

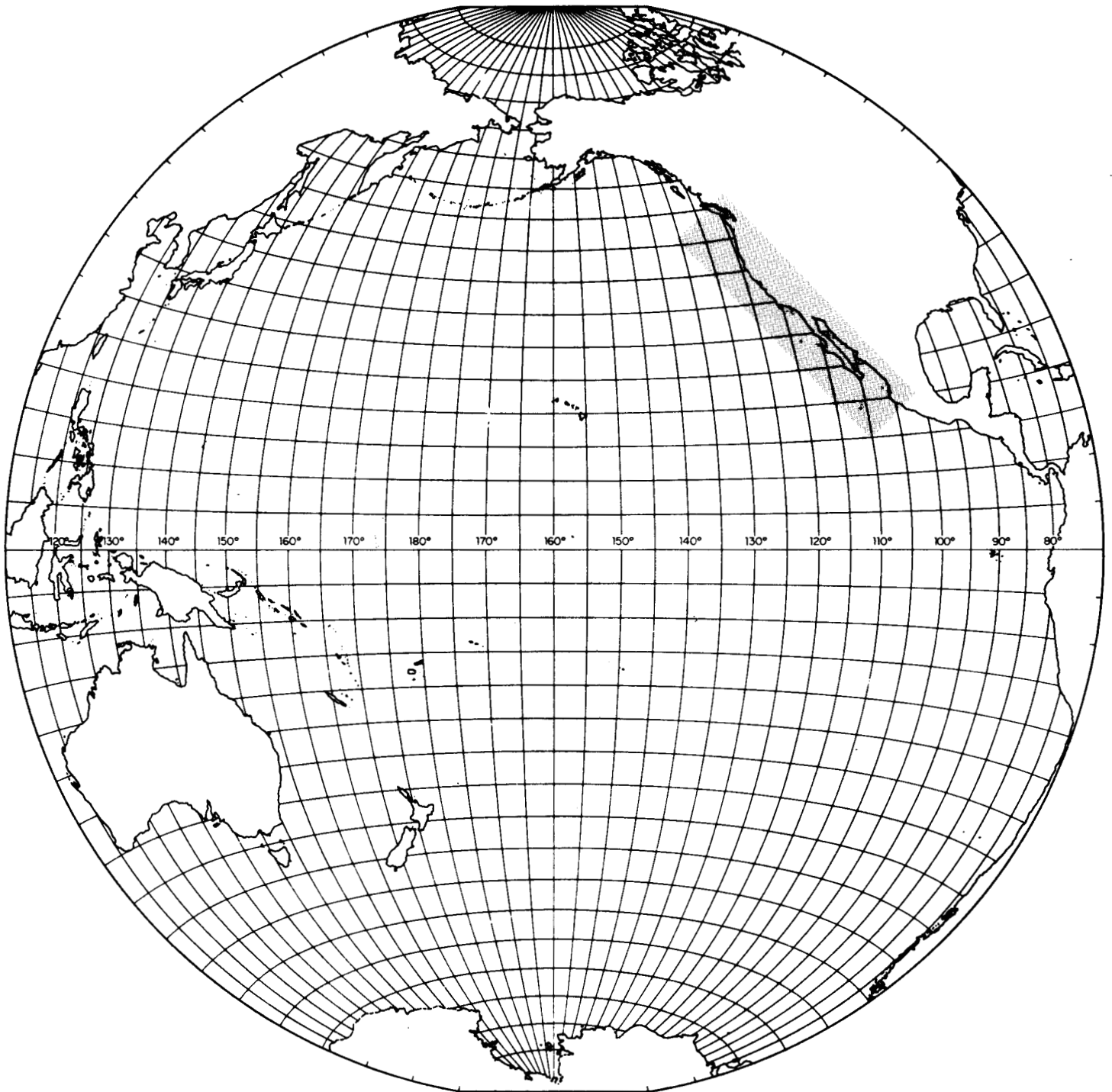
Atlas 23: Ahlstrom, E. H. and H. G. Moser. Distributional atlas of fish larvae in the California current region: flatfishes, 1955-1960. Published June 1975.

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.

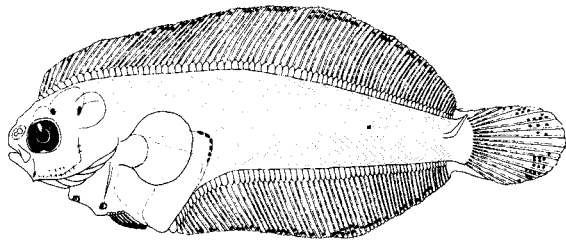
The report for each year usually is published about 7-9 months after the fall cruise, and includes notes about nomenclature changes, etc. The ultimate goal is to update the old ichthyoplankton identifications to current standards; the database is updated as re-identifications for each cruise are completed.

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MARINE RESEARCH COMMITTEE

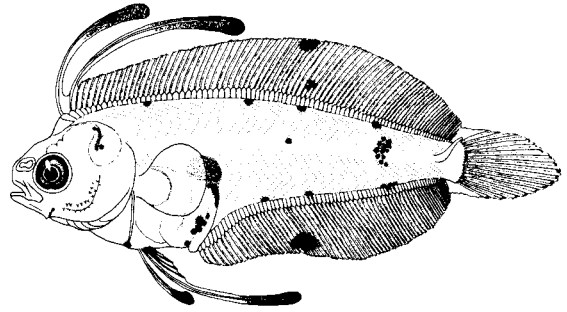


CALIFORNIA COOPERATIVE OCEANIC FISHERIES INVESTIGATIONS

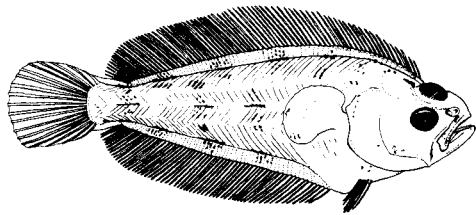
ATLAS No.23



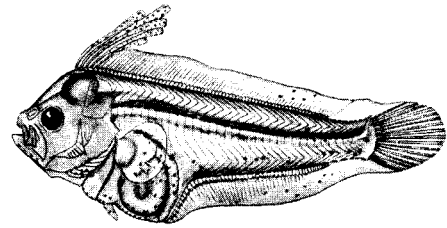
Speckled Sanddab
14.8 mm



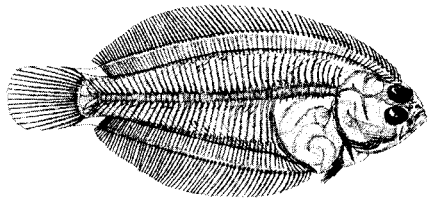
Pacific Sanddab
14.5 mm



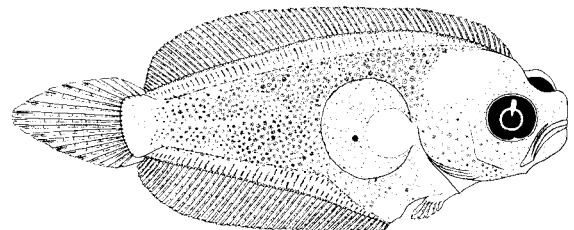
Slender Sole
23.0 mm



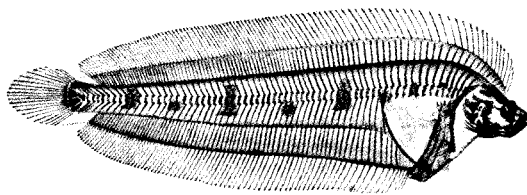
California Halibut
7.0 mm



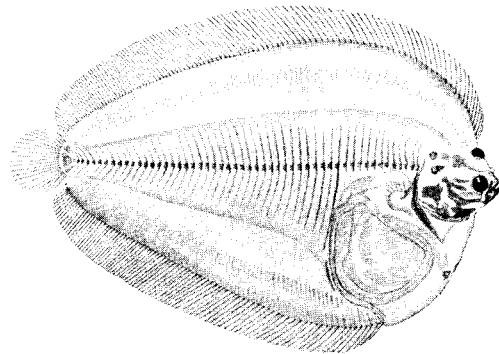
English Sole
20.1 mm



Hornyhead Turbot
8.7 mm



Rex Sole
48.7 mm



Dover Sole
43.4 mm

CALIFORNIA
COOPERATIVE
OCEANIC
FISHERIES
INVESTIGATIONS

Atlas No. 23

STATE OF CALIFORNIA
MARINE RESEARCH COMMITTEE

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UNIVERSITY OF CALIFORNIA, SCRIPPS INSTITUTION OF OCEANOGRAPHY

June, 1975

THE CALCOFI ATLAS SERIES

This is the twenty third 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 Investigations¹, 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 Service²
University of California, Scripps Institution of Oceanography

CalCOFI atlases³ are issued as individual units as they become available. They provide processed physical, chemical and biological measurements of the California Current region. Each number may contain one or more contributions. A general description of the CalCOFI program with its objectives appears in the preface of Atlas No. 2.

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

CalCOFI Atlas Editorial Staff:

Abraham Fleminger and John G. Wyllie, Editors

CalCOFI atlases in this series, through June 1975, 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. 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*, *Stenobranchius 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.

¹Usually abbreviated CalCOFI, sometimes CALCOFI or CCOFI.

²Formerly called U.S. Fish and Wildlife Service, Bureau of Commercial Fisheries.

³For citation this issue in the series should be referred to as CalCOFI Atlas No. 23.

**DISTRIBUTIONAL ATLAS OF FISH LARVAE IN THE
CALIFORNIA CURRENT REGION: FLATFISHES,
1955 THROUGH 1960**

Elbert H. Ahlstrom and H. Geoffrey Moser

CALCOFI ATLAS NO. 23

A. Fleminger and J. G. Wyllie, Editors
Marine Life Research Program
Scripps Institution of Oceanography
La Jolla, California

June, 1975

DISTRIBUTIONAL ATLAS OF FISH LARVAE IN THE CALIFORNIA CURRENT REGION: FLATFISHES, 1955 THROUGH 1960

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Introduction

This atlas is a companion volume to CalCOFI Atlas No. 17 in that the distribution charts are limited to the six-year period, 1955 through 1960. The former atlas dealt with six common mesopelagic fish larvae; this atlas deals with eight kinds of flatfish larvae. These include five of the family Pleuronectidae, *Microstomus pacificus*, *Glyptocephalus zachirus*, *Lyopsetta exilis*, *Parophrys vetulus* and *Pleuronichthys* spp (predominantly *P. verticalis*); and three of the family Bothidae, *Paralichthys californicus*, *Citharichthys stigmaeus* and *Citharichthys* spp.

The distributions are from the samples of sixty-nine monthly CalCOFI cruises made during the years, 1955 through 1960. Collections made on the wide-ranging NORPAC expedition (August 1955) are not included. No surveys were made in November and December, 1960. Occurrences on 5509 and 5511, two multiple occupancy cruises in the southern California channel islands region, are

excluded for *C. stigmaeus*, *C. spp*, *Parophrys vetulus* (5509) and *Pleuronichthys* spp. The abundance of the larvae by month and year is shown in Table 1; a dash indicates exclusion of the data for that time sequence.

For *Citharichthys* spp, *Citharichthys stigmaeus*, and *Lyopsetta exilis*, distribution charts are arranged on a monthly basis; for *Parophrys vetulus*, *Paralichthys californicus*, and *Pleuronichthys* spp, occurrences over a sequence of three successive months are shown in each chart, i.e., January through March, April through June, July through September and October through December. Only one chart per year is presented for *Glyptocephalus zachirus* and *Microstomus pacificus*, which summarizes occurrences from April through July of each year, most records of the two species being limited to these four months.

Distribution charts were prepared for a species when it occurred in five or more collections (monthly) or stations (quarterly). The number of distribution charts prepared for each species is summarized in Table 2; the pagination of the distribution charts is also shown in this table. As is seen in the charts, coverage of the CalCOFI pattern of stations was more extensive during January through July and October, and often was restricted to a portion of the pattern during the remaining four months. Records of larvae not included in distribution charts are summarized in Table 3.

The standard CalCOFI ichthyoplankton hauls are described in a number of the earlier CalCOFI distributional Atlases and in Kramer *et al.* (1972). The average depth of the oblique hauls was approximately 140 meters, depth of water permitting. The tow was taken at a vessel speed of 1½ to 2 knots. A flow meter fastened in the mouth of the net permitted determination of the volume of water strained during a haul. Estimates of abundance of larvae were made comparable between samples by standardizing the counts to the number under ten square meters of sea surface.

The bodies of flatfish larvae are strongly compressed, with the eyes on either side of the head. One eye migrates during a metamorphosis stage that occurs between the larval and juvenile stages. In the illustrations of flatfish larvae included in this atlas, those larvae which face to left are sinistral flatfishes,

whose two eyes will be on the left side of the head after metamorphosis whereas those larvae which face to the right are dextral flatfishes. Simply stated, bothid flatfishes are usually sinistral; pleuronectid flatfishes are dextral.

TABLE 1. Relative abundance of larvae of eight kinds of flatfishes in the California Current region off California and Baja California during 1955-60. (Standard haul summations.)

	Year	01	02	03	04	05	06	07	08	09	10	11	12	Total
<i>Citharichthys stigmaeus</i>	1955	101	92	131	145	83	470	192	-	-	1,048	-	428	2,690
	1956	223	139	90	49	131	304	611	335	134	192	144	177	2,529
	1957	6	102	301	131	162	155	265	18	14	286	176	37	1,653
	1958	204	35	87	60	45	25	54	0	12	14	12	8	556
	1959	11	21	3	23	15	28	118	84	9	58	10	21	401
	1960	21	7	7	13	6	39	56	12	0	50	-	-	211
	Total	566	396	619	421	442	1,021	1,296	449	169	1,648	342	671	8,040
<i>Citharichthys spp.</i>	1955	694	1,418	716	499	2,311	4,042	4,589	-	-	713	-	208	15,190
	1956	150	338	407	432	572	1,652	7,046	8,804	1,299	237	132	34	21,102
	1957	980	2,704	734	262	953	2,470	1,888	2,347	1,328	226	42	14	13,948
	1958	450	1,570	1,394	1,122	175	253	262	223	117	242	49	31	5,888
	1959	146	296	246	645	240	437	251	361	850	387	4	25	3,888
	1960	680	217	520	157	228	1,783	1,017	605	738	696	-	-	6,641
	Total	3,100	6,543	4,017	3,117	4,479	10,636	15,053	12,340	4,332	2,501	227	312	66,657
<i>Lyopsetta exilis</i>	1955	0	38	90	68	174	98	42	-	0	0	0	0	510
	1956	26	39	176	394	119	120	74	7	0	0	0	0	955
	1957	0	61	199	225	266	101	56	6	0	0	3	3	920
	1958	28	6	19	48	45	63	45	0	1	0	0	2	257
	1959	6	22	34	68	103	4	0	0	0	0	0	0	237
	1960	15	14	27	109	10	6	12	0	2	0	-	-	195
	Total	75	180	545	912	717	392	229	13	3	0	3	5	3,074
<i>Paralichthys californicus</i>	1955	27	49	17	0	9	34	134	-	27	0	0	5	302
	1956	1	21	32	6	0	62	109	62	0	8	29	0	330
	1957	12	22	85	11	27	9	74	31	6	18	8	0	303
	1958	59	81	43	12	15	27	7	4	5	6	0	0	259
	1959	77	37	24	35	26	9	12	27	1	0	0	3	251
	1960	6	76	23	35	5	8	50	8	2	4	-	-	217
	Total	182	286	224	99	82	149	386	132	41	36	37	8	1,662
<i>Parophrys vetulus</i>	1955	44	72	73	30	39	27	24	-	-	40	0	13	362
	1956	0	30	82	82	60	45	66	52	2	0	0	0	419
	1957	0	31	98	96	46	22	3	16	2	0	0	0	314
	1958	16	13	58	124	67	25	9	0	3	0	0	0	315
	1959	53	6	17	98	32	2	15	0	0	0	0	0	223
	1960	11	17	65	36	3	5	0	0	0	0	-	-	137
	Total	124	169	393	466	247	126	117	68	7	40	0	13	1,770

TABLE 1. (Continued)

	Year	01	02	03	04	05	06	07	08	09	10	11	12	Total
<i>Pleuronichthys</i> spp.	1955	17	112	22	22	196	162	216	-	-	173	-	46	966
	1956	0	127	65	154	129	109	270	209	47	3	2	0	1,115
	1957	10	12	40	50	85	152	69	128	26	3	7	0	582
	1958	12	24	0	15	27	30	25	6	9	14	3	0	165
	1959	3	6	6	22	20	12	15	23	21	5	0	0	133
	1960	11	18	26	37	3	5	28	18	46	8	-	-	200
	Total	53	299	159	300	460	470	623	384	149	206	12	46	3,161
<i>Glyptocephalus</i> <i>zachirus</i>	1955	0	0	0	0	3	27	0	-	0	0	3	0	33
	1956	0	0	0	14	0	10	16	0	0	0	0	0	40
	1957	0	0	0	16	19	9	14	0	0	0	0	0	58
	1958	0	0	0	15	20	30	42	0	0	0	0	0	107
	1959	0	0	0	9	14	3	3	0	0	0	0	0	29
	1960	2	0	0	34	0	0	0	0	0	0	0	0	36
	Total	2	0	0	88	56	79	75	0	0	0	3	0	303
<i>Microstomus</i> <i>pacificus</i>	1955	0	0	3	18	26	94	26	-	3	3	3	0	176
	1956	0	0	0	18	160	28	6	0	0	0	0	0	212
	1957	0	0	0	21	93	42	14	0	0	0	0	0	170
	1958	0	0	0	6	16	30	26	0	0	0	0	0	78
	1959	0	0	0	15	28	20	14	3	0	0	0	0	80
	1960	0	2	0	66	3	8	3	0	0	0	-	-	82
	Total	0	2	3	144	326	222	89	3	3	3	3	0	798

TABLE 2. Number and pagination of distribution charts.

Species or genus	Type of chart	Year							Total	Chart numbers
		1955	1956	1957	1958	1959	1960			
<i>Citharichthys stigmaeus</i>	M	9	12	9	9	7	4	50	2 to 51	
<i>Citharichthys</i> spp.	M	9	12	11	12	10	10	64	52 to 115	
<i>Lyopsetta exilis</i>	M	6	6	6	4	3	3	28	116 to 143	
<i>Paralichthys californicus</i>	Q	3	3	3	2	3	3	17	144 to 160	
<i>Parophrys vetulus</i>	Q	4	3	2	2	3	2	15	161 to 175	
<i>Pleuronichthys</i> spp.	Q	4	3	3	4	3	3	20	176 to 195	
<i>Glyptocephalus zachirus</i>	O	1	1	1	1	1	1	6	196 to 201	
<i>Microstomus pacificus</i>	O	1	1	1	1	1	1	6	202 to 207	

M—Monthly, Q—Quarterly, O—Other (i.e., includes four months, April through July).

TABLE 3. Record of stations containing one to four positive hauls per cruise. (These data do not appear in the distribution charts.)

Category	Year	Cruise	Station	No. of larvae	Category	Year	Cruise	Station	No. of larvae						
<i>Citharichthys stigmaeus</i>	1957	5701	103.40	6	<i>Lyopsetta exilis</i> (cont'd)	1959	5901	90.37	3						
			110.33	6				5903	83.43	11					
			110.35	3					87.35	9					
			118.30	3					90.50	11					
			118.35	6					100.30	3					
								5712	80.60	22		5906	77.70	2	
							80.90	3			87.40	2			
							83.90	9	1960	6002	73.53	3			
							90.80	3					87.35	3	
		1958	5811				80.51	3					87.40	6	
							80.55	3					93.35	3	
							80.60	3				6005	83.43	3	
				83.60		3					87.55		2		
				80.51		2				93.30	3				
				80.60		3				103.30	2				
		83.60	3			6006	73.55	3							
	1959	5903		90.45			3				87.35		3		
			5909				90.65	3			6007	60.55	3		
							93.30	6					70.55	3	
							77.53	2				100.35	3		
				80.55			3			117.40		3			
				90.70		5			113.30	2					
		5912		77.55		9	1955	5512	120.40	5					
				80.52		6		1956	5610	80.55	2				
				82.47		3					90.28	6			
				90.37		3					5611	93.27	29		
	1960	6002		77.70		4				1957	5710	120.35	7		
				87.70		3							137.23	7	
			6003			80.80	3						137.35	4	
						87.60	2				5711	97.30	8		
						93.28	2				5807	83.40	3		
			6004			67.55	10					93.27	4		
				93.55		3		1958	5808	120.40	4				
		6005				77.55	3			5809	90.28	5			
						87.35	3			5810	87.35	3			
						87.35	5				93.30	3			
				87.45		2			1959	5912	87.35	3			
			90.70	3			1960			6010	83.40	4			
		93.35	2	<i>Parophrys vetulus</i>		1955		5507		117.26	9				
	<i>Citharichthys</i> spp.	1957	5712					80.51		2			117.35	6	
										80.55	9			120.25	4
										97.32	3			120.30	5
1959					5911				87.35	2		1957	5707	110.33	3
								93.35	2				5708	115.30	10
				5912			82.47	3					117.30	3	
		83.40	16						118.25	3					
		90.28	3					5709	110.33	2					
		93.35	3			1958	5807	40.38	3						
<i>Lyopsetta exilis</i>	1956	5601	110.33	2				80.51	3						
				117.26	3				83.43	3					
				118.39	10				5809	110.33	3				
				120.30	11		<i>Pleuronichthys</i> spp.	1956	5610	90.37	3				
				115.35	4						5611	93.27	2		
				120.35	3				1957	5710	119.33	3			
1957	5708		115.35	6						5711	87.55	3			
			87.55	3							97.30	4			
			80.55	3		1959				5910	120.35	5			
1958	5801		60.52	25	1960		6010	97.30		5					
			87.55	3							117.30	3			
			80.55	6					5511	87.55	3				
			82.47	6				1960	6001	63.55	2				
			100.45	4			<i>Glyptocephalus zachirus</i> <i>Microstomus pacificus</i>		1955	5503	83.60	3			
			120.30	6							5509	83.60	3		
	120.50	3			5510	97.32				3					
	90.28	1			5511	90.50				3					
	5809		80.55	2	1959	5908				77.55	3				
	5812		82.47	3		1960		6002		80.60	2				
	1959	5901													

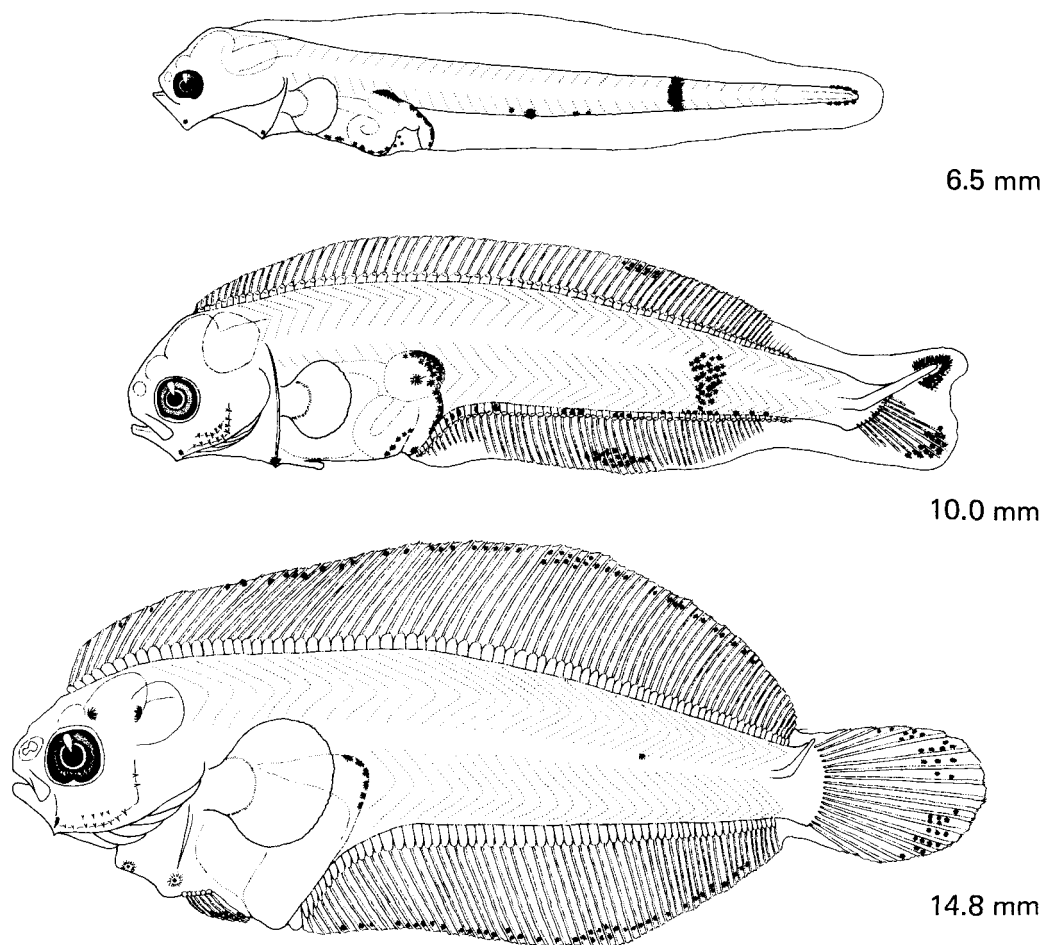


Figure 1. Speckled sanddab, *Citharichthys stigmaeus* (Jordan and Gilbert)

Larvae of the speckled sanddab, *Citharichthys stigmaeus*, Family Bothidae (Figure 1: Distribution Charts 2-51)

Larvae of three species of *Citharichthys* are illustrated in Ahlstrom (1965): 6.5, 10.0 and 14.75 mm specimens of *C. stigmaeus*; 6.9, 10.0 and 14.5 mm specimens of *C. sordidus*; 6.2, 9.0 and 15.3 mm specimens of *C. xanthostigma*. In *Citharichthys* both eyes become located on the left side of the head (sinistral). Larvae of *C. stigmaeus* larger than about 6 mm can be positively identified by the lack of two elongated dorsal rays that develop on the back of the head of 5 to 6 mm specimens of the other two species. Larvae of *C. fragilis* (not illustrated as yet in literature) also develop two elongated dorsal rays.

As noted above, the records of *C. stigmaeus* are for specimens about 6 mm and larger. Specimens as large as 37 mm are occasionally taken in the plankton, usually offshore. Al-

though specimens of this species were obtained in all months, largest numbers were taken in June and July. *C. stigmaeus* was commonly taken on 5509 and 5511, when a grid of closely spaced stations were occupied in the southern California channel islands area on lines 83, 85, 87 and 90 out to station 60; charts are not shown for these special cruises. On cruise 5509 two vessels separately occupied the grid twice, and on cruise 5511, one vessel occupied the grid twice. The number of occurrences and standardized counts of larvae of *C. stigmaeus* for these six coverages of the same grid are as follows: 5509—Black Douglas - I, 24 occurrences, 261 larvae; 5509—Black Douglas - II, 19 occurrences, 243 larvae; 5509—Paolina T - I, 22 occurrences, 194 larvae; 5509—Paolina T - II, 31 occurrences, 424 larvae; 5511—Paolina T - I, 27 occurrences, 191 larvae; 5511—Paolina T-II, 36 occurrences, 278 larvae.

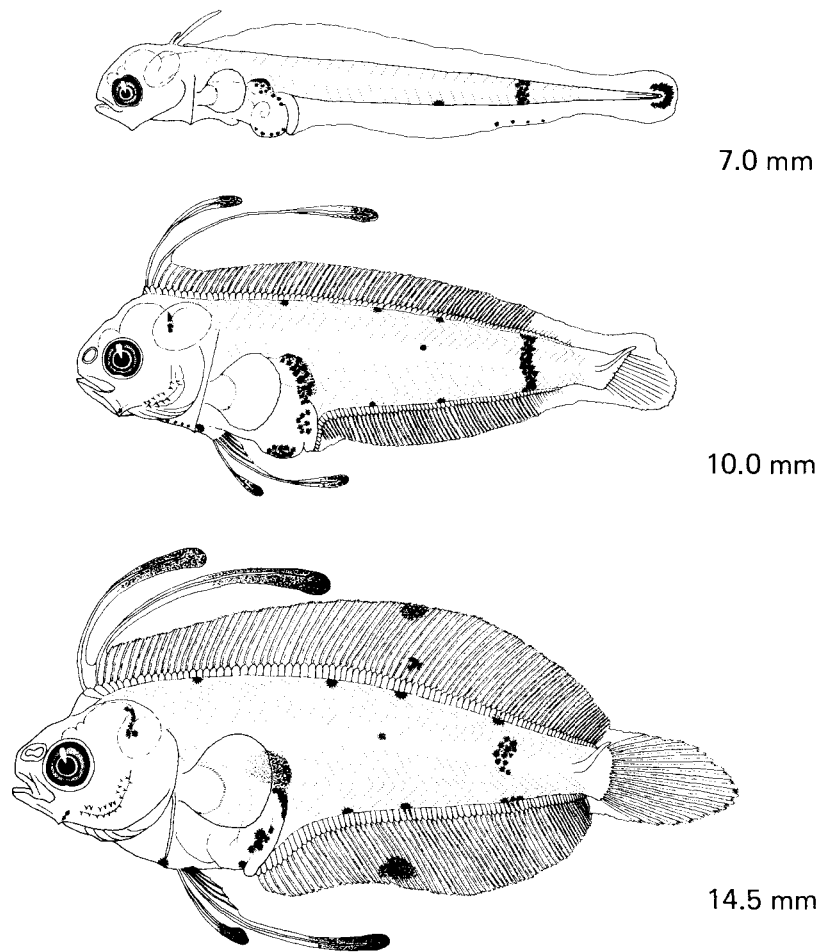


Figure 2. Pacific sanddab, *Citharichthys sordidus* (Girard)

Larvae of other sanddabs, *Citharichthys* spp, Family Bothidae (Figure 2: Distribution Charts 52-115)

There are four species of *Citharichthys* that are common in the California Current region off California and Baja California: *C. sordidus*, *C. stigmaeus*, *C. xanthostigma*, and *C. fragilis*. All except *C. stigmaeus* develop two elongated, ornamented rays at the beginning of the dorsal fin and two correspondingly long ornamented rays in the pelvic fins; these rays first form on larvae about 5 mm long. Larvae smaller than 5 mm of the four species are so similar in appearance that they cannot be routinely separated and thus are recorded simply as *Citharichthys* spp. *C. stigmaeus* larvae larger than 6 mm can be separated readily from larvae of the other three species. Larger larvae of all four species can be identified by using a combination of pigment characters and meris-

tic counts. Since the four species have somewhat different distributional patterns, the location of capture has to be taken into consideration when making identifications. *C. sordidus* and *C. stigmaeus* are the common species off California and are distributed as far north as Alaska. *C. xanthostigma* and *C. fragilis* occur mostly off Baja California and in the Gulf of California. Larvae of *C. xanthostigma* are sometimes taken off southern California but we have no records for *C. fragilis* from this area.

Larvae of the four species of *Citharichthys* comprise over 87% of all flatfish larvae taken on CalCOFI surveys. Larvae are collected during all months, but in largest numbers during June, July and August. They occur along the extent of the CalCOFI sampling pattern, most frequently inshore, but with some specimens occurring considerable distances offshore.

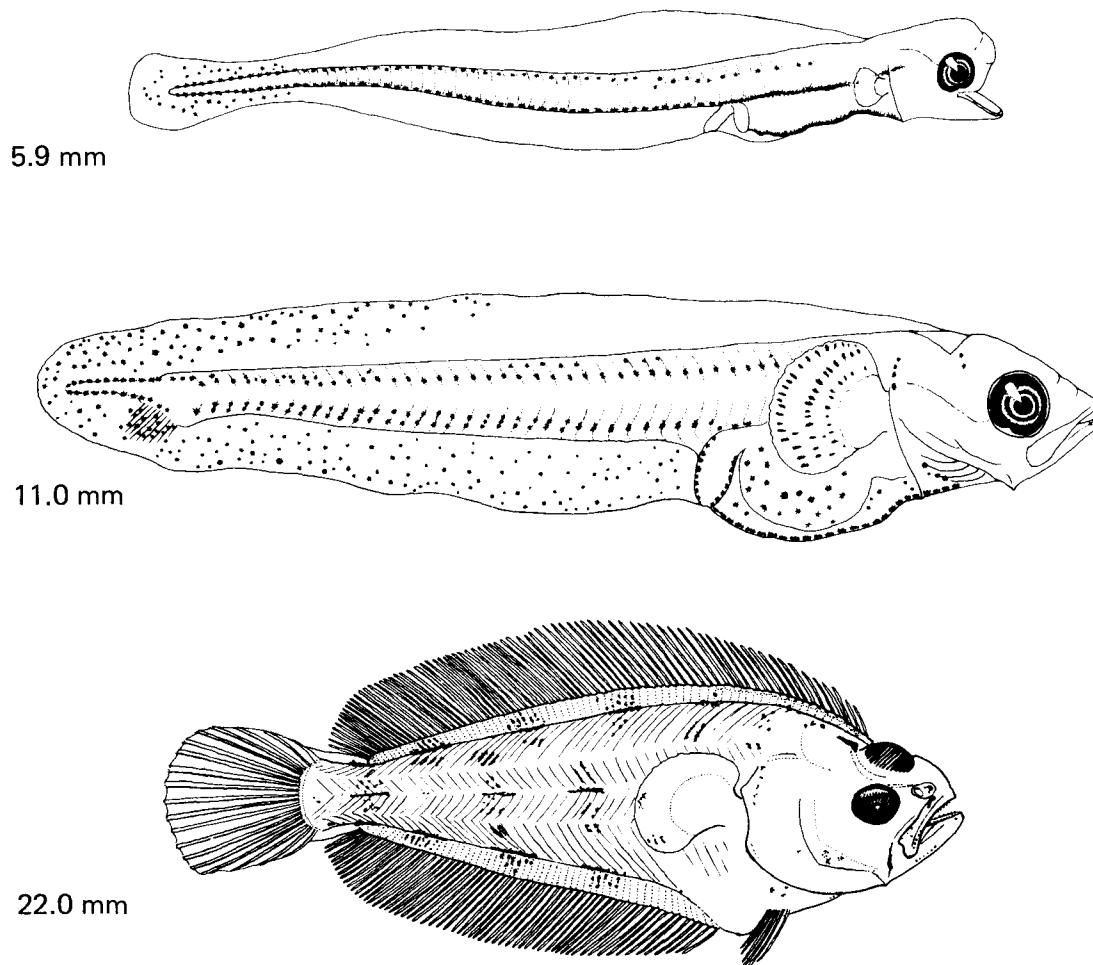


Figure 3. Slender sole, *Lyopsetta exilis* (Jordan and Gilbert)

Larvae of the slender sole, *Lyopsetta exilis*, Family Pleuronectidae (Figure 3: Distribution Charts 116-143)

The early life history stages of the slender sole have not been described in previous publications. The eggs are relatively large, measuring 1.6 to 1.7 mm in diameter; they are pelagic, lack ornamentation of the outer shell, have homogeneous yolk and lack an oil globule. The newly hatched larva is approximately 5 mm long. The younger stages of larvae have dorsal and ventral margin pigment, some lateral pigment and pigment in the fin-fold posteriorly. Larvae undergoing notochord flexion and early postflexion larvae have myoseptal pigment outlining the ventro-lateral myomeres between the termination of the gut and the developing caudal fin and similar dorso-lateral myoseptal pigment along the length of the body; pigment develops over the

gut and along the fan of the pectoral fins. In later stage larvae, pigment concentrates into a series of patches along the dorsal and ventral margins of the body and along the lateral line. Metamorphosis occurs between approximately 18 to 22 mm. *Lyopsetta* has 11 or 12 abdominal vertebrae, 42 to 47 total vertebrae, 72 to 88 dorsal rays, 57 to 66 anal rays, and 19 caudal rays.

Lyopsetta larvae are collected over an extensive area of the CalCOFI sampling pattern, from Cape Mendocino, northern California to Pta. Abreojos, Baja California (see inside rear cover). They have been collected every month except October, most commonly during April and May and only occasionally during August through December. Monthly distributions are shown in 28 charts. The largest counts of larvae were obtained in 1956 and 1957, the lowest counts in 1960 (Table 1).

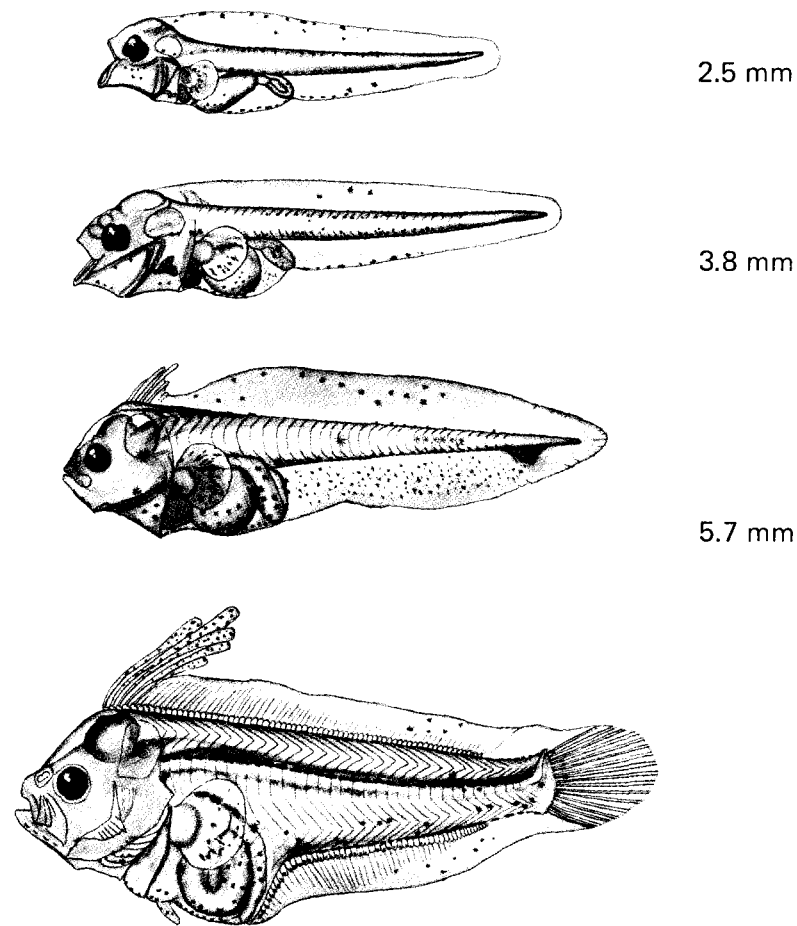


Figure 4. California halibut, *Paralichthys californicus* (Ayres)

Larvae of the California halibut, *Paralichthys californicus*, Family Bothidae (Figure 4: Distribution Charts 144-160)

California halibut have been identified routinely from CalCOFI collections since 1950, although a developmental series has not yet been published. There are larval series of two species of *Paralichthys* in the literature. Eggs and larvae of the Atlantic species, *P. dentatus* (L.) were described by Smith and Fahay (1970); eggs of the northwest Pacific species, *P. olivaceus* (Temminck and Schlegel) were described by Pertseva-Ostroumova (1961) and larvae by Okiyama (1967). Egg diameter of *P. dentatus* is 0.90-1.10 mm (mean 1.02 mm) with a single oil globule 0.18 to 0.31 mm in diameter (mean 0.25 mm). Those of *P. olivaceus* are 0.83 to 0.96 mm, with a single oil globule 0.13 to 0.19 mm. The eggs have an

unsculptured outer shell, homogeneous yolk and a narrow perivitelline space. Eggs of the California halibut average about 0.90 mm in diameter and have a single small oil globule. Larvae of all three species develop about 5 elongated rays at the anterior end of the dorsal fin prior to notochord flexion; the rays of the ventral fins are not elongated as in *Citharichthys*. Eye migration begins in the California halibut in specimens as small as 8 or 9 mm; the eyes move either to the right or left side of the head, although sinistral specimens are more common. The following meristics are useful in identifying larvae of the California halibut: vertebrae 10 + 25 or 26; dorsal rays, 66 to 76, anal rays 49 to 59; caudal rays 18½; gill rakers 7 to 11 + 18 to 23. Larvae of *Paralichthys* are mostly confined to a coastal band from southern California to southern Baja California.

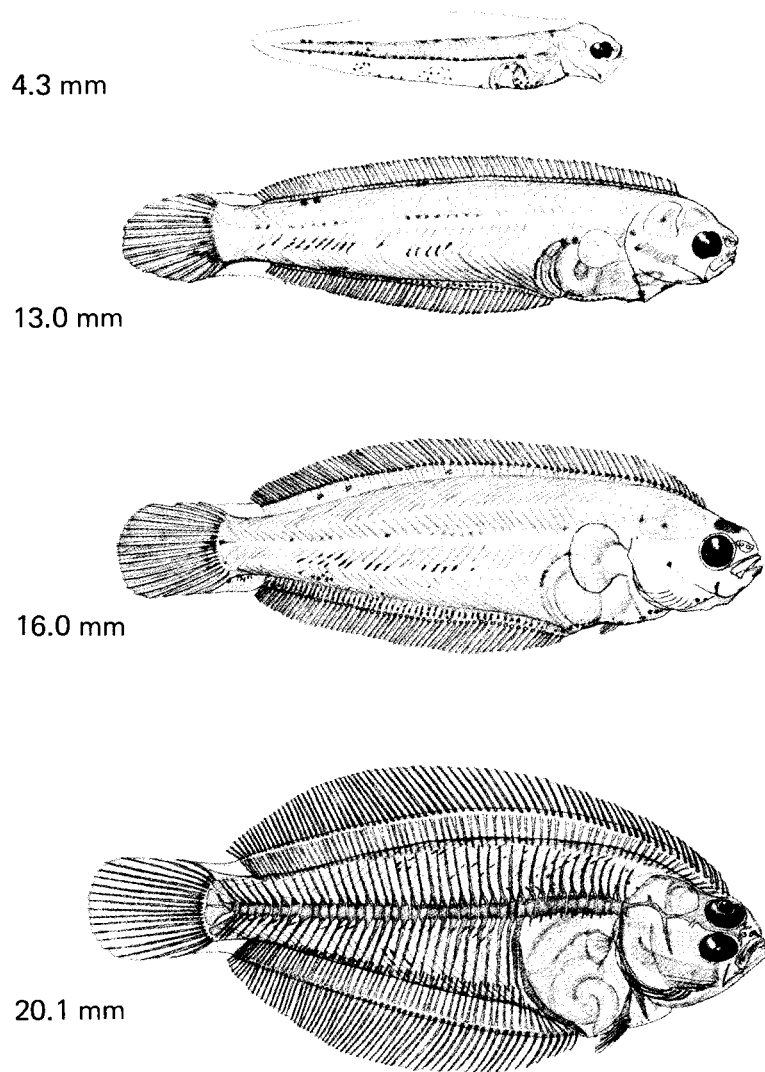


Figure 5. English sole, *Parophrys vetulus* (Girard)

Larvae of the English sole, *Parophrys vetulus*, Family Pleuronectidae (Figure 5: Distribution Charts 161-175)

Eggs and early stage larvae were described by Budd (1940). The eggs are pelagic, transparent, lack an oil globule, have a thin unornamented shell and a diameter of about 0.9 mm (0.89 to 0.93 mm). Budd reported that the newly hatched larva was 2.8 mm long, and that larvae reared for 9 days without feeding were 4.0 mm long. The 6.3 mm larva illustrated by Budd from a plankton haul is not that of *P. vetulus*. The larvae are only moderately pigmented, as can be seen in the illustrations of the 13 and 16 mm specimens. Pigment outlines myomeres (myoseptal) on the tail portion of the body below the lateral line

and is distributed over the anal pterygiophores, along the ventral margin of the head and gut, and at the base of the caudal fin. The larvae are quite slender. The larger one illustrated (16 mm) is in the early stage of metamorphosis with the eye on the left side beginning to migrate. Metamorphosis is completed by about 20 mm SL. Meristic counts which help in identifying postflexion larvae are: vertebrae 42-45 (ave. 43.5), dorsal rays 71 to 86, anal rays 54 to 68, and caudal fin rays, 18.

Although larvae of *Parophrys* were taken in every month except November, the months of peak abundances were March and April and few larvae were taken during September through December.

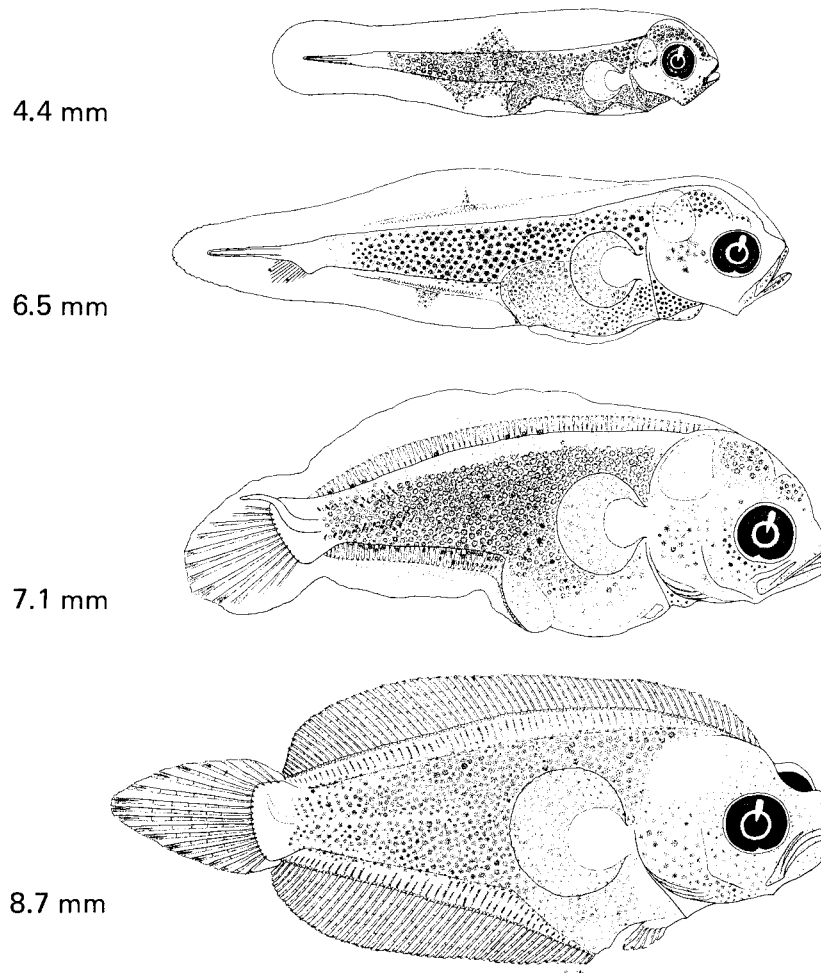


Figure 6. Hornyhead turbot, *Pleuronichthys verticalis* (Jordan and Gilbert)

Larvae of turbot, *Pleuronichthys* spp, Family Pleuronectidae (Figure 6: Distribution Charts 176-195)

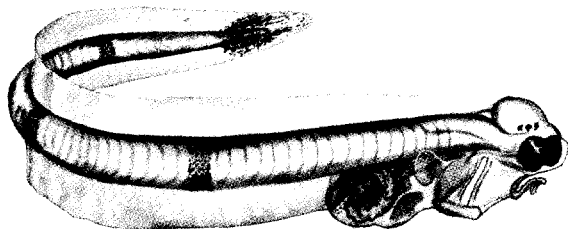
Eggs and early stage larvae were described for three species of *Pleuronichthys* by Budd (1940). Whereas the eggs of most flatfishes have a smooth, unornamented outer shell, those of *Pleuronichthys* are covered by an hexagonal pattern extending through the entire thickness of the membrane. The eggs of the three species described by Budd can be readily distinguished from one another by size alone. The eggs of *P. verticalis* average 1.07 mm (1.00 - 1.10 mm) in diameter, those of *P. decurrens* average 1.44 mm (1.31 - 1.50), and those of *P. coenosus* average 1.88 mm. The width of each hexagon on the egg shell is about 0.04 mm in all three species. The newly hatched larvae of *P. verticalis* are 3.16 mm, those of *P. decurrens* are 3.8 mm

and those of *P. coenosus* are 5.54 mm SL.

All *Pleuronichthys* larvae are heavily pigmented over the head and body except at the tail portion of the body near the tip of the notochord or the caudal fin. Larvae of *P. coenosus* also have the finfold heavily pigmented throughout, but the finfold pigment is less extensive and distinctively different in the other two species.

Although most specimens of *Pleuronichthys* larvae can be identified to species, they were not consistently so identified from our CalCOFI collections. Hence we are reporting on distributions of *Pleuronichthys* collectively. In our collections, *Pleuronichthys verticalis* larvae outnumber those of the other species by perhaps 10 to 1 and all larvae taken off central Baja California are of this species. For this reason, we are including illustrations of a developmental series of *P. verticalis* (prepared by Barbara Sumida).

6.0 mm



22.8 mm



48.7 mm

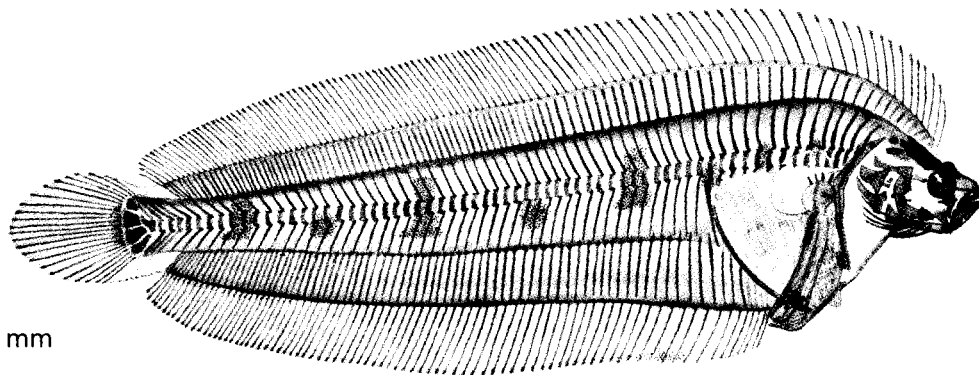


Figure 7. Rex sole, *Glyptocephalus zachirus* (Lockington)

Larvae of the Rex sole, *Glyptocephalus zachirus*, Family Pleuronectidae (Figure 7: Distribution Charts 196-201)

Although the larvae of the rex sole have not been described in the literature, they have been known and identified from CalCOFI collections since 1949. Eggs and larvae have been described for two related species, *G. cynoglossus* from the Atlantic by C. G. J. Peterson (1904) and *G. stelleri* from the Pacific by Deknik (1959), Pertseva-Ostroumova (1961), and Okiyama (1963). The larvae of all three species are strikingly similar in appearance and pigmentation. *Glyptocephalus* larvae can be readily distinguished from larvae of other pleuronectid flatfish by their pigment pattern, high myomere counts, and slender,

elongate bodies. They can attain a large size before transformation; it is not unusual to collect larvae of *G. zachirus* that are between 50 to 70 mm SL. The meristic counts are high for pleuronectid flatfishes, especially the presence of 62 to 65 vertebrae and 21 to 24 caudal fin rays.

During the six-year period covered in this Atlas, there were only 57 occurrences of *Glyptocephalus* larvae, with all but two of these taken during the months of April through July. In the six distribution charts presented for the species each represents the summation of larvae taken on four cruises, April through July. Most of the specimens were obtained off central and northern California indicating we are sampling the southern end of its spawning range.

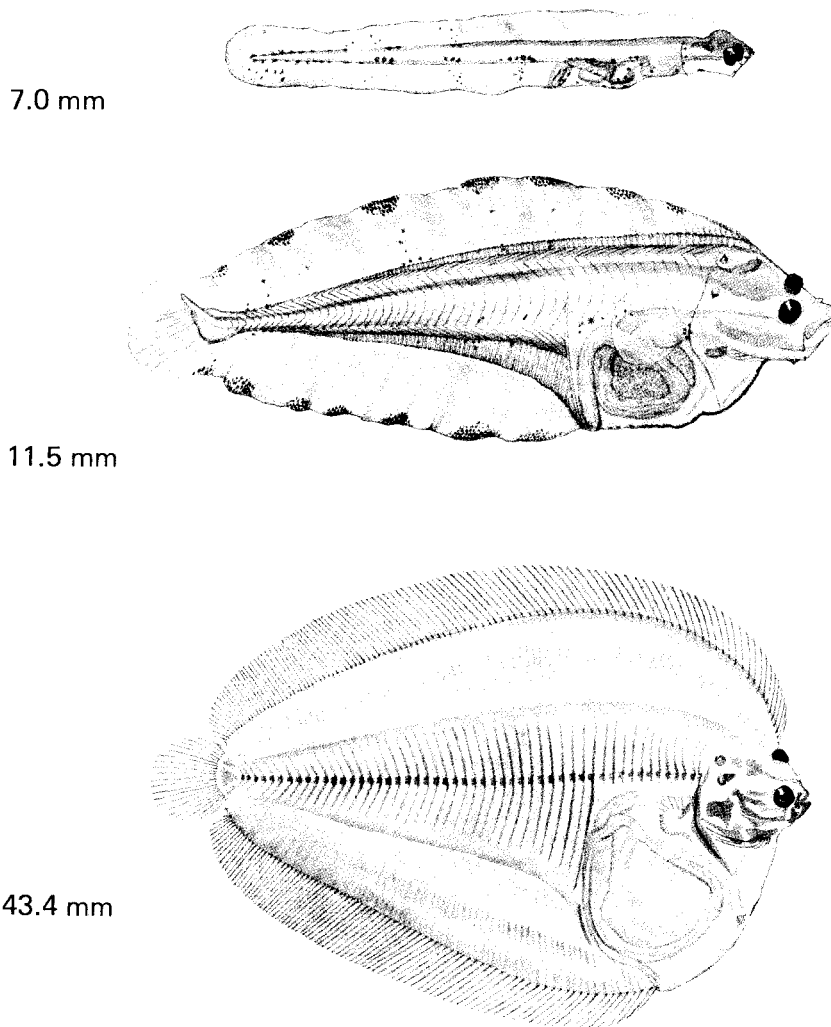


Figure 8. Dover sole, *Microstomus pacificus* (Lockington)

Larvae of the Dover sole, *Microstomus pacificus*, Family Pleuronectidae (Figure 8: Distribution Charts 202-207)

Hagerman (1952) reported on the biology of the Dover sole. A batch of running ripe eggs measured 2.05 to 2.57 mm (mean 2.33 mm) in diameter. He illustrates a 11.5 mm specimen and includes a photograph of a 26 mm specimen. We have identified eggs from *M. pacificus* from plankton hauls and these are similar in size to the measurements given above (i.e., 2.04 to 2.26 mm). The yolk is homogeneous and oil globules are lacking. The embryos are well developed before hatching; they have pigmented eyes, larval pectorals and a developed mouth. Newly

hatched larvae are about 6.5 mm long. Larvae become quite deep bodied and can remain in the larval stage until about 50 mm long. A pair of spines develop on the back of the head. Meristic counts aid in identifying larger larvae; these include the caudal count of 21 to 22 rays, 50 to 53 vertebrae, 94 to 106 dorsal rays and 80 to 88 anal rays. Because of the large size at hatching, characteristic finfold pigment on preflexion larvae as well as distinctive meristics, there is little difficulty in identifying Dover sole larvae whenever sampled. Larvae are taken chiefly during the four-month period, April through July. These months are combined in each of the six distribution charts of *Microstomus*.

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Citharichthys stigmaeus

Citharichthys spp.

Lyopsetta exilis

Paralichthys californicus

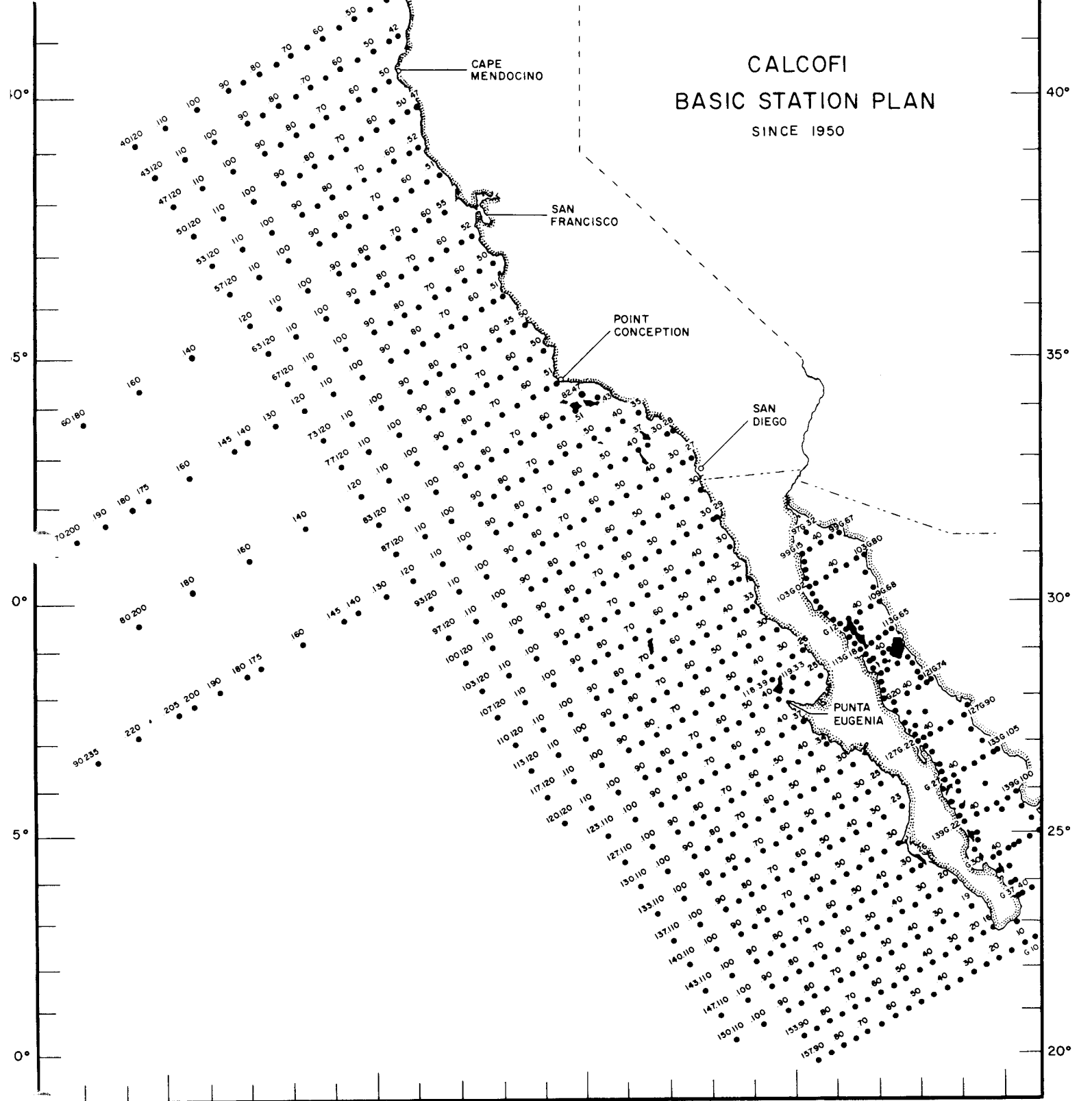
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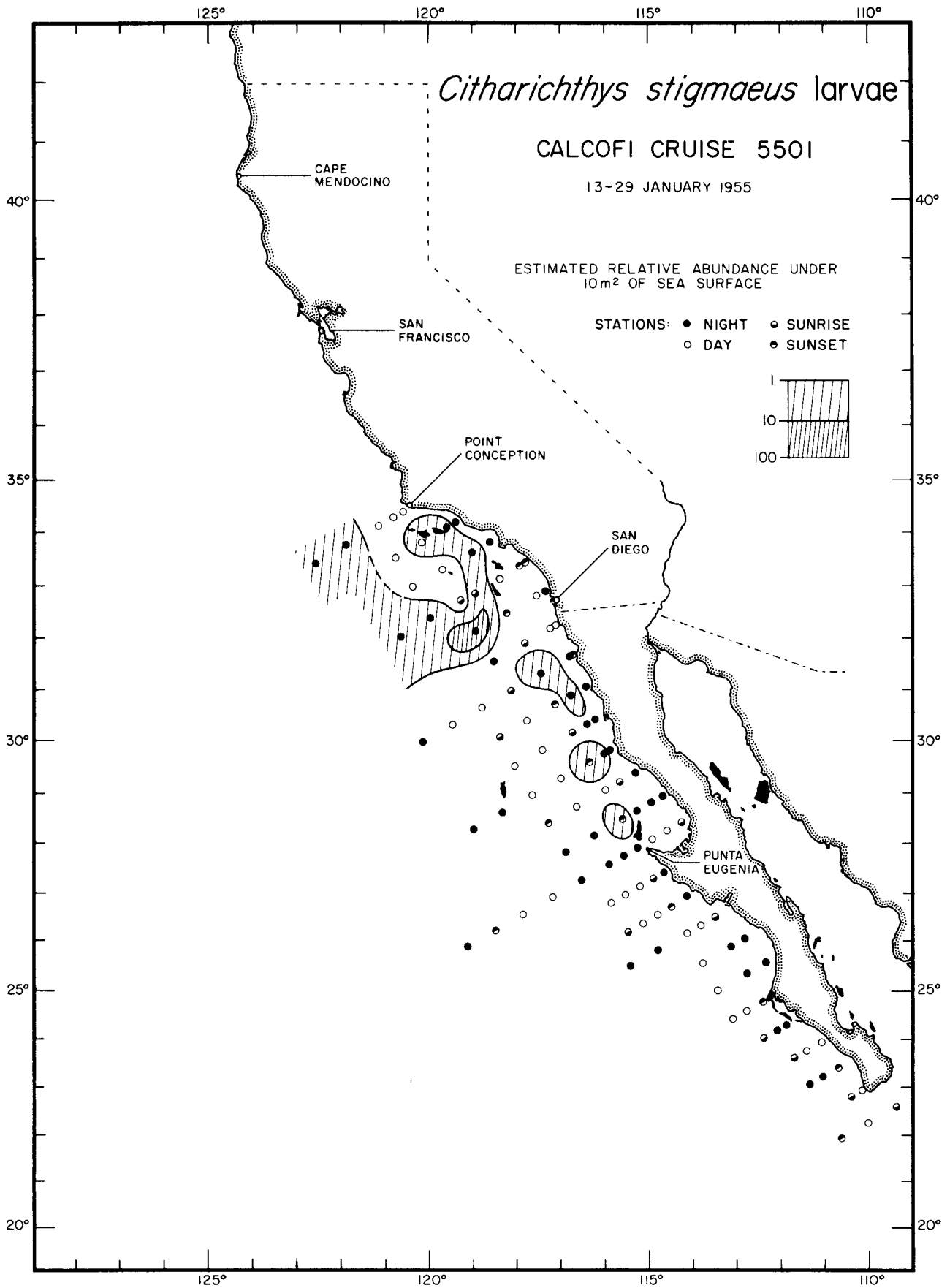
Pleuronichthys spp.

Glyptocephalus zachirus

Microstomus pacificus

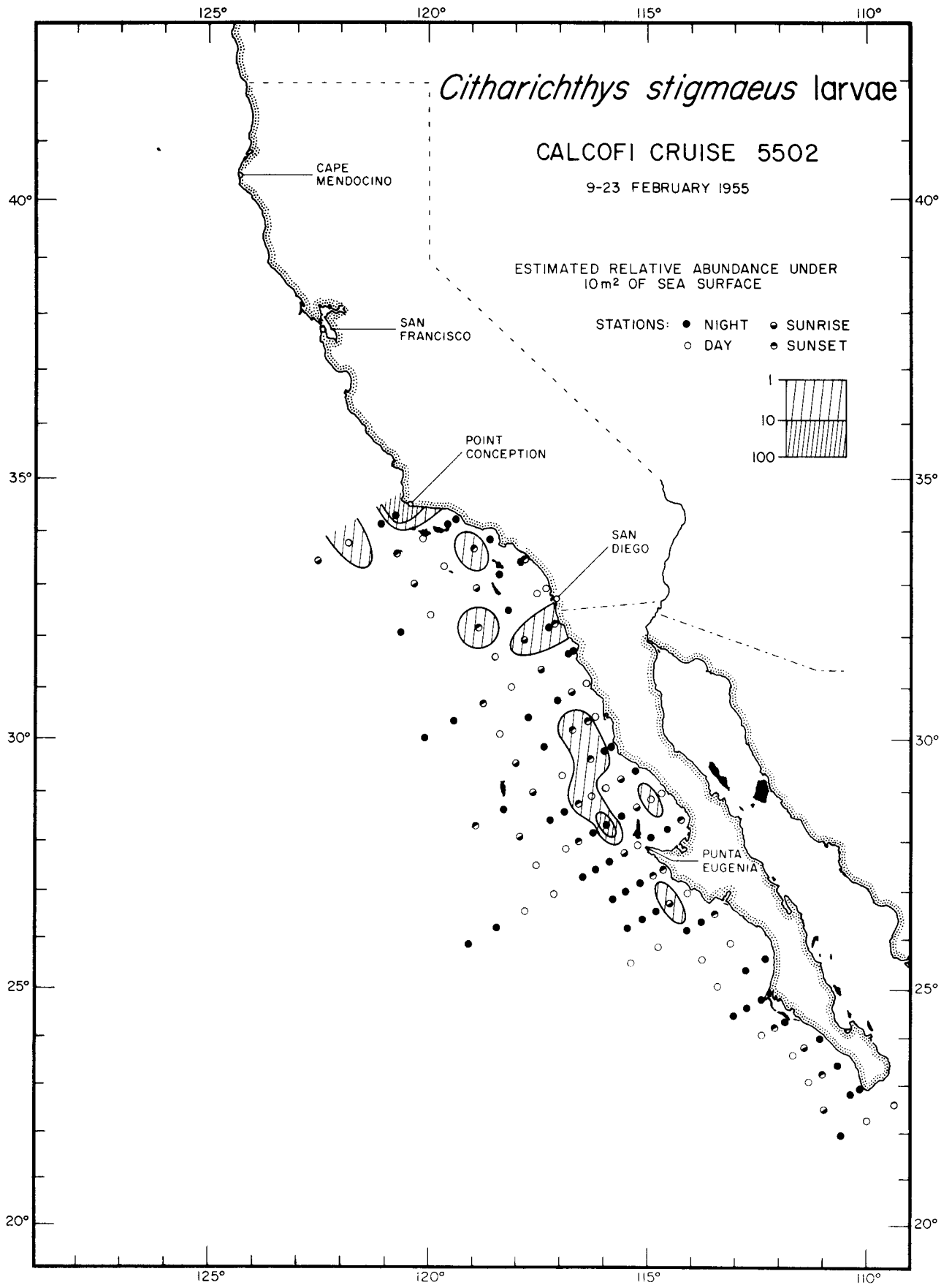
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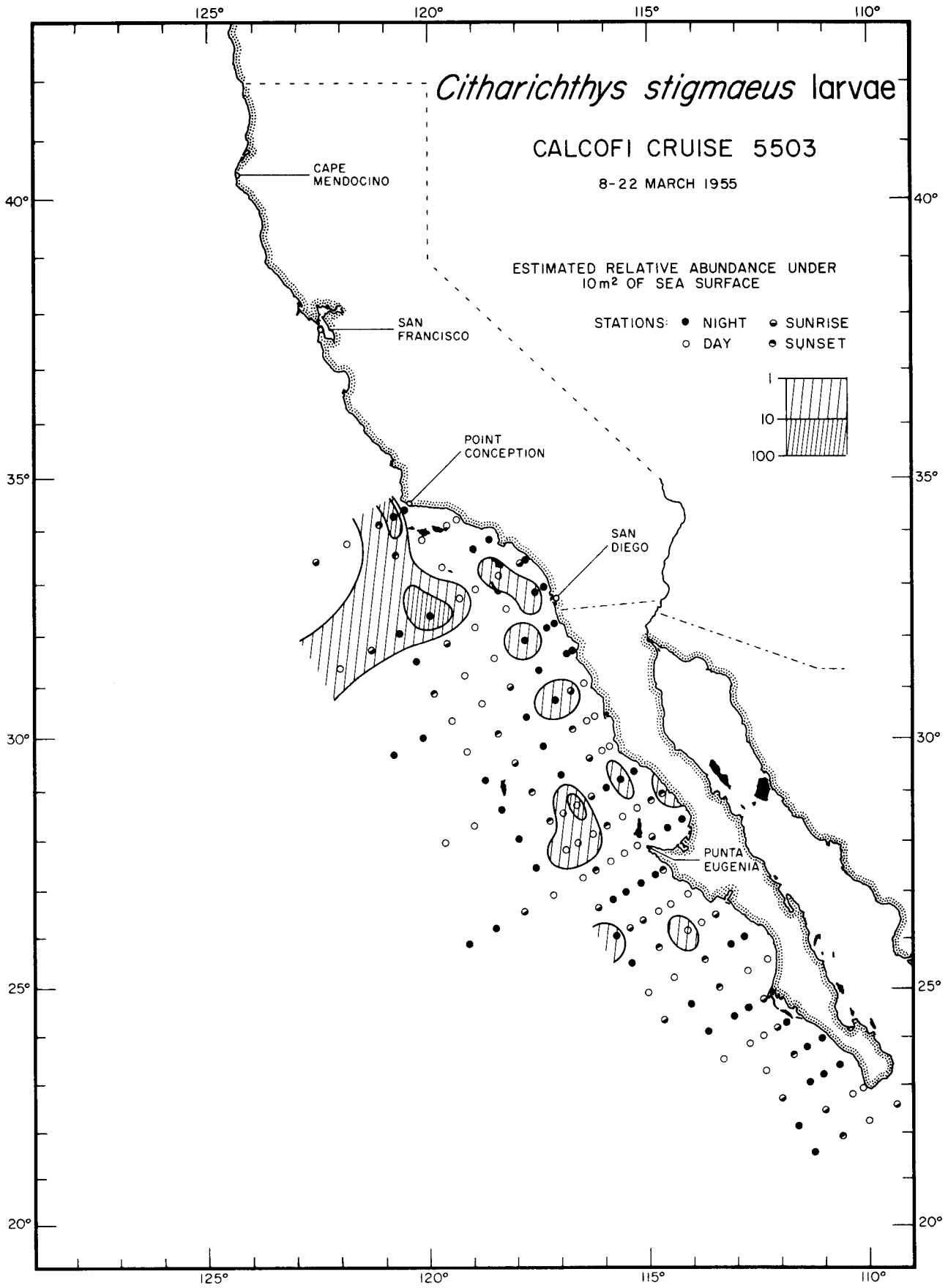
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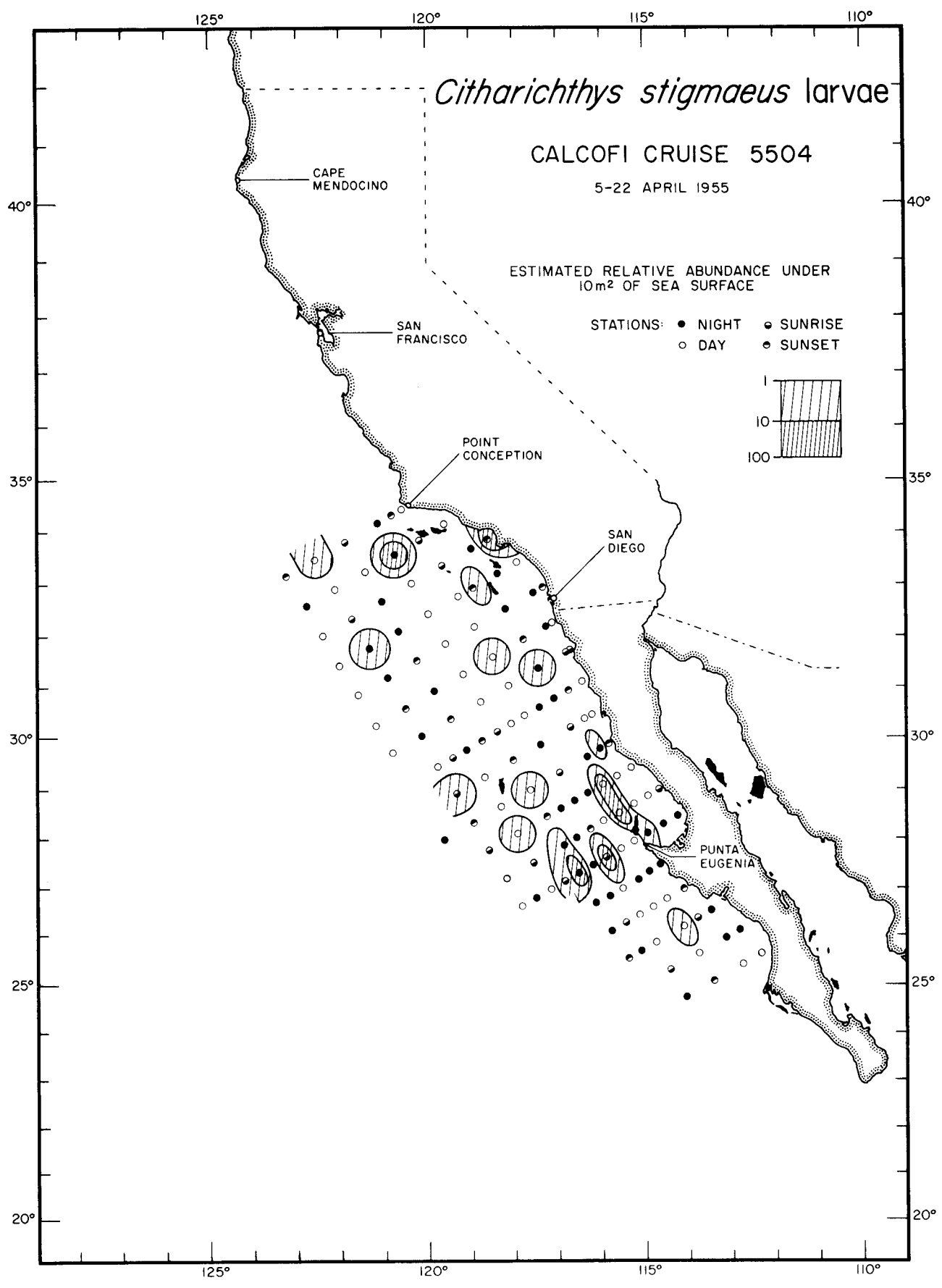
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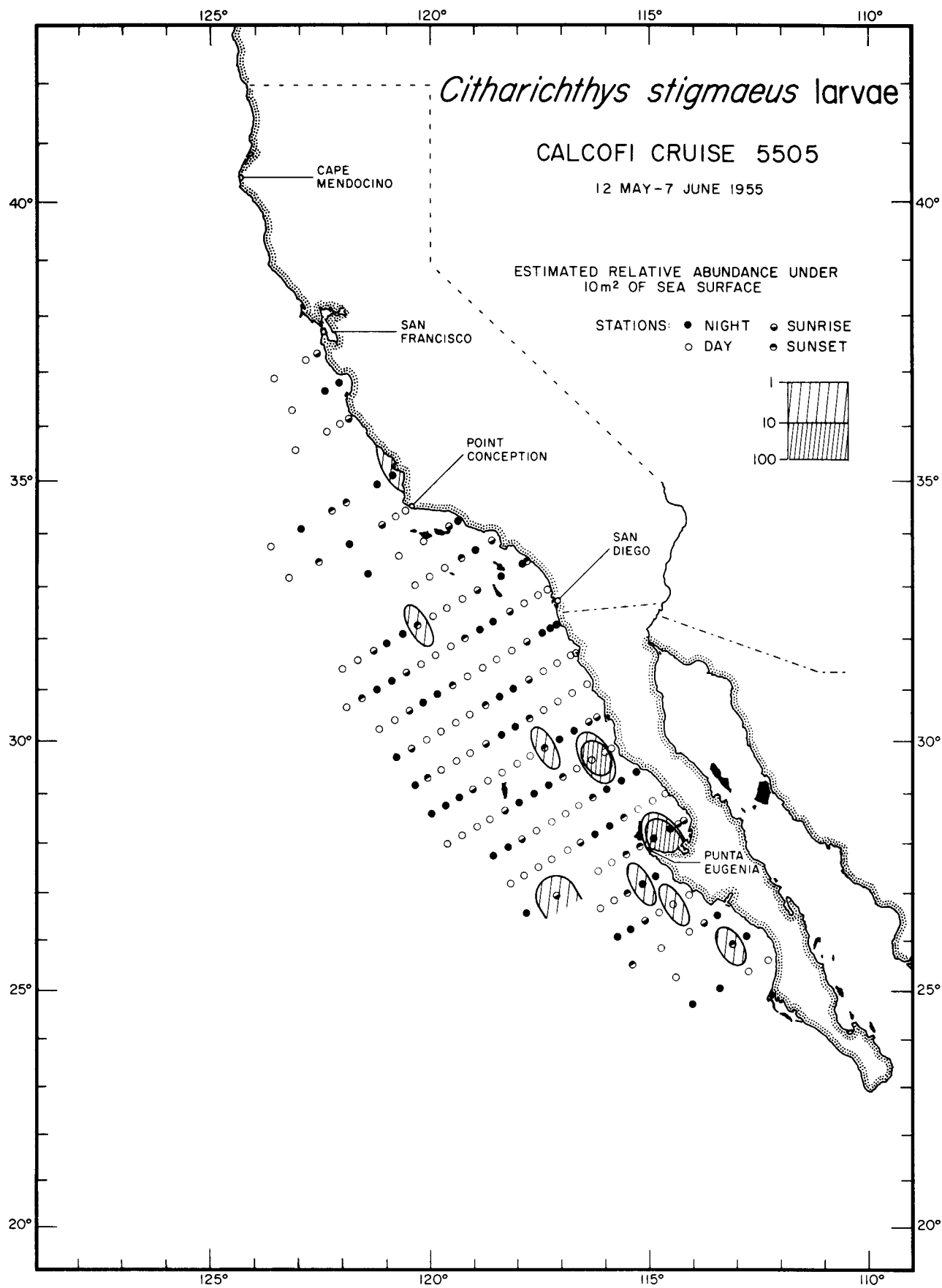


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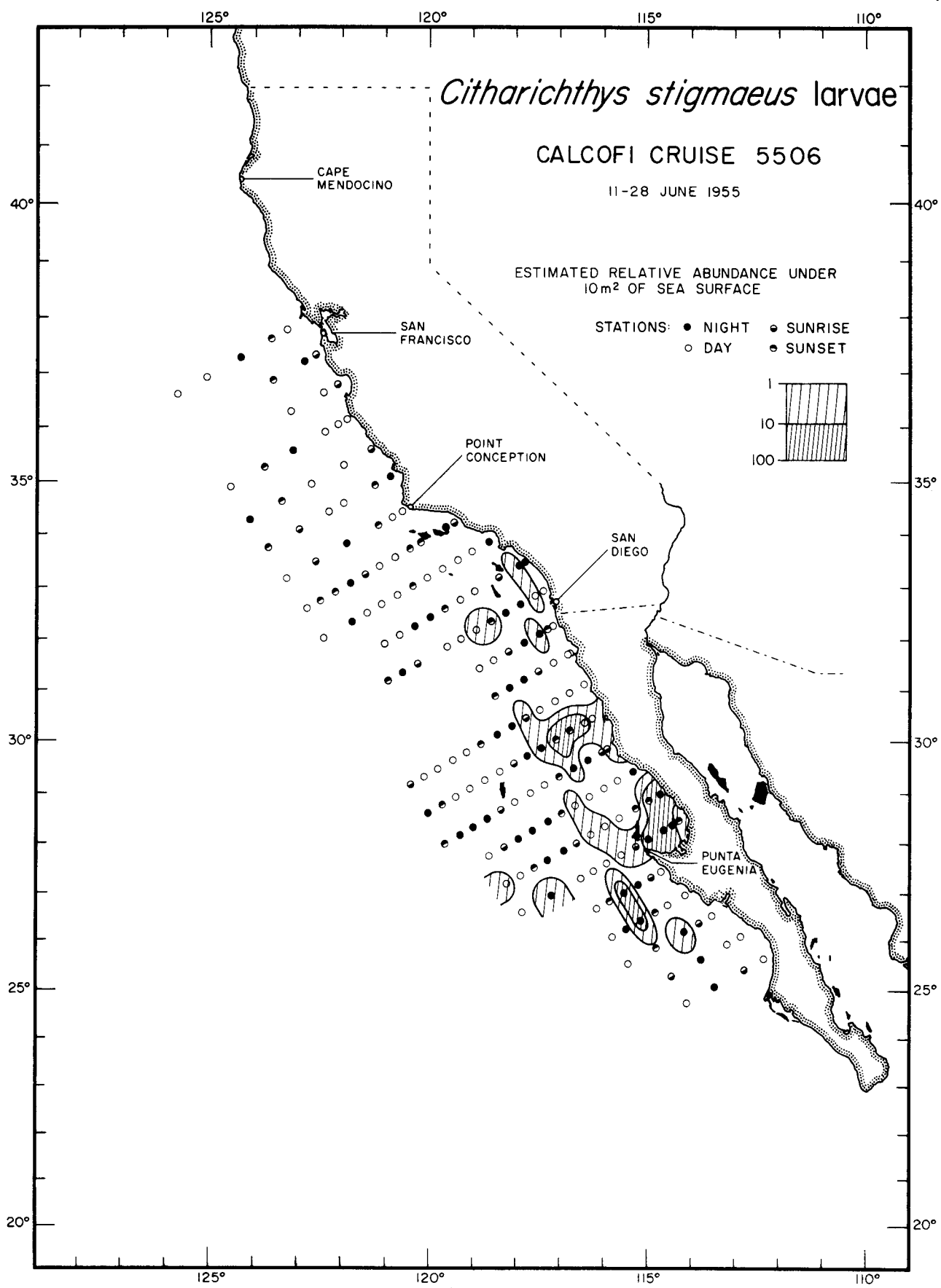


