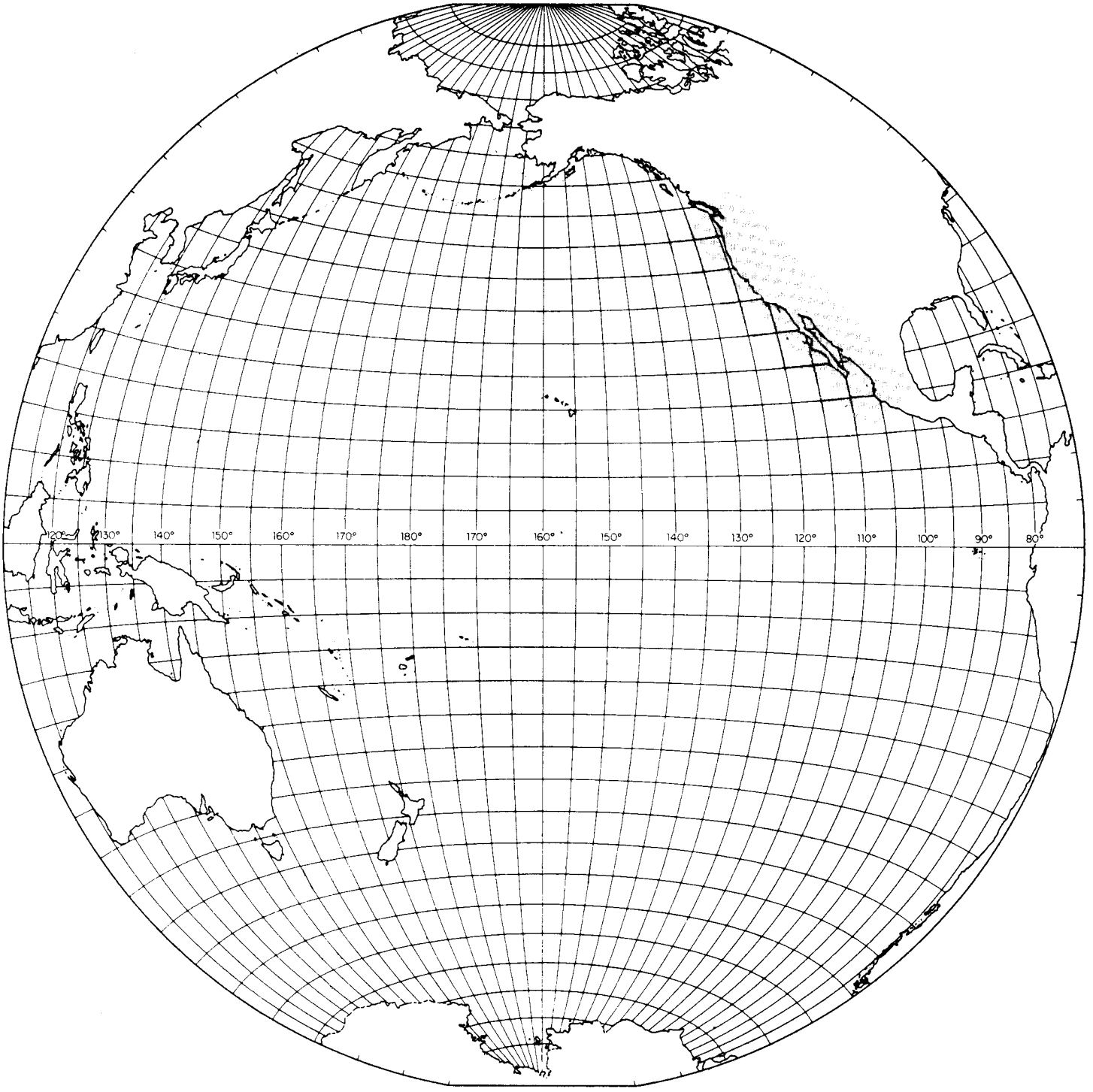
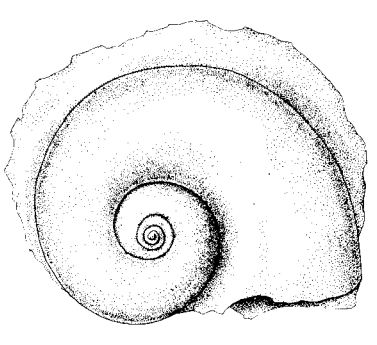
STATE OF CALIFORNIA
MARINE RESEARCH COMMITTEE




# CALIFORNIA COOPERATIVE OCEANIC FISHERIES INVESTIGATIONS

# ATLAS No. 6

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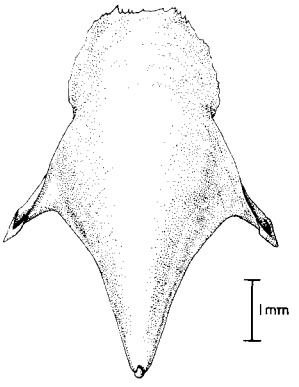
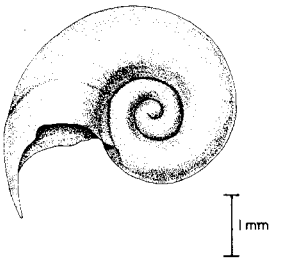



*Cavolinia inflexa*

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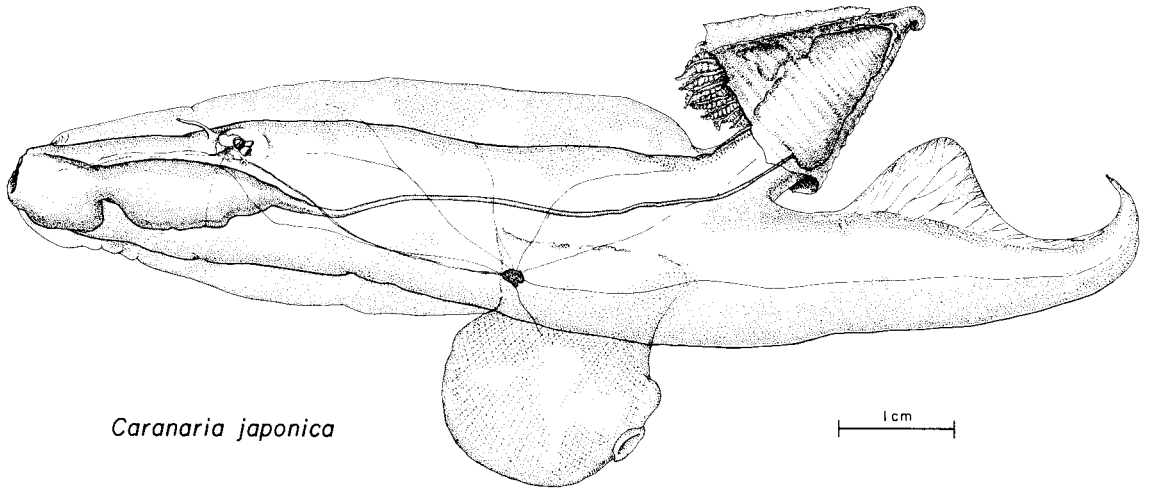


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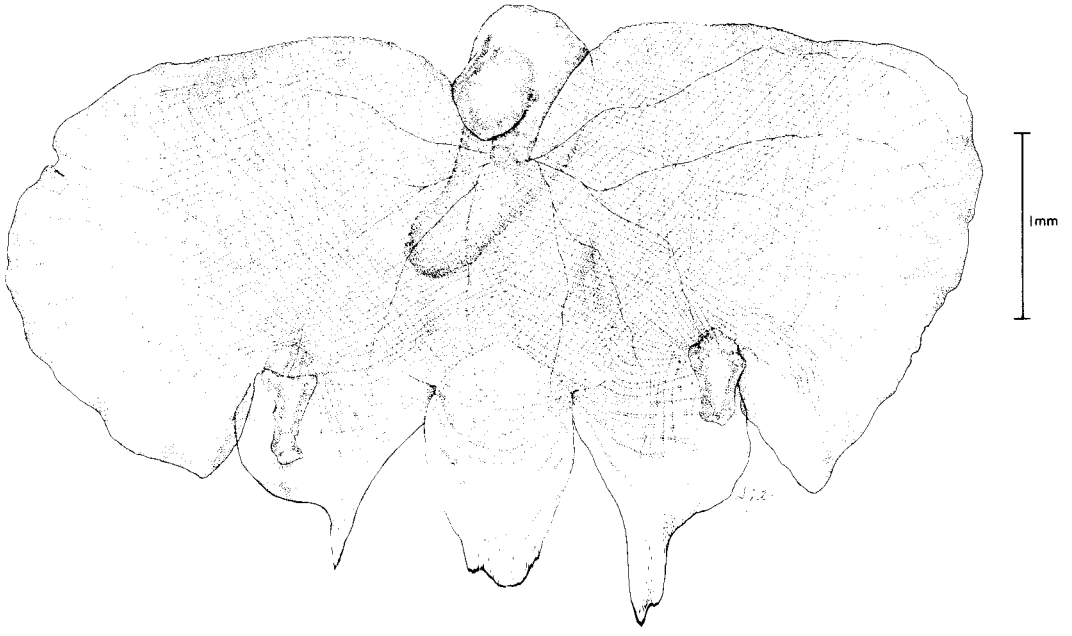


*Desmopterus pacificus*

# CALIFORNIA COOPERATIVE OCEANIC FISHERIES INVESTIGATIONS

*Atlas No. 6*

STATE OF CALIFORNIA
MARINE RESEARCH COMMITTEE

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

April, 1967

## THE CALCOFI ATLAS SERIES

This is the sixth in a series of atlases containing data on the hydrography and plankton from the region of the California Current. The field work was carried out by the California Cooperative Oceanic Fisheries Investigations,[1] a program sponsored by the State of California under the direction of the State's Marine Research Committee. The cooperating agencies in the program are:

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

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

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

CalCOFI Atlas Editorial Staff:

Abraham Fleminger and Hans T. Klein, Editors
John G. Wyllie, Cartographer

Atlases in this series, through June 1967, are:

CalCOFI Atlas No. 1
Anonymous. CalCOFI atlas of 10-meter temperatures and salinities 1949 through 1959.

CalCOFI Atlas No. 2
Fleminger, A. Distributional atlas of calanoid copepods in the California Current region, Part I.

CalCOFI Atlas No. 3
Alvariño, A. Distributional atlas of Chaetognatha in the California Current region.

CalCOFI Atlas No. 4
Wyllie, J. G. Geostrophic flow of the California Current at the surface and at 200 meters.

CalCOFI Atlas No. 5
Brinton, E. Distributional atlas of Euphausiacea (Crustacea) in the California Current region, Part I.

CalCOFI Atlas No. 6
McGowan, J. A. Distributional atlas of pelagic molluscs in the California Current region.

CalCOFI Atlas No. 7
Fleminger, A. Distributional atlas of calanoid copepods in the California Current region, Part II.

CalCOFI Atlas No. 8
Berner, L. Distributional atlas of Thaliacea in the California Current region.

[1] Usually abbreviated CalCOFI, sometimes CALCOFI or CCOFI.
[2] For citation this issue in the series should be referred to as CalCOFI Atlas No. 6.

CONTENTS

# DISTRIBUTIONAL ATLAS OF PELAGIC MOLLUSCS IN THE CALIFORNIA CURRENT REGION[1]

John A. McGowan[2]



## Introduction

Before the advent of the CalCOFI Program there were few records for pelagic molluscs within the California Current. Meisenheimer (1905) showed only five localities from this area in his summary of world-distribution records of thecosomes and gymnosomes. Tesch (1946, 1948, 1949) showed only five additional records including those of the Heteropoda. With the exception of Loligo opalescens almost no published records of larval squid exist for this area. It is the purpose of this atlas to record the distribution and estimates of abundance of the Thecosomata (Opisthobranchia), Heteropoda (Prosobranchia) and larval Cephalopoda. Further information on aspects of the ecology, distribution and general biology of many of the species in this atlas is available (McGowan, 1963; Fager and McGowan, 1964; Okutani and McGowan, in press; and McGowan, in press).

## Estimates of Abundance

The data on which the charts are based came from zooplankton tows taken on six cruises made within the California Current (4911, 5004, 5204, 5206, 5208 and 5210). The methods used in taking tows has been described (Ahlstrom, 1948; Fleminger, 1964) and the station positions and times of sampling have been presented (Staff, South Pac. Fish. Invest., 1953, 1954).

[1] This research was carried out under the Scripps Institution's Marine Life Research Program with partial support from the National Science Foundation, Grant GB-2861.

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

The identification of species and the counts for this study were done from unsorted zooplankton samples. The samples were prepared for examination by pouring them into a transparent tray 50 x 20 cm. The bottom of the tray was divided into ten squares of 10 cm length. Each square, in turn, was subdivided into one hundred squares of 1 cm length. Thus any decimal fraction of the entire sample down to a 1/1000 could be examined without aliquoting. For a sample that contained both abundant and rare species a fraction could be counted for the former and the entire sample for the latter. In actual practice entire samples were counted for most species. Only certain species of the genera Limacina and Creseis were counted from 10 to 20% fractions. No counts were made on fractions of less than 10%. The estimates derived from these counts were standardized to number of individuals per 1000 $m^3$ of water filtered by the net. On most occasions the volume of water actually filtered varied between 450 and 950 $m^3$.

Since it is one of the purposes of this atlas to present estimates of abundance some consideration of the accuracy of the methods used for sampling and for laboratory analysis are necessary. There are three major sources of error:

1. The patchy nature of the small-scale (100-1000 m) distribution of pelagic molluscs introduces a large amount of variability into estimates based on net tows which traverse distances of the same order as the patch (or non-patch) size.

2. Avoidance of the net by species capable of sensing its presence.

3. Aliquoting the sample so that a non-representative sub-sample is counted.

It is convenient to attempt to consider these sources of error separately. A series of 30 net tows was taken while following a parachute drogue set at a depth of 10 meters (Brinton, 1962; Kramer, 1963). The purpose of these tows was to obtain a set of replicate samples from the same body of water. The net used and the manner in which the tows were taken was the same as for the tows used to derive the data on which this atlas is based. Duplicate counts were made of the most abundant thecosome in 10% fractions of the samples from the first 12 tows of this series. The data on this species, Limacina inflata, were transformed to logarithms and variances for within-tow counts (the duplicates) and between-tow counts (the mean of the duplicates) were calculated. The results of these calculations yielded a between-tow variance of 0.165 and a within-count variance of 0.028. The ratio of the variance of "between/within", i.e., 0.165/0.028 equals 5.89. It may be shown that this ratio indicates ($p<0.01$) that almost all of the variability of the data was due to sampling and very little due to counting. It would be possible to calculate the confidence

limits of a single observation from these data. This, however, implies that the tows were true replicates from the same population and that the confidence limits may be applied to all subsequent tows. Since there is no way of knowing that the tows were true replicates, the approach is questionable. The best that can be done in this case is to use the range of values as an indication of sampling variability. The largest mean value of the duplicate counts, 178 individuals per 1000 $m^3$ is ten times that of the smallest value (18 individuals per 1000 $m^3$). That the variability is due primarily to patchiness rather than vertical migration during the period of sampling is indicated by the fact that in both the day and night sets of samples the number of counts greater or less than the median value for the entire series was about the same. The extent to which Limacina inflata is capable of avoiding the net used in this study (7853 $cm^2$ mouth area) is not fully known. It has been shown, however, (McGowan and Fraundorf, 1966) that this species is not capable of avoiding this net any better than one of a much larger mouth area (15393 $cm^2$). Again, it would seem that the observed variability in the estimates of abundance is due primarily to patchiness.

## Presence and Absence of Species

Each of the net tows taken on the cruises used for the preparation of this atlas are supposed to be "representative" of a much larger volume of water than that filtered by the net. The average net tow samples approximately 1 part in 1.5 billion ($1.5 \times 10^9$) of this volume. Since these samples are very small and have been used to indicate presence or absence of species as well as abundance, some consideration of the validity of such samples for this purpose is appropriate. Certain aspects of this problem have been studied (McGowan and Fraundorf, 1966). It appears that net tows of the type used here catch only 31 to 56% of the species of pelagic molluscs actually present in the immediate area of the tow. McGowan and Fraundorf found that most of the species present in the area that were not caught by individual net tows, were present at estimated levels of abundance of less than 20 individuals per 1000 $m^3$. Additional information on this problem comes from the set of 30 tows, taken while following the ten-meter drogue (Brinton, 1962; Kramer, 1963). Of the tows taken, 23 were examined in their entirety for the presence or absence of pelagic molluscs other than Limacina inflata. Five of these species, Clio pyramidata, Cavolinia inflexa, Creseis virgula, Desmopterus pacificus and Pterotrachea coronata were present in one or another of these samples. When present, the mean abundance of each was estimated to be less than 20 individuals per 1000 $m^3$ of water filtered. A runs test on the frequency of these "rare" species in the 23 tows indicated ($p<0.01$) that they were random in their occurrence. This implies that when these species are present at low levels of abundance it is likely that our ability to catch them is due to chance. The average frequency of these five species was 6.8 occurrences in

23 samples. The range among the five was four to twelve in 23 samples. Thus, on the average we would catch one of these species in about seven out of 23 tows which represents a probability of 0.30.

Presentation of the Data

It is not entirely appropriate to apply the estimates of our ability to catch rare species directly to the data presented in this atlas. The sampling studies discussed above were all done in the immediate vicinity ($\lesssim$1 km in any direction) of a drogue and represent estimated sampling efficiencies for volumes of water approximately 1/100 of the volume the sample is meant to represent. Thus, it is possible that the sampling plan of the CalCOFI-grid surveys is much less sensitive in detecting the presence of species present at low levels of abundance than were the sampling studies. Therefore, it seems unlikely that much significance may be attached to negative records at stations that are contiguous with a number of positive stations. These negative records can only be taken to mean that the species was probably rare at the point of sampling, not necessarily absent.

Brinton (1962) has discussed various types of presentations of areal abundance data, and has pointed out the advantages of contouring such estimates for zooplankton species. Contouring is used here with a contour interval of a factor of 10. This interval was selected on the basis of the evidence from the sampling-variability study done on Limacina inflata. There are no good reasons to believe, however, that this interval is appropriate (i.e., distinguishes real variations in abundance) for the other species of pelagic molluscs.

It is frequently the case when contouring data of this nature that there are alternative possibilities in drawing the isopleths. In an effort to introduce an element of objectivity into what is an admittedly subjective process of selecting an alternative isopleth, current flow diagrams were used. These diagrams were derived (by John G. Wyllie) from the surface geostrophic flow charts of the month previous to, and the month of zooplankton sampling. Since it is probable that much of the areal pattern of abundance is due to transport by the currents, this technique is appropriate.

If a species did not occur in any of the samples taken on a particular cruise, no chart for that species appears. For instance, Cavolinia tridentata appeared only in Cruise 4911 and Cymbulia peroni only in Cruise 5206. Thus, only one distributional chart for these species appears, although all the samples from the other five cruises were also examined for their presence. A number of charts are presented for genera only; for example, Clio sp., Cavolinia sp., and Atlanta sp. In these cases it was impossible to identify these specimens to species because their shells

had dissolved in the acidic preservative of the sample. While it is possible to identify many of the thecosomes and heteropods from their soft parts alone, it is frequently difficult for certain species of some genera. It is likely that the collection records listed as Clio sp. are C. pyramidata, but this is not certain. Further, it is probable that the records of Cavolinia sp. do not include C. inflexa, but rather one or more of the other three species of this genus. In the case of Atlanta sp., it is fairly certain that A. turriculata and A. inclinata specimens were not included. Both the shells and the soft parts of the larvae (veligers) of Carinaria japonica are readily identified and the data on their distribution and abundance are presented separately from those of the adults of this species.

In addition to the charts of monthly distribution and abundance the total areal range of all positive collection records for most species are shown. In some cases the individual records (black dots) on these charts represent more than one occurrance. The number of collection records each dot represents may be determined by referring to the monthly cruise charts.

The sequence in which the species of Thecosomata and Heteropoda are presented follows that of Boas (1886), Pelseneer (1888), Meisenheimer (1905) and Tesch (1946, 1950) and is essentially phylogenetic. The cephalopod distributions presented here are for larval specimens only. Generally, no individuals of these larger than 10 mm (dorsal mantle length) were caught in our tows.

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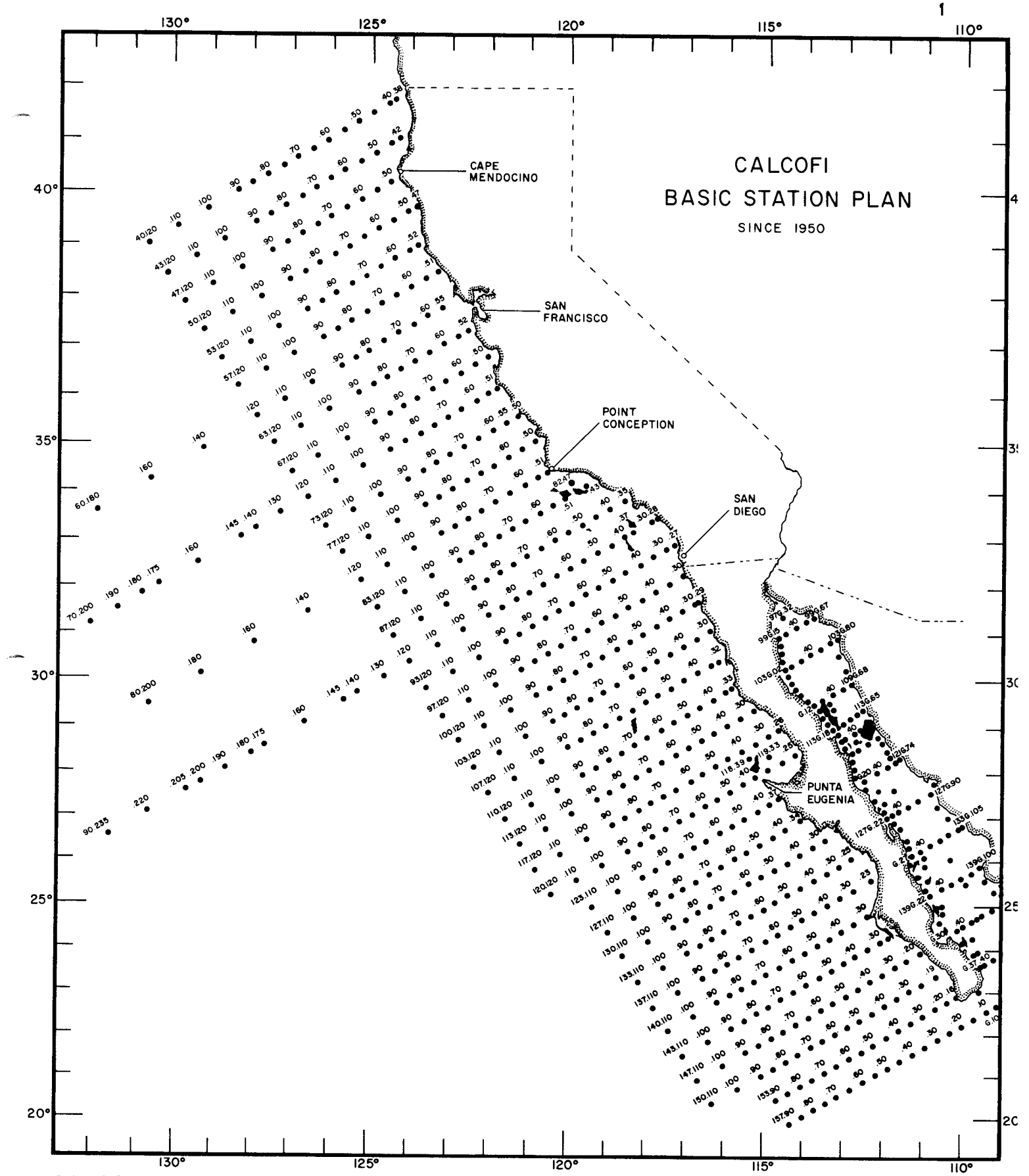
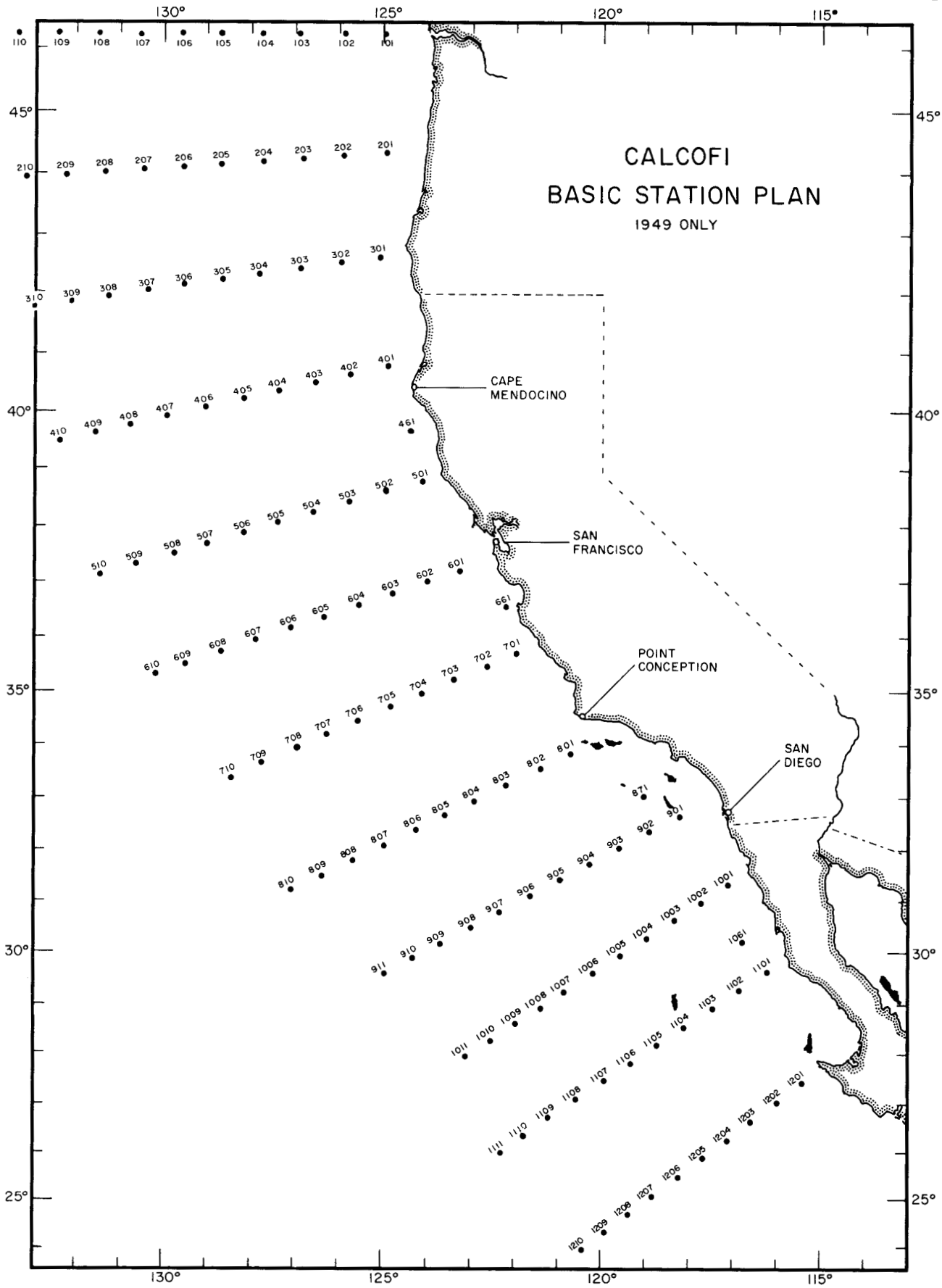
## List of Charts




CALCOFI

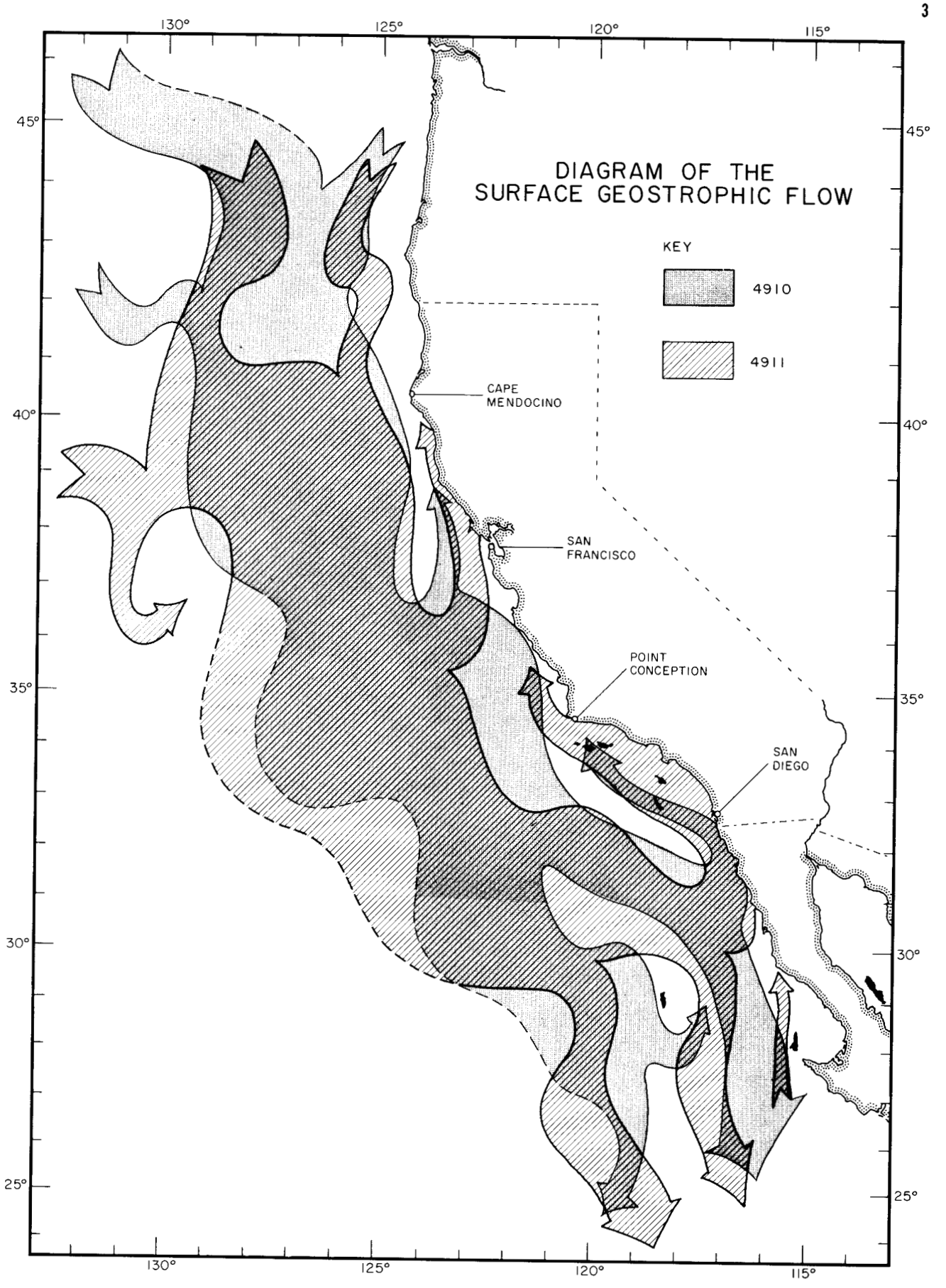
BASIC STATION PLAN

SINCE 1950




CALCOFI BASIC STATION PLAN

1949 ONLY




CURRENT DIAGRAM

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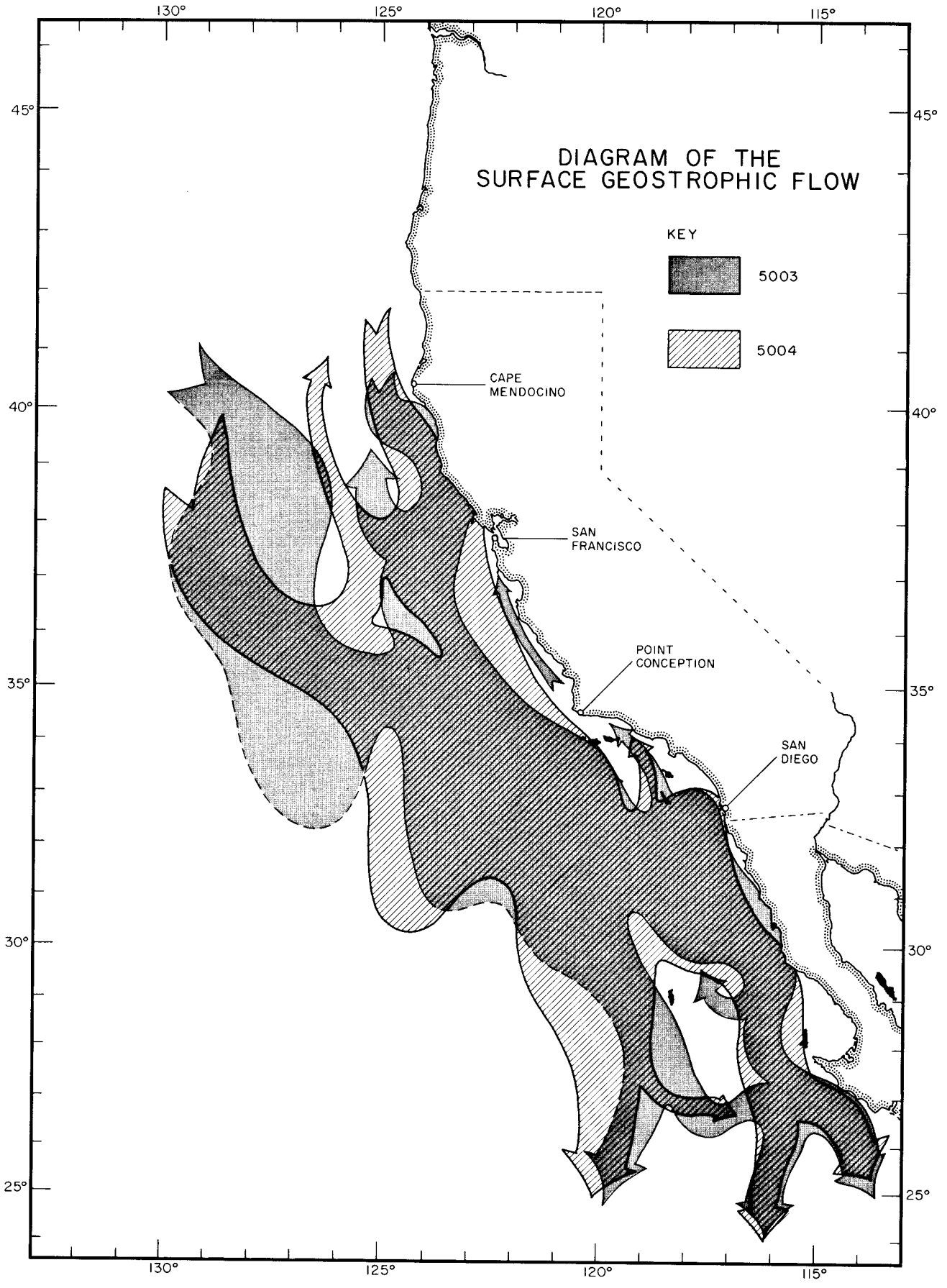
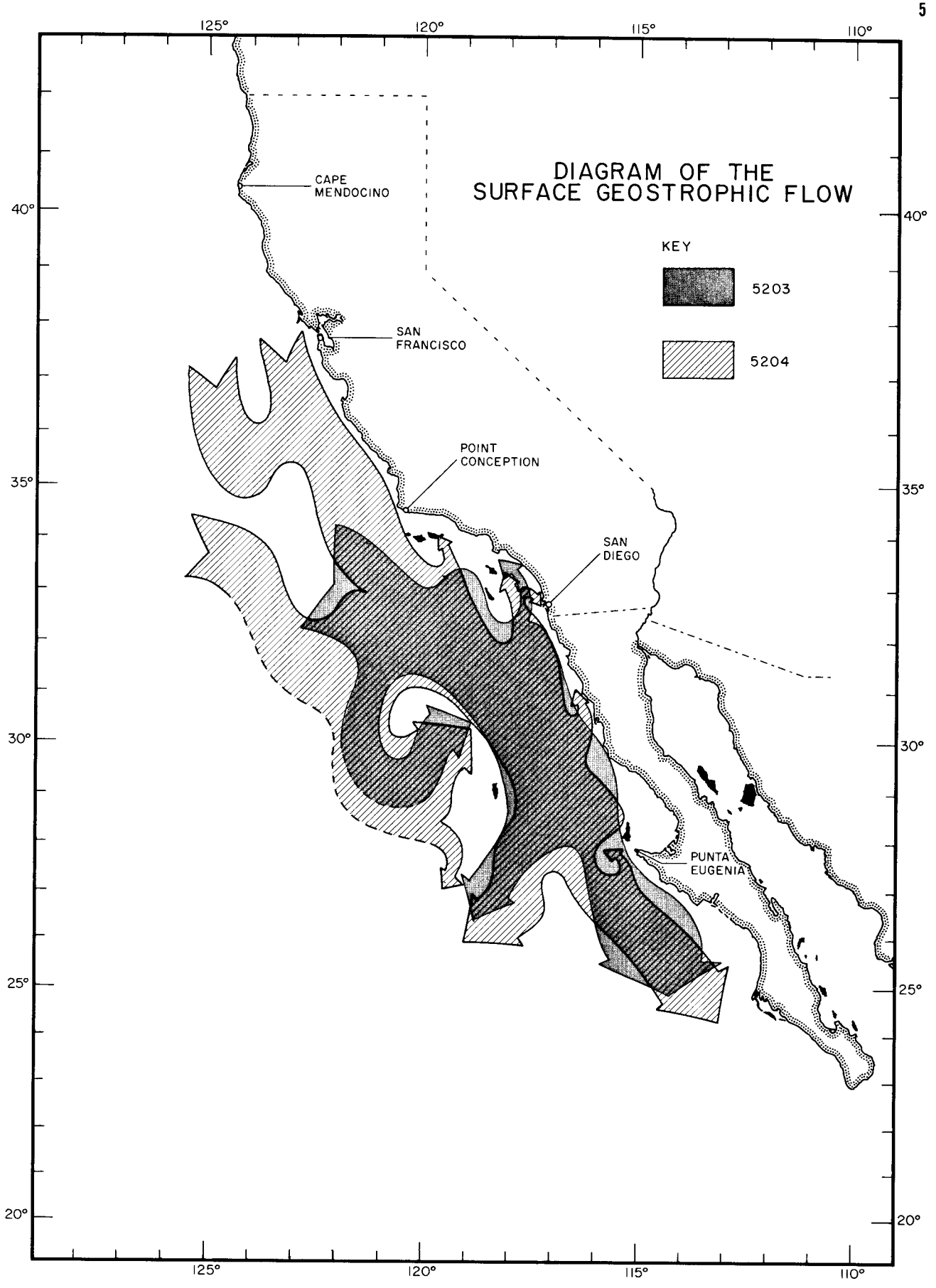



CURRENT DIAGRAM

5004

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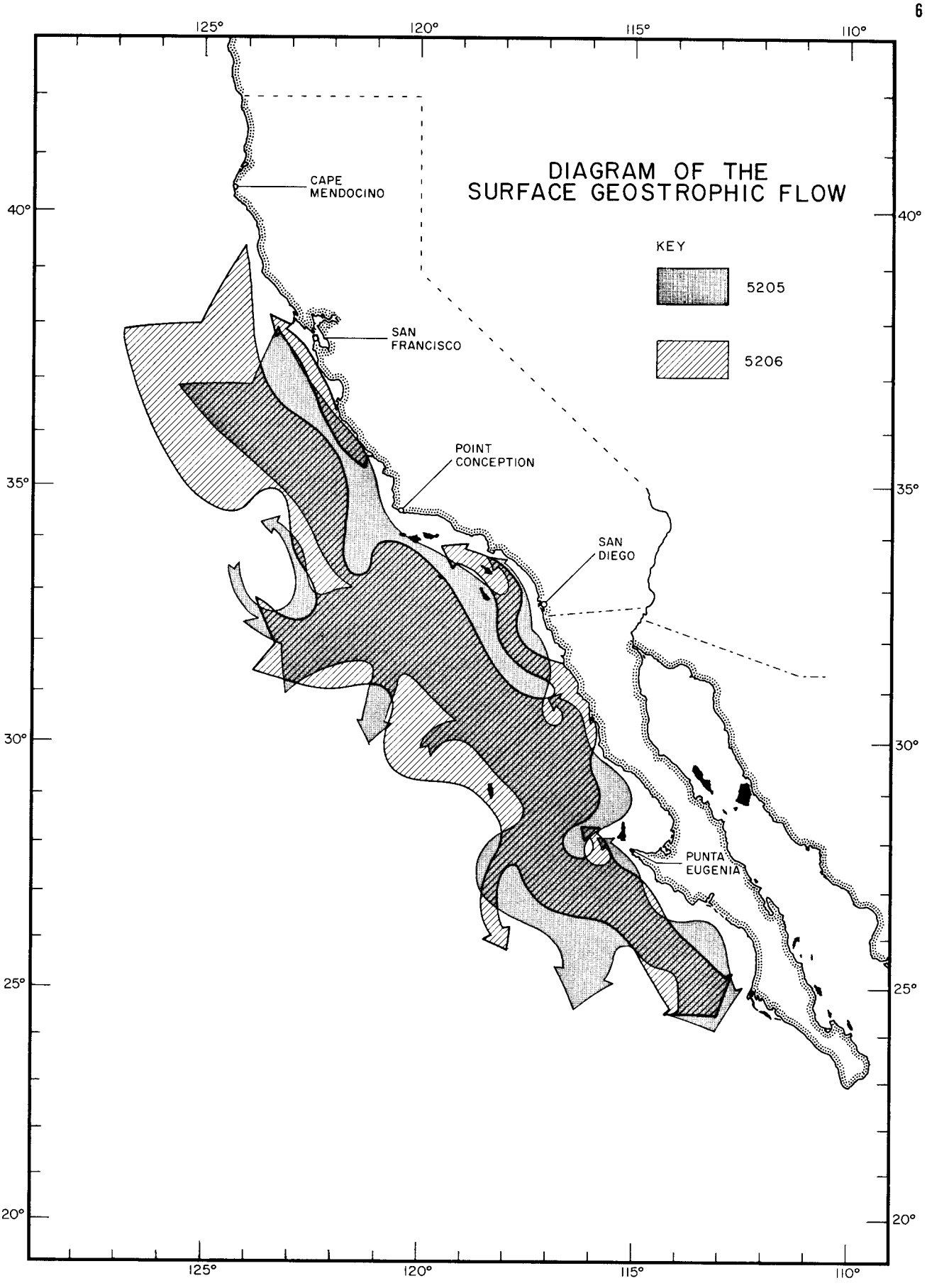
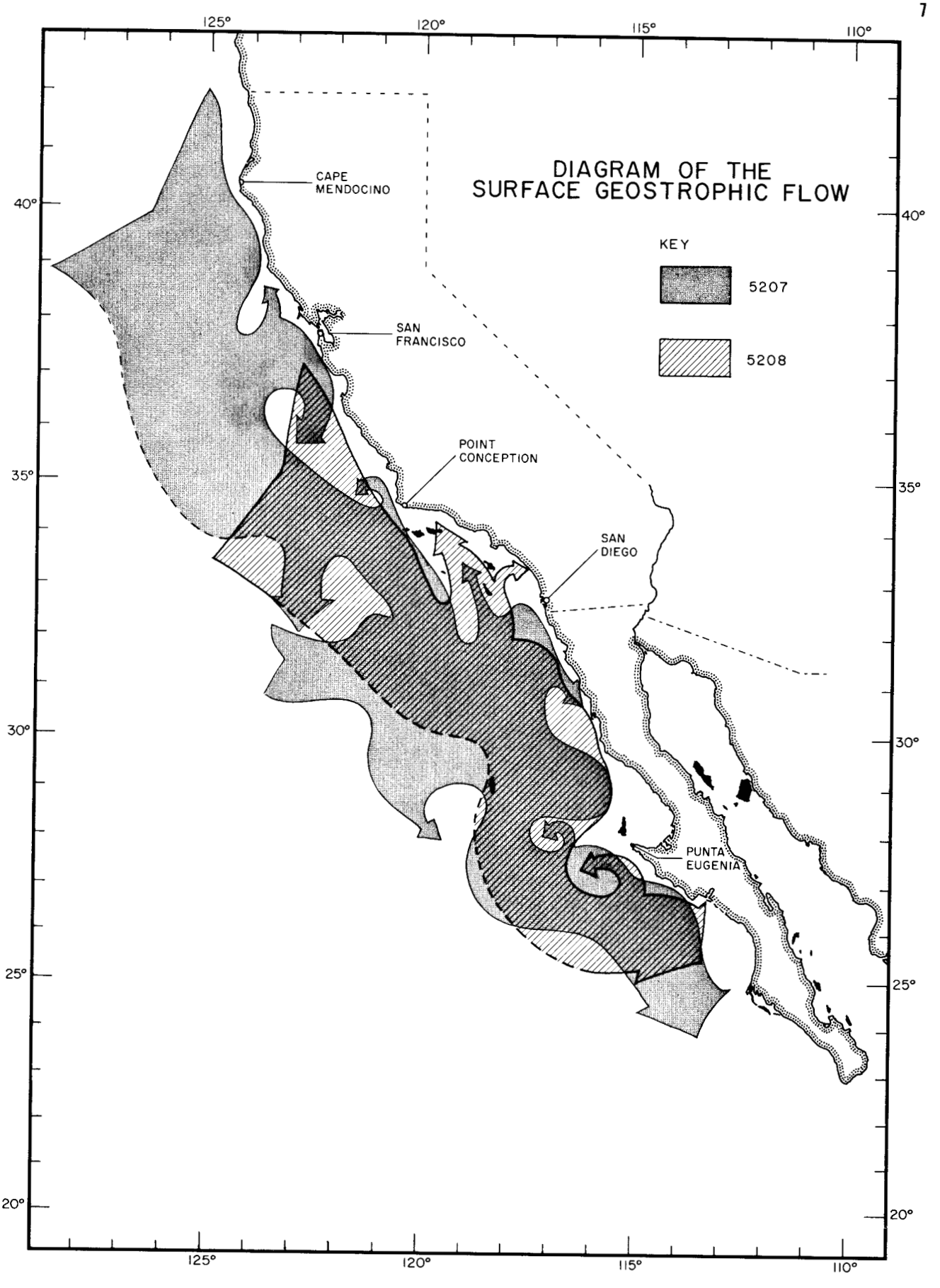
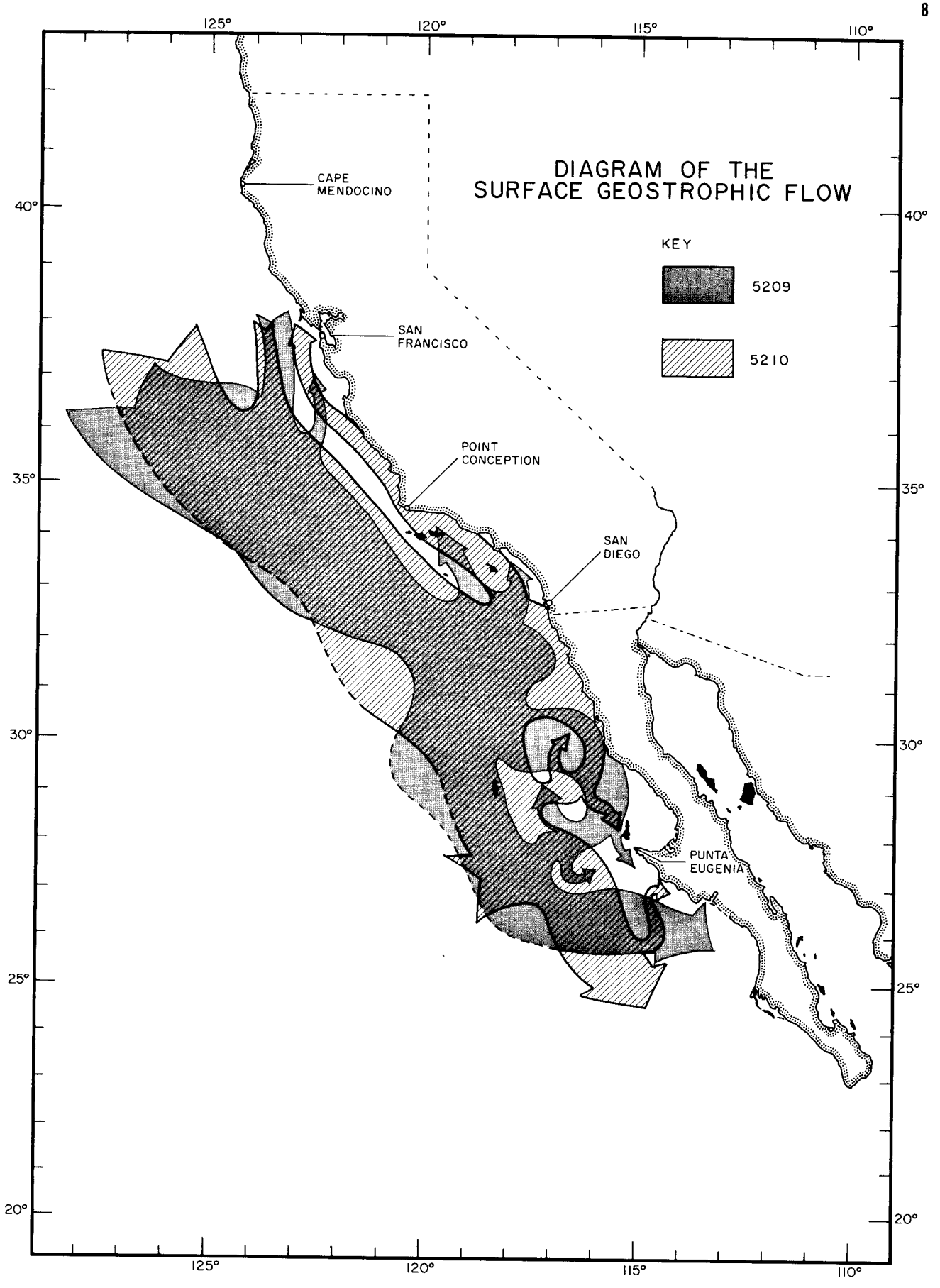



