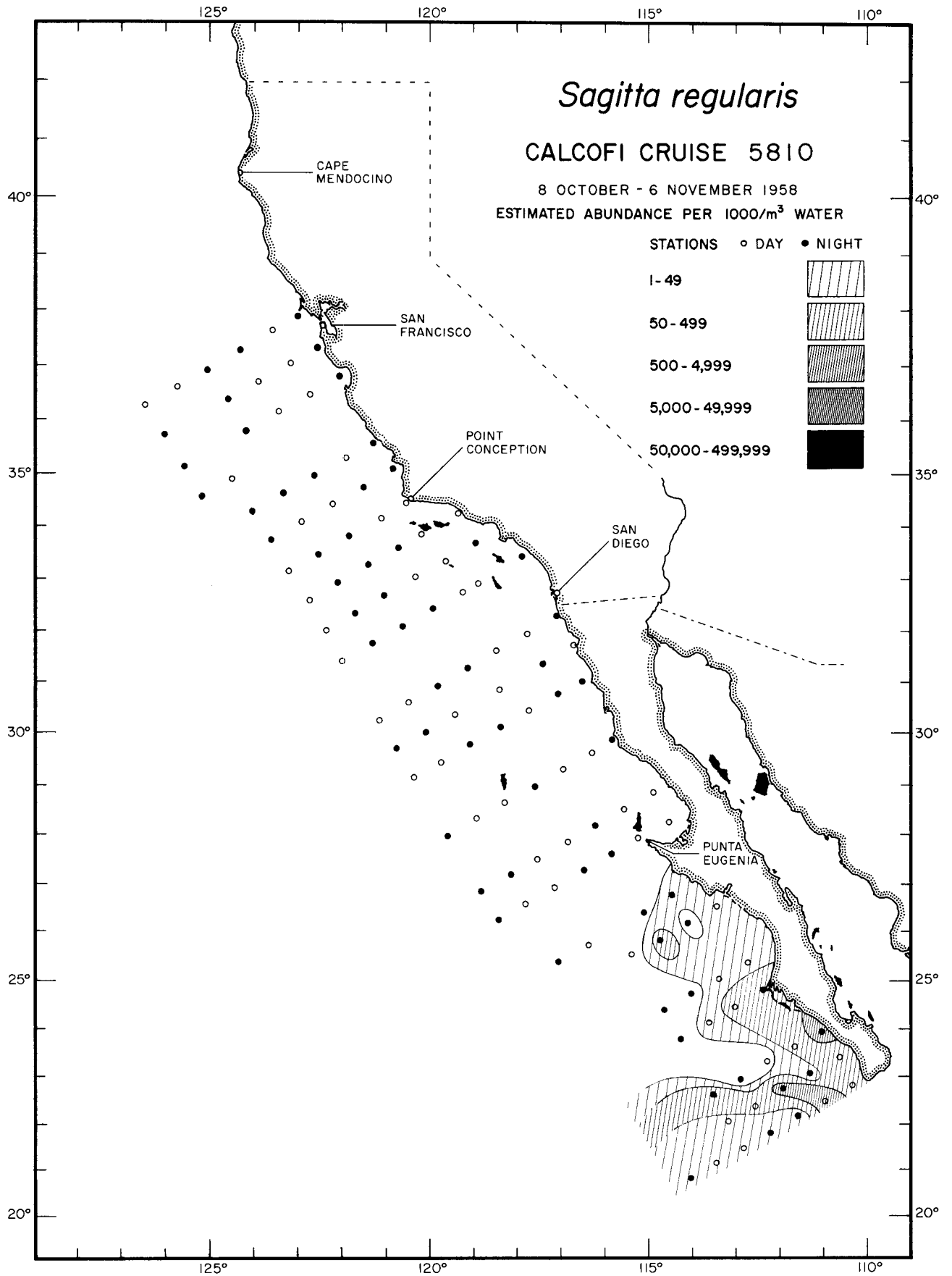
Chaetognatha
Sagitta neglecta
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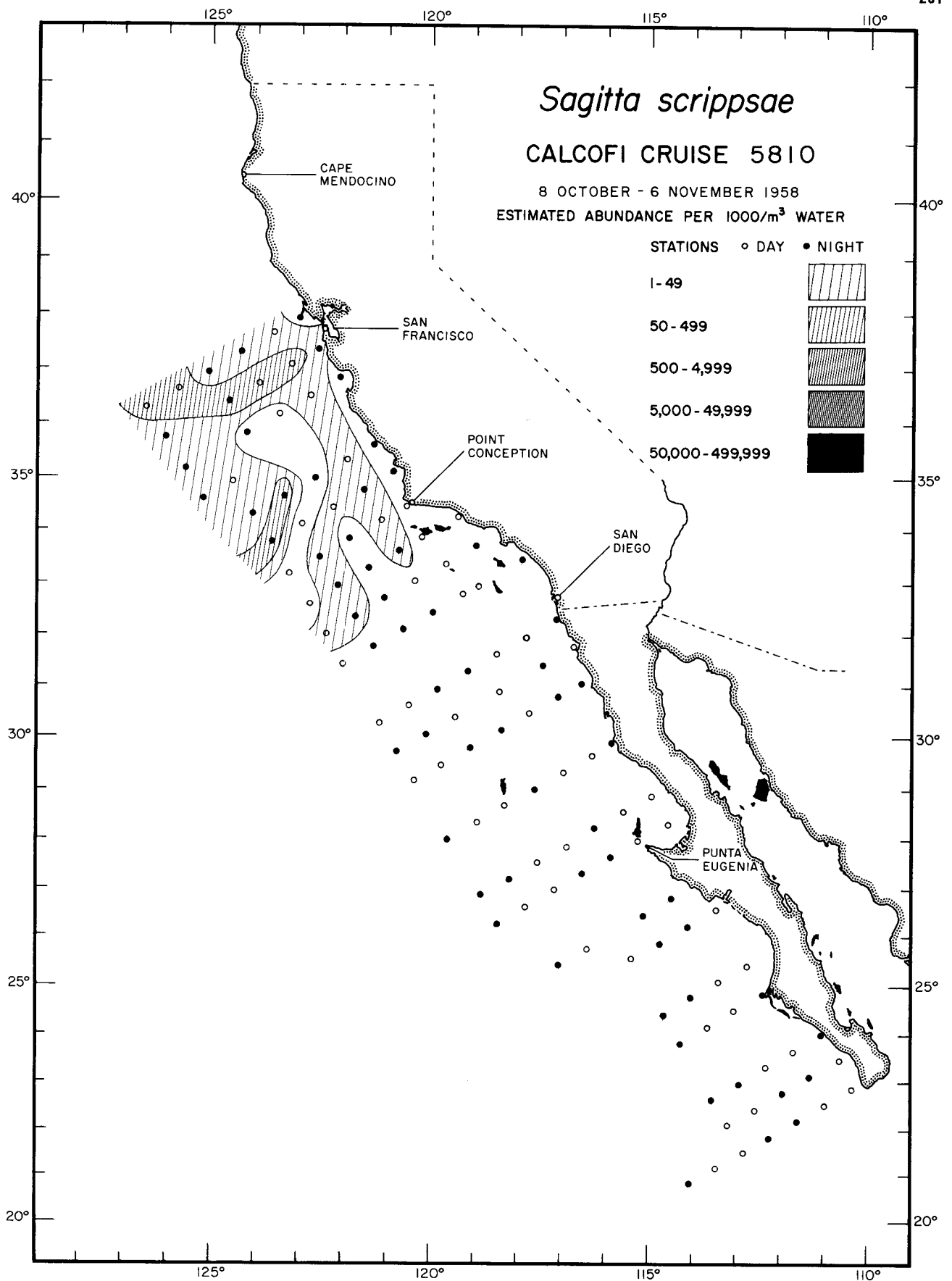
Chaetognatha
Sagitta pacifica
