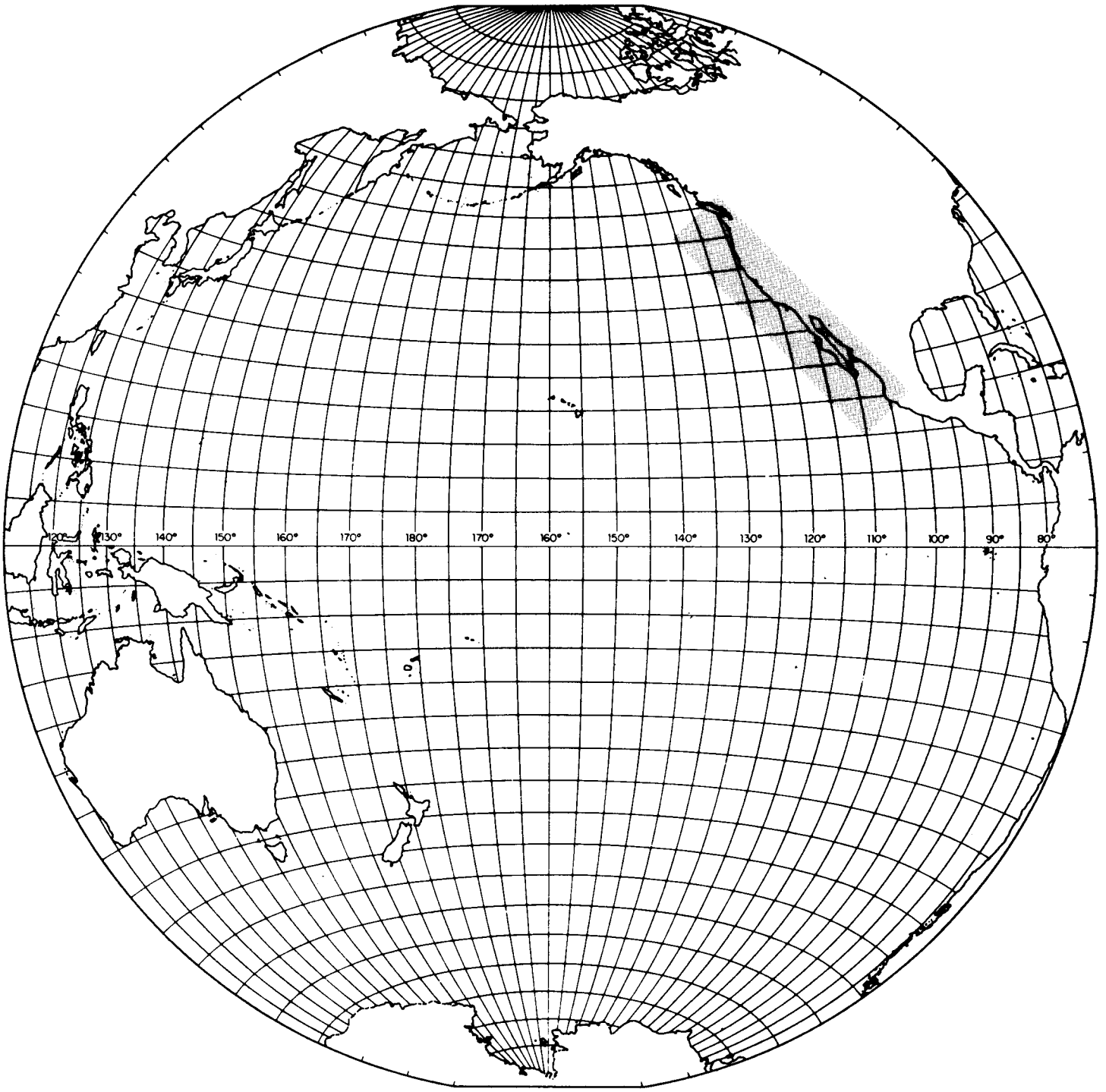
Atlas 26: Ahlstrom, E. H., H. G. Moser, and E. M. Sandknop. Distributional atlas of fish larvae in the California Current region: rockfishes, *Sebastes* spp., 1950-1975. Published June 1978.

23 May 2007

References to the data, published in annual ichthyoplankton data reports are given in the introduction to the Atlas. In addition, these data are available in PDF format on the SWFSC web site at http://swfsc.noaa.gov/publications/swcpub/qryPublications.asp, enter "ichthyoplankton" in the Subject line and "California Cooperative Oceanic Fisheries Investigations" in the Title line. Checking the ALL YEARS button will produce the entire list of available data.

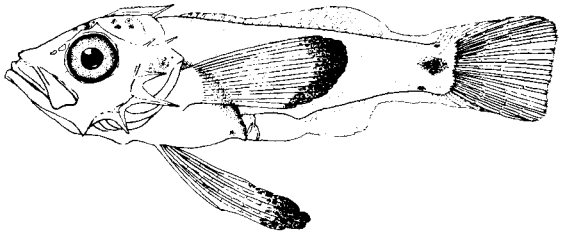
The report for each year usually is published about 7-9 months after the fall cruise, and includes notes about nomenclature changes, etc. The ultimate goal is to update the old ichthyoplankton identifications to current standards; the database is updated as re-identifications for each cruise are completed.

STATE OF CALIFORNIA
MARINE RESEARCH COMMITTEE

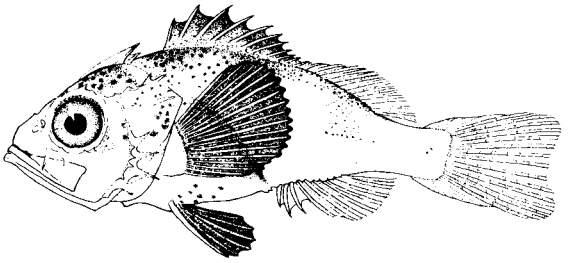


CALIFORNIA COOPERATIVE OCEANIC FISHERIES INVESTIGATIONS

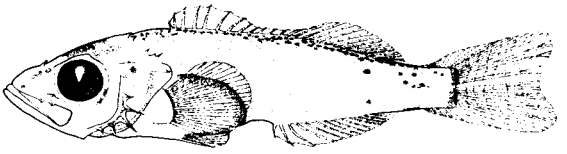
ATLAS No. 26



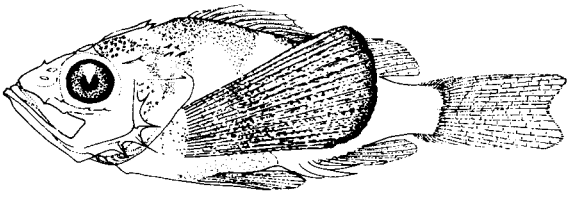
Sebastes paucispinis
(14.0mm larva)



Sebastes macdonaldi
(15.4mm transforming specimen)



Sebastes jordani
(21.0mm larva)



Sebastes levis
(19.1mm transforming specimen)

CALIFORNIA COOPERATIVE OCEANIC FISHERIES INVESTIGATIONS

Atlas No. 26

STATE OF CALIFORNIA
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UNIVERSITY OF CALIFORNIA, SCRIPPS INSTITUTION OF OCEANOGRAPHY

June, 1978

THE CALCOFI ATLAS SERIES

This is the twenty-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
National Oceanic and Atmospheric Administration, National Marine Fisheries Service[2]
University of California, Scripps Institution of Oceanography

CalCOFI atlases[3] 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, Editor

CalCOFI atlases in this series, through June 1978, are:

No. 1. Anonymous, 1963. CalCOFI atlas of 10-meter temperatures and salinities 1949 through 1959.
No. 2. Fleminger, A., 1964. Distributional atlas of calanoid copepods in the California Current region, Part I.
No. 3. Alvarino, A., 1965. Distributional atlas of Chaetognatha in the California Current region.
No. 4. Wyllie, J.G., 1966. Geostrophic flow of the California Current at the surface and at 200 meters.
No. 5. Brinton, E., 1967. Distributional atlas of Euphausiacea (Crustacea) in the California Current region, Part I.
No. 6. McGowan, J.A., 1967. Distributional atlas of pelagic molluscs in the California Current region.
No. 7. Fleminger, A., 1967. Distributional atlas of calanoid copepods in the California Current region, Part II.
No. 8. Berner, L.D., 1967. Distributional atlas of Thaliacea in the California Current region.
No. 9. Kramer, D., and E. H. Ahlstrom, 1968. Distributional atlas of fish larvae in the California Current region: Northern Anchovy, *Engraulis mordax* (Girard). 1951 through 1965.
No. 10. Isaacs, J.D., A. Fleminger and J. K. Miller, 1969. Distributional atlas of zooplankton biomass in the California Current region: Spring and Fall 1955-1959.
No. 11. Ahlstrom, E. H., 1969. Distributional atlas of fish larvae in the California Current region: jack mackerel, *Trachurus symmetricus*, and Pacific hake, *Merluccius productus*, 1951 through 1966.
No. 12. Kramer, D., 1970, Distributional atlas of fish eggs and larvae in the California Current region: Pacific sardine, *Sardinops caerulea* (Girard). 1951 through 1966.
No. 13. Smith, P. E., 1971. Distributional atlas of zooplankton volume in the California Current region, 1951 through 1966.
No. 14. Isaacs, J. D., A. Fleminger and J. K. Miller, 1971. Distributional atlas of zooplankton biomass in the California Current region: Winter 1955-1959.
No. 15. Wyllie, J.G., and R.J. Lynn, 1971. Distribution of temperature and salinity at 10 meters, 1960-1969 and mean temperature, salinity and oxygen at 150 meters, 1950-1968 in the California Current.
No. 16. Crowe, F. J. and R. A. Schwartzlose, 1972. Release and recovery records of drift bottles in the California Current region, 1955 through 1971.
No. 17. Ahlstrom, E. H., 1972. Distributional atlas of fish larvae in the California Current region: six common mesopelagic fishes—*Vinciguerria lucetia, Triphoturus mexicanus. Stenobrachius leucopsarus, Leuroglossus stilbius, Bathylagus wesethi* and *Bathylagus ochotensis*. 1955 through 1960.
No. 18. Brinton, E., 1973. Distributional atlas of Euphausiacea (Crustacea) in the California Current region. Part II.

No. 19. Bowman, T. E. and M. W. Johnson, 1973. Distributional atlas of calanoid copepods in the California Current region, 1949 and 1950.

No. 20. Thomas, W. H. and D. L. R. Seibert, 1974. Distribution of nitrate, nitrite, phosphate and silicate in the California Current Region, 1969.
Owen, R. W., Jr., 1974. Distribution of primary production, plant pigments and Secchi depth in the California Current region, 1969.
Smith, P. E., 1974. Distribution of zooplankton volumes in the California Current region, 1969.

No. 21. Fleminger, A., J.D. Isaacs and J. G. Wyllie, 1974. Zooplankton biomass measurements from CalCOFI cruises of July 1955 to 1959 and remarks on comparison with results from October, January, and April cruises of 1955 to 1959.

No. 22. Namias, J., 1975. Northern hemisphere seasonal sea level pressure and anomaly charts, 1947-1974.

No. 23. Ahlstrom, E. H. and H. G. Moser, 1975. Distributional atlas of fish larvae in the California Current region: Flatfishes, 1955 through 1960.

No. 24. Brinton, E., and J. G. Wyllie, 1976. Distributional atlas of euphausiid growth stages off southern California, 1953 through 1956.

No. 25. Eber, L. E., 1977. Contoured depth-time charts (0 to 200m, 1950 to 1966) of temperature, salinity, oxygen and sigma-t at 23 CalCOFI stations in the California Current.

No. 26. Ahlstrom, E. H., H. Geoffrey Moser, and Elaine M. Sandknop, 1978. Distributional atlas of fish larvae in the California Current region: Rockfishes, *Sebastes* spp., 1950 through 1975.

[1] Usually abbreviated CalCOFI, sometimes CALCOFI or CCOFI.
[2] Formerly called U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries.
[3] For citation this issue in the series should be referred to as CalCOFI Atlas No. 26.

Library of Congress Catalog Card Number 67-4238.

DISTRIBUTIONAL ATLAS OF FISH LARVAE IN THE CALIFORNIA CURRENT REGION: ROCKFISHES, *Sebastes* spp., 1950 THROUGH 1975.

Elbert H. Ahlstrom, H. Geoffrey Moser and Elaine M. Sandknop

CALCOFI ATLAS NO. 26

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Scripps Institution of Oceanography
La Jolla, California

June, 1978

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Elbert H. Ahlstrom, H. Geoffrey Moser and Elaine M. Sandknop[1]

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Introduction

This CalCOFI Atlas deals with the distribution and relative abundance of rockfish larvae, *Sebastes* spp., in California Current waters off California and Baja California on CalCOFI cruises from 1950 through 1975. Larvae of *Sebastes* spp. are among the more common taken on CalCOFI cruises, usually exceeded only by larvae of the northern anchovy, *Engraulis mordax,* and the Pacific hake, *Merluccius productus.*

This is the sixth CalCOFI Atlas dealing with distribution and relative abundance of fish larvae in the California Current region. CalCOFI Atlas No. 9 (Kramer and Ahlstrom, 1968) dealt with larvae of the northern anchovy, *Engraulis mordax;* No. 11 (Ahlstrom, 1969) with larvae of jack mackerel, *Trachurus symmetricus* and Pacific hake, *Merluccius productus;* No. 12 (Kramer, 1970) with eggs and larvae of the Pacific sardine, *Sardinops caerulea;* No. 17 (Ahlstrom, 1972) with six common mesopelagic fishes; and No. 23 (Ahlstrom and Moser, 1975) with eight kinds of flatfishes. With the appearance of this Atlas, distributional charts of all of the more common kinds of larvae taken in CalCOFI collections will be available in this series. As a group, these species contribute 90% or more of the fish larvae obtained on CalCOFI cruises.

The genus *Sebastes* is represented by 69 species in the eastern North Pacific (Dr. L. Chen, pers. comm.). Rockfish are ovoviviparous, i.e., the female carries fertilized eggs until they hatch and then releases the larvae. Intraovarian and newborn larvae of *Sebastes* have been described and/or illustrated for 39 of the eastern Pacific species. However, complete developmental series have been described for only *S. paucispinis* (Moser, 1967), *S. macdonaldi* (Moser, 1972), *S. jordani, S. levis* (Moser, Ahlstrom and Sandknop, 1977) and *S. melanostomus* (Moser and Ahlstrom, 1978).

Sebastes is an arctic to temperate water genus, occurring from as far north as the Bering Sea to approximately as far south as the vicinity of Magdalena Bay, Baja California. *Sebastes* also occurs in the upper part of the Gulf of California (Moser, Ahlstrom, Kramer and Stevens, 1974; Chen, 1975). The center of distribution of the genus *Sebastes* is in the eastern North Pacific with the largest complement of species occurring off California. According to Dr. L. Chen (pers. comm.), 35 species of *Sebastes* occur in the western North Pacific off Japan and Russia. Several species are commercially important in the North Atlantic, and one (or more) species occurs off South Africa and off Chile.

[1]Southwest Fisheries Center, National Marine Fisheries Service, La Jolla, California.

Table 1. Total rockfish landings in California by commercial fishermen and by sportfishermen on partyboats, 1950 to 1976(77).

Year	Pounds (in 000's)	Source: CF&G Fish Bull. No.	Dollar value (in 000's)	Rank weight/ value	Rockfish in party-boat catch (in 000's)	Total partyboat sport catch (in 000's)	% Rock-fish	Source: CF&G Fish Bull. No.
1950	8,116	86	No value given	9-11	679	2,190	31.0	145
1951	10,994	89	$ 655	10-10	722	2,351	30.7	145
1952	10,723	95	610	10-12	706	2,306	30.6	145
1953	12,222	102	541	7-10	696	2,280	30.5	145
1954	12,651	102	554	10-12	1,149	3,275	35.1	145
1955	12,682	105	514	10-11	1,738	3,114	55.8	145
1956	14,944	105	631	9-11	2,037	3,263	62.4	145
1957	16,091	108	683	10-10	1,395	3,500	39.9	145
1958	17,842	108	794	8- 8	1,561	3,951	39.5	145
1959	15,281	111	710	10-10	1,178	4,329	27.2	145
1960	13,714	117	672	8-10	1,016	4,090	24.8	145
1961	10,831	121	587	9-11	899	3,454	26.0	145
1962	9,834	125	574	9- 9	956	3,656	26.2	145
1963	11,761	129	683	7- 9	963	4,279	22.5	145
1964	8,118	132	490	11-12	967	4,434	21.8	145
1965	9,392	135	573	9-10	1,347	4,635	29.1	145
1966	10,064	138	660	11-11	1,689	5,408	31.2	145
1967	9,799	144	680	10-11	1,894	4,444	42.6	145
1968	9,444	149	668	10- 9	2,103	5,731	36.7	166
1969	9,227	153	694	10-12	1,979	5,726	34.6	166
1970	10,687	154	824	9-11	2,664	5,631	47.3	166
1971	11,169	159	942	10-11	2,223	4,604	48.3	166
1972	16,421	161	1,490	10-10	3,055	5,462	55.9	166
1973	22,052	163	2,251	8- 9	3,570	5,923	60.3	166
1974	21,499	166	2,814	7- 8	4,045	5,692	71.1	166
1975	23,565	circ. #50	?	-	3,916	5,354	73.1	*MS-CPF
1976	24,598	circ. #51	?	-	3,597	5,149	69.9	*MS-CPF
1977	-	-	-	-	3,216	4,849	66.3	*MS-CPF

*Marine Sportcatch by California Partyboat Fleet – Annual Report.

The only scorpaenid genus with a similar distribution to *Sebastes* in the North Pacific is *Sebastolobus* (Moser, 1974). Four other scorpaenid genera are known to occur in the eastern North pacific: *Scorpaena, Pontinus, Scorpaenodes* and *Ectreposebastes,* but these prefer or are limited to tropical and subtropical waters (Moser, Ahlstrom and Sandknop, 1977); of these, only larvae of *Scorpaena guttata* occur as far north as California.

Some 40 species of rockfish are taken by commercial and sportfishermen off California. The important constituents of the commercial catch are: the bocaccio, *Sebastes paucispinis;* the chilipepper, *S. goodei;* the vermilion rockfish, *S. miniatus;* and the canary rockfish, *S. pinniger.* The marine sport catch from the California partyboat fleet takes a variety of rockfishes, depending on the location of the sportfishery. The boccacio is by far the most numerous rockfish in the partyboat catch. In summer, when sportfishermen fish more in kelp beds, the other important rockfishes are the olive rockfish, *S. serranoides,* the blue, *S. mystinus,* and the brown, *S. auriculatus.* In winter when the partyboat fleet fishes more particularly for rockfish over reefs, the chilipepper, vermilion and green-spotted, *S. chlorostictus,* are more often taken. Miller and Gotshall (1965) reported on the average annual catch of sportfish between Oregon and Pt. Arguello, 1958-1961, by all methods of fishing – pier, skindiving, shore, skiff and partyboat; they reported the five most important rockfish in this area as the blue, the black, *S. melanops,* the yellowtail rockfish,

Table 2. Numbering scheme for charts of *Sebastes* larvae included in this Atlas.

Year	01	02	03	04	05	06	07	08	09	10	11	12
1950	-	2	3	4	5	6	7	8	9	[1]	-	-
51	10	11	12	13	14	15	16	17	18	19	20	21
52	22	23	24	25	26	27	28	29	30	31	32	-
53	33	34	35	36	37	38	39	40	41	42	43	44
54	45	46	47	48	49	50	51	52	-	53	-	54
1955	55	56	57	58	59	60	61	Norpac	62	63	64	65
56	66	67	68	69	70	71	72	73	*[2]	74	75	76
57	77	78	79	80	81	82	83	84	85	86	87	88
58	89	90	91	92	93	94	95	*	96	97	98	99
59	100	101	102	103	104	105	106	107	108	109	110	111
1960	112	113	114	115	116	117	118	119	120	121	-	-
61	122	-	-	123	-	-	124	-	-	125	-	-
62	126	-	-	127	-	-	128	-	-	129	-	-
63	130	-	-	131	-	-	132	-	-	133	-	-
64	134	-	-	135	-	-	136	-	-	137	-	-
1965	138	-	-	139	-	-	140	-	141	-	-	-
66	142	143	-	144	145	146	147	148	149	150	*	151
67	-	-	-	-	-	-	152	-	-	-	-	153
68	154	-	-	155	-	156	-	-	-	-	-	-
69	157	158	-	159	160	161	162	163	164	165	-	166
1972	167	168	169	-	170	-	171	-	-	172	-	-
74	-	-	-	-	-	-	-	-	-	-	-	173
75	174	-	175	-	176	-	177	-	-	178	-	-

[1]A dash (-) indicates no CalCOFI cruise was made during this month.

[2]An asterisk (*) indicates that a cruise was made, but *Sebastes* larvae were taken on fewer than 5 stations.

S. flavidus, the olive, and the copper, *S. caurinus.* The only rockfish reported separately in the partyboat catch is the cowcod, *S. levis,* which, although prized for its large size, seldom ranks among the top 10 rockfish in partyboat catches.

The commercial catch and partyboat sport catch of rockfishes off California from 1950 through 1977 is given in Table 1. Between 1950-1972, the commercial catch fluctuated between 8 and 16 million pounds (average 11.9 million), but since 1973 the catch has ranged between 21.5 and 24.6 million pounds (average 22.9 million).

The marine sportcatches of rockfishes made from the California partyboat fleet have also increased dramatically in recent years, constituting between 66.7% and 73.1% of the total sportfish catch since 1974. In all fairness it should be pointed out that rockfishes usually are not the principal fish sought by sportfishermen from partyboats; rather barracuda, bonito, yellowtail, albacore, and, of course, salmon, are the preferred species. When these are scarce, or not available, rockfish become the primary sportfish, and the popularity of rockfish is increasing among sportfishermen.

This atlas documents the distribution and relative abundance of *Sebastes* larvae on all CalCOFI cruises made during the 26-year period 1950 through 1975, with the exception of Norpac (5508) and three cruises on which *Sebastes* larvae were taken on fewer than five stations. The cruises not represented by charts are 5609 (0 occurrences), 5808 (1 occurrence) and 6611 (2 occurrences). *Sebastes* larvae were taken on Norpac, but mostly outside the regular CalCOFI coverage. CalCOFI

Table 3. Regional abundance of *Sebastes* spp. larvae: cumulative annual totals, by region, for number of stations occupied, positive hauls for *Sebastes* larvae, standardized numbers of *Sebastes* larvae, and average number of larvae per occupancy.

	Northern California (Lines 40-57)				Central California (Lines 60-77)				Southern California (Lines 80-97)			
Year	No. sta. occup.	+ sta.	Std. no. larvae	$\bar{x}$ per occup.	No. sta. occup.	+ sta.	Std. no. larvae	$\bar{x}$ per occup.	No. sta. occup.	+ sta.	Std. no. larvae	$\bar{x}$ per occup.
1950	119	98	2,442	20.5	104	79	1,615	15.5	233	142	5,728	24.6
51	32	30	513	16.0	163	107	3,522	21.6	350	232	9,107	26.0
52	29	23	602	20.8	163	98	2,487	15.2	396	254	11,383	28.7
53	0	-	-	-	111	76	1,844	16.6	472	338	19,740	41.8
54	12	8	216	18.0	105	79	4,777	45.5	479	351	30,797	64.3
1955	0	-	-	-	86	57	2,893	33.6	388	281	14,564	37.5
56	54	24	411	7.6	112	58	1,558	13.9	479	276	15,199	31.7
57	0	-	-	-	101	66	3,082	30.5	438	258	24,584	56.1
58	41	28	1,174	28.6	217	130	5,199	24.0	550	278	12,154	22.1
59	22	3	60	2.7	232	137	3,170	13.7	665	271	5,489	8.2
1960	59	36	1,257	21.3	144	95	3,895	27.0	492	240	6,348	12.9
61	0	-	-	-	92	66	3,938	42.8	238	134	3,142	13.2
62	0	-	-	-	61	43	5,046	82.7	238	127	4,846	20.4
63	0	-	-	-	63	50	21,891	347.5	280	132	6,406	22.9
64	0	-	-	-	192	150	8,964	46.7	347	202	8,029	23.1
1965	0	-	-	-	122	107	14,145	115.9	290	148	6,505	22.4
66	0	-	-	-	241	163	15,055	62.5	632	308	14,894	23.6
67	0	-	-	-	0	-	-	-	65	45	1,001	15.4
68	0	-	-	-	60	50	14,339	239.0	128	90	7,020	54.8
69	42	38	8,262	196.7	325	200	31,849	98.0	485	244	24,157	49.8
1972	110	70	3,503	31.8	111	94	11,085	99.9	258	169	21,058	81.6
74-5	0	-	-	-	206	126	12,513	60.7	639	345	34,711	54.3
Total	520	358	18,440	35.5	3,011	2,031	172,867	57.4	8,542	4,865	286,862	33.6

cruises are designated by month and year, thus 5609 is the cruise made in September 1956. The basic CalCOFI station plan utilized since 1950 is given as chart No. 1. All distribution charts based on cruises are numbered sequentially, beginning with 5002 as chart No. 2 through 7511 as chart 178 (Table 2). Thus, a total of 177 distribution charts are included in this Atlas in addition to the basic station plan.

Although the basic CalCOFI station plan remained the same over the years, the complete pattern was never encompassed on any given cruise. Furthermore, most cruises made from January through July had fairly extensive coverage of the pattern, while many cruises made later in the year were restricted to a portion of the pattern. In some recent years, particularly on 1975 CalCOFI cruises, nearshore stations were added to the pattern and these stations, on the average, yielded more *Sebastes* larvae than did offshore stations. Despite differences in the extent of coverage and in its intensity, we are using all occupancies made on CalCOFI cruises out to station 90 in our principal summary table (Table 3). All stations occupied seaward of station 90 on any line are excluded. The poorest year in the series is 1959, the year with the most intensive coverage (2050 stations occupied). The percentage of positive hauls was only 29.6% compared to the long-term average of 42.2%. The average number of rockfish larvae obtained per occupancy was 5.6 larvae compared to the long-term average of 22.3 larvae. Of the years with "monthly" cruises the better ones in the series are 1954, with 57.1% positive hauls and 35.3 larvae

Table 3. *(continued)*

Year	Northern Baja California (Lines 100-117)				Central Baja California (Lines 120-137)				Total (All Lines)				
	No. sta. occup.	+ sta.	Std. no. larvae	$\bar{x}$ per occup.	No. sta. occup.	+ sta.	Std. no. larvae	$\bar{x}$ per occup.	No. sta. occup.	+ sta.	% + sta.	Std. no. larvae	$\bar{x}$ per occup.
1950	112	56	1,144	10.2	119	33	360	3.0	687	408	59.4	11,289	16.4
51	320	158	4,050	12.6	233	65	1,321	5.7	1,098	592	53.9	18,513	16.9
52	456	202	4,968	10.9	355	94	2,183	6.1	1,399	671	48.0	21,623	15.5
53	429	203	6,102	14.2	339	105	2,131	6.3	1,351	722	53.4	29,817	22.1
54	486	233	9,614	19.8	339	140	4,815	14.2	1,421	811	57.1	50,219	35.3
1955	499	205	8,532	17.1	258	90	2,117	8.2	1,231	633	51.4	28,106	22.8
56	458	168	9,733	21.2	219	73	2,135	9.8	1,322	599	45.3	29,036	22.0
57	520	159	7,133	13.7	320	69	1,541	4.8	1,379	552	40.0	36,340	26.4
58	572	164	3,292	5.8	342	52	2,012	5.9	1,722	652	37.9	23,831	13.8
59	706	130	1,877	2.6	425	66	850	2.0	2,050	607	29.6	11,446	5.6
1960	606	136	2,248	3.7	348	61	1,452	4.2	1,649	568	34.4	15,200	9.2
61	287	69	854	3.0	215	34	800	3.7	832	303	36.4	8,734	10.5
62	294	75	1,780	6.0	207	26	404	2.0	800	271	33.9	12,076	15.1
63	329	63	2,738	8.3	250	28	533	2.1	922	273	29.6	31,568	34.2
64	339	89	1,550	4.6	261	39	1,027	3.9	1,139	480	42.1	19,570	17.2
1965	340	88	4,348	12.8	254	36	450	1.8	1,006	379	37.7	25,448	25.3
66	677	170	5,396	8.0	381	41	840	2.2	1,931	682	35.3	36,185	18.7
67	122	27	388	3.2	62	0	-	-	249	72	28.9	1,389	5.6
68	83	49	1,124	13.5	38	16	89	2.3	309	205	66.3	22,572	73.0
69	524	143	3,744	7.1	267	36	509	1.9	1,643	661	40.2	68,521	41.7
1972	290	95	2,006	6.9	176	21	1,012	5.8	945	449	47.5	38,664	40.9
74-5	451	126	5,297	11.7	238	25	579	2.4	1,534	622	40.6	53,100	34.6
Total	8,900	2,808	87,918	9.9	5,646	1,150	27,160	4.8	26,619	11,212	42.1	593,247	22.3

per occupancy, and 1972 with 47.5% positive hauls and 40.9 larvae per occupancy.

Regional distribution of rockfish larvae must be taken into account. During the 26-year period covered by CalCOFI surveys (1950-1975), larvae of *Sebastes* were taken in 42.1% of all CalCOFI collections made between the shore and station 90 within the usual CalCOFI pattern. Larvae decreased in frequency of occurrence from north to south – 68.8% of collections made off northern California (station lines 40 through 57) contained *Sebastes* larvae, 67.5% off central California (lines 60 through 77), 57.0% off southern California (lines 80 through 97), 31.6% off northern Baja California (lines 100 through 117 and the portion of line 120 within Sebastian Viscaino Bay), and 20.4% off central Baja California (remainder of line 120 through line 137). The average number of larvae per occupancy was highest off central California with 57.4 larvae and relative abundance decreased dramatically southward to an average of only 4.8 larvae per occupancy off central Baja California.

To determine whether there has been any marked change in frequency of occurrence or in average abundance of *Sebastes* larvae over time, rockfish data are summarized by 5-year periods in Table 4 for hauls made off California (lines 40 through 97) and off Baja California (lines 100 through 137). Frequency of occurrences of *Sebastes* larvae off California were higher during 1950-1954 with 69.2% of hauls positive for rockfish than for subsequent periods. The lowest period was 1955-1959, with 55.2% positive hauls. By 1972-1975, the percentage of positive hauls was 60.7%, slightly

Table 4. Summary by 5-year periods of CalCOFI data dealing with larvae of rockfish, *Sebastes* sp.

Years	Number of stations occupied	Number of positive stations	% of positive stations	Standard number of larvae	Average number per occupancy
		Collections made off California (Lines 40-97)			
1950-54	2,768	1,915	69.2	94,773	34.24
55-59	3,385	1,867	55.2	89,537	26.45
60-64	2,206	1,275	57.8	73,762	33.44
65-69	2,390	1,393	58.3	137,227	57.42
1972+1975	1,324	804	60.7	82,870	62.59
Total	12,073	7,254	60.1	478,169	39.61
		Collections made off Baja California (Lines 100-137)			
1950-54	3,188	1,289	40.4	36,688	11.51
55-59	4,319	1,176	27.2	39,222	9.08
60-64	3,136	620	19.8	13,386	4.27
65-69	2,748	606	22.0	16,888	6.15
1972+1975	1,155	267	23.1	8,894	7.70
Total	14,546	3,958	27.2	115,078	7.91
		Collections from both California and Baja California			
1950-54	5,956	3,204	53.8	131,461	22.07
55-59	7,704	3,043	39.5	128,759	16.71
60-64	5,342	1,895	35.5	87,148	16.31
65-69	5,138	1,999	38.9	154,115	30.00
1972+1975	2,479	1,071	43.2	91,764	37.02
Total	26,619	11,212	42.1	593,247	22.29

above the long-term average of 60.1%. The abundance of *Sebastes* larvae based on the average number of larvae obtained per occupancy was higher during 1965-1975 than previously. These higher values during the most recent decade could be due, in fact, to more intensive inshore sampling, especially in the Los Angeles Bight area.

In order to follow changes in relative abundance of rockfish larvae in a completely comparable fashion over the 26-year period, 1950-1975, a group of 38 stations that have been occupied continuously over the years off southern California were examined. The station lines involved are 80, 83, 87, 90 and 93. The average abundance of *Sebastes* larvae at these stations was determined for each year. The results for 20 different CalCOFI "years" are presented in Table 6. The value listed for each station during any given year represents the sum of the standardized totals of *Sebastes* larvae taken at that station during the year, divided by the number of occupancies of the station.

The seasonal abundance of rockfish larvae was determined for the southern California area, using the assemblage of stations given in Table 5. A value was obtained for each cruise in the series by dividing the total number of *Sebastes* larvae taken on that cruise by the number of stations occupied. The only month in the series that has a cruise made during each of the 20 CalCOFI years is July. The month of peak abundance is February with 28.2% of the annual total. The three winter months, January-March, contributed 65.1% of the annual

Table 5. Average monthly abundance of rockfish larvae off the Southern California area (Lines 80 through 93 out to station 90) based on average abundance per occupancy for each CalCOFI cruise, 1950-1975, arranged by month.

Month	Total all cruises 1950-1975	No. of cruises involved	Average monthly abundance	% of average yearly abundance
January	1,582	18	88	20.3
February	1,579	13	122	28.2
March	859	12	72	16.6
April	797	17	47	10.8
May	369	14	26	6.0
June	130	11	12	2.8
July	158	20	8	1.8
August	43	8	5	1.2
September	56	8	7	1.6
October	92	18	5	1.2
November	139	7	20	4.6
December	234	11	21	4.8
Total	6,038	-	433	99.9

catch of rockfish larvae. The summer months represent the period of minimal abundance, with only 4.6% of the larvae taken during the July through September period. Completing the yearly cycle, 19.6% were taken during the spring months of April through June, and 10.6% during the fall months of October through December.

Illustrations and descriptions of four common rockfish are given below. Of these, the bocaccio, *S. paucispinis* is the most important. As already noted, it usually is the most abundant rockfish in both the commercial and sportfish catches. The Mexican rockfish, *S. macdonaldi,* becomes the most abundant species off central Baja California. The shortbelly rockfish, *S. jordani,* although one of the most abundant off California, is a minor element in the catch because of its small size. *S. levis,* the cow rockfish, is a prime sportfish because of its large size but is not common either as larvae or as adults.

Sebastes paucispinis (Ayres) — Bocaccio

Literature. Newly hatched larvae of *S. paucispinis* were illustrated by Morris (1956). Moser (1967) gave a complete description of the development of embryos, larvae, and juveniles of this rockfish. The developmental series illustrated here (Fig. 1) is reproduced from Moser, Ahlstrom and Sandknop (1977).

Distinguishing Features. As is characteristic of all species of *Sebastes,* eggs are fertilized internally and embryonic development occurs within the ovaries of females. The eggs of *Sebastes* have an outer shell, and probably receive no nutrition from the female other than that enclosed within the egg. Early stage eggs of bocaccio are round and measure 0.85 to 1.0mm in diameter; each has a single large oil globule, ranging from 0.3 to 0.4mm in diameter. As embryonic development proceeds the eggs enlarge and become ovoid in shape; late-stage eggs measure up to 2.0mm in diameter across the major axis. Late-stage embryos develop three areas of pigmentation in the following sequence: initially, melanophores form along the dorso-lateral surface of the gut, followed by a single median series of melanophores along the ventral margin of the tail, and in the most advanced, intra-ovarian embryos melanophores develop on the posterior margins of the pectoral fins. Bocaccio larvae hatch and are extruded from the female at a length of 4.0 to 5.0mm; at this stage they have functional jaws, eyes and pectoral fins.

The larval period extends from hatching to about 15mm SL. We separate the larval period into three stages, which are associated with the development of the caudal fin; the three stages are termed preflexion, flexion, and postflexion stage. These are stages before, during and after the upward flexing of the tip of the notochord. The preflexion stage

Table 6. Relative average abundance of *Sebastes* larvae in the Southern California region, based on 20 years of CalCOFI surveys, 1950-1975 (see text for explanations of listed values).

	Stations																			
	80.51	.55	.60	.70	.80	.90	83.40	.43	.51	.55	.60	.70	.80	.90	87.35	.40	.50	.60	.70	.80	.90
Year																					
1950	-	9	15	7	9	0	-	-	-	78	7	15	2	0	85	126	58	34	2	0	0
1951	26	15	9	3	2	<1	-	50	-	60	137	26	8	1	38	92	281	113	3	2	20
1953	22	61	138	10	2	3	1	122	144	113	53	7	1	1	51	78	80	6	6	0	3
1954	55	124	56	6	3	2	58	109	136	77	34	11	3	2	88	63	259	14	6	2	0
1955	21	108	59	16	19	6	10	106	104	21	75	29	34	6	61	62	192	63	33	3	2
1956	11	64	59	14	3	1	9	115	136	20	41	5	3	1	66	98	236	20	18	7	0
1957	30	487	94	14	1	2	11	36	264	30	16	0	5	1	52	73	342	63	33	6	2
1958	94	85	13	6	2	3	10	103	46	48	24	5	0	0	44	49	23	10	1	0	0
1959	19	28	6	2	2	1	7	47	52	37	7	3	1	1	13	28	61	7	9	1	0
1960	23	28	10	1	1	<1	2	64	49	8	7	4	2	0	35	32	38	4	2	0	1
1961	67	58	10	3	3	0	4	38	68	26	31	6	14	29	6	14	67	18	1	3	0
1962	236	202	6	2	0	0	<1	30	68	52	20	23	2	0	36	41	56	6	1	1	0
1963	49	36	4	3	0	0	1	62	42	49	31	0	2	0	47	397	211	9	1	0	0
1964	37	37	17	7	2	3	2	51	10	130	12	3	0	0	44	30	167	12	3	0	0
1965	88	26	10	4	1	0	9	50	40	52	3	12	4	0	45	86	319	1	0	2	0
1966	140	36	46	6	1	3	4	113	144	42	11	2	2	0	45	115	216	6	<1	0	1
1968	175	137	77	4	0	0	20	118	340	558	25	0	17	0	46	162	98	58	4	14	2
1969	131	174	39	1	<1	0	2	155	264	125	106	3	10	6	93	337	159	8	35	4	7
1972	87	276	31	84	10	2	1	307	129	226	166	5	15	1	22	19	611	11	3	0	1
1975	105	100	44	7	0	0	19	101	288	337	44	2	3	0	45	49	482	11	11	2	1
Total	1,416	2,091	743	200	62	28	171	1,777	2,324	2,089	850	161	128	49	962	1,951	3,956	474	173	47	40
No. of occup.	19	20	20	20	20	20	18	19	18	20	20	20	20	20	20	20	20	20	20	20	20
Avg. abun.	75	105	37	10	3	1	10	94	129	104	42	8	6	2	48	98	198	24	9	2	2

Table 6. *(continued)*

Years	Stations 90.28	.30 or .32	.37	.45	.53 or .55	.60	.70	.80	.90	93.27	.30	.40	.50	.60	.70	.80	.90	Total
1950	-	6	17	38	80	48	2	0	0	-	11	53	13	81	6	2	1	805
1951	81	45	23	22	42	7	8	3	2	10	23	70	40	12	7	4	0	1,286
1953	51	28	6	13	39	12	5	2	0	18	29	21	15	6	30	2	0	1,179
1954	35	80	77	52	52	48	3	3	0	78	9	19	14	25	10	0	0	1,613
1955	21	18	32	18	26	26	10	1	0	30	11	8	15	5	11	5	0	1,267
1956	67	35	42	85	93	19	41	16	9	26	17	20	15	6	11	4	1	1,434
1957	52	69	27	78	160	19	23	12	5	48	24	30	133	15	23	1	2	2,283
1958	25	36	3	6	14	18	6	<1	4	18	16	16	12	5	1	<1	1	749
1959	7	2	4	3	22	2	0	0	0	6	4	7	13	1	<1	<1	<1	406
1960	8	13	17	10	31	9	5	5	<1	12	10	7	9	6	0	3	0	458
1961	35	12	5	2	5	2	0	2	3	12	4	1	10	4	6	2	0	571
1962	36	28	34	11	108	5	2	0	0	17	10	3	7	11	2	2	0	1,059
1963	28	8	11	48	26	0	0	0	0	28	29	28	51	5	1	0	0	1,207
1964	11	26	57	7	5	7	2	0	1	10	18	3	6	5	10	3	0	738
1965	16	23	20	32	10	11	1	0	2	18	20	4	19	11	6	0	0	945
1966	32	2	8	5	23	4	2	0	0	47	12	19	8	12	19	1	0	1,128
1968	5	23	114	84	144	8	8	12	0	2	8	20	92	2	6	0	0	2,383
1969	42	13	17	36	112	217	2	<1	2	24	7	19	8	33	0	1	0	2,194
1972	17	16	54	59	131	49	4	15	44	17	8	17	12	14	3	1	7	2,475
1975	23	14	15	13	64	97	10	1	0	61	1	7	16	9	20	0	0	2,002
Total	592	497	583	622	1,187	608	134	74	73	482	271	372	508	268	173	33	13	26,182
No. of occup.	19	20	20	20	20	20	20	20	20	19	20	20	20	20	20	20	20	-
Avg. abun.	31	25	29	31	59	30	7	4	4	25	14	19	25	13	9	2	1	1,335

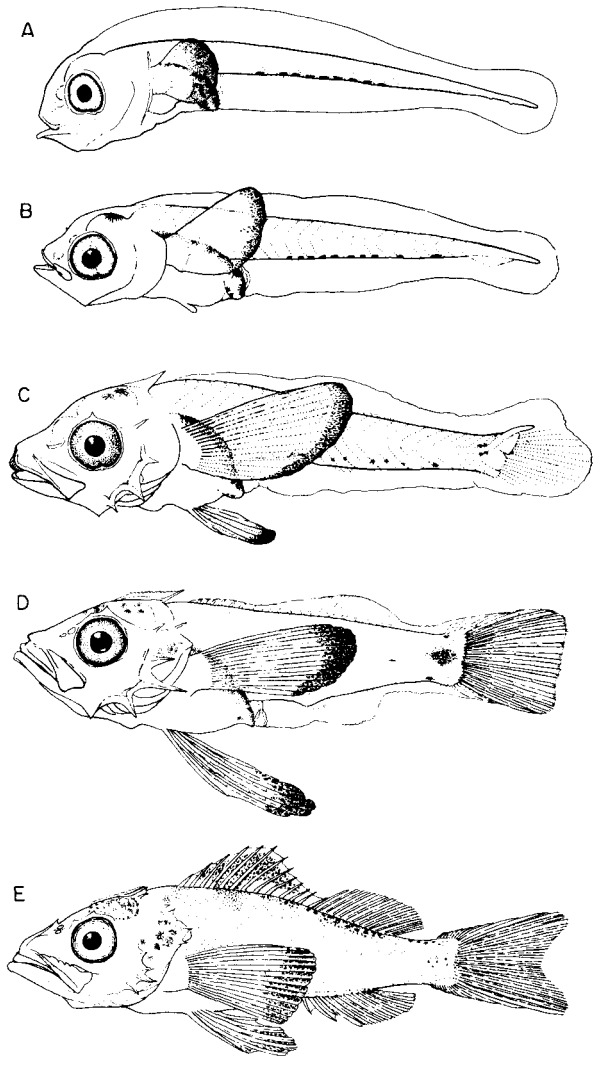

Figure 1. Developmental series of *Sebastes paucispinis*. A. 4.7-mm larva; B. 6.1-mm larva; C. 8.7-mm larva; D. 14.0-mm larva; E. 24.2-mm pelagic juvenile.

extends from hatching to about 7.0mm. Flexion occurs between about 7.0 to 9.0mm; at the completion of flexion the caudal fin base becomes terminal. The postflexion stage extends from 9mm to approximately 15mm.

A prominent morphological feature of scorpaenid larvae is the development of numerous head spines. These reach their most conspicuous development on postflexion larvae of *S. paucispinis* between 10 to 13mm in length. Although spines form on a number of head bones, the most characteristic are the spines on the preopercle and the paired parietal spines and ridges. A number of spines form on the preopercle with the spine at the angle becoming the largest head spine. The paired parietal spines develop early in the larval period and attain their greatest size (20% of head length) in 10 to 13mm larvae in concert with most head spines. In larvae larger than 13mm and in early juveniles the spines regress; only the opercular and preopercular spines persist in juveniles and adults.

Perhaps the most striking morphological features of bocaccio larvae are the paired fins. The pectoral fins are large and fan-shaped at birth. The fins lengthen rapidly during larval development with the dorsal part of each fin growing relatively faster than its ventral part, resulting in an aliform shape. This shape is retained in larvae up to about 10mm in length, after which the posterior margin again becomes vertical. The pectorals reach a maximum relative length of 37% of body length in 13mm larvae and then gradually diminish in relative length during the remainder of the larval and pelagic juvenile stages to about 25% of the body length in late pelagic juveniles. The pelvic fins begin to form as small rounded buds in 5mm larvae and also undergo spectacular development. They lengthen rapidly and reach their greatest relative length of 40% of body length in 13mm larvae. Like the pectorals they diminish to about 25% of body length in pelagic juveniles.

The melanistic pigment which develops on *S. paucispinis* larvae also is a diagnostic character. The three pigment areas described for late-stage embryos persist into the larval period. The single median series of melanistic dashes along the ventral margin of the tail consists of 6 to 14 melanophores (mean of 9). Among 33 species of *Sebastes* larvae obtained from pregnant females, only 2 had a lower number of melanophores in the ventral tail series. These melanophores persist through the flexion stage, then gradually become embedded in the growing hypaxial musculature. Perhaps the most diagnostic pigment is the outer band of pigment on the pectoral fins; a similar band develops on the pelvic fins. These fin pigments persist into the juvenile stage. The larvae also develop pigment on the head, on the caudal fin, and over the base of the hypurals.

The pelagic juvenile stage begins at about 15mm. It is characterized by diminution of parietal and preopercular spines and development of dorsal pigment saddles. The pelagic juvenile stage ends at about 30 to 35mm length, with specimens settling to the bottom as demersal juveniles. Moser (1967) showed that juveniles inhabit waters shallower than 20m during their first year. However, juveniles up to 75mm SL have been collected from a drifting mass of kelp.

Distribution. Adults of *S. paucispinis* range from Kodiak Island, Alaska to as far south as Punta Blanca, Baja California, although the principal distribution of the species is off California; they have been reported offshore to a depth of 320m (Miller and Lea, 1972). Bocaccio larvae are taken in CalCOFI hauls for an 8-month period, November to June, with peak abundance in January and February. Bocaccio larvae are taken as far seaward on CalCOFI cruises as 400km and frequently to 200kms (see Moser et al., 1977, for distribution chart of bocaccio larvae). The distribution of bocaccio larvae is not known north of the California-Oregon border since the CalCOFI sampling pattern usually is terminated at the California-Oregon border.

Sebastes macdonaldi (Eigenmann and Beeson) — Mexican Rockfish

Literature. Development and geographic distribution of the rockfish *Sebastes macdonaldi* is treated in Moser (1972), and in Moser, Ahlstrom and Sandknop (1977).

Distinguishing Features. Larvae of *S. macdonaldi* are similar in general appearance to those of *S. paucispinis* (Fig. 2). They are of similar size at hatching, 4 to 5mm. Early stage larvae are characterized by a low number of melanophores in the series on the ventral midline of the tail with a median count of 8 melanophores (range 6 to 14). Only larvae of *S. melanostomus* and *S. paucispinis* have comparable low counts in this series. They lack melanophores on the dorsal side of the tail. Early larvae of *S. macdonaldi* are also characterized by their small, densely pigmented pectoral fins. Also characteristic is the series of melanophores which extends from the nape to the pectoral fin base, a pattern of pigmentation found on early larvae of only 1 or 2 other species of rockfish. The other pigmented area on preflexion larvae is associated with the gut which is heavily pigmented over its dorsal surface and more sparsely pigmented on the lateral and ventral surfaces.

The pectoral fins of *S. macdonaldi* offer an interesting contrast to those of *S. paucispinis*. In early stage larvae the fins are short and compact, with fin length only 8% of body length before flexion, 13% during flexion, and 19% in postflexion larvae. The fin elongates markedly in pelagic juveniles to about 31% of body length. The pectorals remain heavily pigmented throughout the larval period although when rays develop the solid pigmentation is restricted to the membrane between the rays; even so, the overall appearance is a dark compact fin with light striations.

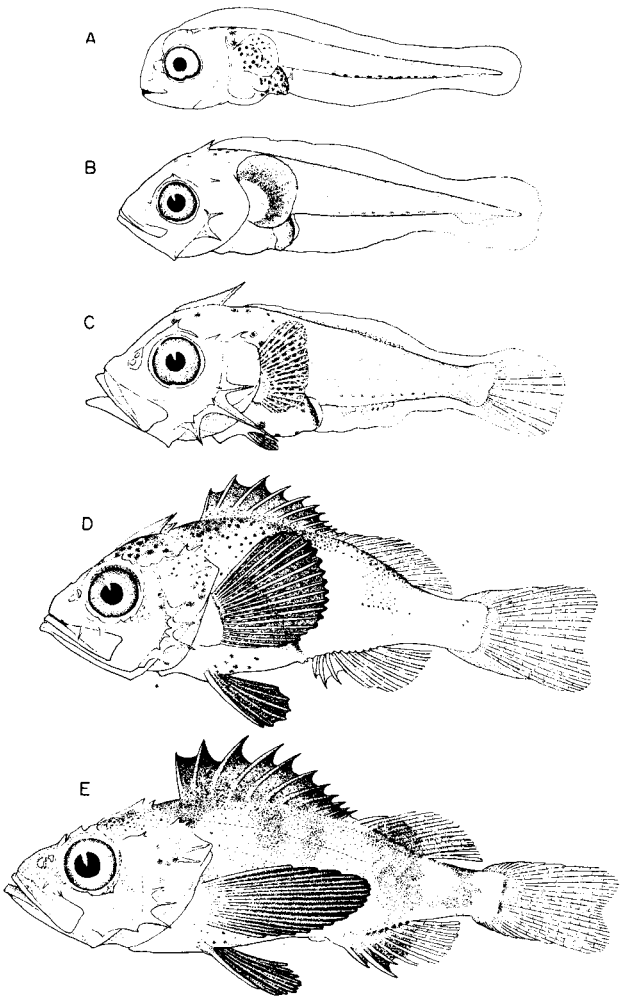

Figure 2. Developmental series of *Sebastes macdonaldi*. A. 4.5-mm larva; B. 6.3-mm larva; C. 9.0-mm larva; D. 15.4-mm transforming specimen; E. 29.2-mm pelagic juvenile.

The pelvic fins develop pigmentation similar to the pectorals. The pelvic fin buds are formed on larvae as small as 6.4mm, and rays begin to differentiate in 7mm larvae and are fully formed by 9.4mm. Pelvic fin length increases from 4% of body length at the initiation of notochord flexion to 10% at its completion, to 18 to 21% body length in late postflexion larvae and to 21 or 22% body length in pelagic juveniles.

Flexion of the notochord, concurrent with caudal fin formation occurs on larvae between 7.7 to 9.0mm (Moser et al., 1977, Table 9). Thus, preflexion stage larvae of *S. macdonaldi* are approximately 4.0 to 7.6mm, and postflexion stage larvae 9.0 to about 15 or 16mm in length. Transformation into the pelagic juvenile stage is gradual, and the stage appears to be highly protracted,inasmuch as the smallest demersal juveniles known are about 60mm in length and pelagic juveniles as large as 44.4mm have been collected.

Larvae of *S. macdonaldi* are relatively deep bodied. Body depth at the base of the pectoral fins averages 23% of body length before notochord flexion, 33% during flexion and 34% in postflexion larvae.

The conspicuous elements of the pigment pattern were discussed above, and can be seen on the illustrations of larvae and early juveniles. Large larvae of *S. macdonaldi* are among the most heavily pigmented of all rockfish species (Moser, 1972). The head, especially, becomes heavily pigmented on late stage larvae, as well as the dorsal portion of the body adjacent to the dorsal fins. The spinous portion of the dorsal fin becomes heavily pigmented on late stage larvae, and saddles of pigment develop laterally and ventrally on pelagic stage juveniles.

Distribution. *S. macdonaldi* has the most southerly distribution of any species of *Sebastes* in the eastern North Pacific. Adults have been taken as far north as Pt. Sur, California, and as far south as Morgan Bank, near Cape San Lucas, Baja California. It also occurs in the Gulf of California, and it is the only species of *Sebastes* known to occur both inside and outside the Gulf although the two populations may now be isolated from each other (Chen, 1975).

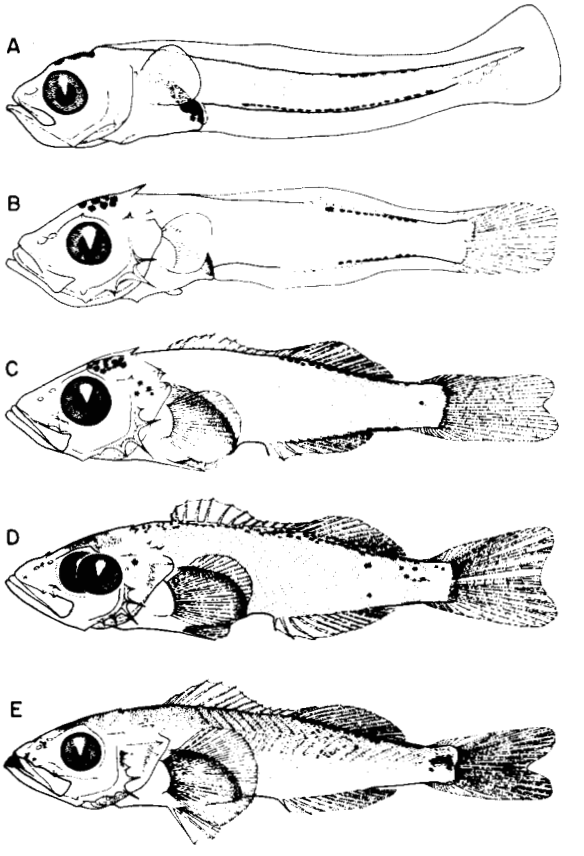

Figure 3. Developmental series of *Sebastes jordani*. A. 7.2-mm larva; B. 10.0-mm larva; C. 15.5-mm larva; D. 21.0-mm larva; E. 29.6-mm pelagic juvenile.

Sebastes jordani (Gilbert) — Shortbelly Rockfish

Literature. Morris (1956) described briefly and figured a newly hatched larva of *S. jordani*, 6.8mm in length, stripped from a pregnant female. Moser, Ahlstrom and Sandknop (1977) described and illustrated a developmental series of *S. jordani*. The illustrations presented here (Fig. 3) were taken from this publication.

Distinguishing Features. The common name of shortbelly rockfish is a very descriptive one. A character that separates juveniles and adults of *S. jordani* from all other known species of *Sebastes* is the anterior placement of the anus. There is a wider space between the anus and the origin of the anal fin in *S. jordani* than in other *Sebastes*. This character also can be seen in larvae. Snout-anus distance averages 36% of body length in preflexion larvae, 42% during flexion, 51% following flexion, and 54% in pelagic juveniles. Comparative mean percentages for larvae of *S. paucispinis* are 41 before flexion, 45 during flexion and 59 following flexion; for *S. macdonaldi* the comparative percentages are 42, 50, and 60.

Newly hatched larvae of *S. jordani* are among the larger observed by us. In size at hatching, pigment pattern and body shape they resemble newly hatched larvae of the *S. marinus* group of the Atlantic.

The pigment patterns on early stage larvae of *S. jordani* differ from the preceding two species in that there are a series of melanophores along the dorsal midline of the tail in addition to the ventral midline series present on all early stage larvae of *Sebastes*. The ventral series begins at the 3rd to 5th postanal myomere and extends to the 14 to 16th postanal myomere. The dorsal midline series is shorter, extending from the 7th to 12th postanal myomere to the 14 to 16th postanal myomere. In addition, early stage larvae of *S. jordani* have the melanistic shield over the gut, and a group of melanophores over the brain. However, the pectoral fins are unpigmented. The development of pigment on later-stage larvae and pelagic juveniles is shown in Figure 3.

Larvae of *S. jordani* are the most slender of any *Sebastes* yet described. Body depth averages 17% of body length before notochord flexion, 21% during flexion, and 23.5% following flexion. Pelagic juveniles 28 to 68mm are slightly more slender, with a mean of 22%. The above body depth values, beginning with flexion, are so similar that *S. jordani* could be characterized as having a constant body depth during much of its early life history period.

The pectoral fins are short, rounded and unpigmented. Larvae of *S. jordani* have the shortest pectoral fins of any larvae of rockfish yet described. Pectoral fin length averages 7% of body length prior to notochord flexion, 8% during flexion, 11% in early postflexion larvae increasing to 20% in largest larvae and 22% in the largest pelagic juvenile available (ca. 63mm). Pelvic fin buds form during the flexion stage, prior to formation of dorsal and anal fin rays. The complete complement of pelvic fin rays (I,5) is developed on some larvae of 12.5mm long. pelvic fins are always shorter than pectoral fins. Preflexion larvae of *S. jordani* measure 5.4 to 7.7mm, flexion larvae 8 to 10mm and postflexion larvae 10.5 to 27mm. Thus, *S. jordani* has an extended larval period. Pelagic juveniles remain in the surface waters; they appear to form schools after transformation from the larval stage. They are often seen at the surface under nightlights and can be readily dipnetted; juveniles in the 30 to 50mm size range are commonly dipnetted. The largest specimen collected under lights is about 63mm long.

Distribution and Abundance. According to Miller and Lea (1972), *S. jordani* ranges from British Columbia south to Cape Colnett, Baja California. As noted in Moser et al. (1977) a pelagic juvenile was dipnetted off west San Benitos Island at latitude 28°18'N. Distribution of *S. jordani* larvae is illustrated for composite occurrences during CalCOFI year 1966 in Moser et al., 1977. Distribution of larvae of this species extends from the northern limit of the sampling pattern off San Francisco to the vicinity of Ensenada, Baja California. All larvae were taken in the shoreward region of the sampling grid, with largest catches made on stations adjacent to the coast. Off southern California on 1966 CalCOFI cruises, larvae of *S. jordani* contributed 20% of the total catch of *Sebastes* larvae. It obviously is one of the abundant species of rockfishes.

Sebastes levis (Eigenmann and Eigenmann) — Cow Rockfish

Literature. A 5mm specimen of larva obtained from a pregnant female cow rockfish and reared to yolk exhaustion is illustrated in Moser (1972, Fig. 16-I). Illustrations and discussions of a developmental series through larval and pelagic juvenile stages are given in Moser, Ahlstrom and Sandknop (1977). The illustrations presented here (Fig. 4) are reproduced from this publication.

Distinguishing Features. The cow rockfish is a choice catch of sportfishermen because this species attains the largest size of any California rockfish. Larvae at the stage of yolk exhaustion are about 5.0mm which is middling in size for early stage rockfish larvae. Notochord flexion occurs between about 7.5 to 10.5mm body length and postflexion larvae are taken up to about 21mm body length, but some specimens transforming into pelagic juveniles are as small as 19mm. Hence larvae of *S. levis* attain a somewhat larger size at transformation than those of *S. paucispinis* or *S. macdonaldi,* but they are considerably smaller at transformation than larvae of *S. jordani.* The pelagic juvenile stage is a relatively long one; individuals between about 19 to 58mm were studied, while the smallest demersal juvenile available was 66.5mm.

The large fan-like pectoral fins are the most conspicuous diagnostic feature of *S. levis* larvae. The pectoral is only about 9% of body length at yolk exhaustion, but increases rapidly to about 45% at the completion of flexion and retains this large size during the postflexion stage into the pelagic juvenile stage. Later in this stage the fin shortens. Thus, the pectoral fin is 47% body length in a 33mm pelagic juvenile, 38% in a 47mm specimen, 32% in the largest pelagic juvenile available and only 29% in the 66.5mm benthic juvenile.

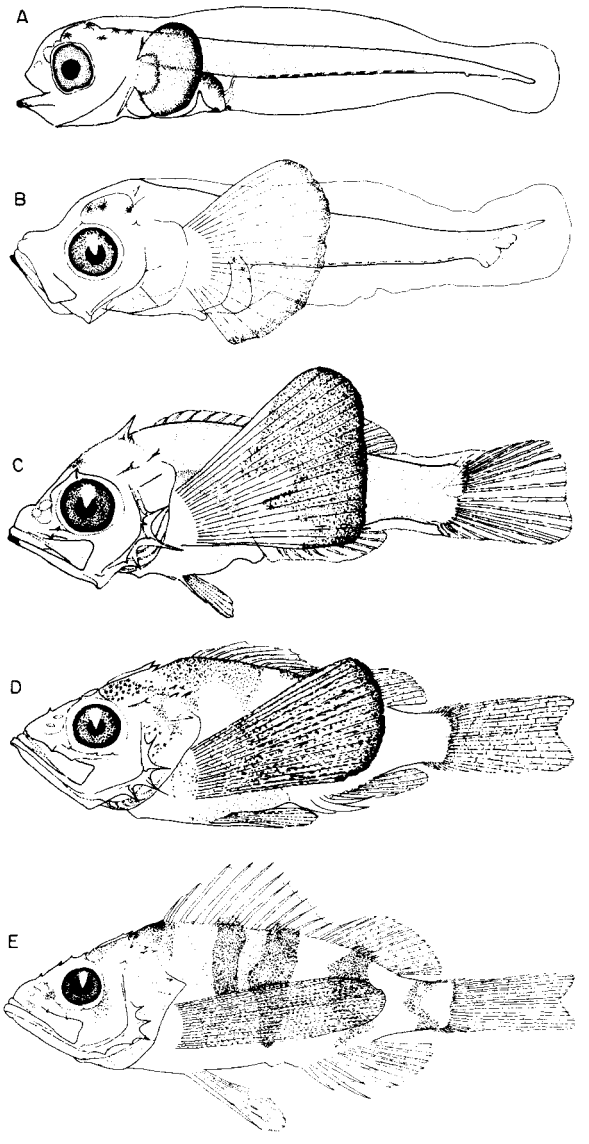

Figure 4. Developmental series of *Sebastes levis*. A. 5.0-mm larva; B. 7.2-mm larva; C. 10.4-mm larva; D. 19.1-mm transforming specimen; E. 32.8-mm pelagic juvenile.

The pigmentation of cow rockfish larvae is also an aid to identification. The midline melanophores on the tail are confined to the ventral margin; the number of melanophores falls in the middle of the range observed on 33 species of *Sebastes* (Moser et al., 1977, Table 5), with an average count of 17 and a range of 13 to 22. Newborn larvae have a melanistic shield over the gut, a patch of melanophores over the brain, heavy pigment on the tip of the lower jaw, and a varying pattern of pigment on the pectoral fins depending on stage of larval development. In early stage larvae the pectoral fin is covered with fine melanophores which concentrate into a band at the distal margin. In late preflexion and early flexion larvae, the melanophores over most of the fin are lost and only the marginal band persists. By the completion of flexion, the pigment has again spread over most of the fin and this pigment is retained into the pelagic juvenile stage. Pelagic juveniles have developed 4 or 5 pigment saddles which widen into bands across the body.

Distribution. Adult cow rockfish have a comparatively limited geographic range from central California to central Baja California, with the center of distribution off southern California. The larvae are rare in CalCOFI samples and most specimens have been obtained in the California Bight area (Moser et al., 1977, Fig. 12). Cow rockfish larvae are taken from January to June.

Acknowledgements

This contribution utilizes all data available on rockfish larvae from CalCOFI cruises made from 1958 through 1975. Over the years many persons aided in identifying and tabulating rockfish data. We wish to thank particularly Elizabeth Stevens, Susan D'Vincent, John Butler, Barbara Sumida, Lois Hunter, Amelia Gomes, Dennis Gruber, and the late David Kramer. Barbara Sumida also aided us greatly in preparation of this Atlas, including help in preparation of tables.

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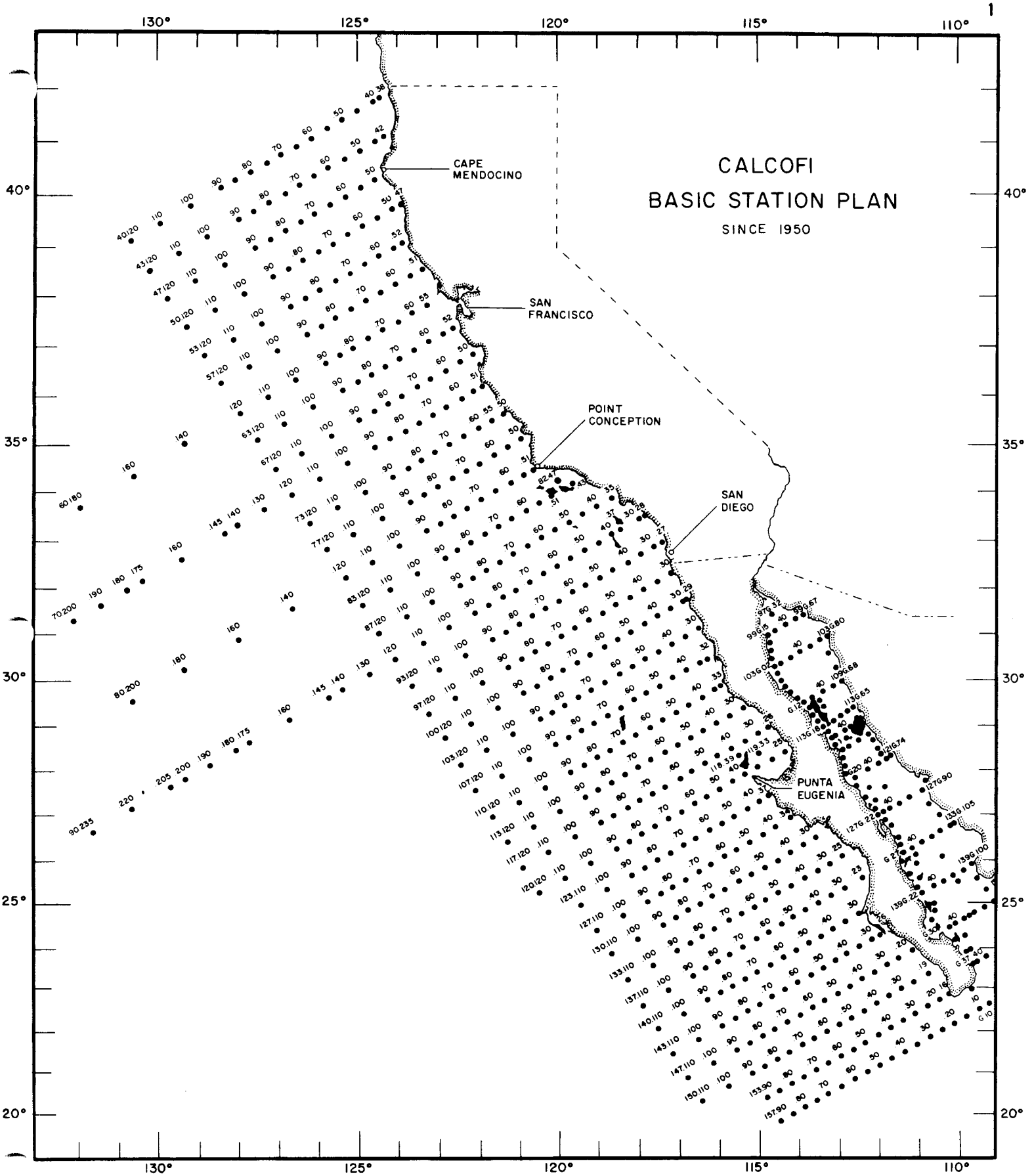

CALCOFI

BASIC STATION PLAN
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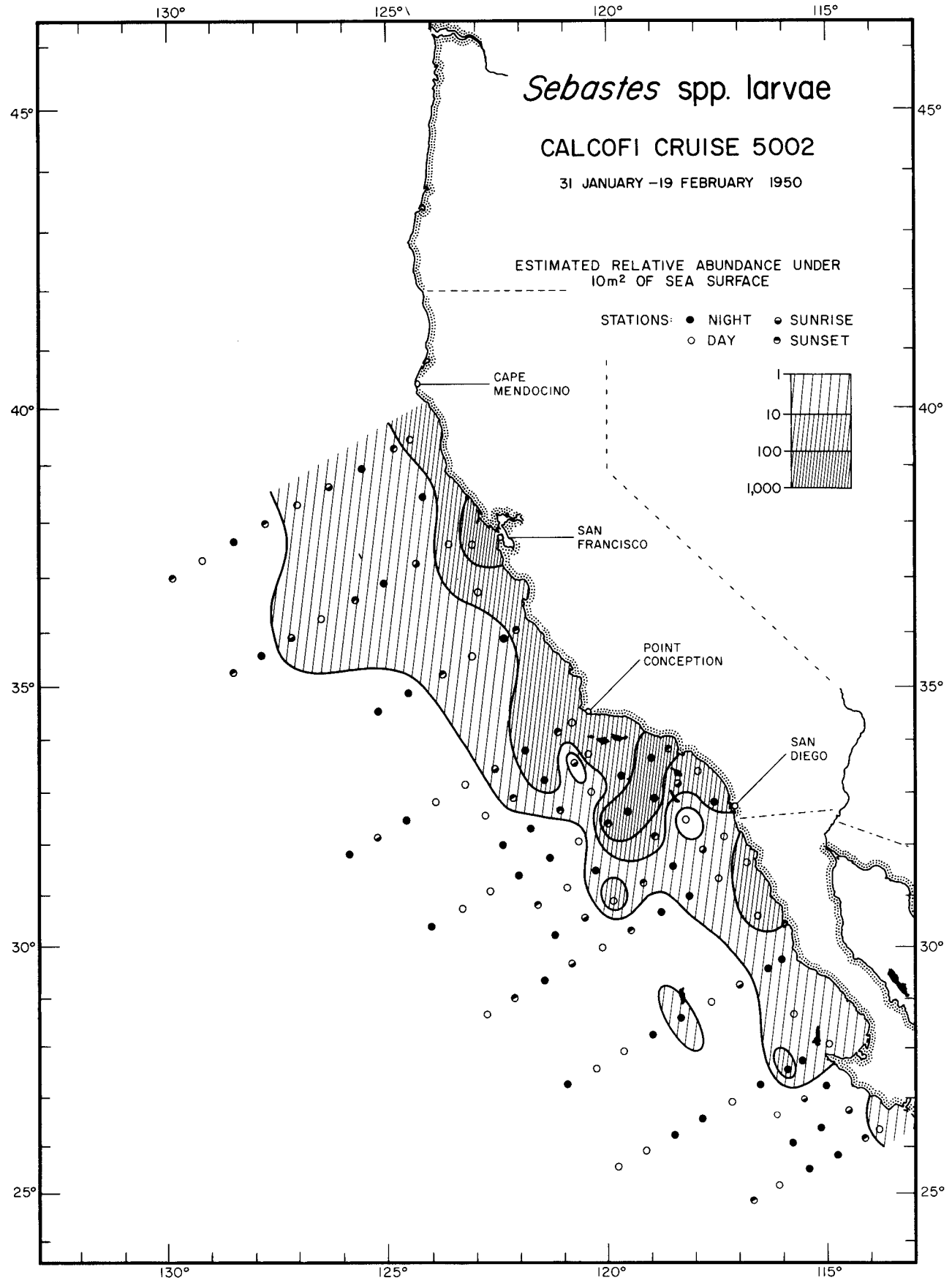

Sebastes spp. larvae

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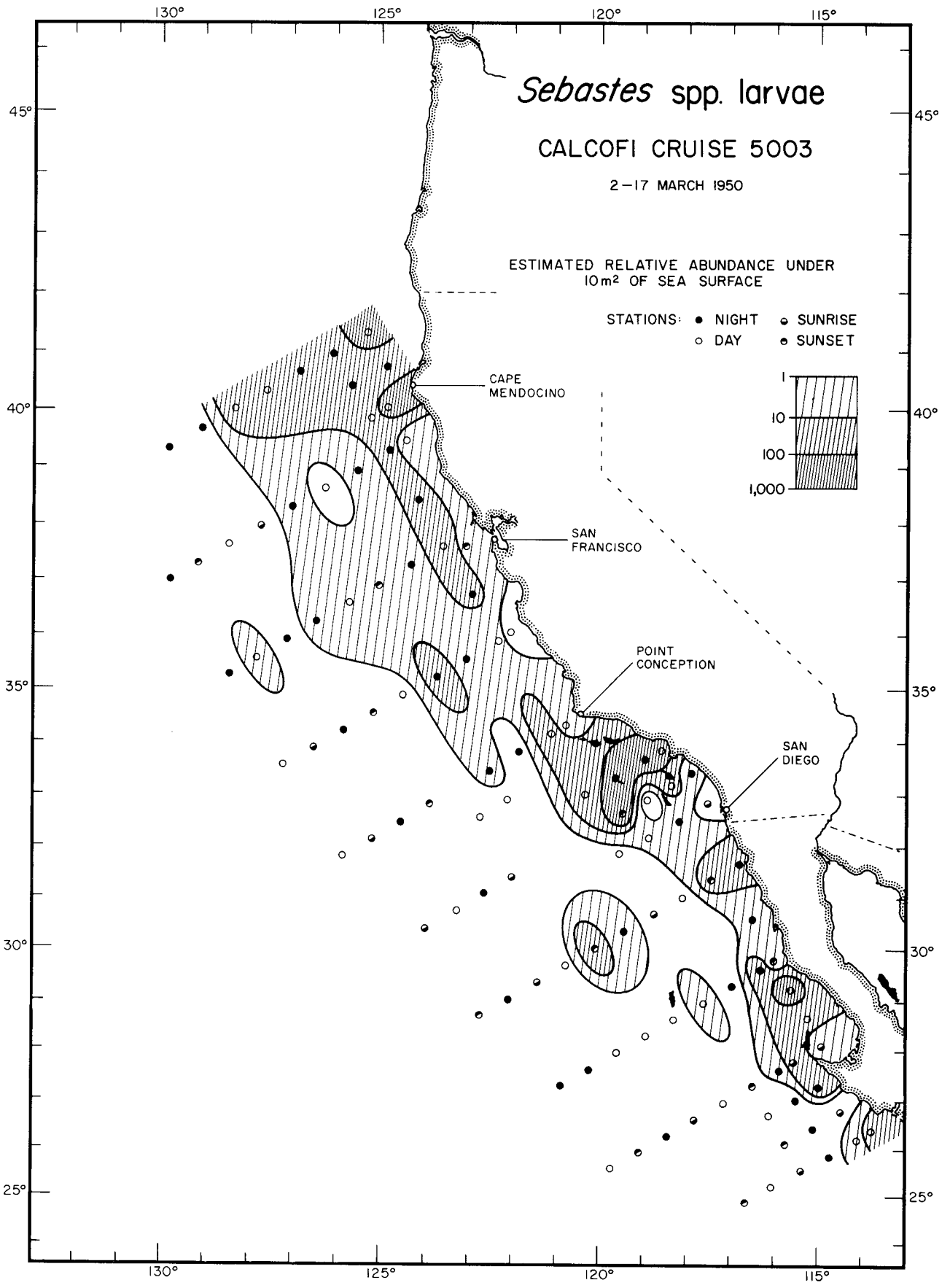

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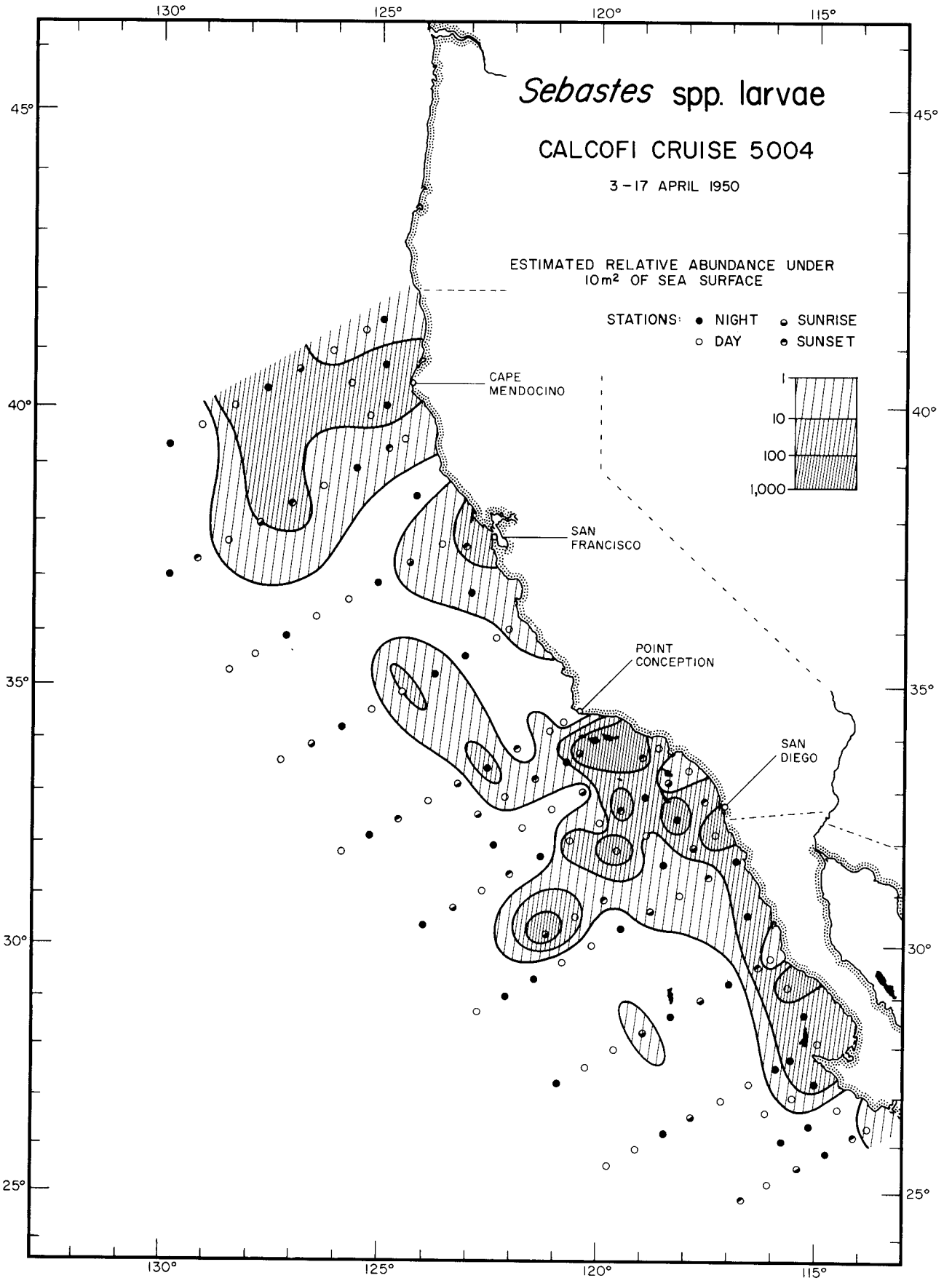

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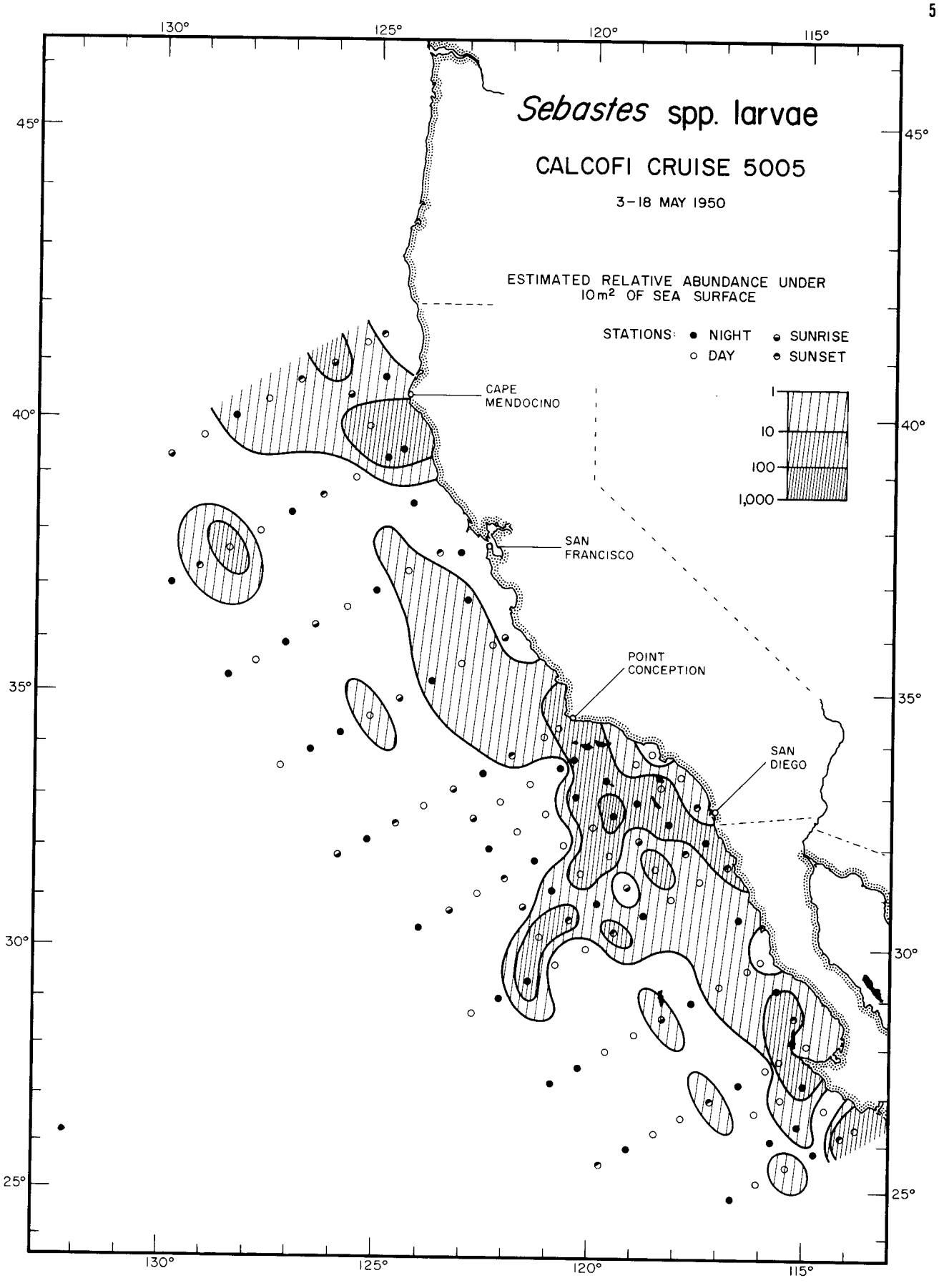

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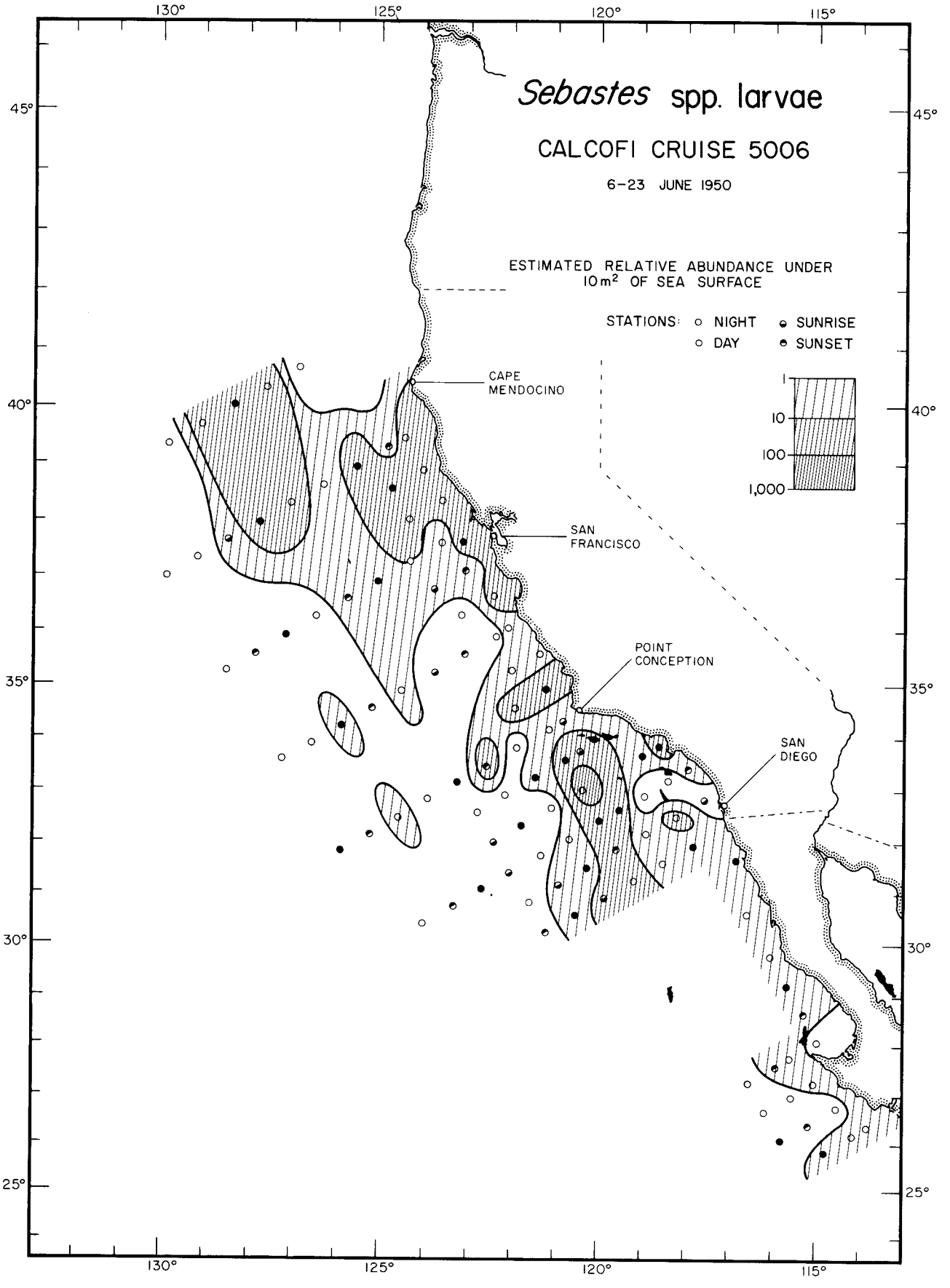

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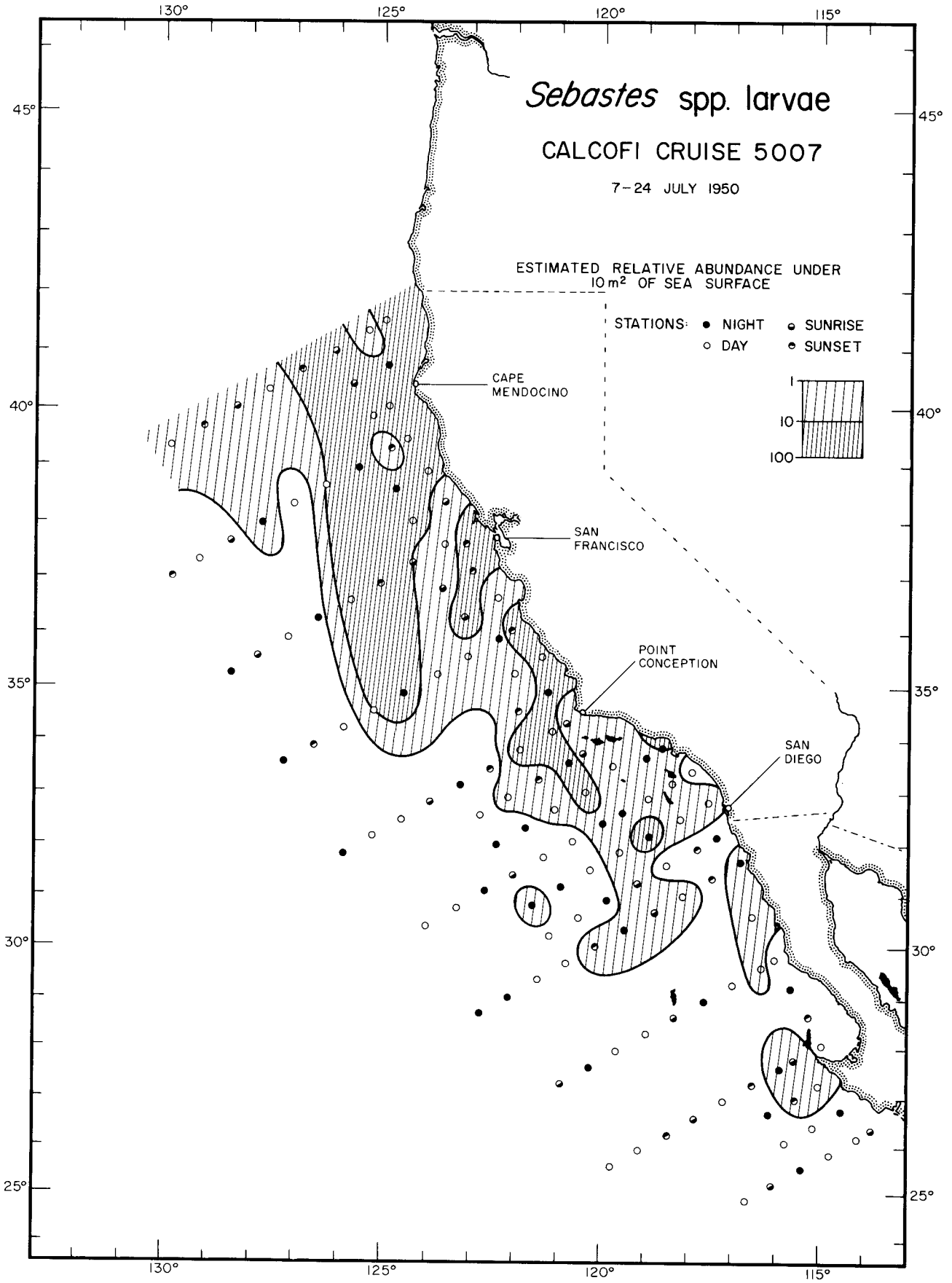

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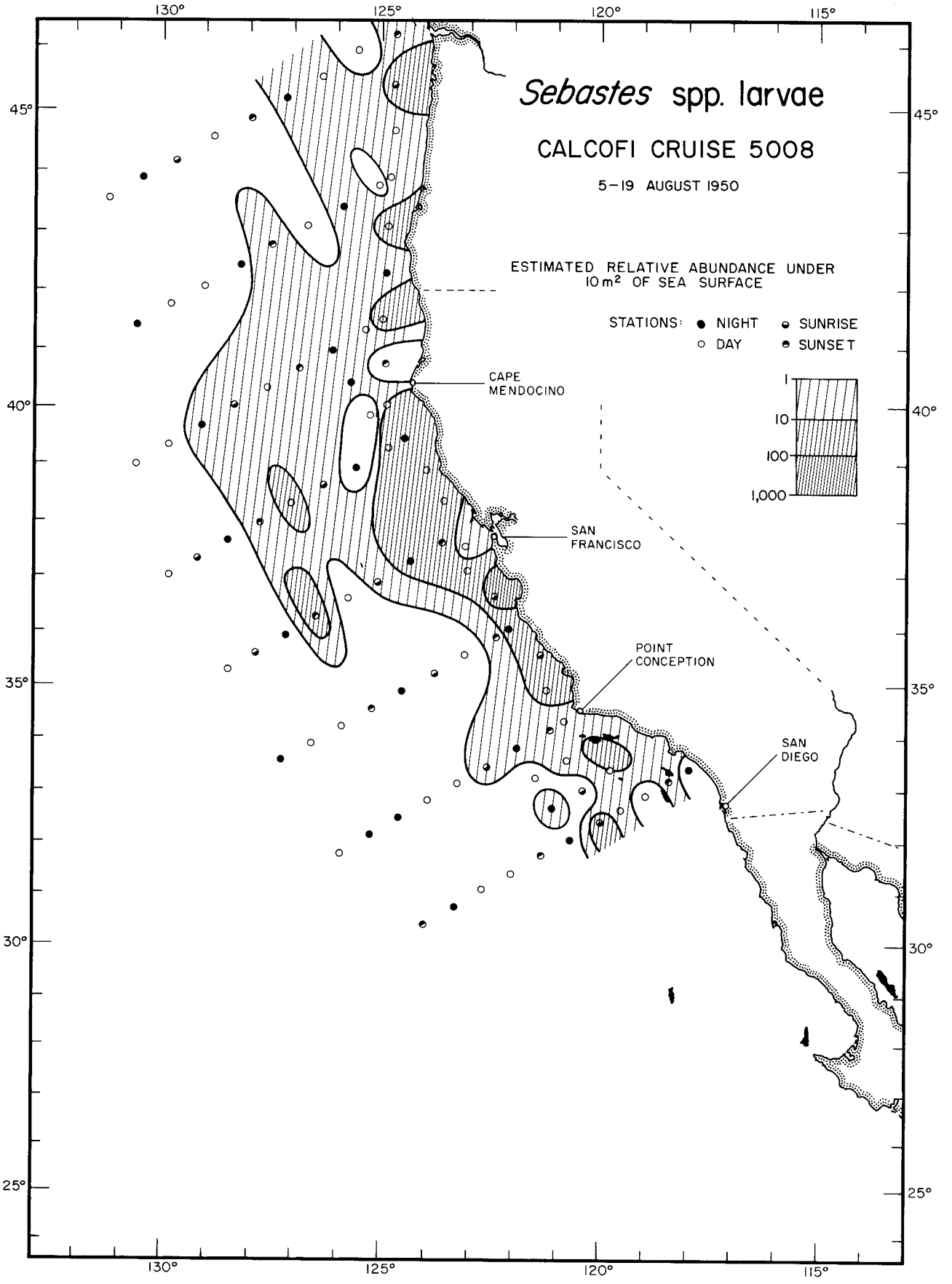