CURRENT DIAGRAM

5206

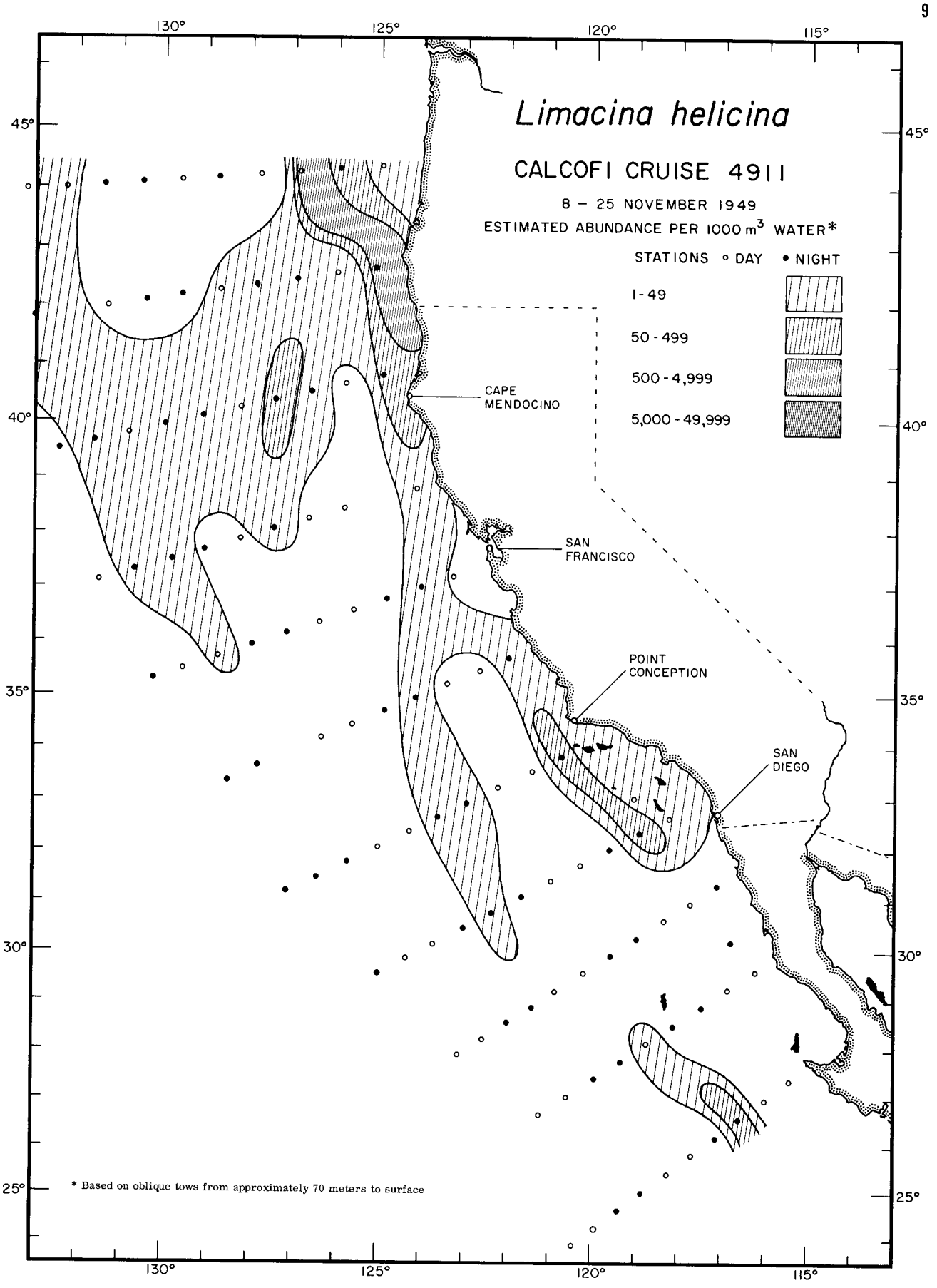



CURRENT DIAGRAM
5208




CURRENT DIAGRAM

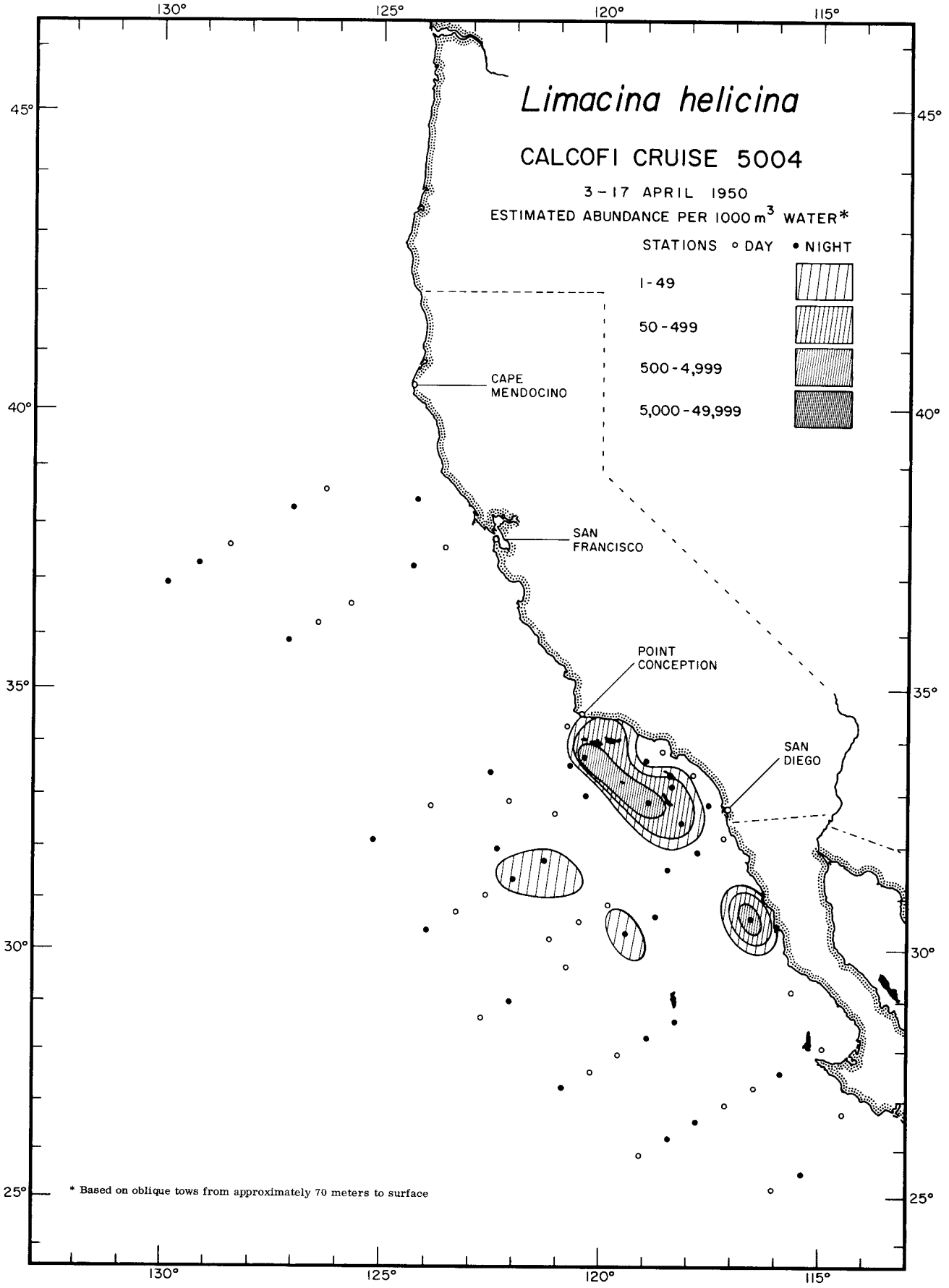
5210




Thecosomata

*Limacina helicina*

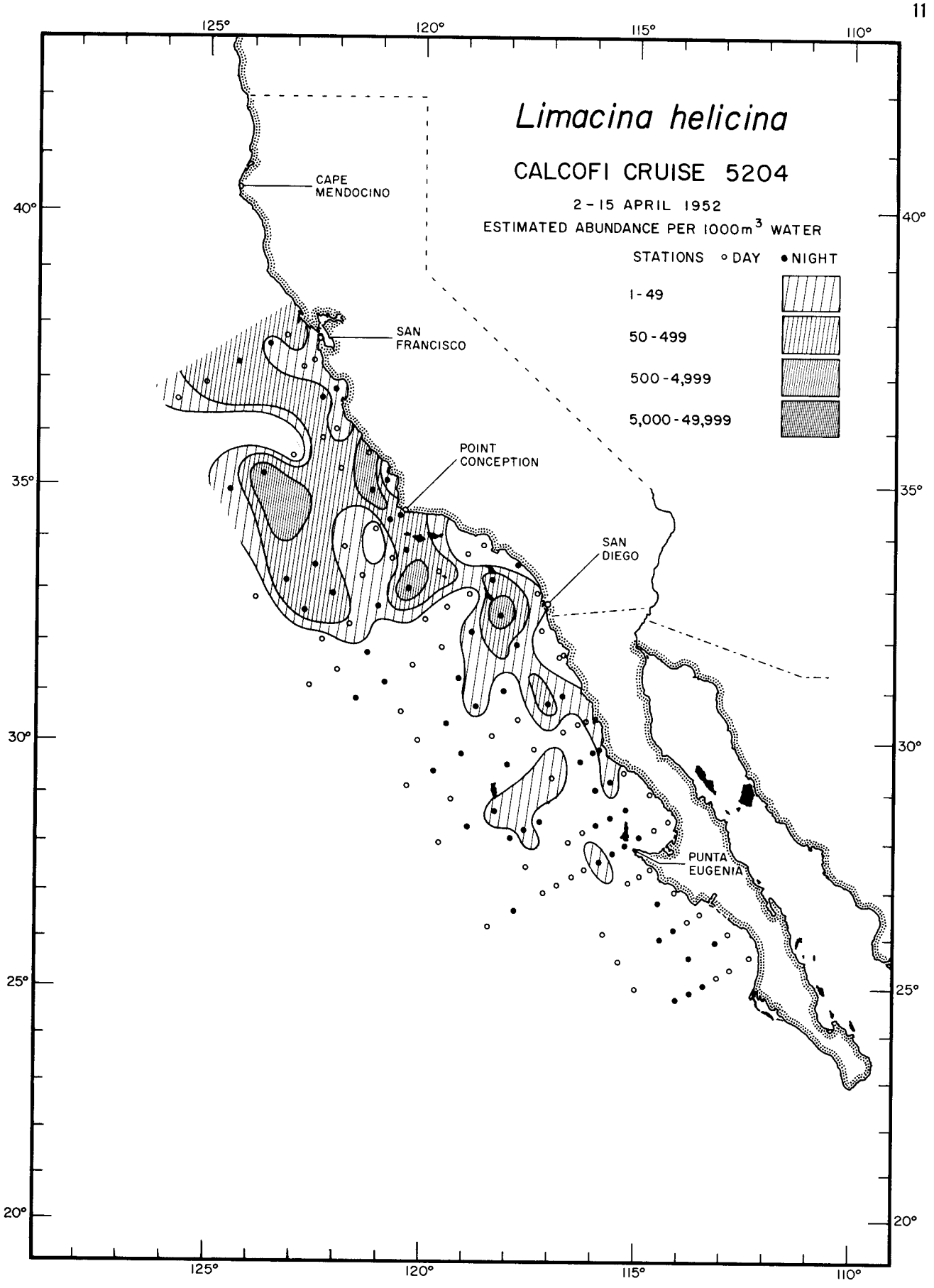
4911




Thecosomata

*Limacina helicina*

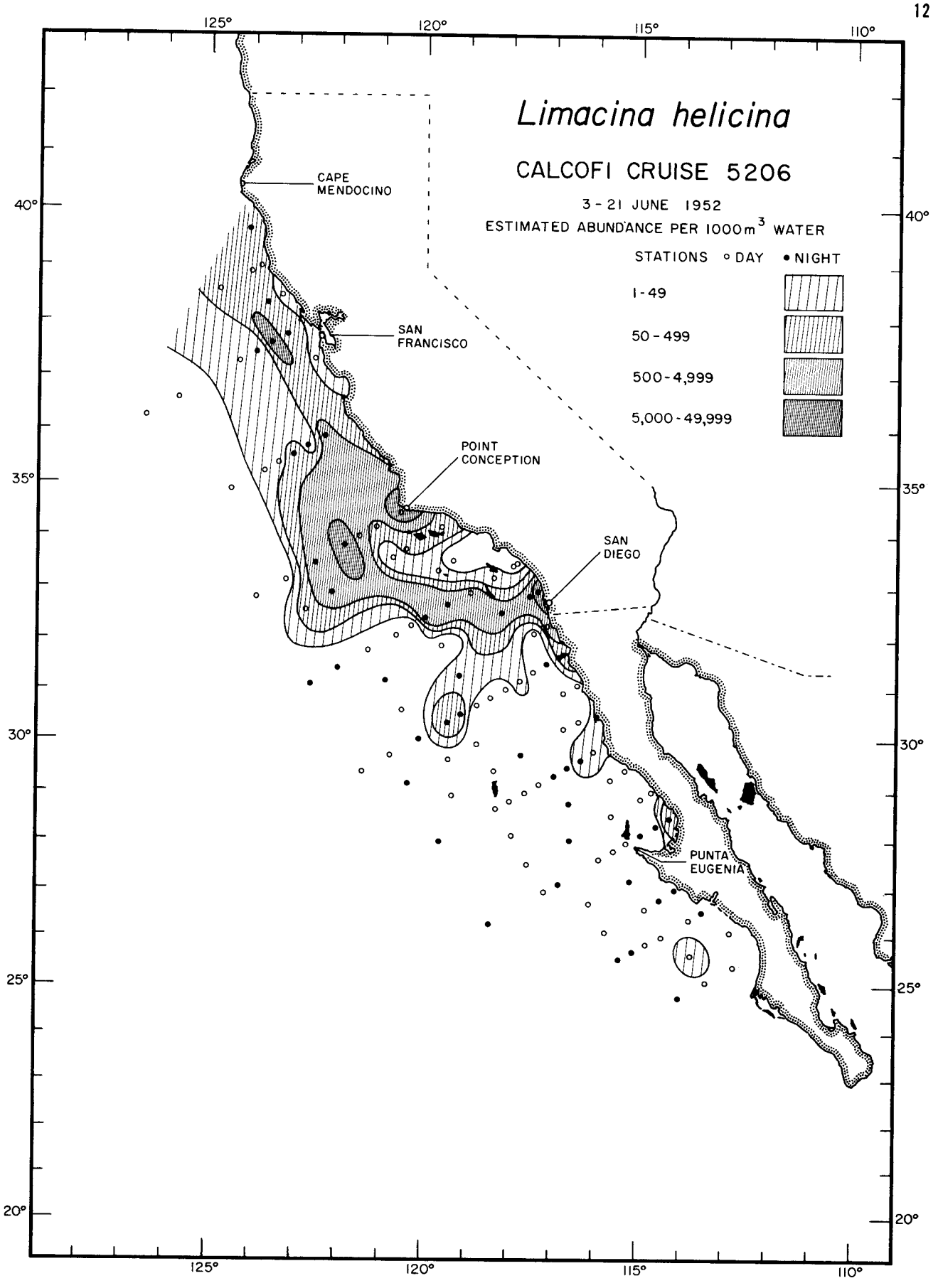
5004




Thecosomata

*Limacina helicina*

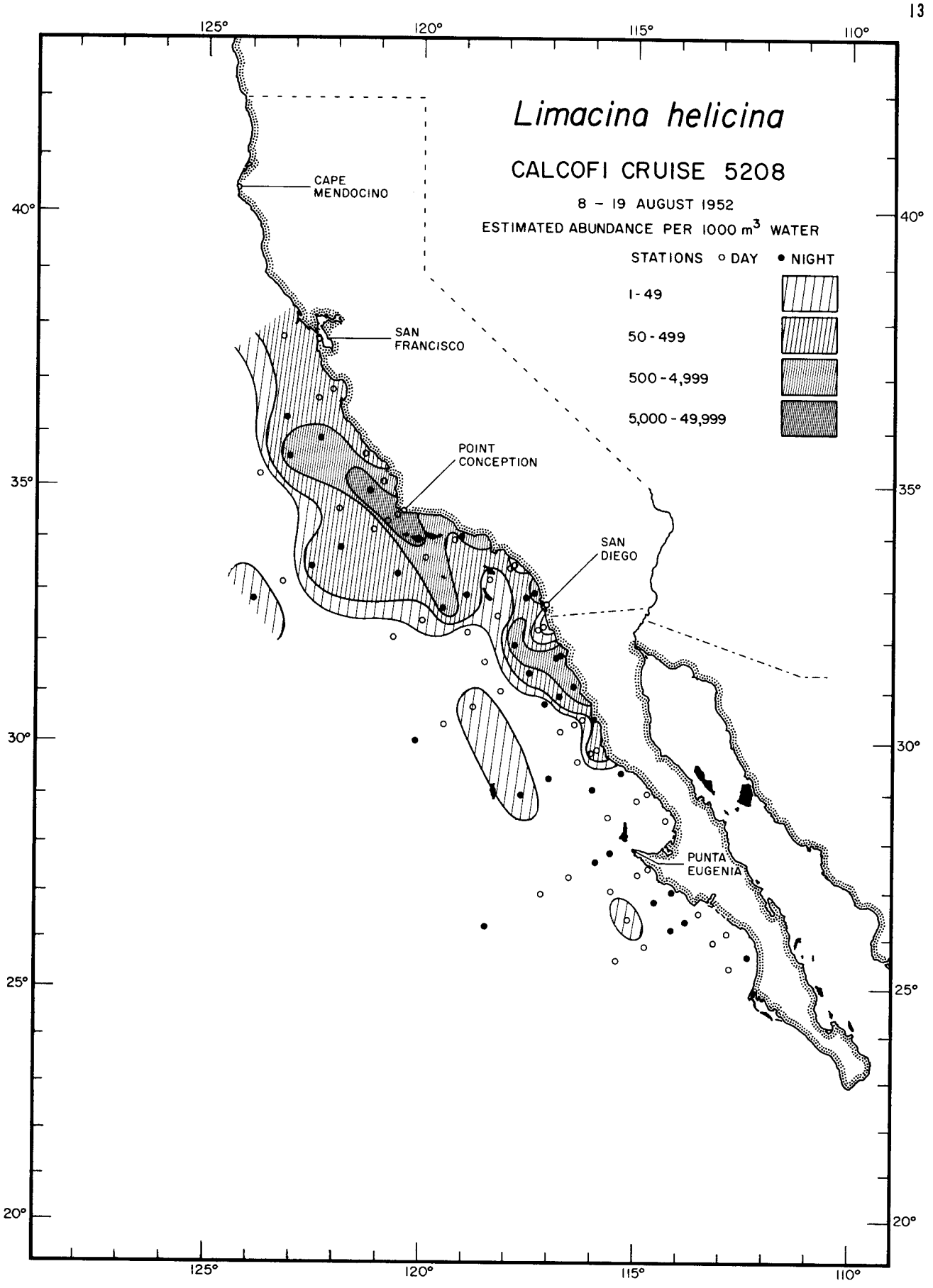
5204




Thecosomata

*Limacina helicina*

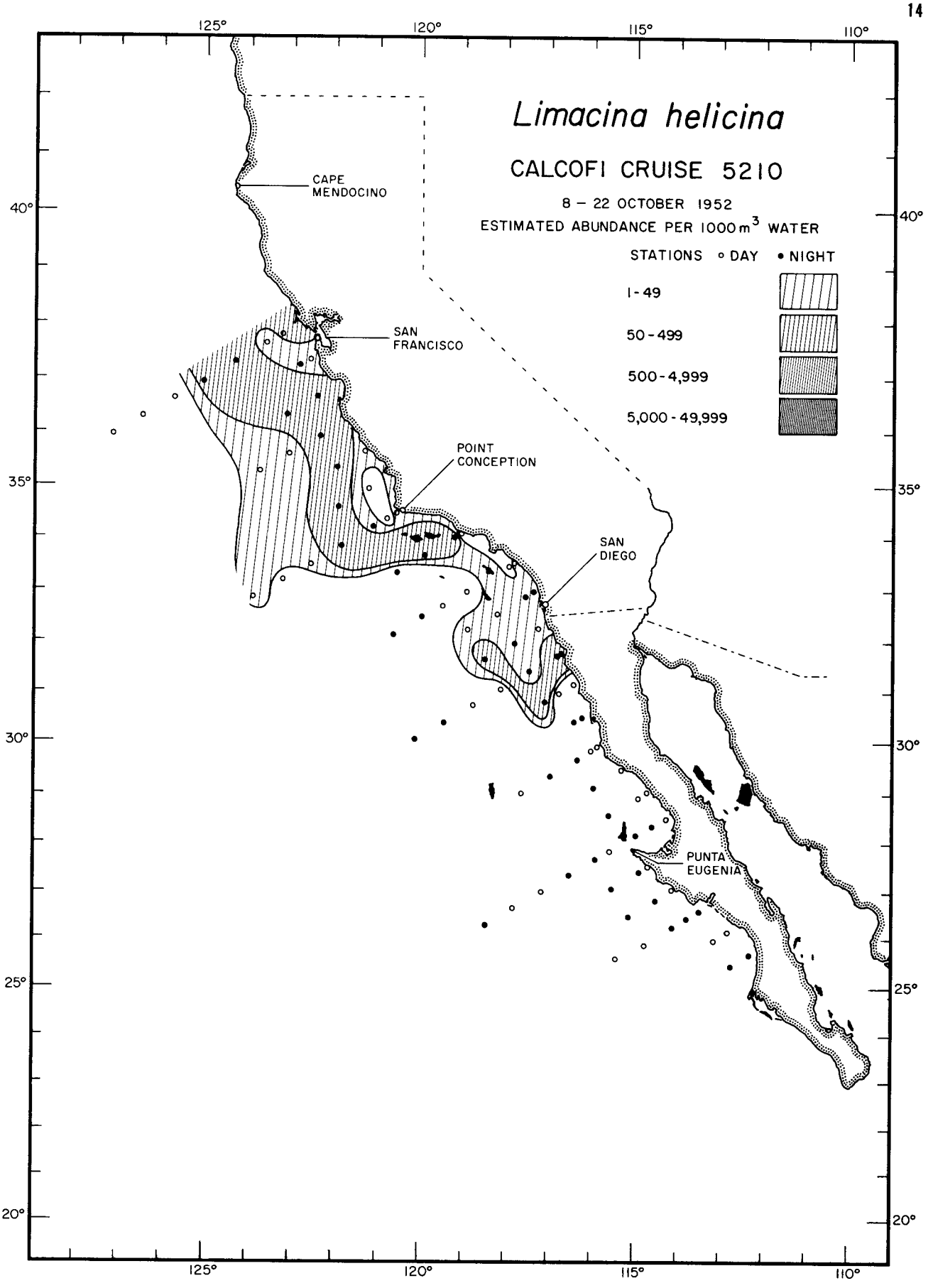
5206




Thecosomata

*Limacina helicina*

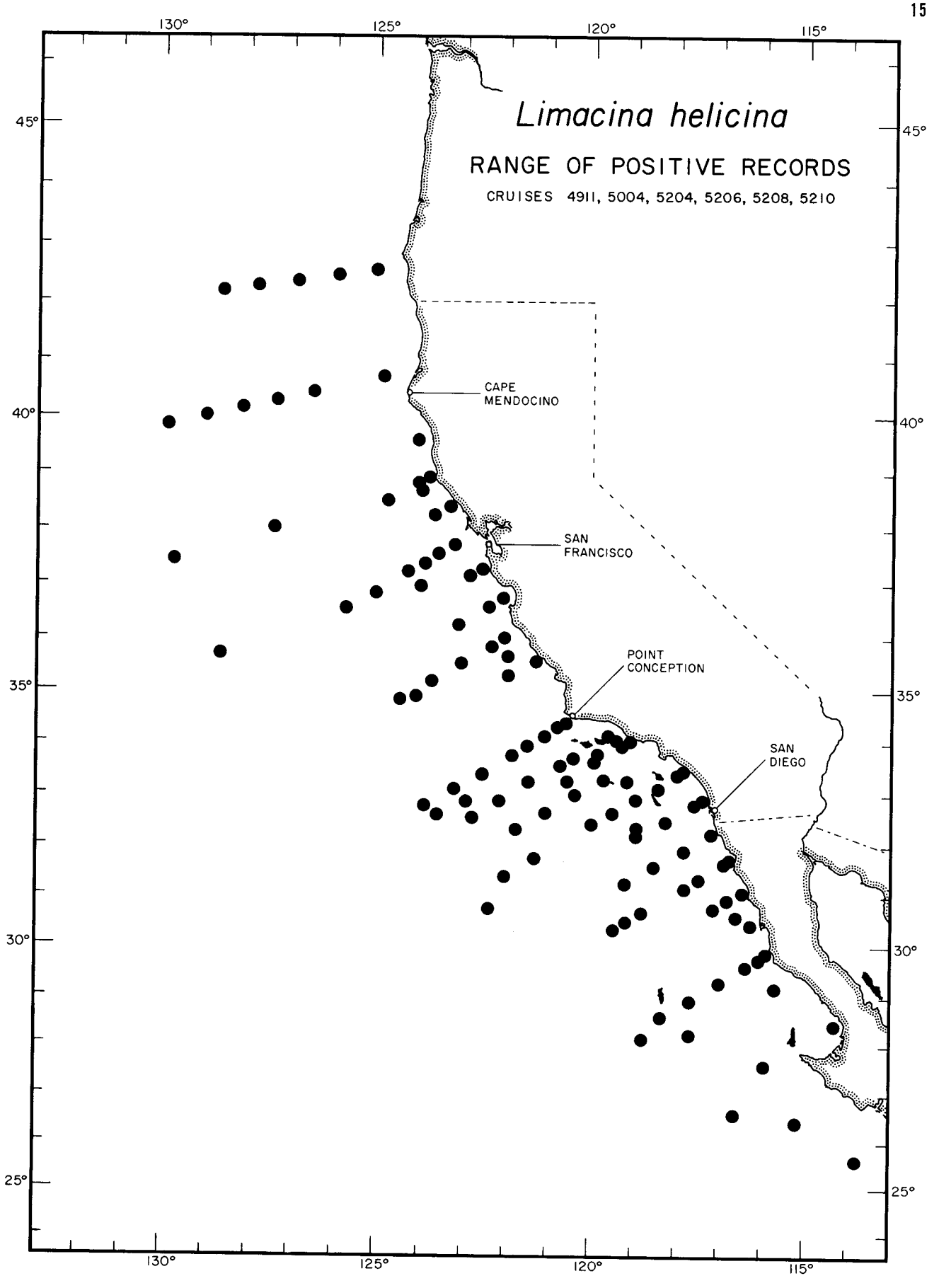
5208




Thecosomata

*Limacina helicina*

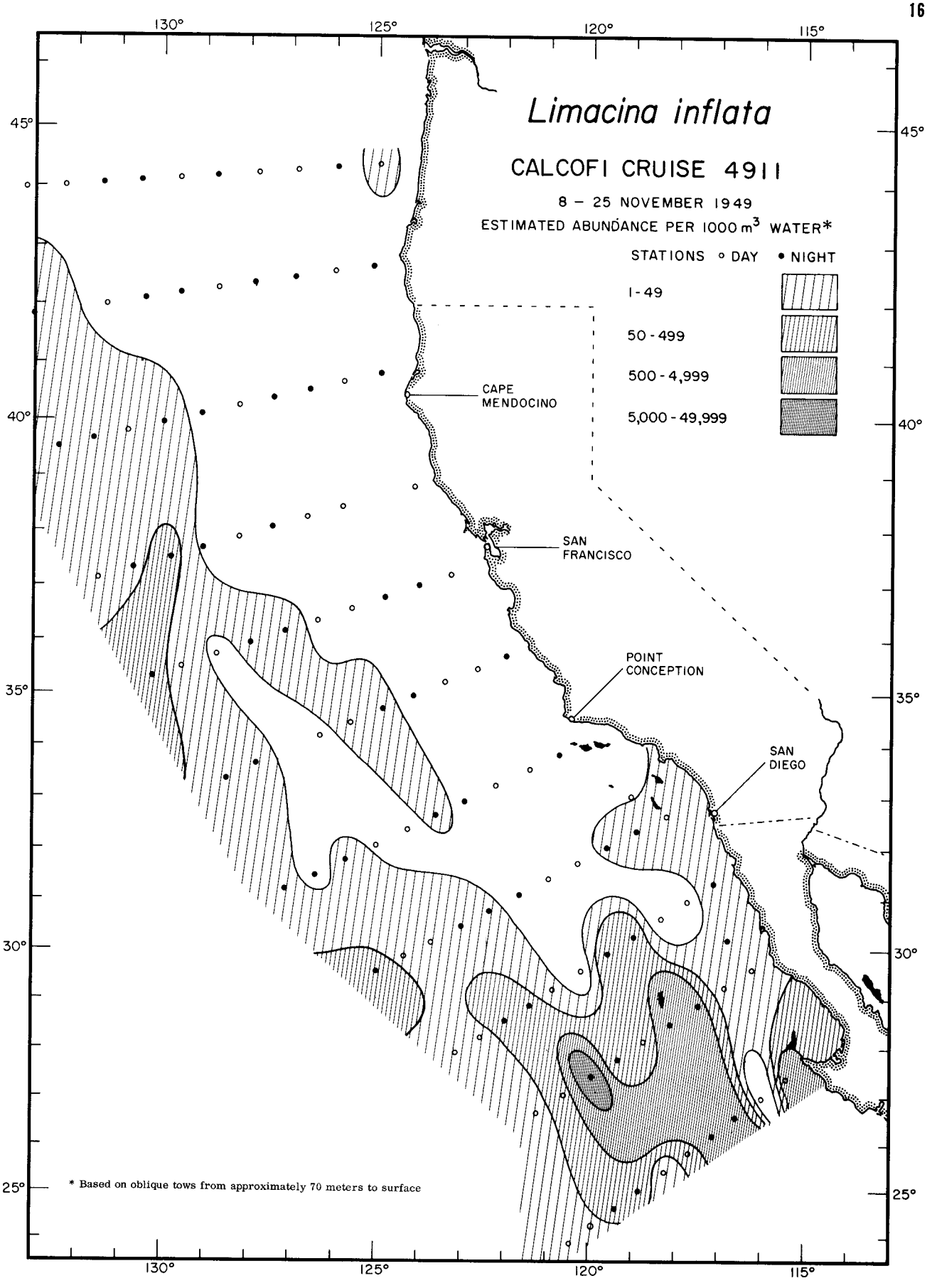
5210




Thecosomata

*Limacina helicina*

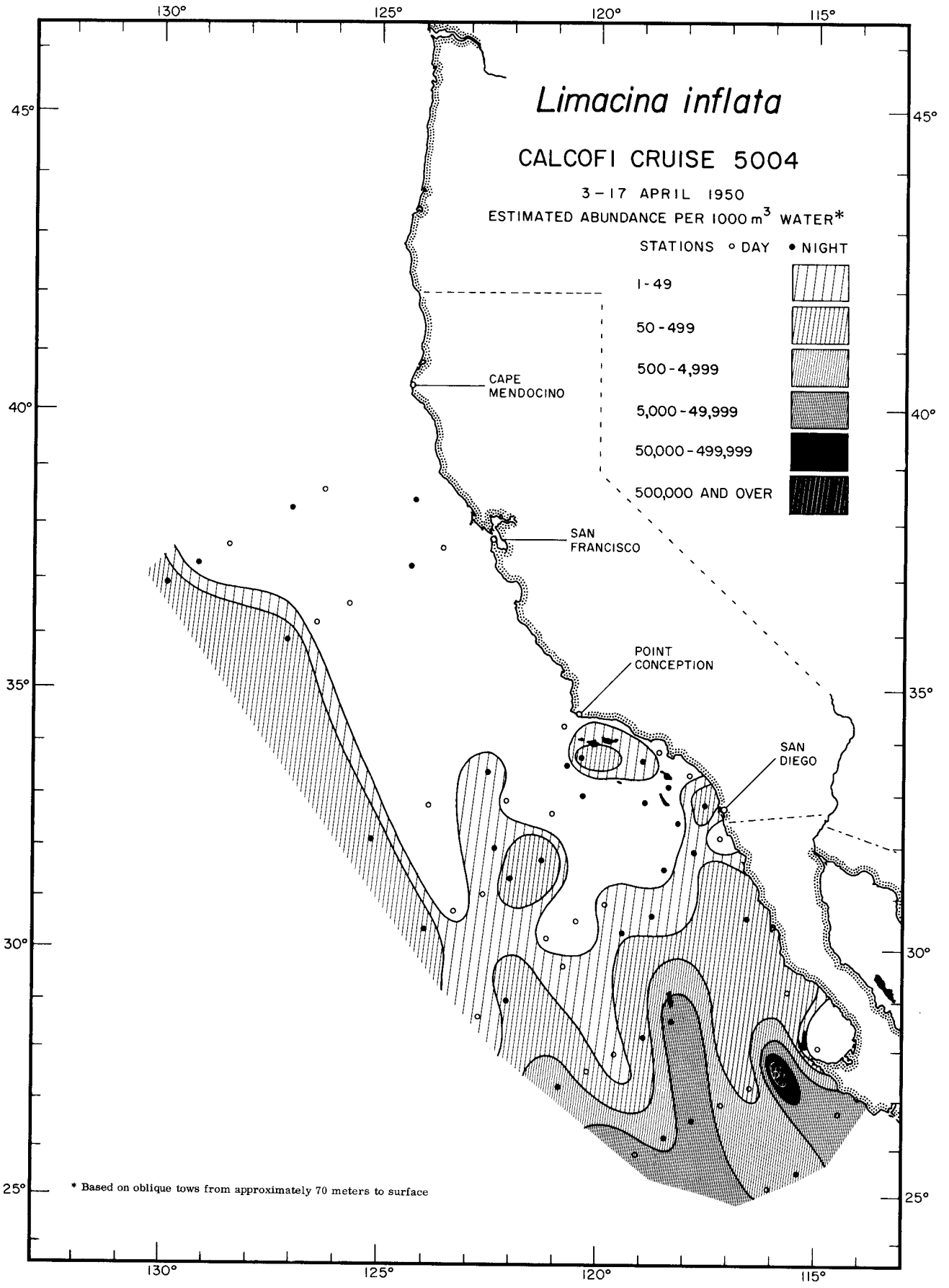
RANGE OF POSITIVE RECORDS




Thecosomata

*Limacina inflata*

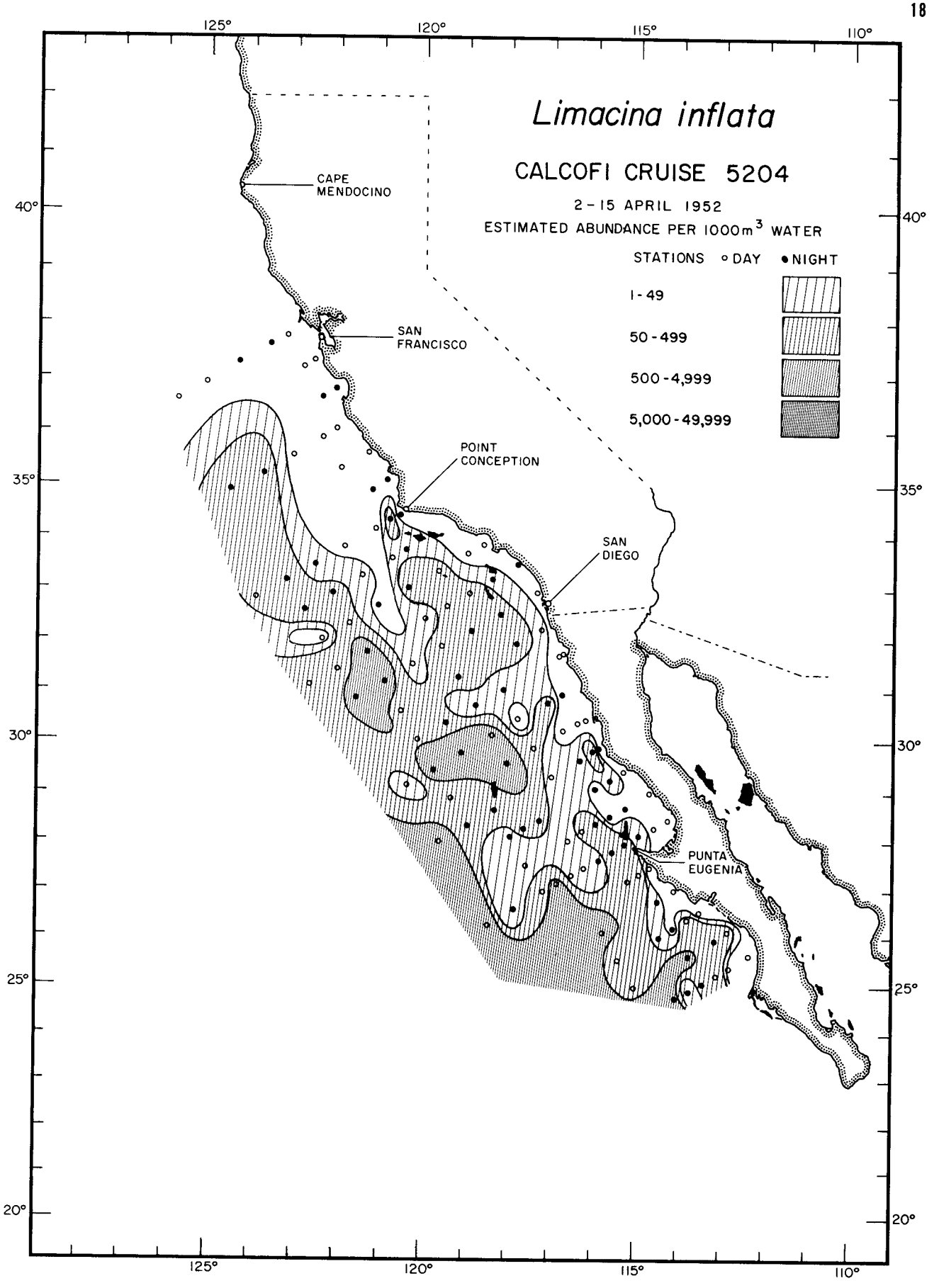
4911




Thecosomata

*Limacina inflata*

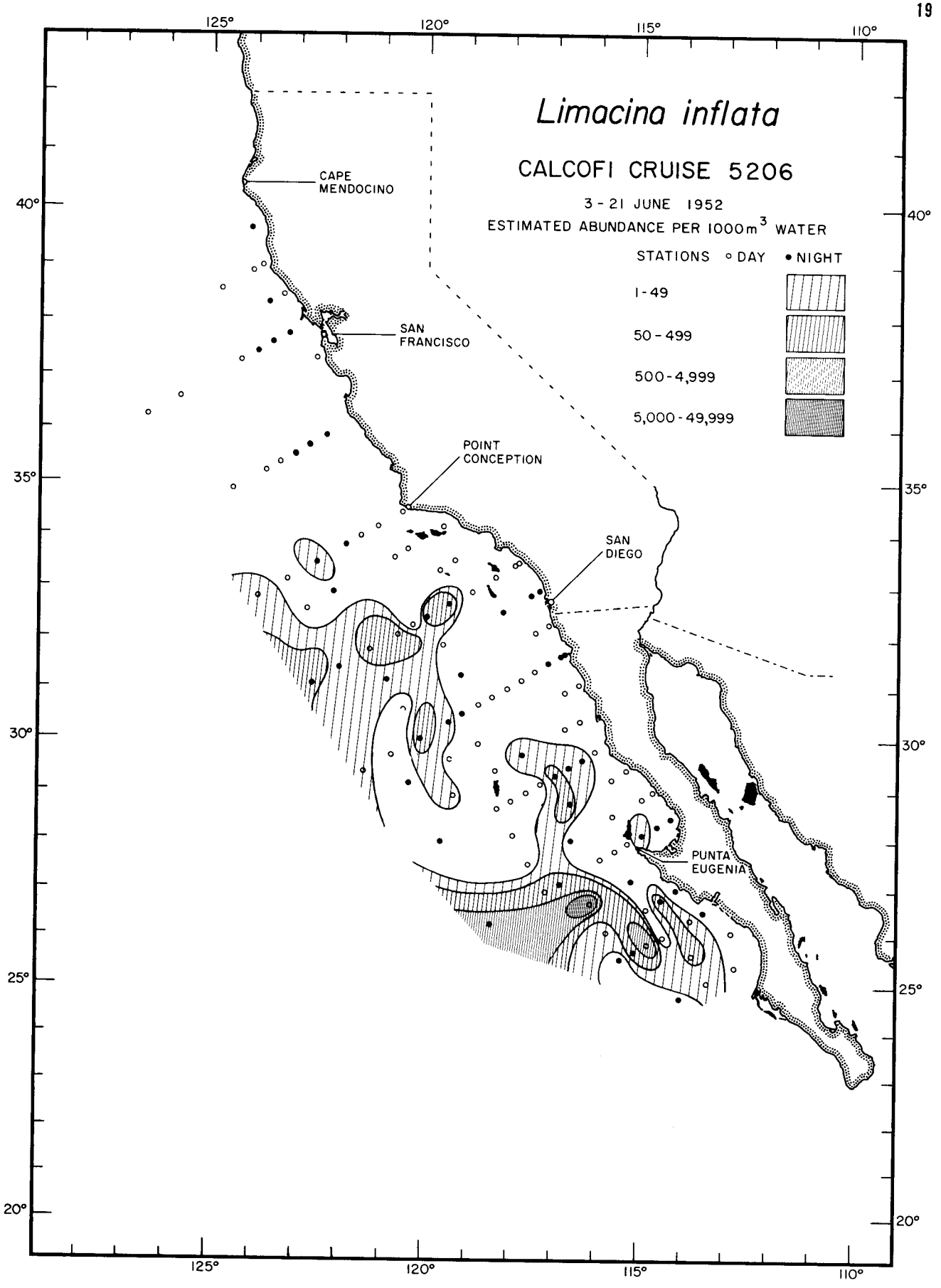
5004




Thecosomata

*Limacina inflata*

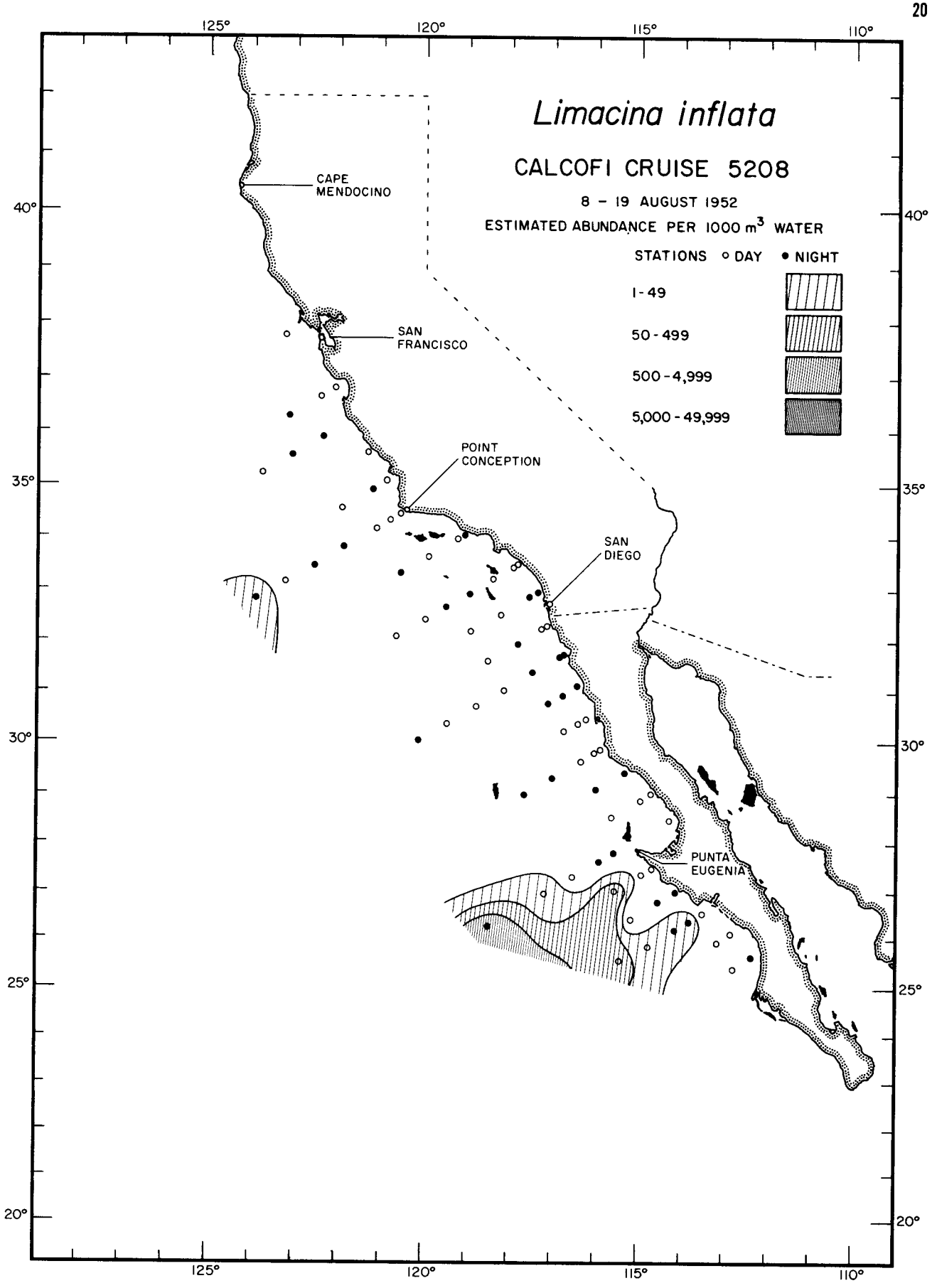
5204




Thecosomata

*Limacina inflata*

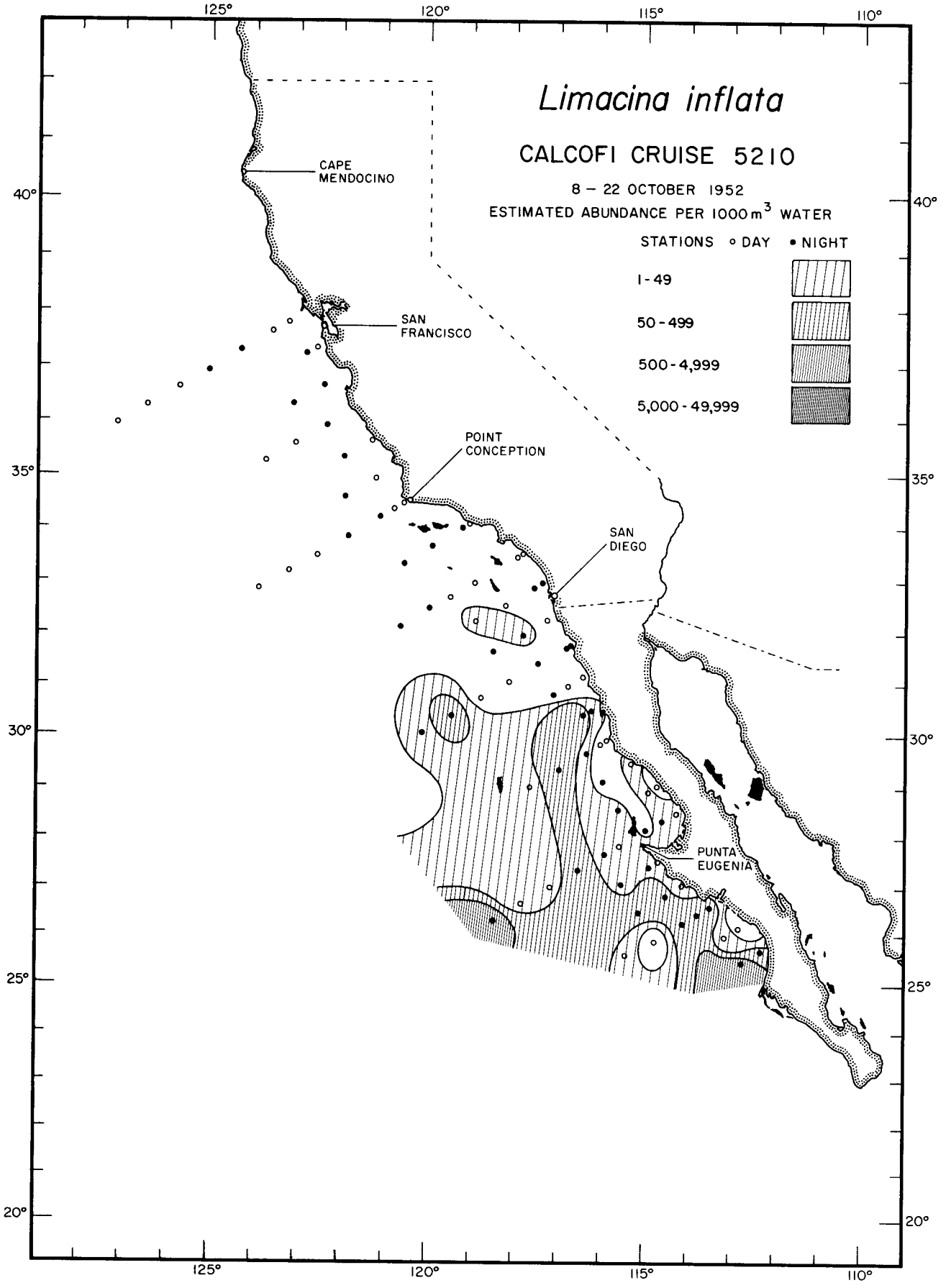
5206




Thecosomata

*Limacina inflata*

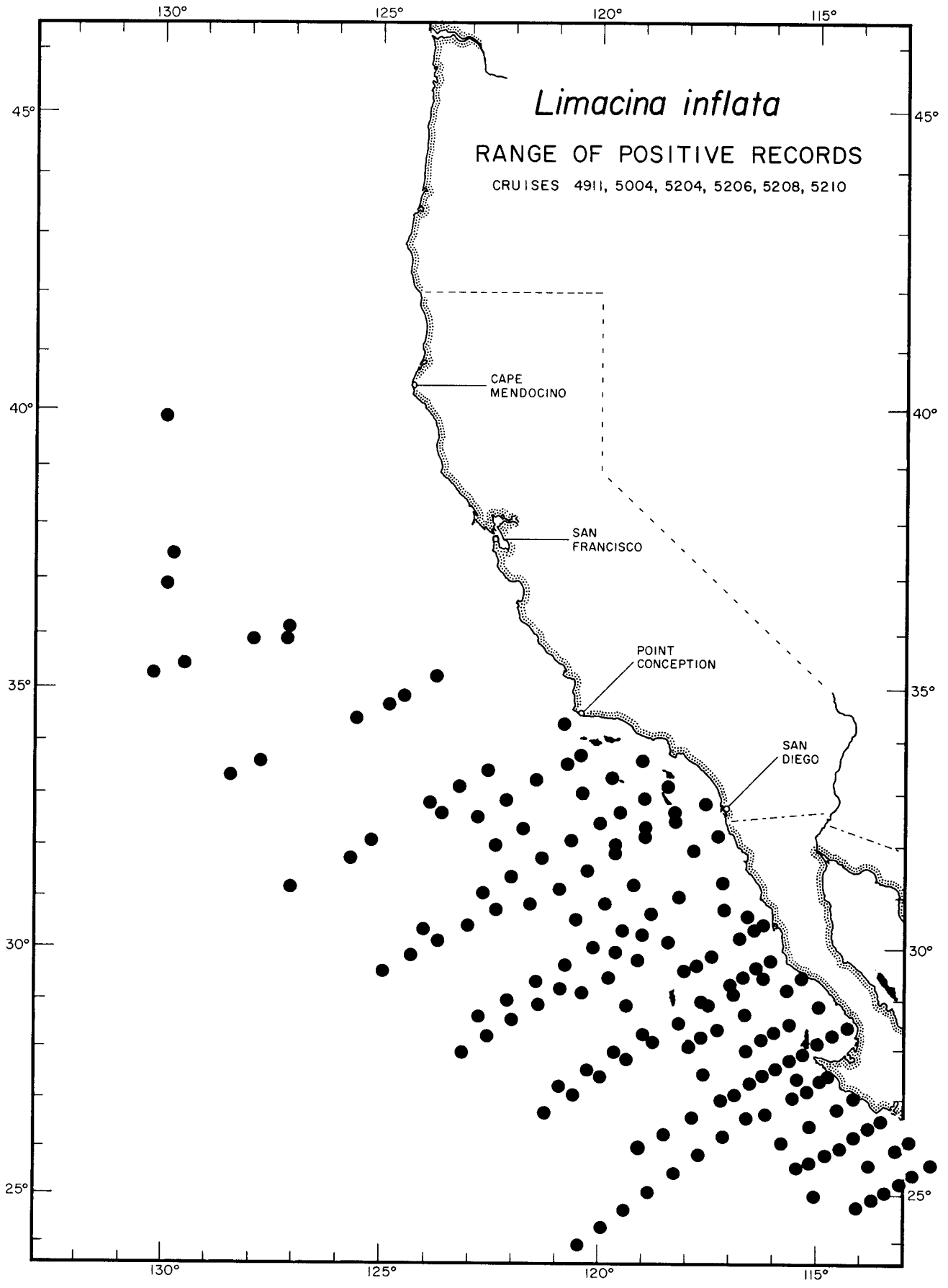
5208




Thecosomata

*Limacina inflata*

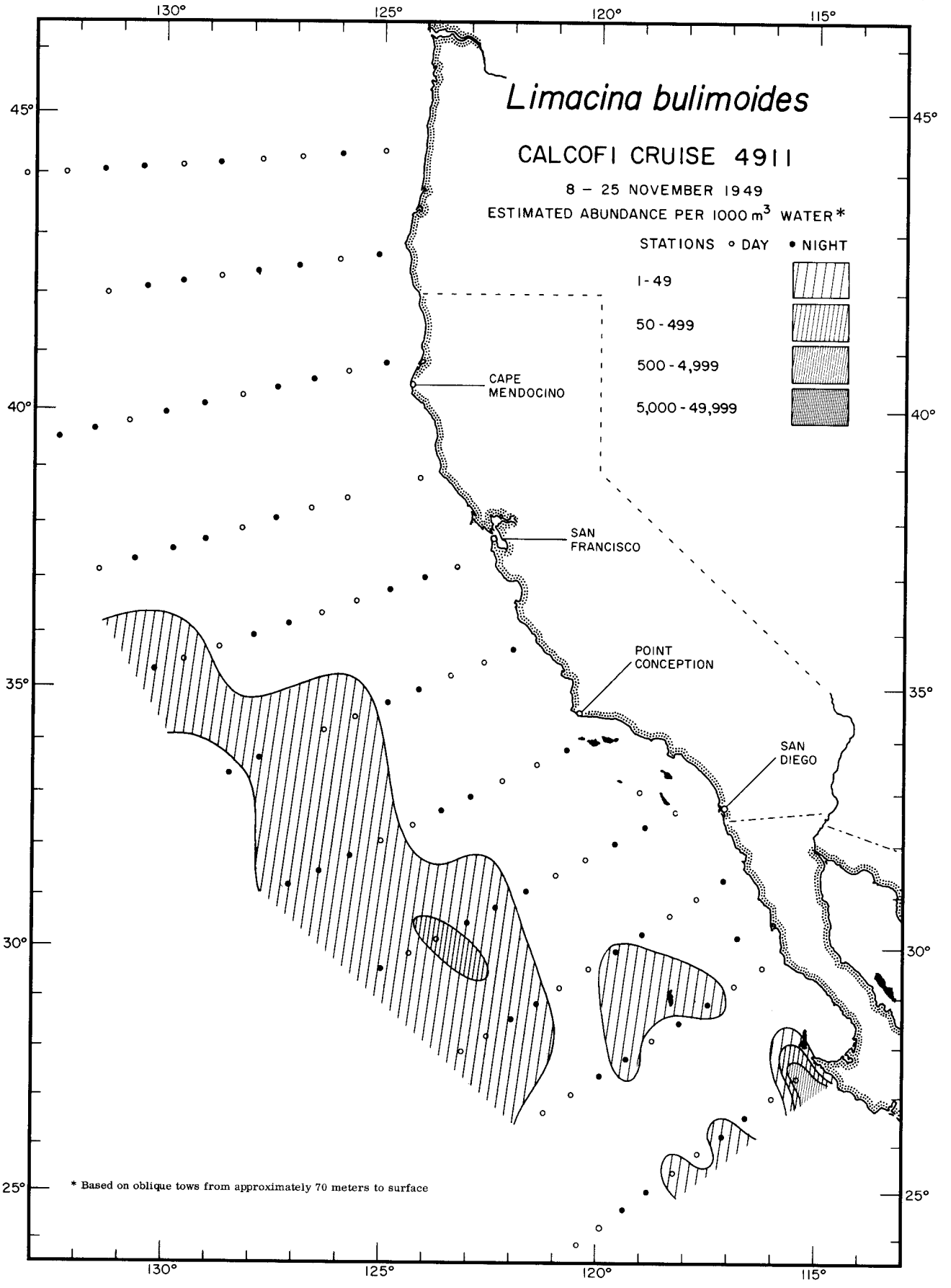
5210




Thecosomata

*Limacina inflata*

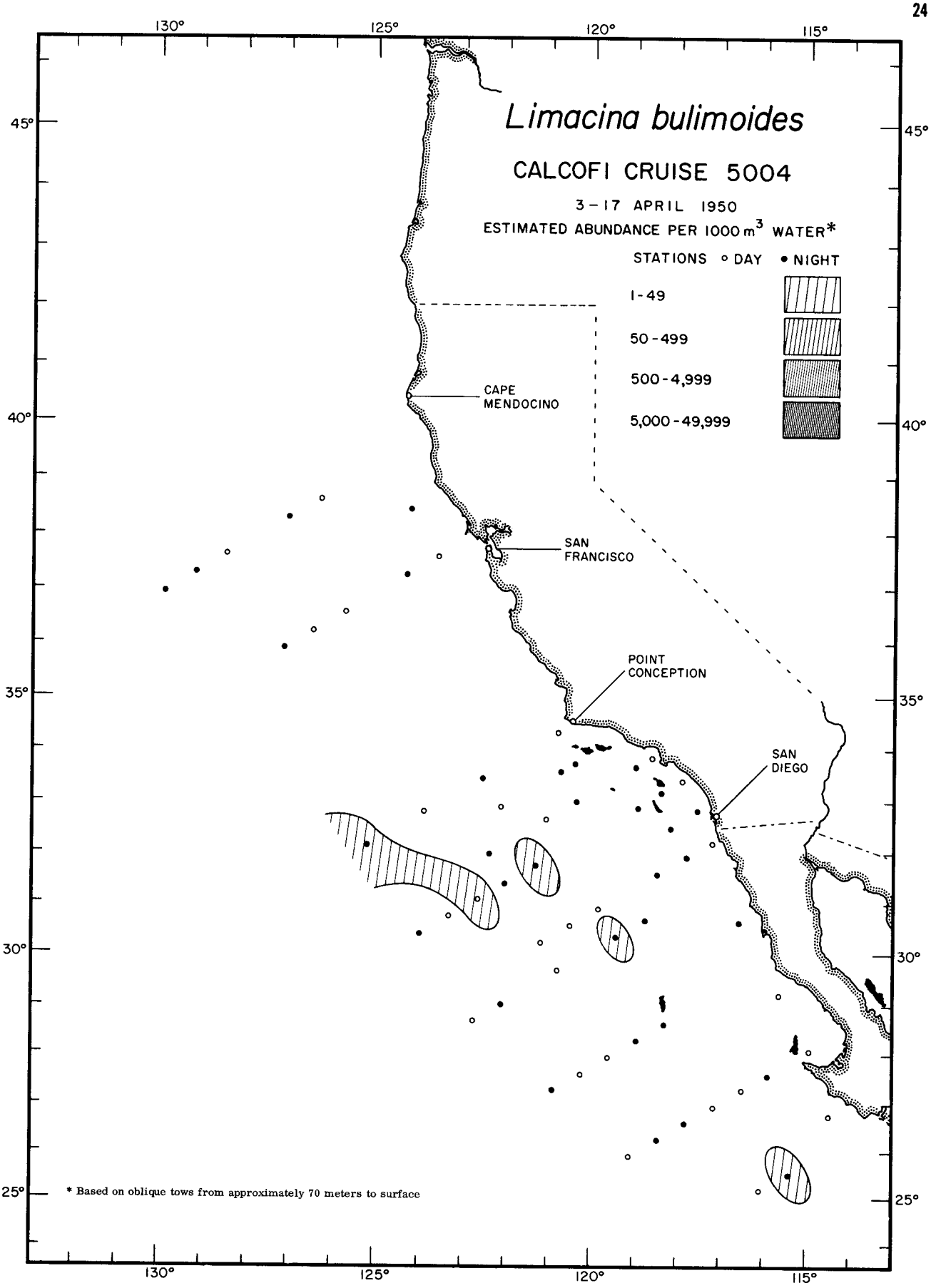
RANGE OF POSITIVE RECORDS




Thecosomata

*Limacina bulimoides*

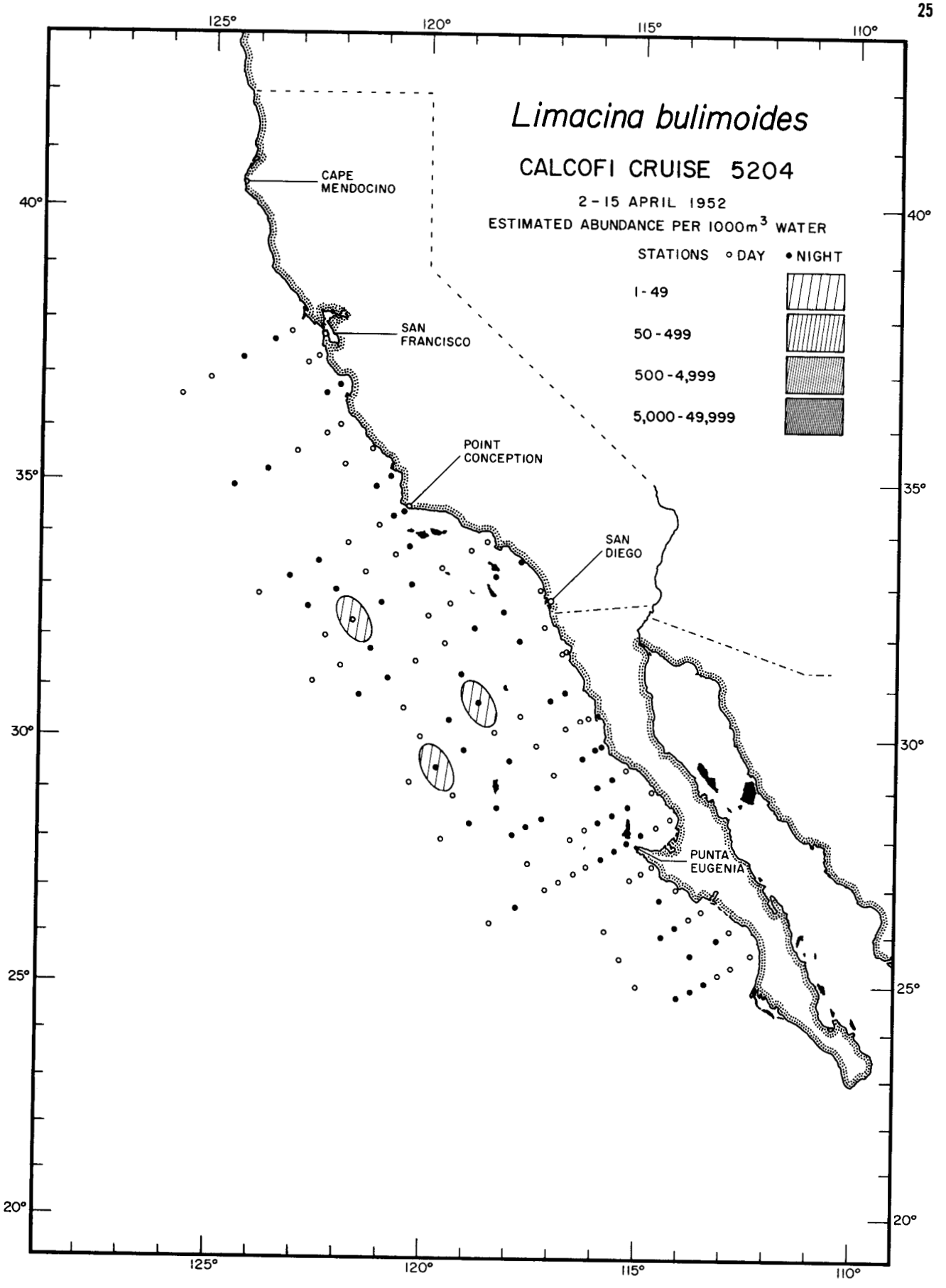
4911




Thecosomata

*Limacina bulimoides*

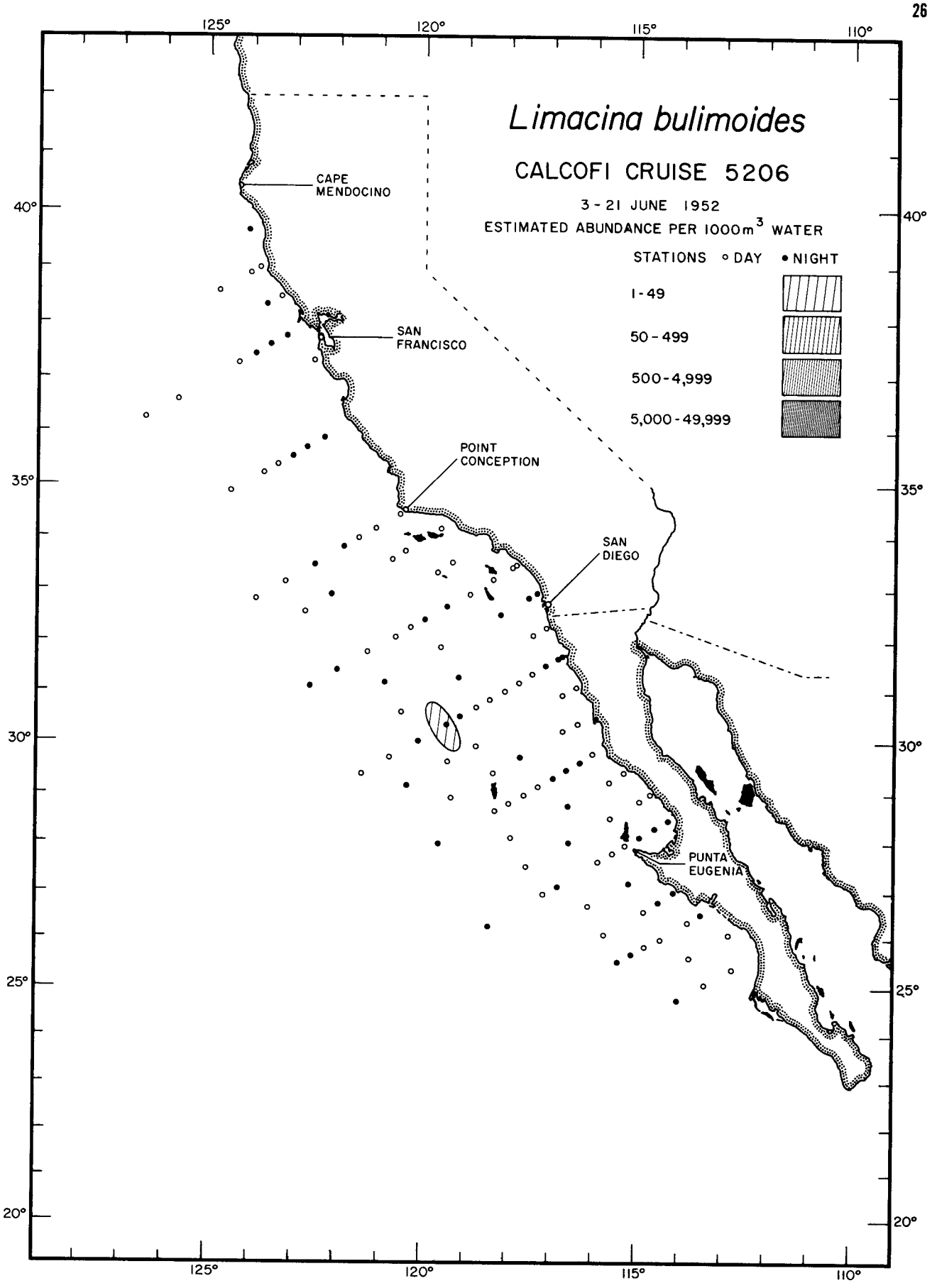
5004




Thecosomata

*Limacina bulimoides*

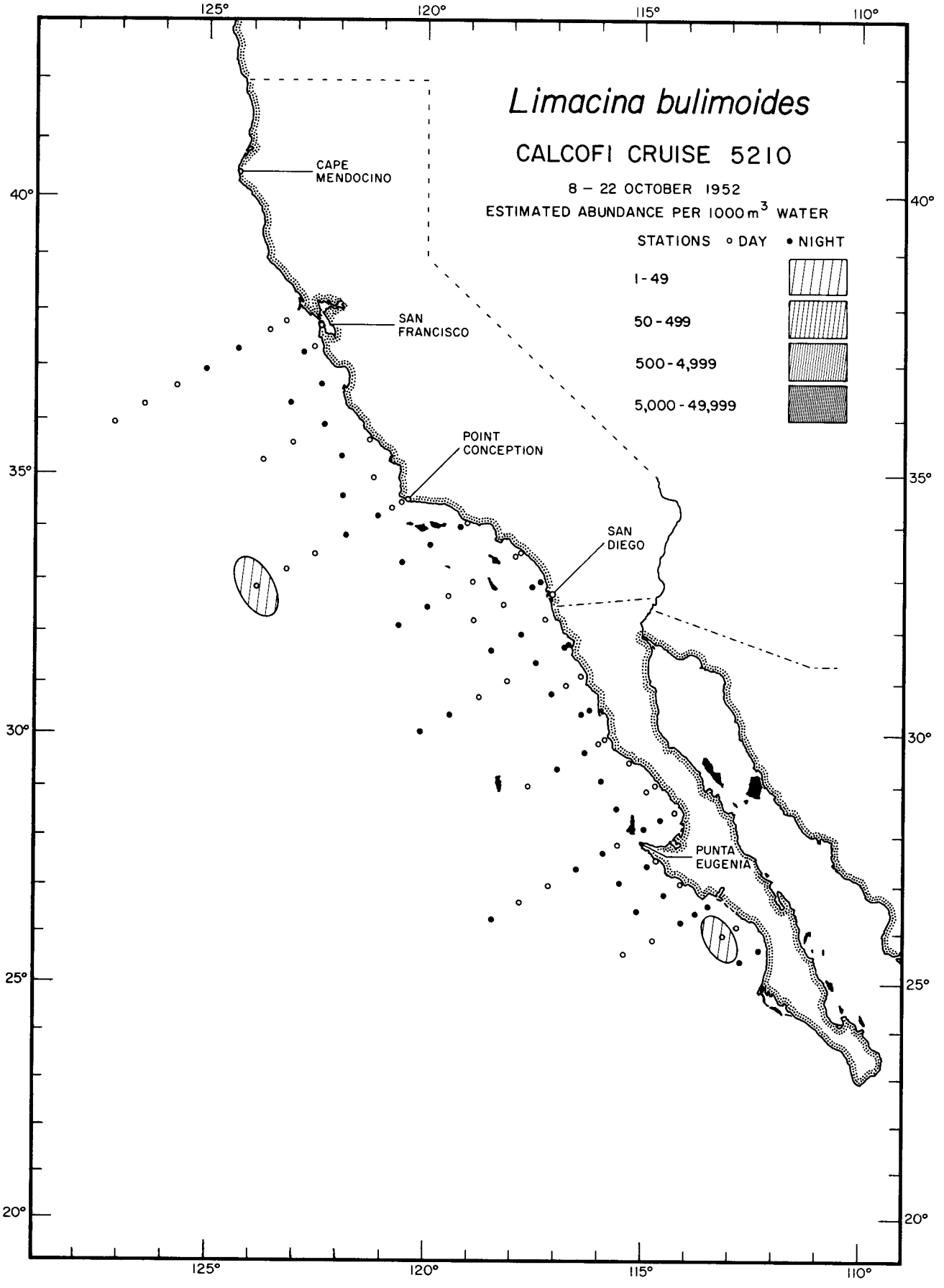
5204




Thecosomata

*Limacina bulimoides*

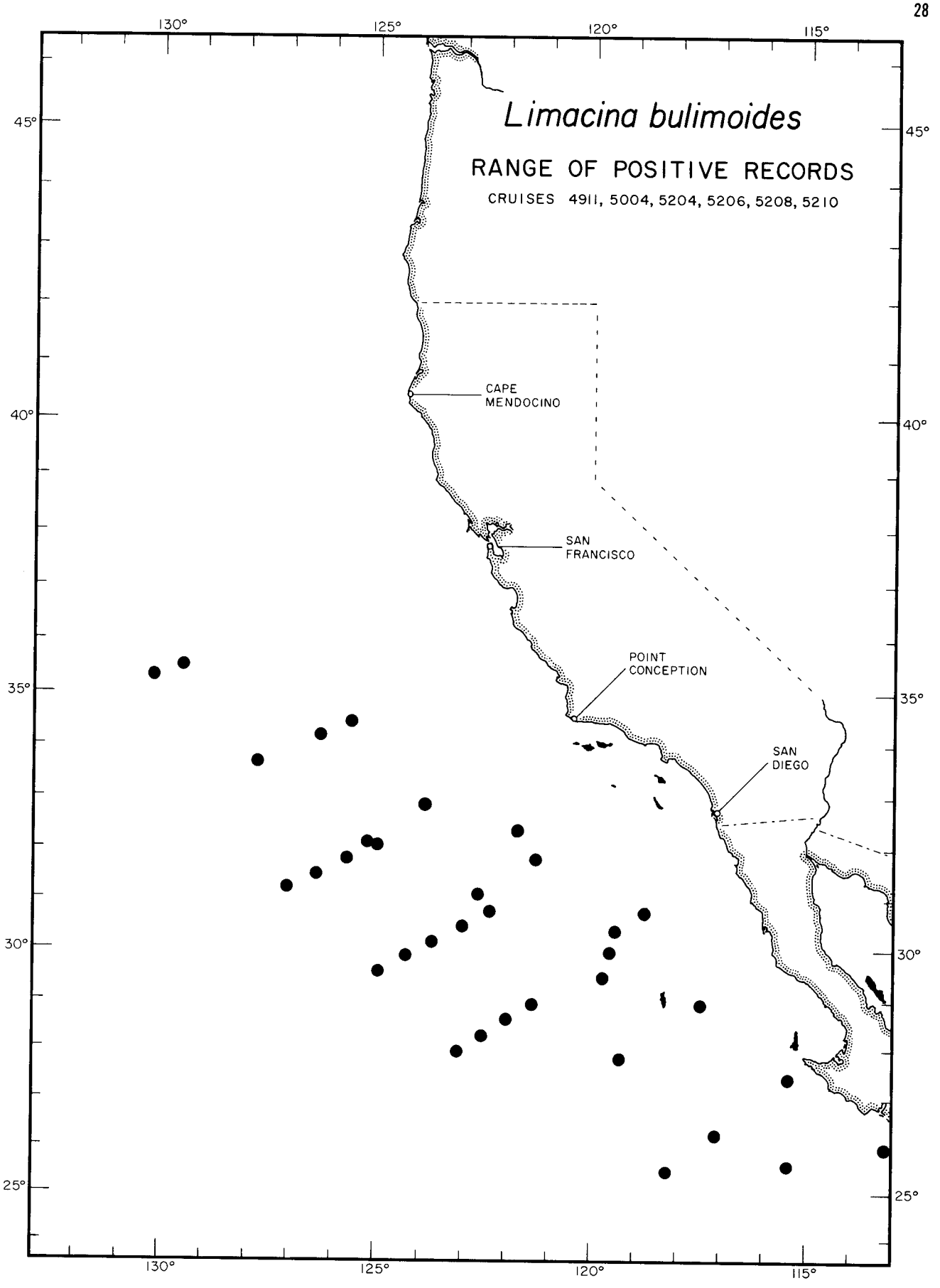
5206




Thecosomata

*Limacina bulimoides*

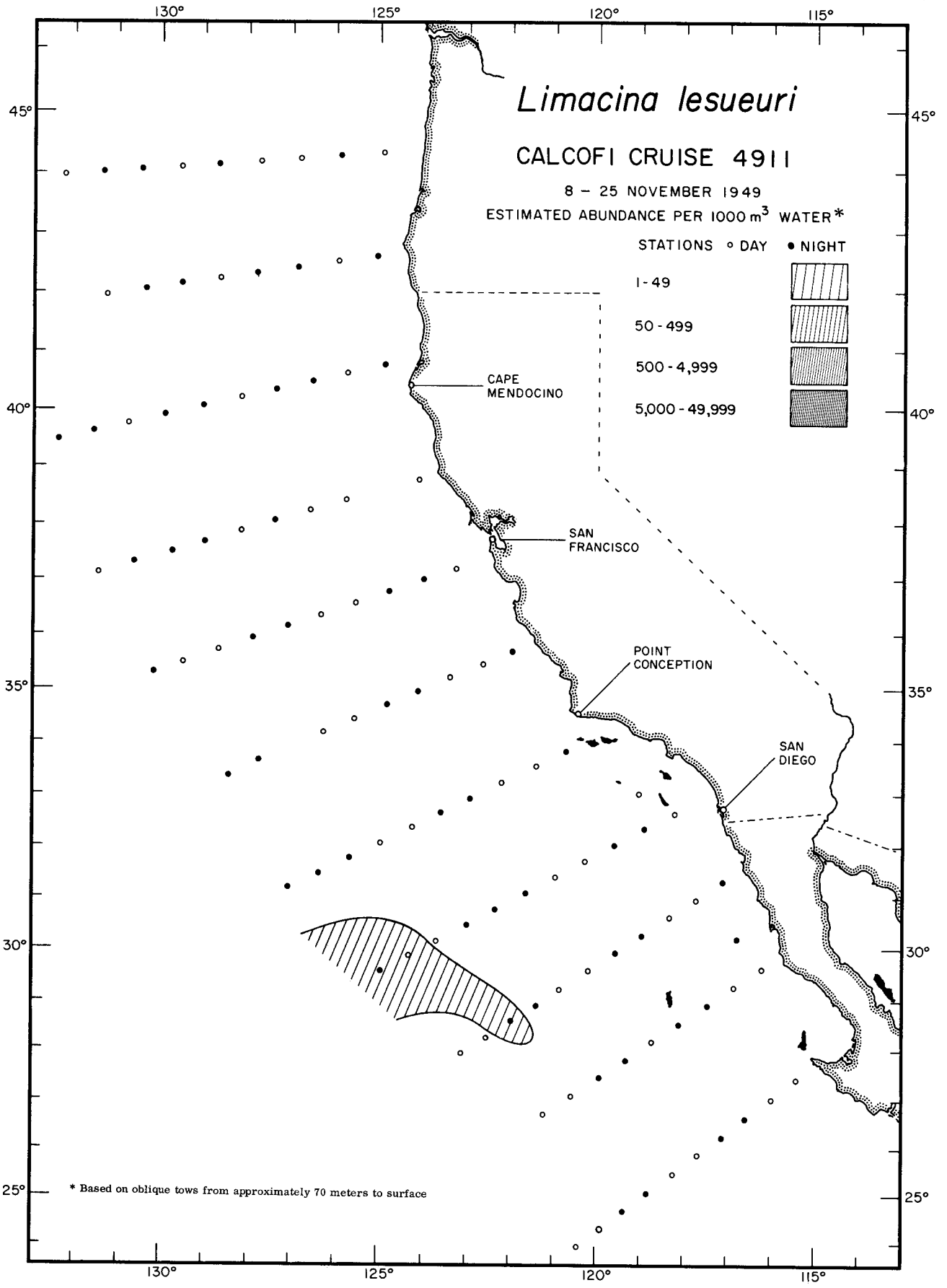
5210




Thecosomata

*Limacina bulimoides*

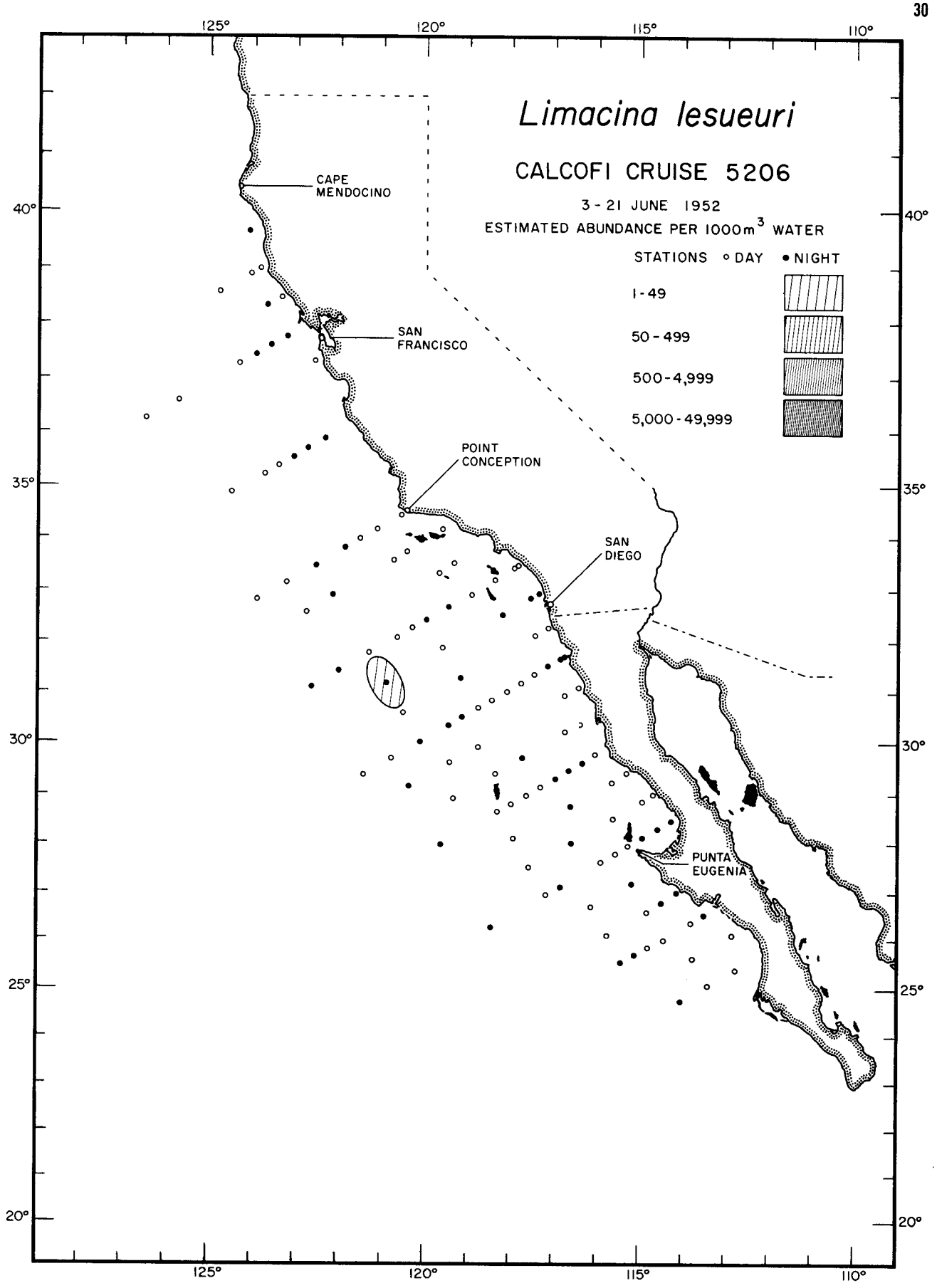
RANGE OF POSITIVE RECORDS




Thecosomata

*Limacina lesueuri*

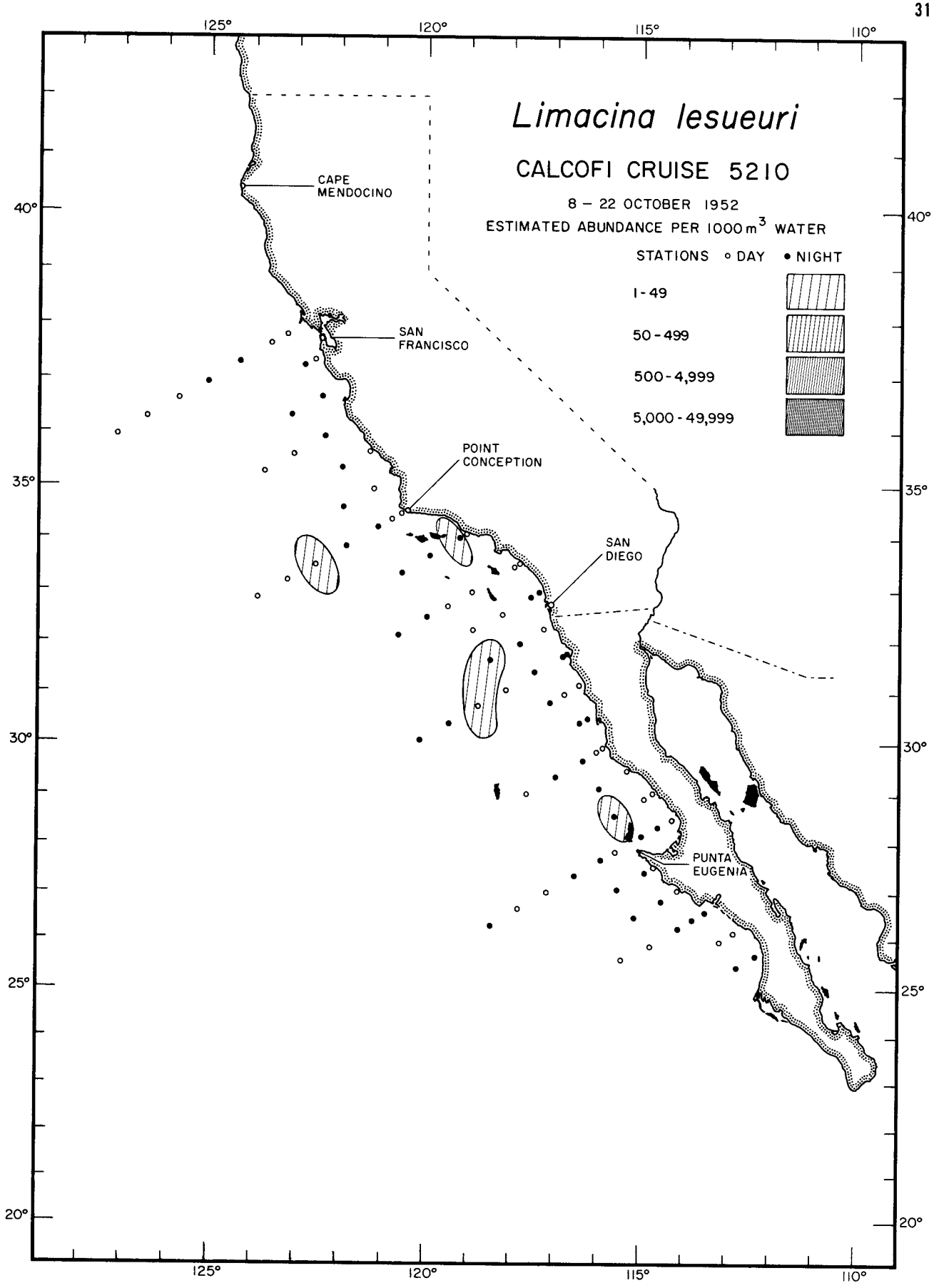
4911




Thecosomata

*Limacina lesueuri*

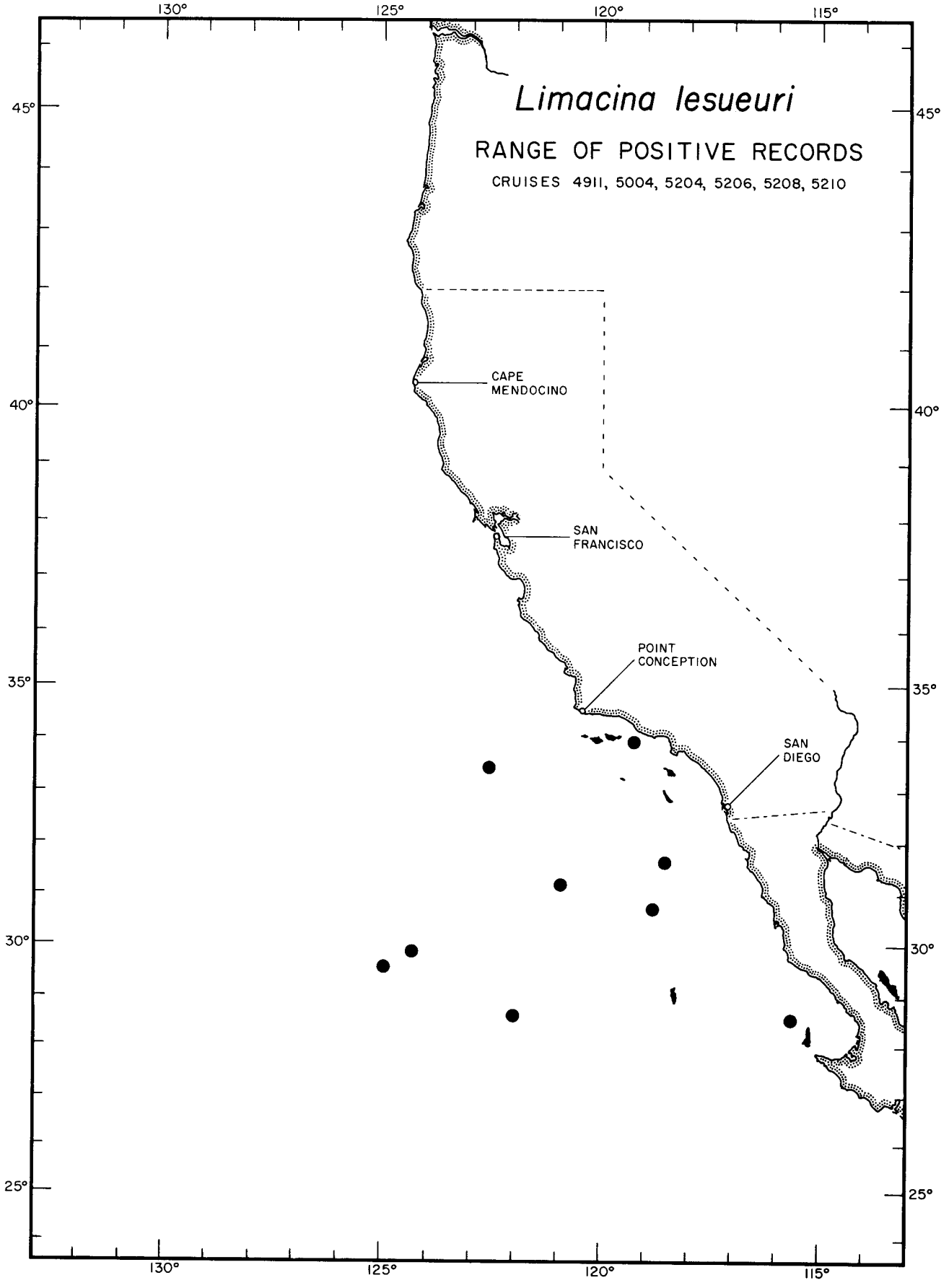
5206




Thecosomata

*Limacina lesueuri*

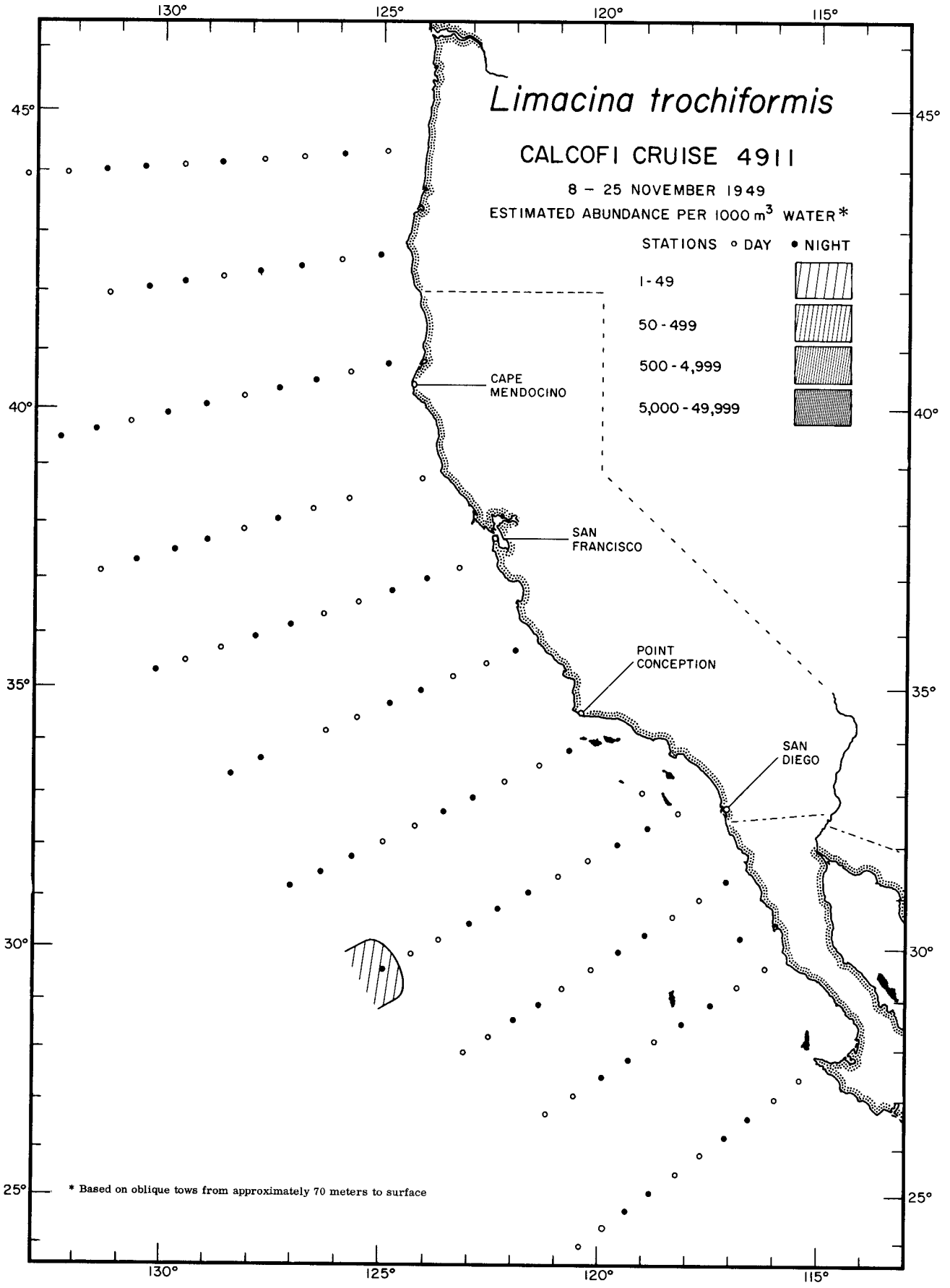
5210




Thecosomata

*Limacina lesueuri*

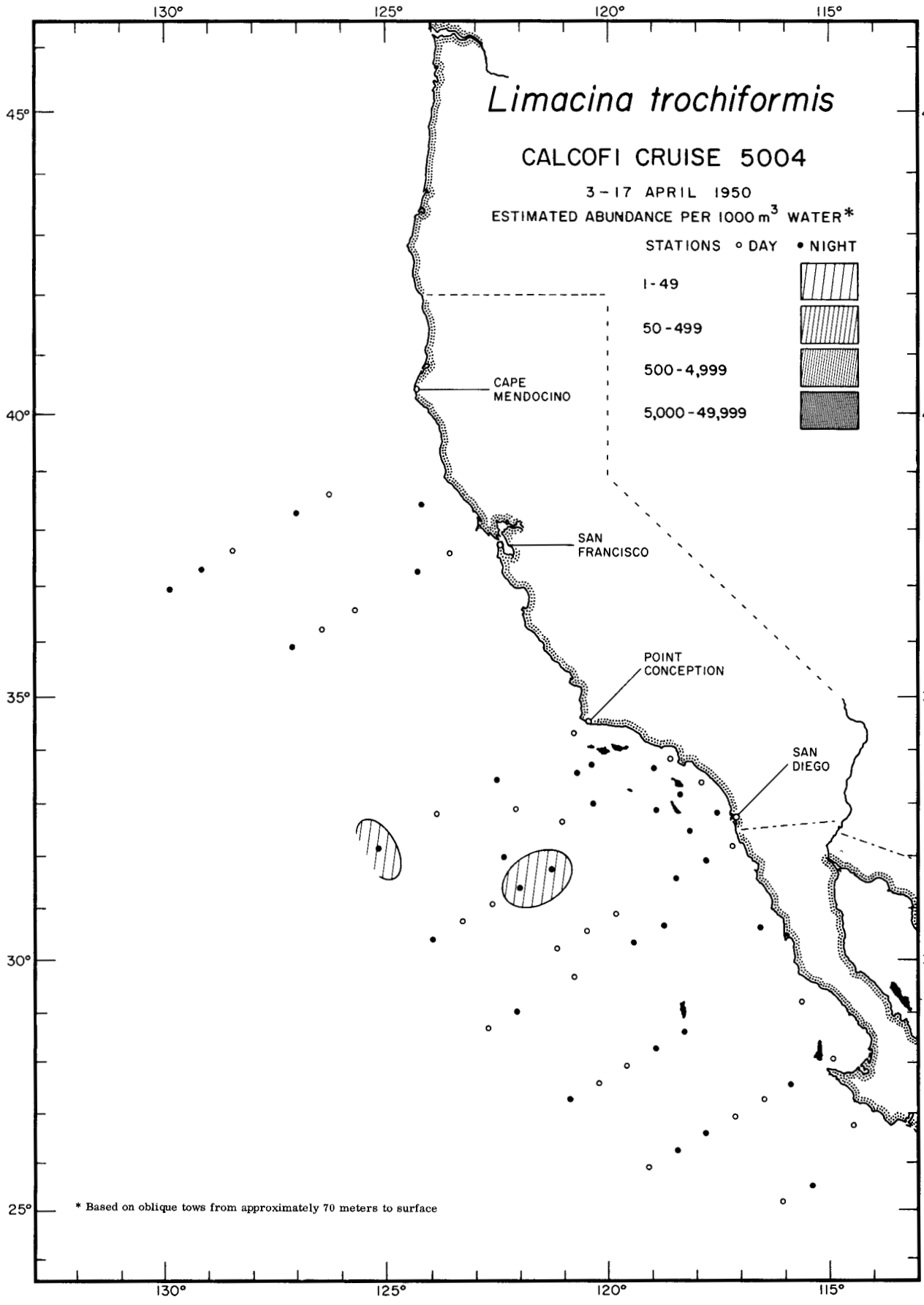
RANGE OF POSITIVE RECORDS




Thecosomata

*Limacina trochiformis*

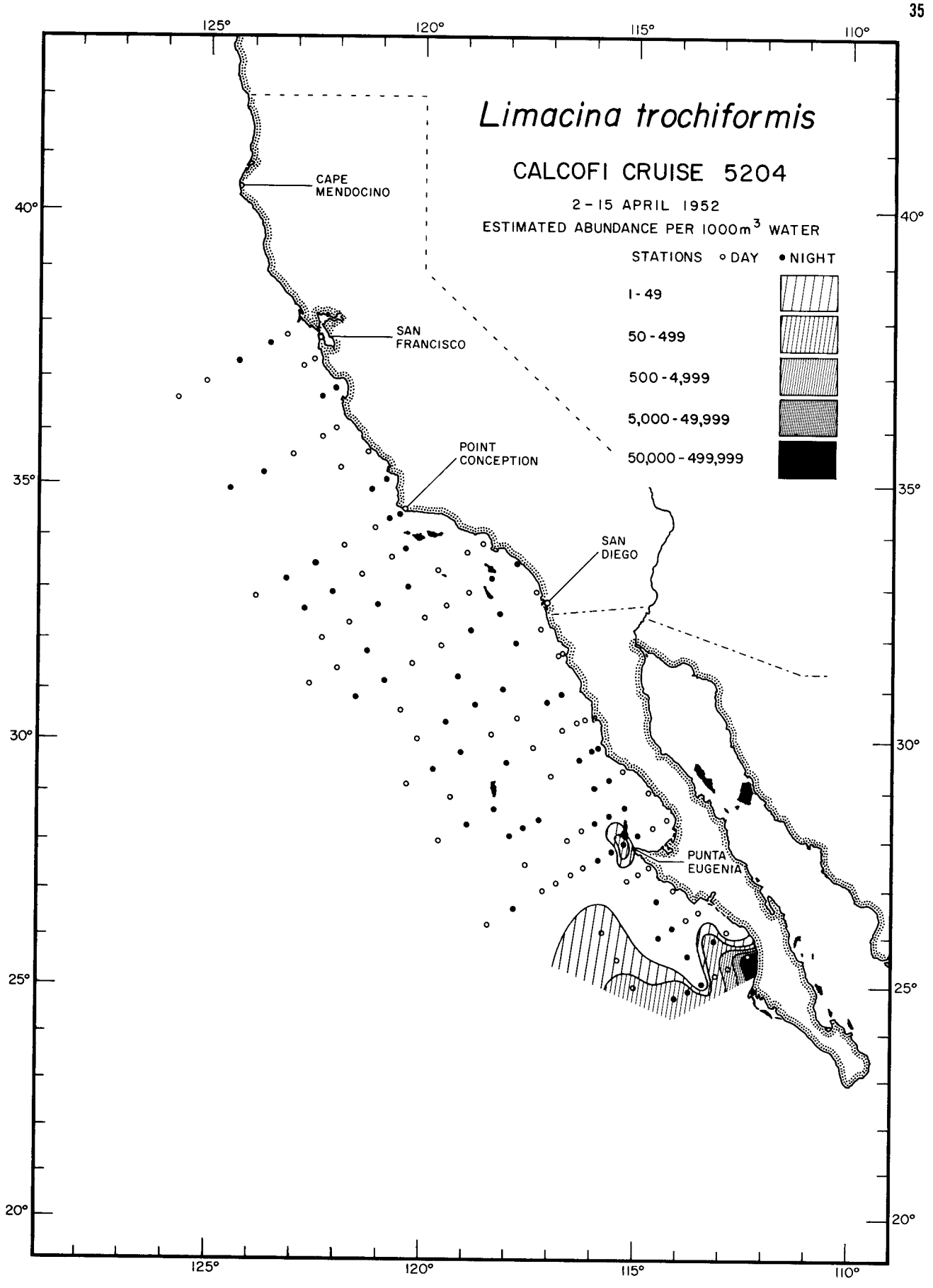
4911




Thecosomata

*Limacina trochiformis*

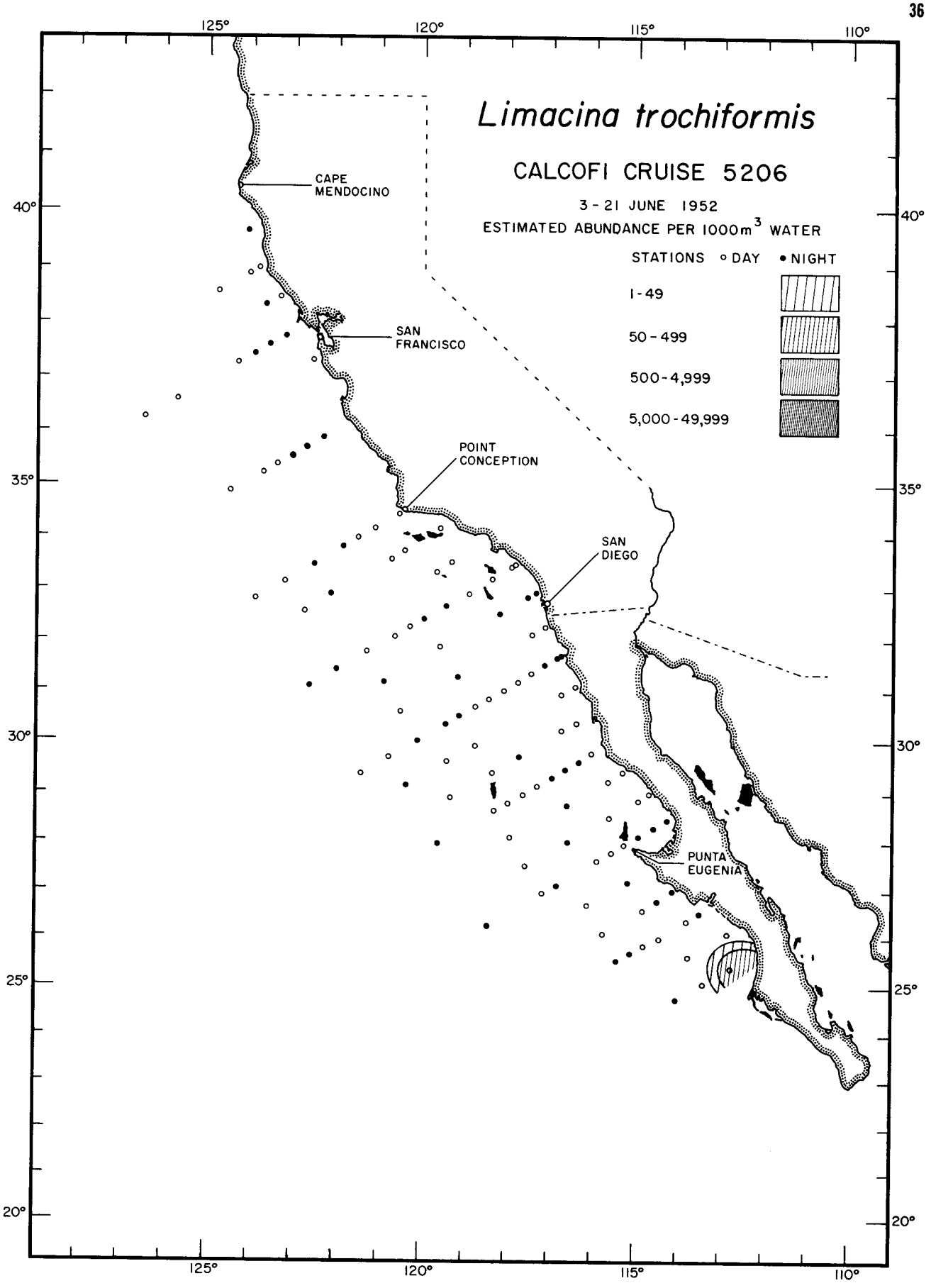
5004




Thecosomata

*Limacina trochiformis*

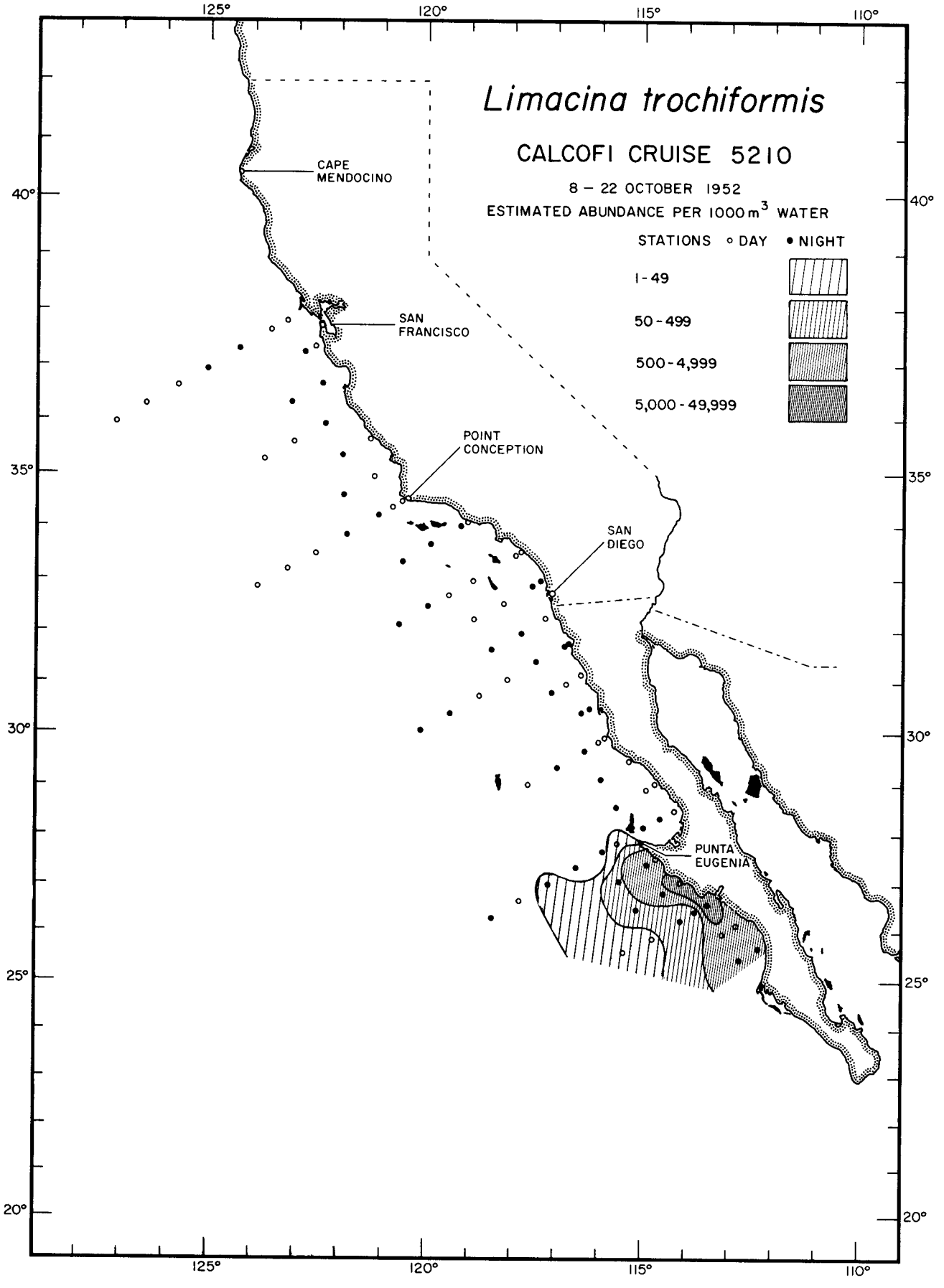
5204




Thecosomata

*Limacina trochiformis*

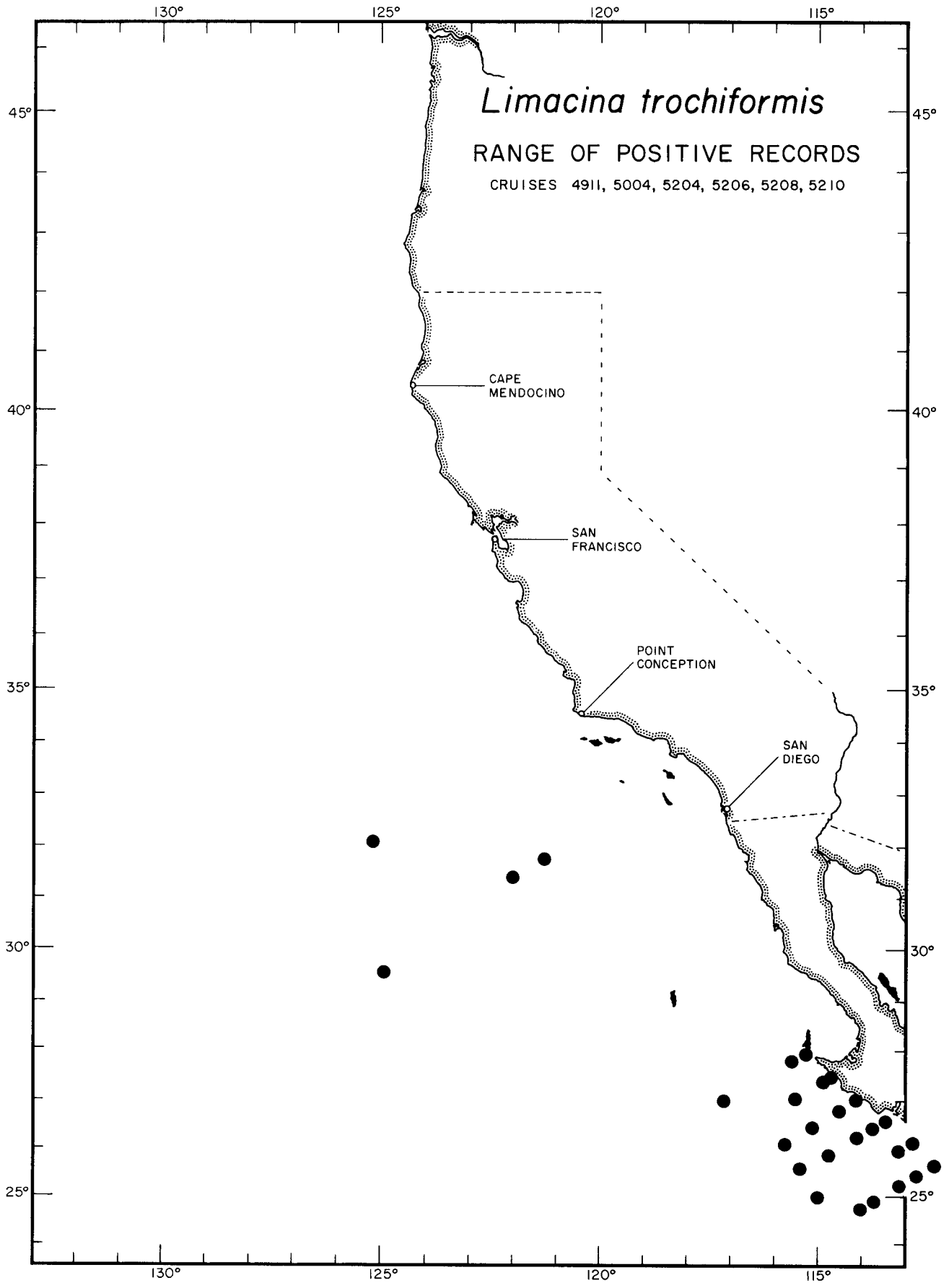
5206




Thecosomata

*Limacina trochiformis*

