



Atlas 2: Fleminger, A. Distributional atlas of calanoid copepods in the California Current region, Part I. Published December 1964.

16 May 2007

The taxonomic nomenclature in the atlas is exactly as published, even though the copepods have undergone taxonomic revision. Below are several references that may be useful in updating the species names:

the Smithsonian web site,

http://ravenel.si.edu/iz/copepod/species/species_Search.cfm

Frost, B. and Fleminger, A. 1968. A revision of the genus *Clausocalanus* (Copepoda: Calanopoda) with remarks on distributional patterns in diagnostic characters. Bulletin of the Scripps Institution of Oceanography 12, 1-235.

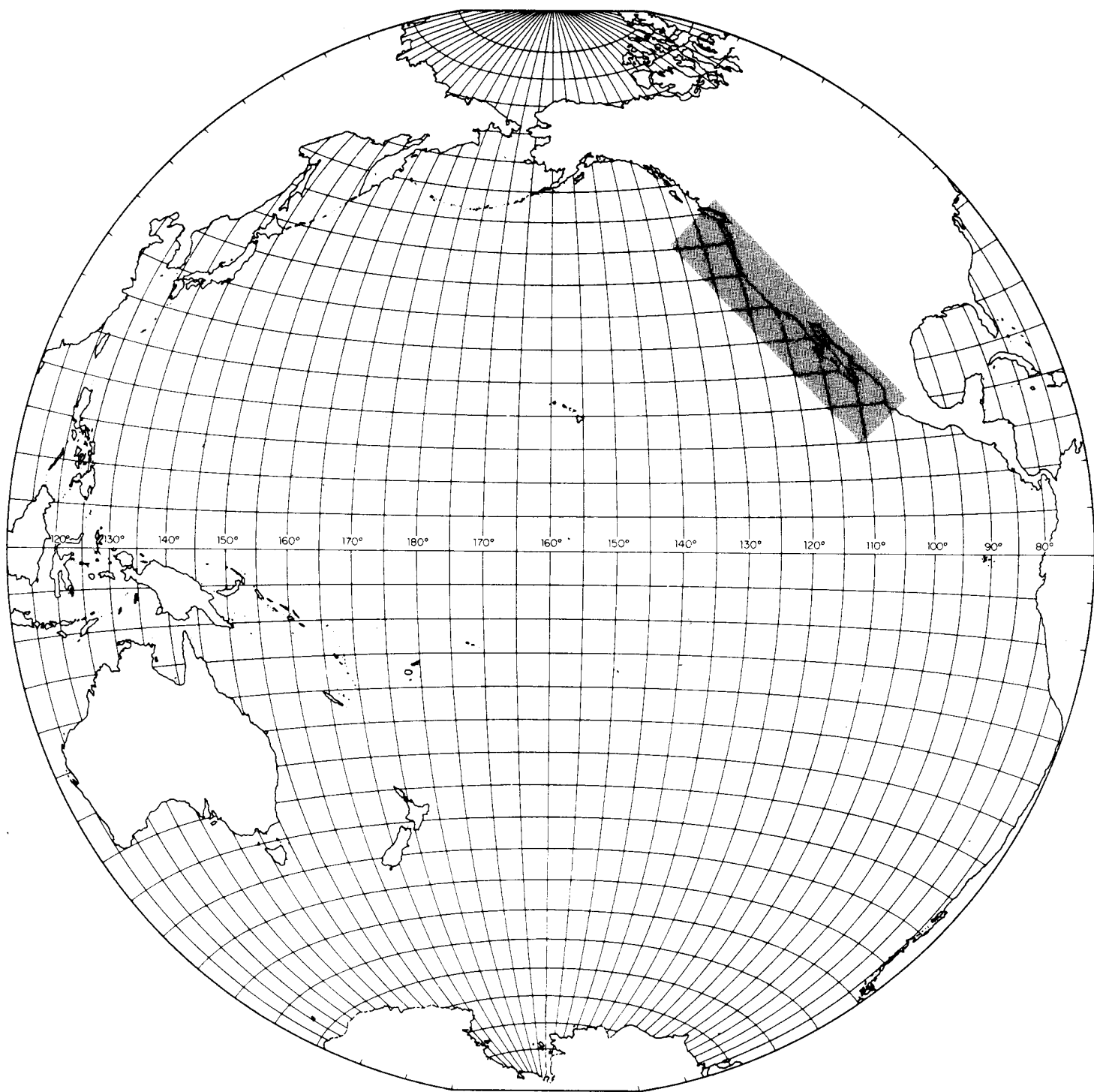
Bradford, J. 1976. Partial Revision of the *Acartia* subgenus *Acartiura* (Copepoda: Calanoida: Acartiidae). N.Z. Journal of Marine and Freshwater Research 19(1): 159-202.

Park, T. 1994. Taxonomy and distribution of the marine calanoid copepod family Euchaetidae. Bulletin of the Scripps Institution of Oceanography 29: 1-203.

Mauchline, J. 1998. The Biology of Calanoid Copepods. Advances in Marine Biology 33: 1-710.

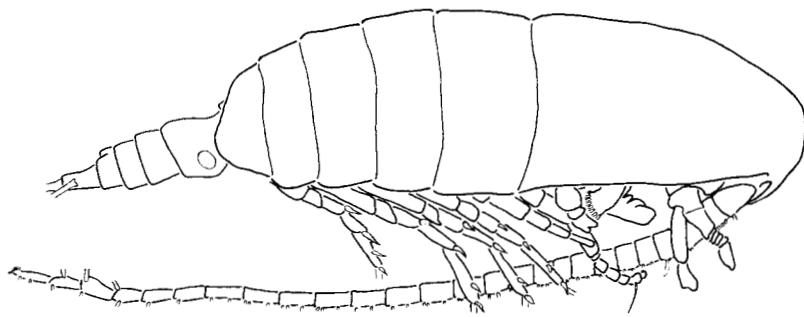
Park, T. 1999. Taxonomy and distribution of the marine calanoid copepod family Heterorhabdidae. Bulletin of the Scripps Institution of Oceanography 31: 1-269.

STATE OF CALIFORNIA
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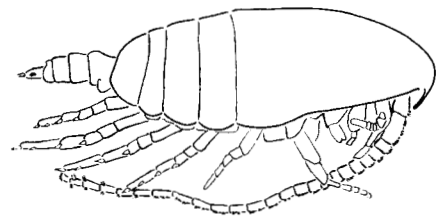
CALIFORNIA COOPERATIVE OCEANIC FISHERIES INVESTIGATIONS

ATLAS No. 2



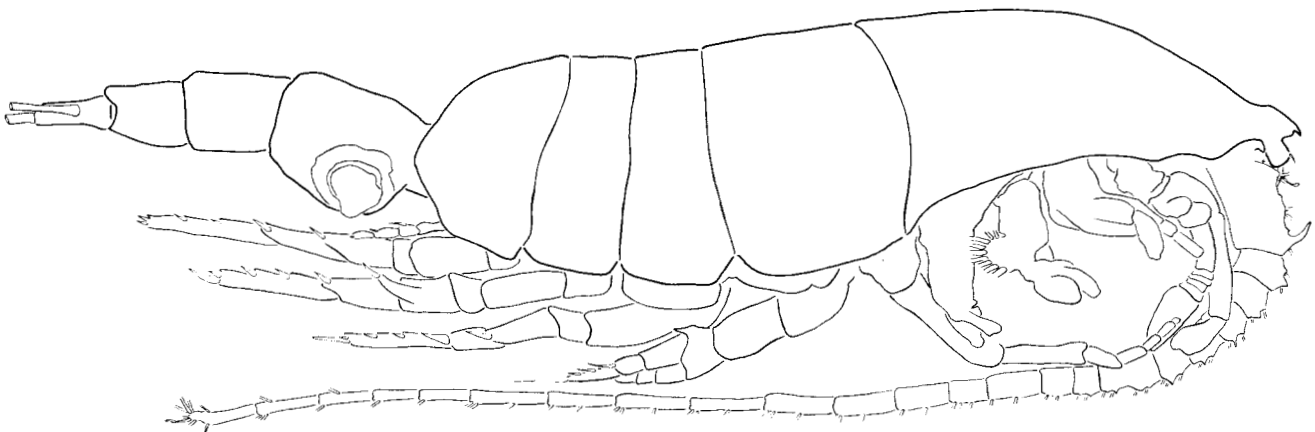
1 mm

Calanus helgolandicus



Canthocalanus pauper

Pleuromamma xiphias



STATE OF CALIFORNIA
MARINE RESEARCH COMMITTEE

CALIFORNIA
COOPERATIVE
OCEANIC
FISHERIES
INVESTIGATIONS

Atlas No. 2

Cooperating Agencies:
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UNIVERSITY OF CALIFORNIA, SCRIPPS INSTITUTION OF OCEANOGRAPHY

December, 1964

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PREFACE

This is the second 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 supported by the Marine Research Committee of the State of California. These data were processed and are presented by the Marine Life Research Program of Scripps Institution of Oceanography, University of California, San Diego, La Jolla, California. Atlas No. 1, already issued (Anon., 1963), contains charts of 10-meter temperatures and salinities throughout the California Current region for the years 1949 to 1959 inclusive. Future hydrographic and biological atlases on the California Current are planned and will be issued as individual units are completed.

The atlases provide processed physical, chemical and biological data plotted on standard charts which are printed one to a page. They should be considered both a source and a tool for examining this complex region in which there is mixing between several different oceanic environments. Publication of this atlas series will make the data available much sooner than if they were to await presentation in analytical reports. The series will also permit publication of a fuller spectrum of the data. By issuing this uniformly processed information while widespread interest prevails, the atlases should serve to encourage more interdisciplinary studies on the oceanography of the California Current.

The CalCOFI Program undertook monthly cruises over an extensive grid of stations in the waters off California and Baja California from 1949 to 1961. A basic station plan is shown in Chart 1. It should be noted that all stations were not occupied during each cruise. At the outset the plan was to monitor and accumulate a prolonged series of observations on fundamental hydrographic and biological features of the region. Such a background would then provide the context within which to examine population fluctuations of the California sardine (Sardinops caerulea). This objective has since been expanded and the current aim of the program is to contribute to a basic understanding of the ecology of the pelagic realm.

The first step toward this objective is determination of the chemical and physical characteristics of the environment and the variety, abundance and distribution of the organisms comprising the plankton community. Hydrographic data from CalCOFI

¹ Usually abbreviated CalCOFI, sometimes CALCOFI or CCOFI.

cruises are systematically assembled by the Data Collection and Processing Group of Scripps Institution of Oceanography. CalCOFI plankton has been under study by a number of systematists working in their respective specialities with the Marine Life Research Program.

Plankton data do not attain the precision generally attributed to physical and chemical oceanographic data, because the extent to which a single plankton sample is quantitatively and qualitatively representative is a function of many uncontrolled variables; e.g., biological phenomena such as patchiness, vertical migration, grazing effects, growth, reaction to collecting gear as well as selectivity of collecting gear. Despite these adverse features, plankton samples offer information that cannot be duplicated at present in any other fashion. At best, they comprise a remarkably sensitive measure of the environmental quality of the sea water from which they were taken. In terms of terrestrial features, plankton samples from a seemingly monotonous ocean can permit identification of desert from prairie, meadow from forest, alpine heights from valley. In general they provide a cumulative index of the recent environmental history within a volume or parcel of water. Support for these claims is empirical and rests upon a persistent high degree of concordance in the distribution of physical-chemical oceanographic features and biogeographical-ecological groups of species from cruise to cruise and year to year. That is, wherever hydrographic and biological features have been monitored simultaneously for long periods of time, seasonal and yearly variations in the two are usually related. Even the effects of local phenomena such as upwelling and coastal countercurrents are readily apparent in the distribution of both organisms and oceanic properties routinely measured by the CalCOFI Program.

The procedures used to analyze the plankton samples have been designed to meet the particular requirements of the taxon. They will be described by each contributing author in conjunction with other pertinent comments on the number of species covered in his report and the total of the group known from the California Current region.

Quantitative distributions will be shown by contouring standard contour intervals based on a logarithmic scale to the base 10. Efforts have been made to maintain a degree of uniformity in drawing the contours. The plankton distributions to be presented in these atlases are based on examination of standard CalCOFI plankton samples.²

² A standard CalCOFI tow is taken with a net 1 meter in diameter, roughly 5 meters long, constructed of 30 xxx grit gauze (heavy duty silk bolting cloth, mesh size about

It should be noted that biological and hydrographic samples were obtained when the ship arrived on station irrespective of time of day. Hence, the effects of diurnal vertical migration must be borne in mind, especially when considering the abundance of those species whose amplitude of migration normally exceeds the maximum depth of the tow.

Atlases dealing with plankton will also contain charts showing standard and selected hydrographic conditions prevailing at the time of the biological collections. Usually, each chart will show the distribution of one species during a single cruise. Charts will be the same in size and scale as the hydrographic charts and will be printed on one side to facilitate any combination of direct comparisons by overlay. Holes have been punched to simplify use and rearrangement in loose-leaf binders. The abbreviated legend in the lower right-hand corner of the page will help to sort the charts quickly or to select those of particular interest. Future atlases will be prepared in as similar a manner as their individual contents permit.

December 1964

A. Fleminger

Footnote 2 (cont.)

0.55 mm after shrinkage) and having a short posterior straining section and cod end of 56 xxx grit gauze (mesh size 0.31 mm). The net is equipped with a flow meter which allows the amount of water filtered to be calculated and is fixed to the towing wire by a short three-lead bridle preceded by a short length of line. The length of line attaches to the towing wire by a wire clamp placed 3 meters above a 100-lb. hydrographic weight fixed to the end of the towing wire. The haul is taken with the ship steaming under way at 1-1/2 to 2 knots. The wire is payed out at 50 meters per minute for 4 minutes. With 200 meters of wire out (about 140 meters actual fishing depth) the net is towed at maximum depth for 1/2 minute. The net is retrieved at 20 meters per minute. During the haul the angle of the towing wire straying from the vertical is maintained as close as possible to 45° by varying ship's speed. Further discussion of the net and field techniques are given by Ahlstrom (1948, 1952, 1954) and King and Demond (1953).

REFERENCES CITED

- Ahlstrom, E. H., 1948. A record of pilchard eggs and larvae collected during surveys made in 1939 to 1941. Spec. sci. Rep. U. S. Fish Wildl. Serv., Fish. No. 54: 76 pp.
- Ahlstrom, E. H., 1952. Pilchard eggs and larvae and other fish larvae, Pacific Coast - 1950. Spec. sci. Rep. U. S. Fish Wildl. Serv., Fish. No. 80: 58 pp.
- Ahlstrom, E. H., 1954. Distribution and abundance of egg and larval populations of the Pacific sardine. U. S. Fish and Wildlife Service, Fishery Bulletin 93, vol. 56: 83-140.
- Anonymous, 1963. CALCOFI Atlas of 10-meter temperatures and salinities 1949 through 1959. California Cooperative Fisheries Investigations, Atlas No. 1.
- King, J. E. and J. Demond, 1953. Zooplankton abundance in the Central Pacific. U. S. Fish and Wildlife Service, Fishery Bulletin 82, vol. 54: 112-144.

DISTRIBUTIONAL ATLAS OF CALANOID COPEPODS
IN THE CALIFORNIA CURRENT REGION, PART I¹

A. Fleminger²

Faunistics	xv
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List of Charts

CalCOFI Basic Station Plan	1
Distribution of Day and Night Samples	2

<u>Hydrographic Charts</u>	<u>Cruise</u>	
10-Meter Temperature	5804	3
10-Meter Temperature	5807	4
10-Meter Temperature	5810	5
10-Meter Temperature	5901	6
140-Meter Temperature	5804	7
140-Meter Temperature	5807	8
140-Meter Temperature	5810	9
140-Meter Temperature	5901	10

¹ This research was carried out under Scripps Institution's Marine Life Research Program with partial support from the National Science Foundation, Grant G - 19417, and the Office of Naval Research. Reproduction in whole or part is permitted for any purpose by the United States Government.

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

<u>Hydrographic Charts (cont.)</u>	<u>Cruise</u>	
10-Meter Salinity	5804	11
10-Meter Salinity	5807	12
10-Meter Salinity	5810	13
10-Meter Salinity	5901	14
140-Meter Salinity	5804	15
140-Meter Salinity	5807	16
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140-Meter Salinity	5901	18
Topography of Dynamic Height Anomaly, 0 over 500 decibars,	5804	19
Topography of Dynamic Height Anomaly, 0 over 500 decibars,	5807	20
Topography of Dynamic Height Anomaly, 0 over 500 decibars,	5810	21
Topography of Dynamic Height Anomaly, 0 over 500 decibars,	5901	22

Biological Charts

Acartia	clausi**	(= Acartiura _____)	23-24
	lilljeborgi**	(= Odontacartia _____)	25-26
	danae**	(= Planktacartia _____)	27-30
	negligens**	(= Planktacartia _____)	31-34
	tonsa**	(= Acanthacartia _____)	35-38
Acrocalanus	longicornis		39-42
Calanus	cristatus		43-44
	plumchrus		43-44
	gracilis	(= Neocalanus _____)	45-48
	helgolandicus s. l.	(= _____ pacificus)	49-52
	lighti		53-55

Biological Charts (cont.)

Calanus (cont.)	minor	(= Nannocalanus _____)	56-59
	robustior	(= Neocalanus _____)	60-63
	tenuicornis		64-67
Candacia	aethiopica		68-71
	bipinnata		72-75
	catula		76-79
	pofi		76-79
	curta		80-83
	longimana †		84-87
	tenuimana		84-87
Centropages	bradyi		88-91
	calaninus †		88-91
	elegans †		92-94
	elongatus		95-98
	furcatus		99-101
	gracilis		102-104
	violaceus s. l.		105-108
Clausocalanus ¹	arcuicornis 1		109-112
	arcuicornis 2		113-116
	arcuicornis 3		117-120
	arcuicornis 4		125-128

¹ Two or more distinct forms can be referred to each of three of the described species of this genus. Pending completion of a revision of Clausocalanus, these forms are placed in existing taxa and are distinguished by Arabic numerals.

Biological Charts (cont.)

Clausocalanus (cont.)	farrani 1** †		121-124
	farrani 2** †		125-128
	furcatus**		129-132
	paululus** †		133-136
	pergens 1** †		137-140
	pergens 2** †		141-144
Ctenocalanus	vanus**		145-148
Euaetideus	acutus		149-152
	bradyi		153-156
Eucalanus	attenuatus		157-160
	bungii californicus		161-164
	crassus		165-168
	elongatus hyalinus		169-172
	inermis		173
	pileatus (includes E. subcrassus)		174-177
	subtenuis		178-181
Euchaeta	acuta		182-185
	californica	(= _____ dubia)	186-188
	elongata	(= Paraeuchaeta _____)	186-188
	tonsa	(= Paraeuchaeta _____)	186-188
	longicornis		189-192
	marina		193-195
	media		196-199
	pubera †		200-203
spinosa		200-203	

Biological Charts (cont.)

Euchaeta (cont.)	tenuis		200-203
	wolfendini		204-206
Gaidius	pungens*		207-210
Heterorhabdus	papilliger		211-214
Lucicutia	flavicornis		215-218
Mecynocera	clausi**		219-222
Metridia	lucens s. l.	(= _____ pacifica)	223-226
Paracalanus	aculeatus**		227-230
	denudatus**		231-234
	nanus** †		231-234
	nudus** †		231-234
	parvus**		235-238
Paracandacia	bispinosa	(= Candacia _____)	239-242
	simplex	(= Candacia _____)	243-246
	truncata	(= Candacia _____)	247-249
Pleuromamma	abdominalis*		250-253
	borealis*		254-257
	gracilis*		258-261
	indica †		262-265
	quadrungulata*		262-265
	xiphias*		266-269
Racovitzanus	antarcticus †		270-273
Rhincalanus	nasutus		274-277

Biological Charts (cont.)

Scaphocalanus	curtus** †	278-281
	echinatus	282-285
Scolecithricella	abyssalis*	286-289
	ctenopus	290-293
	nicobarica** †	290-293
	tenuiserrata**	290-293
	dentata*	294-297
	ovata* (= _____ subdentata)	298-301
Scolecithrix	bradyi**	302-305
	danae	306-309
Temora	discaudata	310-313

* Occurring primarily in night samples.

** Relatively small-sized species which may have been inadequately sampled by the CalCOFI net.

† New records for the Pacific Ocean east of 140°W longitude.

Faunistics

Distribution charts of about one-third of the species of calanoid copepods that were collected during CalCOFI Cruises 5804 (30 March - 27 April 1958), 5807 (30 June - 22 July 1958), 5810 (8 October - 6 November 1958) and 5901 (7 - 29 January 1959) are presented in this volume. The remaining species will be dealt with in a subsequent atlas. A complete species list will be presented elsewhere together with a discussion of the fundamental types of distribution shown by calanoids in the region.

The species dealt with in this atlas are listed alphabetically in the Table of Contents. Frequently occurring forms typical of the California Current fauna as well as some relatively rarer species appear in this list. Some of the rarer species represent biogeographical areas that lie adjacent to the California Current and into which this current intrudes. In the Table of Contents species not recorded previously from the Pacific Ocean east of longitude 140° W are designated by a dagger (+), while those appearing primarily in night tows are designated by an asterisk (*).

Identifications are based on comparison of specimens with published descriptions. A number of endemic species distinguishes the boreal-temperate, epi- and mesopelagic copepods of the North Pacific from those of the North Atlantic. However, many other species of these faunas are known in which North Atlantic and North Pacific cognates are barely distinguishable, if at all, on a morphological basis. Although there may be a lack of genetic exchange between these populations at present, the disjunct seems to be a temporary one of relatively short duration in geological time. Several of these cases have been examined (unpublished) and no evidence was found of appreciable, morphological divergence. These species have been identified sensu lato and are so noted (s. l.) in the species list in the Table of Contents.

Only a portion of the collections of the four cruises (5804, 5807, 5810, 5901) was selected for examination as described below. In response to an initial objective of surveying the calanoid fauna of the California Current region, stations were chosen: 1) to observe the assemblage of species within the maximum geographical length and breadth covered by each cruise, and 2) to monitor north-south and east-west seasonal features at regular geographic intervals. Counts were restricted to adult, sexually mature individuals because rapid identifications were more dependable and because the relatively coarse mesh of the meter net probably did not sample smaller-sized individuals quantitatively. Extended appendages and setae help retain individual copepods on the mesh but it seems certain that adults below 2.00 mm in total length are not retained as efficiently as larger-sized species. Hence abundance estimates are minimal, and the minima are especially low for smaller species, which are designated in the Table of Contents by a double asterisk (**).

Quantitative Analysis of Samples

Samples were routinely brought to 600 cc total combined volume of fluid and organisms (in the standard CalCOFI tow the net usually filtered from 500 to 700 m³ of ocean water, thus the samples were examined in concentration of about 10⁶). All adult calanoids in a 10% sub-sample were identified and counted to obtain estimates of abundance of each species. The 10% sub-sample represents the sum of three separate aliquots of 20 cc. Each aliquot was removed, counted and returned to the original prior to removal of a subsequent aliquot. The 20 cc aliquots were taken with a piston (Stempel) pipette immediately after stirring the total sample through five clockwise rotations followed by two counterclockwise rotations, all made in fairly rapid succession.

The aliquots were counted in a plexiglass tray, 2-3/4 x 1-7/8 x 3/8 inches, internal dimensions, which was partitioned into 9 parallel channels by plexiglass walls to minimize movement of organisms during microscopic analysis. Counts were made at 16 x magnification with a stereomicroscope equipped with a mechanical stage. At this magnification the field of view spans the distance across a single channel. After completion of the aliquot counts, the entire sample was examined for species which had not appeared in the aliquots. A portion of the total sample was poured into the counting tray and scanned at 16 x magnification, this procedure being repeated until the entire sample was examined. Scanning generally increased the species list by about 25%. Quantitatively, these rarer species were assumed to fall within the lowest interval of abundance used in the contouring.

Counts of individuals of a species were transformed to number per 1000 m³ of sea water filtered using the formula

$$\frac{10,000 n}{V} = N,$$

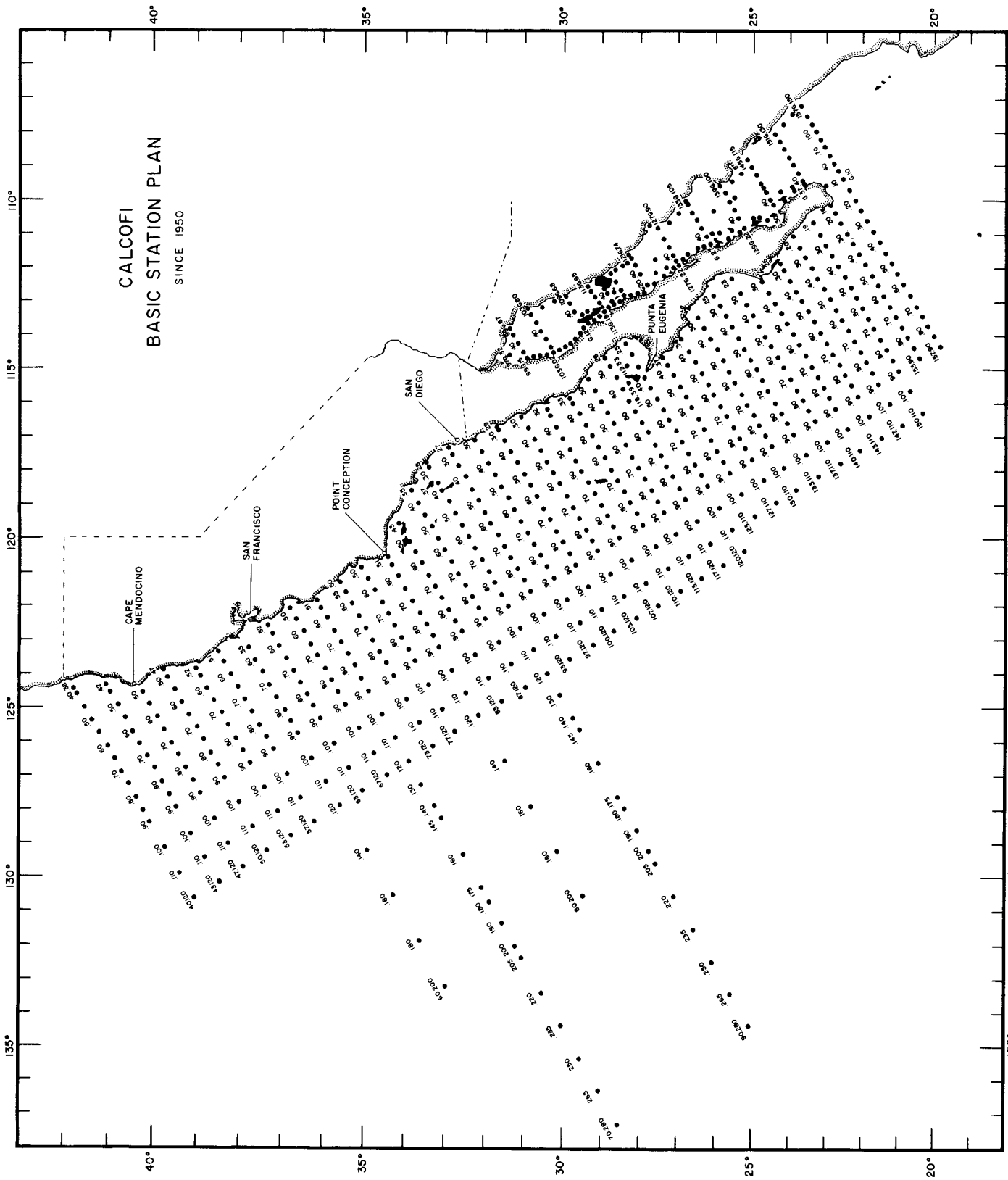
where n = number of individuals in 10% subsample,

V = number of m³ of water filtered during the tow, and

N = number of individuals in 1000 m³ filtered.

Copies of the actual counts are on file in the Library and with the Marine Life Research Program Director, Scripps Institution of Oceanography, La Jolla, California.

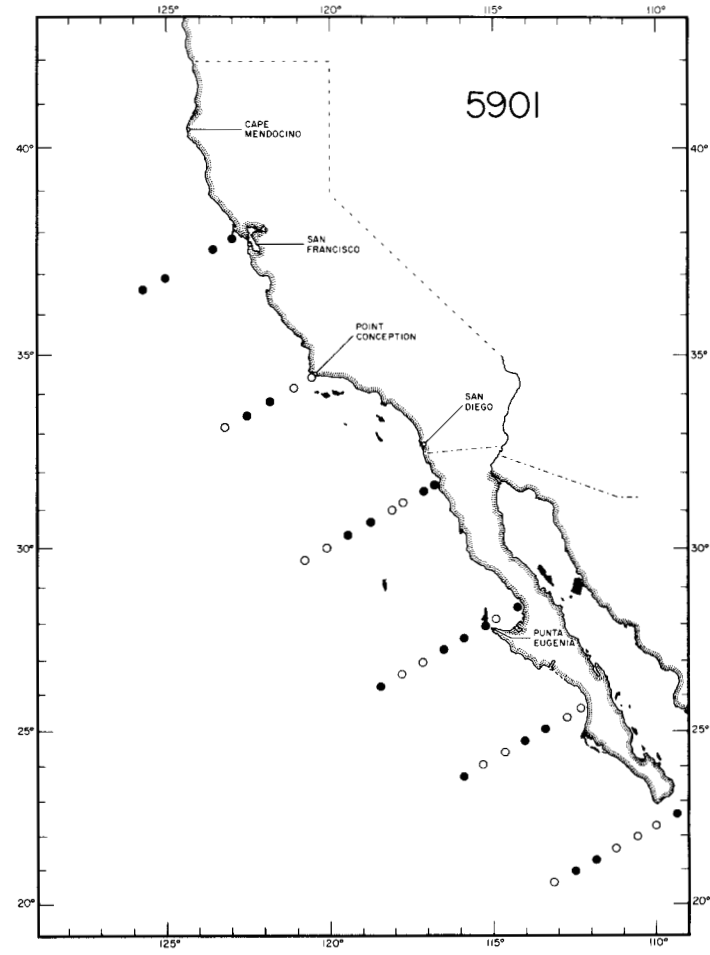
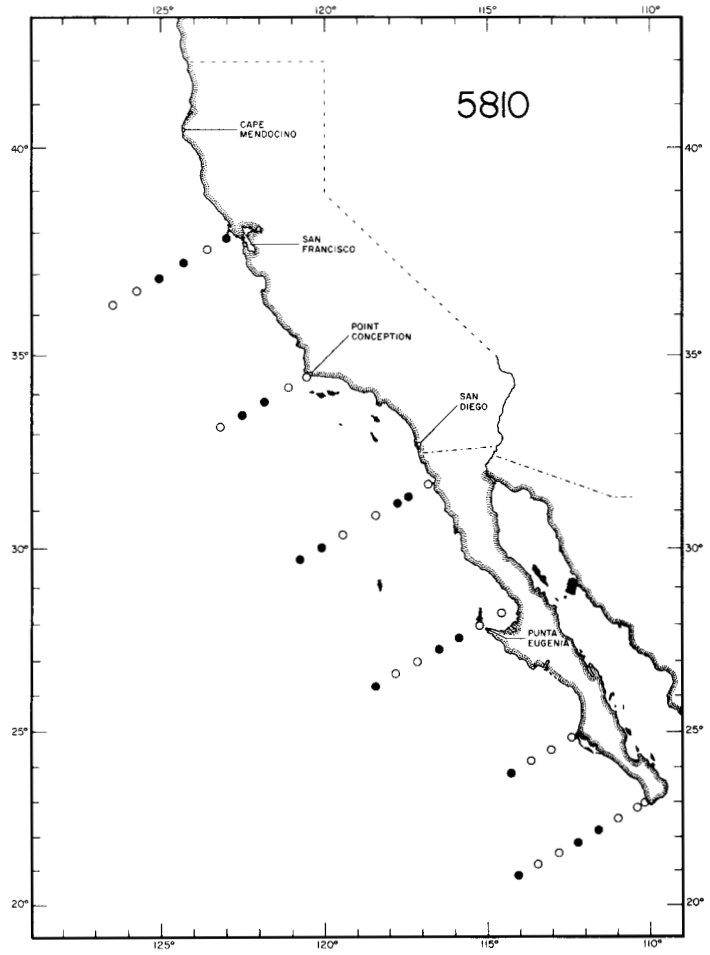
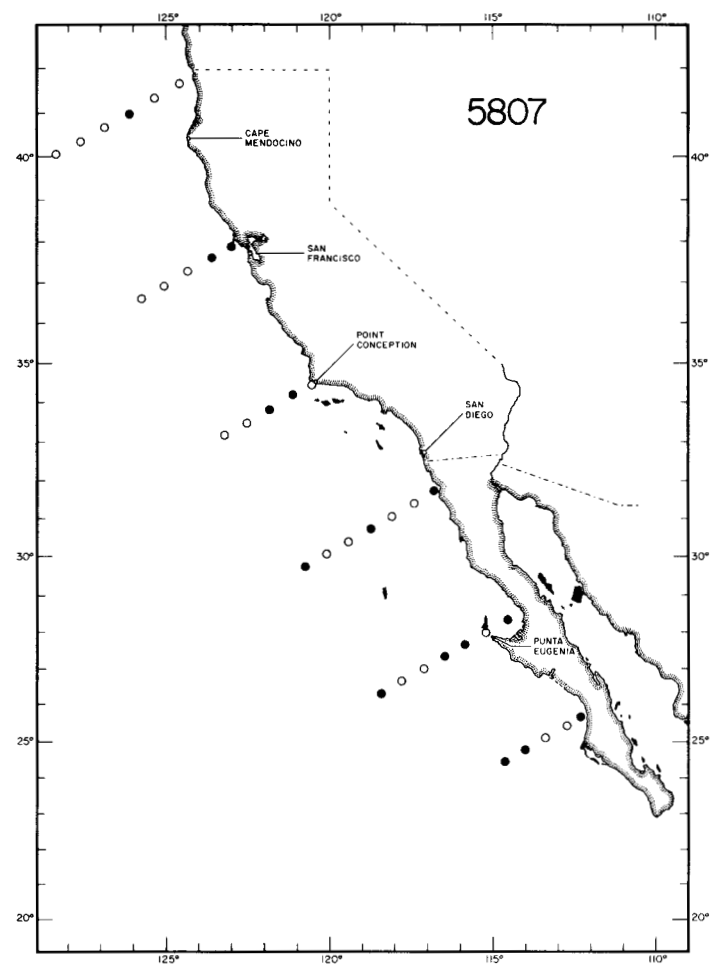
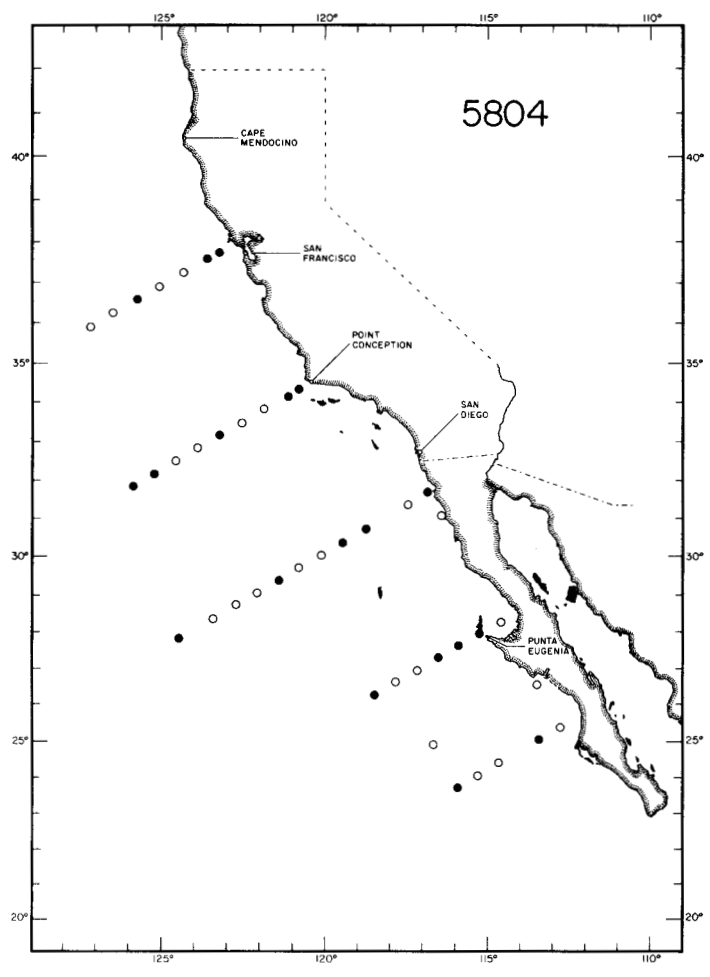
The author wishes to express his gratitude to Miss F. M. Fischer of the CalCOFI Atlas staff, for the overall excellence of the plotting and drafting of the biological charts. The analyses for the physical data charts were made by Mr. John G. Wyllie, Data Collection and Processing Group, Scripps Institution of Oceanography.



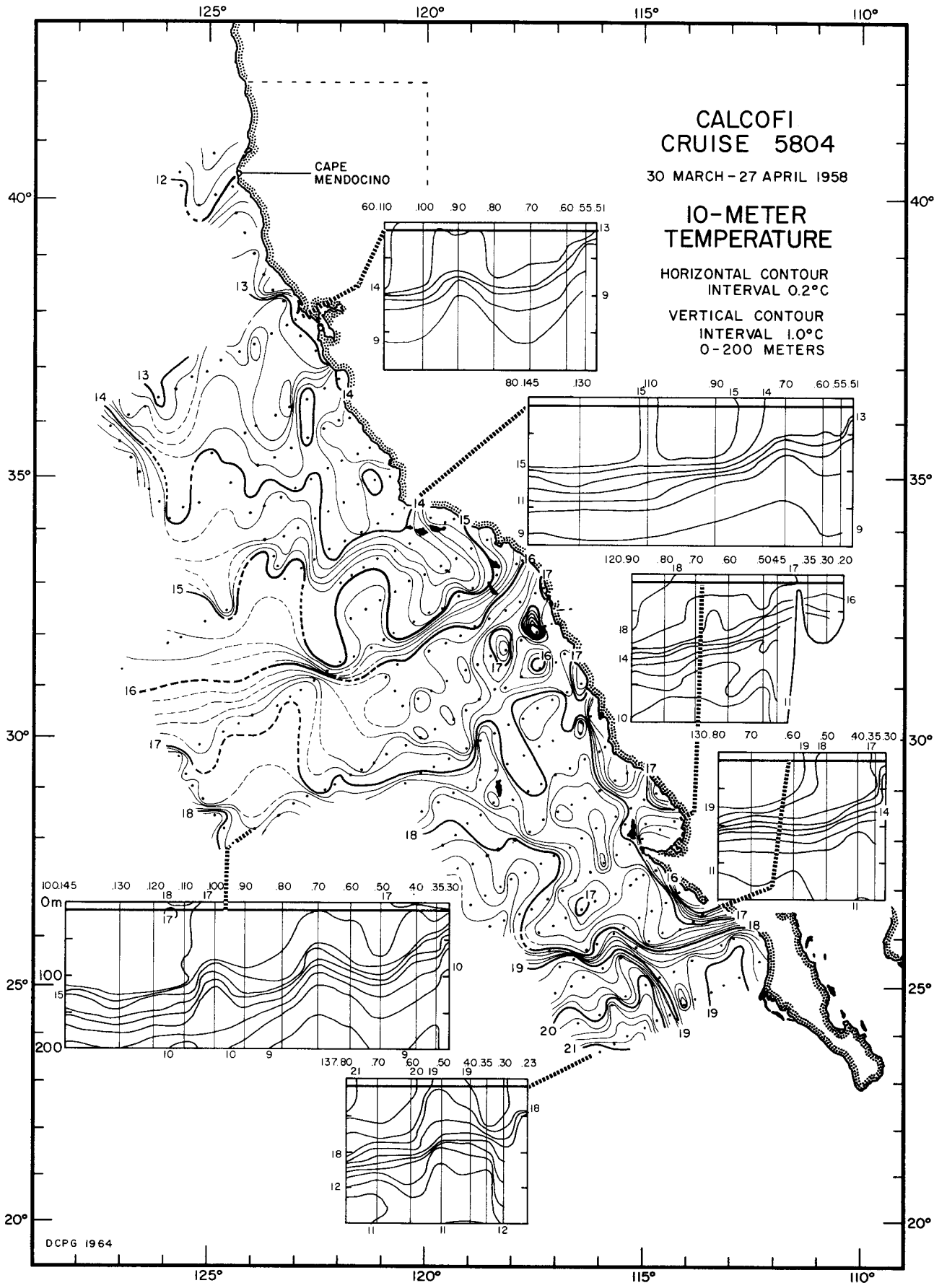
BASIC STATION PLAN
SINCE 1950

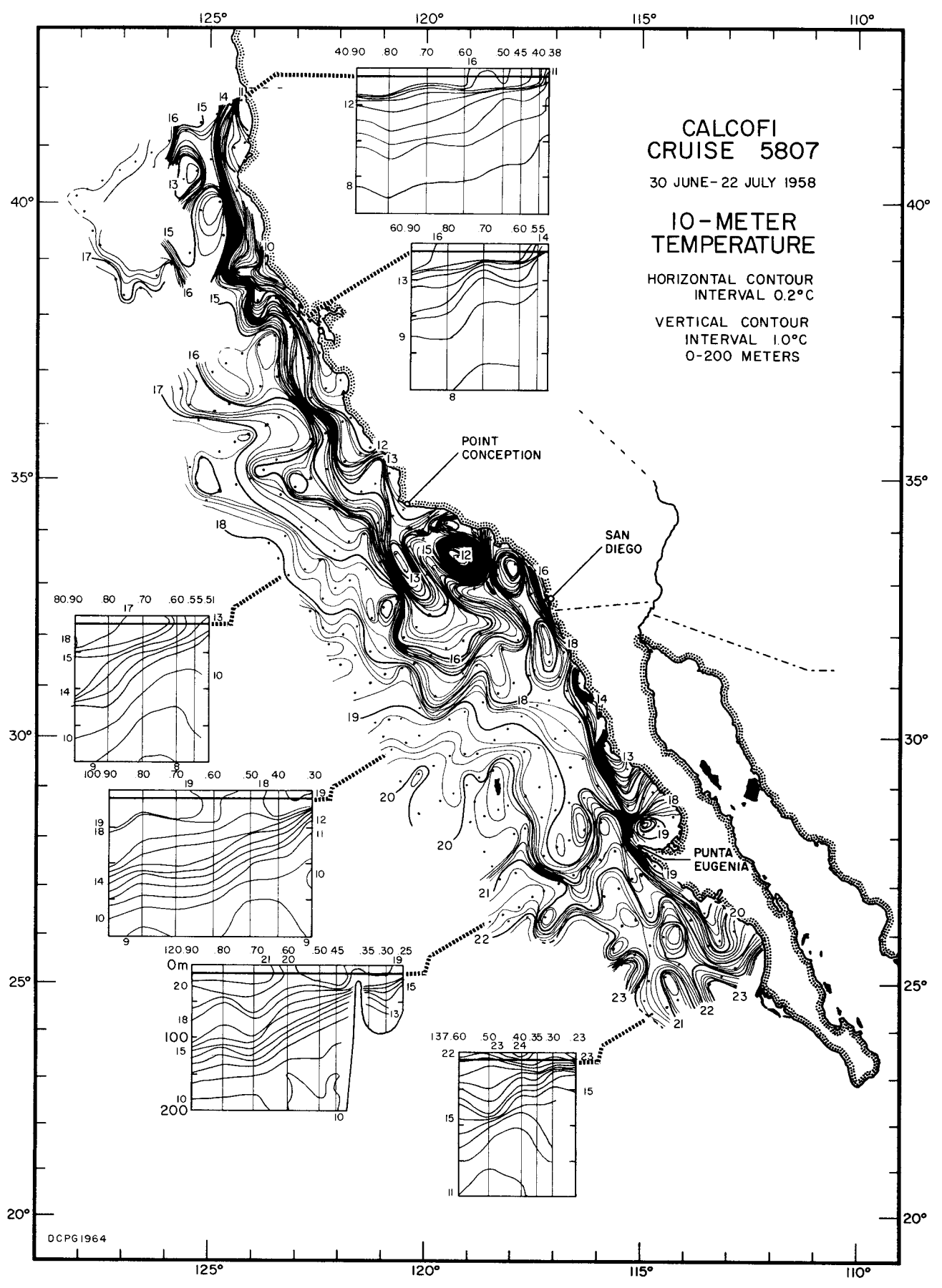
BASIC STATION PLAN
SINCE 1950

CALCOFI



STATIONS ○ DAY ● NIGHT





**CALCOFI
CRUISE 5807**

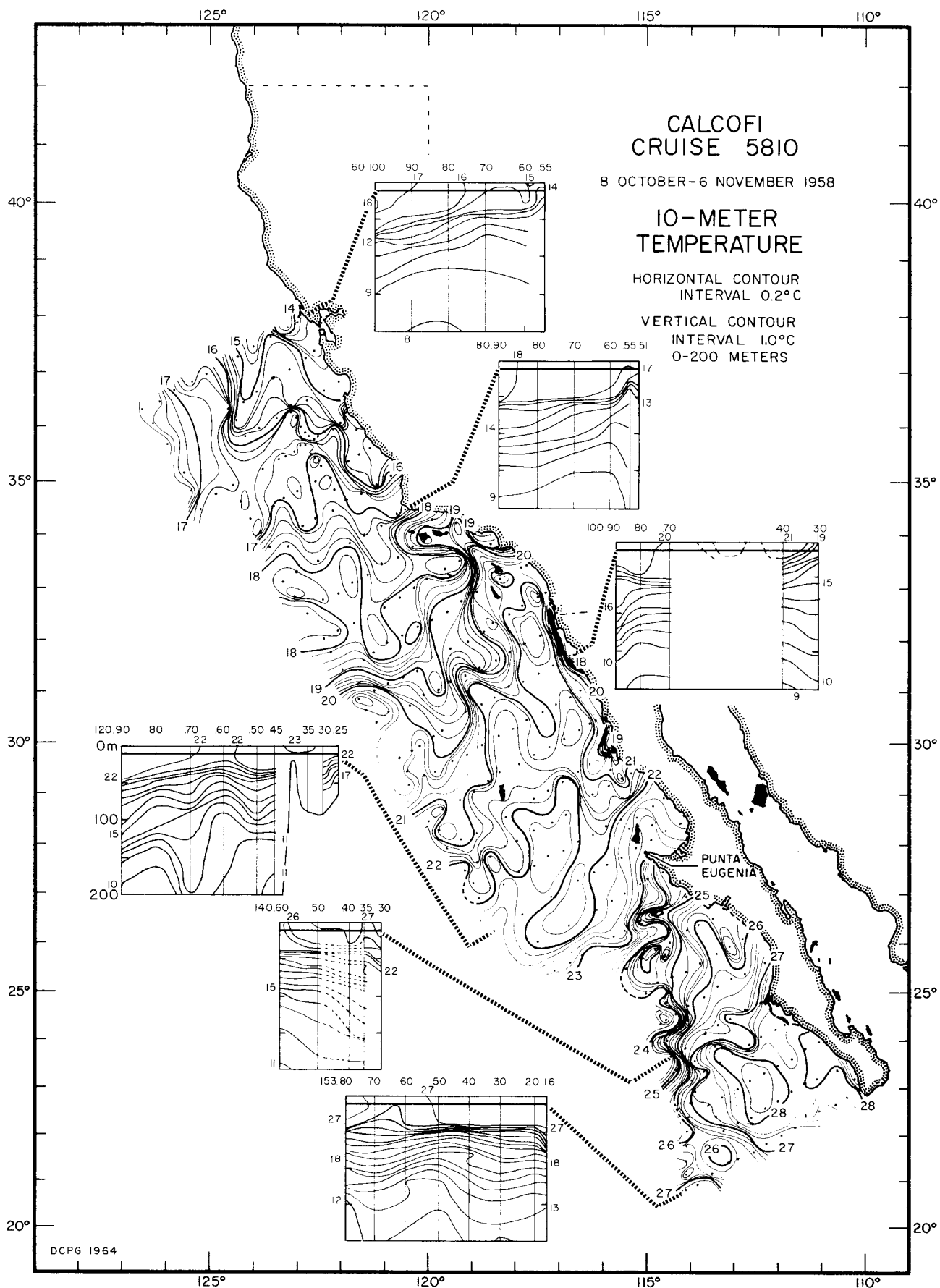
30 JUNE - 22 JULY 1958

**10-METER
TEMPERATURE**

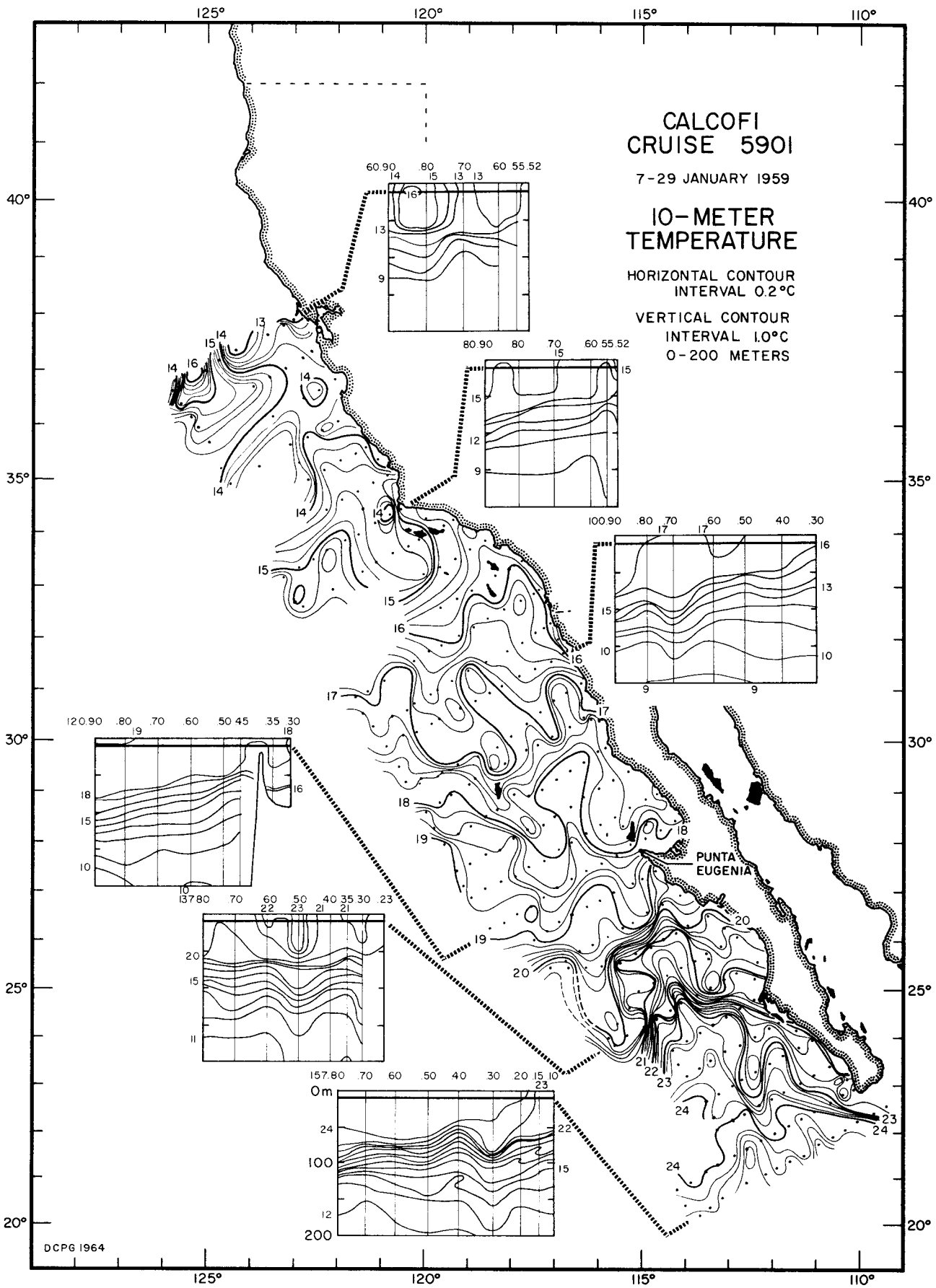
HORIZONTAL CONTOUR
INTERVAL 0.2°C

VERTICAL CONTOUR
INTERVAL 1.0°C
0-200 METERS

10m T
5807



10m T
5810



**CALCOFI
CRUISE 5901**

7-29 JANUARY 1959

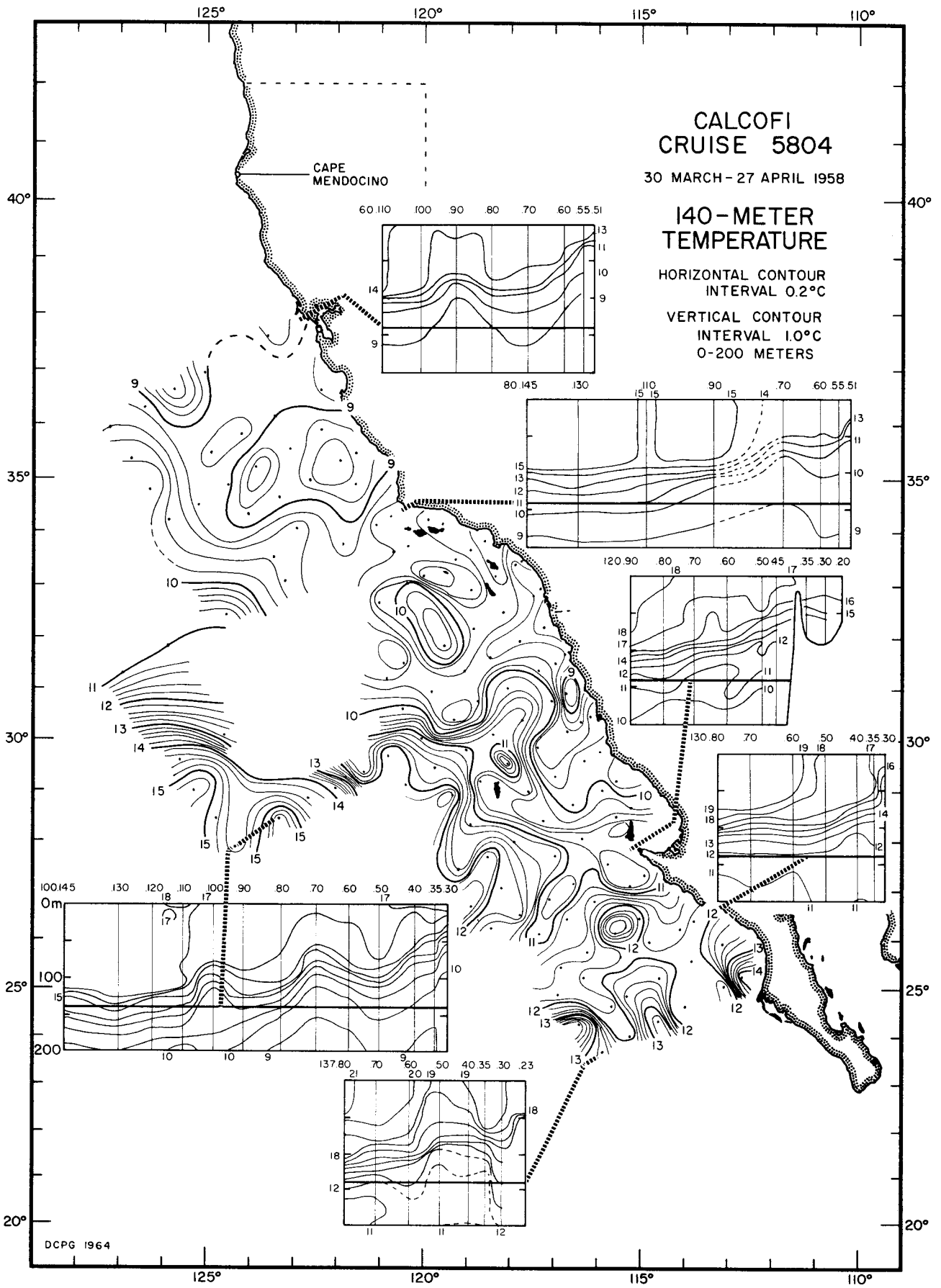
**10-METER
TEMPERATURE**

HORIZONTAL CONTOUR
INTERVAL 0.2°C

VERTICAL CONTOUR
INTERVAL 1.0°C
0-200 METERS

DCPG 1964

10m T
5901

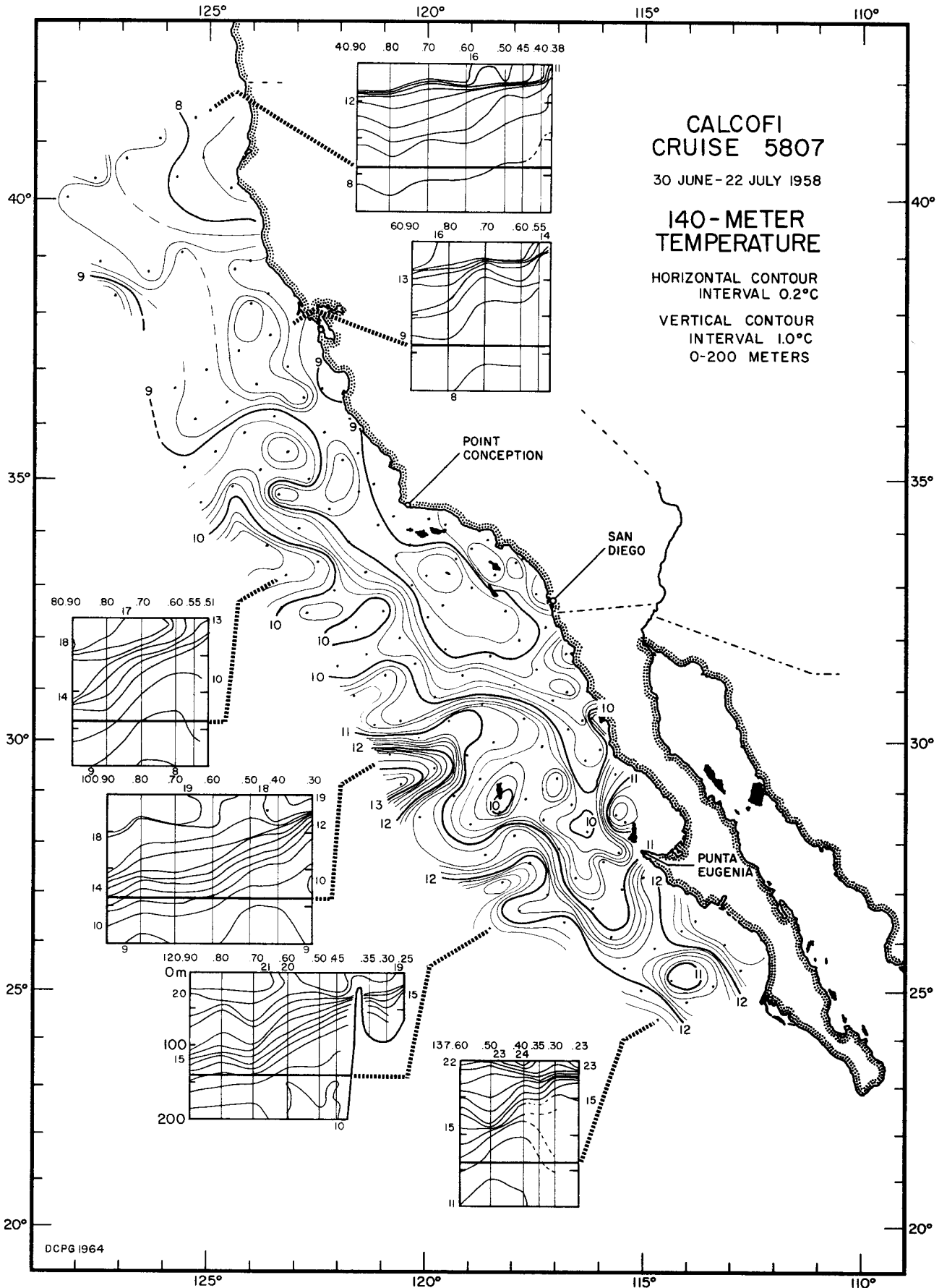


CALCOFI
 CRUISE 5804
 30 MARCH - 27 APRIL 1958

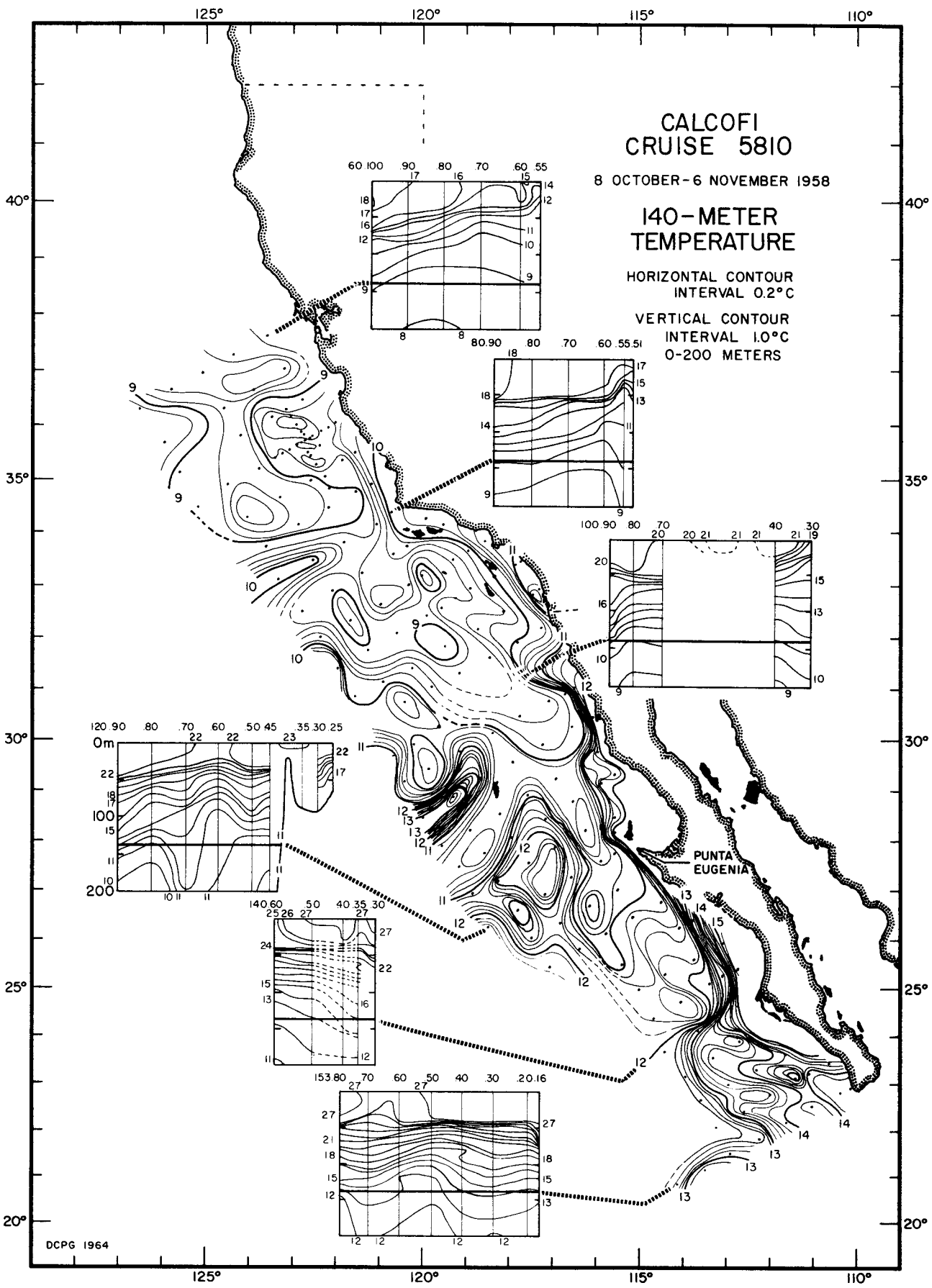
140-METER
 TEMPERATURE
 HORIZONTAL CONTOUR
 INTERVAL 0.2°C
 VERTICAL CONTOUR
 INTERVAL 1.0°C
 0-200 METERS

DCPG 1964

140m T
 5804



140m T
5807



**CALCOFI
CRUISE 5810**

8 OCTOBER - 6 NOVEMBER 1958

**140-METER
TEMPERATURE**

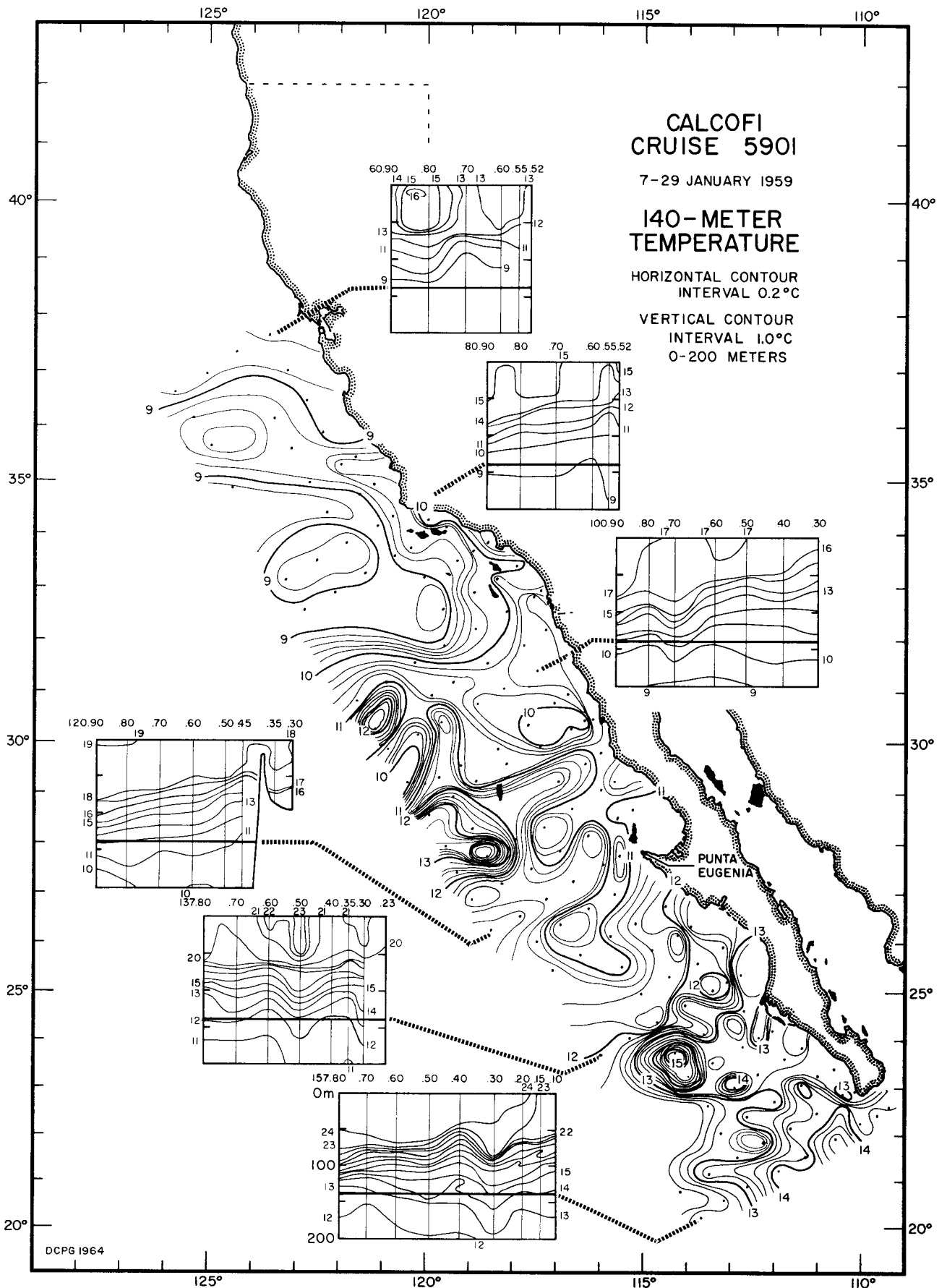
HORIZONTAL CONTOUR
INTERVAL 0.2°C

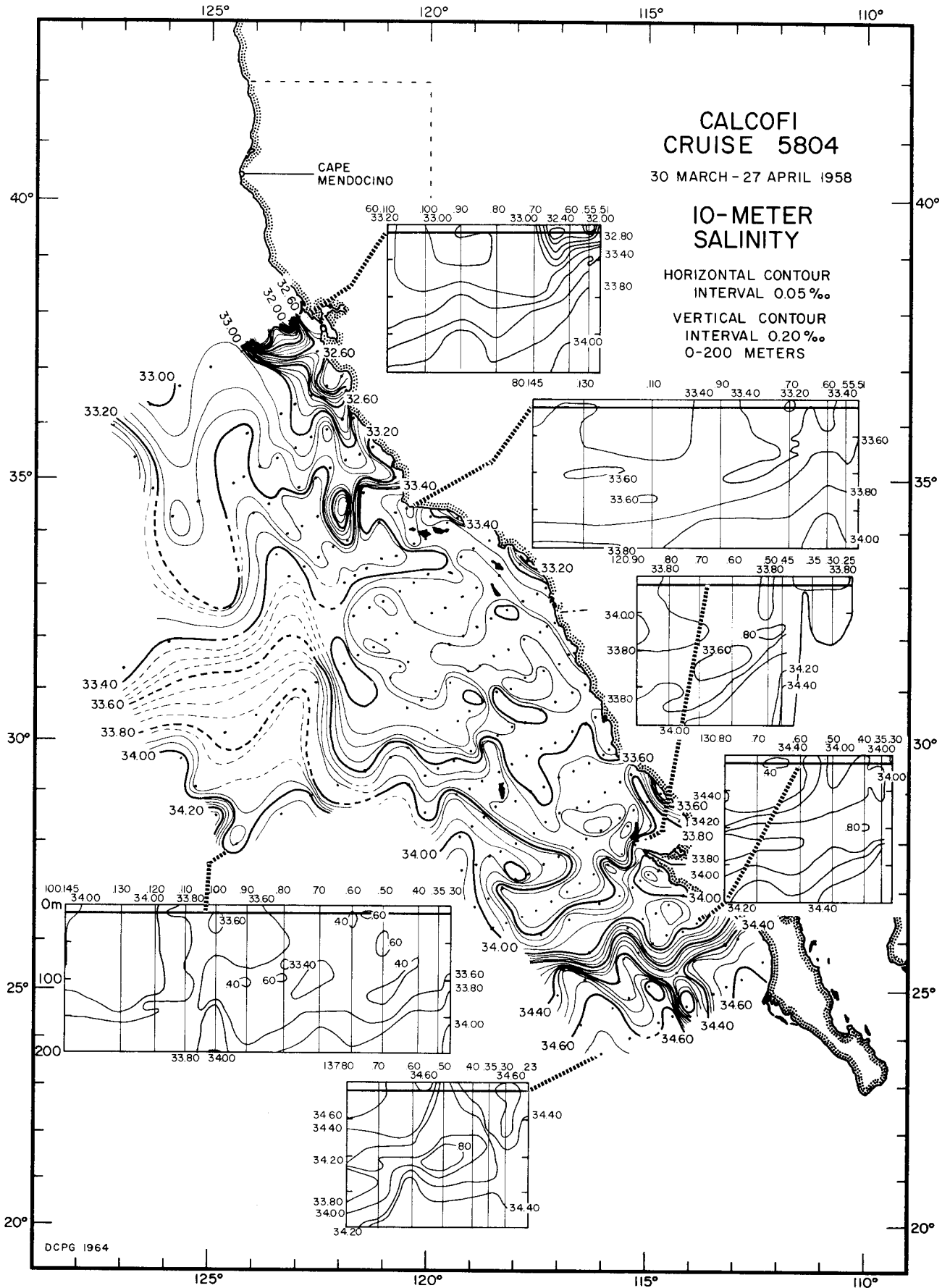
VERTICAL CONTOUR
INTERVAL 1.0°C
0-200 METERS

PUNTA
EUGENIA

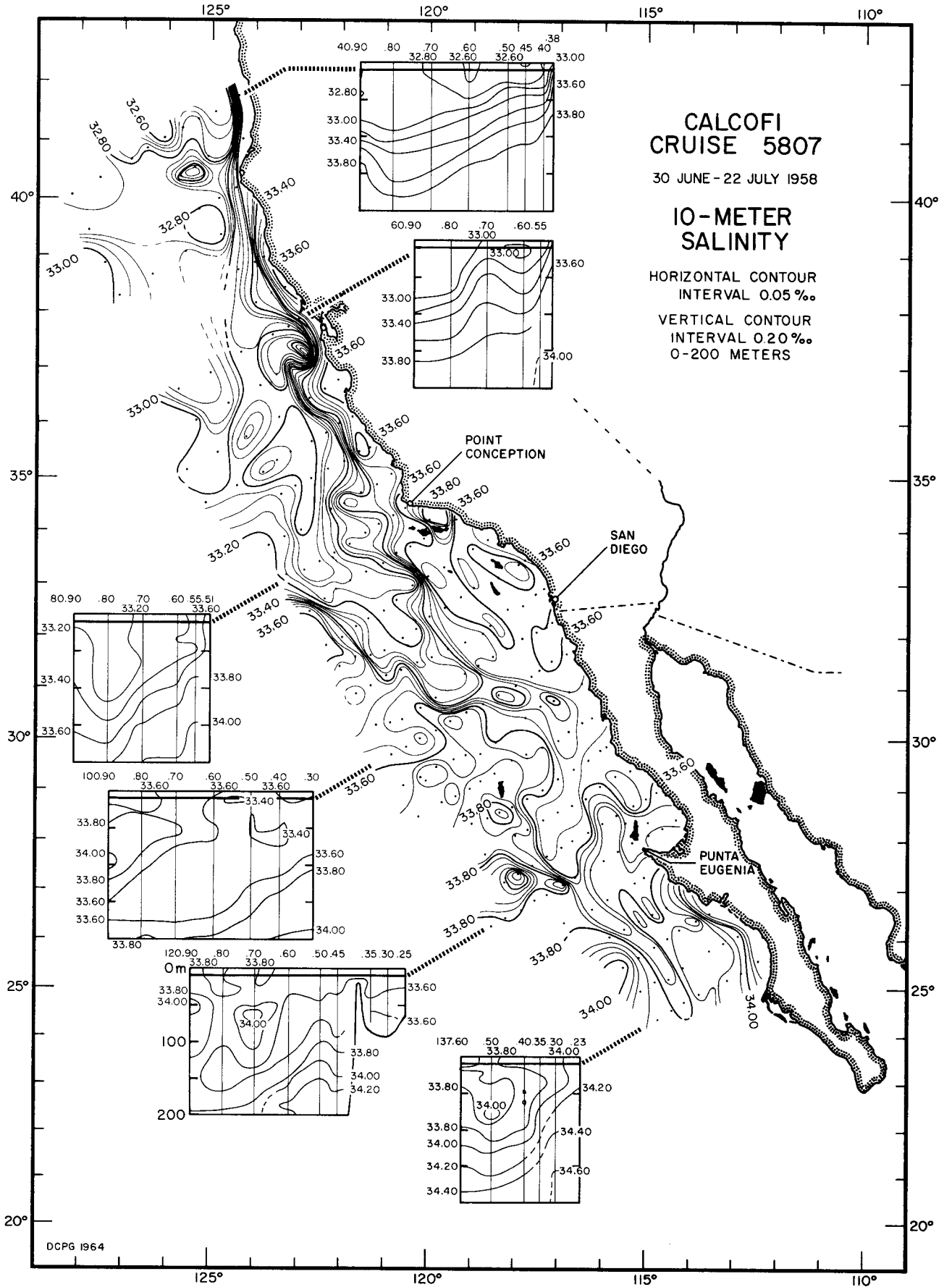
DCPG 1964

140m T
5810

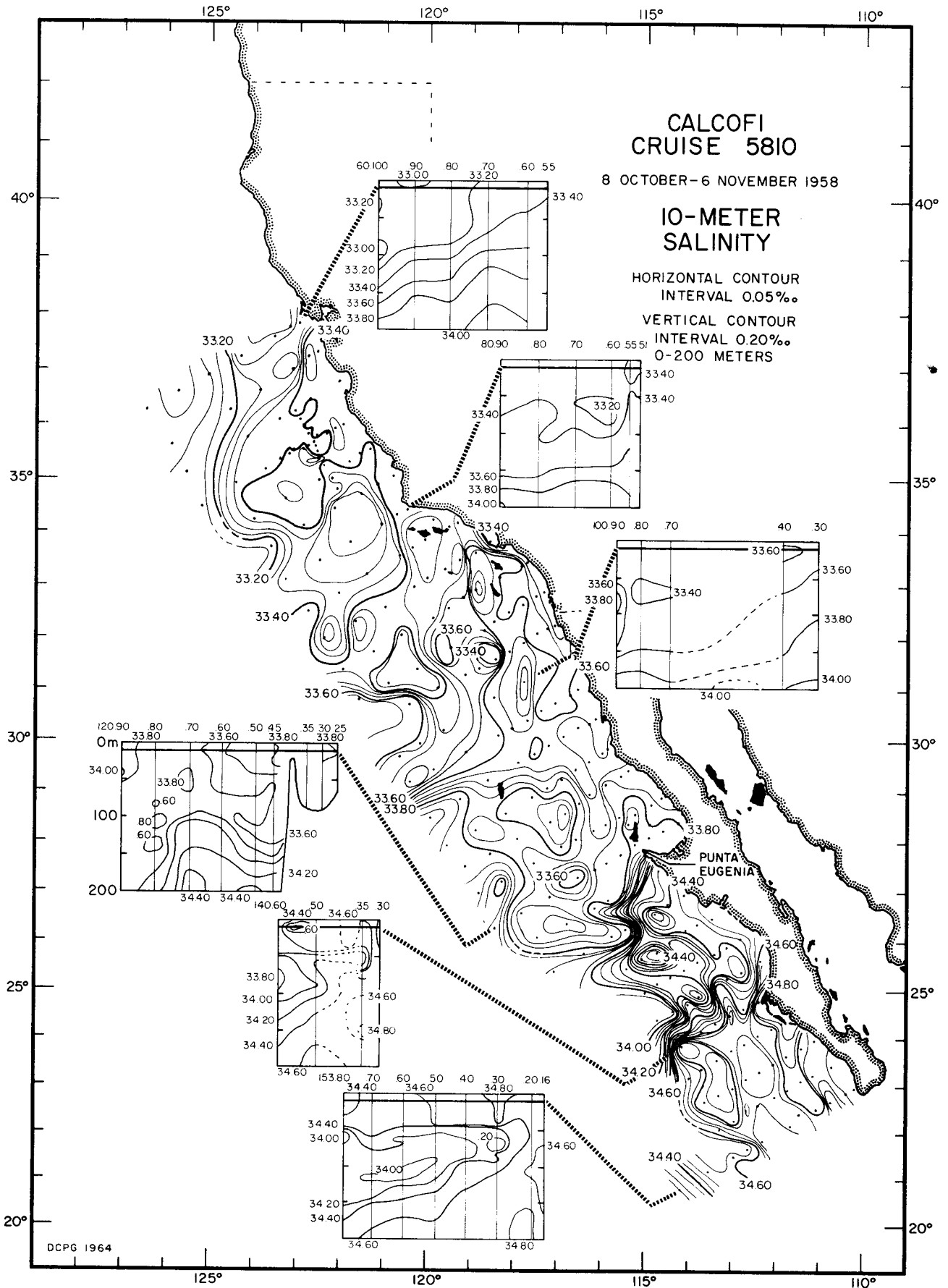




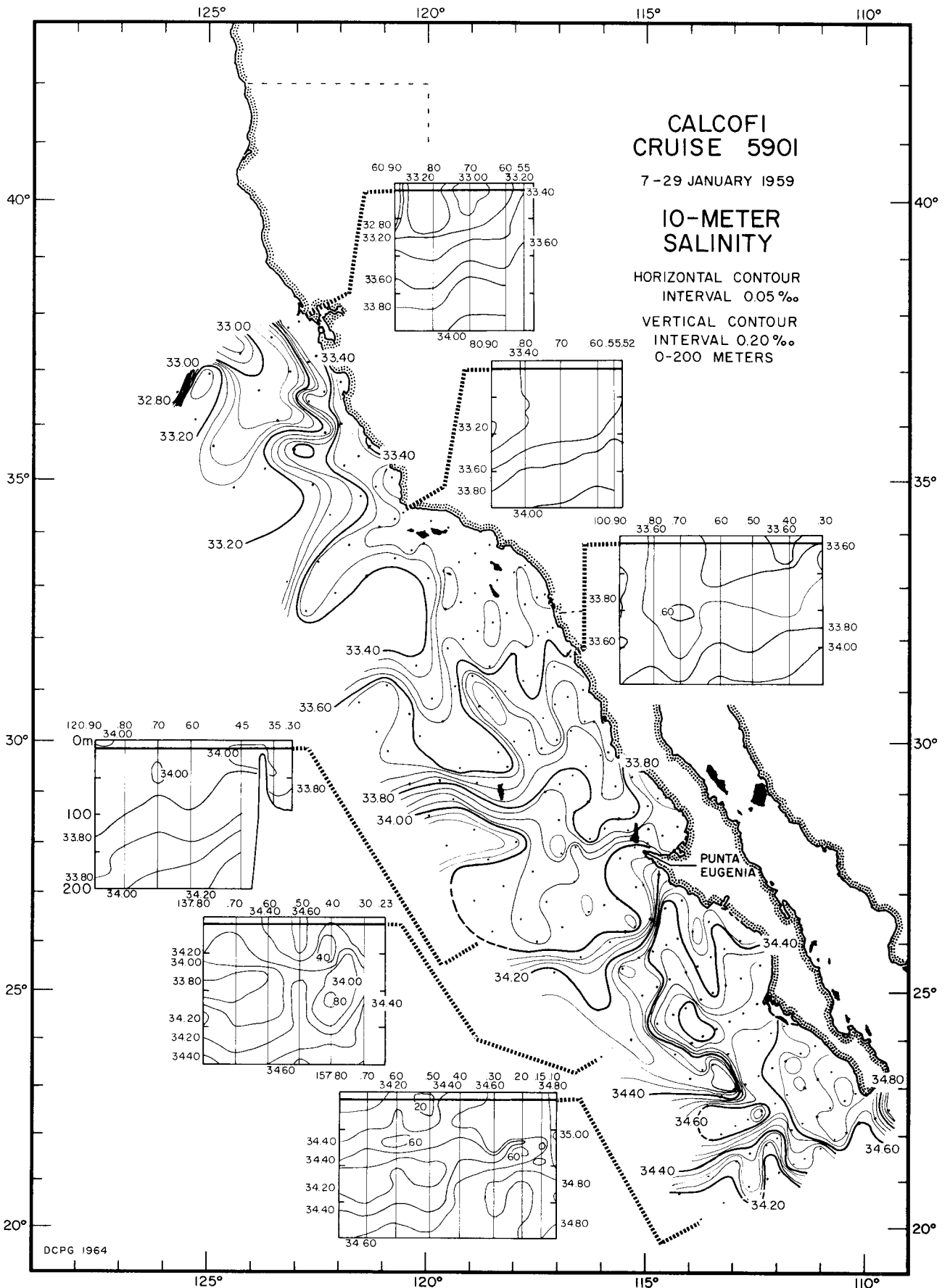
10m S
5804

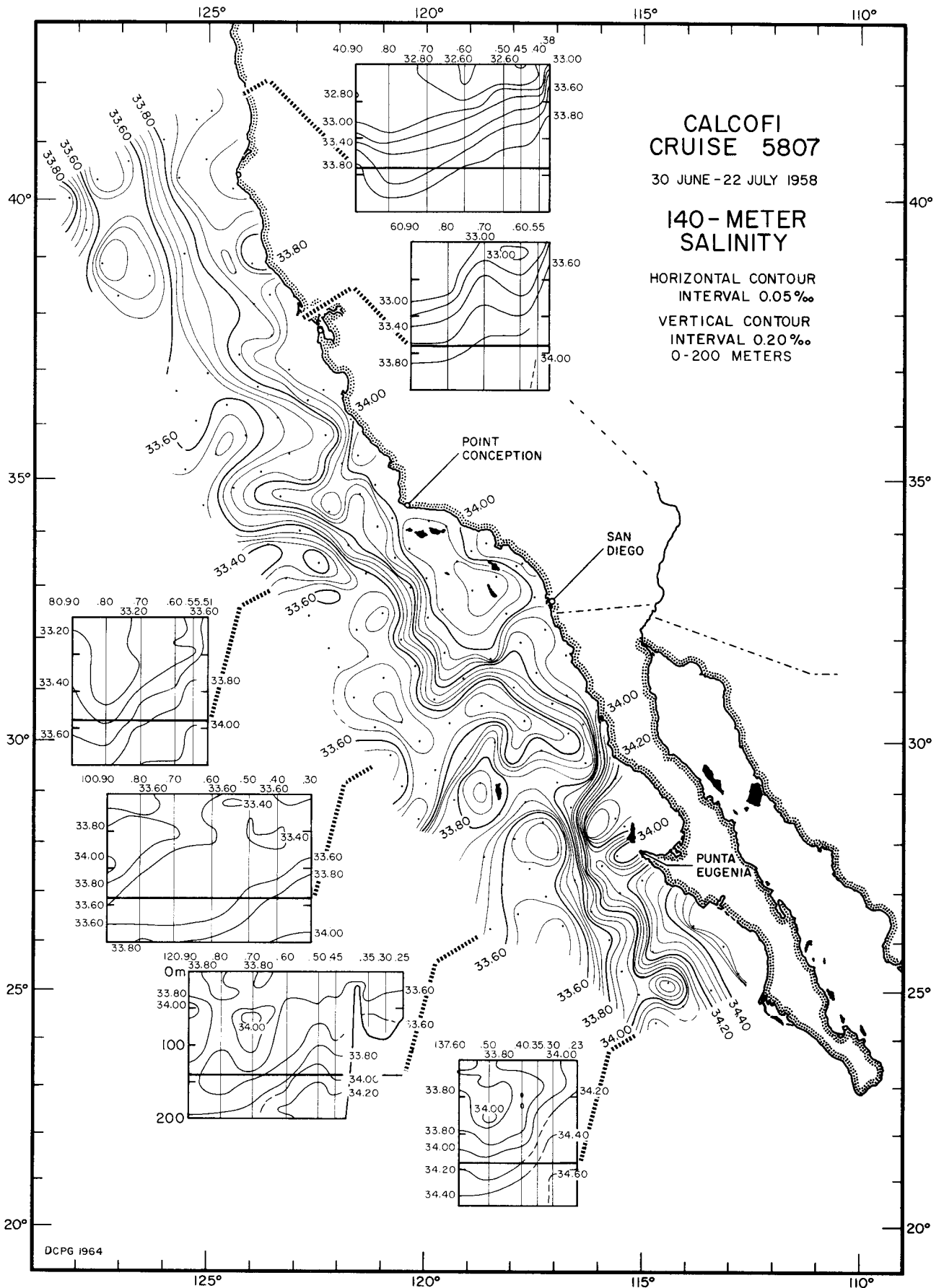


10m S
5807

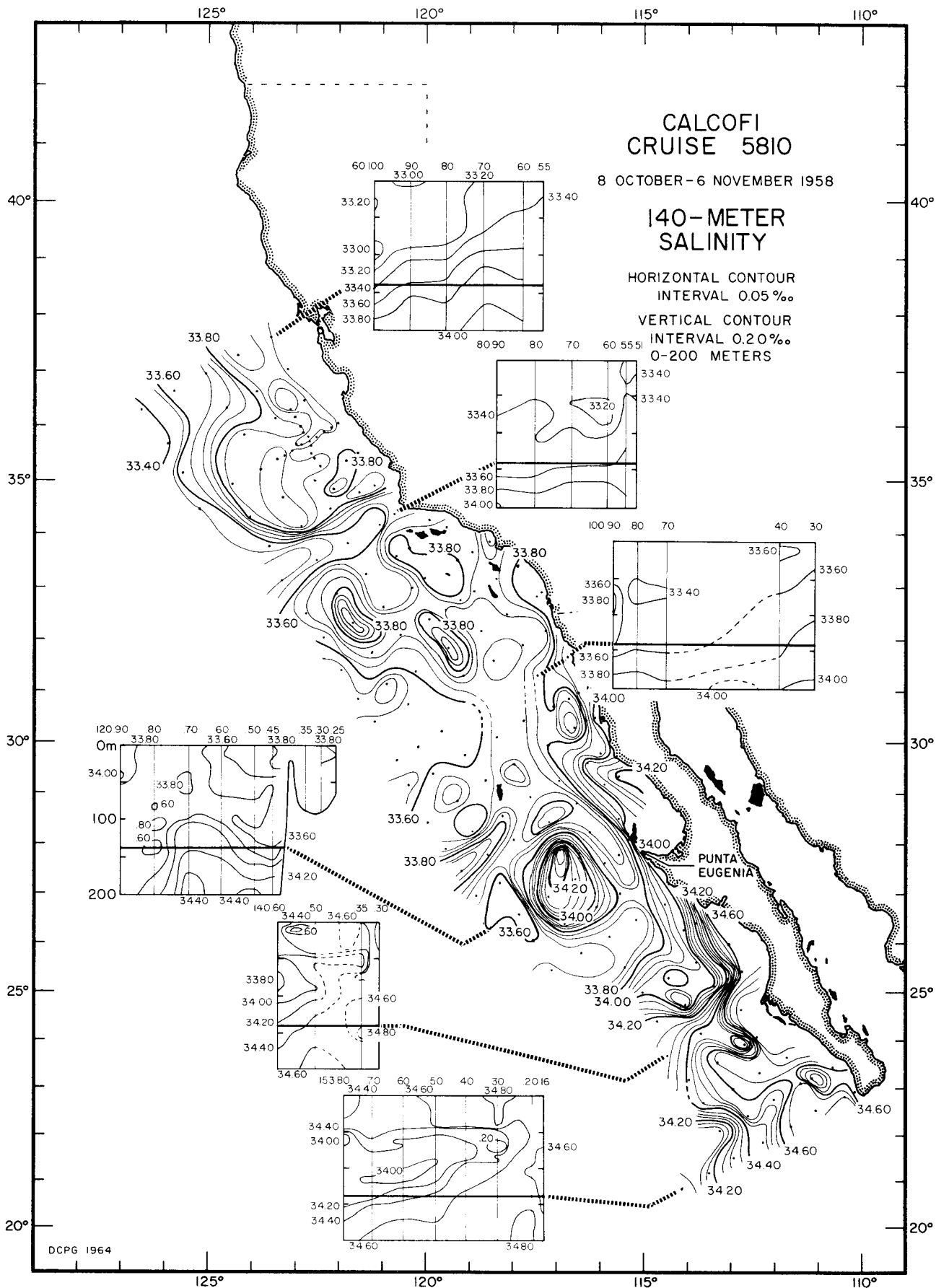


10m S
5810

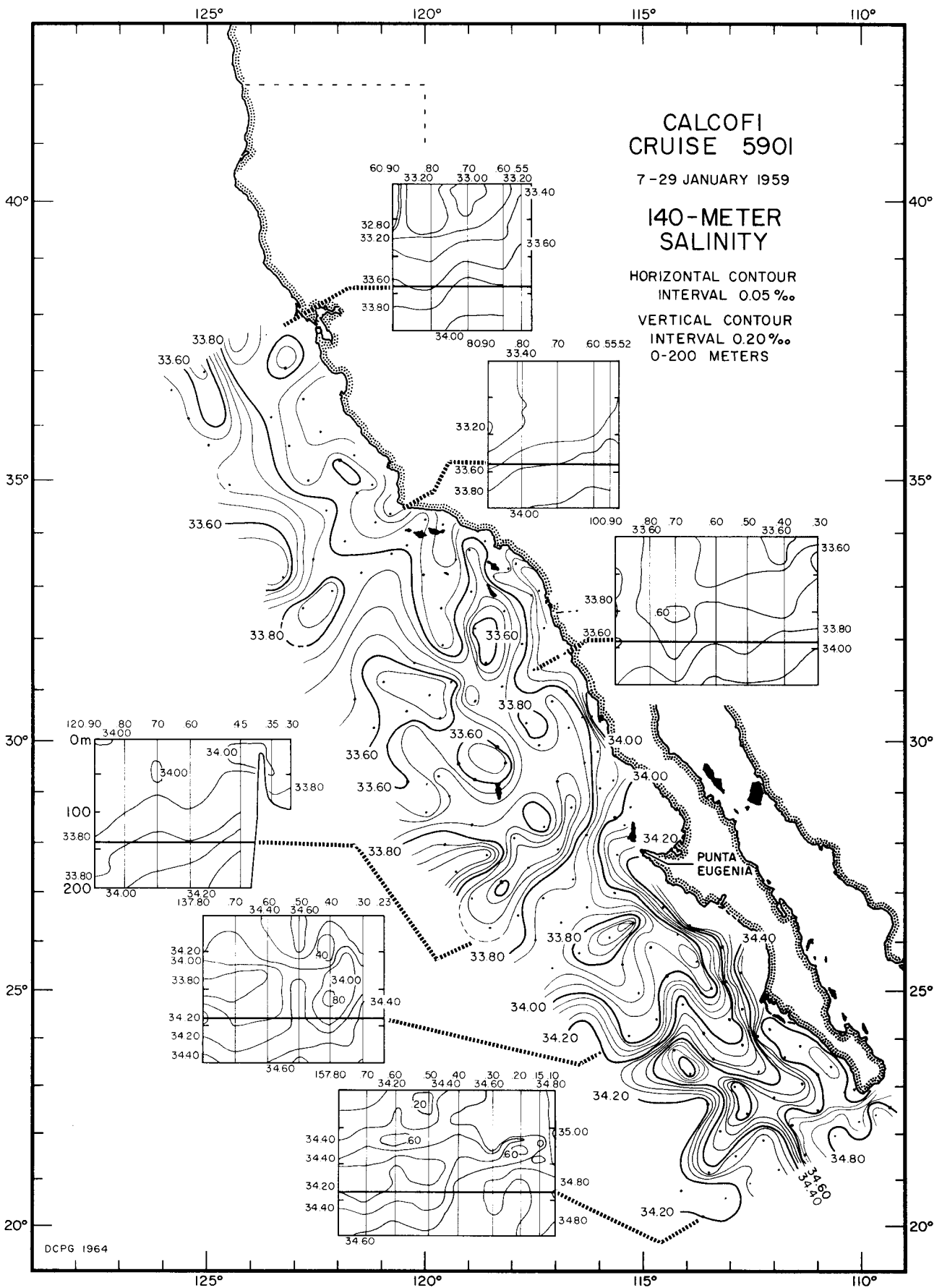




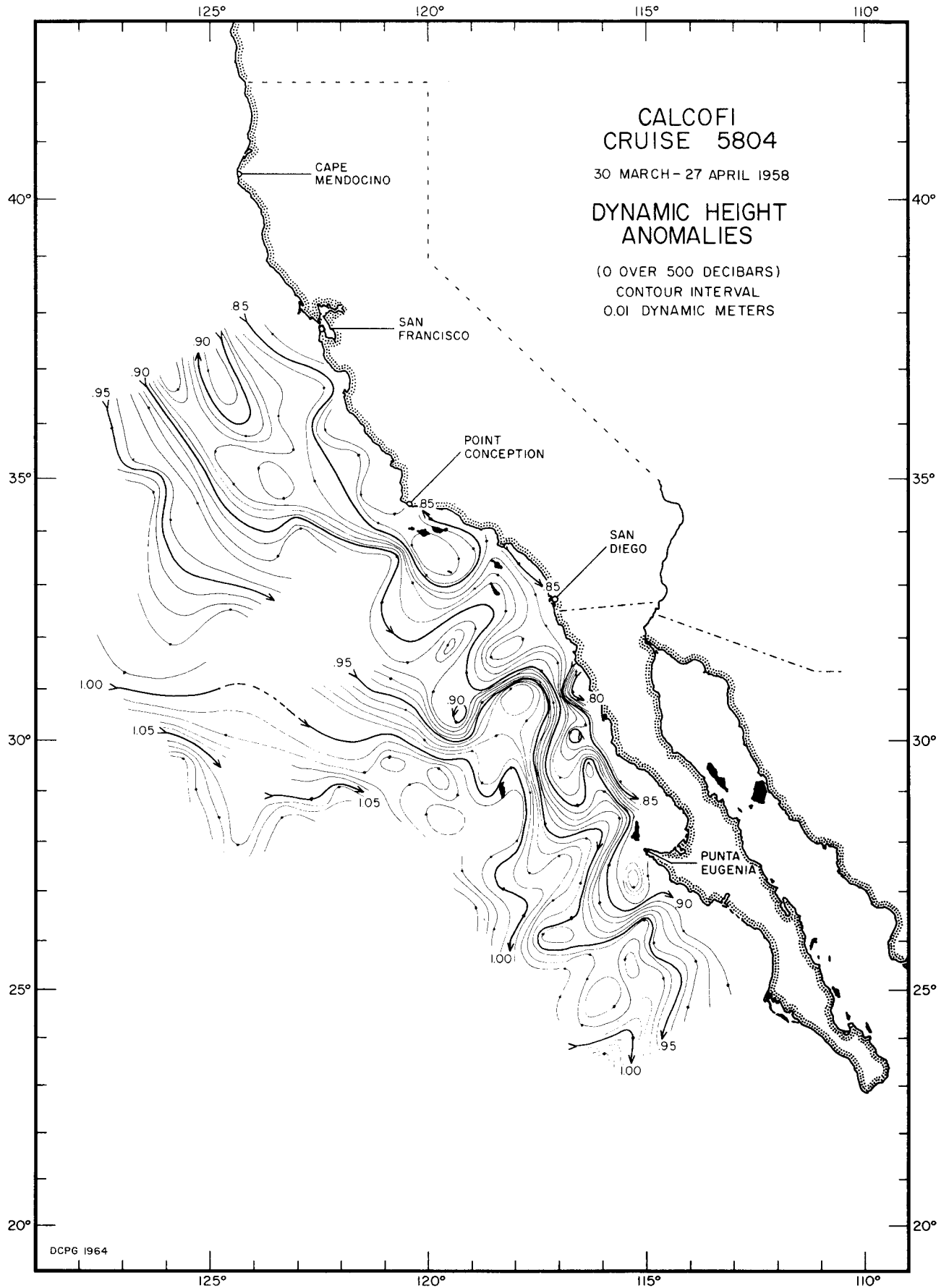
140 m S
5807



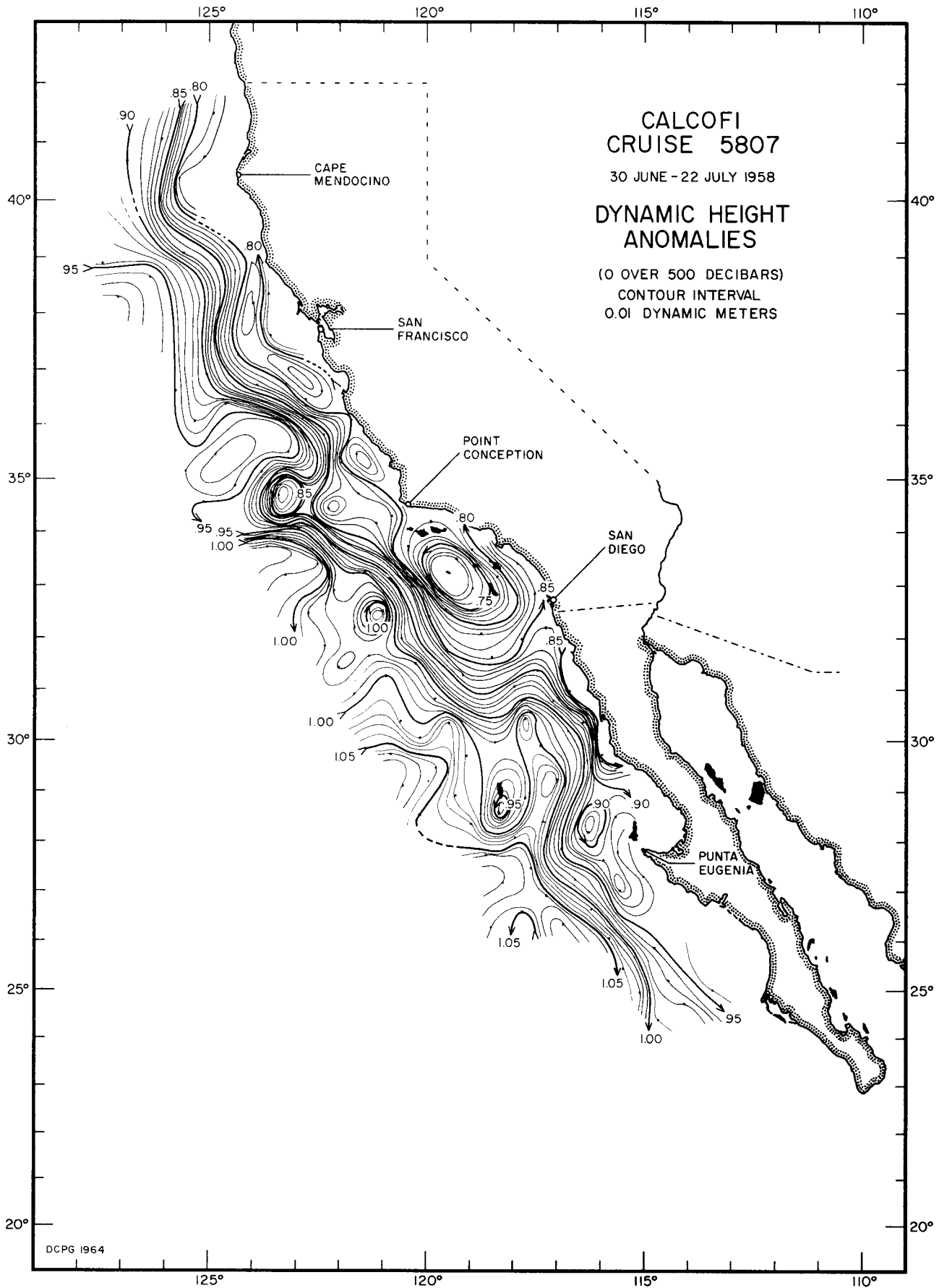
140m S
5810



140m S
5901



ΔD
(0 over 500 db)
5804



CALCOFI
CRUISE 5807

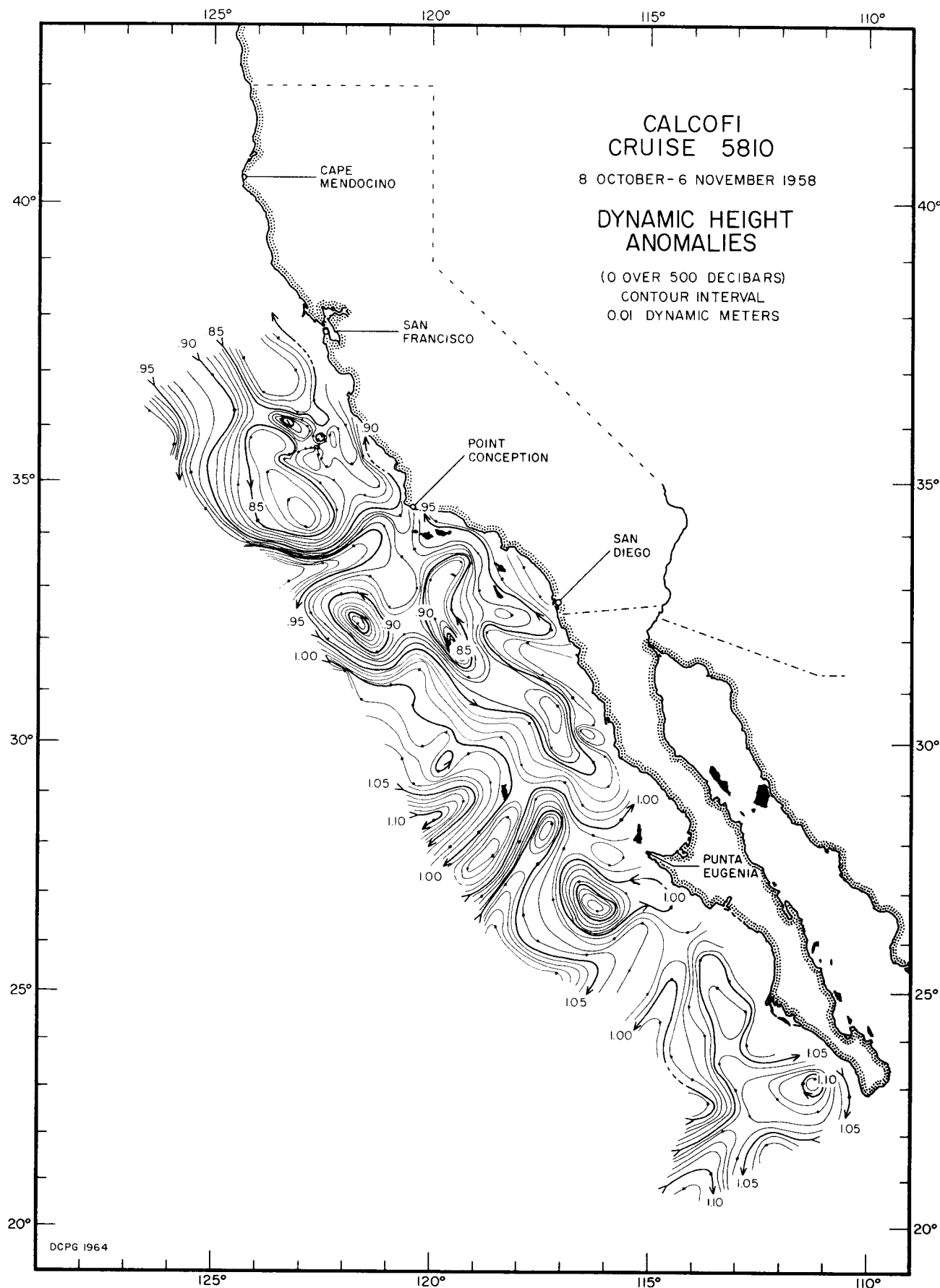
30 JUNE - 22 JULY 1958

DYNAMIC HEIGHT
ANOMALIES

(0 OVER 500 DECIBARS)
CONTOUR INTERVAL
0.01 DYNAMIC METERS

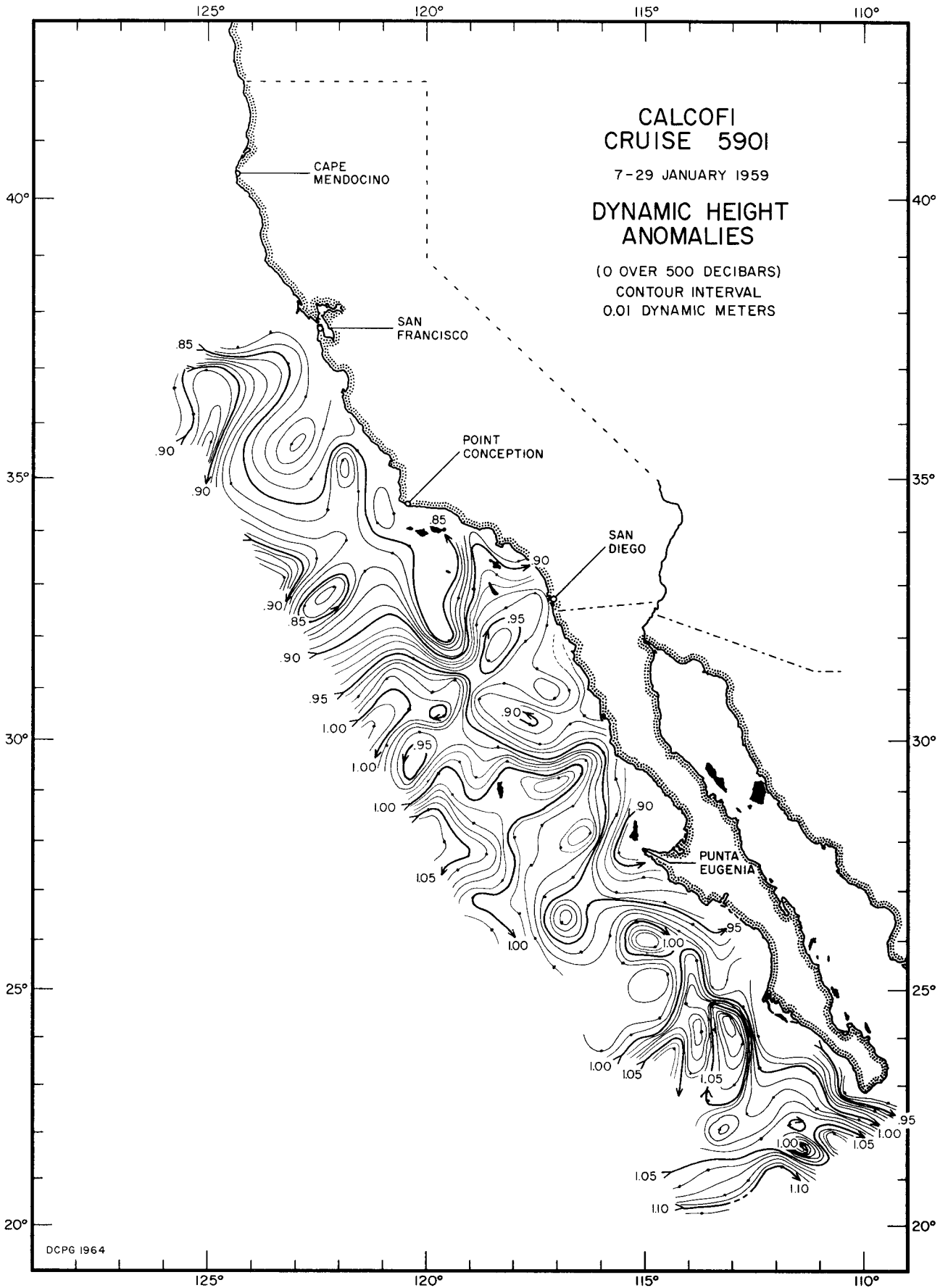
DCPG 1964

ΔD
(0 over 500 db)
5807

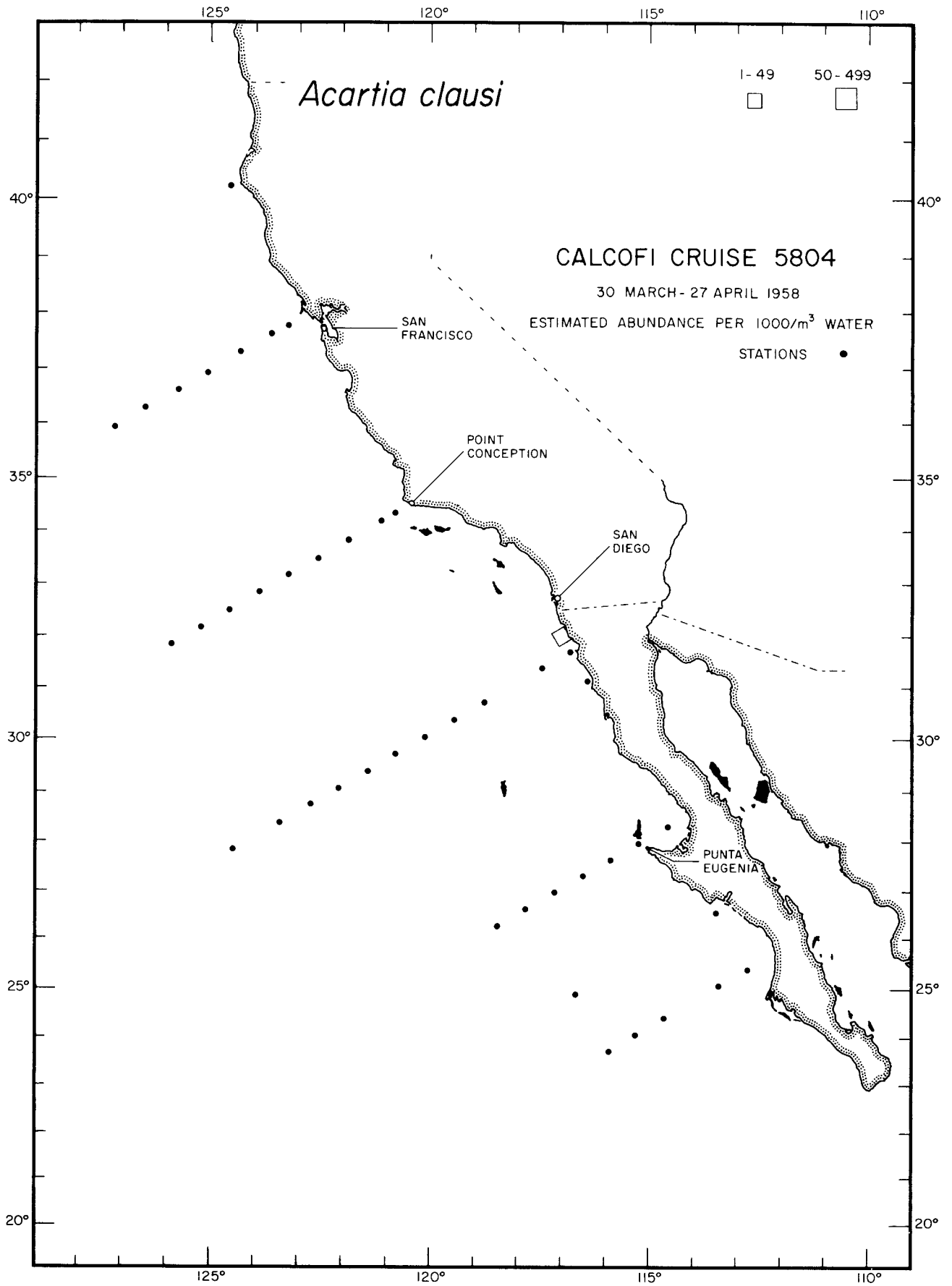


DCPG 1964

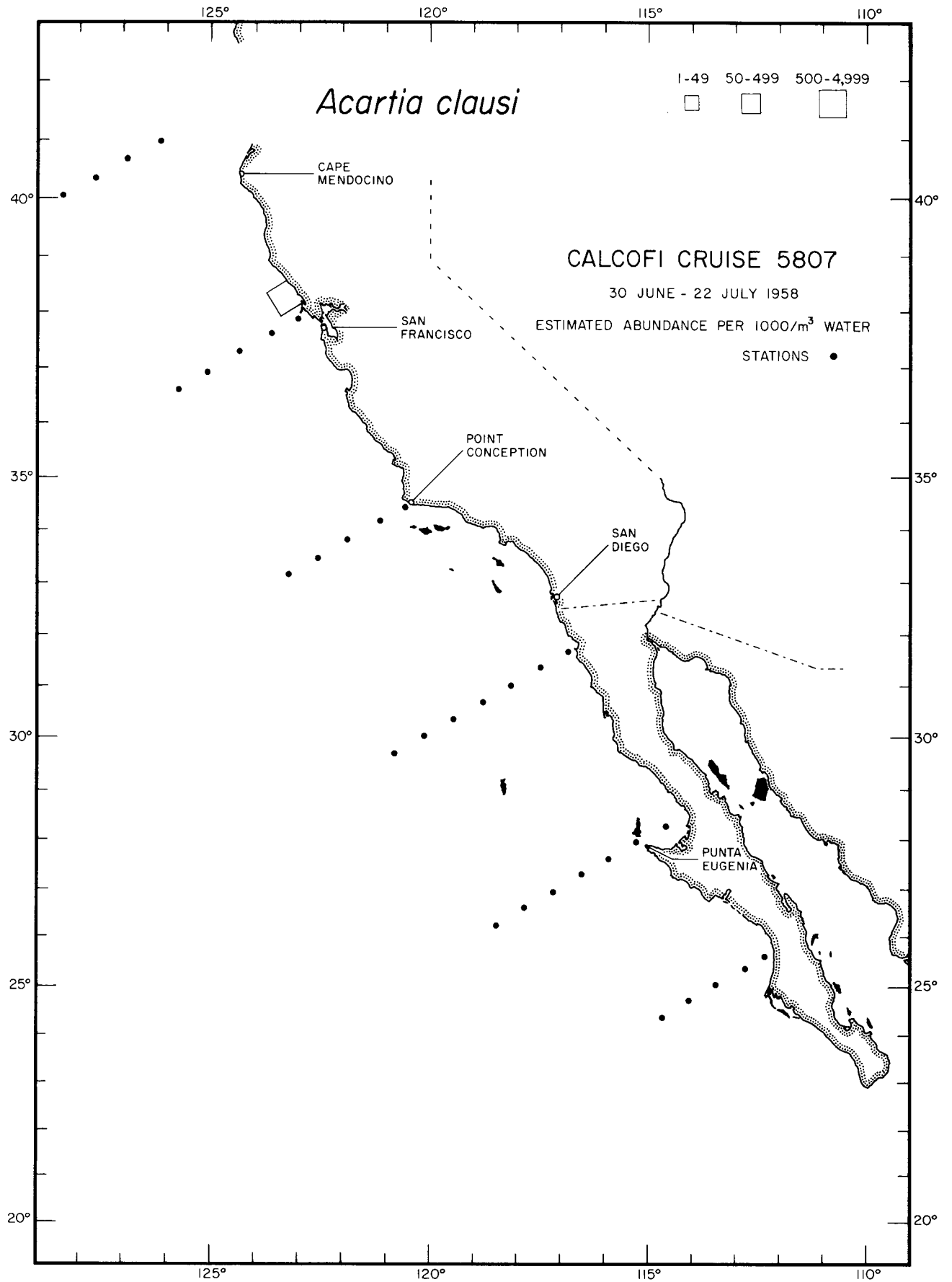
ΔD
(0 over 500 db)
5810



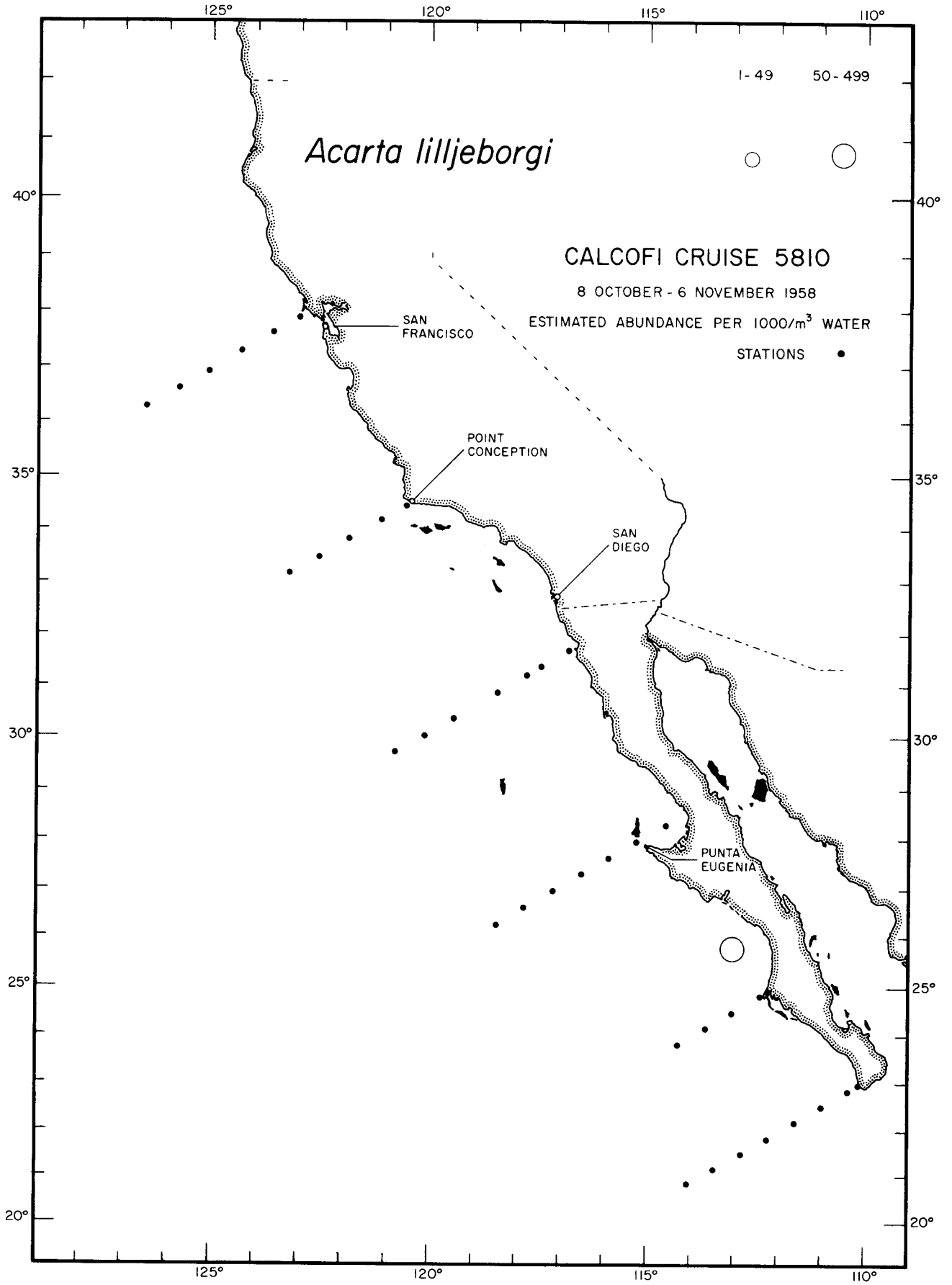
ΔD
(0 over 500 db)
5901



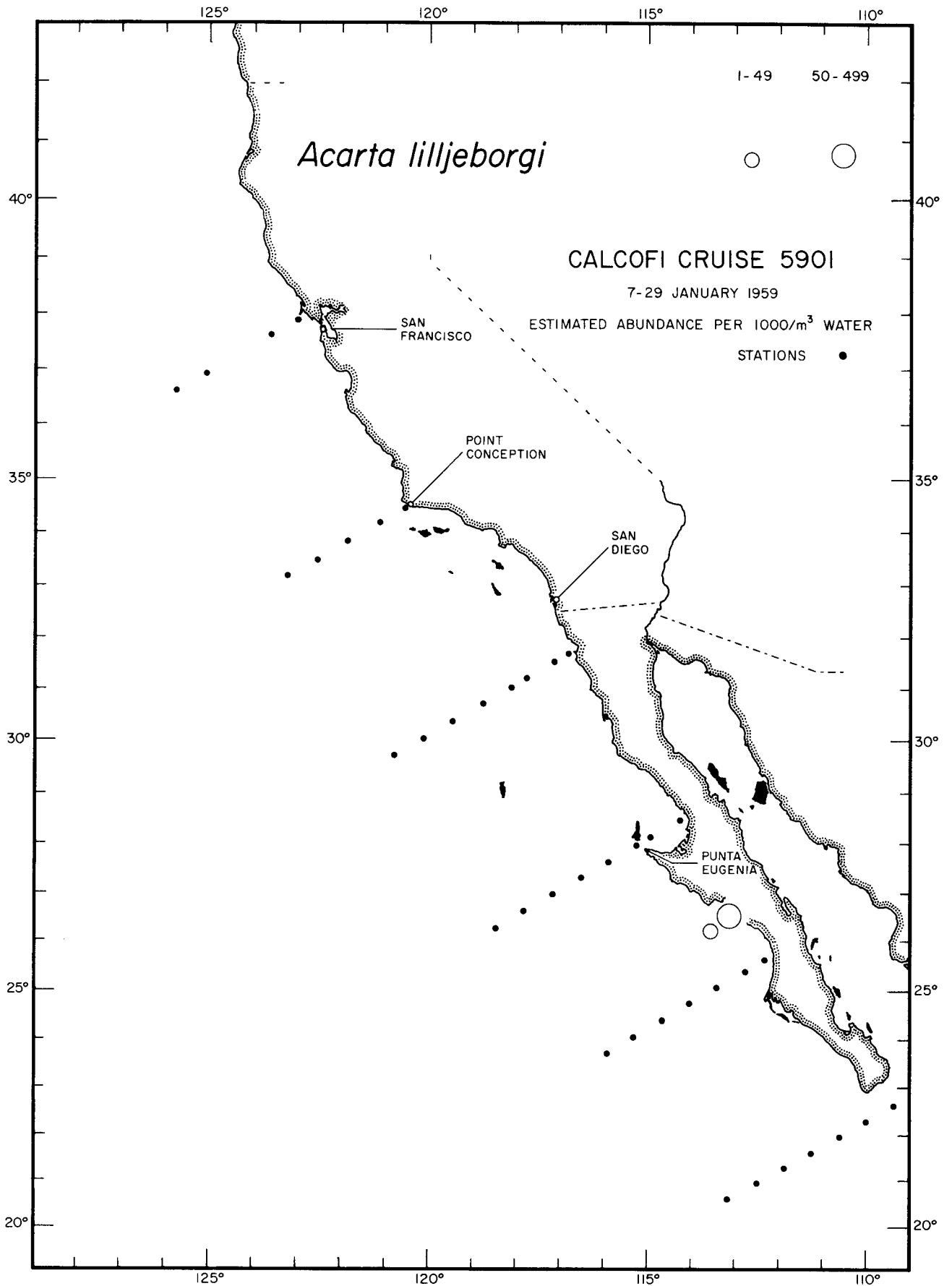
Calanoida
Acartia clausi
5804



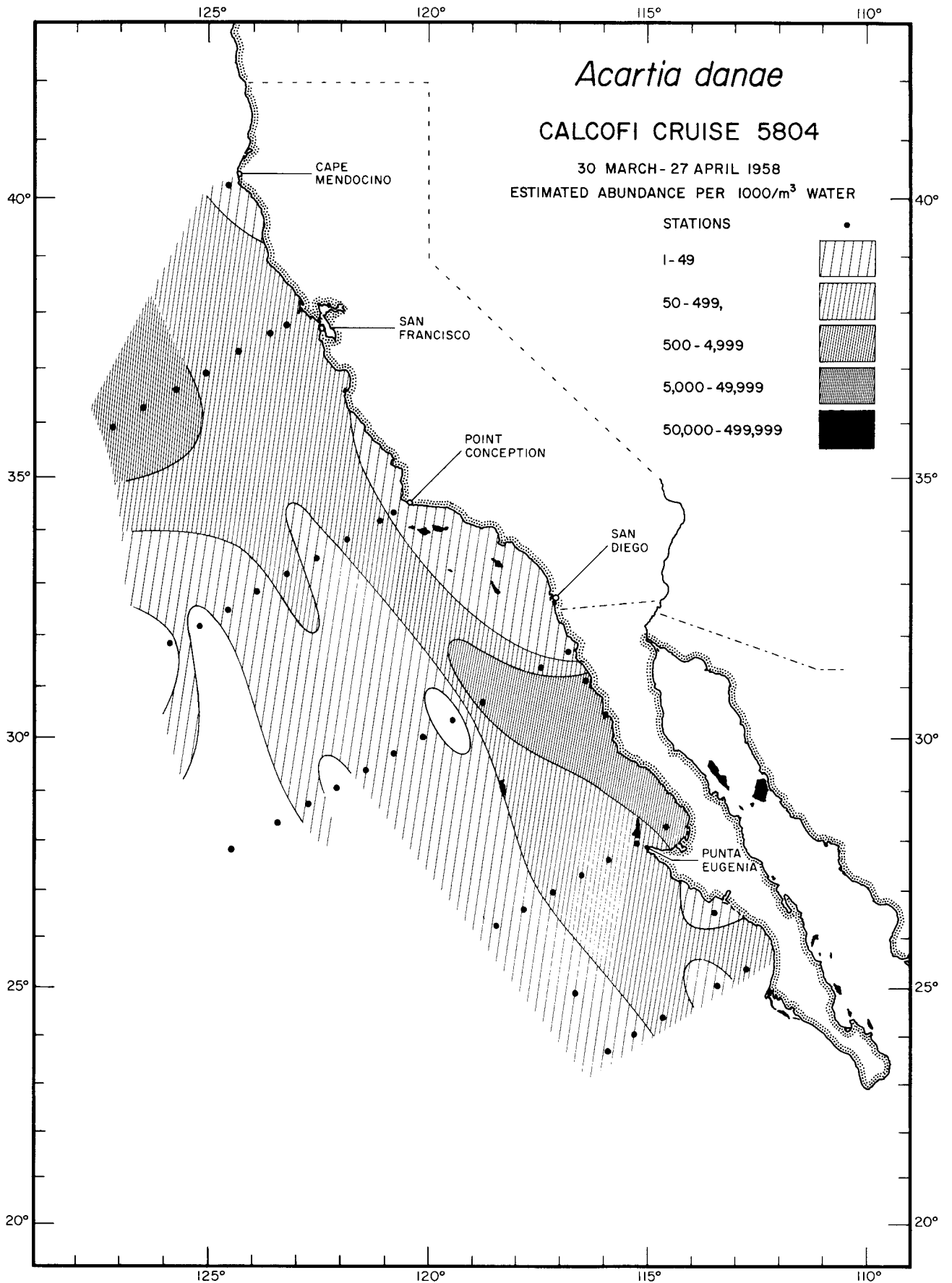
Calanoida
Acartia clausi
5807



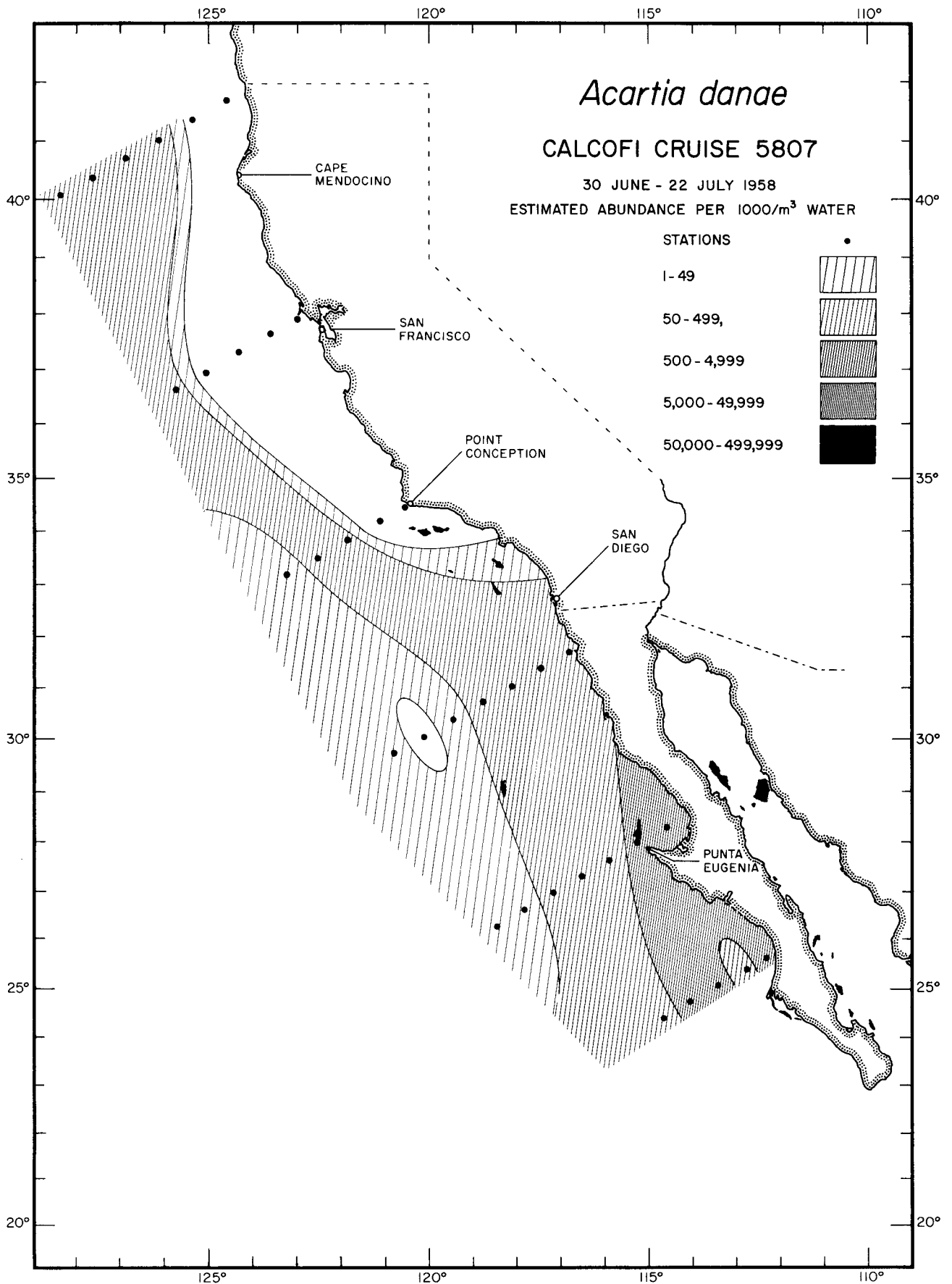
Calanoida
Acartia lilljeborgi
5810

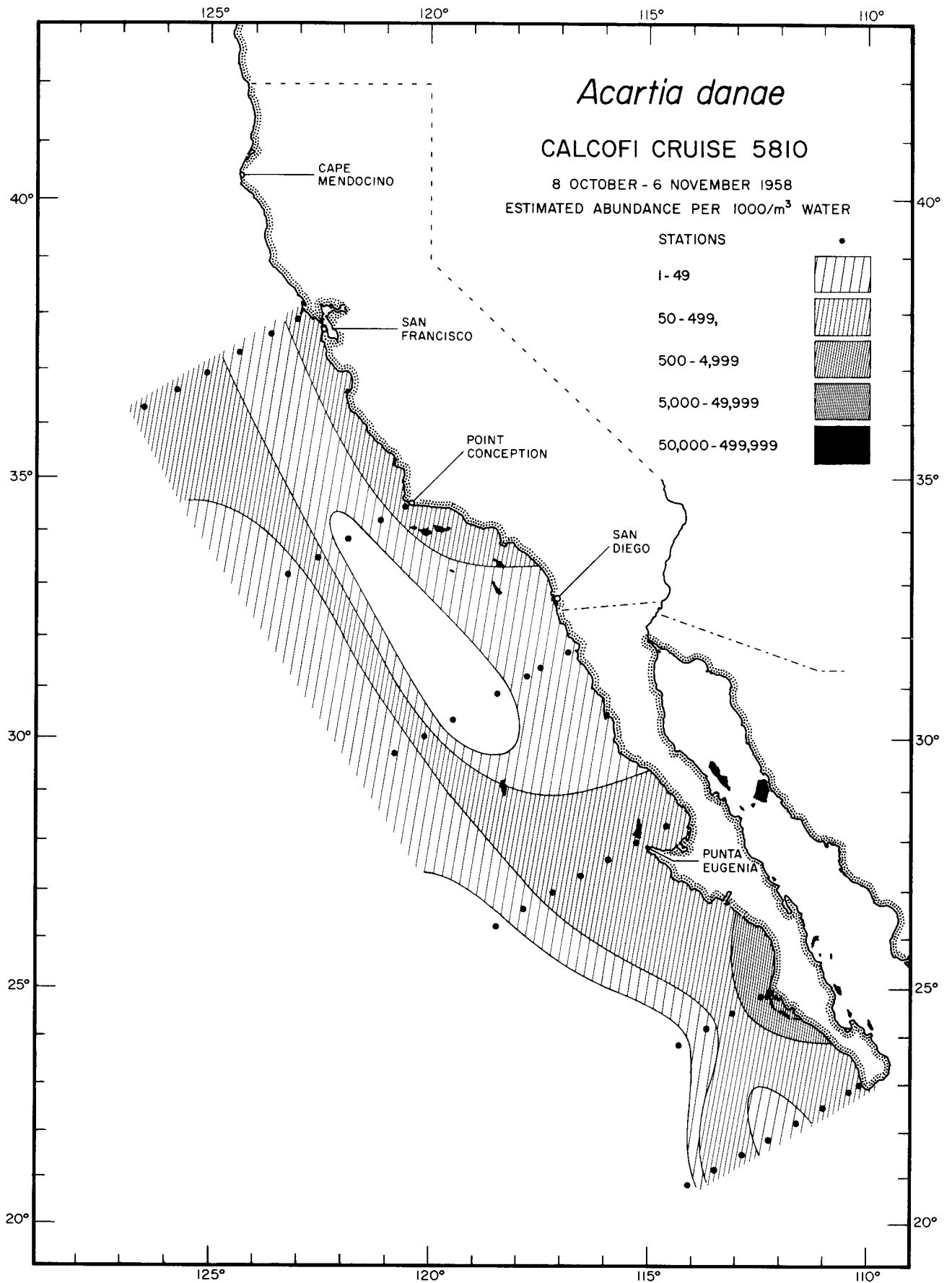


Calanoida
Acartia lilljeborgi
5901

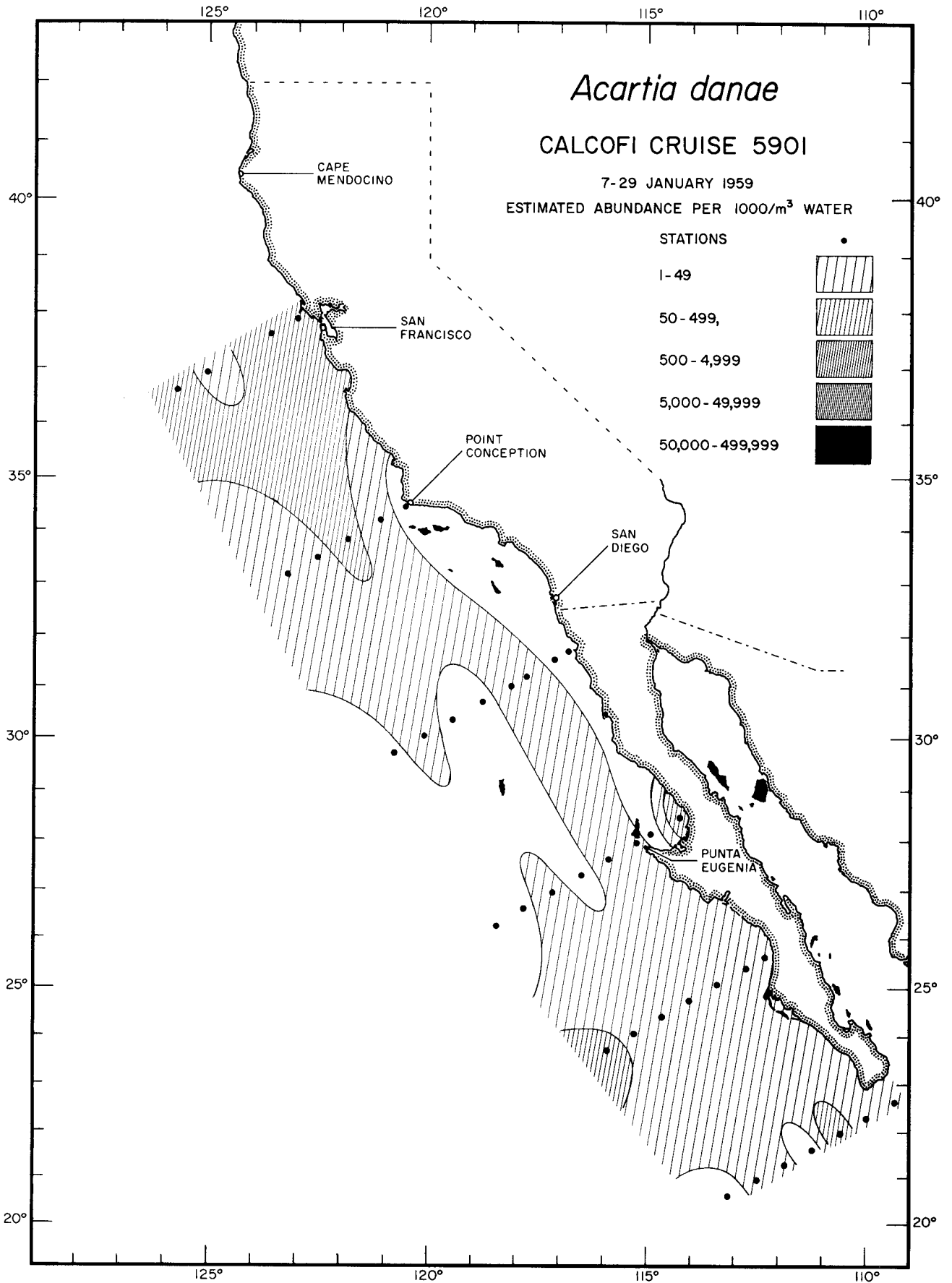


Calanoida
Acartia danae
5804

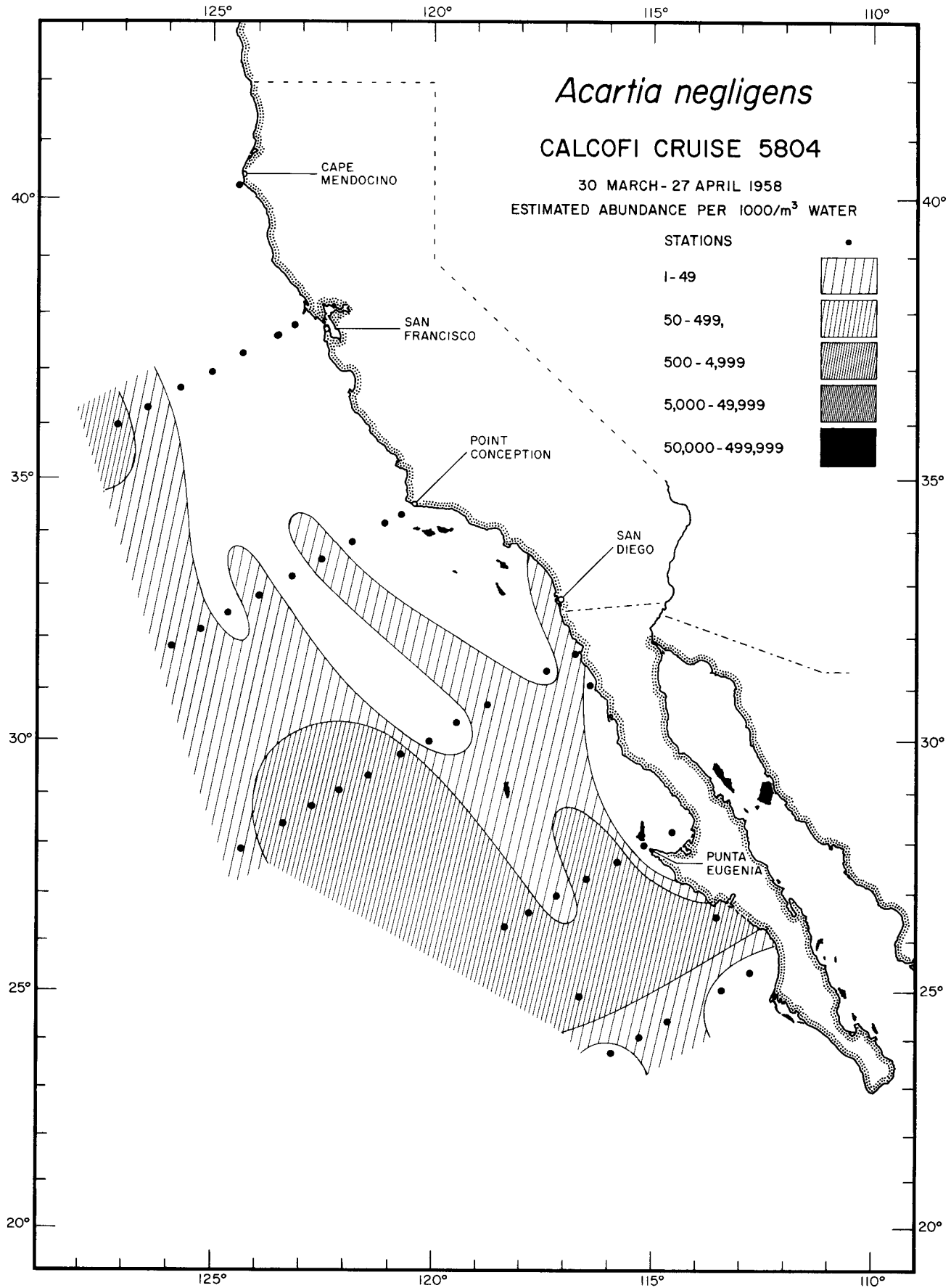




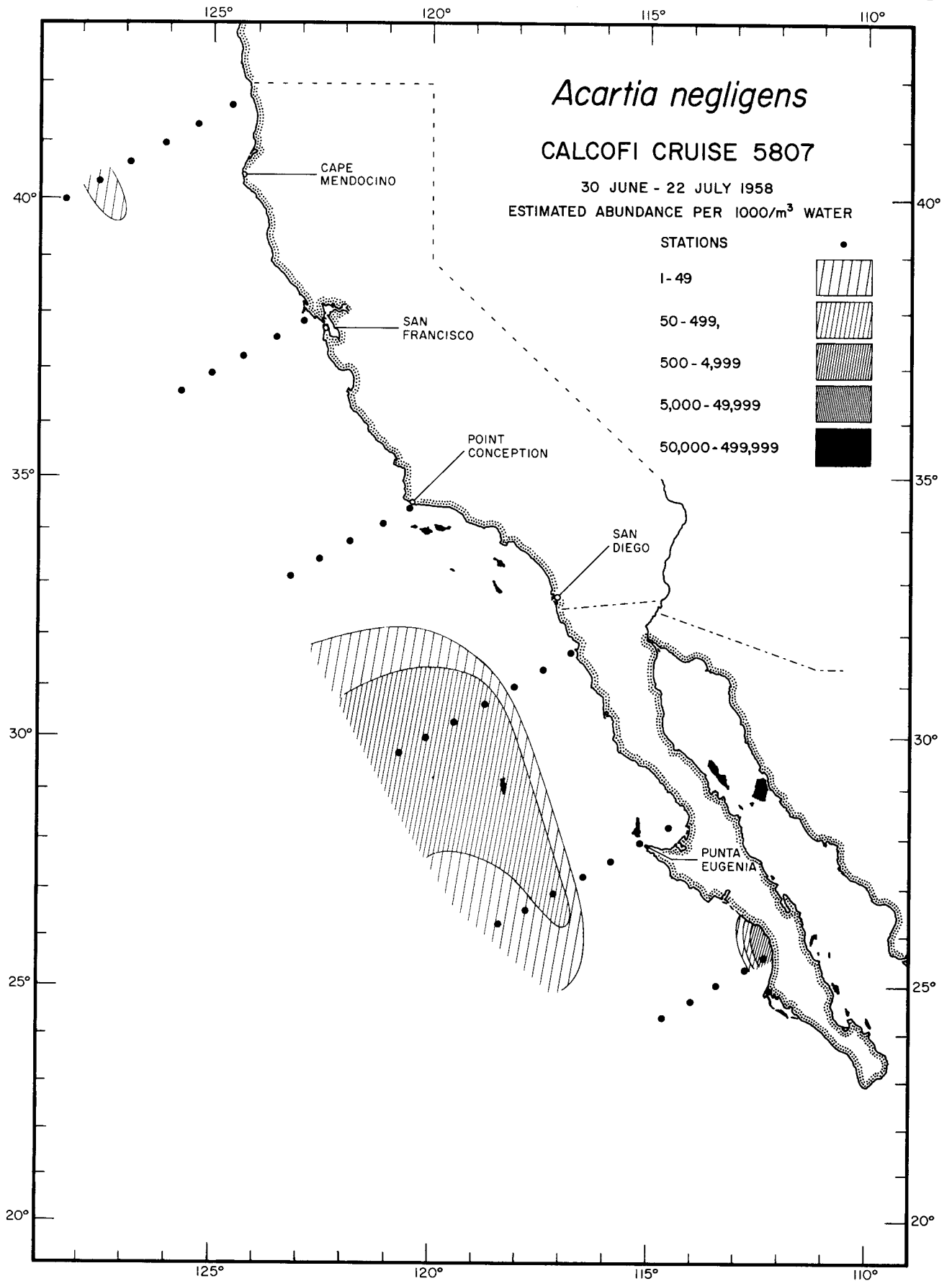
Calanoida
Acartia danae
5810



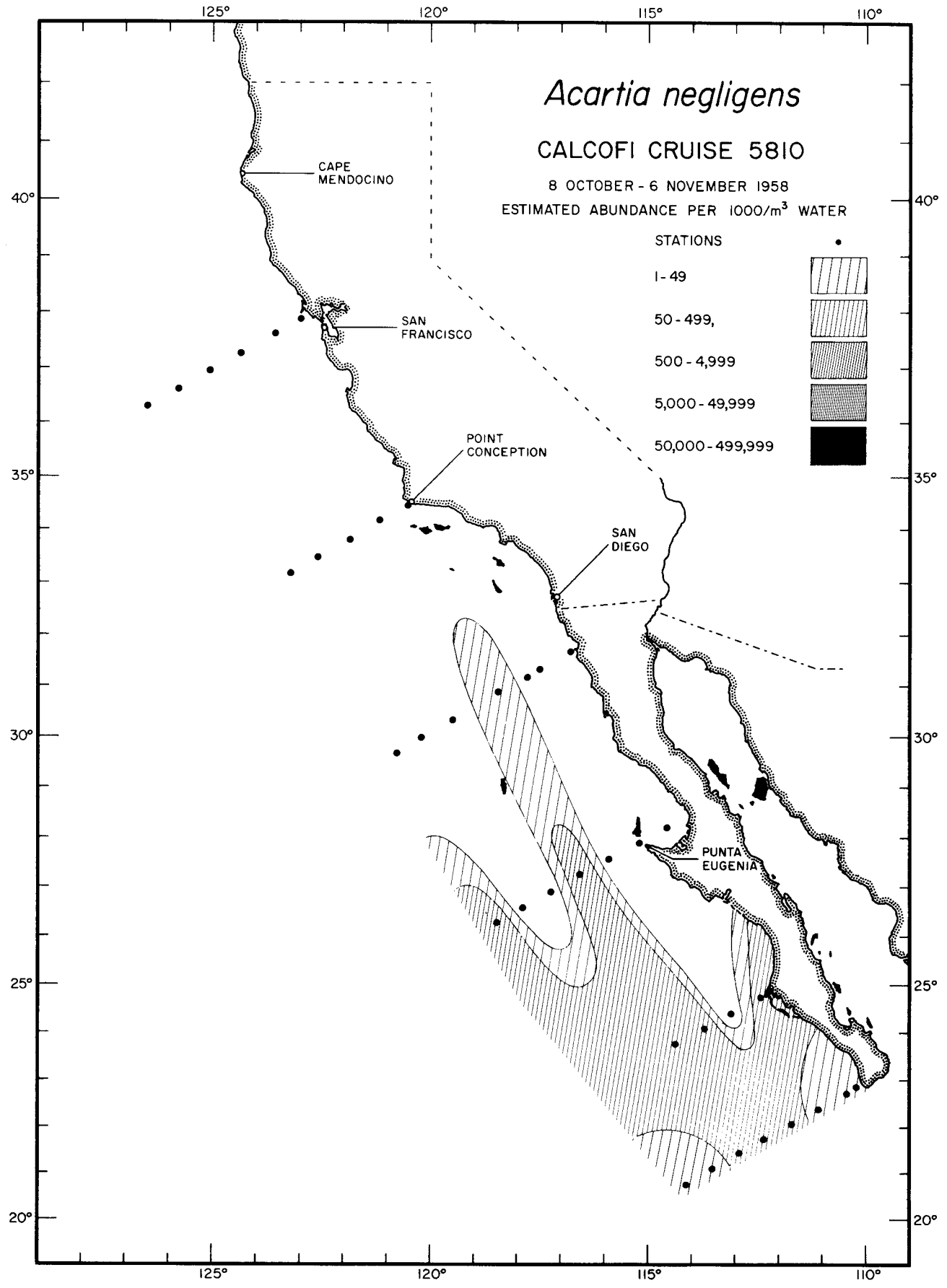
Calanoida
Acartia danae
5901



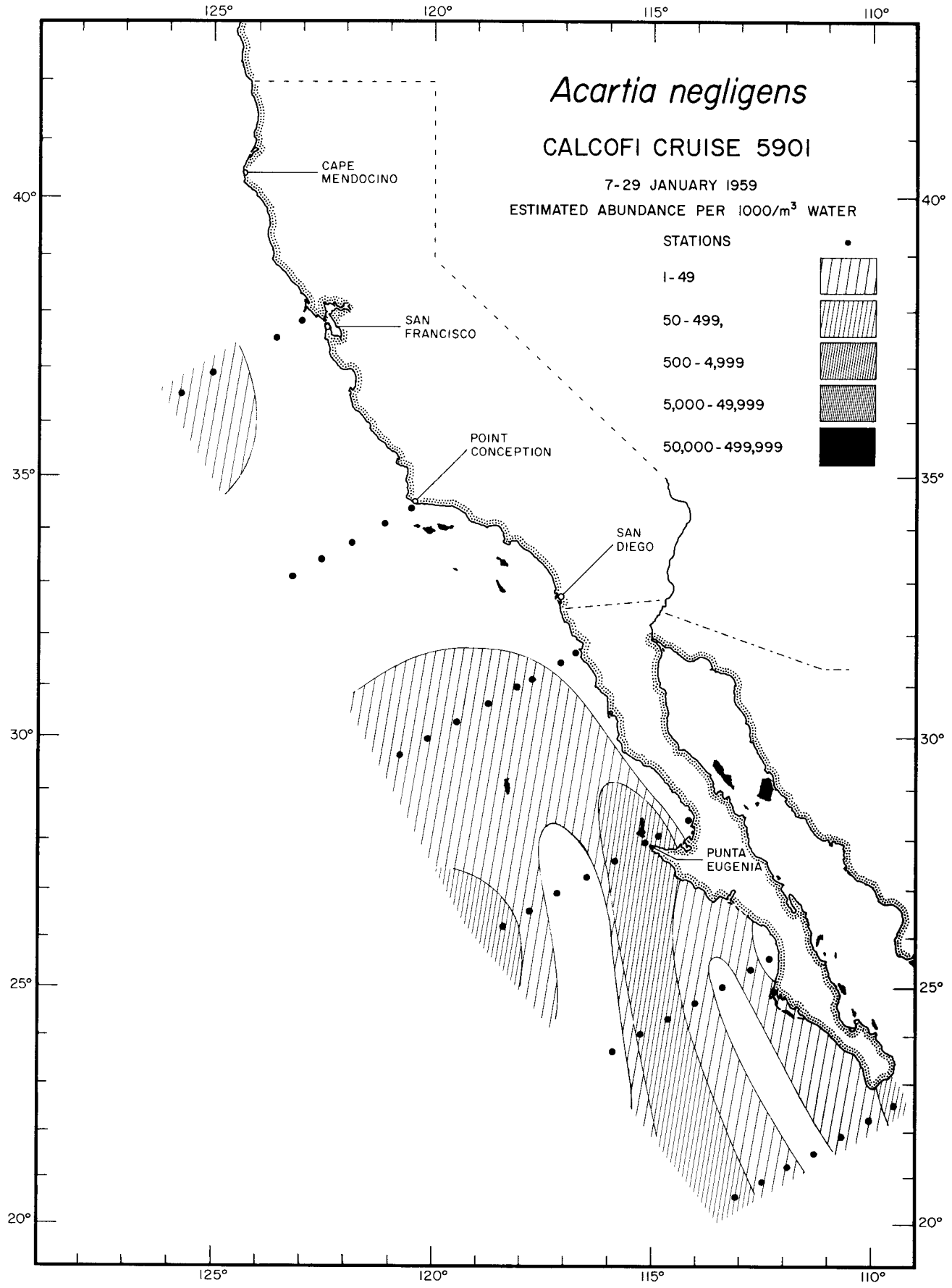
Calanoida
Acartia negligens
5804



Calanoida
Acartia negligens
5807



Calanoida
Acartia negligens
5810



Acartia negligens

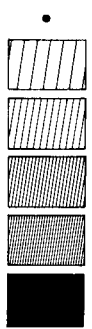
CALCOFI CRUISE 5901

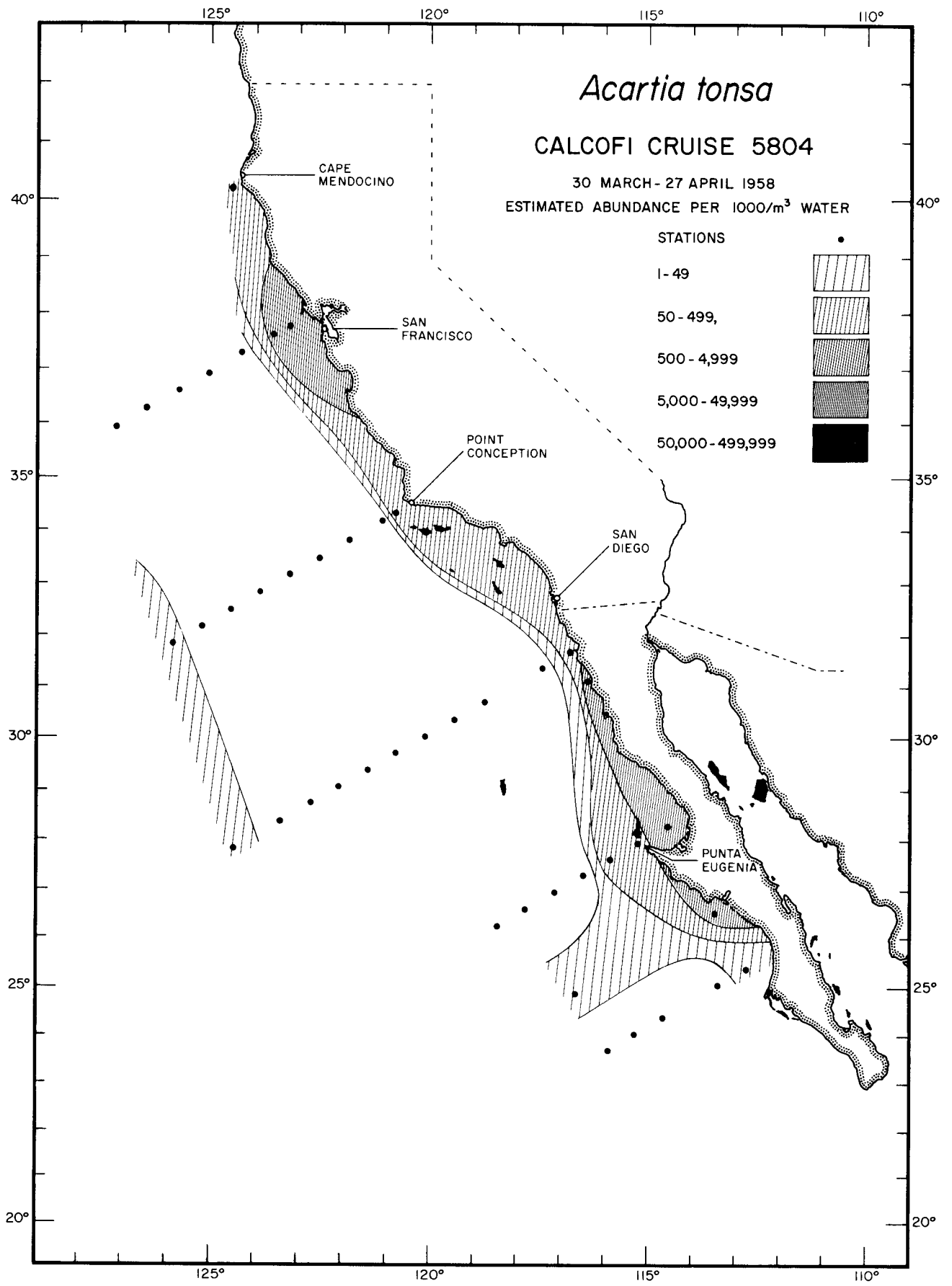
7-29 JANUARY 1959

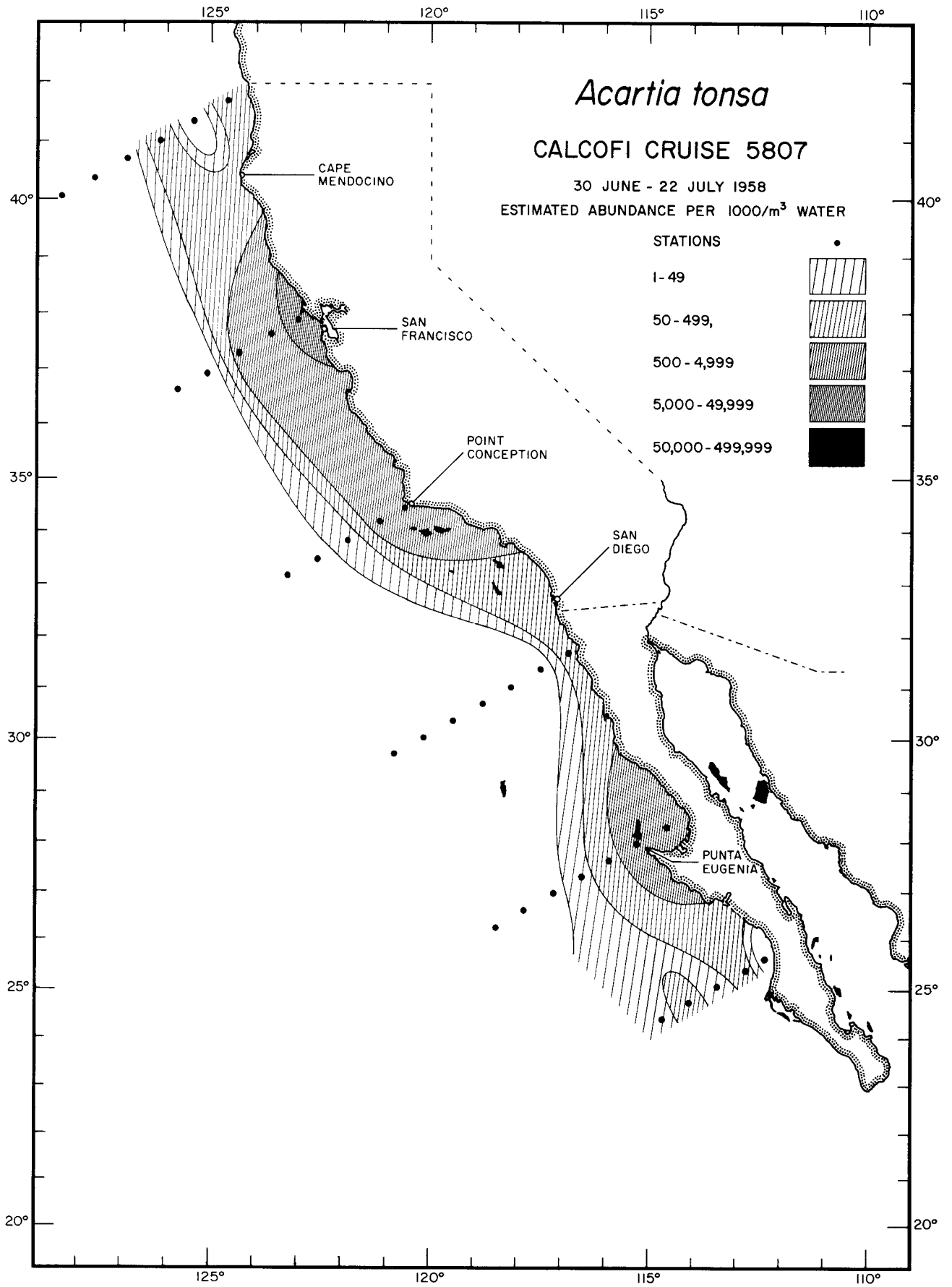
ESTIMATED ABUNDANCE PER 1000/m³ WATER

STATIONS

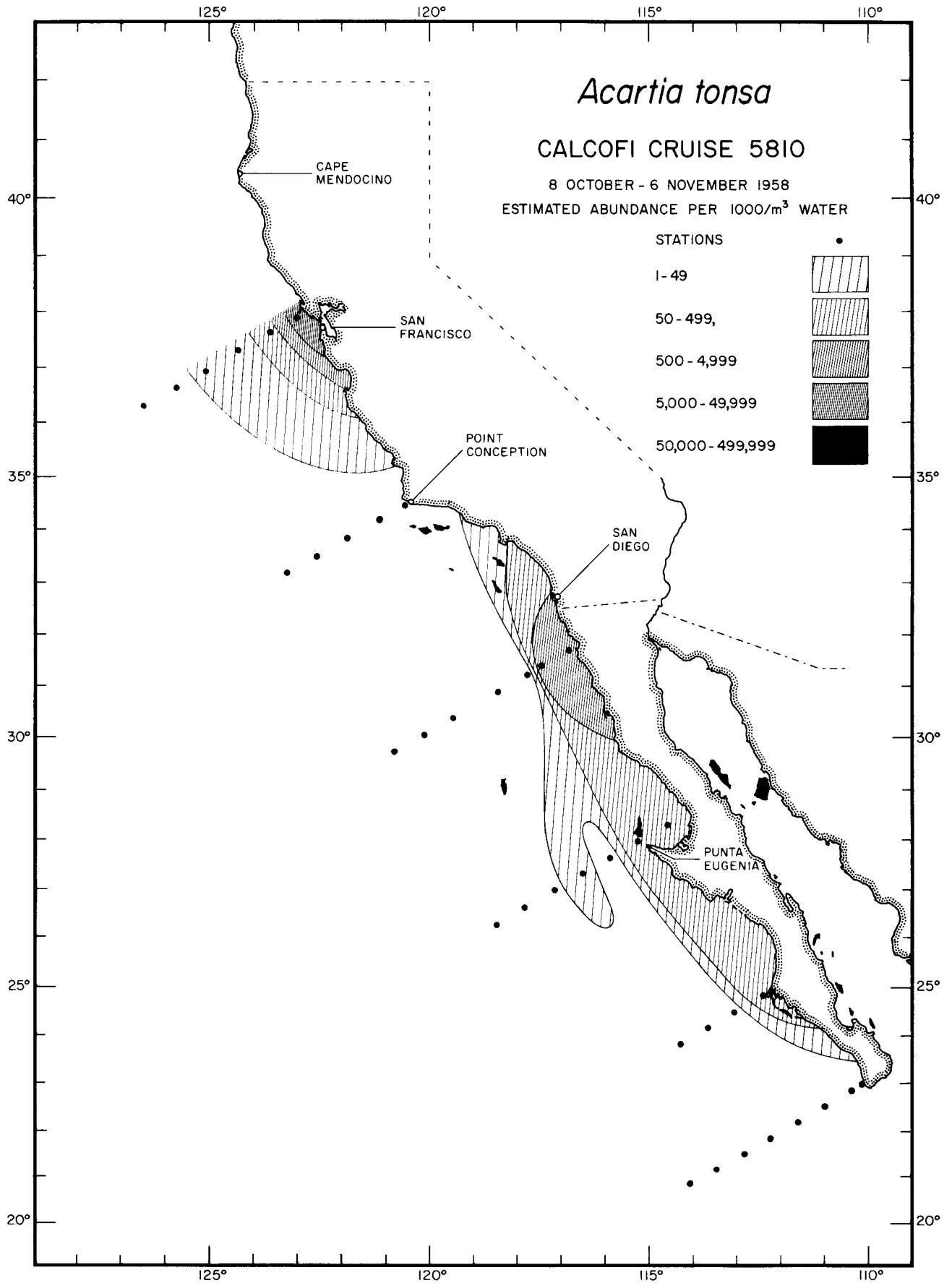
- 1-49
- 50-499,
- 500-4,999
- 5,000-49,999
- 50,000-499,999