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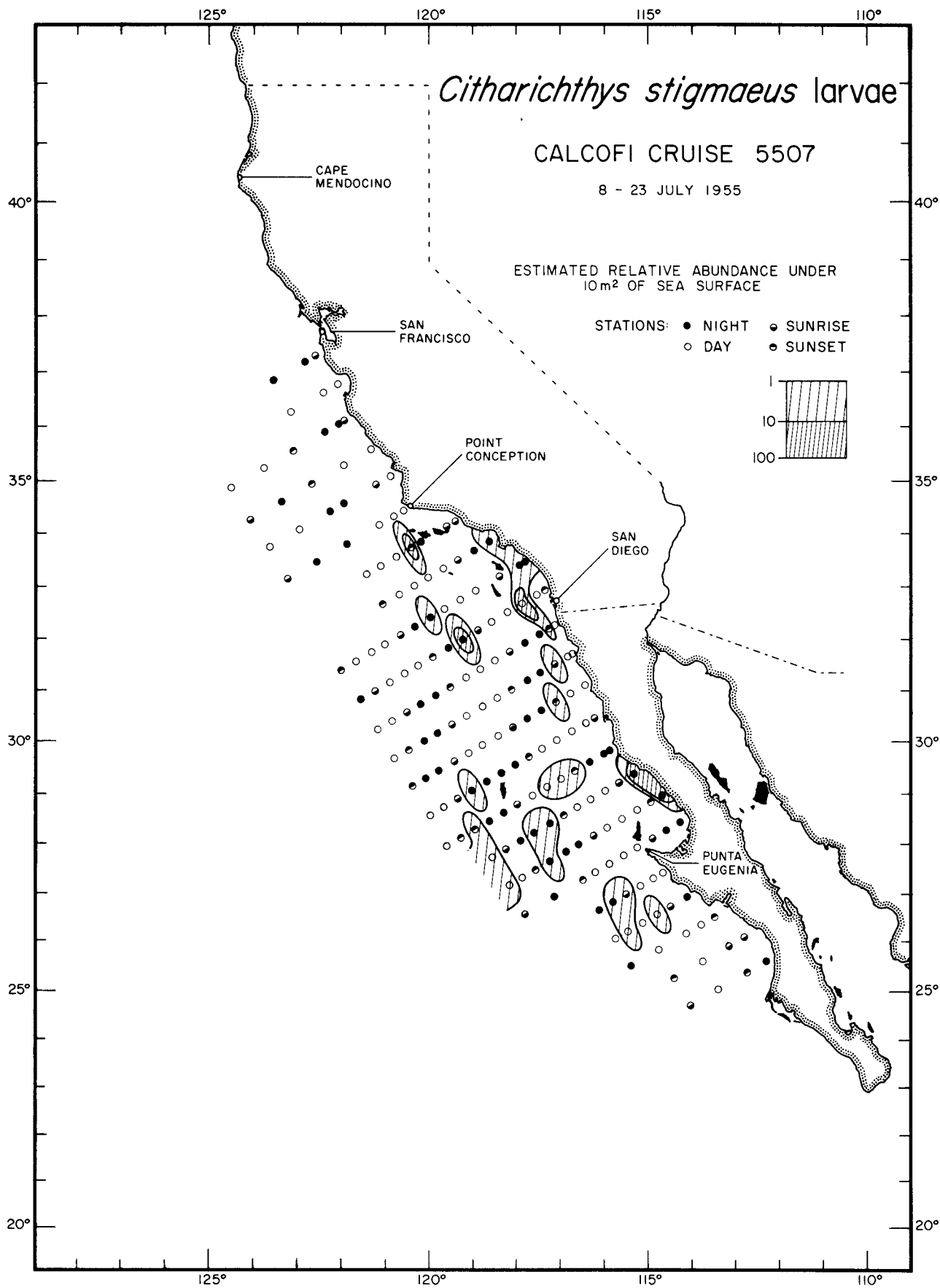


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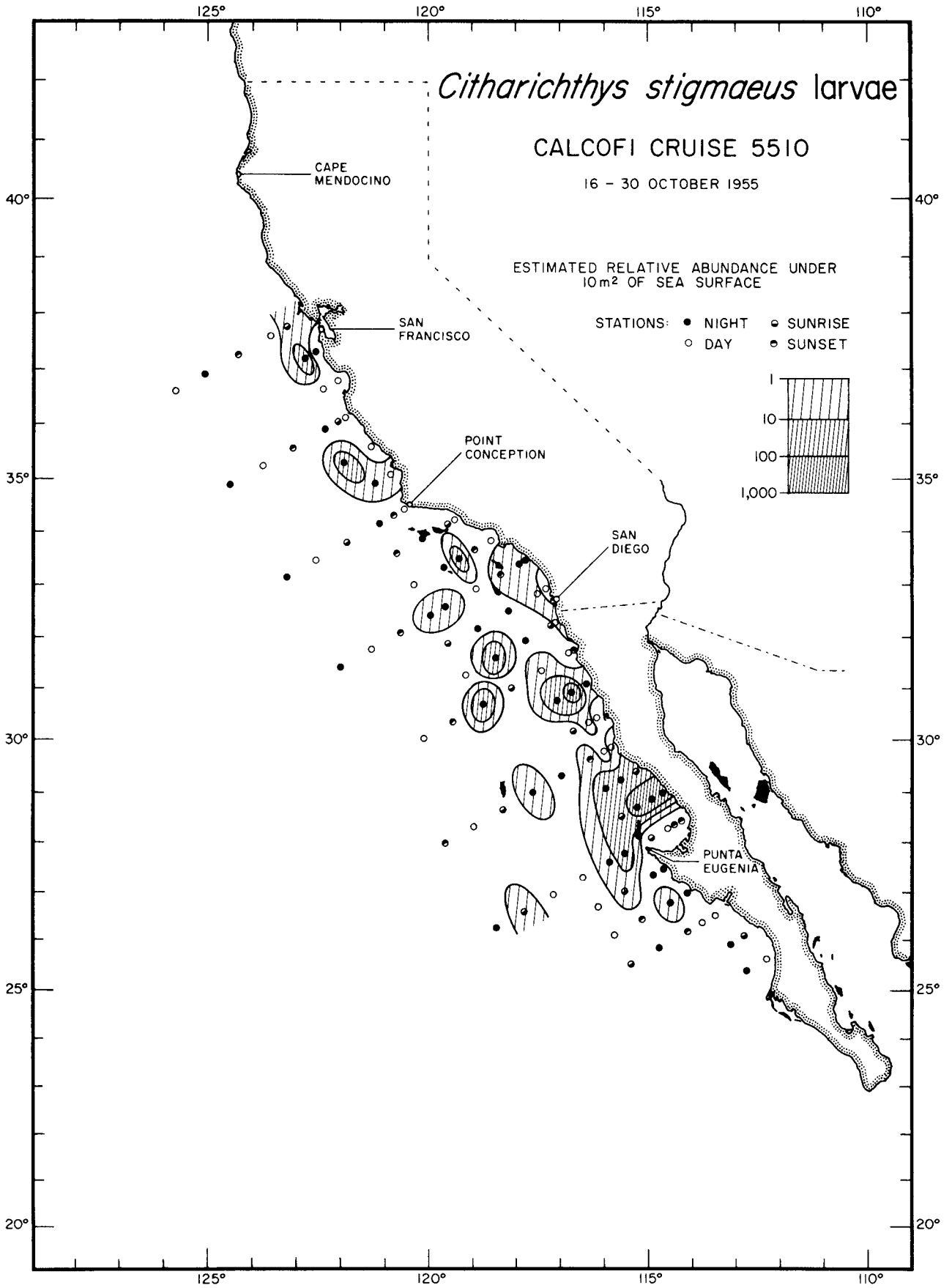


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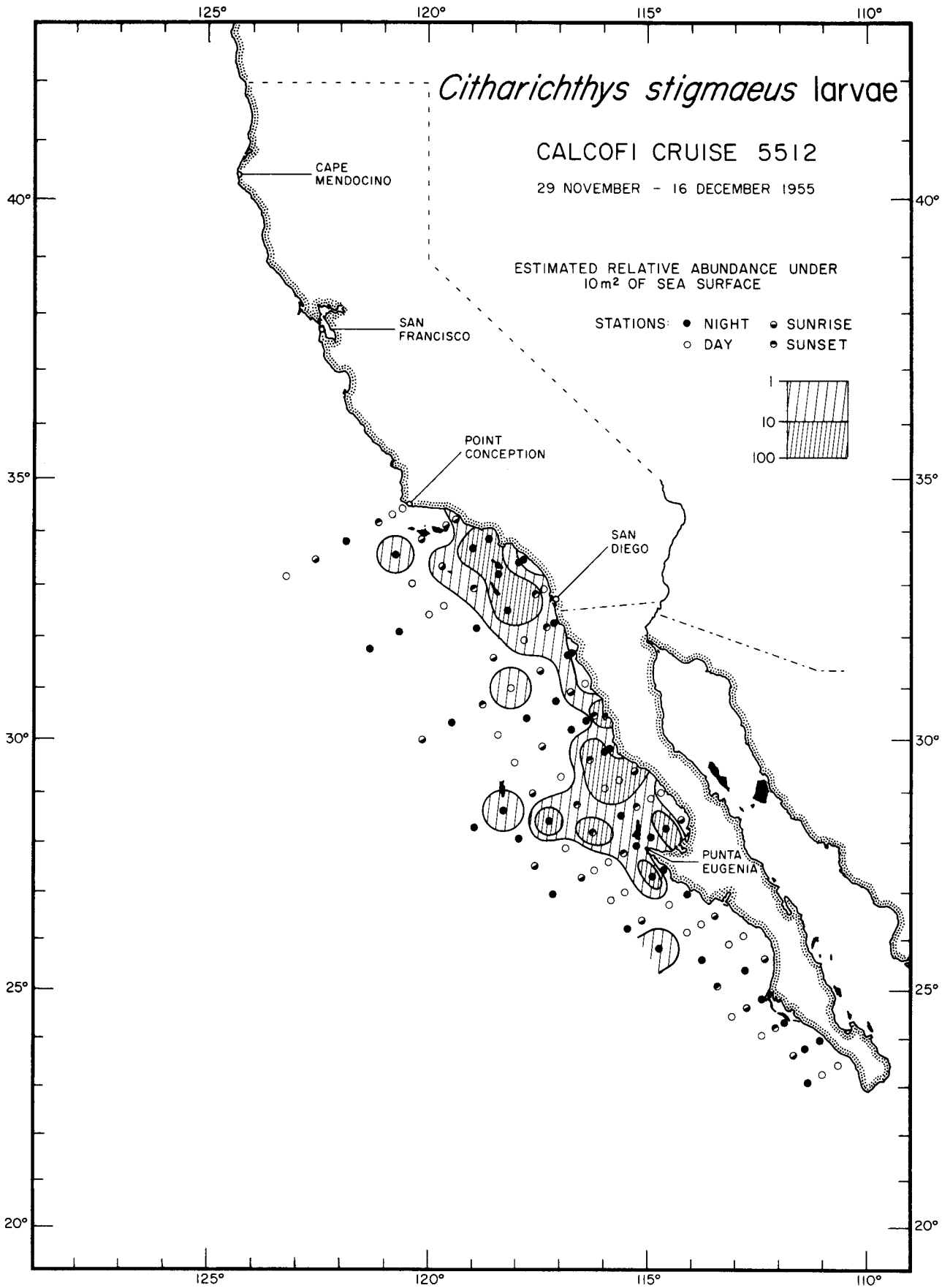
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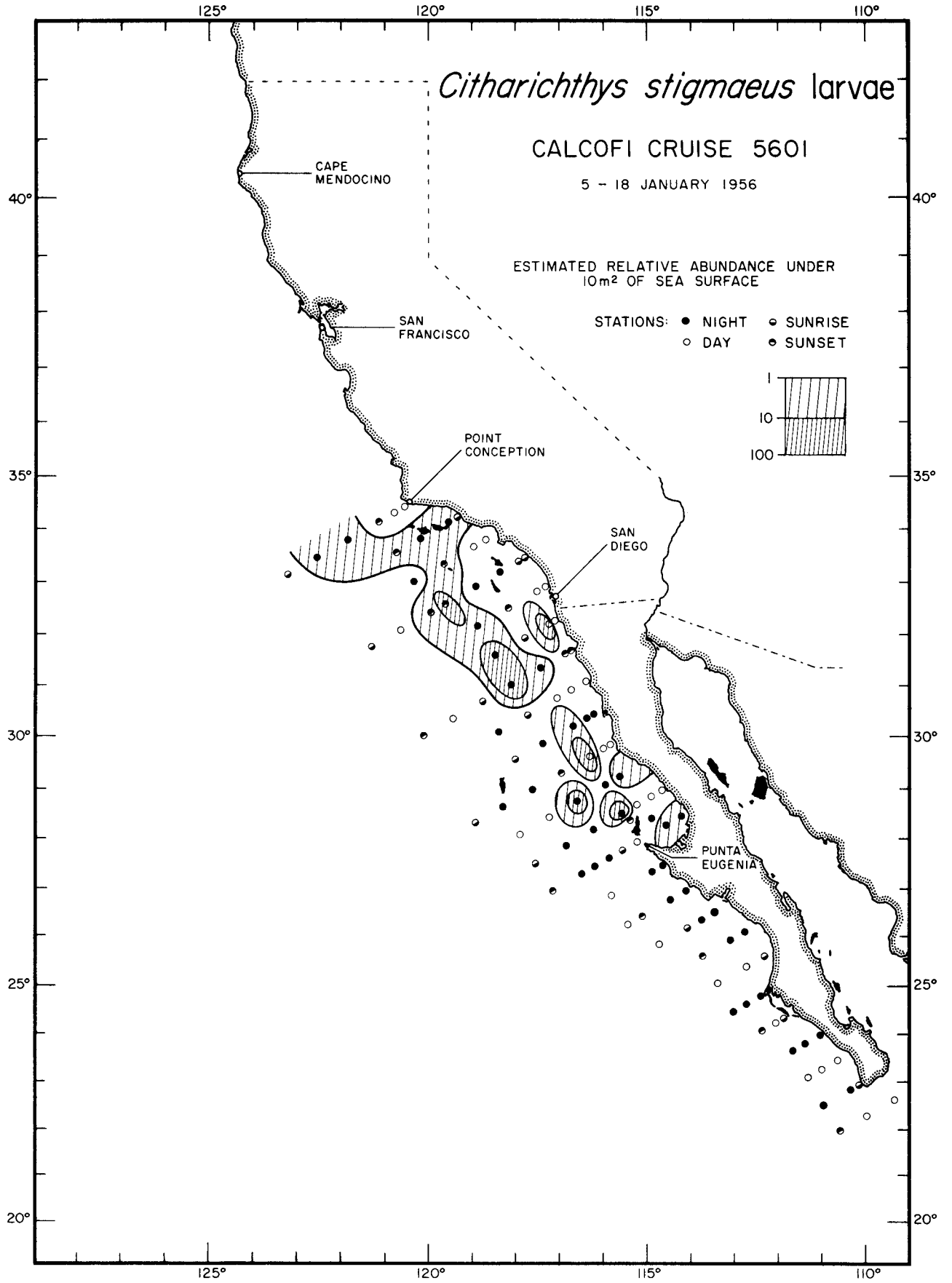


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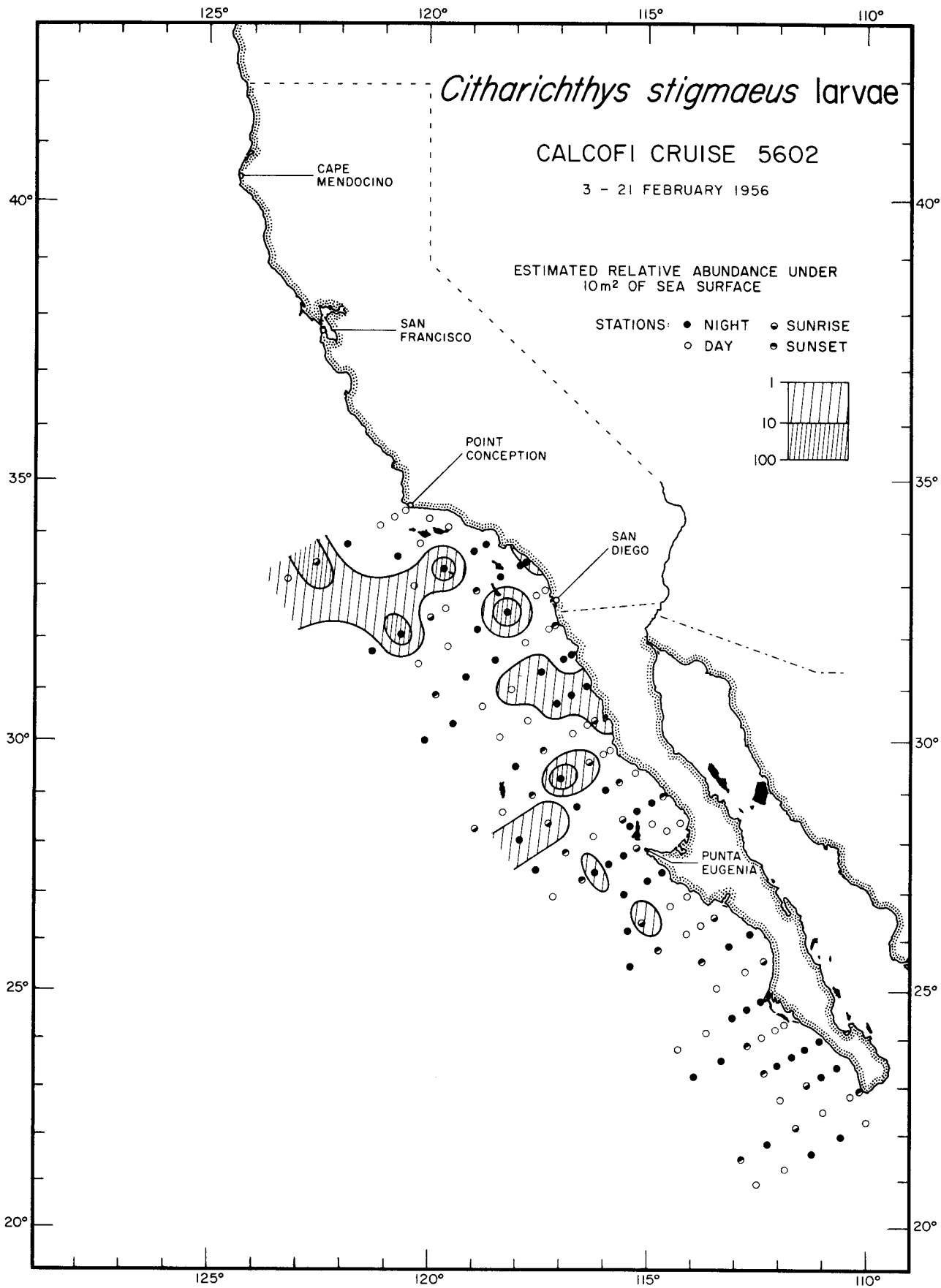
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Citharichthys stigmaeus larvae

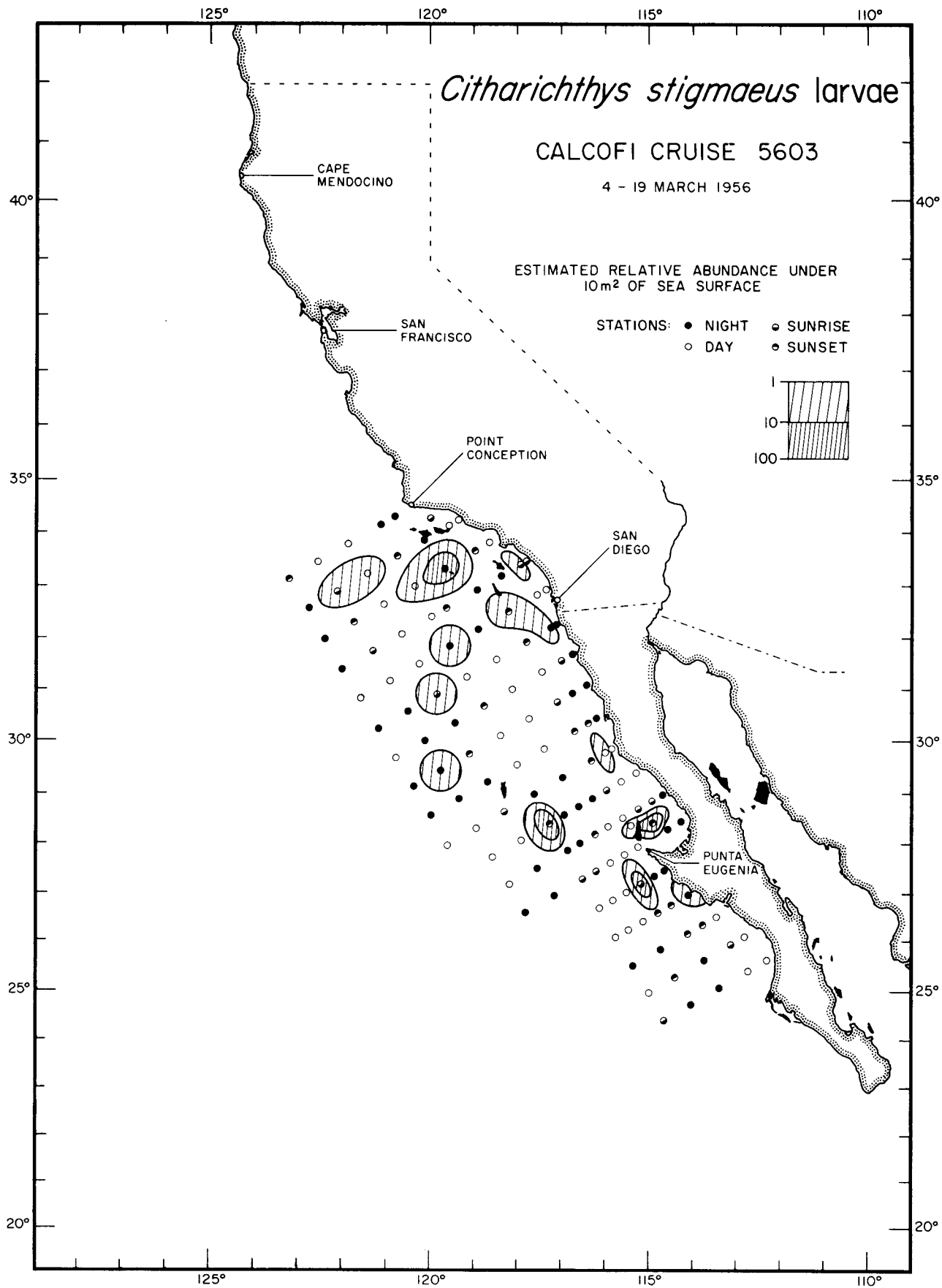


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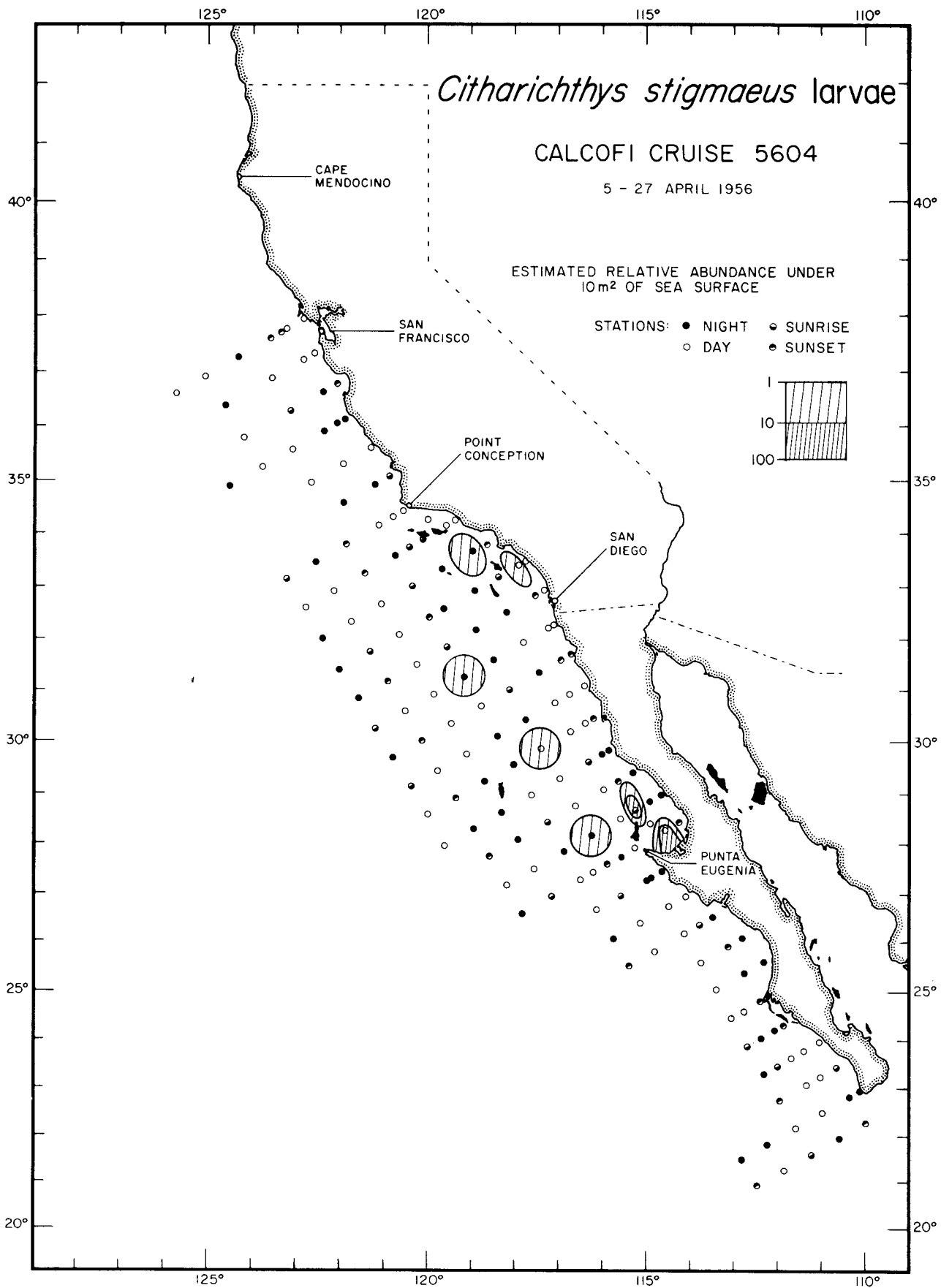
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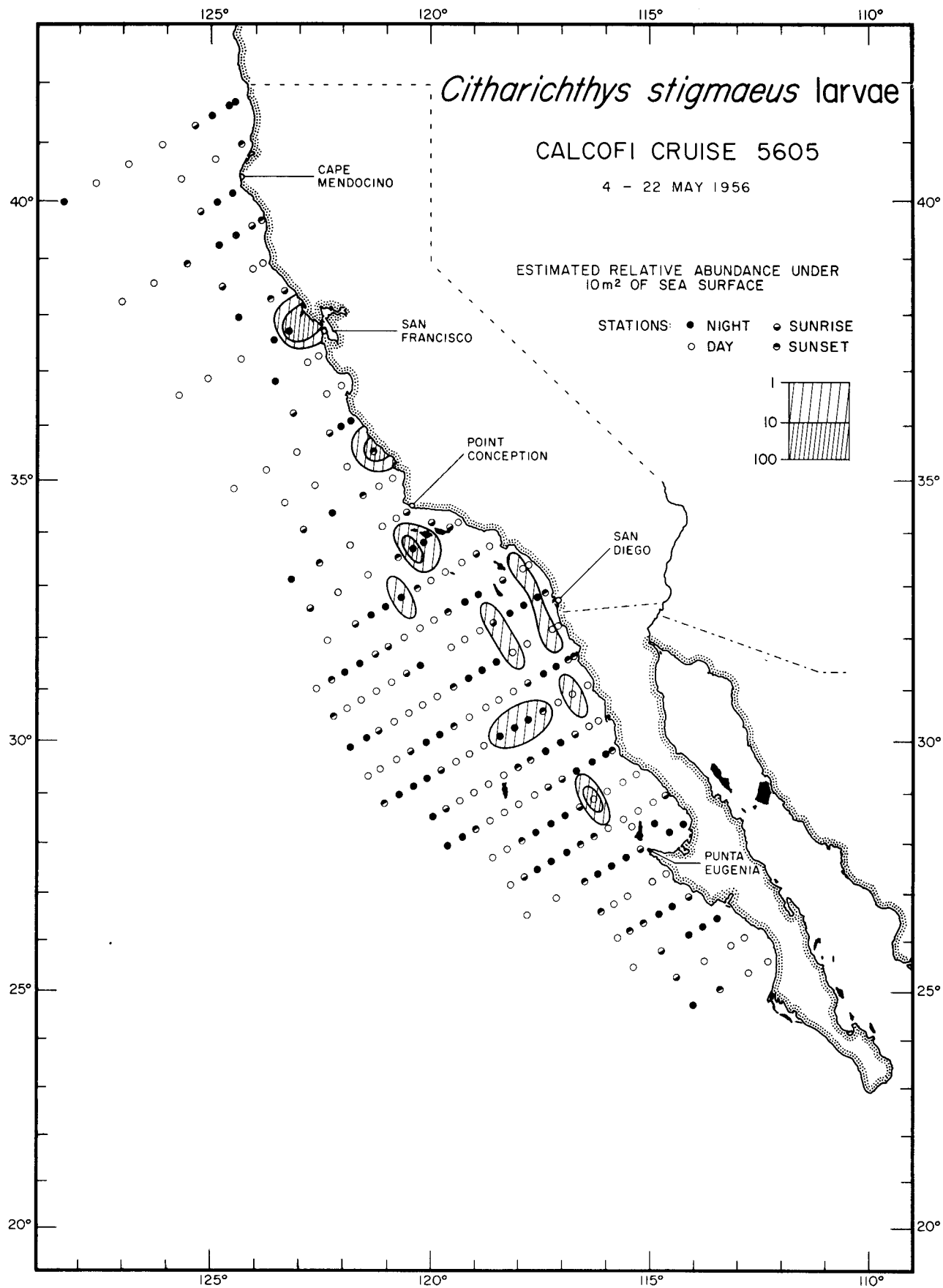
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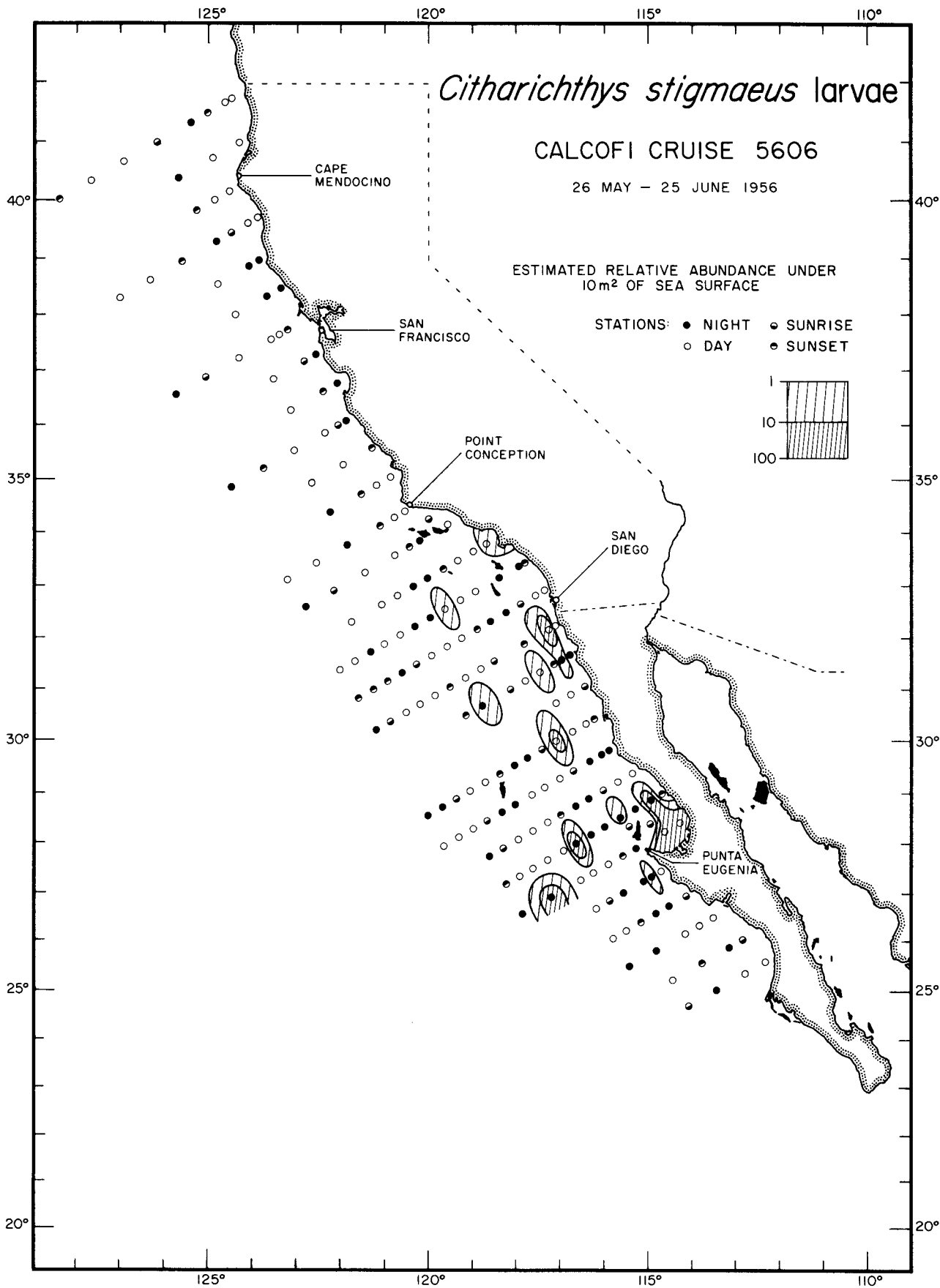
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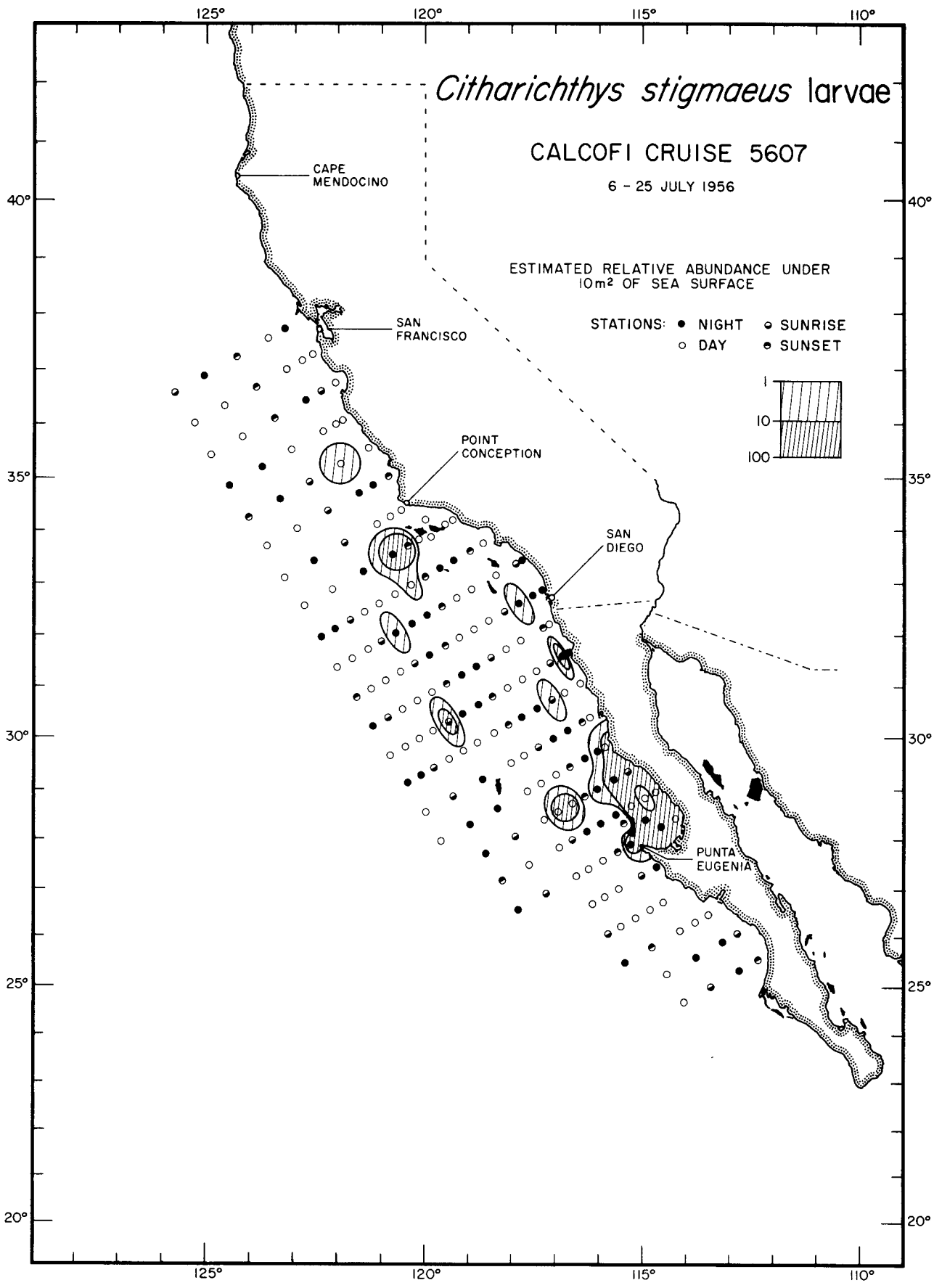
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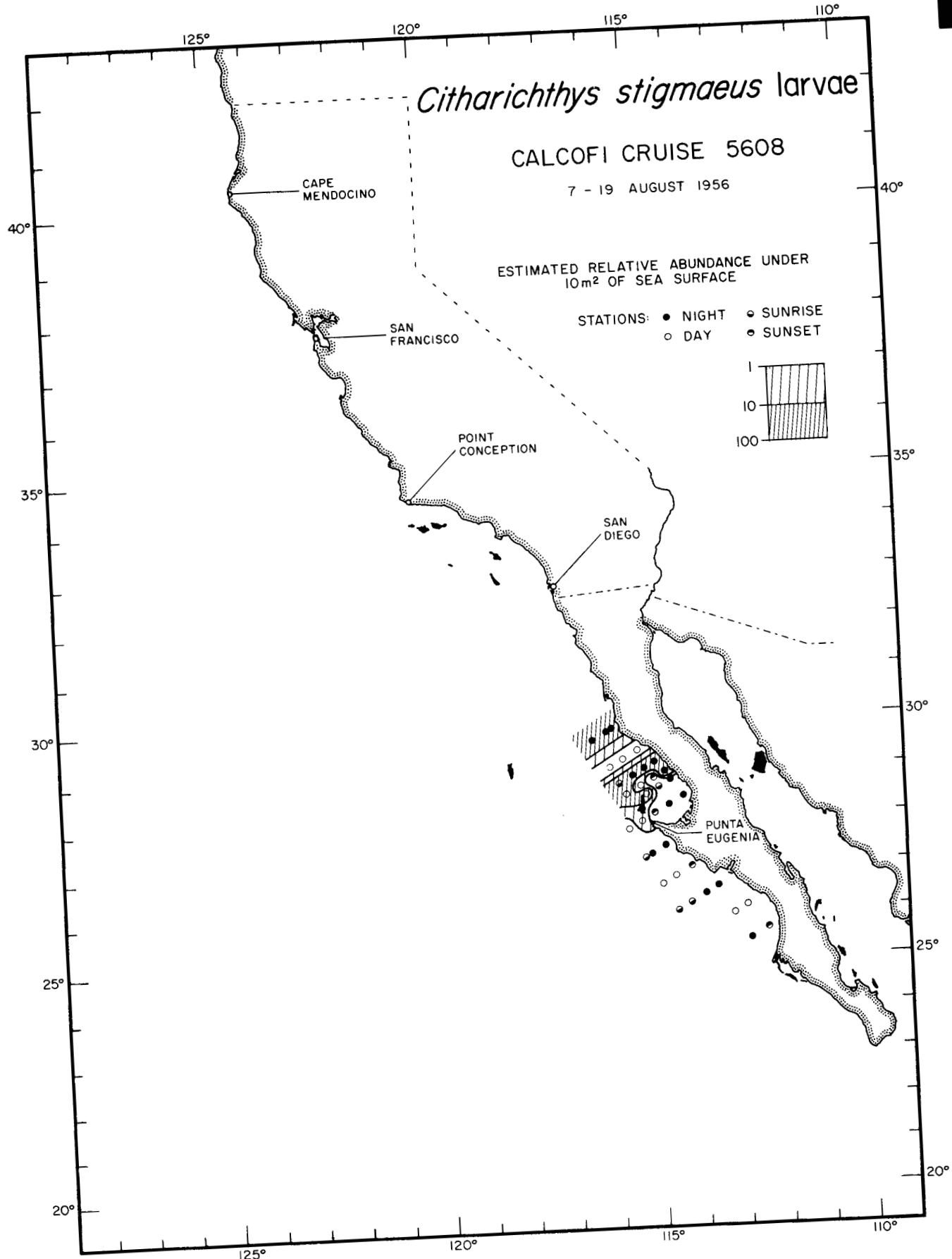


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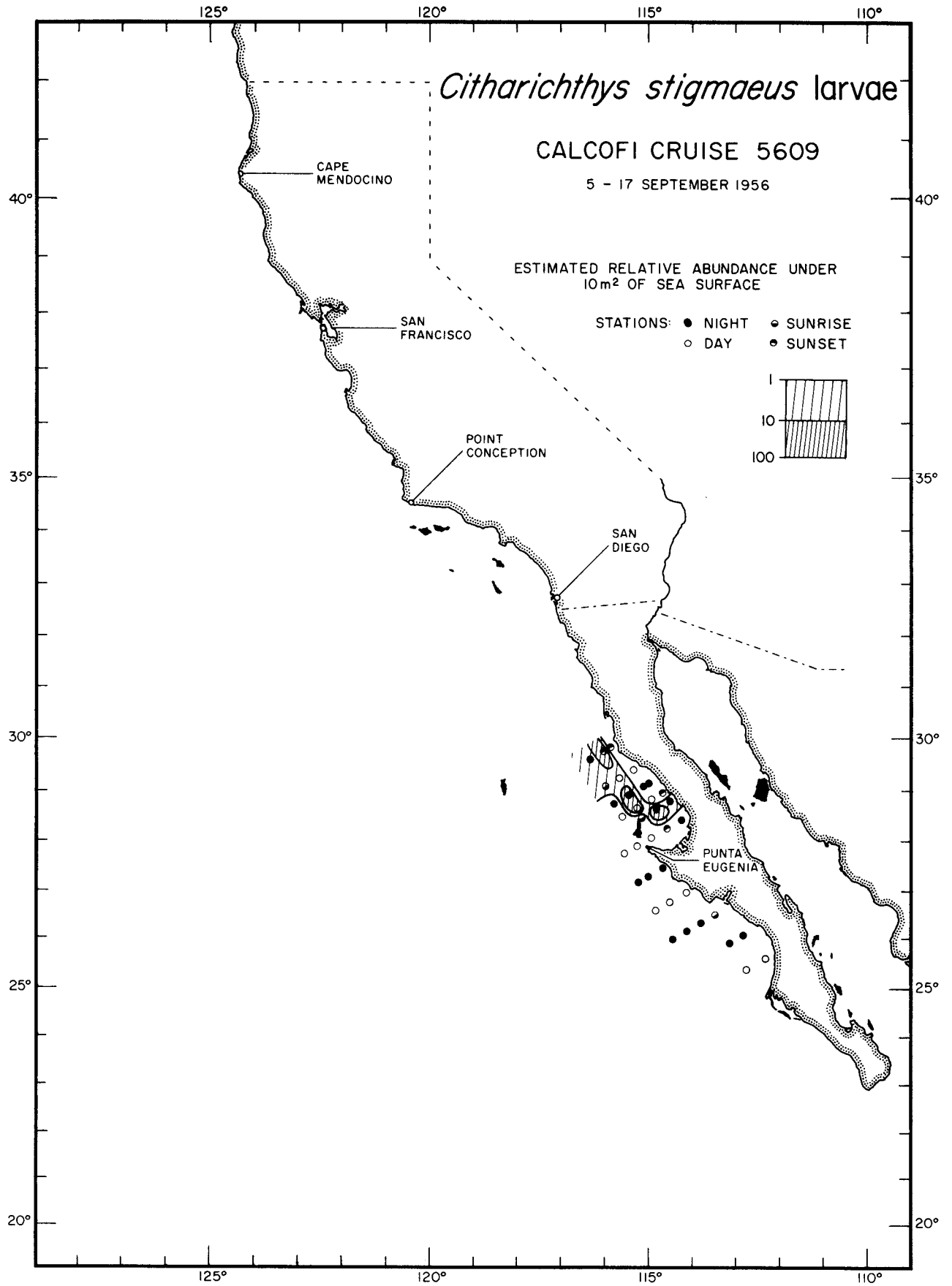


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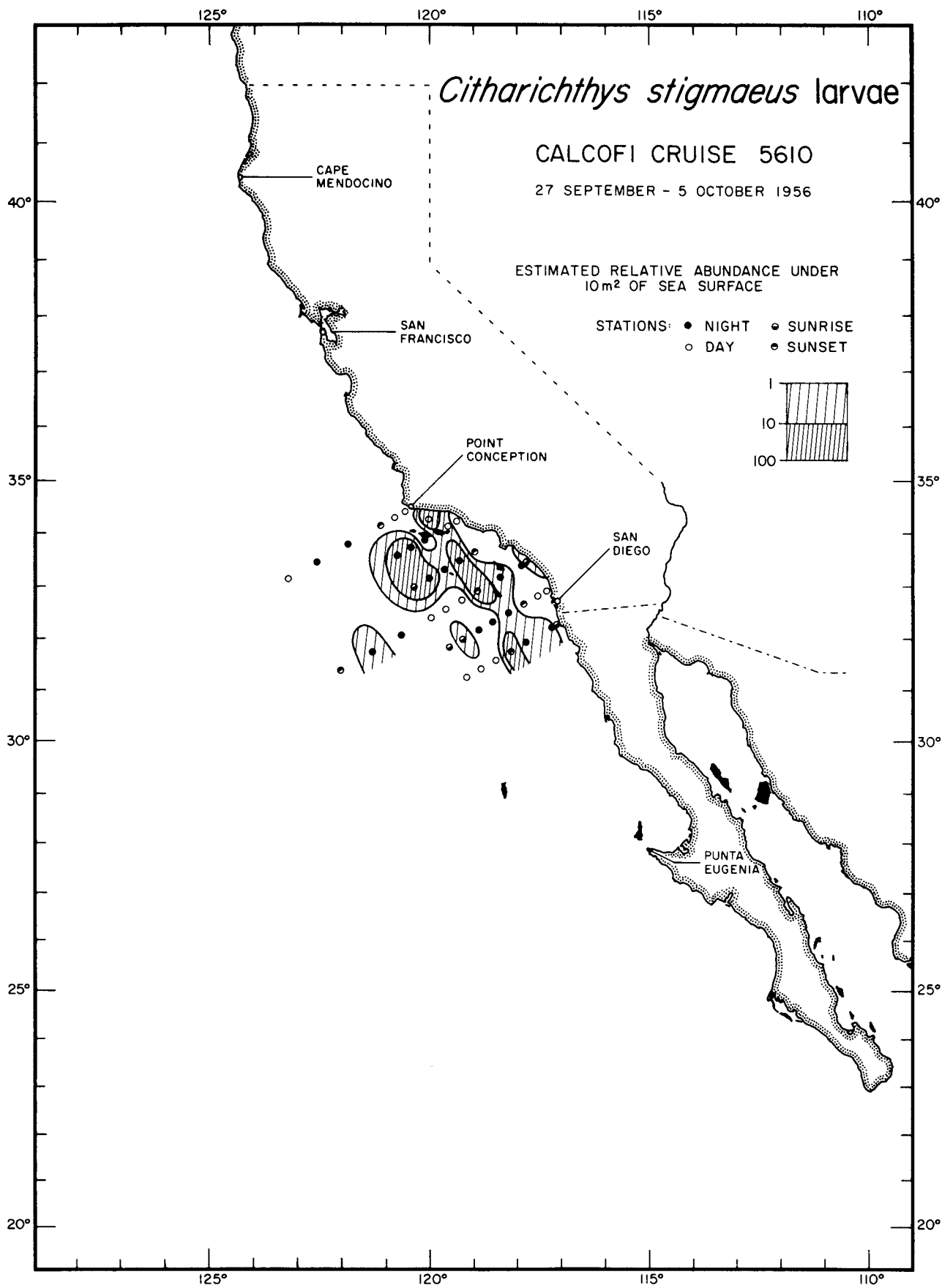
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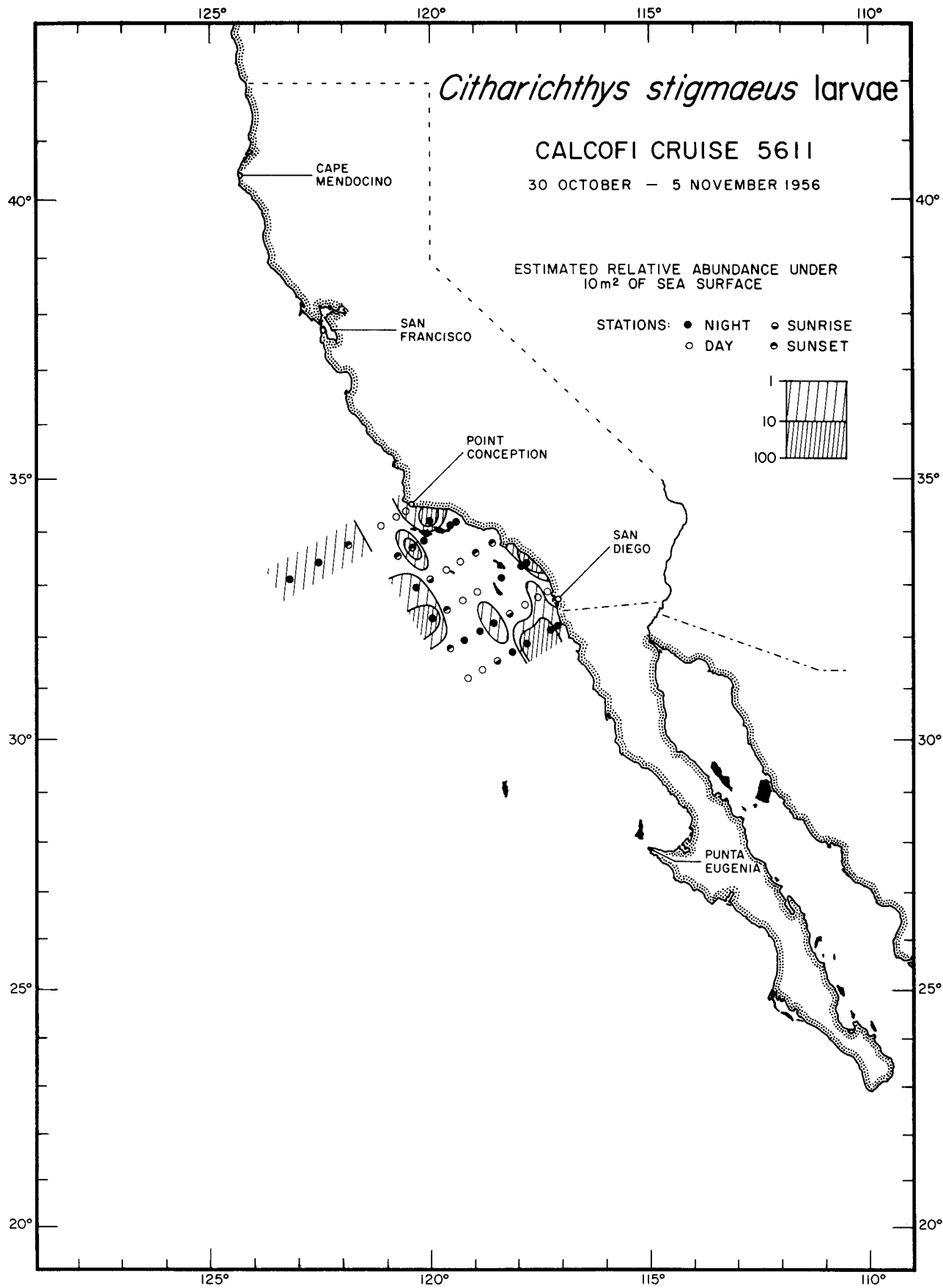
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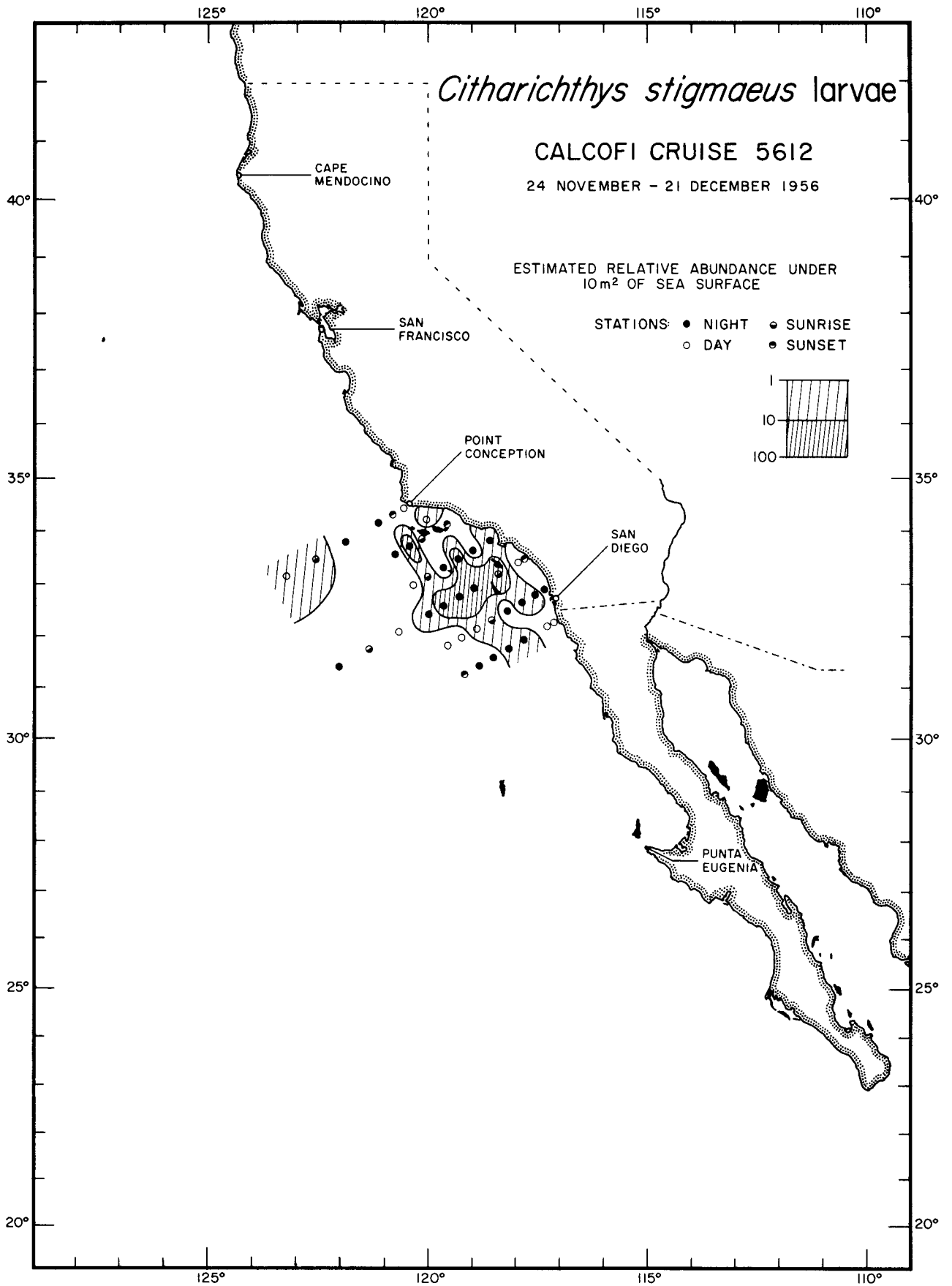
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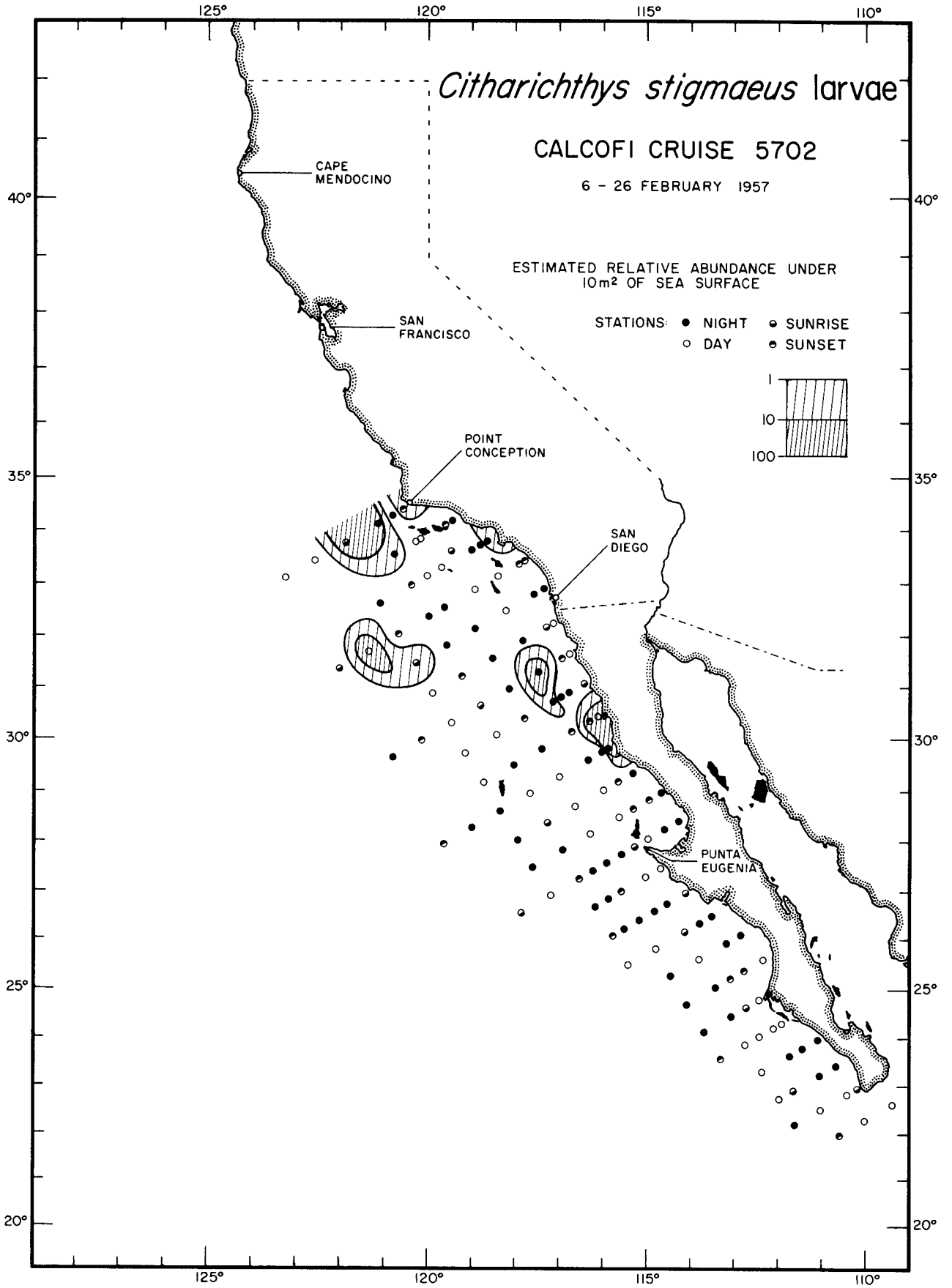
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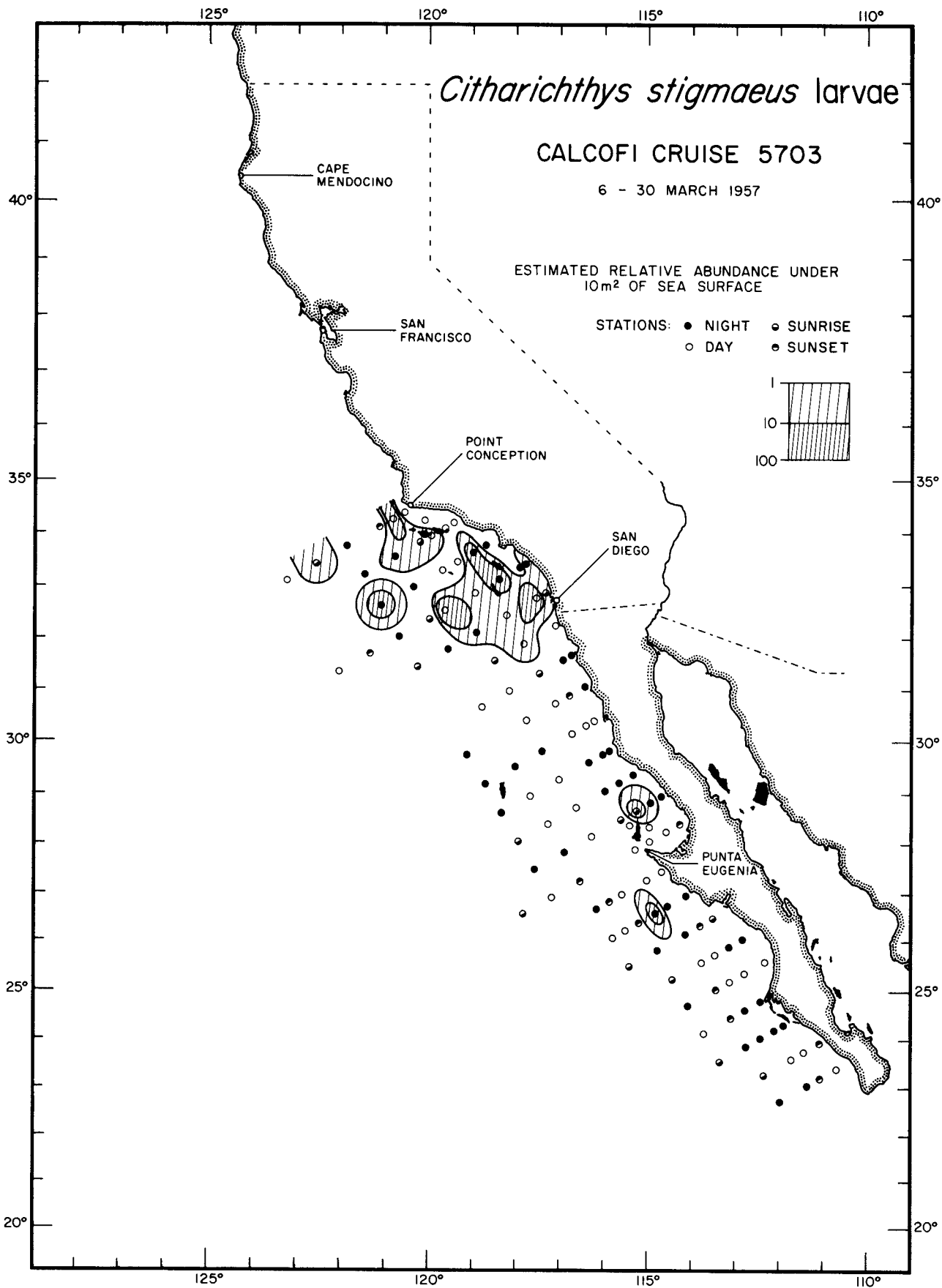
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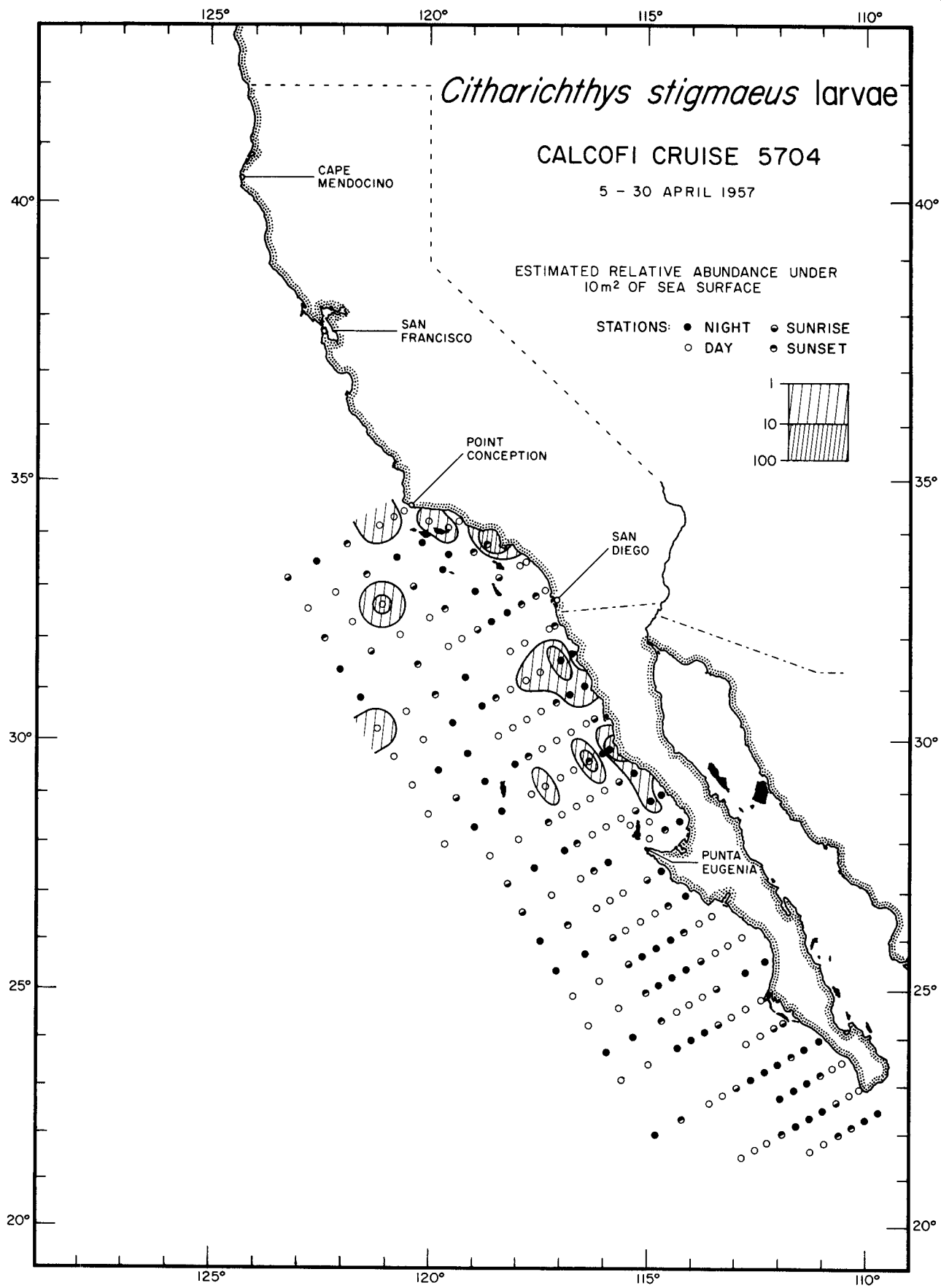
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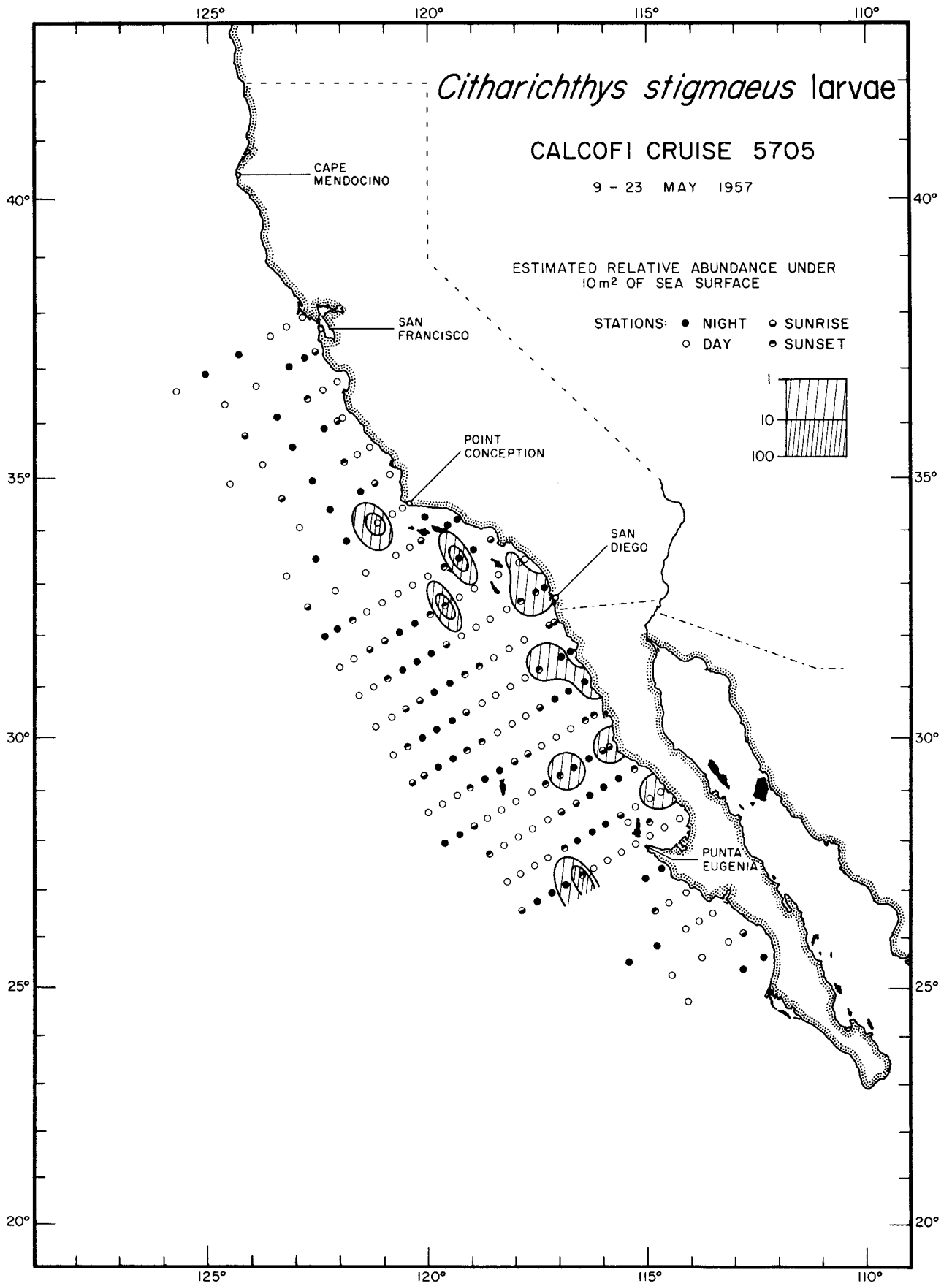
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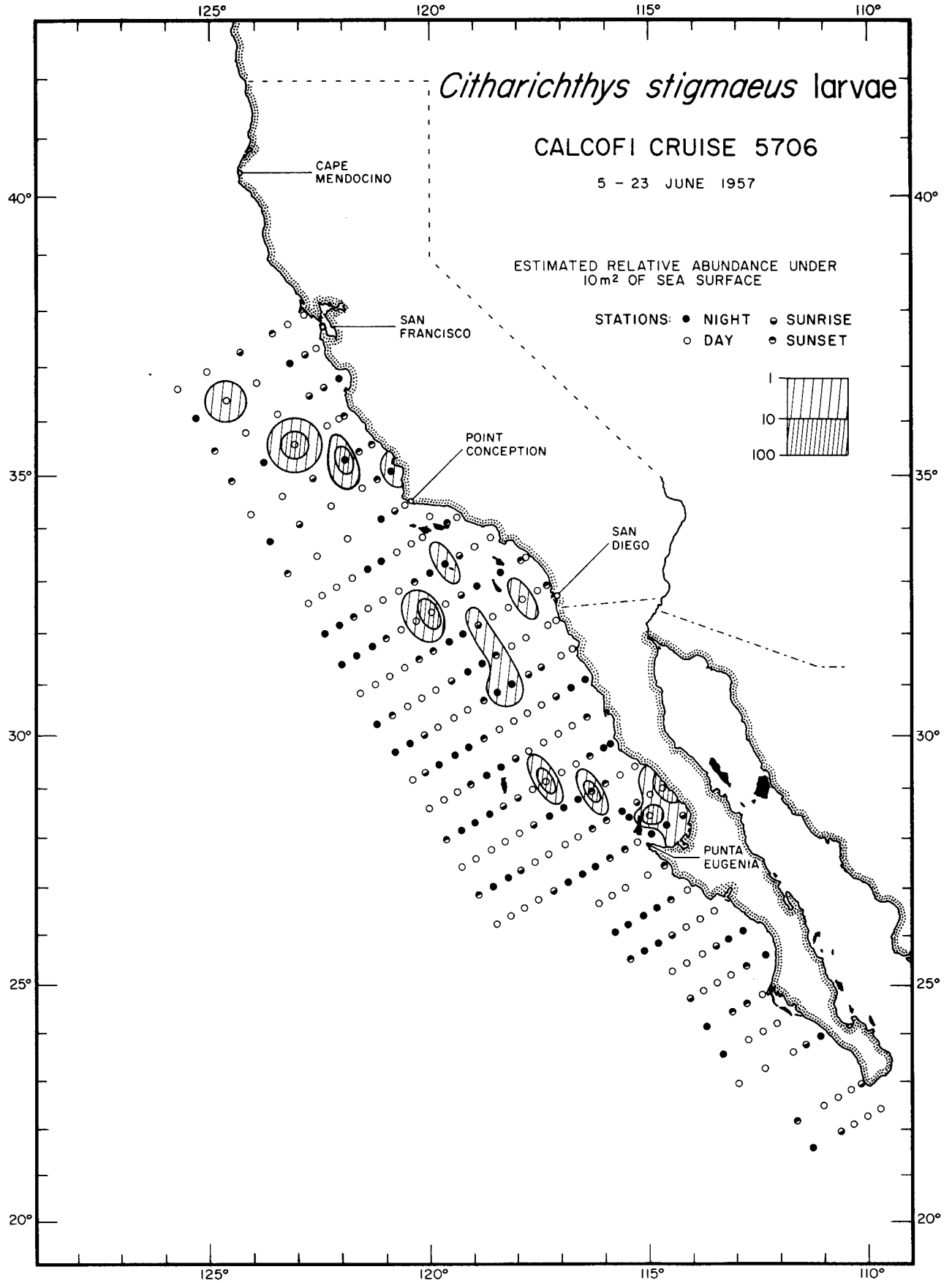
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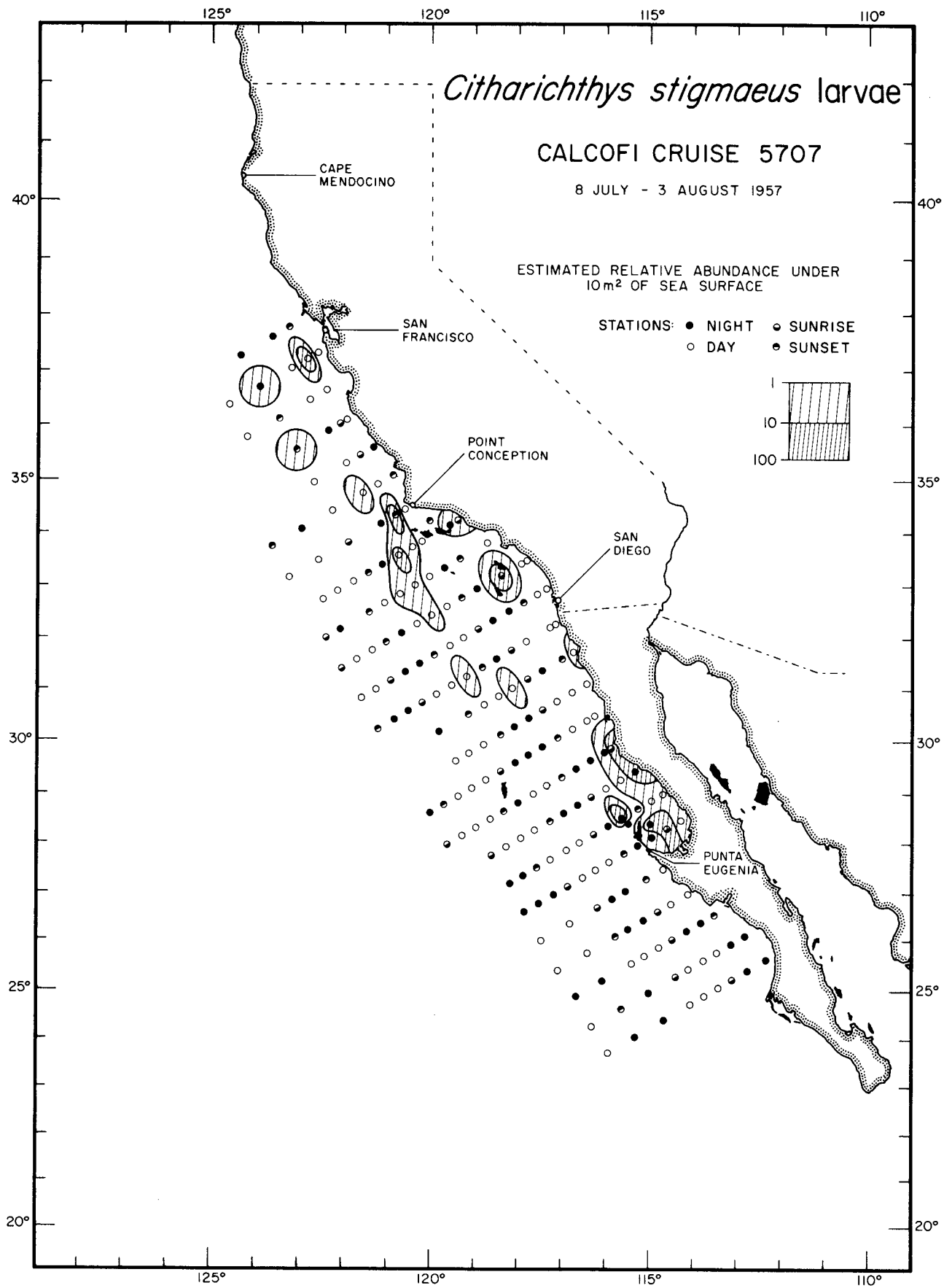
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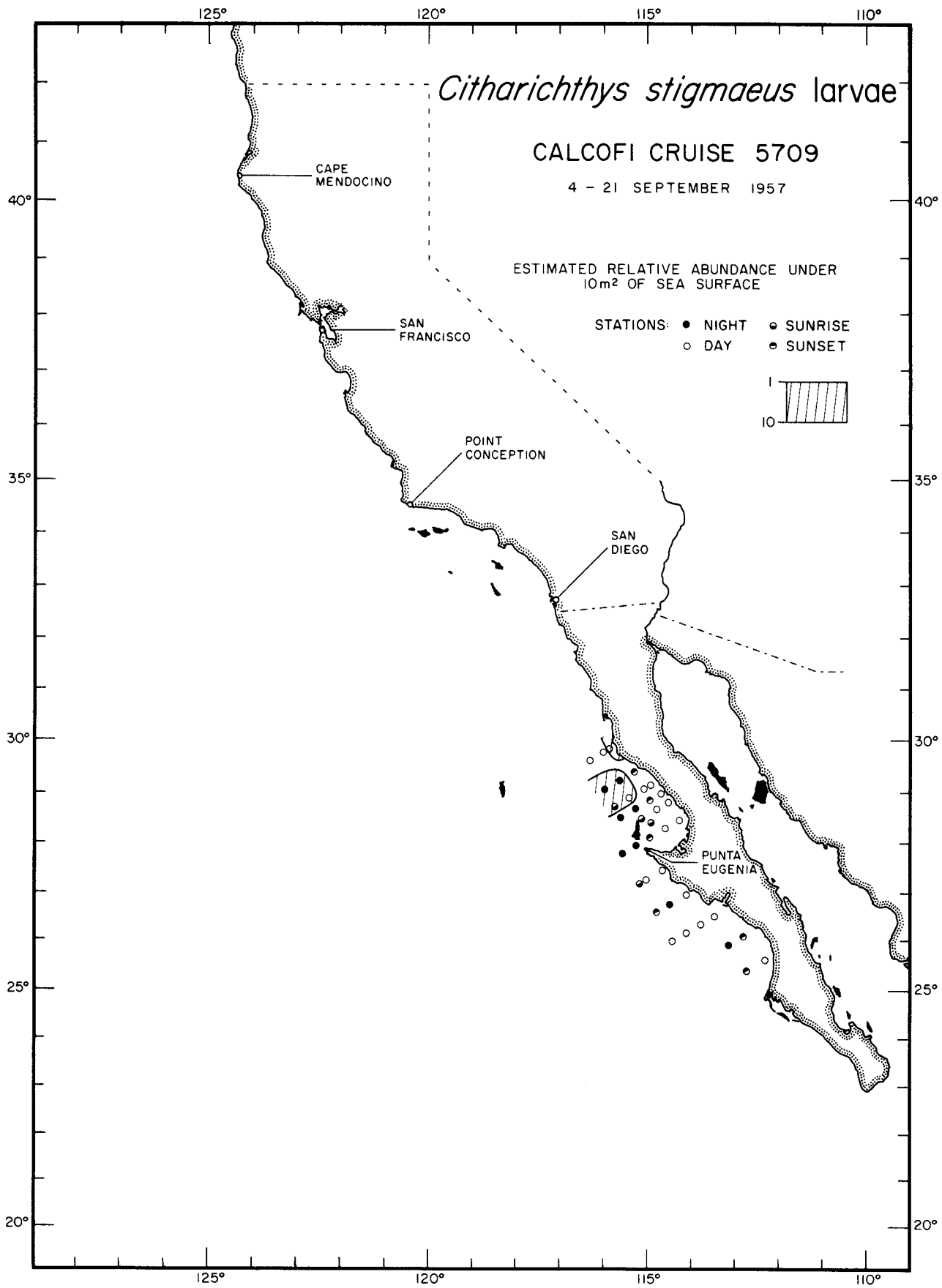
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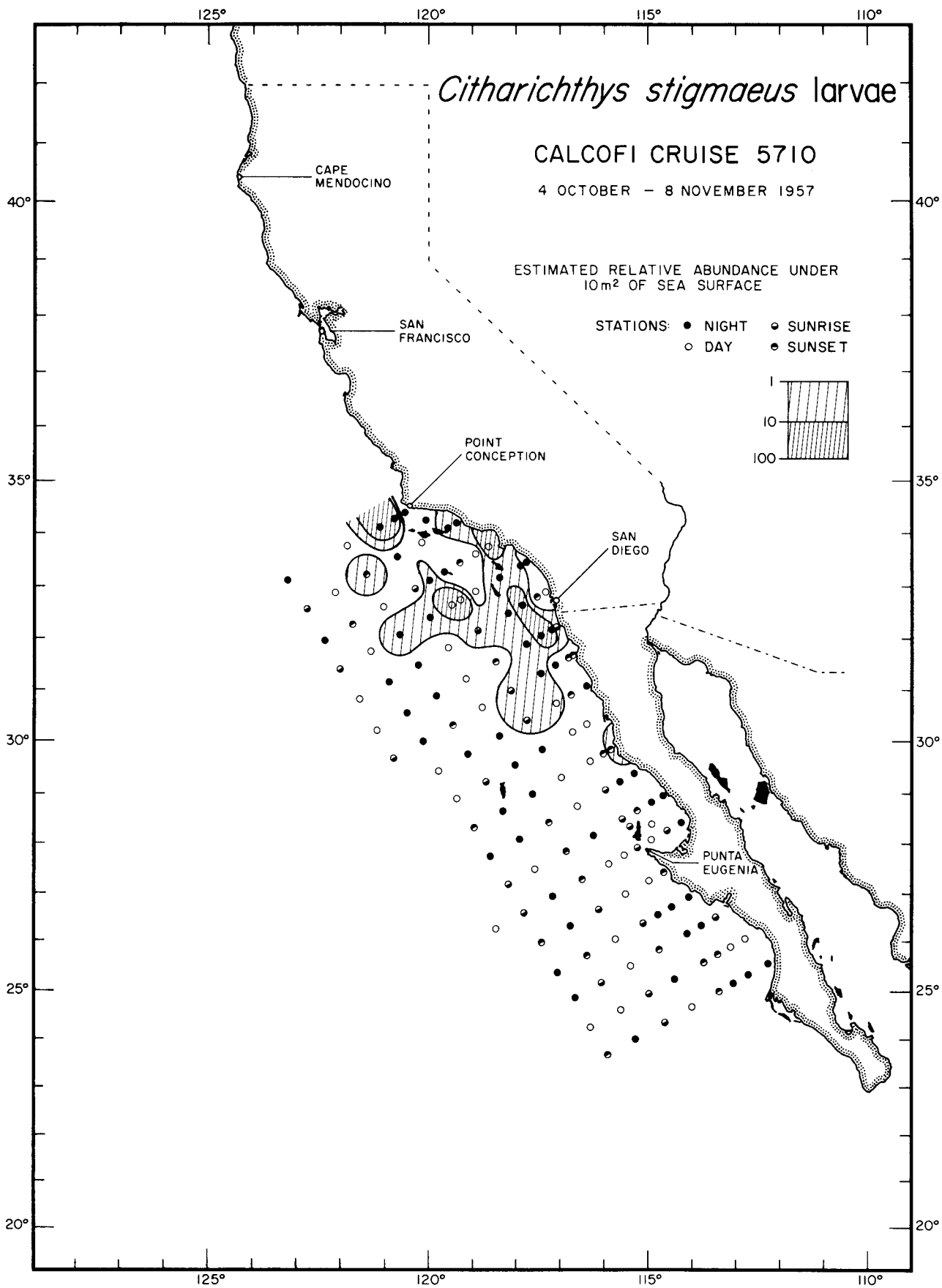
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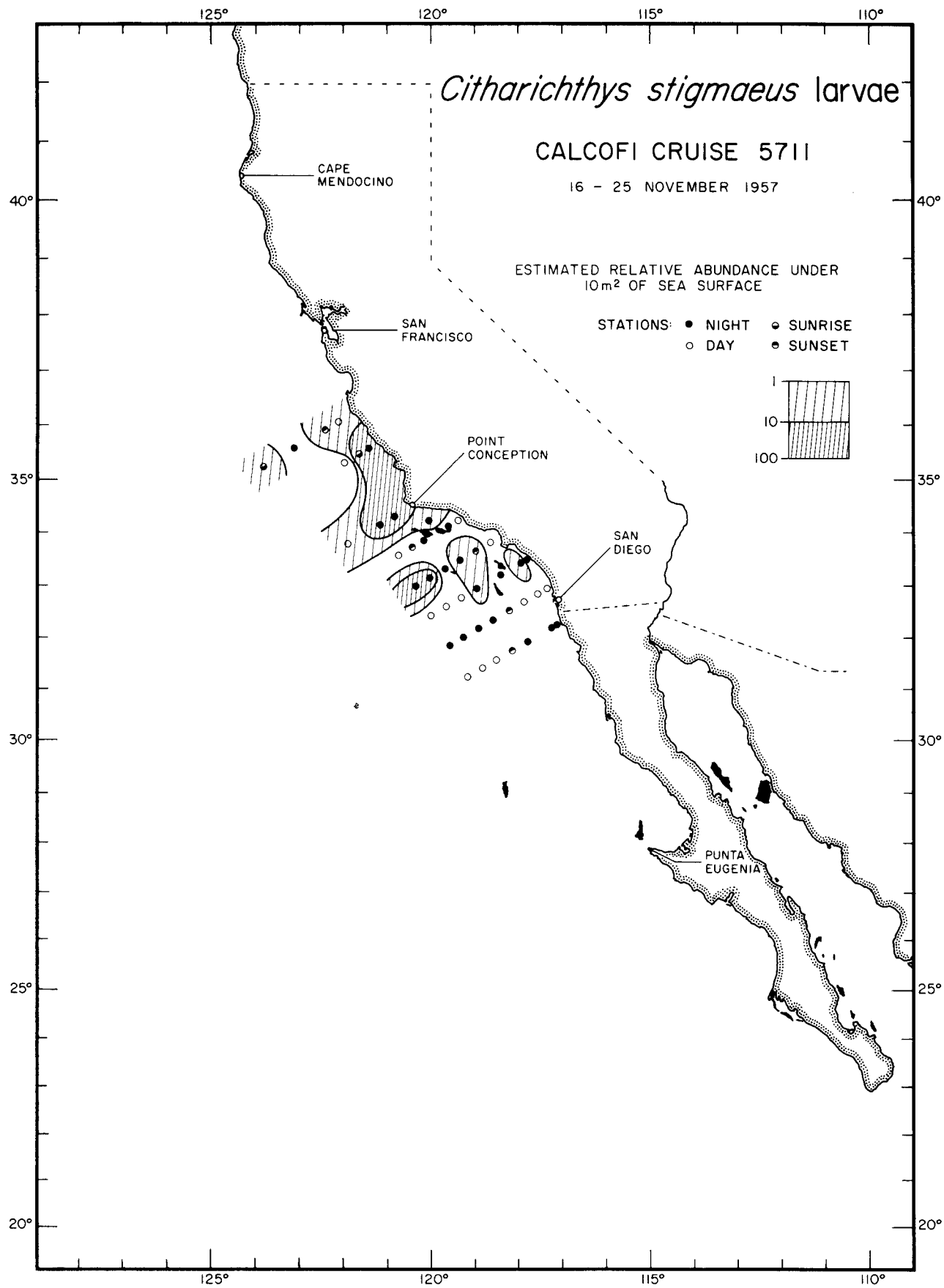
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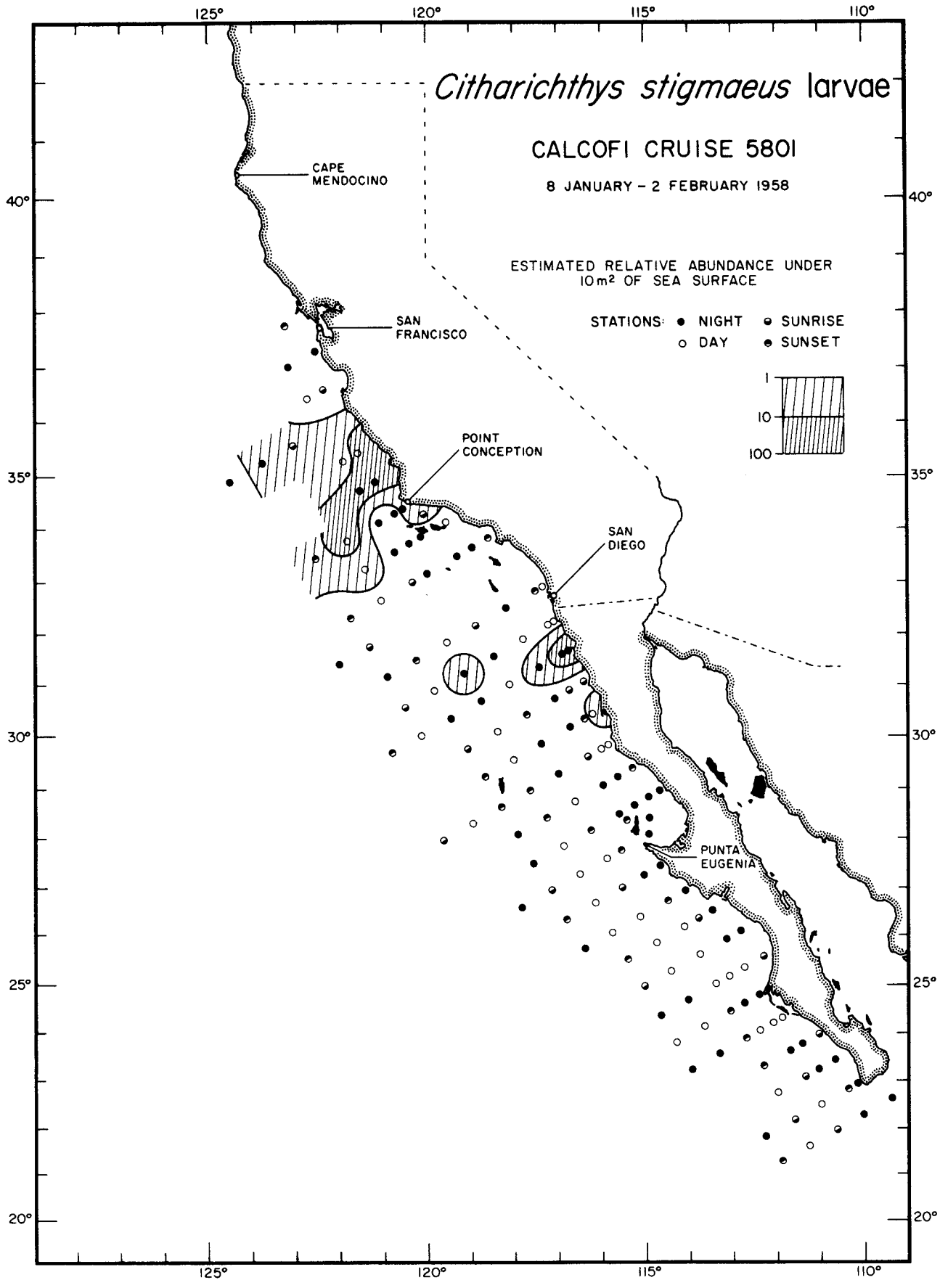
Citharichthys stigmaeus larvae