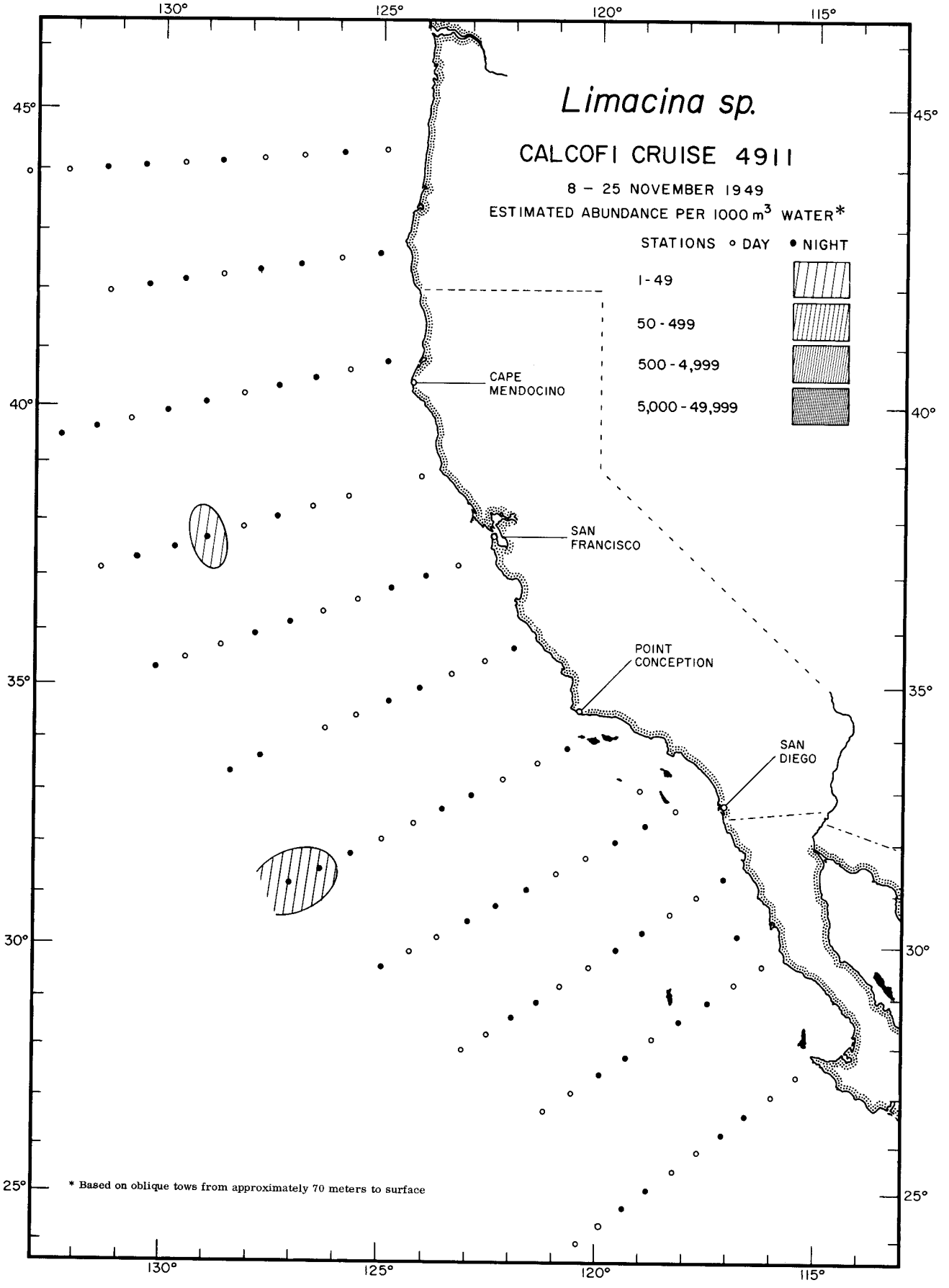
5210




Thecosomata

*Limacina trochiformis*

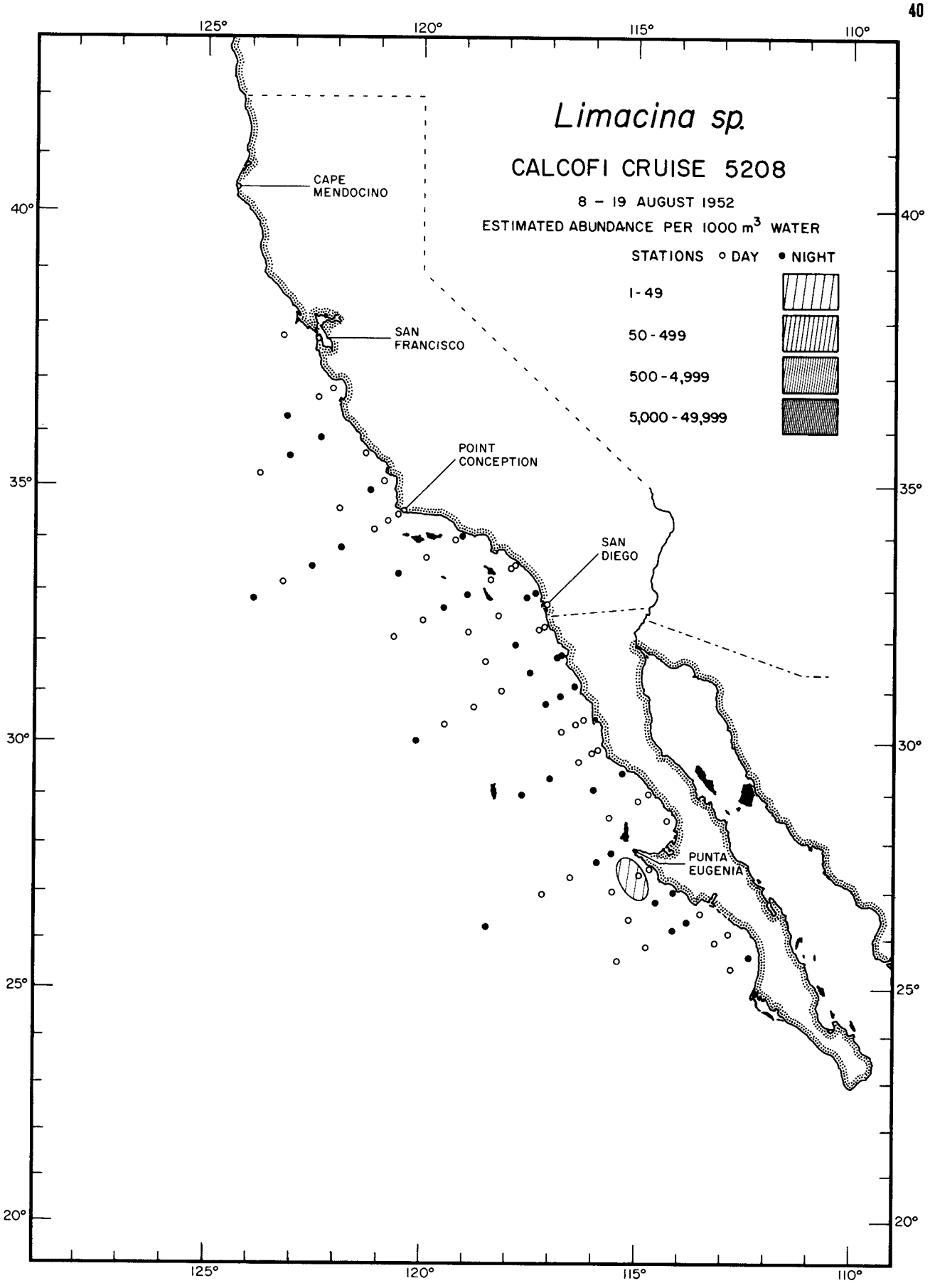
RANGE OF POSITIVE RECORDS




Thecosomata

*Limacina sp.*

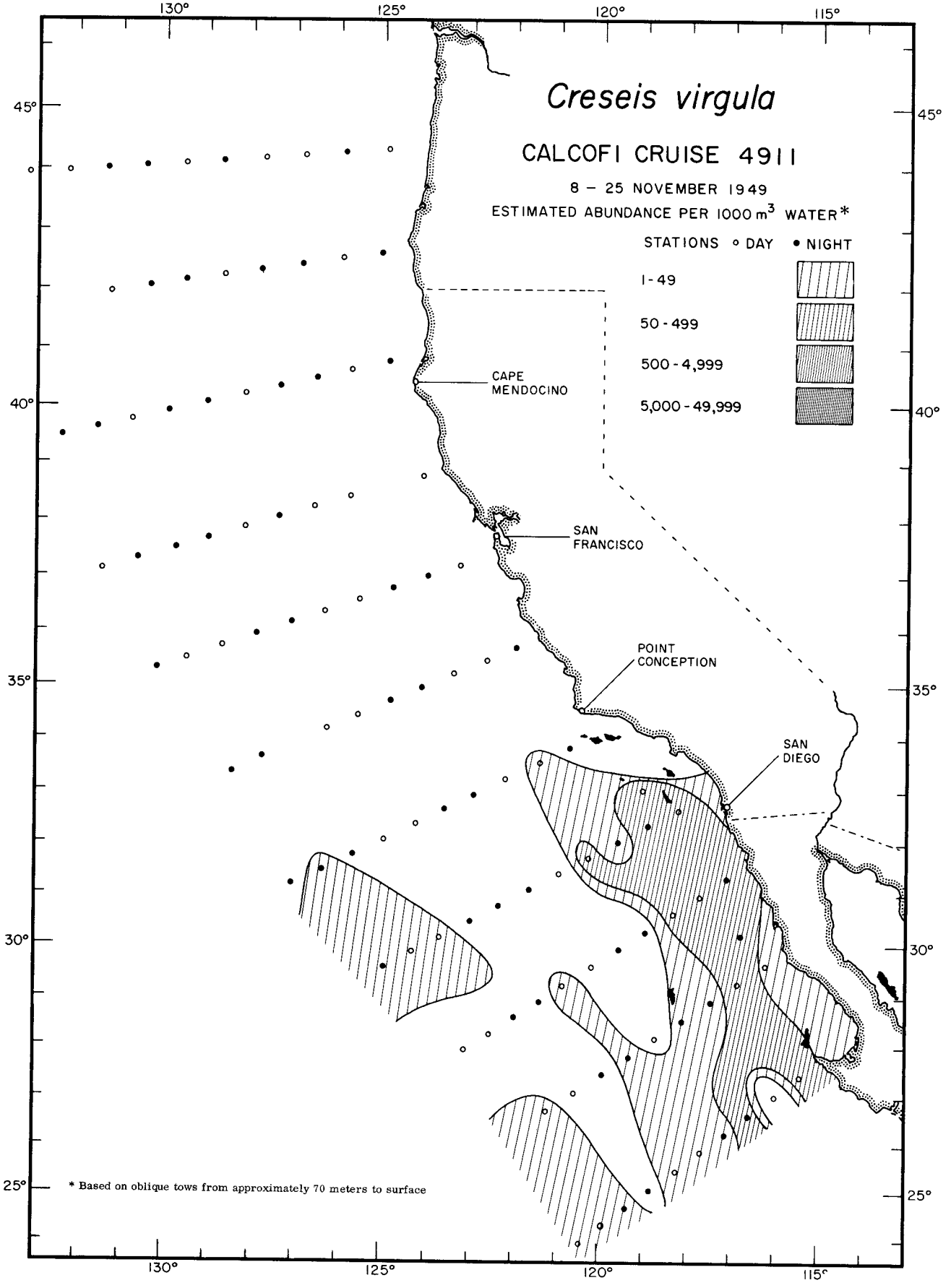
4911




Thecosomata

*Limacina sp.*

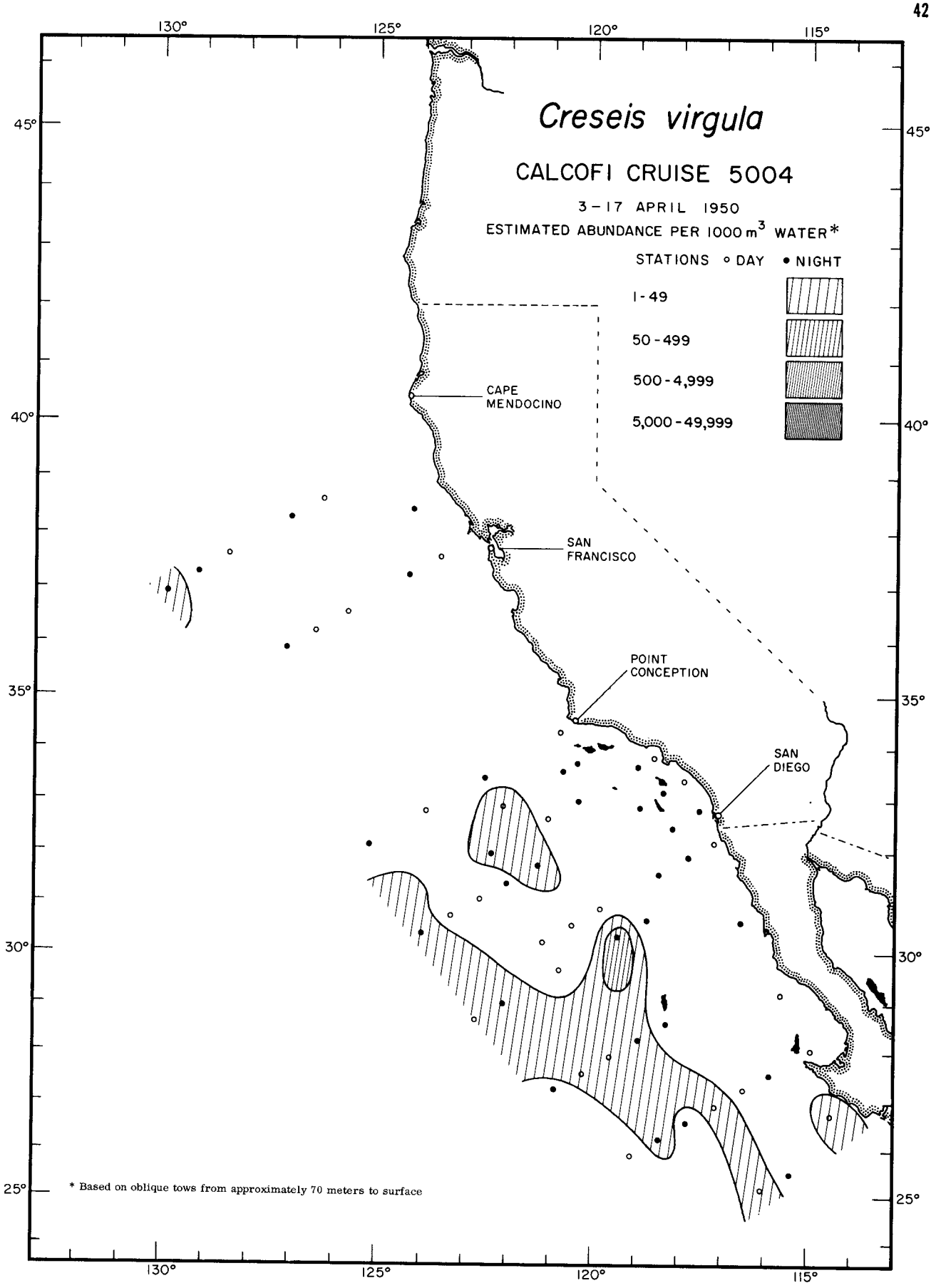
5208




Thecosomata

*Creseis virgula*

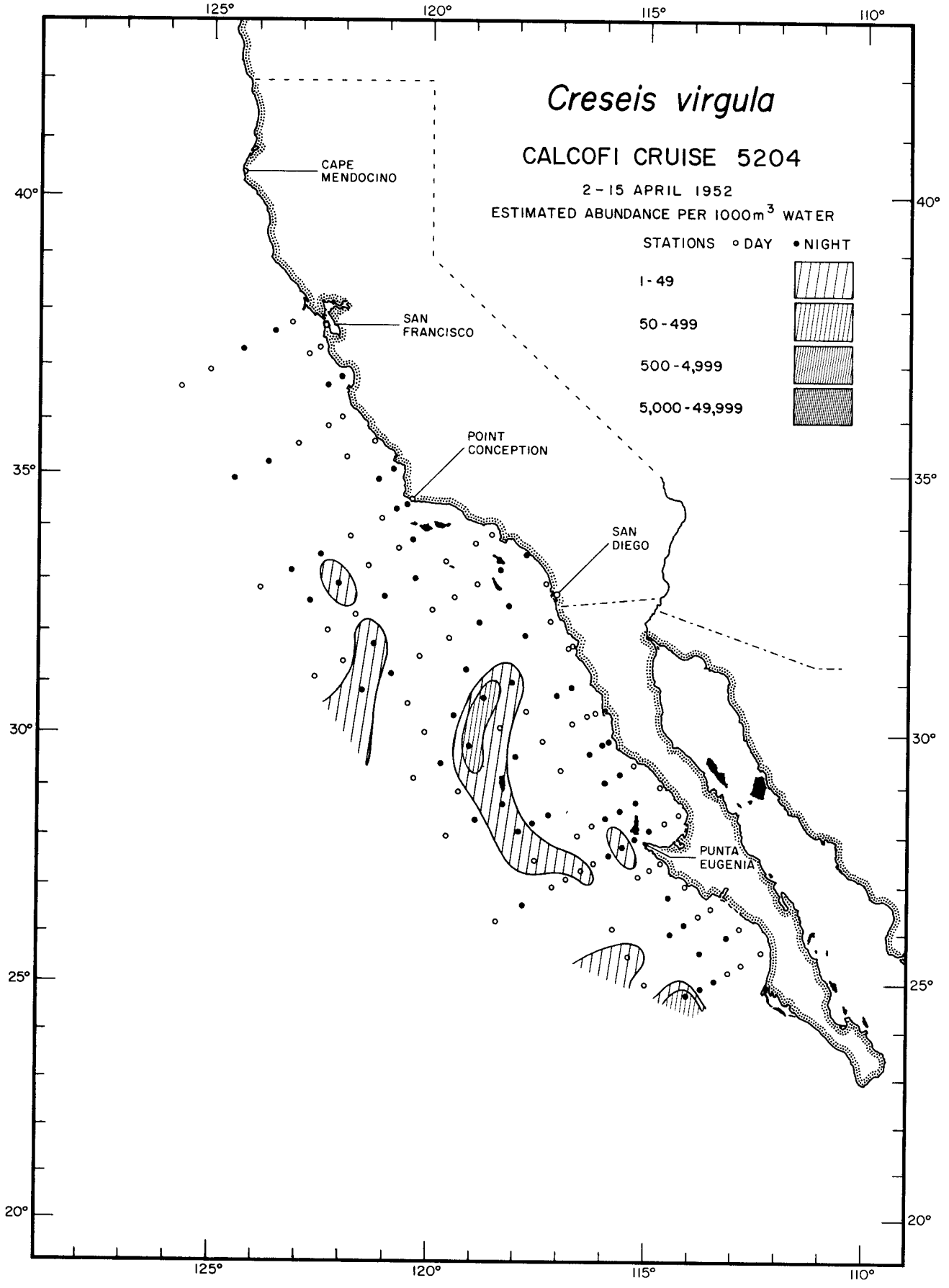
4911




Thecosomata

*Creseis virgula*

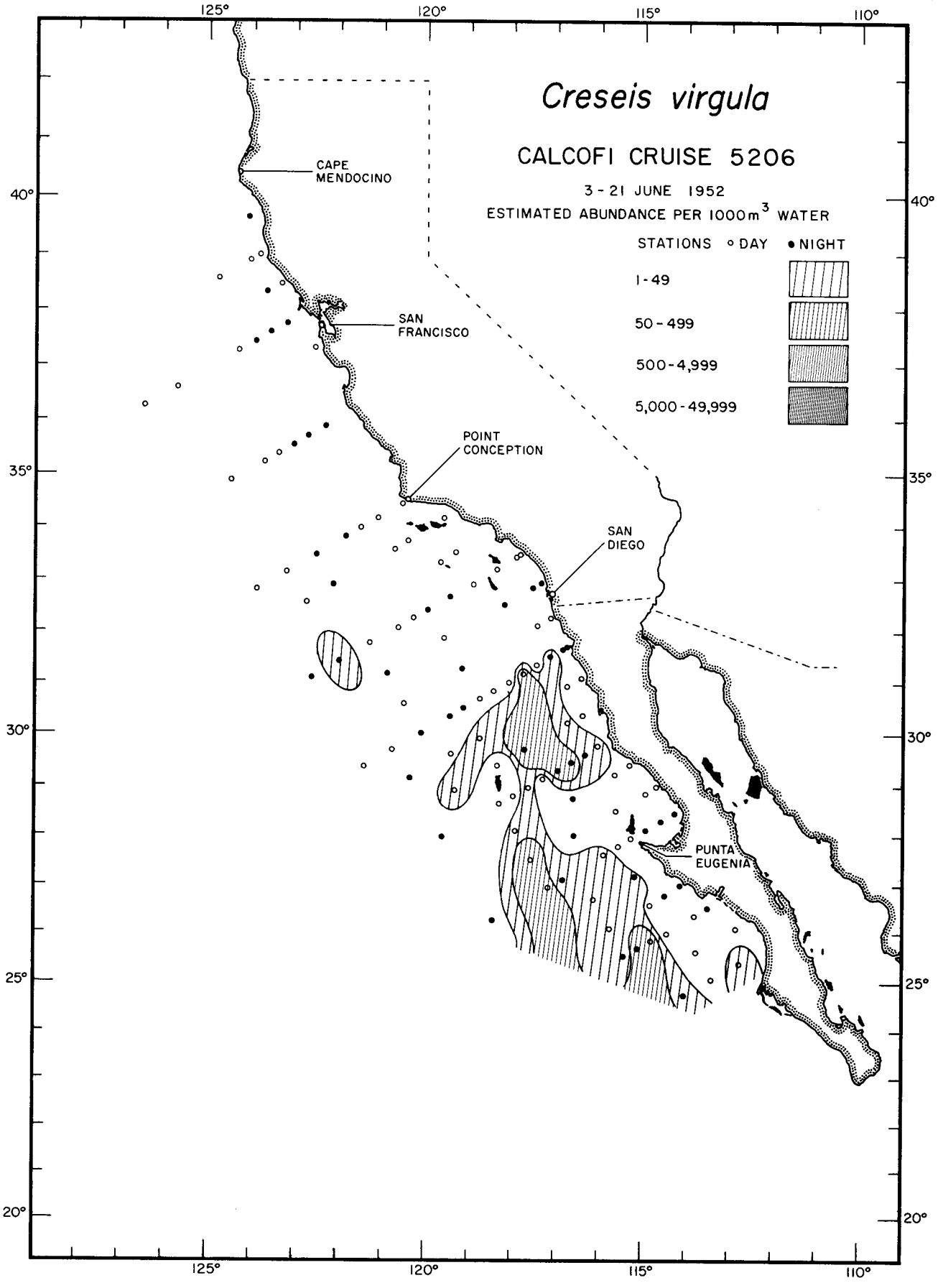
5004




Thecosomata

*Creseis virgula*

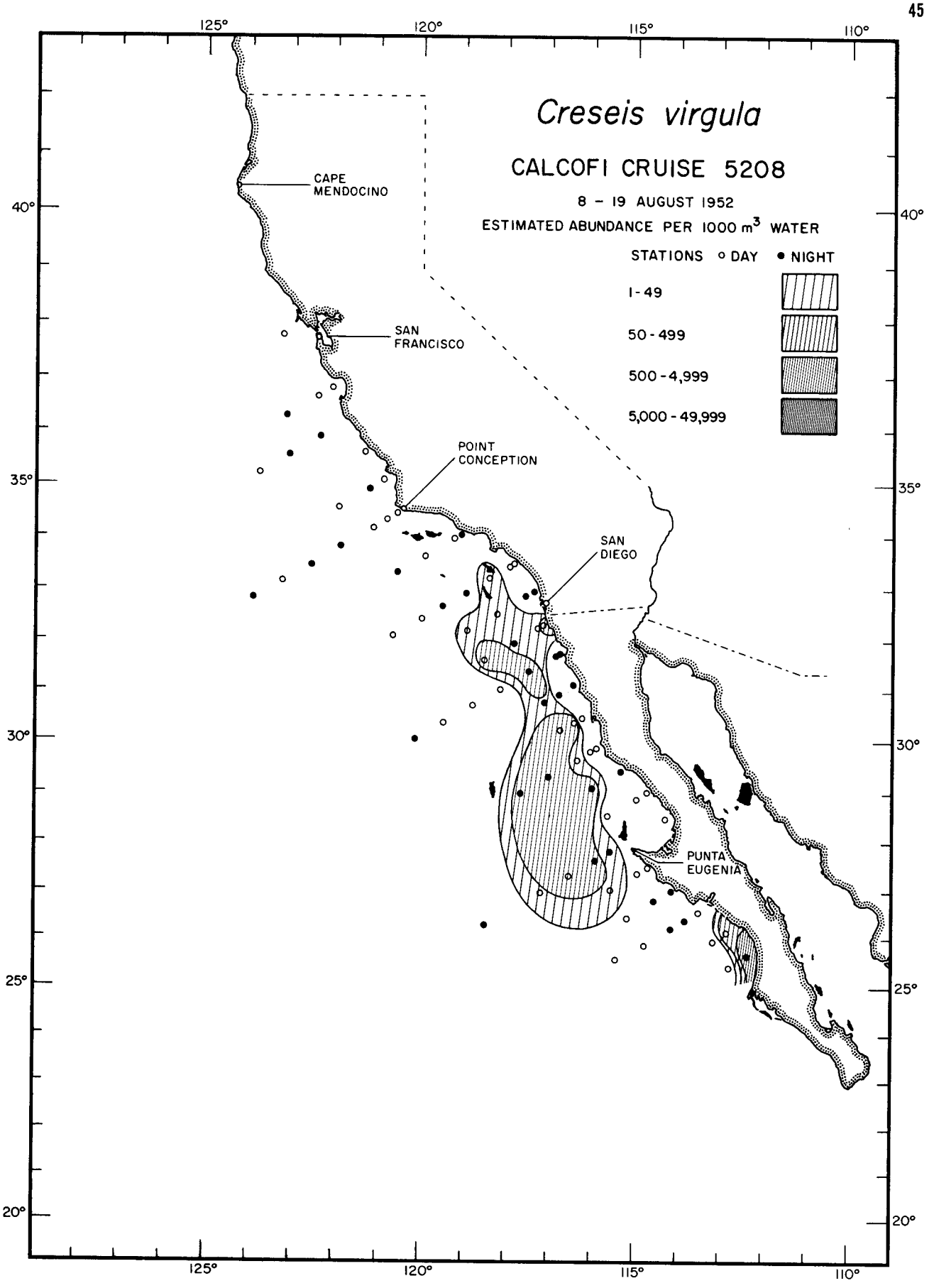
5204




Thecosomata

*Creseis virgula*

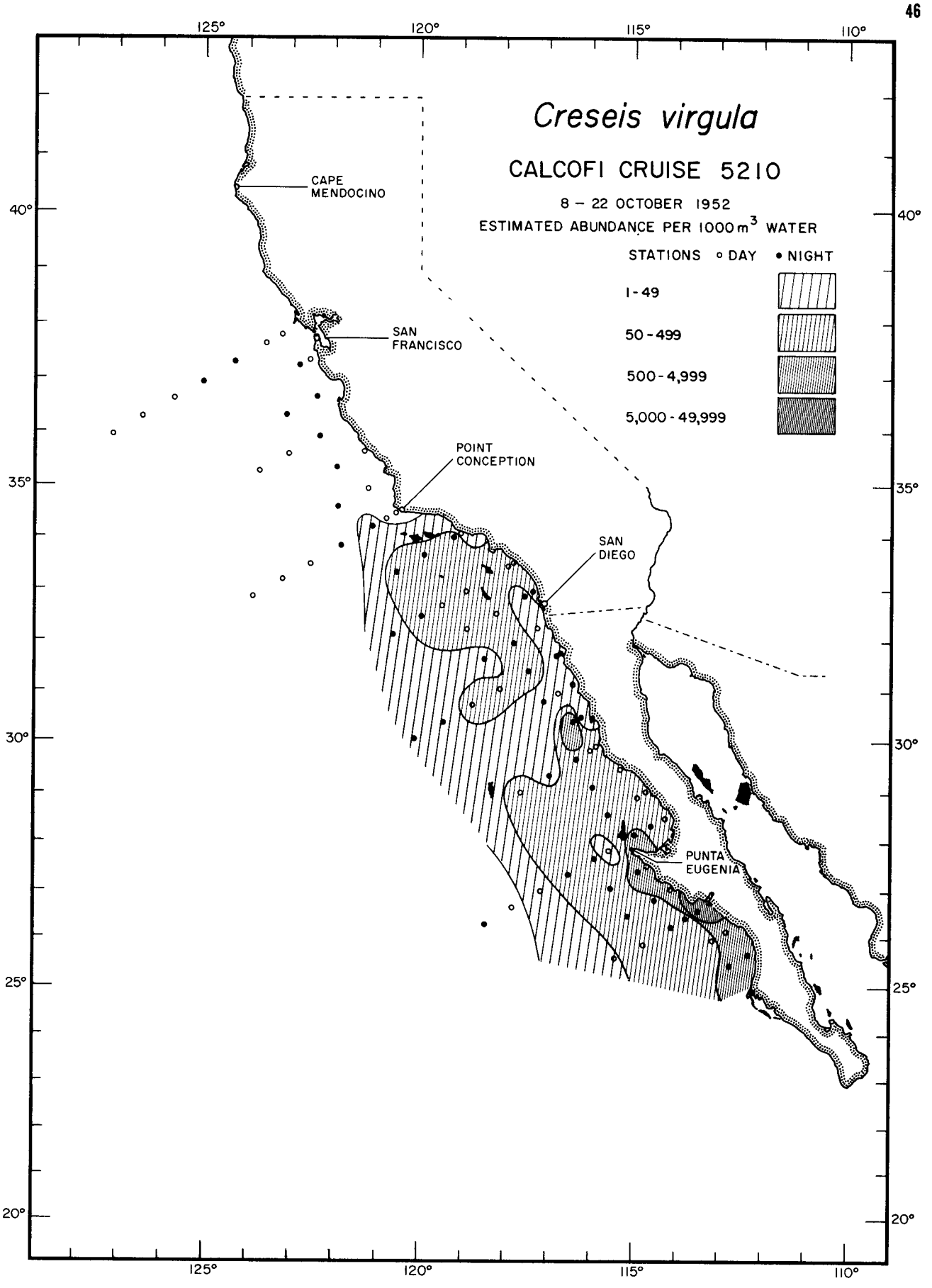
5206




Thecosomata

*Creseis virgula*

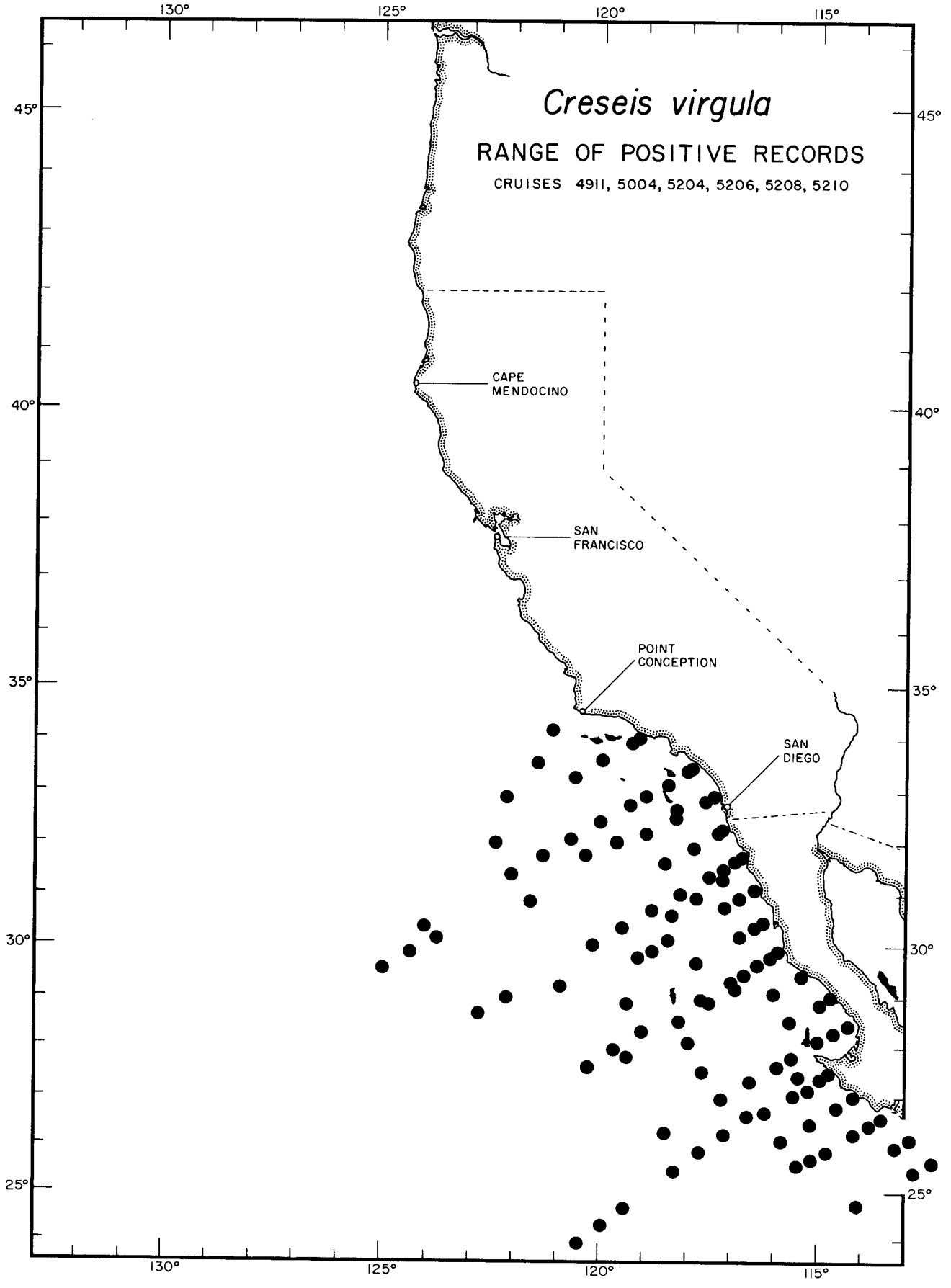
5208




Thecosomata

*Creseis virgula*

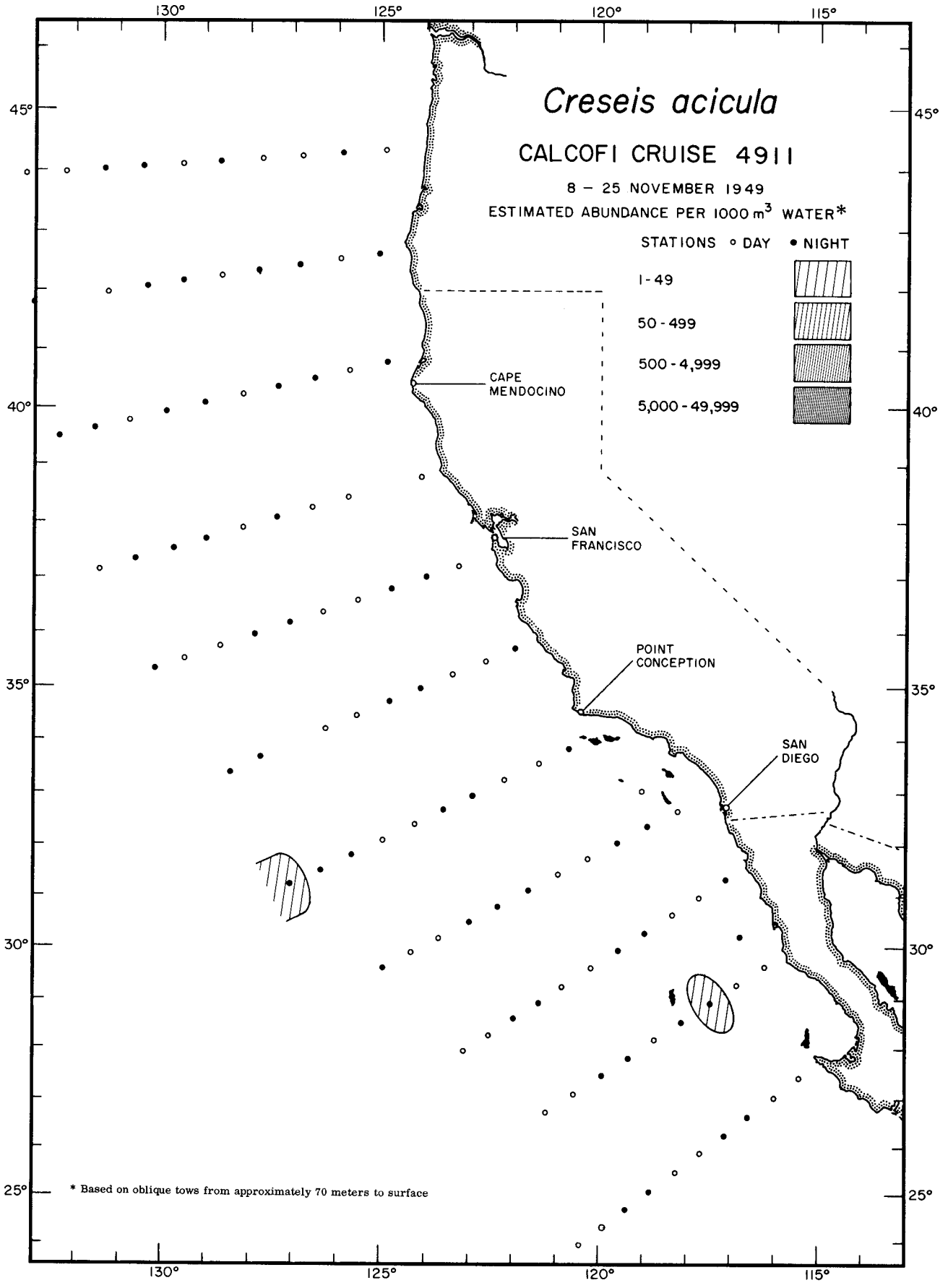
5210




Thecosomata

*Creseis virgula*

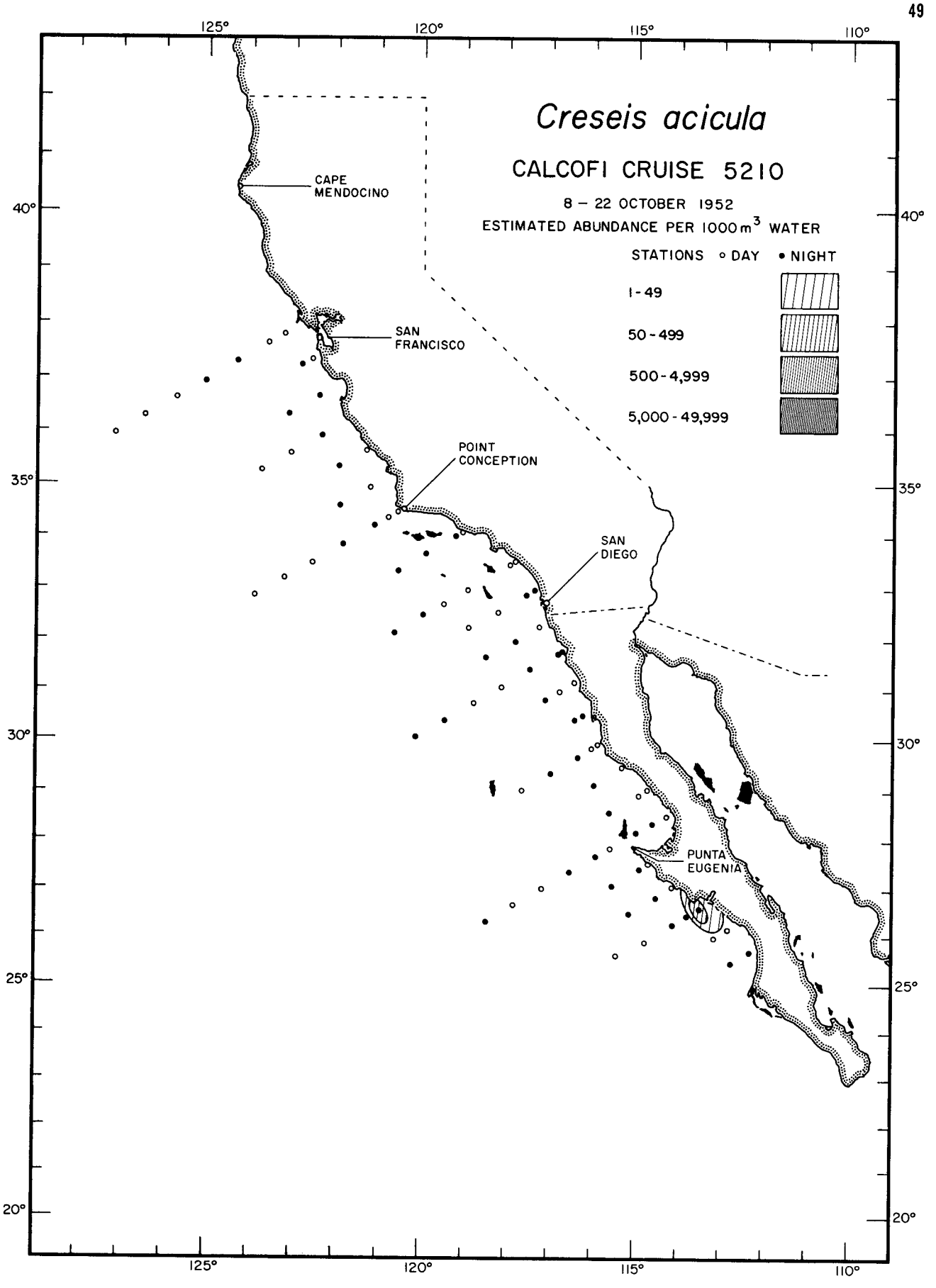
RANGE OF POSITIVE RECORDS




Thecosomata

*Creseis acicula*

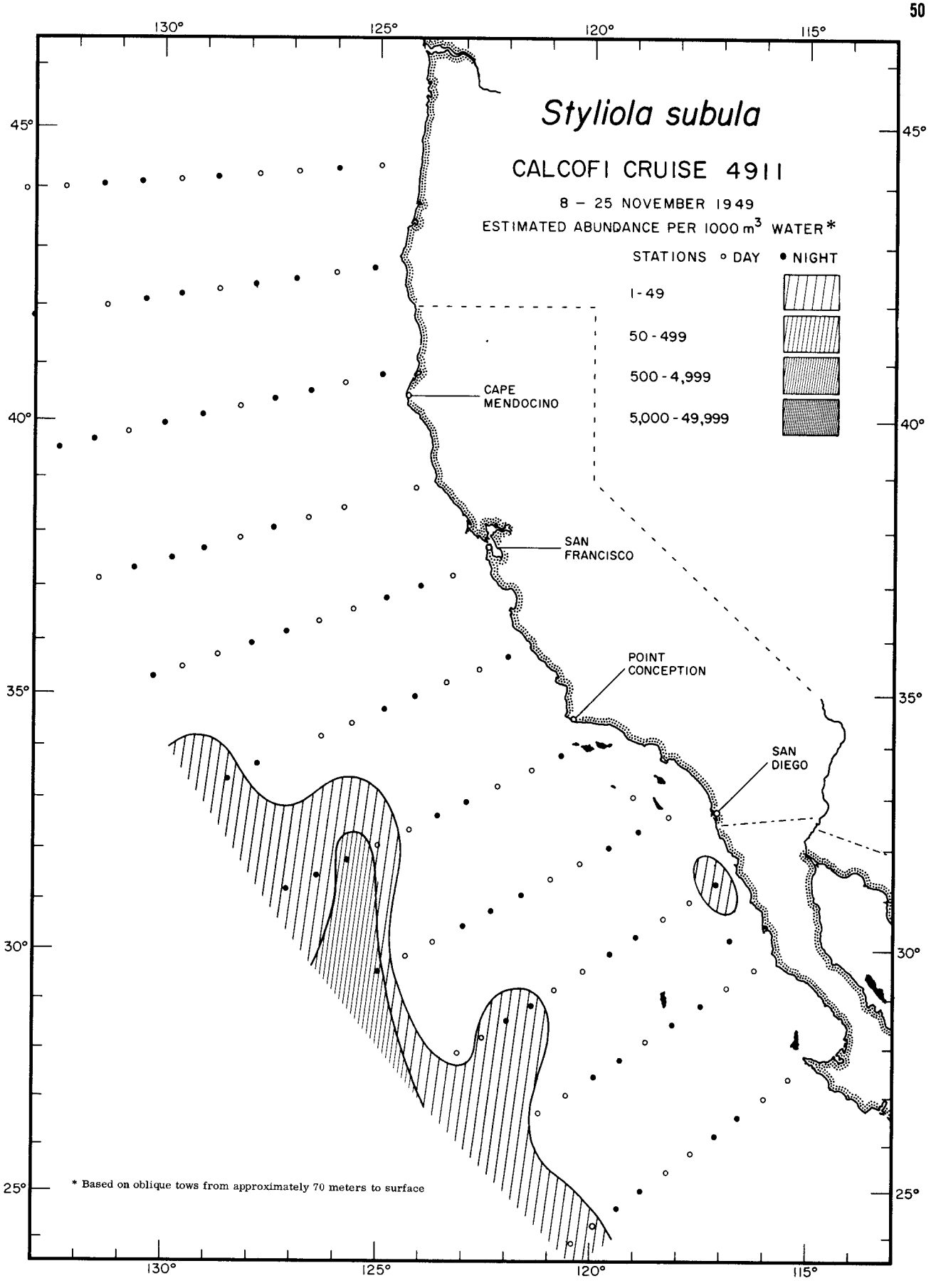
4911




Thecosomata

*Creseis acicula*

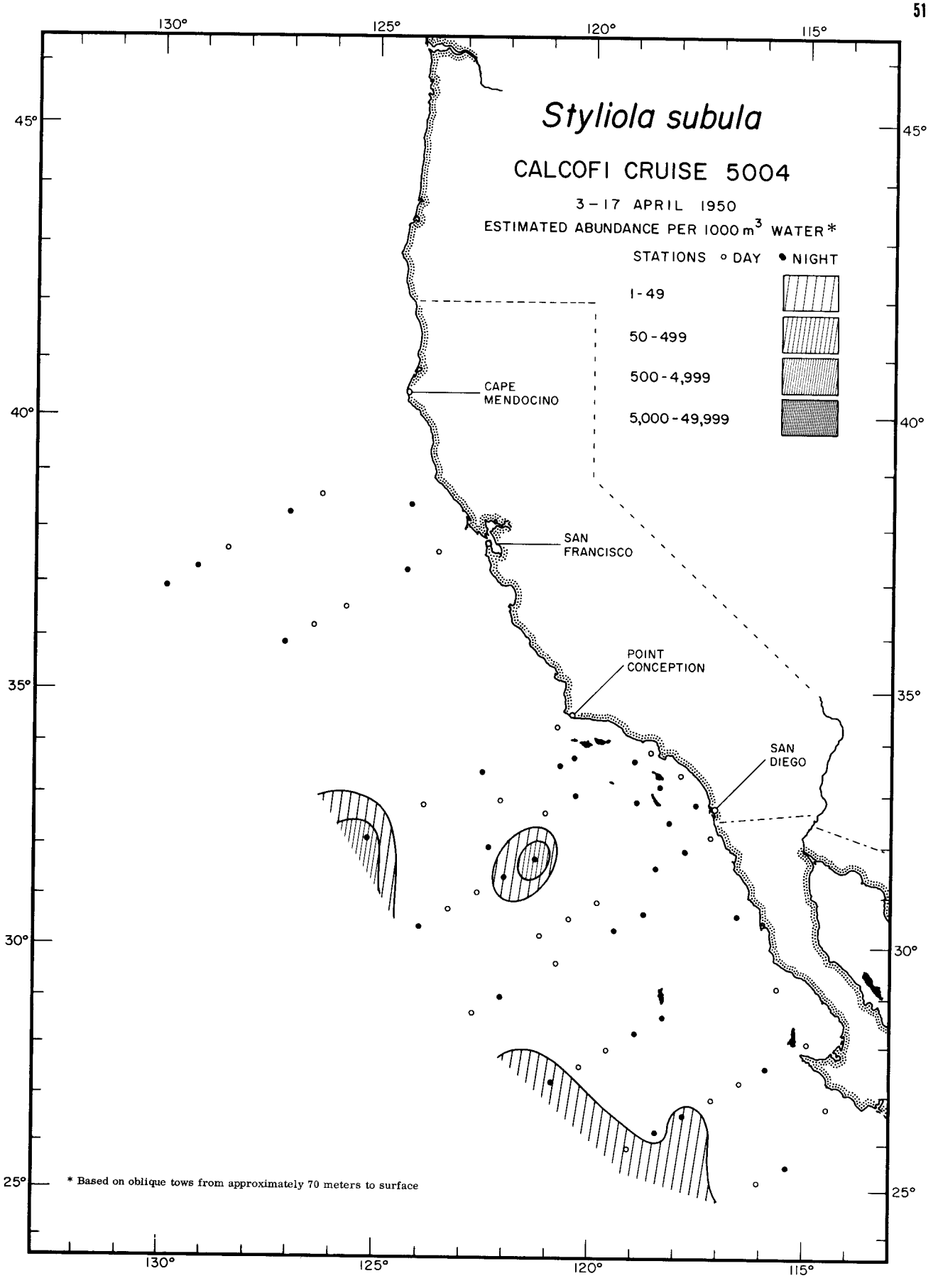
5210




Thecosomata

*Styliola subula*

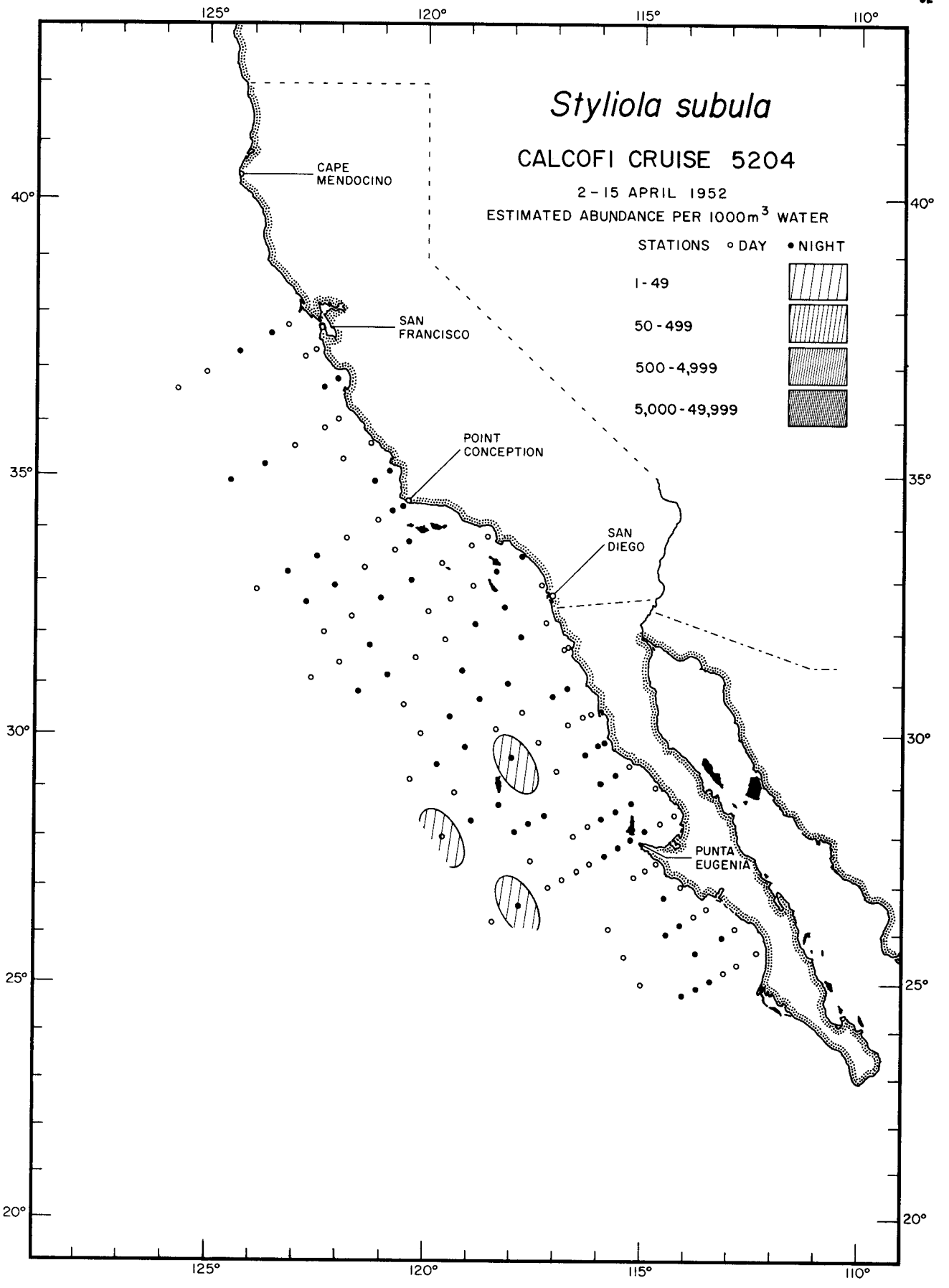
4911




Thecosomata

*Styliola subula*

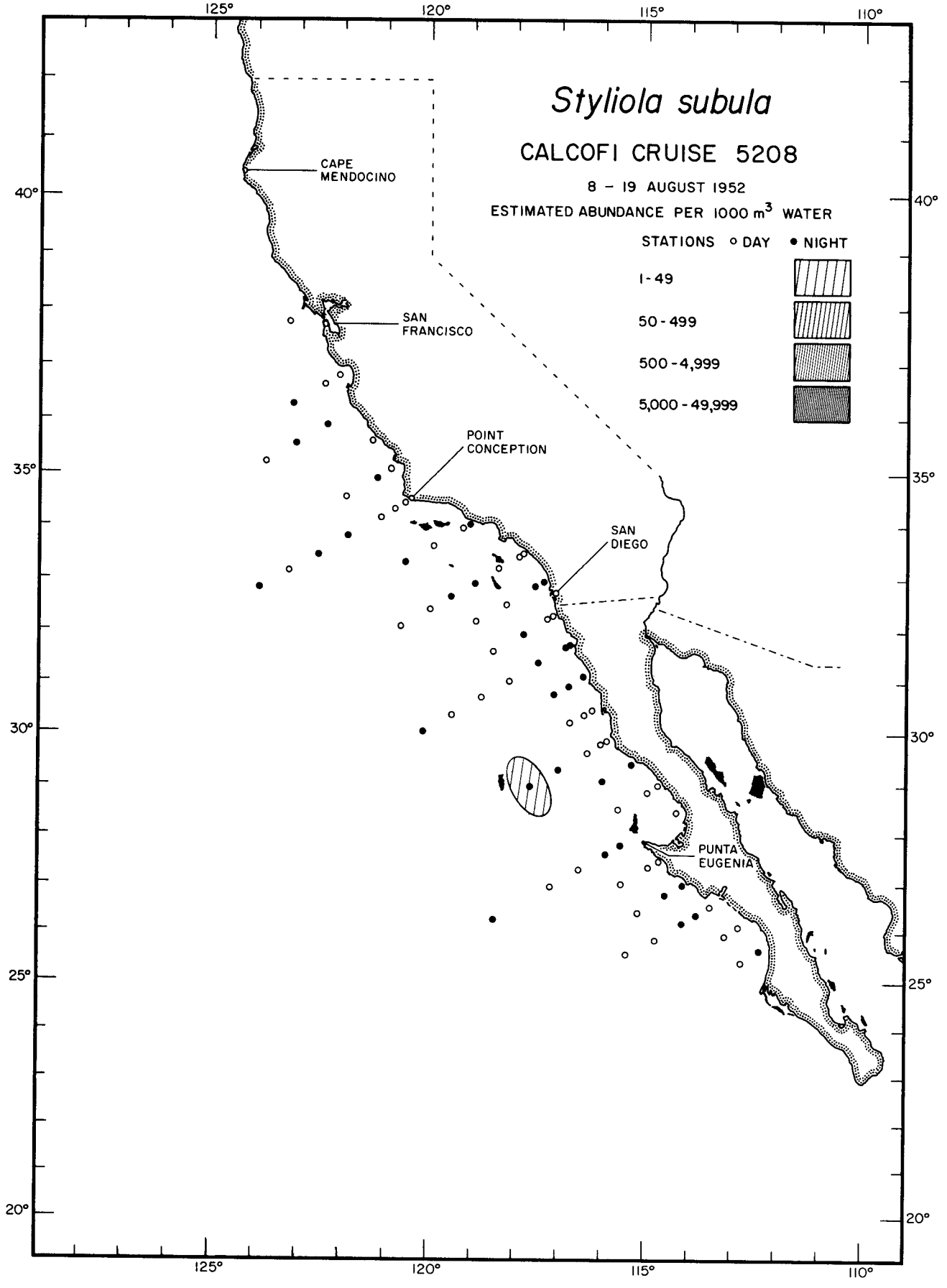
5004




Thecosomata

*Styliola subula*

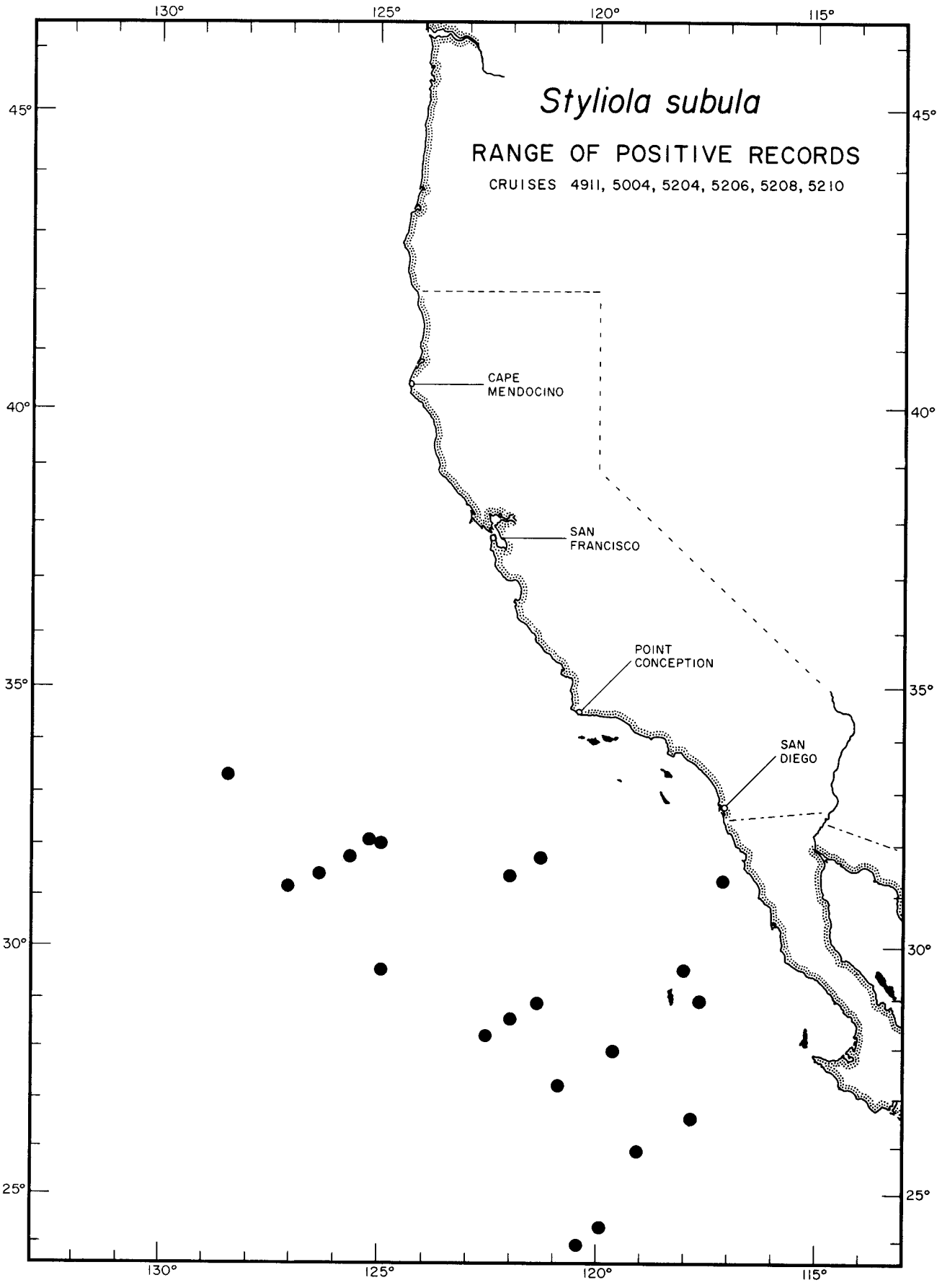
5204




Thecosomata

*Styliola subula*

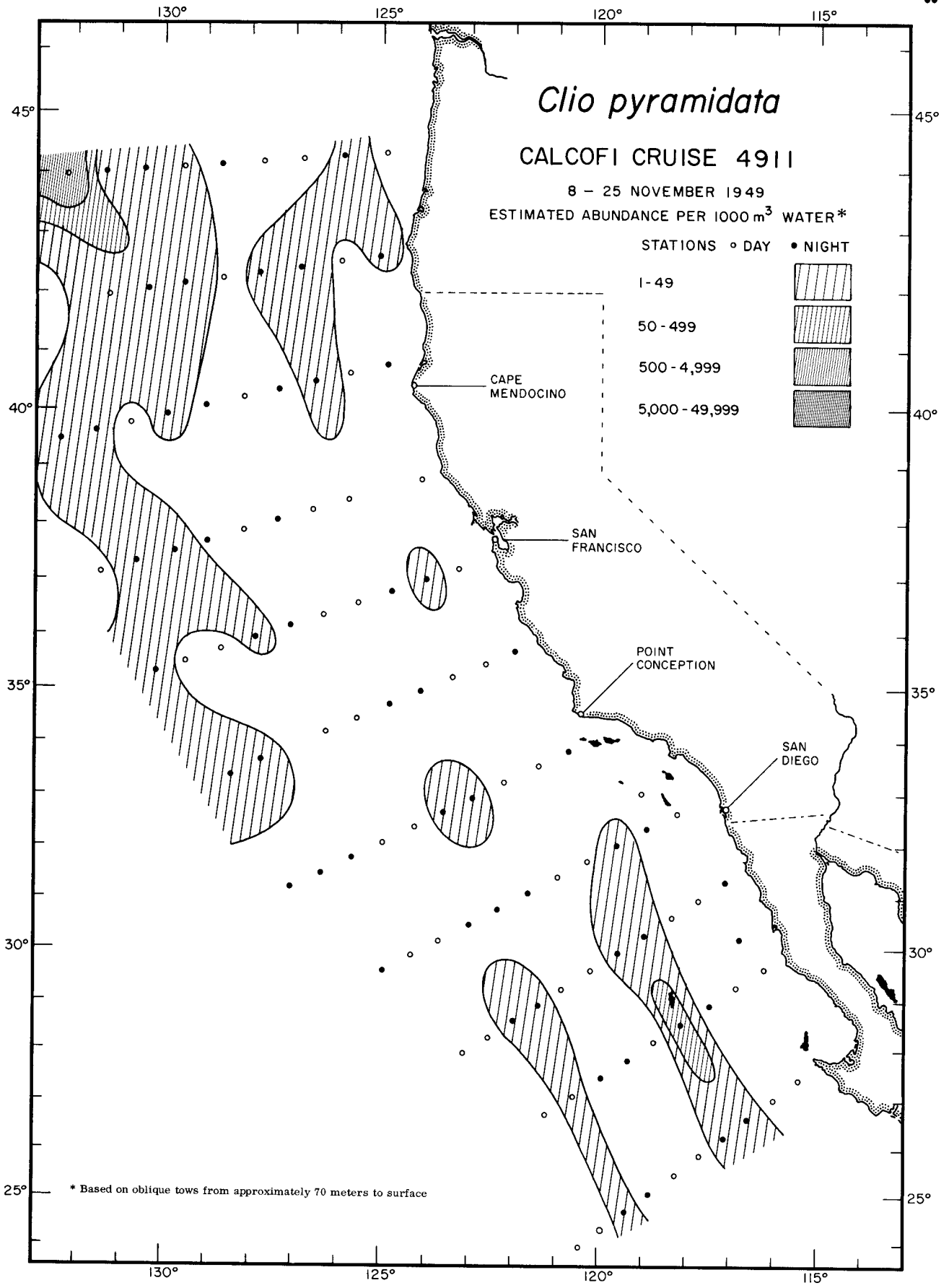
5208




Thecosomata

*Styliola subula*

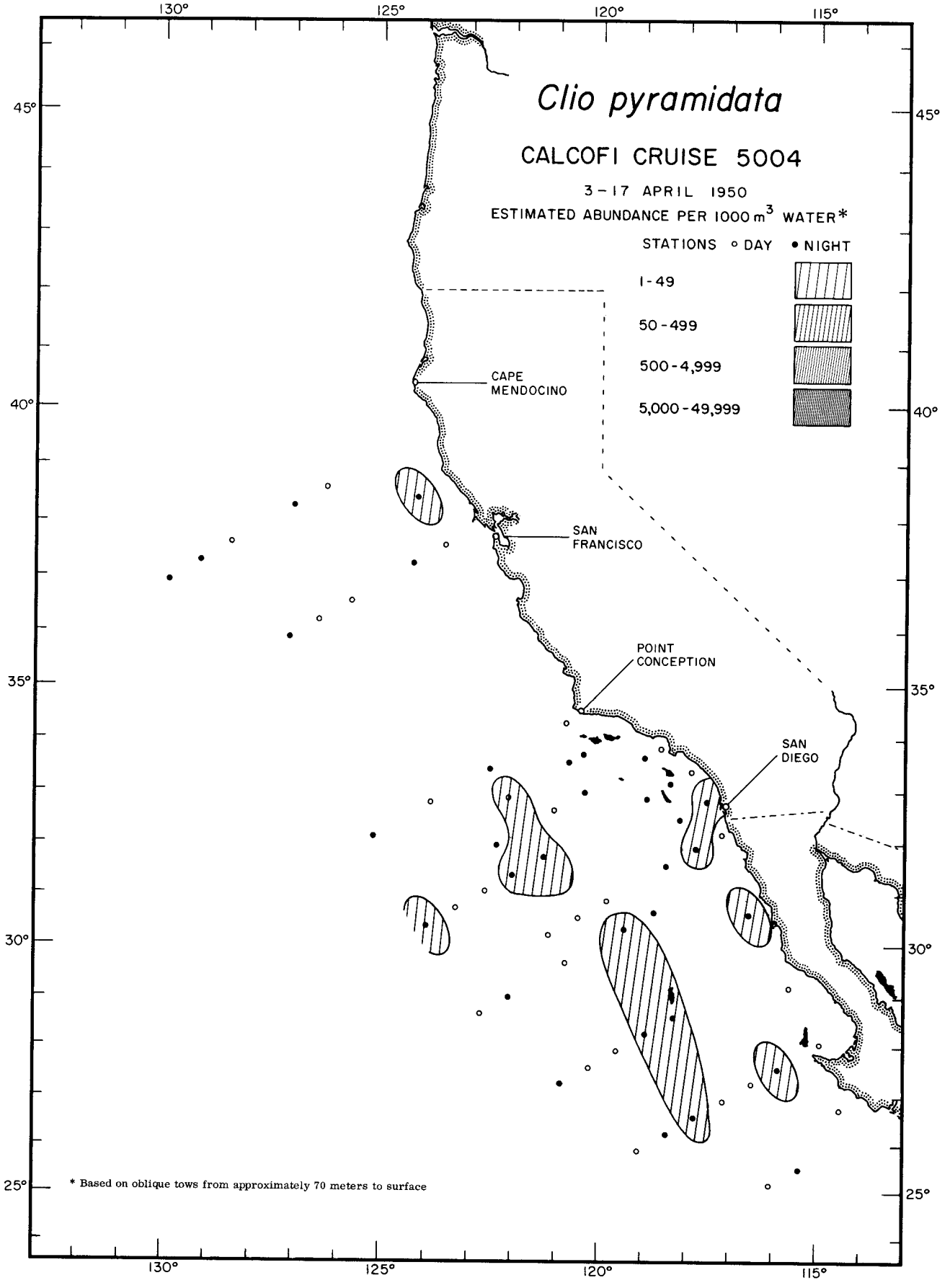
RANGE OF POSITIVE RECORDS




Thecosomata

*Clio pyramidata*

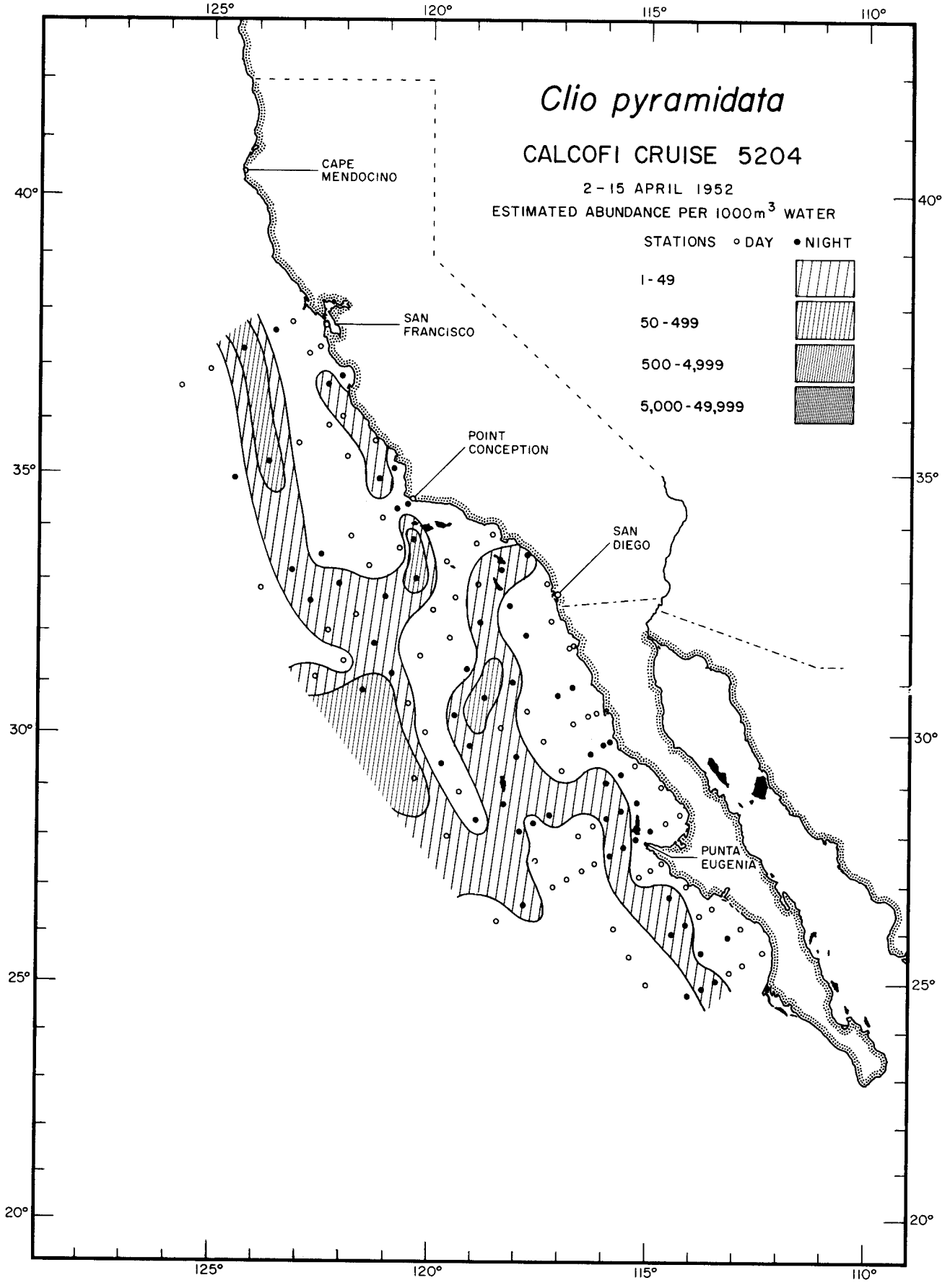
4911




Thecosomata

*Clio pyramidata*

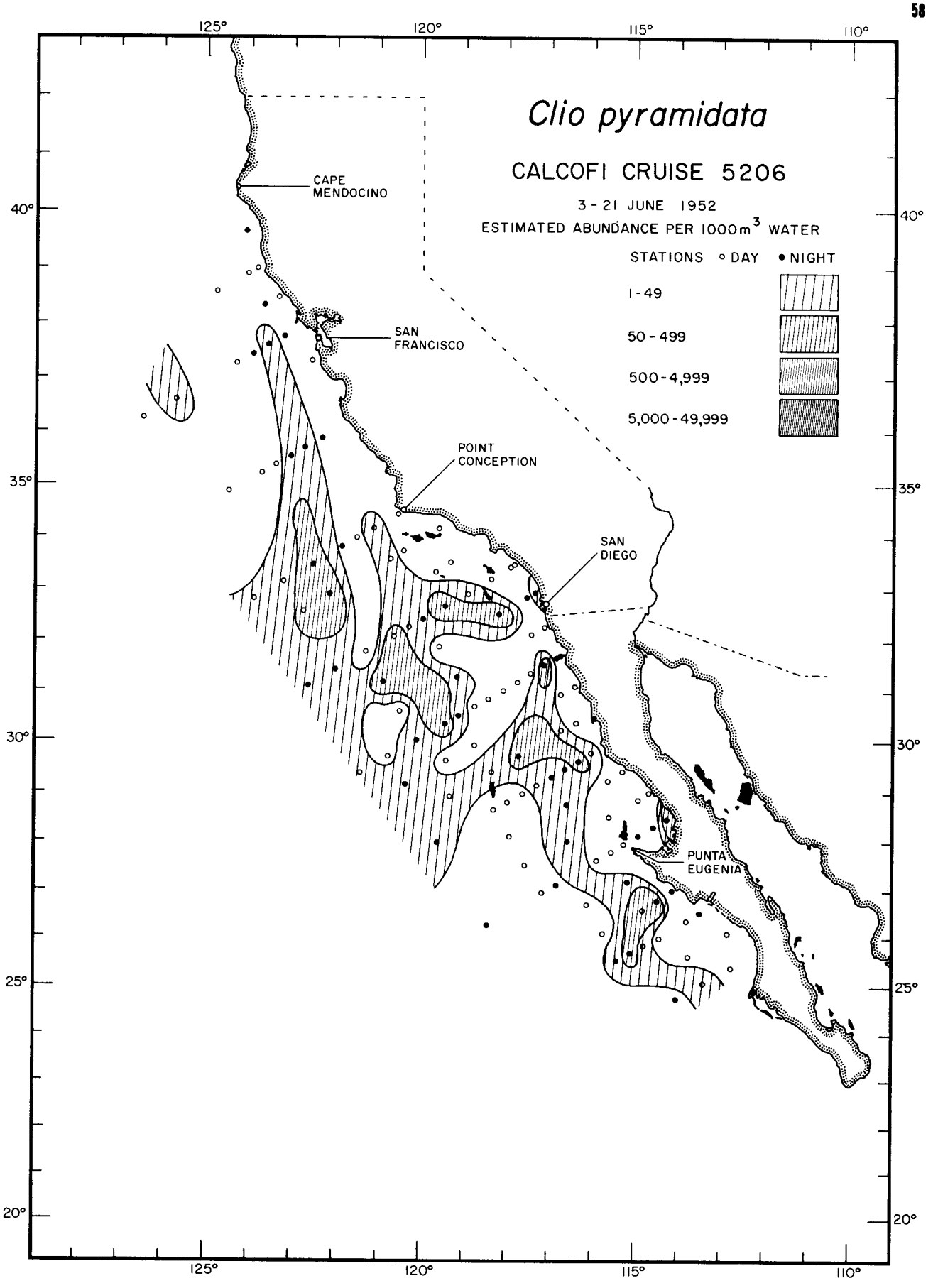
5004




Thecosomata

*Clio pyramidata*

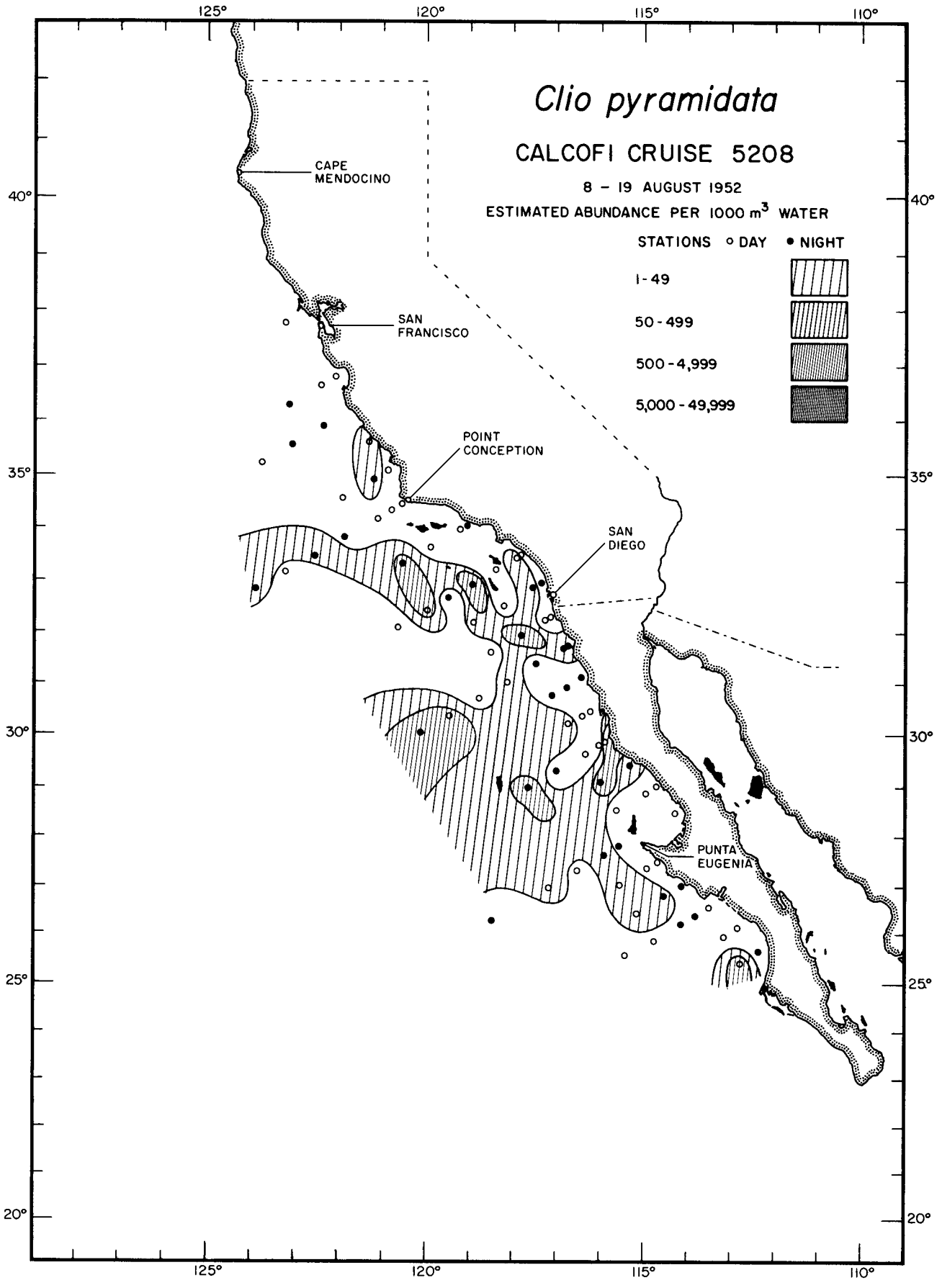
5204




Thecosomata

*Clio pyramidata*

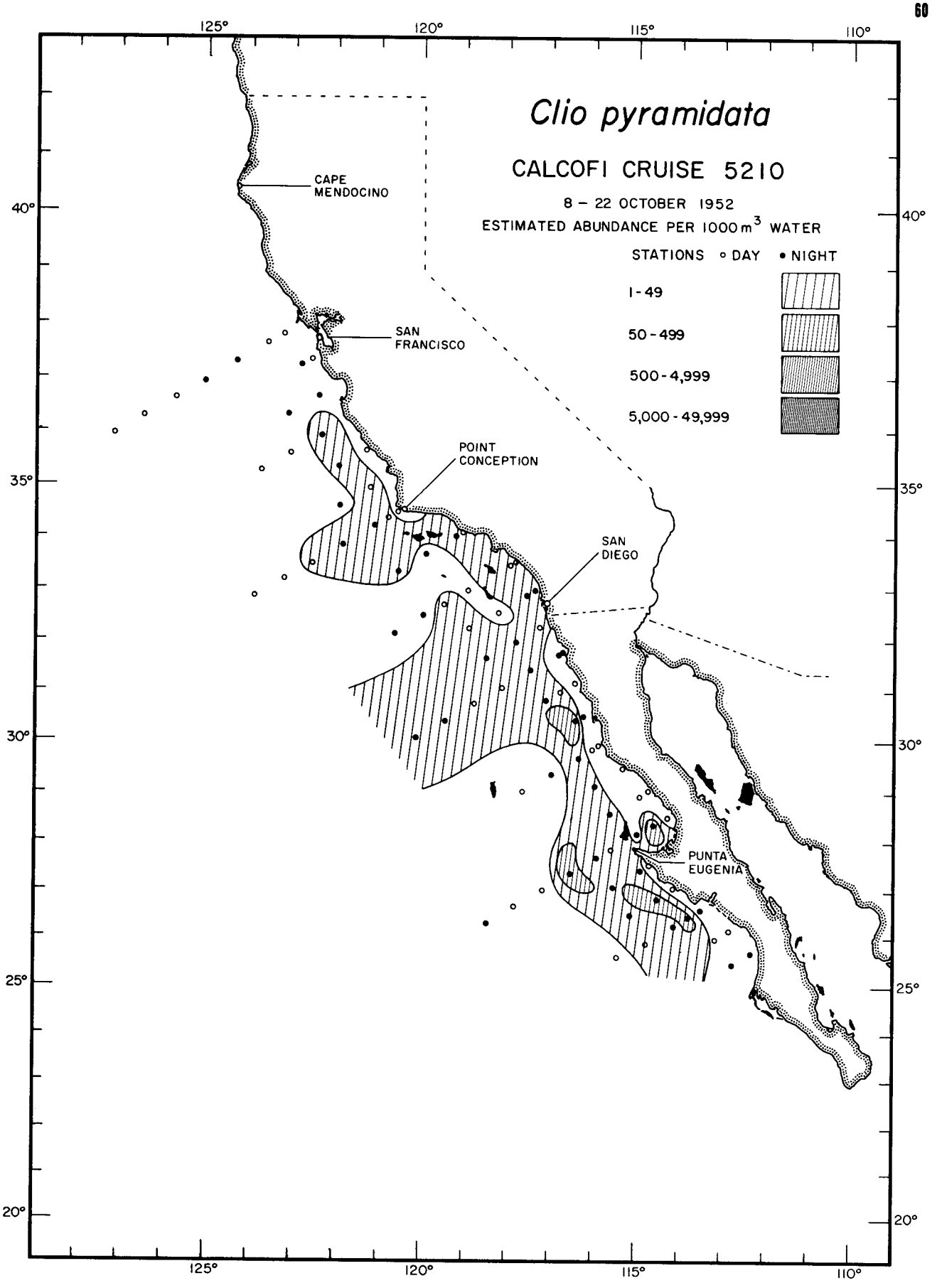
5206




Thecosomata

*Clio pyramidata*

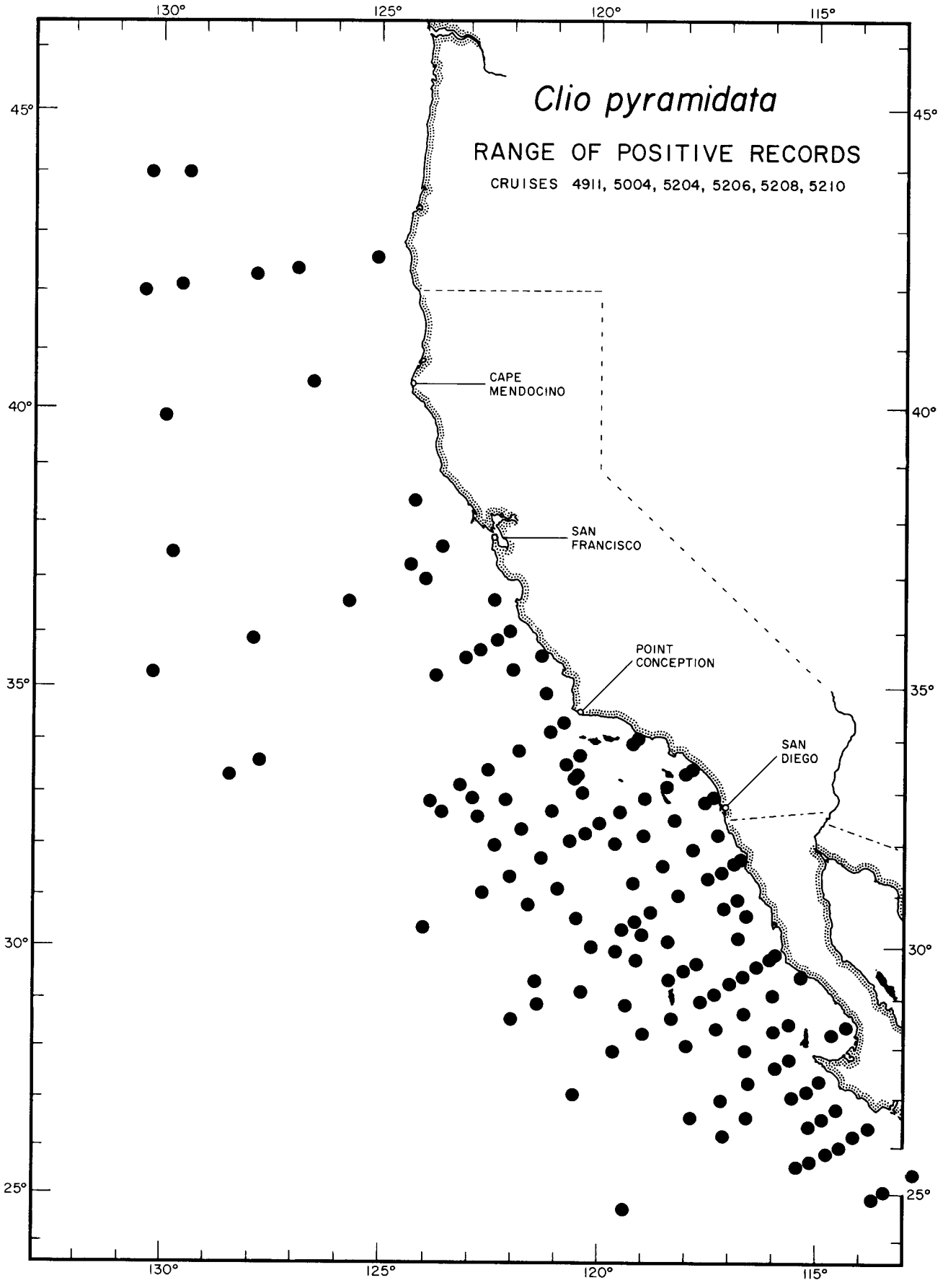
5208




Thecosomata

*Clio pyramidata*

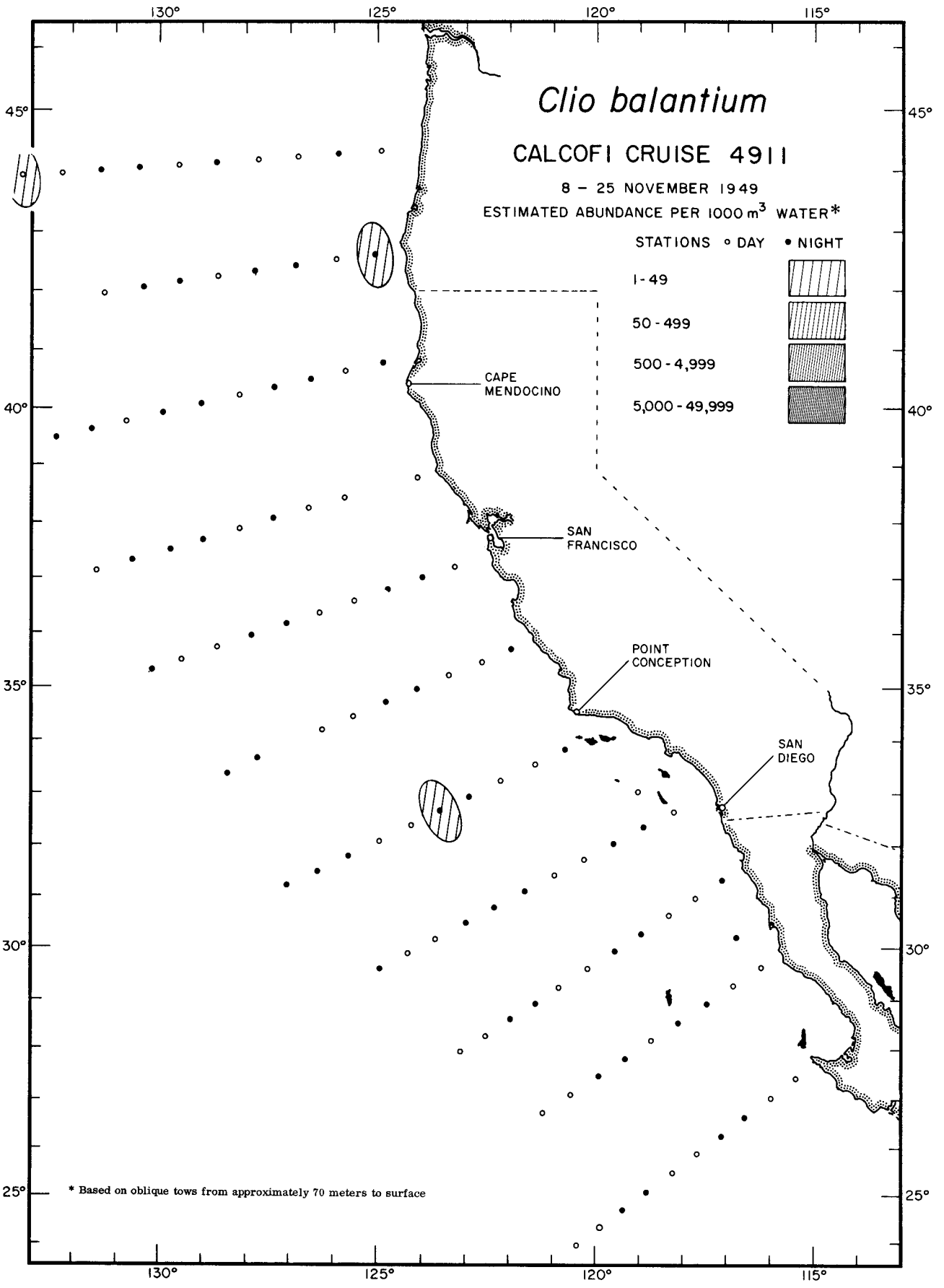
5210




Thecosomata

*Clio pyramidata*

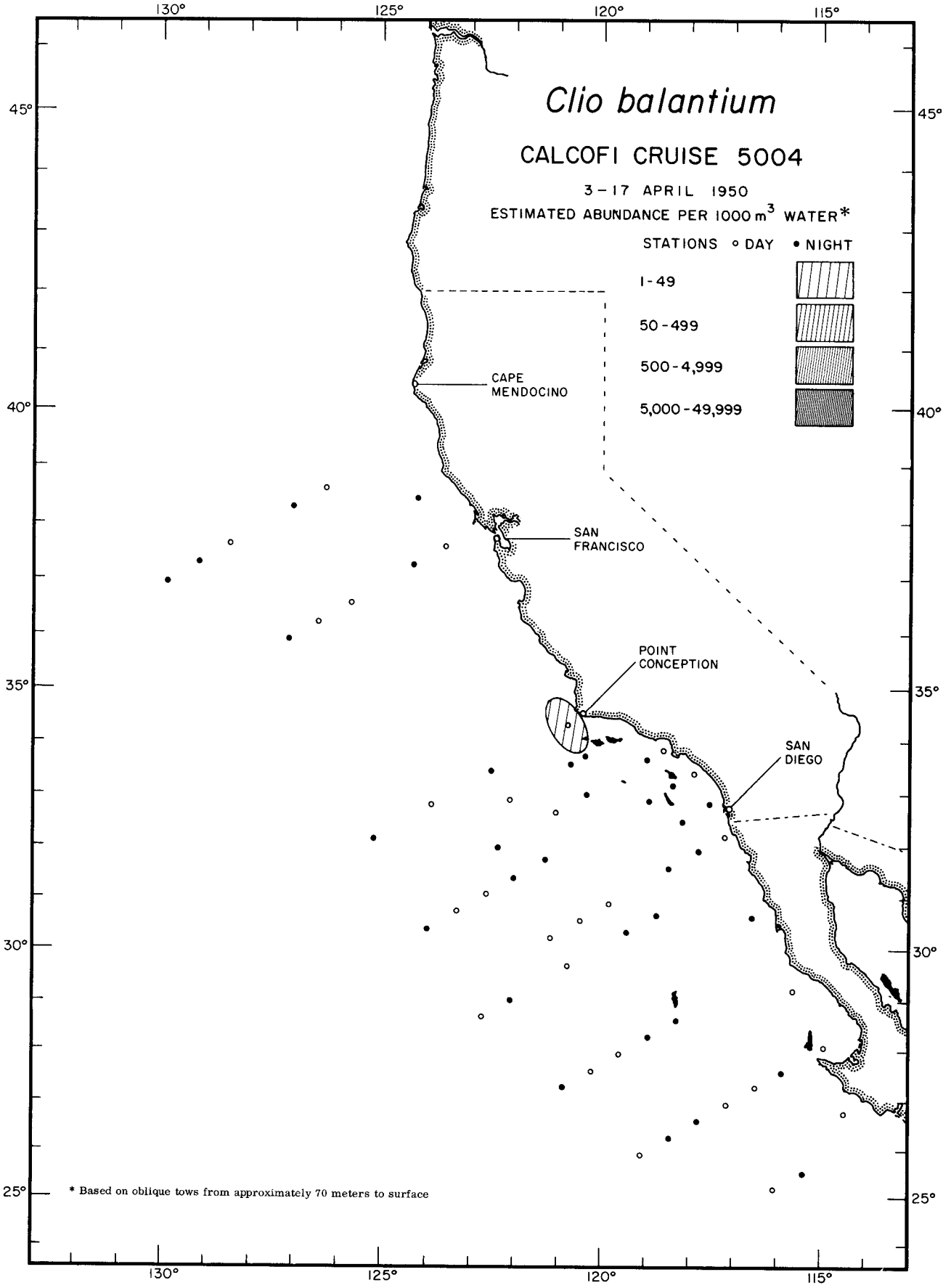
RANGE OF POSITIVE RECORDS




Thecosomata

*Clio balantium*

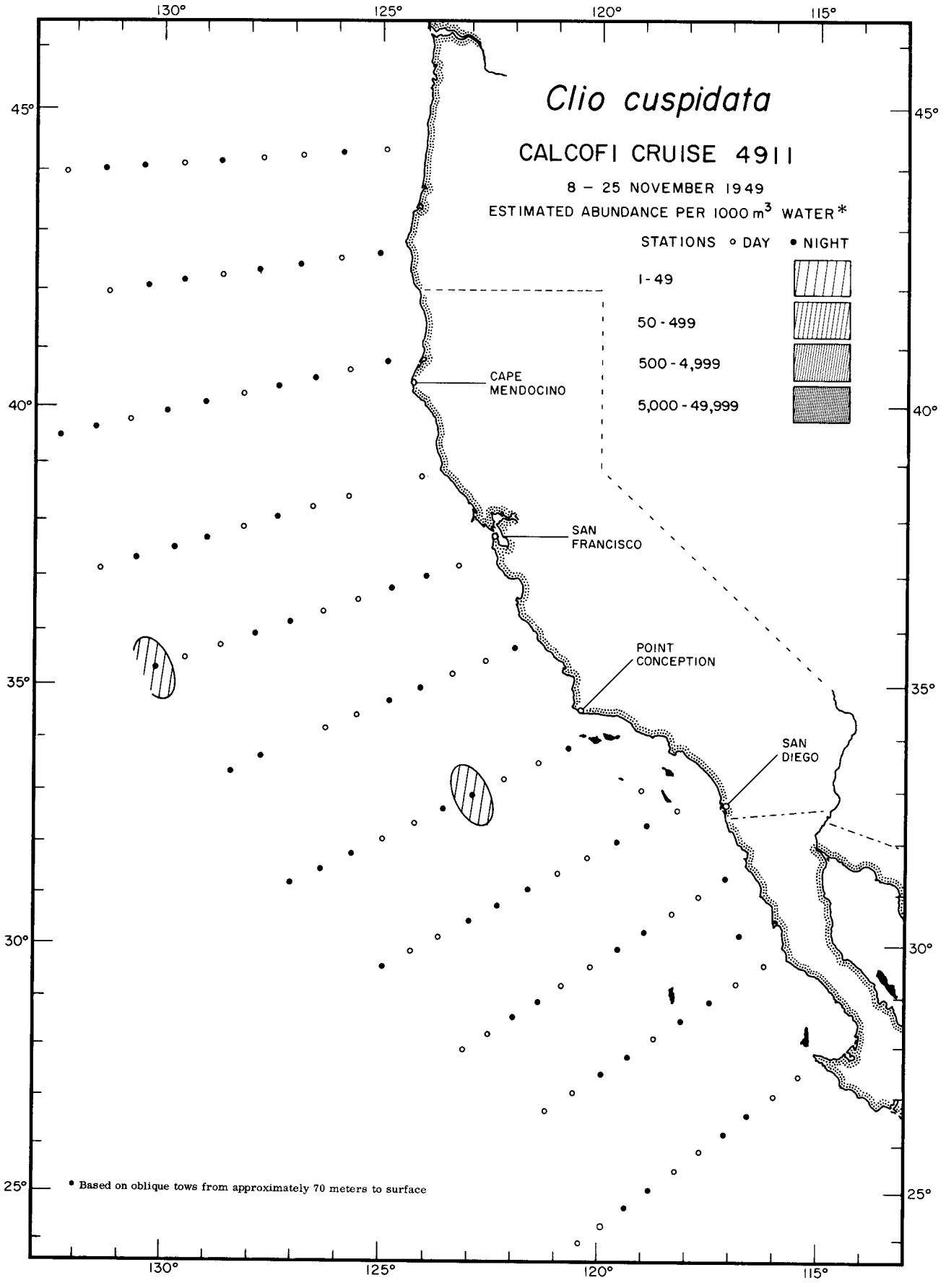
4911




Thecosomata

*Clio balantium*

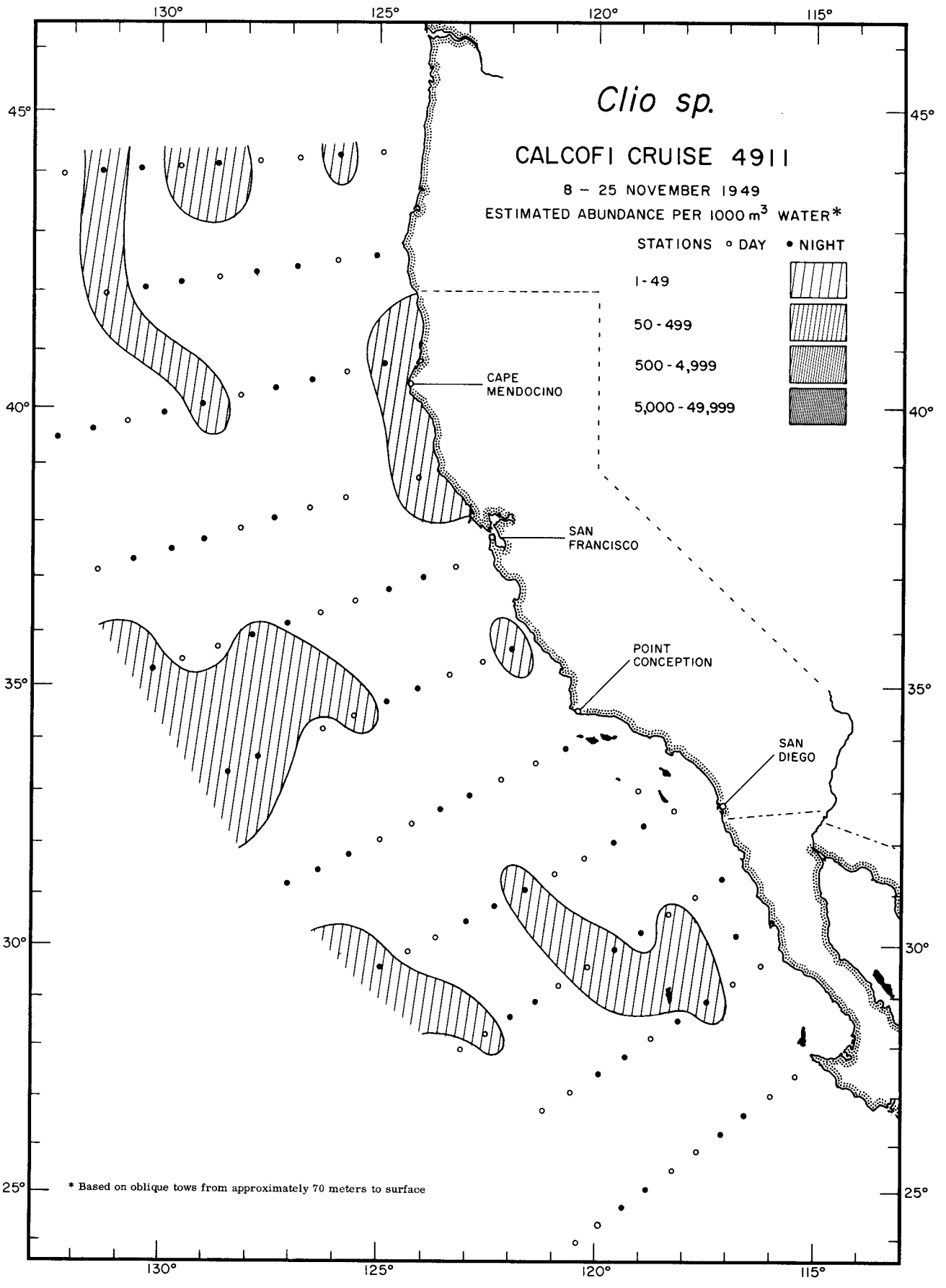
5004




Thecosomata

*Clio cuspidata*

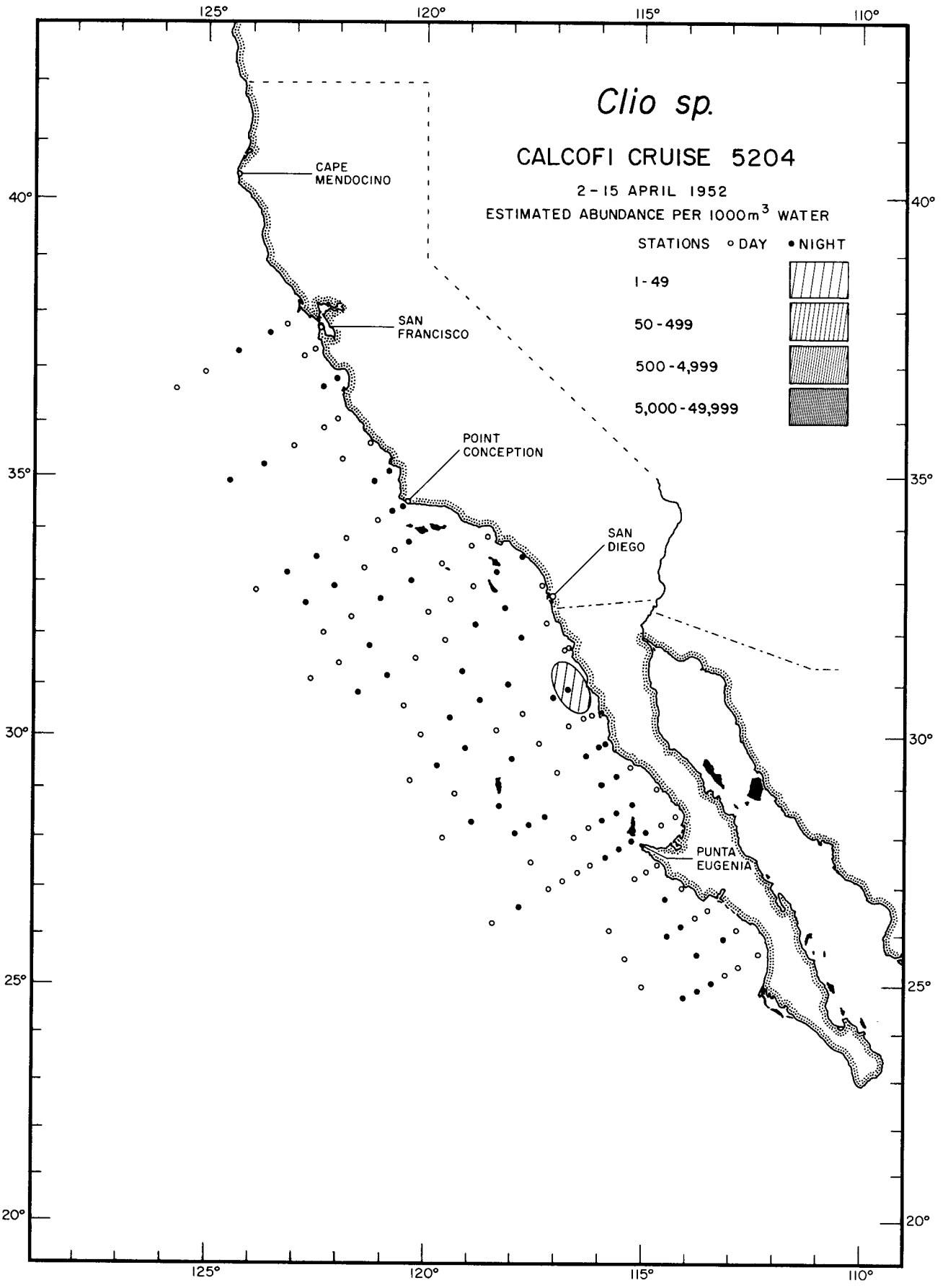
4911




Thecosomata

*Clio sp.*

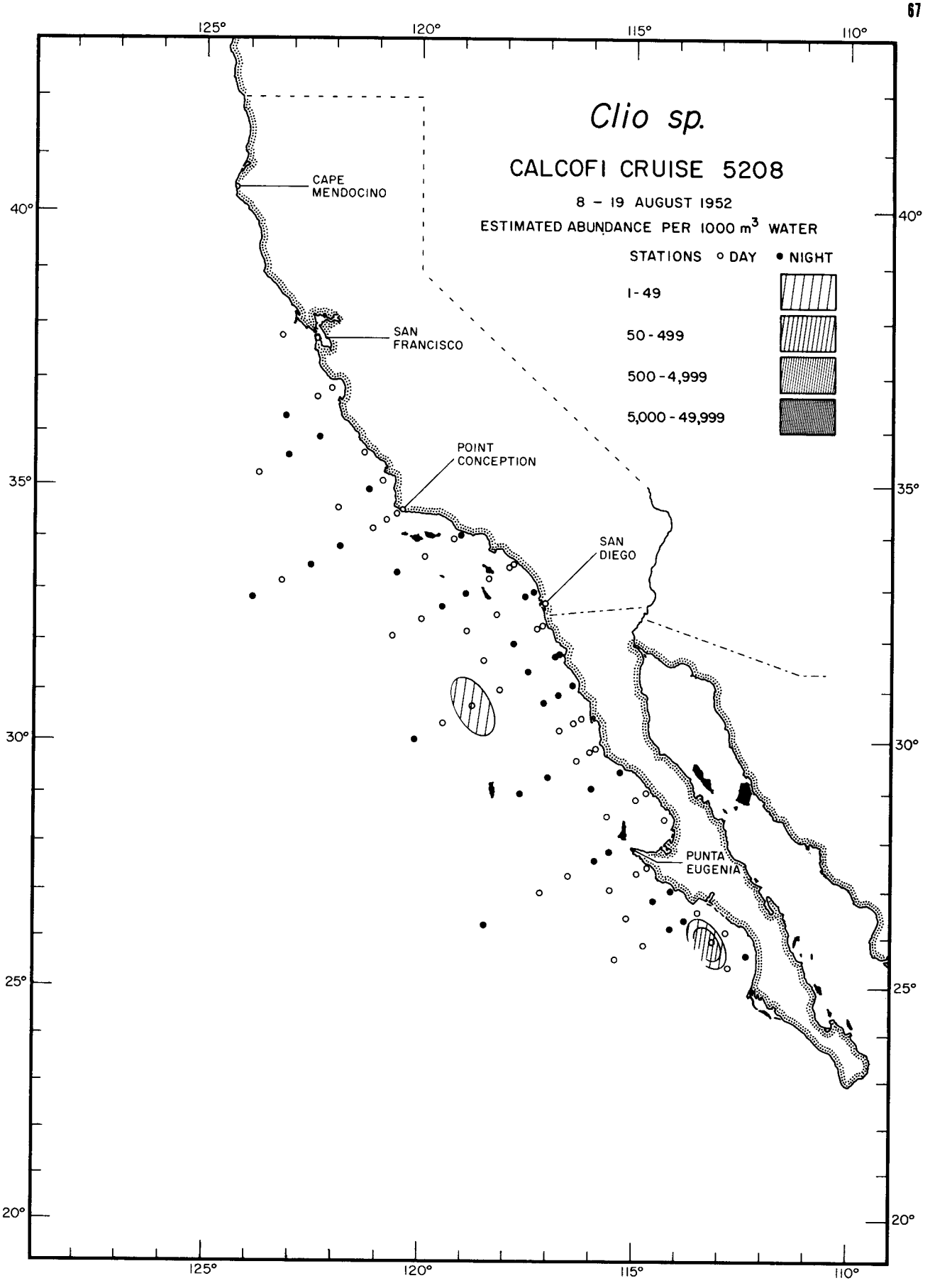
4911




Thecosomata

*Clio sp.*

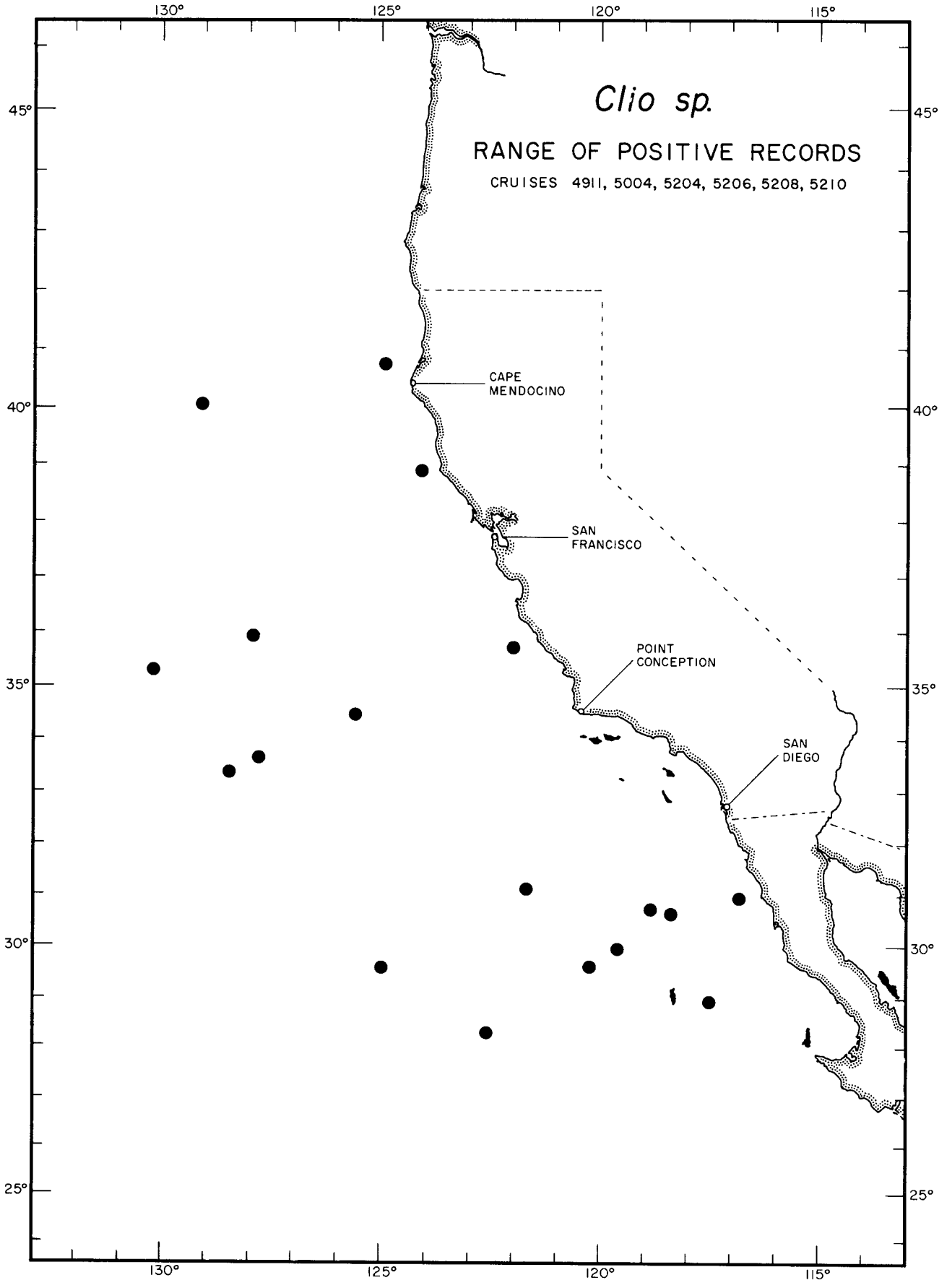
5204




Thecosomata

*Clio sp.*

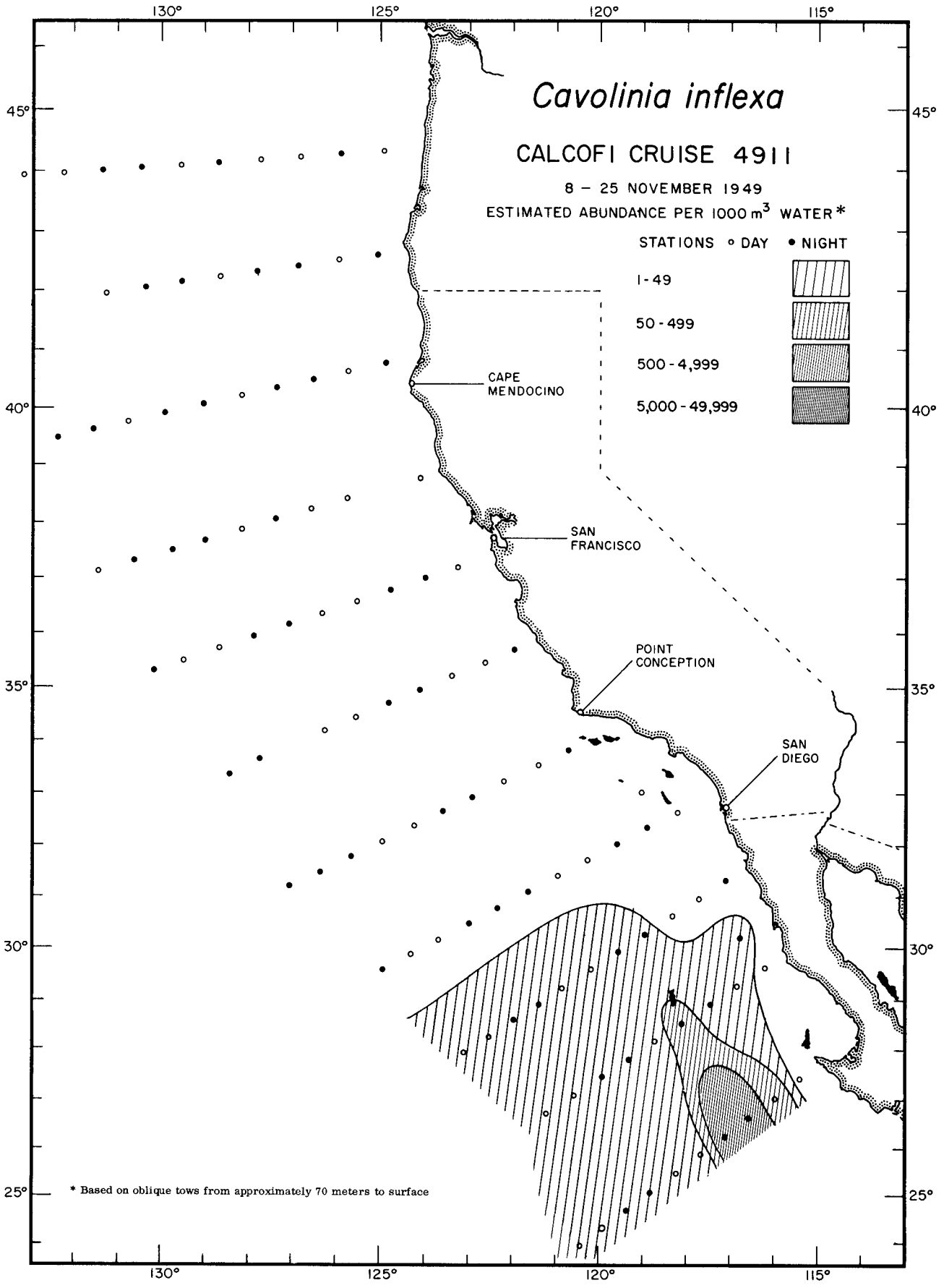
5208




Thecosomata

*Clio sp.*

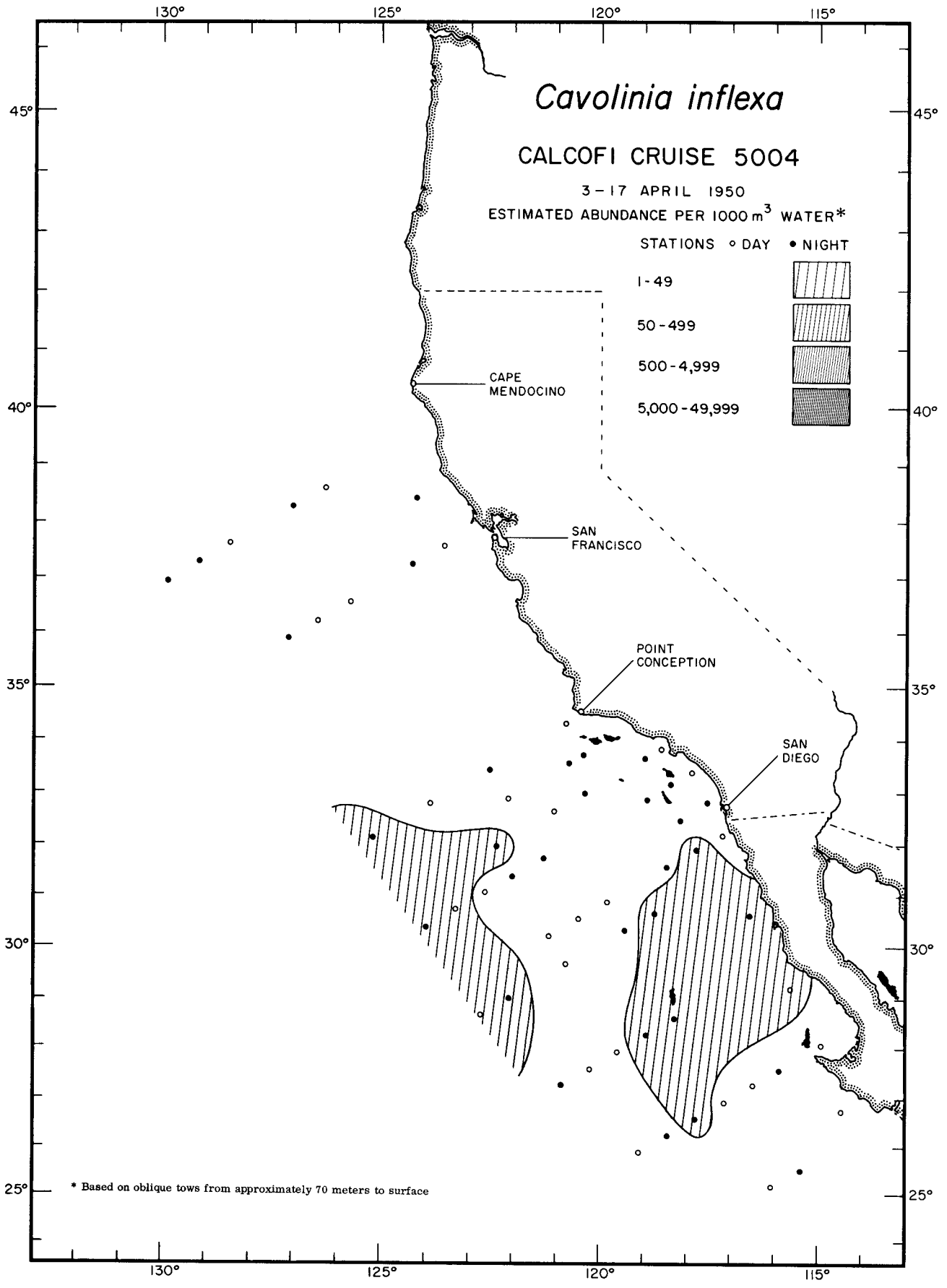
RANGE OF POSITIVE RECORDS




Thecosomata