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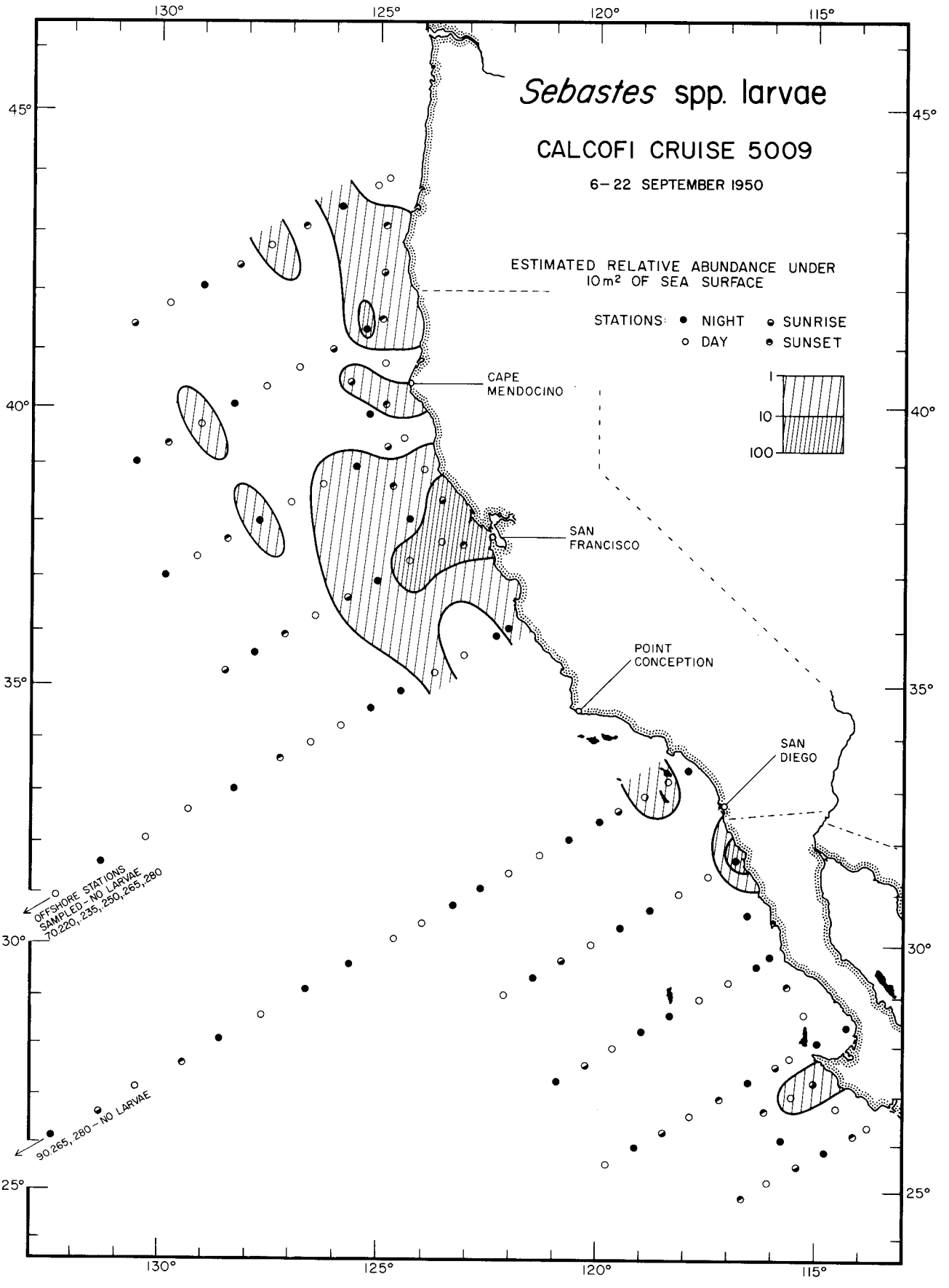

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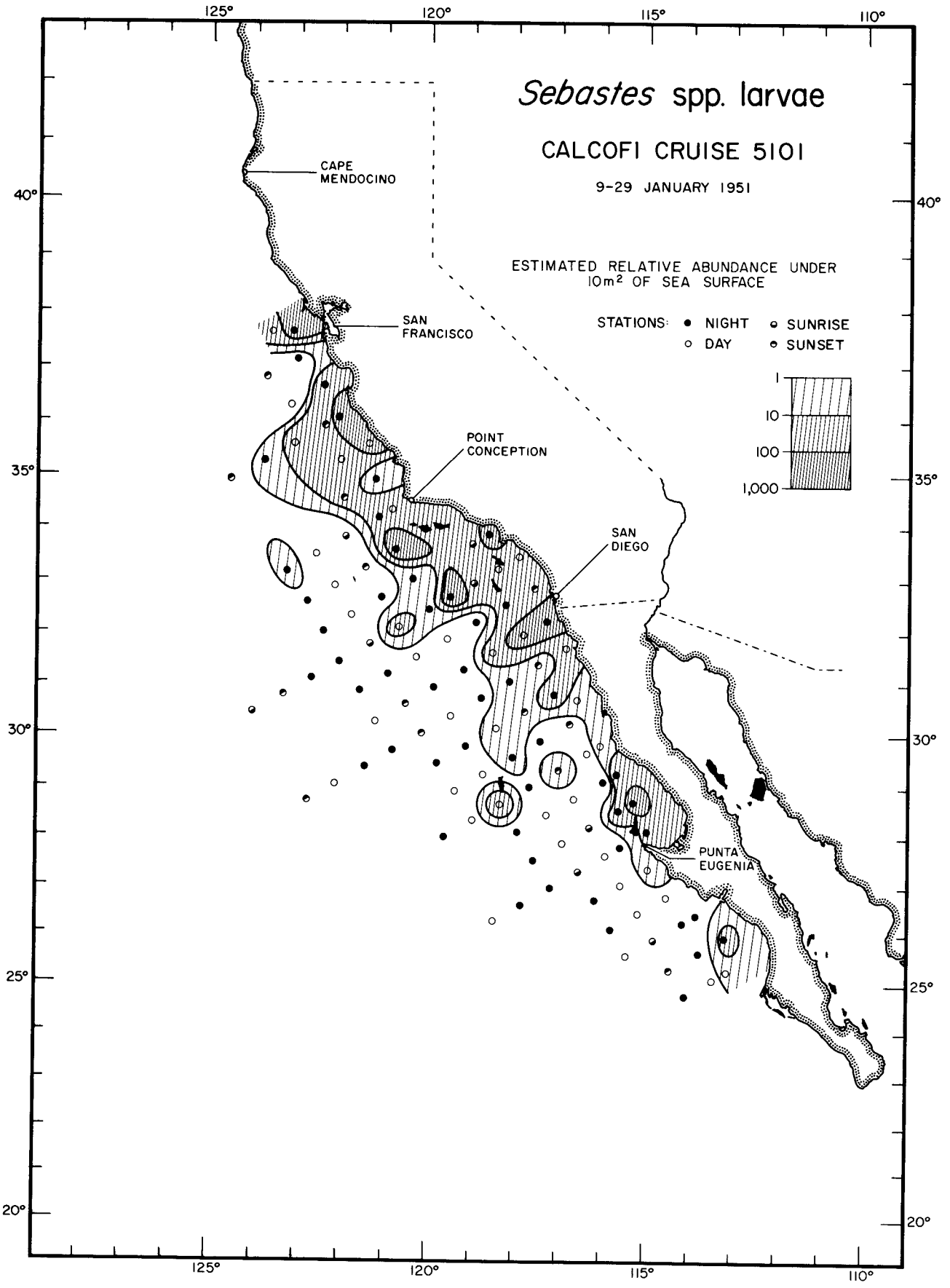

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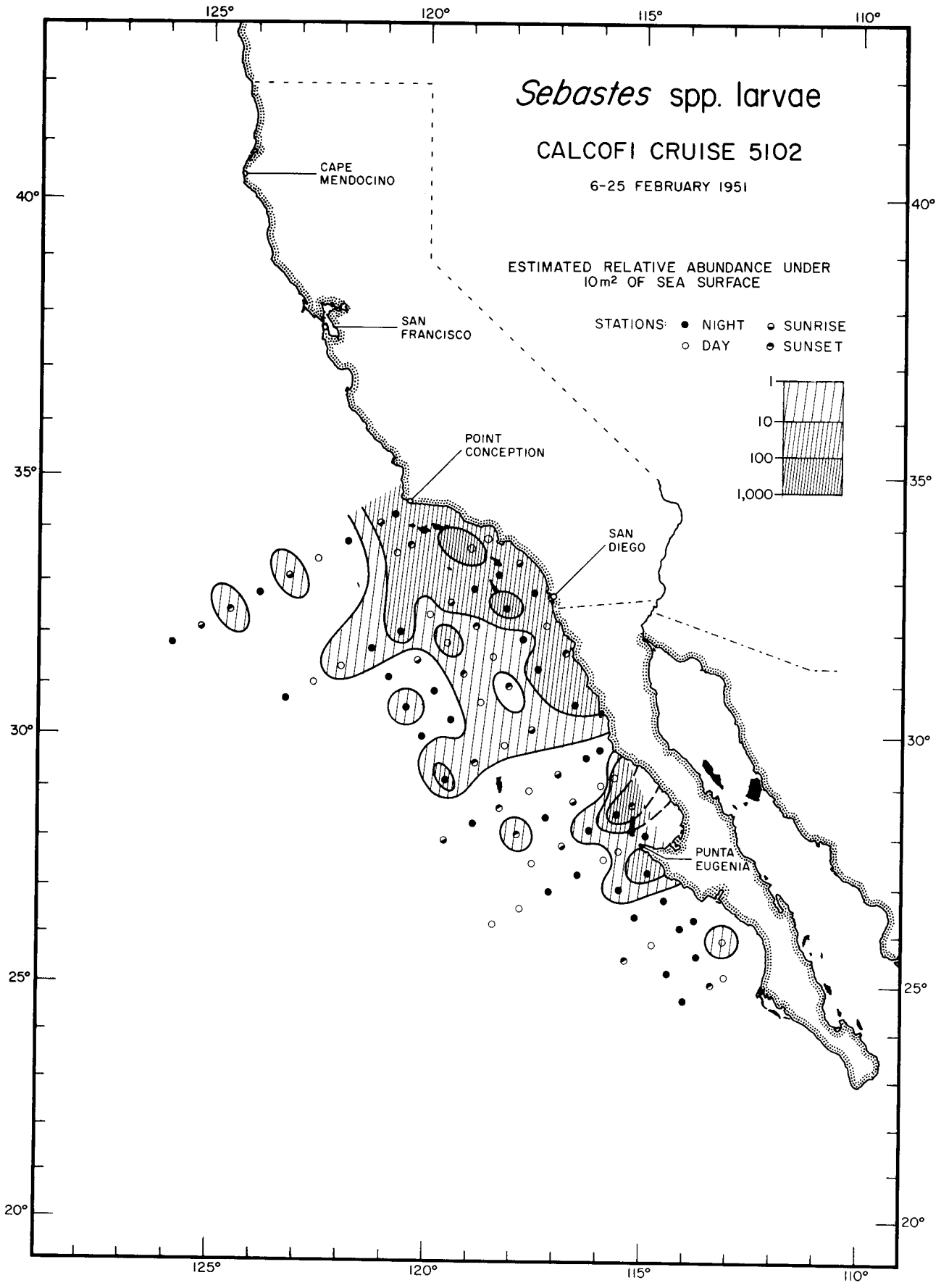

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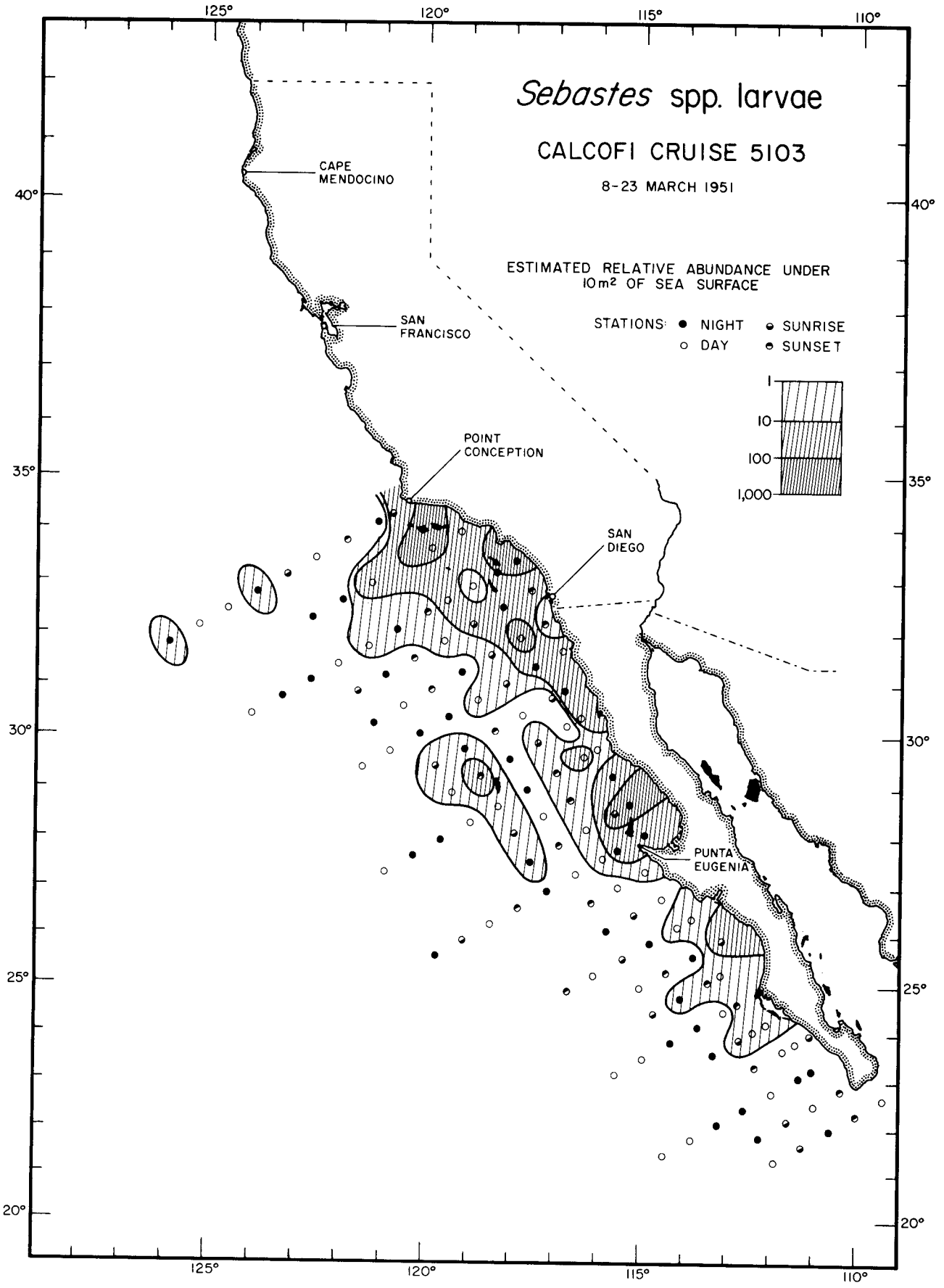

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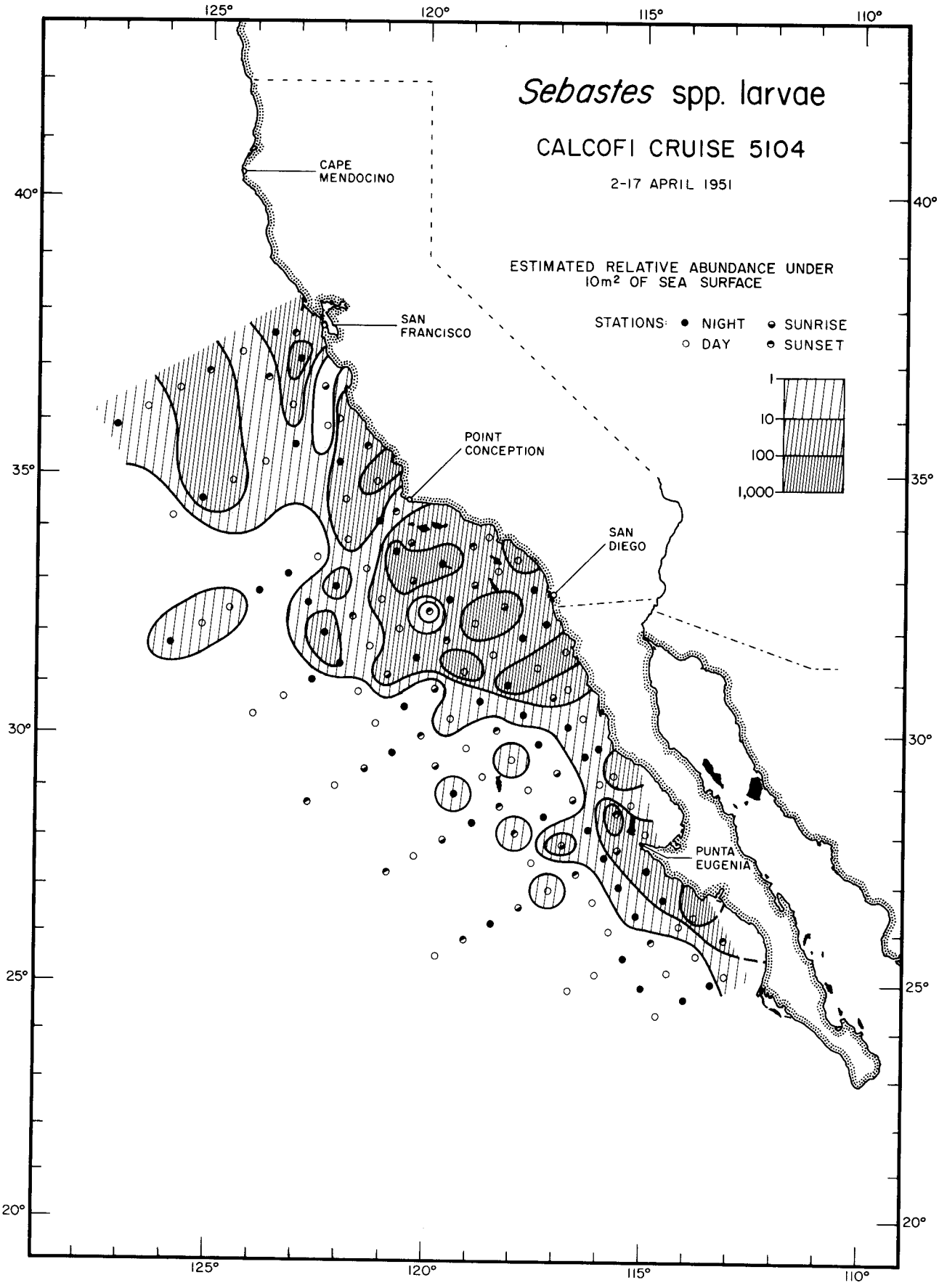

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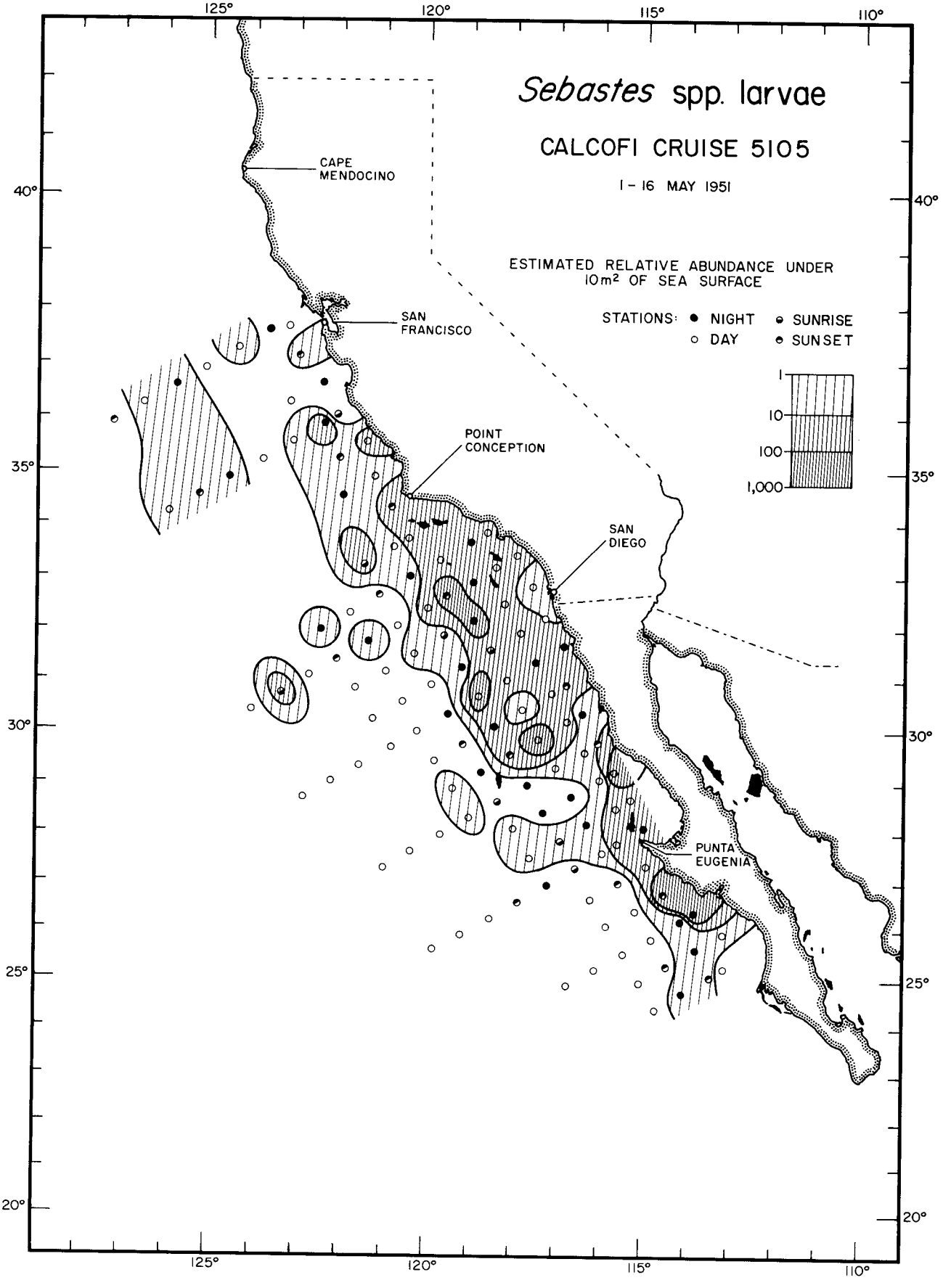

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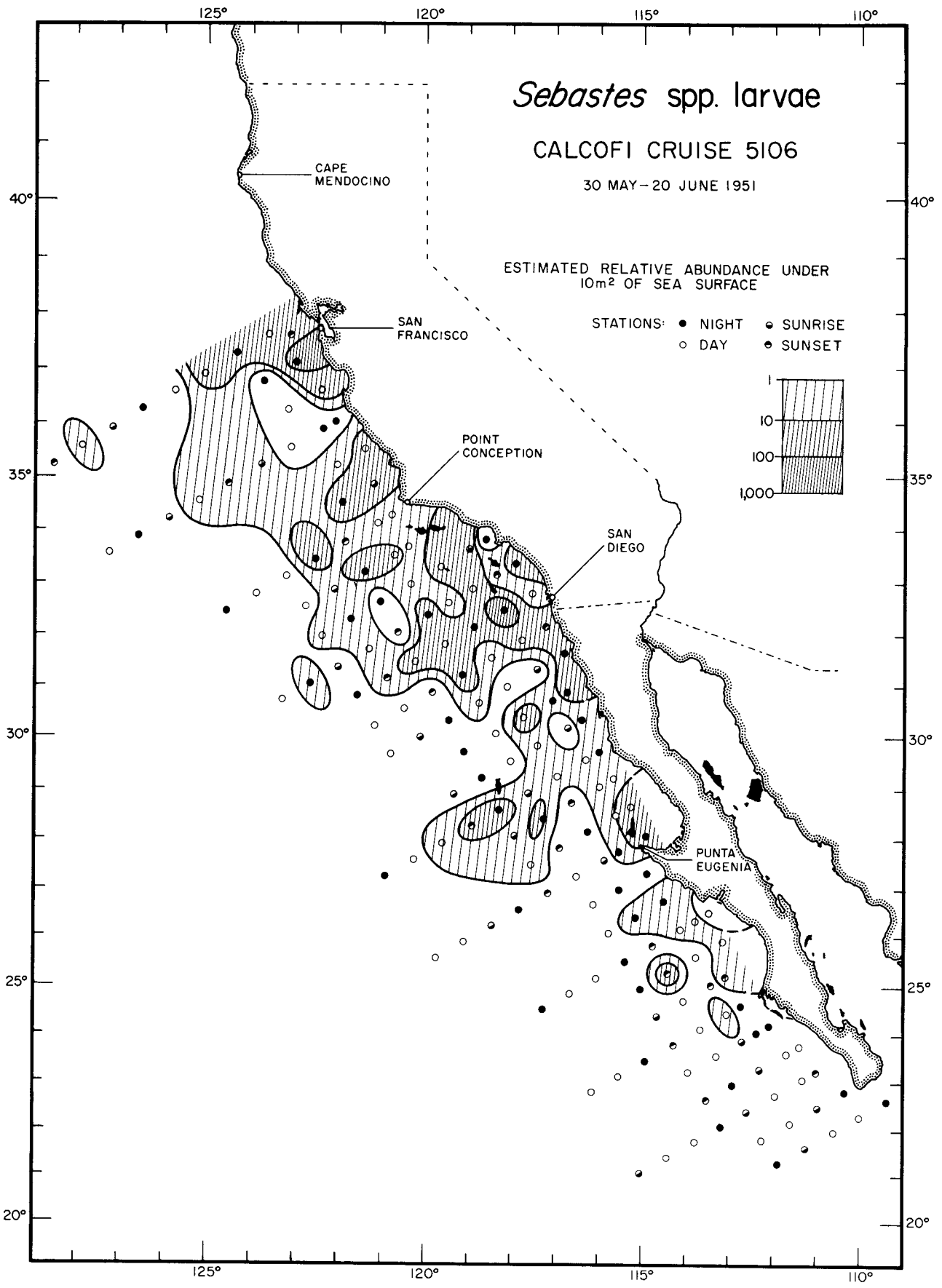

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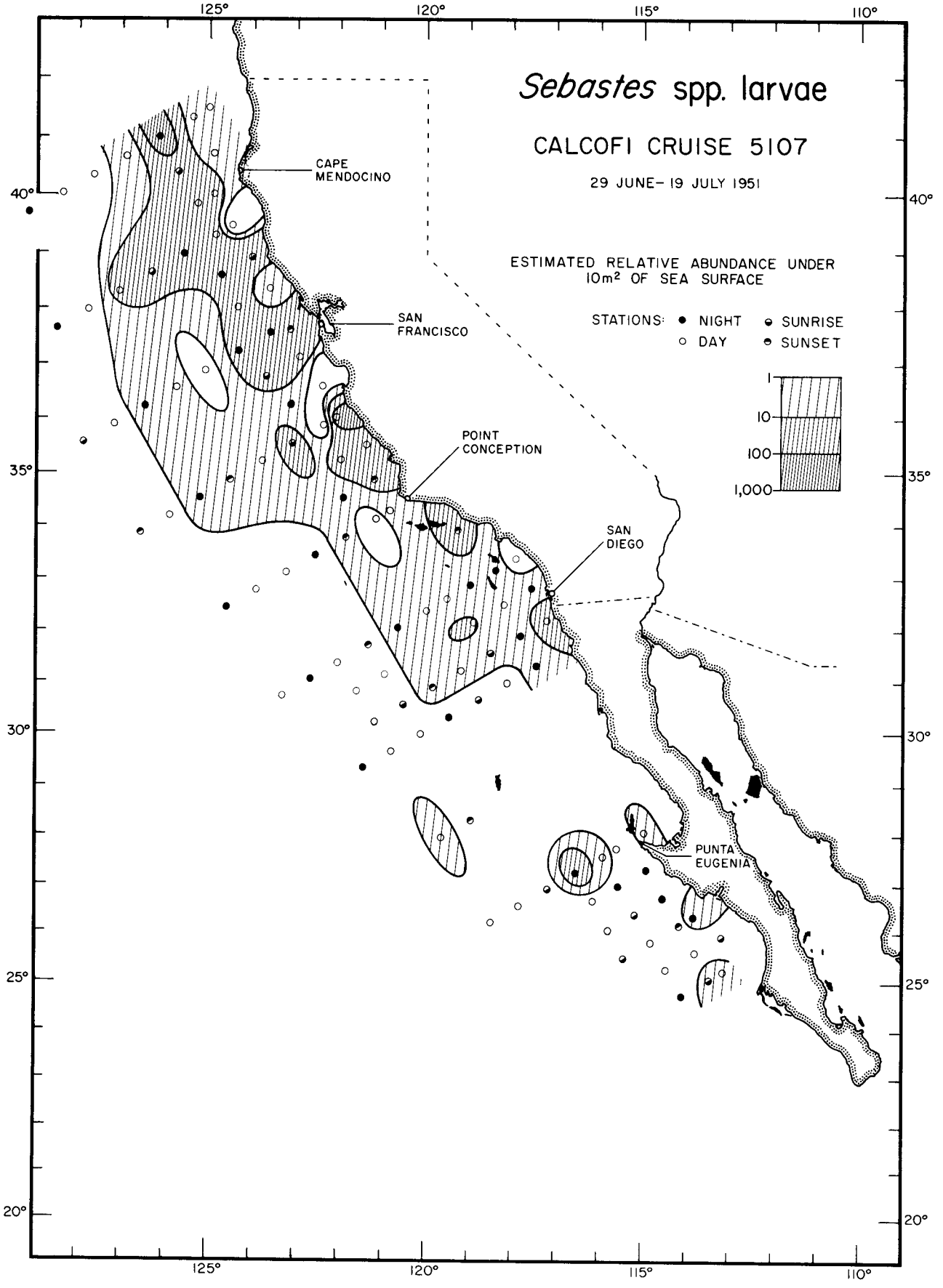

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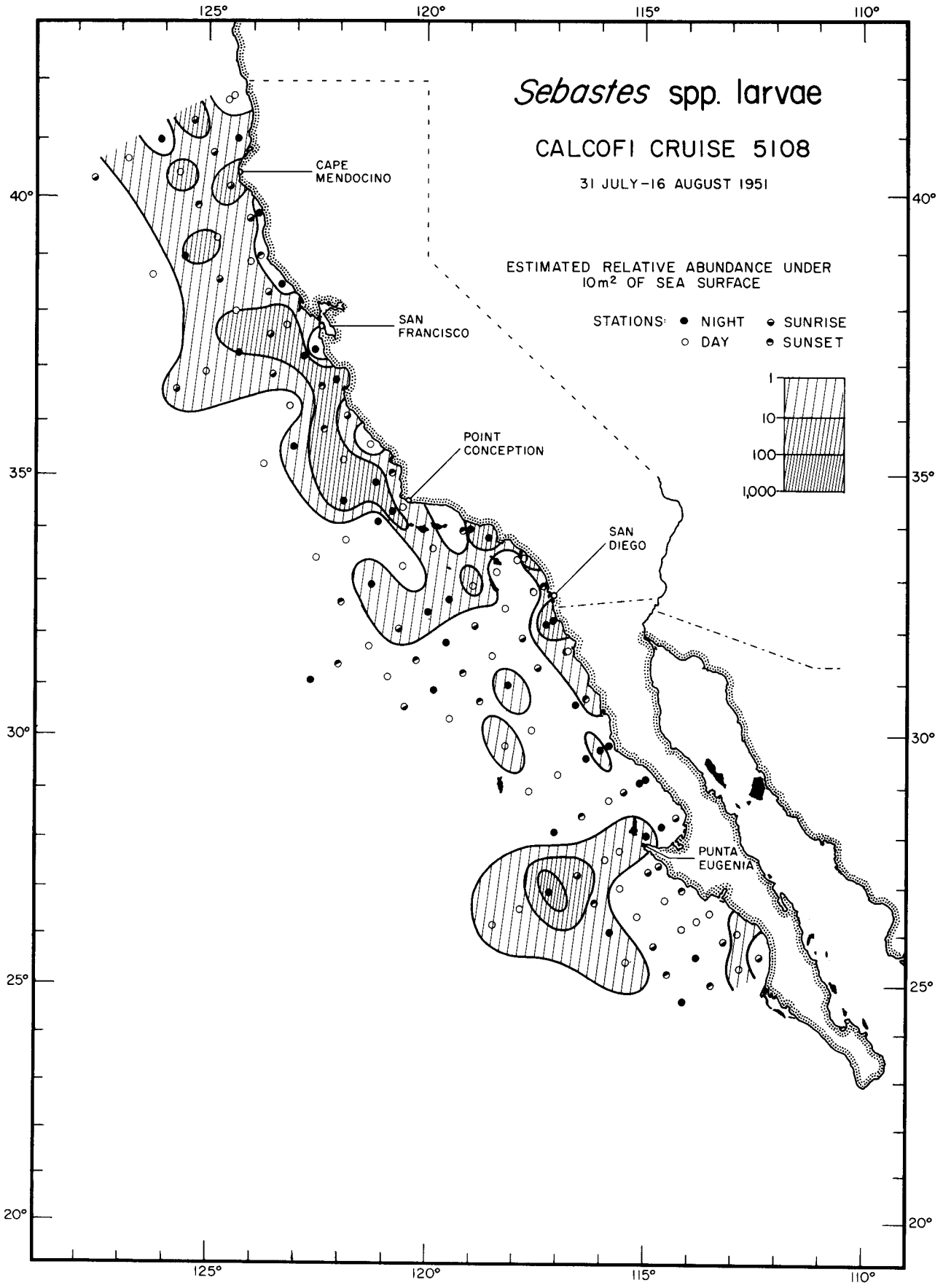

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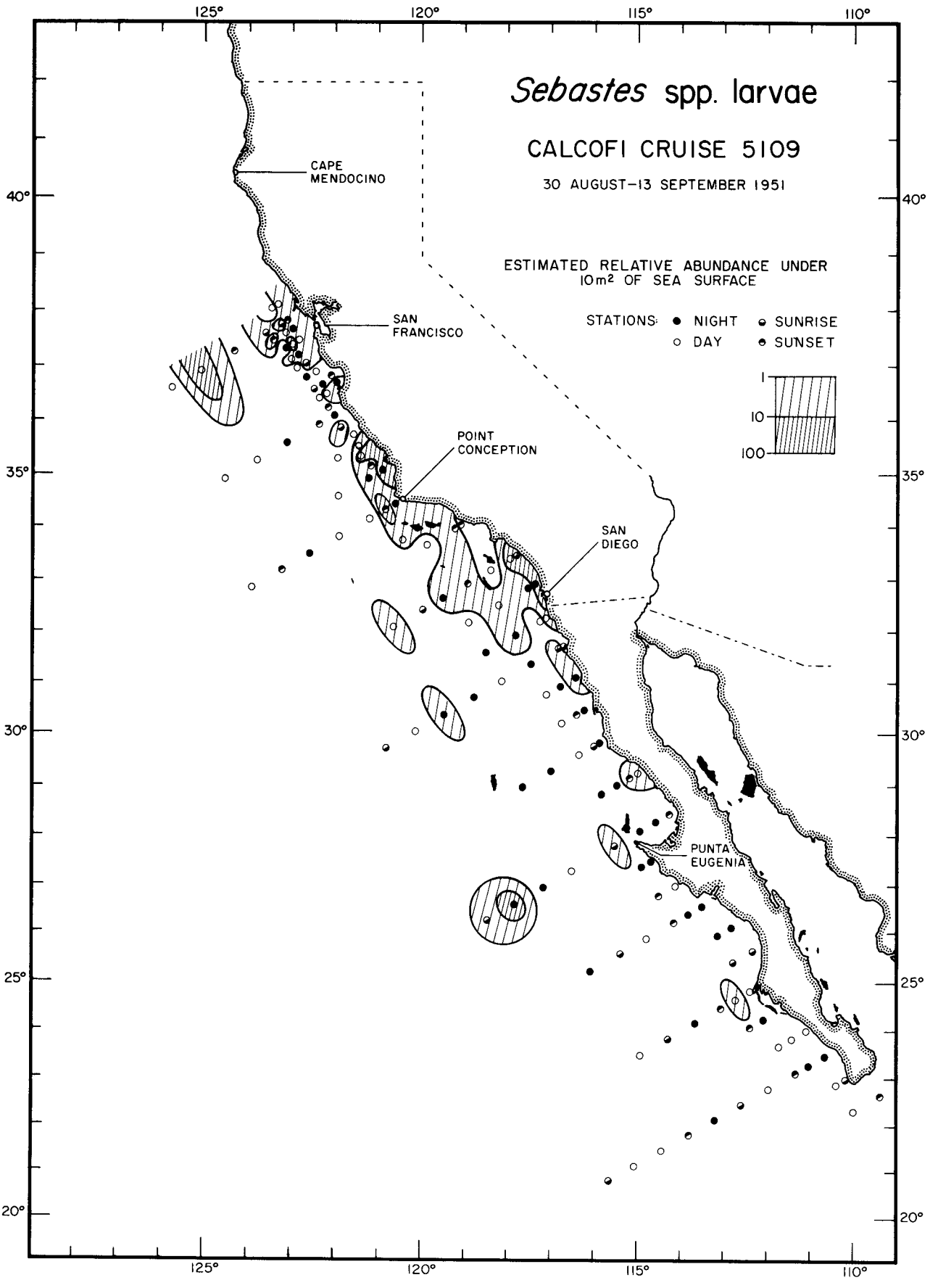

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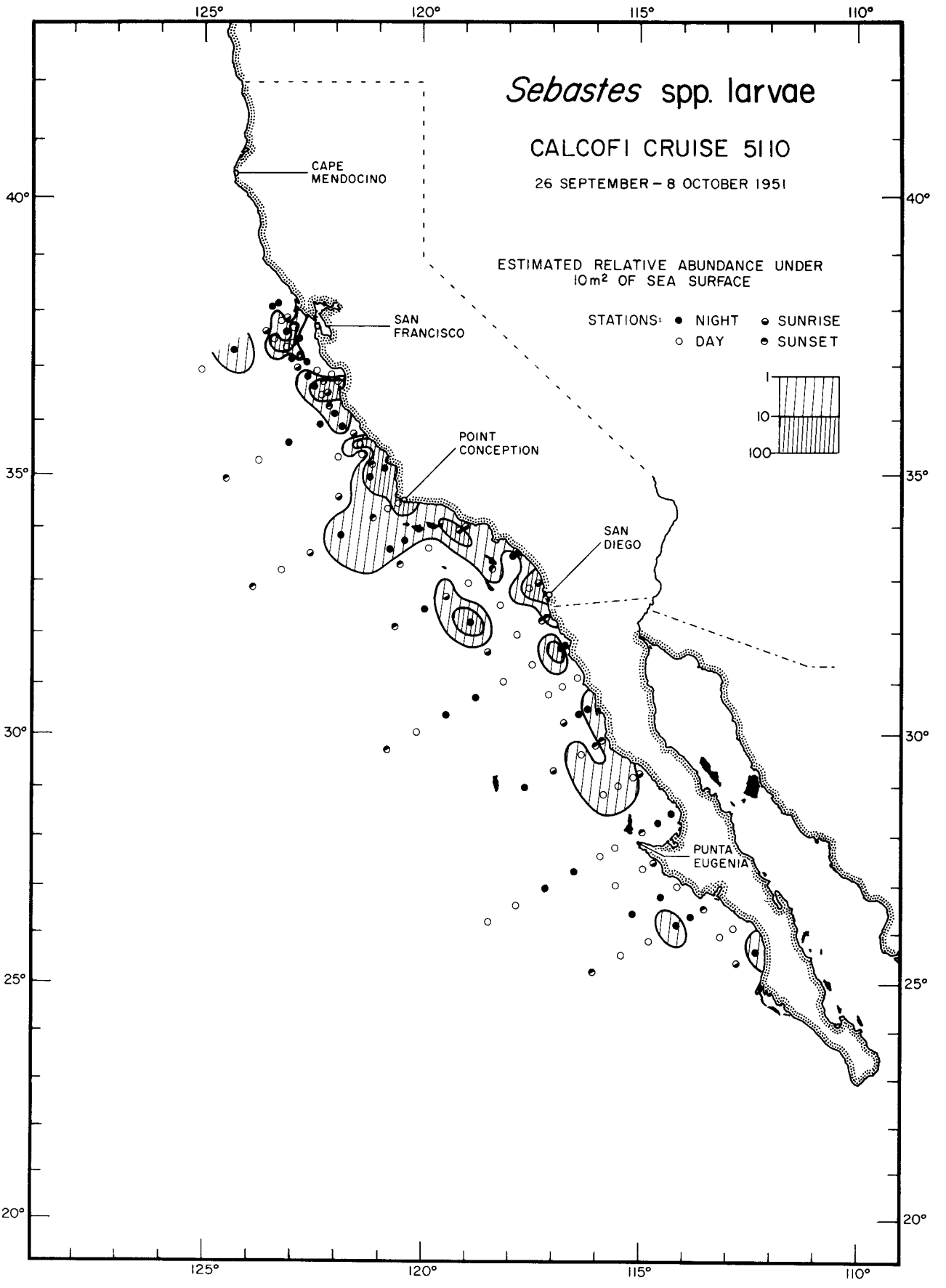

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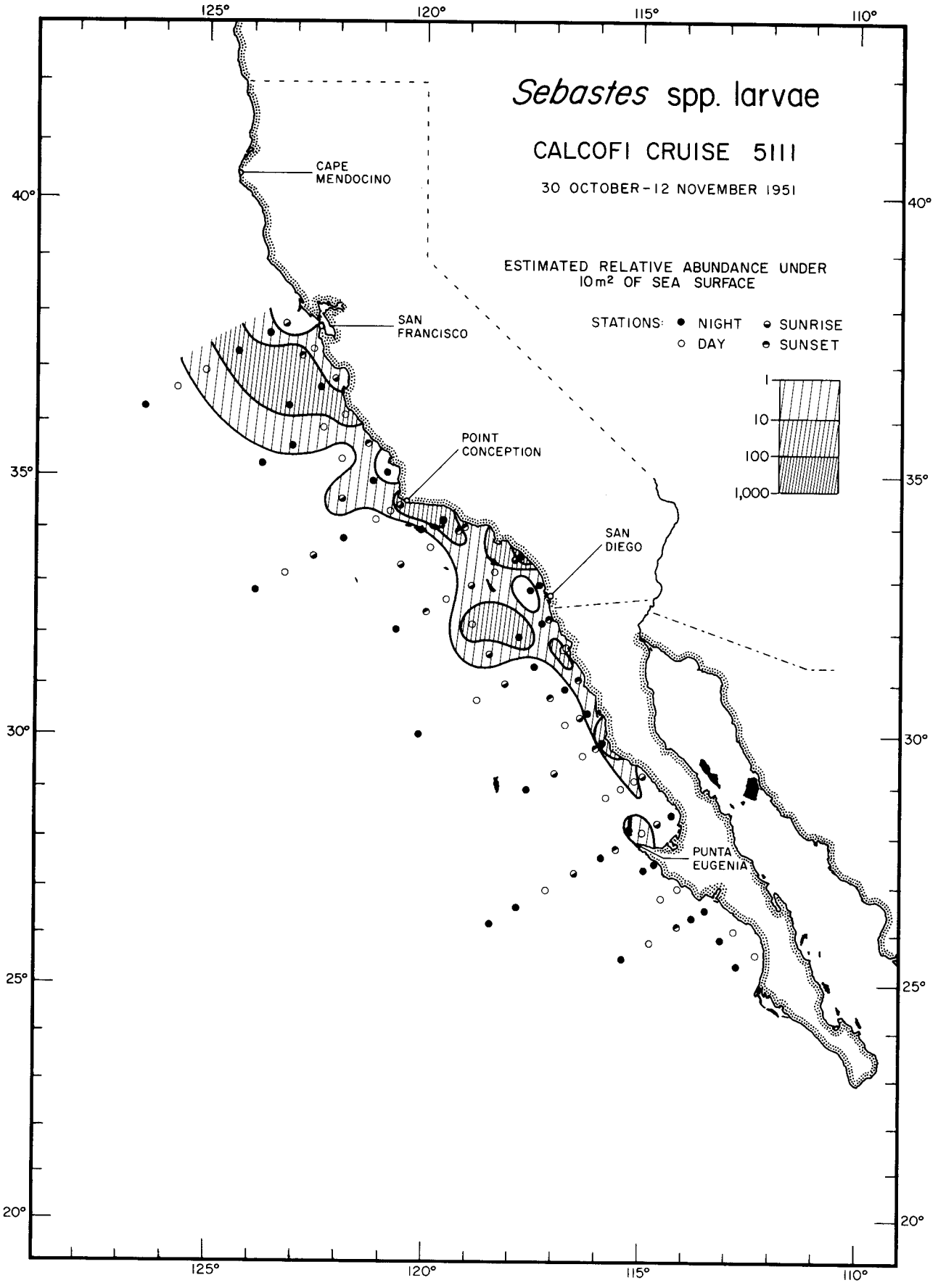

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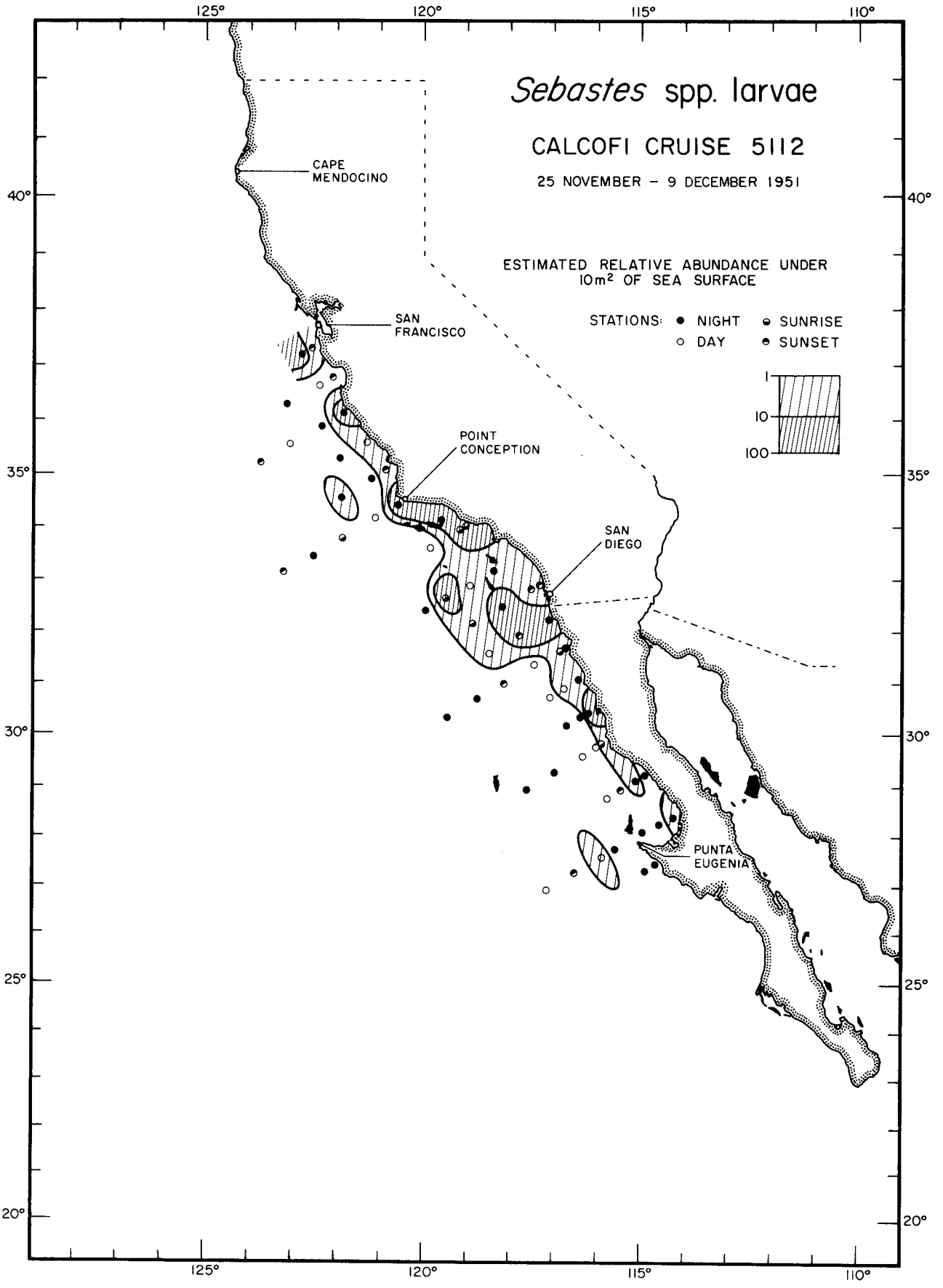

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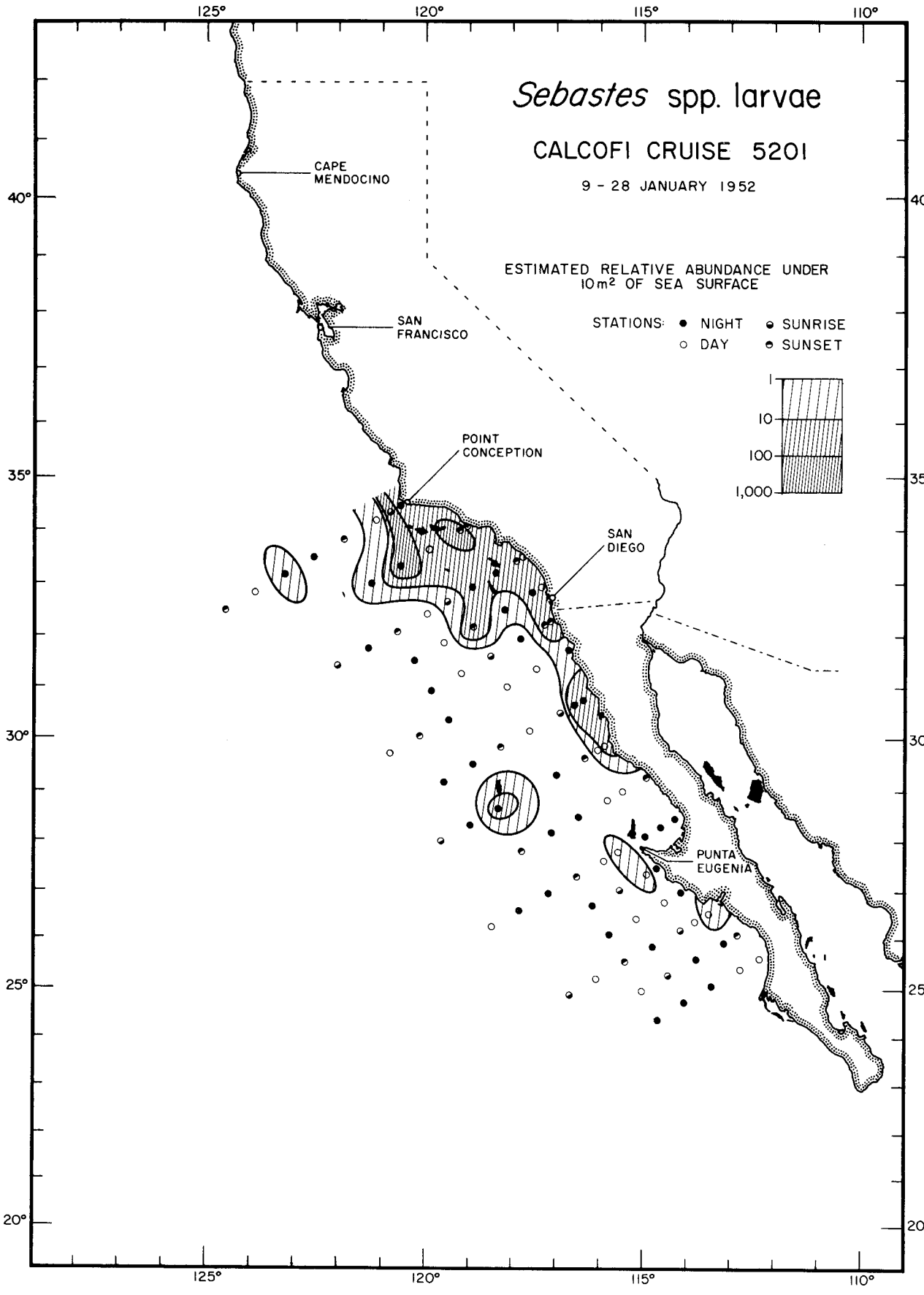

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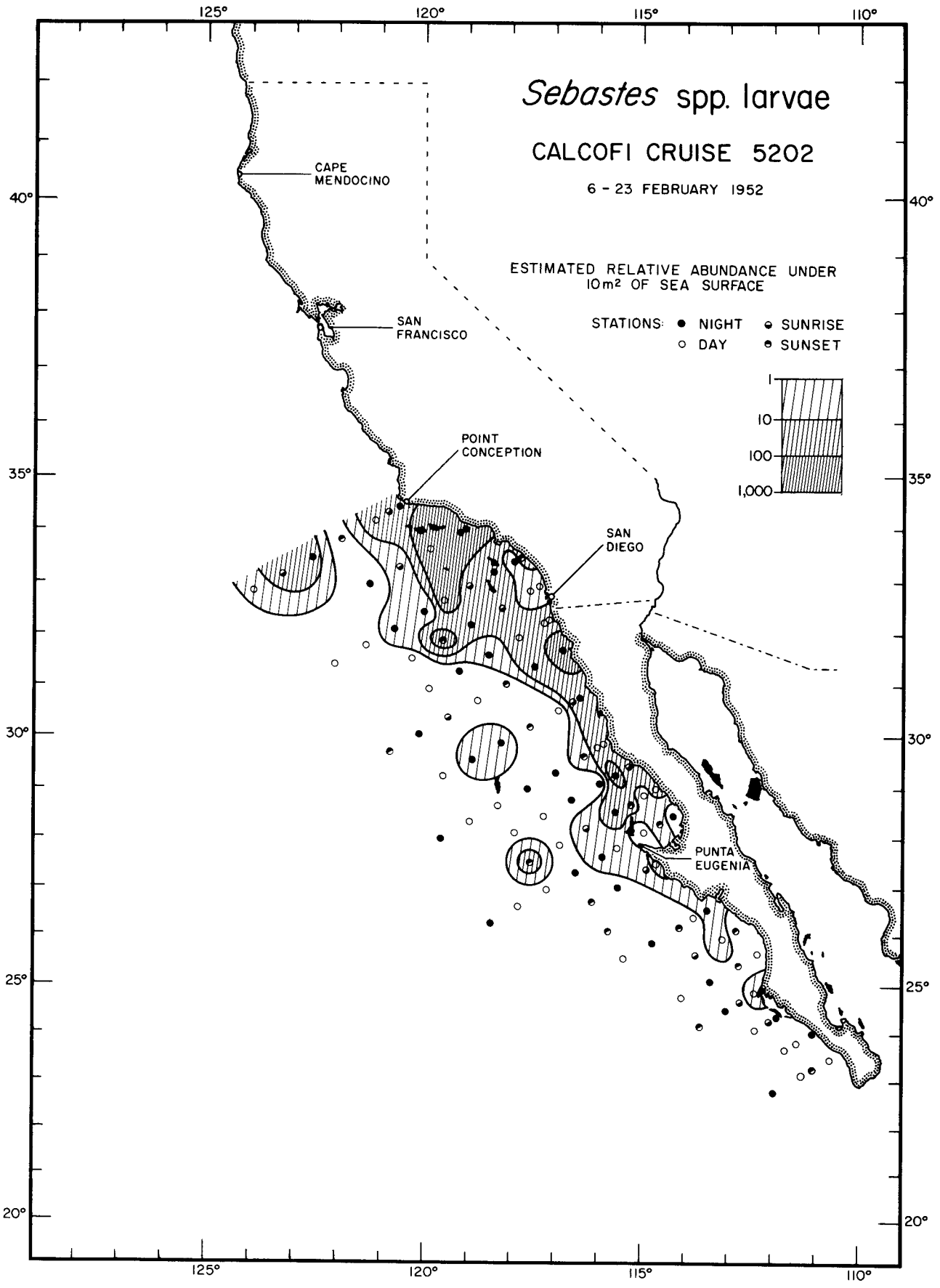

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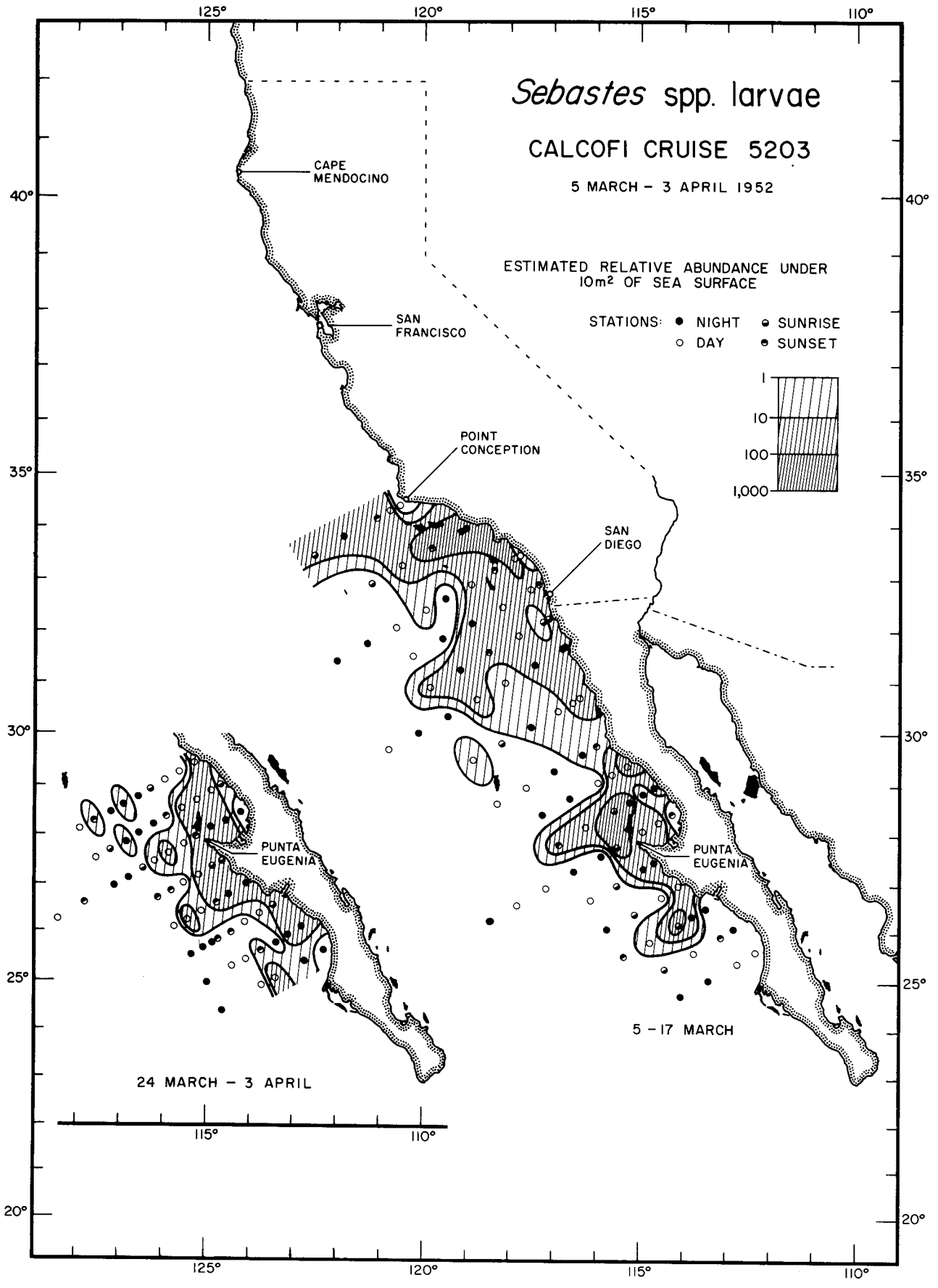

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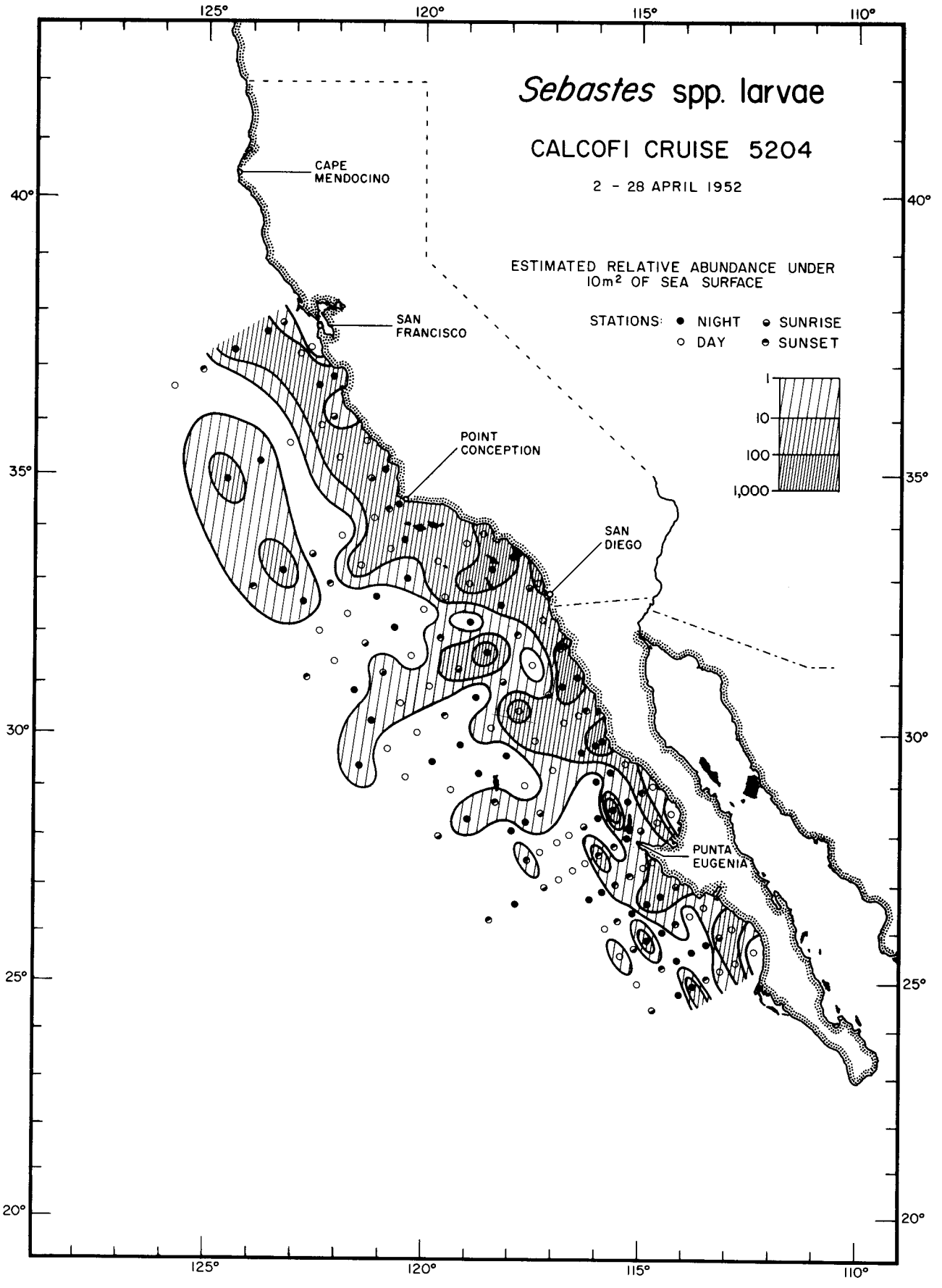

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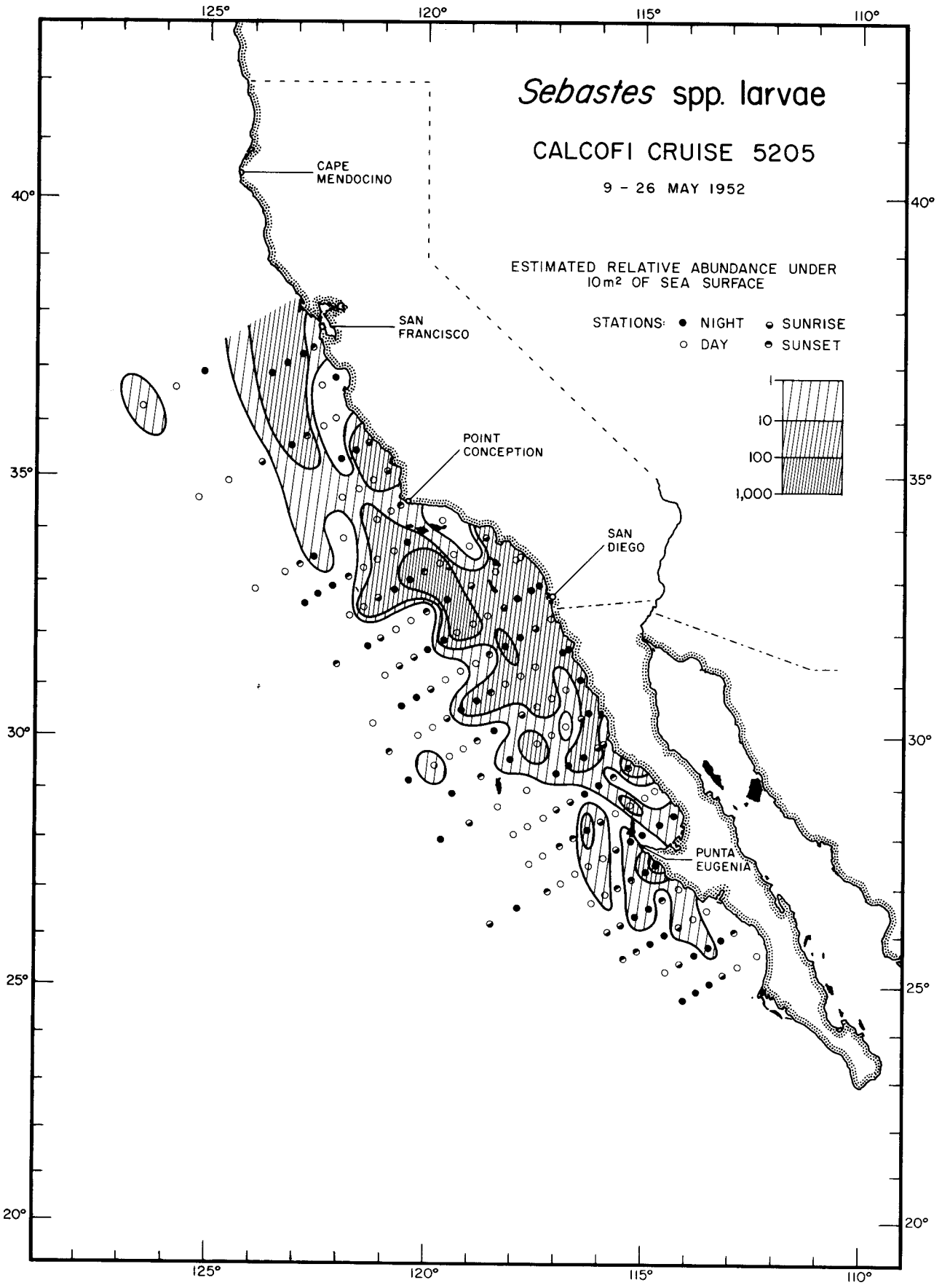

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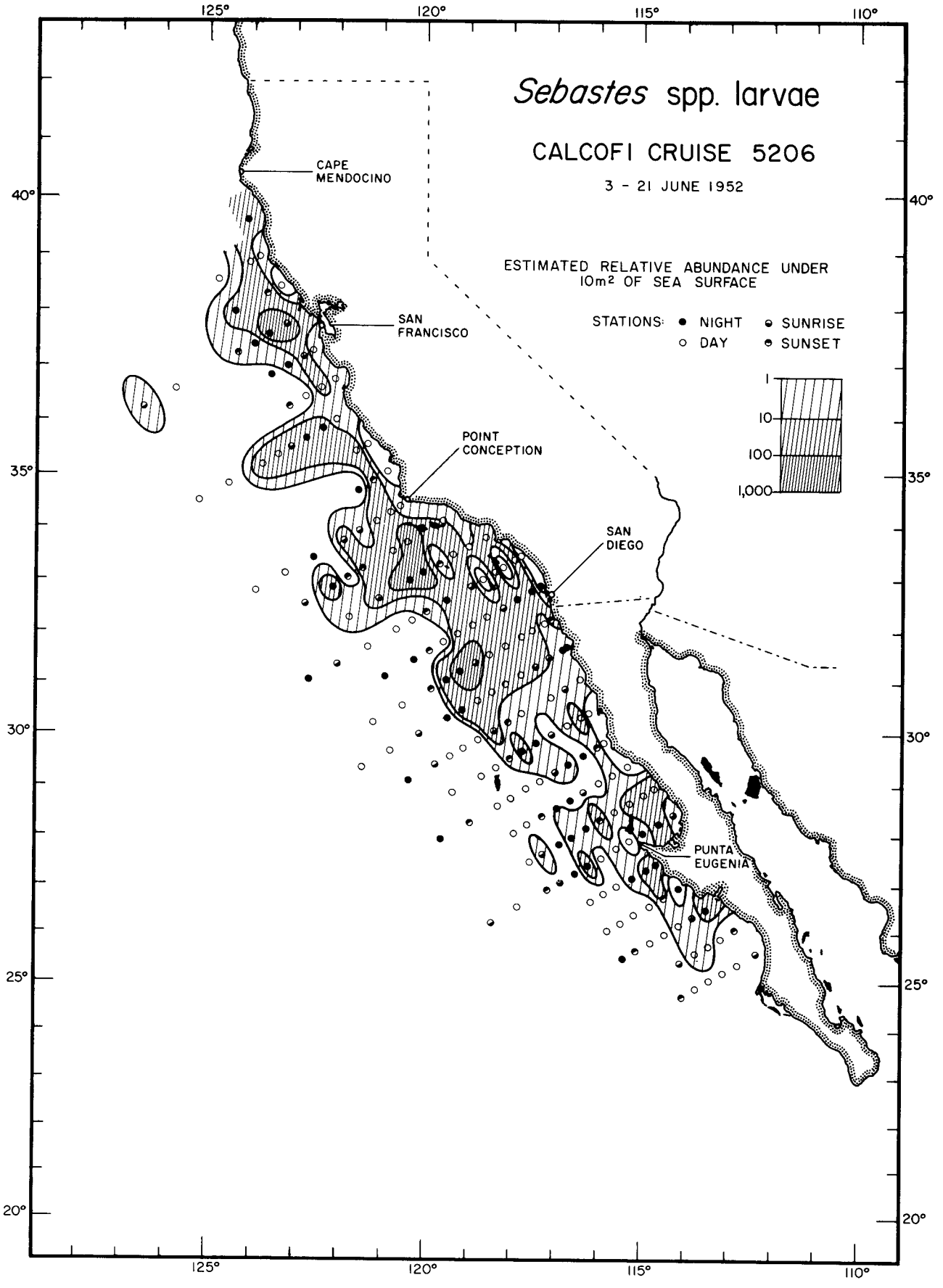

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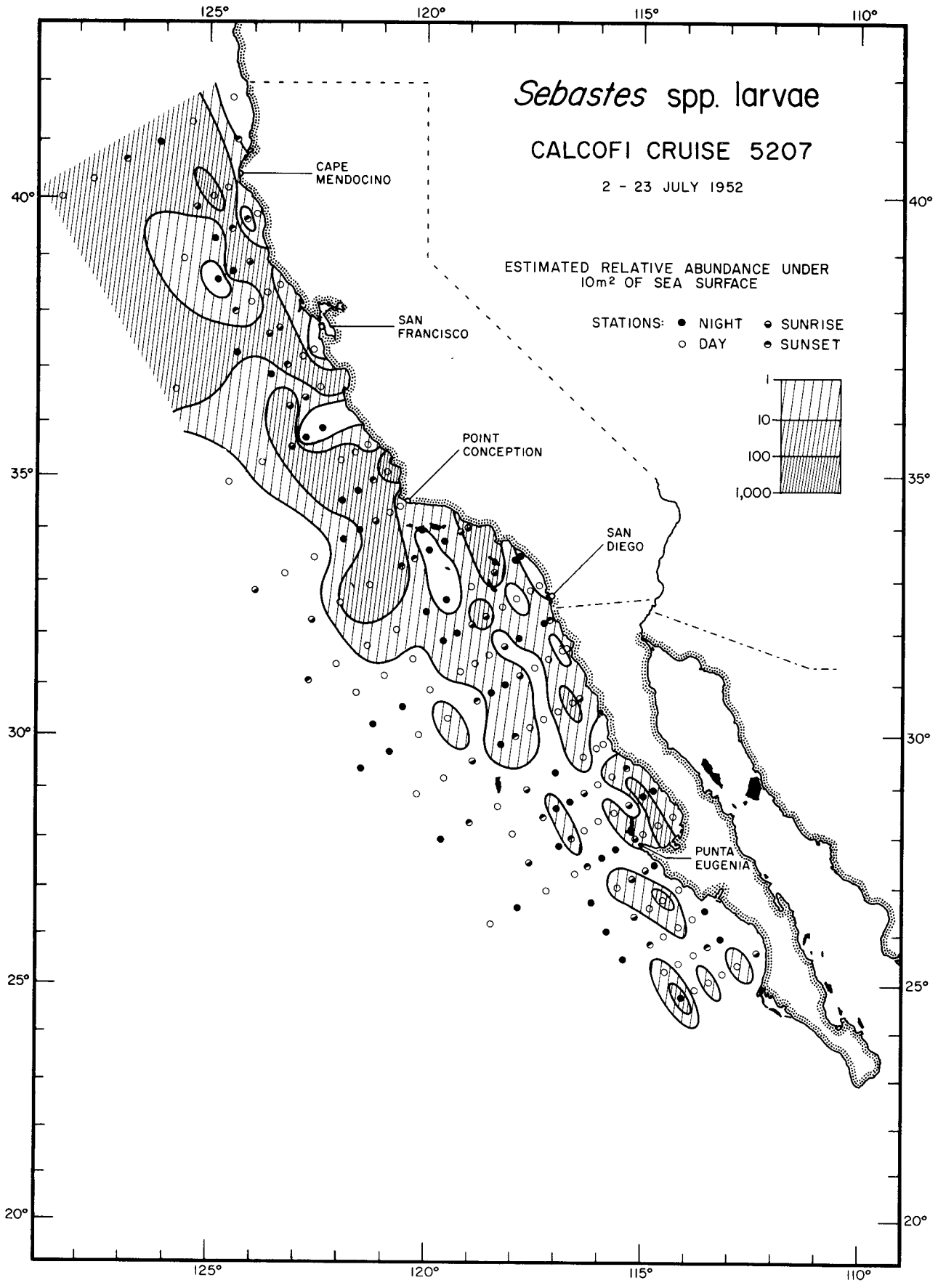

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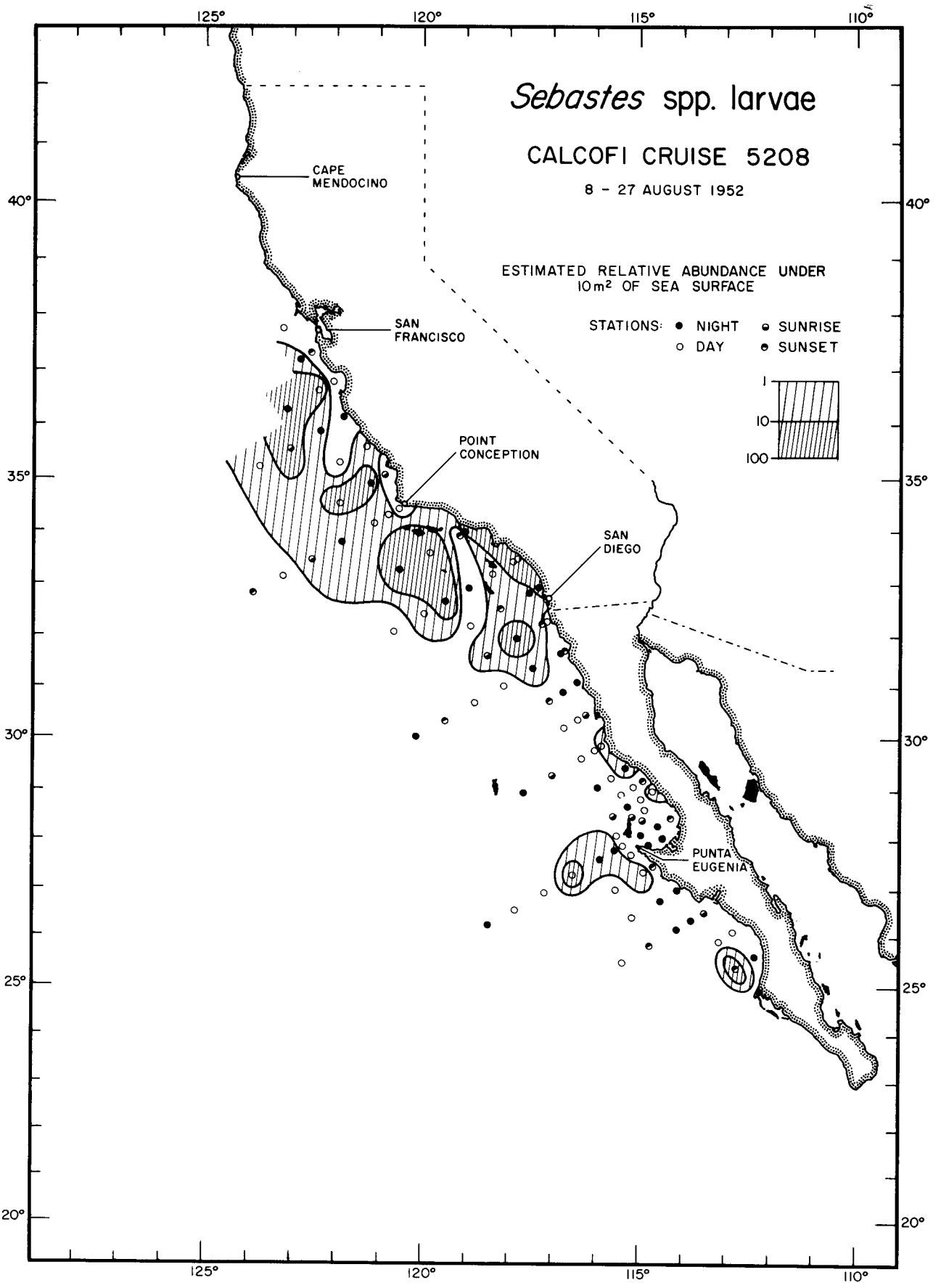

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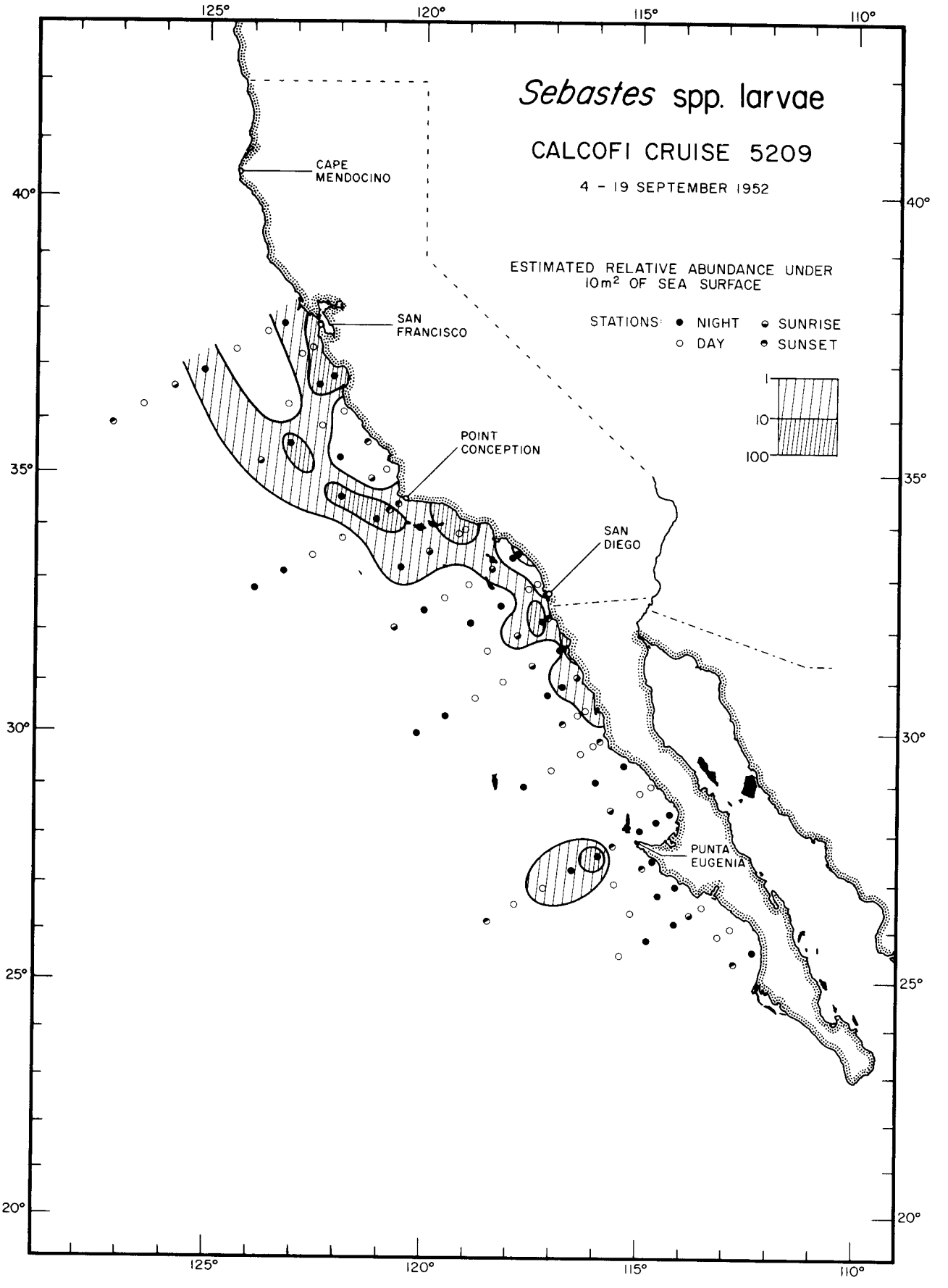

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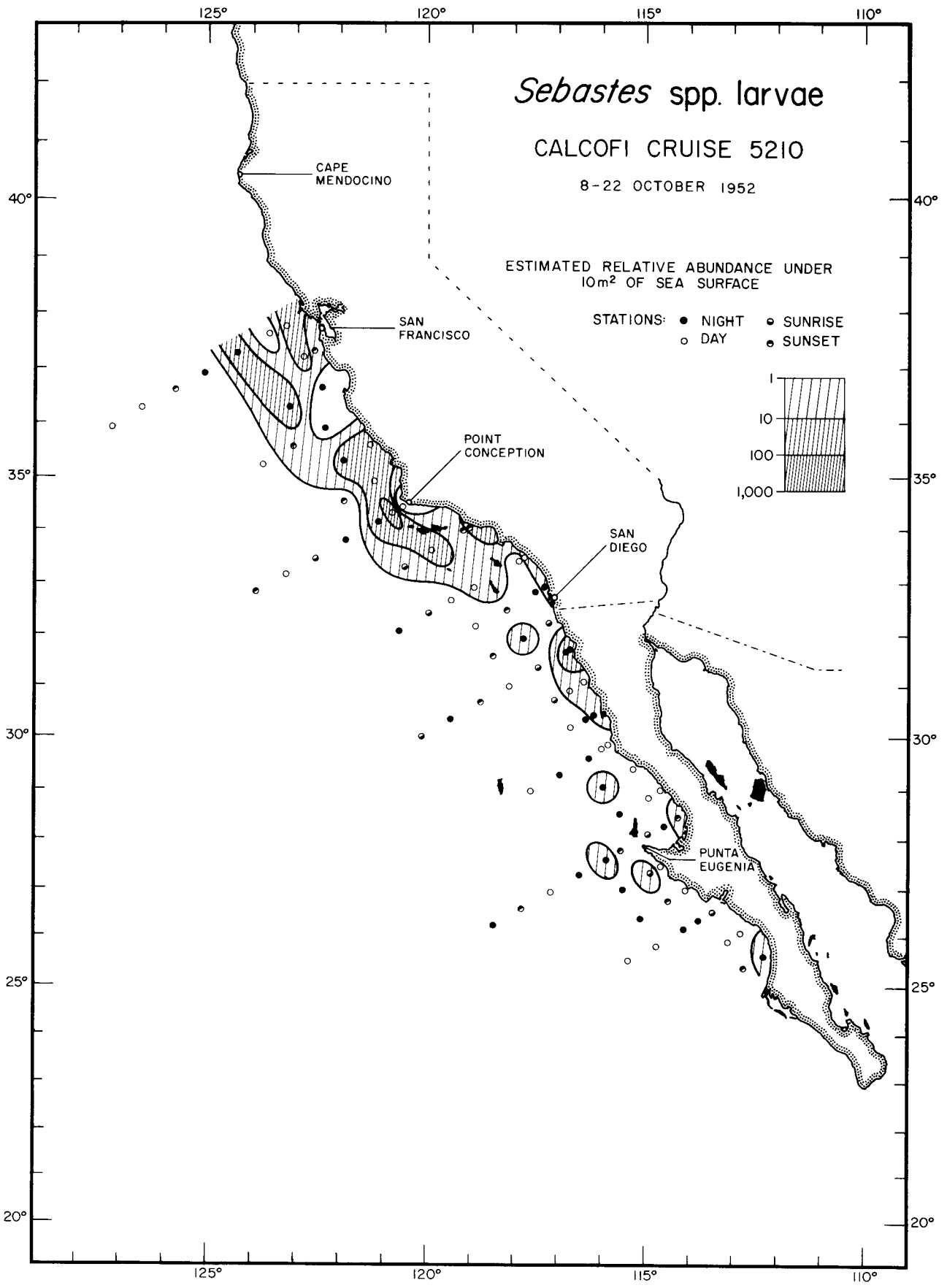

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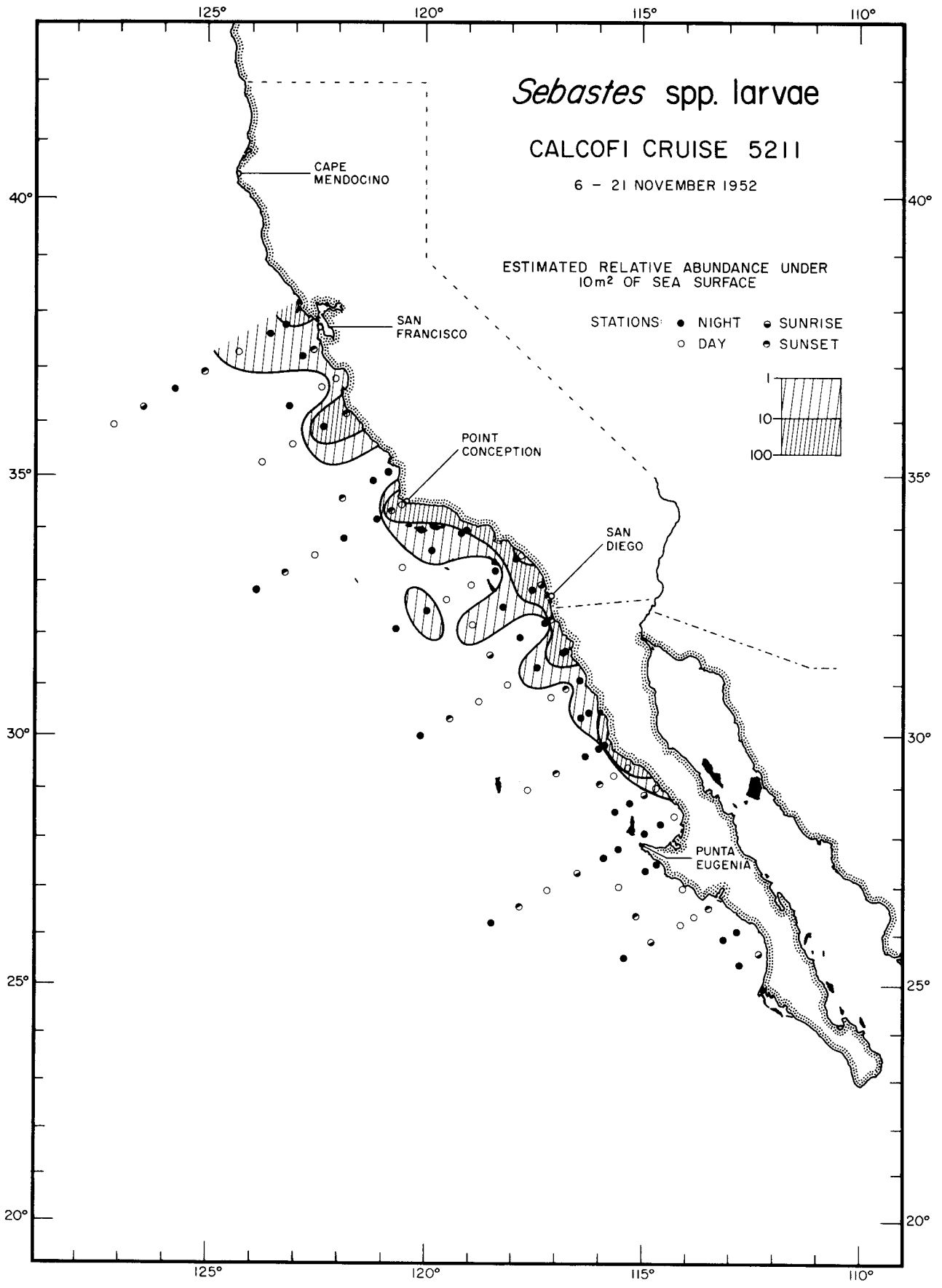

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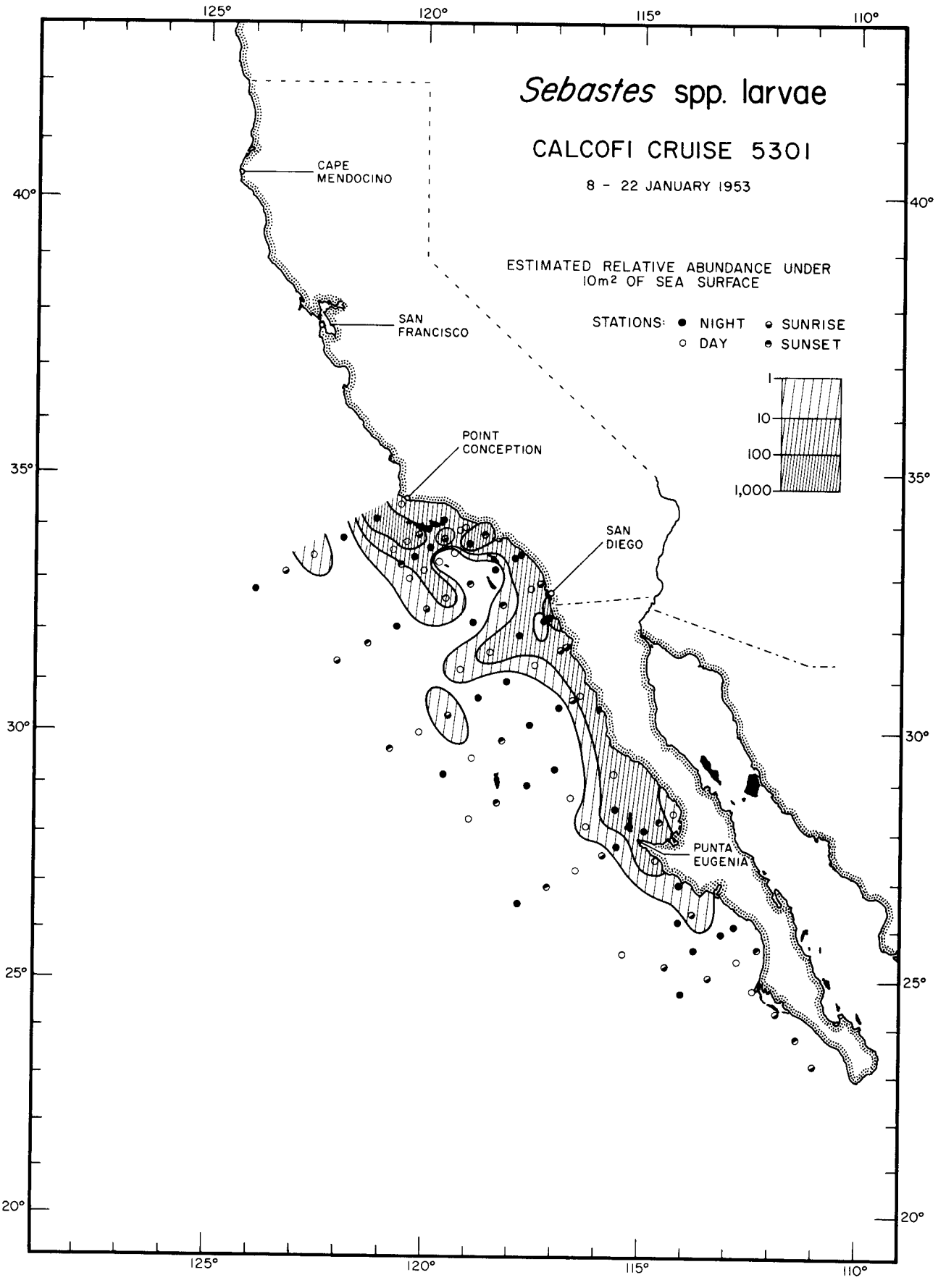