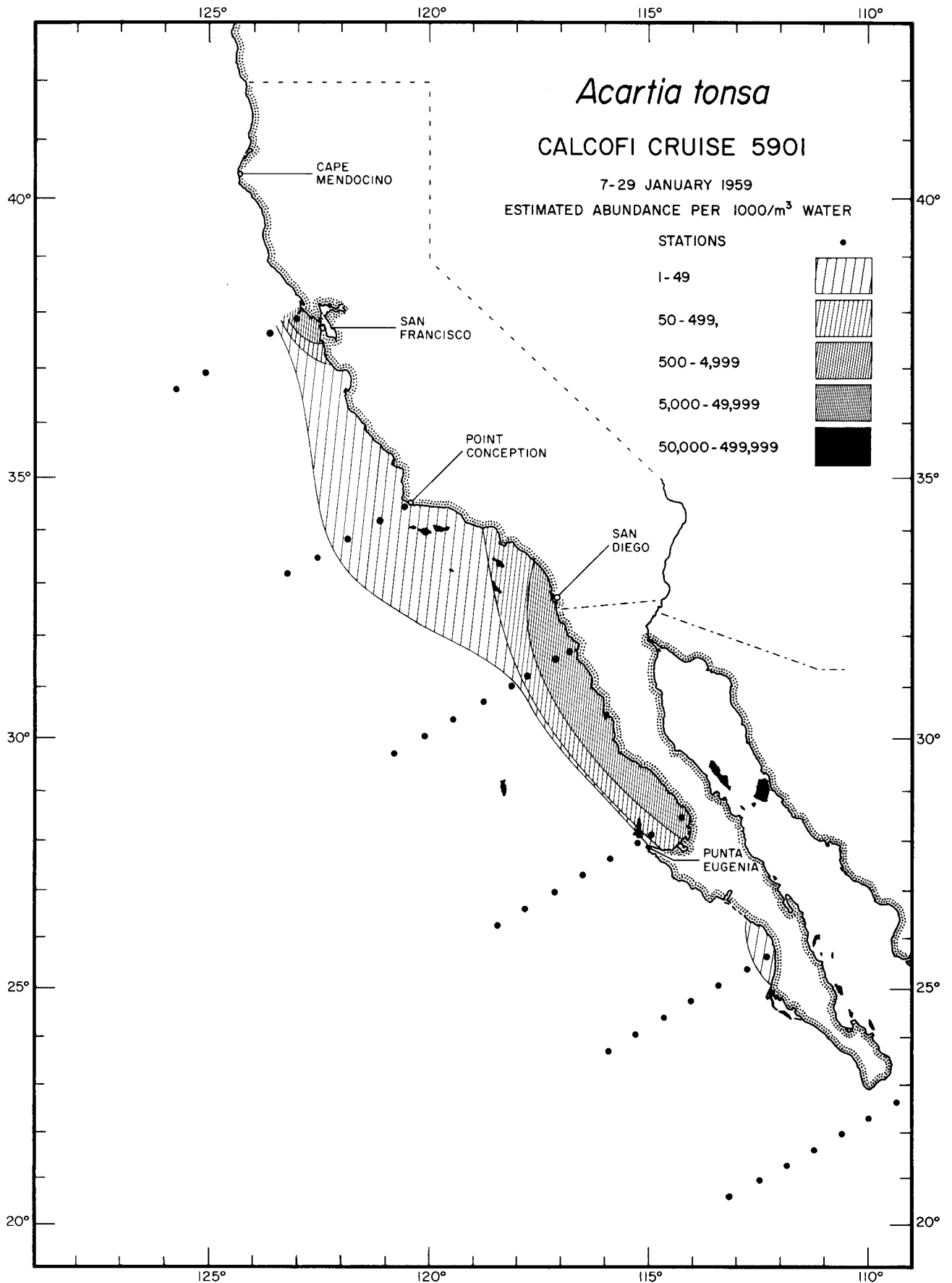


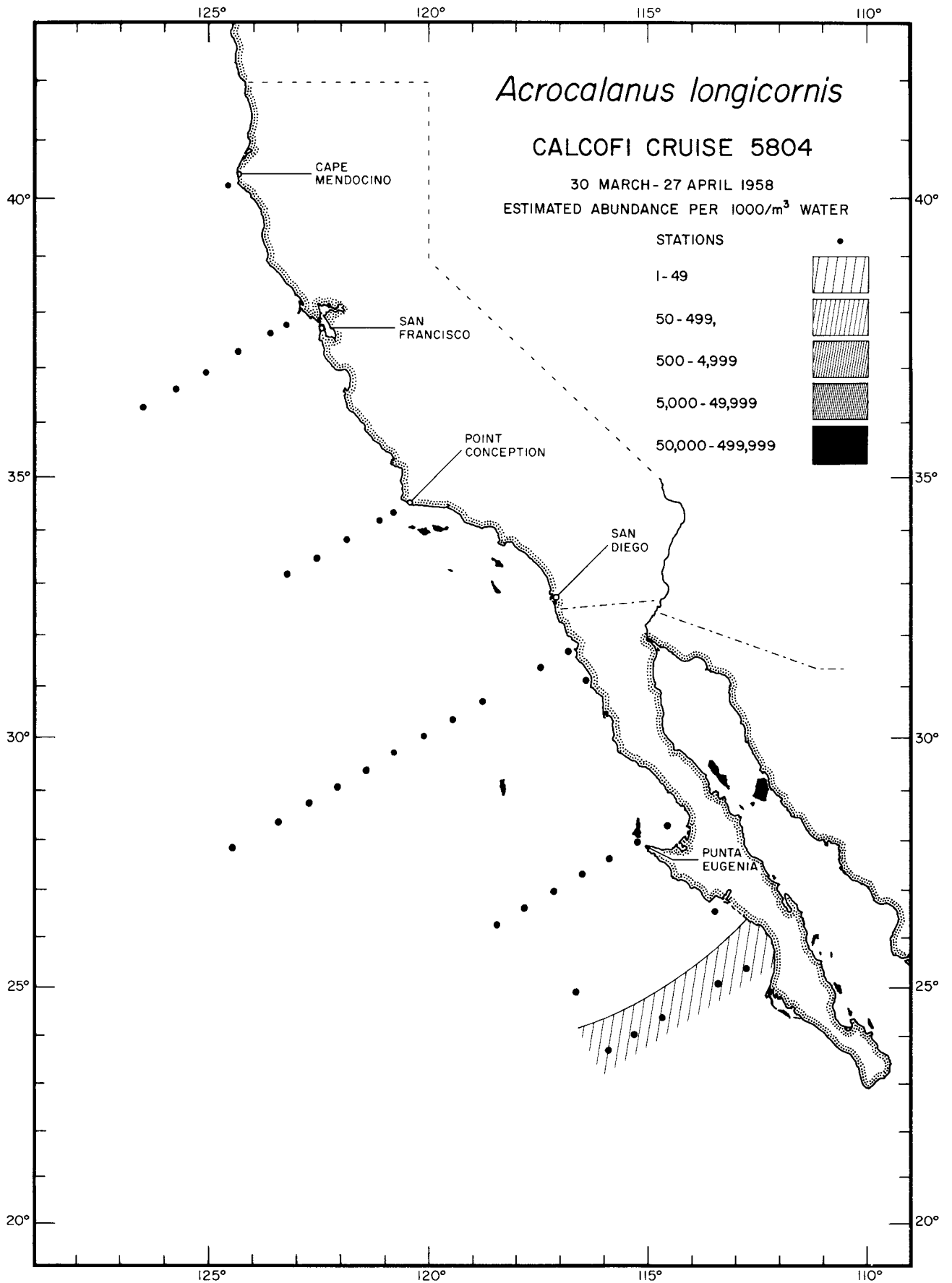


Calanoida
Acartia tonsa
5807

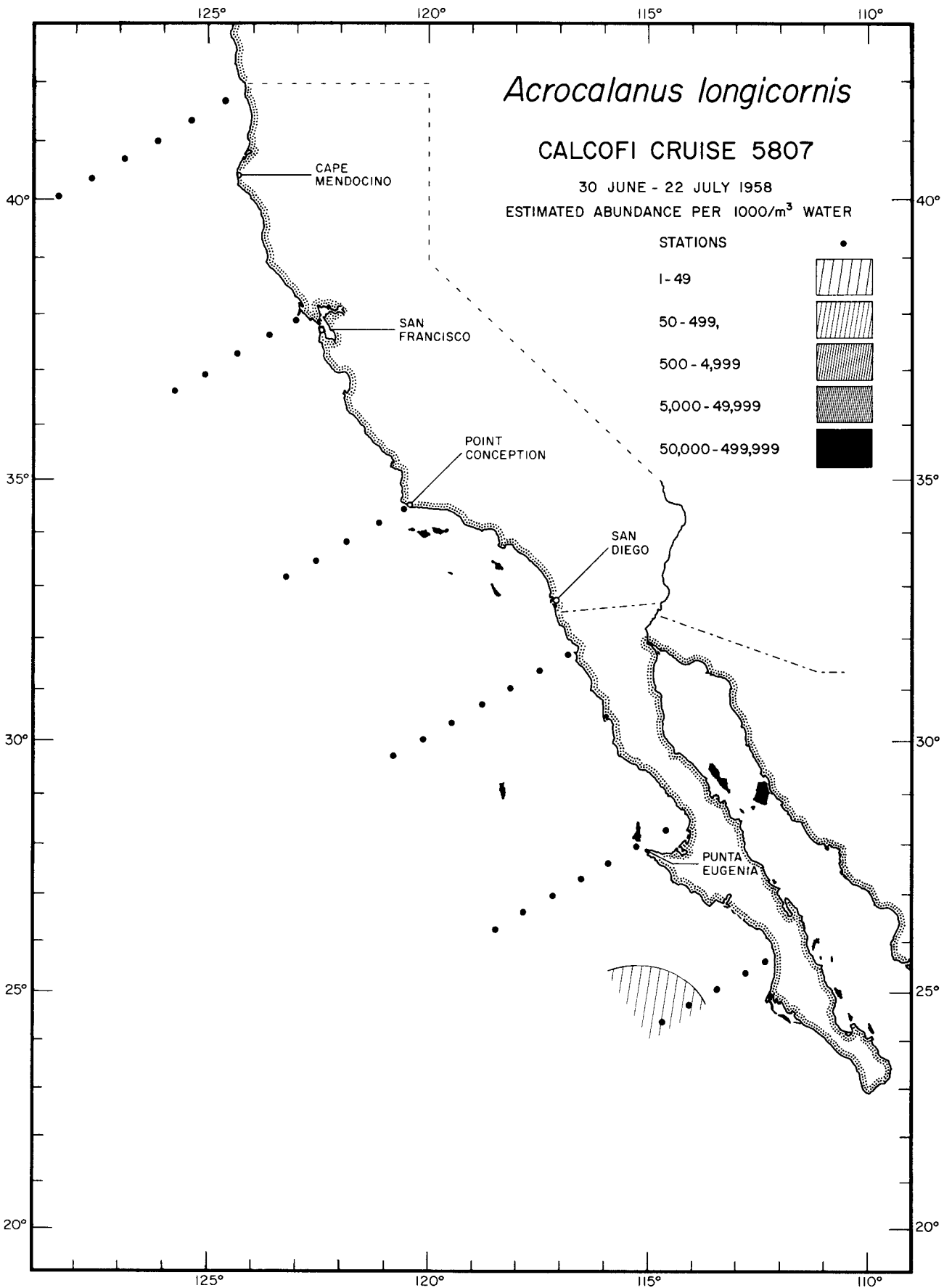


Calanoida
Acartia tonsa
5810





Calanoida
Acrocalanus longicornis
5804



Acrocalanus longicornis

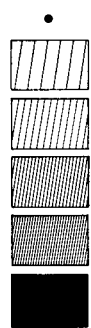
CALCOFI CRUISE 5807

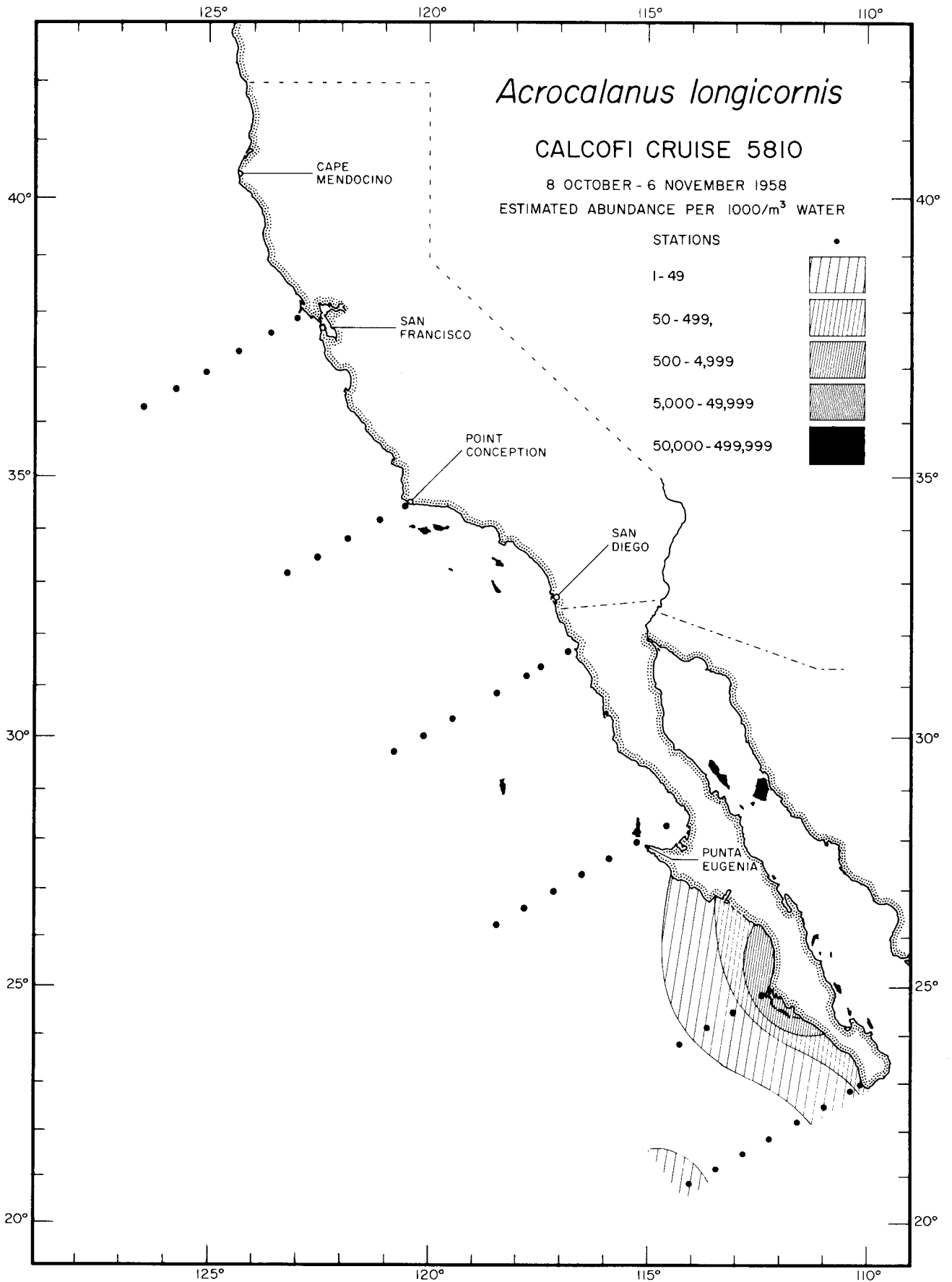
30 JUNE - 22 JULY 1958

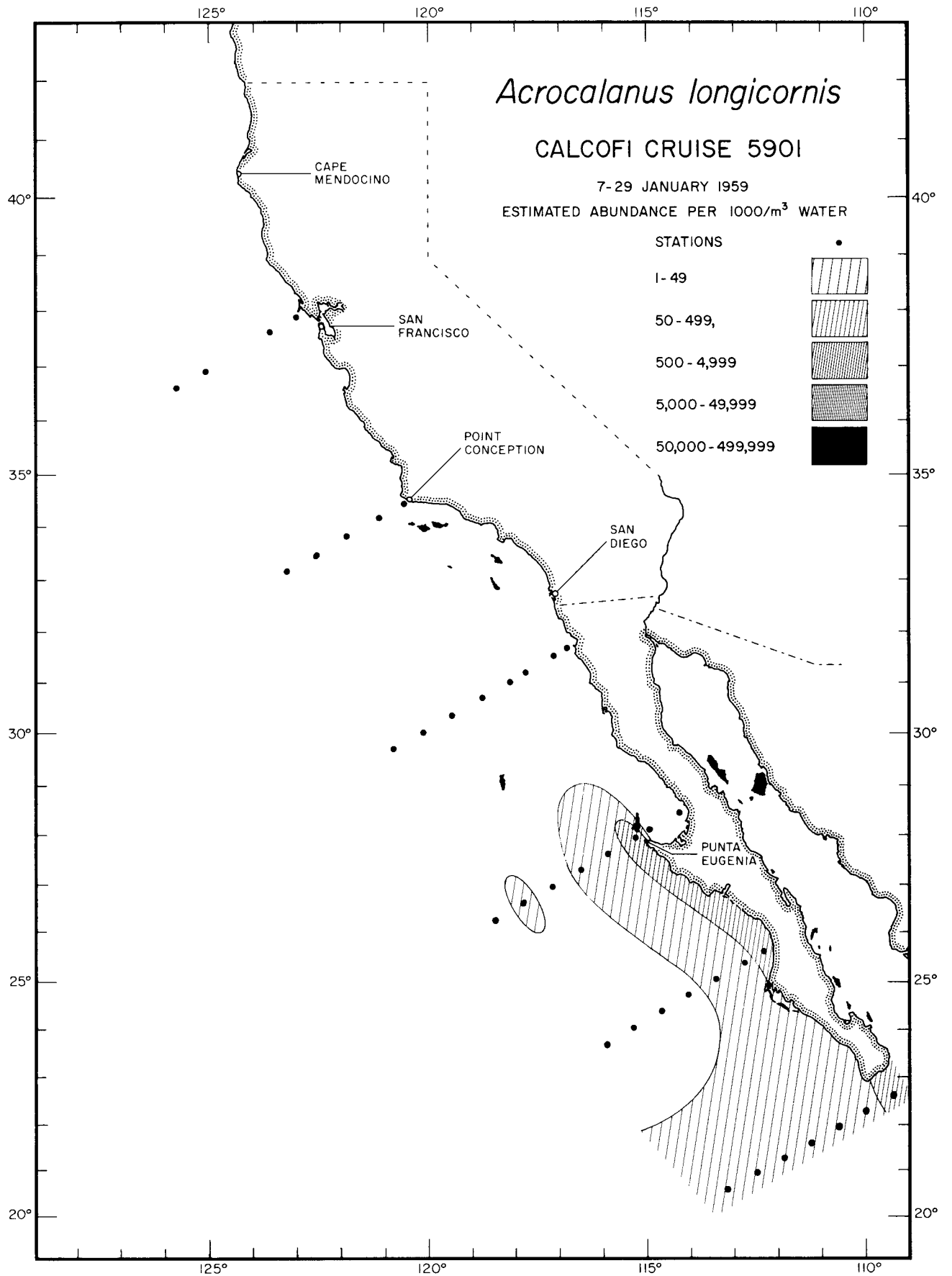
ESTIMATED ABUNDANCE PER 1000/m³ WATER

STATIONS

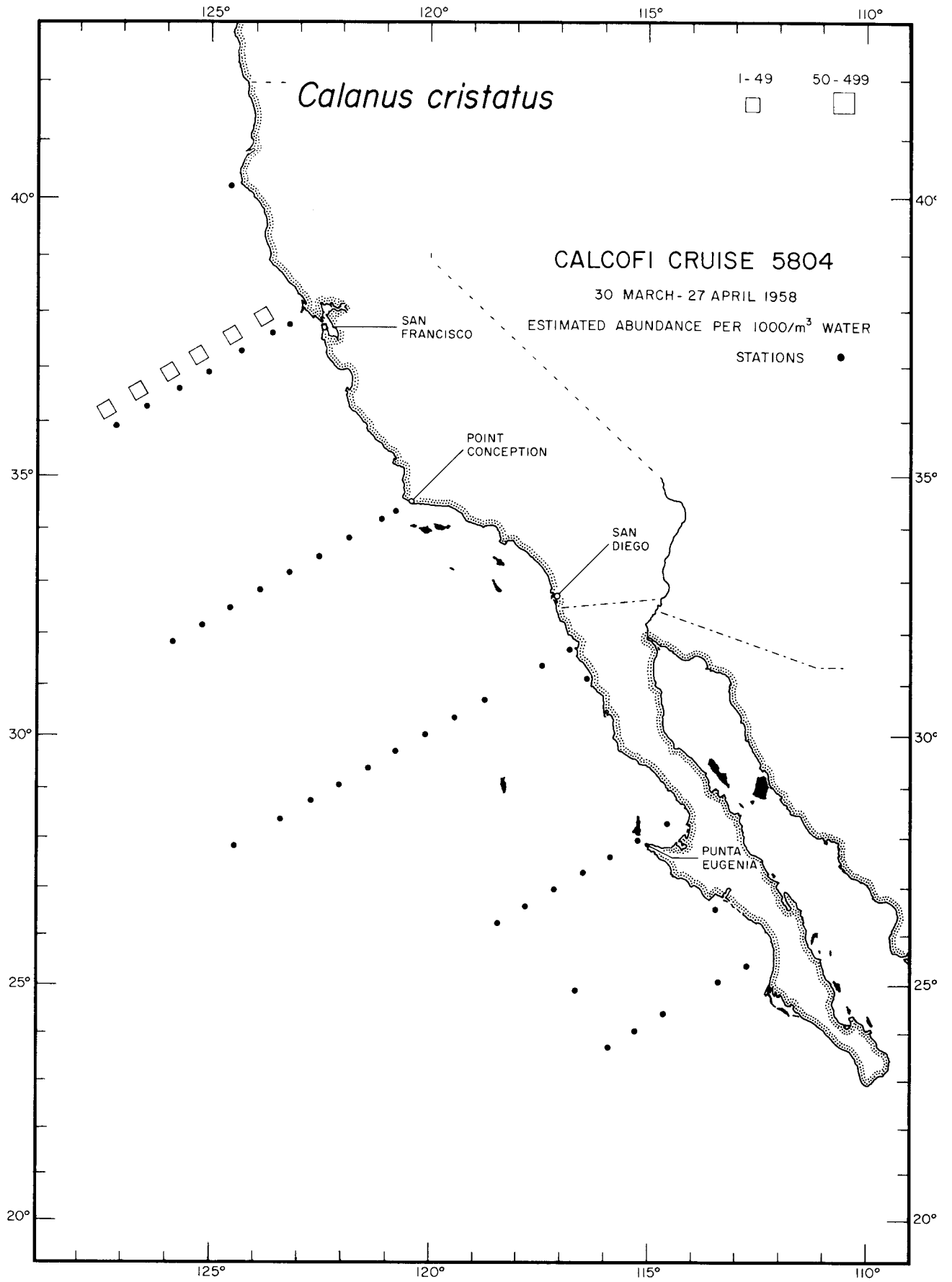
- 1-49
- 50-499,
- 500-4,999
- 5,000-49,999
- 50,000-499,999



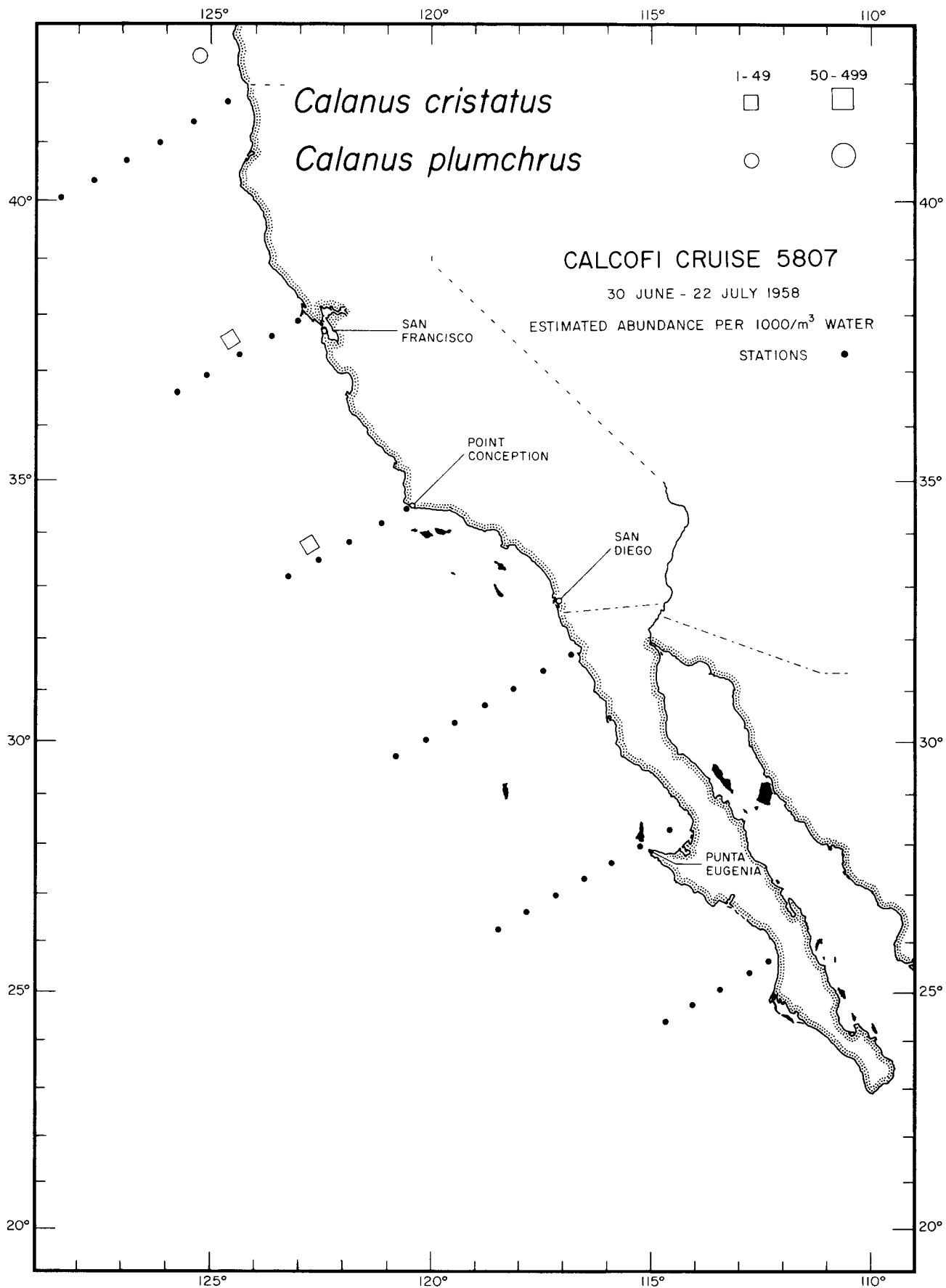




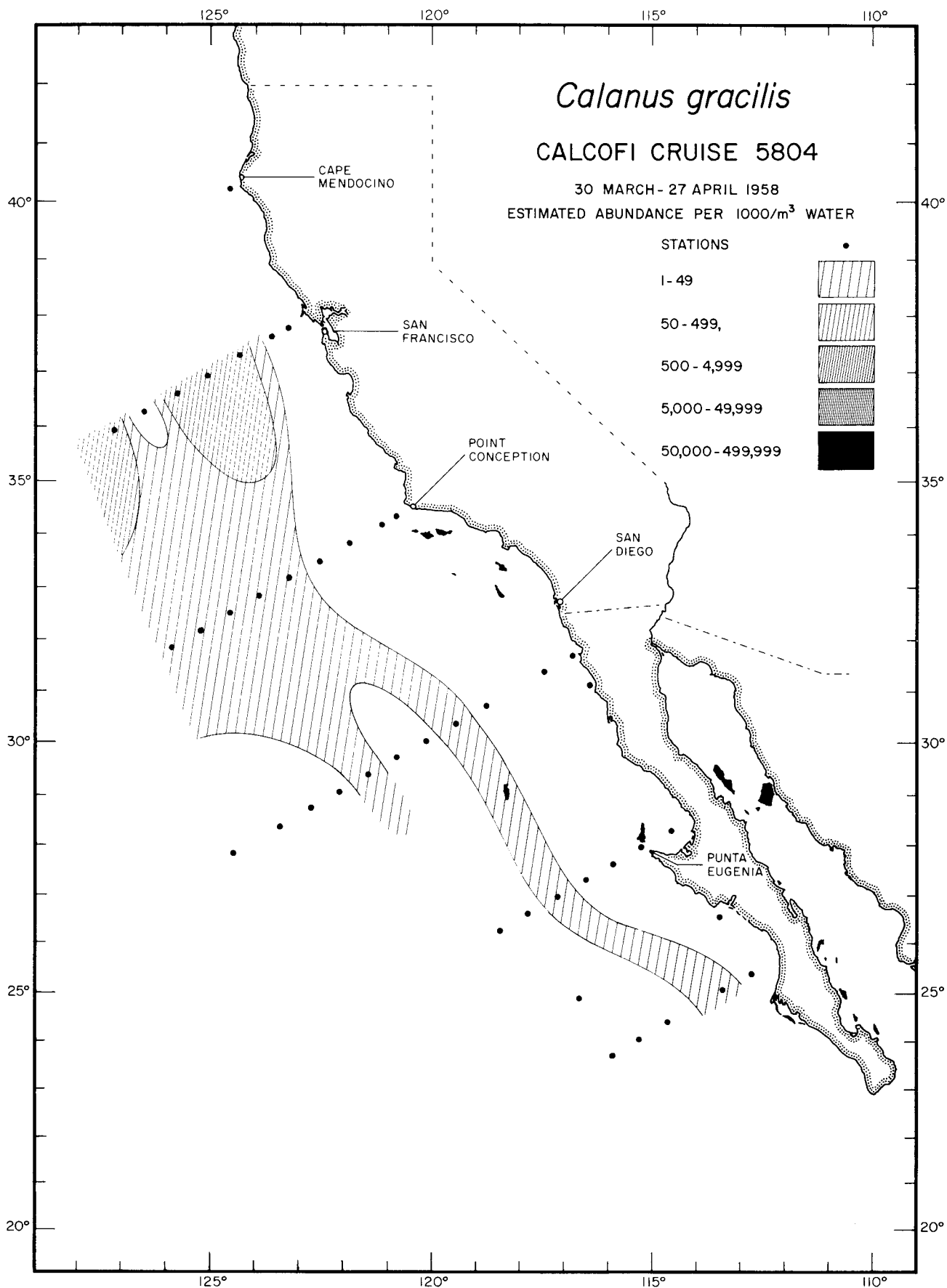
Calanoida
Acrocalanus longicornis
5901



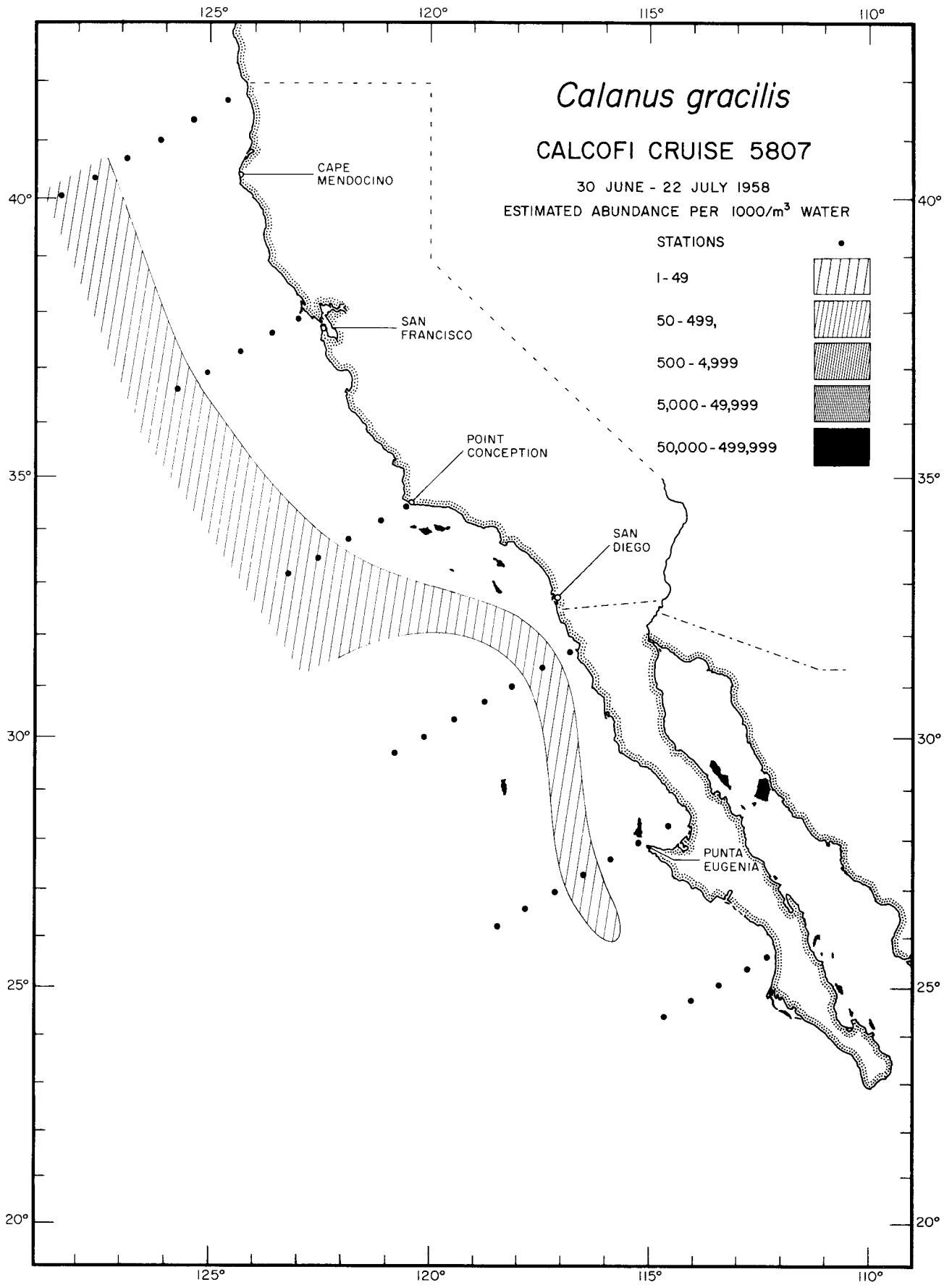
Calanoida
Calanus cristatus
5804



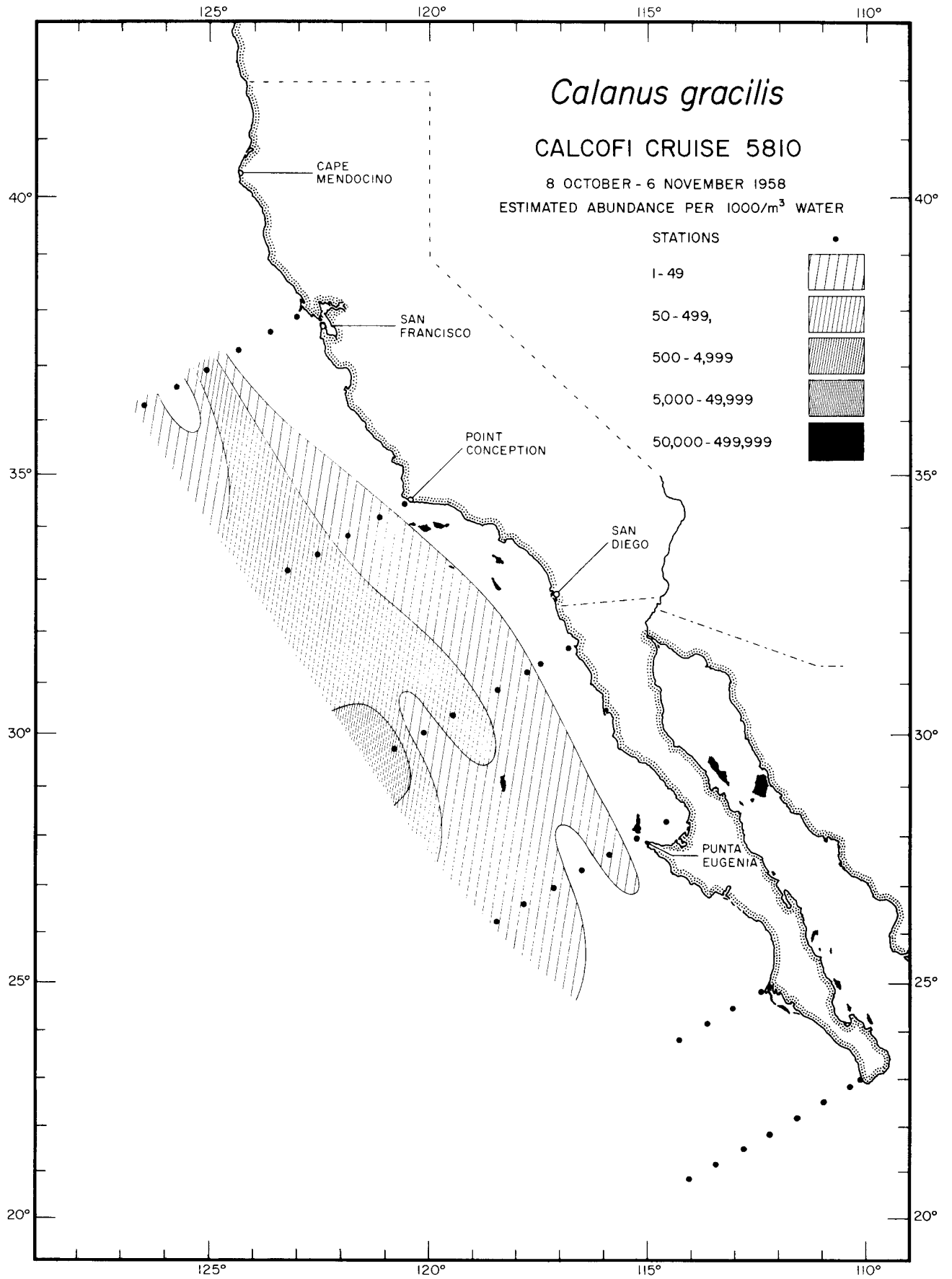
Calanoida
Calanus cristatus
Calanus plumchrus
5807