*Cavolinia inflexa*

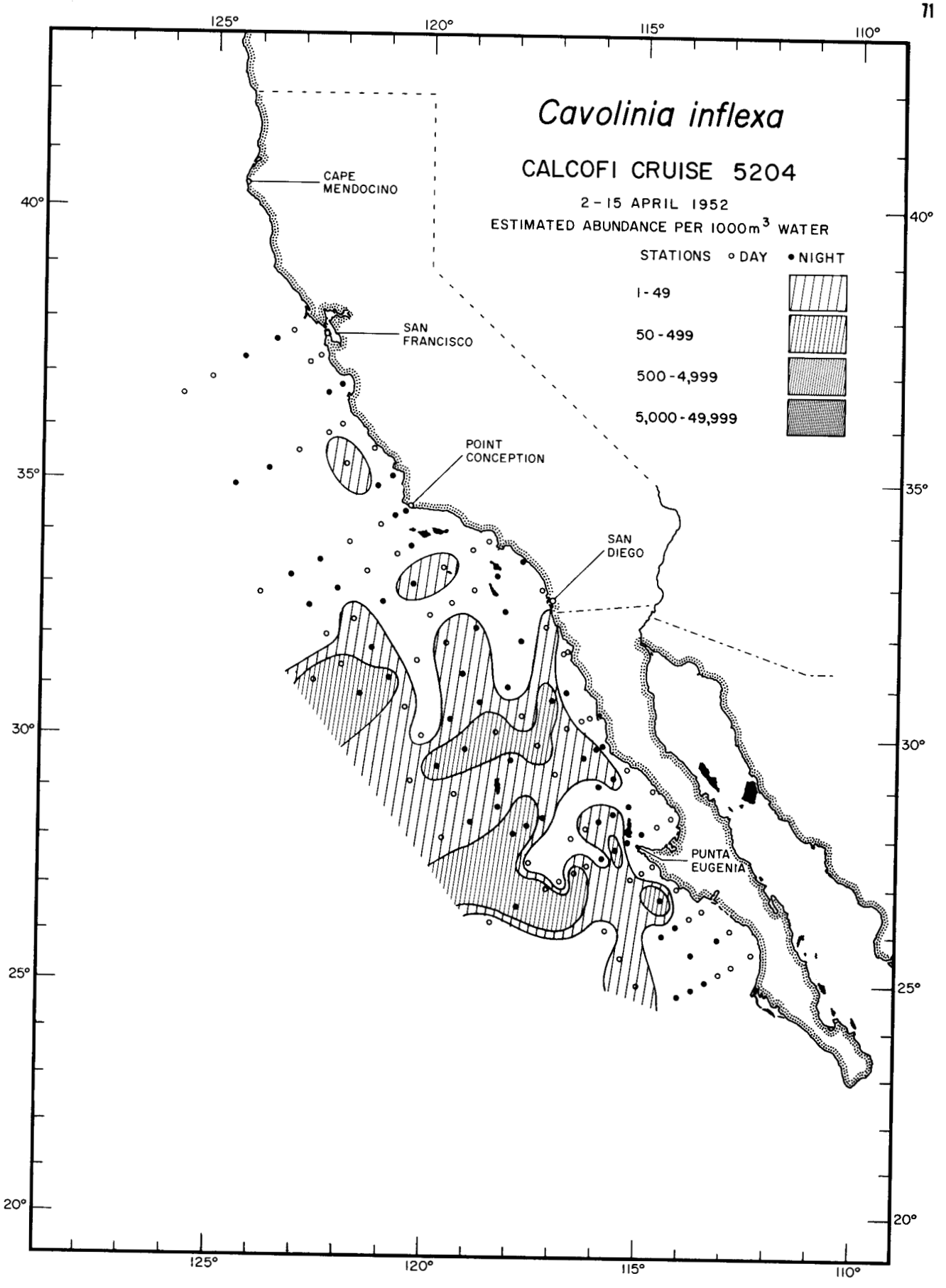
4911




Thecosomata

*Cavolinia inflexa*

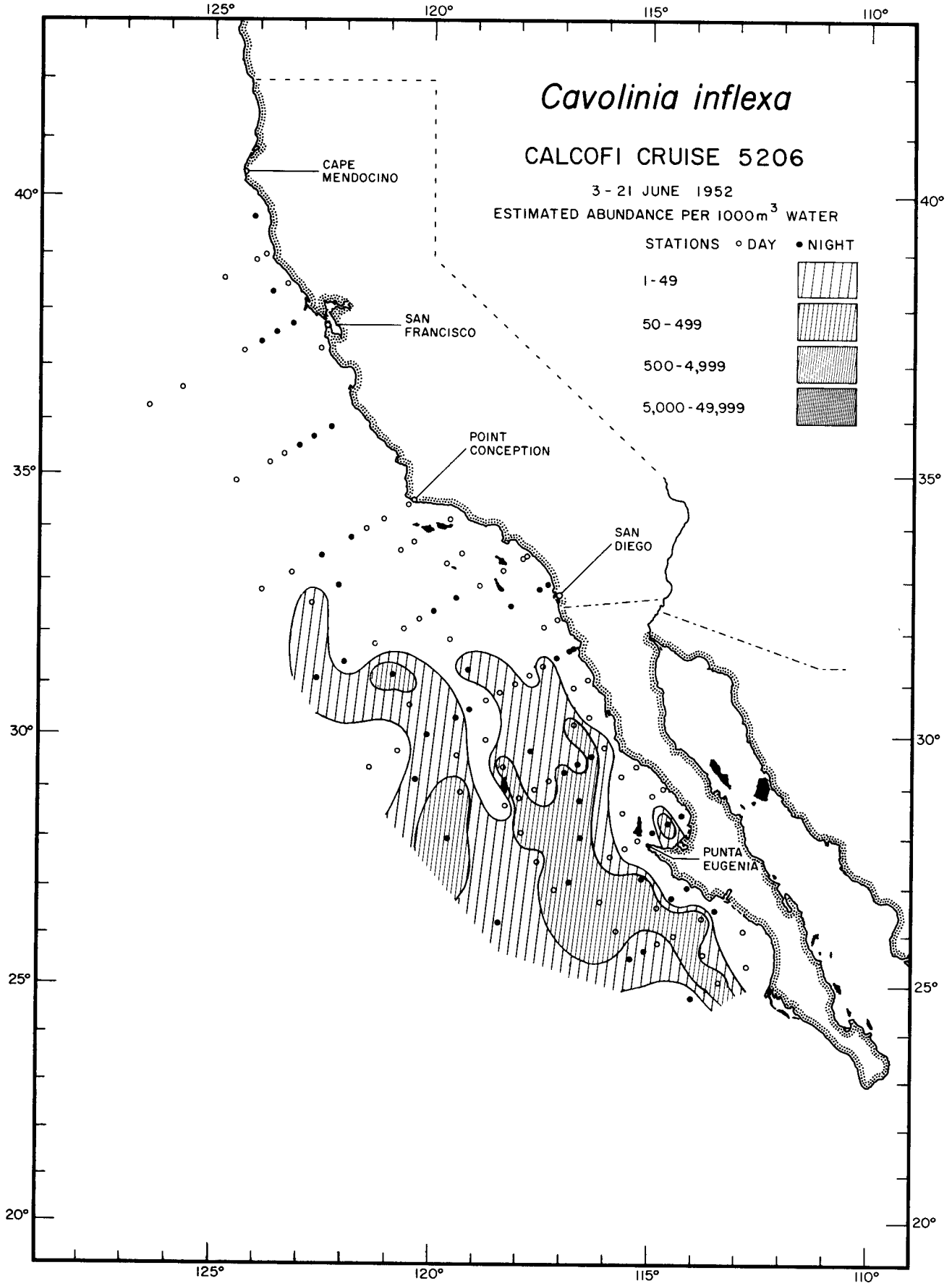
5004




Thecosomata

*Cavolinia inflexa*

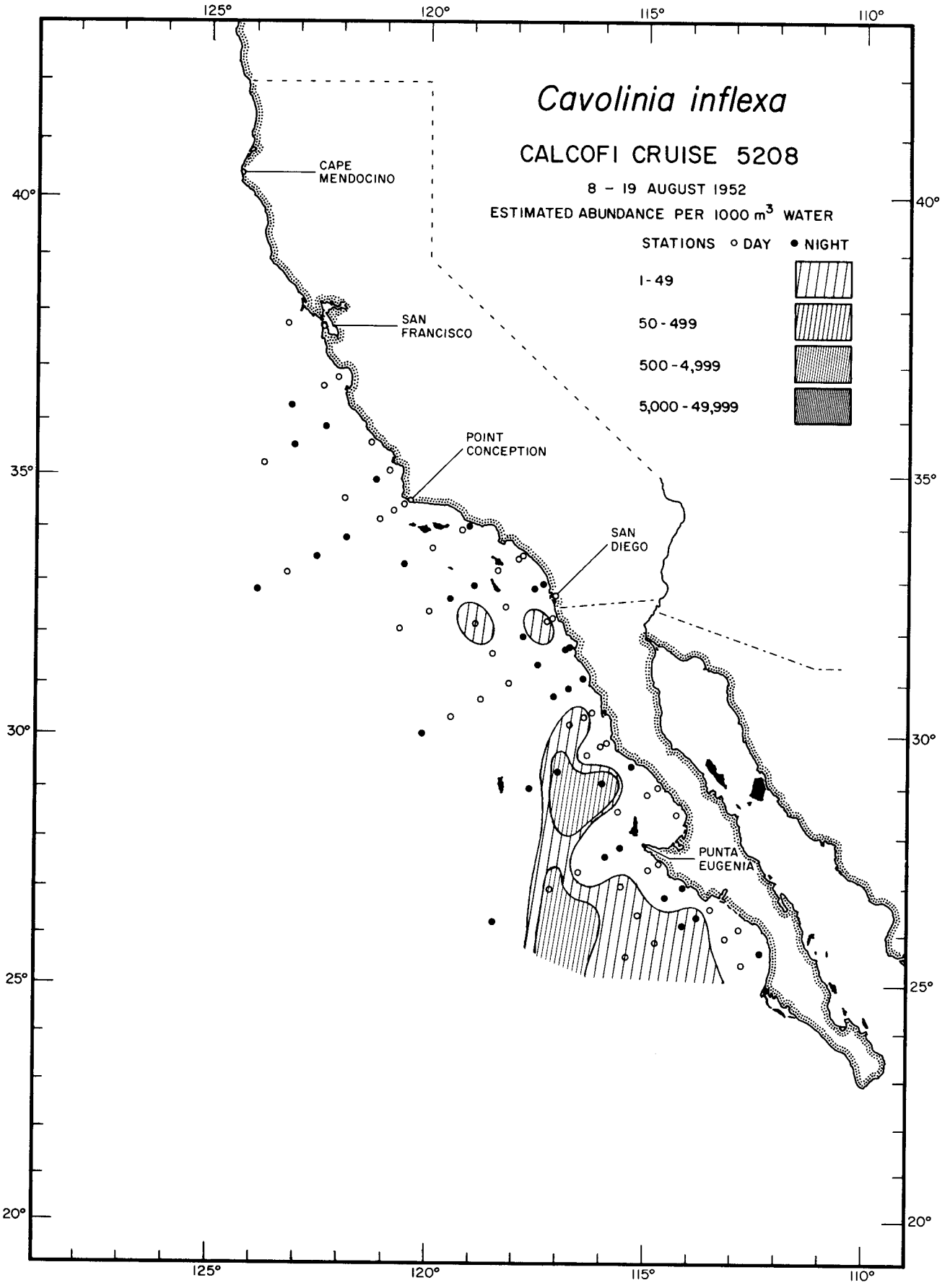
5204




Thecosomata

*Cavolinia inflexa*

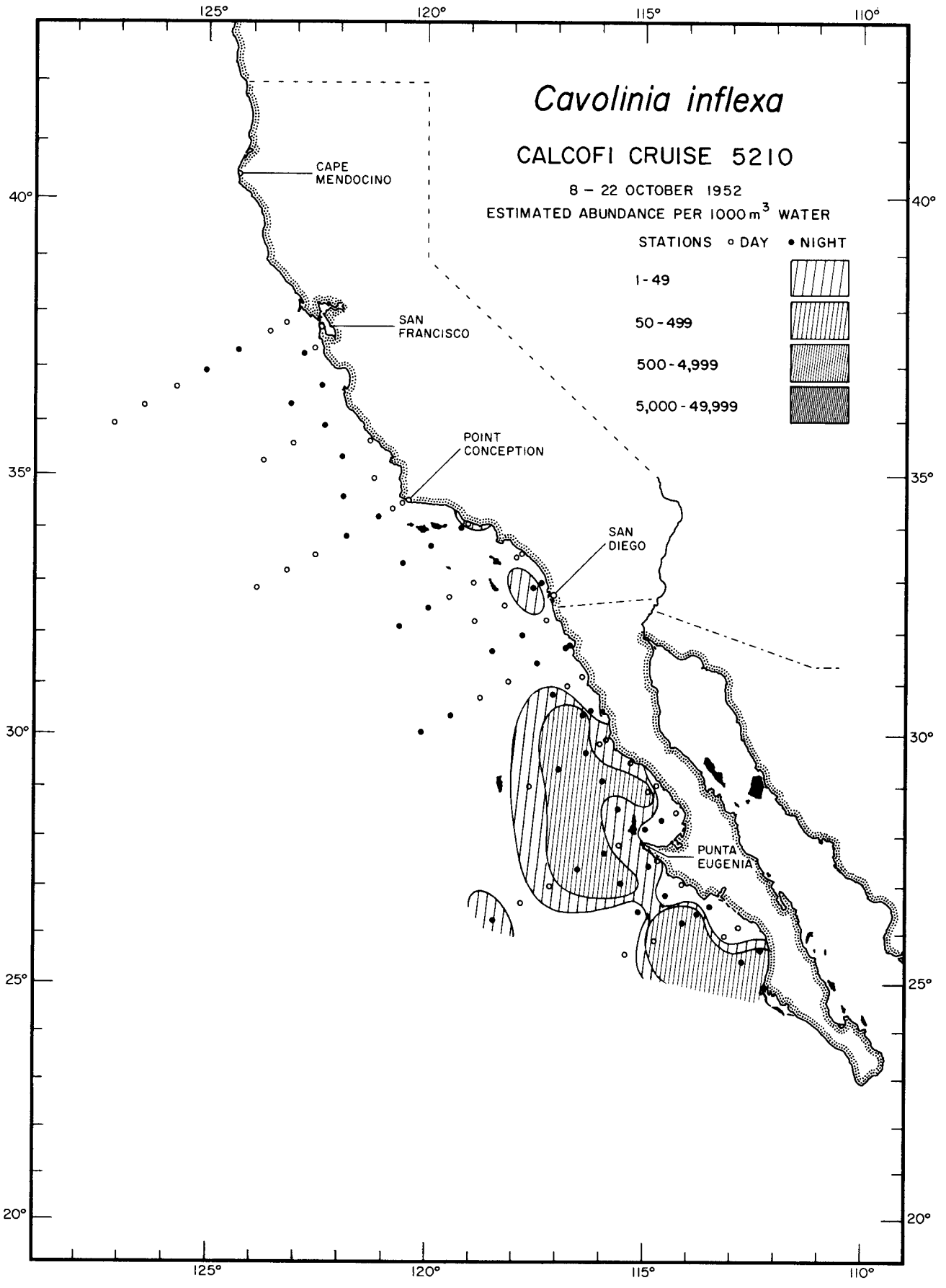
5206




Thecosomata

*Cavolinia inflexa*

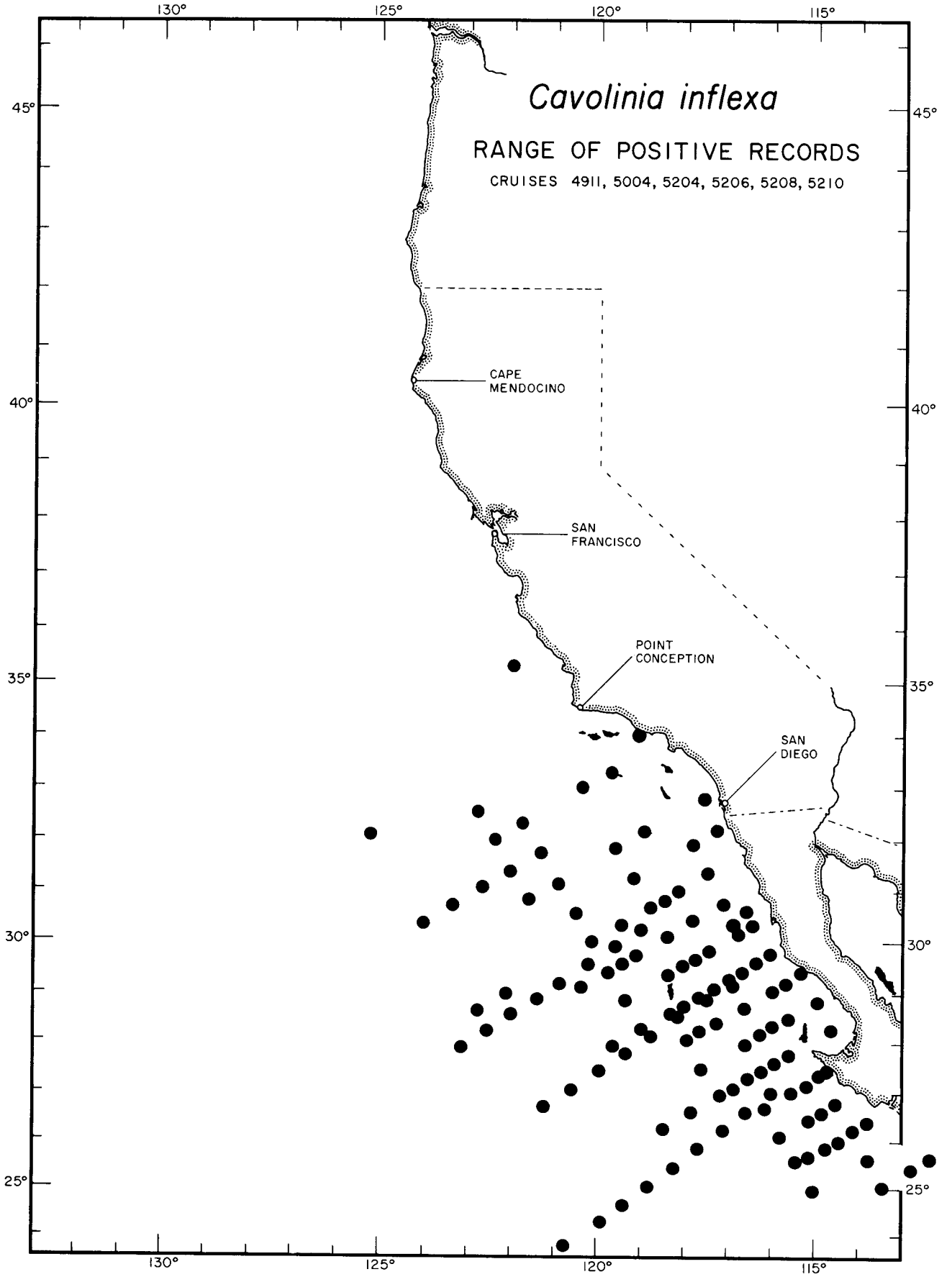
5208




Thecosomata

*Cavolinia inflexa*

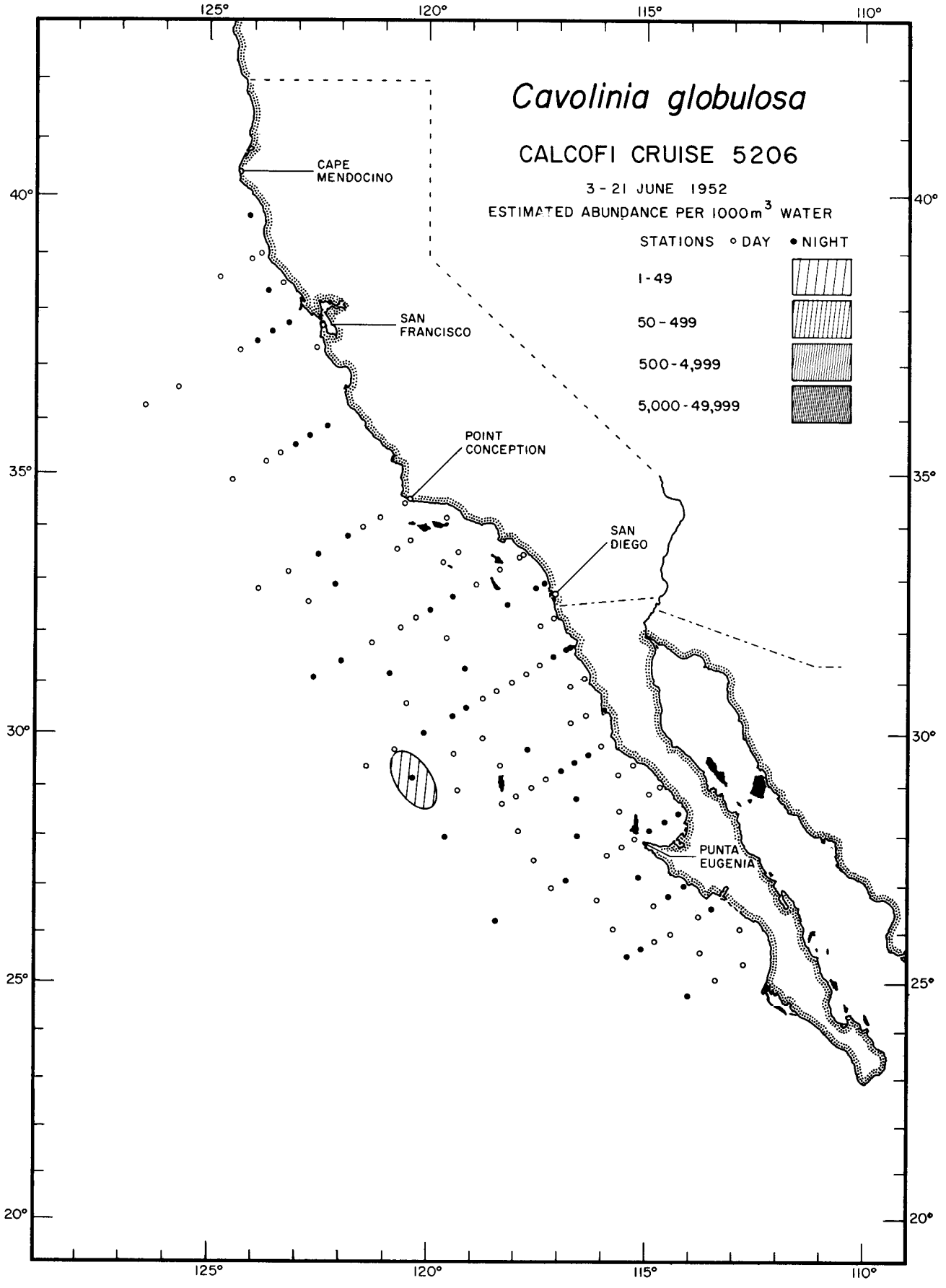
5210




Thecosomata

*Cavolinia inflexa*

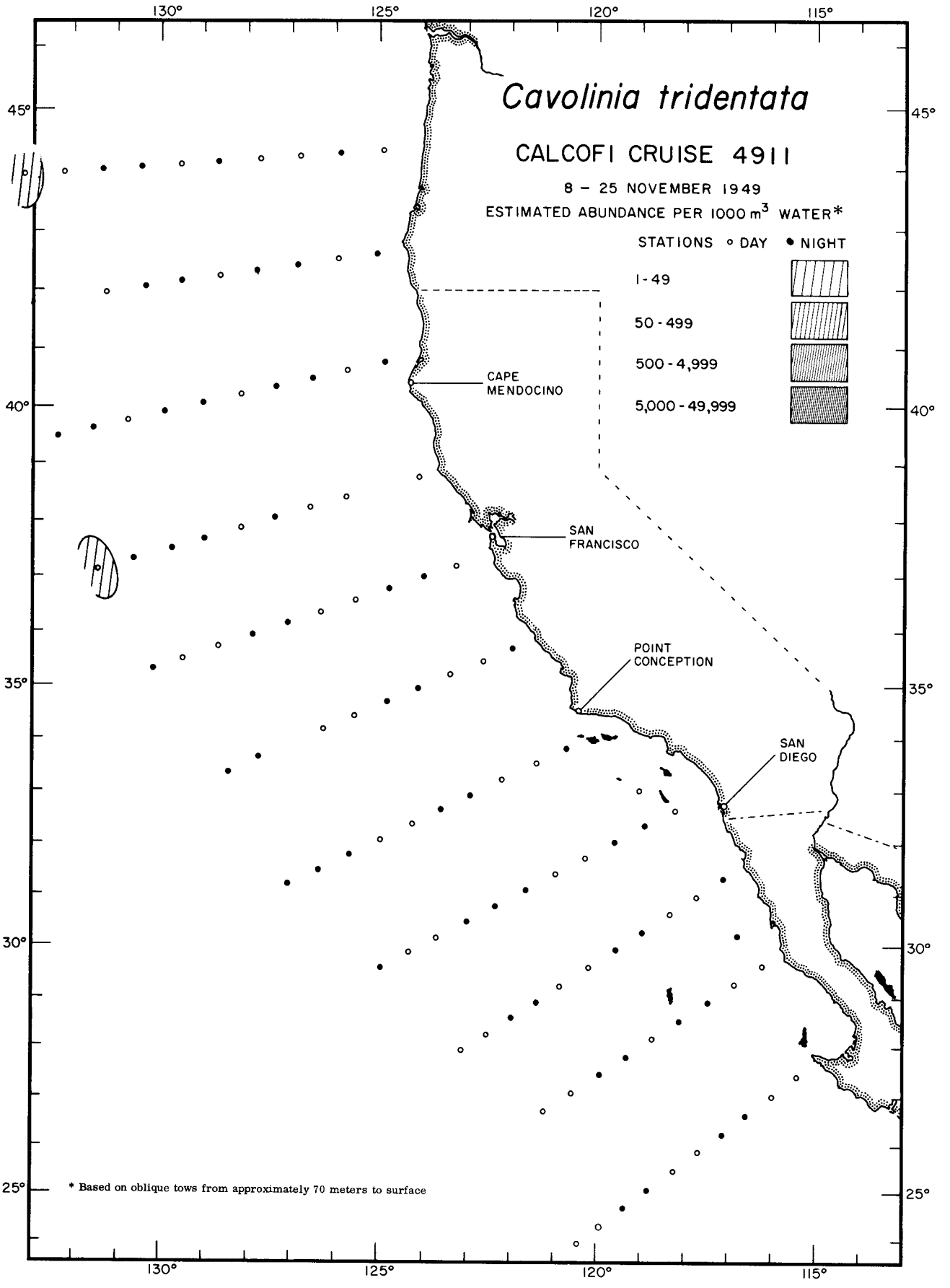
RANGE OF POSITIVE RECORDS




Thecosomata

*Cavolinia globulosa*

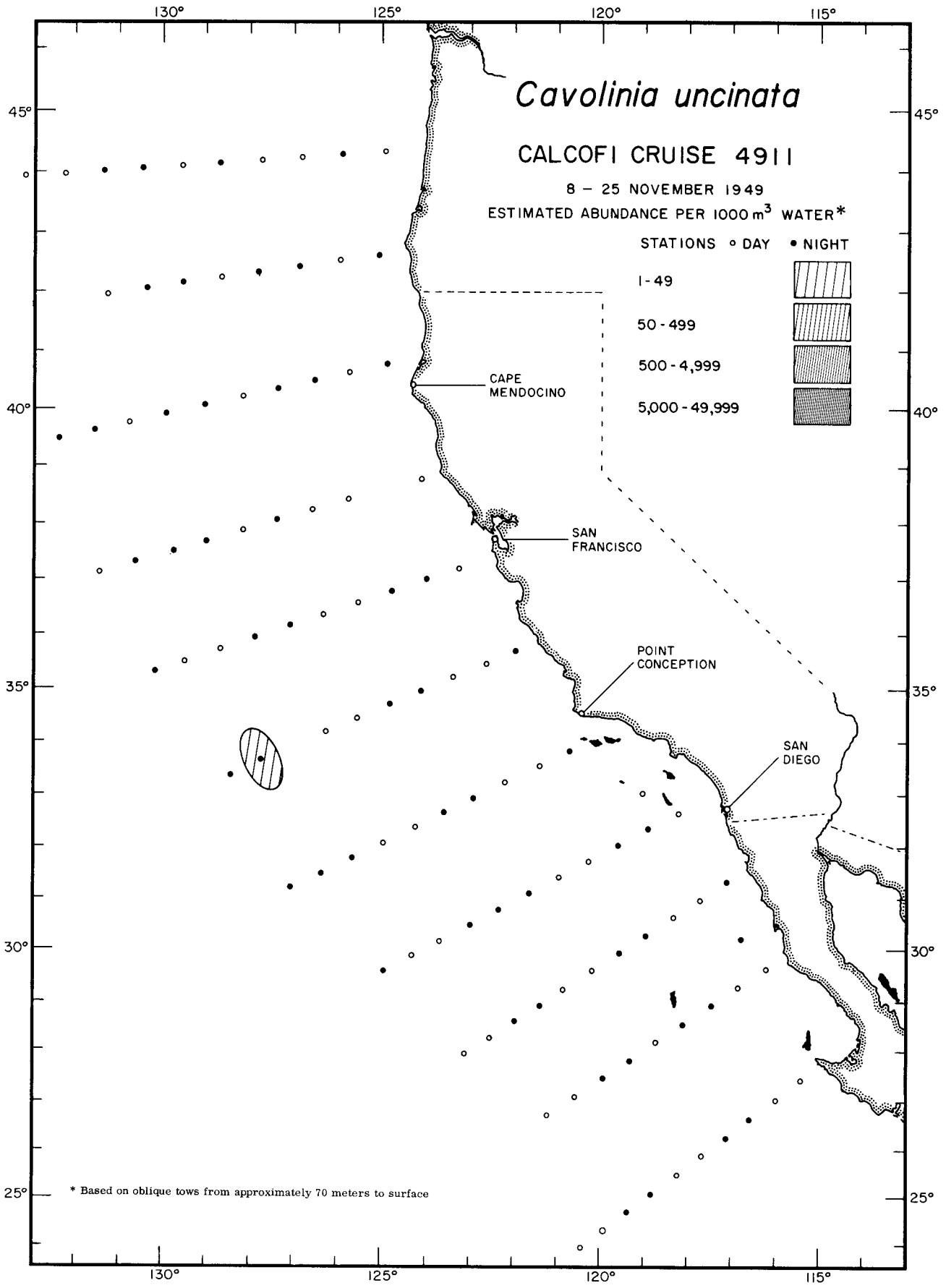
5206




Thecosomata

*Cavolinia tridentata*

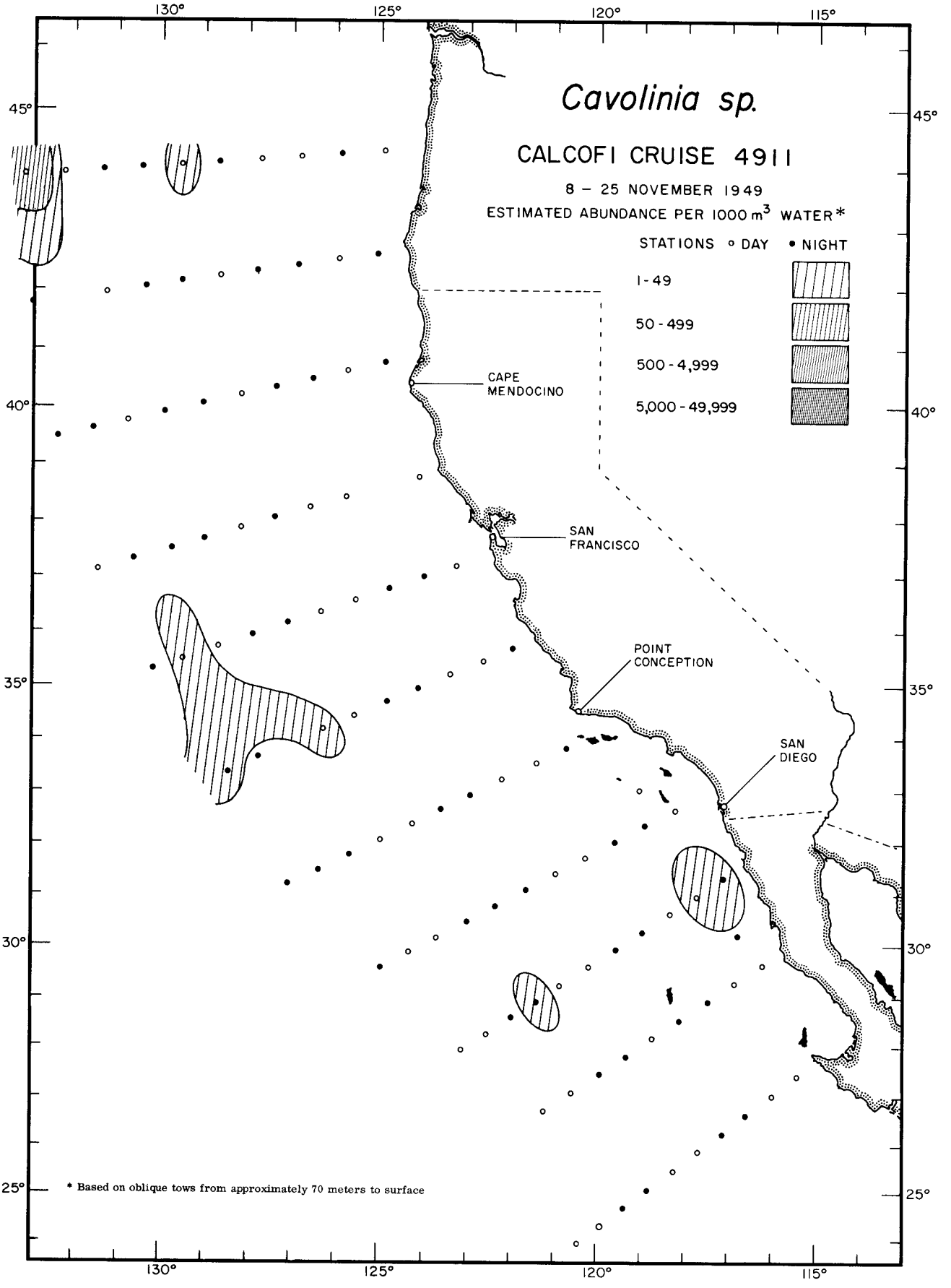
4911




Thecosomata

*Cavolinia uncinata*

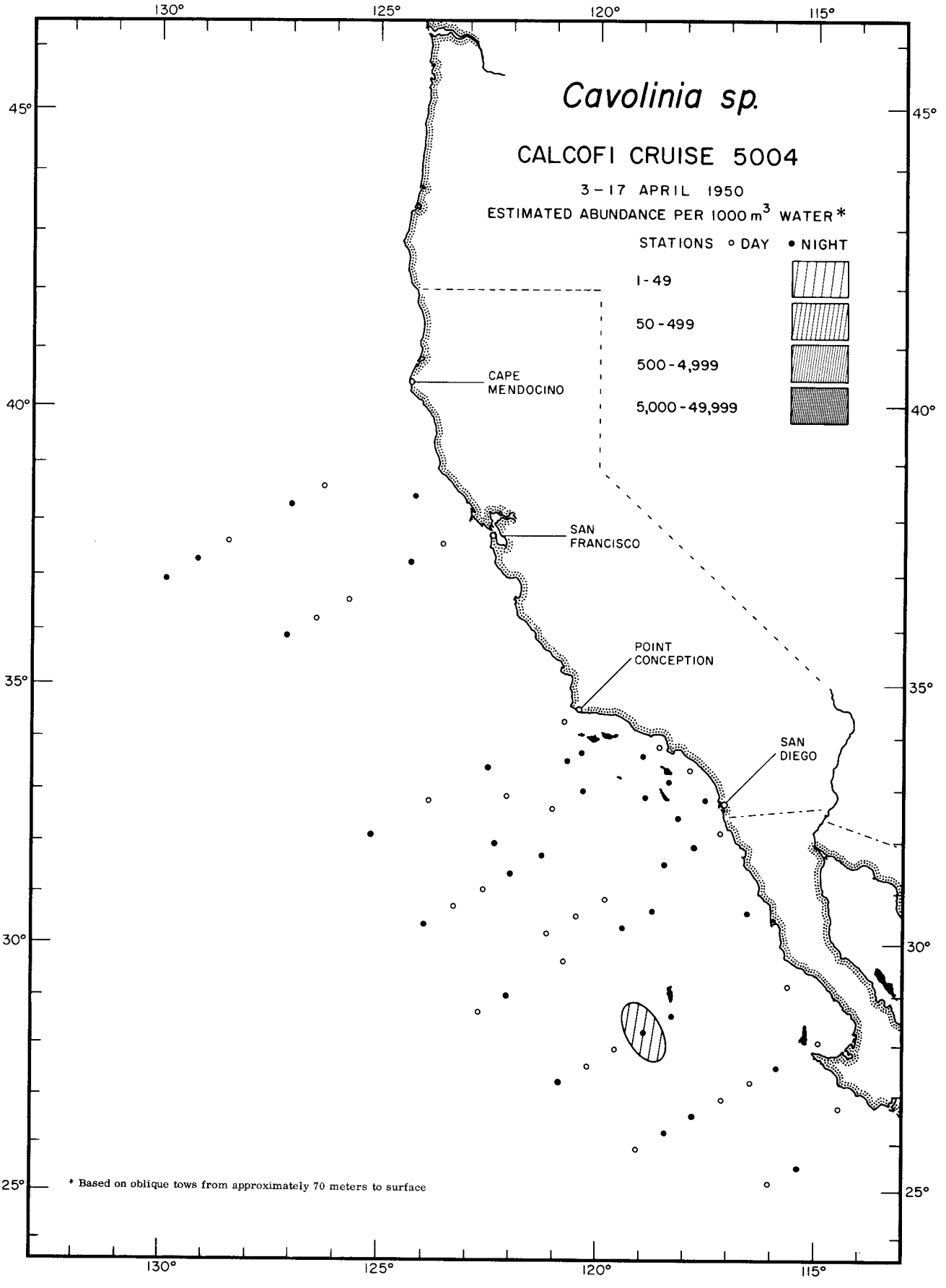
4911




Thecosomata

*Cavolinia sp.*

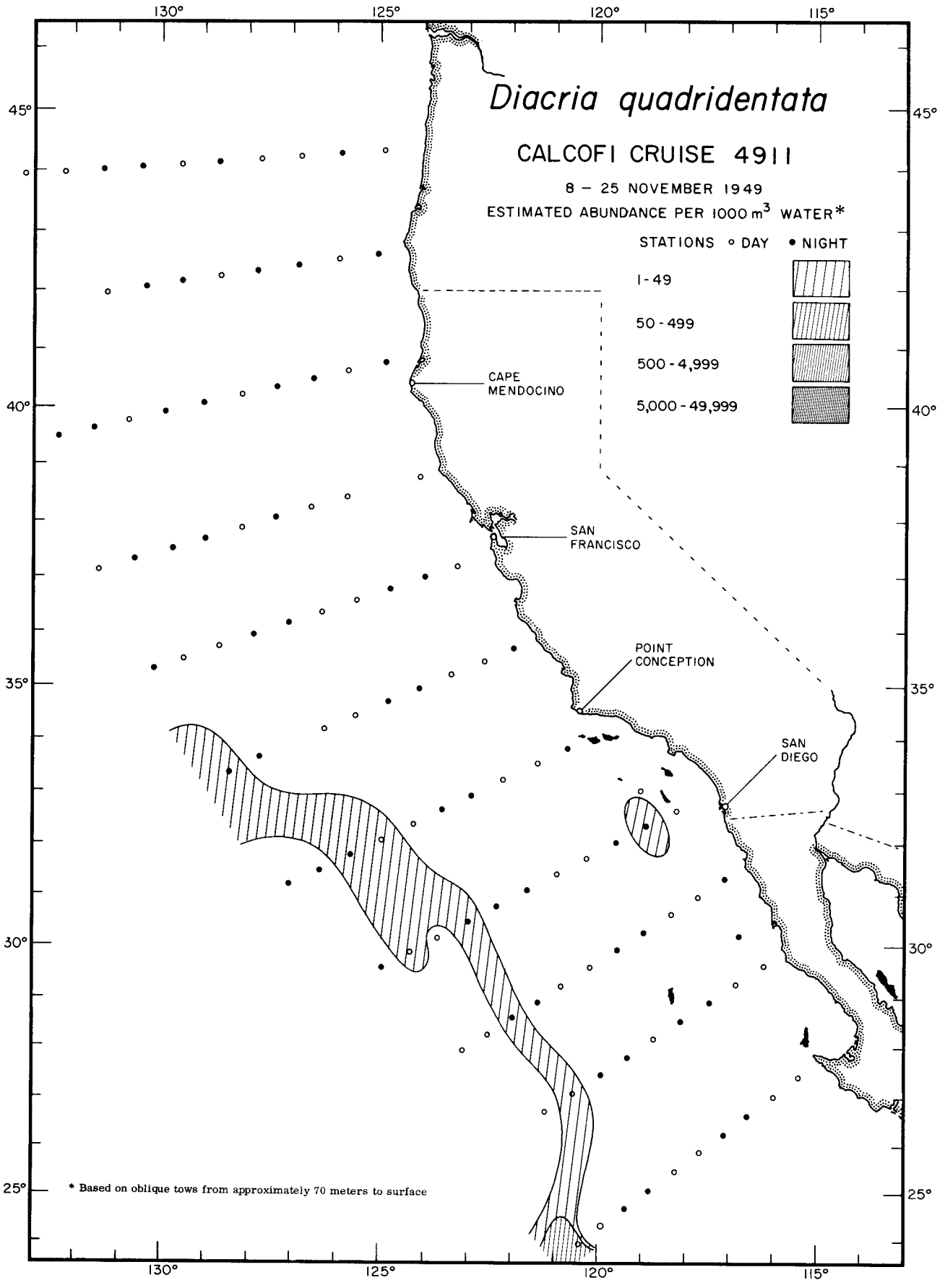
4911




Thecosomata

*Cavolinia sp.*

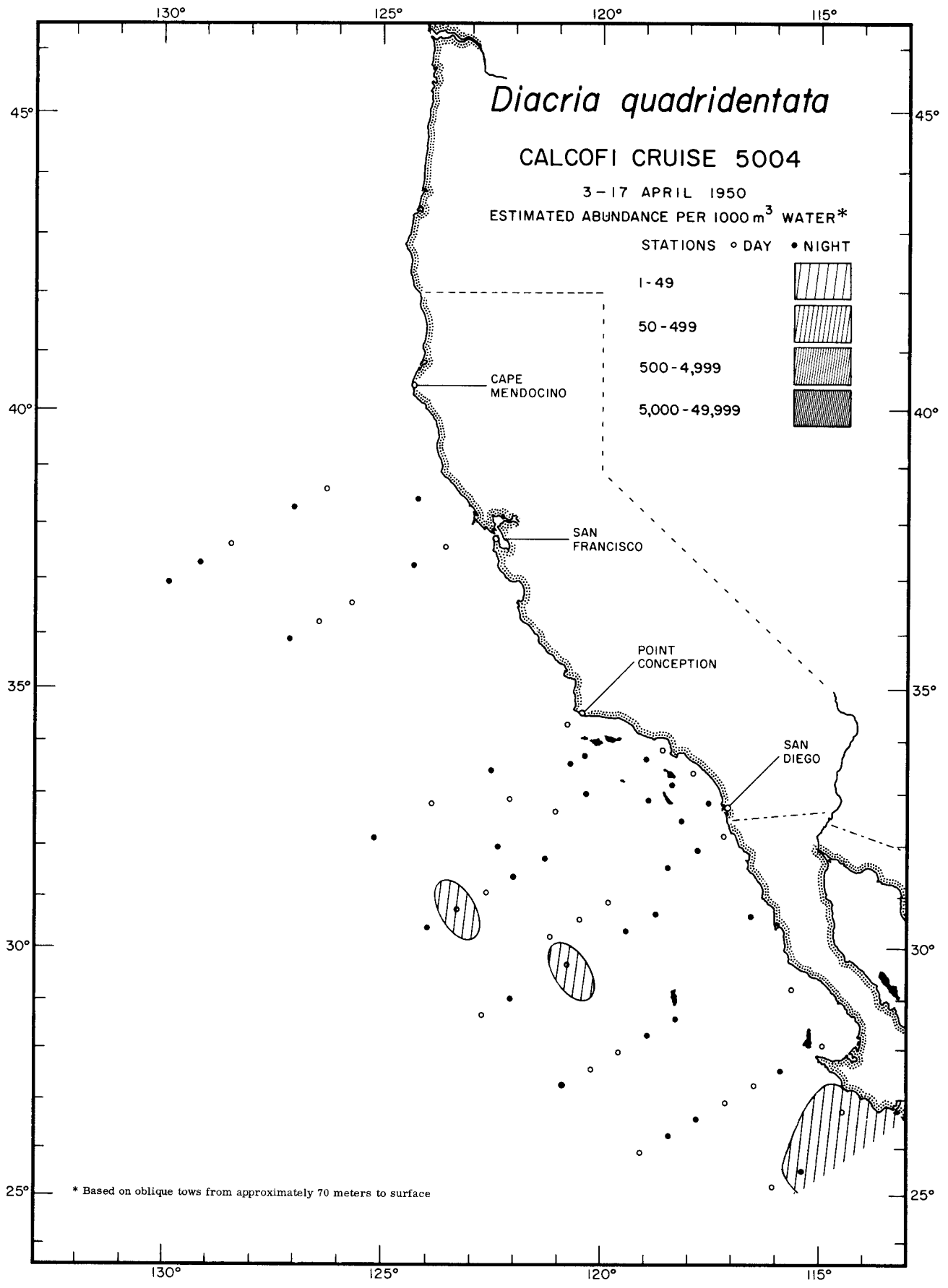
5004




Thecosomata

*Diacria quadridentata*

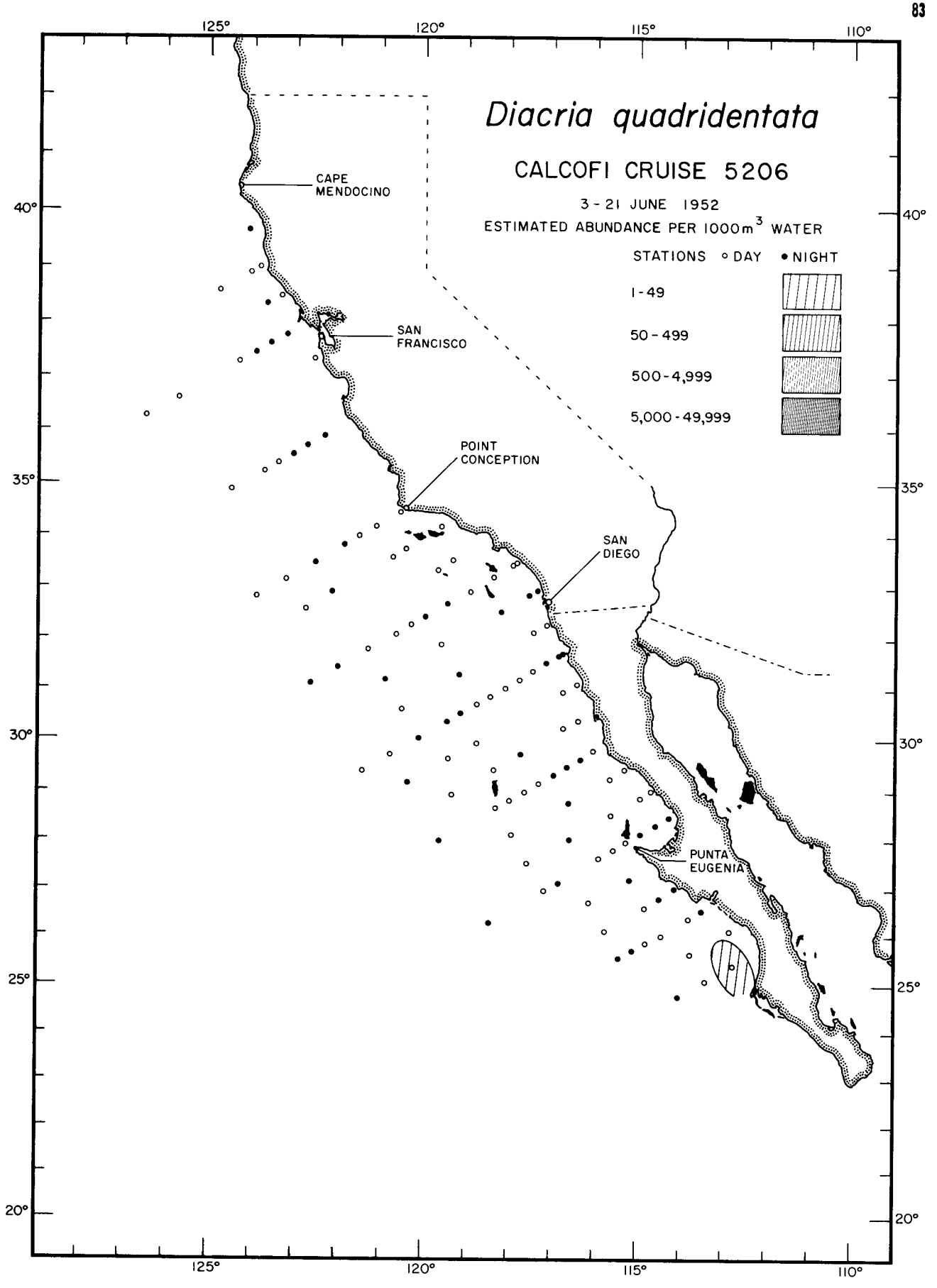
4911




Thecosomata

*Diacria quadridentata*

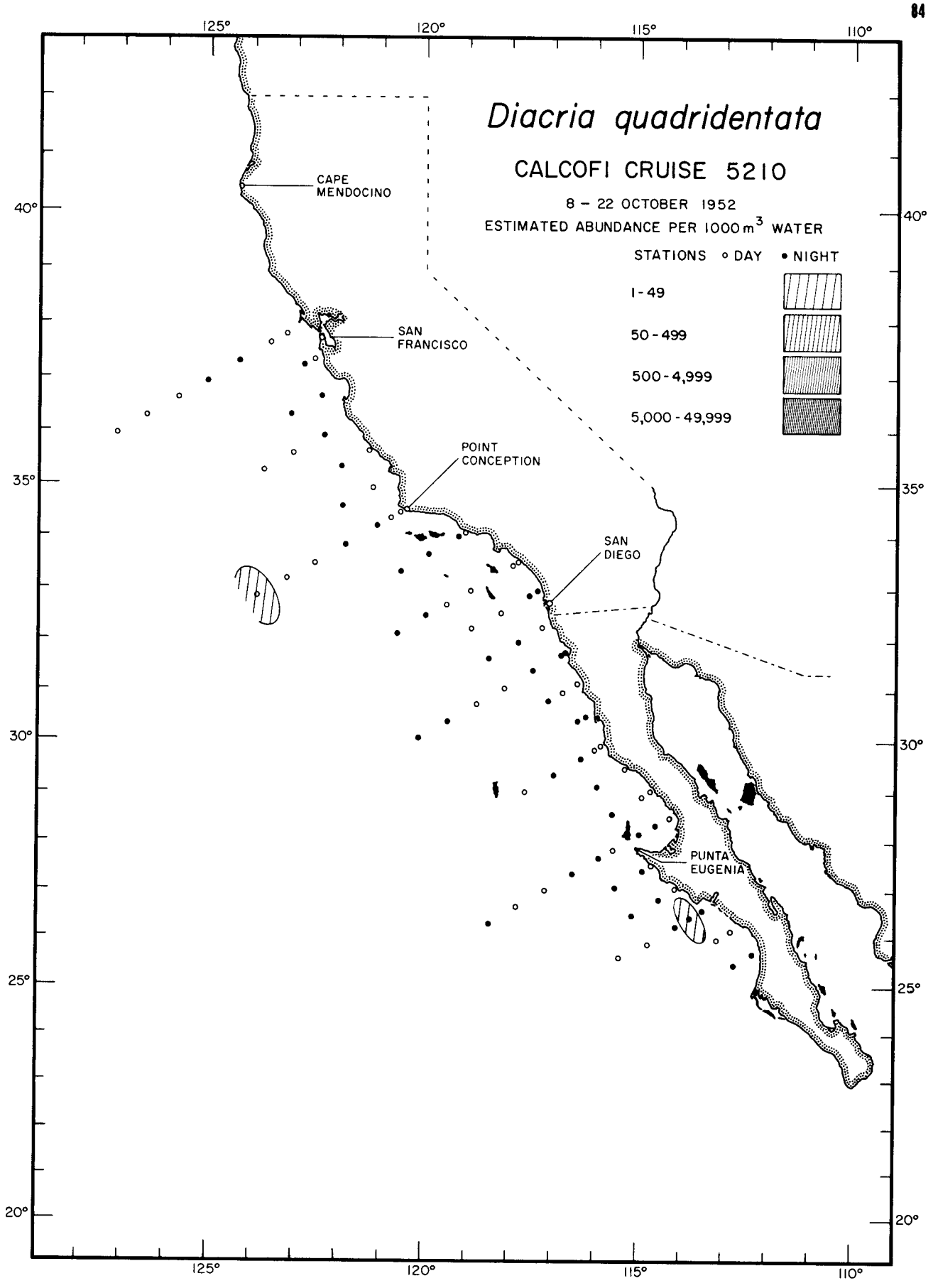
5004




Thecosomata

*Diacria quadridentata*

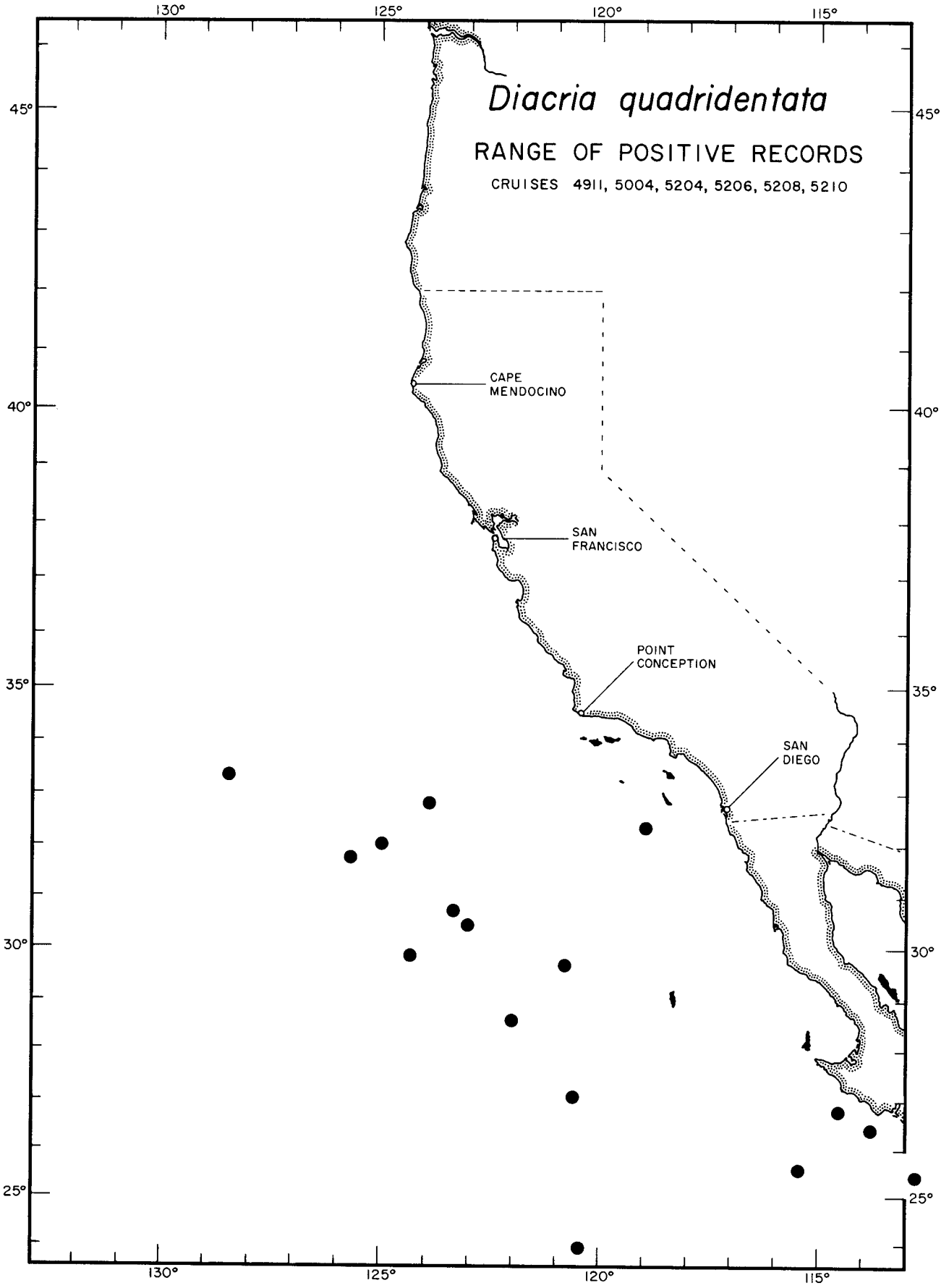
5206




Thecosomata

*Diacria quadridentata*

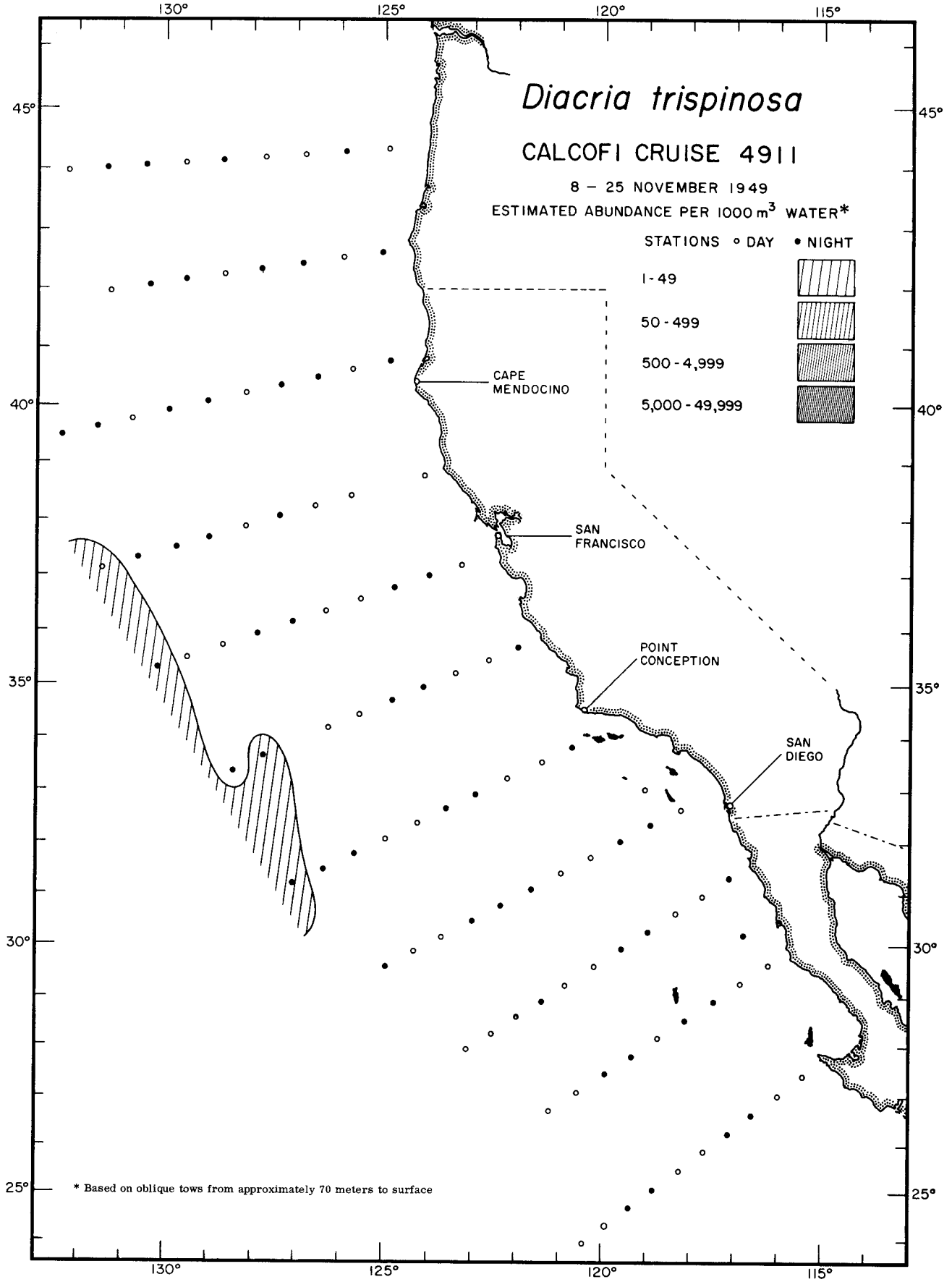
5210




Thecosomata

*Diacria quadridentata*

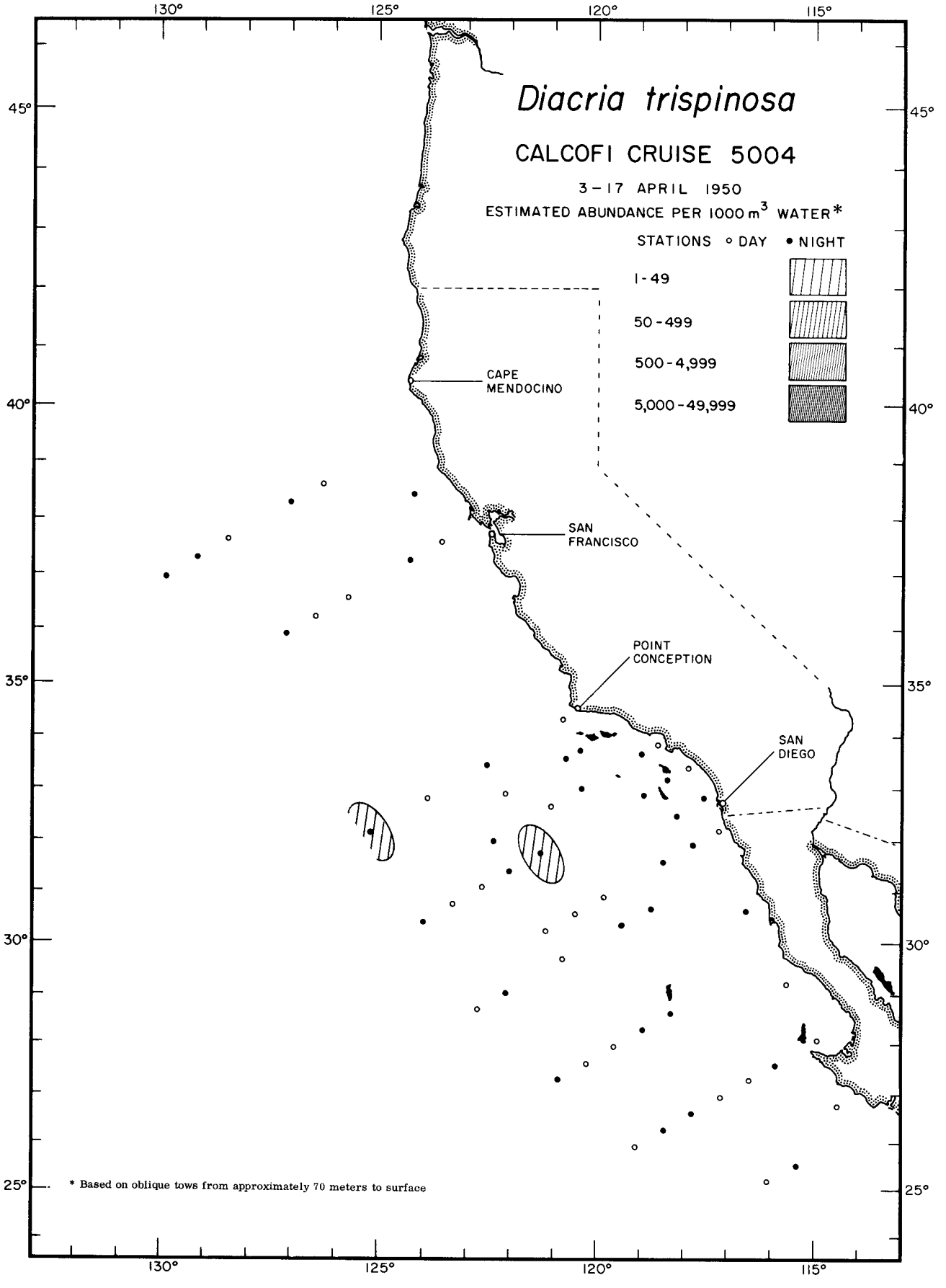
RANGE OF POSITIVE RECORDS




Thecosomata

*Diacria trispinosa*

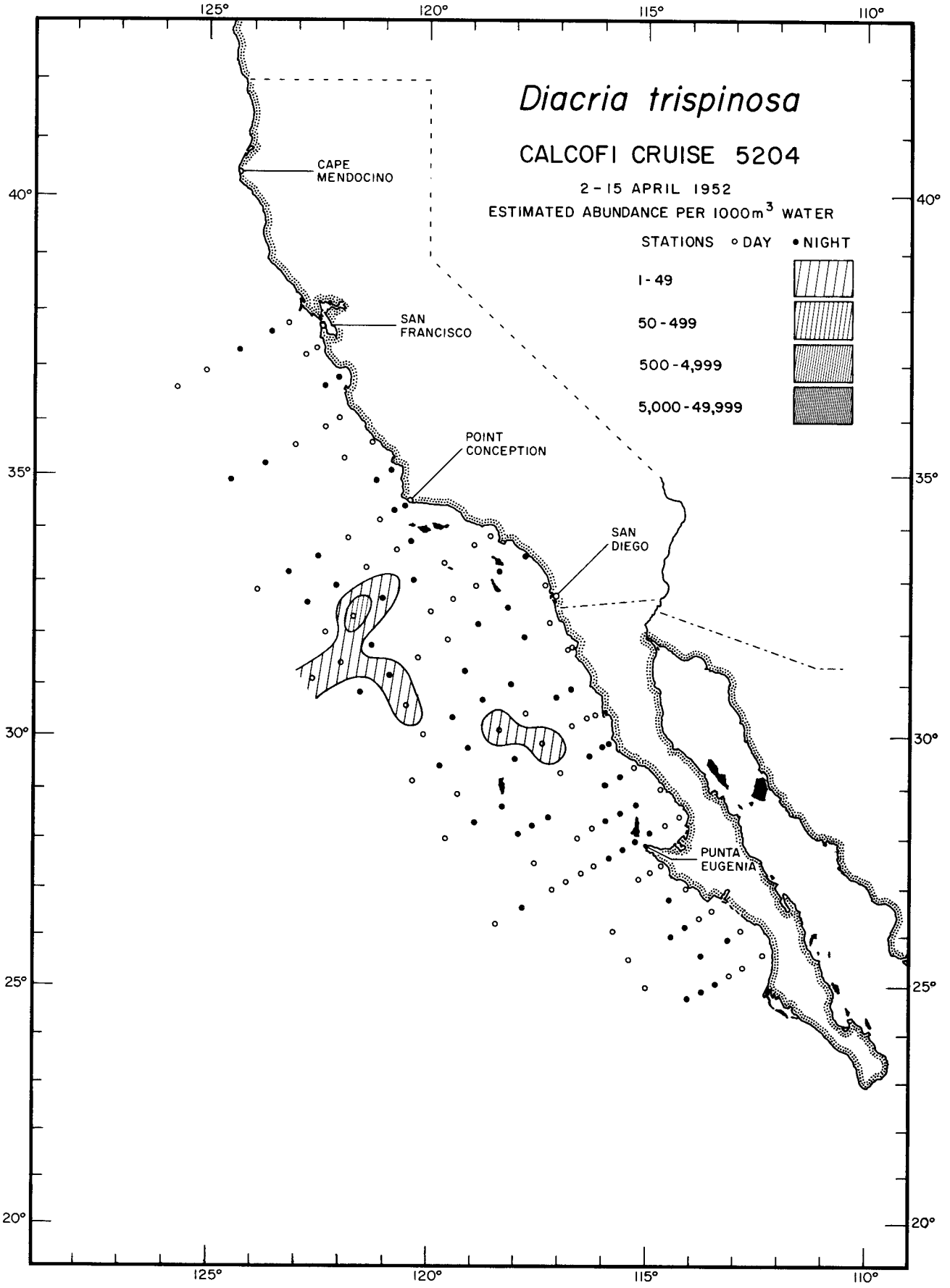
4911




Thecosomata

*Diacria trispinosa*

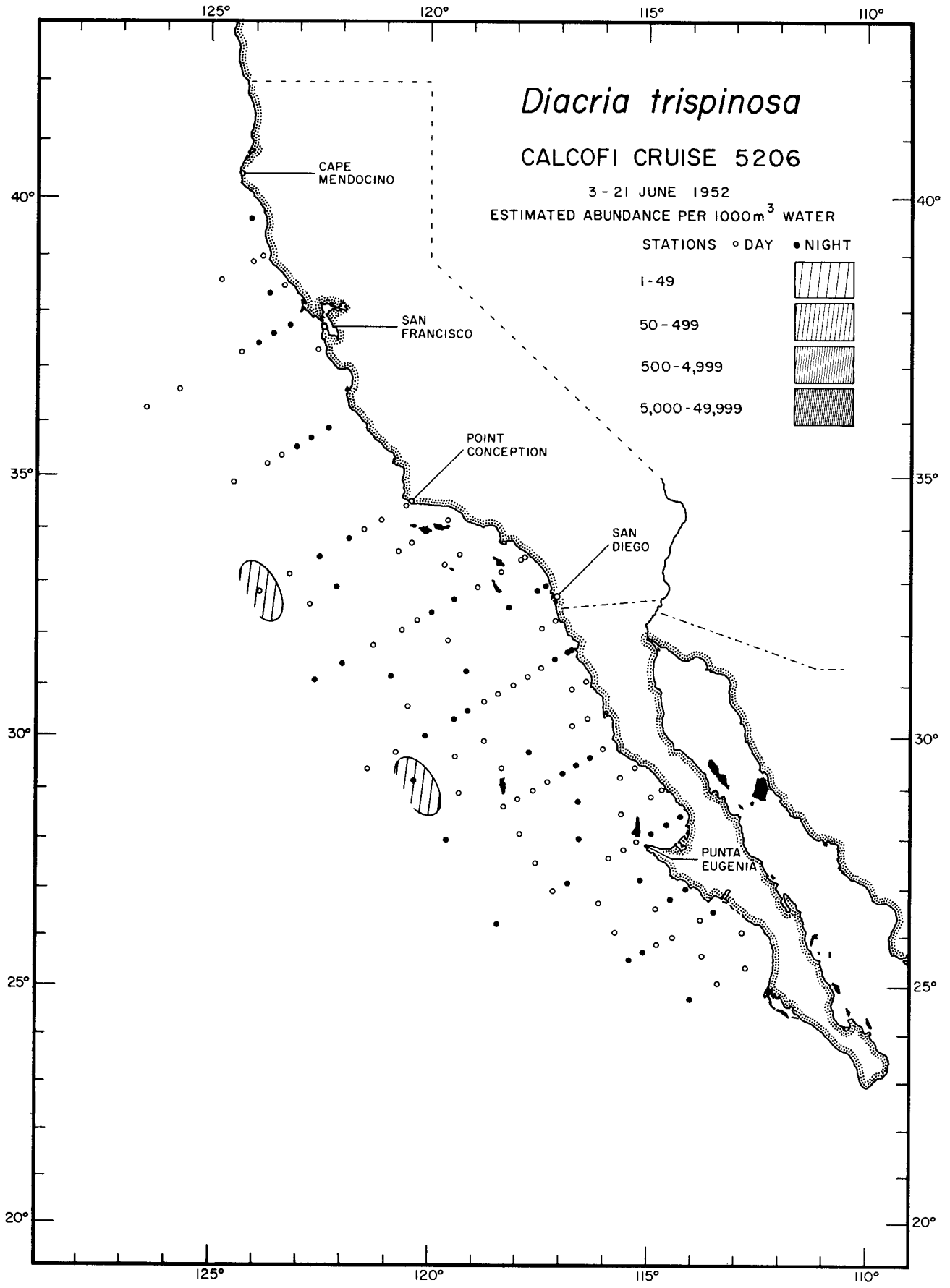
5004




Thecosomata

*Diacria trispinosa*

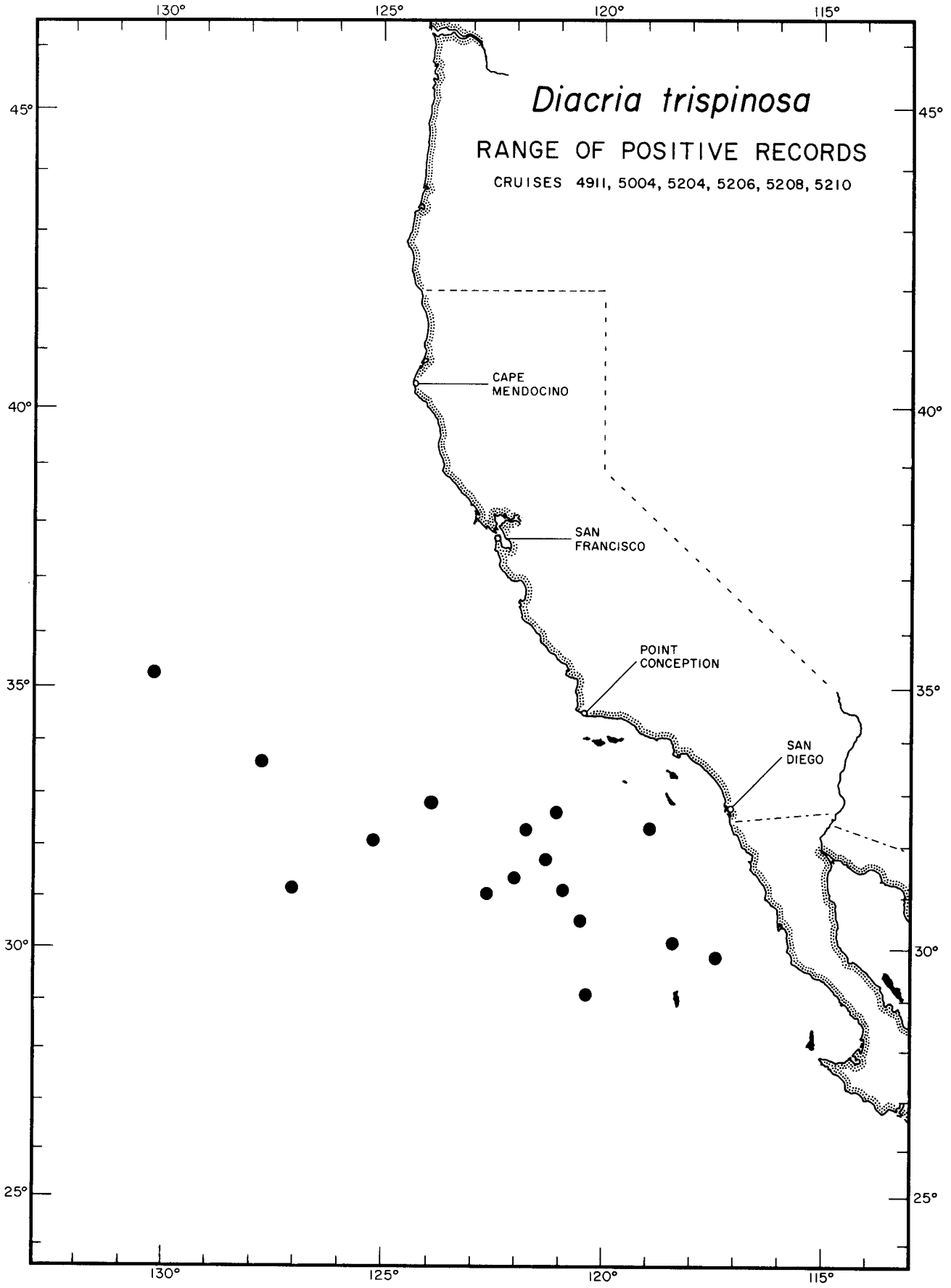
5204




Thecosomata

*Diacria trispinosa*

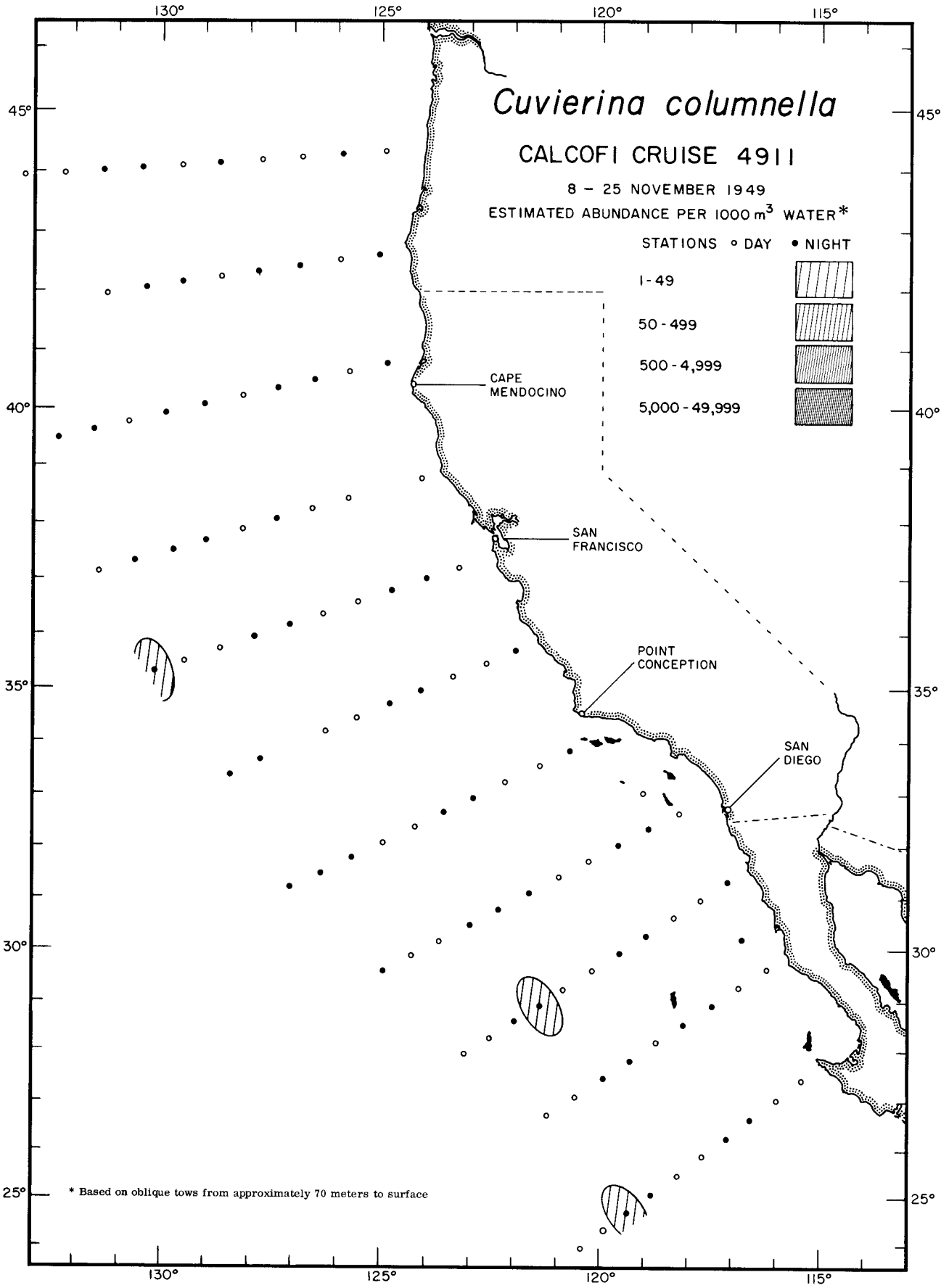
5206




Thecosomata

*Diacria trispinosa*

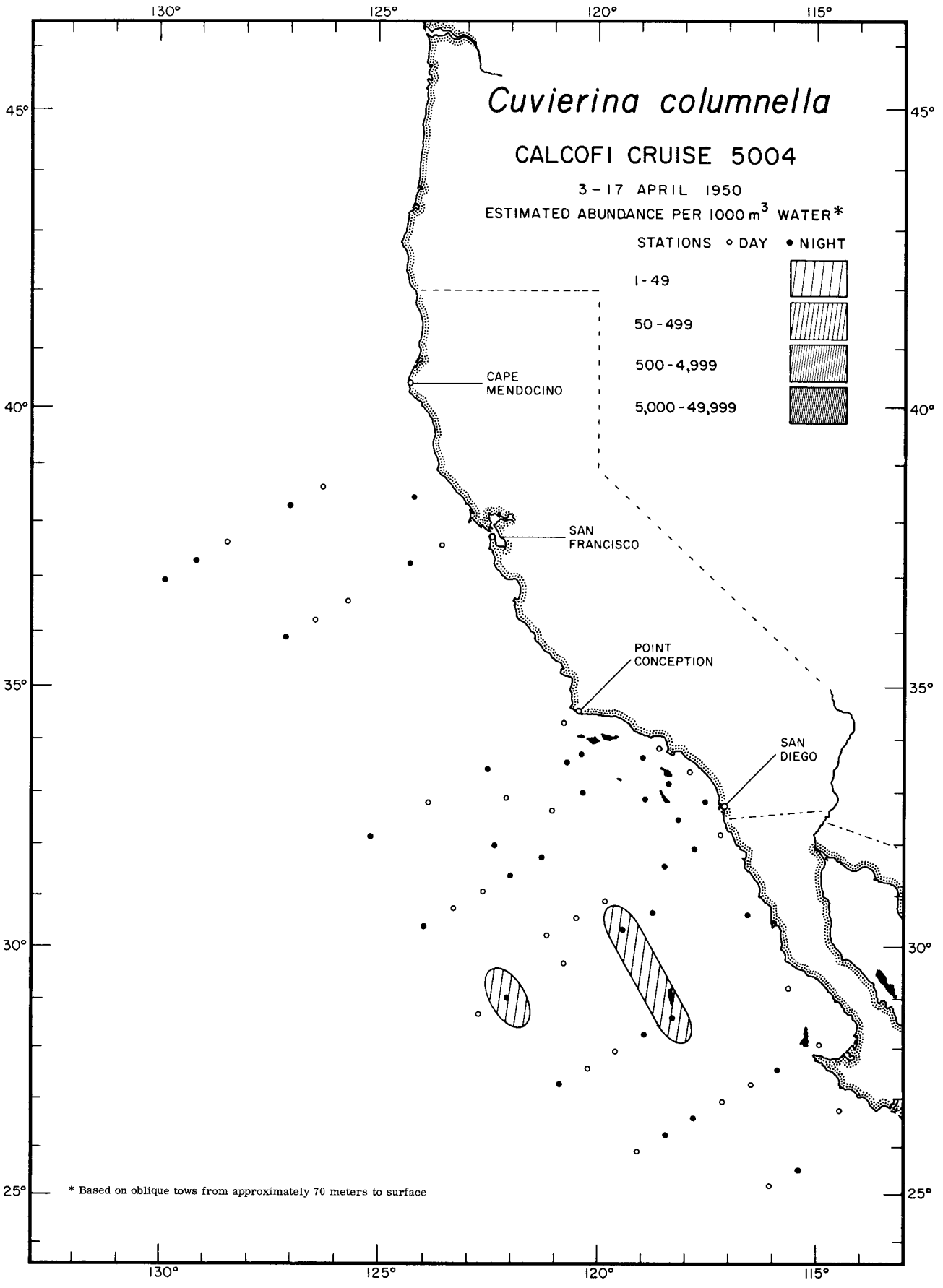
RANGE OF POSITIVE RECORDS




Thecosomata

*Cuvierina columnella*

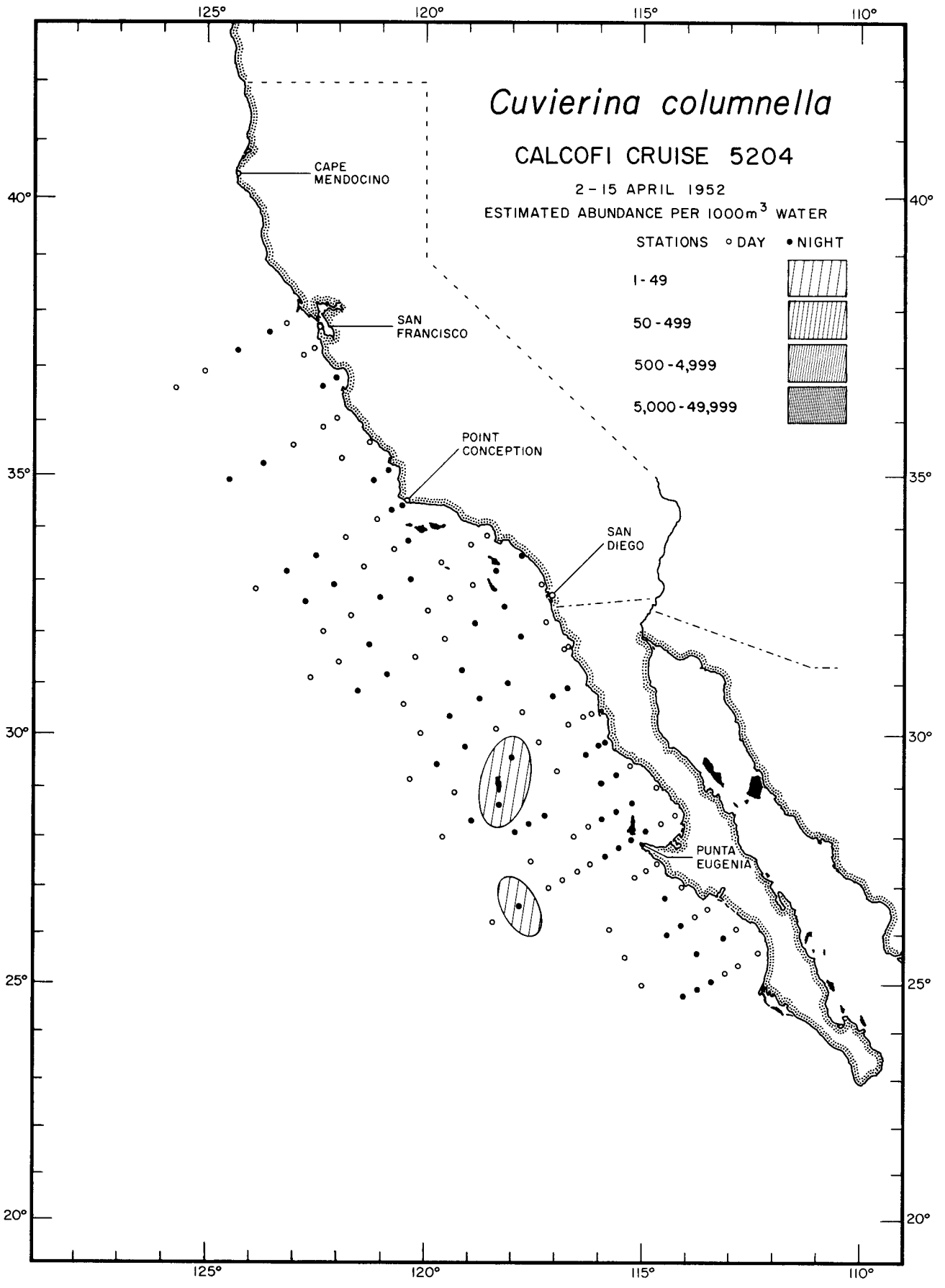
4911




Thecosomata

*Cuvierina columnella*

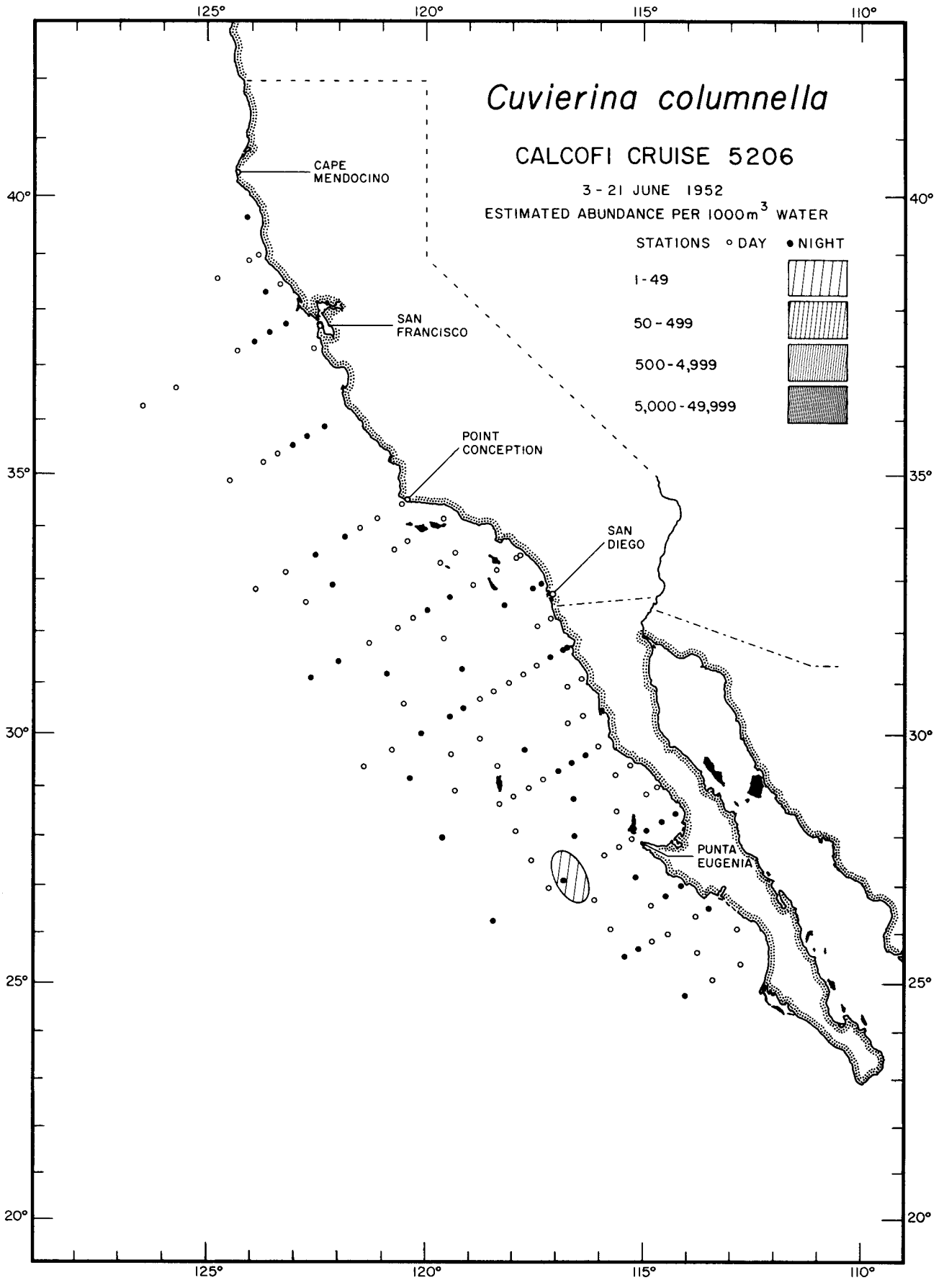
5004




Thecosomata

*Cuvierina columnella*

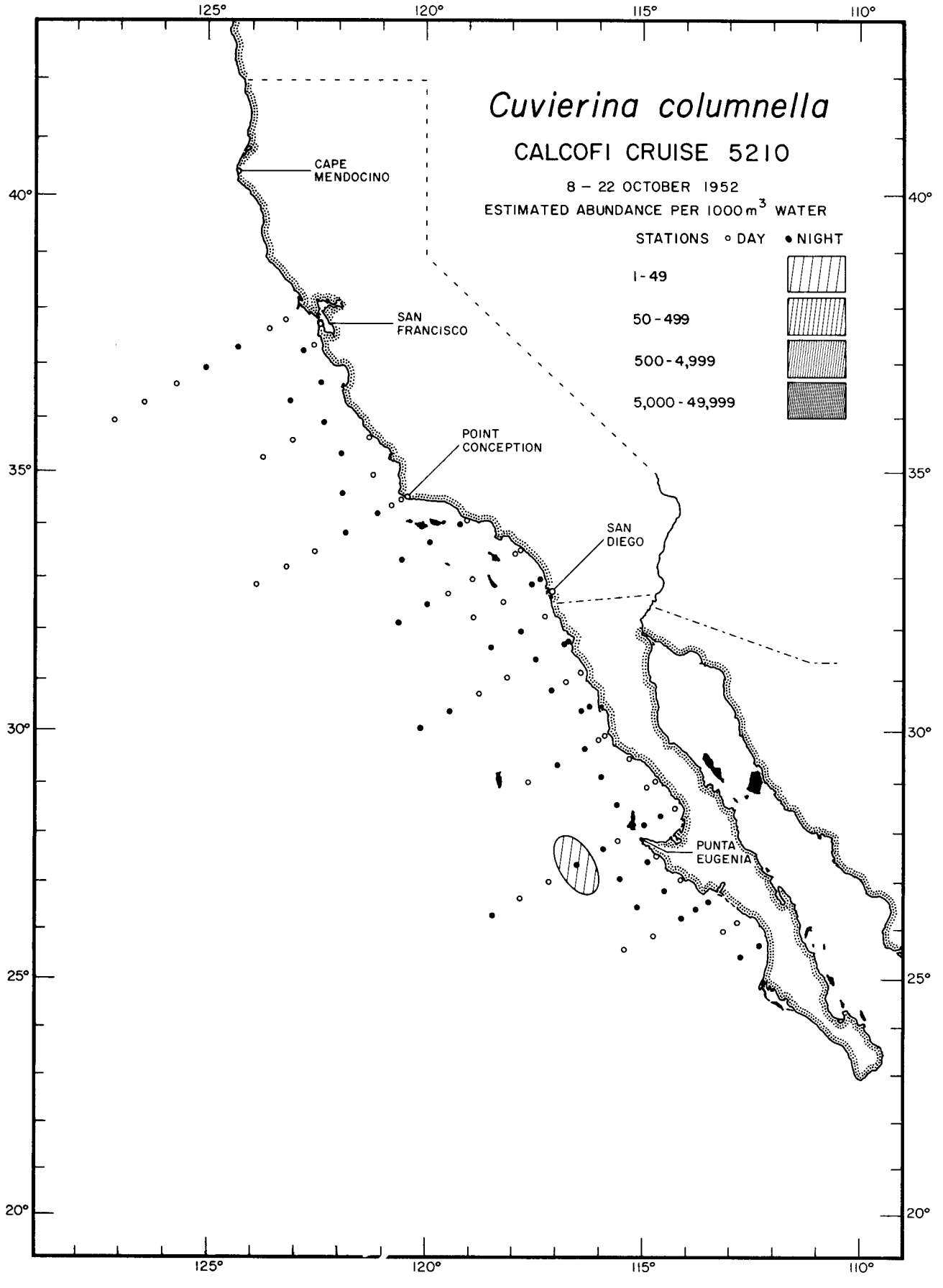
5204




Thecosomata

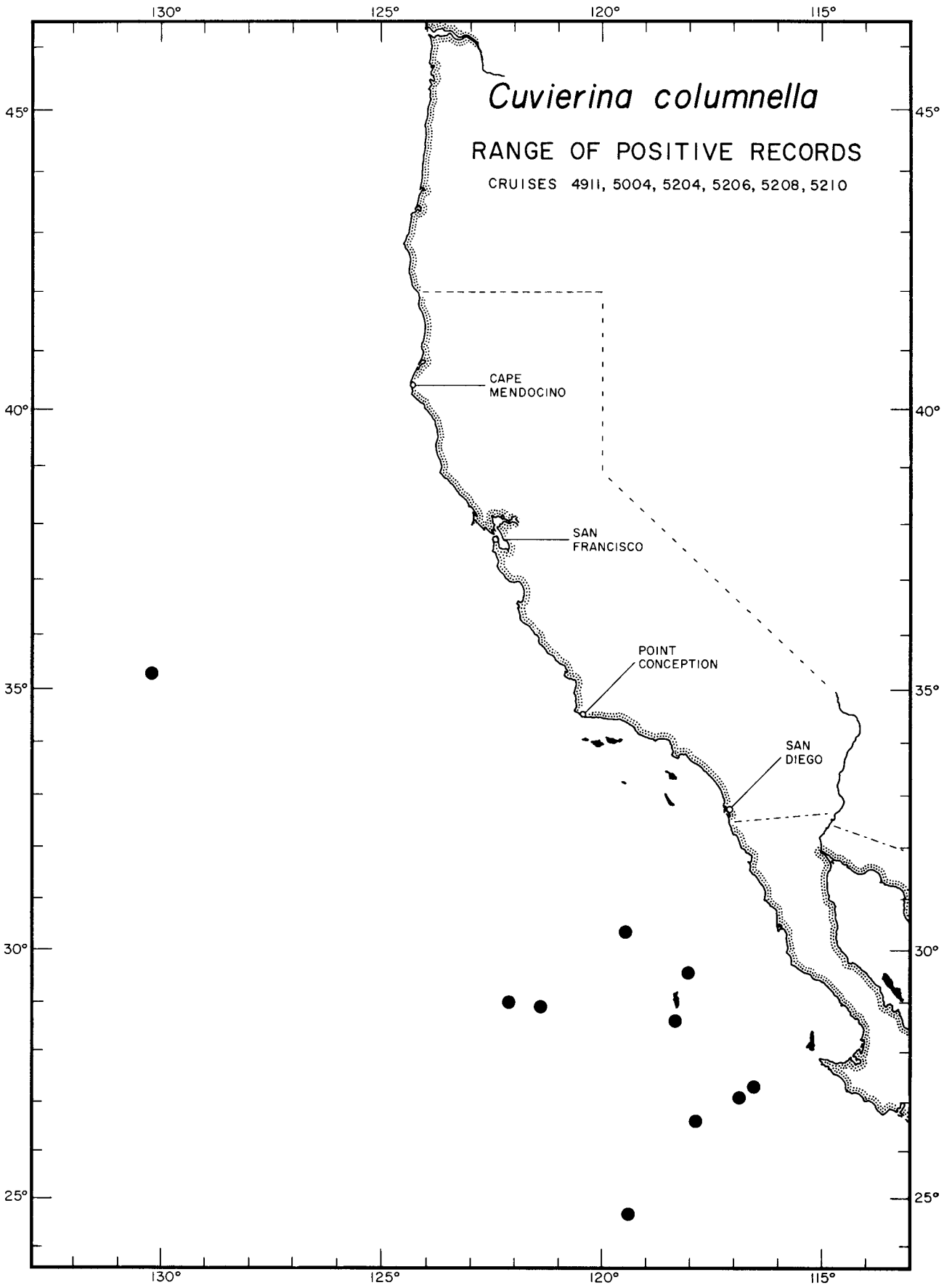
*Cuvierina columnella*

5206




Thecosomata

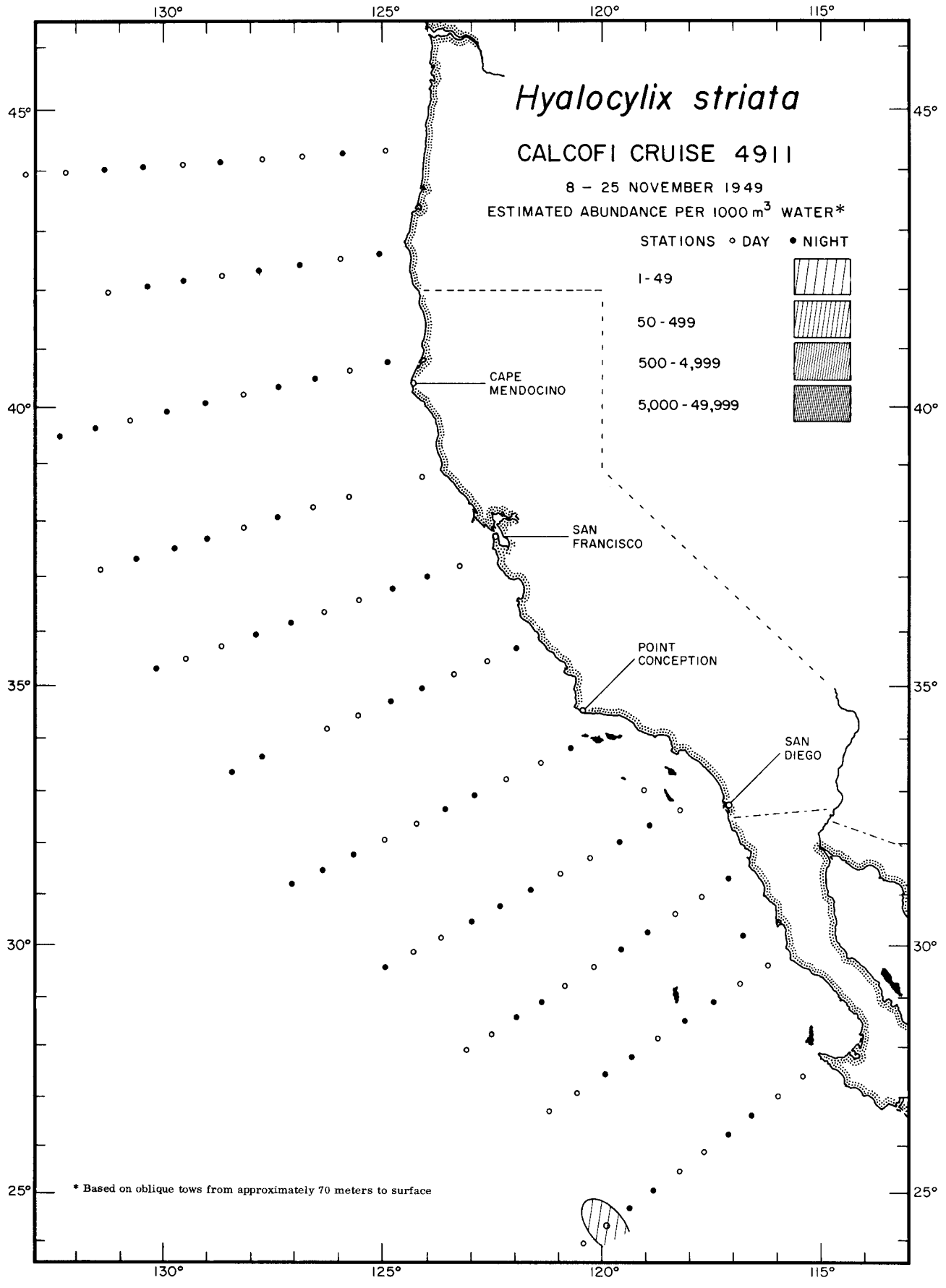
*Cuvierina columnella*
5210




Thecosomata

*Cuvierina columnella*

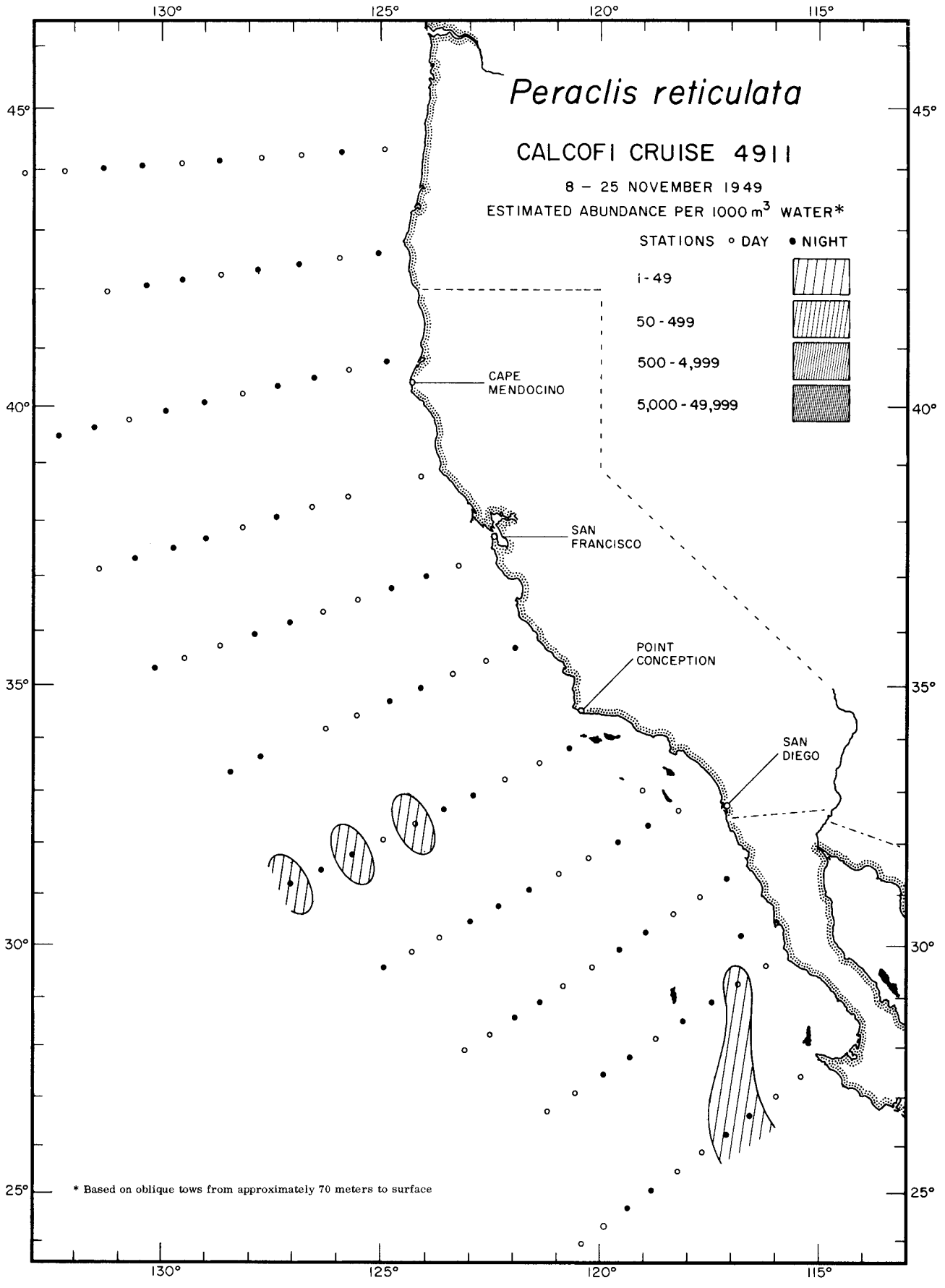
RANGE OF POSITIVE RECORDS




Thecosomata

*Hyalocylix striata*

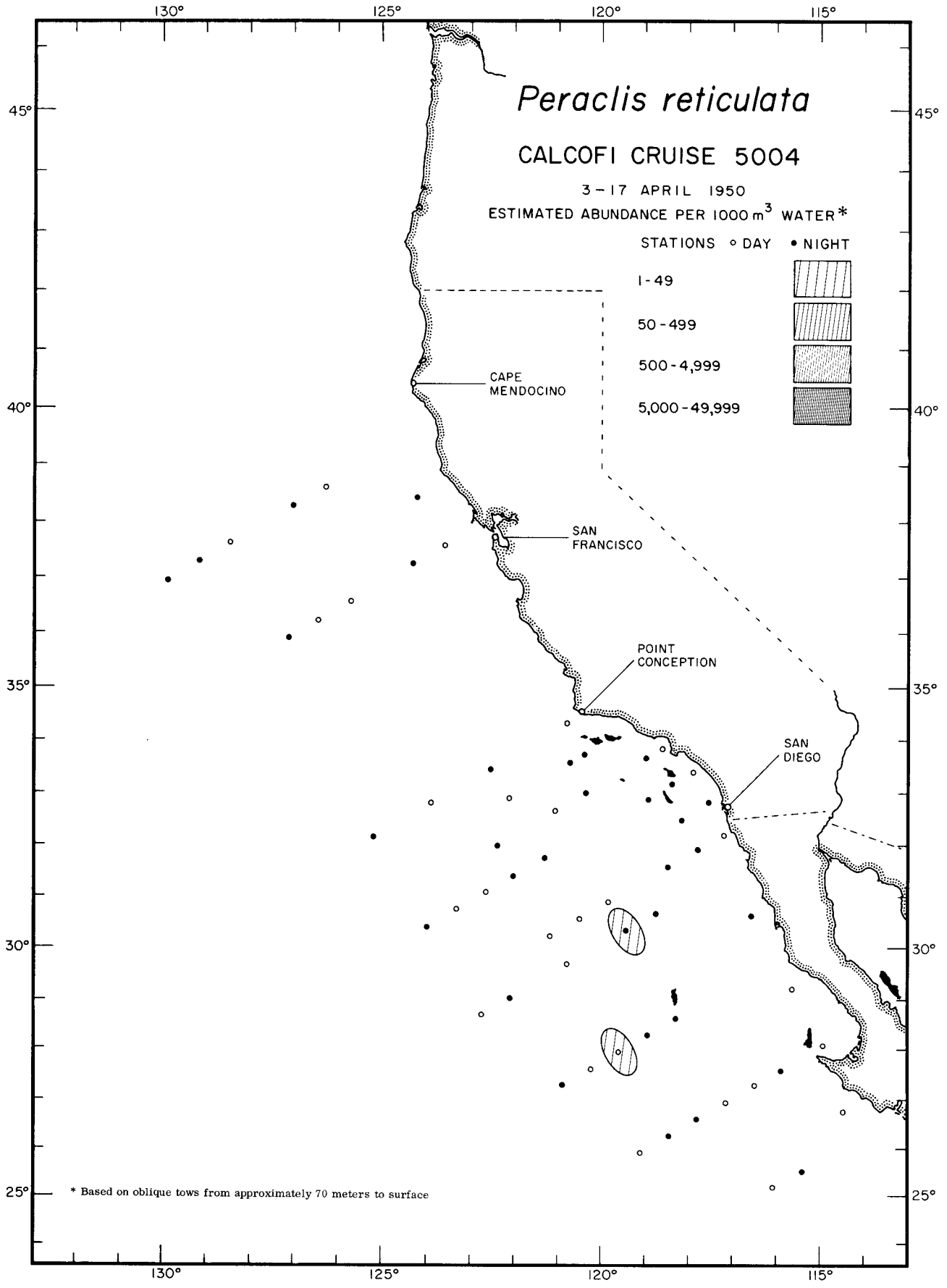
4911




Thecosomata

*Peraclis reticulata*

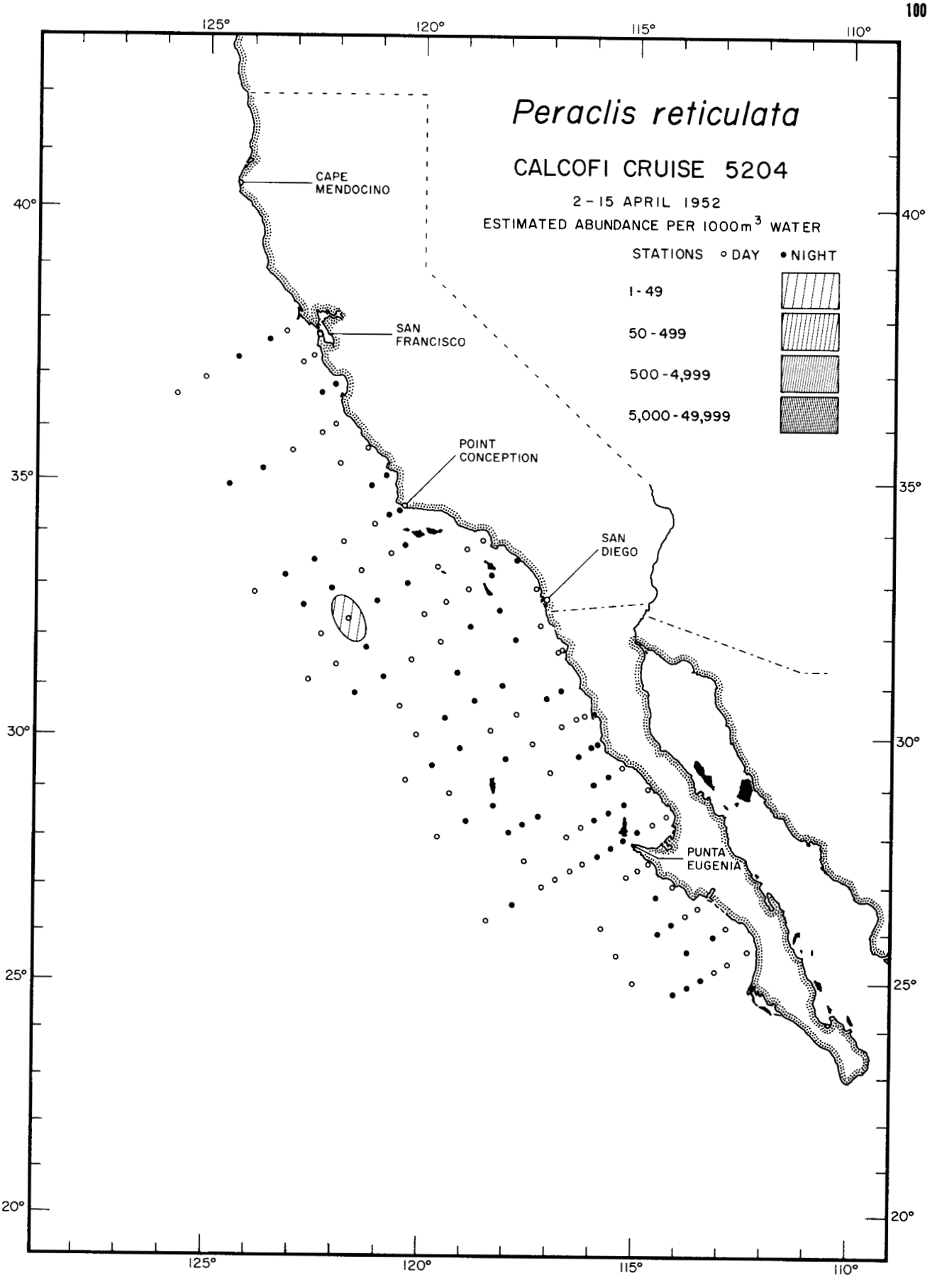
4911




Thecosomata

*Peraclis reticulata*