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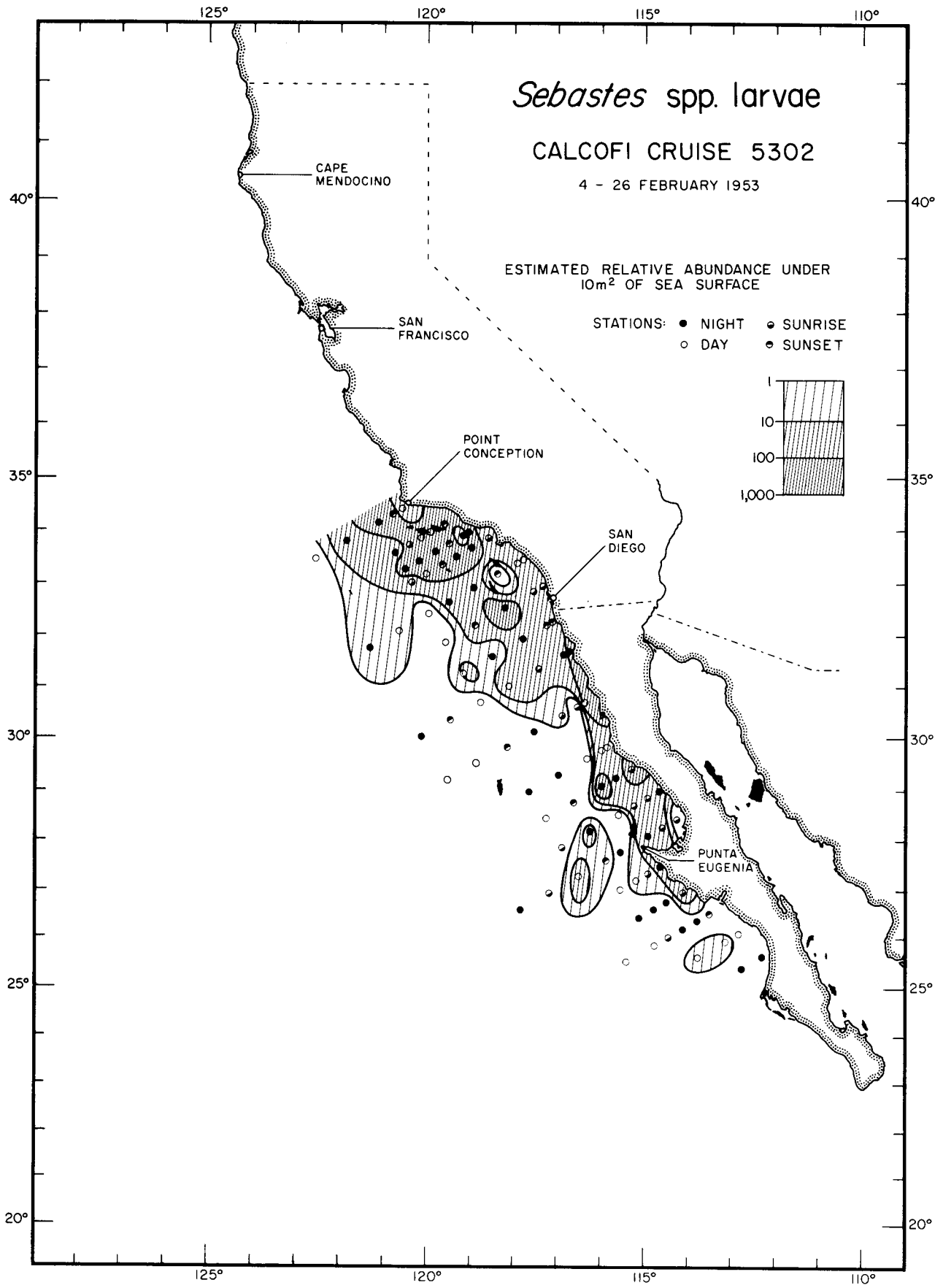

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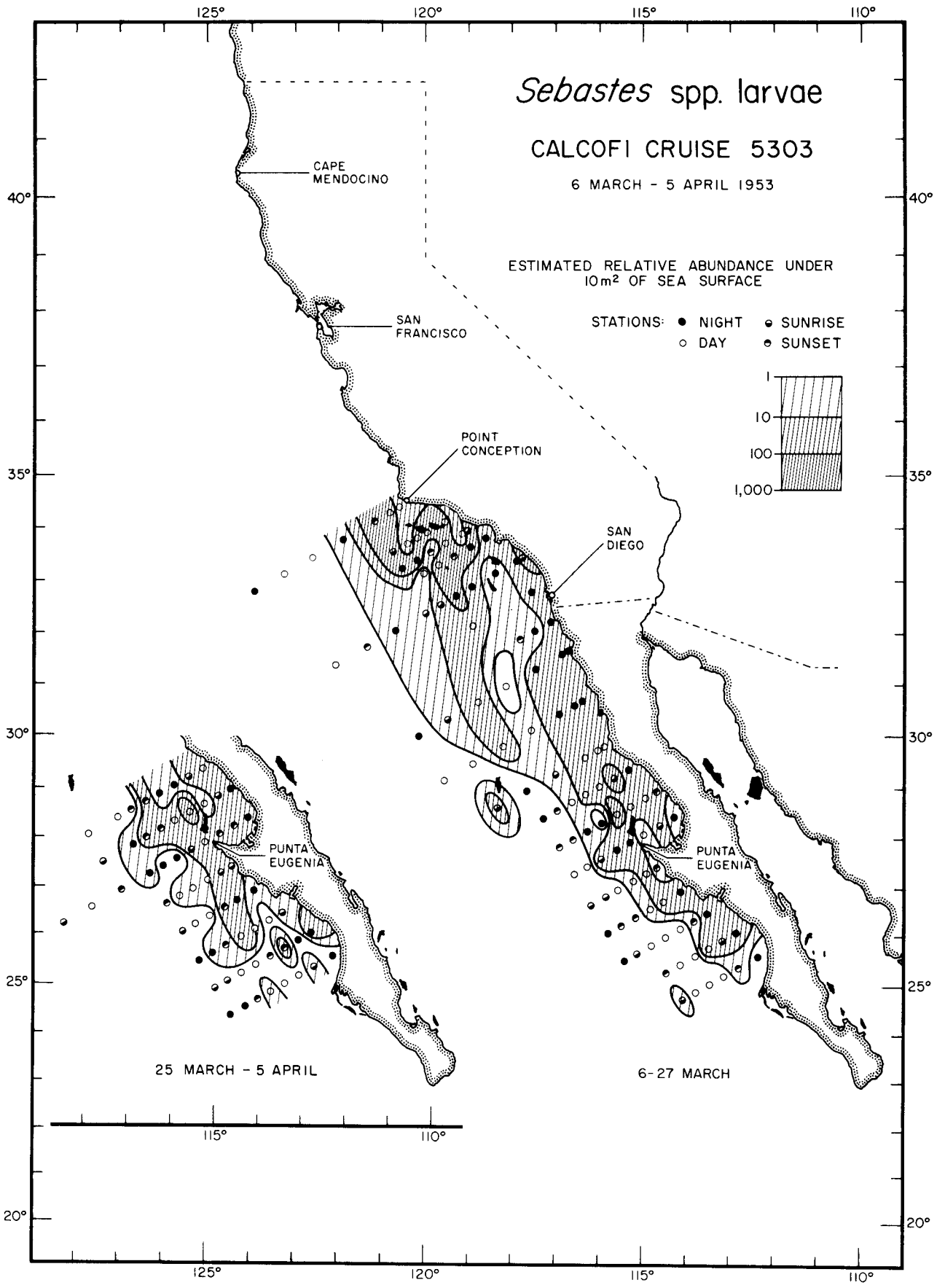

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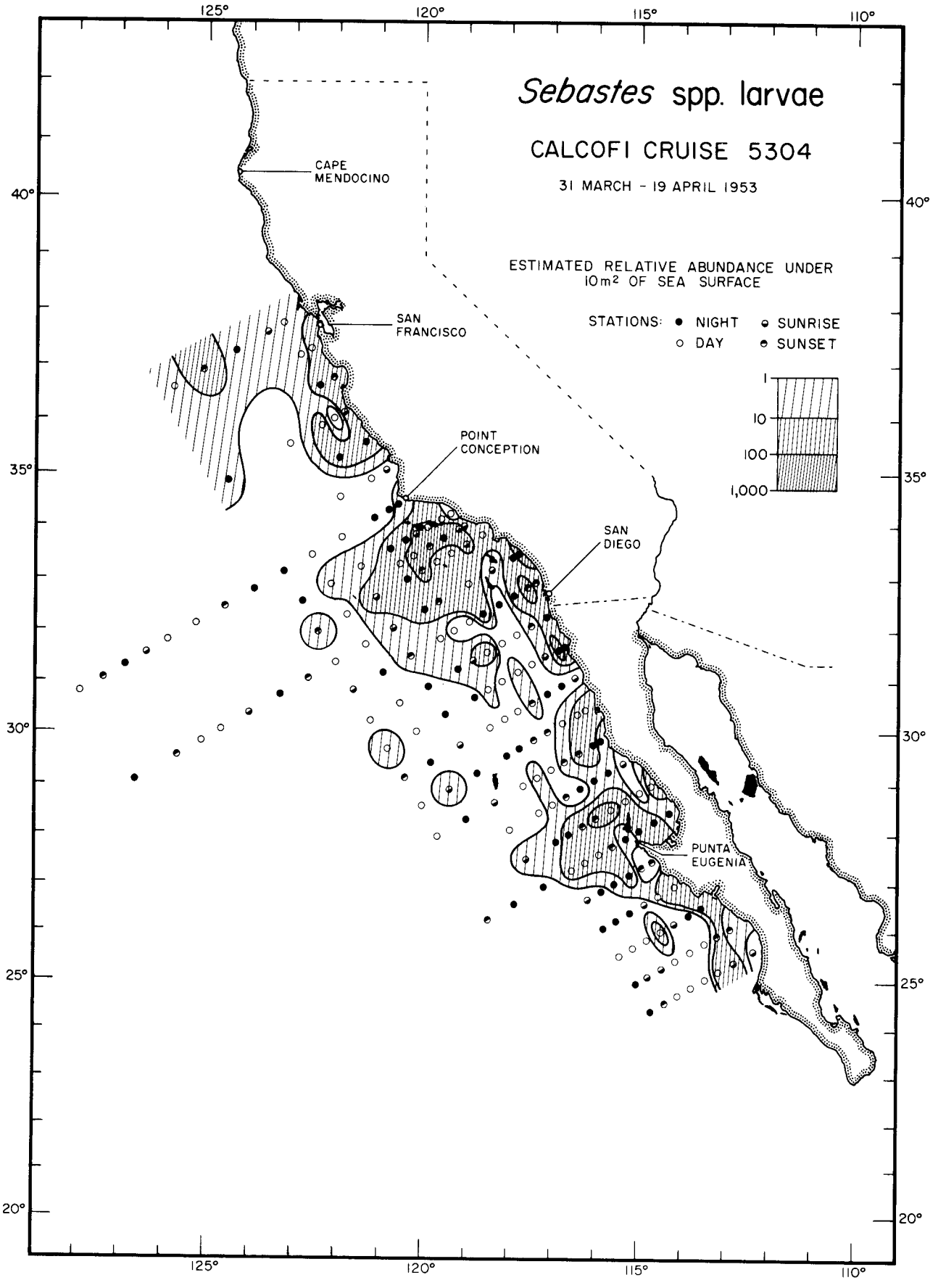

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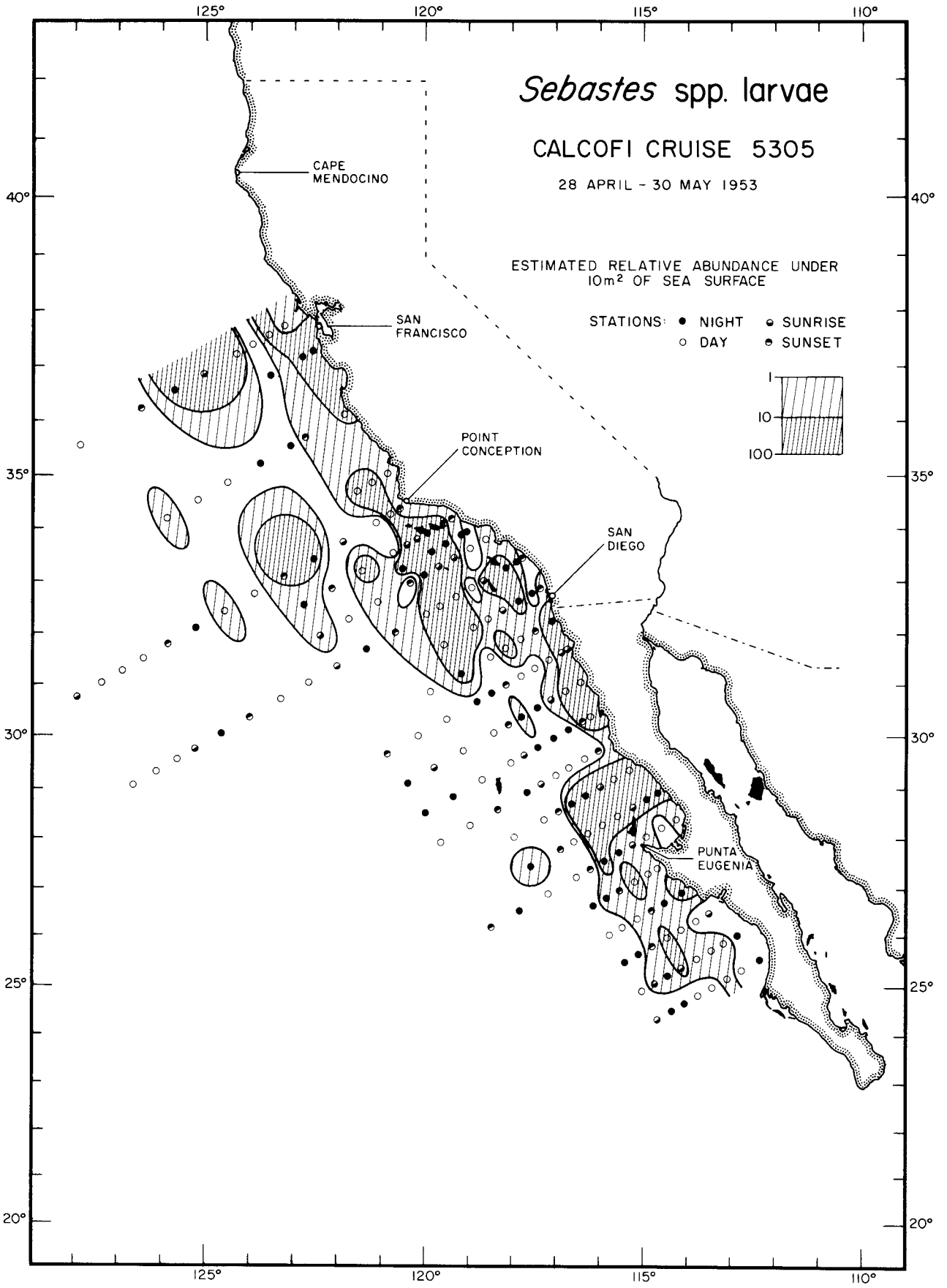

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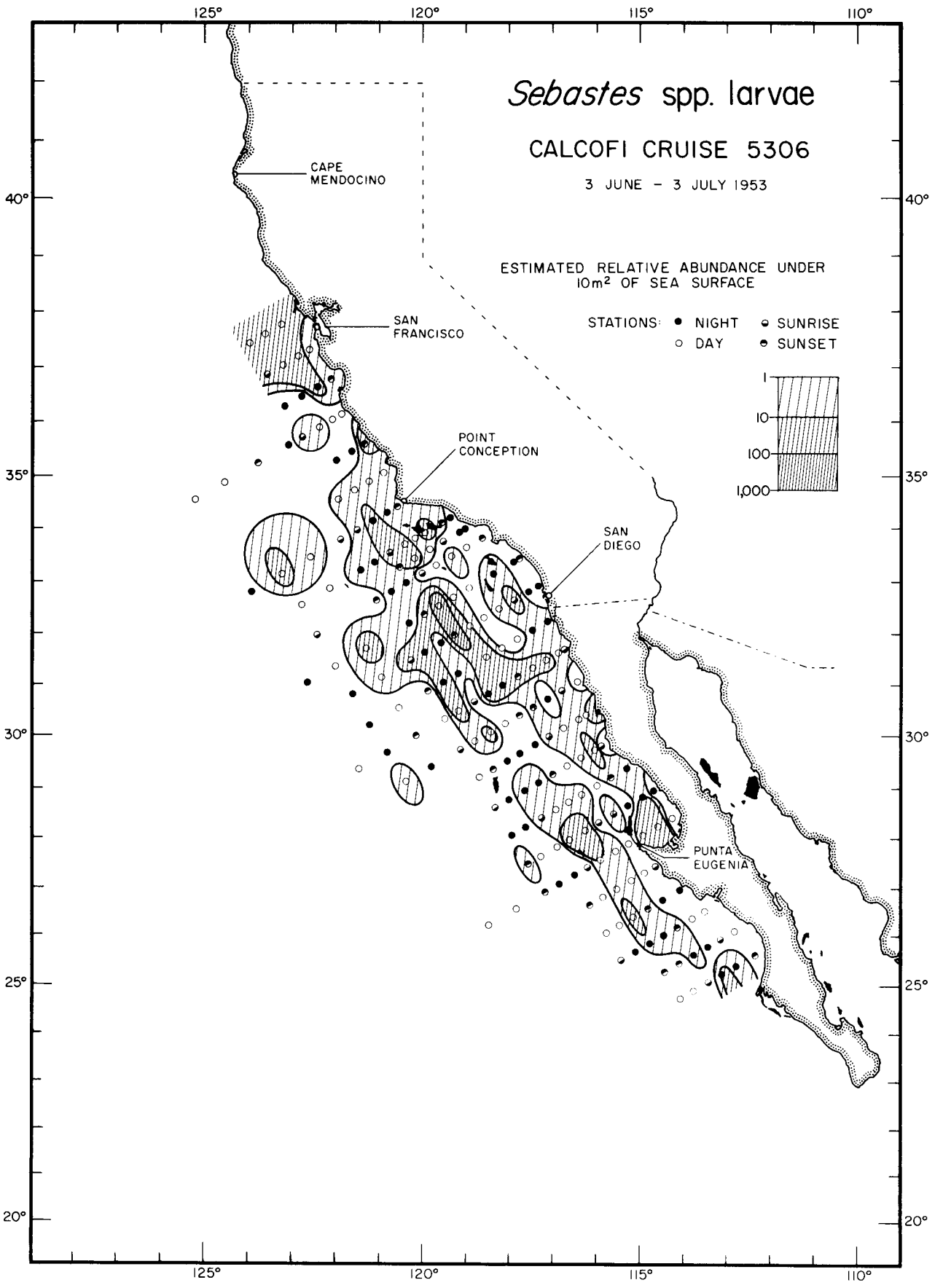
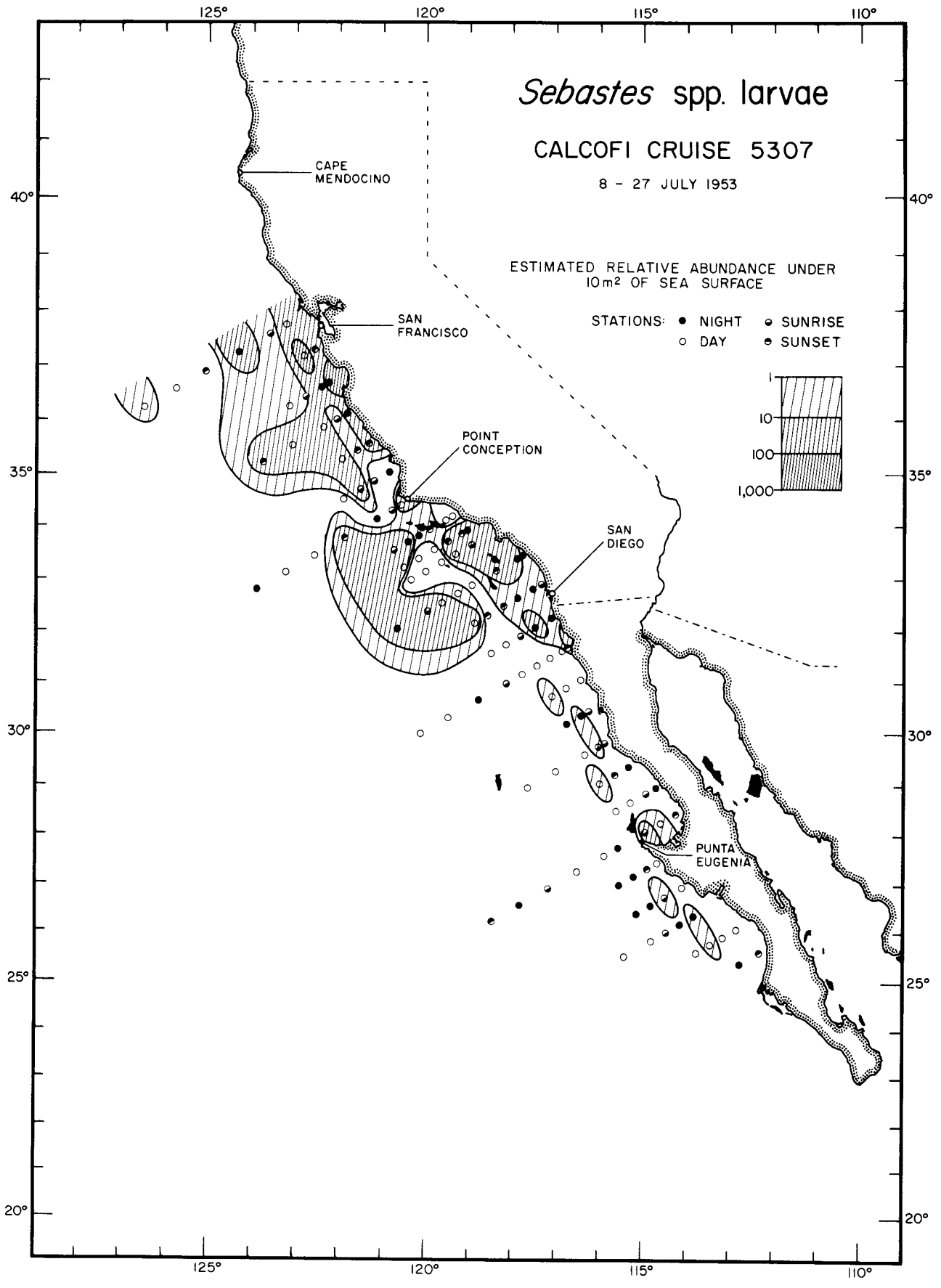