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Chaetognatha
Sagitta pseudoserratodentata
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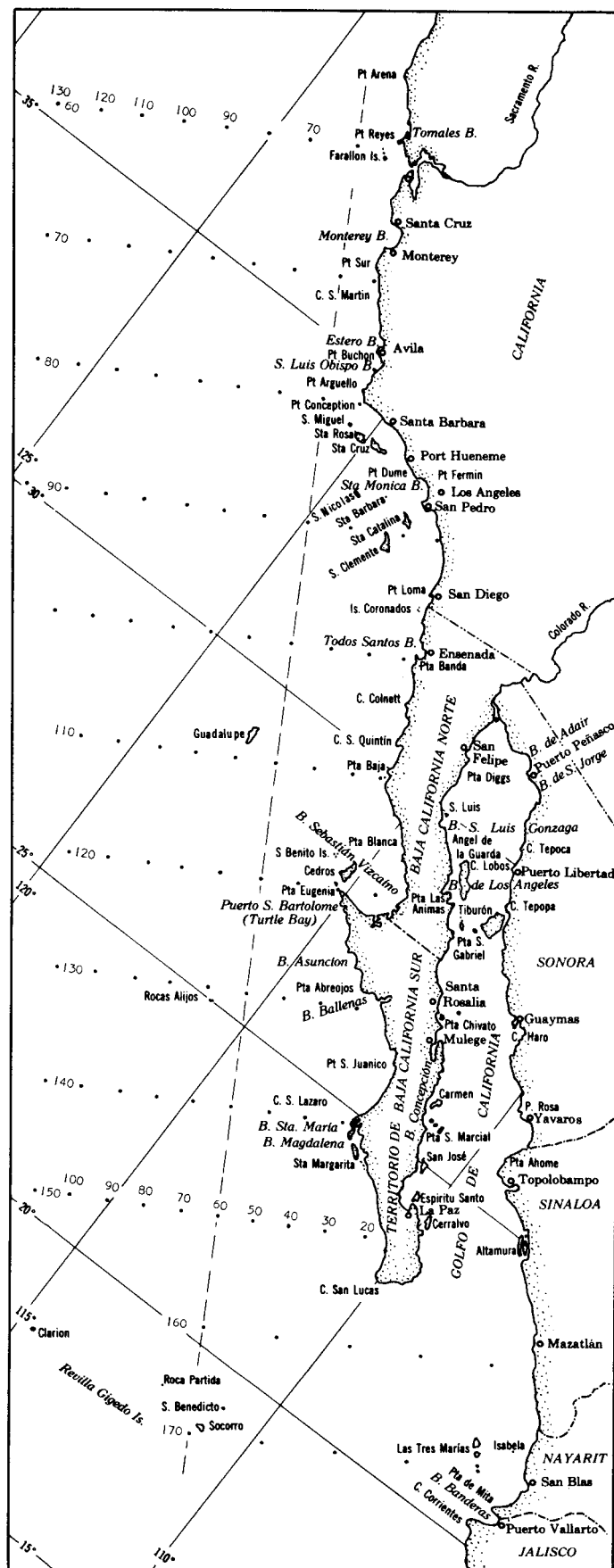