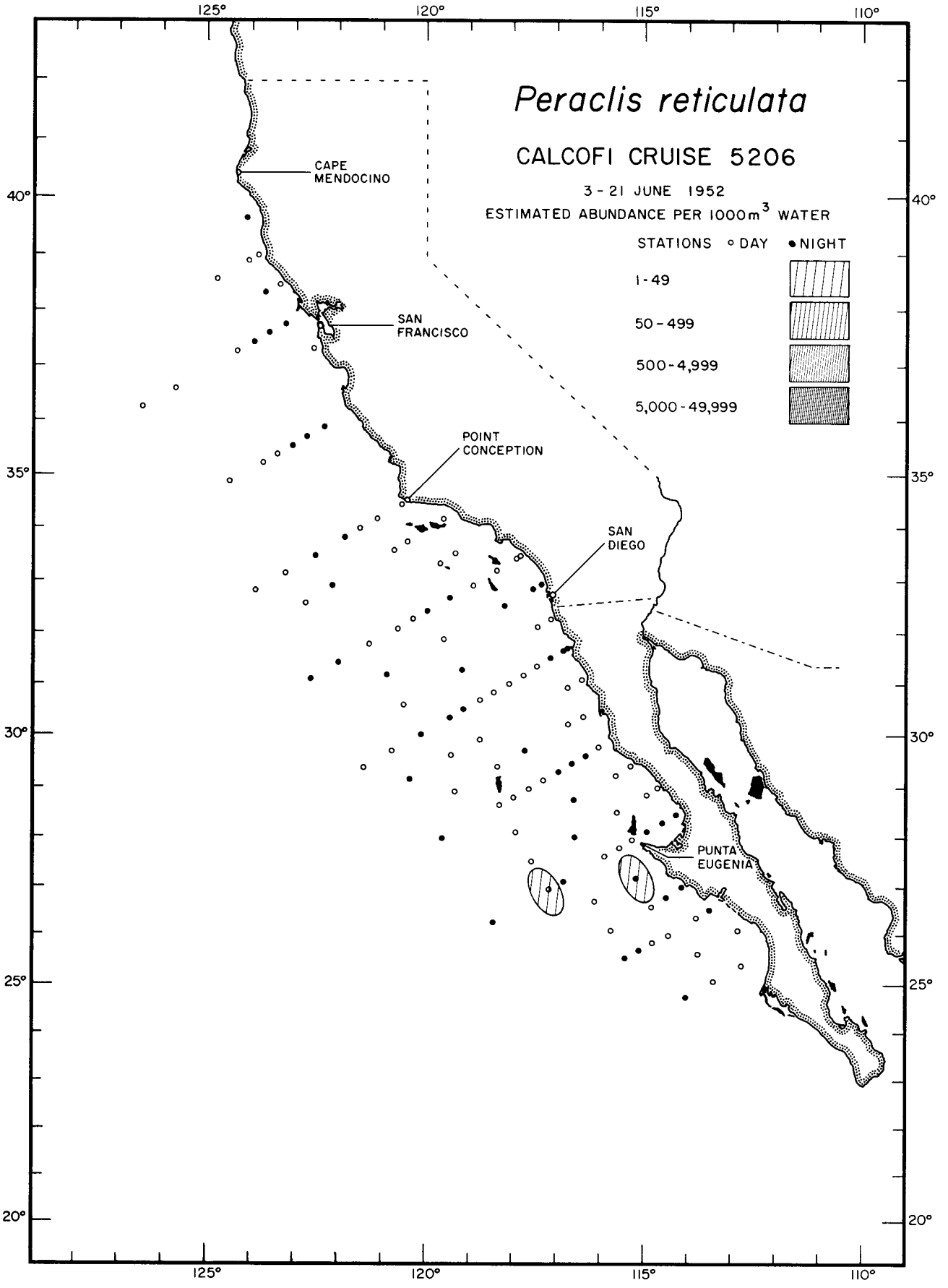
5004




Thecosomata

*Peraclis reticulata*

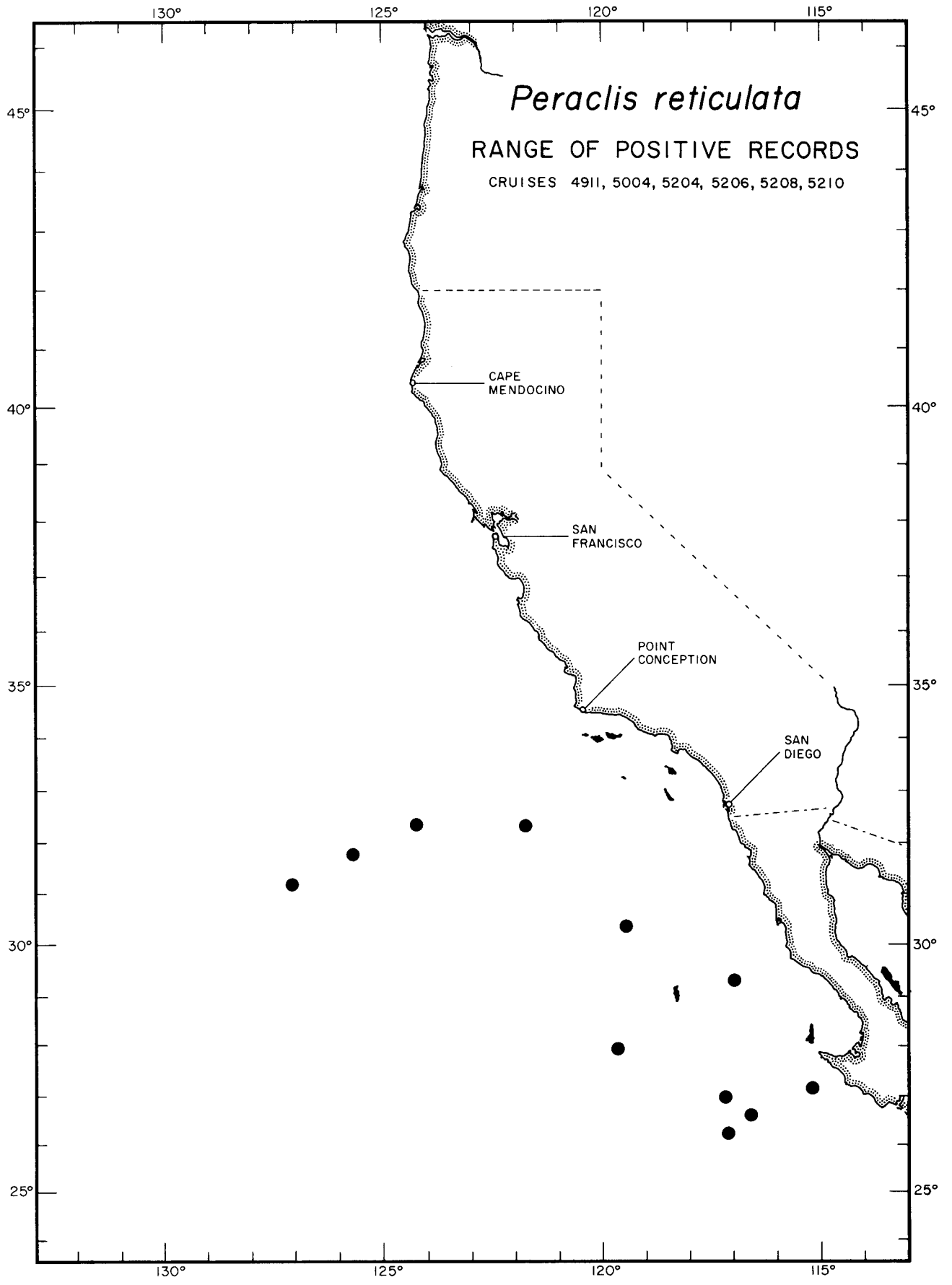
5204




Thecosomata

*Peraclis reticulata*

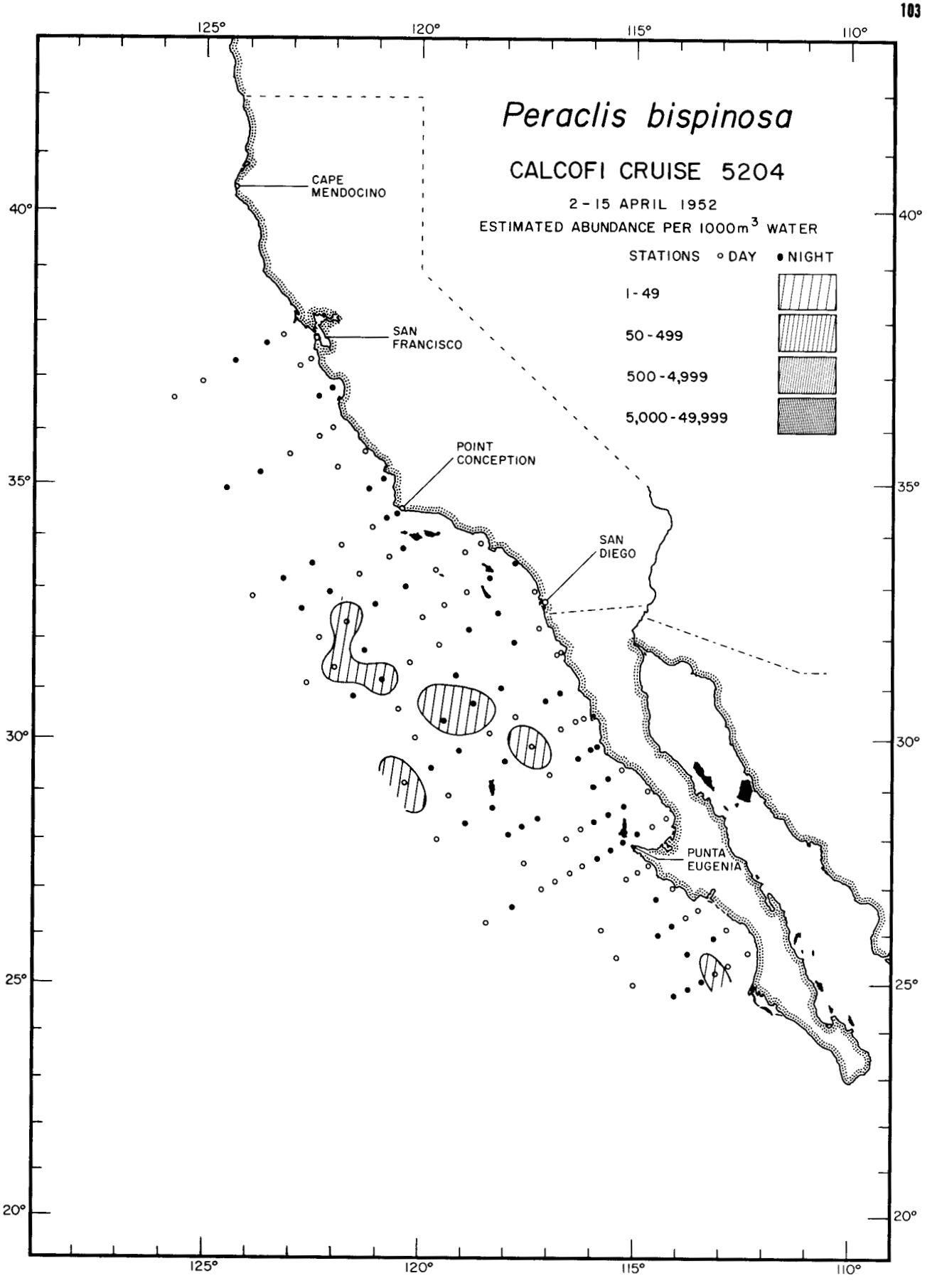
5206




Thecosomata

*Peraclis reticulata*

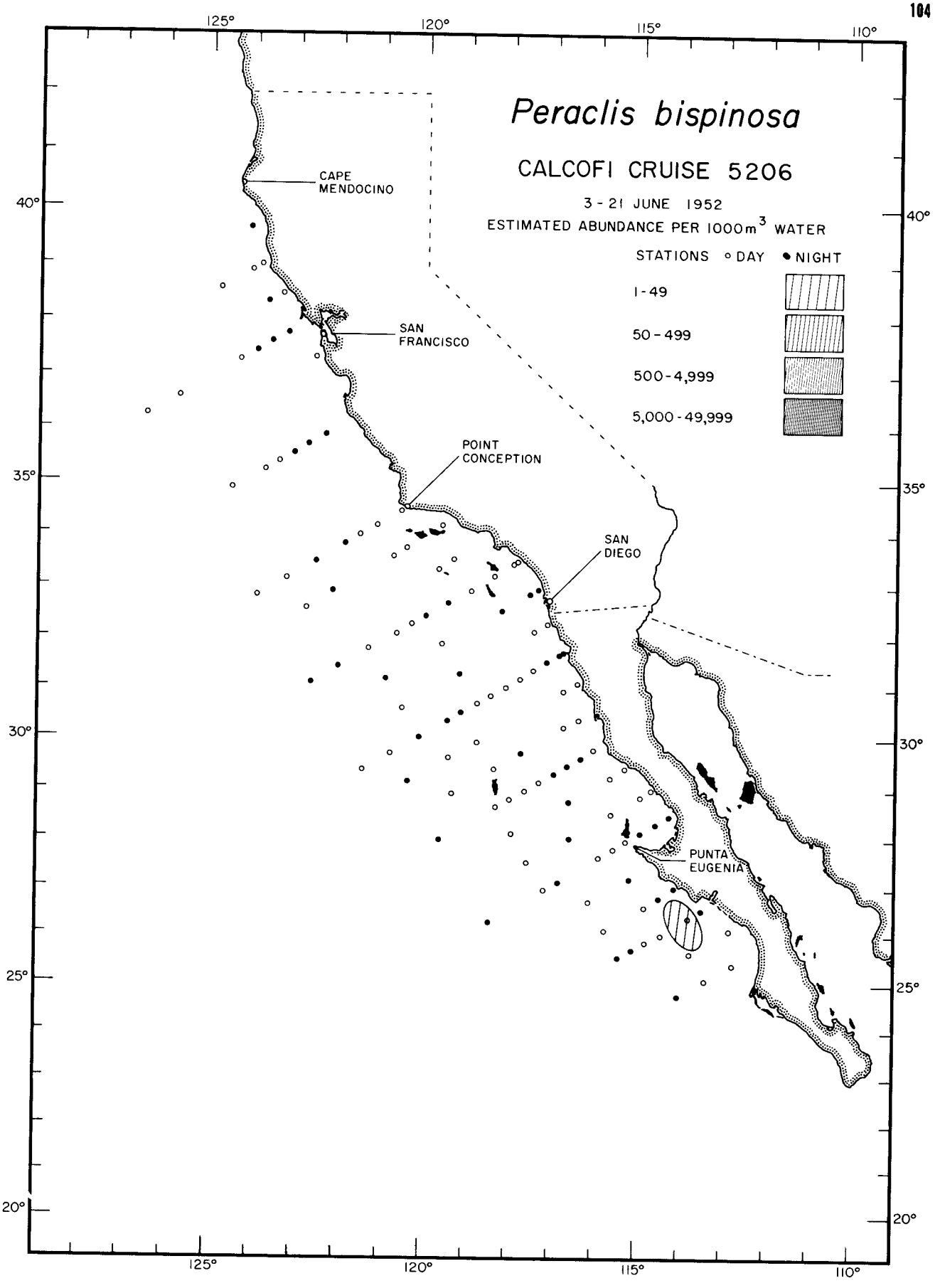
RANGE OF POSITIVE RECORDS




Thecosomata

*Peraclis bispinosa*

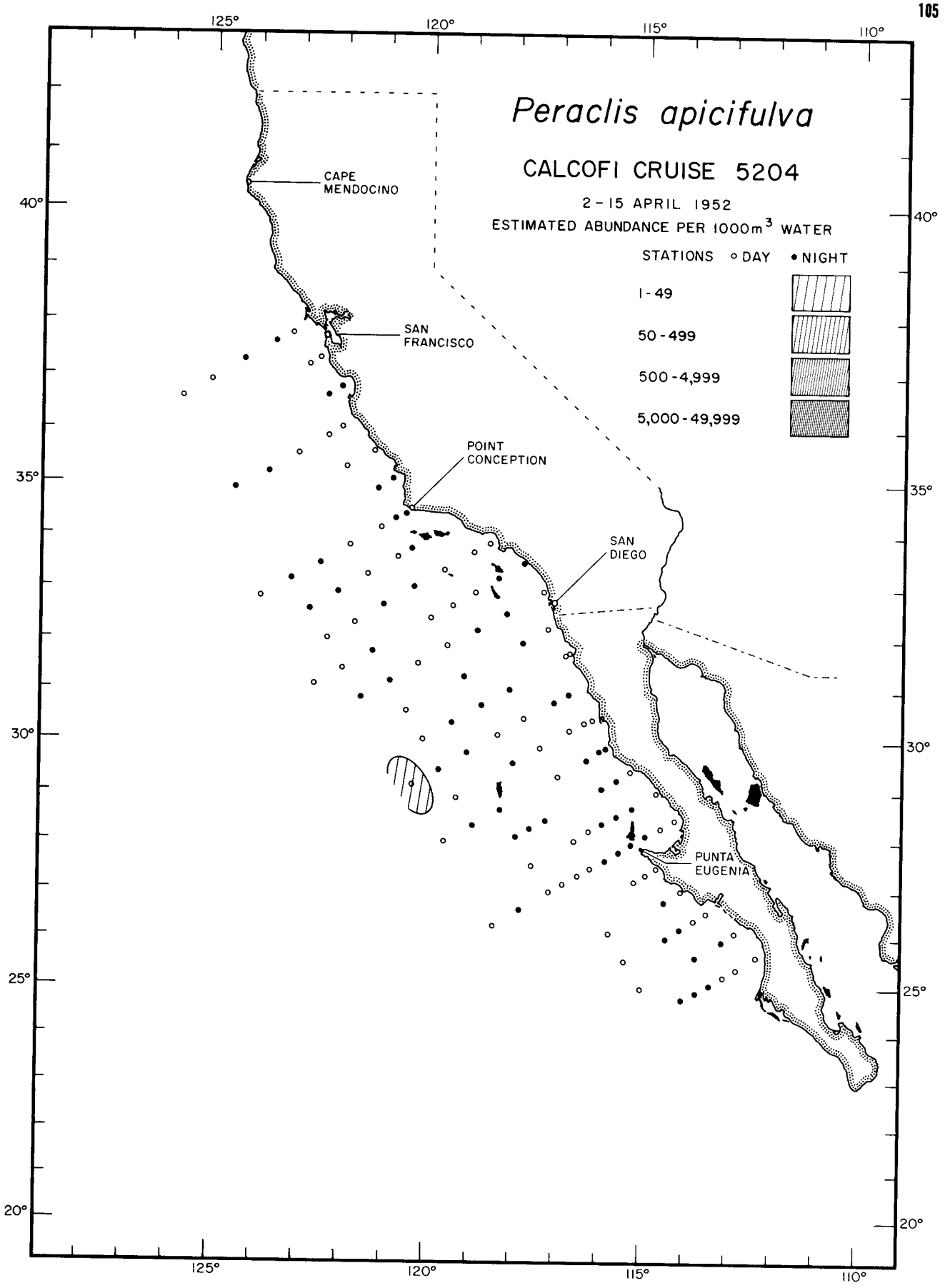
5204




Thecosomata

*Peraclis bispinosa*

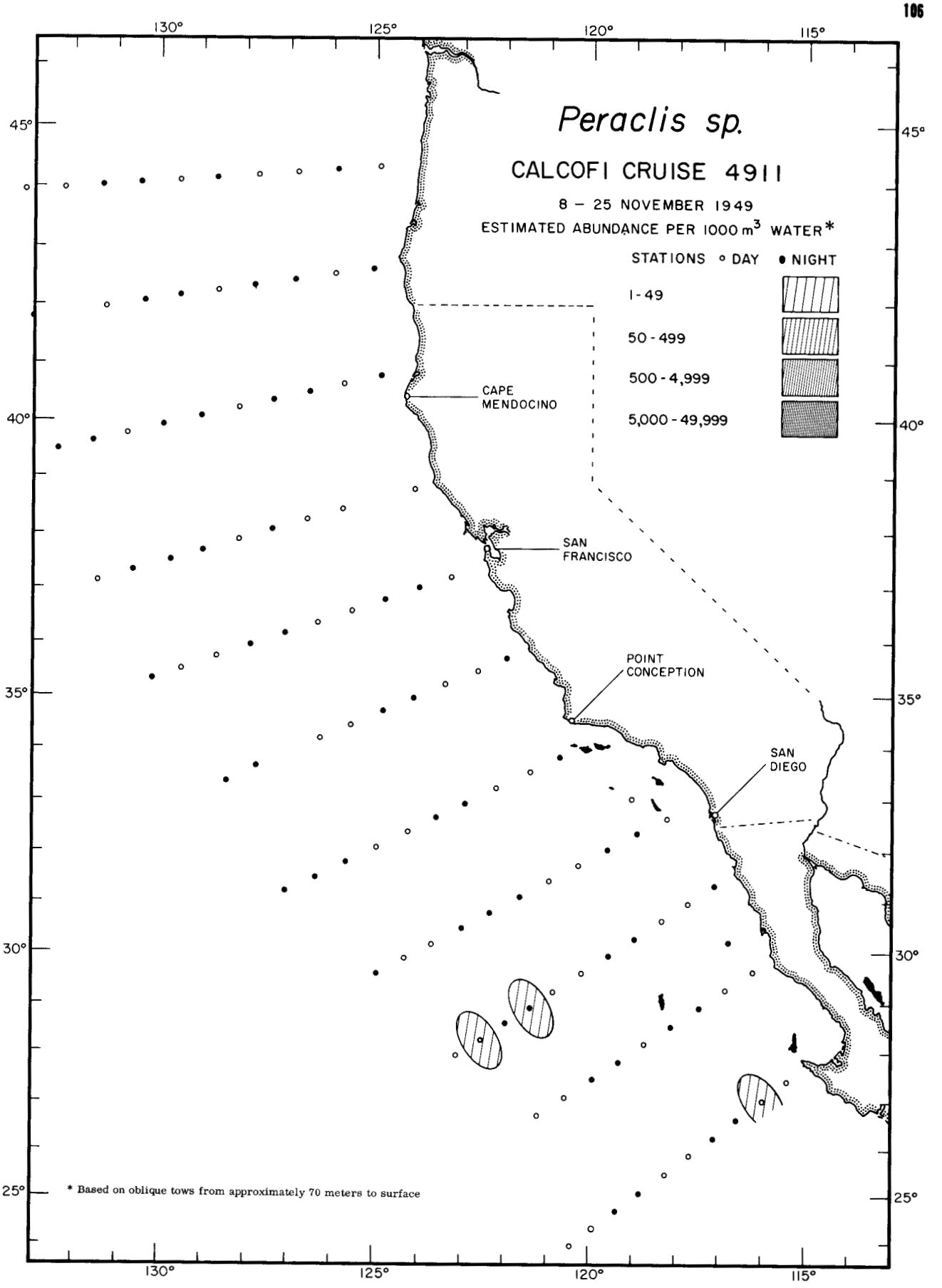
5206




Thecosomata

*Peraclis apicifulva*

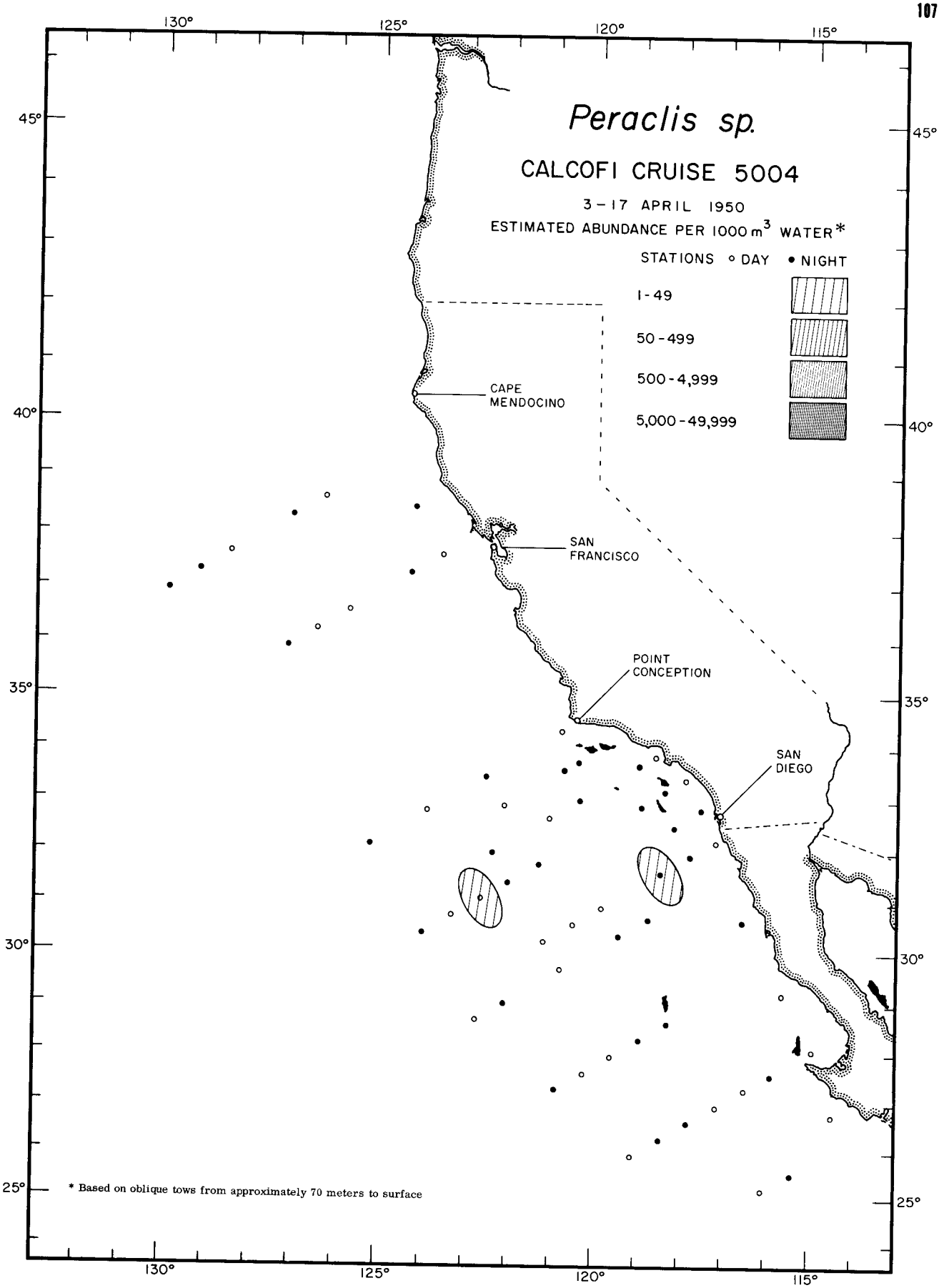
5204




Thecosomata

*Peraclis sp.*

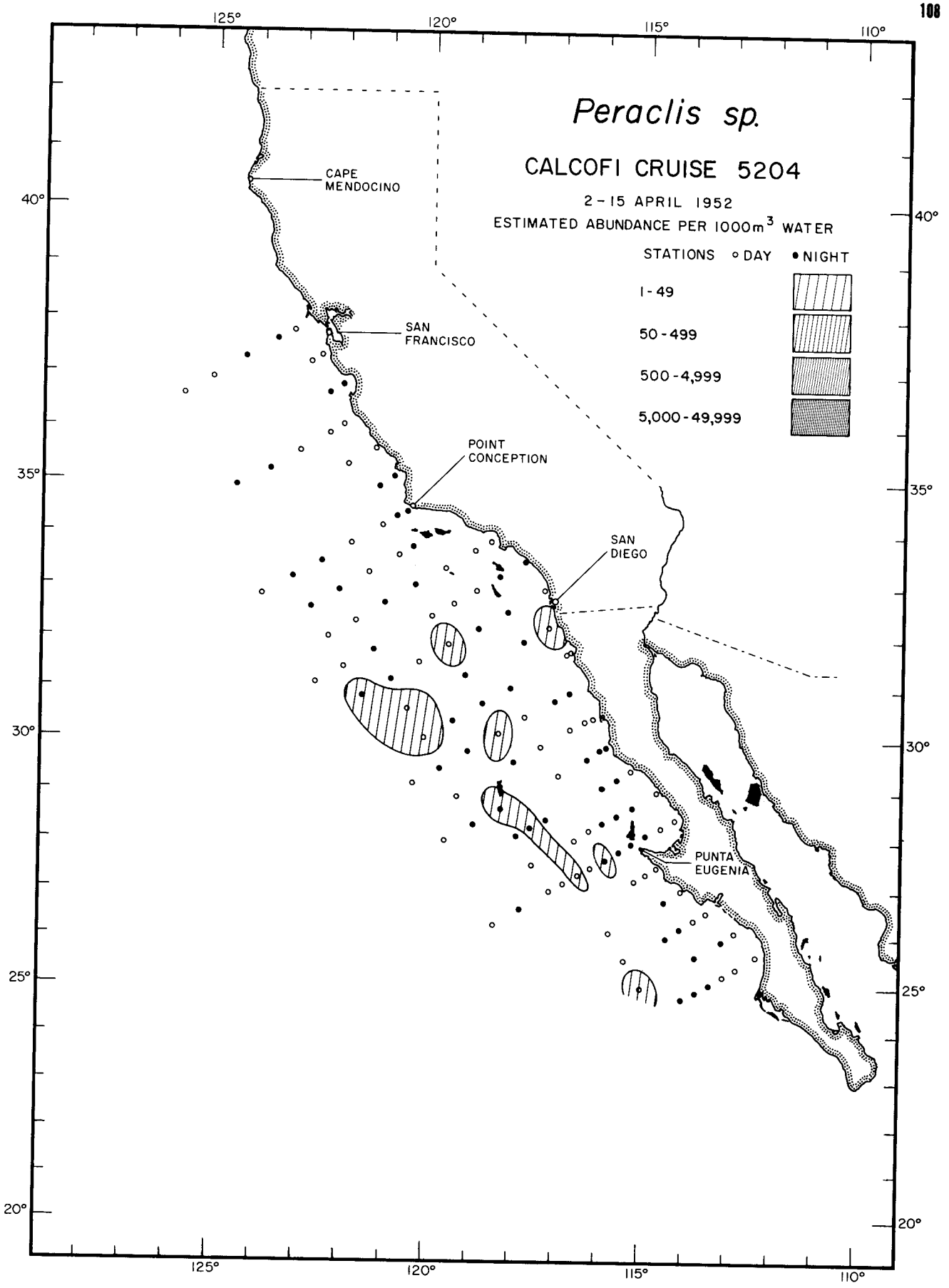
4911




Thecosomata

*Peraclis sp.*

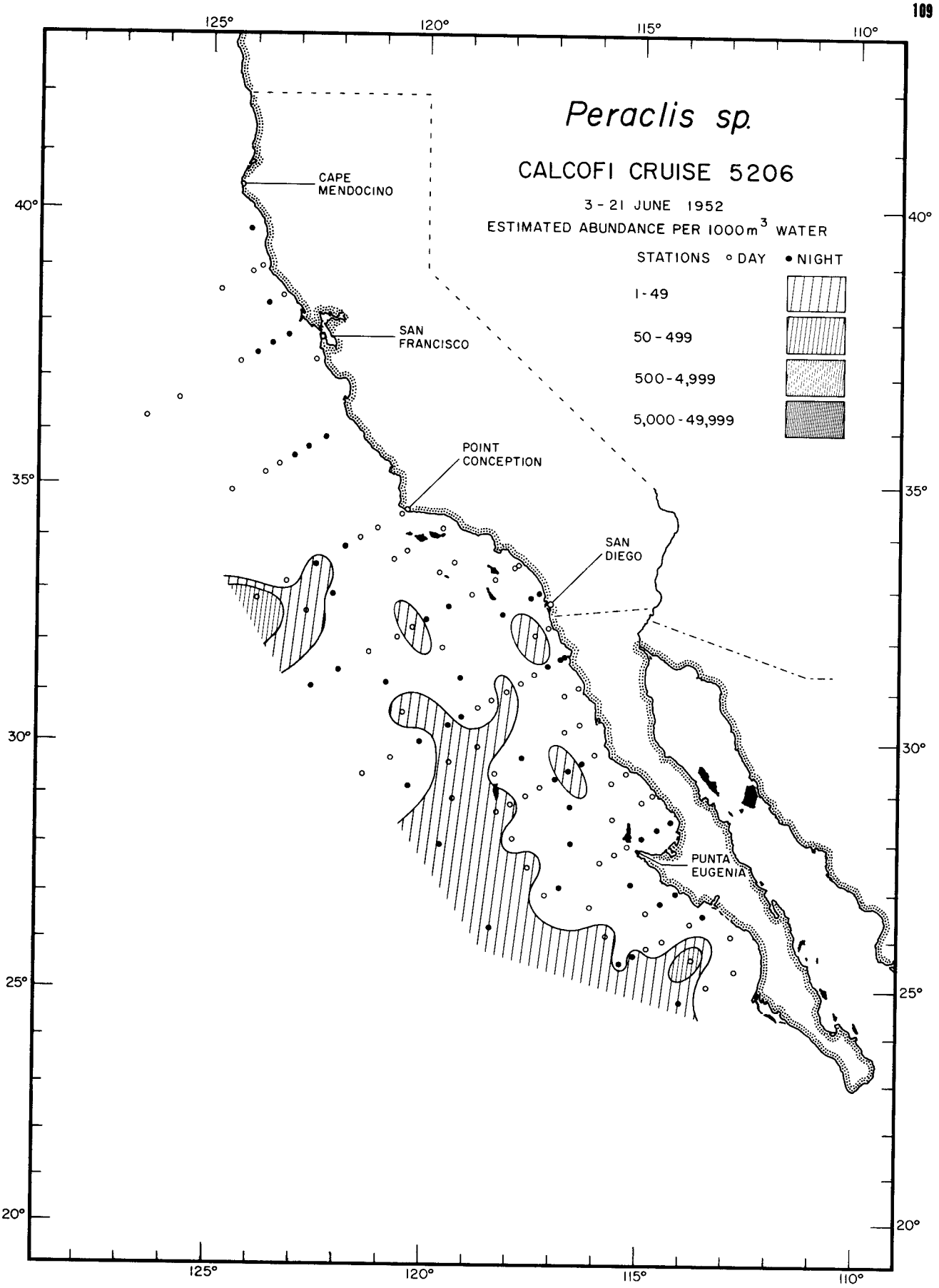
5004




Thecosomata

*Peraclis sp.*

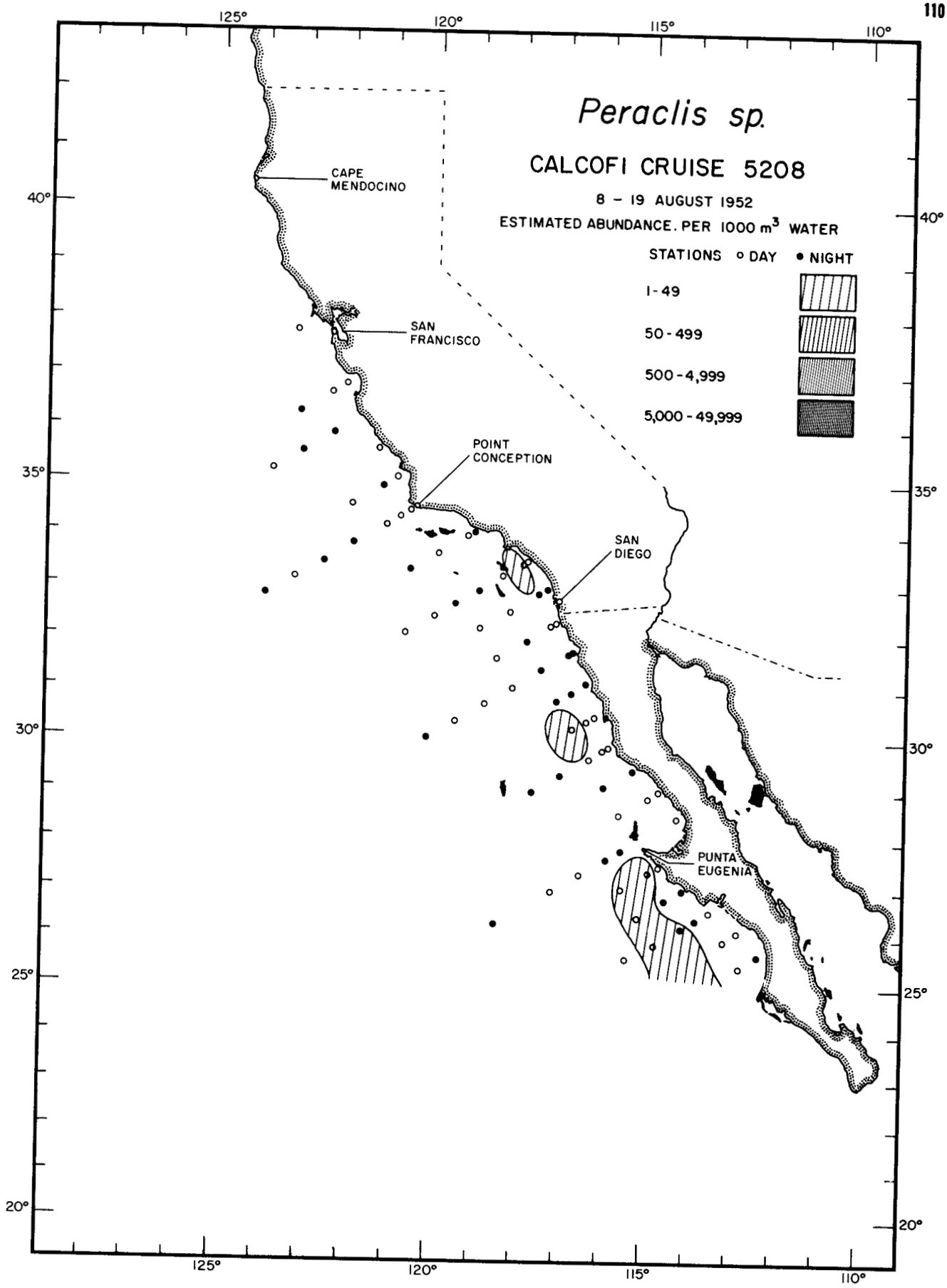
5204




Thecosomata

*Peraclis sp.*

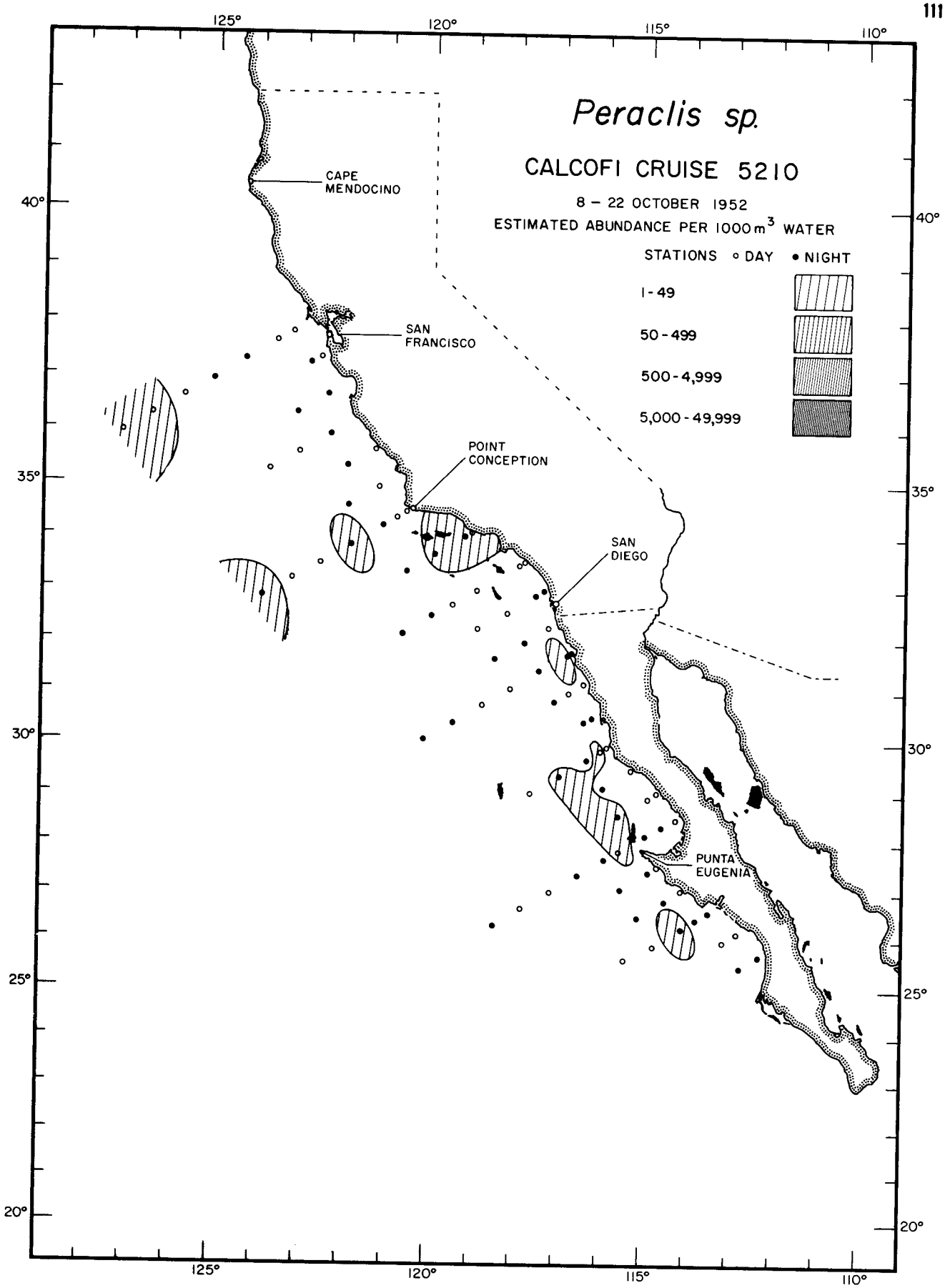
5206




Thecosomata

*Peraclis sp.*

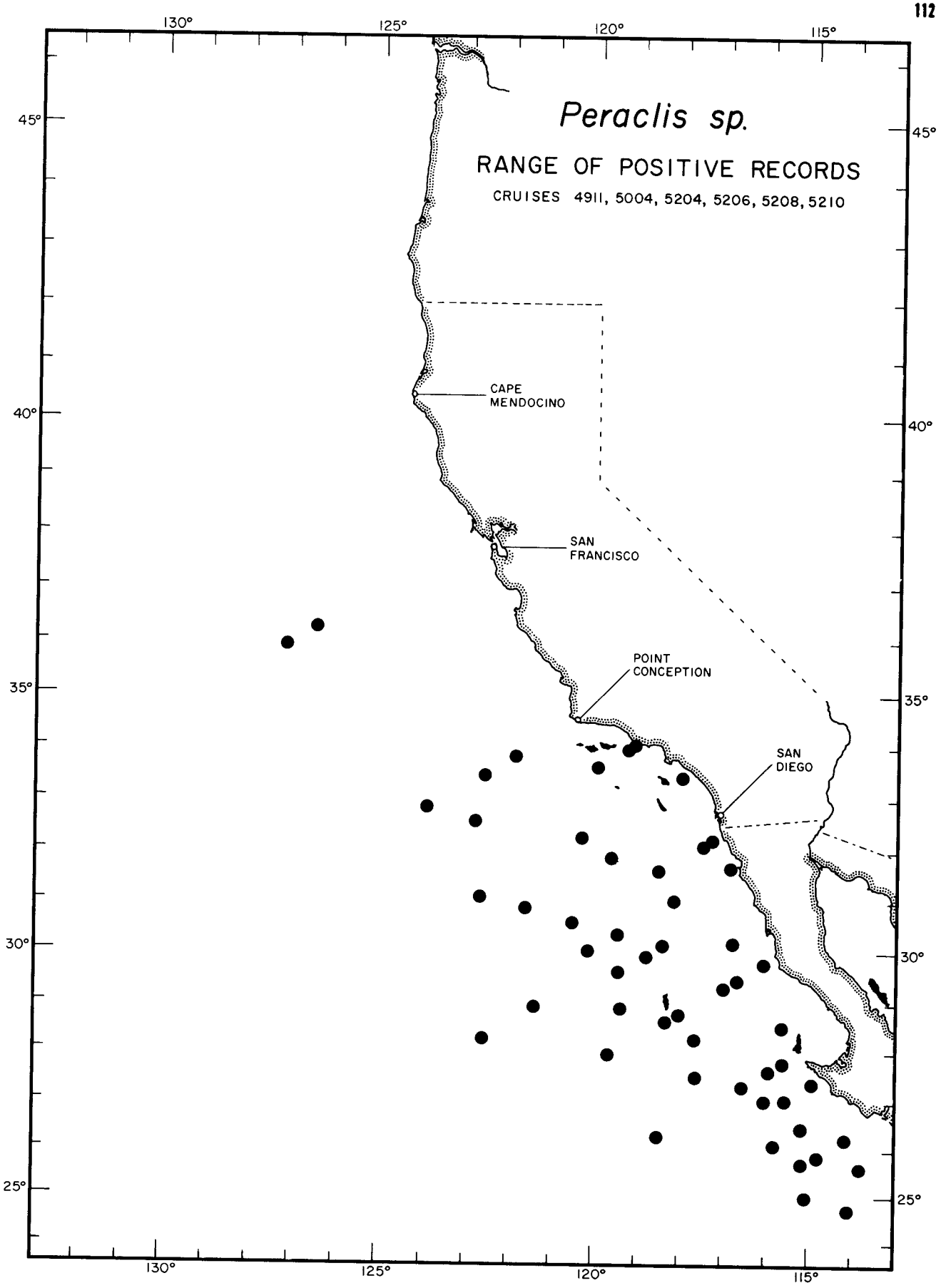
5208




Thecosomata

*Peraclis sp.*

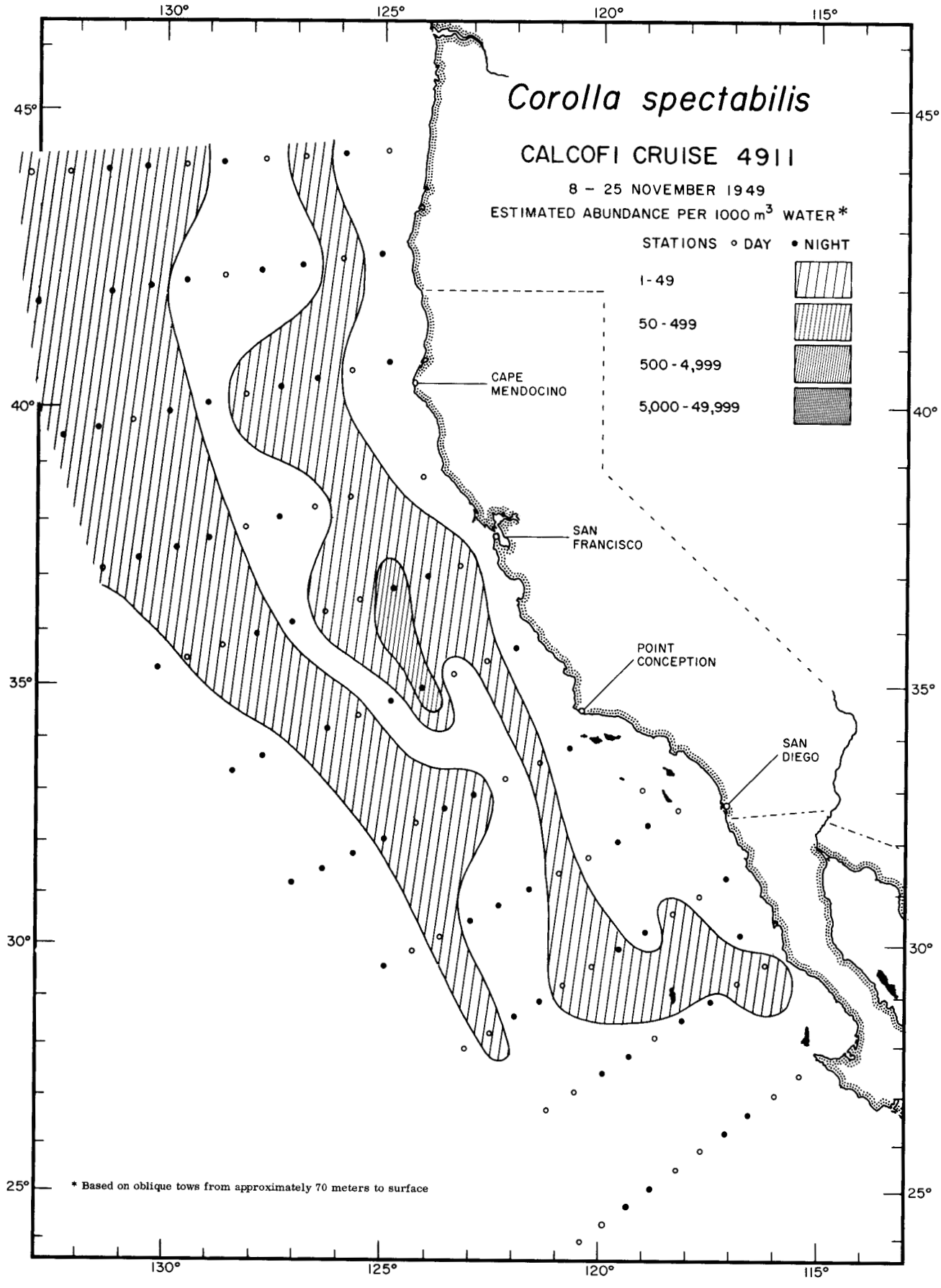
5210




Thecosomata

*Peraclis sp.*

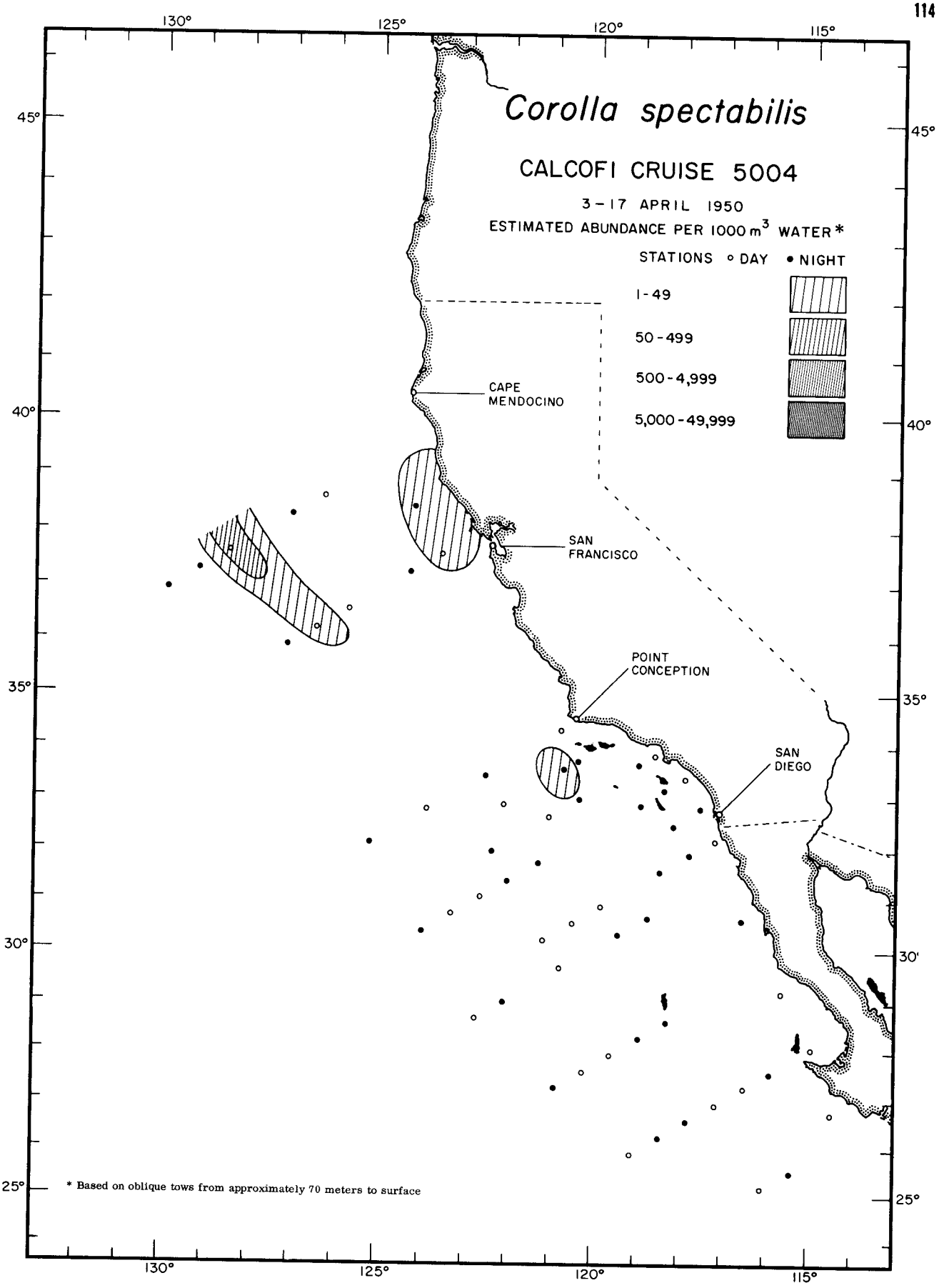
RANGE OF POSITIVE RECORDS




Thecosomata

*Corolla spectabilis*

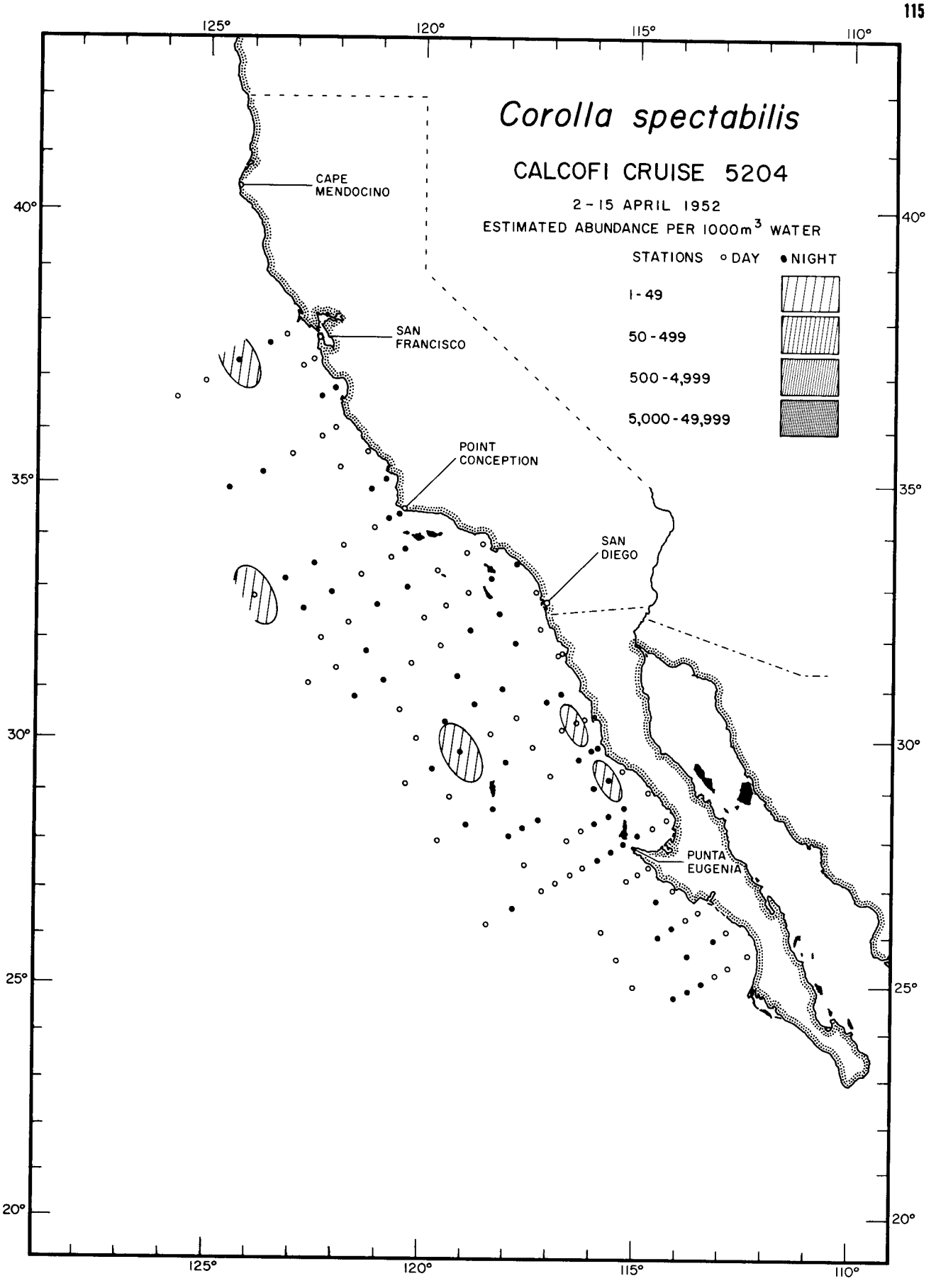
4911




Thecosomata

*Corolla spectabilis*

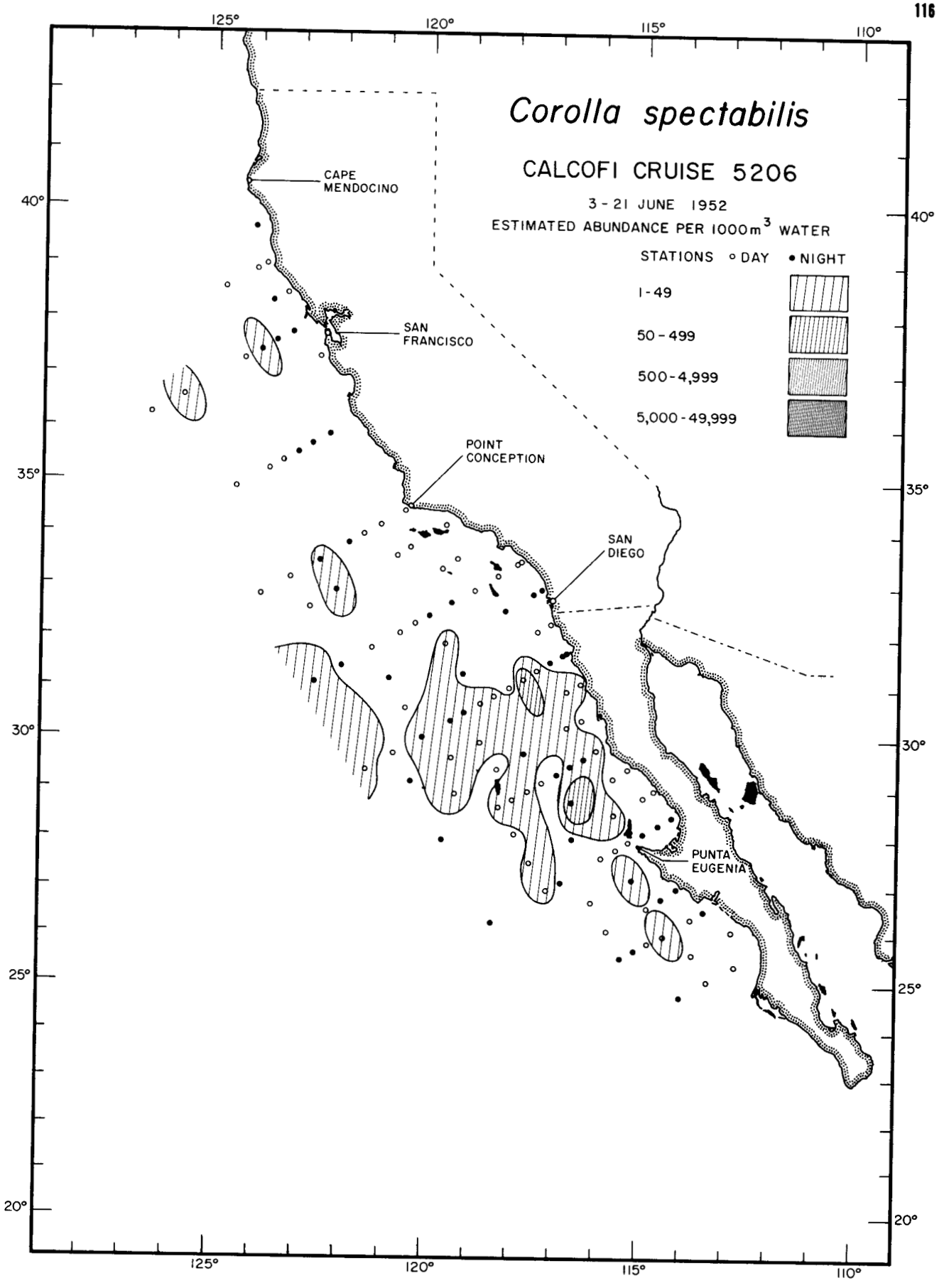
5004




Thecosomata

*Corolla spectabilis*

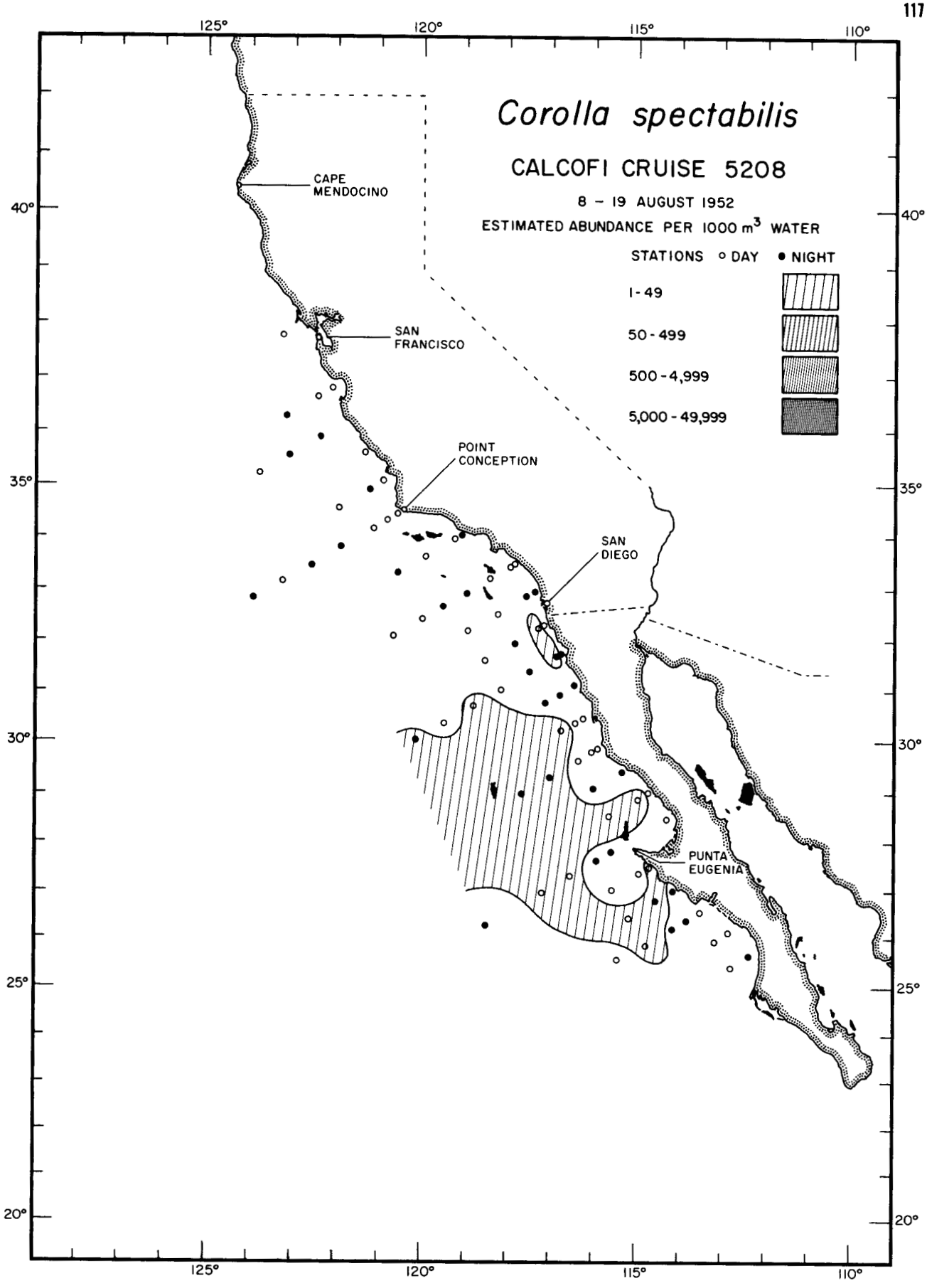
5204




Thecosomata

*Corolla spectabilis*

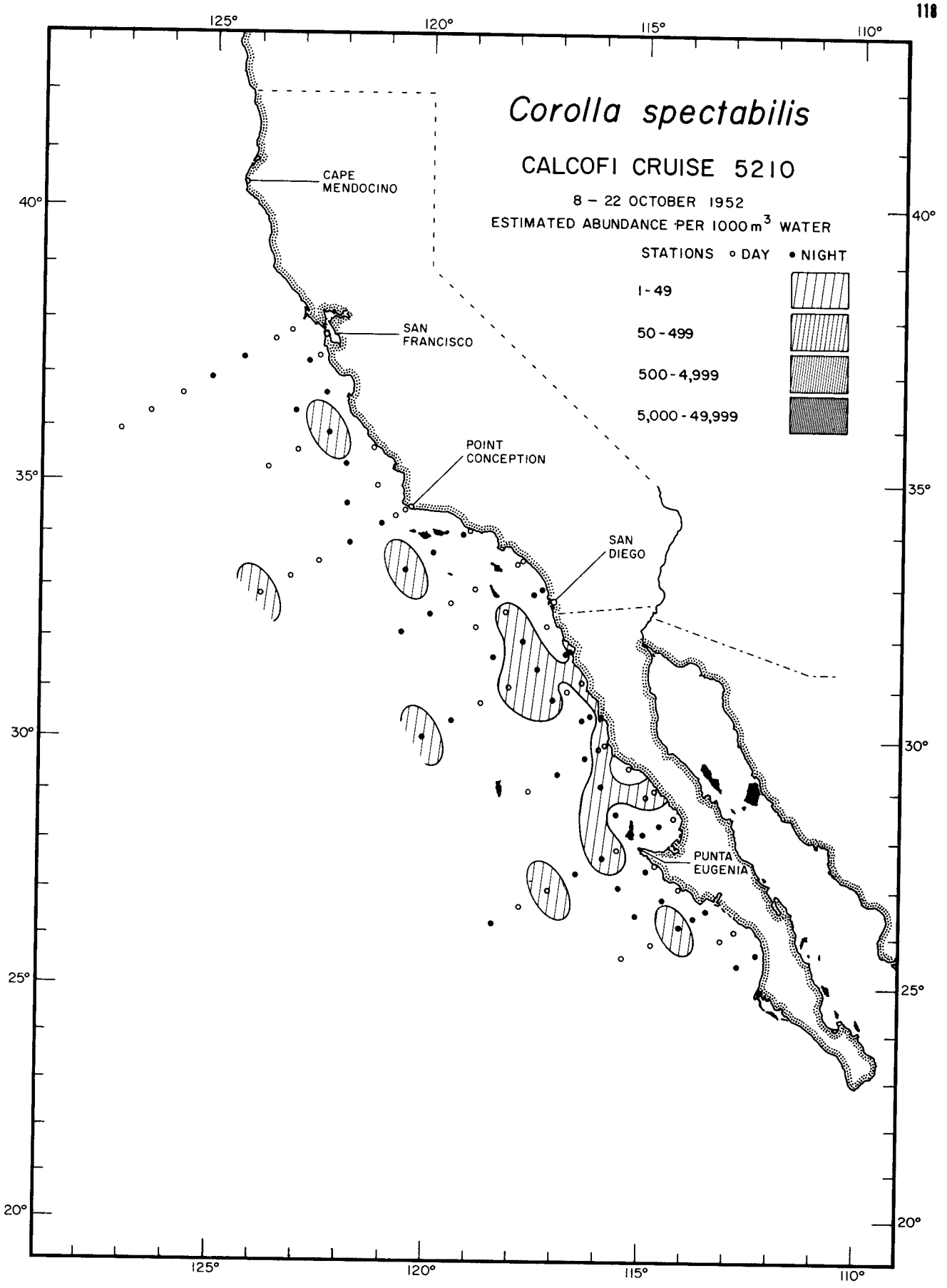
5206




Thecosomata

*Corolla spectabilis*

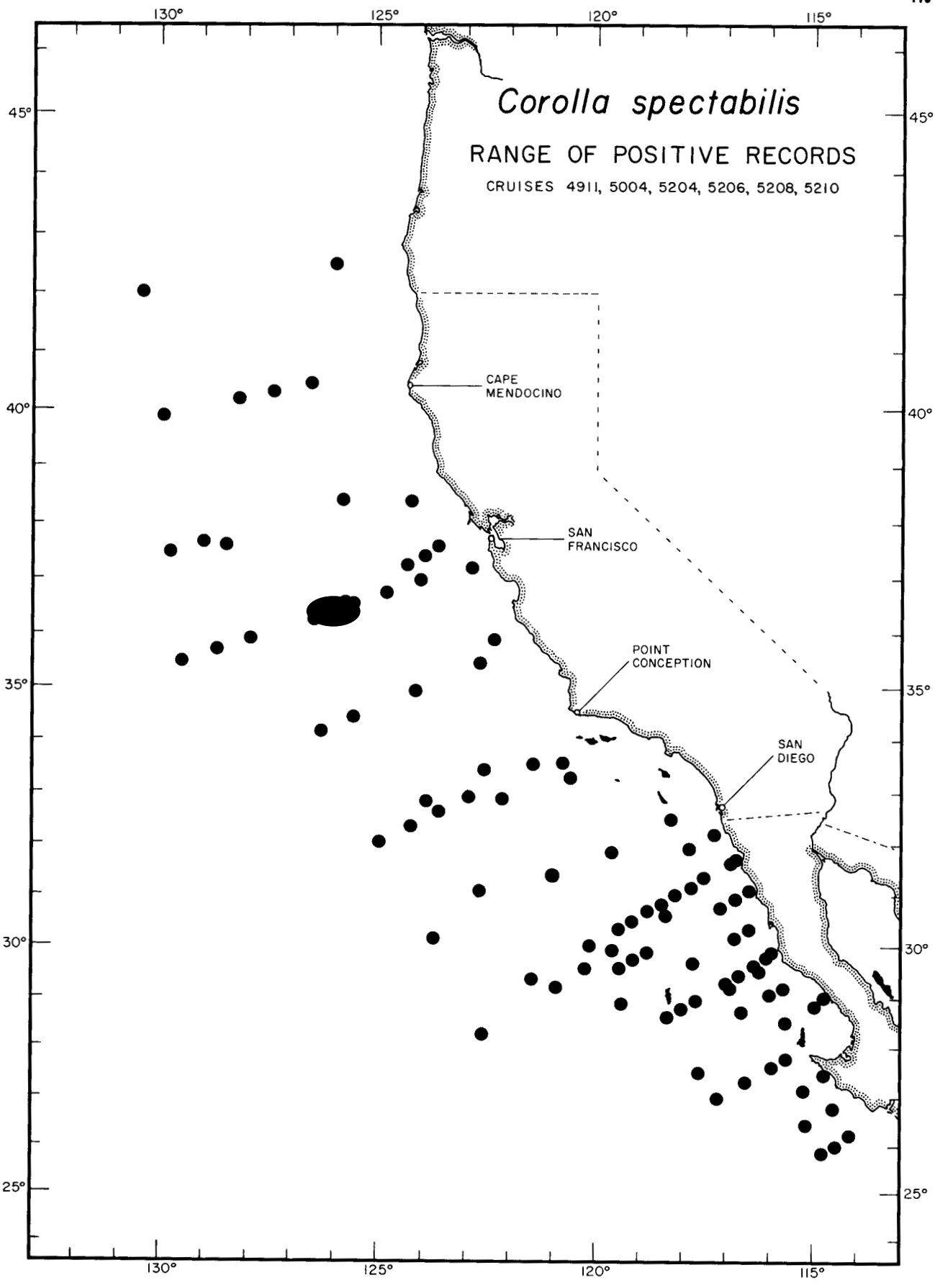
5208




Thecosomata

*Corolla spectabilis*

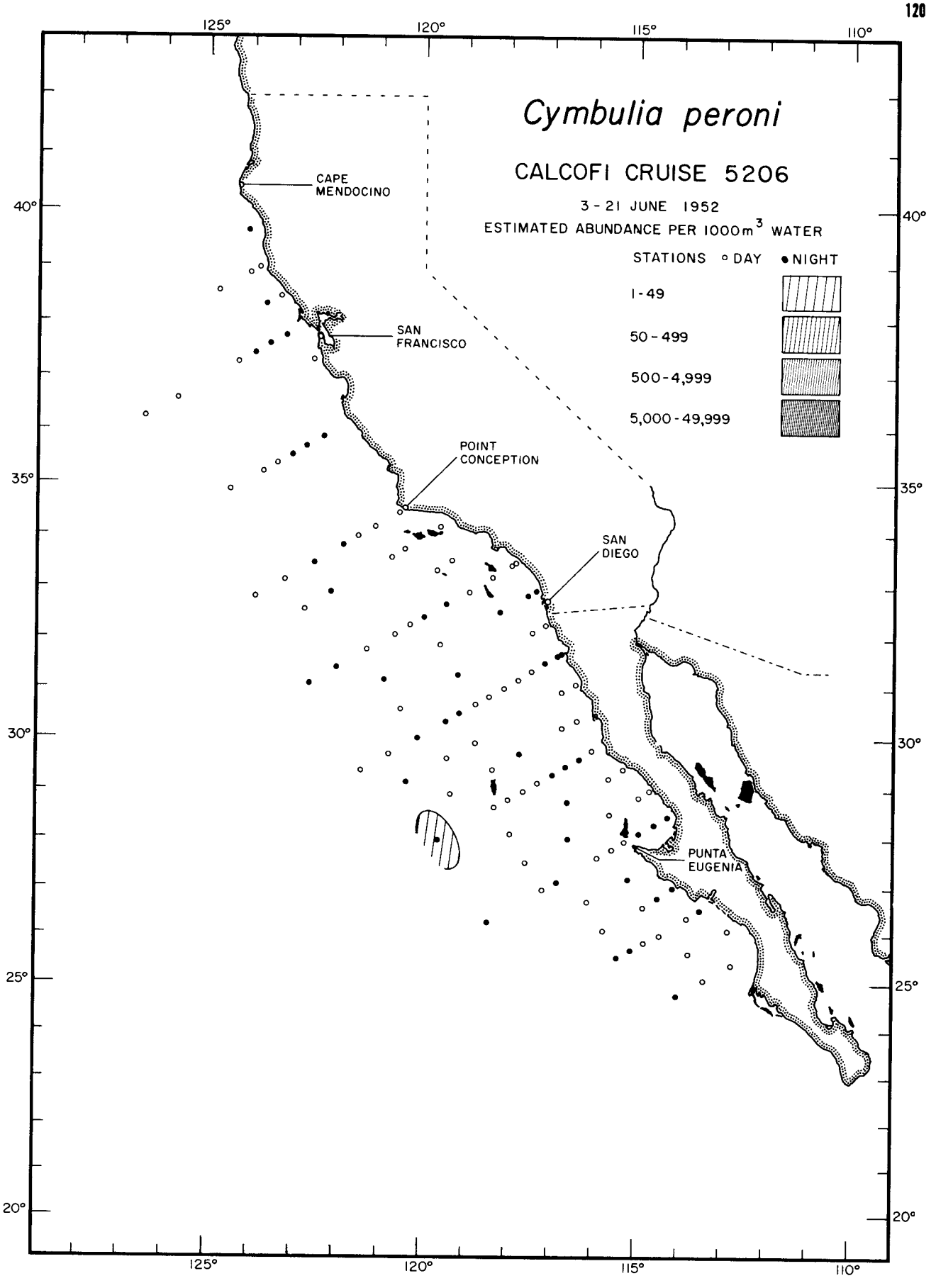
5210




Thecosomata

*Corolla spectabilis*

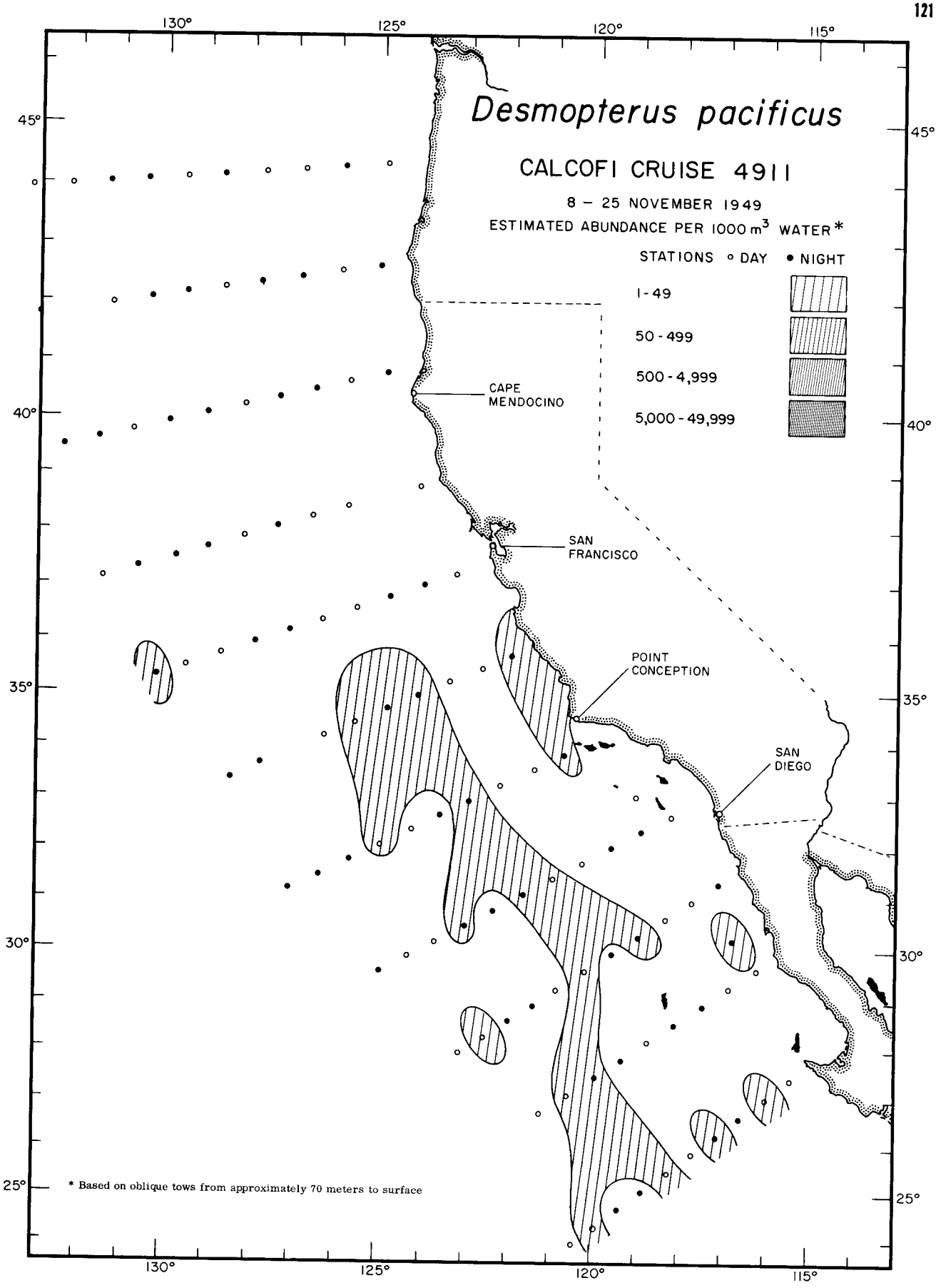
RANGE OF POSITIVE RECORDS




Thecosomata

*Cymbulia peroni*

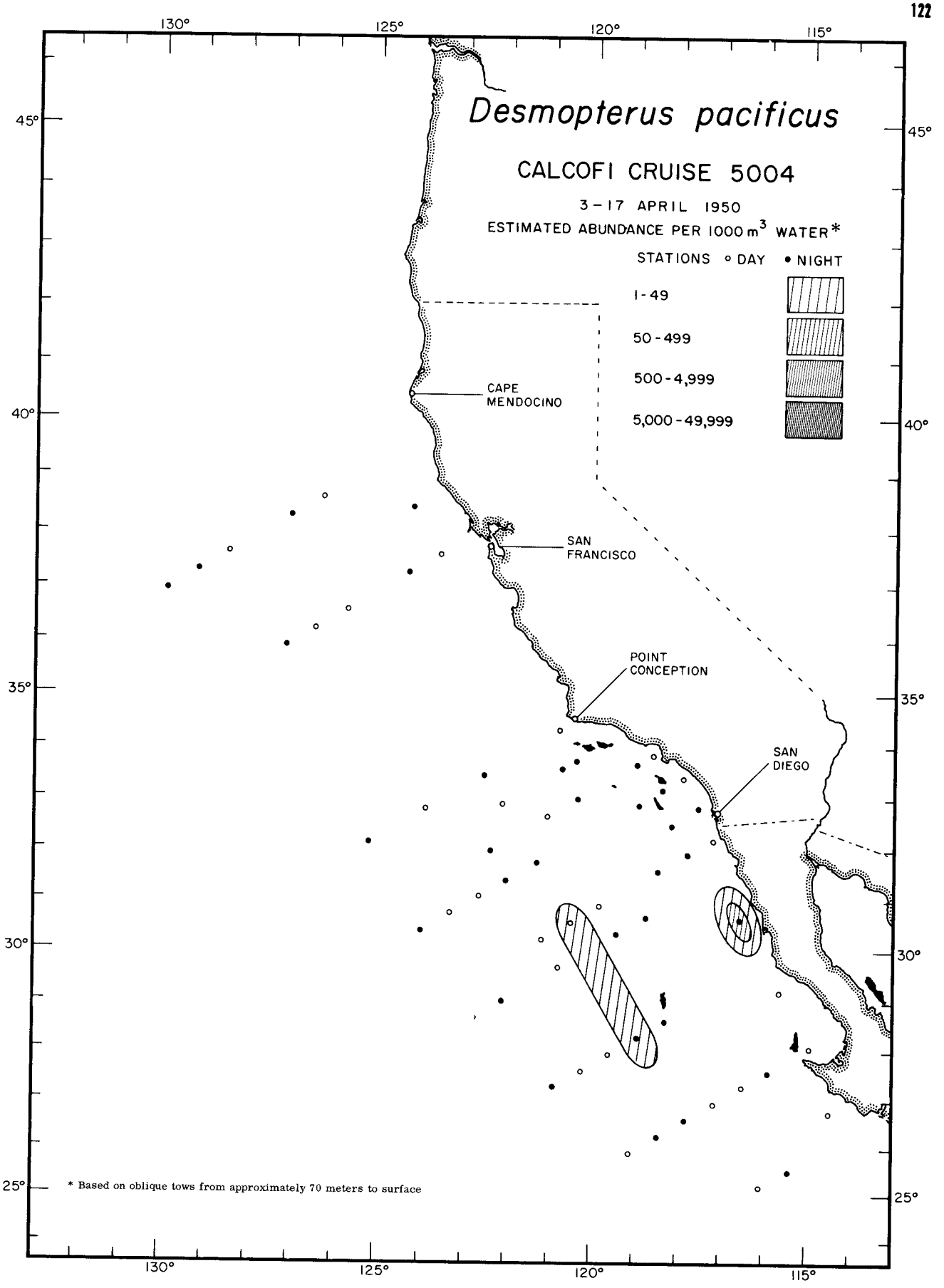
5206




Thecosomata

*Desmopterus pacificus*

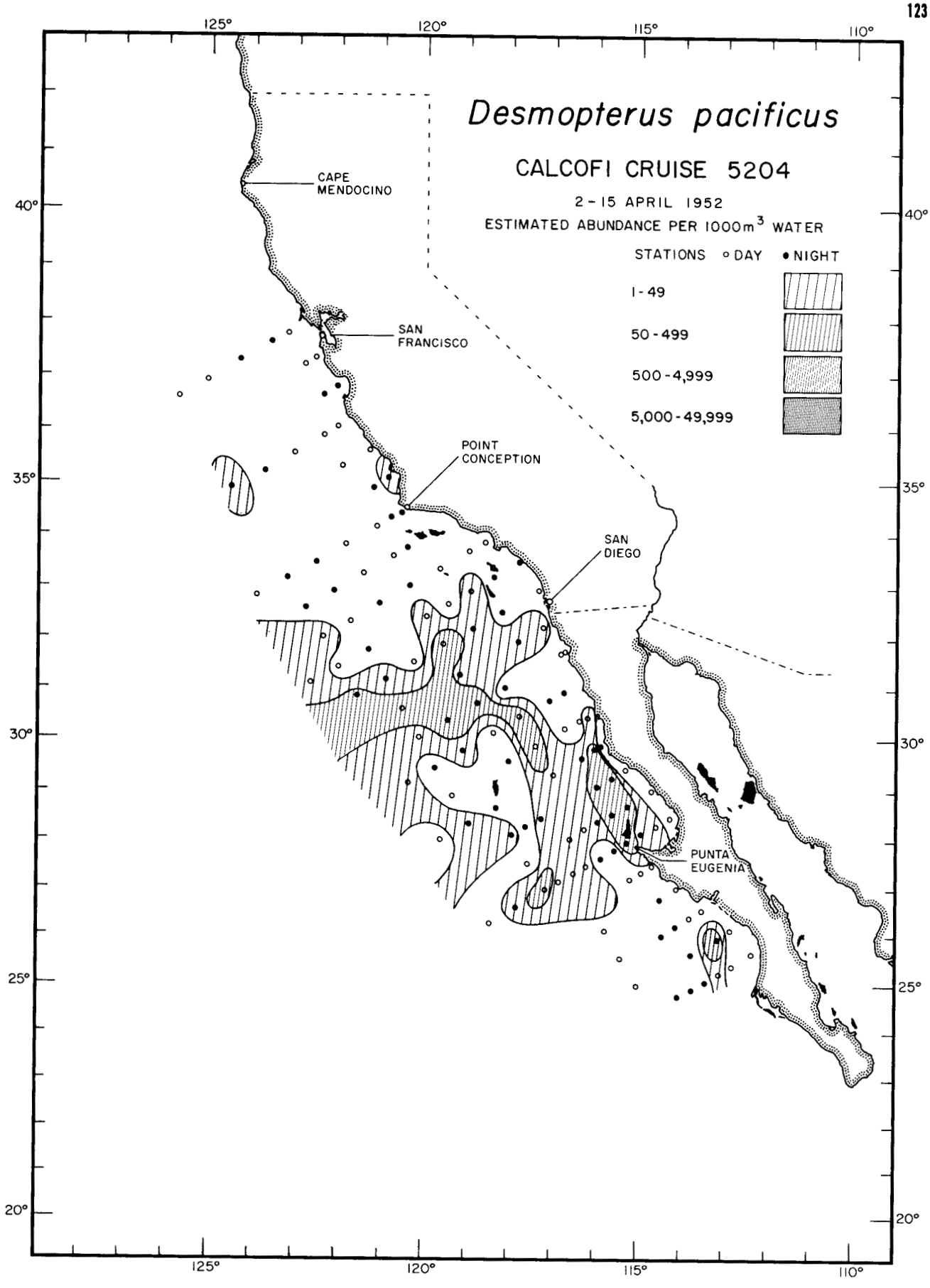
4911




Thecosomata

*Desmopterus pacificus*

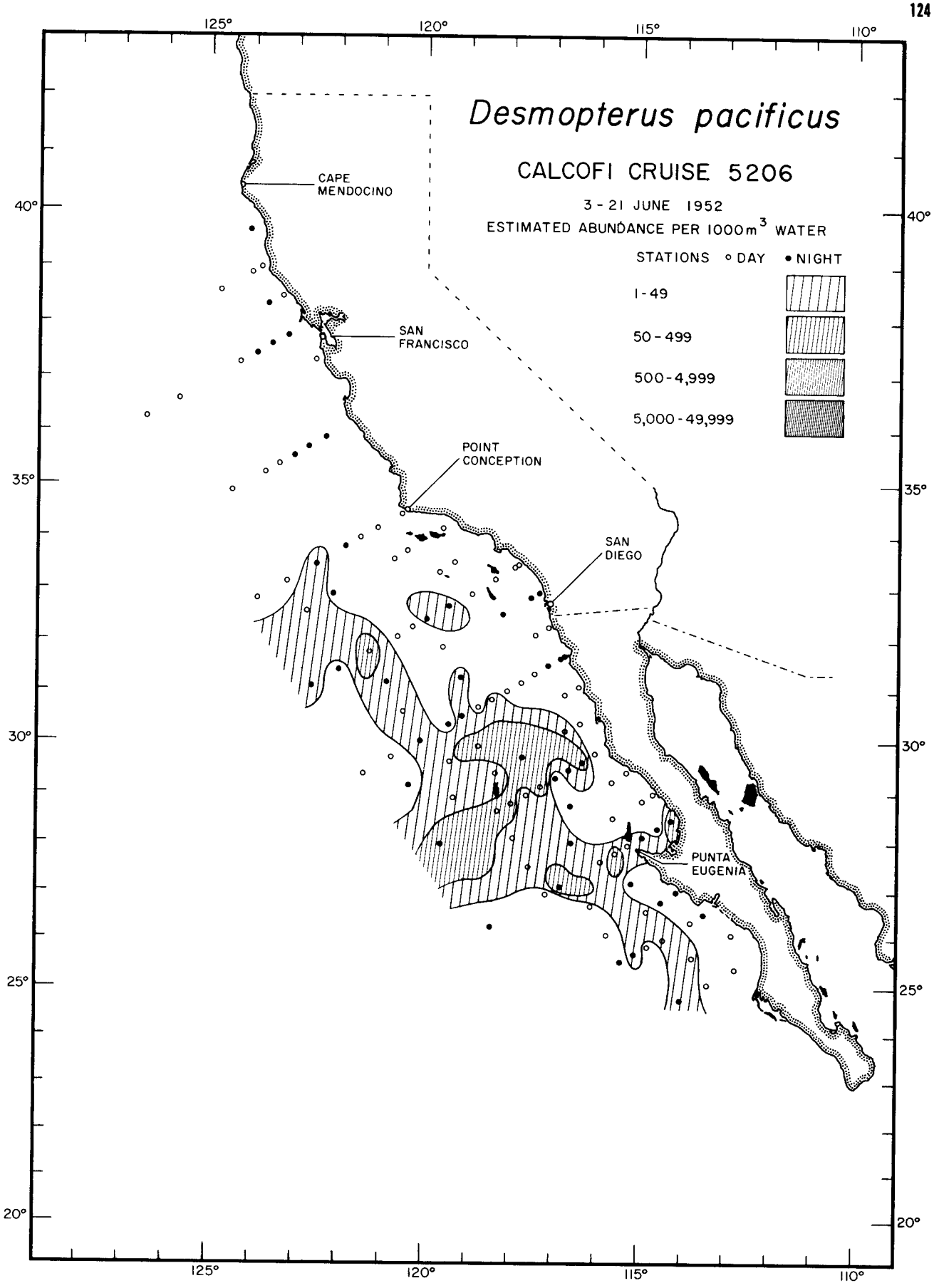
5004




Thecosomata

*Desmopterus pacificus*

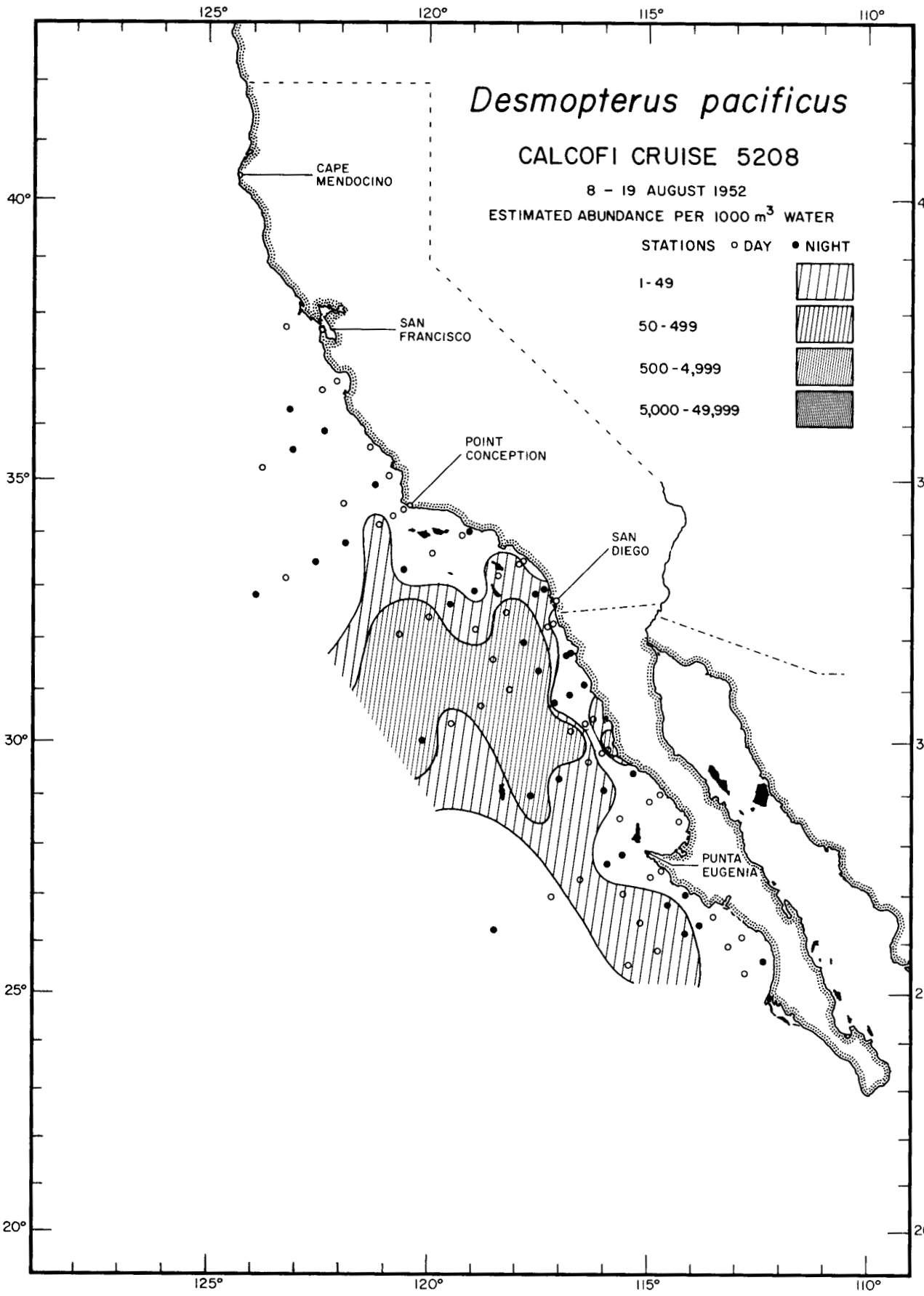
5204




Thecosomata

*Desmopterus pacificus*

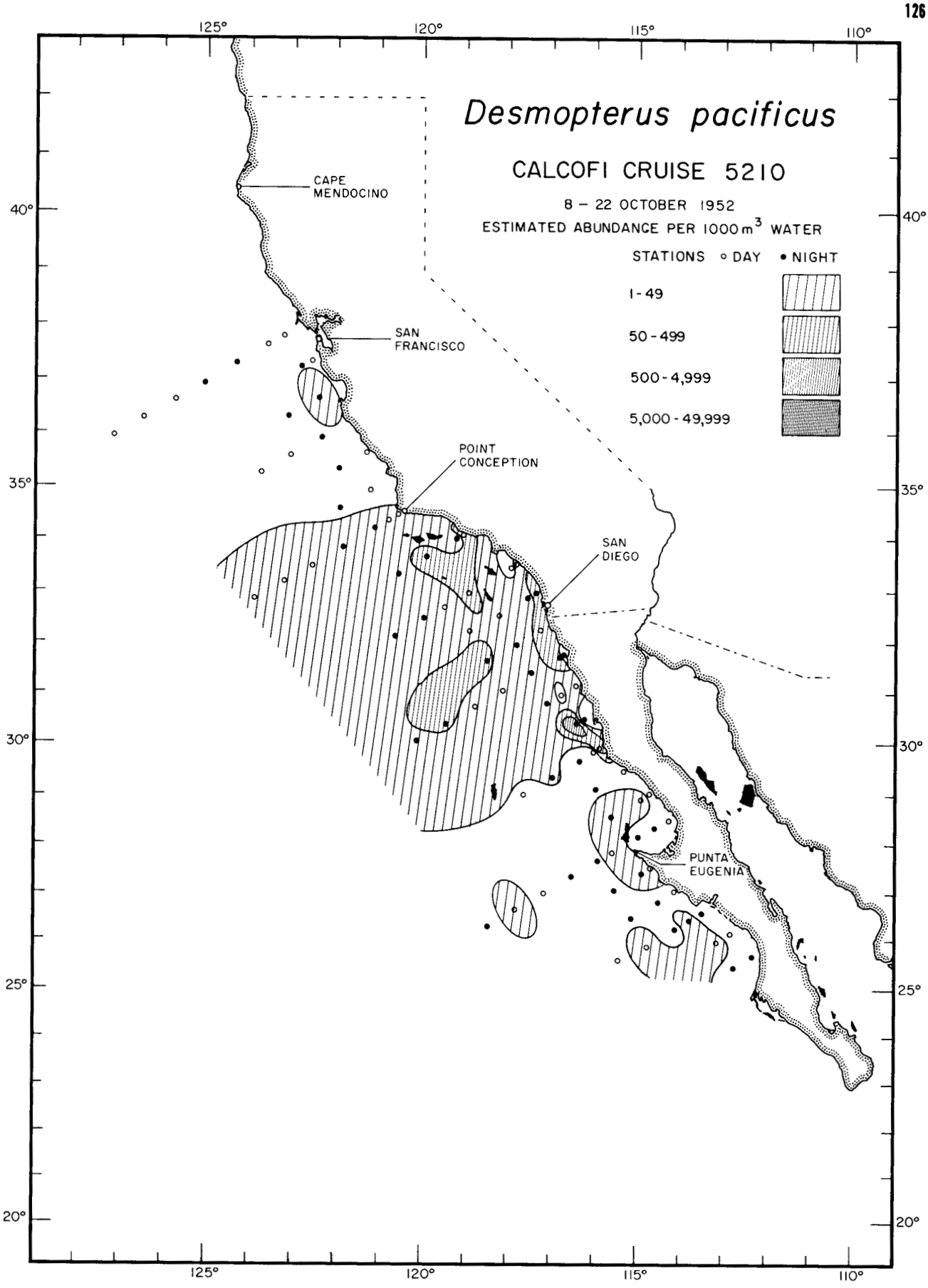
5206




Thecosomata

*Desmopterus pacificus*

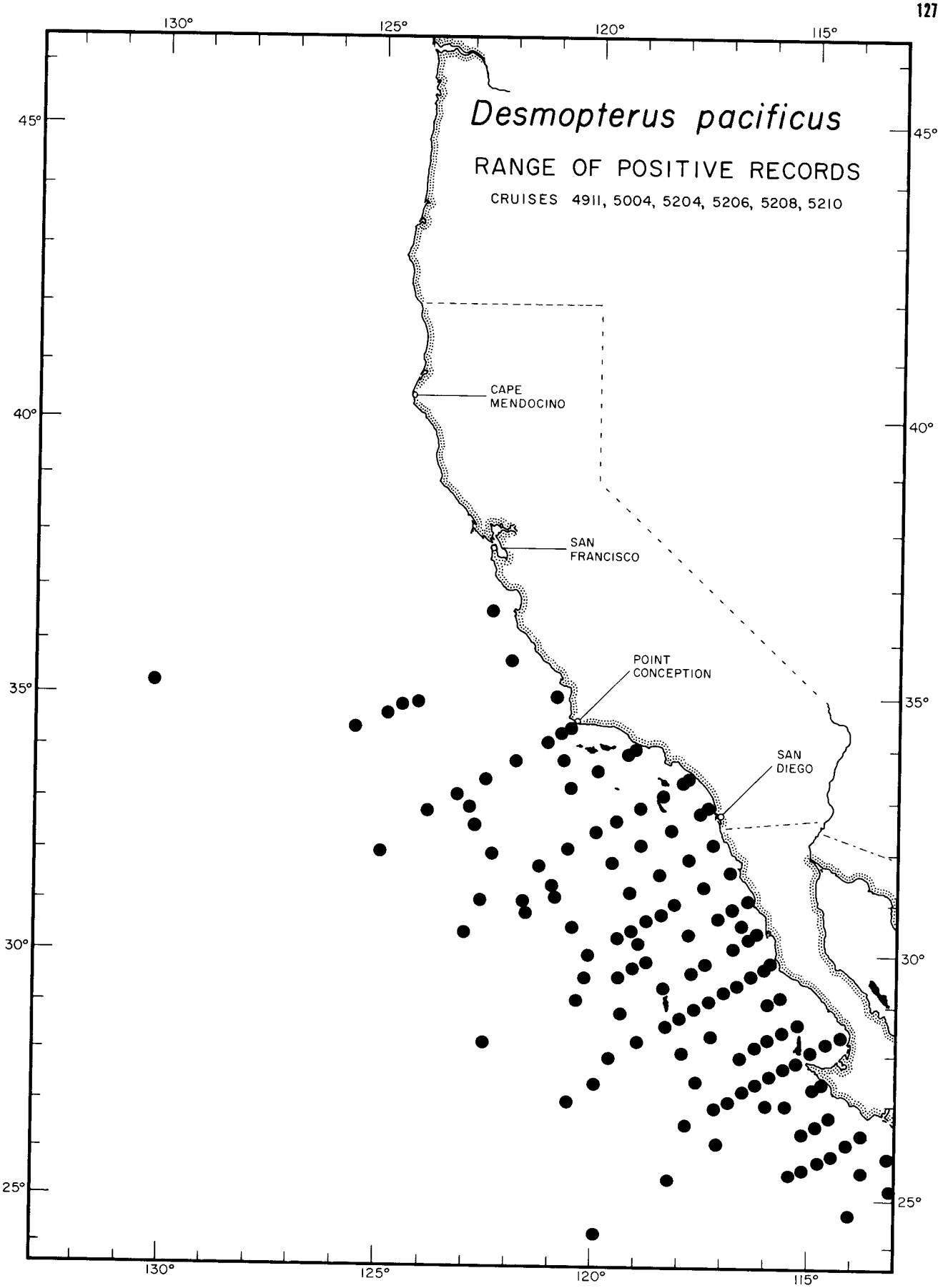
5208




Thecosomata

*Desmopterus pacificus*

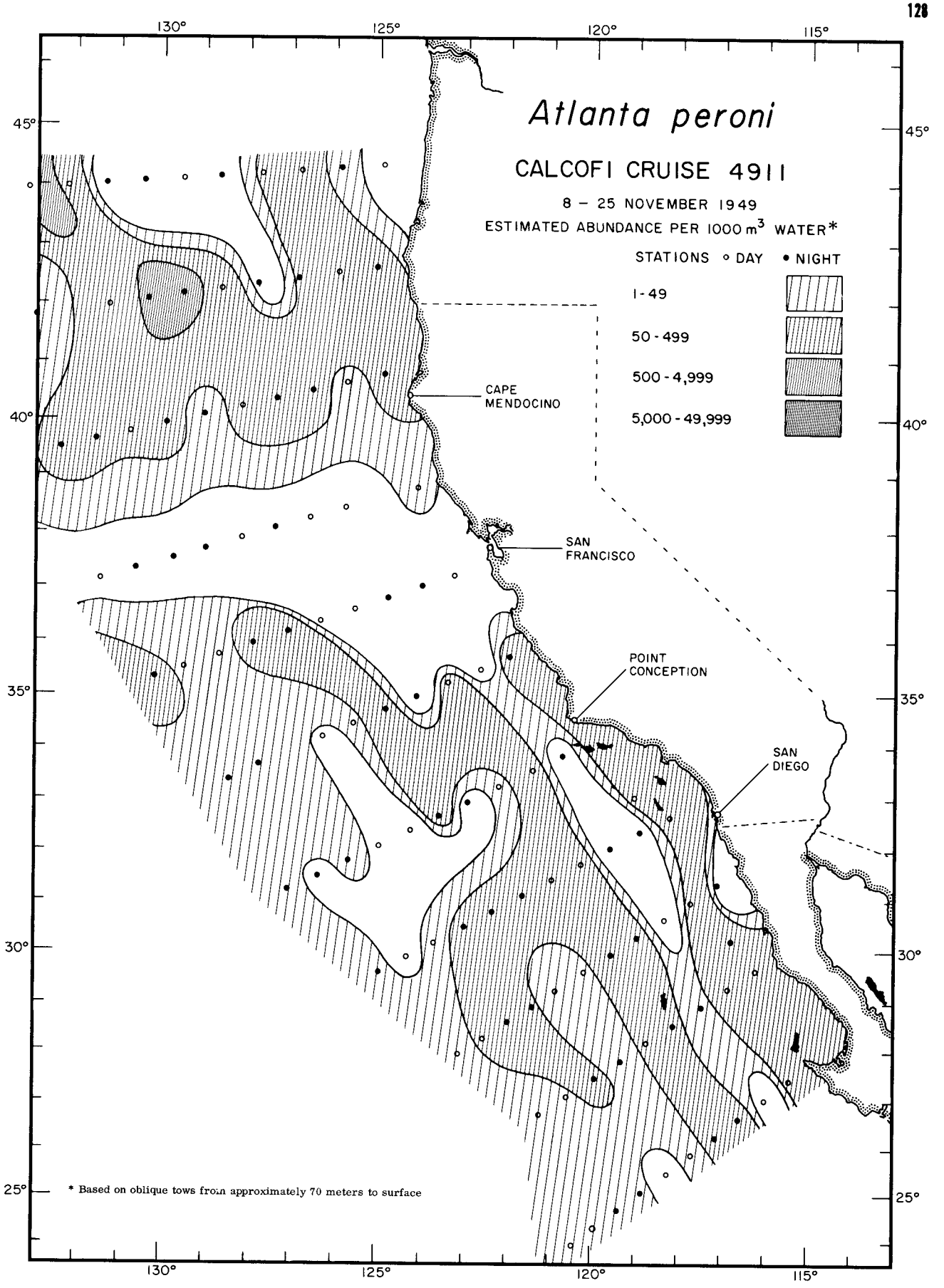
5210




Thecosomata

*Desmopterus pacificus*

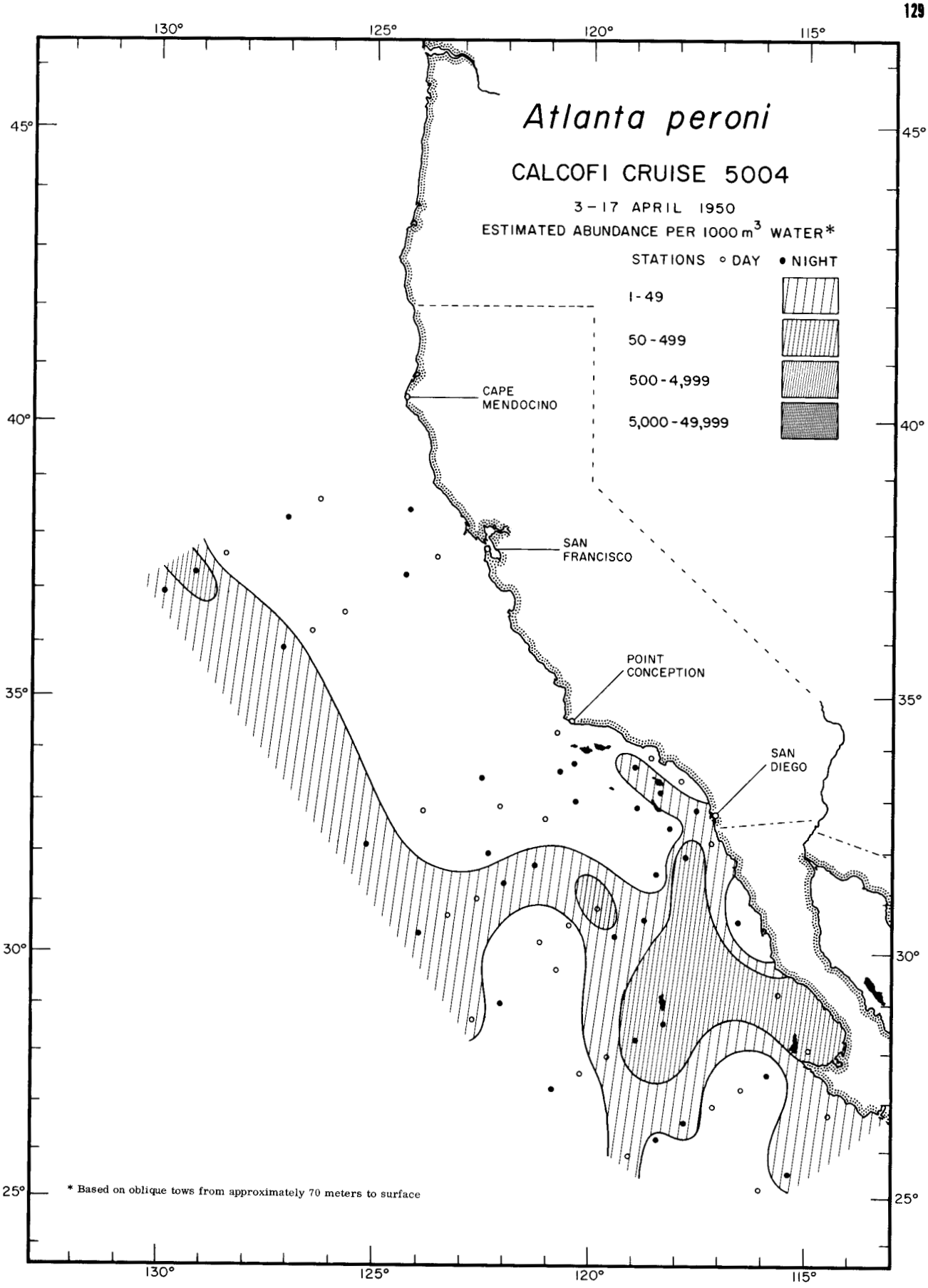
RANGE OF POSITIVE RECORDS




Heteropoda

*Atlanta peroni*

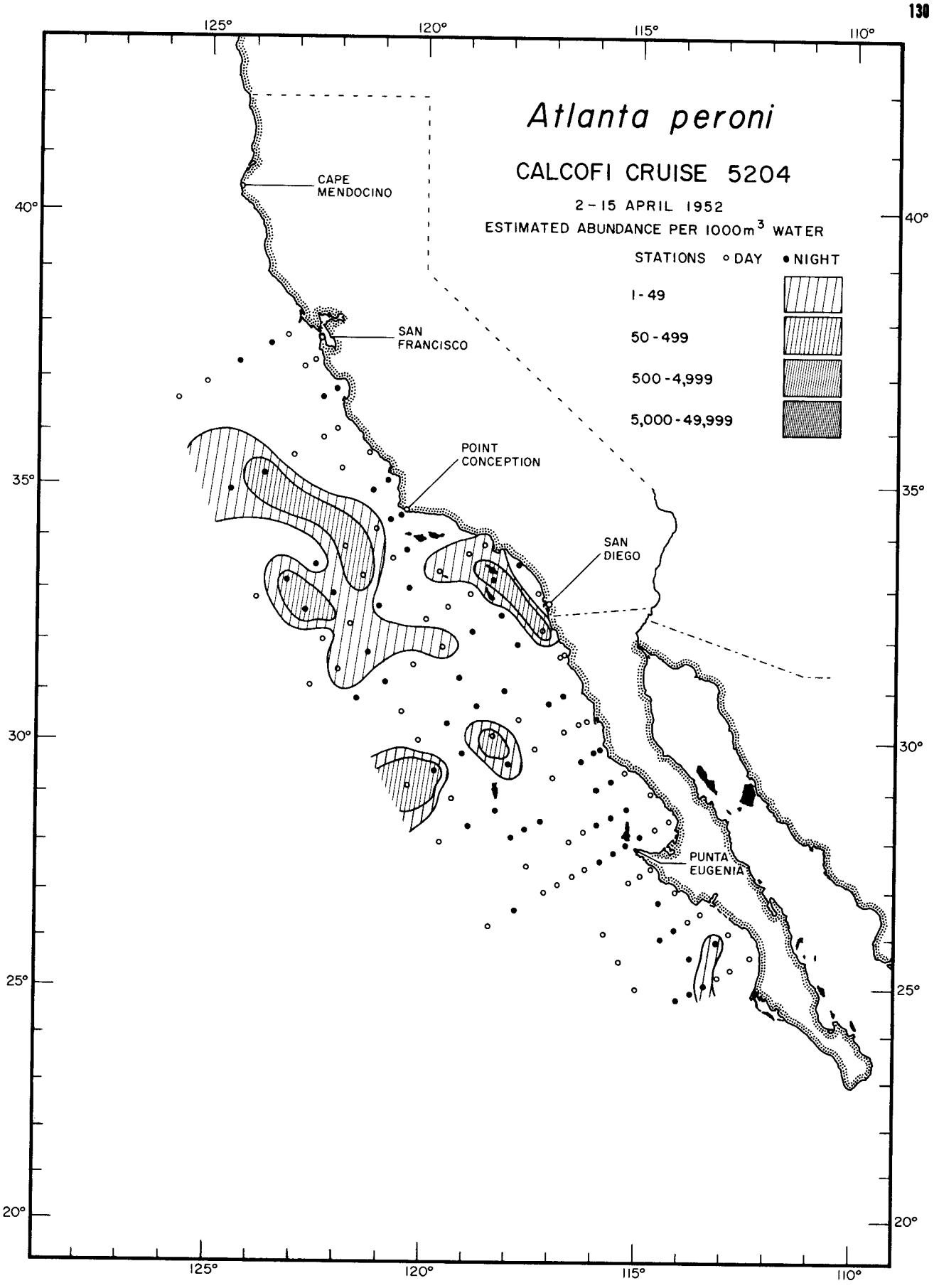
4911




Heteropoda

*Atlanta peroni*

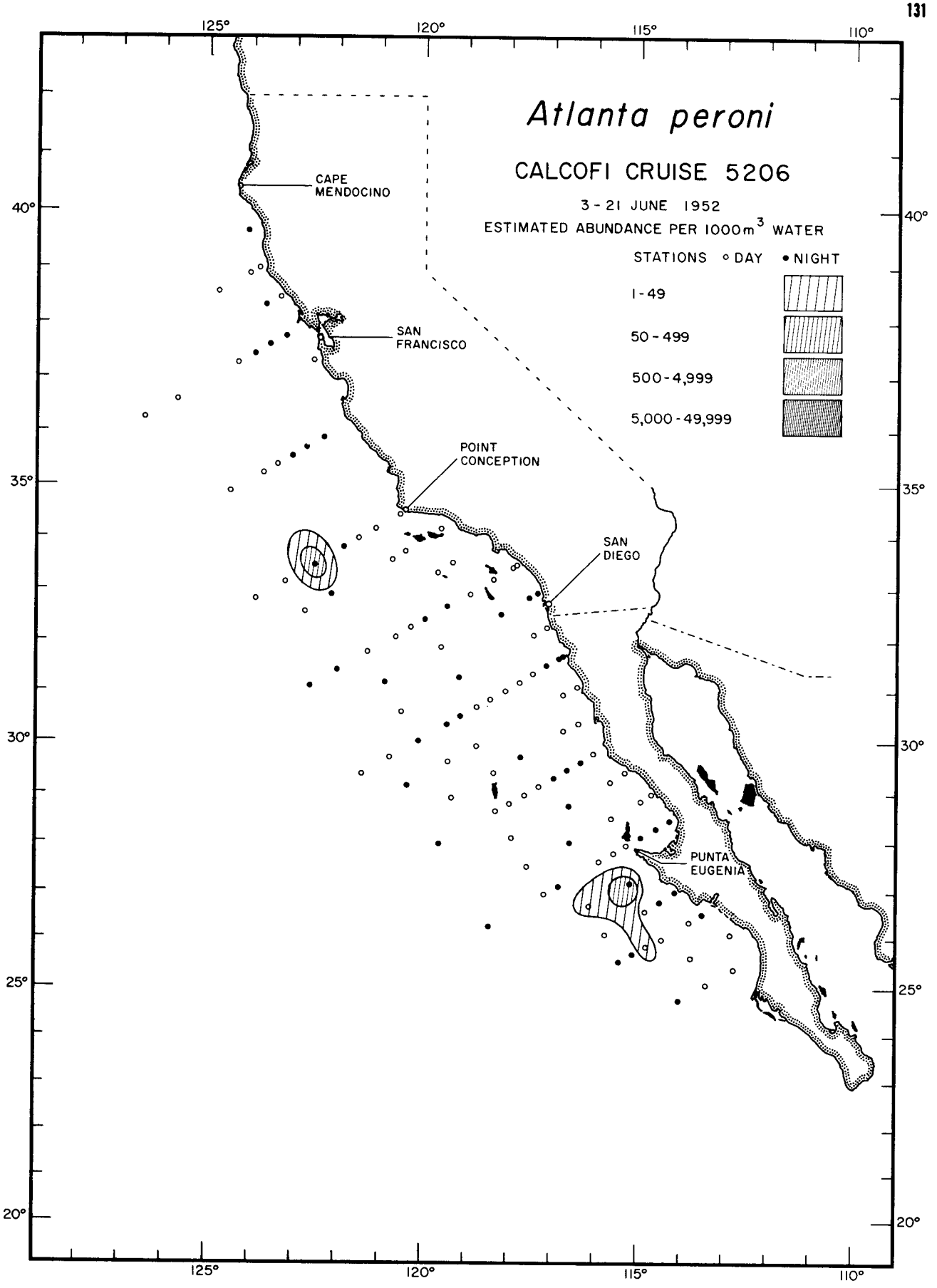
5004