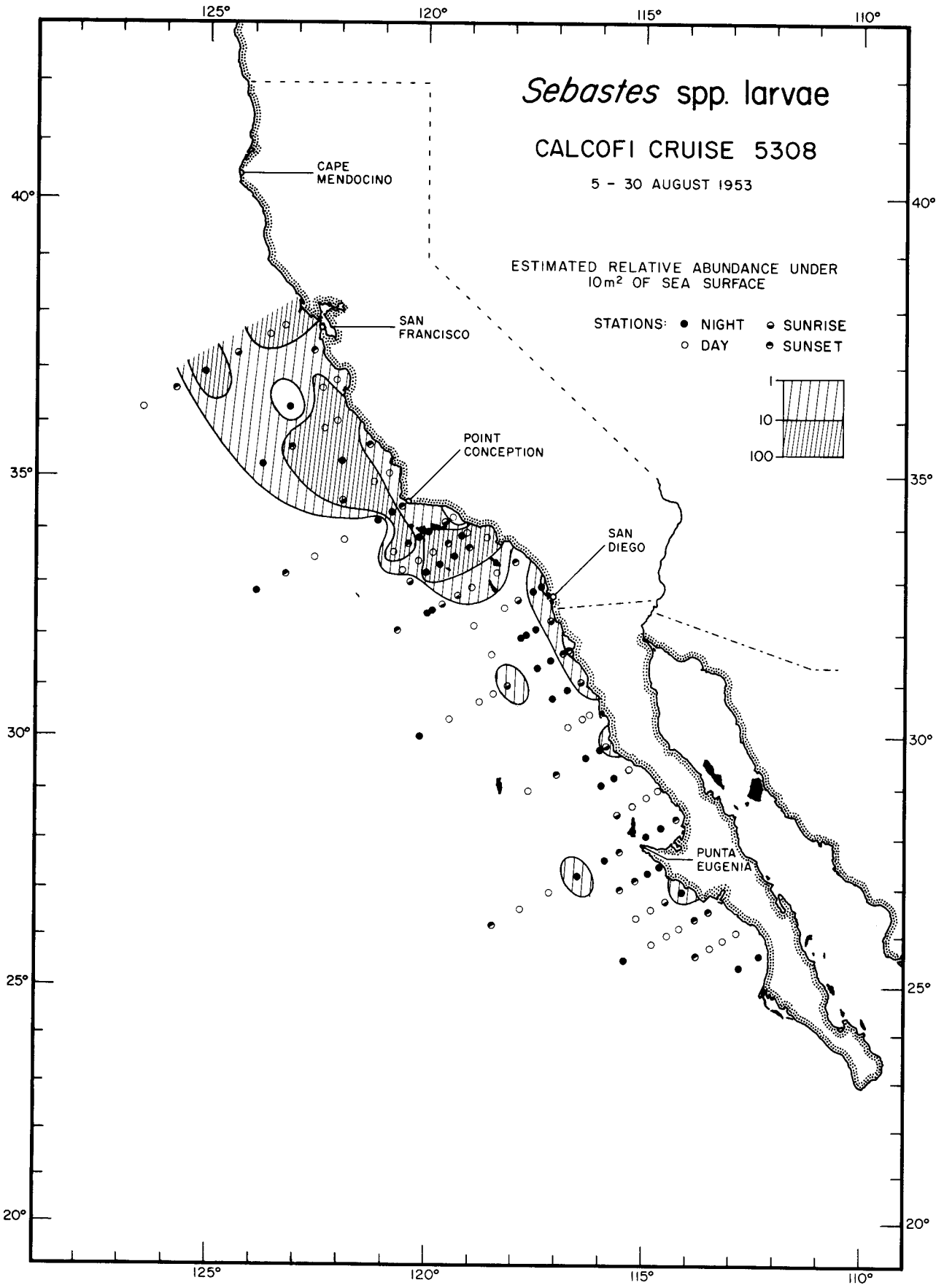
Sebastes spp. larvae

5306



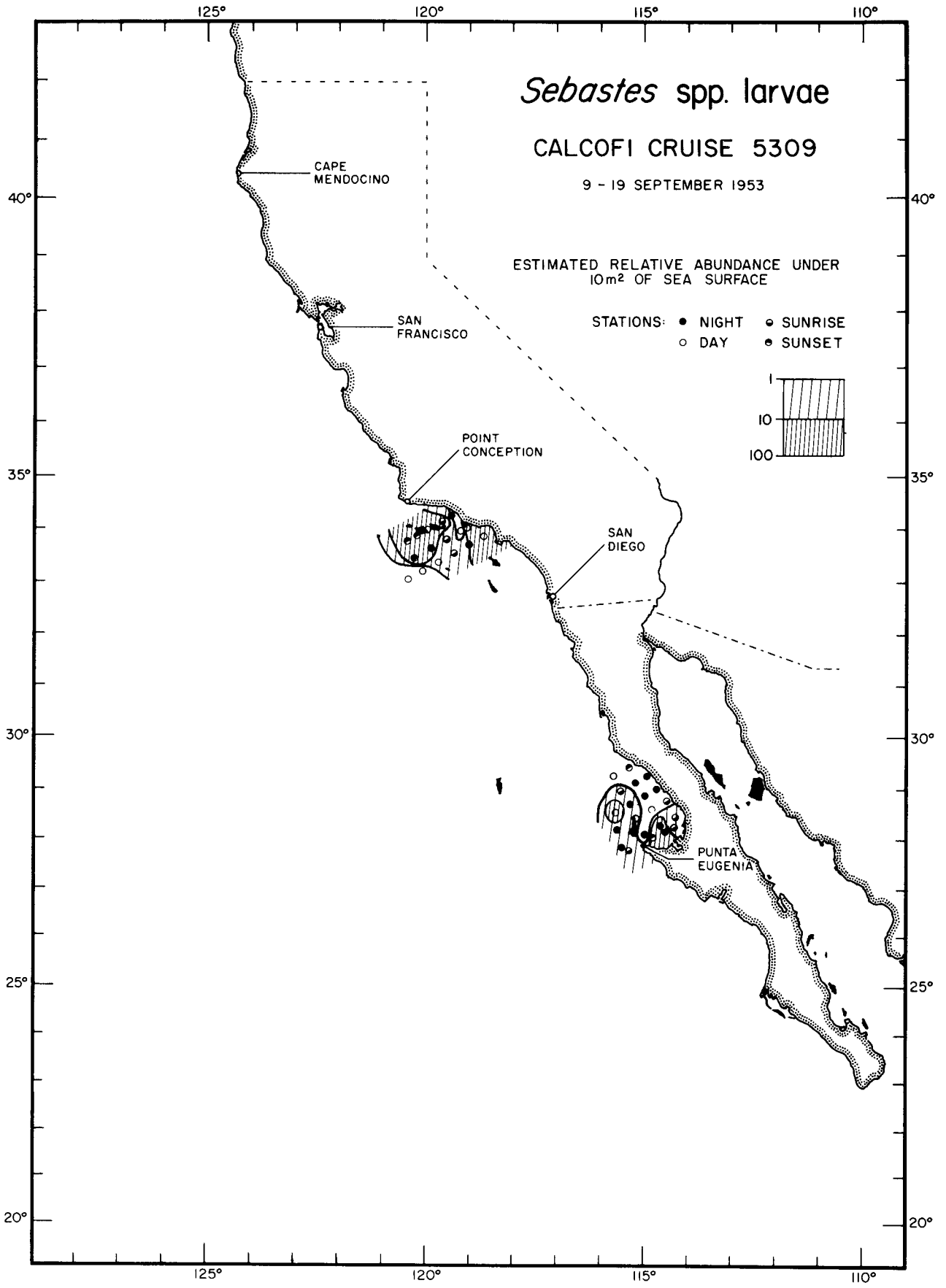
Sebastes spp. larvae

5307



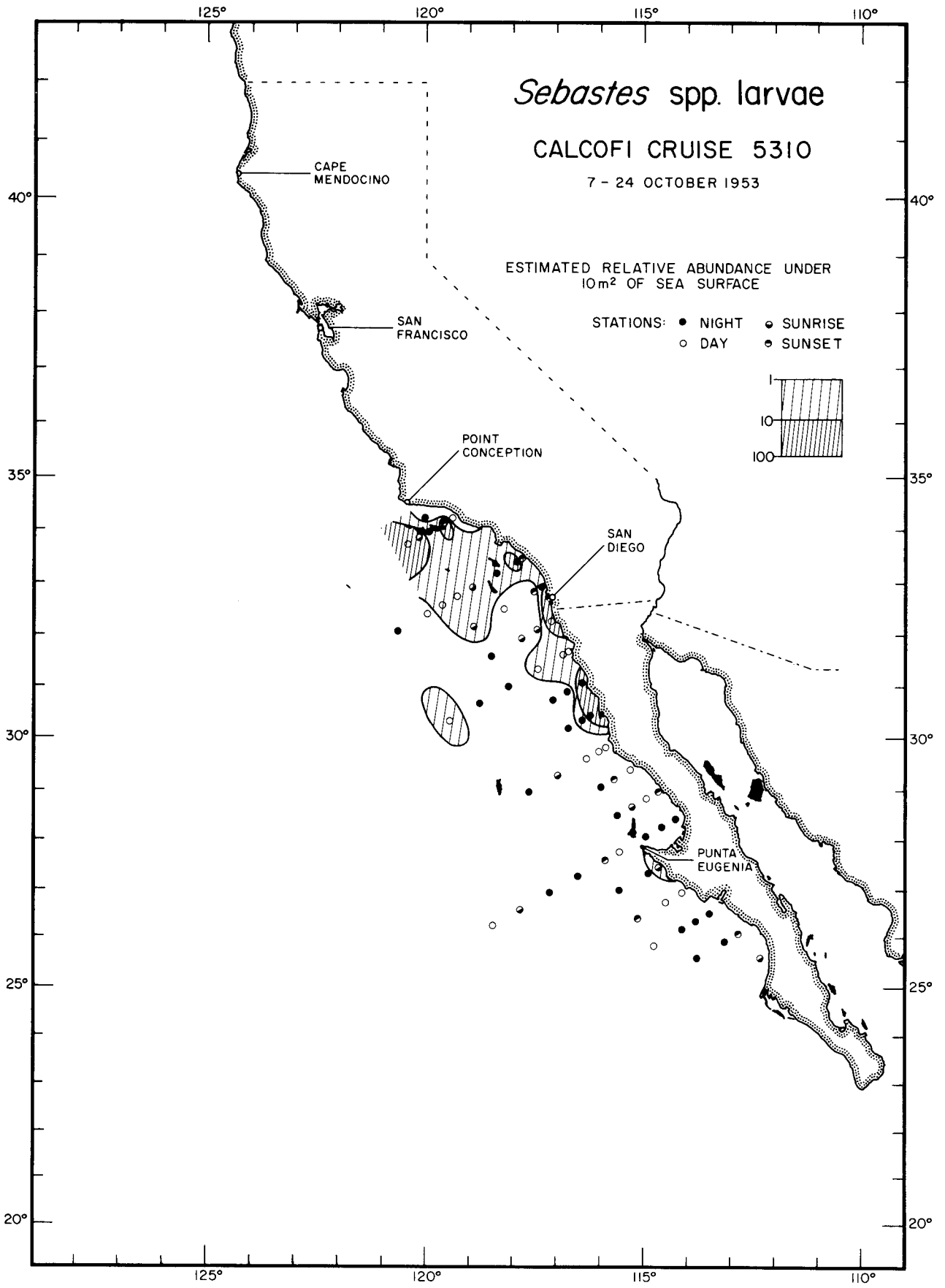
Sebastes spp. larvae

5308



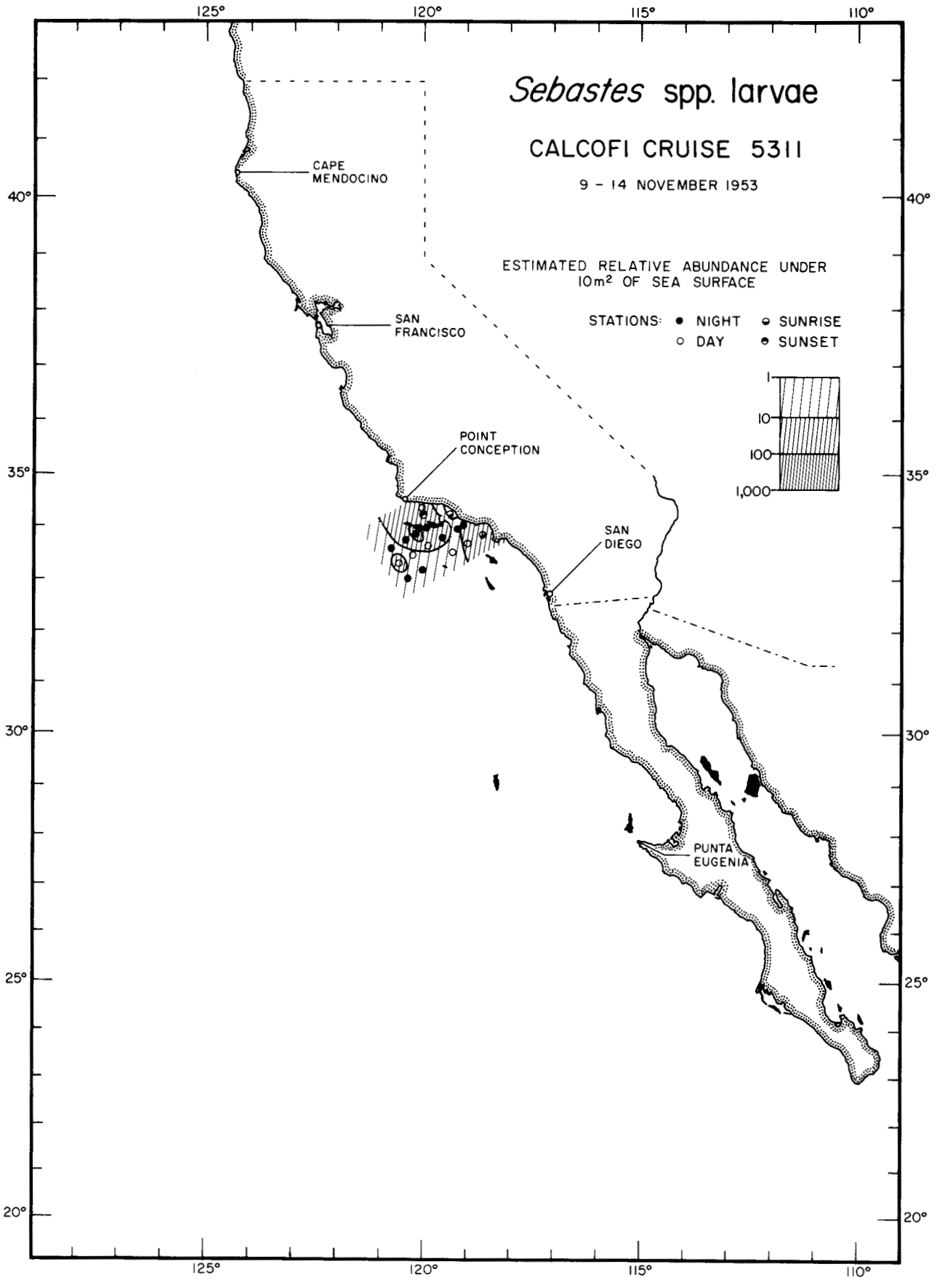
Sebastes spp. larvae

5309



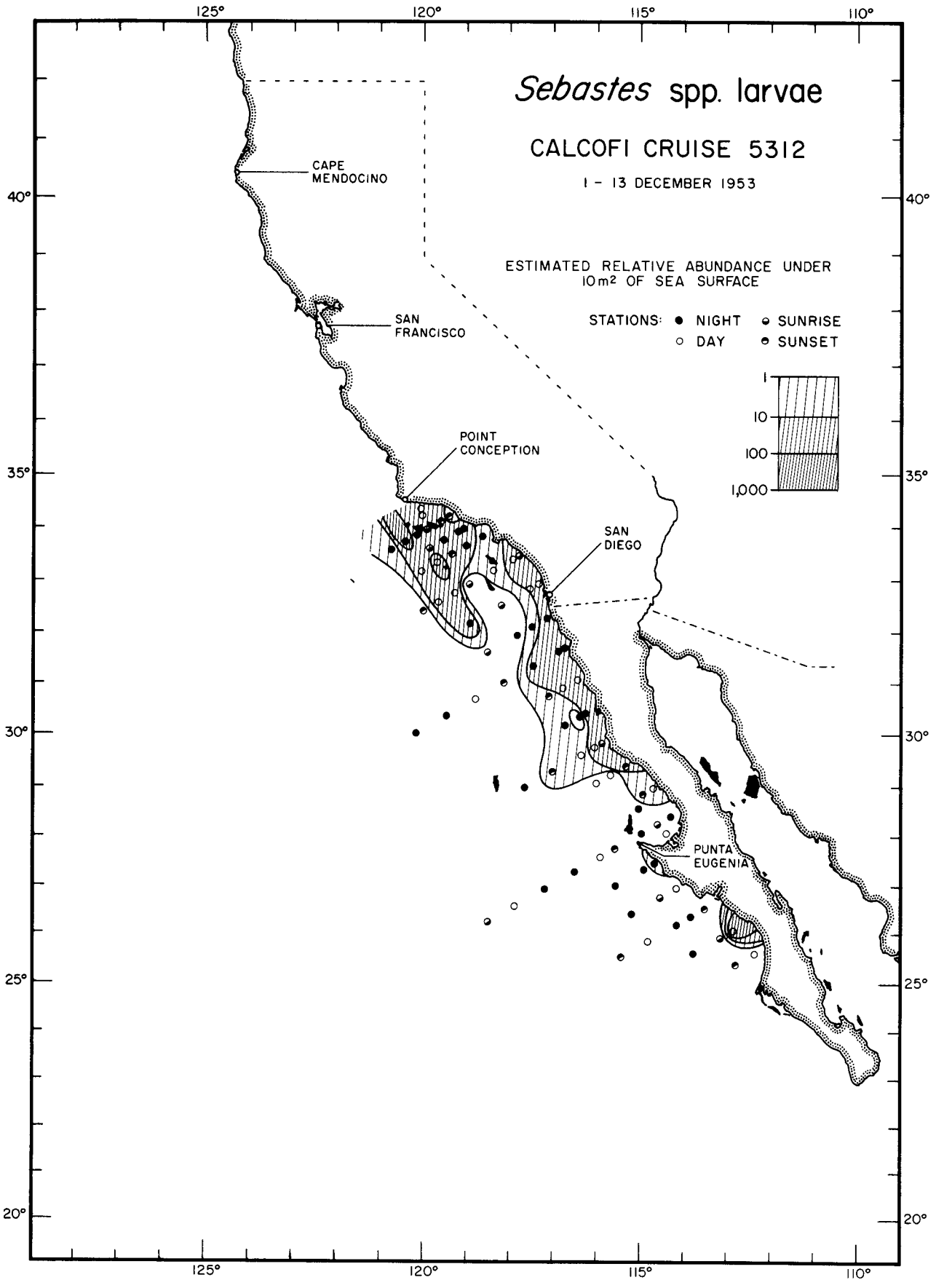
Sebastes spp. larvae

5310



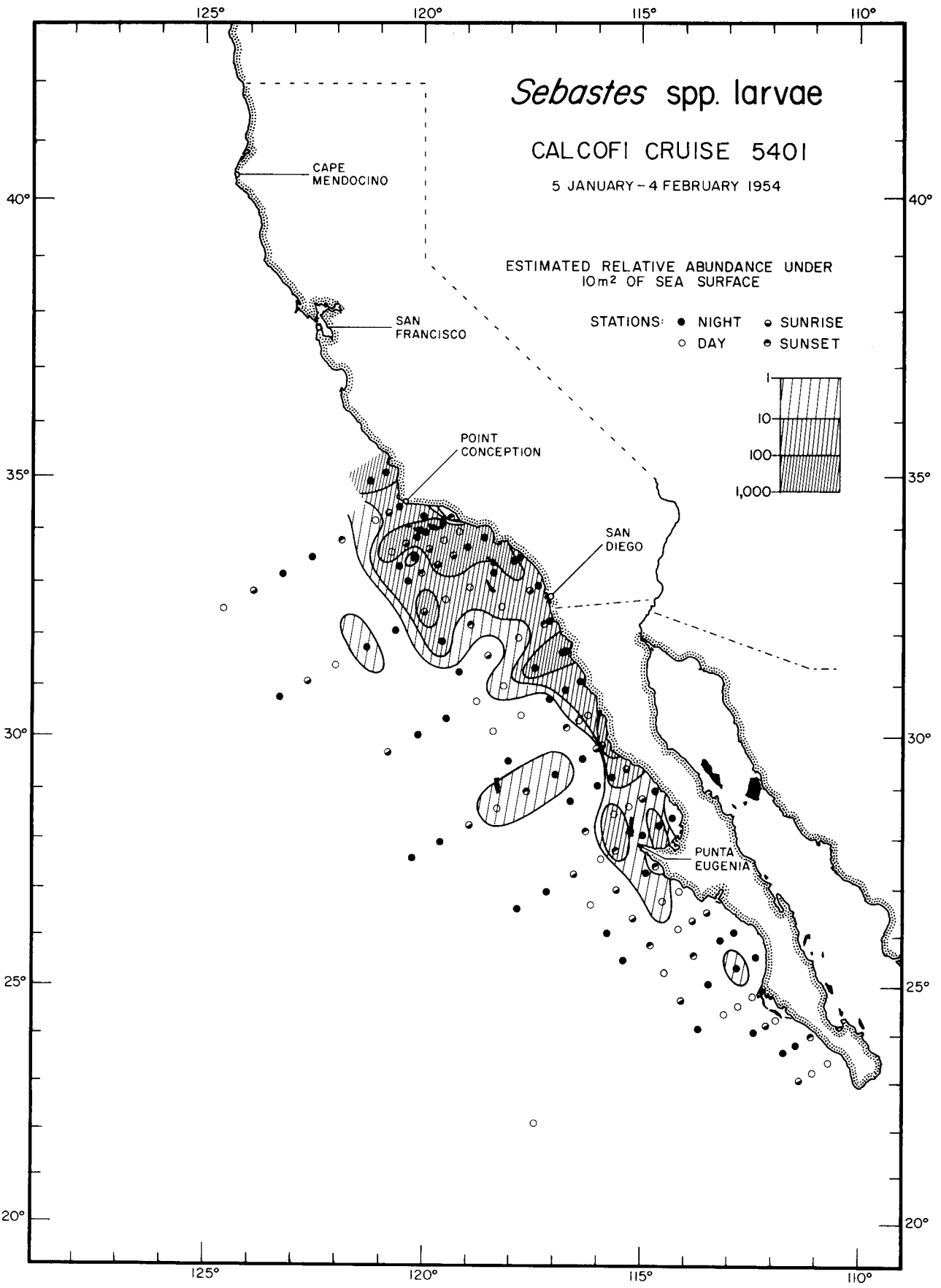
Sebastes spp. larvae

5311



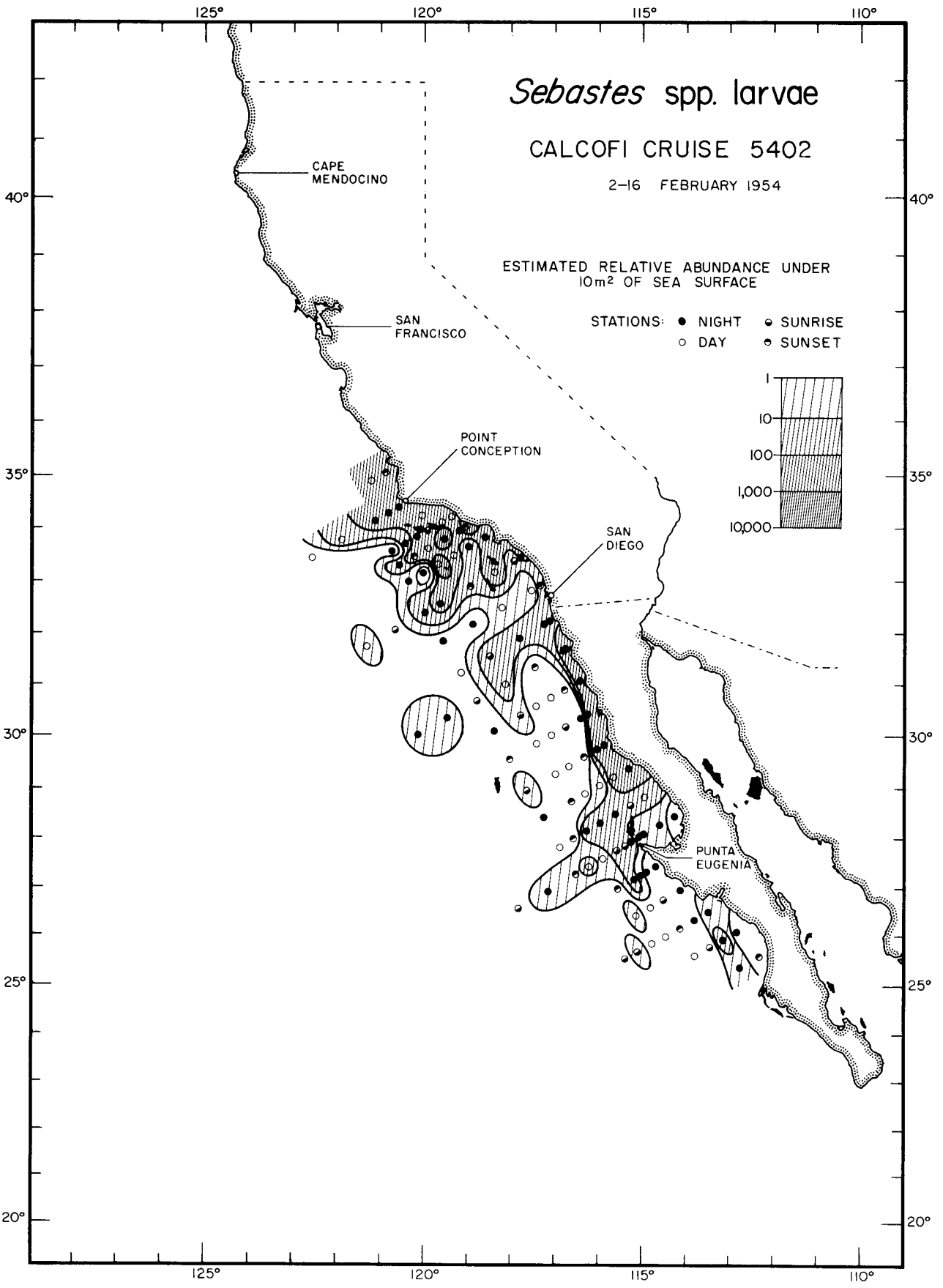
Sebastes spp. larvae

5312



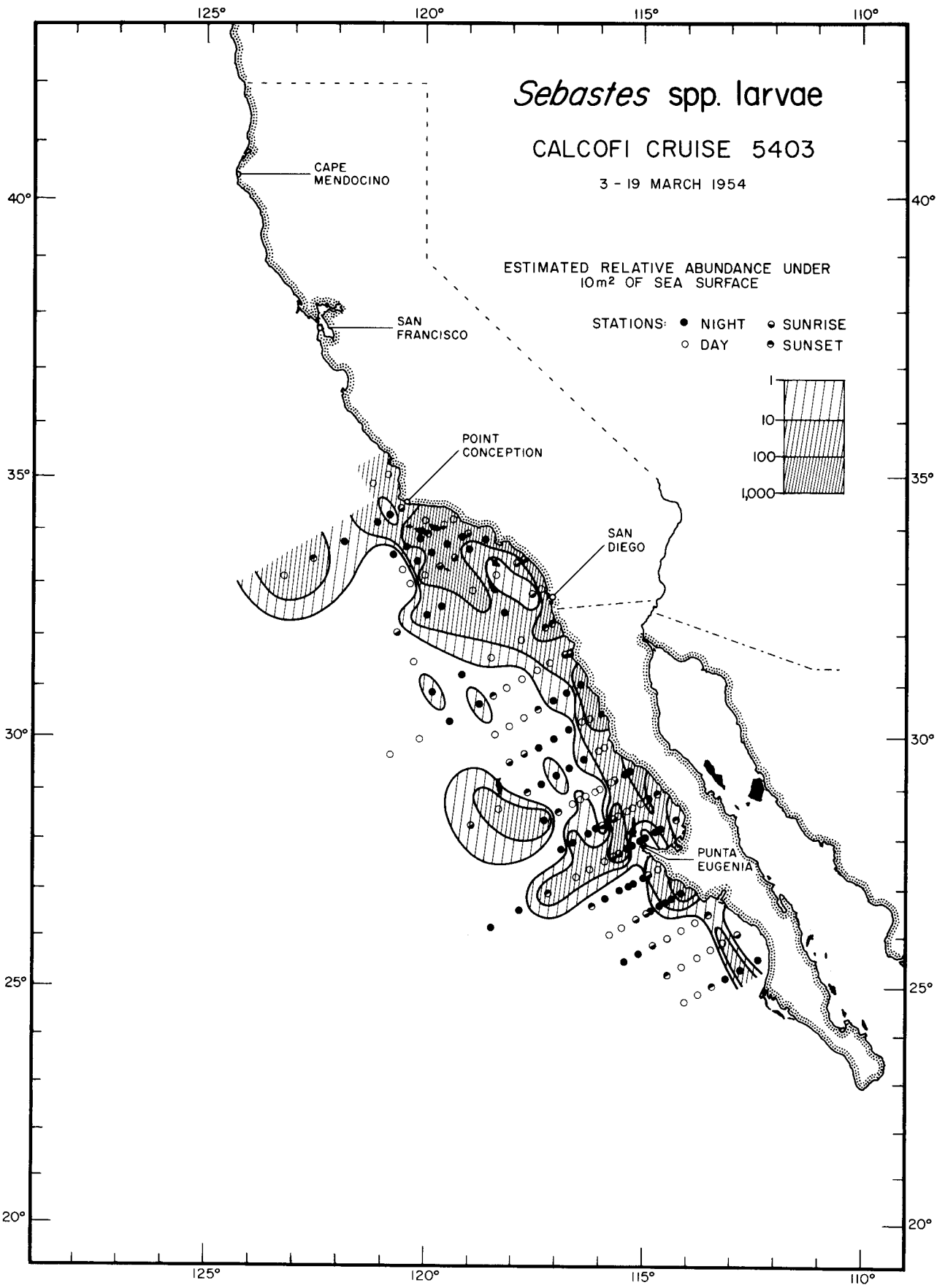
Sebastes spp. larvae

5401



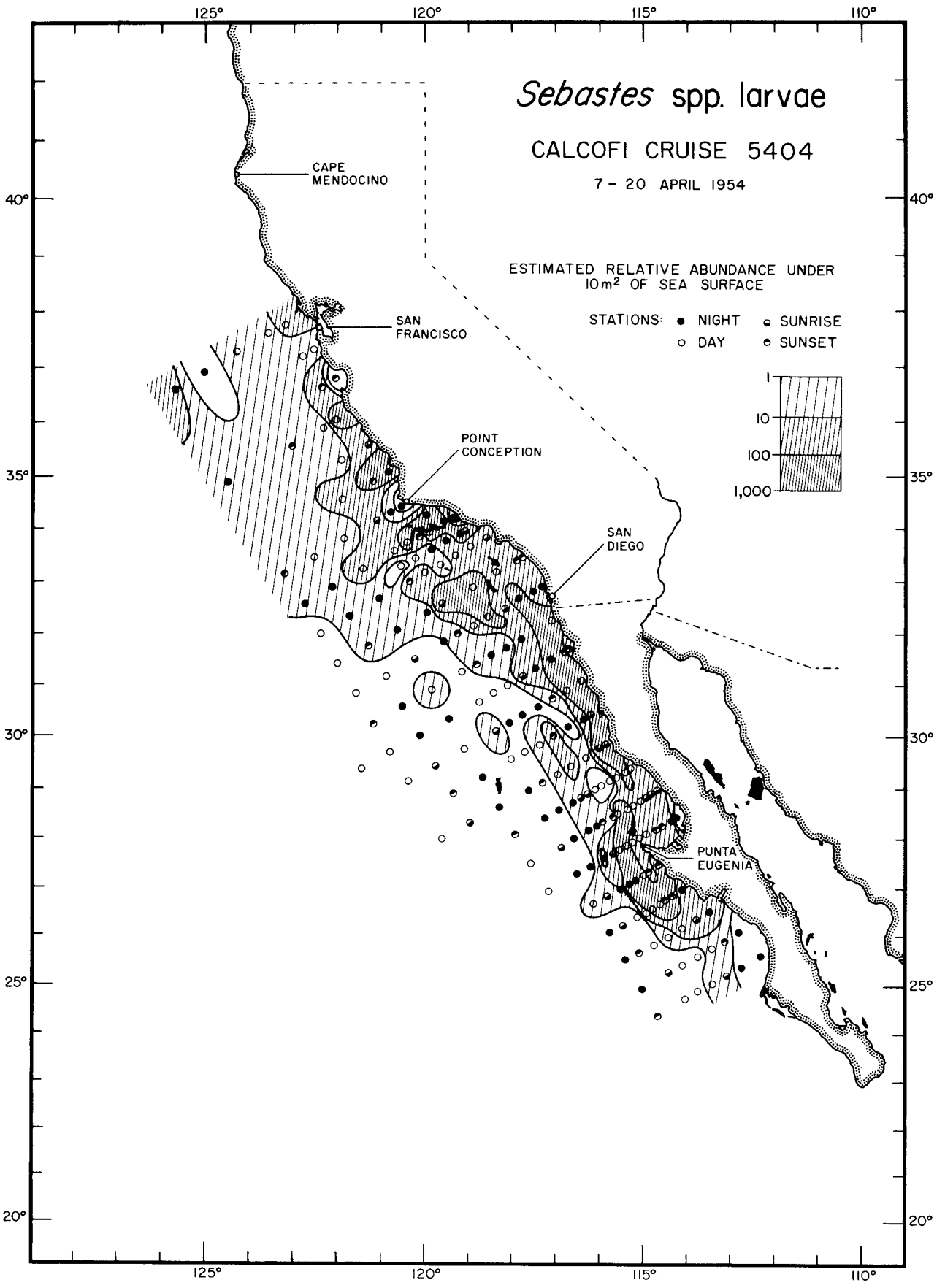
Sebastes spp. larvae

5402



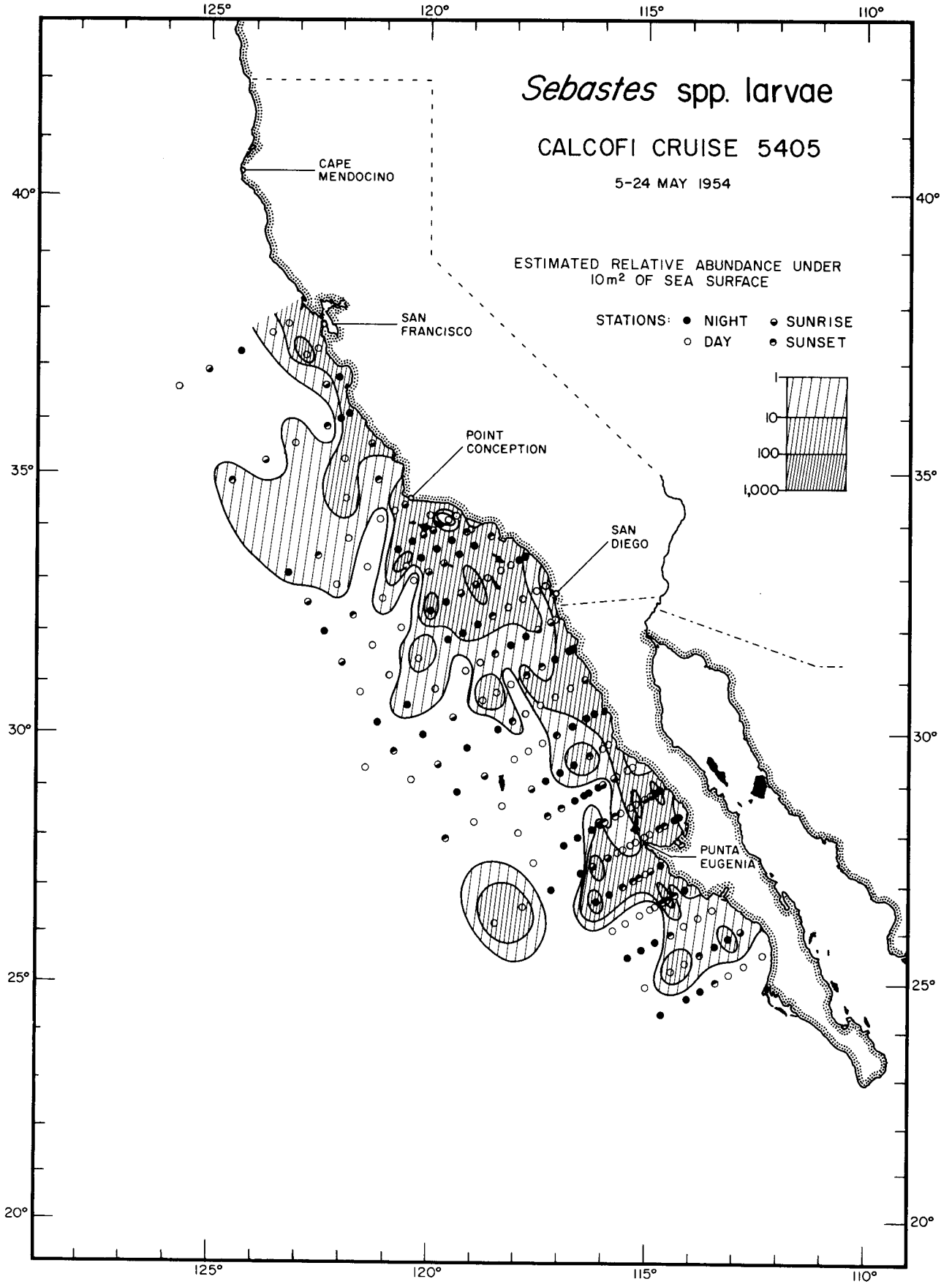
Sebastes spp. larvae

5403



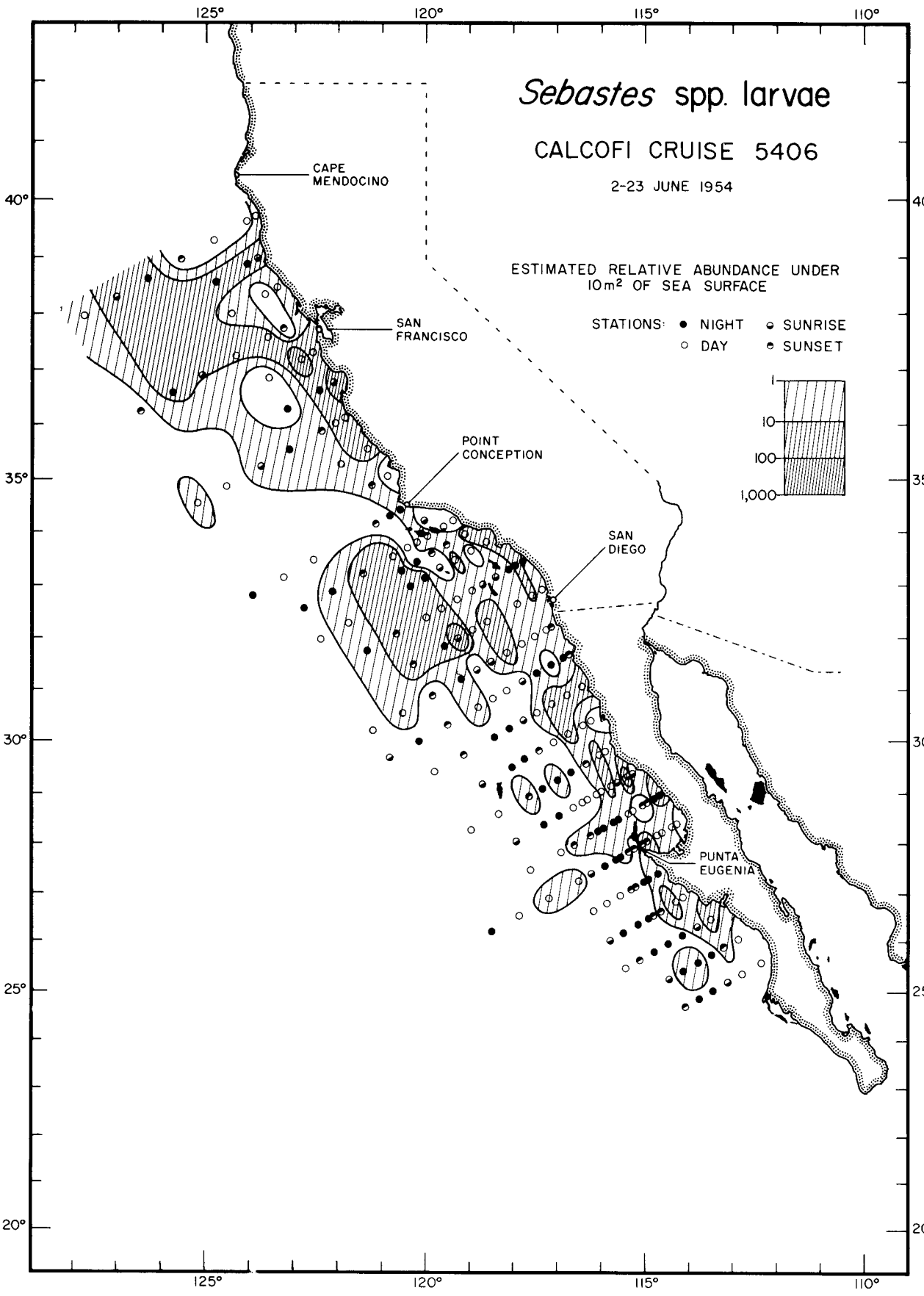
Sebastes spp. larvae

5404



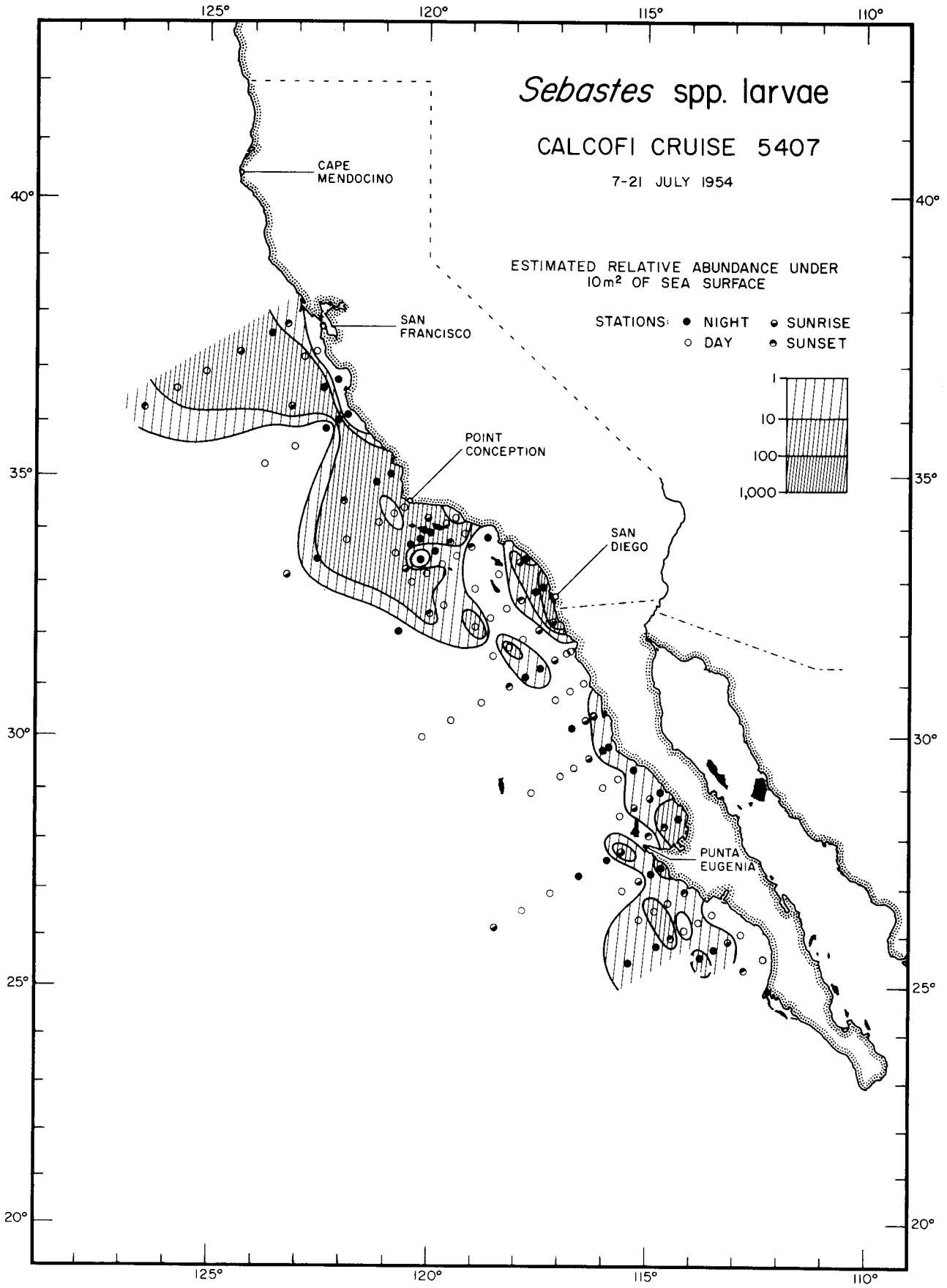
Sebastes spp. larvae

5405



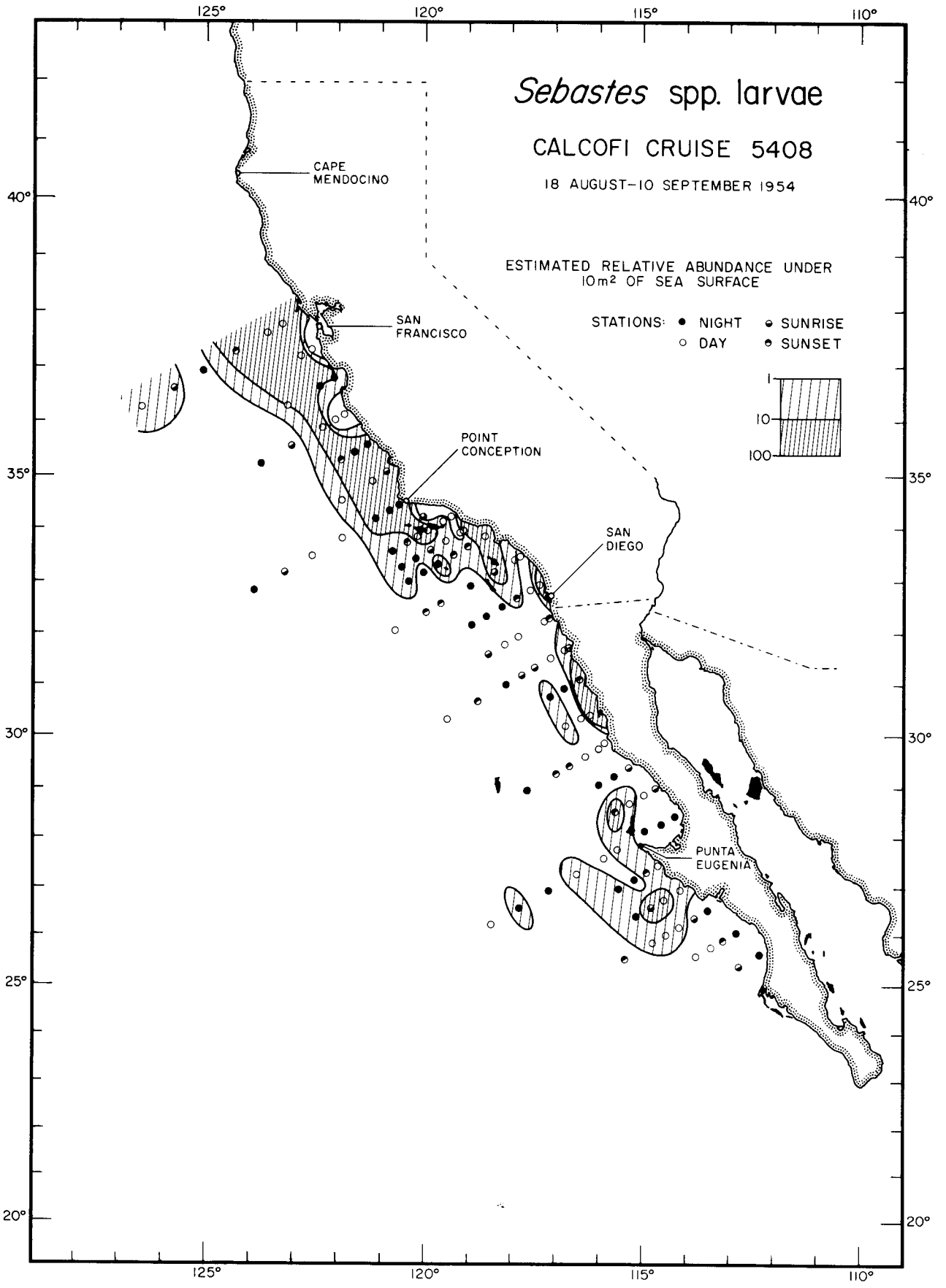
Sebastes spp. larvae

5406



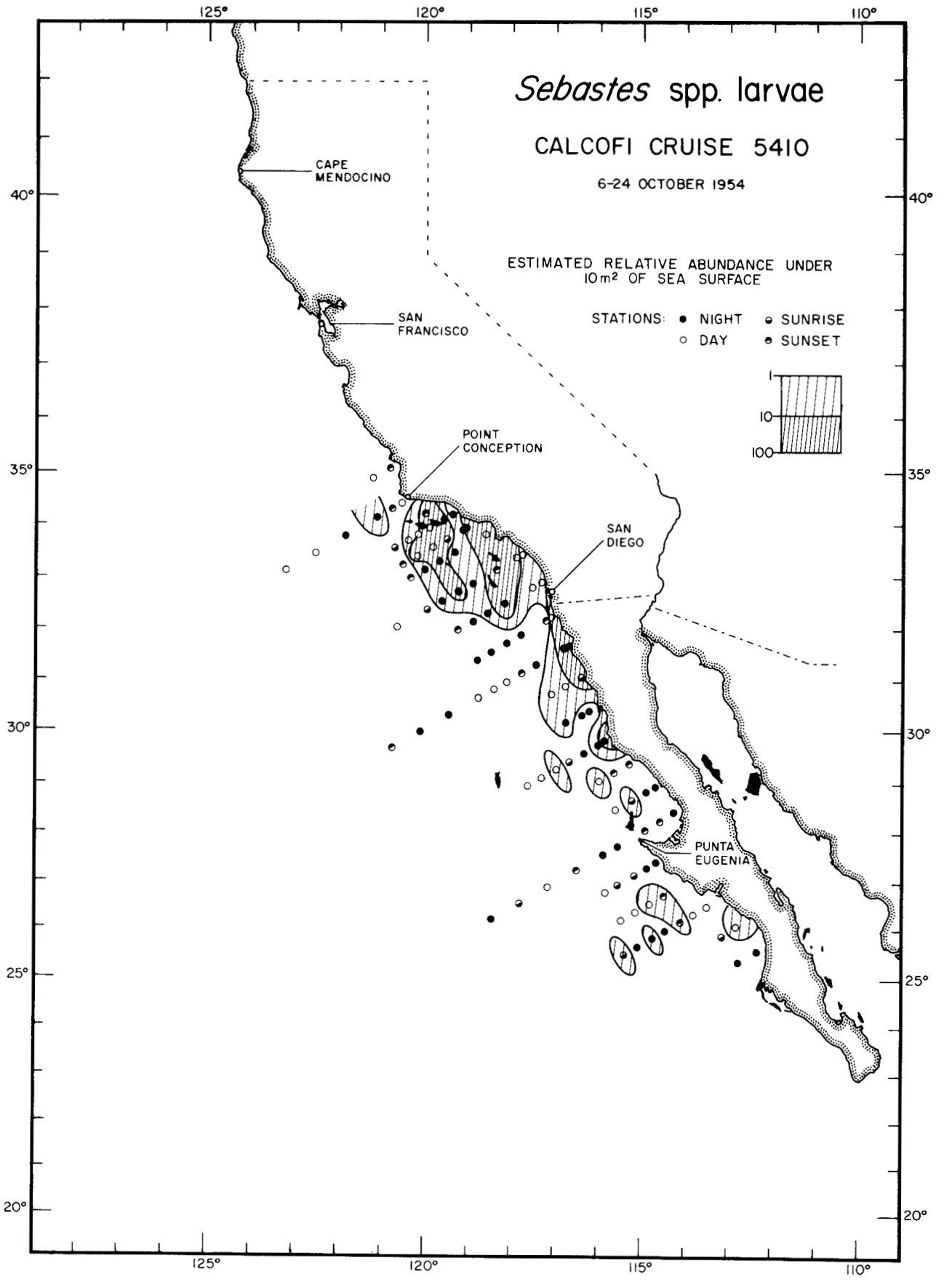
Sebastes spp. larvae

5407



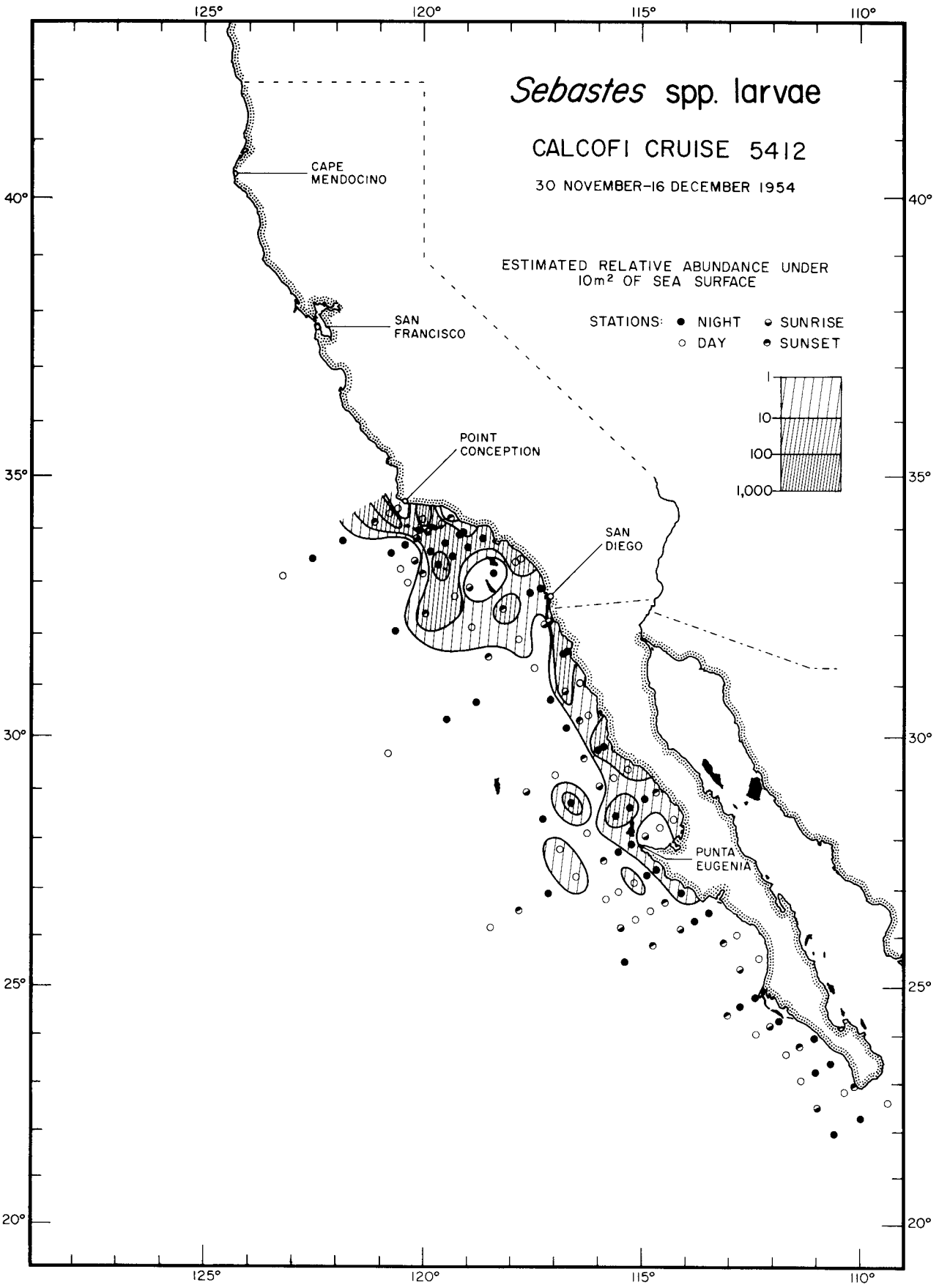
Sebastes spp. larvae

5408



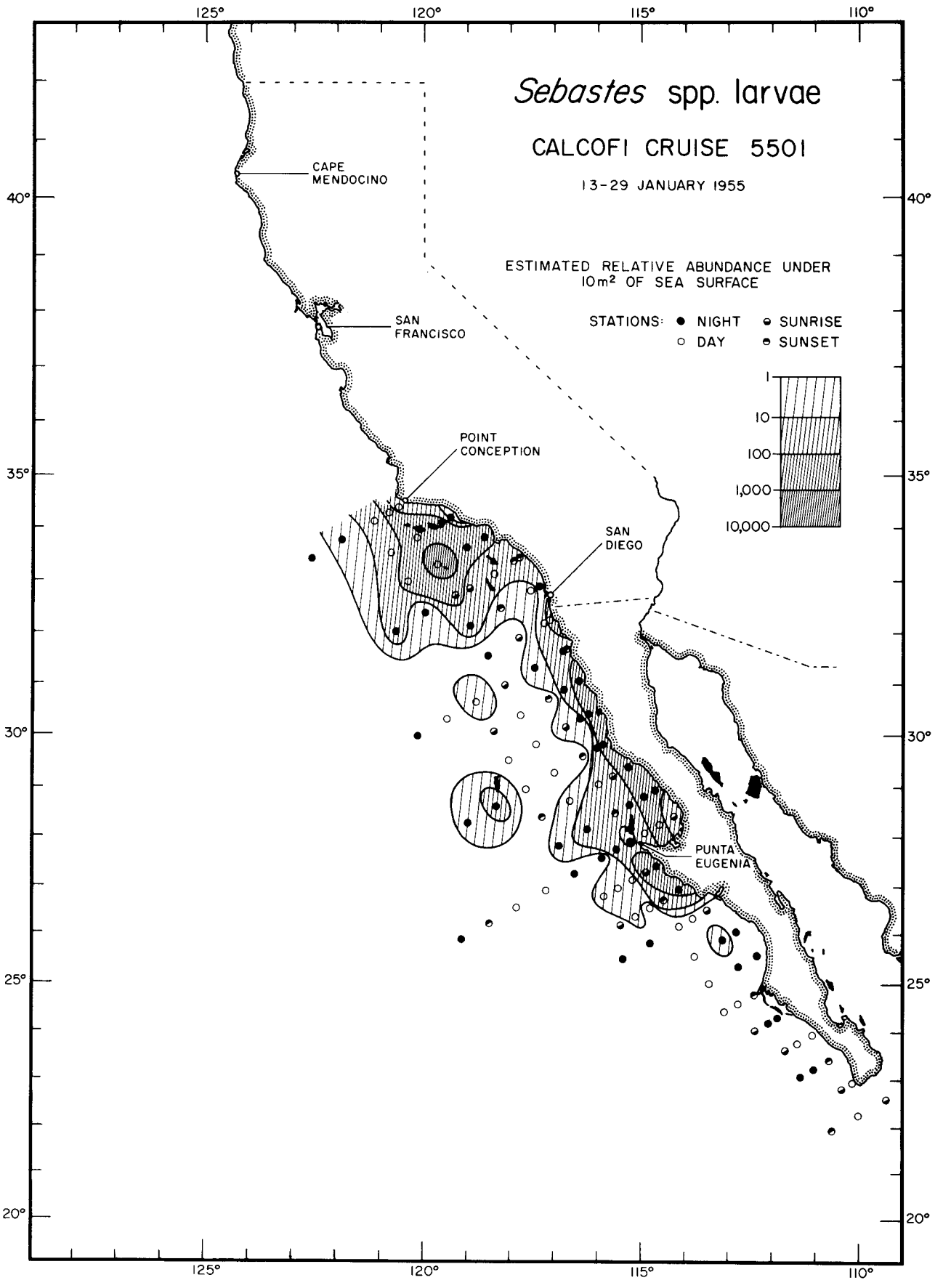
Sebastes spp. larvae

5410



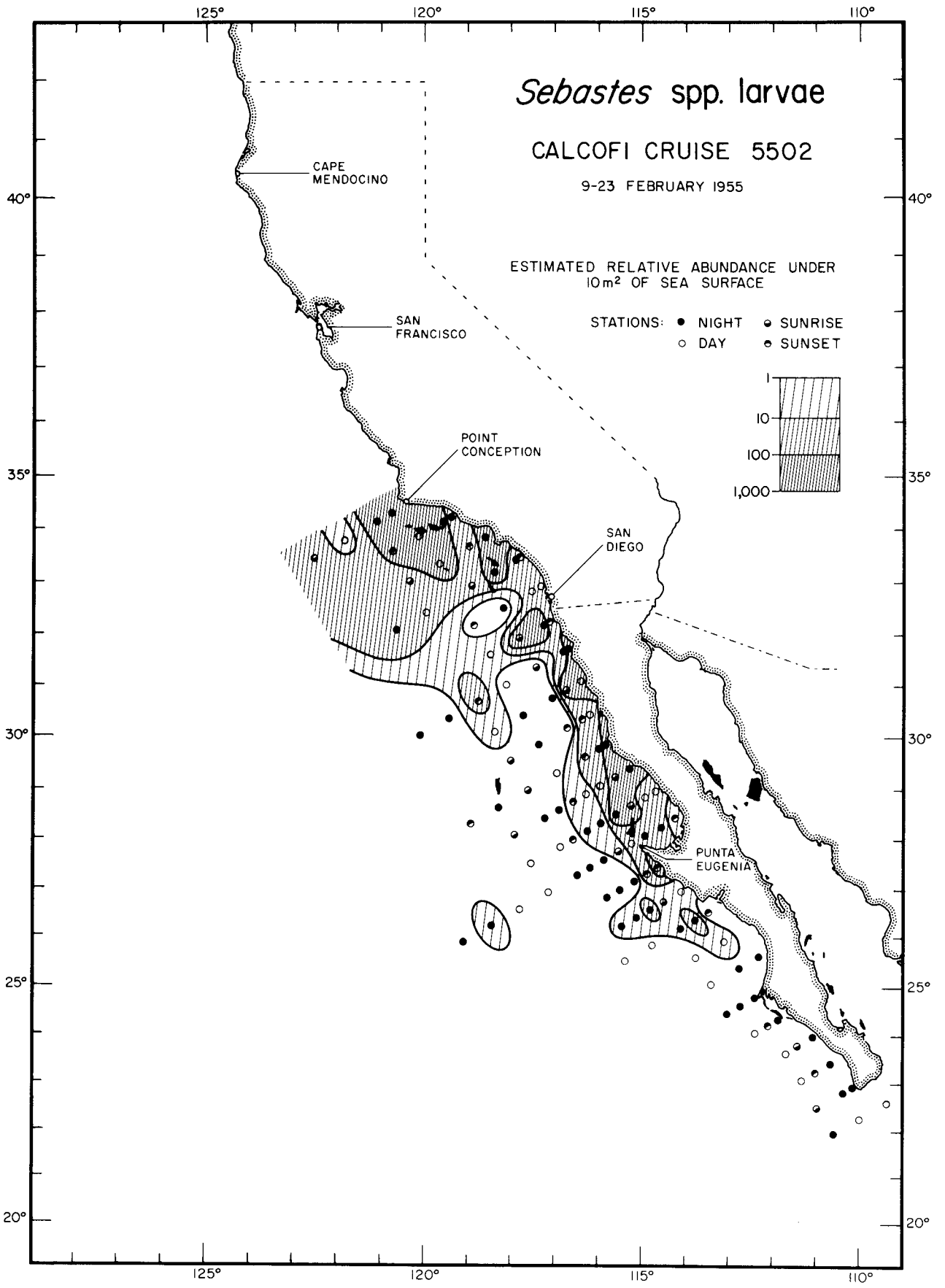
Sebastes spp. larvae

5412



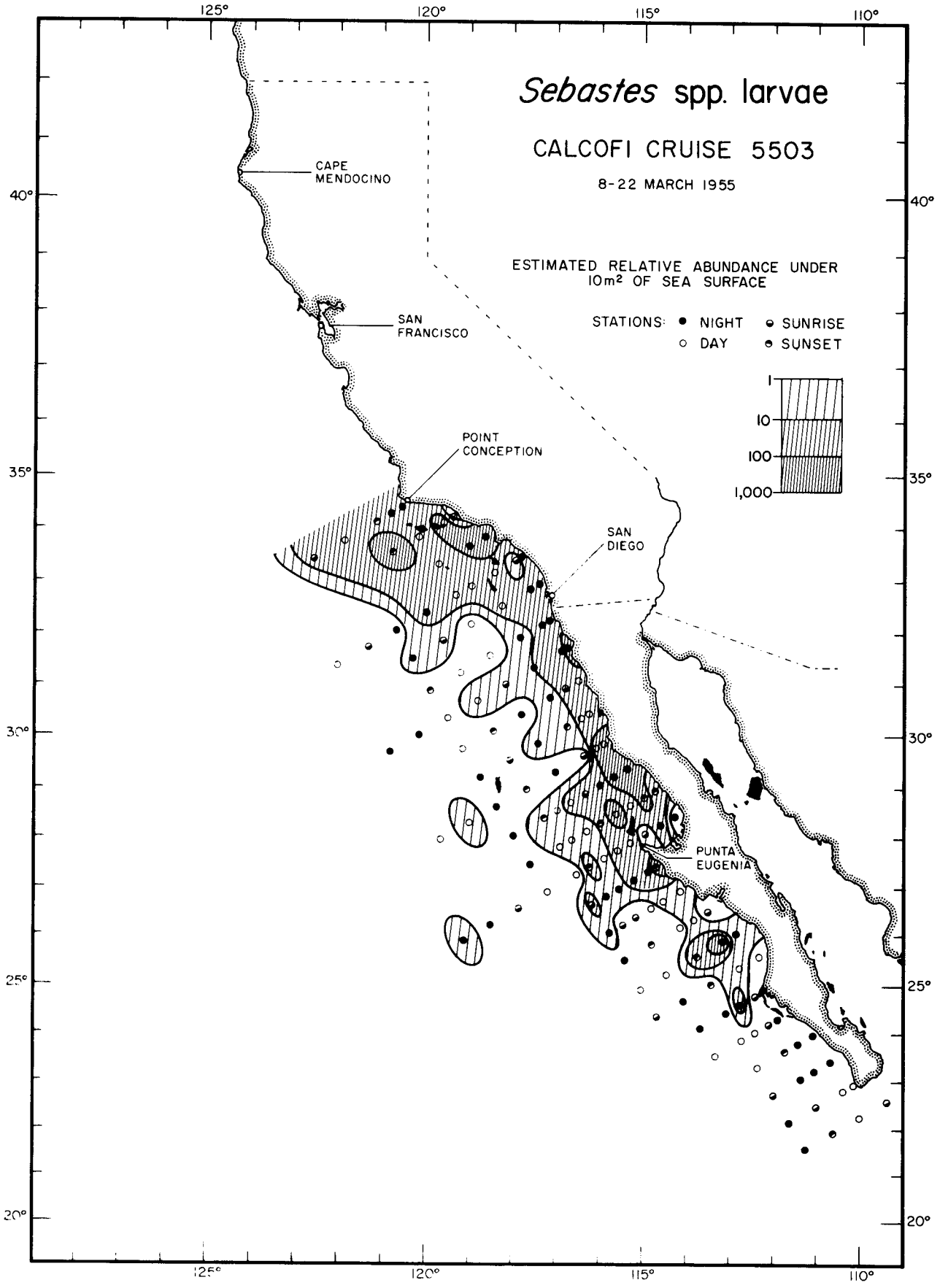
Sebastes spp. larvae

5501



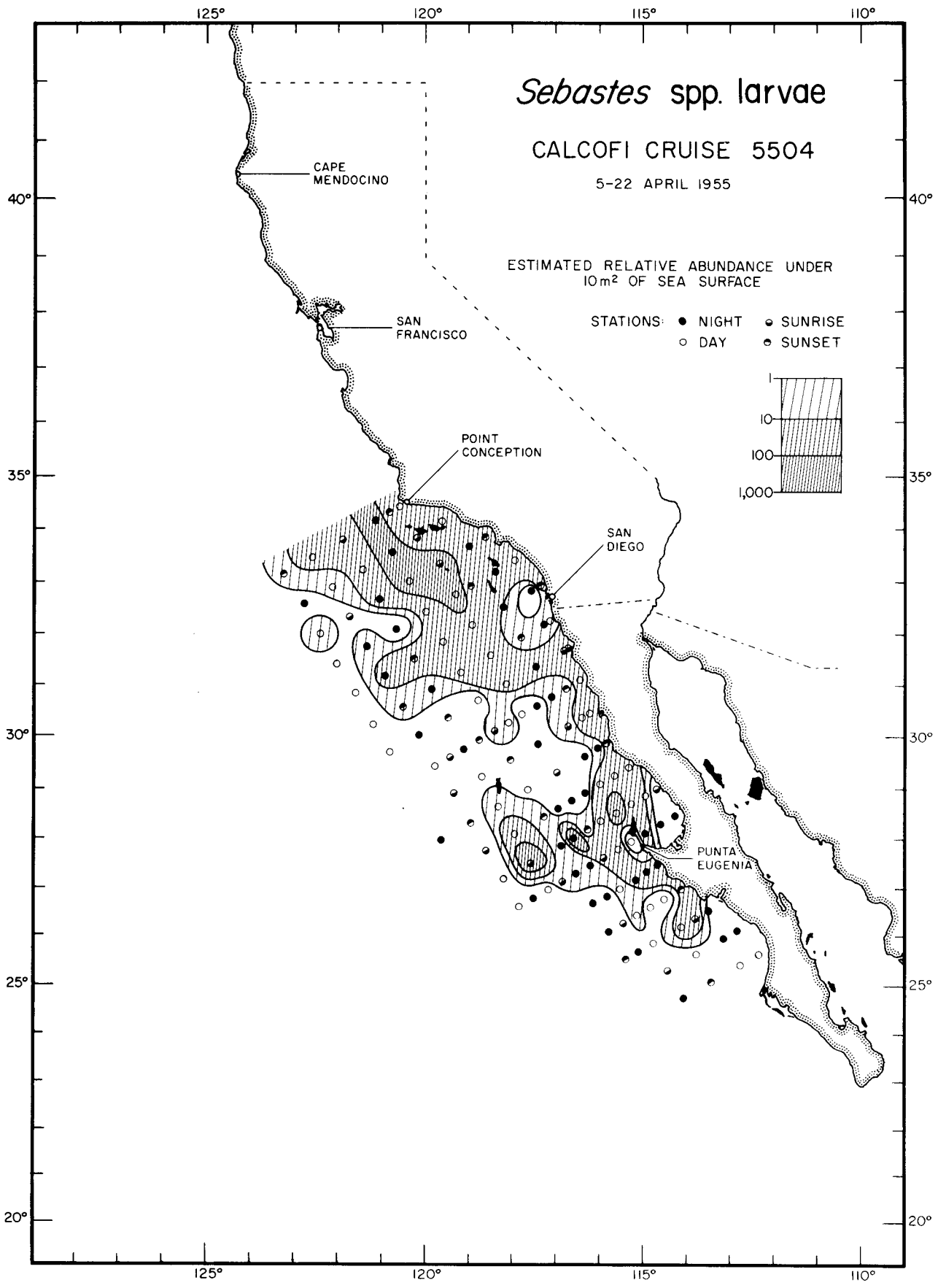
Sebastes spp. larvae

5502



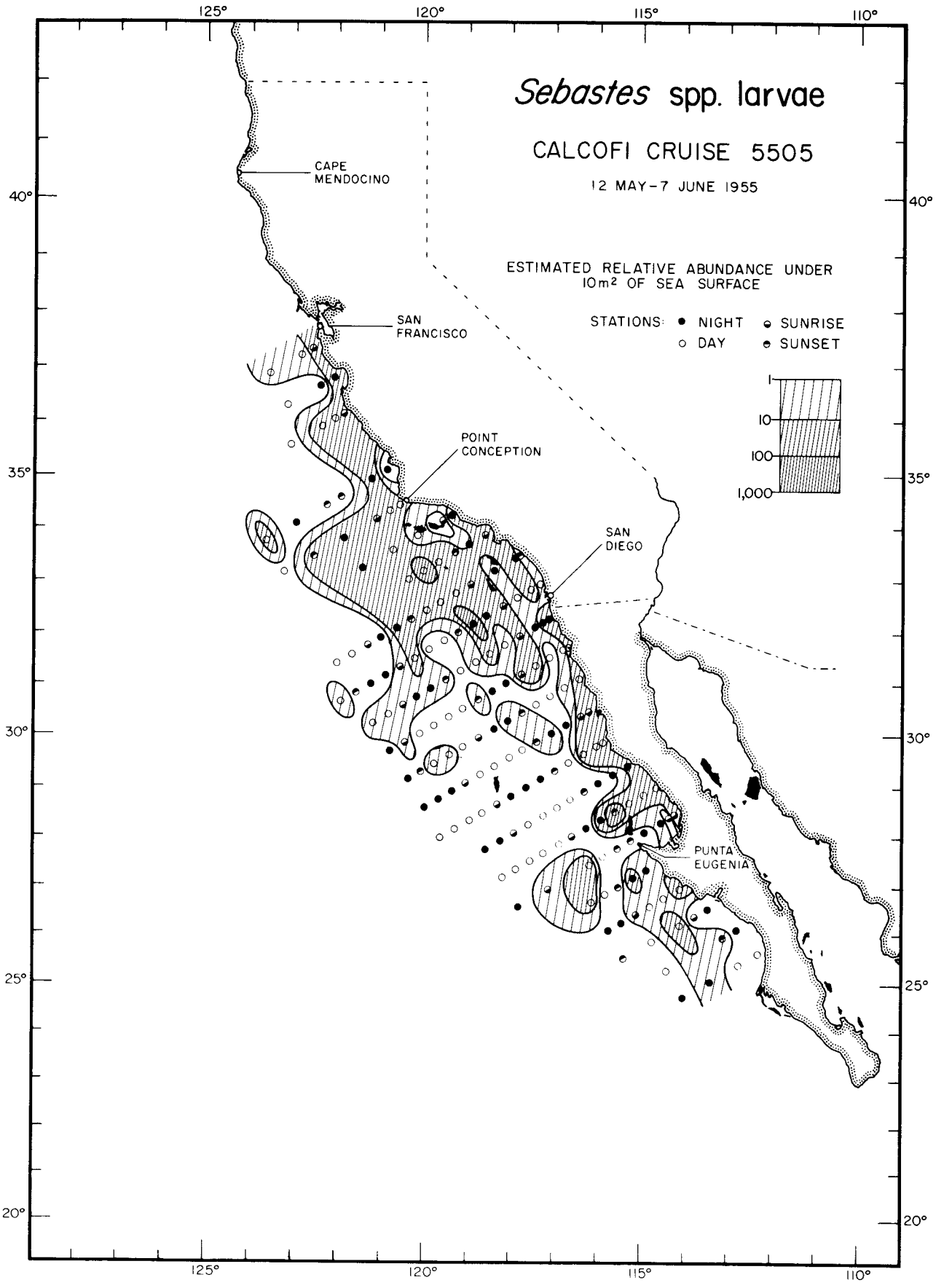
Sebastes spp. larvae

5503



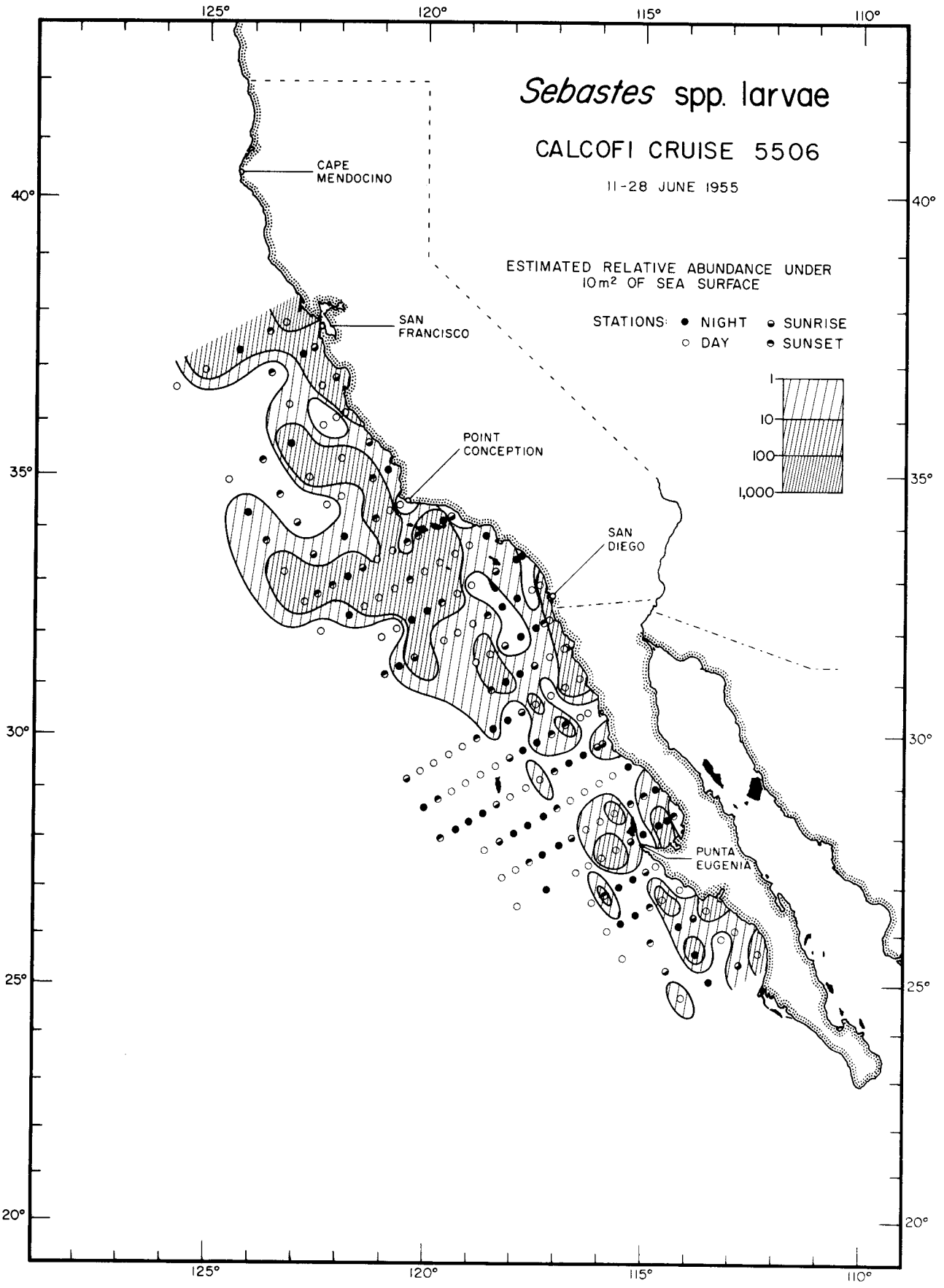
Sebastes spp. larvae

5504



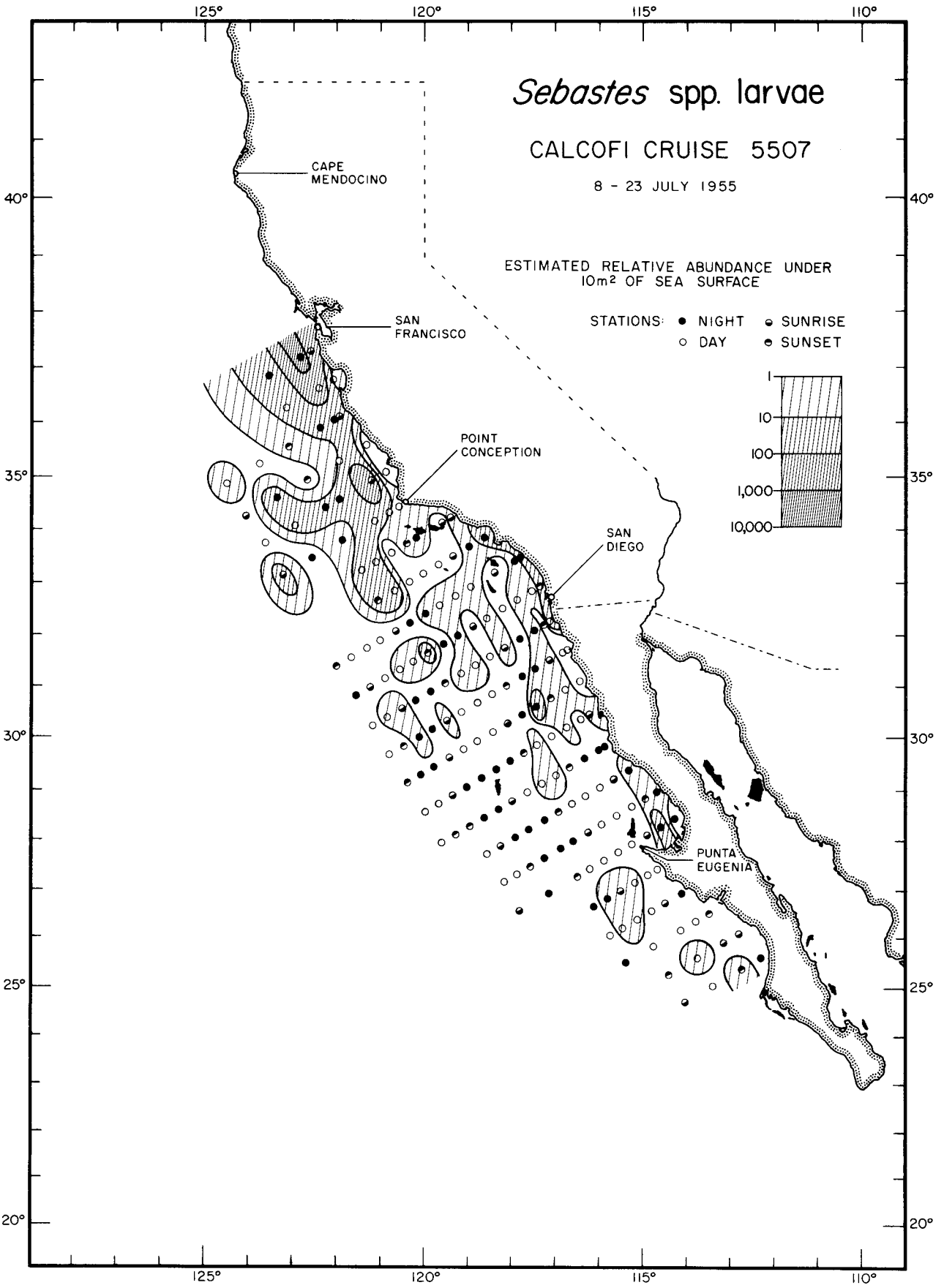
Sebastes spp. larvae

5505



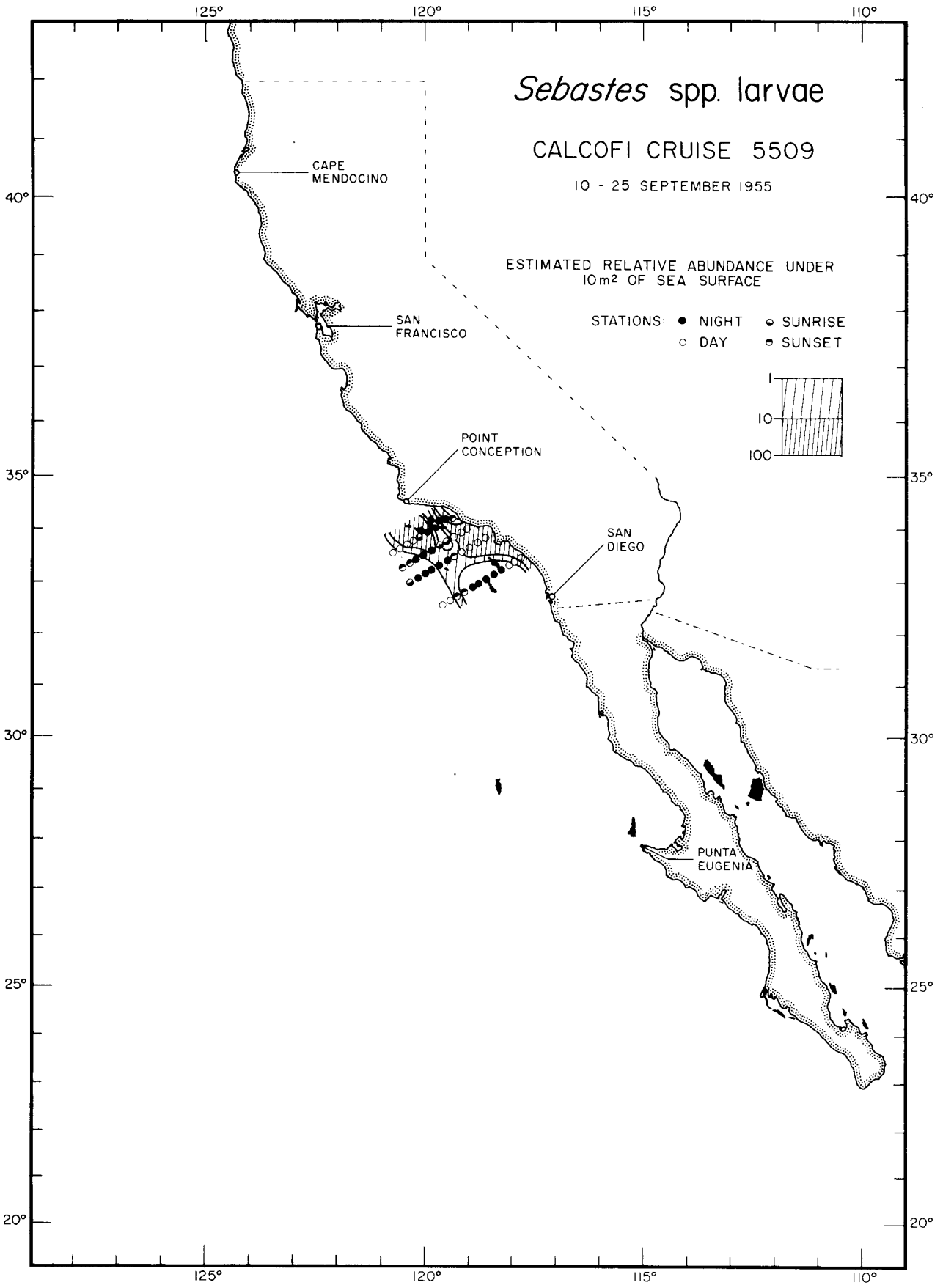
Sebastes spp. larvae

5506



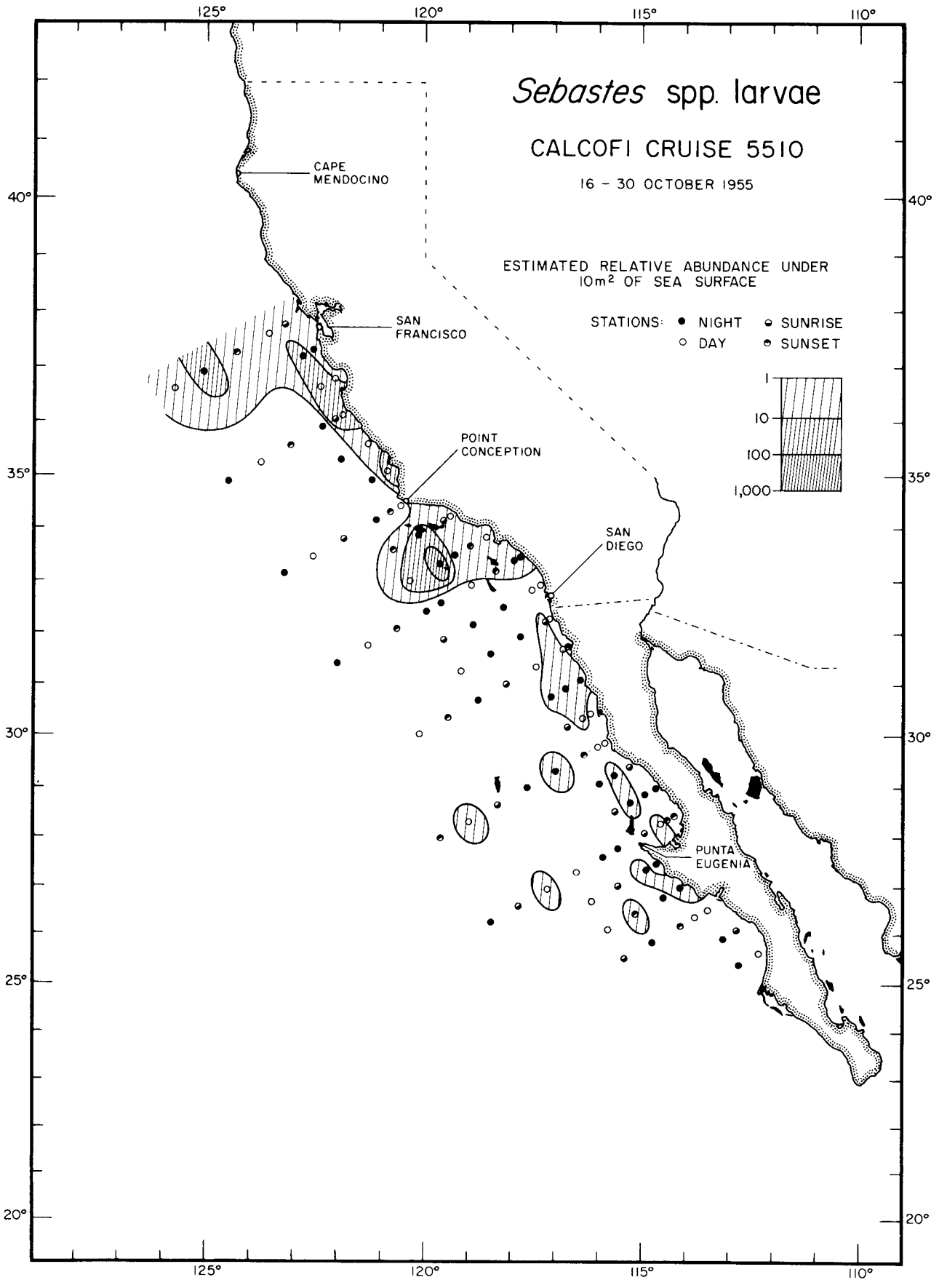
Sebastes spp. larvae

5507



Sebastes spp. larvae

5509



Sebastes spp. larvae

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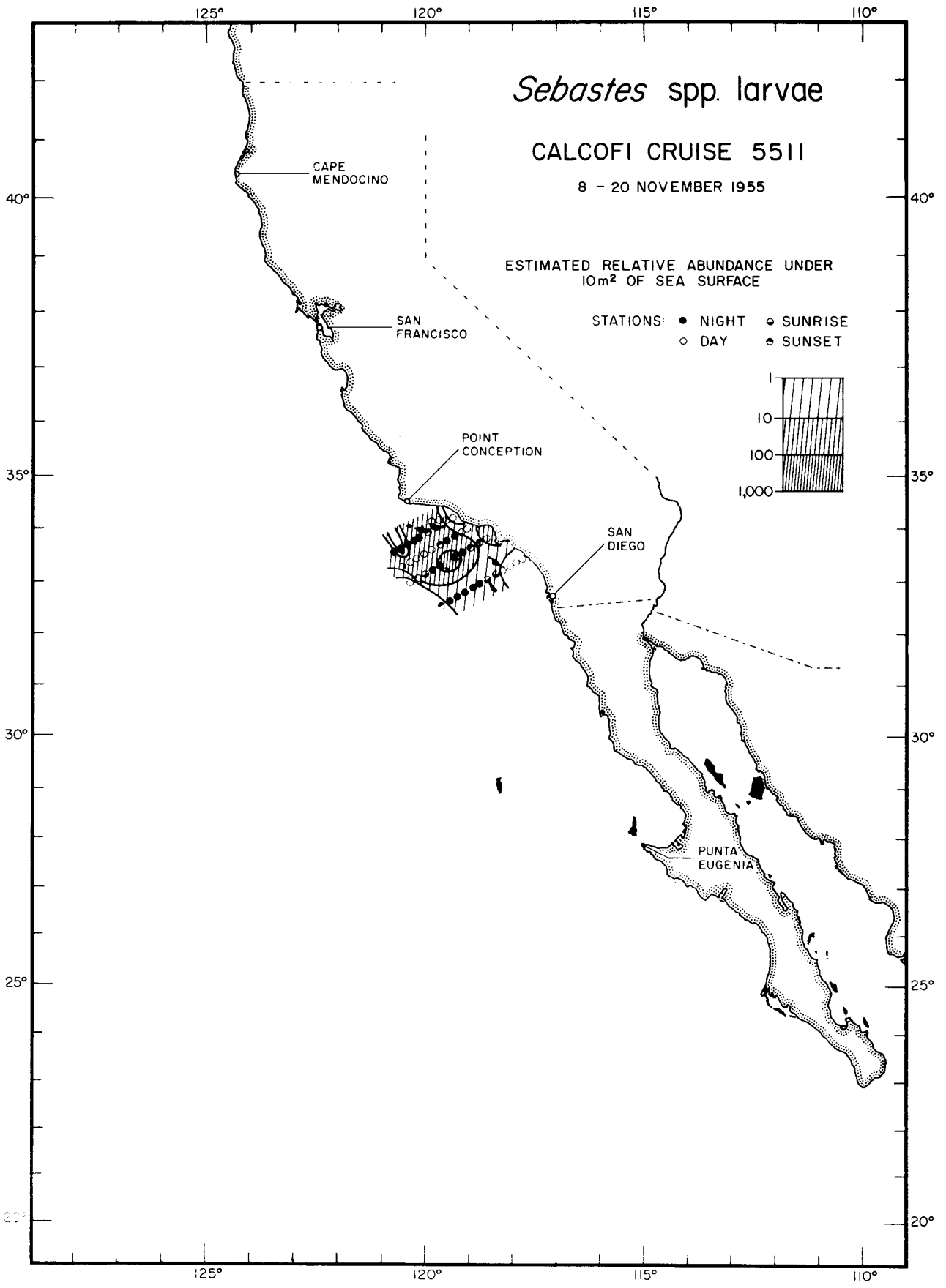

Sebastes spp. larvae

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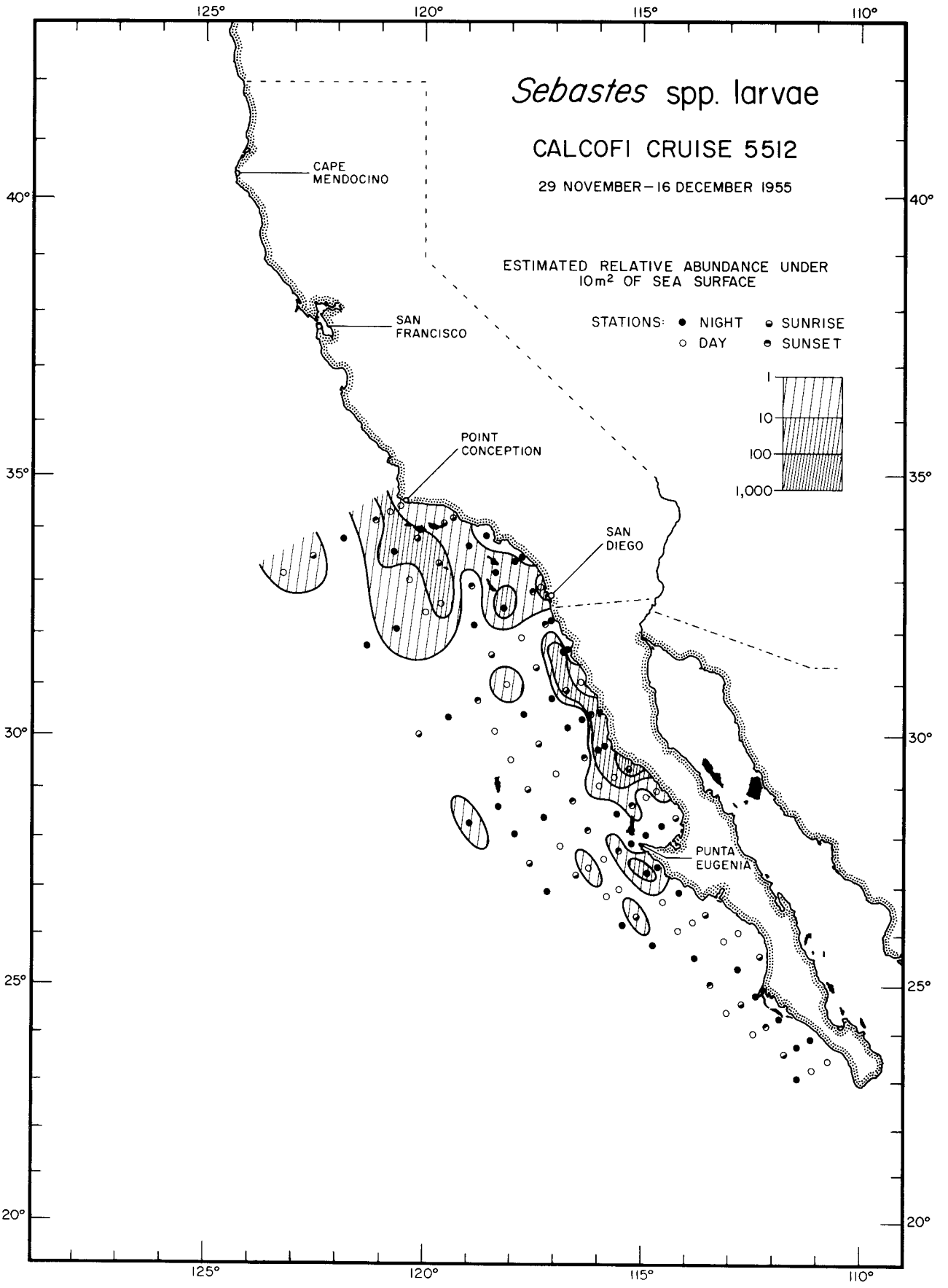

Sebastes spp. larvae

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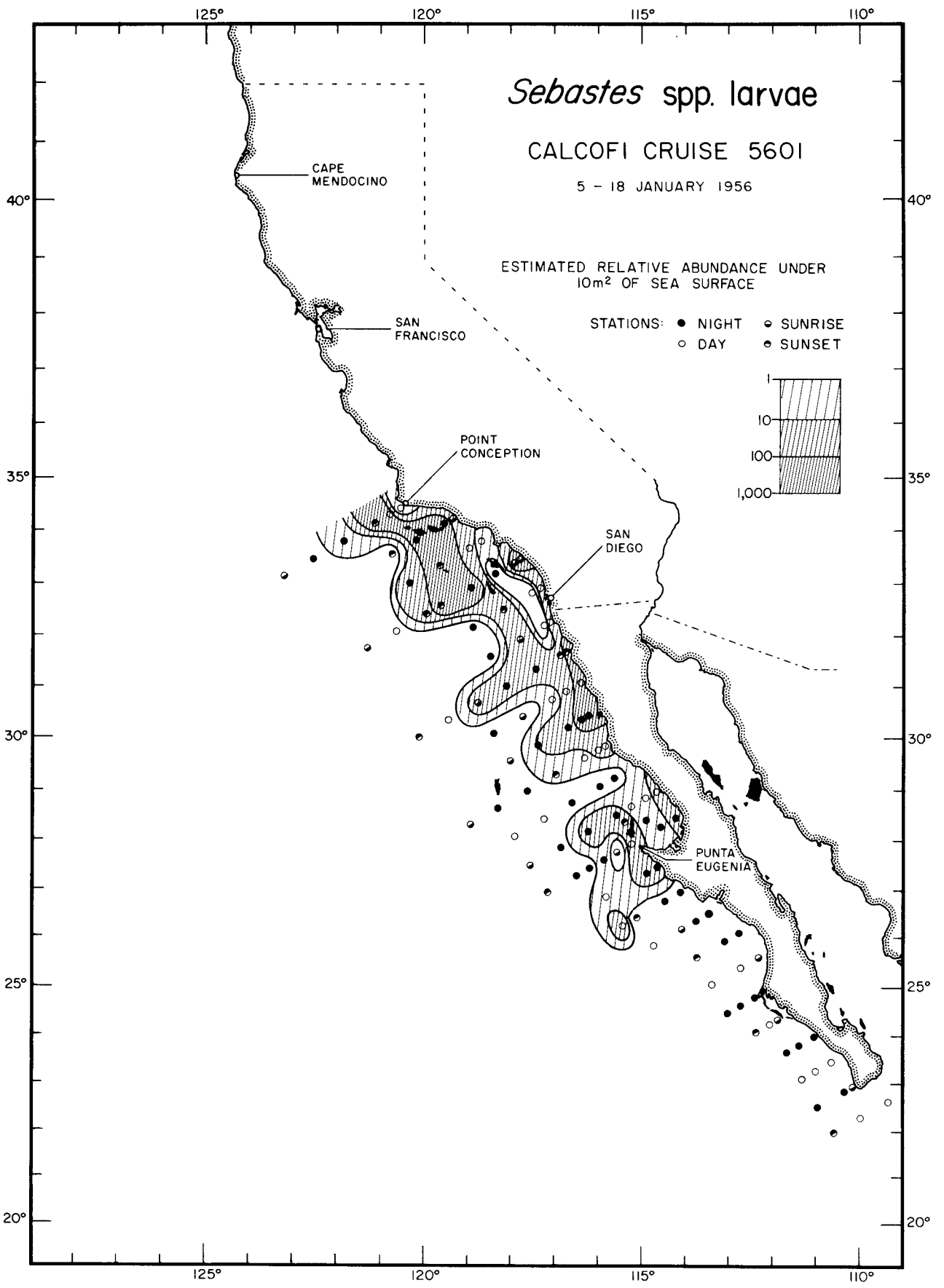
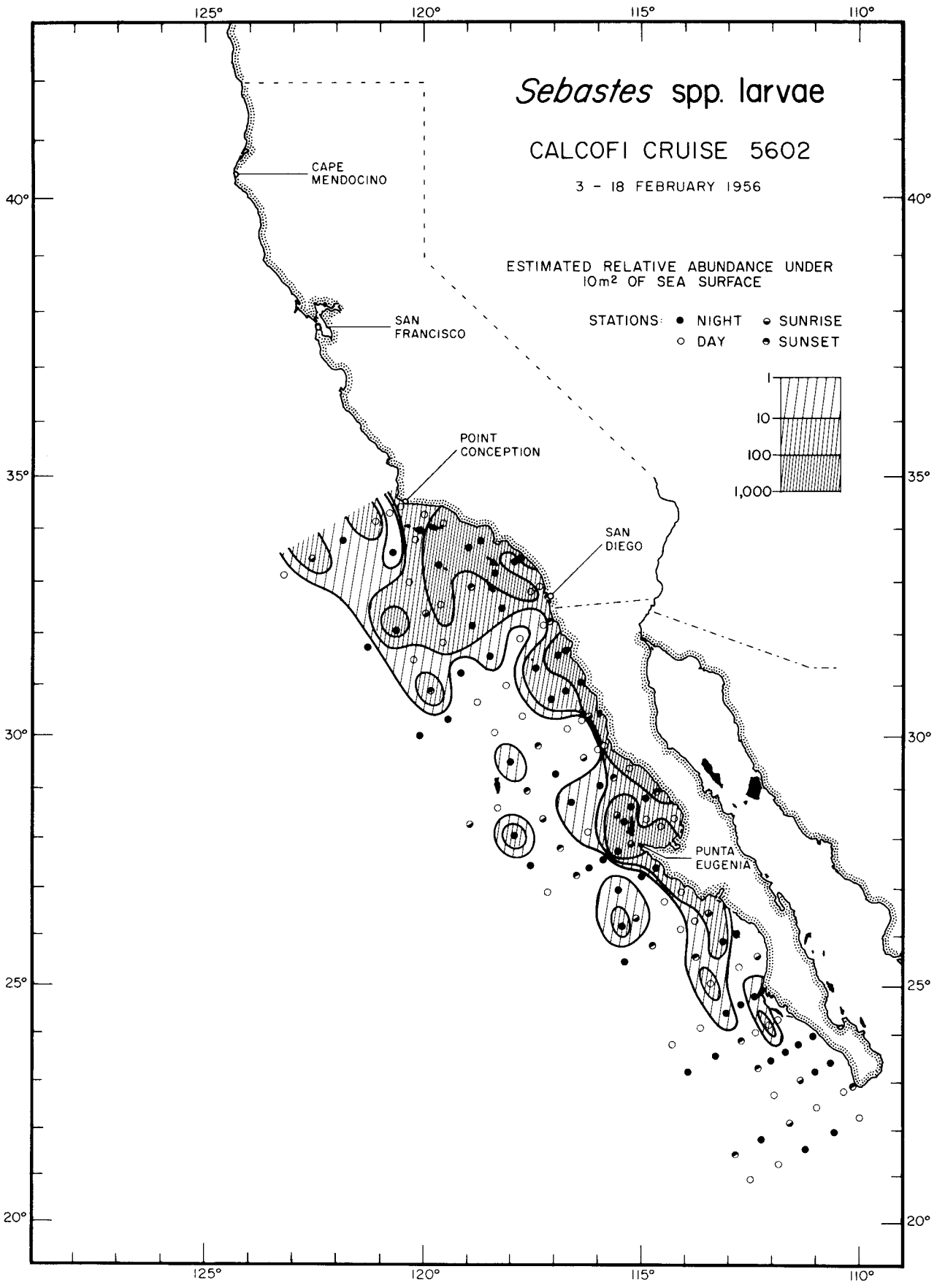