5710

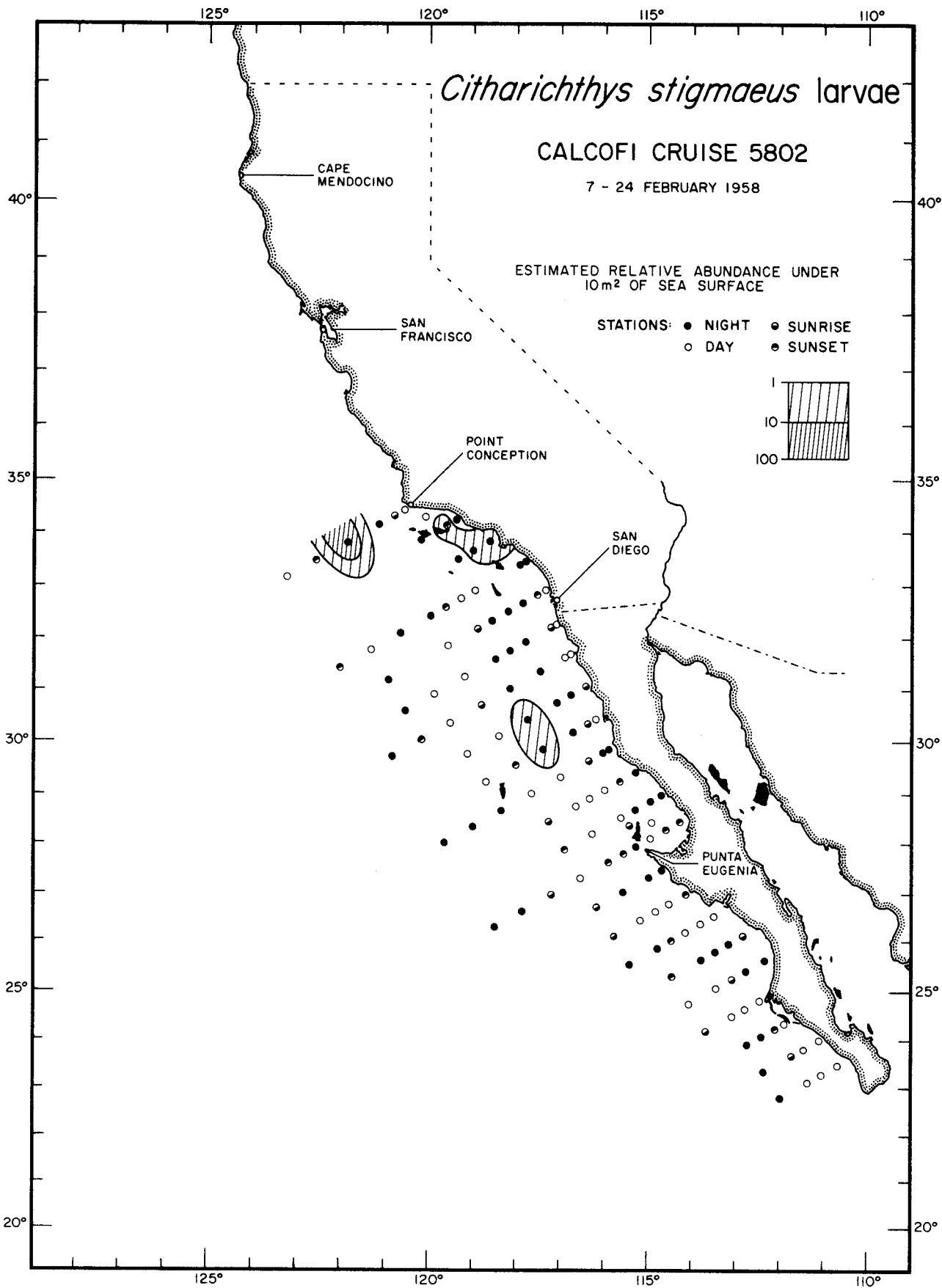


Citharichthys stigmaeus larvae

5711

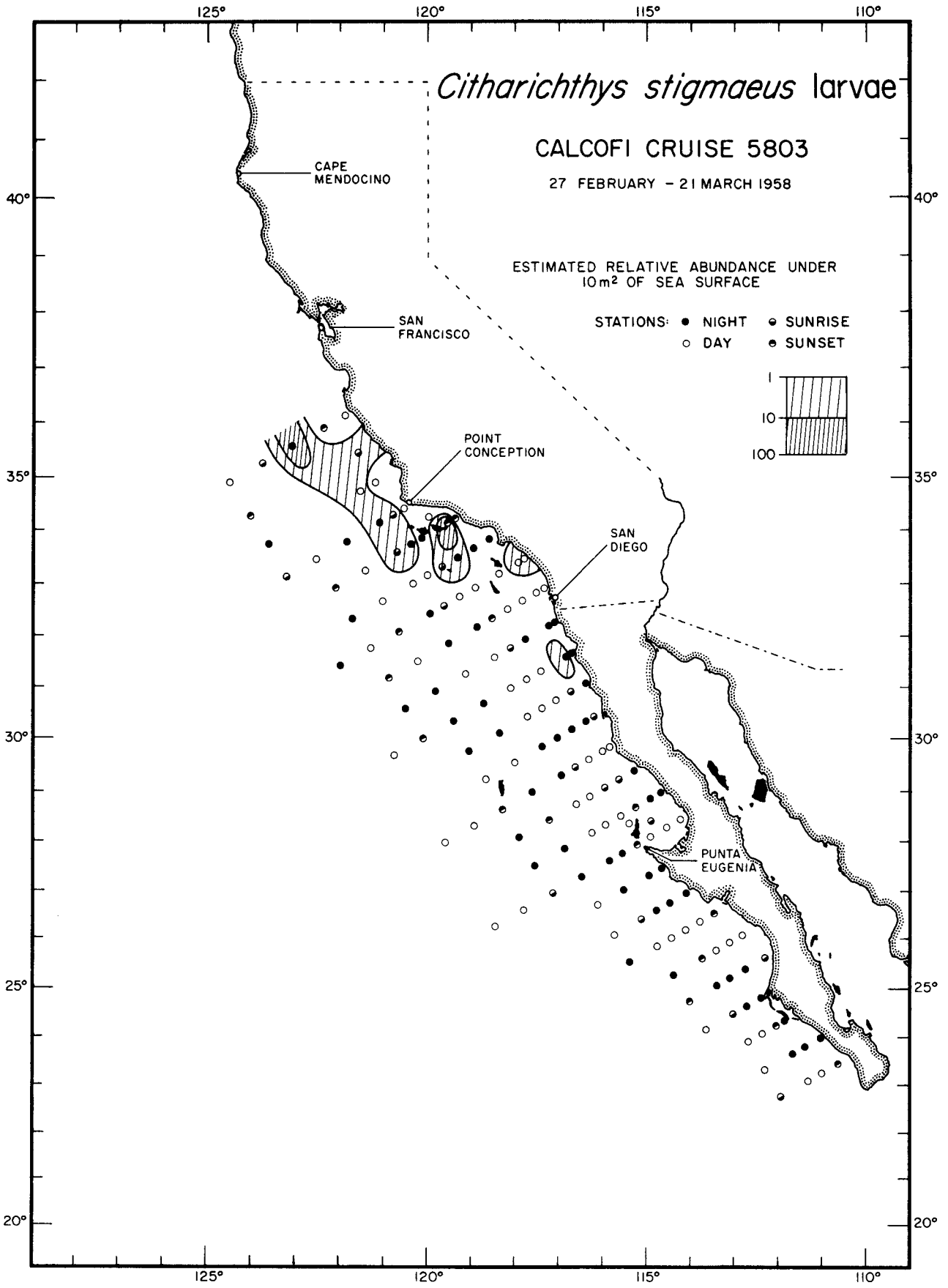


Citharichthys stigmaeus larvae



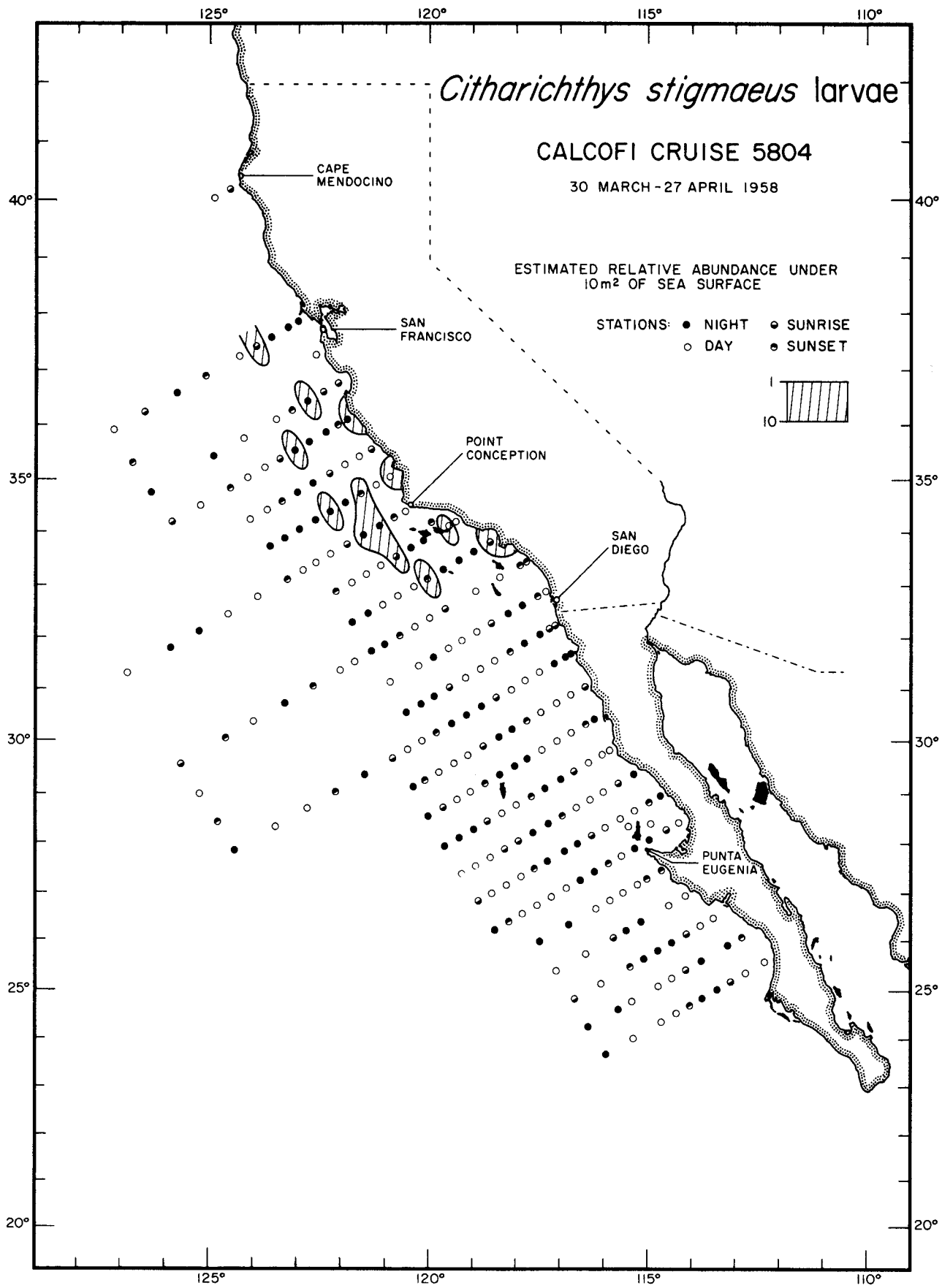
Citharichthys stigmaeus larvae

5802



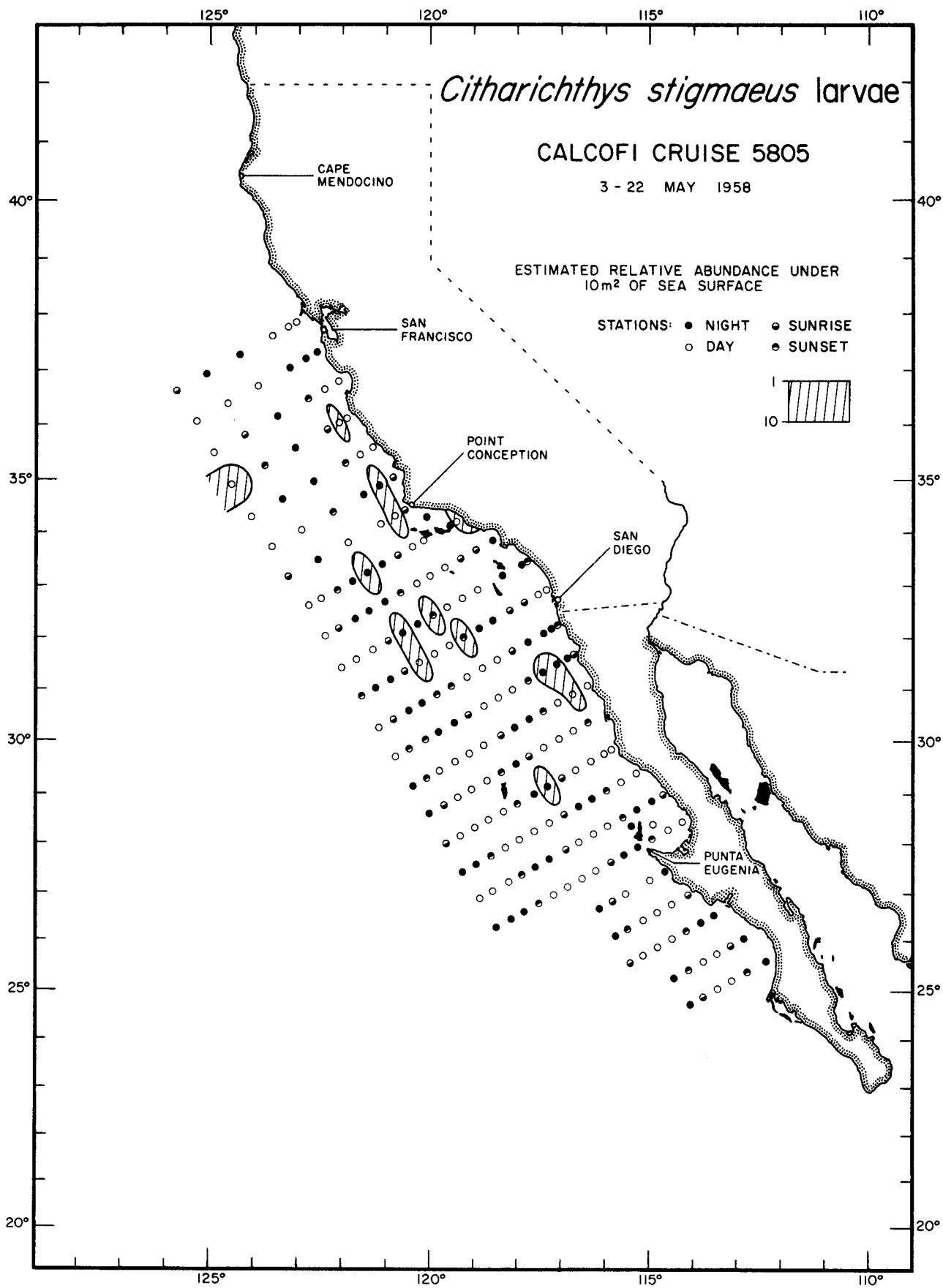
Citharichthys stigmaeus larvae

5803



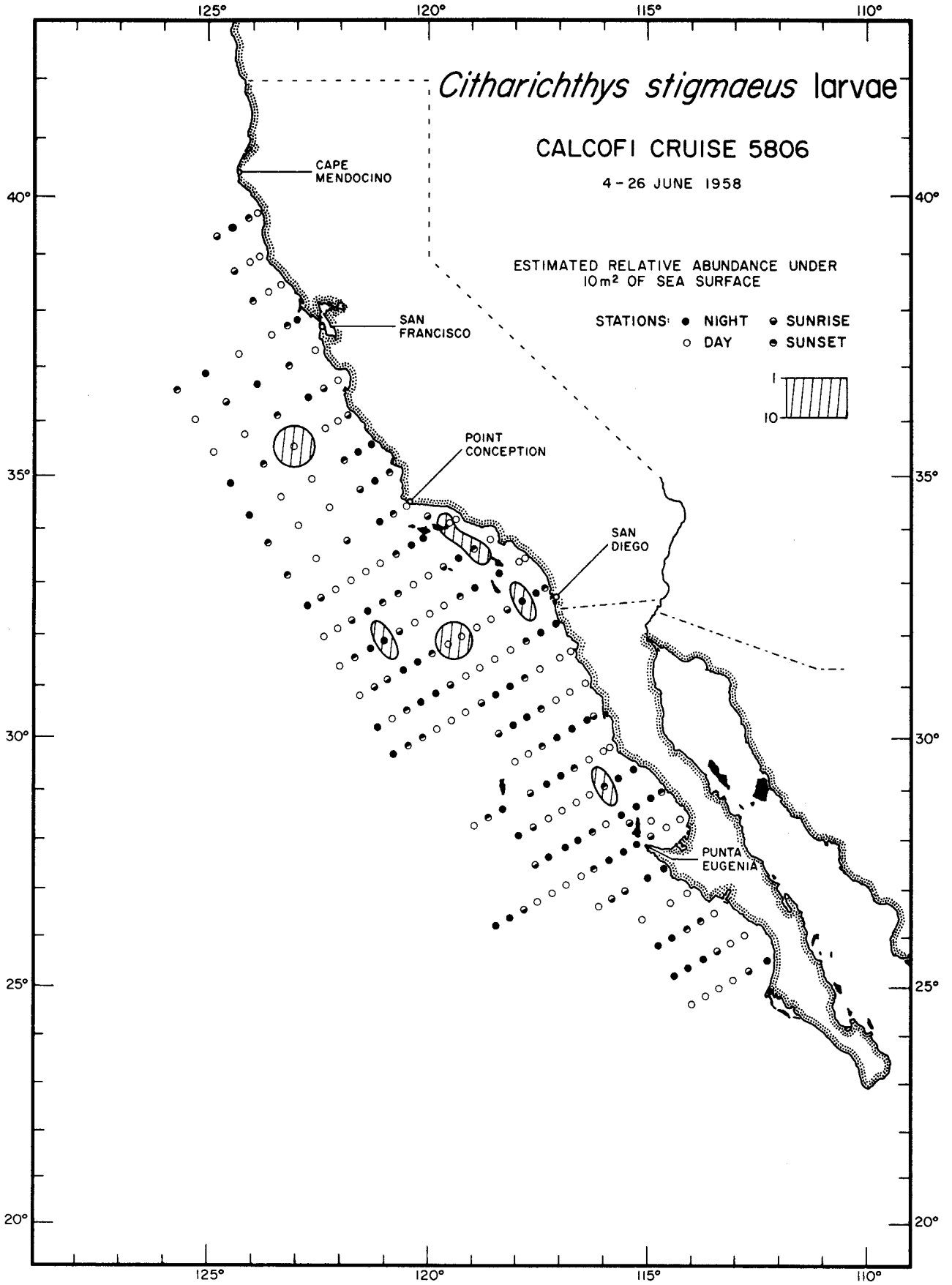
Citharichthys stigmaeus larvae

5804



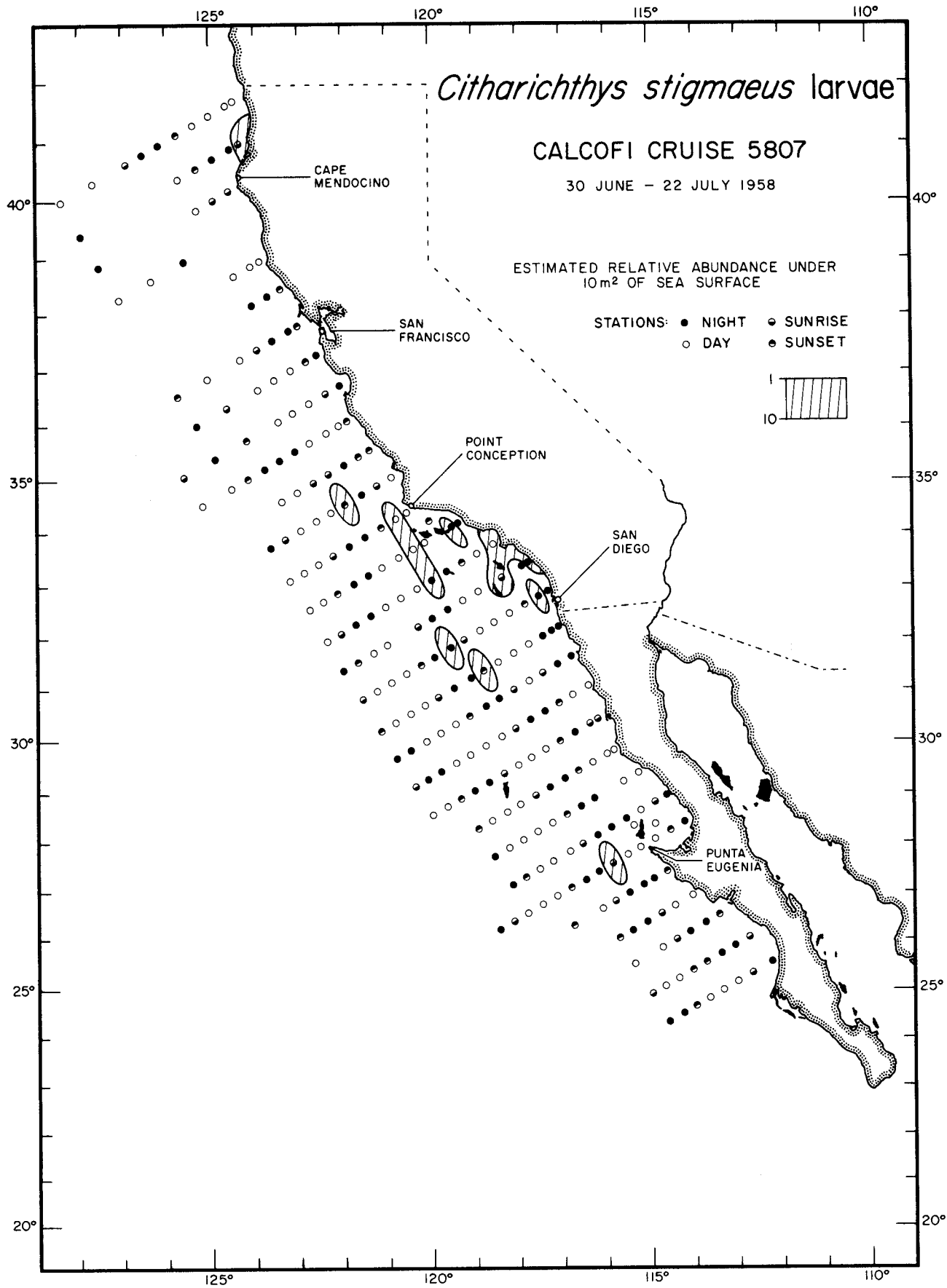
Citharichthys stigmaeus larvae

5805

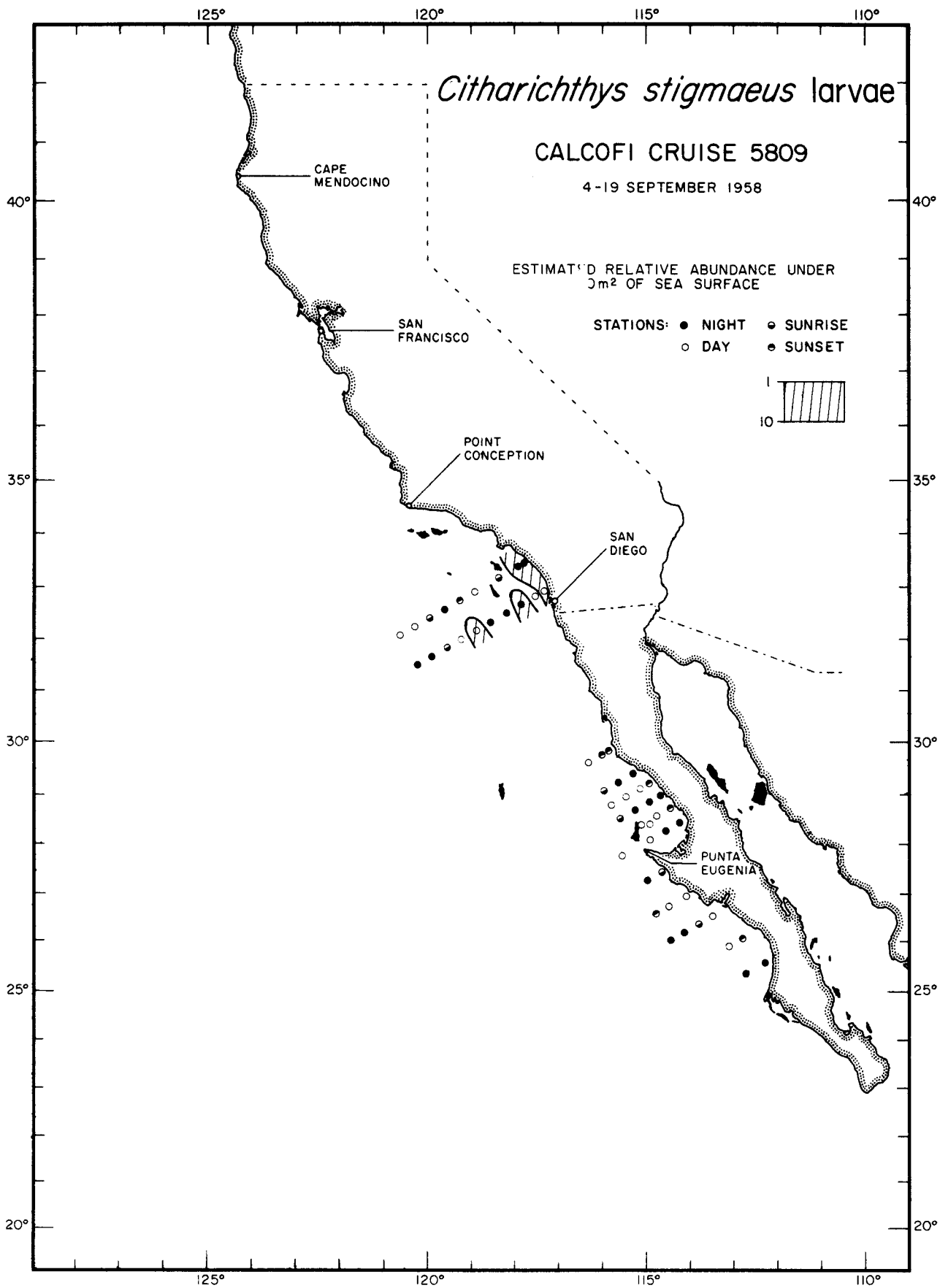


Citharichthys stigmaeus larvae

5806

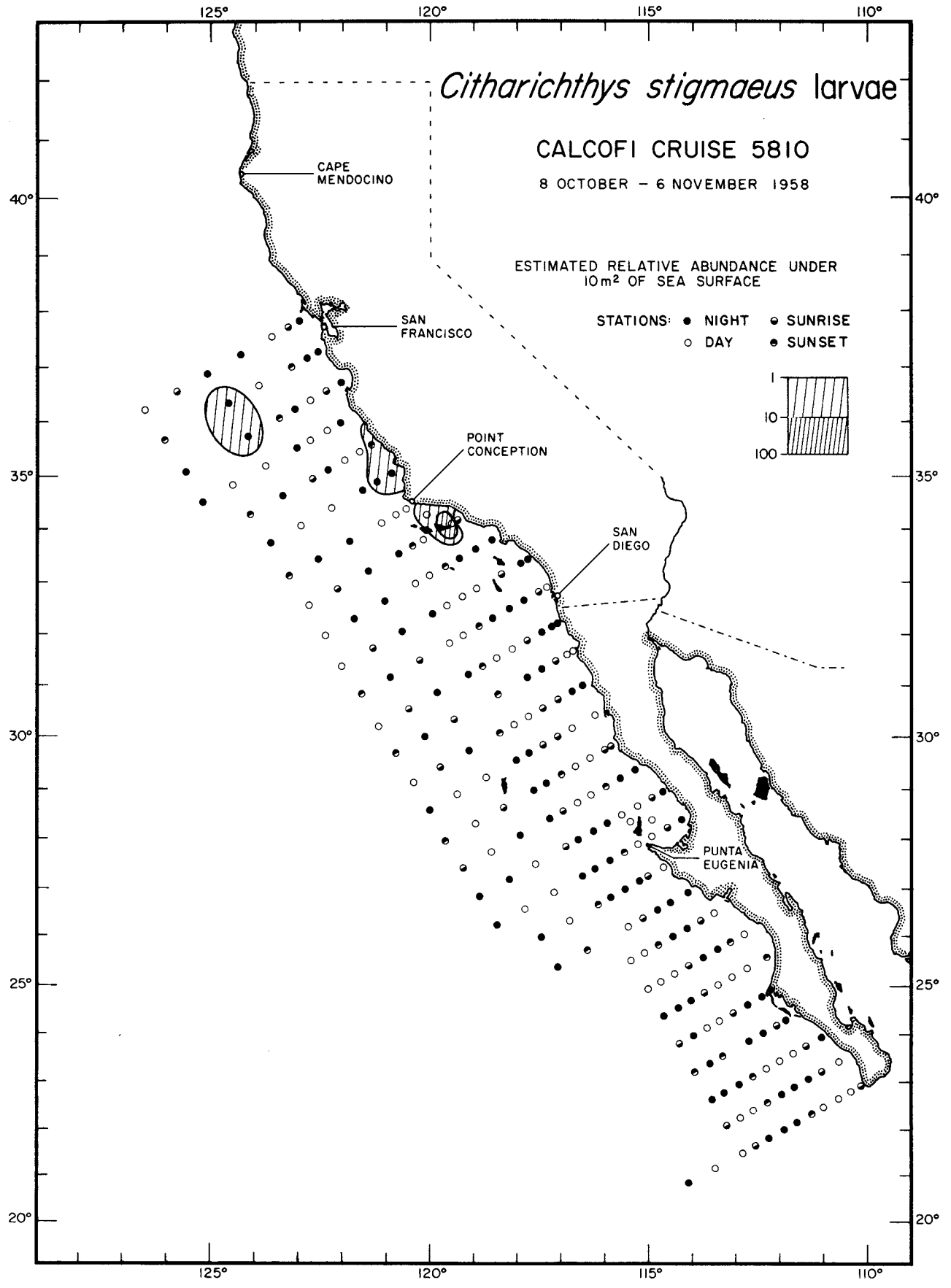


Citharichthys stigmaeus larvae



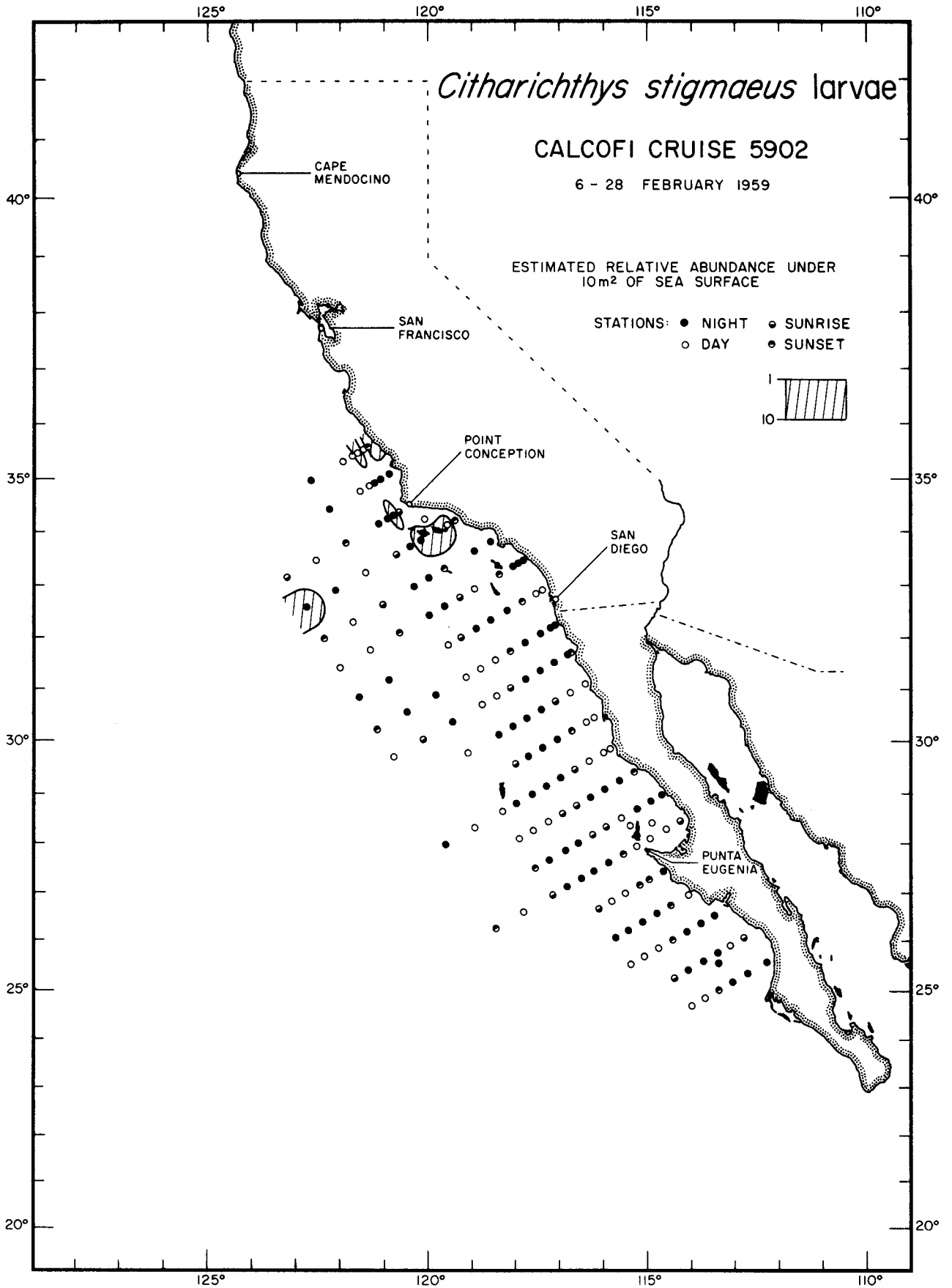
Citharichthys stigmaeus larvae

5809



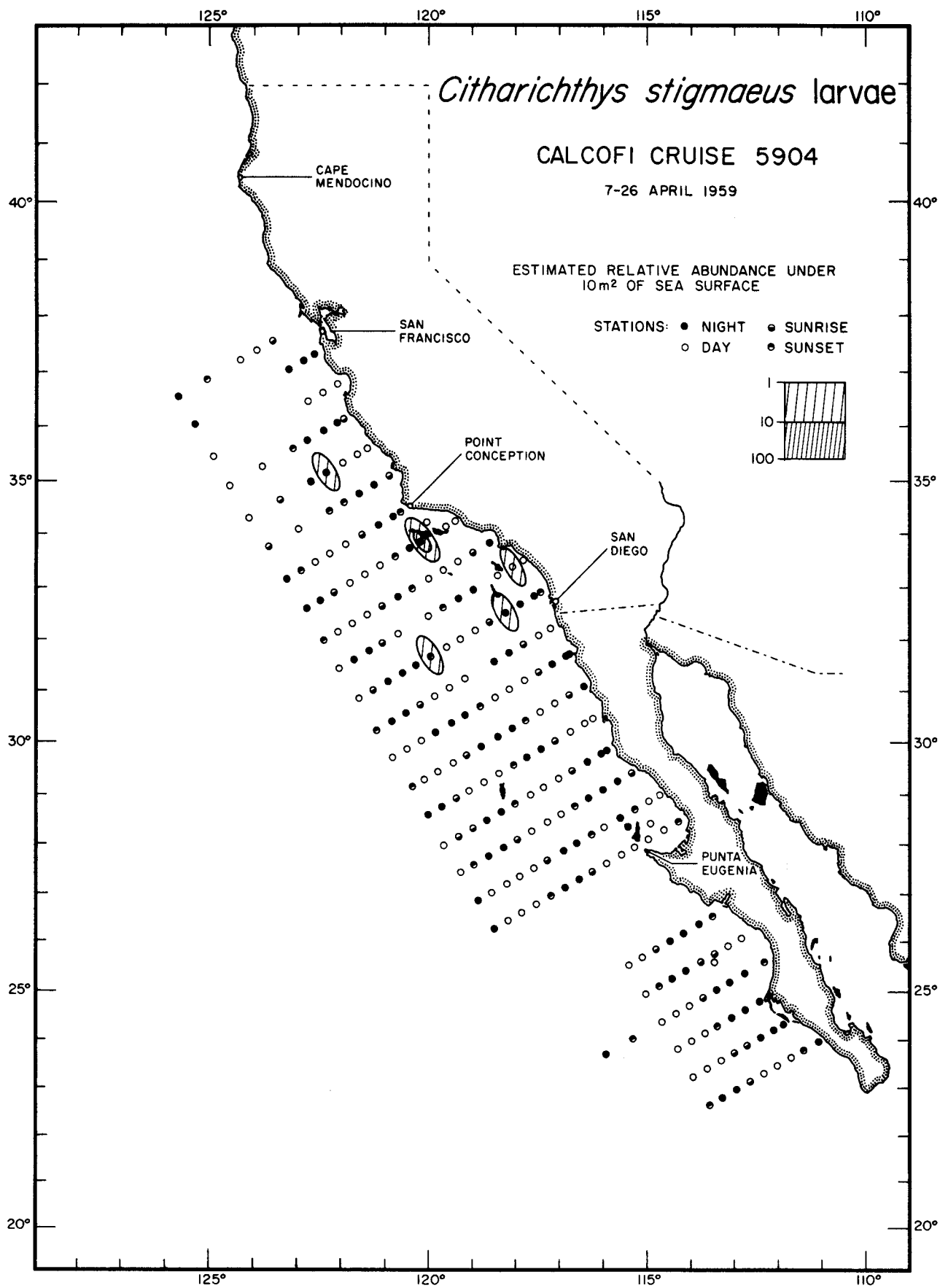
Citharichthys stigmaeus larvae

5810



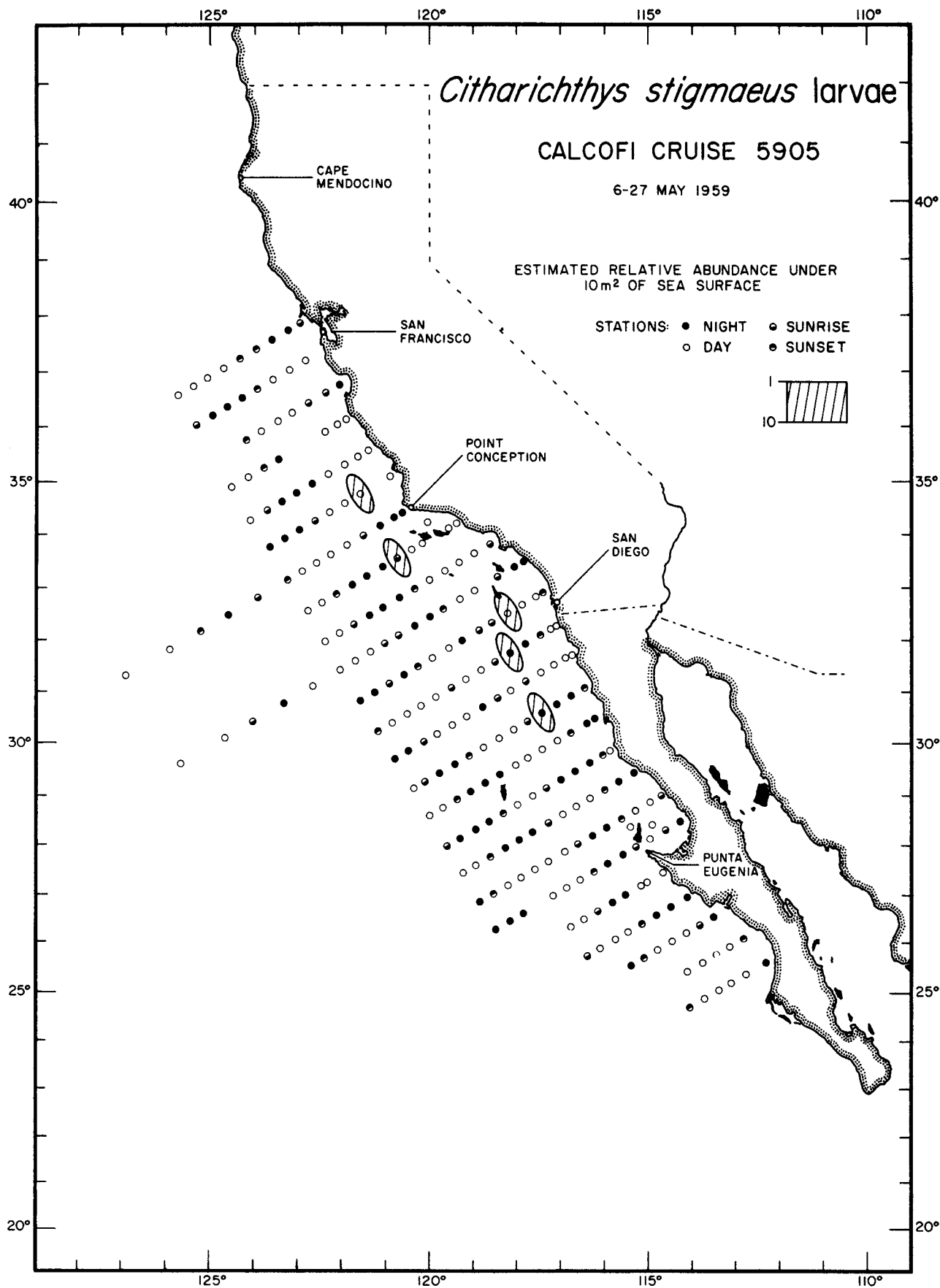
Citharichthys stigmaeus larvae

5902



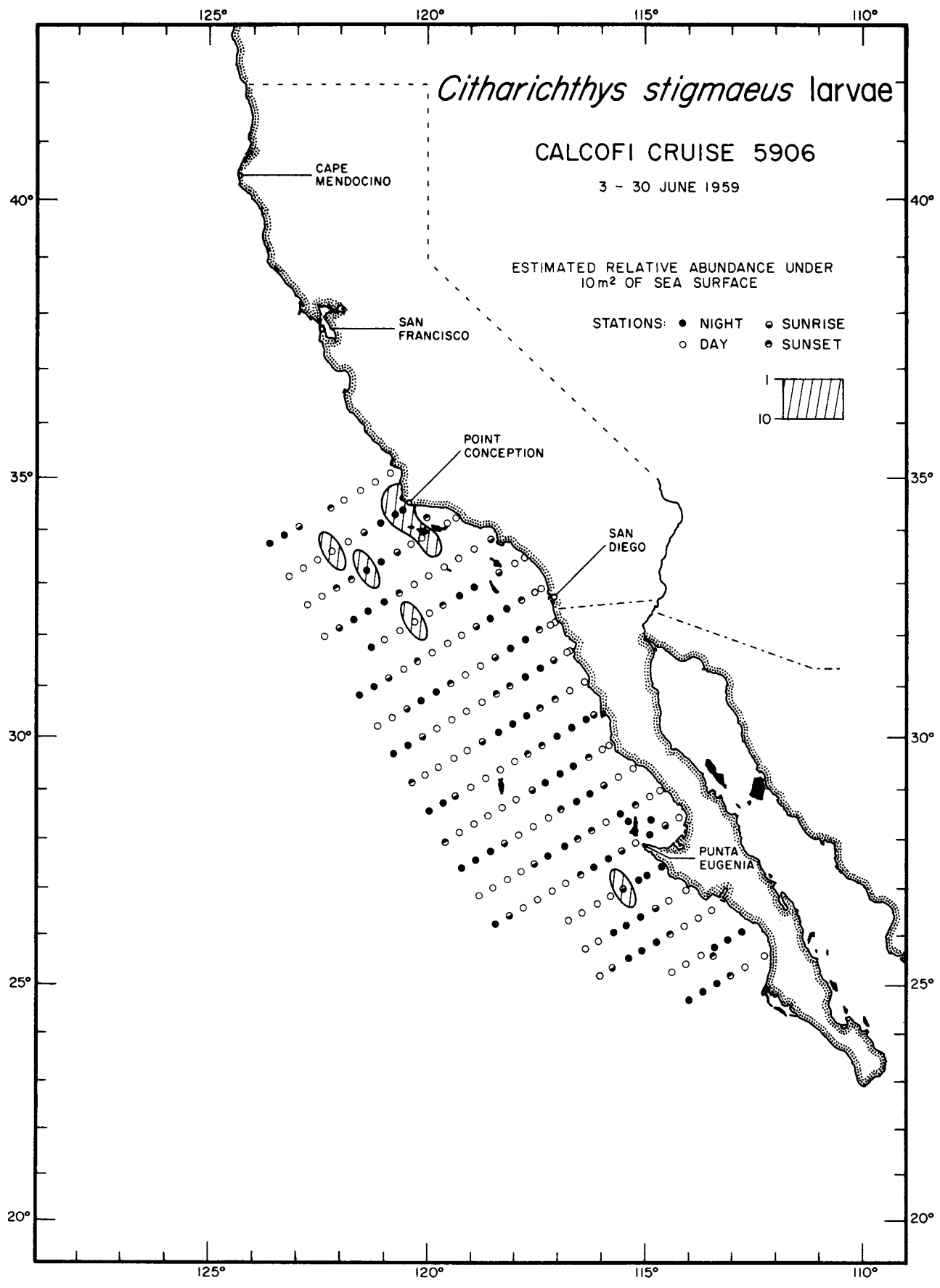
Citharichthys stigmaeus larvae

5904

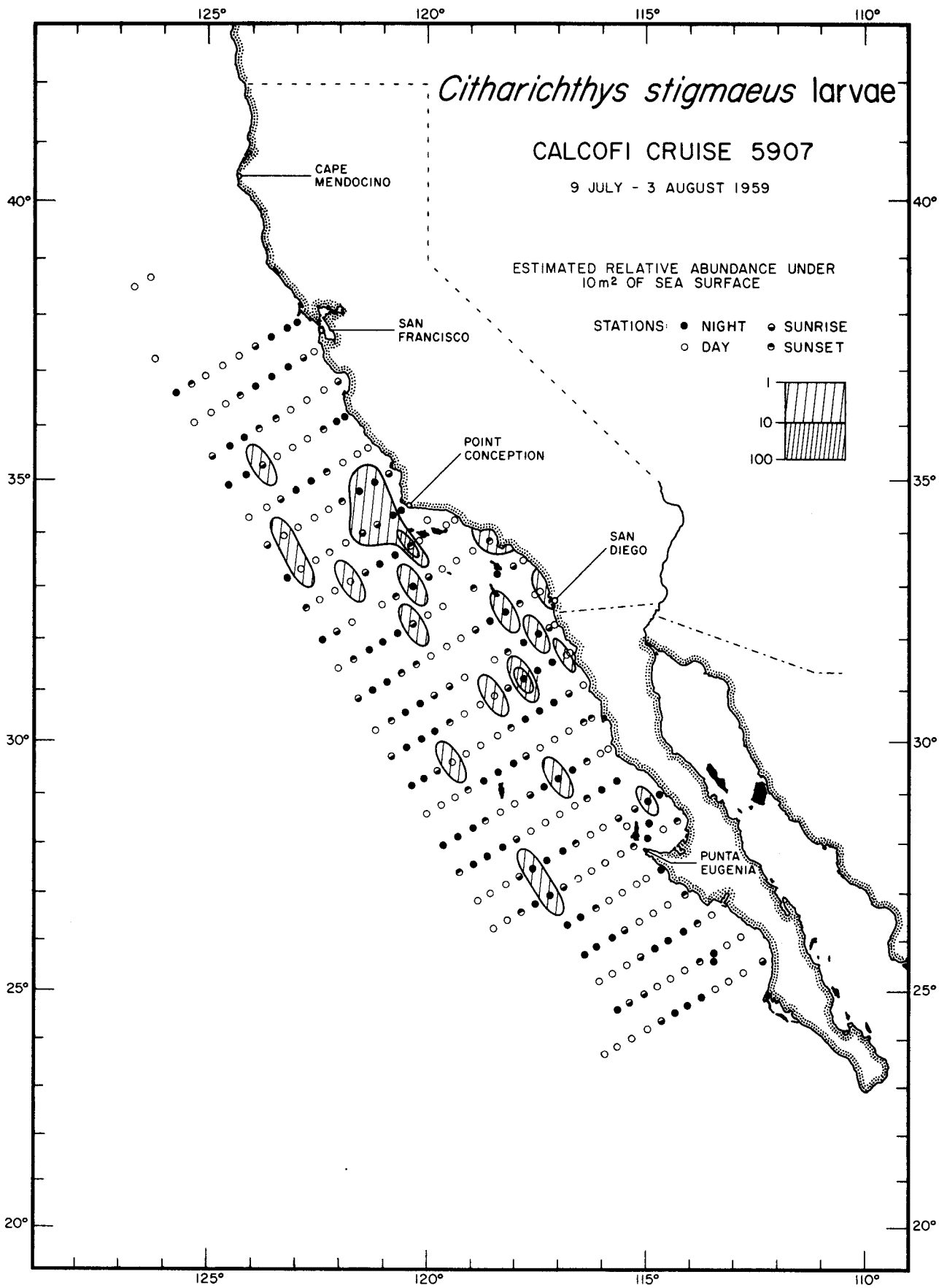


Citharichthys stigmaeus larvae

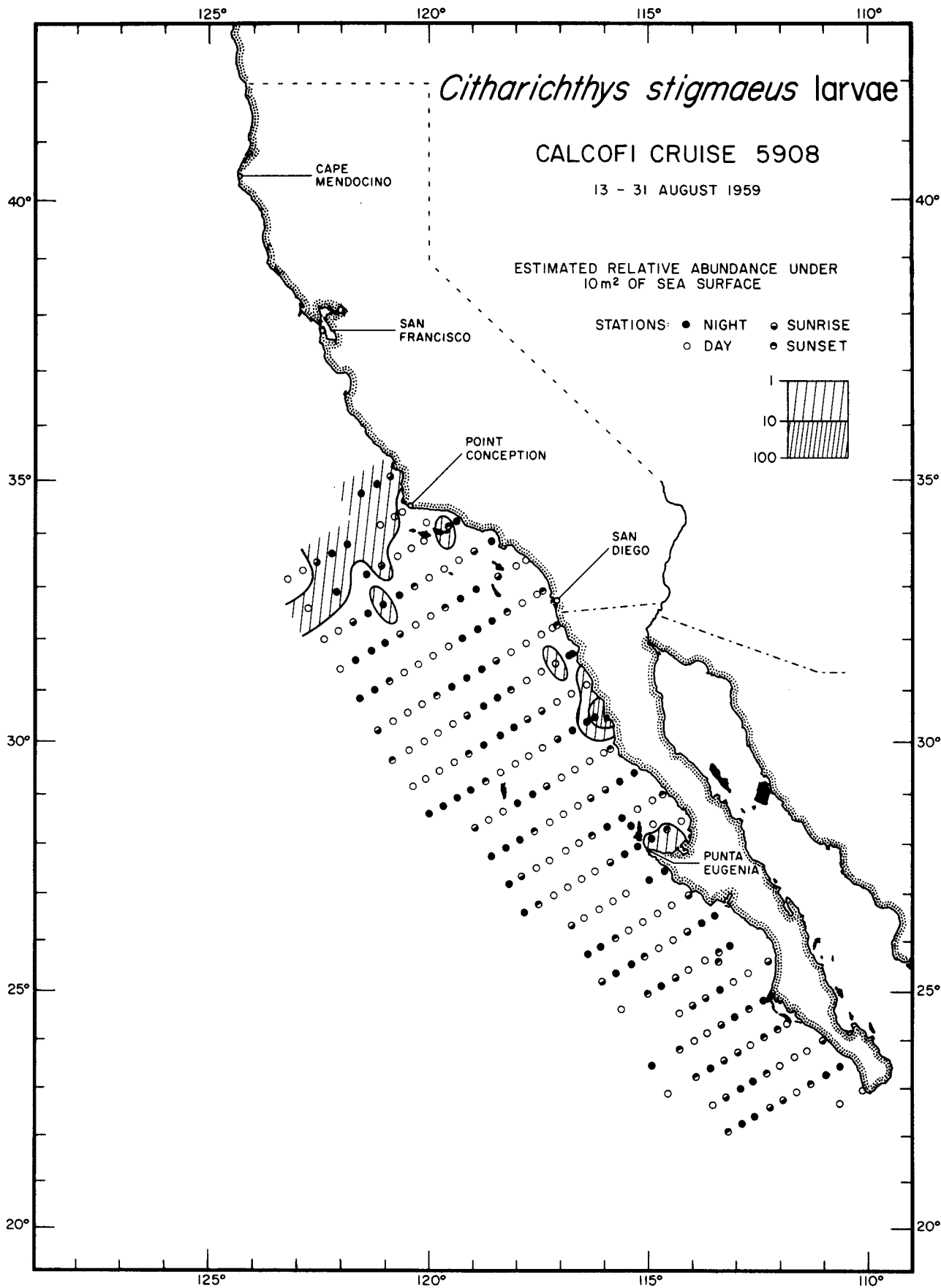
5905



Citharichthys stigmaeus larvae

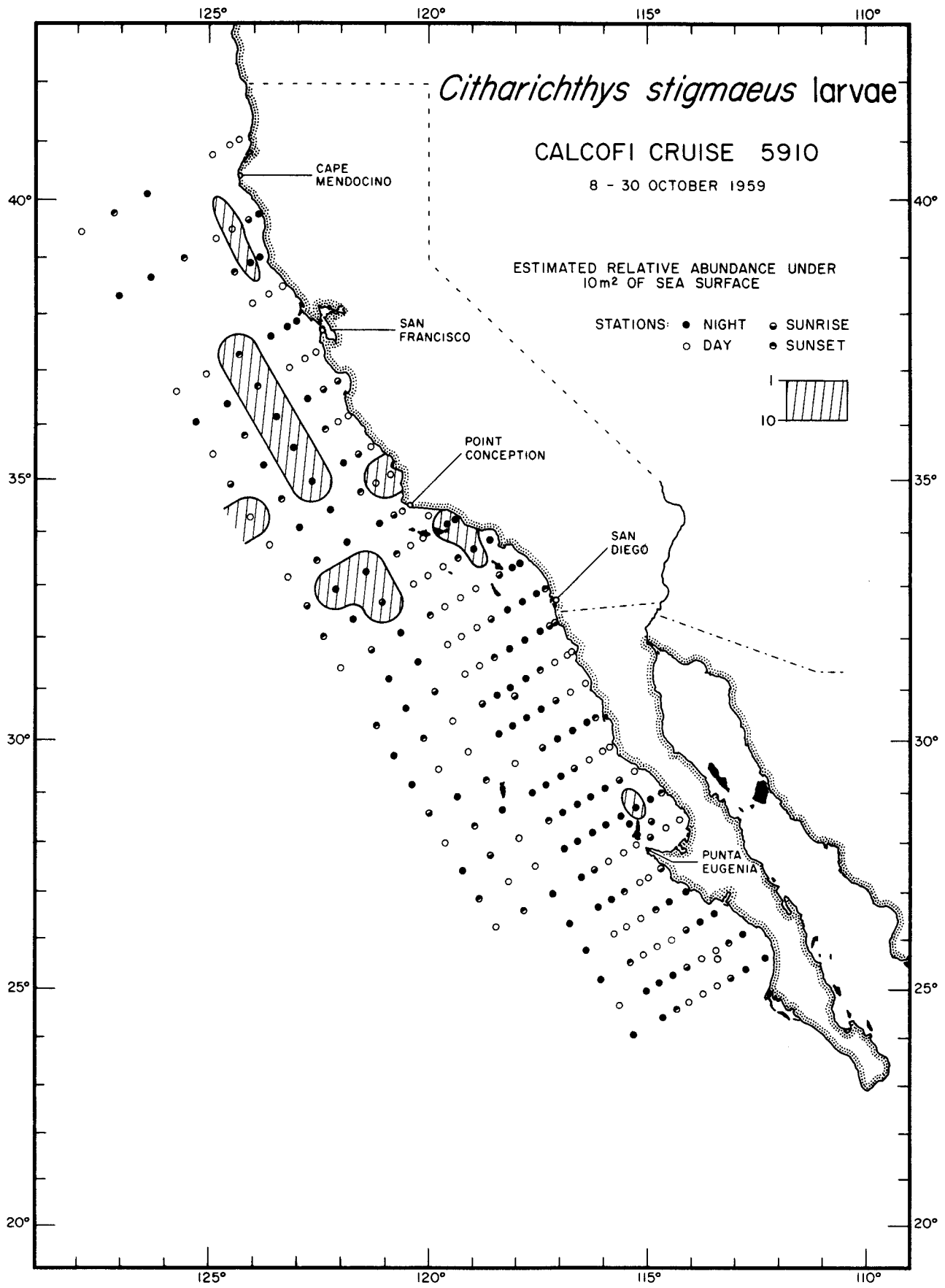


Citharichthys stigmaeus larvae

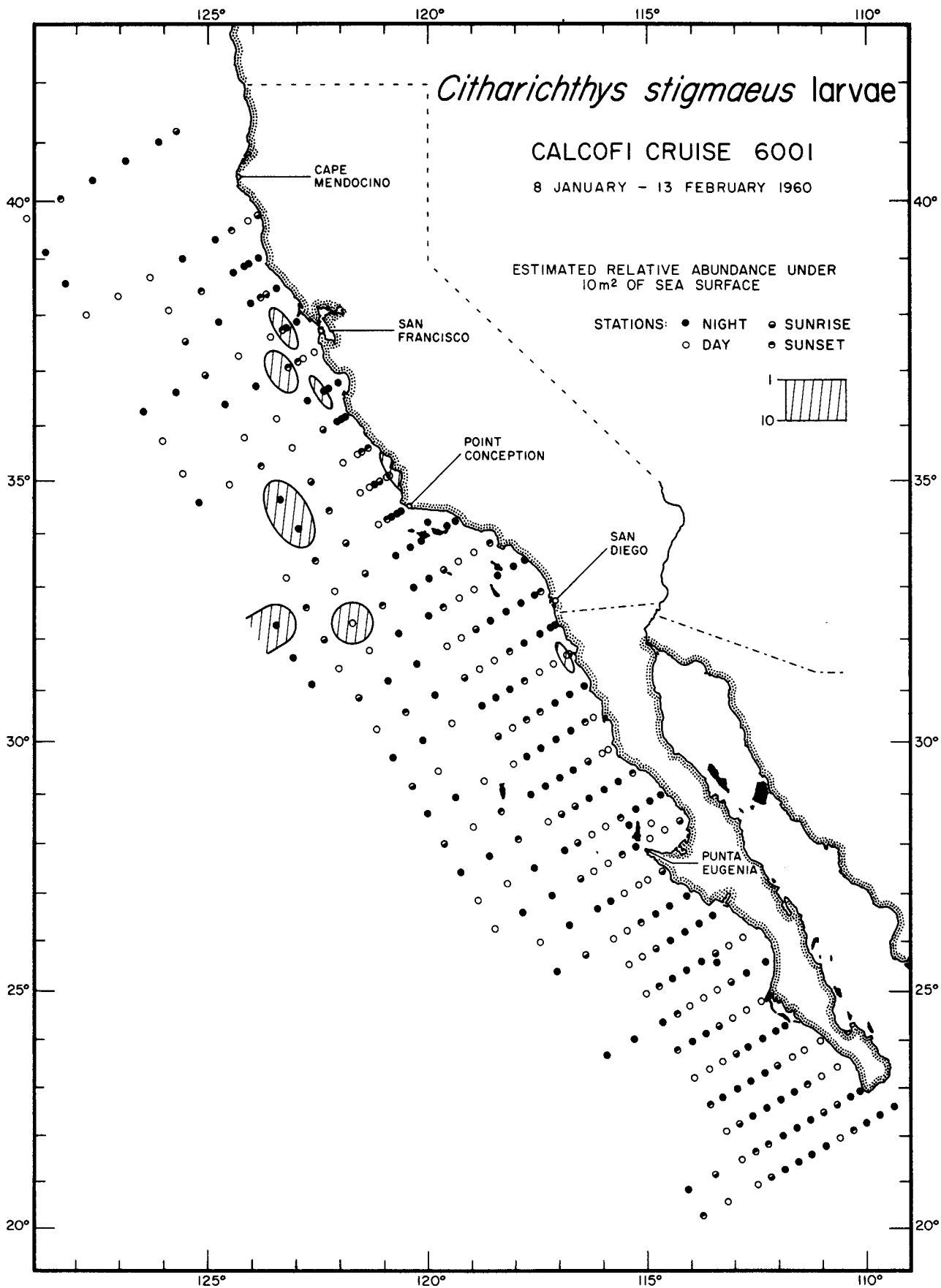


Citharichthys stigmaeus larvae

5908

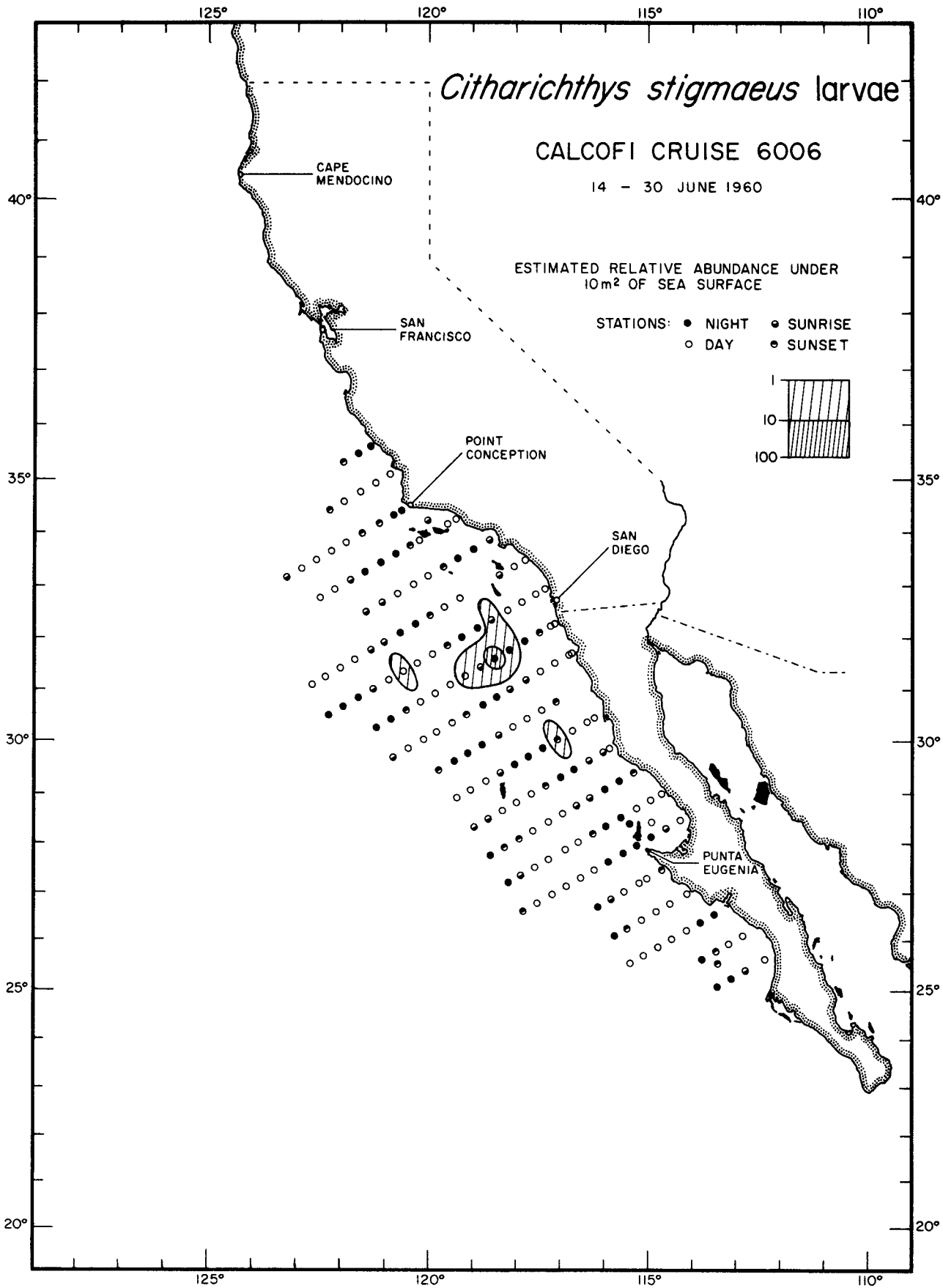


Citharichthys stigmaeus larvae
5910



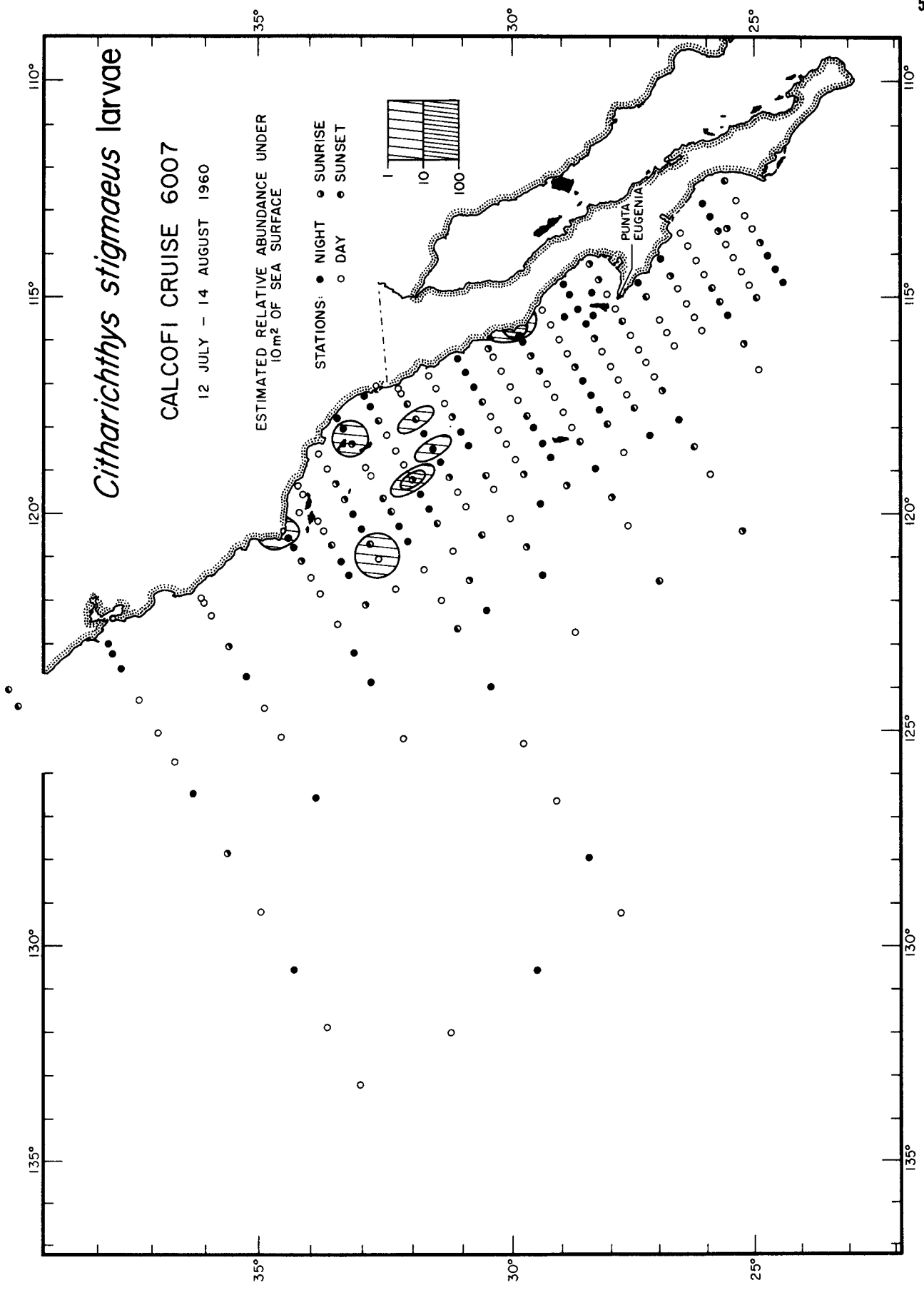
Citharichthys stigmaeus larvae

6001



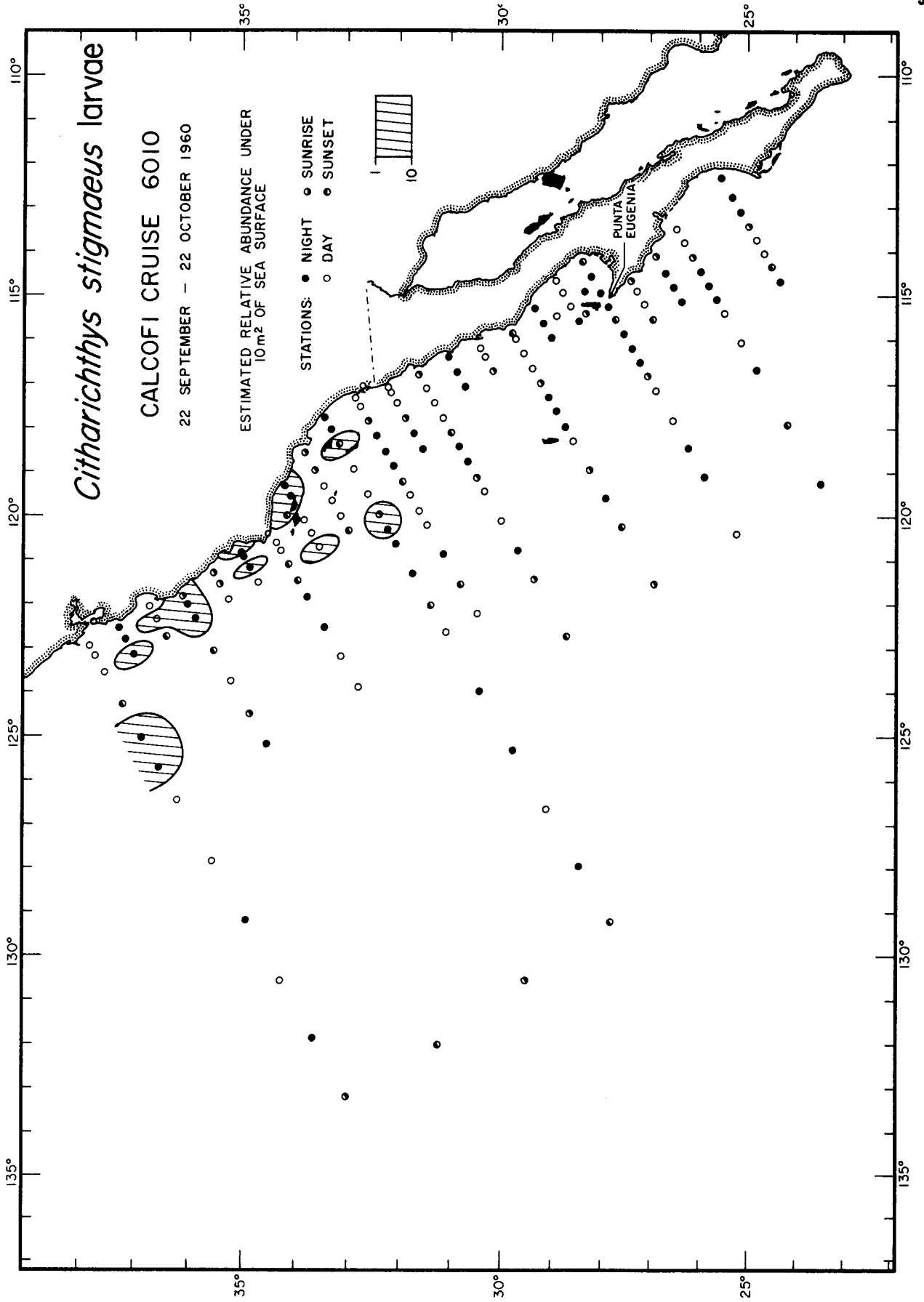
Citharichthys stigmaeus larvae

6006



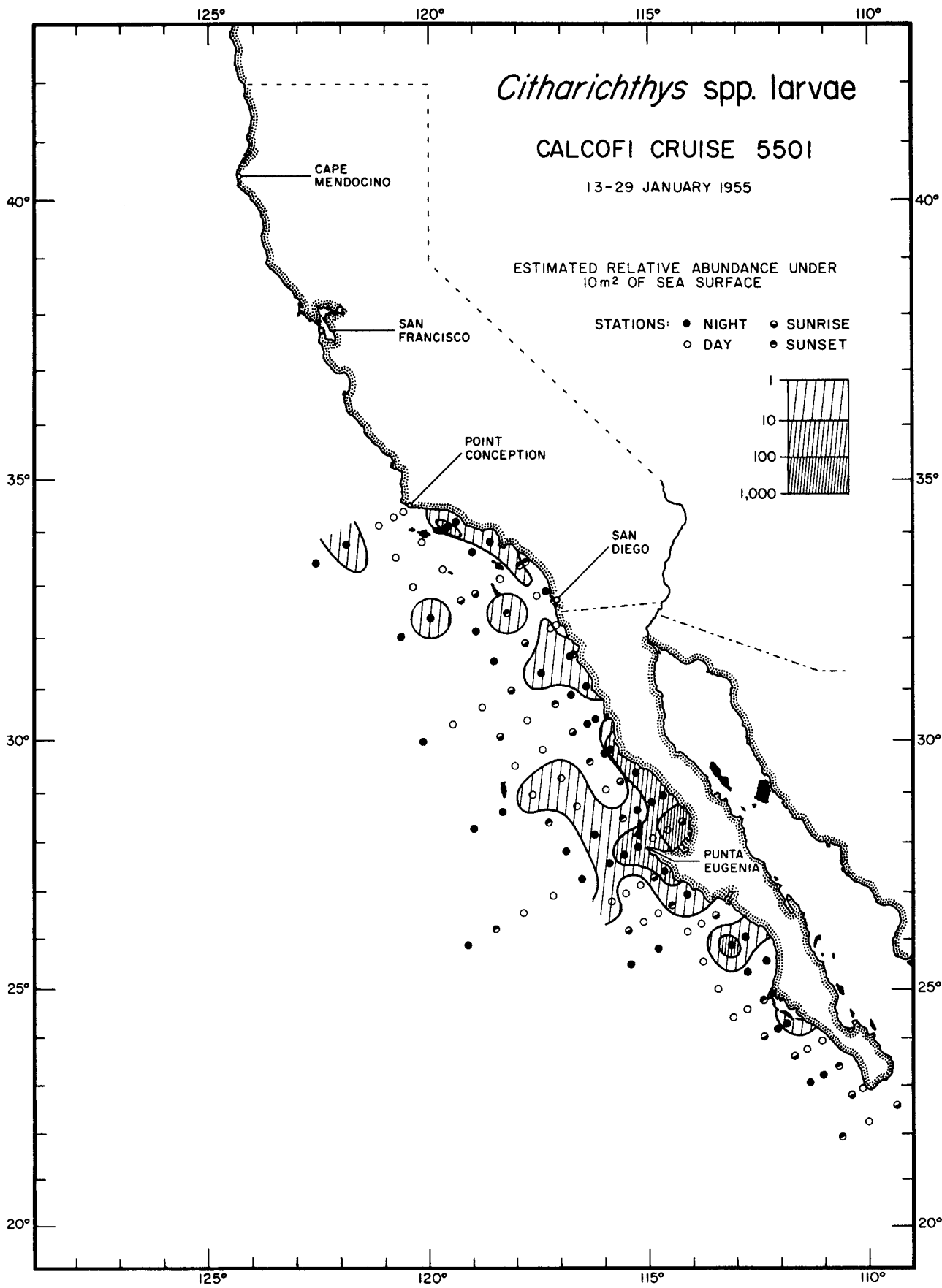
Citharichthys stigmaeus larvae

6007



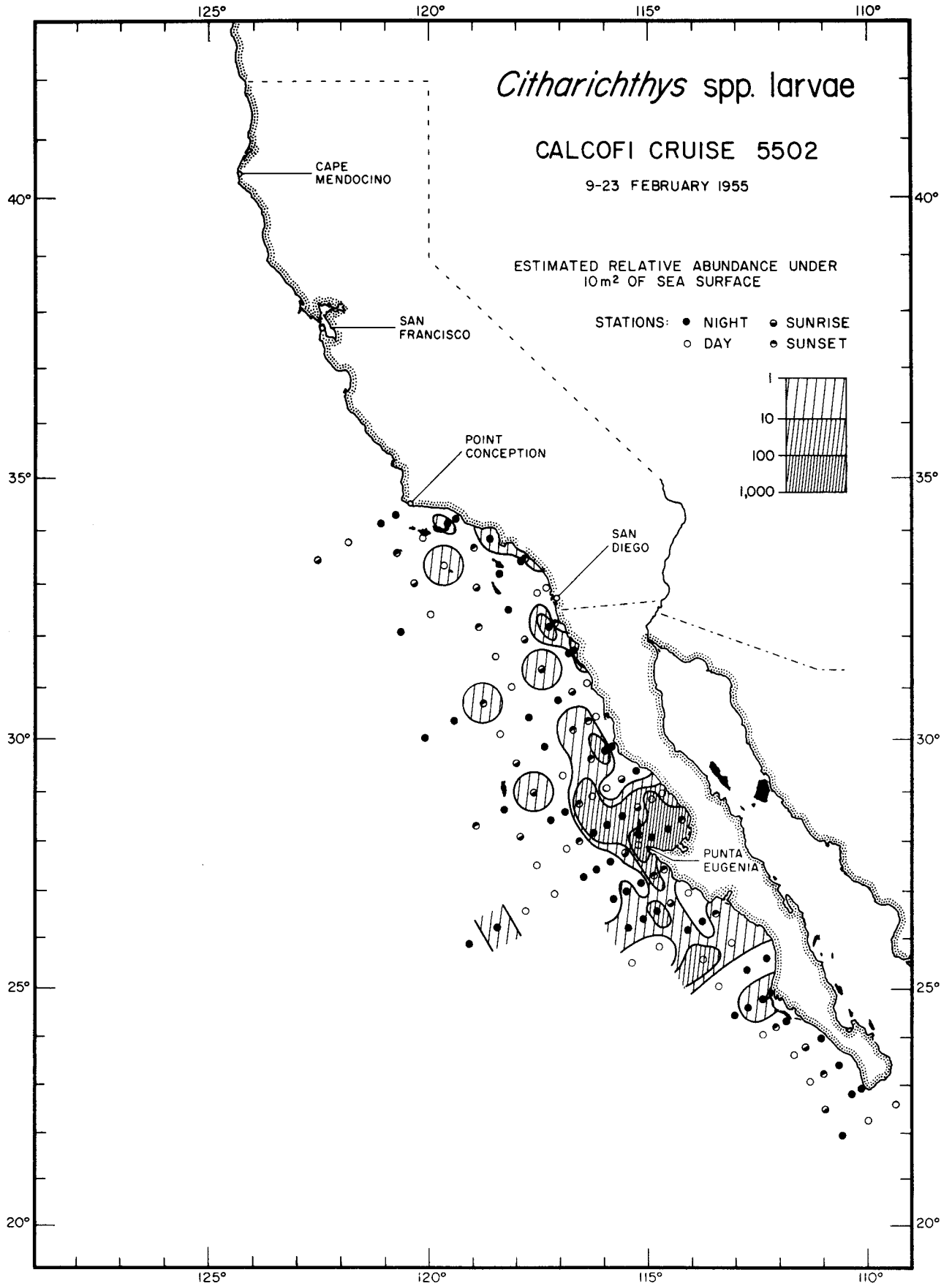
Citharichthys stigmaeus larvae

6010



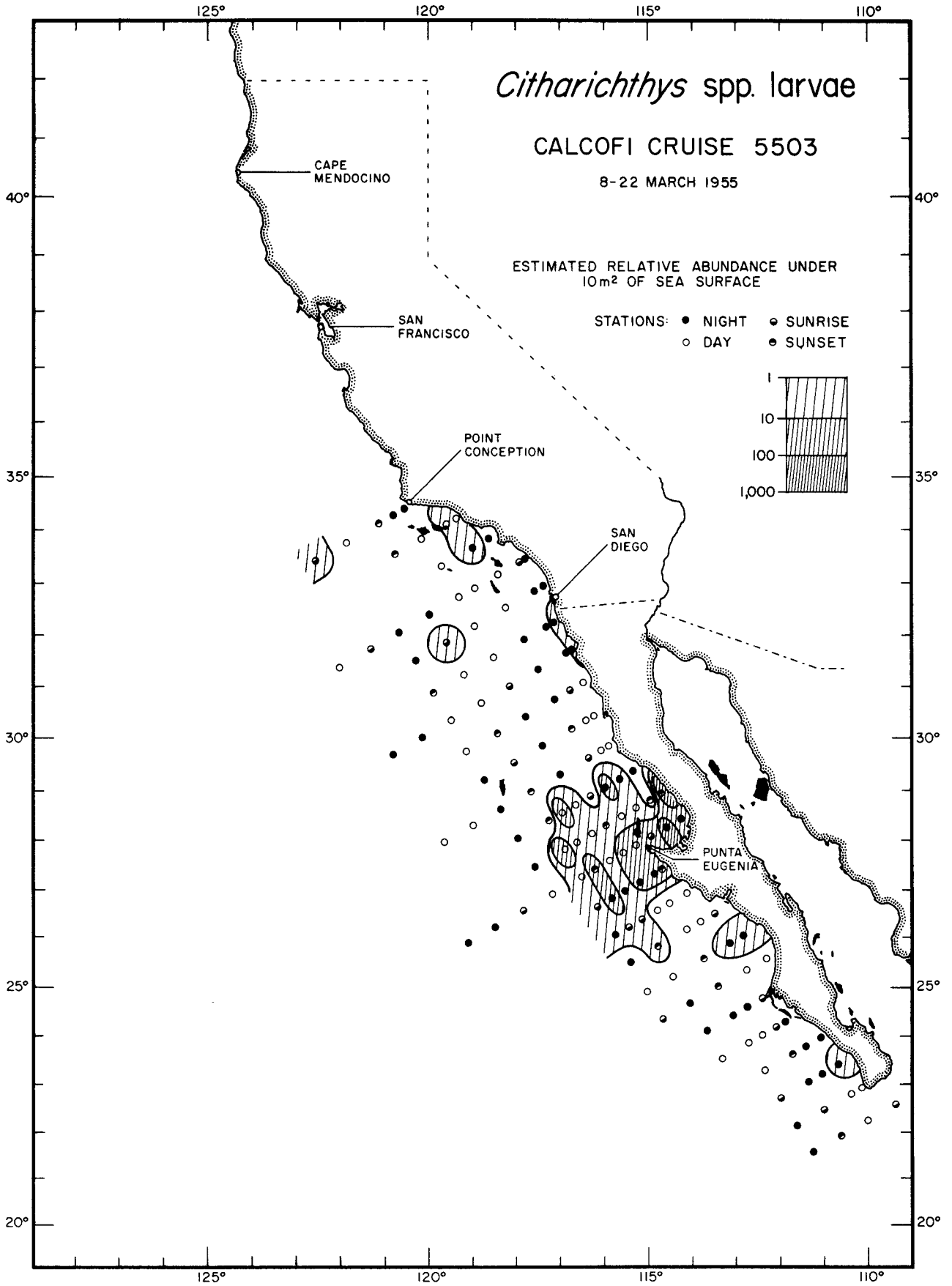