Heteropoda

*Atlanta peroni*

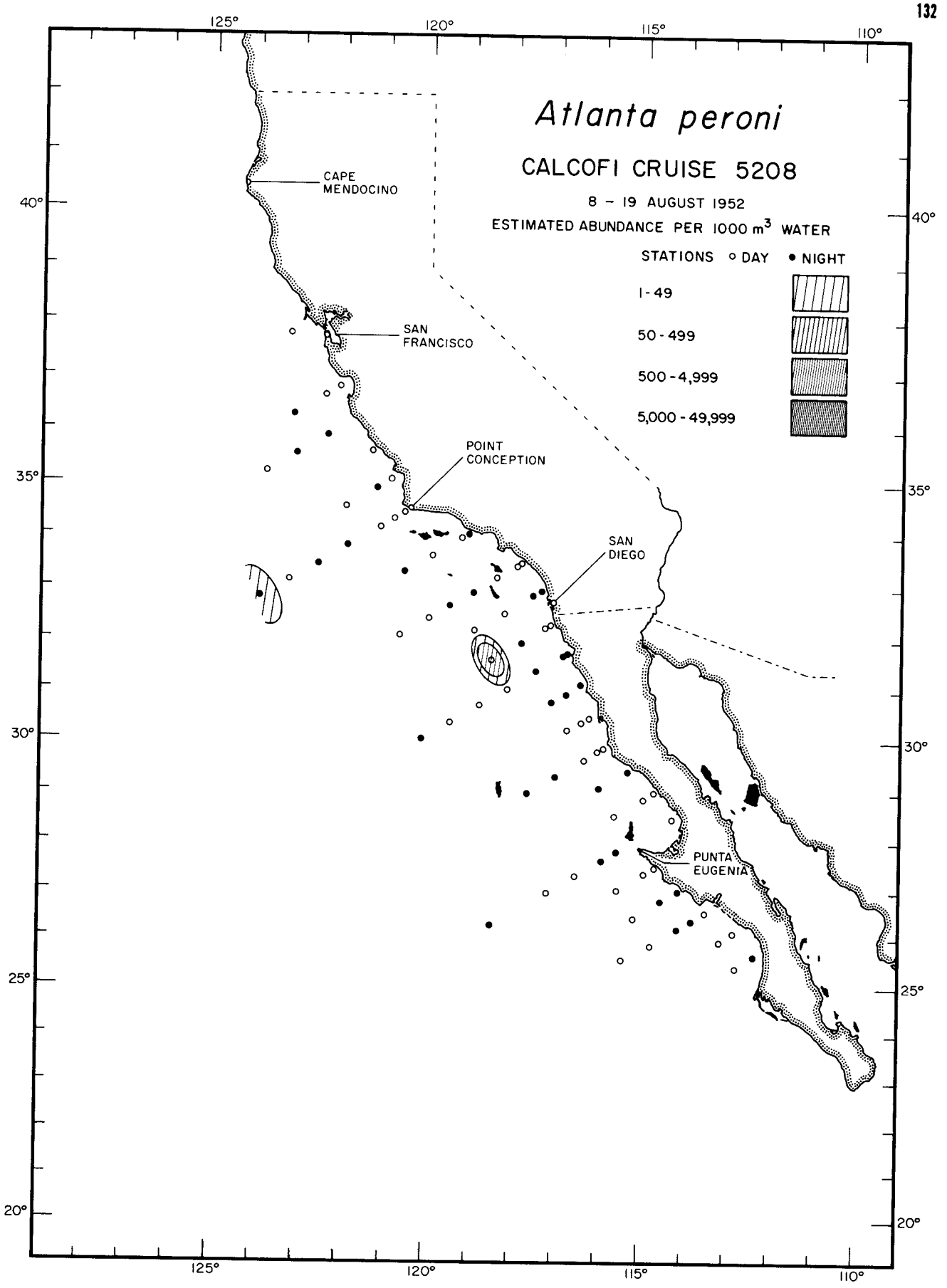
5204




Heteropoda

*Atlanta peroni*

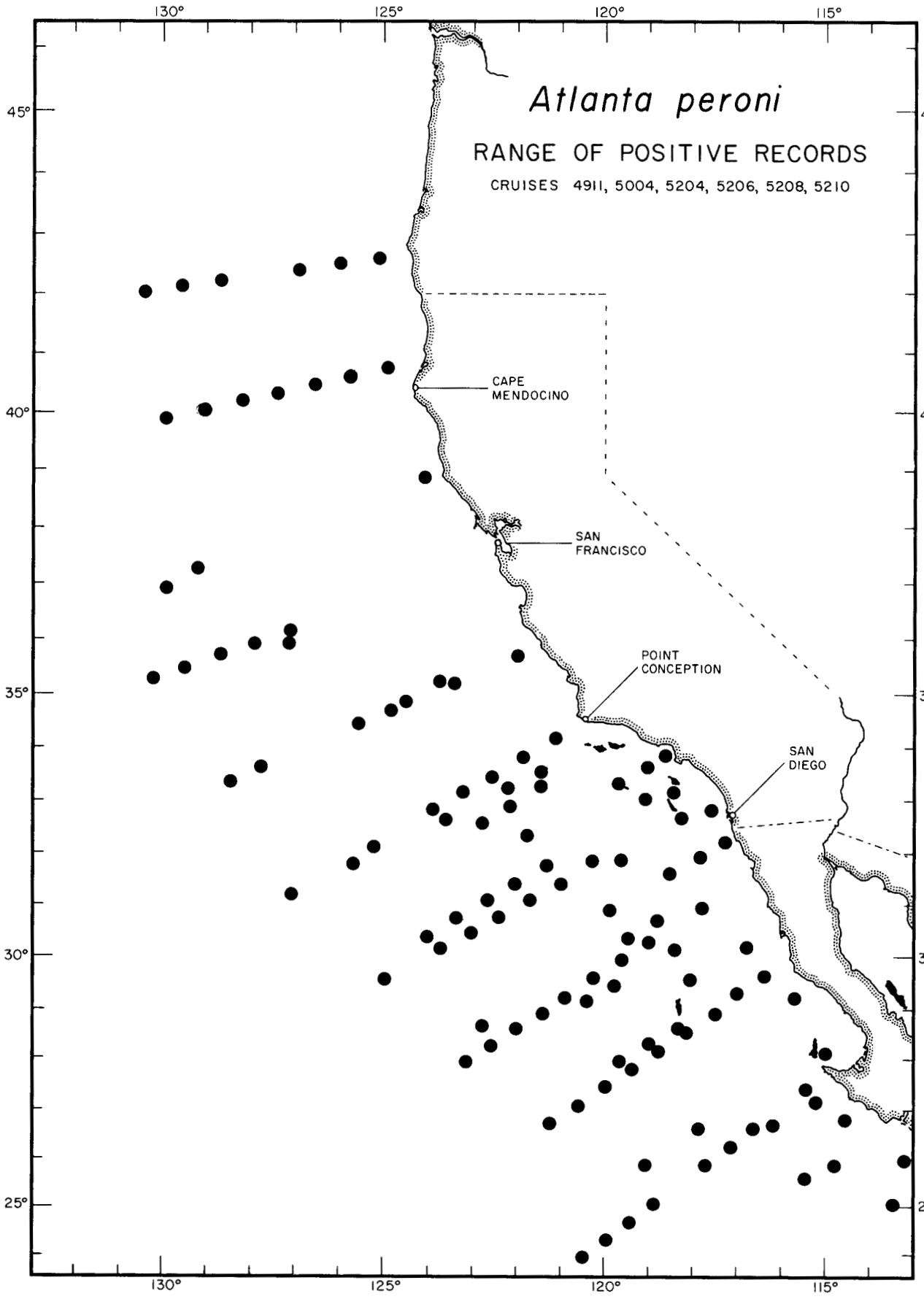
5206




Heteropoda

*Atlanta peroni*

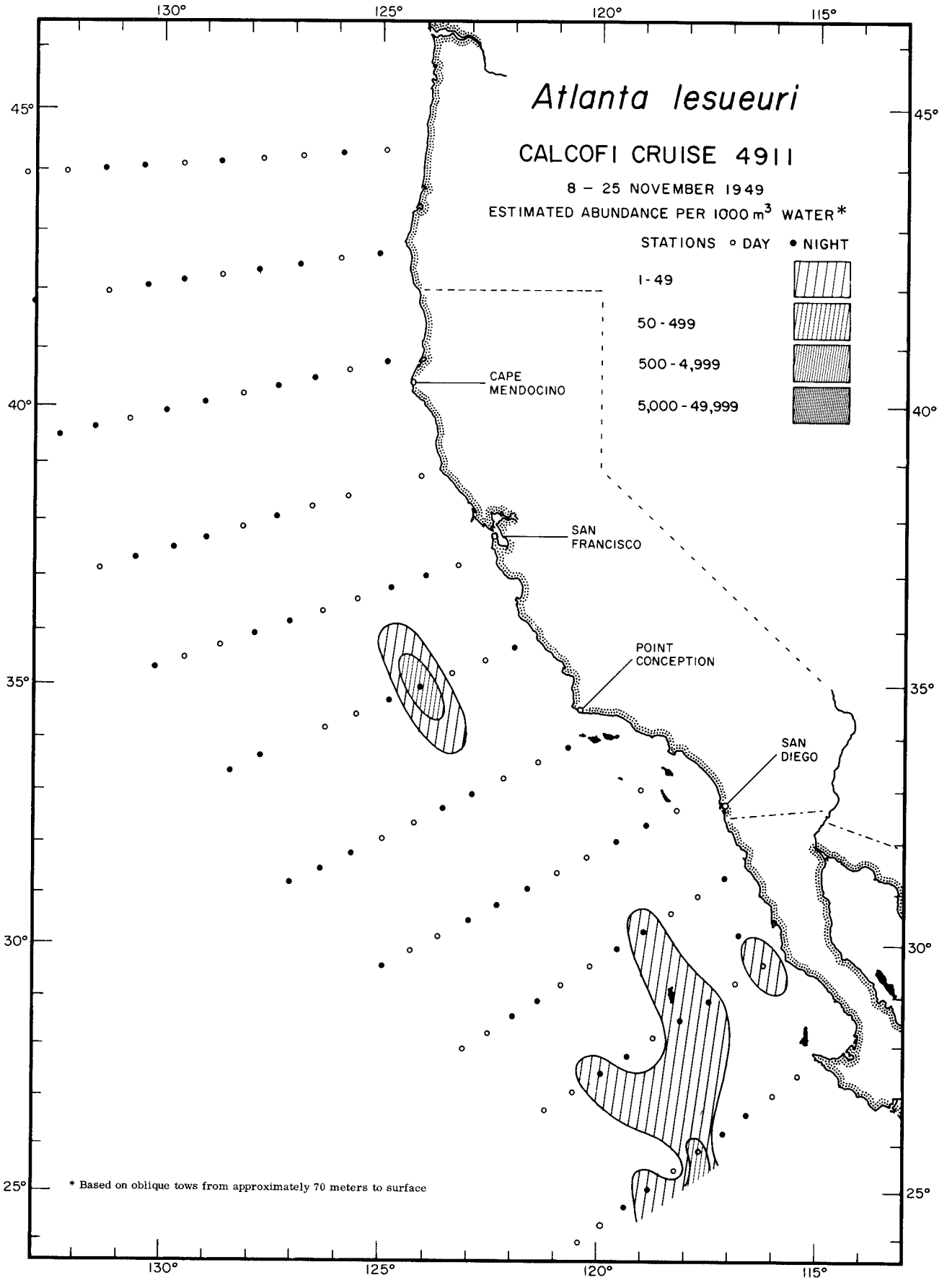
5208




Heteropoda

*Atlanta peroni*

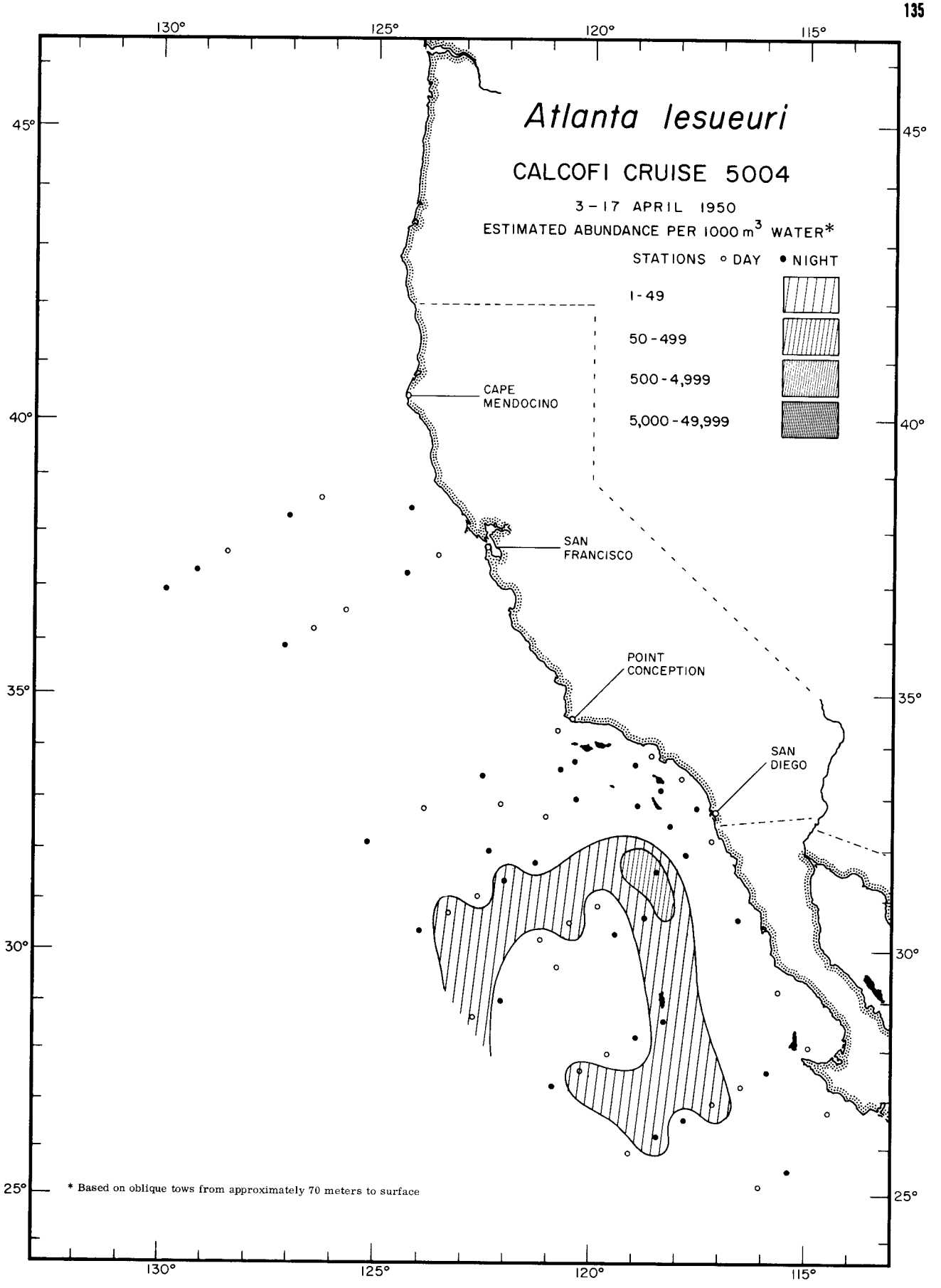
RANGE OF POSITIVE RECORDS




Heteropoda

*Atlanta lesueuri*

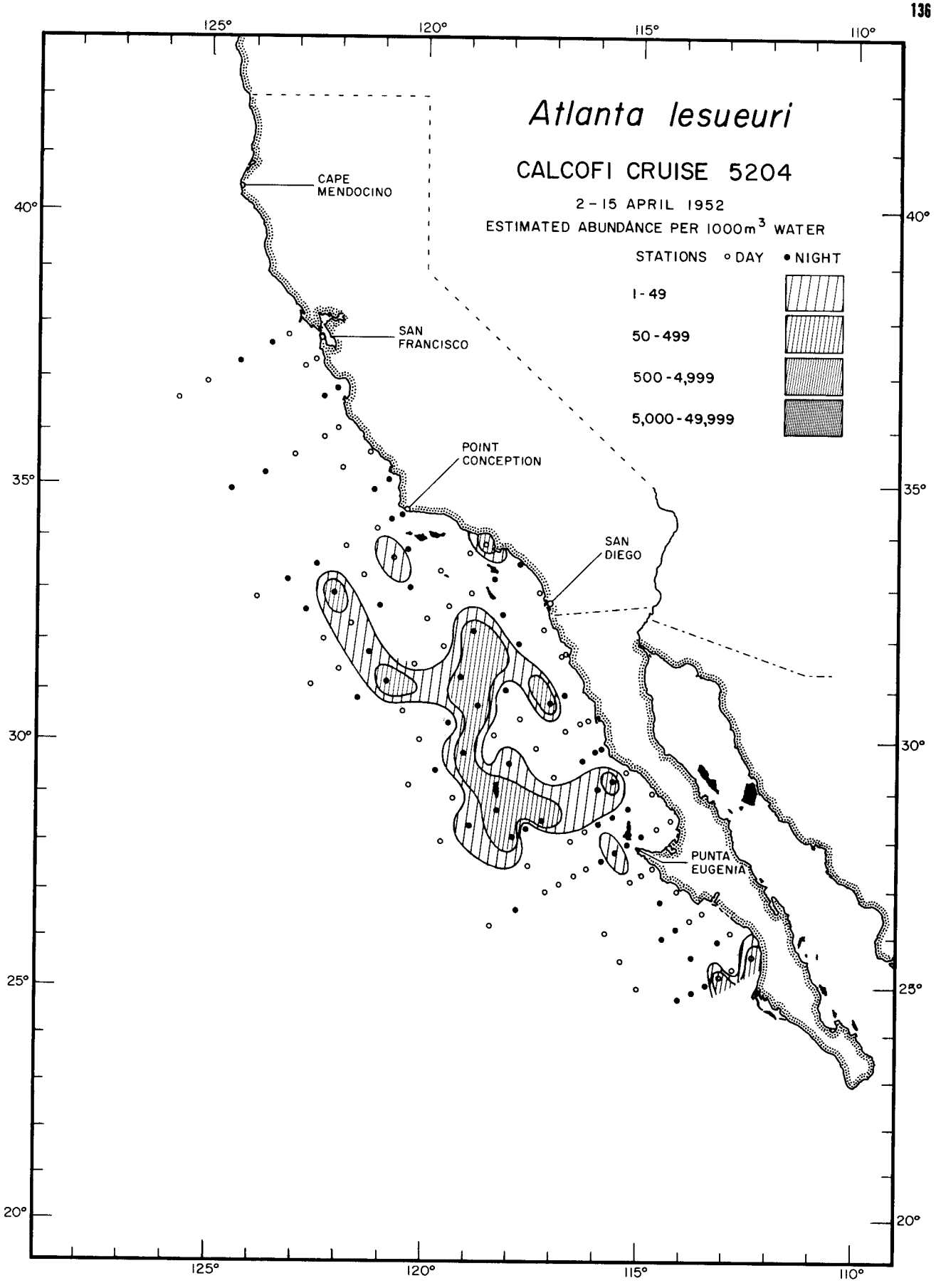
4911




Heteropoda

*Atlanta lesueuri*

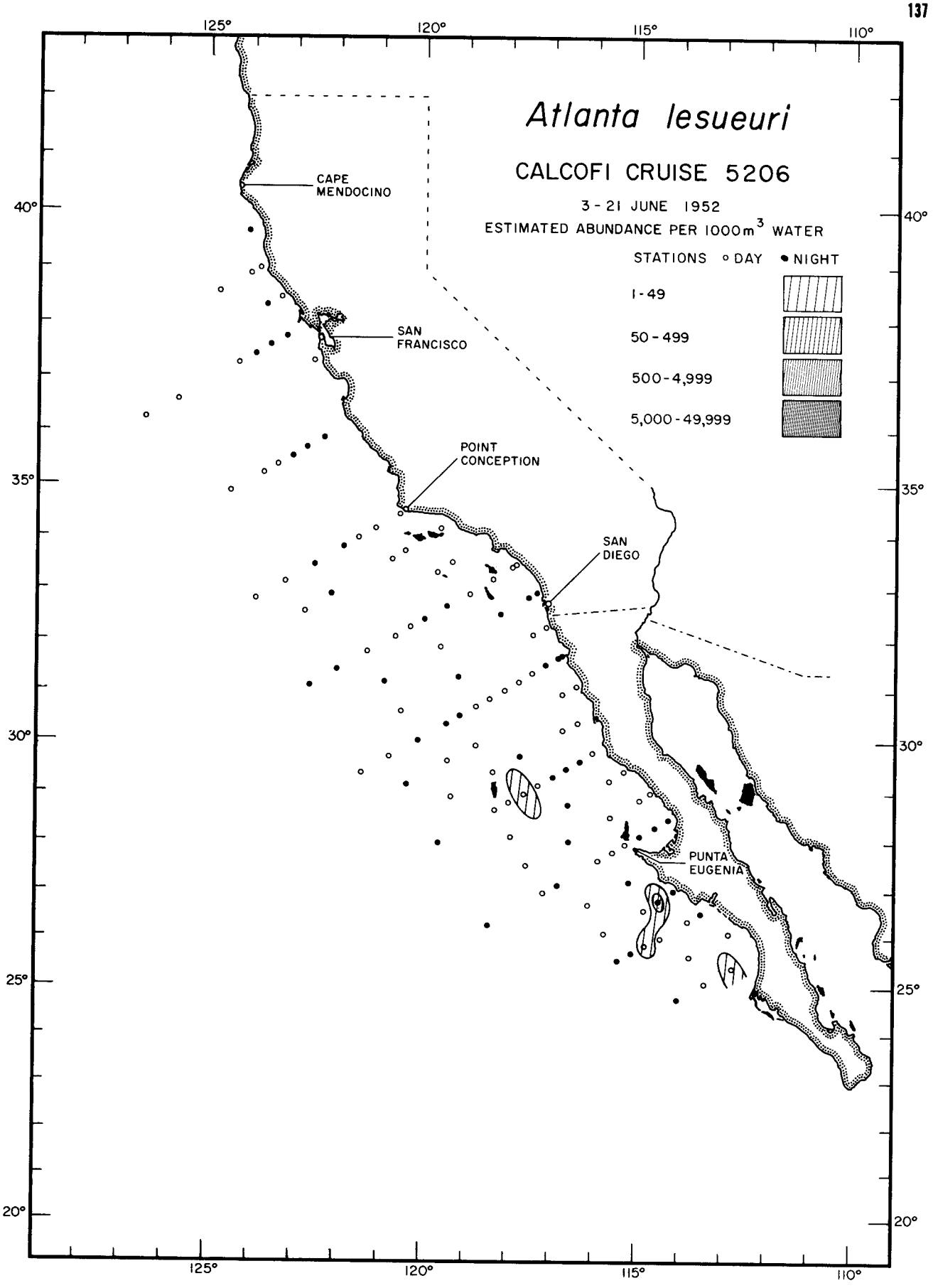
5004




Heteropoda

*Atlanta lesueuri*

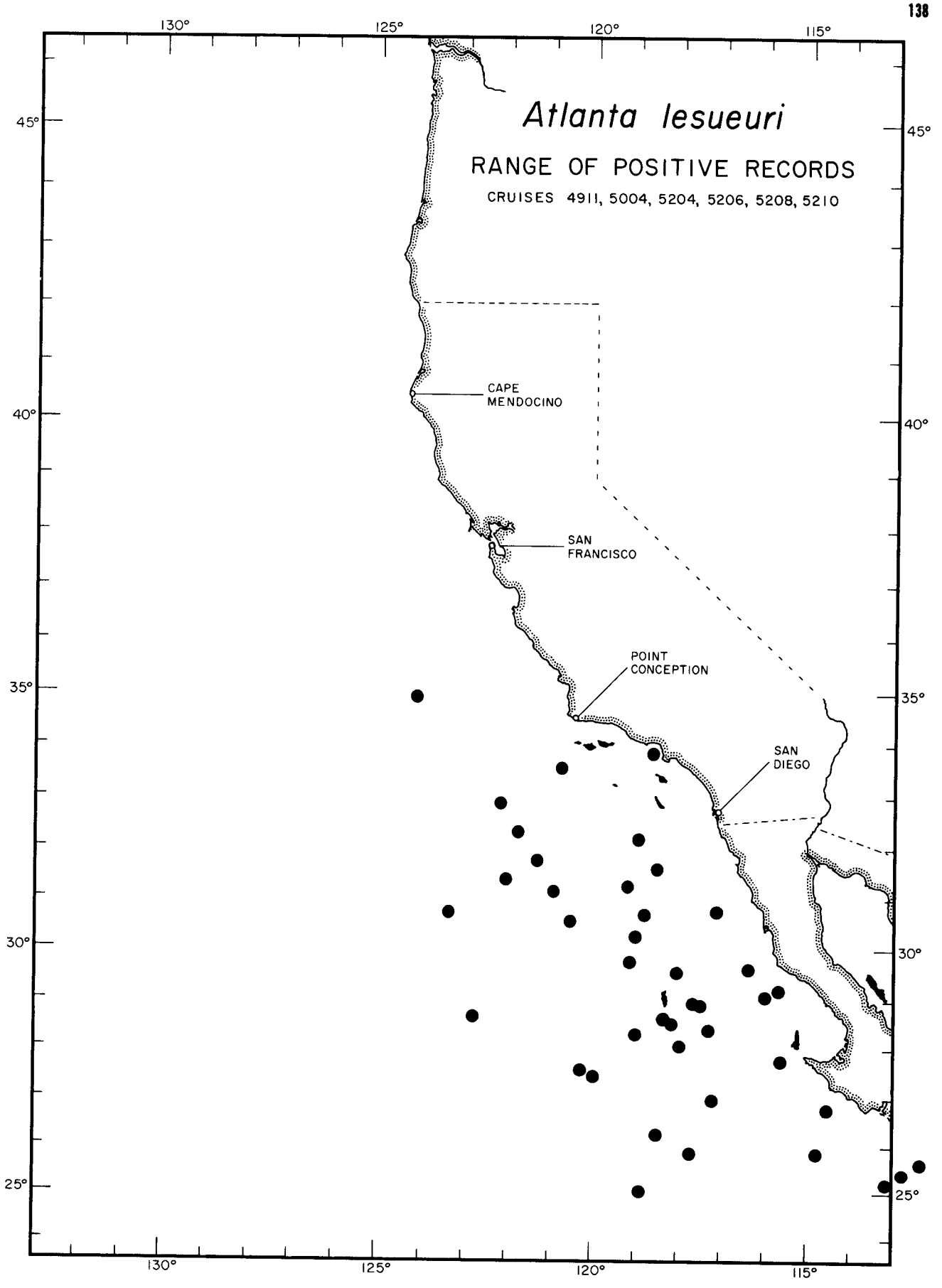
5204




Heteropoda

*Atlanta lesueuri*

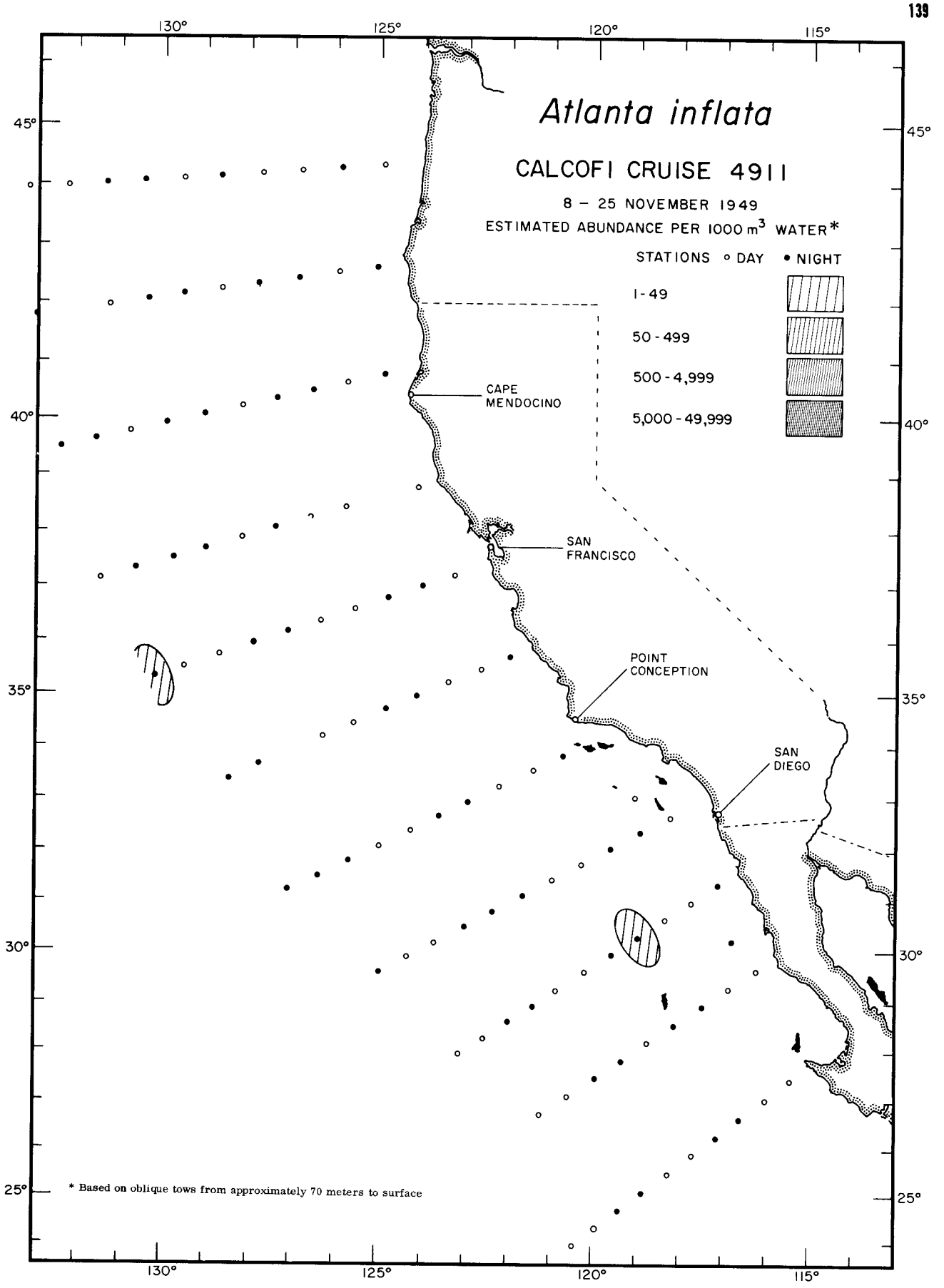
5206




Heteropoda

*Atlanta lesueuri*

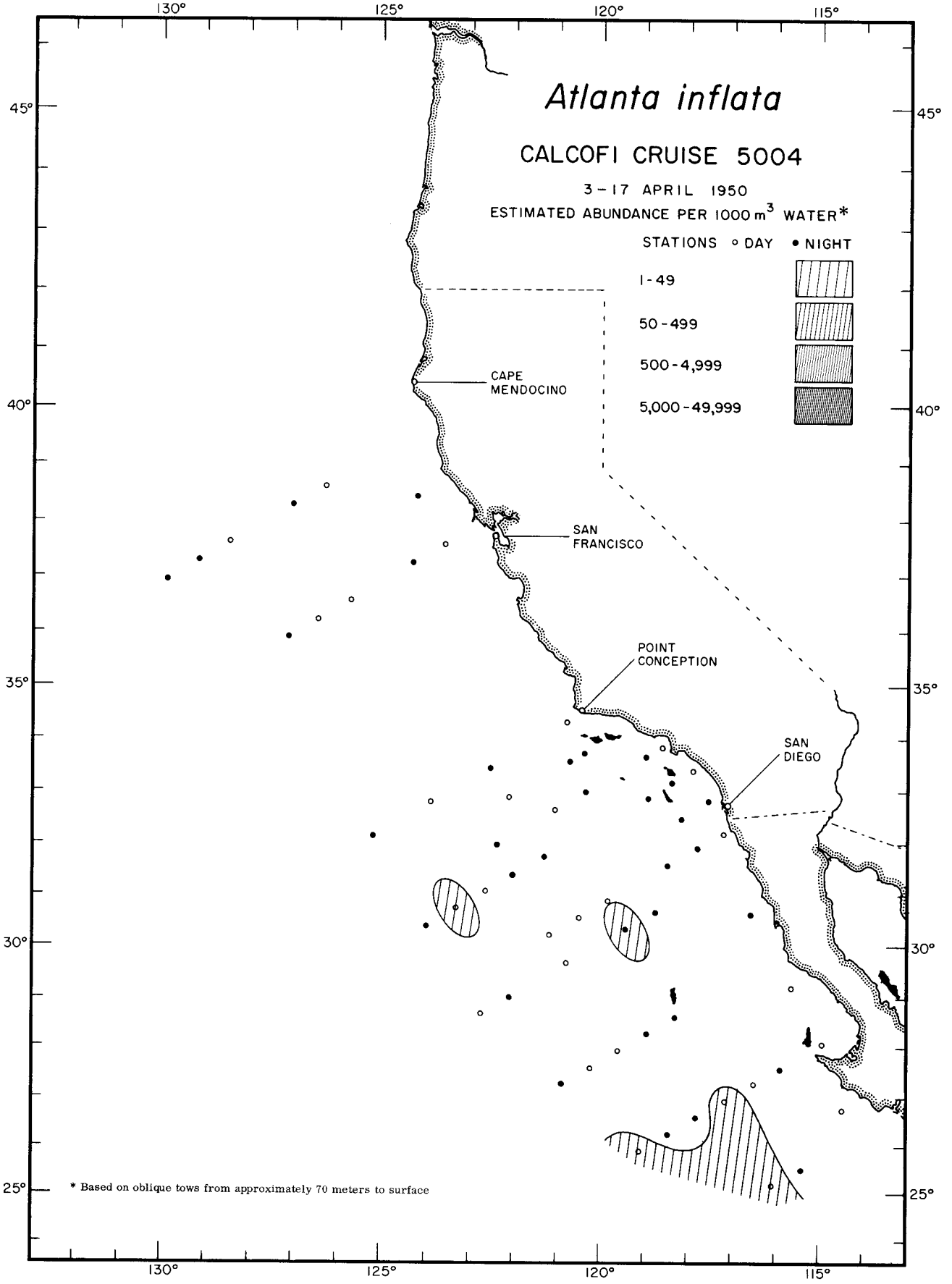
RANGE OF POSITIVE RECORDS




Heteropoda

*Atlanta inflata*

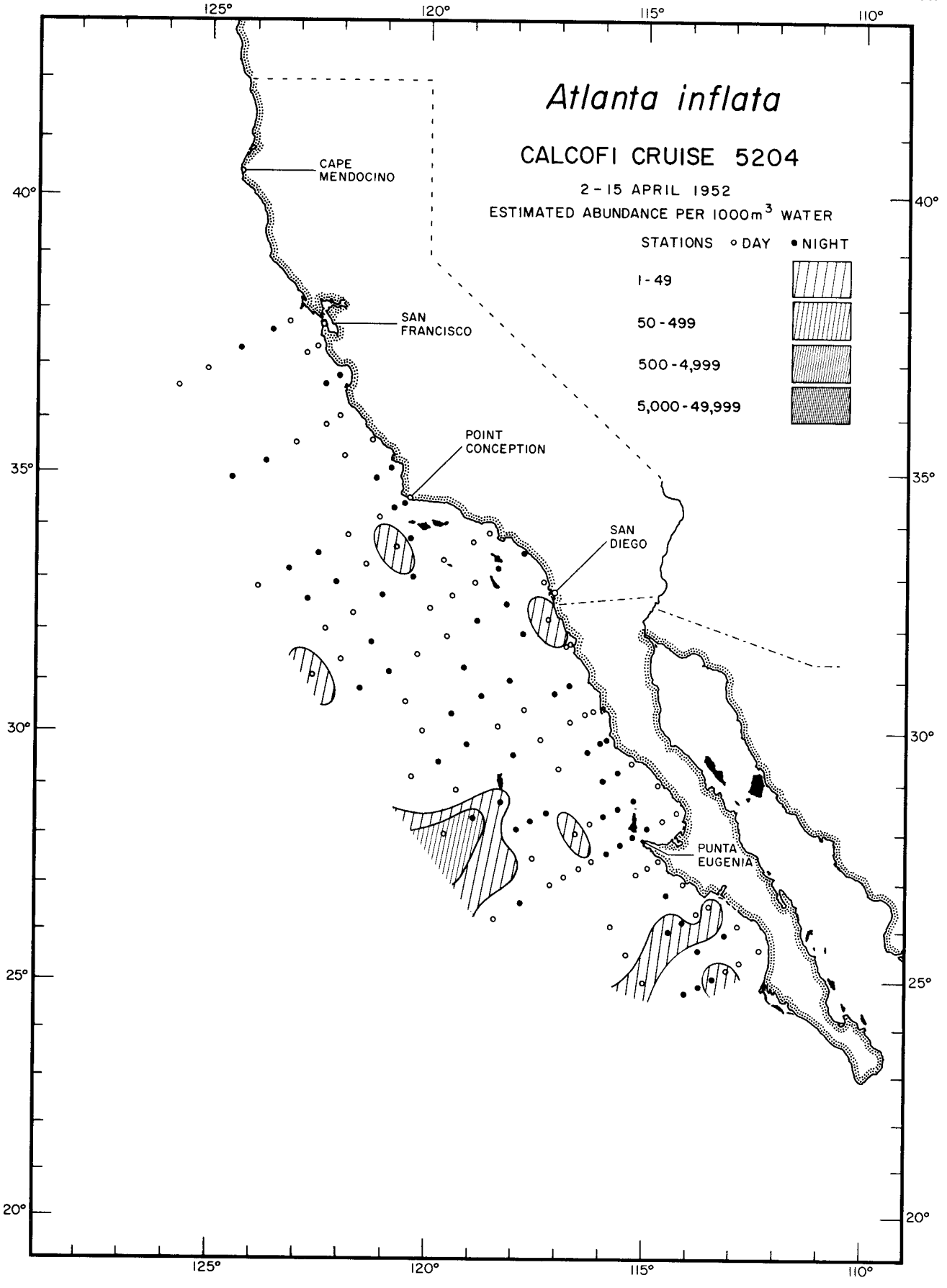
4911




Heteropoda

*Atlanta inflata*

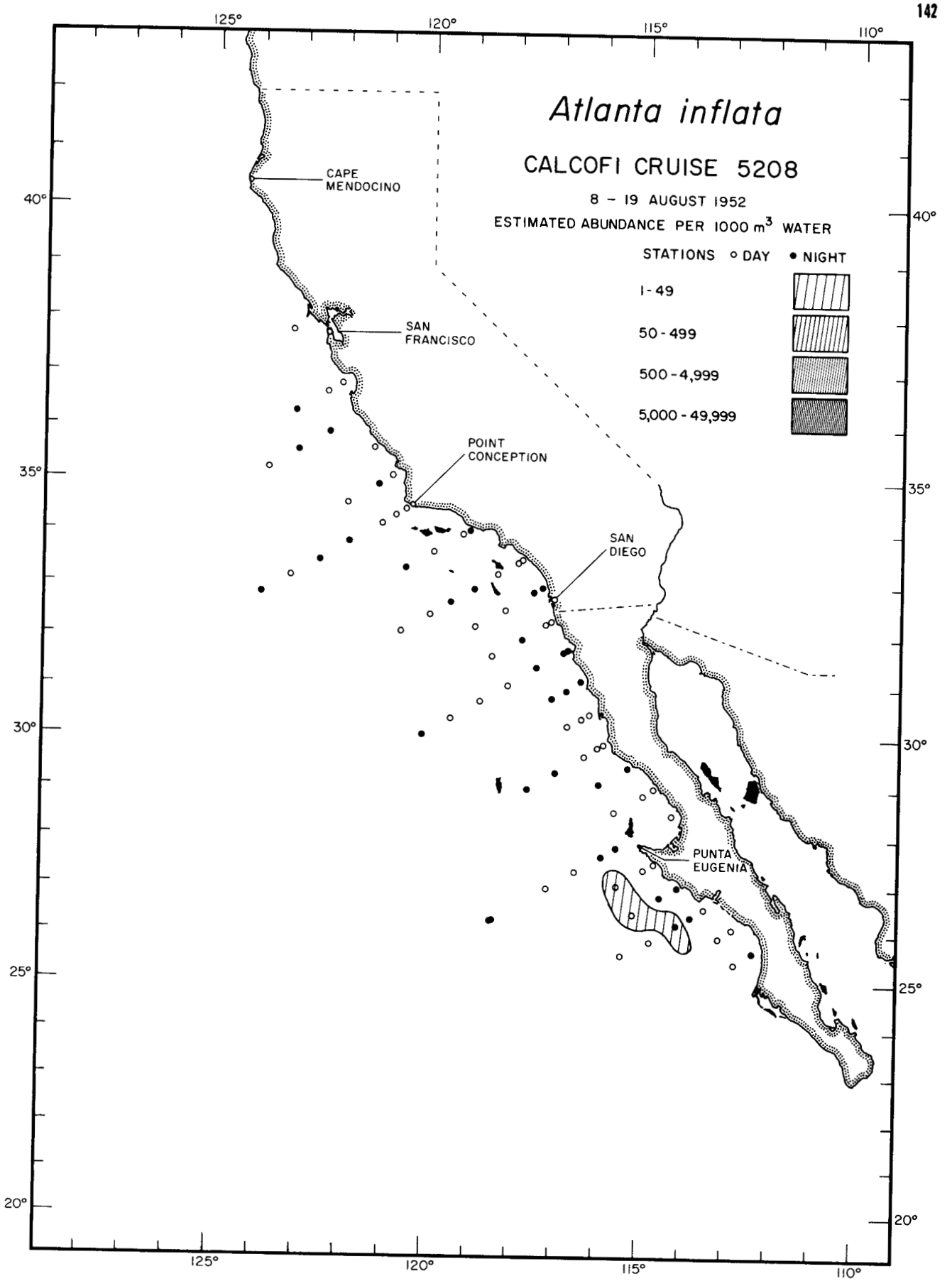
5004




Heteropoda

*Atlanta inflata*

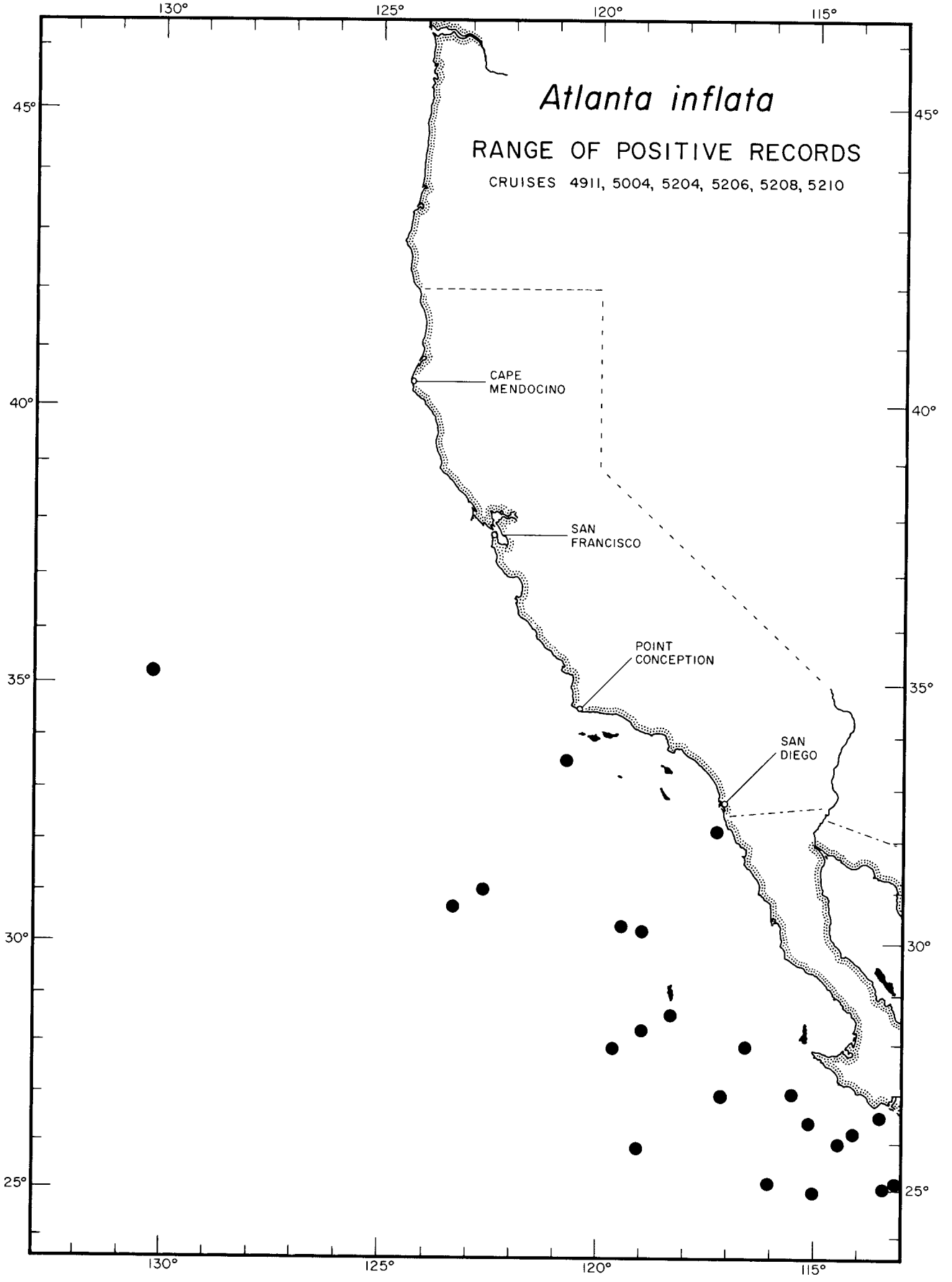
5204




Heteropoda

*Atlanta inflata*

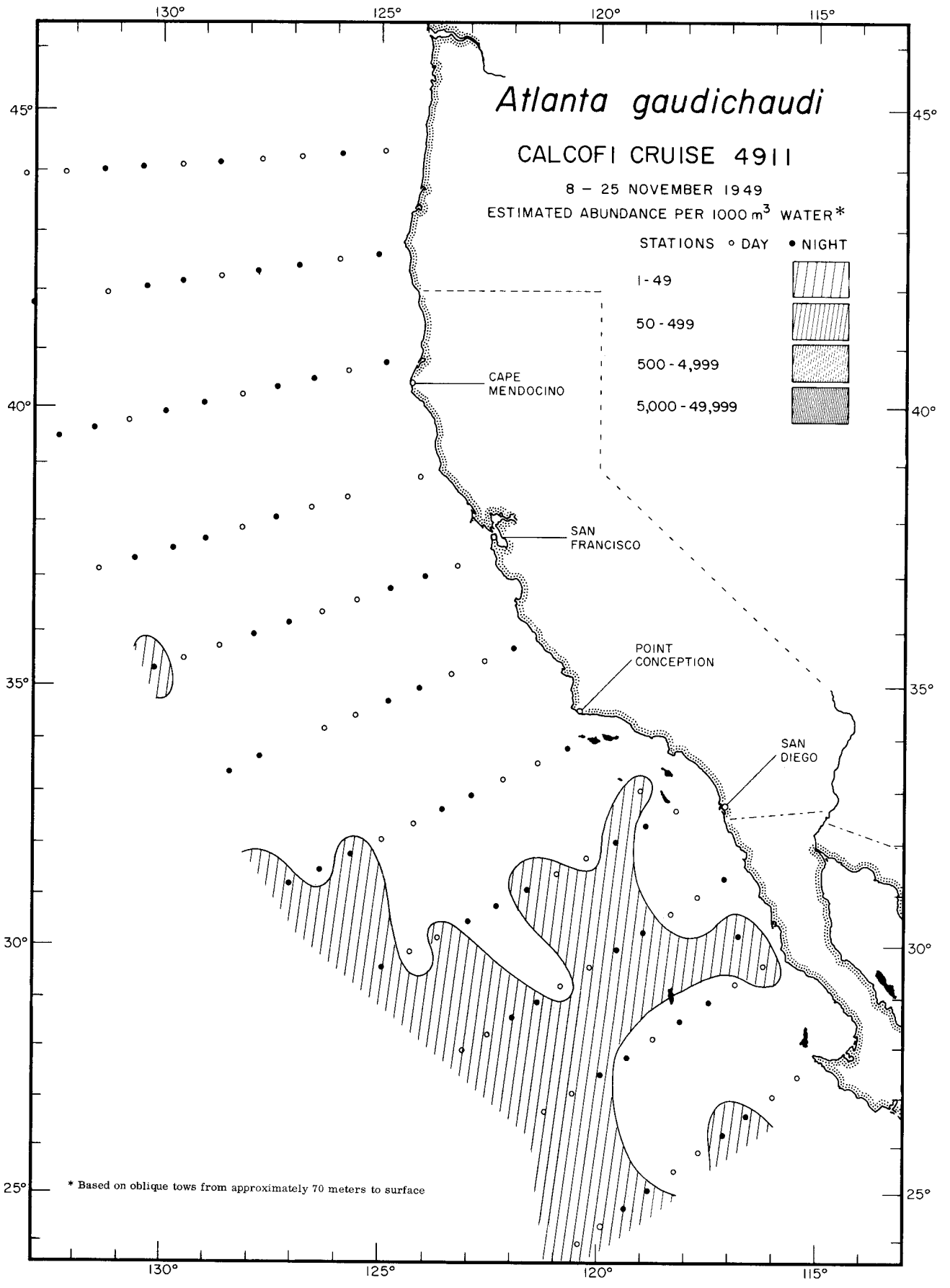
5208




Heteropoda

*Atlanta inflata*

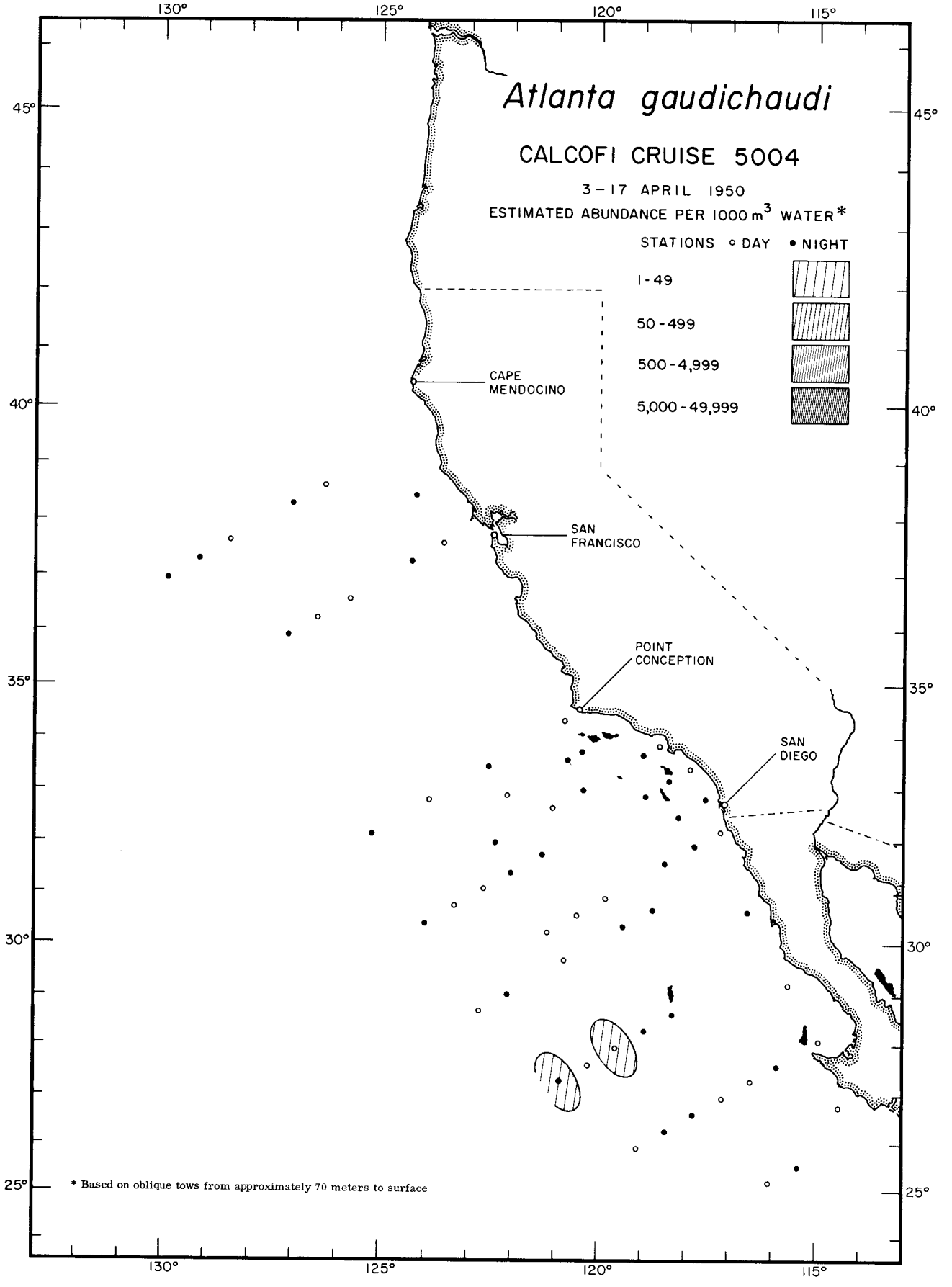
RANGE OF POSITIVE RECORDS




Heteropoda

*Atlanta gaudichaudi*

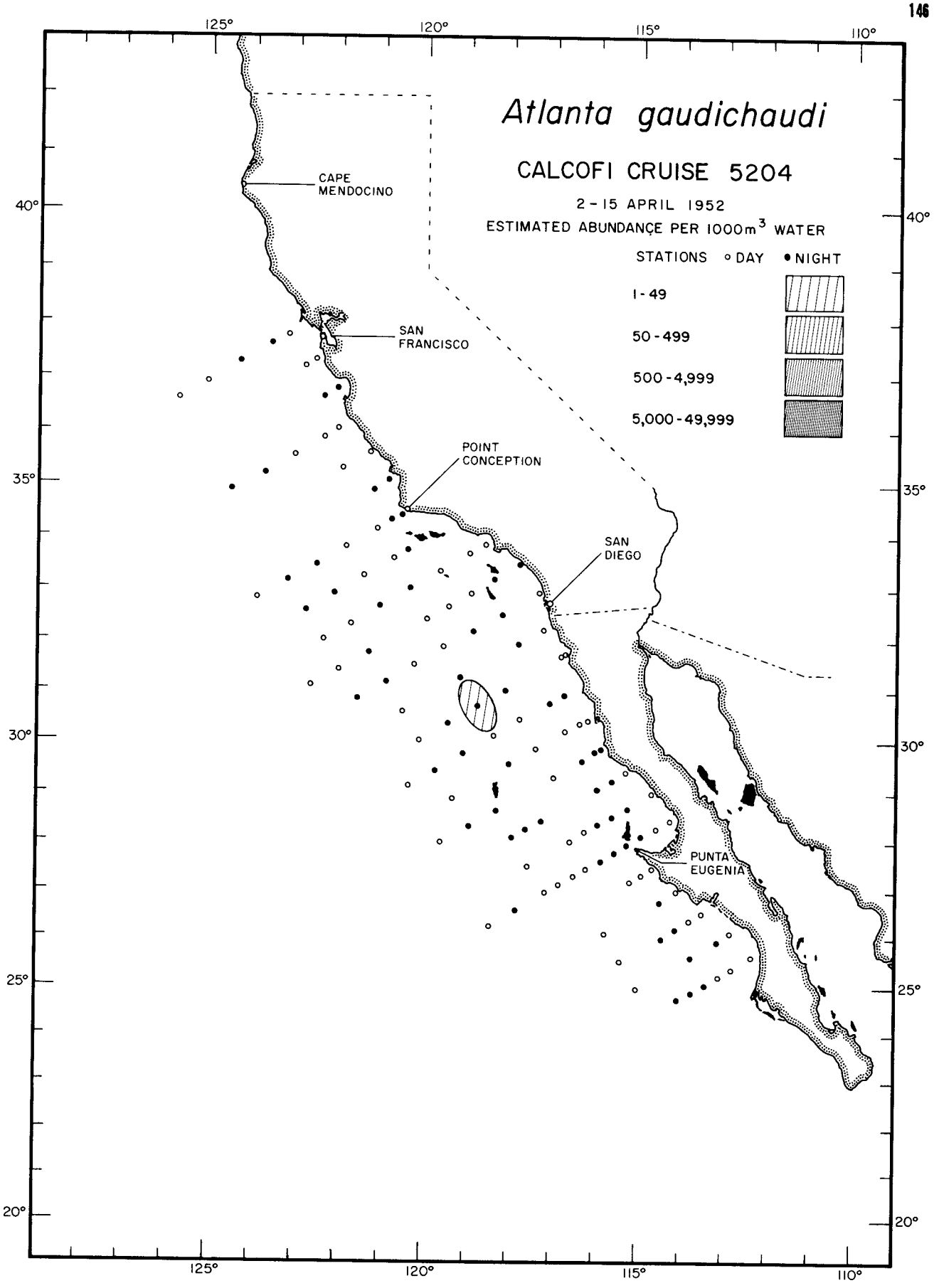
4911




Heteropoda

*Atlanta gaudichaudi*

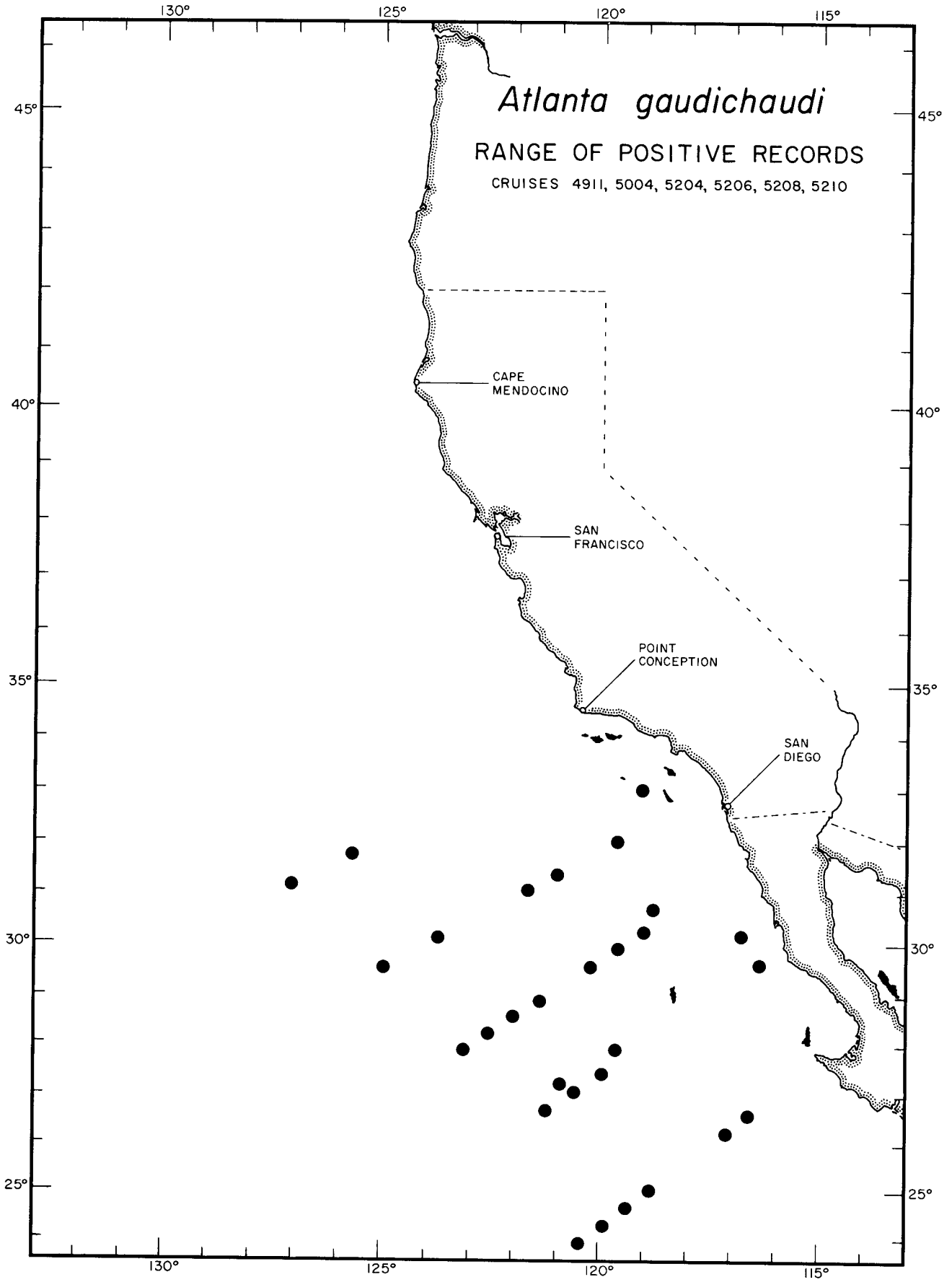
5004




Heteropoda

*Atlanta gaudichaudi*

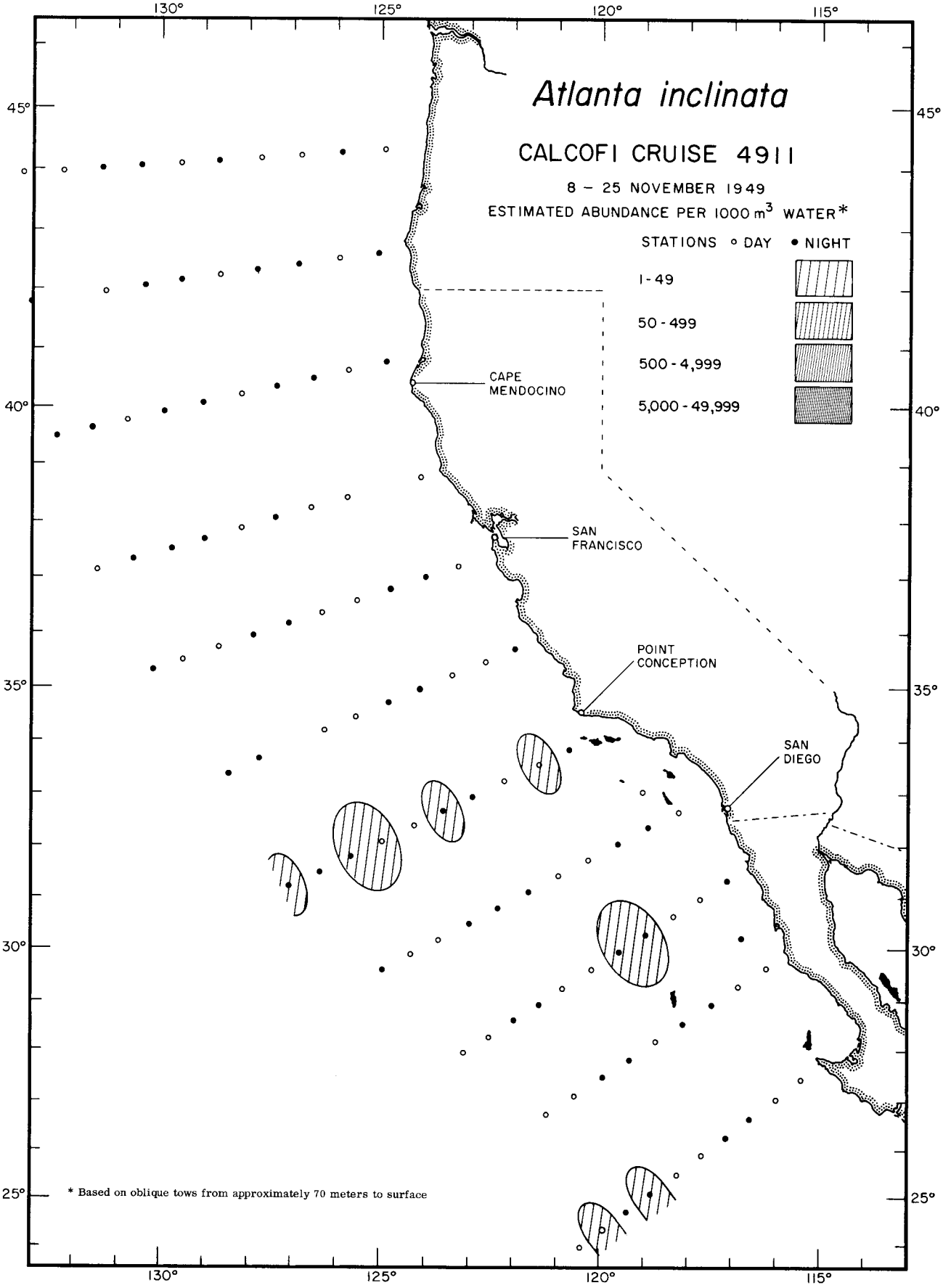
5204




Heteropoda

*Atlanta gaudichaudi*

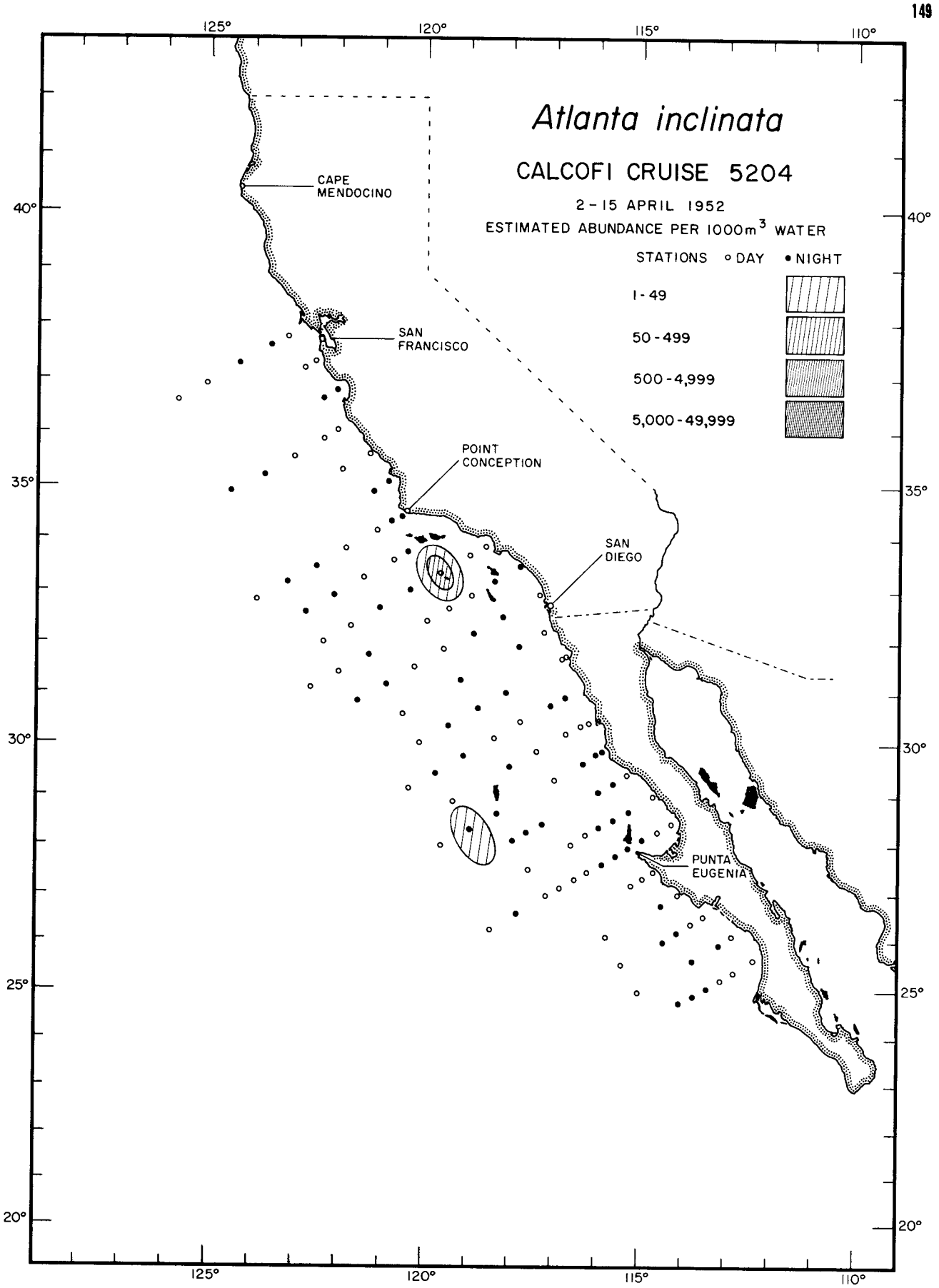
RANGE OF POSITIVE RECORDS




Heteropoda

*Atlanta inclinata*

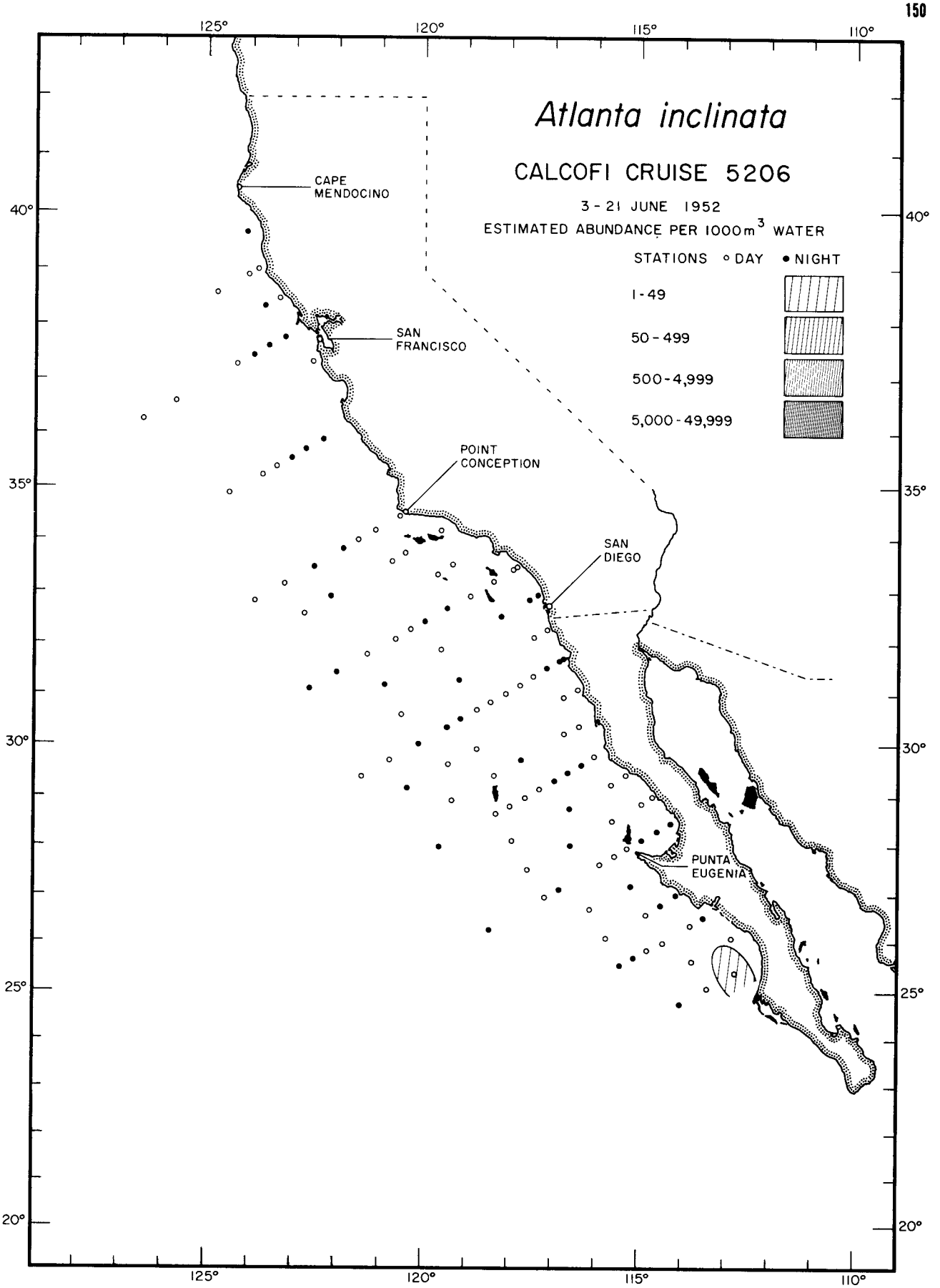
4911




Heteropoda

*Atlanta inclinata*

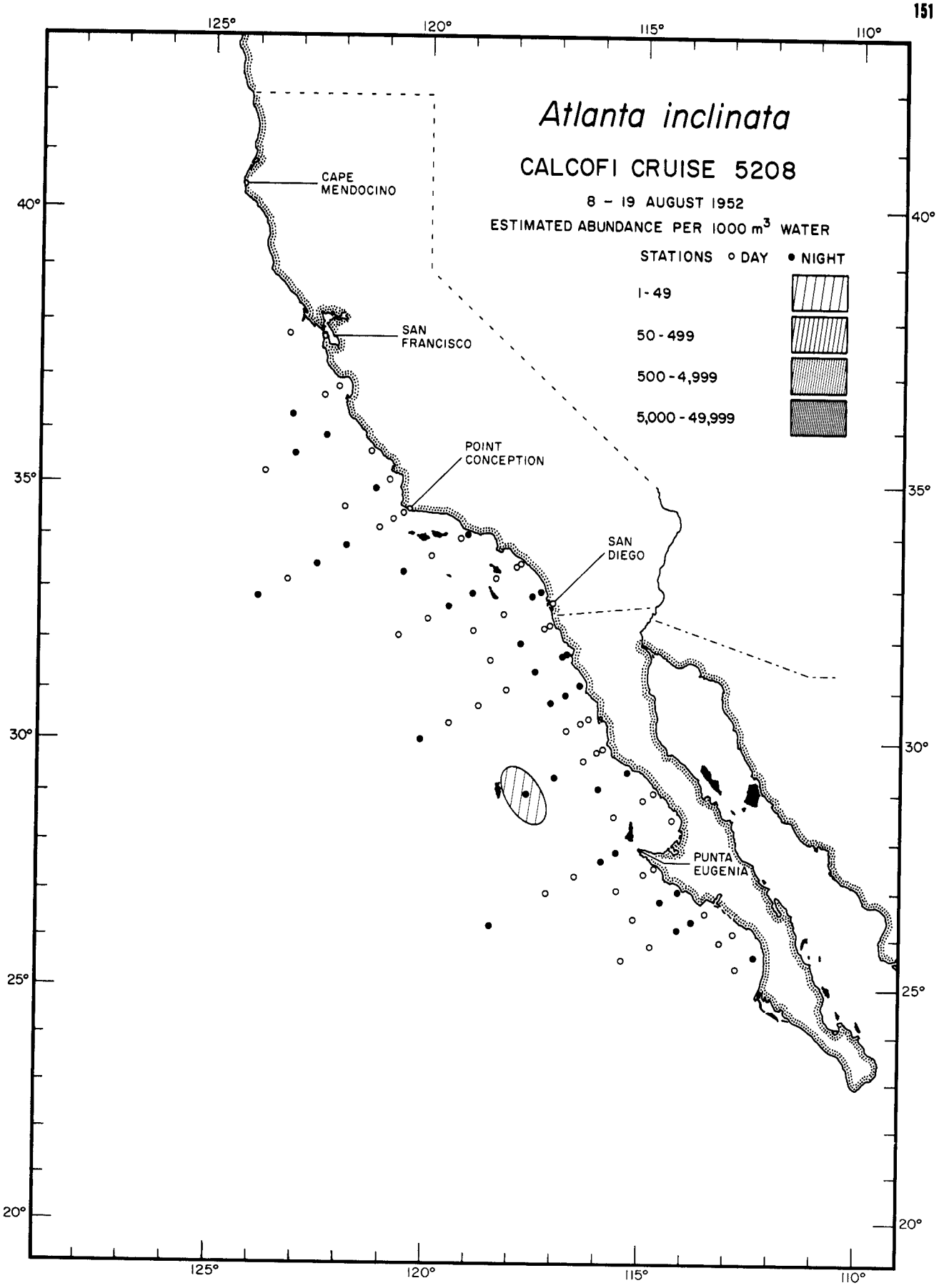
5204




Heteropoda

*Atlanta inclinata*

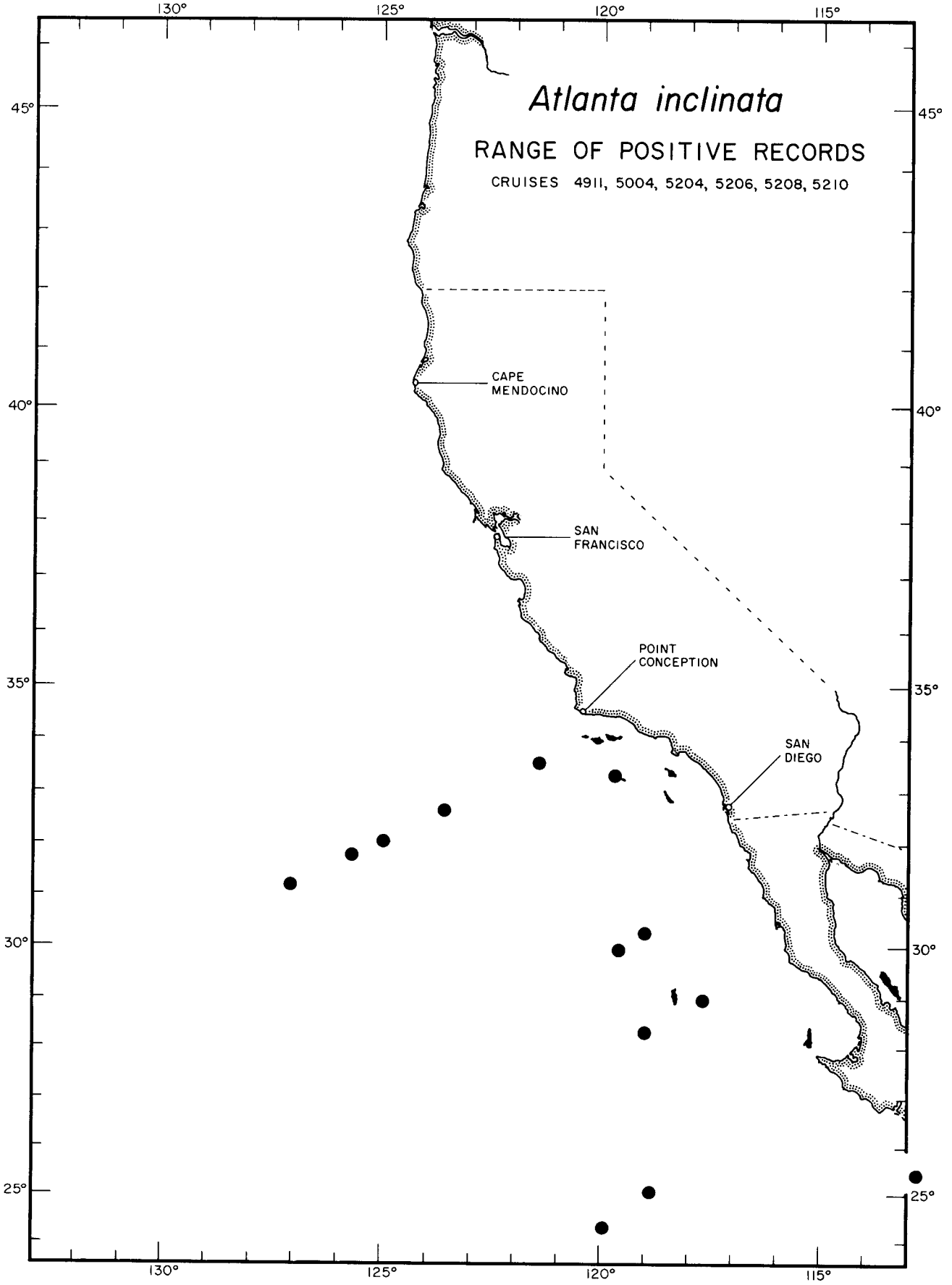
5206




Heteropoda

*Atlanta inclinata*

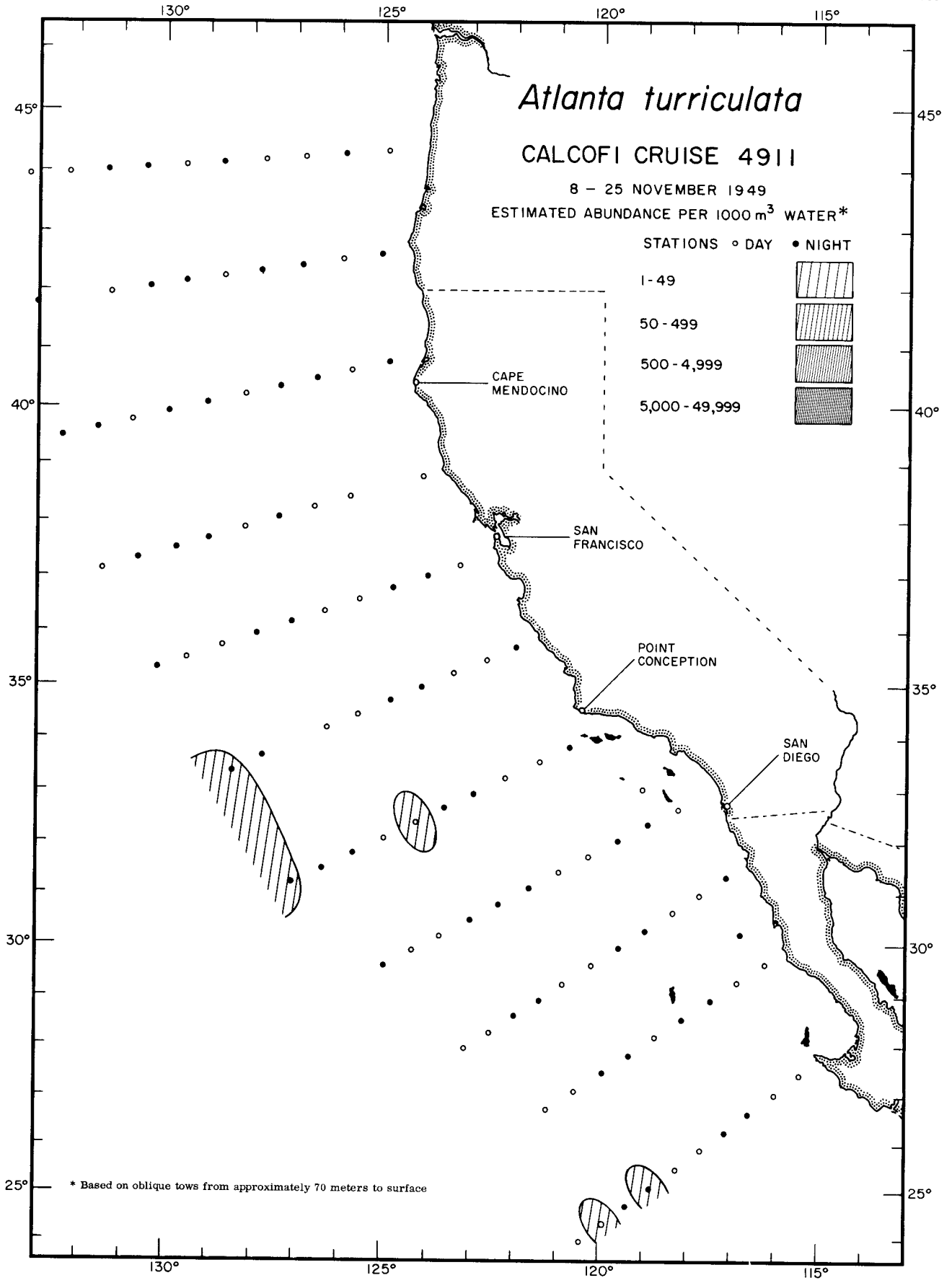
5208




Heteropoda

*Atlanta inclinata*

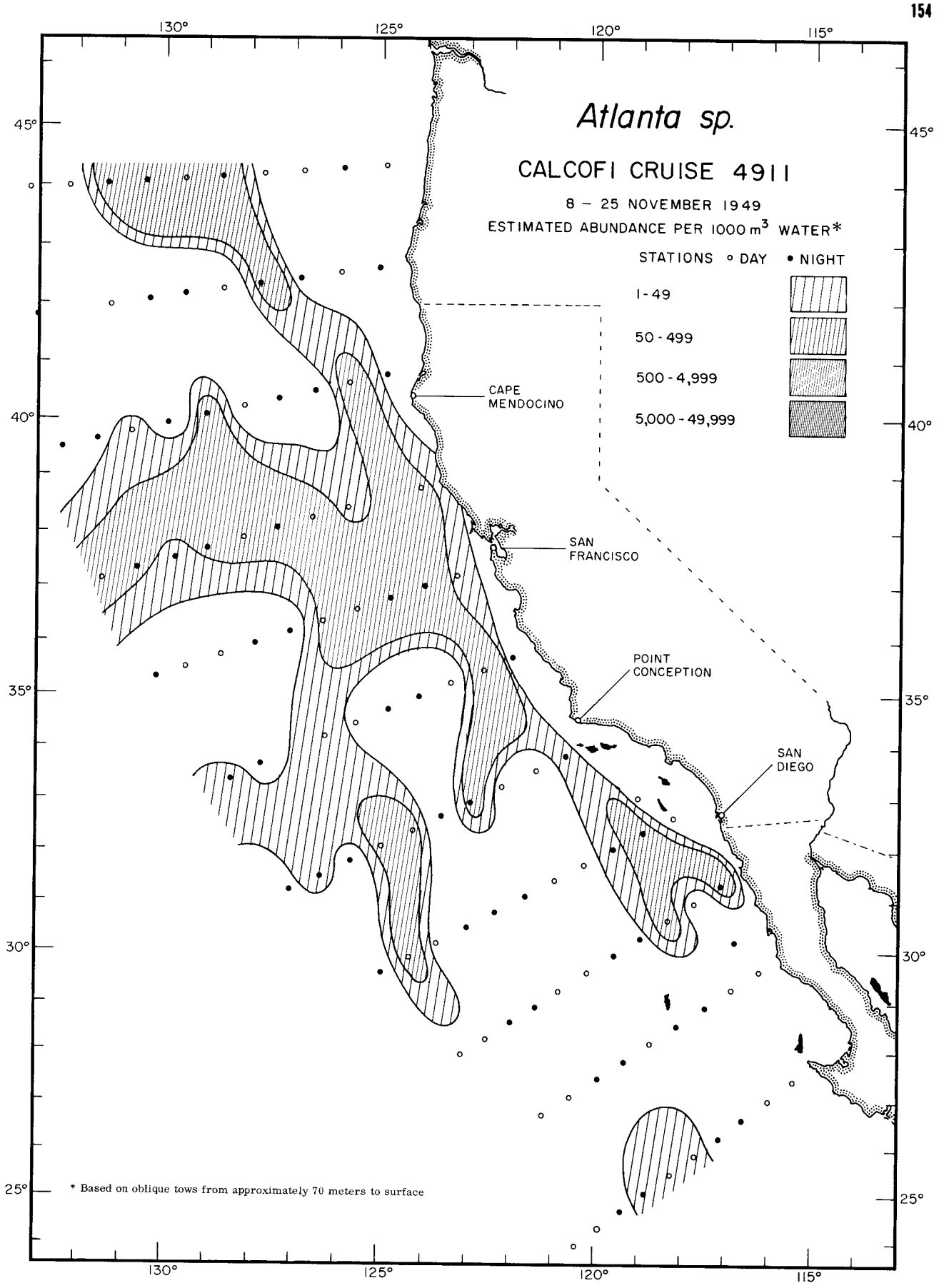
RANGE OF POSITIVE RECORDS




Heteropoda

*Atlanta turriculata*

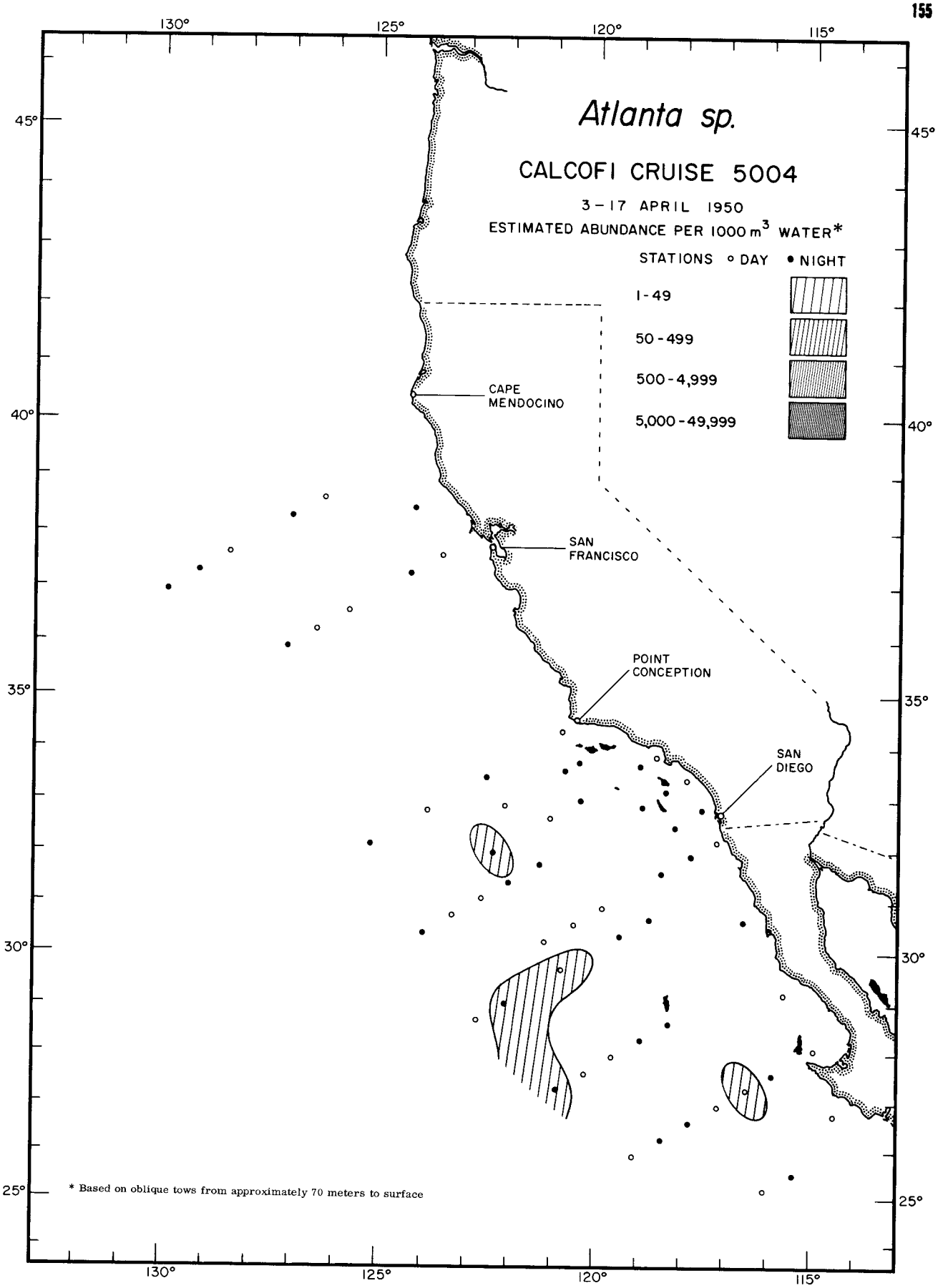
4911




Heteropoda

*Atlanta sp.*

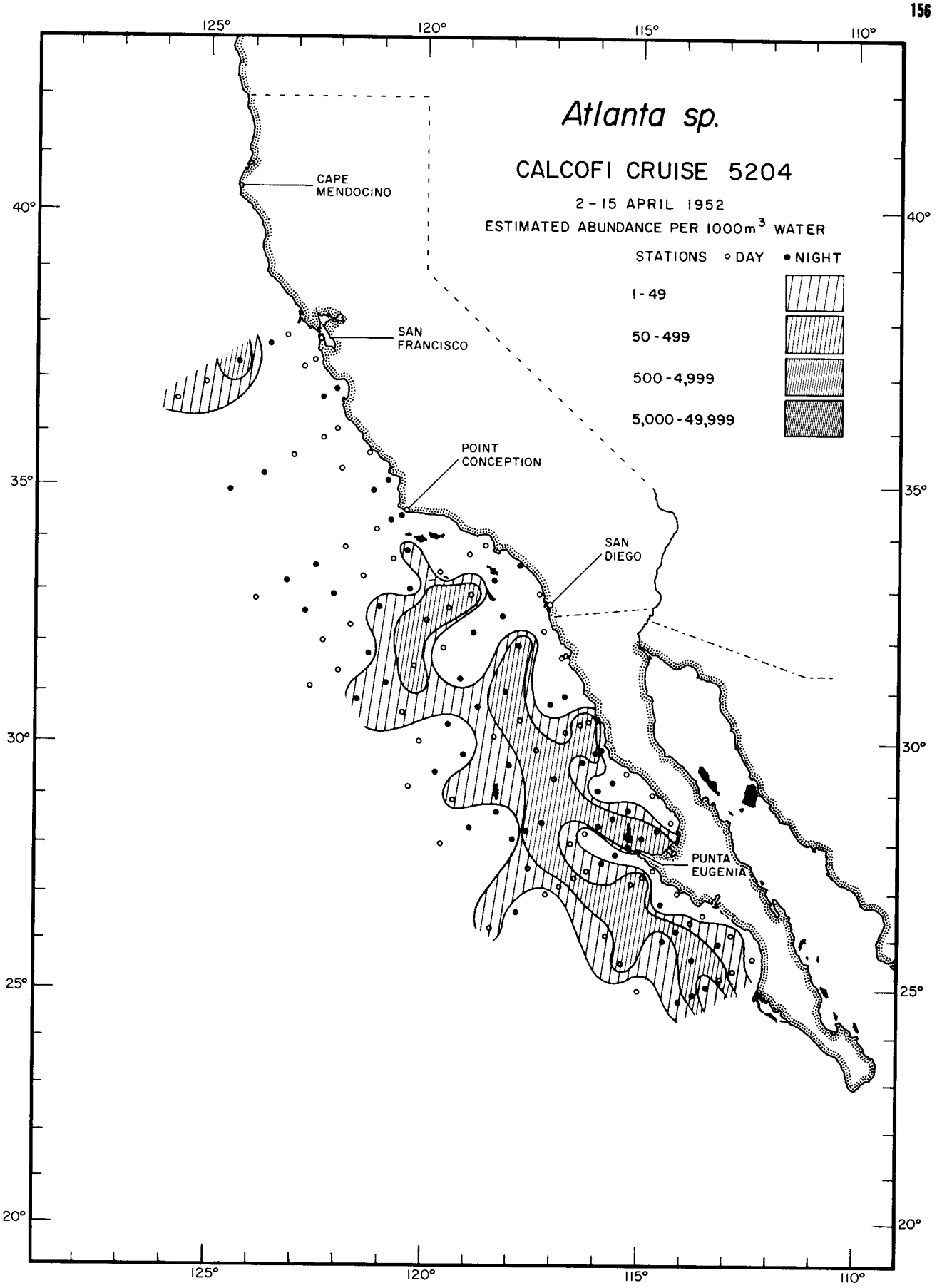
4911




Heteropoda

*Atlanta sp*

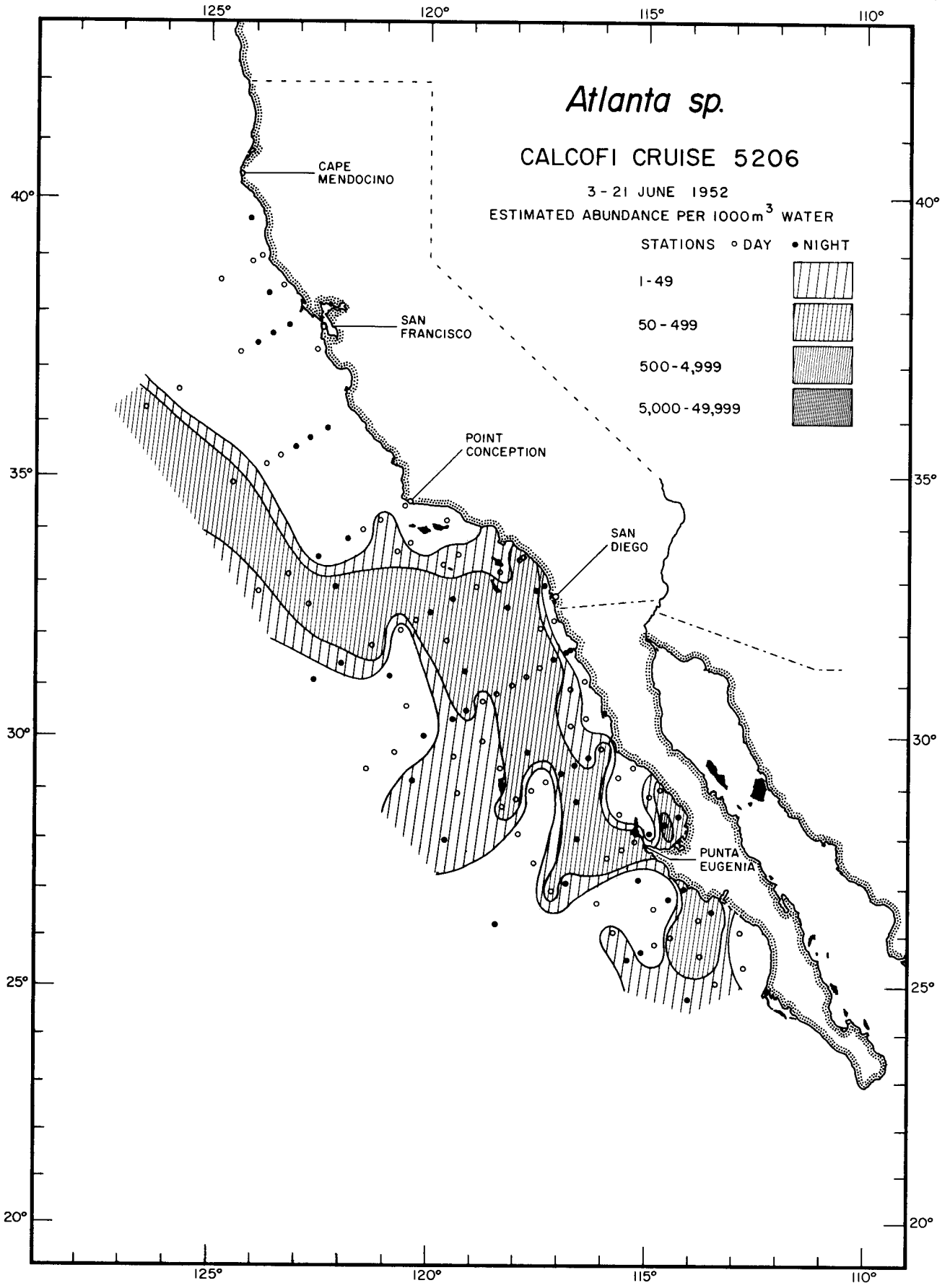
5004




Heteropoda

*Atlanta sp.*

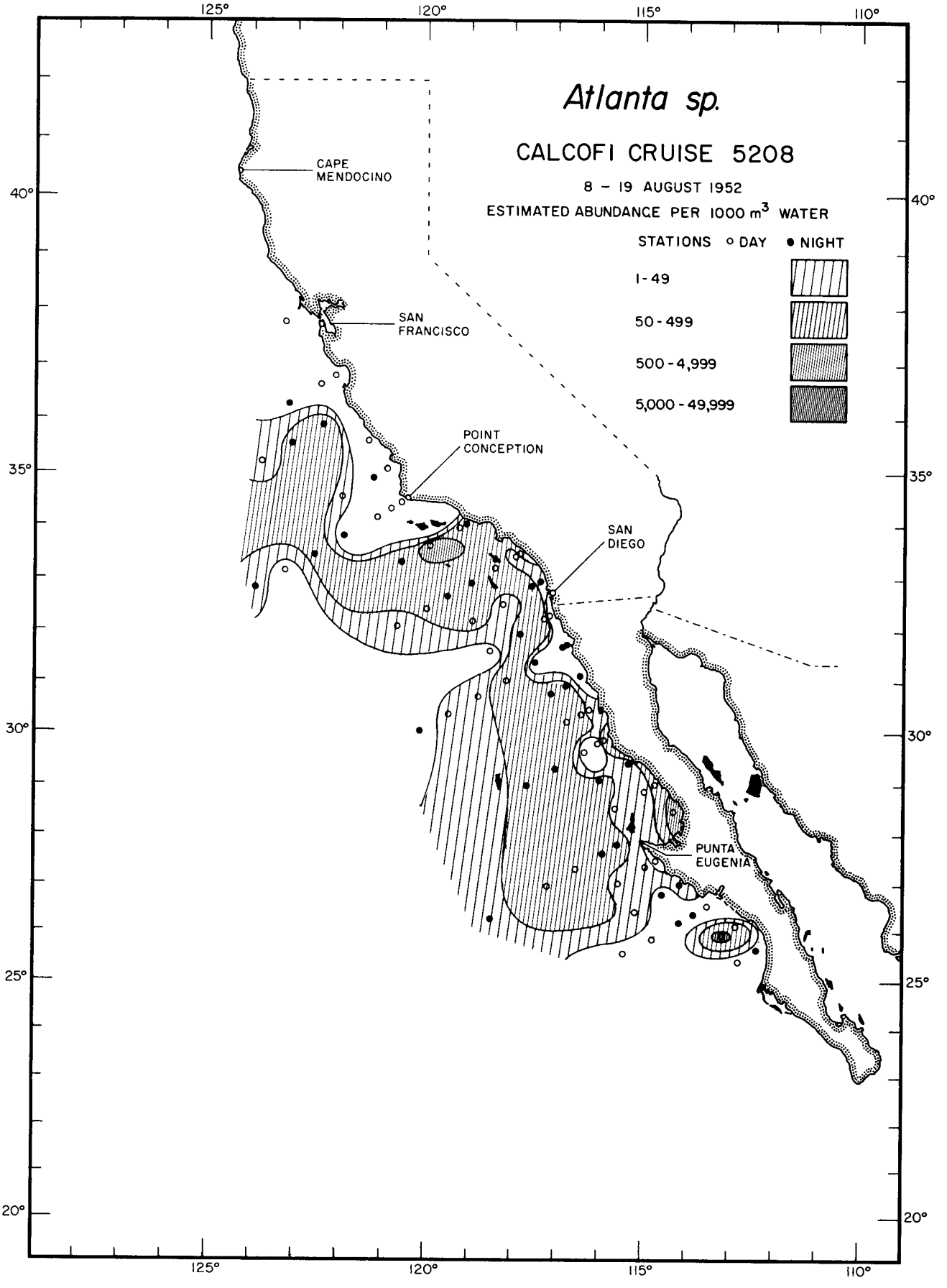
5204




Heteropoda

*Atlanta sp.*

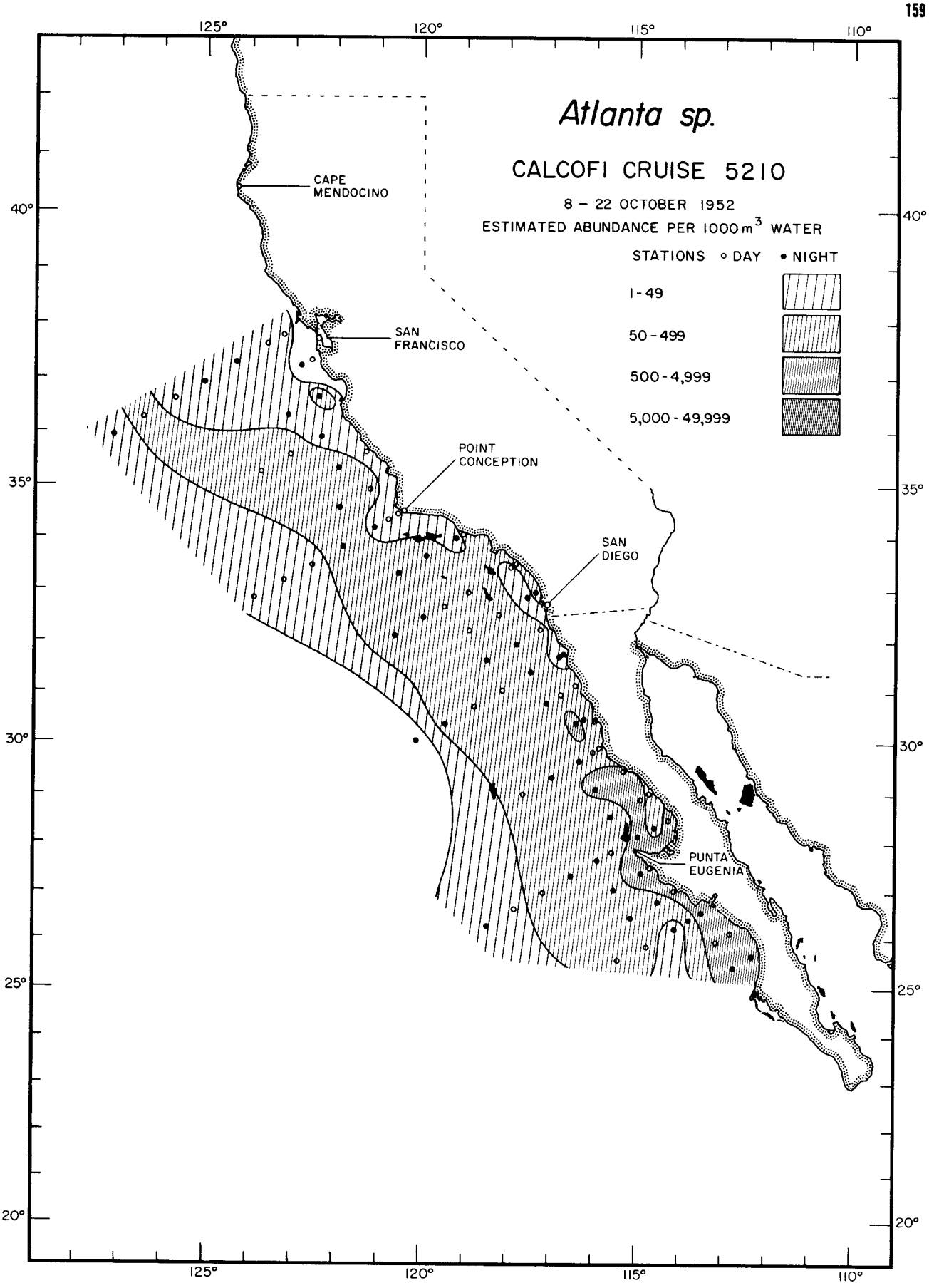
5206




Heteropoda

*Atlanta sp.*

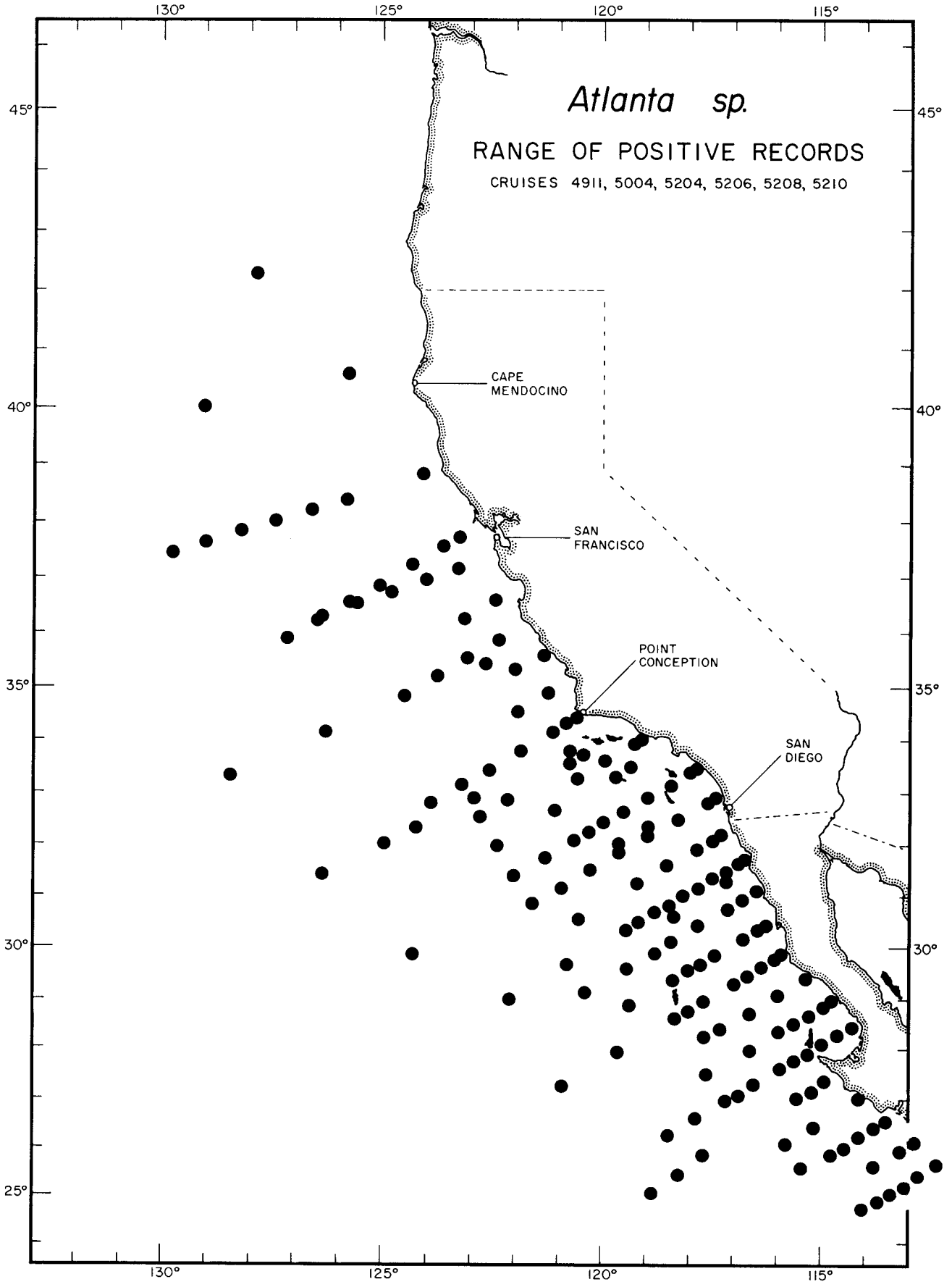
5208




Heteropoda

*Atlanta sp.*

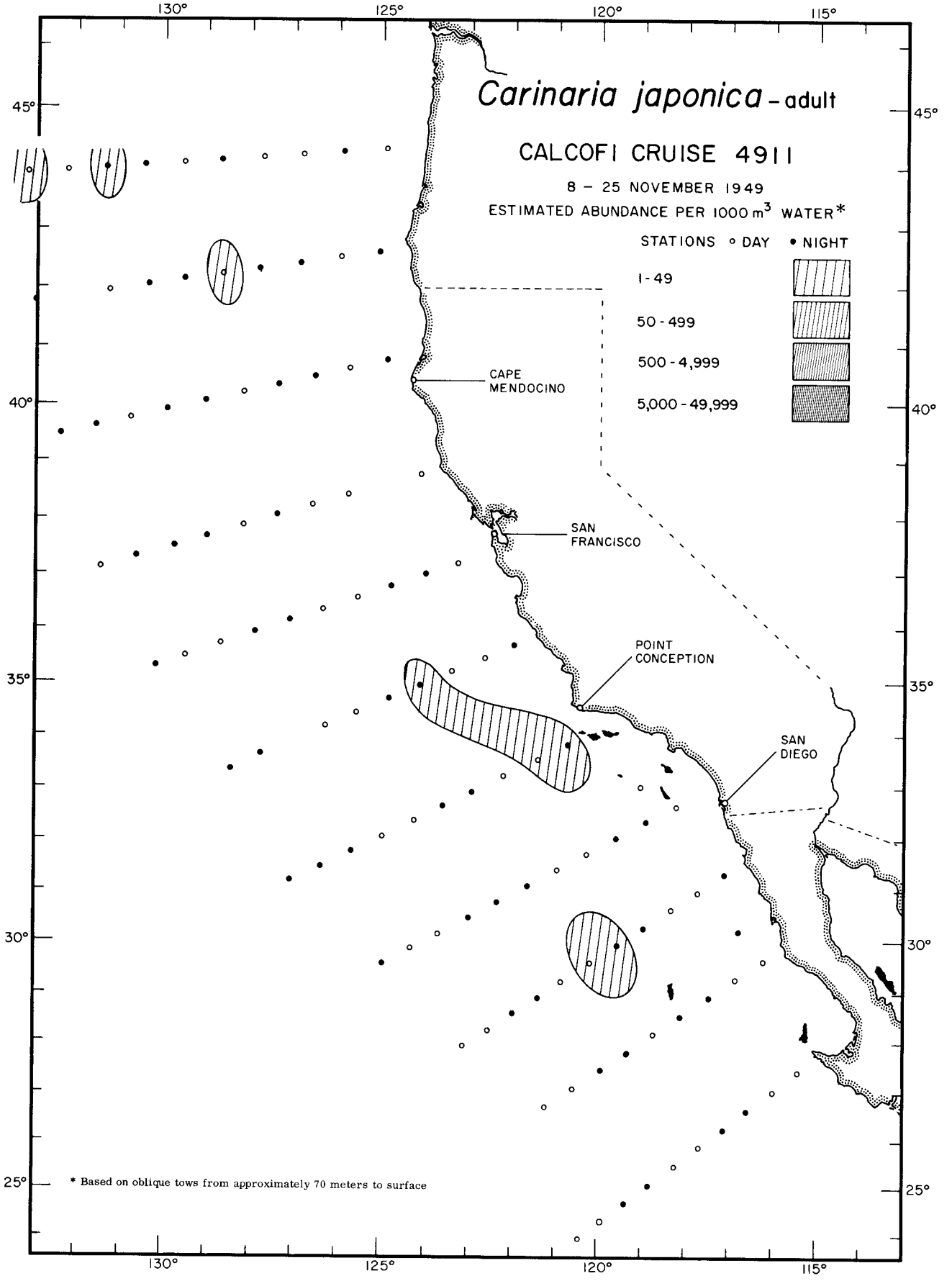
5210




Heteropoda

*Atlanta sp.*

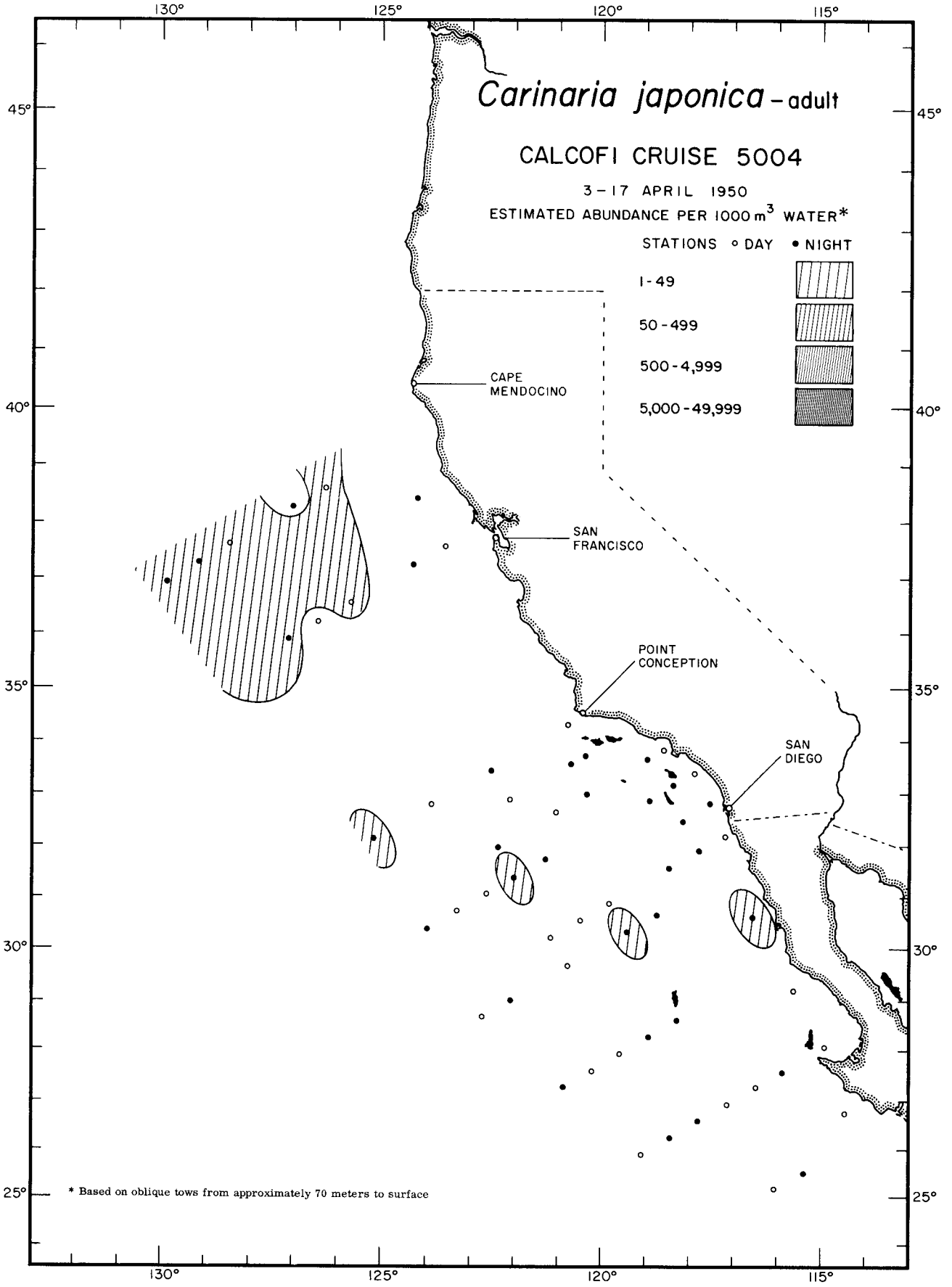
RANGE OF POSITIVE RECORDS




Heteropoda

*Carinaria japonica* - adult