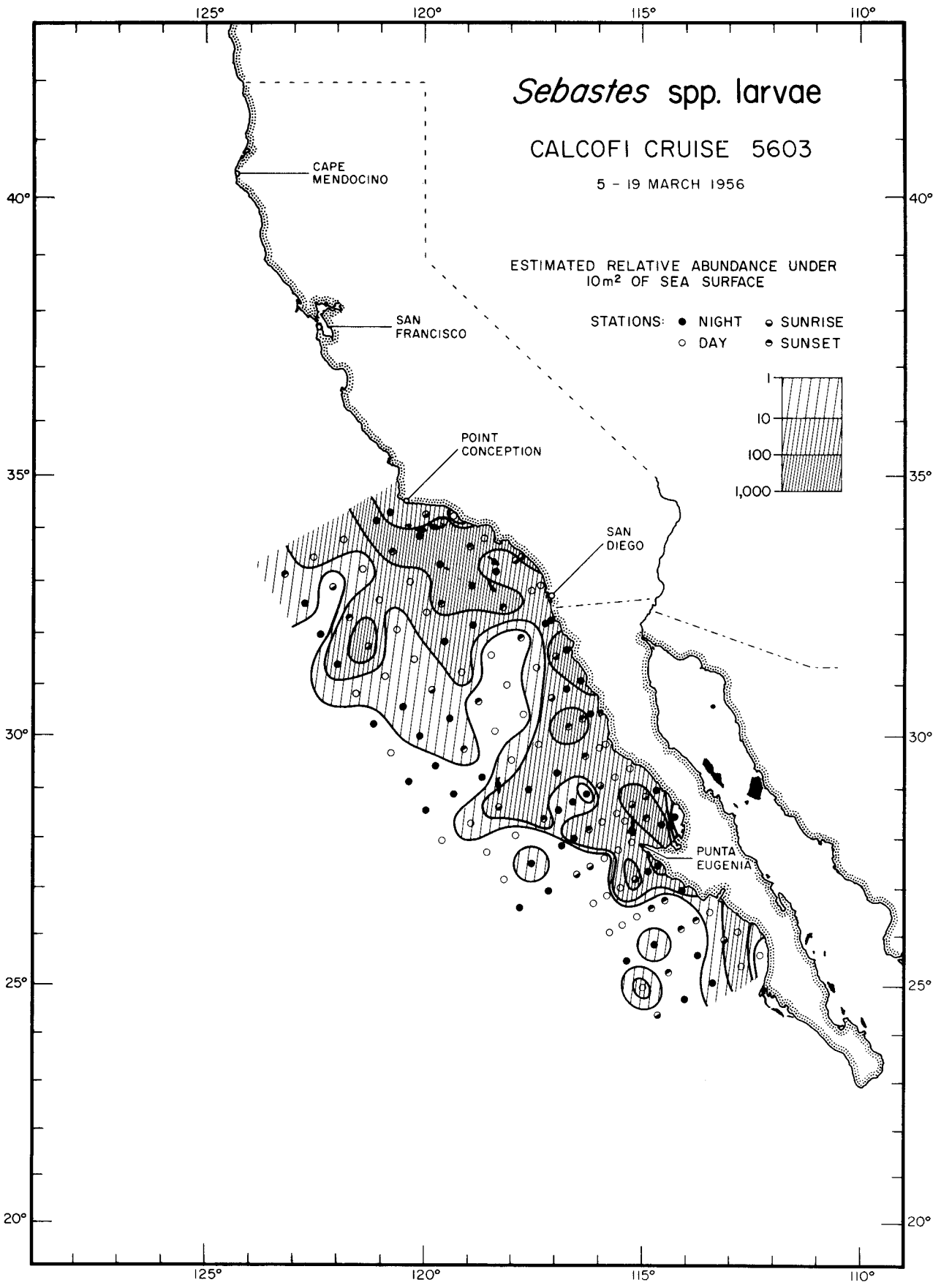
Sebastes spp. larvae

5601



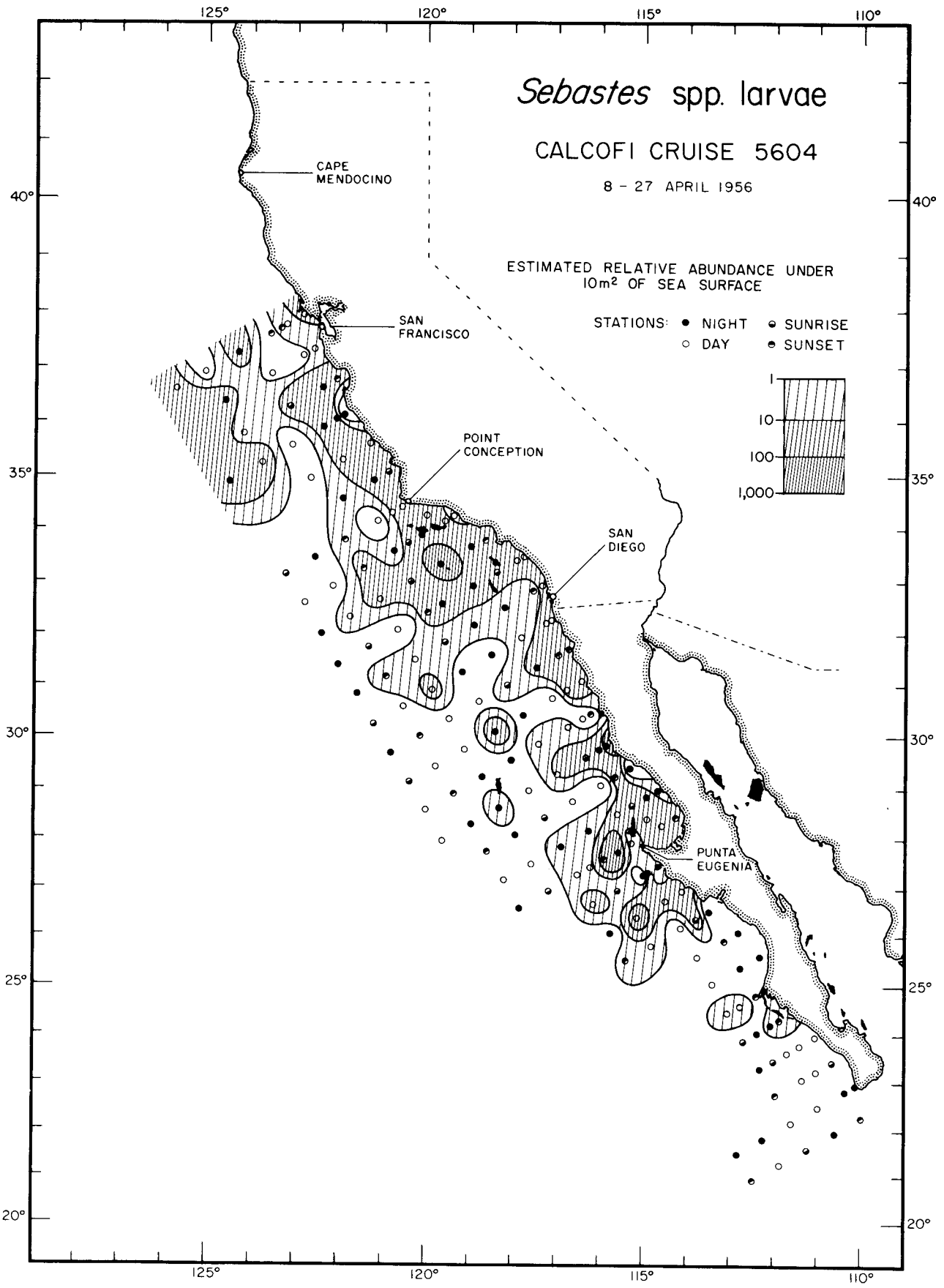
Sebastes spp. larvae

5602



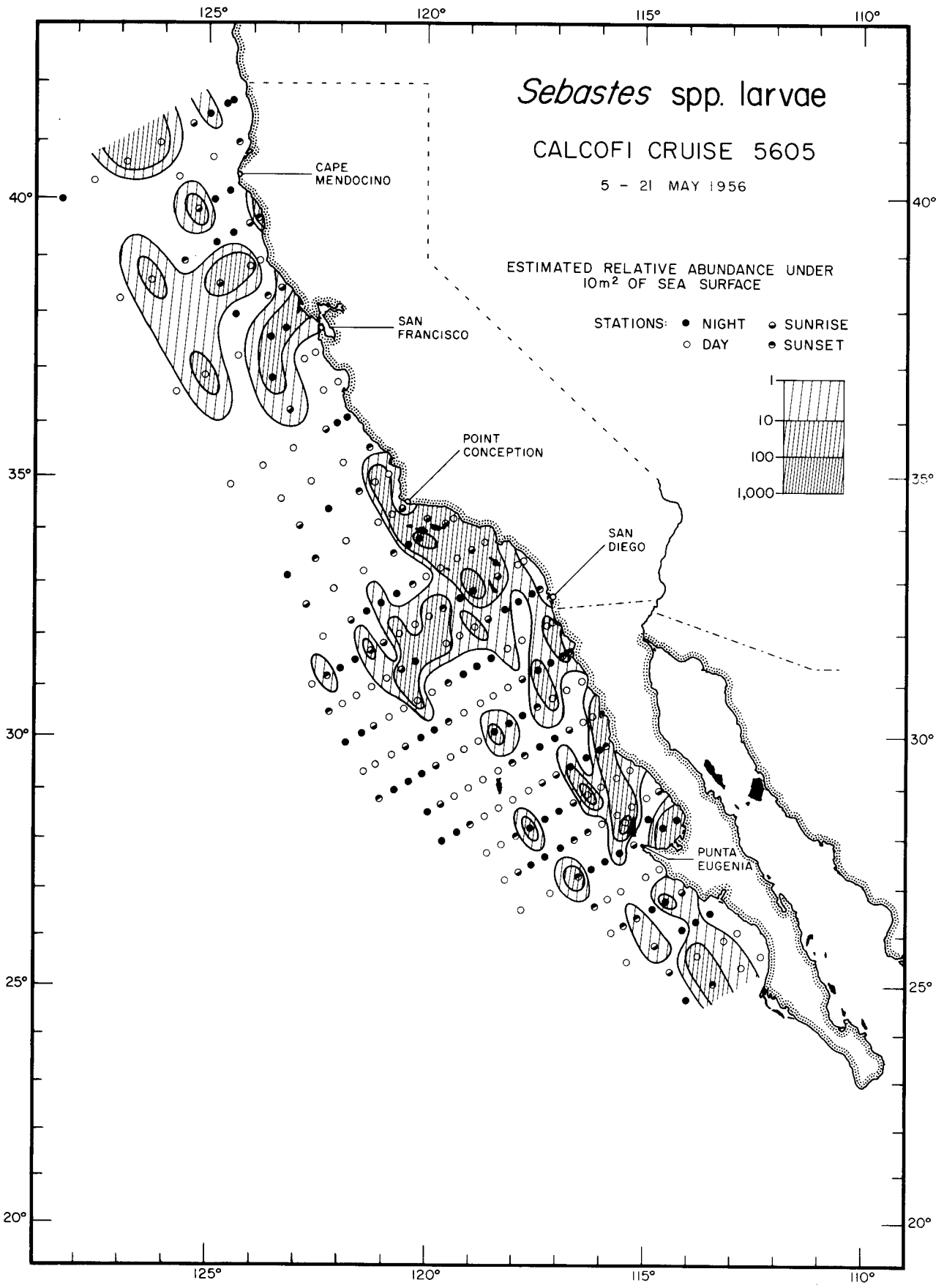
Sebastes spp. larvae

5603



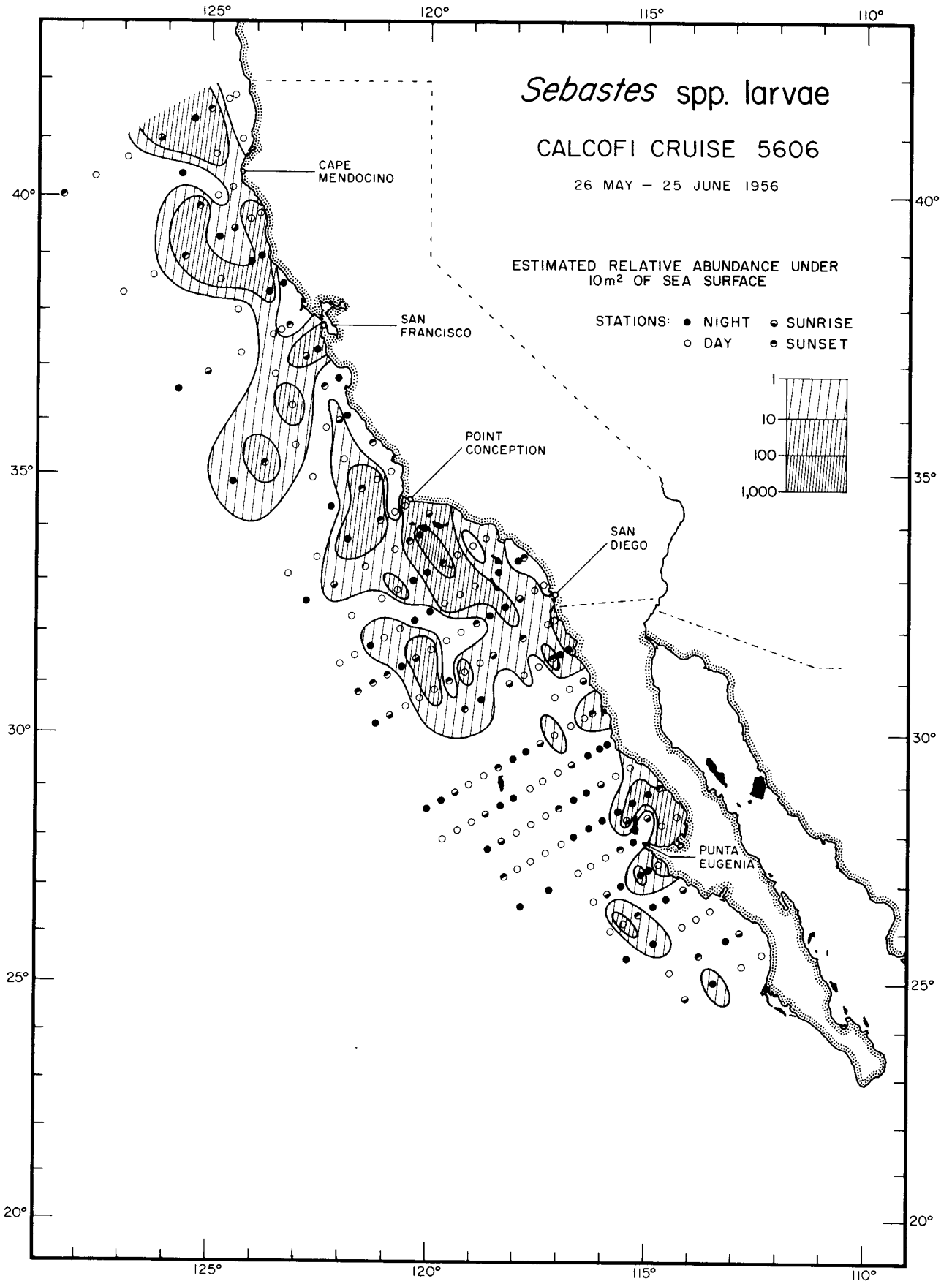
Sebastes spp. larvae

5604



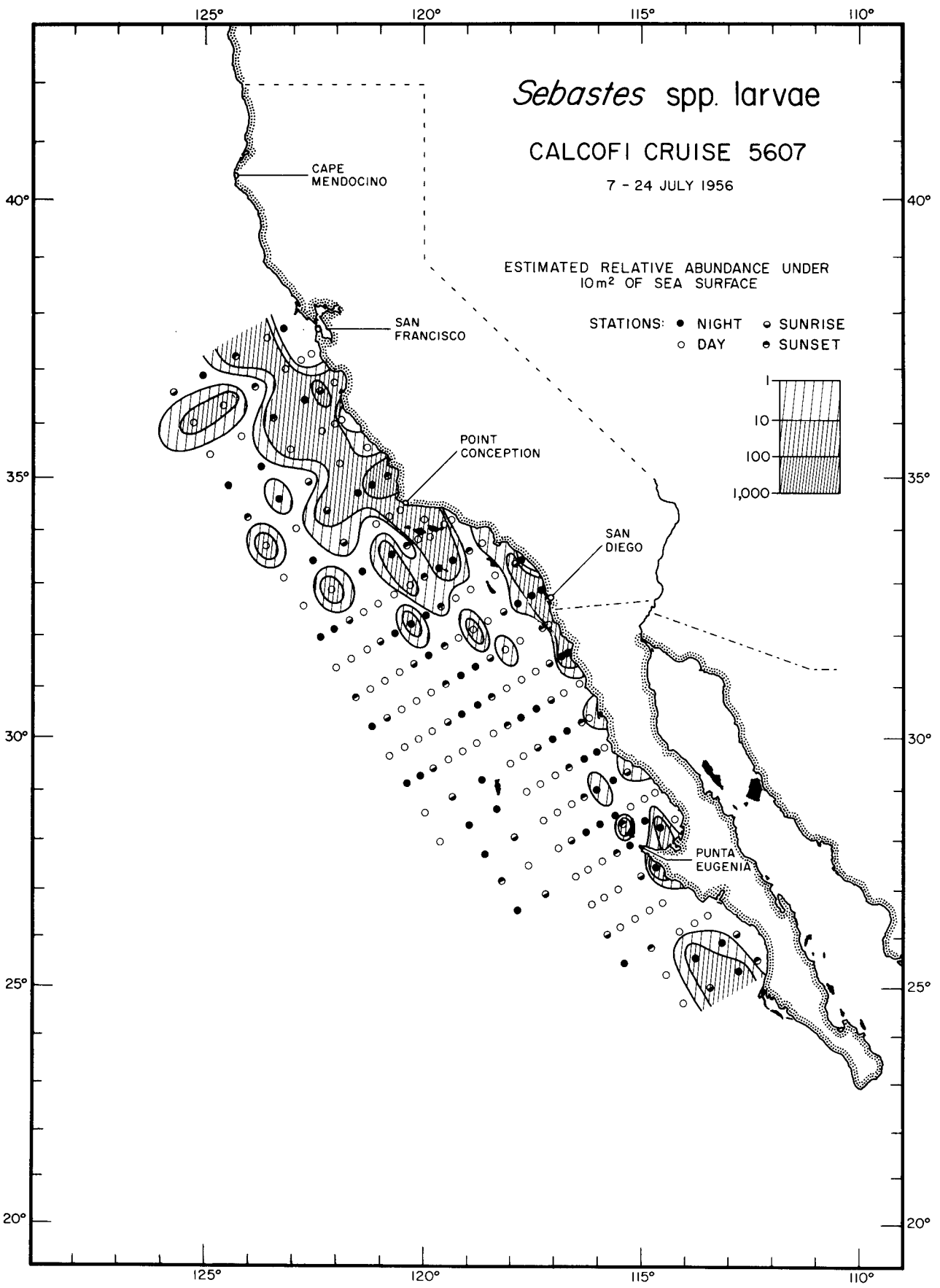
Sebastes spp. larvae

5605



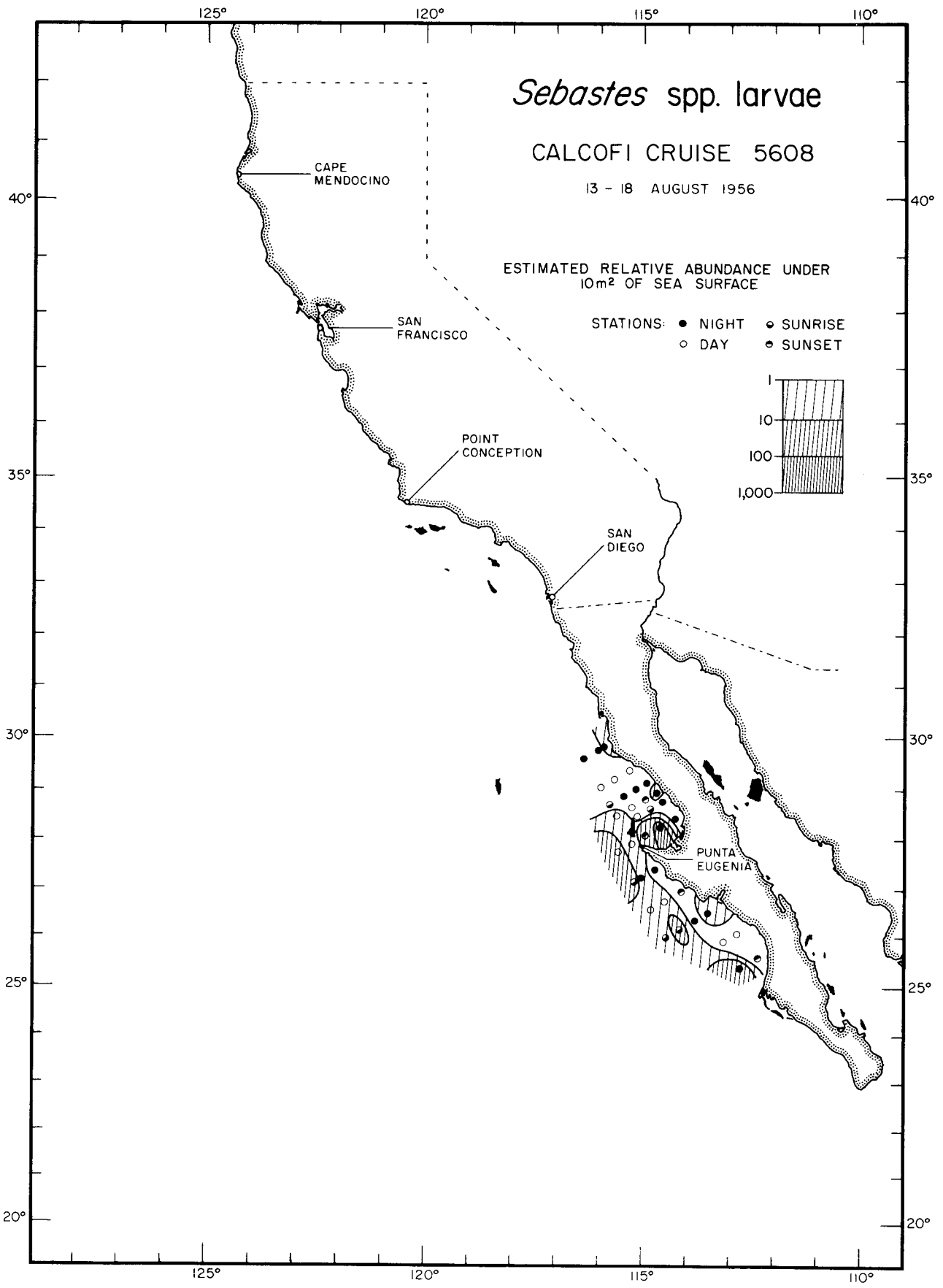
Sebastes spp. larvae

5606



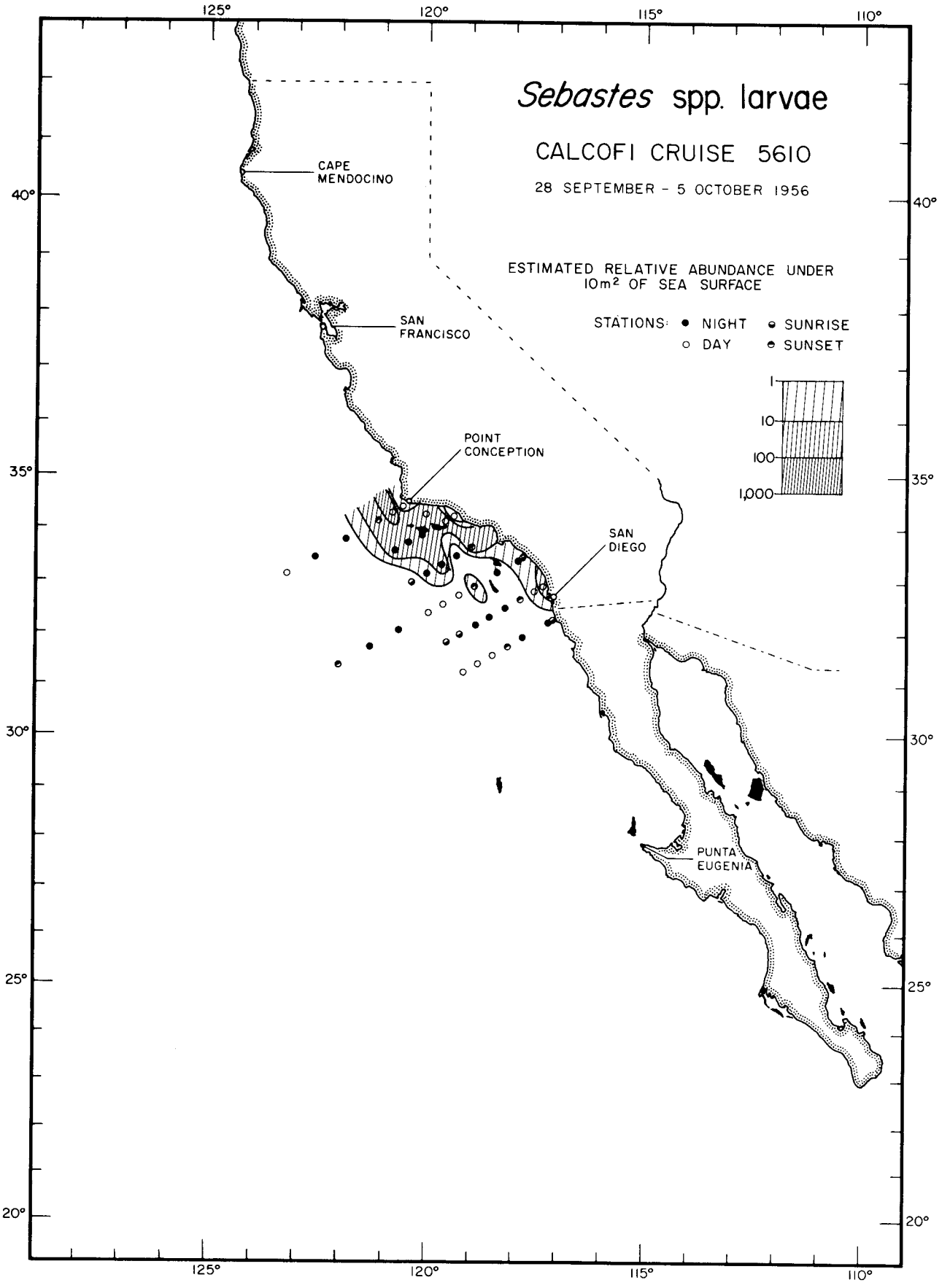
Sebastes spp. larvae

5607



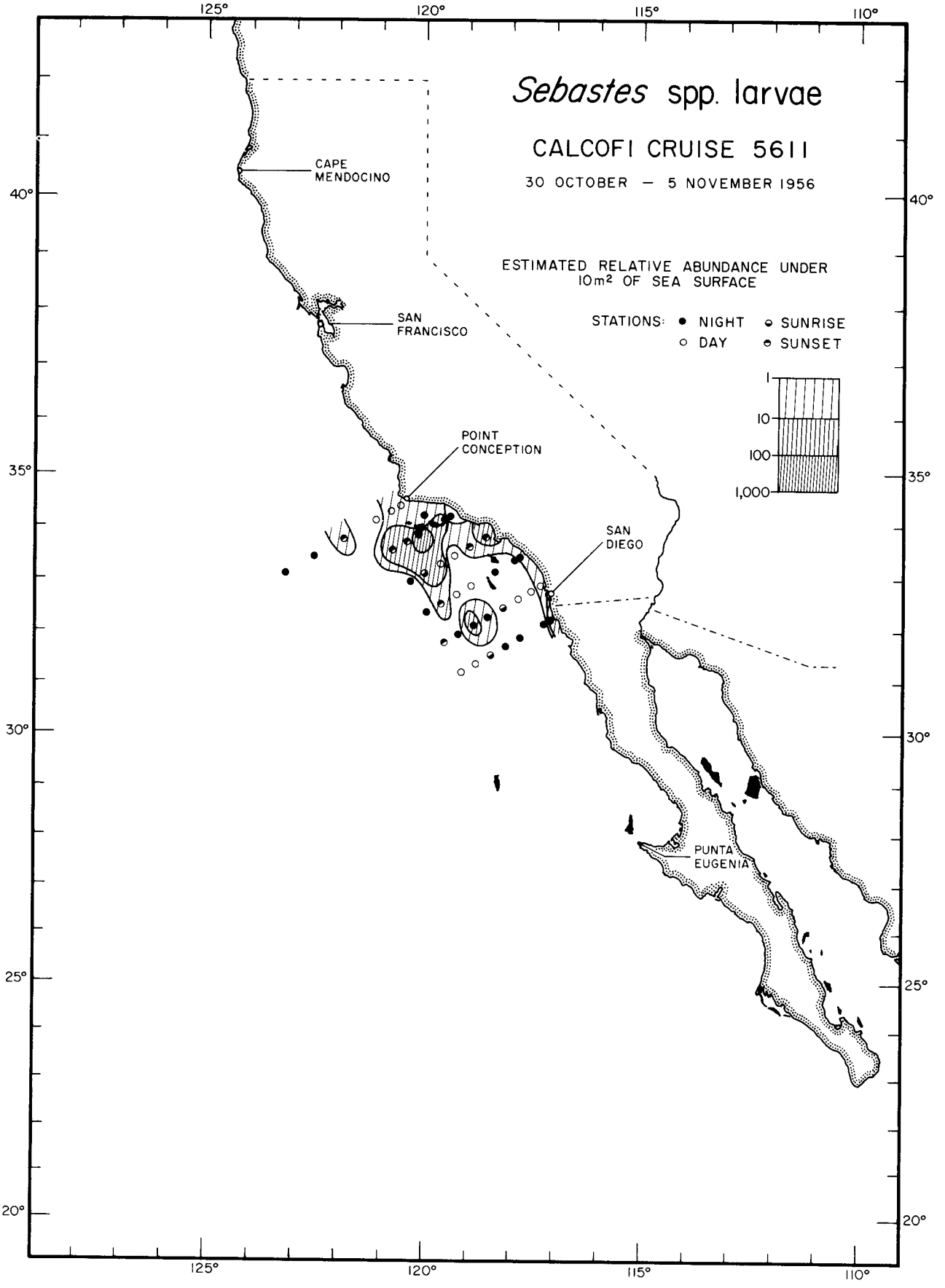
Sebastes spp. larvae

5608



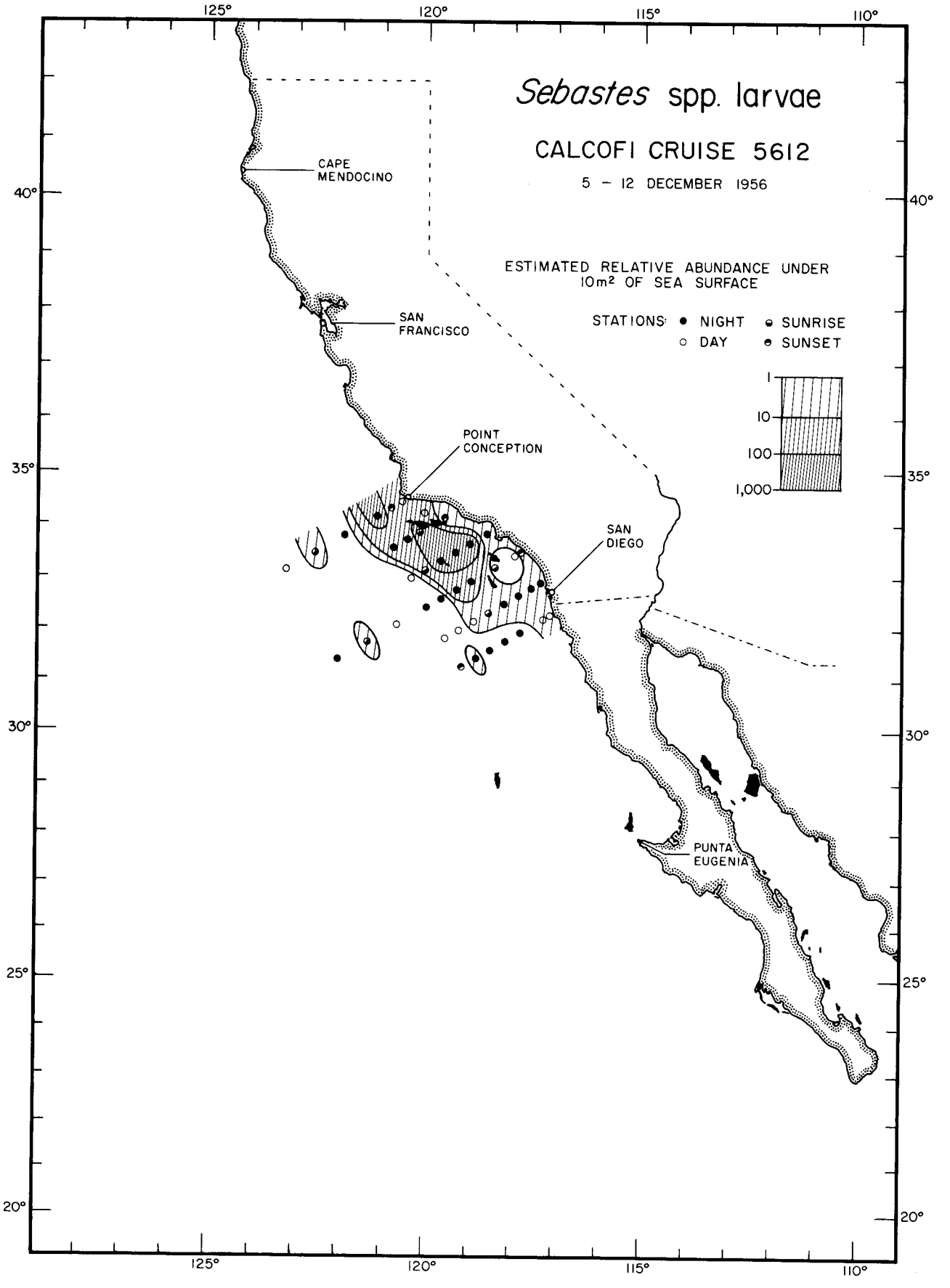
Sebastes spp. larvae

5610



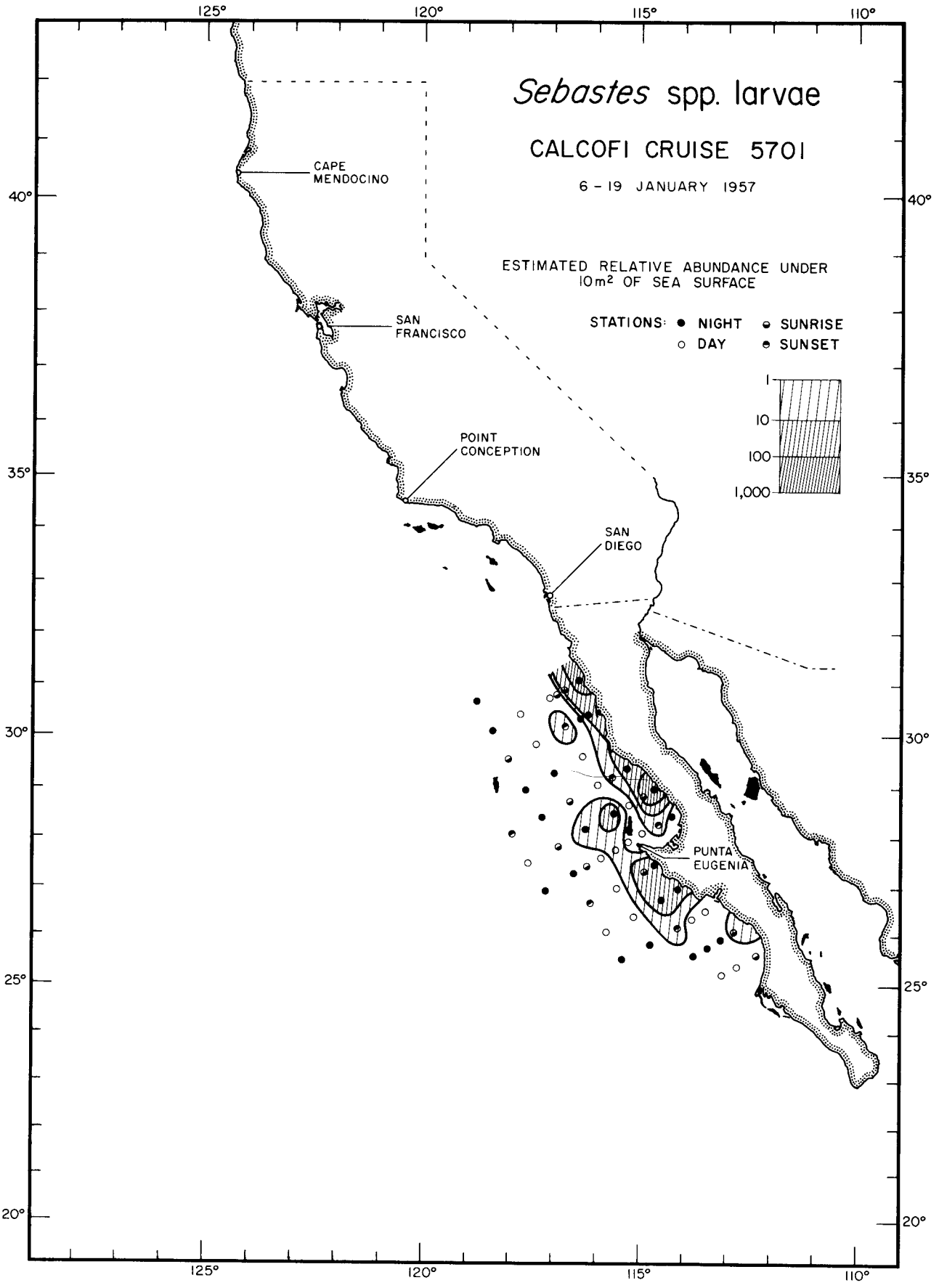
Sebastes spp. larvae

5611



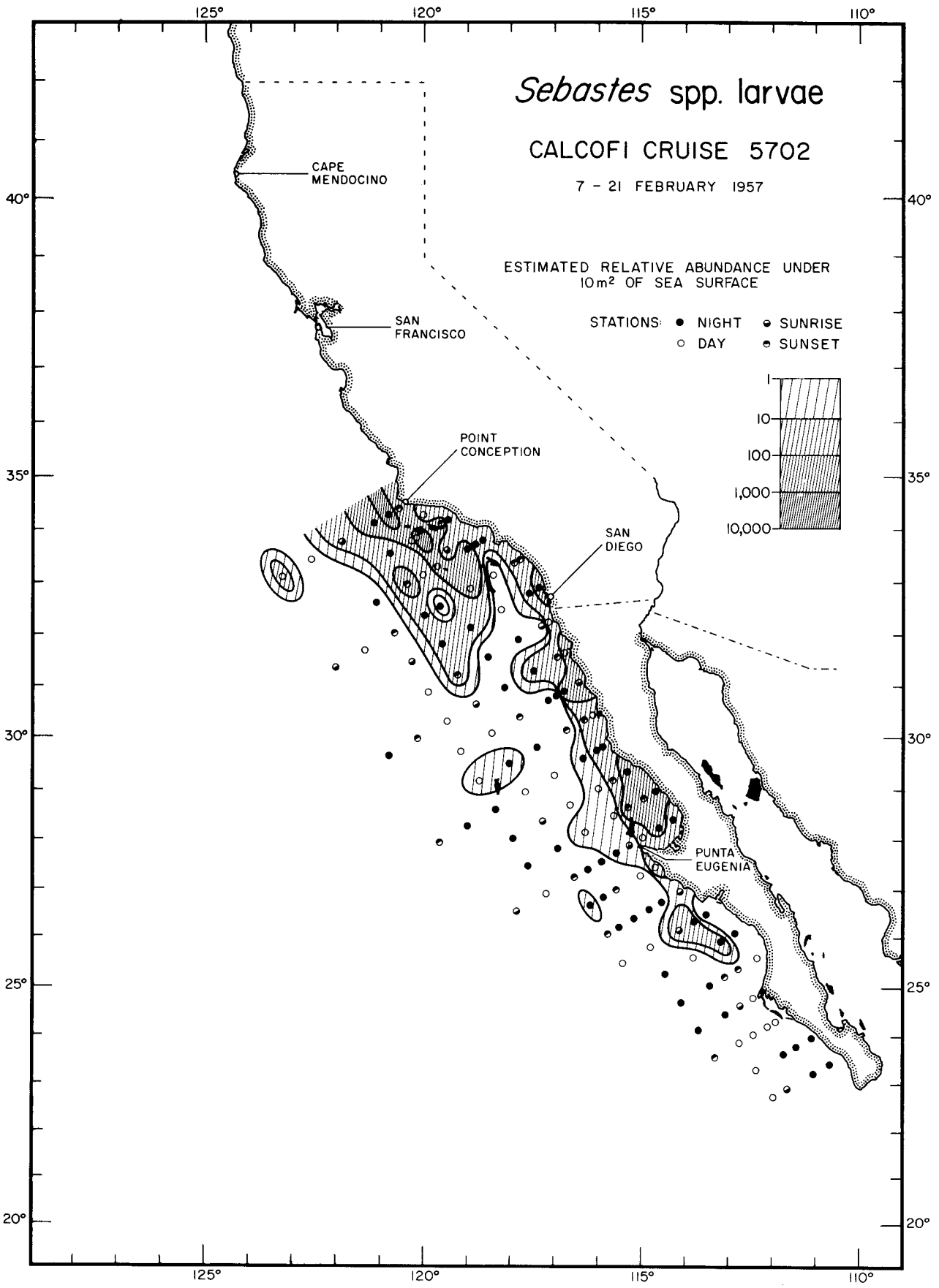
Sebastes spp. larvae

5612



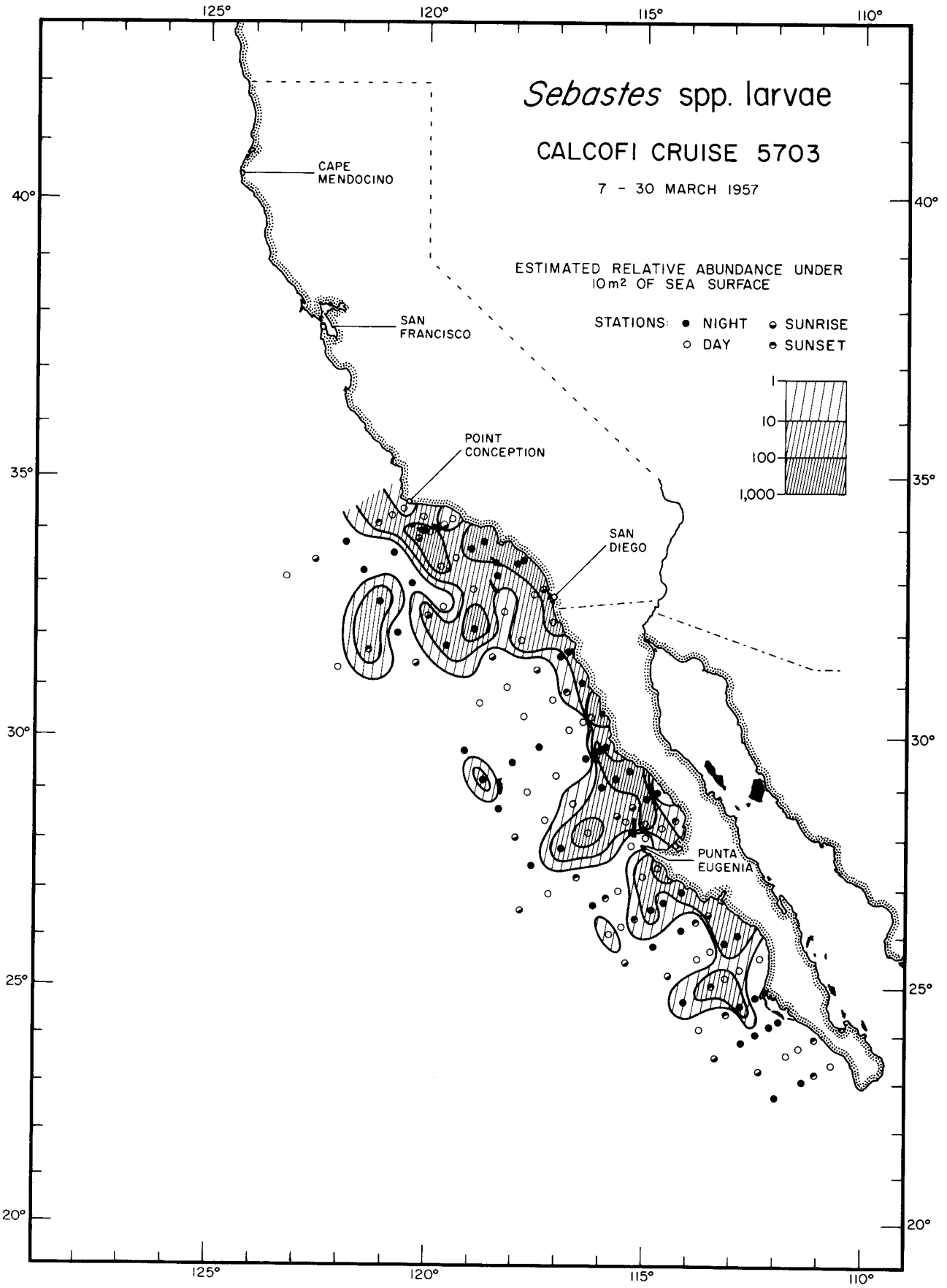
Sebastes spp. larvae

5701



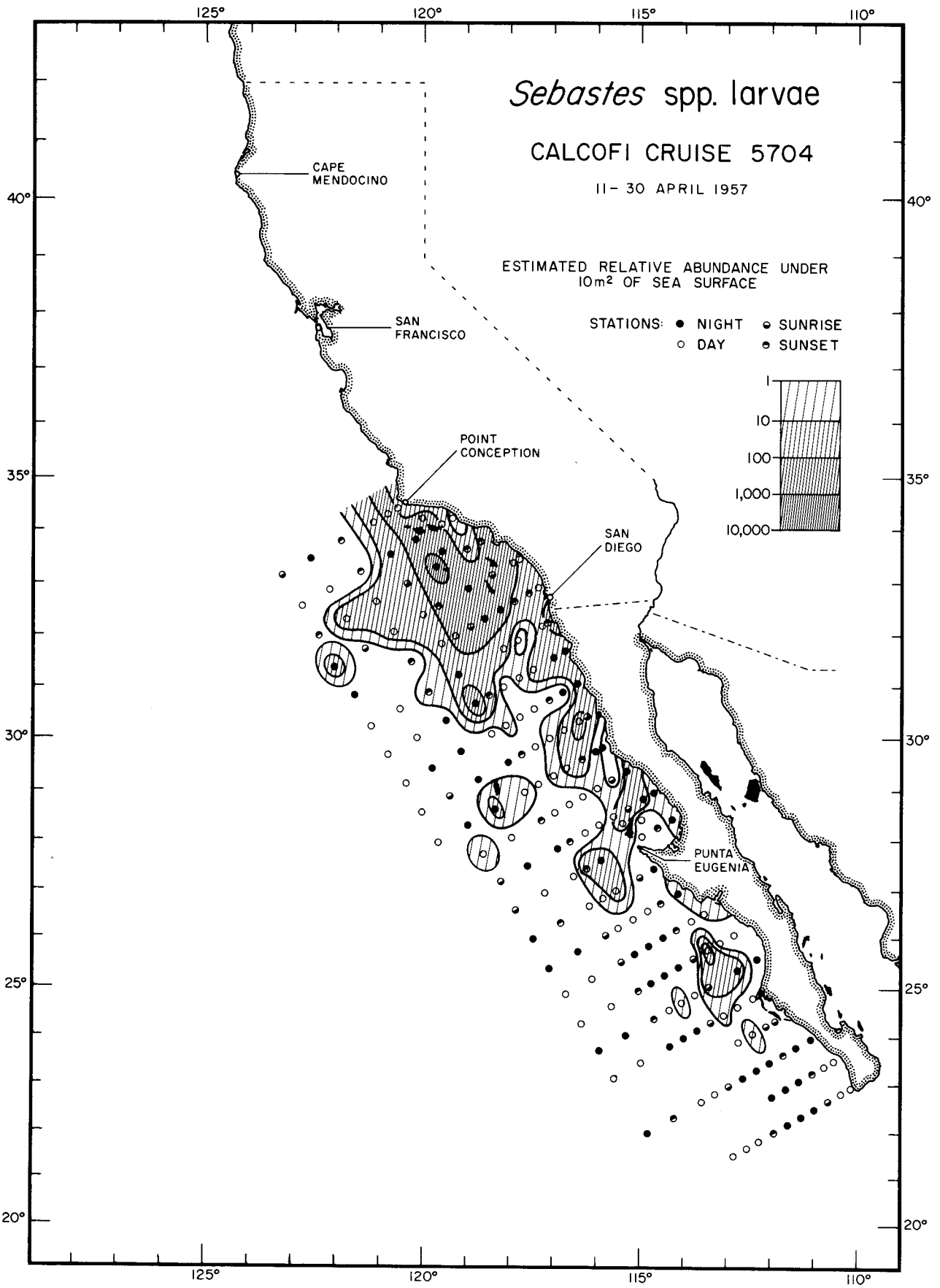
Sebastes spp. larvae

5702



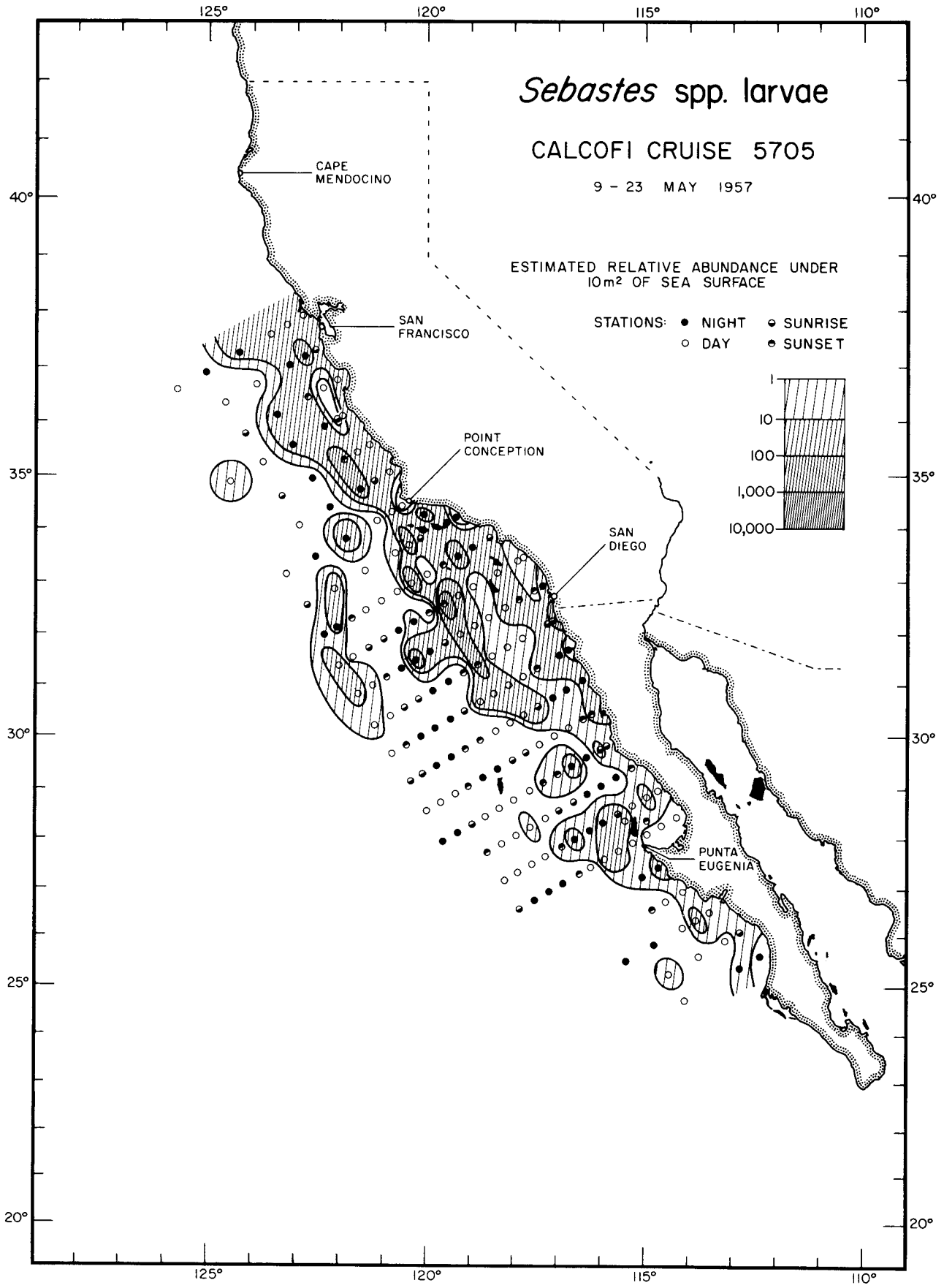
Sebastes spp. larvae

5703



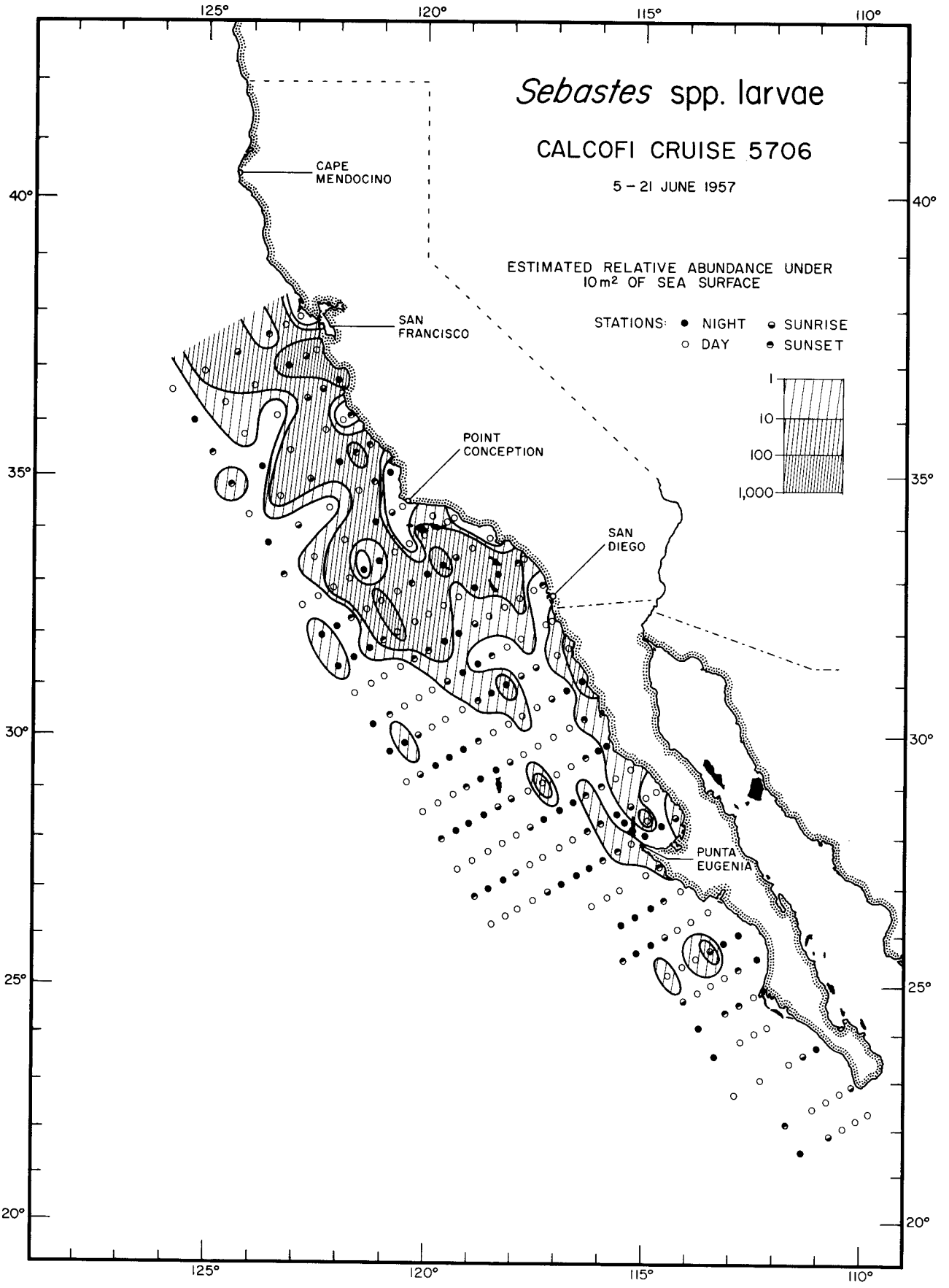
Sebastes spp. larvae

5704



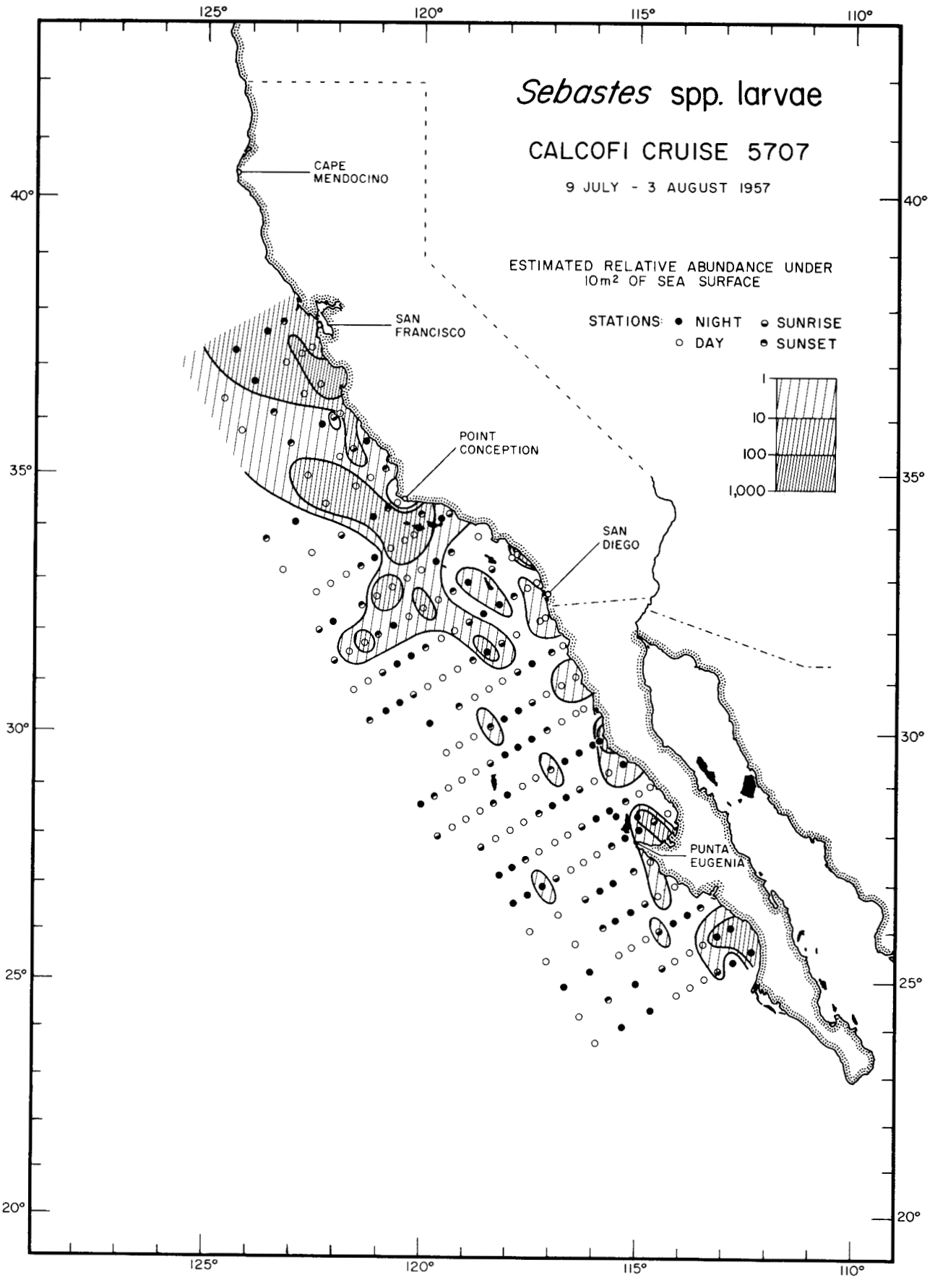
Sebastes spp. larvae

5705



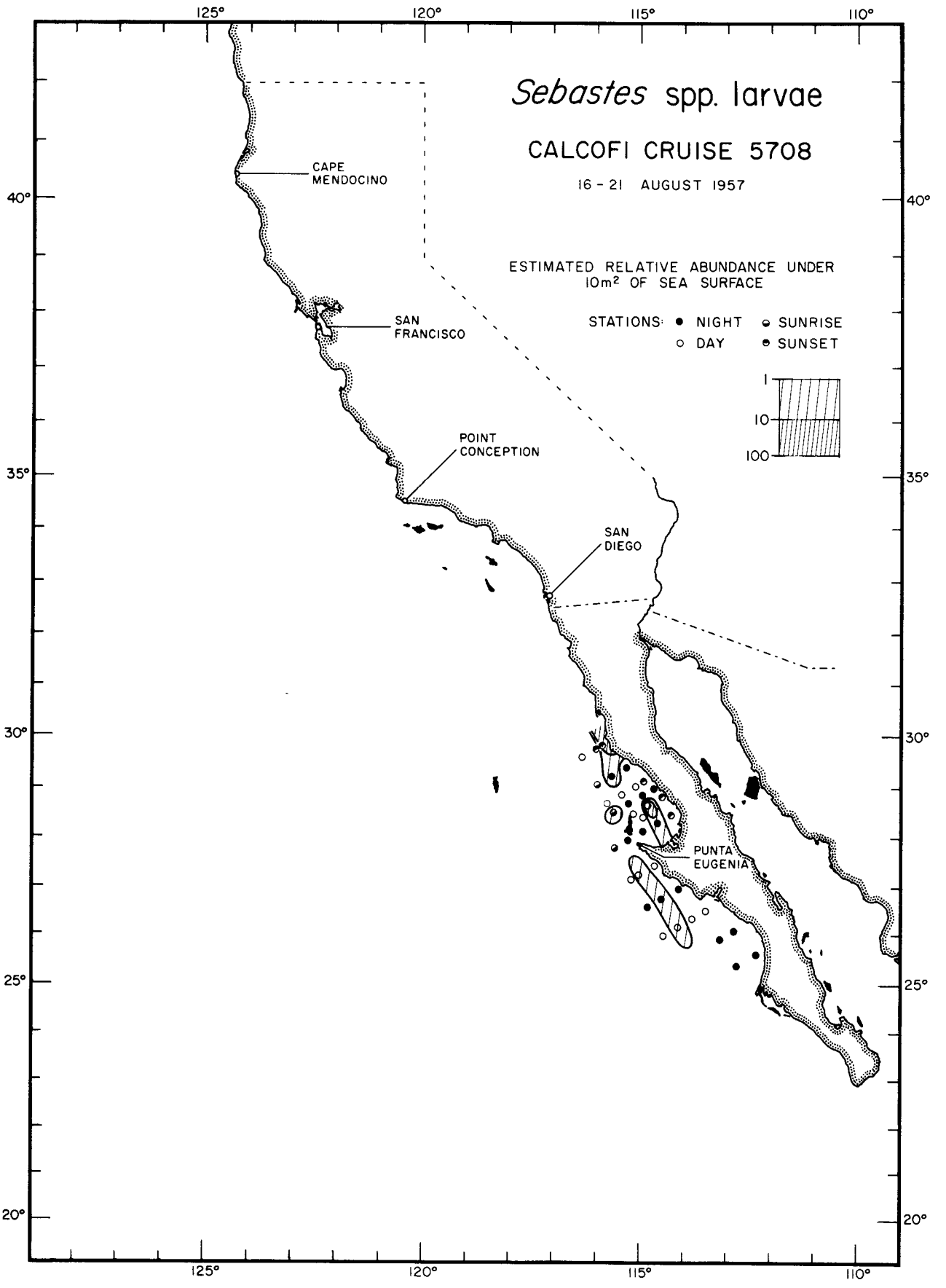
Sebastes spp. larvae

5706



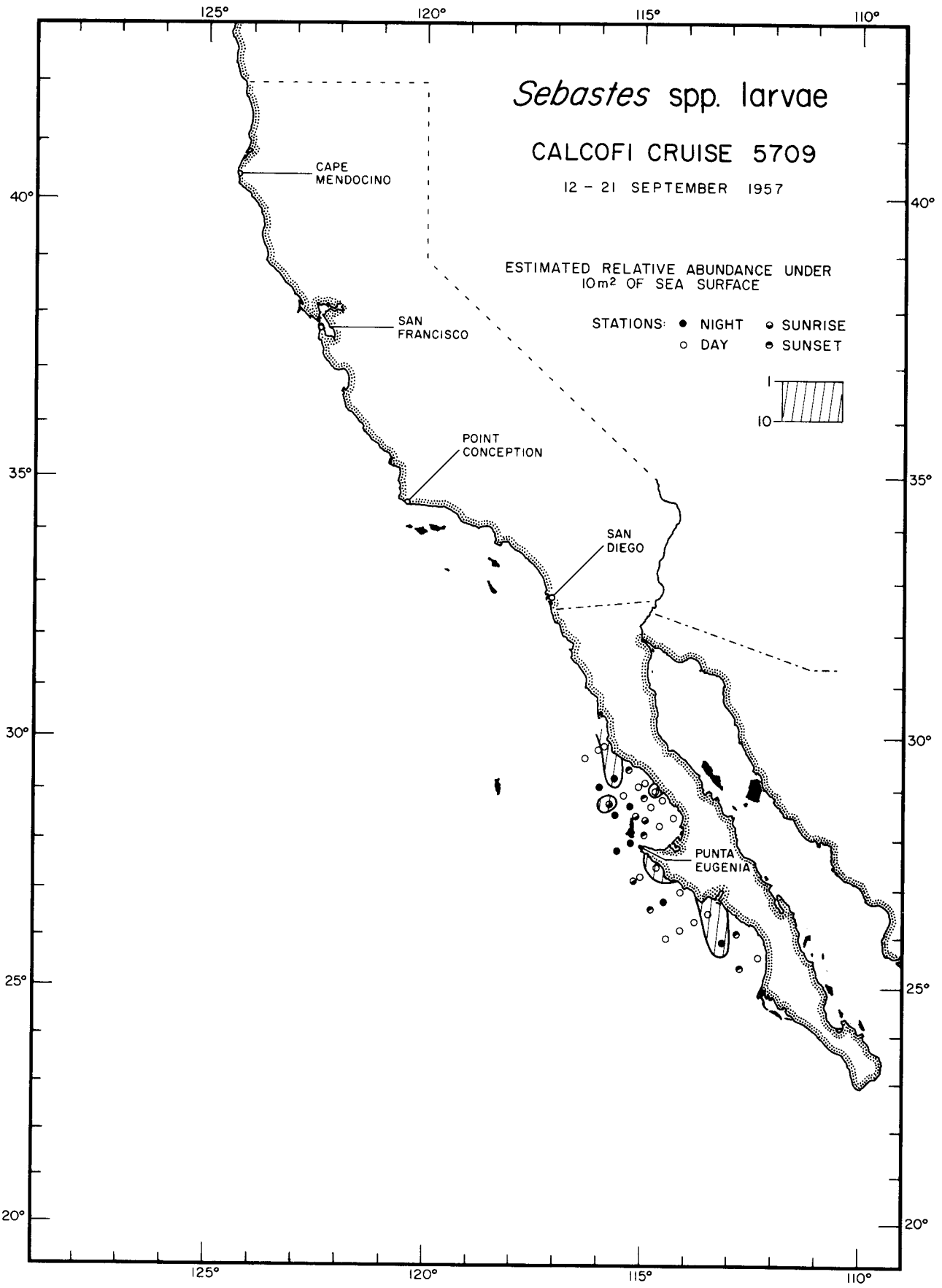
Sebastes spp. larvae

5707



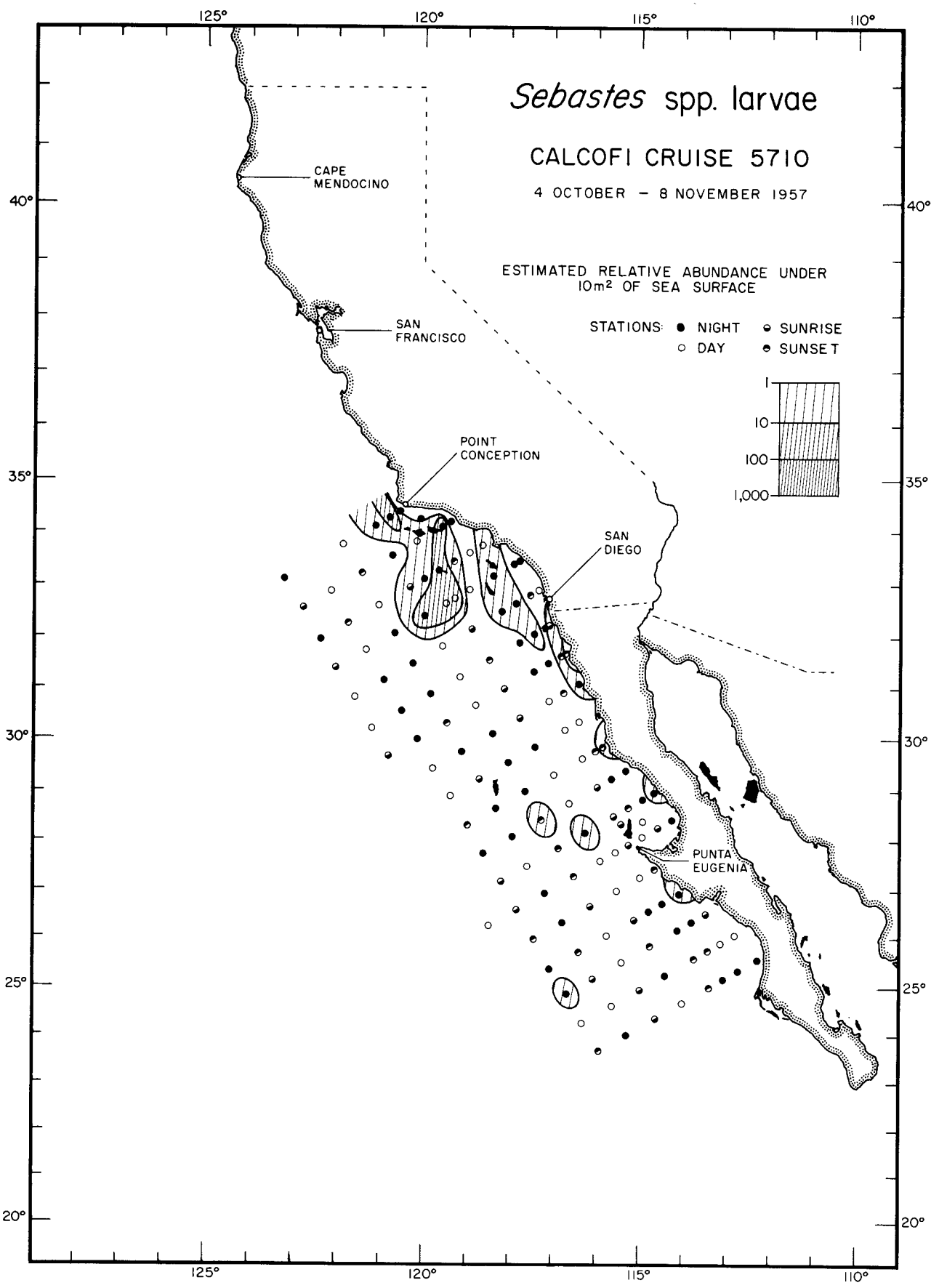
Sebastes spp. larvae

5708



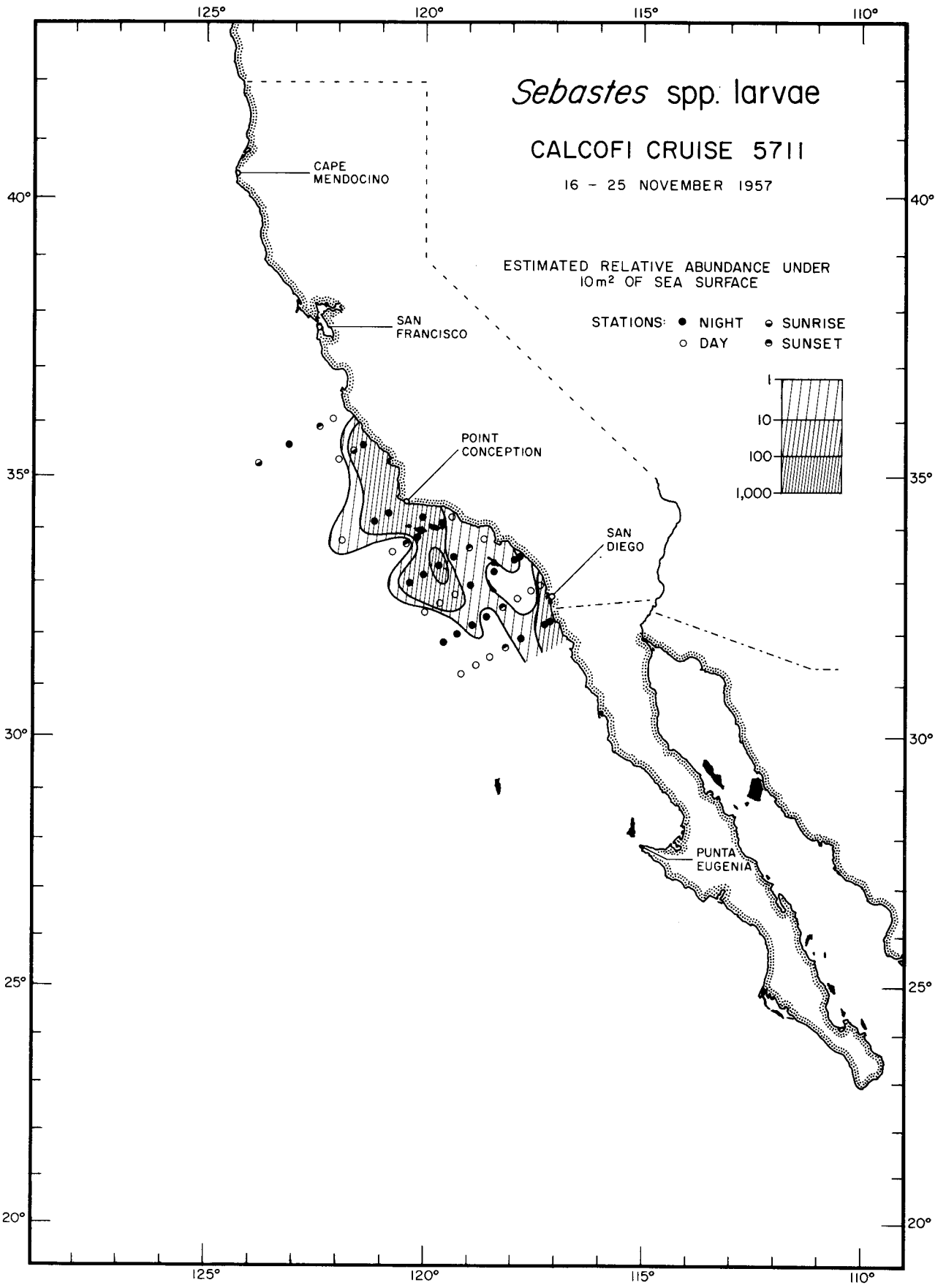
Sebastes spp. larvae

5709



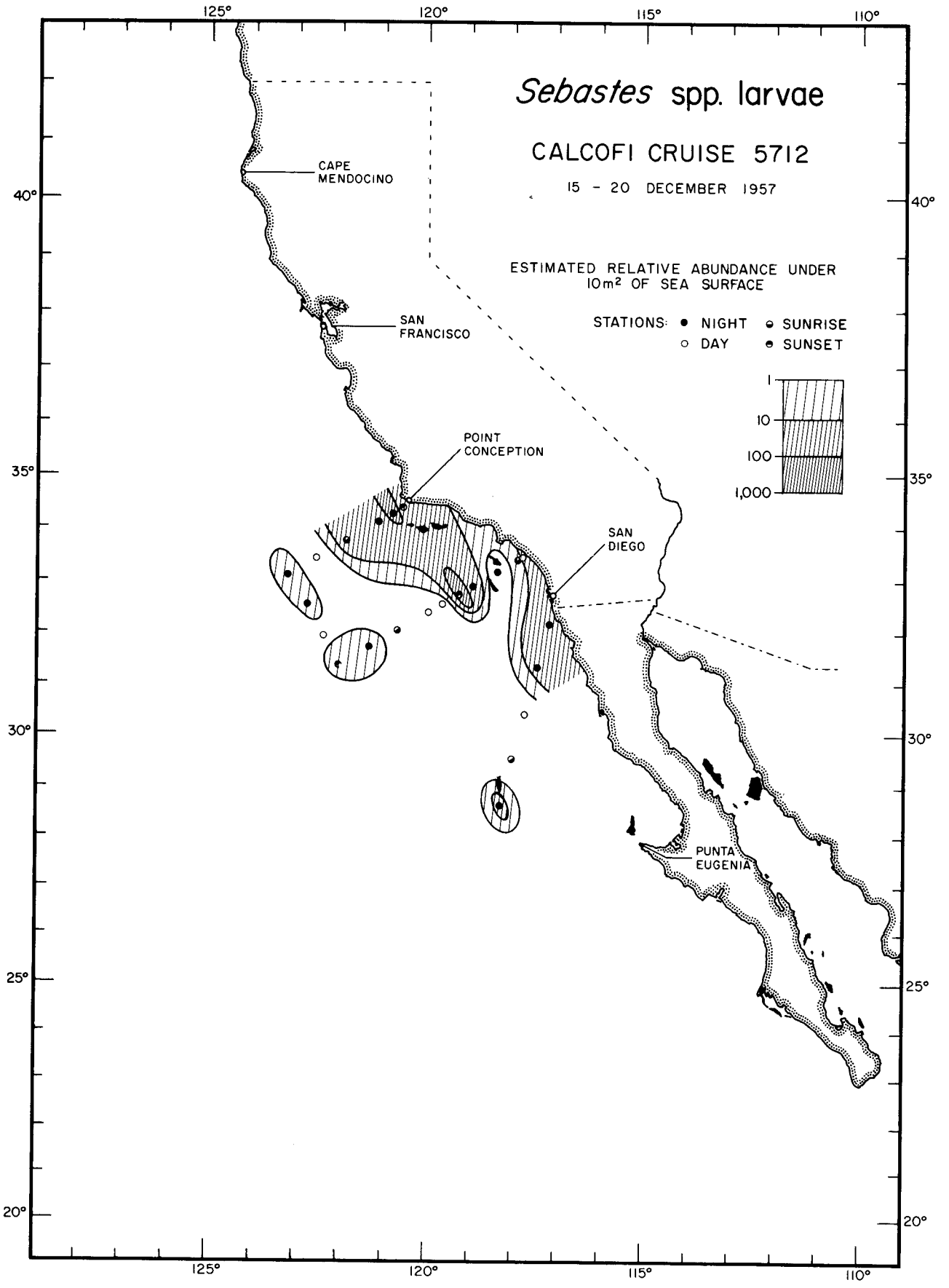
Sebastes spp. larvae

5710



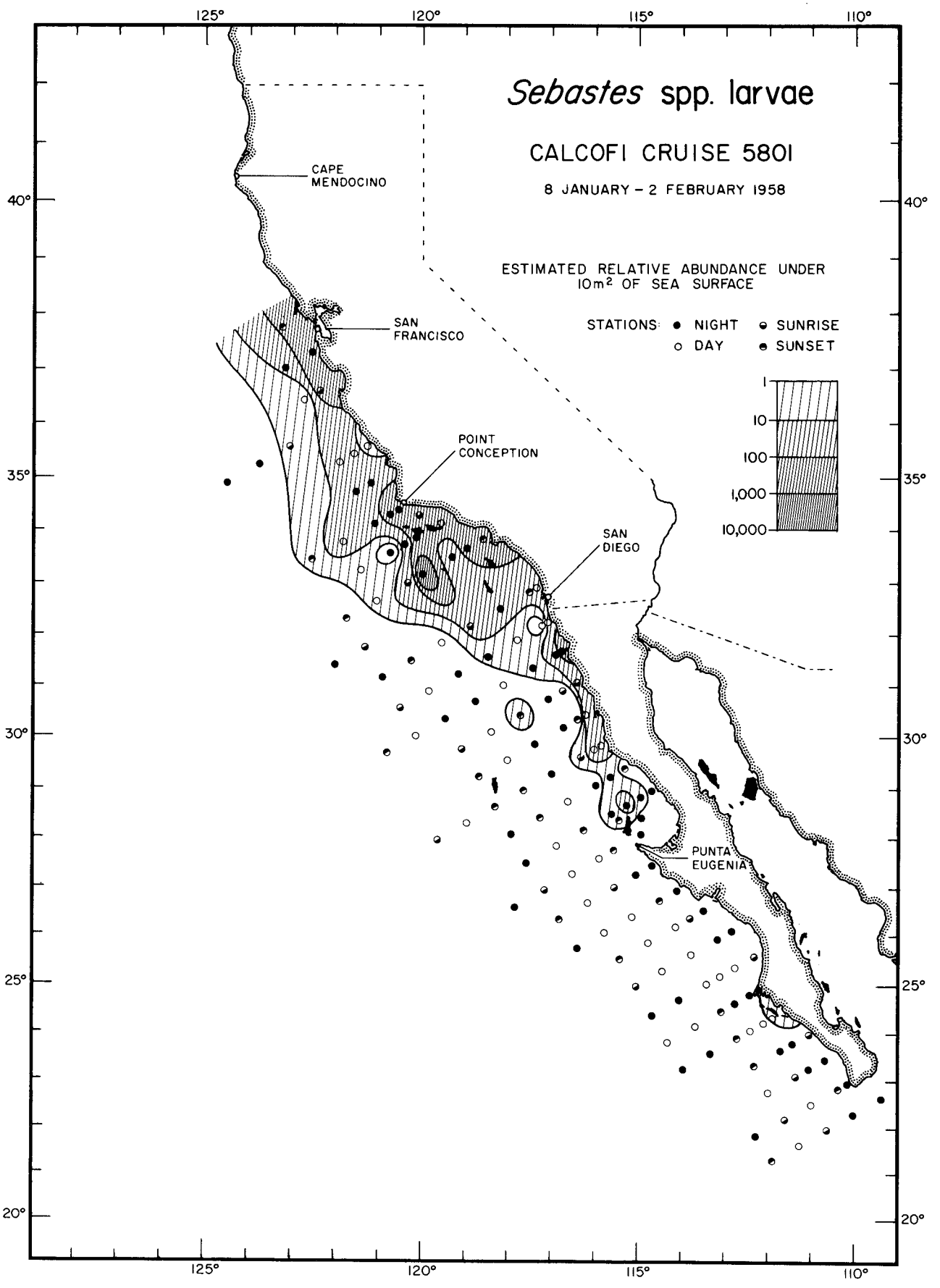
Sebastes spp. larvae

5711



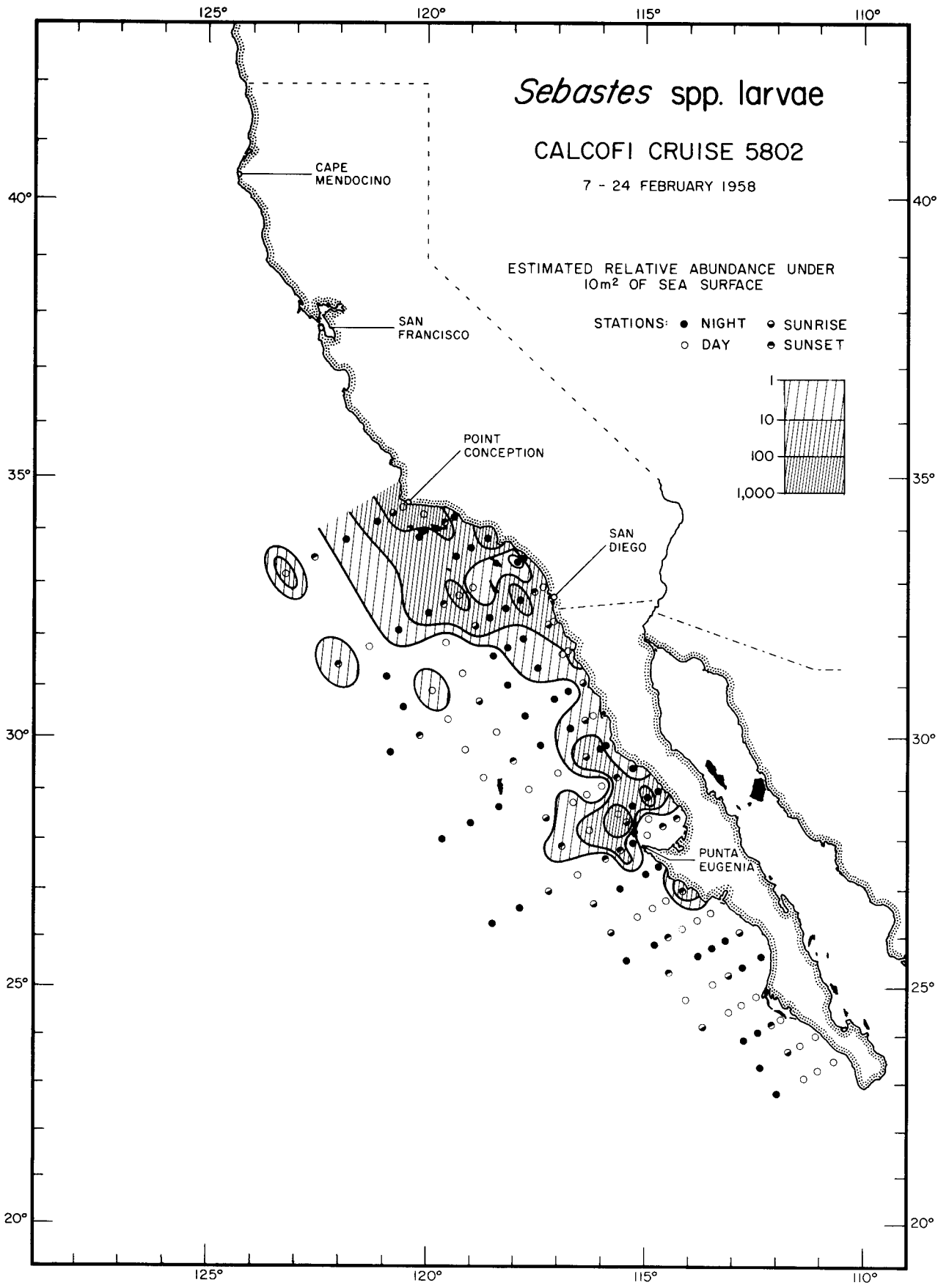
Sebastes spp. larvae

5712



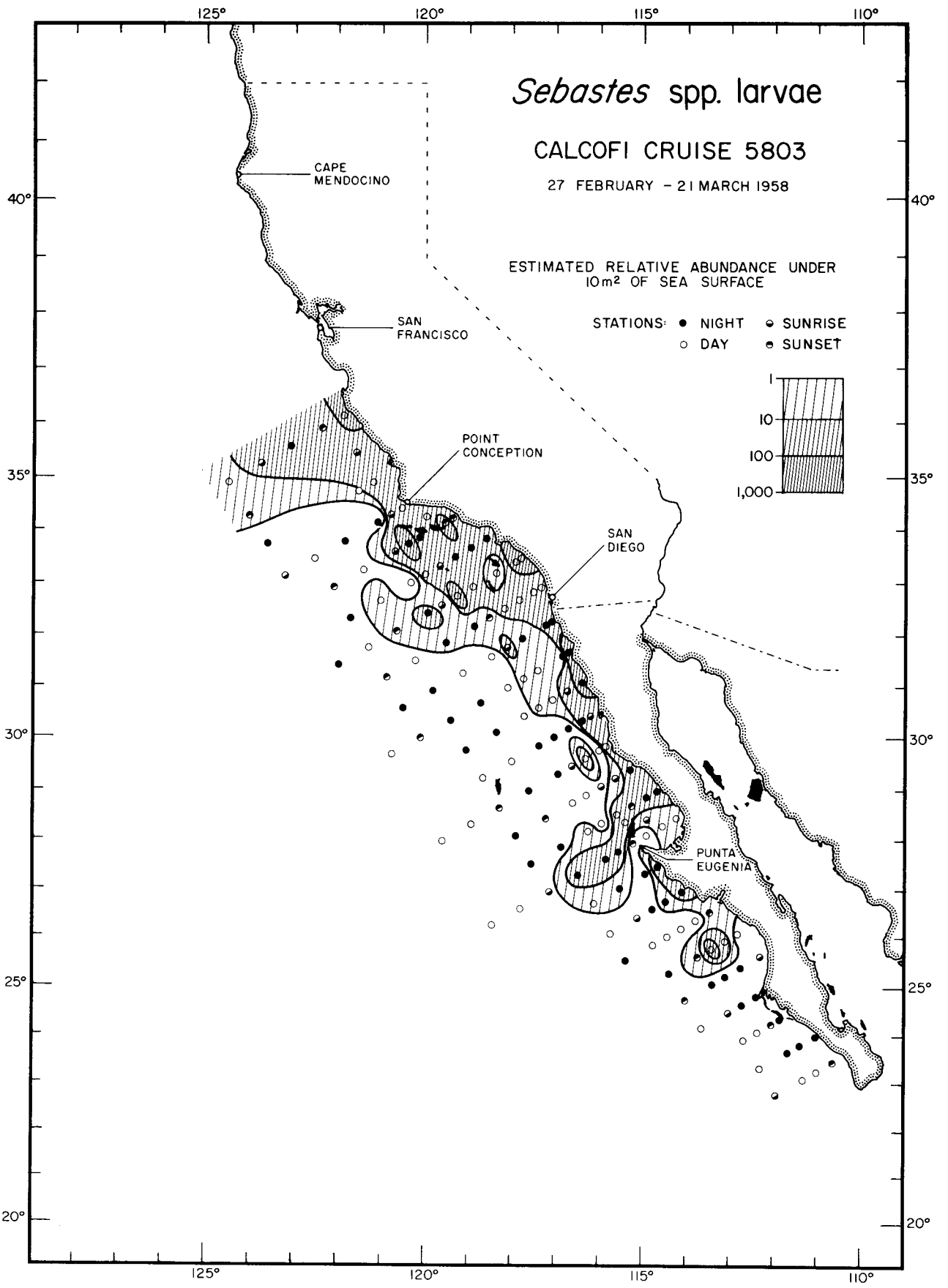
Sebastes spp. larvae

5801



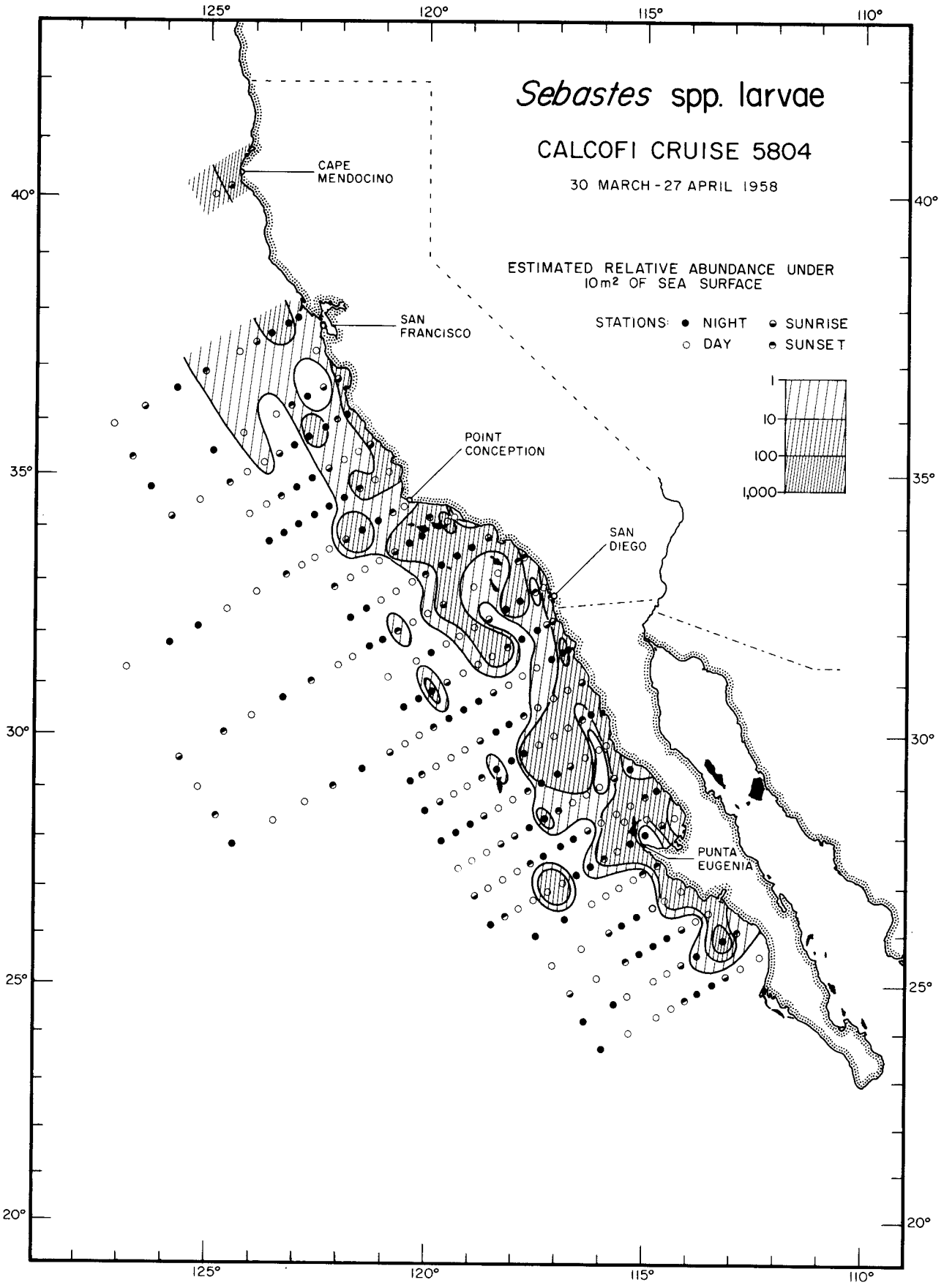
Sebastes spp. larvae

5802



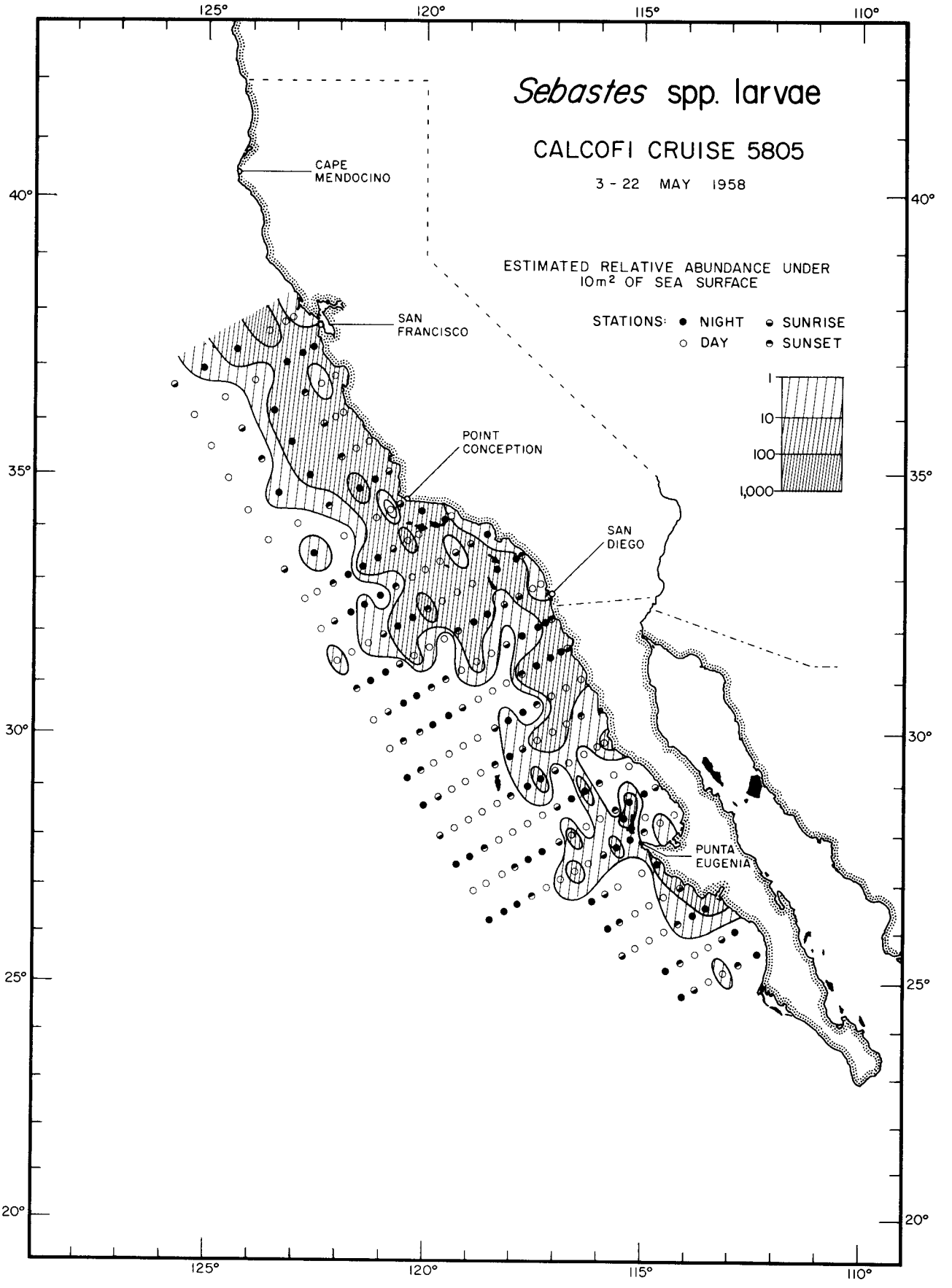
Sebastes spp. larvae

5803



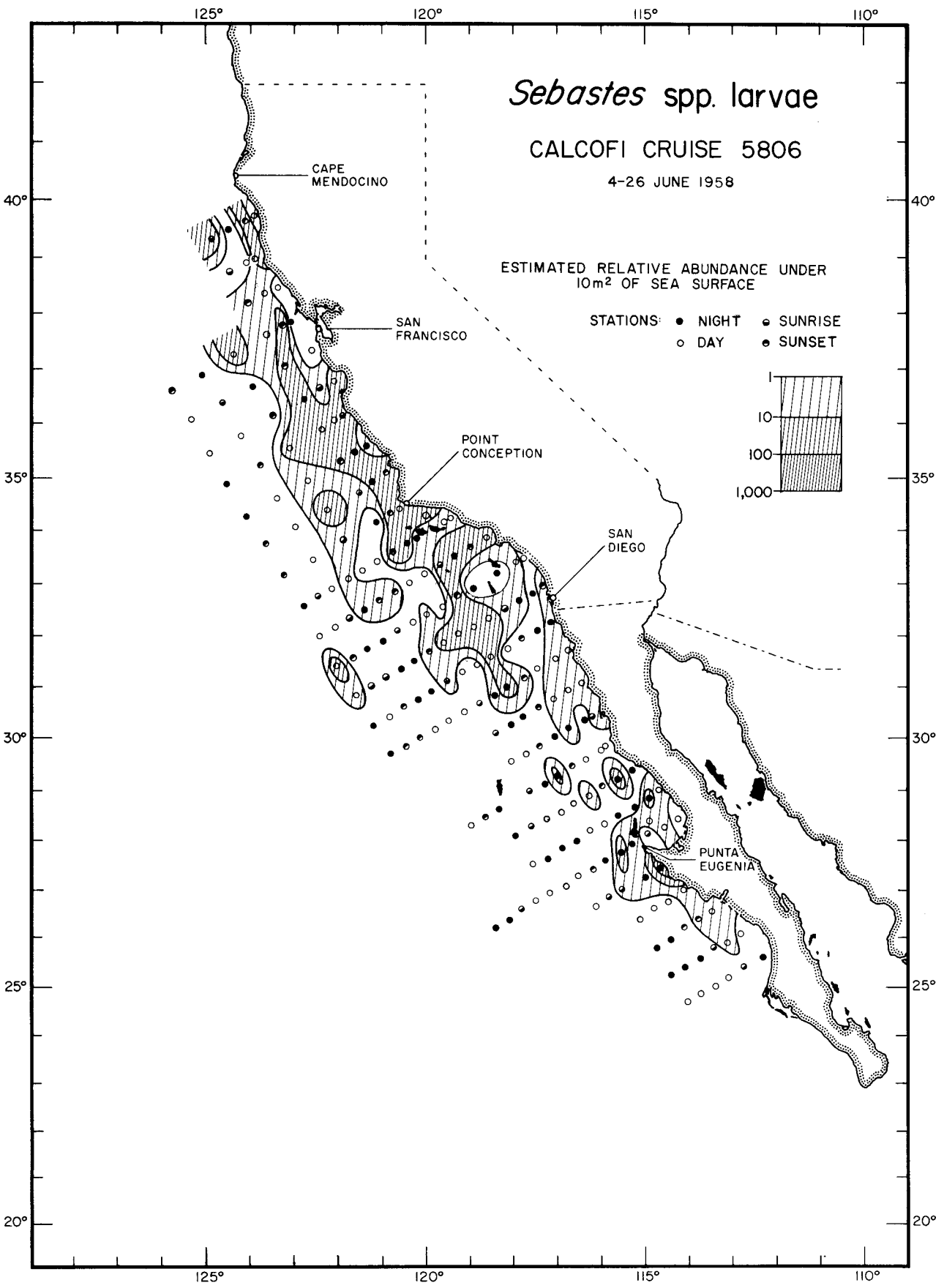
Sebastes spp. larvae

5804



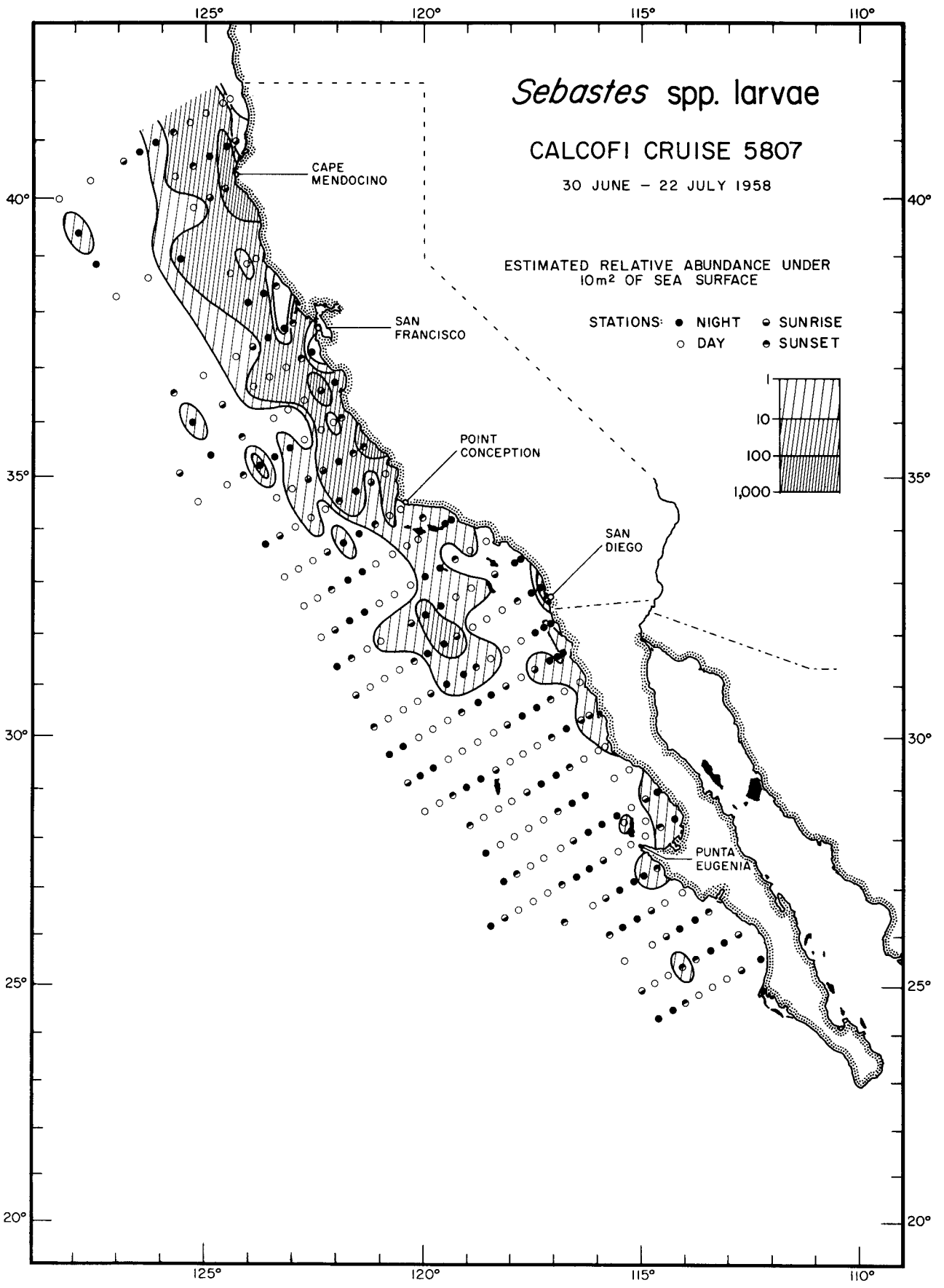
Sebastes spp. larvae

5805



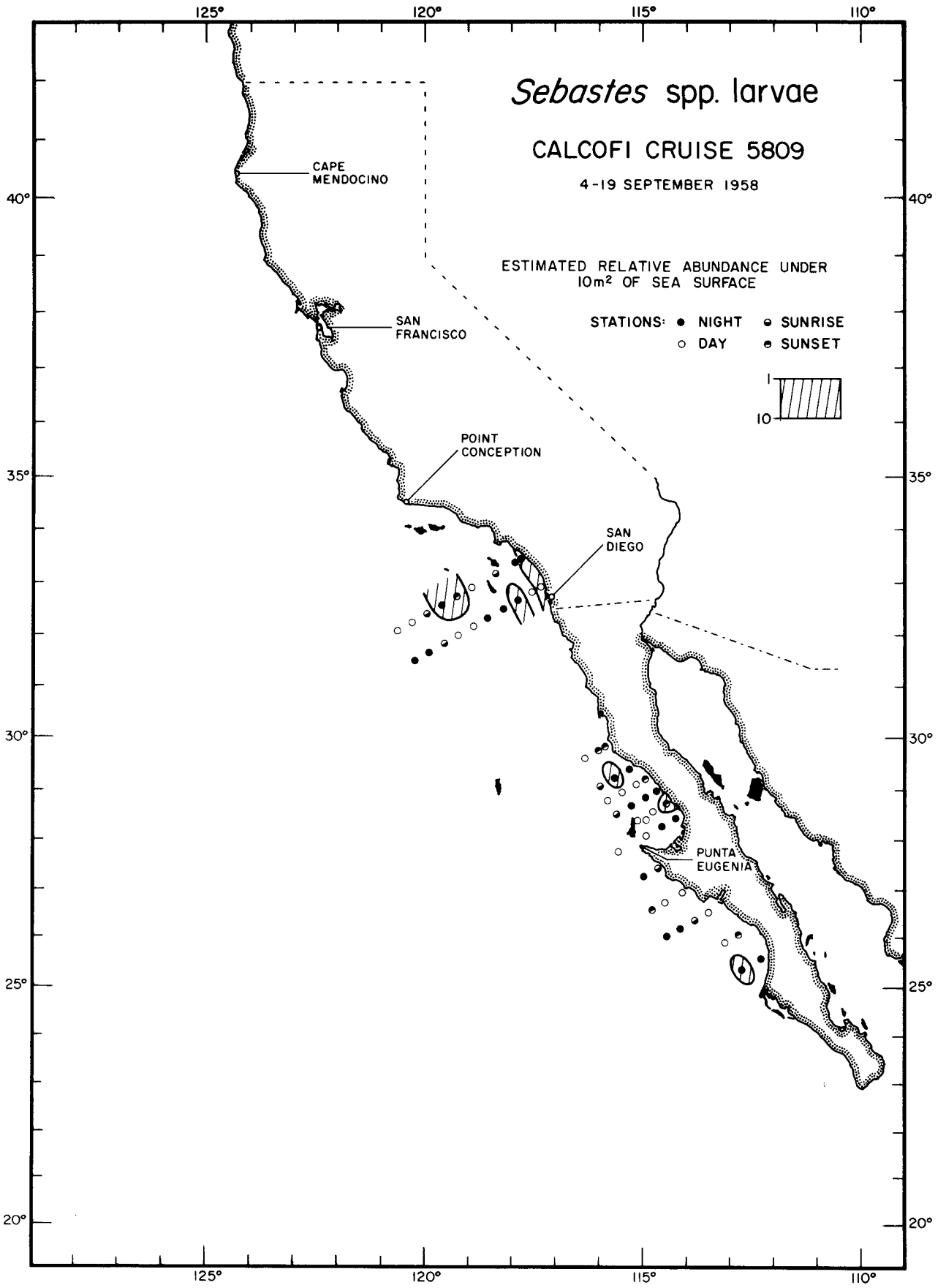
Sebastes spp. larvae

5806



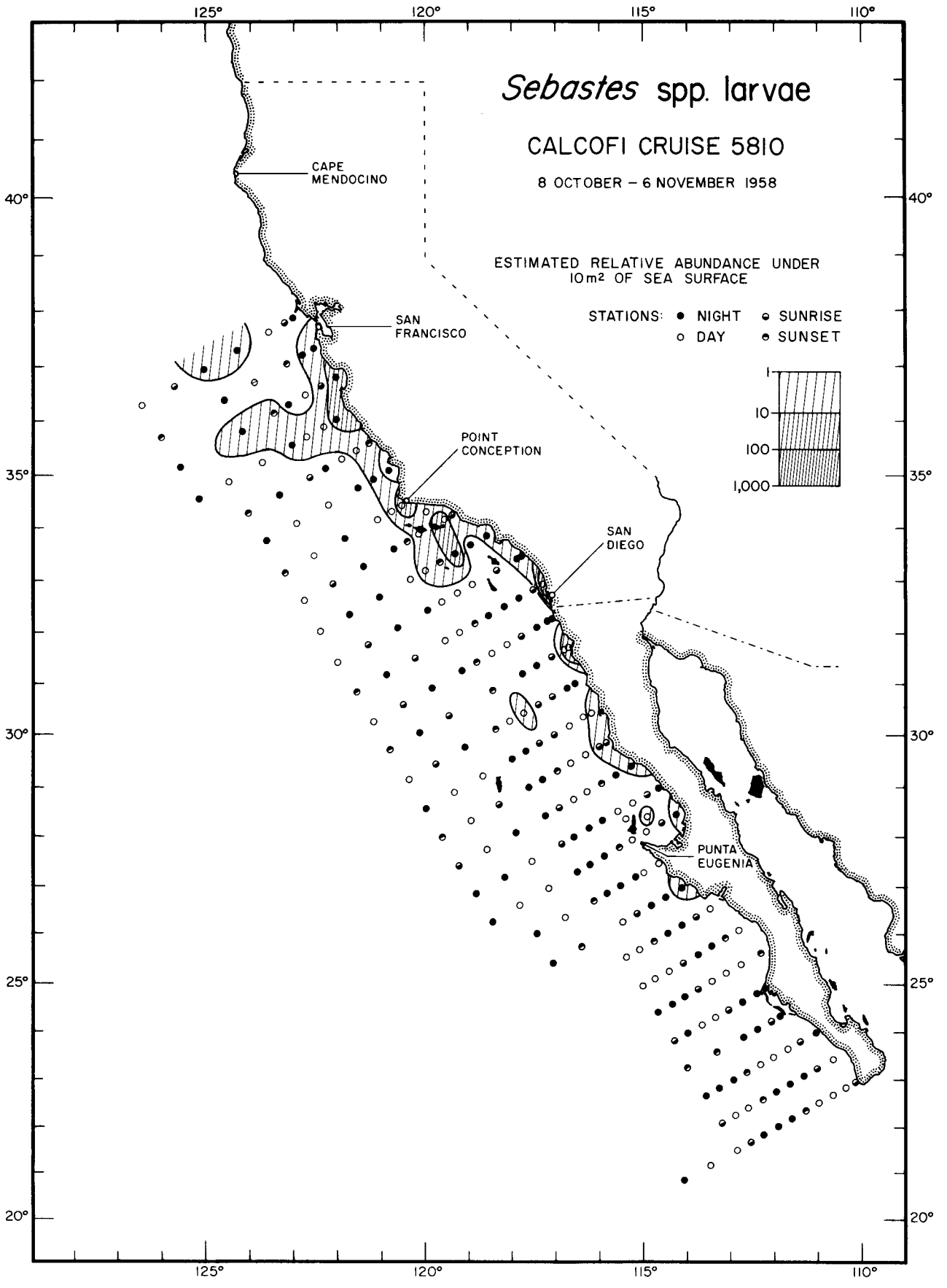
Sebastes spp. larvae

5807



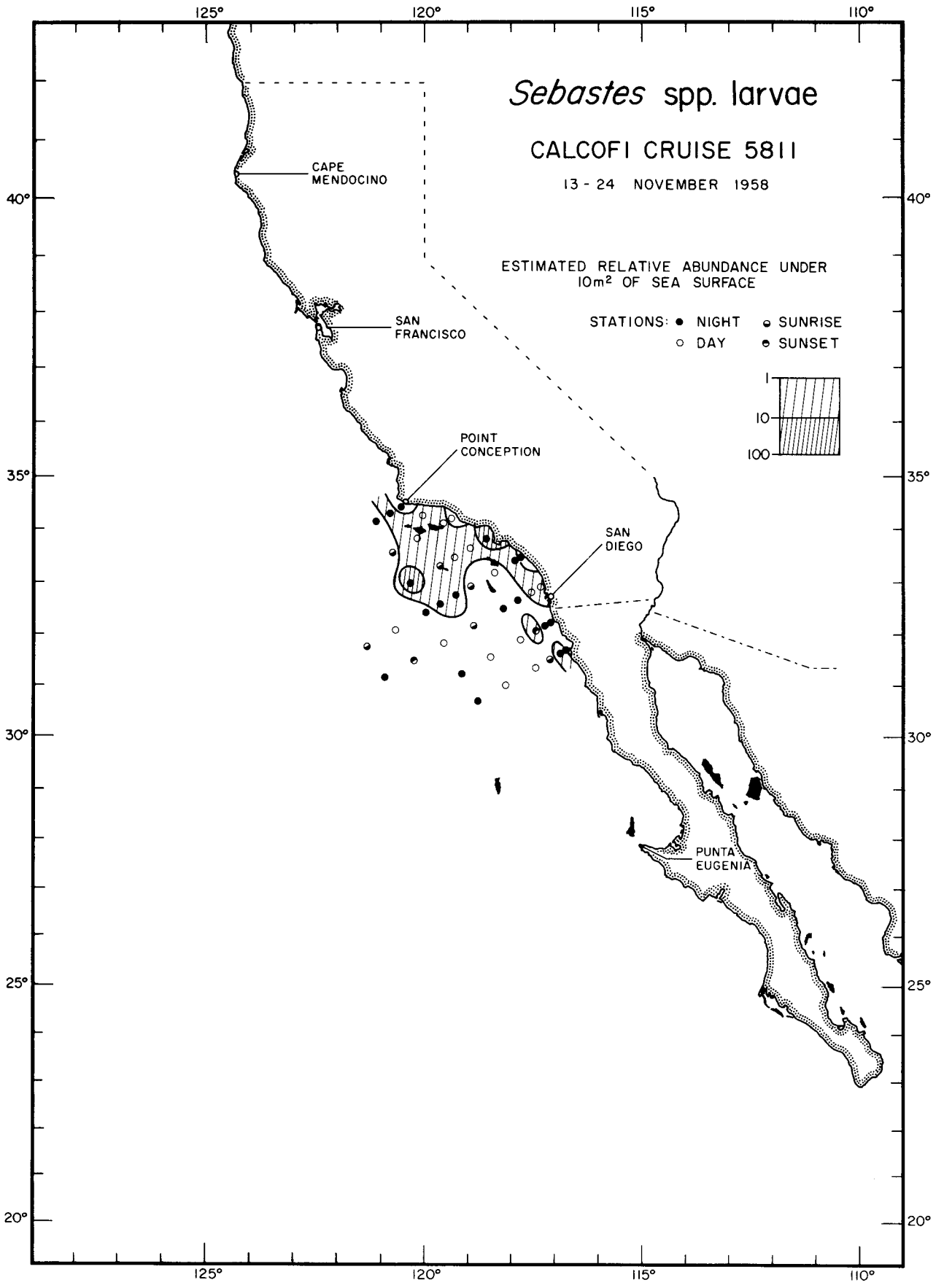
Sebastes spp. larvae

5809



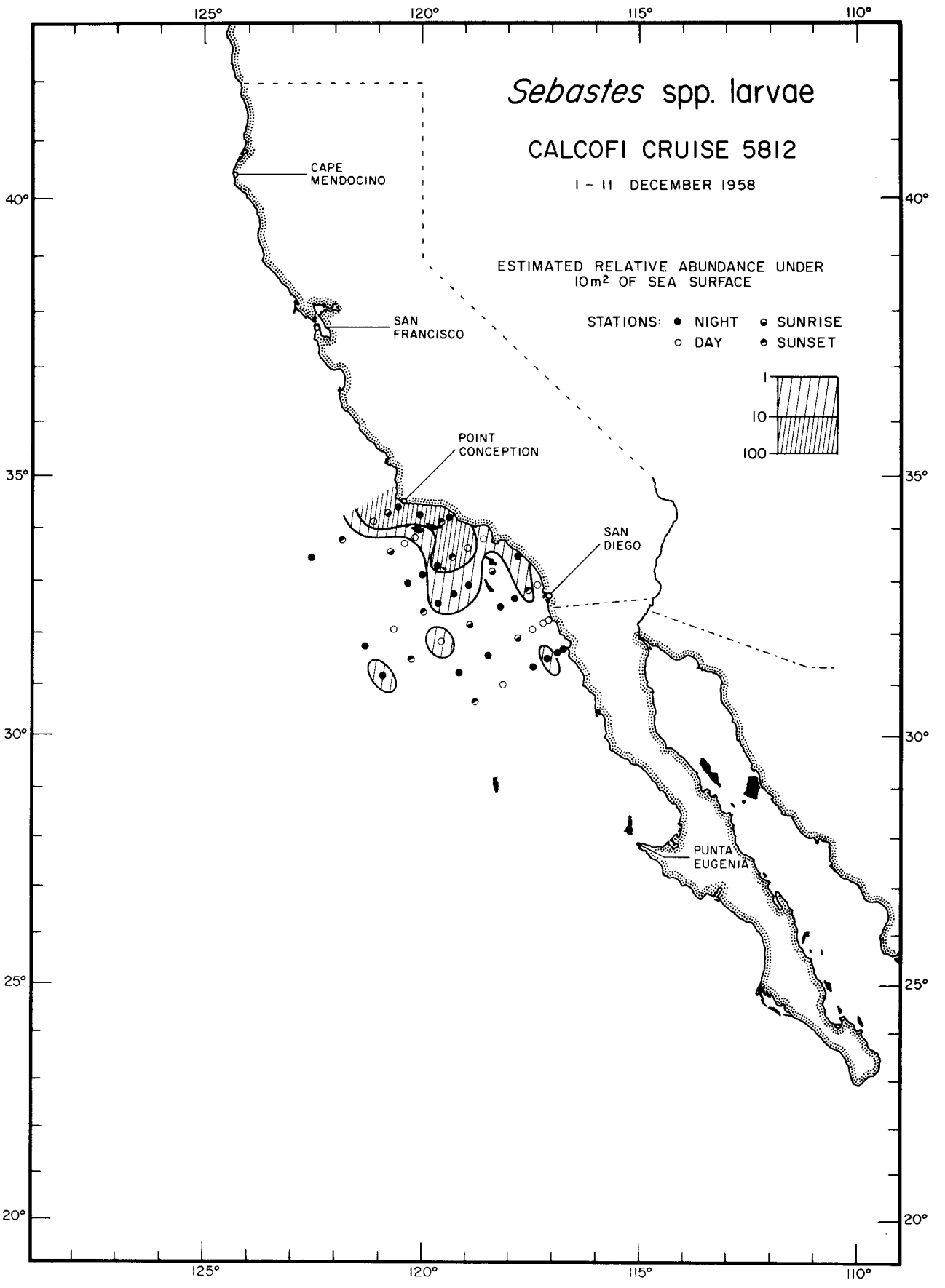
Sebastes spp. larvae

5810



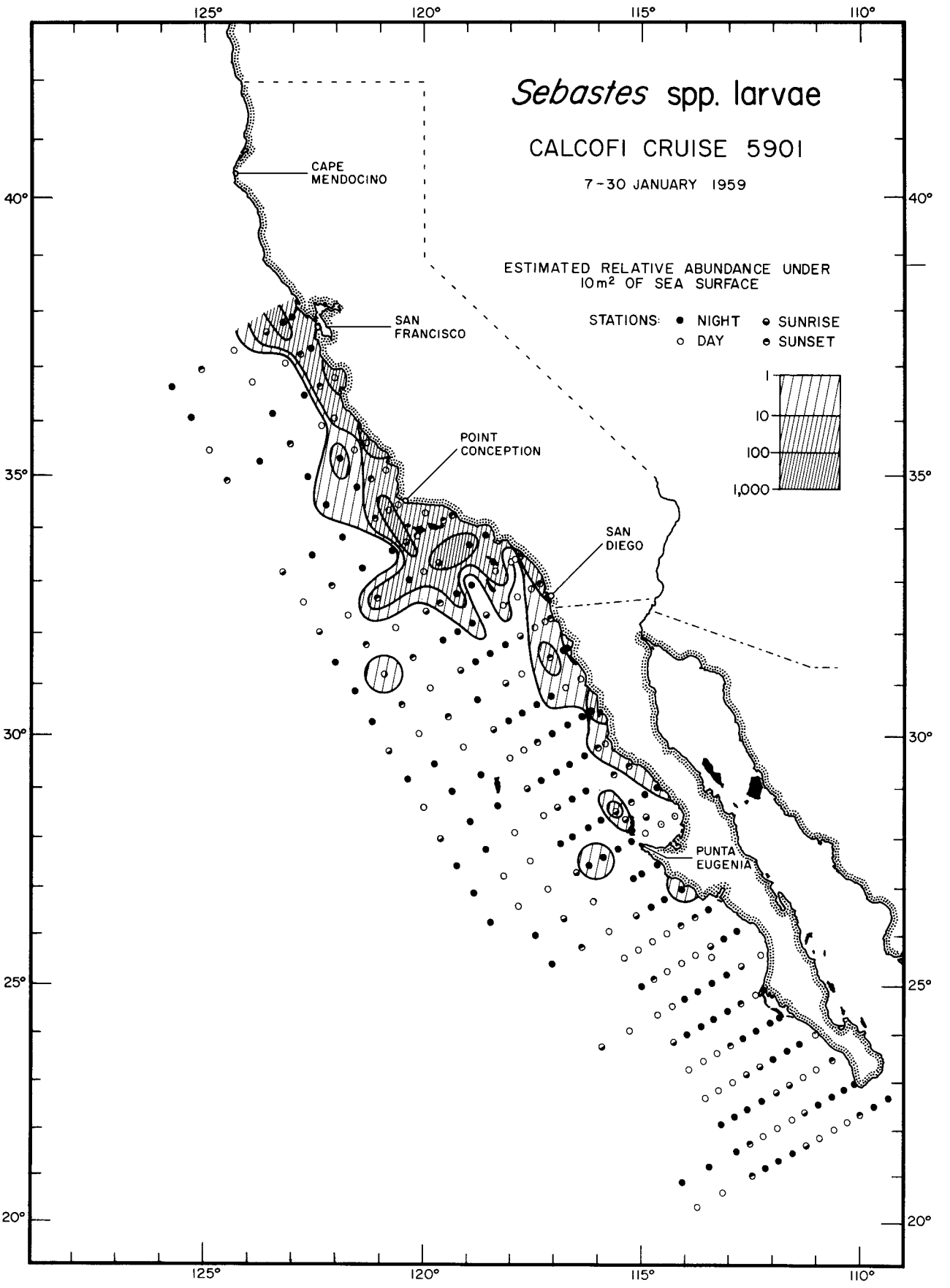
Sebastes spp. larvae

5811



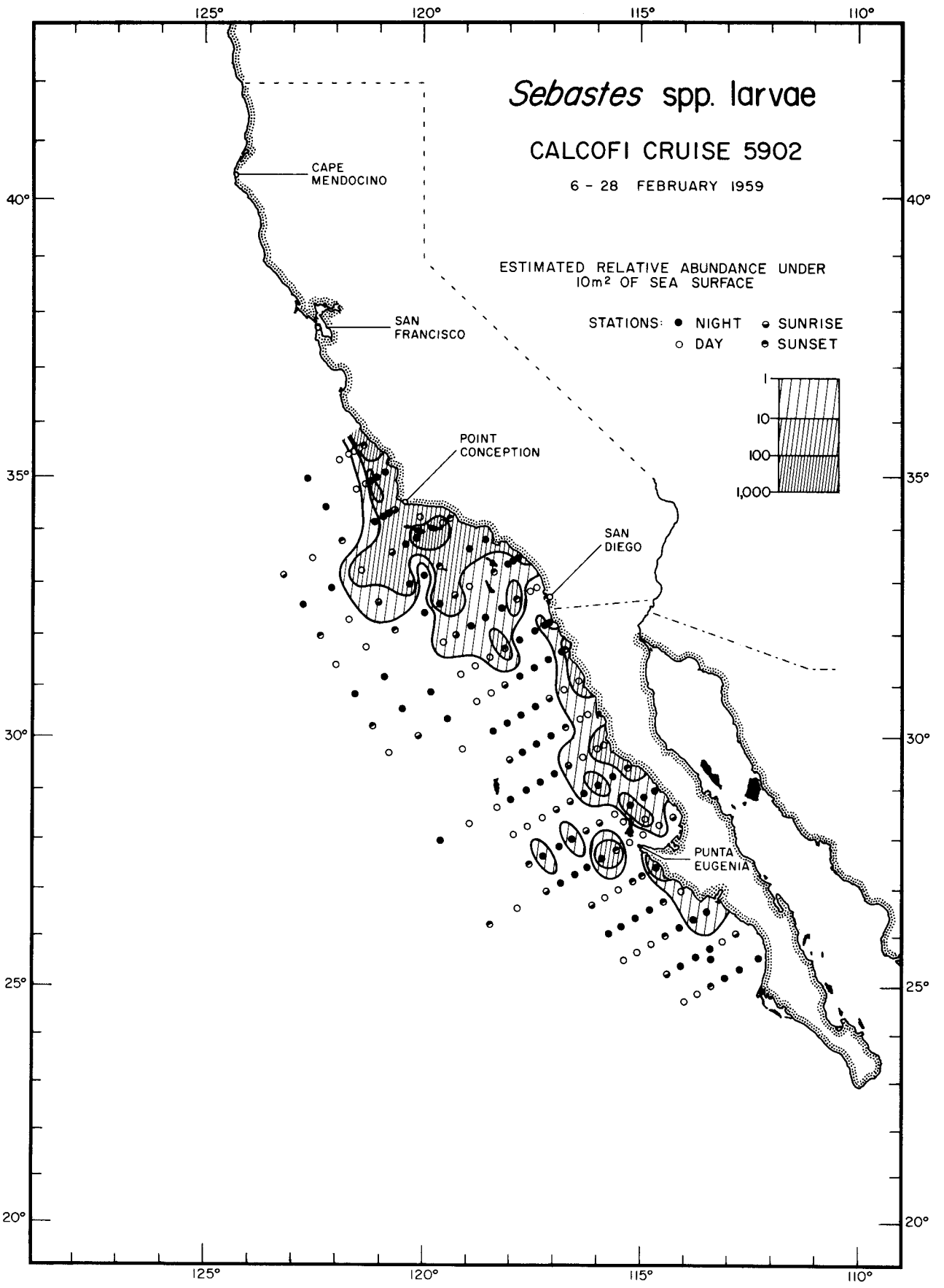
Sebastes spp. larvae

5812



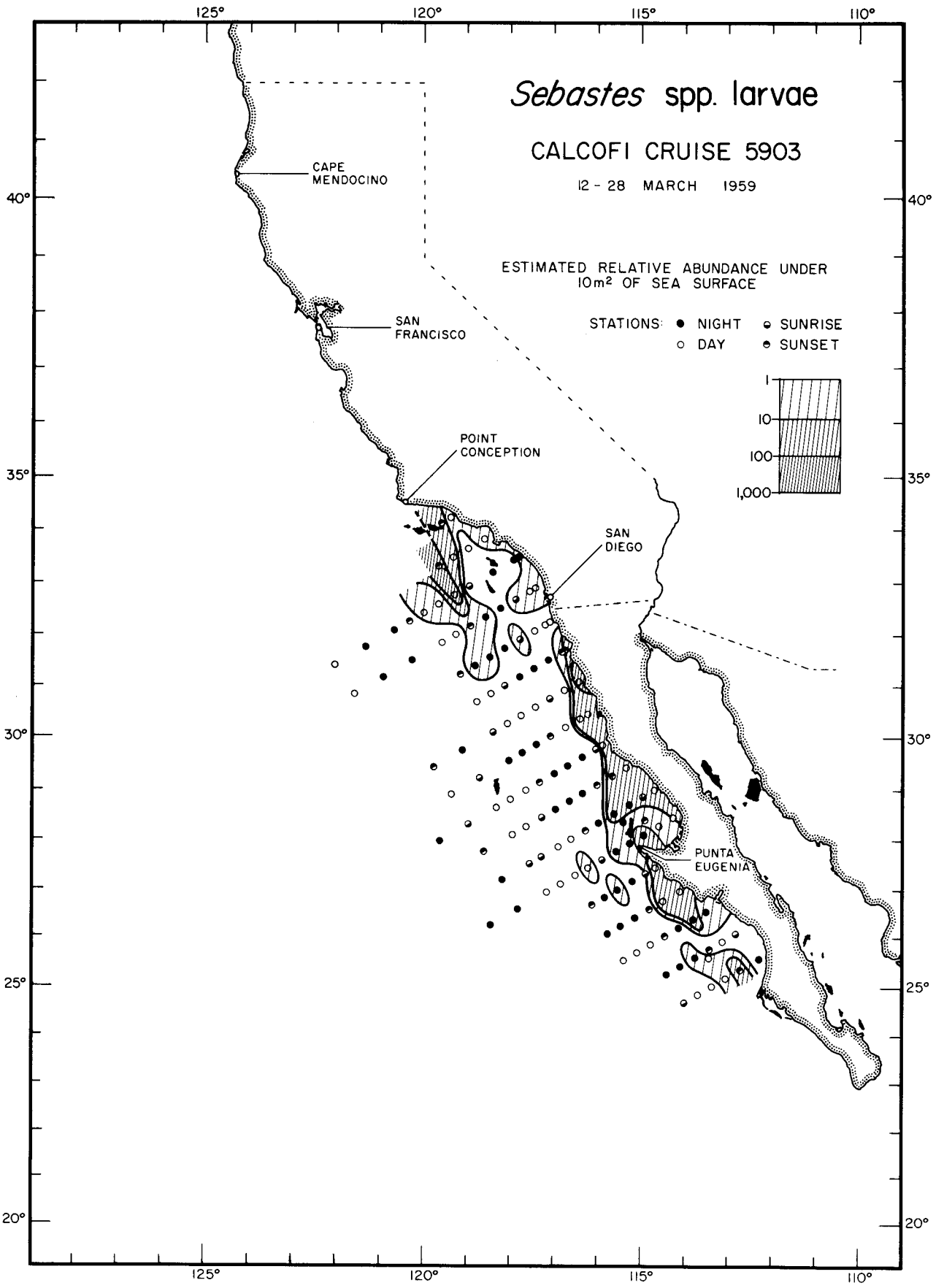
Sebastes spp. larvae

5901



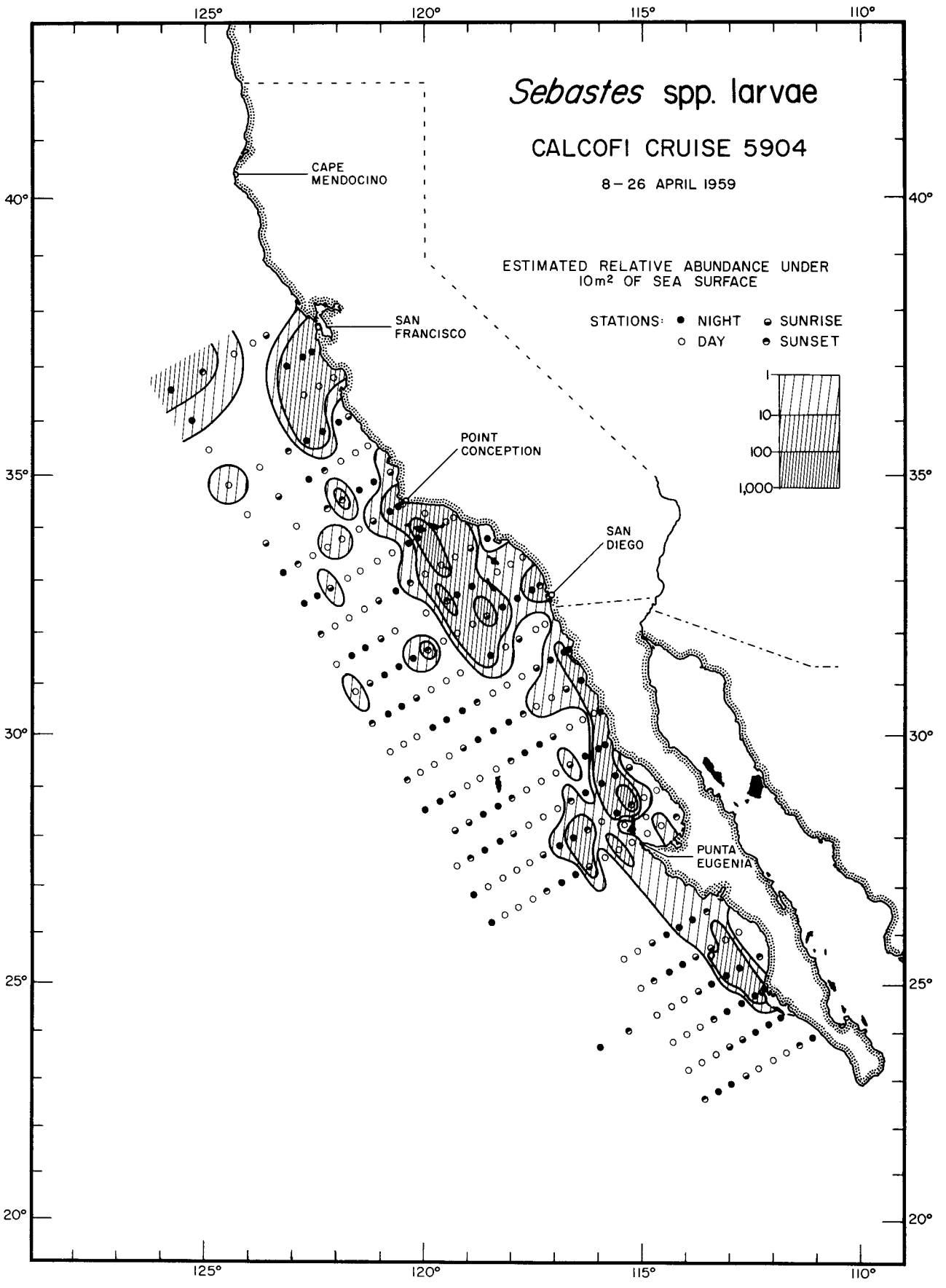
Sebastes spp. larvae

5902



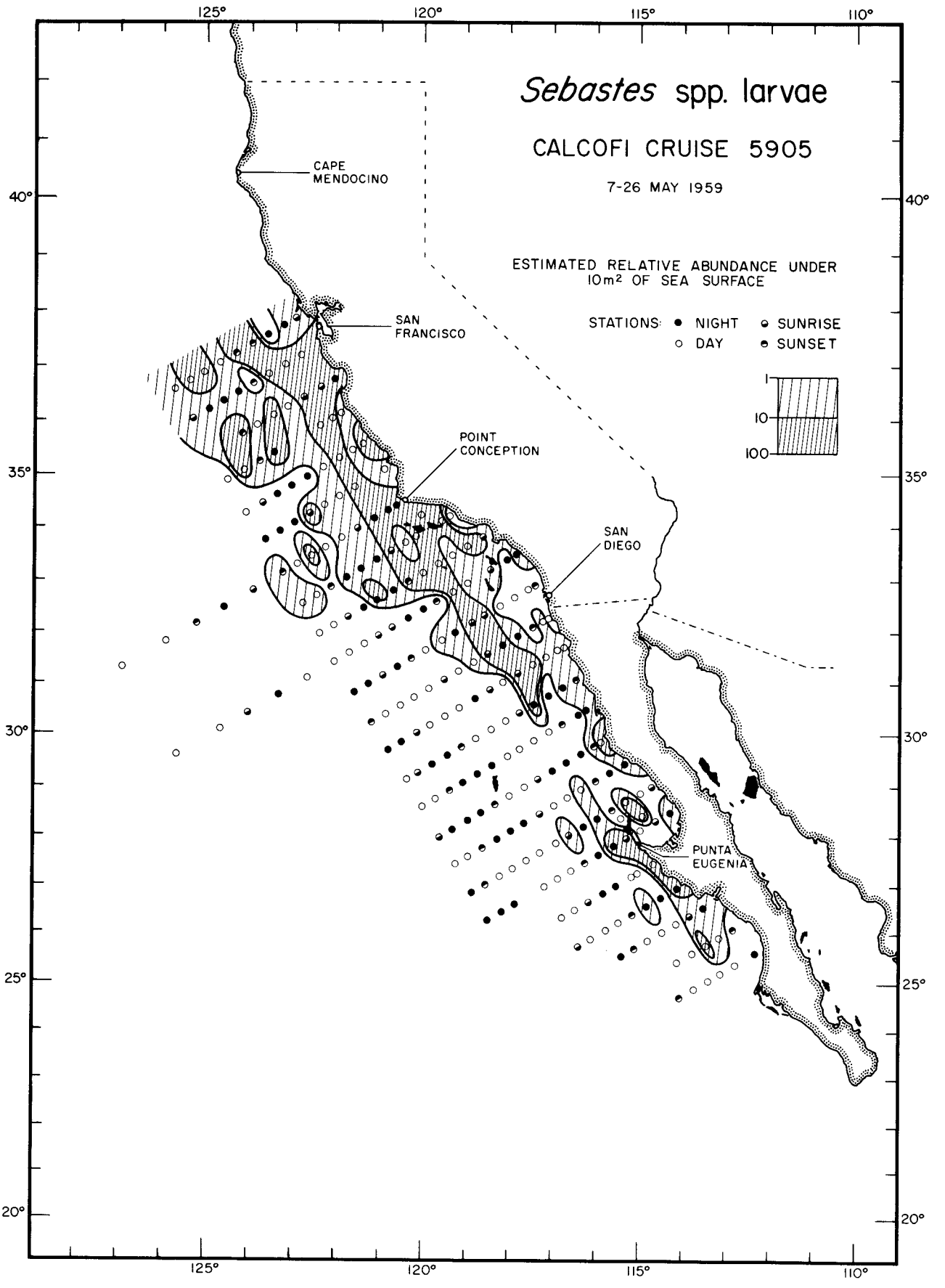