Citharichthys spp. larvae

5501



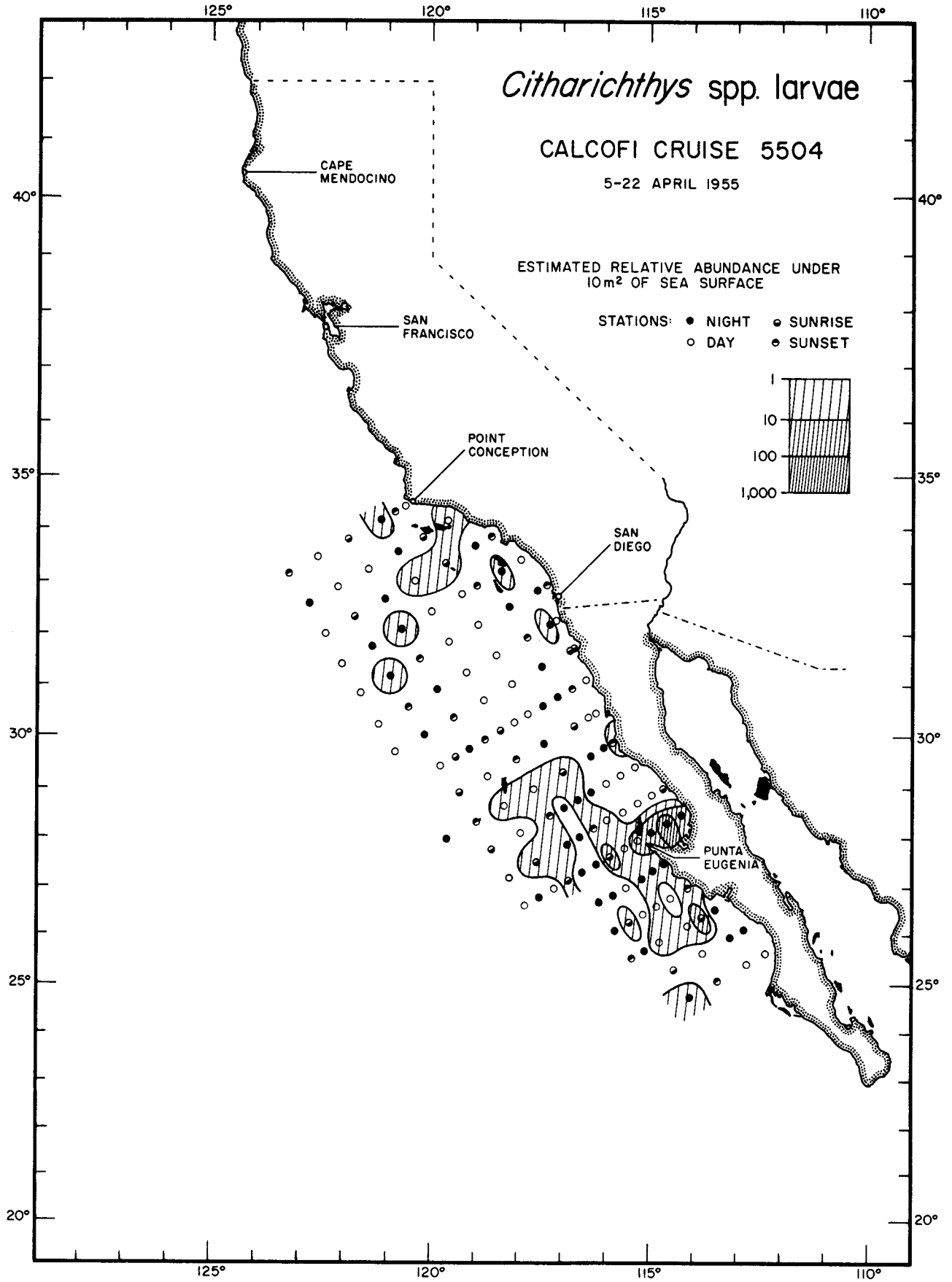
Citharichthys spp. larvae

5502



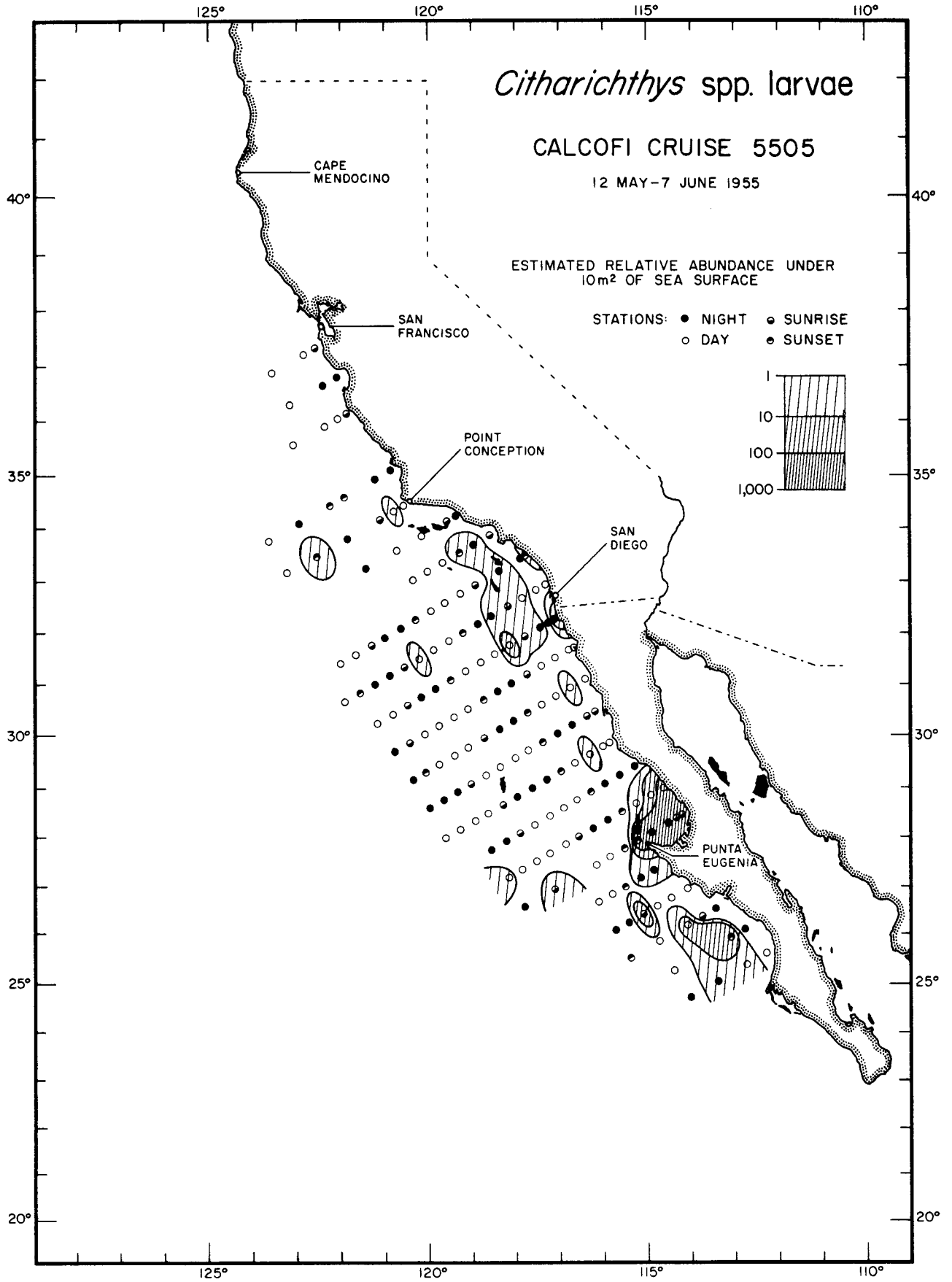
Citharichthys spp. larvae

5503



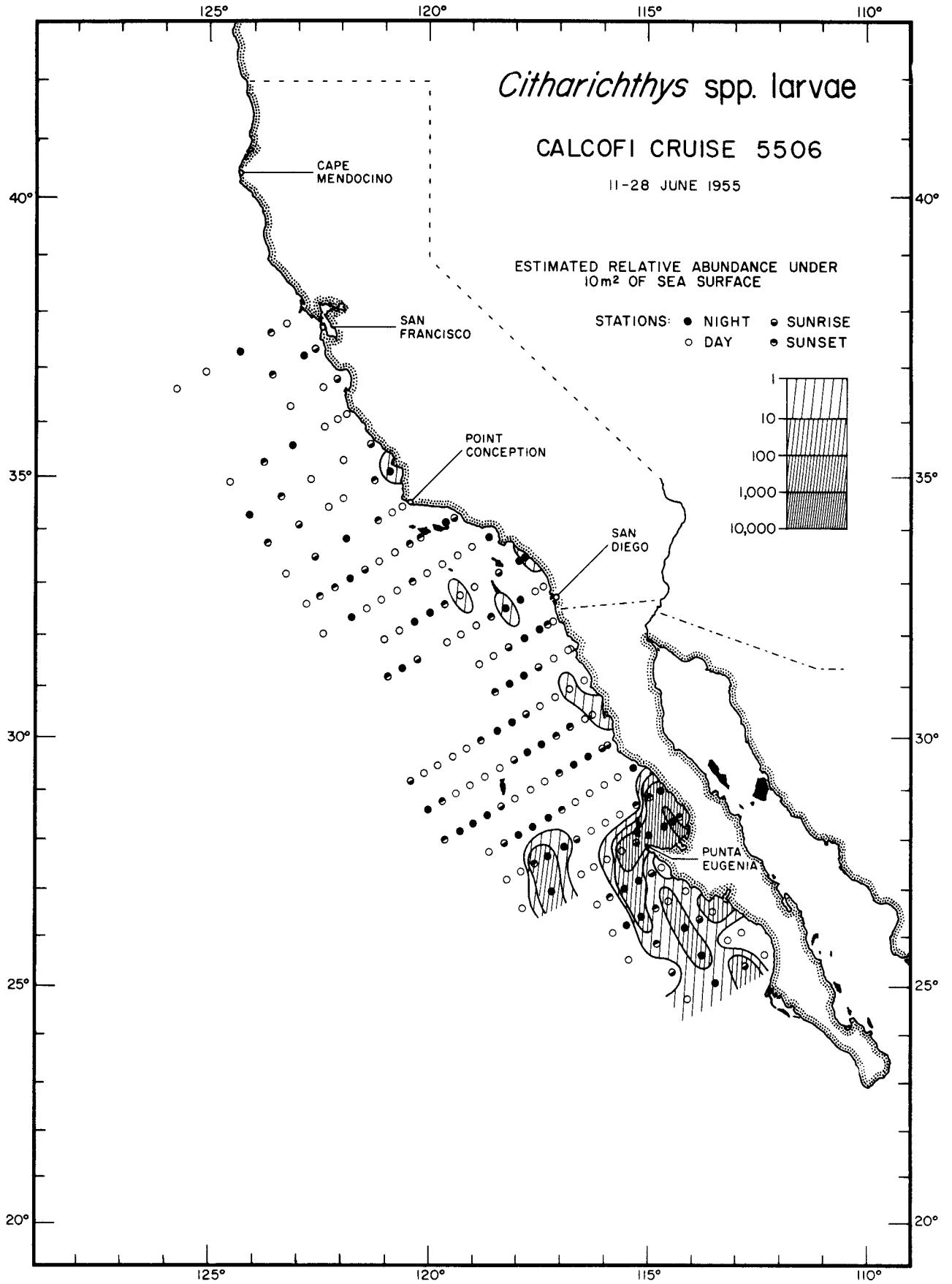
Citharichthys spp. larvae

5504



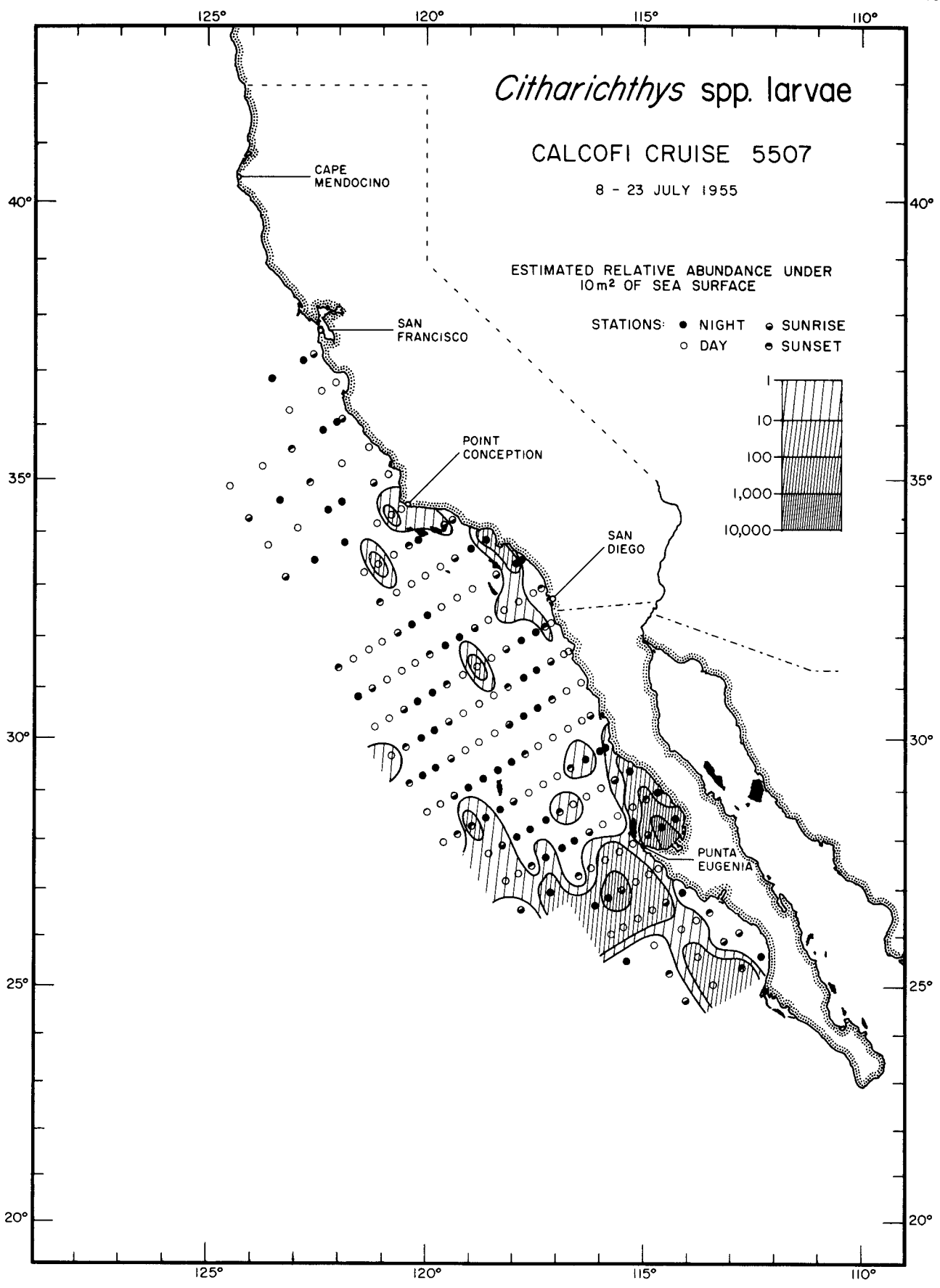
Citharichthys spp. larvae

5505

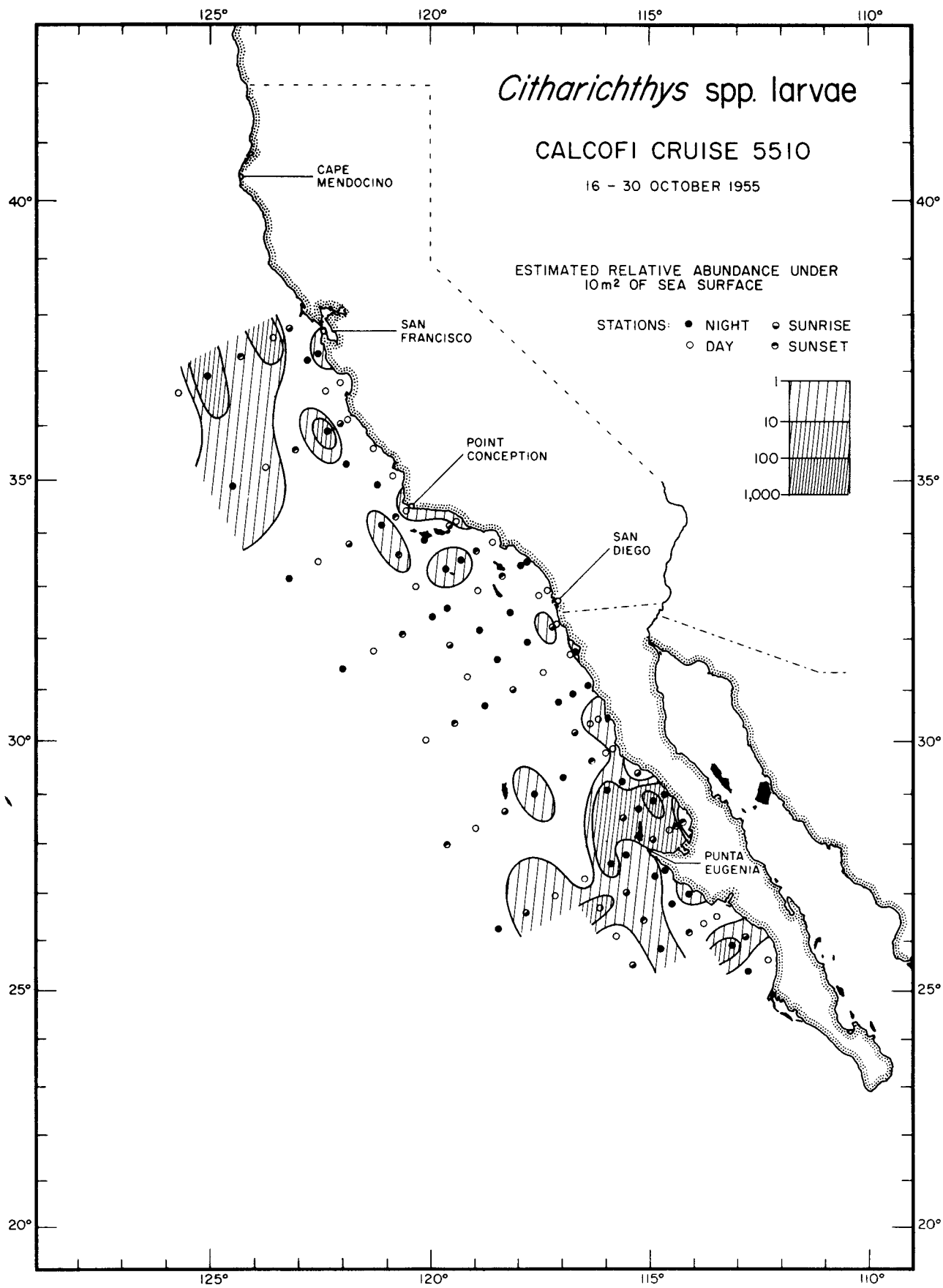


Citharichthys spp. larvae

5506

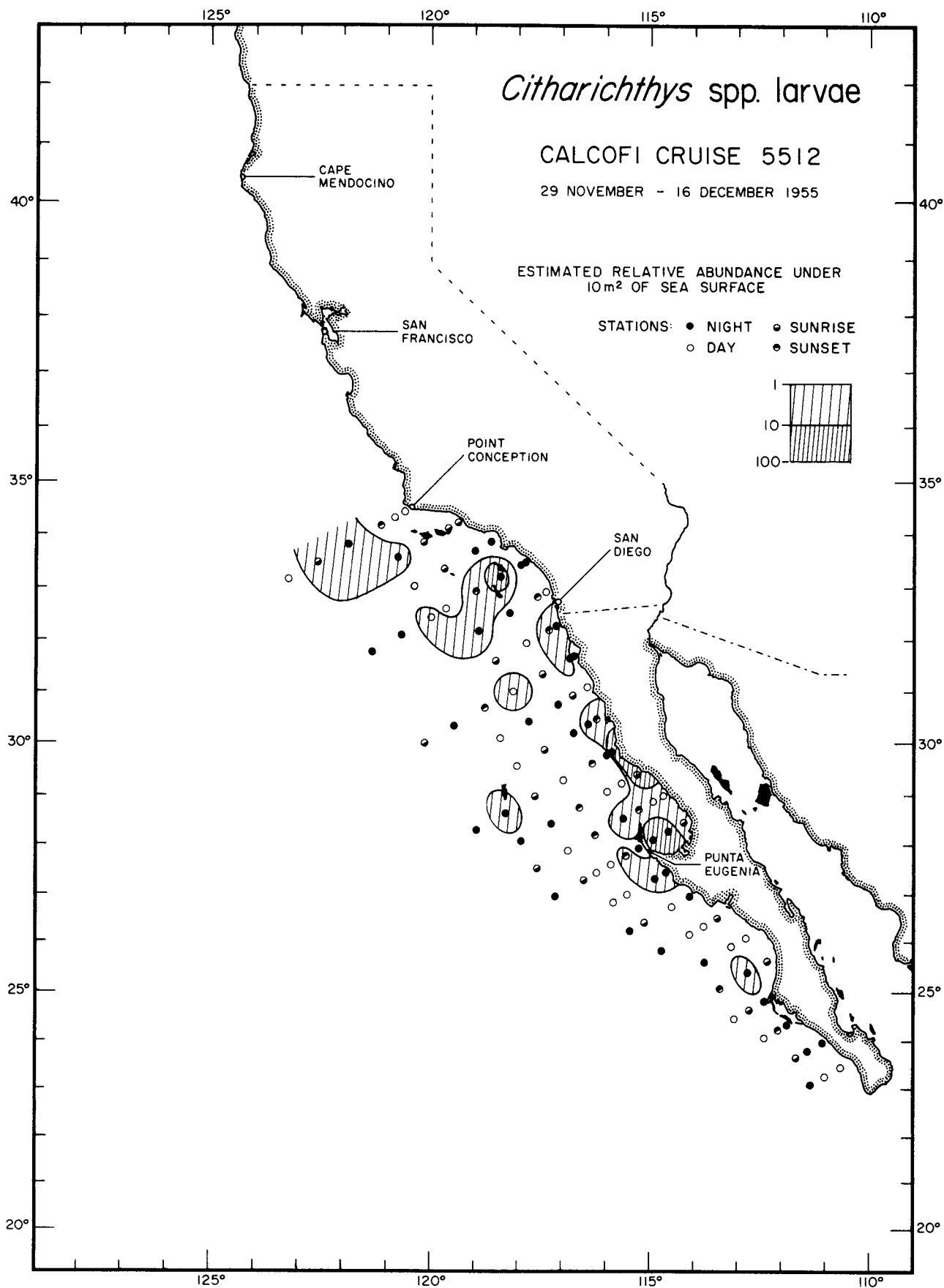


Citharichthys spp. larvae
5507



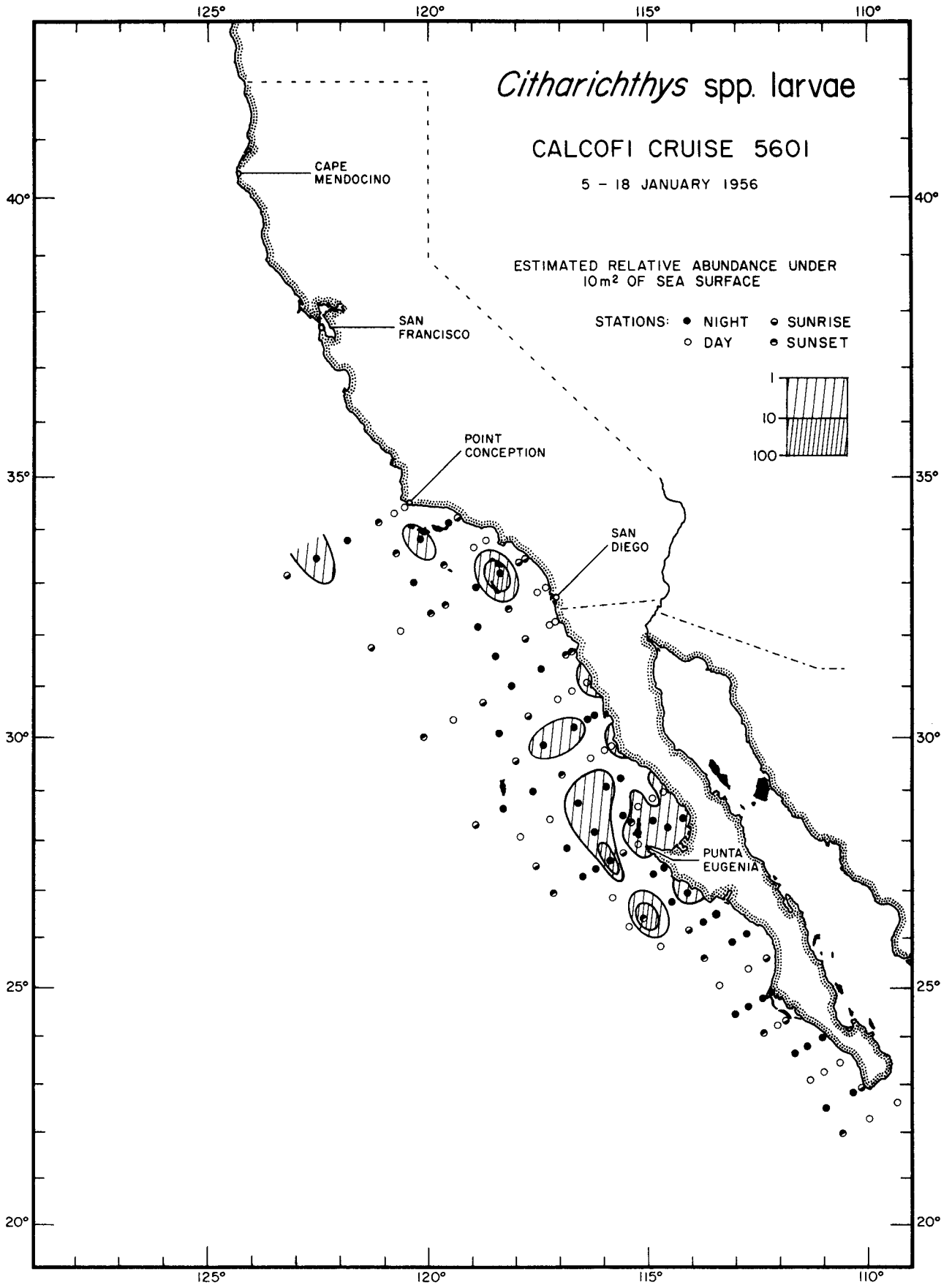
Citharichthys spp. larvae

5510



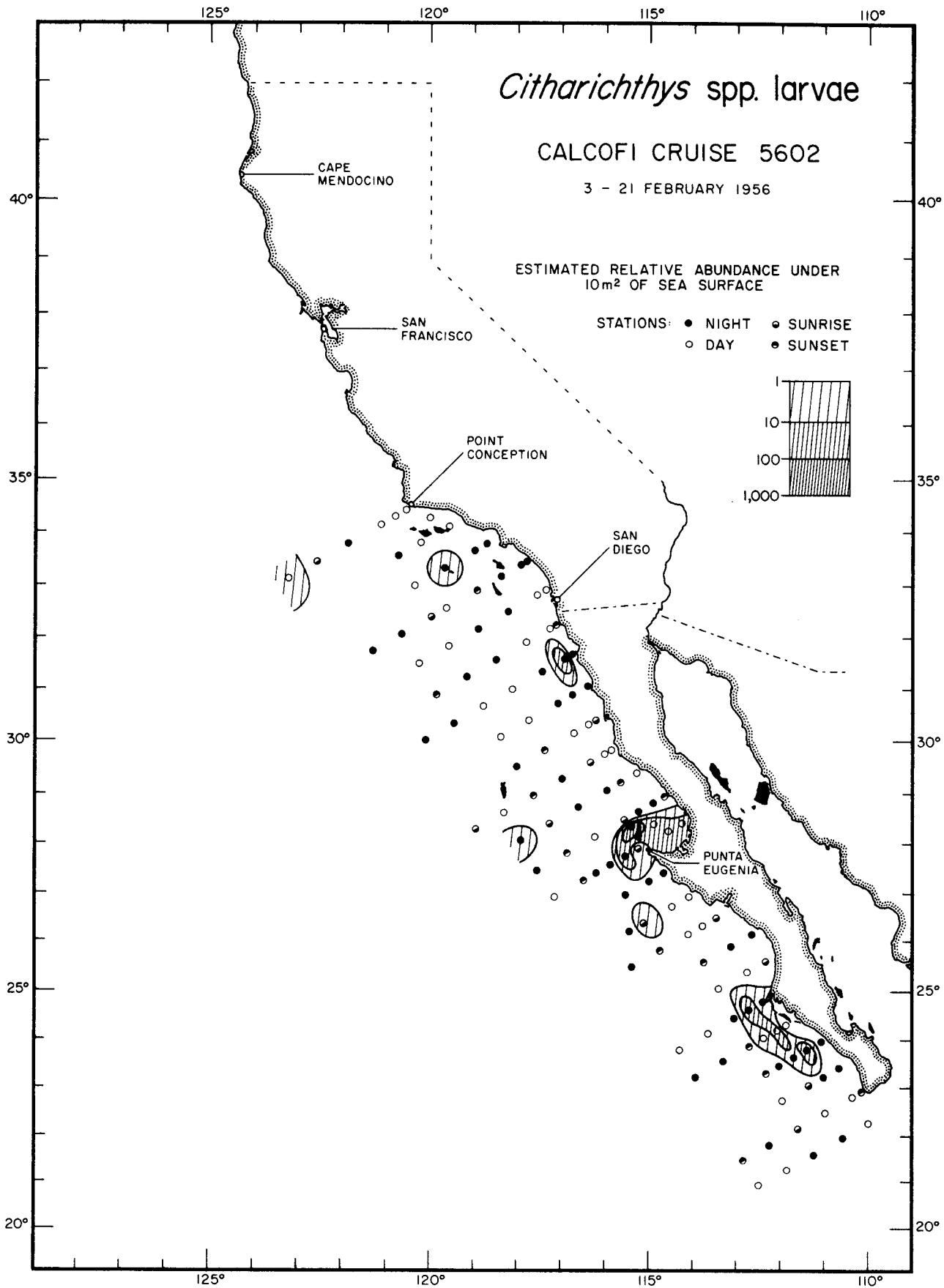
Citharichthys spp. larvae

5512



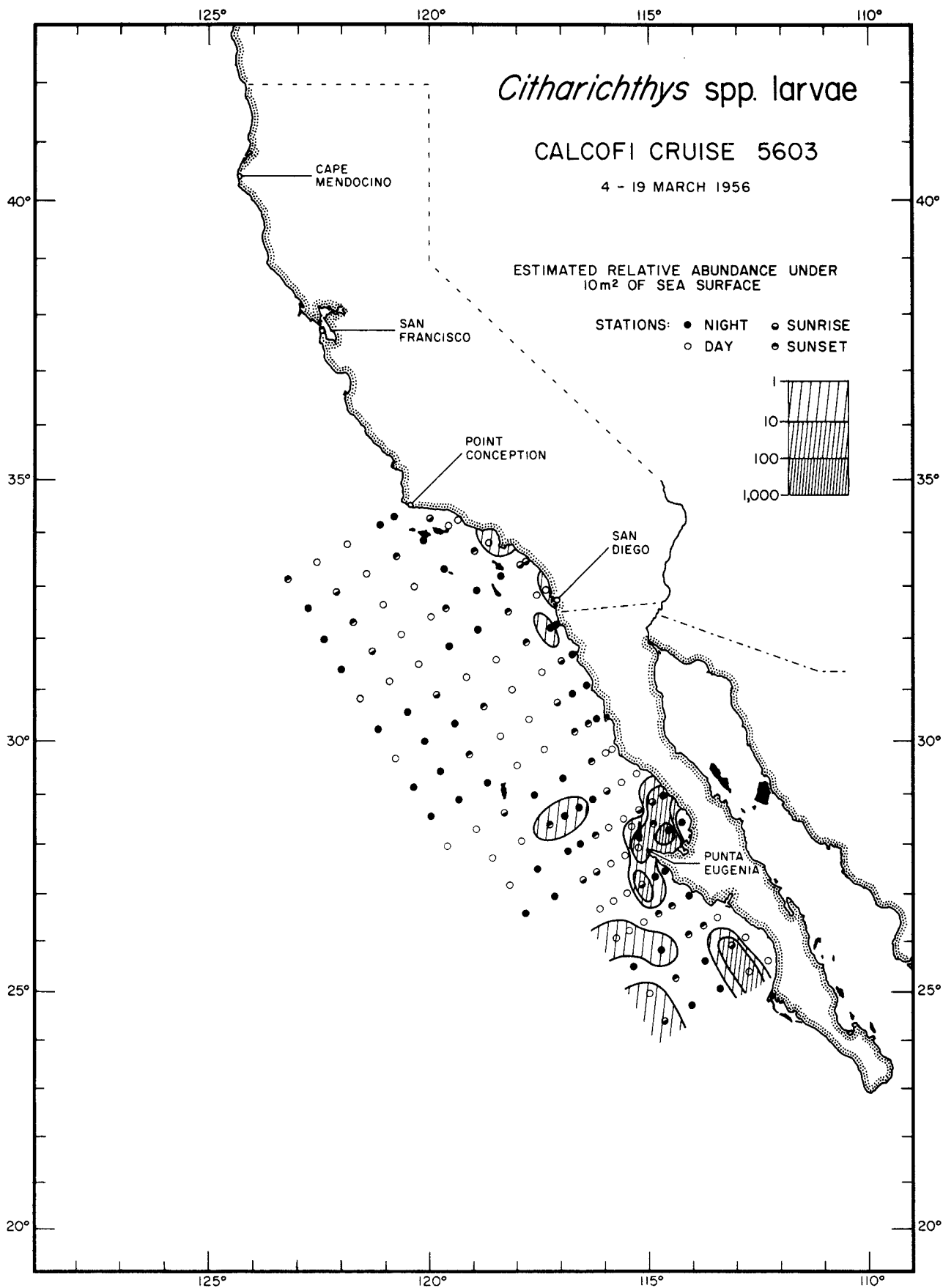
Citharichthys spp. larvae

5601



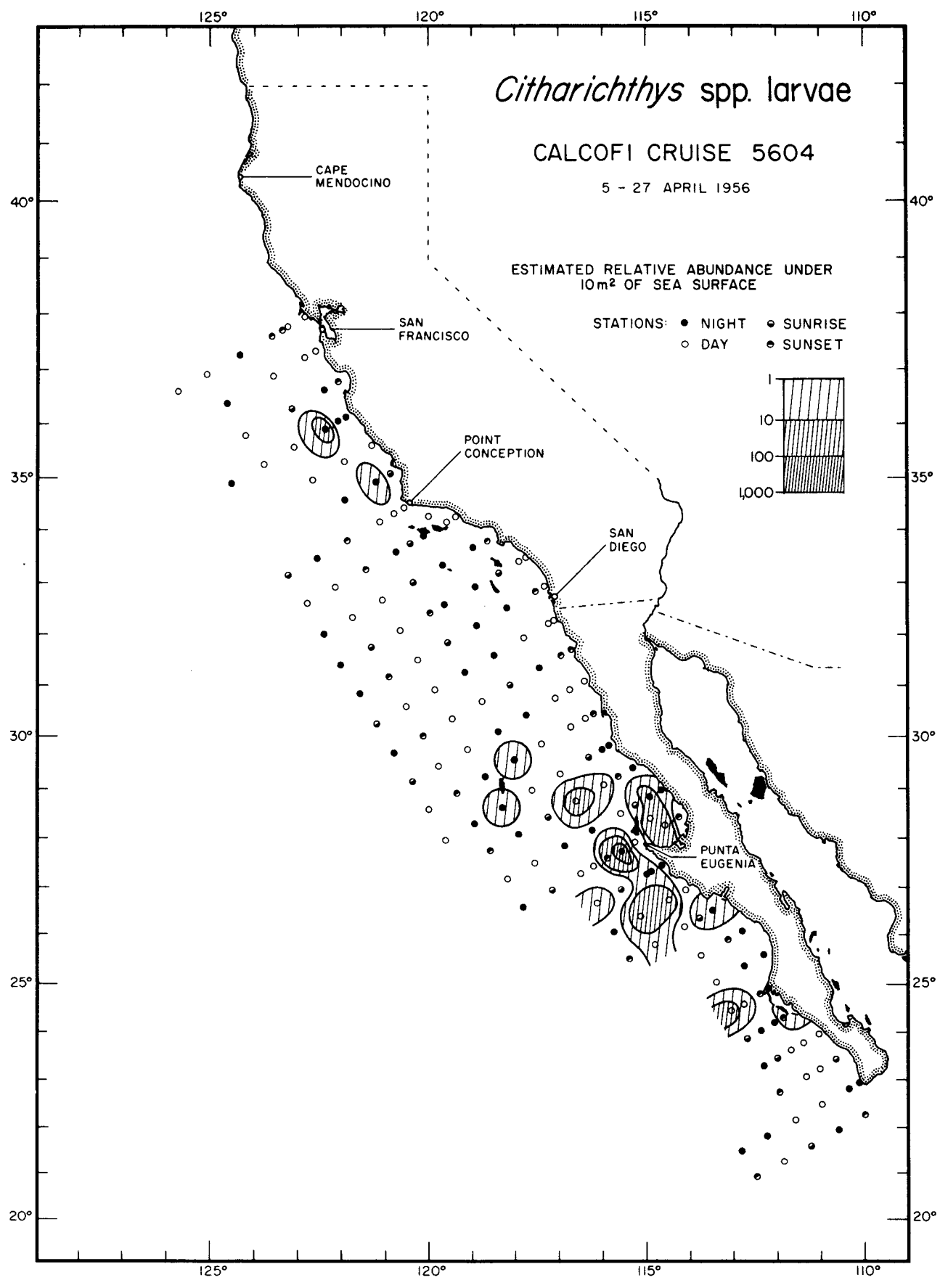
Citharichthys spp. larvae

5602



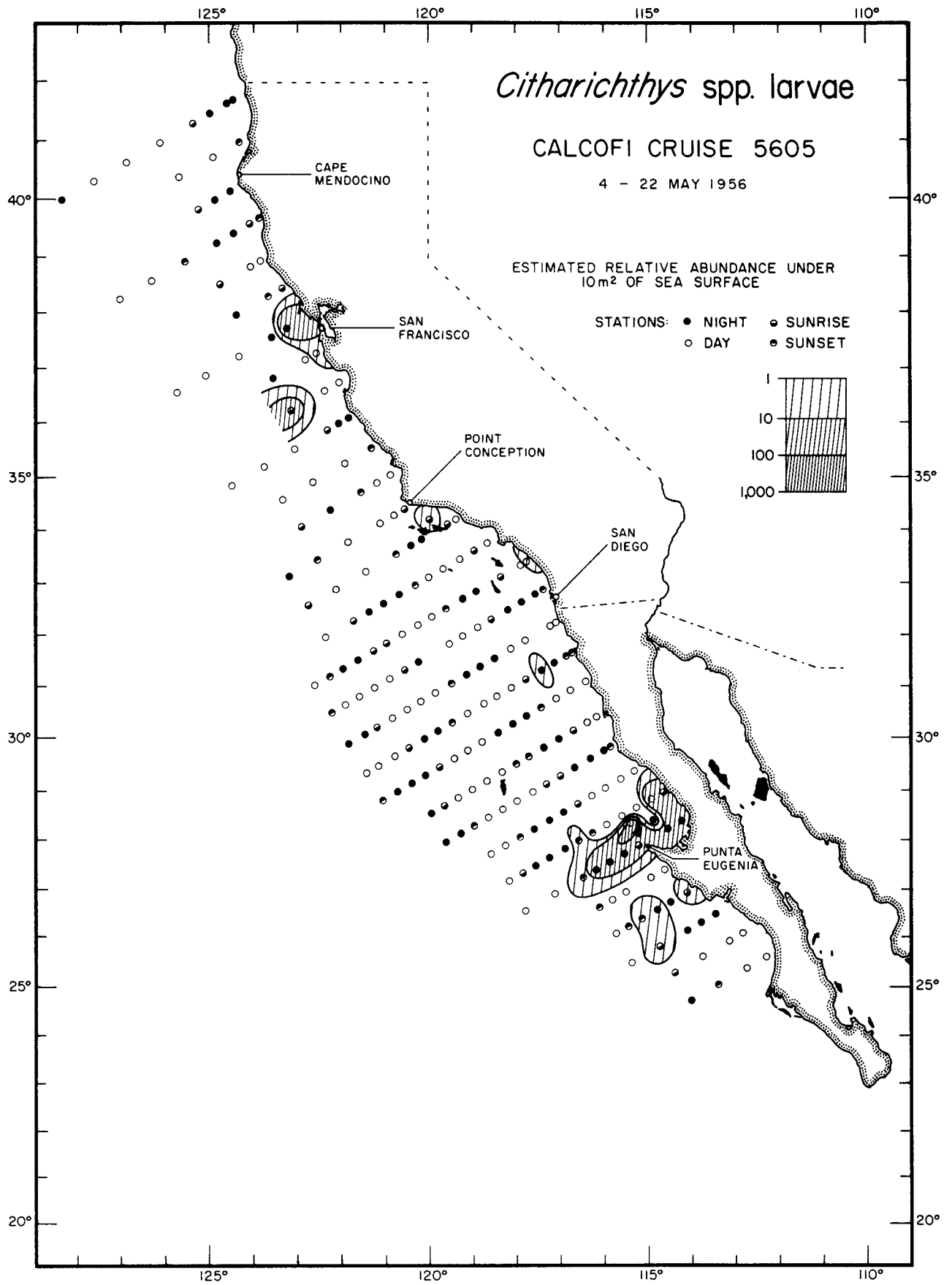
Citharichthys spp. larvae

5603



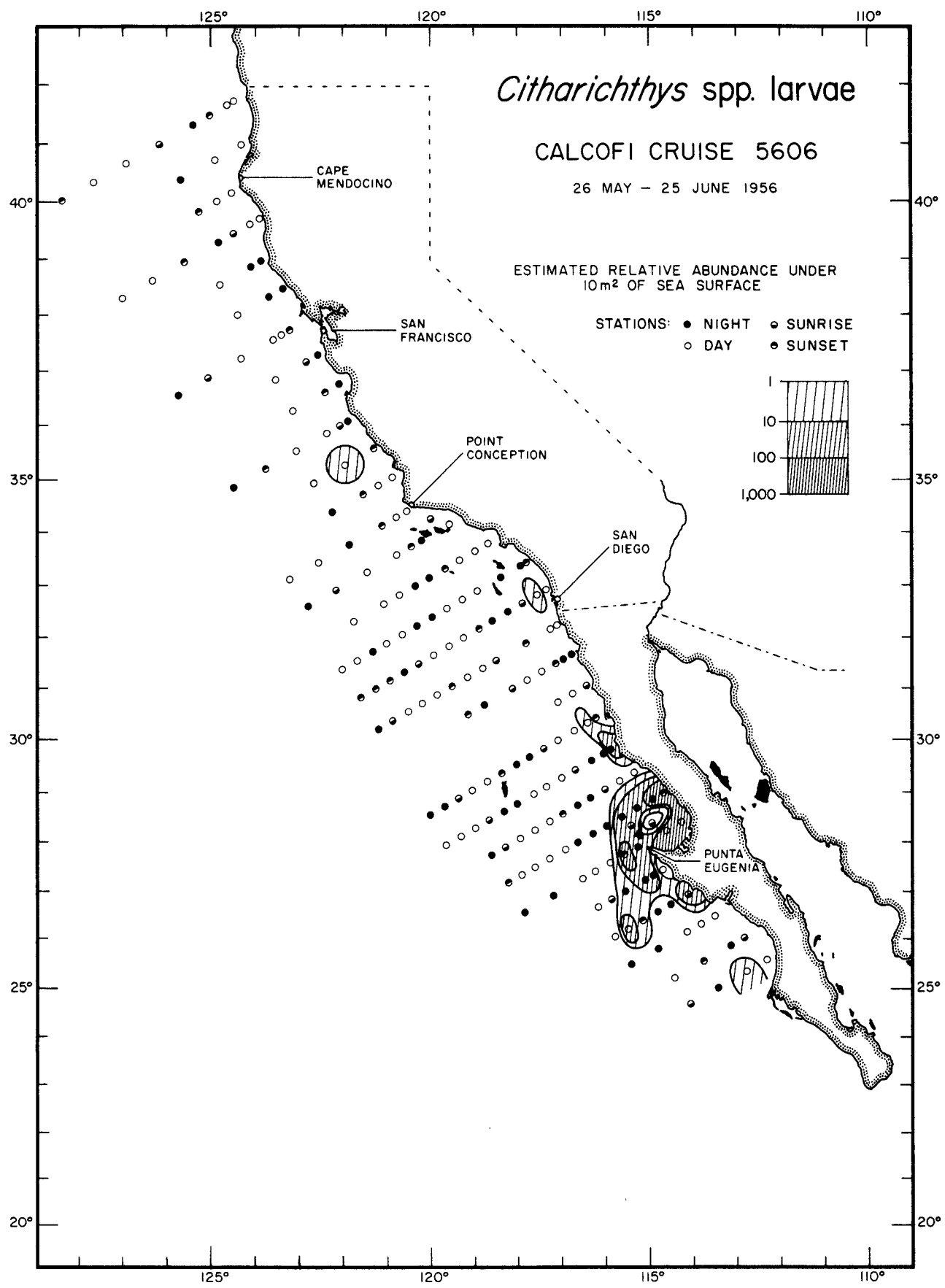
Citharichthys spp. larvae

5604



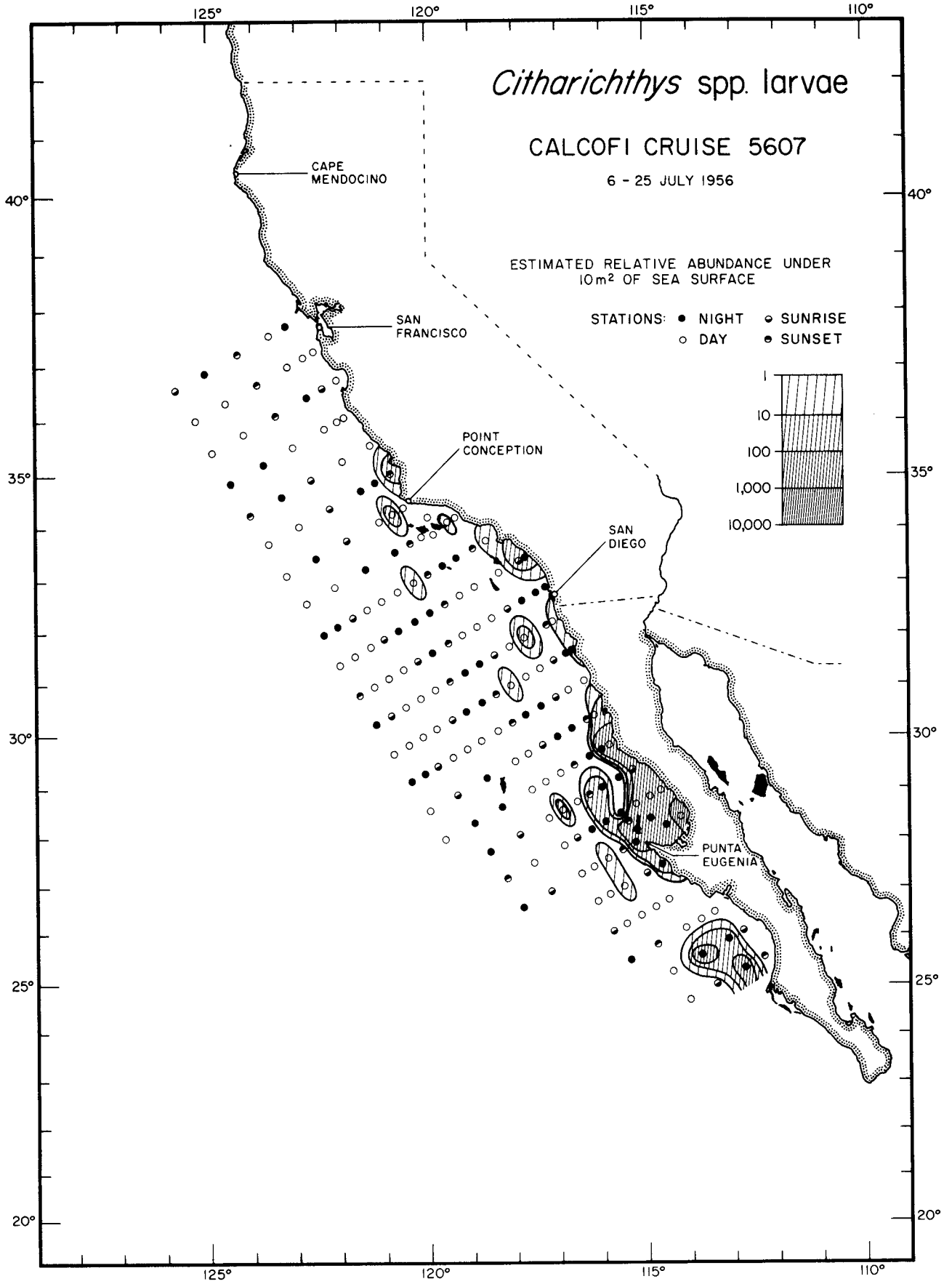
Citharichthys spp. larvae

5605



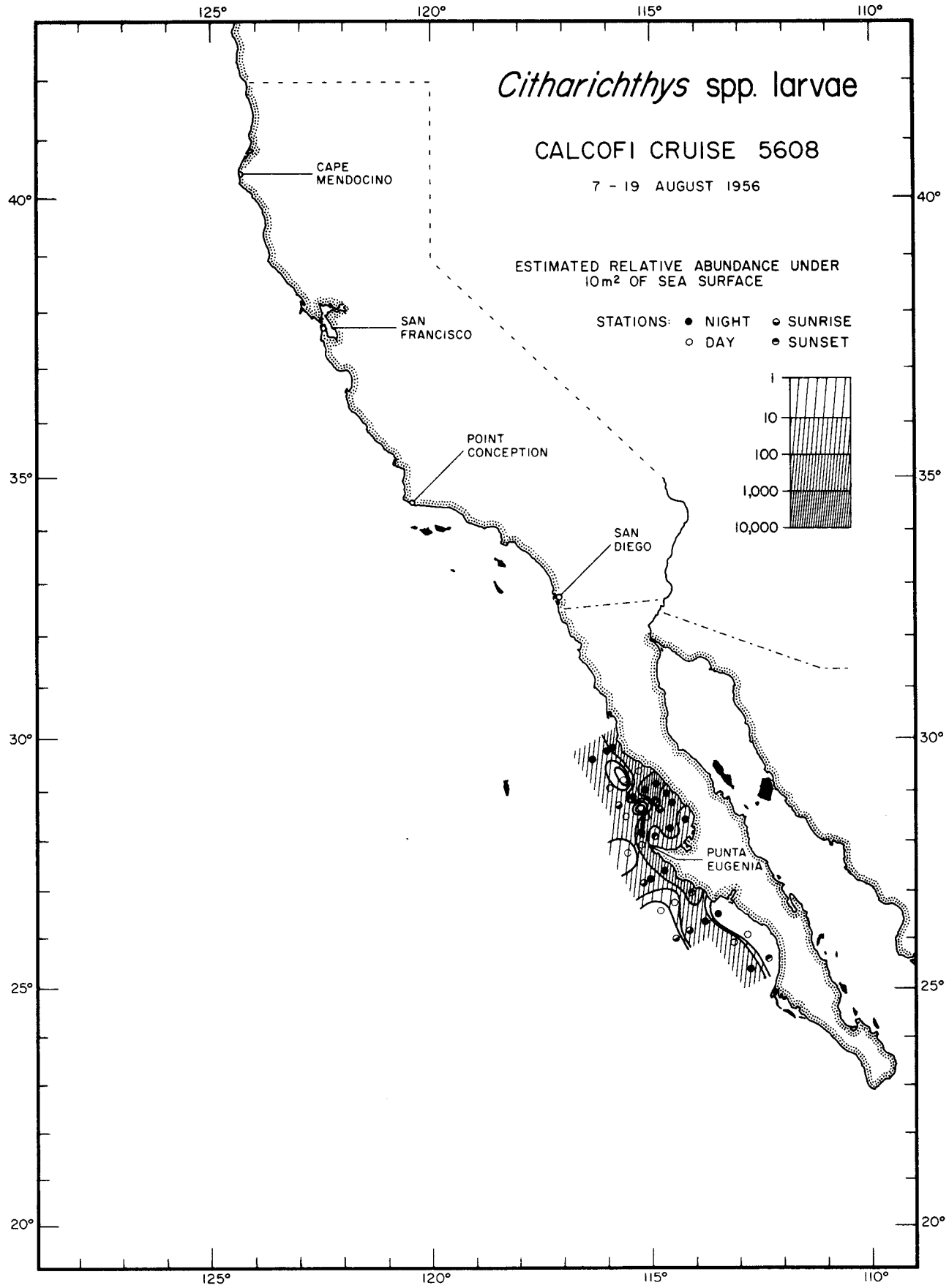
Citharichthys spp. larvae

5606



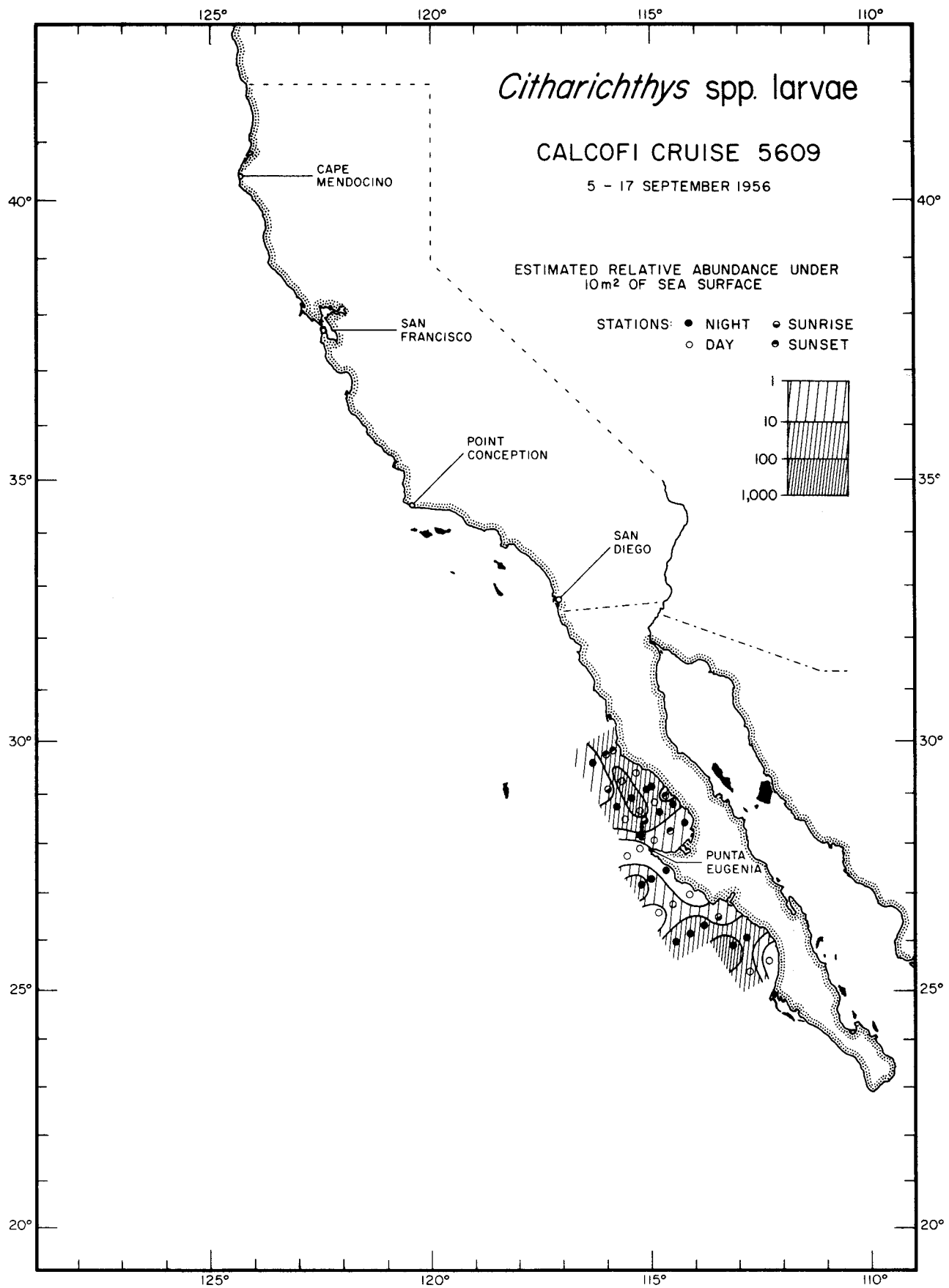
Citharichthys spp. larvae

5607



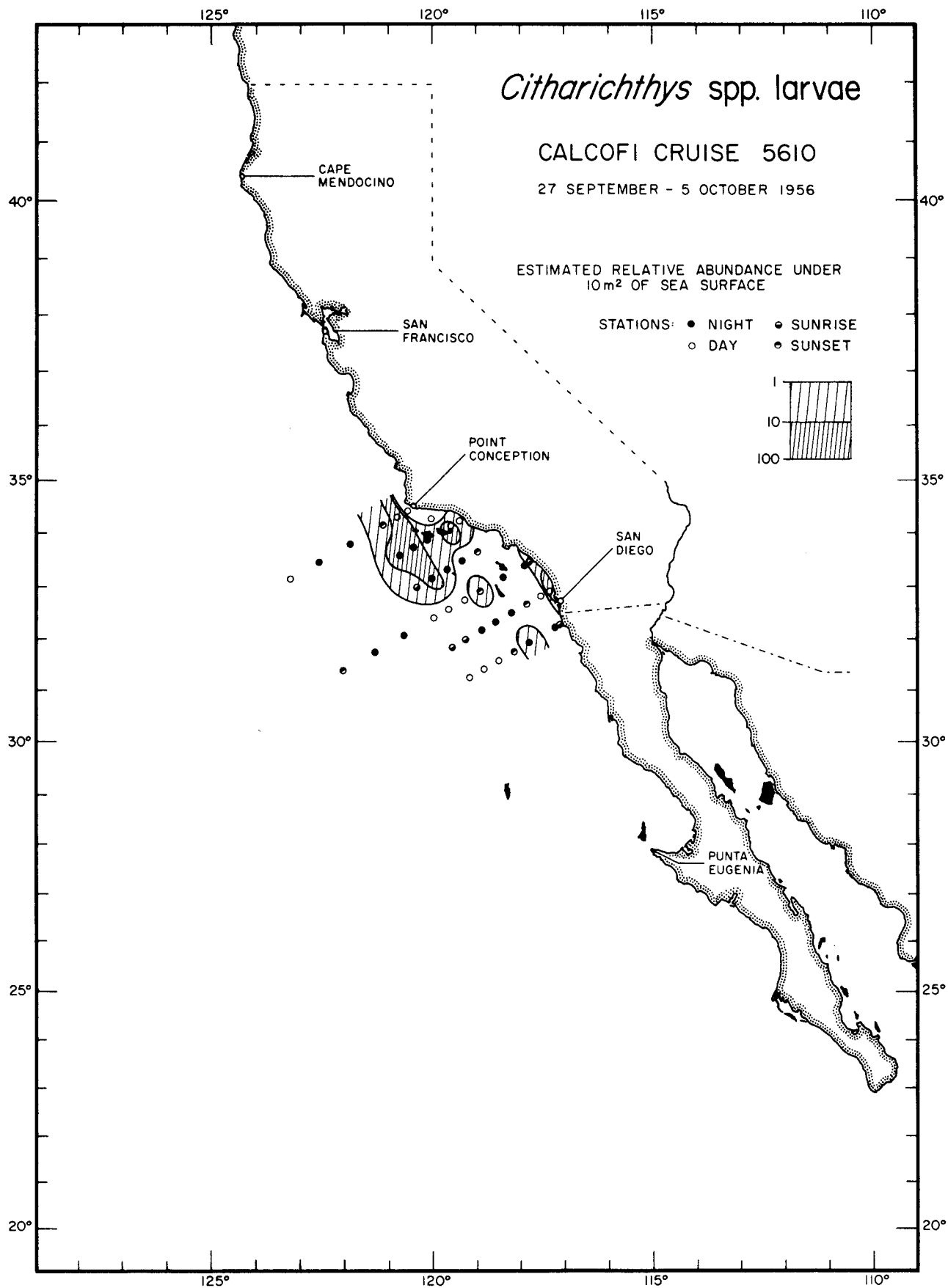
Citharichthys spp. larvae

5608



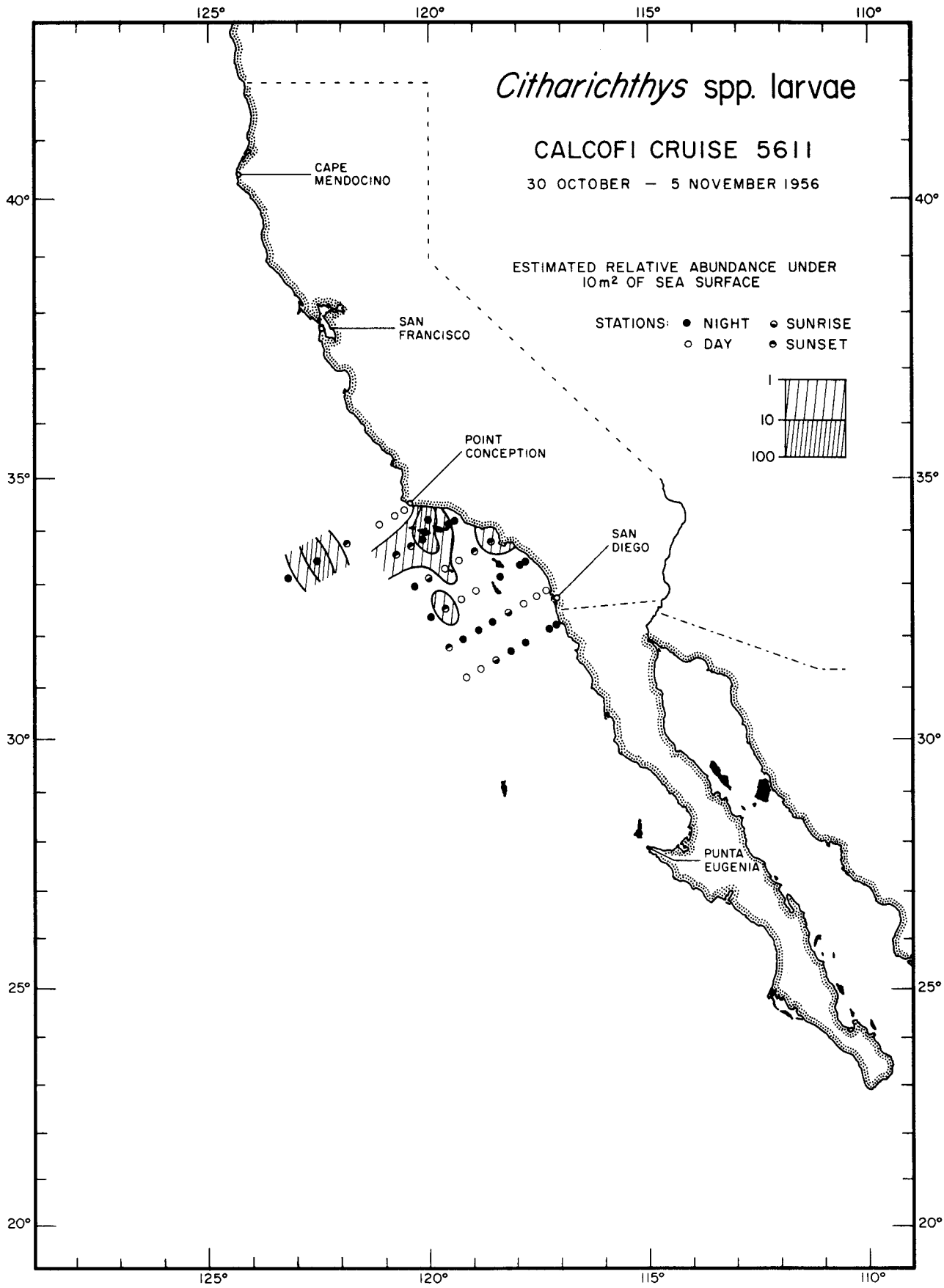
Citharichthys spp. larvae

5609



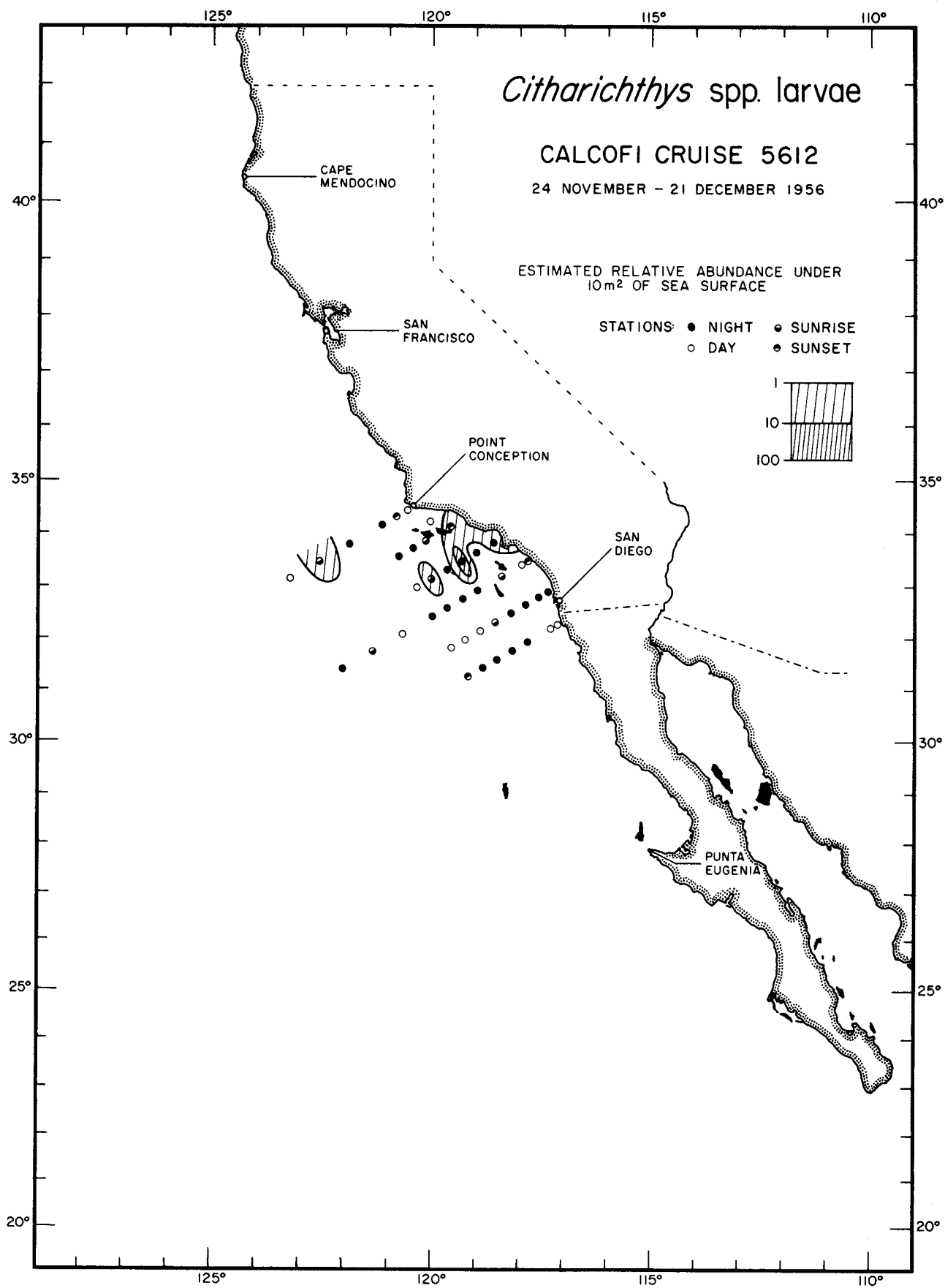
Citharichthys spp. larvae

5610



Citharichthys spp. larvae

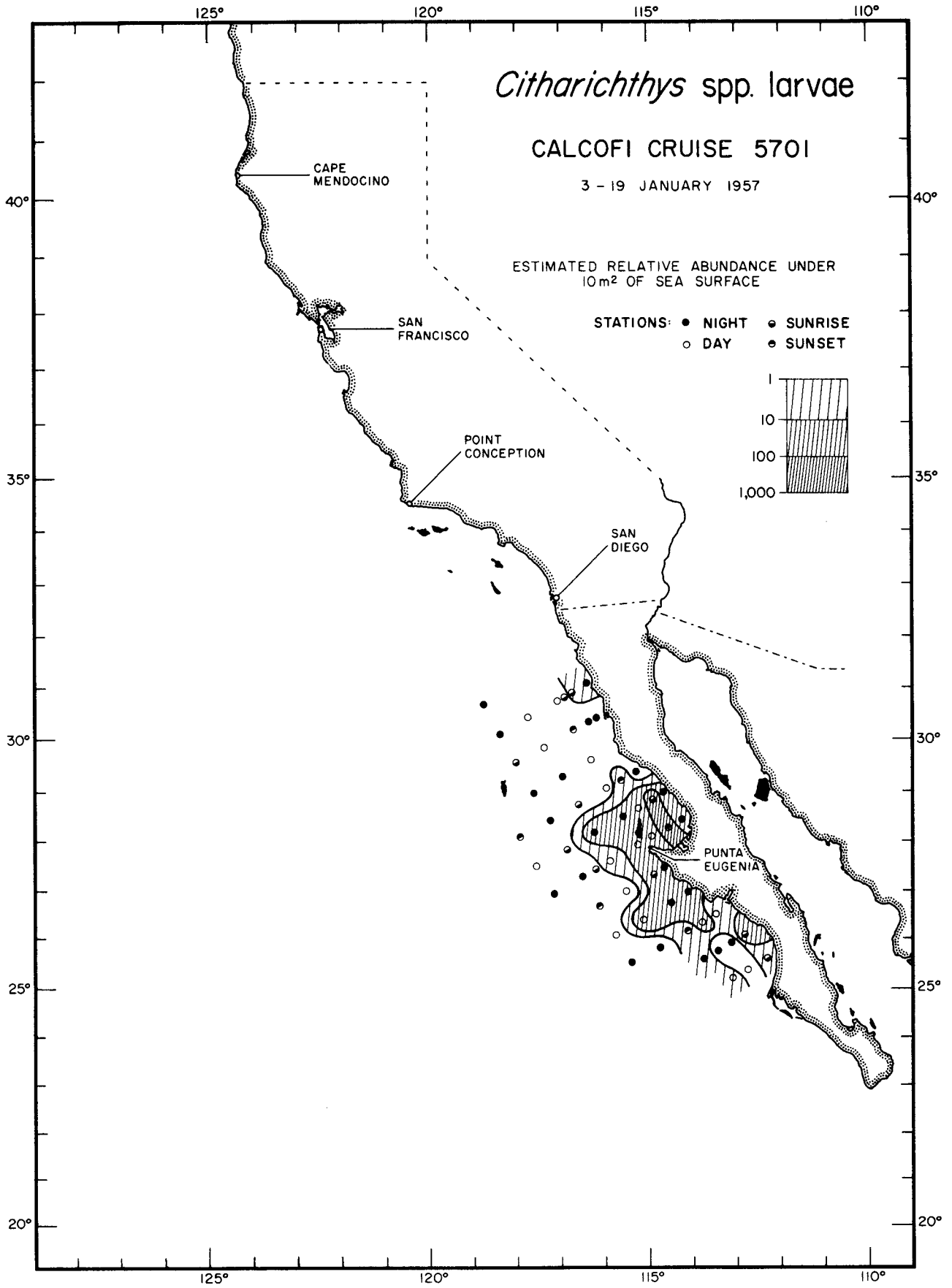
5611



Citharichthys spp. larvae

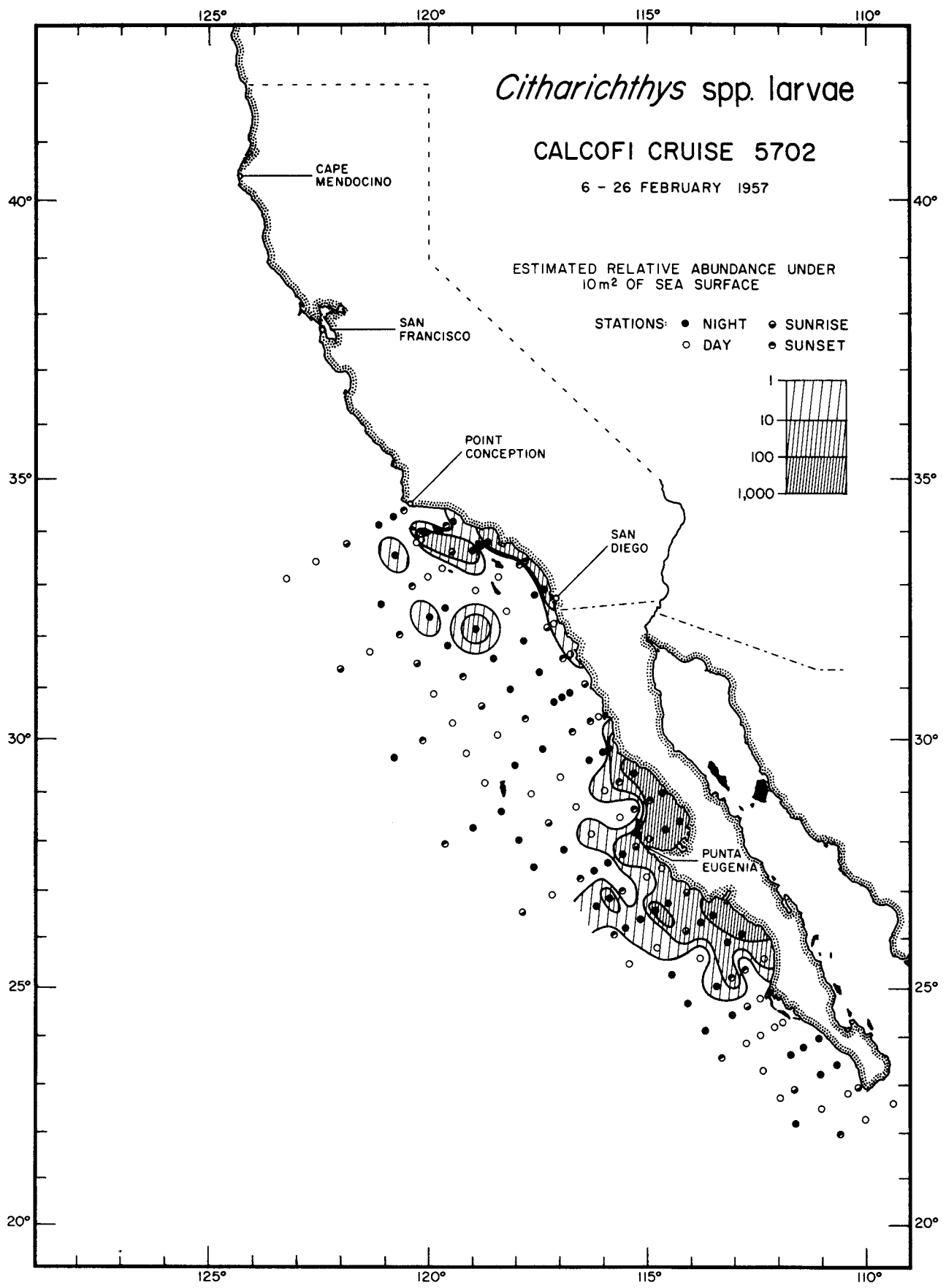
5612

••



Citharichthys spp. larvae

5701



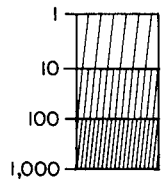
Citharichthys spp. larvae

CALCOFI CRUISE 5702

6 - 26 FEBRUARY 1957

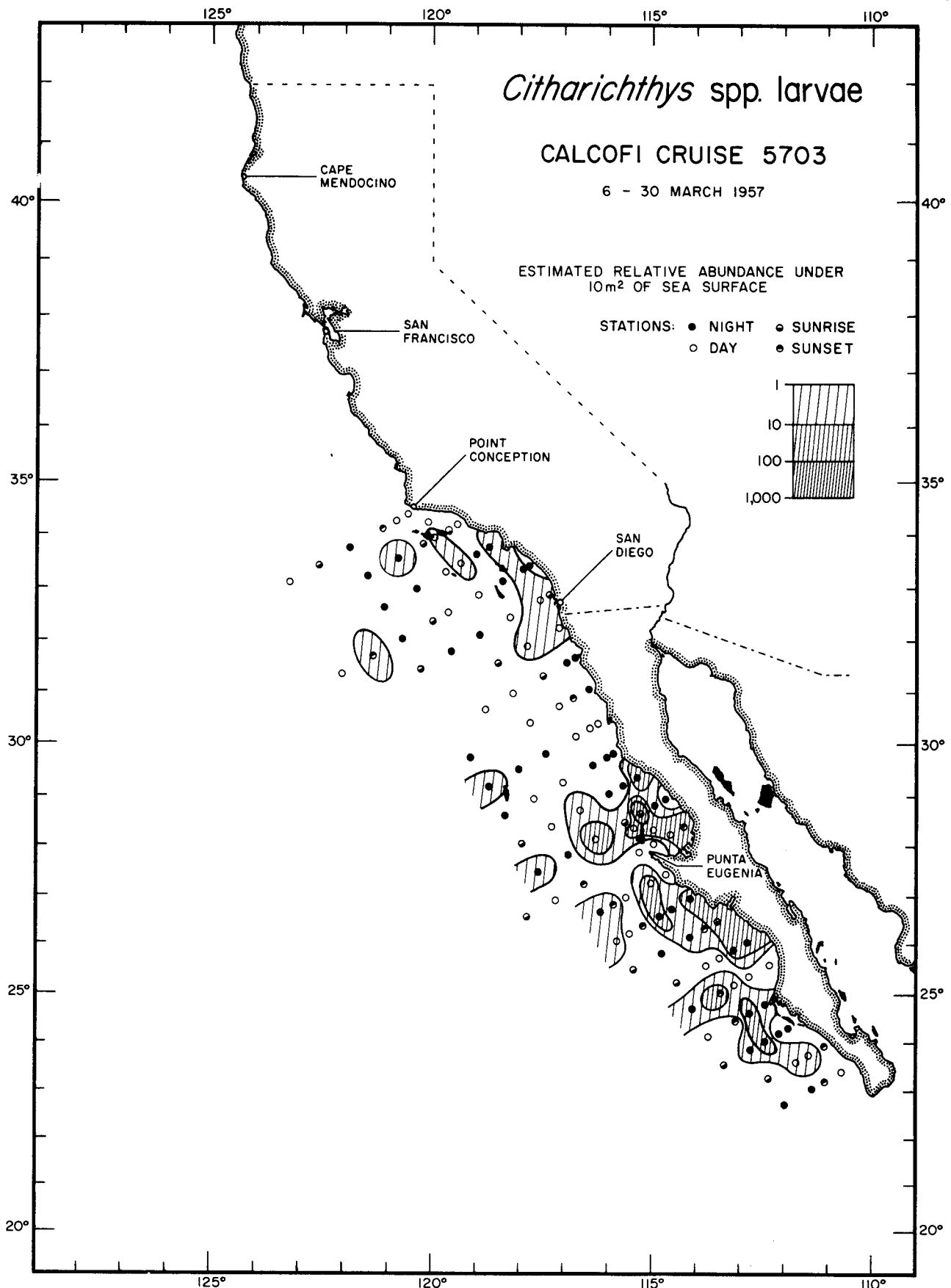