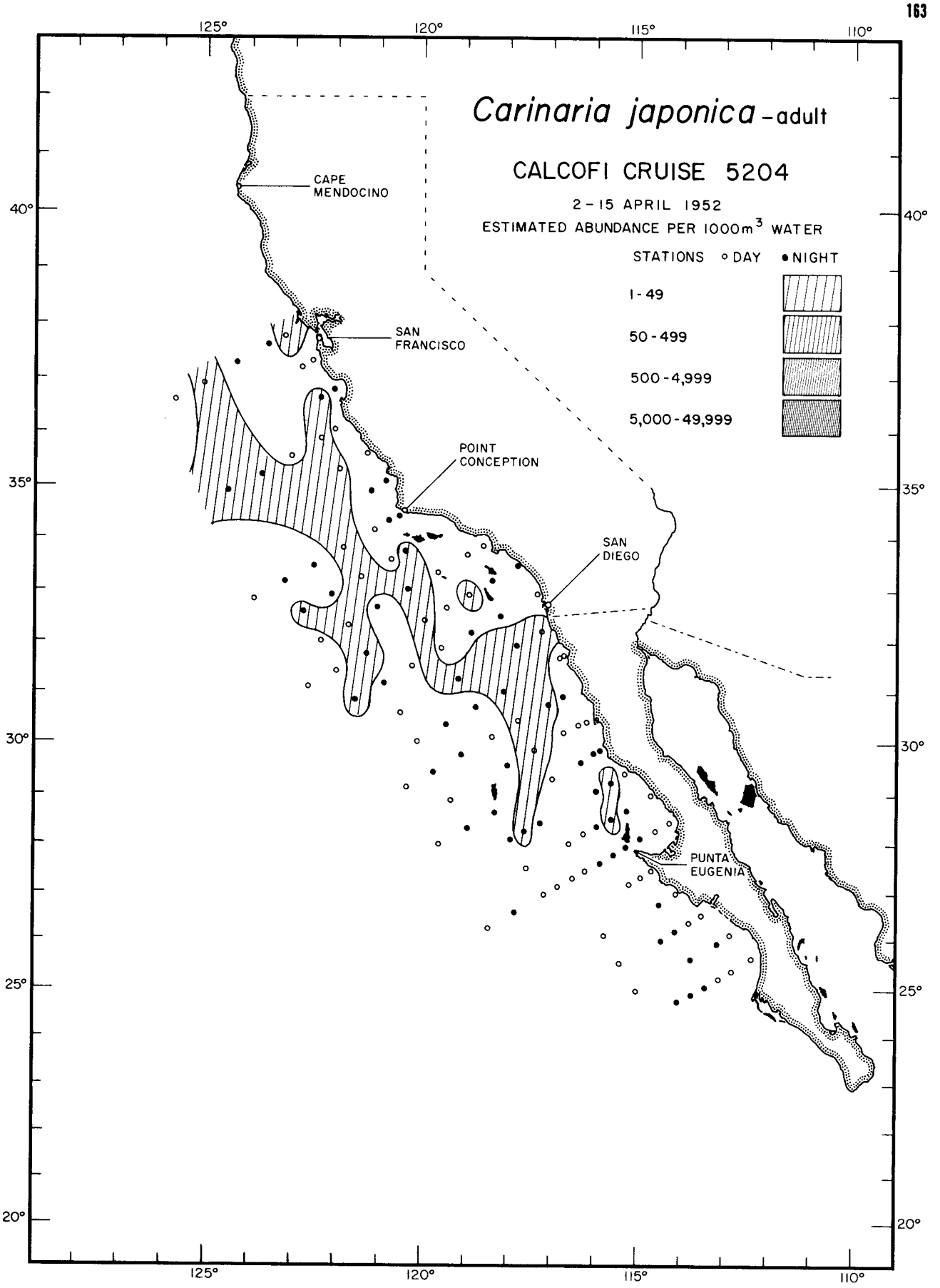
4911




Heteropoda

*Carinaria japonica* - adult

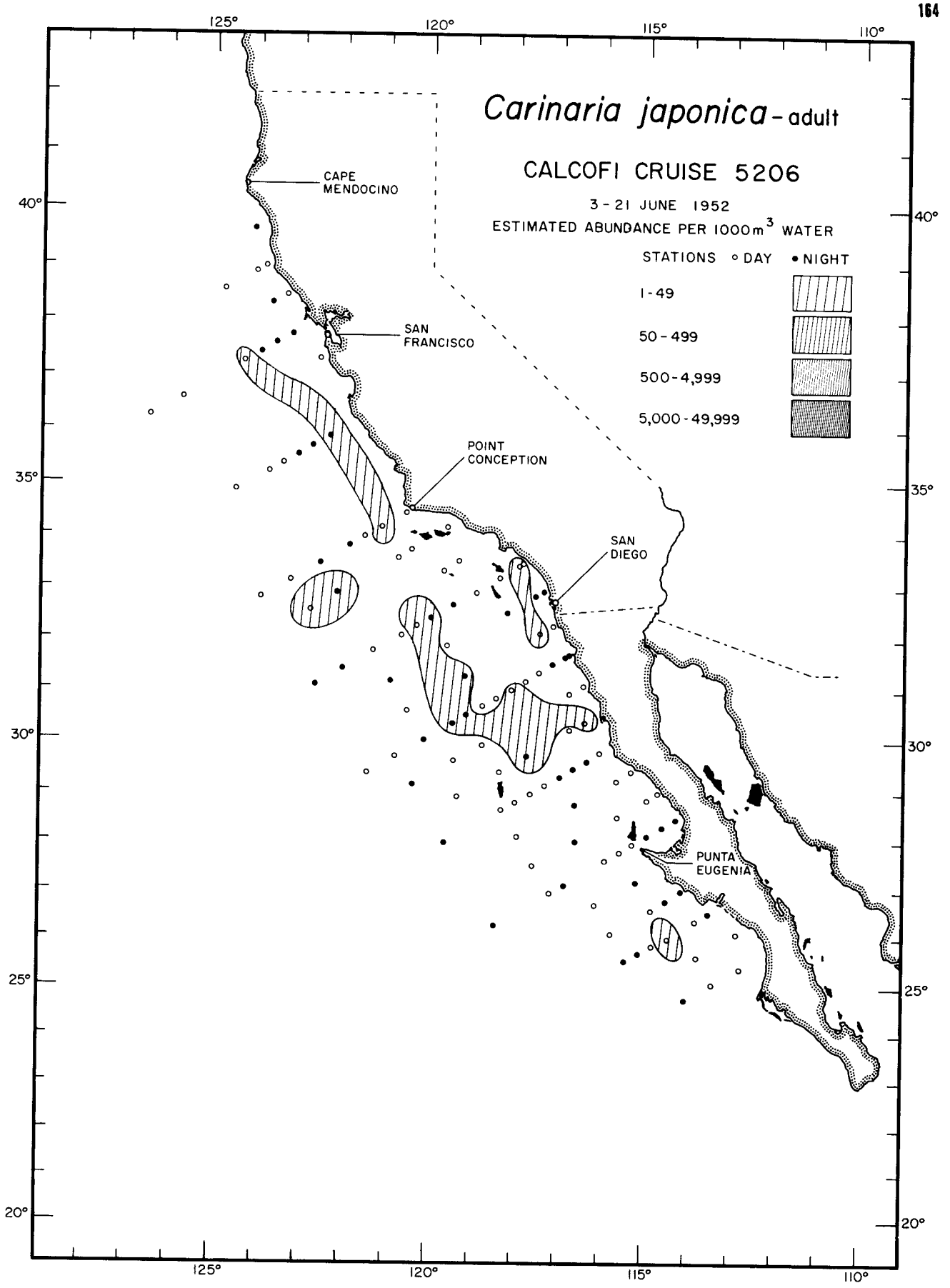
5004




Heteropoda

*Carinaria japonica* - adult

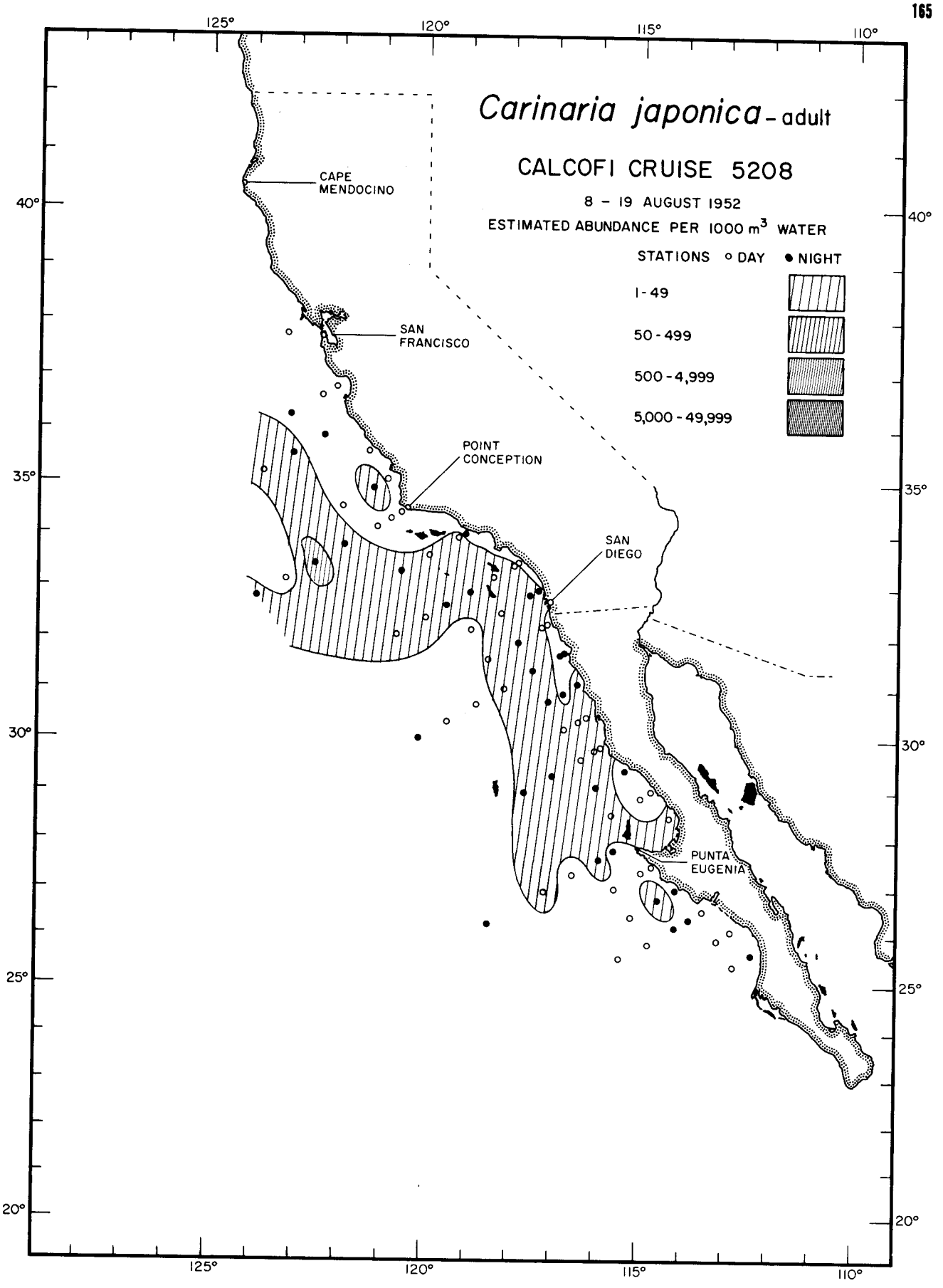
5204




Heteropoda

*Carinaria japonica* - adult

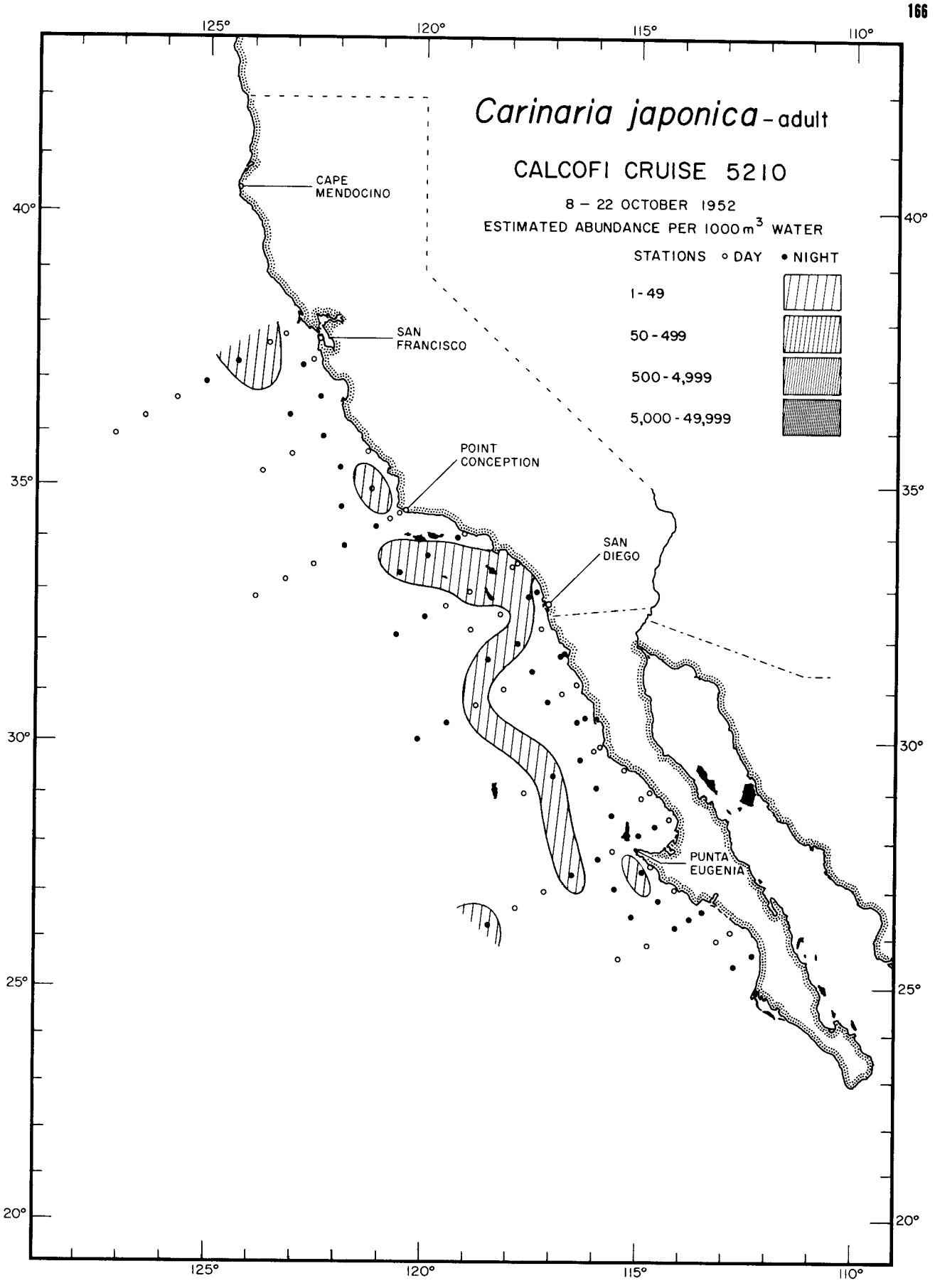
5206




Heteropoda

*Carinaria japonica* - adult

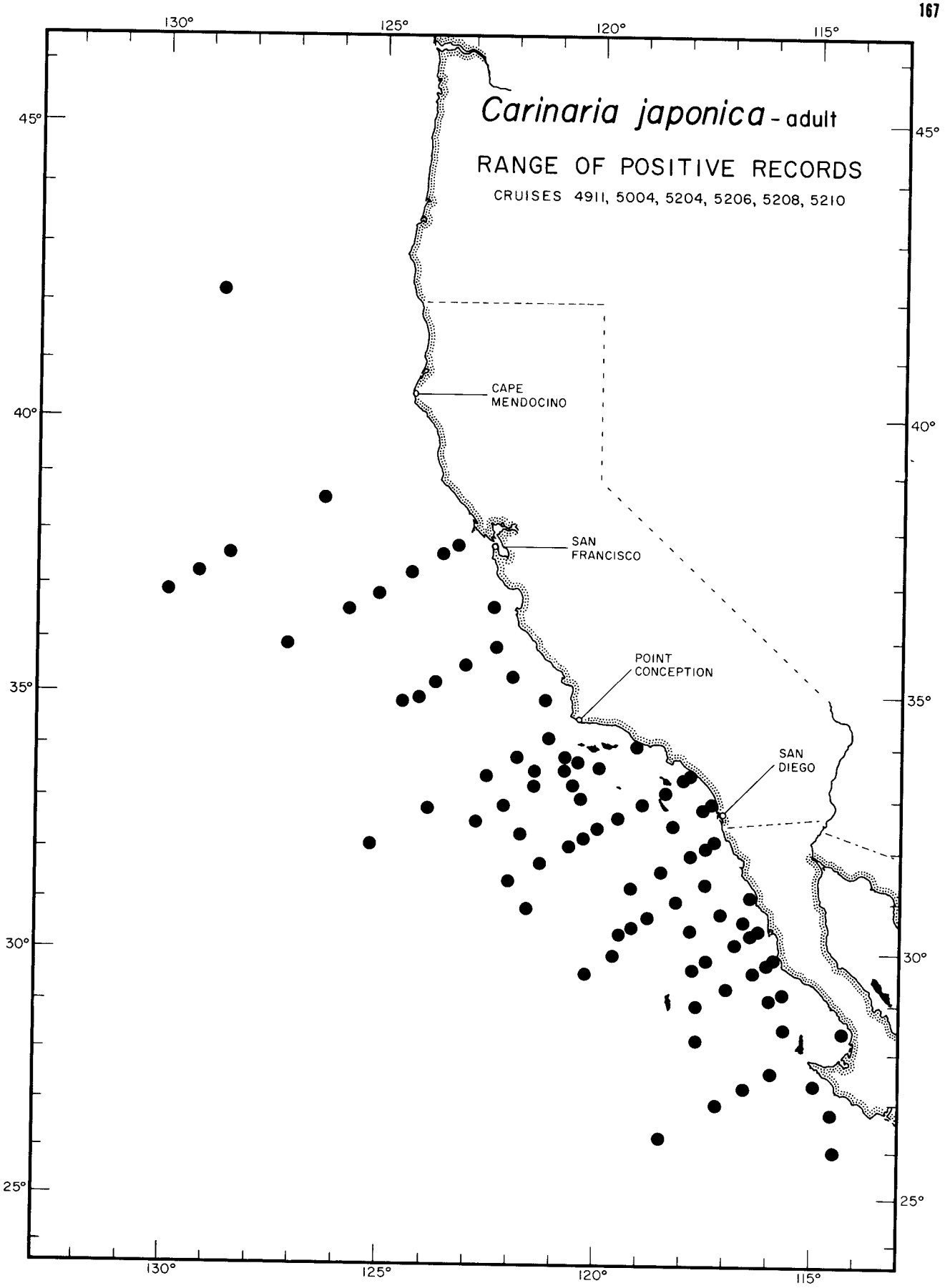
5208




Heteropoda

*Carinaria japonica* - adult

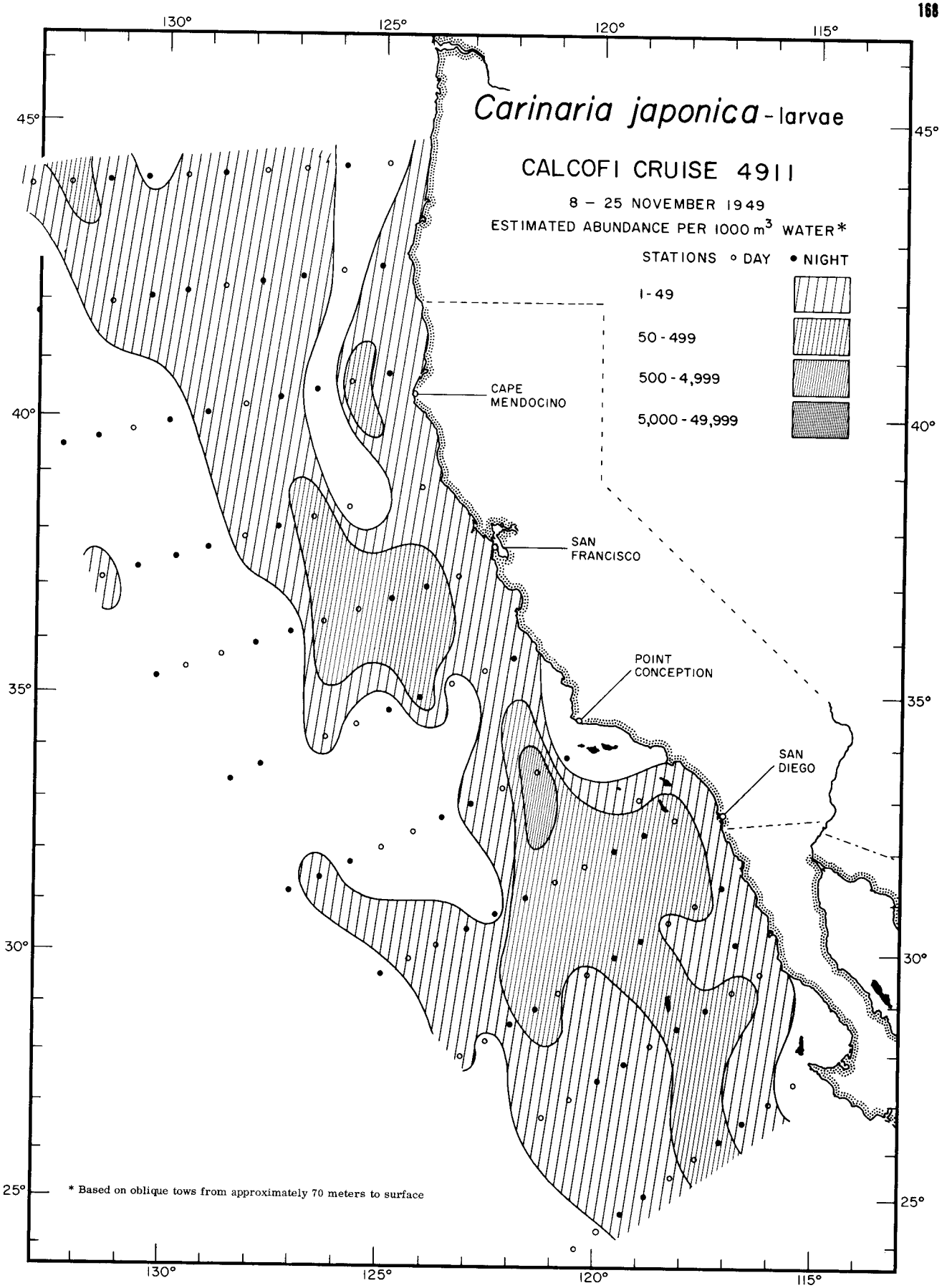
5210




Heteropoda

*Carinaria japonica* - adult

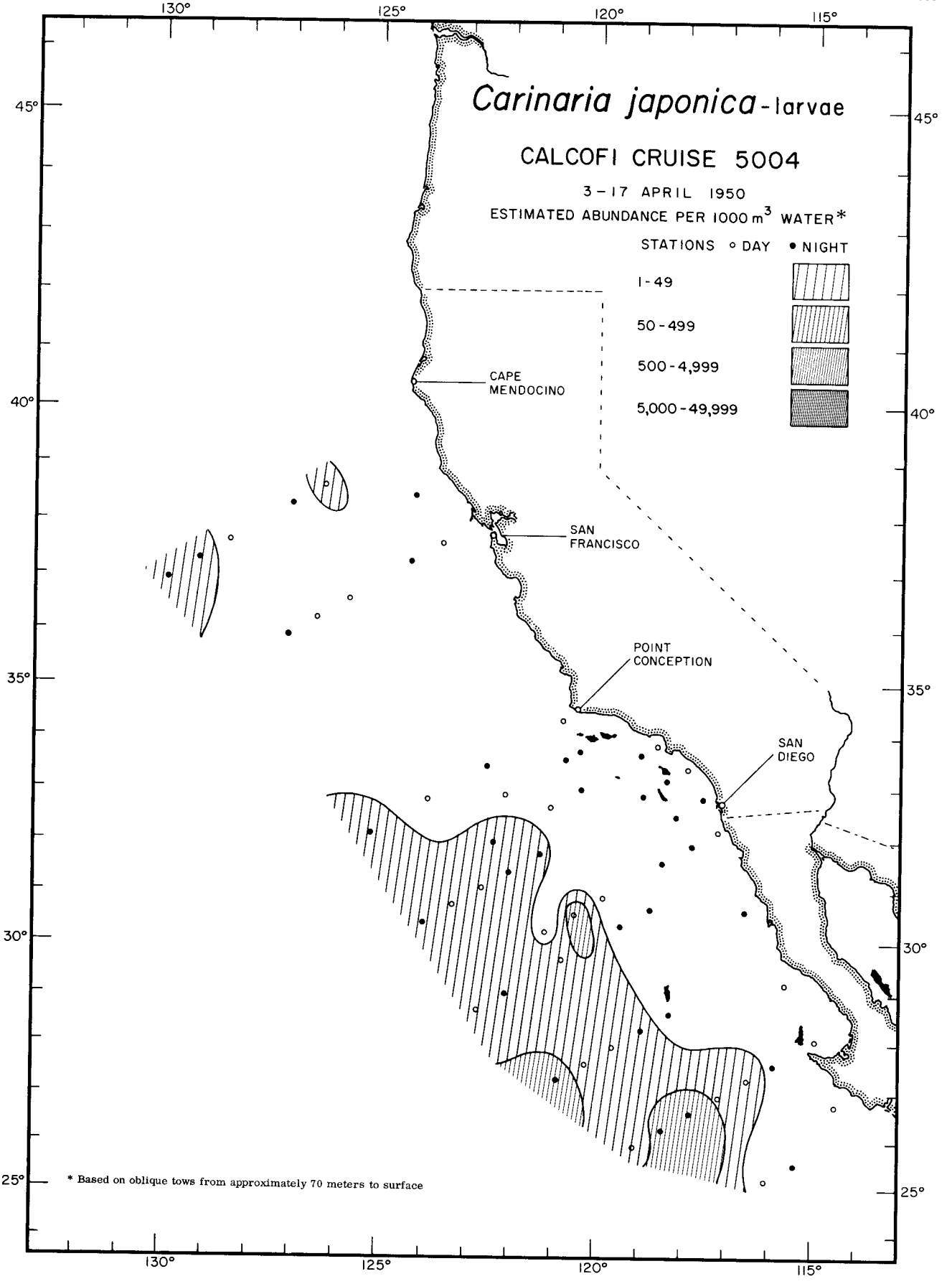
RANGE OF POSITIVE RECORDS




Heteropoda

*Carinaria japonica* - larvae

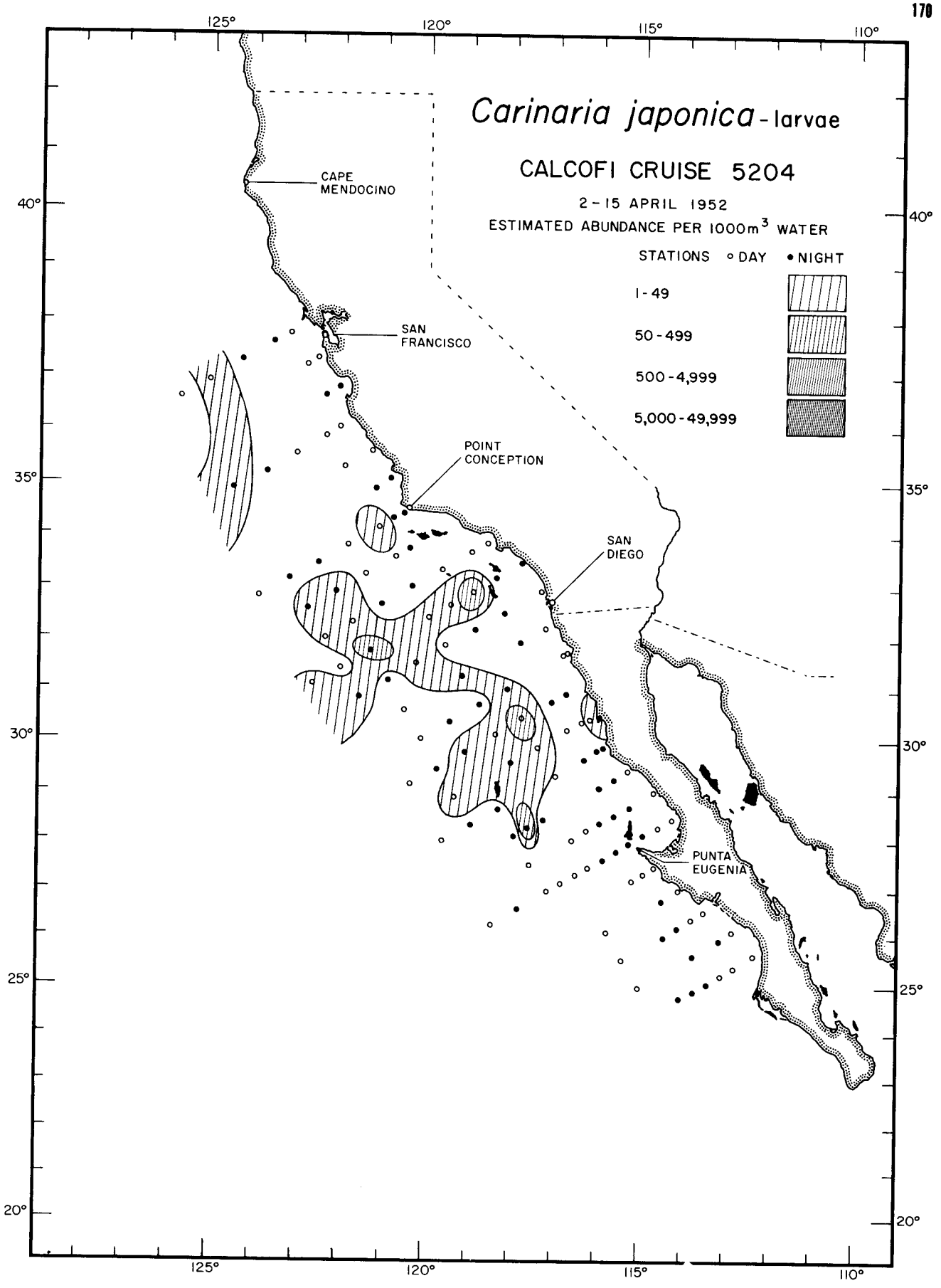
4911




Heteropoda

*Carinaria japonica* - larvae

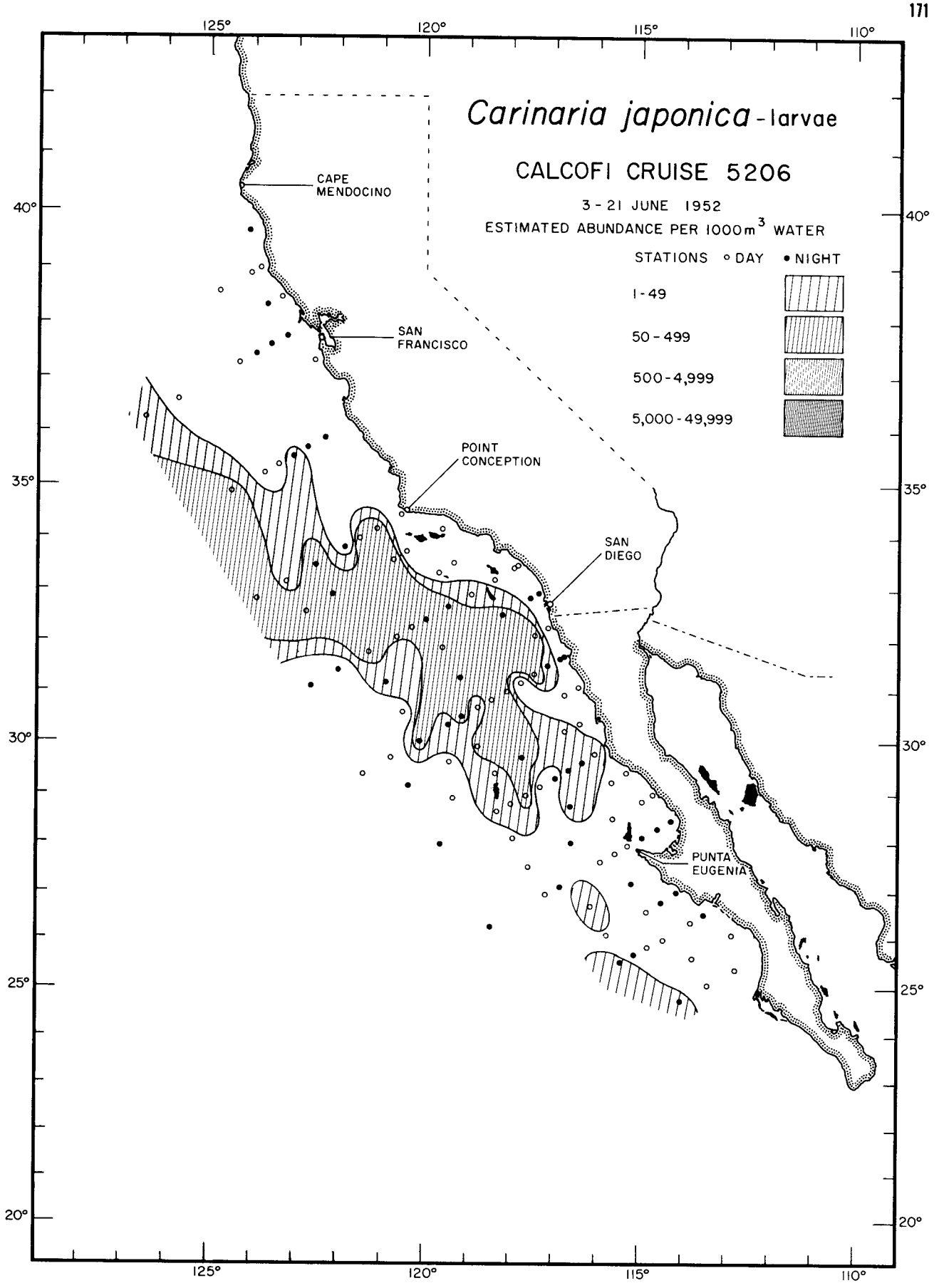
5004




Heteropoda

*Carinaria japonica* - larvae

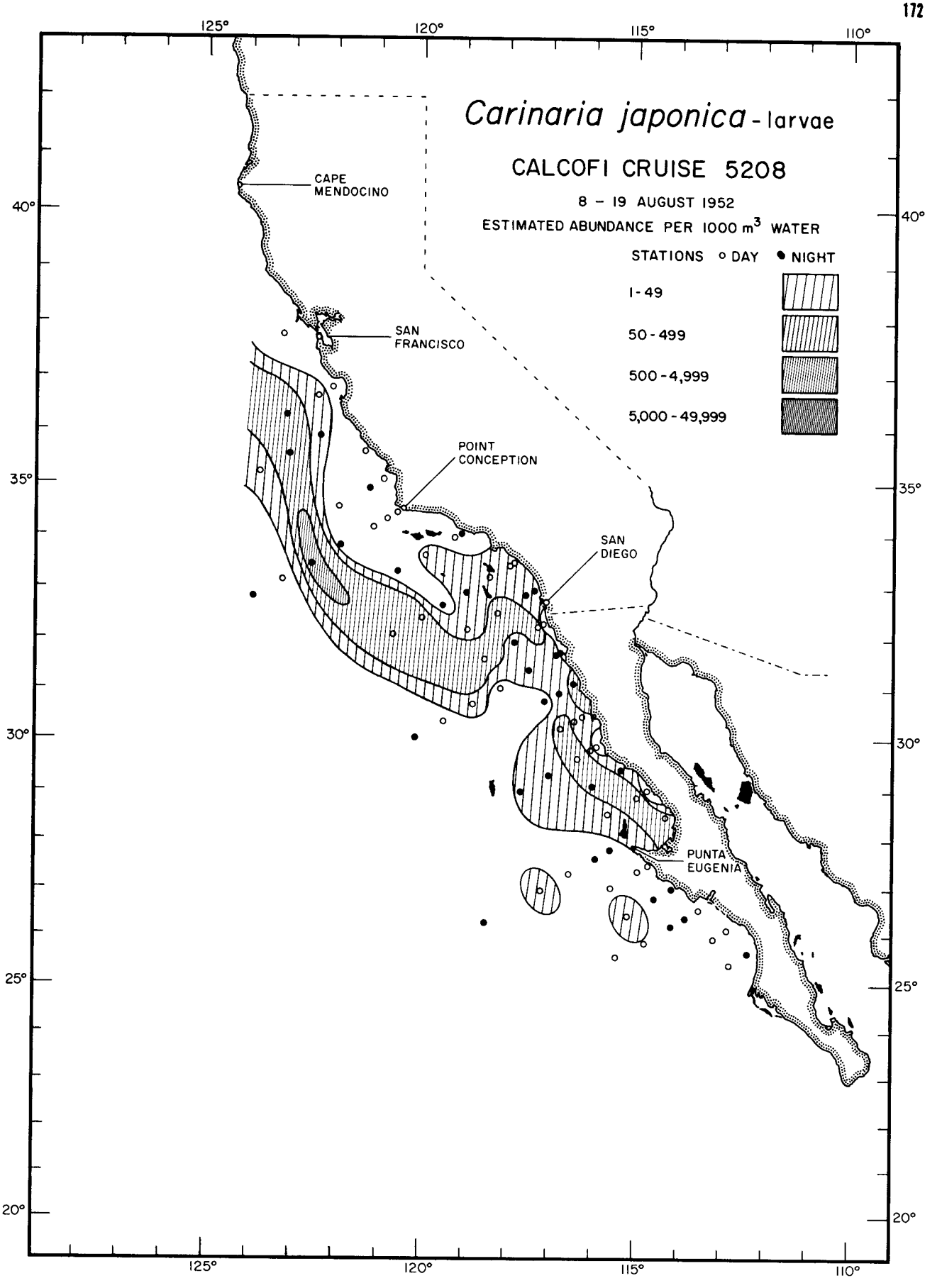
5204




Heteropoda

*Carinaria japonica* - larvae

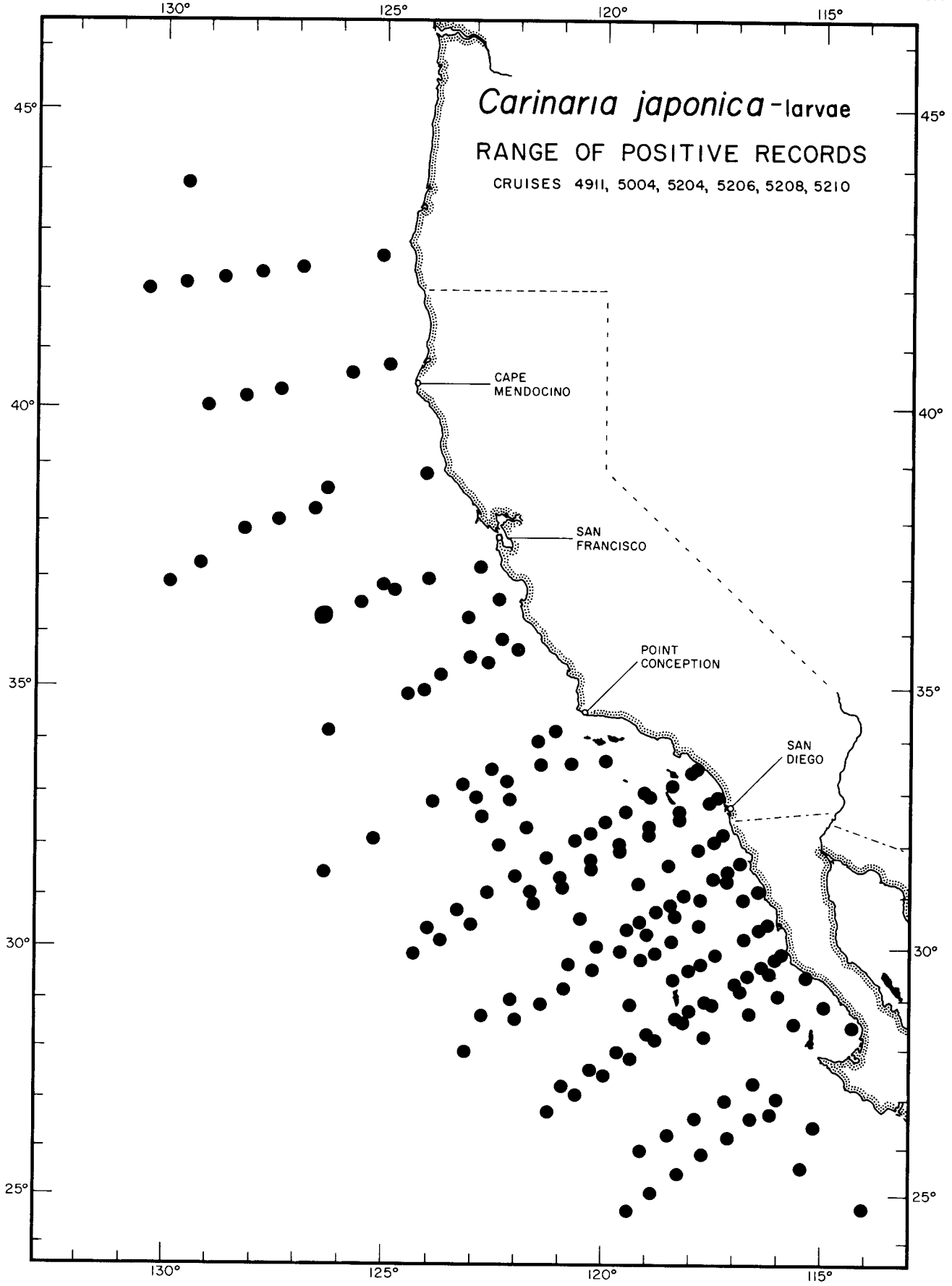
5206




Heteropoda

*Carinaria japonica*-larvae

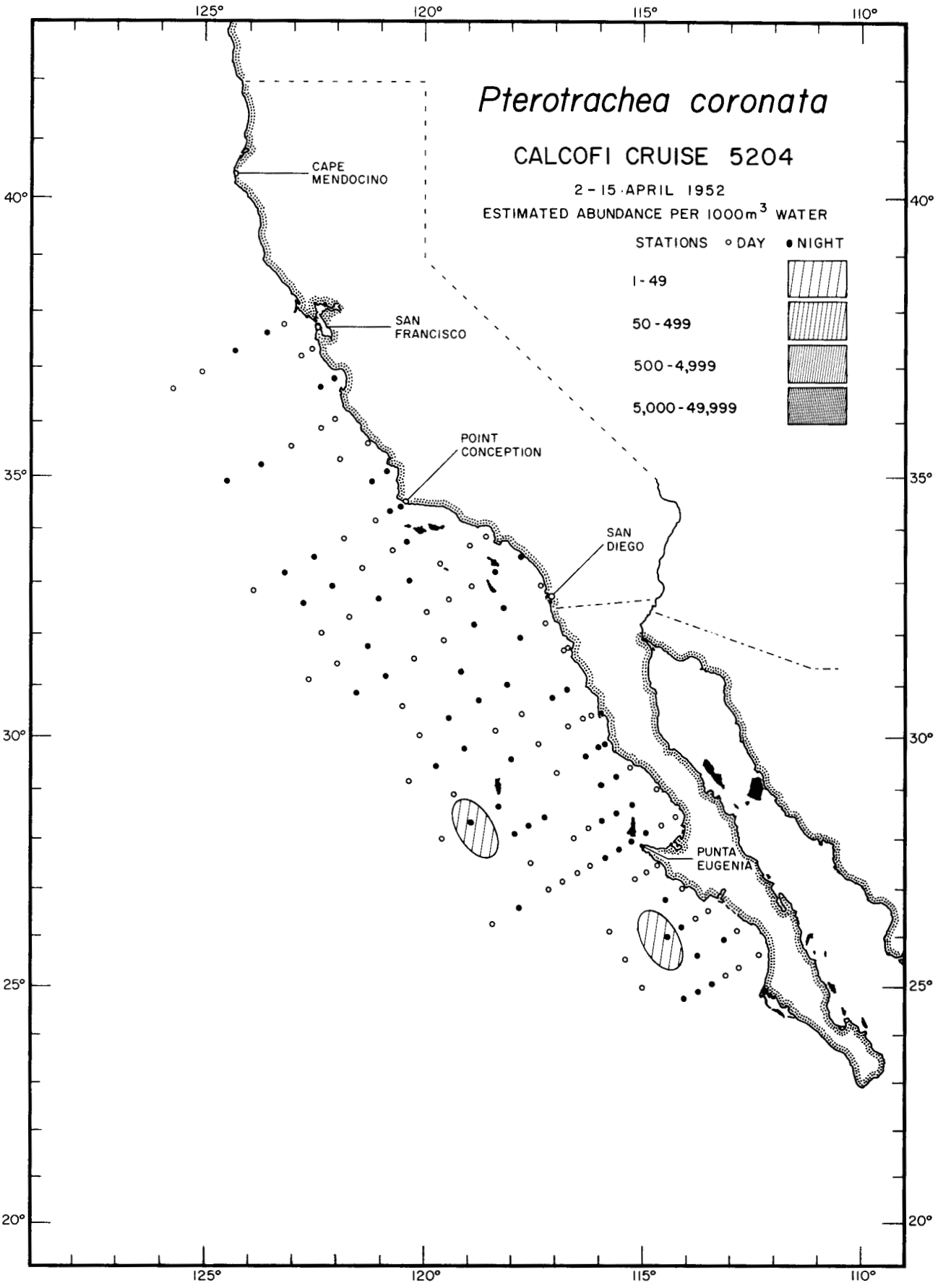
5208




Heteropoda

*Carinaria japonica* - larvae

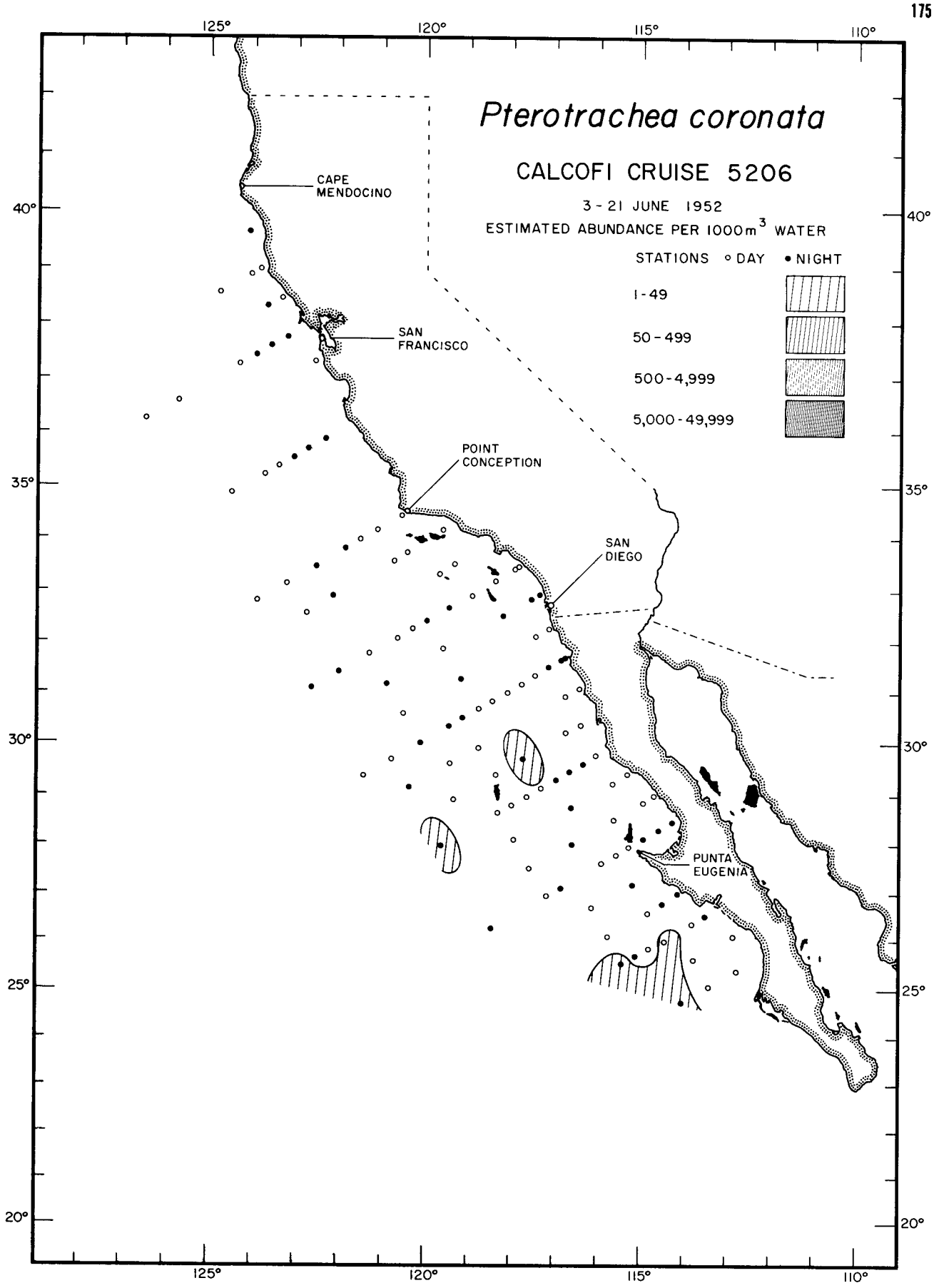
RANGE OF POSITIVE RECORDS




Heteropoda

*Pterotrachea coronata*

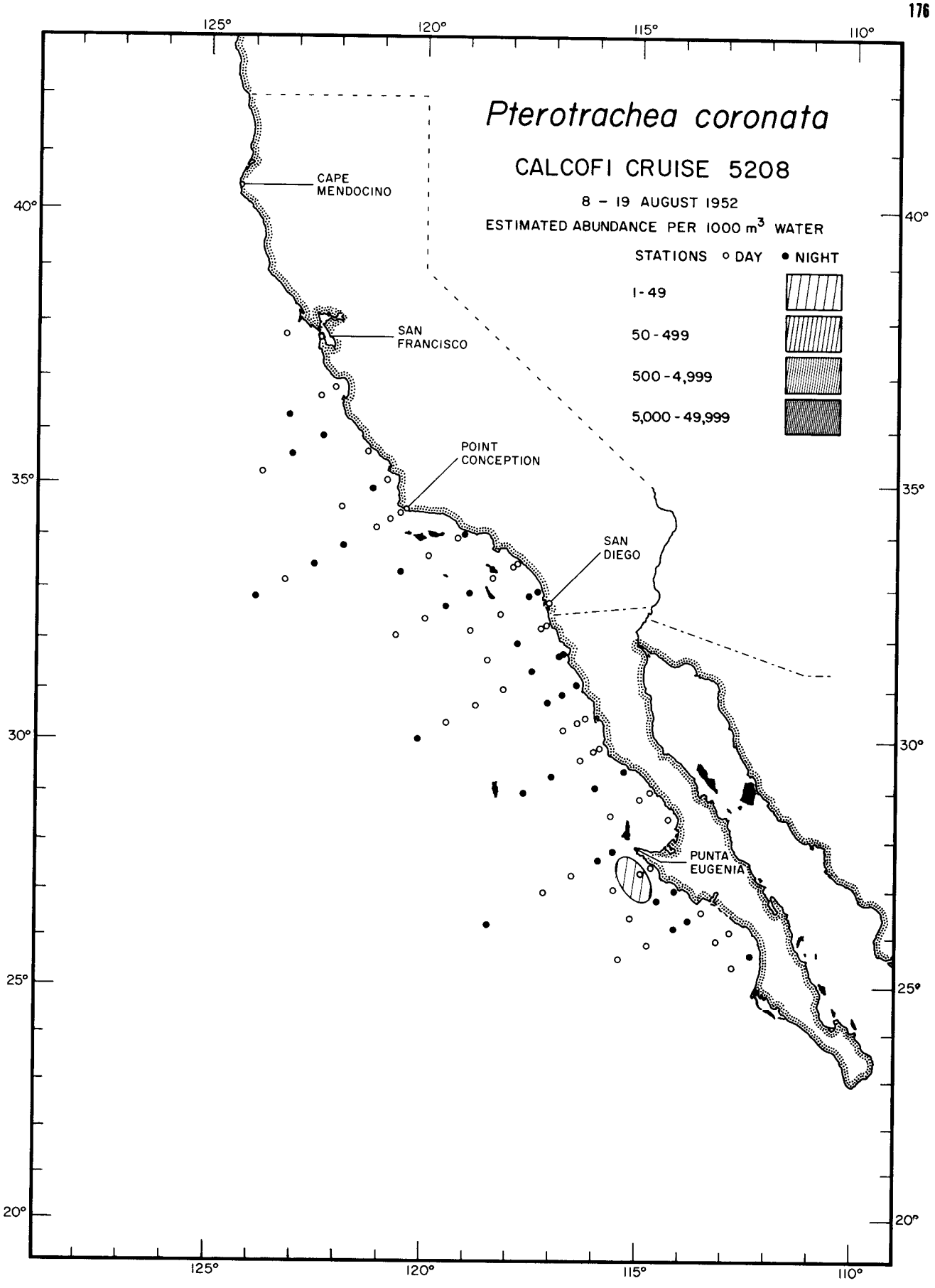
5204




Heteropoda

*Pterotrachea coronata*

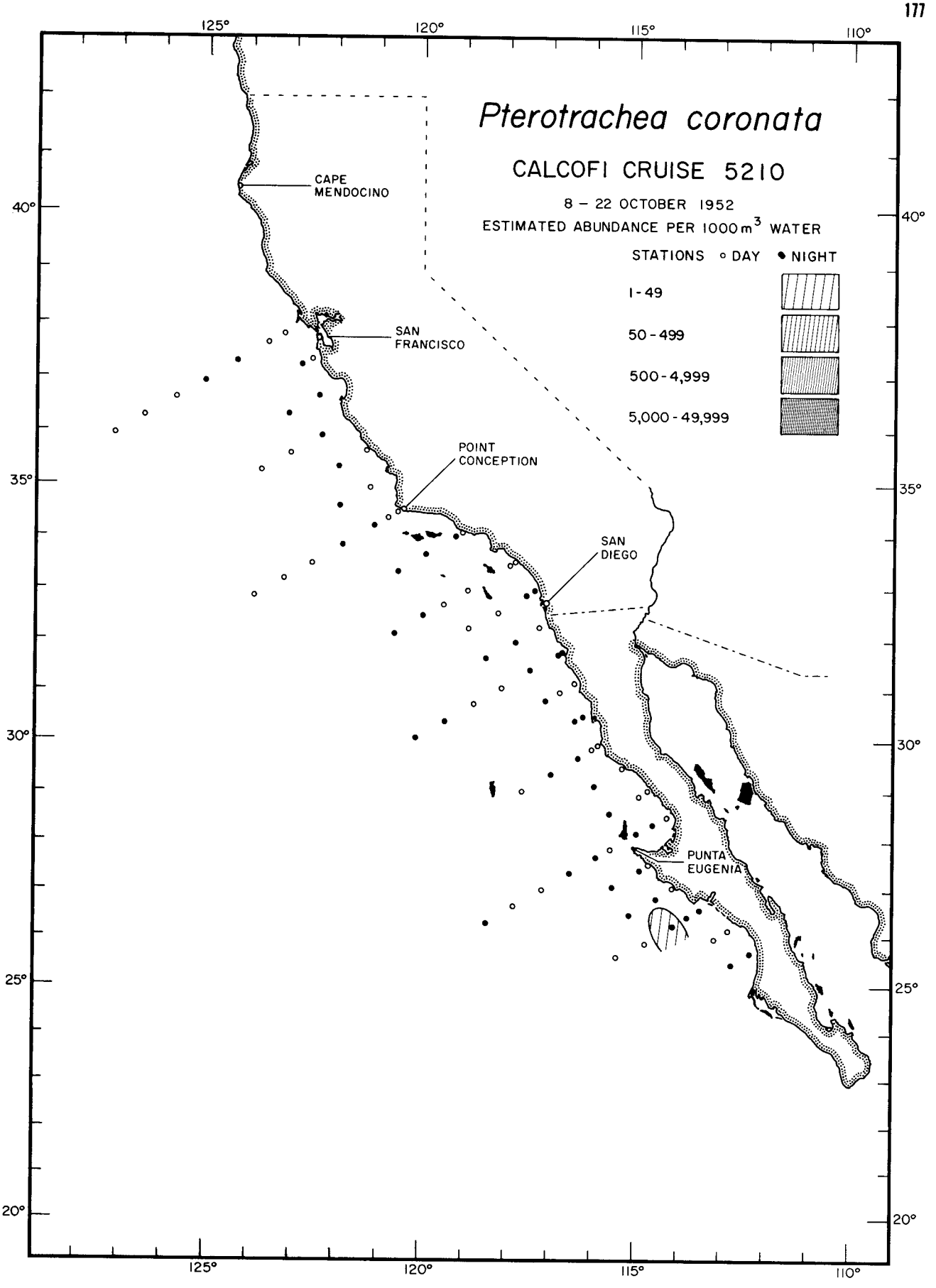
5206




Heteropoda

*Pterotrachea coronata*

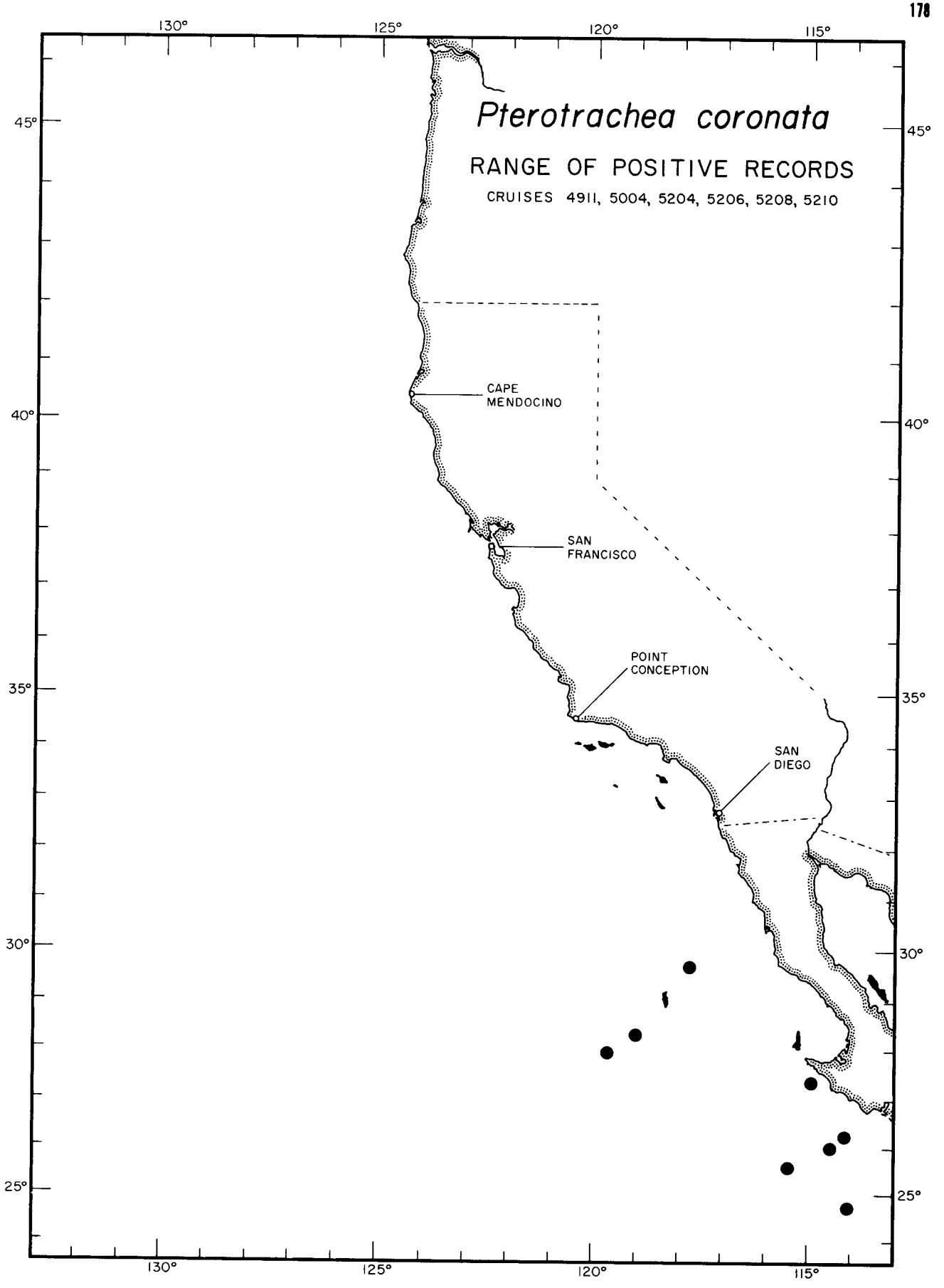
5208




Heteropoda

*Pterotrachea coronata*

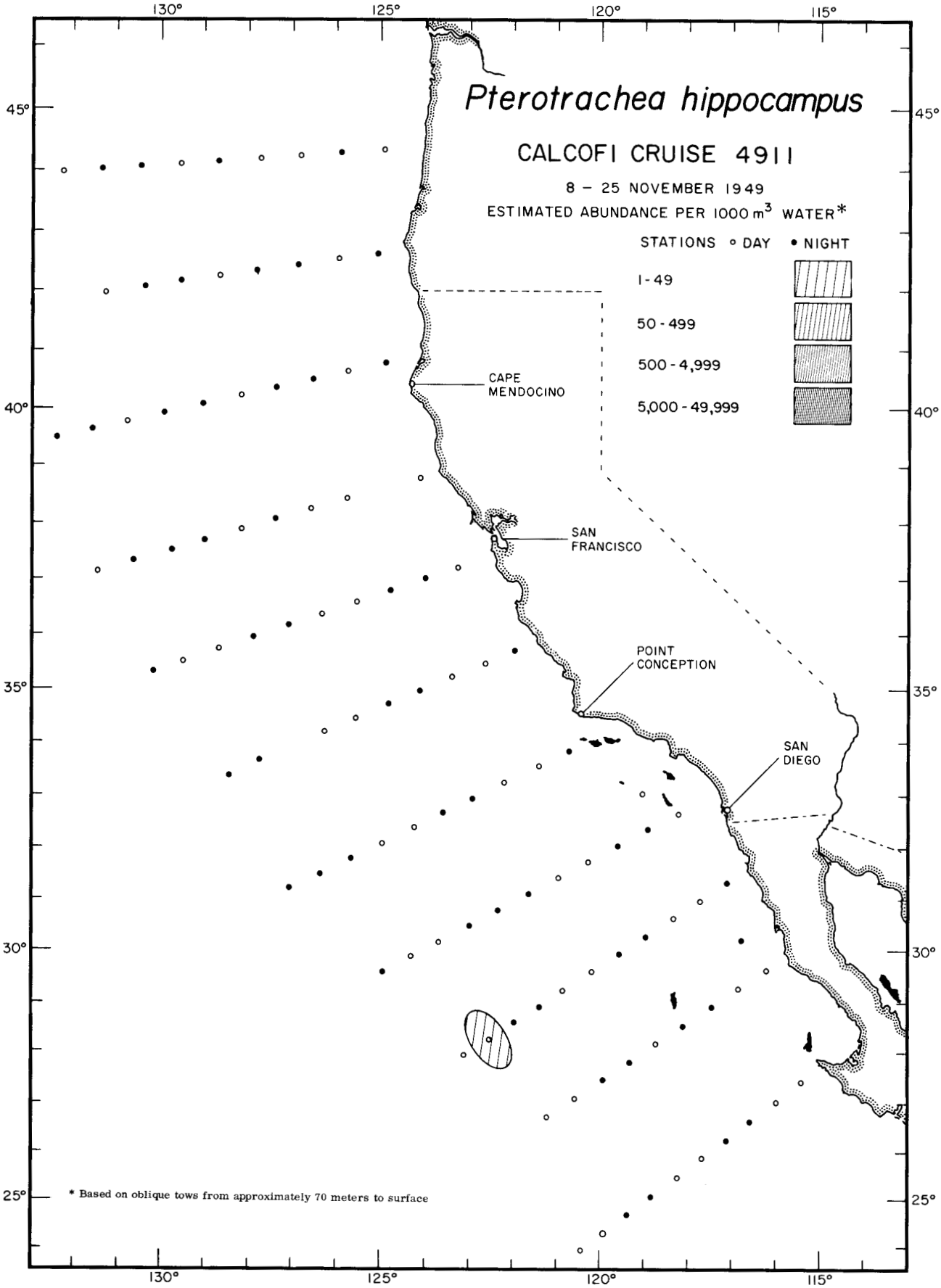
5210




Heteropoda

*Pterotrachea coronata*

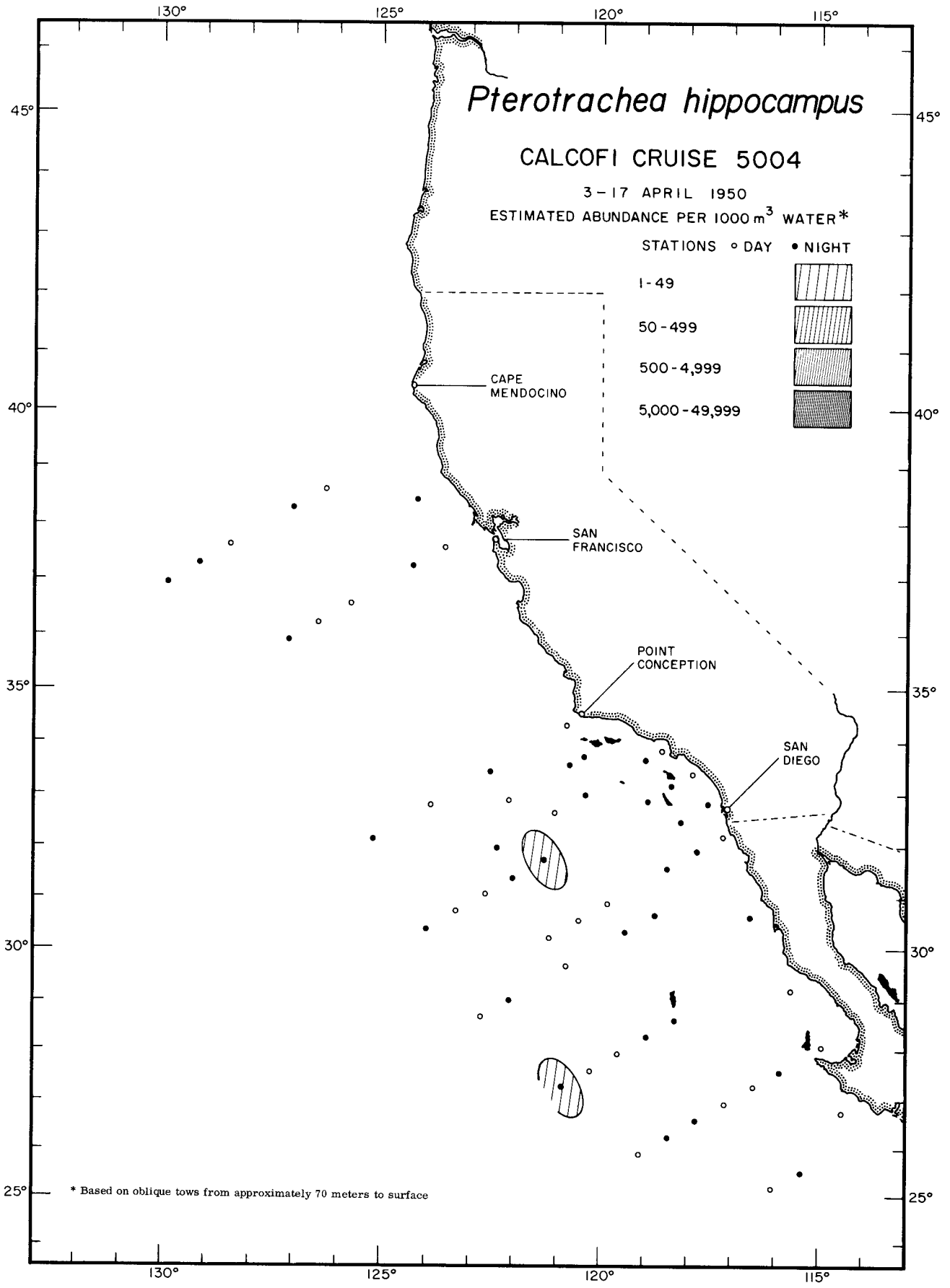
RANGE OF POSITIVE RECORDS




Heteropoda

*Pterotrachea hippocampus*

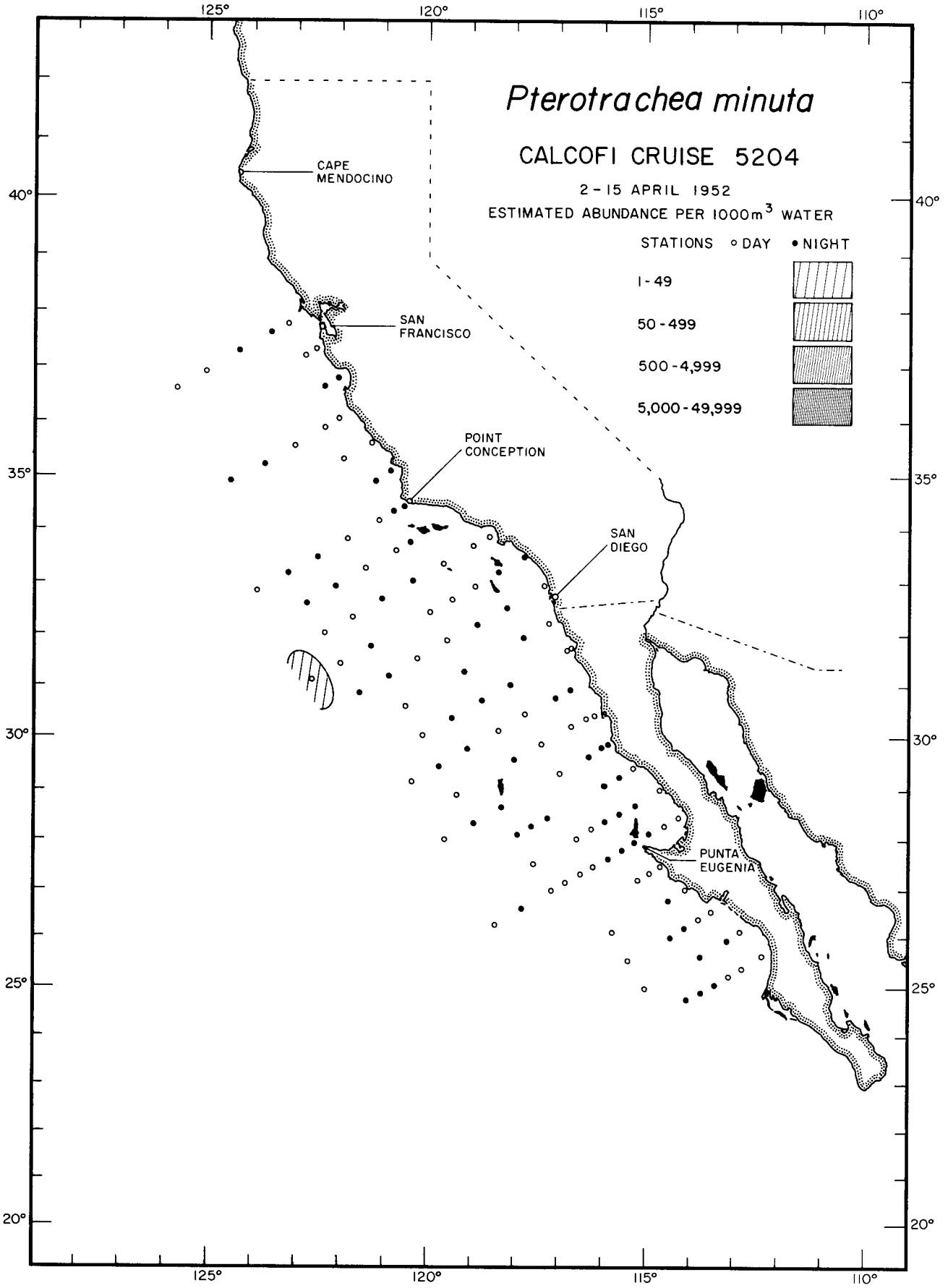
4911




Heteropoda

*Pterotrachea hippocampus*

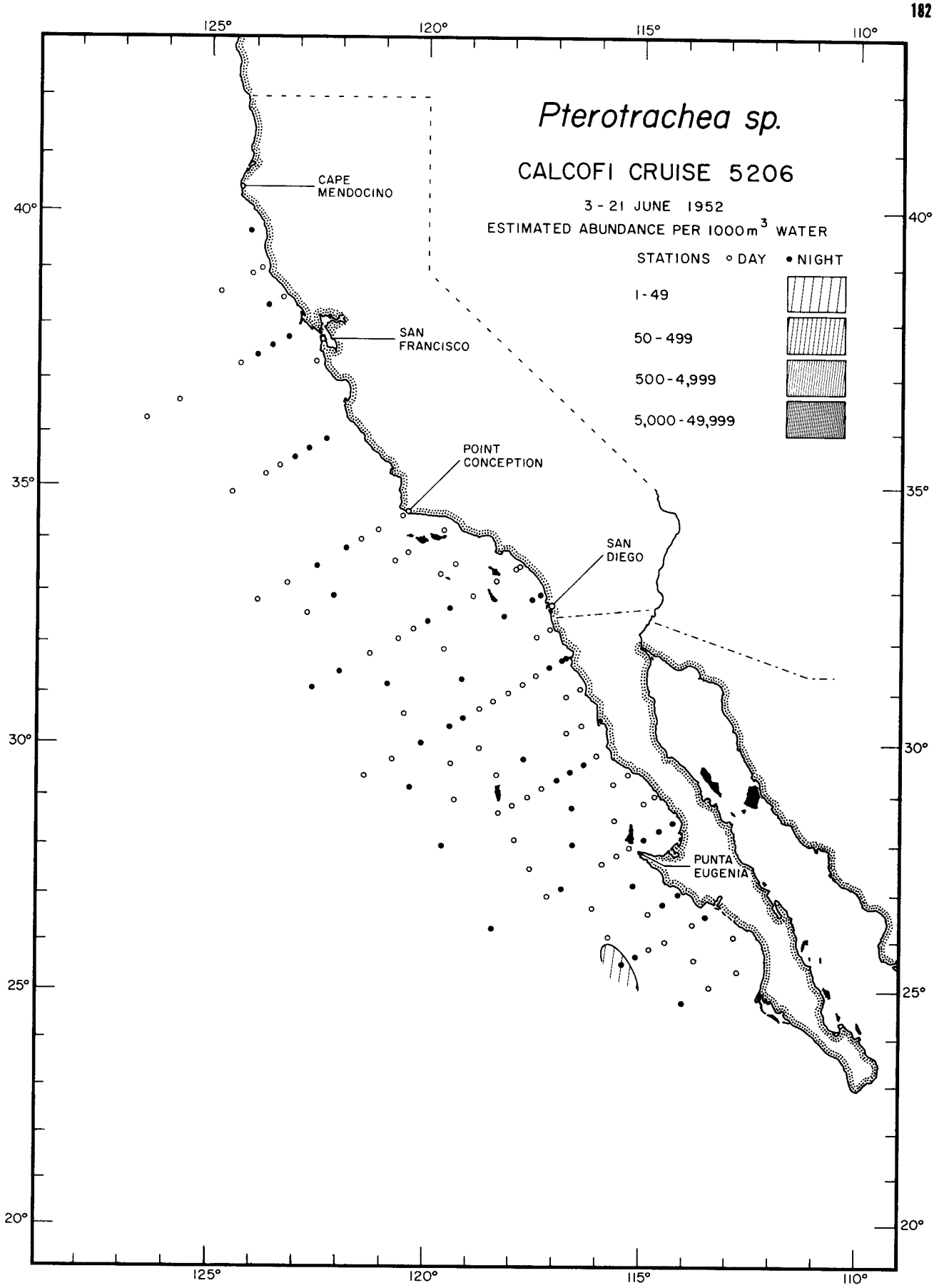
5004




Heteropoda

*Pterotrachea minuta*

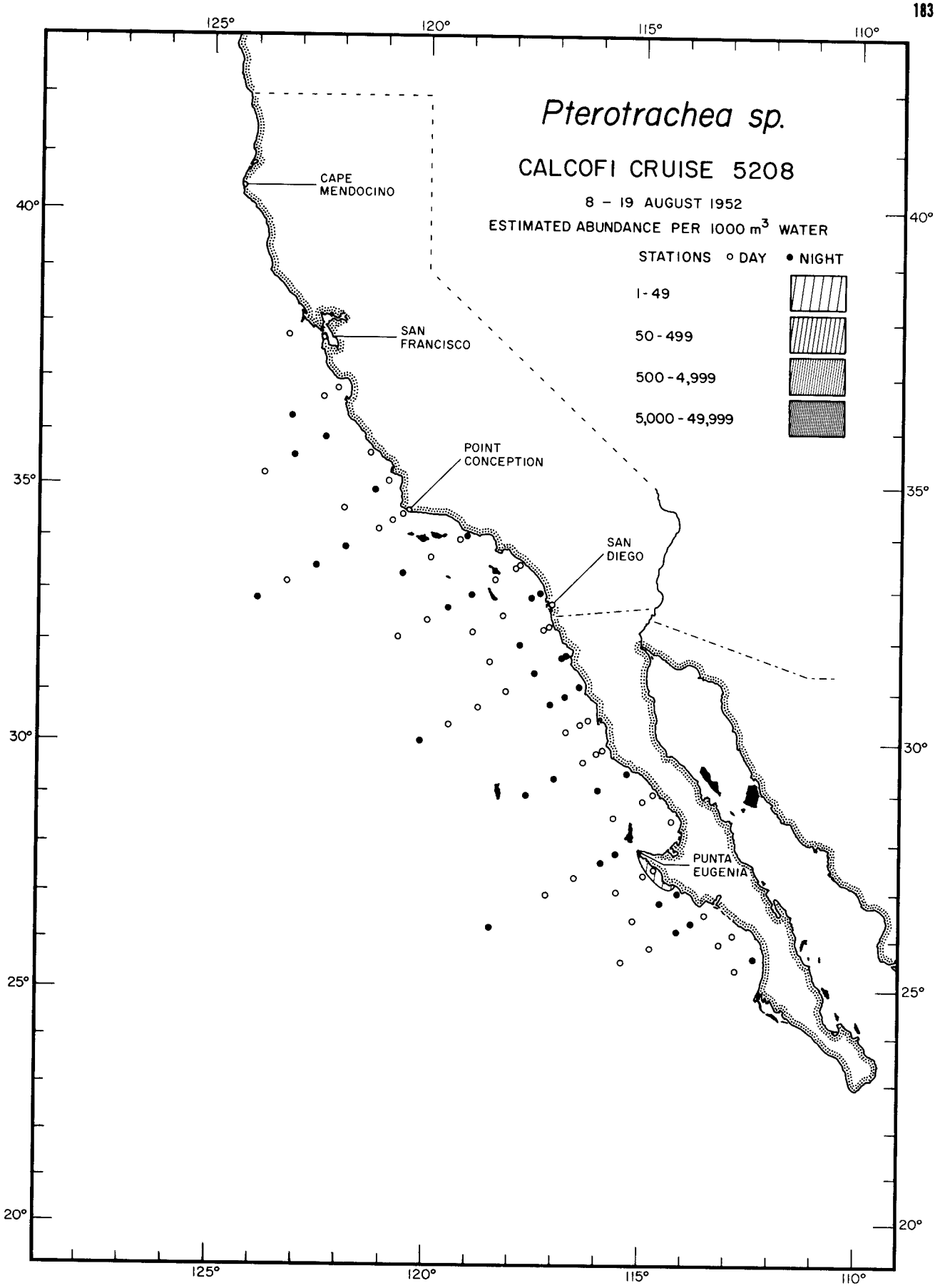
5204




Heteropoda

*Pterotrachea sp.*

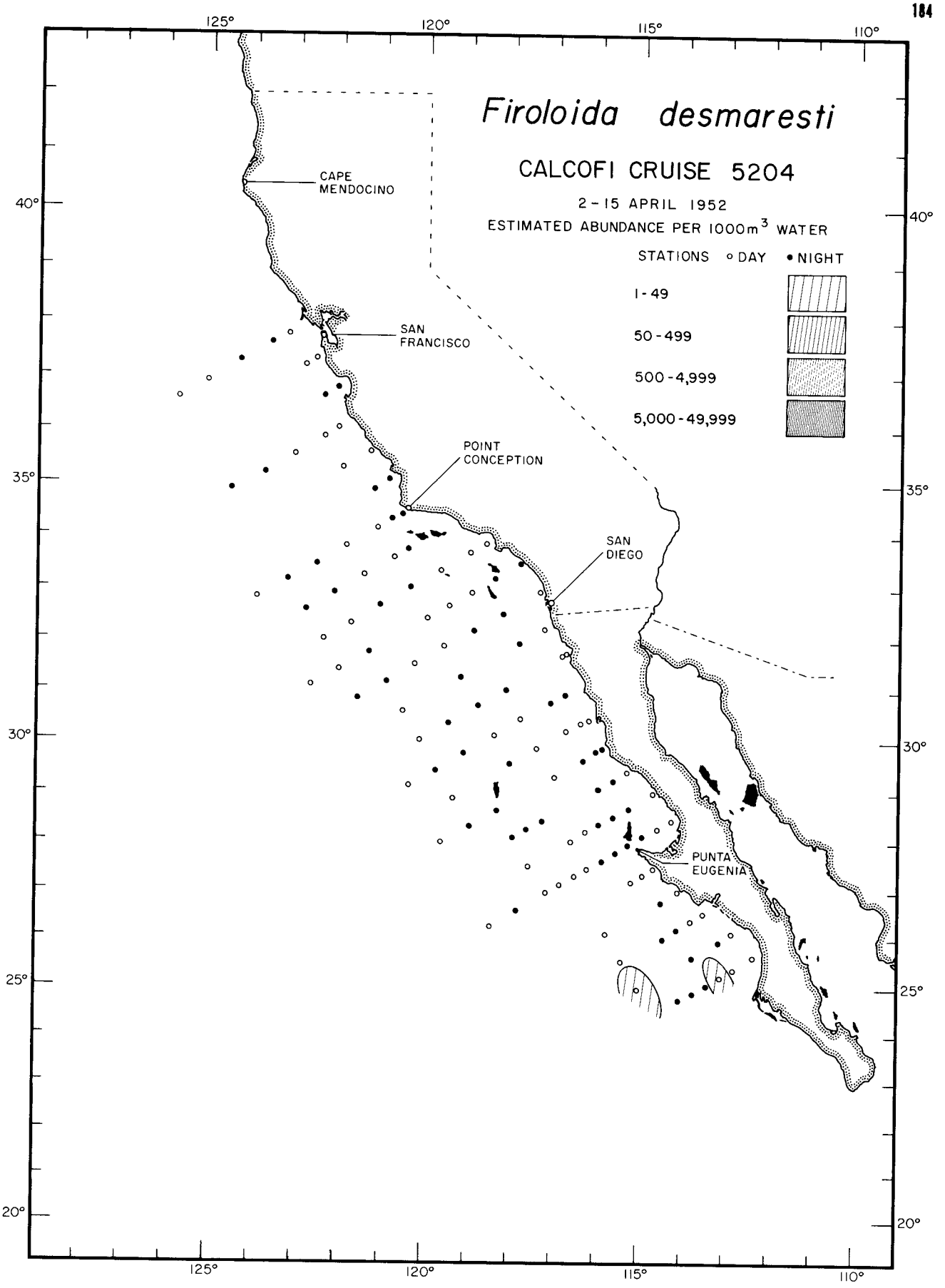
5206




Heteropoda

*Pterotrachea sp.*

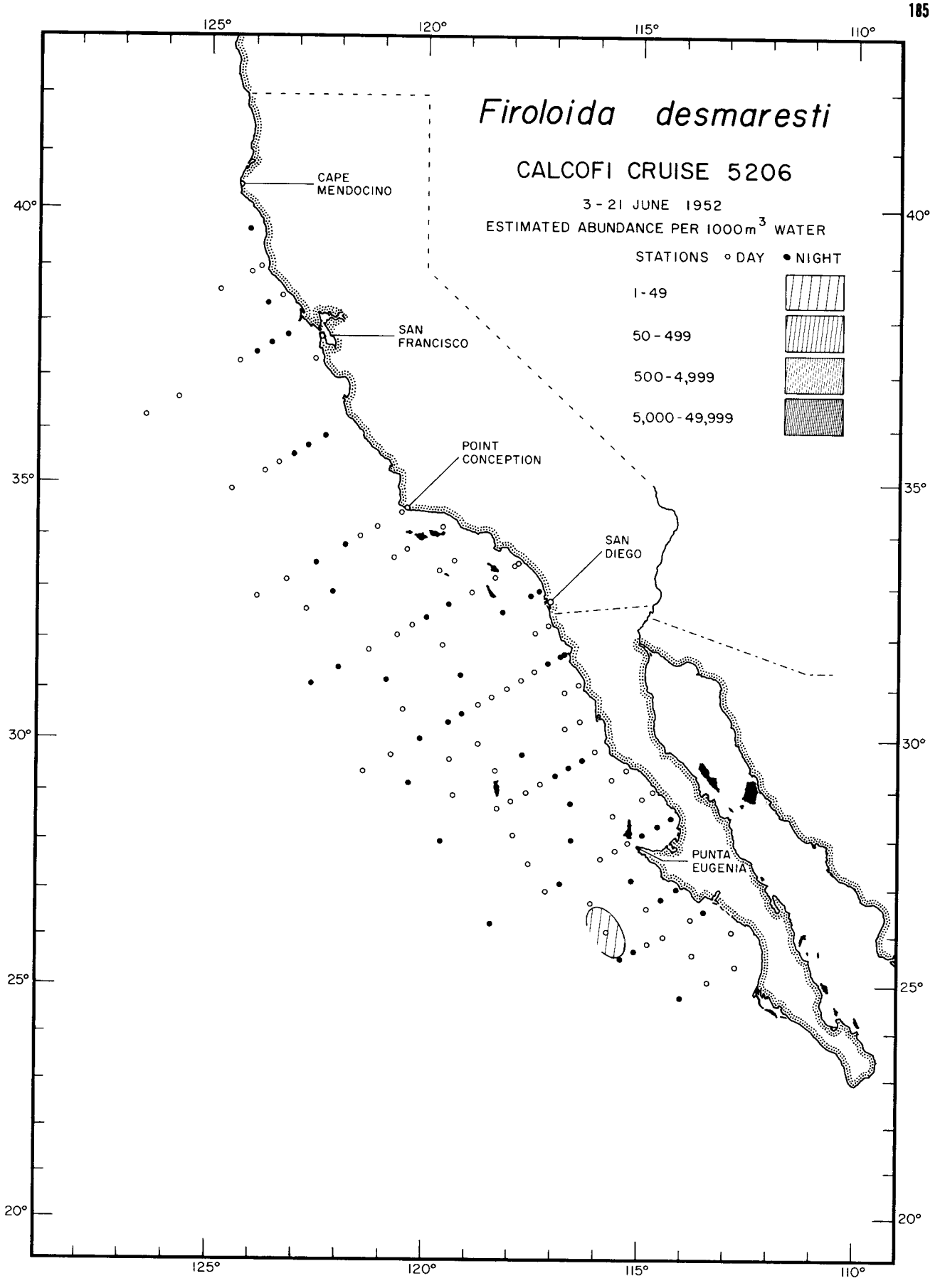
5208




Heteropoda

*Firoloida desmaresti*

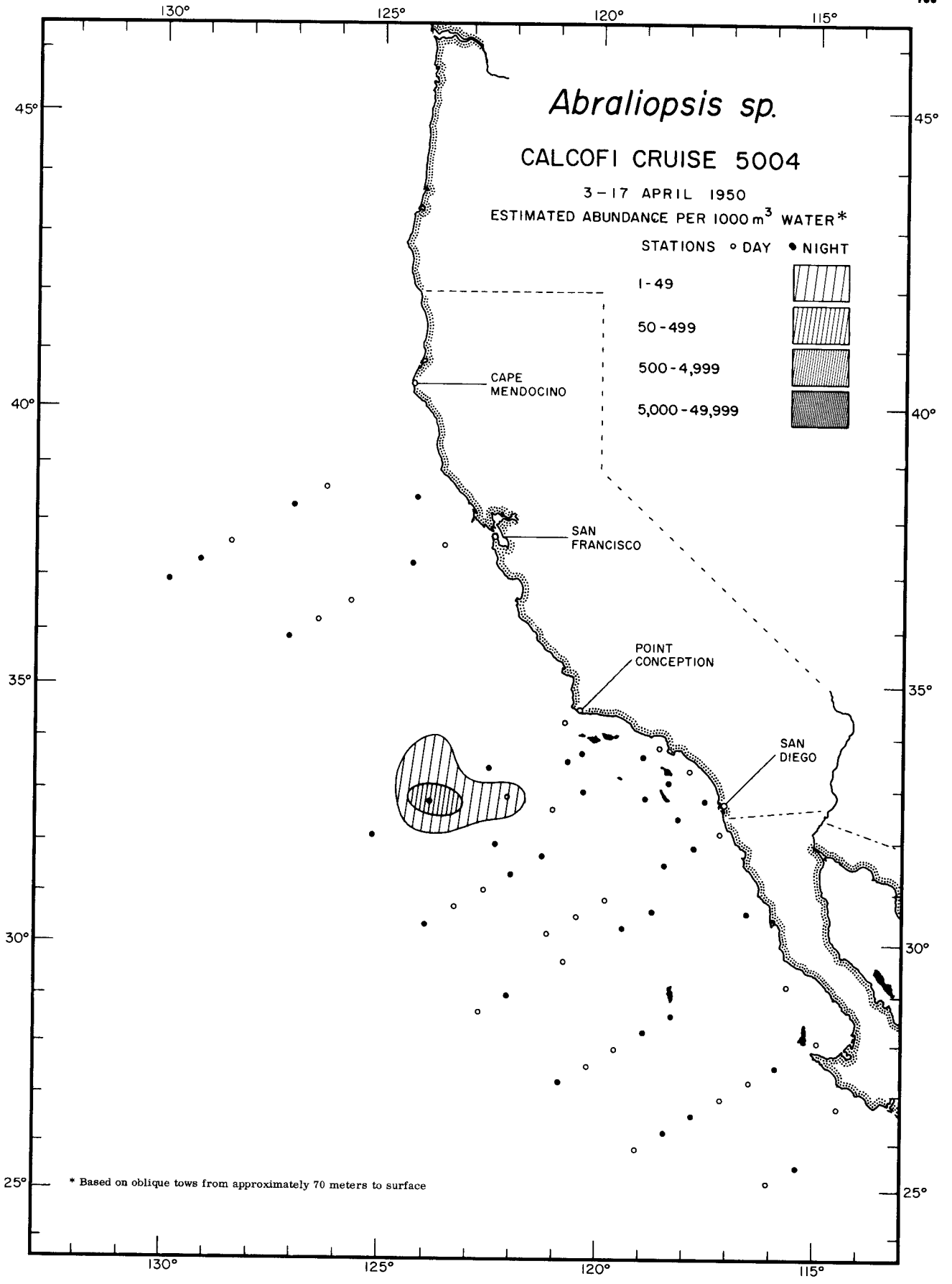
5204




Heteropoda

*Firoloida desmaresti*

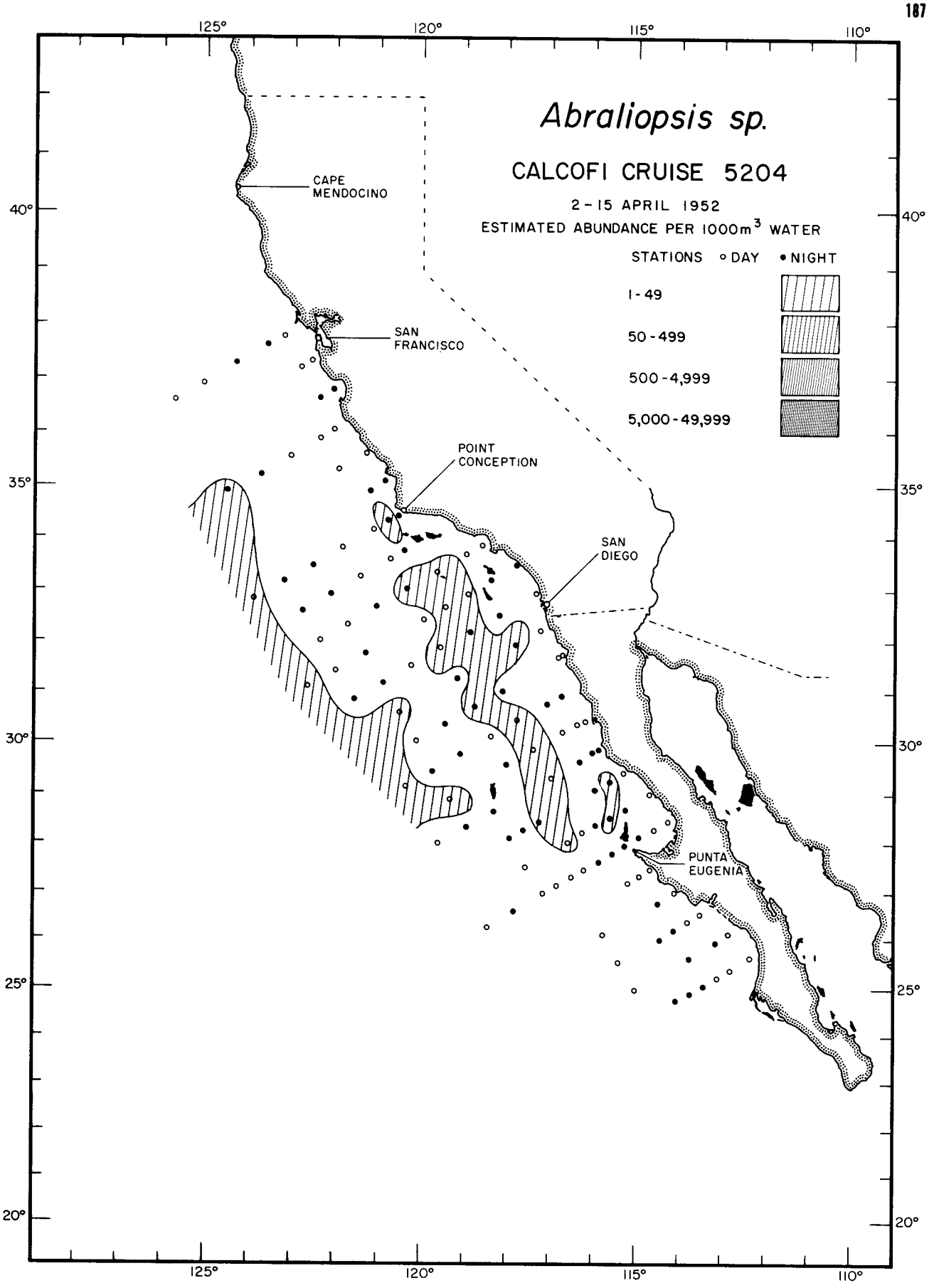
5206




Cephalopoda

*Abraliopsis sp.*

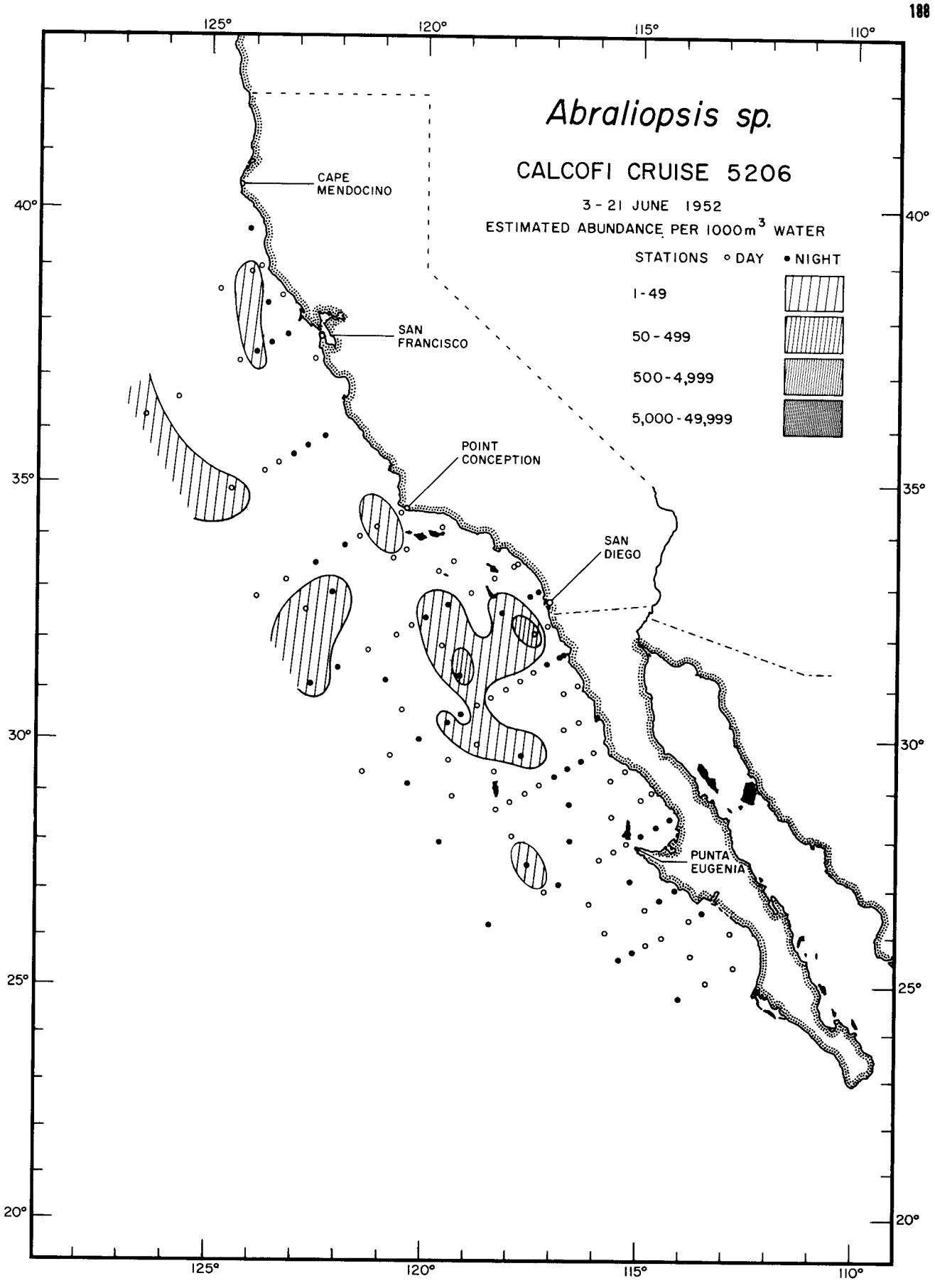
5004




Cephalopoda

*Abraliopsis sp.*

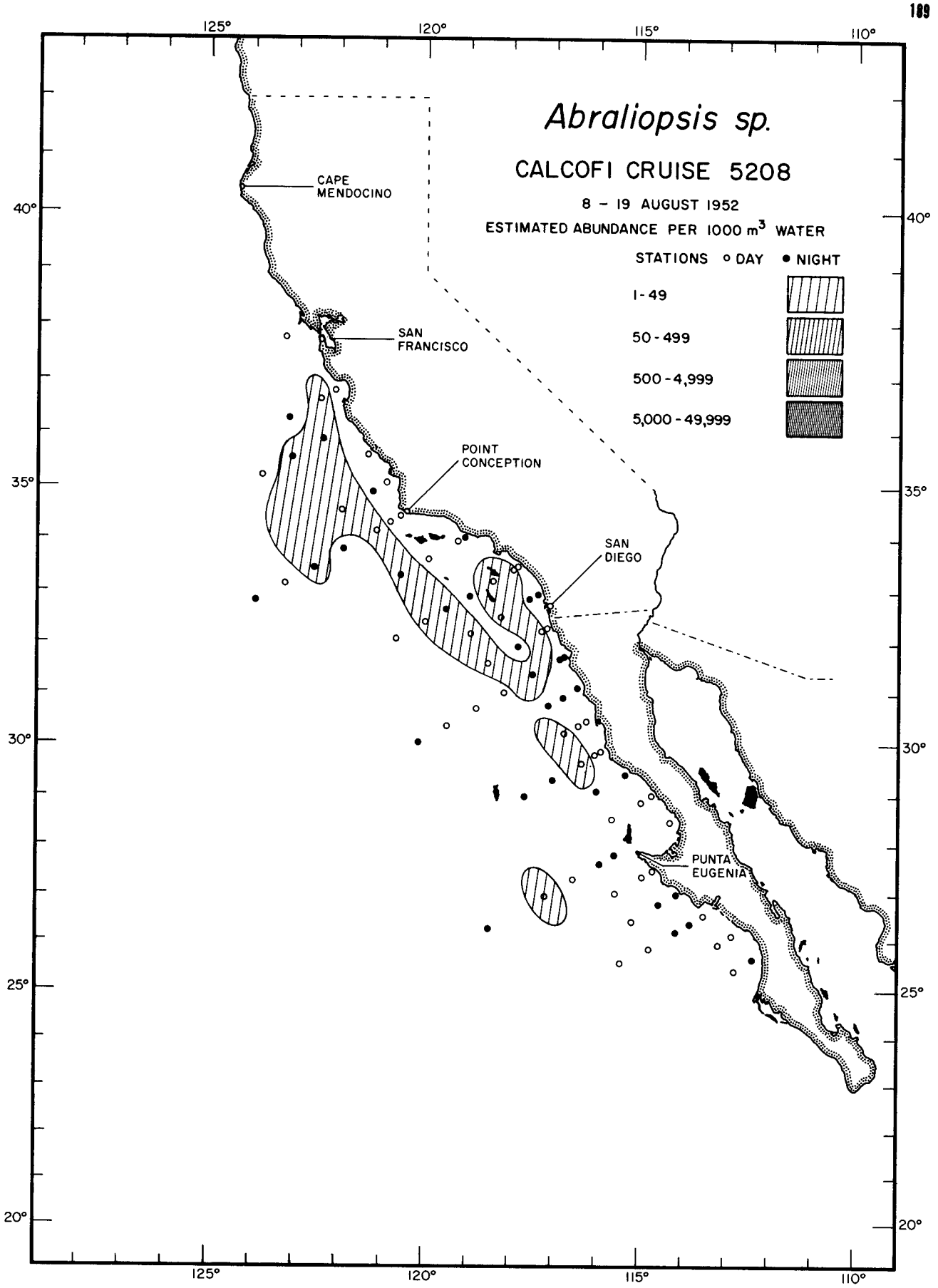
5204




Cephalopoda

*Abraliopsis sp.*

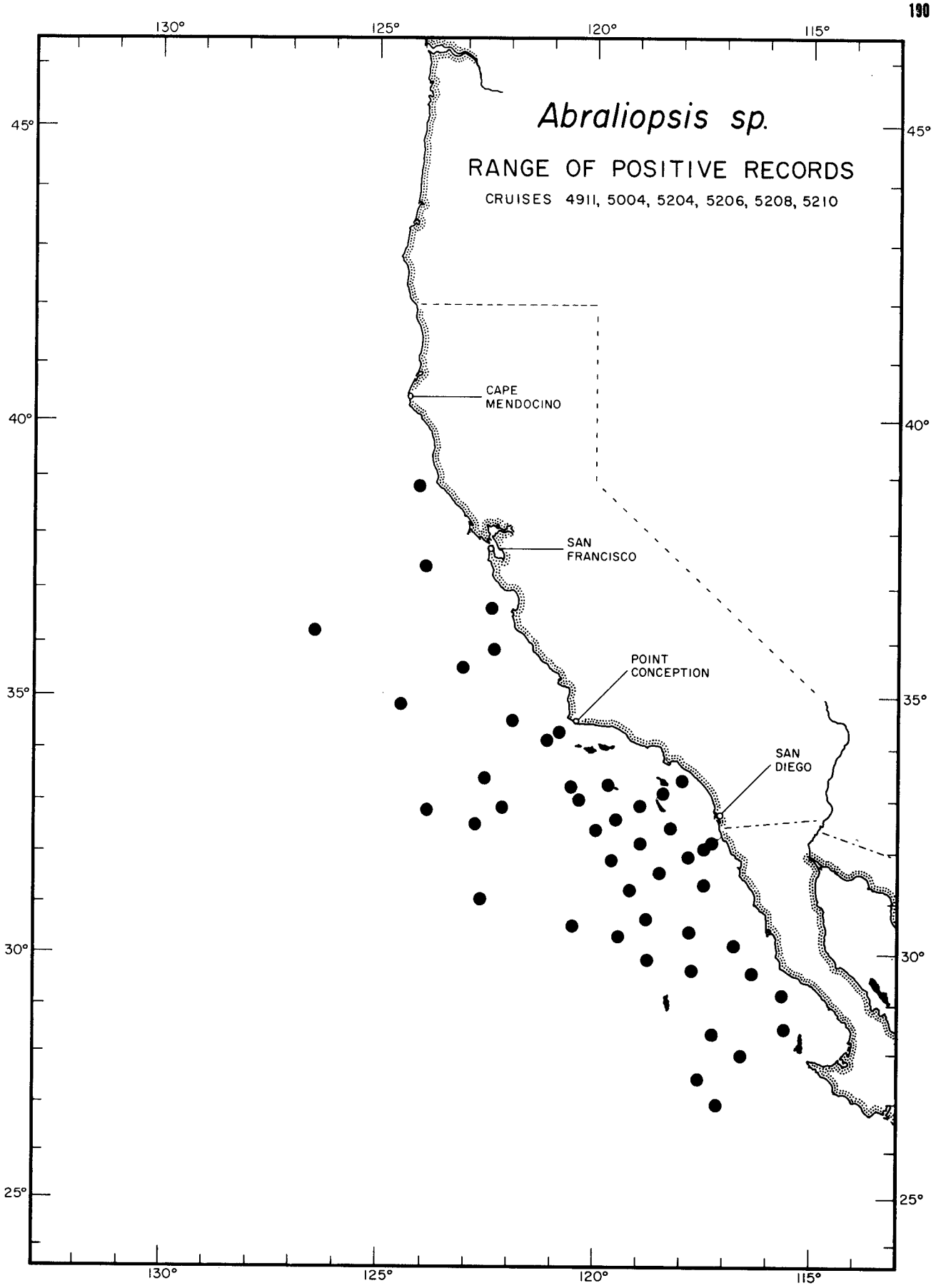
5206




Cephalopoda

*Abraliopsis sp.*

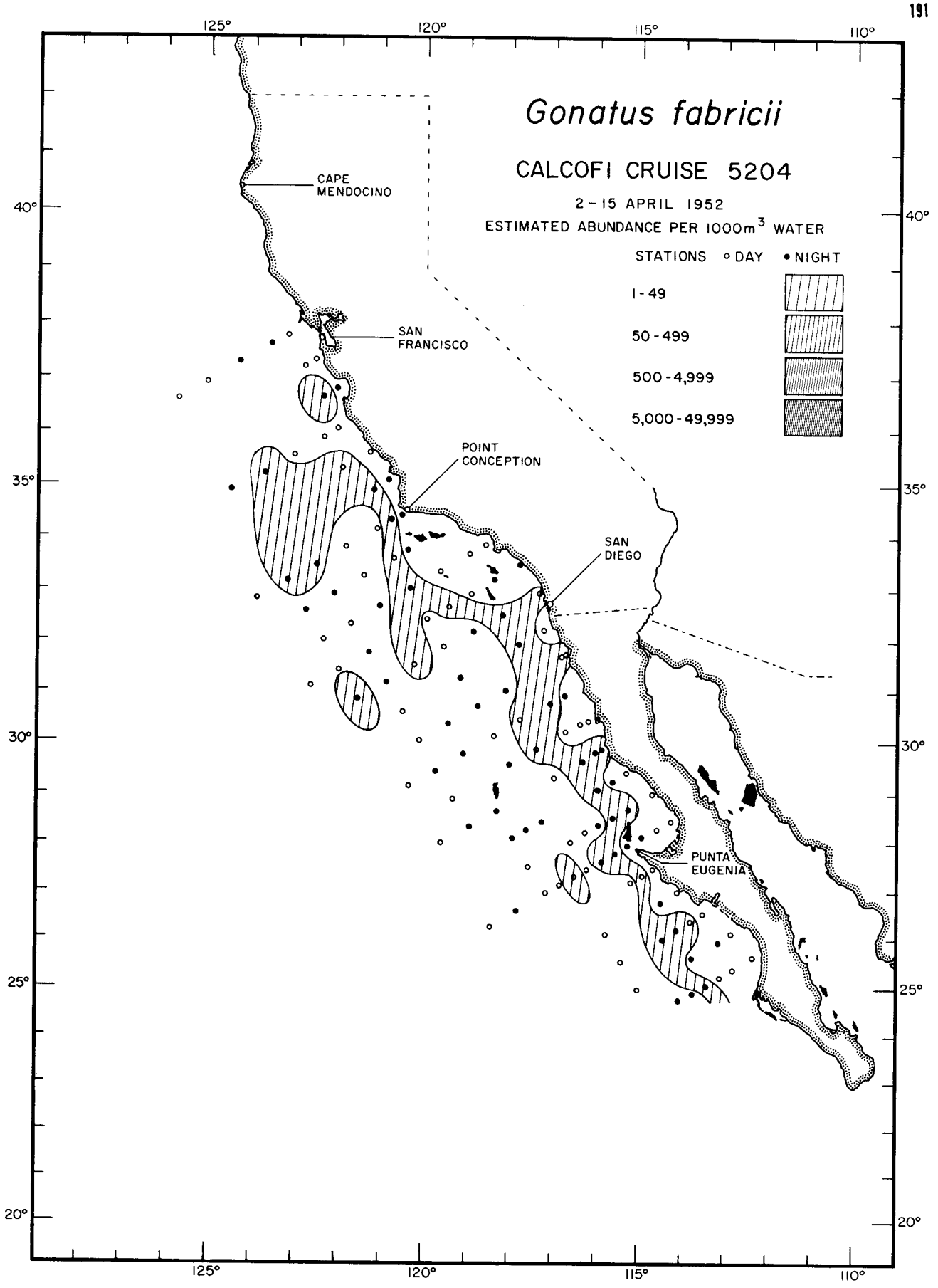
5208




Cephalopoda

*Abraliopsis sp.*

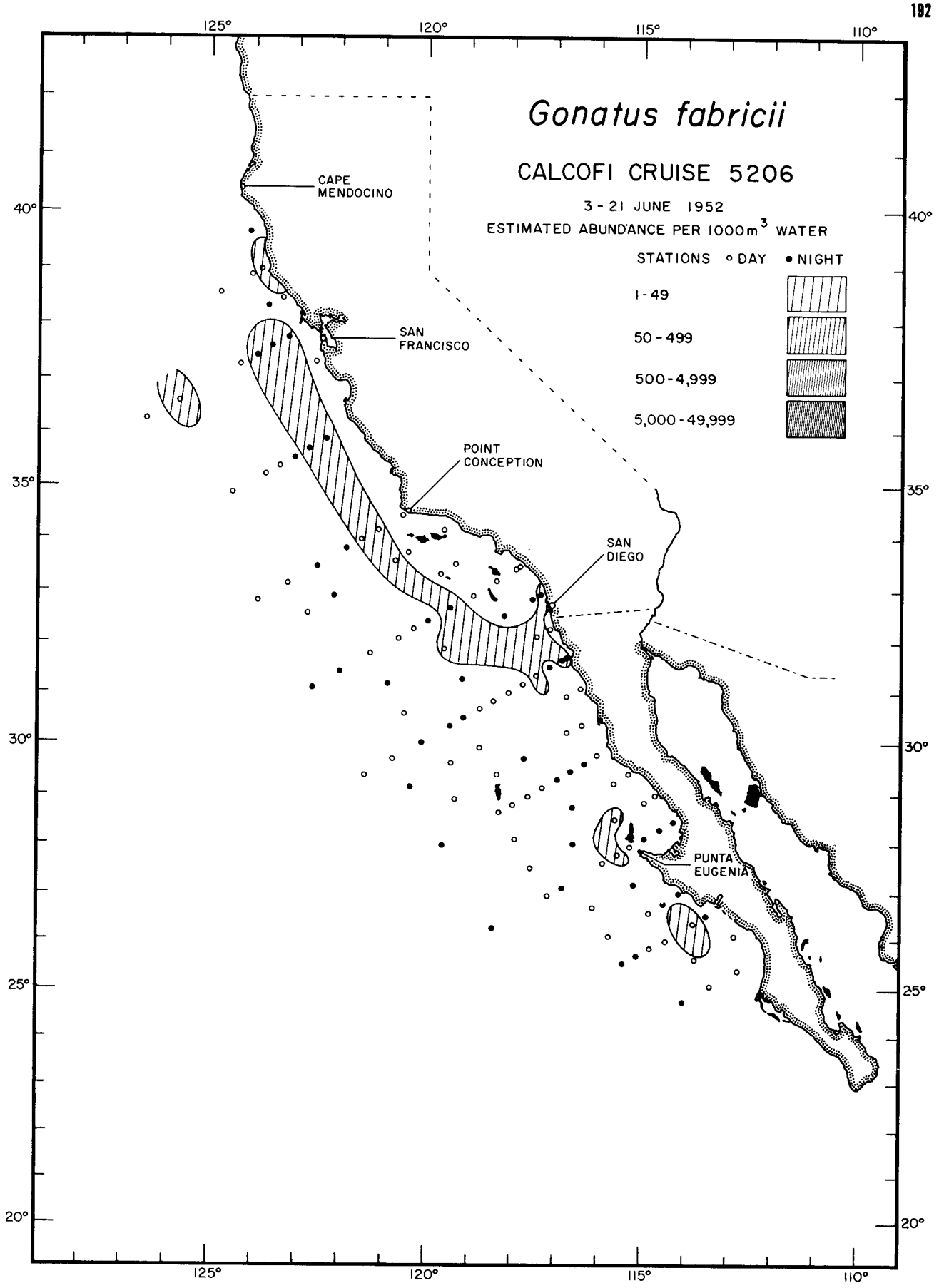