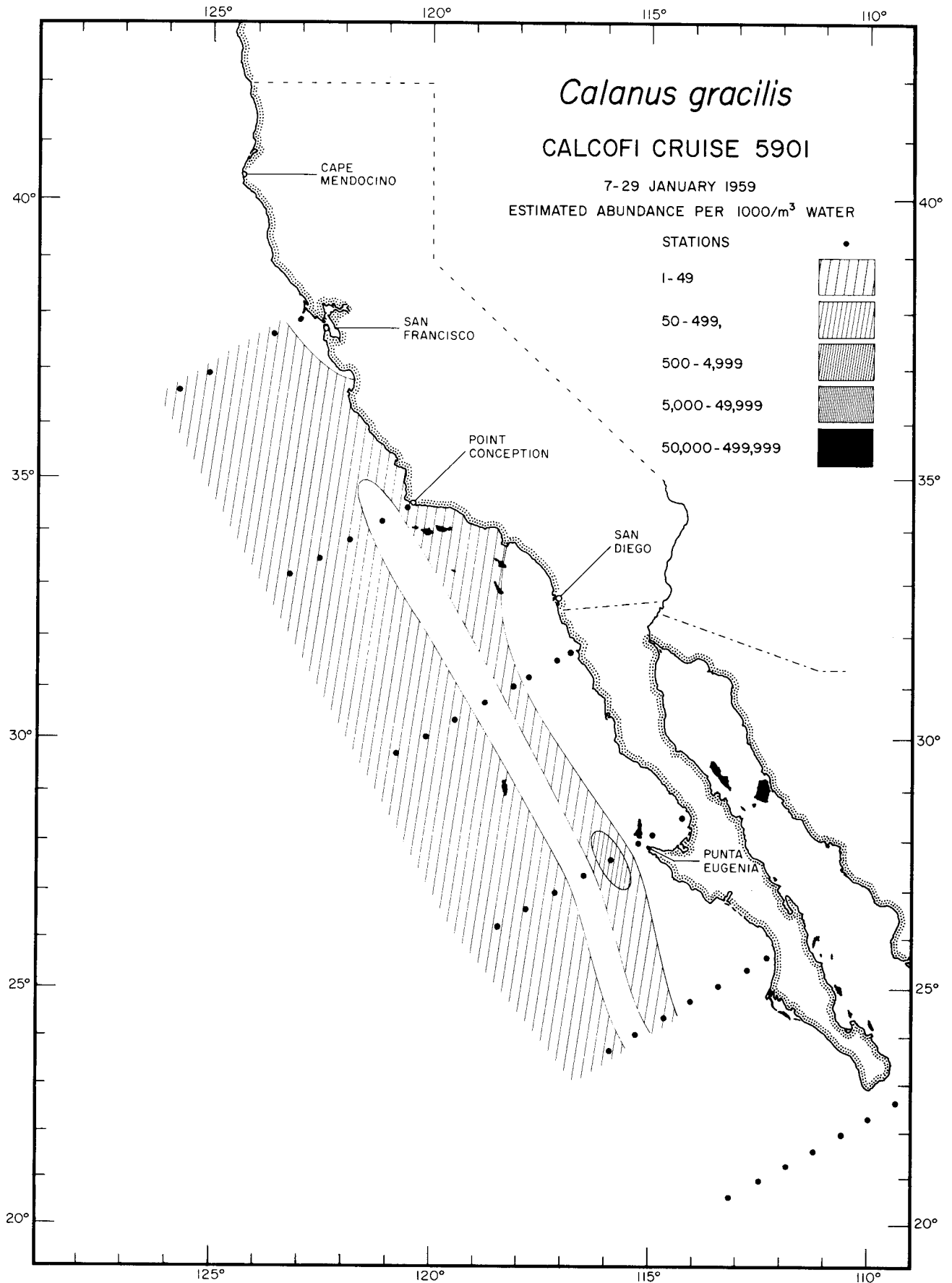
Calanoida
Calanus gracilis
5804



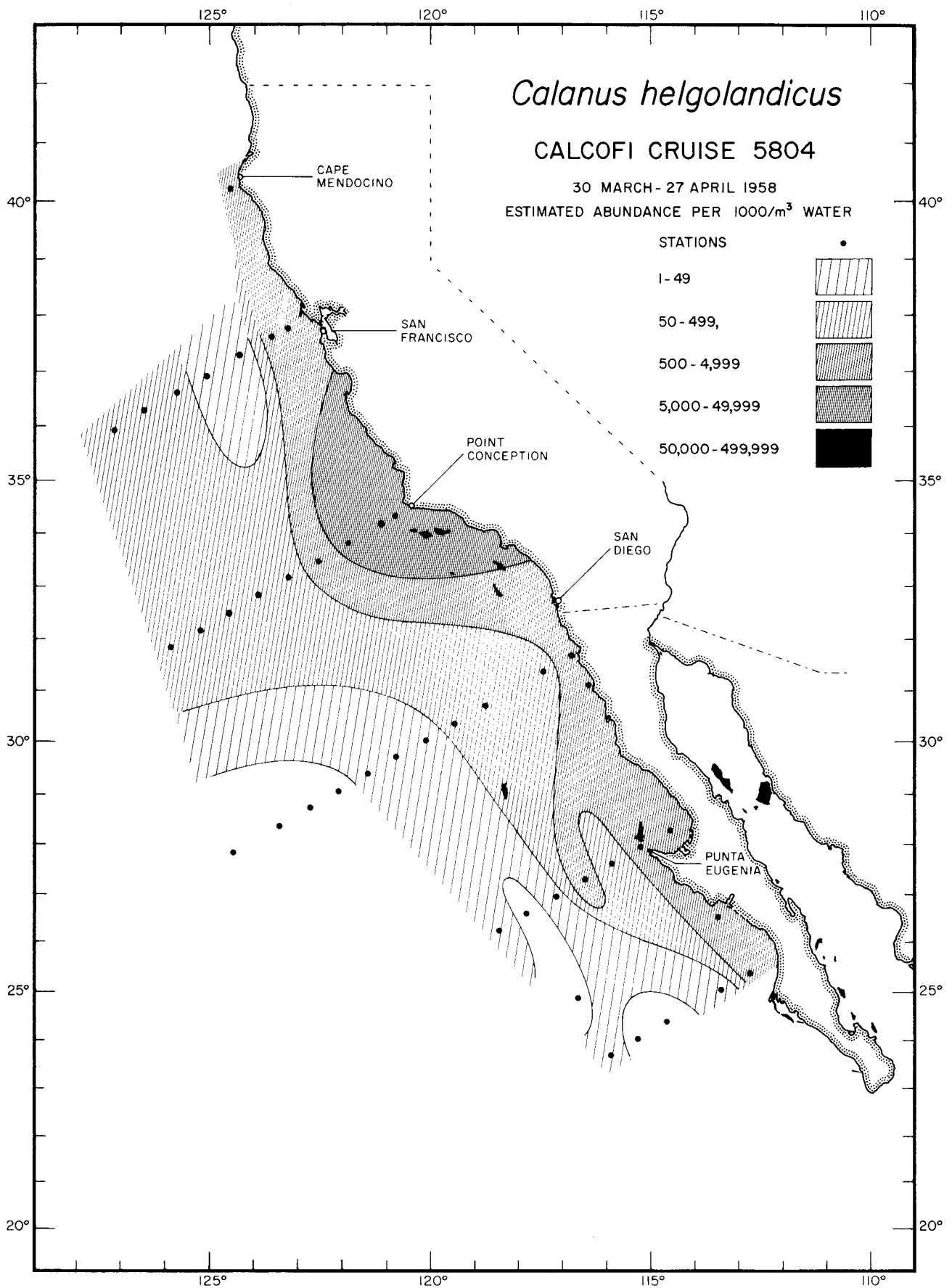
Calanoida
Calanus gracilis
5807



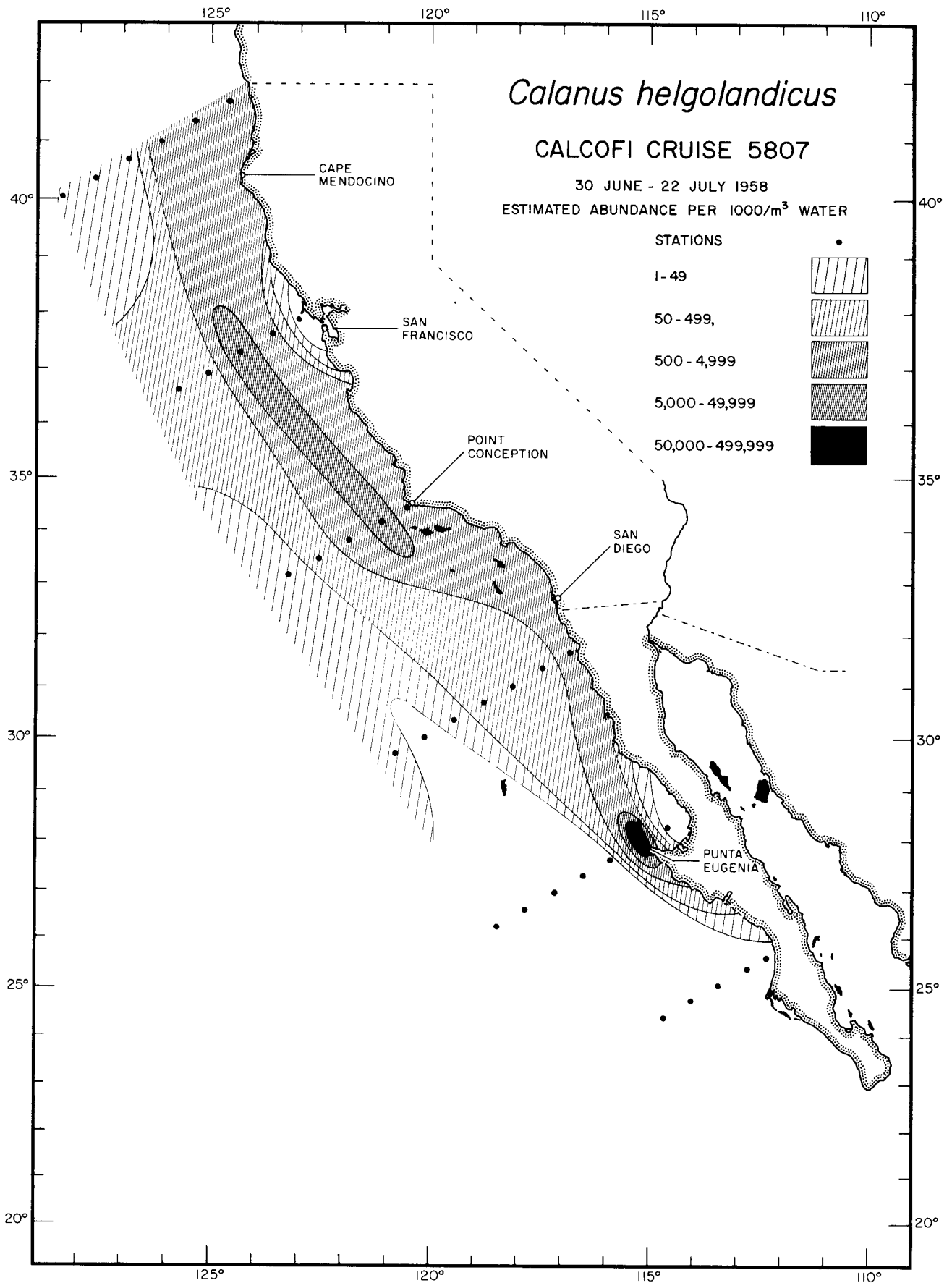
Calanoida
Calanus gracilis
5810



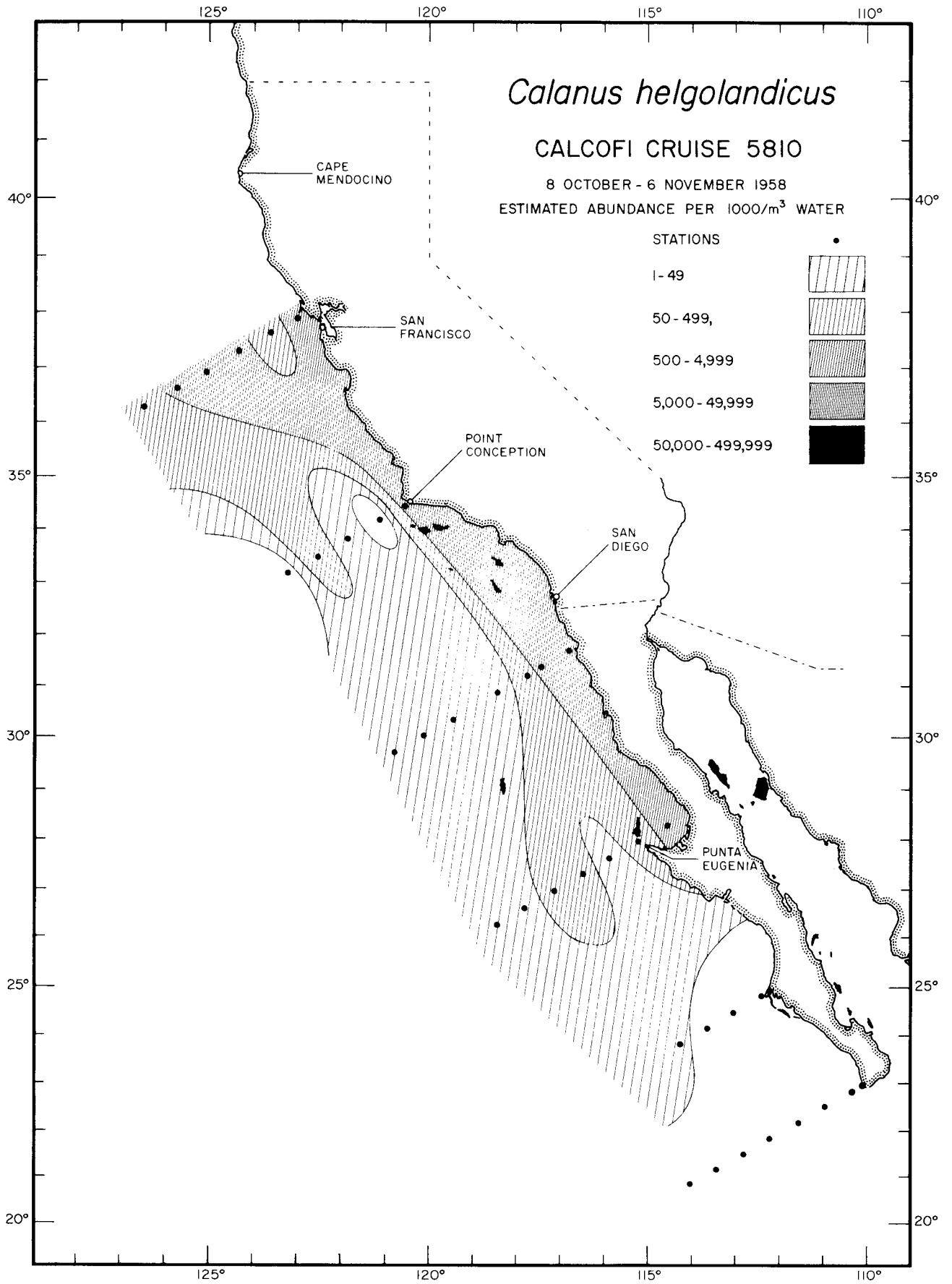
Calanoida
Calanus gracilis
5901



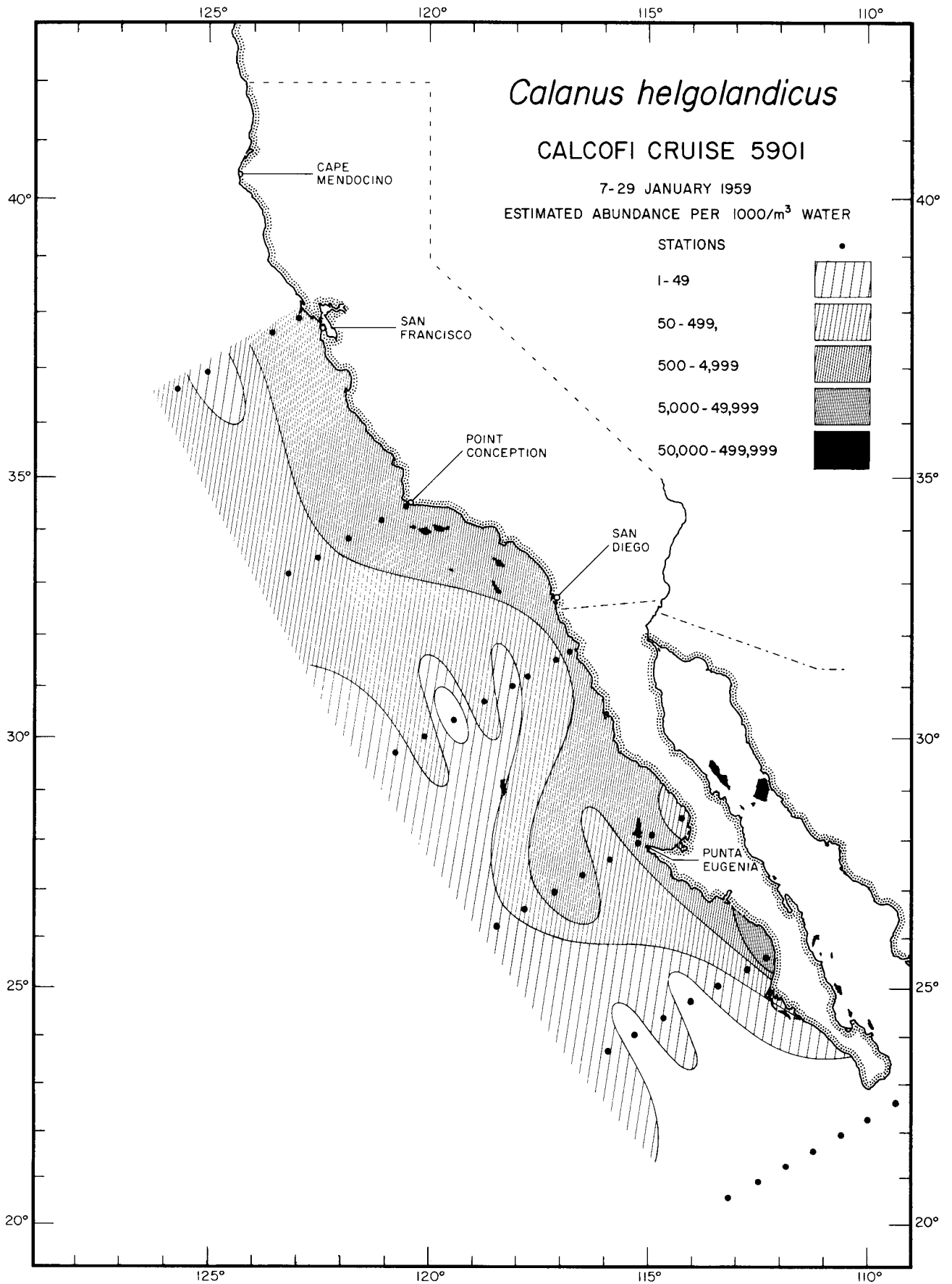
Calanoida
Calanus helgolandicus
5804

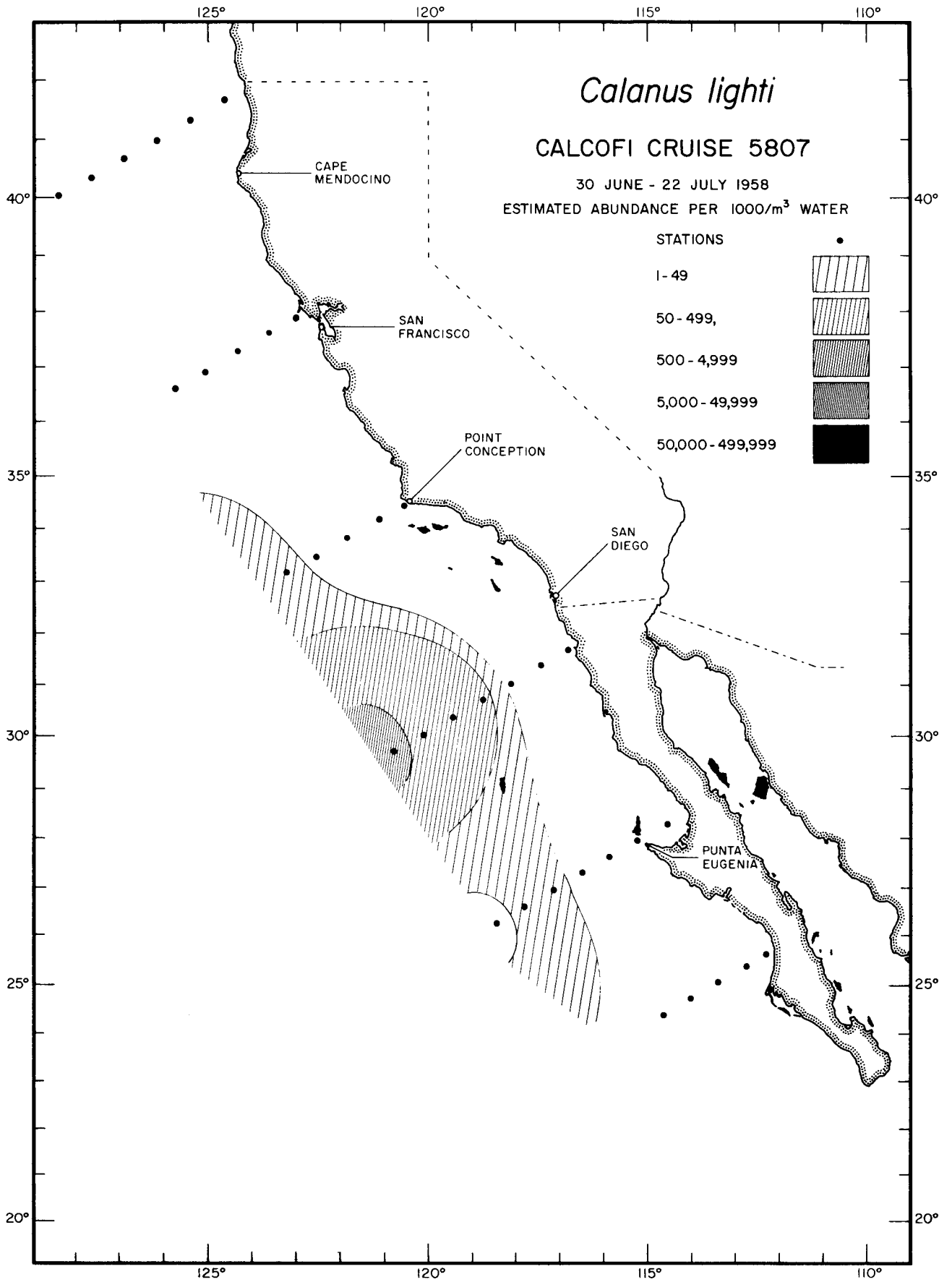


Calanoida
Calanus helgolandicus
5807

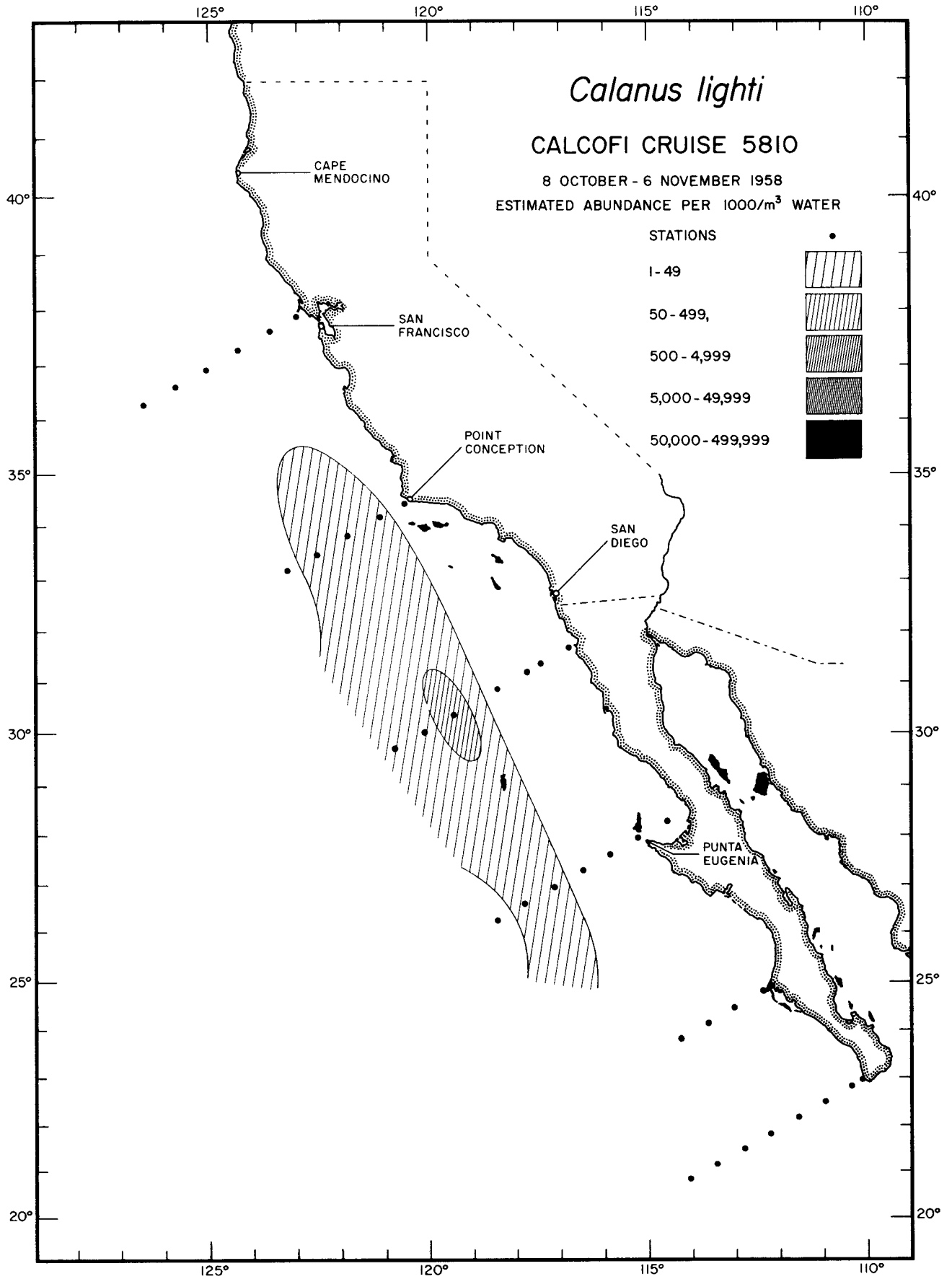


Calanoida
Calanus helgolandicus
5810

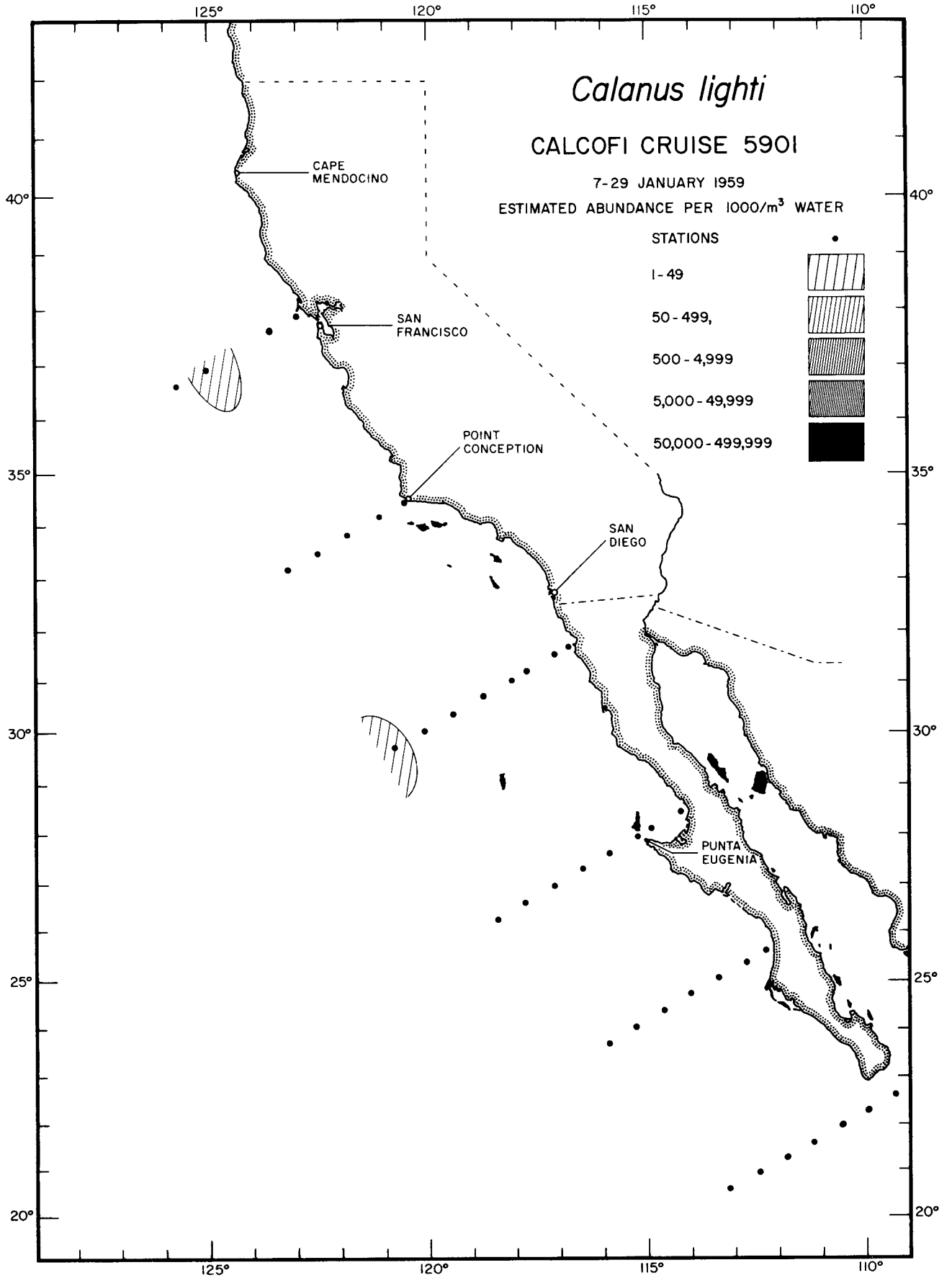




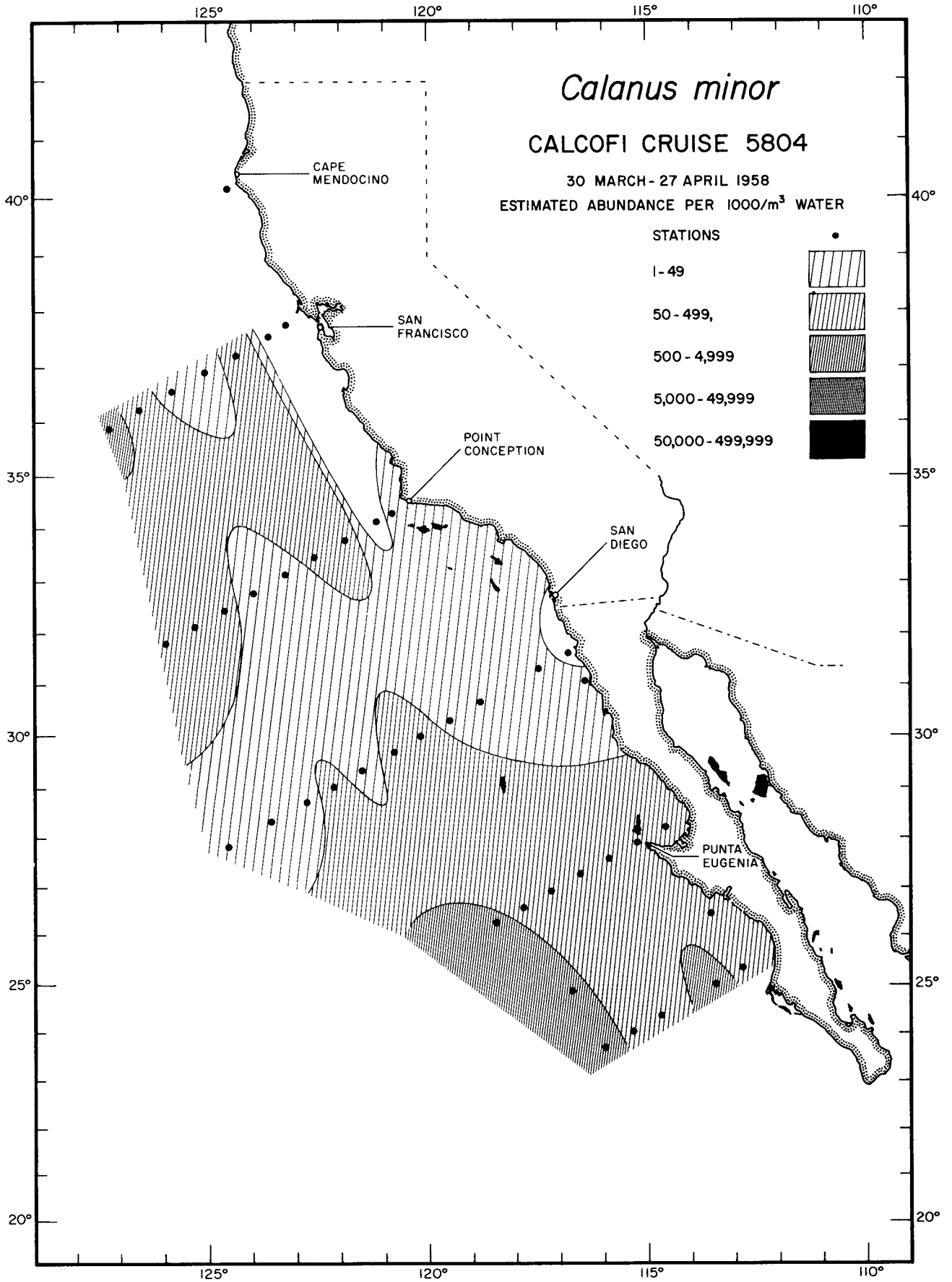
Calanoida
Calanus lighti
5807



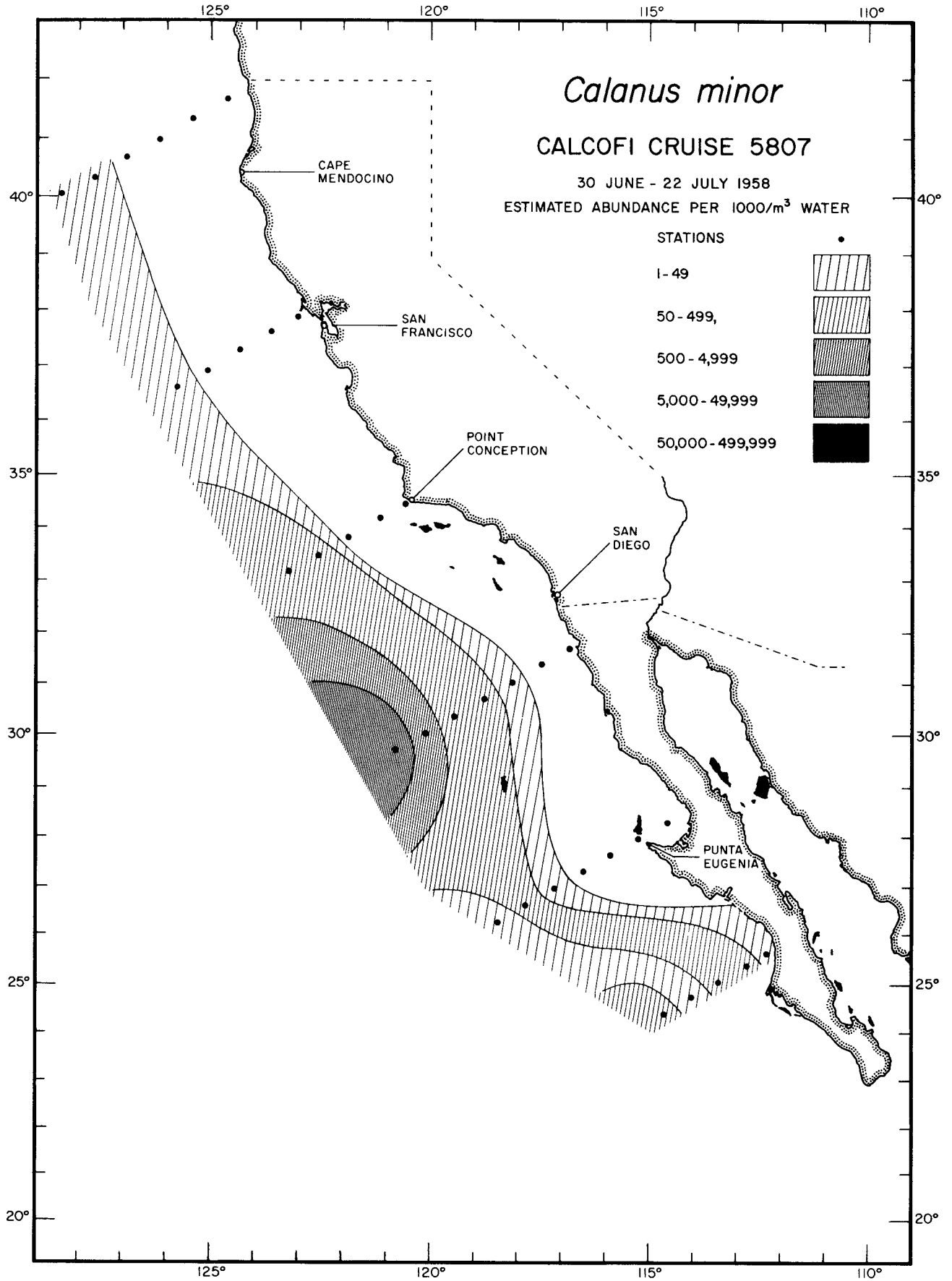
Calanoida
Calanus lighti
5810

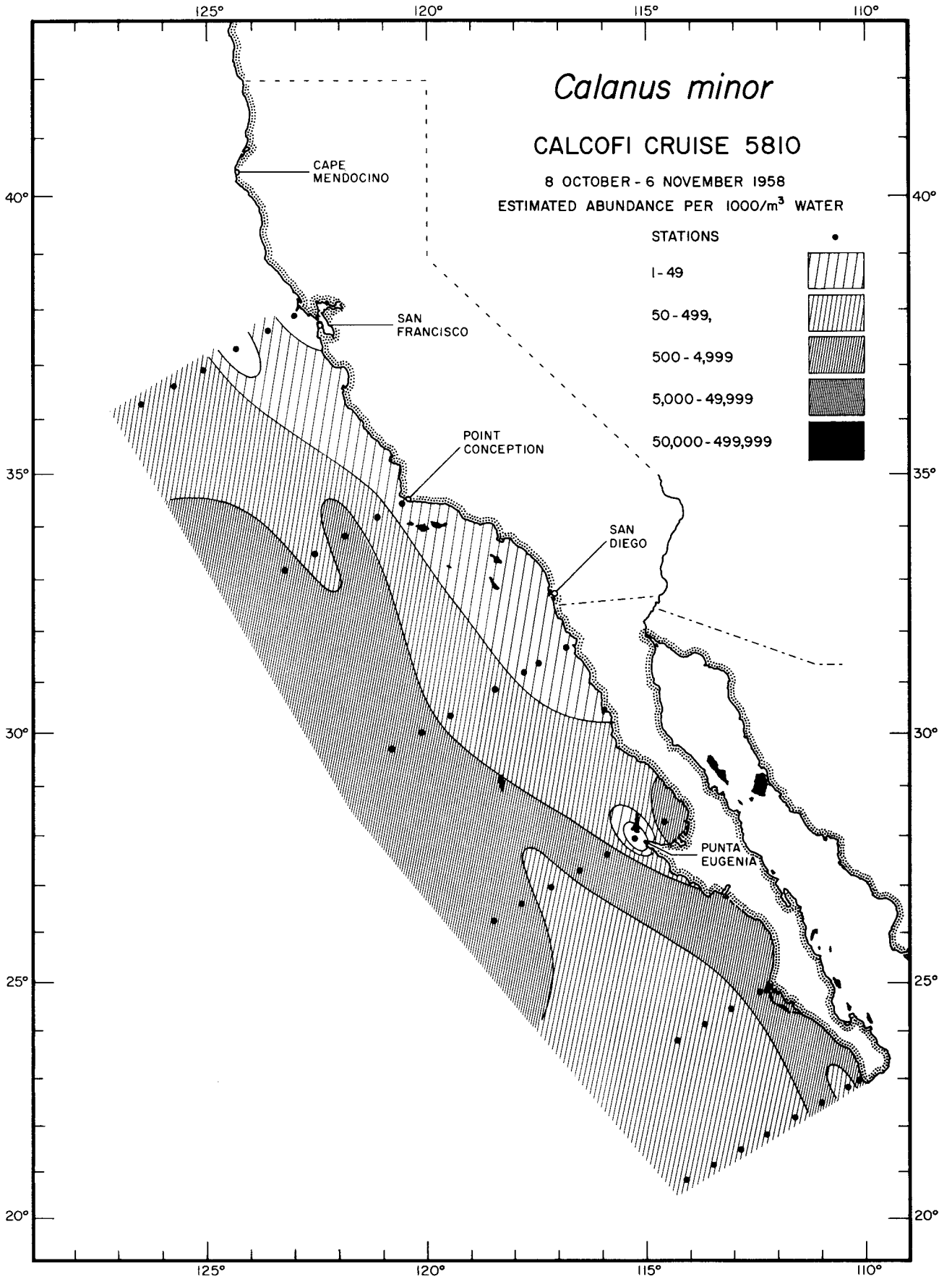


Calanoida
Calanus lighti
5901

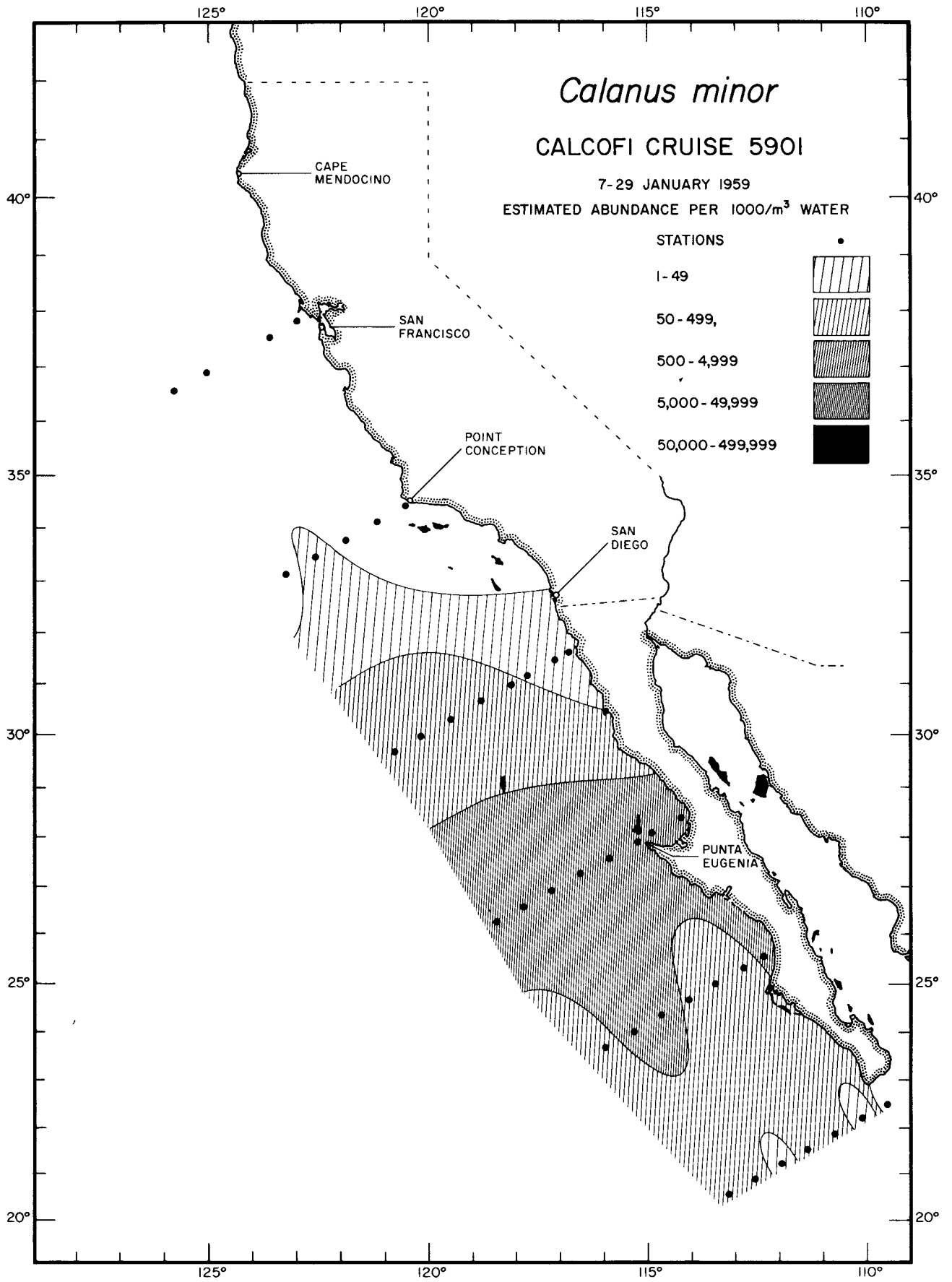


Calanoida
Calanus minor
5804

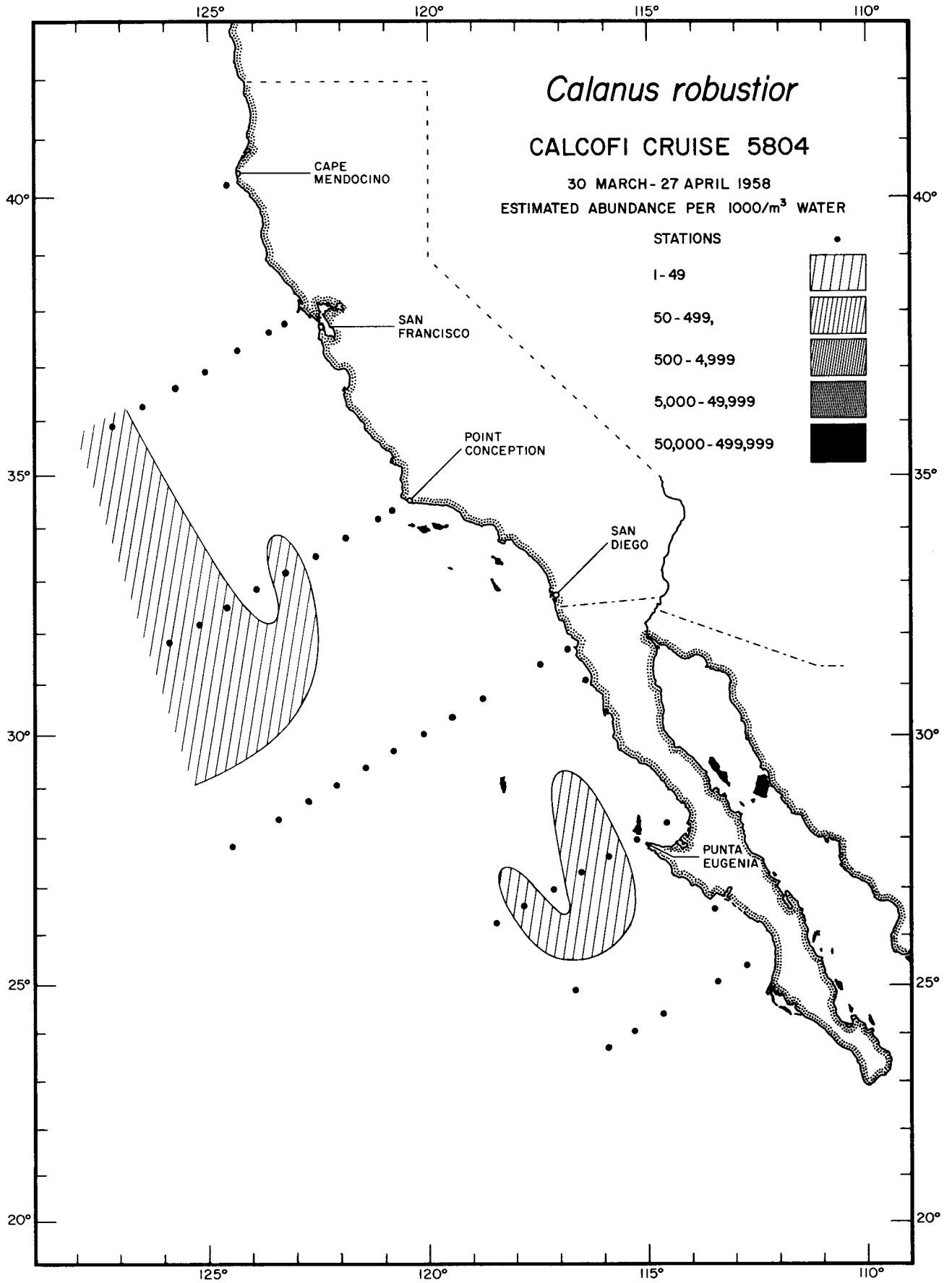




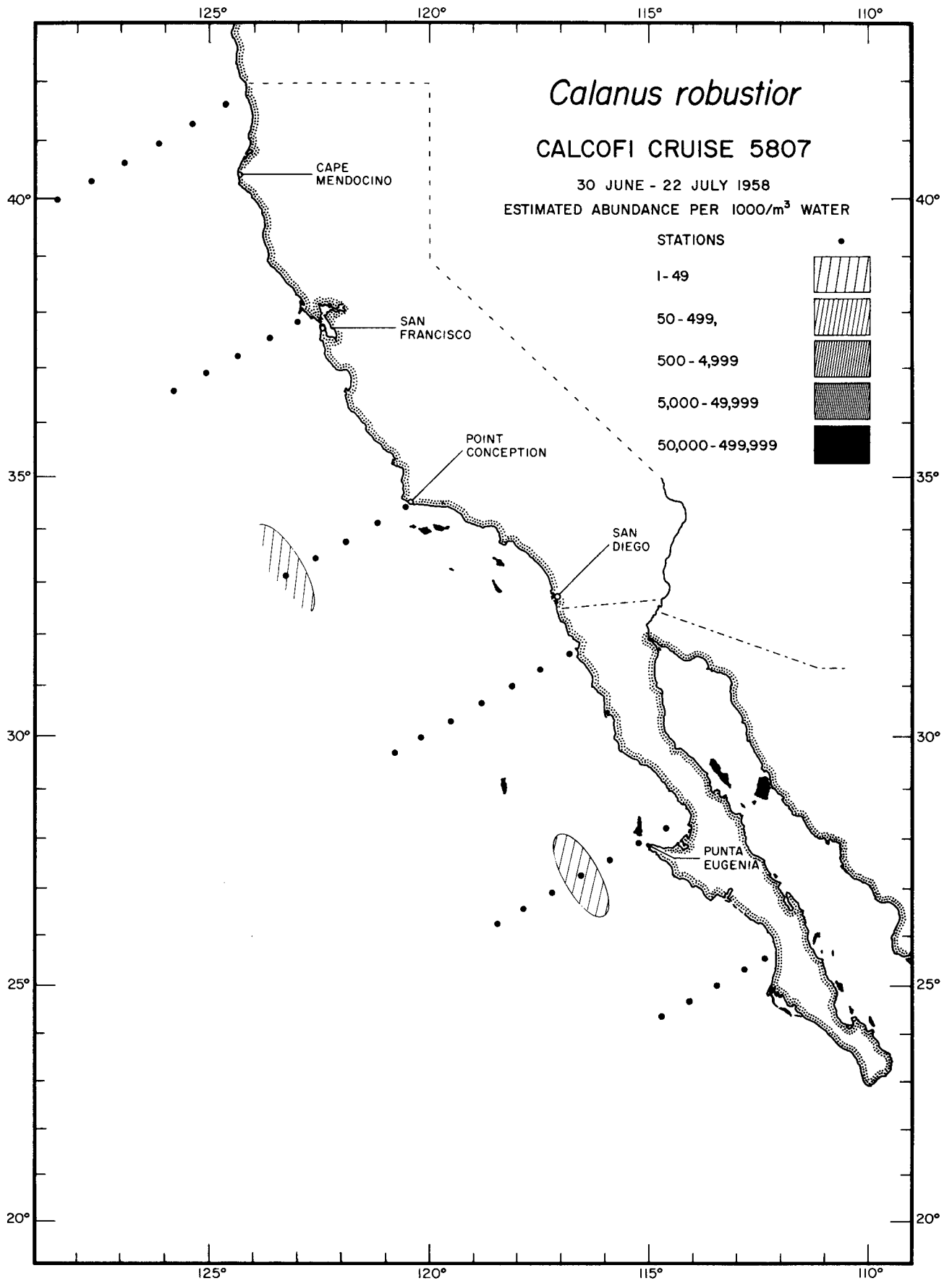
Calanoida
Calanus minor
5810

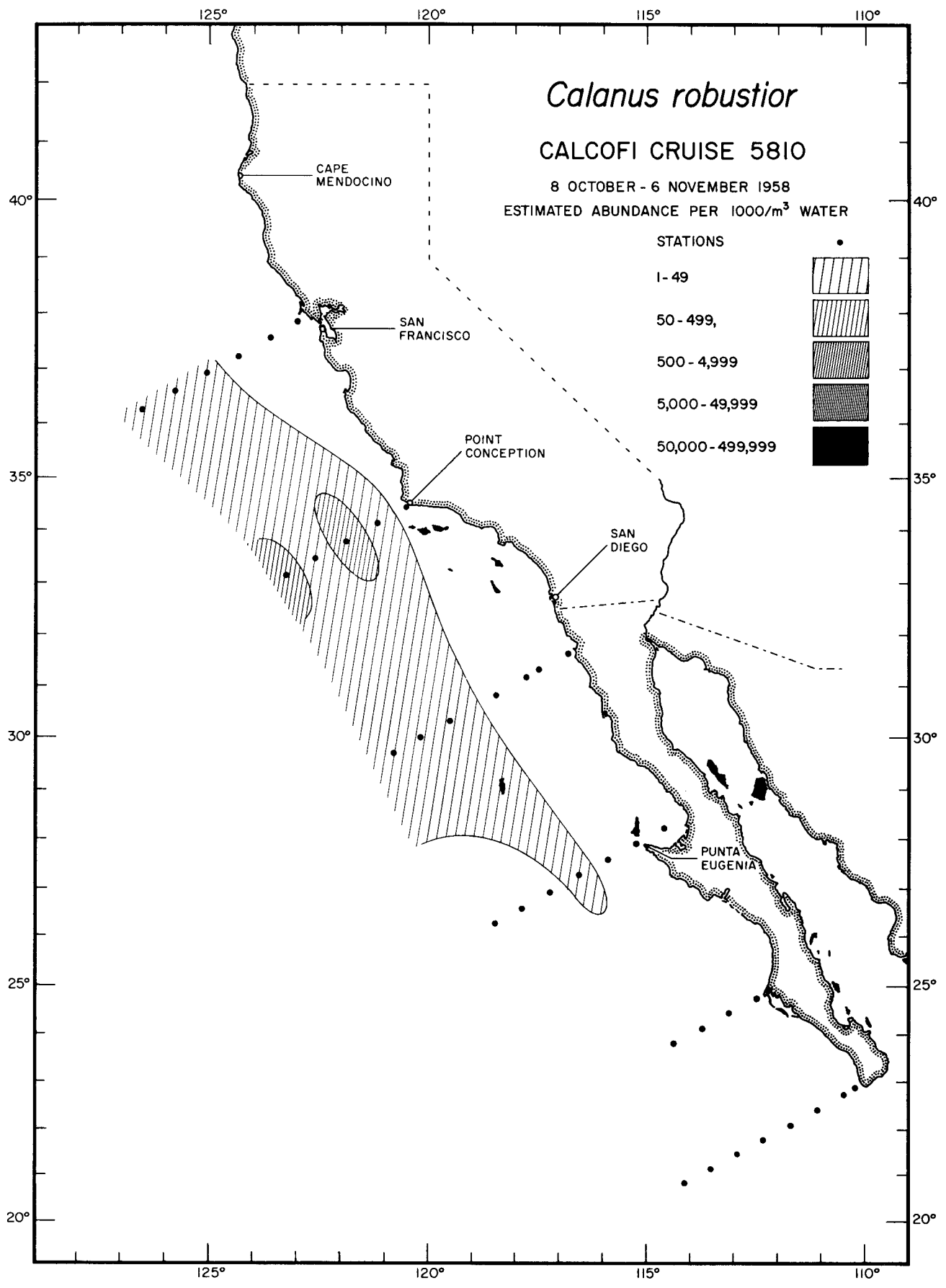


Calanoida
Calanus minor
5901



Calanoida
Calanus robustior
5804





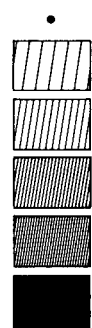
Calanus robustior

CALCOFI CRUISE 5810

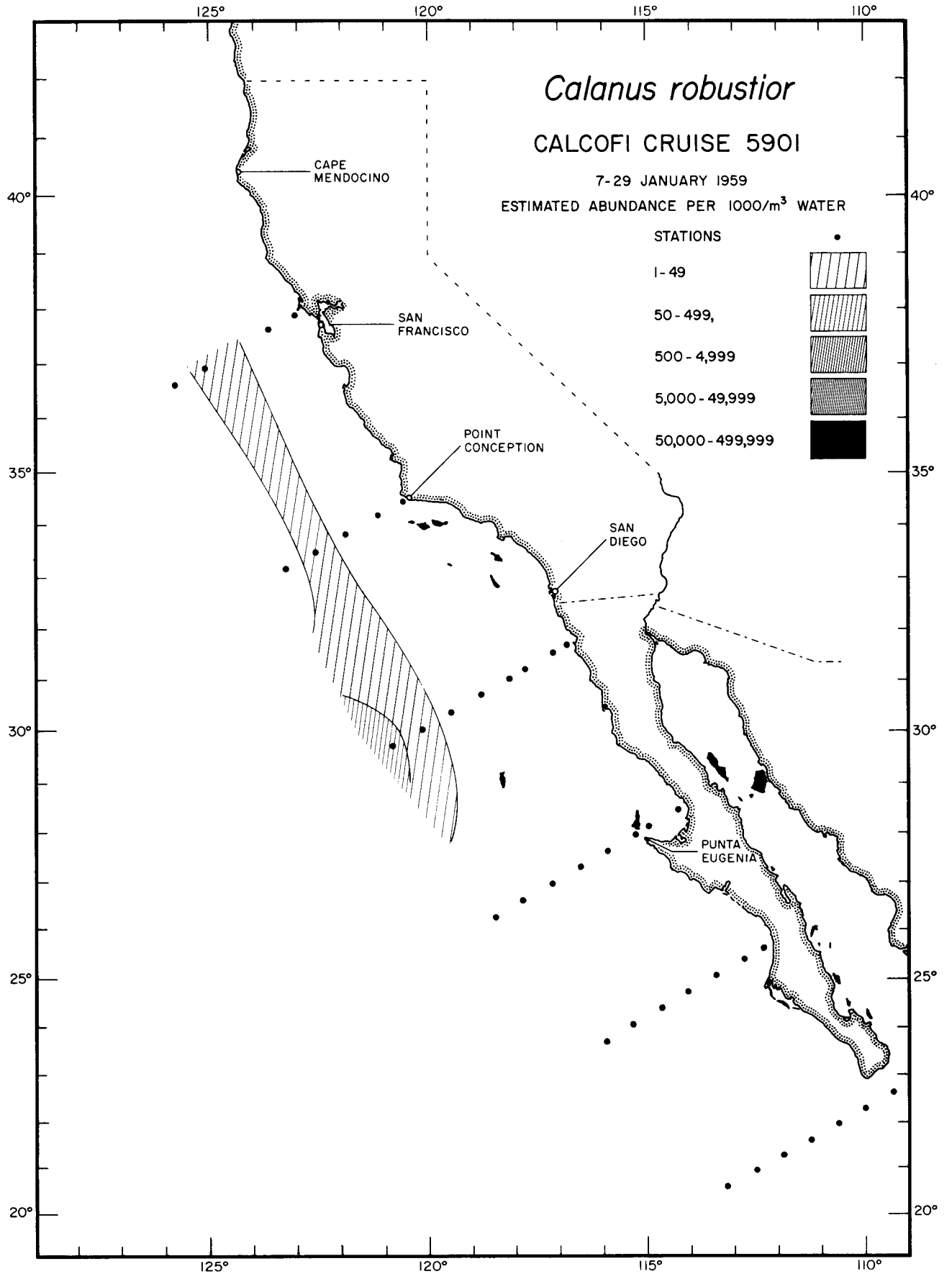
8 OCTOBER - 6 NOVEMBER 1958
ESTIMATED ABUNDANCE PER 1000/m³ WATER

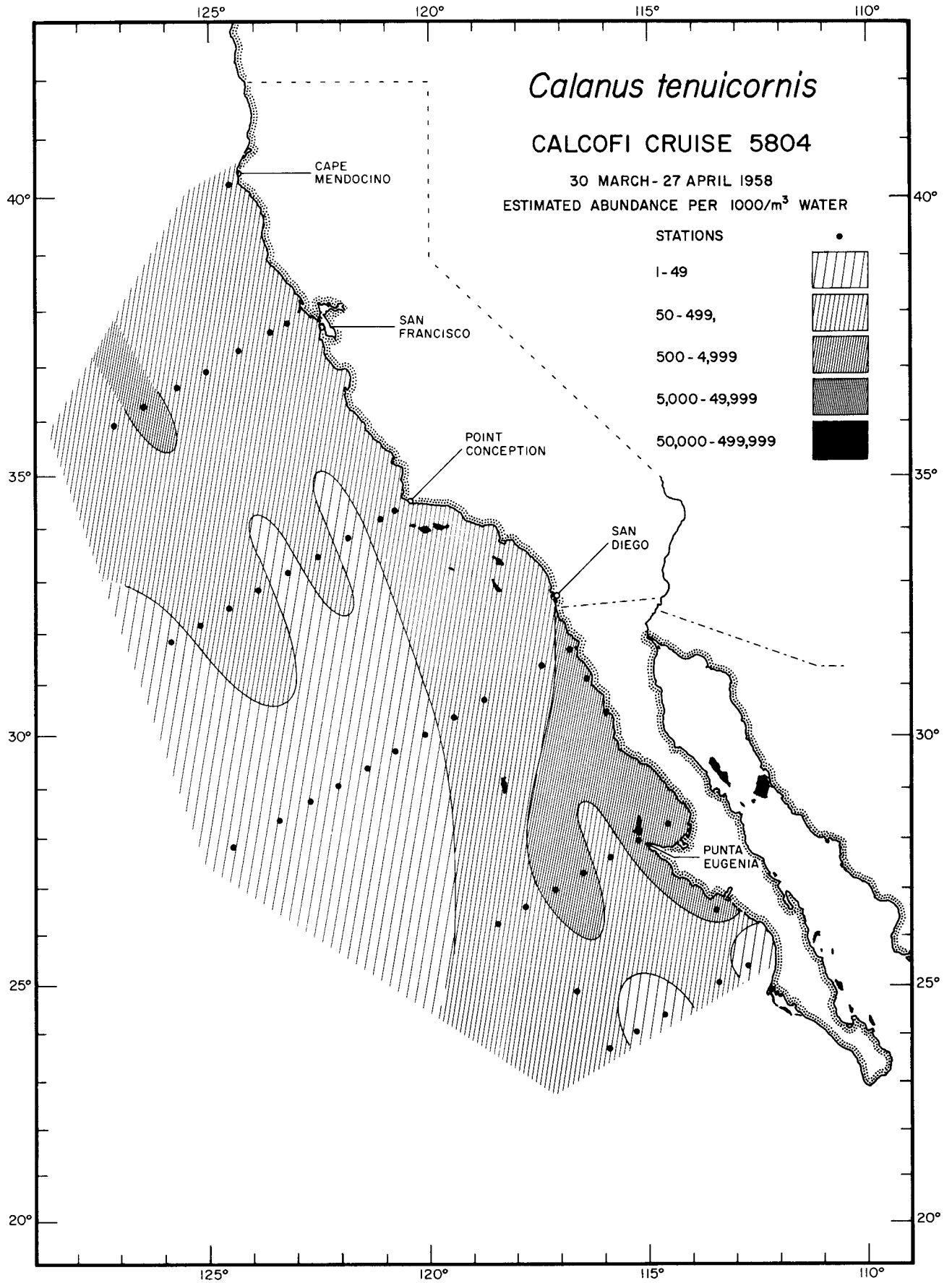
STATIONS

- 1 - 49
- 50 - 499,
- 500 - 4,999
- 5,000 - 49,999
- 50,000 - 499,999

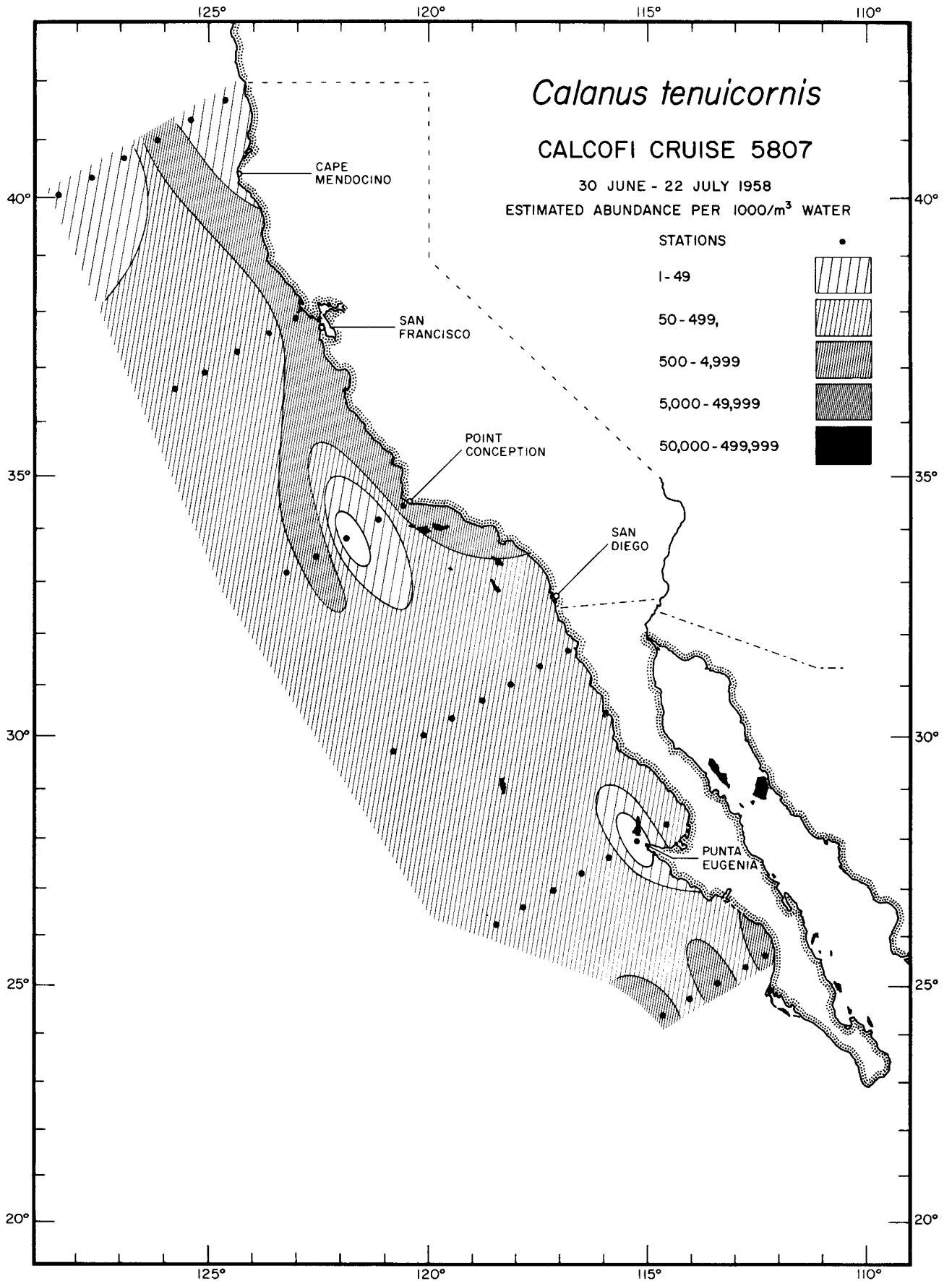


Calanoida
Calanus robustior
5810

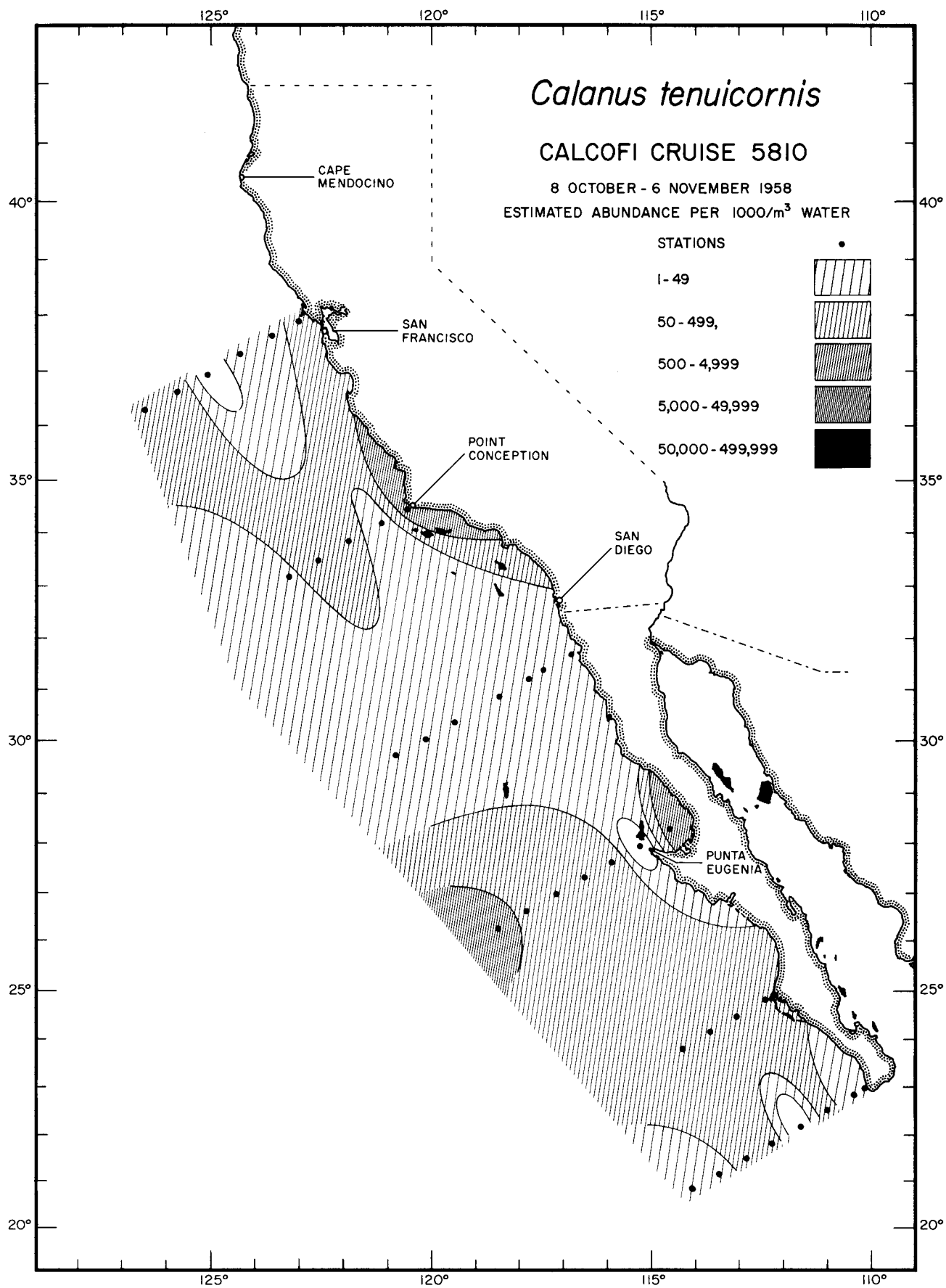




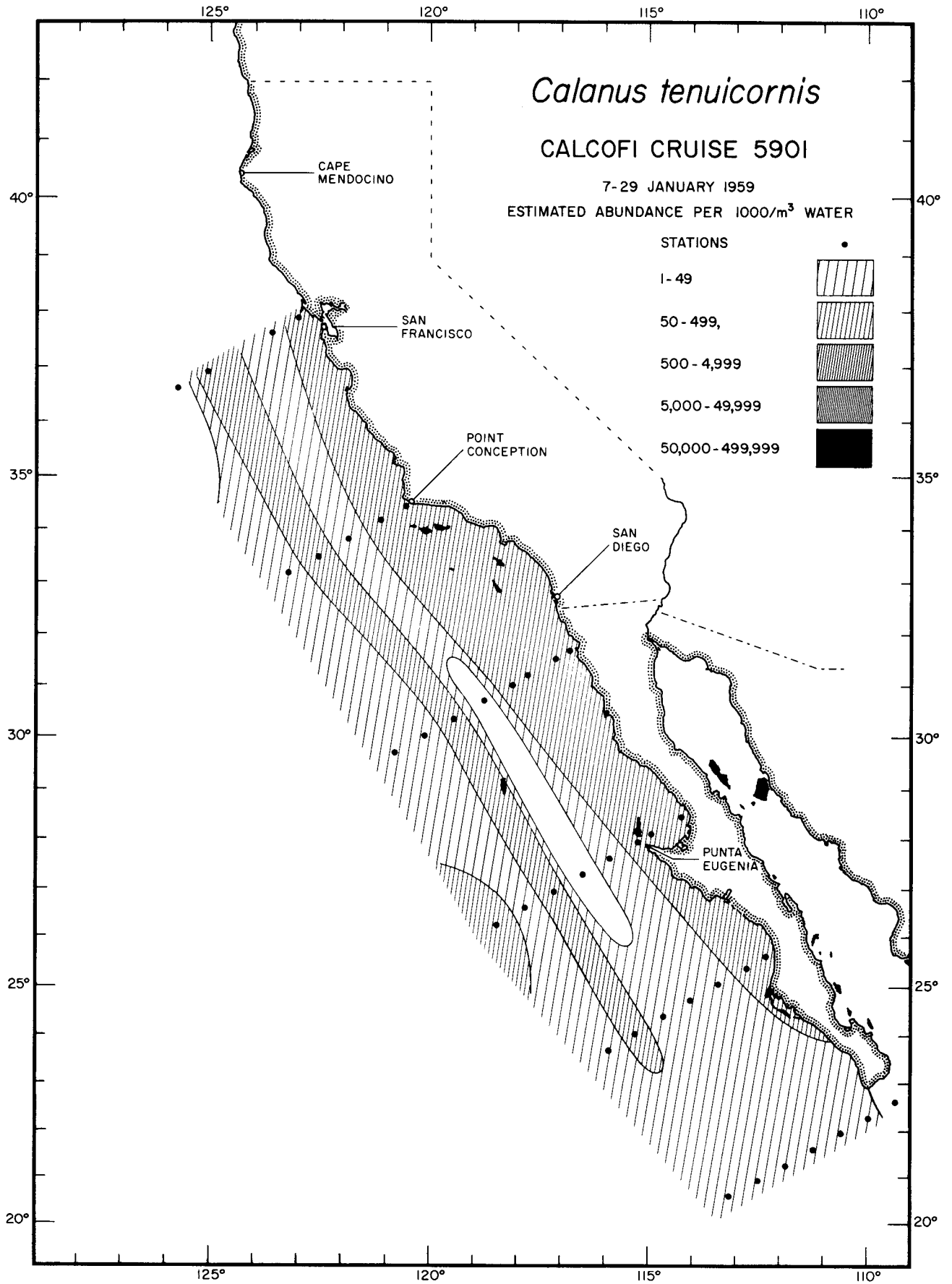
Calanoida
Calanus tenuicornis
5804



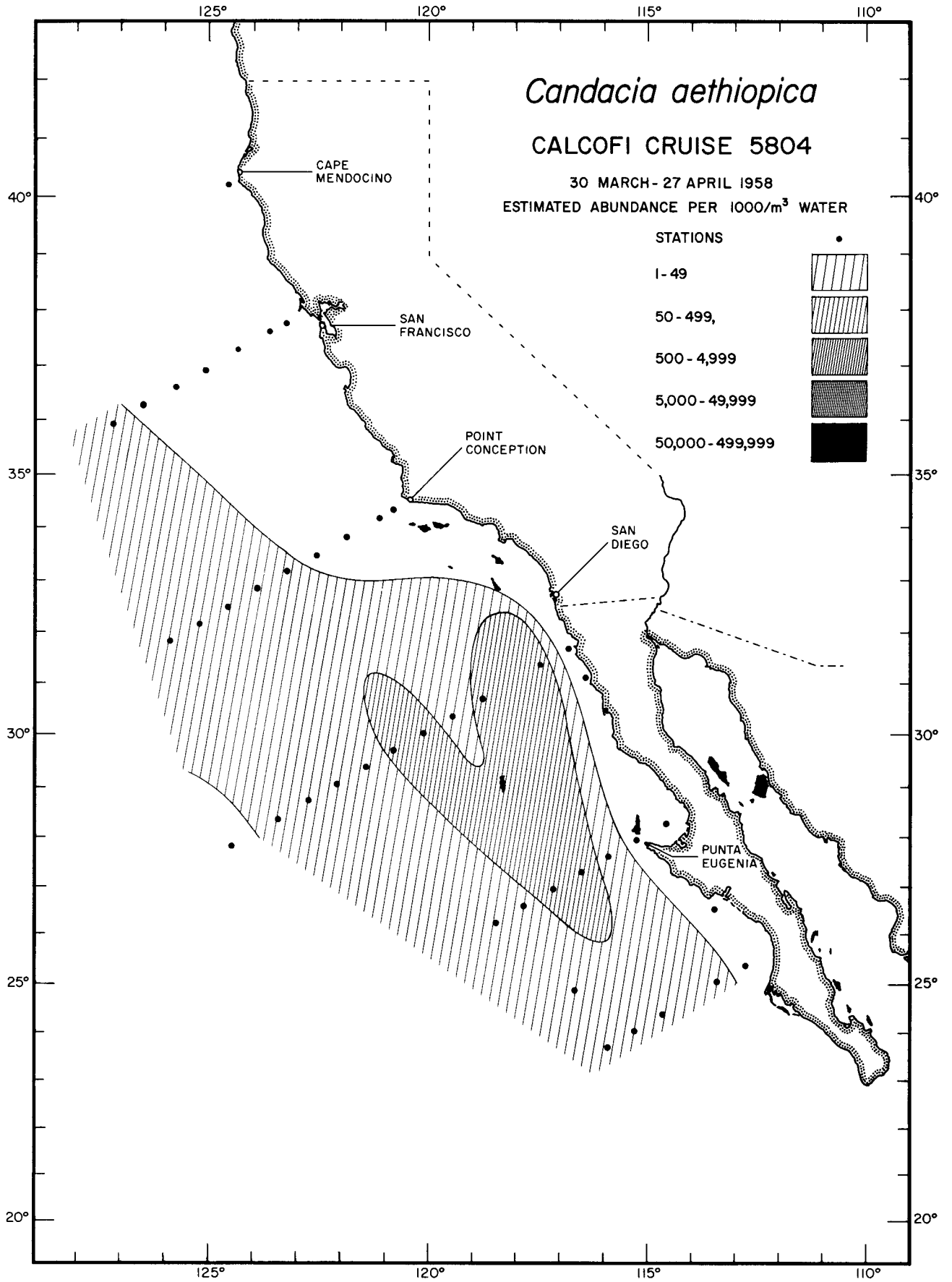
Calanoida
Calanus tenuicornis
5807



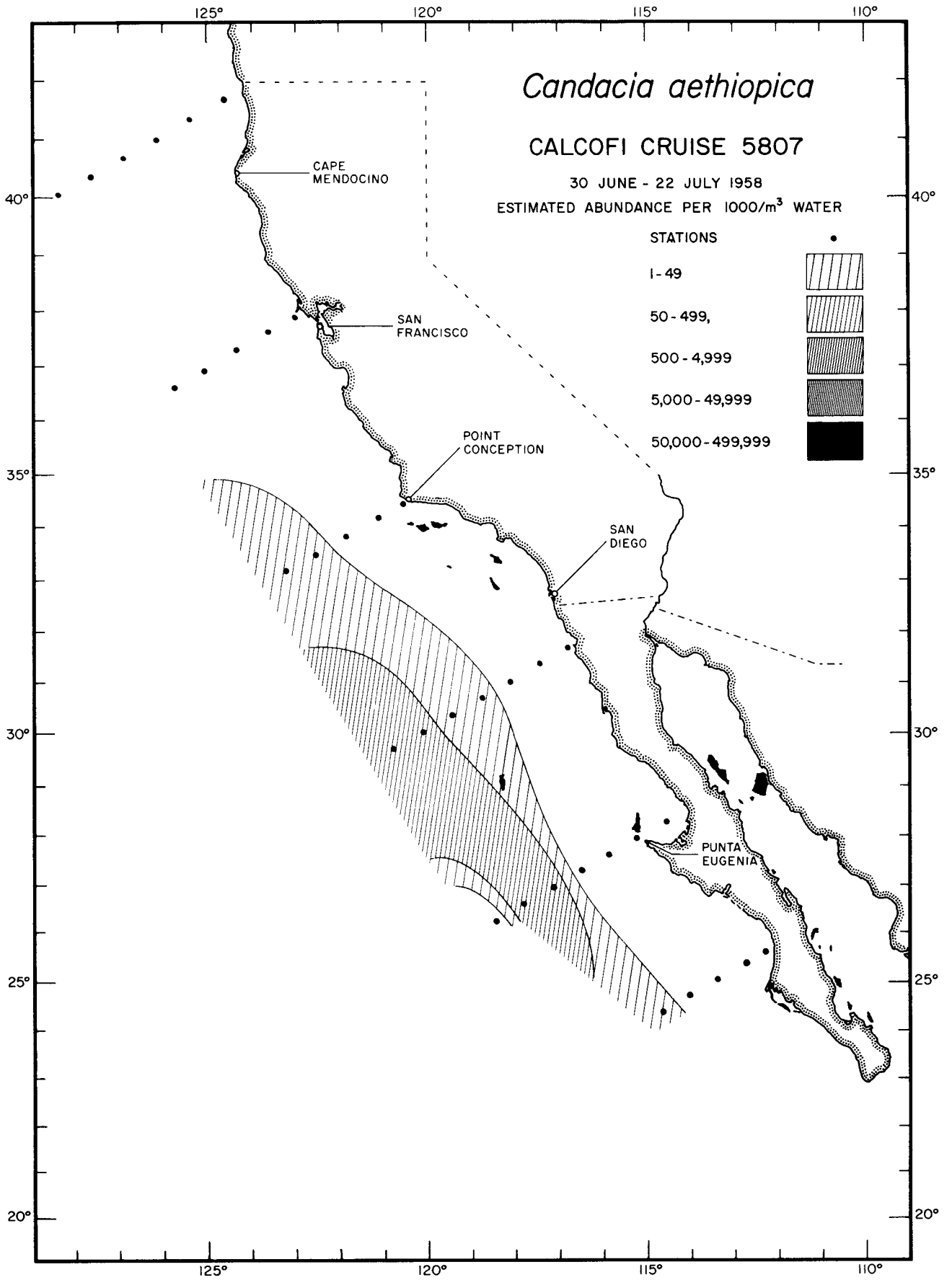
Calanoida
Calanus tenuicornis
5810



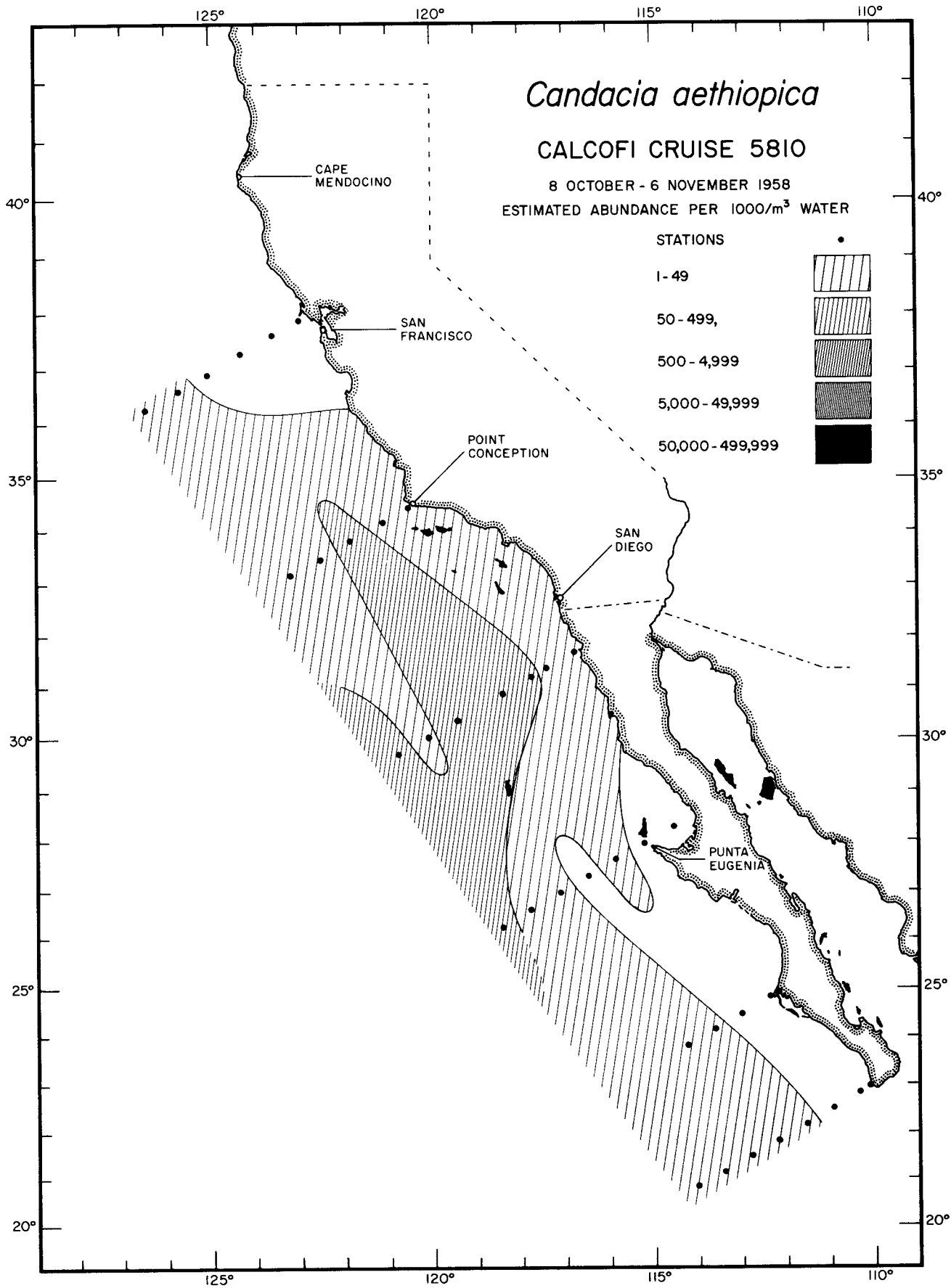
Calanoida
Calanus tenuicornis
5901



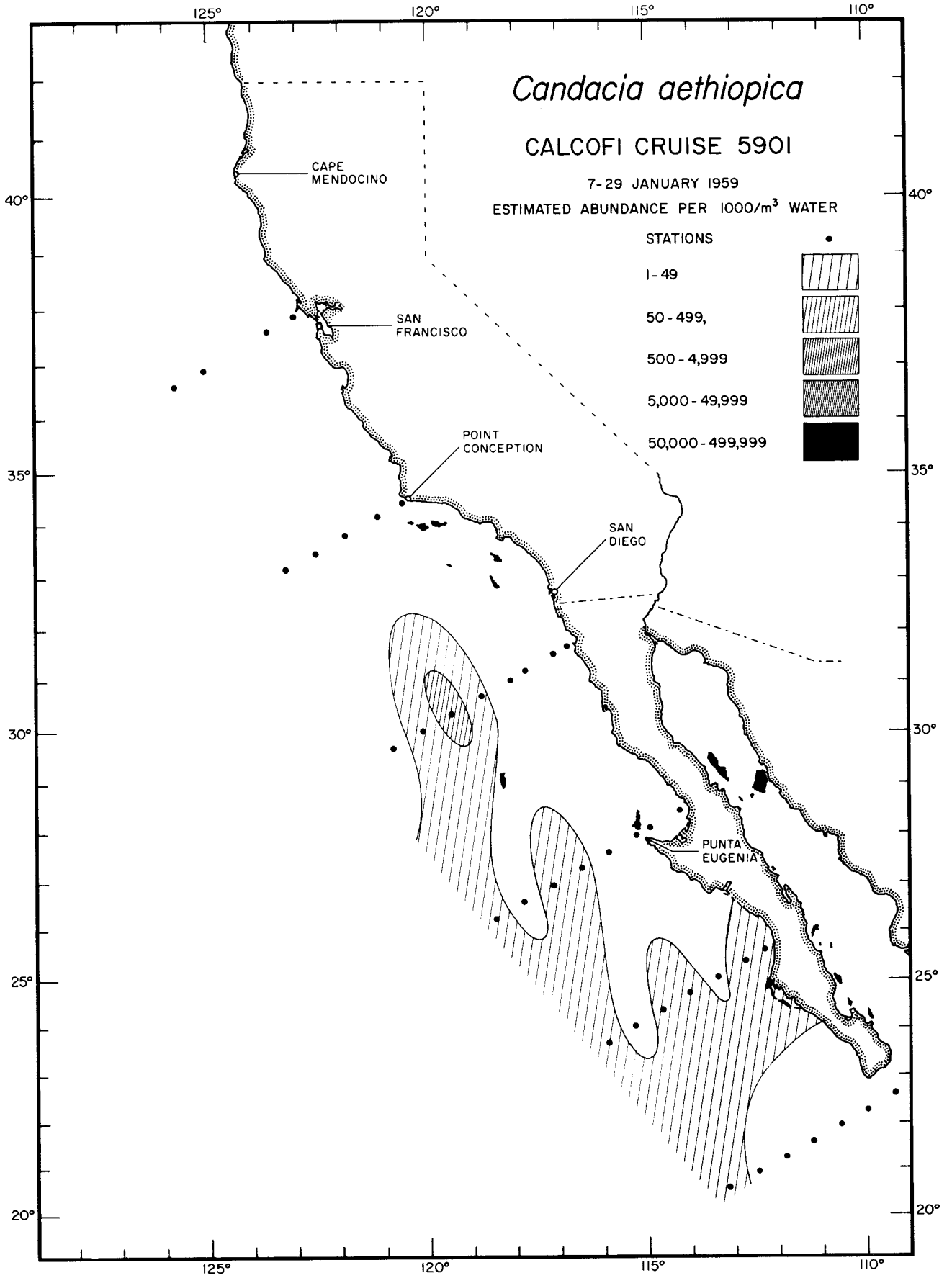
Calanoida
Candacia aethiopica
5804



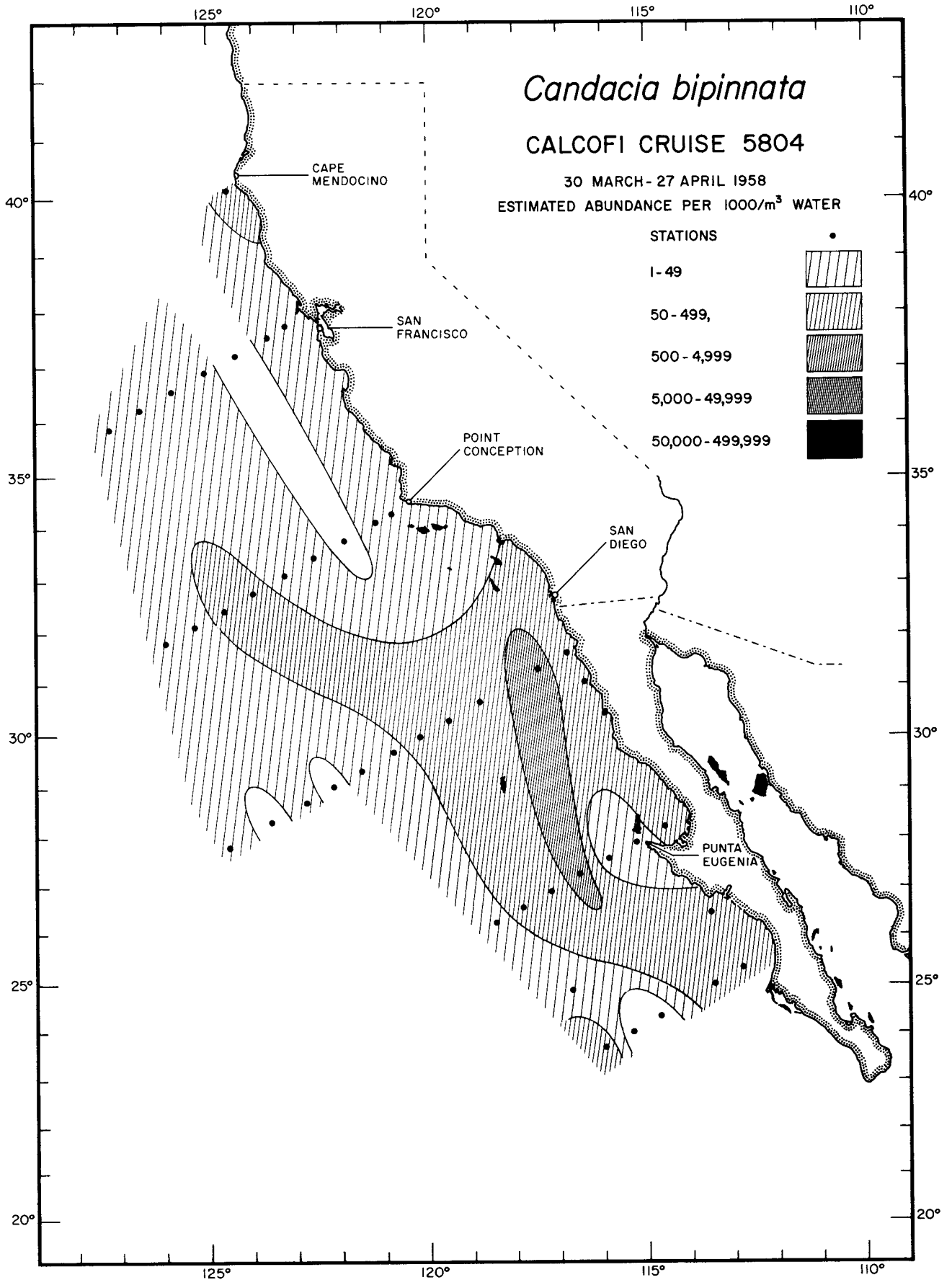
Calanoida
Candacia aethiopica
5807



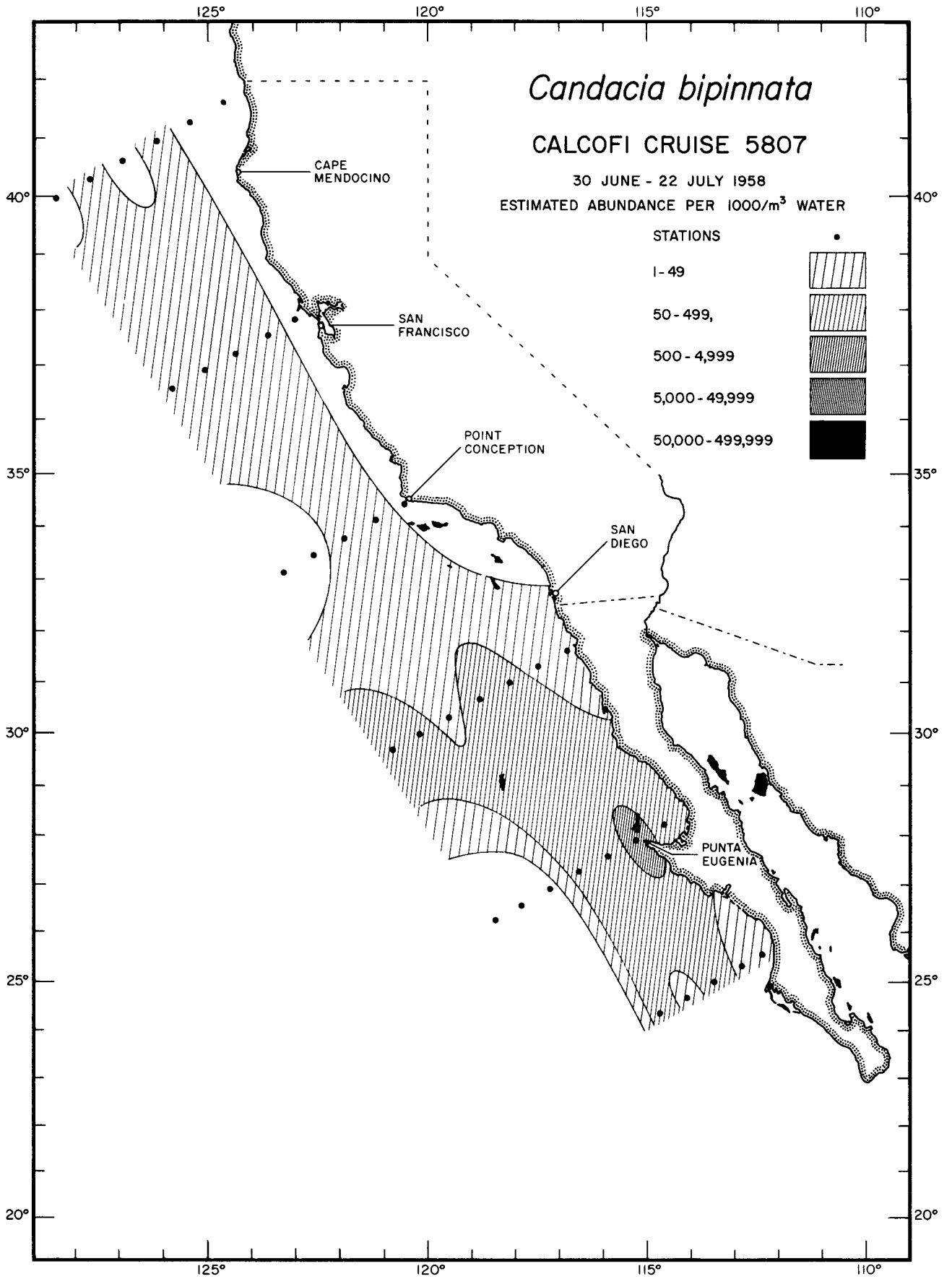
Calanoida
Candacia aethiopica
5810



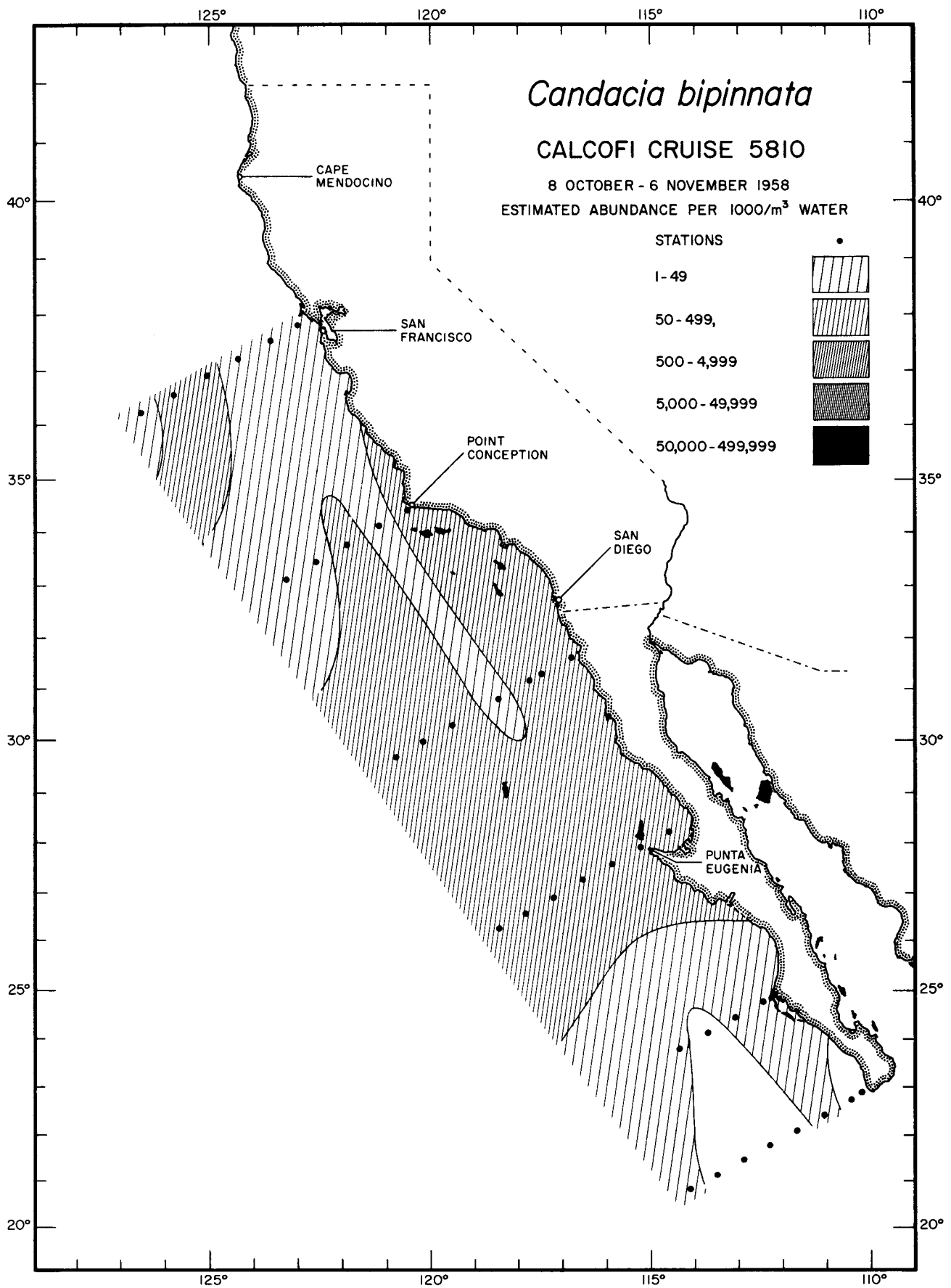
Calanoida
Candacia aethiopica
5901



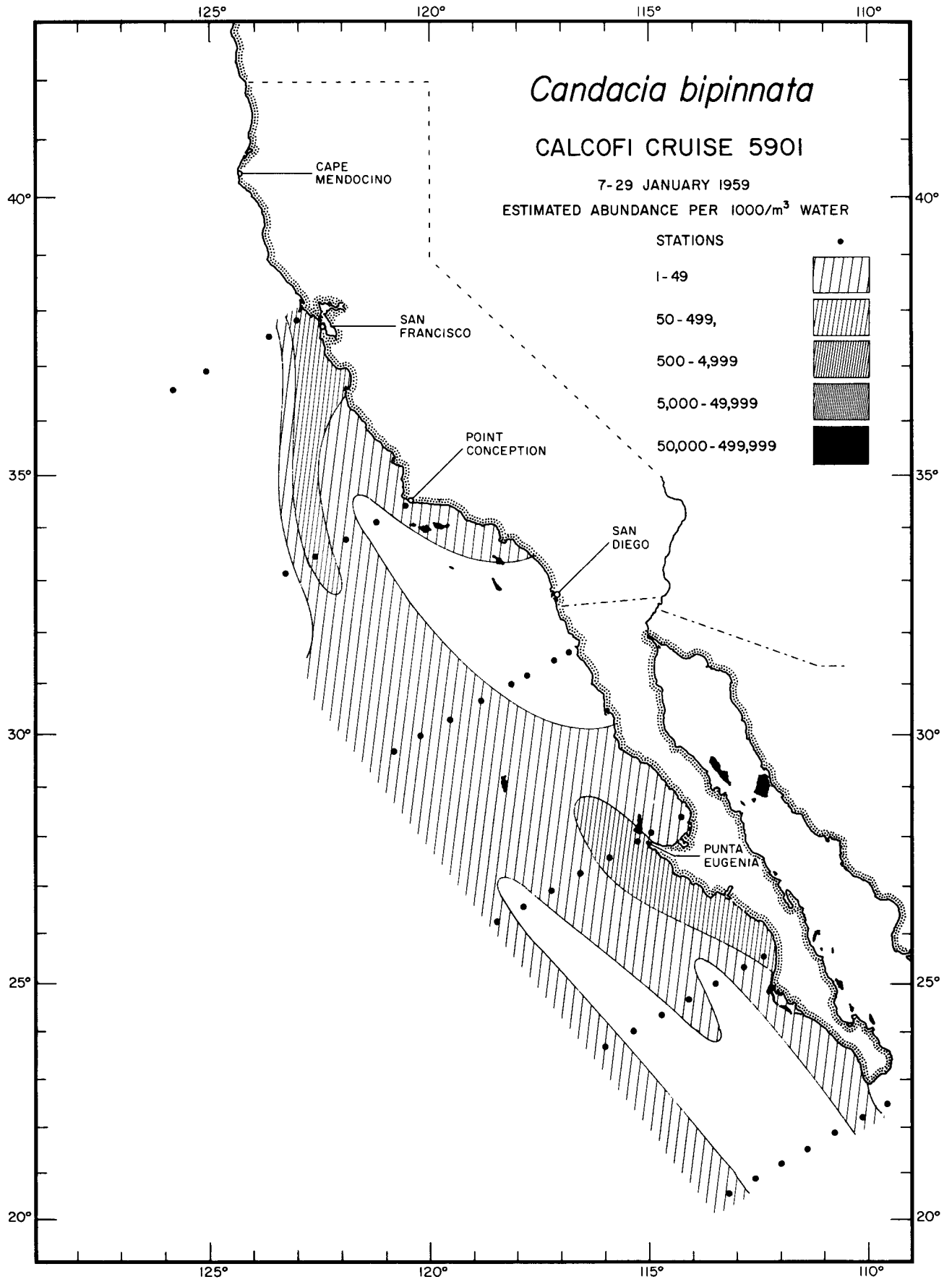
Calanoida
Candacia bipinnata
5804

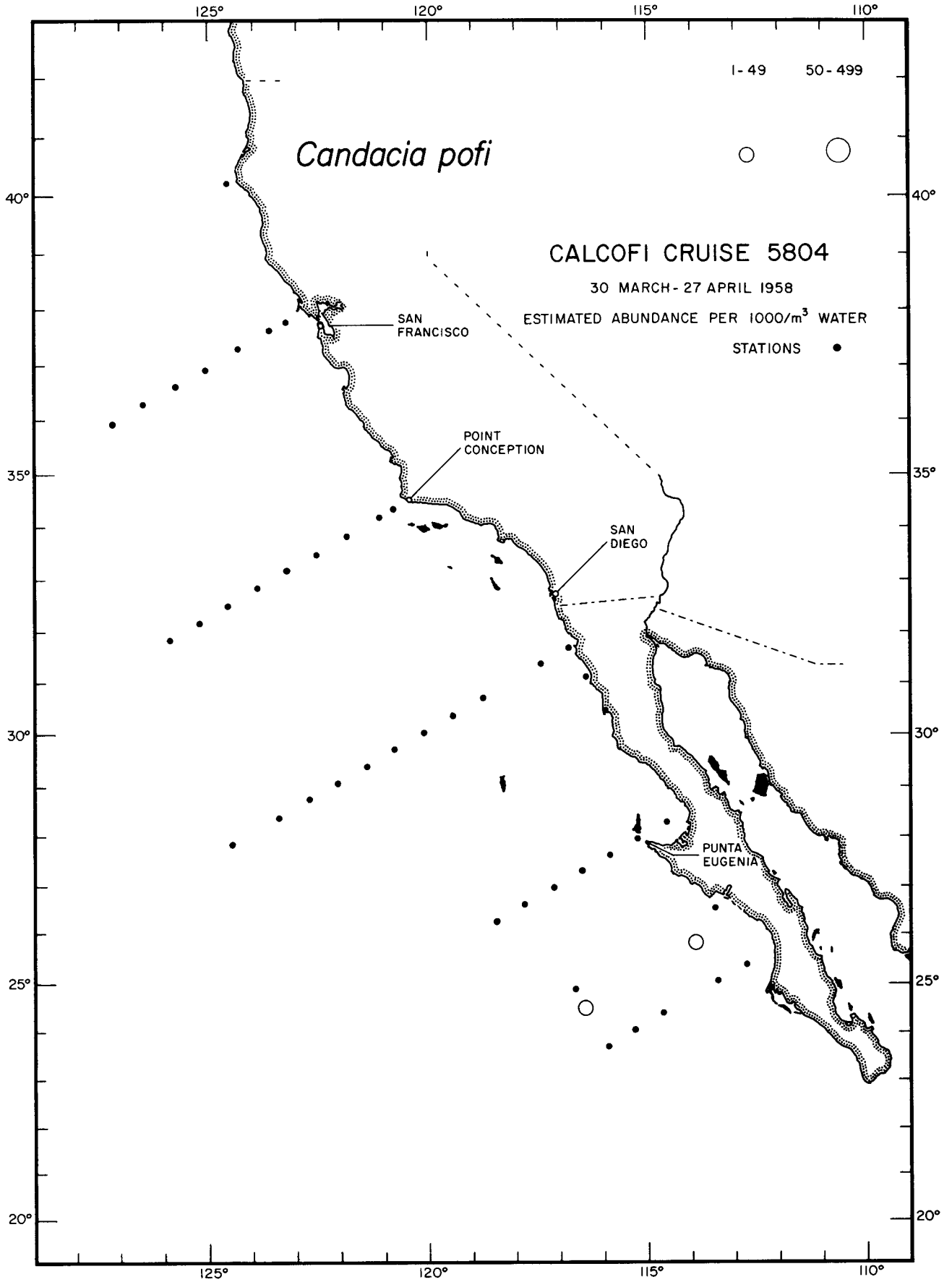


Calanoida
Candacia bipinnata
5807

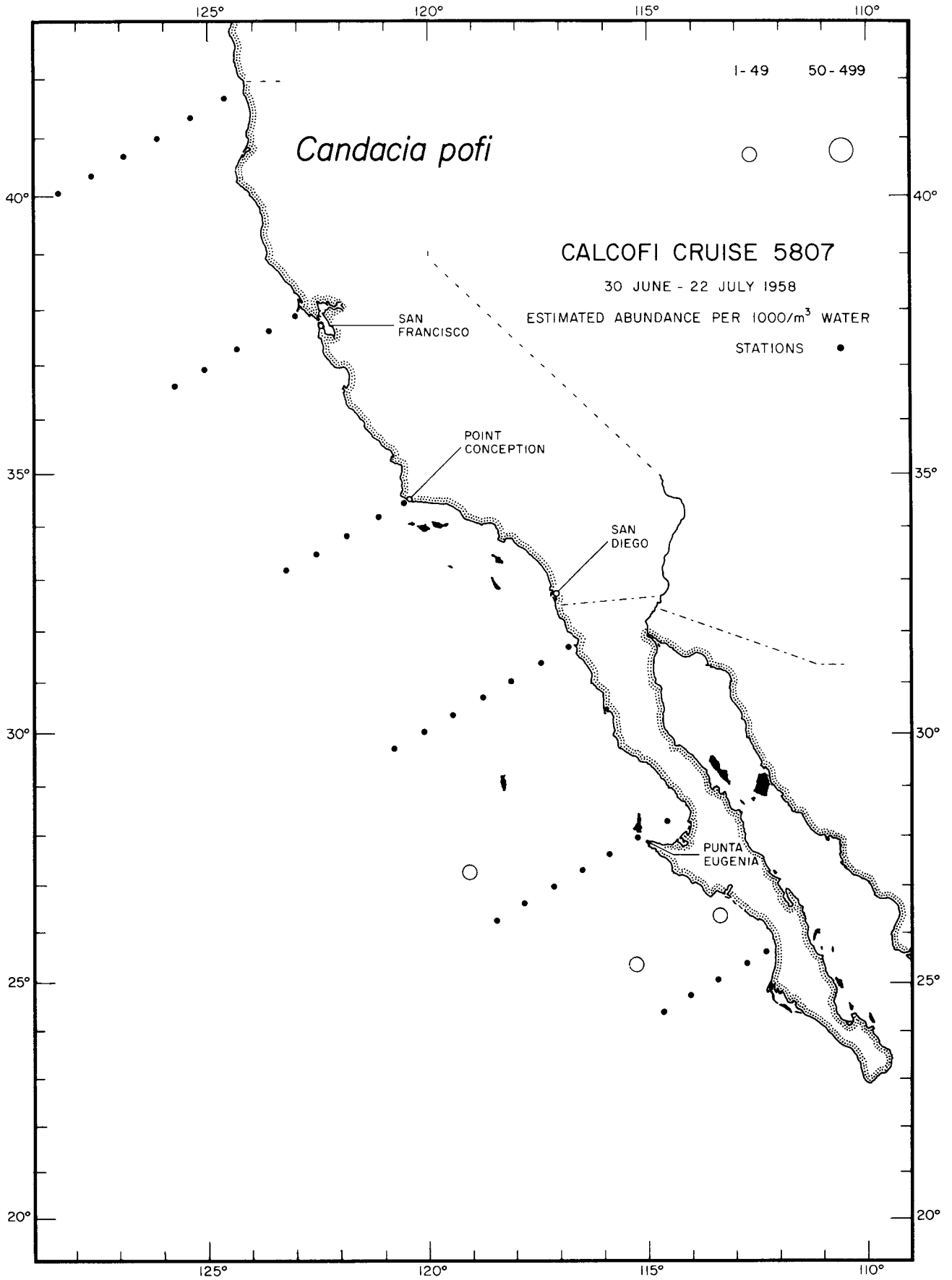


Calanoida
Candacia bipinnata
5810

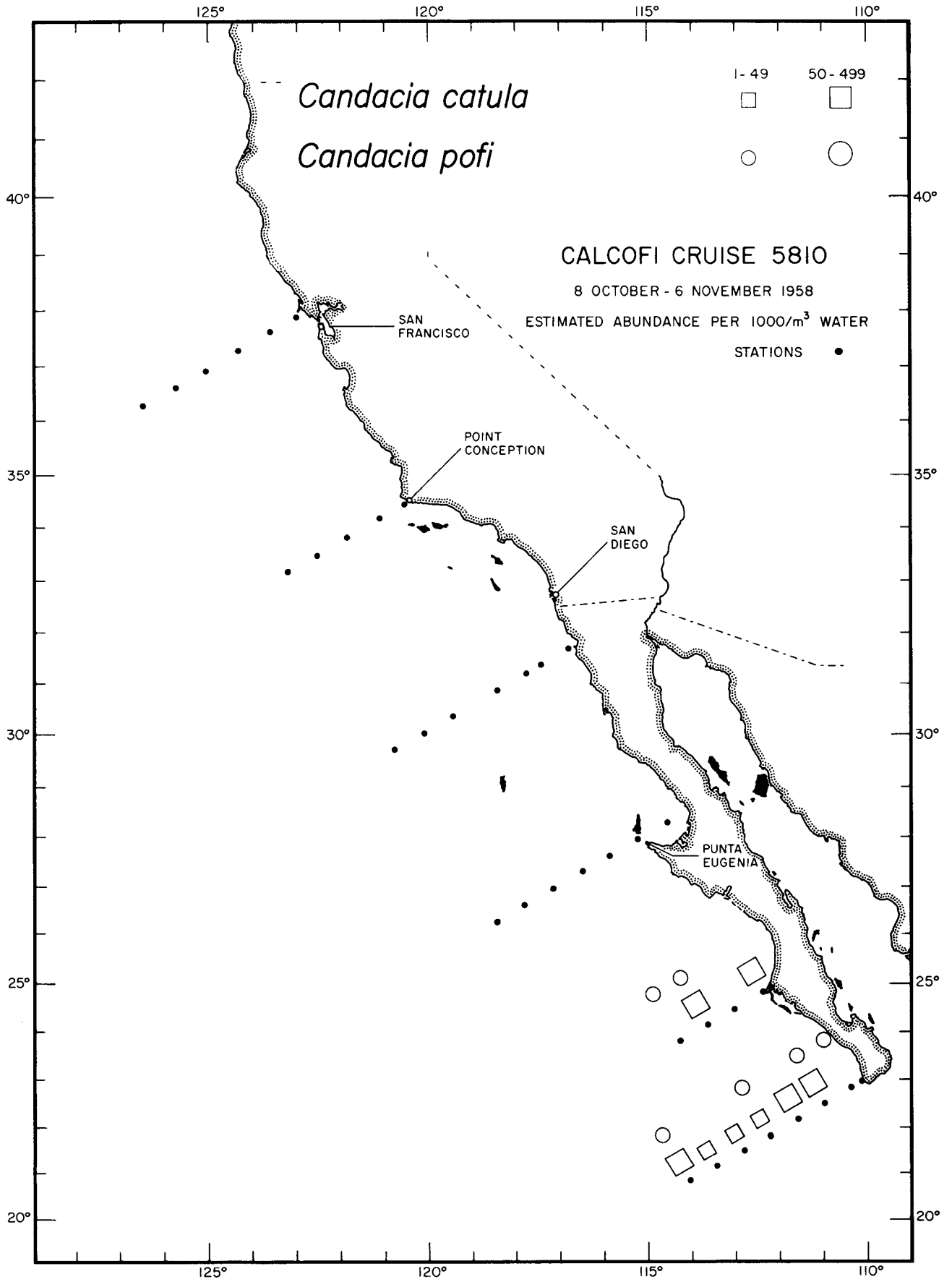




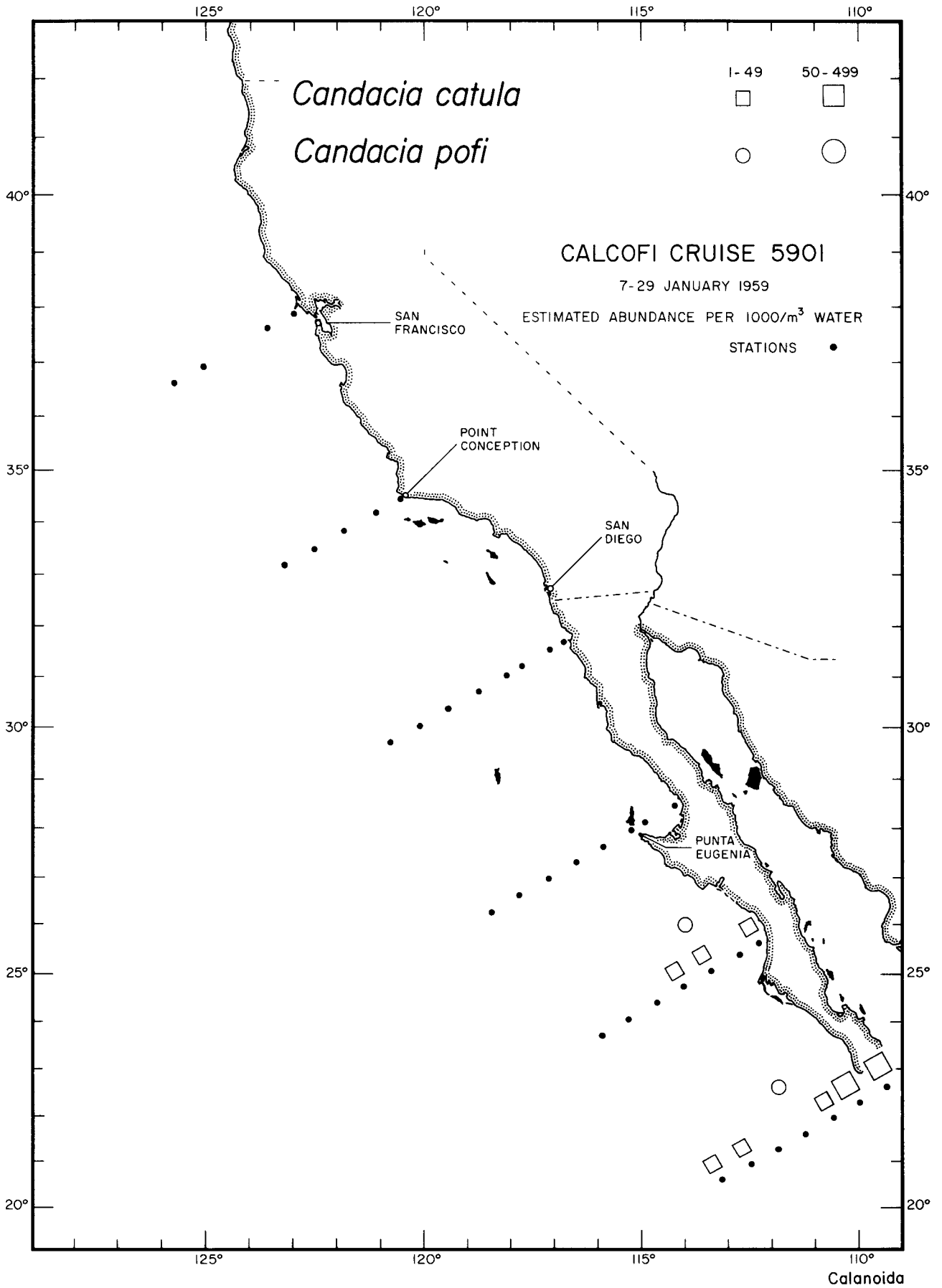
Calanoida
Candacia pofi
5804



Calanoida
Candacia pofi
5807

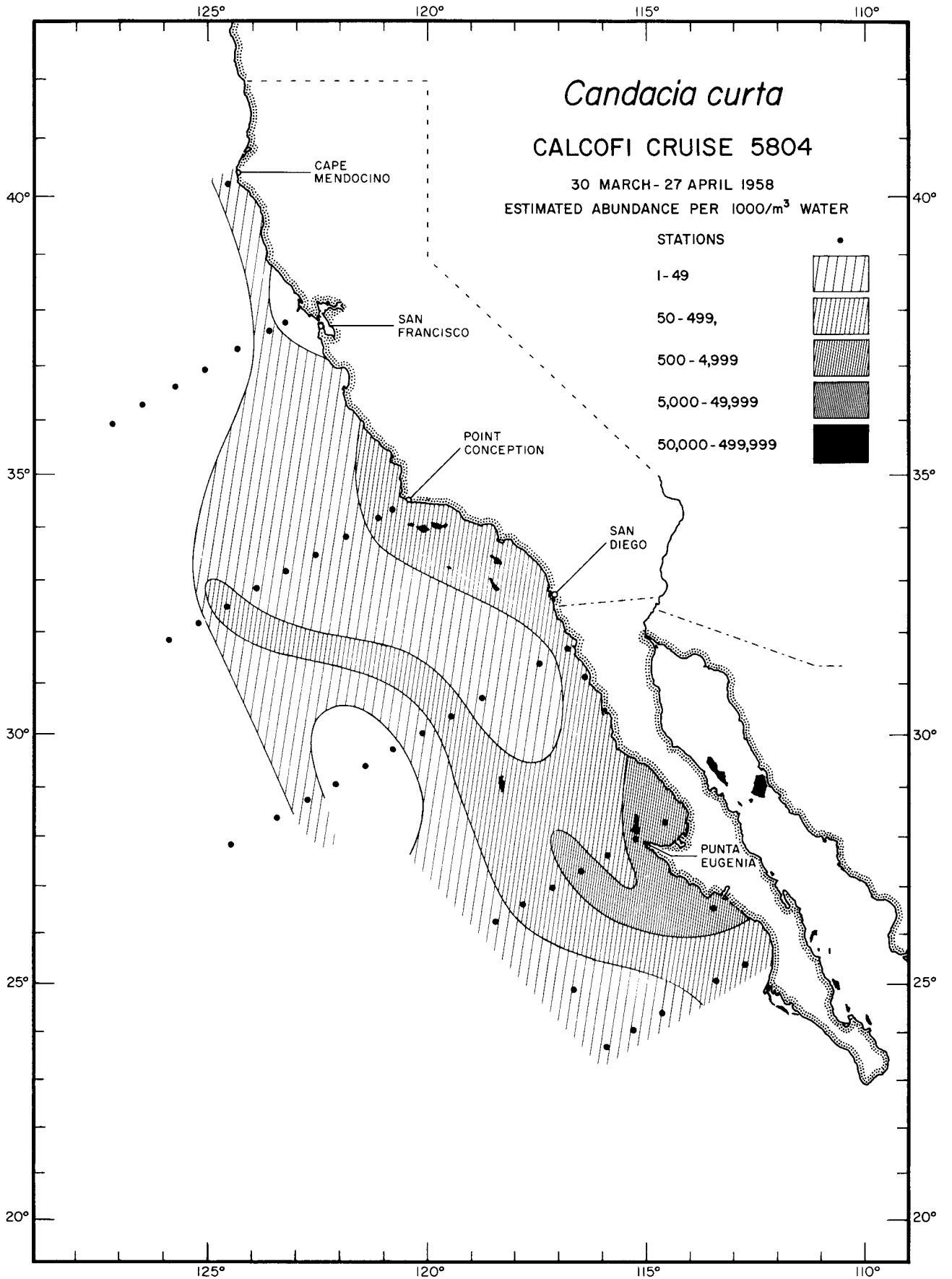


Calanoida
Candacia catula
Candacia pofi
5810

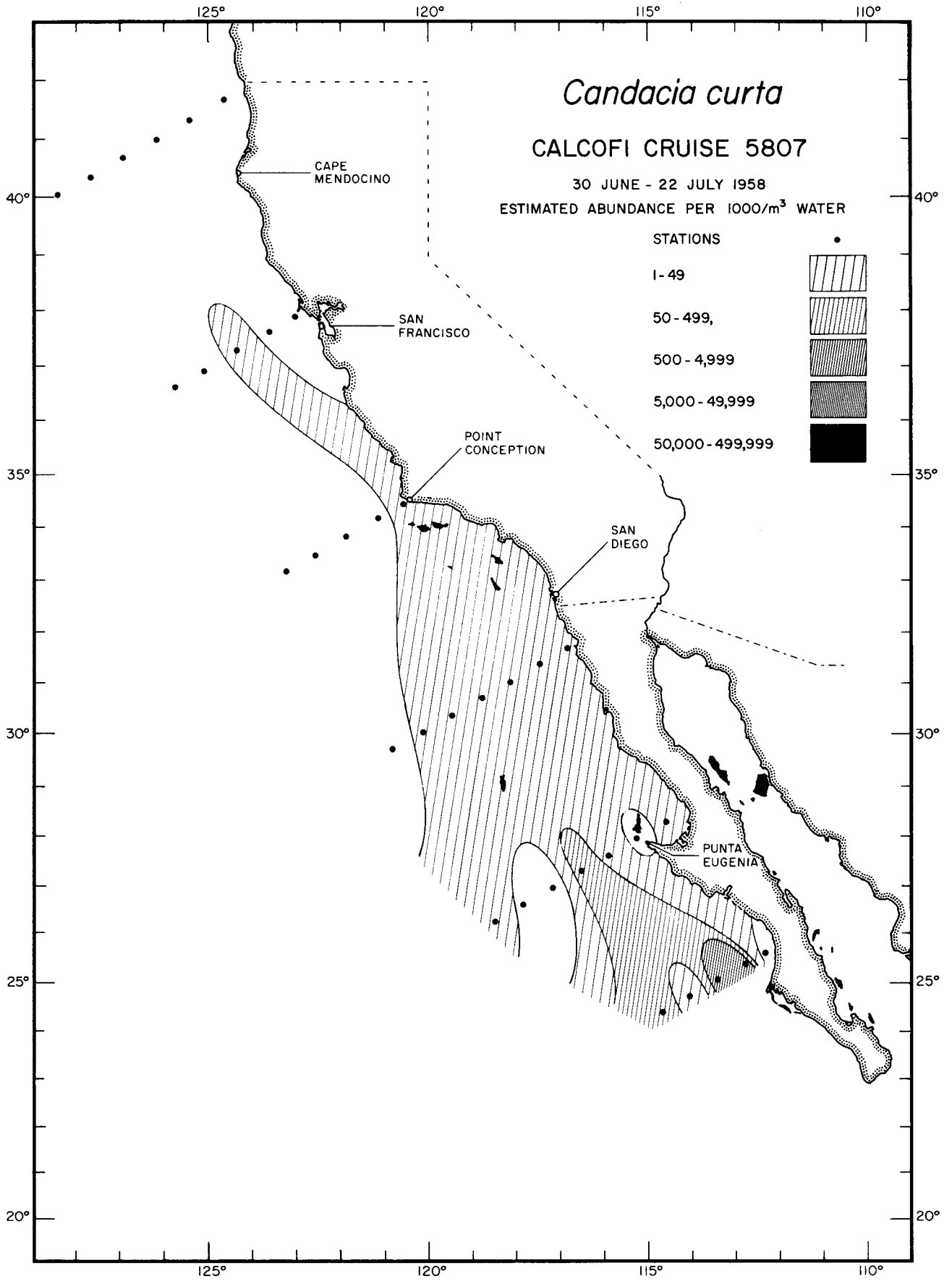


Candacia catula
Candacia pofi

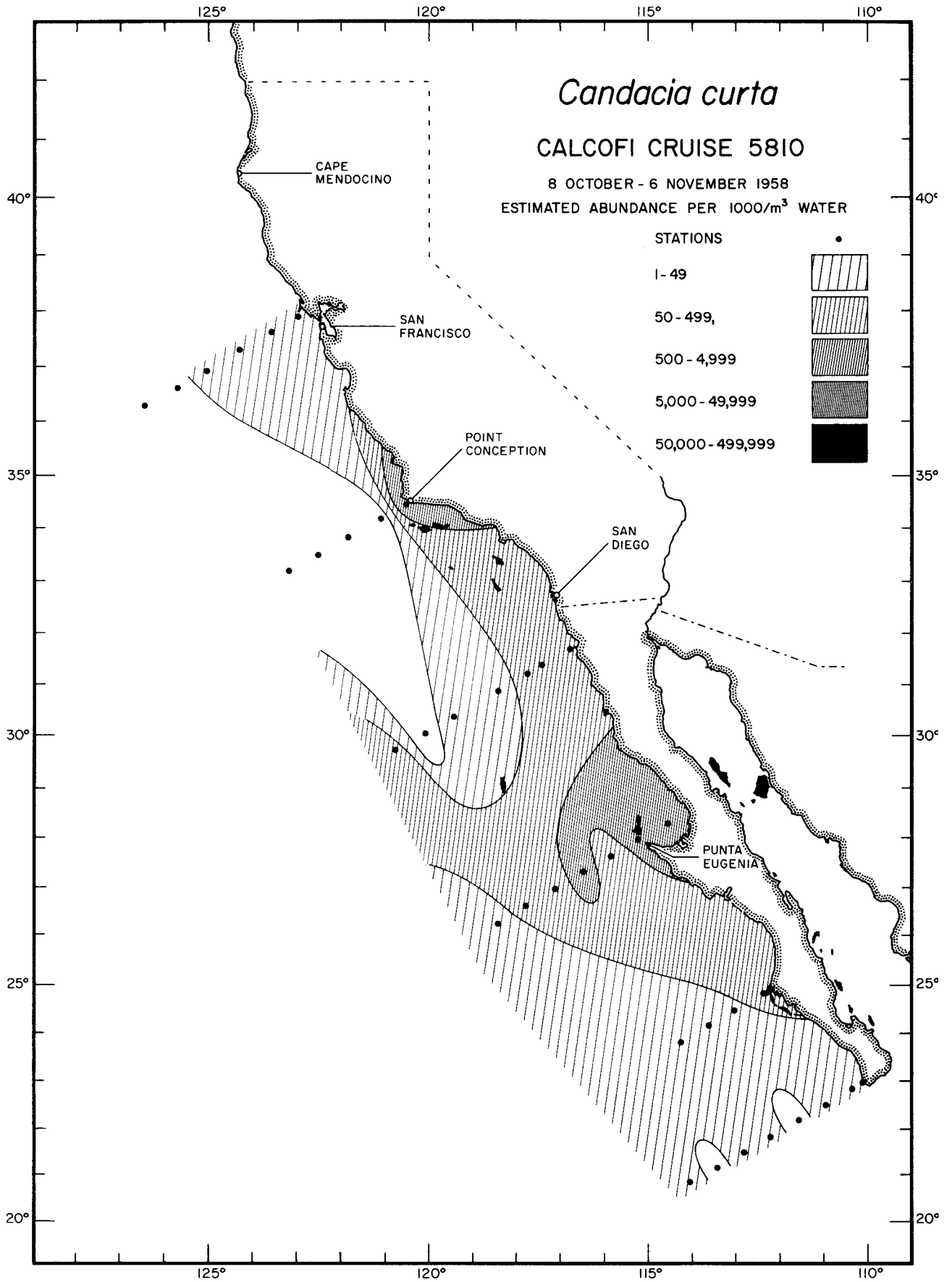
5901



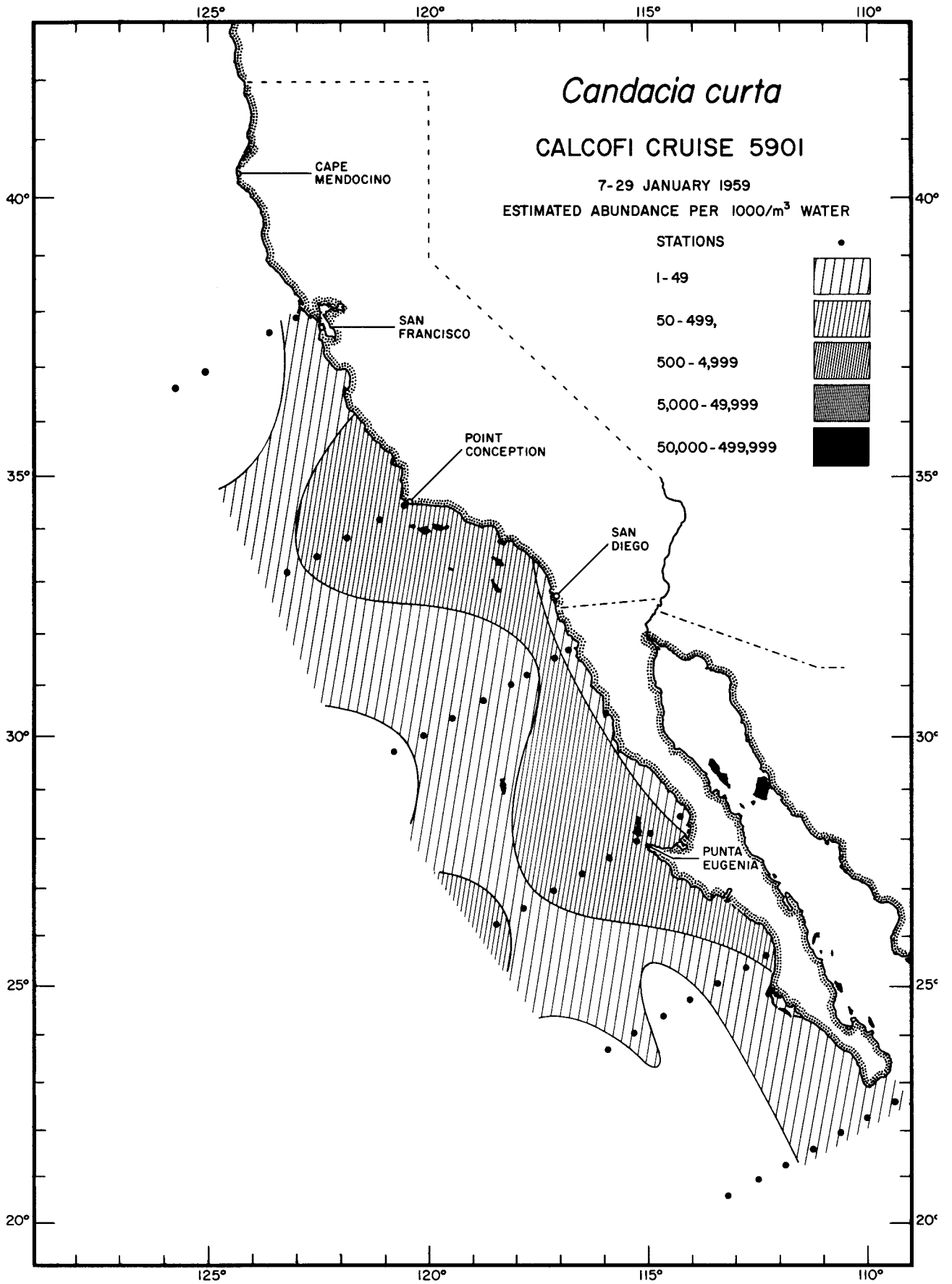
Calanoida
Candacia curta
5804



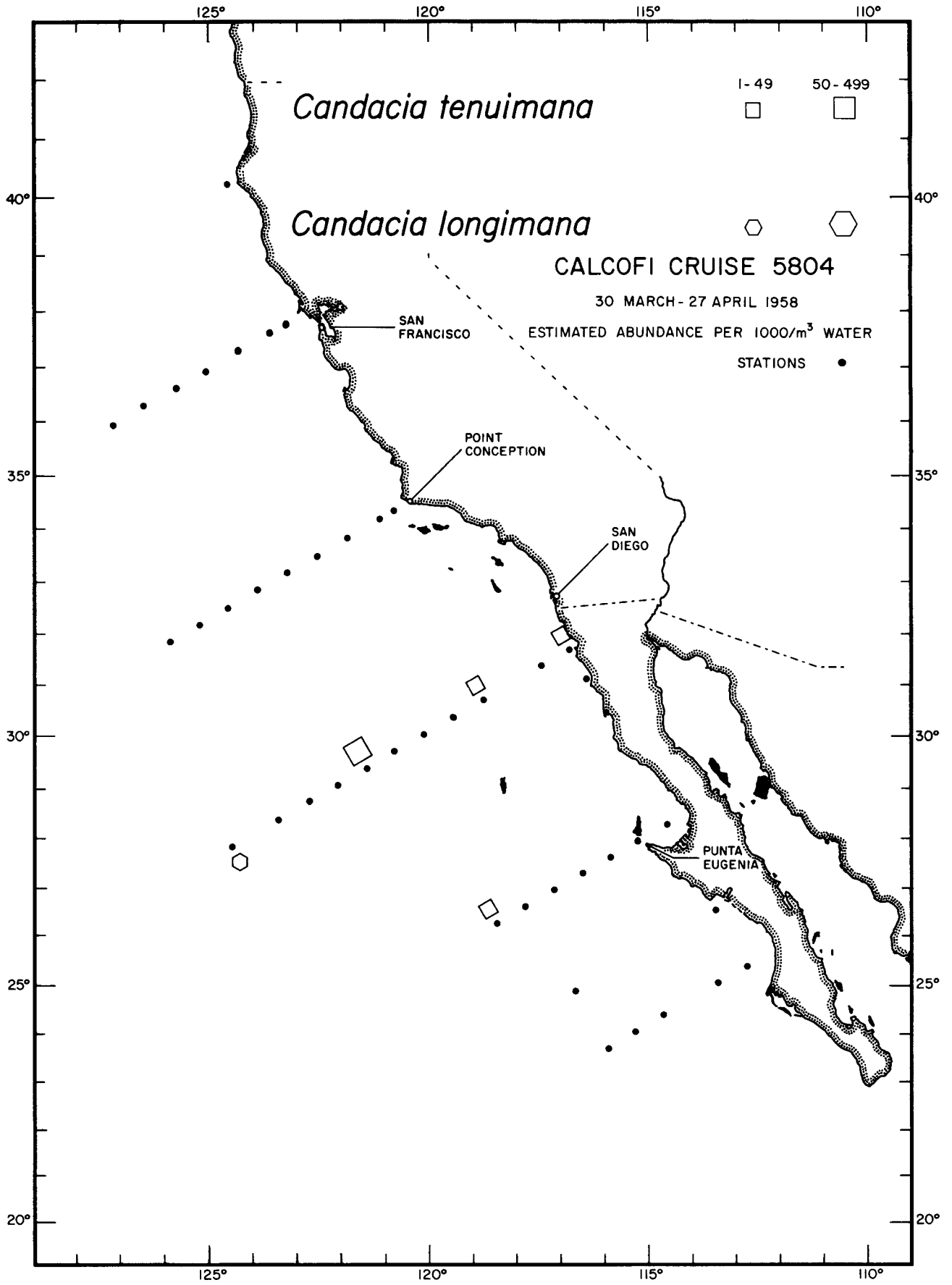
Calanoida
Candacia curta
5807



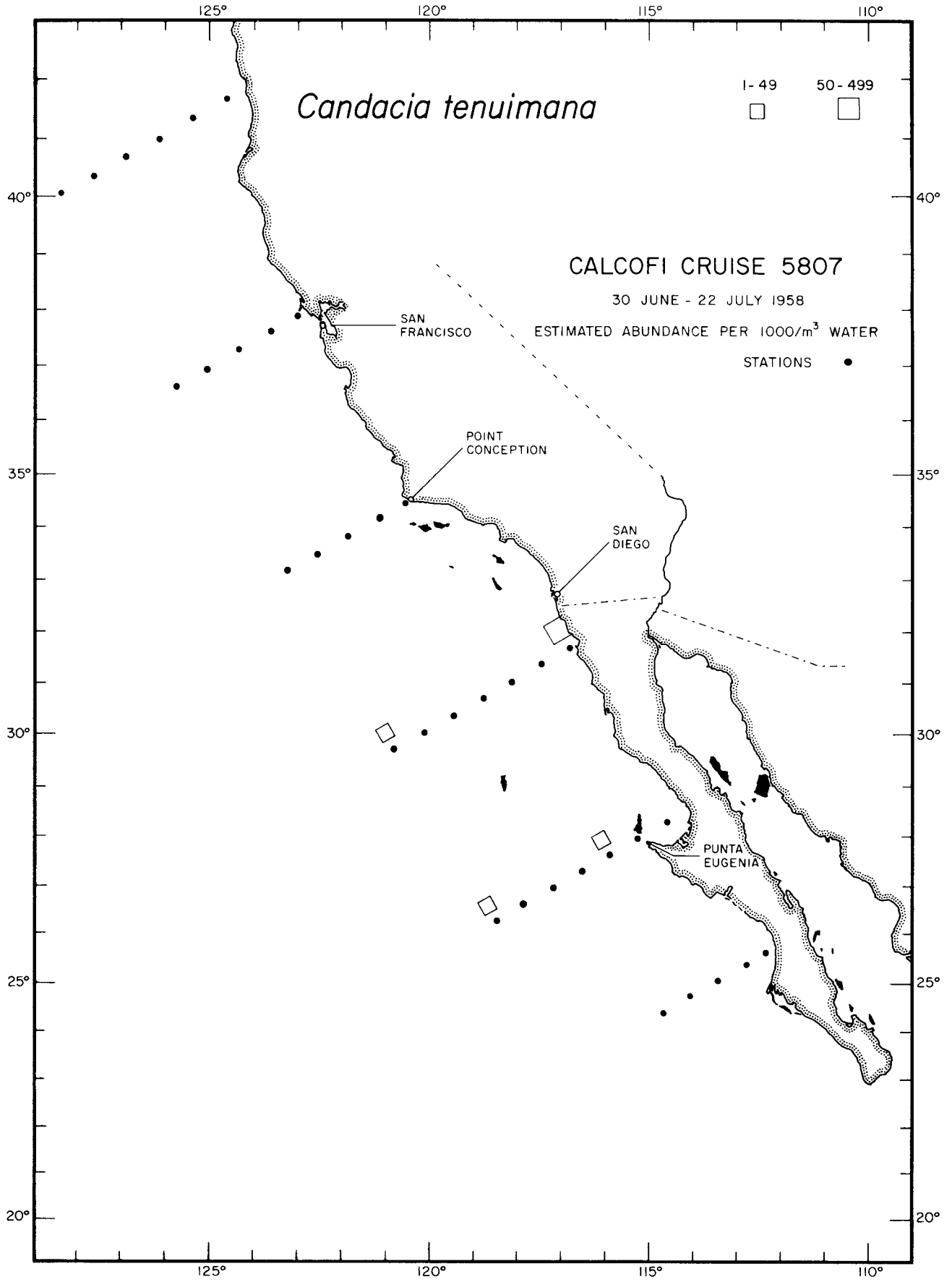
Calanoida
Candacia curta
5810



Calanoida
Candacia curta
5901



Calanoida
Candacia tenuimana
Candacia longimana



Candacia tenuimana

1-49 50-499
□ □

CALCOFI CRUISE 5807

30 JUNE - 22 JULY 1958

ESTIMATED ABUNDANCE PER 1000/m³ WATER

STATIONS ●

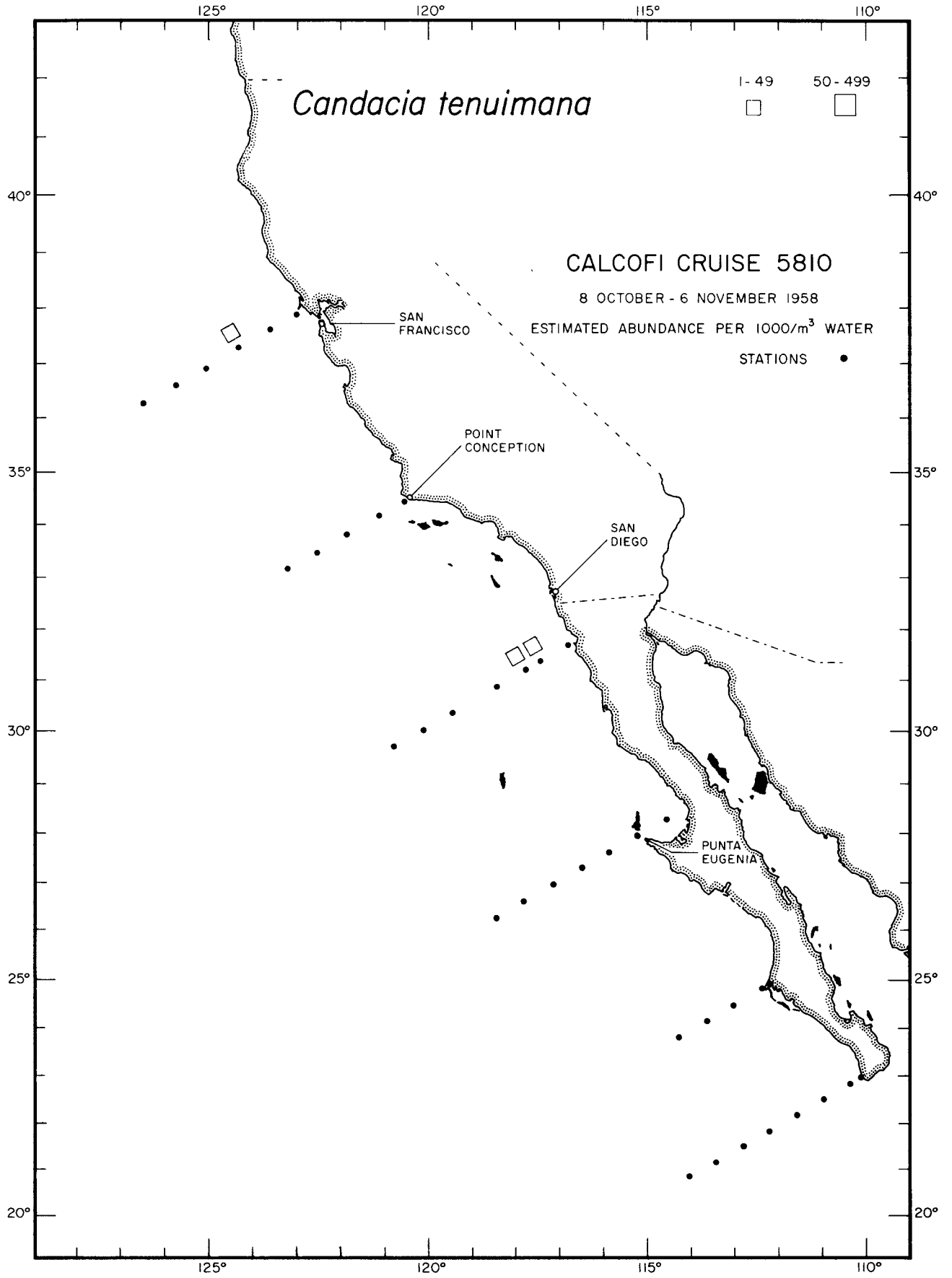
SAN FRANCISCO

POINT CONCEPTION

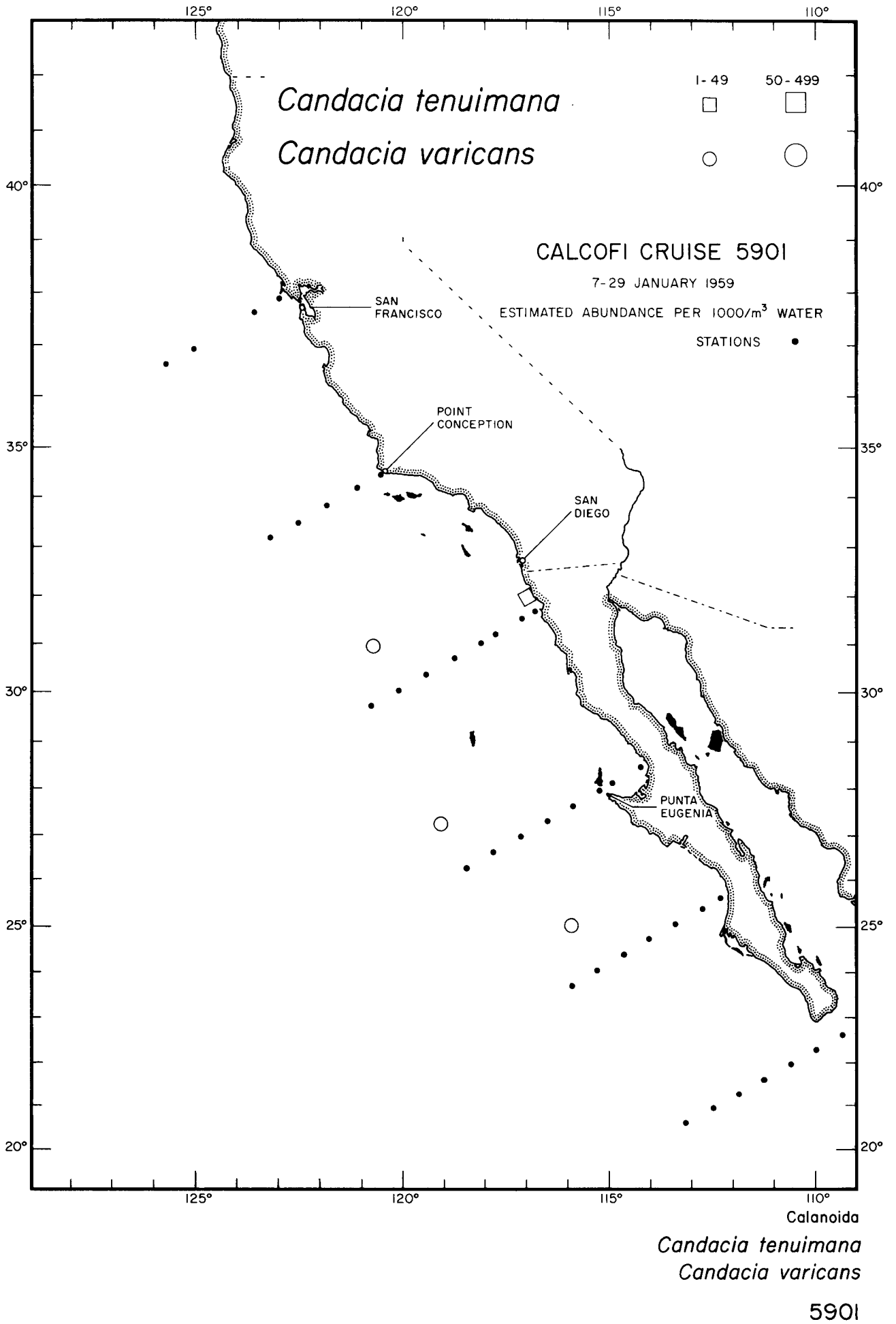
SAN DIEGO

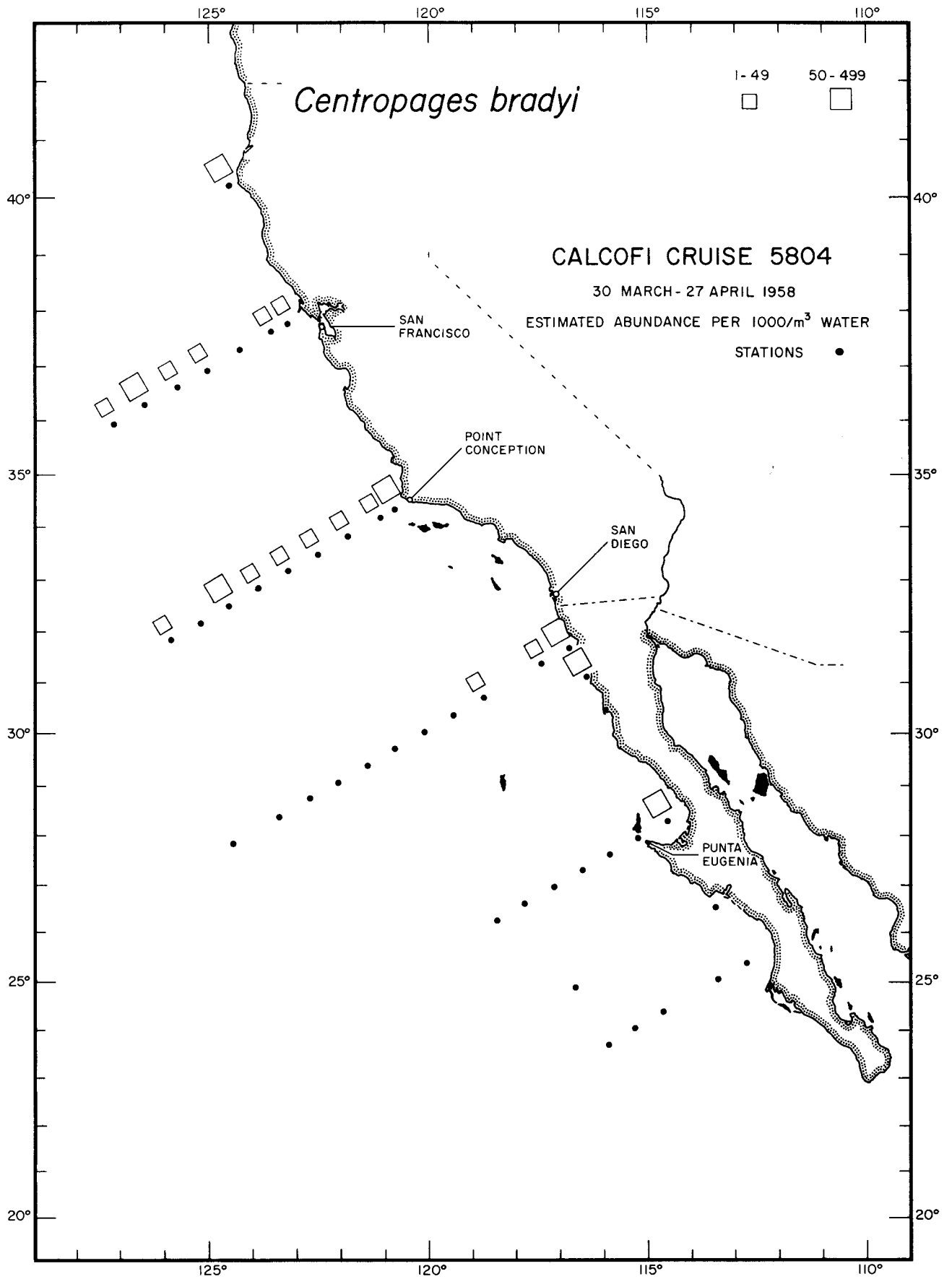
PUNTA EUGENIA

Calanoida
Candacia tenuimana
5807

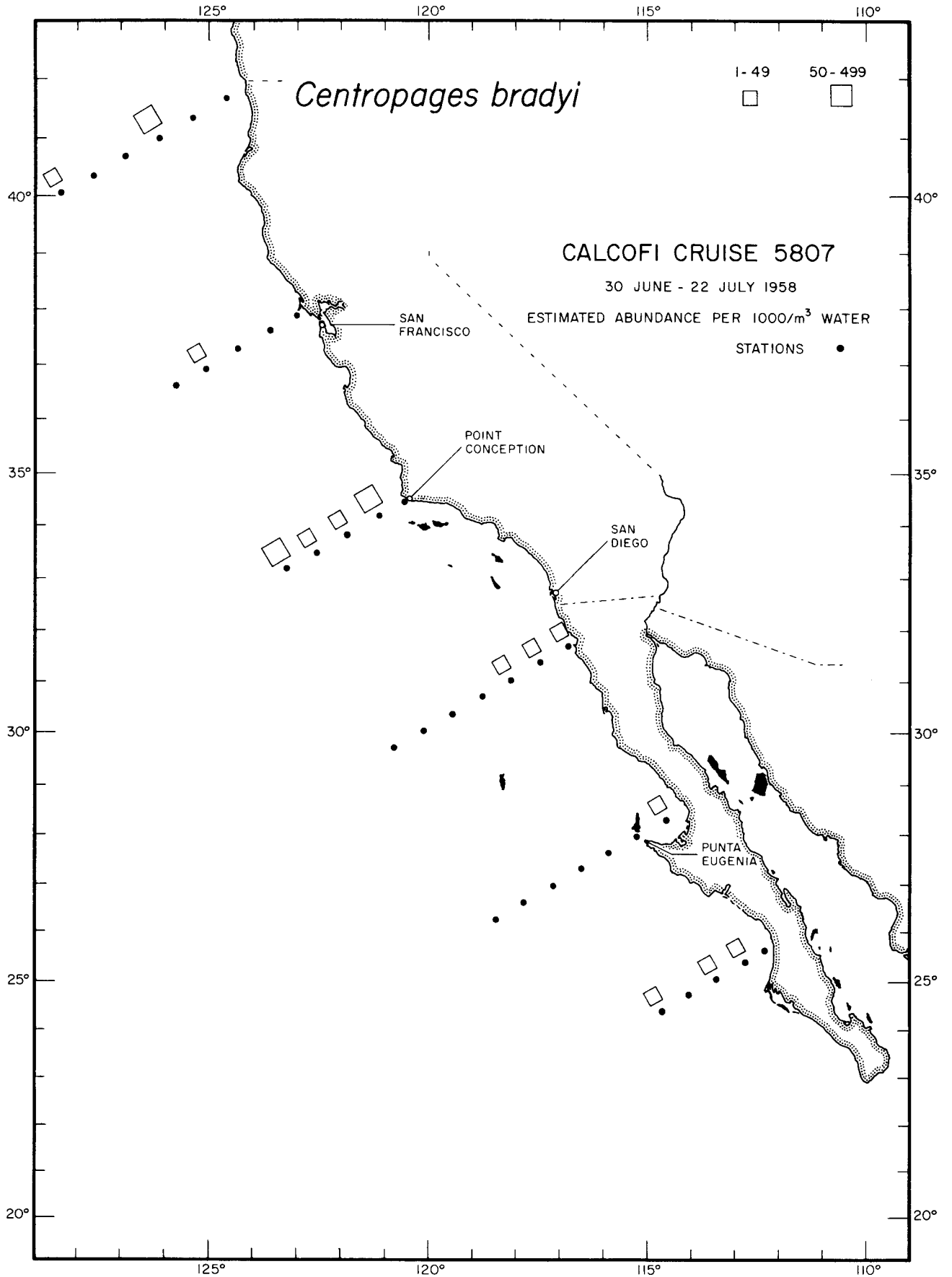


Calanoida
Candacia tenuimana
5810

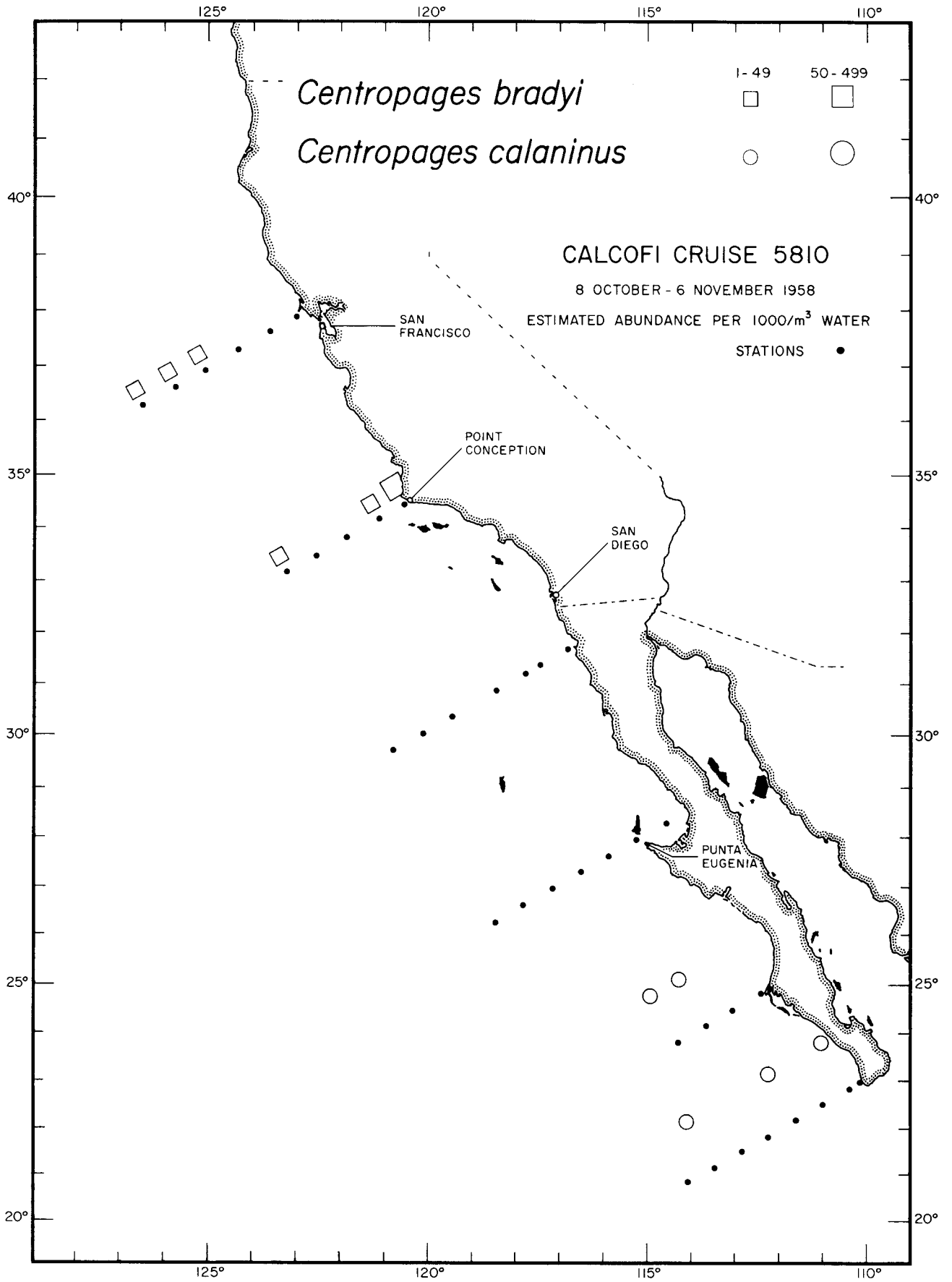




Calanoida
Centropages bradyi
5804



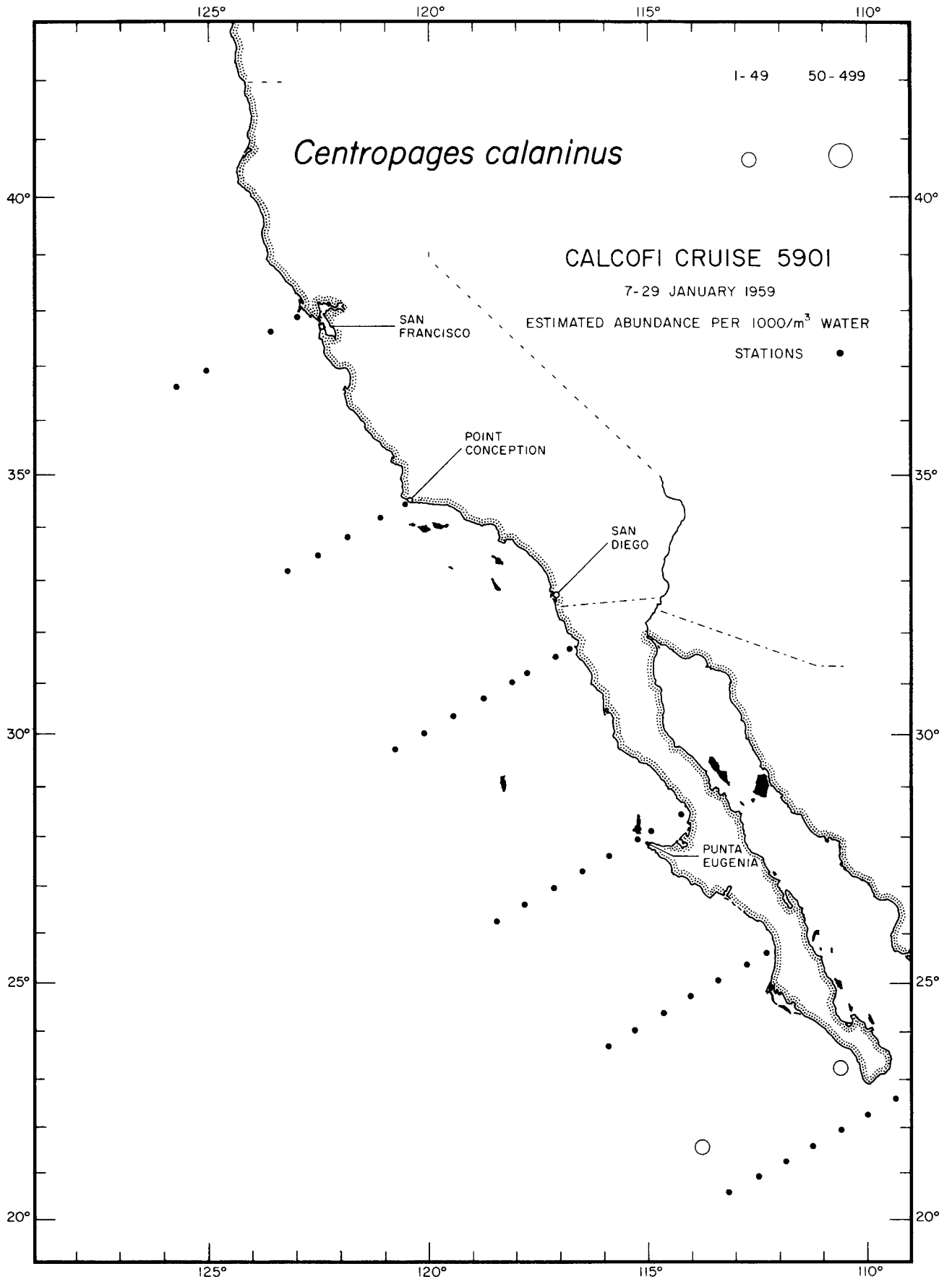
Calanoida
Centropages bradyi
5807



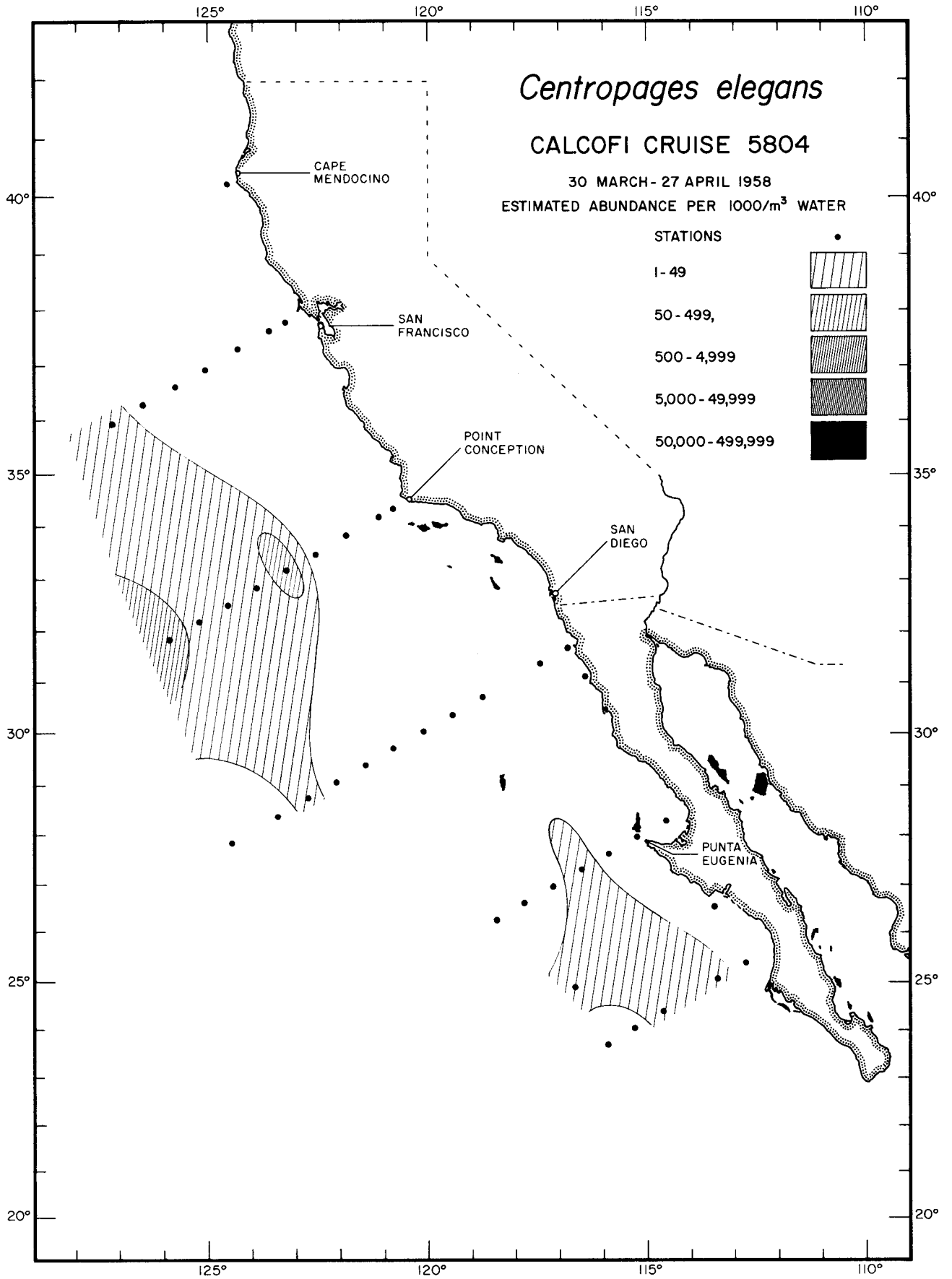
Calanoida

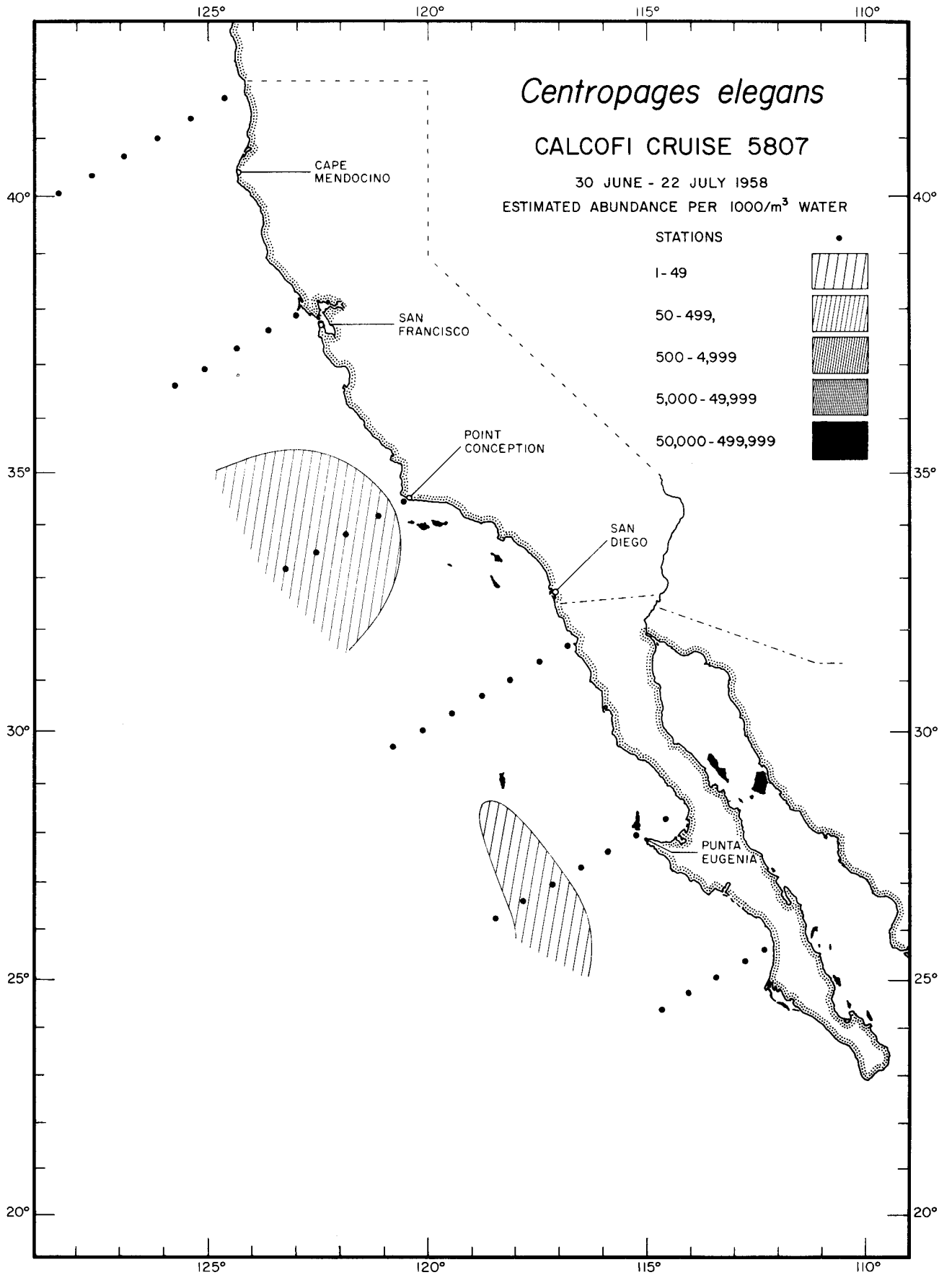
Centropages bradyi
Centropages calaninus

5810

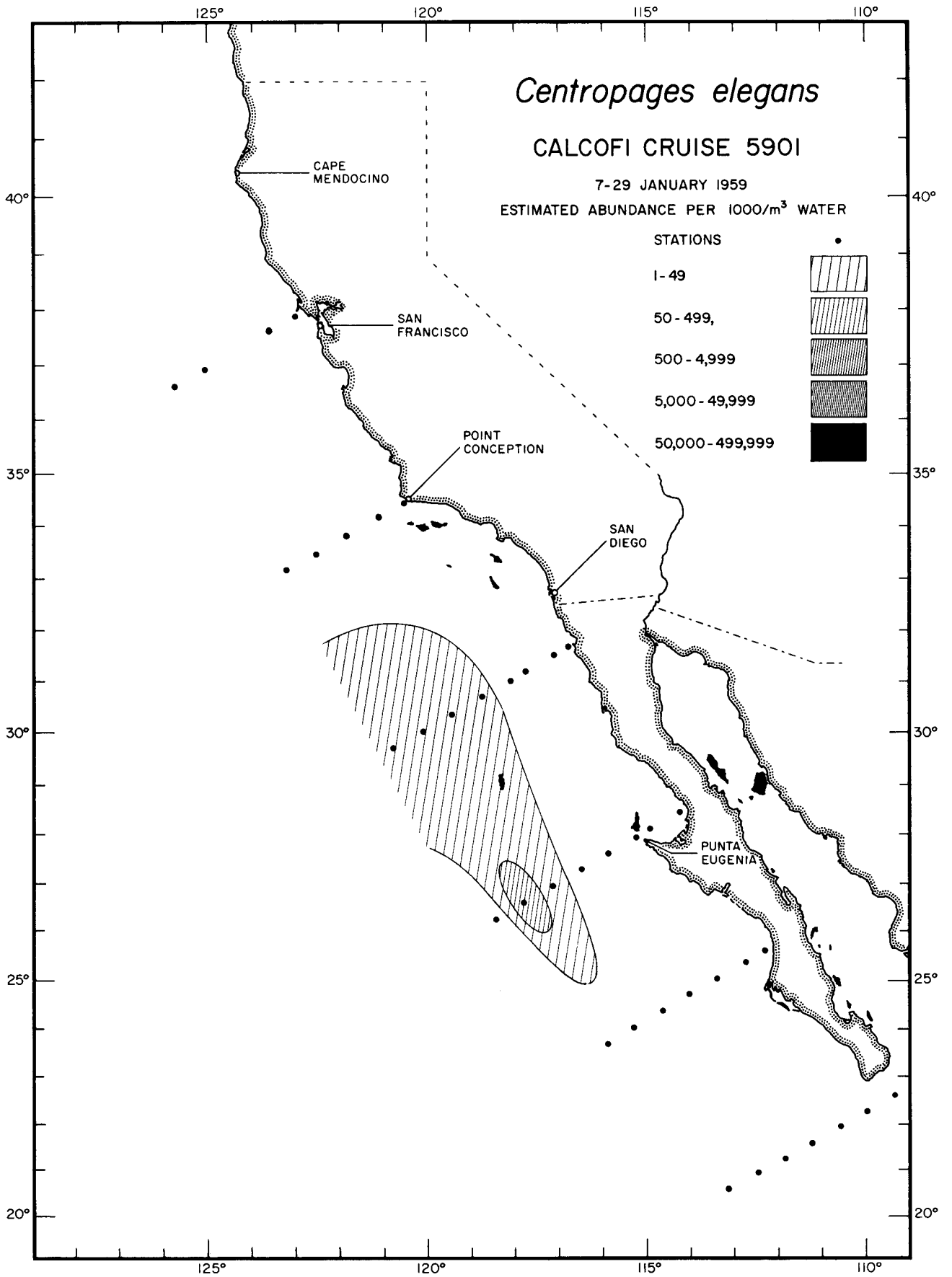


Calanoida
Centropages calaninus
5901

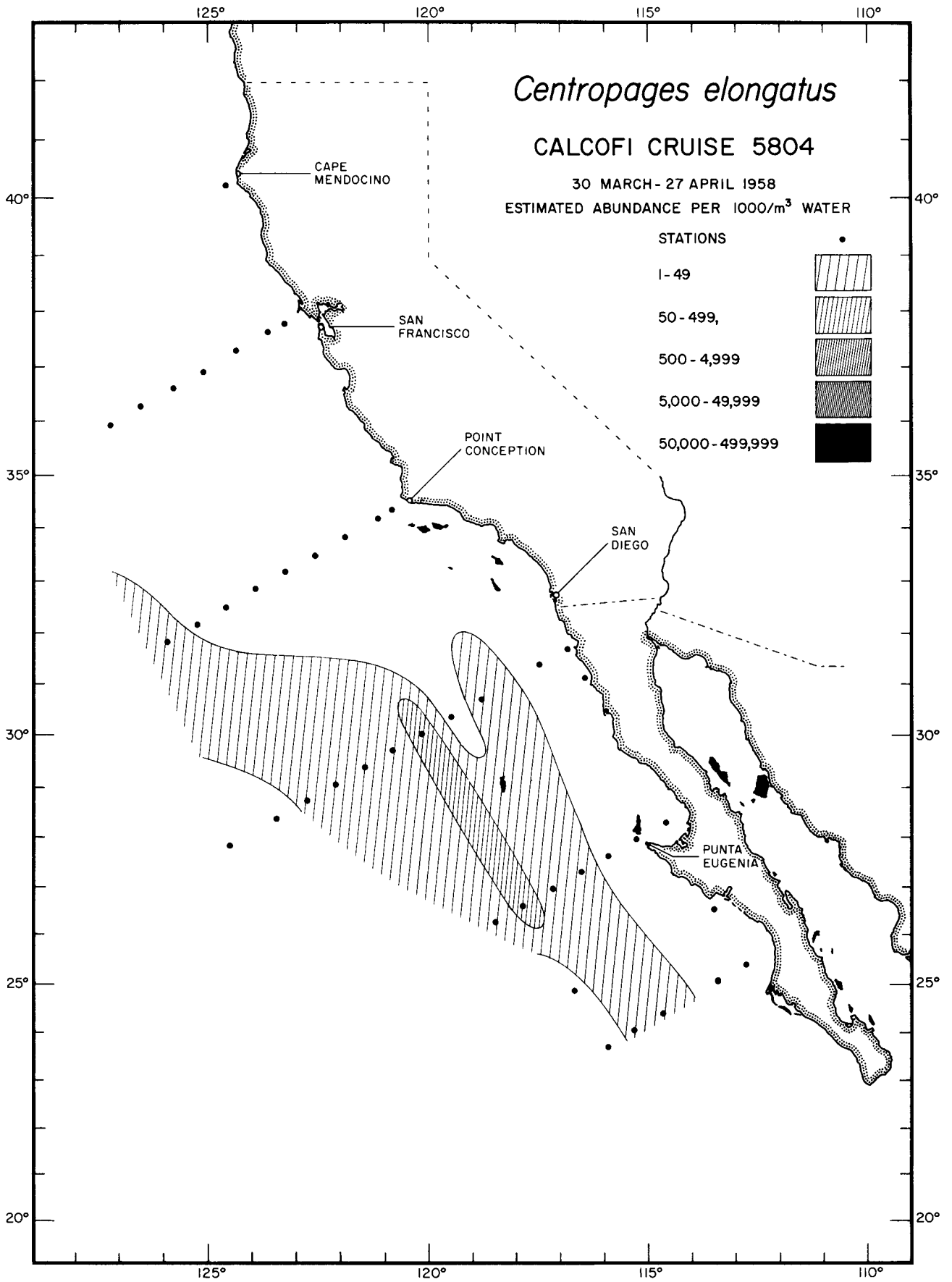




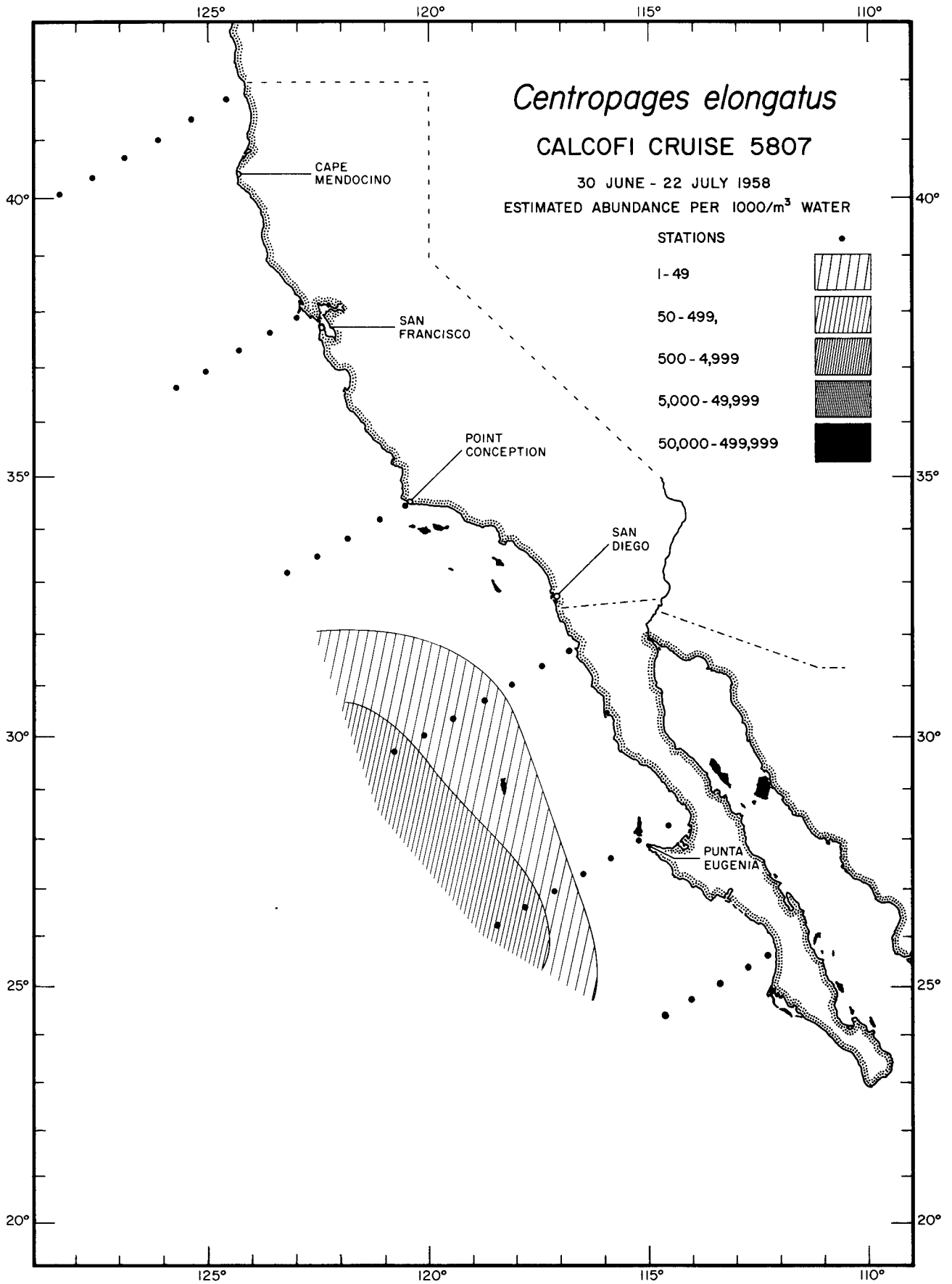
Calanoida
Centropages elegans
5807



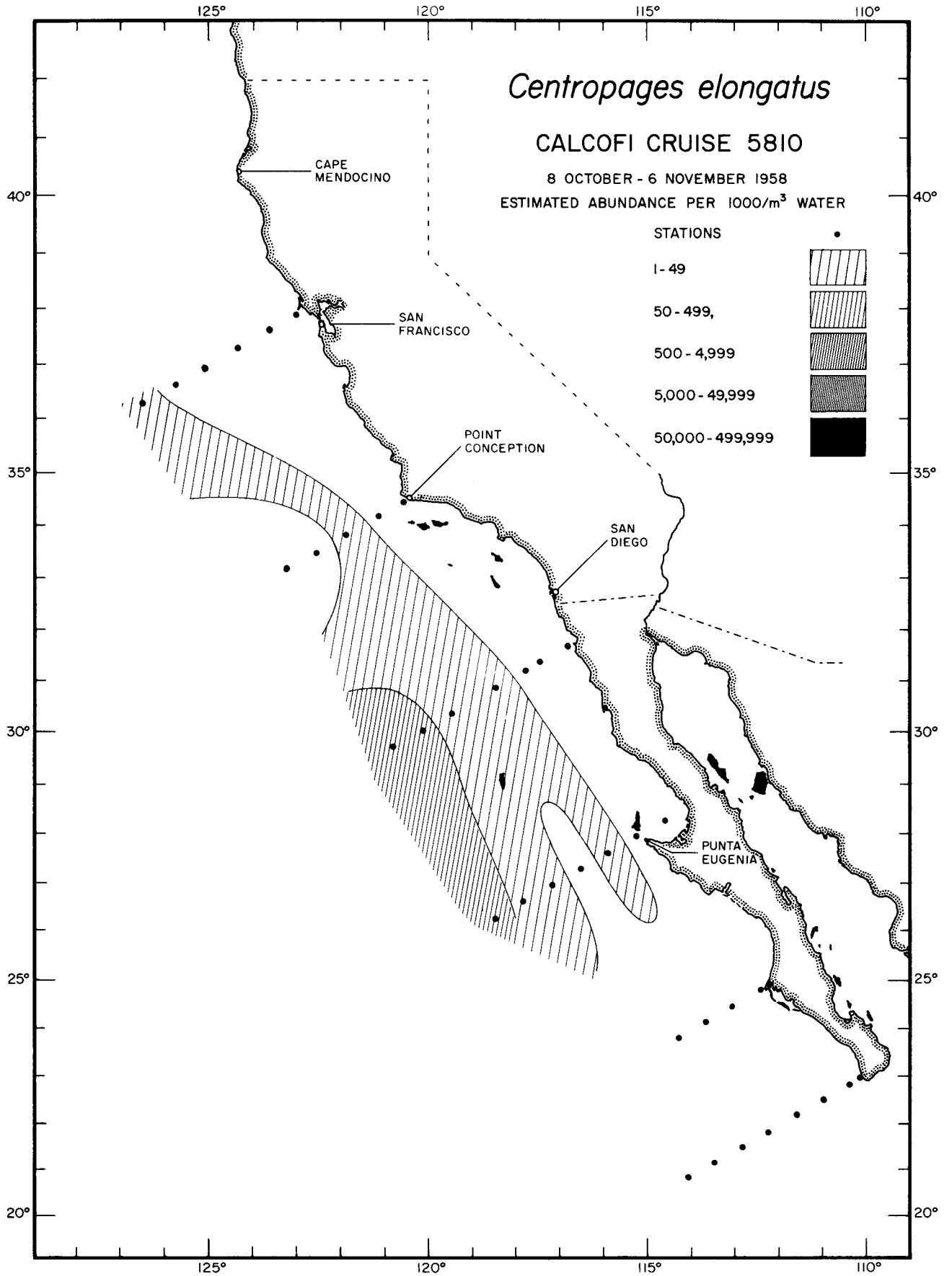
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Centropages elegans
5901



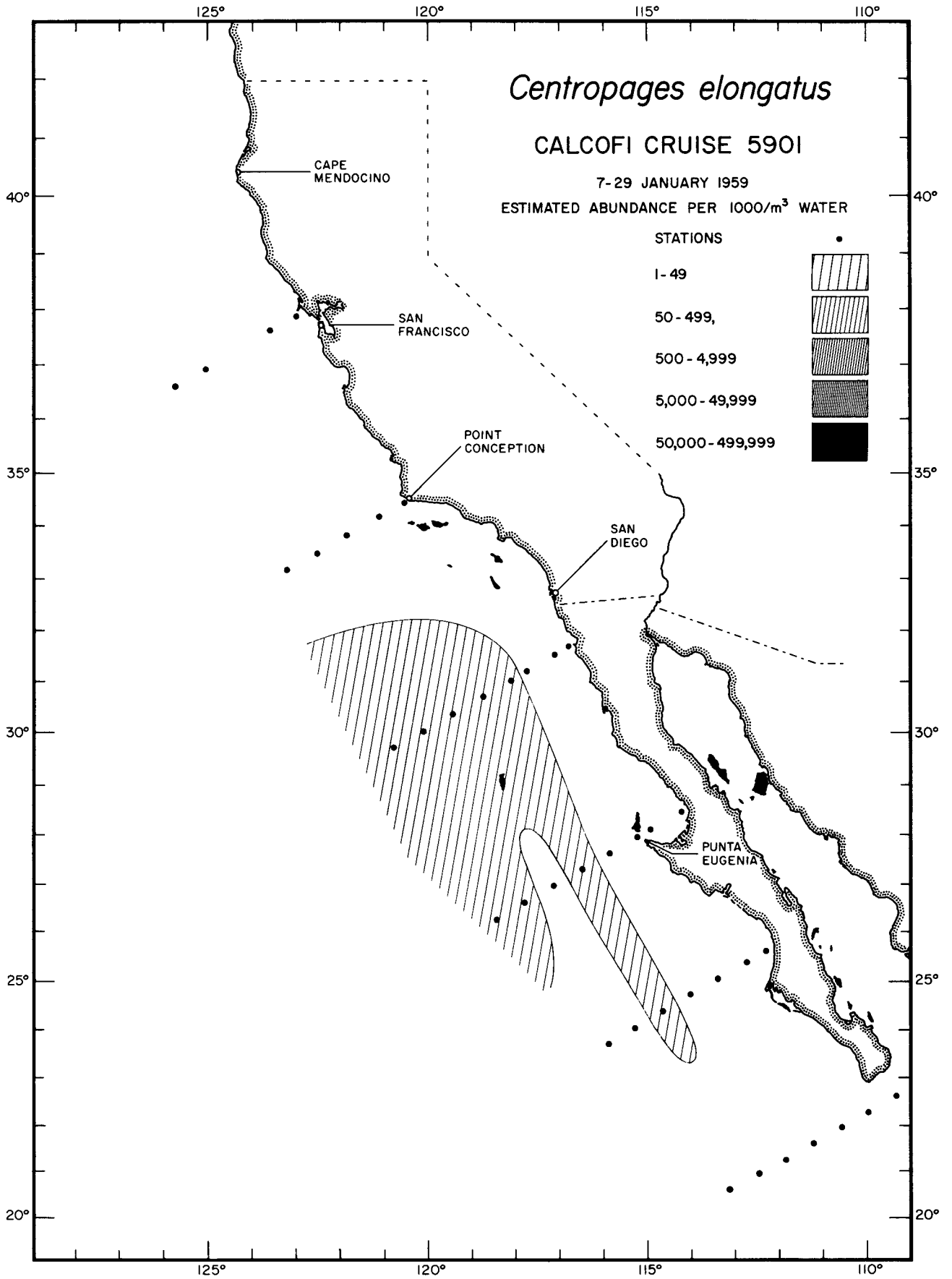
Calanoida
Centropages elongatus
5804



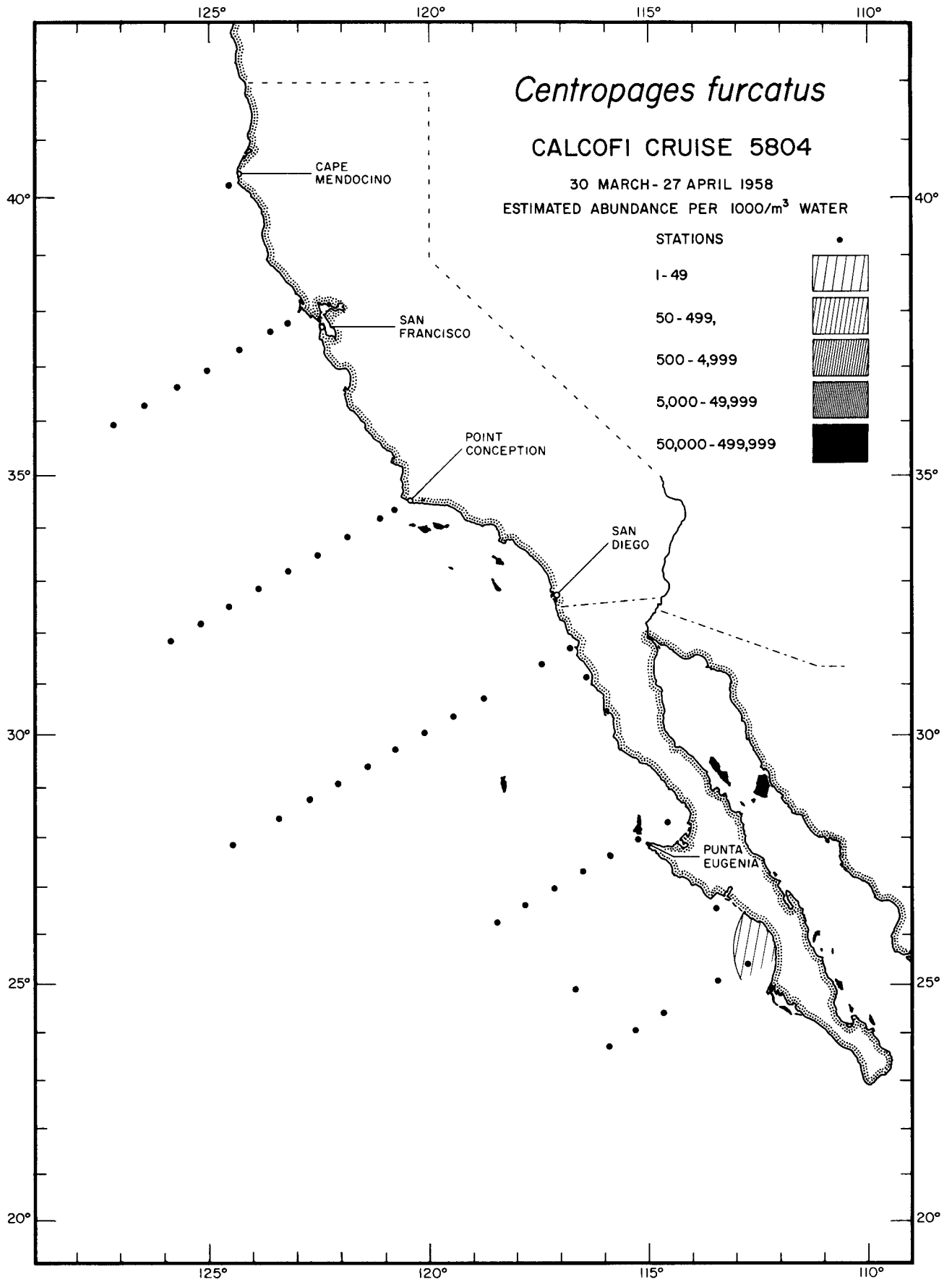
Calanoida
Centropages elongatus
5807

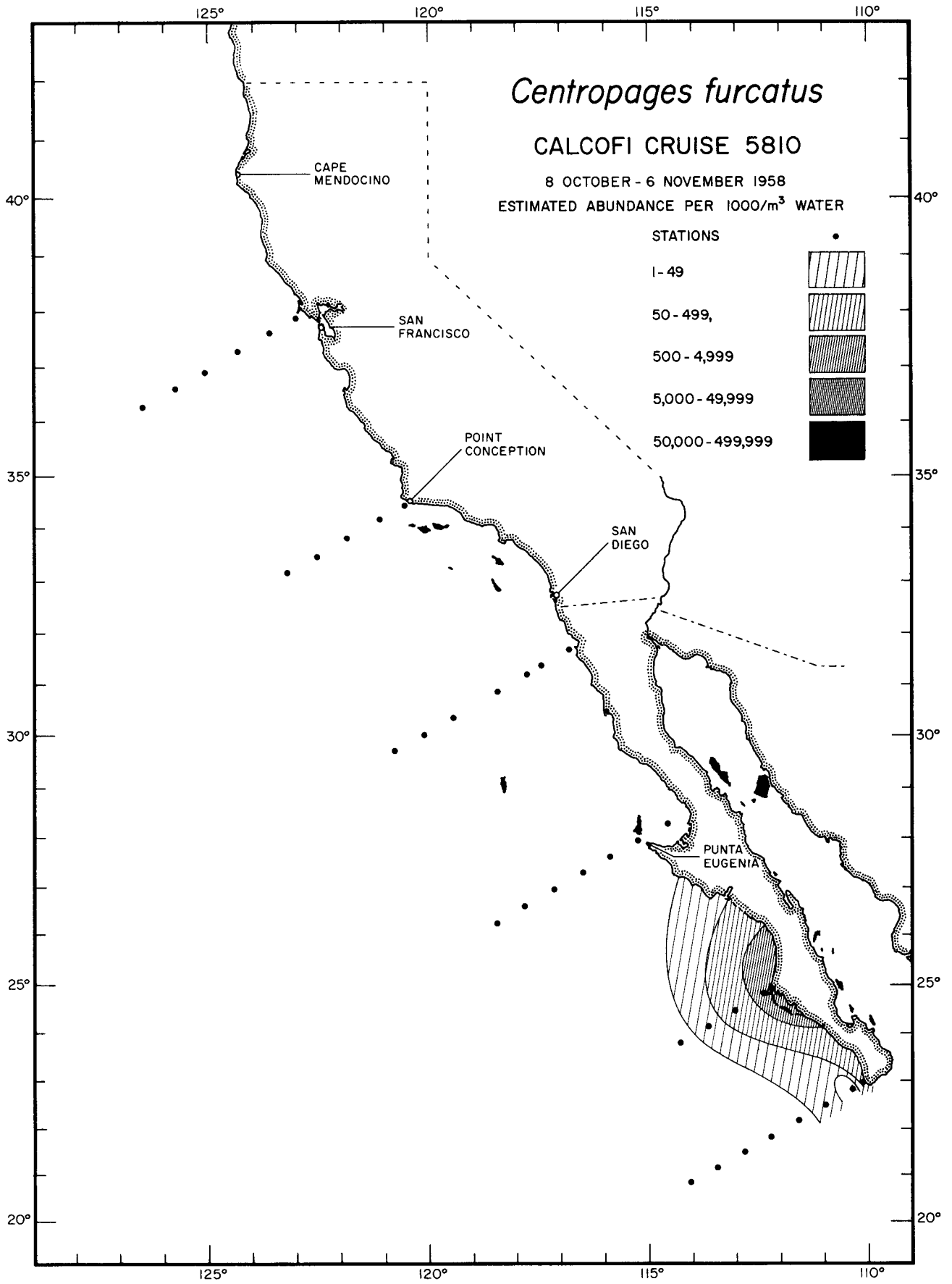


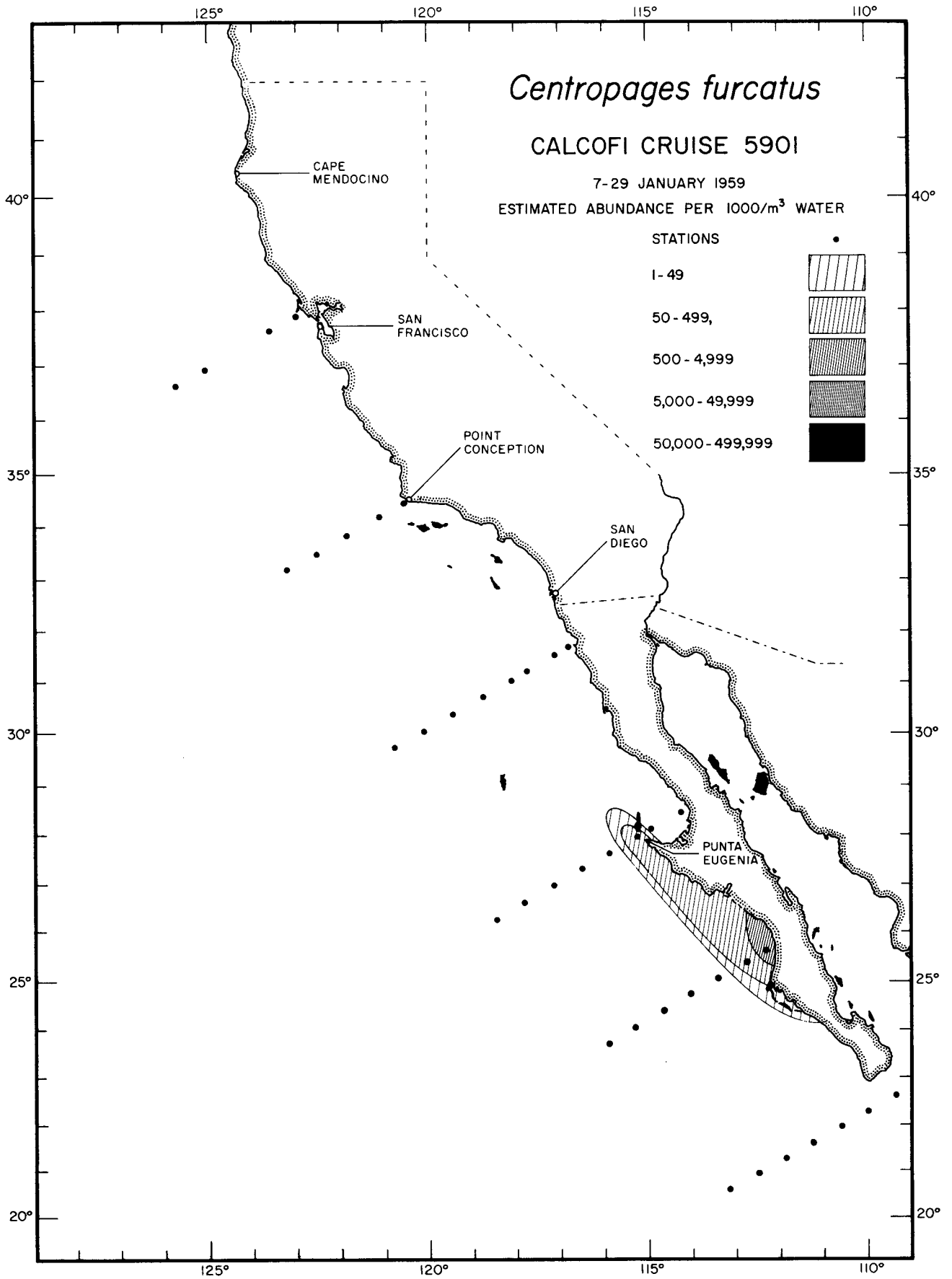
Calanoida
Centropages elongatus
5810



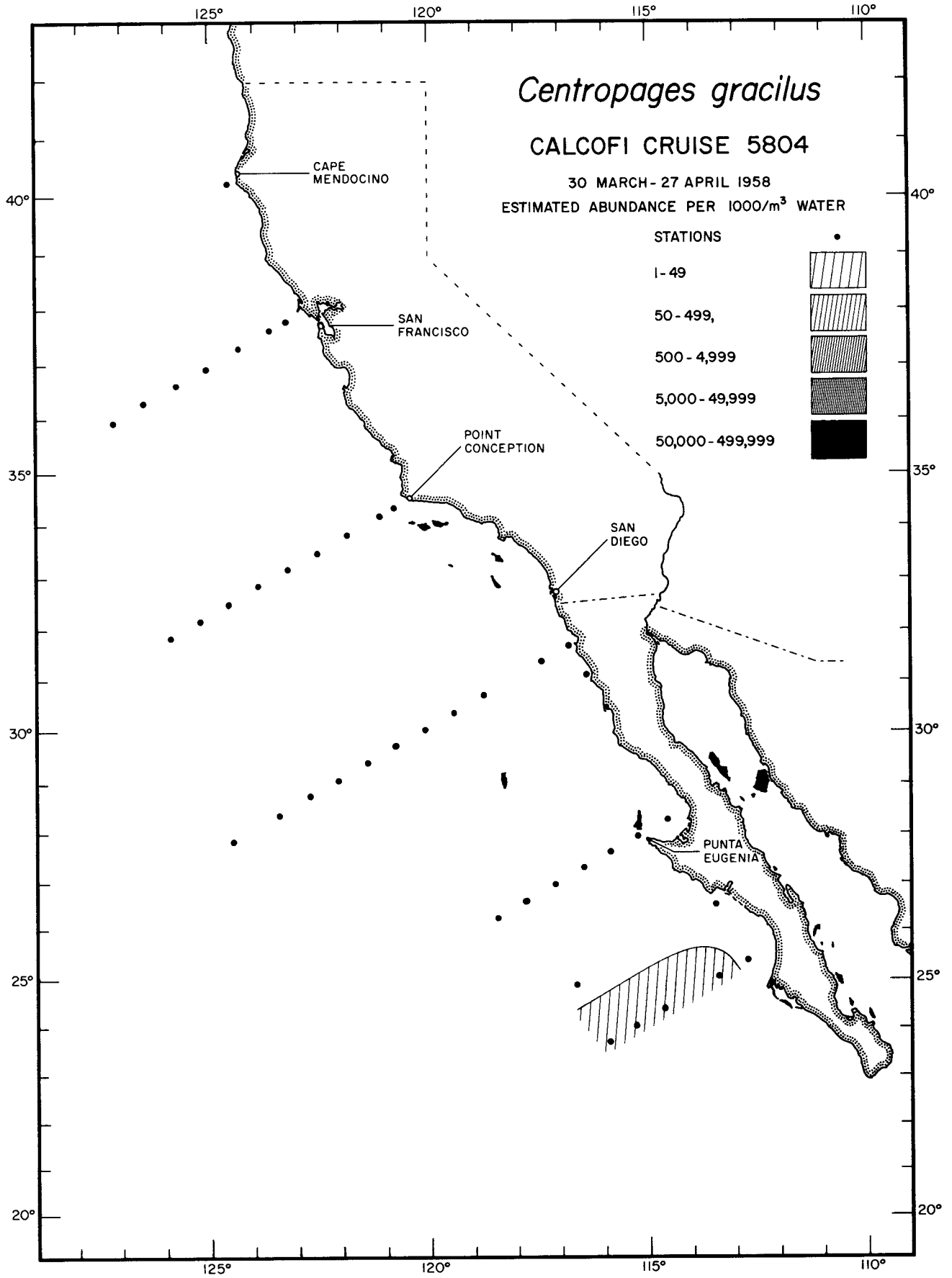
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Centropages elongatus
5901



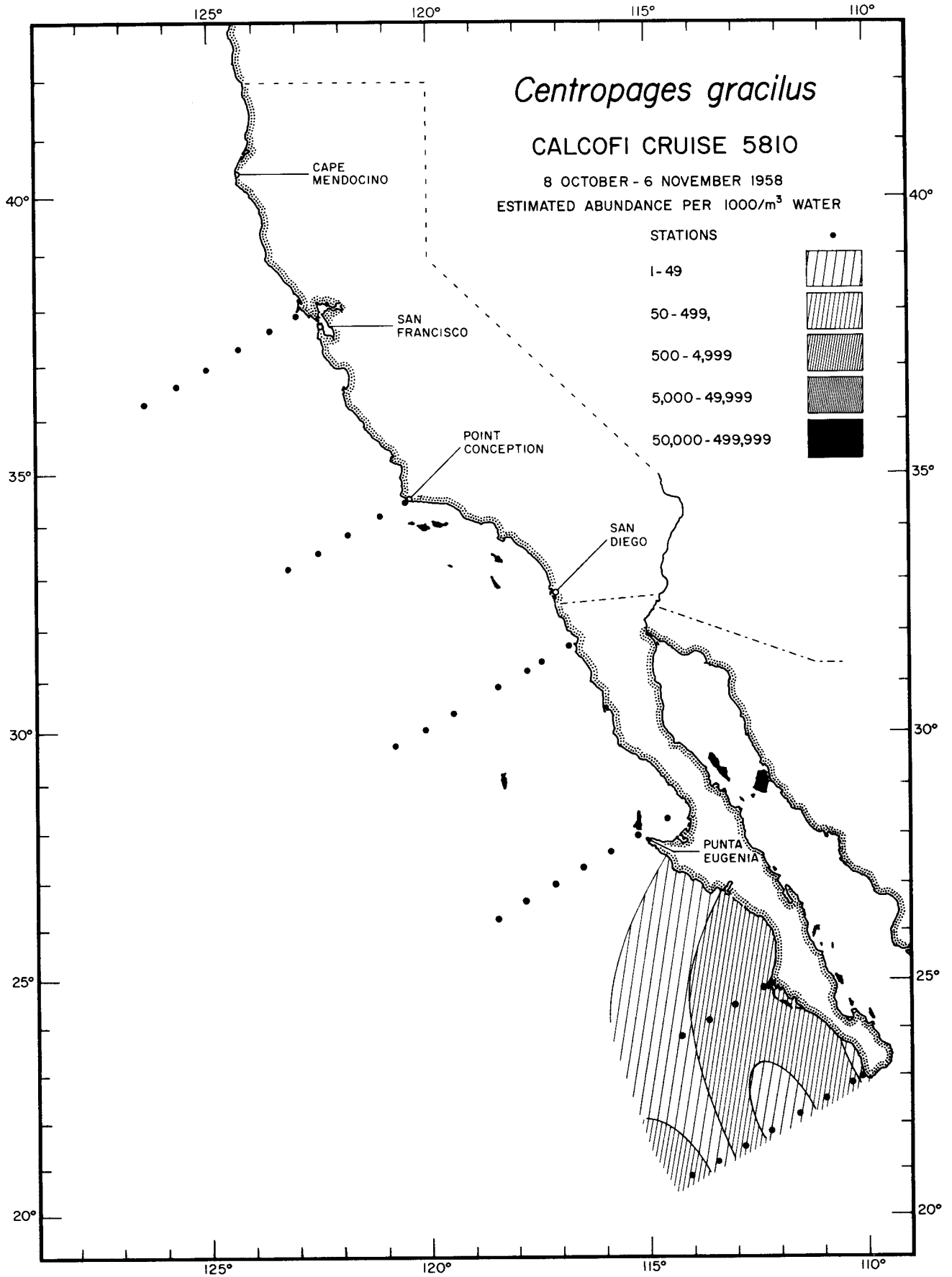




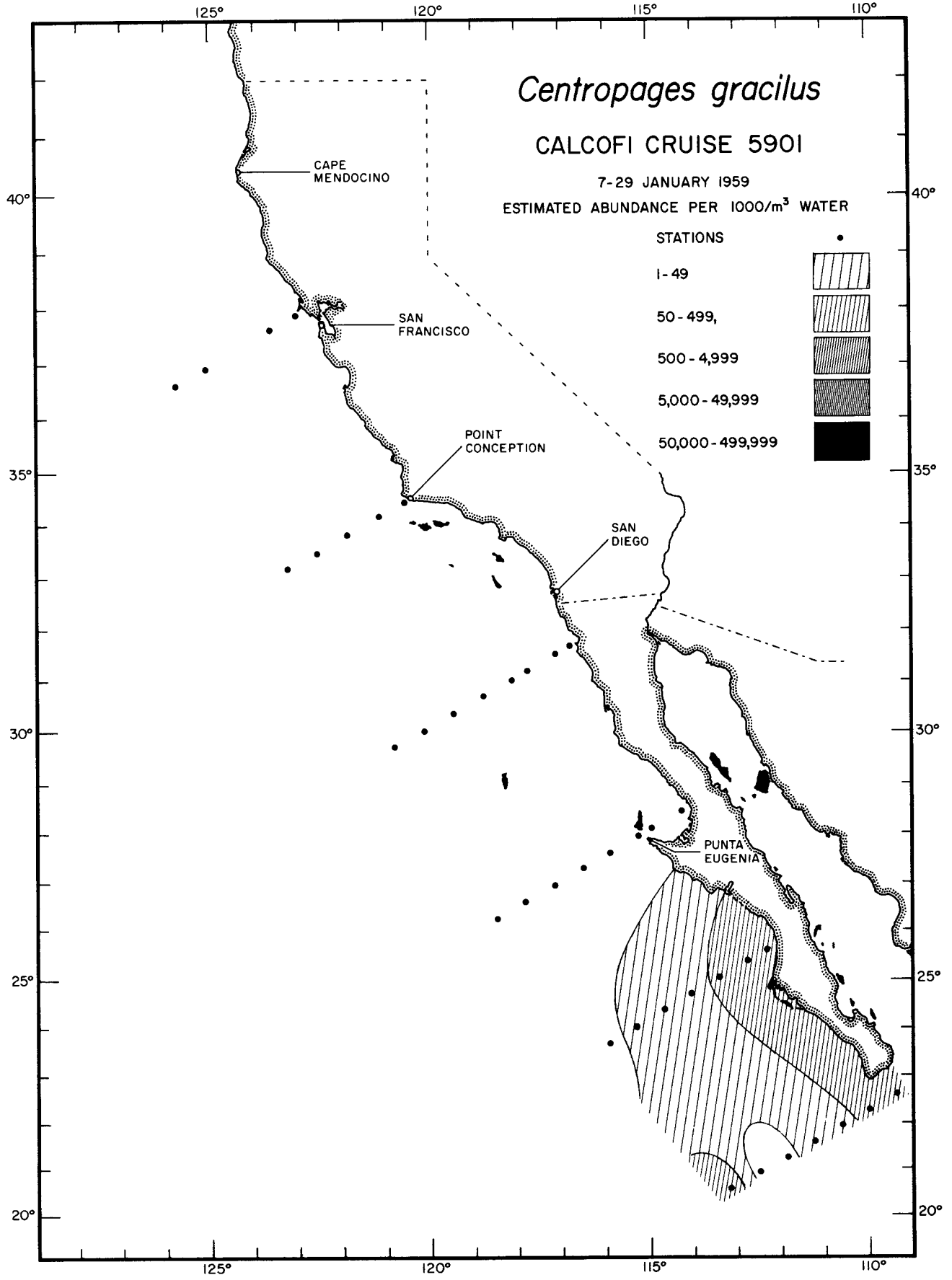
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Centropages furcatus
5901



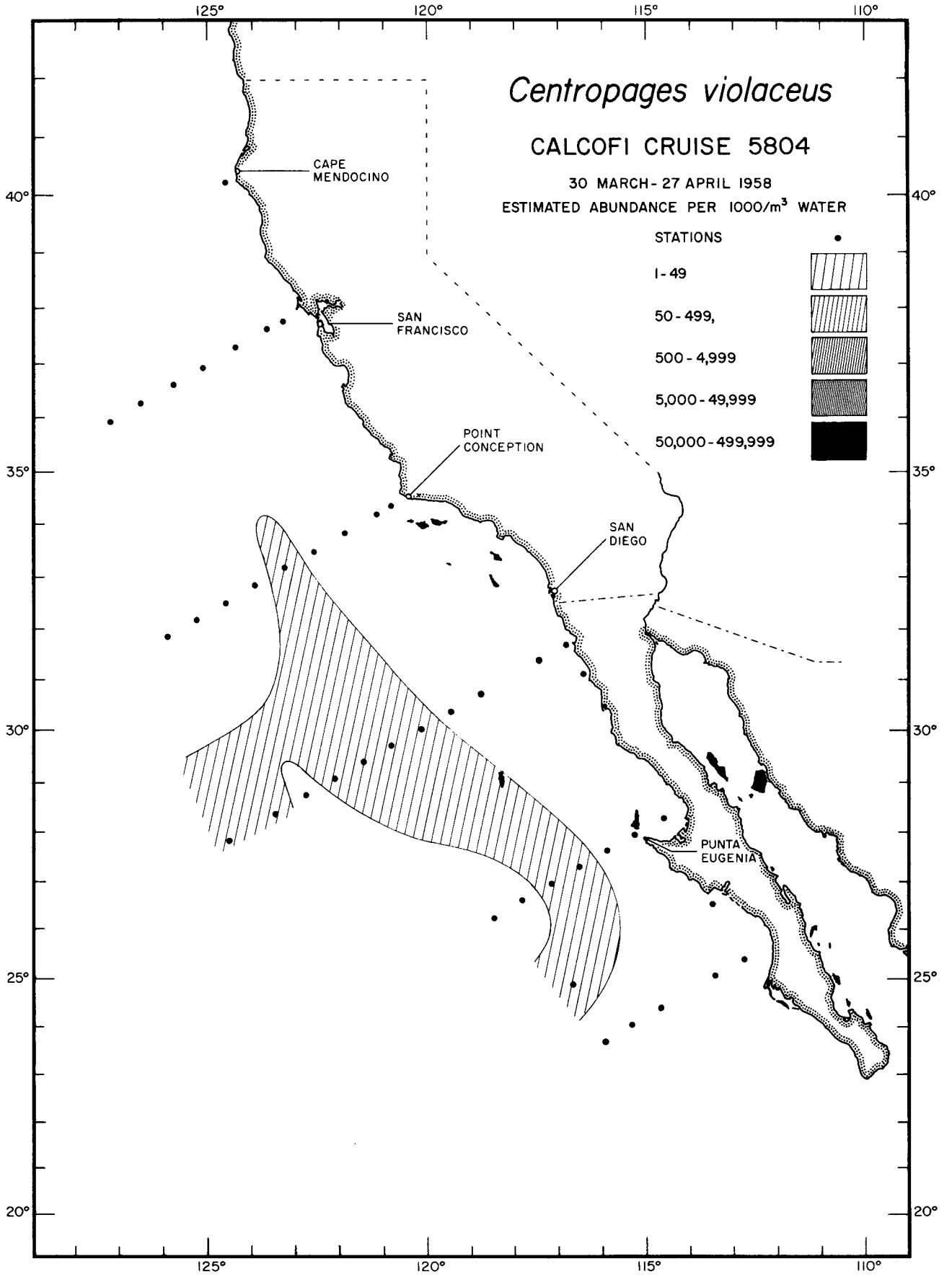
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Centropages gracilis
5804

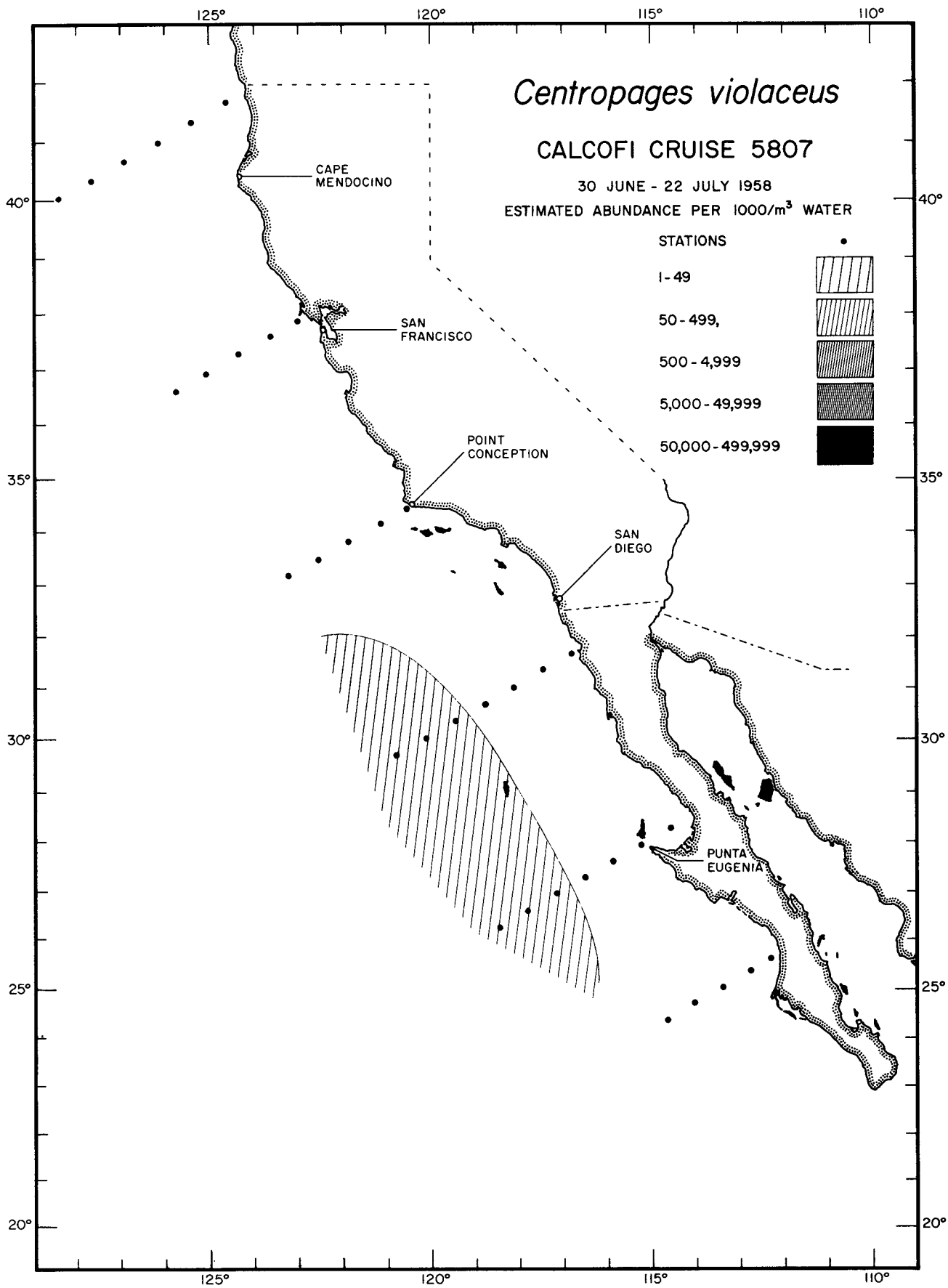


Calanoida
Centropages gracilis
5810

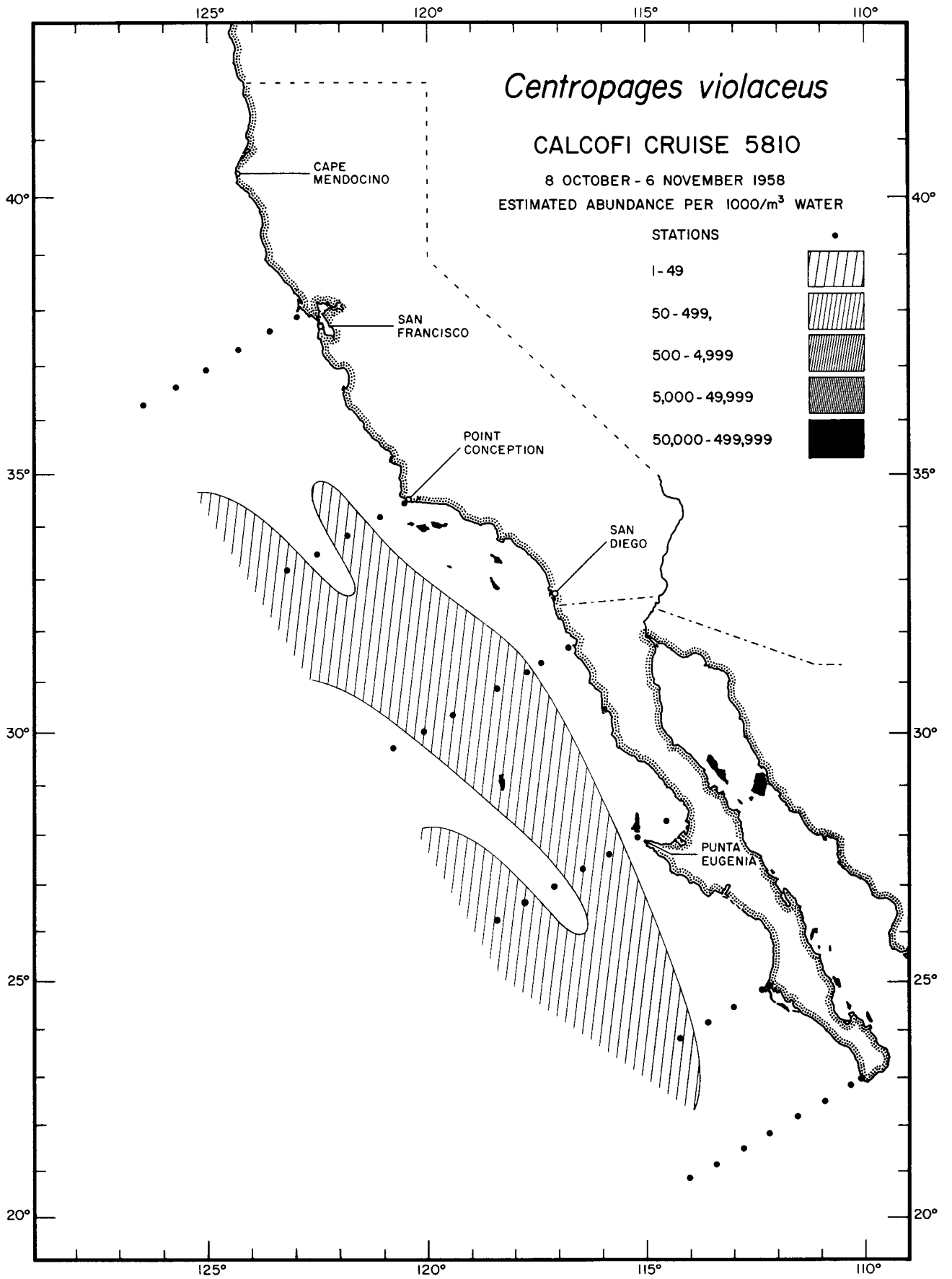


Calanoida
Centropages gracilis
5901

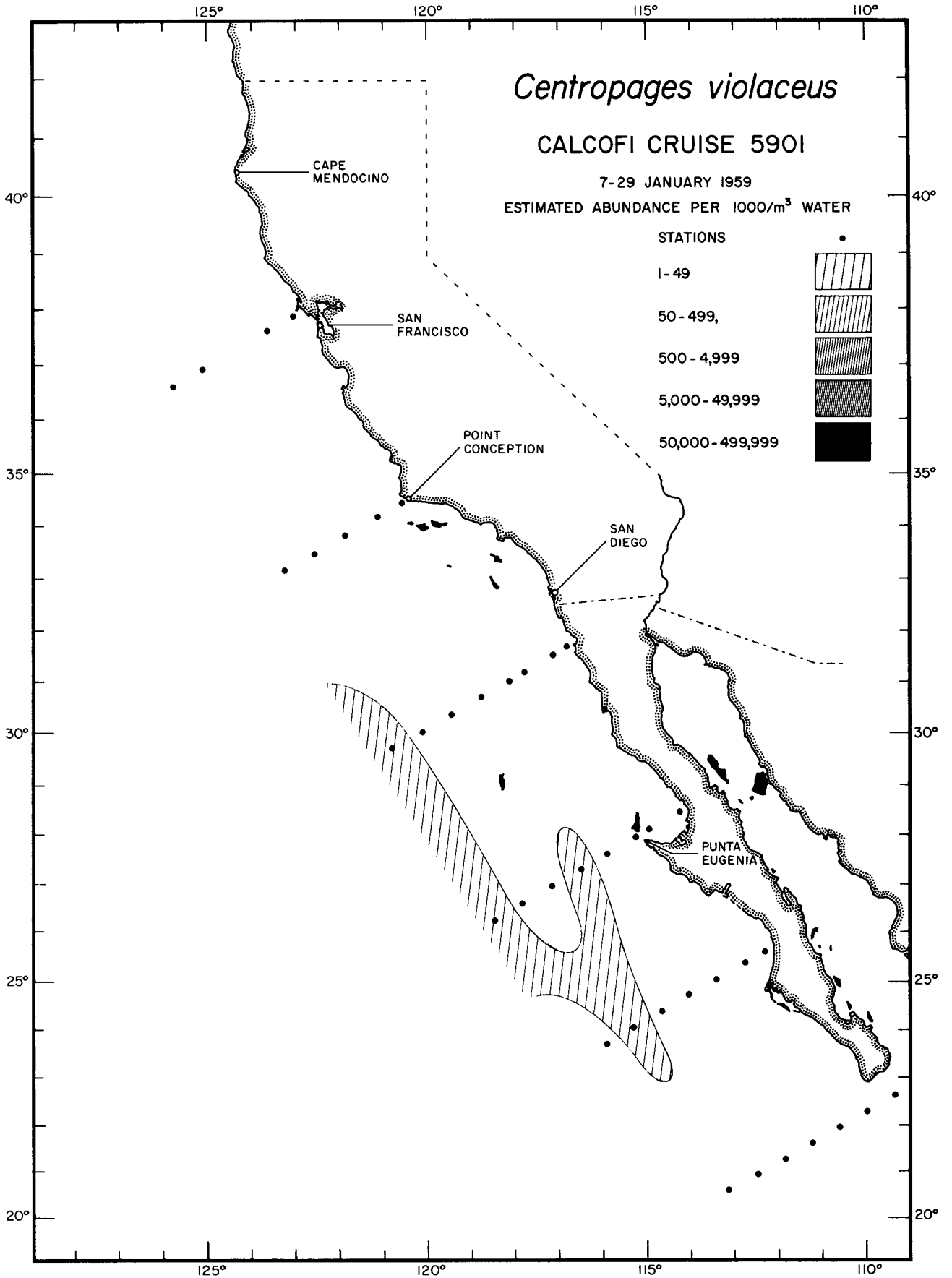




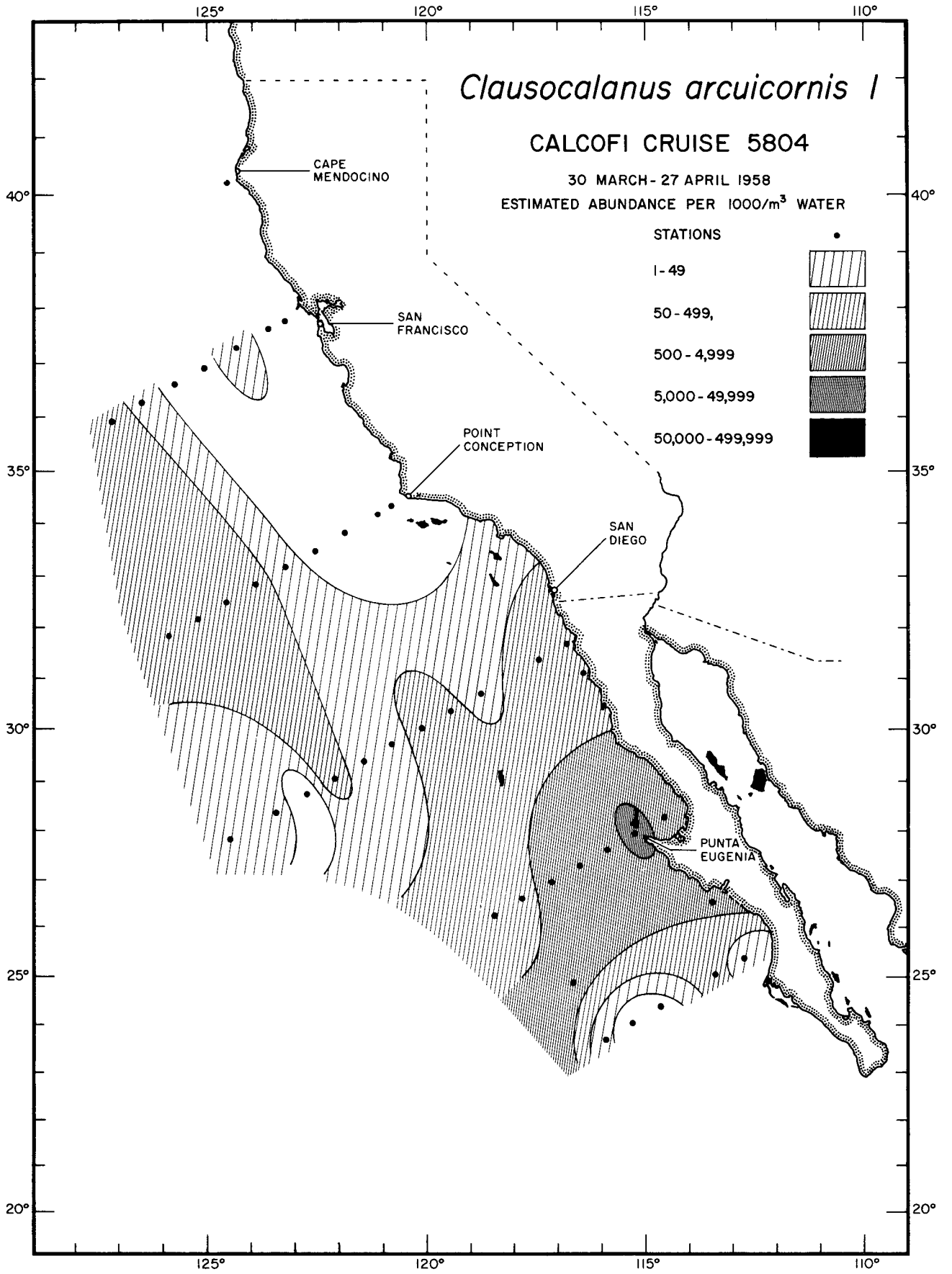
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Centropages violaceus
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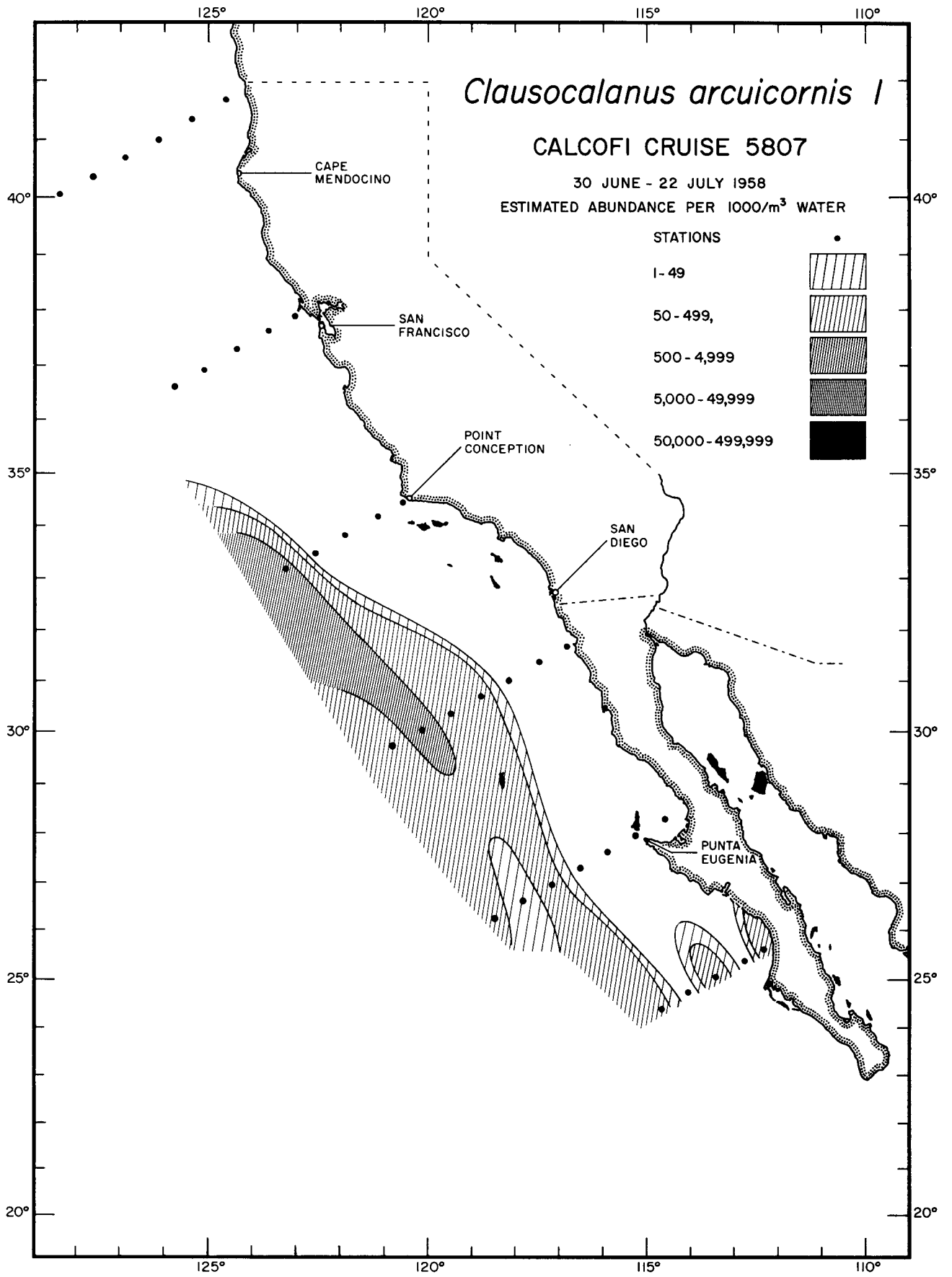
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Centropages violaceus
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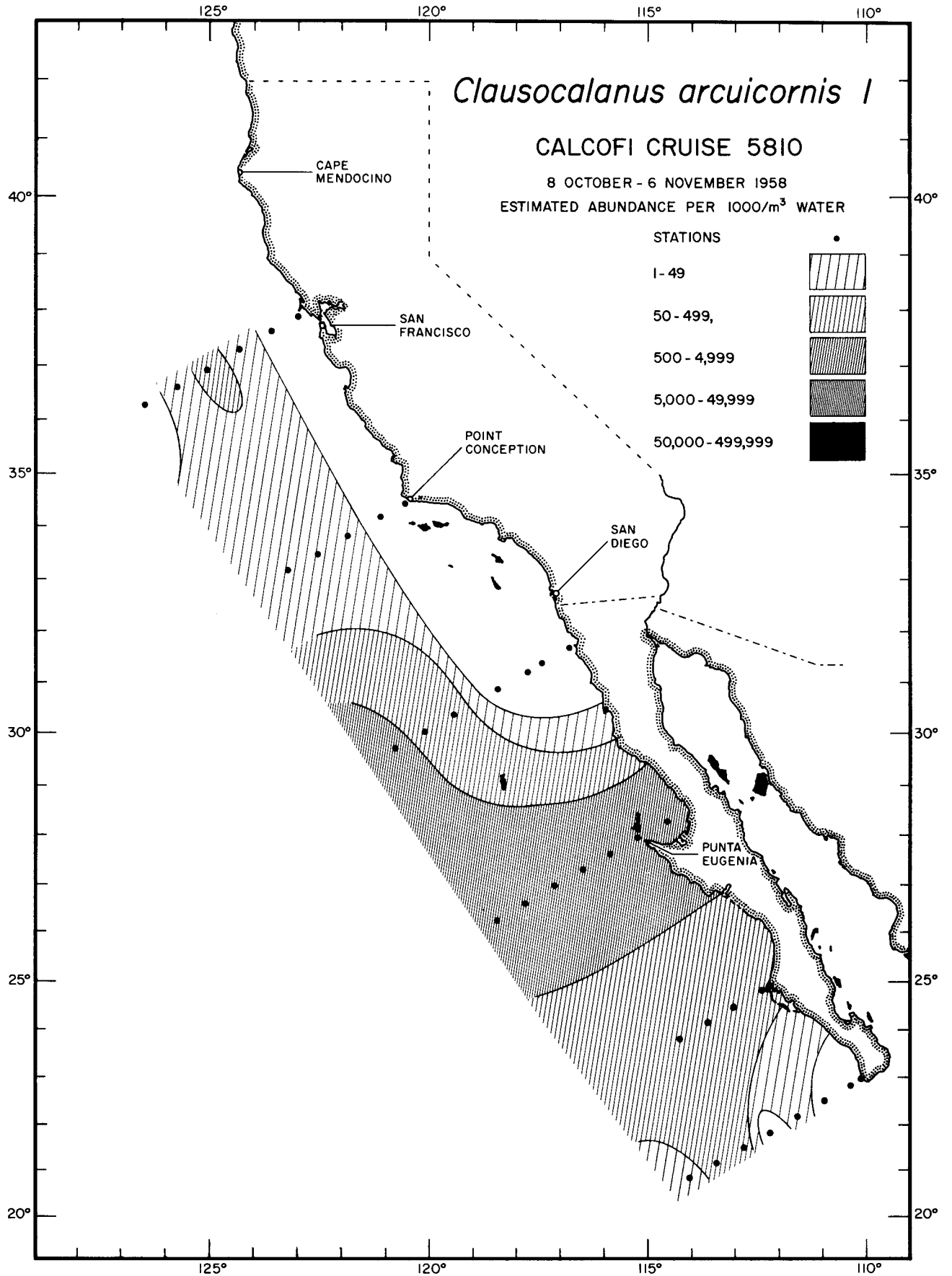
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Centropages violaceus
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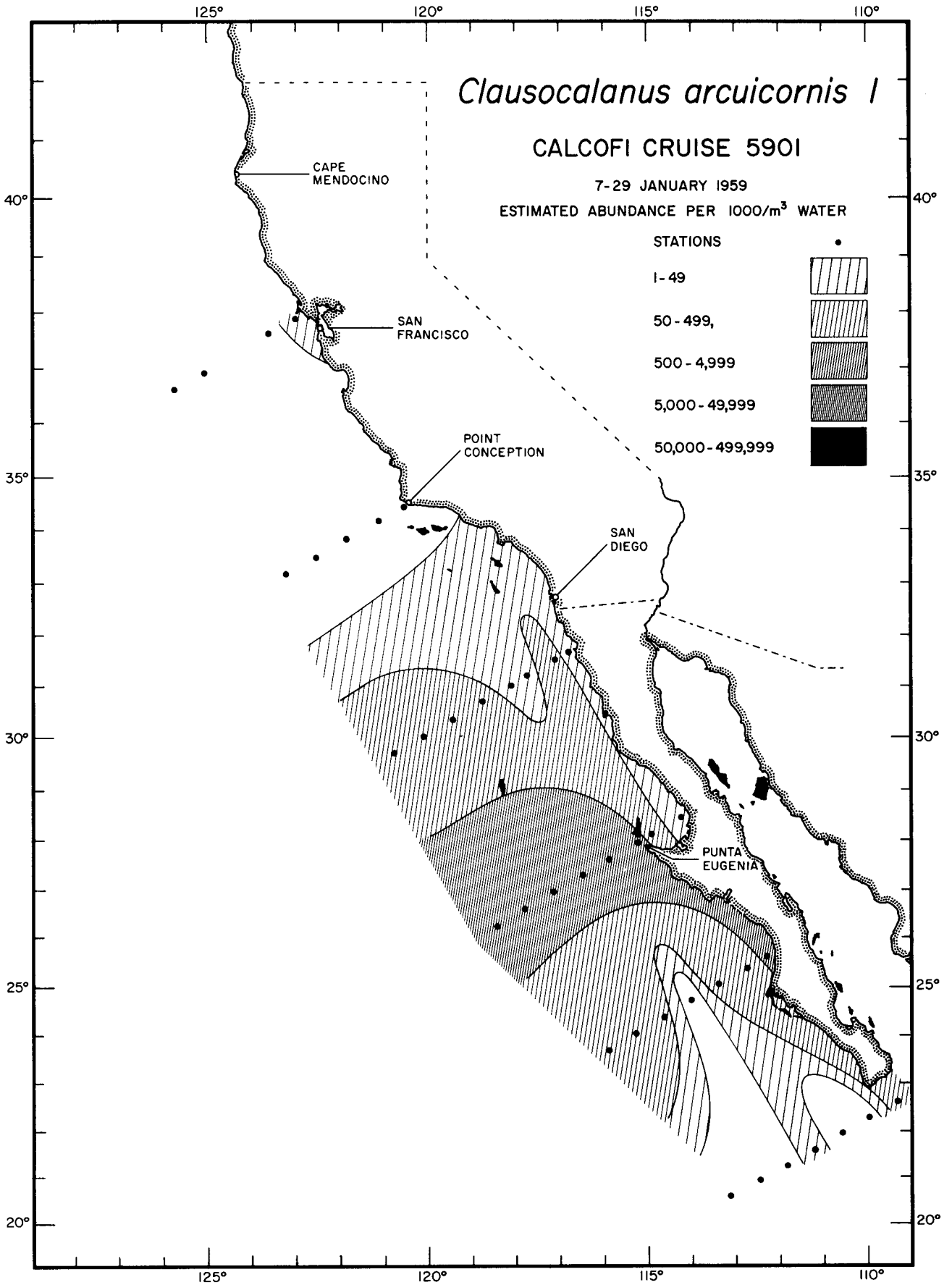
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Clausocalanus arcuicornis I
5804