ESTIMATED RELATIVE ABUNDANCE UNDER 10m² OF SEA SURFACE

STATIONS: ● NIGHT ○ DAY ● SUNRISE ● SUNSET



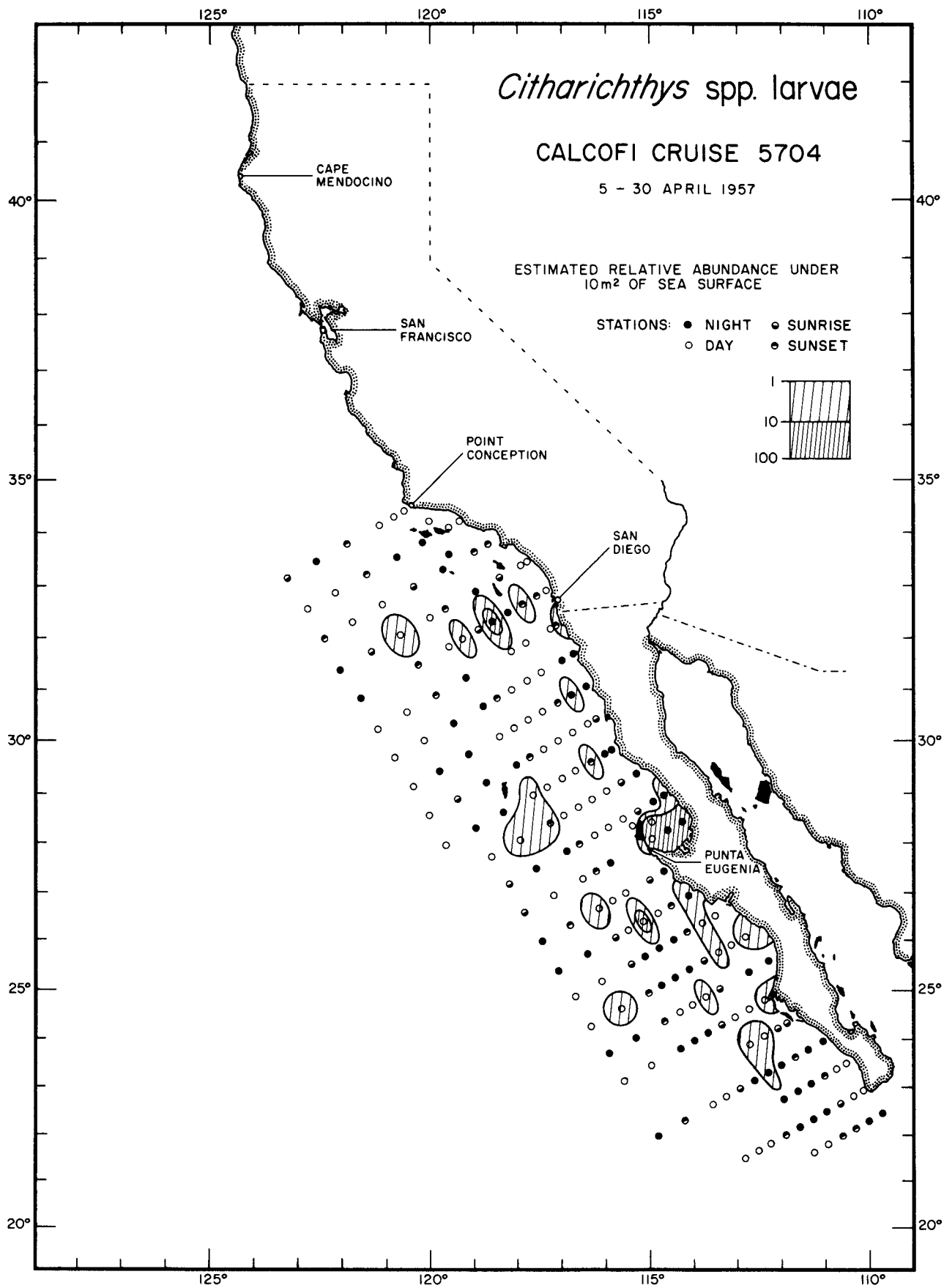
Citharichthys spp. larvae

5702



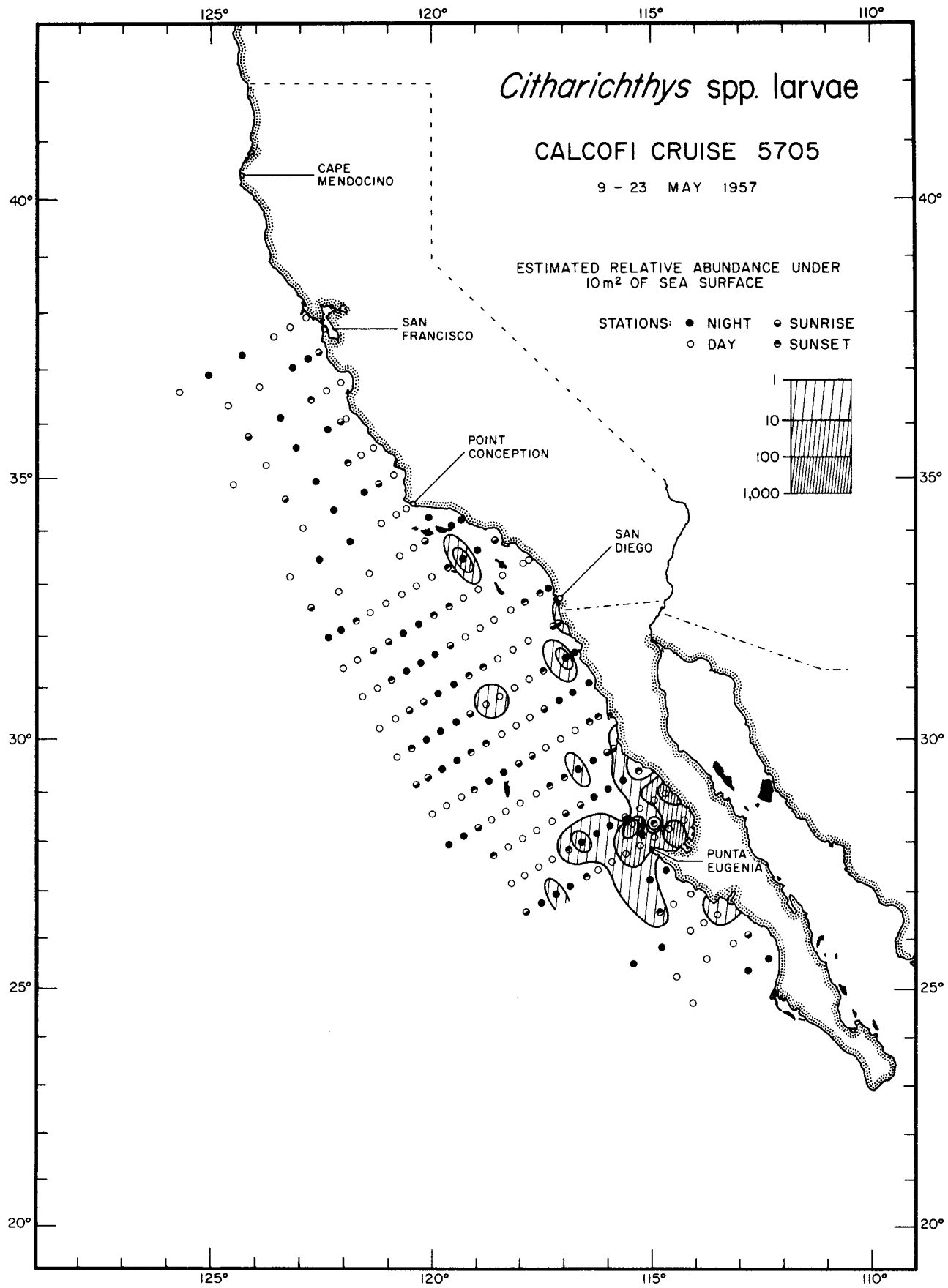
Citharichthys spp. larvae

5703



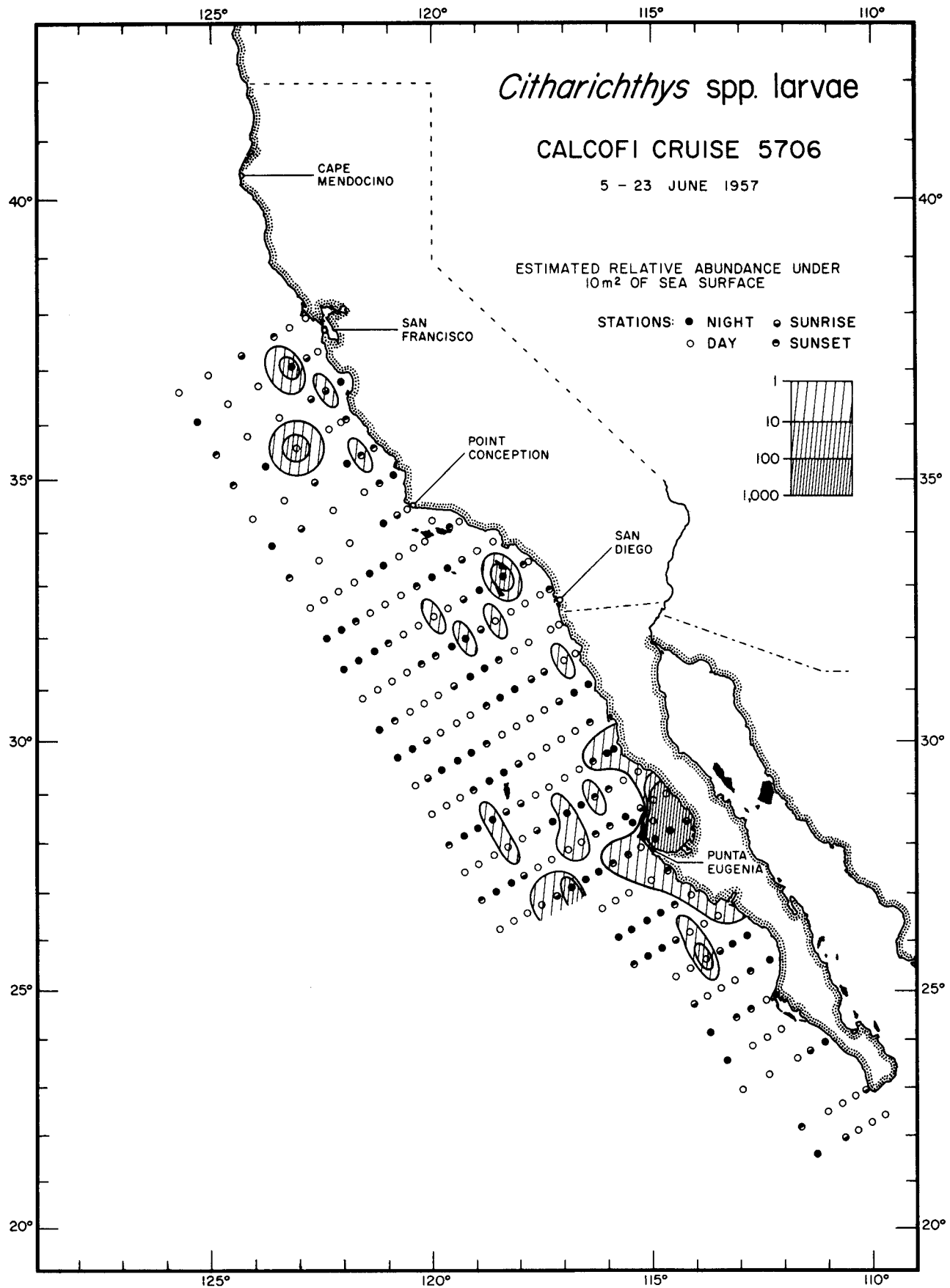
Citharichthys spp. larvae

5704



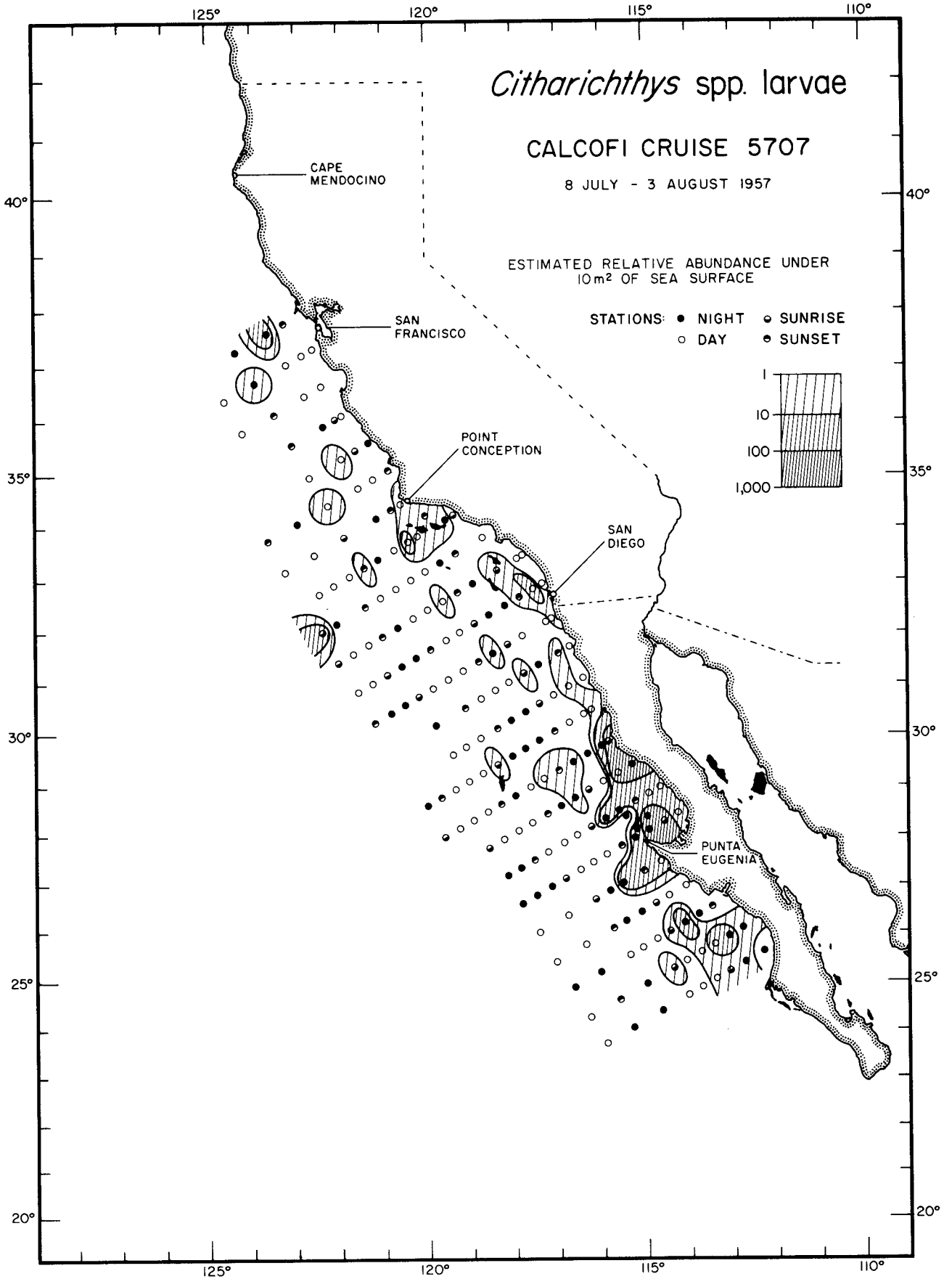
Citharichthys spp. larvae

5705



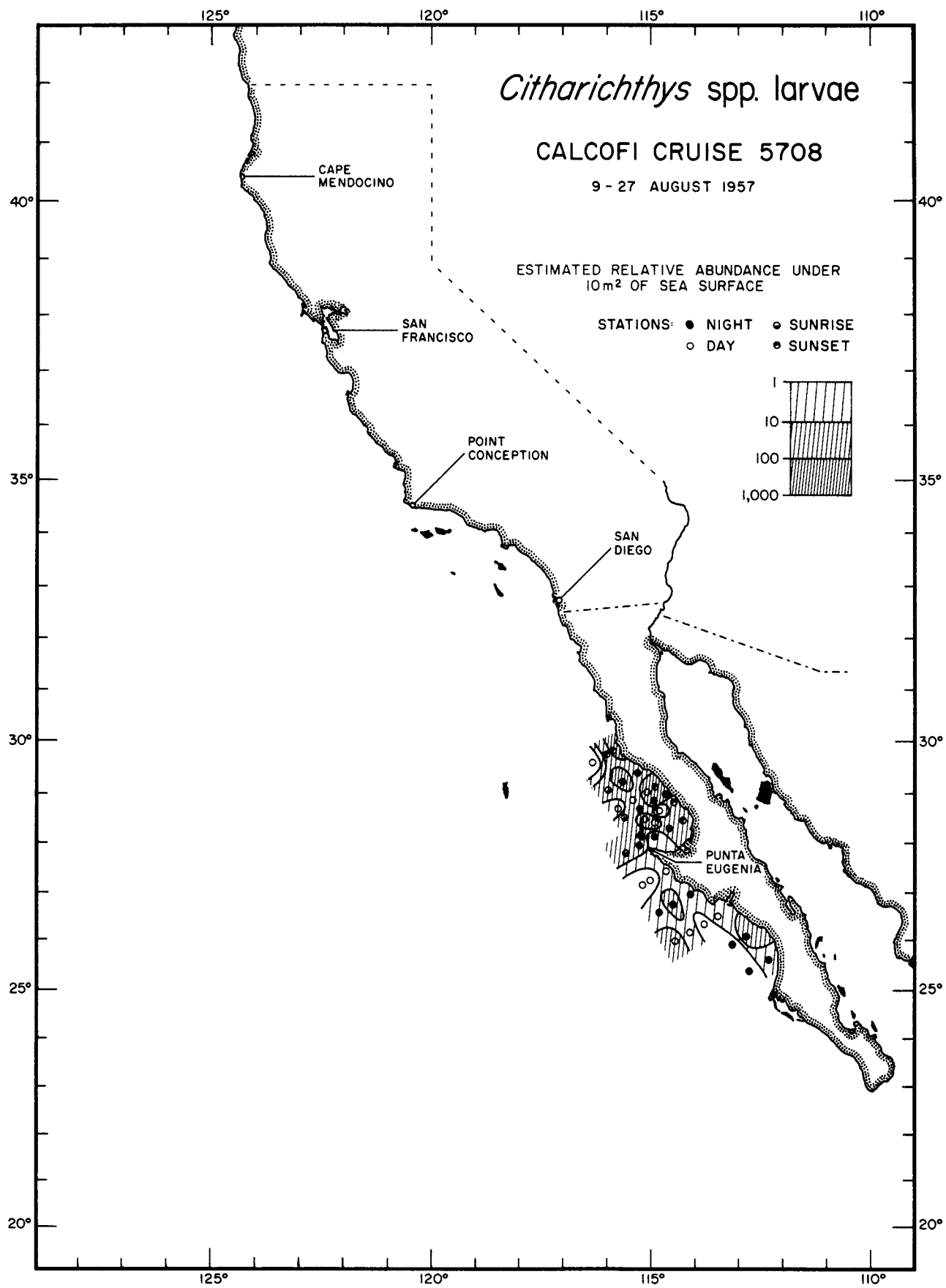
Citharichthys spp. larvae

5706



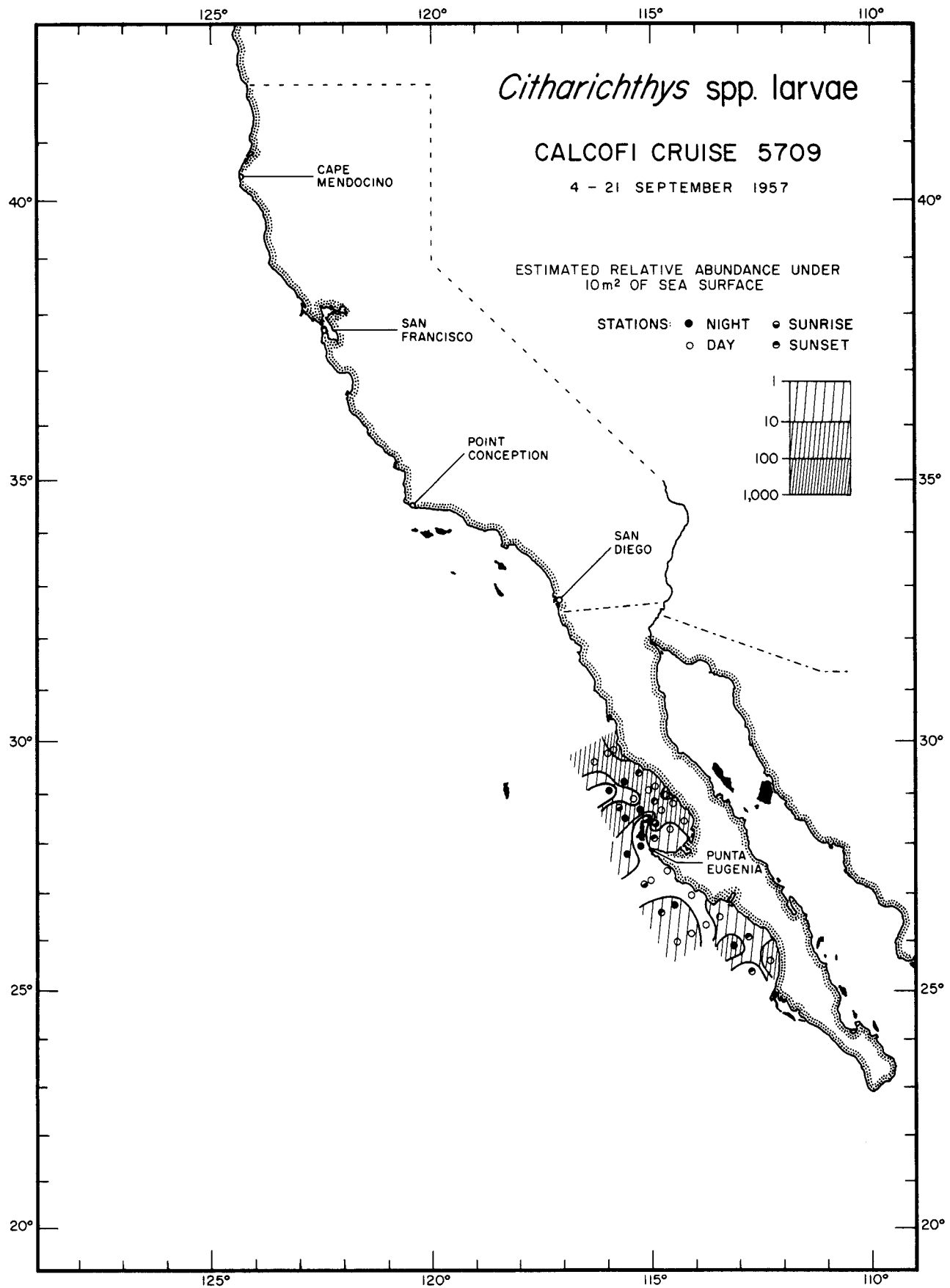
Citharichthys spp. larvae

5707



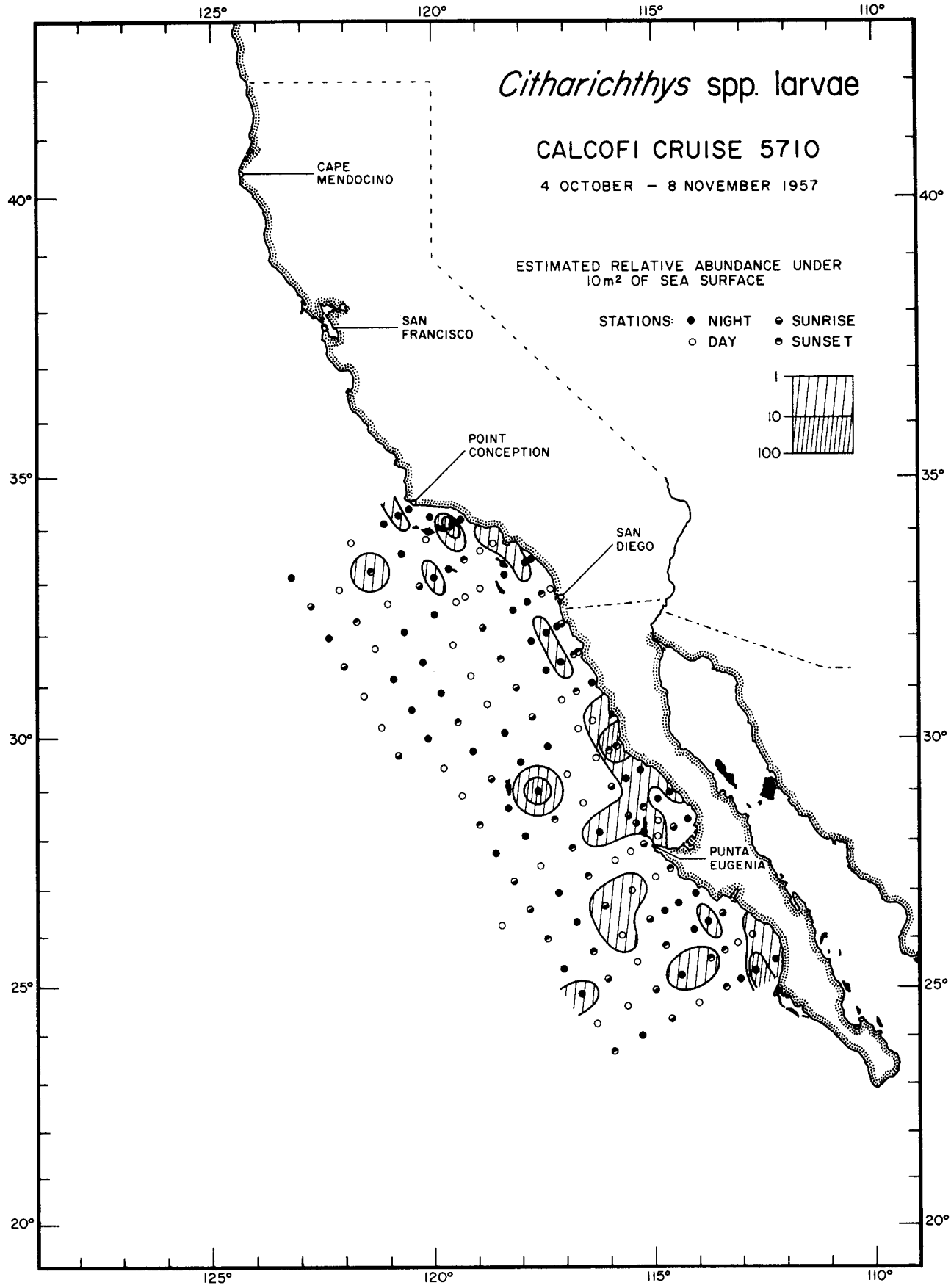
Citharichthys spp. larvae

5708



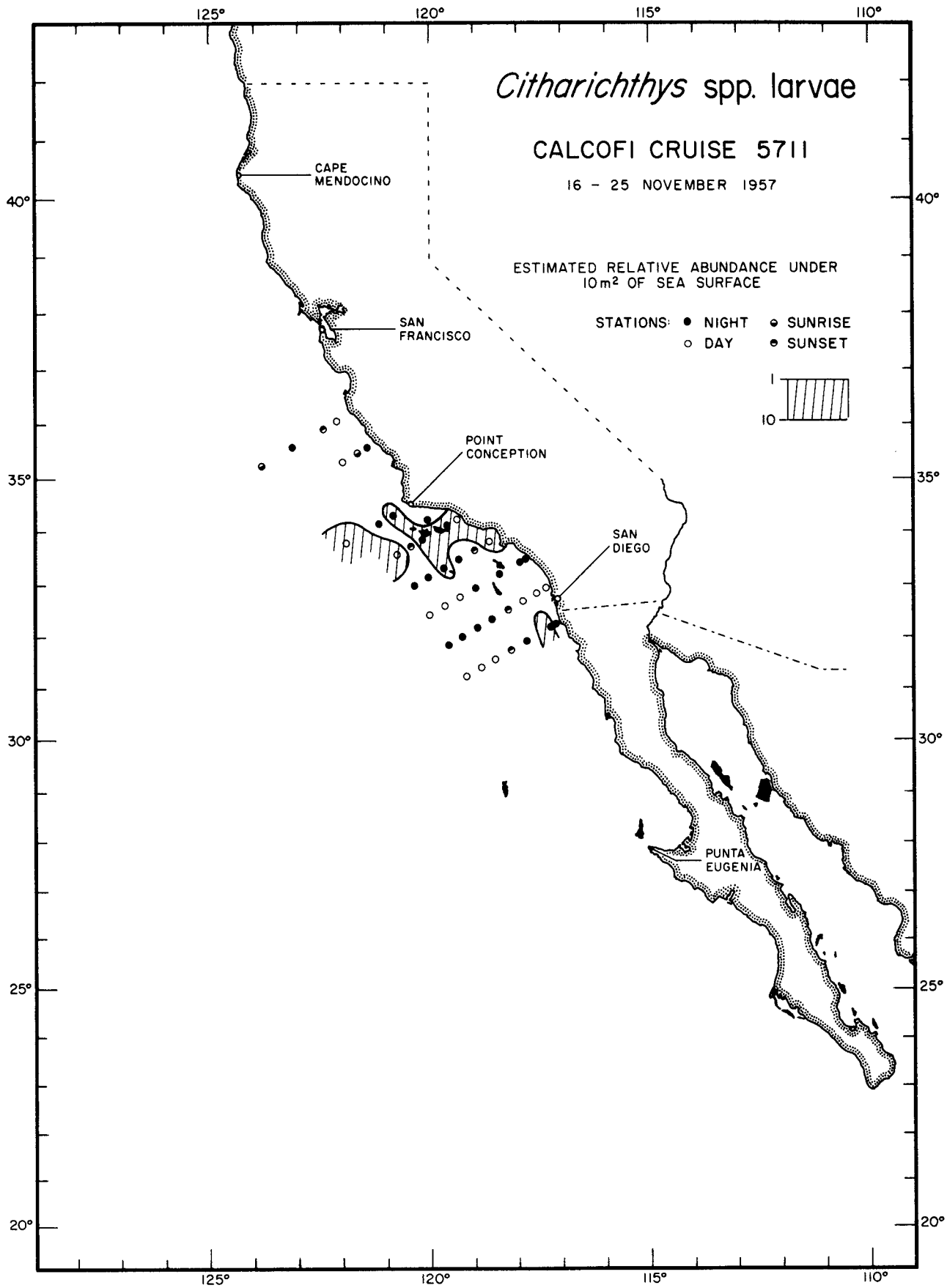
Citharichthys spp. larvae

5709



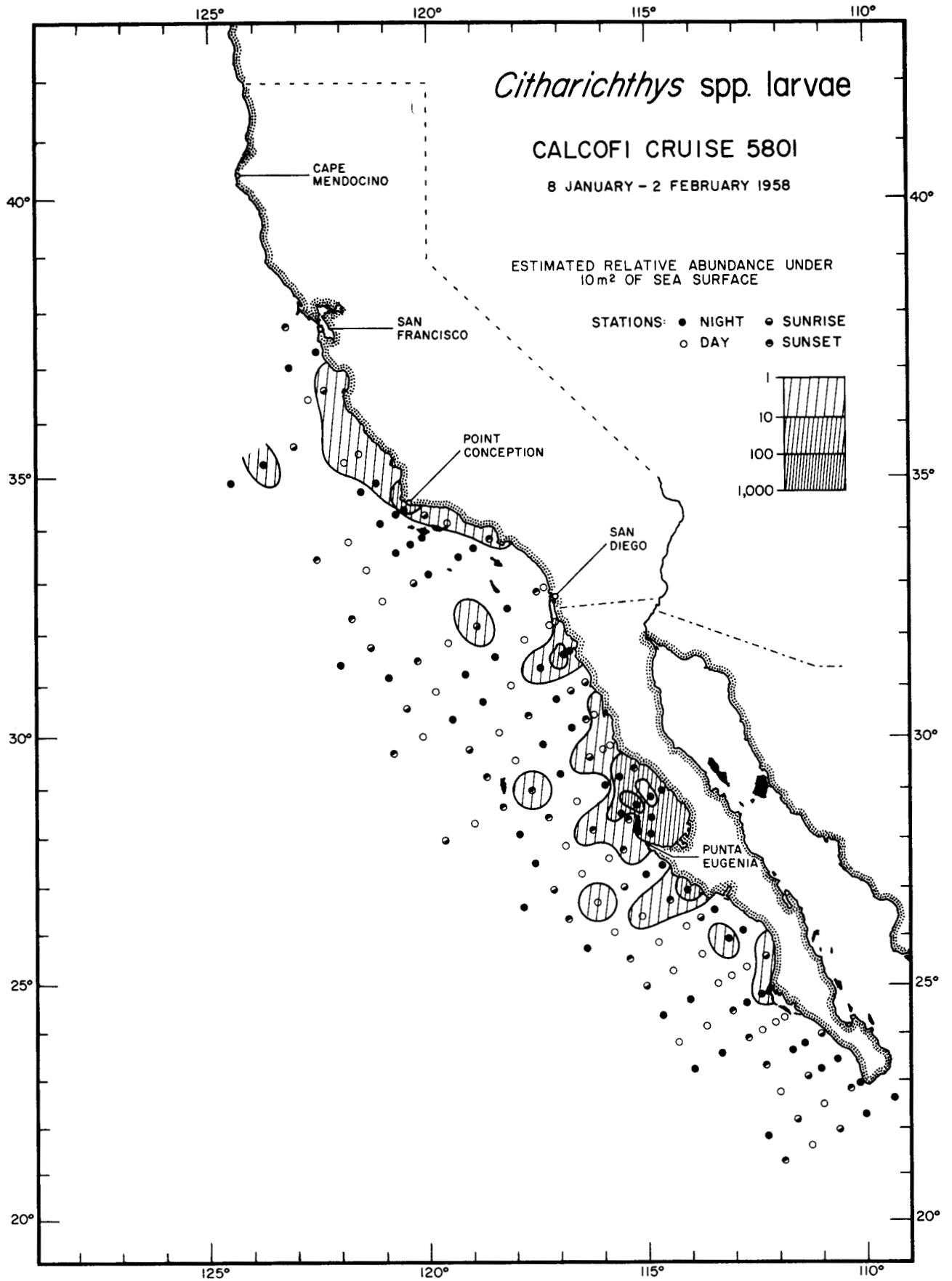
Citharichthys spp. larvae

5710



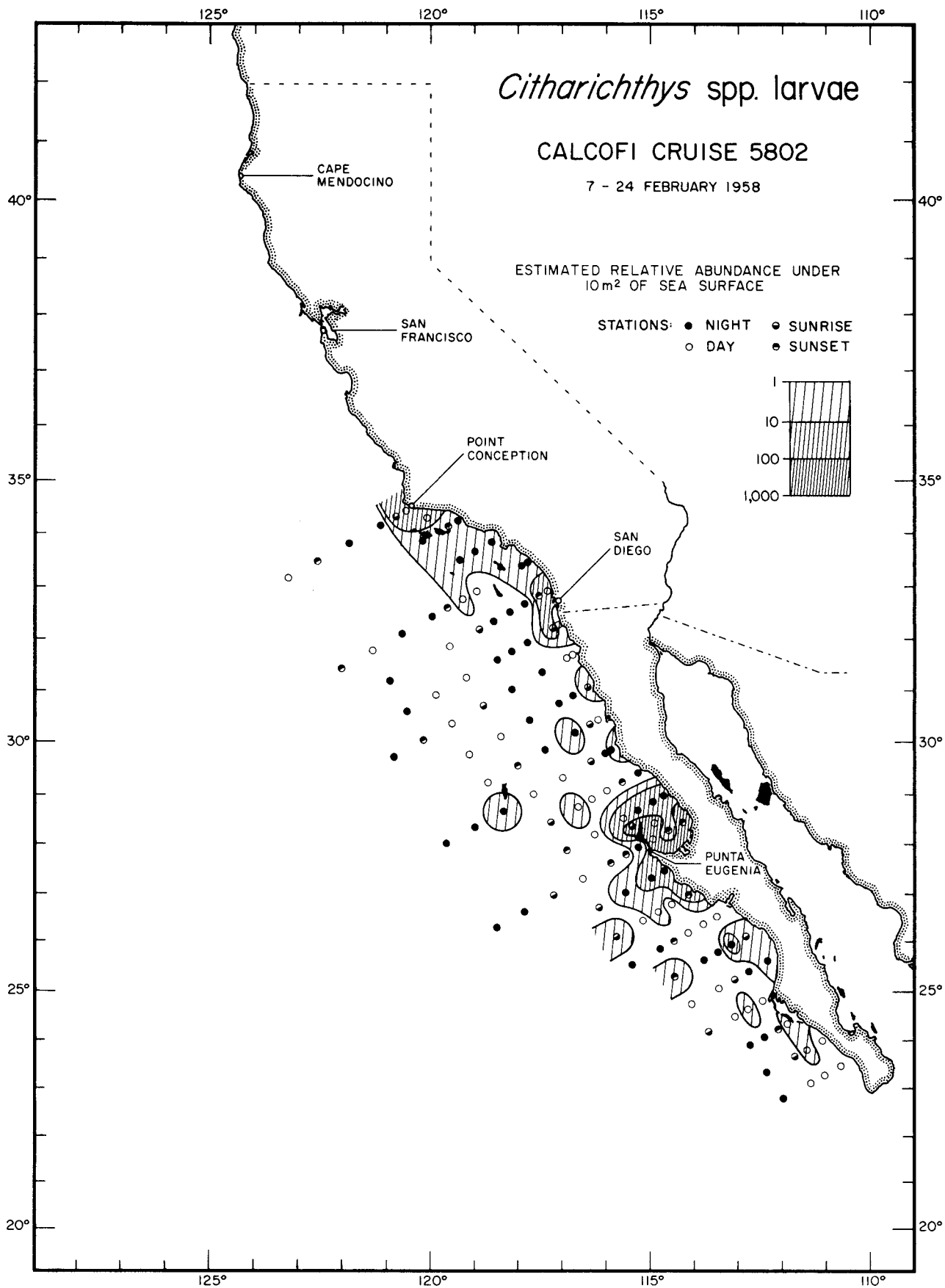
Citharichthys spp. larvae

5711



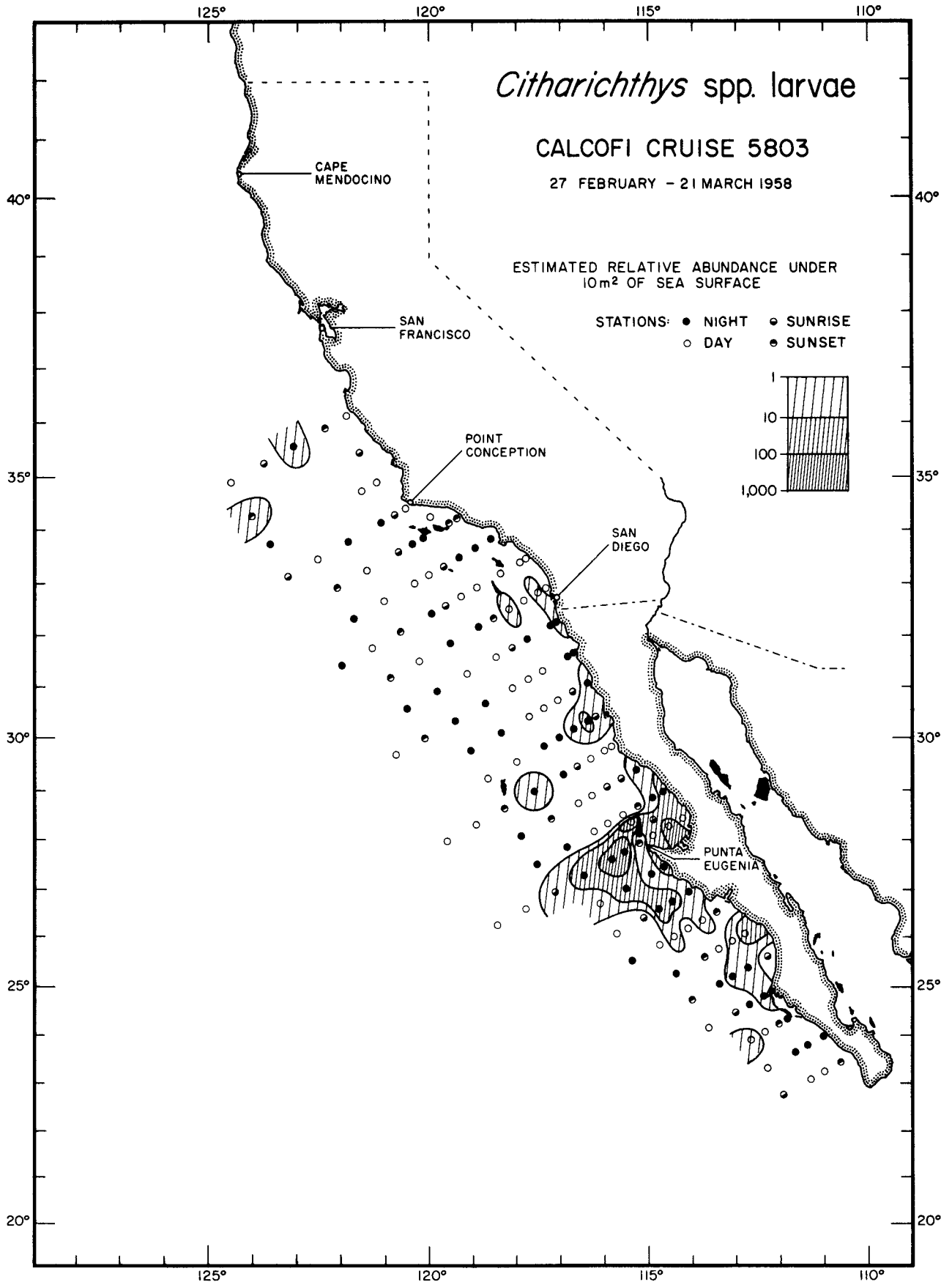
Citharichthys spp. larvae

5801



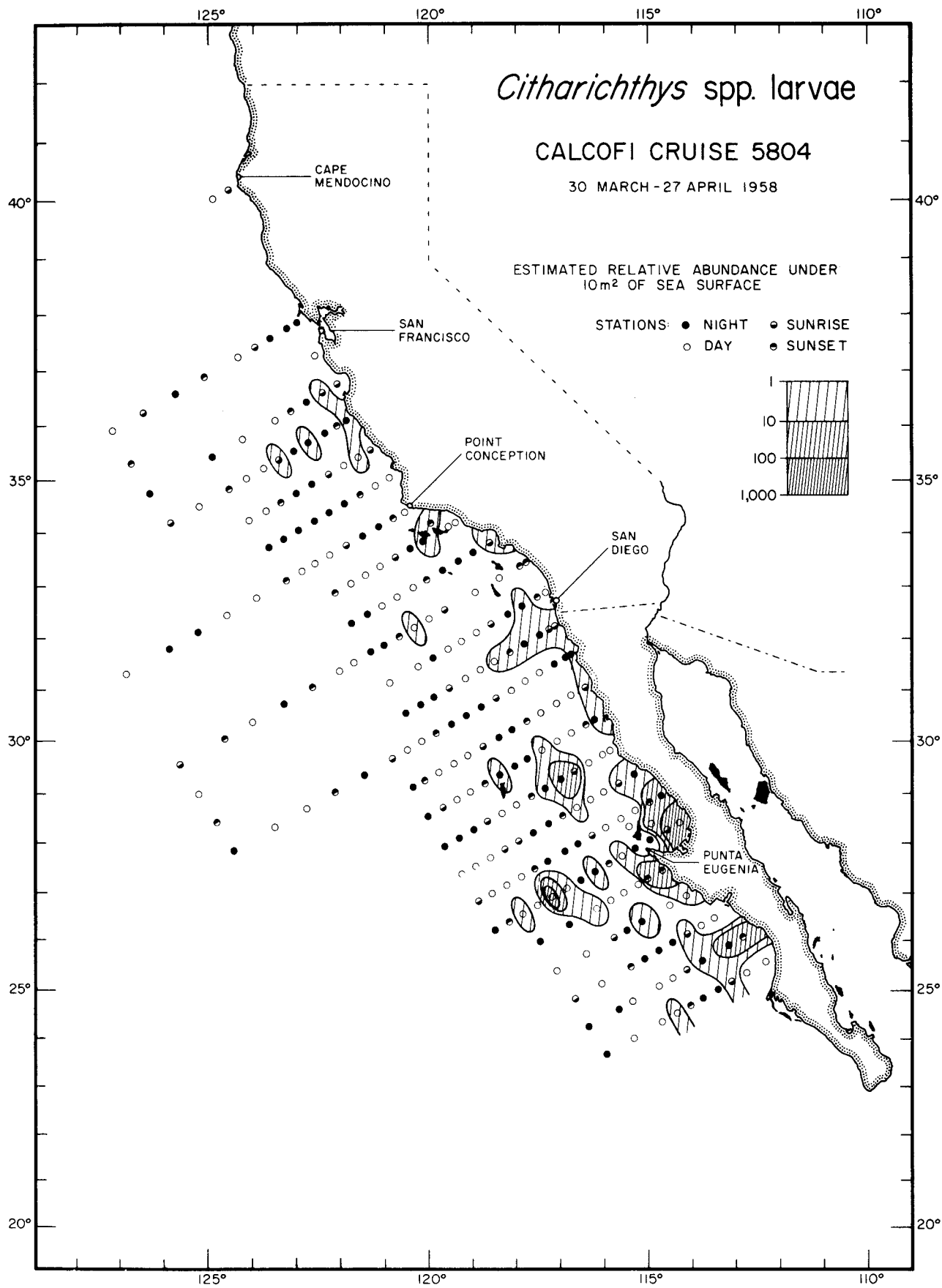
Citharichthys spp. larvae

5802



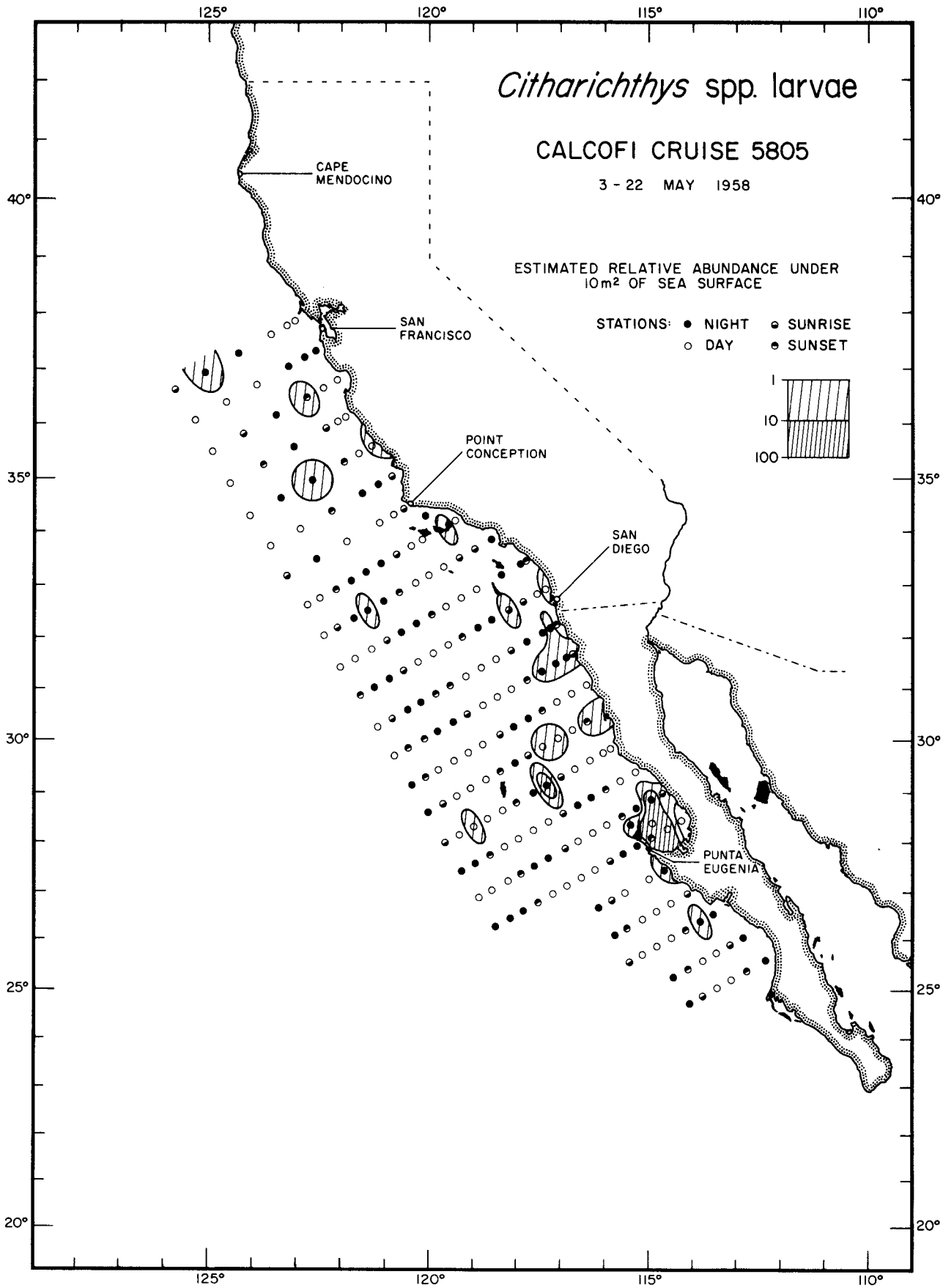
Citharichthys spp. larvae

5803



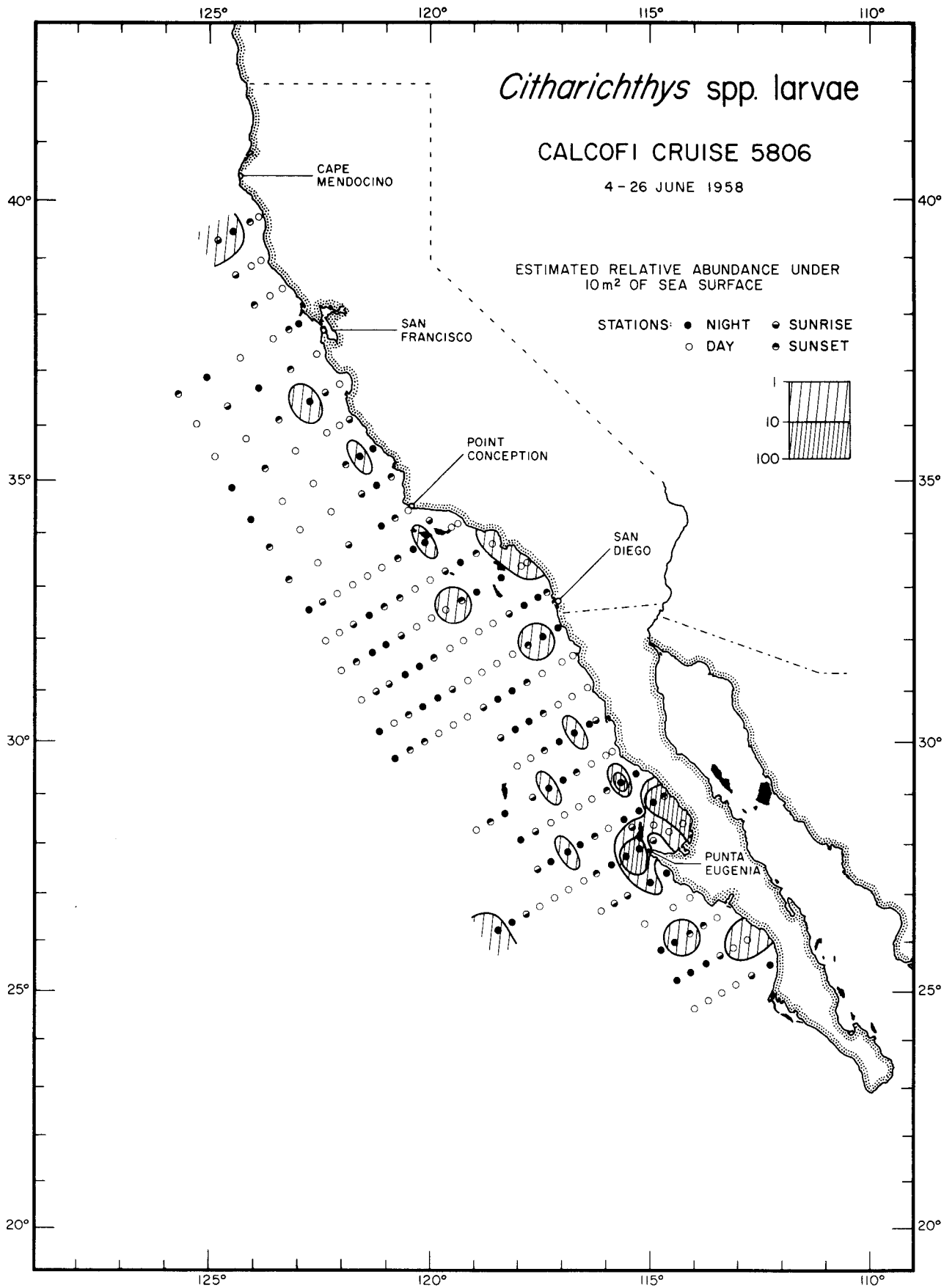
Citharichthys spp. larvae

5804



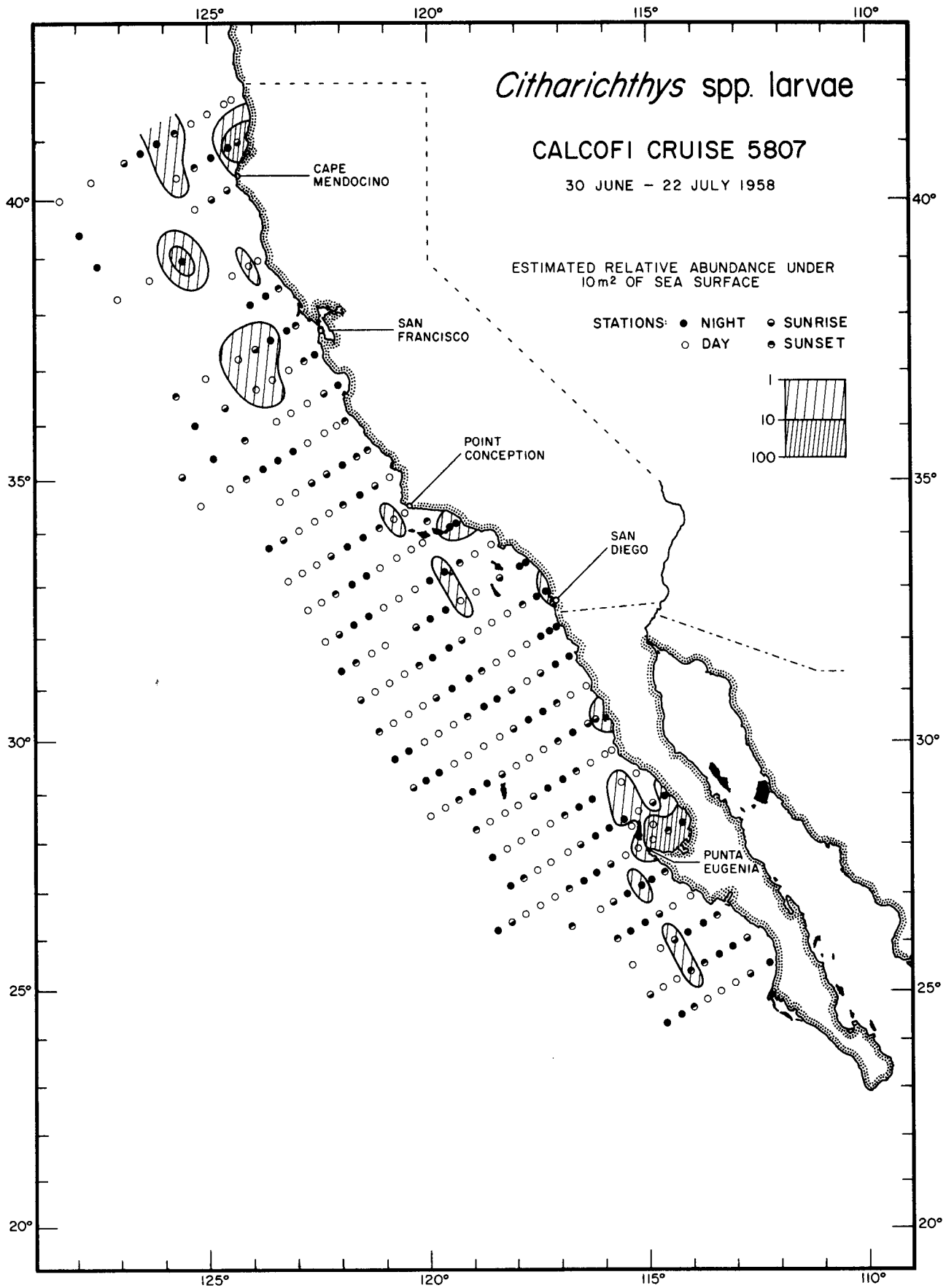
Citharichthys spp. larvae

5805



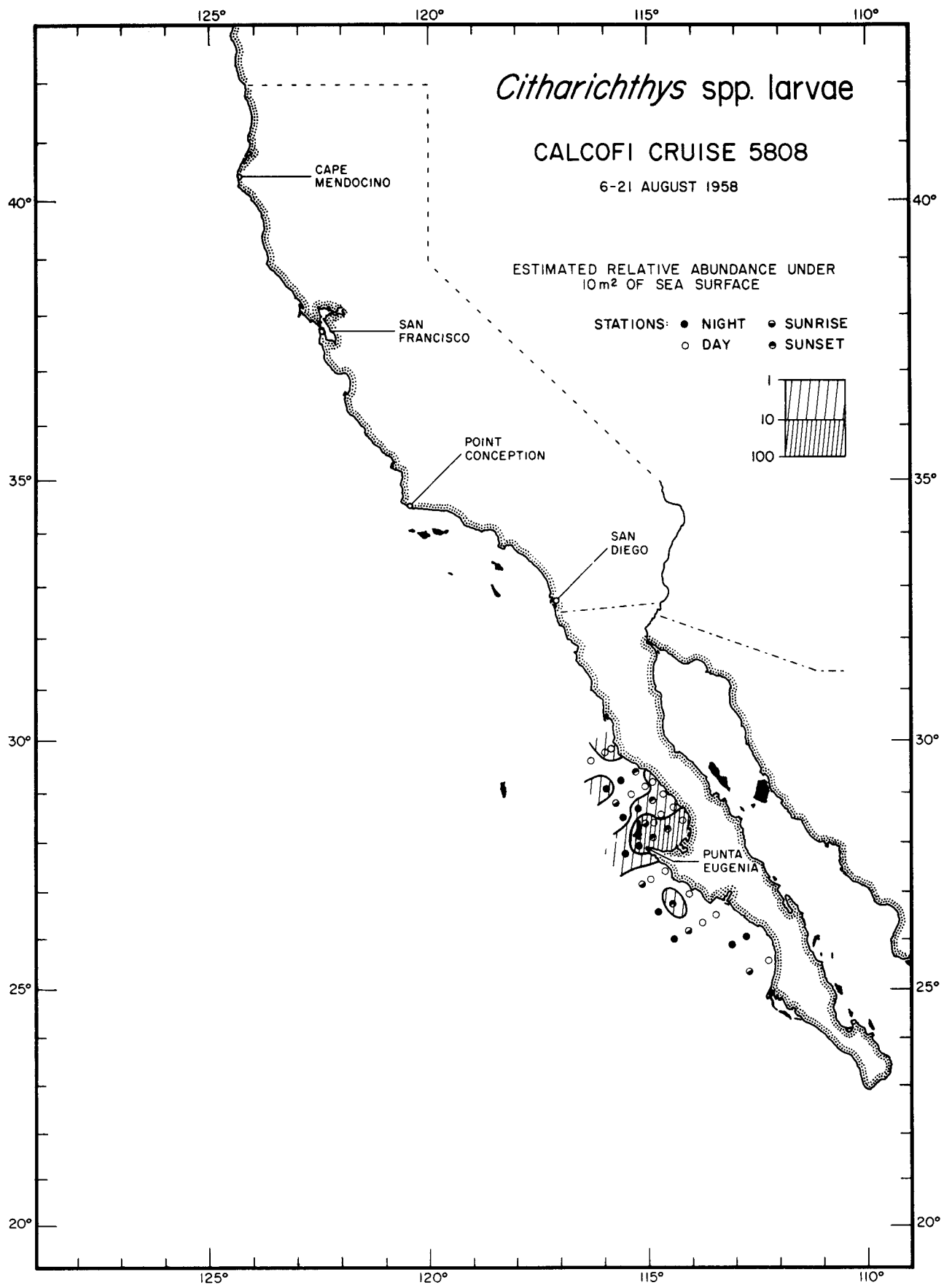
Citharichthys spp. larvae

5806
●●



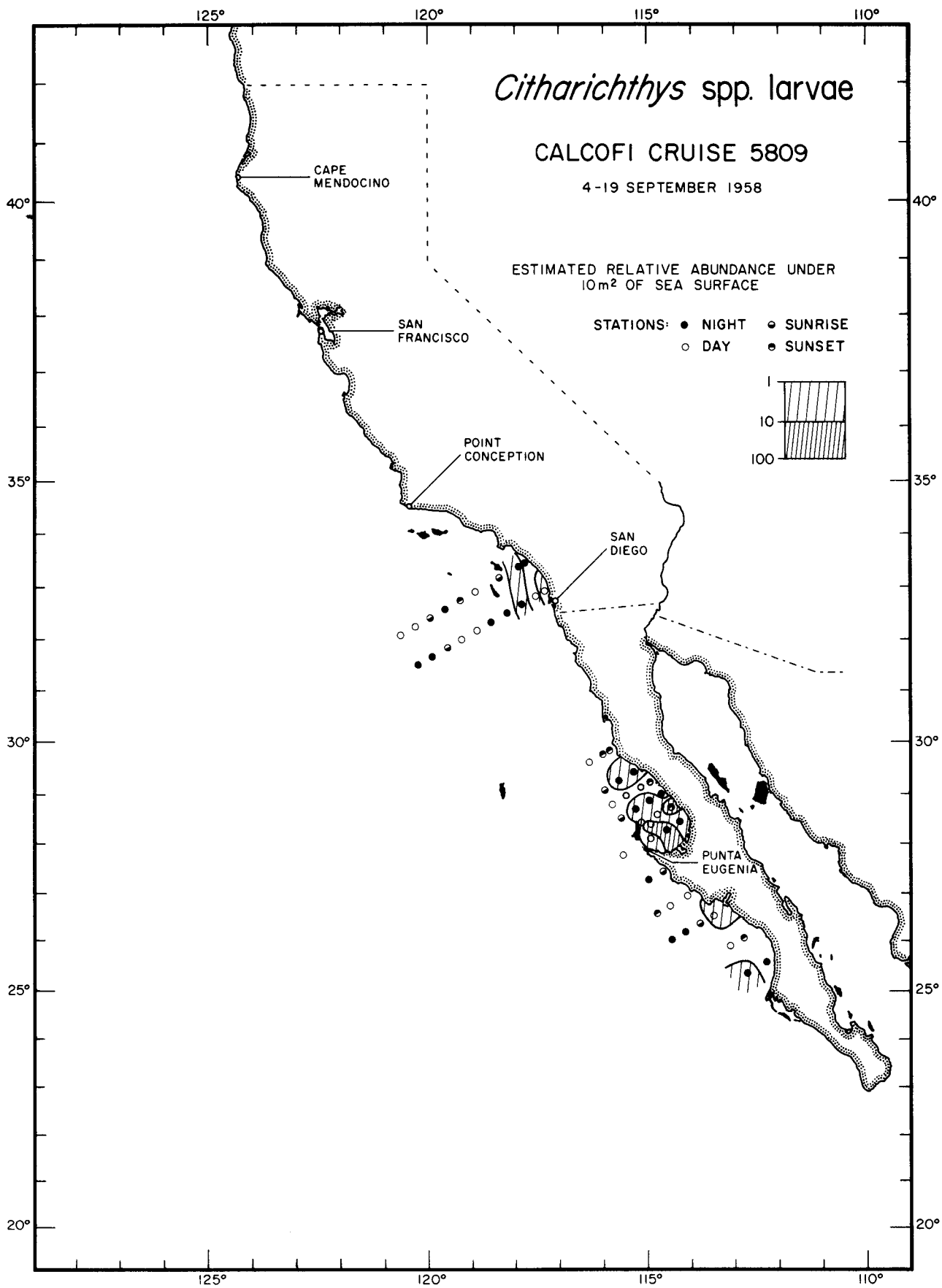
Citharichthys spp. larvae

5807



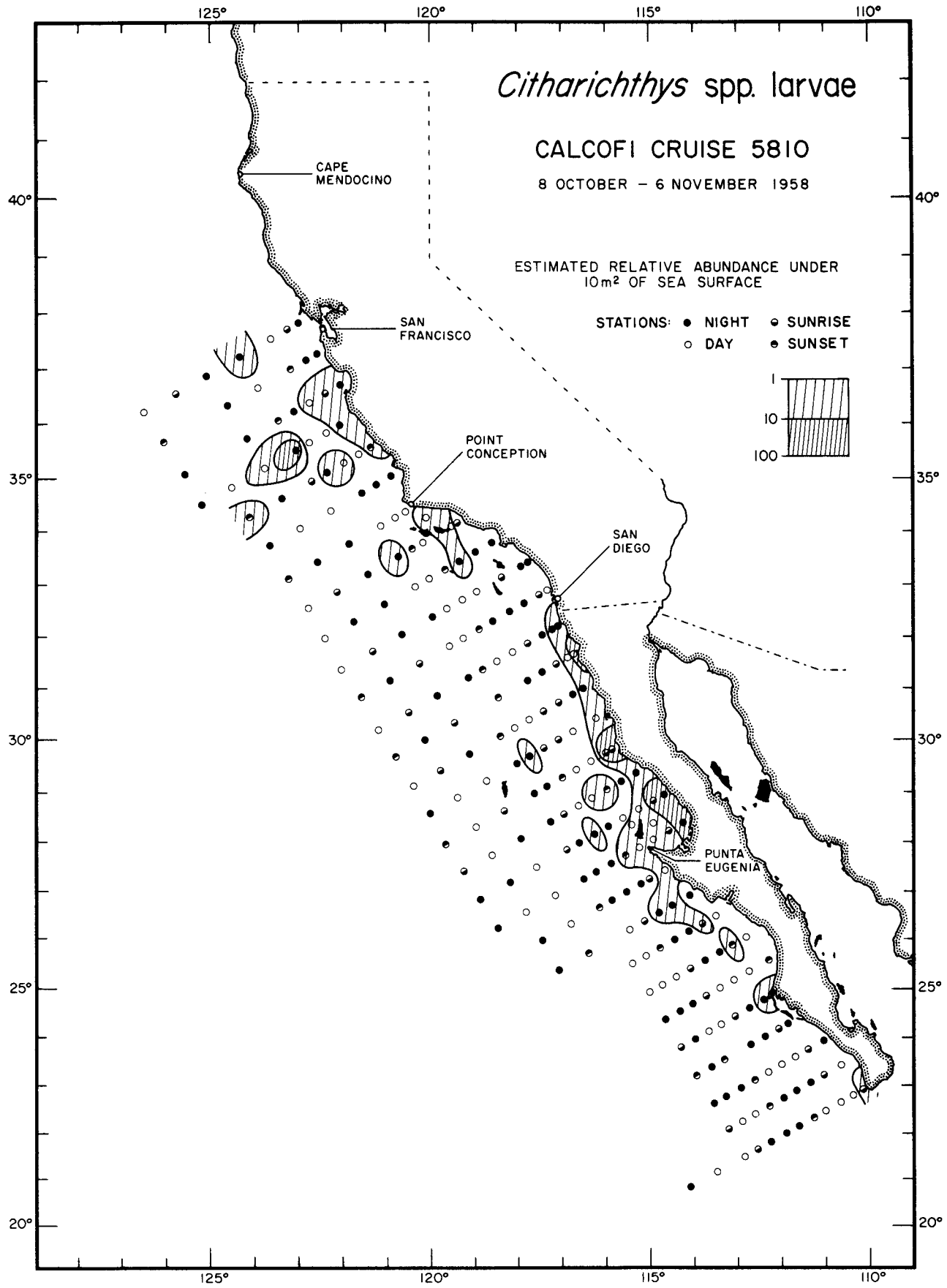
Citharichthys spp. larvae

5808



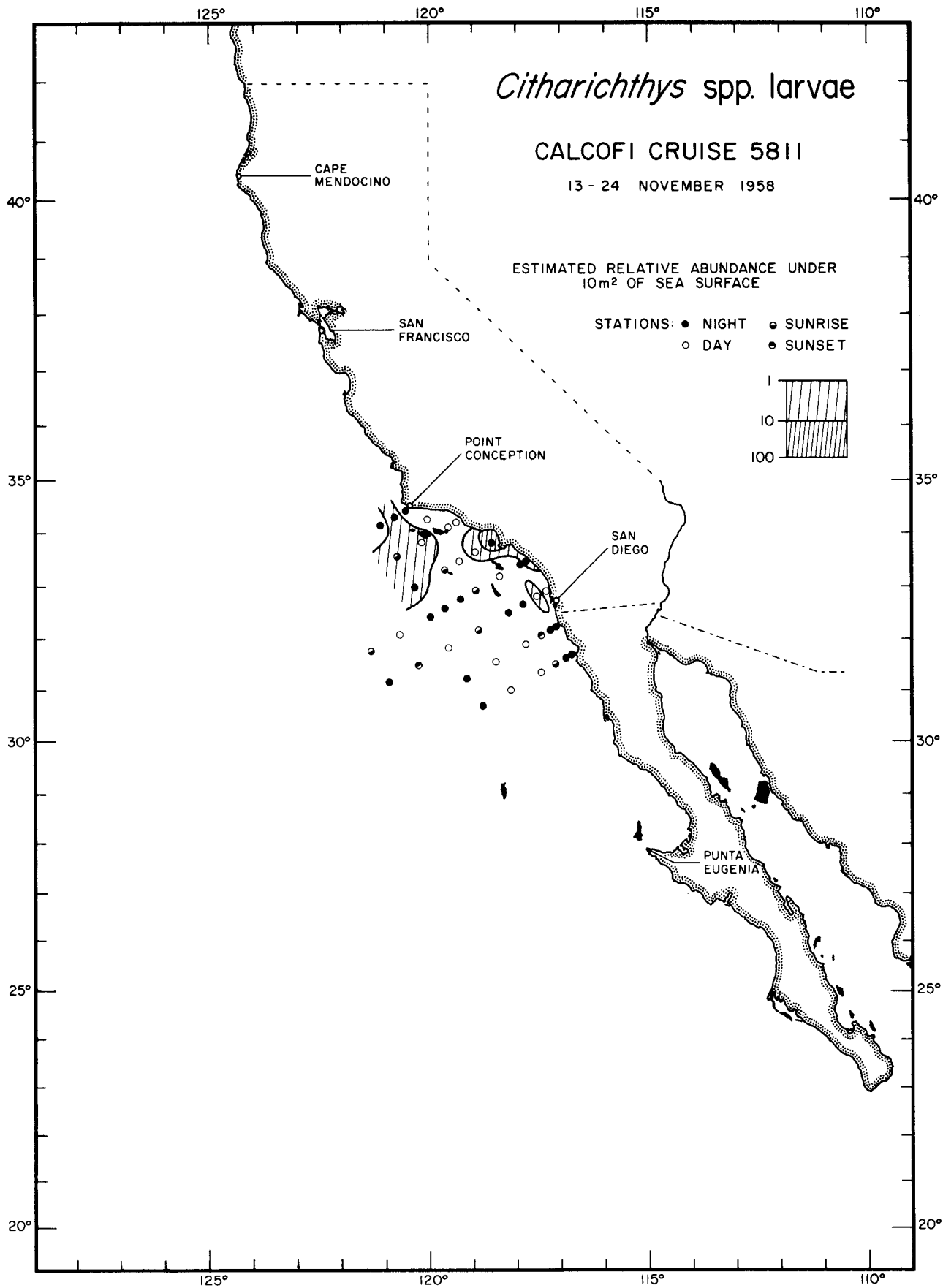
Citharichthys spp. larvae

5809



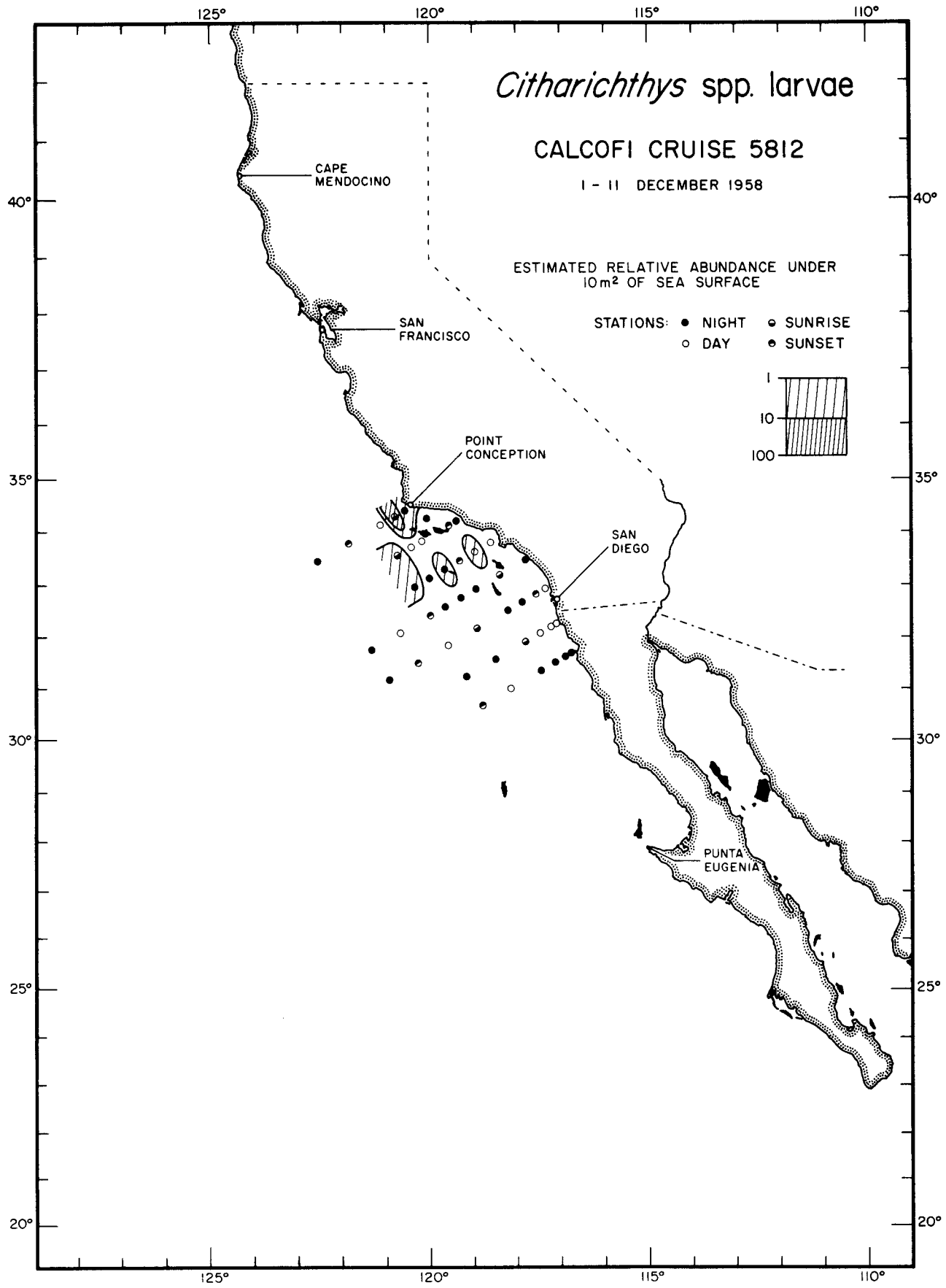
Citharichthys spp. larvae

5810



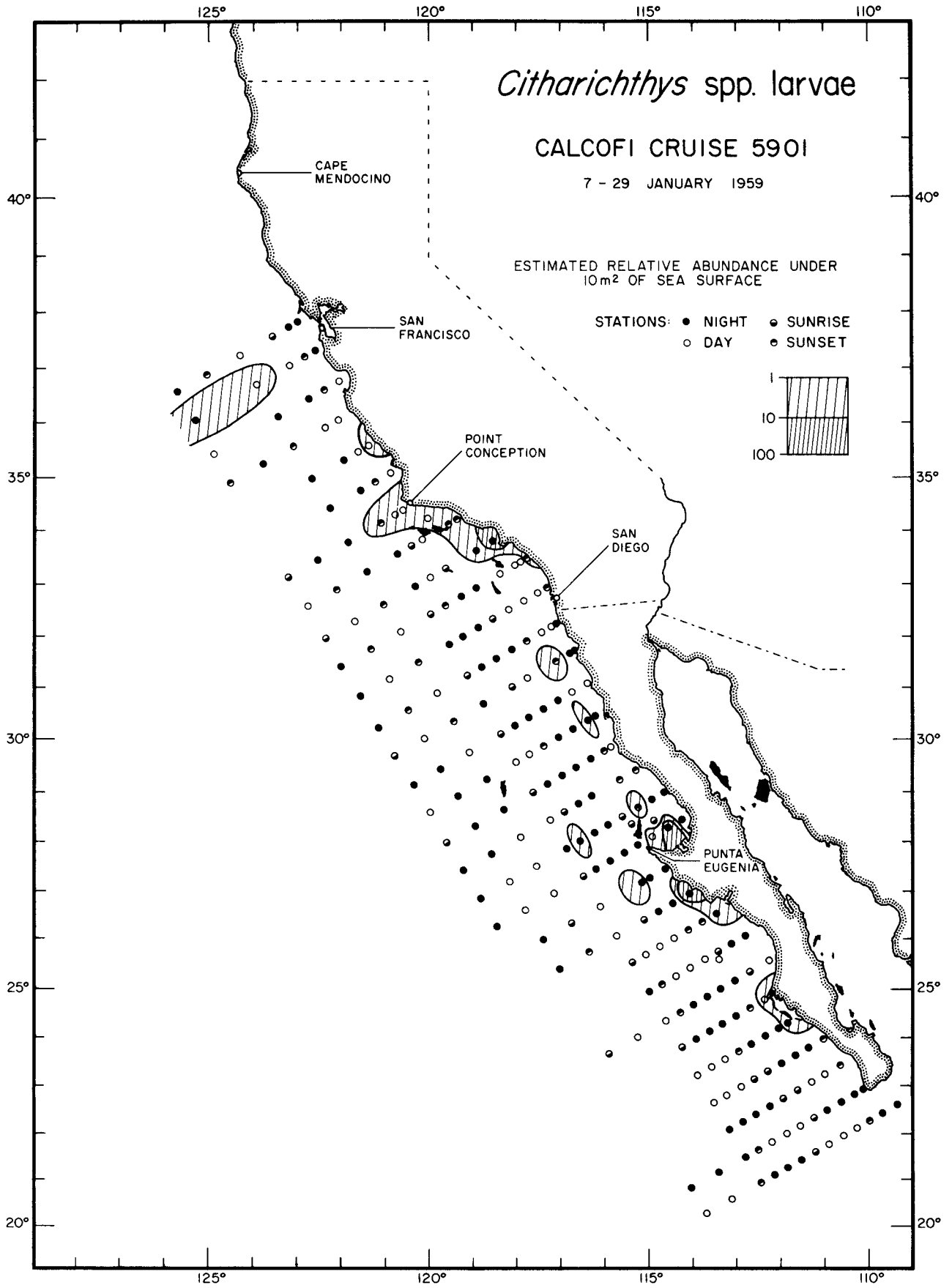
Citharichthys spp. larvae

5811