Sebastes spp. larvae

5903



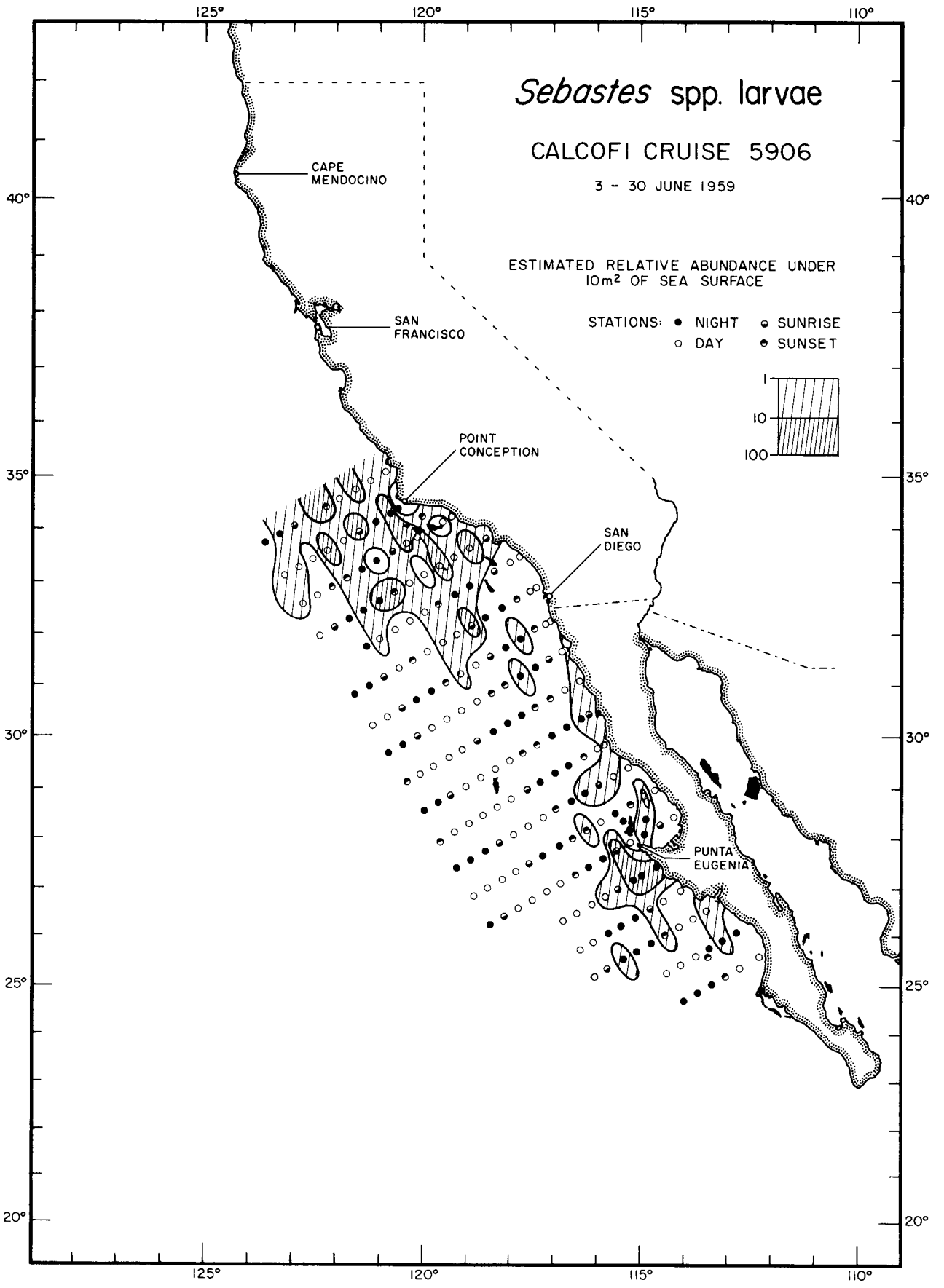
Sebastes spp. larvae

5904



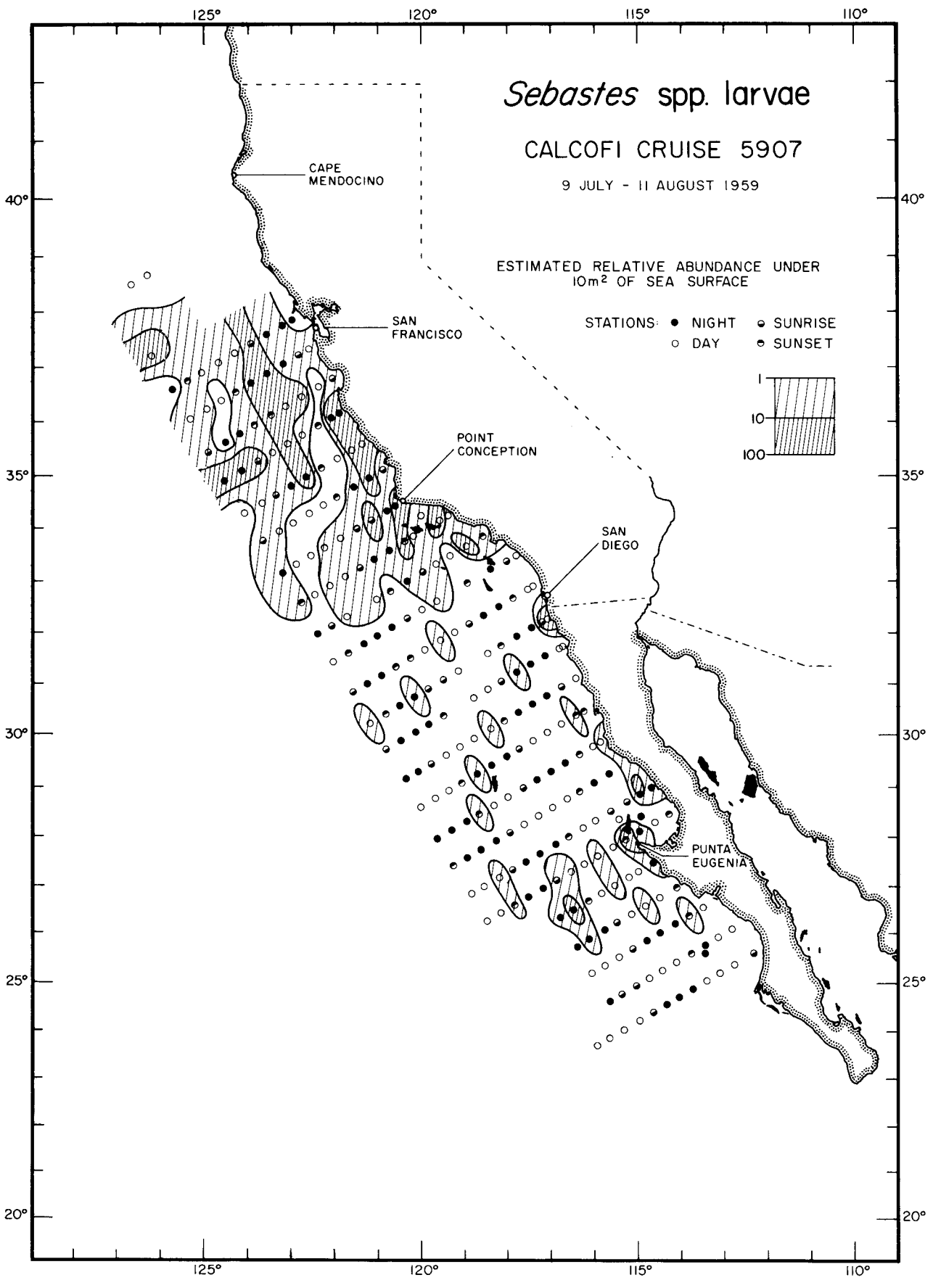
Sebastes spp. larvae

5905



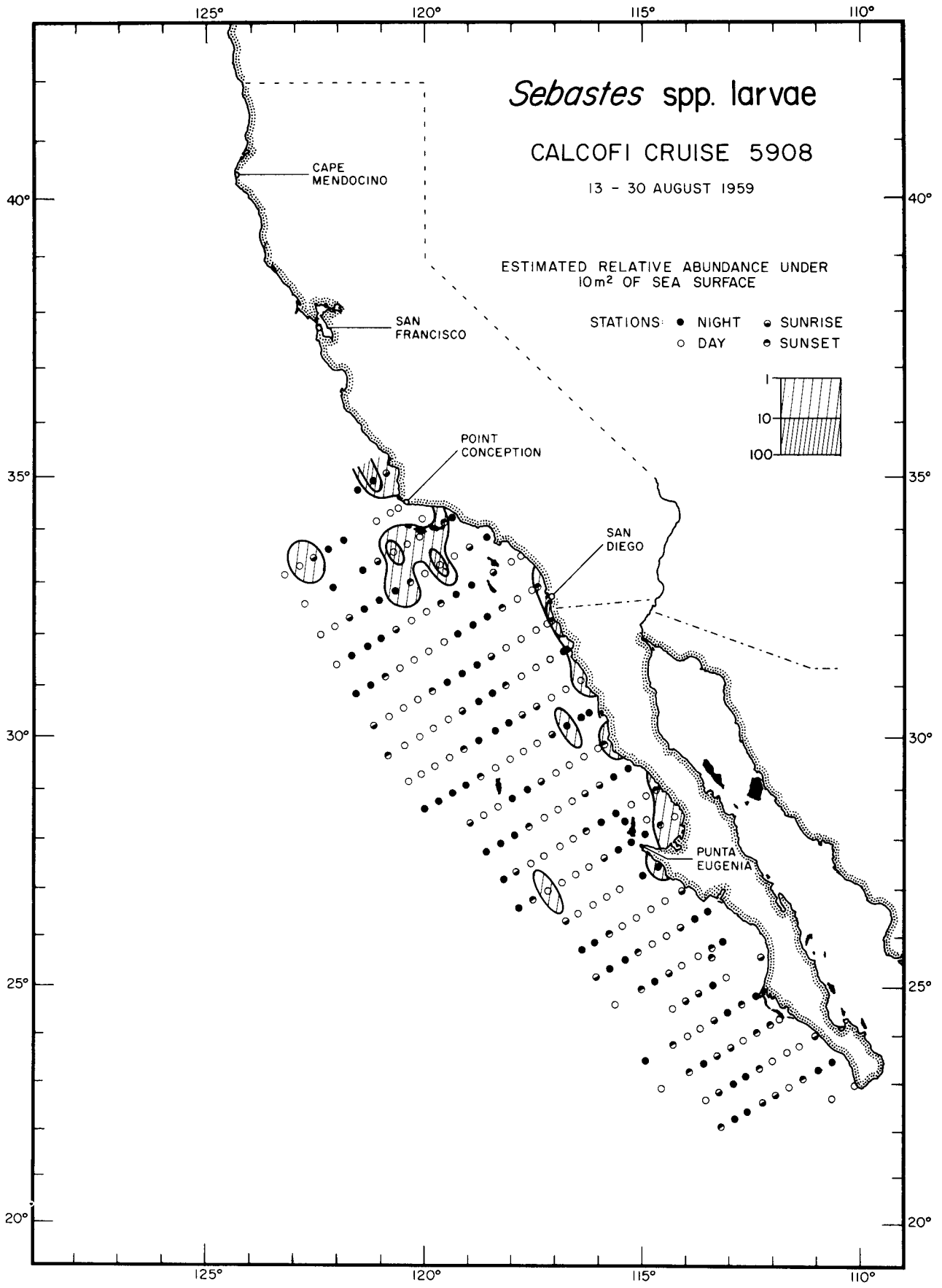
Sebastes spp. larvae

5906



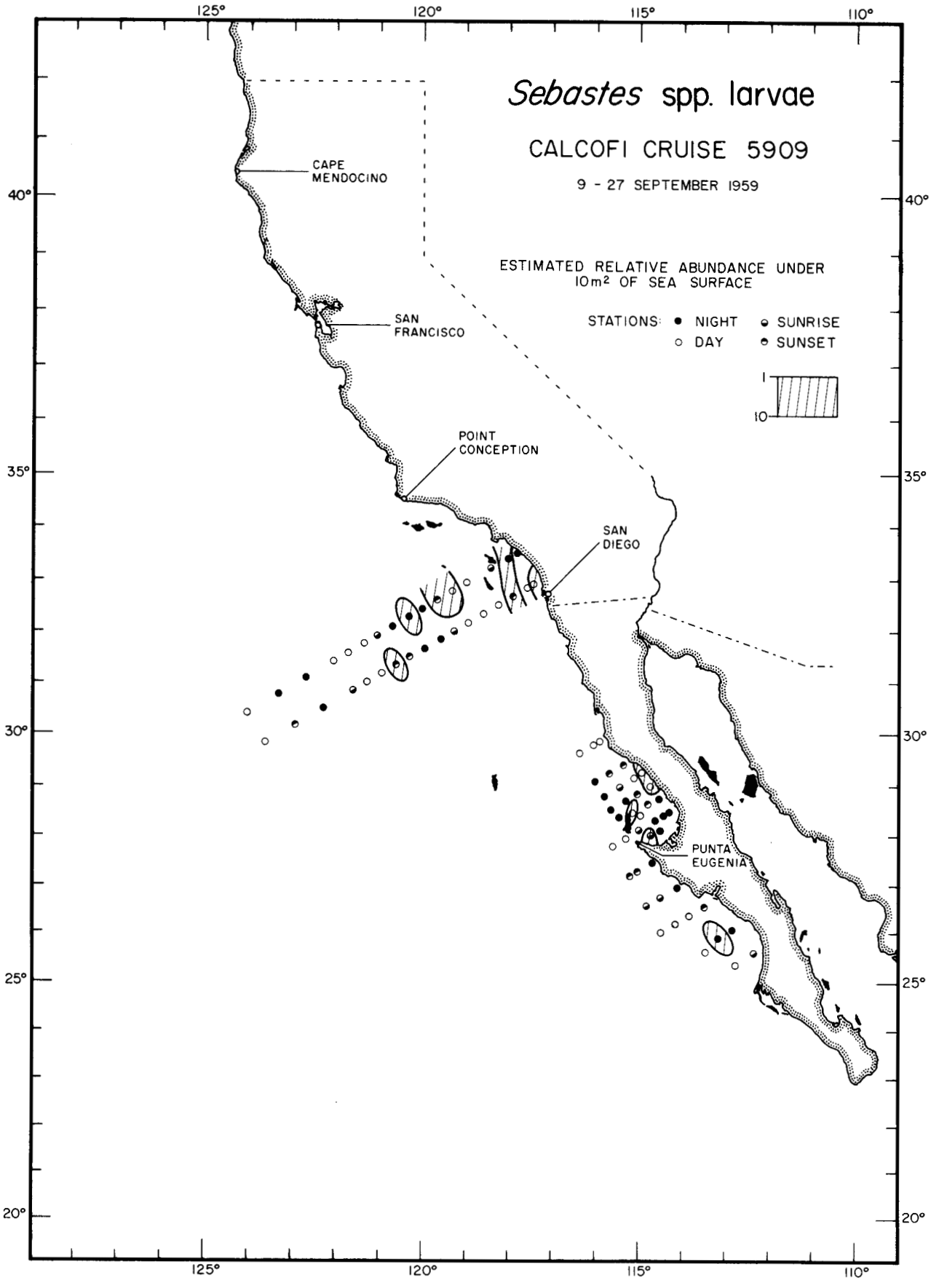
Sebastes spp. larvae

5907



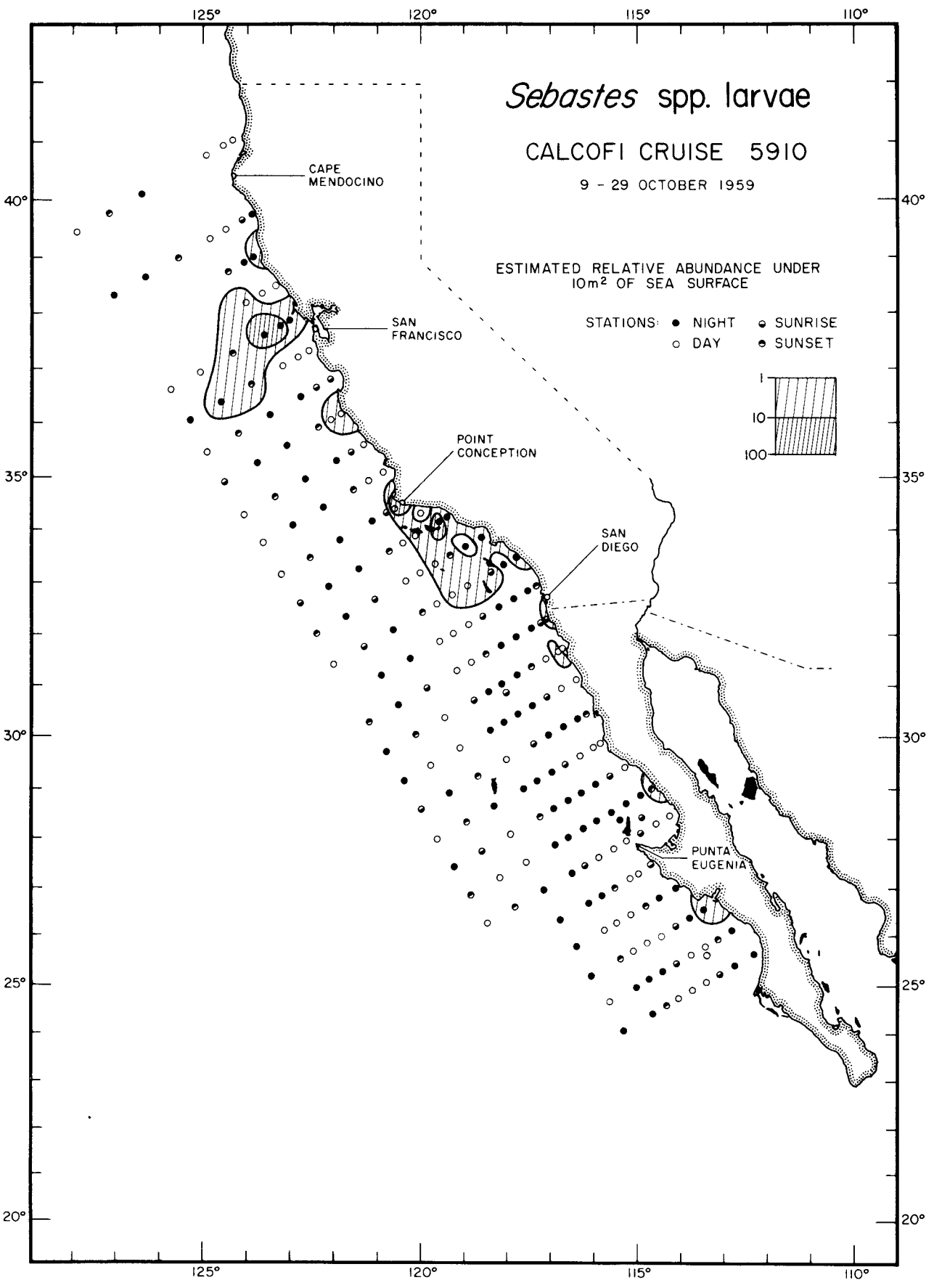
Sebastes spp. larvae

5908



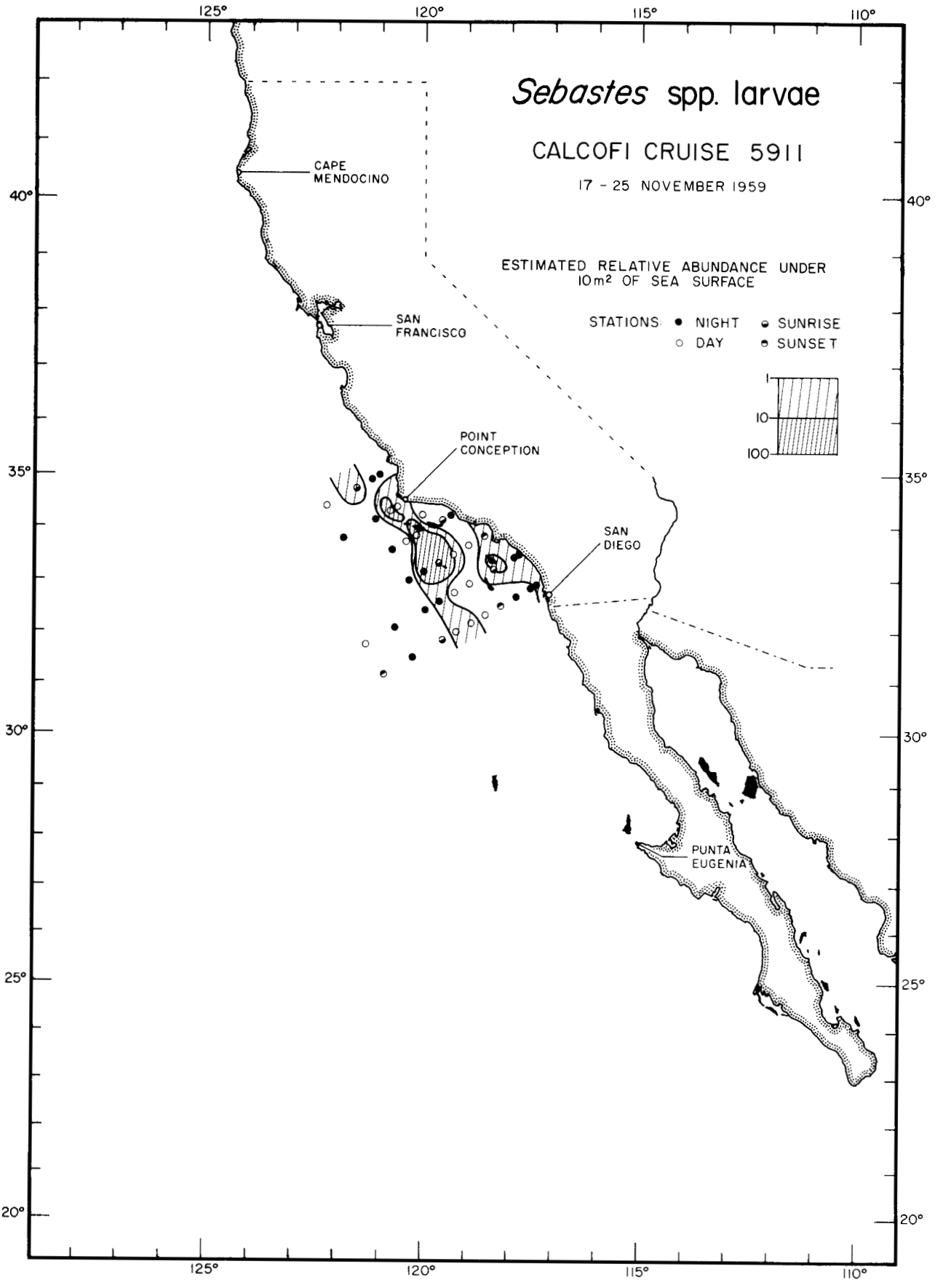
Sebastes spp. larvae

5909



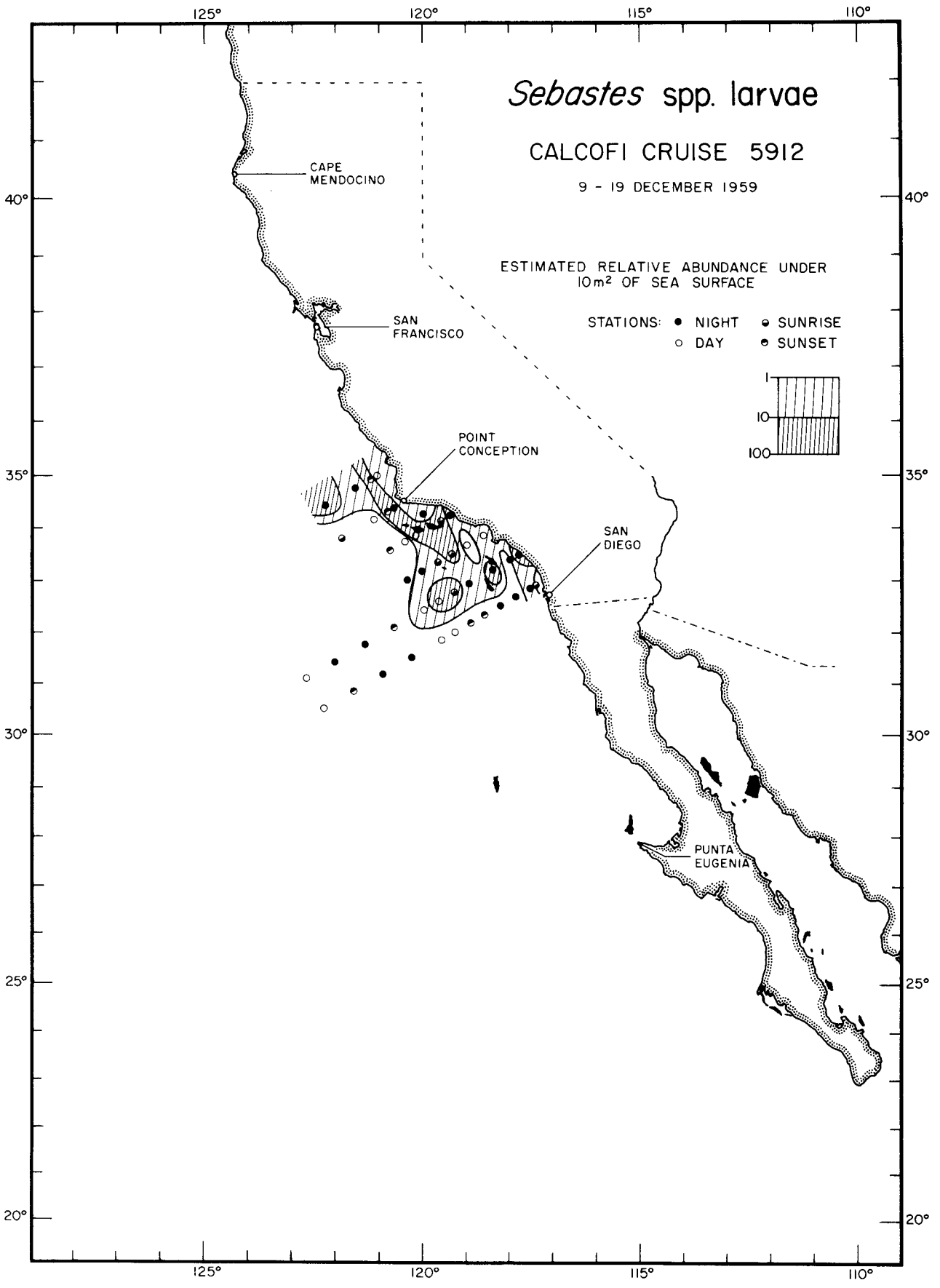
Sebastes spp. larvae

5910



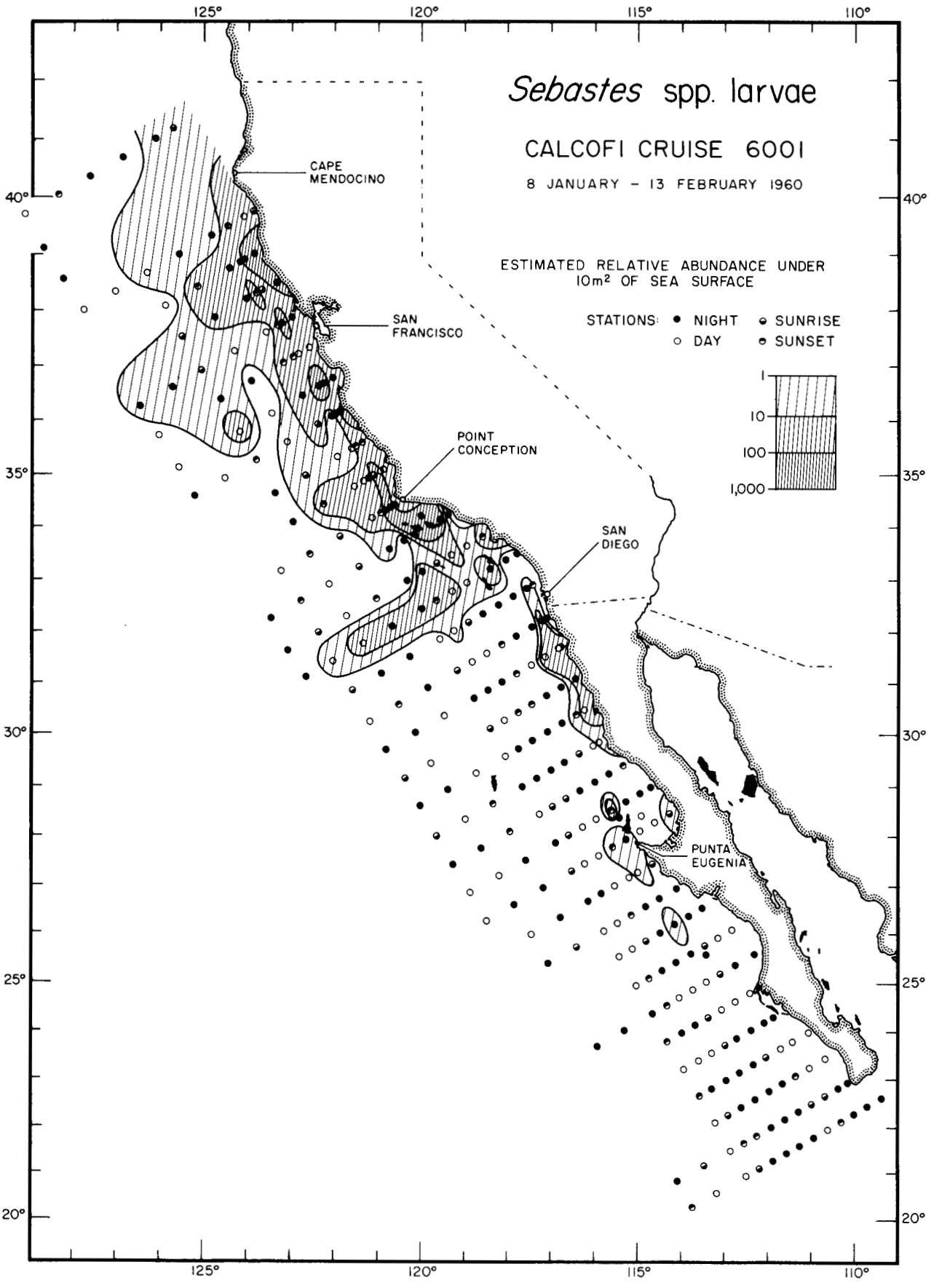
Sebastes spp. larvae

5911



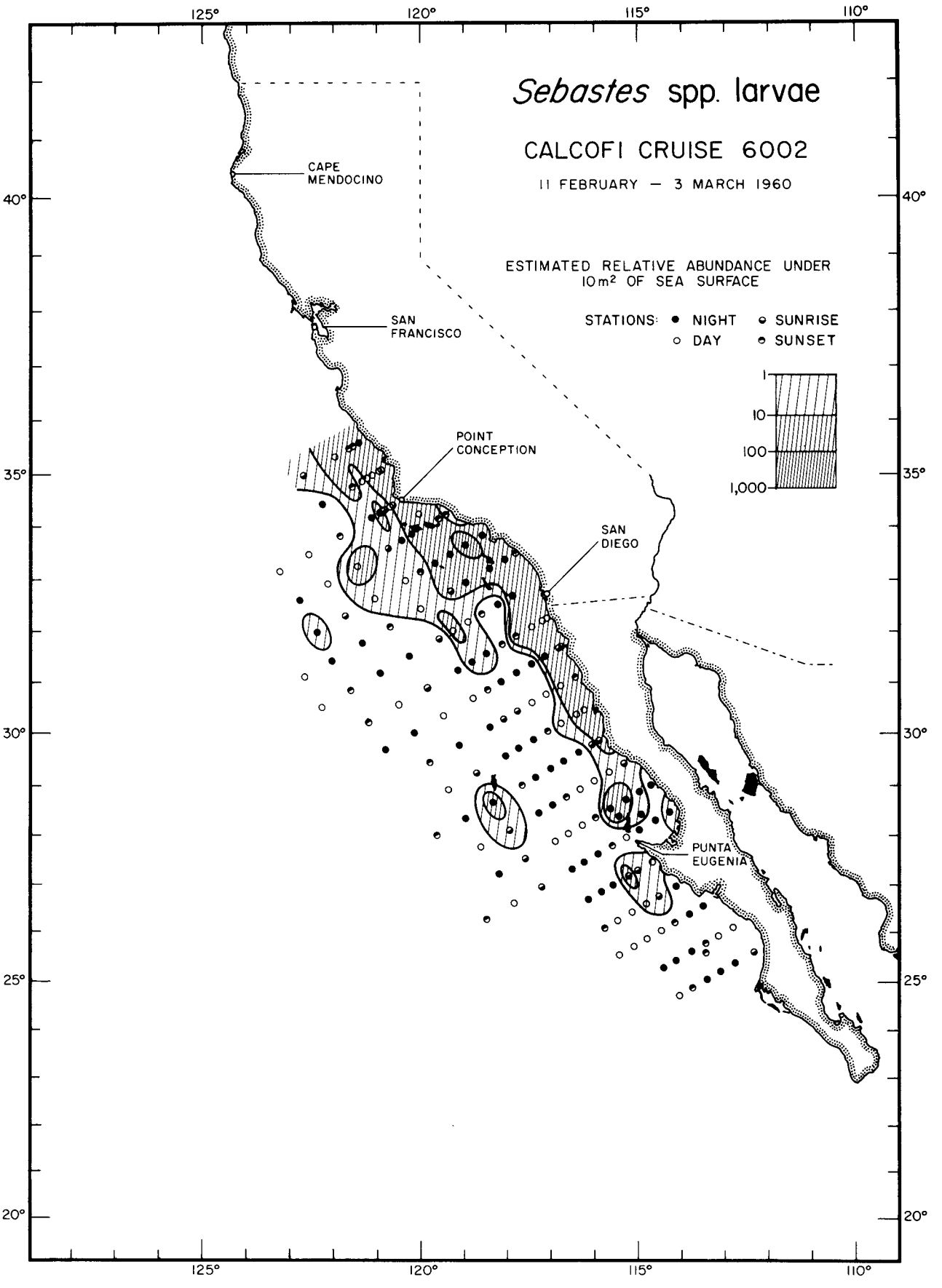
Sebastes spp. larvae

5912



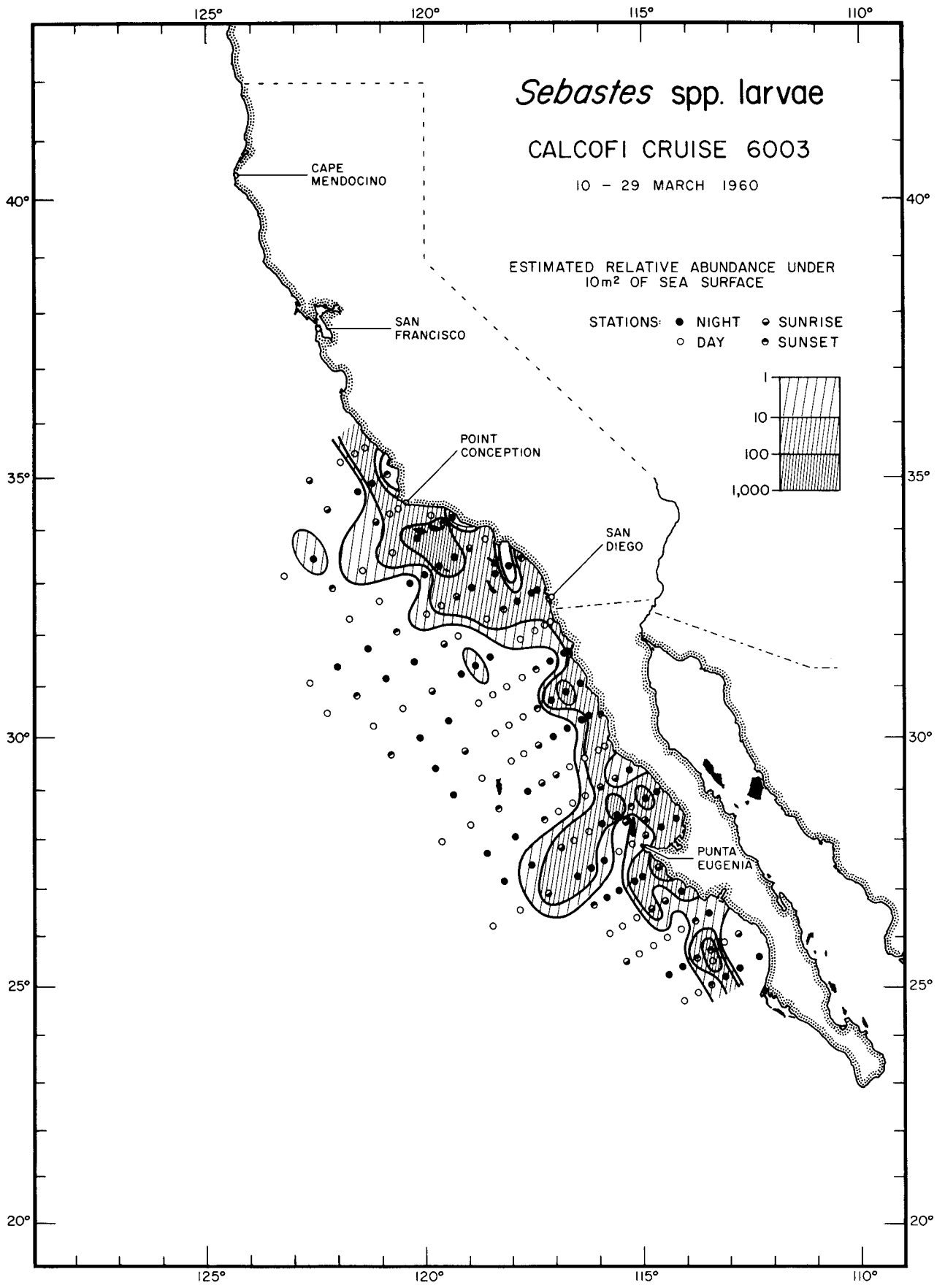
Sebastes spp. larvae

6001



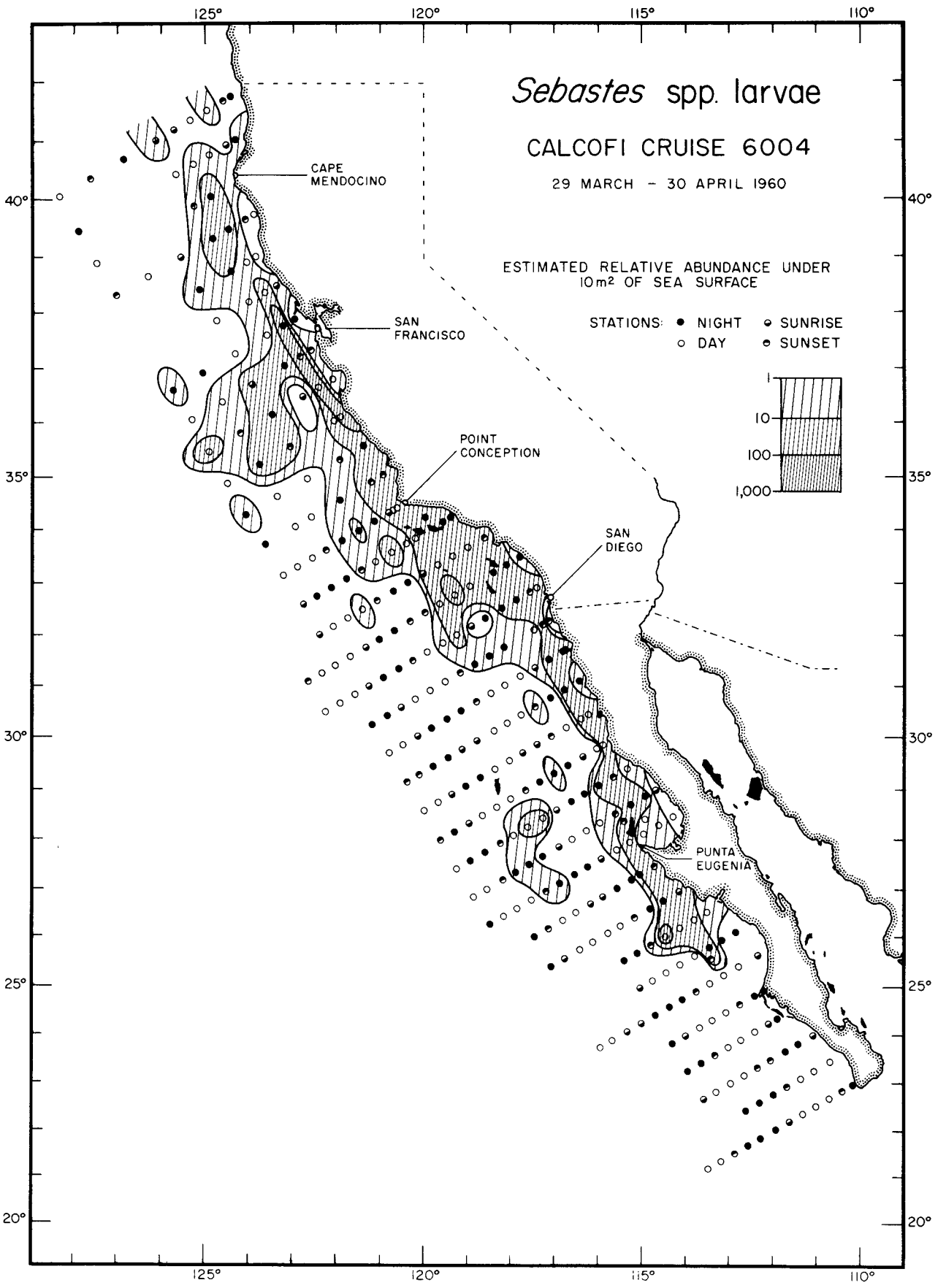
Sebastes spp. larvae

6002



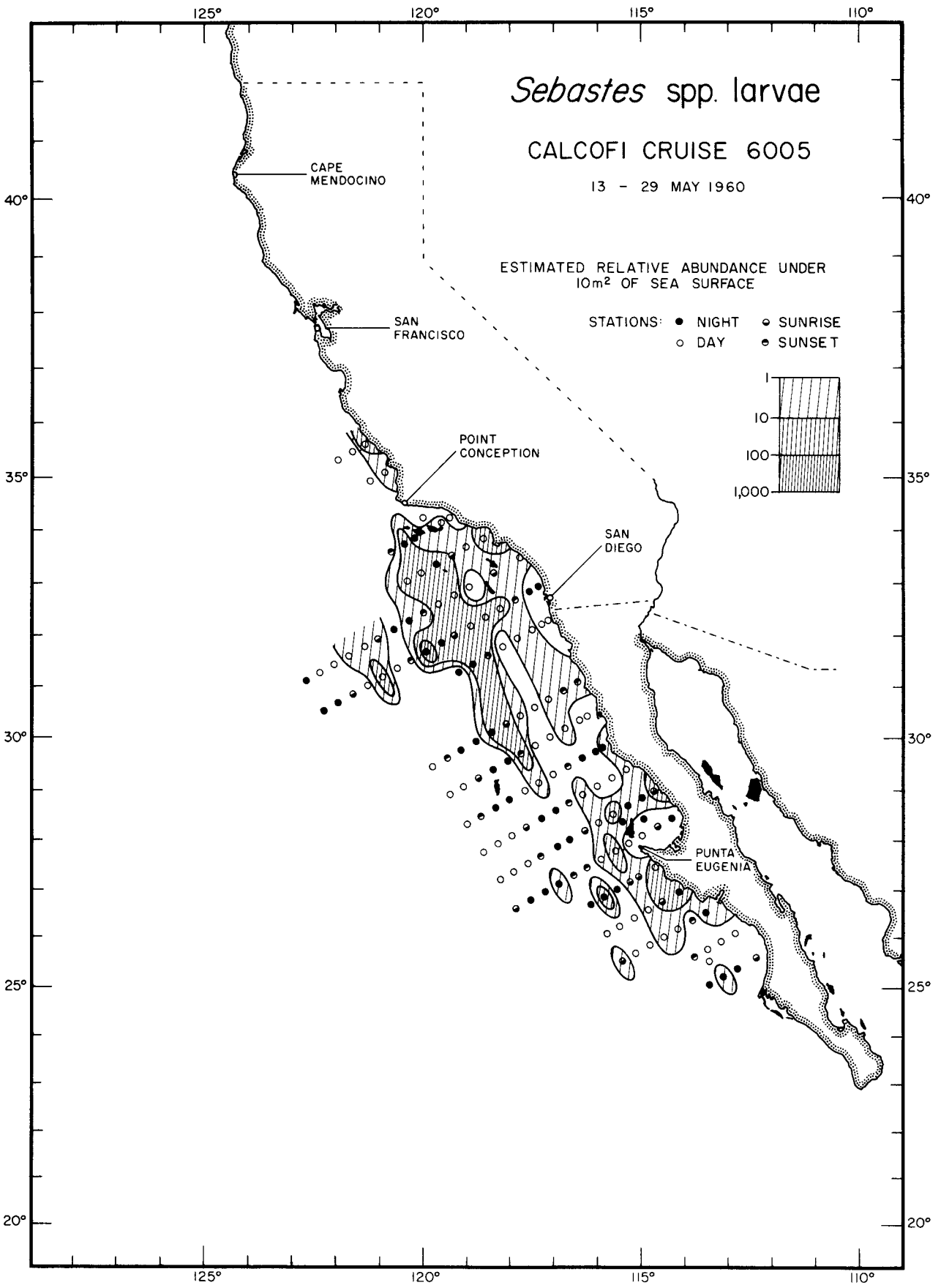
Sebastes spp. larvae

6003



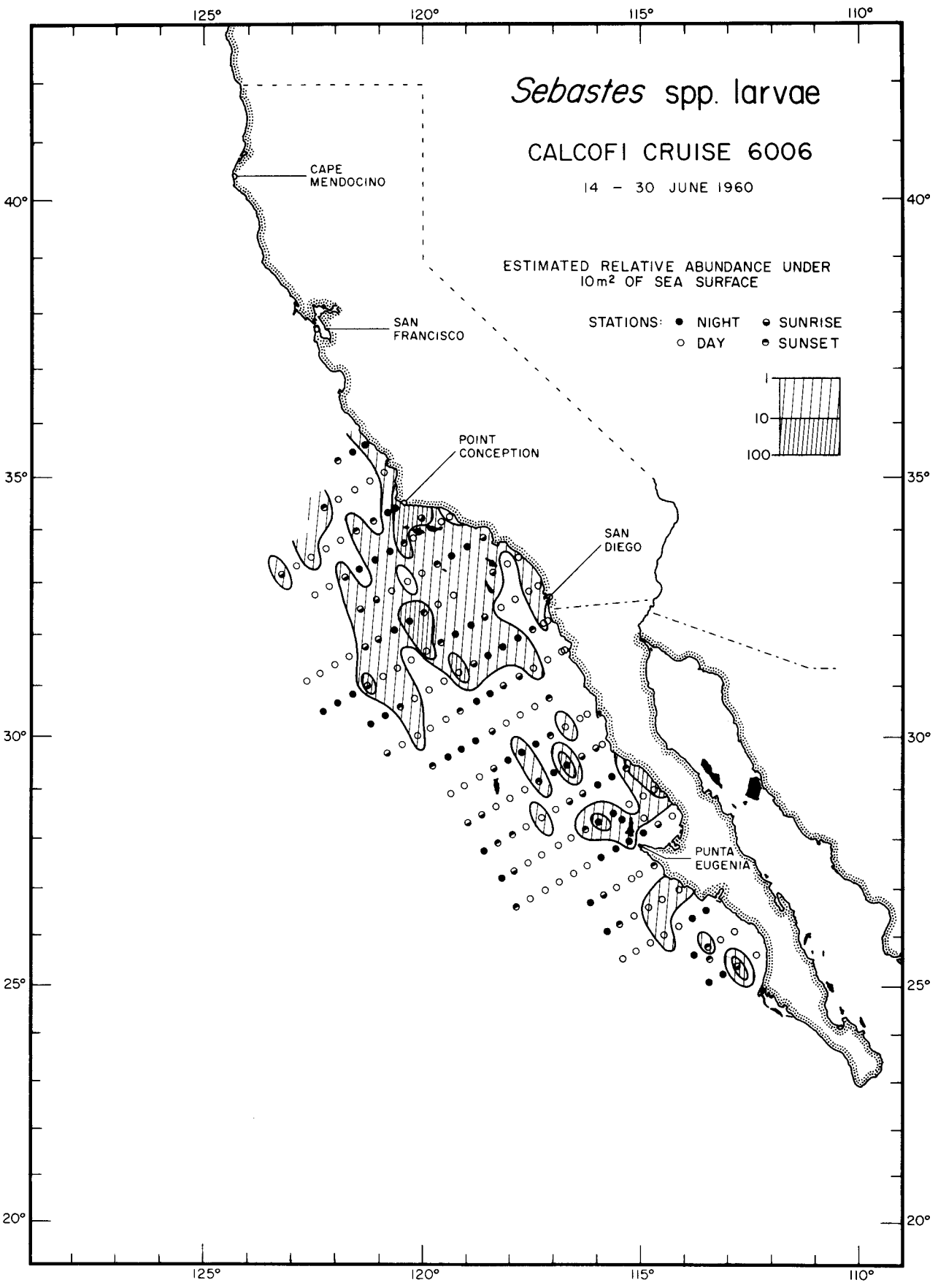
Sebastes spp. larvae

6004



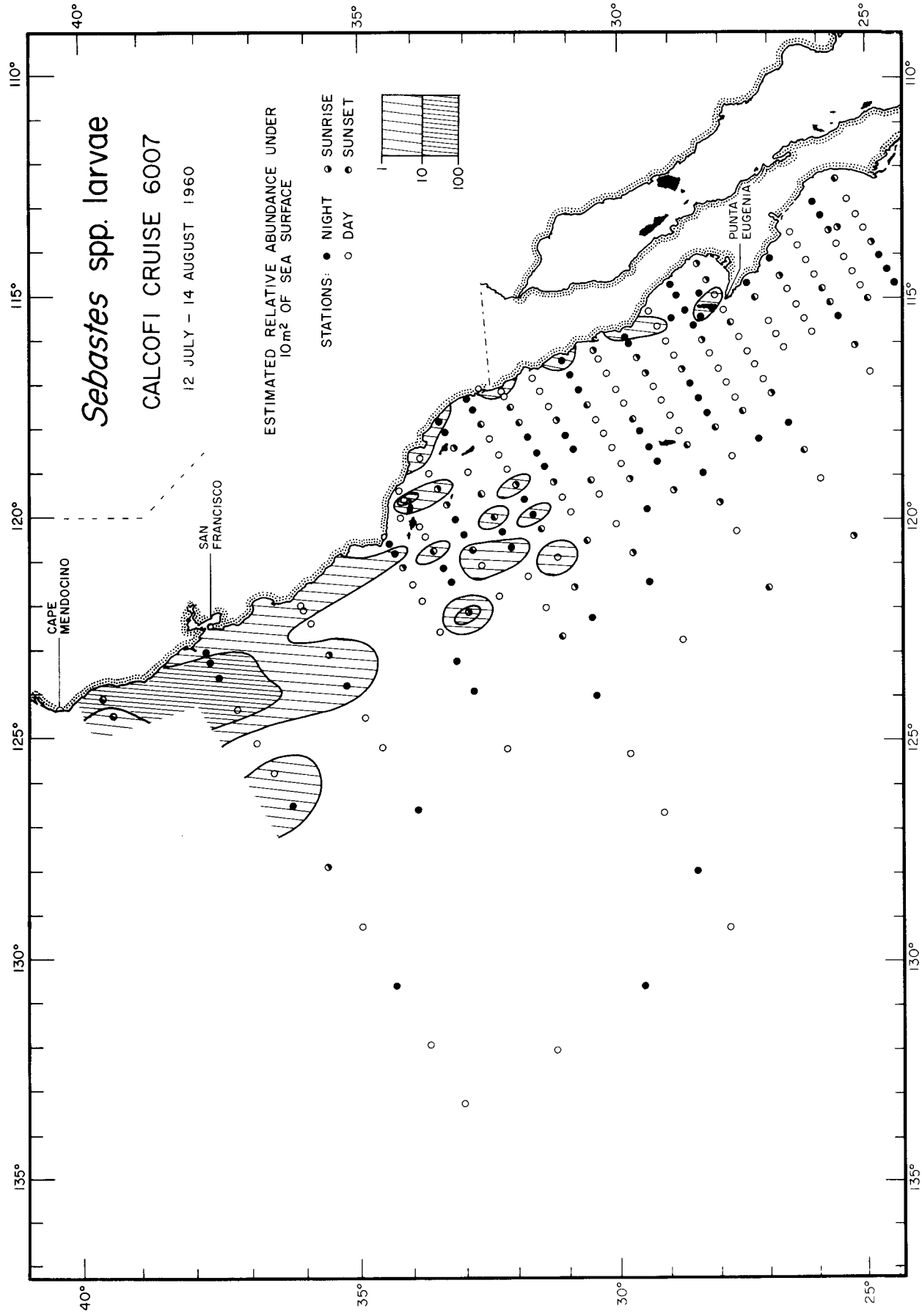
Sebastes spp. larvae

6005



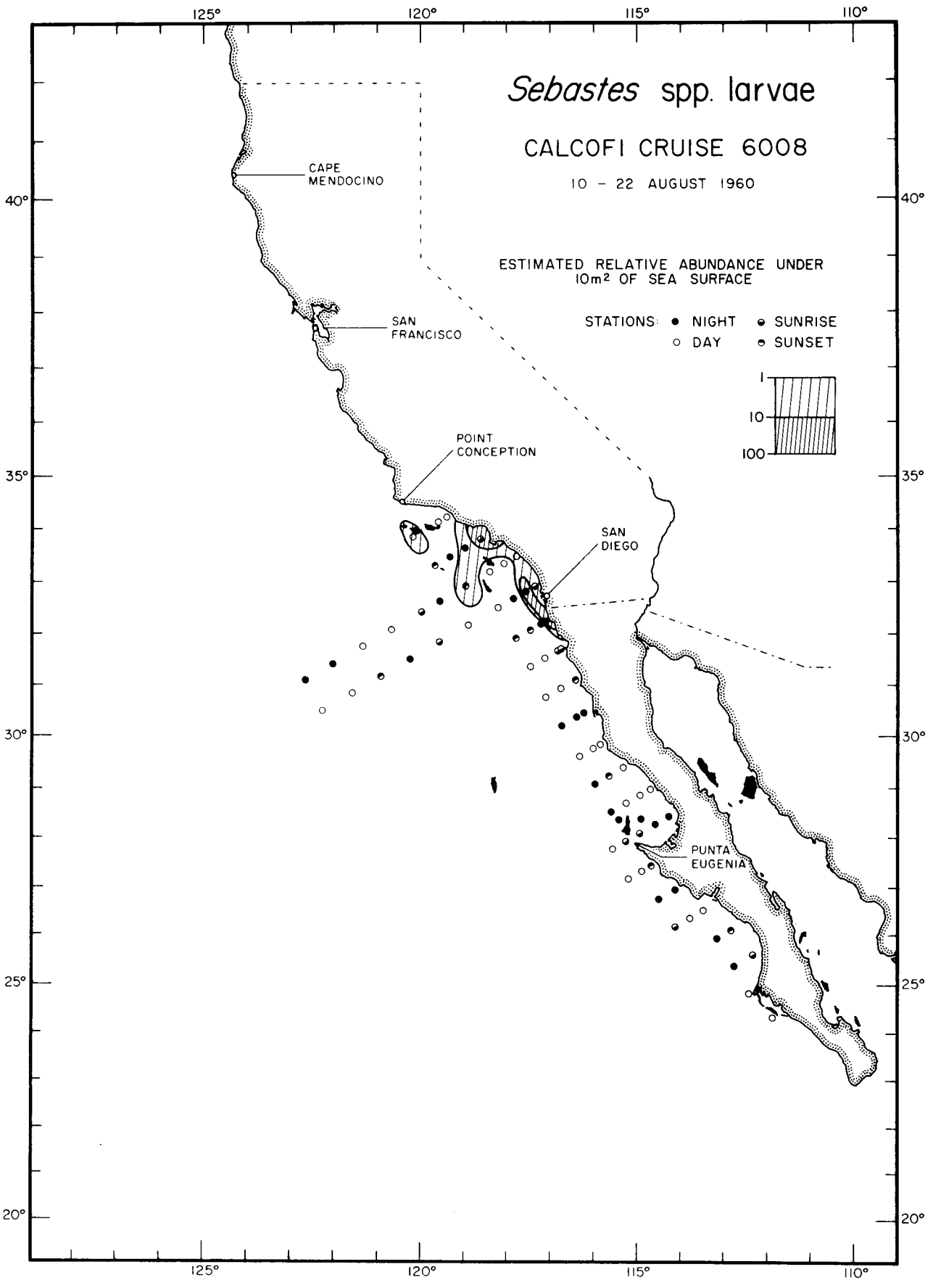
Sebastes spp. larvae

6006



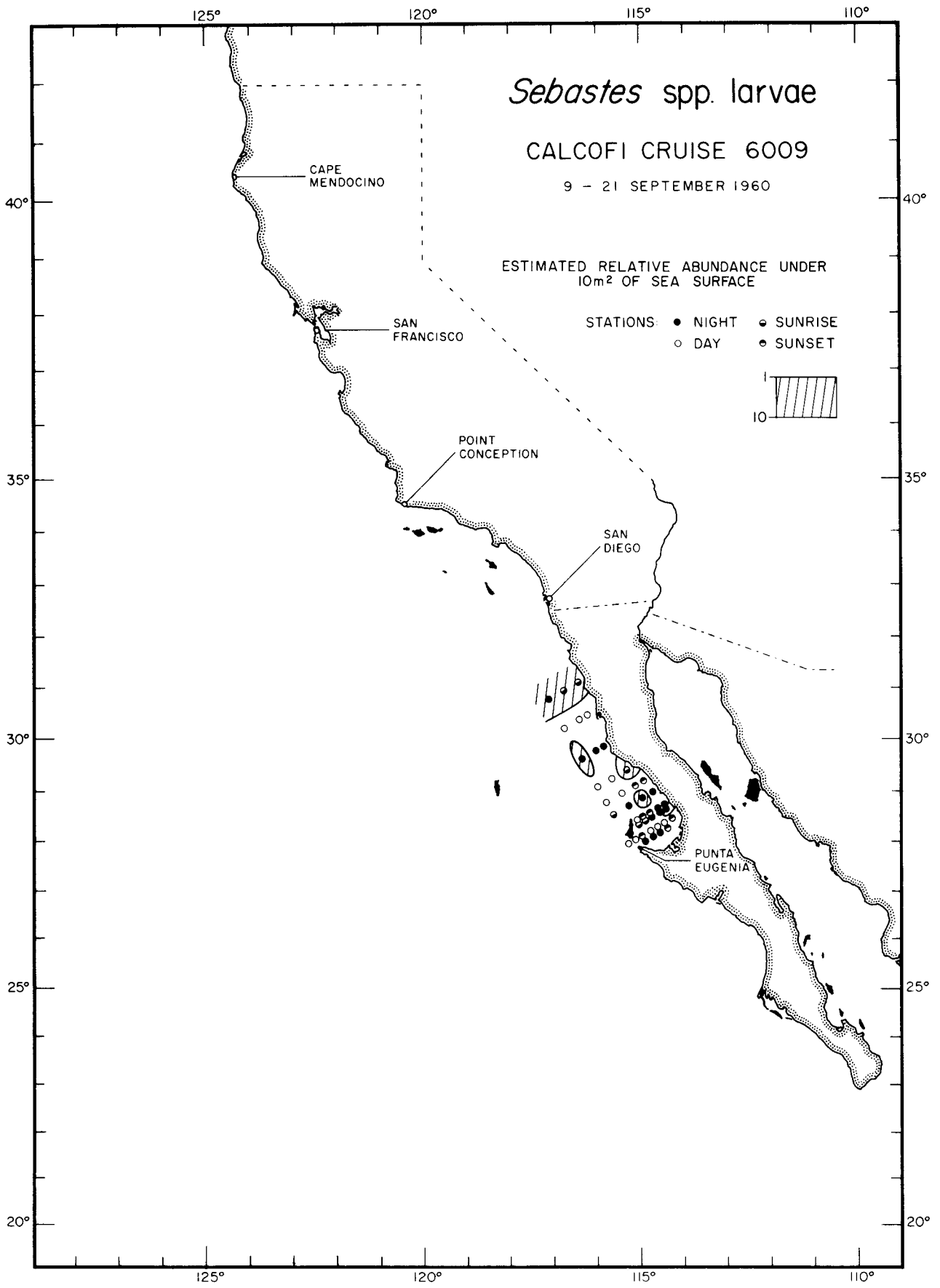
Sebastes spp. larvae

6007



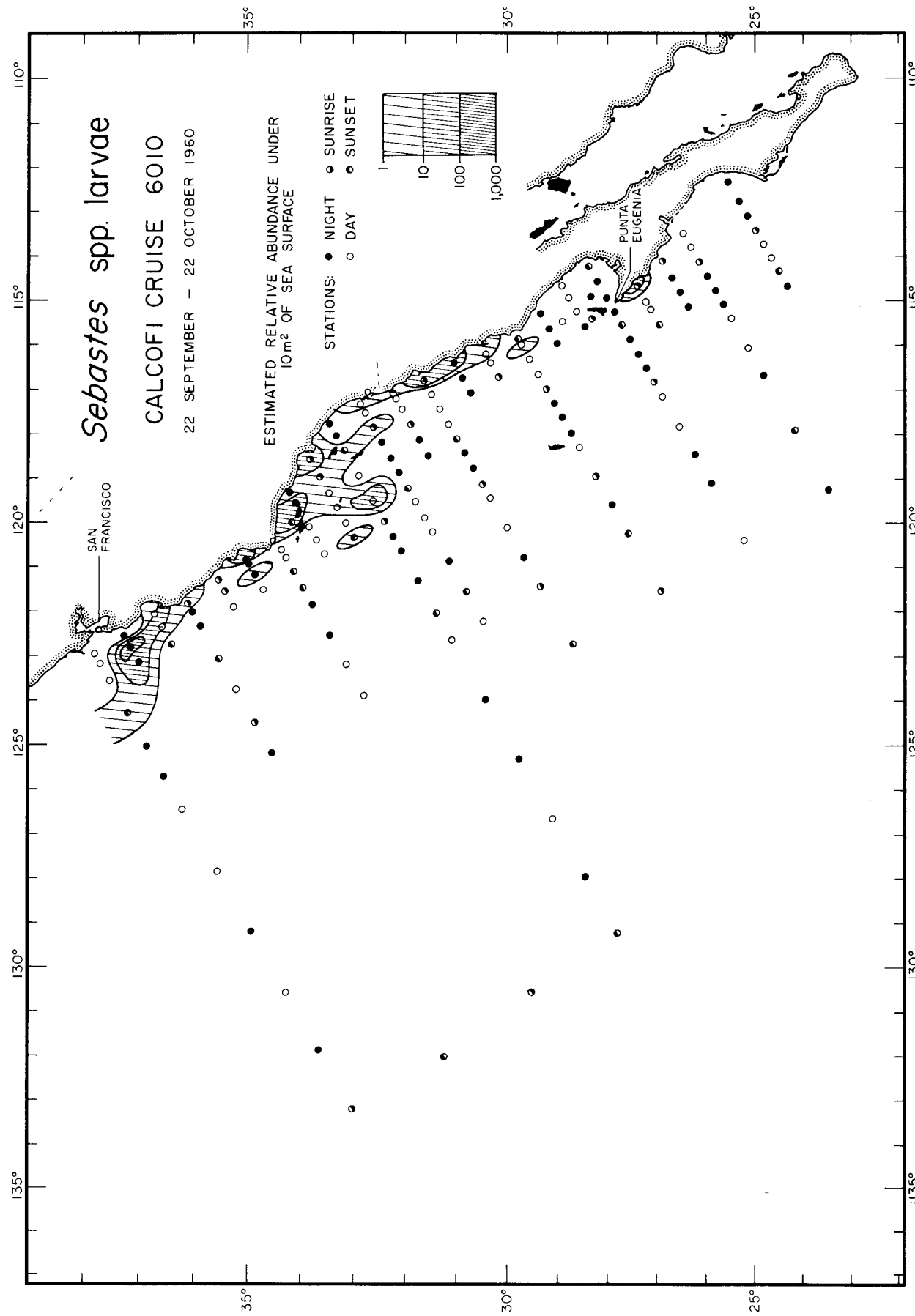
Sebastes spp. larvae

6008



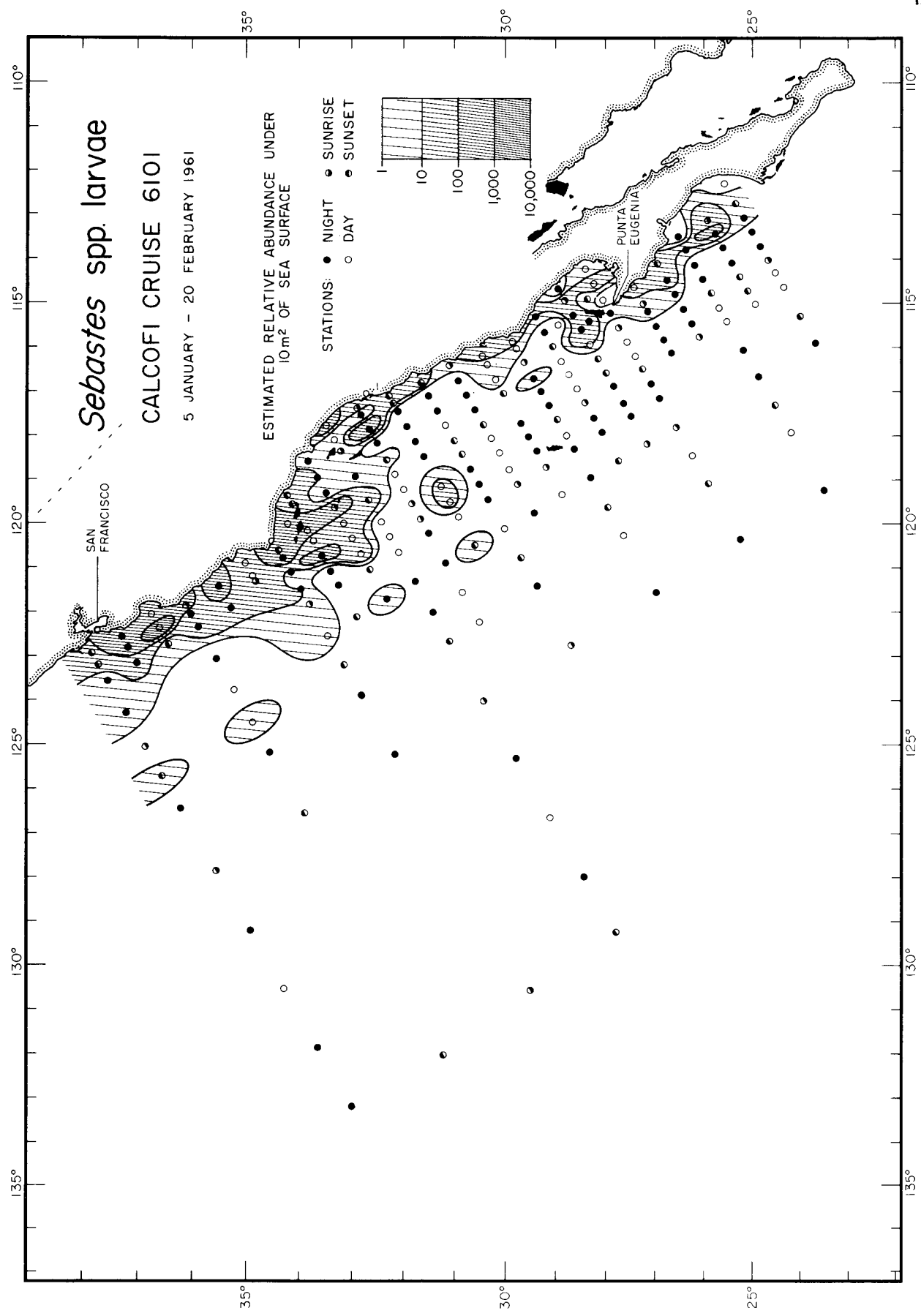
Sebastes spp. larvae

6009



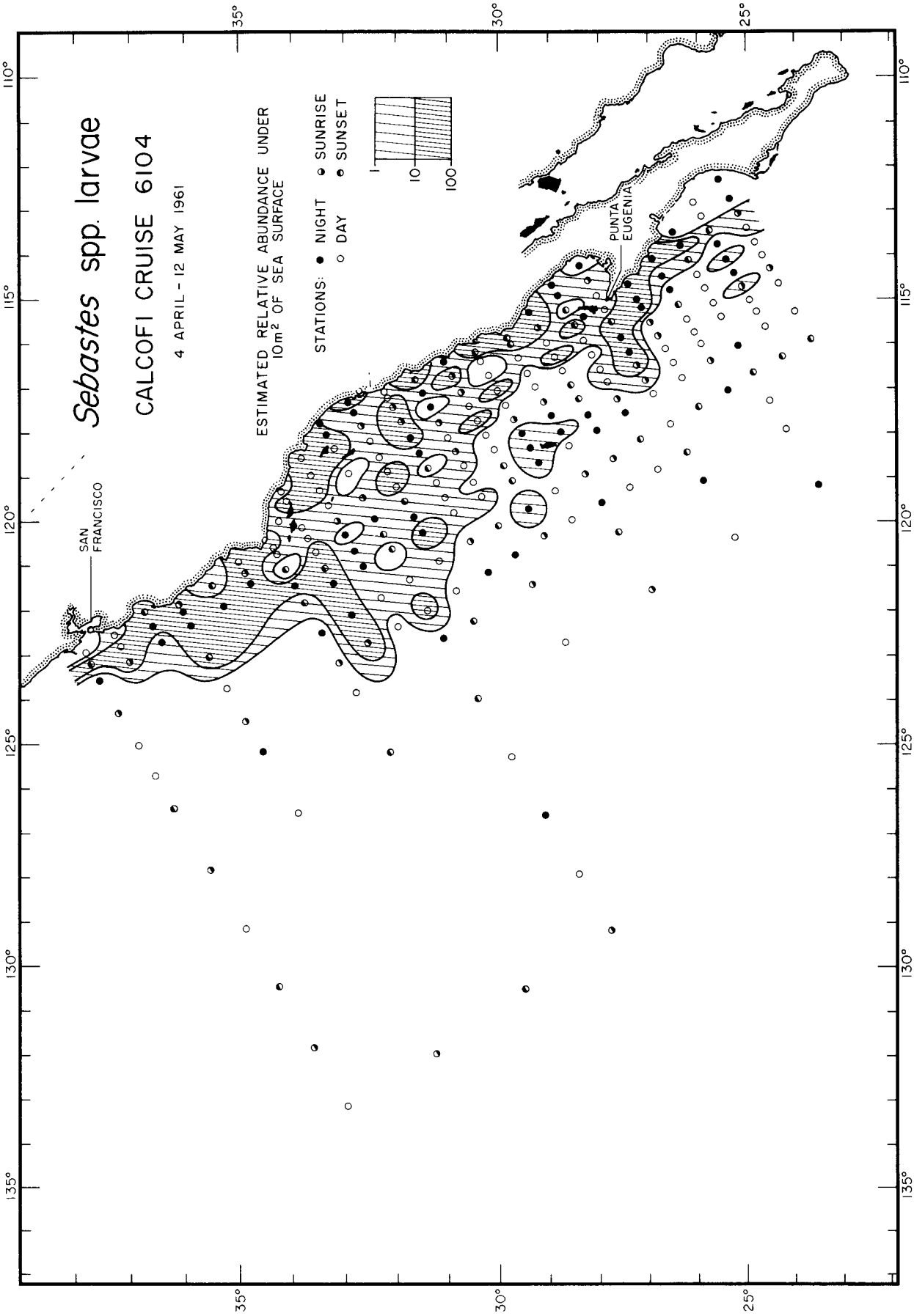
Sebastes spp. larvae

6010



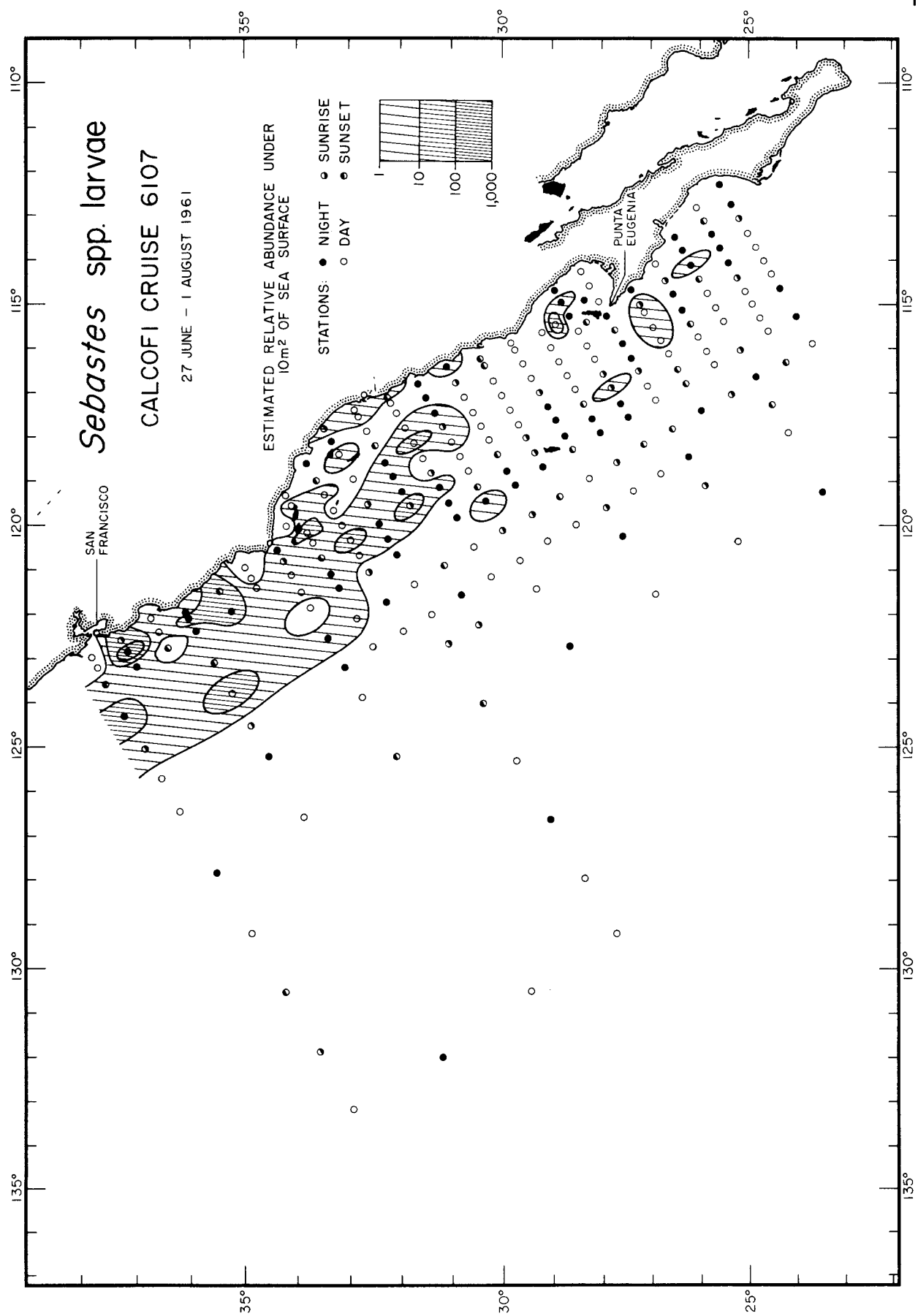
Sebastes spp. larvae

6101



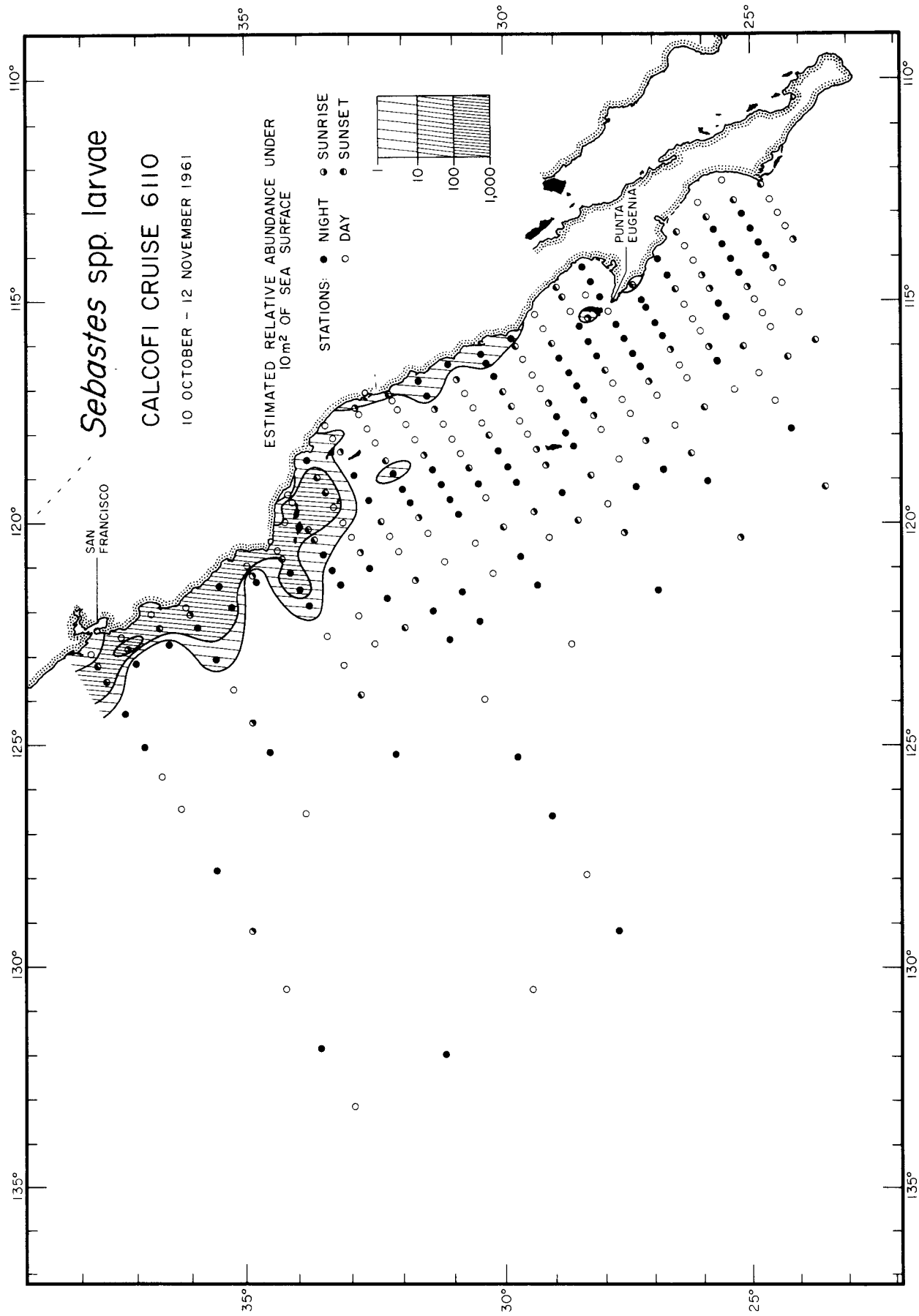
Sebastes spp. larvae

6104



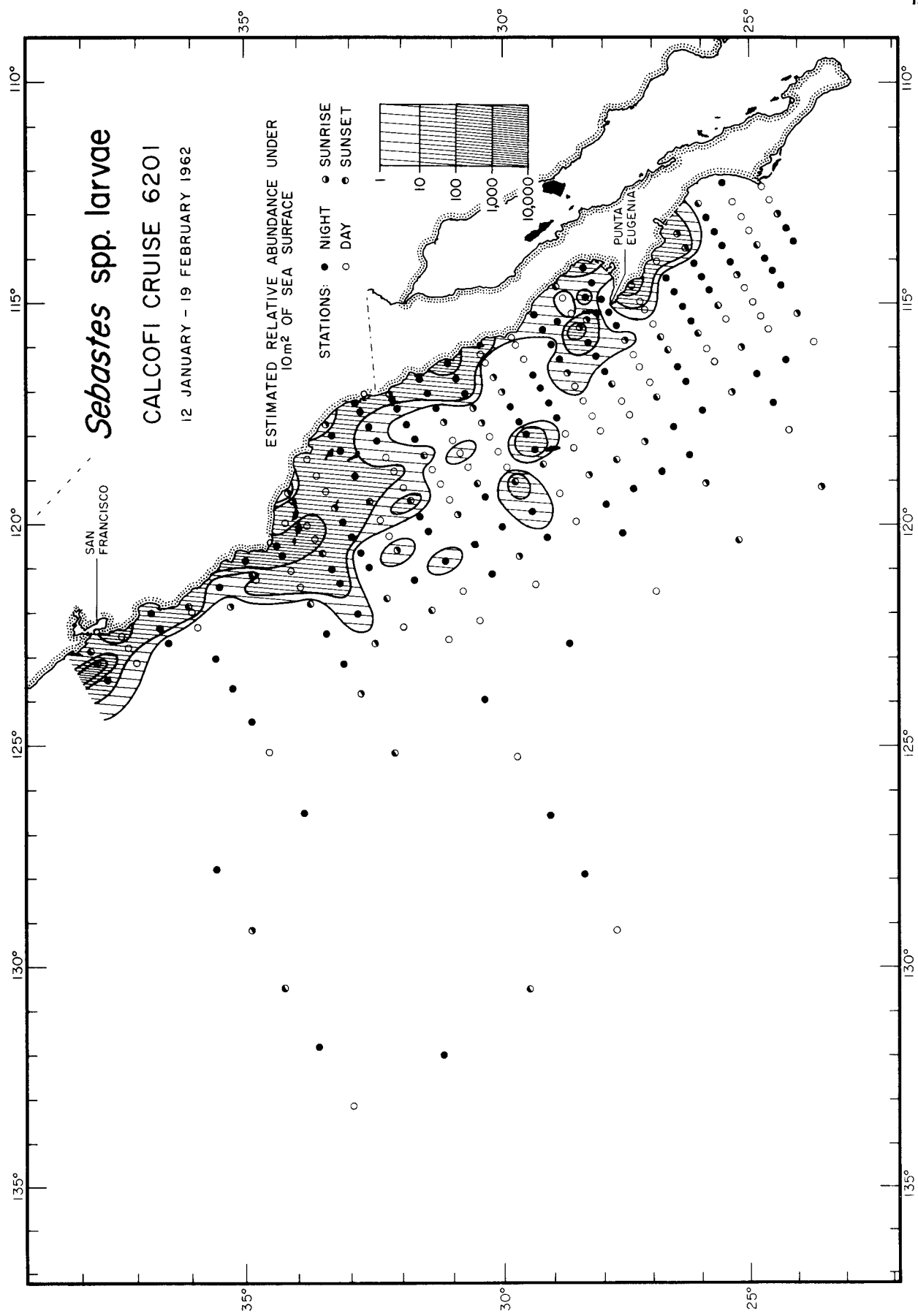
Sebastes spp. larvae

6107



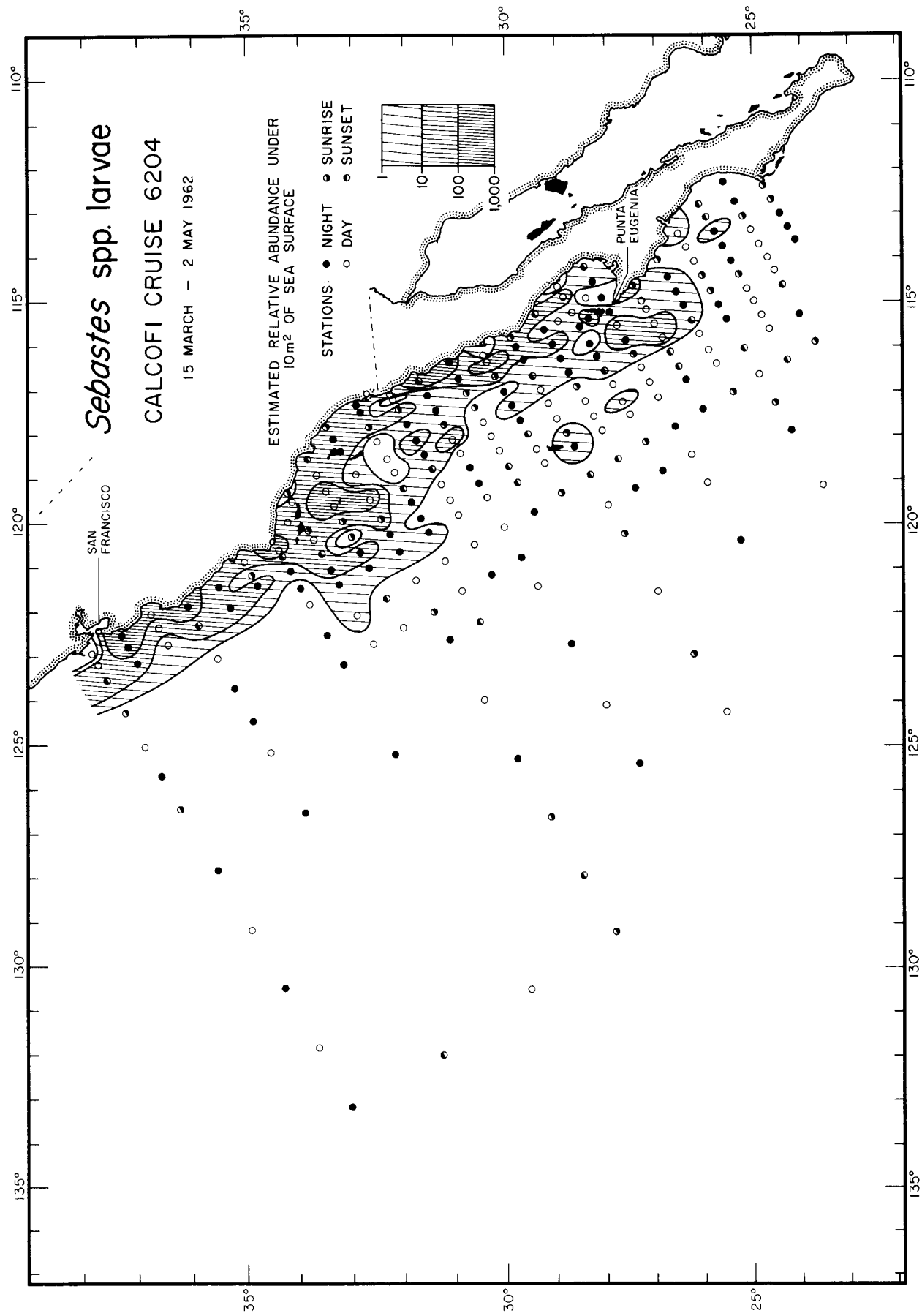
Sebastes spp. larvae

6110



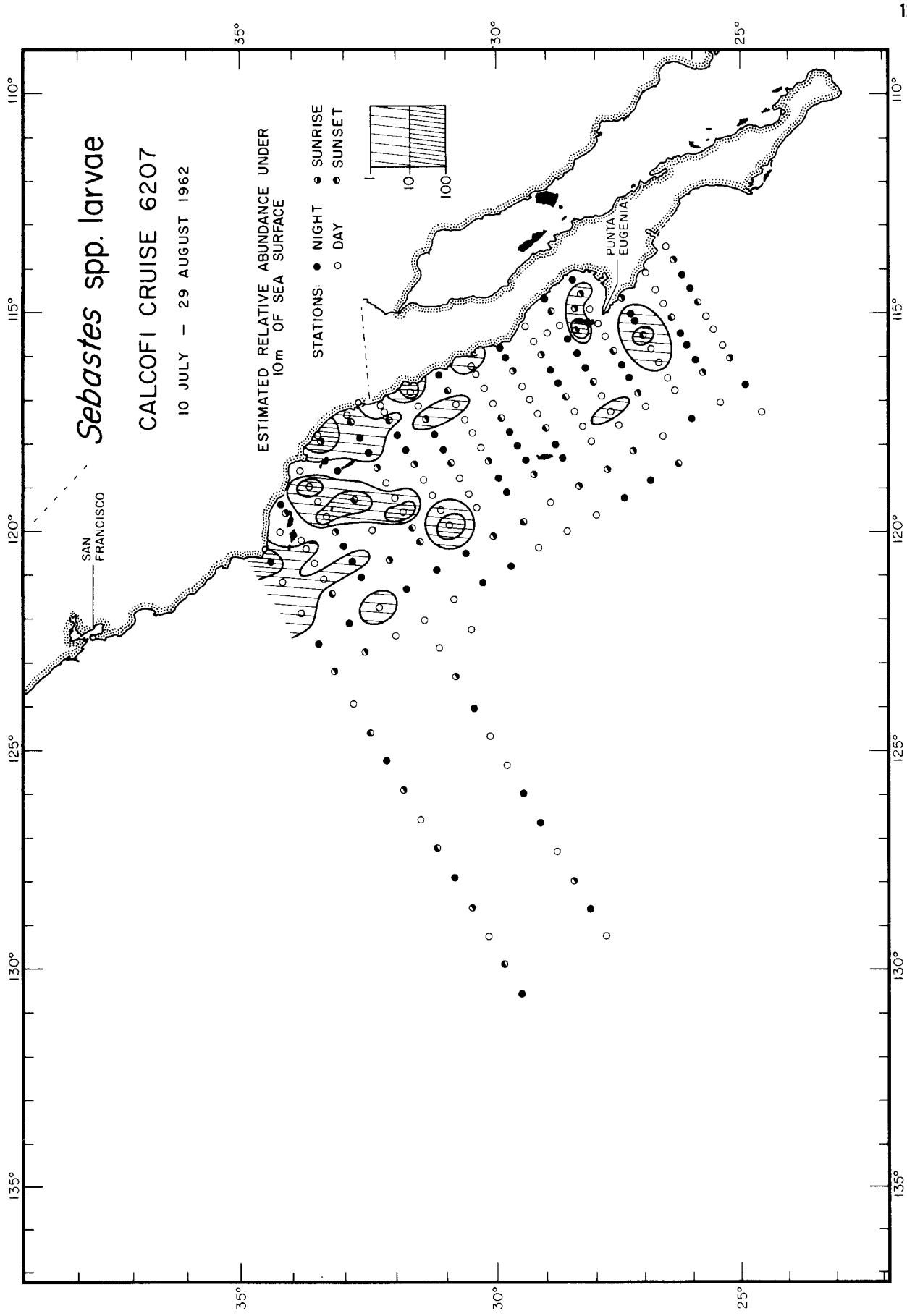
Sebastes spp. larvae

6201



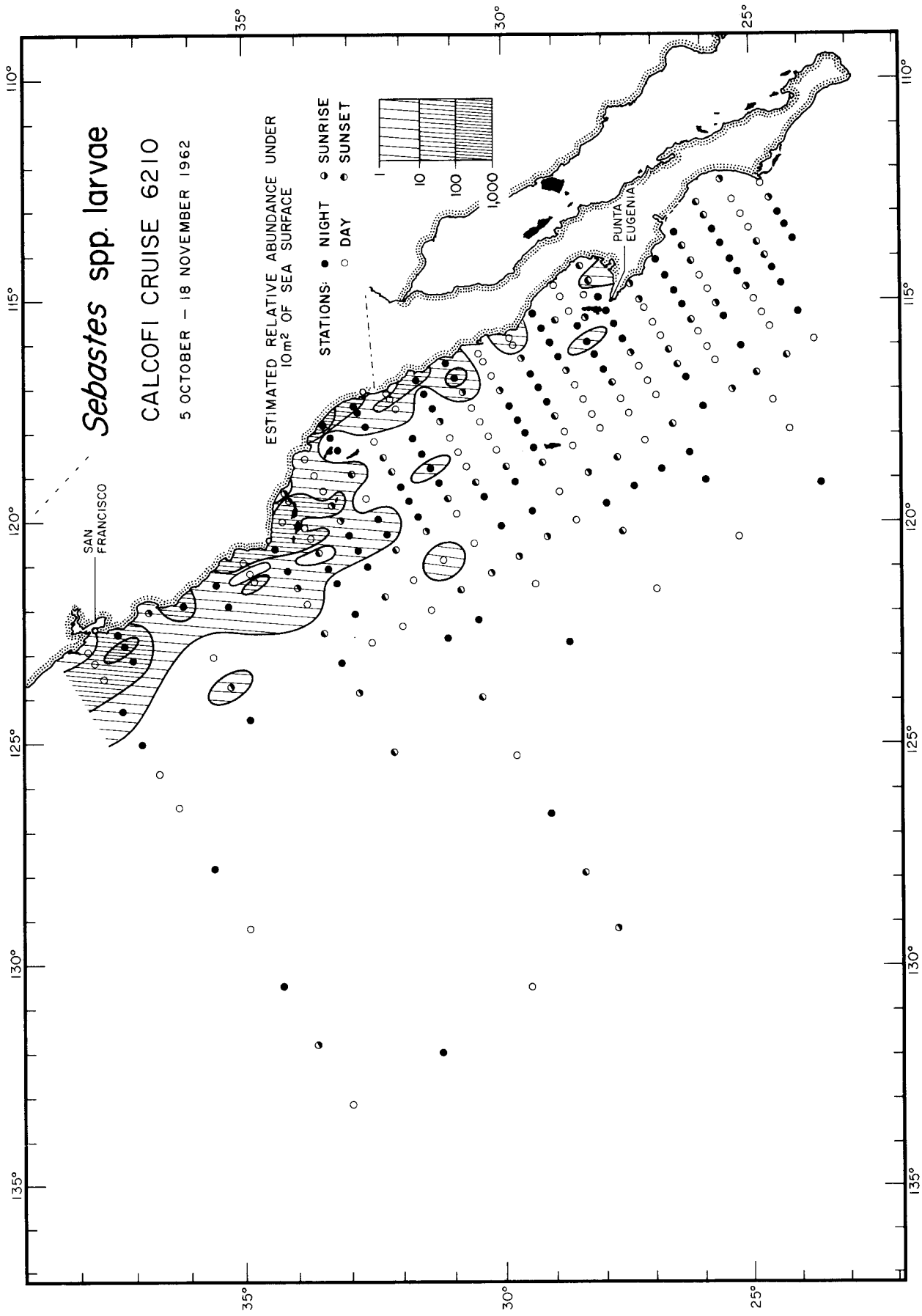
Sebastes spp. larvae

6204



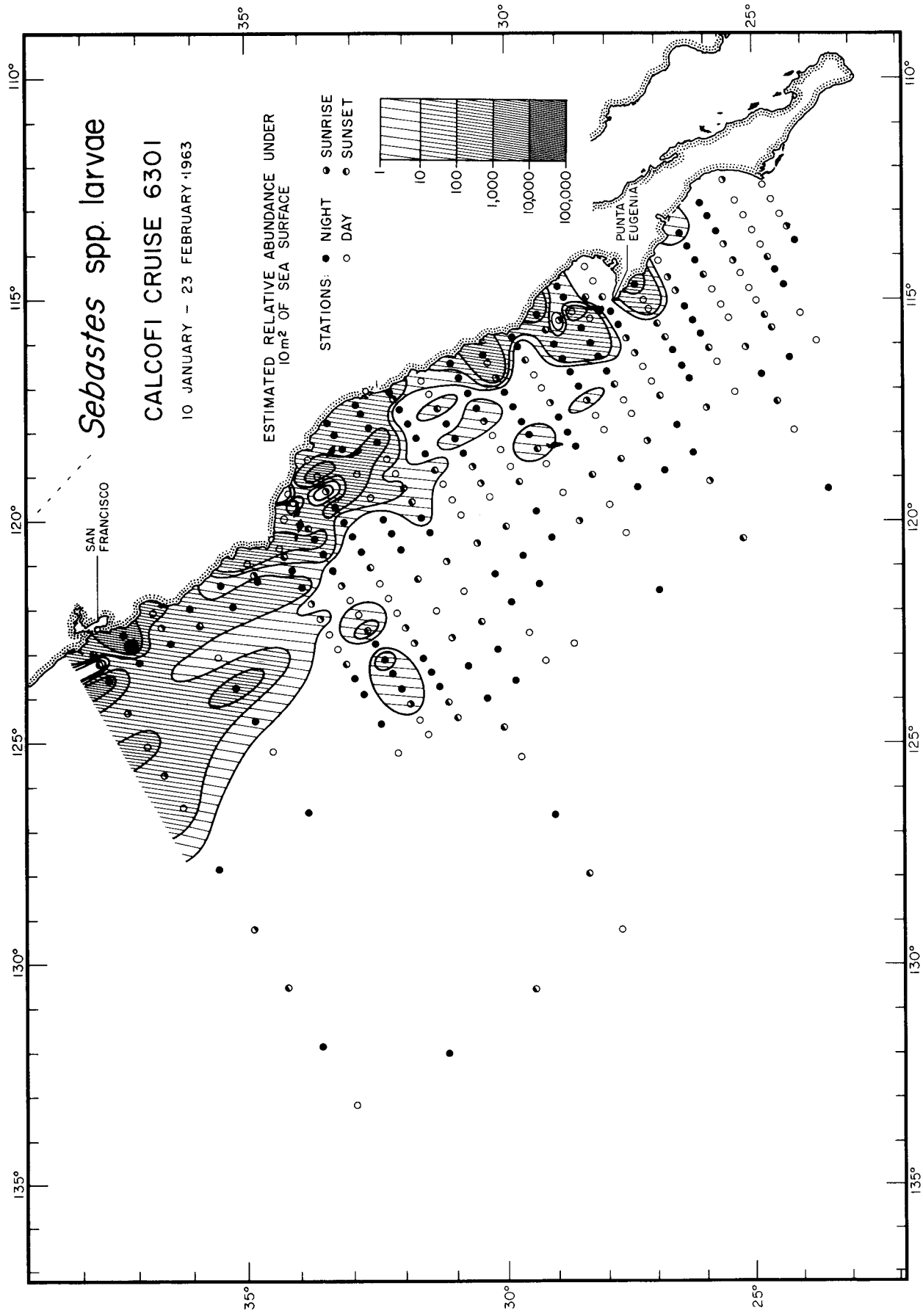
Sebastes spp. larvae

6207



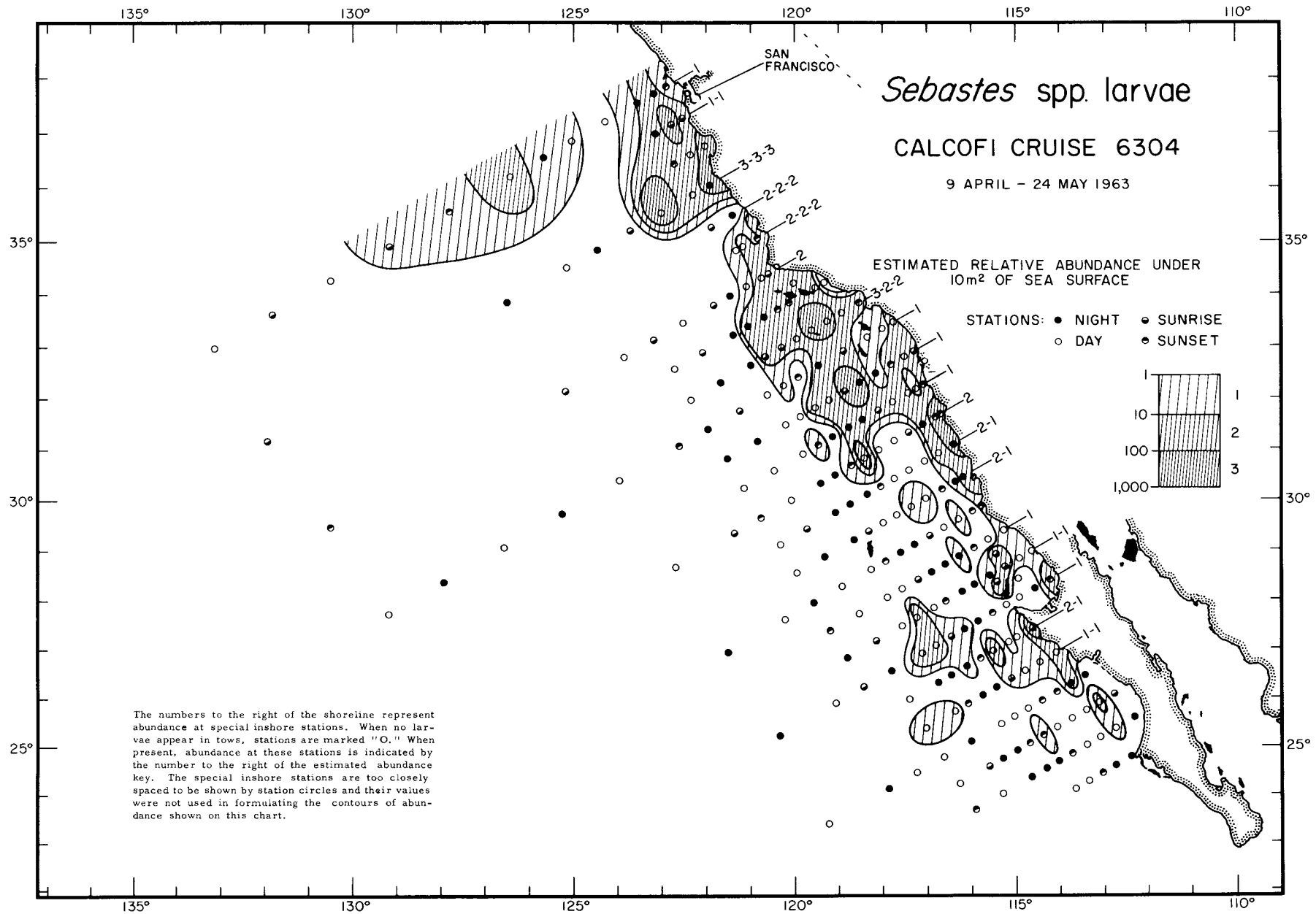
Sebastes spp. larvae

6210



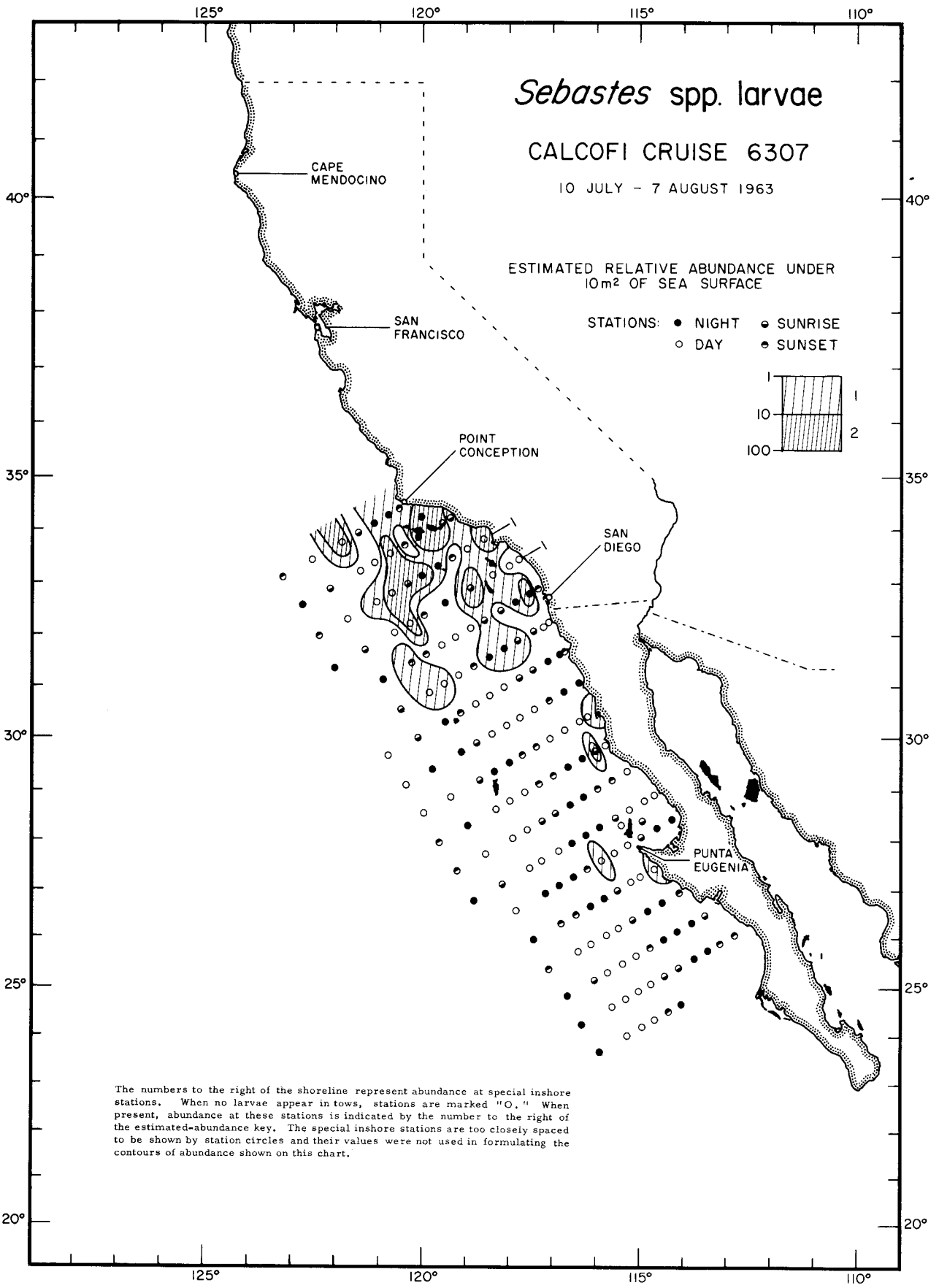
Sebastes spp. larvae

6301



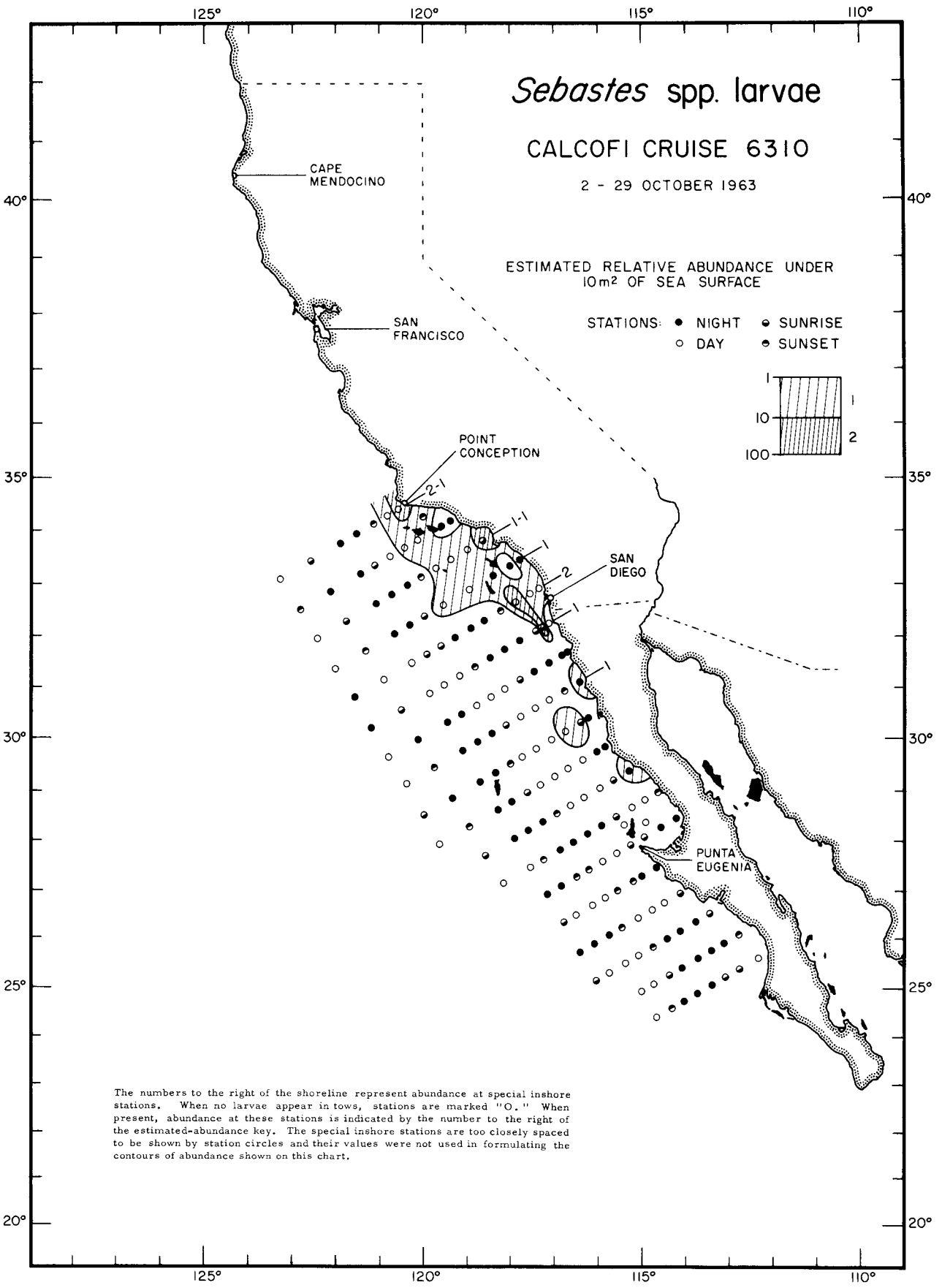
Sebastes spp. larvae

6304



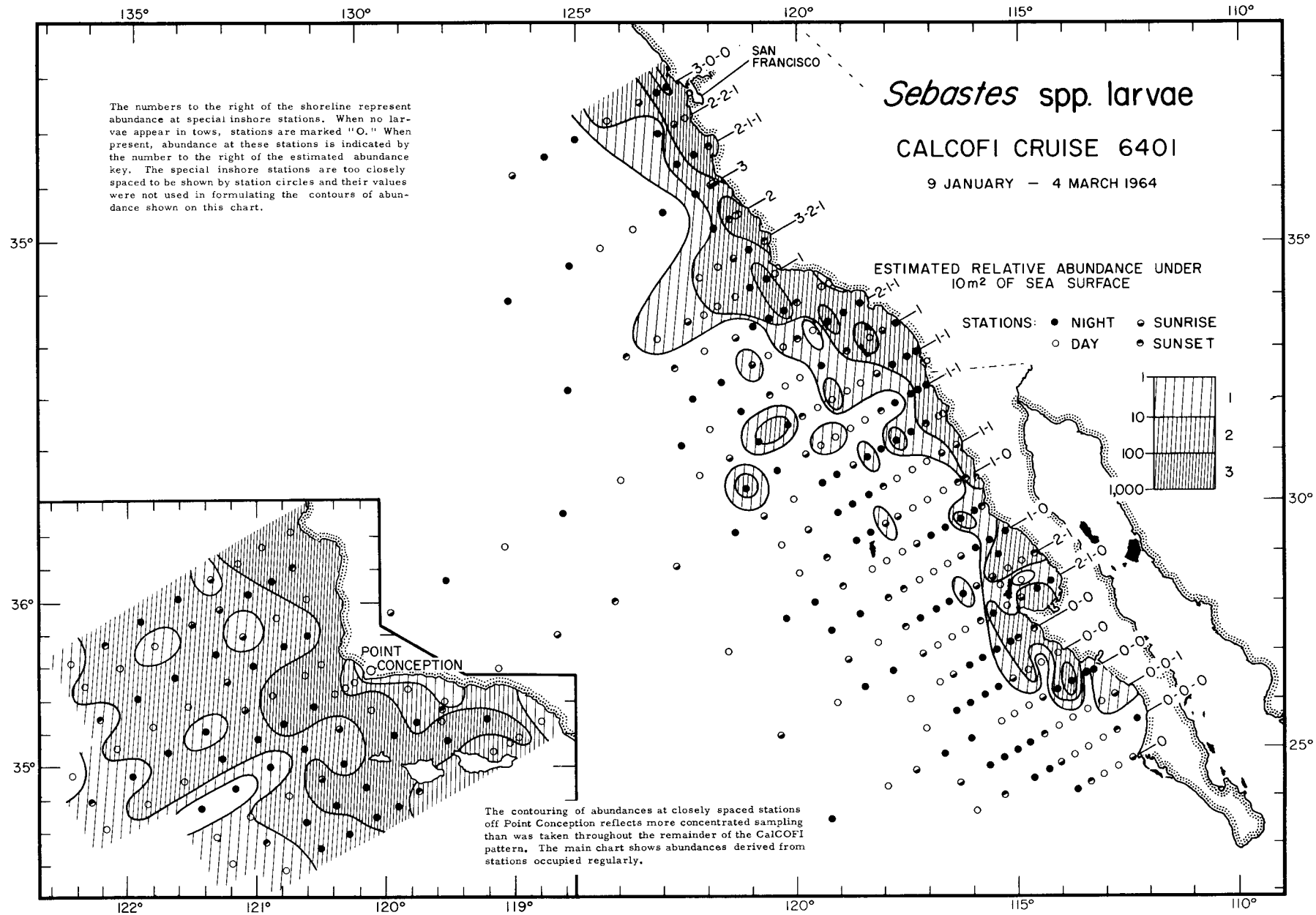
Sebastes spp. larvae

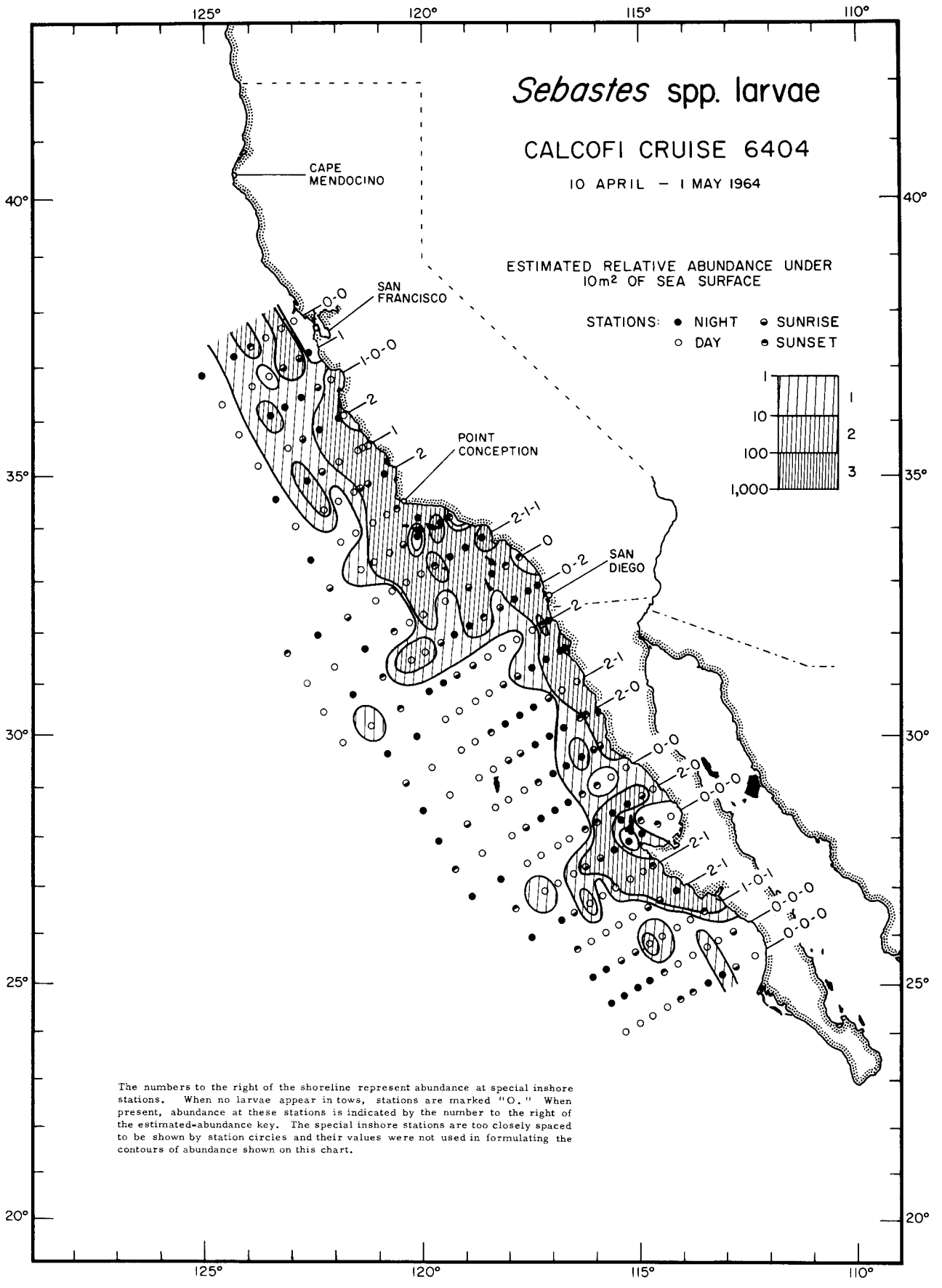
6307



Sebastes spp. larvae

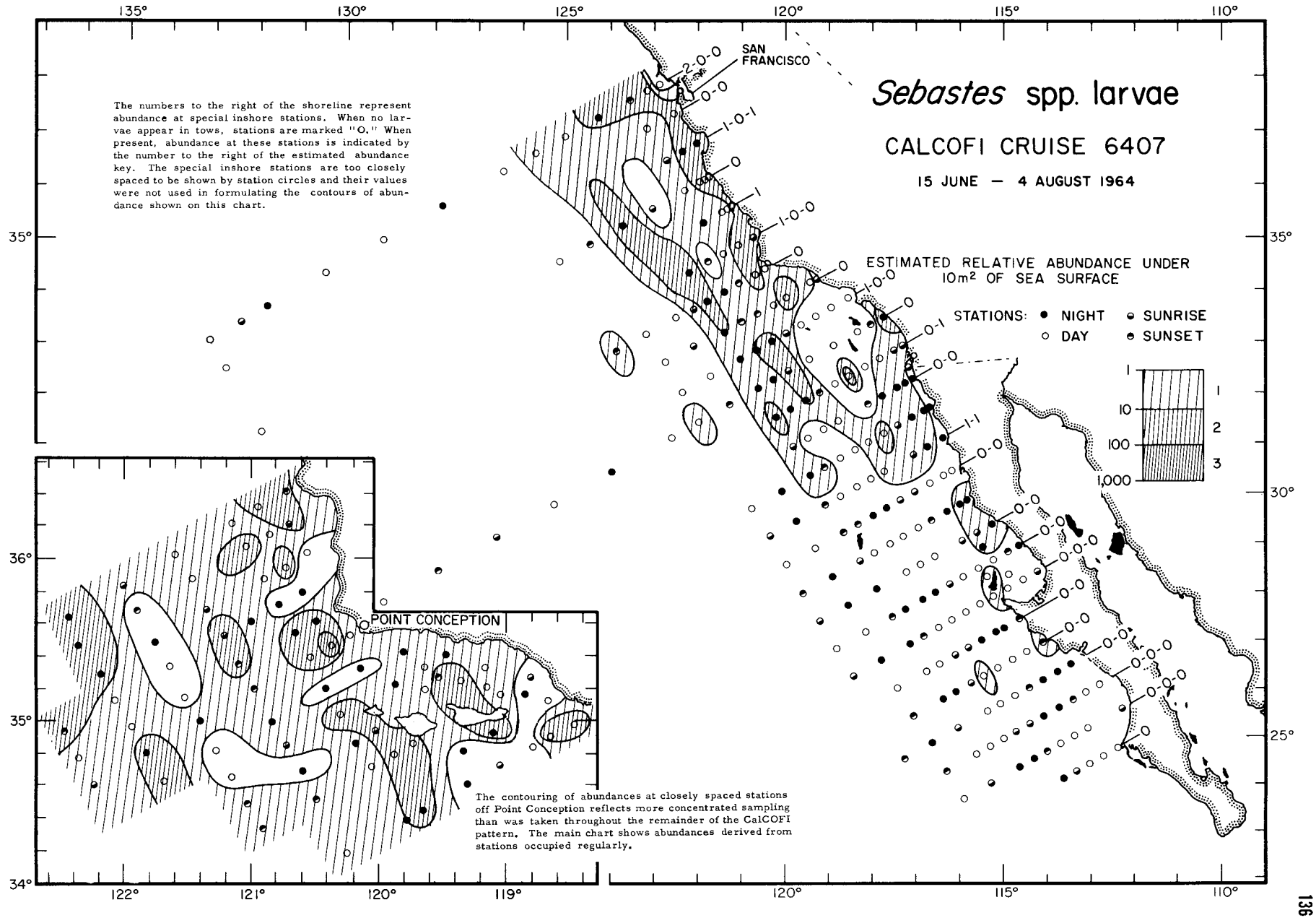
6310

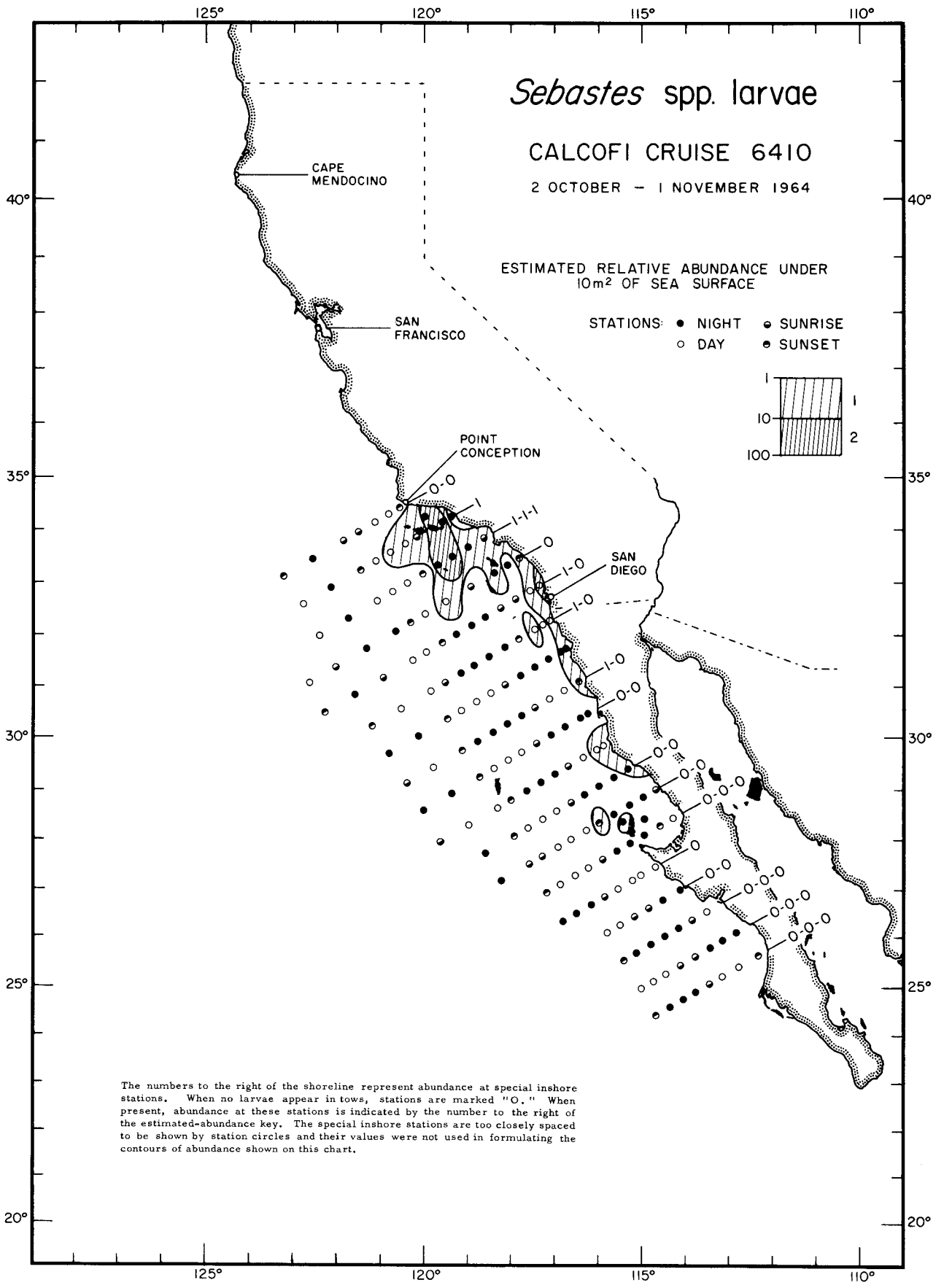

Sebastes spp. larvae
CALCOFI CRUISE 6401
9 JANUARY – 4 MARCH 1964
The numbers to the right of the shoreline represent abundance at special inshore stations. When no larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.
ESTIMATED RELATIVE ABUNDANCE UNDER 10m² OF SEA SURFACE
STATIONS: NIGHT SUNRISE DAY SUNSET