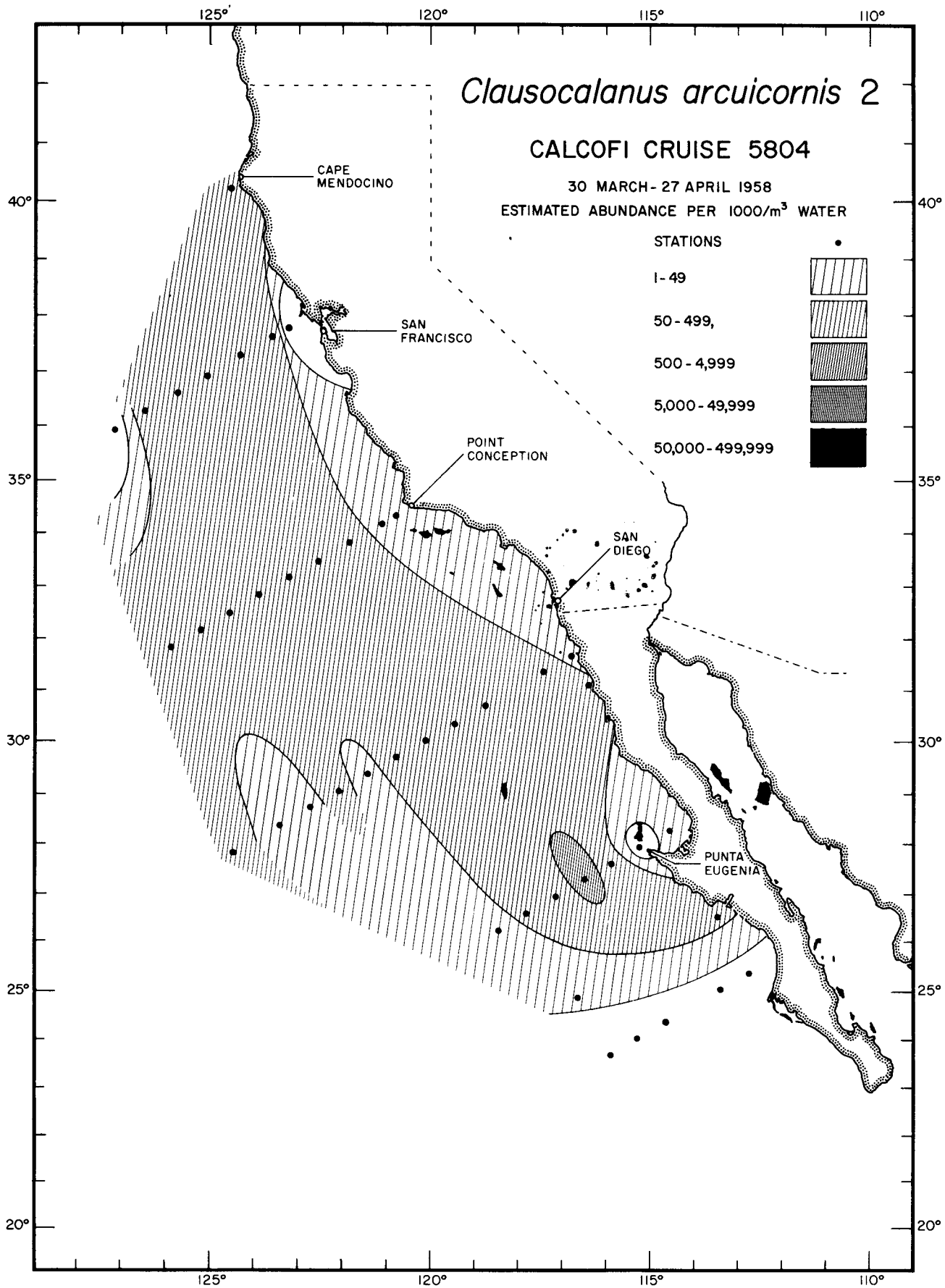
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Clausocalanus arcuicornis I
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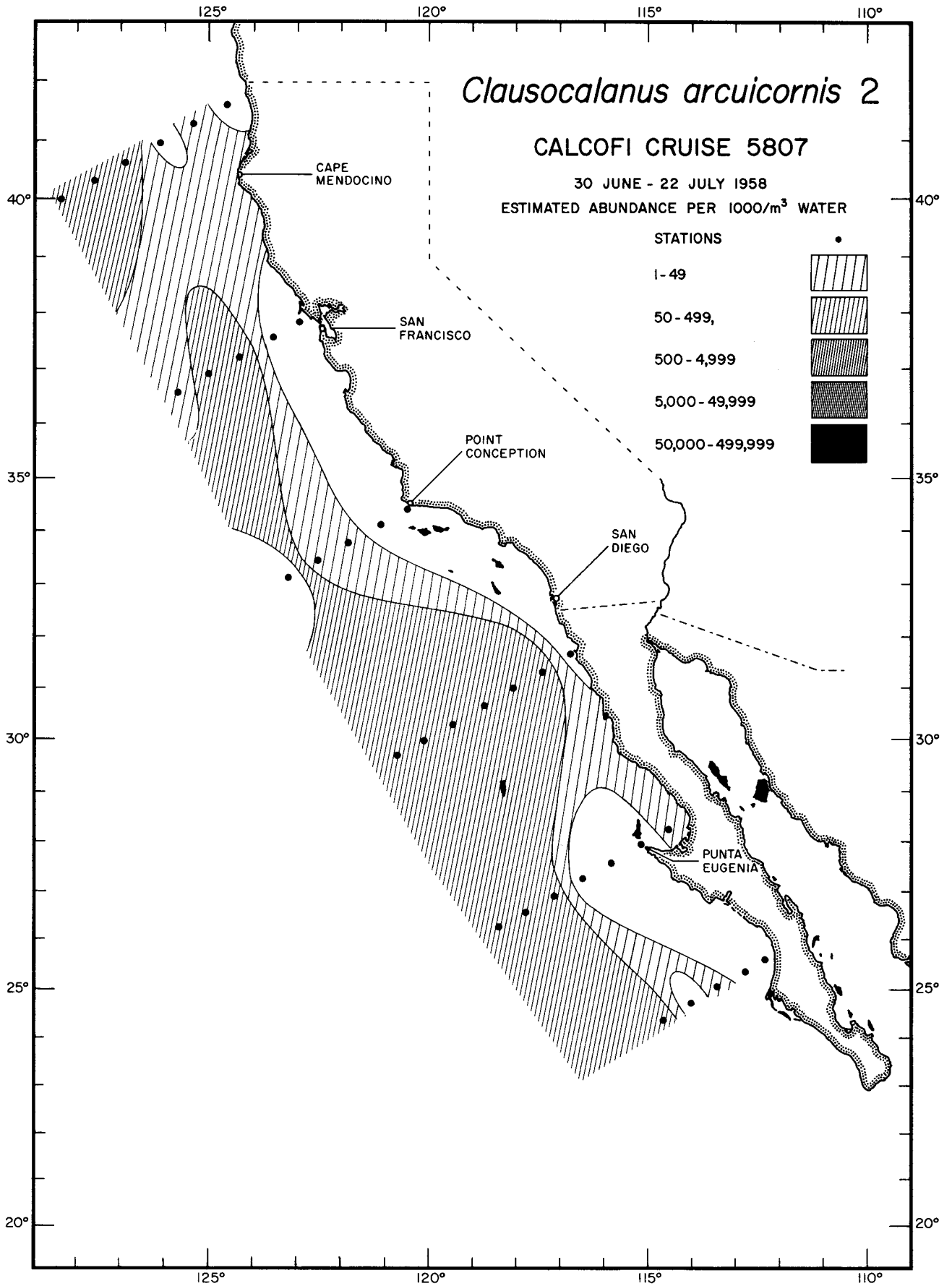
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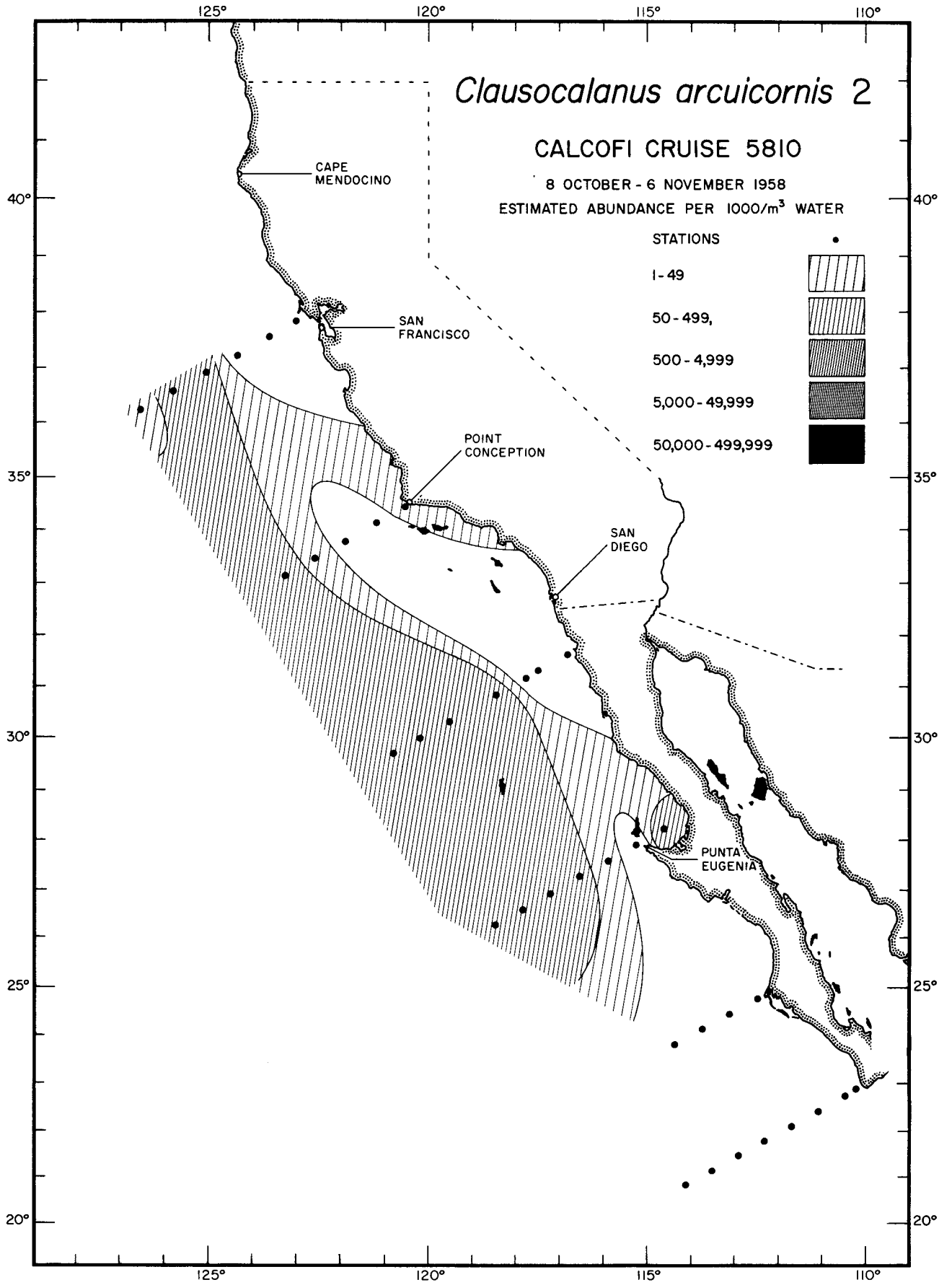
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Clausocalanus arcuicornis I
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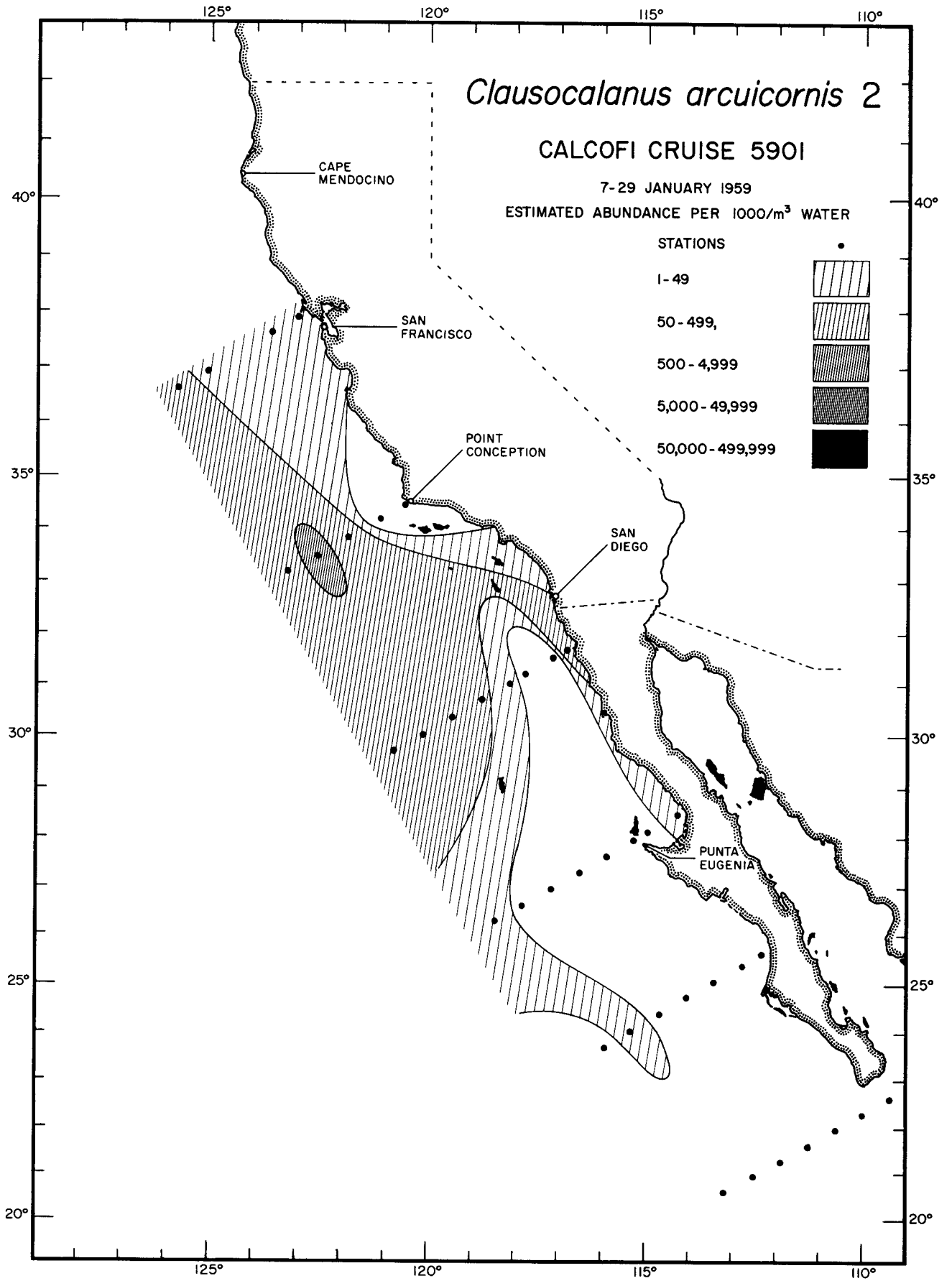
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Clausocalanus arcuicornis 2
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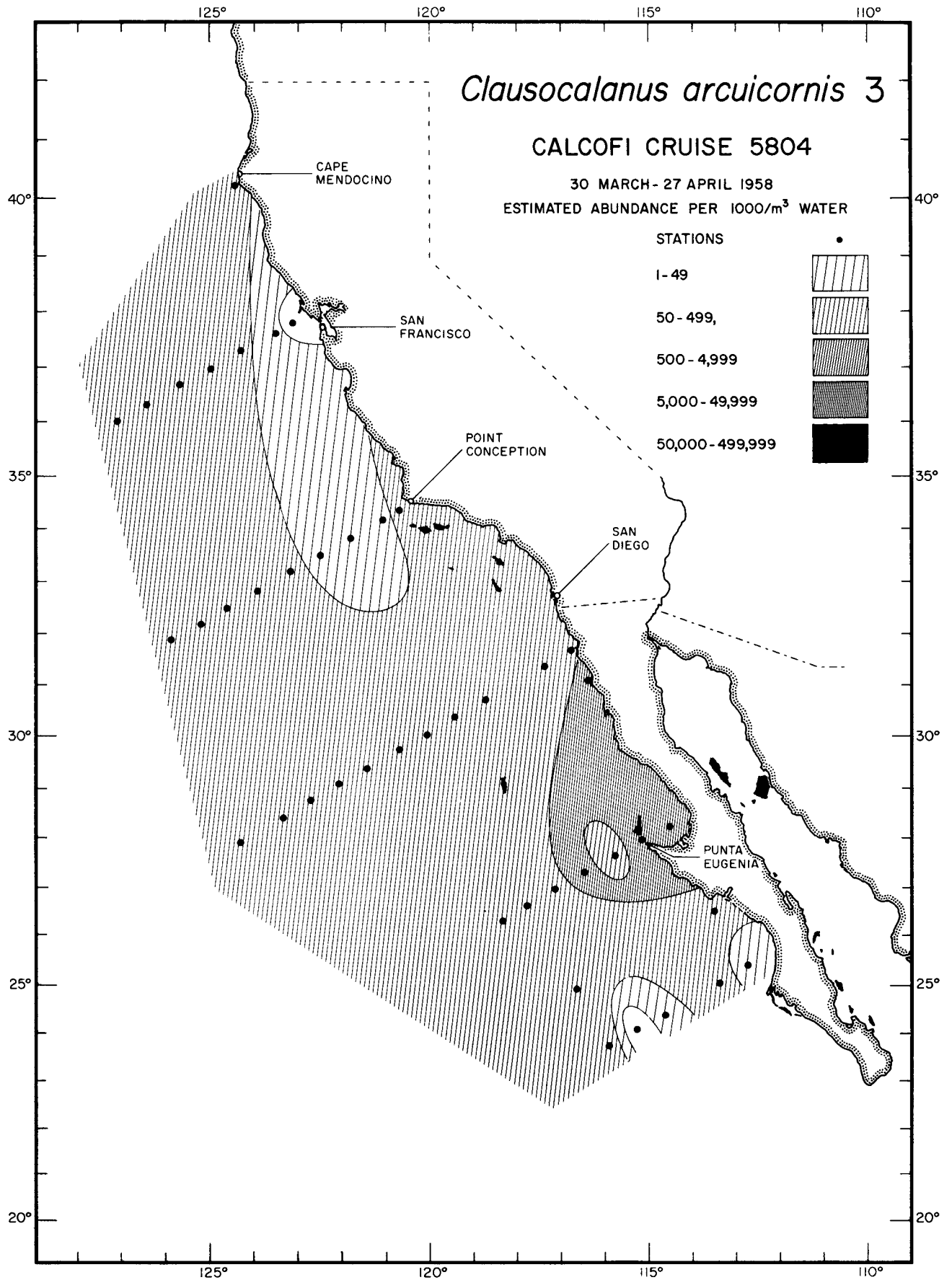
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Clausocalanus arcuicornis 2
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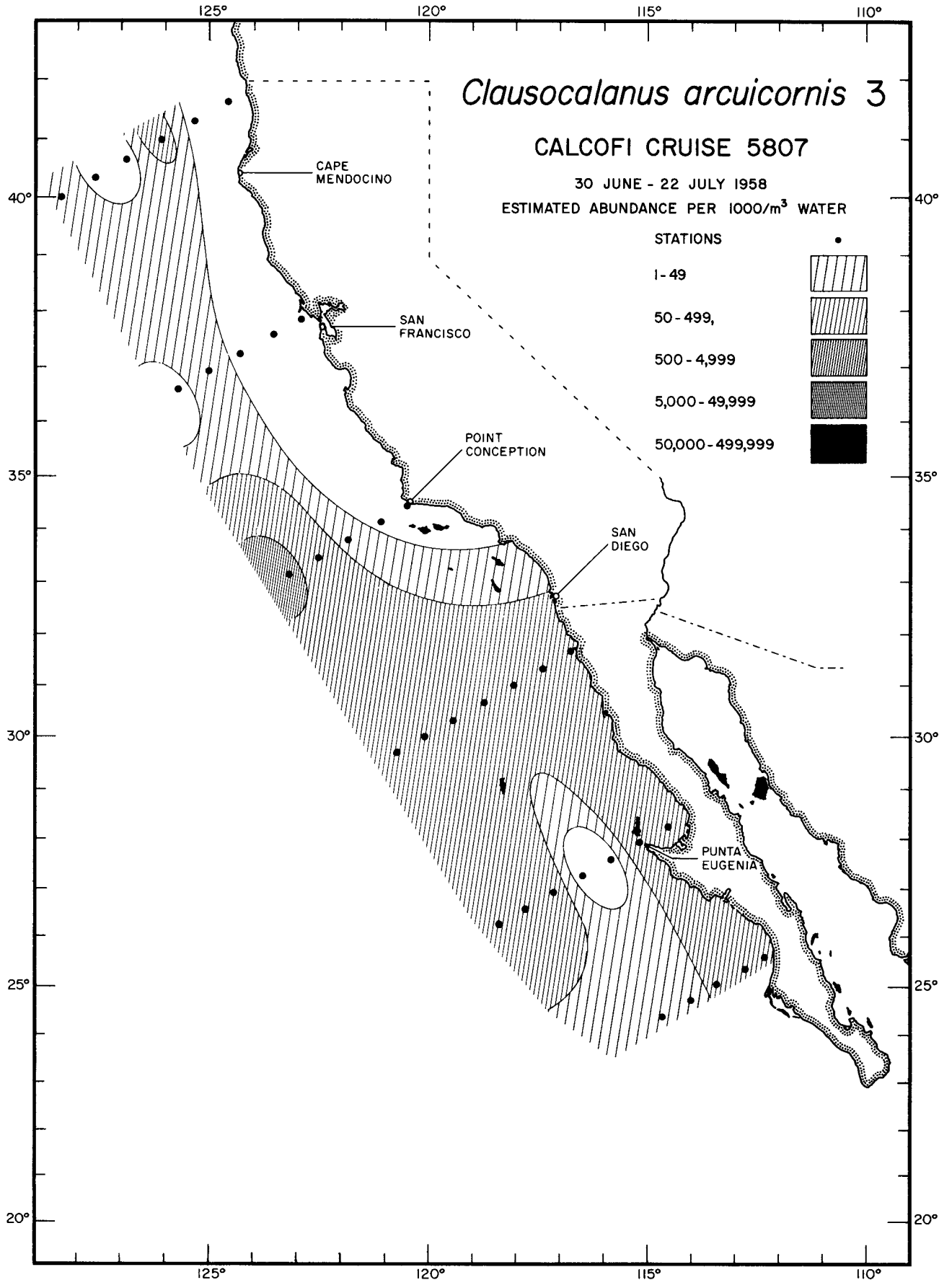


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Clausocalanus arcuicornis 2
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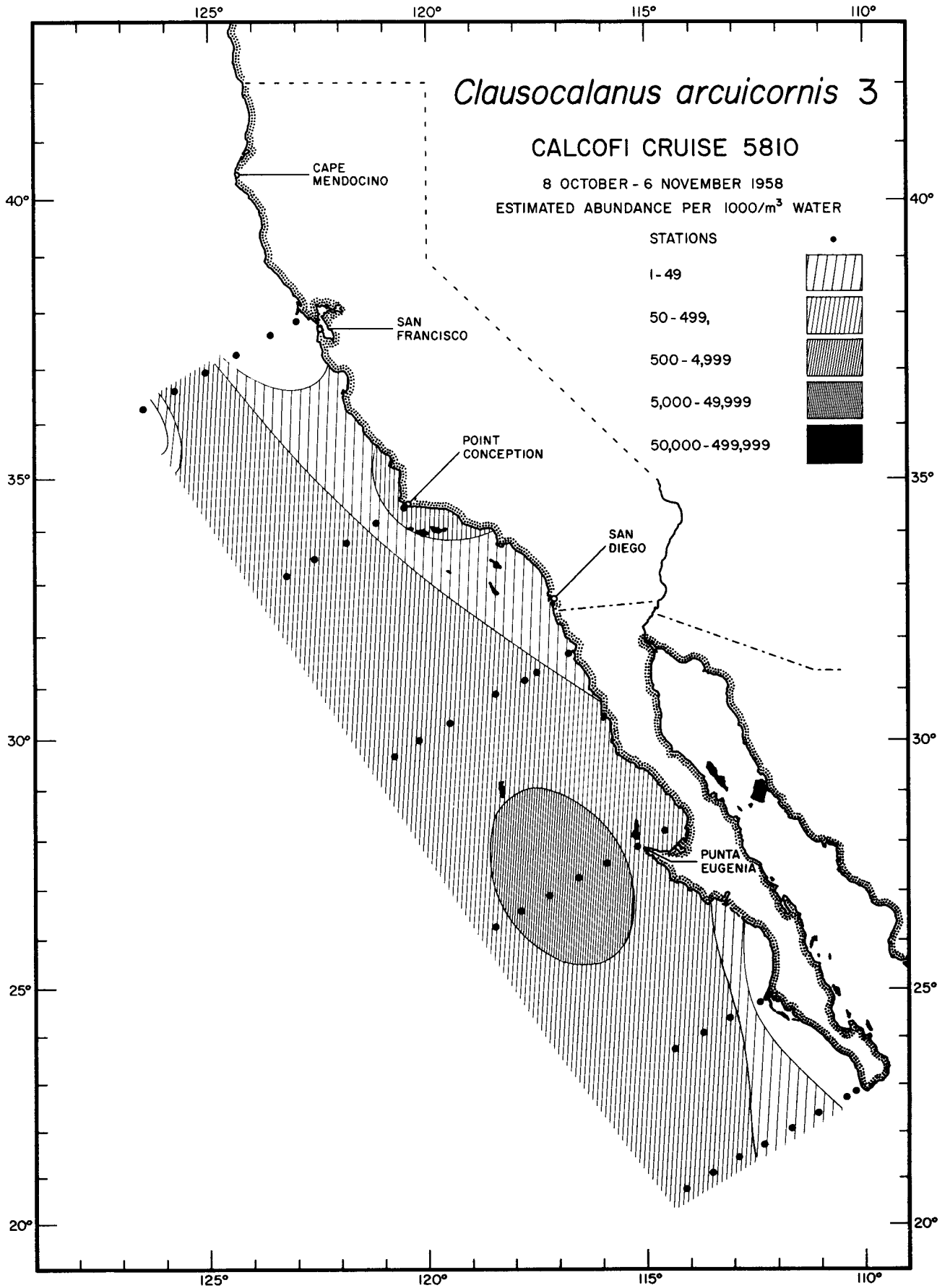


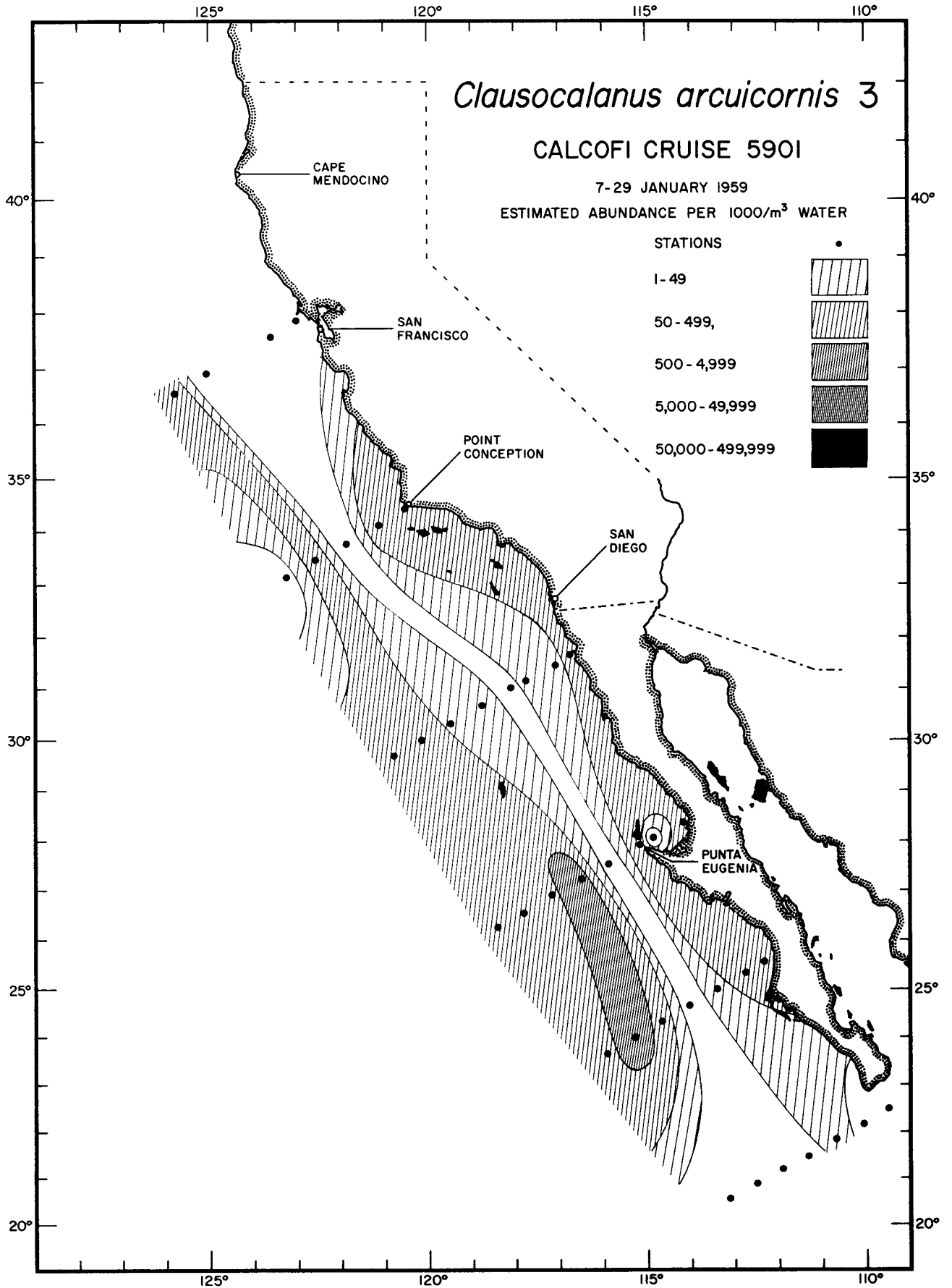
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Clausocalanus arcuicornis 2
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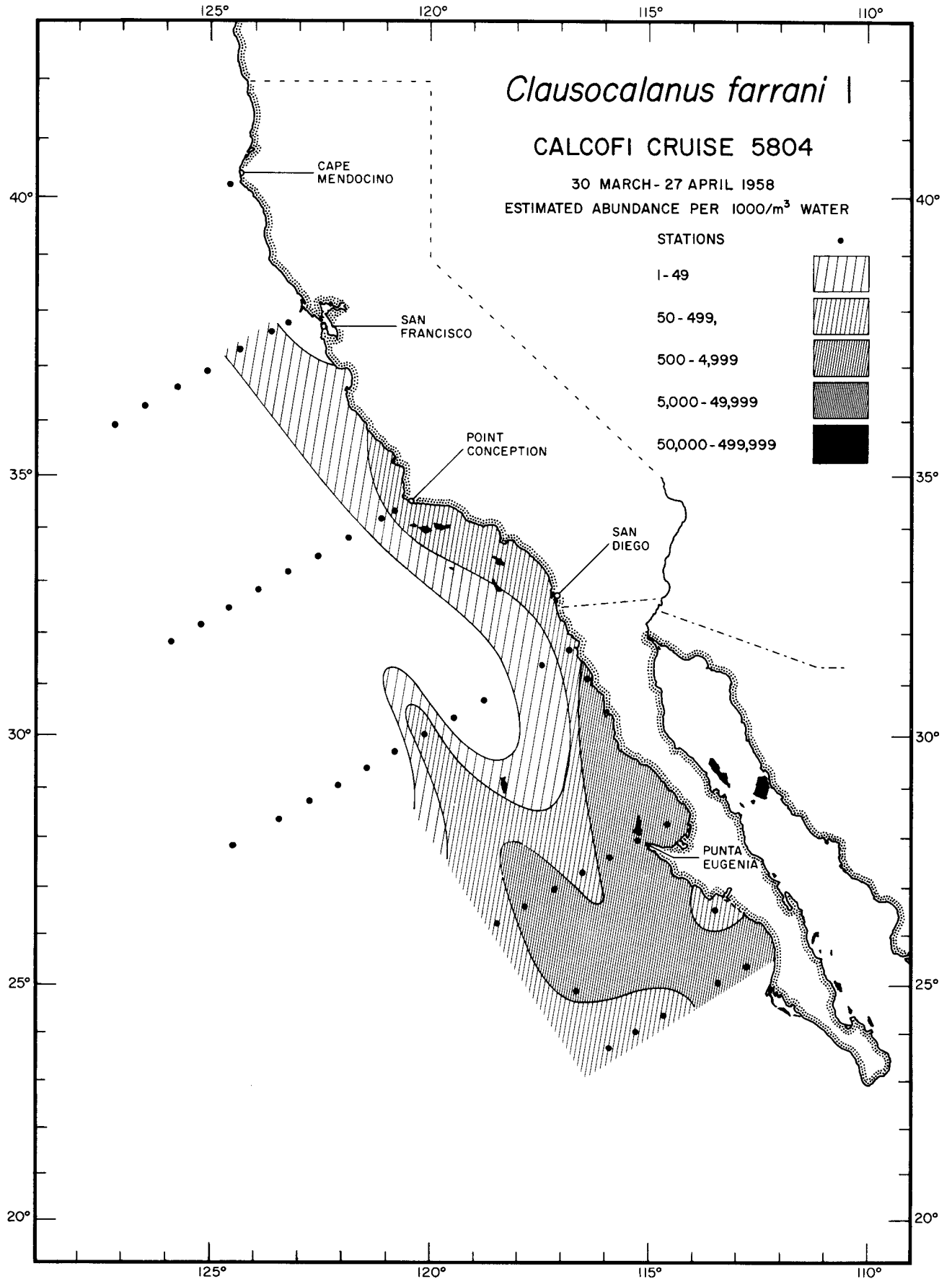


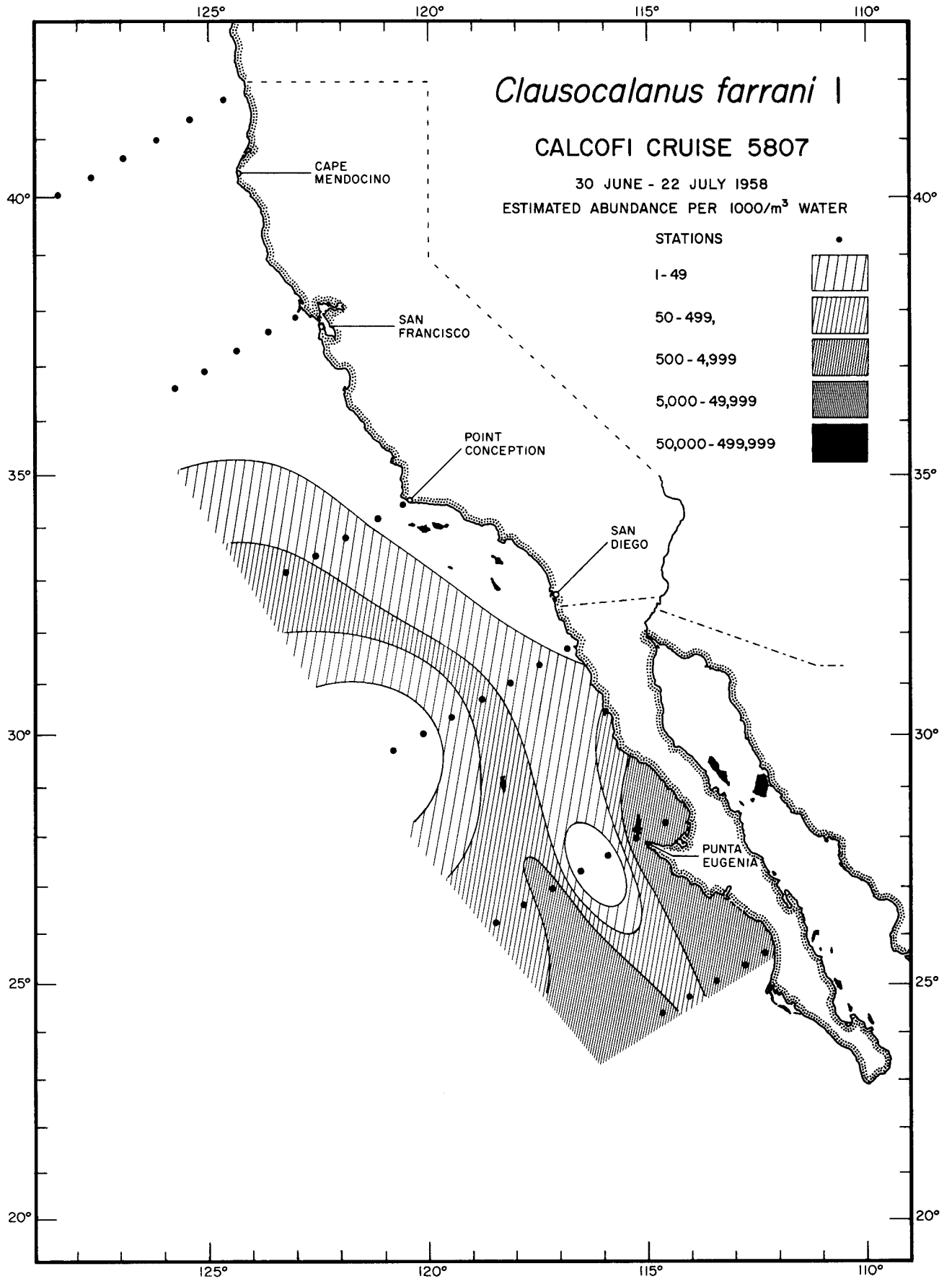


Calanoida
Clausocalanus arcuicornis 3
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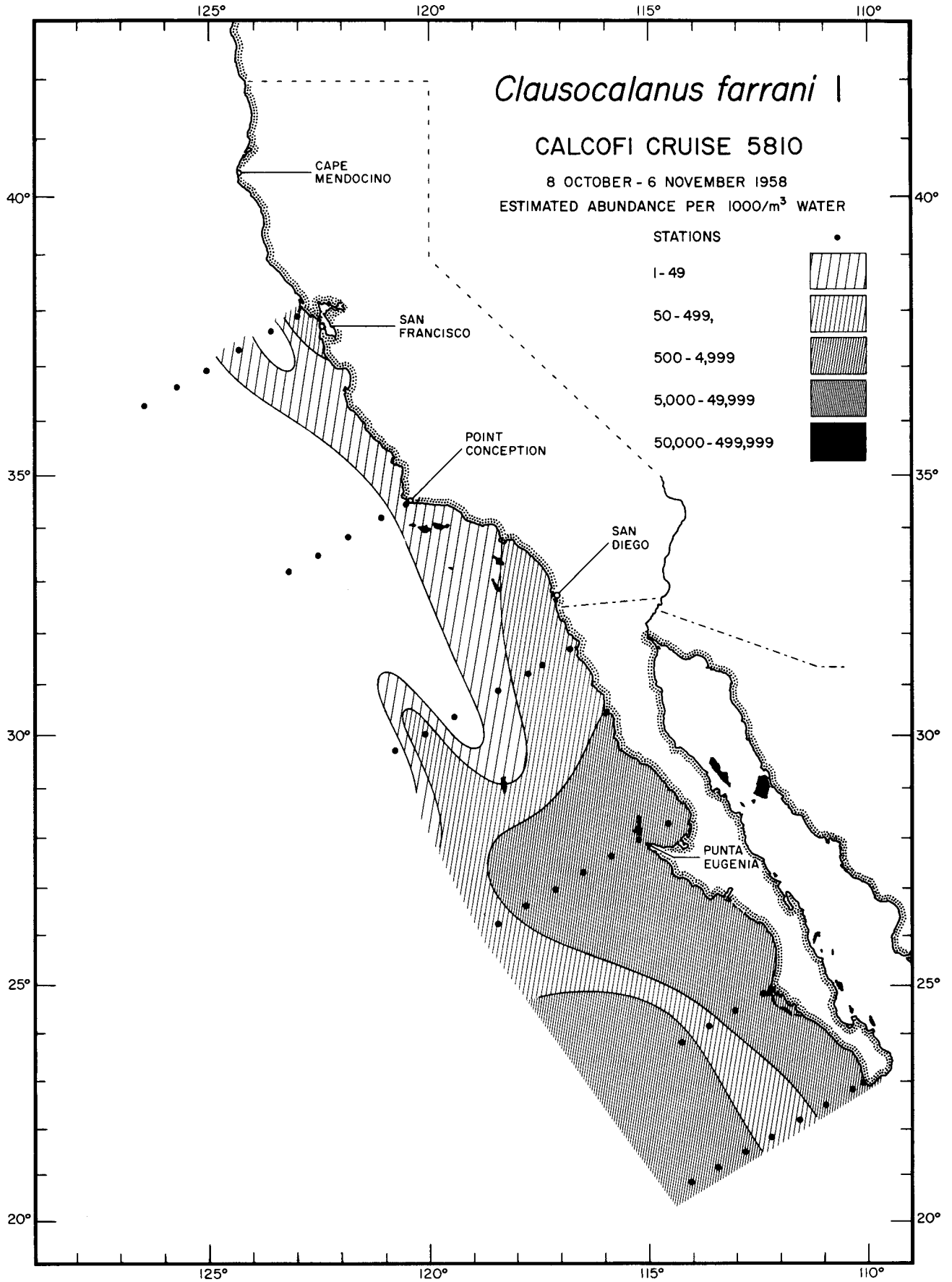




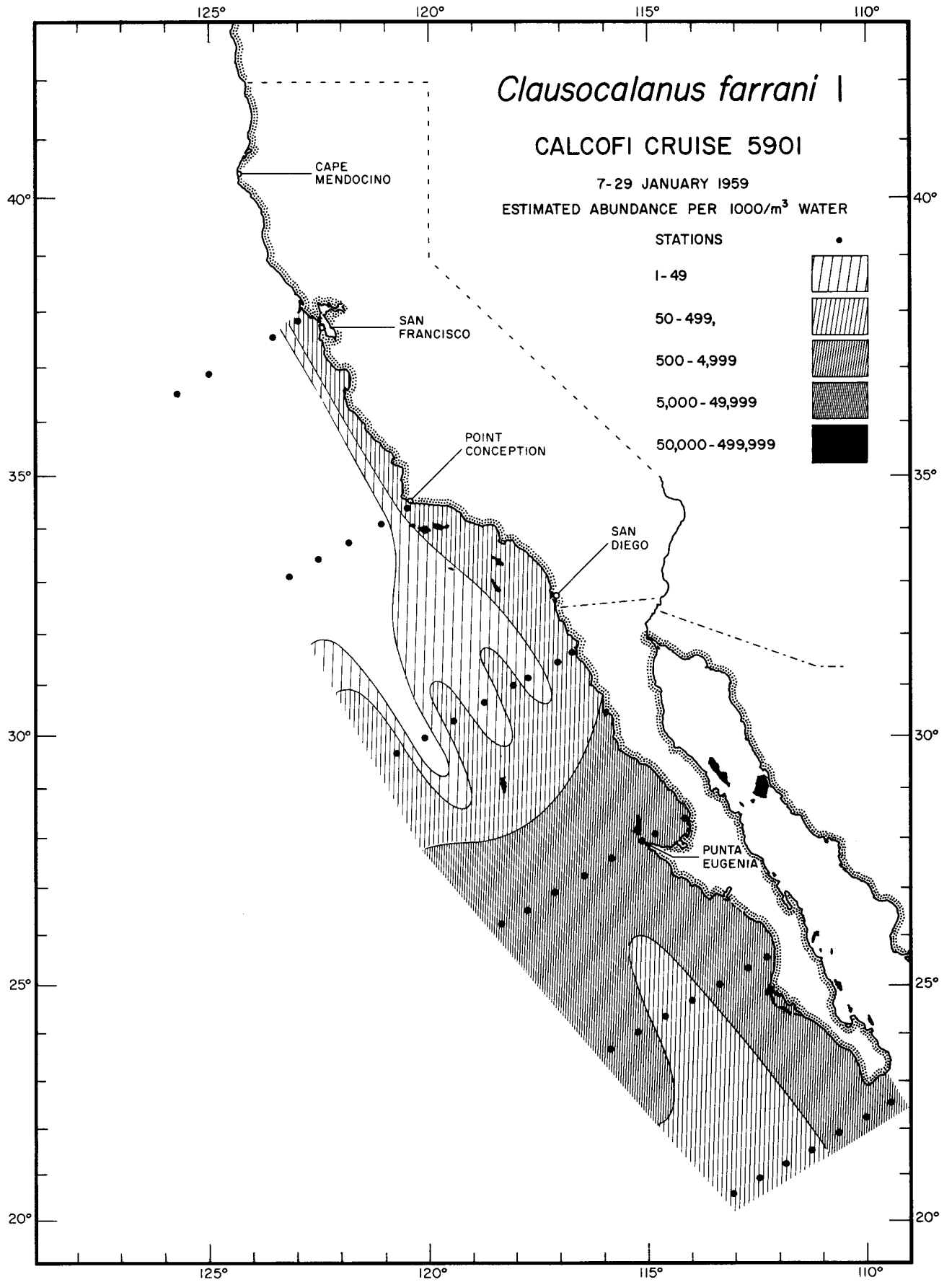


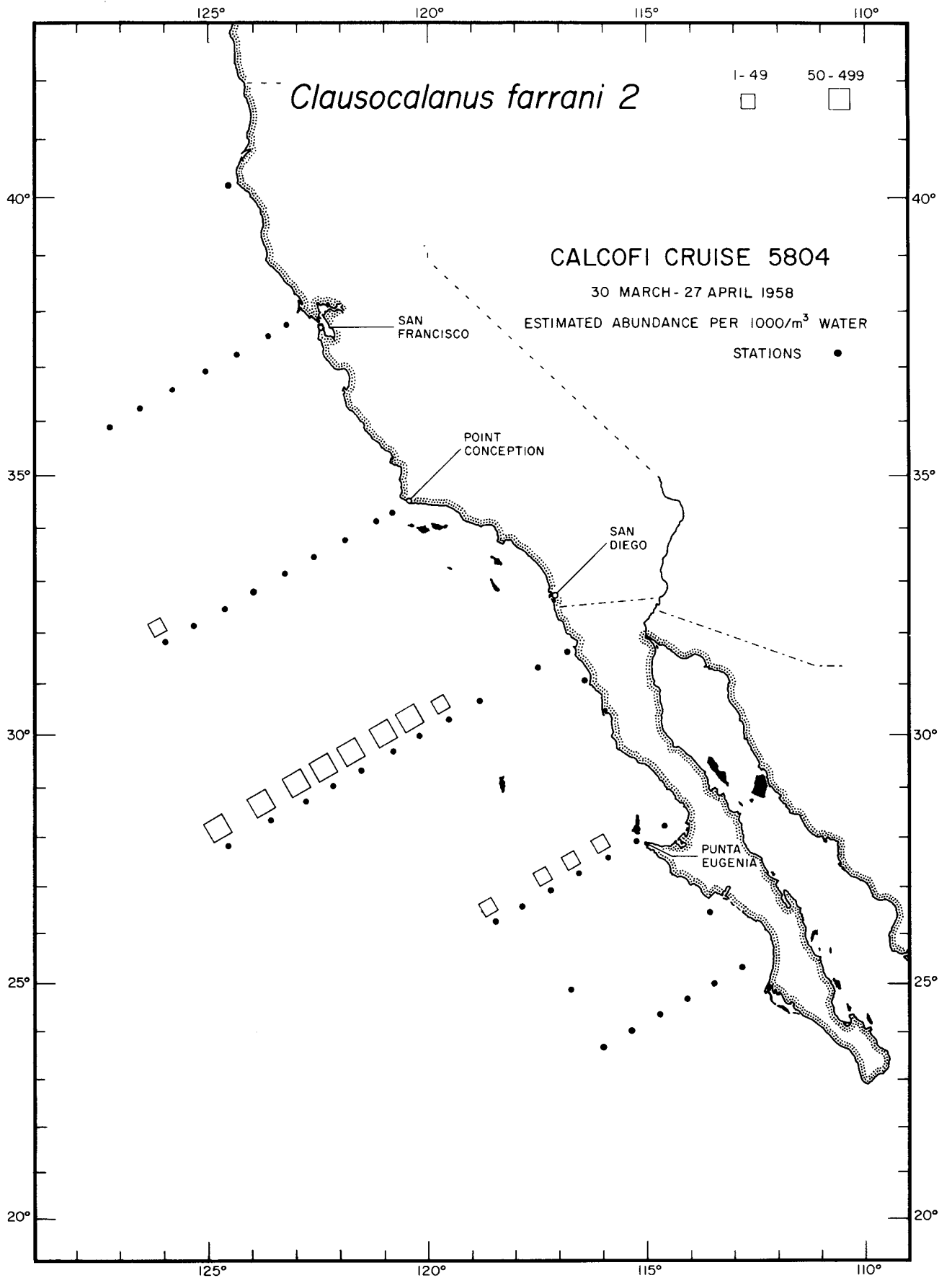


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Clausocalanus farrani I
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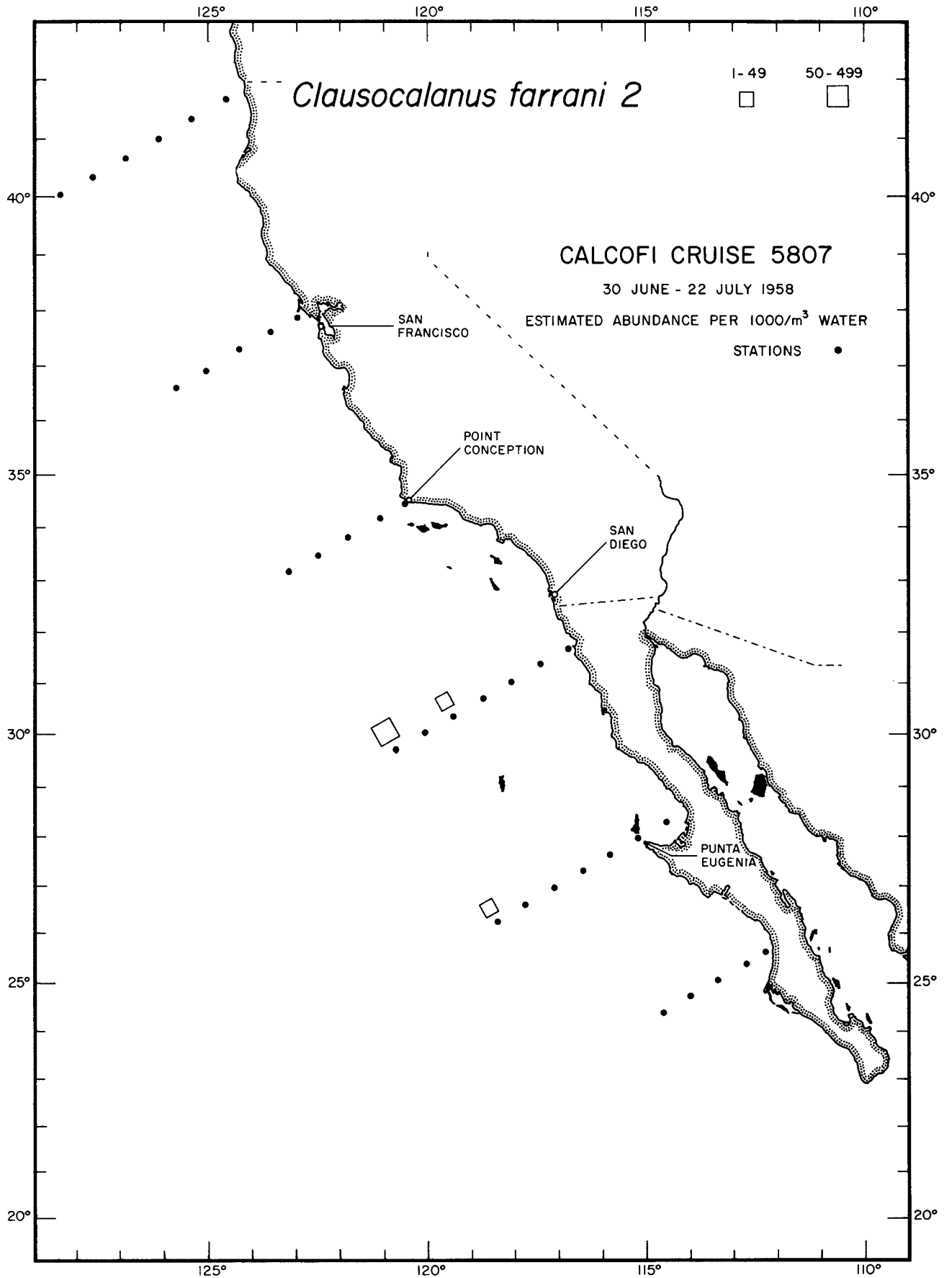


Calanoida
Clausocalanus farrani I
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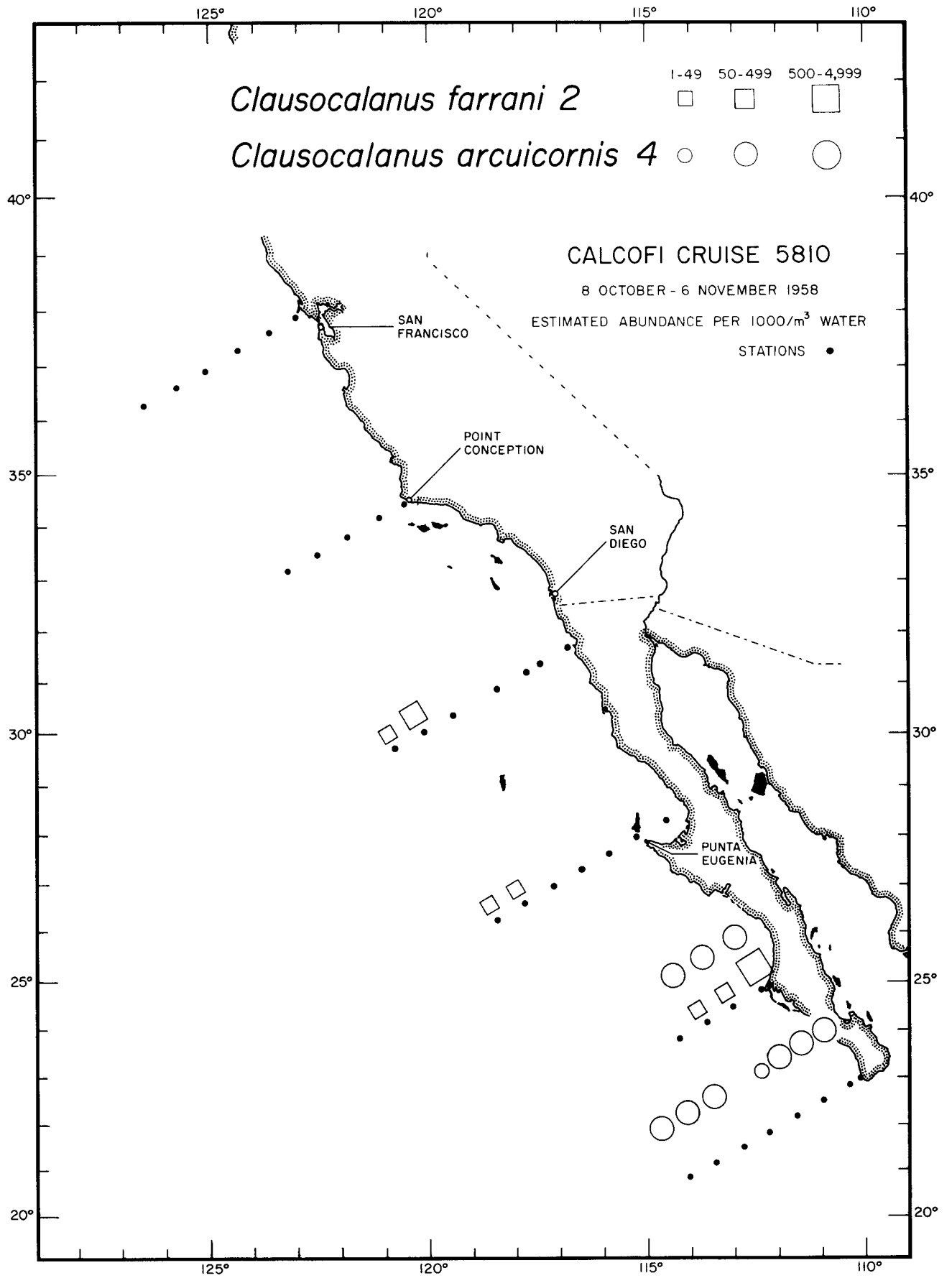




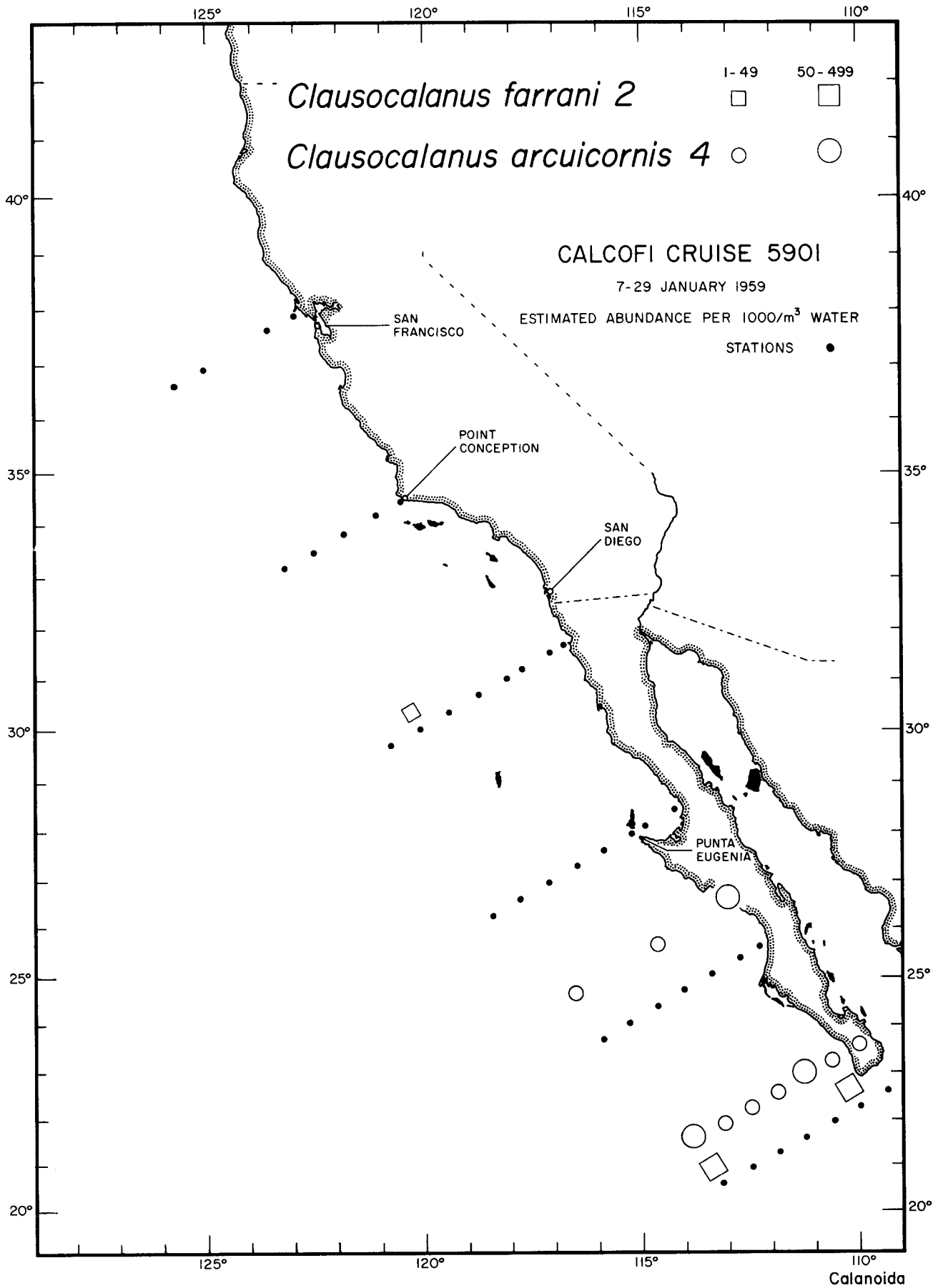
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Clausocalanus farrani 2
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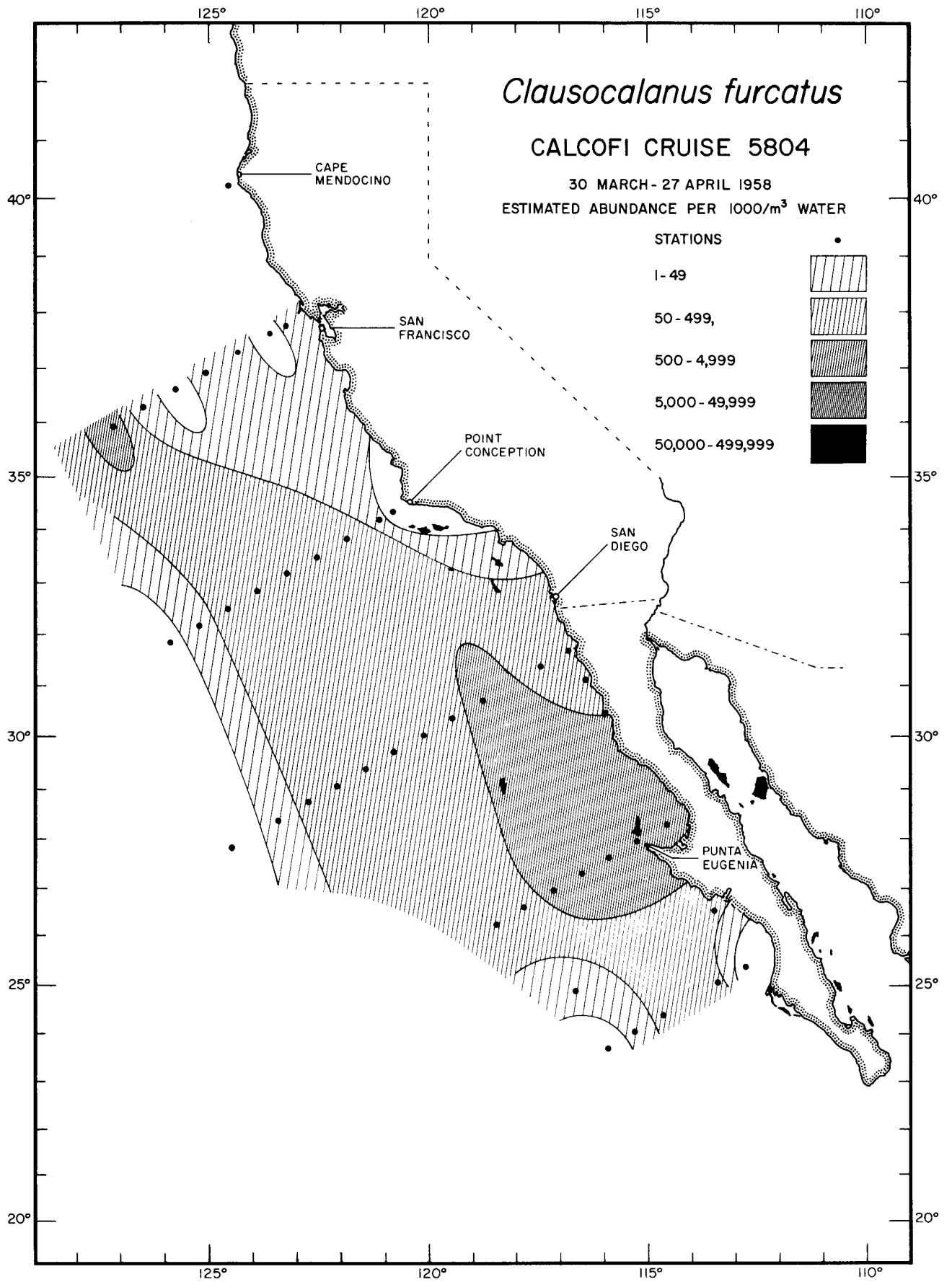
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Clausocalanus farrani 2
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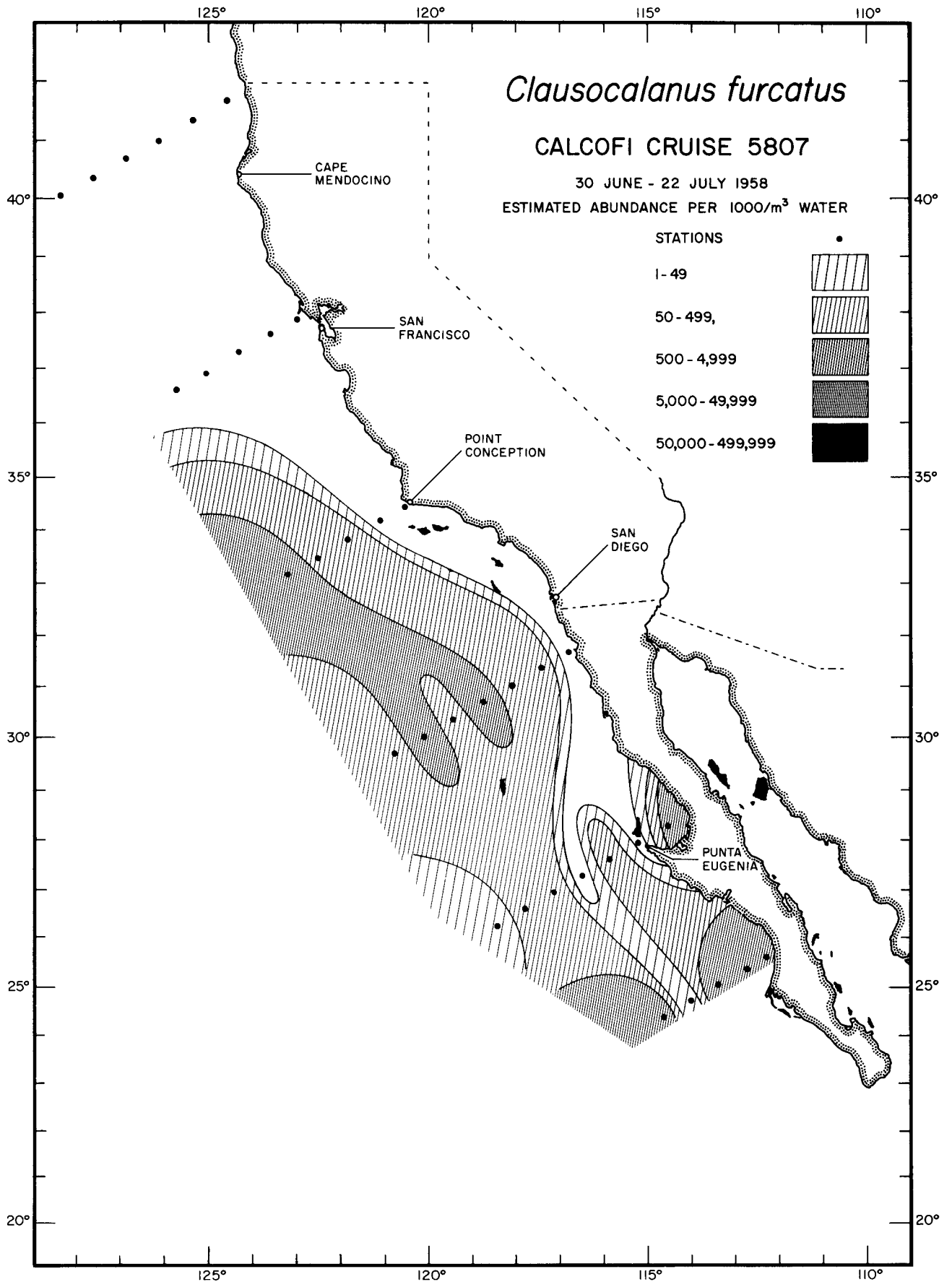
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Clausocalanus farrani 2
Clausocalanus arcuicornis 4
5810



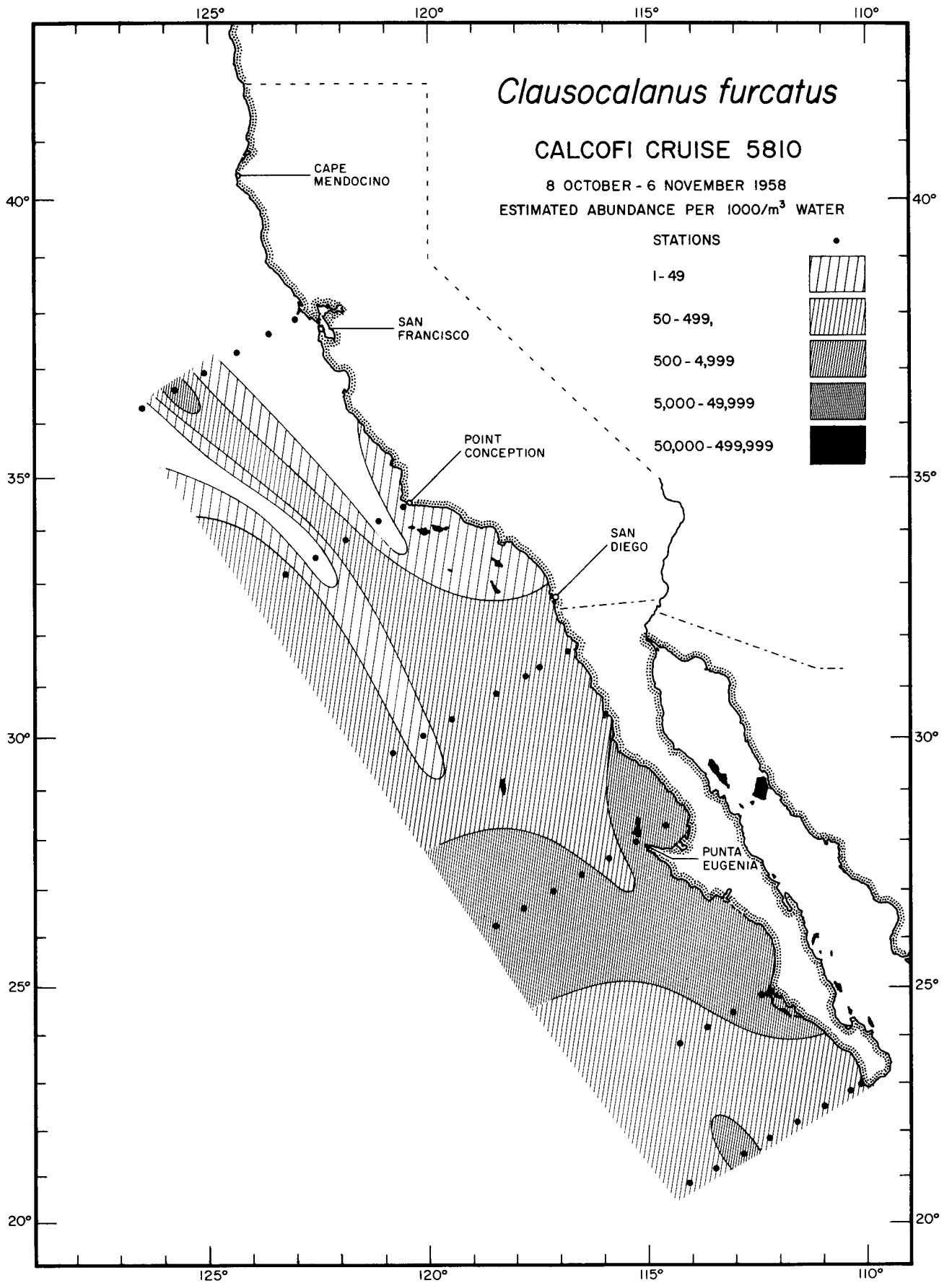
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Clausocalanus farrani 2
Clausocalanus arcuicornis 4
5901



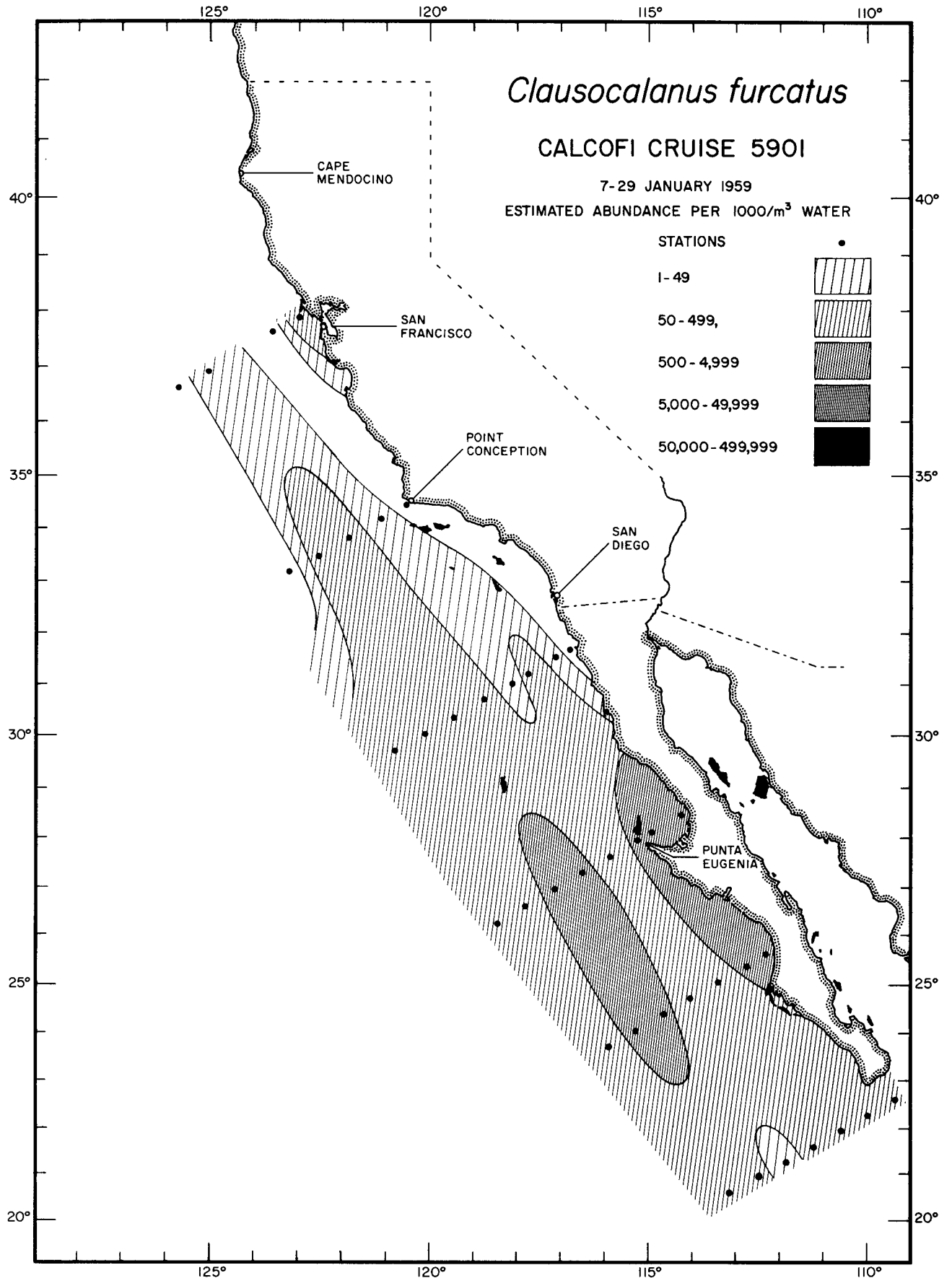
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Clausocalanus furcatus
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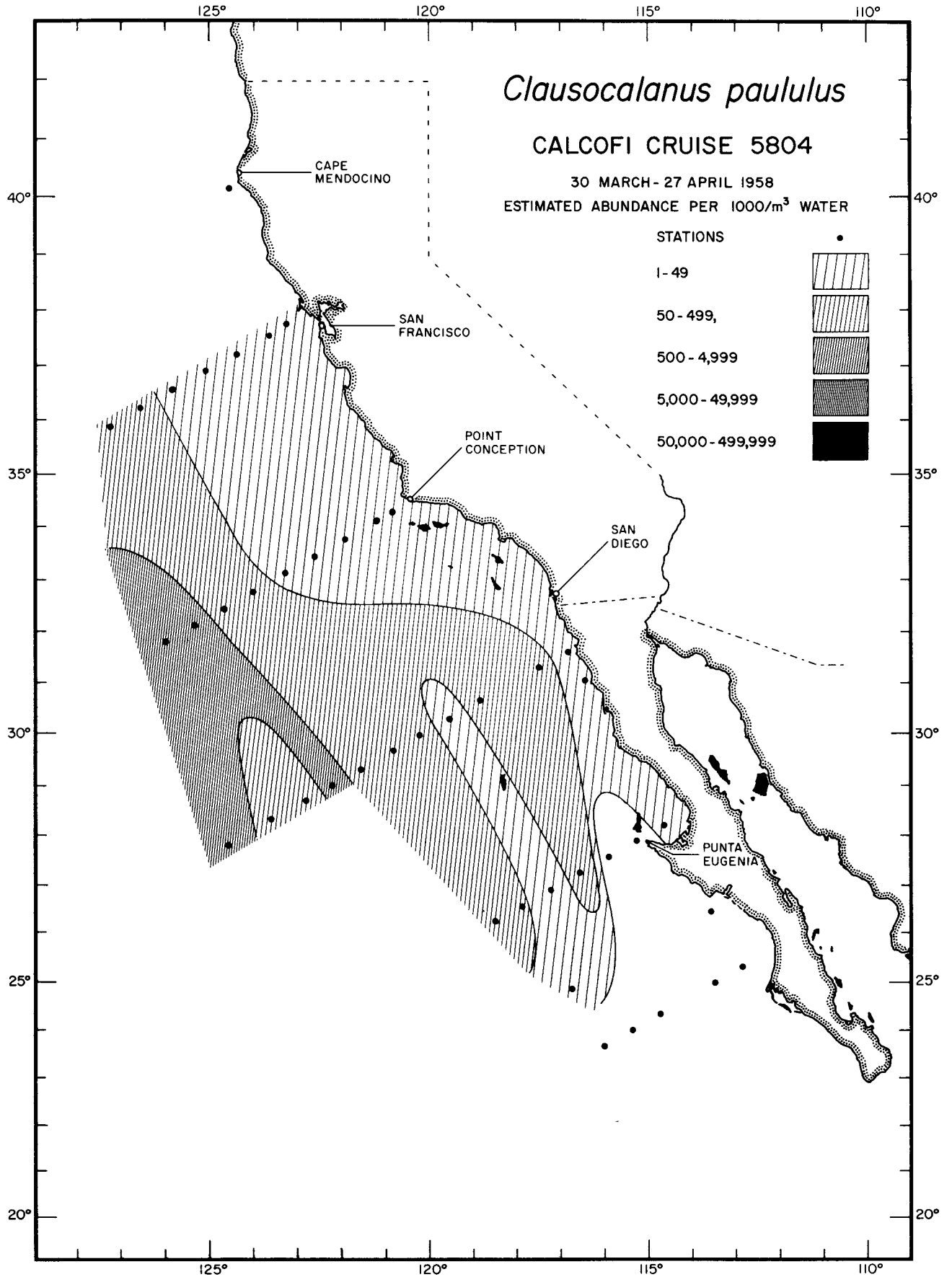
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Clausocalanus furcatus
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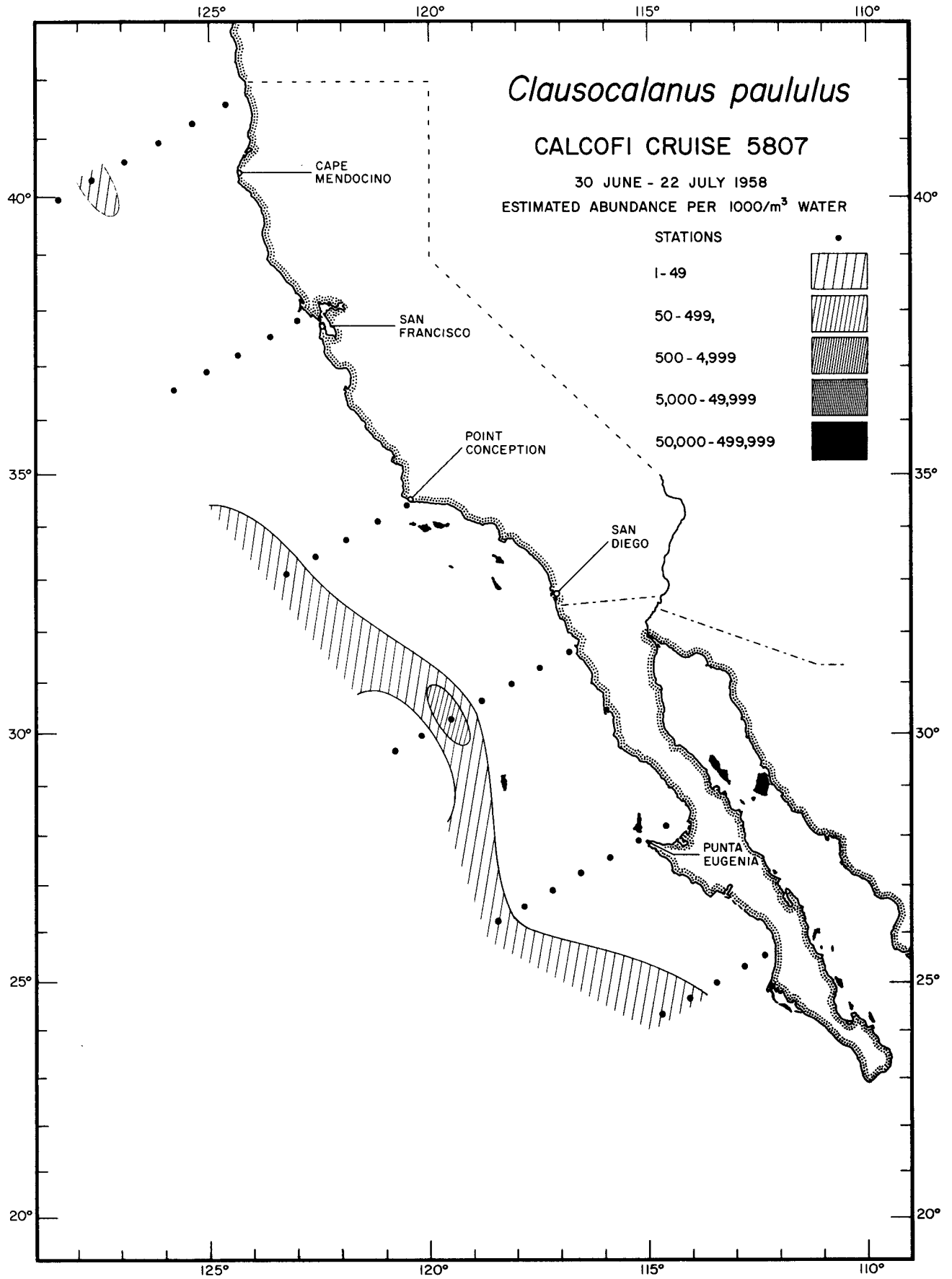
Calanoida
Clausocalanus furcatus
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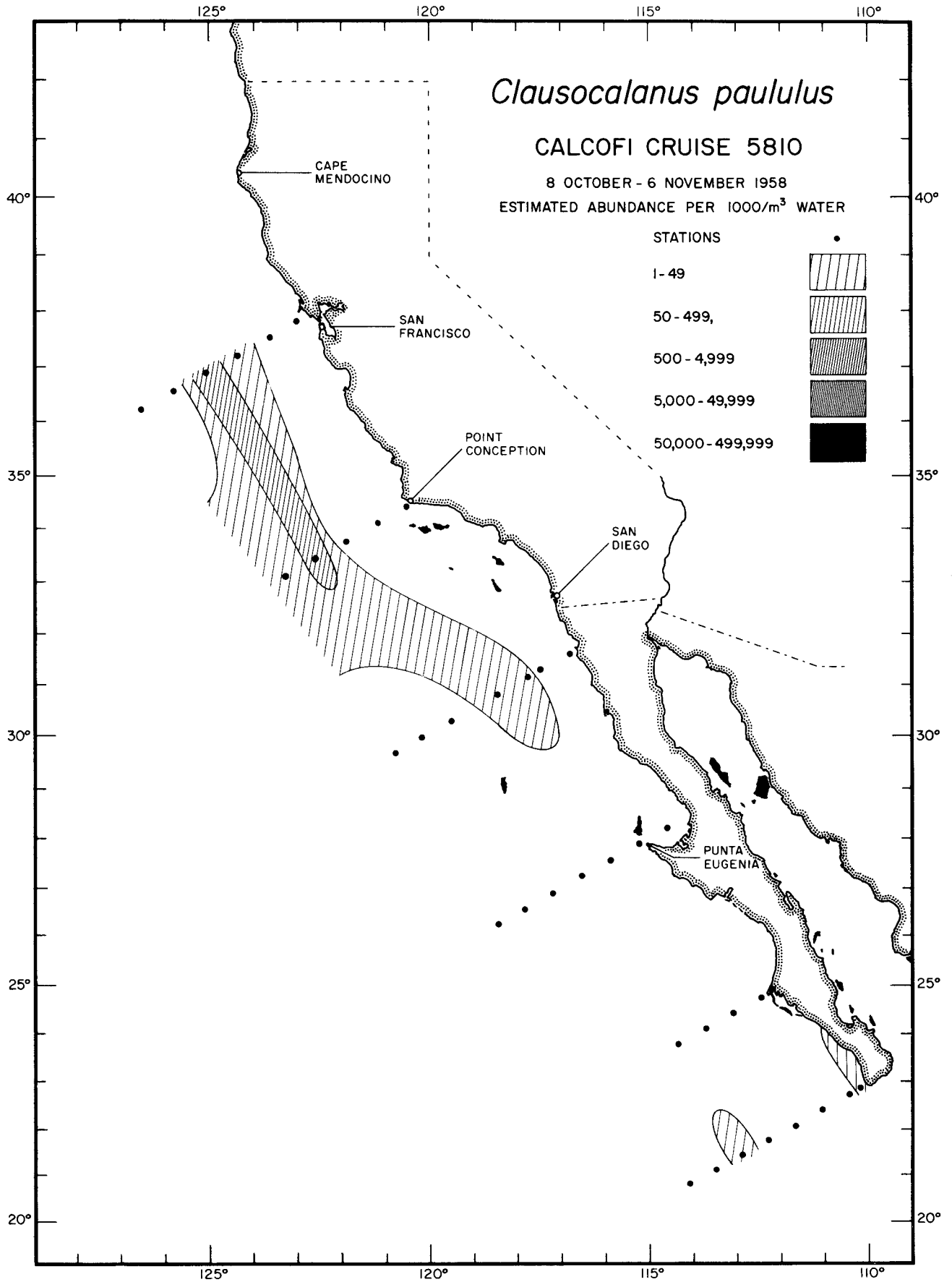
Calanoida
Clausocalanus furcatus
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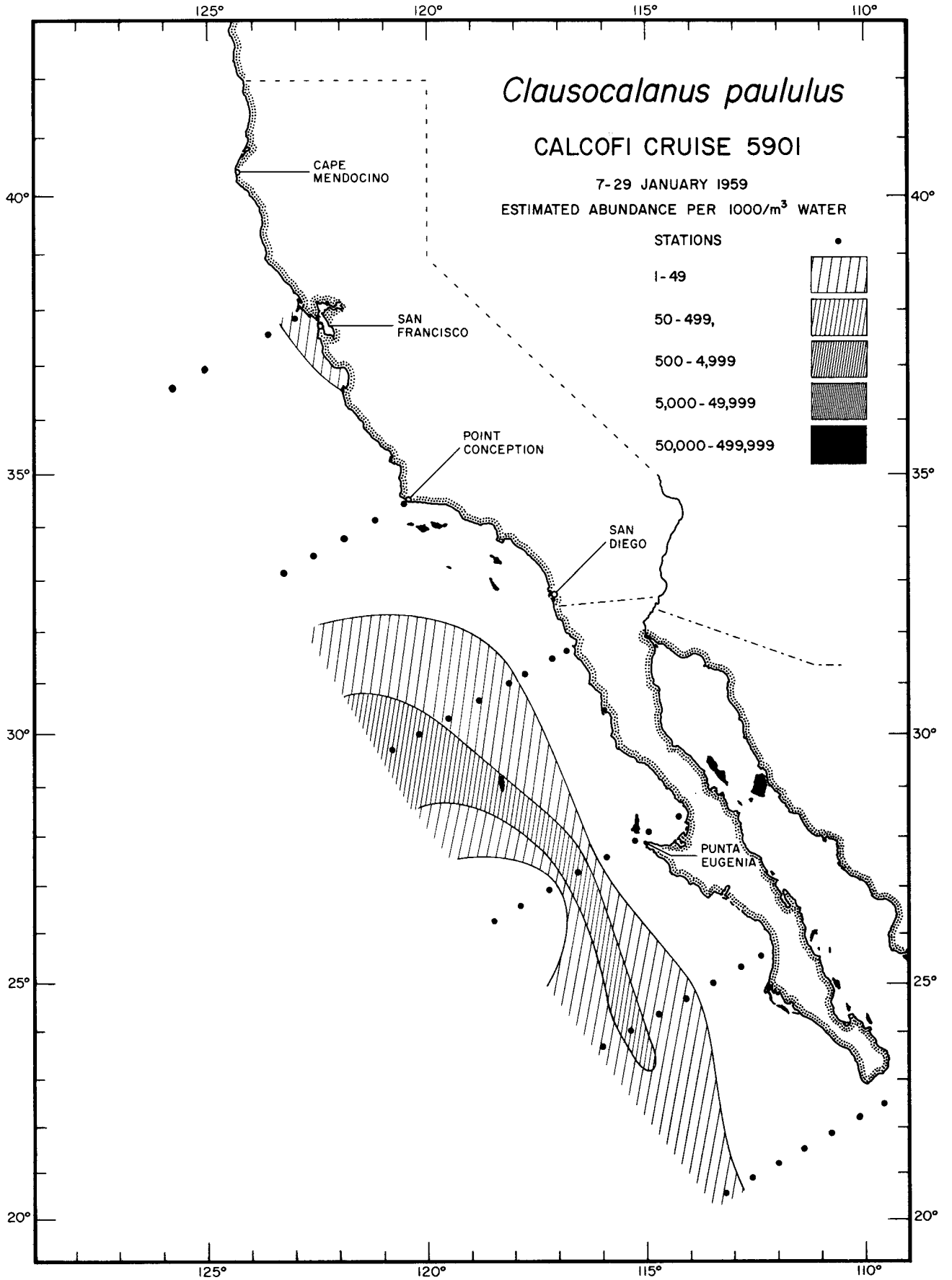
Calanoida
Clausocalanus paululus
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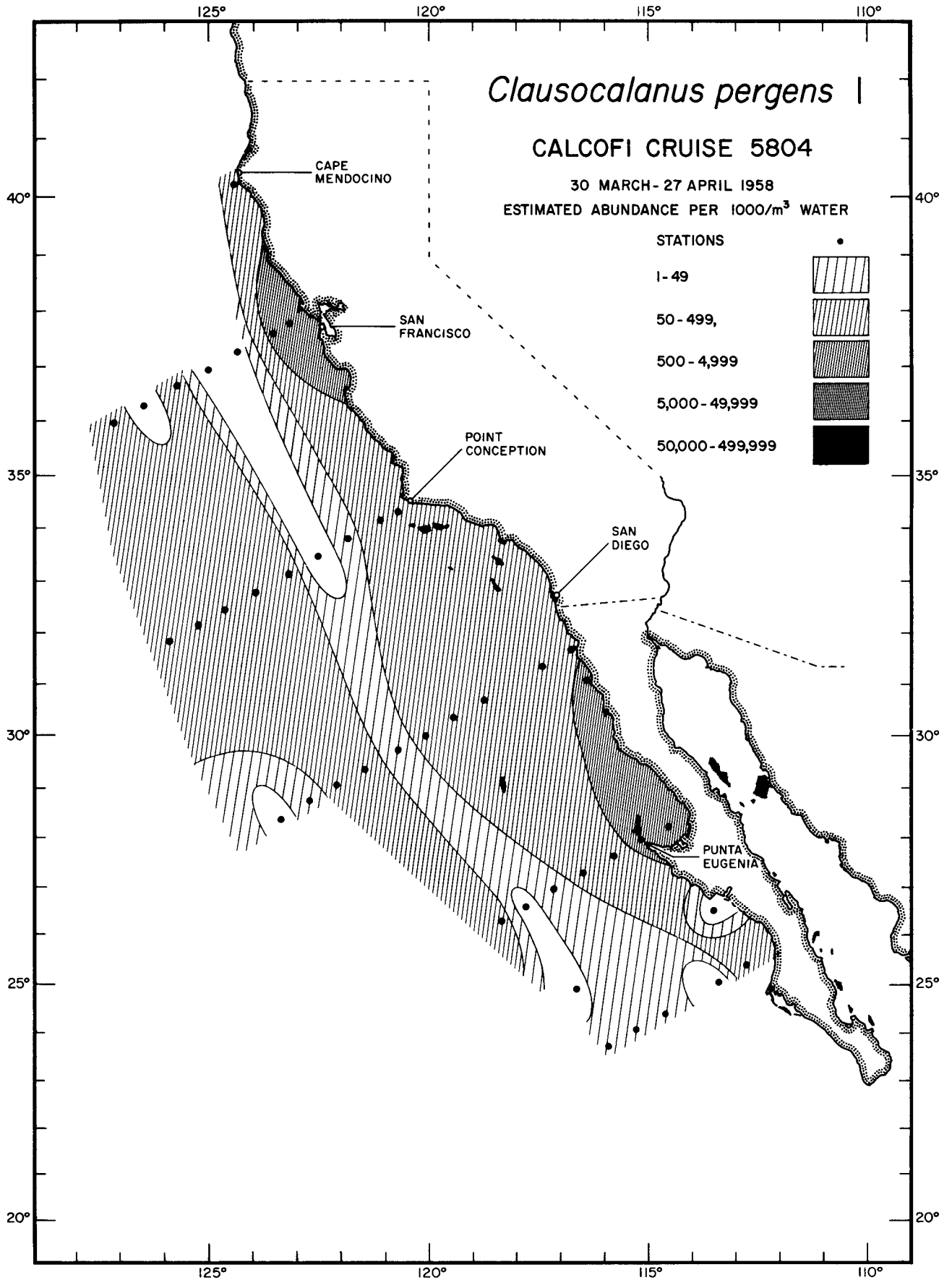
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Clausocalanus paululus
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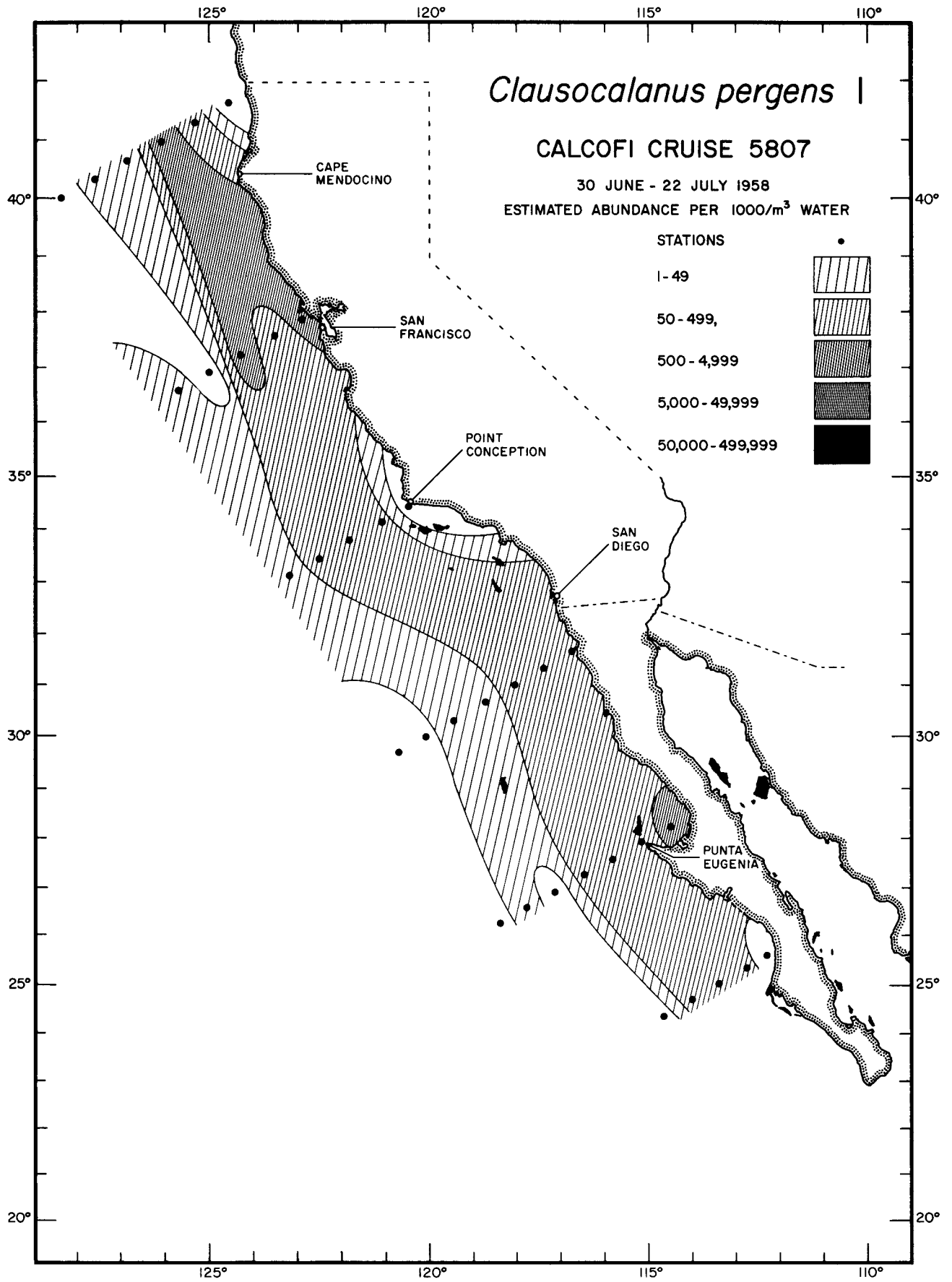
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Clausocalanus paululus
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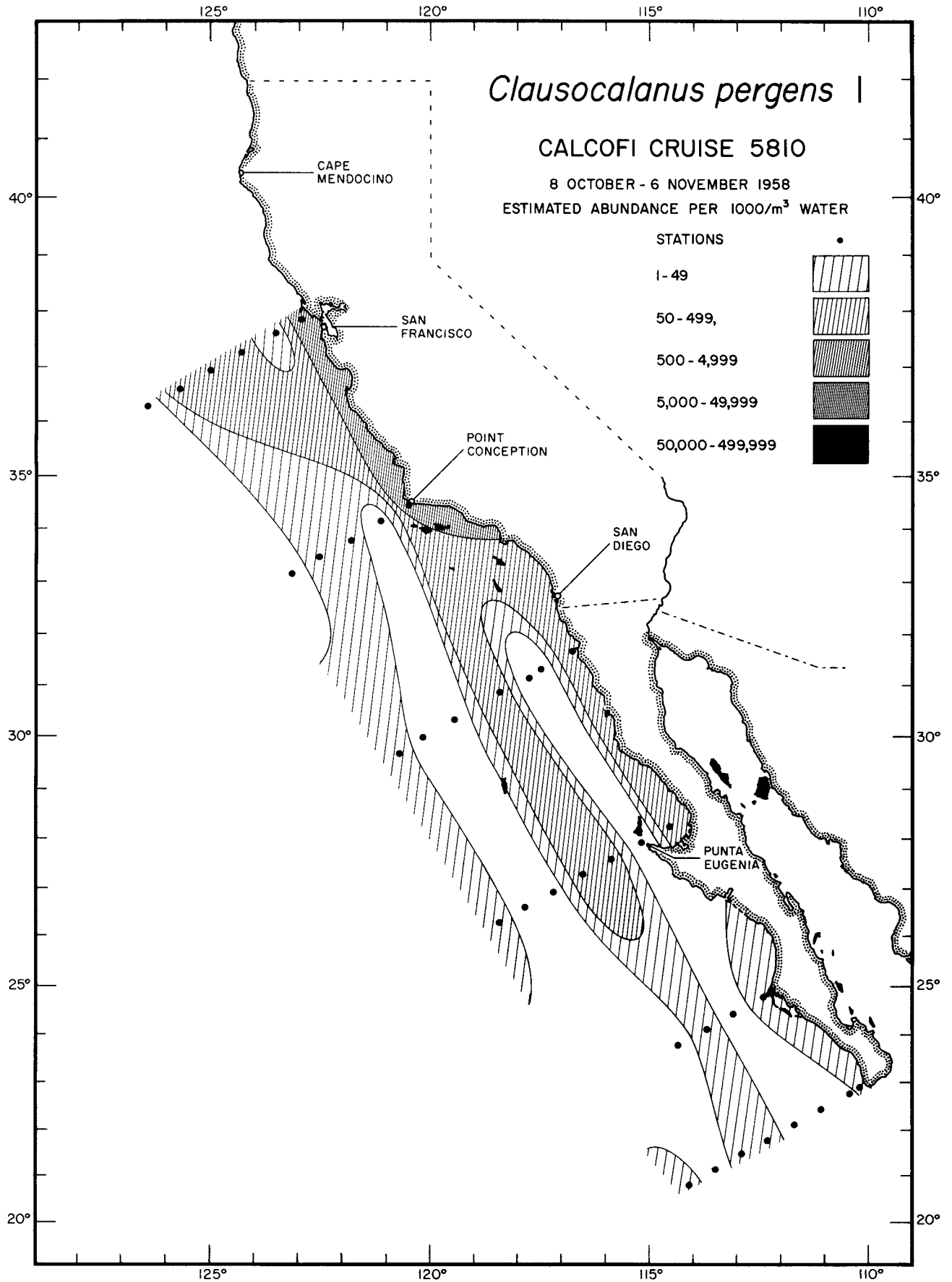
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Clausocalanus paululus
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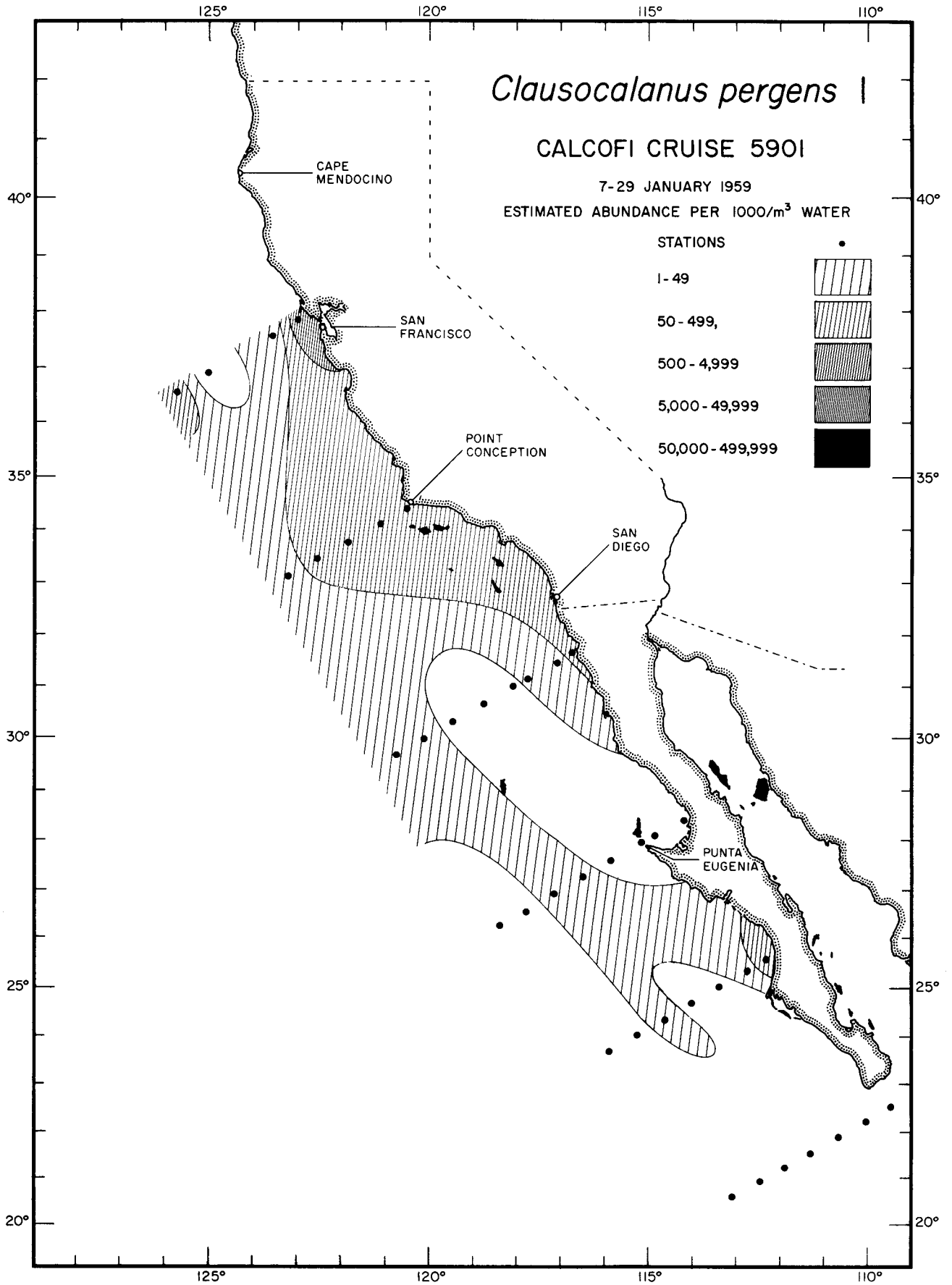
Calanoida
Clausocalanus pergens |
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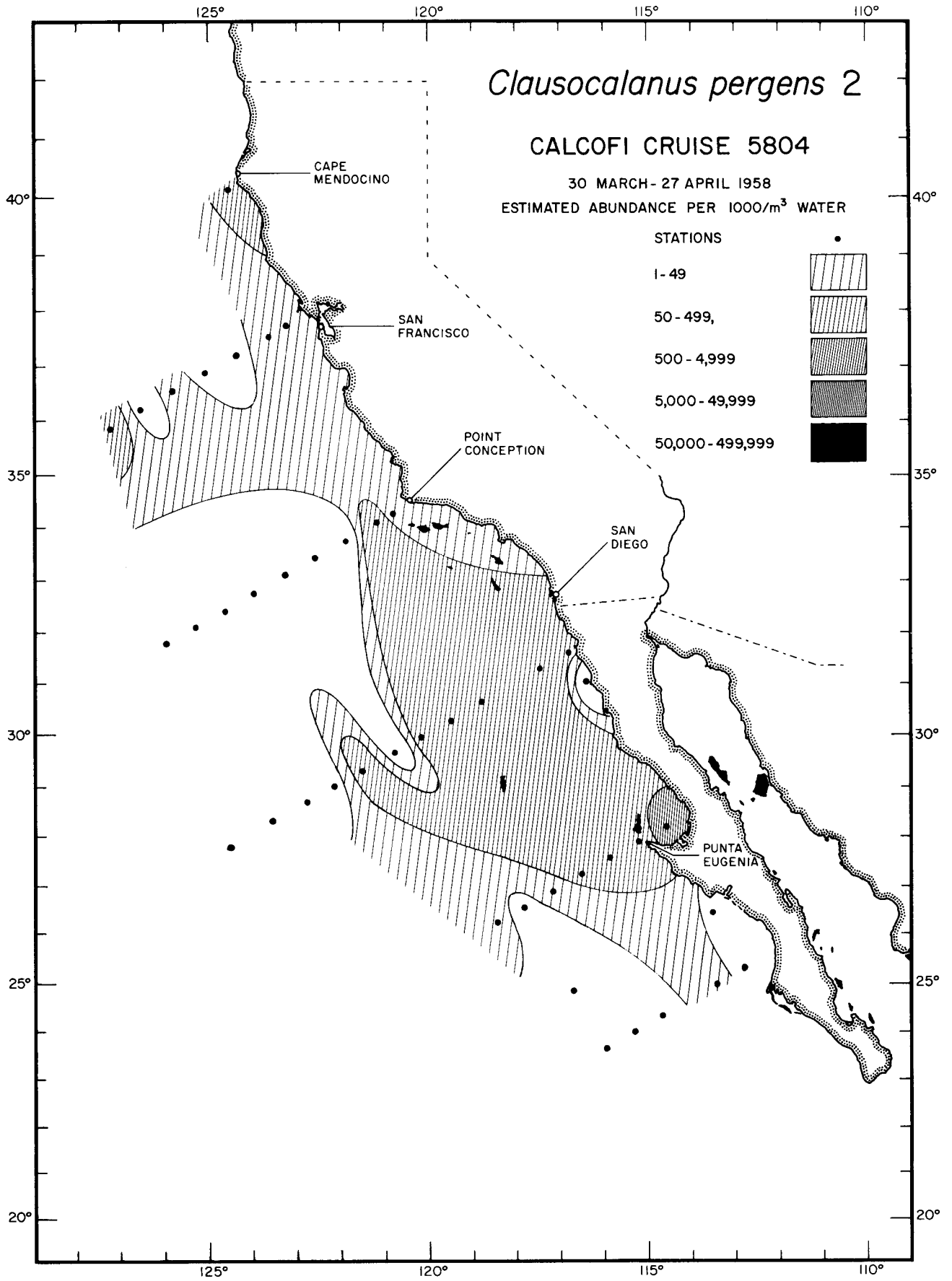
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Clausocalanus pergens |
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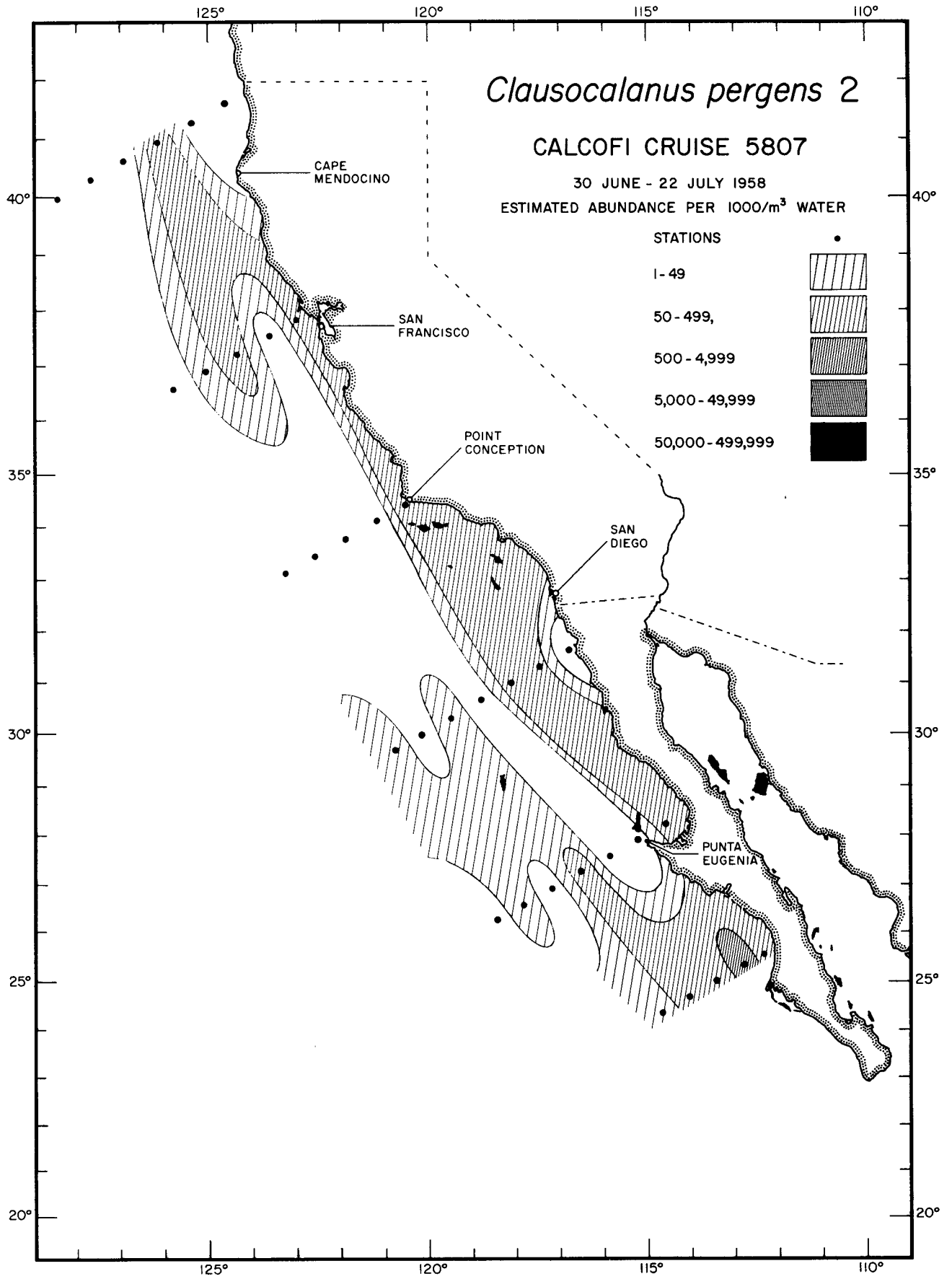
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Clausocalanus pergens I
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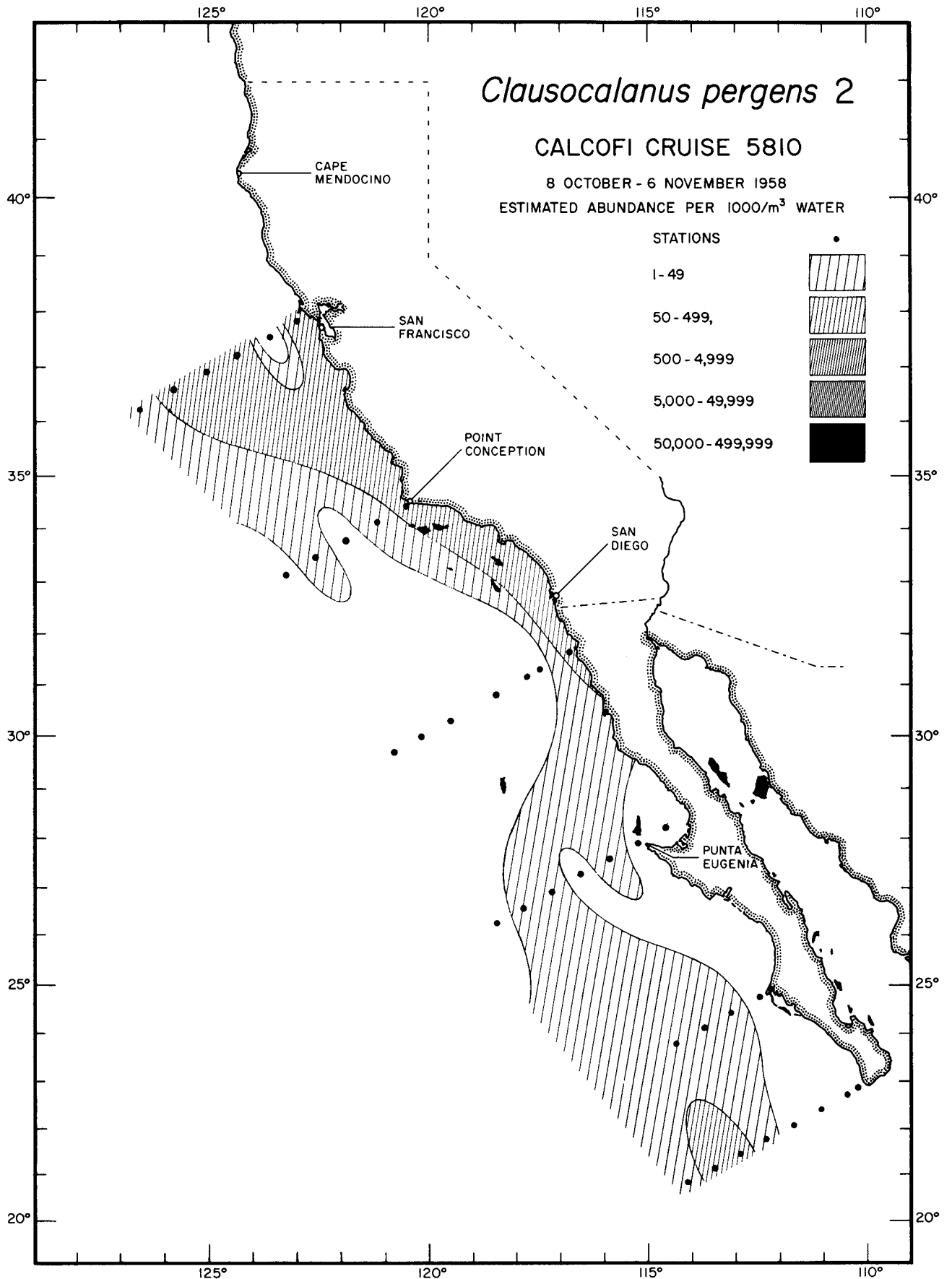
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Clausocalanus pergens I
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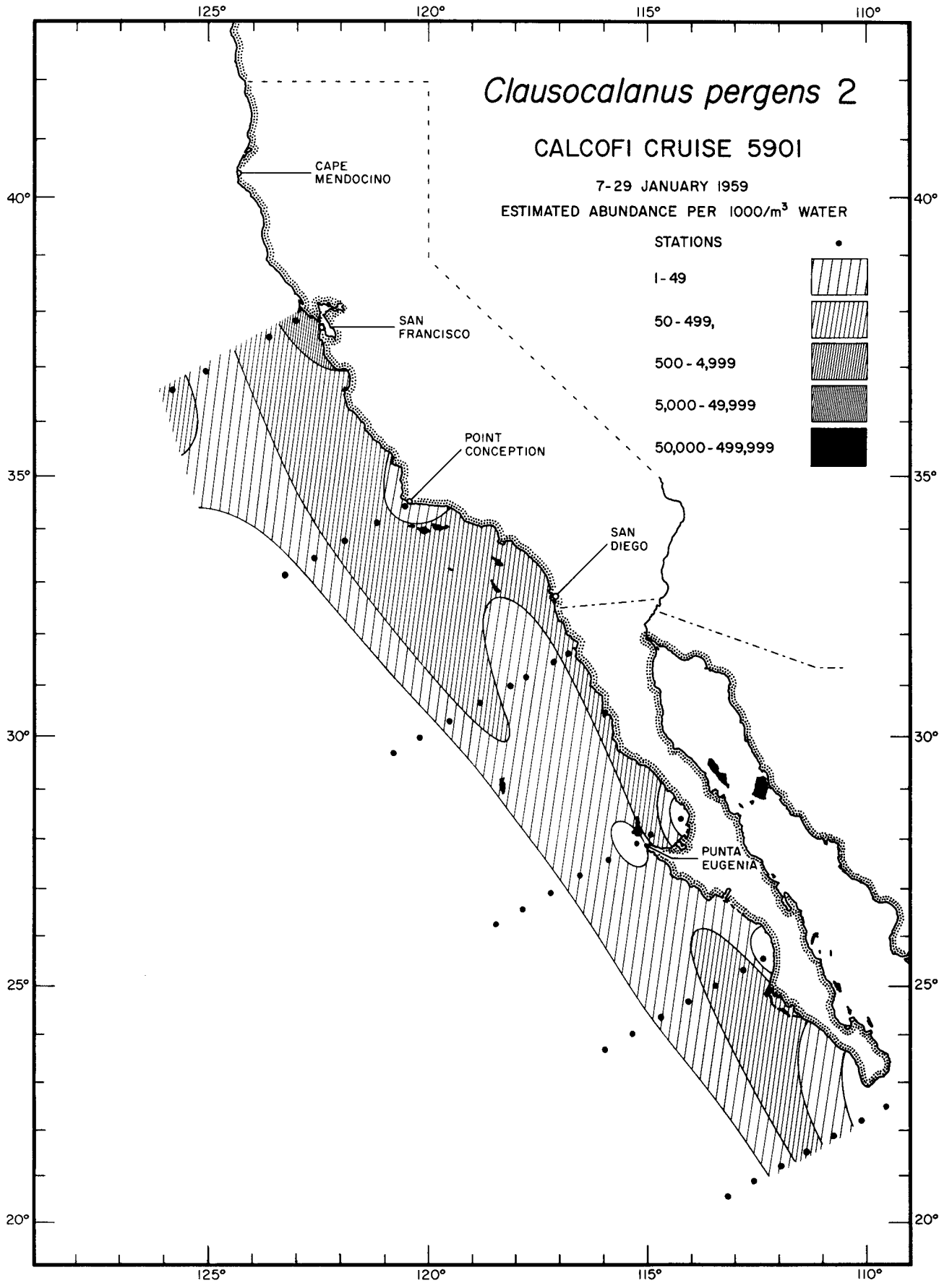
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Clausocalanus pergens 2
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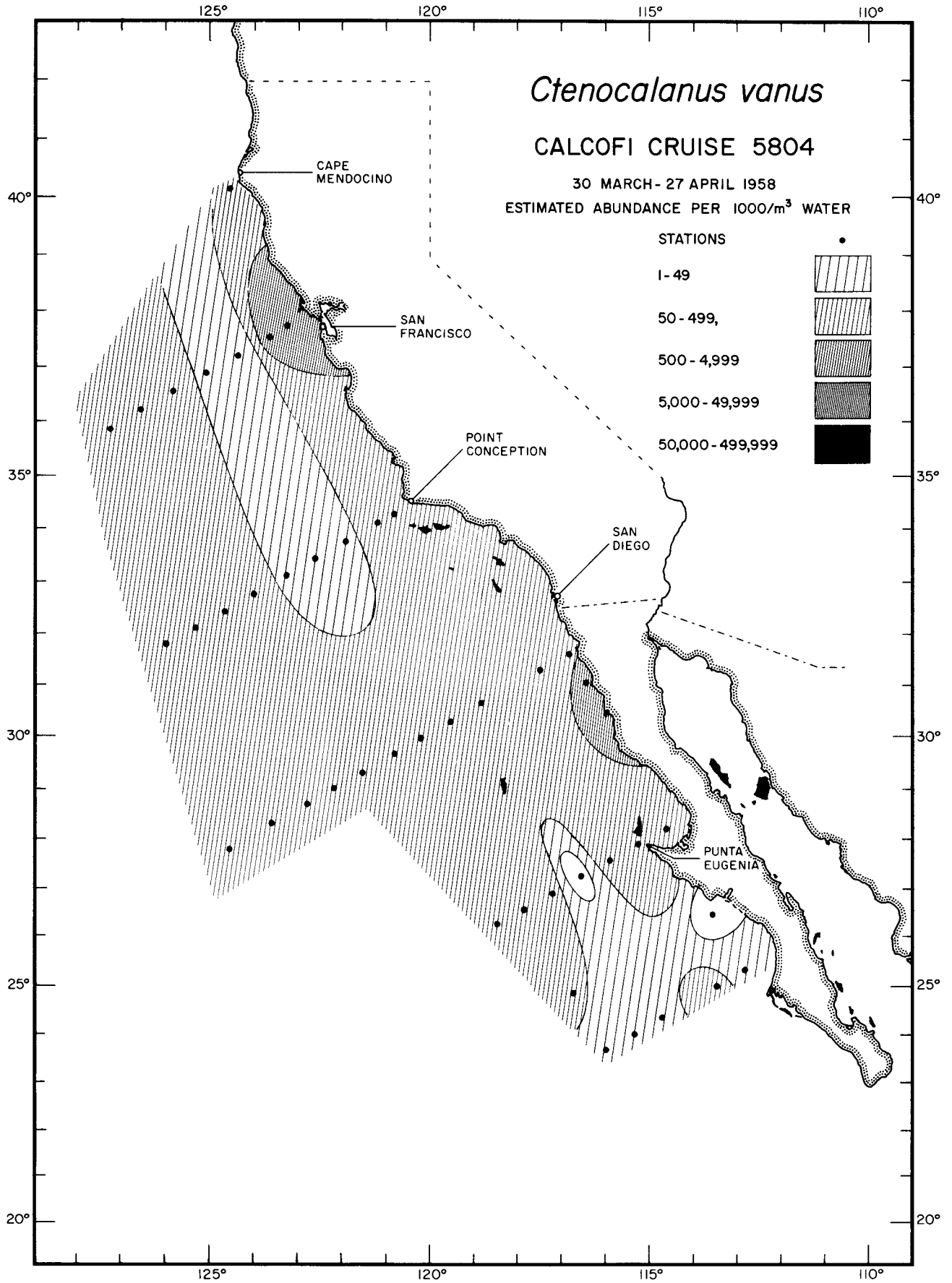
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Clausocalanus pergens 2
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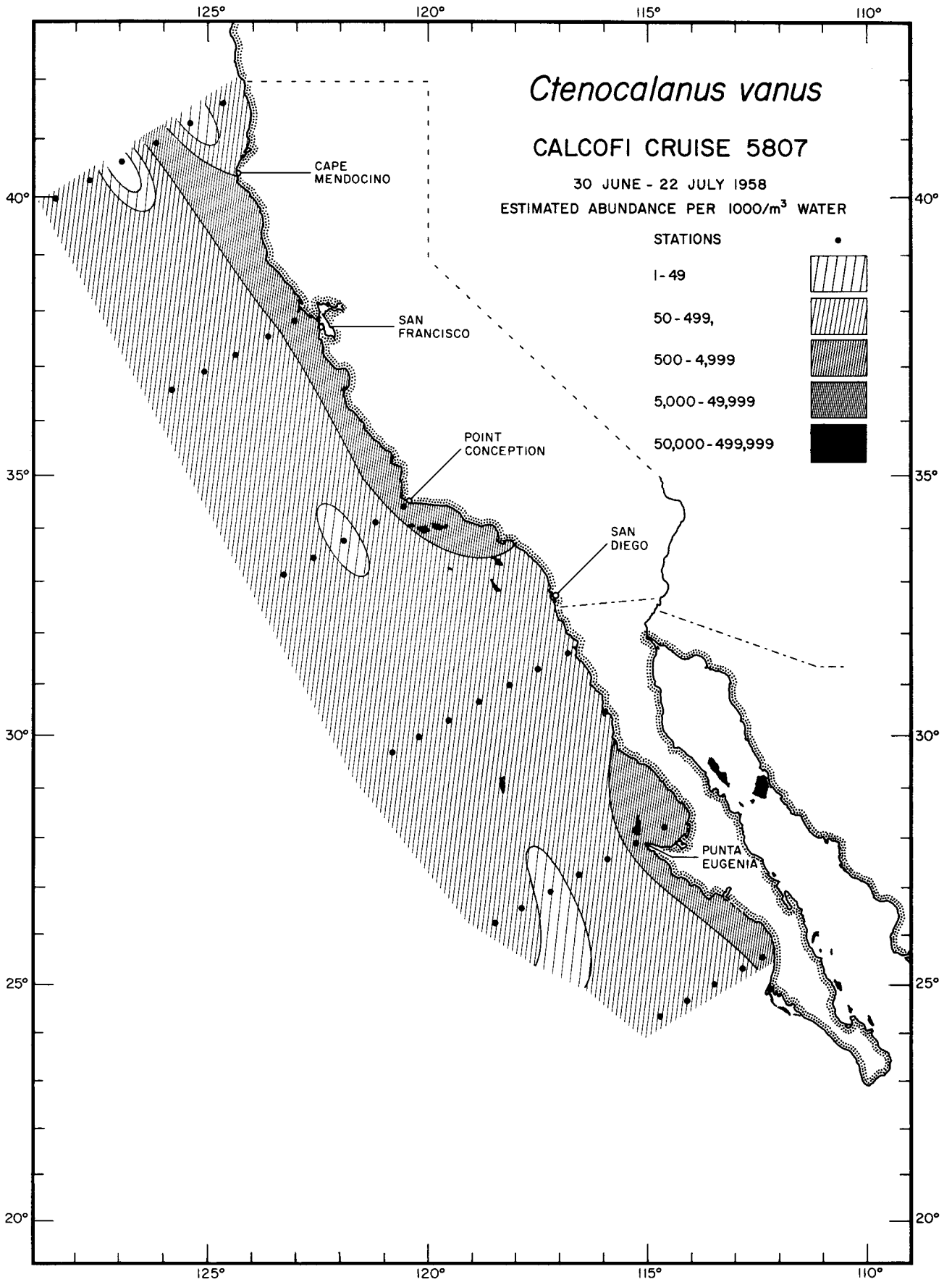
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Clausocalanus pergens 2
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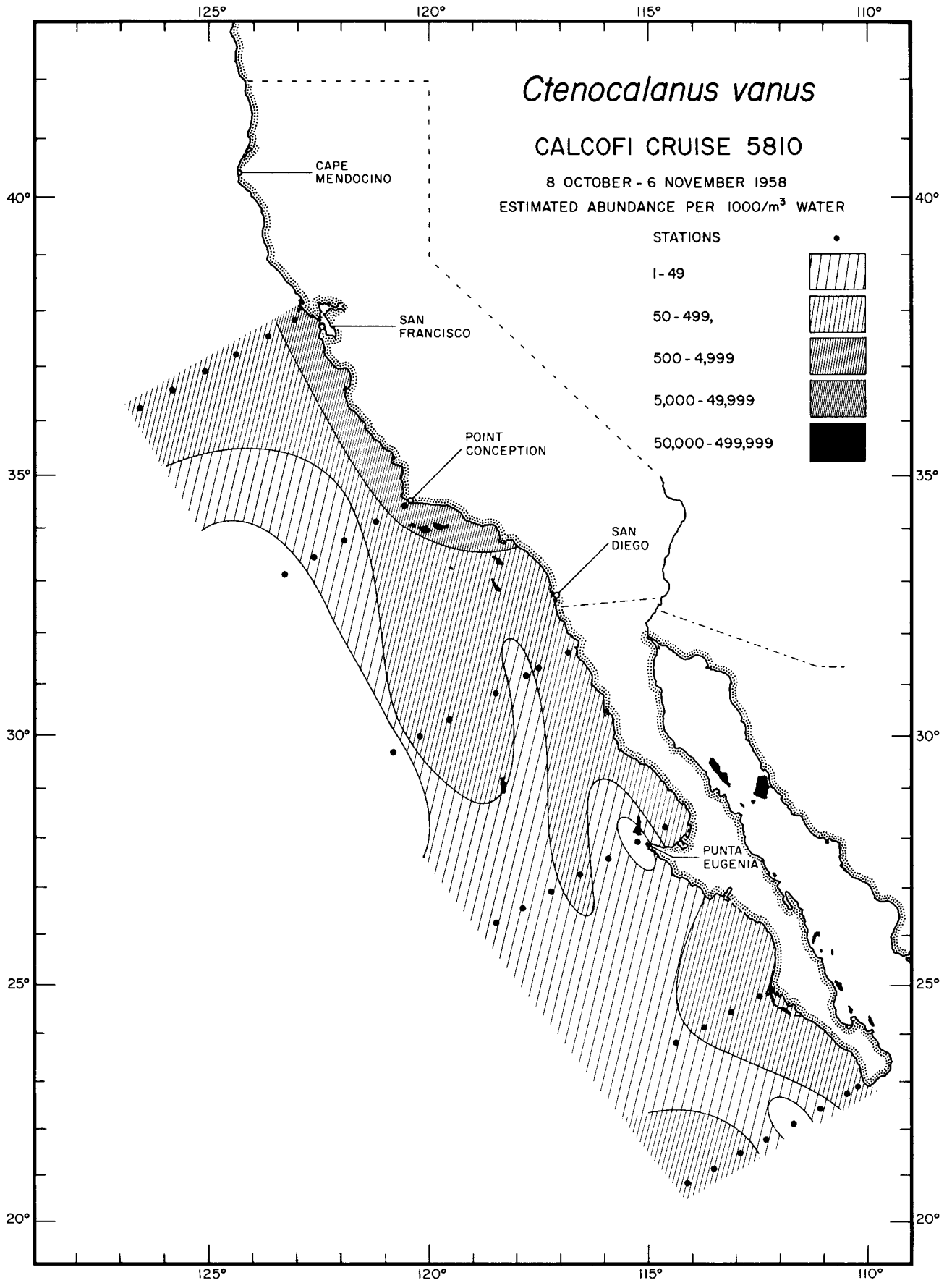
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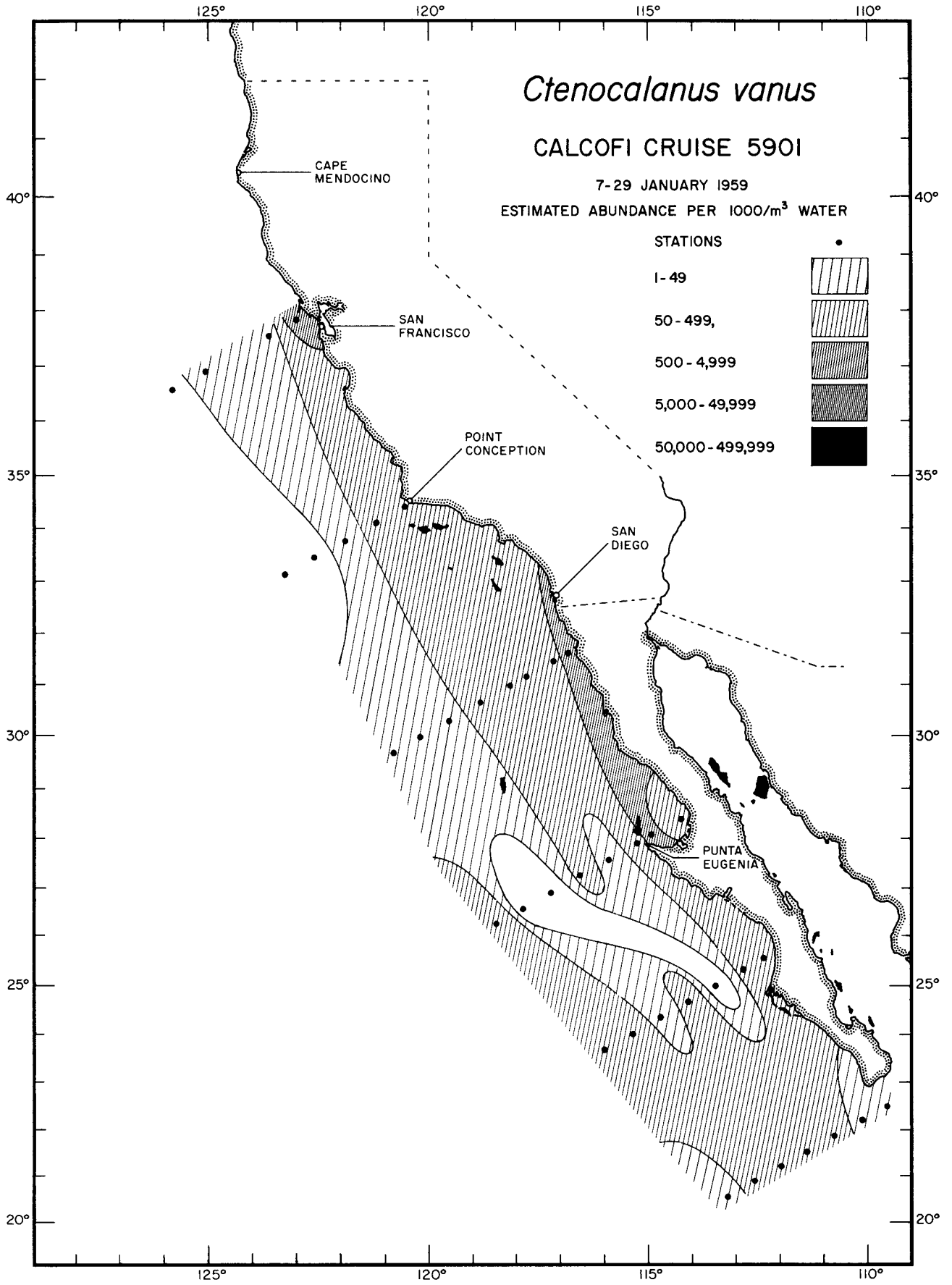
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Ctenocalanus vanus
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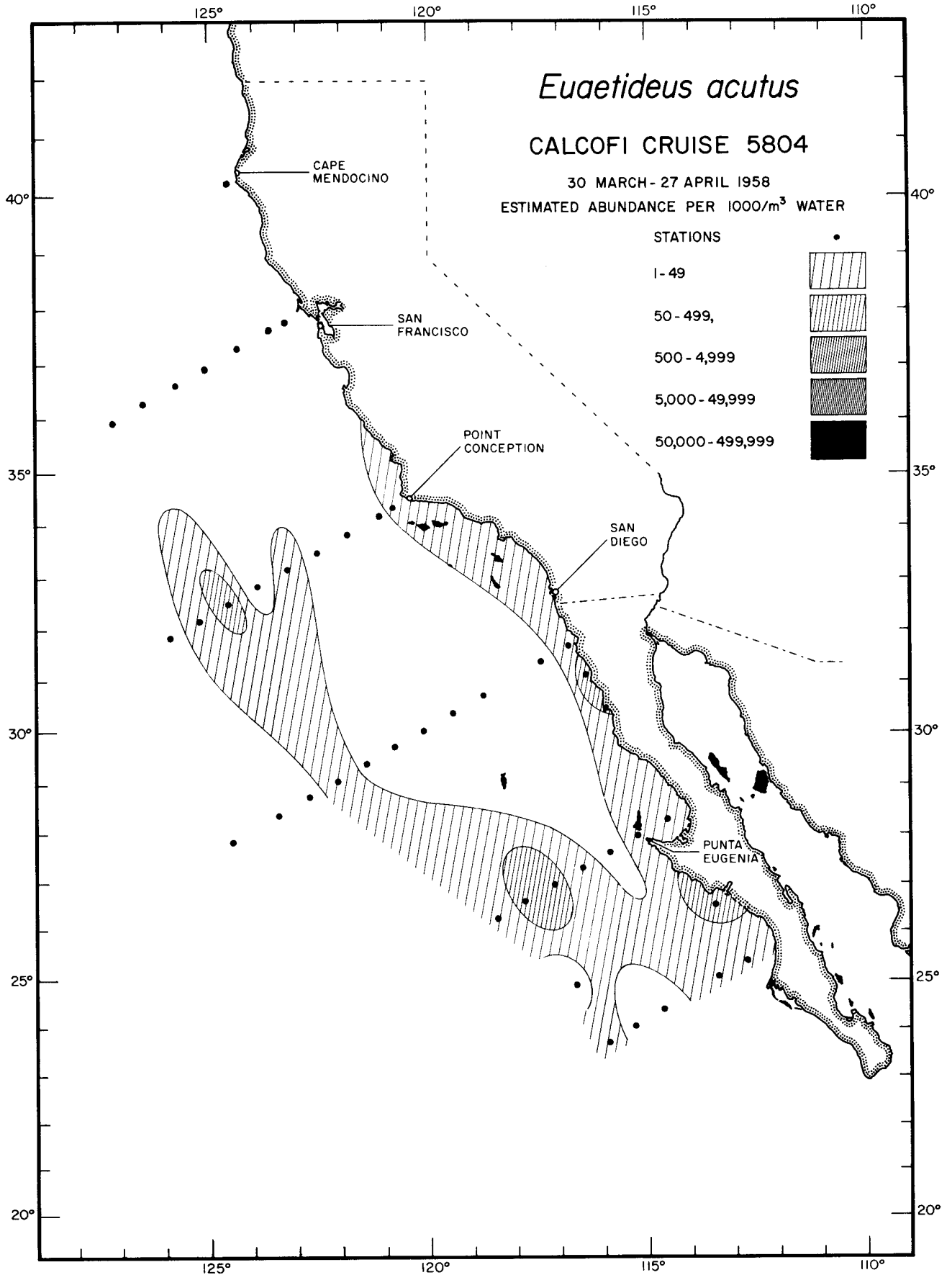
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Ctenocalanus vanus
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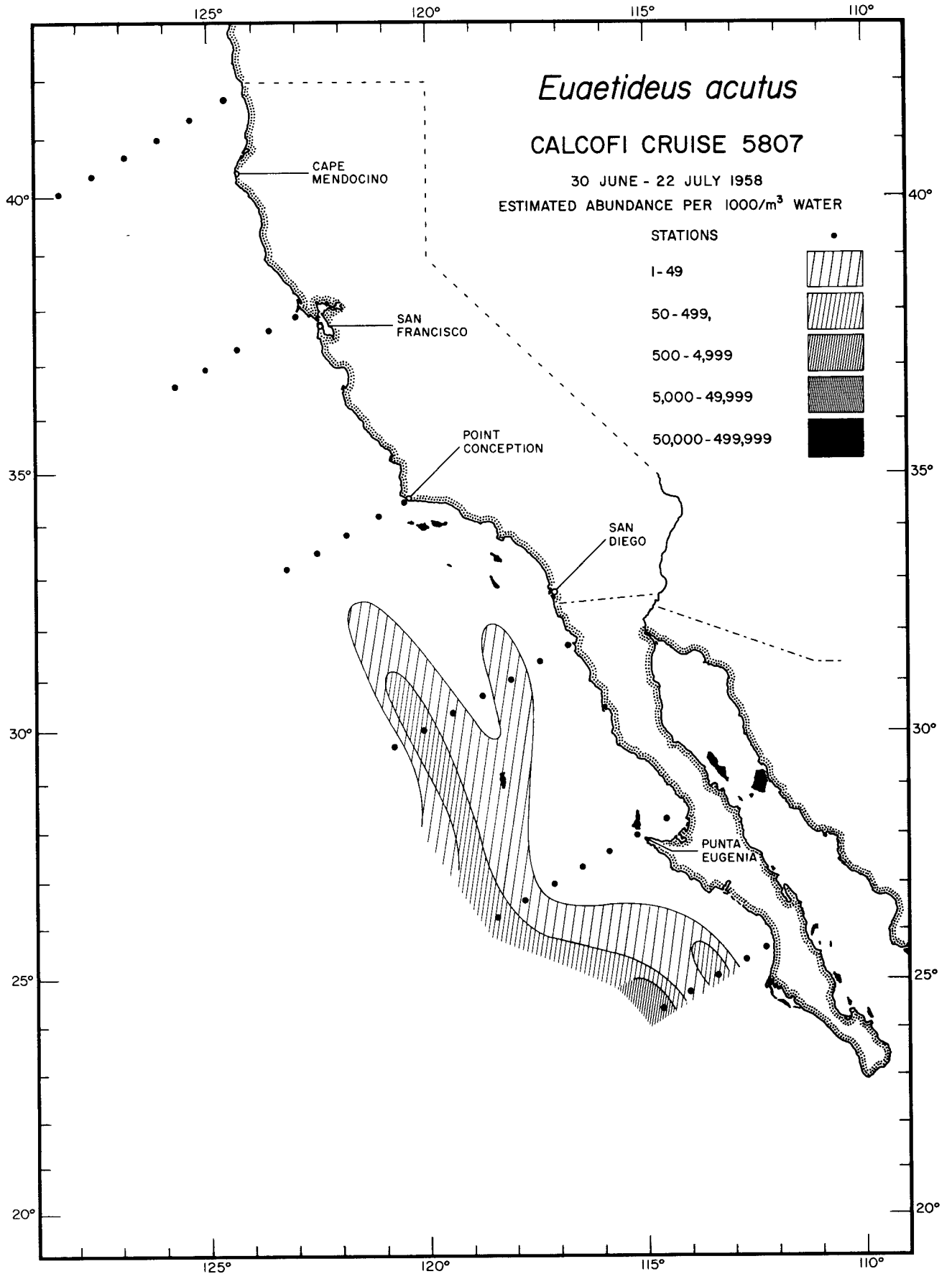
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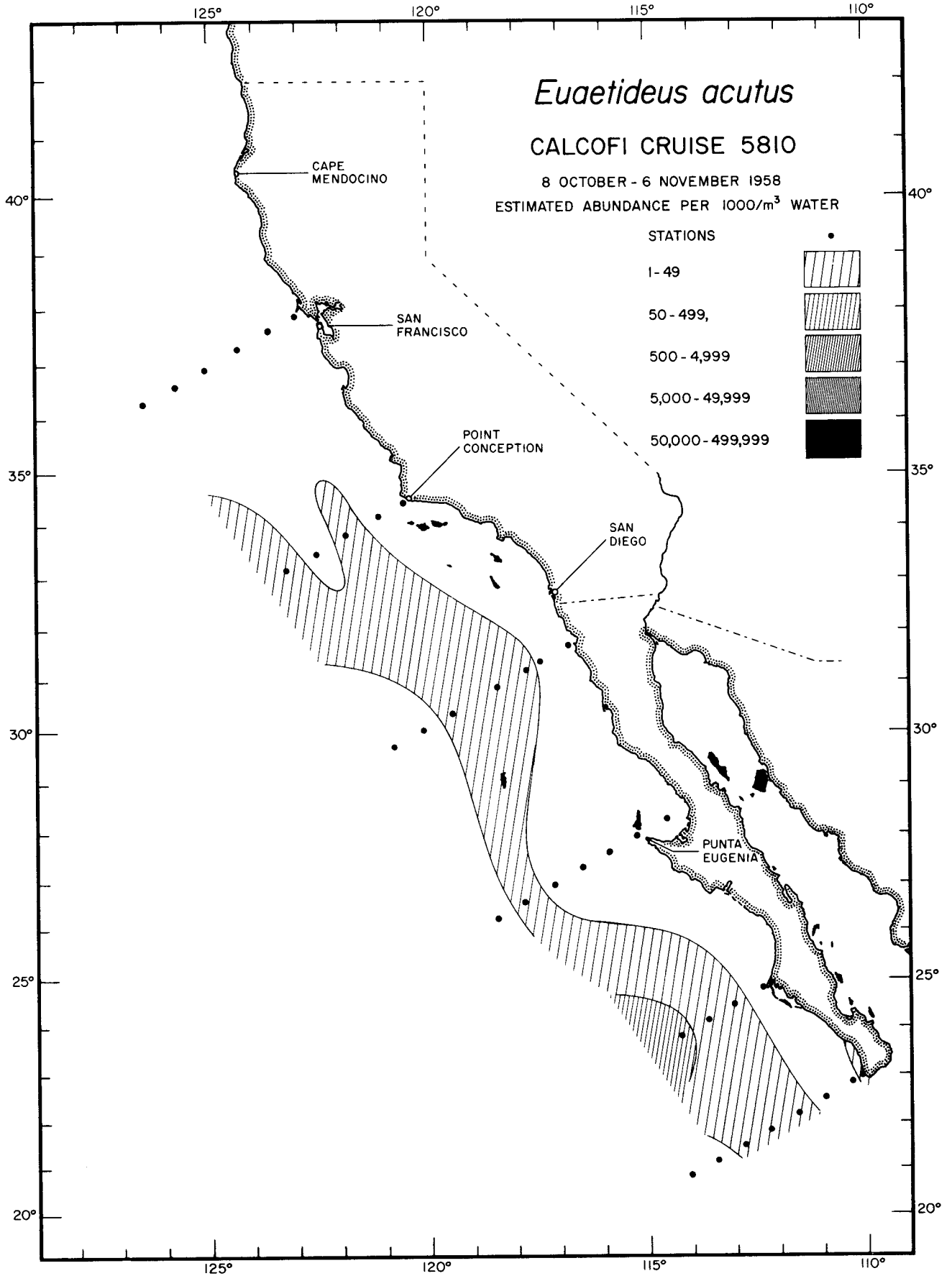
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Ctenocalanus vanus
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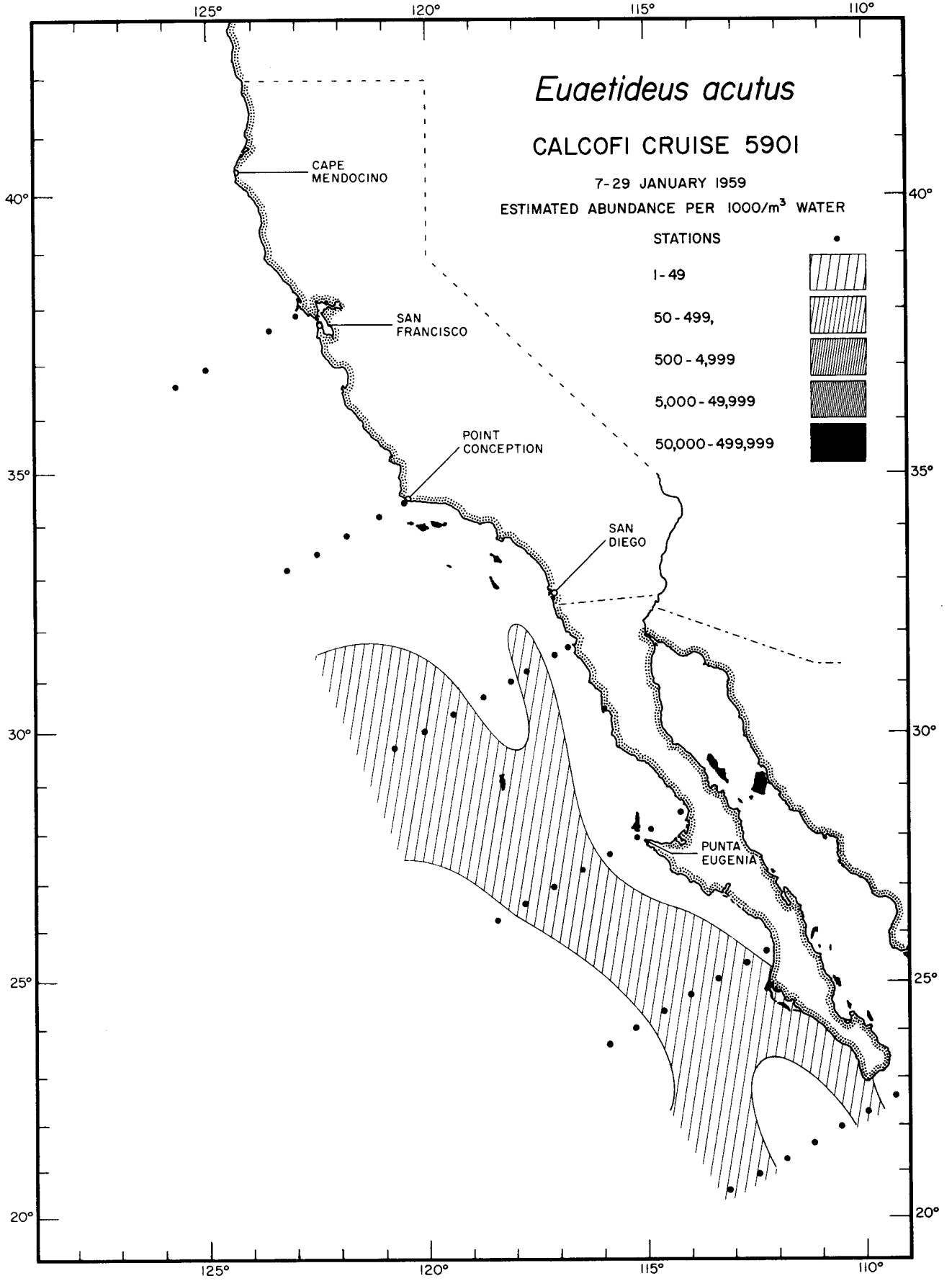
Calanoida
Euaetideus acutus
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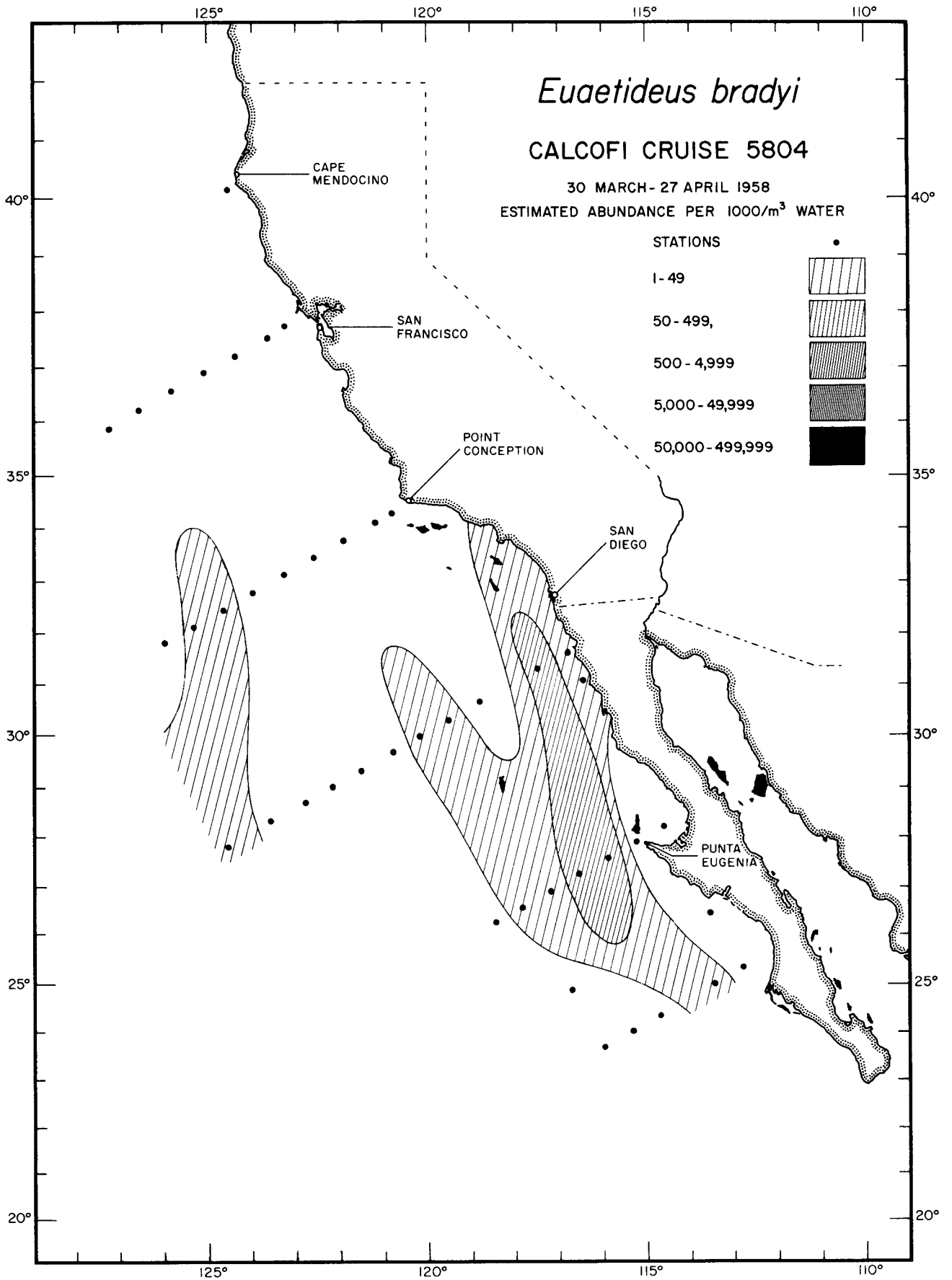
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Euaetideus acutus
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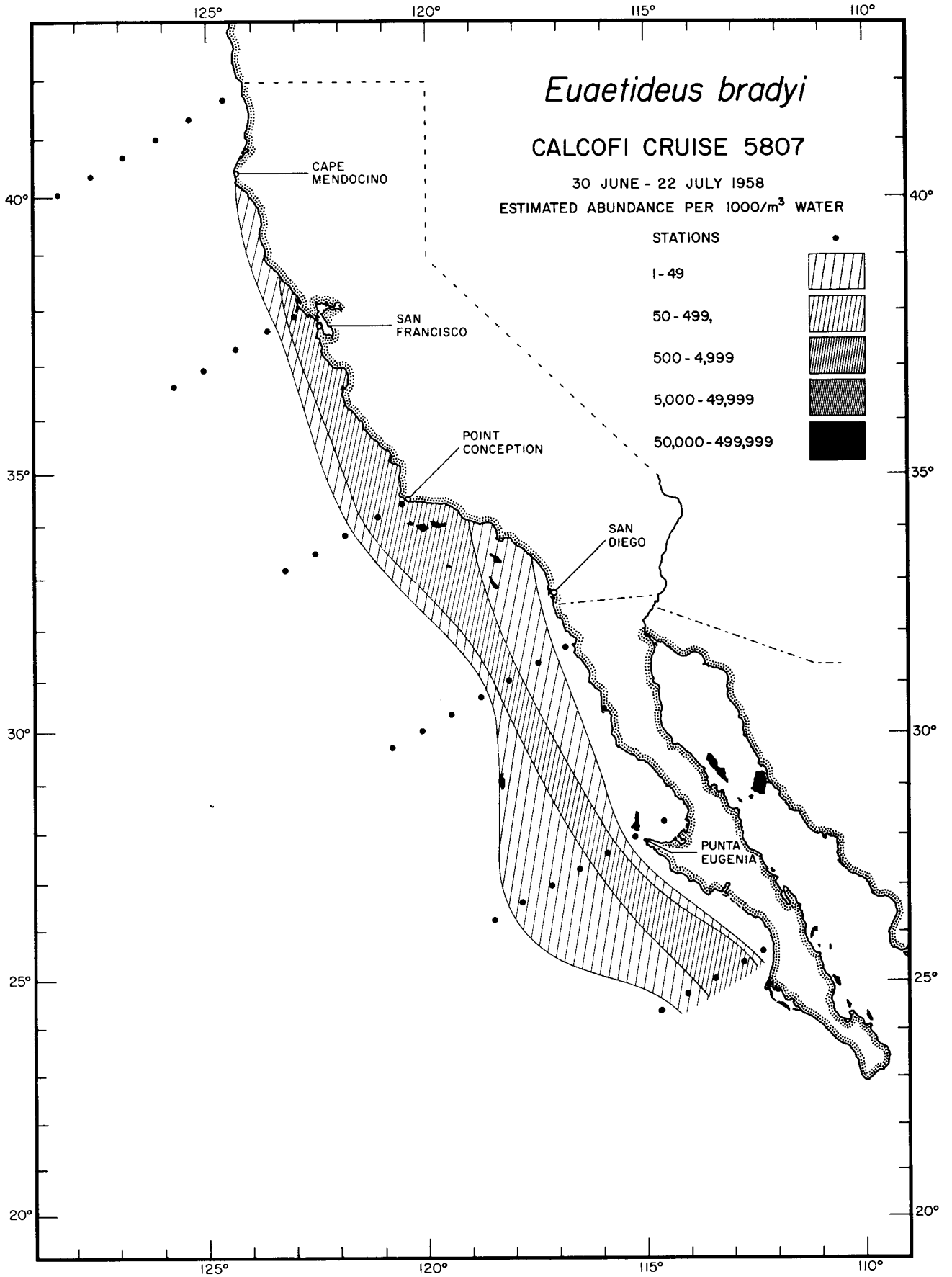