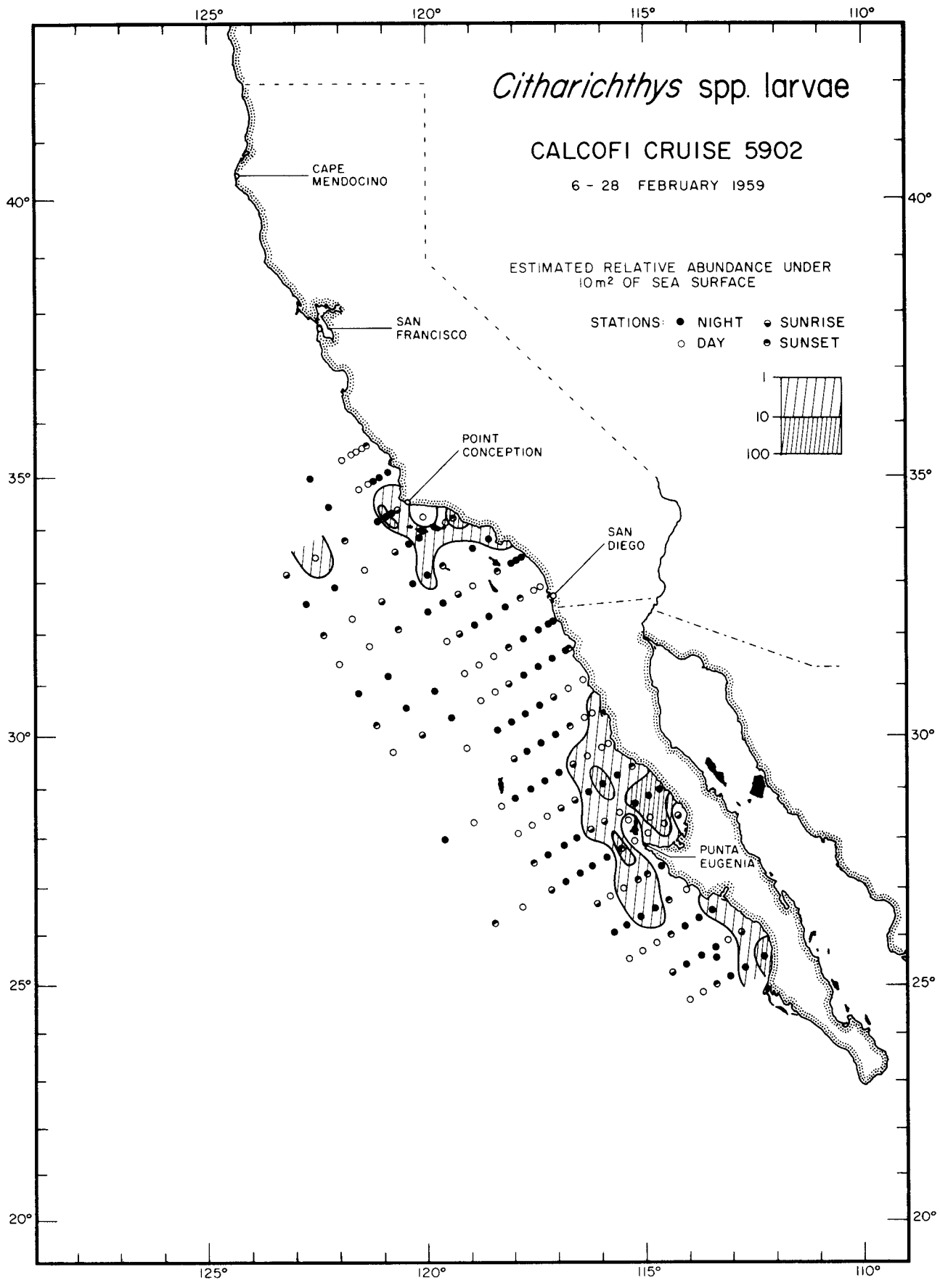
Citharichthys spp. larvae

5812



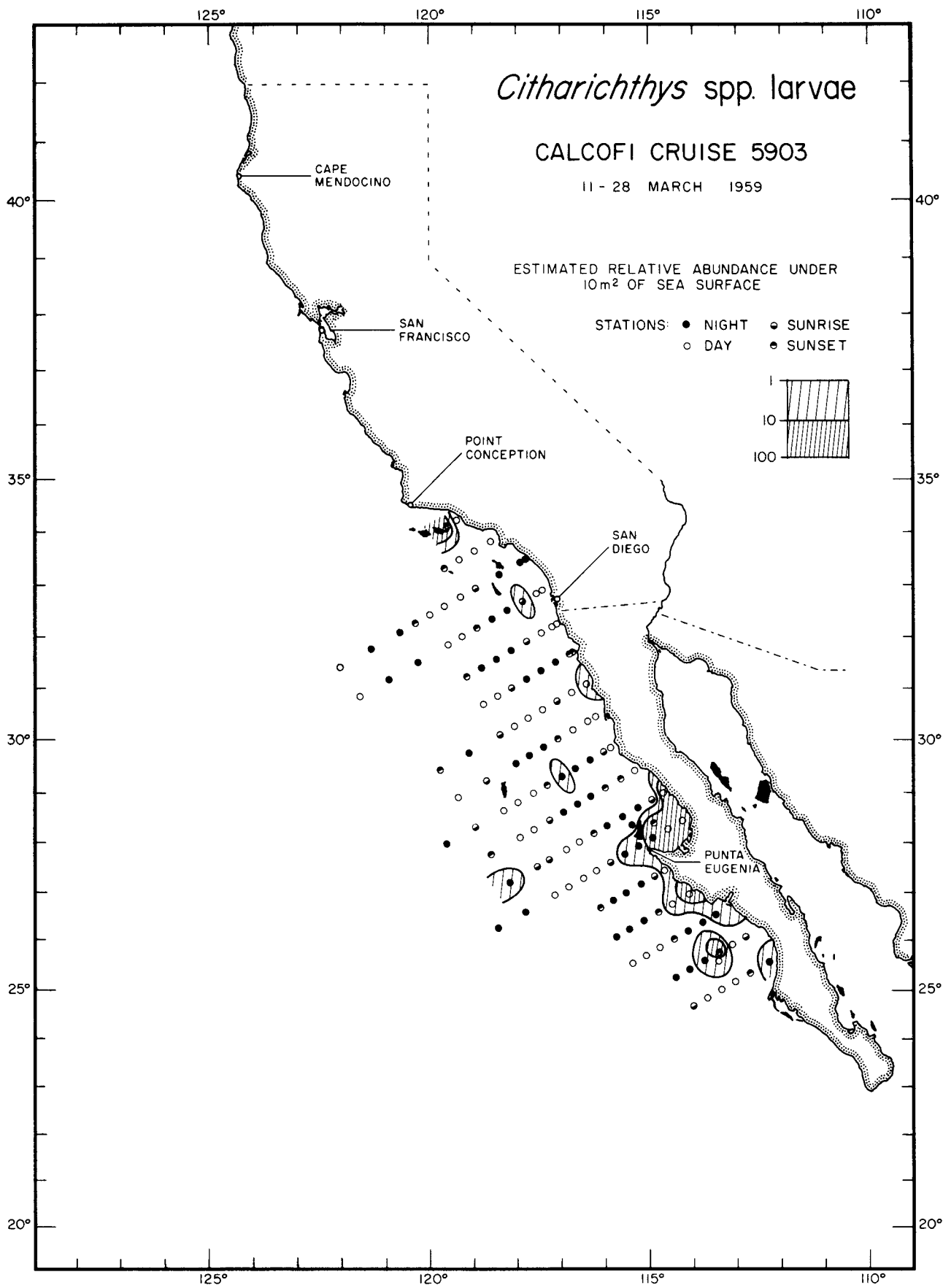
Citharichthys spp. larvae

5901



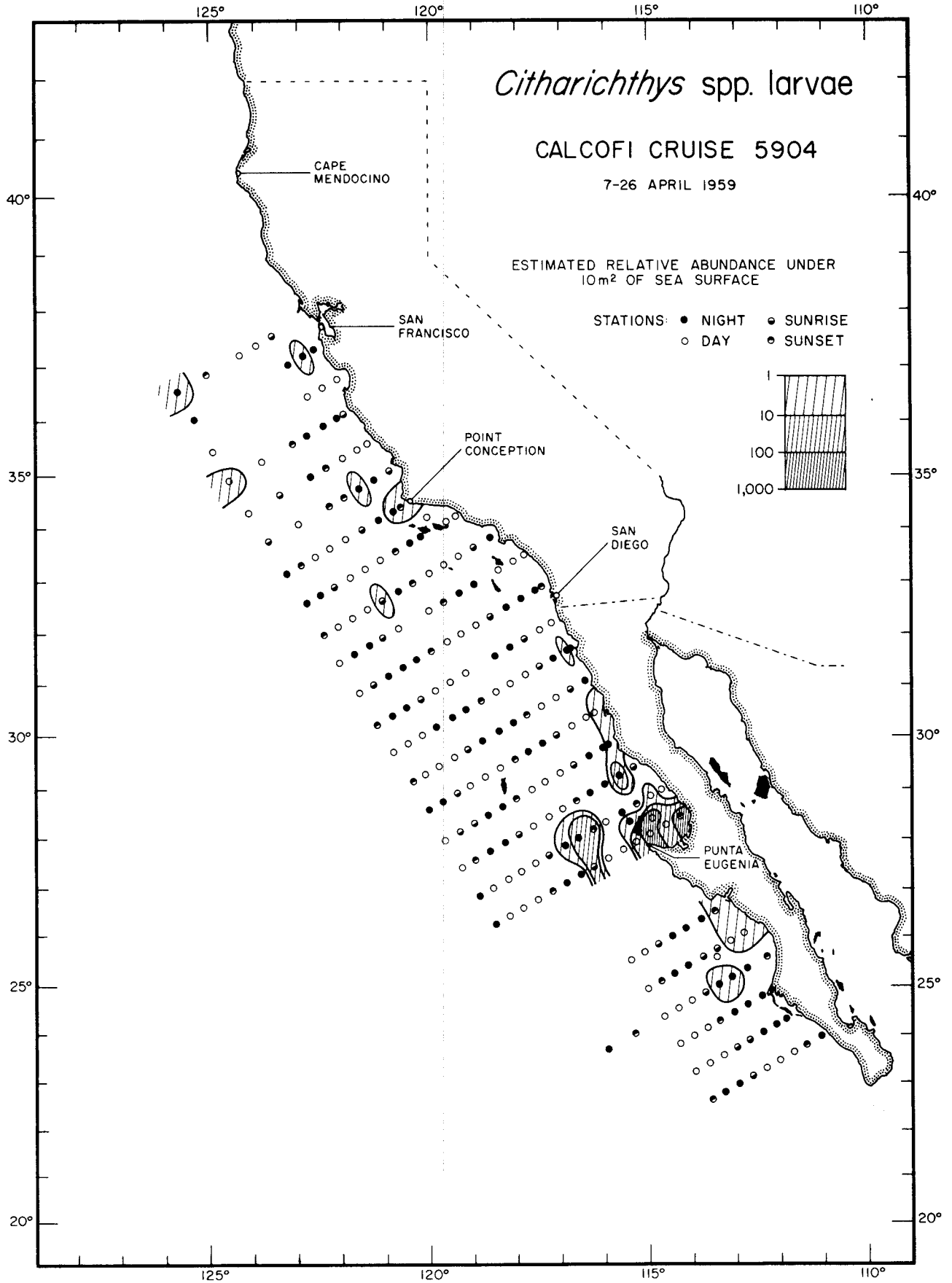
Citharichthys spp. larvae

5902



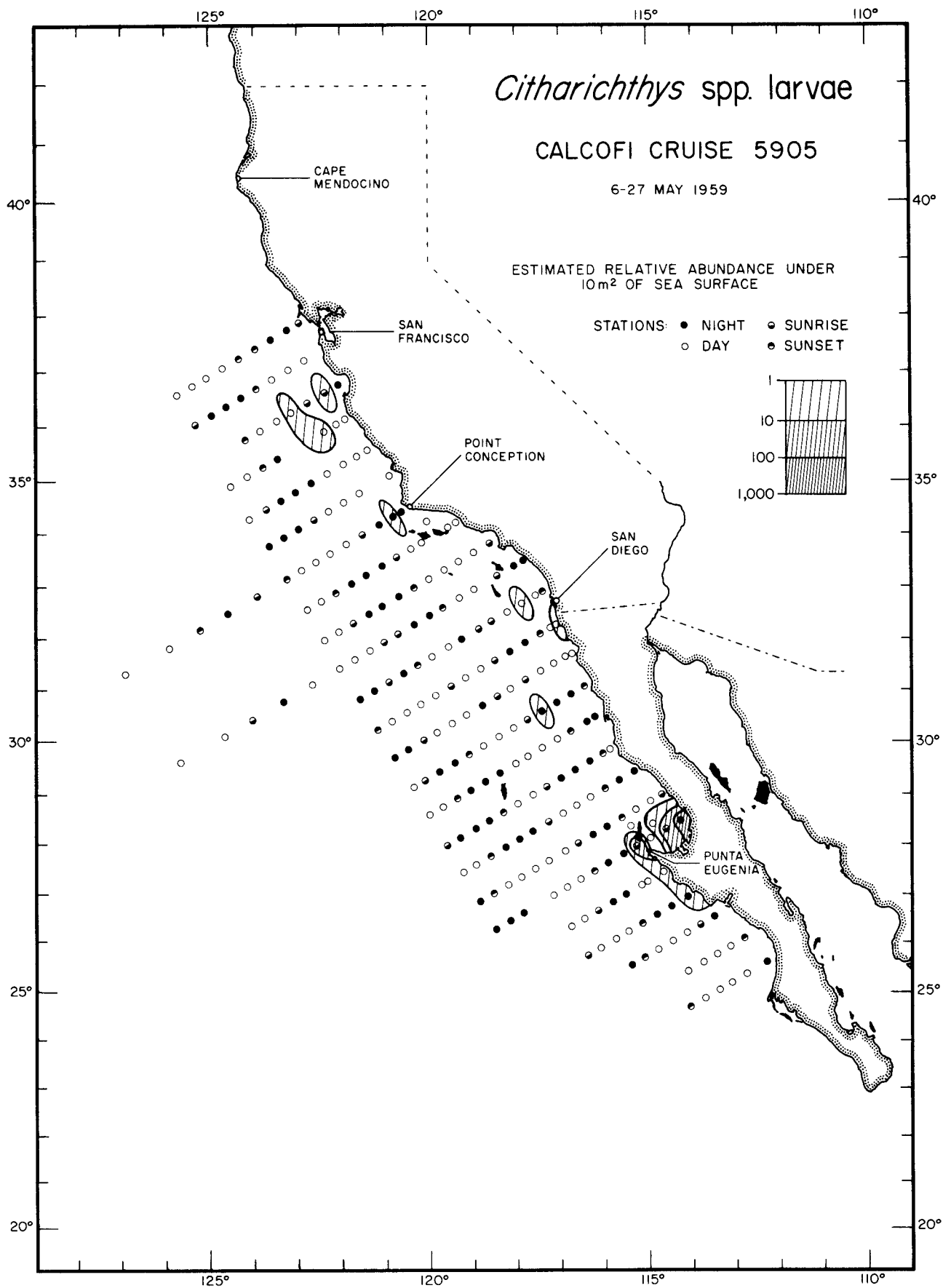
Citharichthys spp. larvae

5903



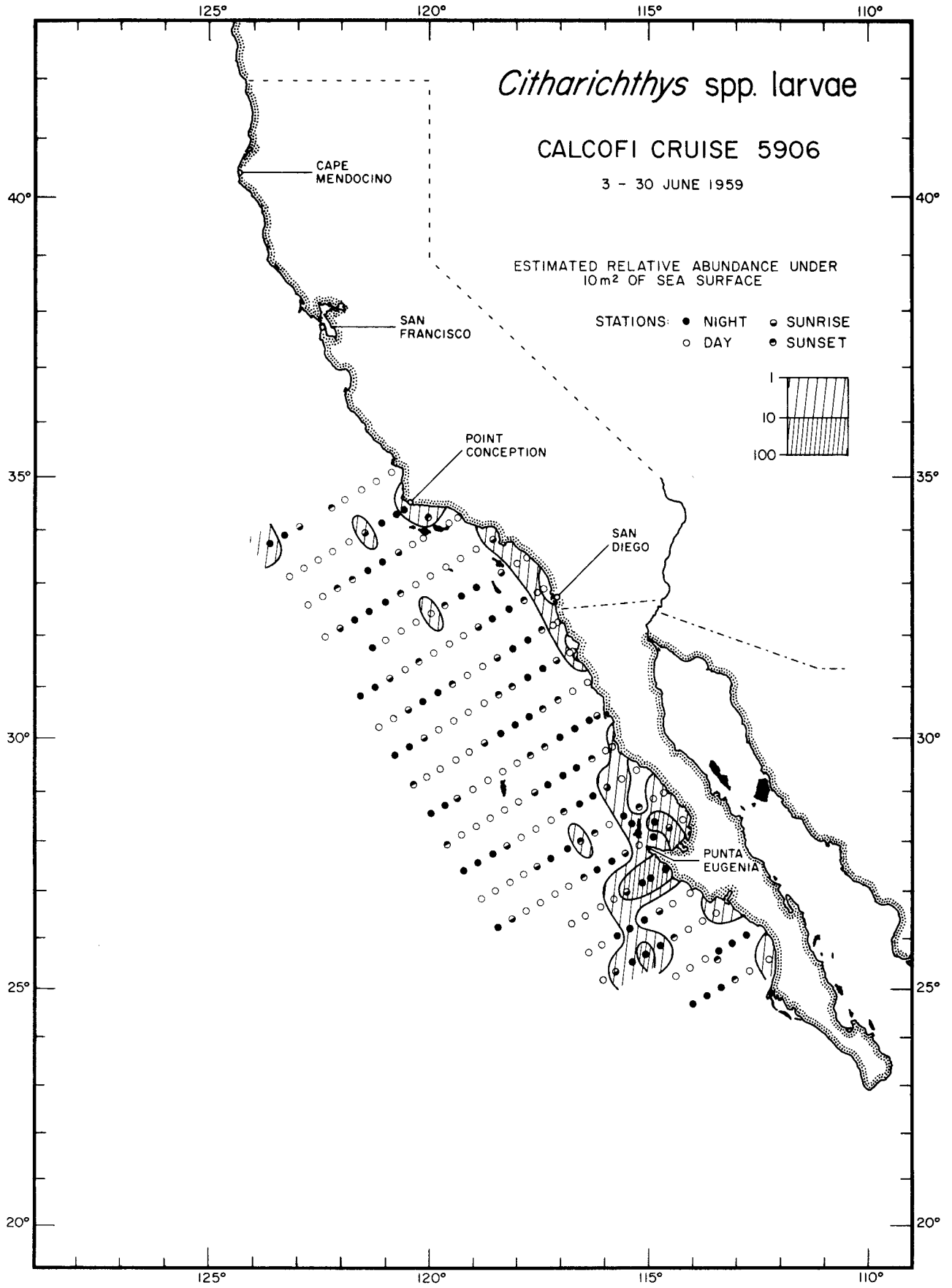
Citharichthys spp. larvae

5904



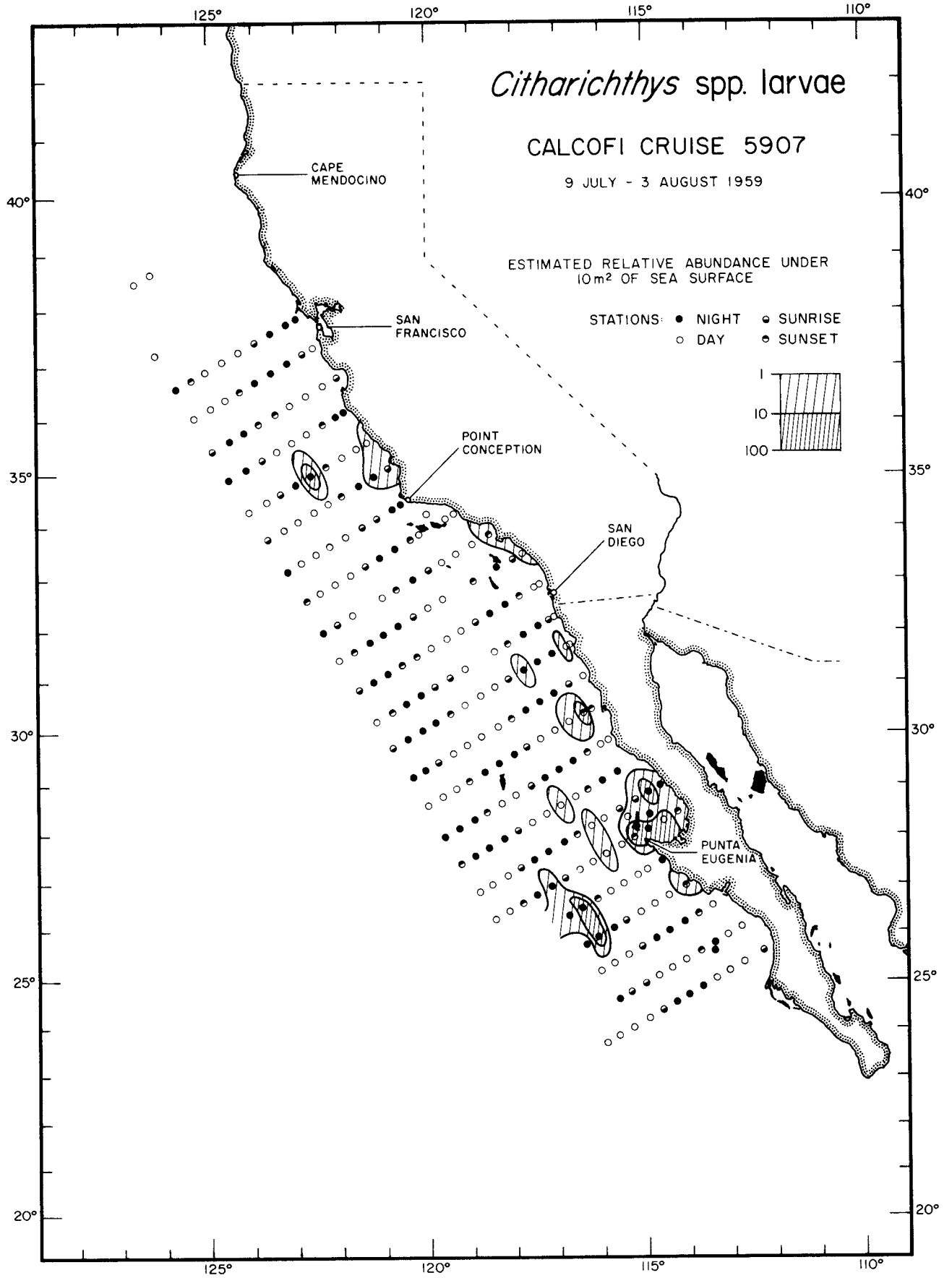
Citharichthys spp. larvae

5905



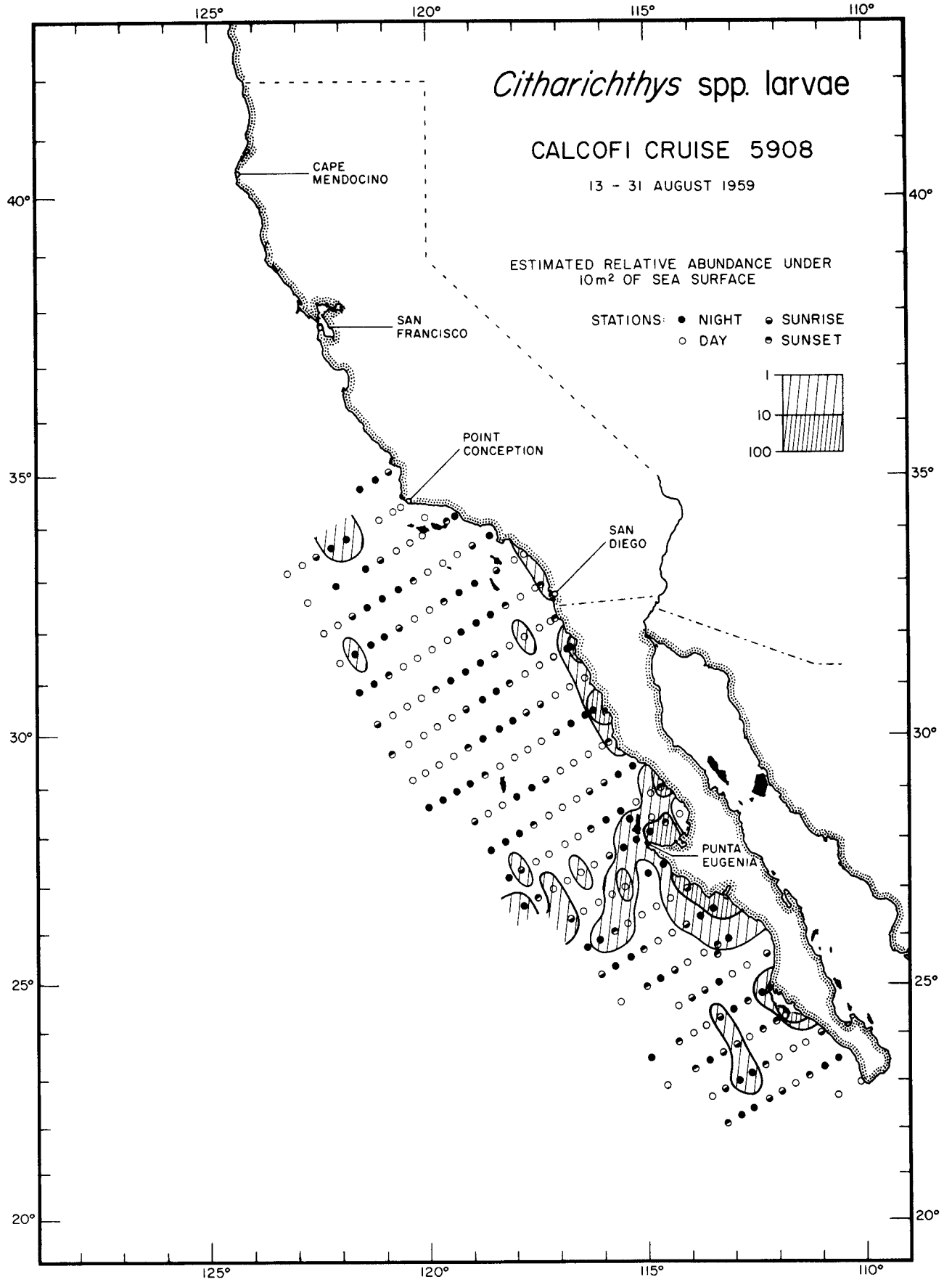
Citharichthys spp. larvae

5906



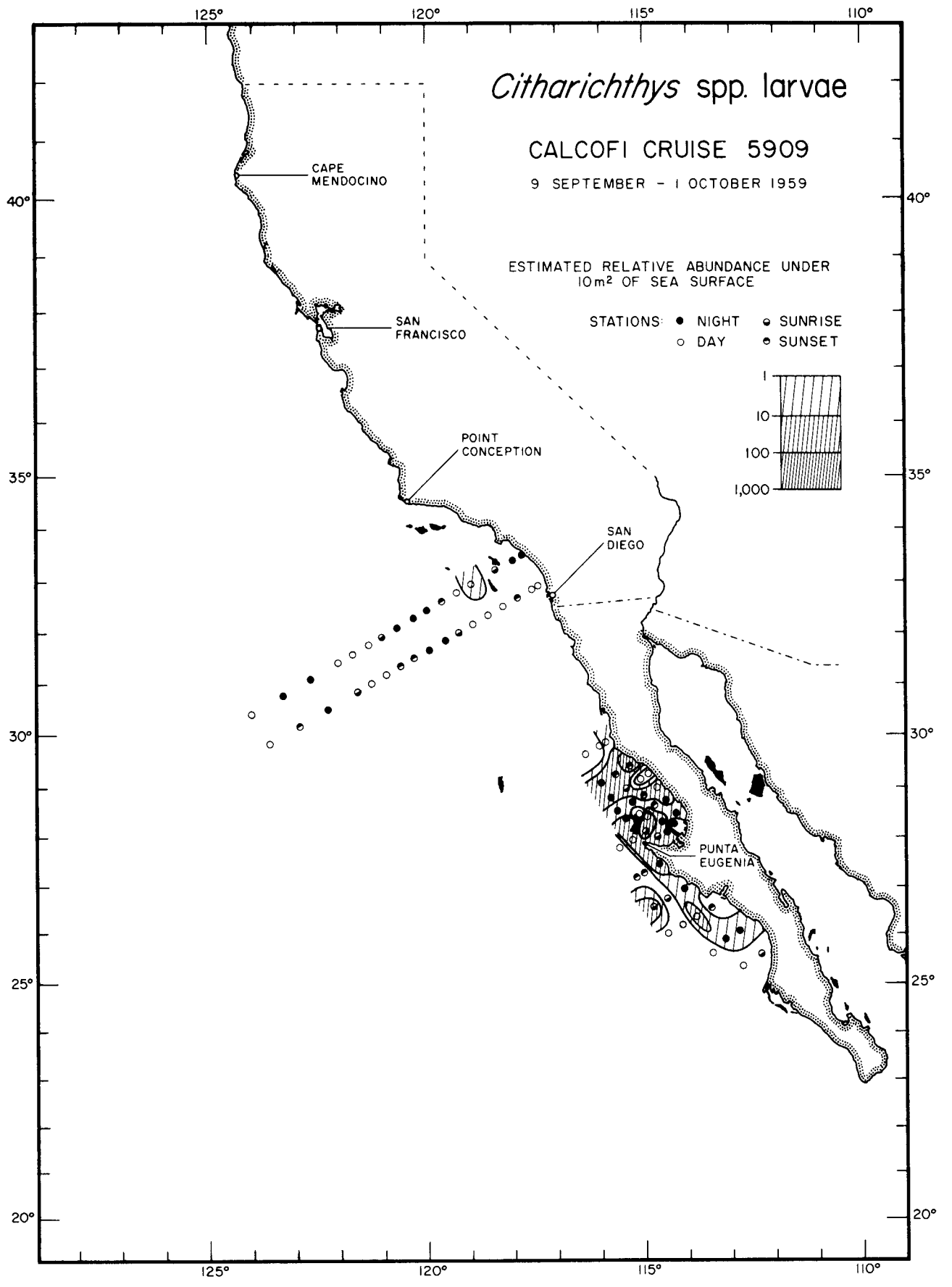
Citharichthys spp. larvae

5907



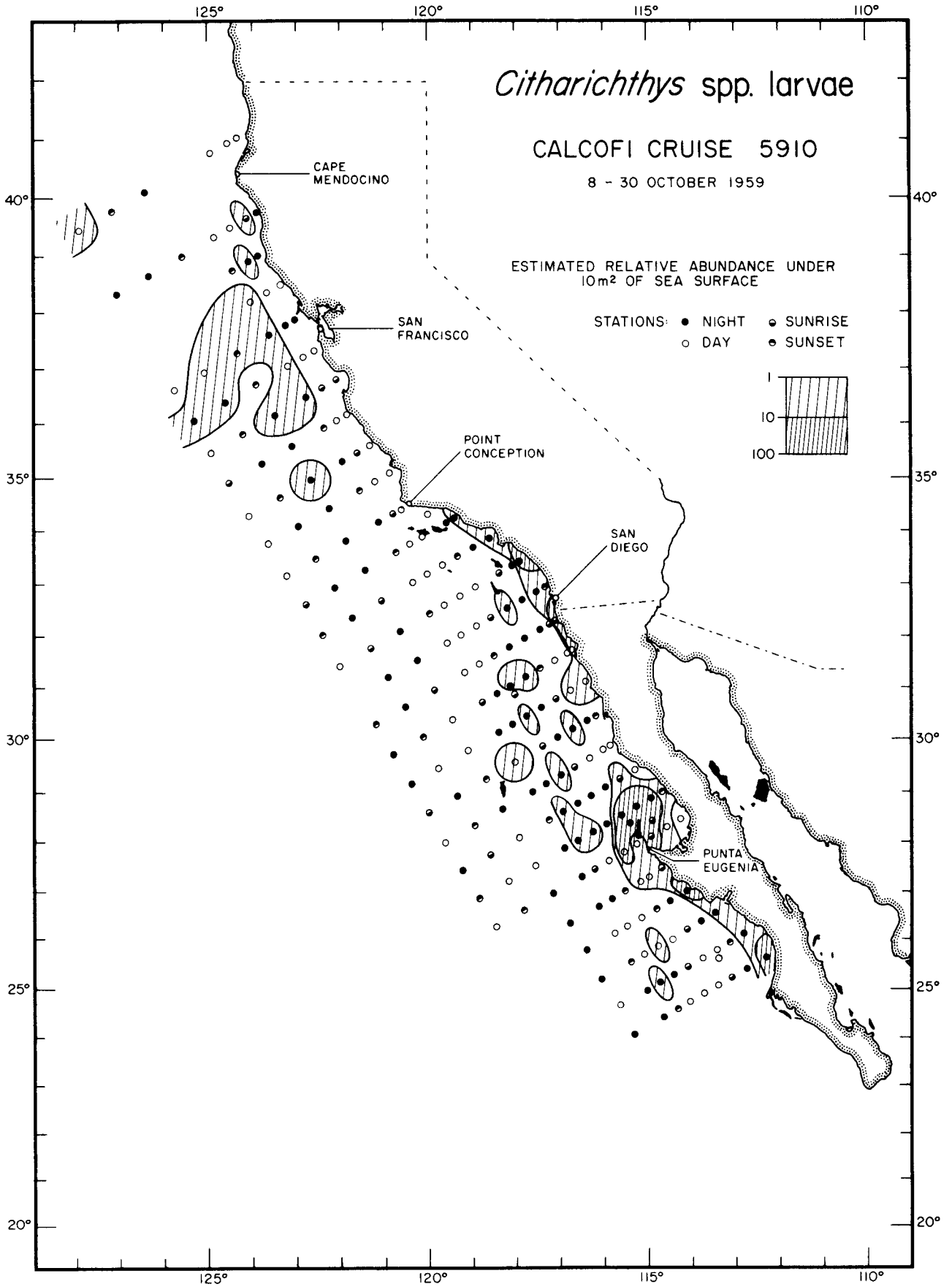
Citharichthys spp. larvae

5908



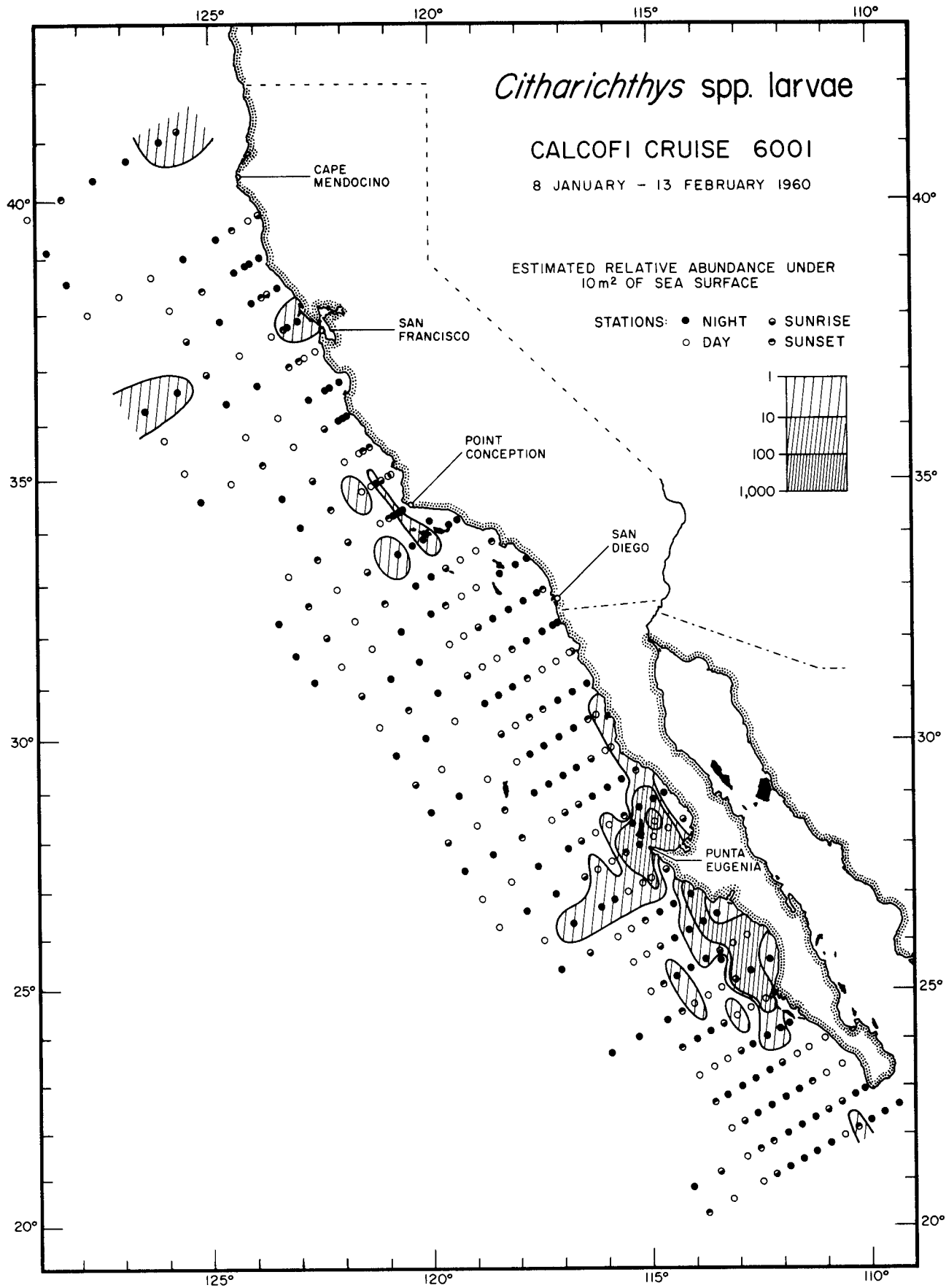
Citharichthys spp. larvae

5909



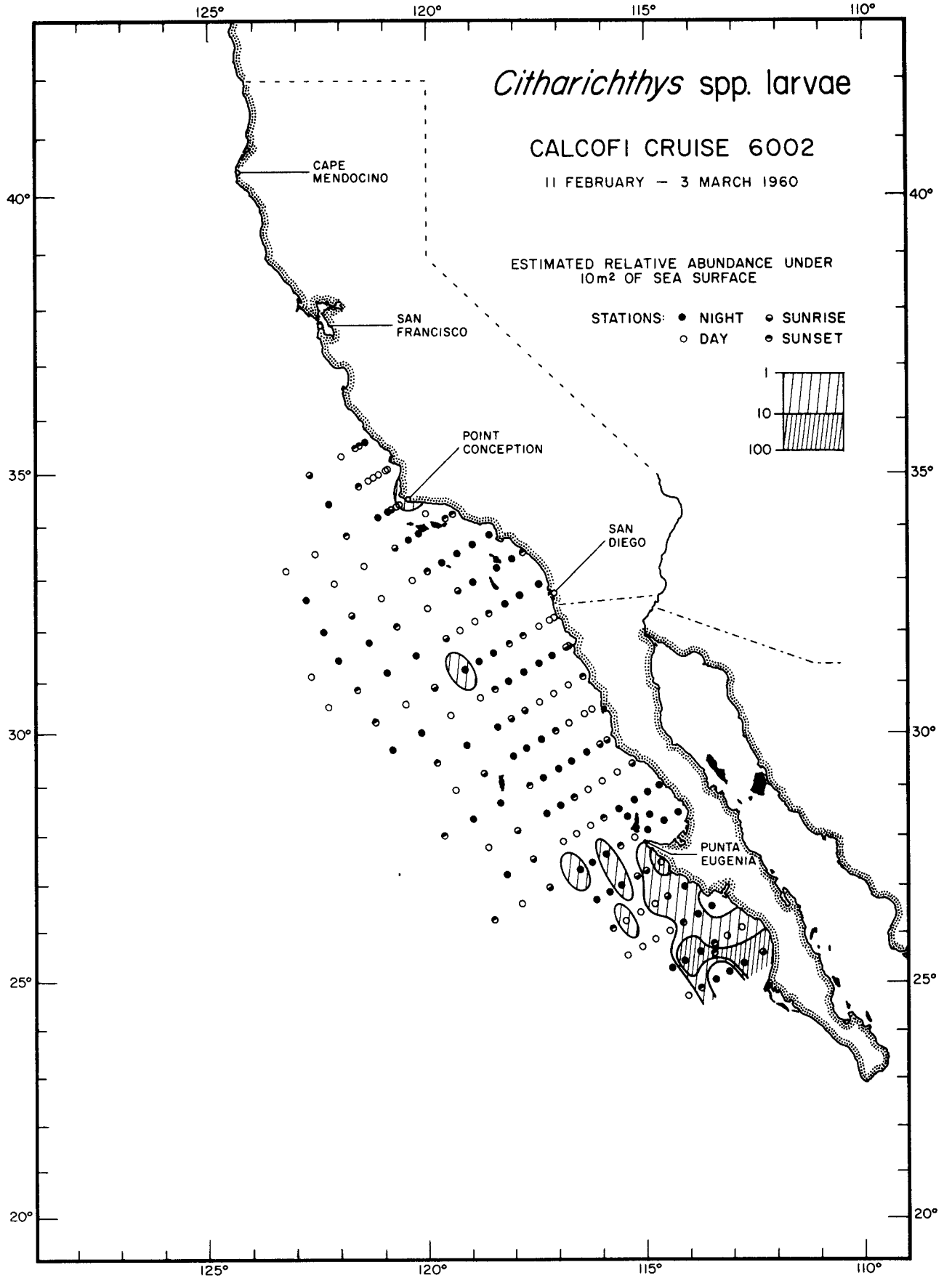
Citharichthys spp. larvae

5910



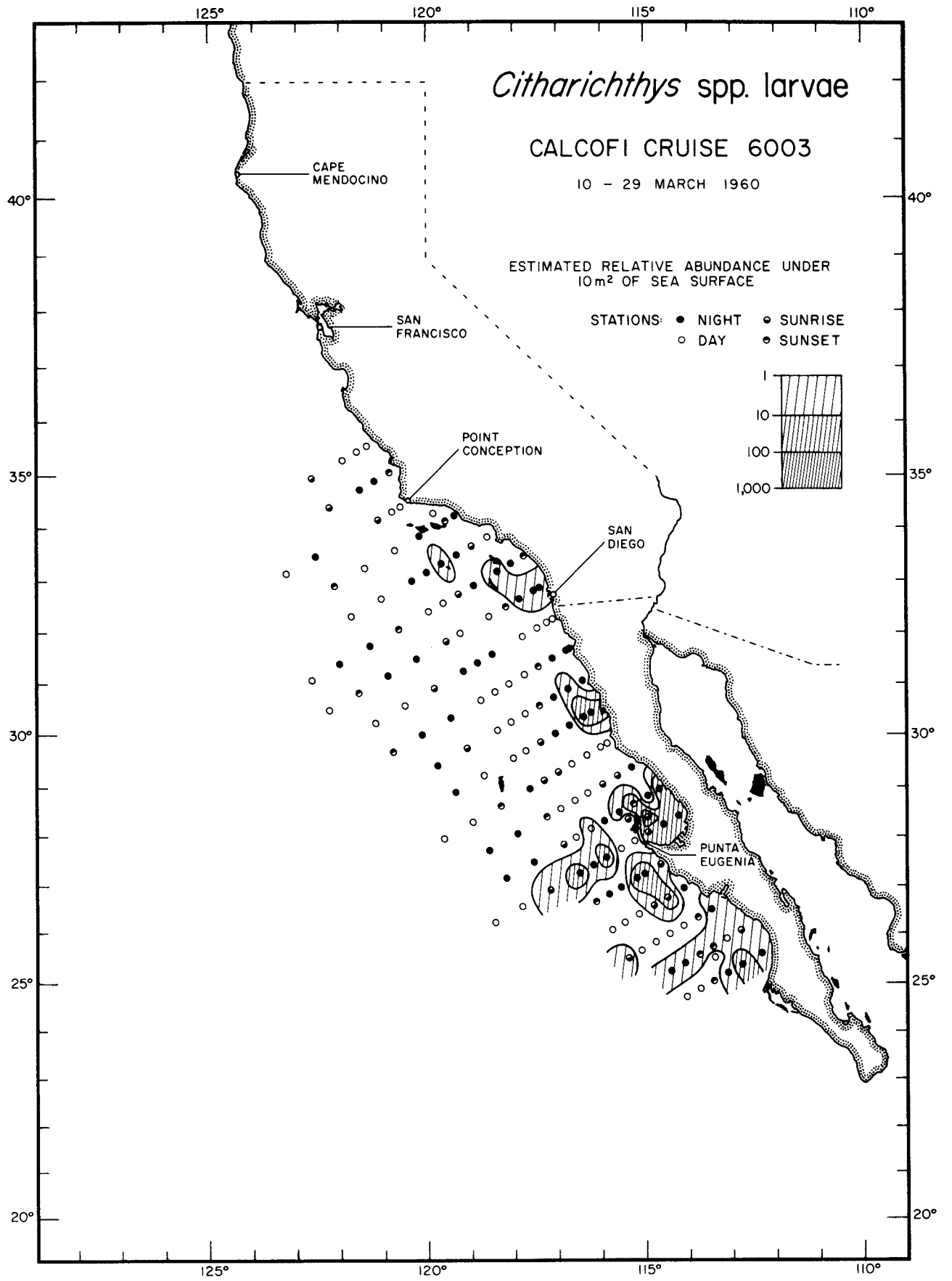
Citharichthys spp. larvae

6001



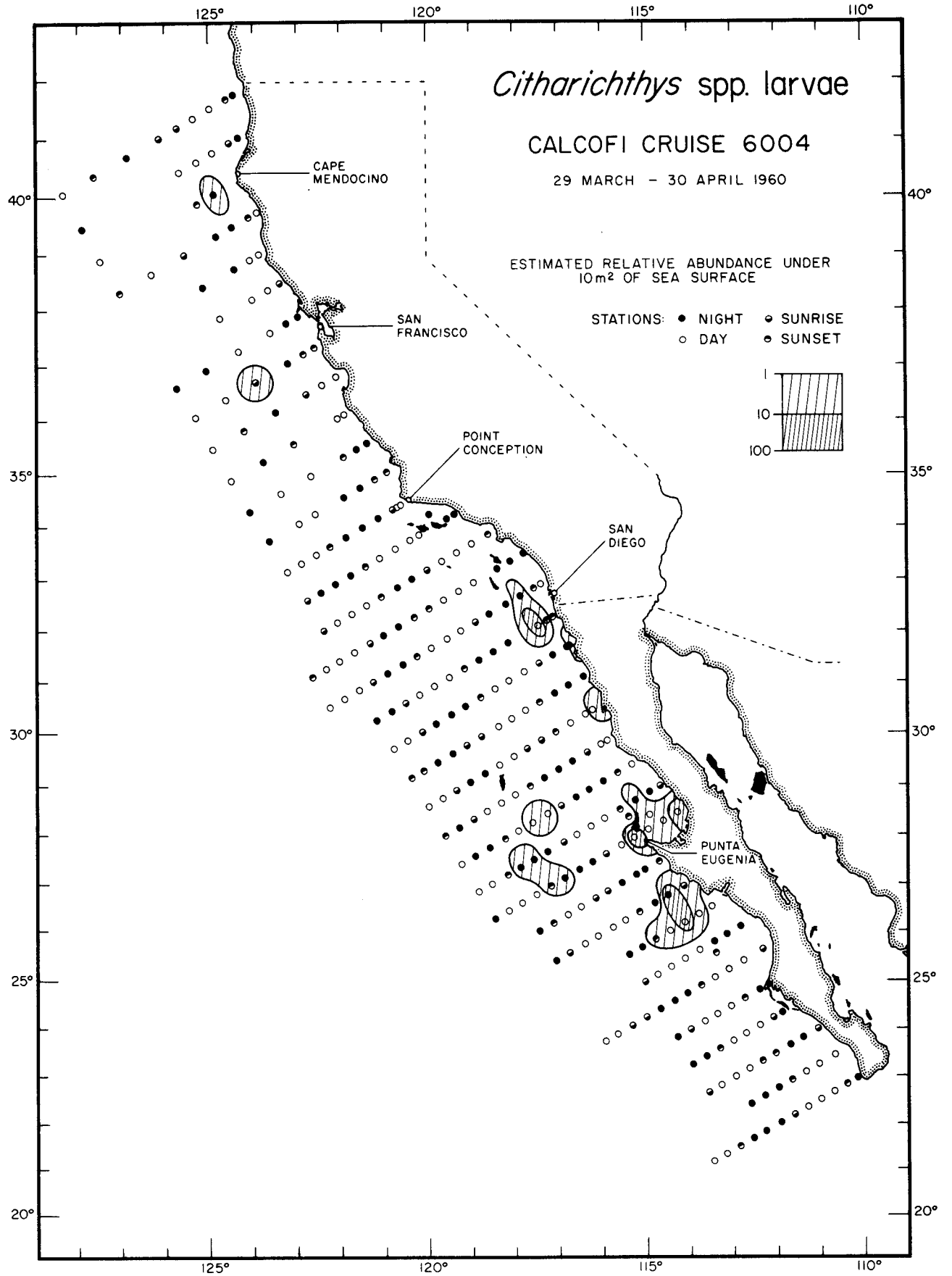
Citharichthys spp. larvae

6002



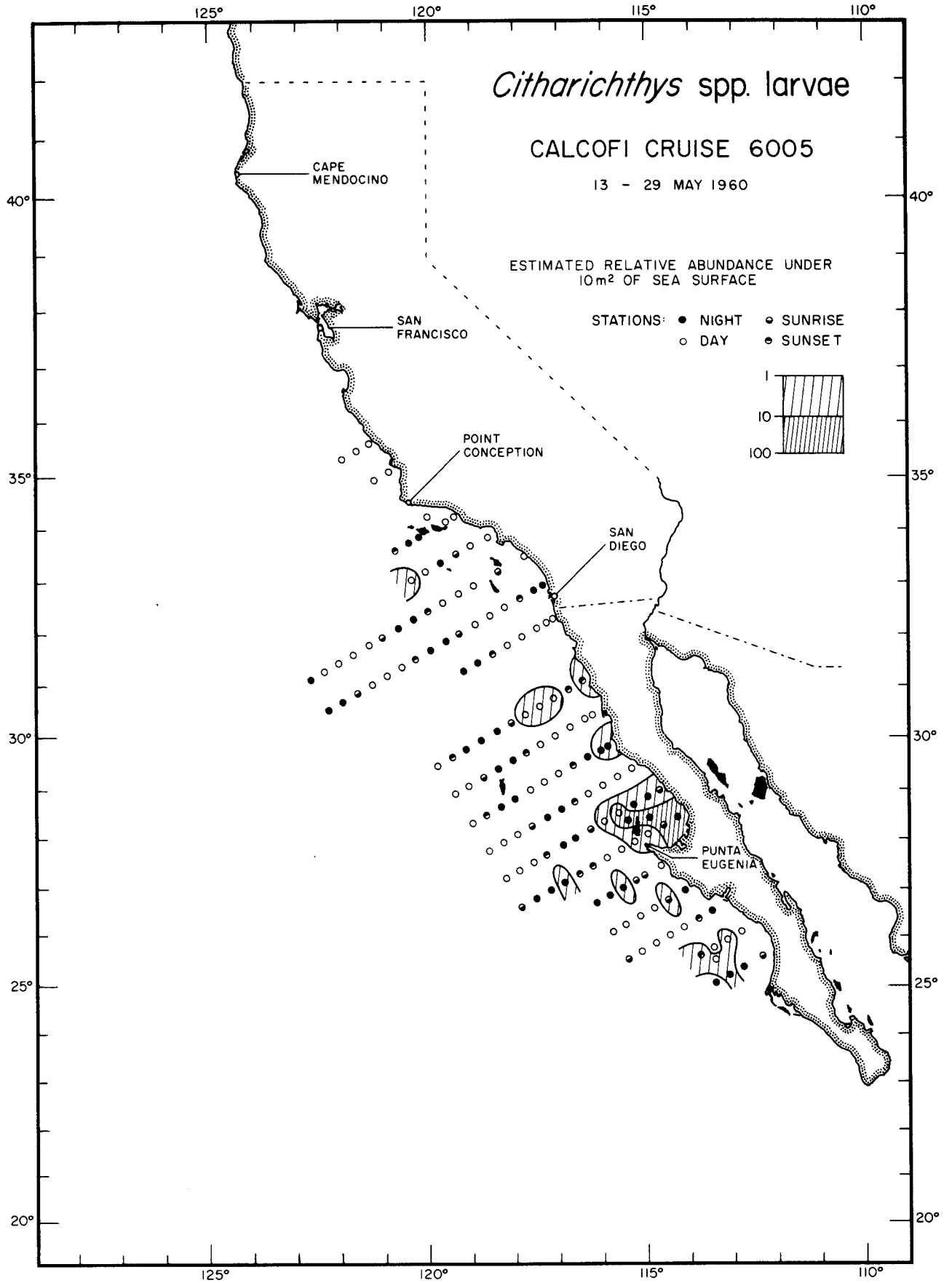
Citharichthys spp. larvae

6003



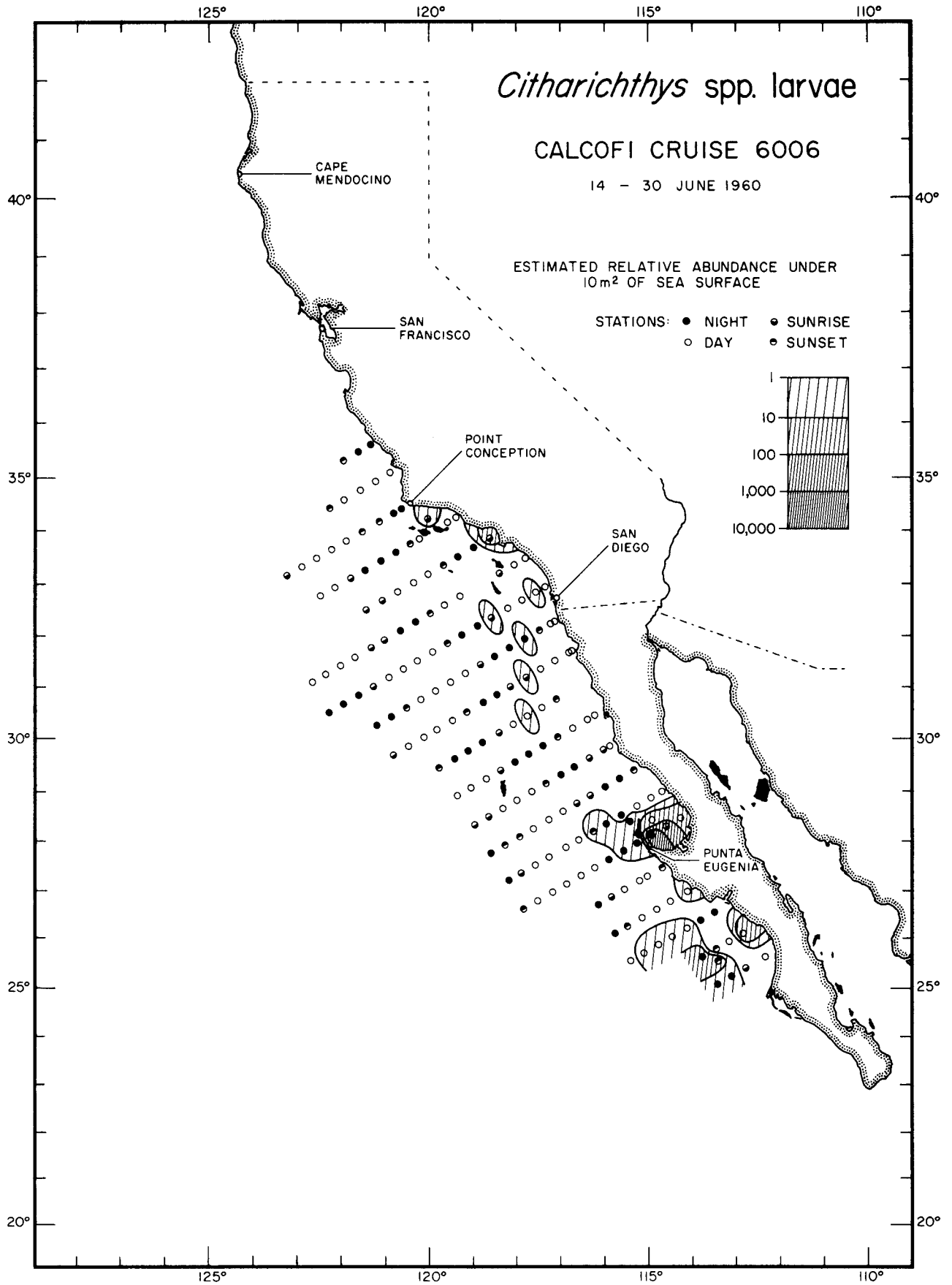
Citharichthys spp. larvae

6004



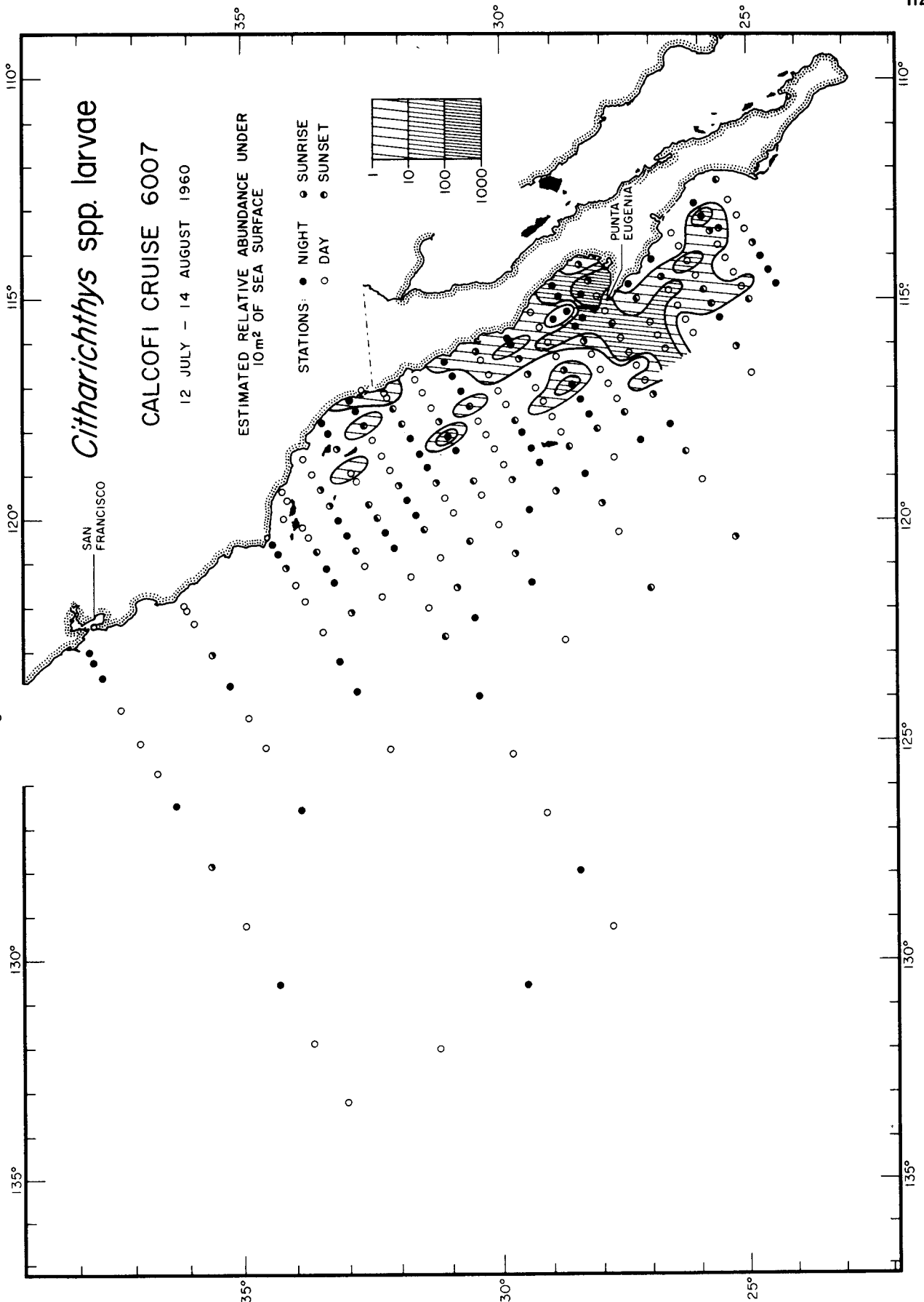
Citharichthys spp. larvae

6005



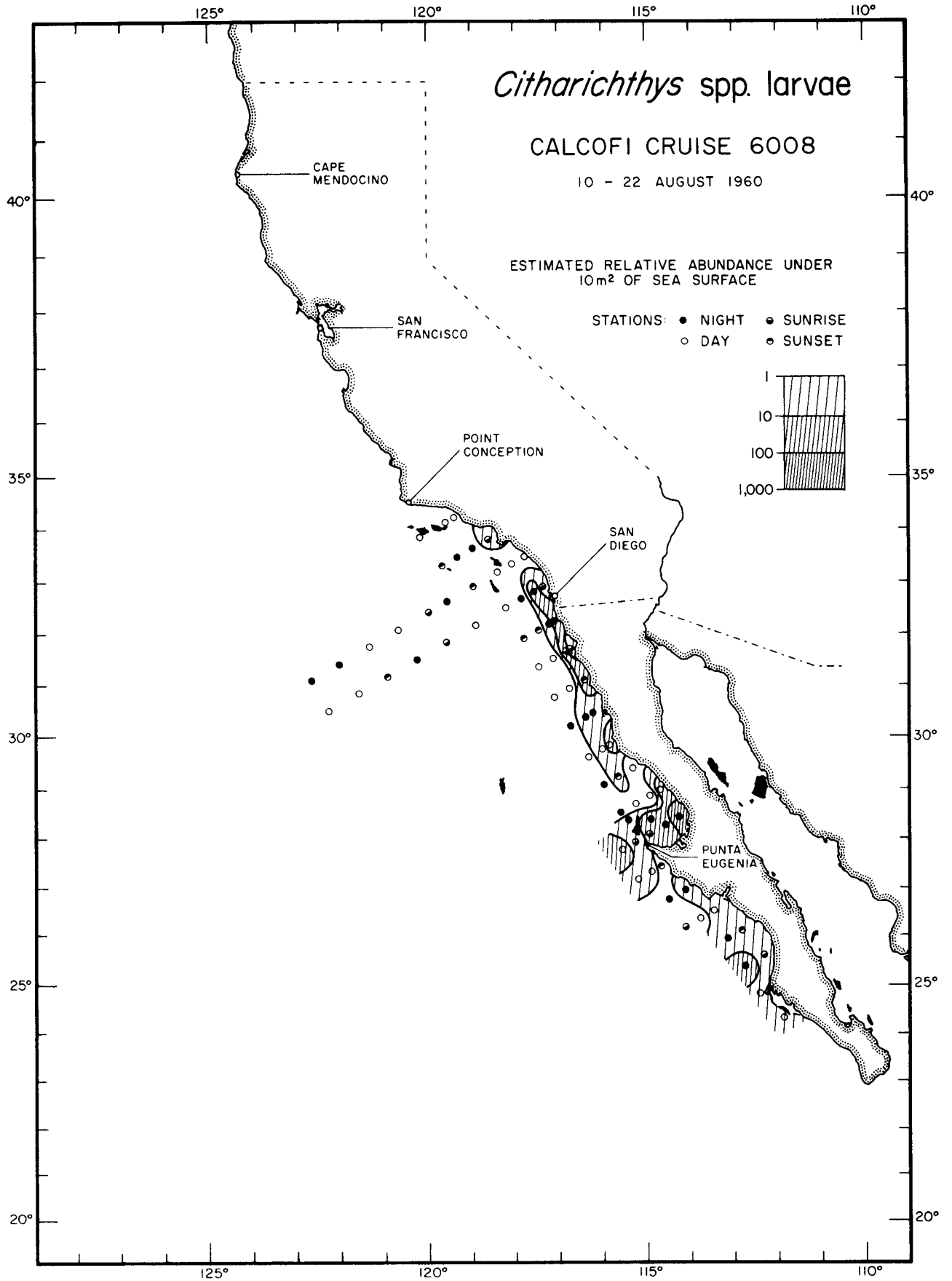
Citharichthys spp. larvae

6006



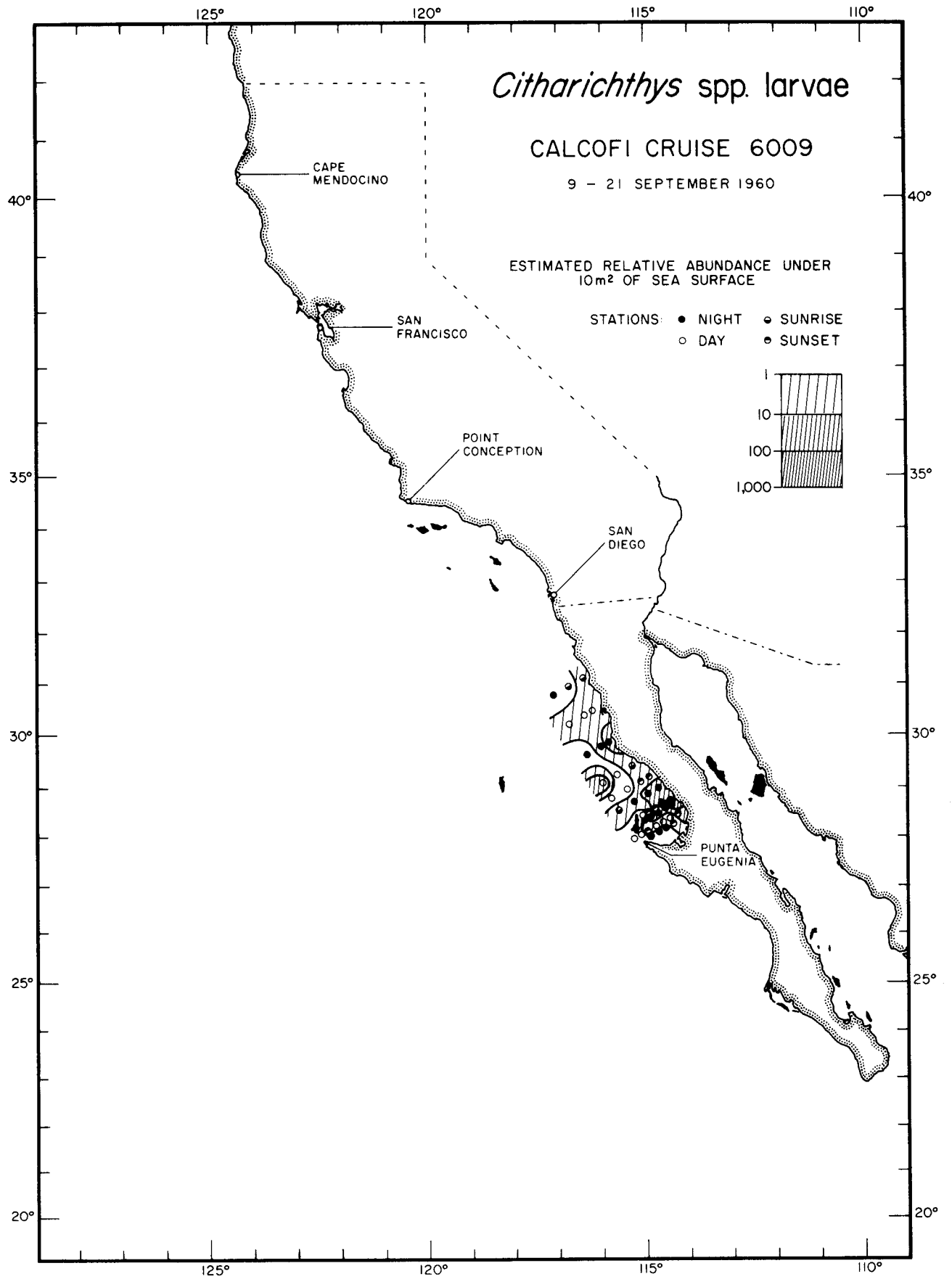
Citharichthys spp. larvae

6007



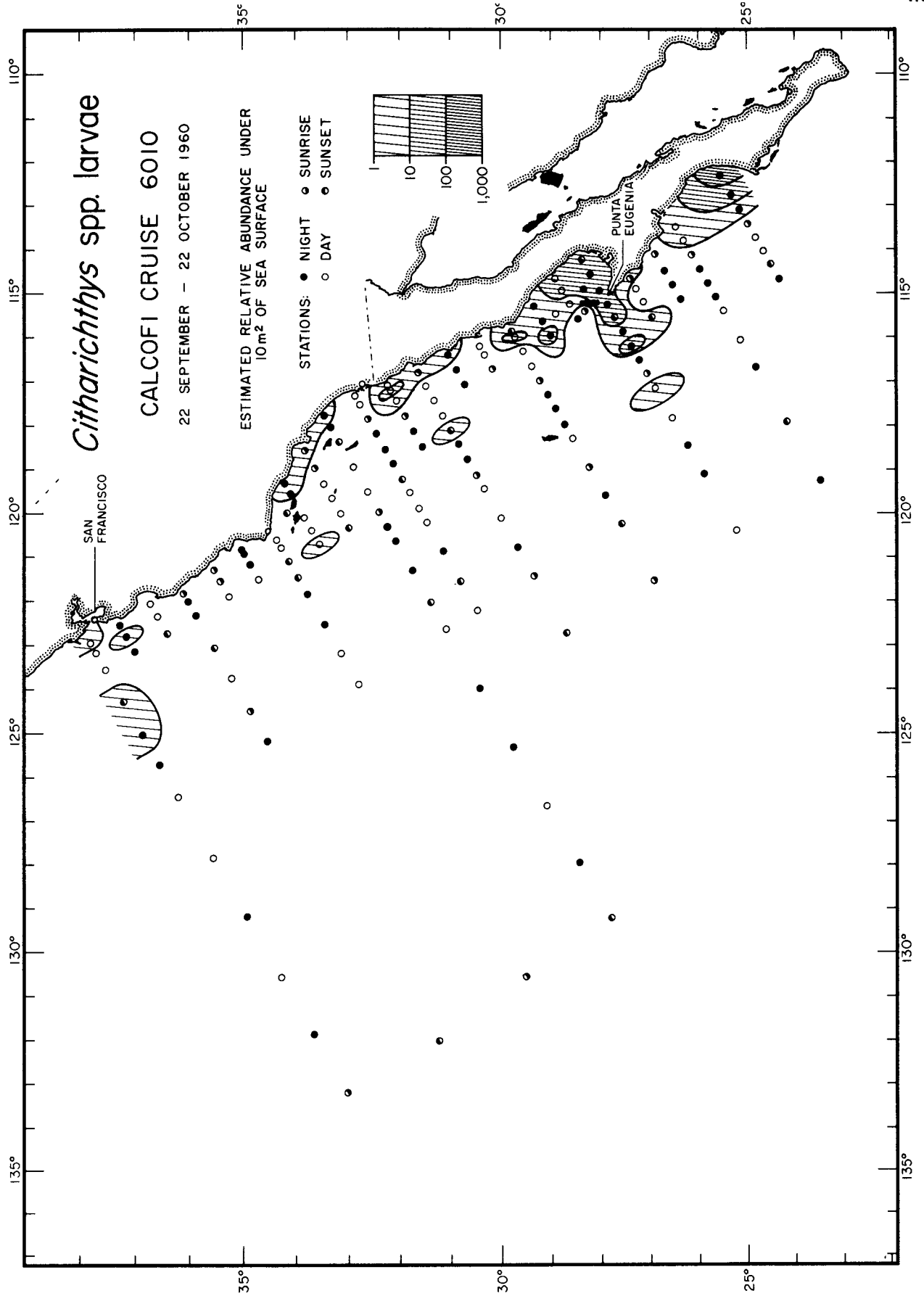
Citharichthys spp. larvae

6008



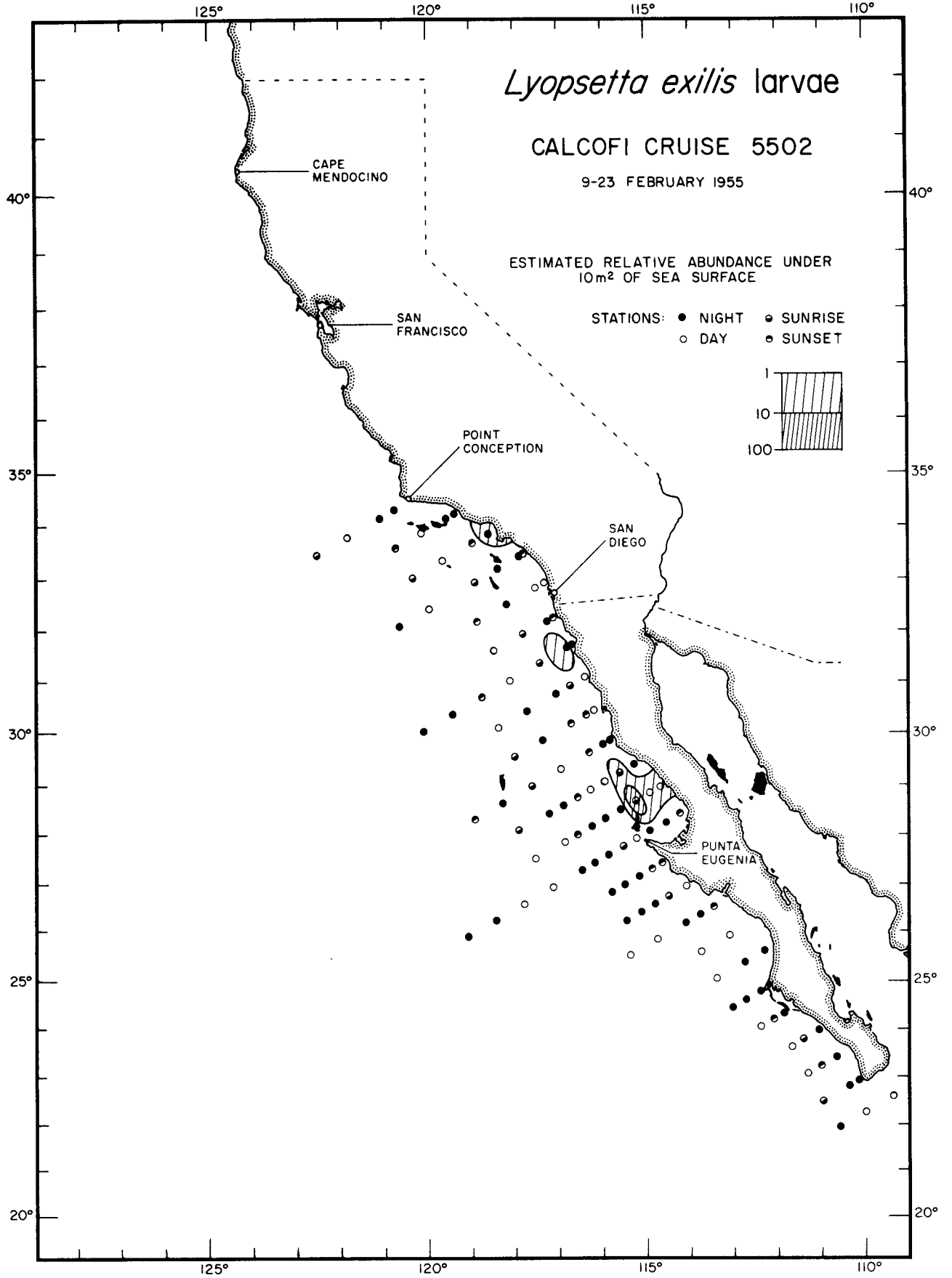
Citharichthys spp. larvae

6009



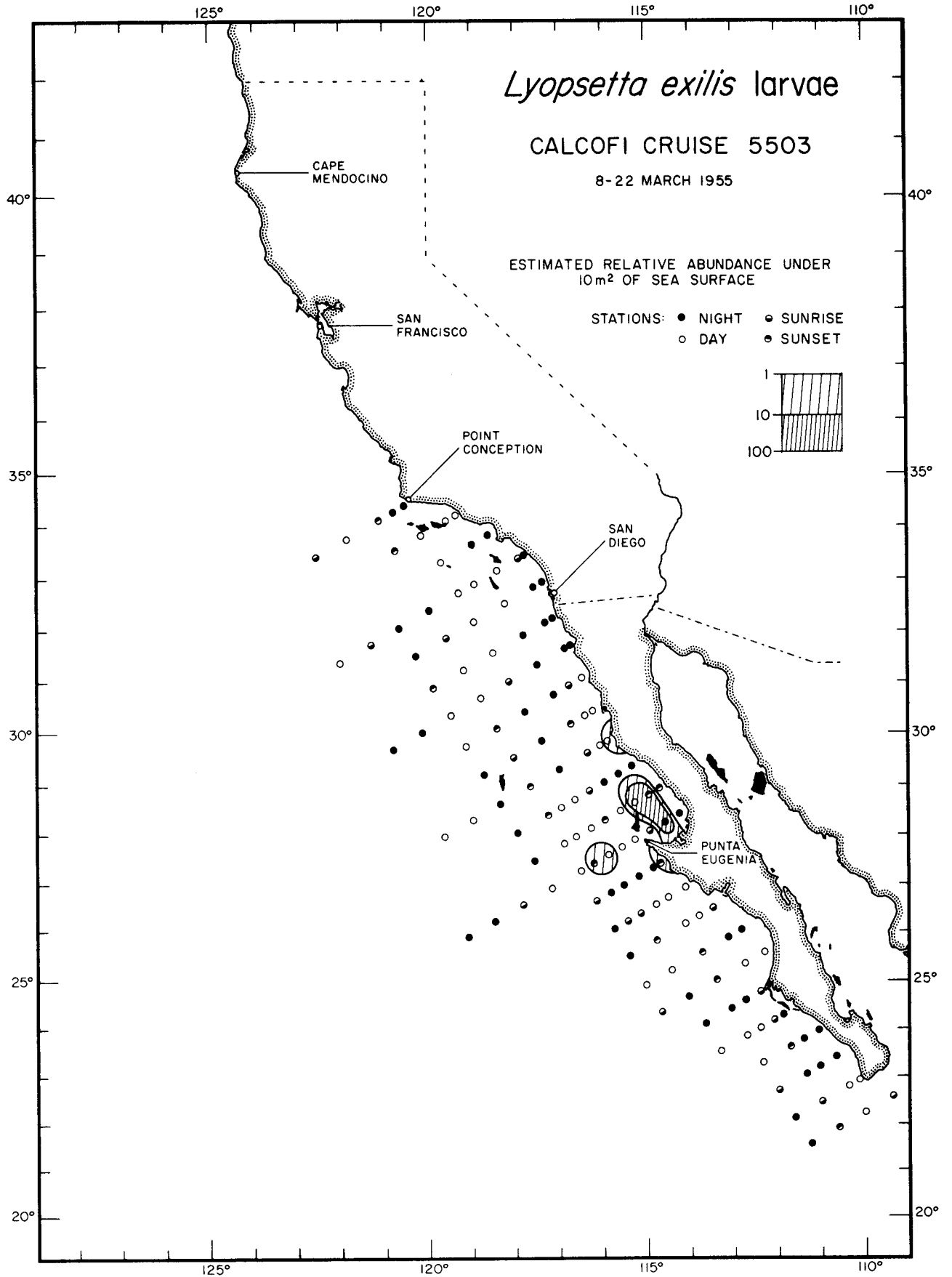
Citharichthys spp. larvae

6010



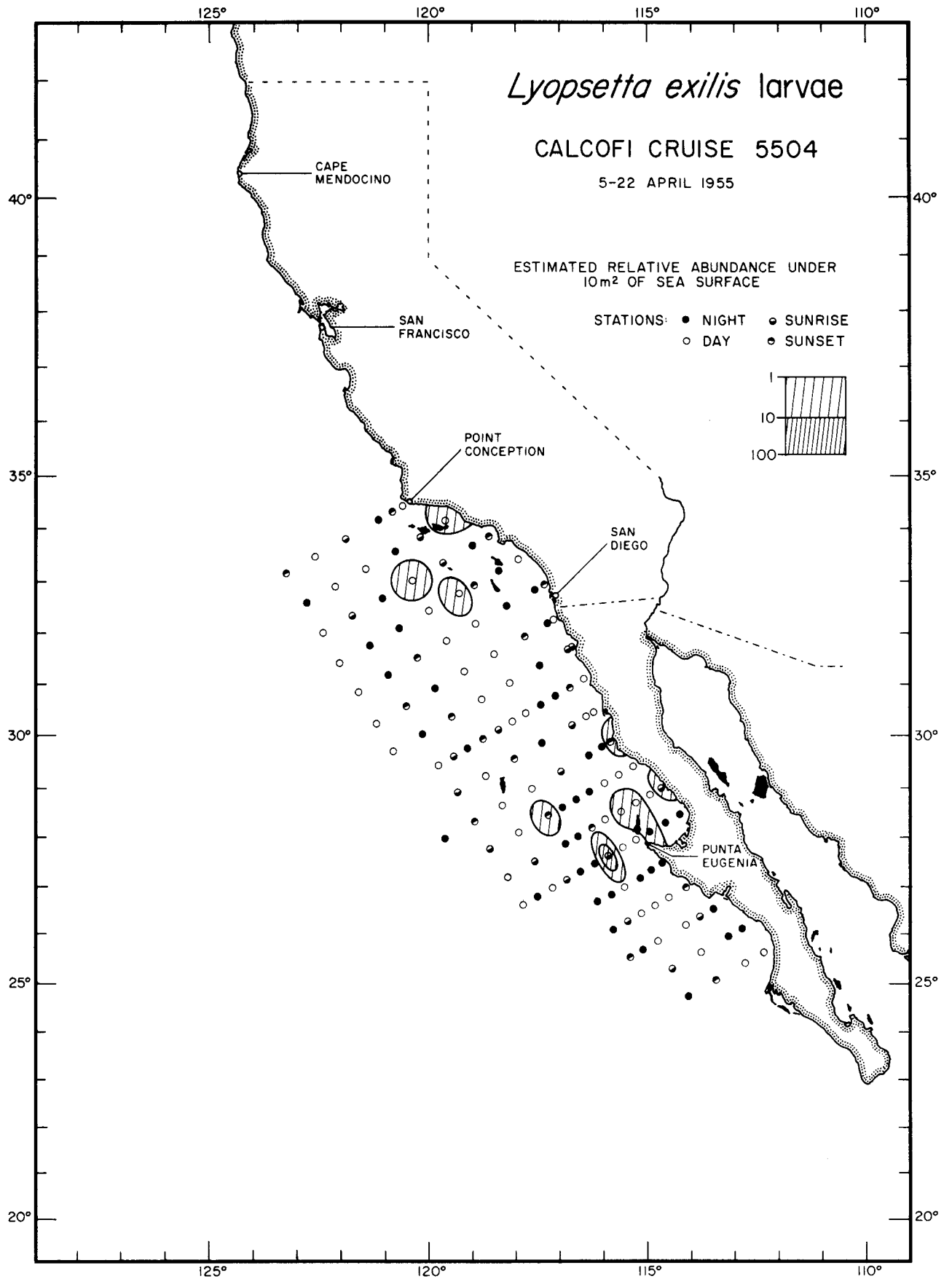
Lyopsetta exilis larvae

5502

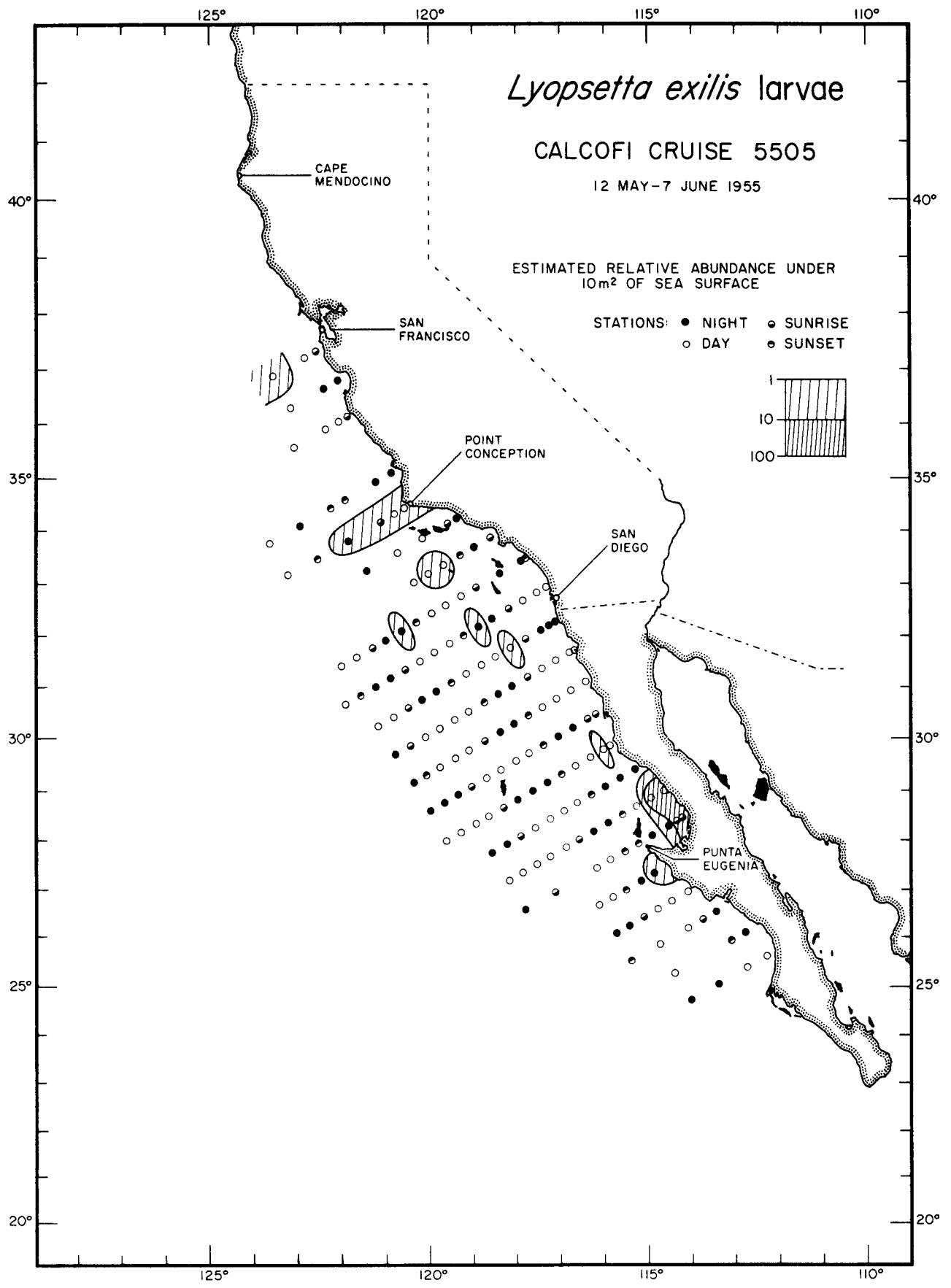


Lyopsetta exilis larvae