1 10 100 1,000
1 2 3
SAN FRANCISCO
POINT CONCEPTION
The contouring of abundances at closely spaced stations off Point Conception reflects more concentrated sampling than was taken throughout the remainder of the CalCOFI pattern. The main chart shows abundances derived from stations occupied regularly.
135° 130° 125° 120° 115° 110°
35° 30° 25°
36° 35°
122° 121° 120° 119°



Sebastes spp. larvae

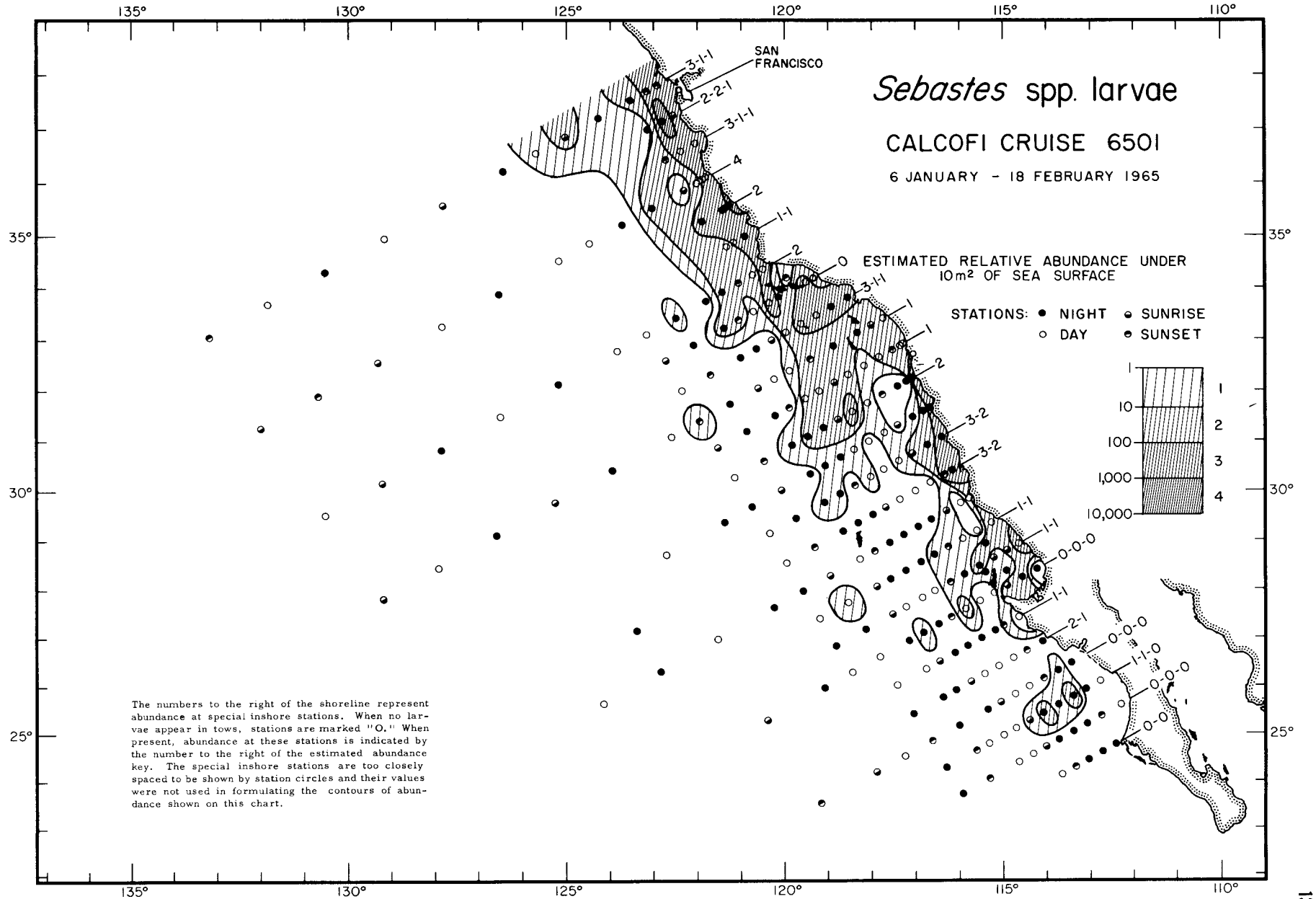
6404


135°
130°
125°
120°
115°
110°
35°
30°
25°
36°
34°
122°
121°
120°
119°
SAN FRANCISCO
POINT CONCEPTION
Sebastes spp. larvae
CALCOFI CRUISE 6407
15 JUNE — 4 AUGUST 1964
The numbers to the right of the shoreline represent abundance at special inshore stations. When no larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.
ESTIMATED RELATIVE ABUNDANCE UNDER 10m² OF SEA SURFACE
STATIONS: NIGHT SUNRISE
DAY SUNSET
1
10
100
1,000
1
2
3
The contouring of abundances at closely spaced stations off Point Conception reflects more concentrated sampling than was taken throughout the remainder of the CalCOFI pattern. The main chart shows abundances derived from stations occupied regularly.



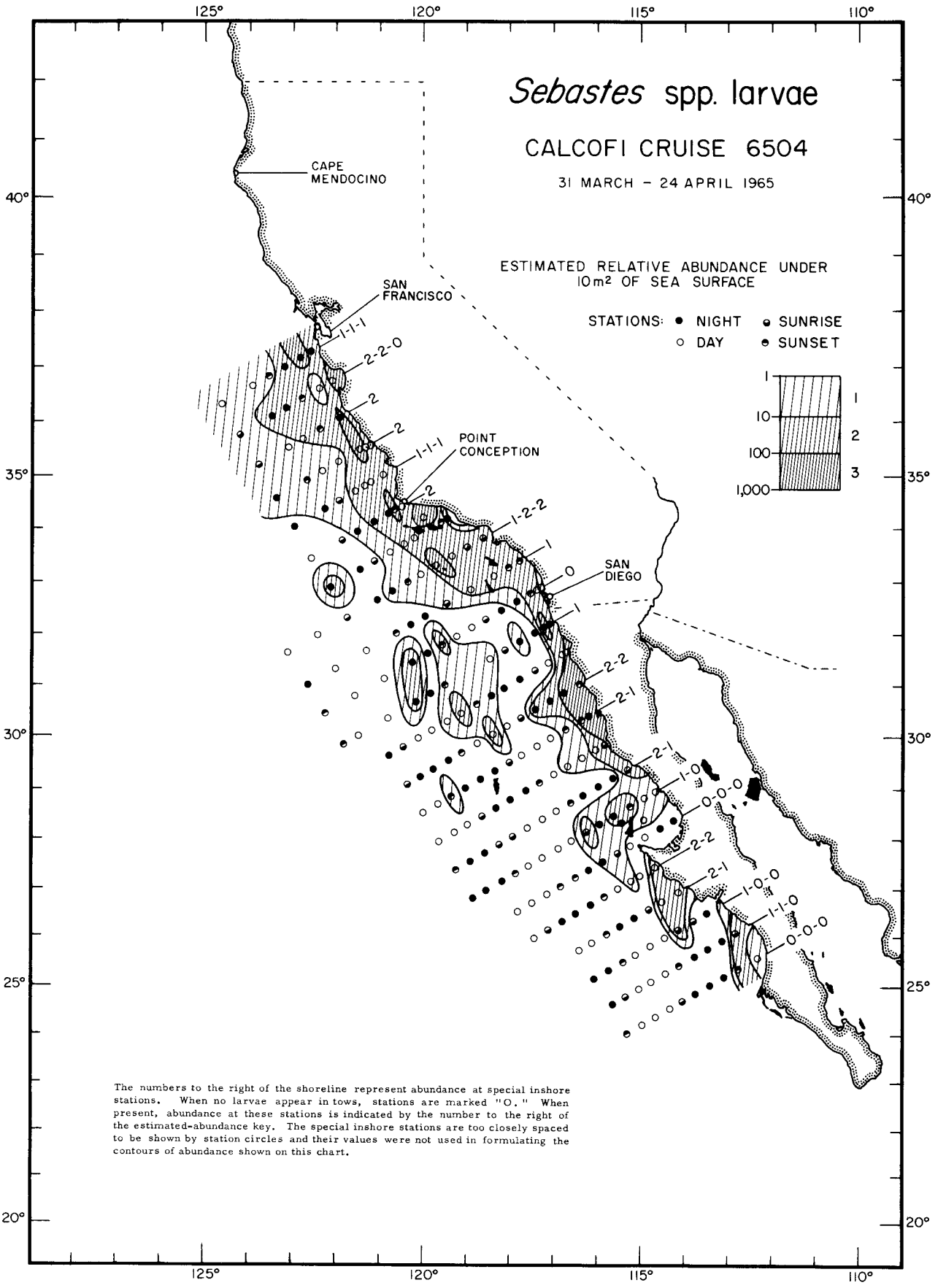
Sebastes spp. larvae

6410



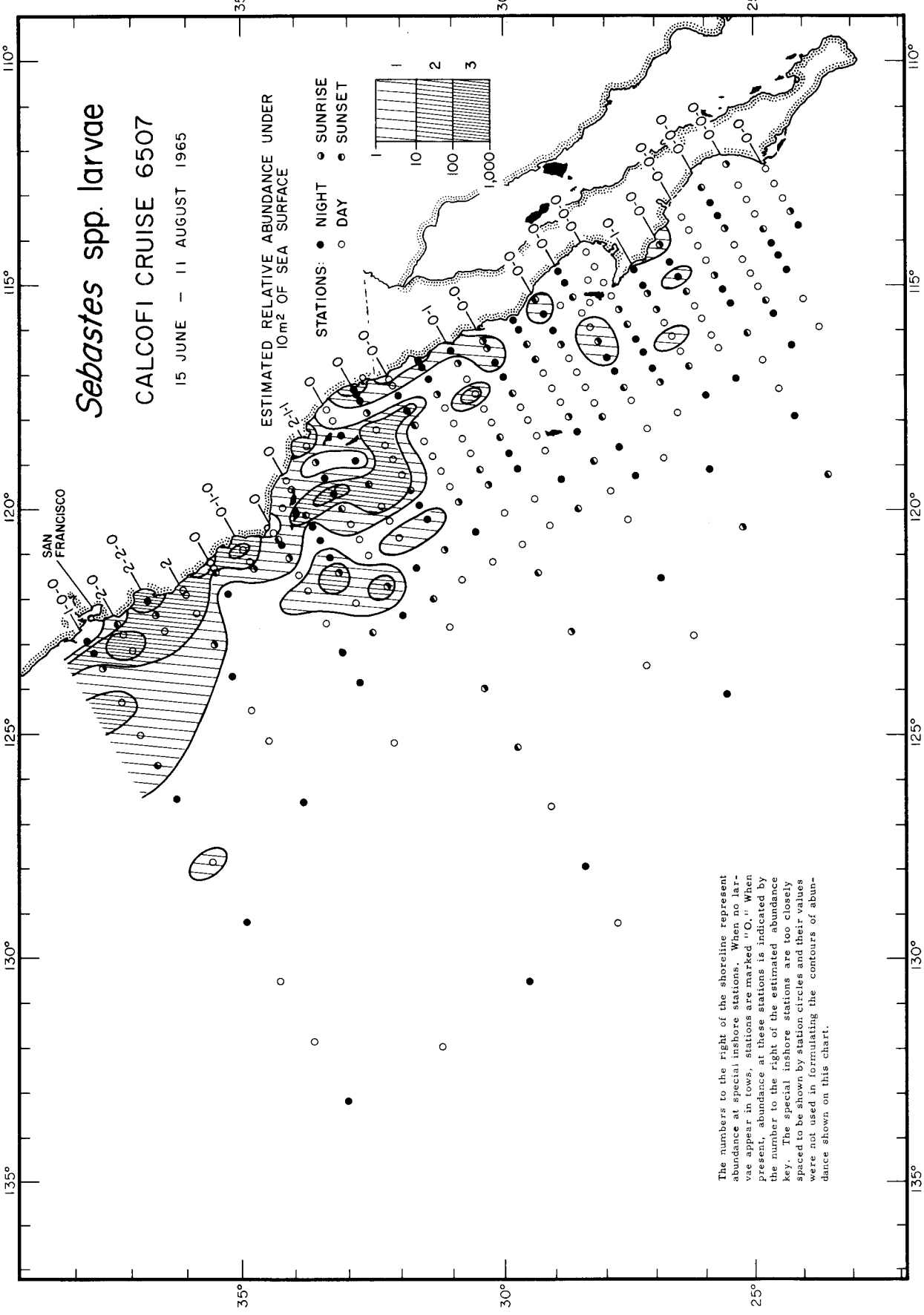
Sebastes spp. larvae

6501



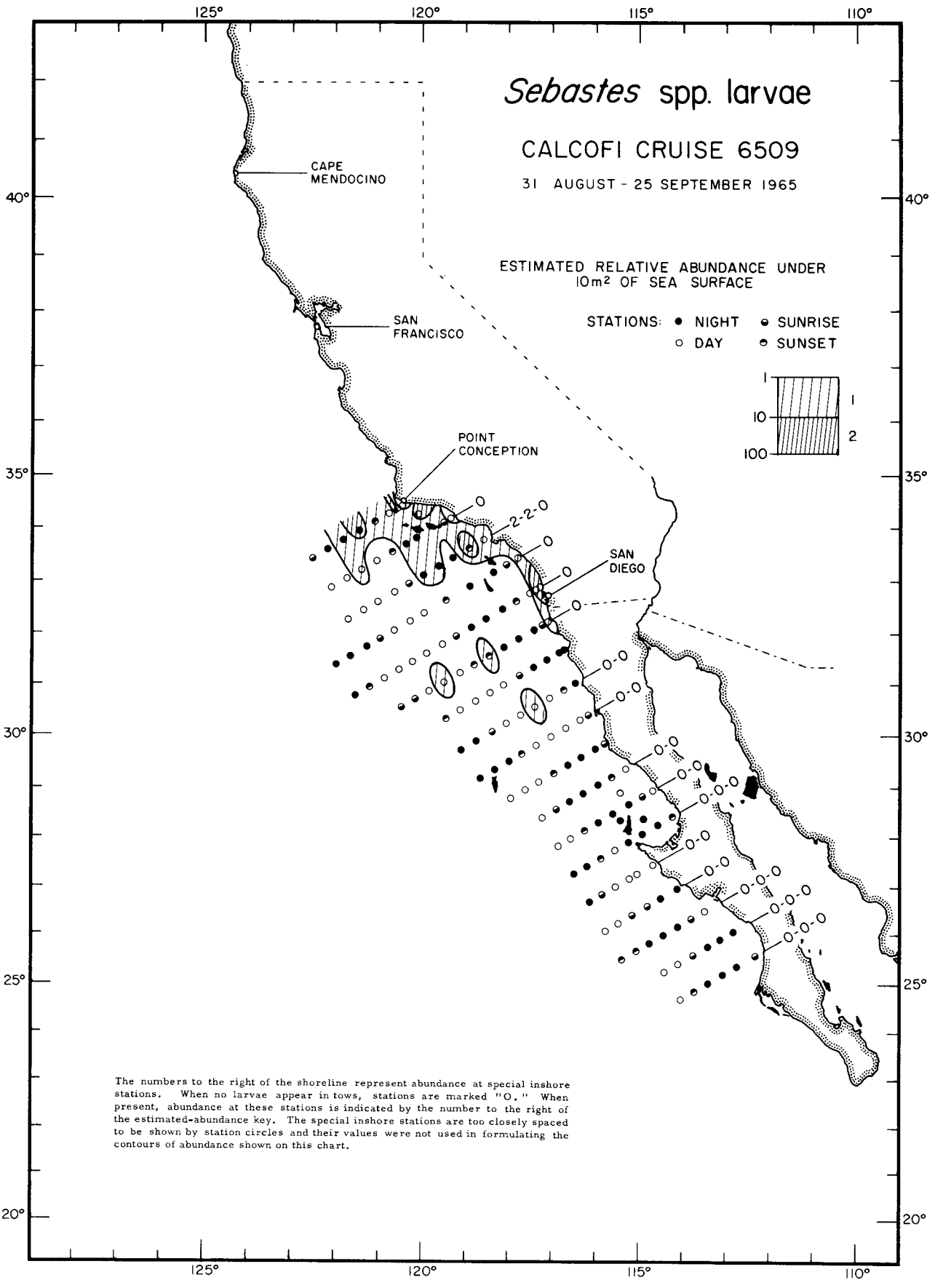
Sebastes spp. larvae

6504



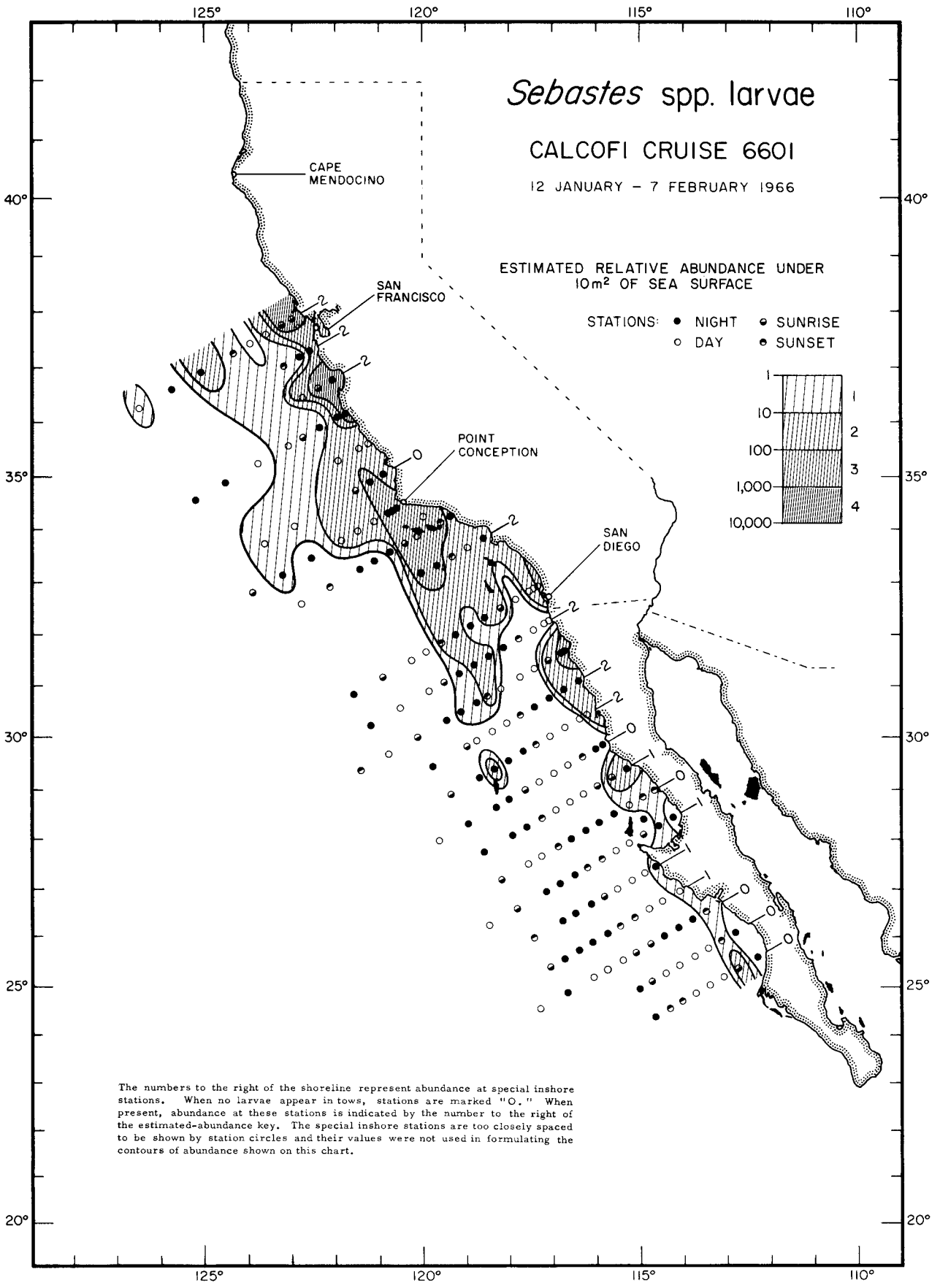
Sebastes spp. larvae

6507



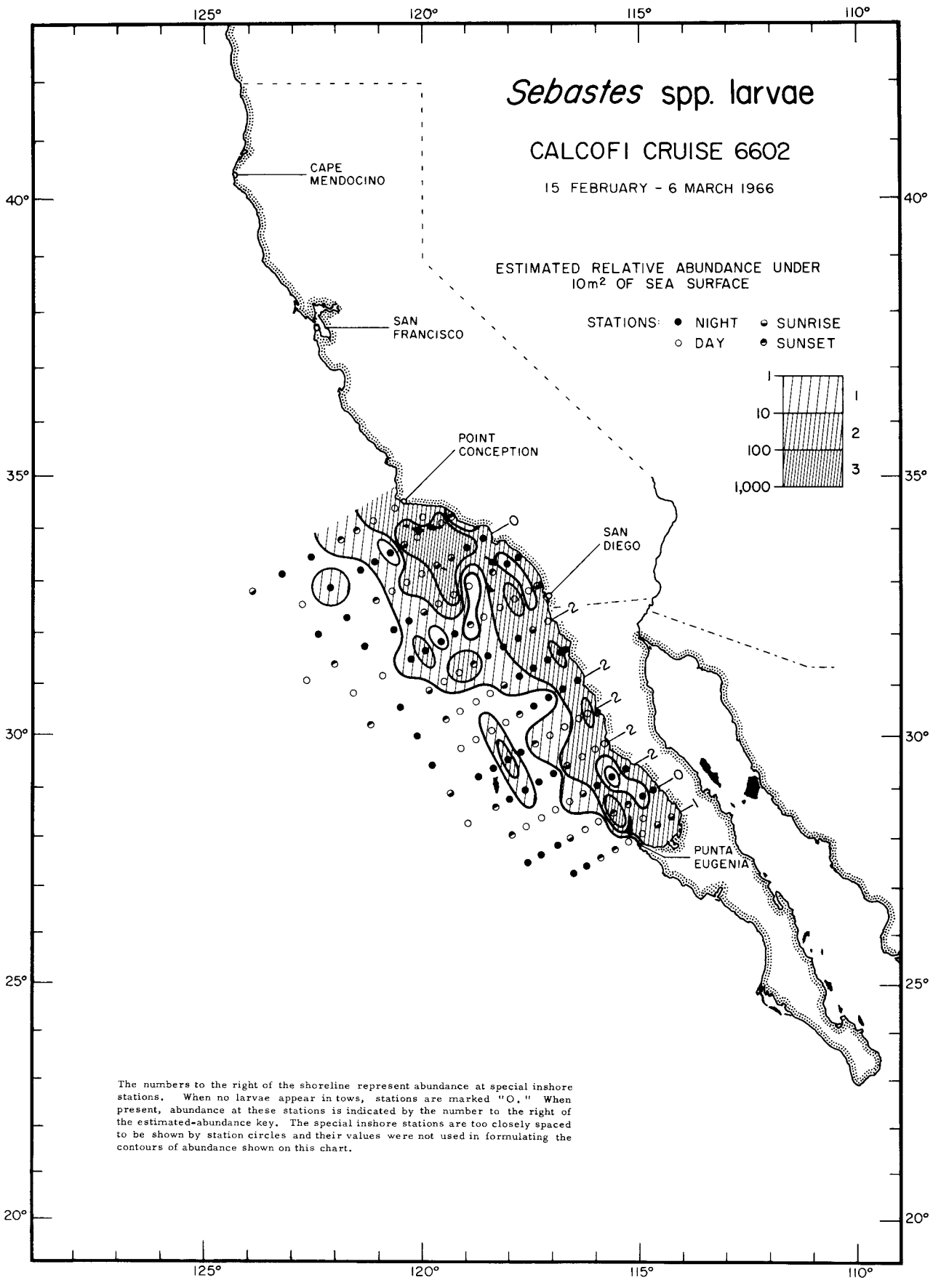
Sebastes spp. larvae

6509



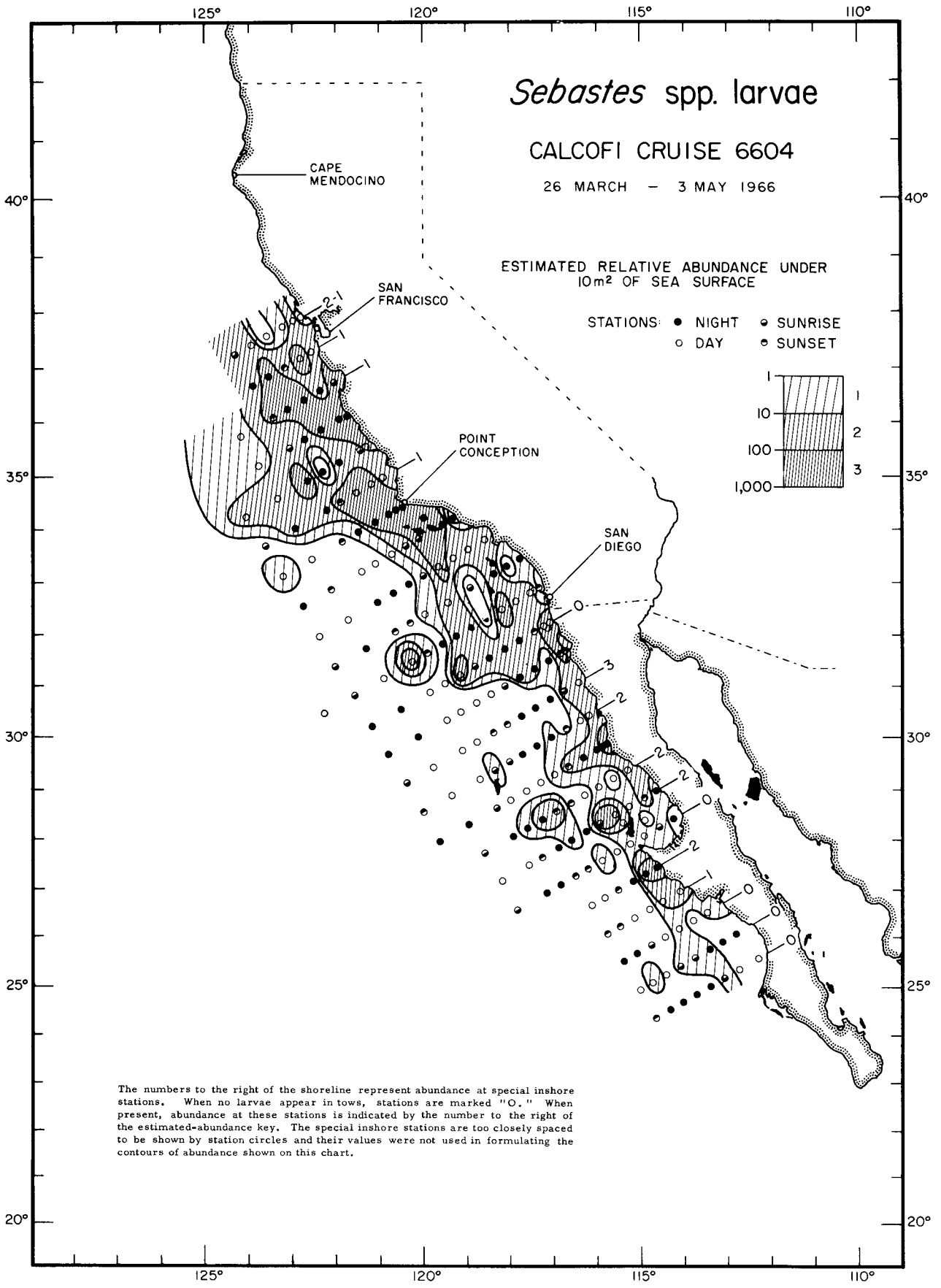
Sebastes spp. larvae

6601



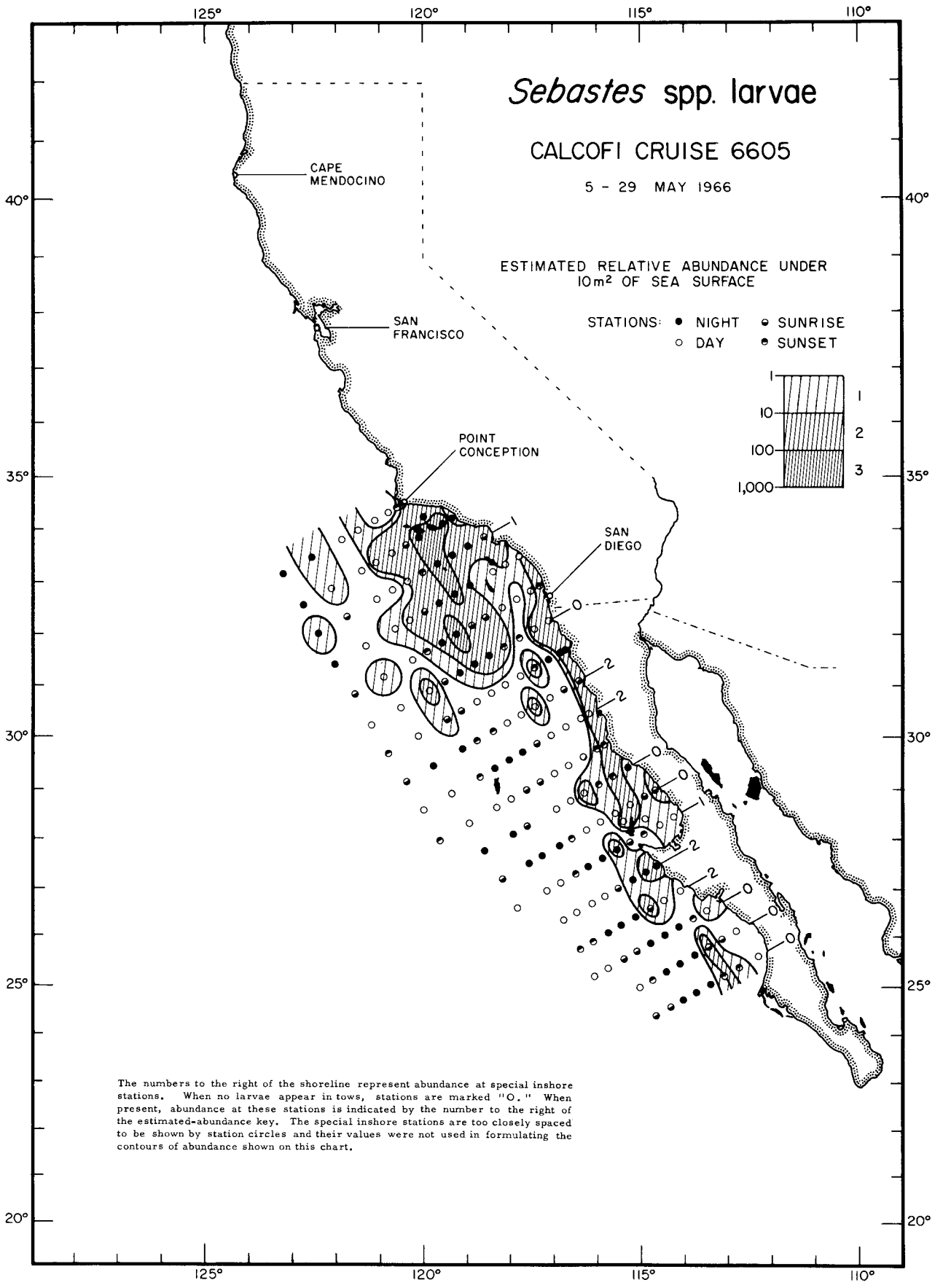
Sebastes spp. larvae

6602



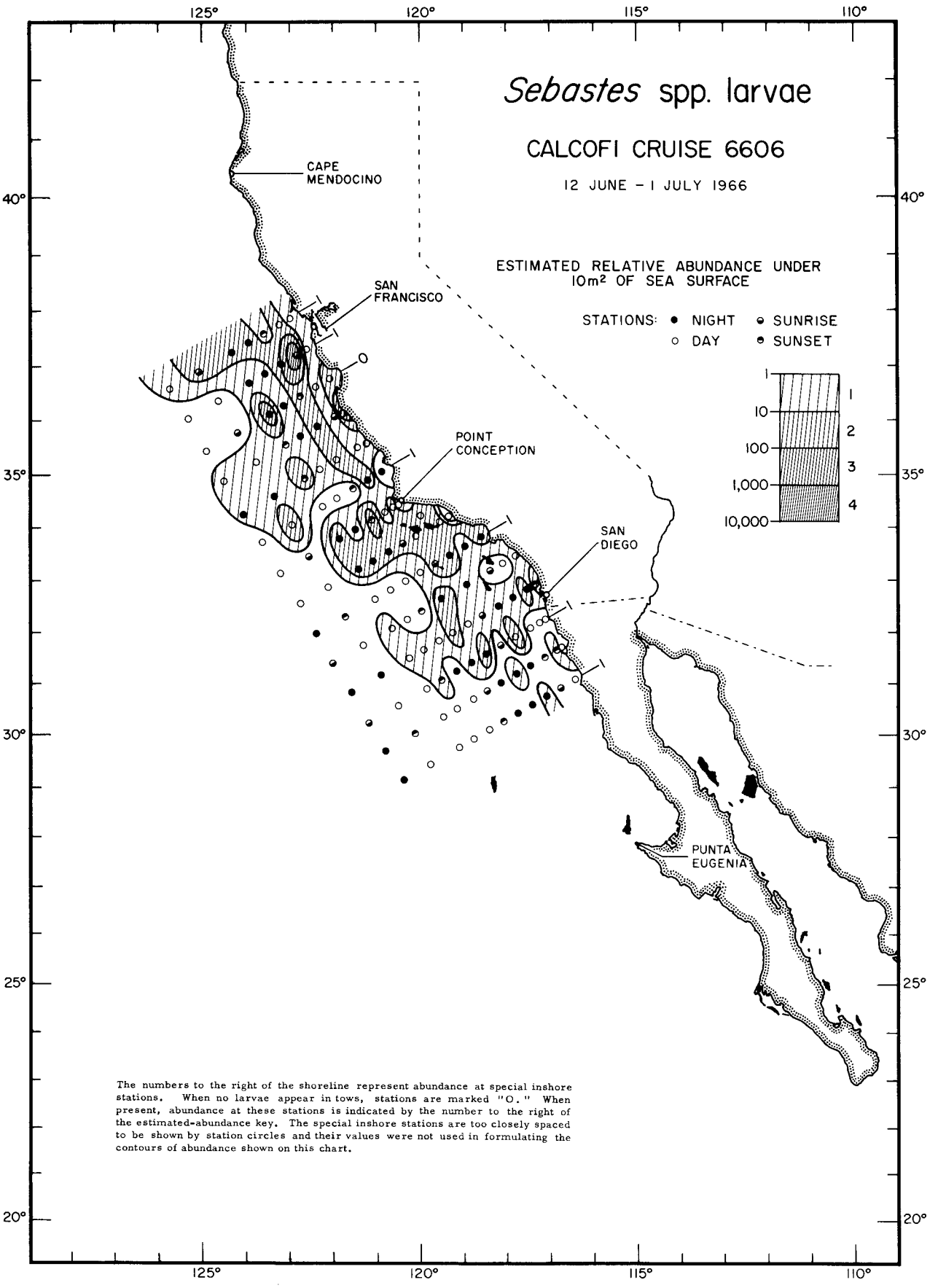
Sebastes spp. larvae

6604



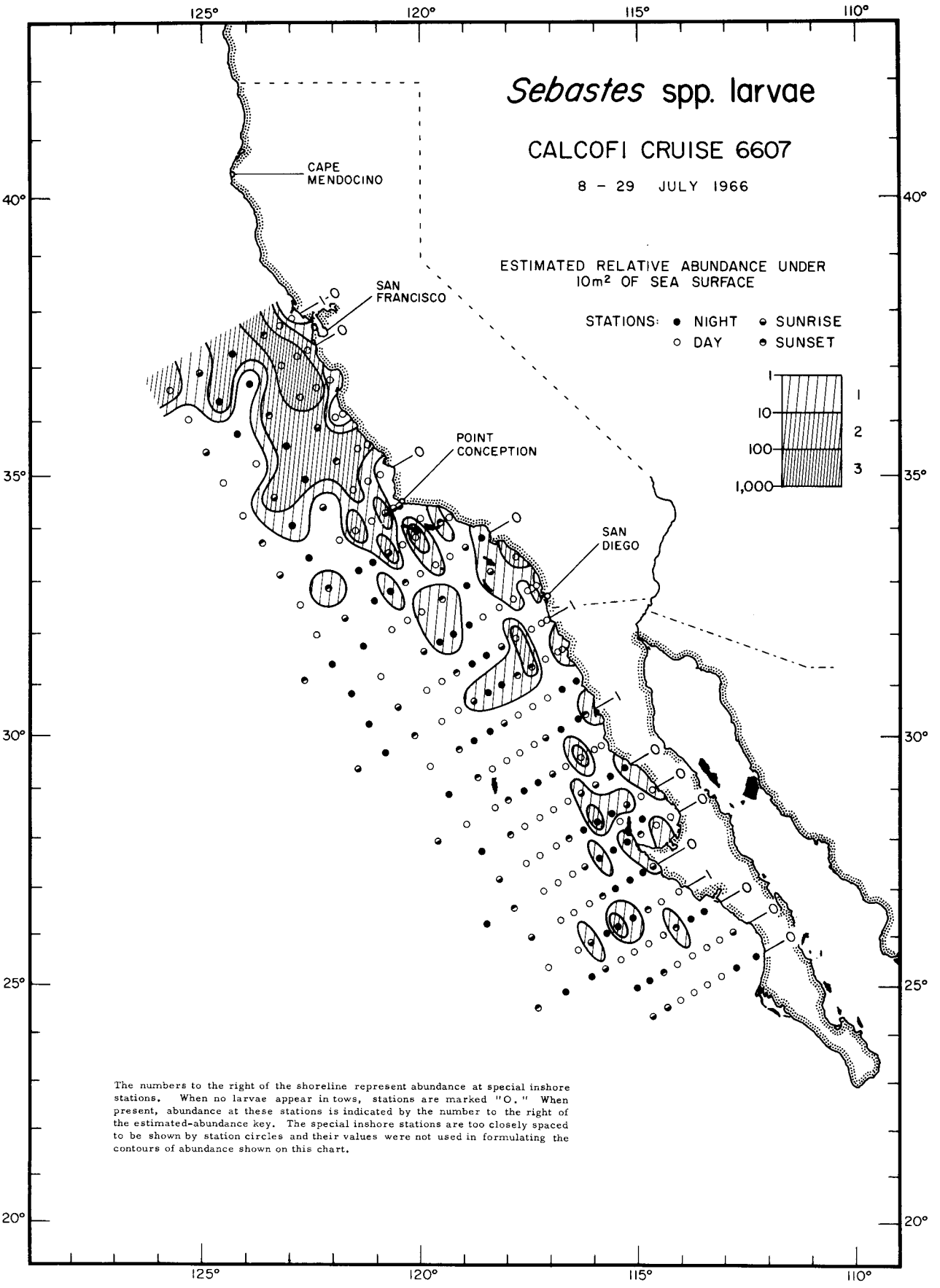
Sebastes spp. larvae

6605



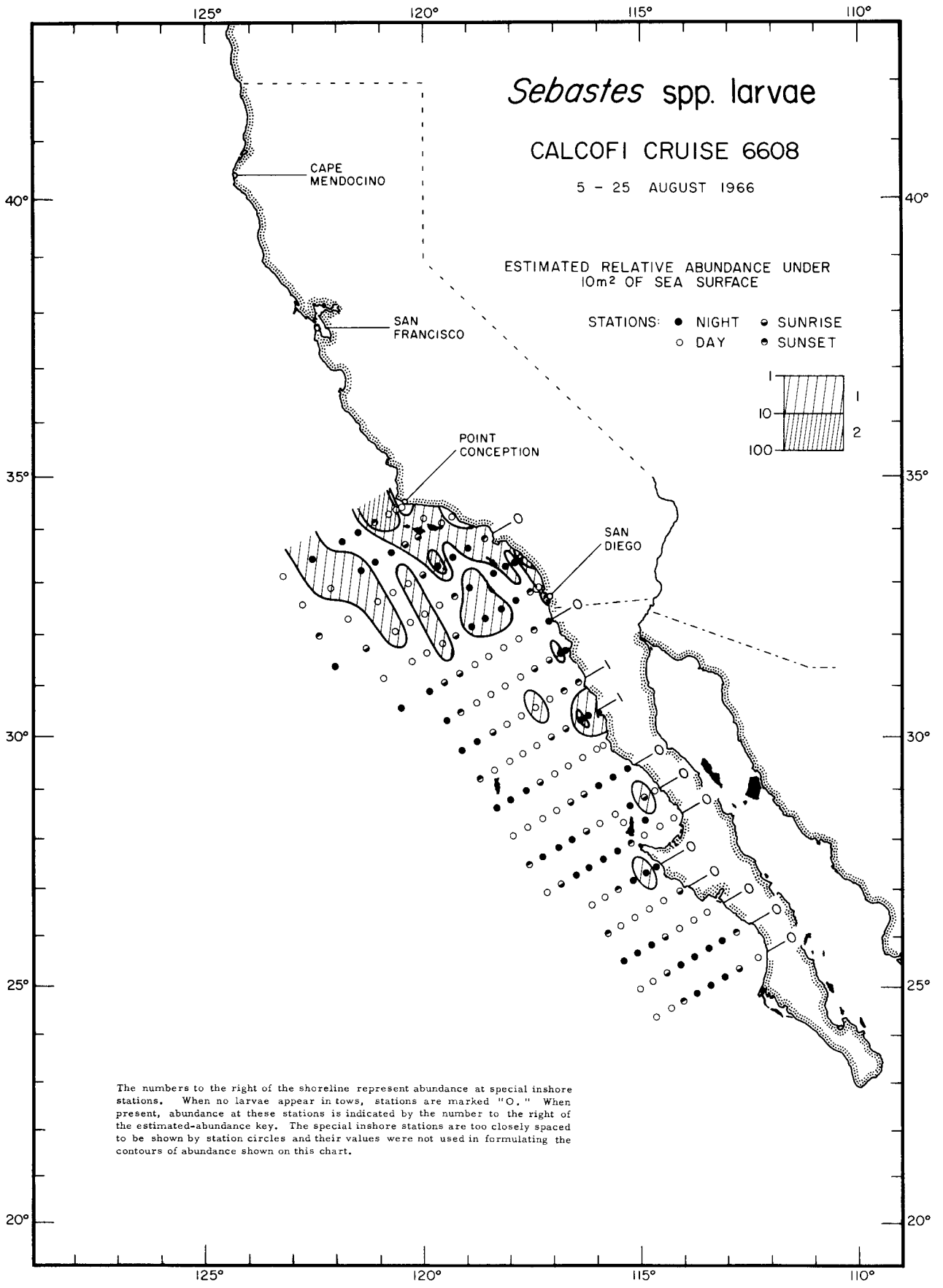
Sebastes spp. larvae

6606



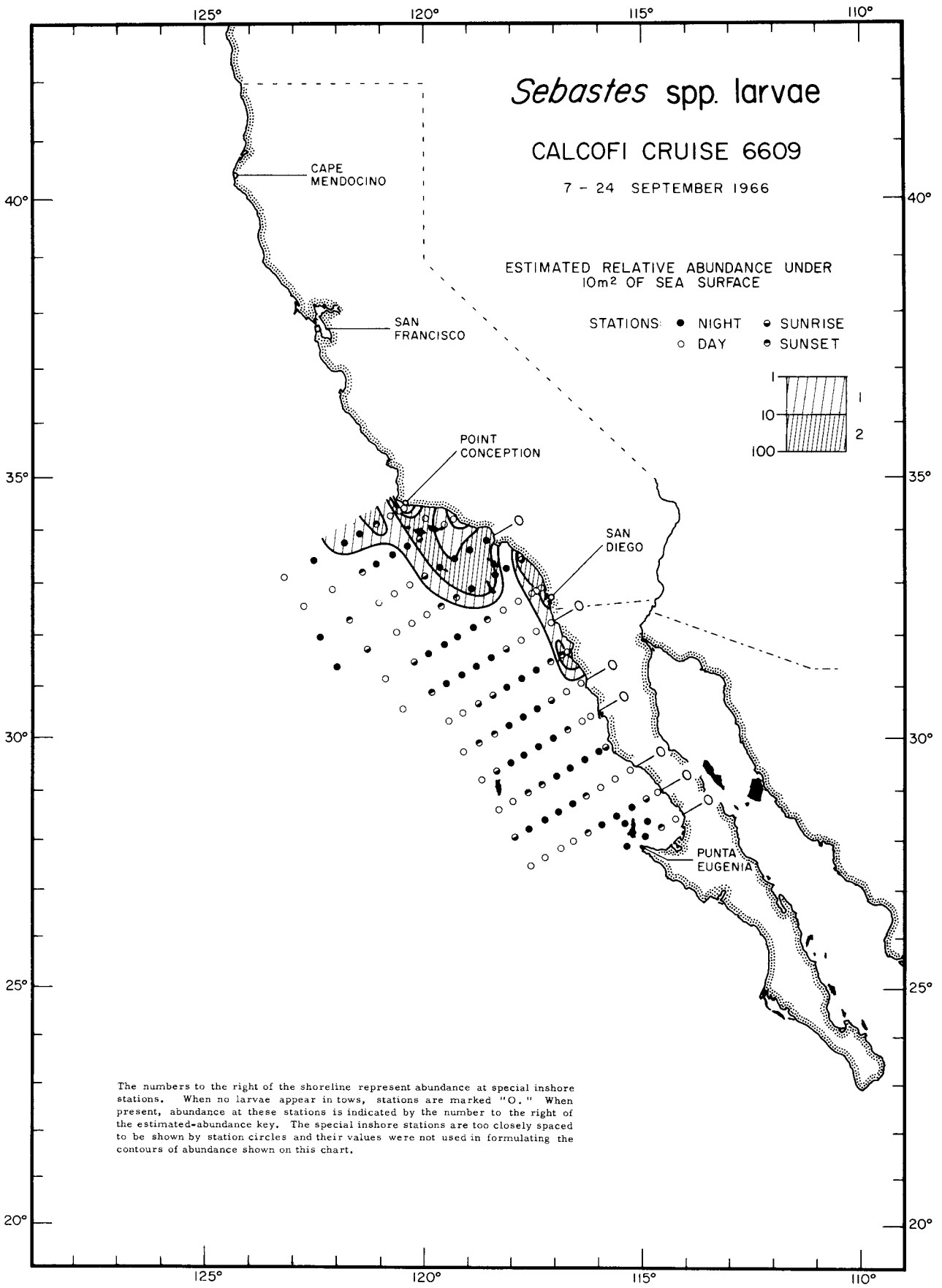
Sebastes spp. larvae

6607



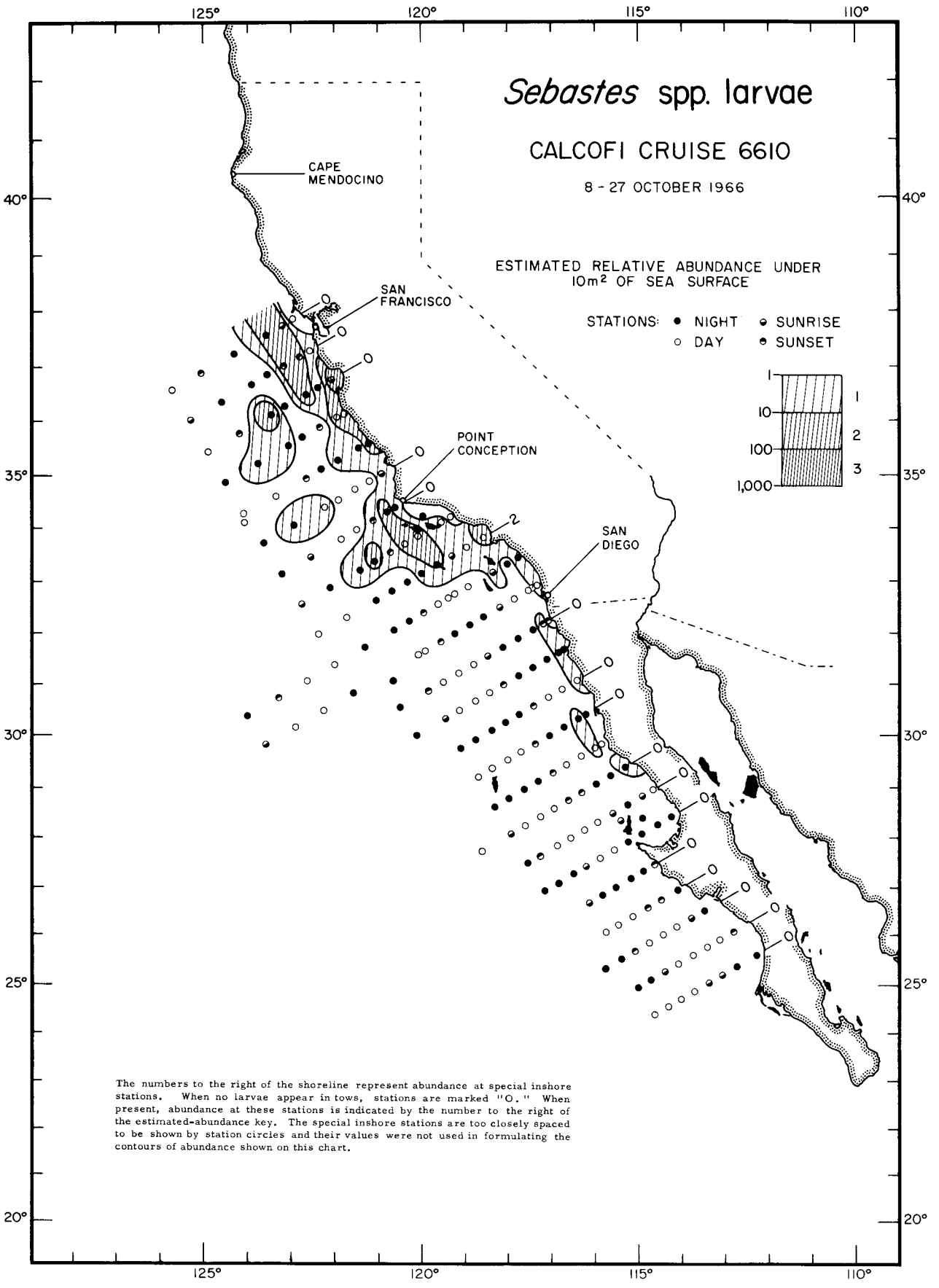
Sebastes spp. larvae

6608



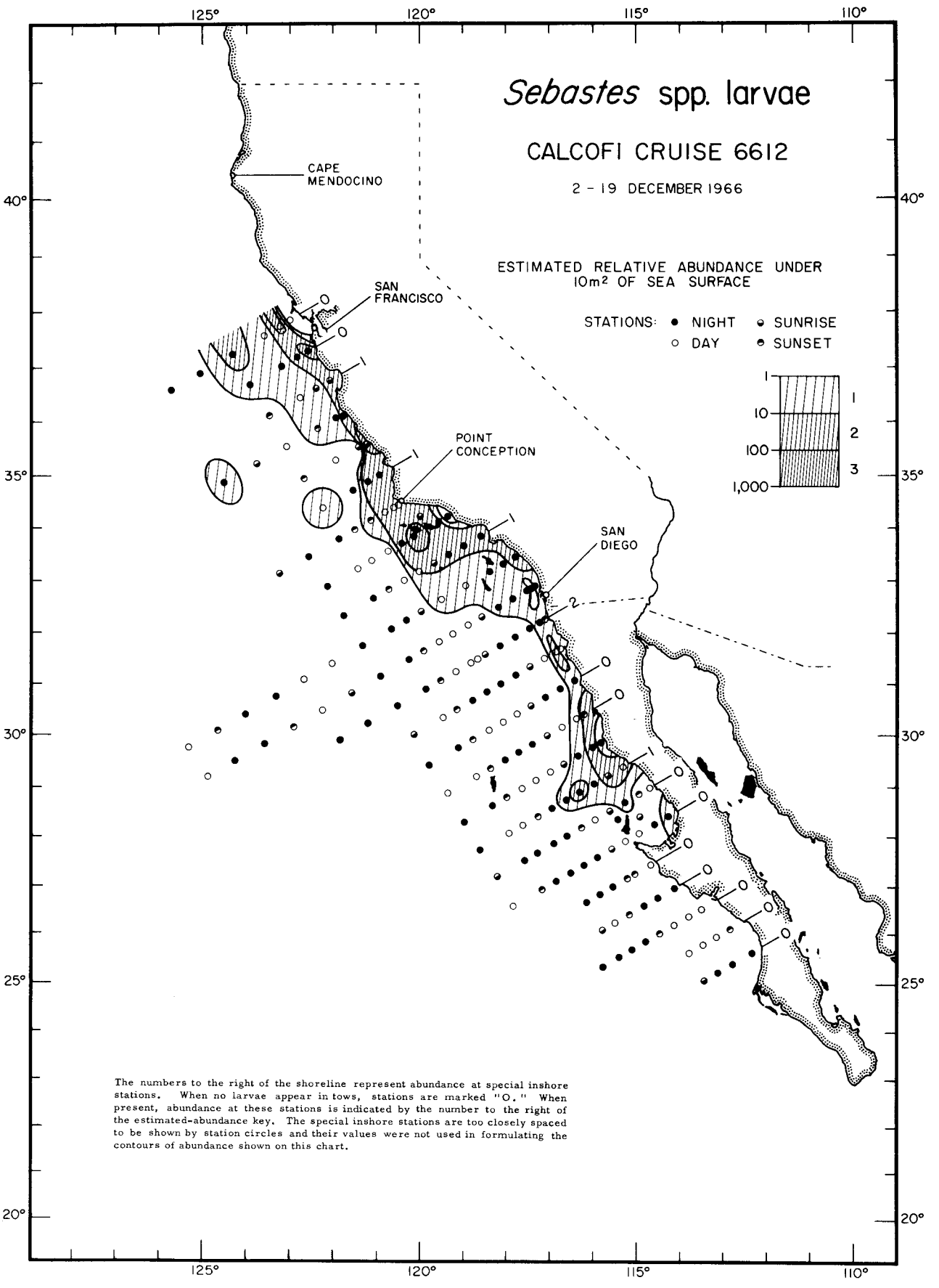
Sebastes spp. larvae

6609



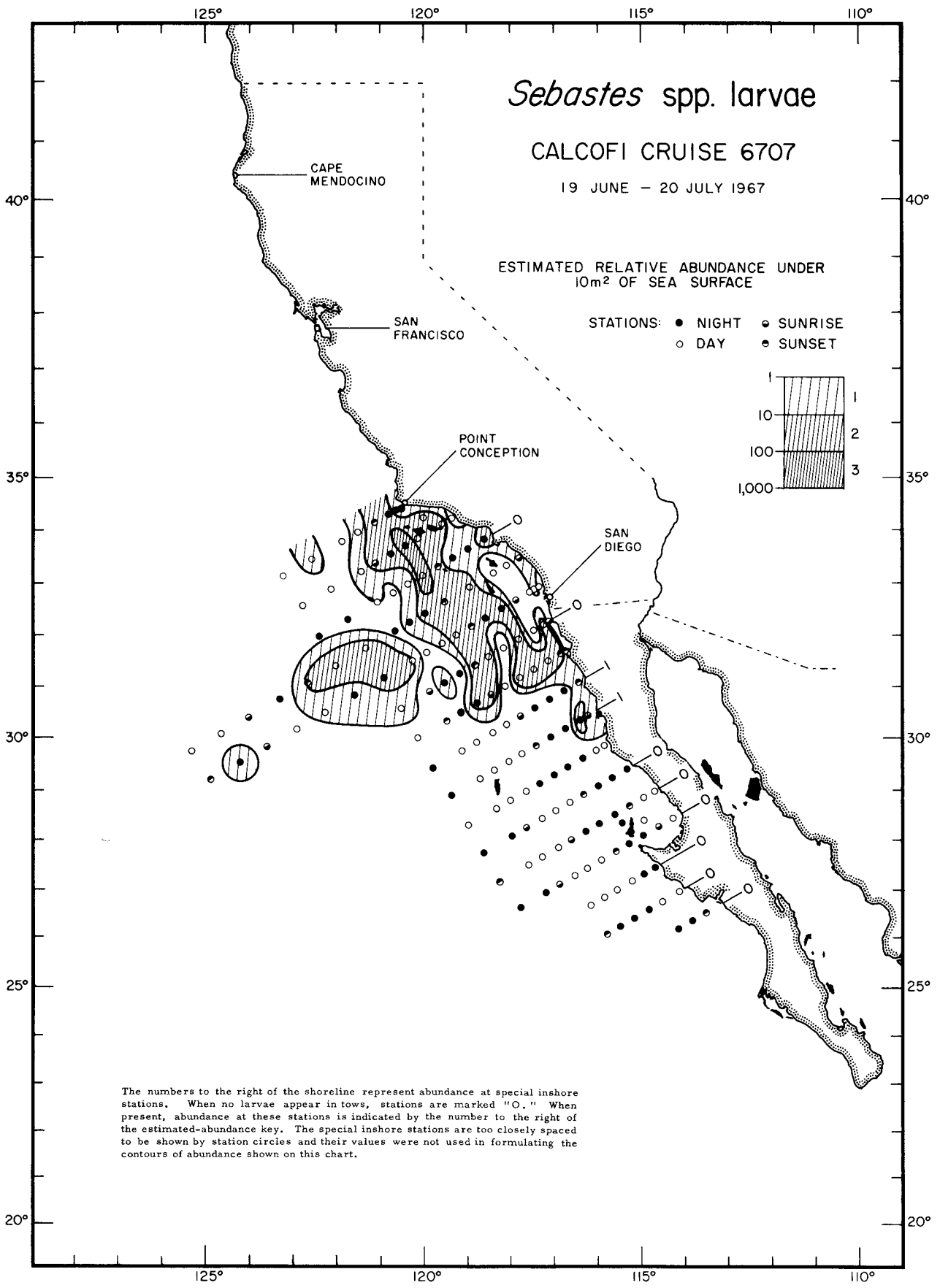
Sebastes spp. larvae

6610



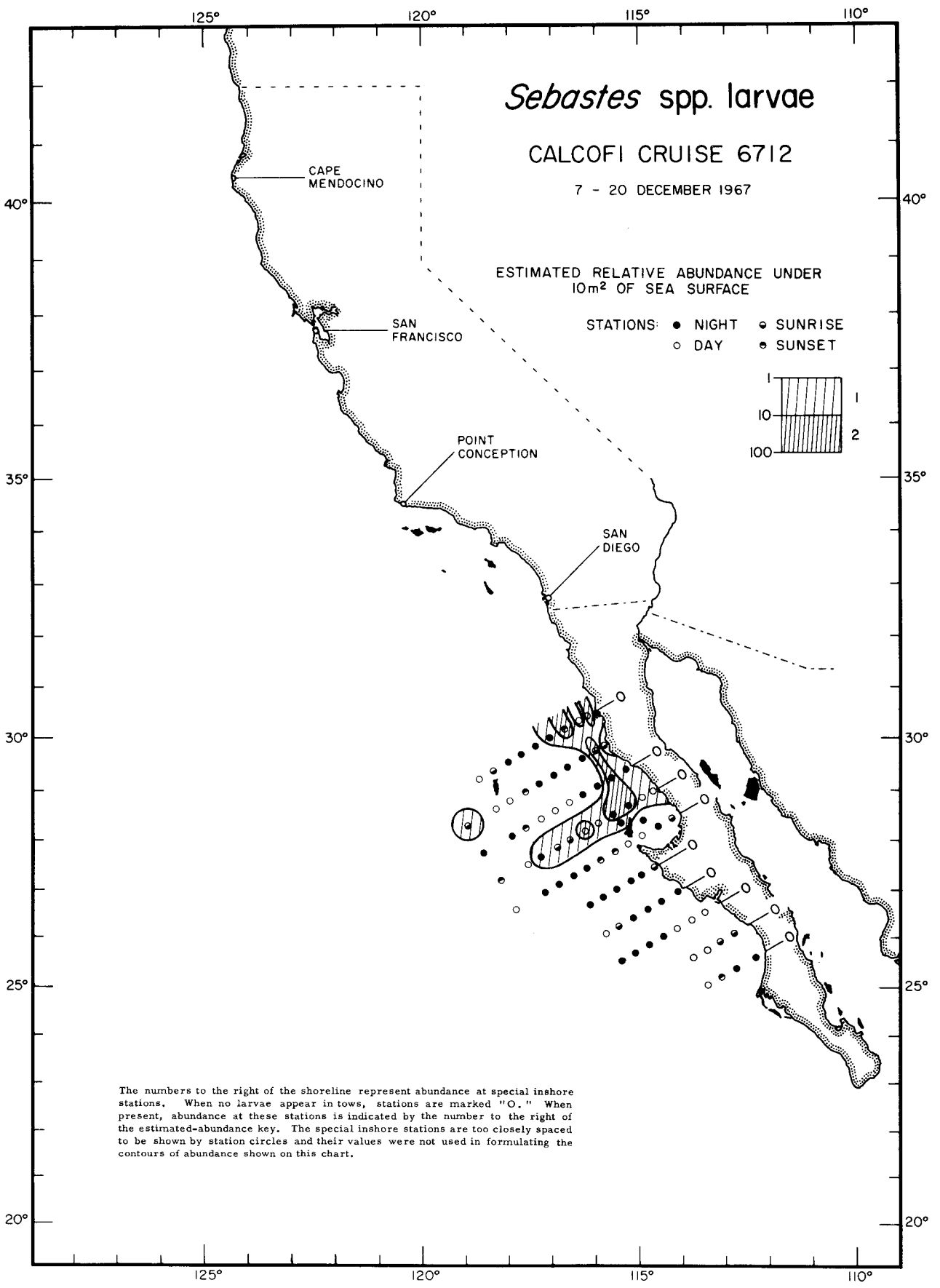
Sebastes spp. larvae

6612



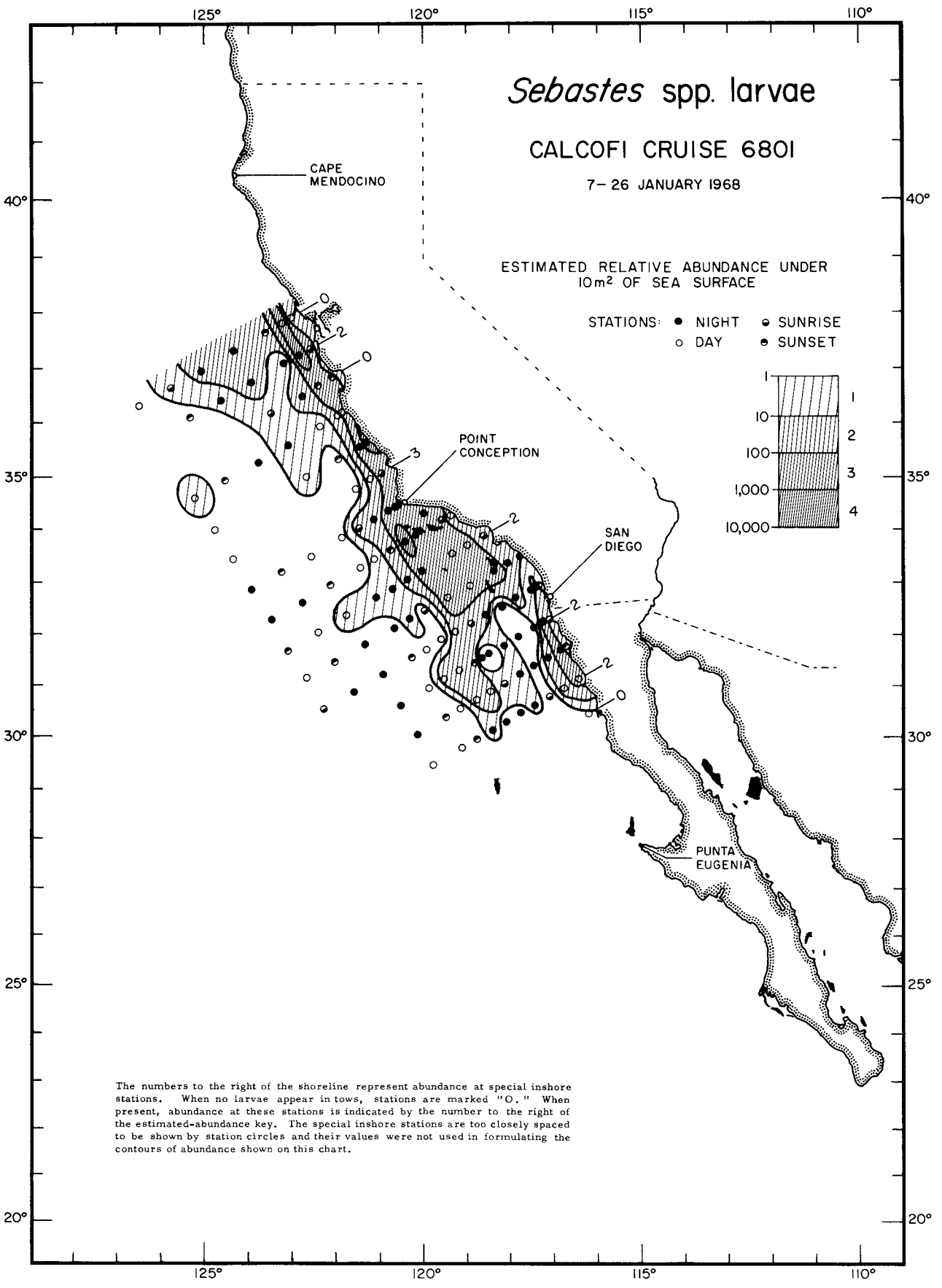
Sebastes spp. larvae

6707



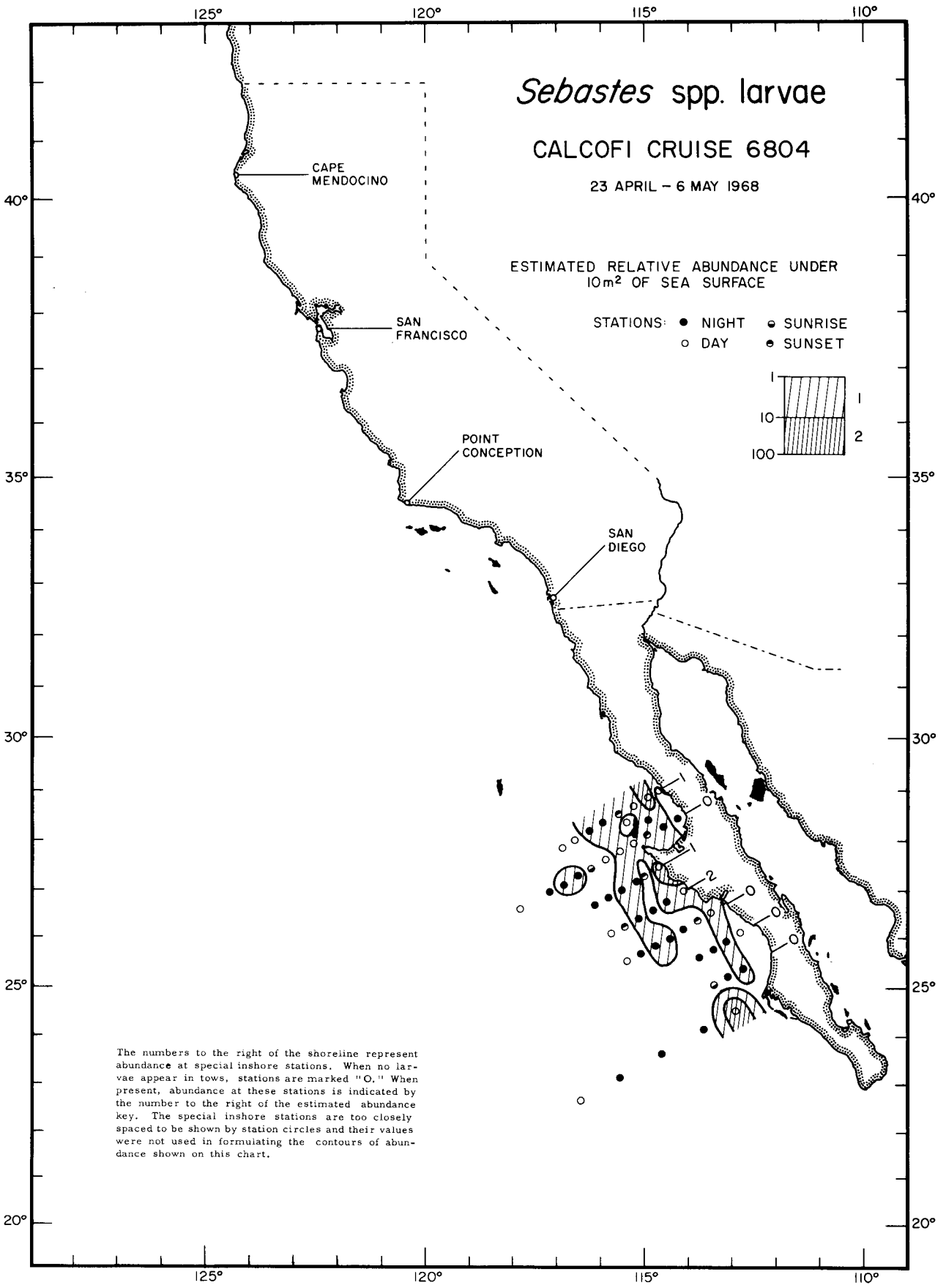
Sebastes spp. larvae

6712



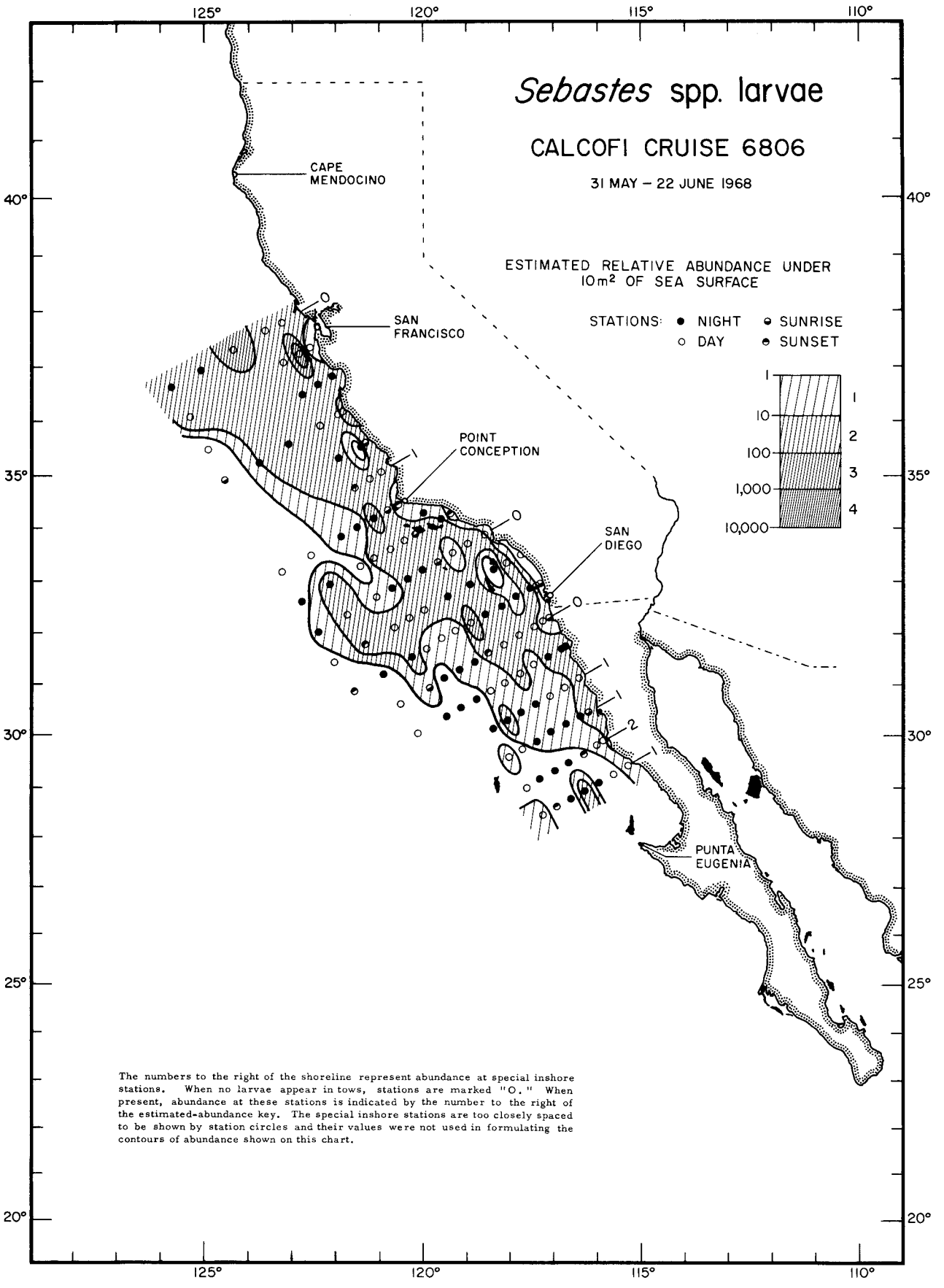
Sebastes spp. larvae

6801



Sebastes spp. larvae

6804



Sebastes spp. larvae

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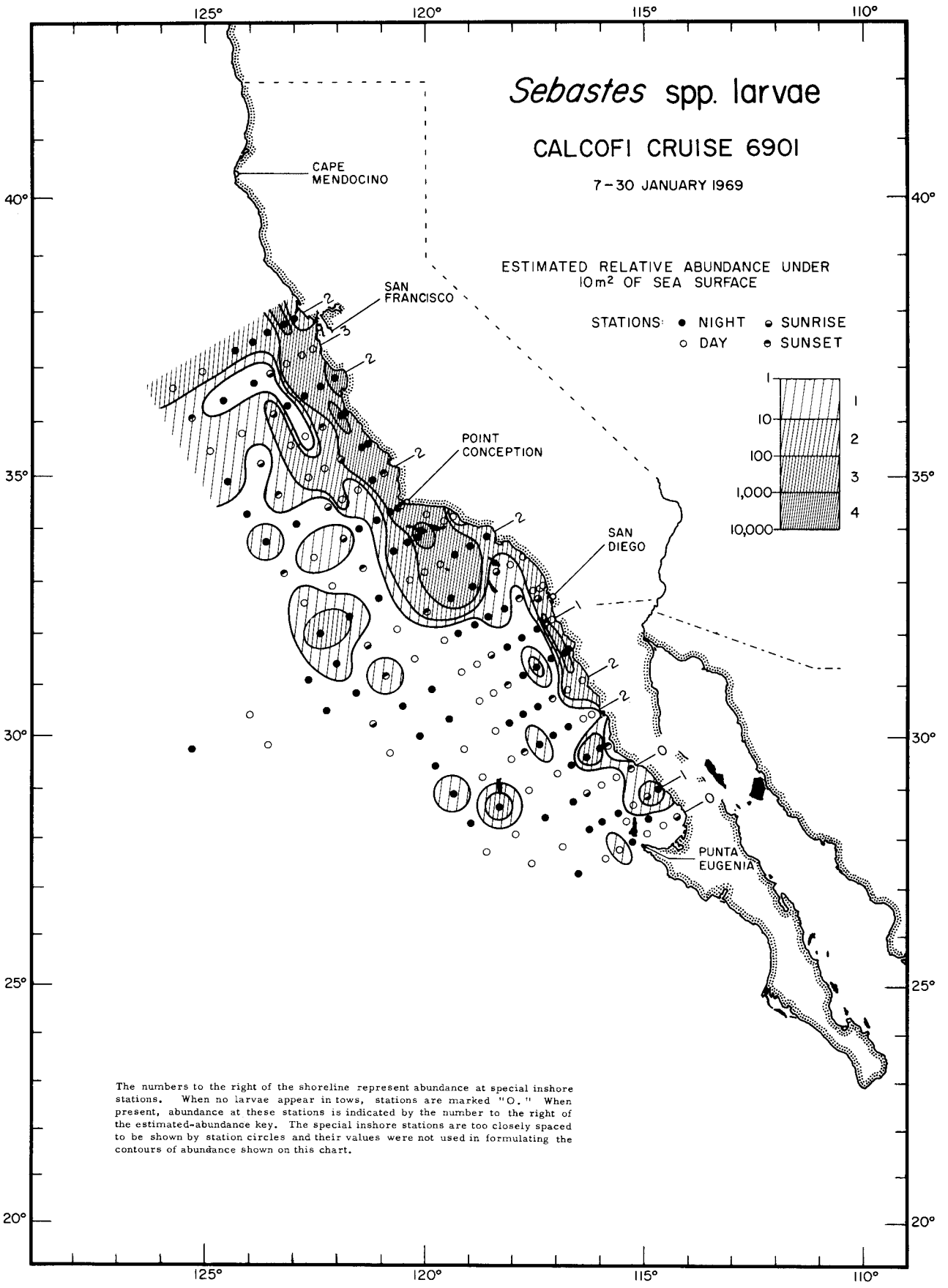
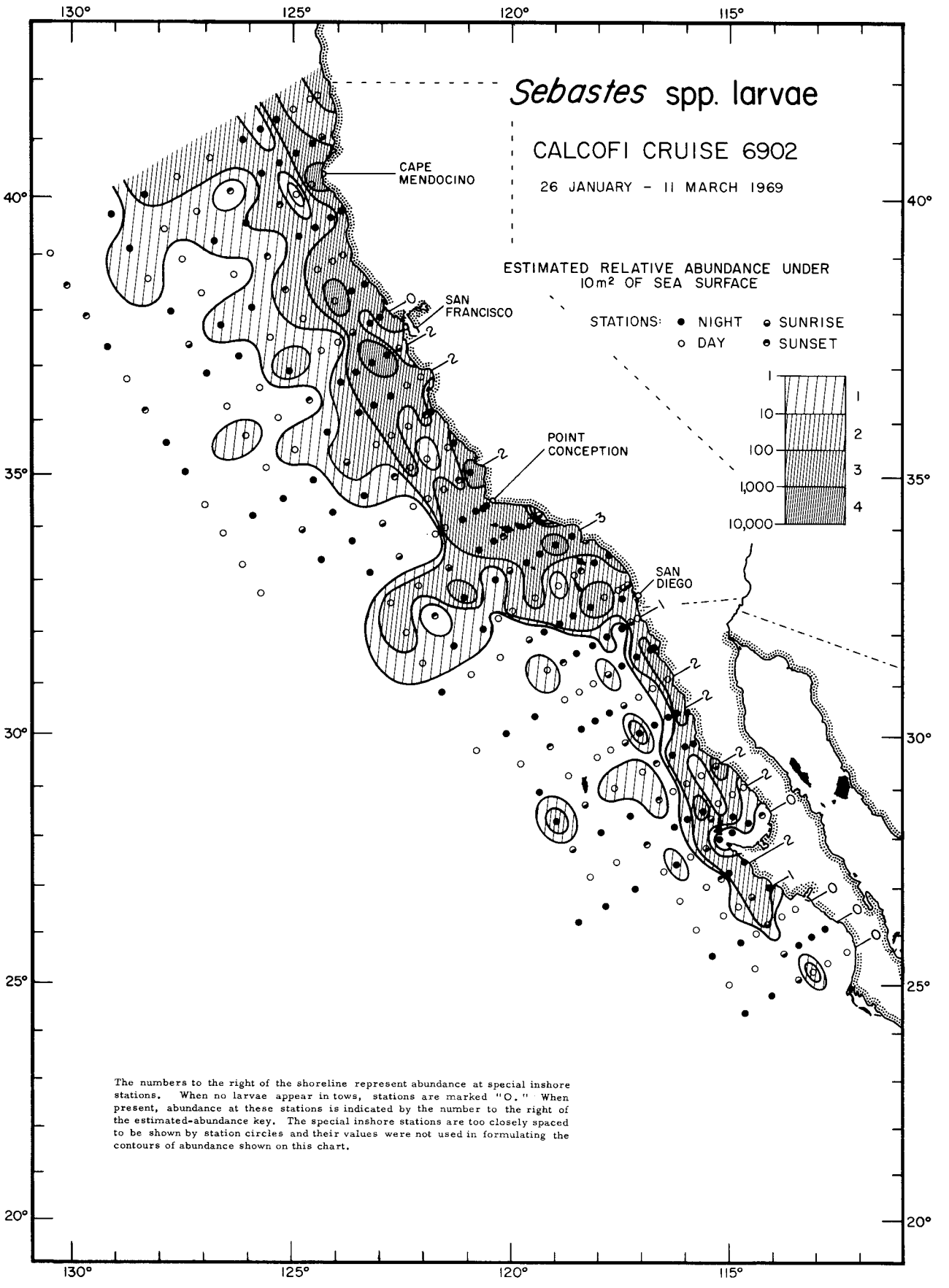