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Euaetideus acutus
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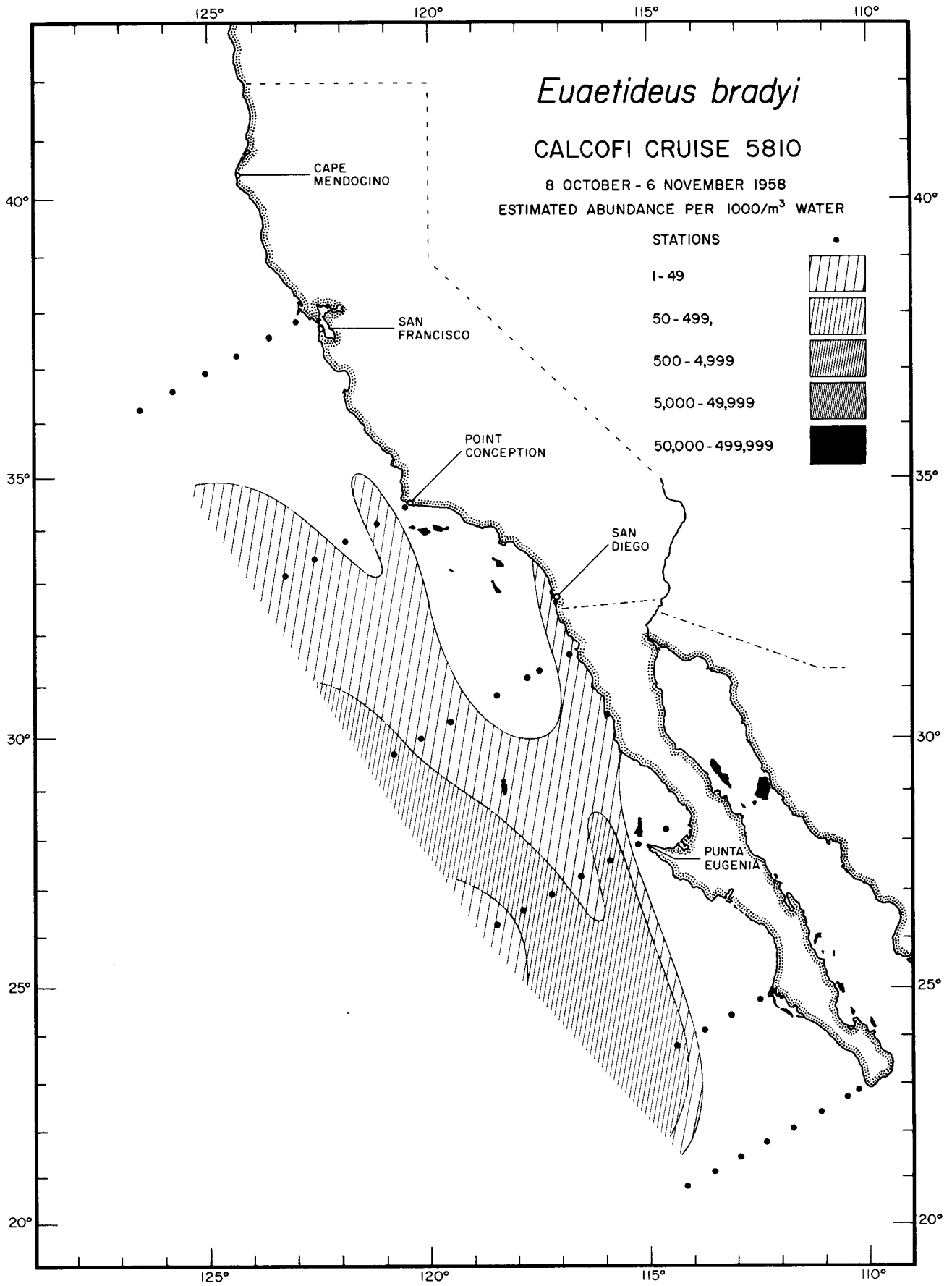


Calanoida
Euaetideus acutus
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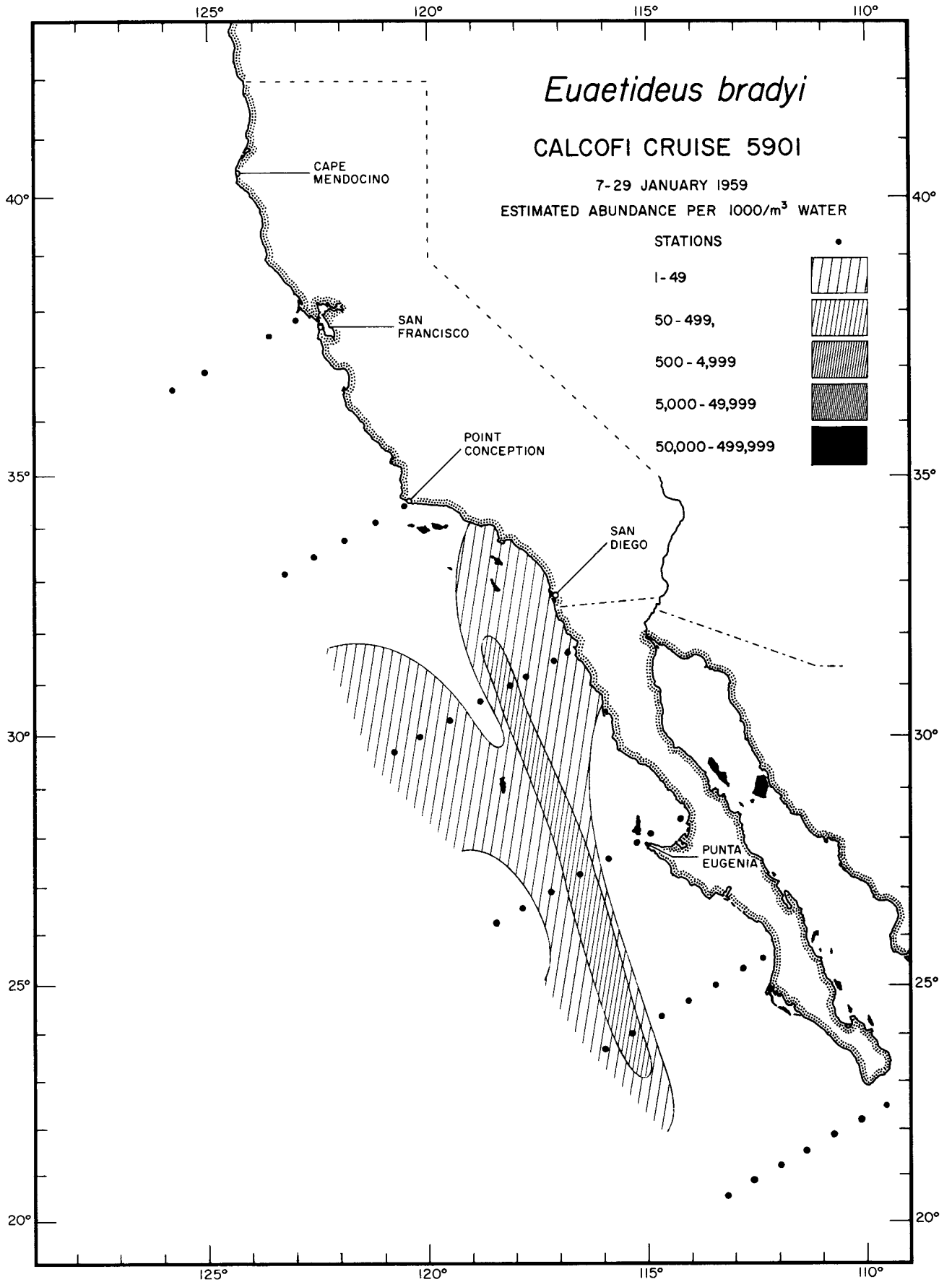




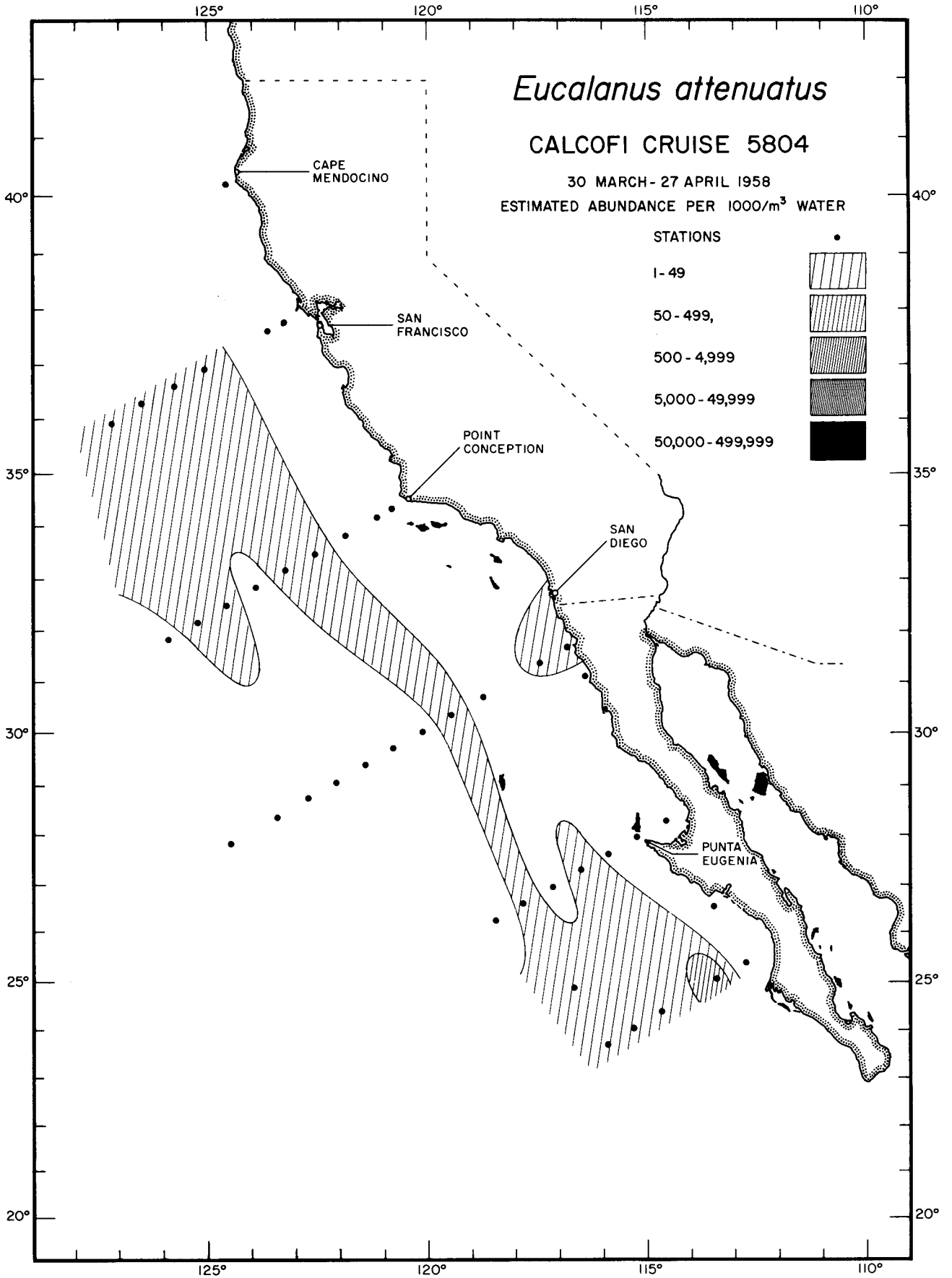
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Euaetideus bradyi
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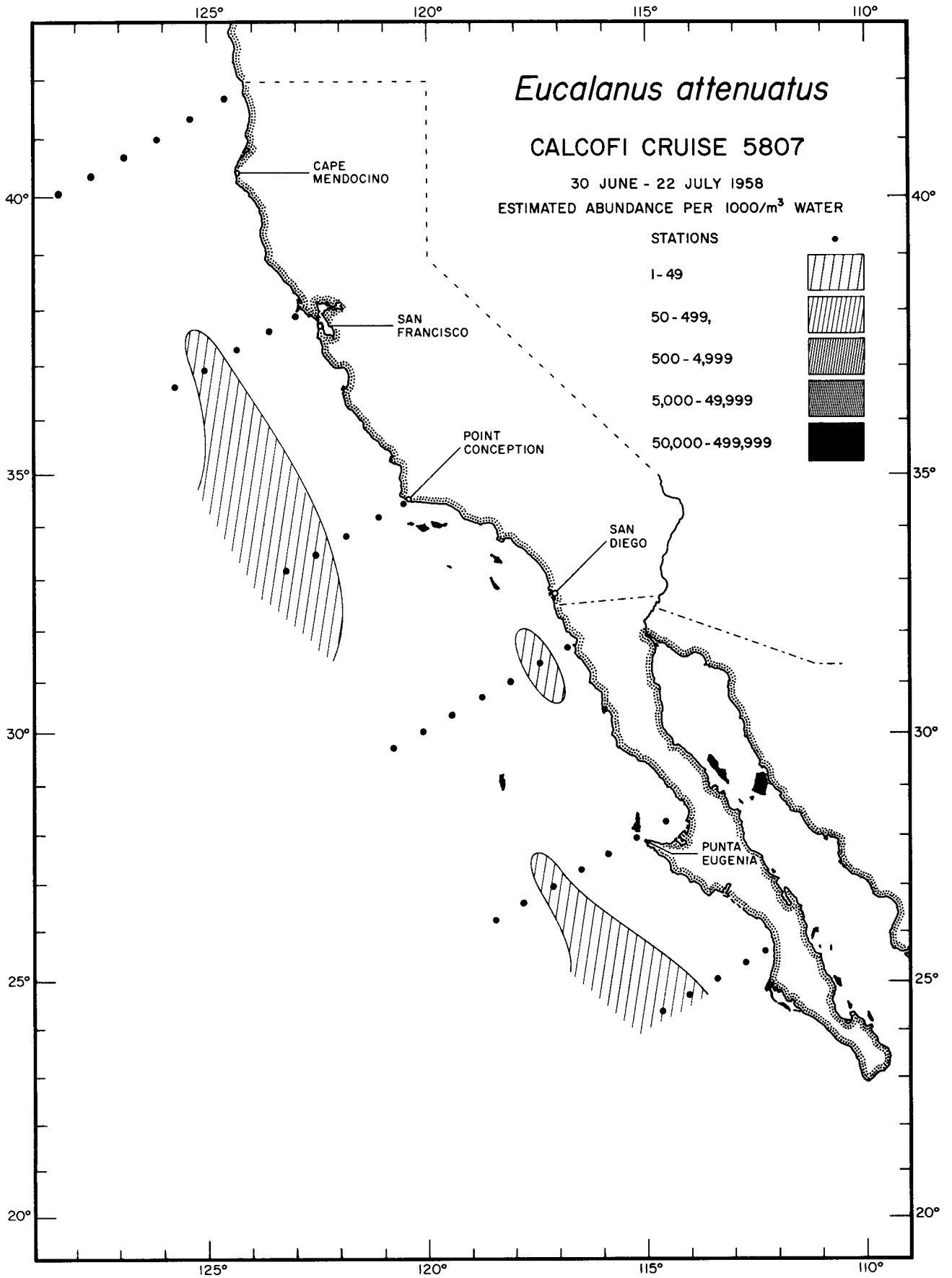
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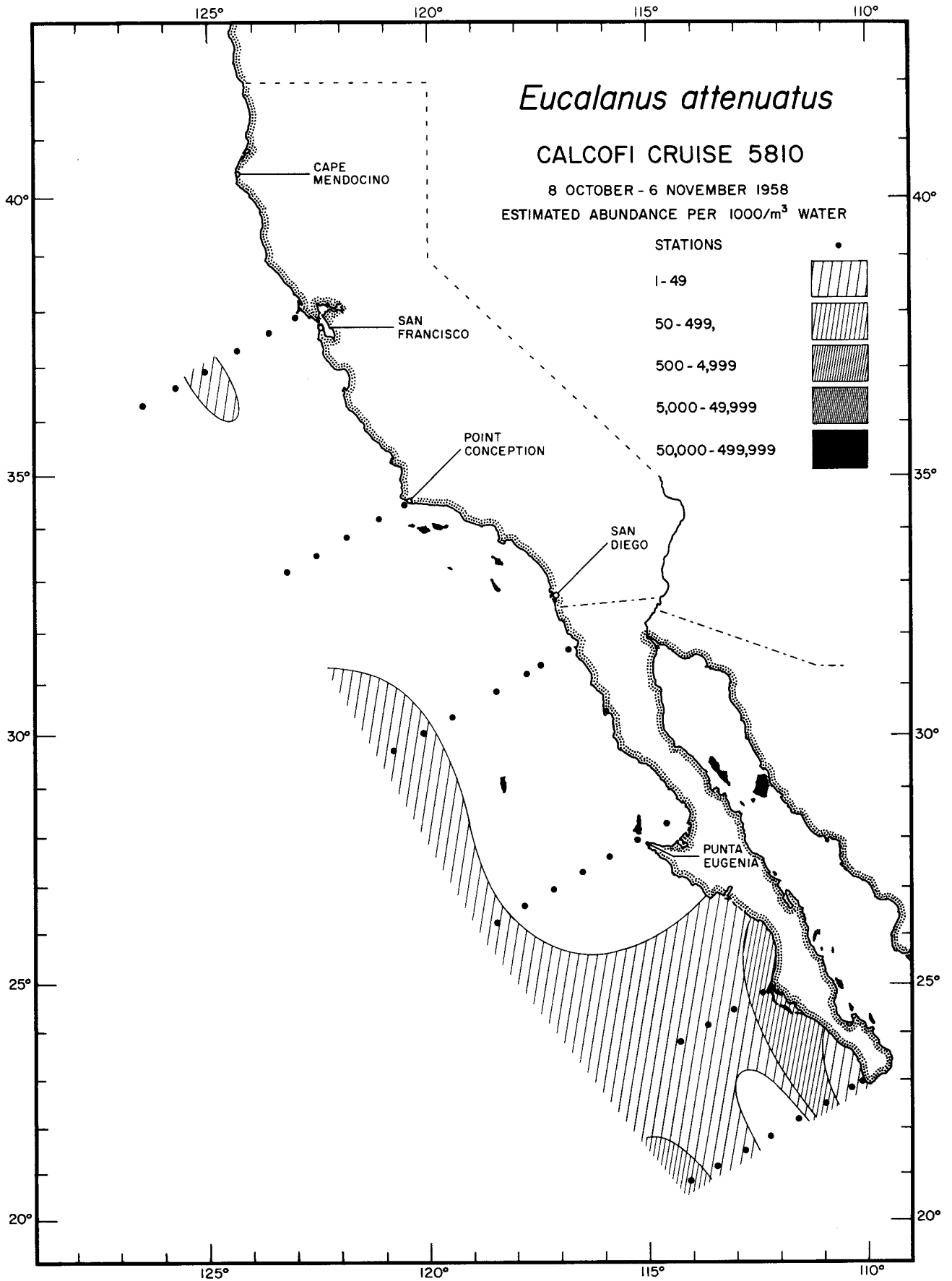
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Euaetideus bradyi
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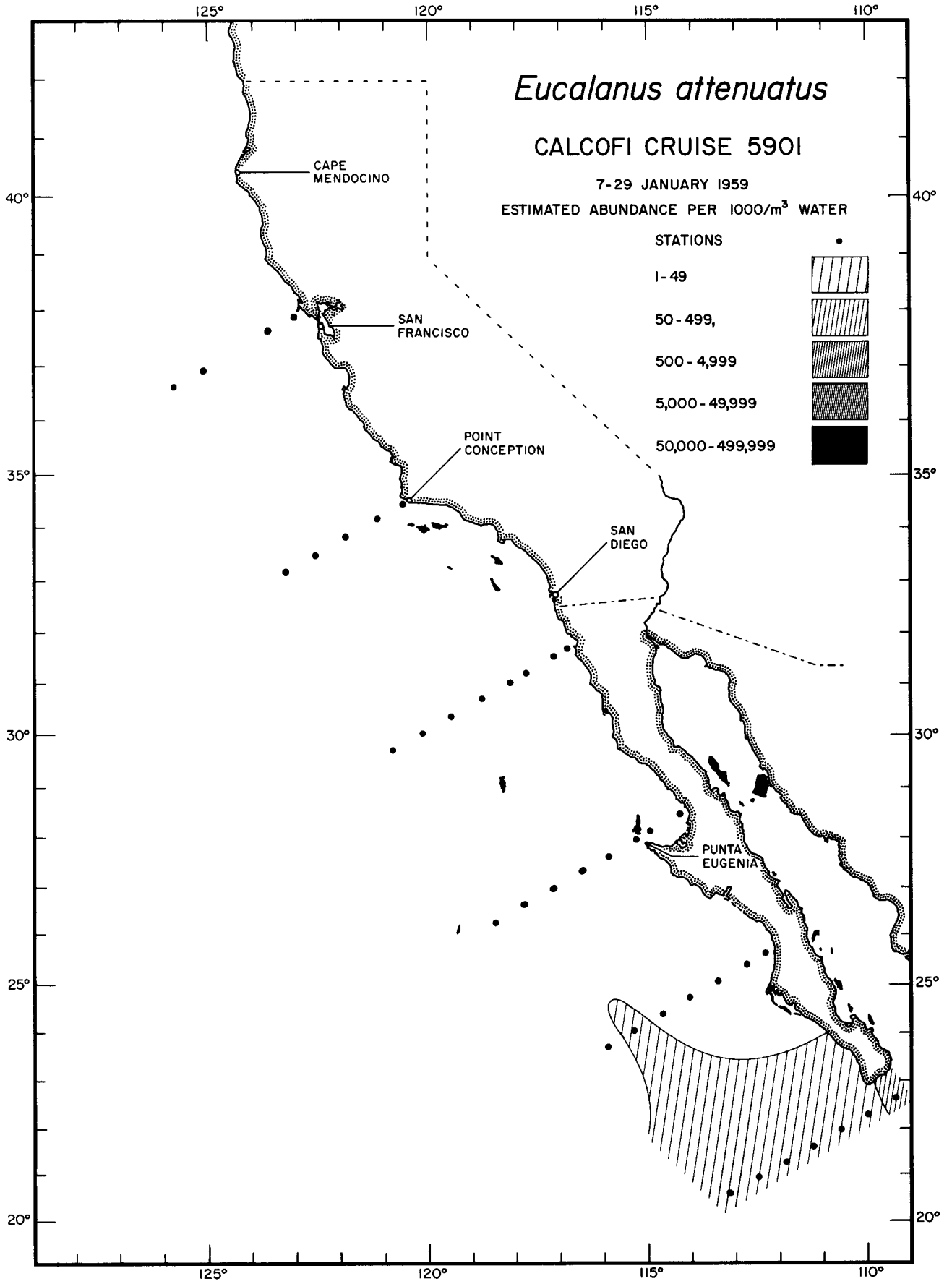
Calanoida
Eucalanus attenuatus
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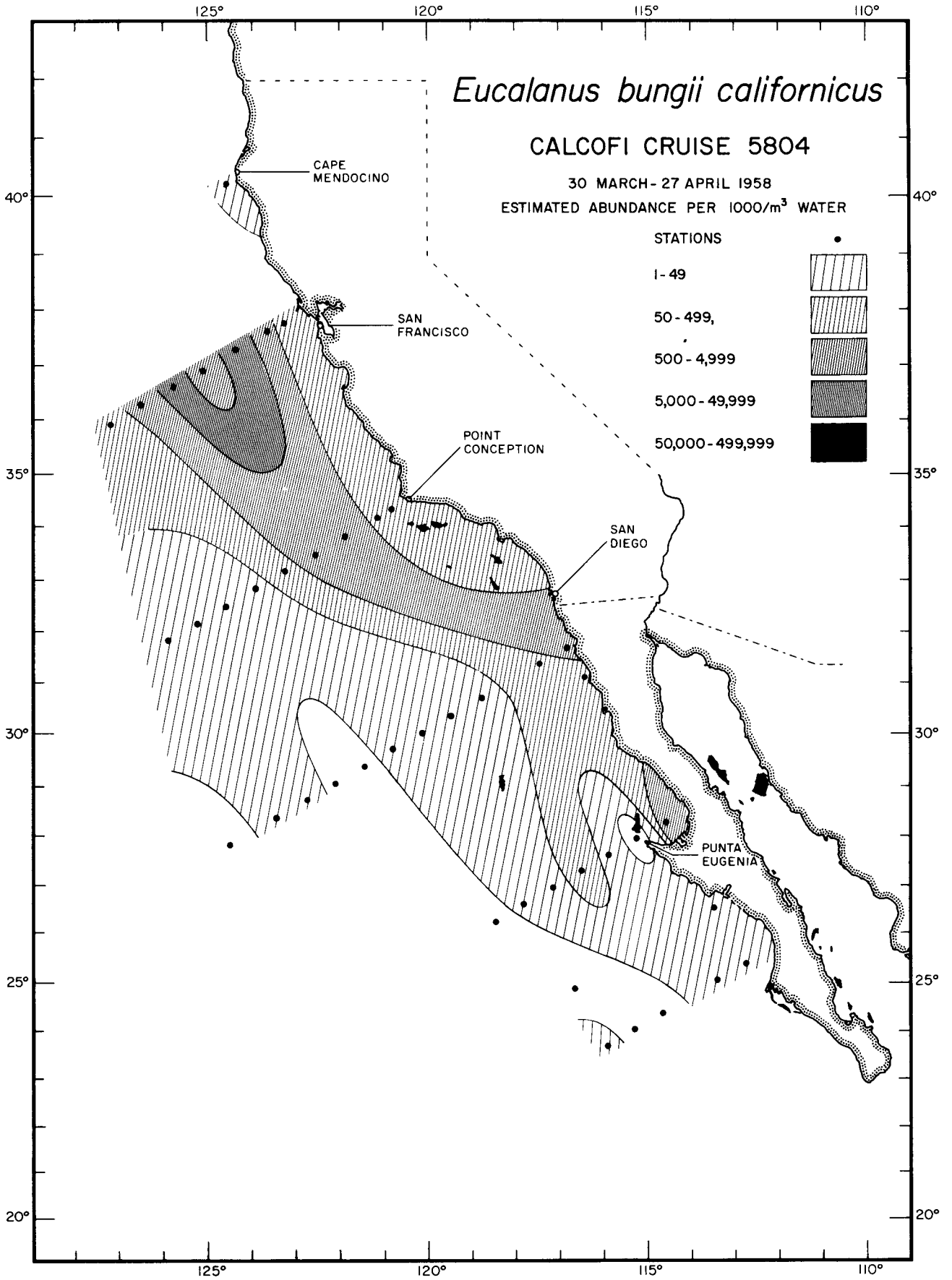
Calanoida
Eucalanus attenuatus
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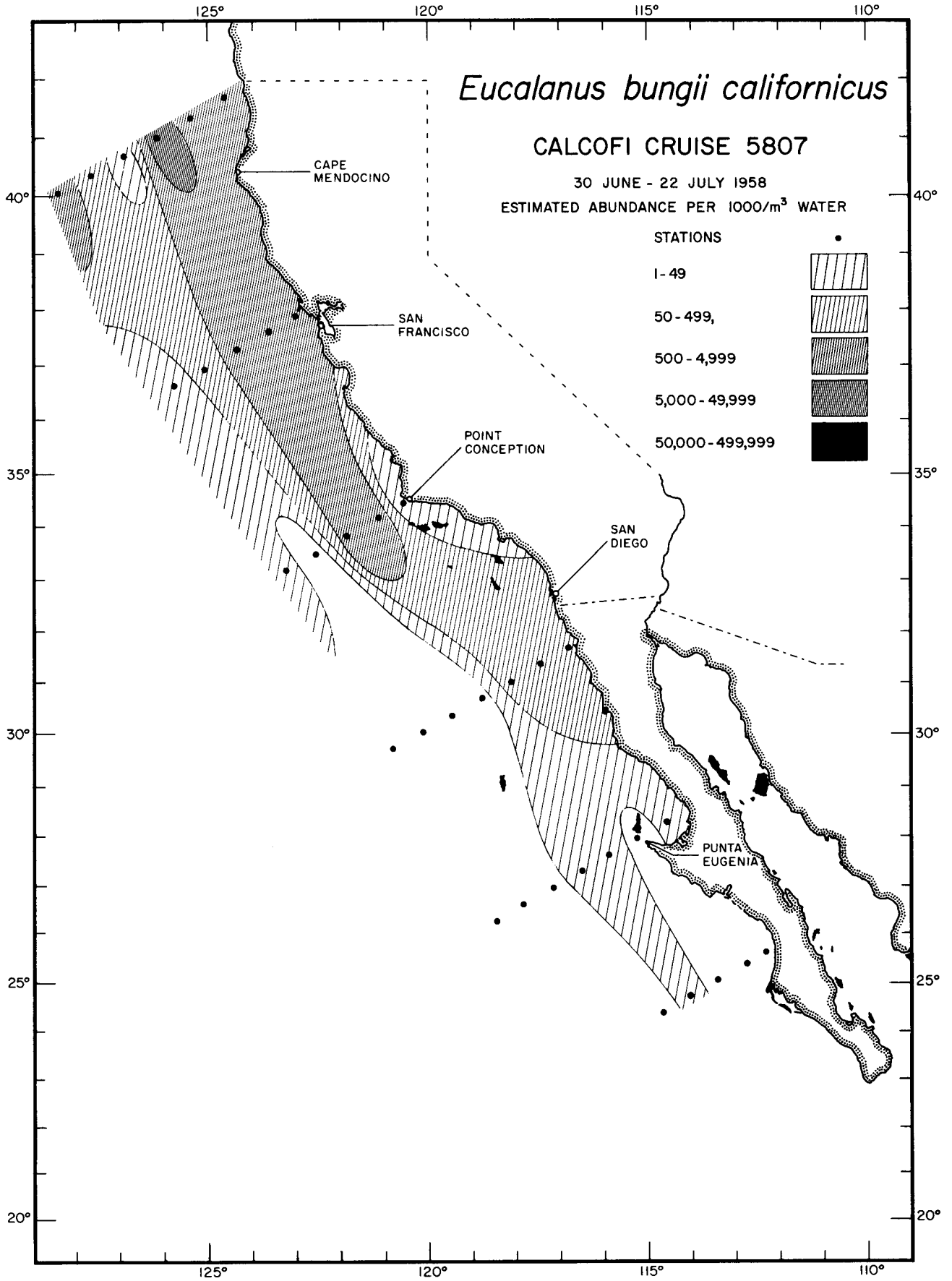


Calanoida
Eucalanus attenuatus
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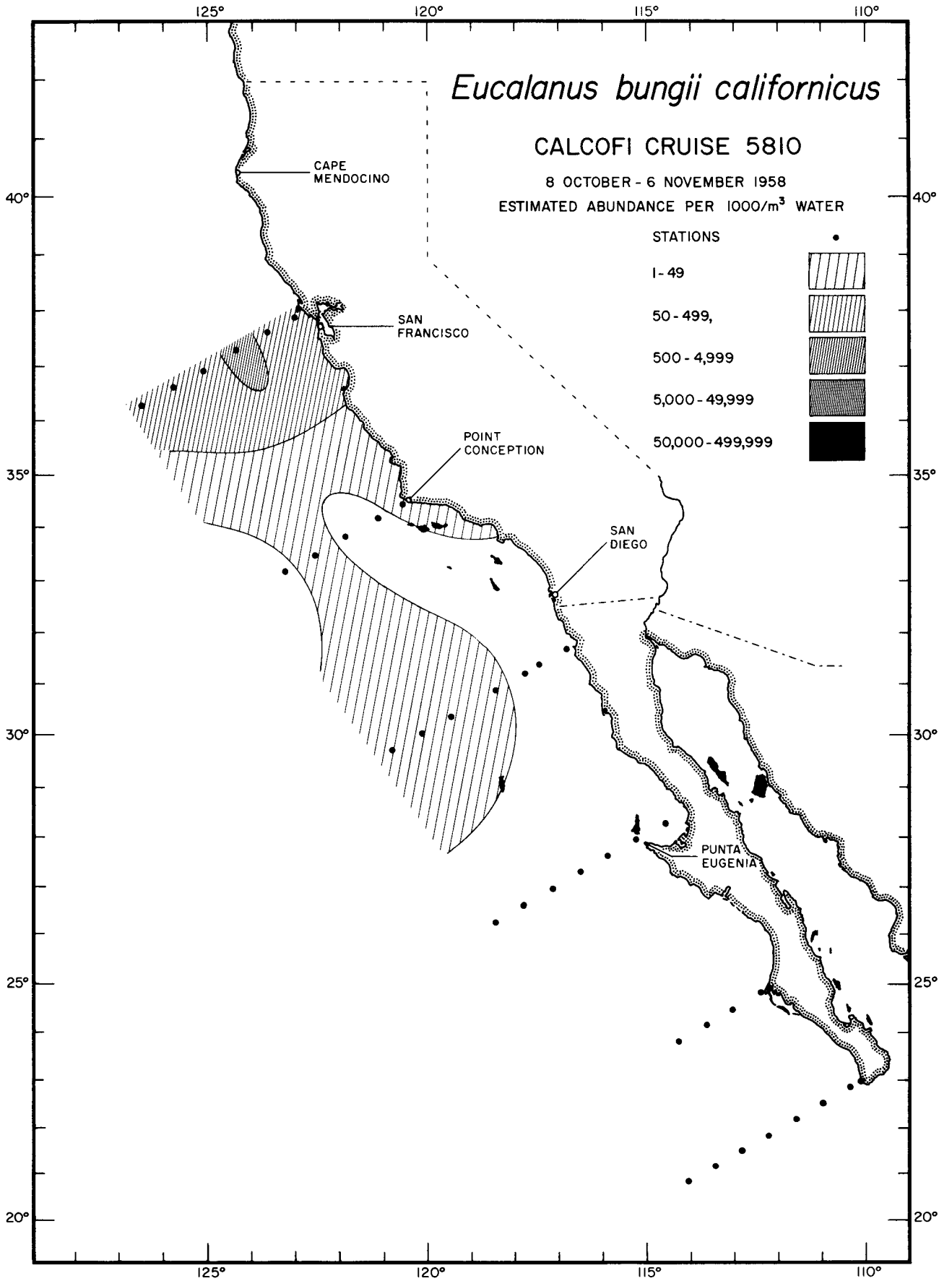


Calanoida
Eucalanus attenuatus
5901

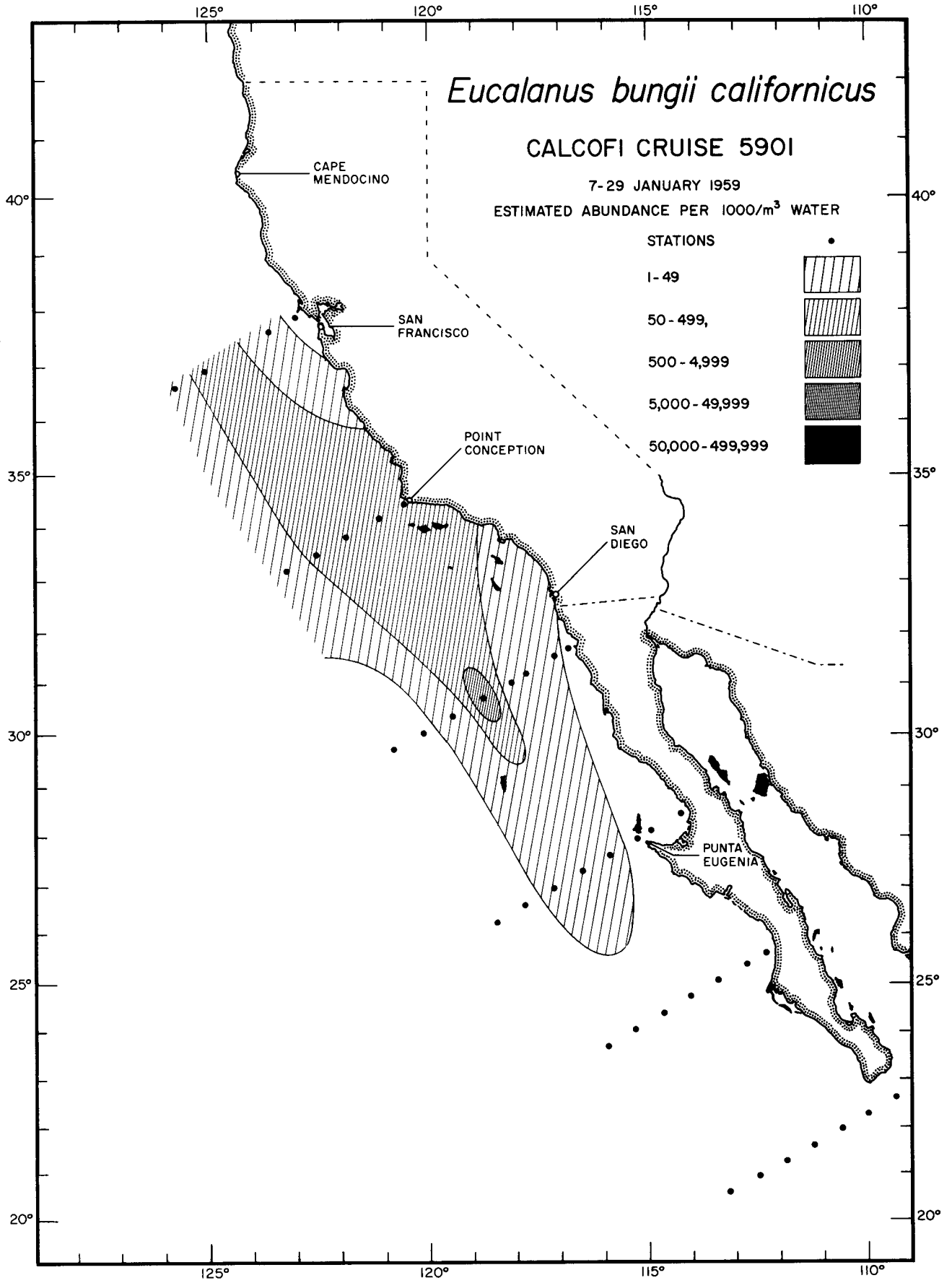




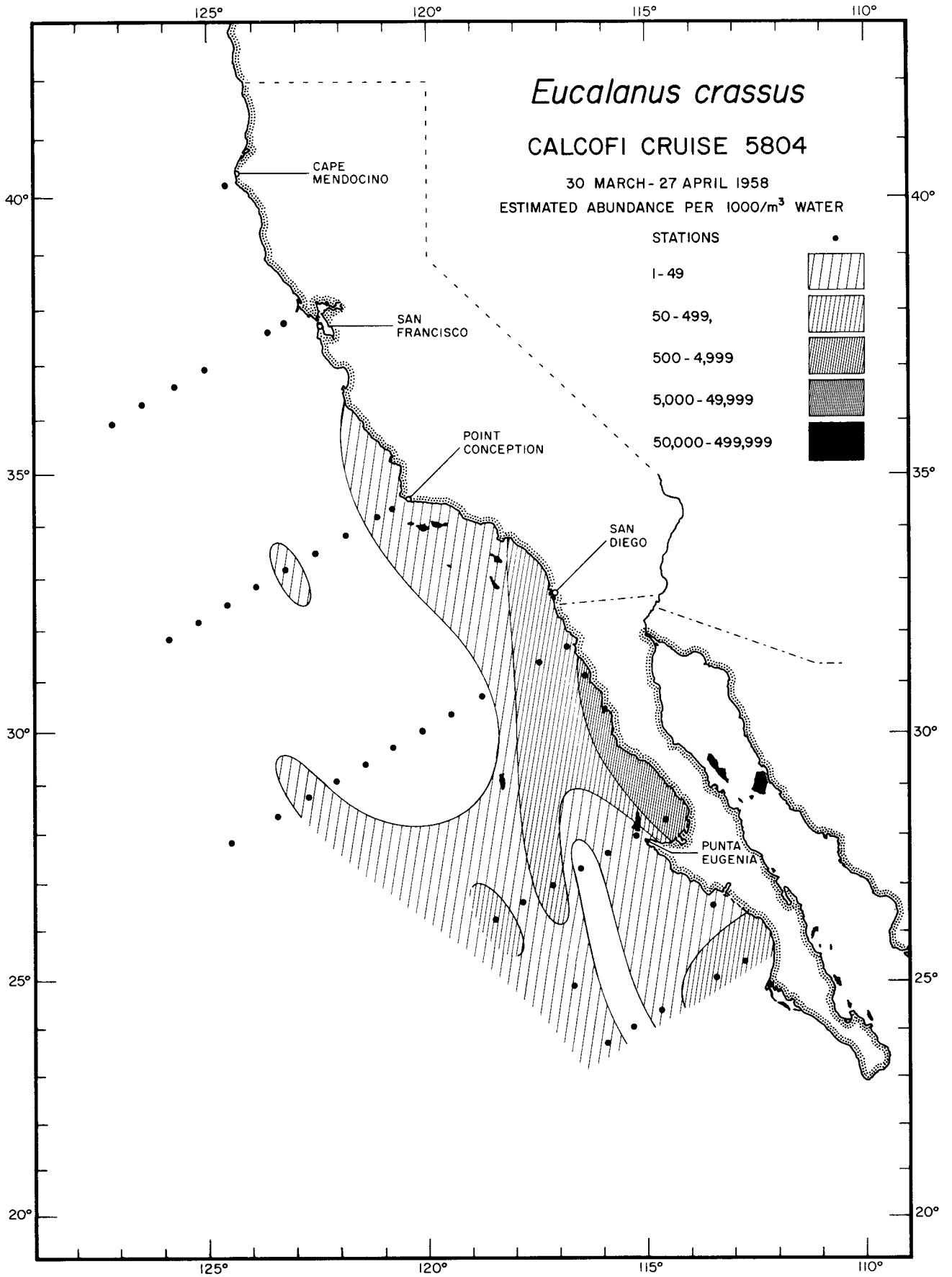
Calanoida
Eucalanus bungii californicus
5807



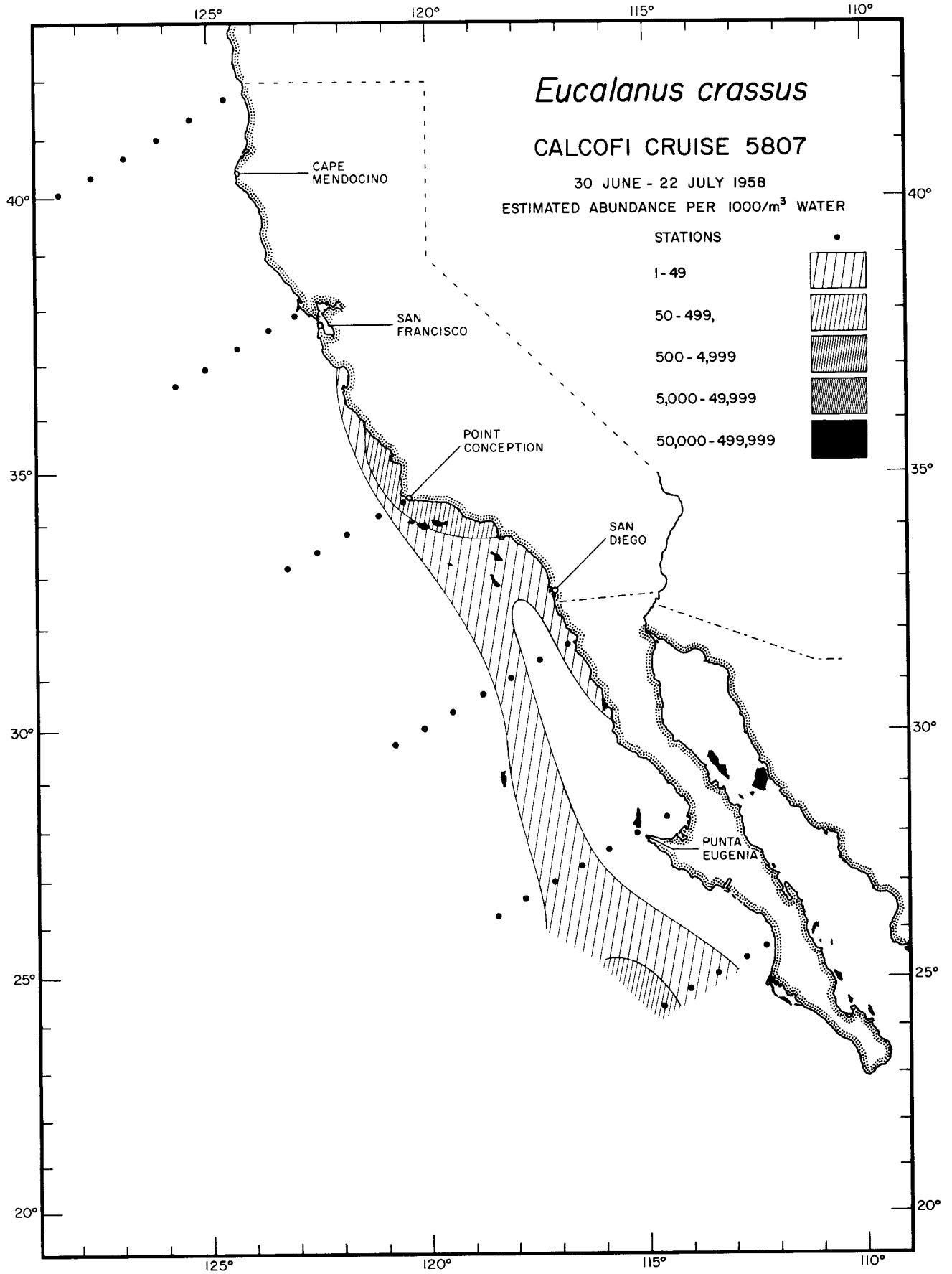
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Eucalanus bungii californicus
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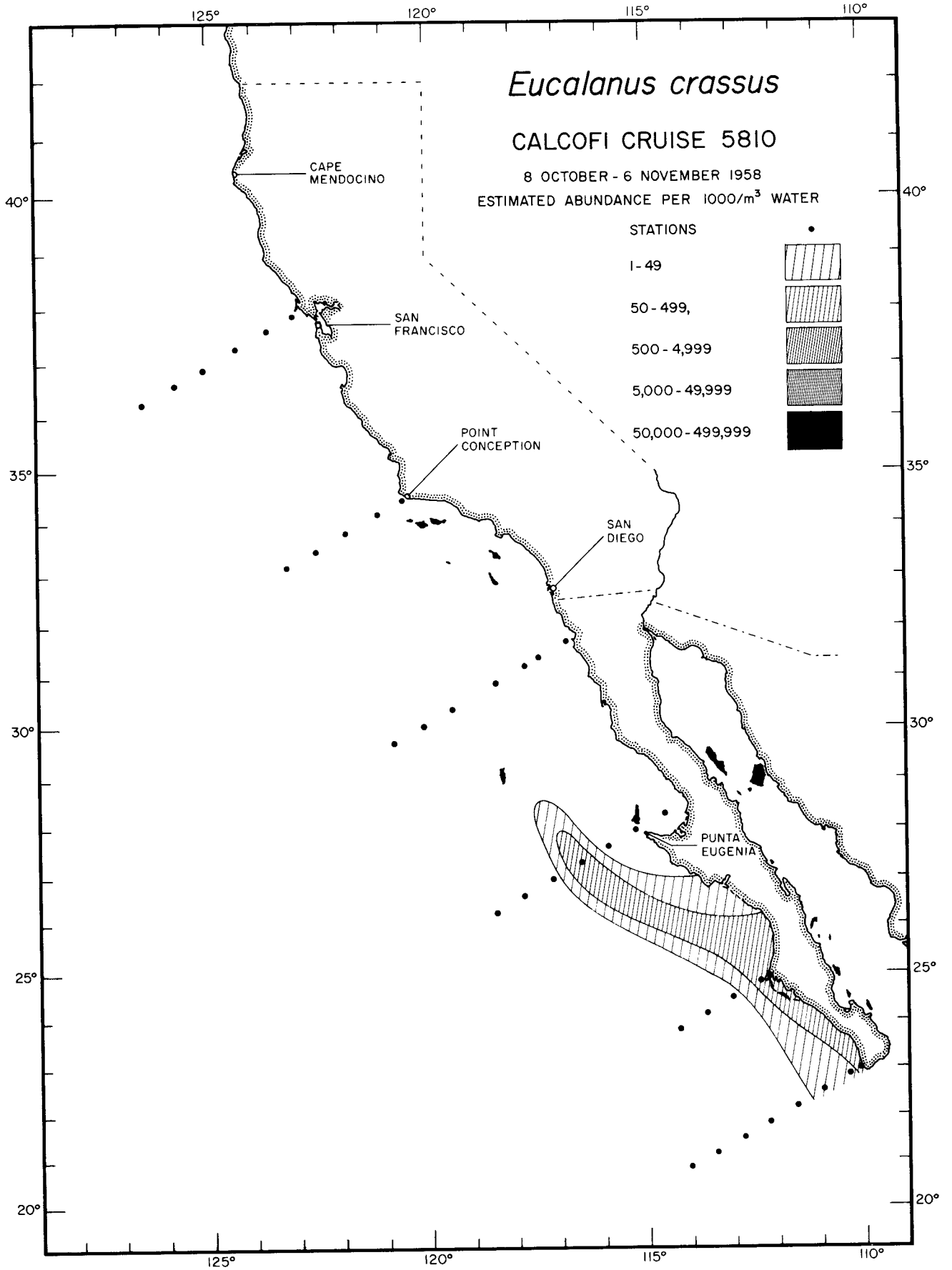
Calanoida
Eucalanus bungii californicus
5901



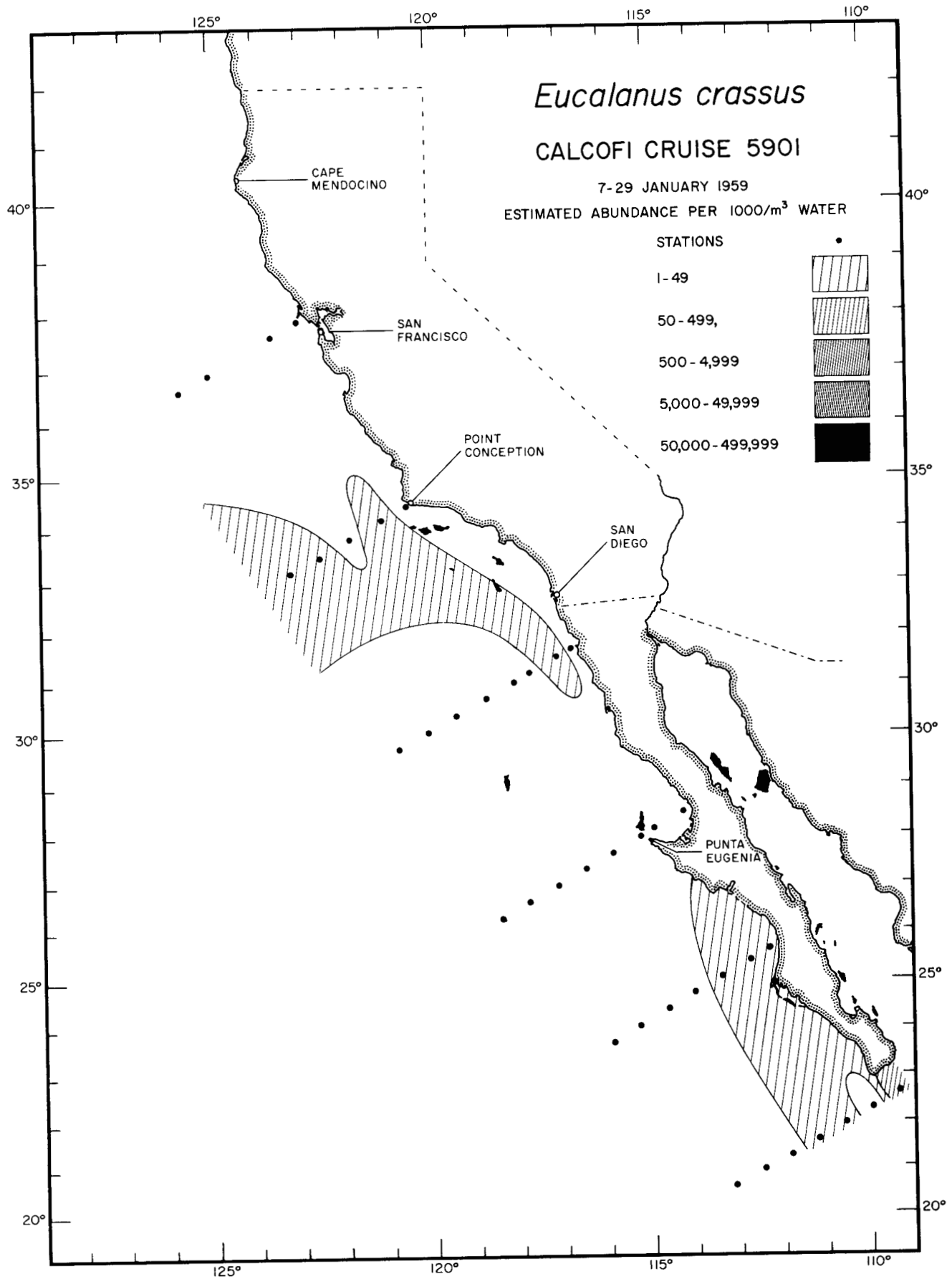
Calanoida
Eucalanus crassus
5804



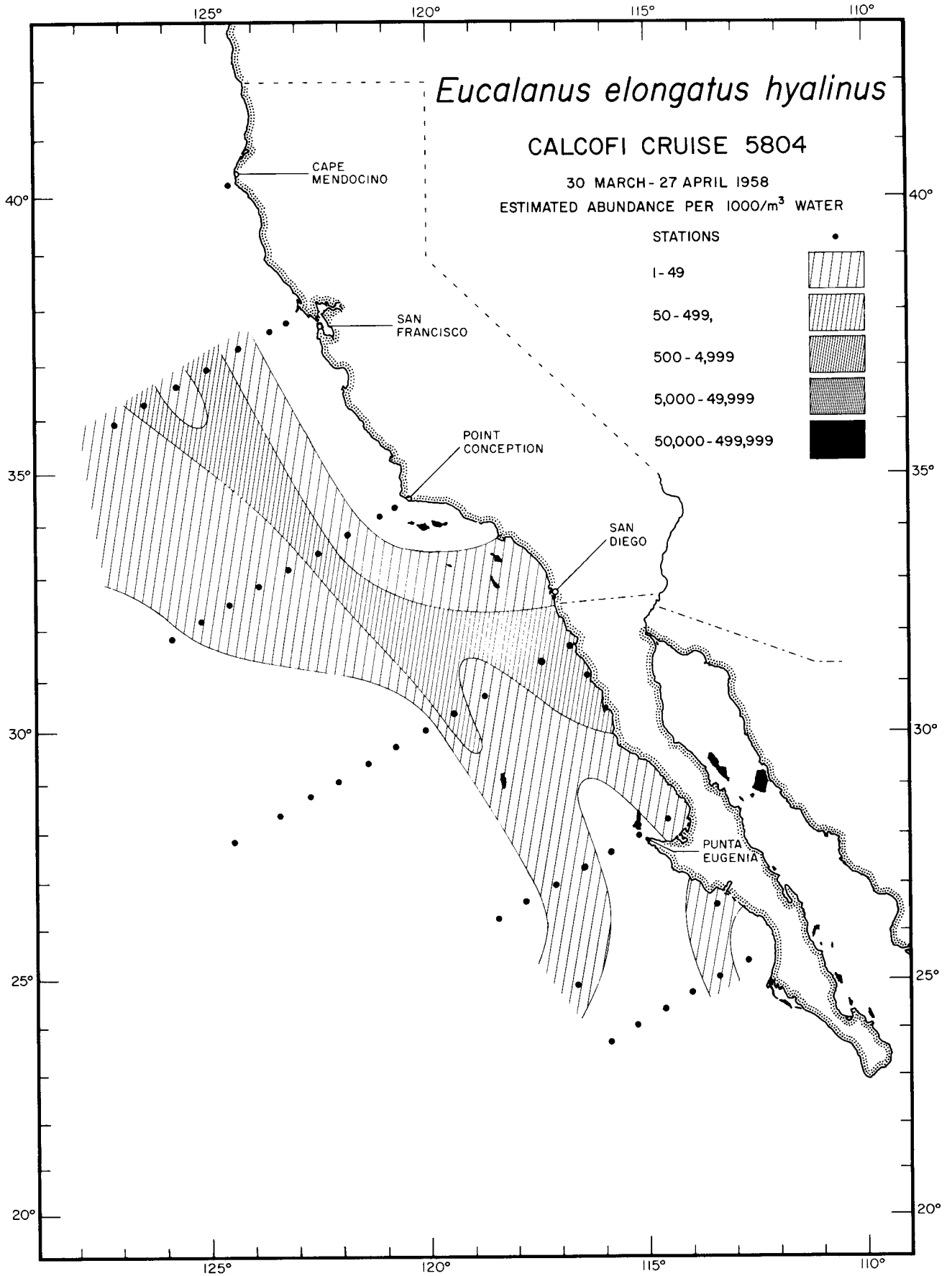
Calanoida
Eucalanus crassus
5807



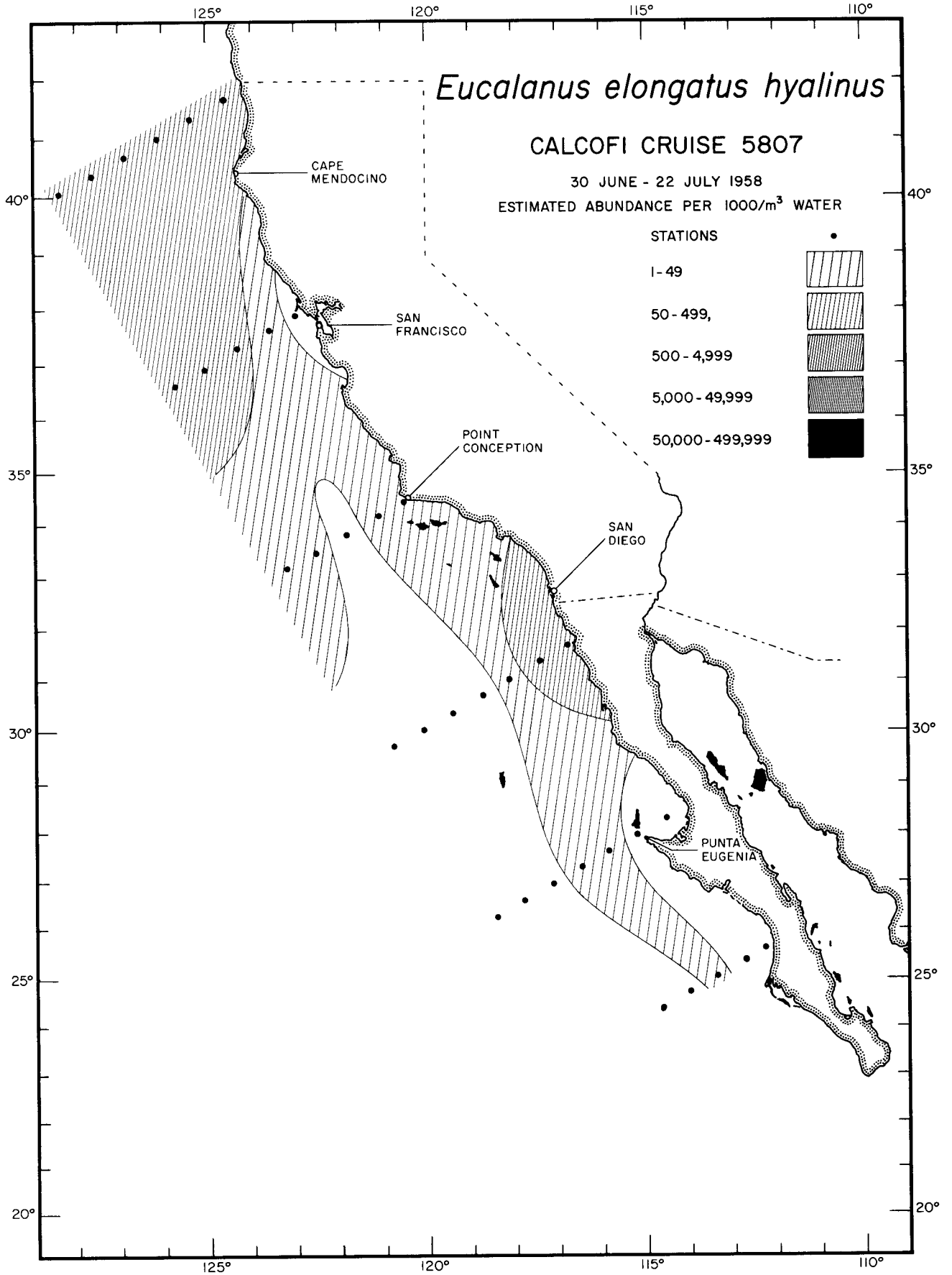
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Eucalanus crassus
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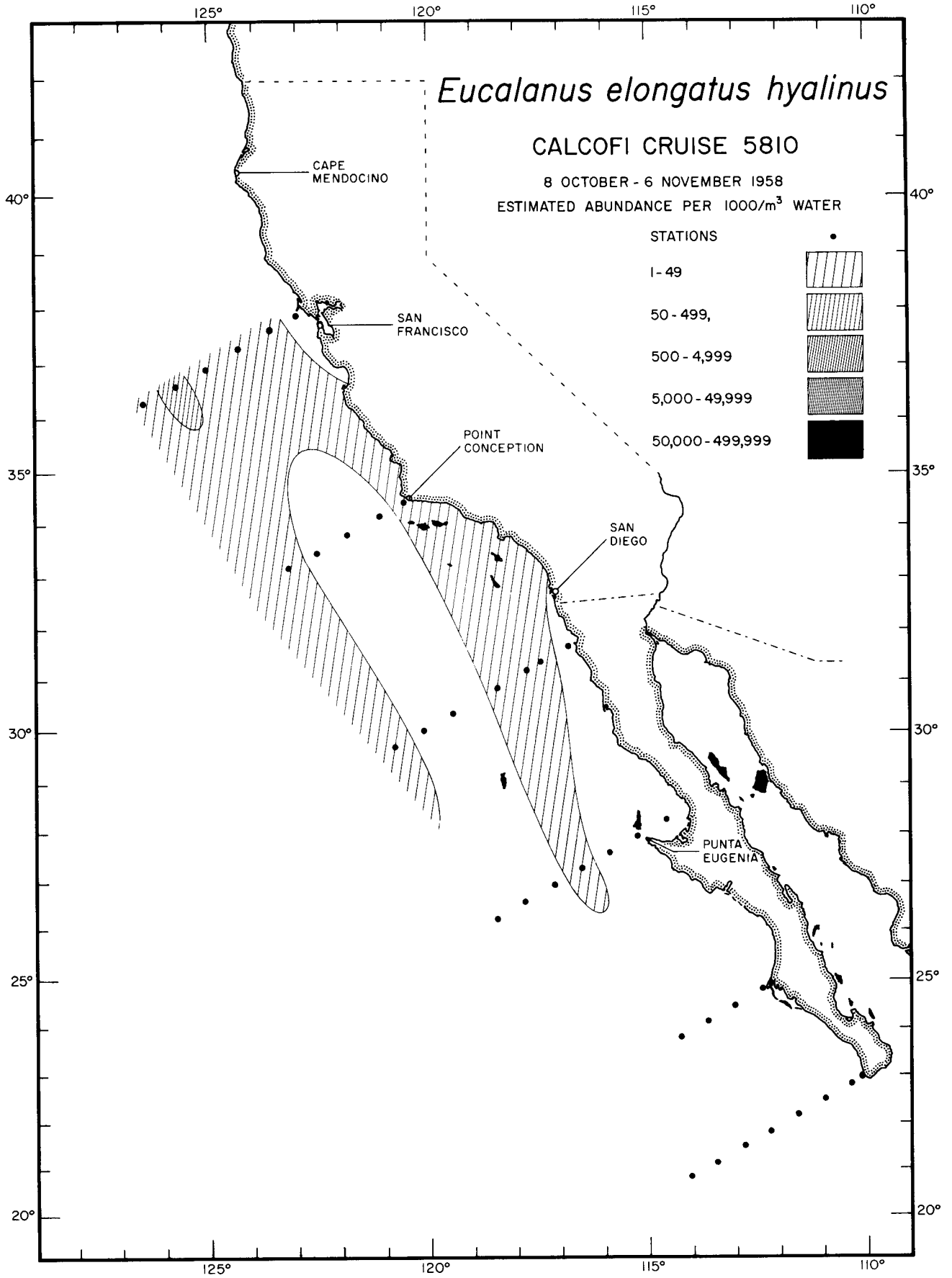
Calanoida
Eucalanus crassus
5901



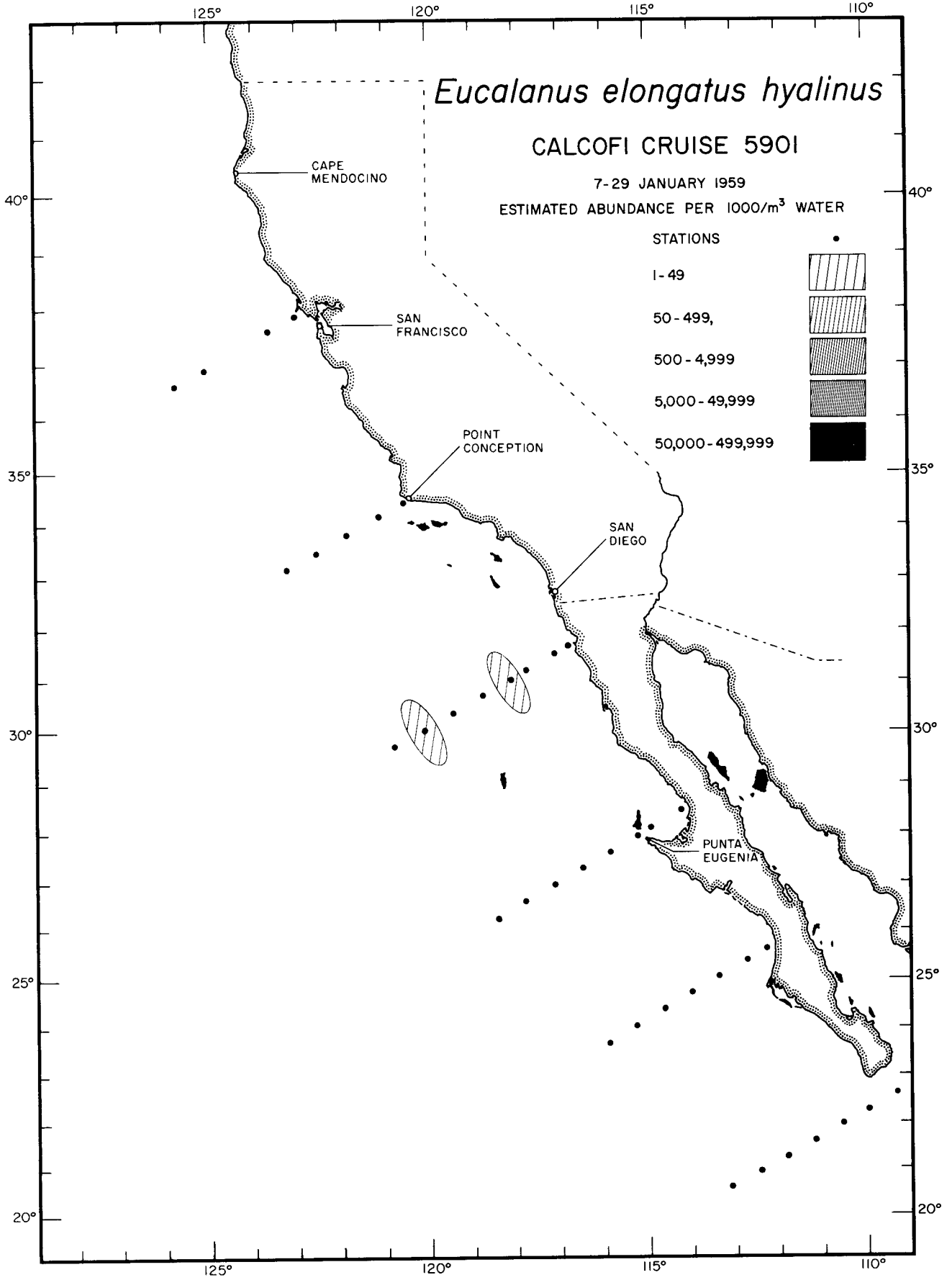
Calanoida
Eucalanus elongatus hyalinus
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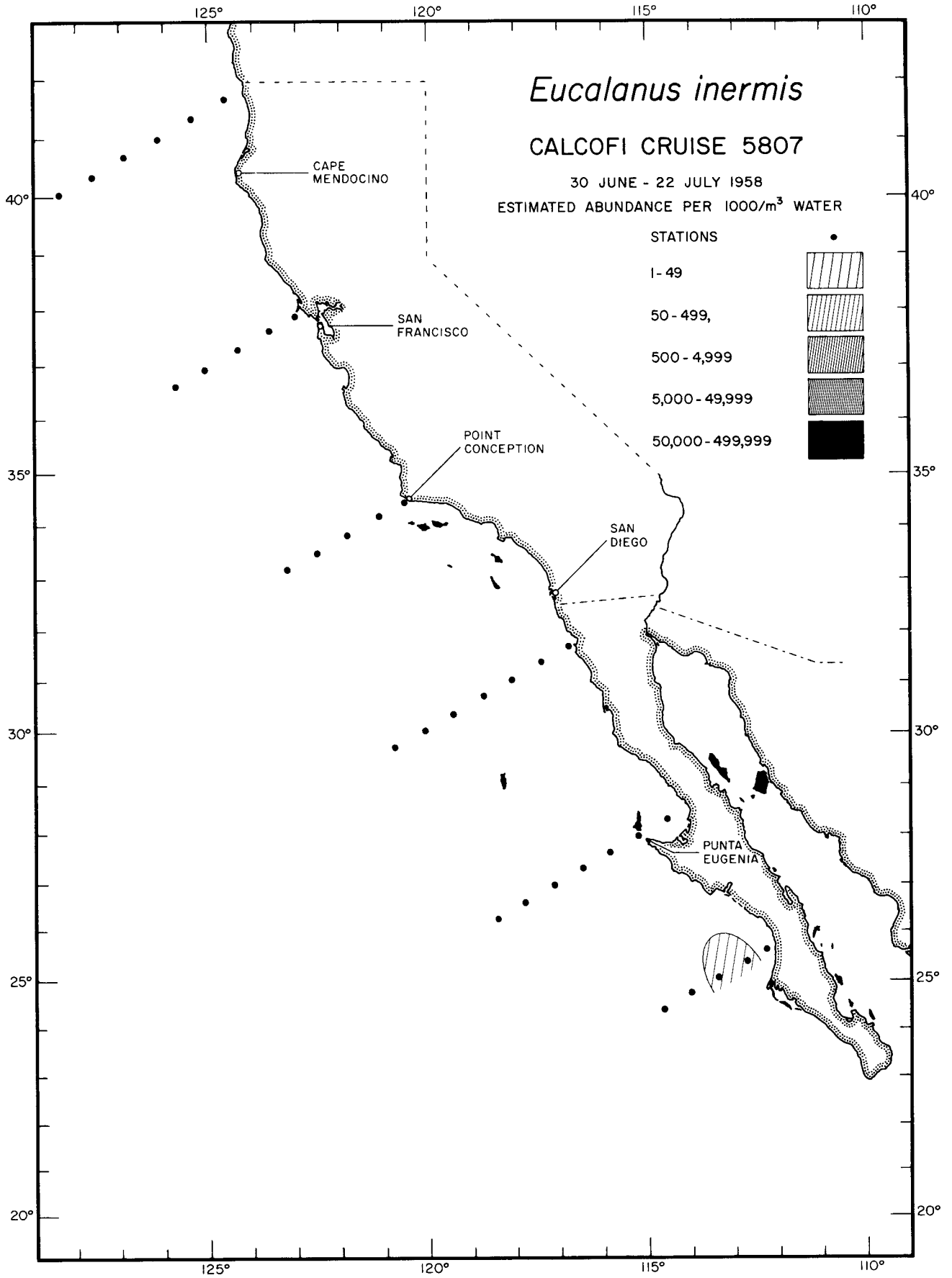
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Eucalanus elongatus hyalinus
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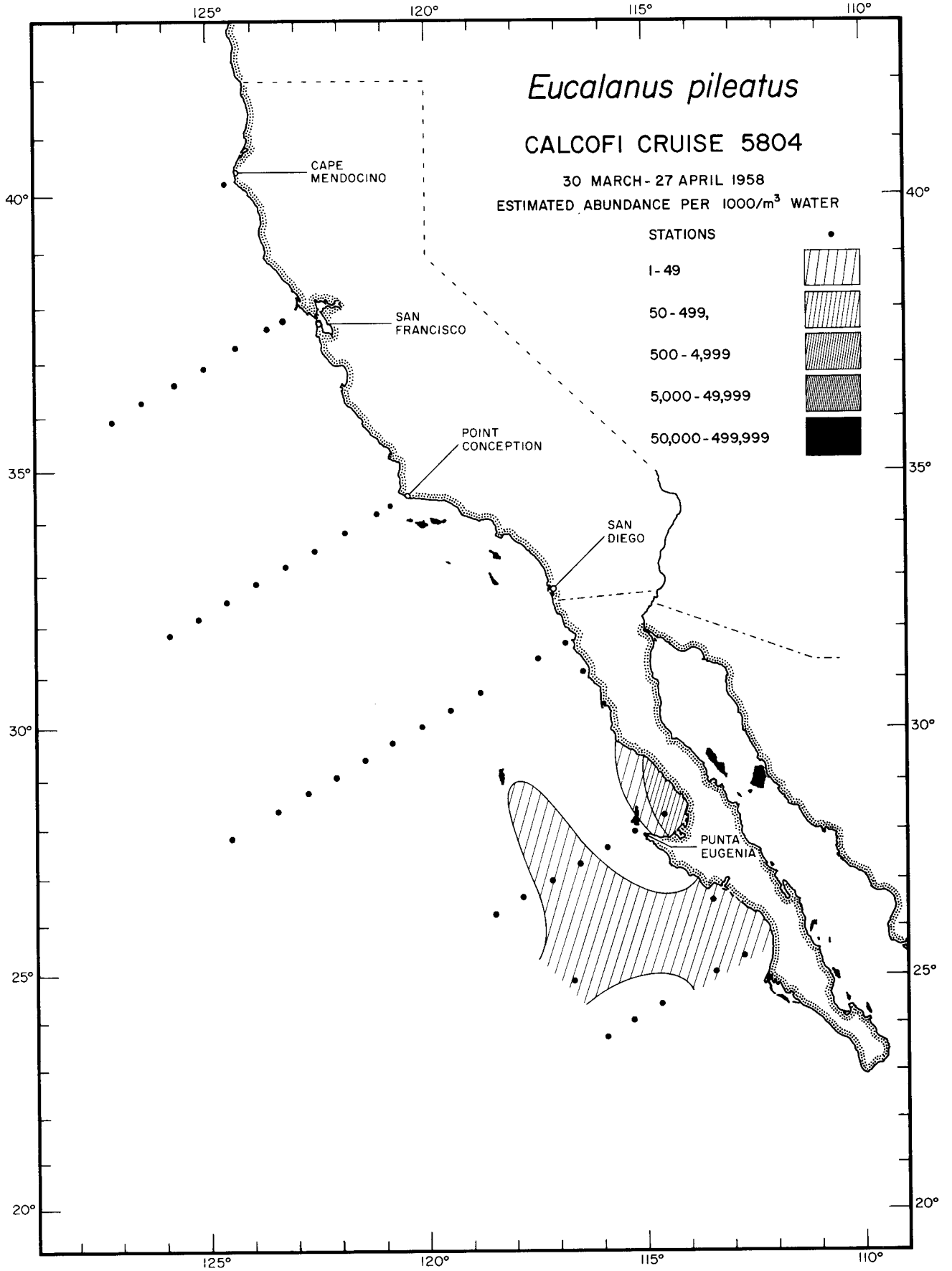
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Eucalanus elongatus hyalinus
5810

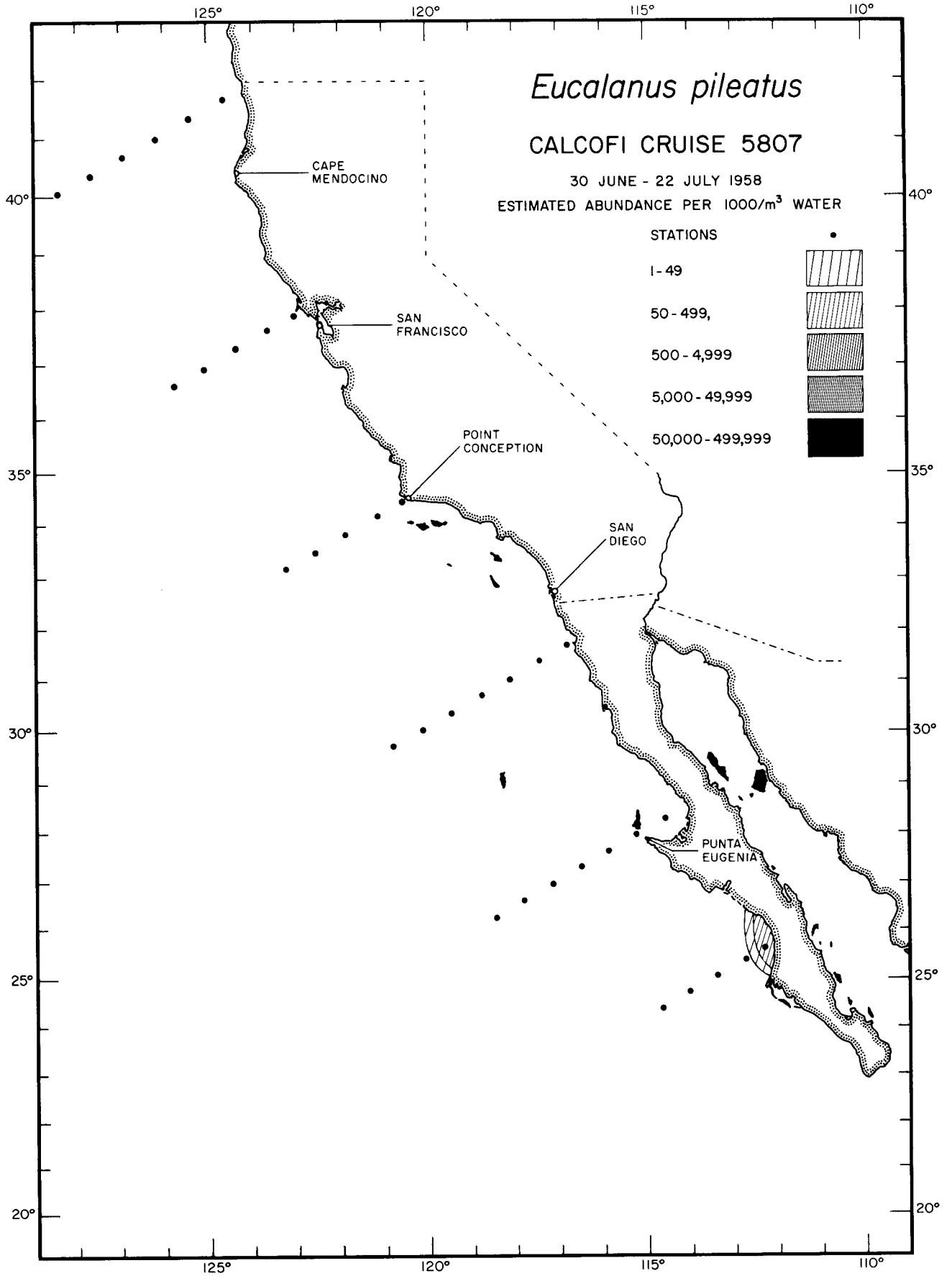


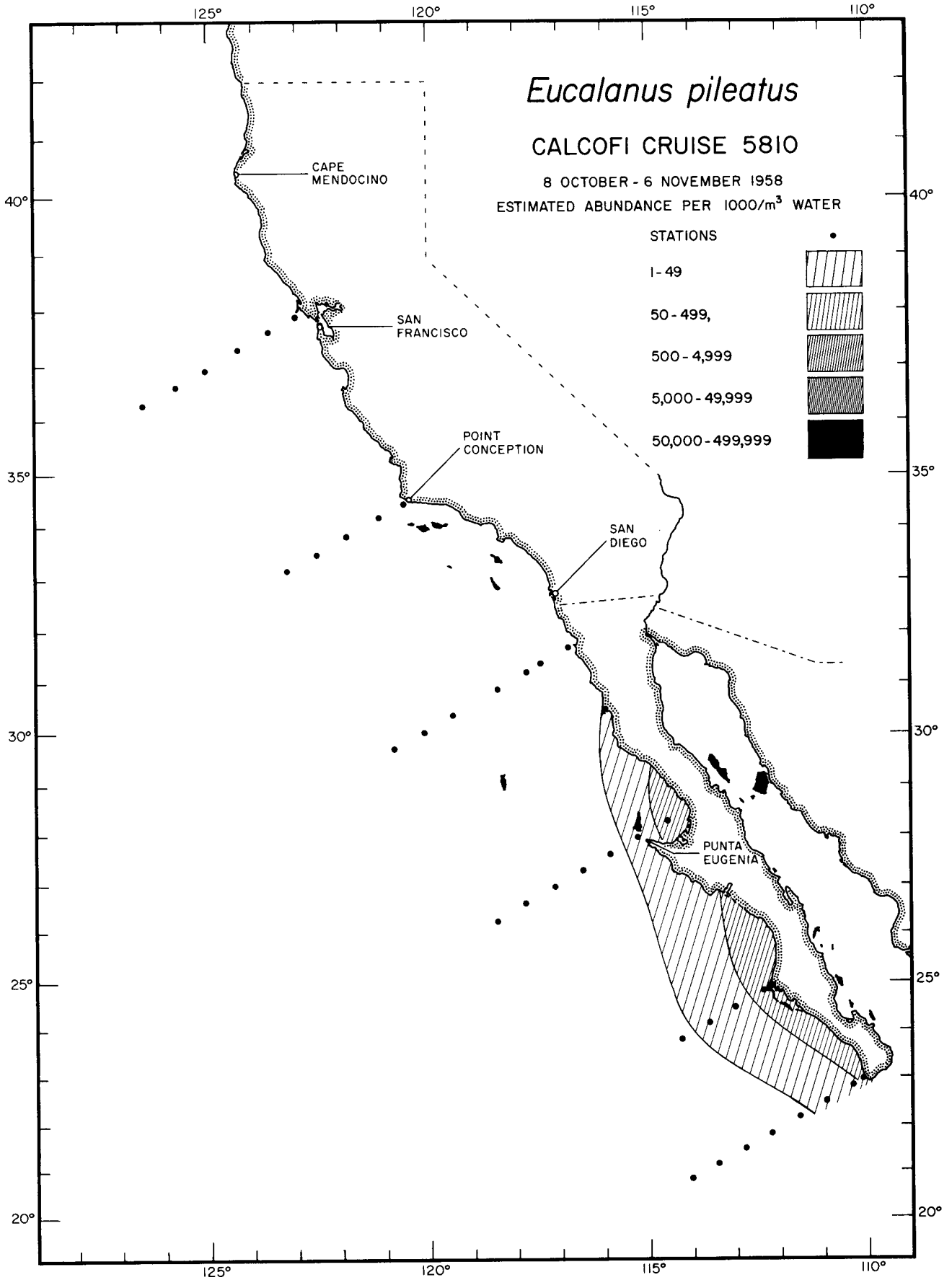
Calanoida
Eucalanus elongatus hyalinus
5901



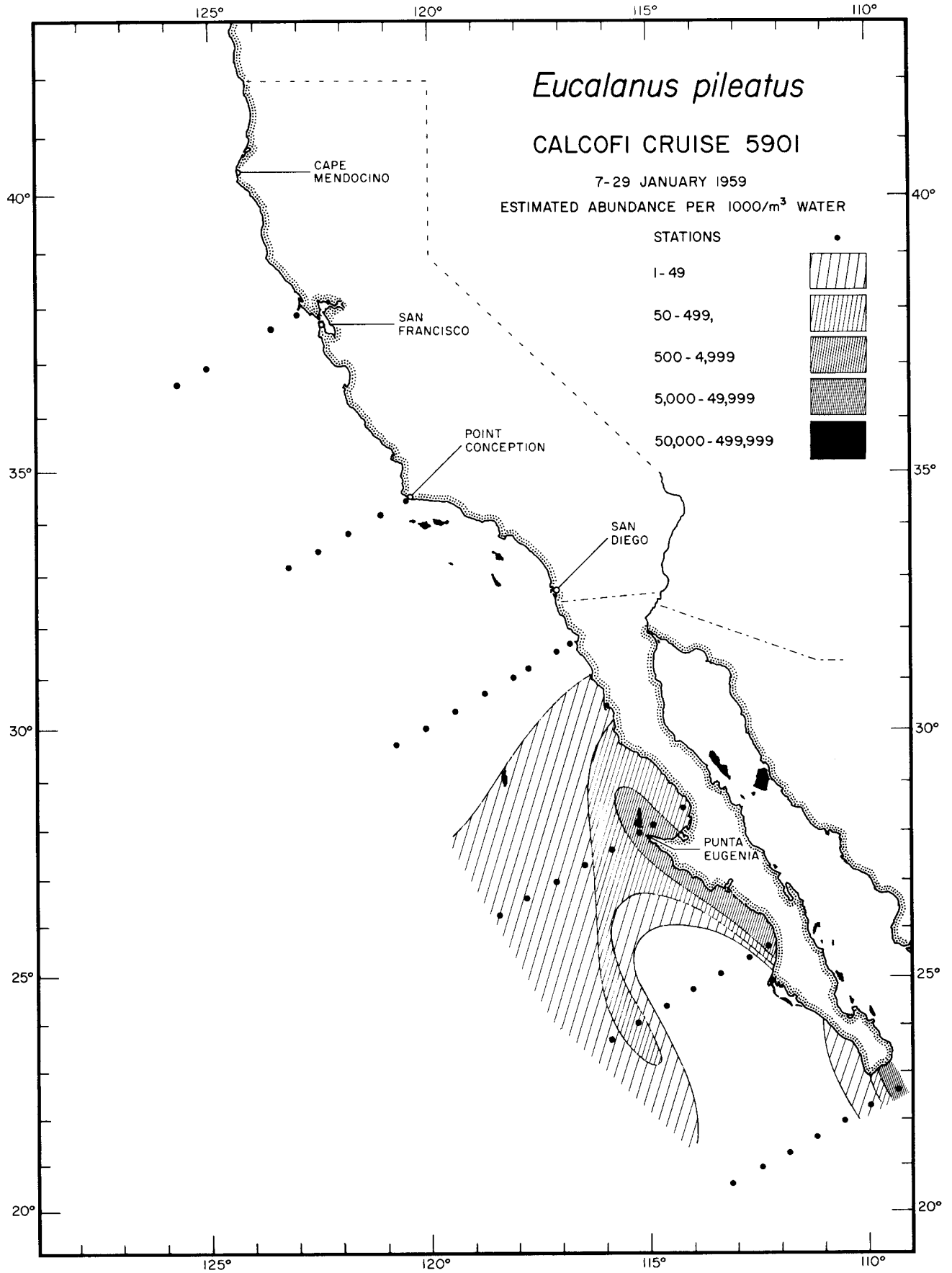
Calanoida
Eucalanus inermis
5807



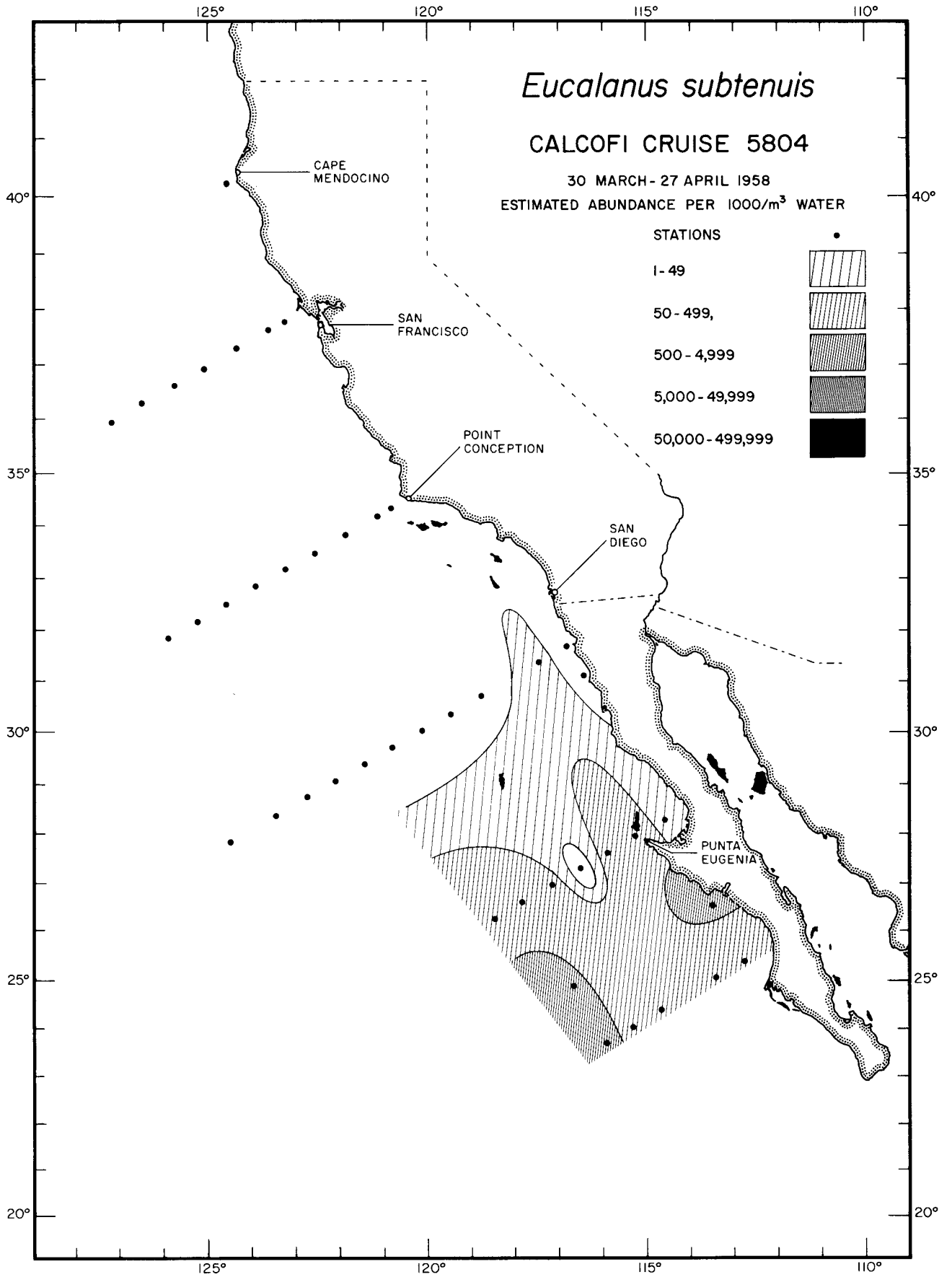




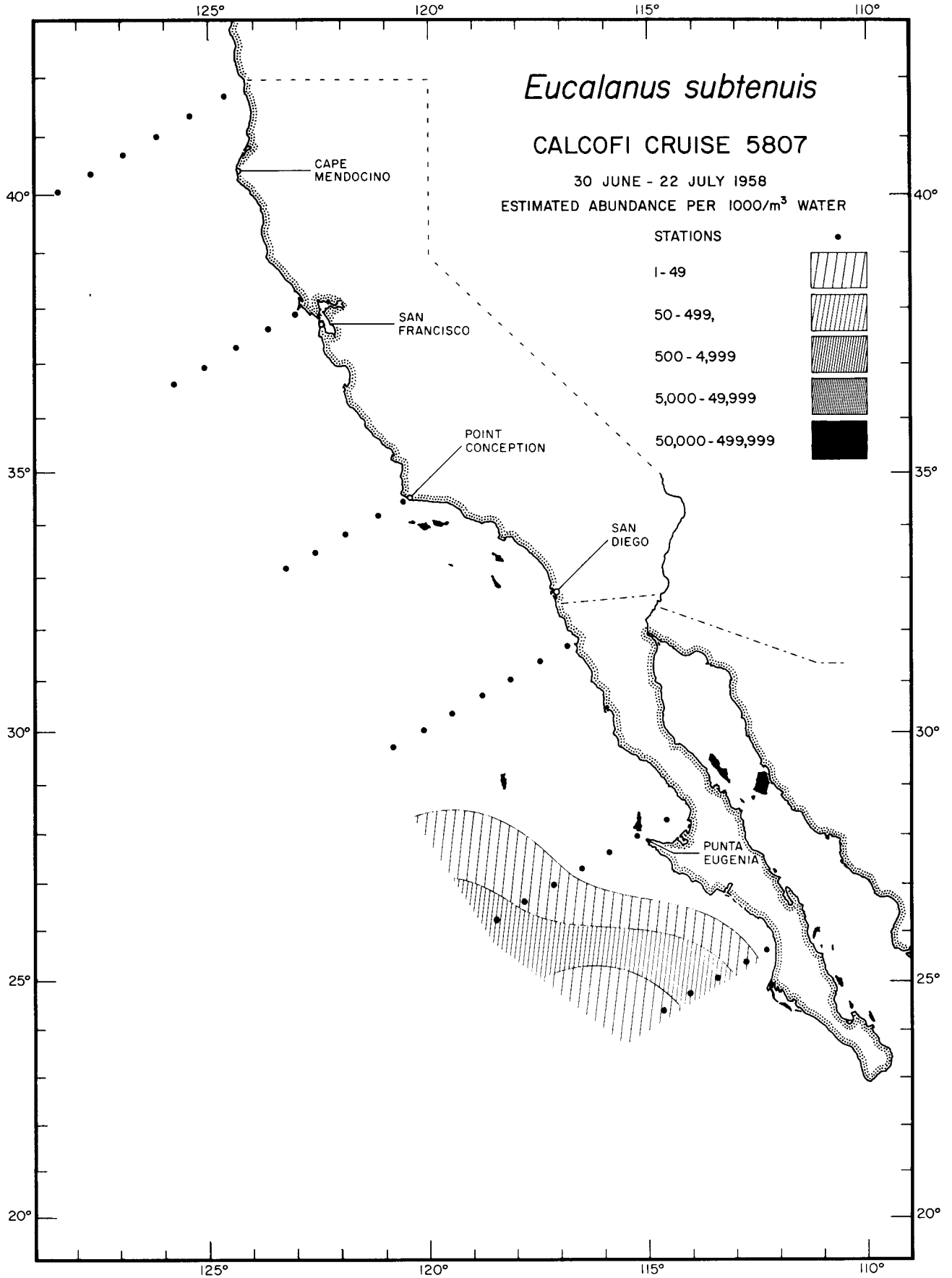
Calanoida
Eucalanus pileatus
5810



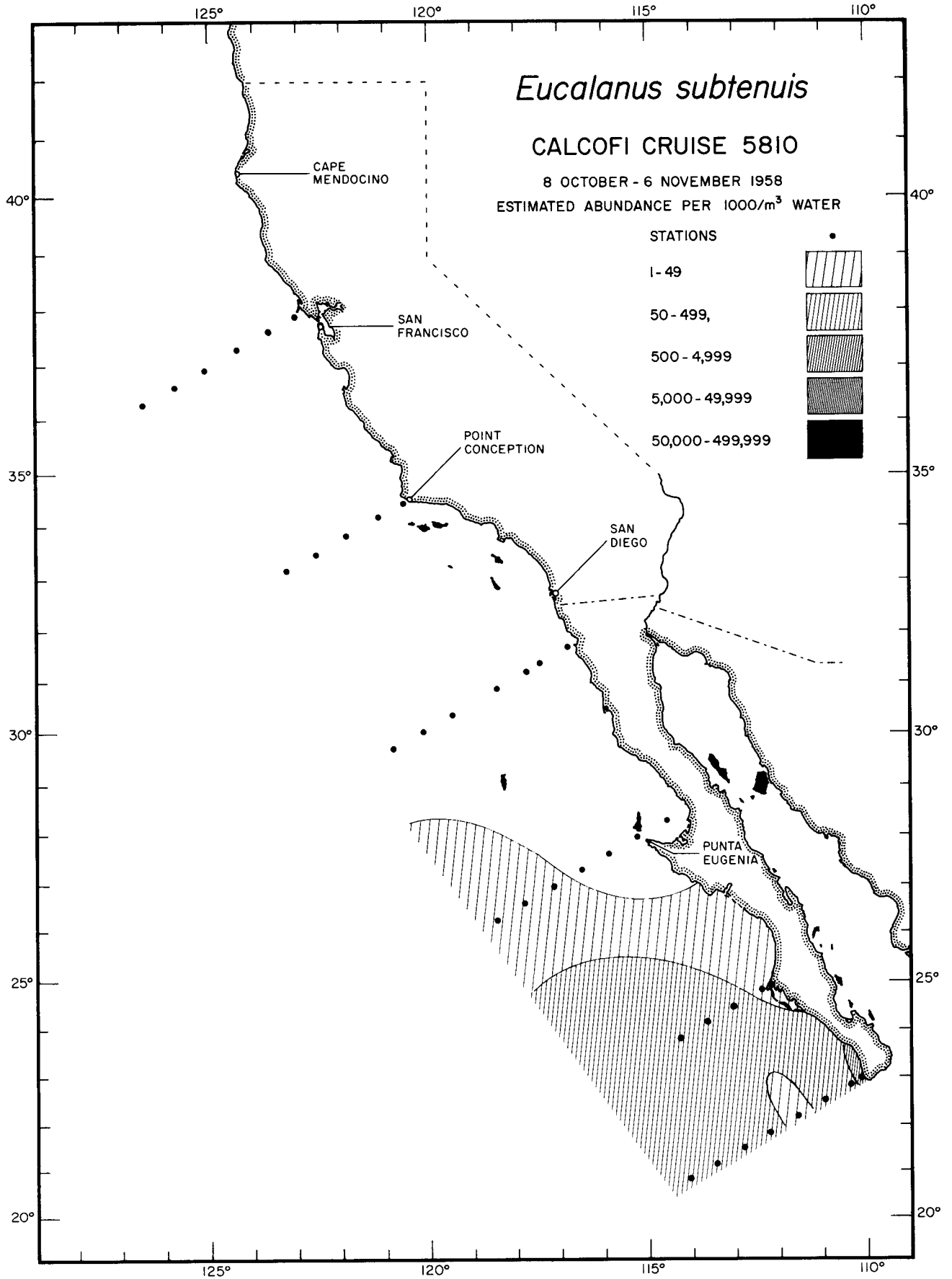
Calanoida
Eucalanus pileatus
5901



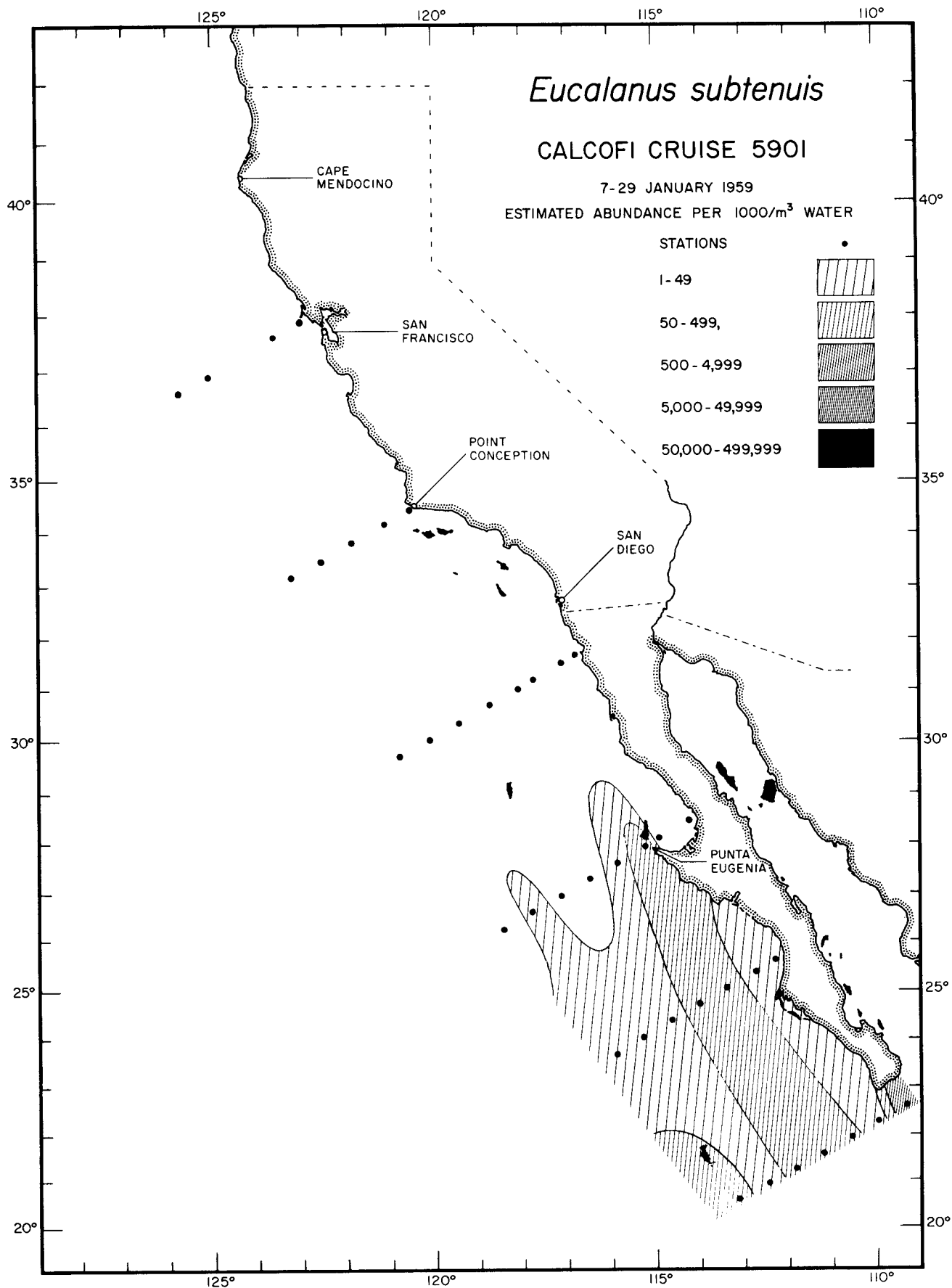
Calanoida
Eucalanus subtenus
5804

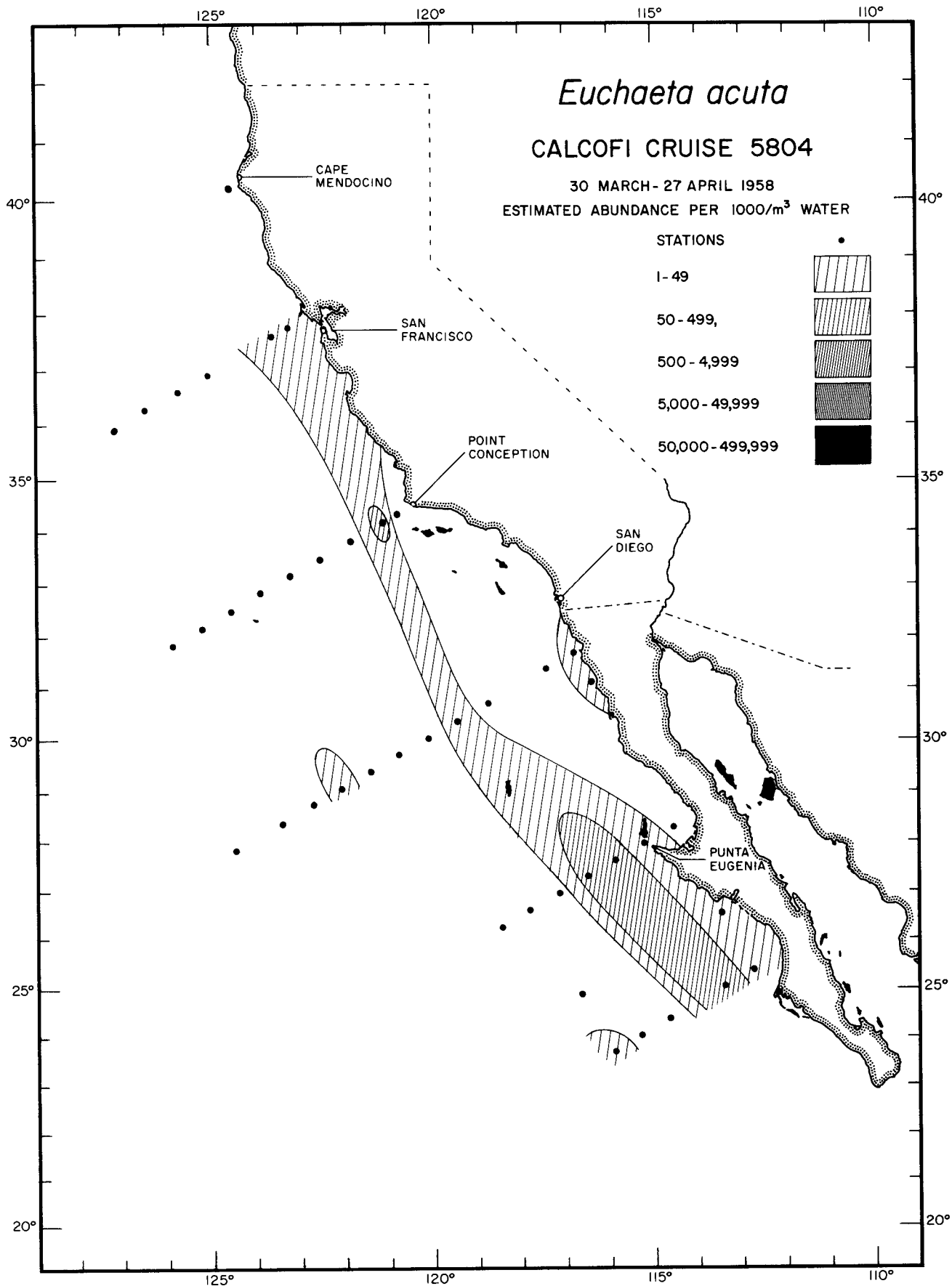


Calanoida
Eucalanus subtenuis
5807

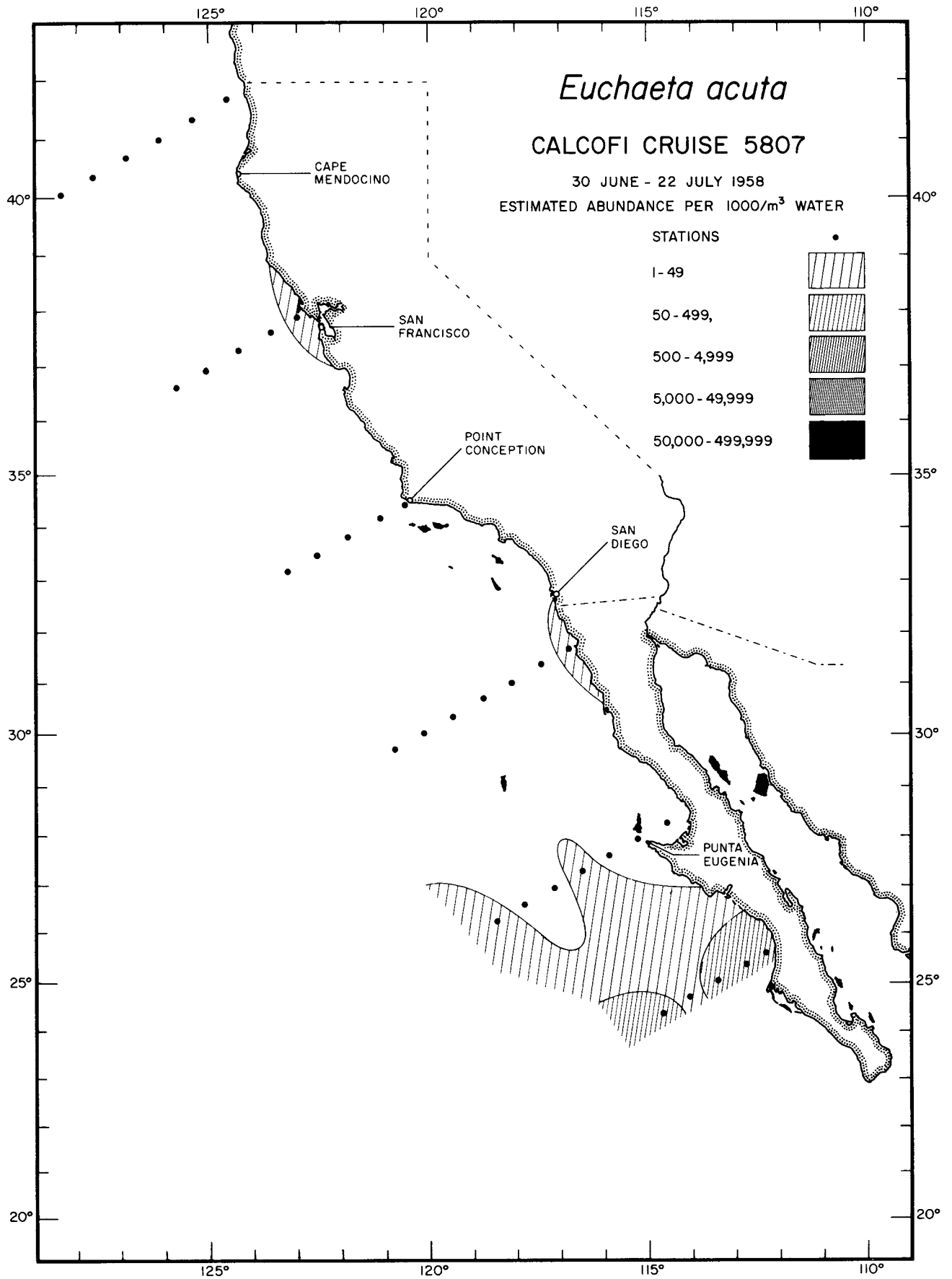


Calanoida
Eucalanus subtenuis
5810

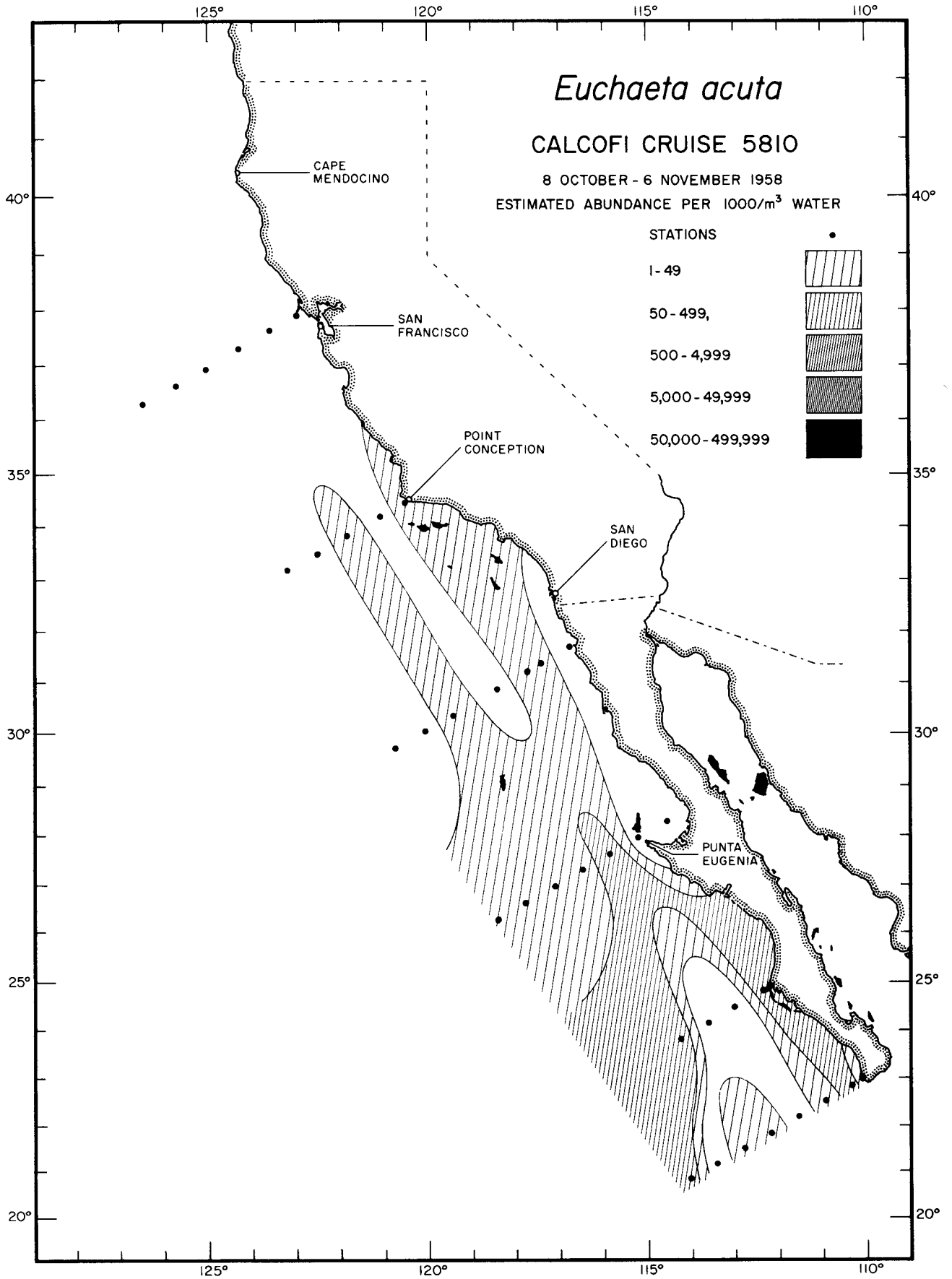




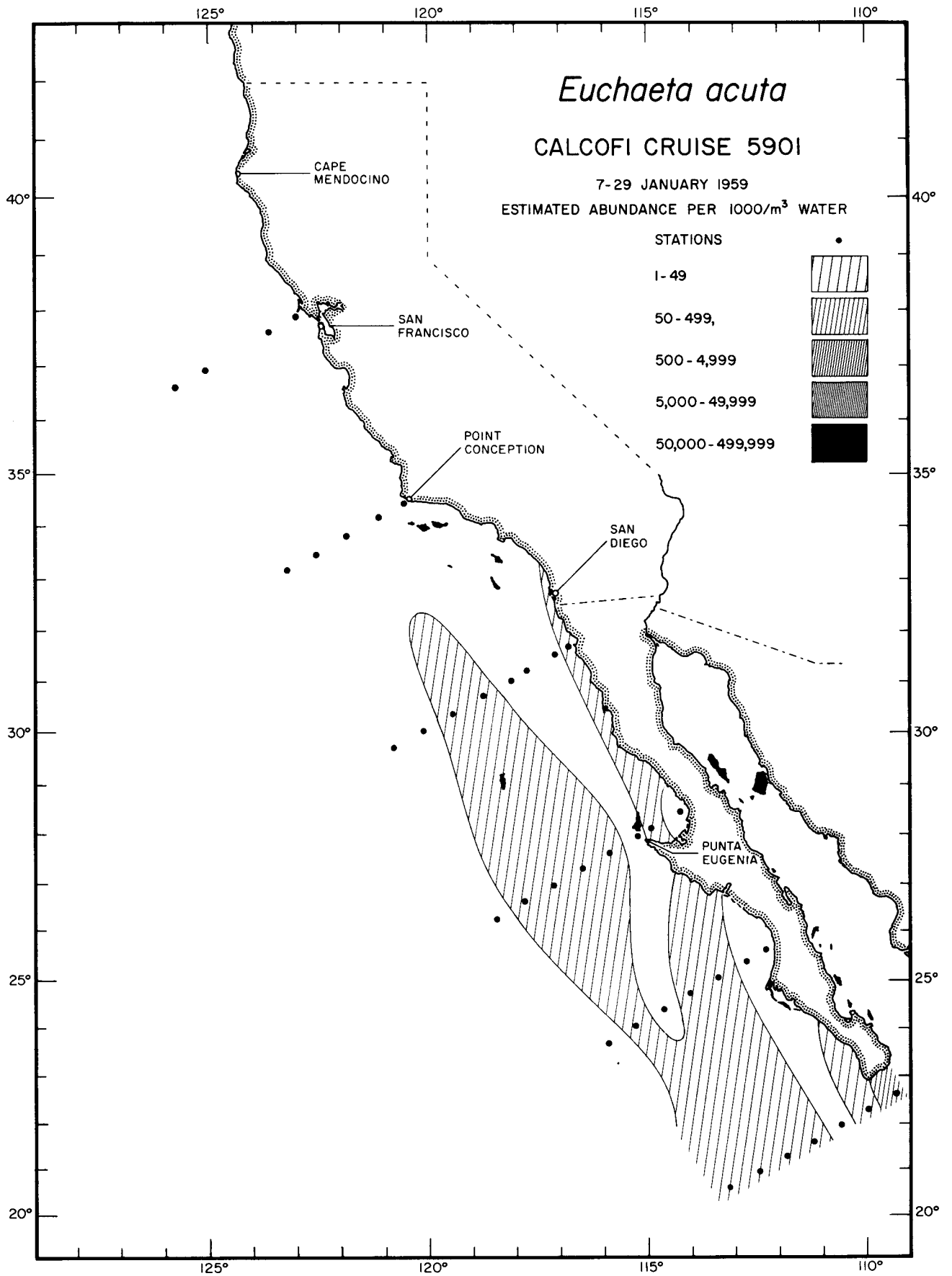
Calanoida
Euchaeta acuta
5804



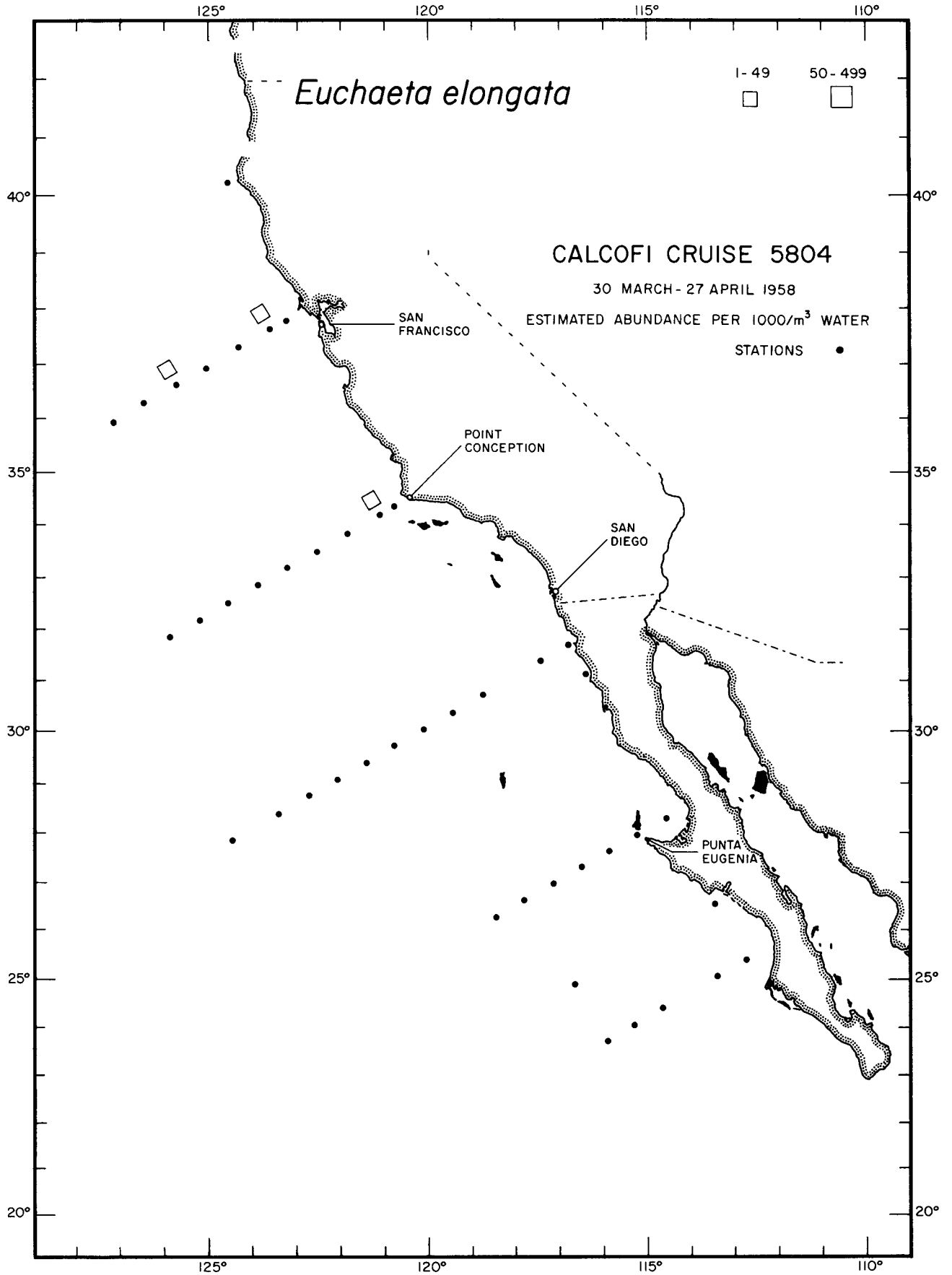
Calanoida
Euchaeta acuta
5807



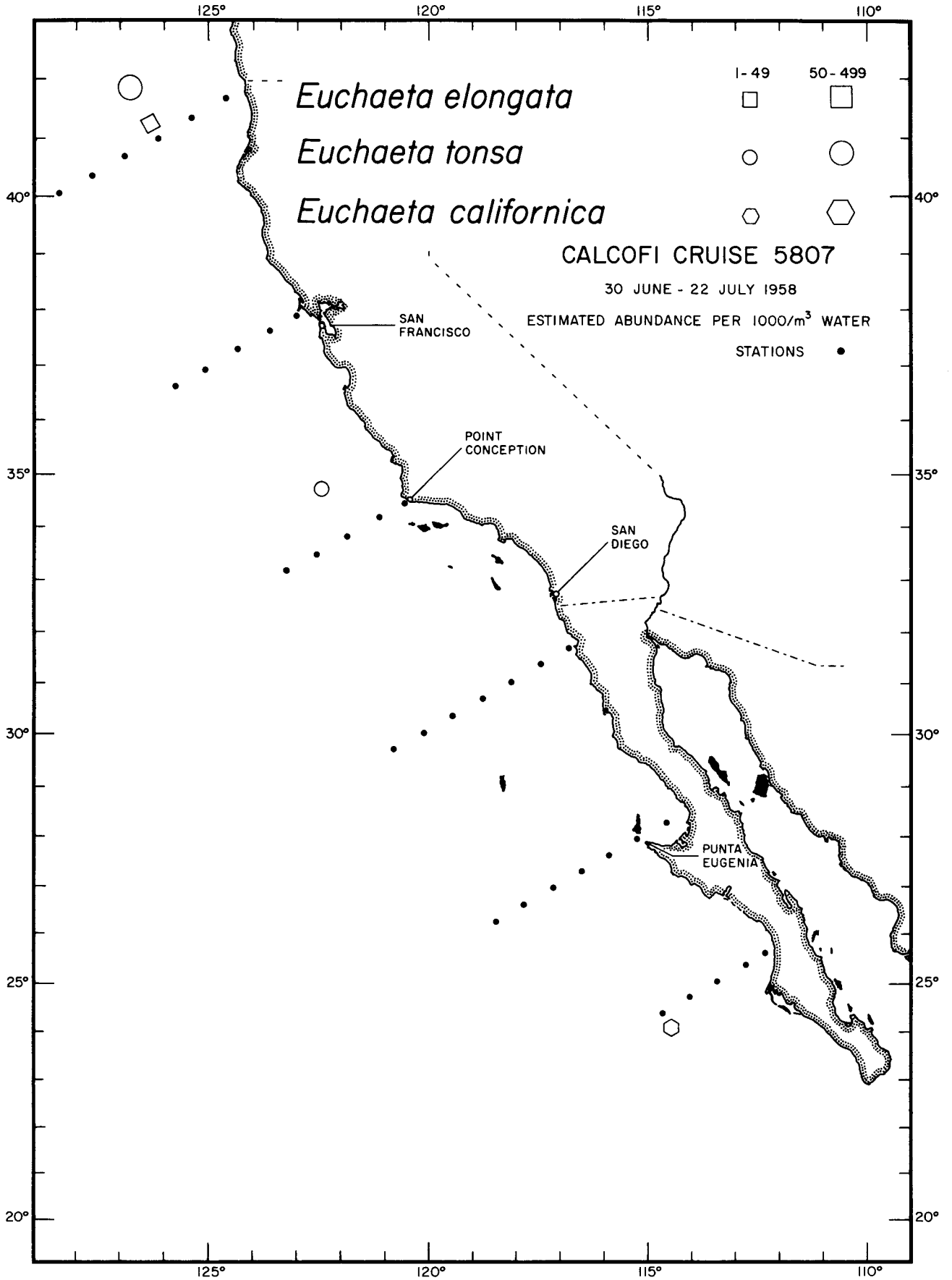
Calanoida
Euchaeta acuta
5810



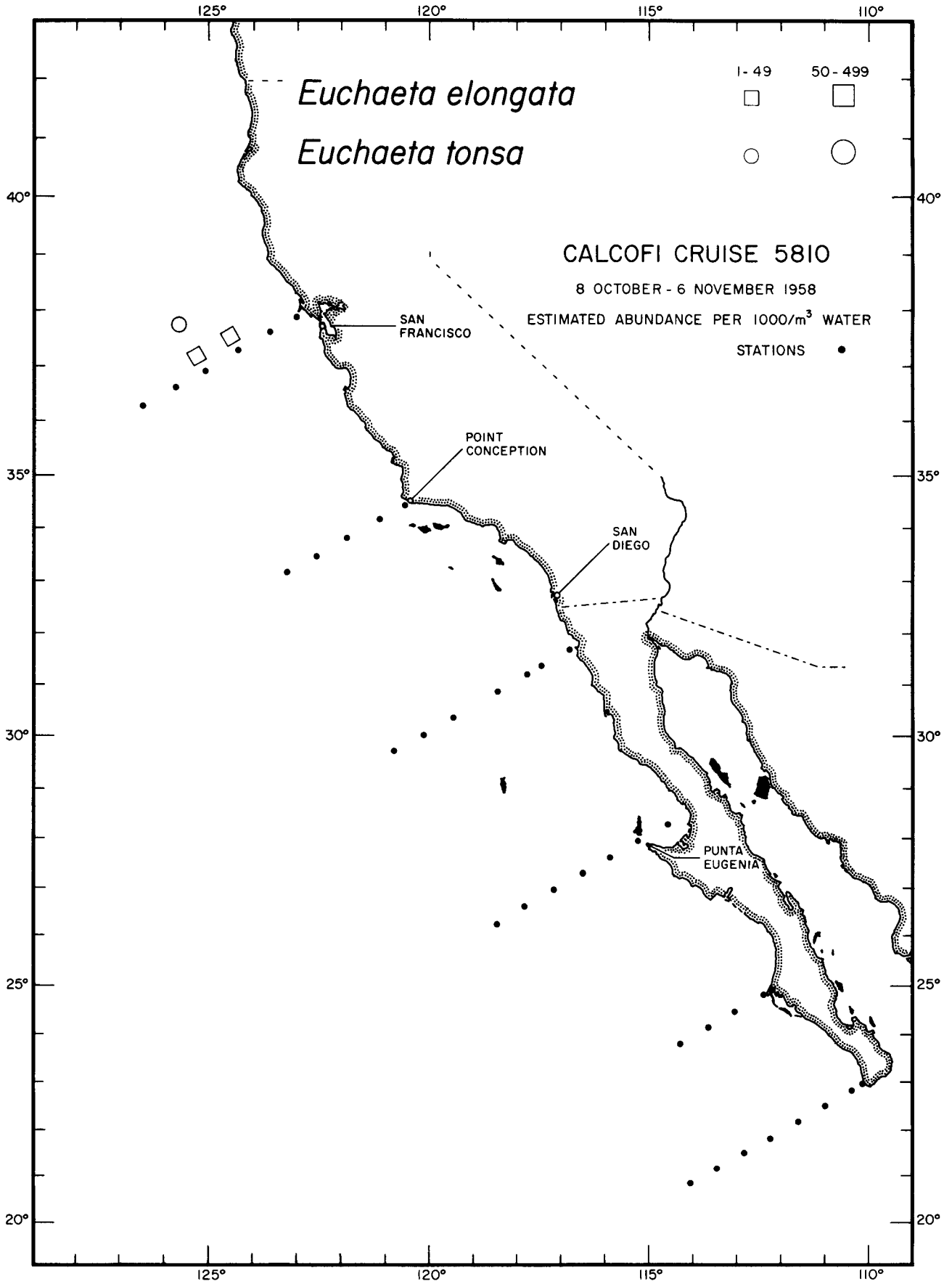
Calanoida
Euchaeta acuta
5901



Calanoida
Euchaeta elongata
5804



Calanoida
Euchaeta elongata
Euchaeta tonsa
Euchaeta californica
5807



1- 49	50 - 499
□	□
○	○

CALCOFI CRUISE 5810

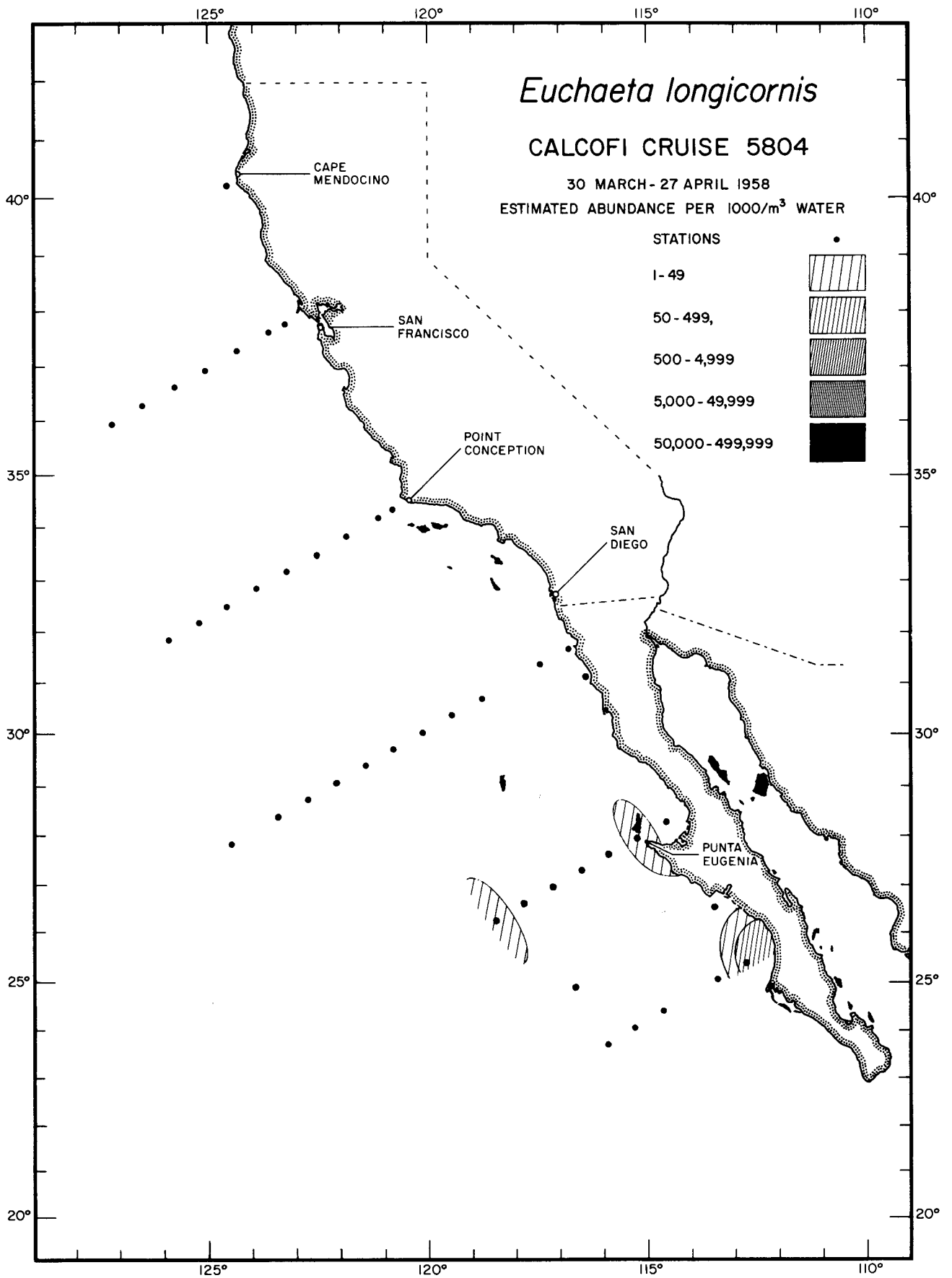
8 OCTOBER - 6 NOVEMBER 1958

ESTIMATED ABUNDANCE PER 1000/m³ WATER

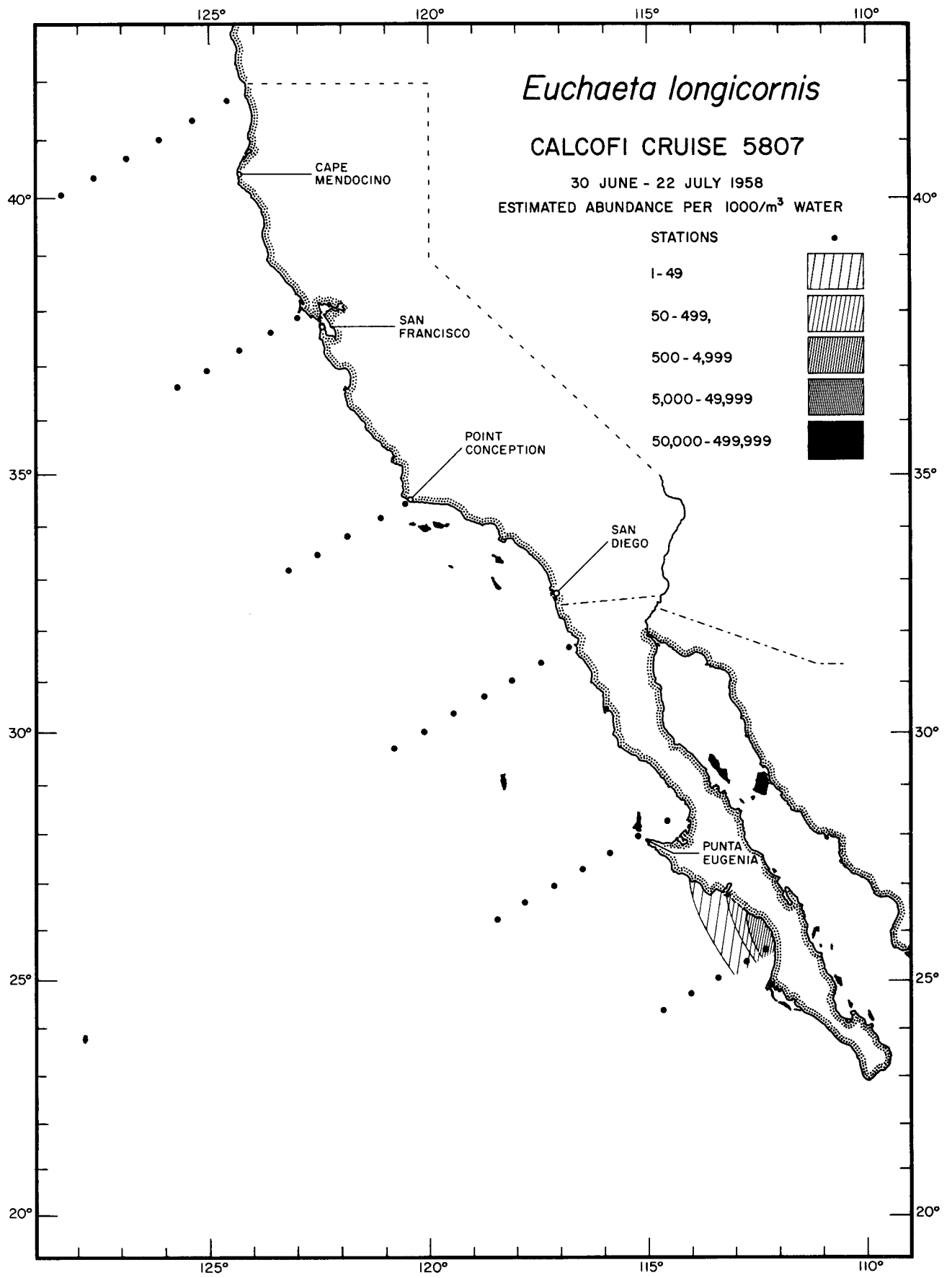
STATIONS ●

Euchaeta elongata
Euchaeta tonsa

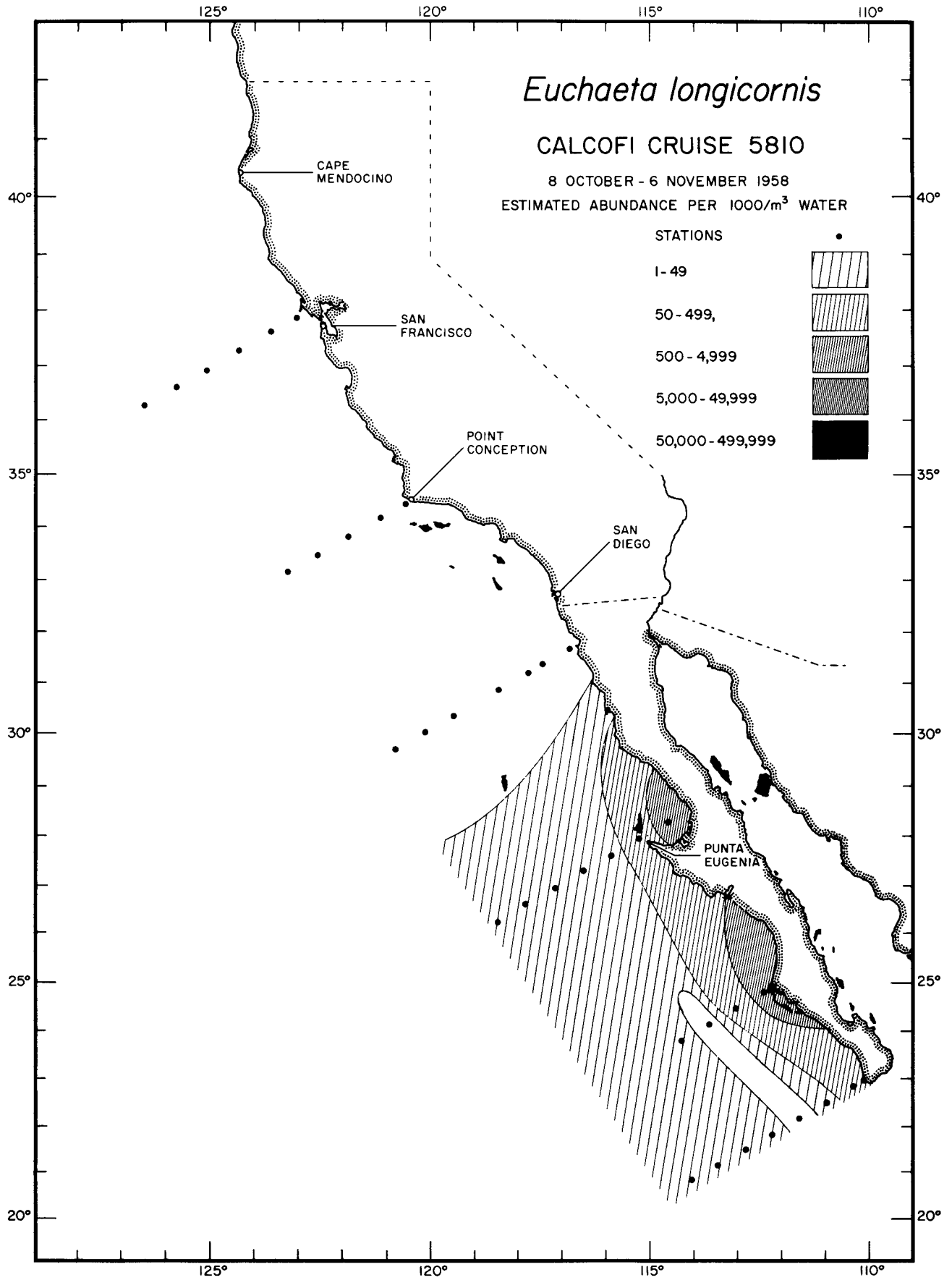
Calanoida
Euchaeta tonsa
Euchaeta elongata
 5901