5503

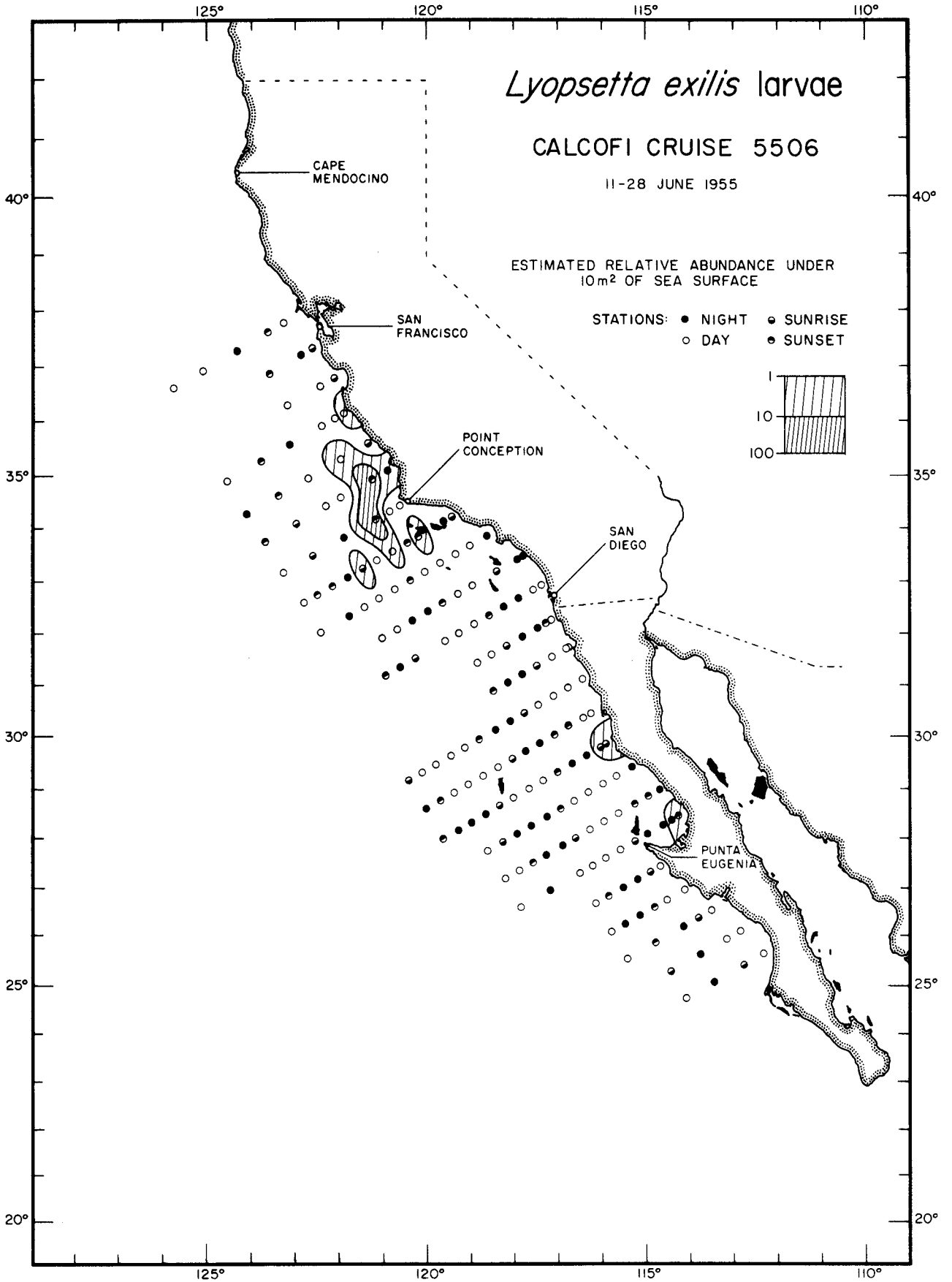
*Lyopsetta exilis* larvae

5504



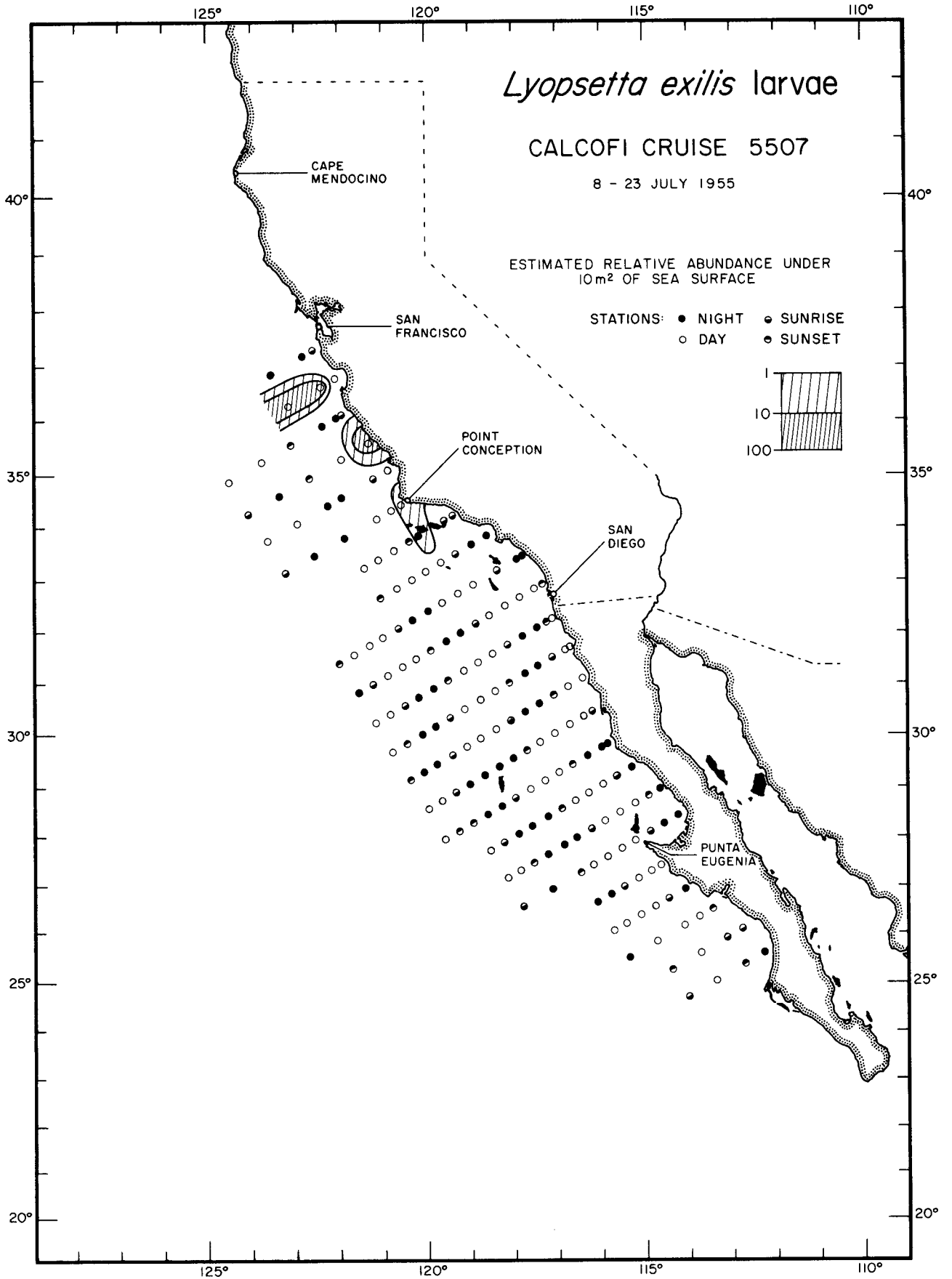
Lyopsetta exilis larvae

5505



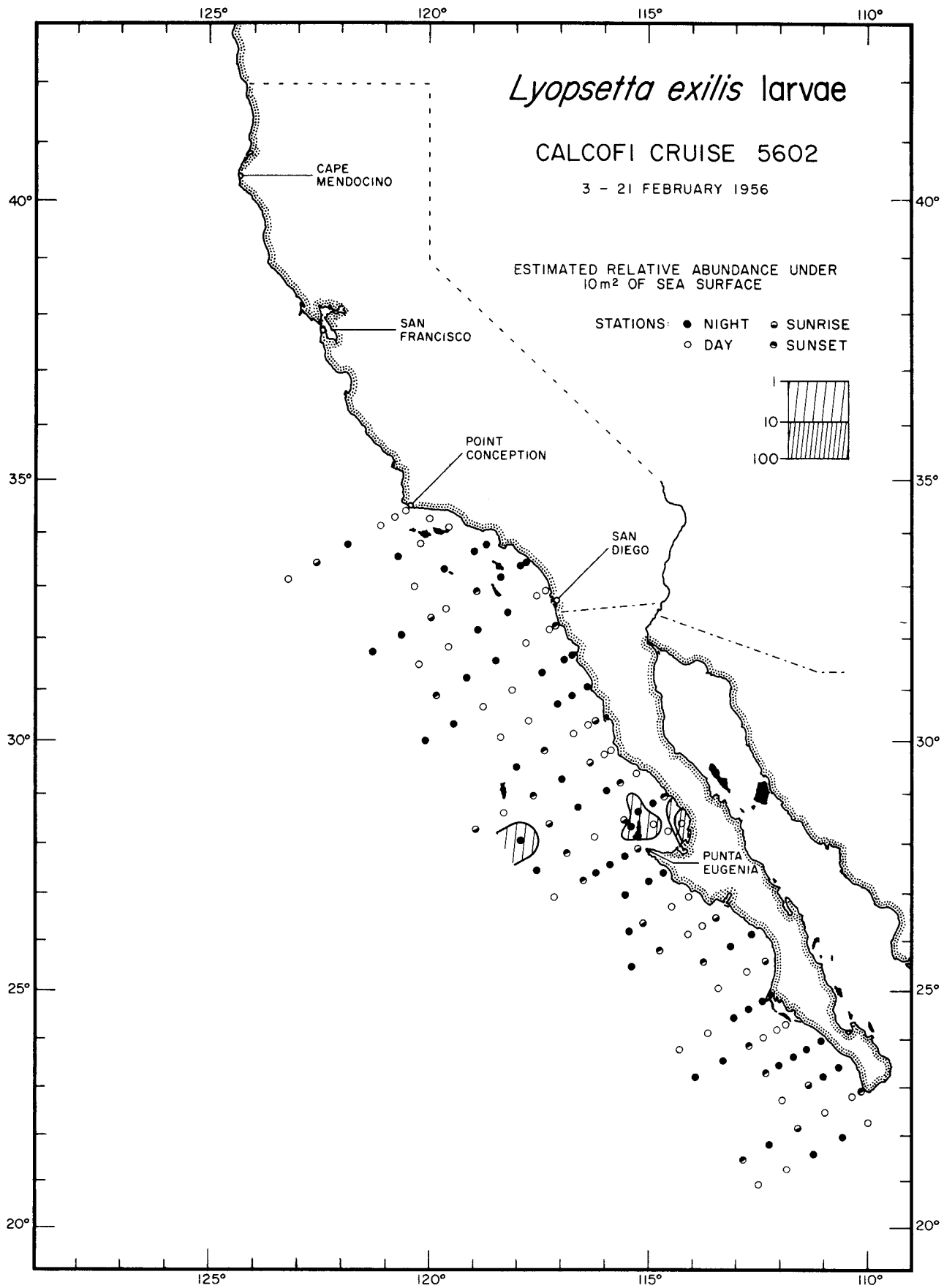
Lyopsetta exilis larvae

5506



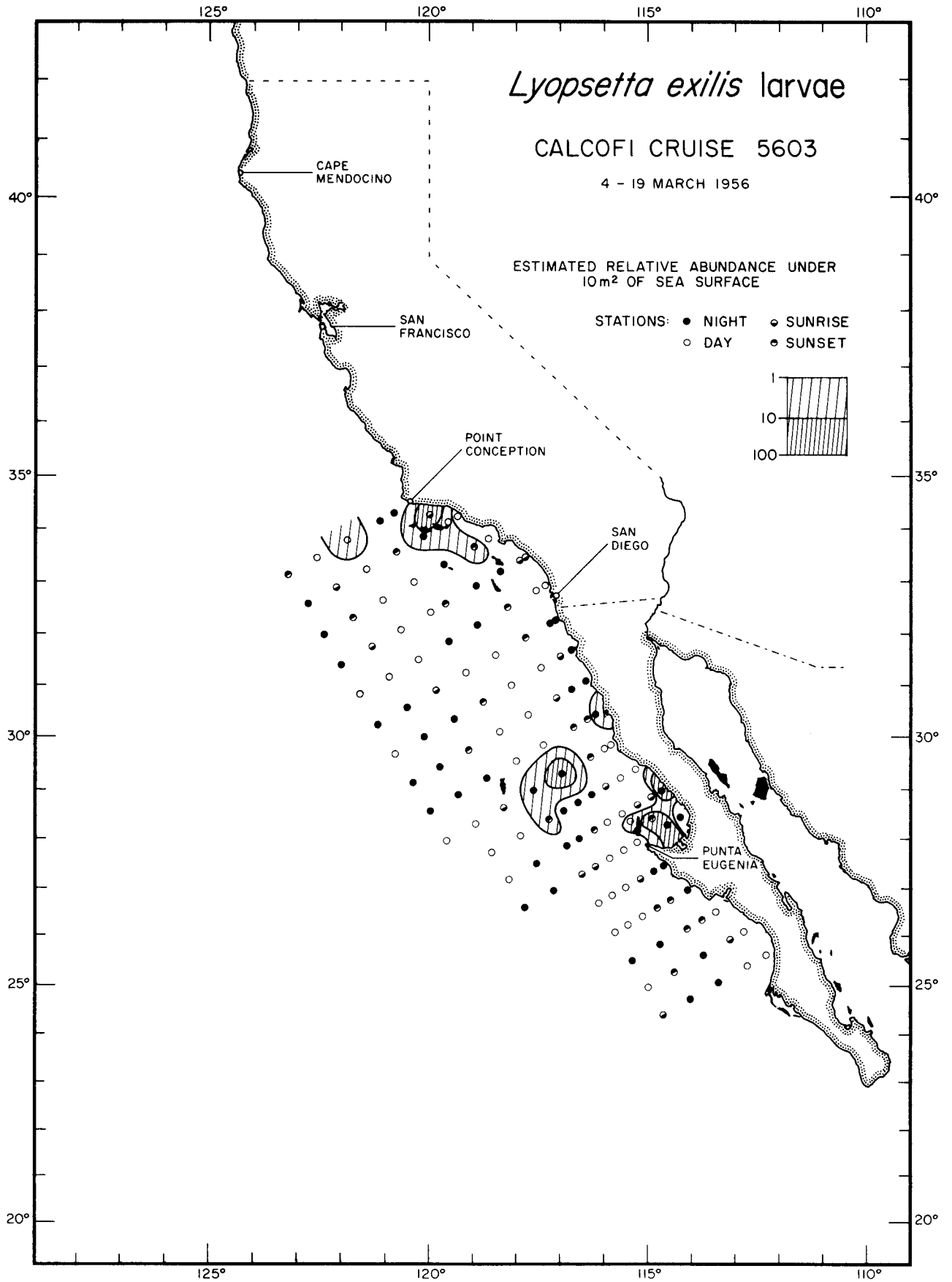
Lyopsetta exilis larvae

5507



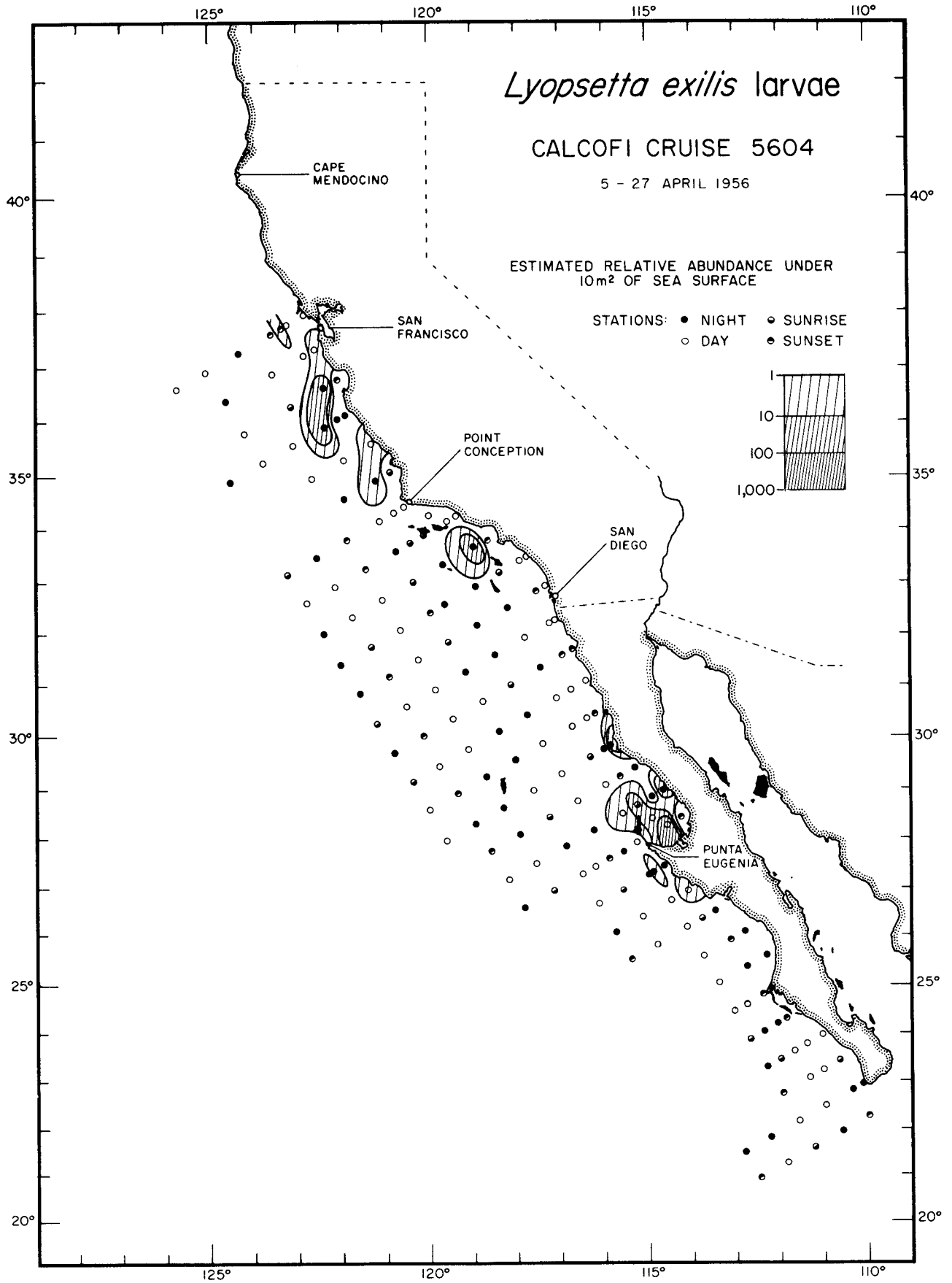
Lyopsetta exilis larvae

5602



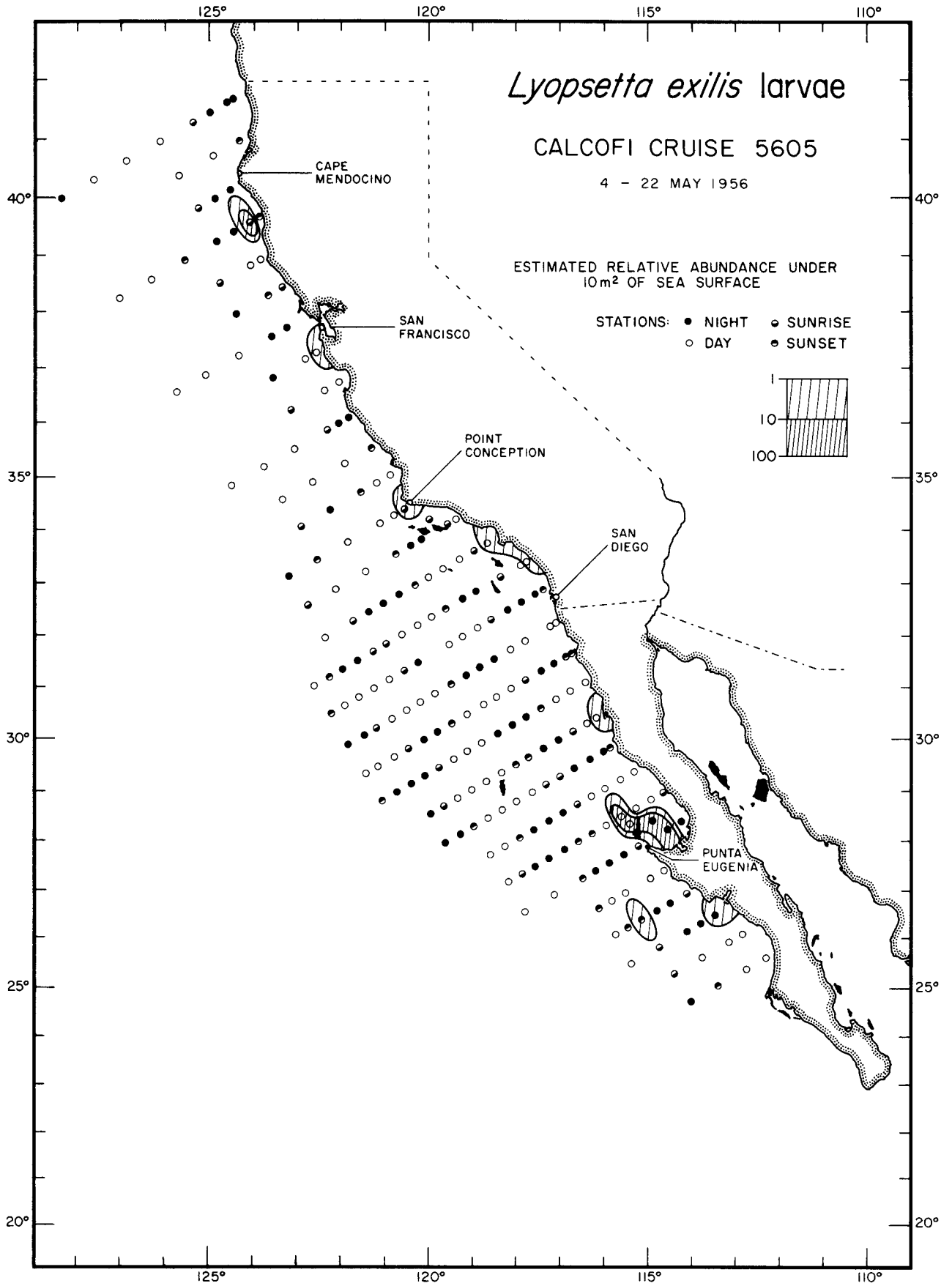
Lyopsetta exilis larvae

5603



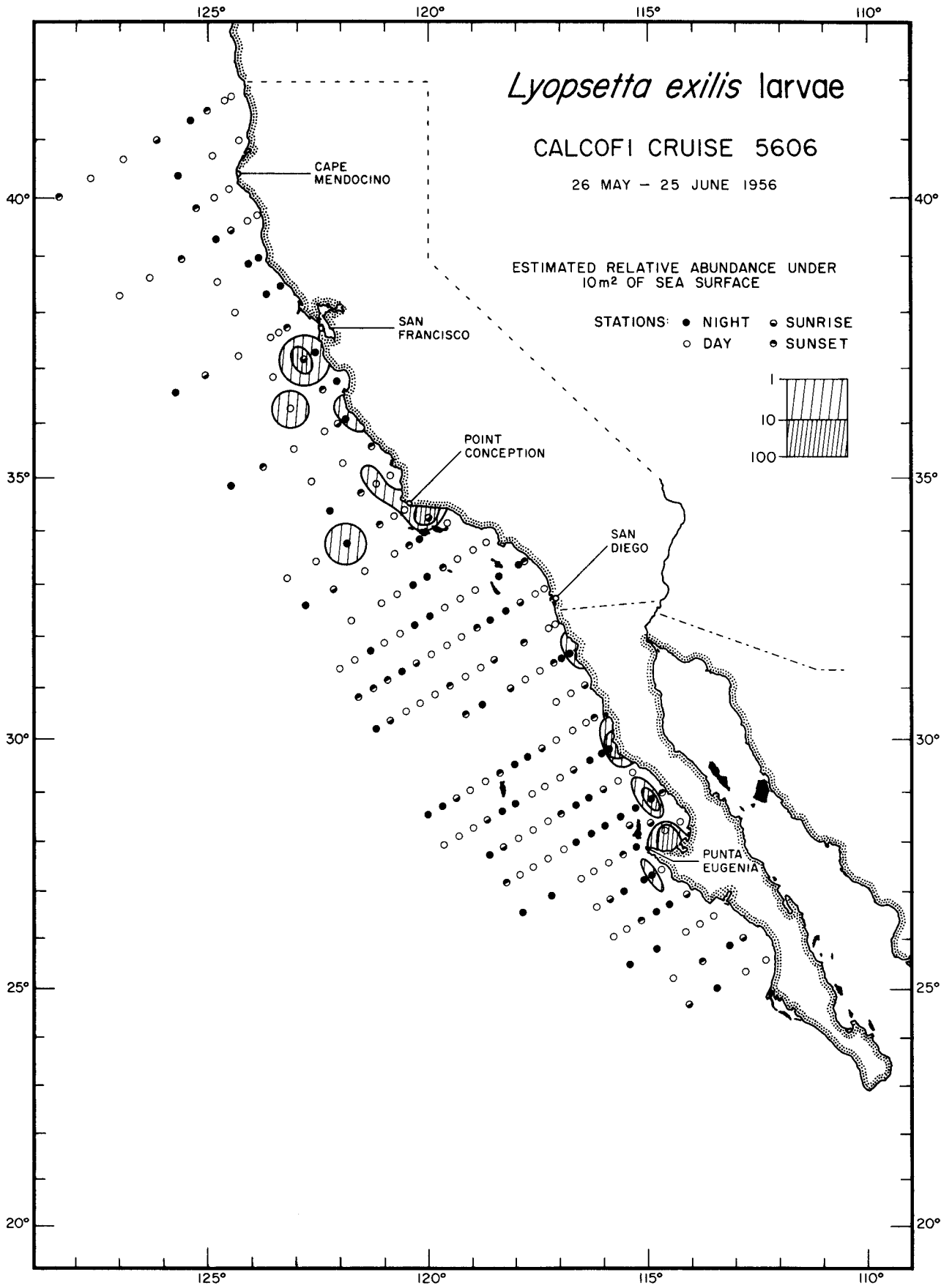
Lyopsetta exilis larvae

5604



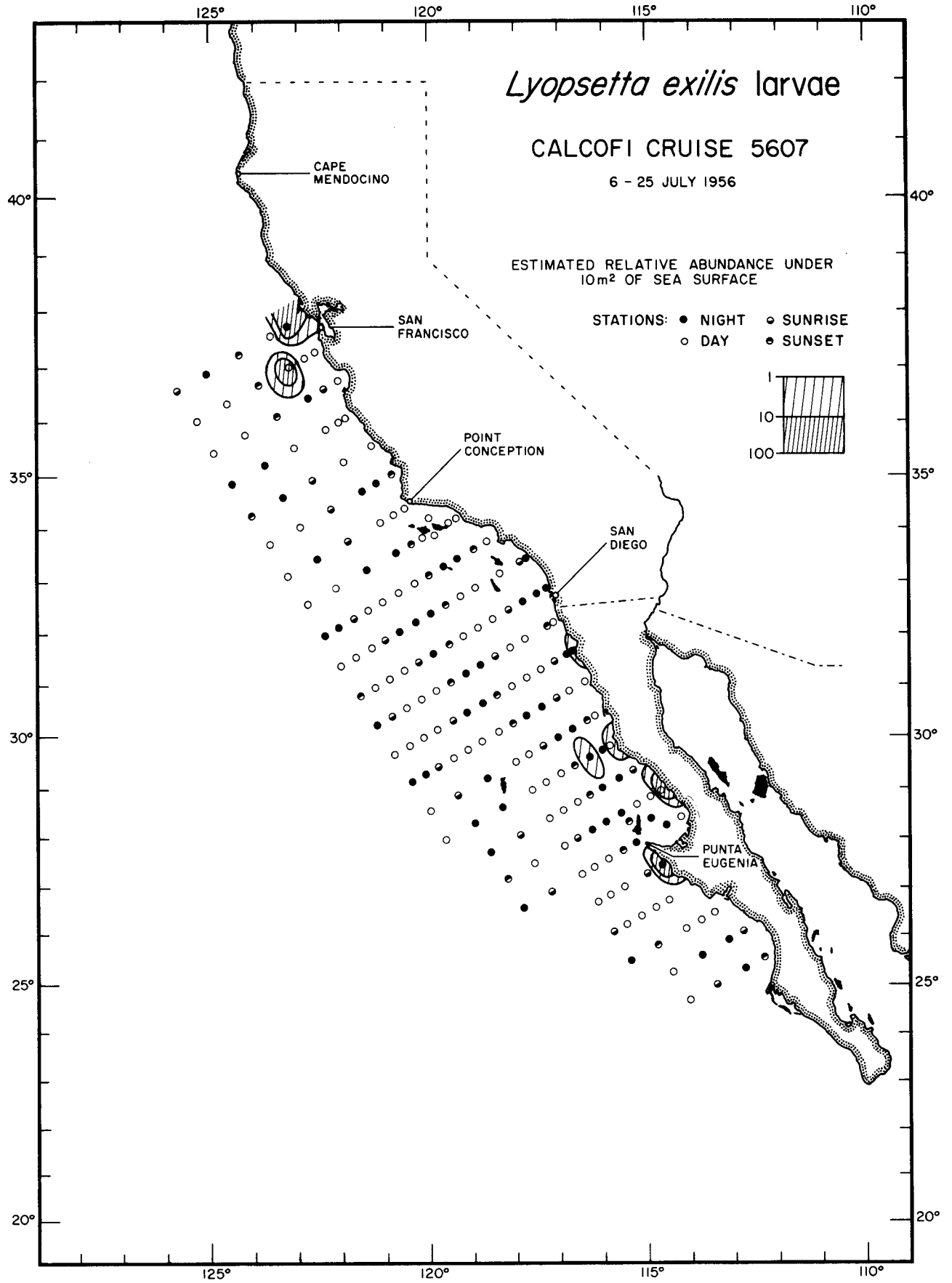
Lyopsetta exilis larvae

5605



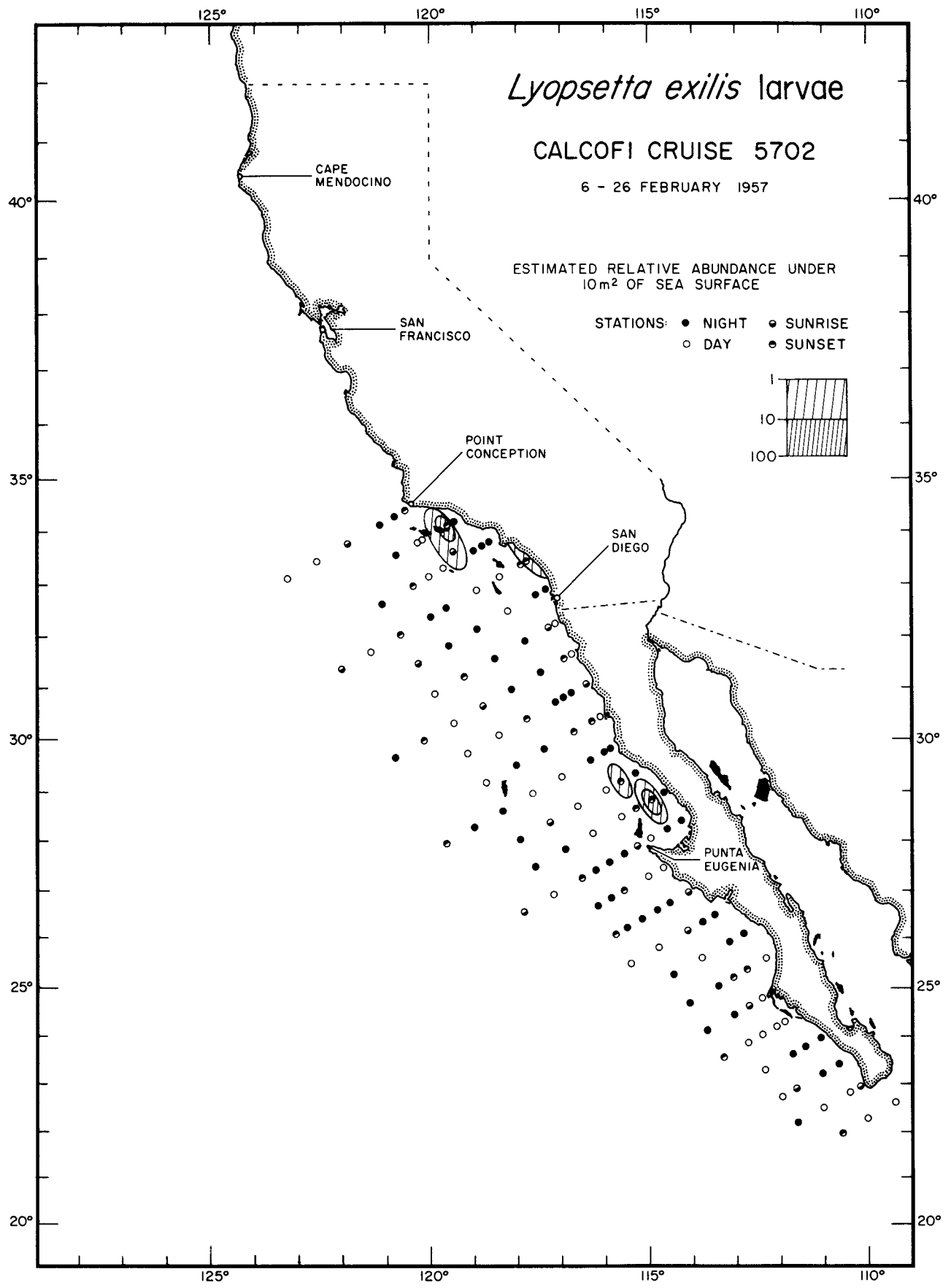
Lyopsetta exilis larvae

5606



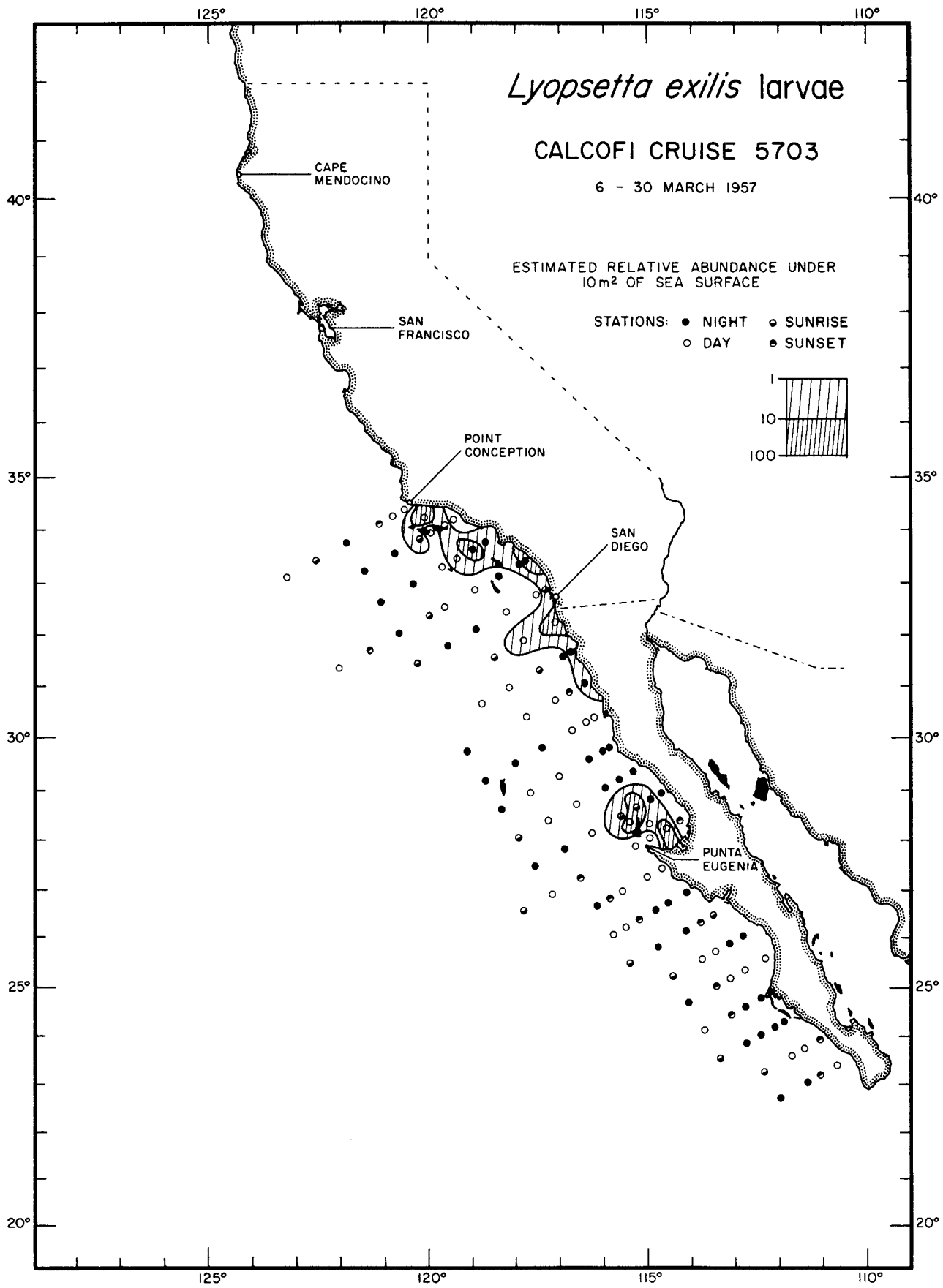
Lyopsetta exilis larvae

5607

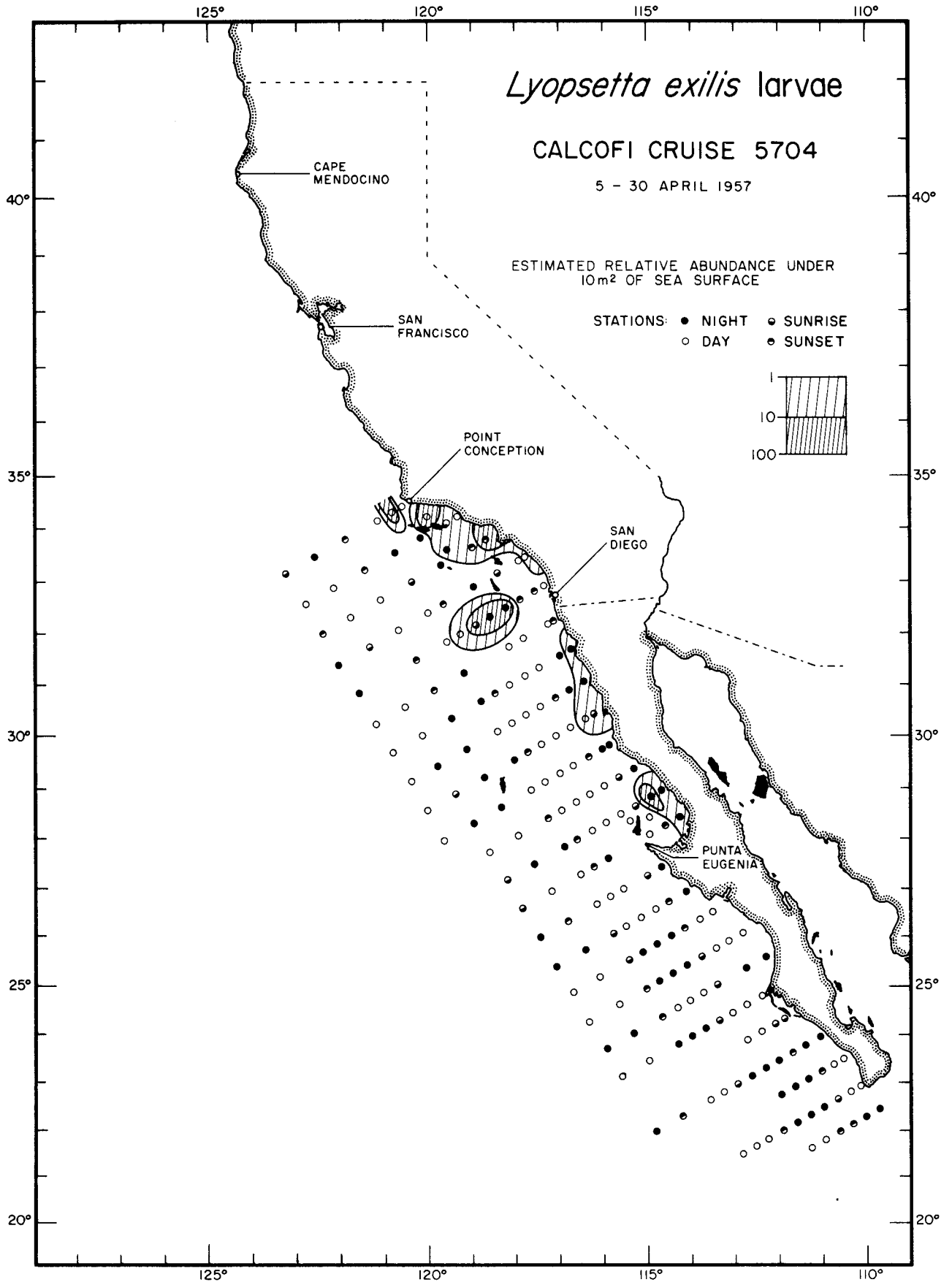


Lyopsetta exilis larvae

5702

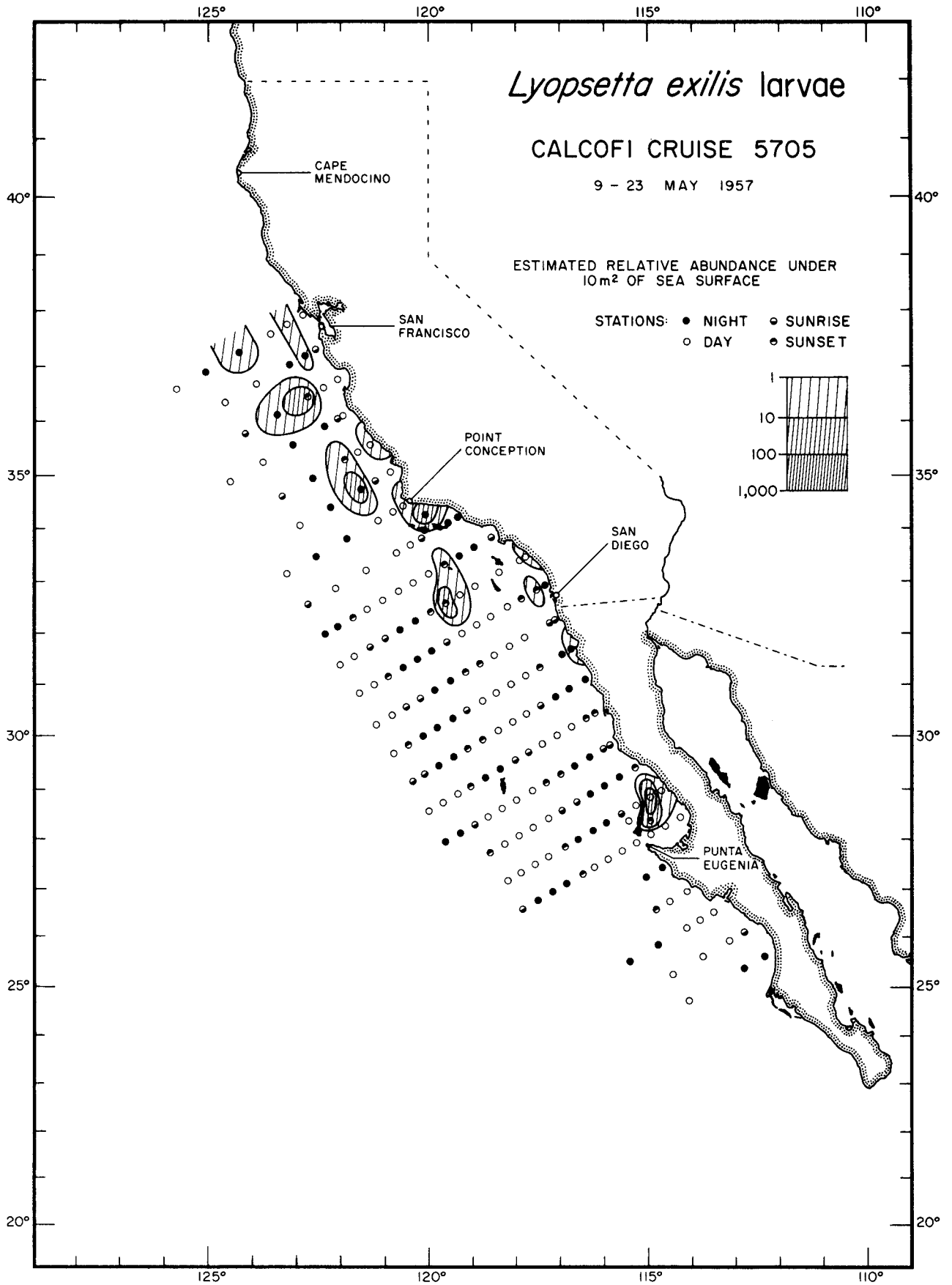


Lyopsetta exilis larvae
5703



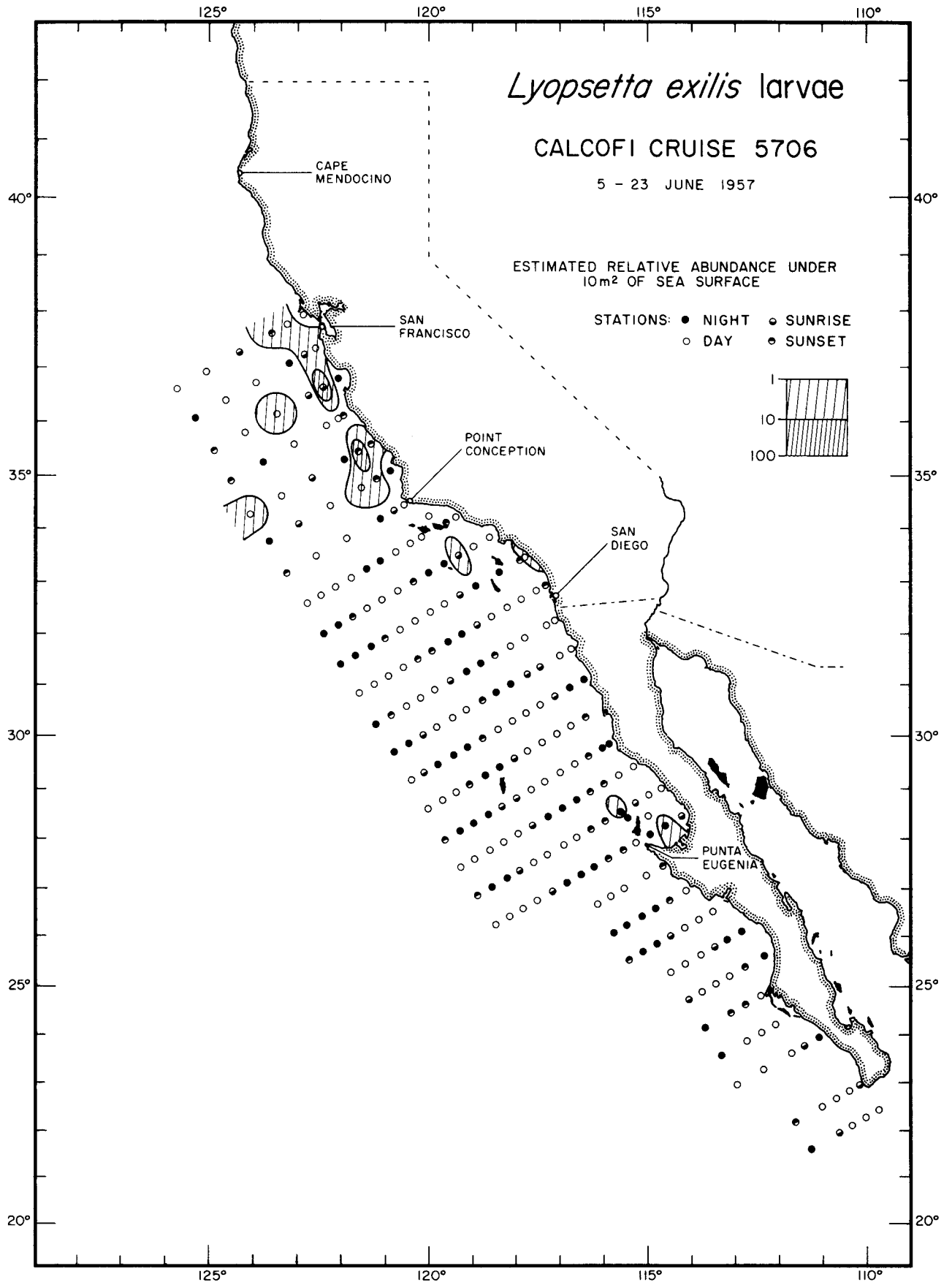
Lyopsetta exilis larvae

5704



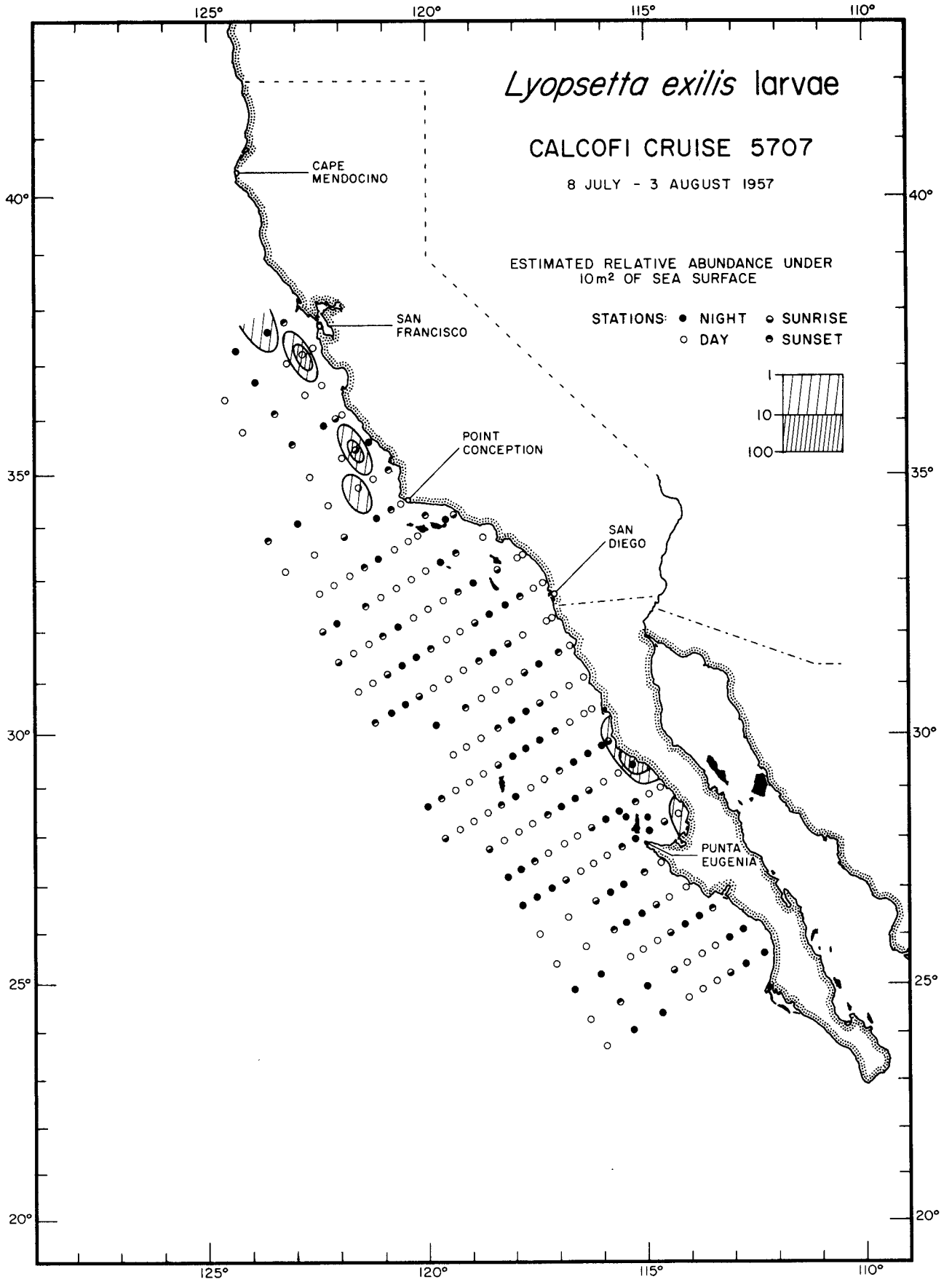
Lyopsetta exilis larvae

5705



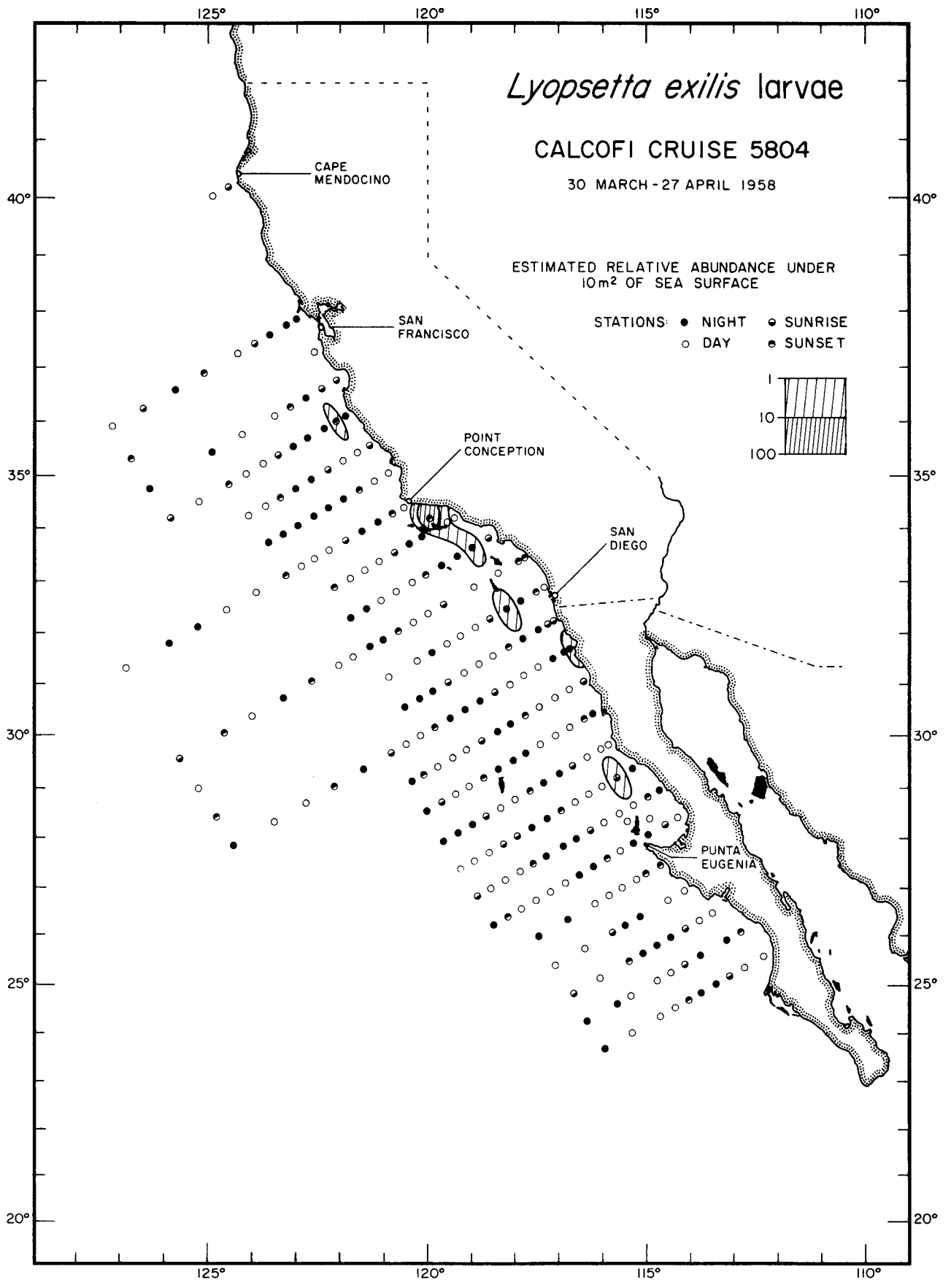
Lyopsetta exilis larvae

5706



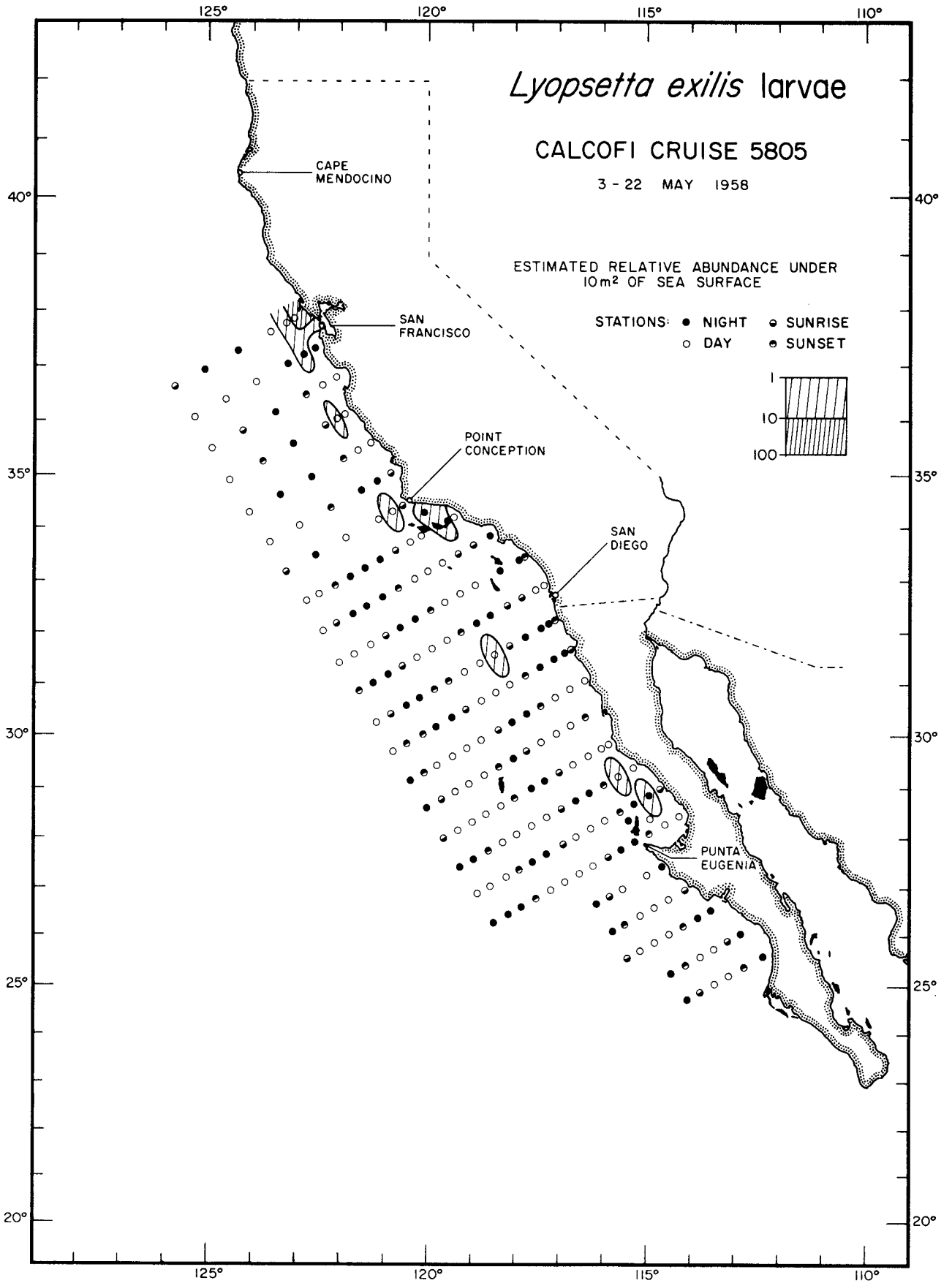
Lyopsetta exilis larvae

5707



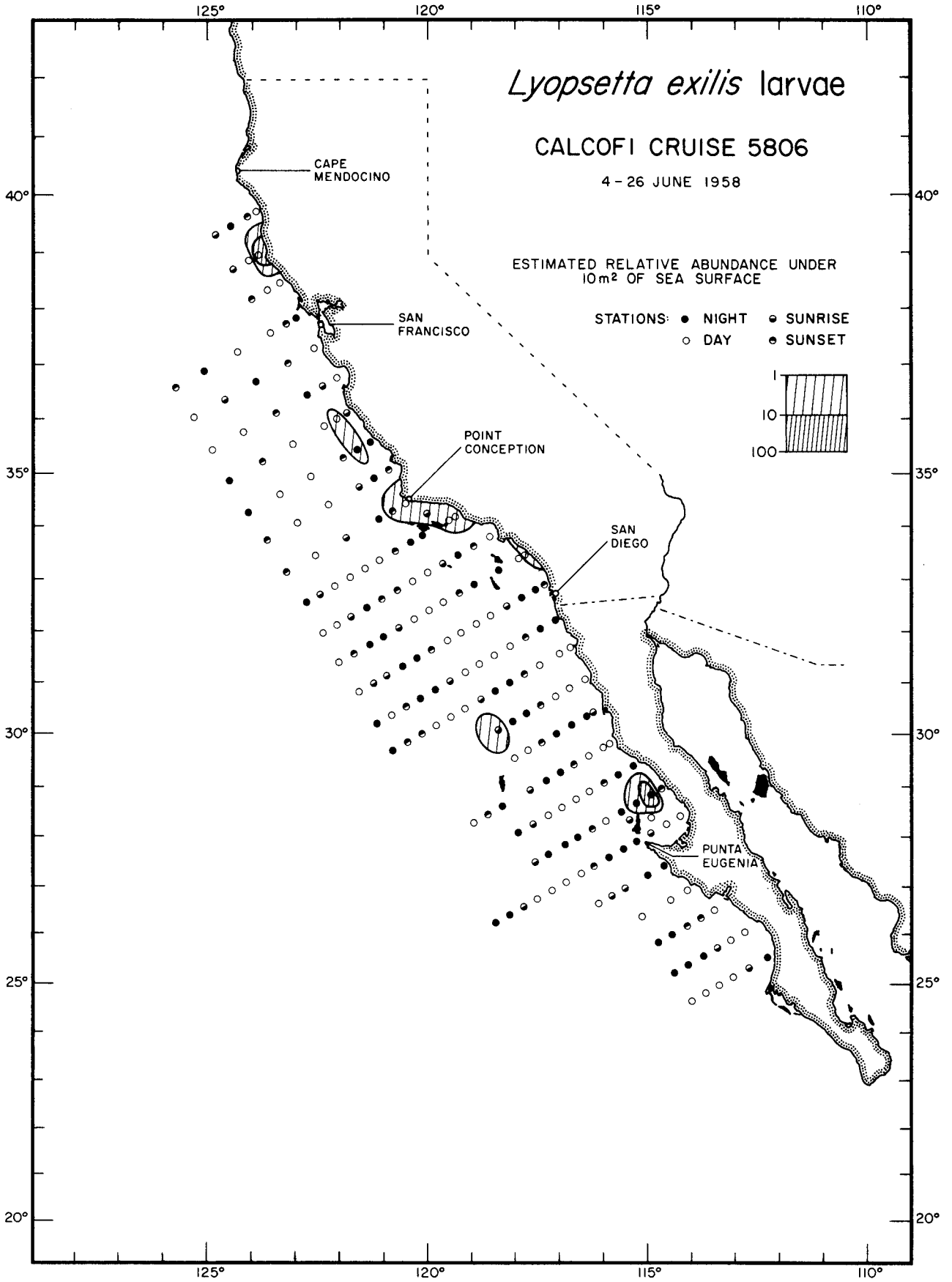
Lyopsetta exilis larvae

5804



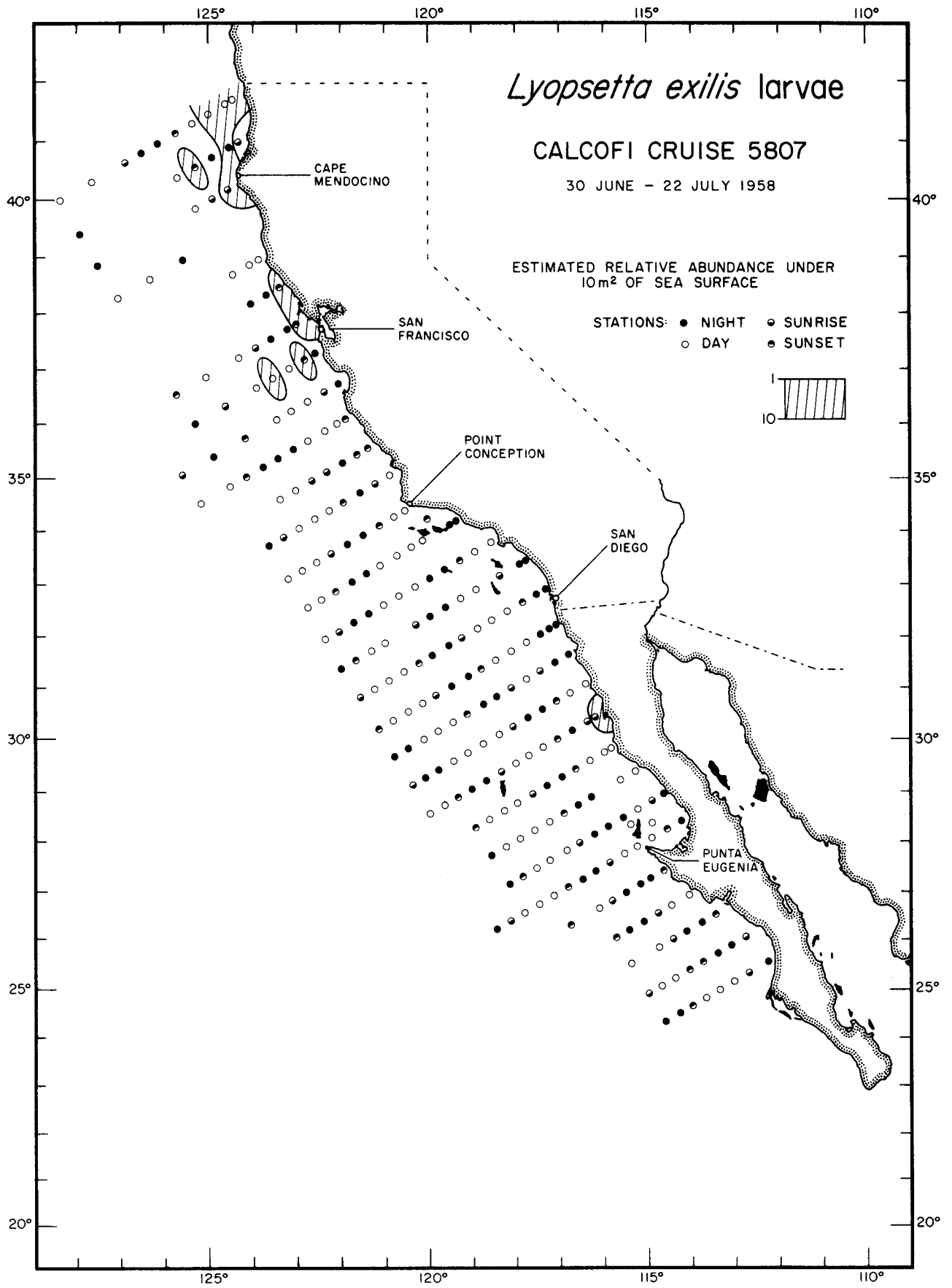
Lyopsetta exilis larvae

5805



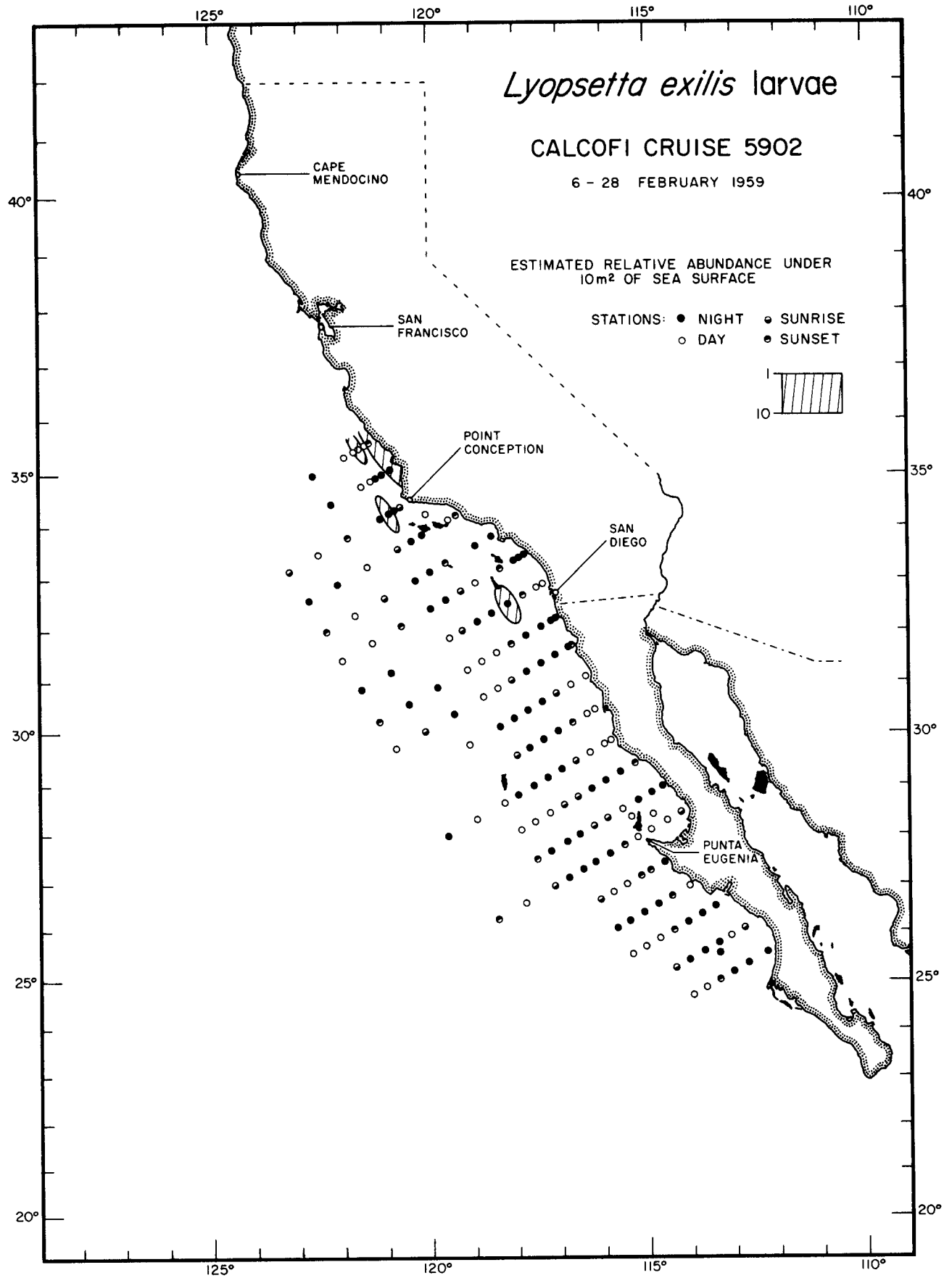
Lyopsetta exilis larvae

5806

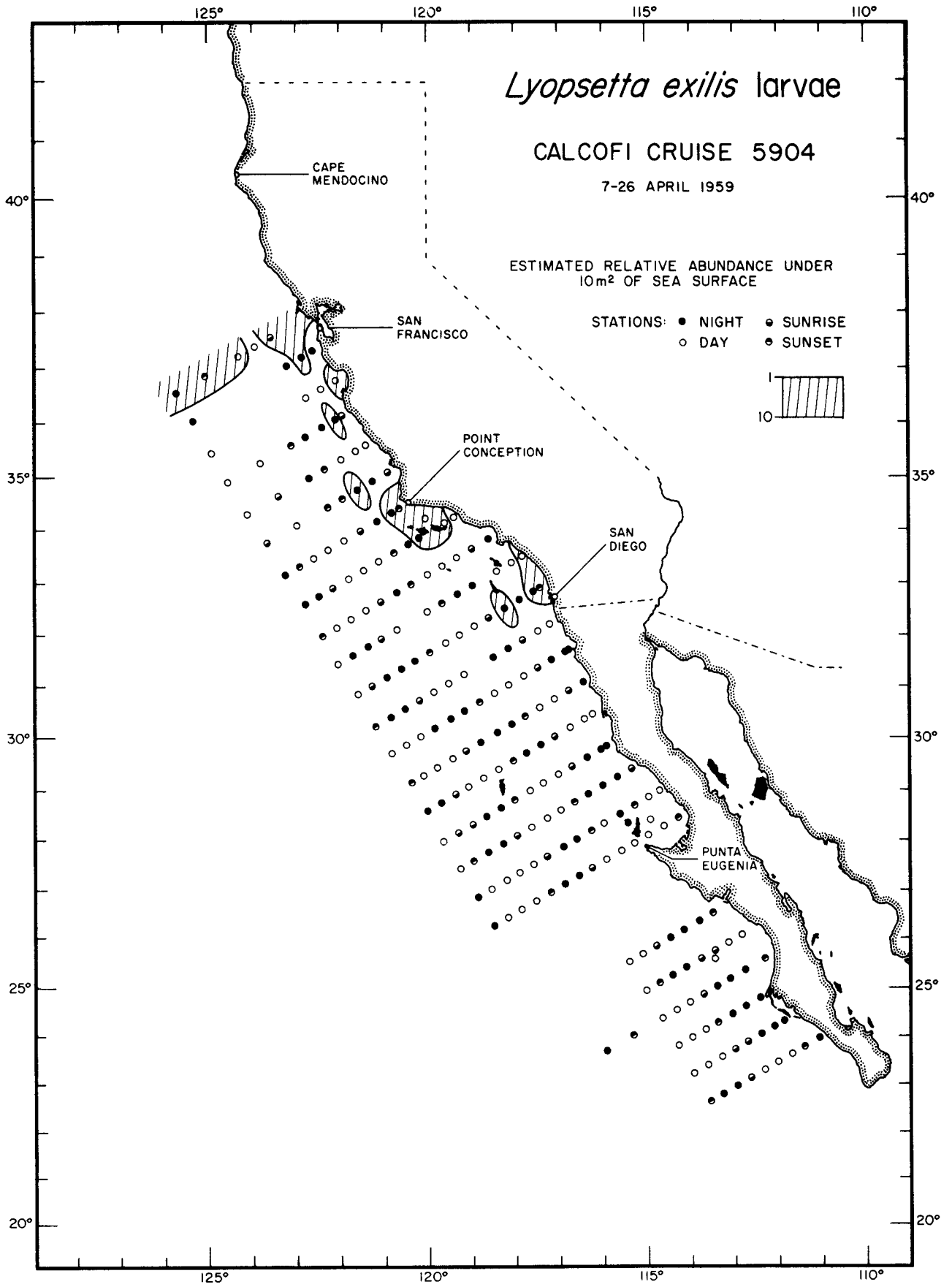


Lyopsetta exilis larvae

5807

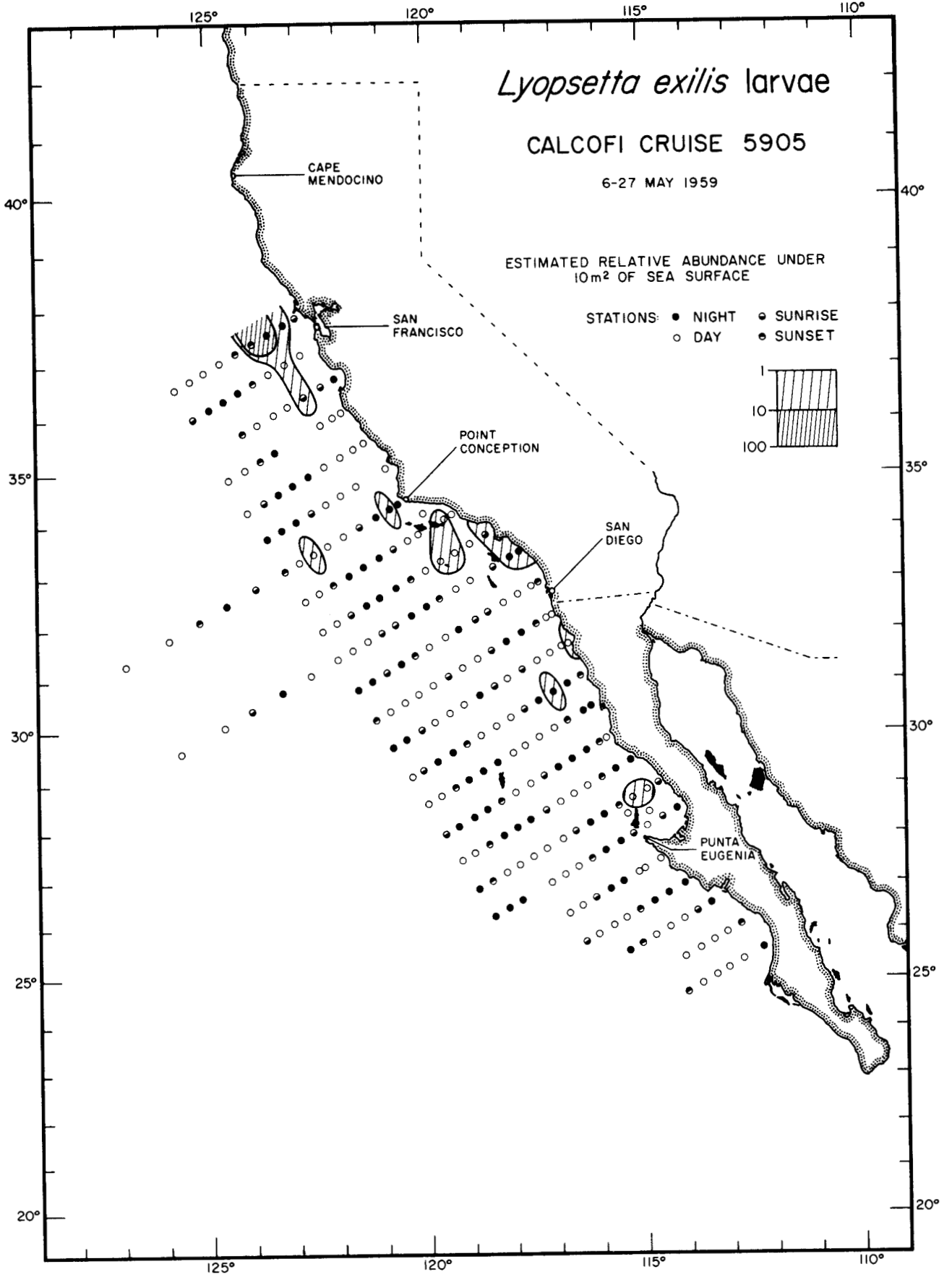
*Lyopsetta exilis* larvae

5902



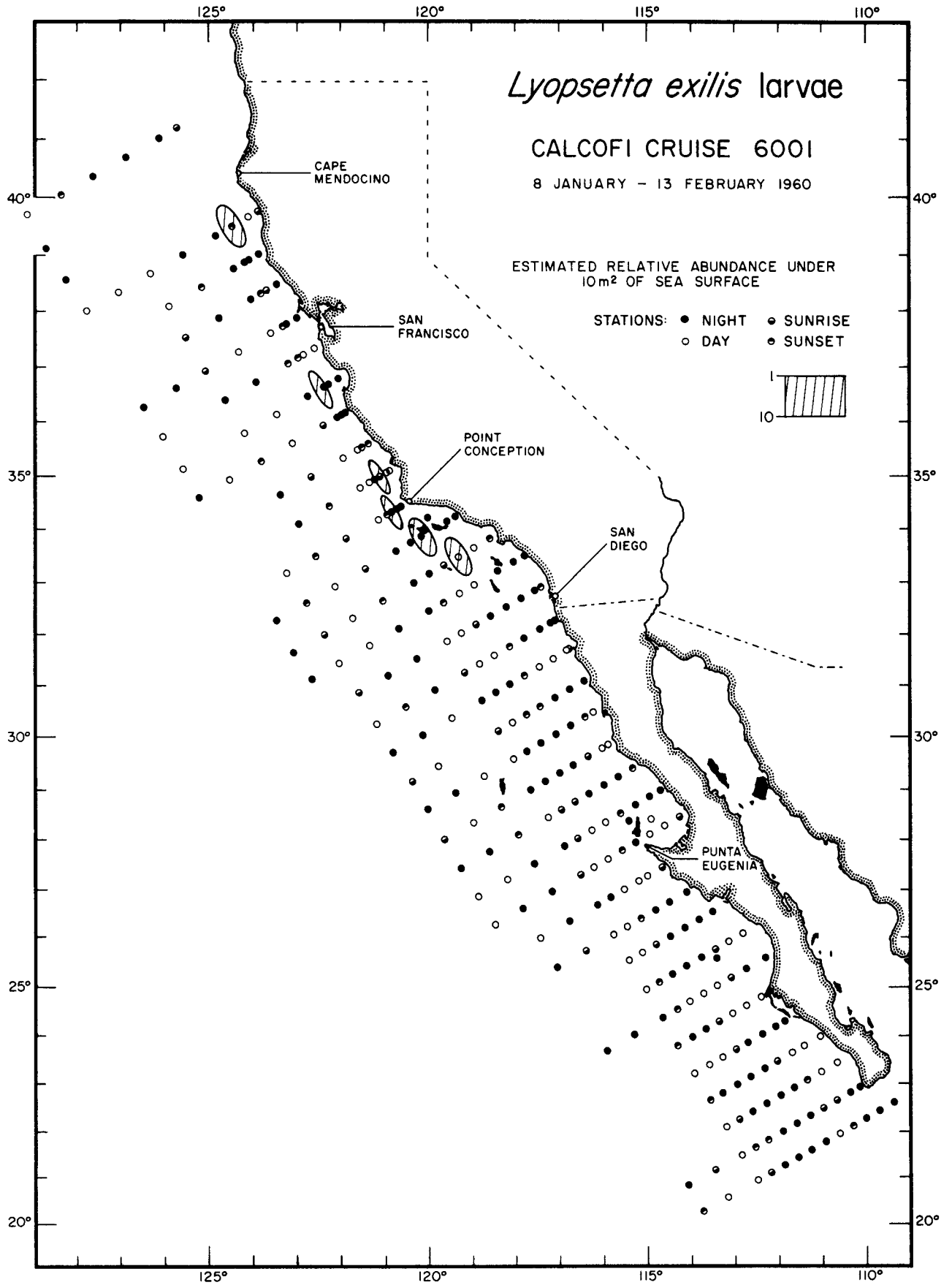
Lyopsetta exilis larvae

5904



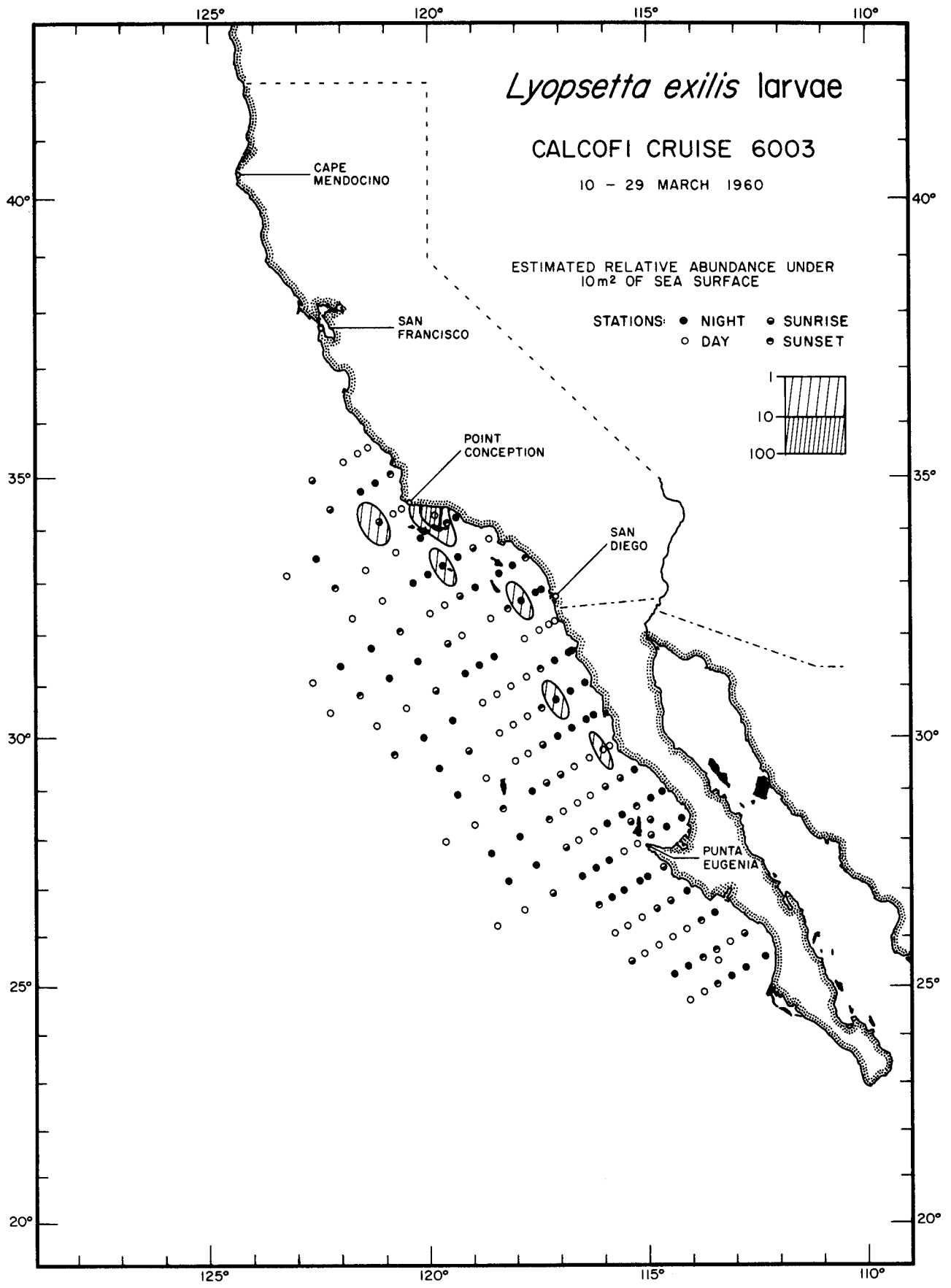
Lyopsetta exilis larvae

5905