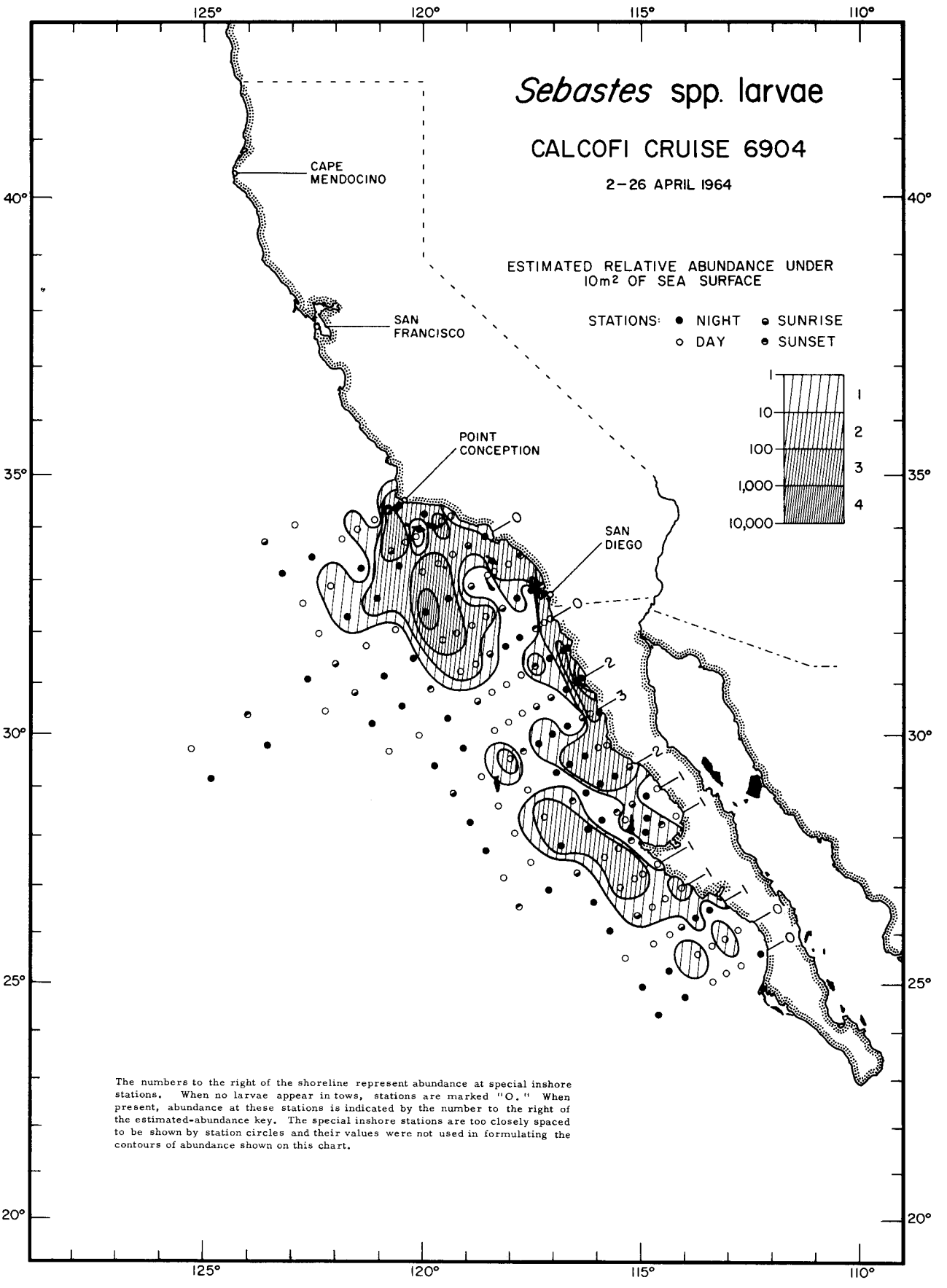
Sebastes spp. larvae

6901



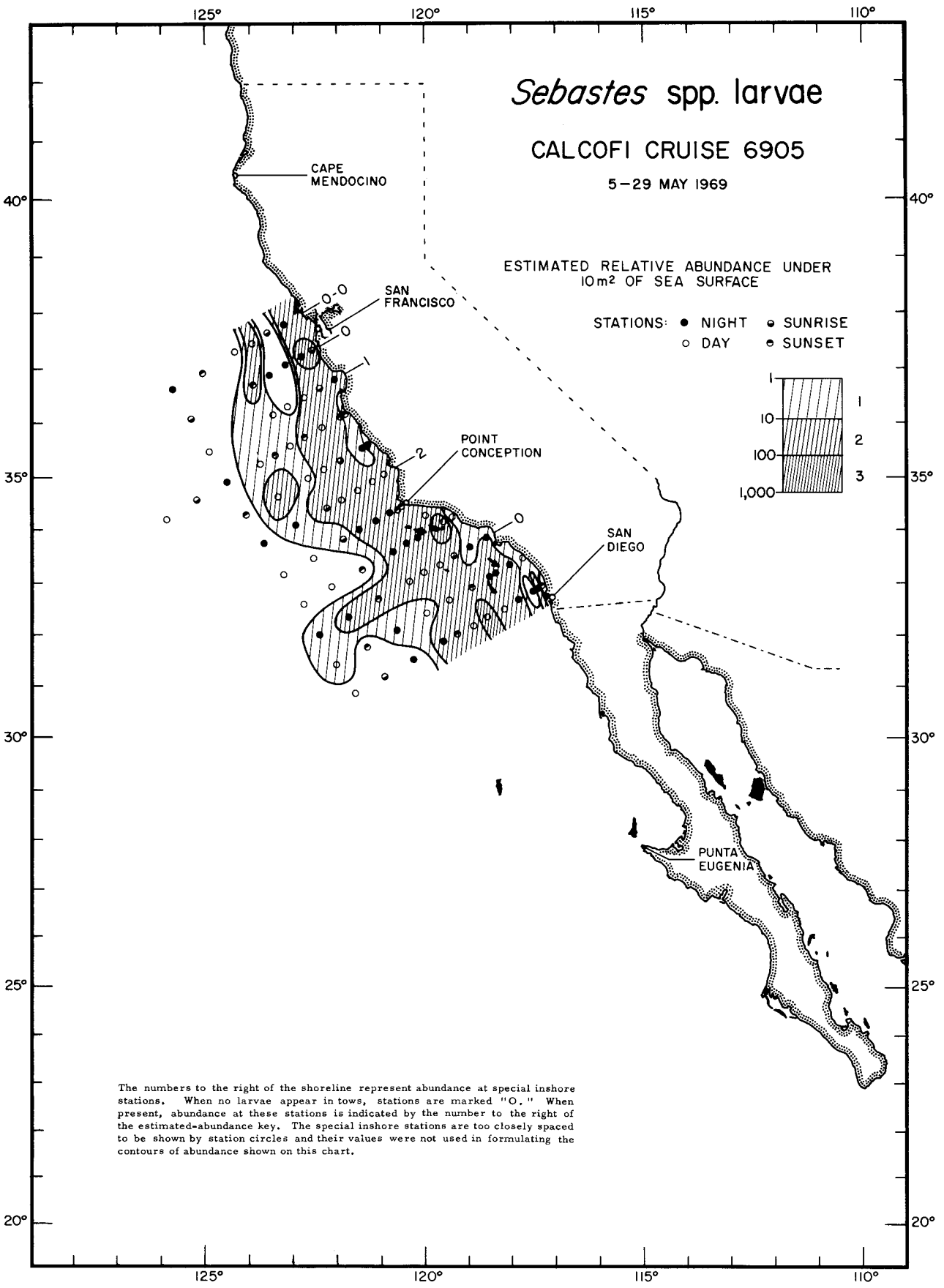
Sebastes spp. larvae

6902



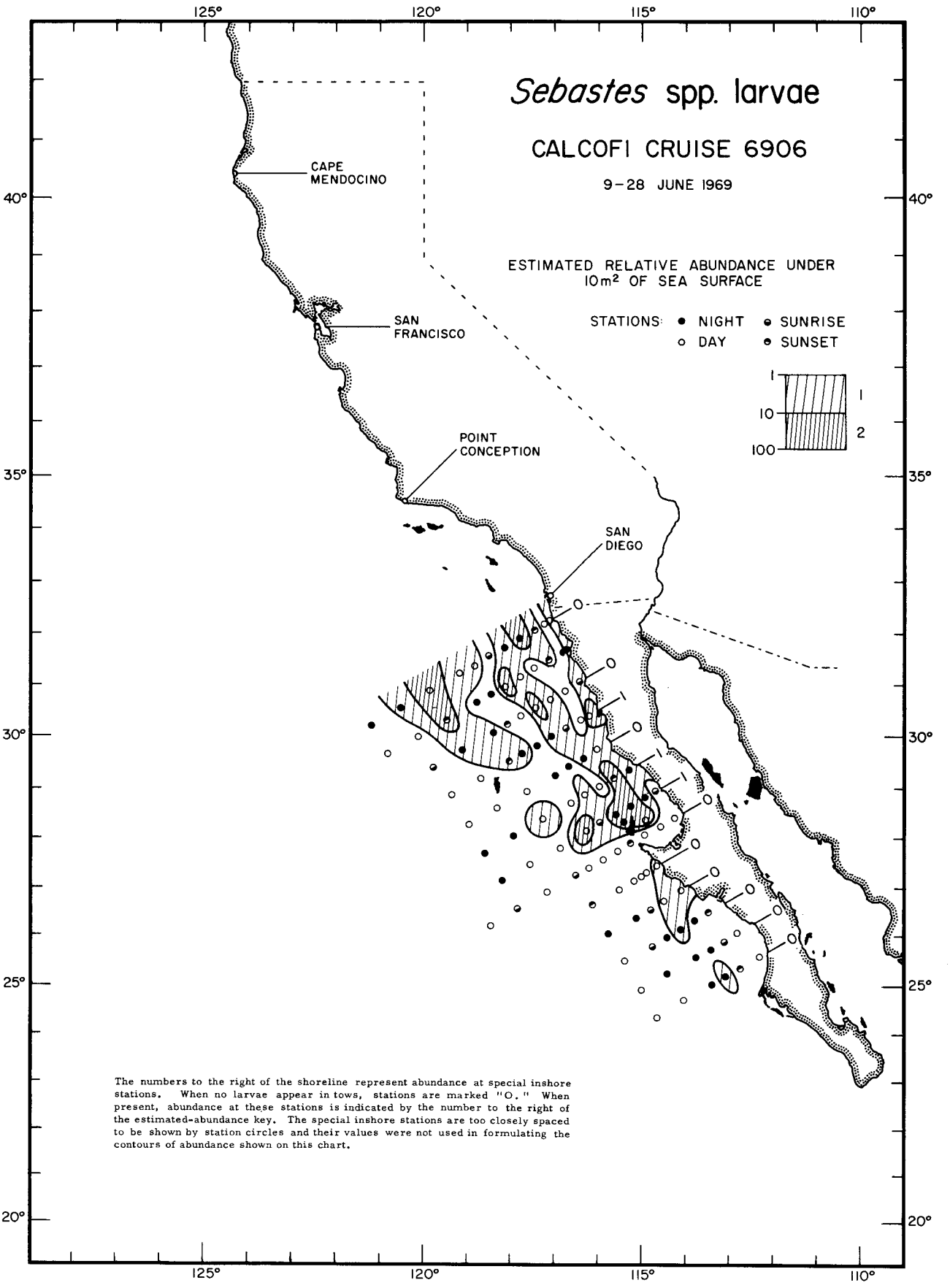
Sebastes spp. larvae

6904



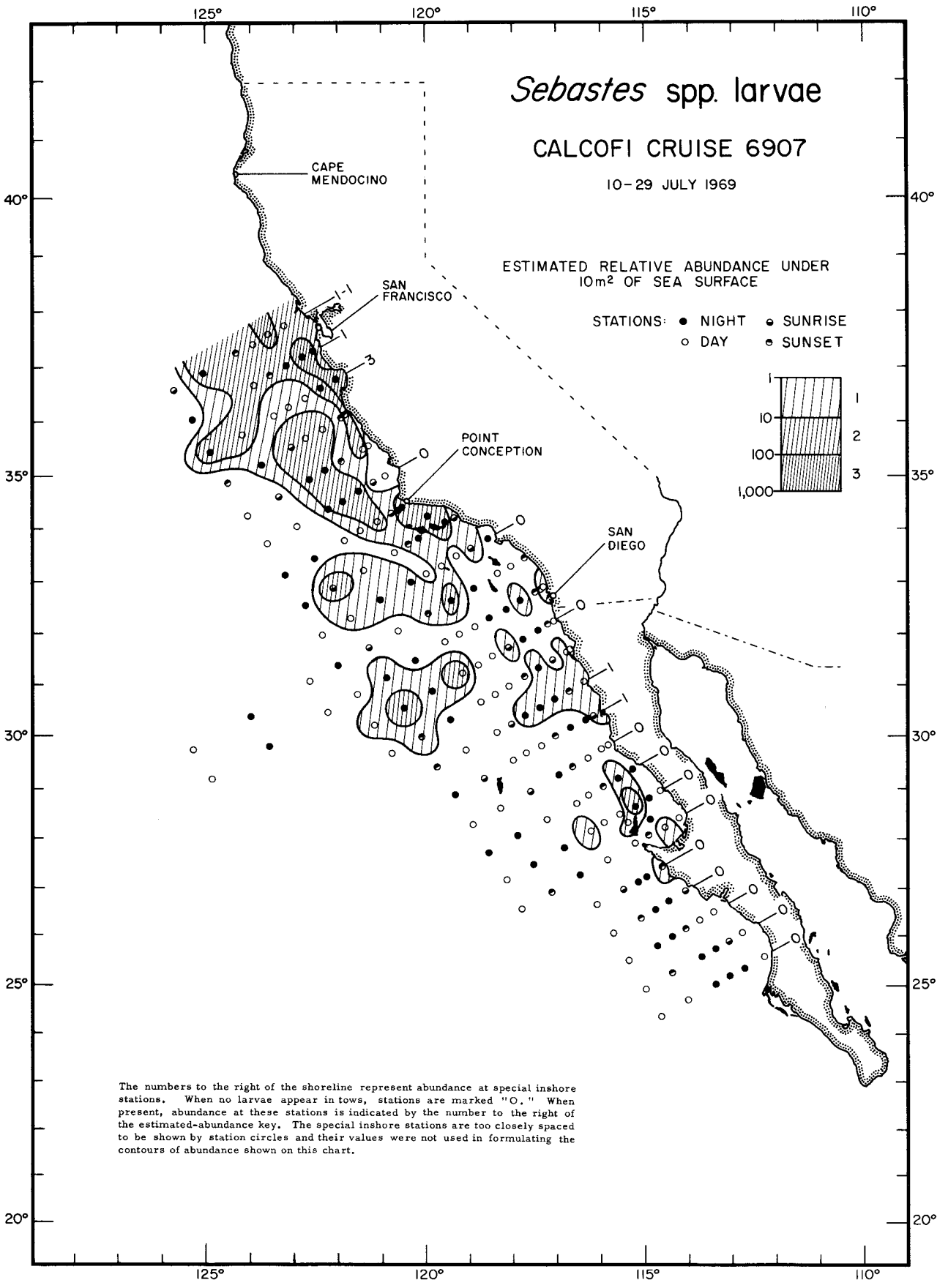
Sebastes spp. larvae

6905



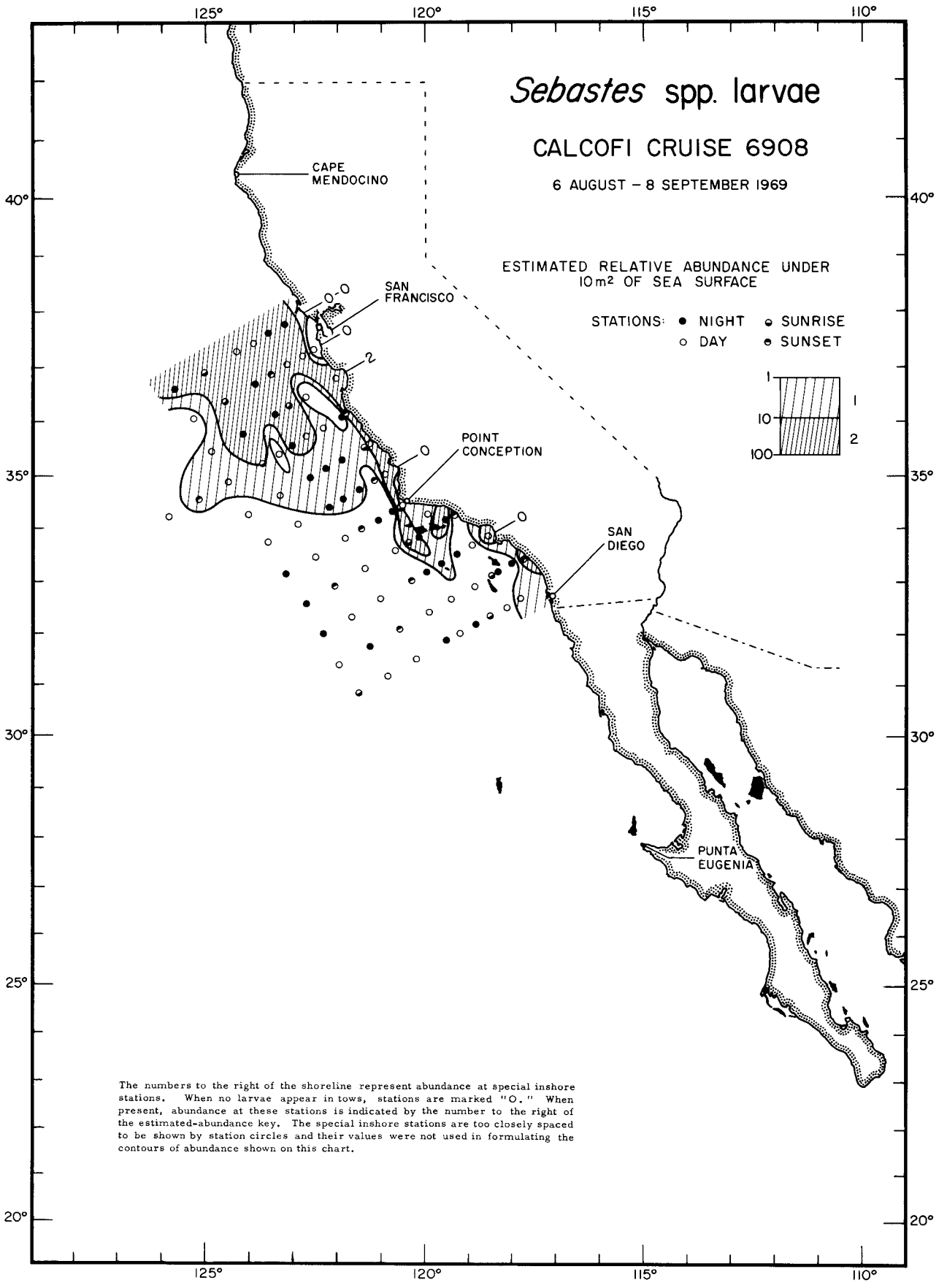
Sebastes spp. larvae

6906



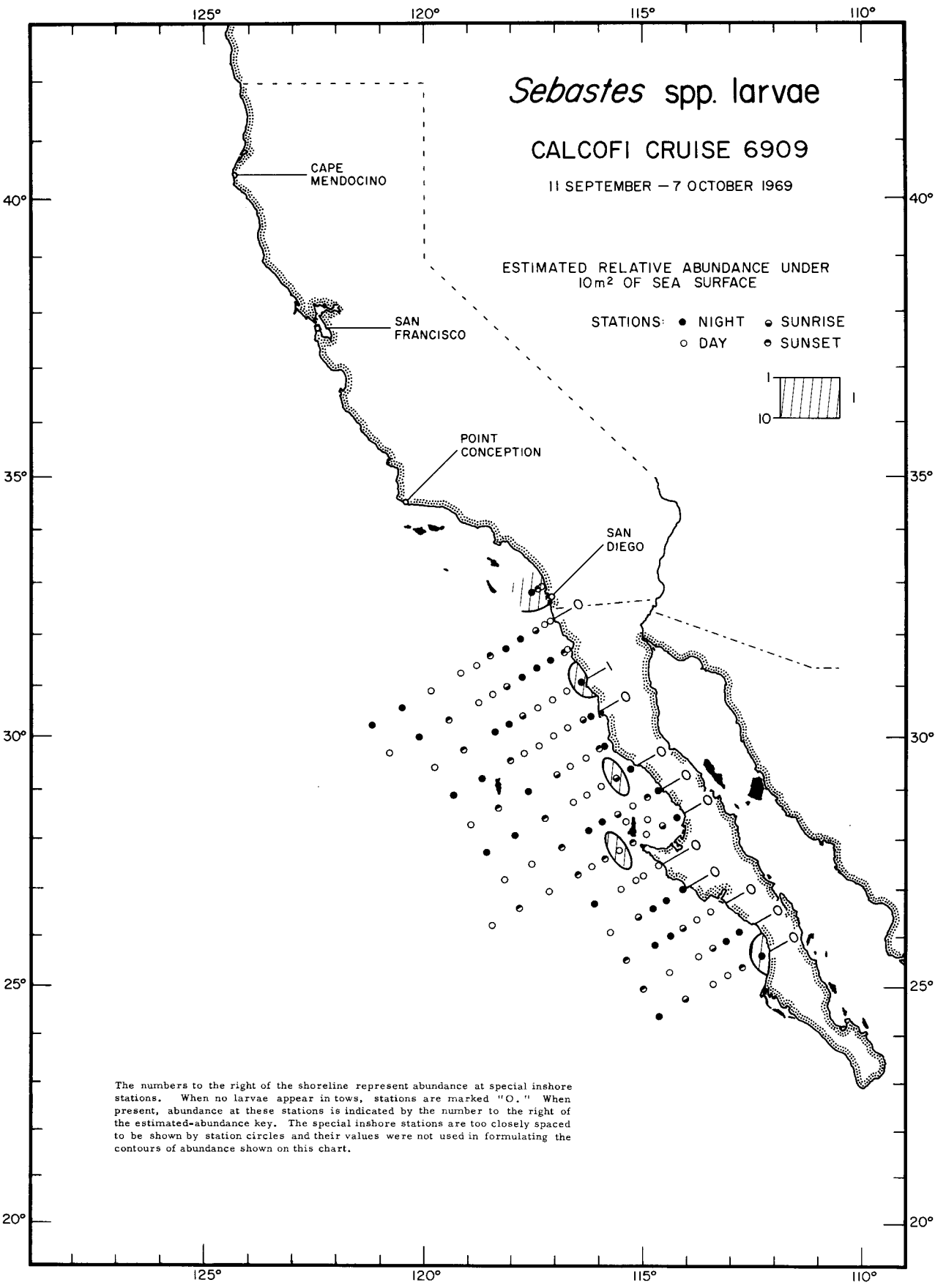
Sebastes spp. larvae

6907



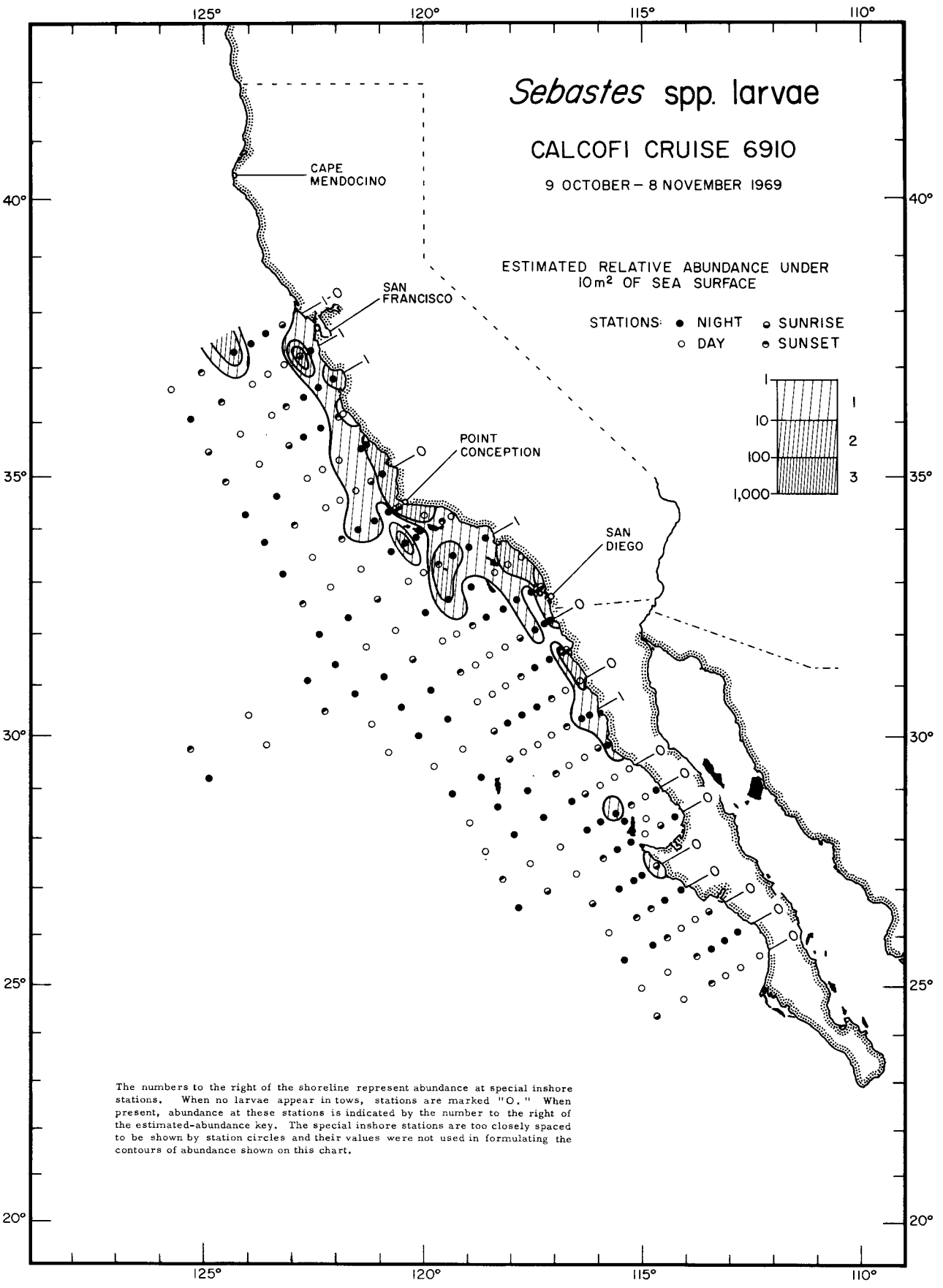
Sebastes spp. larvae

6908



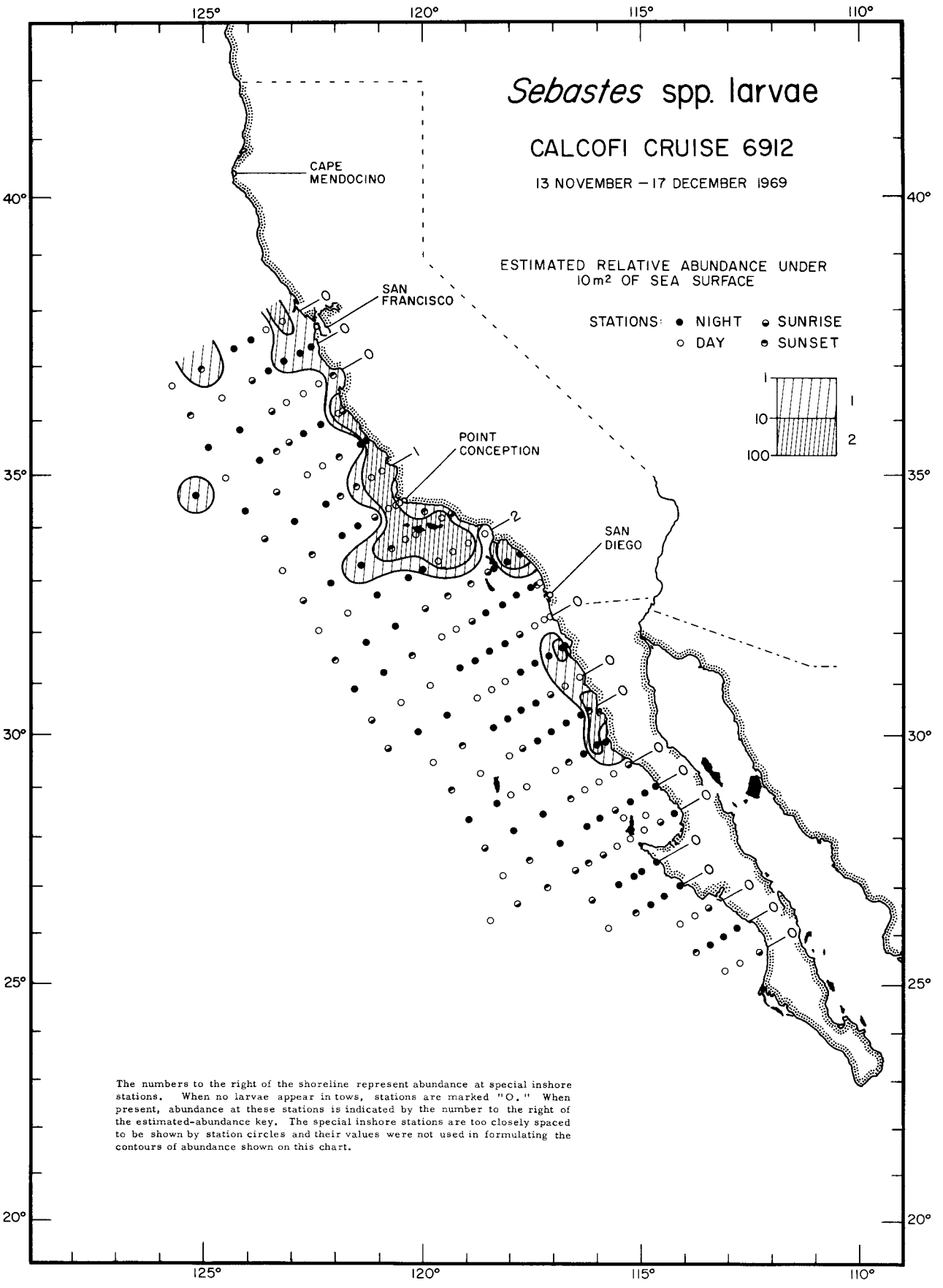
Sebastes spp. larvae

6909



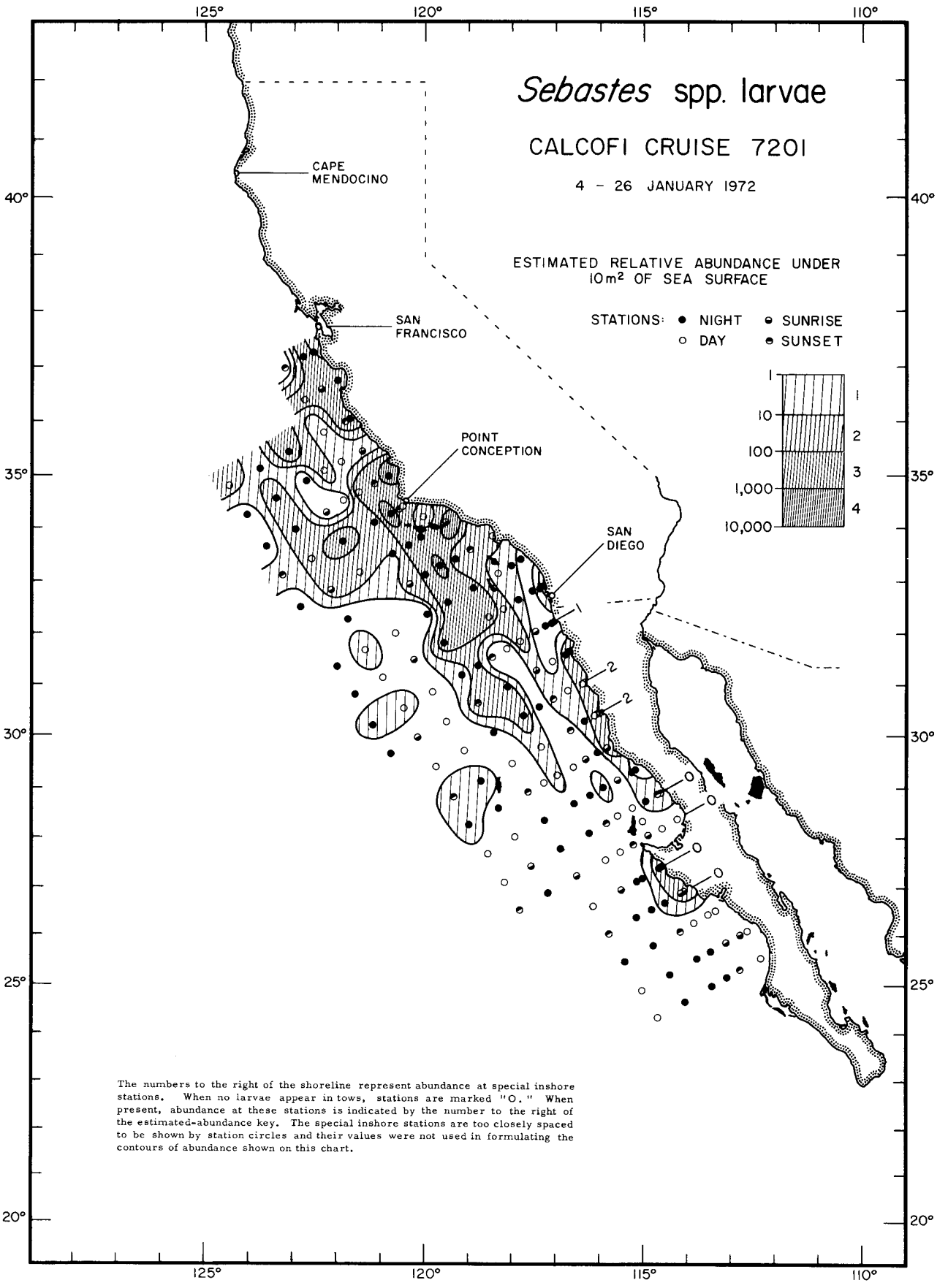
Sebastes spp. larvae

6910



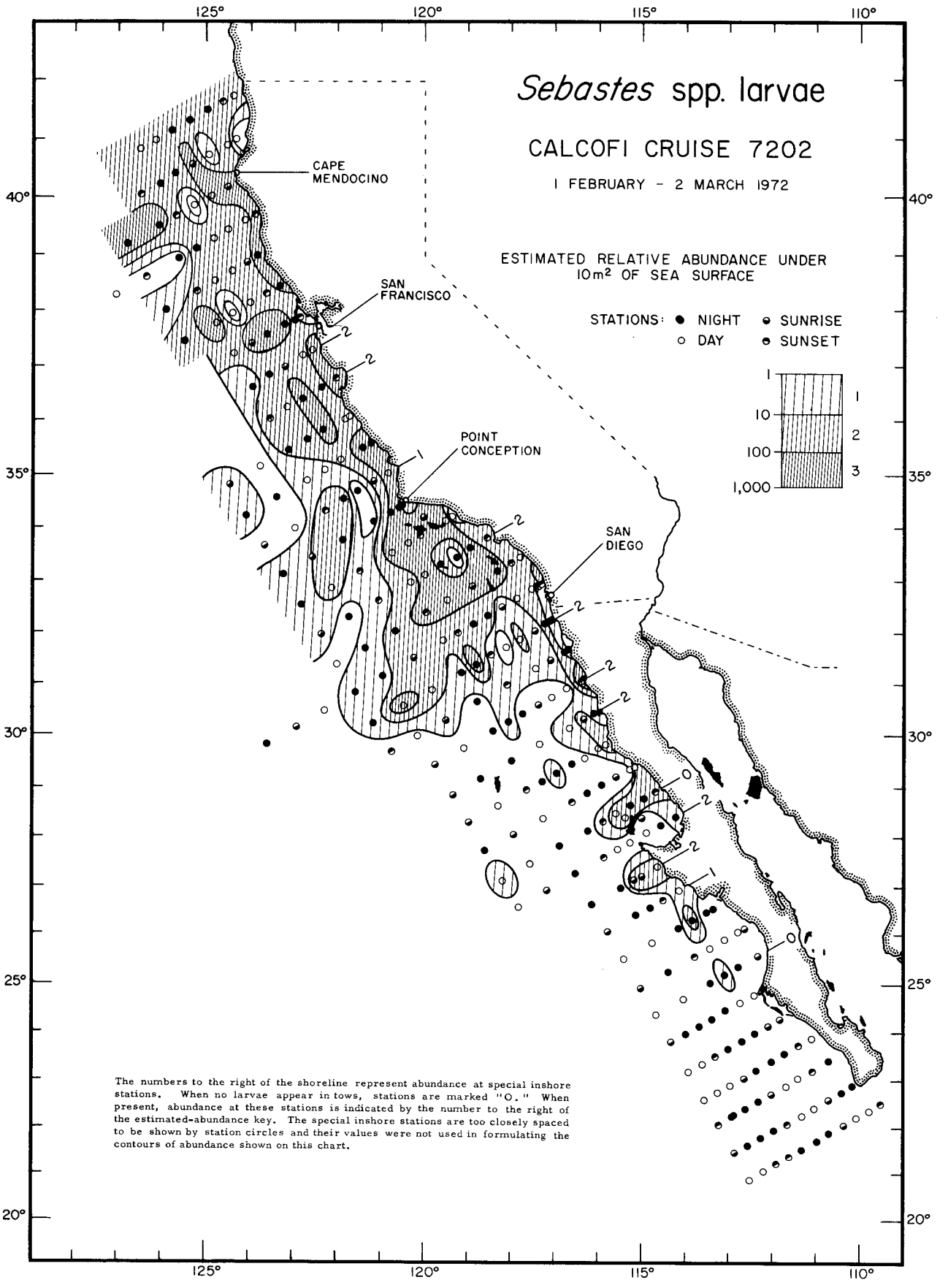
Sebastes spp. larvae

6912



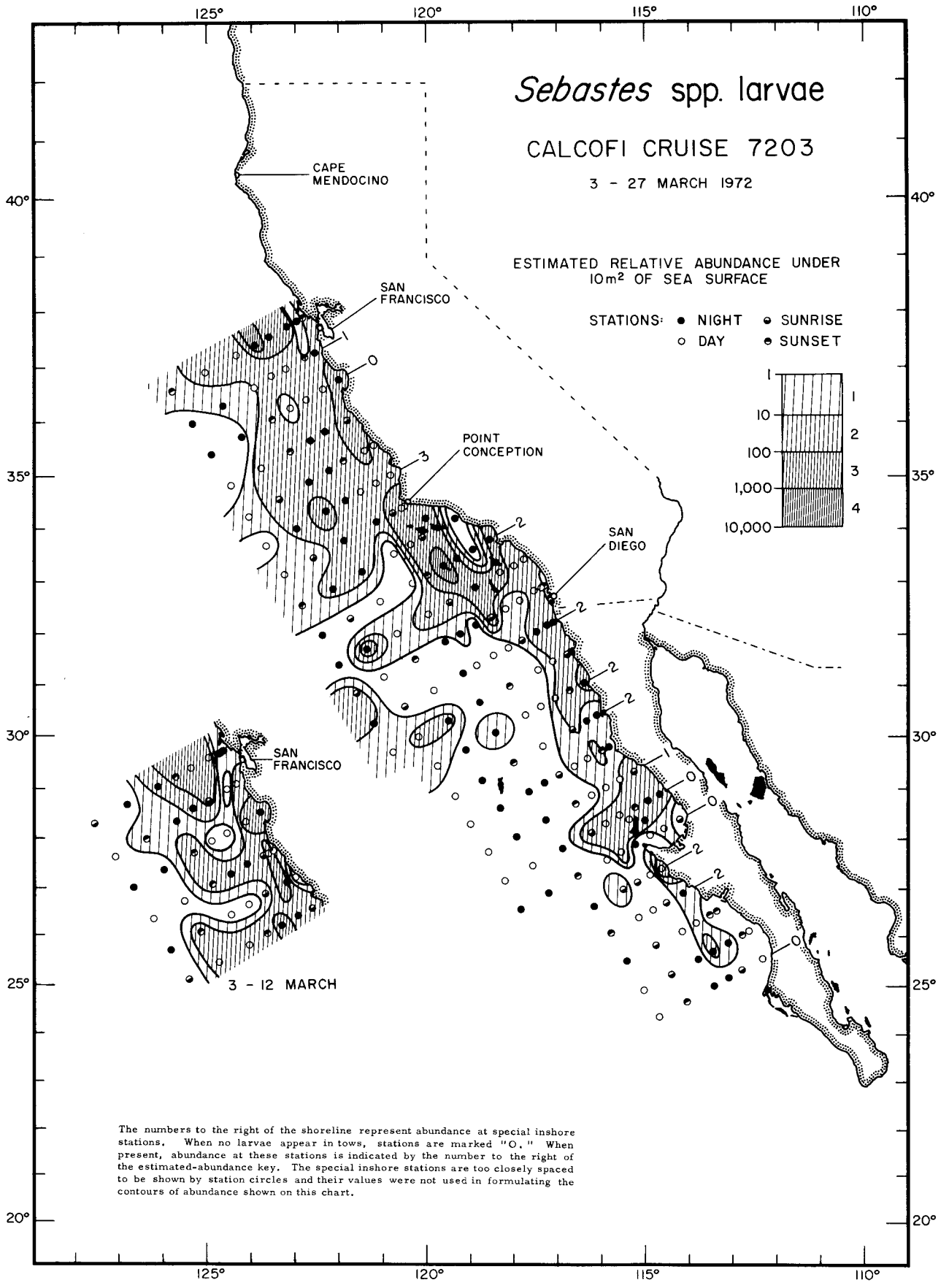
Sebastes spp. larvae

7201



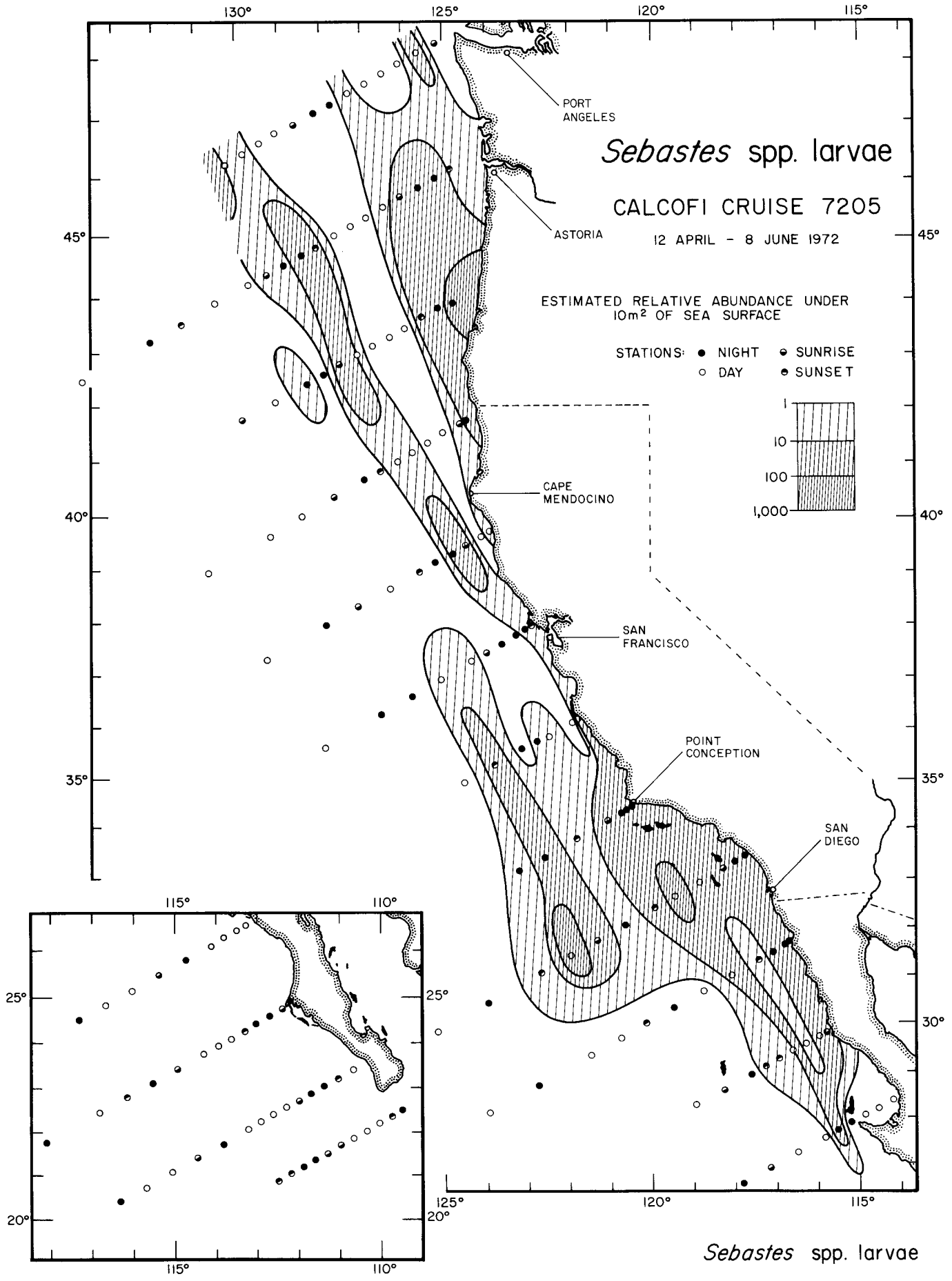
Sebastes spp. larvae

7202



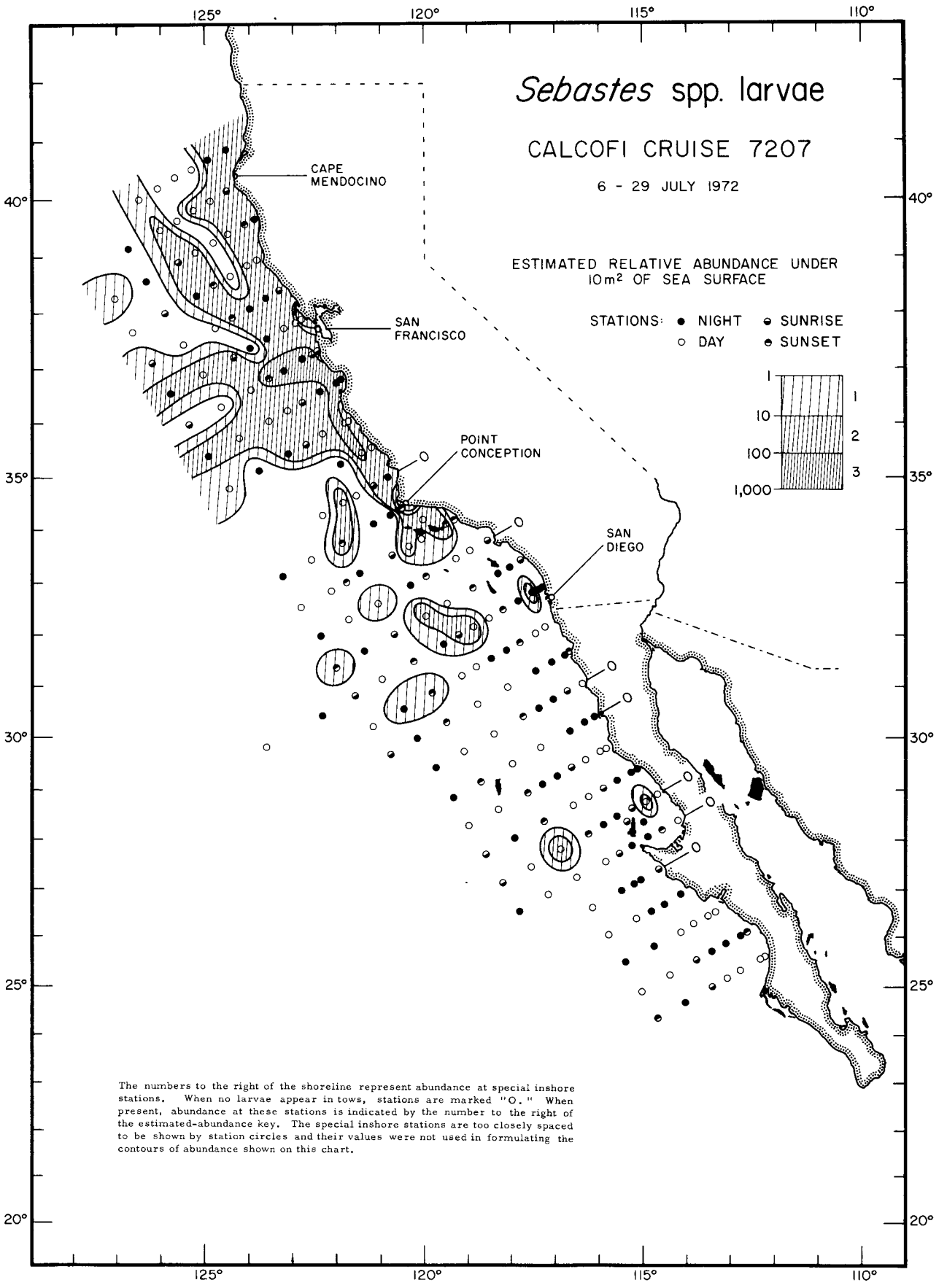
Sebastes spp. larvae

7203



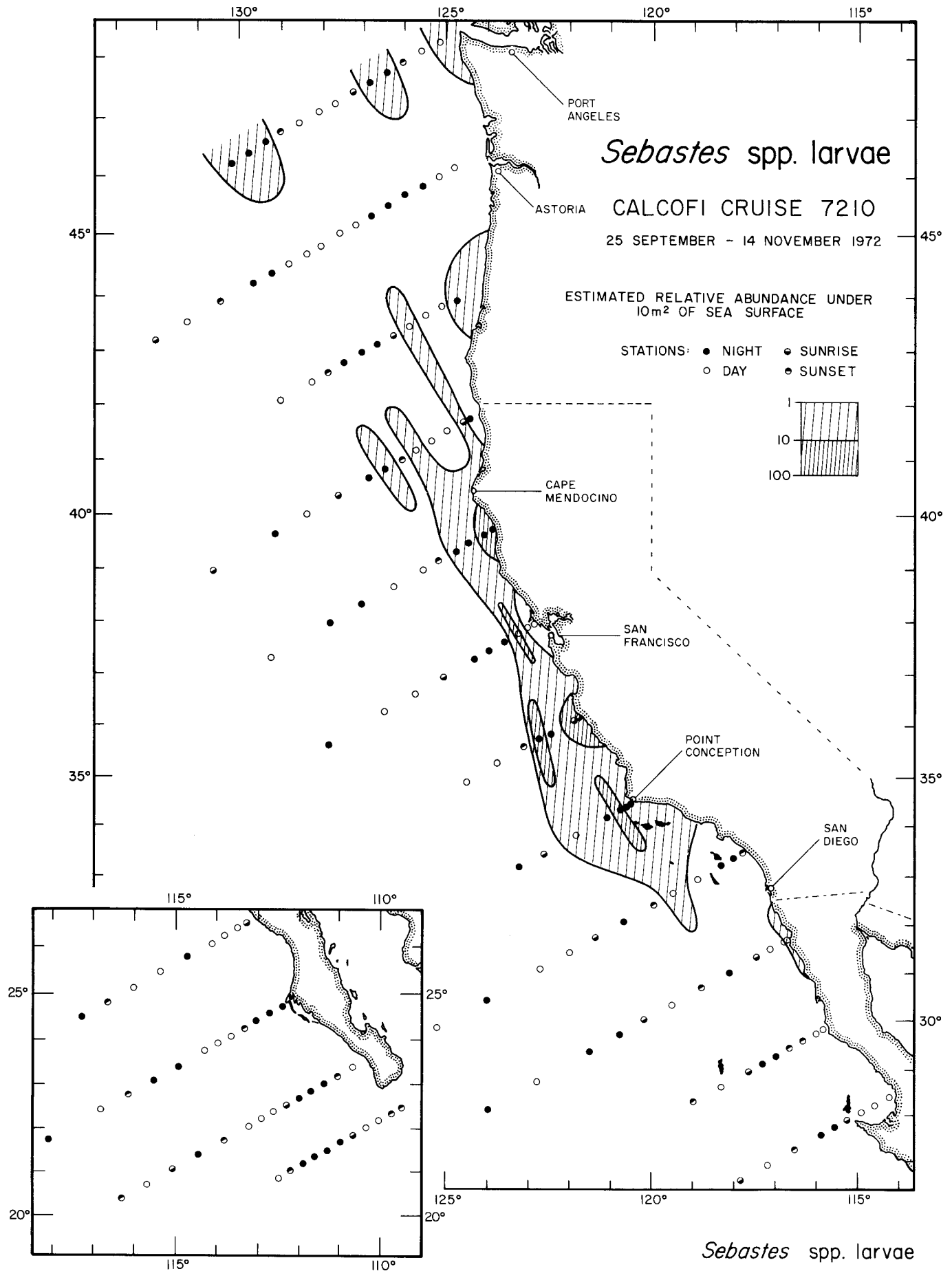
Sebastes spp. larvae

7205



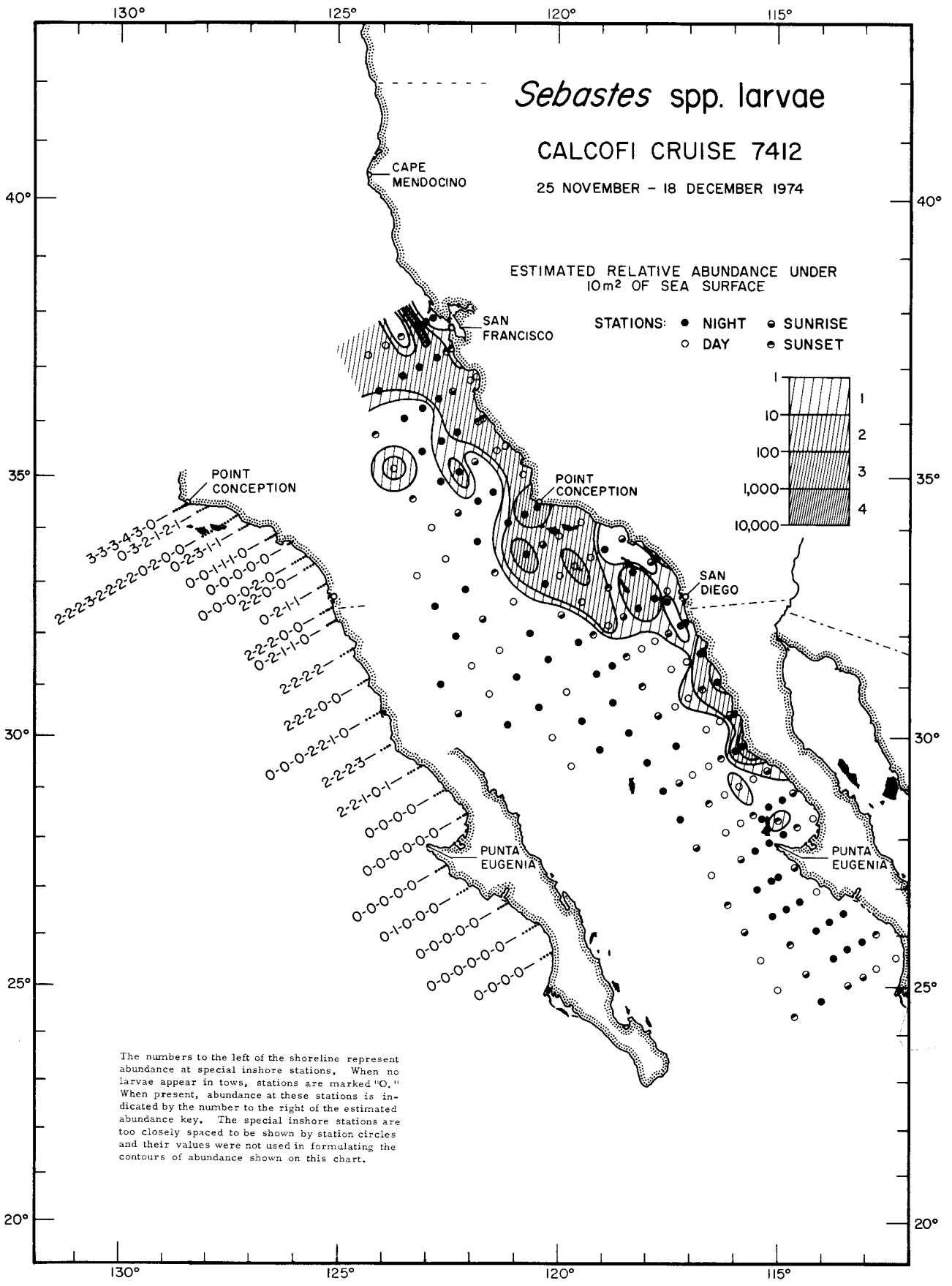
Sebastes spp. larvae

7207



Sebastes spp. larvae

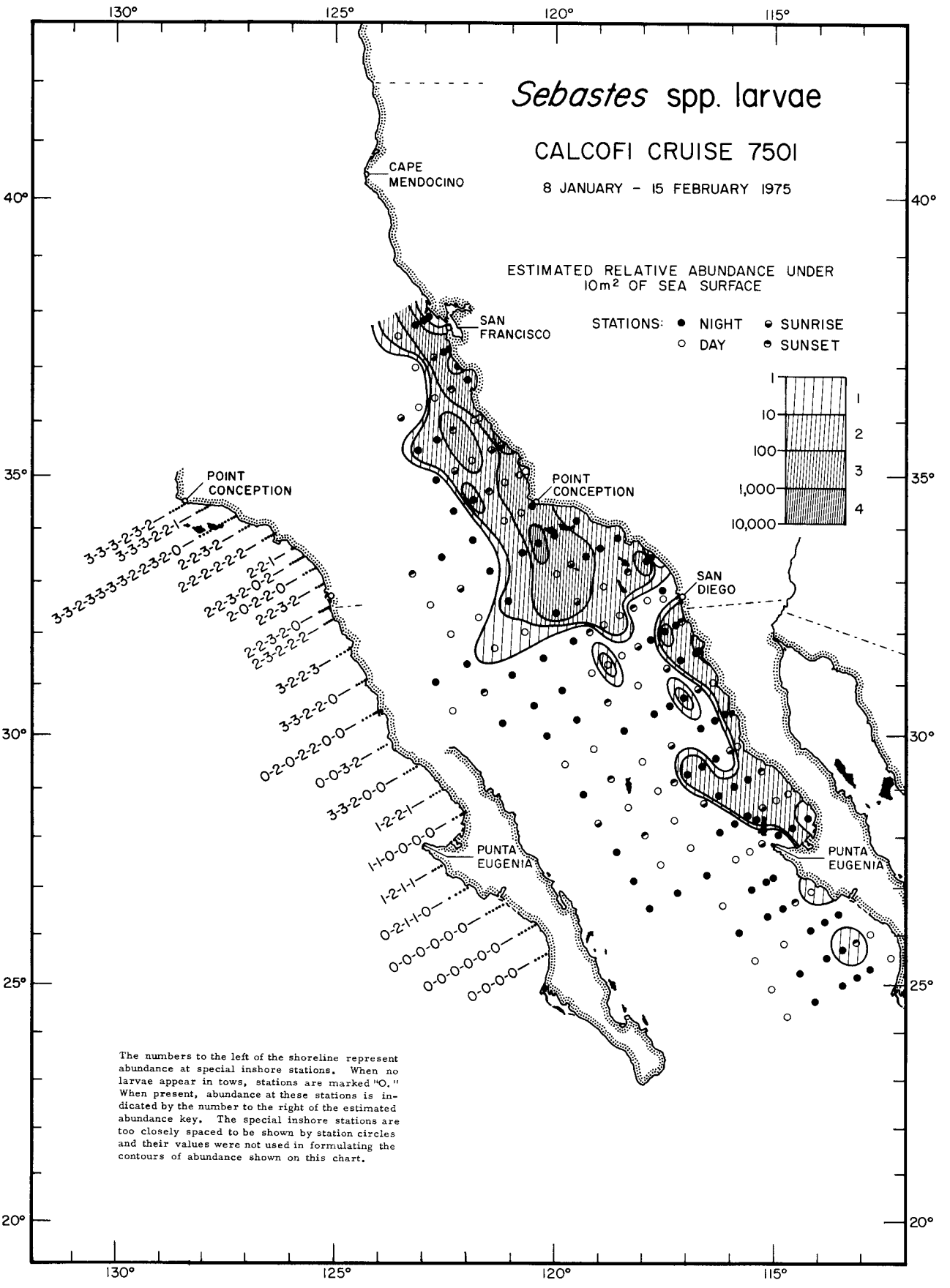
7210



The numbers to the left of the shoreline represent abundance at special inshore stations. When no larvae appear in tows, stations are marked "0." When present, abundance at these stations is indicated by the number to the right of the estimated abundance key. The special inshore stations are too closely spaced to be shown by station circles and their values were not used in formulating the contours of abundance shown on this chart.

Sebastes spp. larvae

7412



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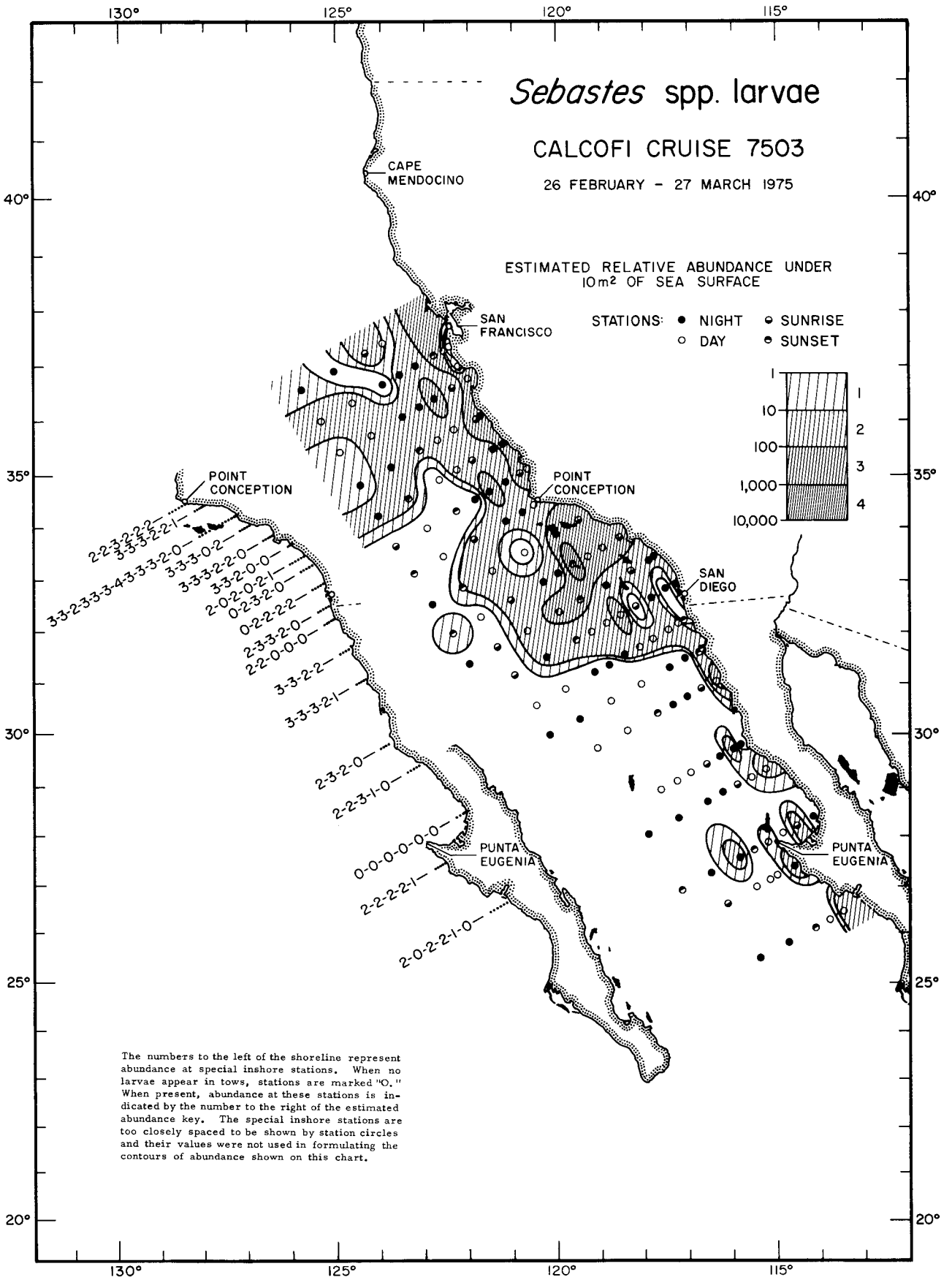
Sebastes spp. larvae

7501



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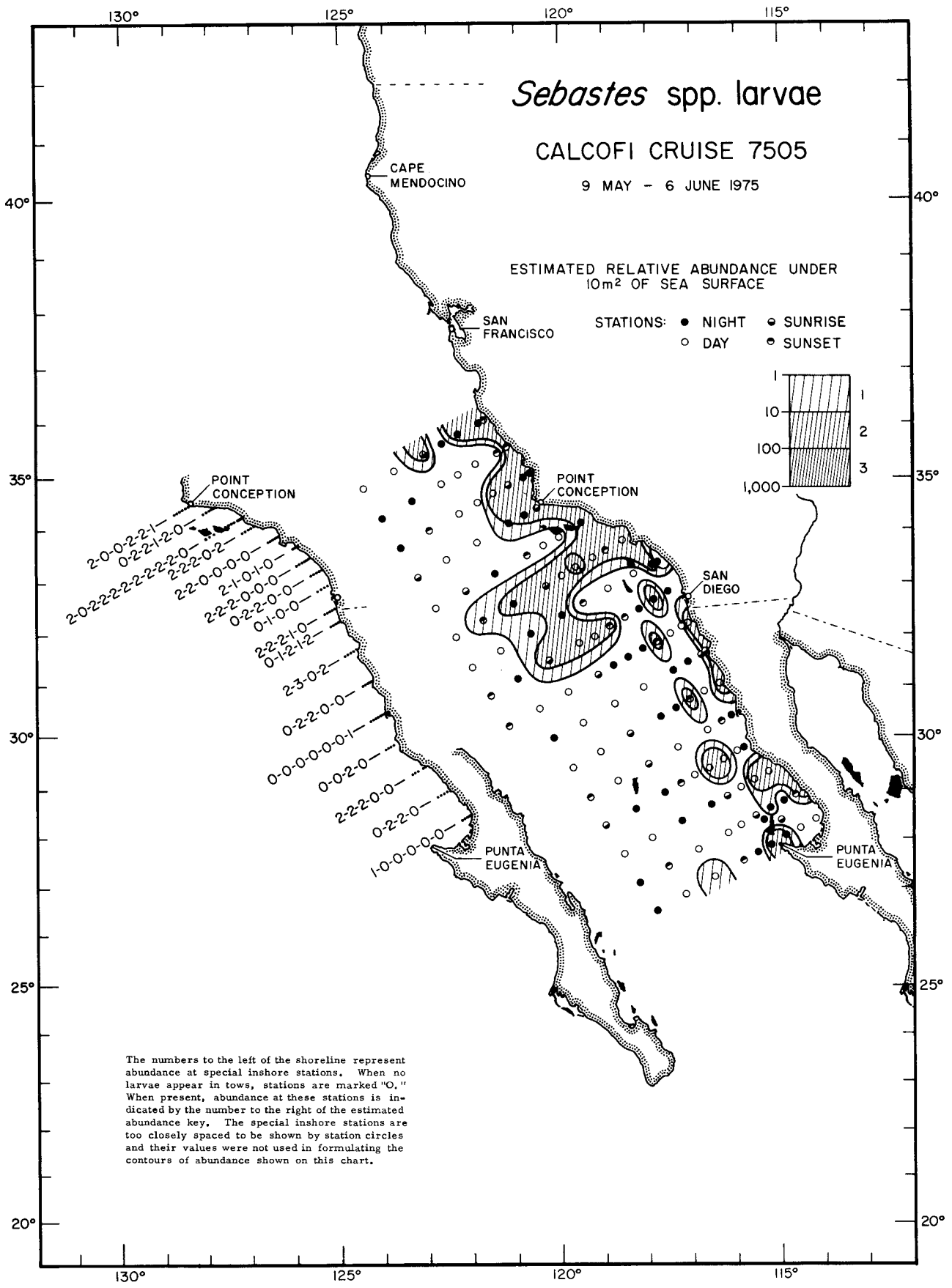
Sebastes - spp. larvae

7503



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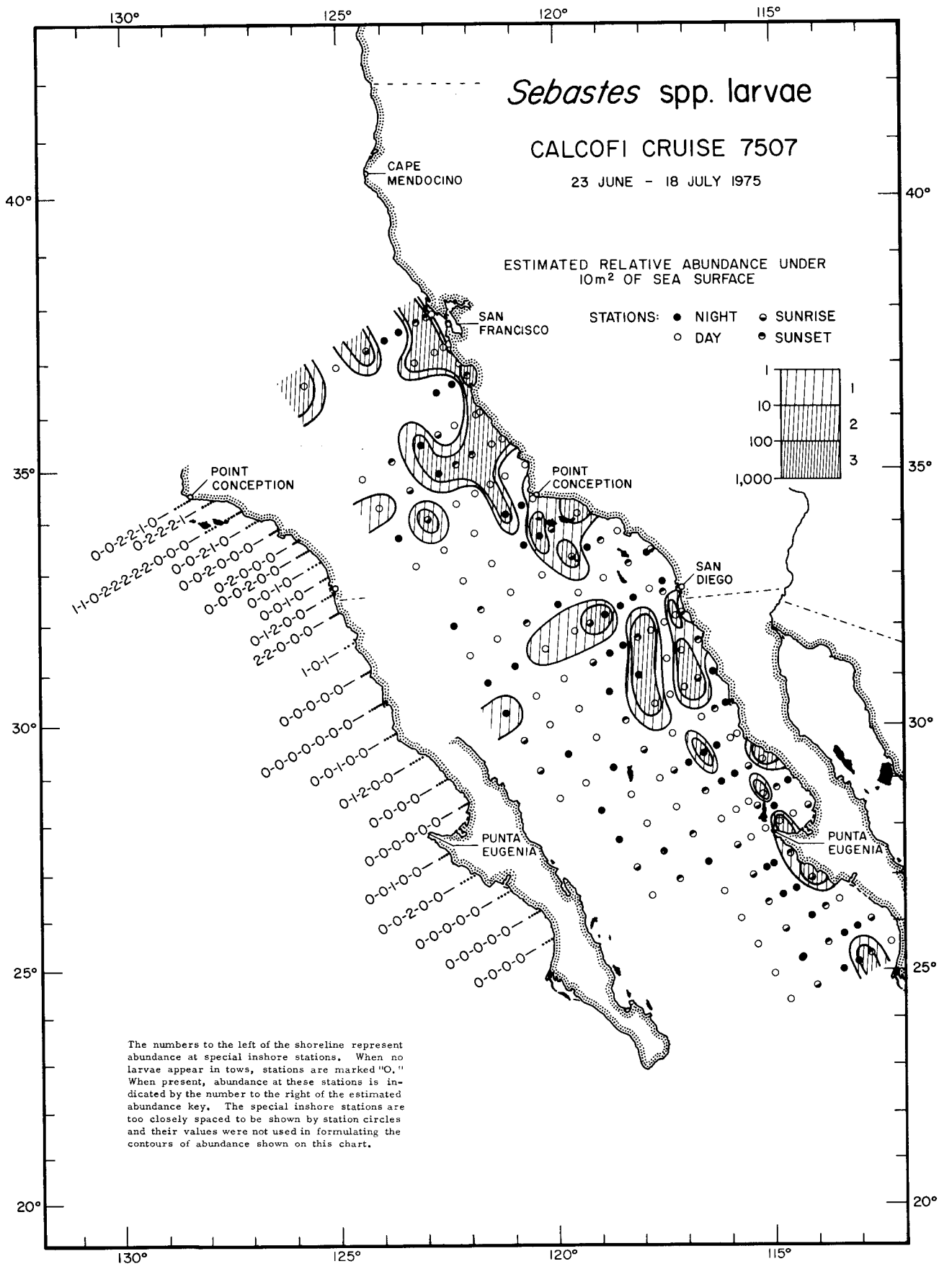
Sebastes spp. larvae

7505



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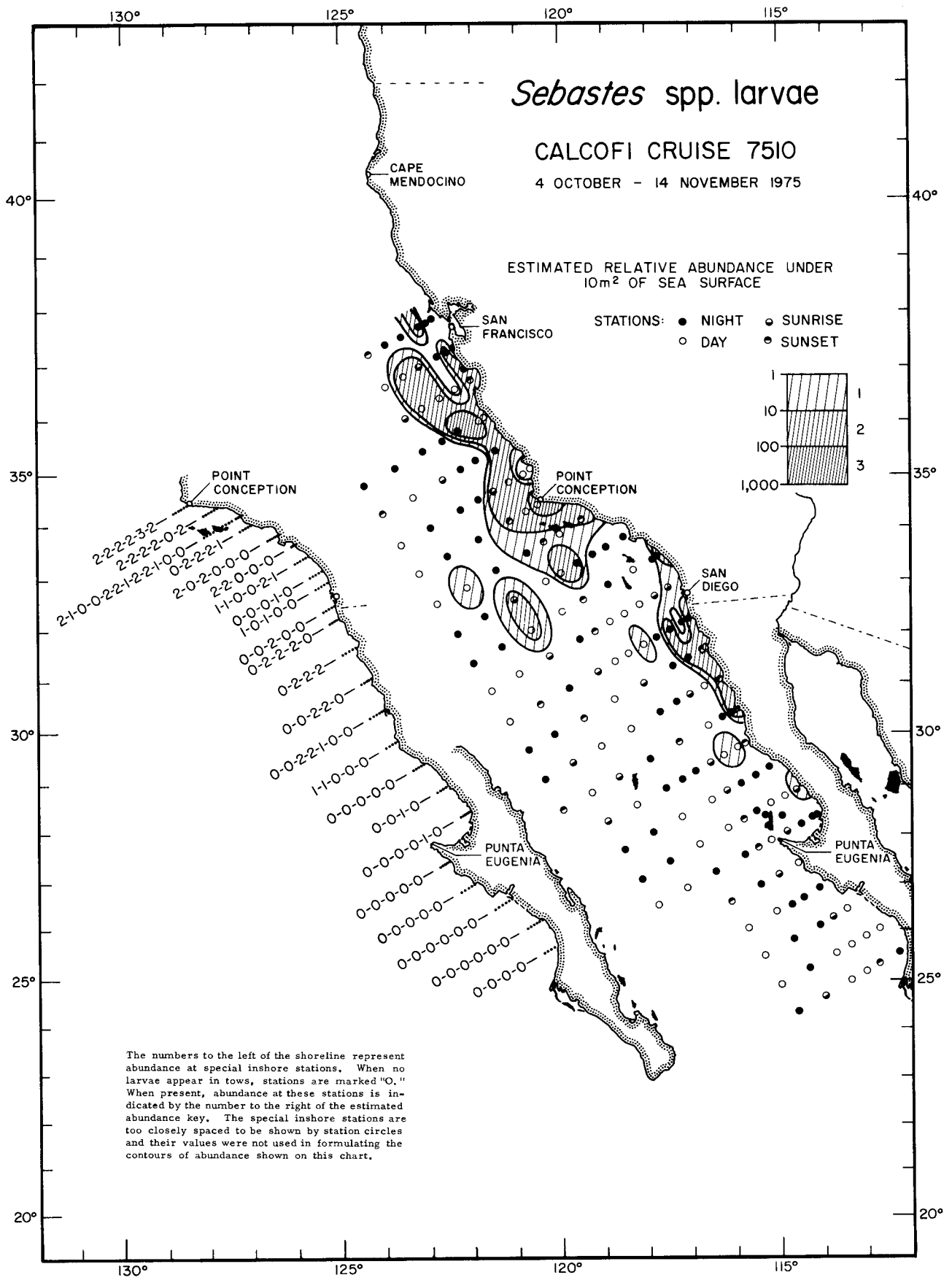
Sebastes spp. larvae

7507



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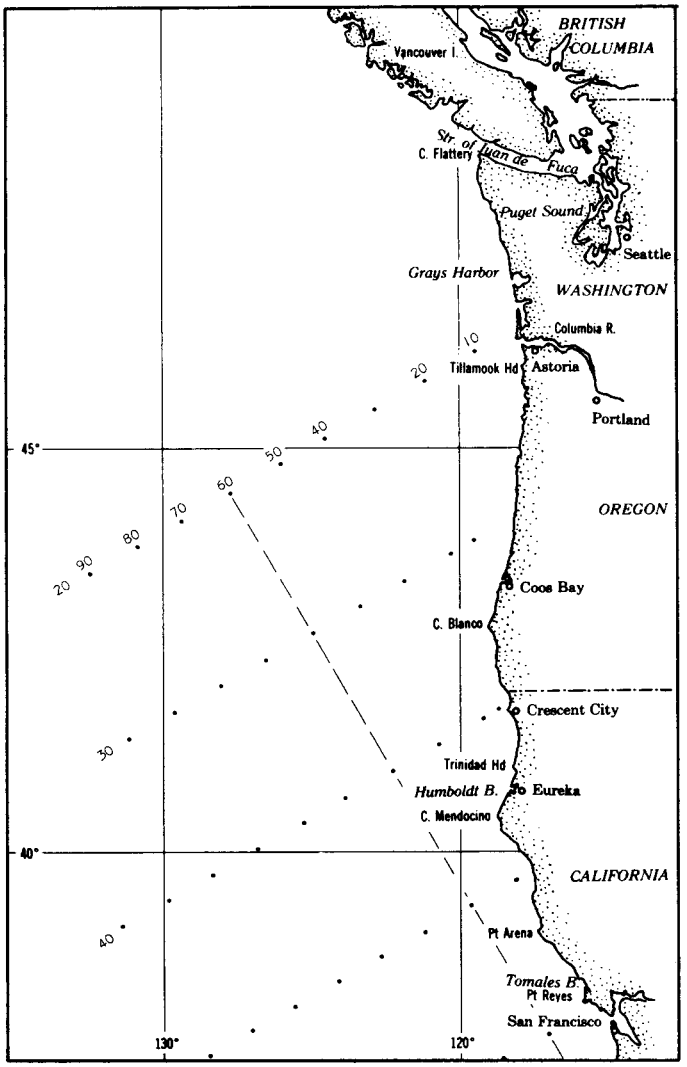
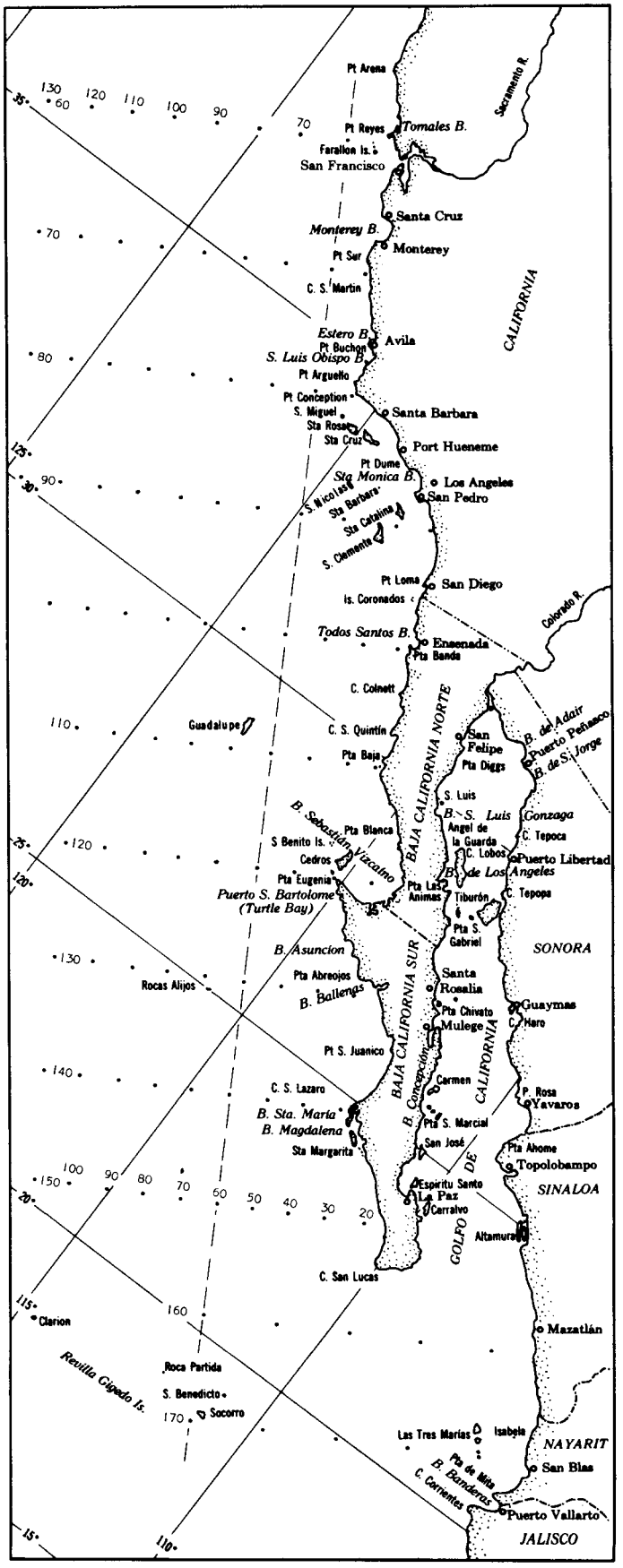
Sebastes spp. larvae

7510





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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