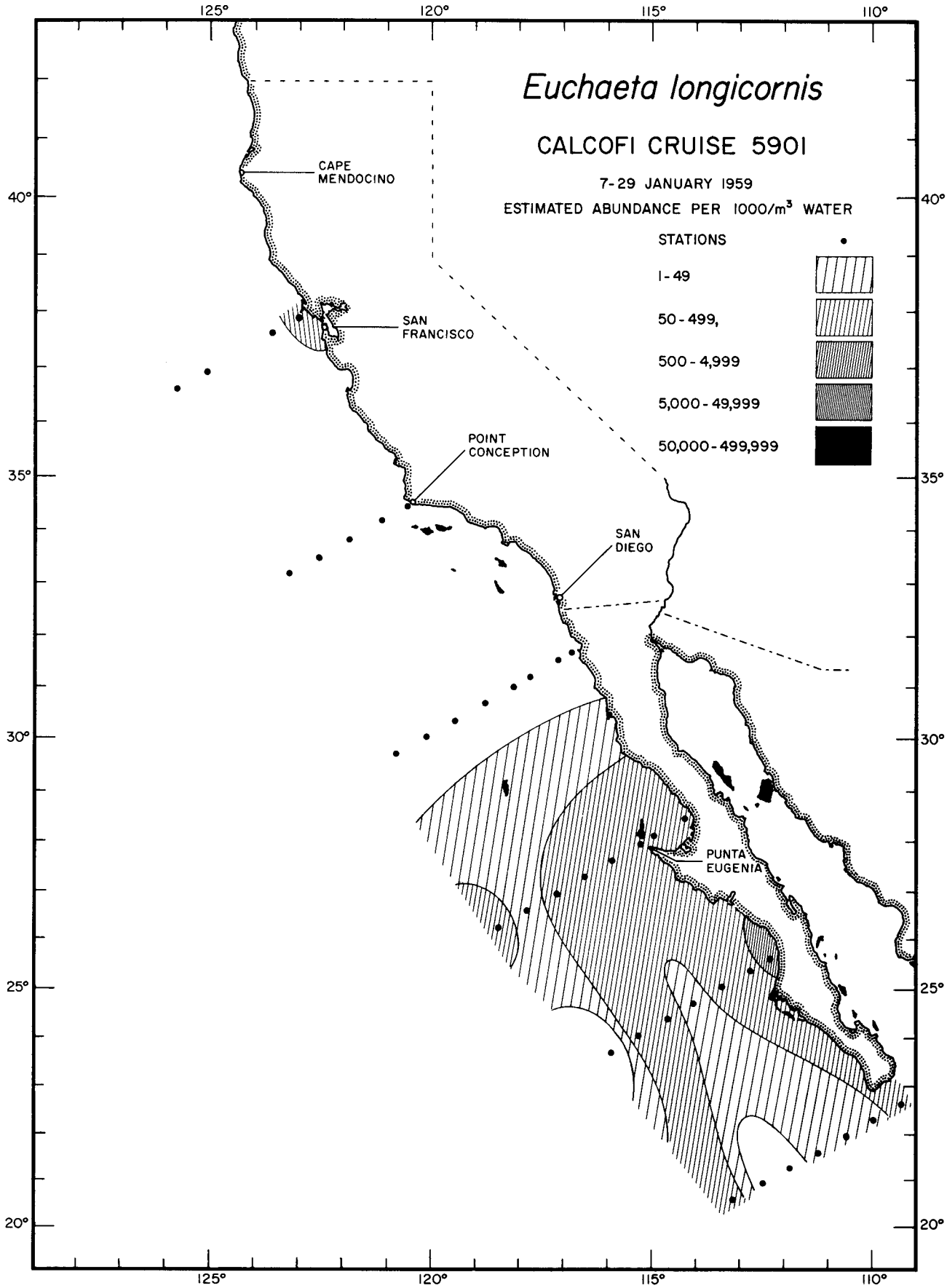
Calanoida
Euchaeta longicornis
5804



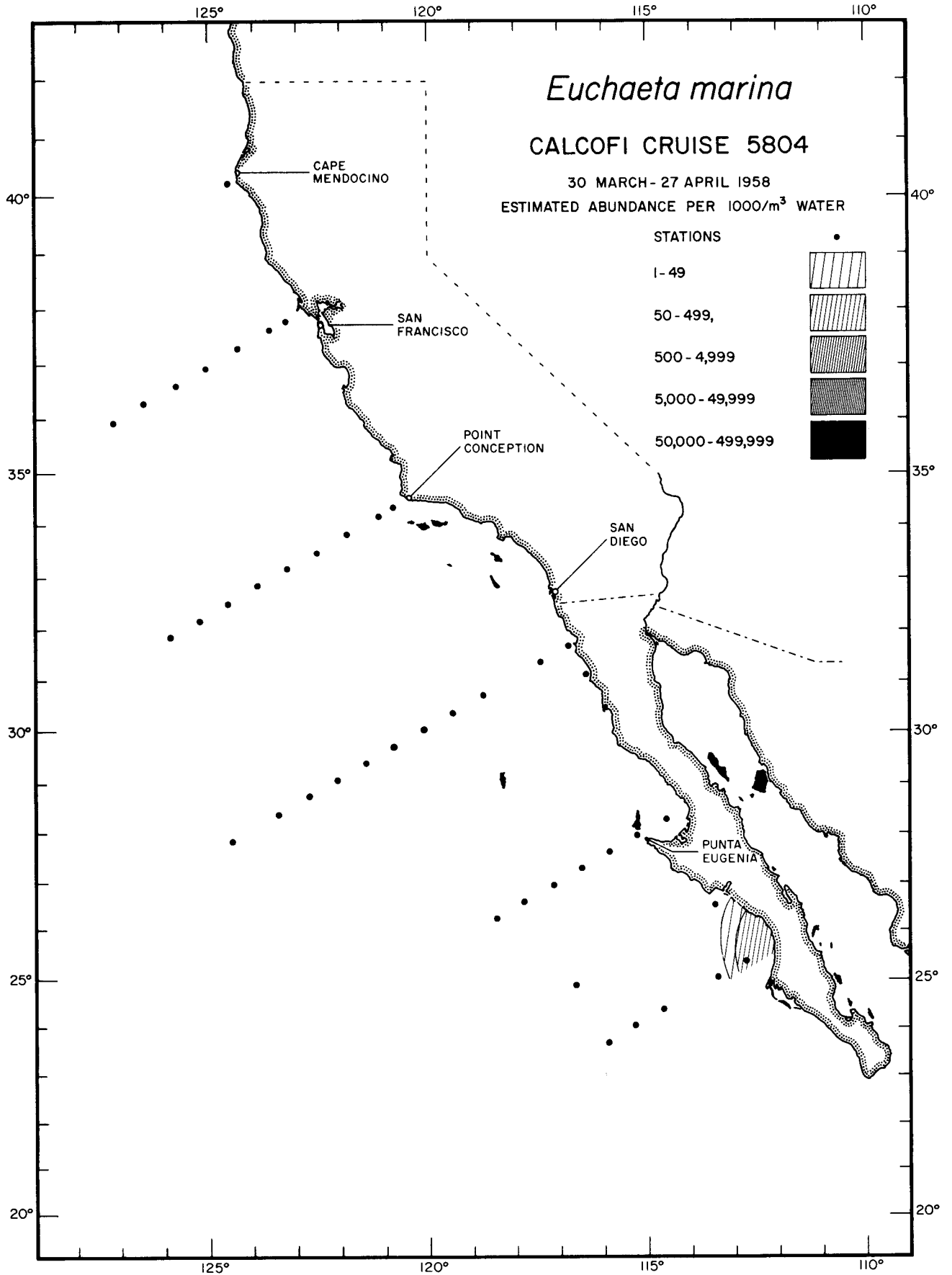
Calanoida
Euchaeta longicornis
5807



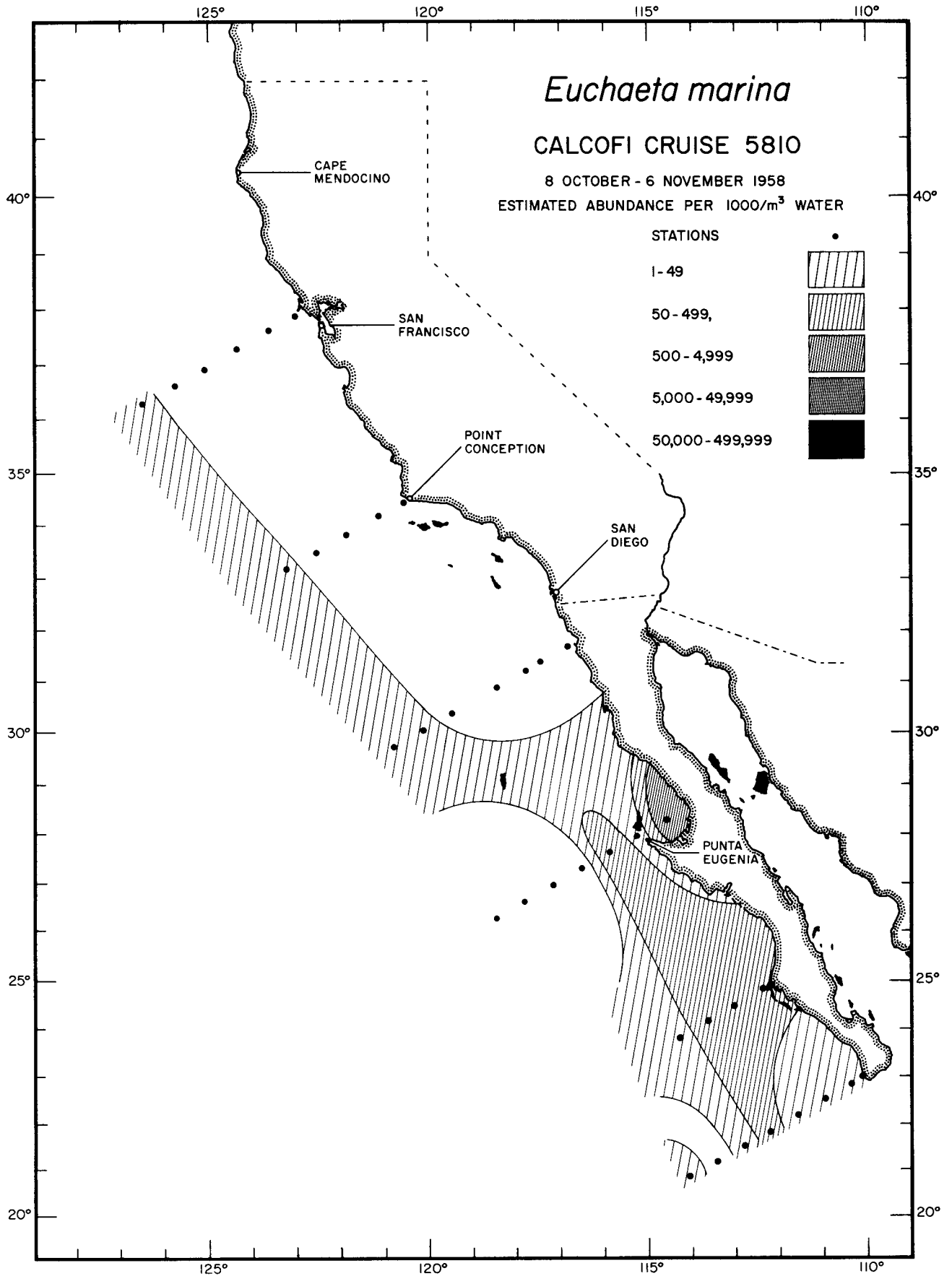
Calanoida
Euchaeta longicornis
5810



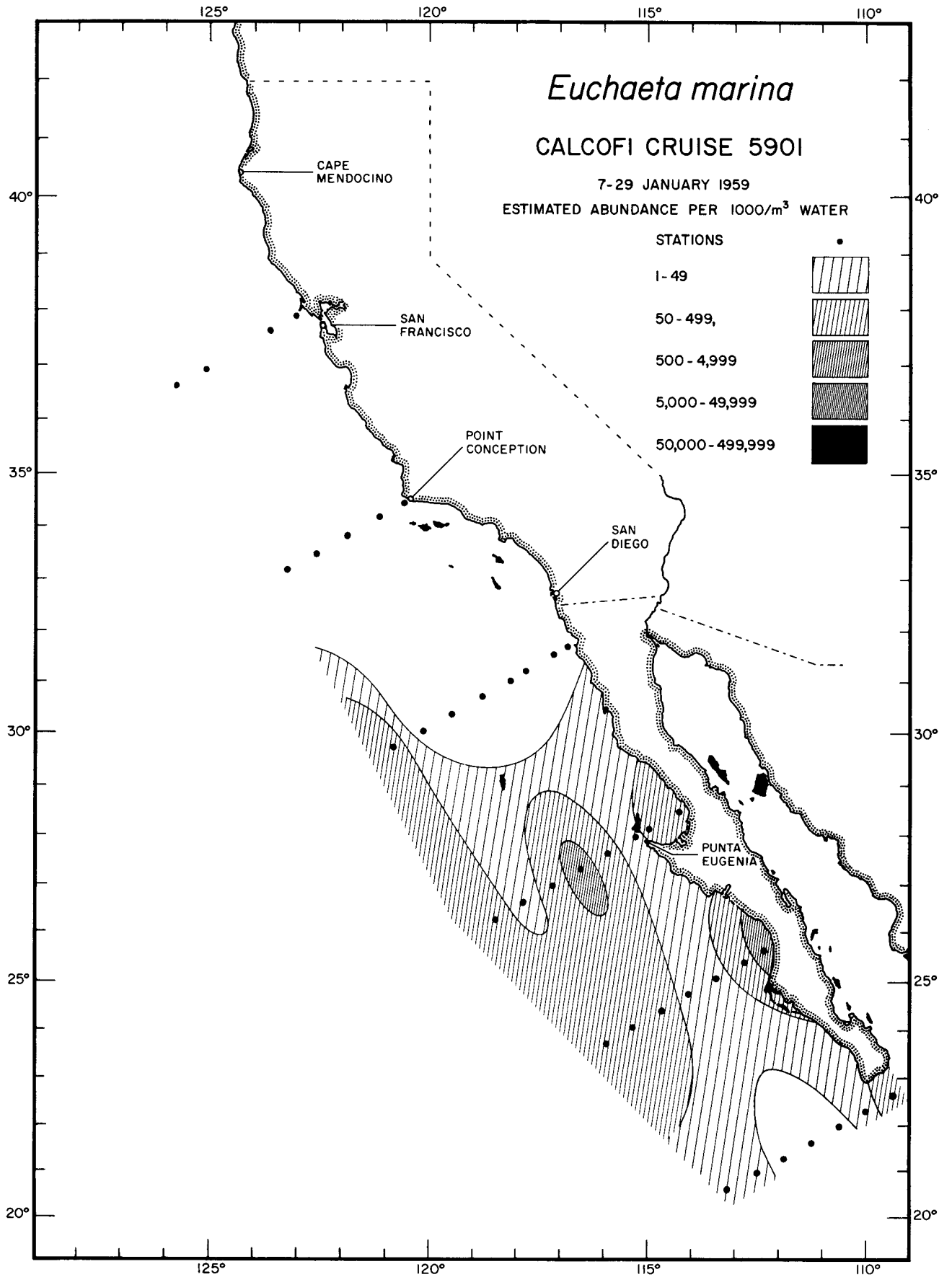
Calanoida
Euchaeta longicornis
5901



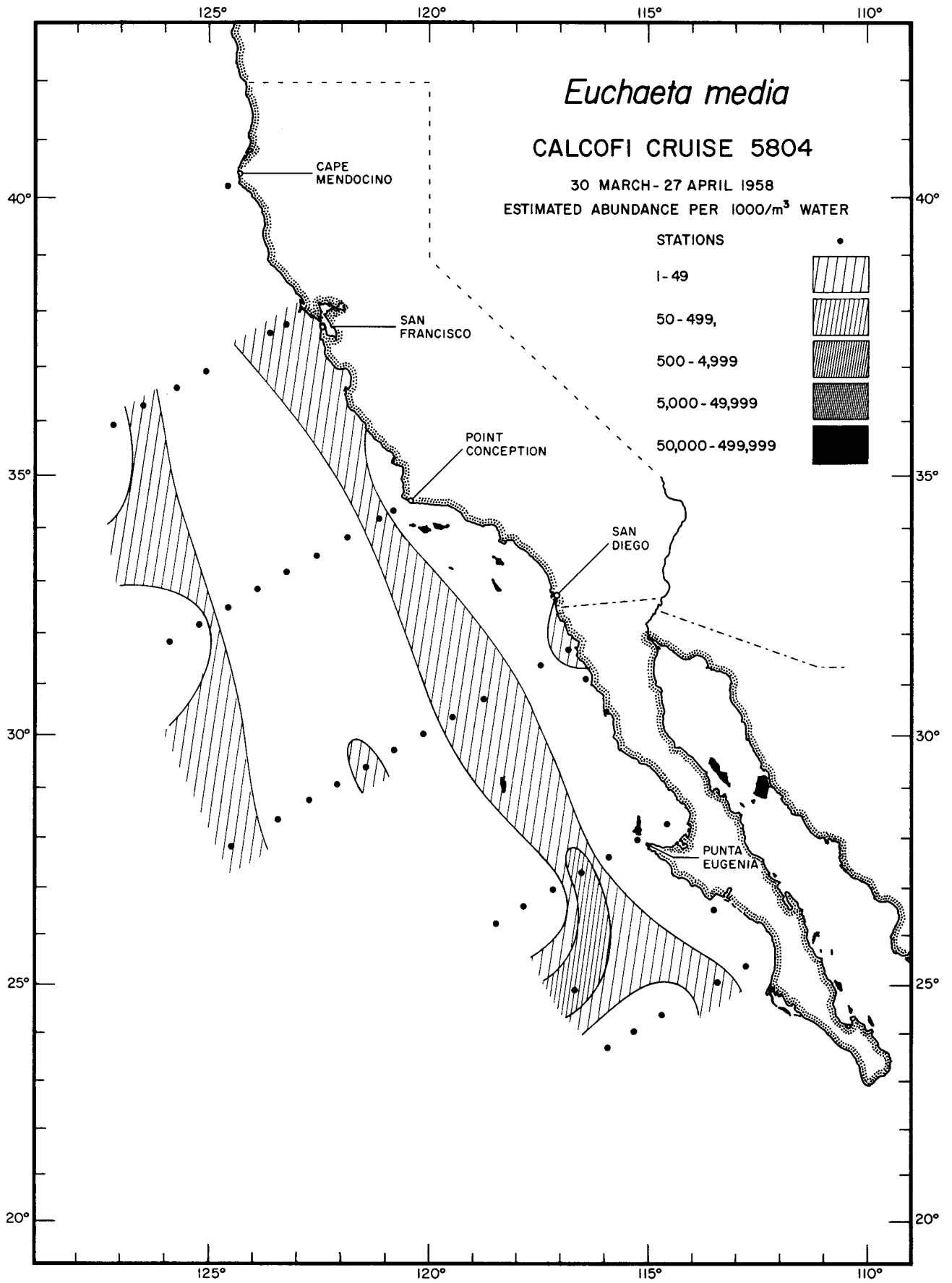
Calanoida
Euchaeta marina
5804



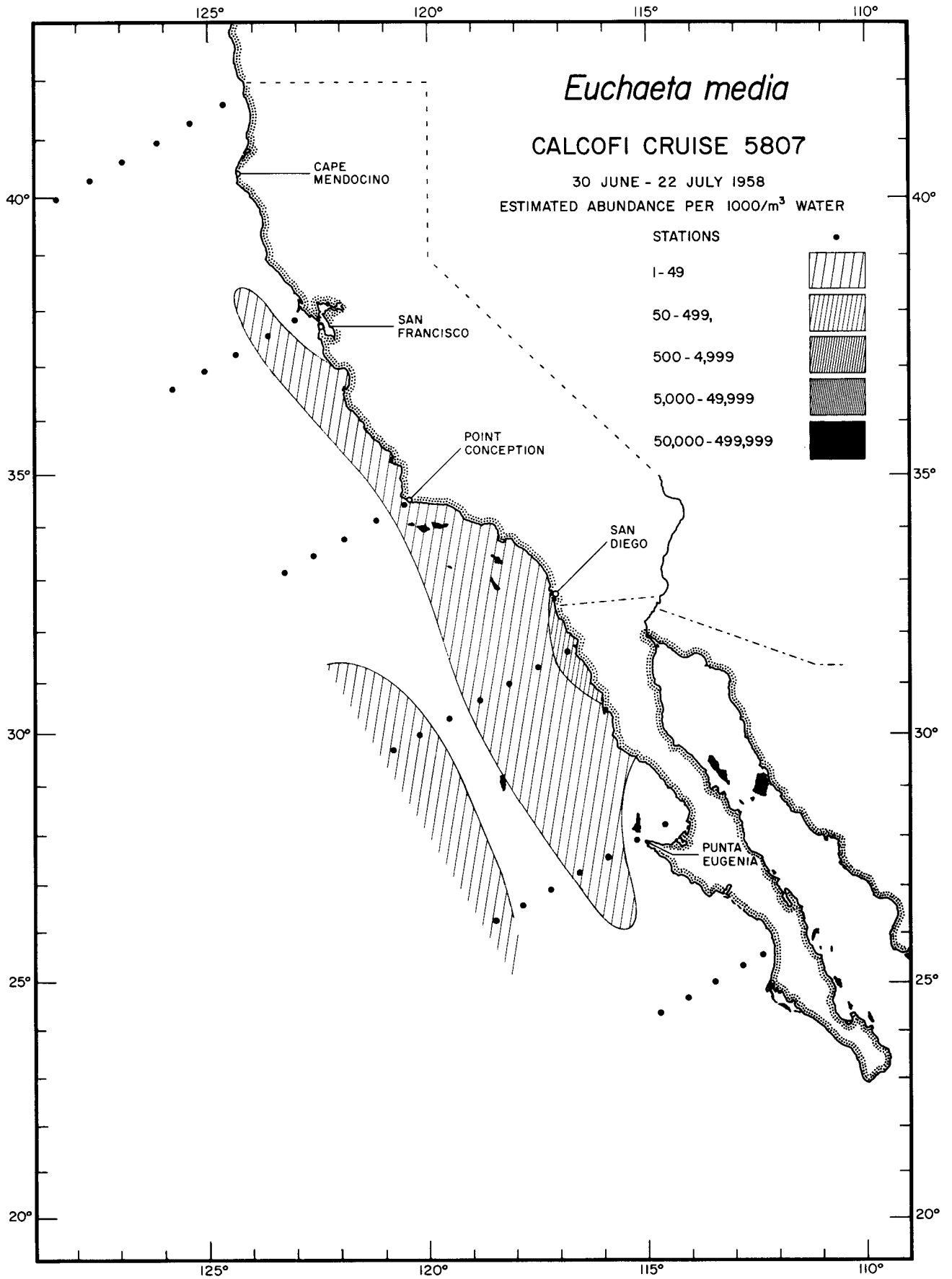
Calanoida
Euchaeta marina
5810



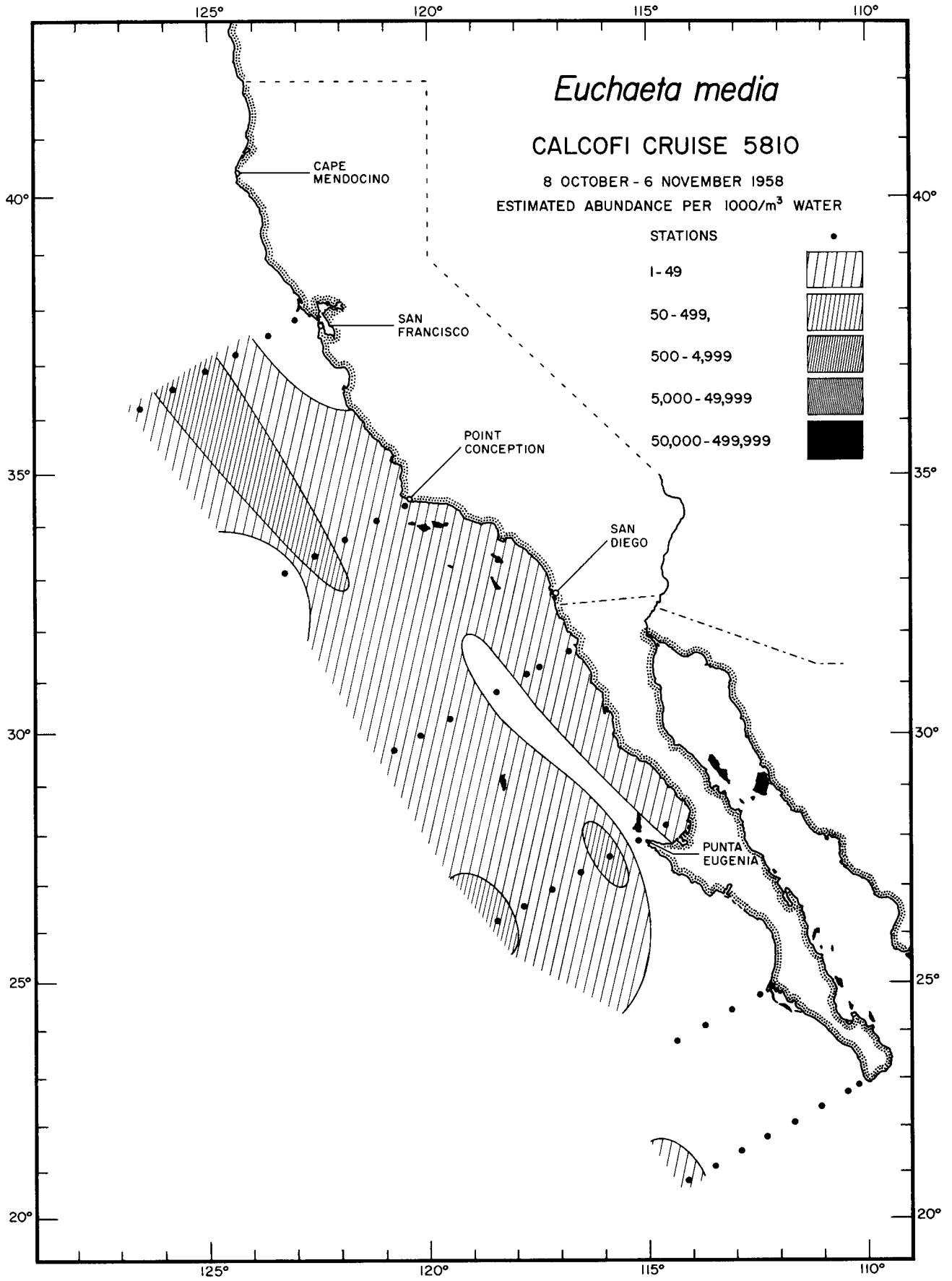
Calanoida
Euchaeta marina
5901



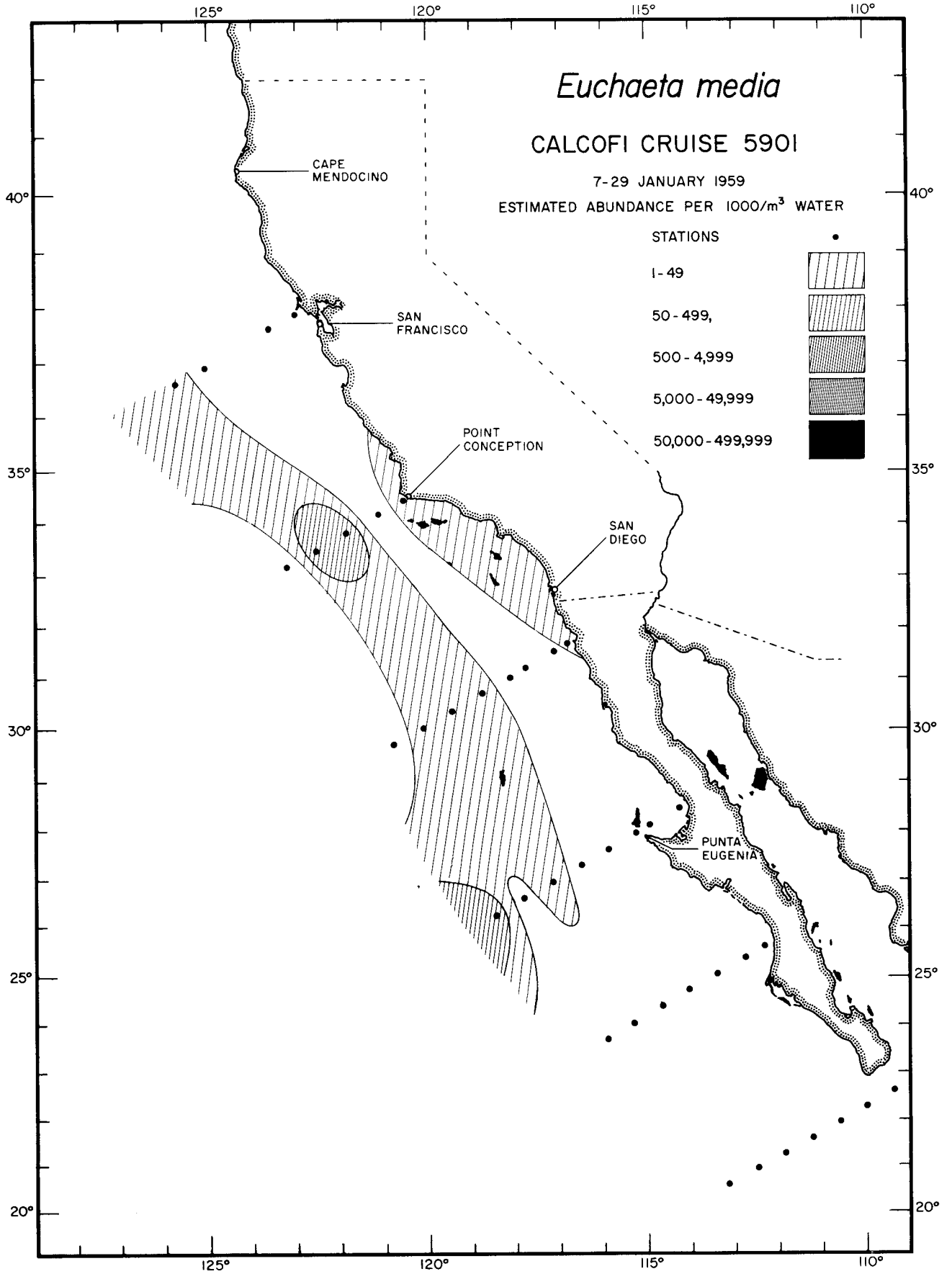
Calanoida
Euchaeta media
5804



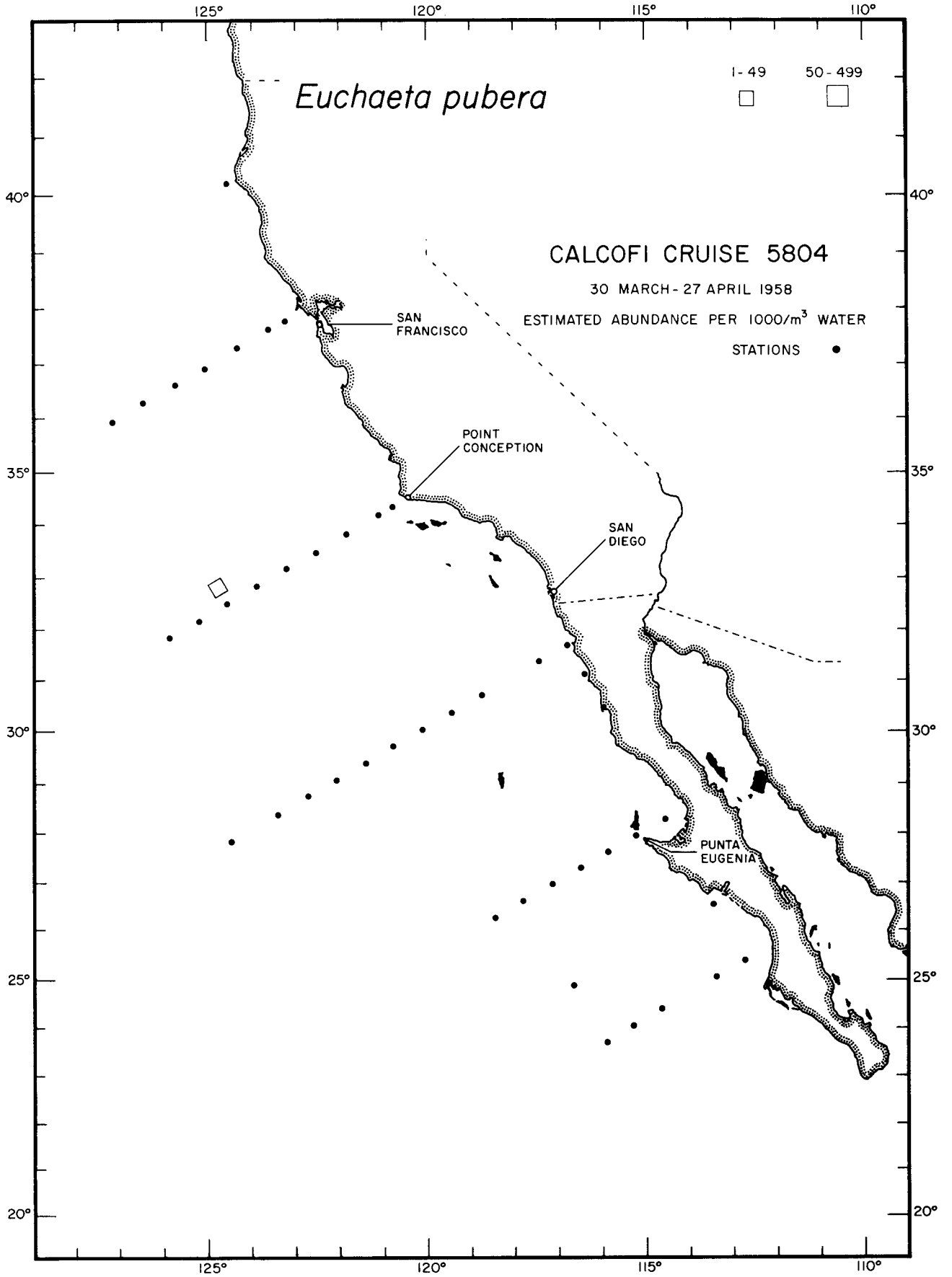
Calanoida
Euchaeta media
5807



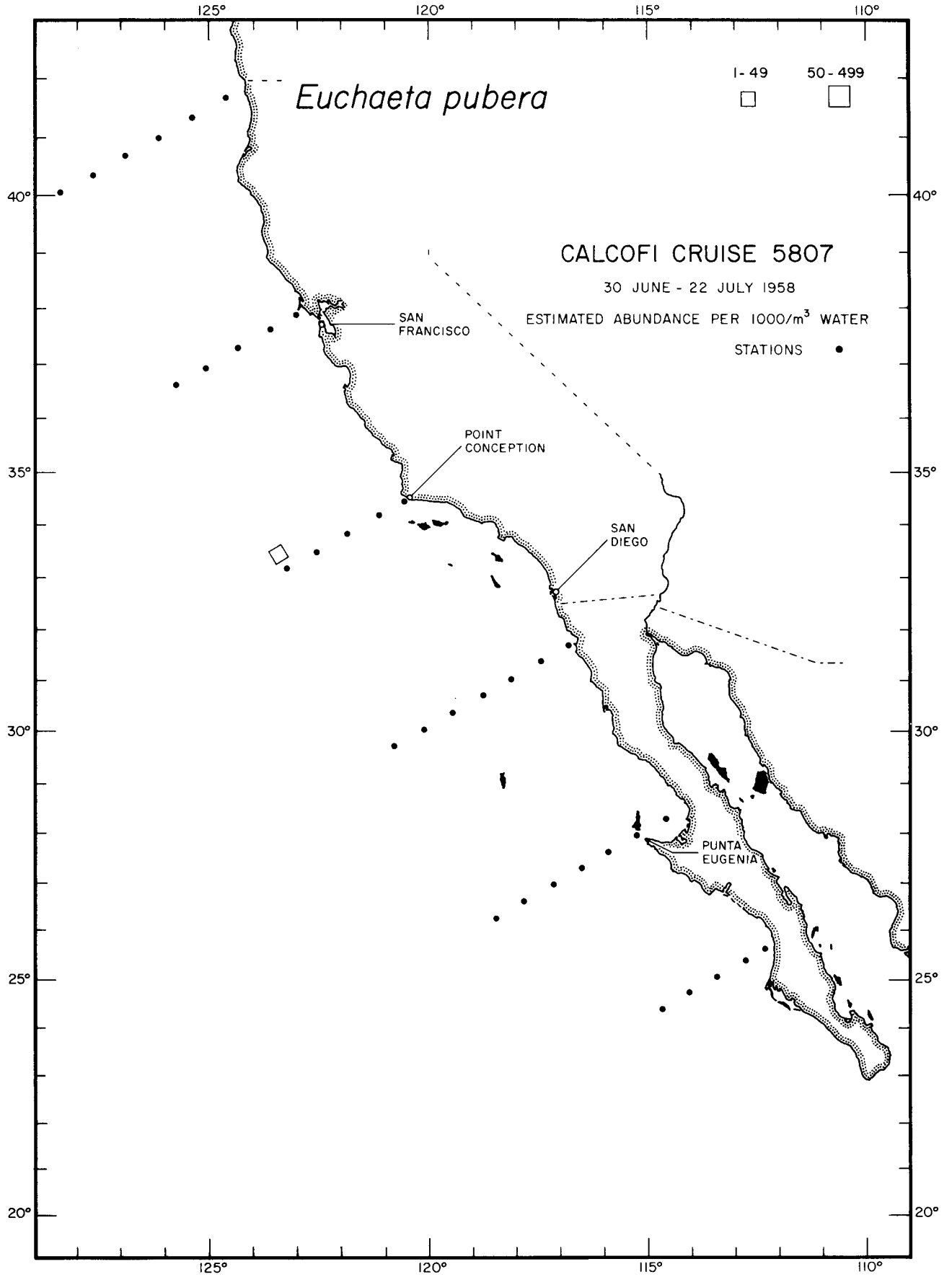
Calanoida
Euchaeta media
5810



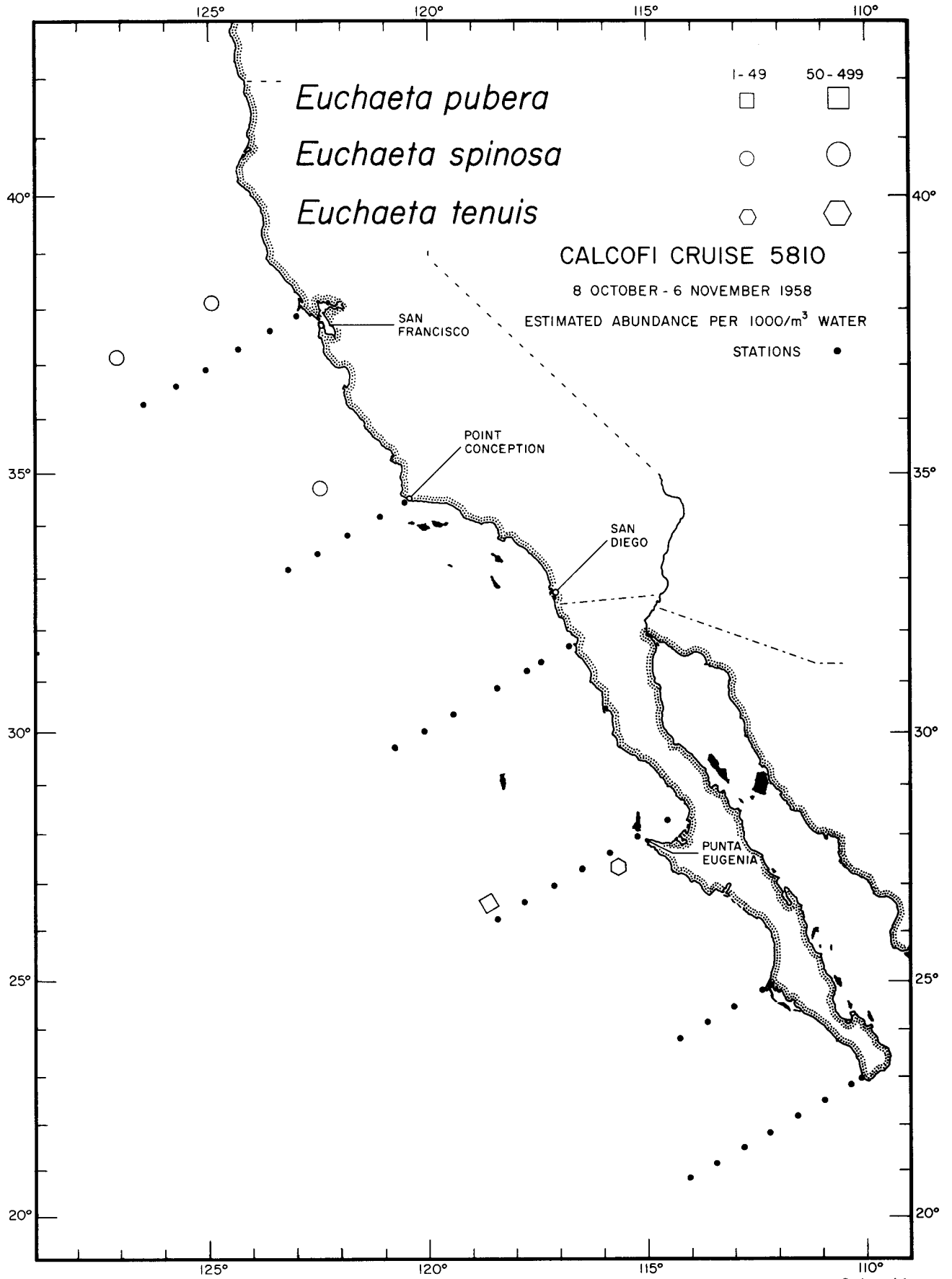
Calanoida
Euchaeta media
5901



Calanoida
Euchaeta pubera
5804

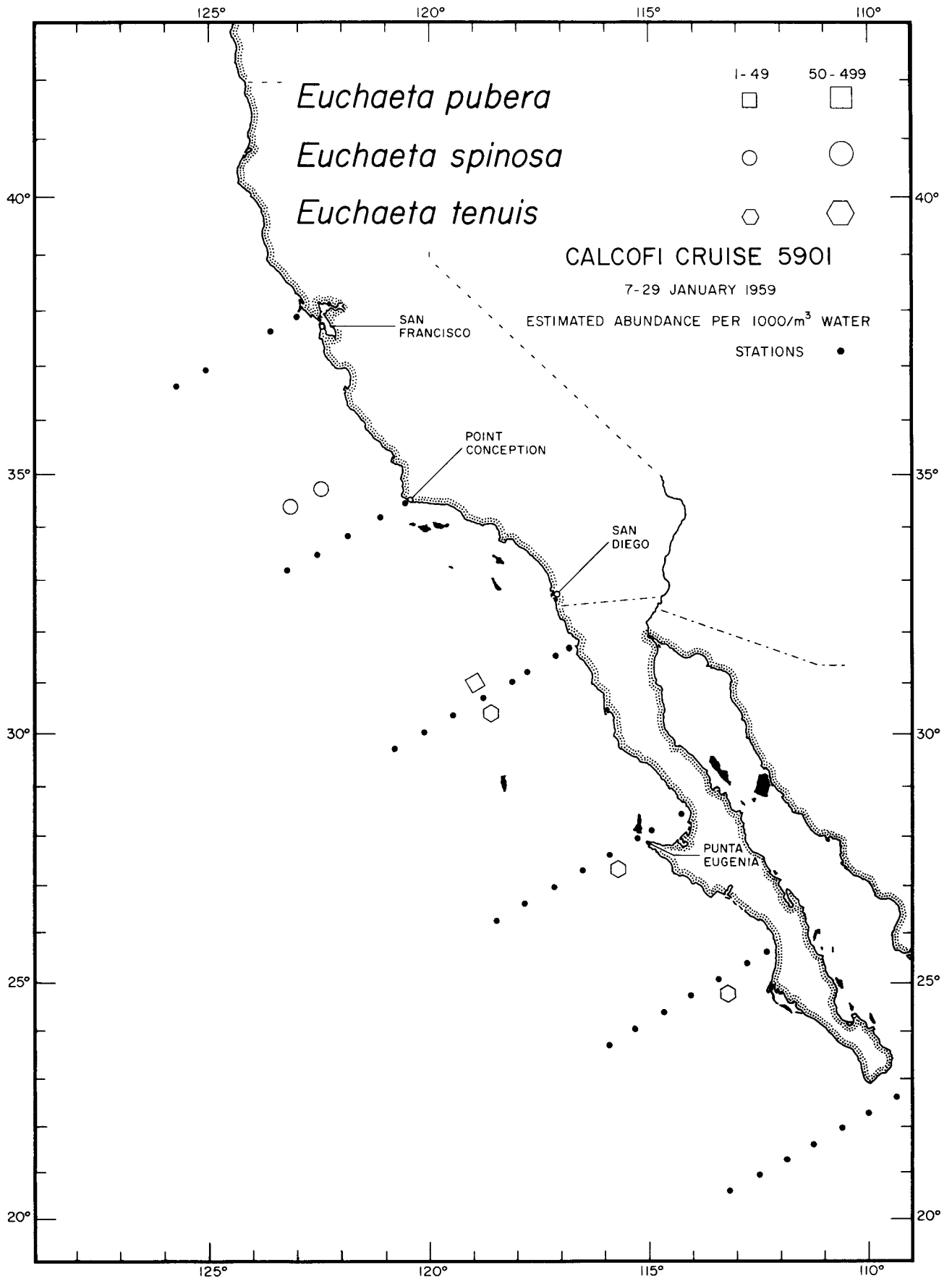


Calanoida
Euchaeta pubera
5807



CALCOFI CRUISE 5810
8 OCTOBER - 6 NOVEMBER 1958
ESTIMATED ABUNDANCE PER 1000/m³ WATER
STATIONS •

Calanoida
Euchaeta pubera
Euchaeta spinosa
Euchaeta tenuis
5810



CALCOFI CRUISE 5901

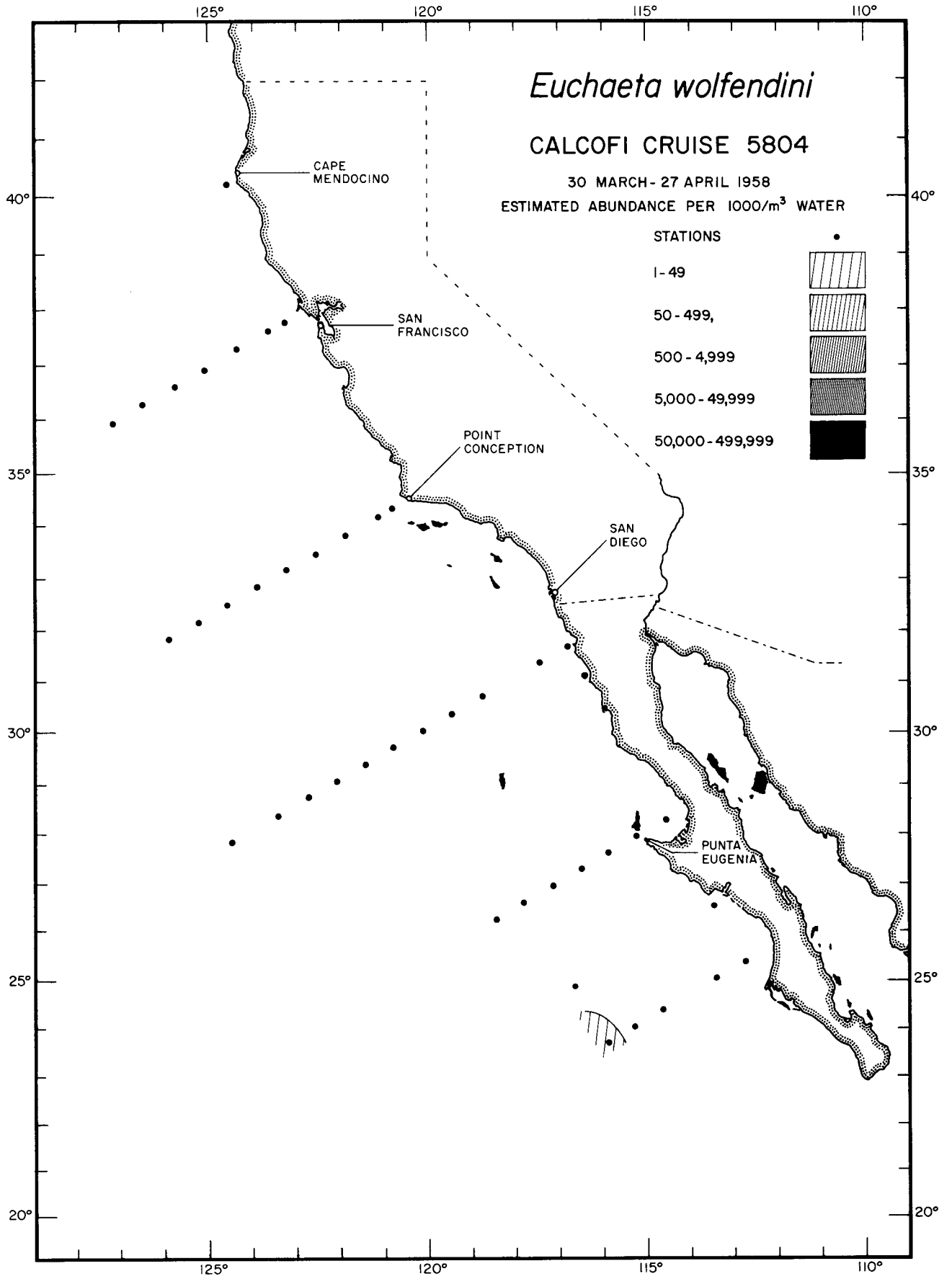
7-29 JANUARY 1959

ESTIMATED ABUNDANCE PER 1000/m³ WATER

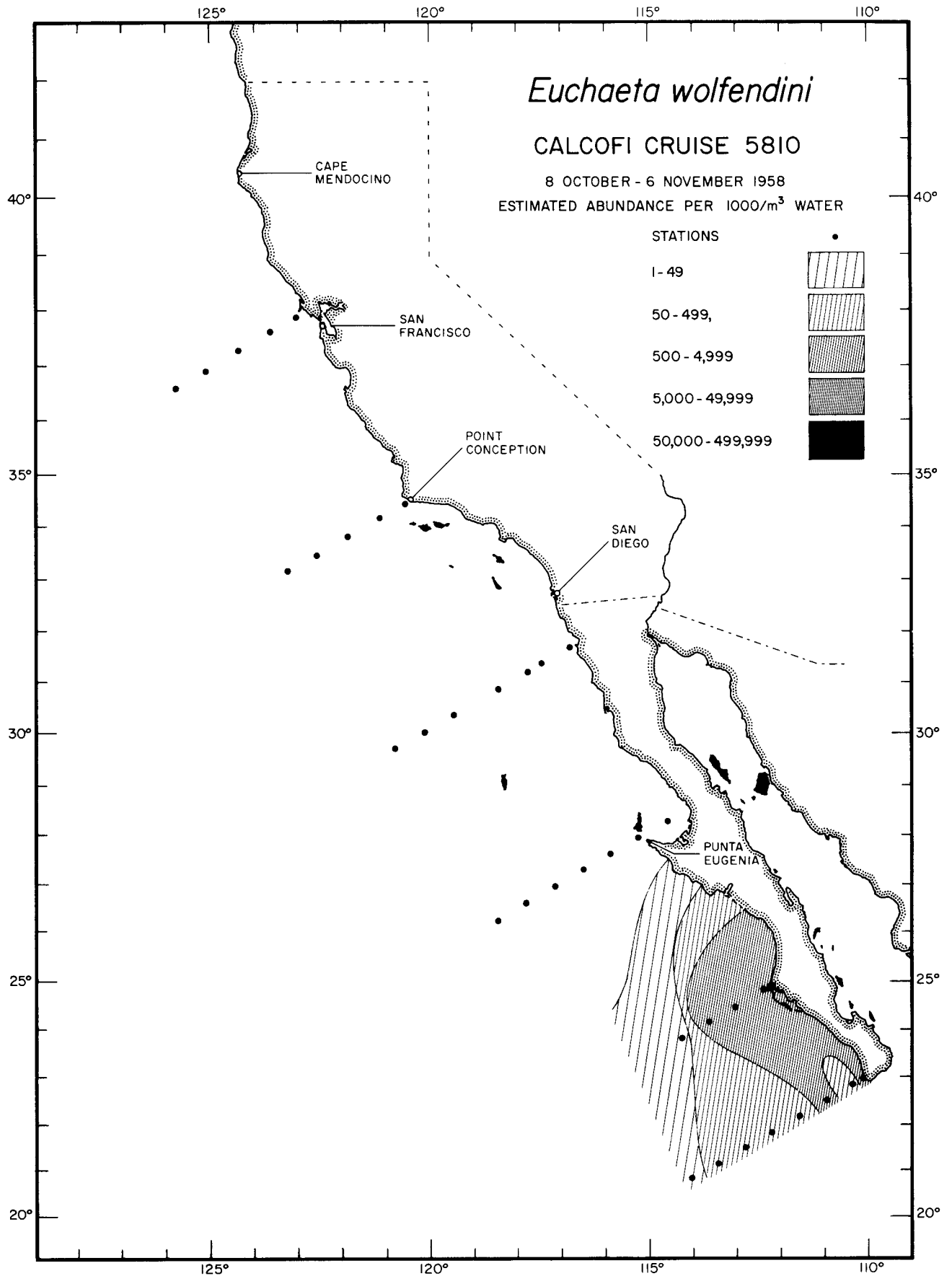
STATIONS

1-49 50-499
□ □
○ ○
⬡ ⬡

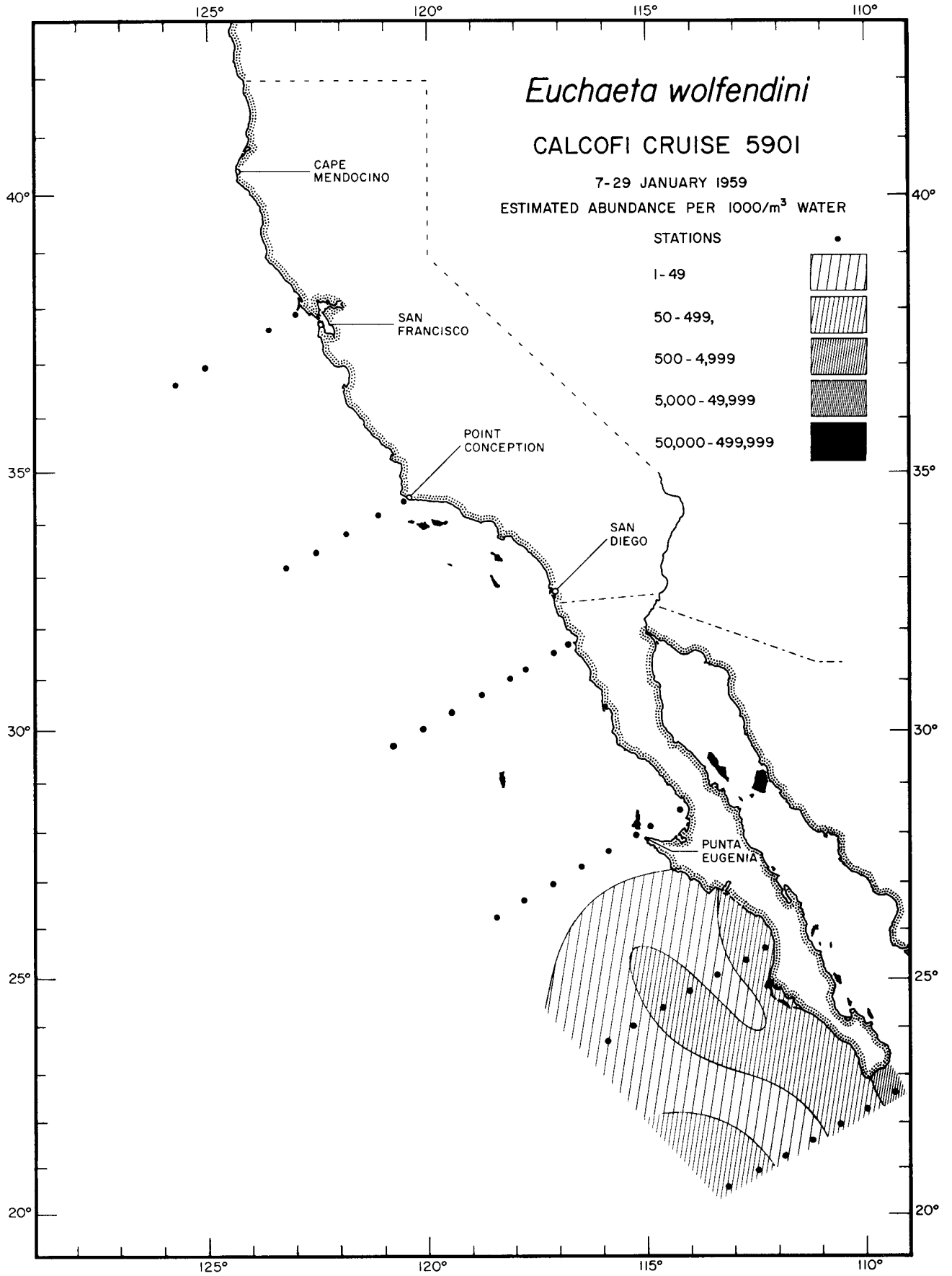
Calanoida
Euchaeta pubera
Euchaeta spinosa
Euchaeta tenuis
5901



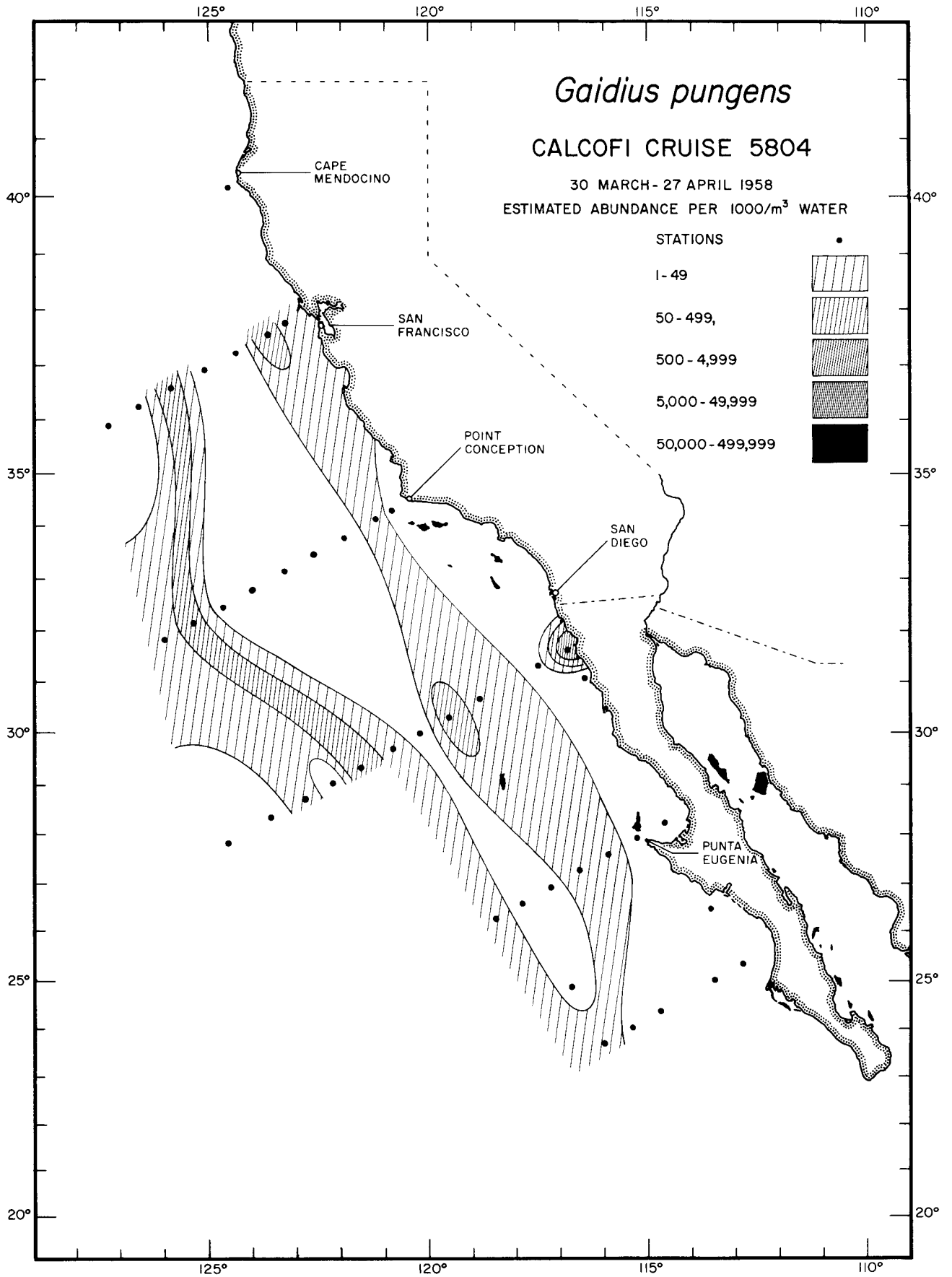
Calanoida
Euchaeta wolfendini
5804

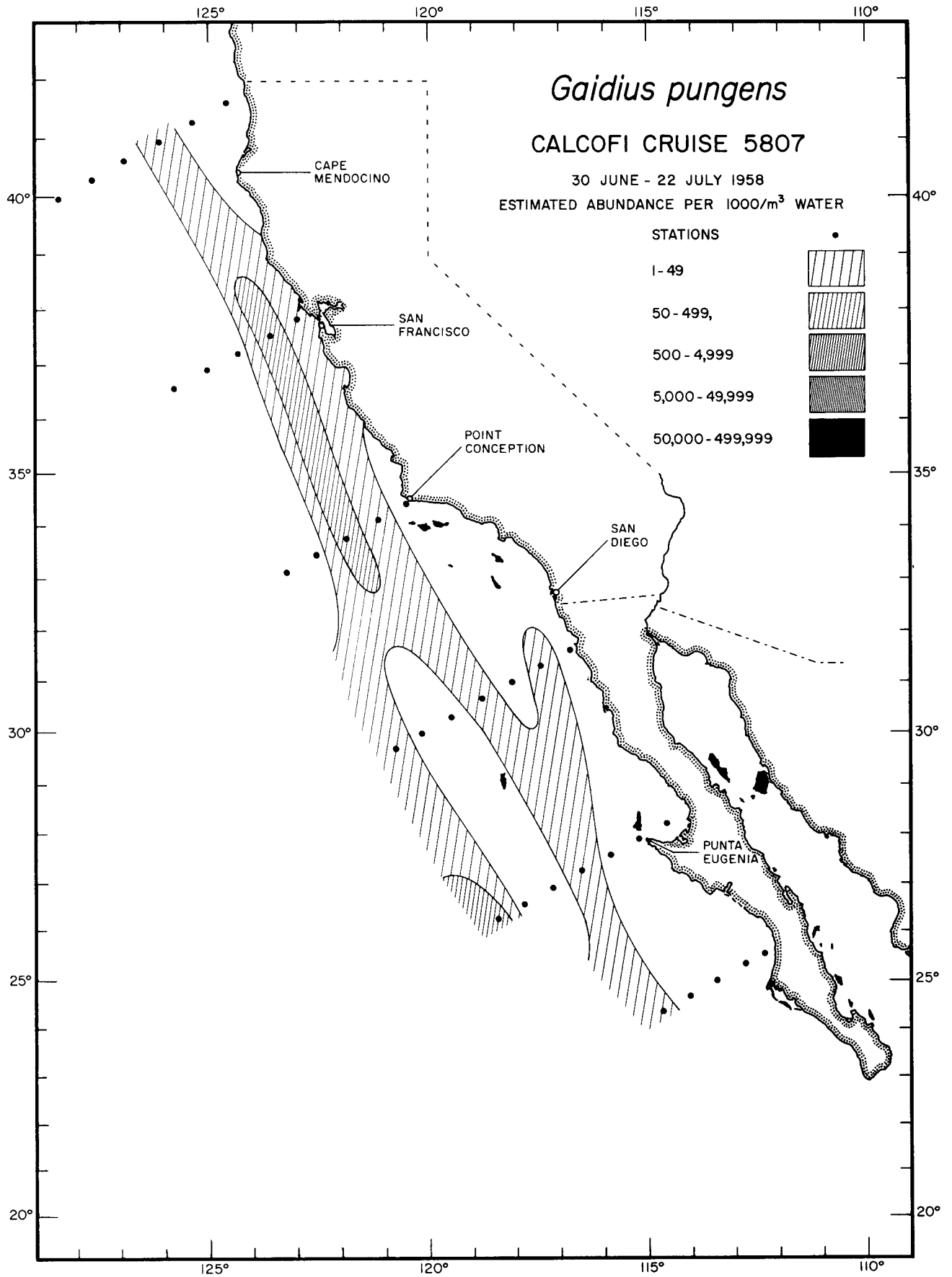


Calanoida
Euchaeta wolfendini
5810

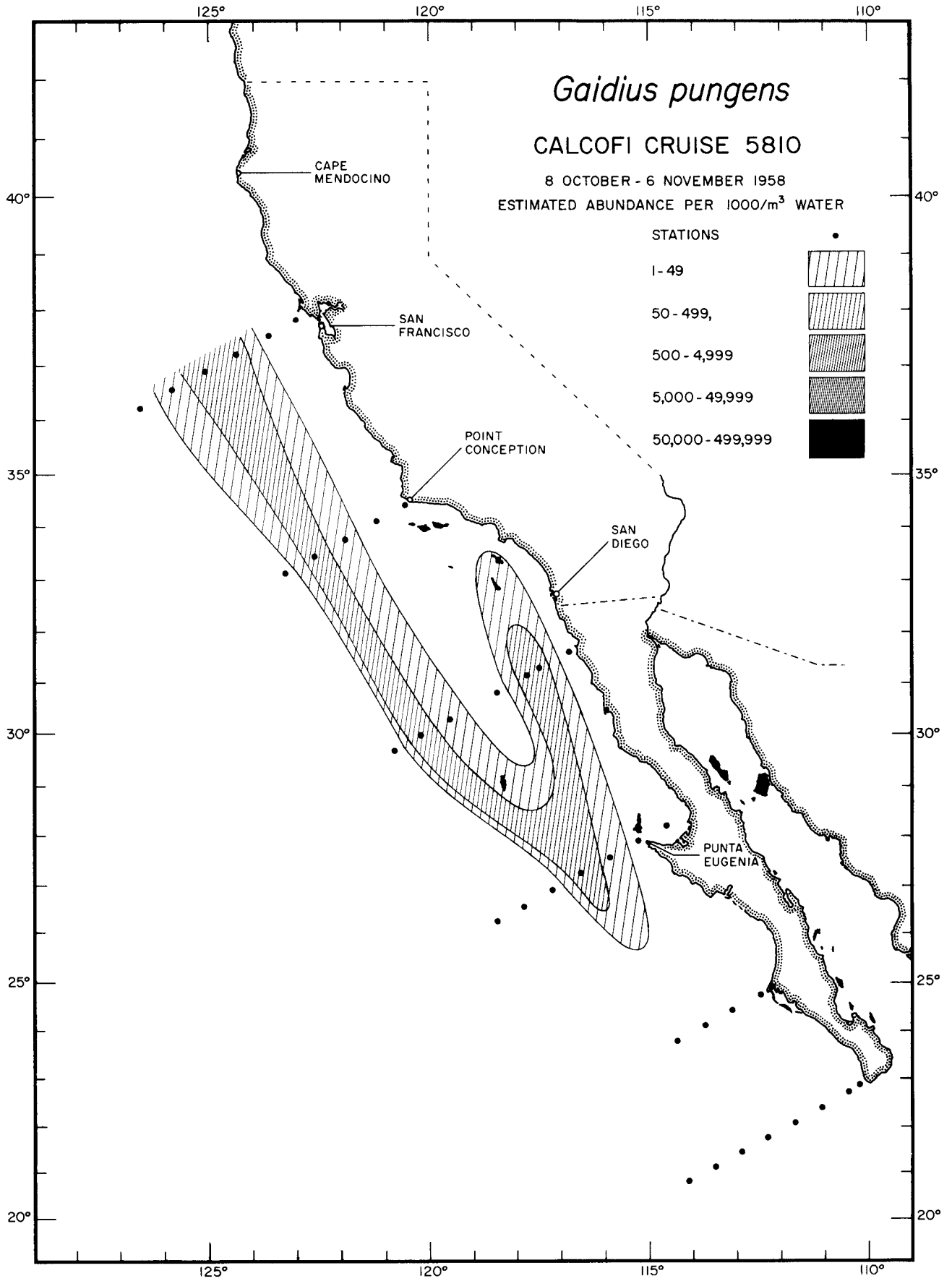


Calanoida
Euchaeta wolfendini
5901

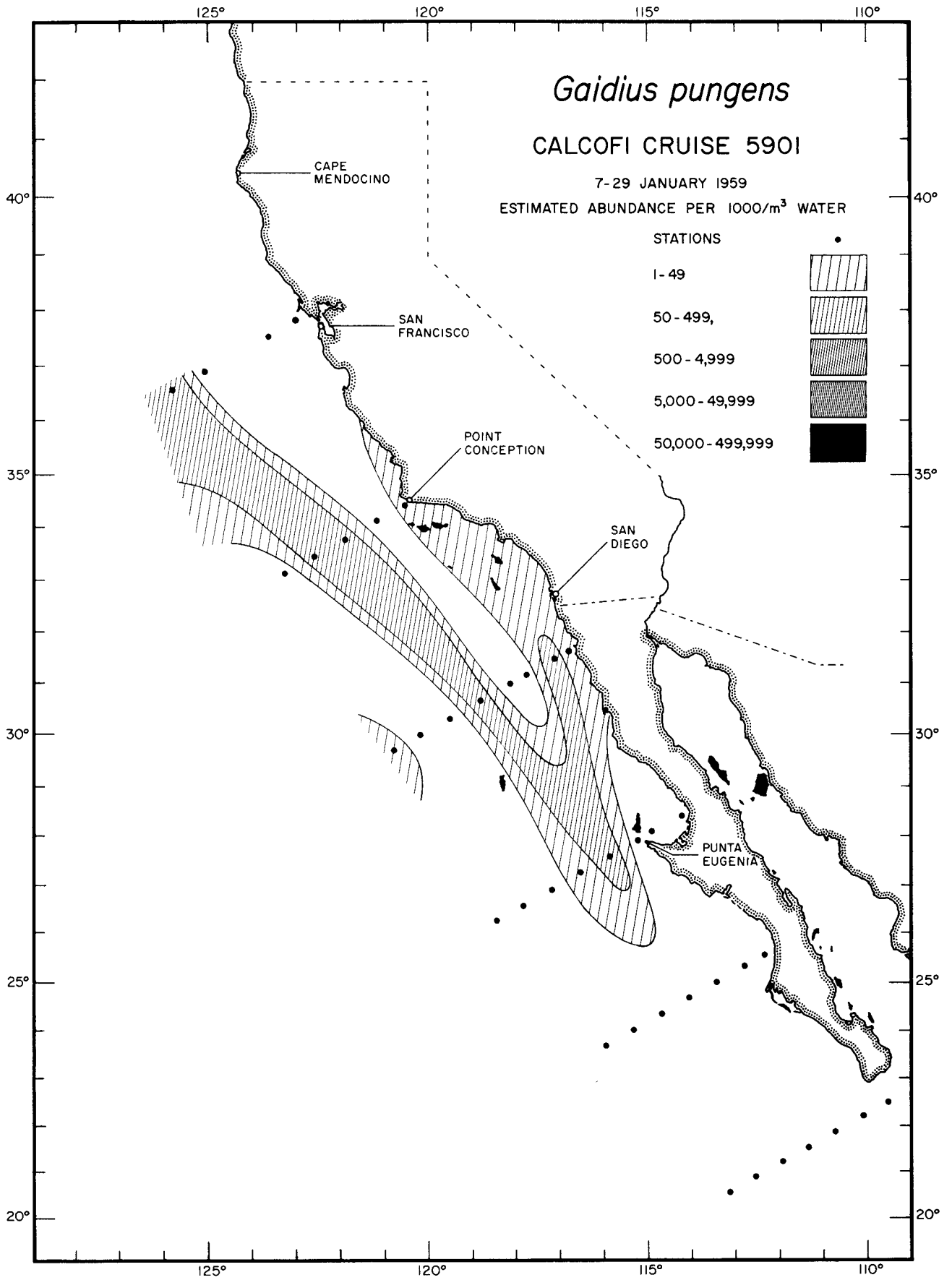




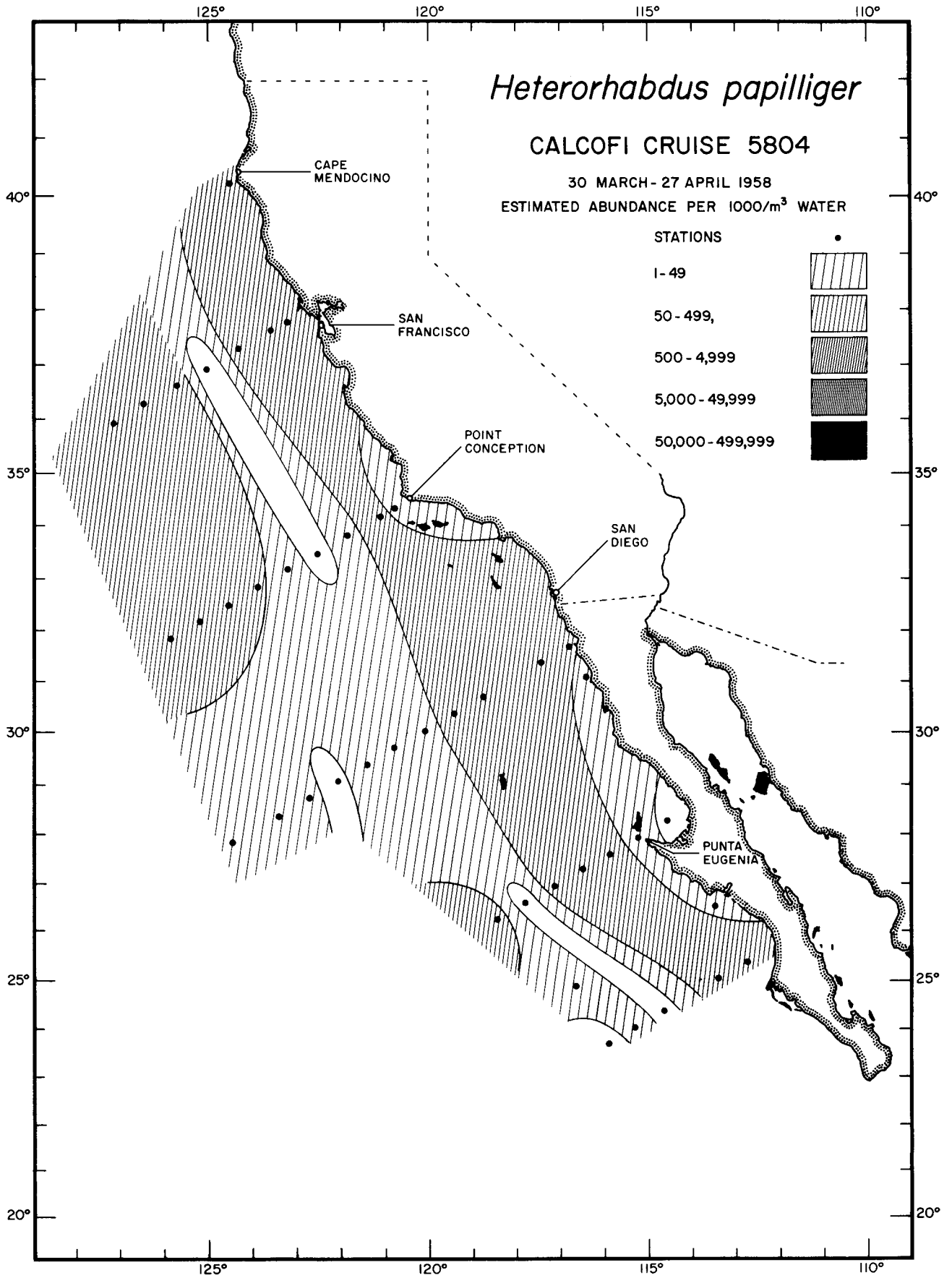
Calanoida
Gaidius pungens
5807



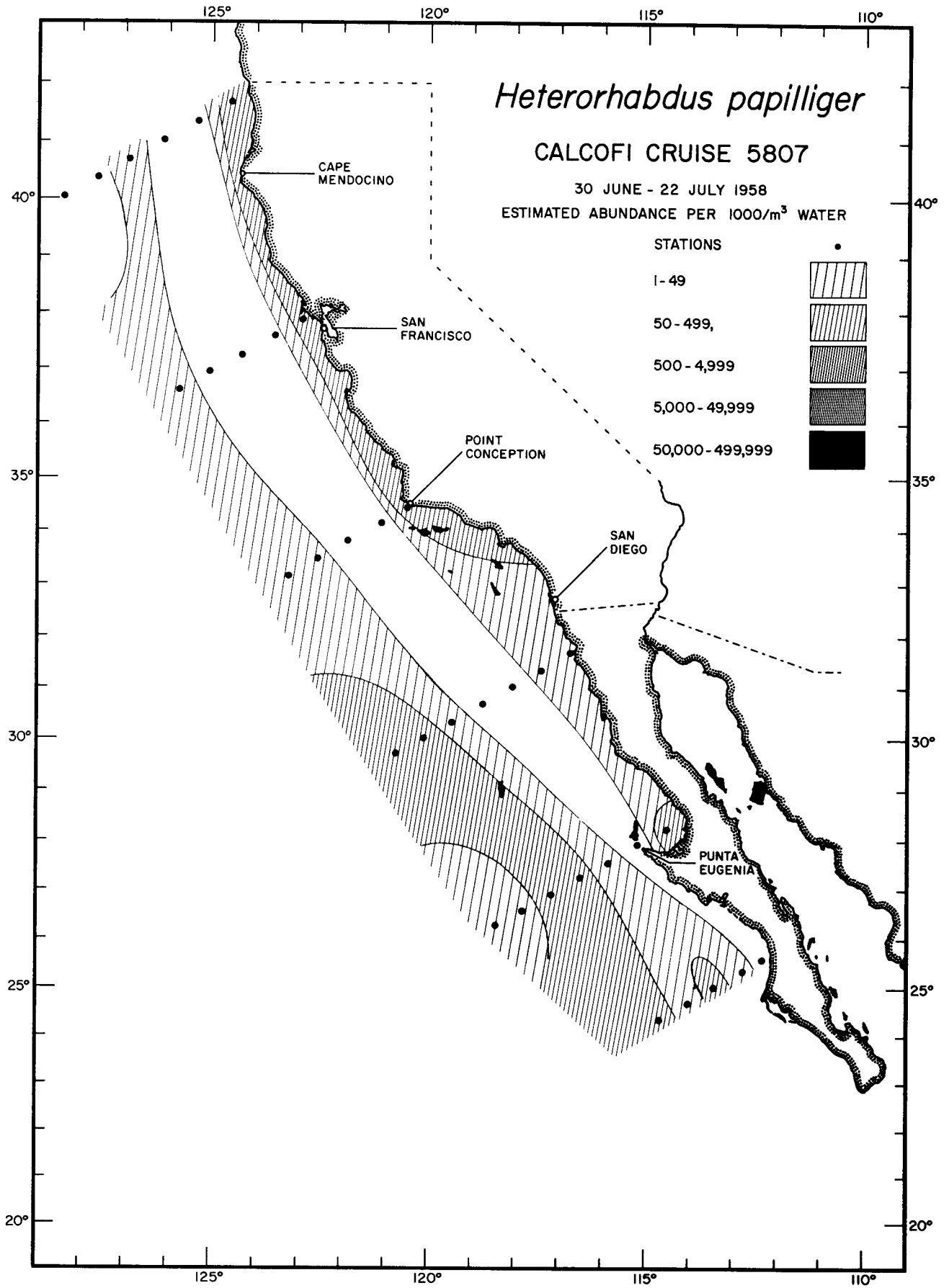
Calanoida
Gaidius pungens
5810



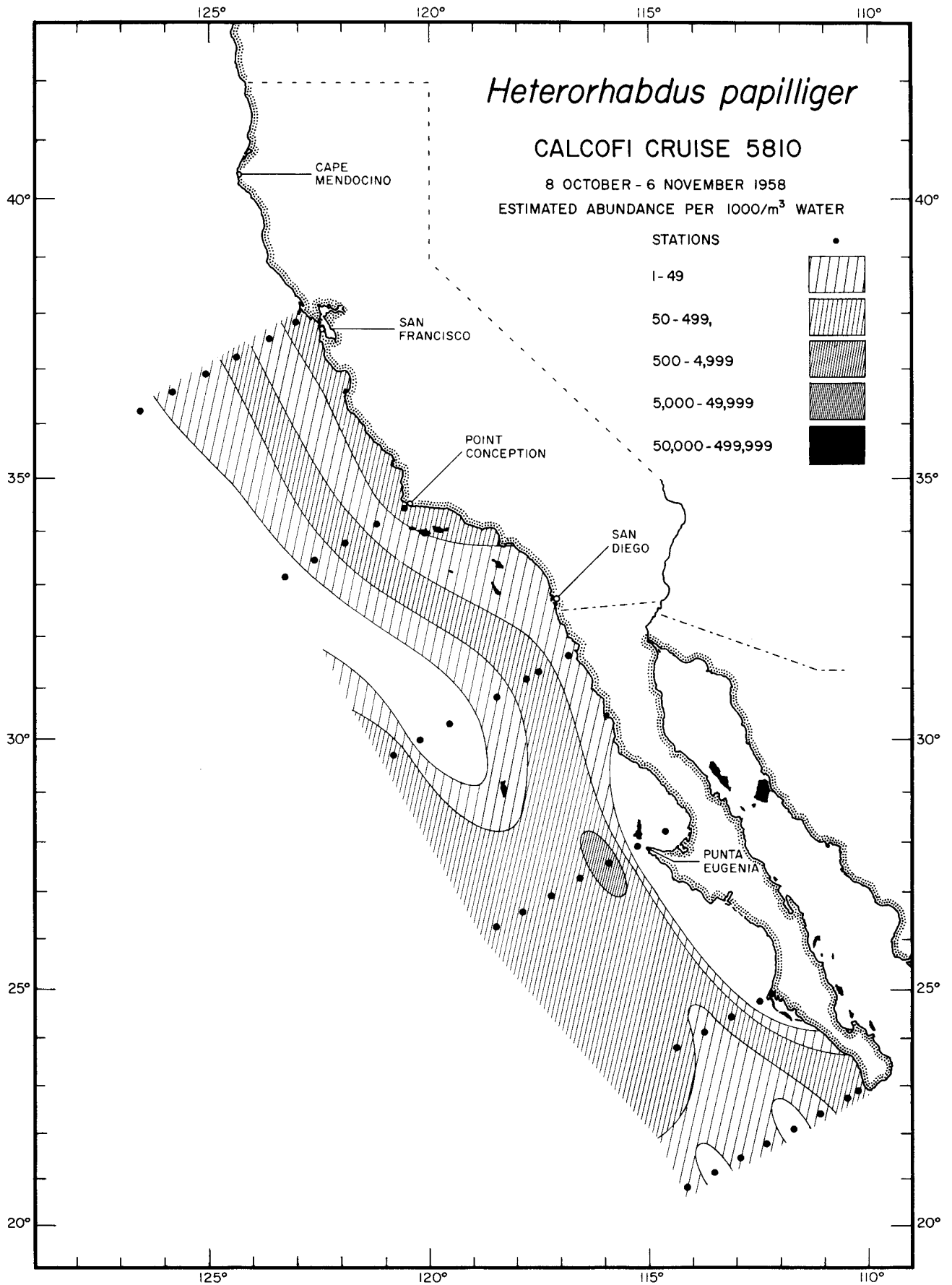
Calanoida
Gaidius pungens
5901



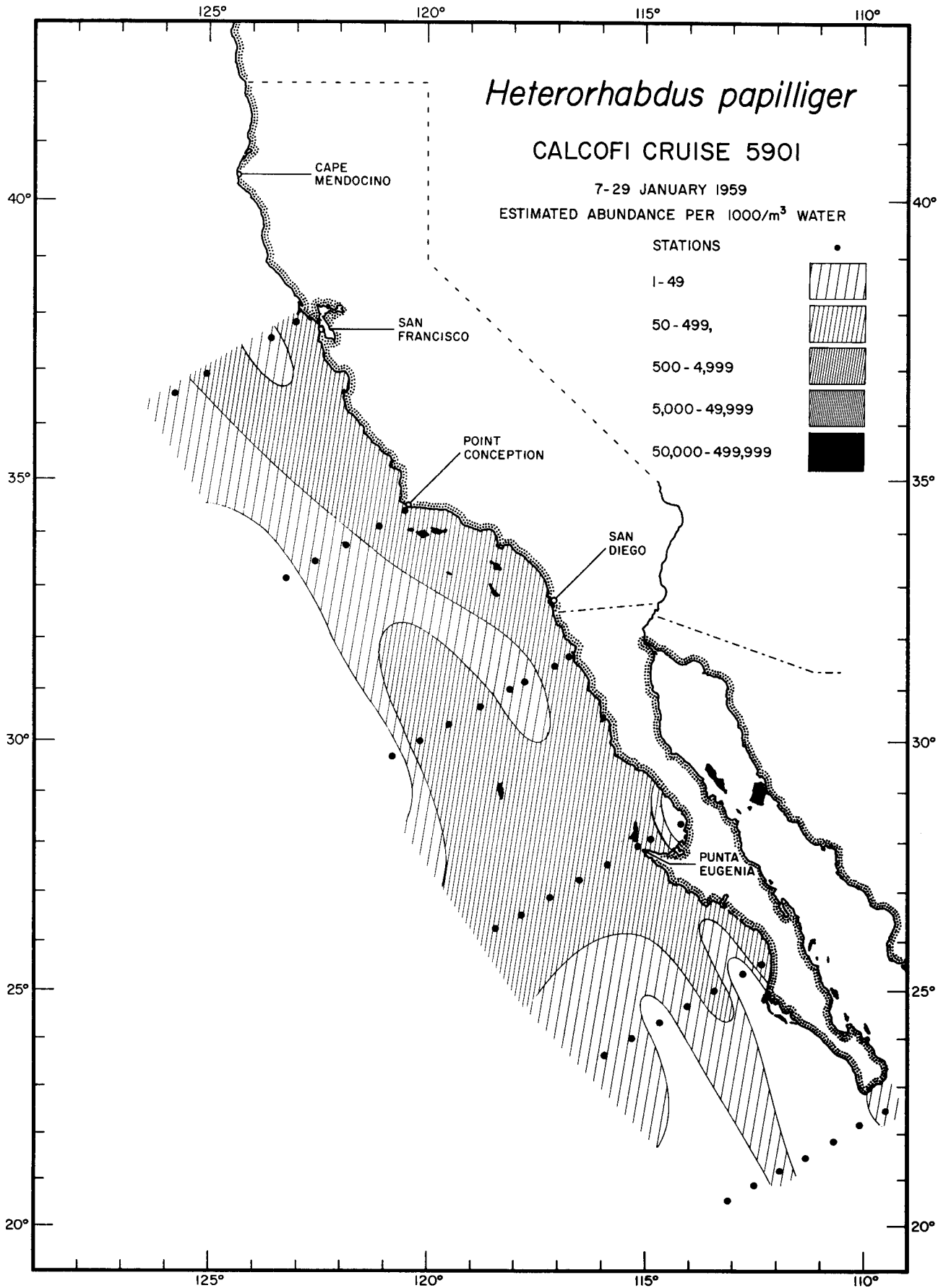
Calanoida
Heterorhabdus papilliger
5804



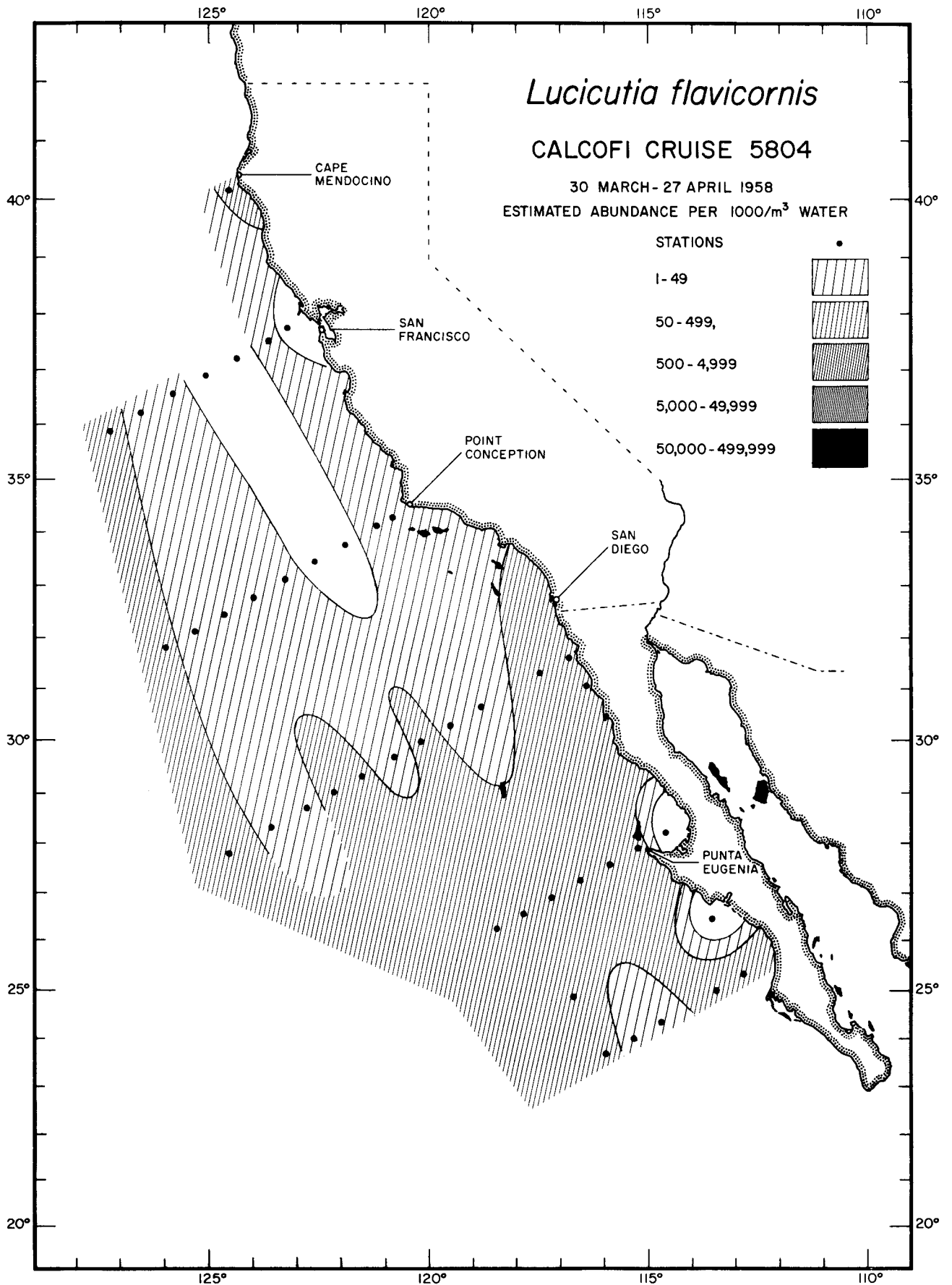
Calanoida
Heterorhabdus papilliger
5807

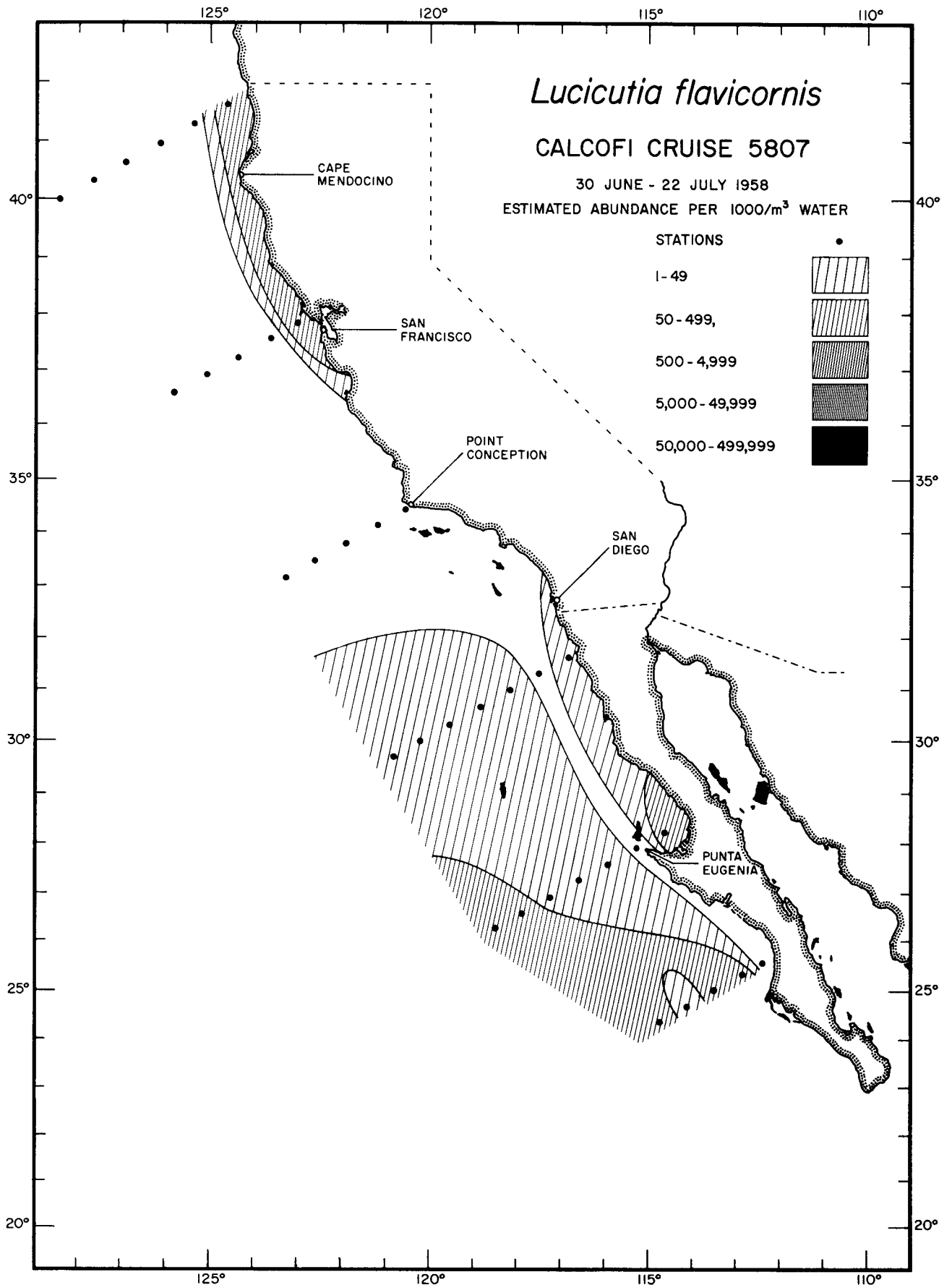


Calanoida
Heterorhabdus papilliger
5810

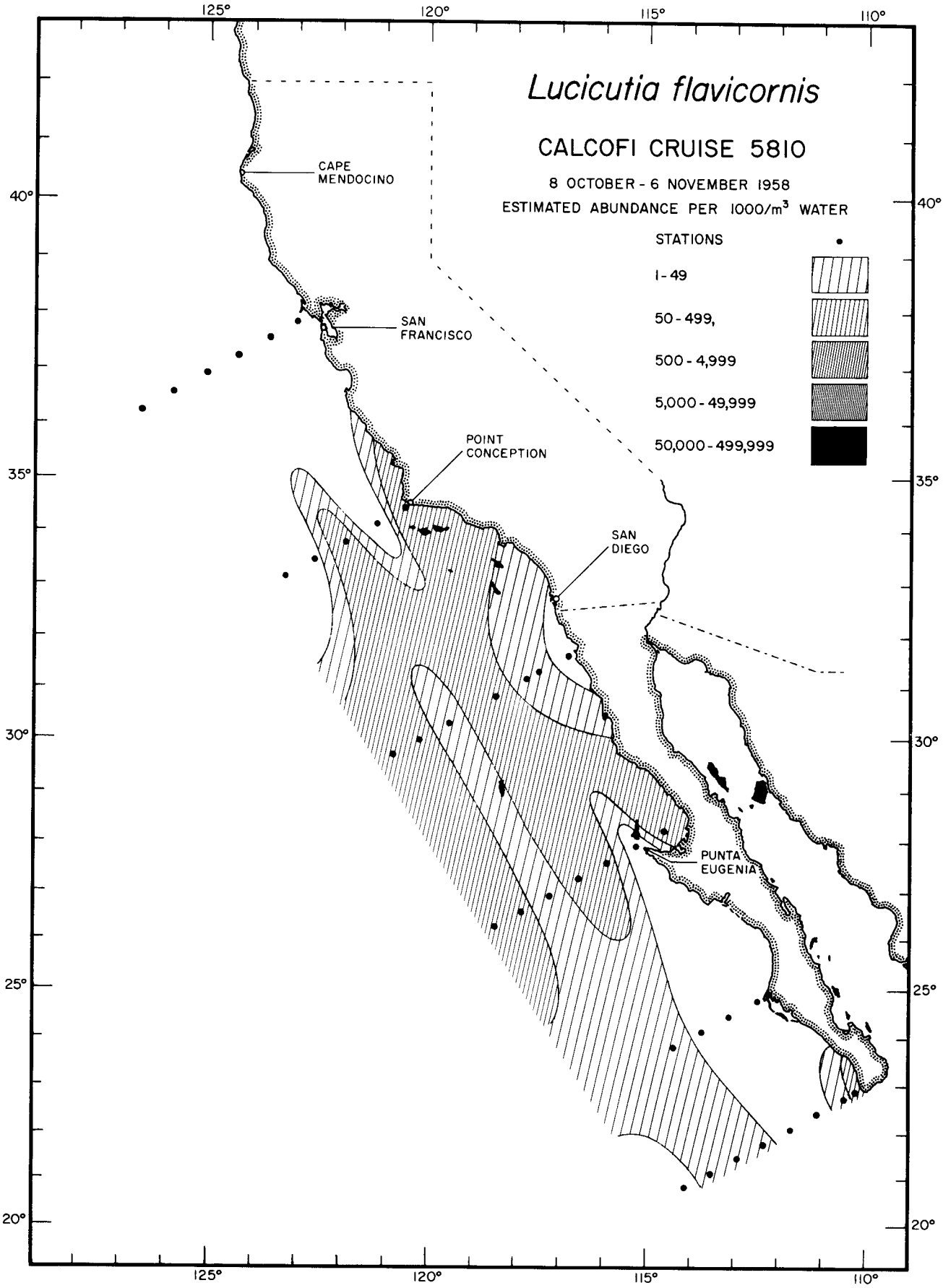


Calanoida
Heterorhabdus papilliger
5901

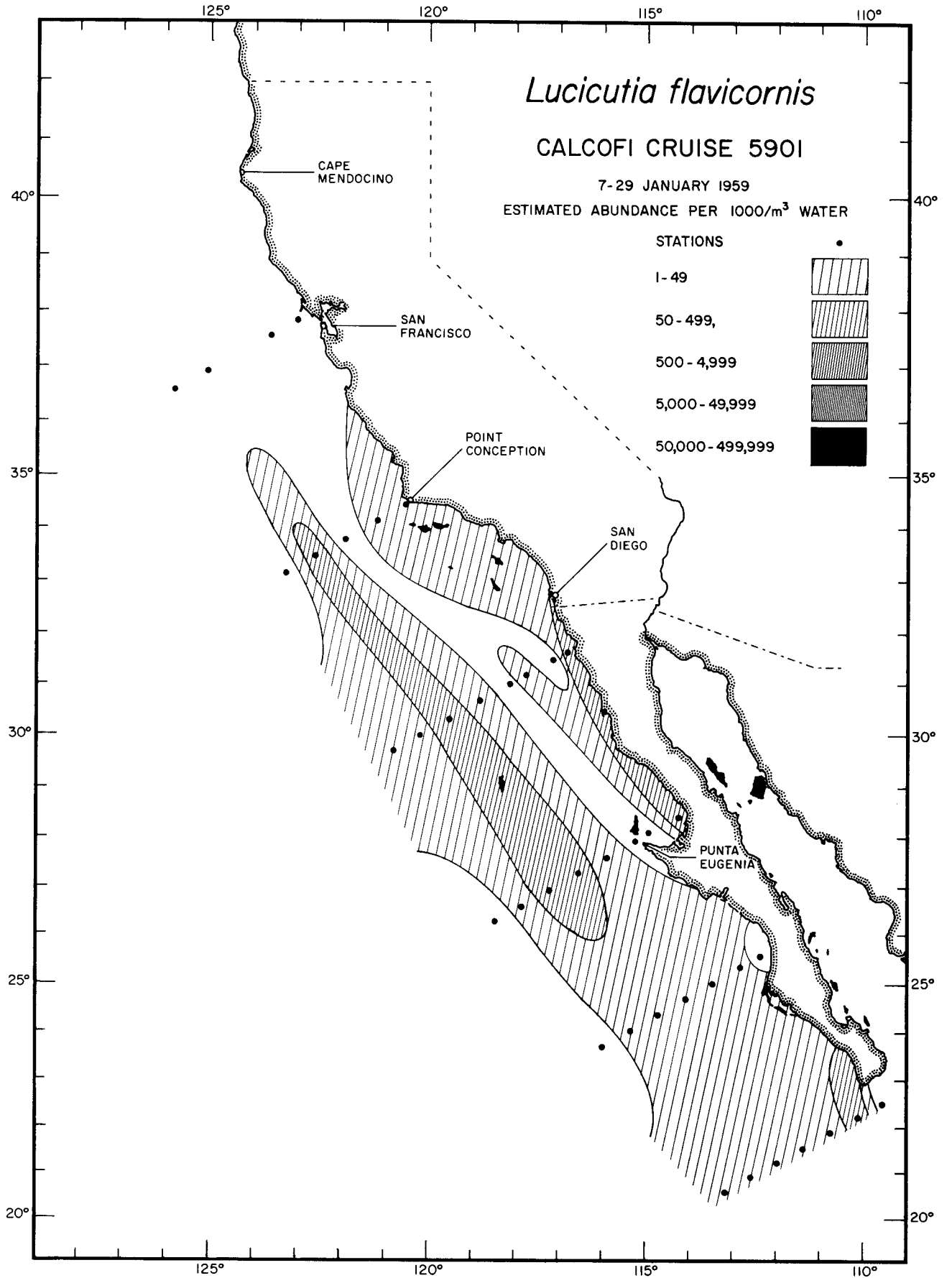




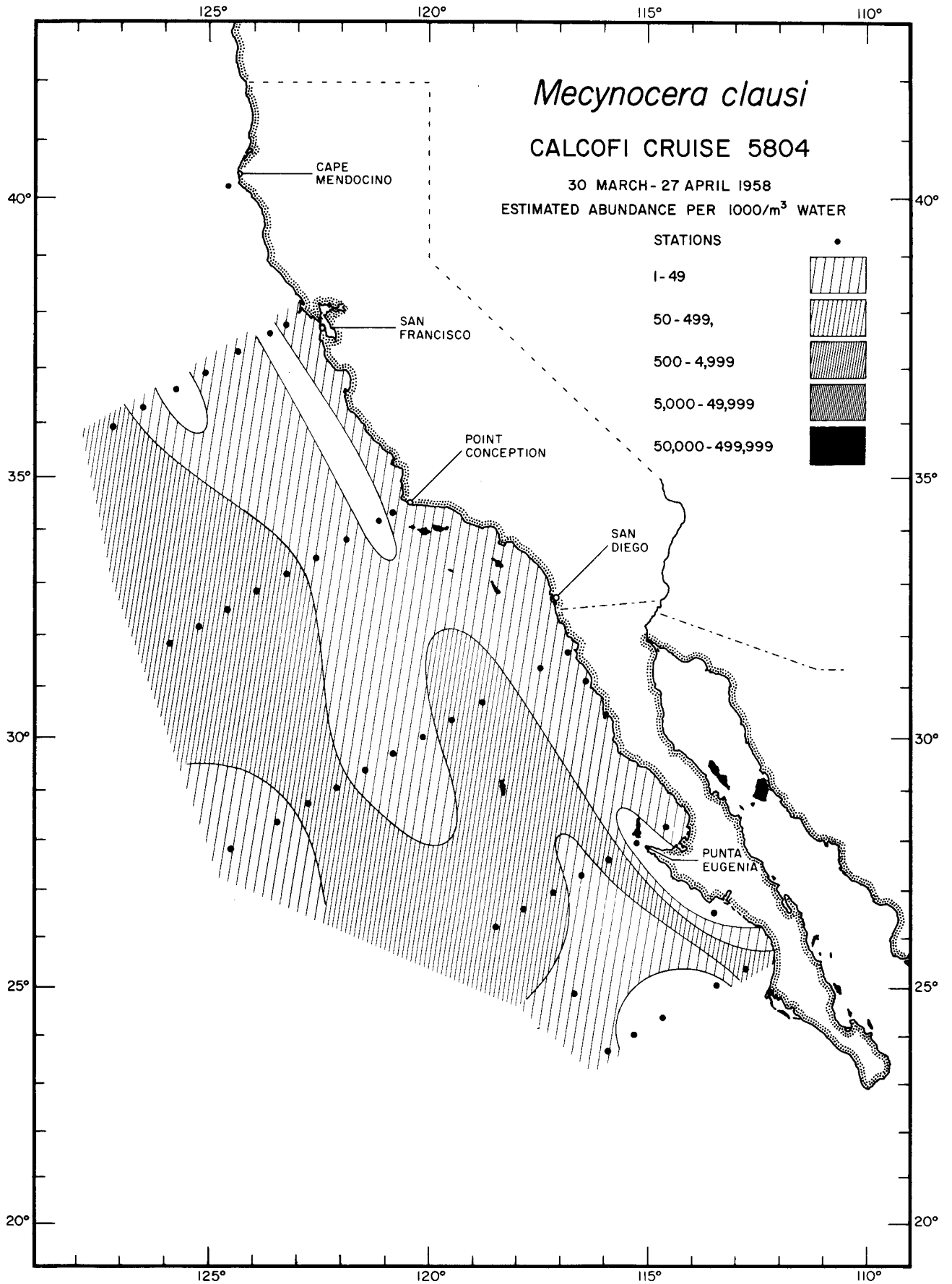
Calanoida
Lucicutia flavicornis
5807

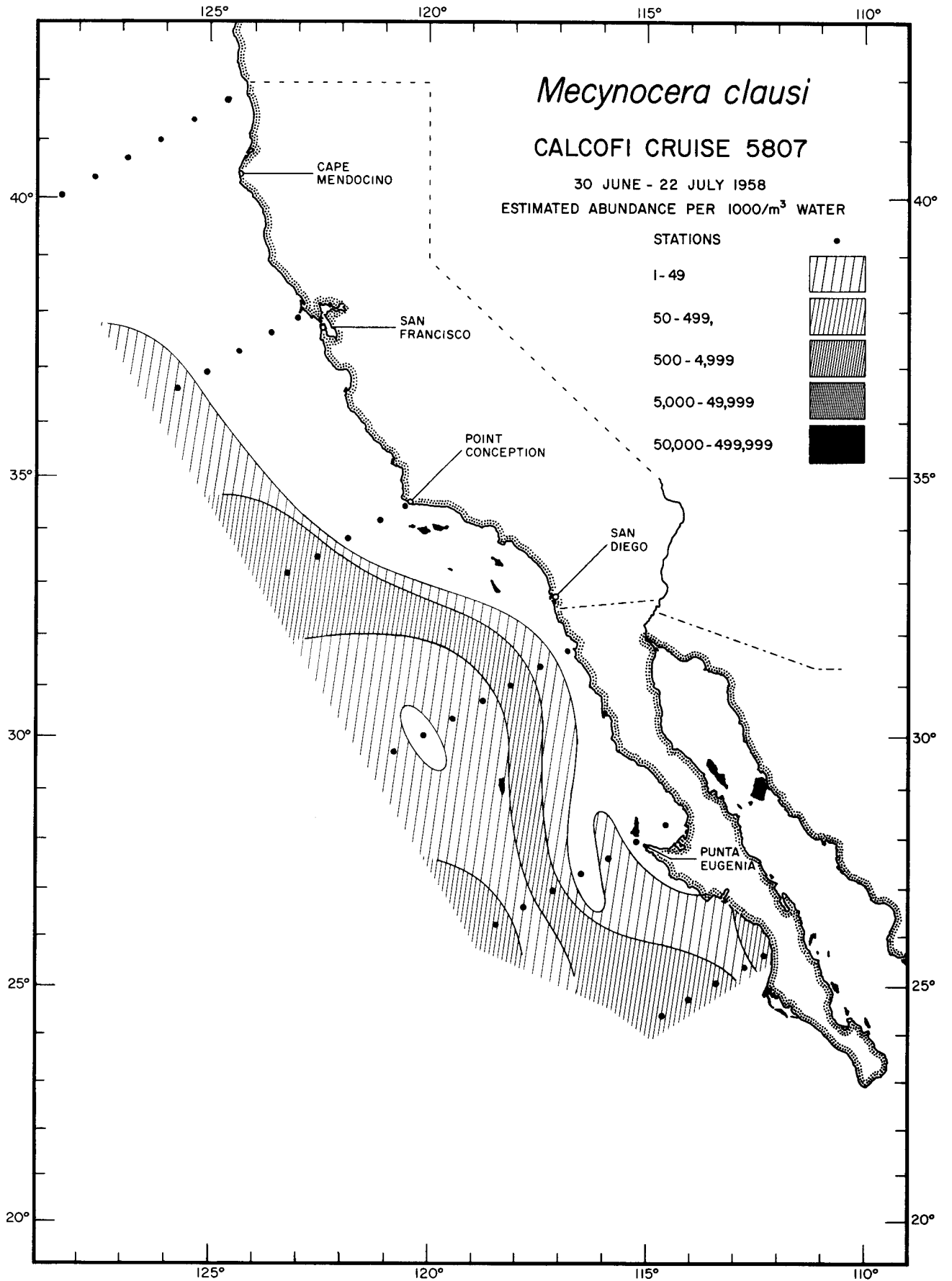


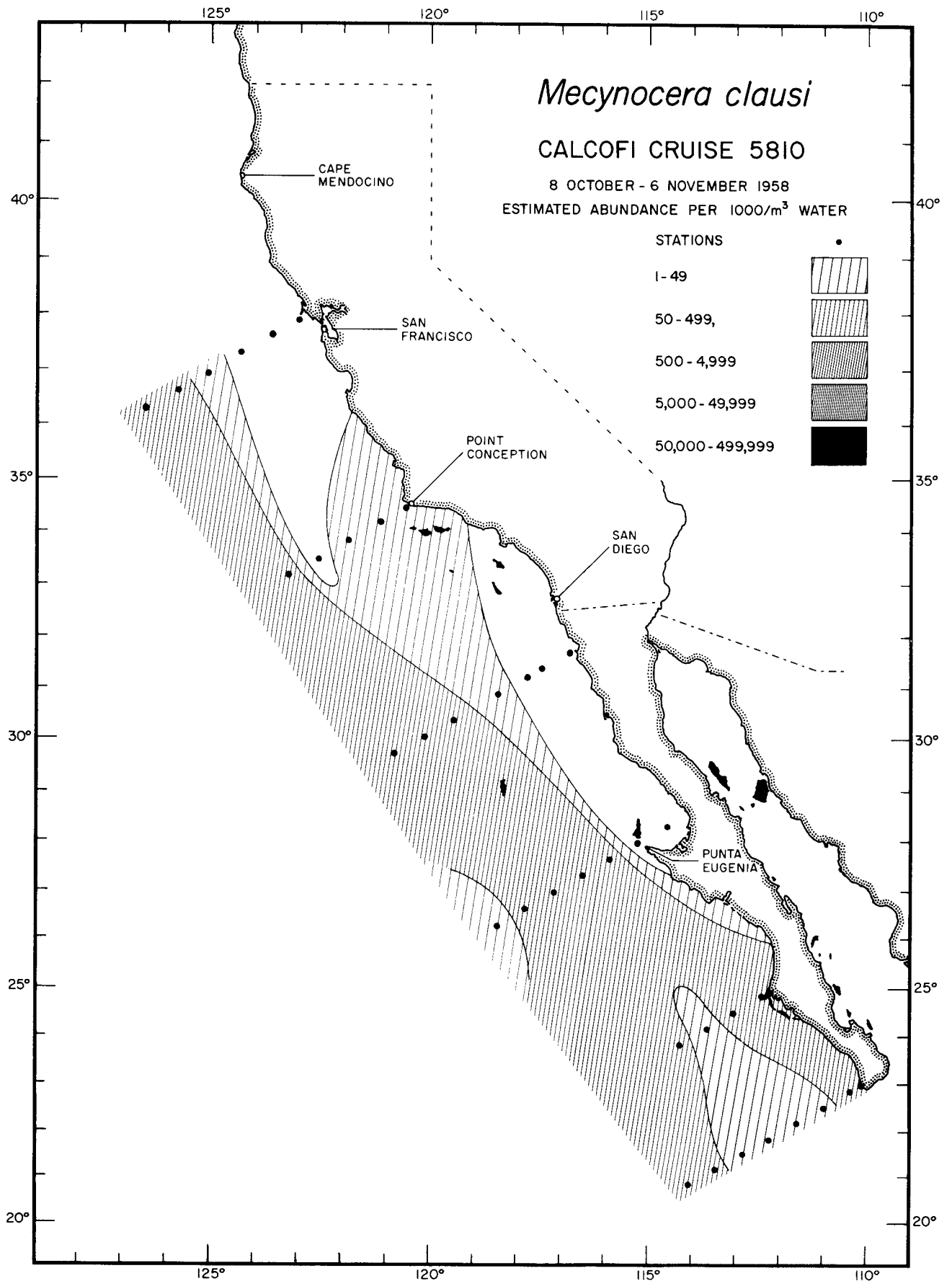
Calanoida
Lucicutia flavicornis
5810



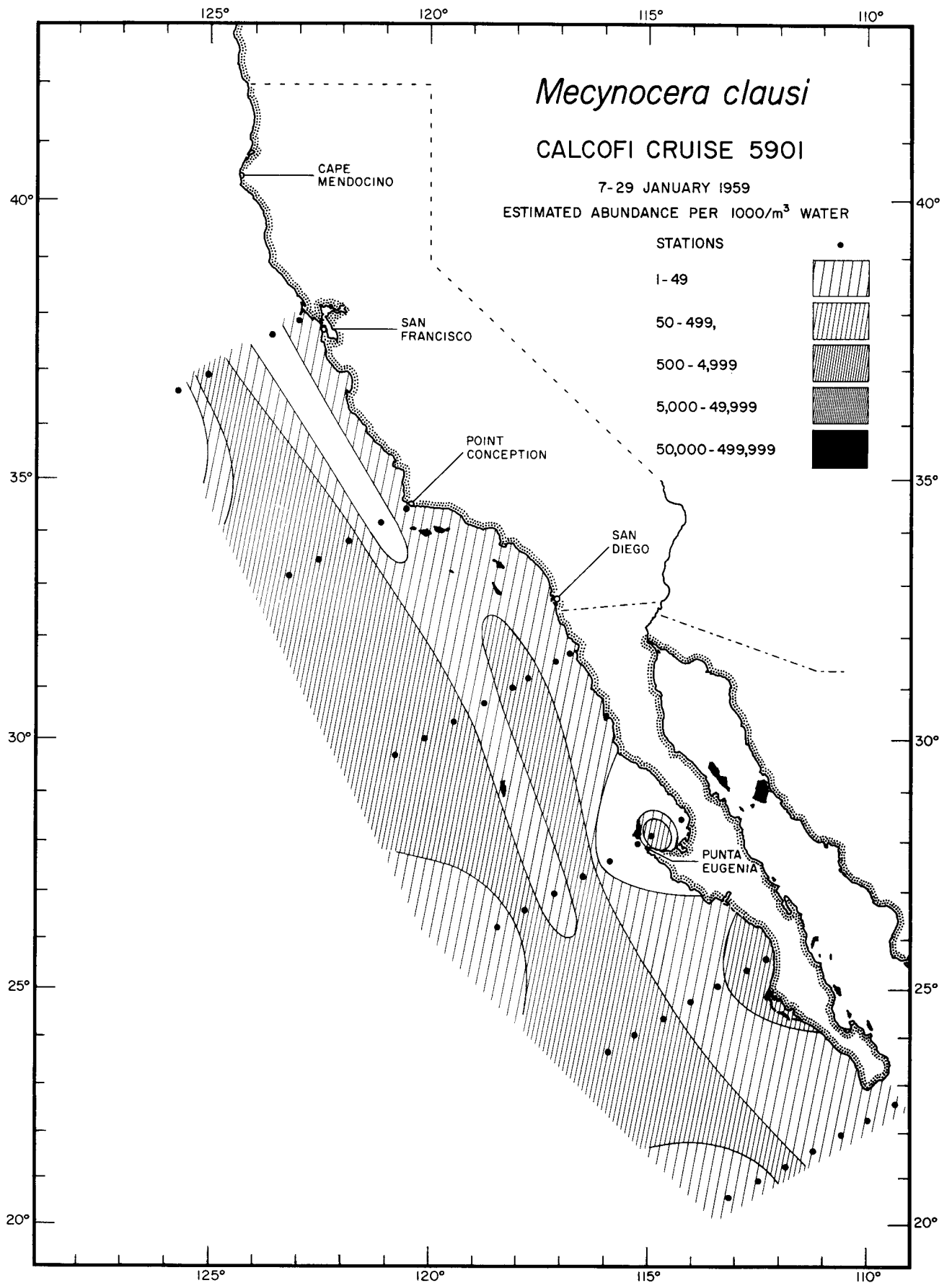
Calanoida
Lucicutia flavicornis
5901



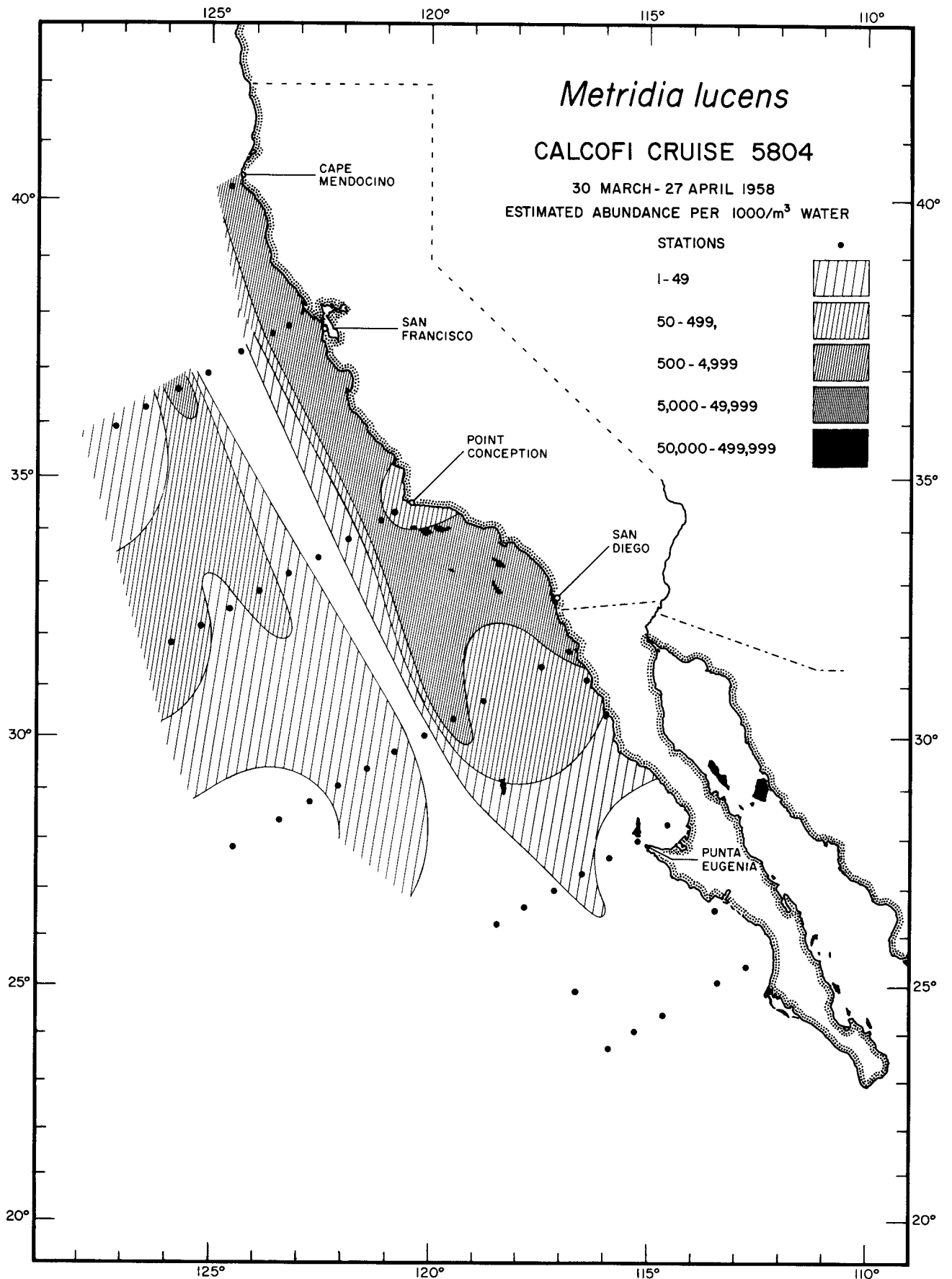


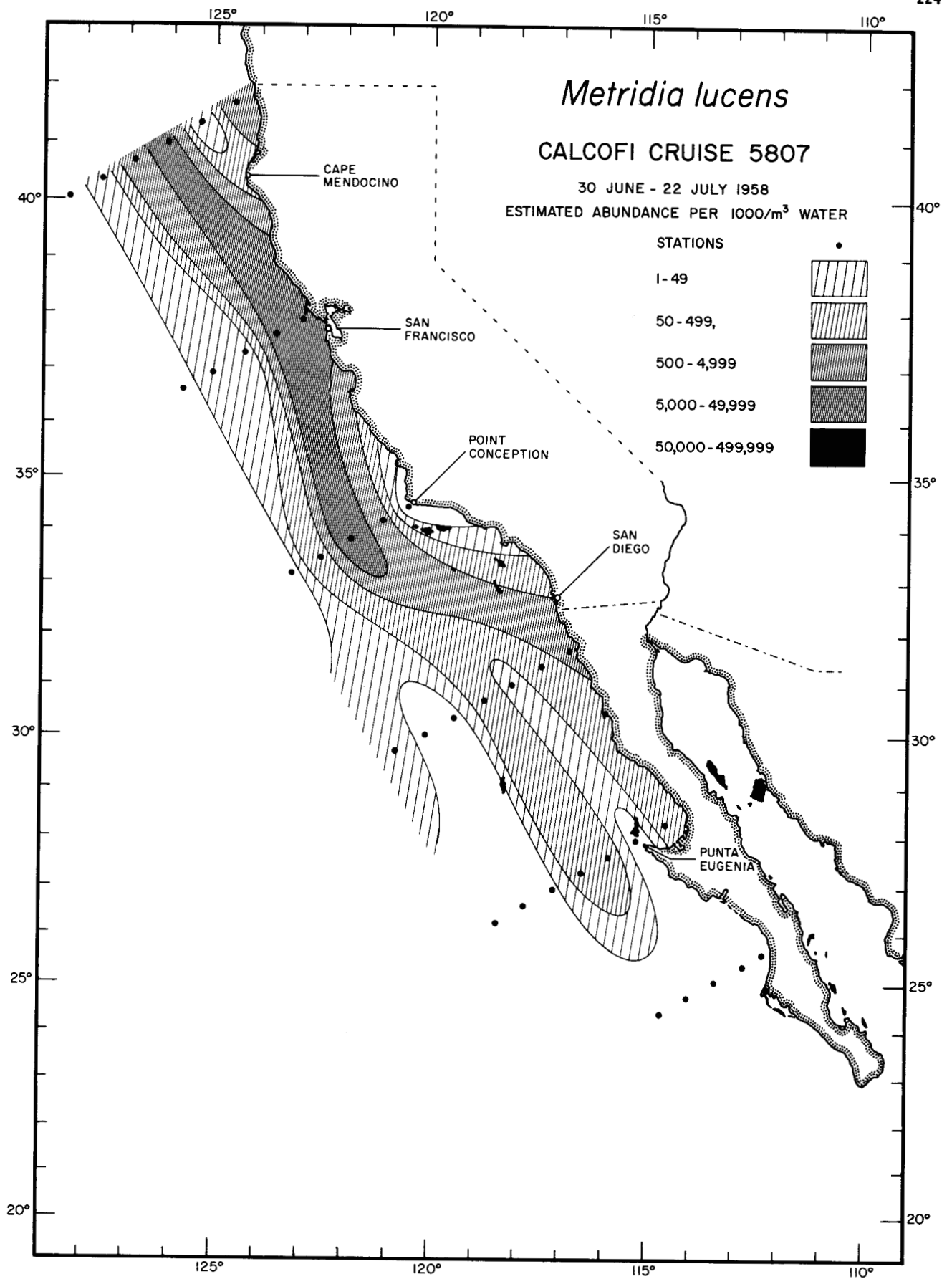


Calanoida
Mecynocera clausi
5810

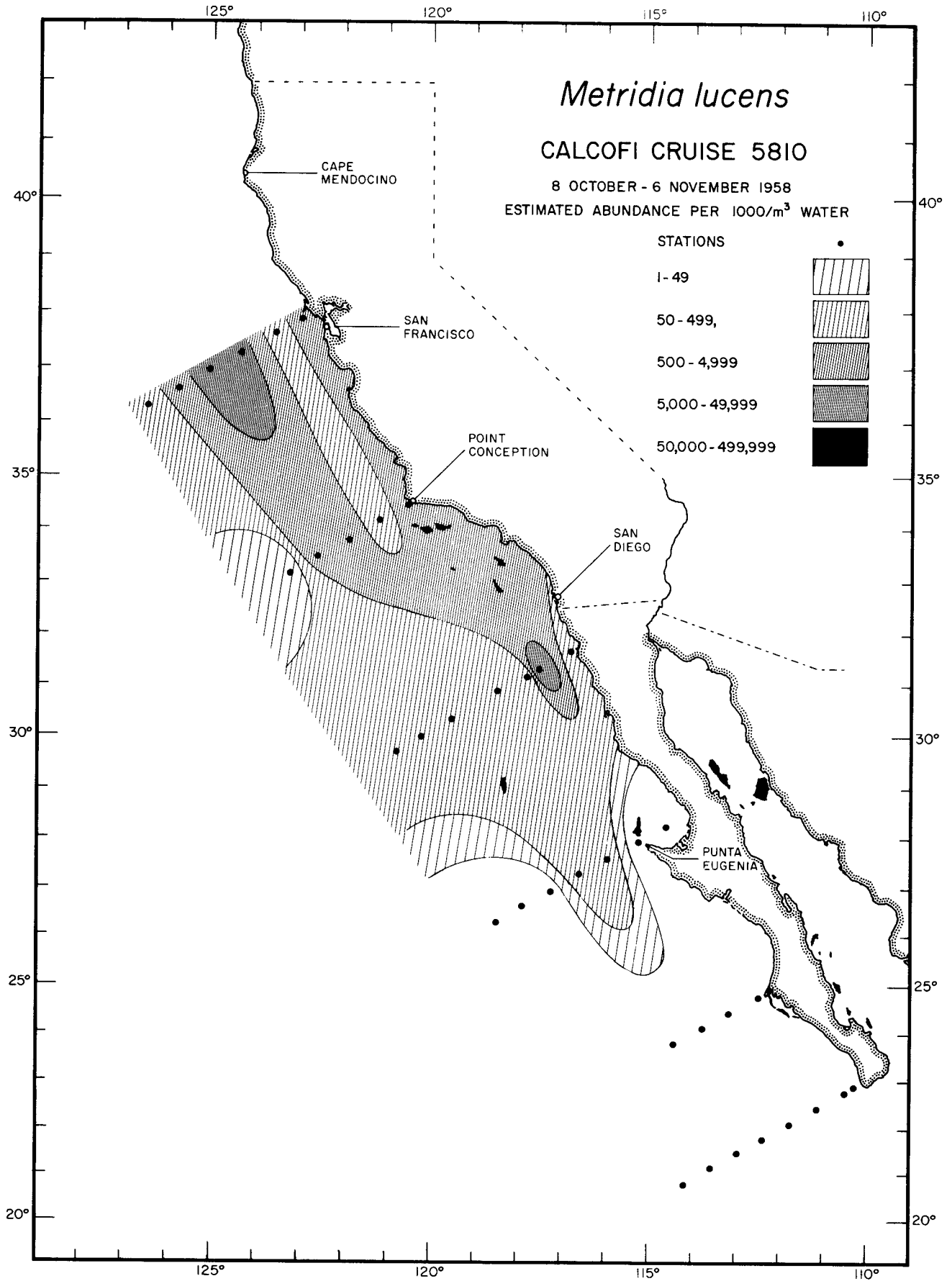


Calanoida
Mecynocera clausi
5901

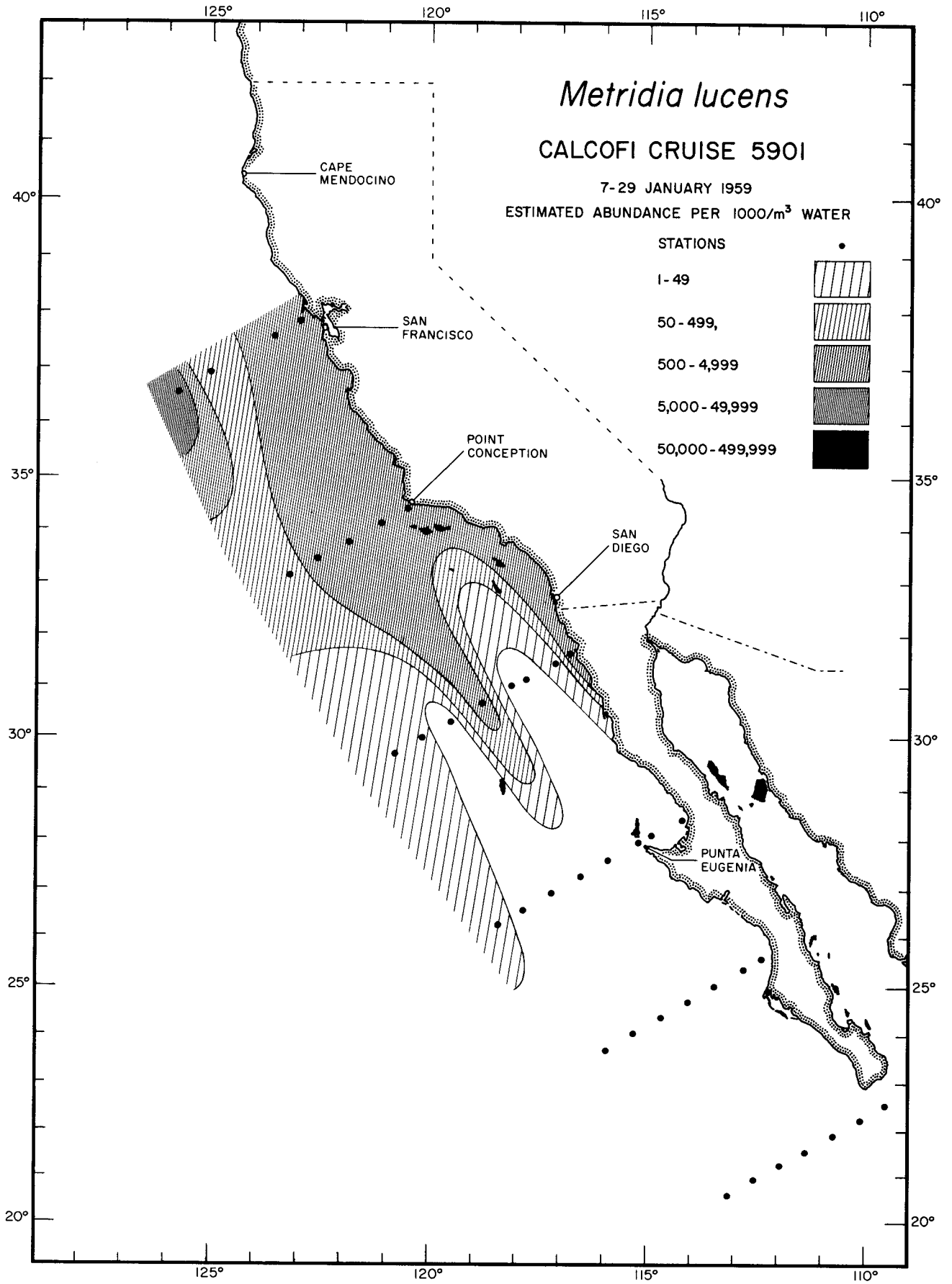


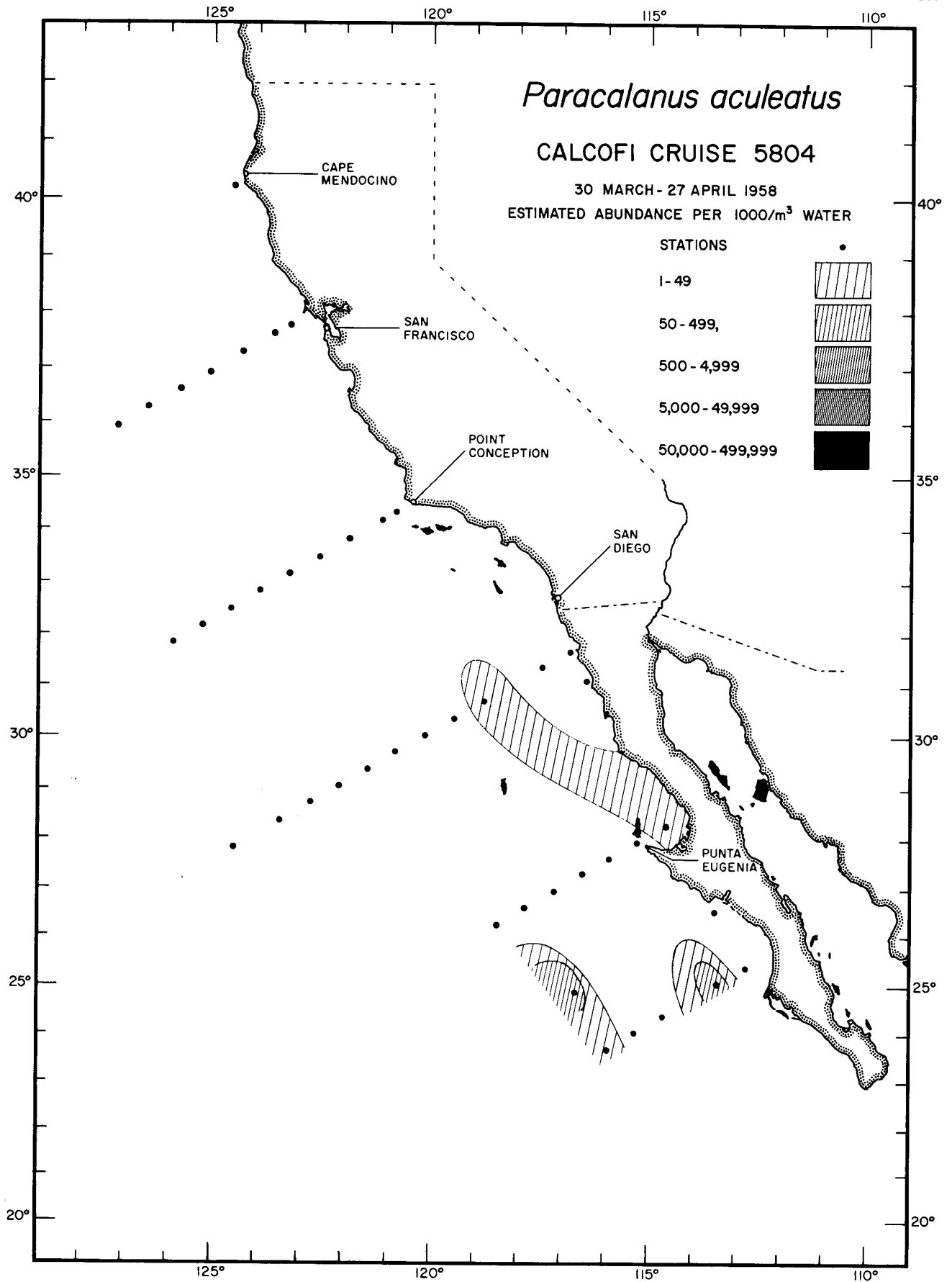


Calanoida
Metridia lucens
5807

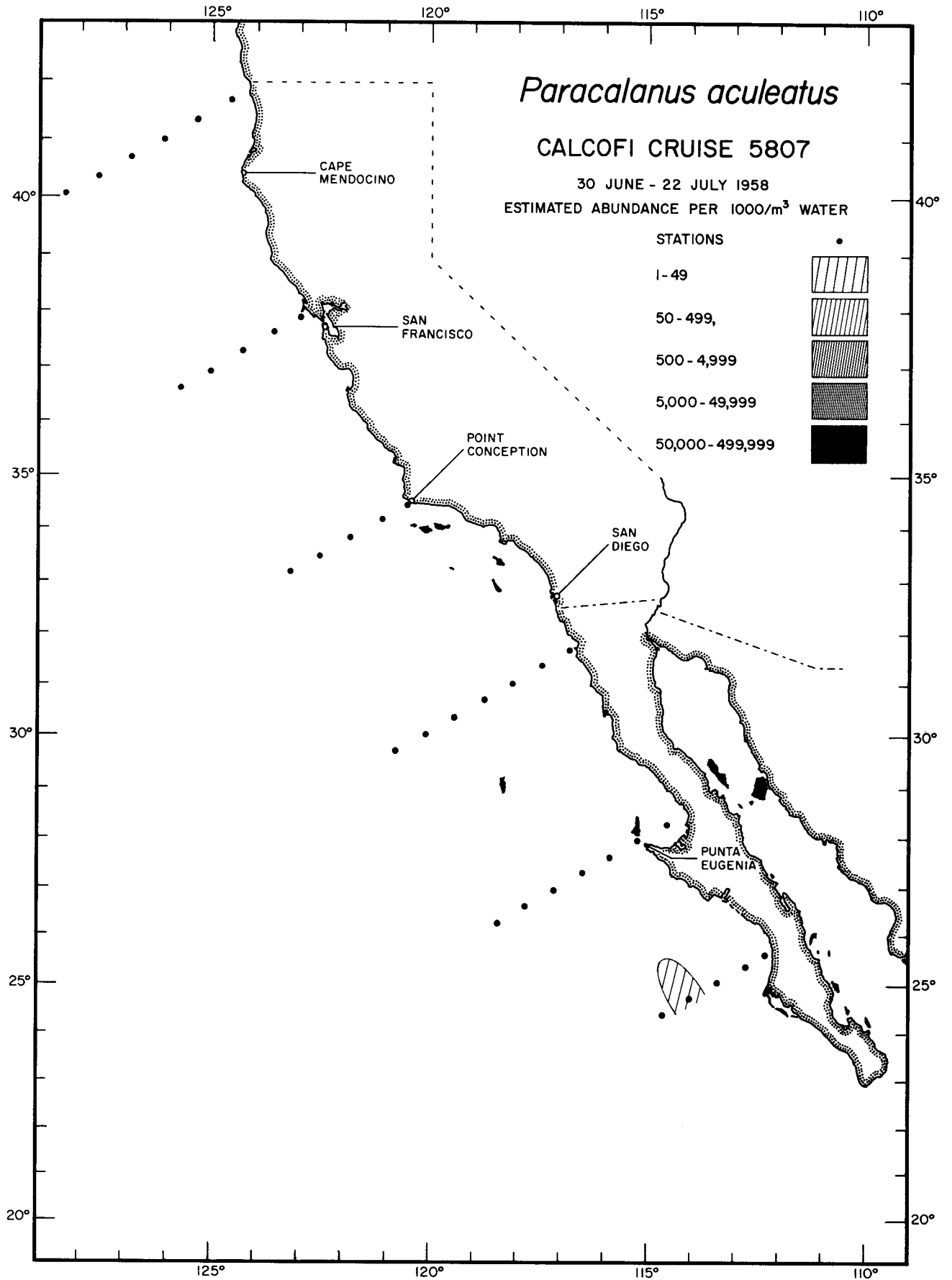


Calanoida
Metridia lucens
5810

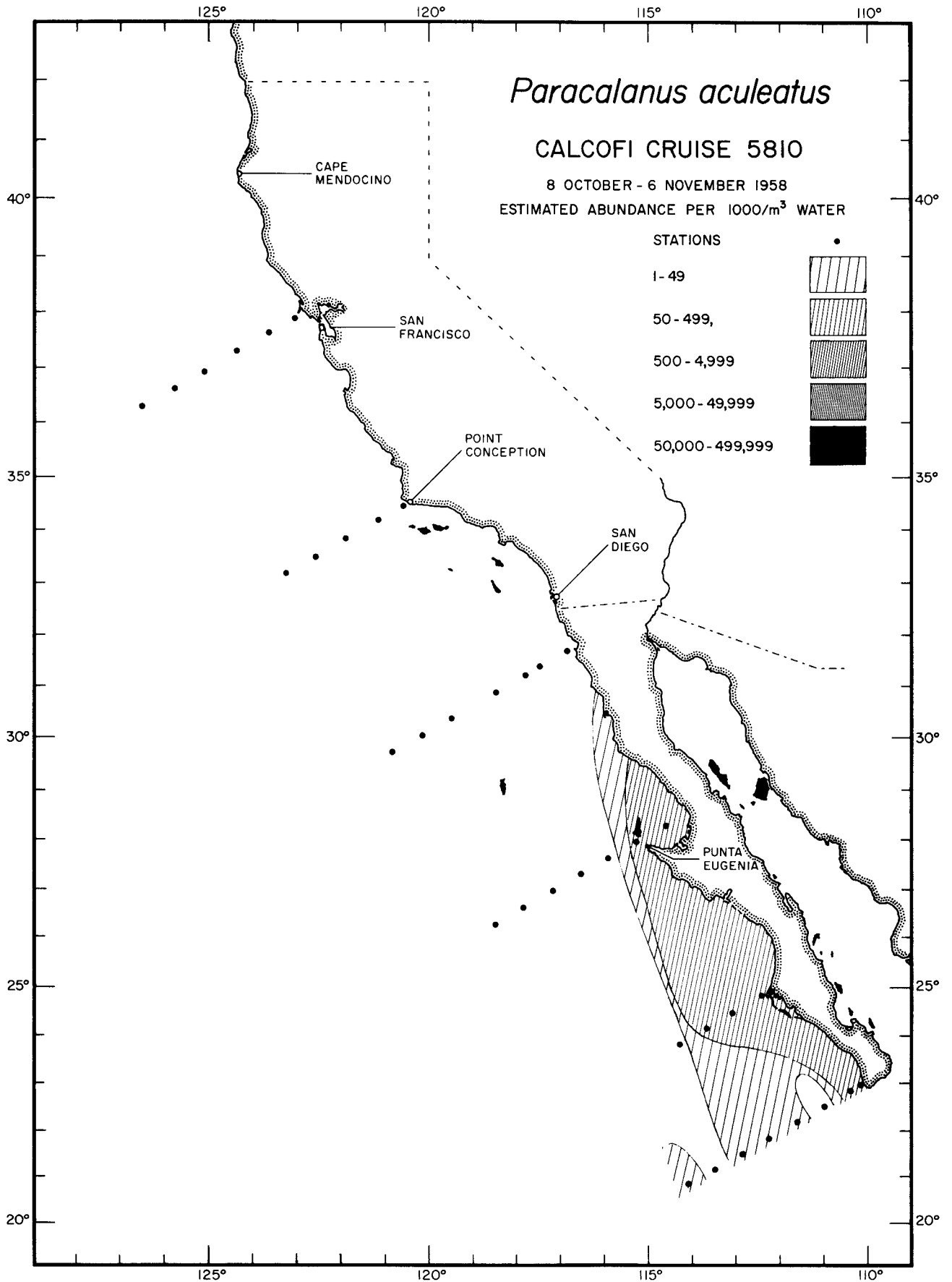




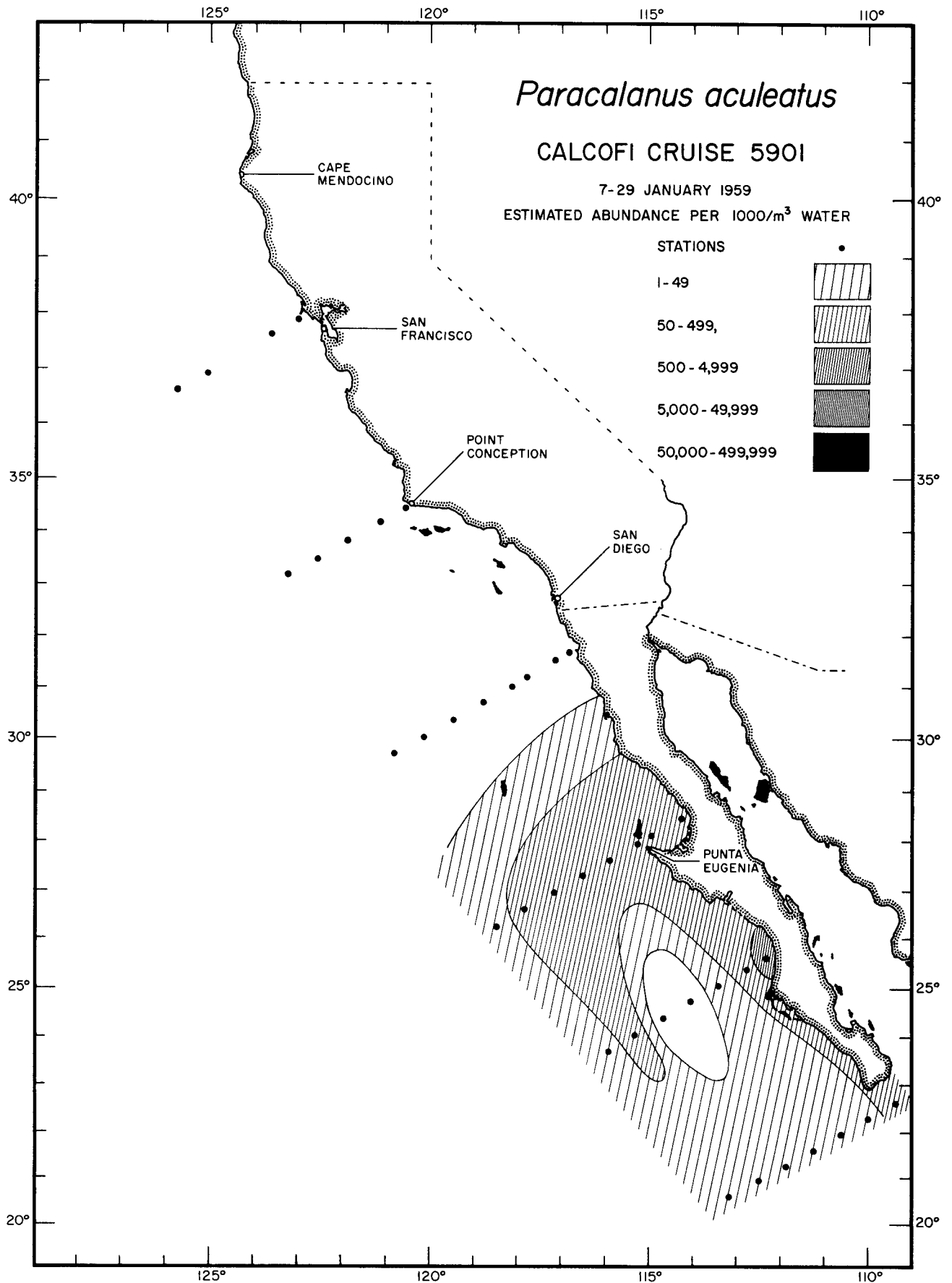
Calanoida
Paracalanus aculeatus
5804



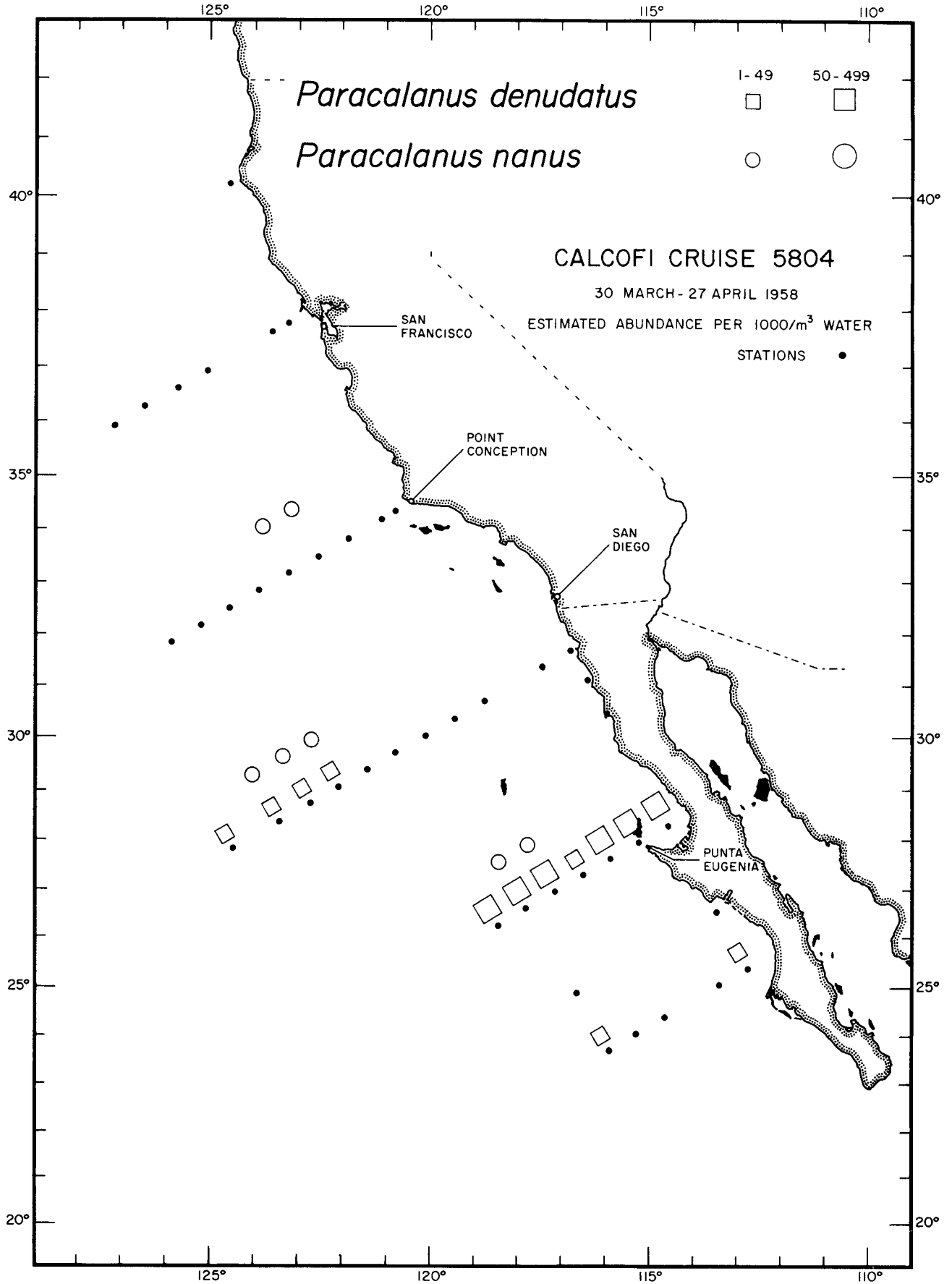
Calanoida
Paracalanus aculeatus
5807



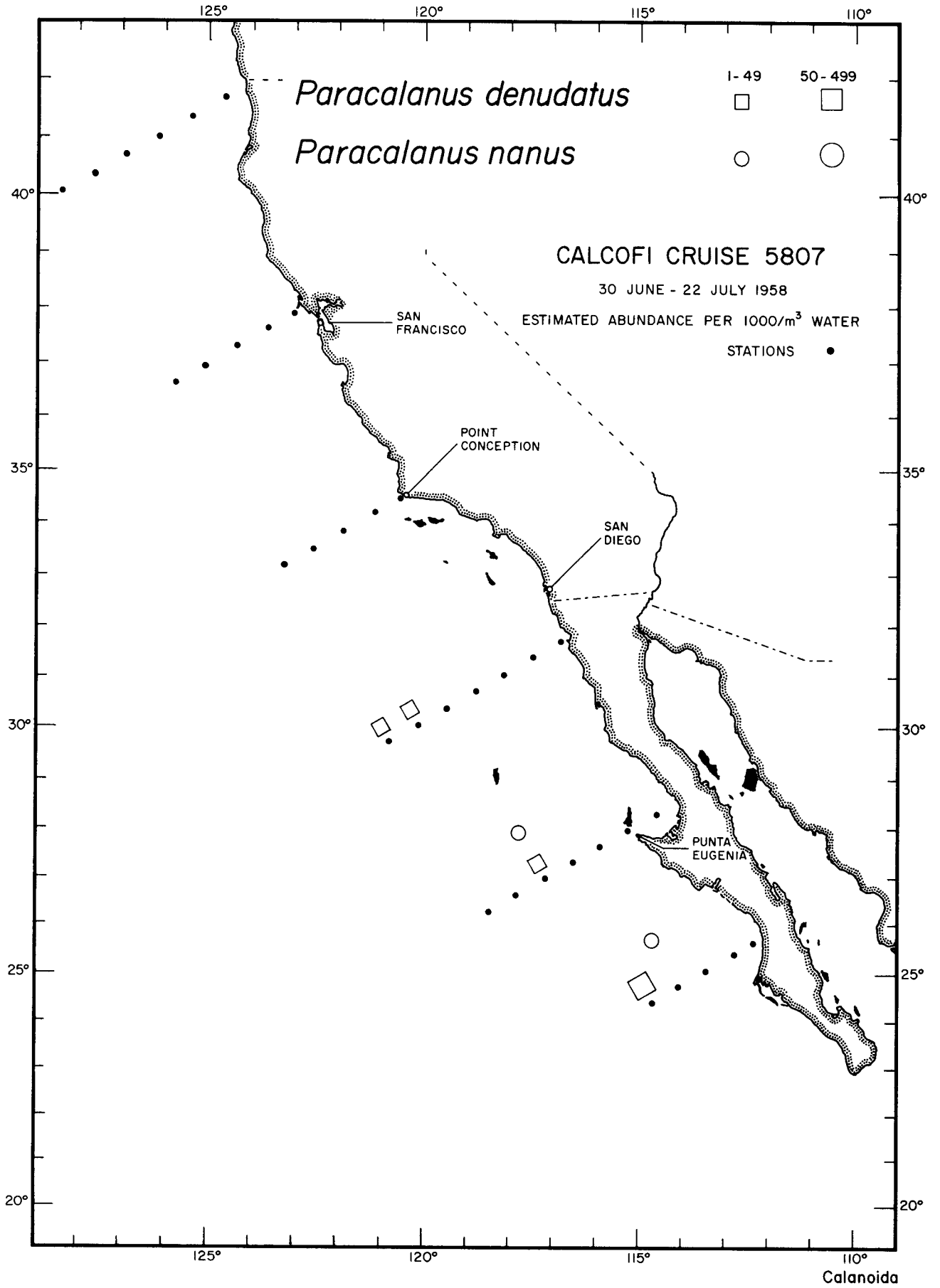
Calanoida
Paracalanus aculeatus
5810



Calanoida
Paracalanus aculeatus
5901

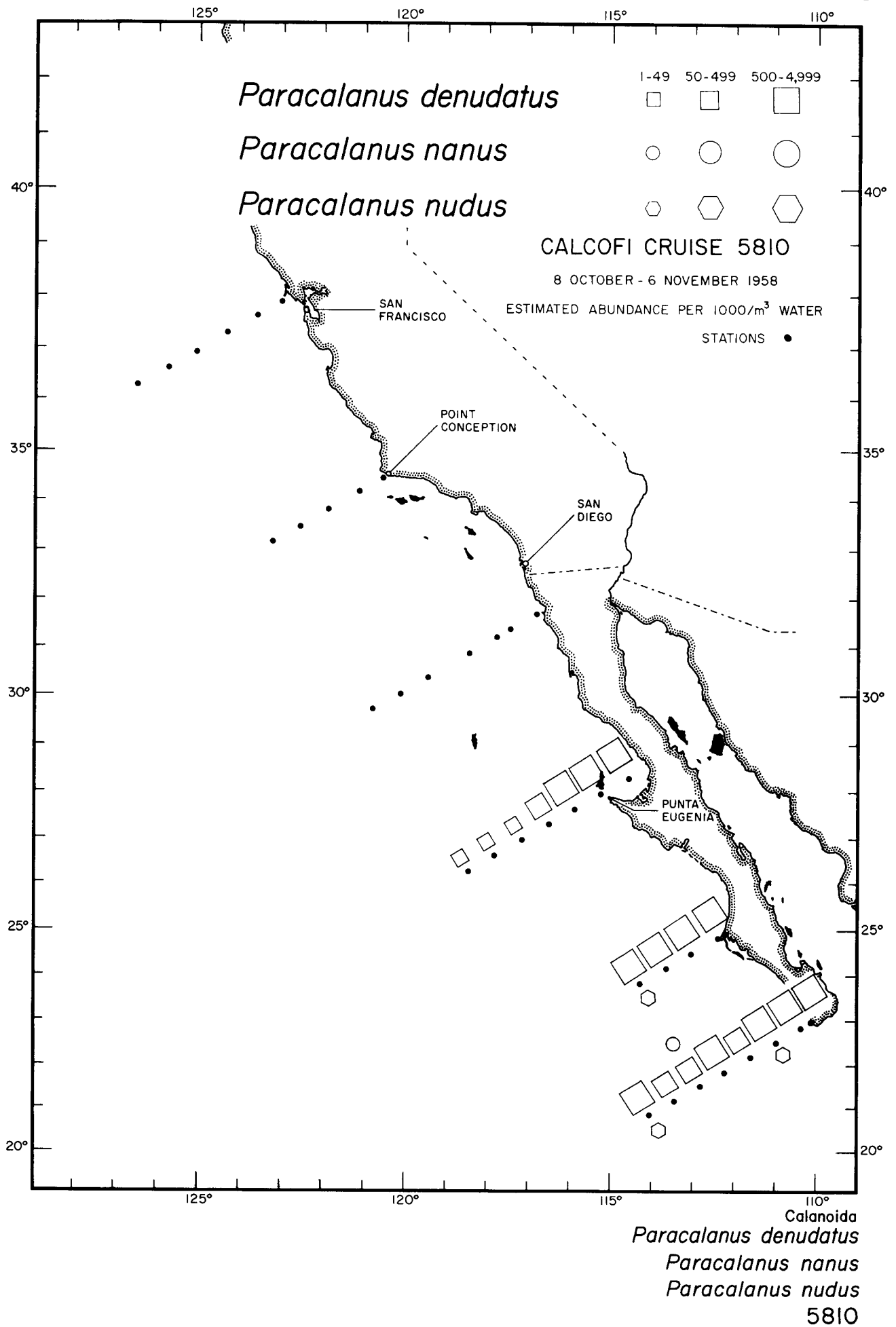


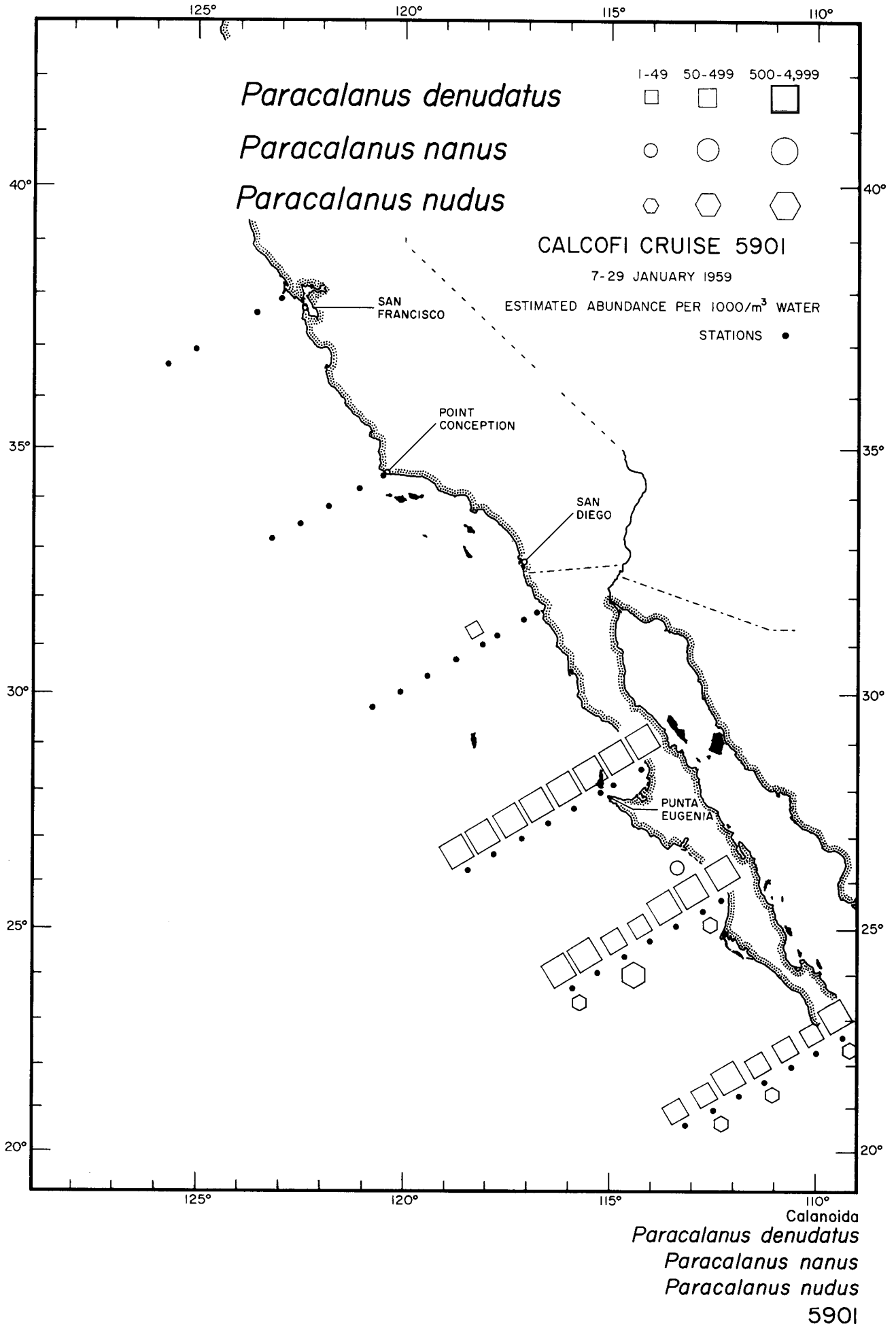
Calanoida
Paracalanus denudatus
Paracalanus nanus