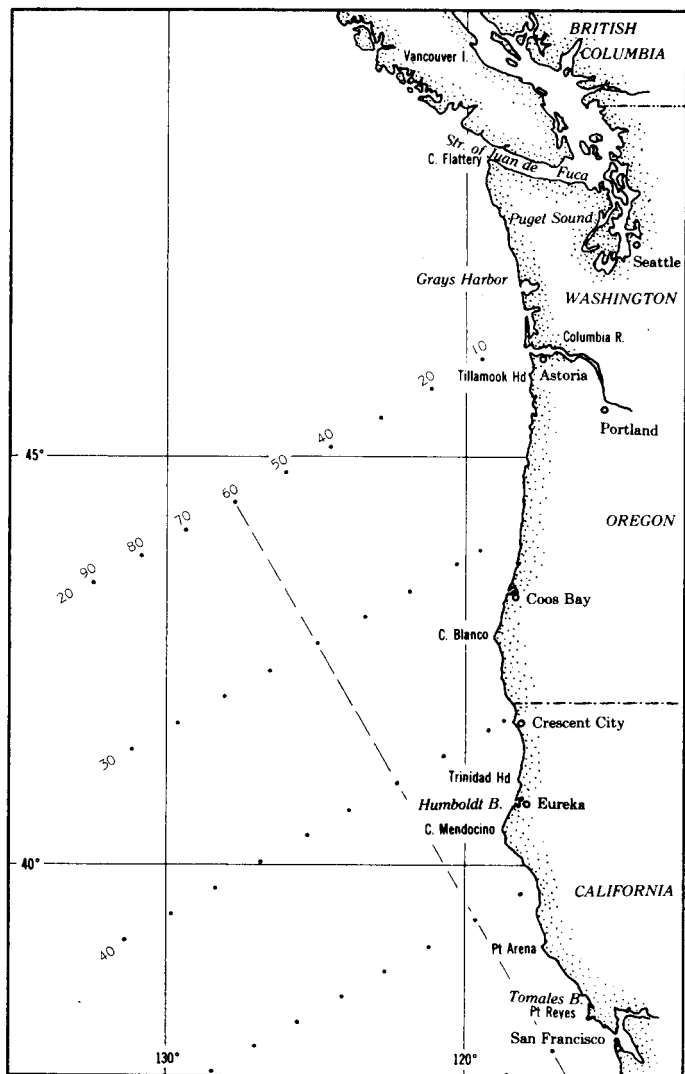


Chaetognatha
Sagitta regularis
5810



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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