RANGE OF POSITIVE RECORDS




Cephalopoda

*Gonatus fabricii*

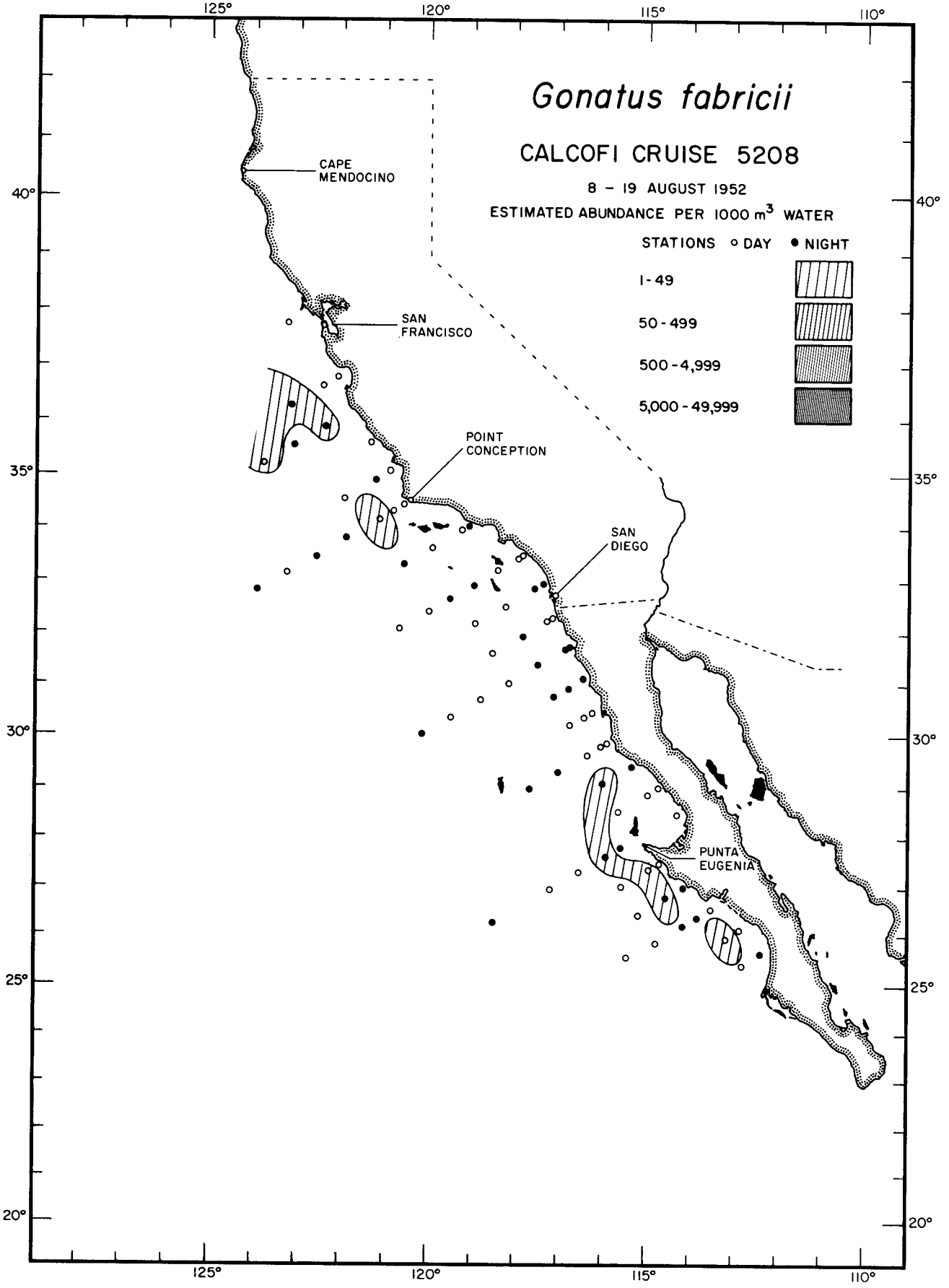
5204




Cephalopoda

*Gonatus fabricii*

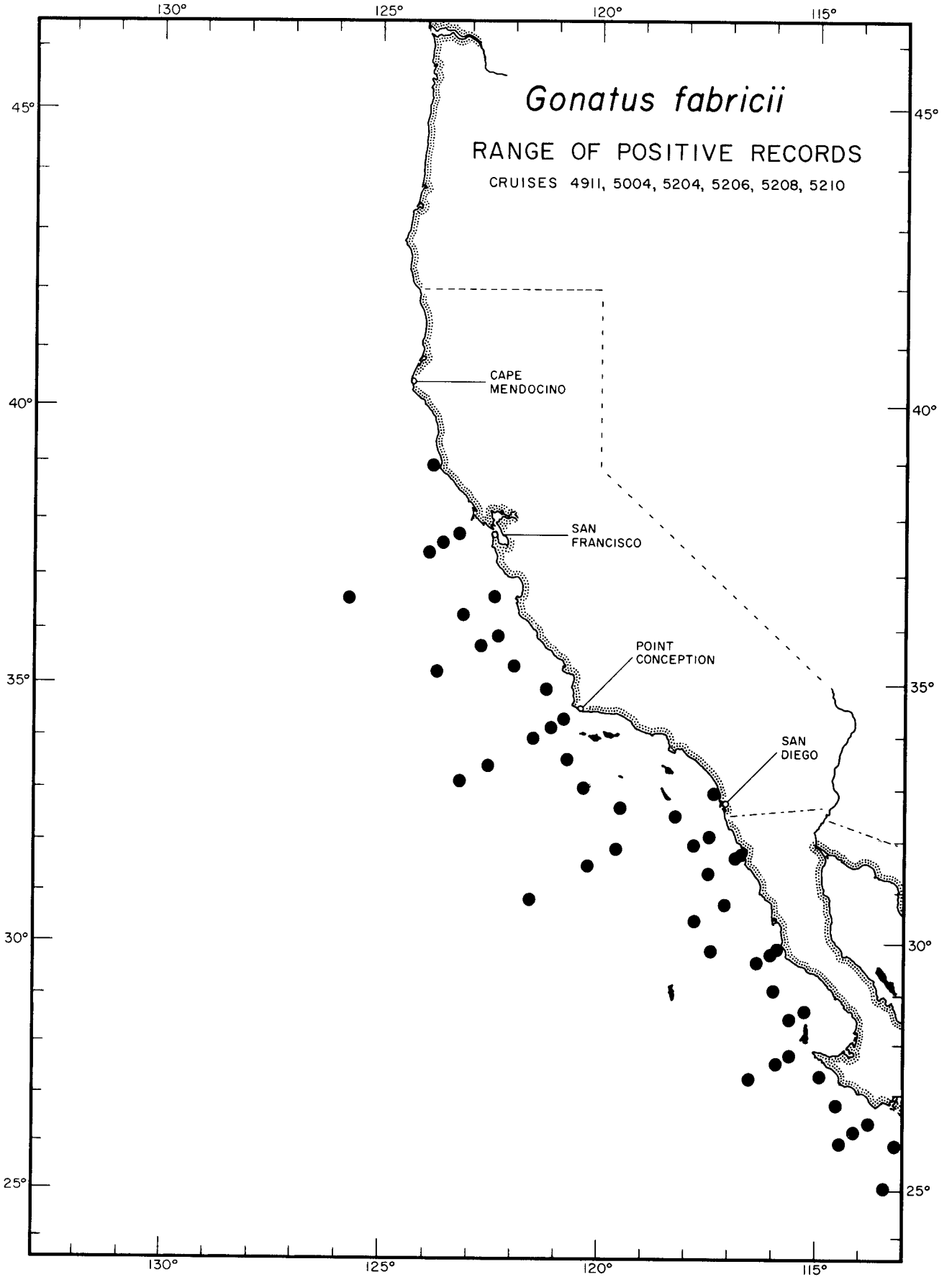
5206




Cephalopoda

*Gonatus fabricii*

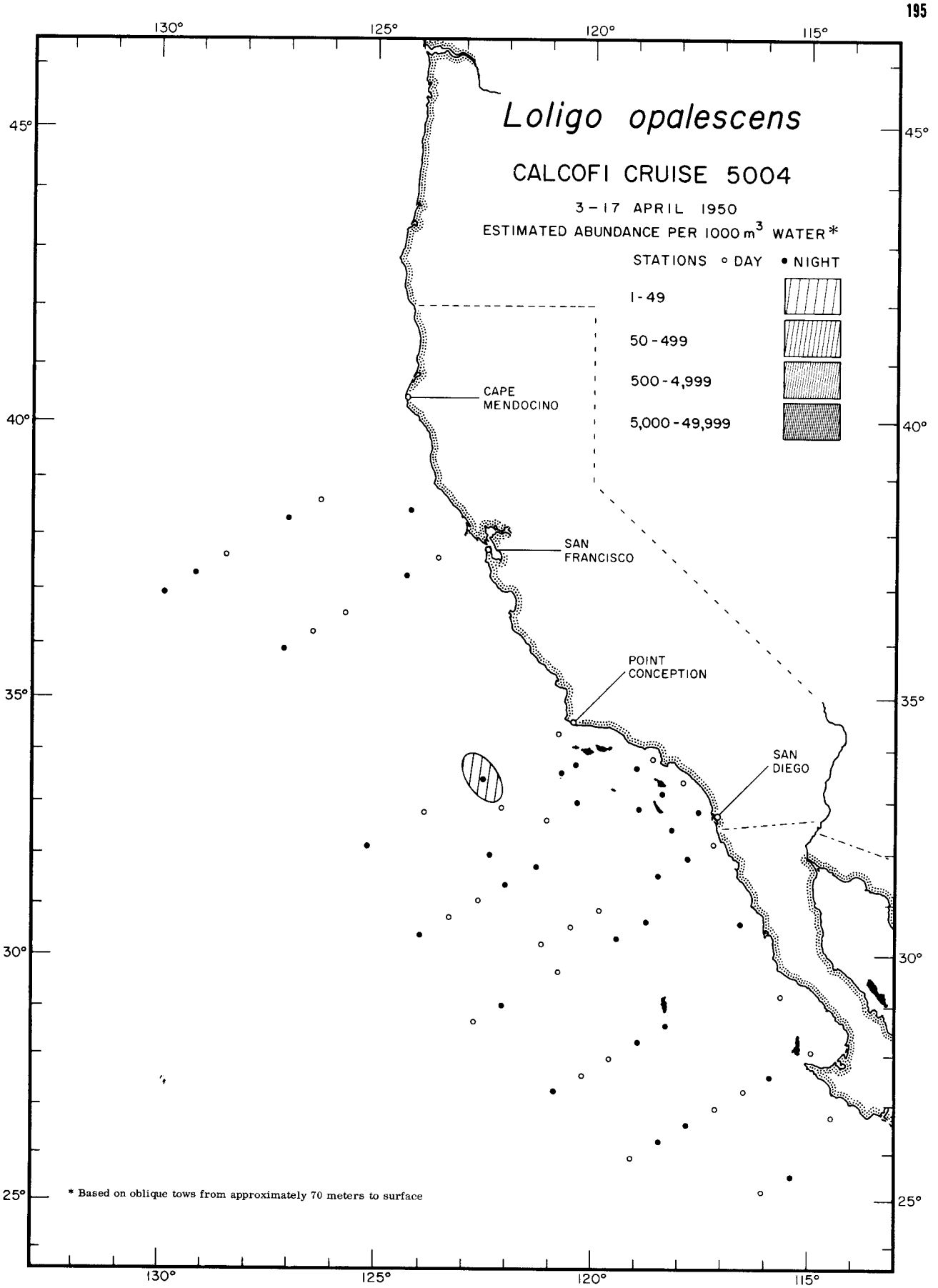
5208




Cephalopoda

*Gonatus fabricii*

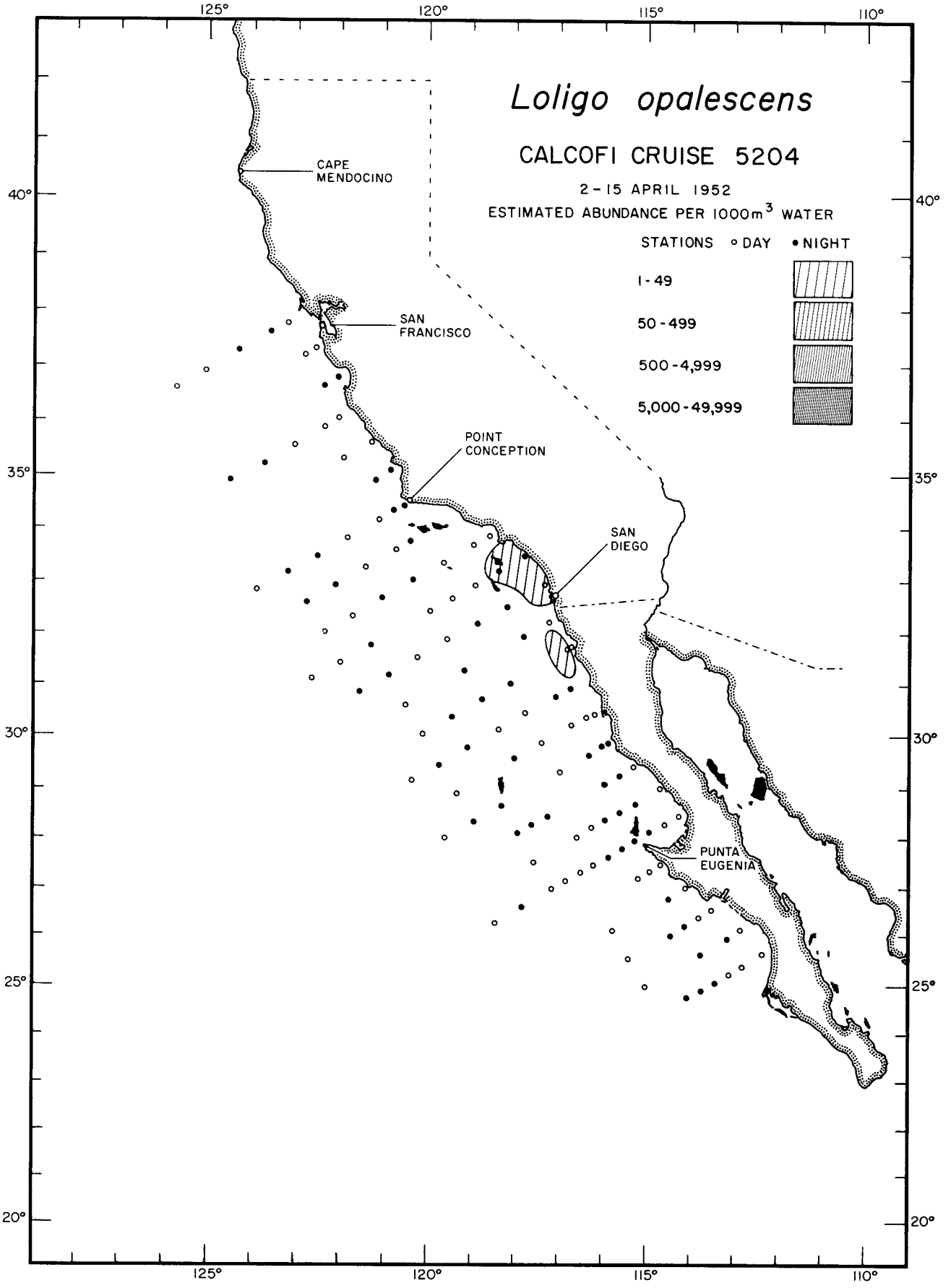
RANGE OF POSITIVE RECORDS




Cephalopoda

*Loligo opalescens*

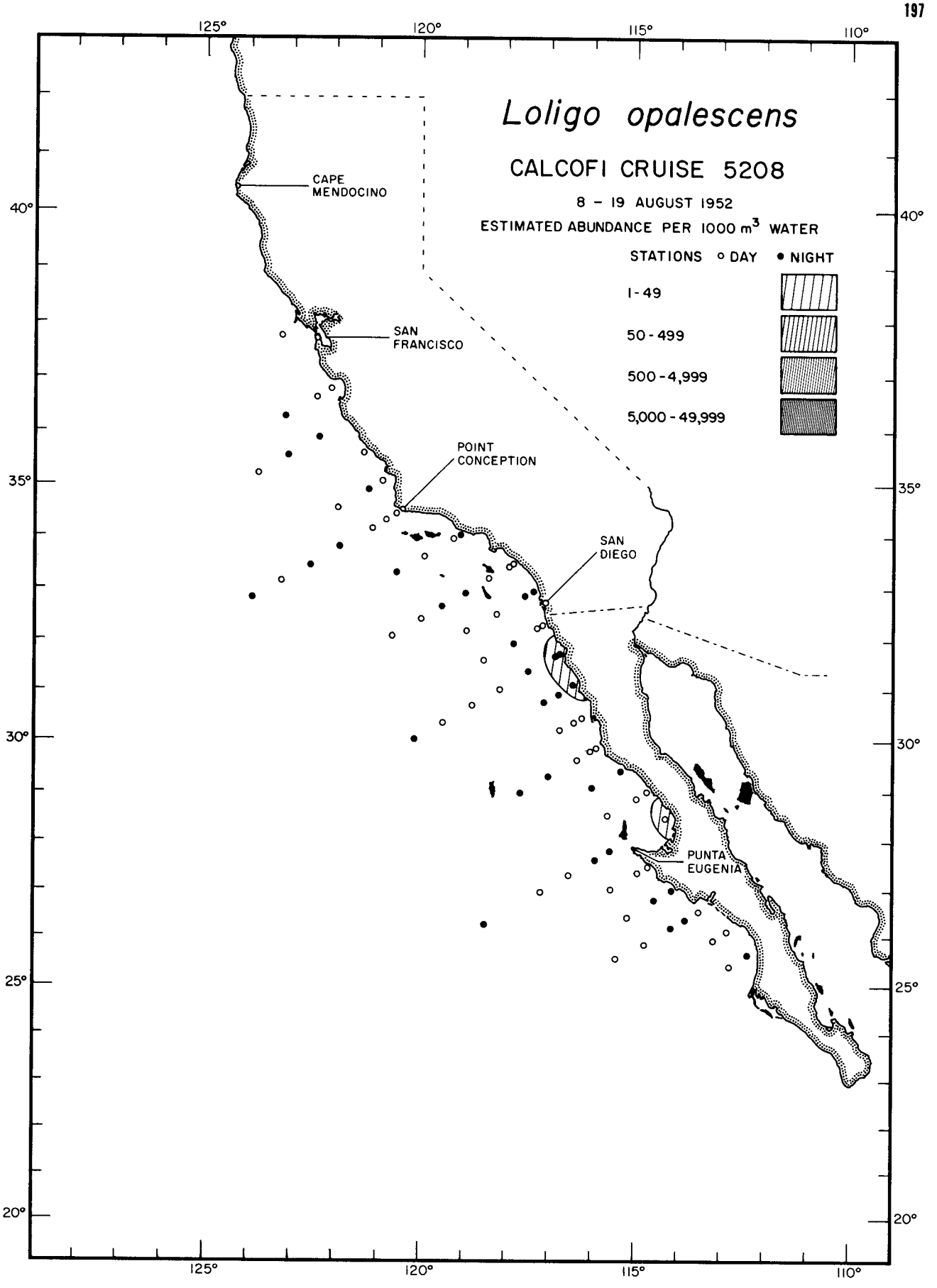
5004




Cephalopoda

*Loligo opalescens*

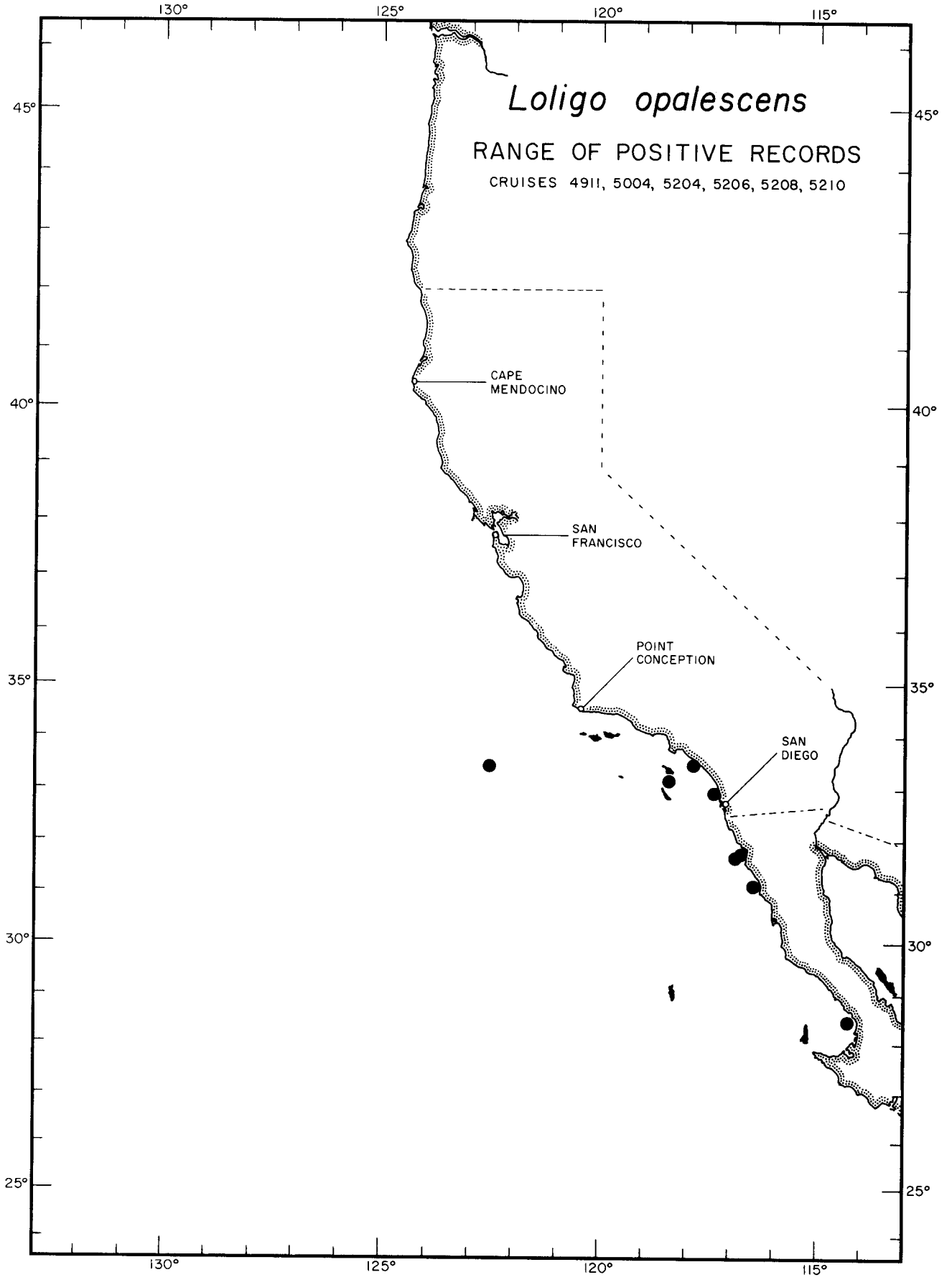
5204




Cephalopoda

*Loligo opalescens*

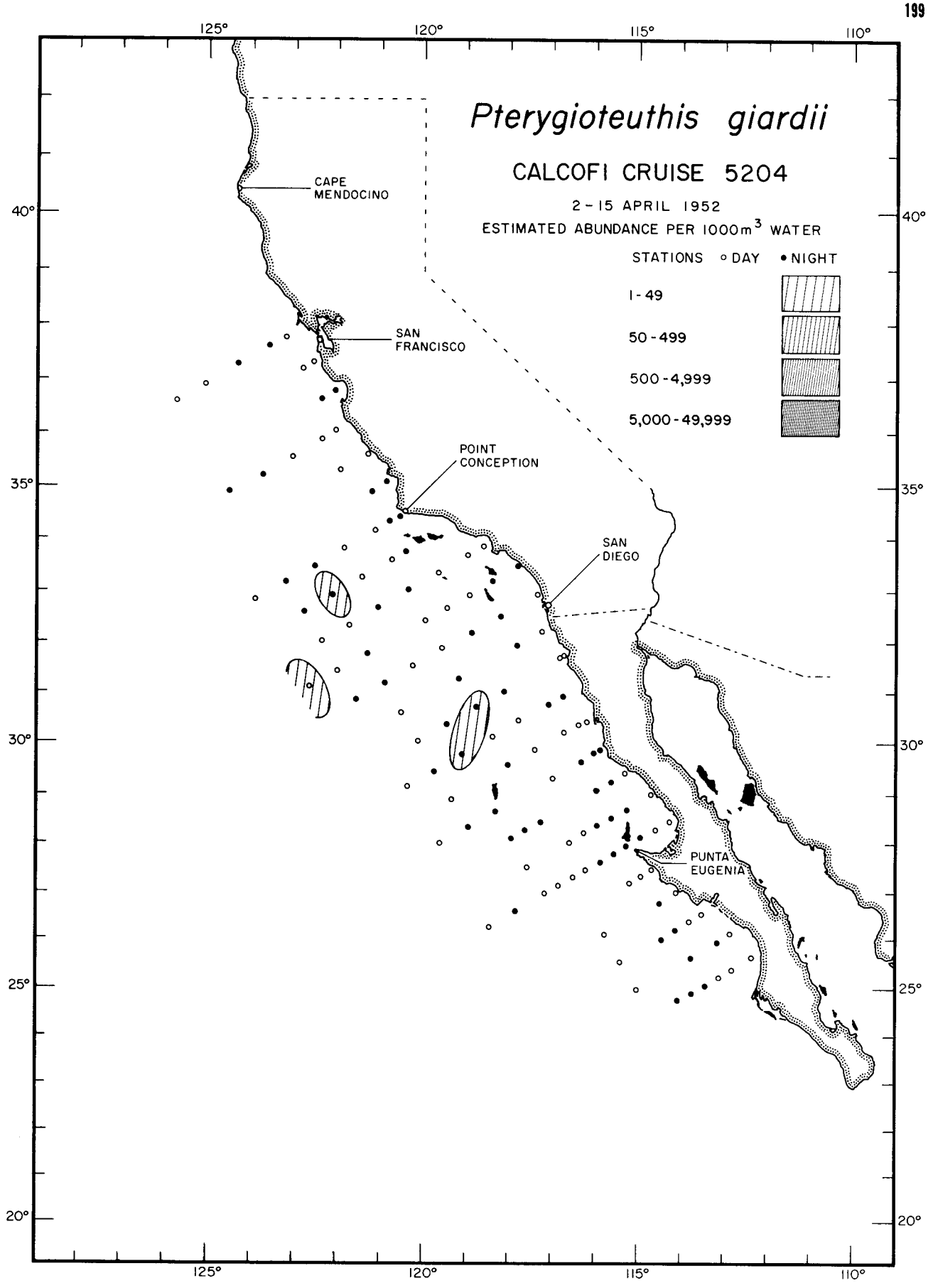
5208




Cephalopoda

*Loligo opalescens*

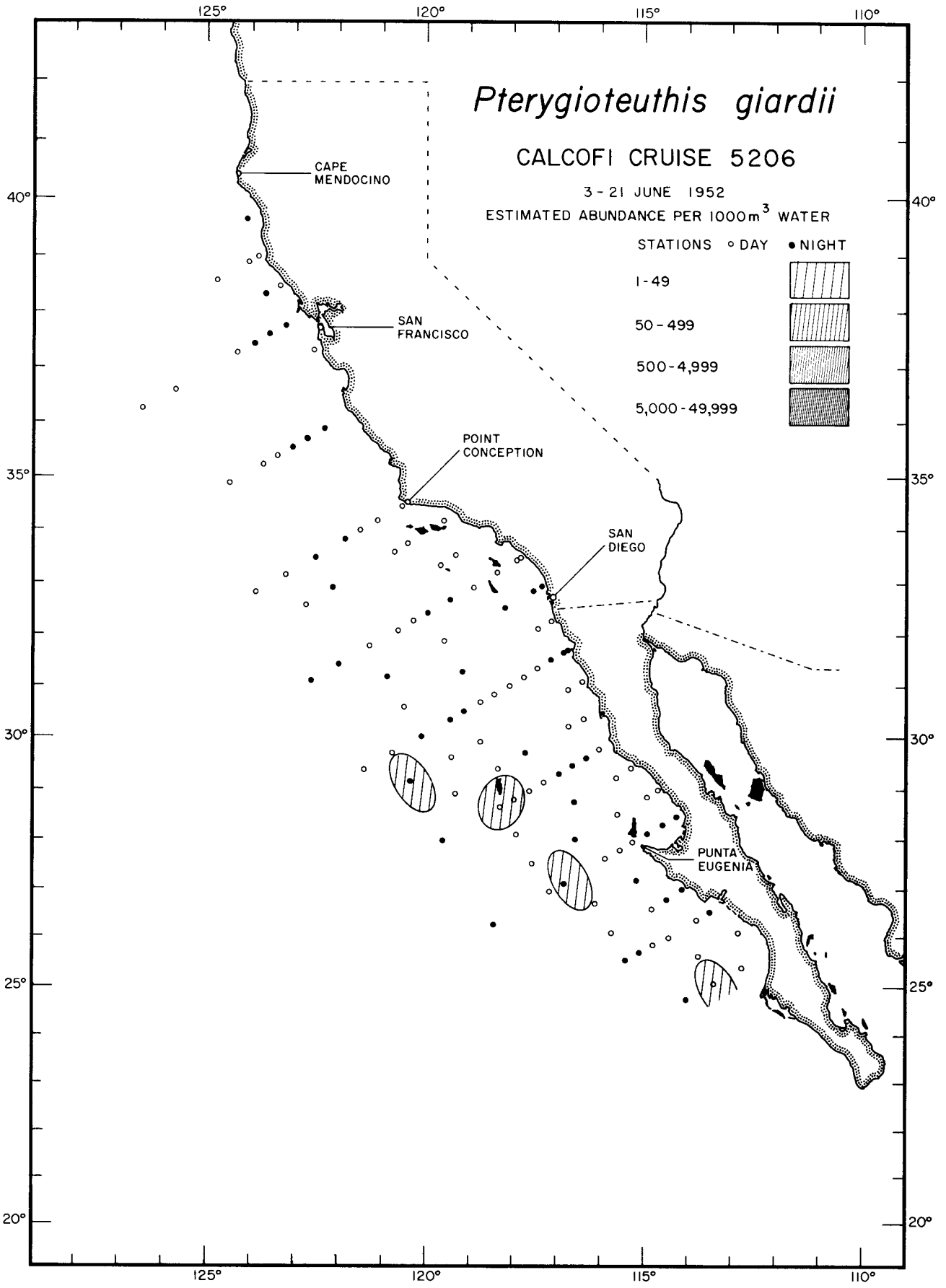
RANGE OF POSITIVE RECORDS




Cephalopoda

*Pterygioteuthis giardii*

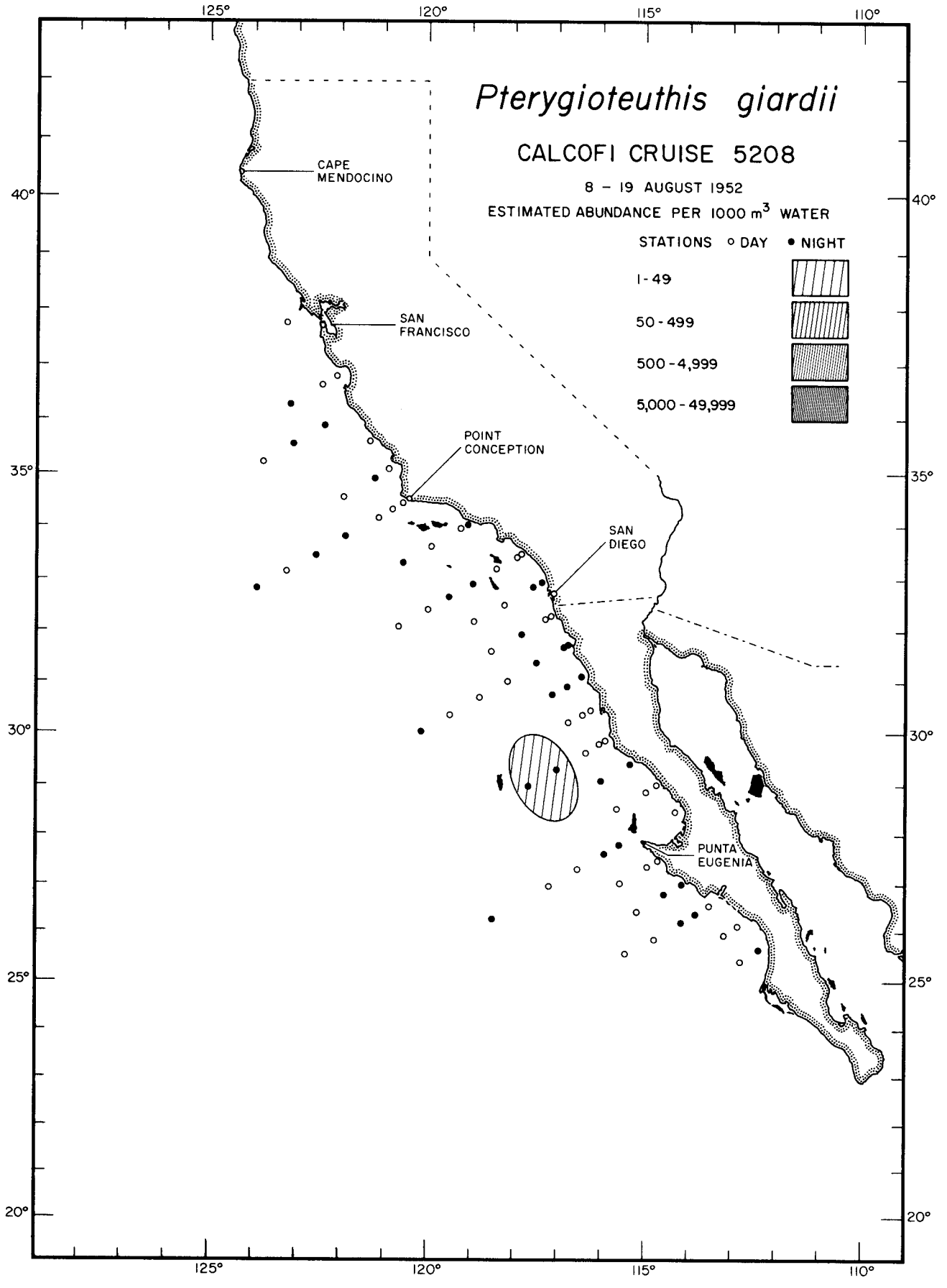
5204




Cephalopoda

*Pterygioteuthis giardii*

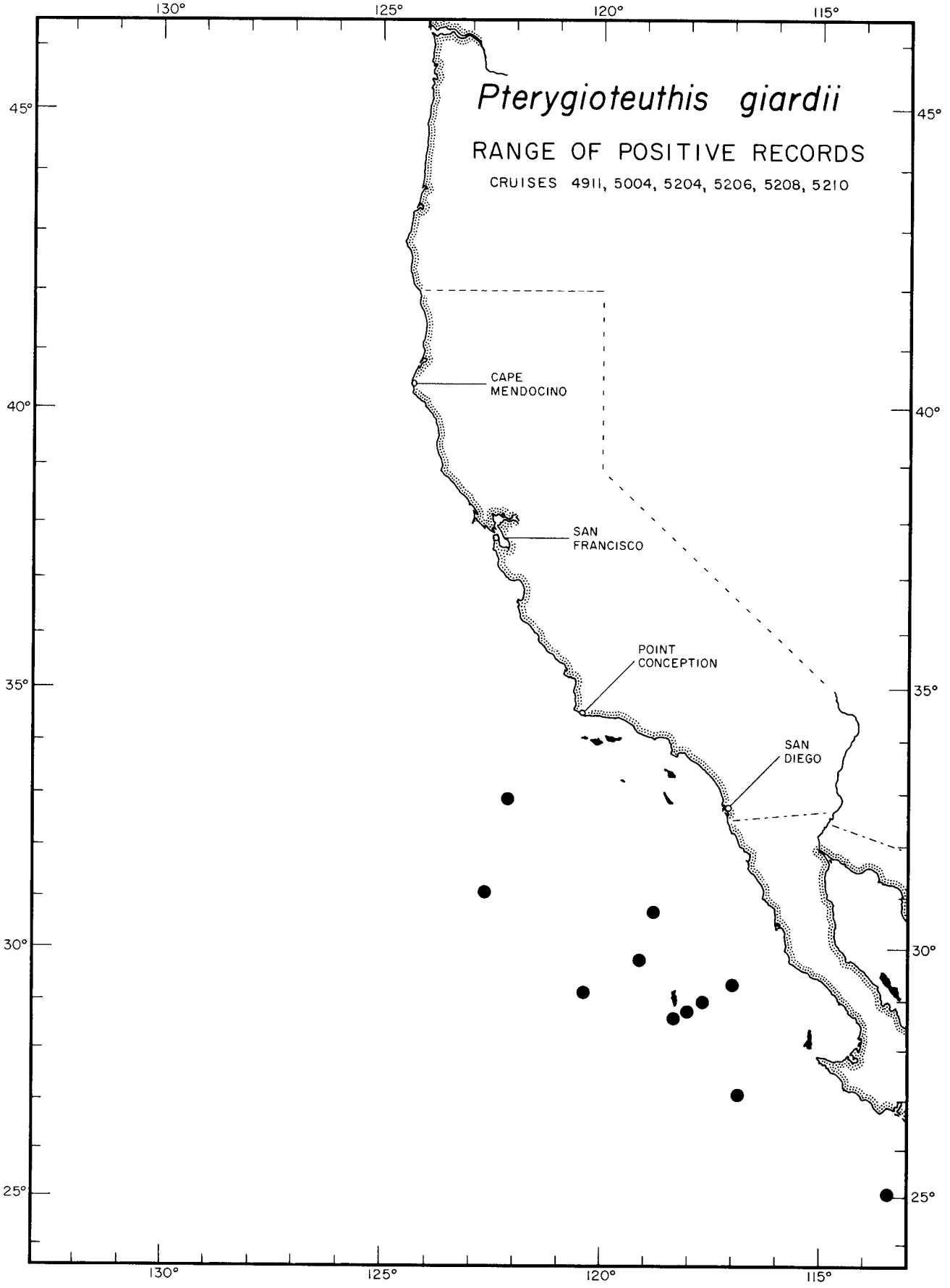
5206




Cephalopoda

*Pterygioteuthis giardii*

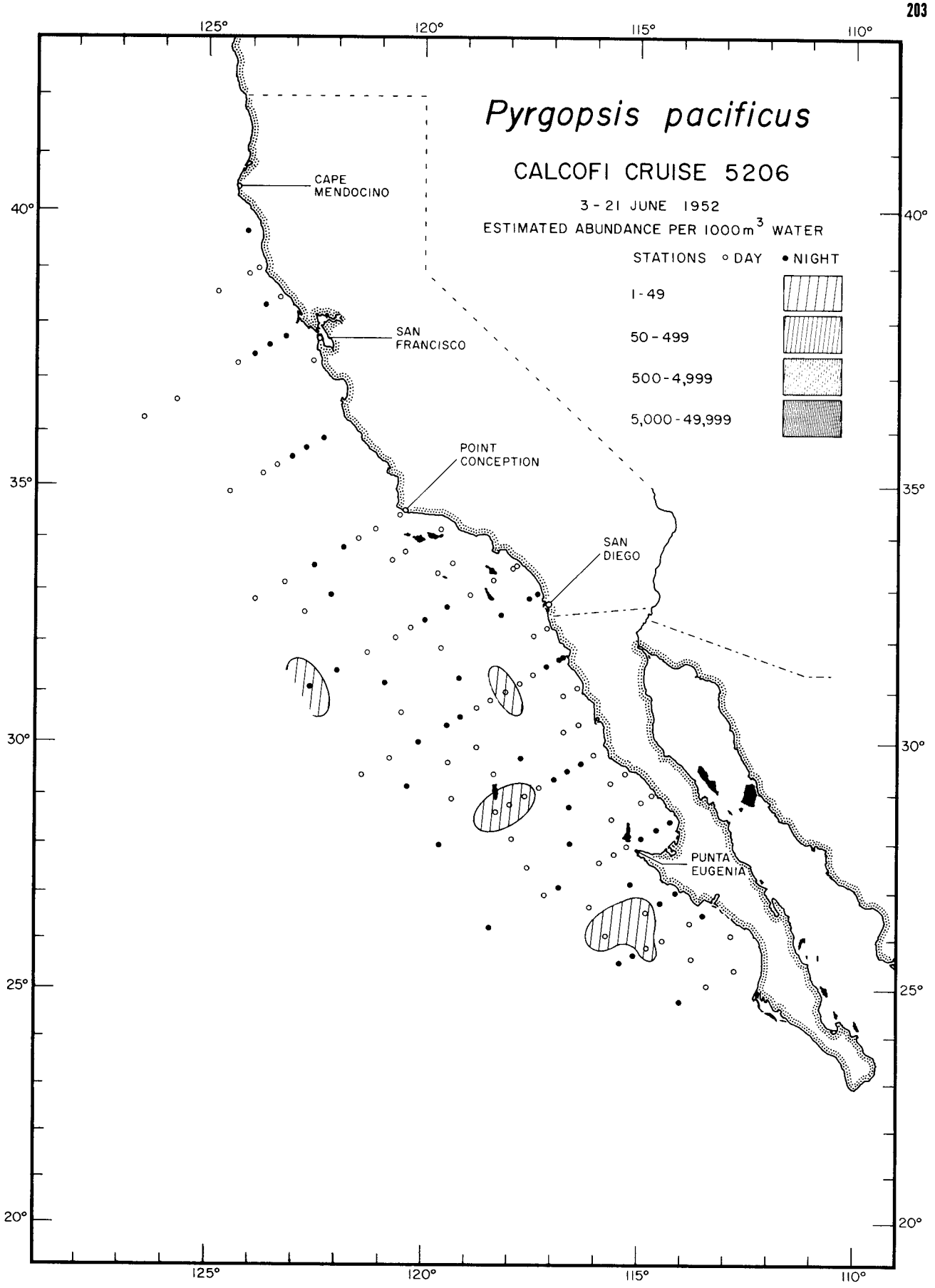
5208




Cephalopoda

*Pterygioteuthis giardii*

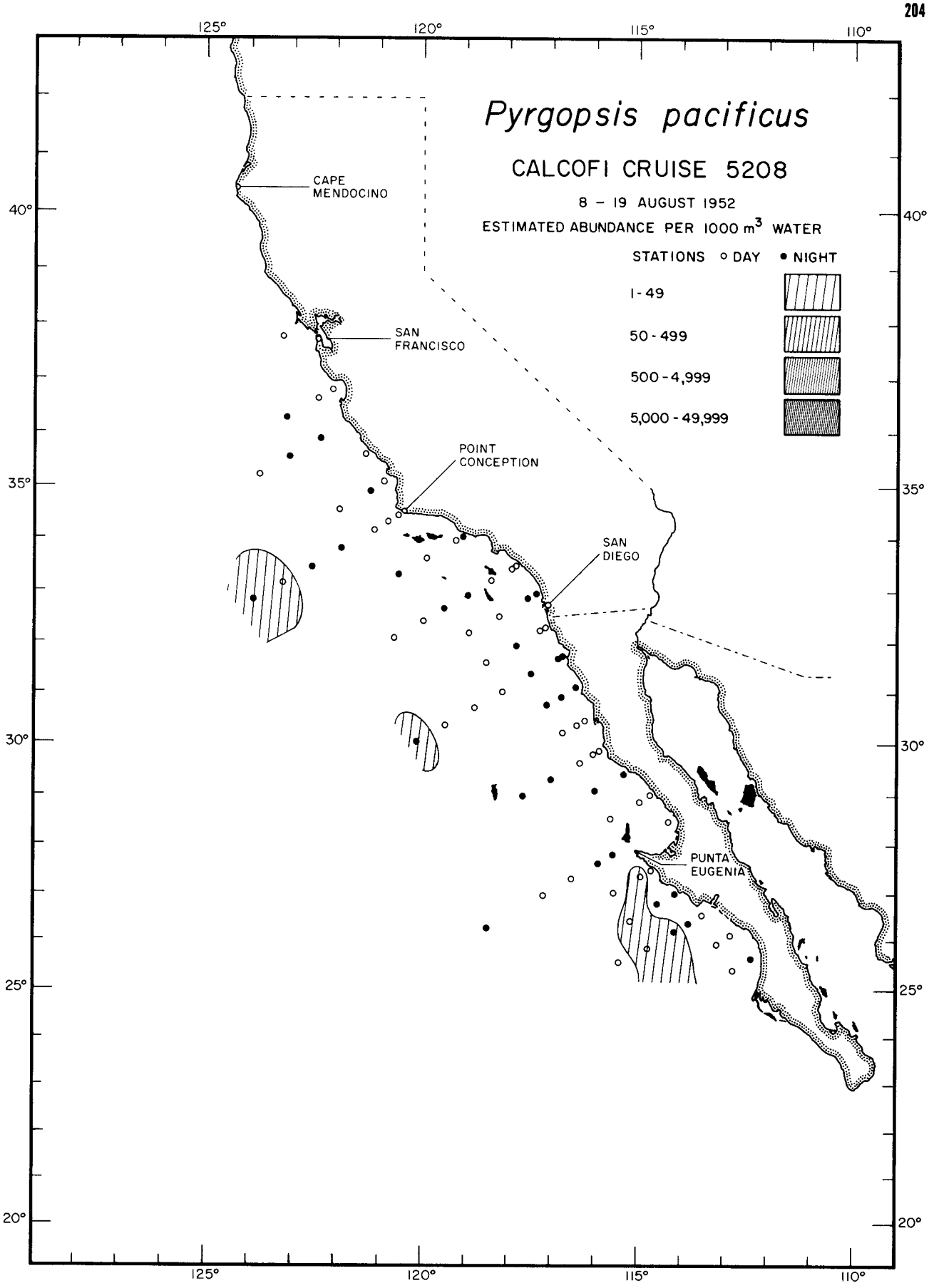
RANGE OF POSITIVE RECORDS




Cephalopoda

*Pyrgopsis pacificus*

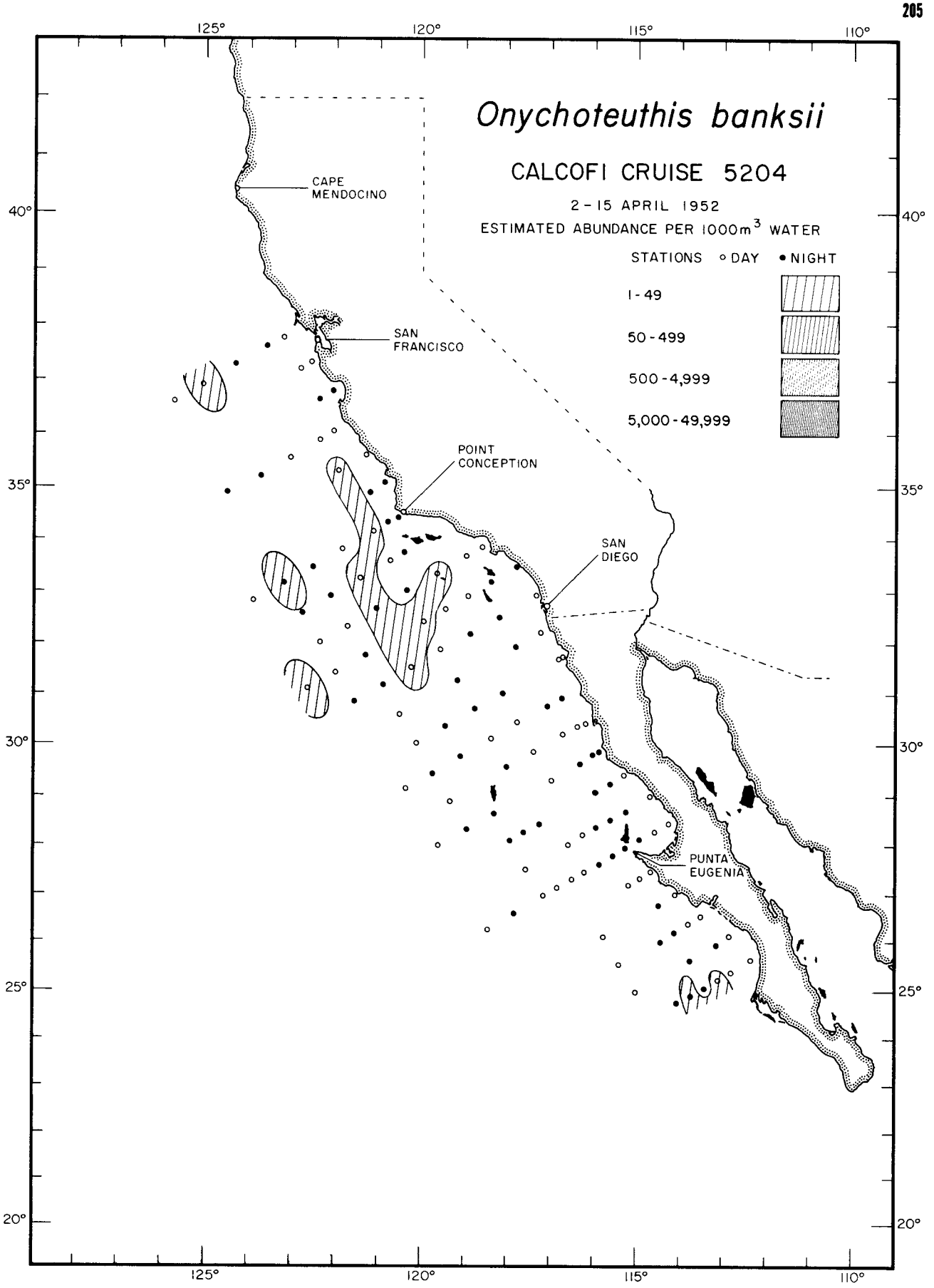
5206




Cephalopoda

*Pyrgopsis pacificus*

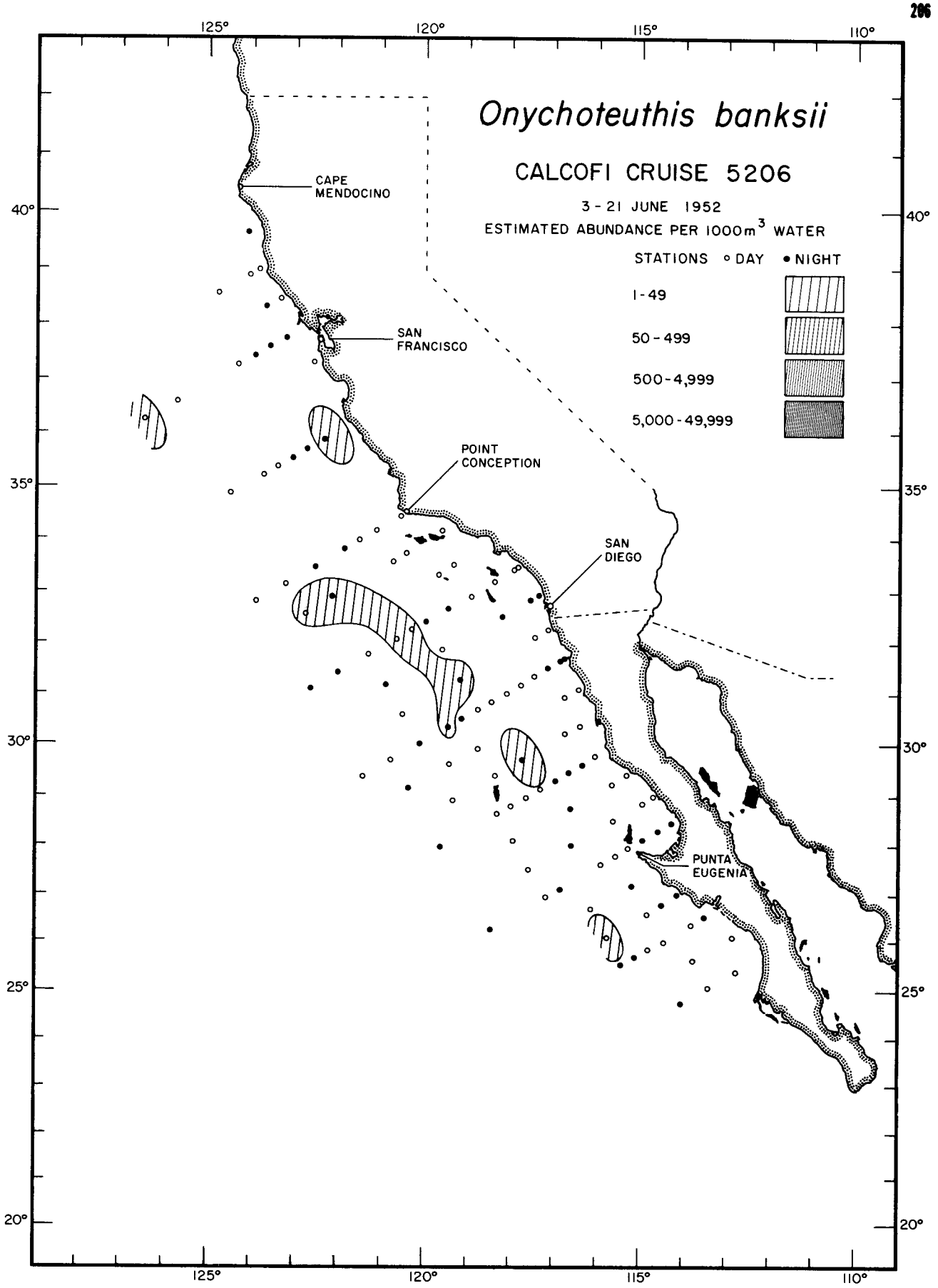
5208




Cephalopoda

*Onychoteuthis banksii*

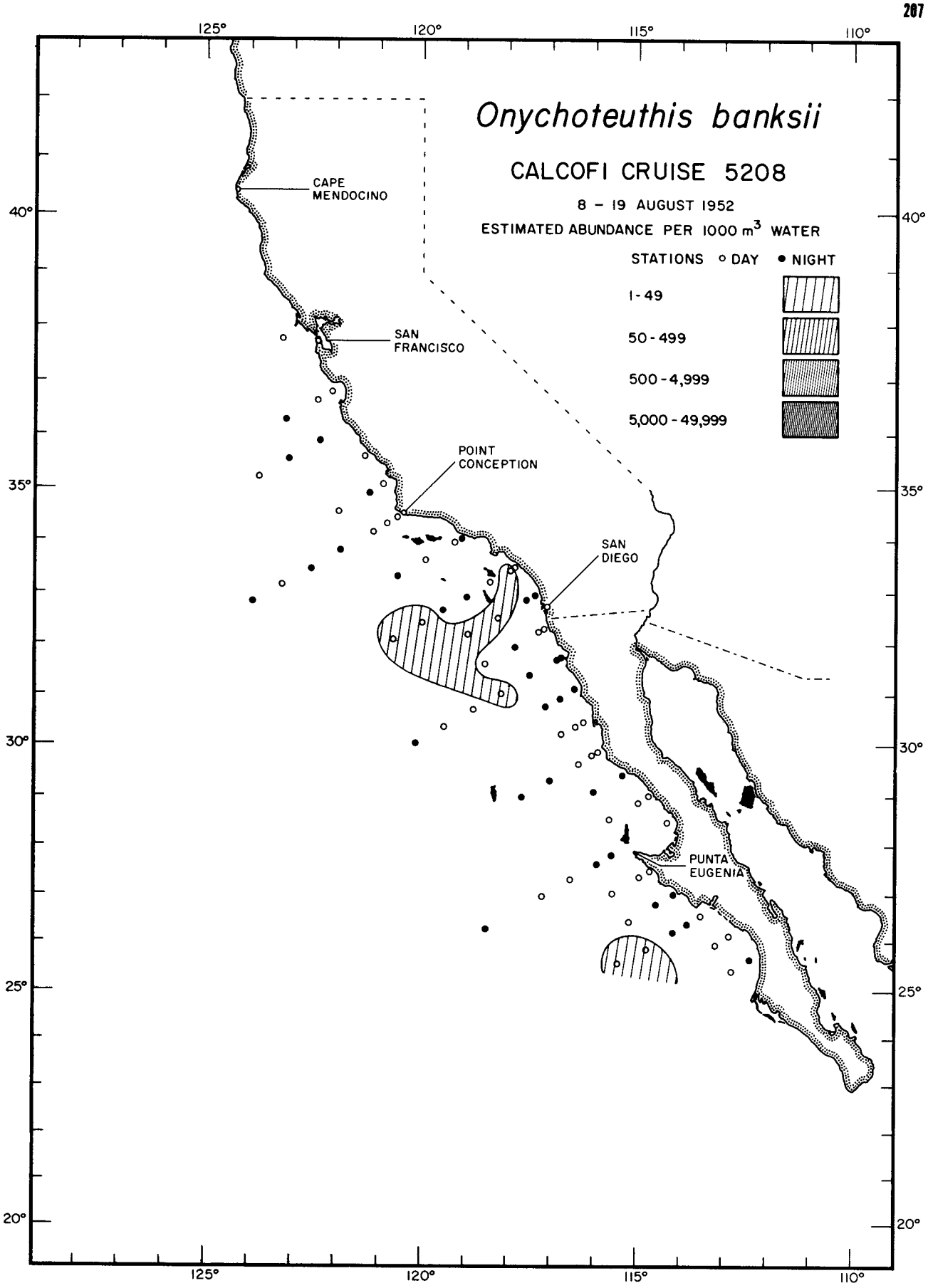
5204




Cephalopoda

*Onychoteuthis banksii*

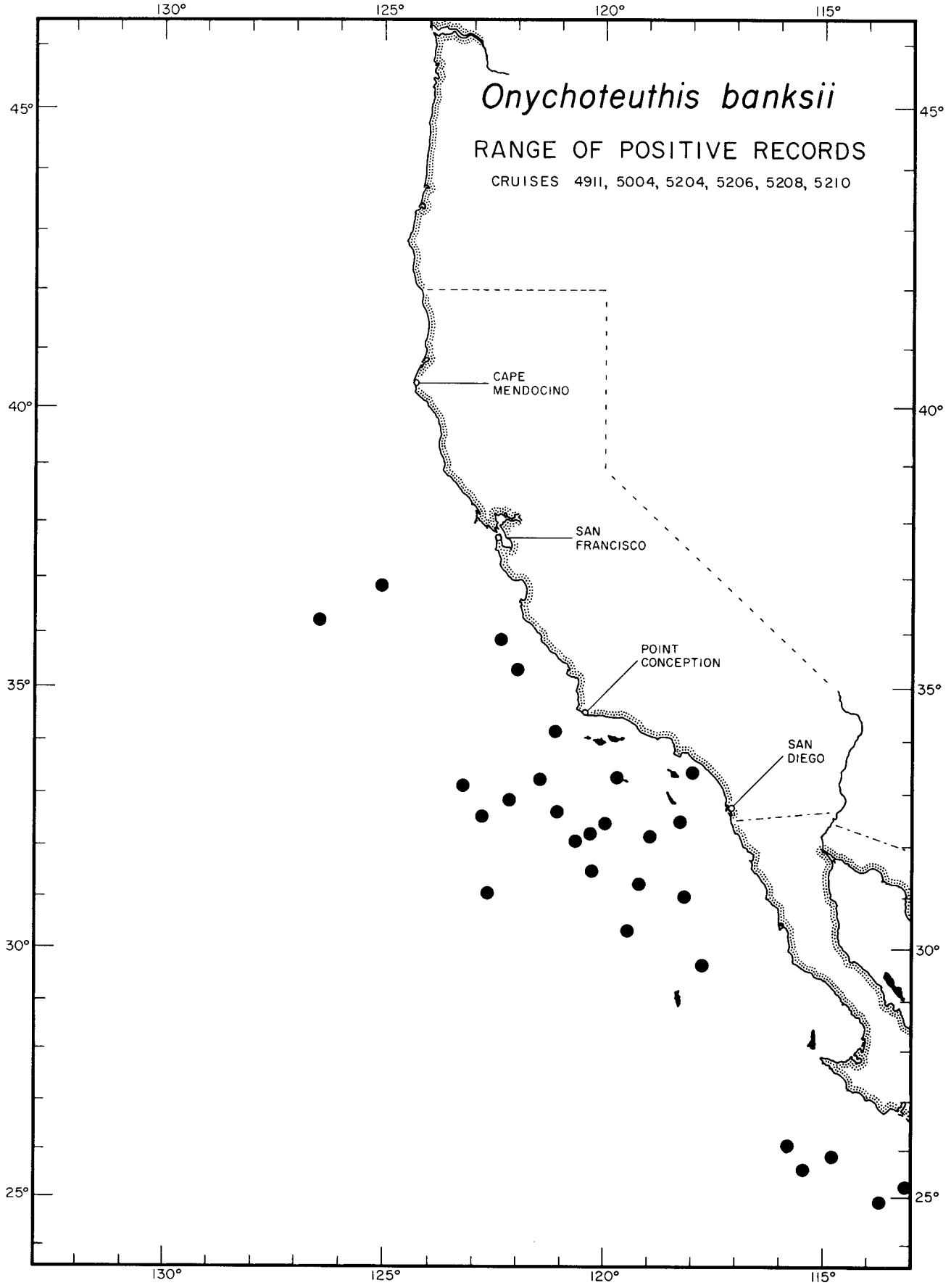
5206




Cephalopoda

*Onychoteuthis banksii*

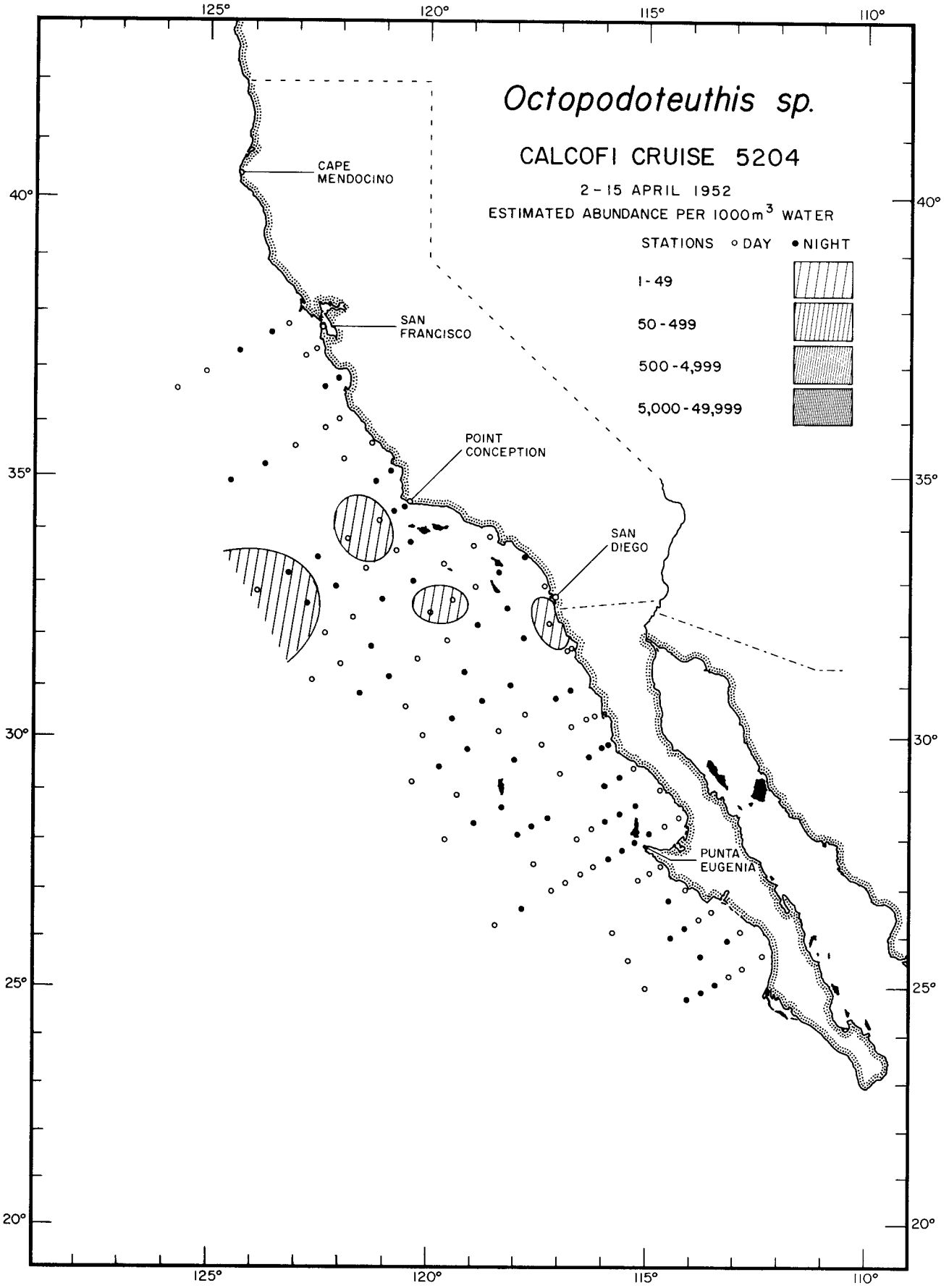
5208




Cephalopoda

*Onychoteuthis banksii*

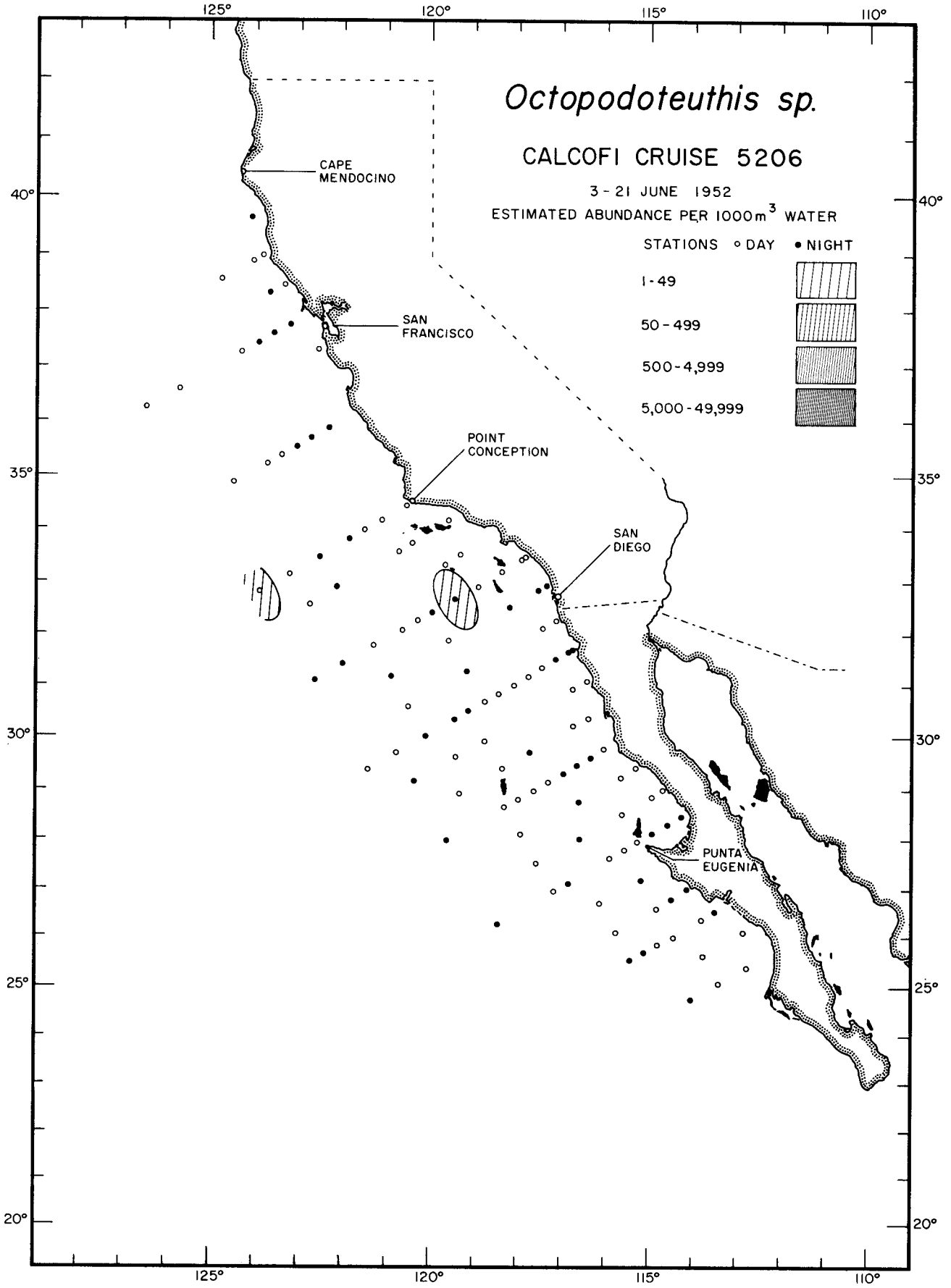
RANGE OF POSITIVE RECORDS




Cephalopoda

*Octopodoteuthis sp.*

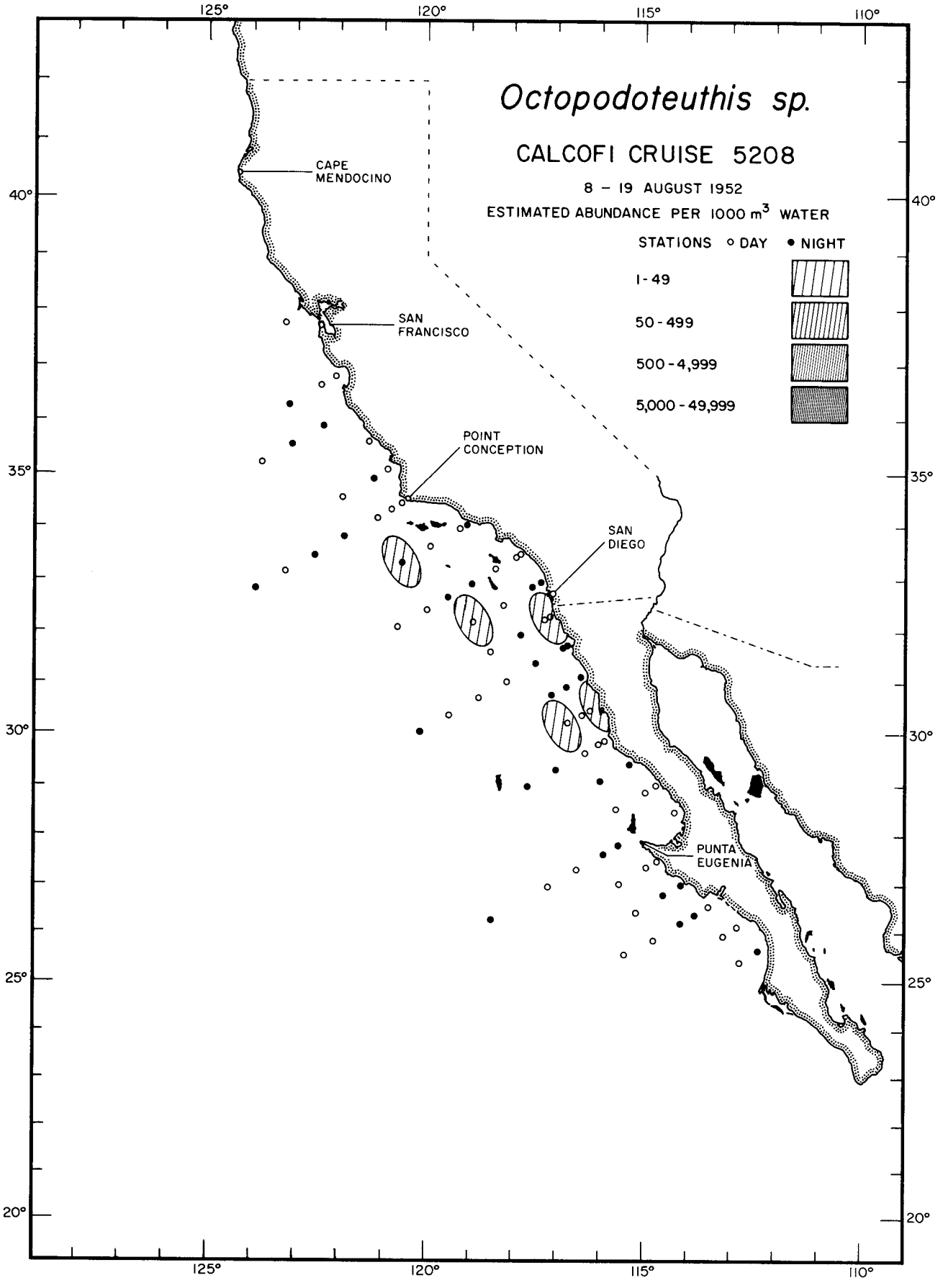
5204




Cephalopoda

*Octopodoteuthis sp.*

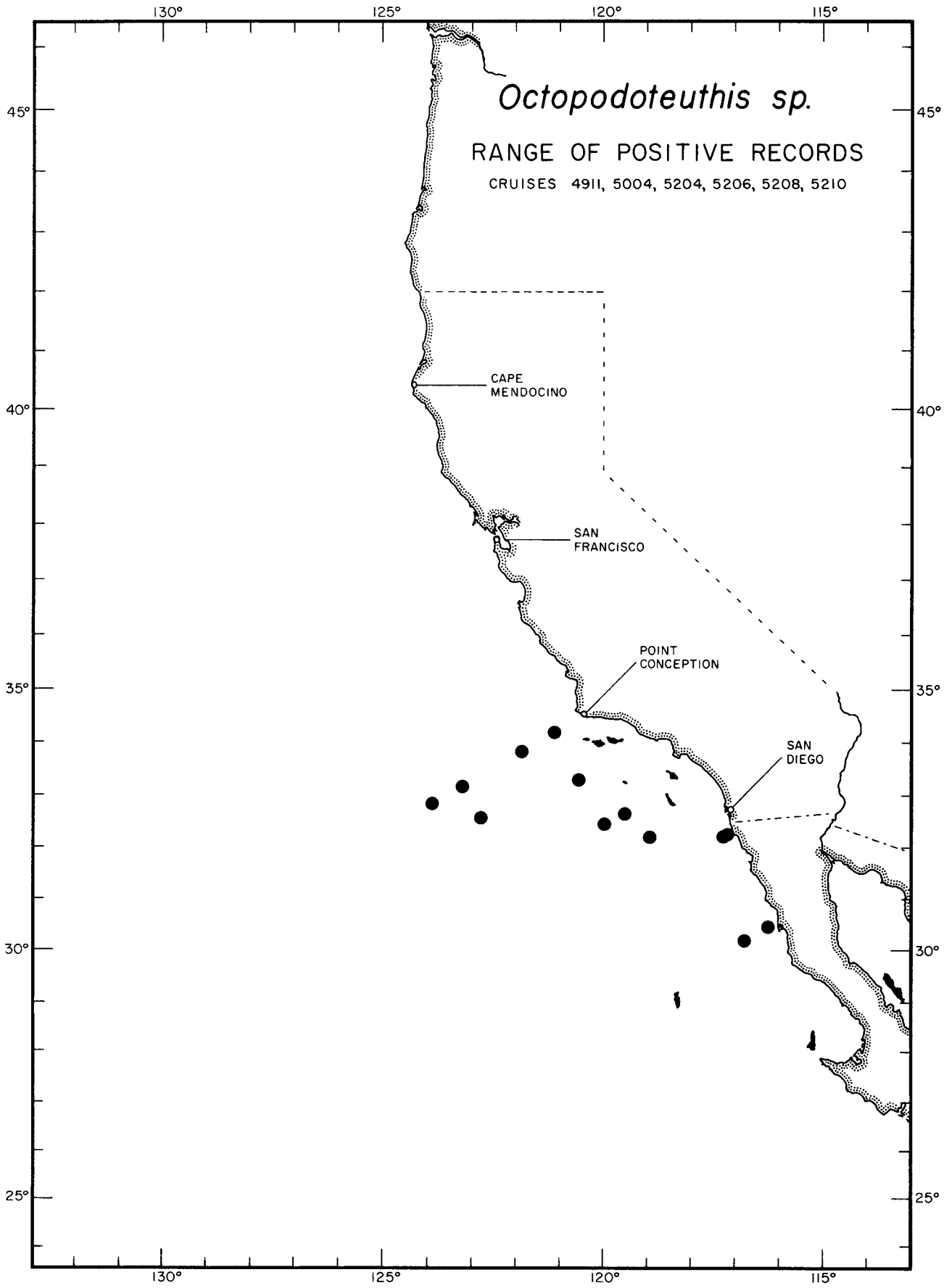
5206




Cephalopoda

*Octopodoteuthis sp.*

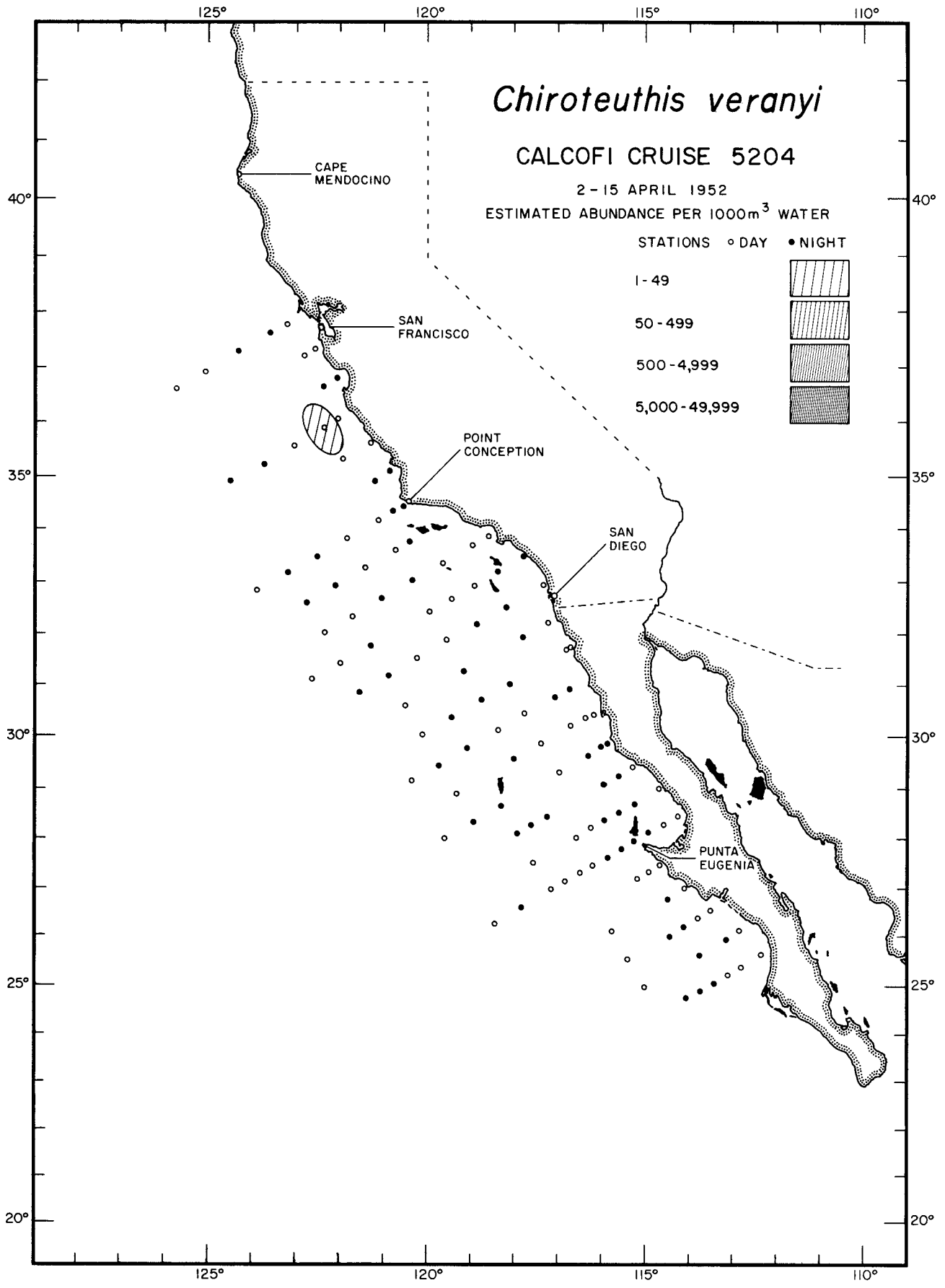
5208




Cephalopoda

*Octopodoteuthis sp.*

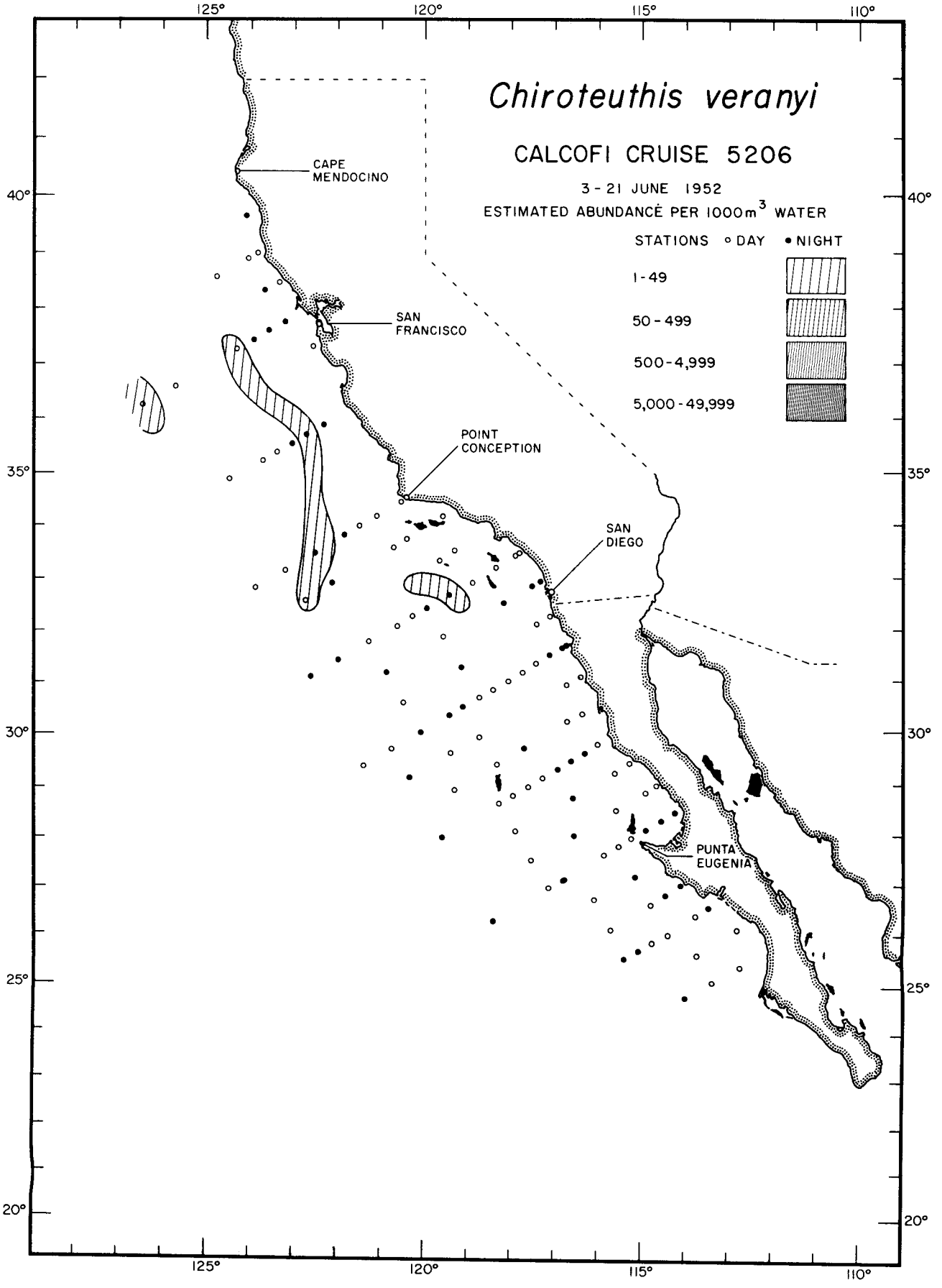
RANGE OF POSITIVE RECORDS




Cephalopoda

*Chiroteuthis veranyi*

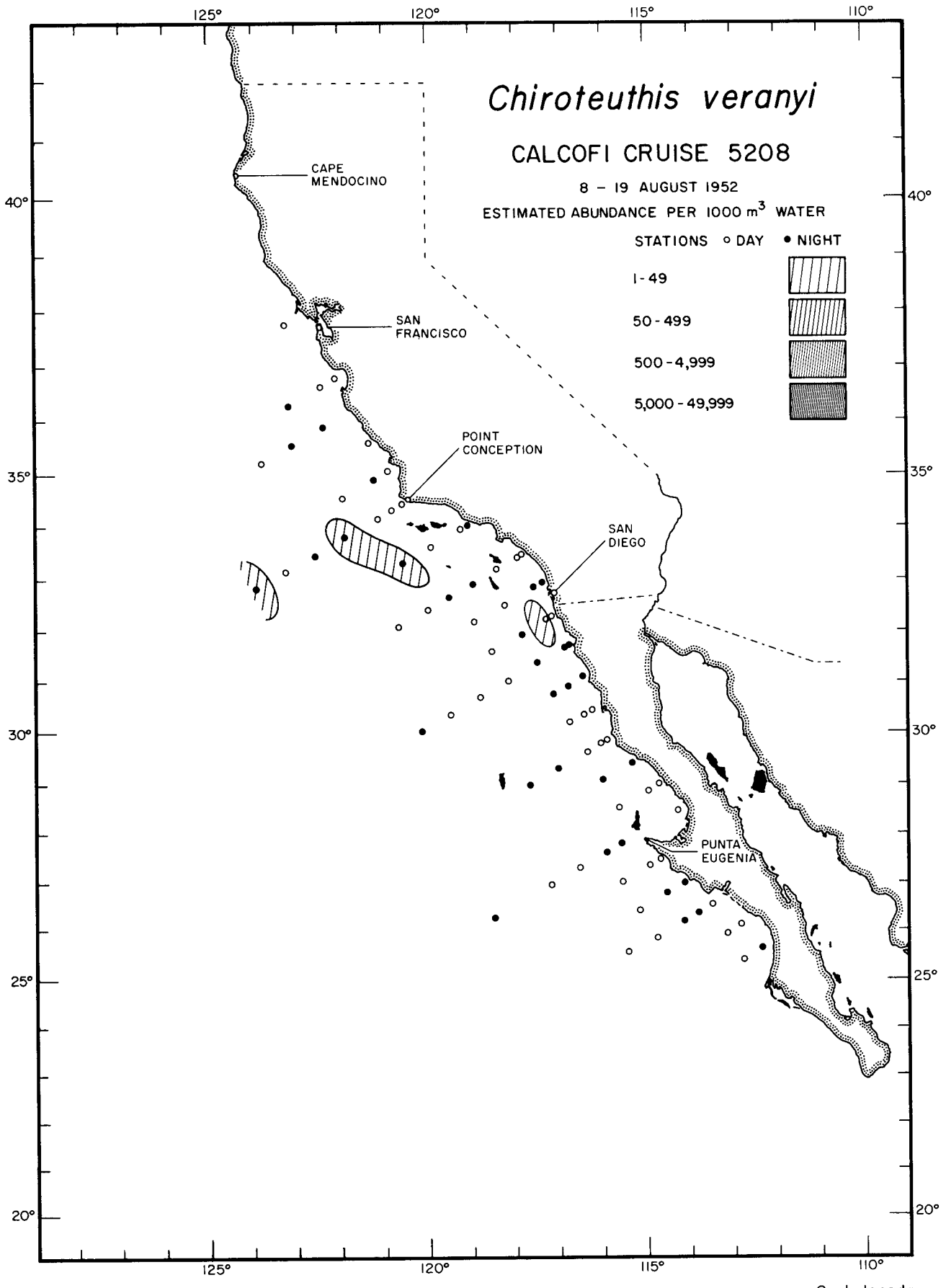
5204




Cephalopoda

*Chiroteuthis veranyi*

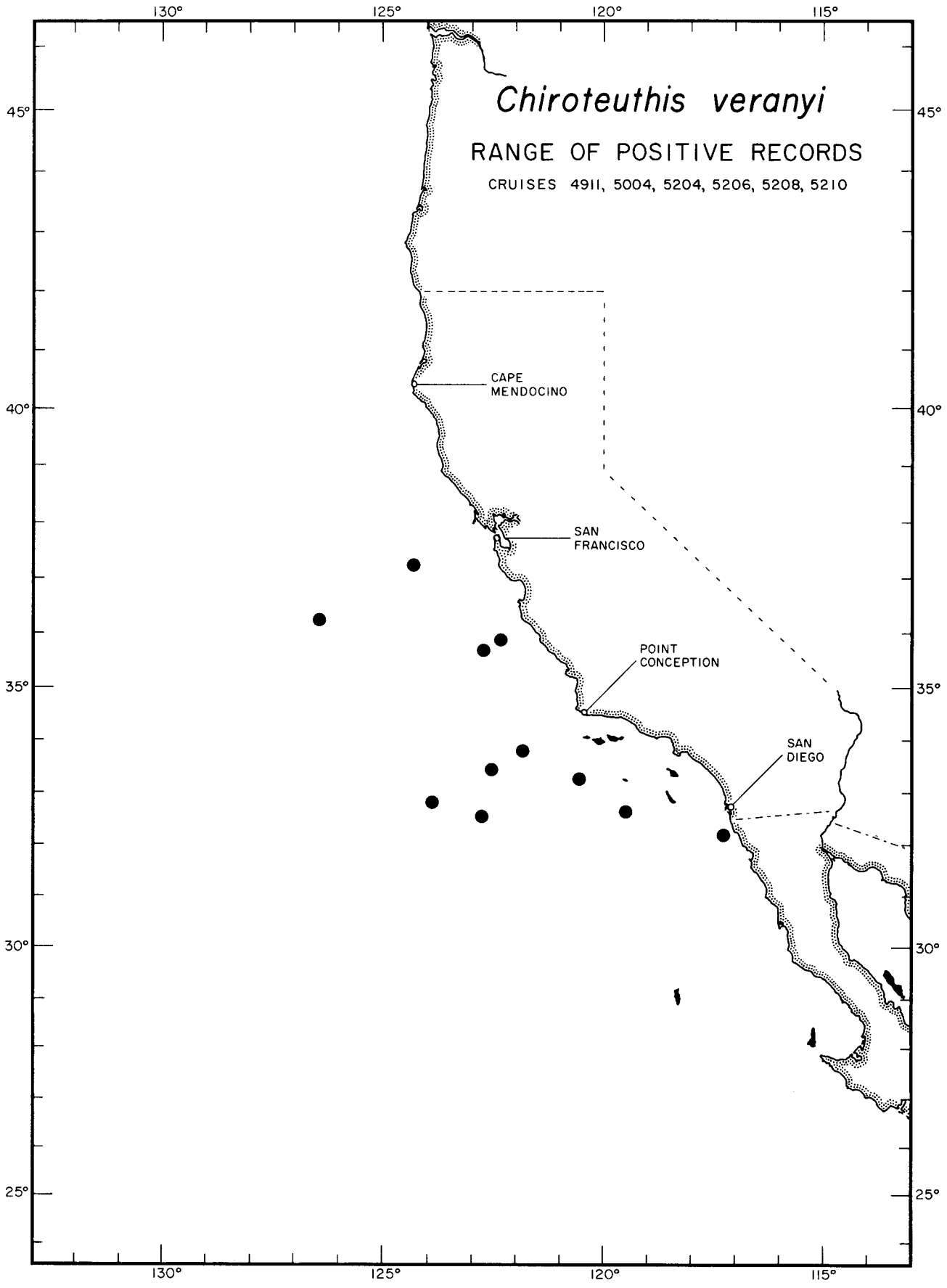
5206




Cephalopoda

*Chiroteuthis veranyi*

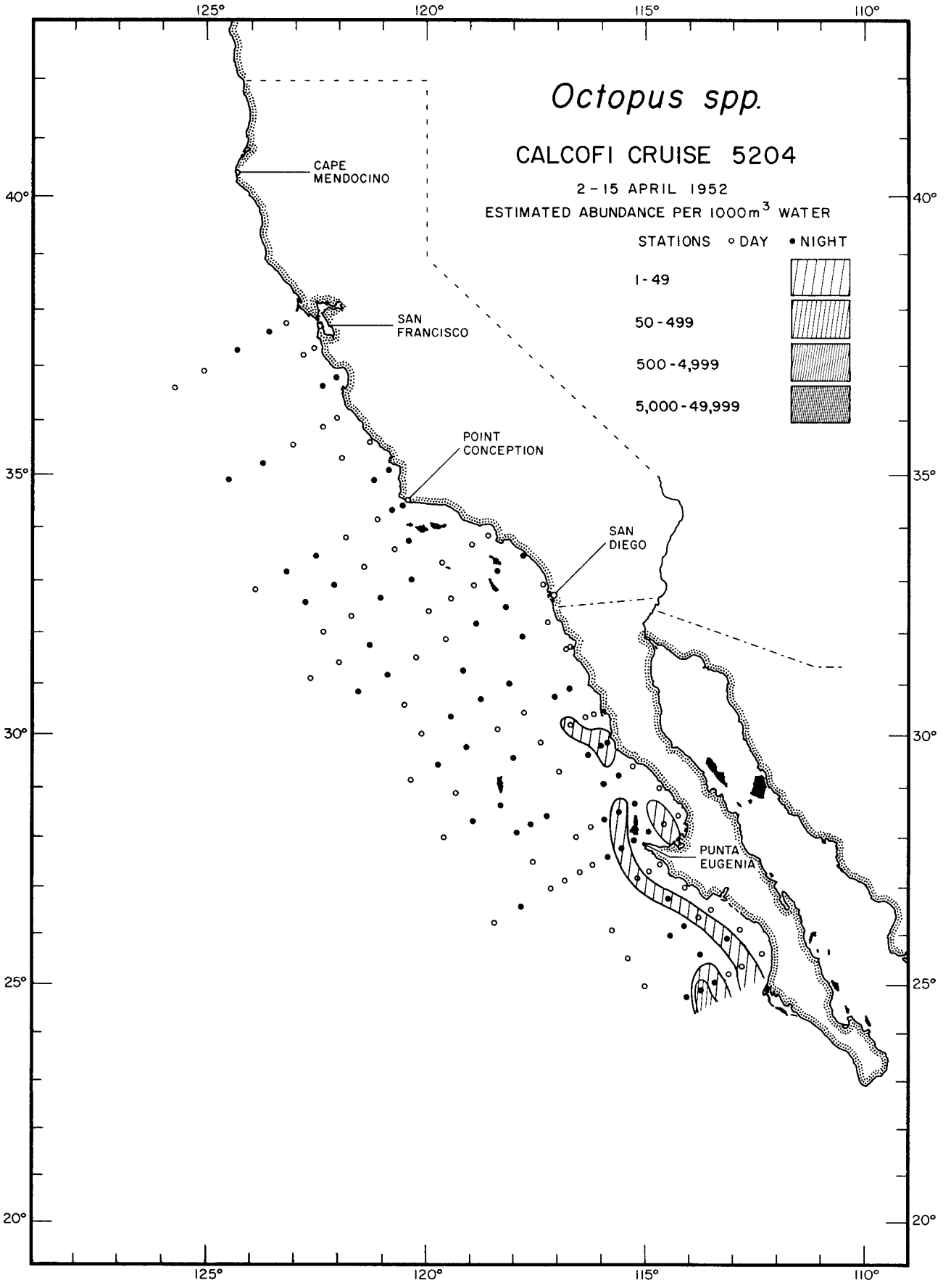
5208




Cephalopoda

*Chiroteuthis veranyi*

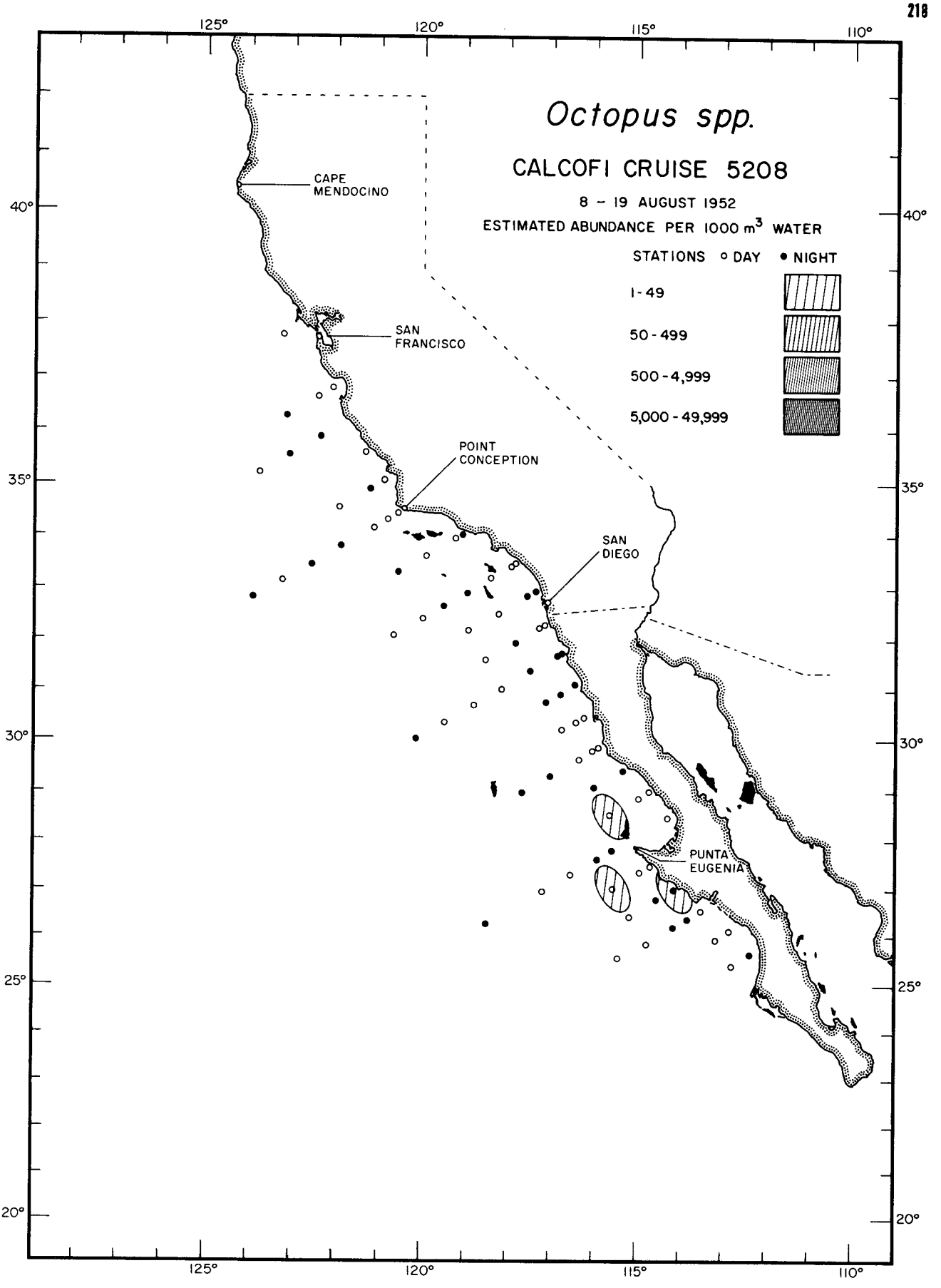
RANGE OF POSITIVE RECORDS




Cephalopoda

*Octopus spp.*

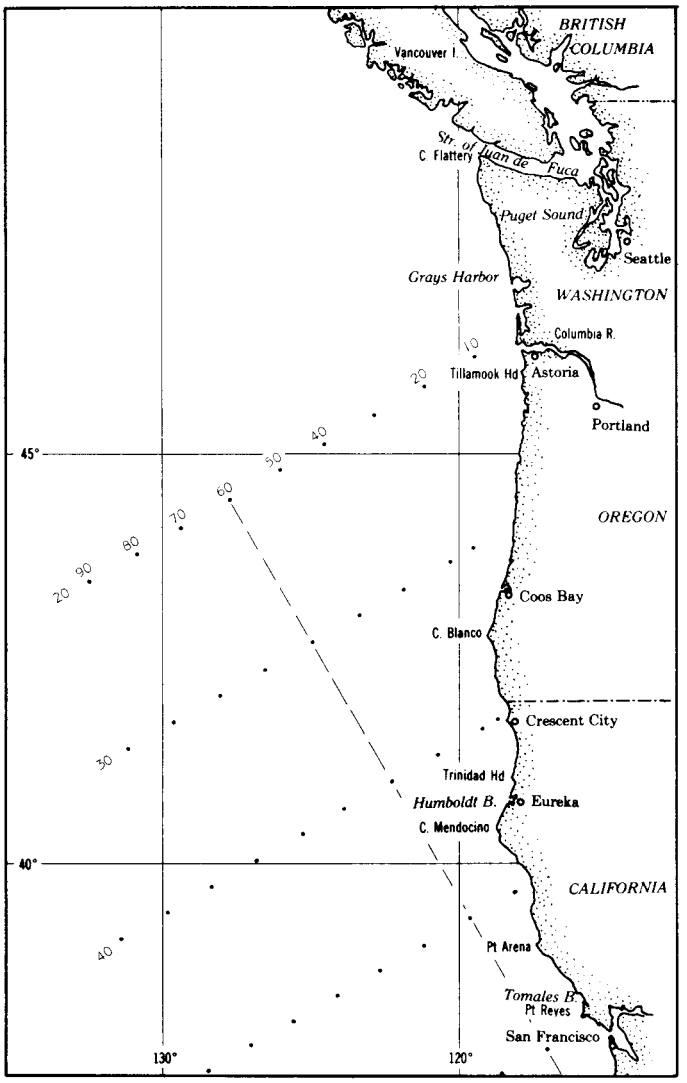
5204

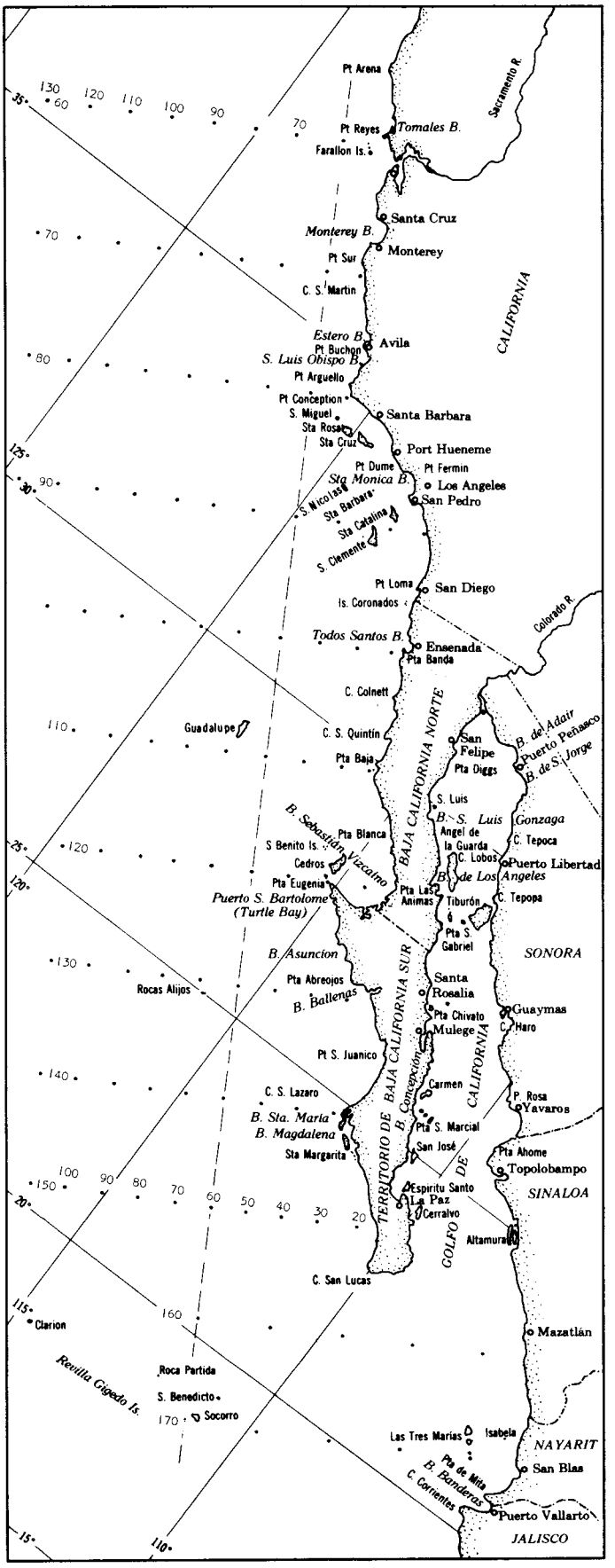



Cephalopoda

*Octopus spp.*

5208




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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