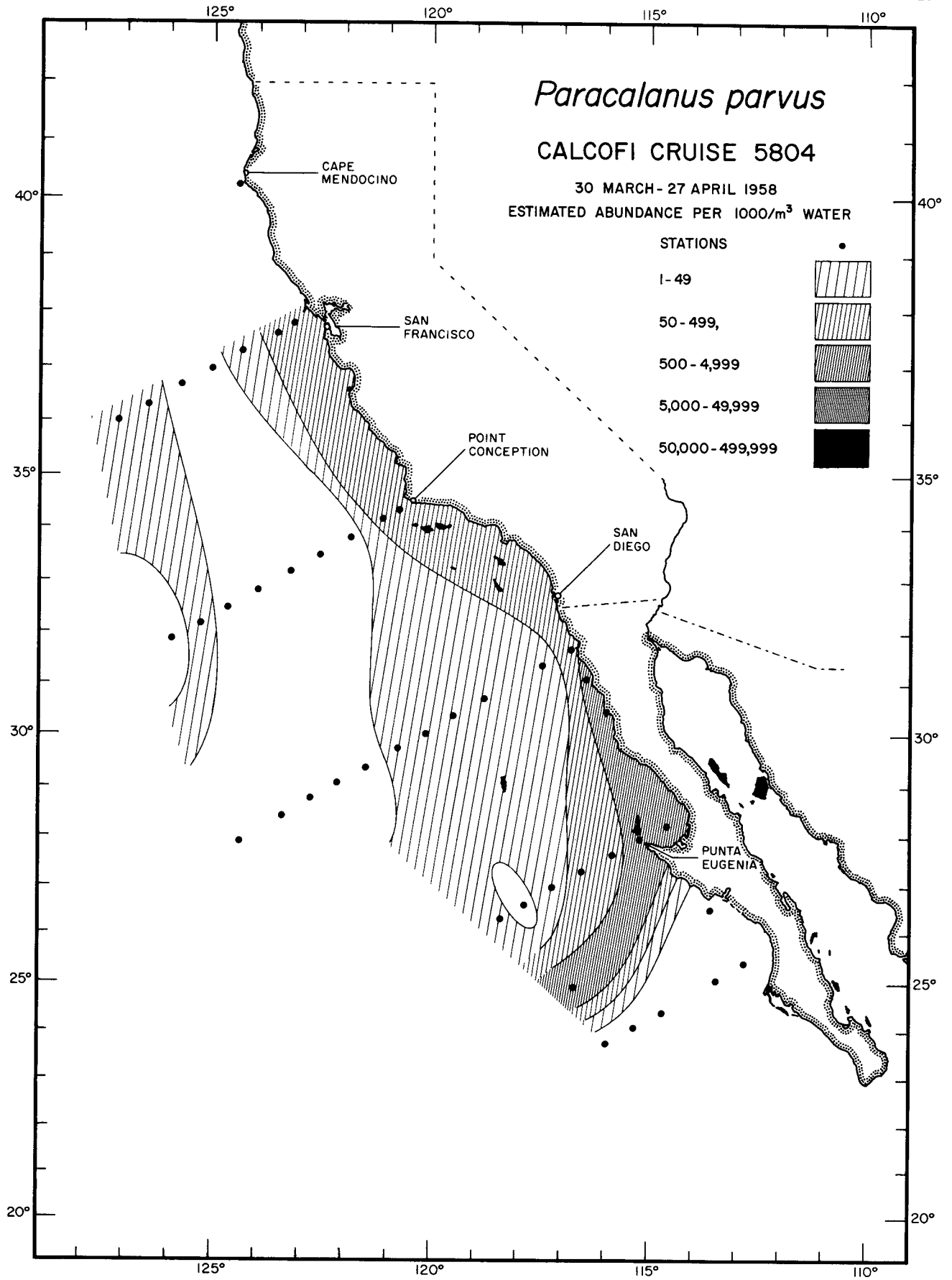


Paracalanus denudatus
Paracalanus nanus

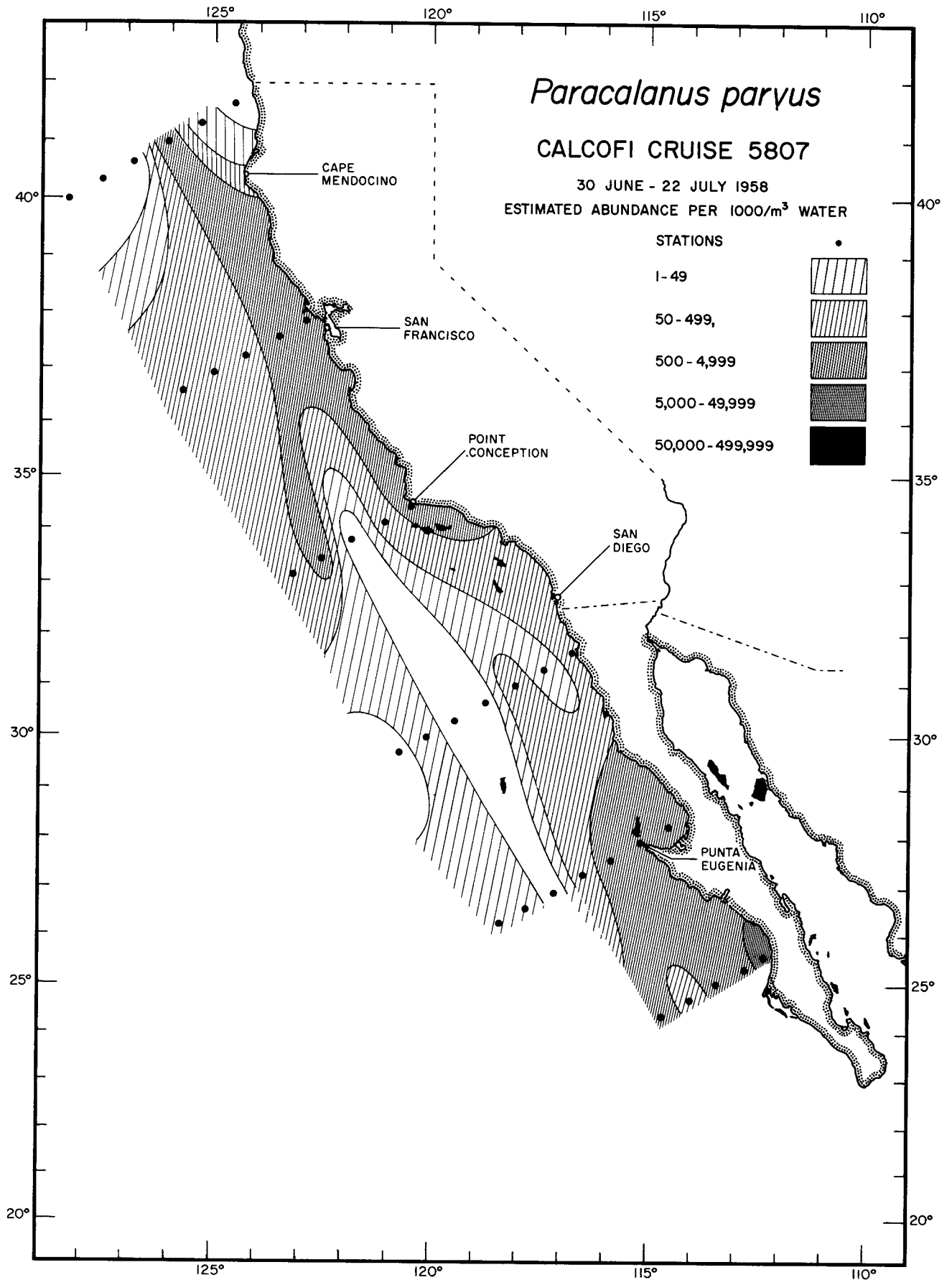
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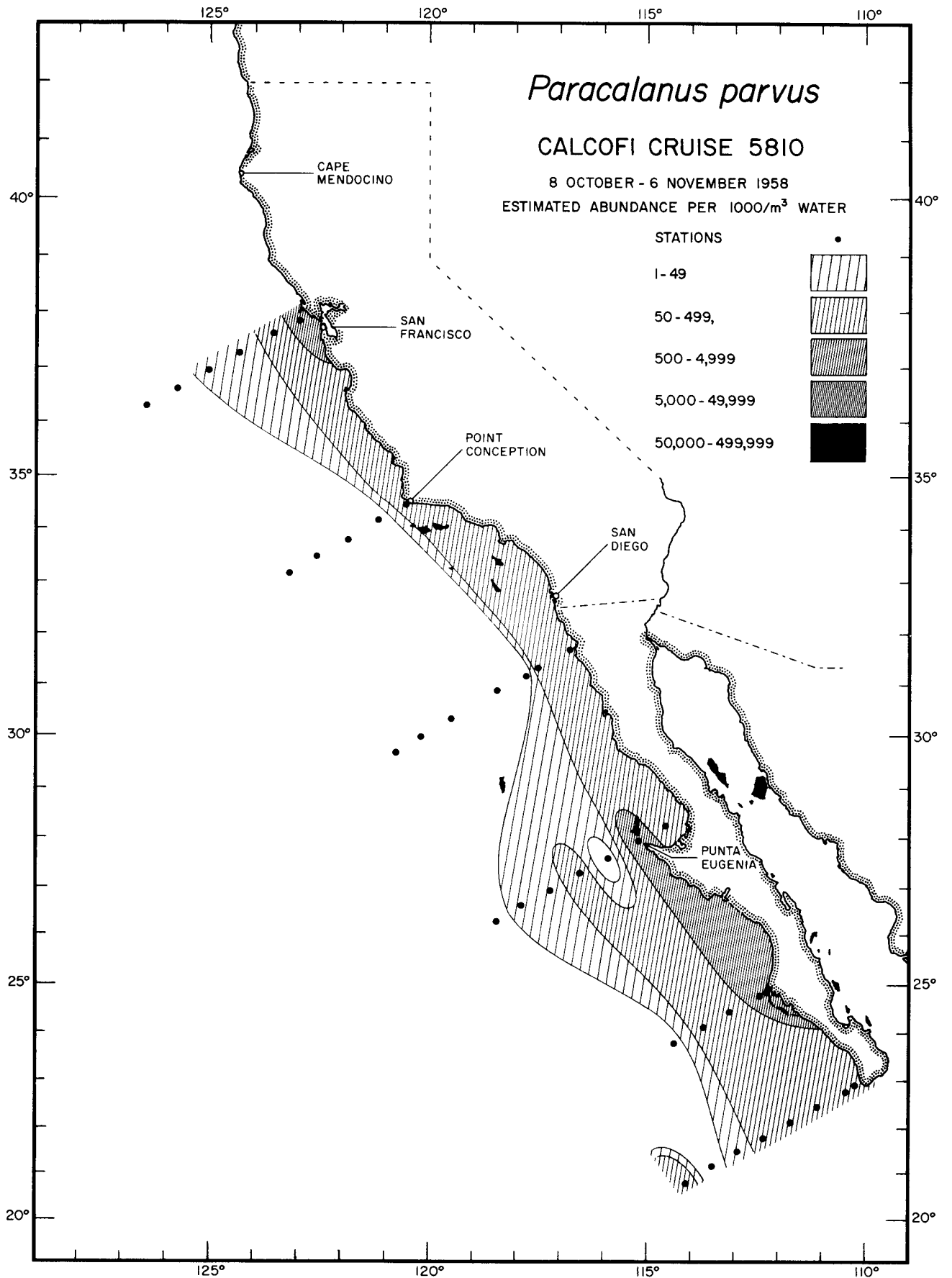




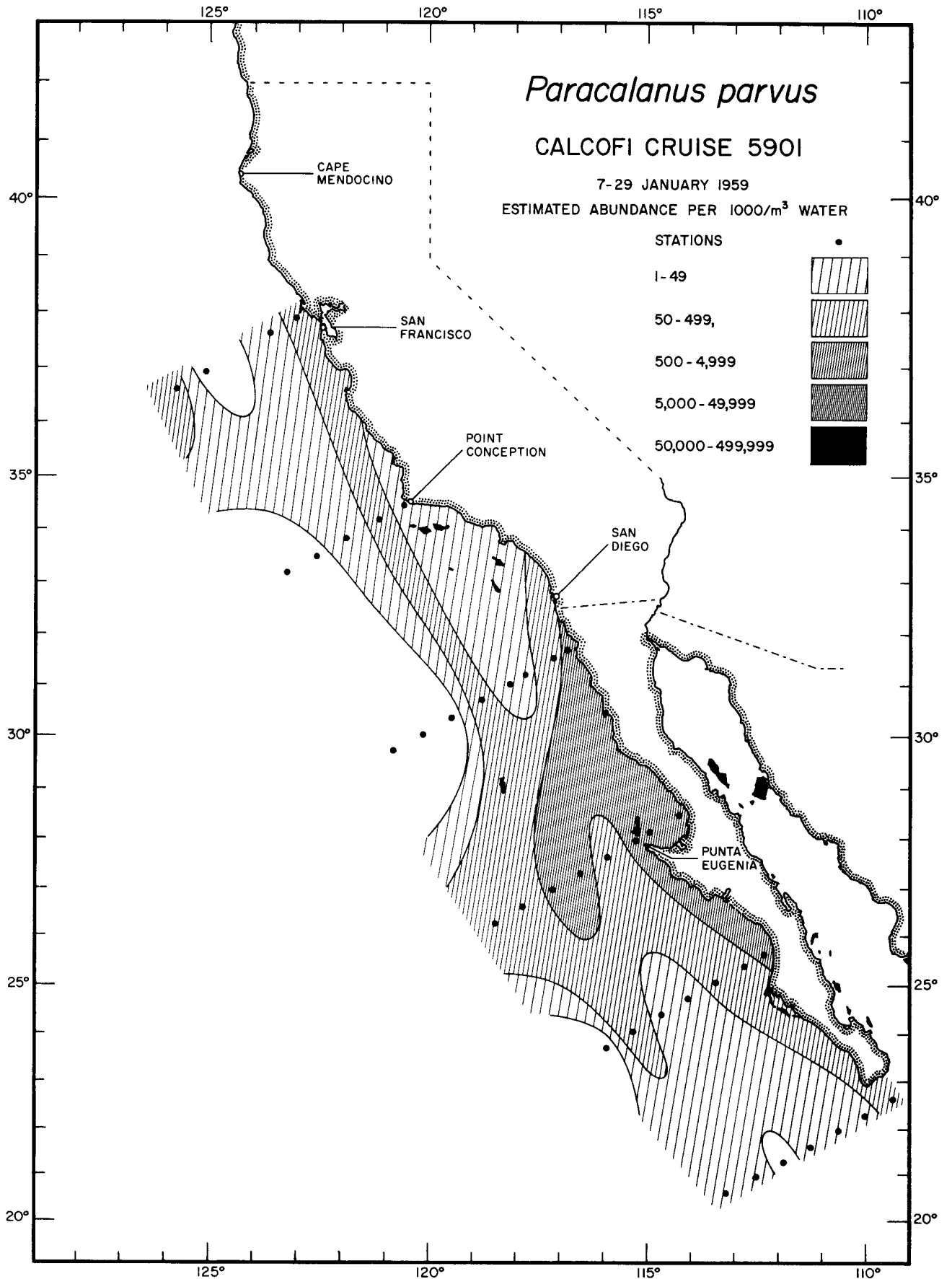
Calanoida
Paracalanus parvus
5804



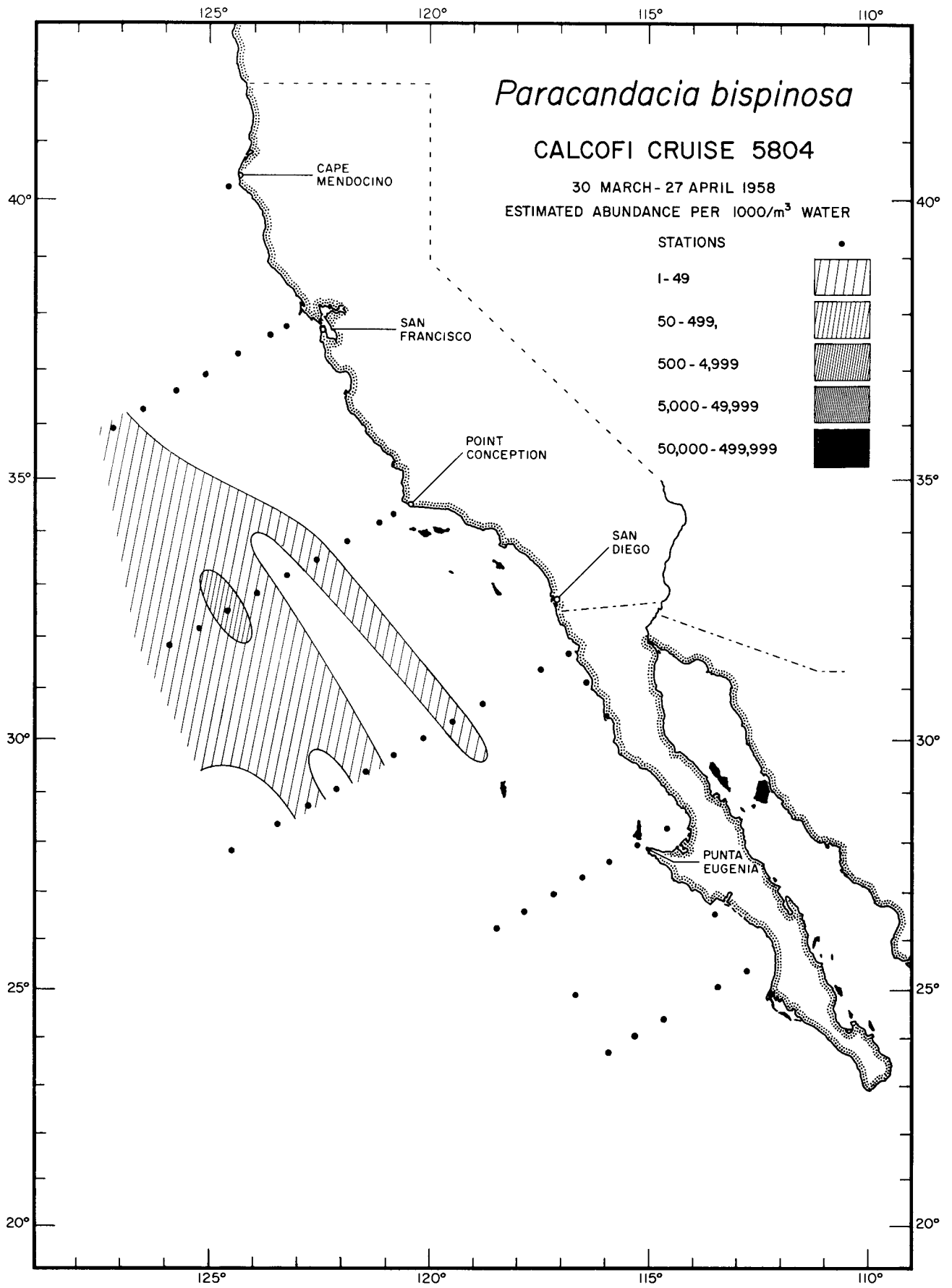
Calanoida
Paracalanus parvus
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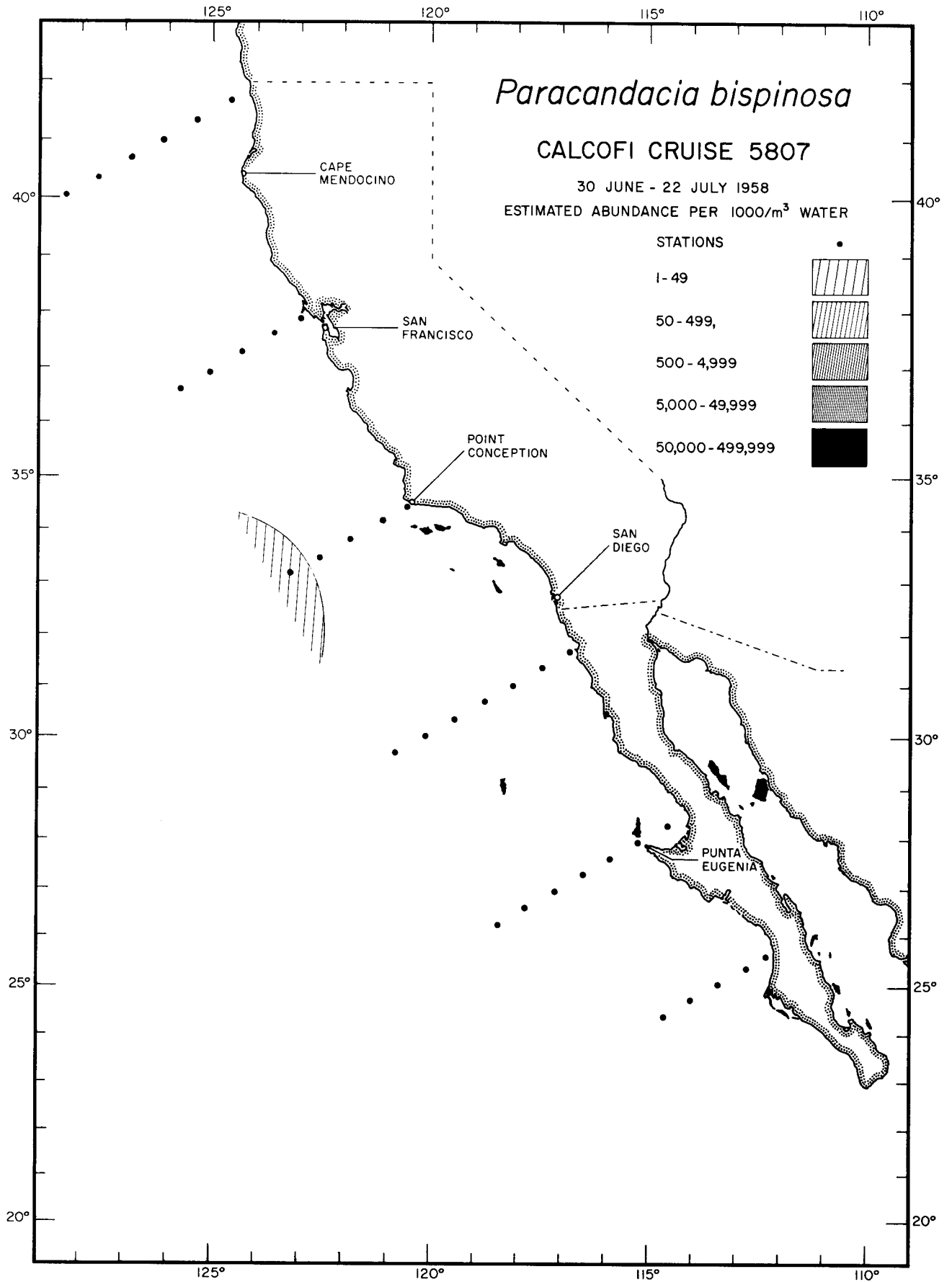
Calanoida
Paracalanus parvus
5810



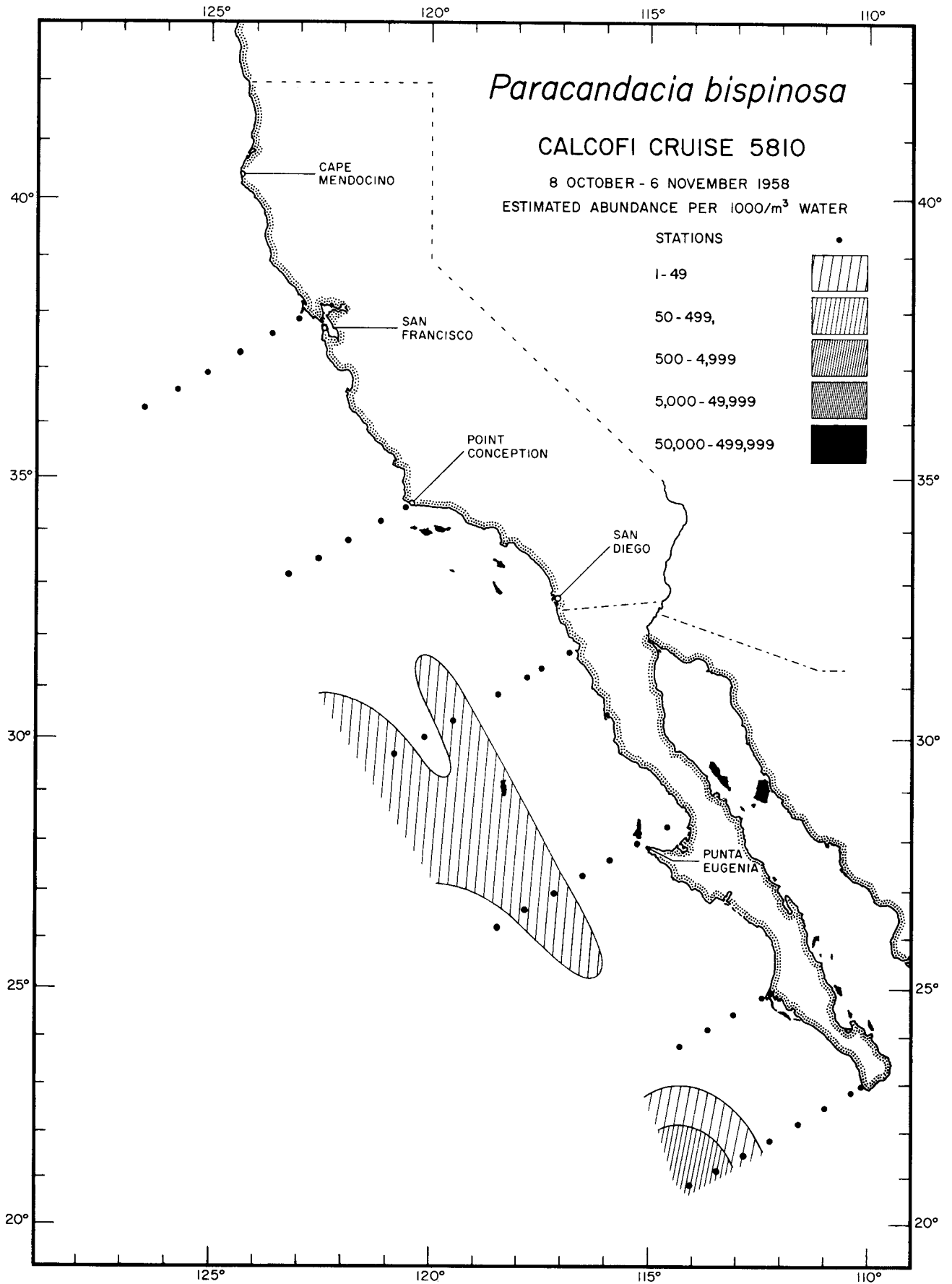
Calanoida
Paracalanus parvus
5901



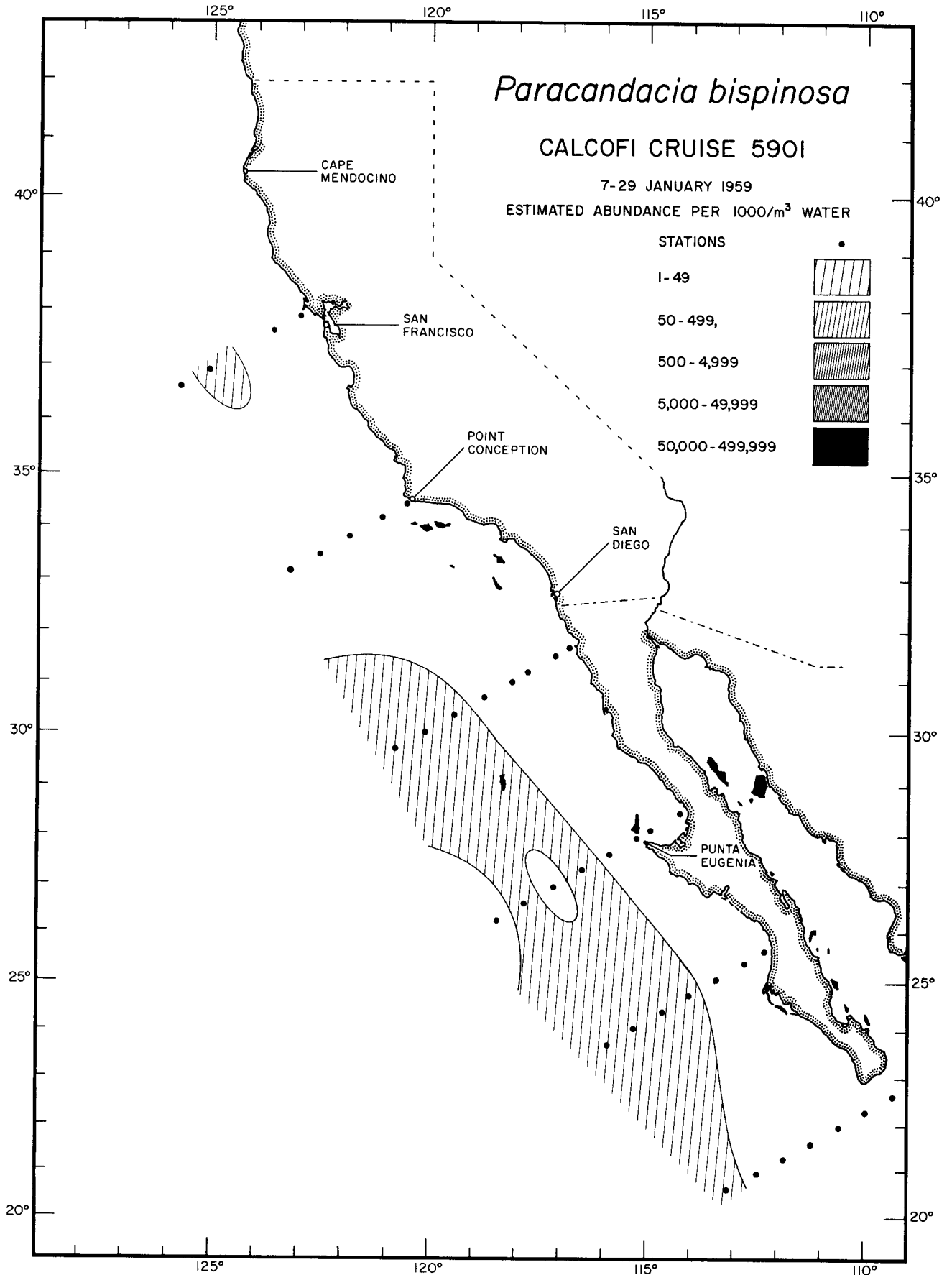
Calanoida
Paracandacia bispinosa
5804



Calanoida
Paracandacia bispinosa
5807



Calanoida
Paracandacia bispinosa
5810



Paracandacia bispinosa

CALCOFI CRUISE 5901

7-29 JANUARY 1959

ESTIMATED ABUNDANCE PER 1000/m³ WATER

STATIONS

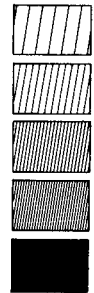
1-49

50-499,

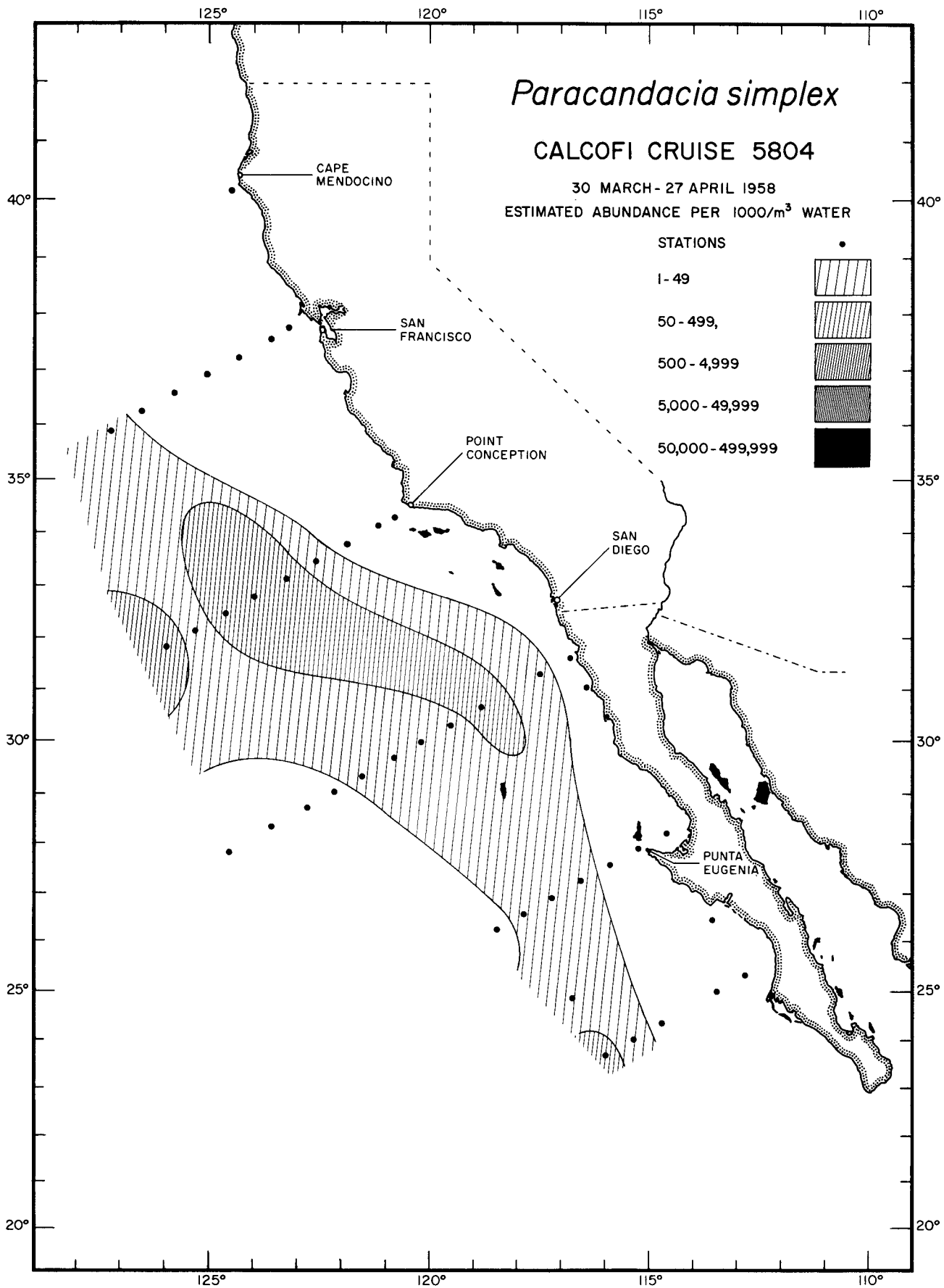
500-4,999

5,000-49,999

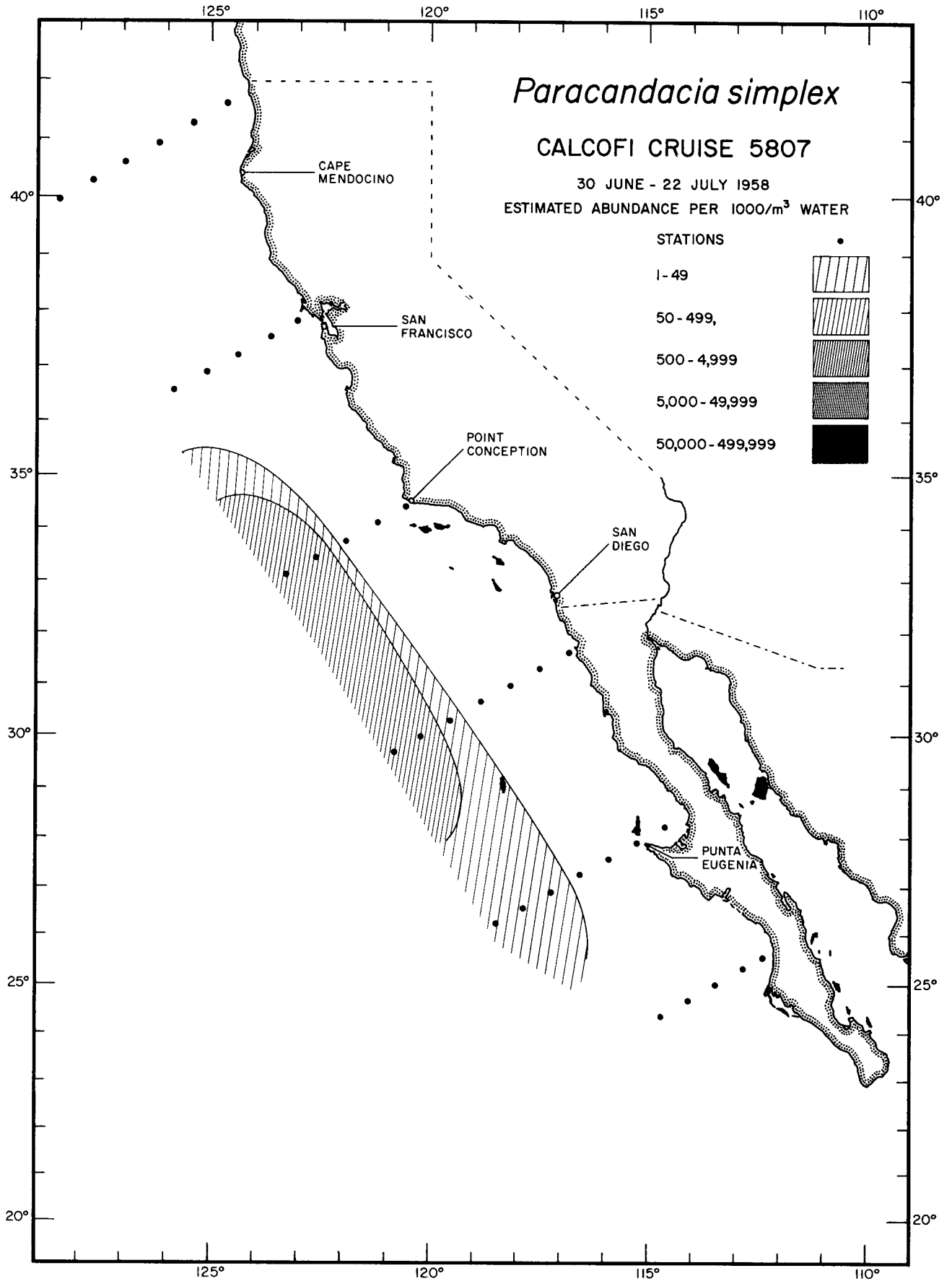
50,000-499,999



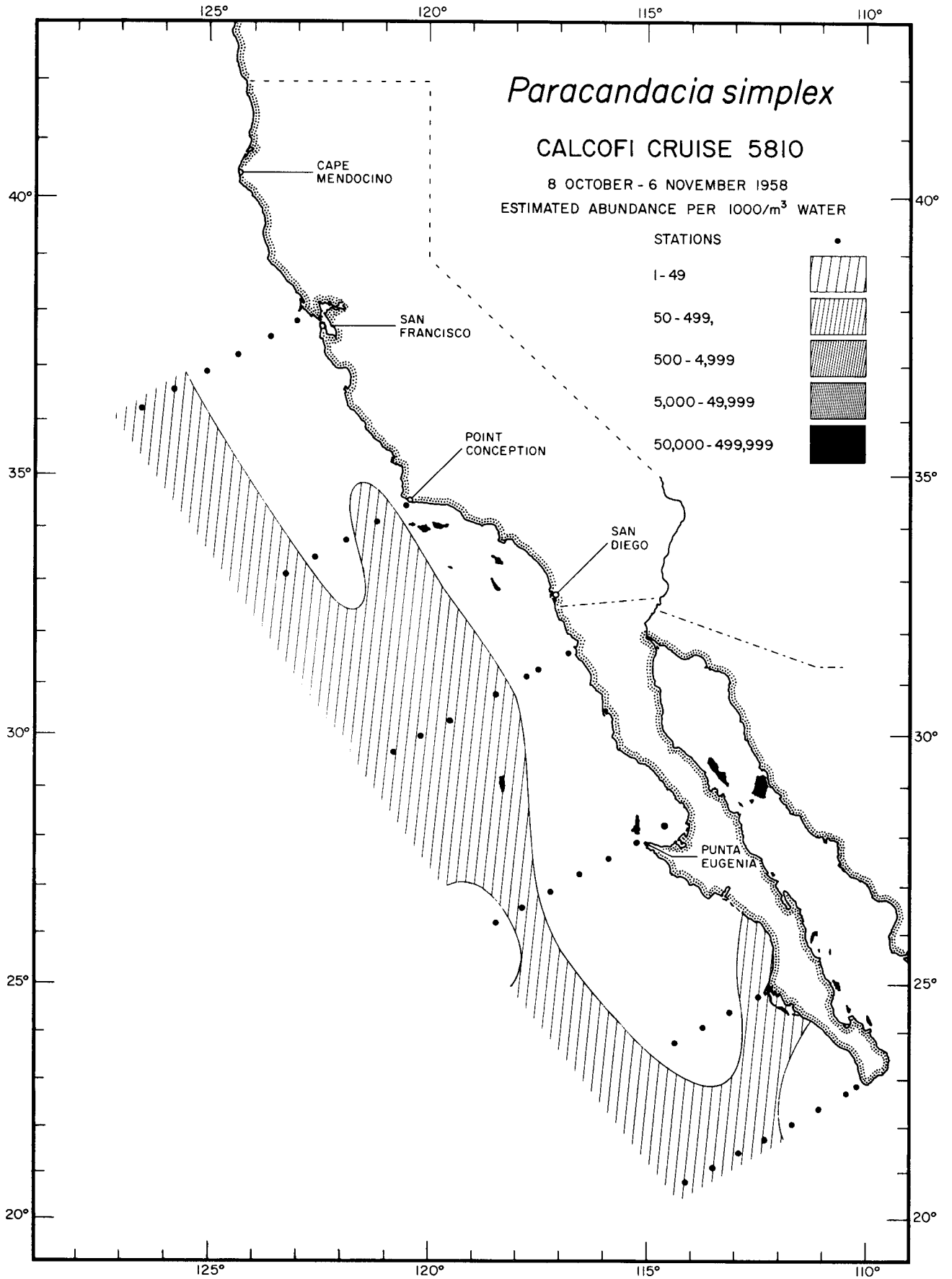
Calanoida
Paracandacia bispinosa
5901



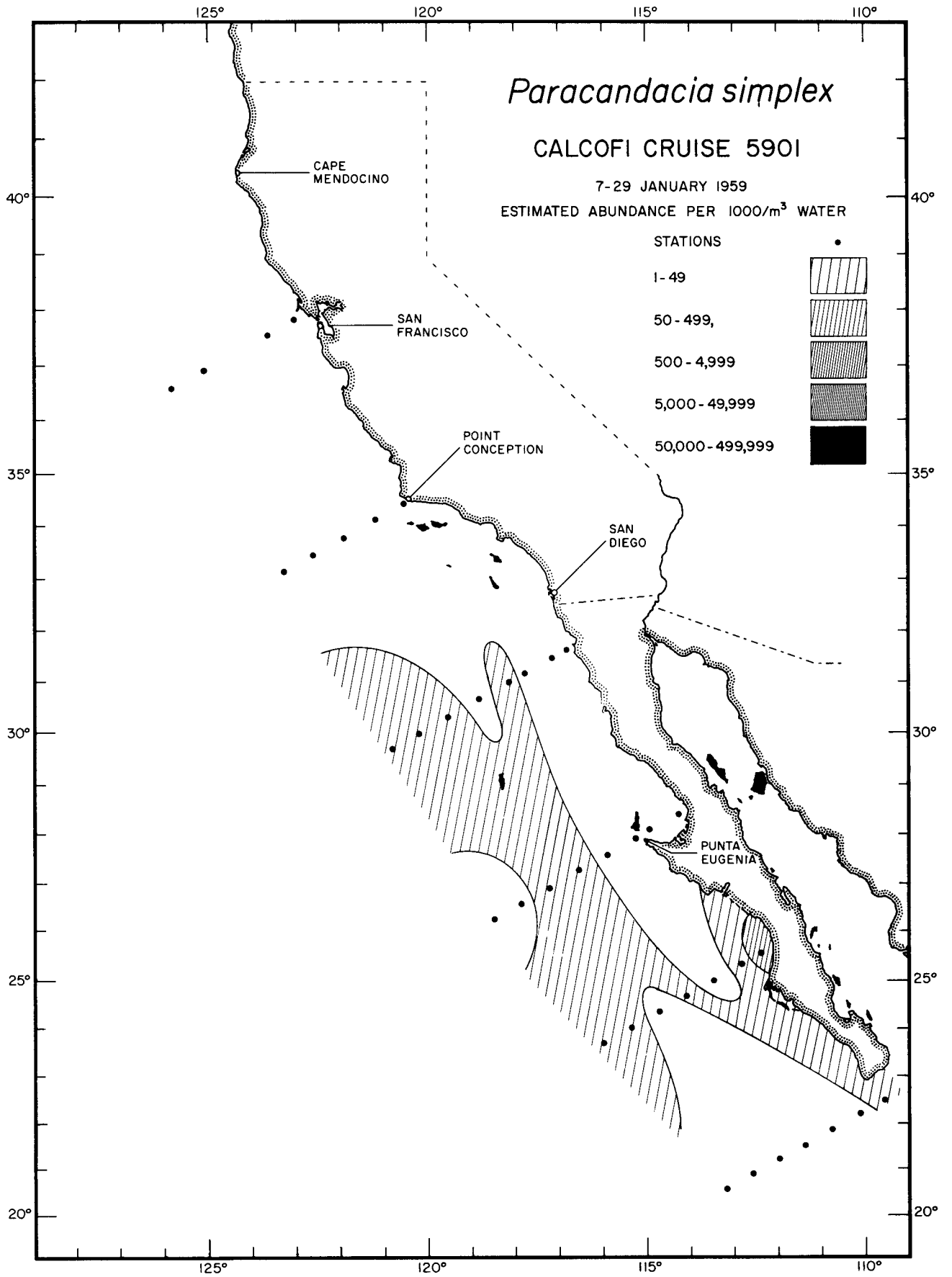
Calanoida
Paracandacia simplex
5804



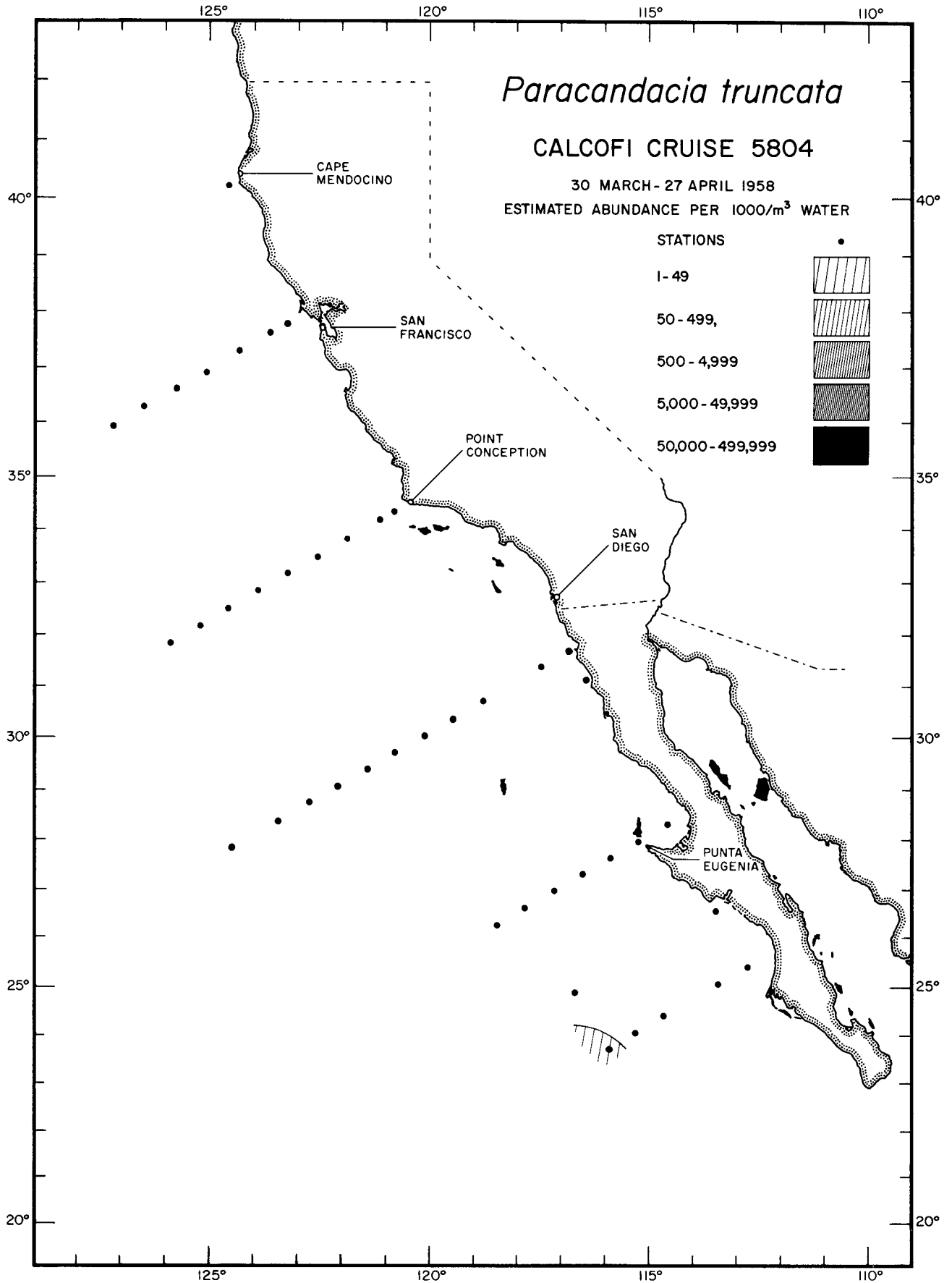
Calanoida
Paracandacia simplex
5807



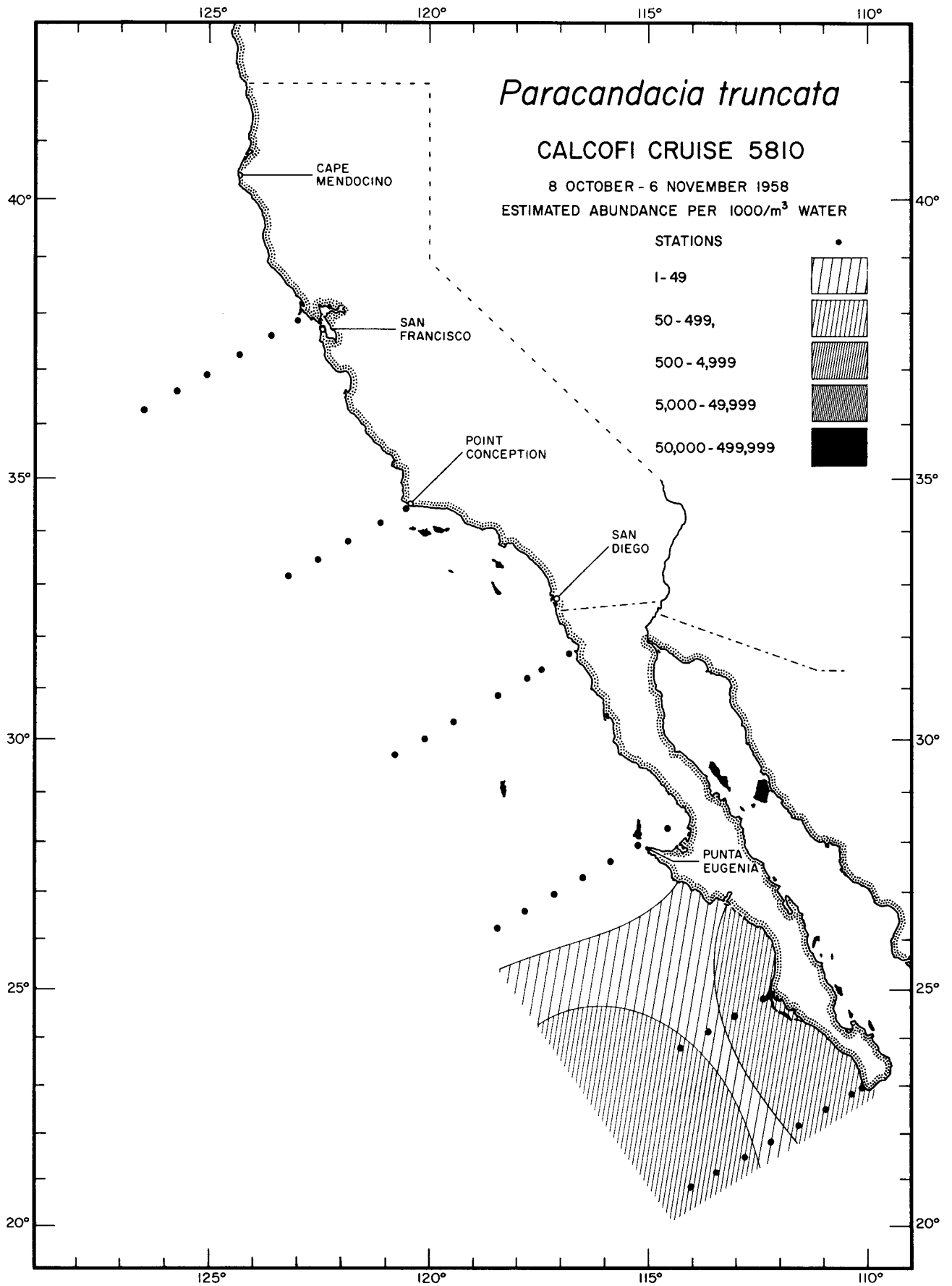
Calanoida
Paracandacia simplex
5810



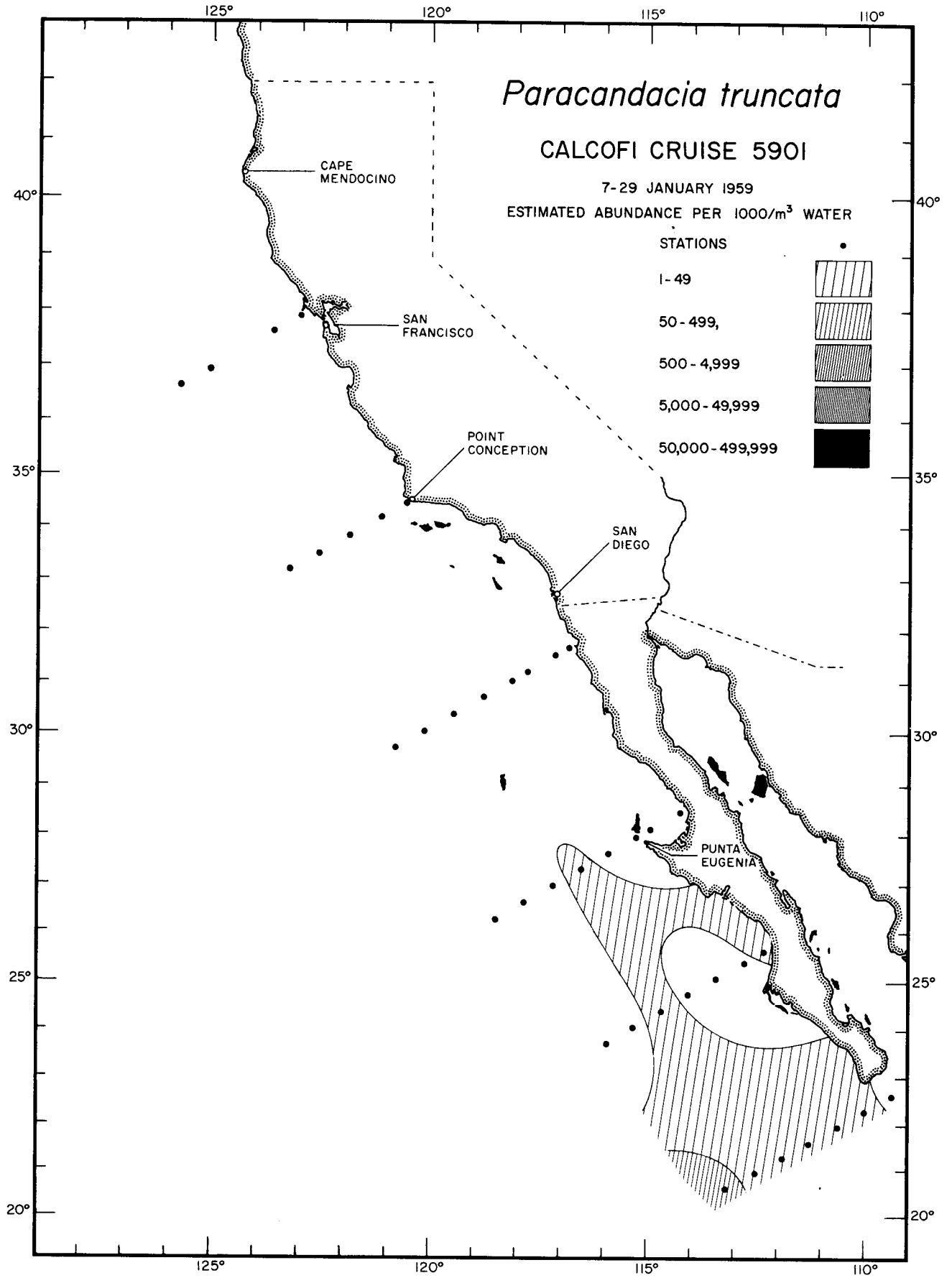
Calanoida
Paracandacia simplex
5901



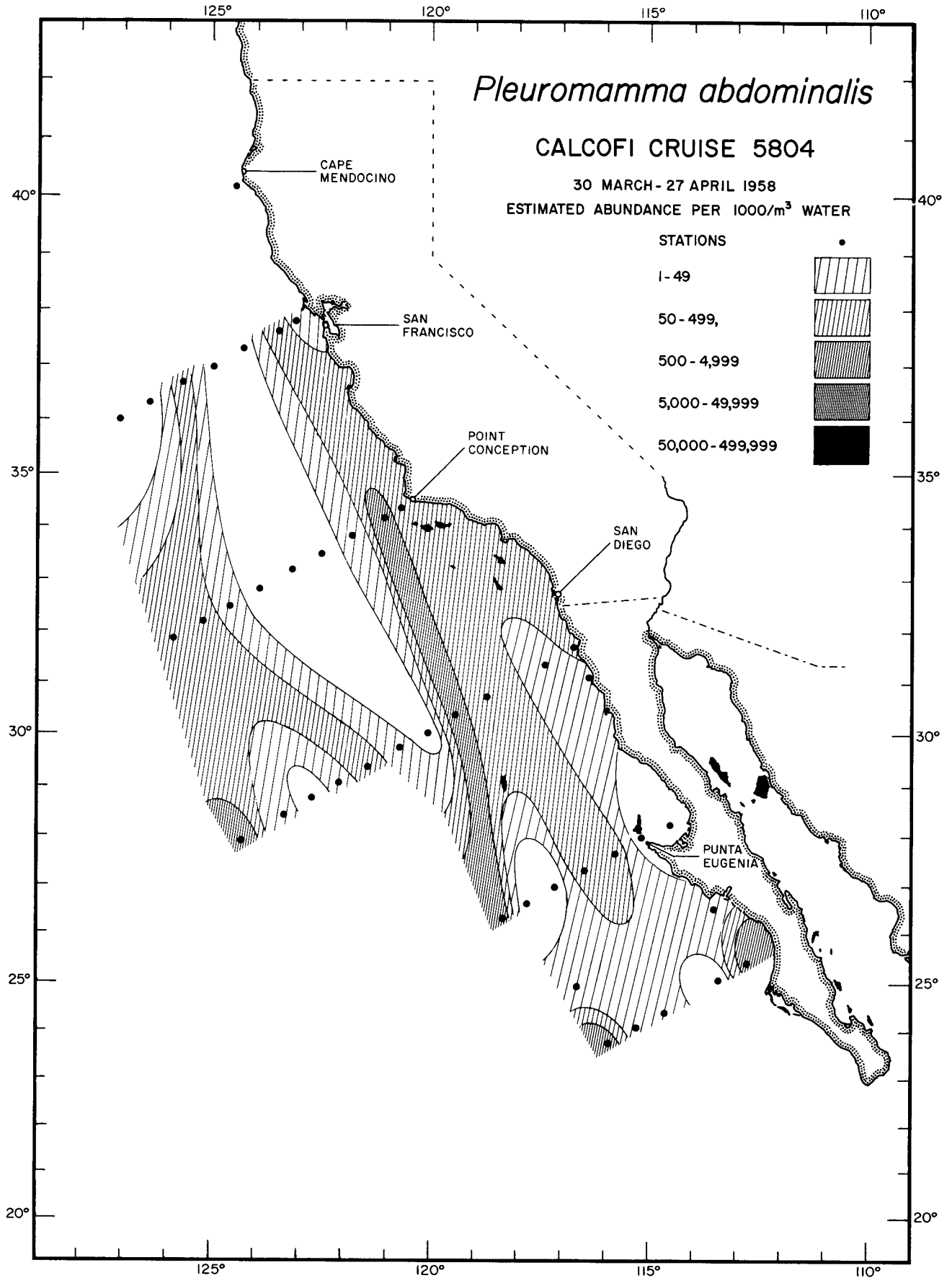
Calanoida
Paracandacia truncata
 5804



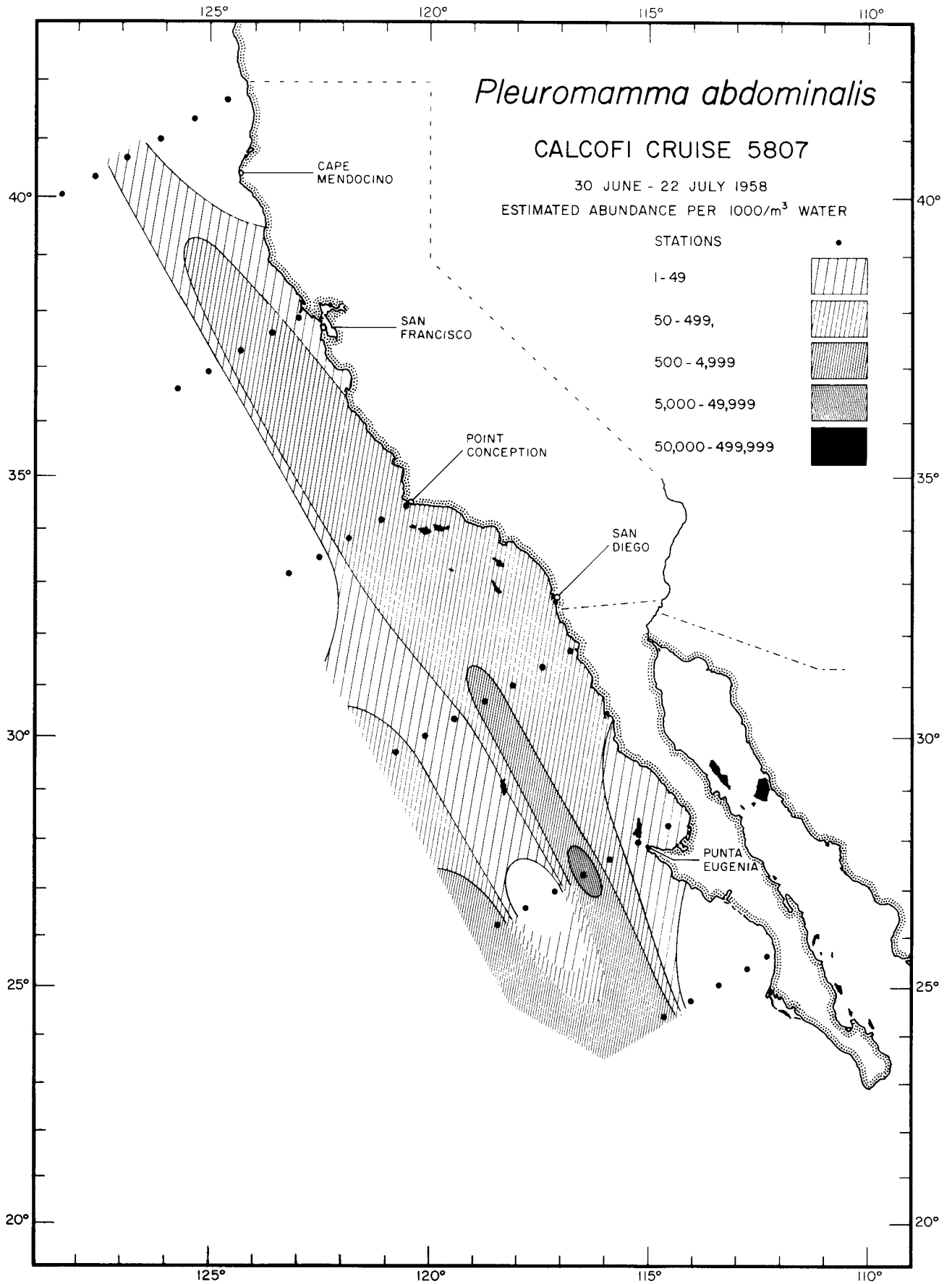
Calanoida
Paracandacia truncata
5810



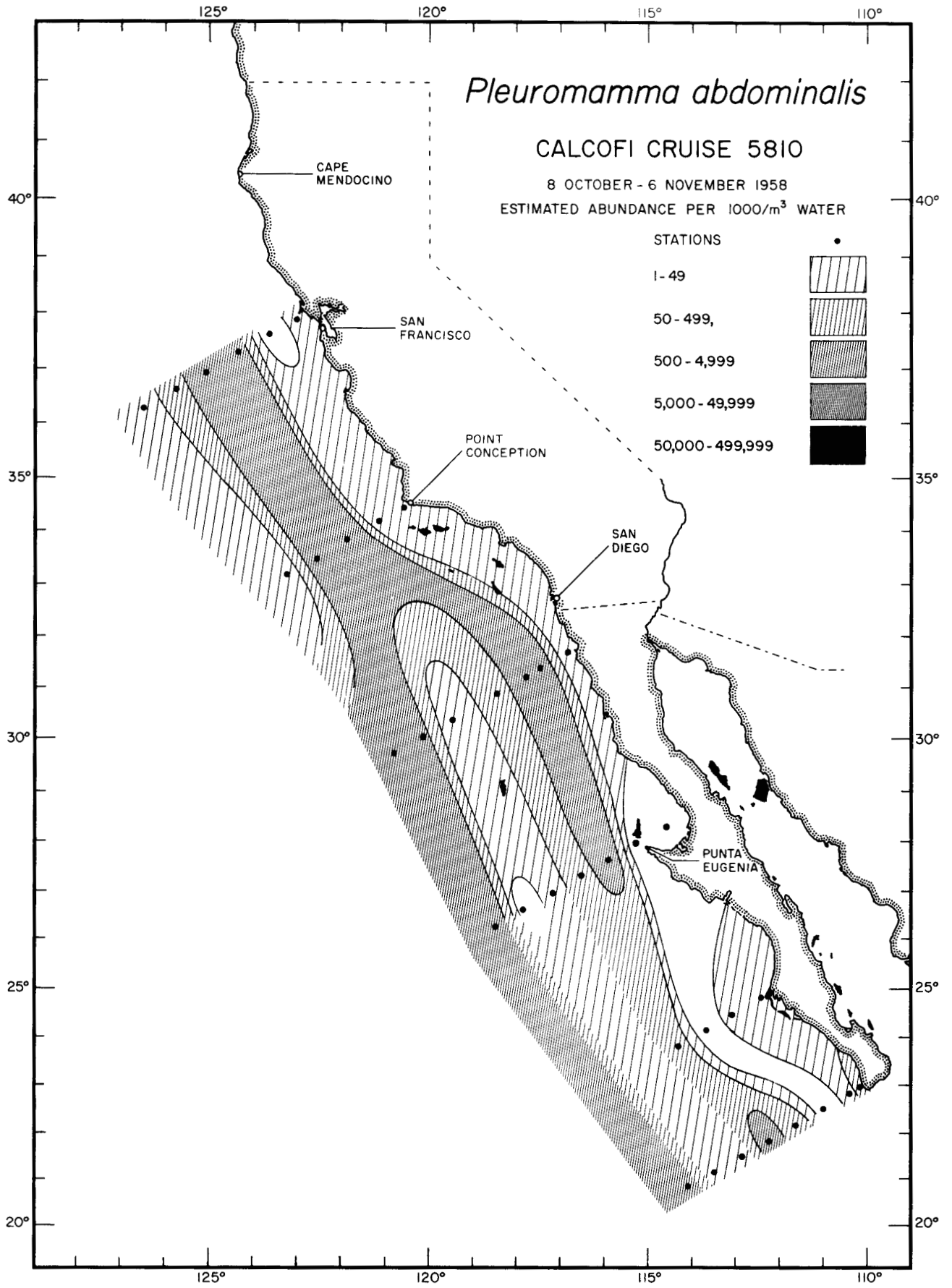
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Paracandacia truncata
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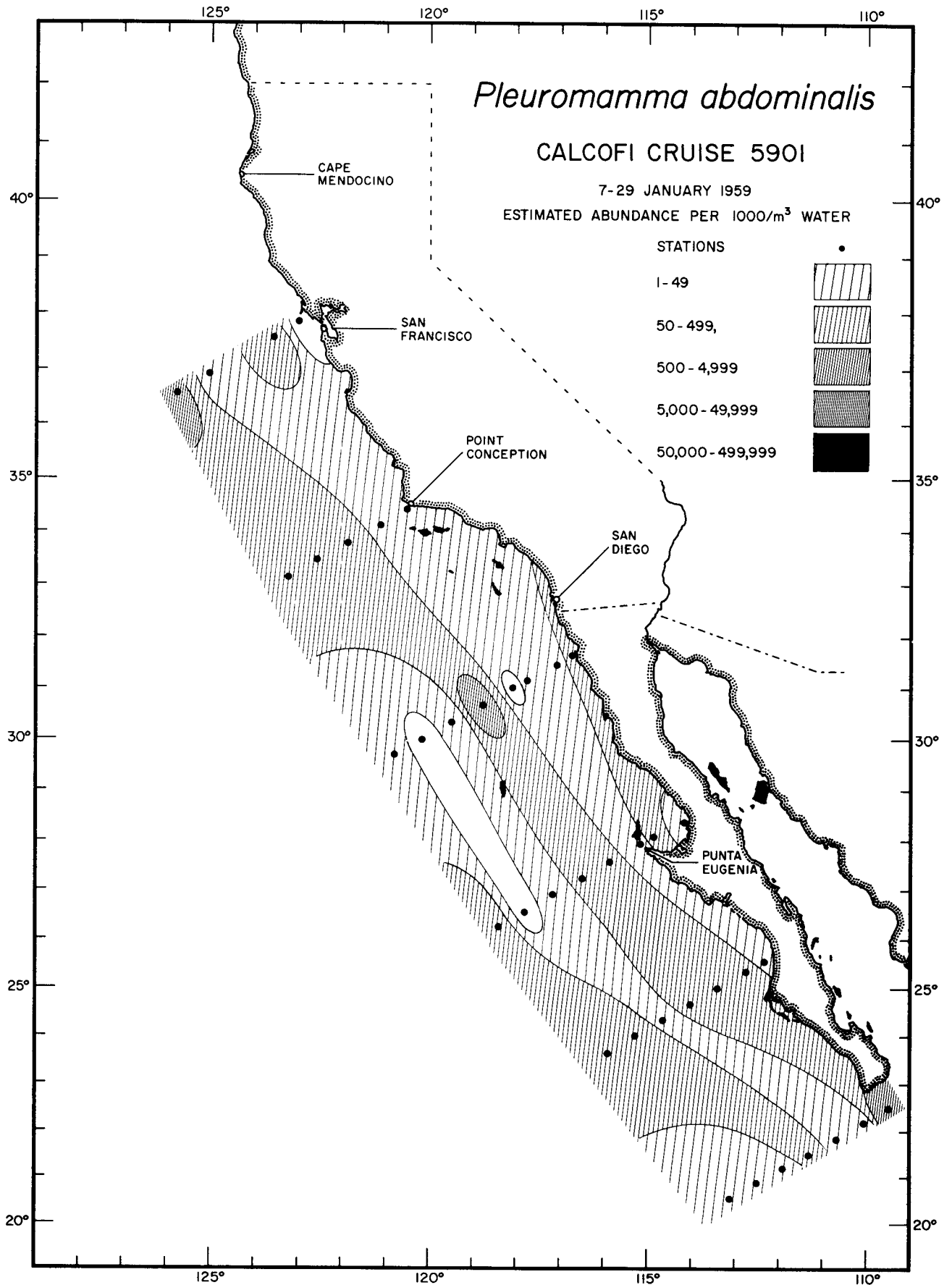
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Pleuromamma abdominalis
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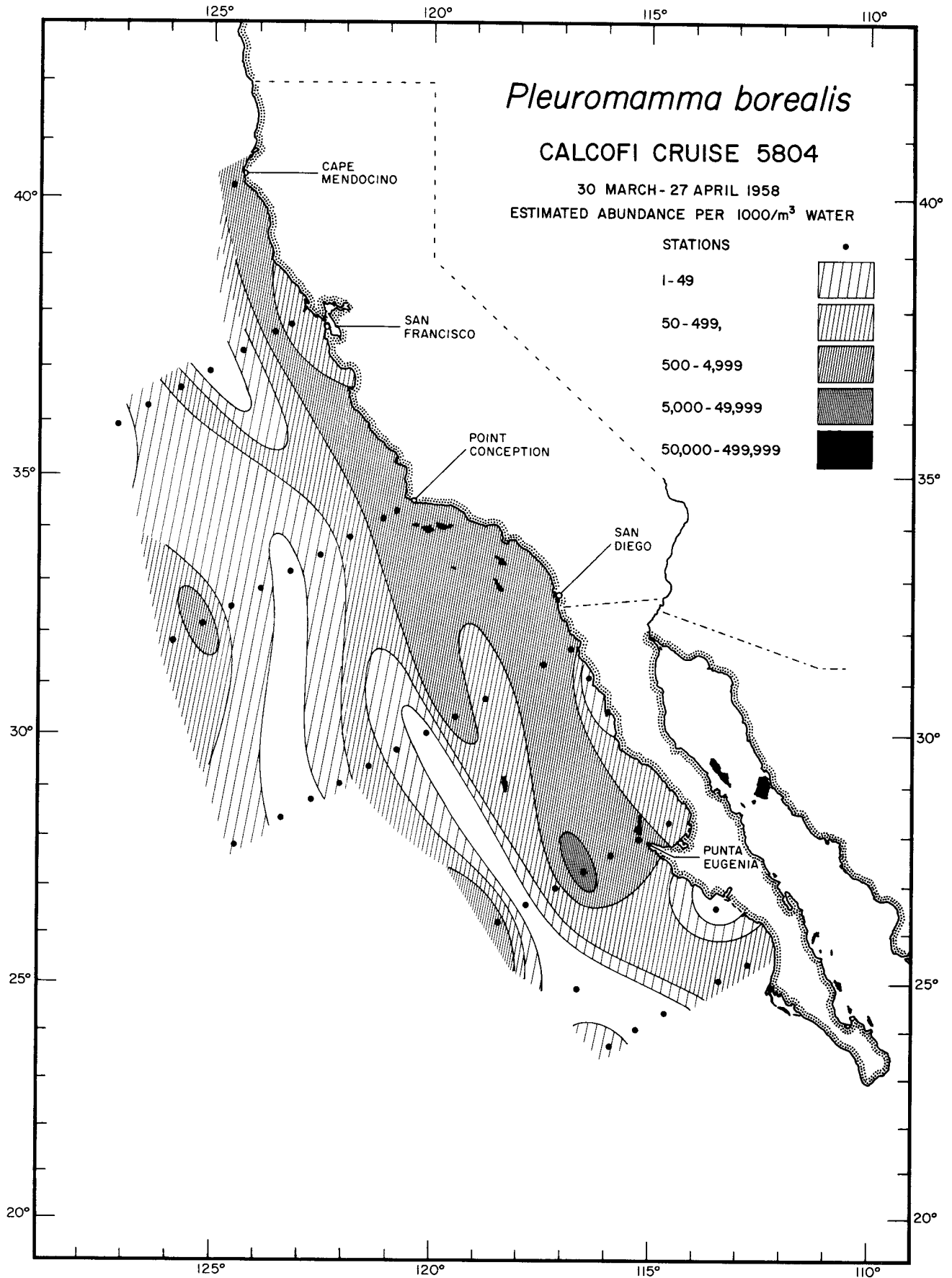
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Pleuromamma abdominalis
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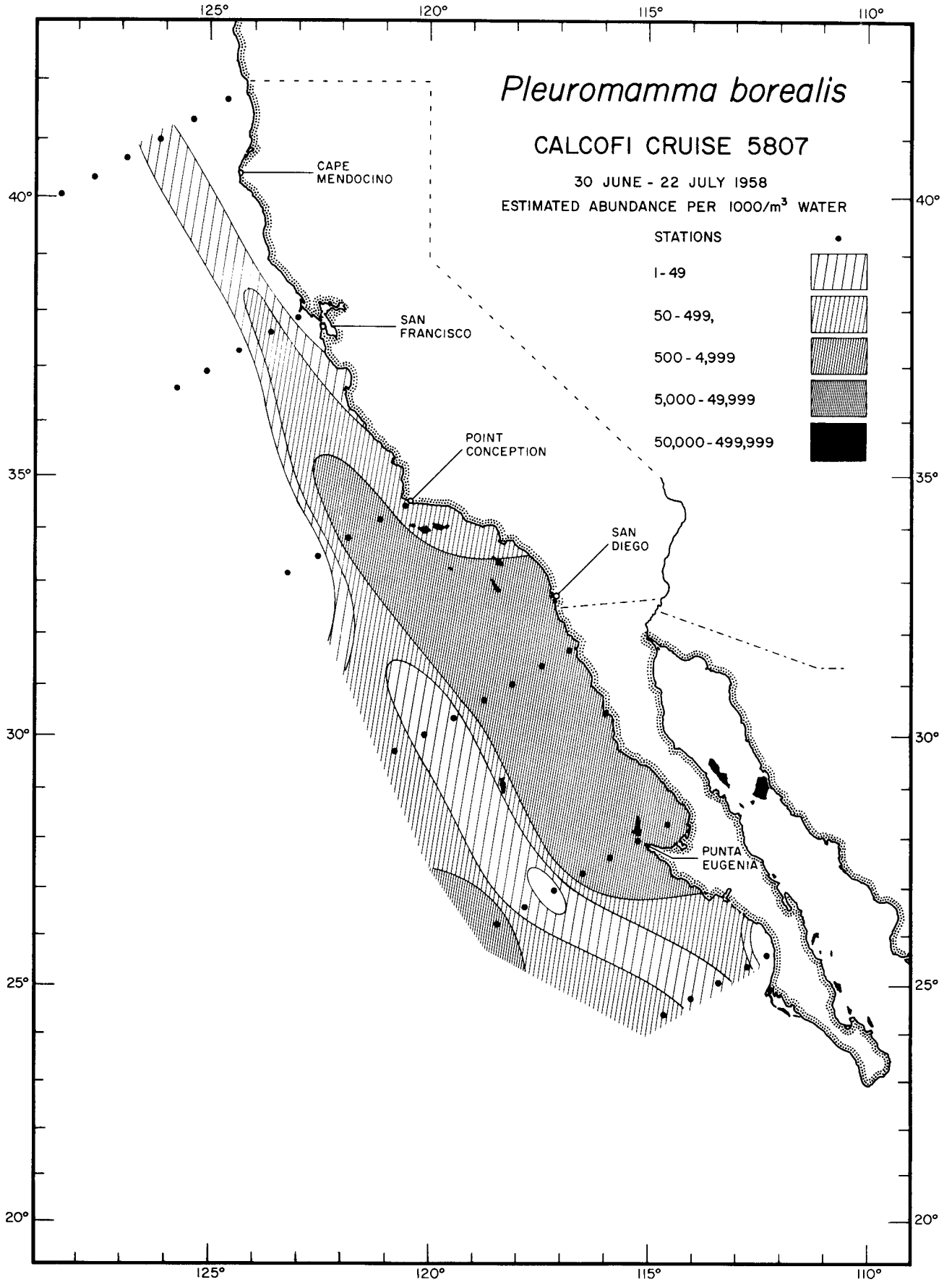
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Pleuromamma abdominalis
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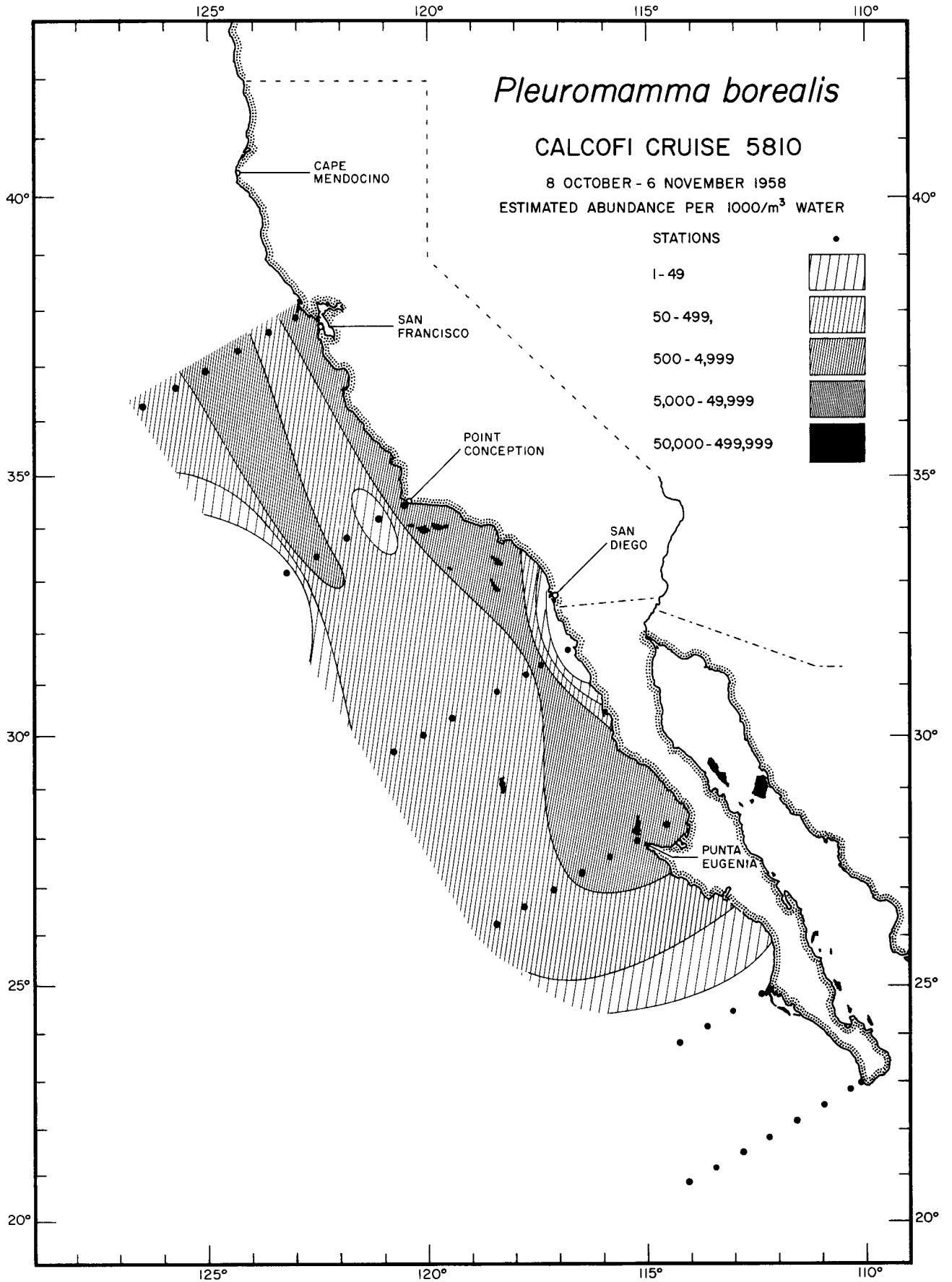
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Pleuromamma abdominalis
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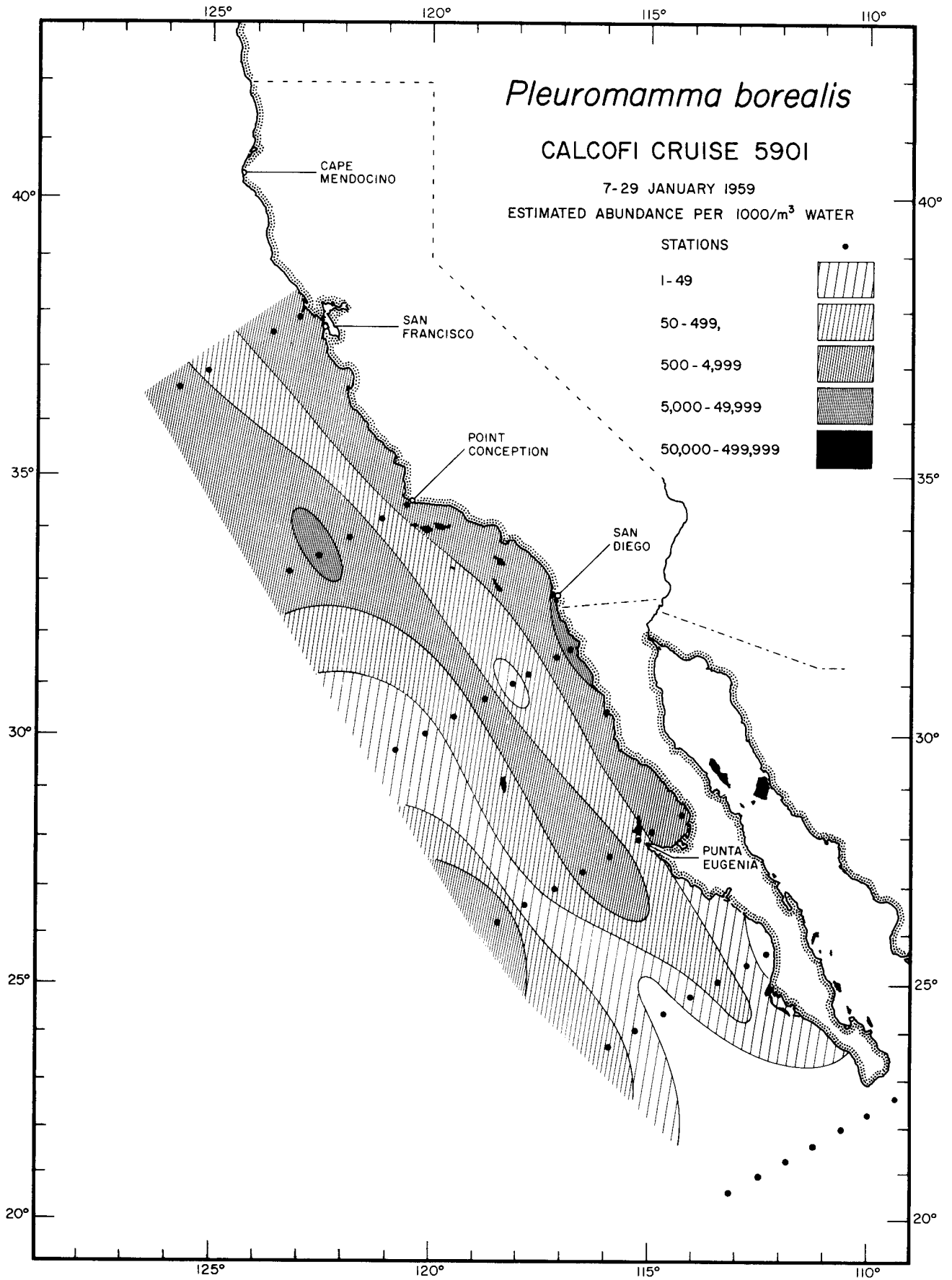
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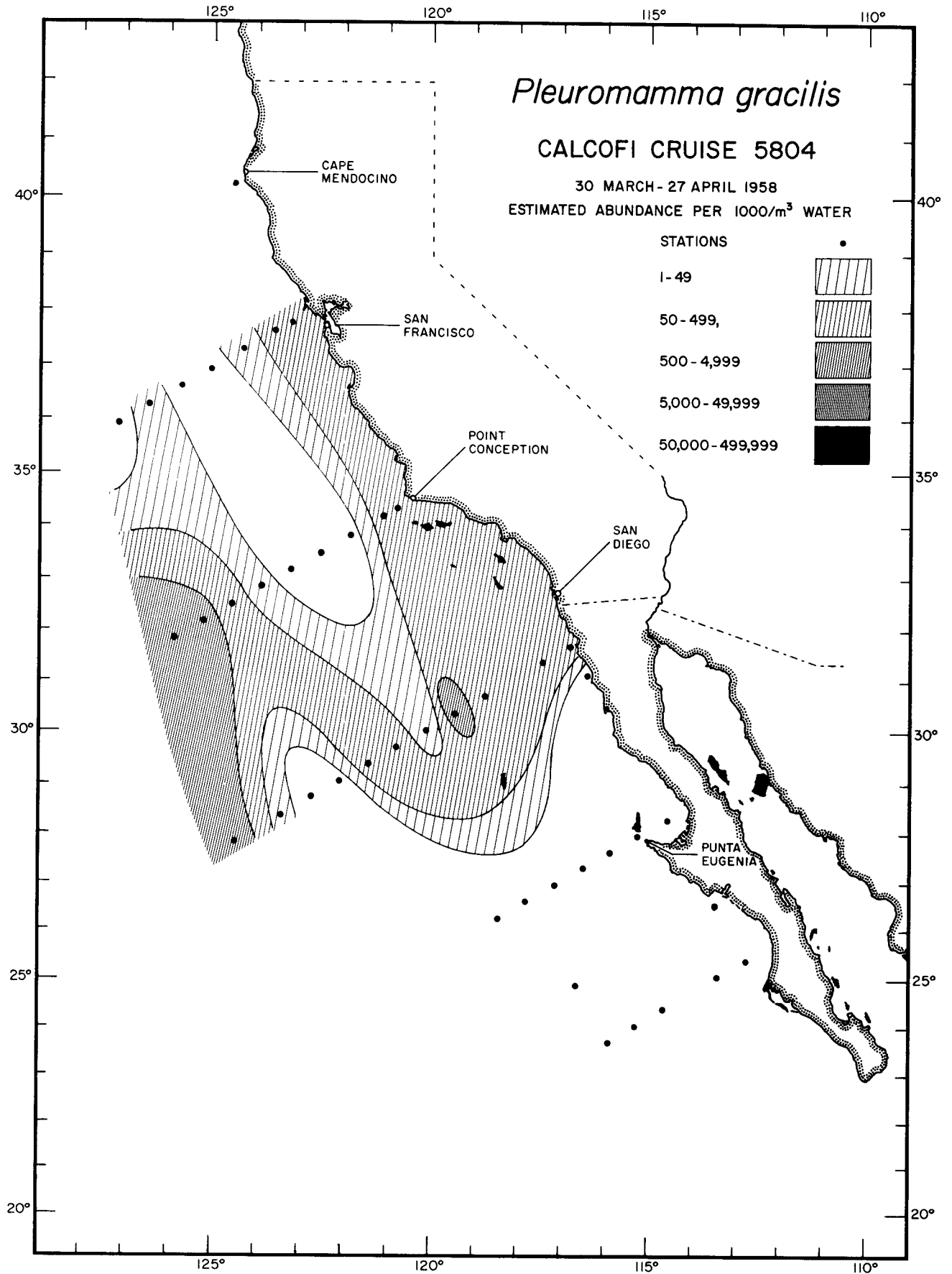
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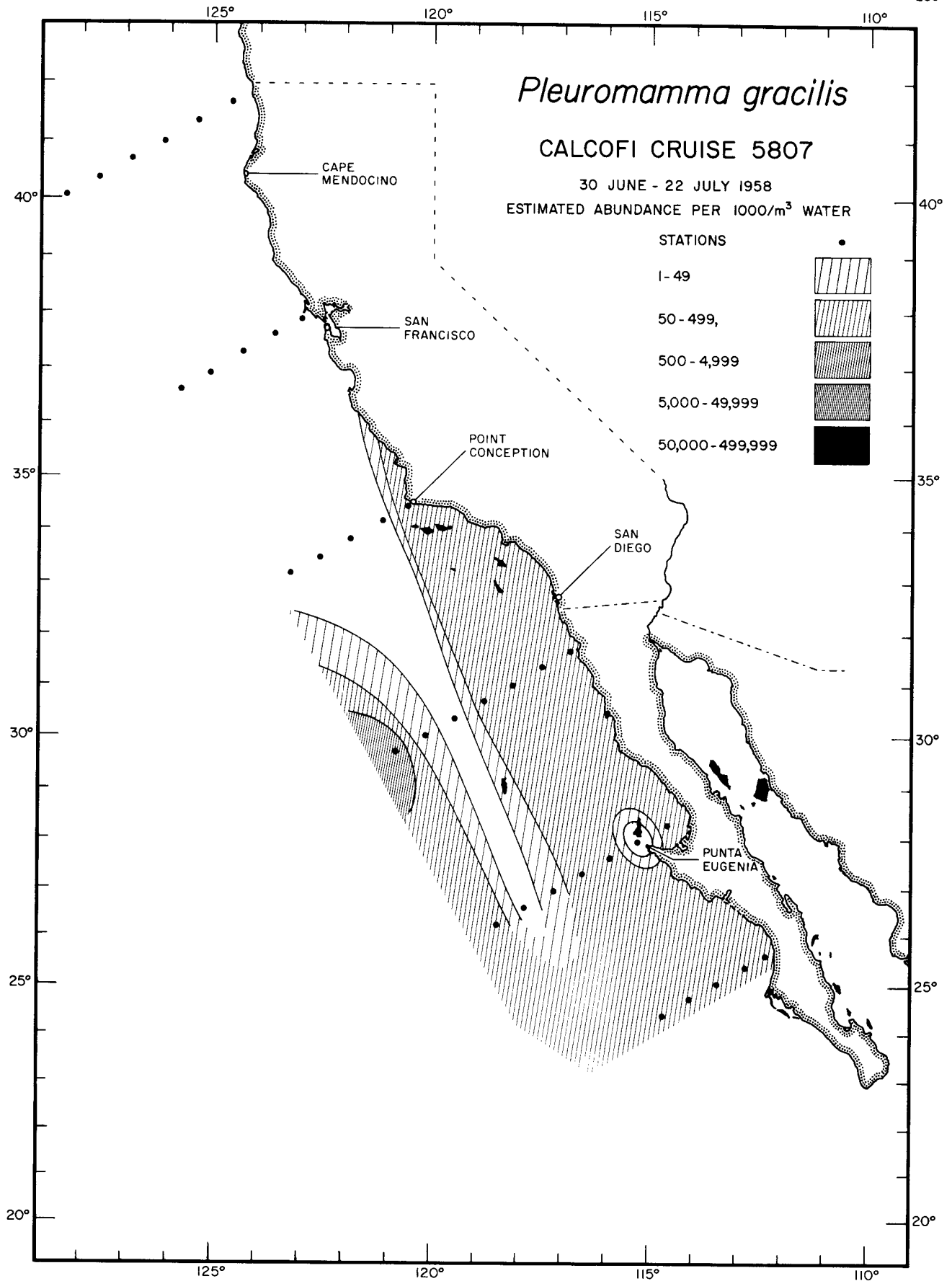
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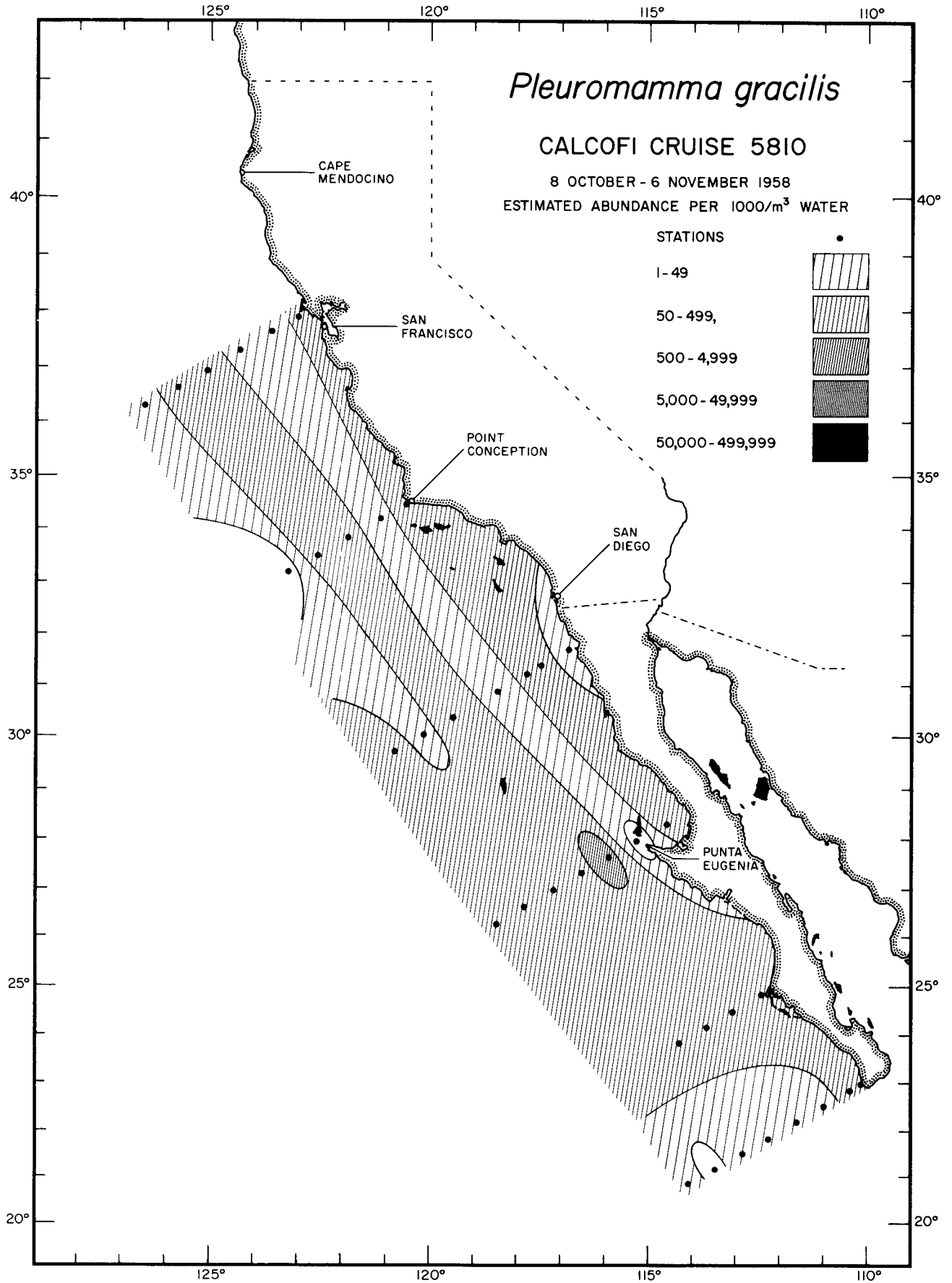
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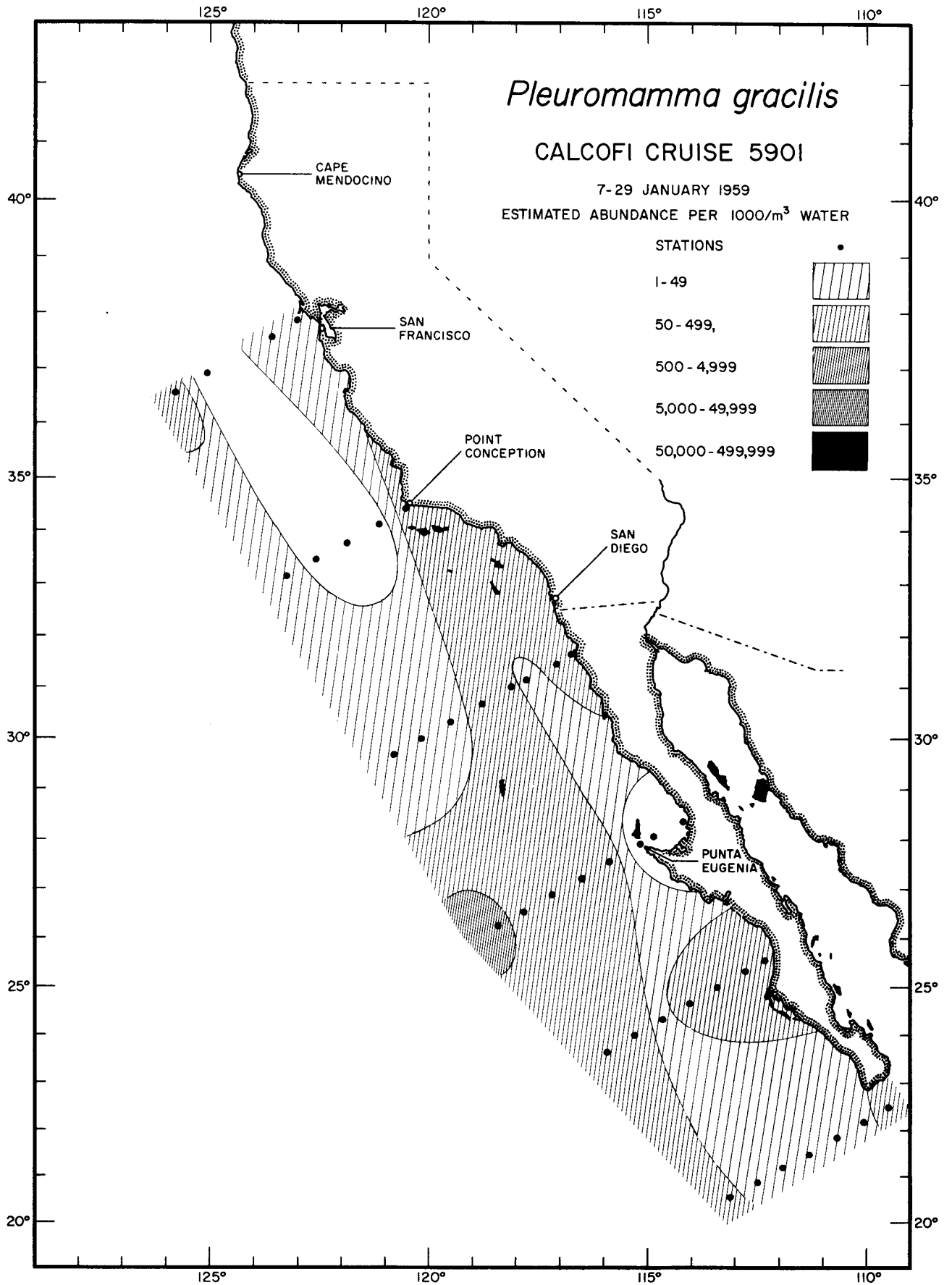
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Pleuromamma gracilis
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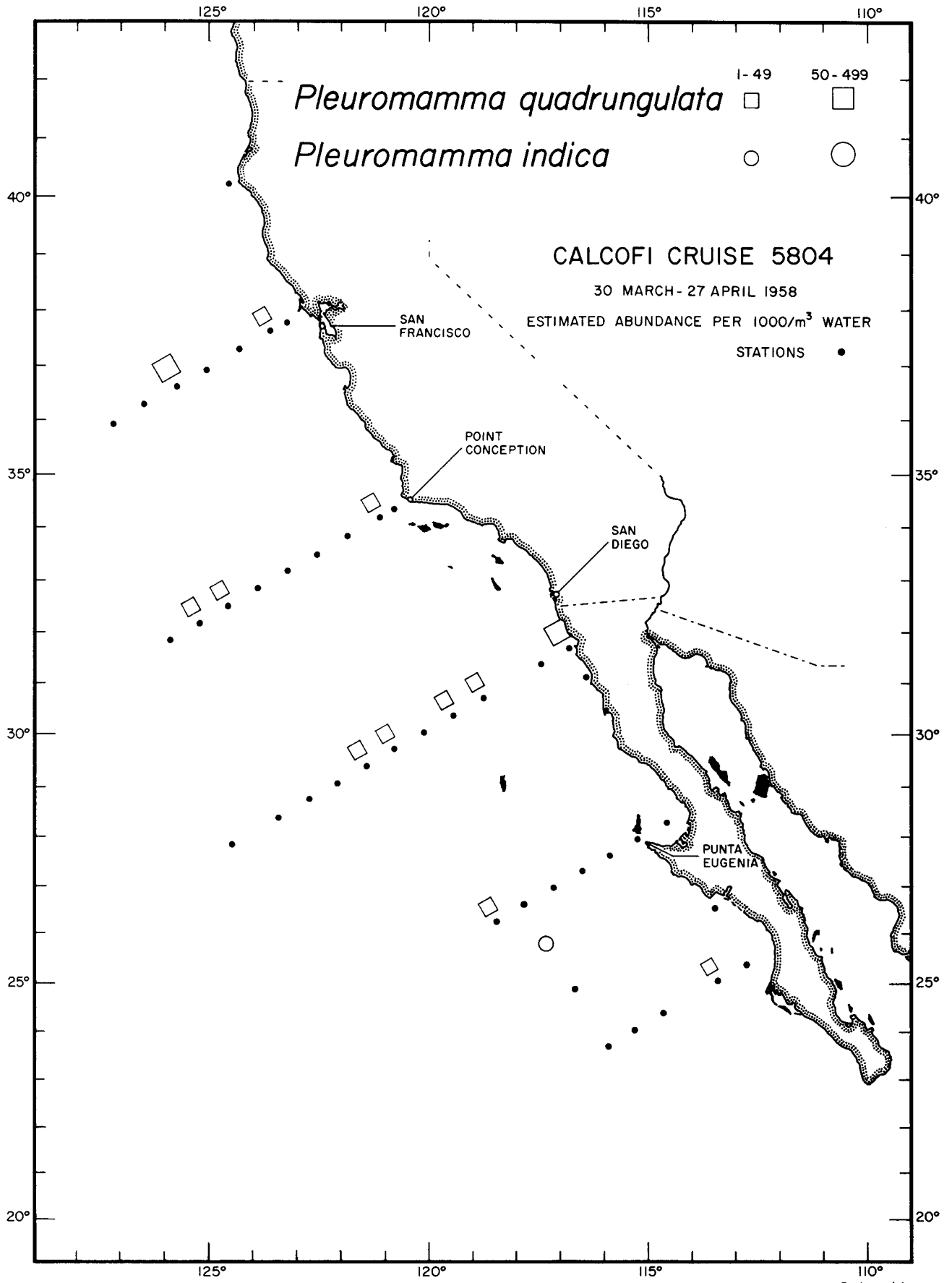


Calanoida
Pleuromamma gracilis
5807



Calanoida
Pleuromamma gracilis
5810





Pleuromamma quadrangulata
Pleuromamma indica

1-49 50-499
□ □
○ ○

CALCOFI CRUISE 5804

30 MARCH - 27 APRIL 1958

ESTIMATED ABUNDANCE PER 1000/m³ WATER

STATIONS ●

SAN FRANCISCO

POINT CONCEPTION

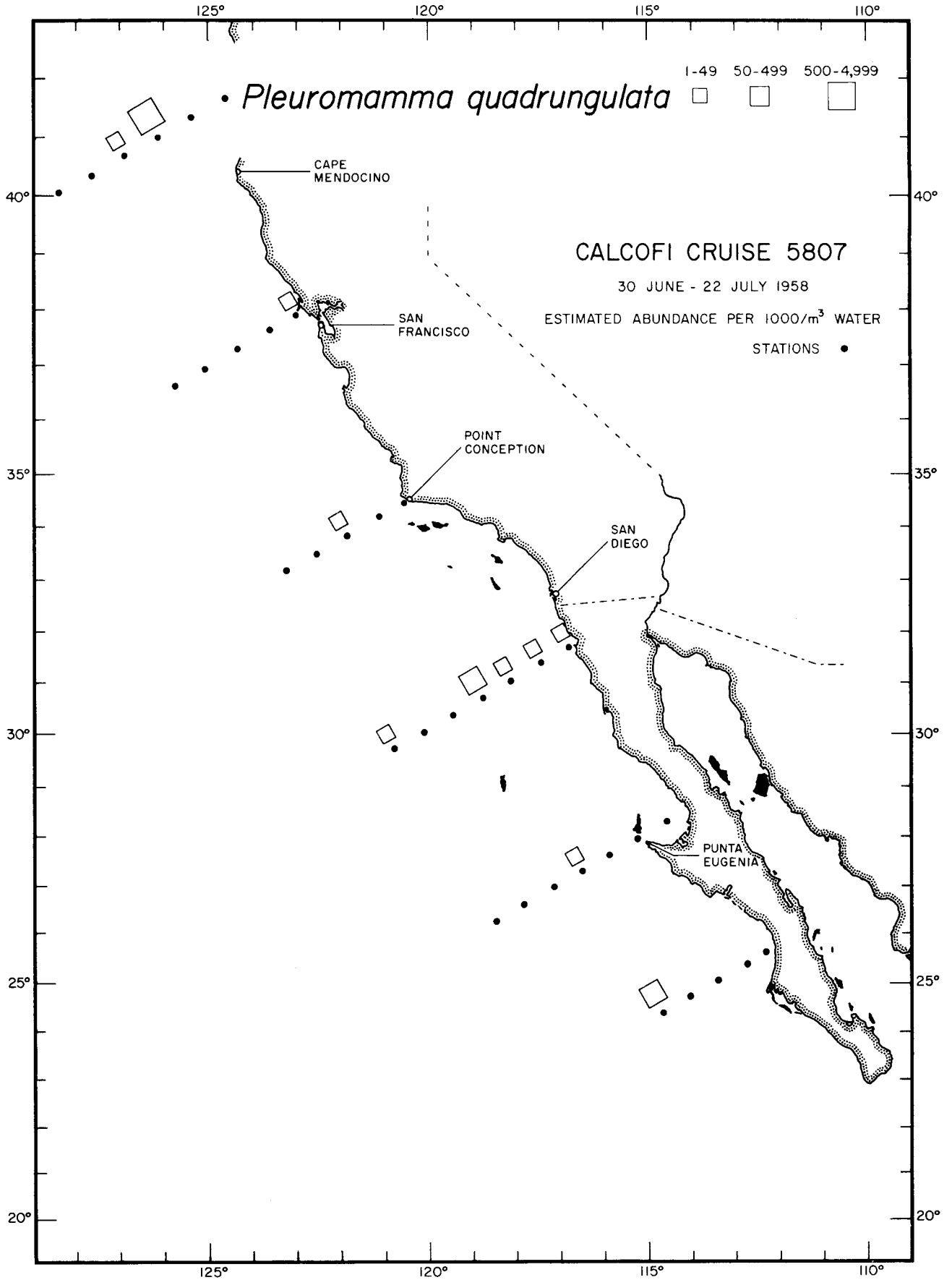
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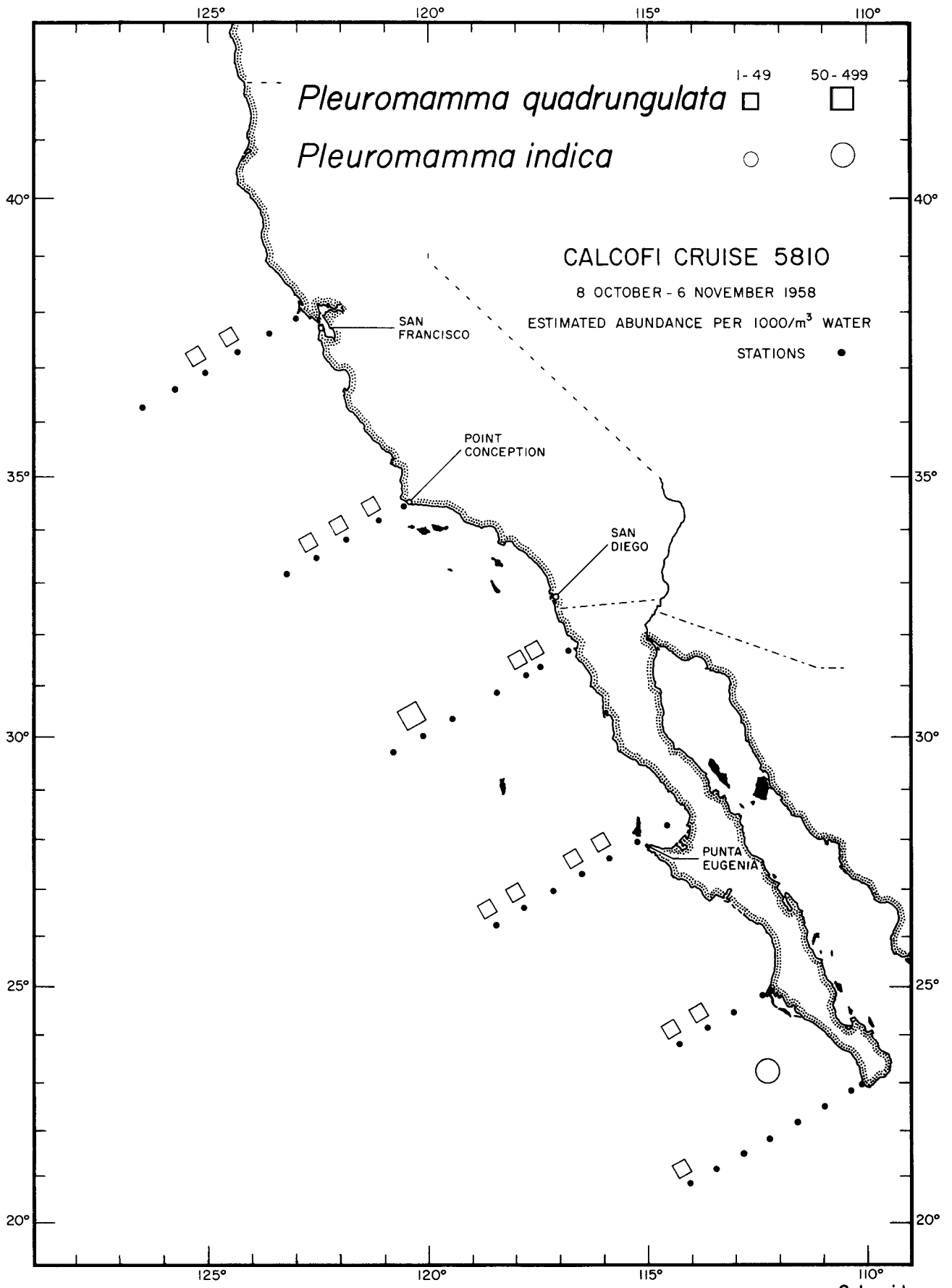
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Pleuromamma indica

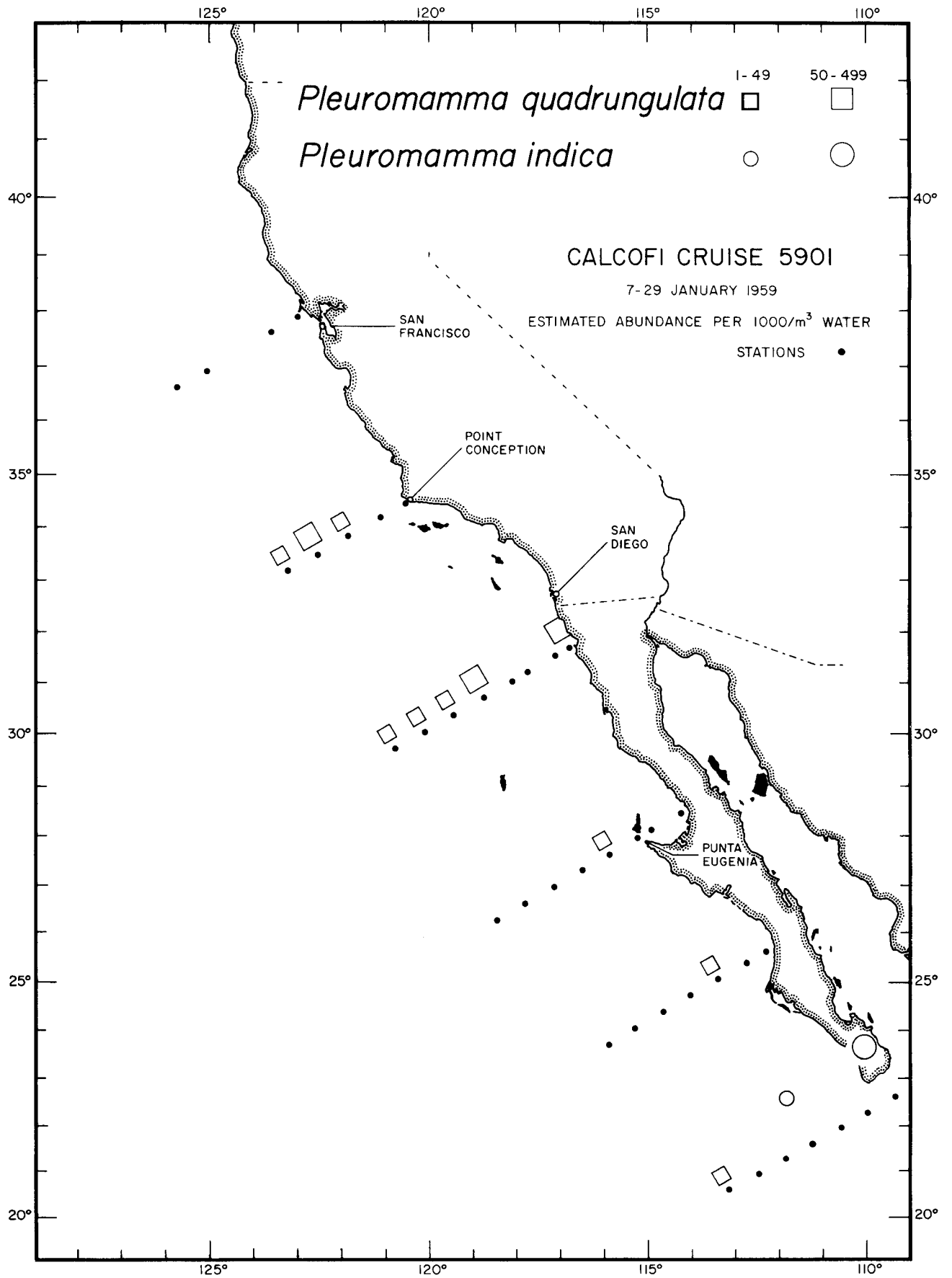
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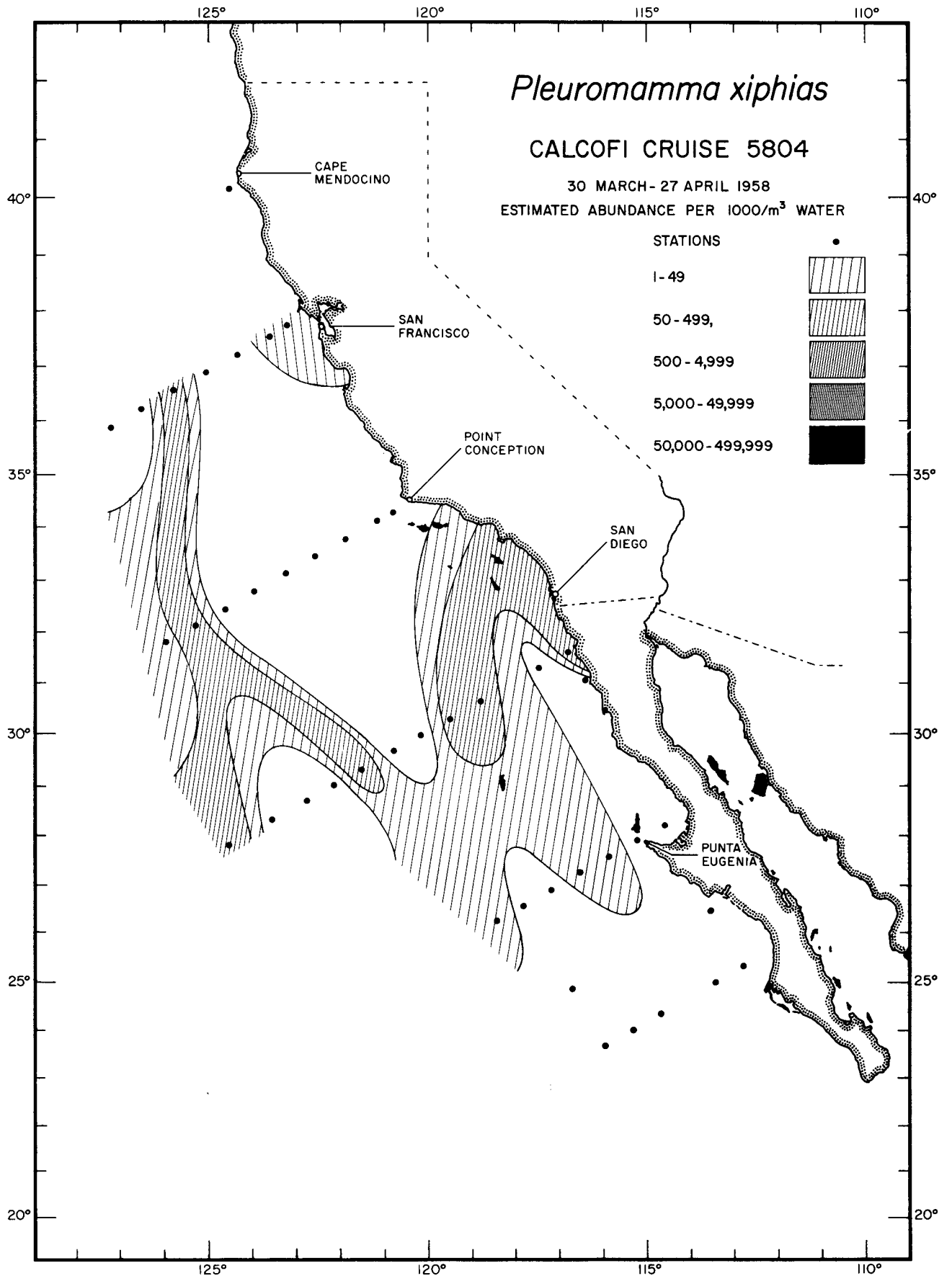
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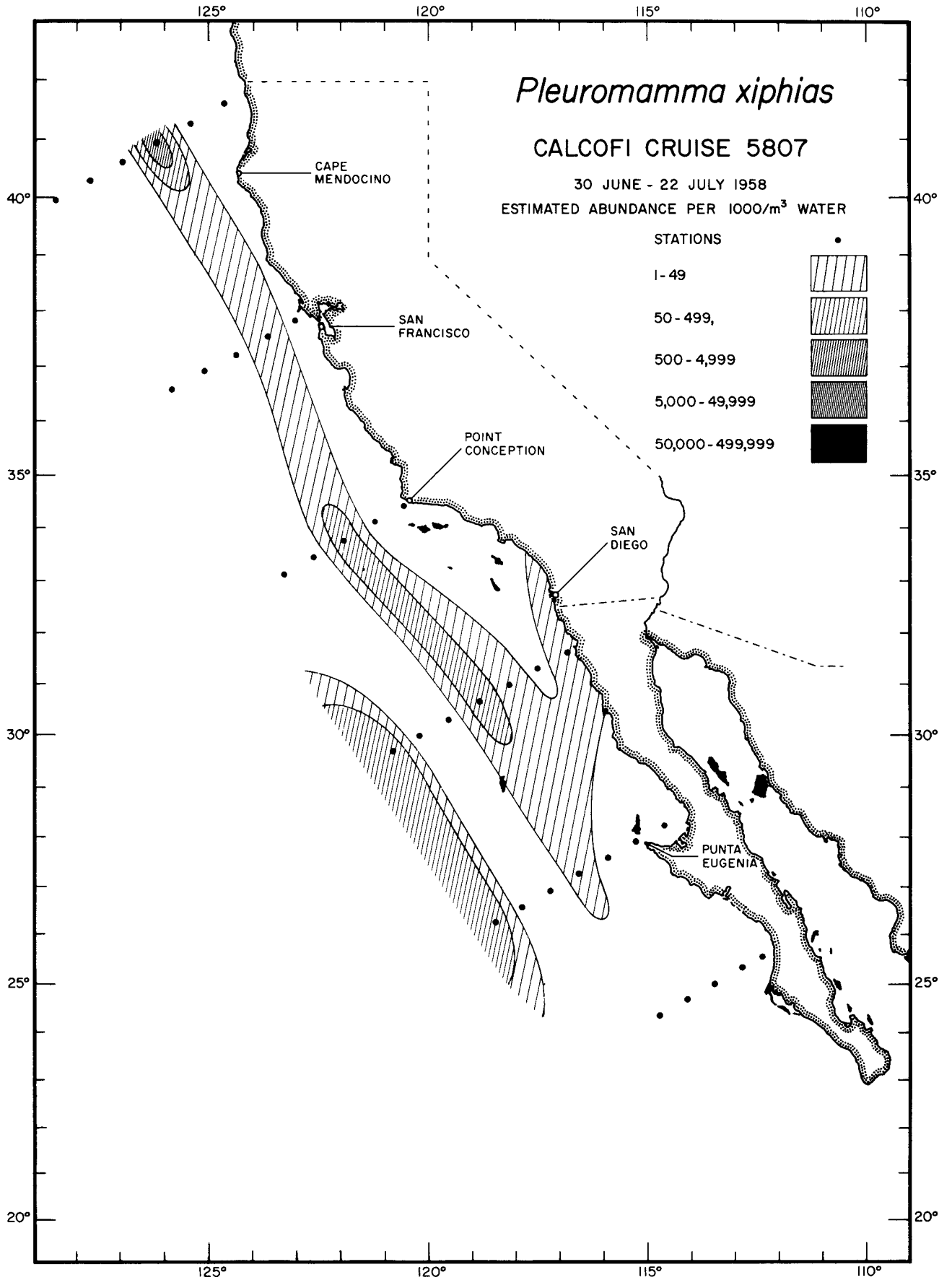
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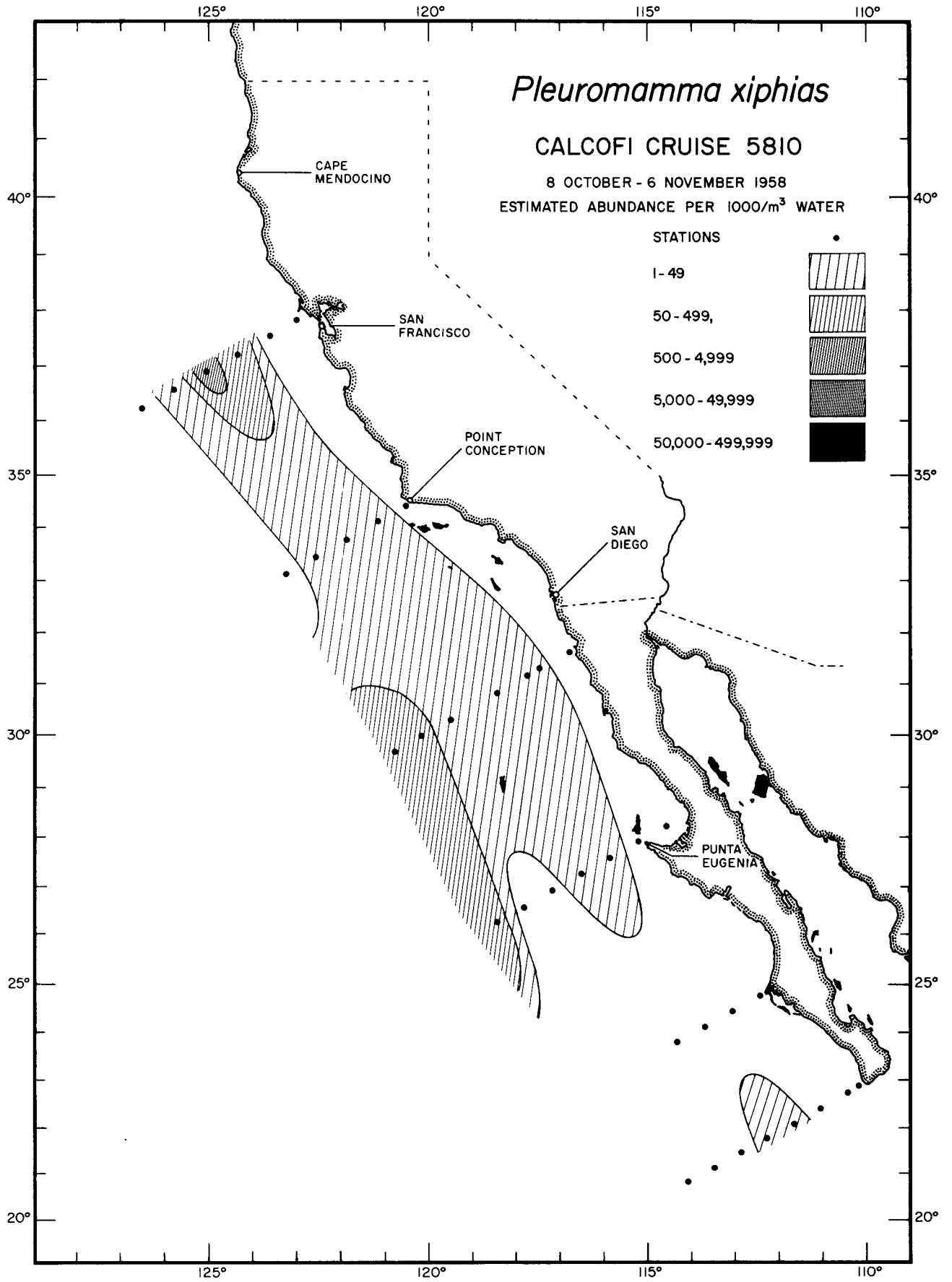
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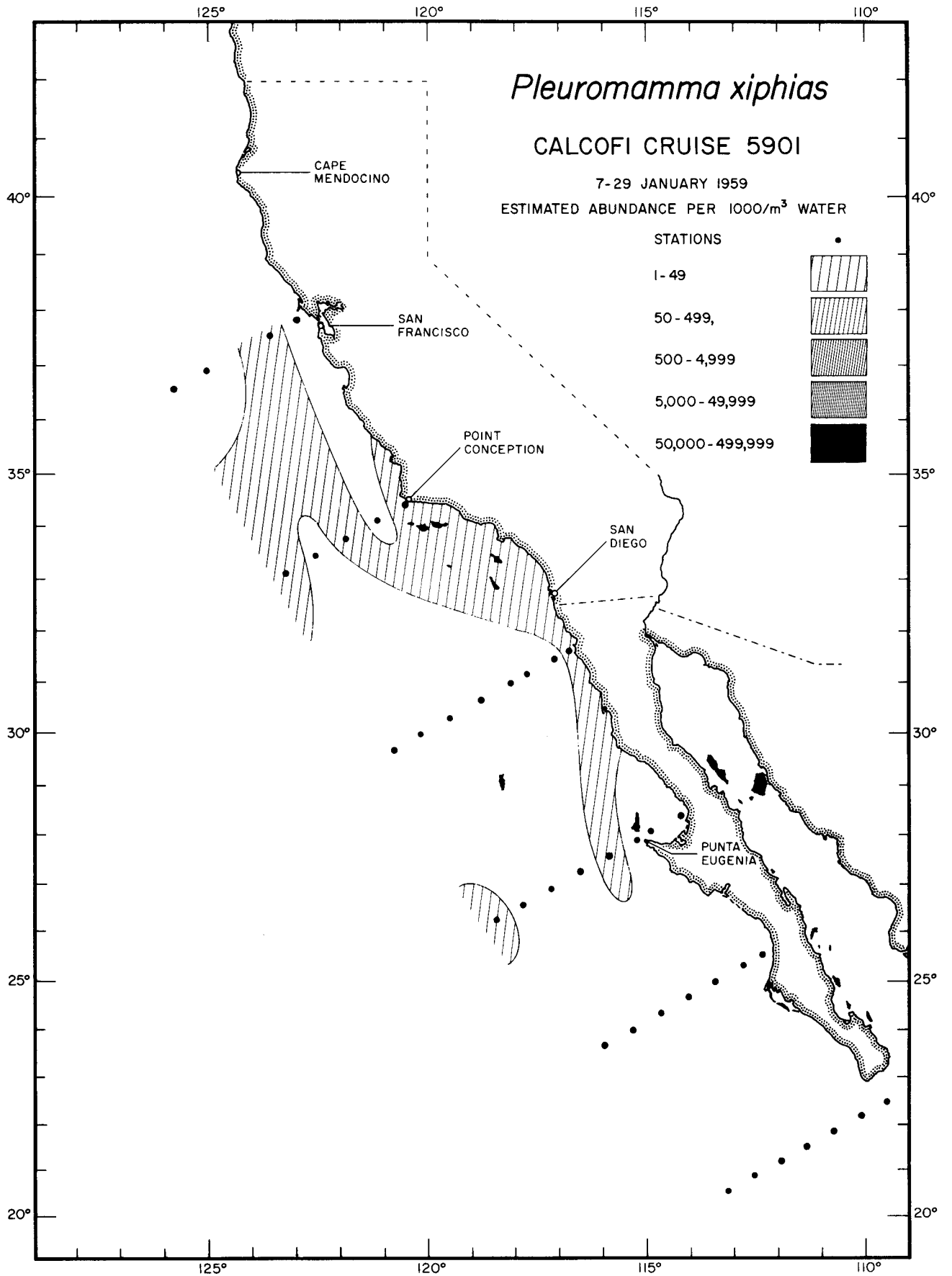
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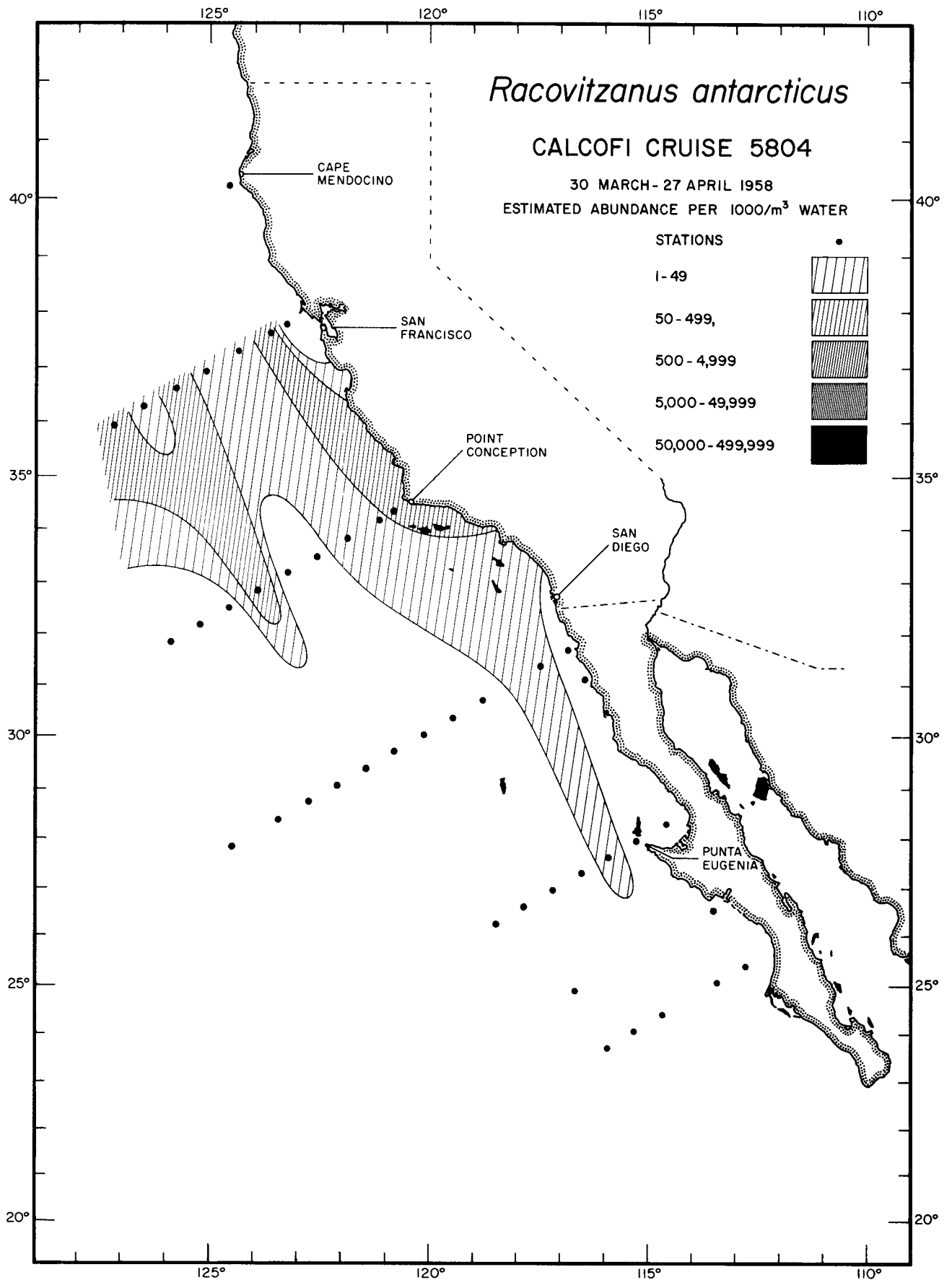
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Pleuromamma xiphias
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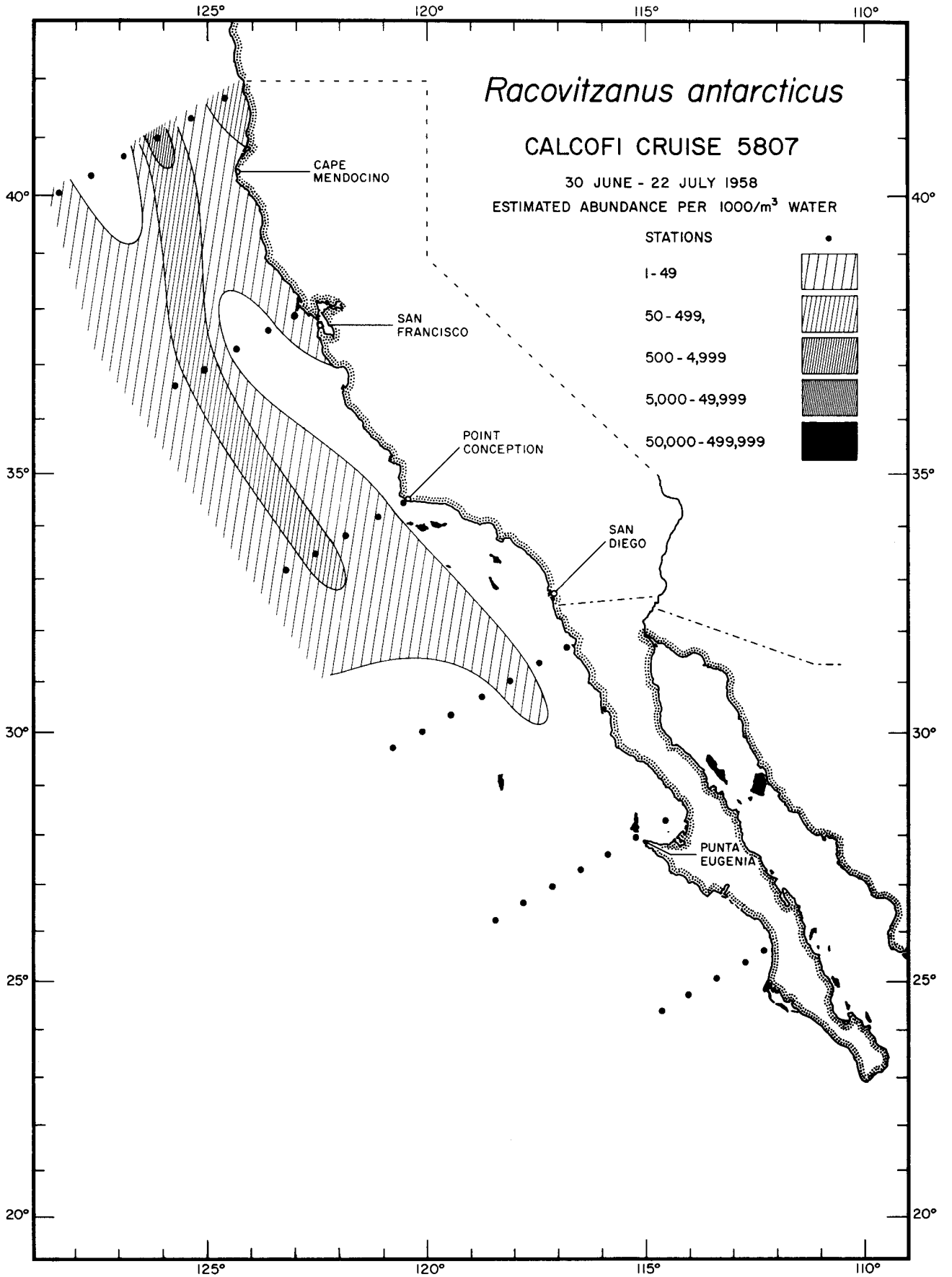
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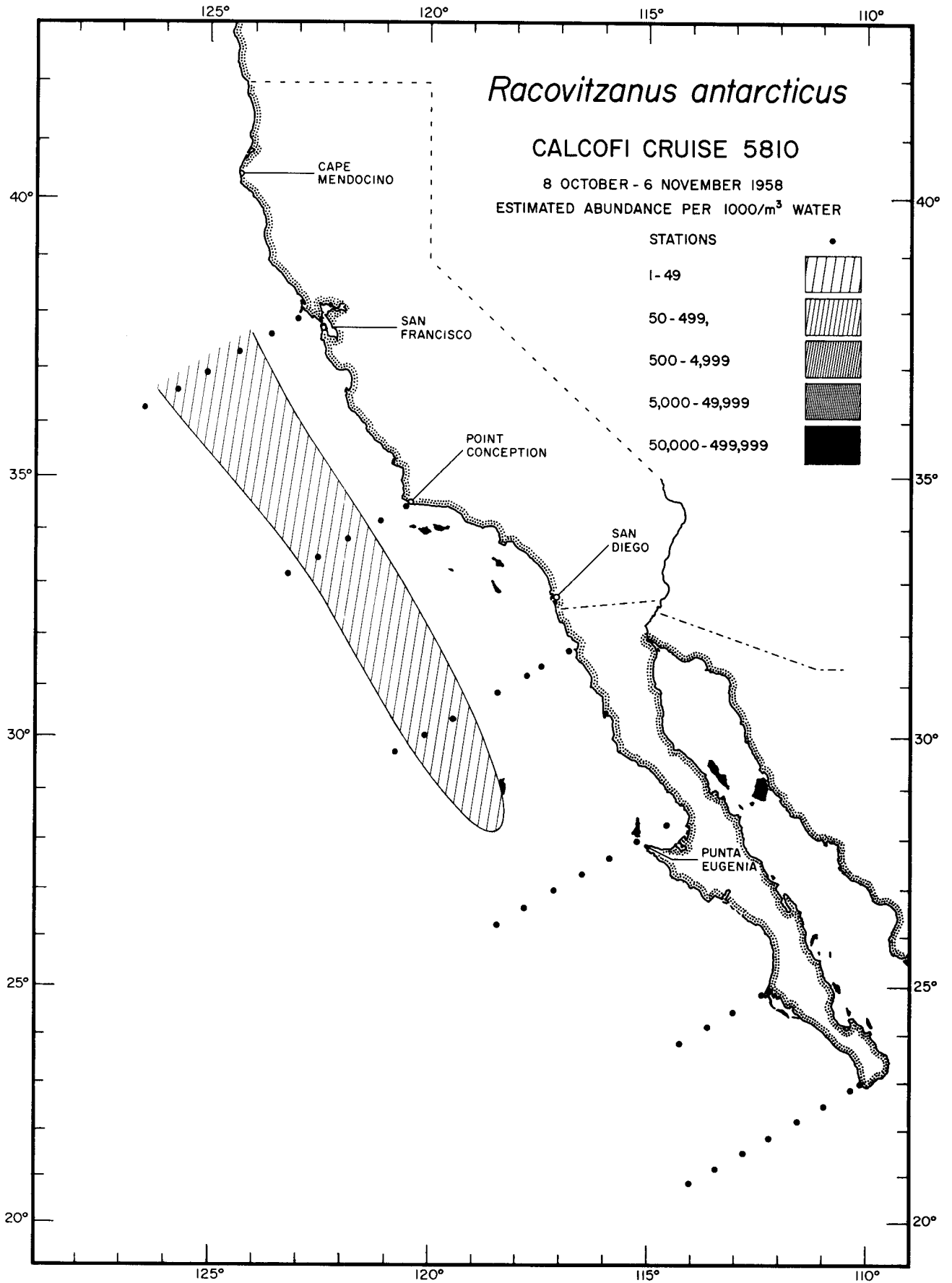
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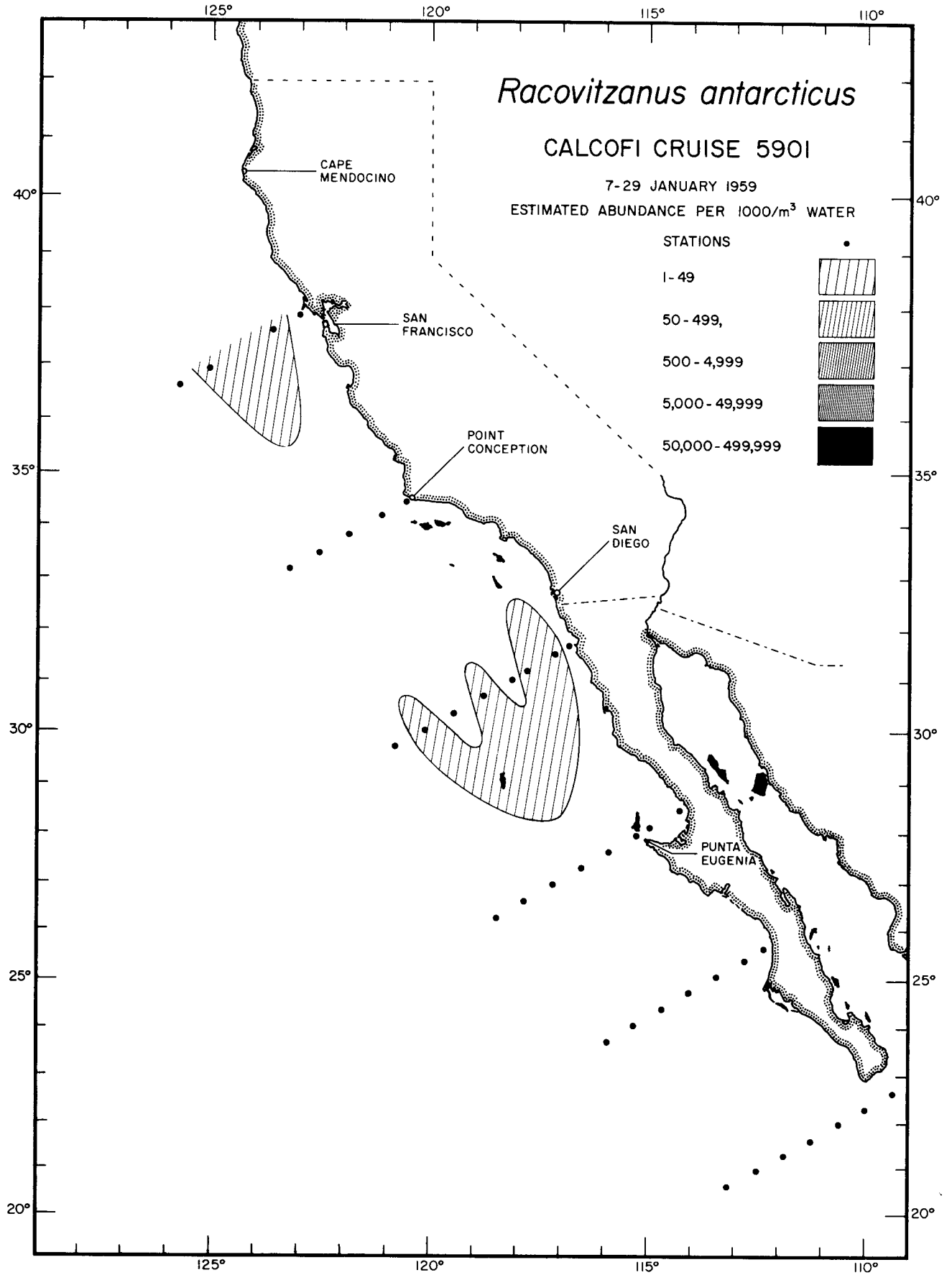
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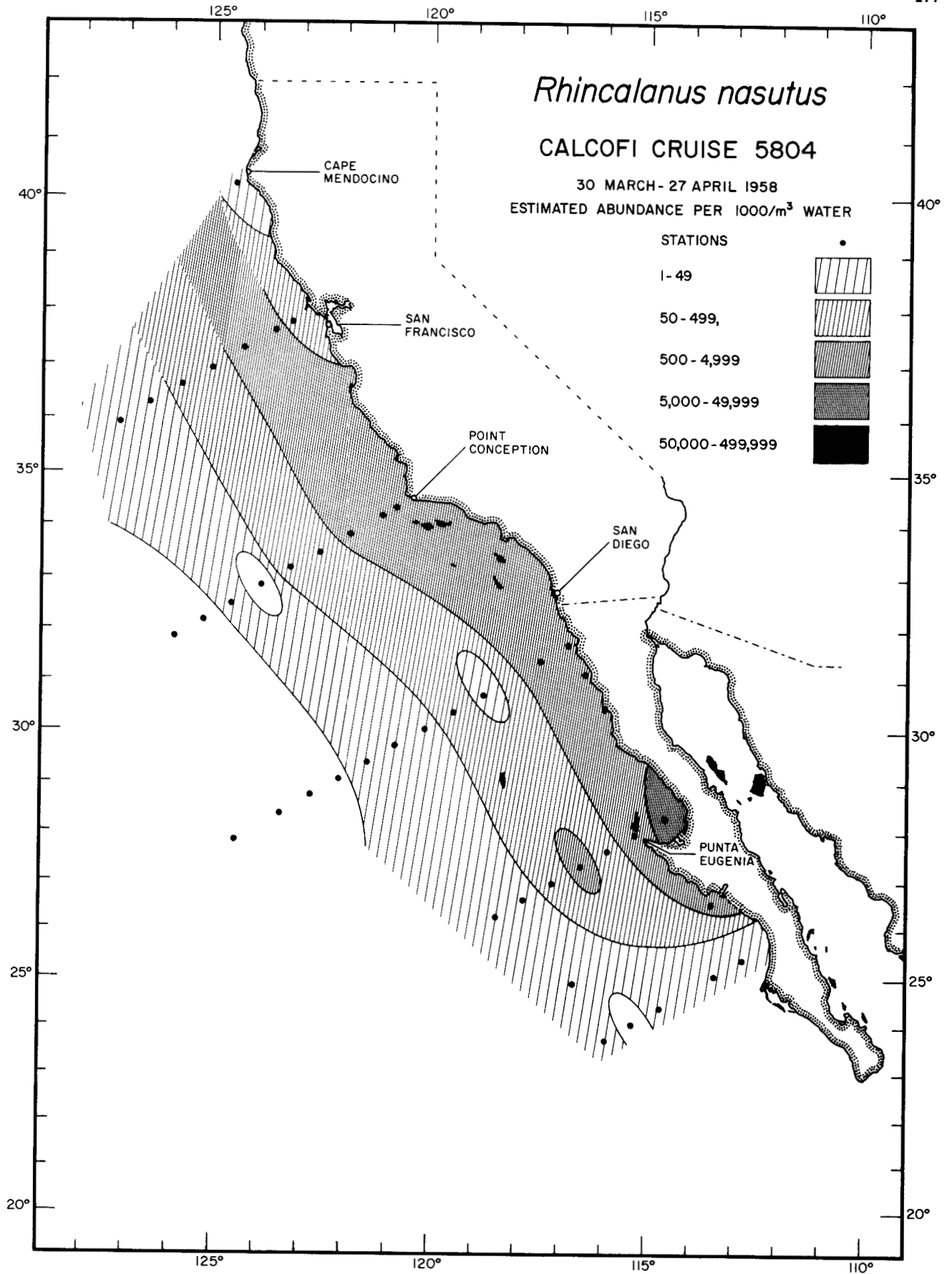


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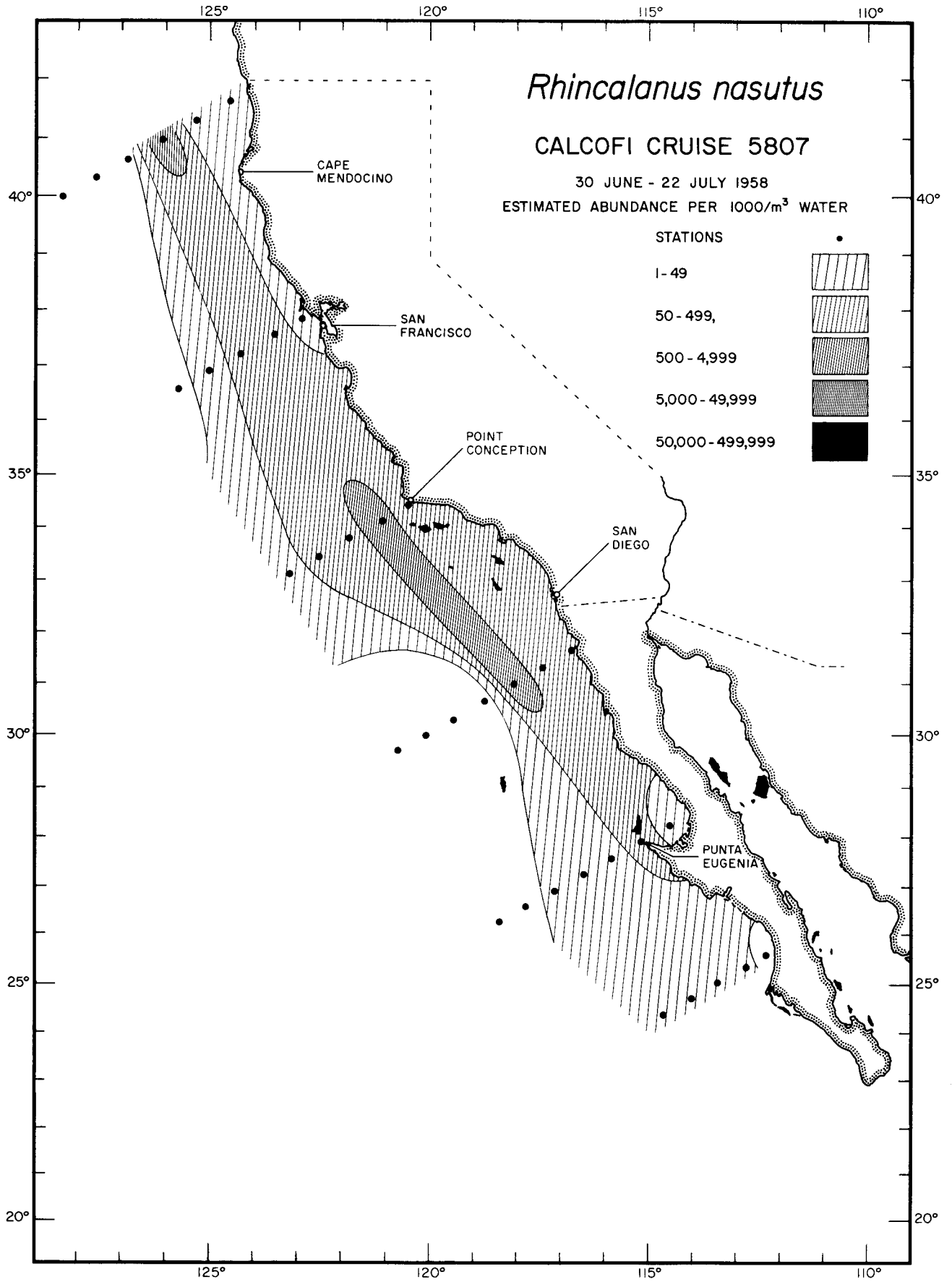


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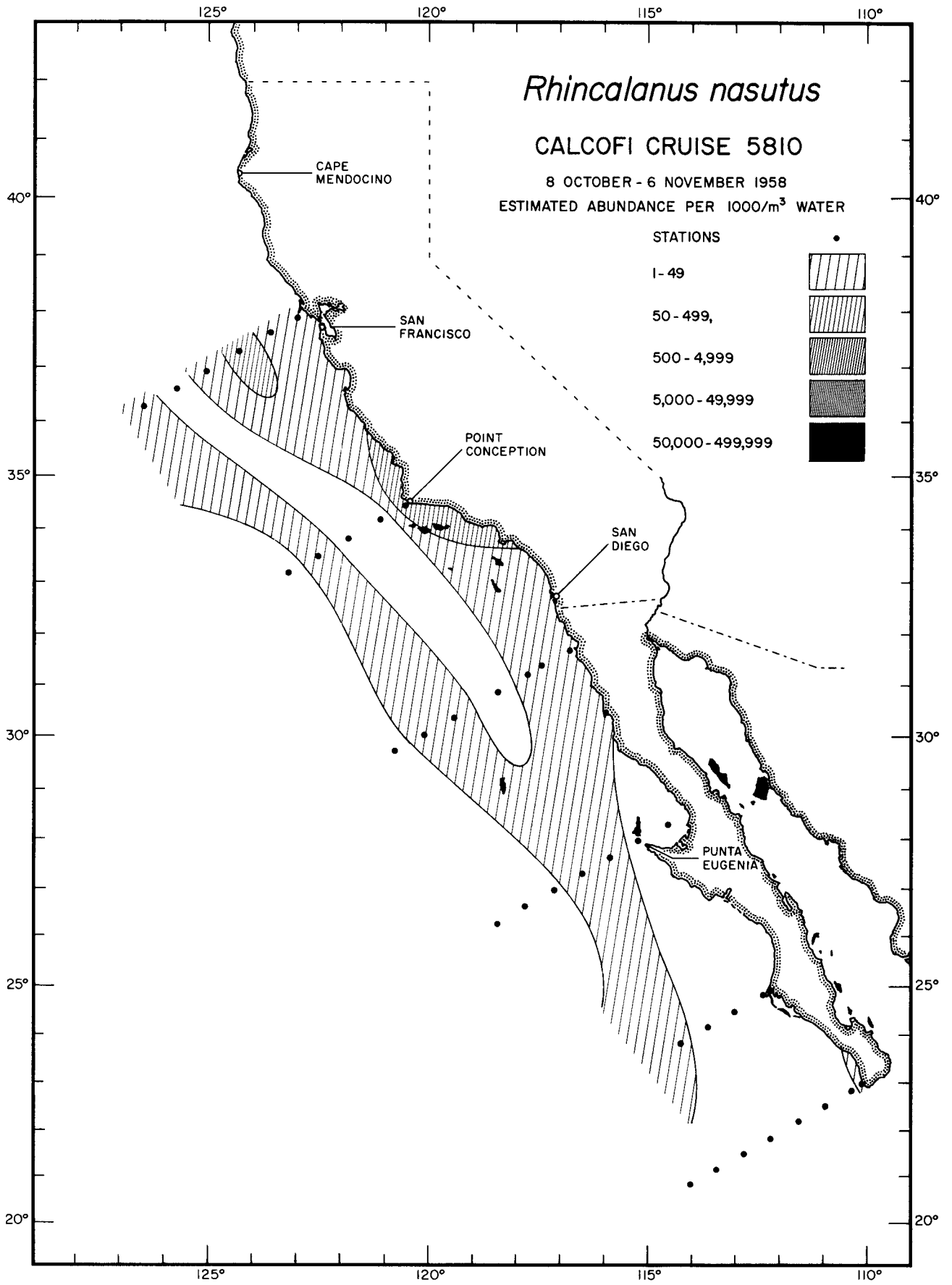




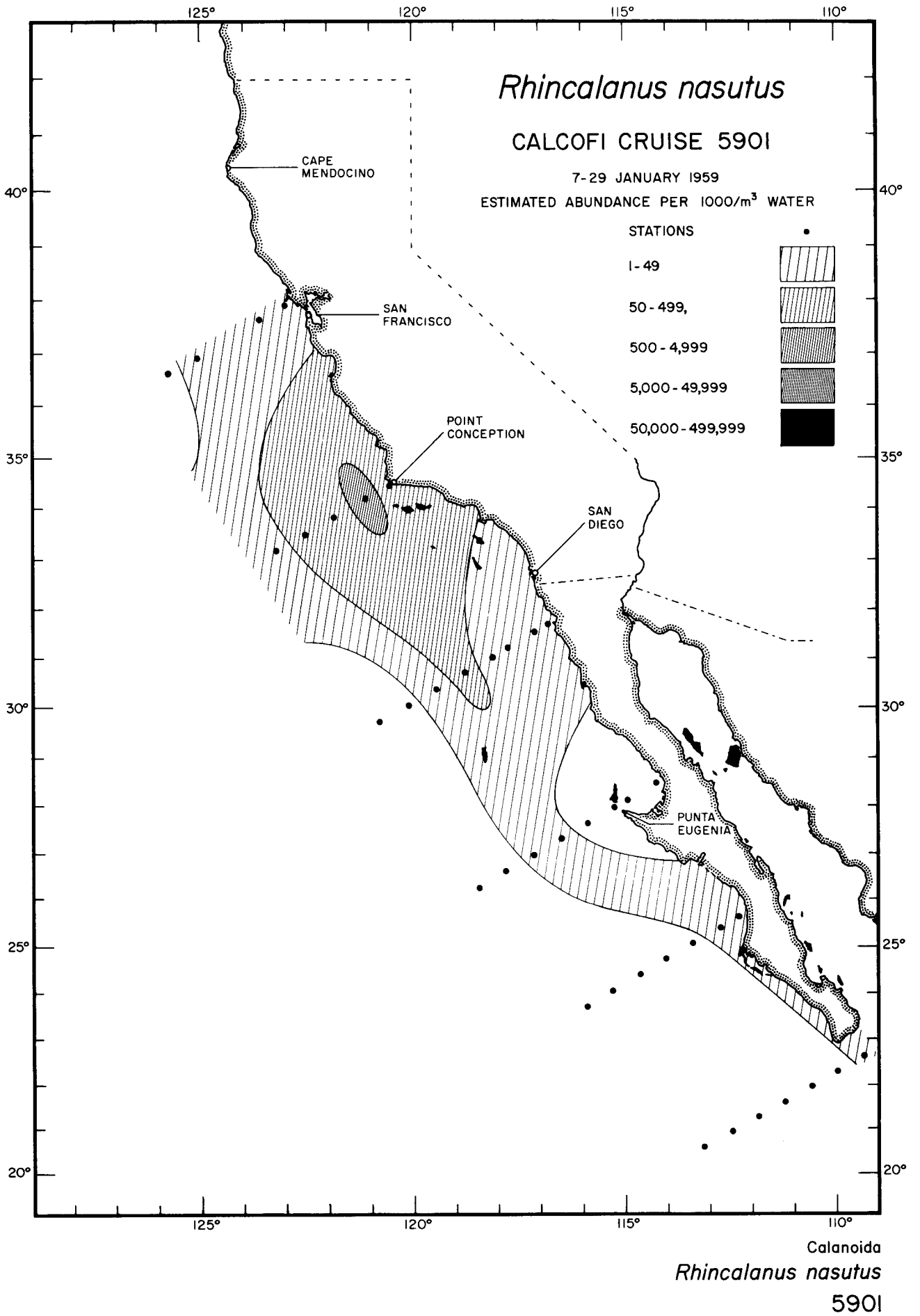
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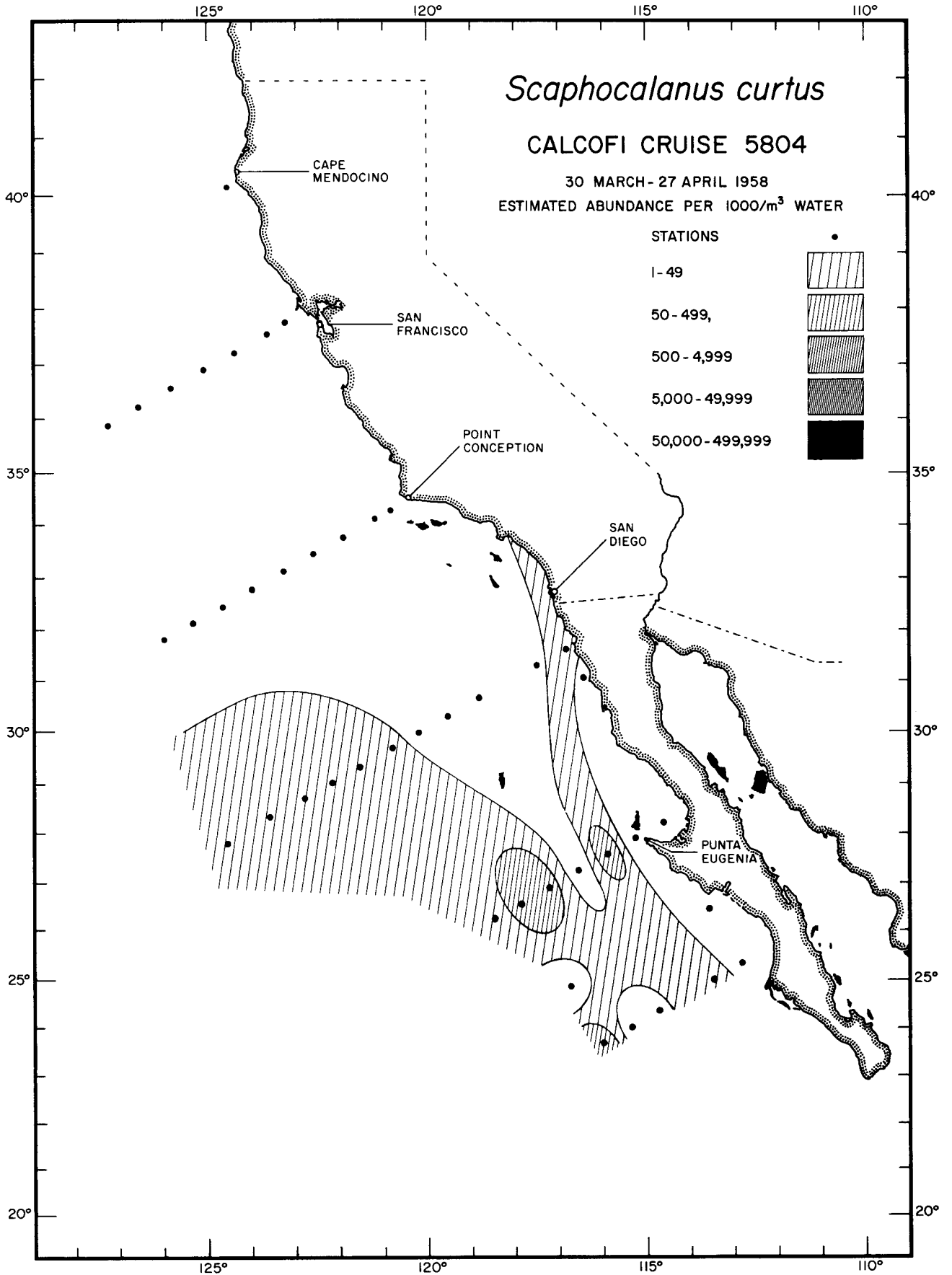


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Rhincalanus nasutus
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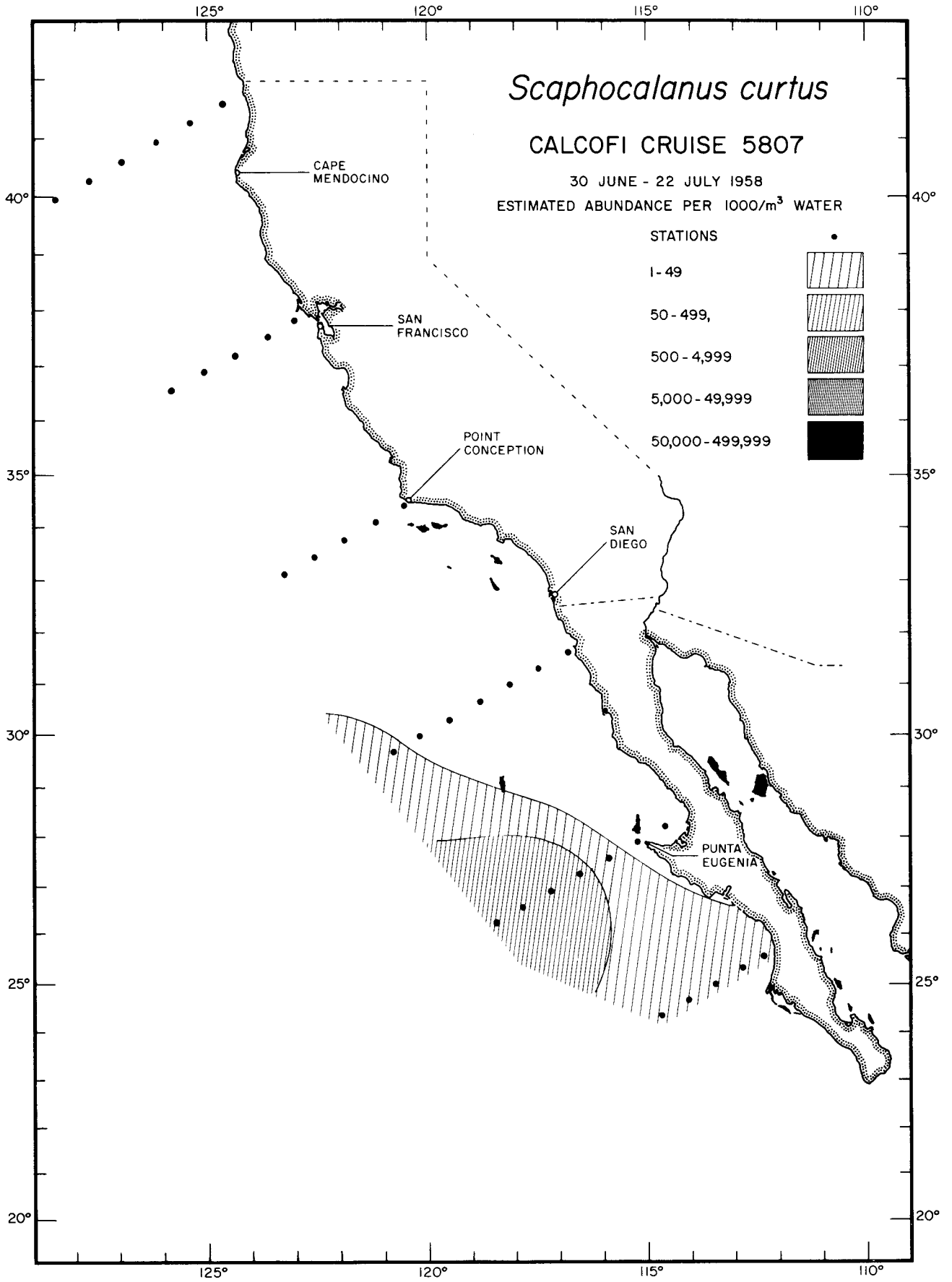


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Rhincalanus nasutus
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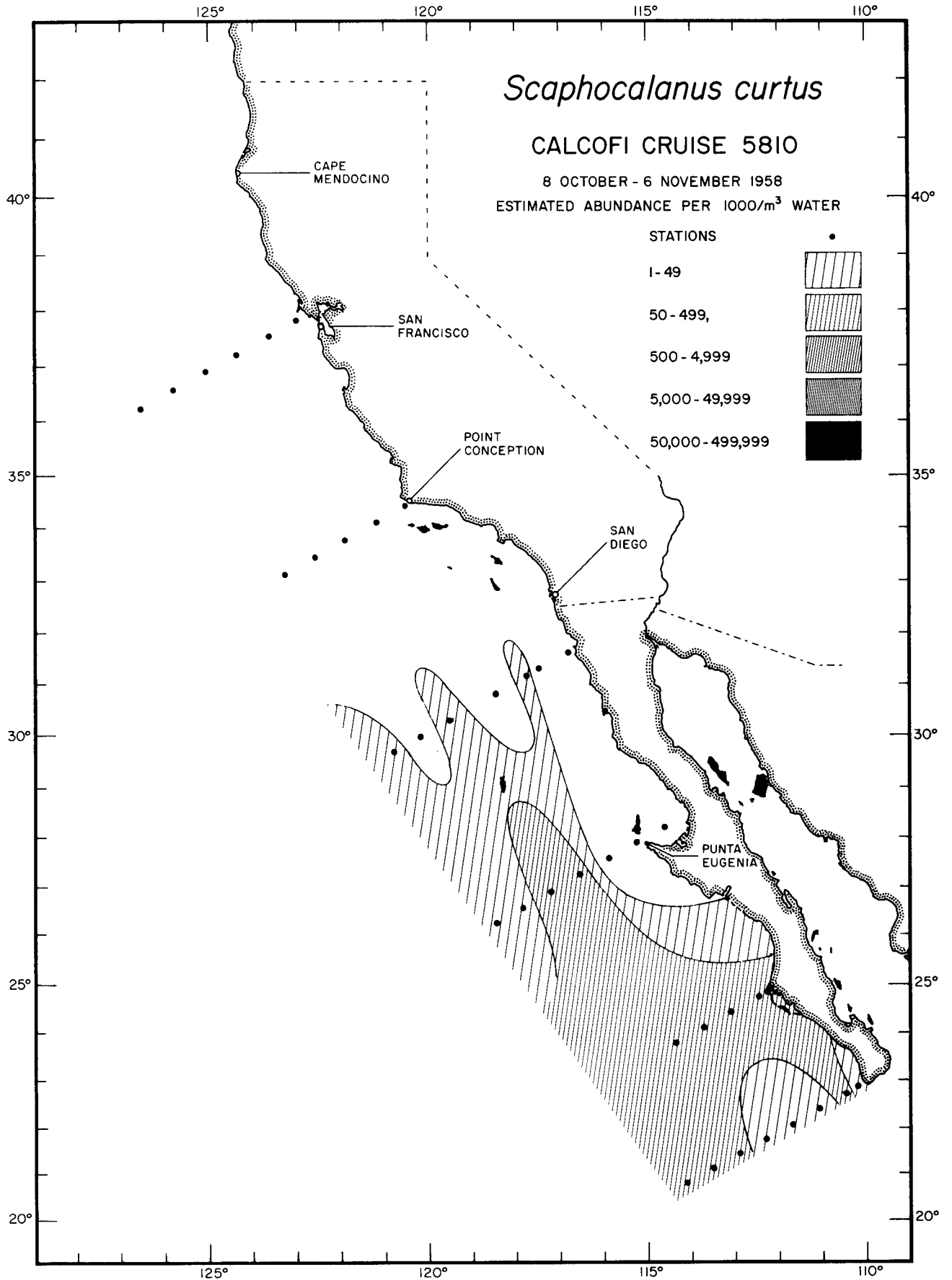




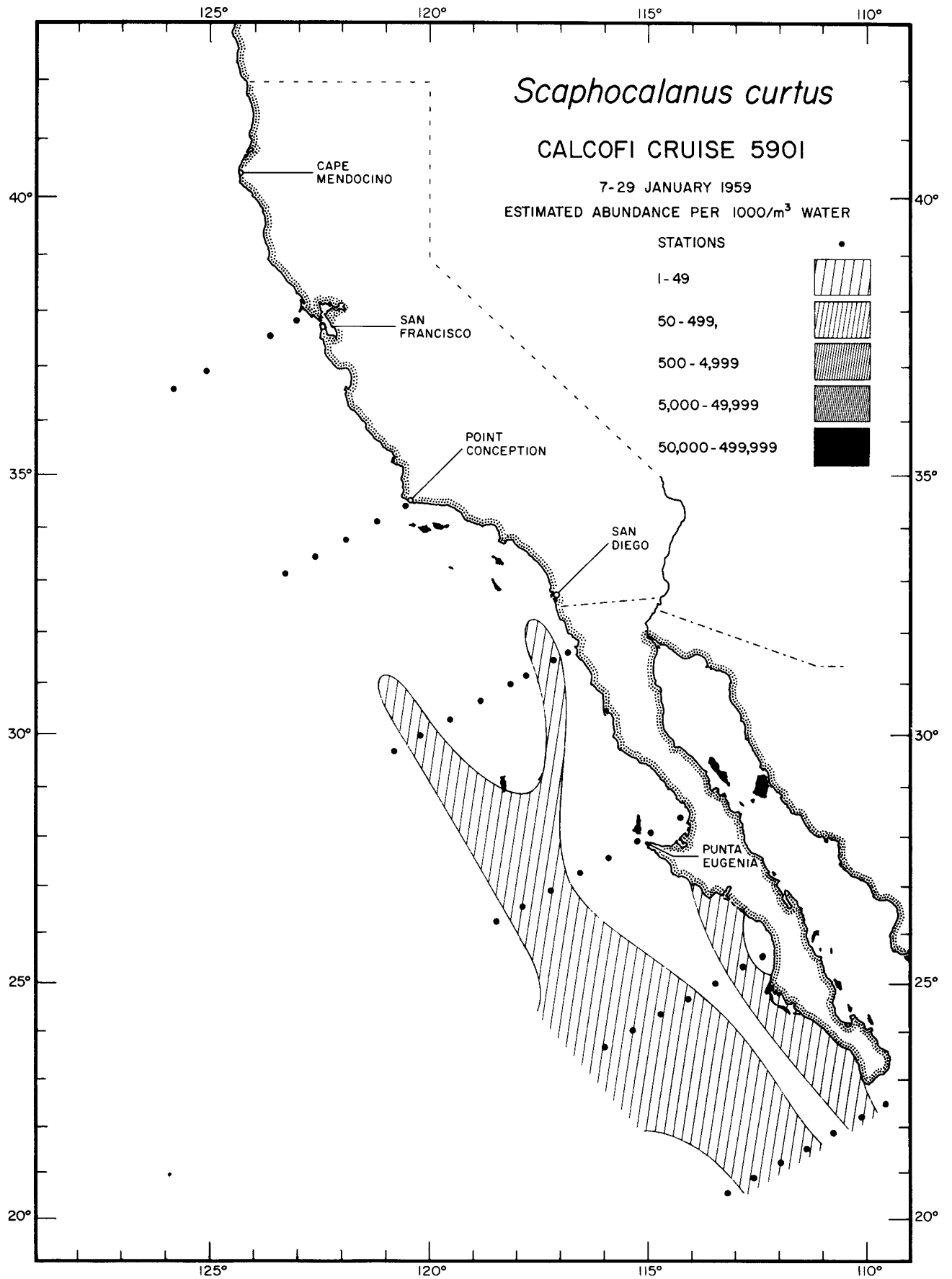
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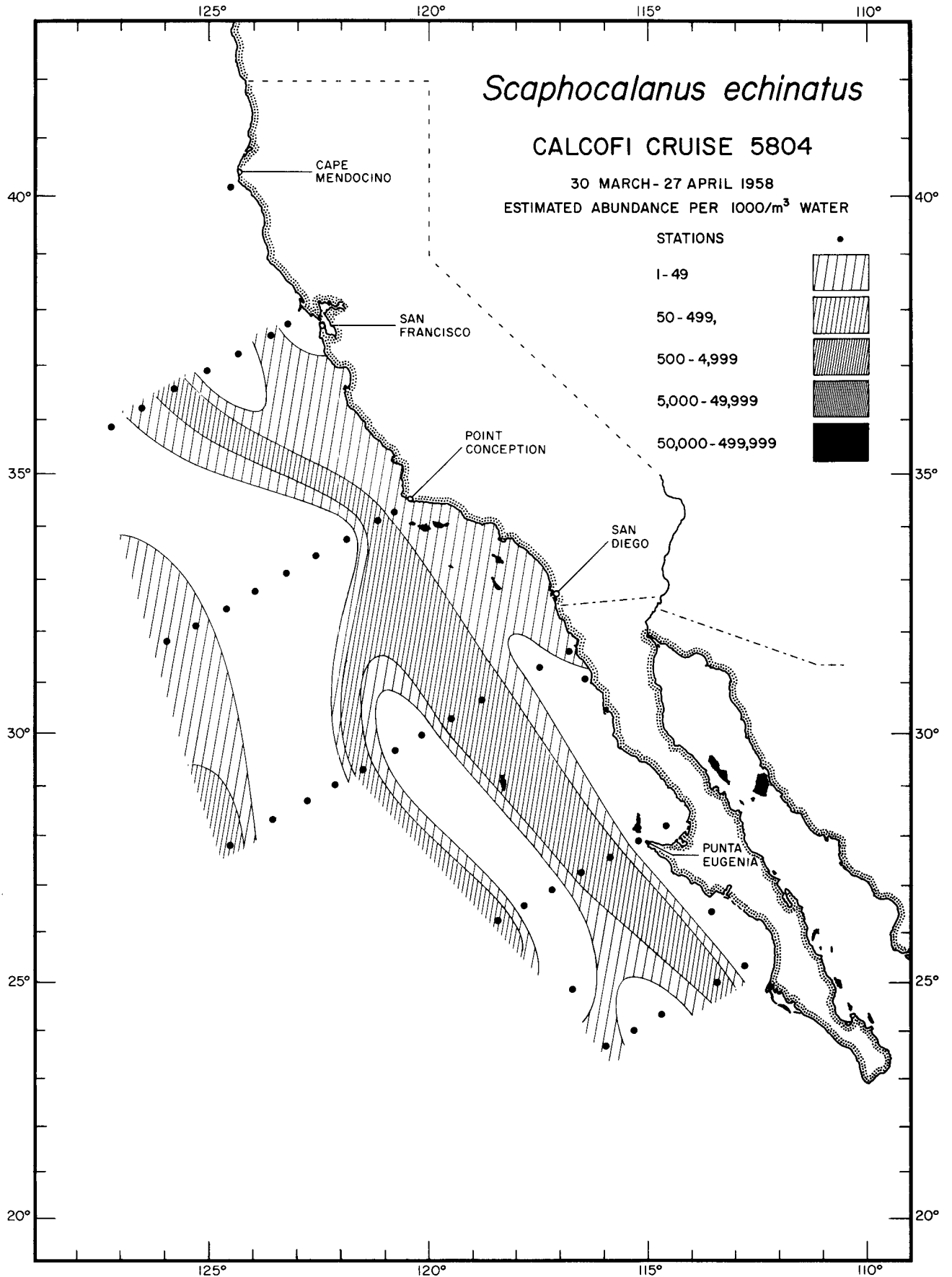
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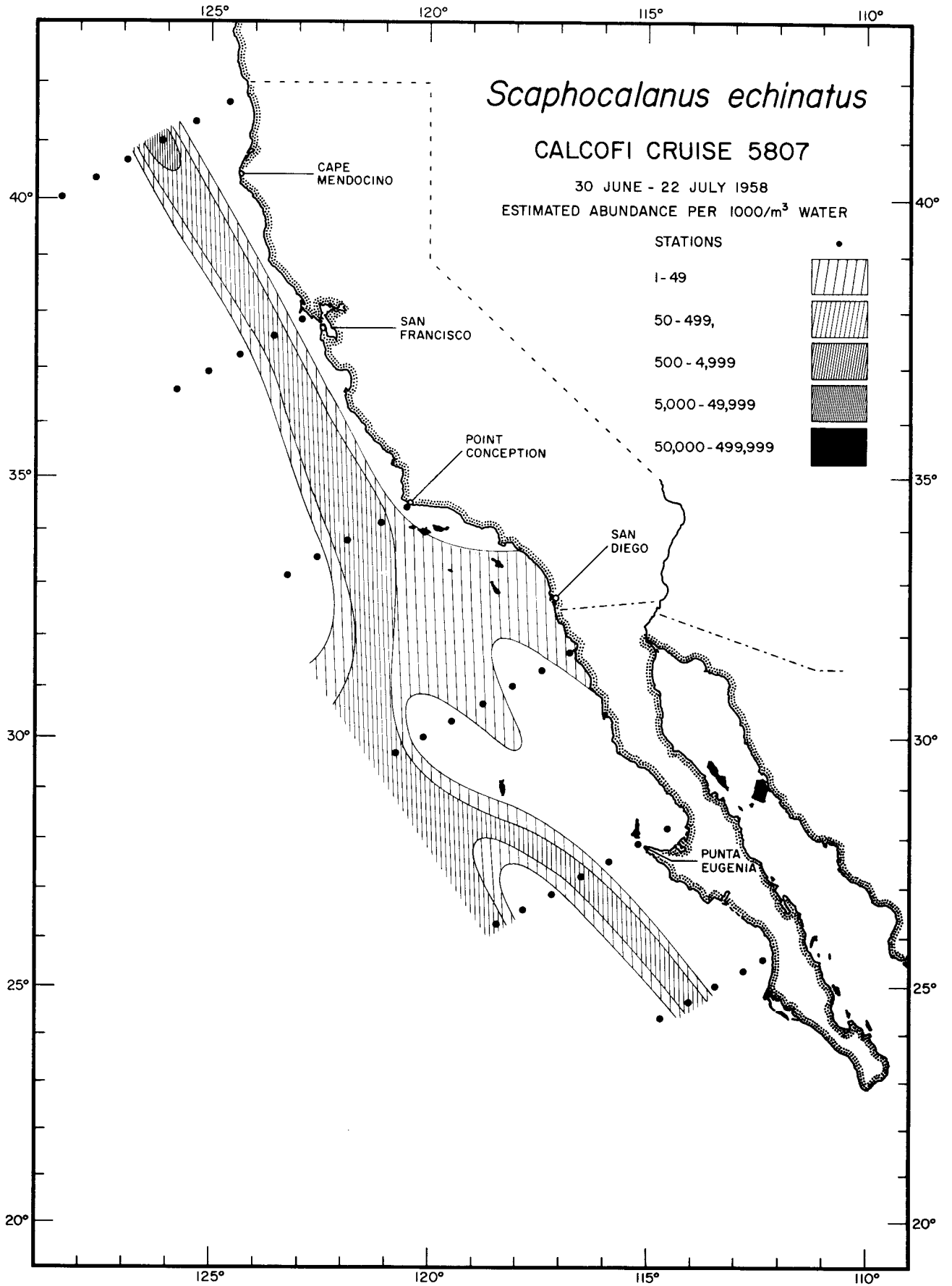
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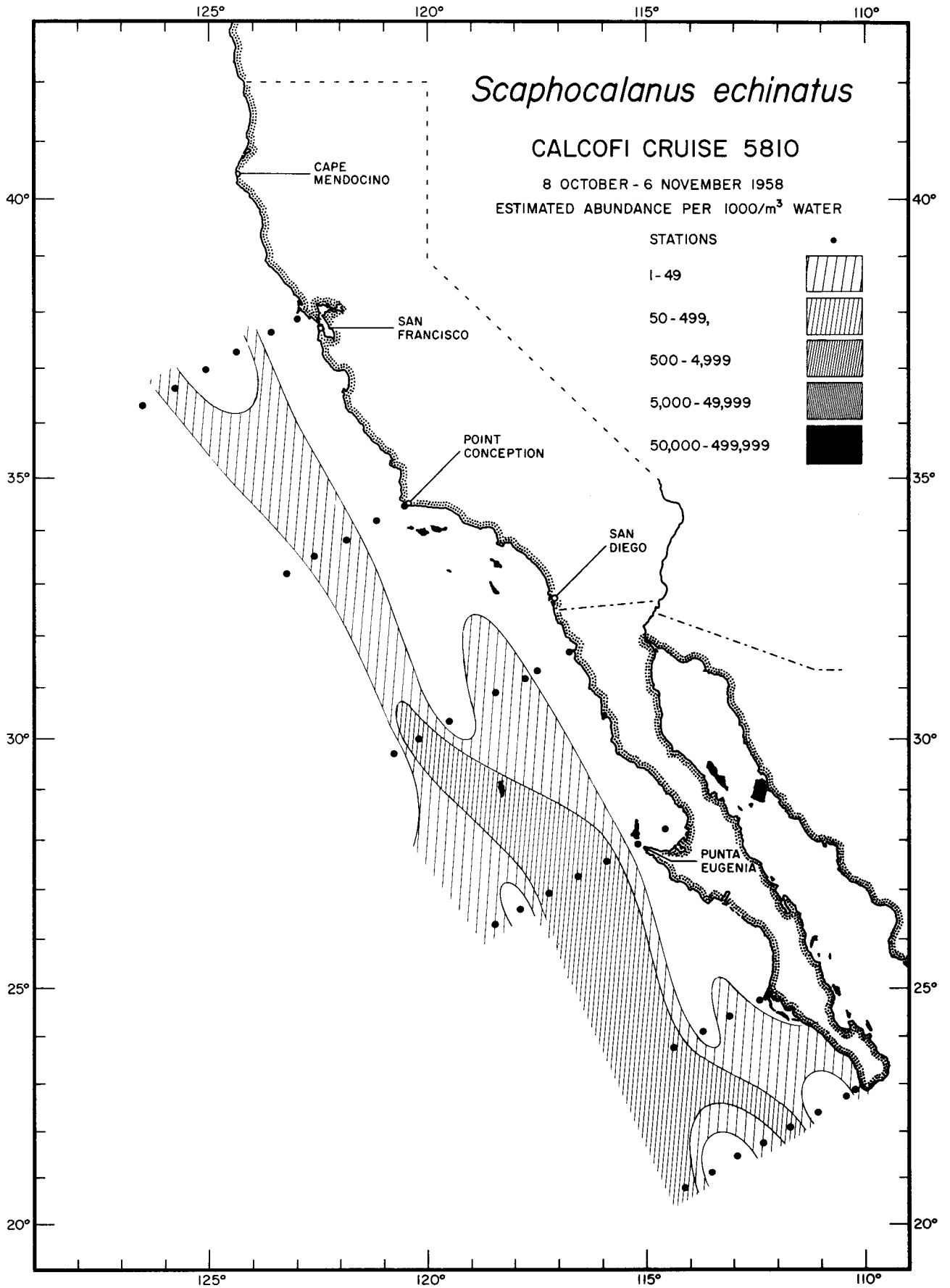
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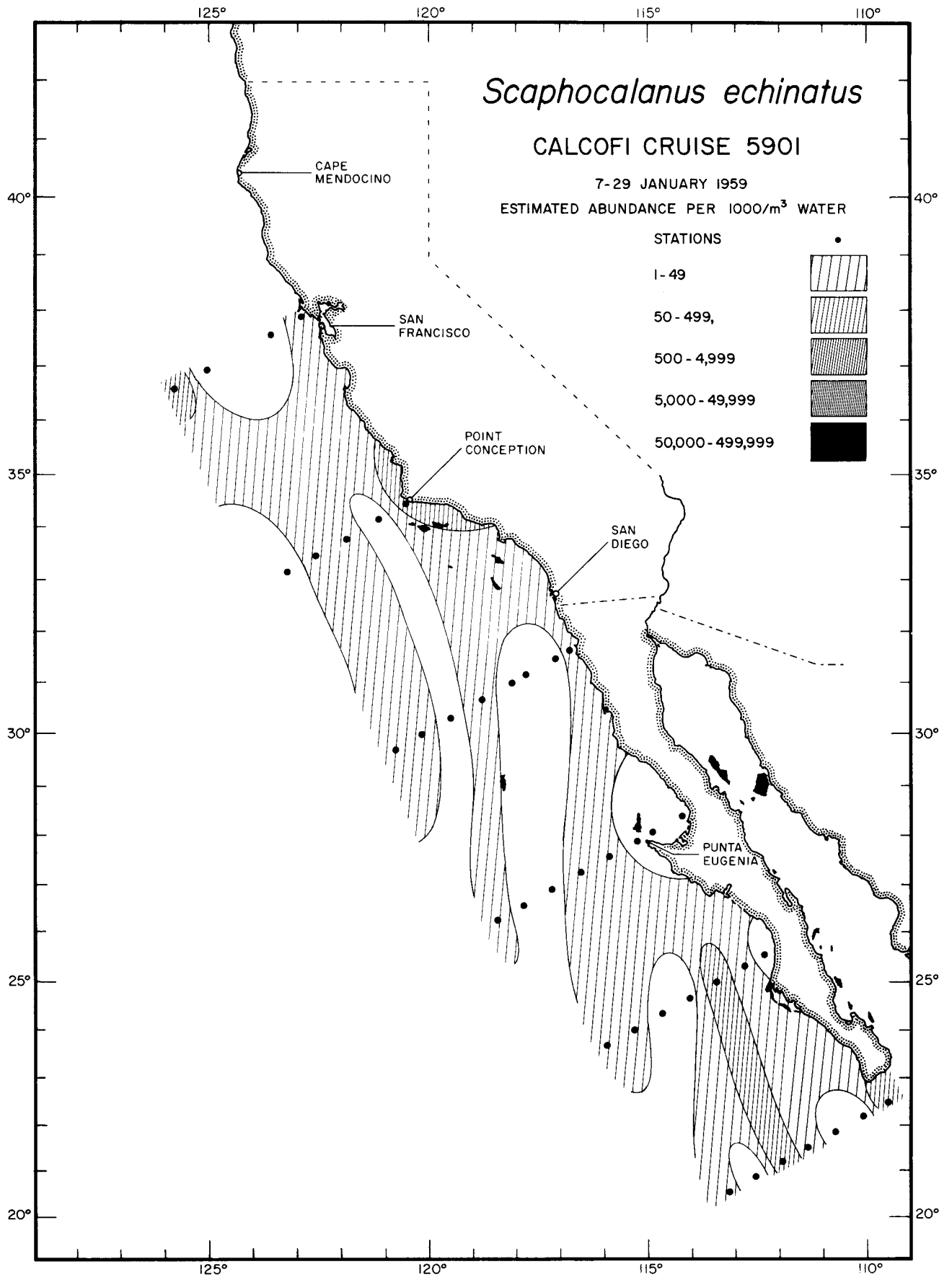
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Scaphocalanus echinatus
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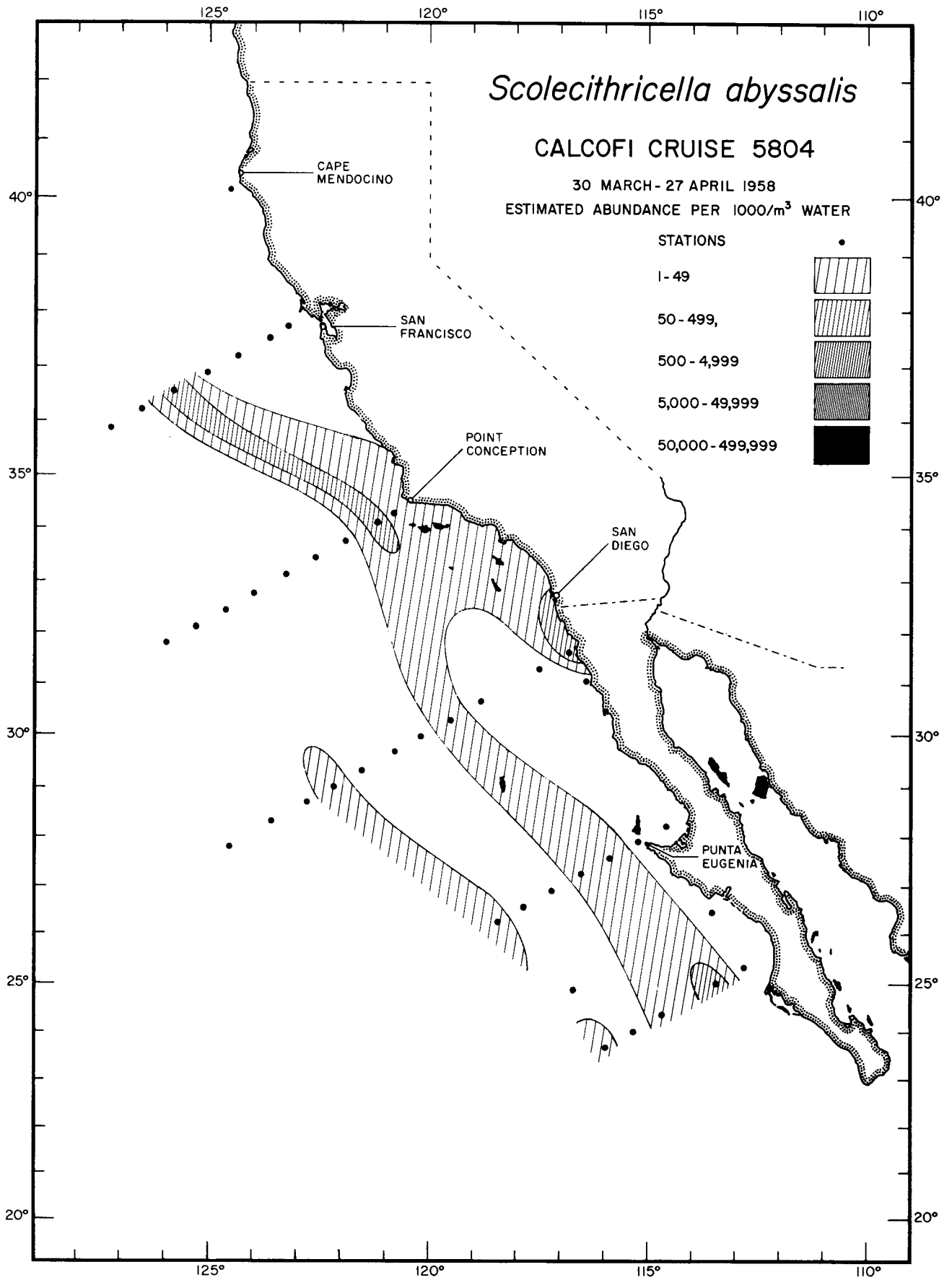
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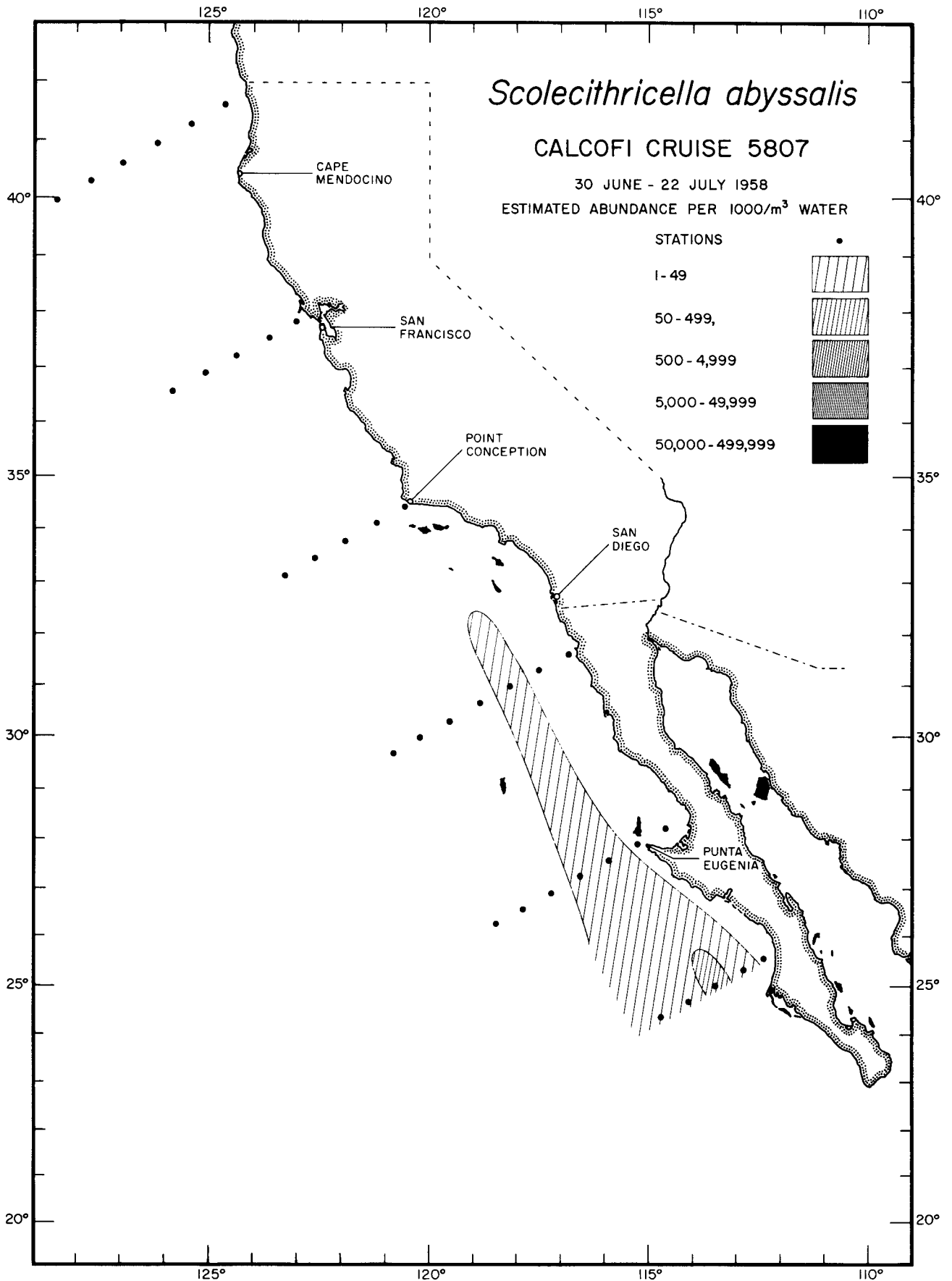
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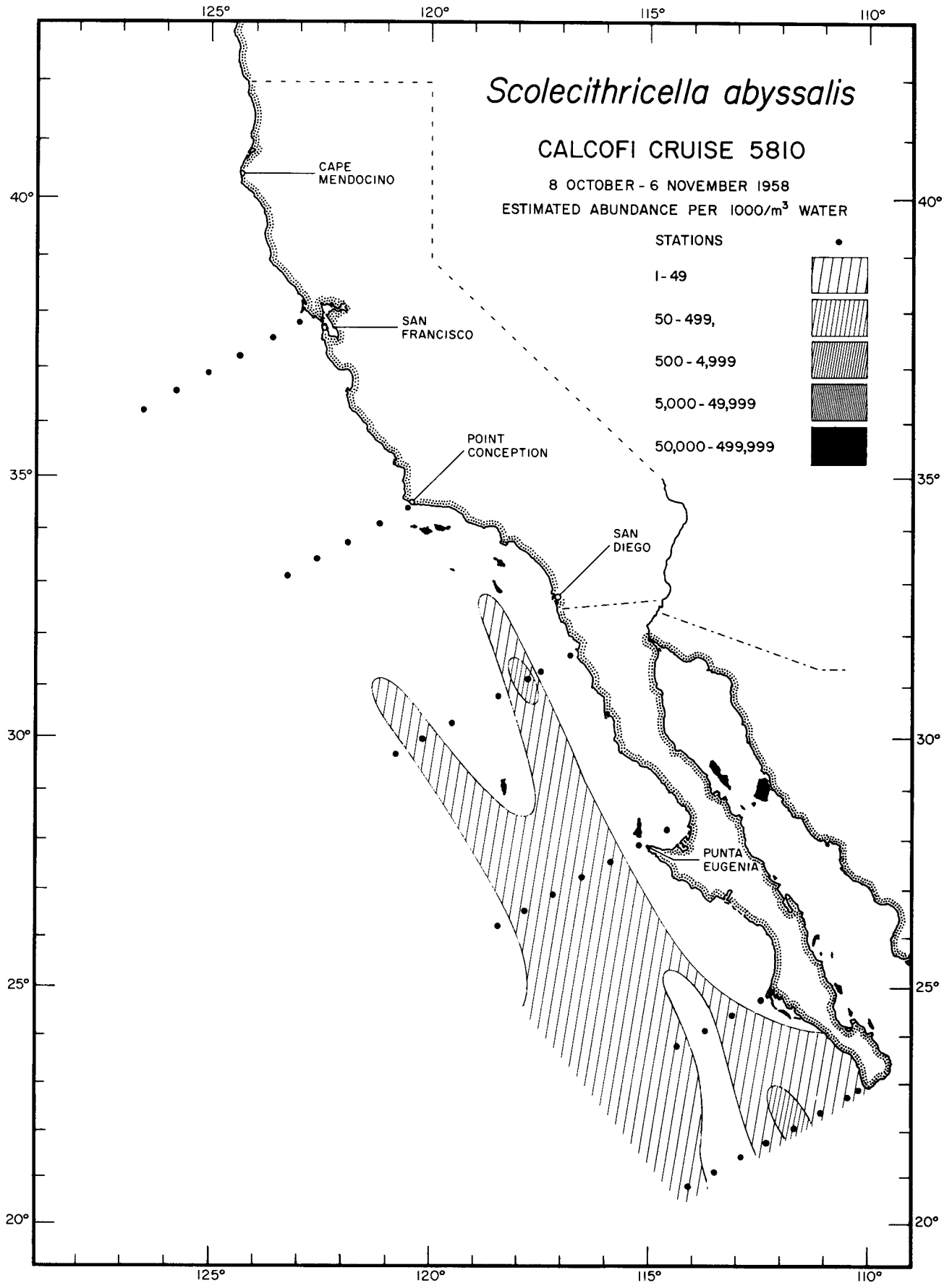
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Scaphocalanus echinatus
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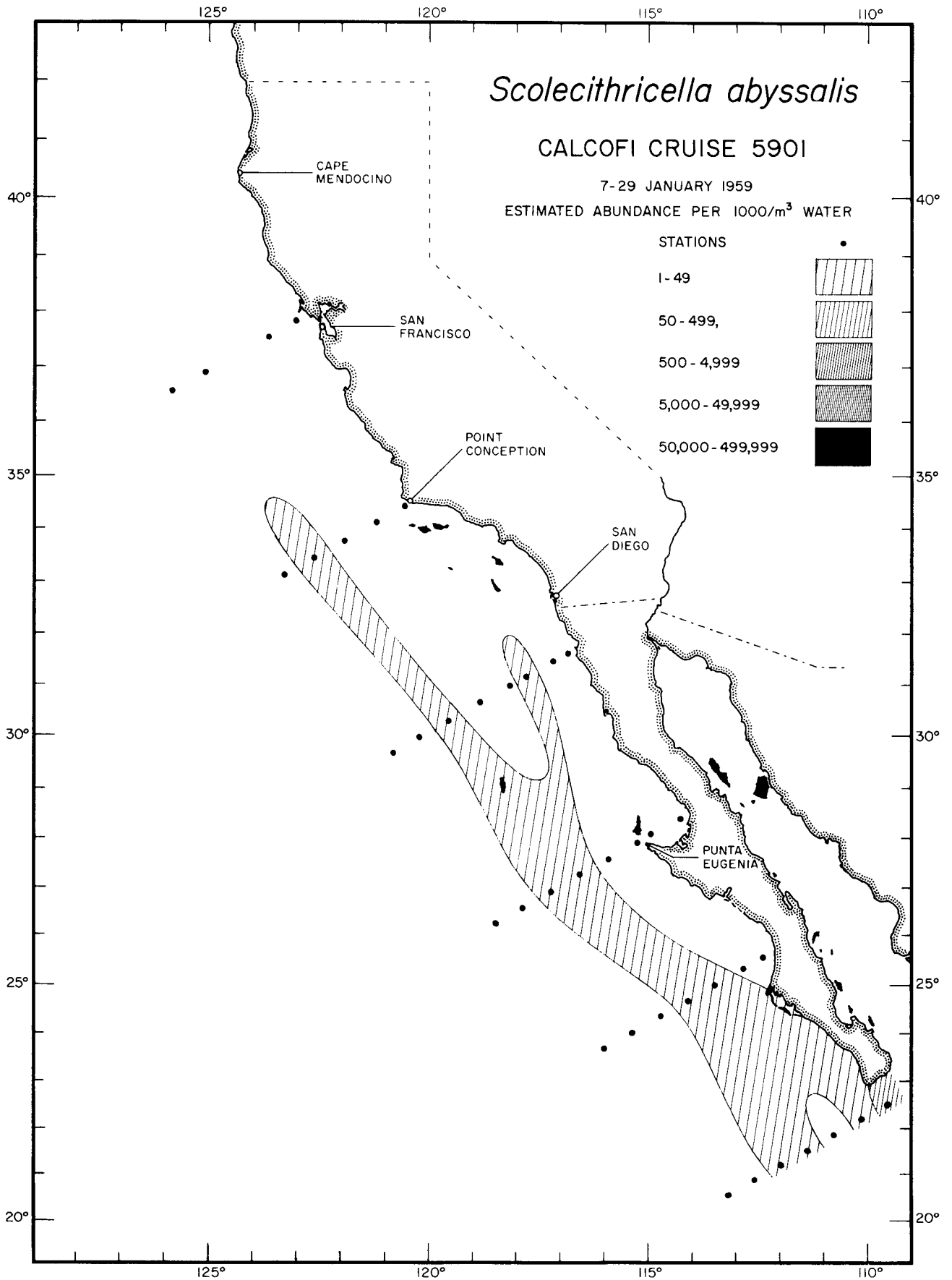
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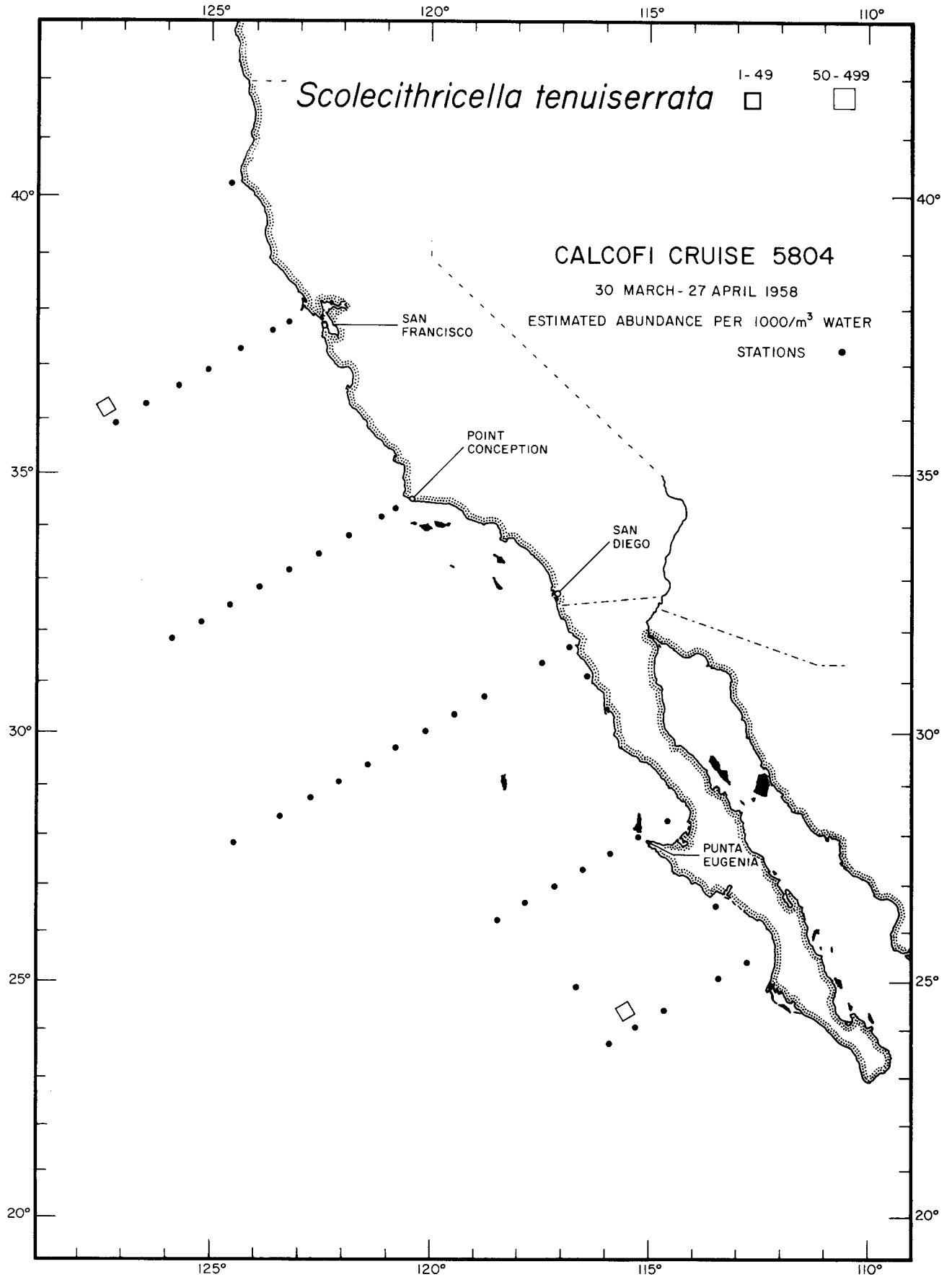
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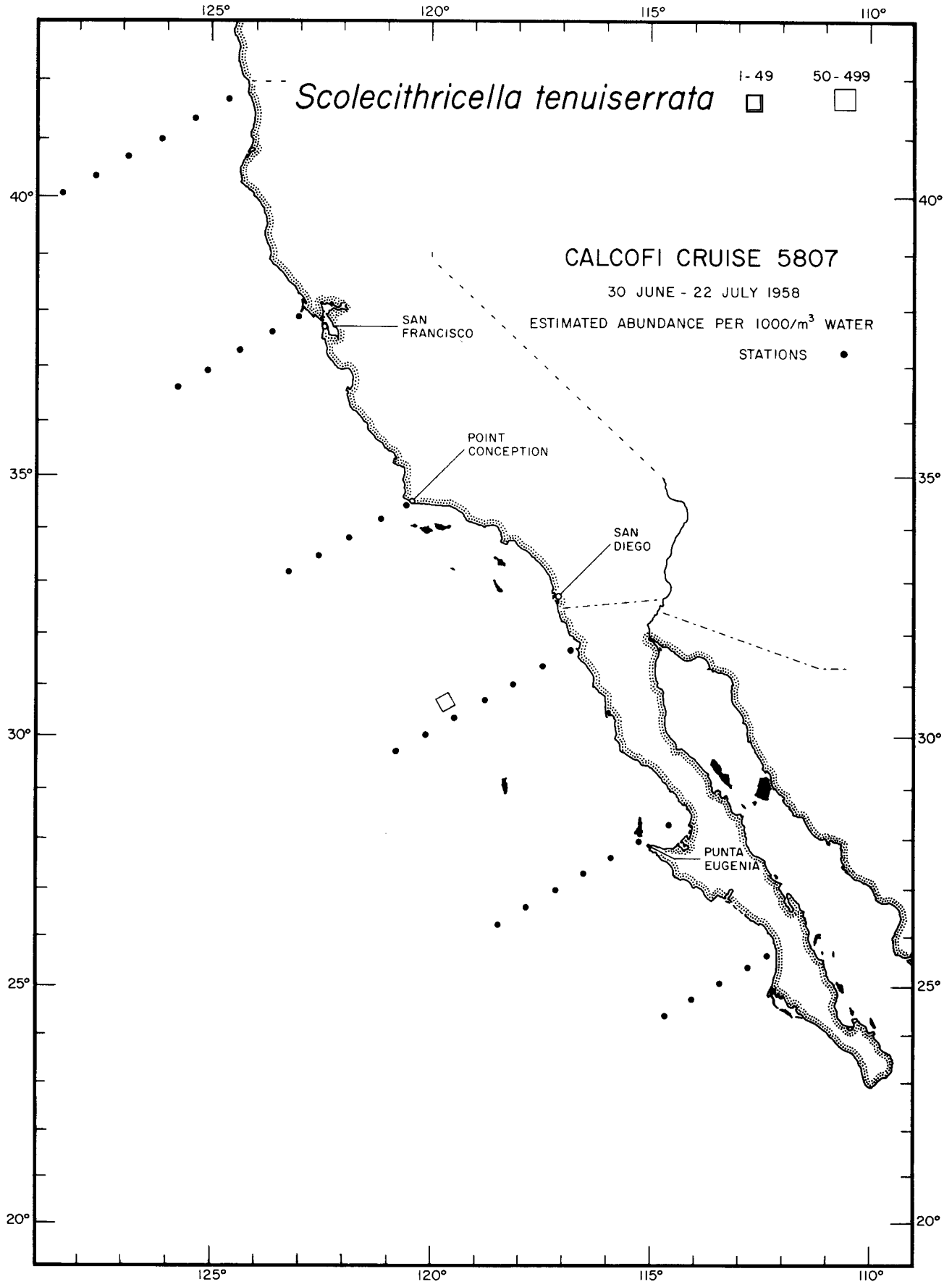
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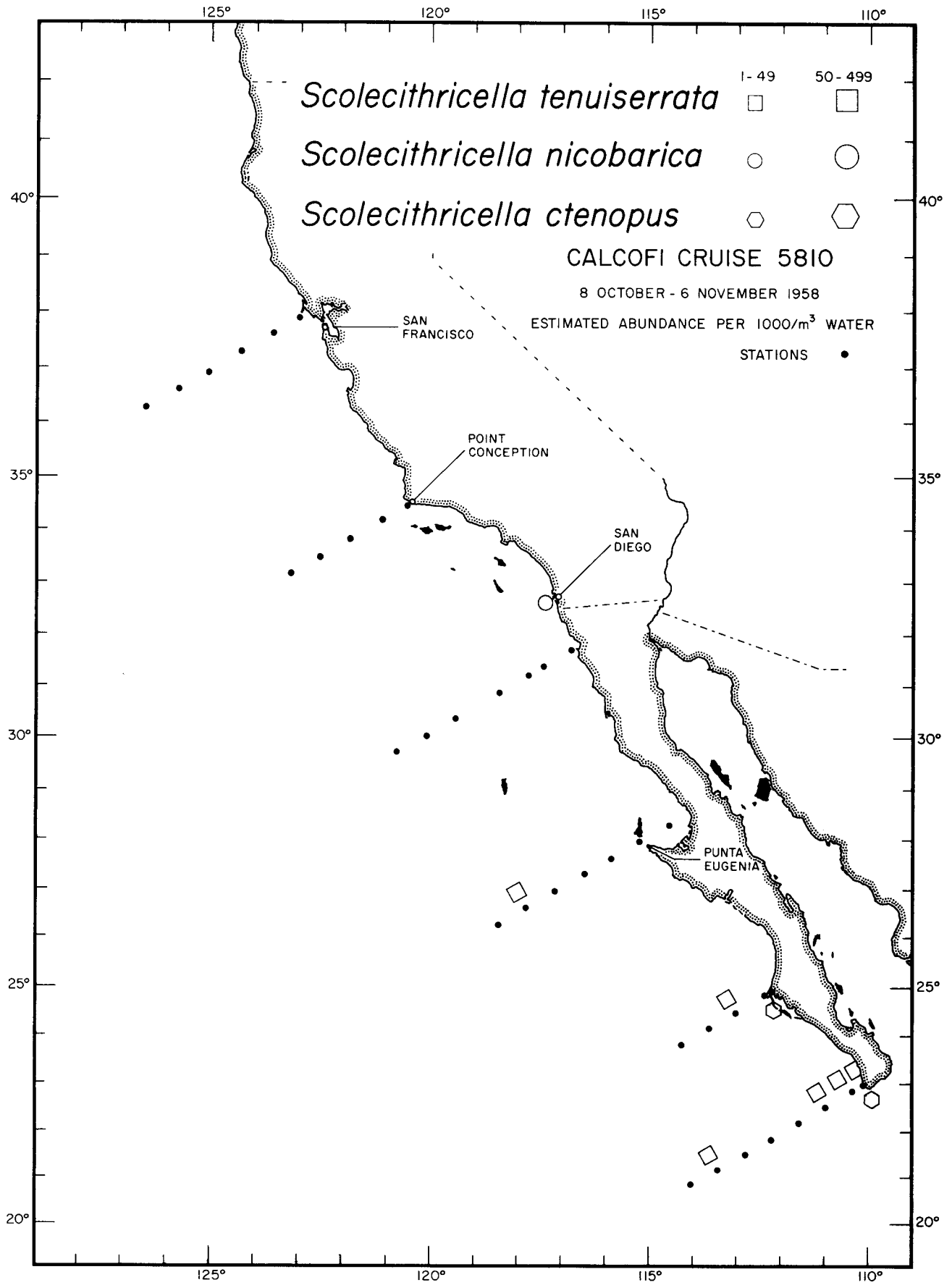
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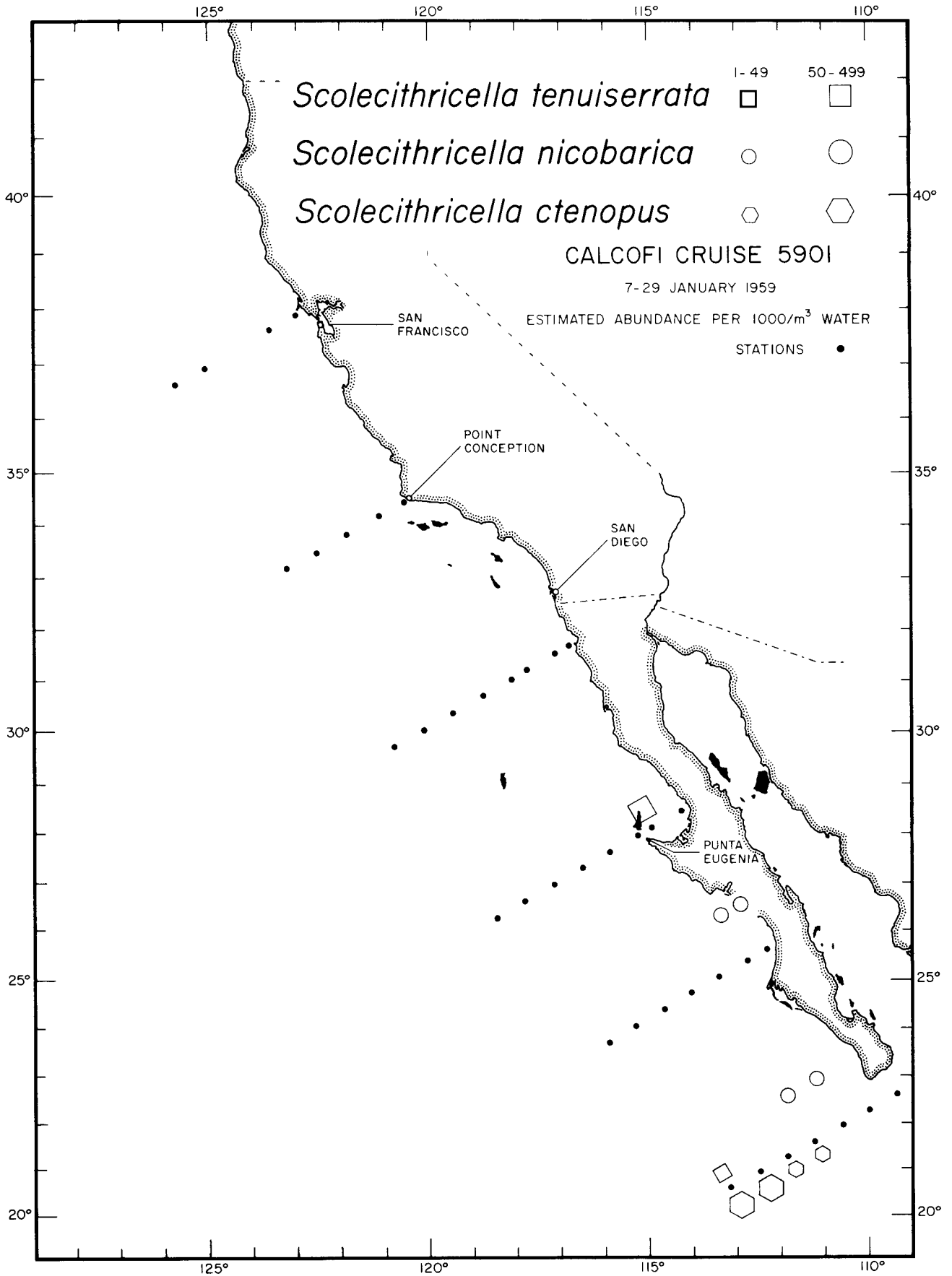
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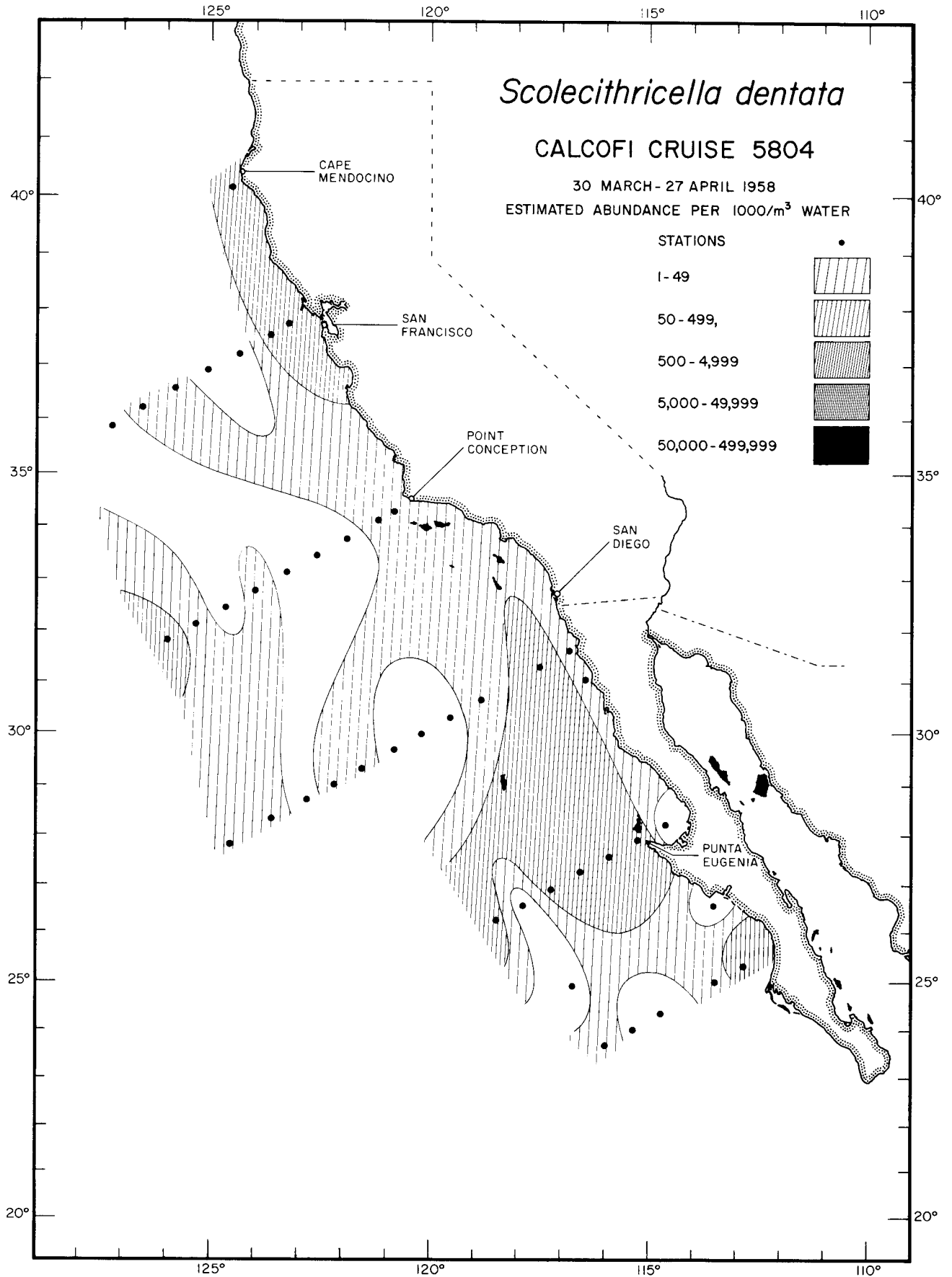
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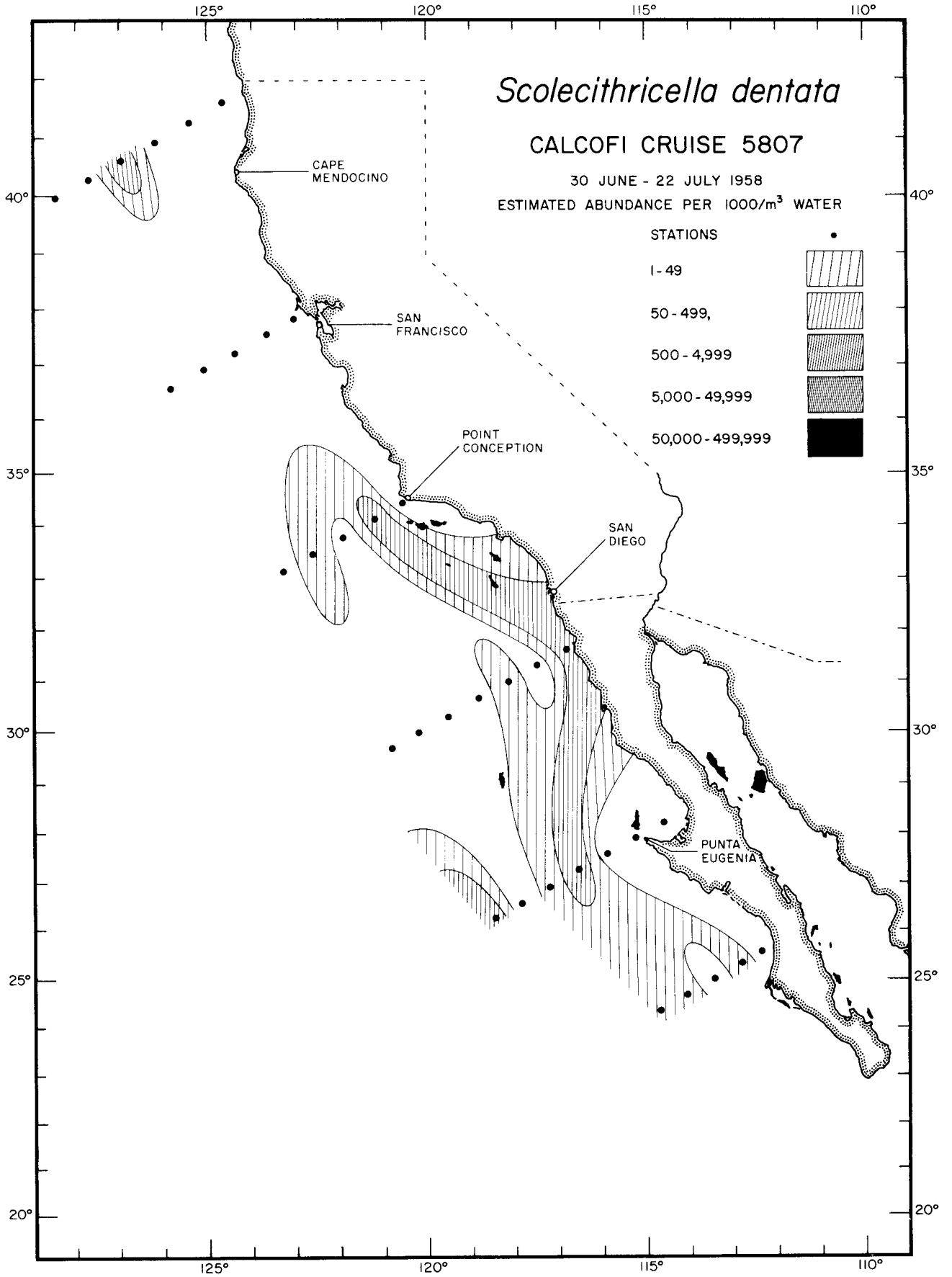
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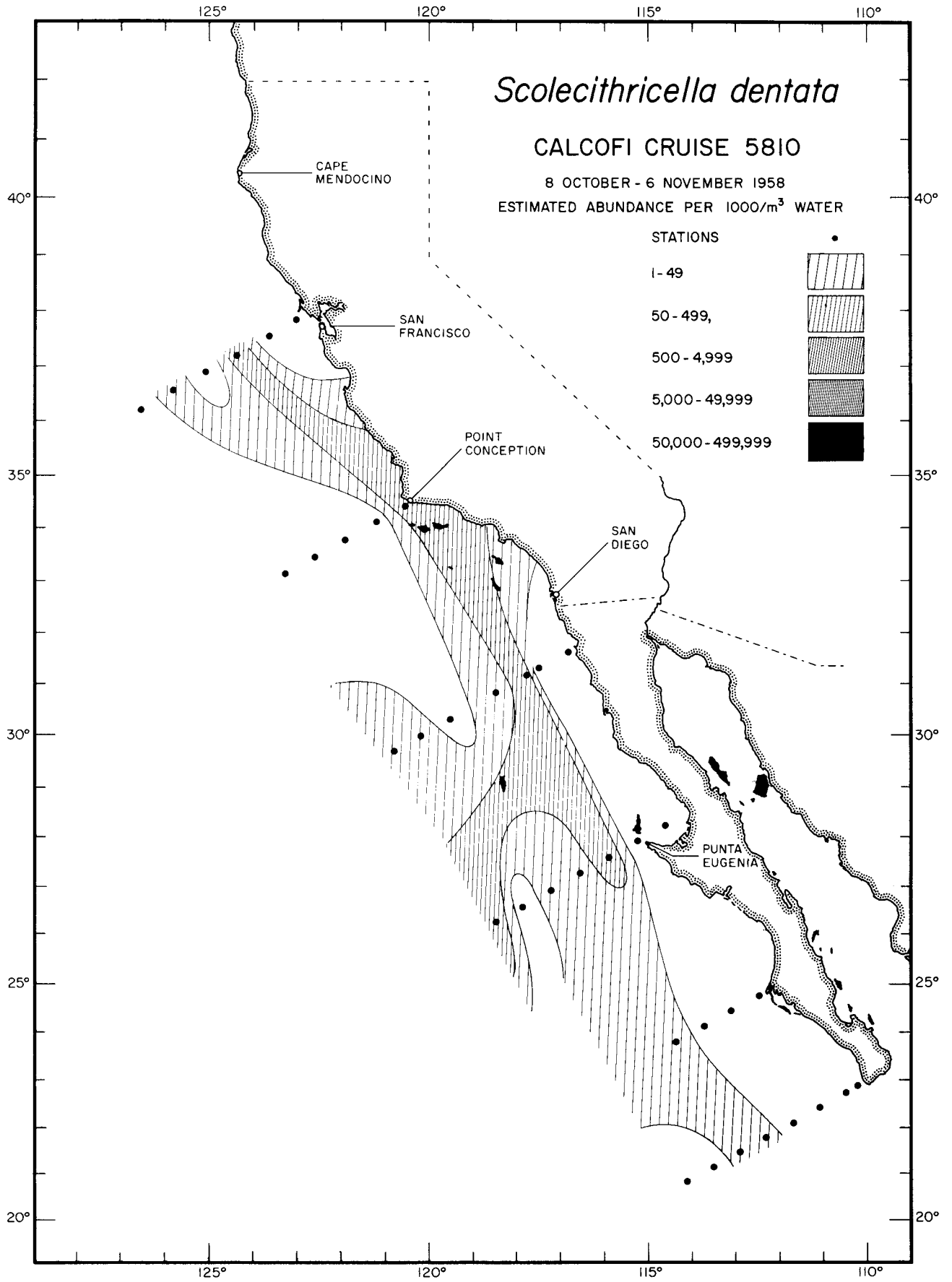
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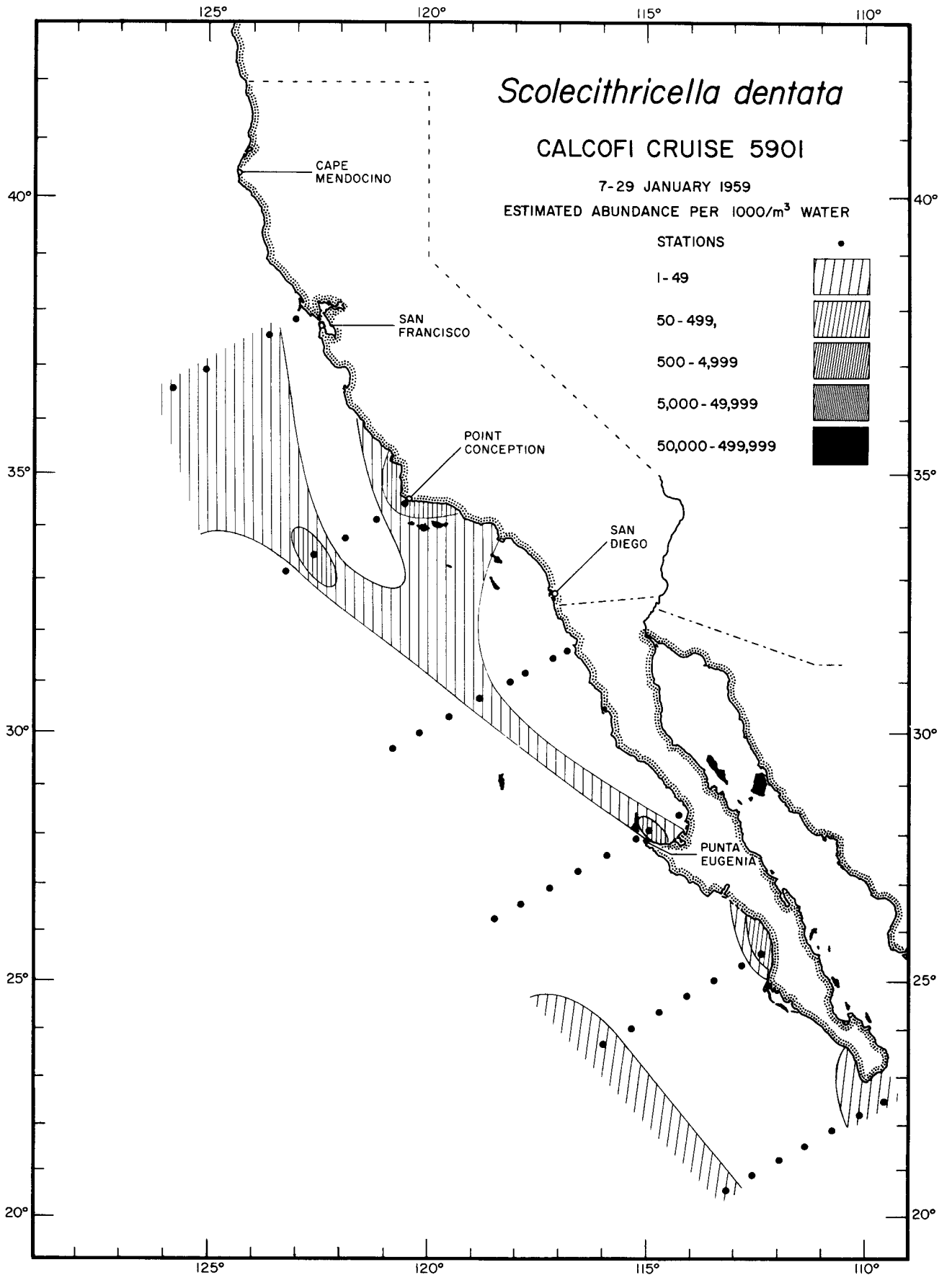
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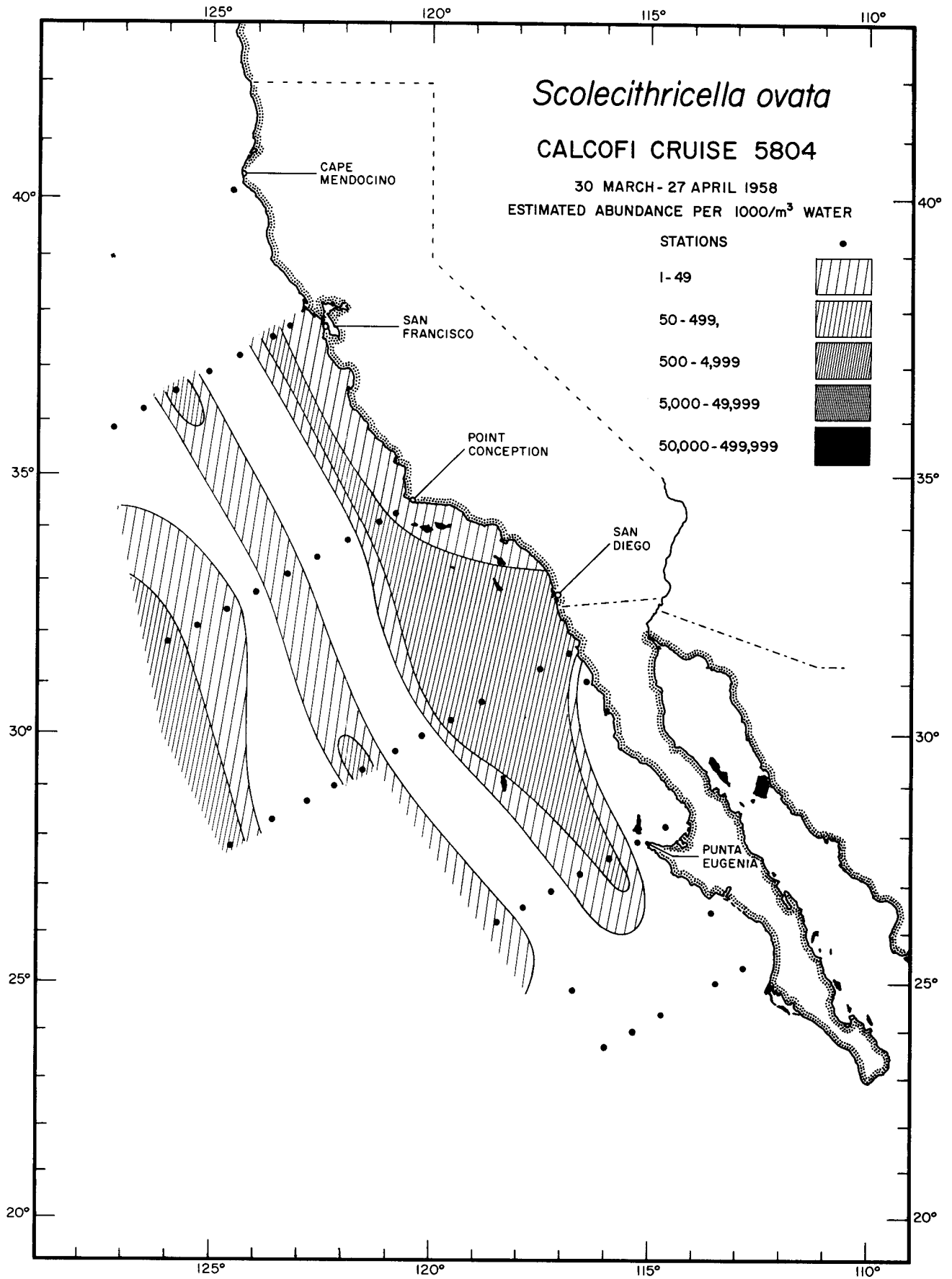
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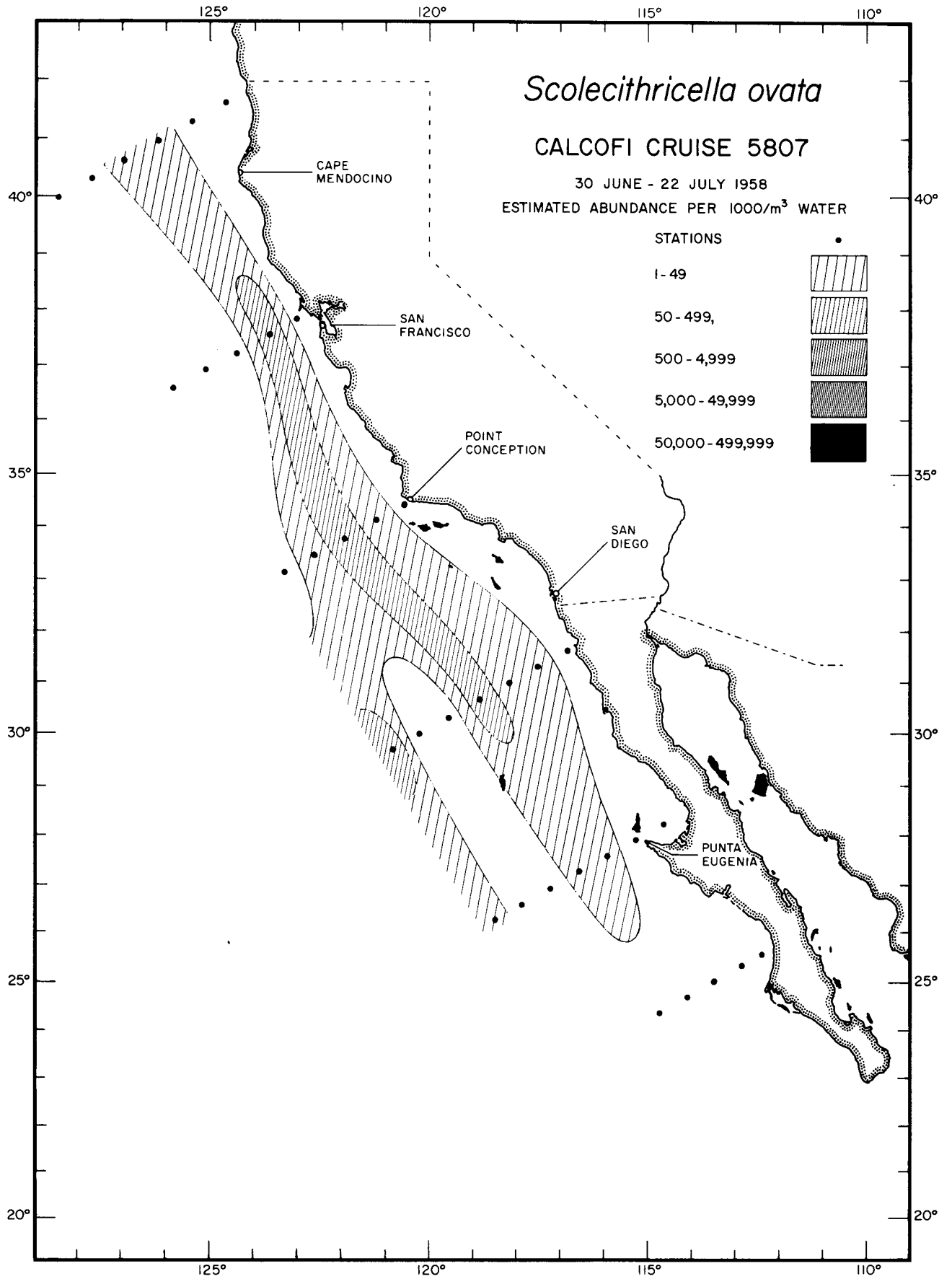
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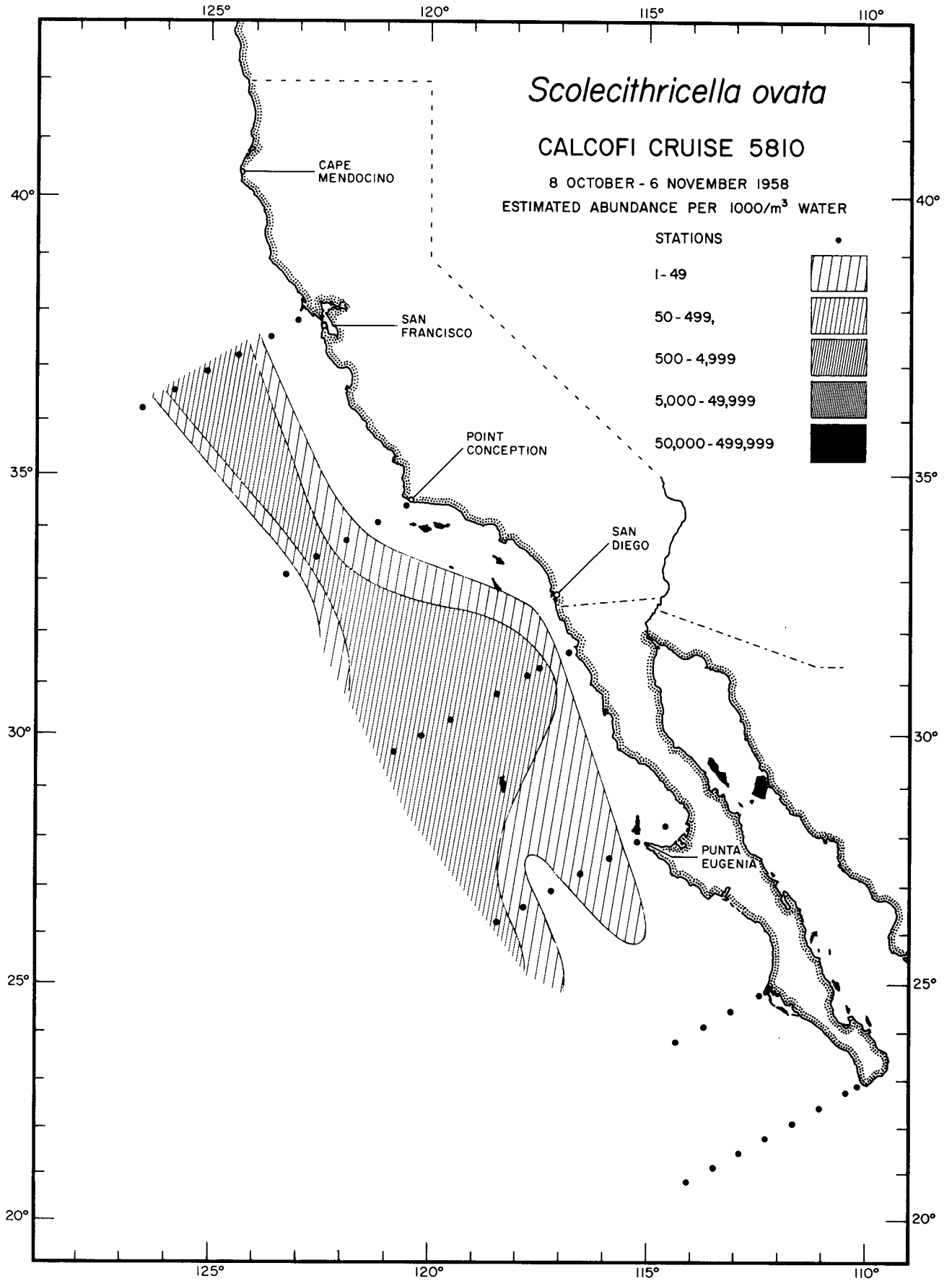
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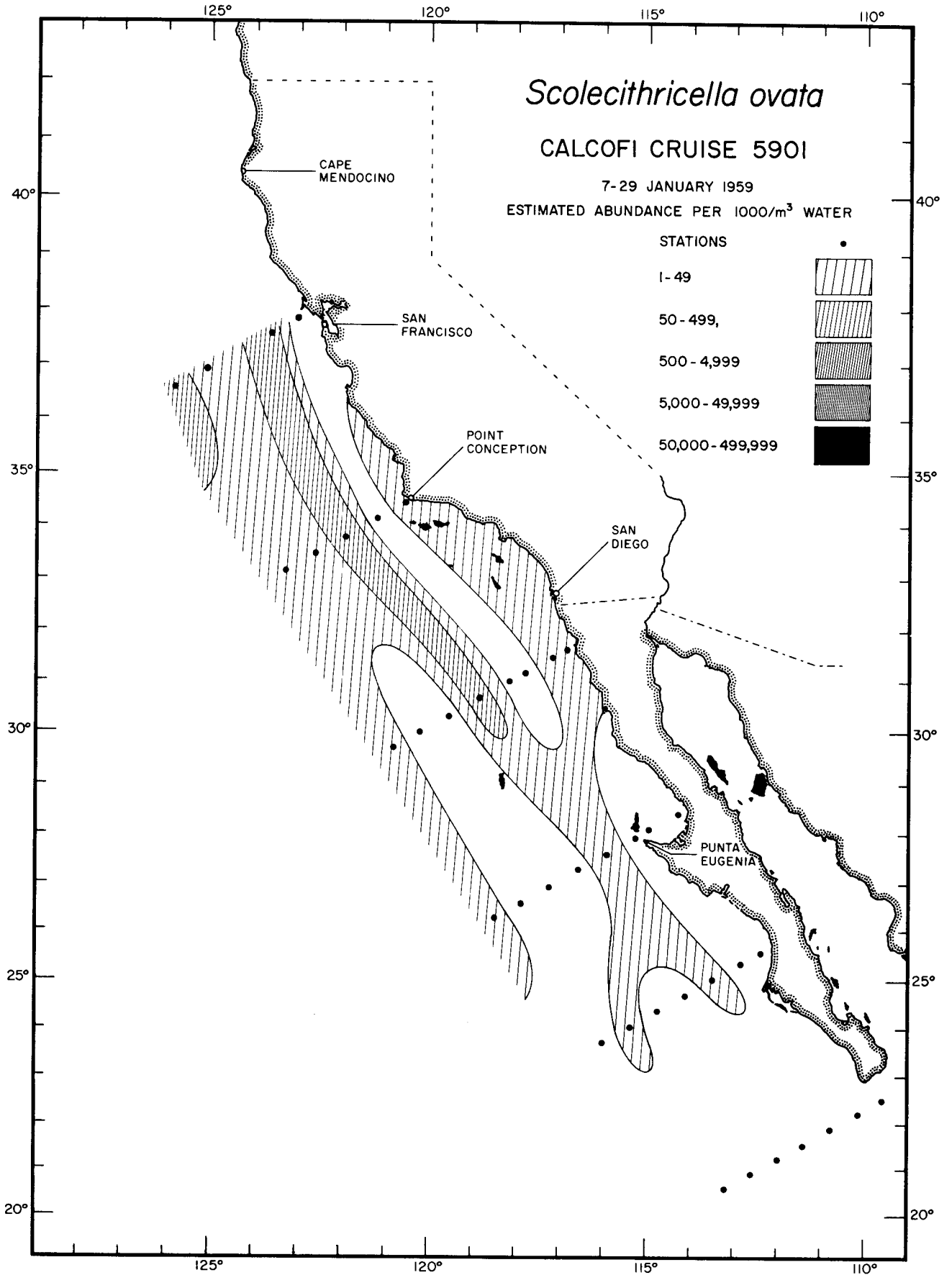
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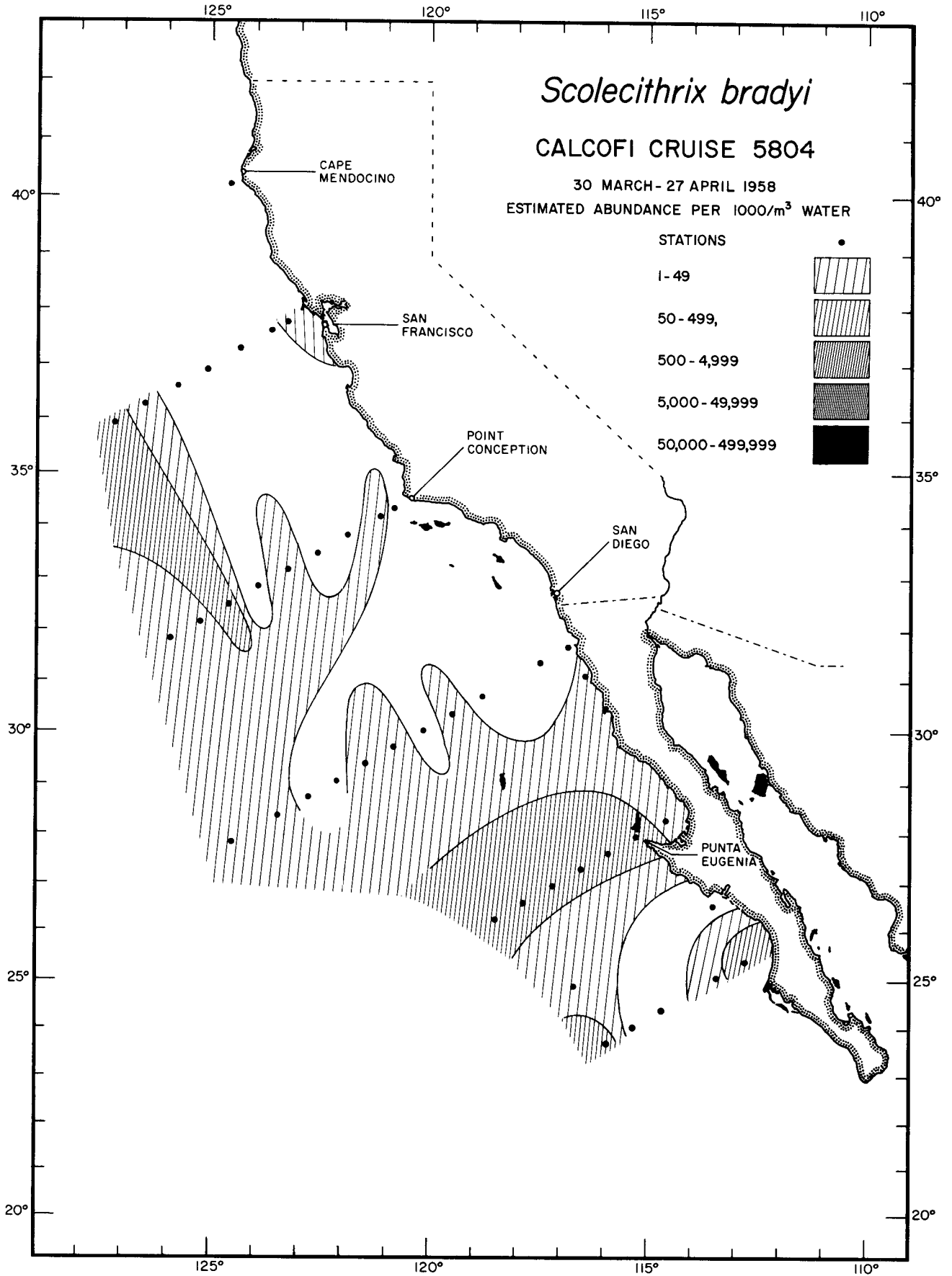
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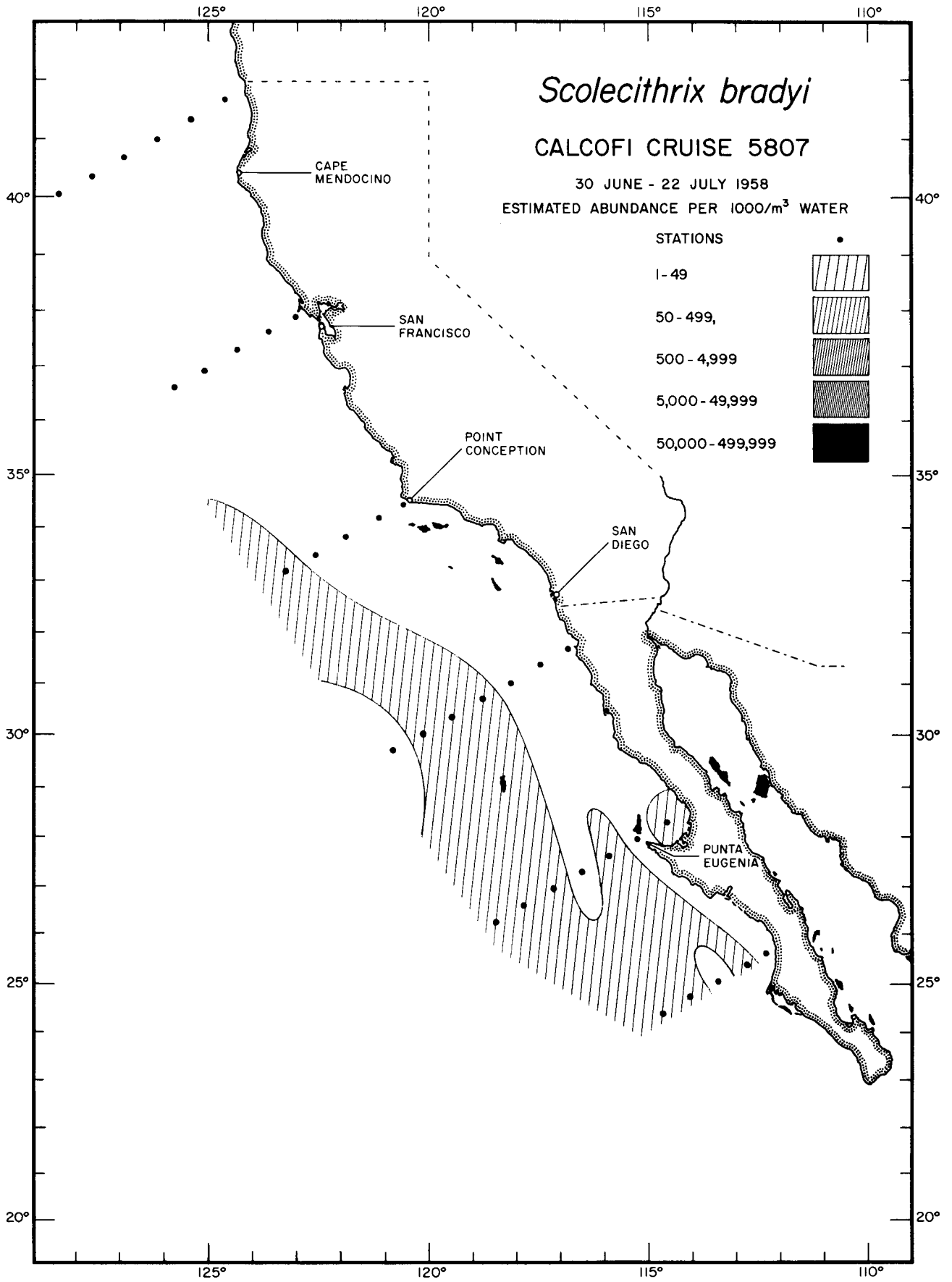
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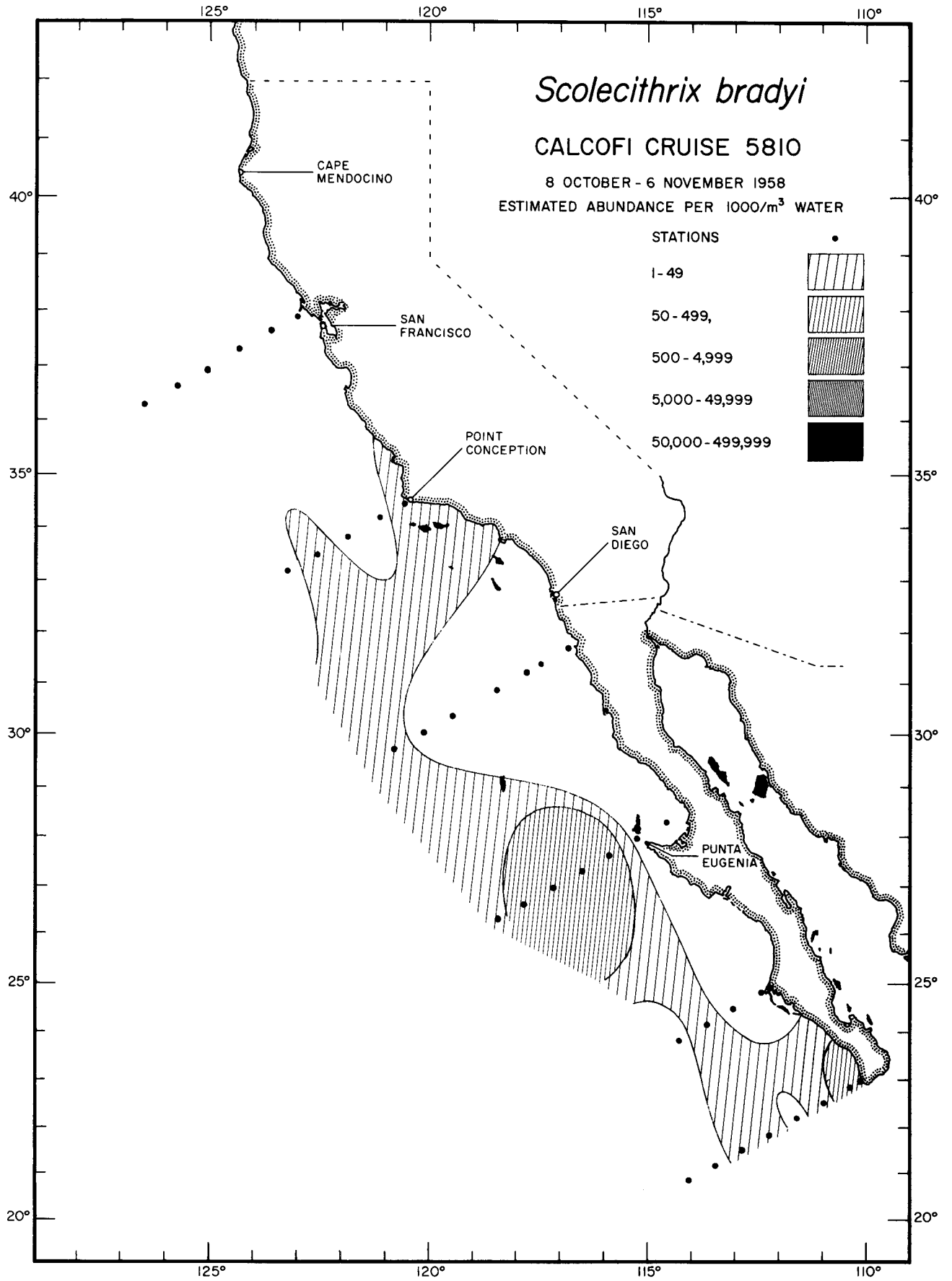
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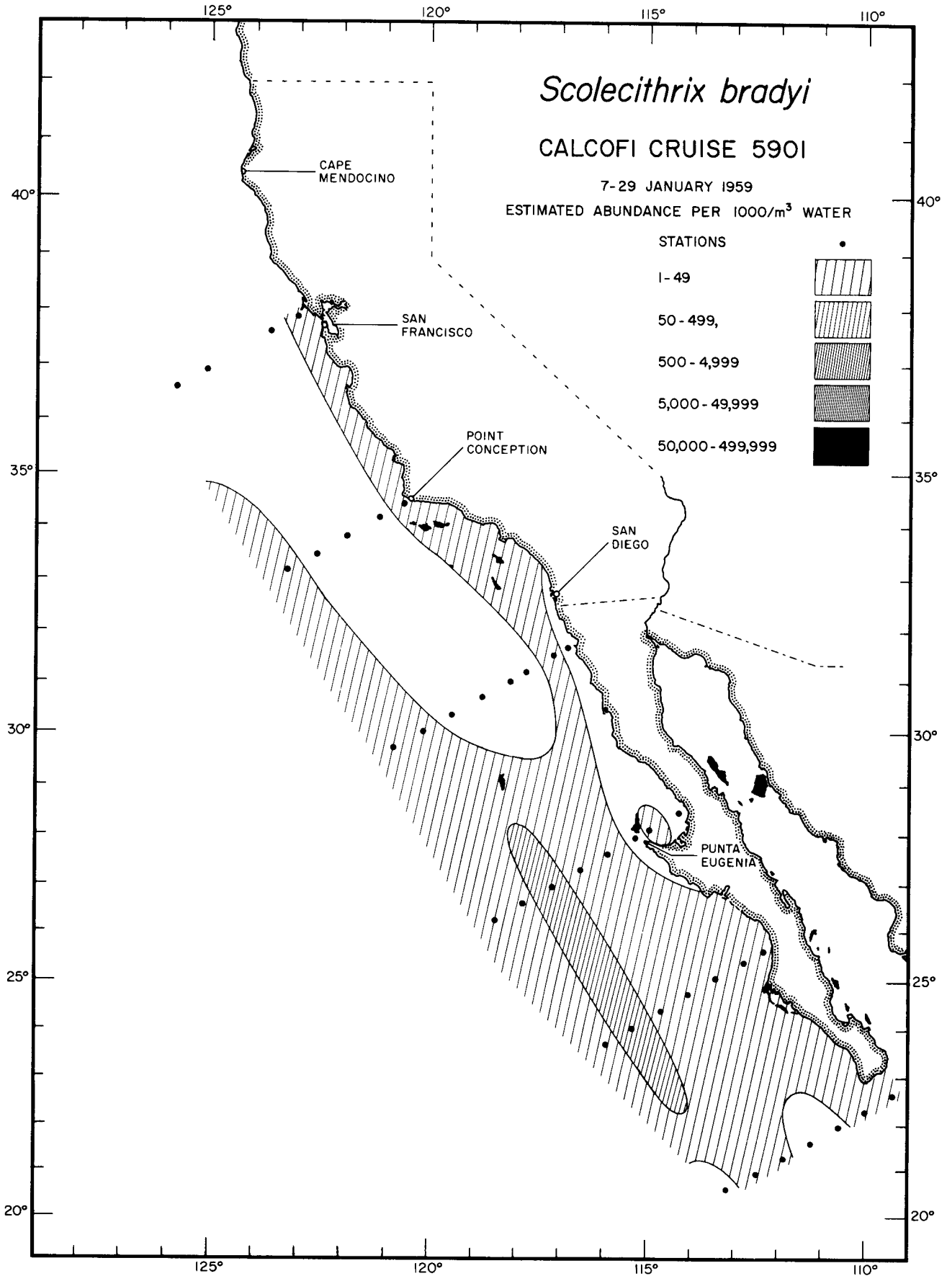
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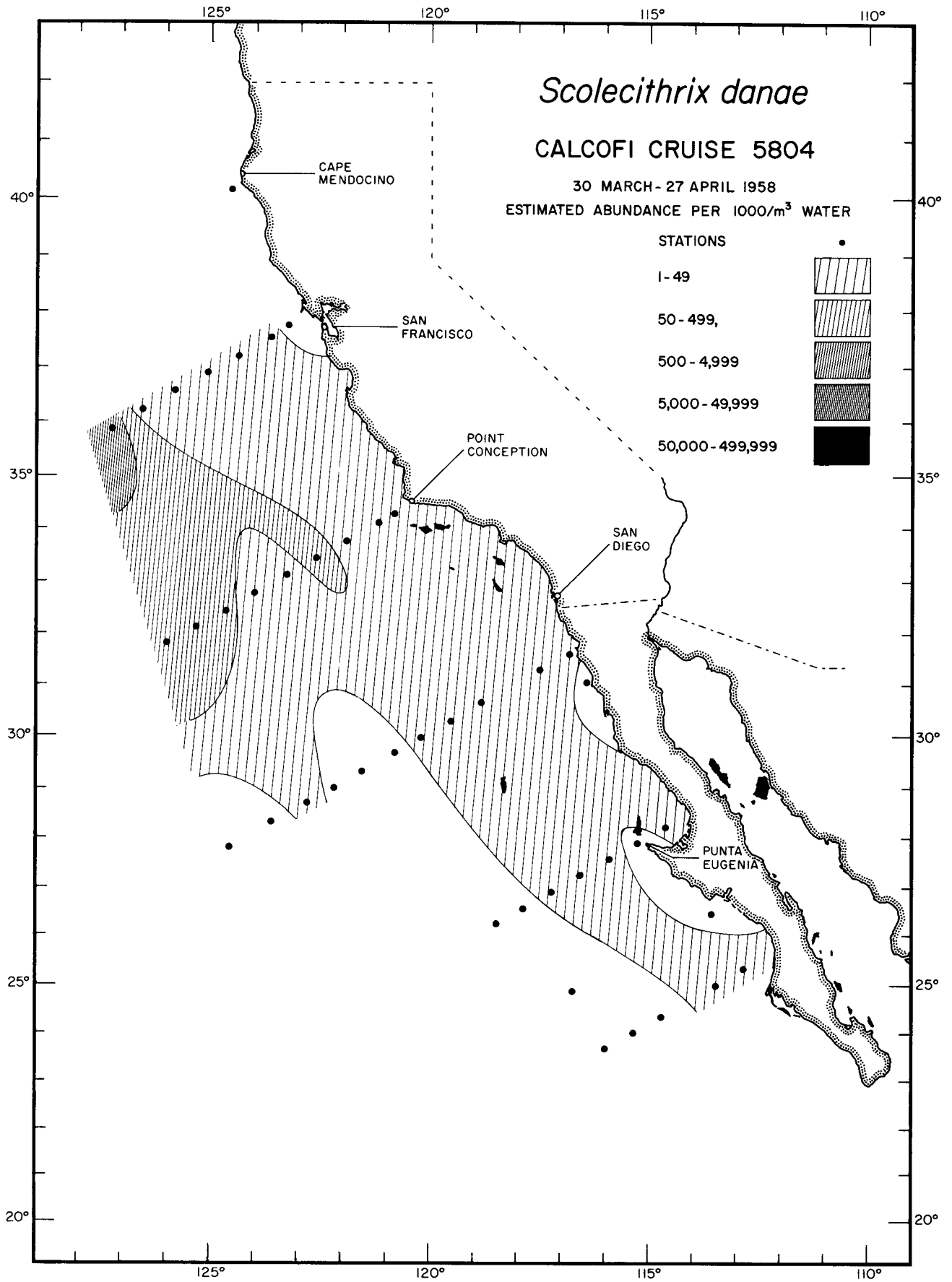
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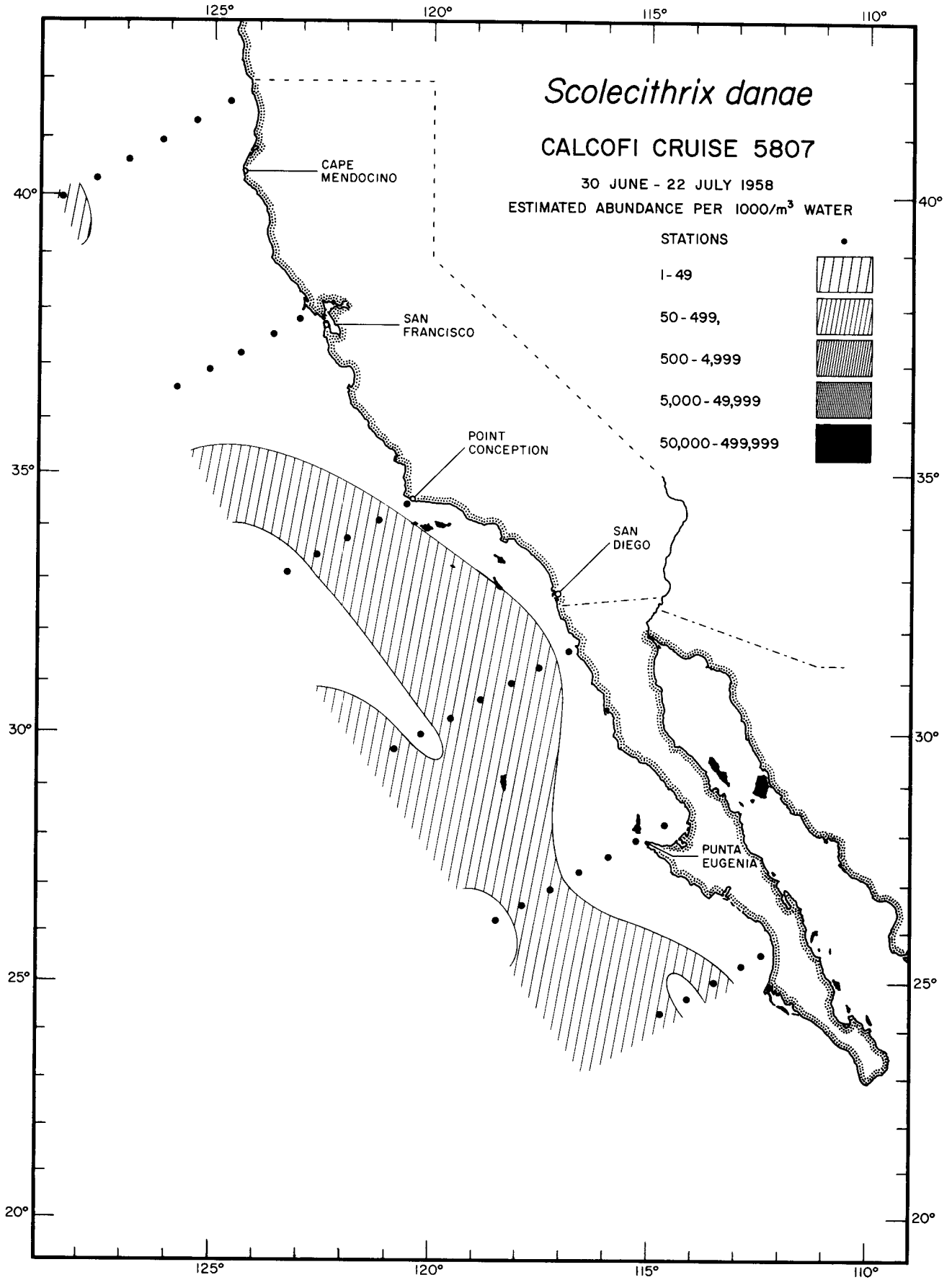
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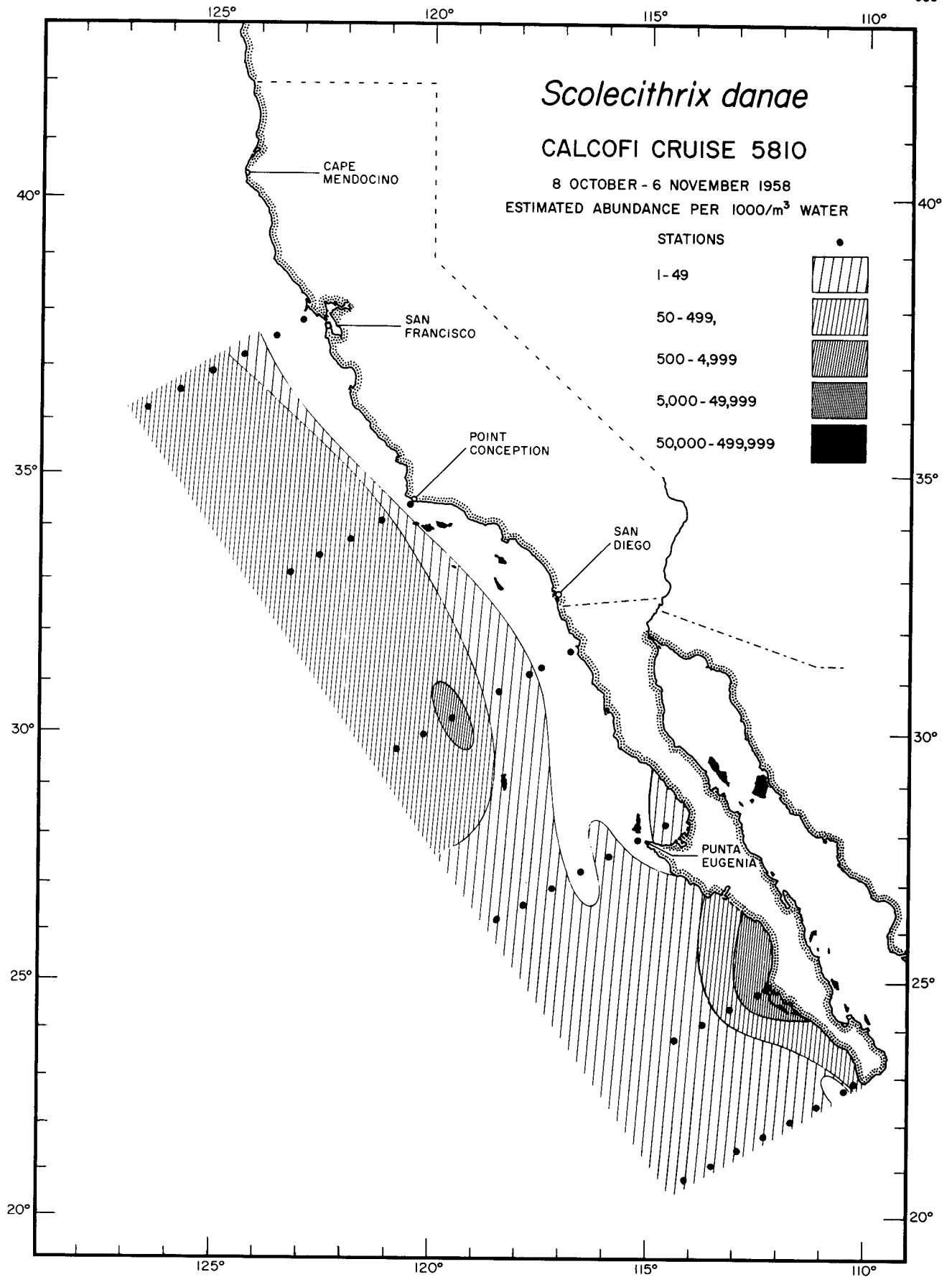
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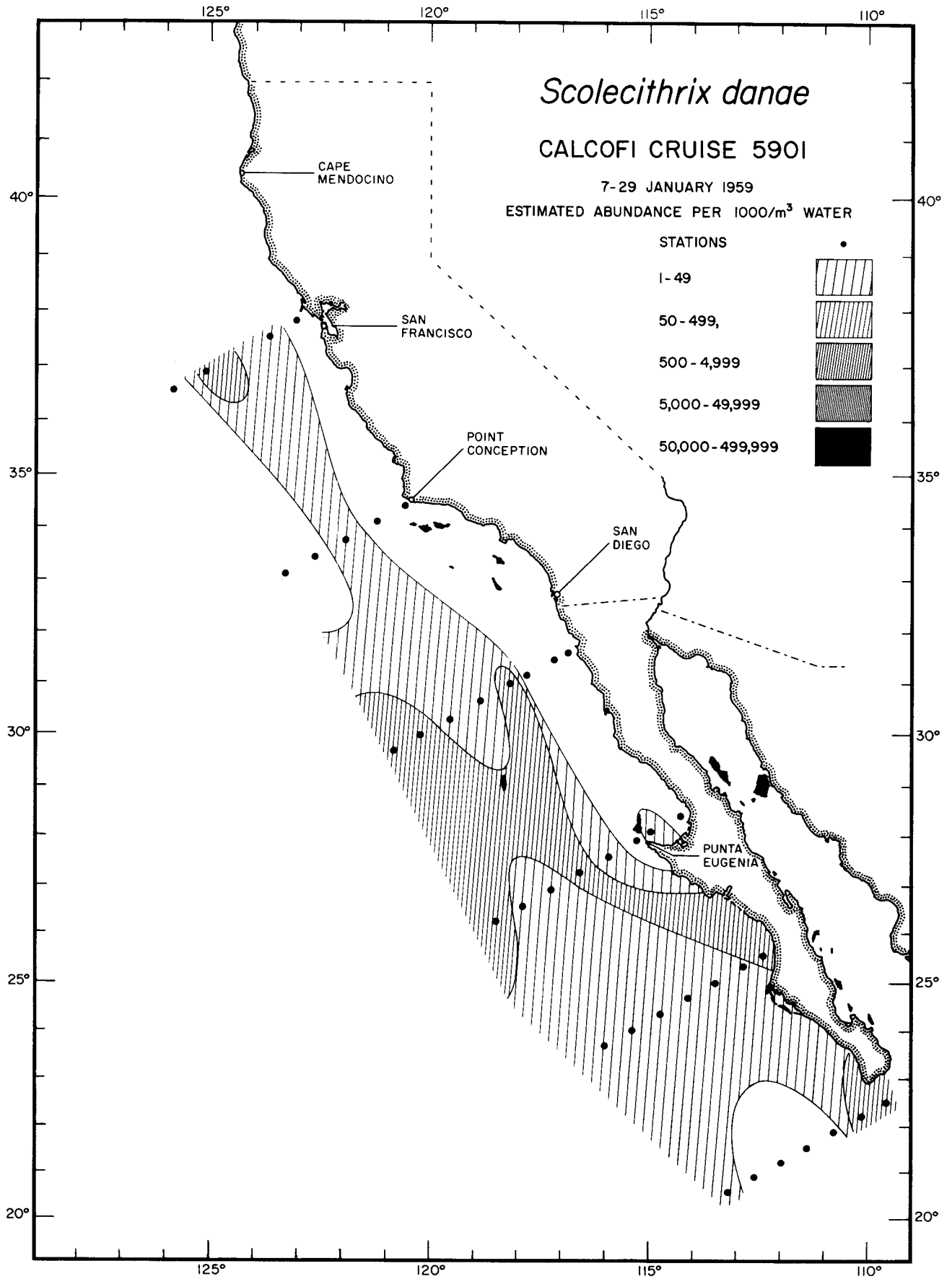
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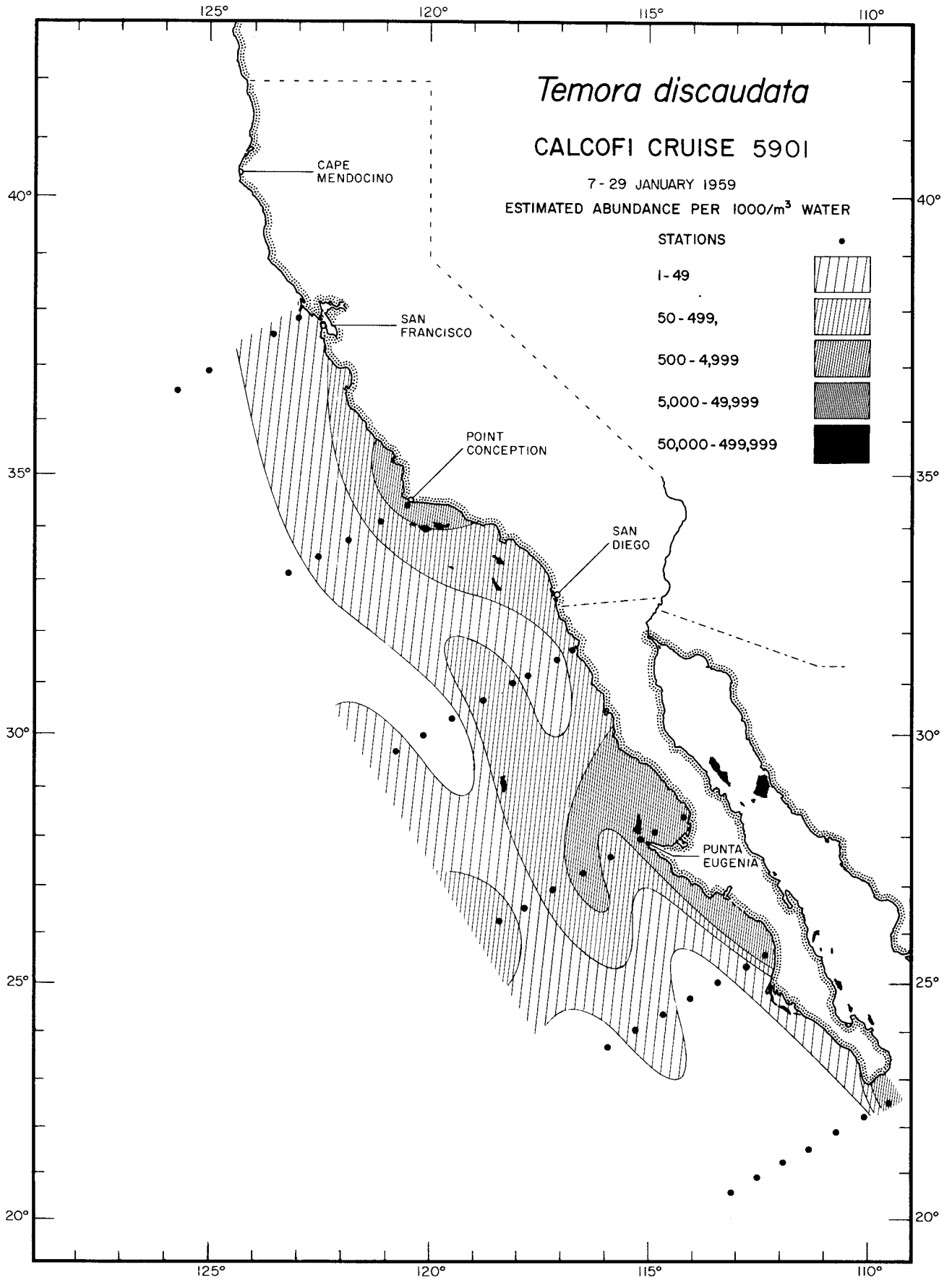
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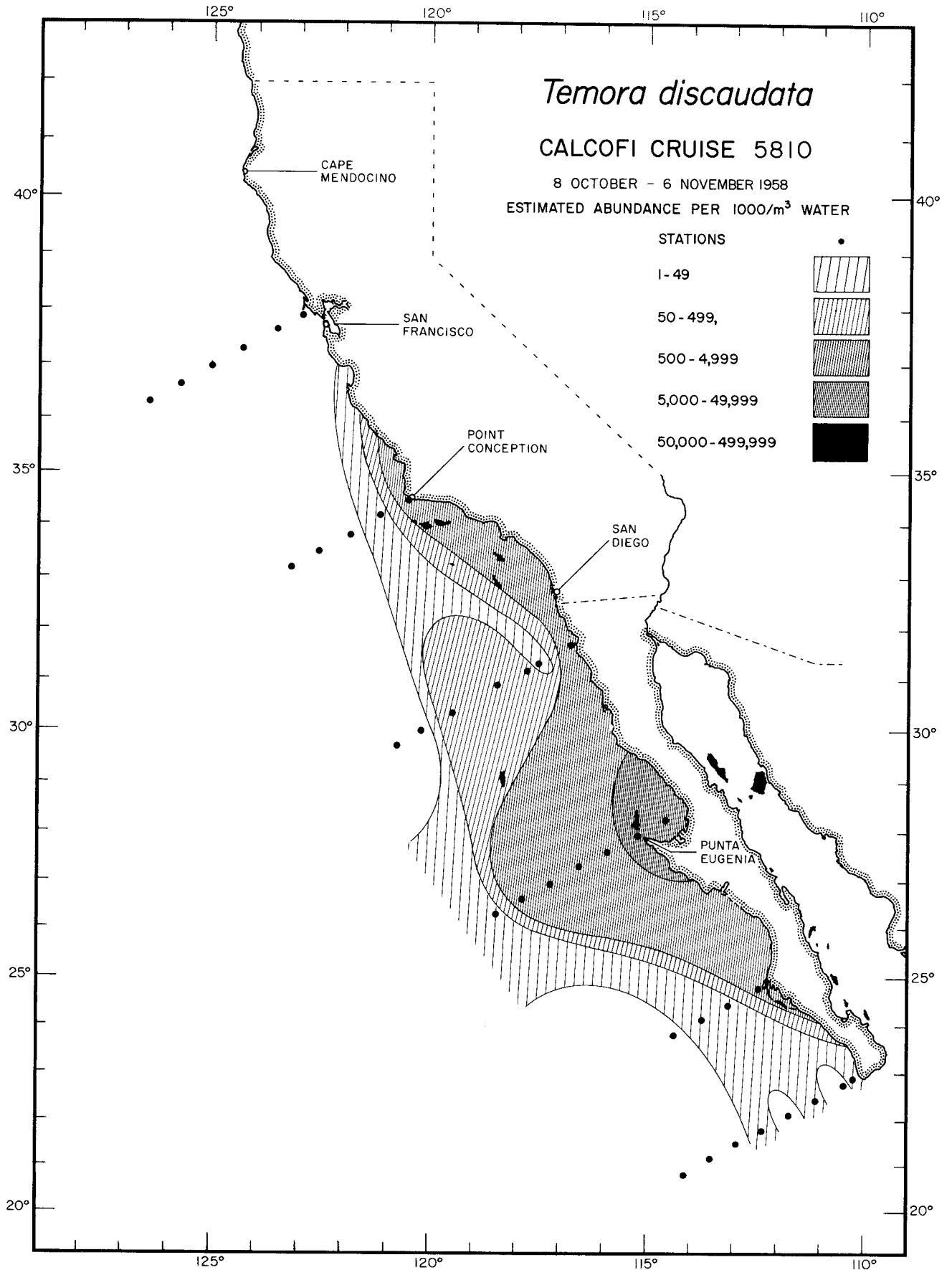
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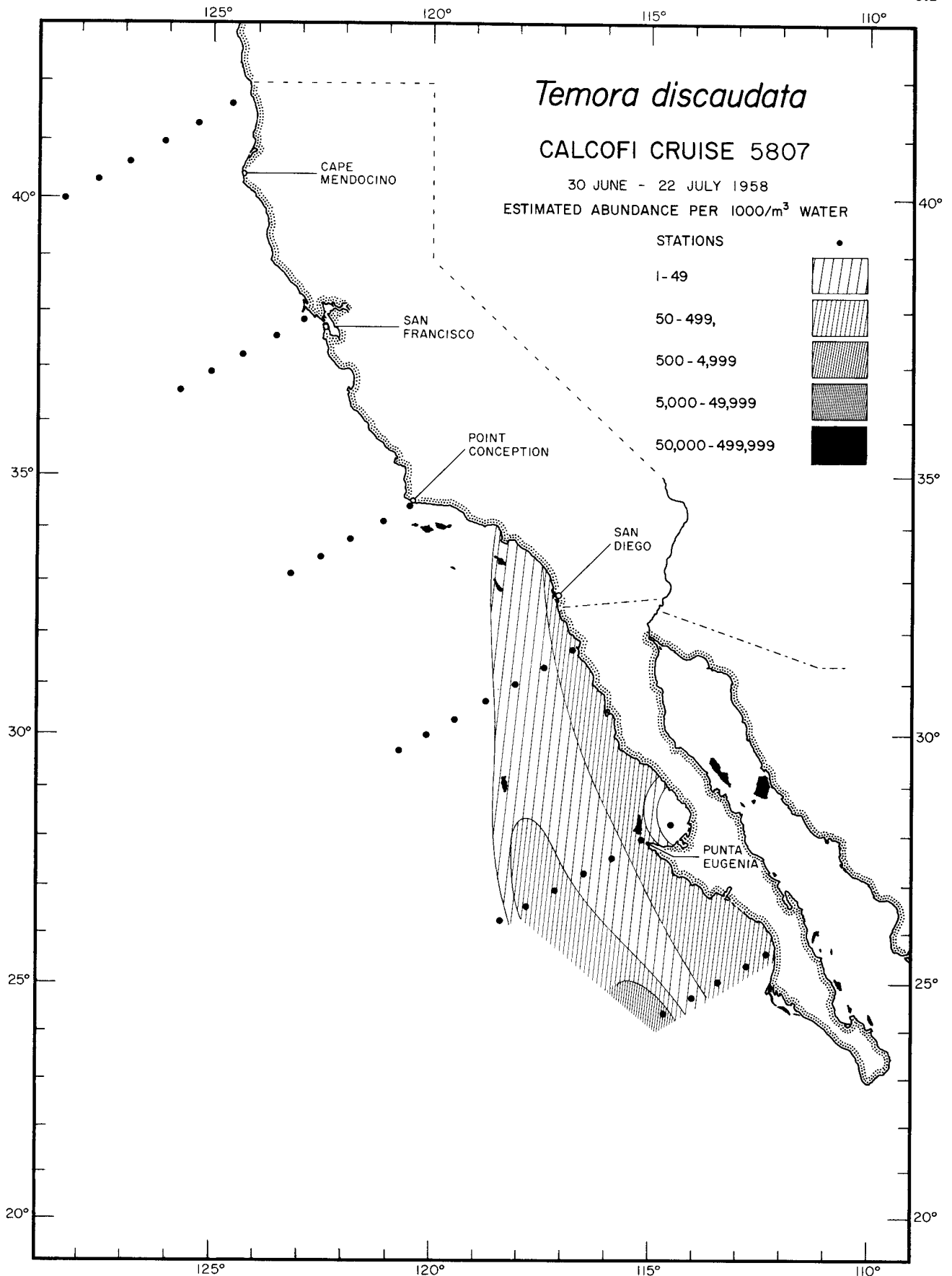
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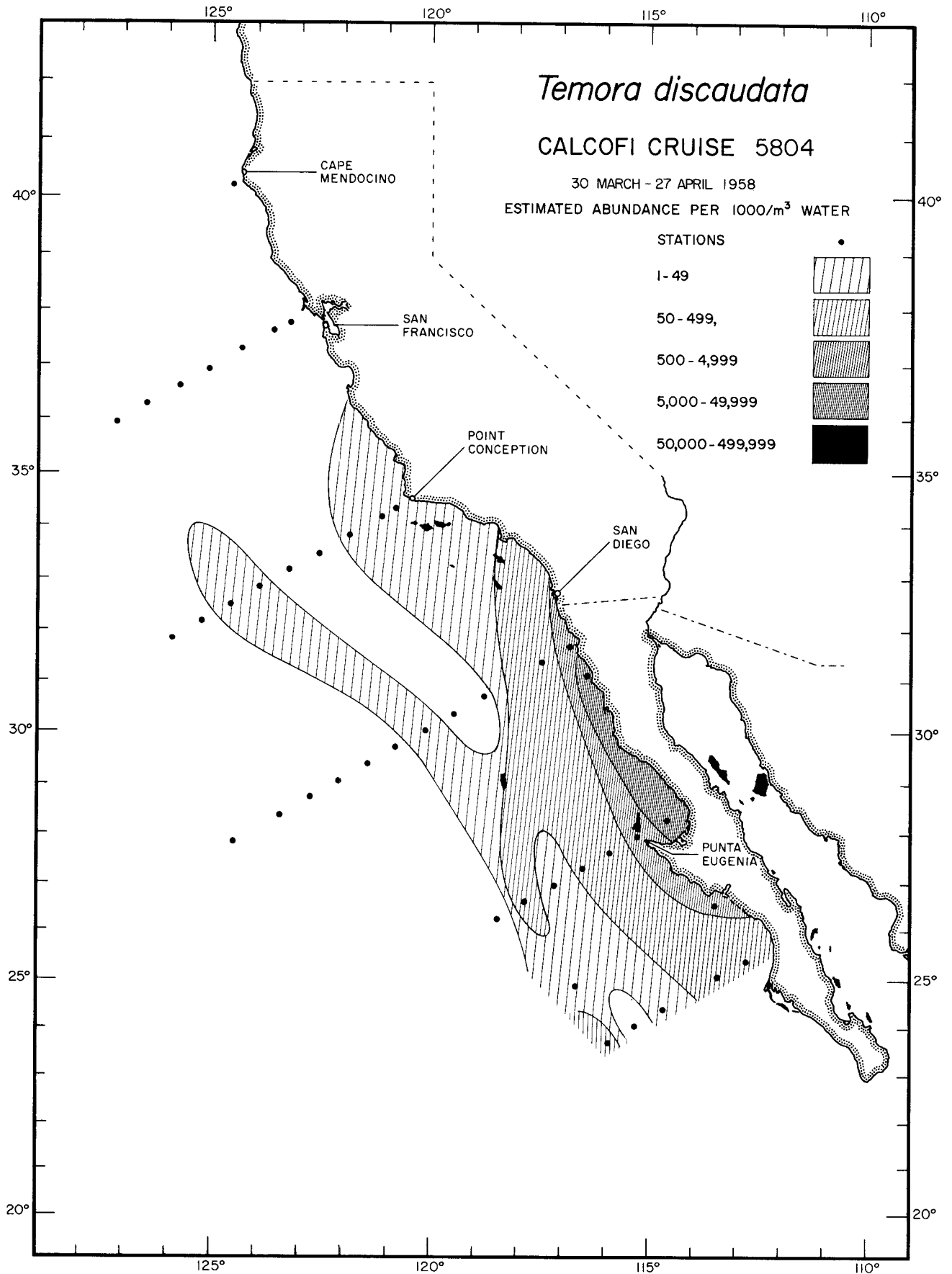
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Temora discaudata
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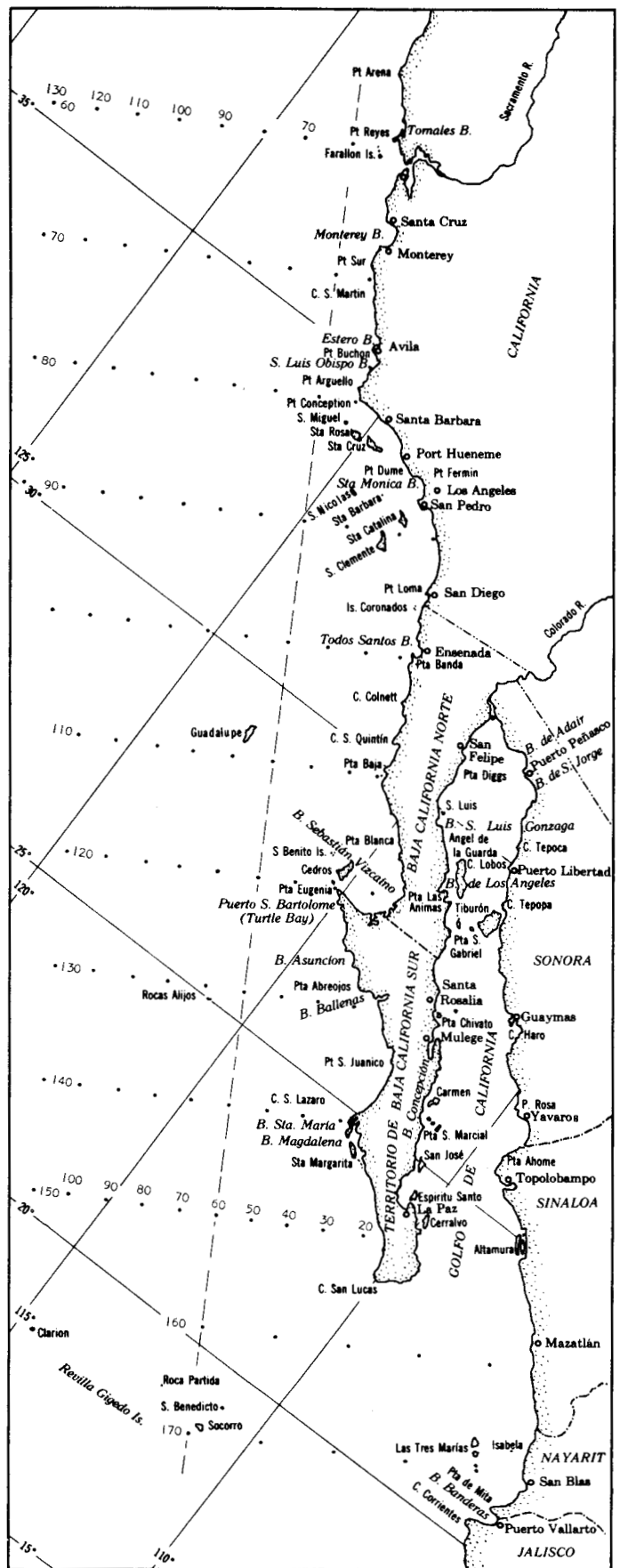
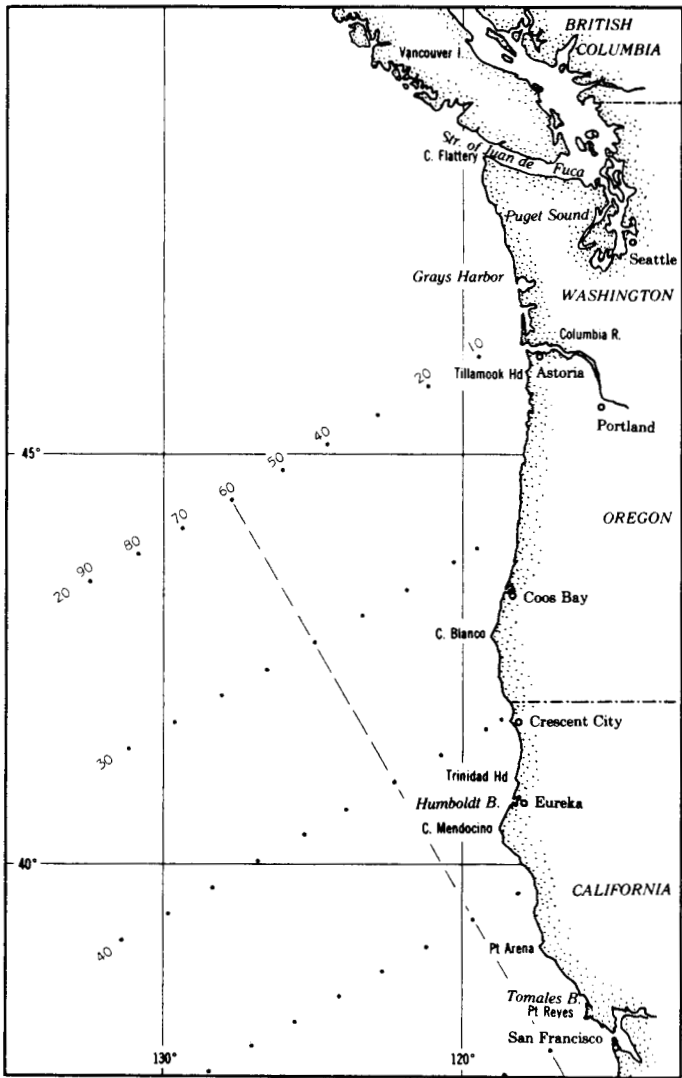
Calanoida
Temora discaudata
5810



Calanoida
Temora discaudata
5807



Calanoida
Temora discaudata
5804



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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