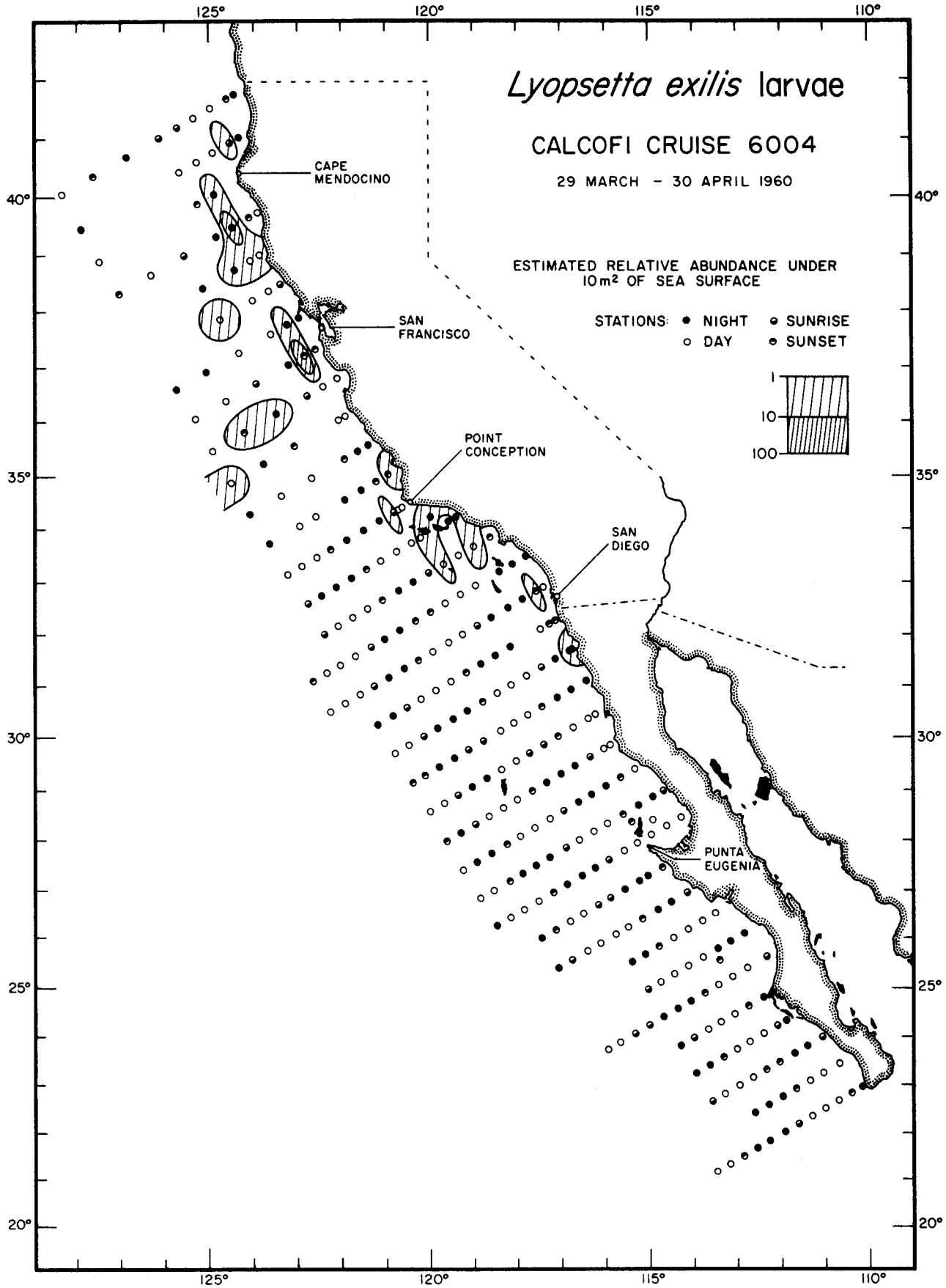


Lyopsetta exilis larvae

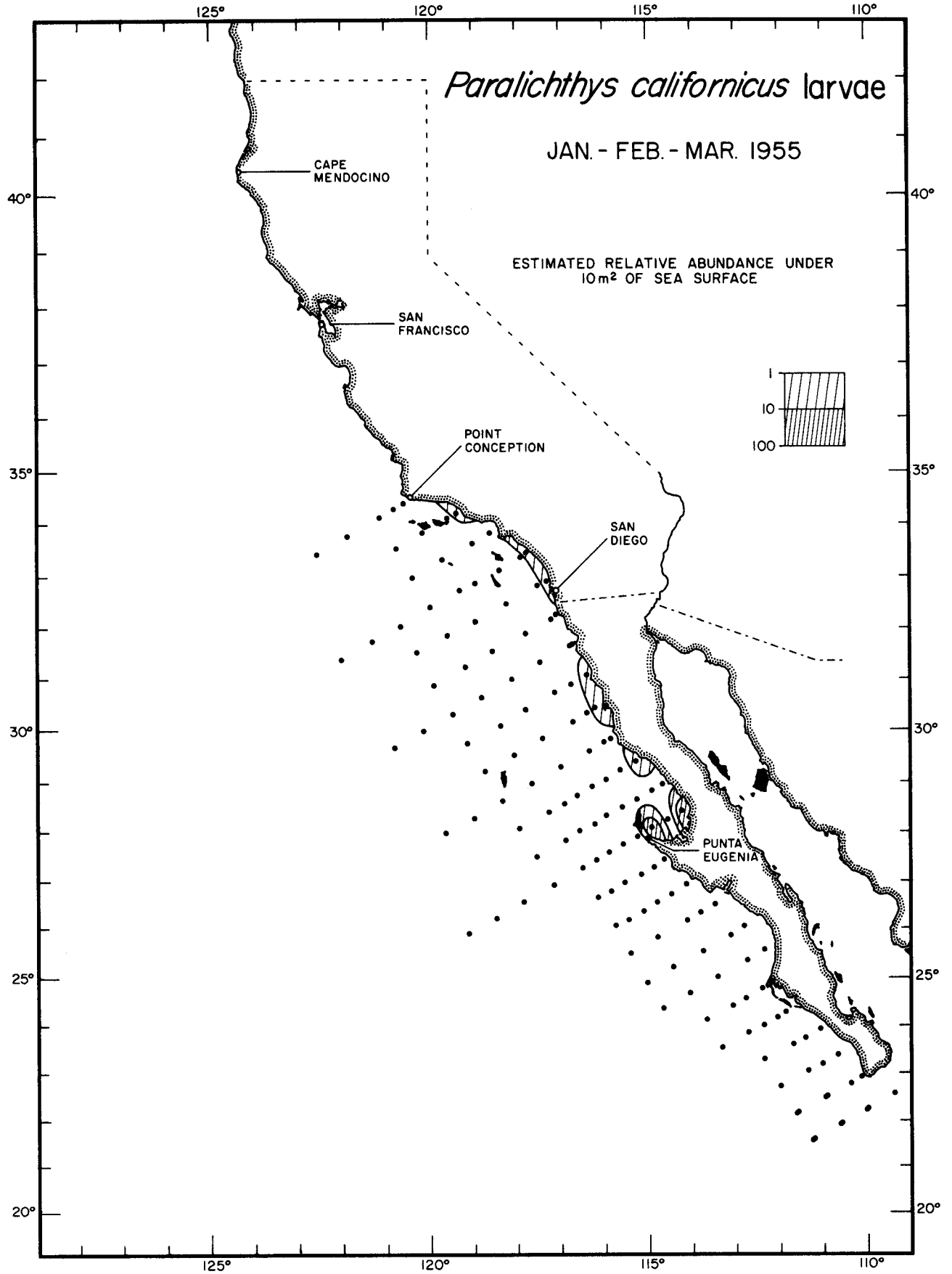
6001



Lyopsetta exilis larvae

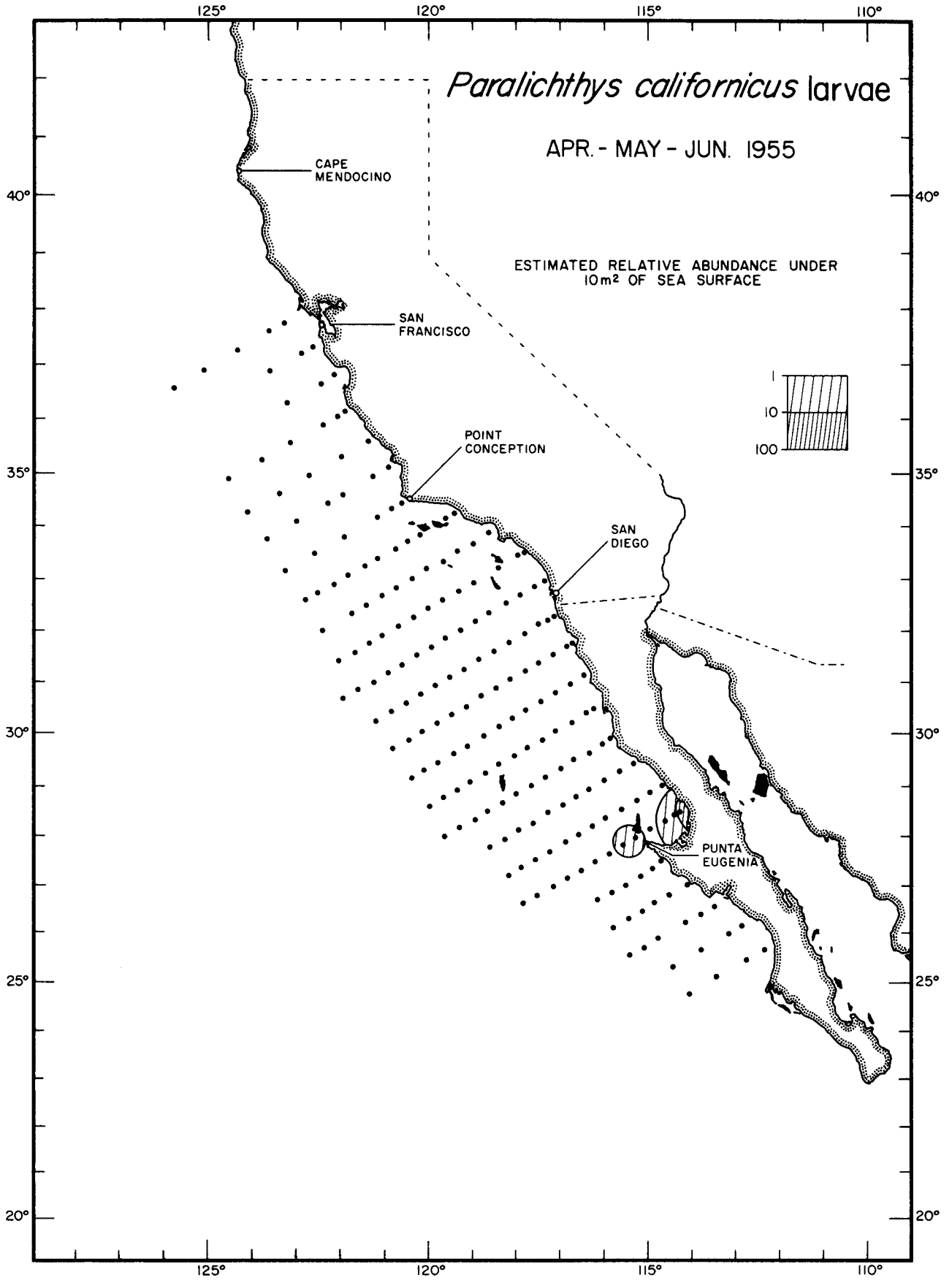


Lyopsetta exilis larvae
6004



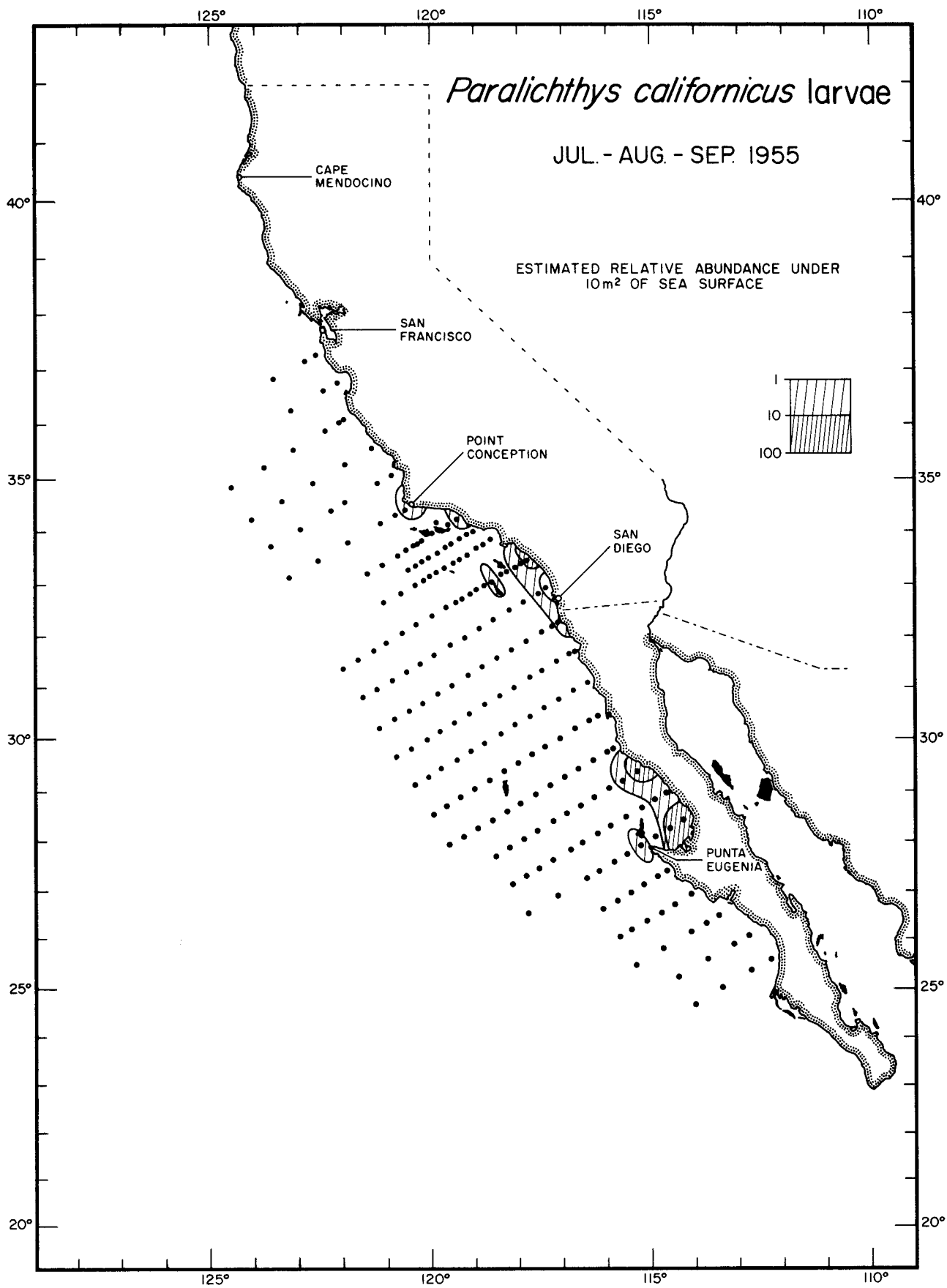
Paralichthys californicus larvae

JAN. - FEB. - MAR. 1955



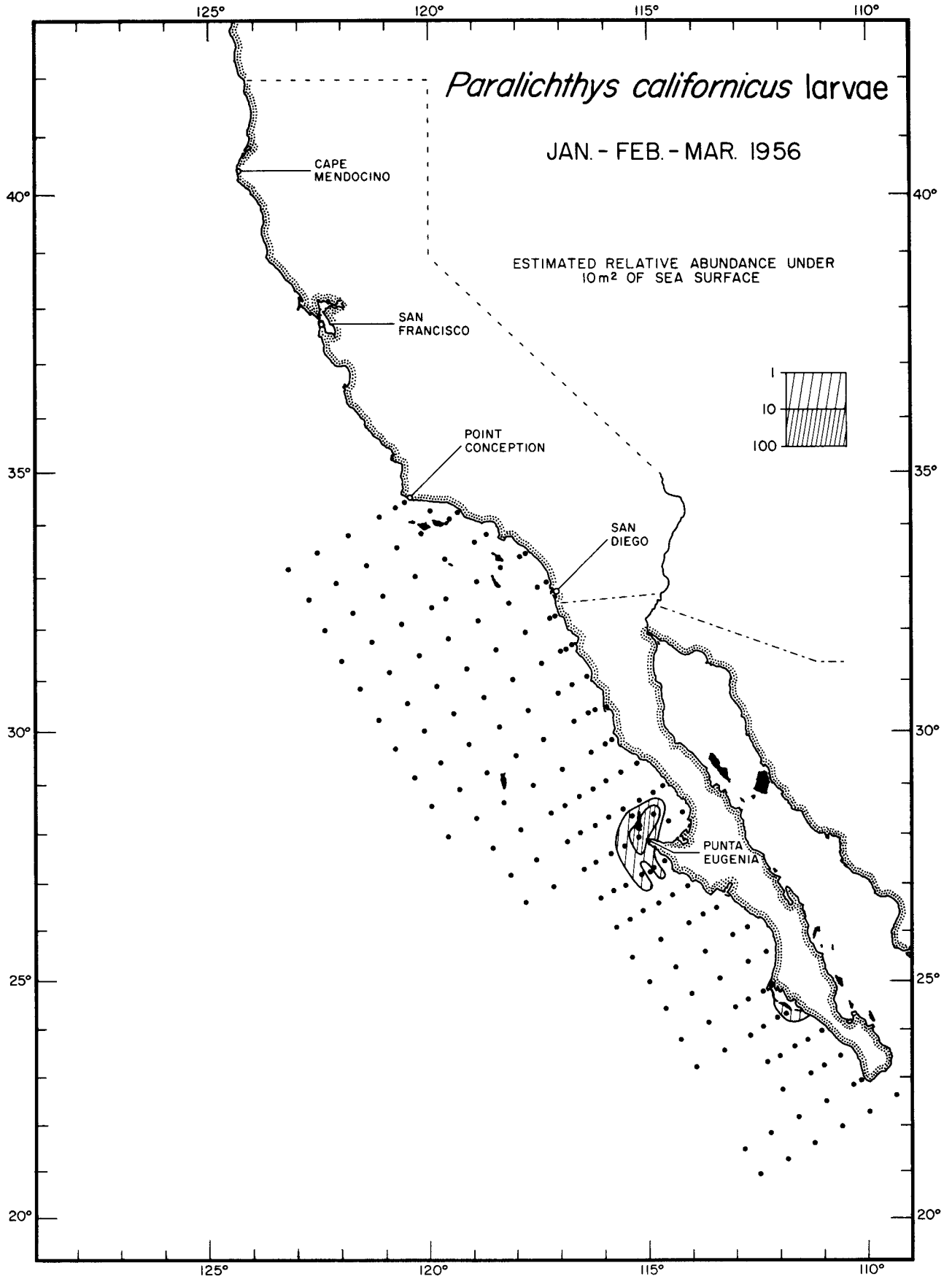
Paralichthys californicus larvae

APR. - MAY - JUN. 1955



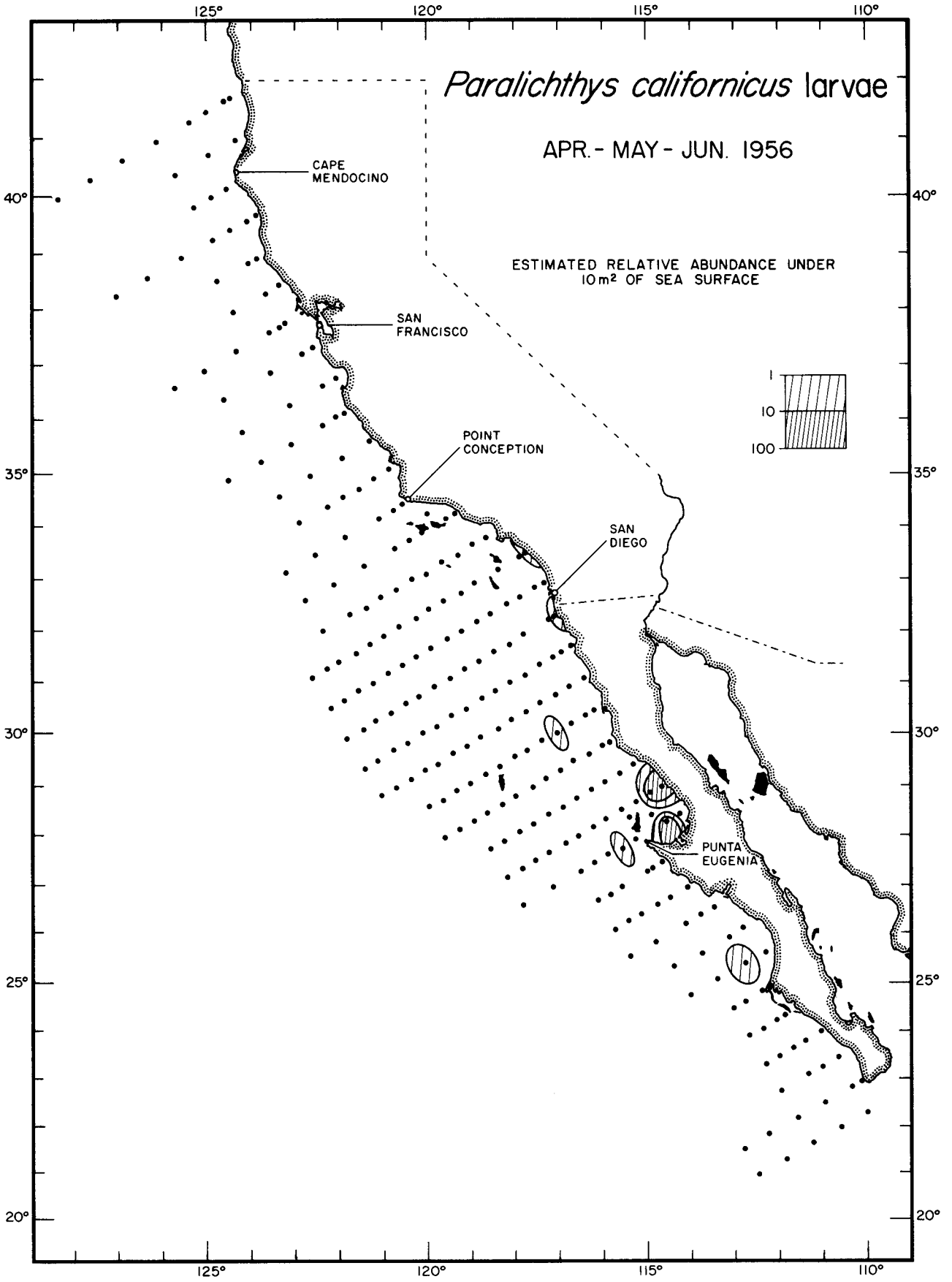
Paralichthys californicus larvae

JUL. - AUG. - SEP. 1955



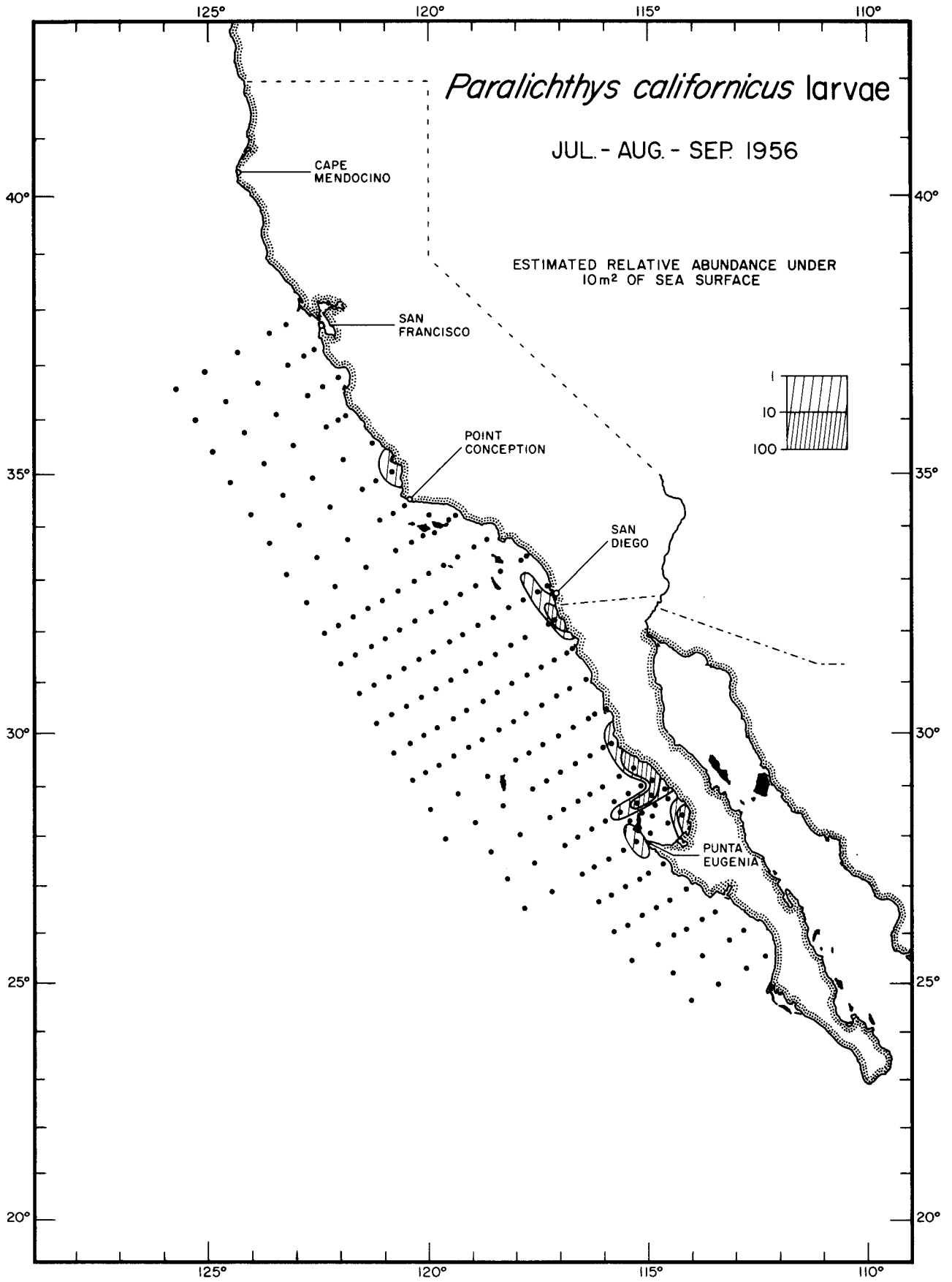
Paralichthys californicus larvae

JAN. - FEB. - MAR. 1956



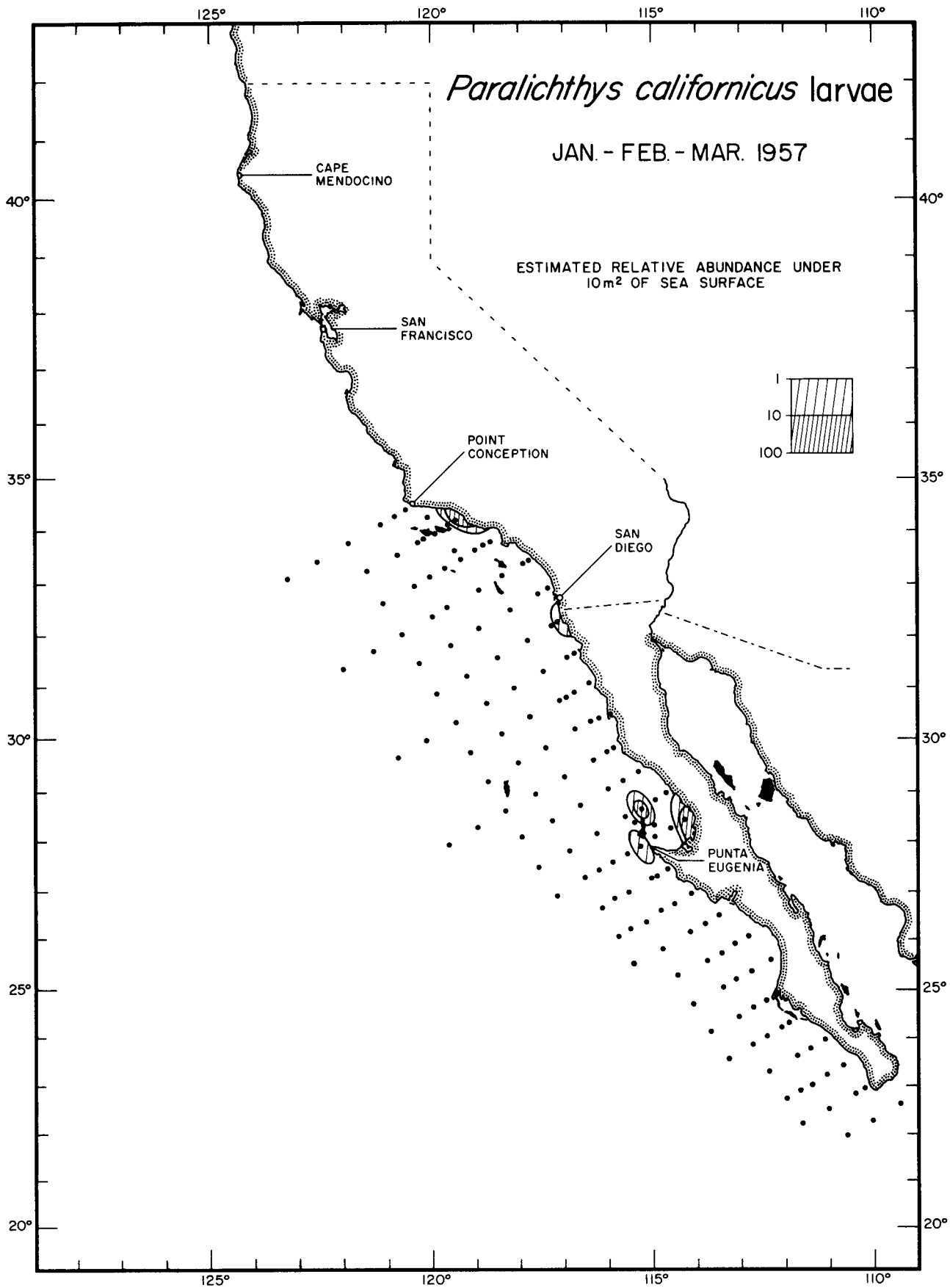
Paralichthys californicus larvae

APR. - MAY - JUN. 1956

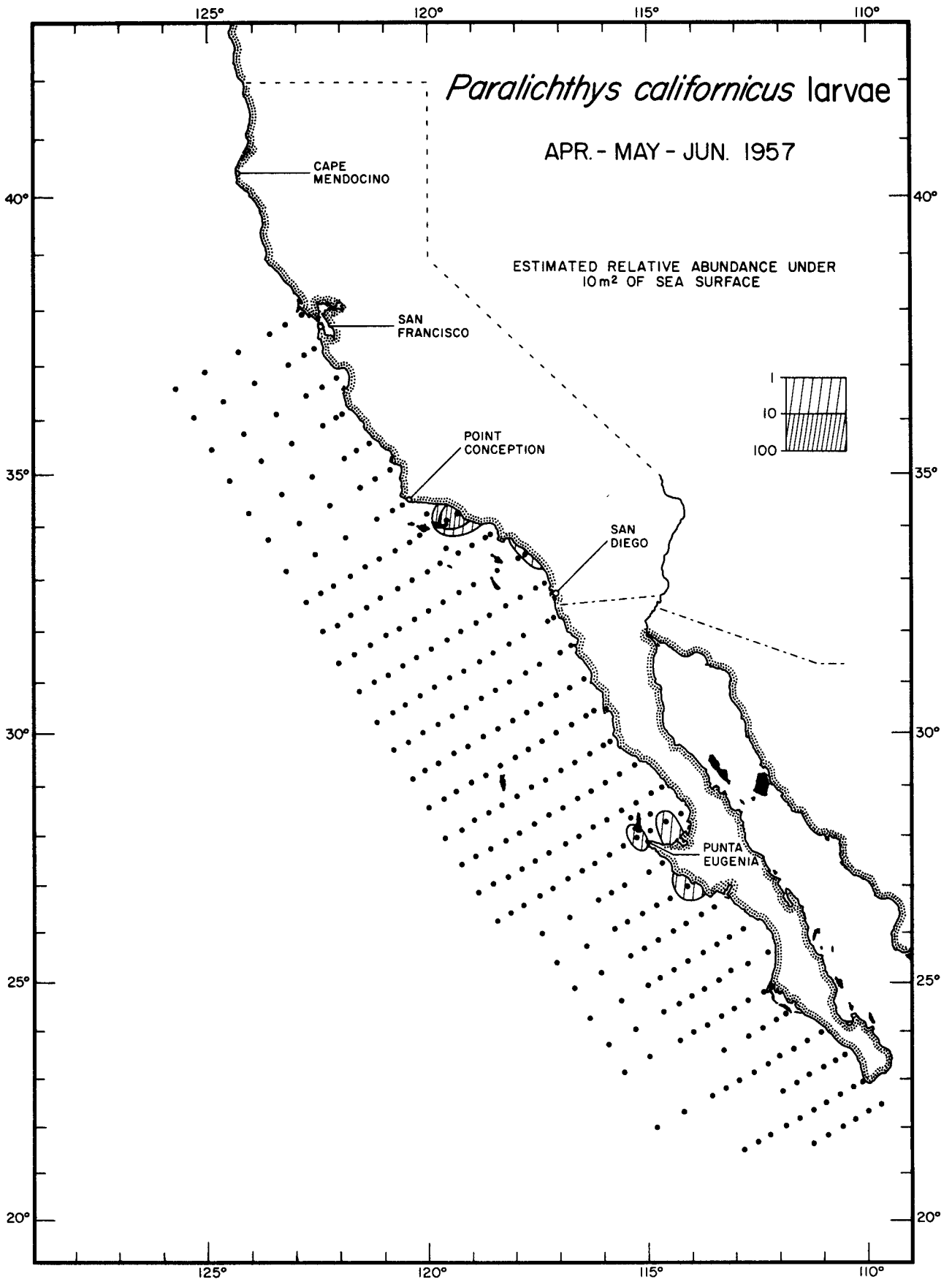


Paralichthys californicus larvae

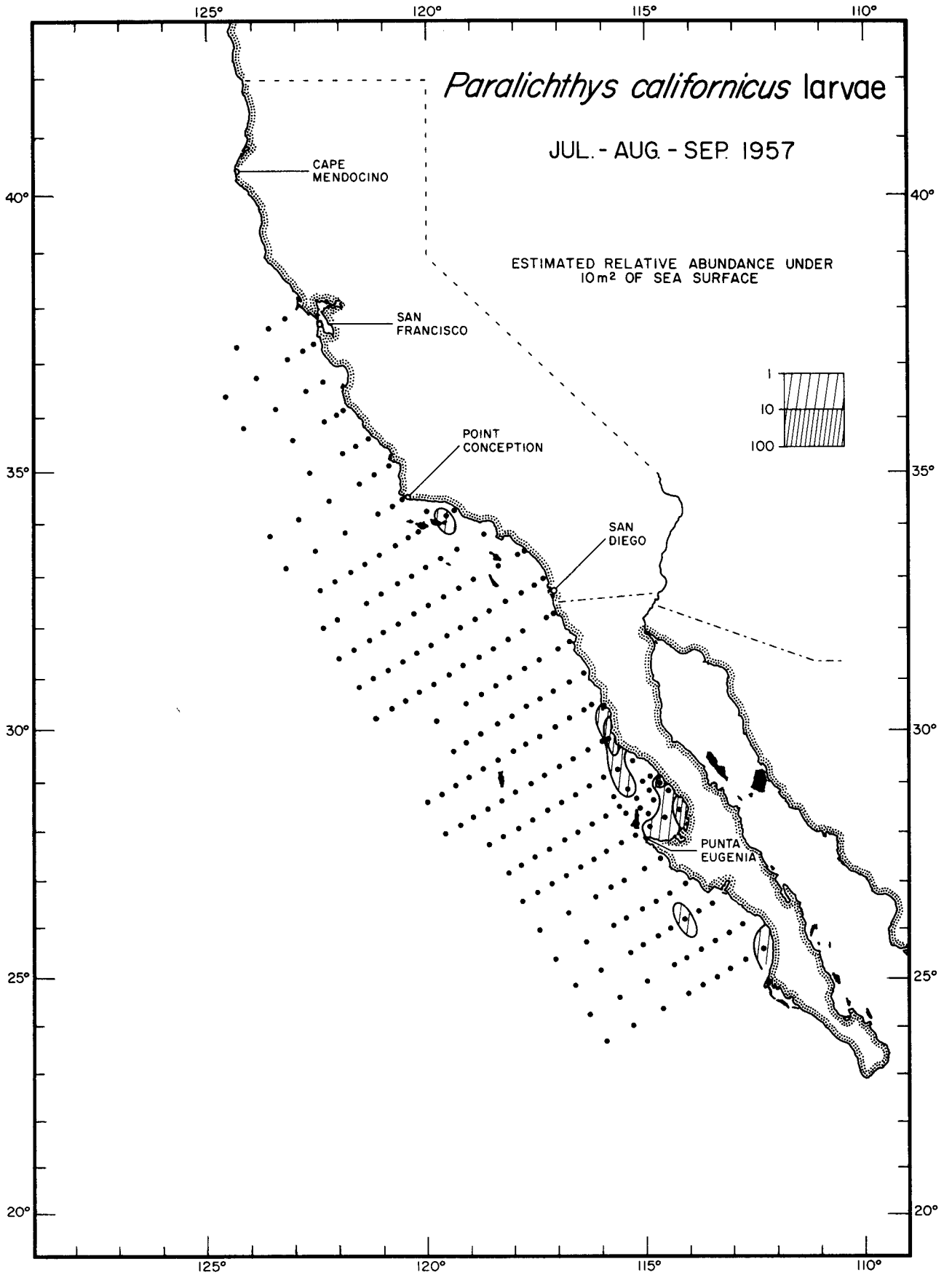
JUL. - AUG. - SEP. 1956



Paralichthys californicus larvae
JAN. - FEB. - MAR. 1957

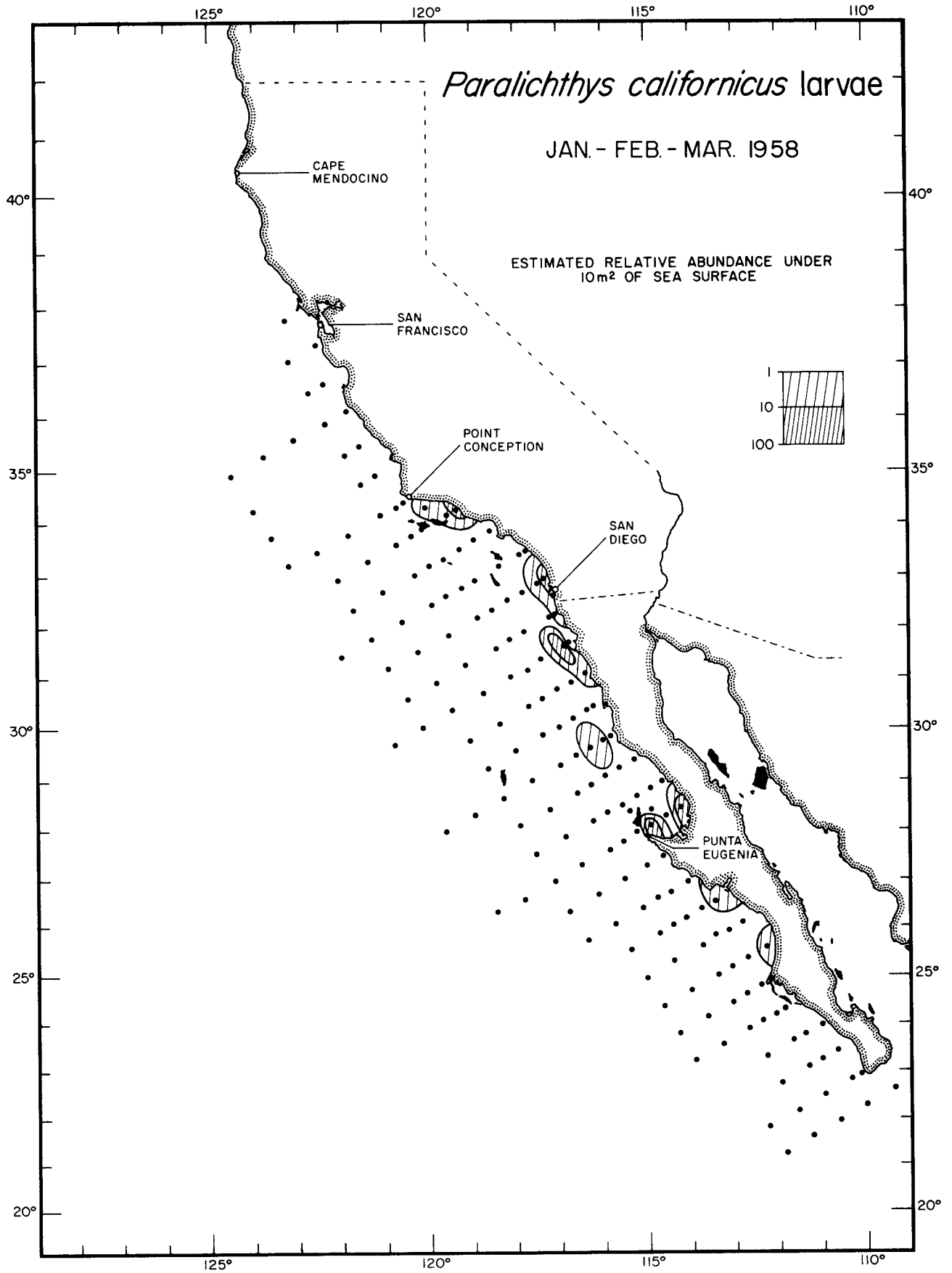


Paralichthys californicus larvae
APR. - MAY - JUN. 1957

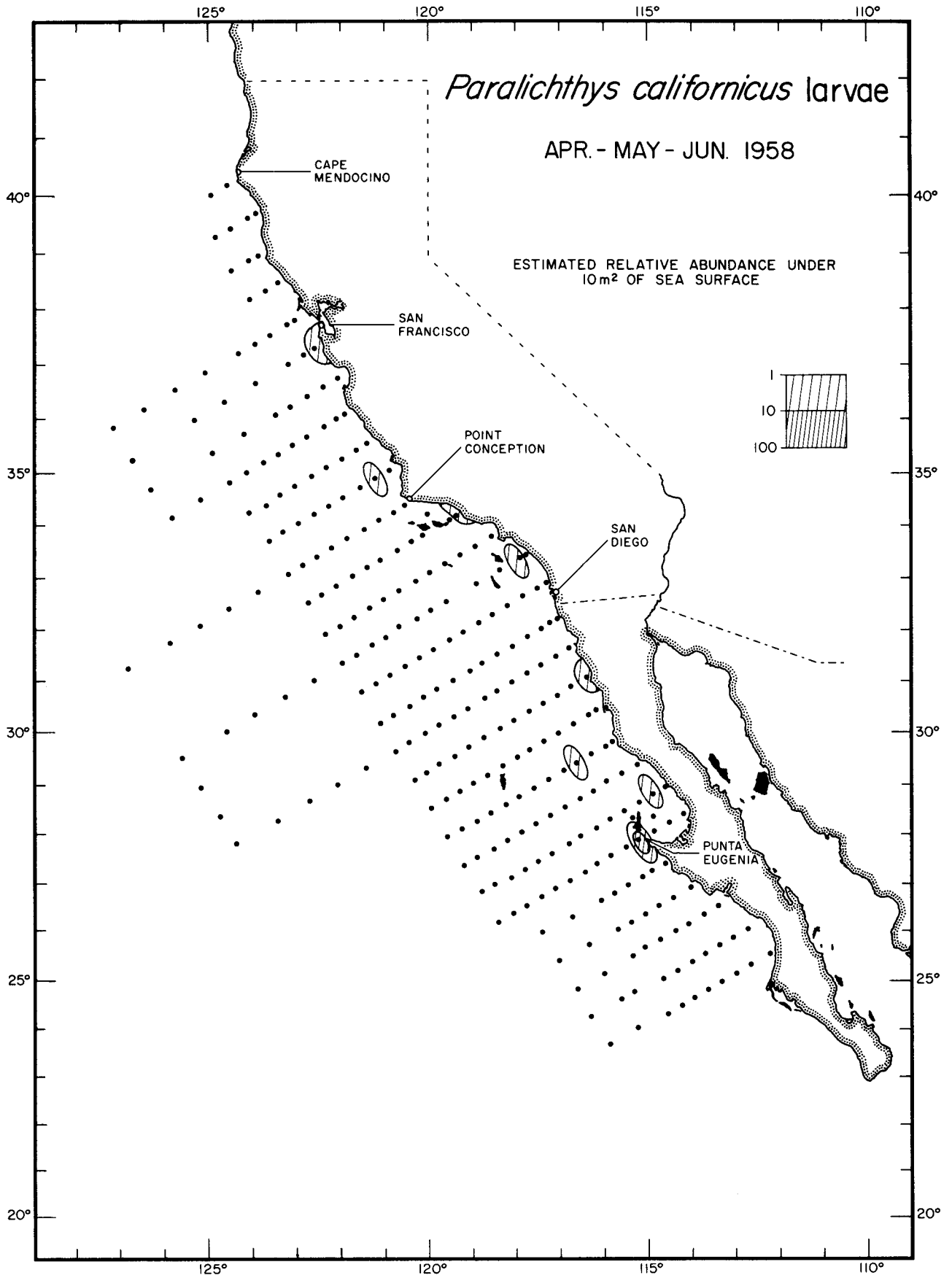


Paralichthys californicus larvae

JUL. - AUG. - SEP. 1957

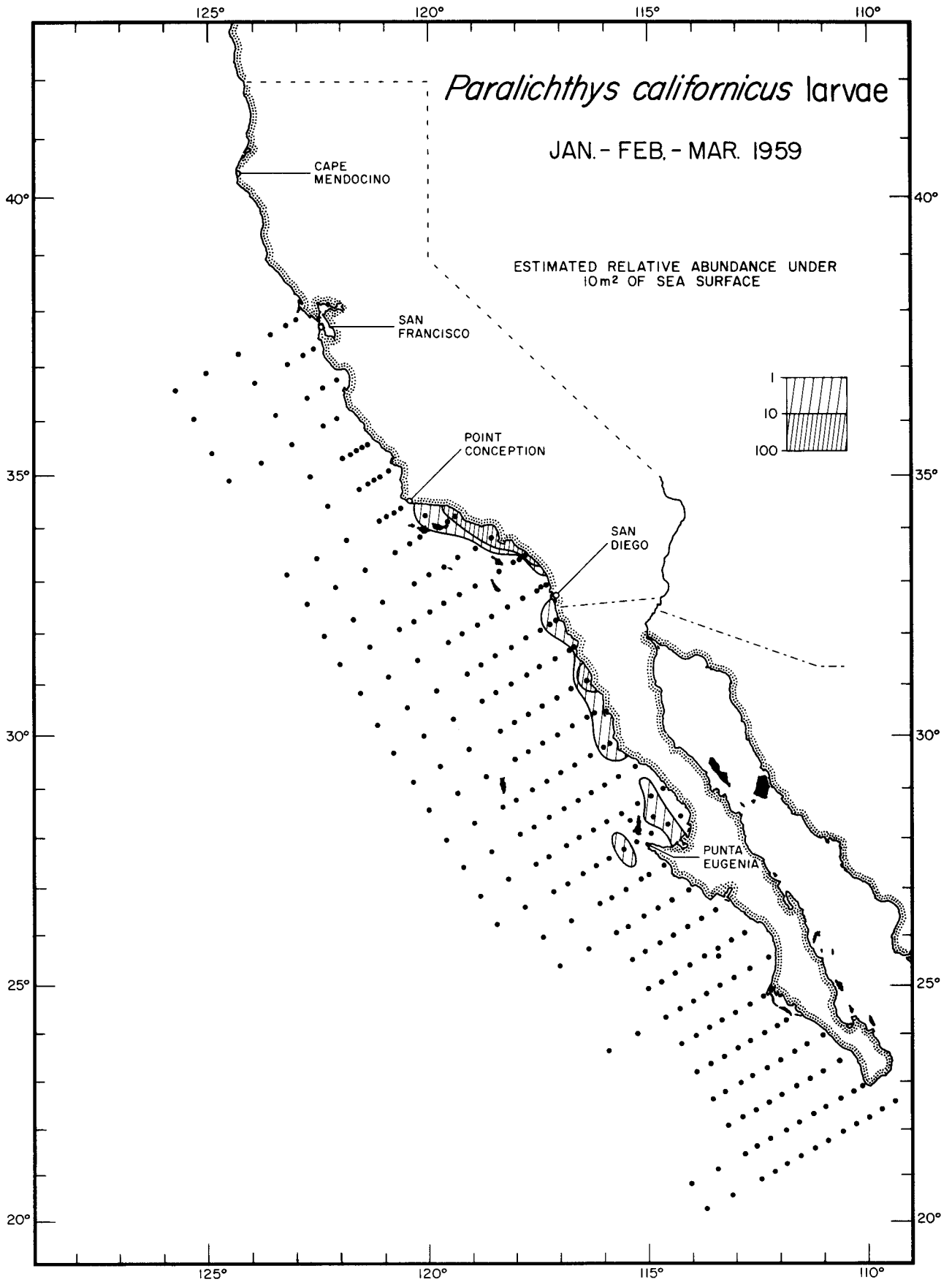


Paralichthys californicus larvae
JAN. - FEB. - MAR. 1958

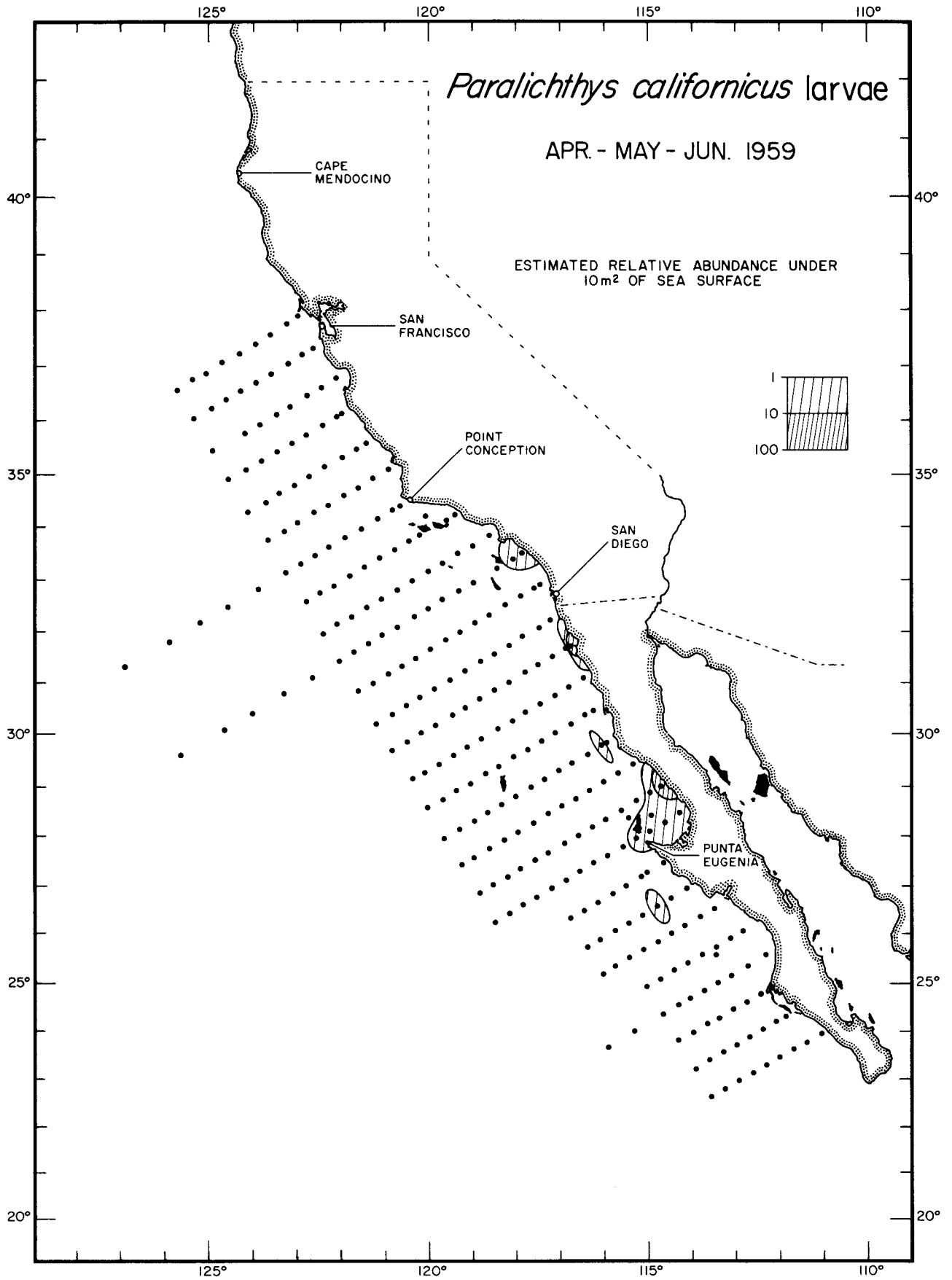


Paralichthys californicus larvae

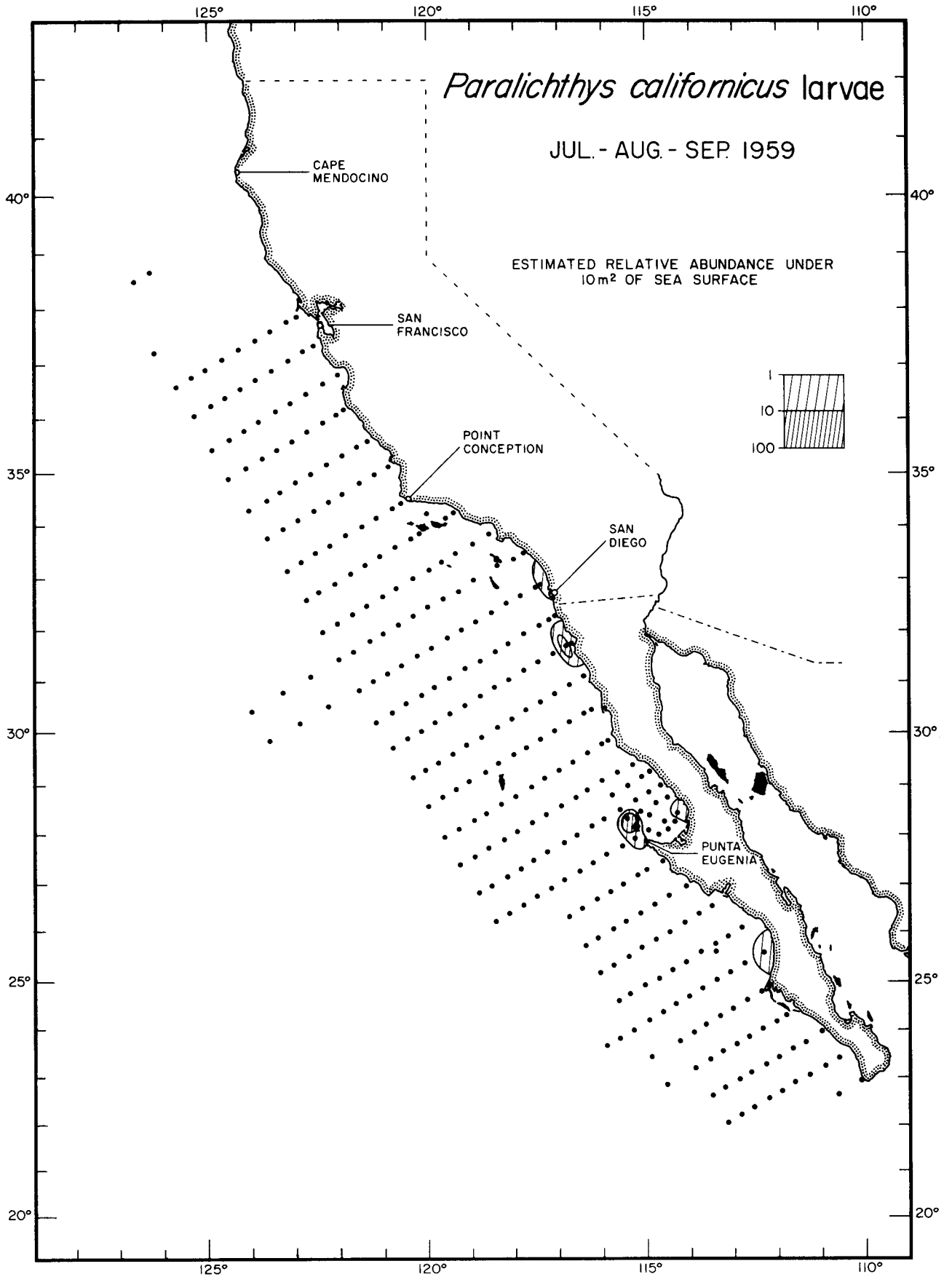
APR. - MAY - JUN. 1958



Paralichthys californicus larvae
JAN. - FEB. - MAR. 1959

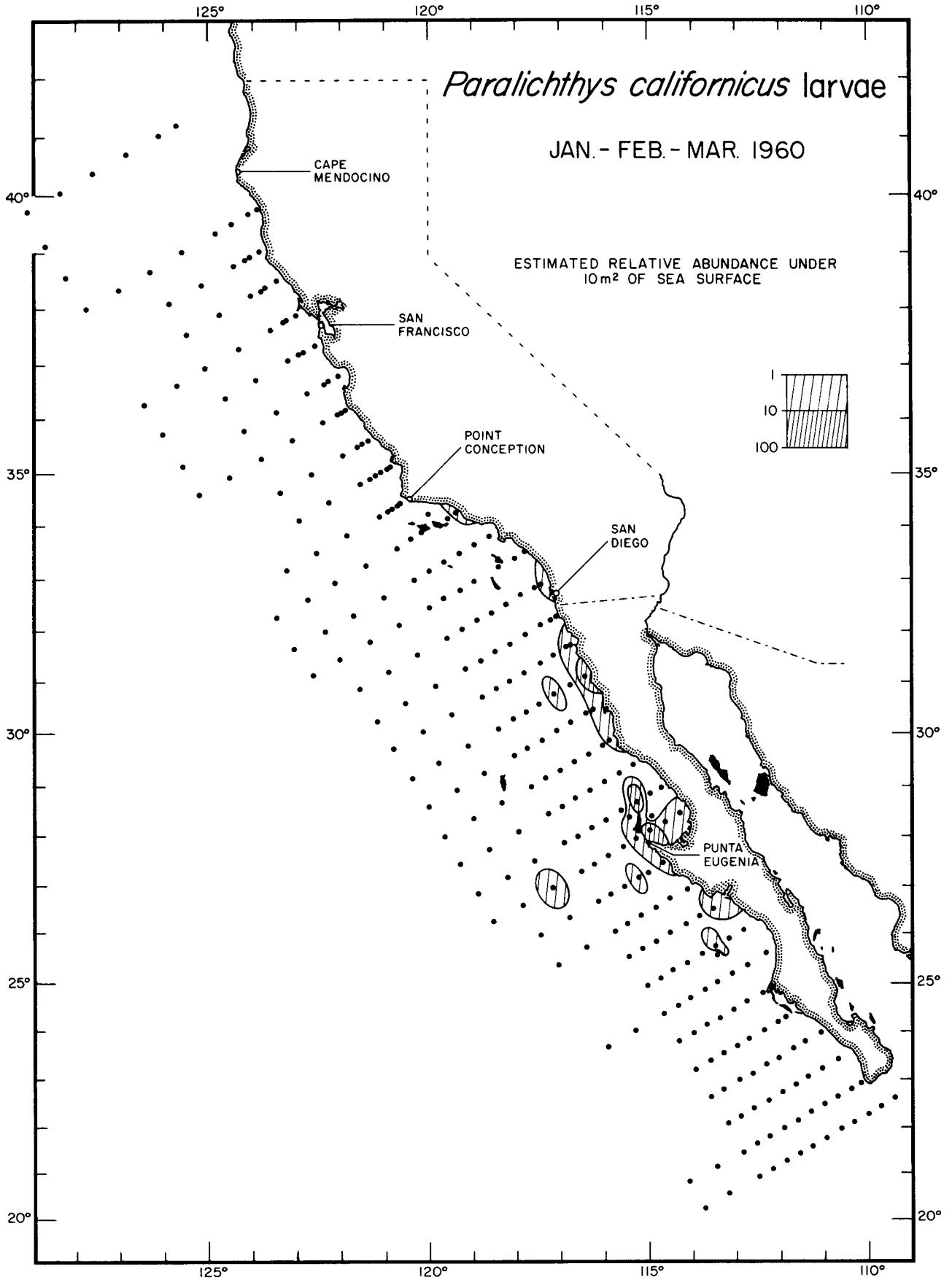


Paralichthys californicus larvae
APR. - MAY - JUN. 1959



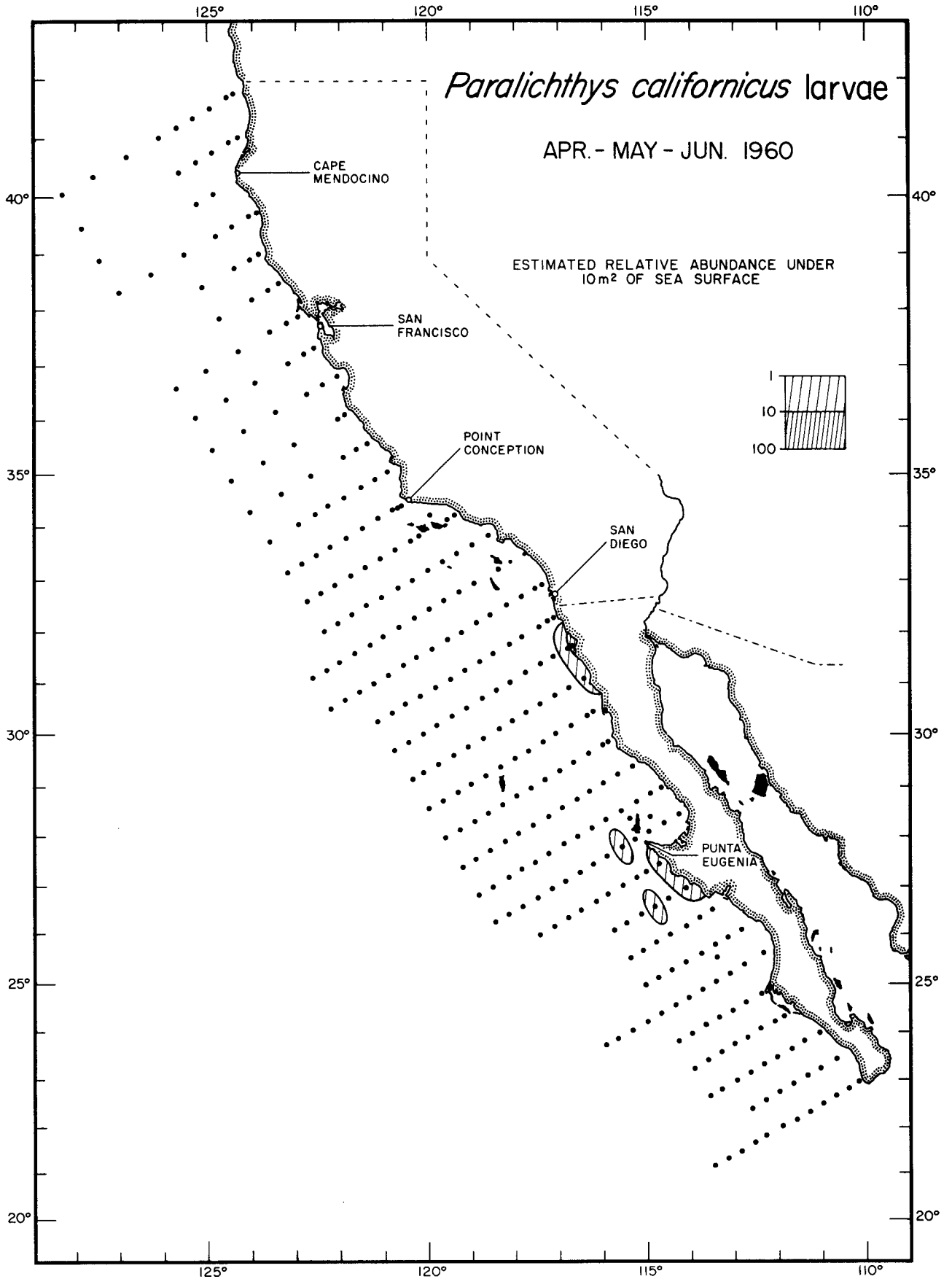
Paralichthys californicus larvae

JUL. - AUG. - SEP. 1959



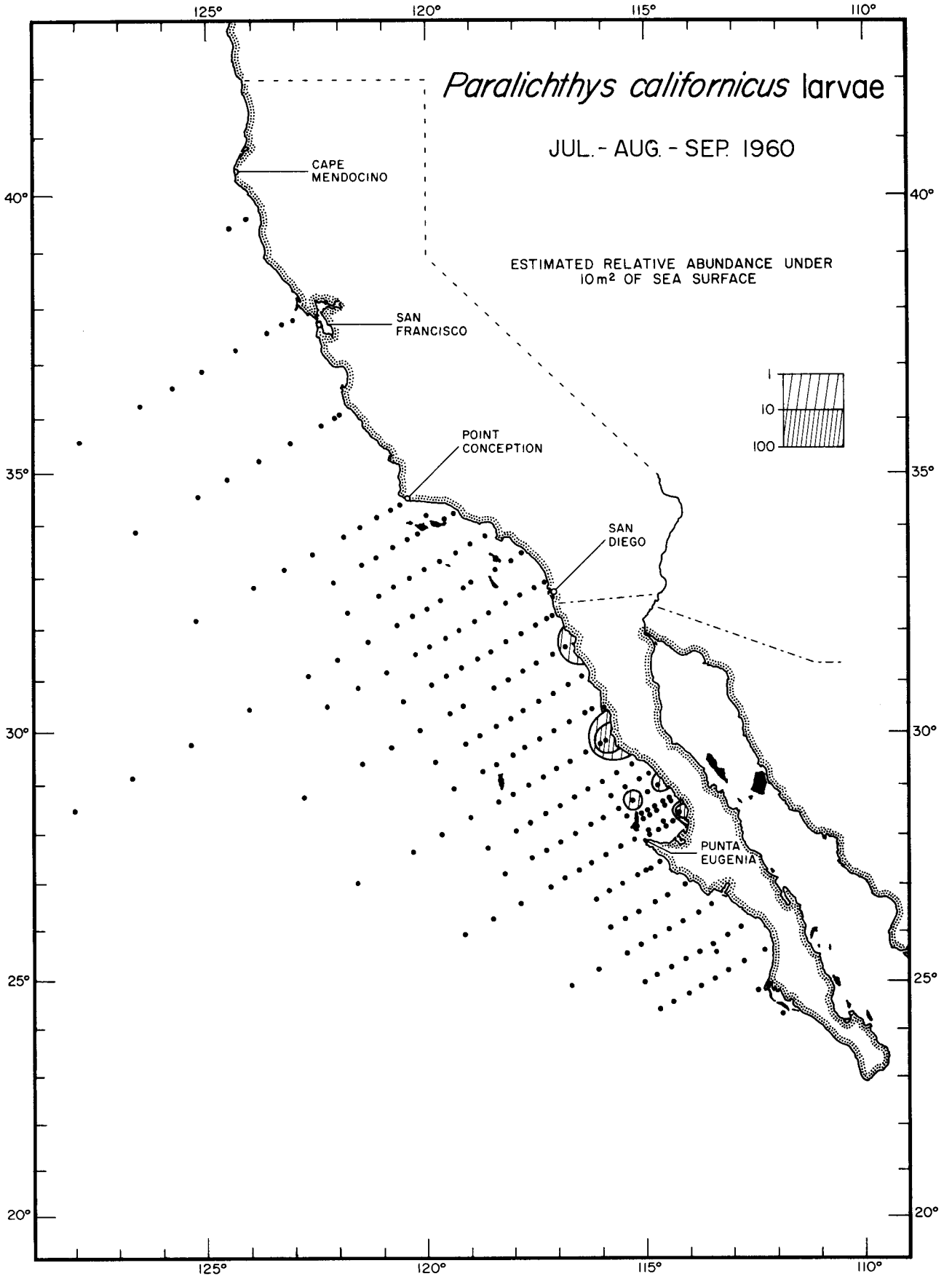
Paralichthys californicus larvae

JAN. - FEB. - MAR. 1960



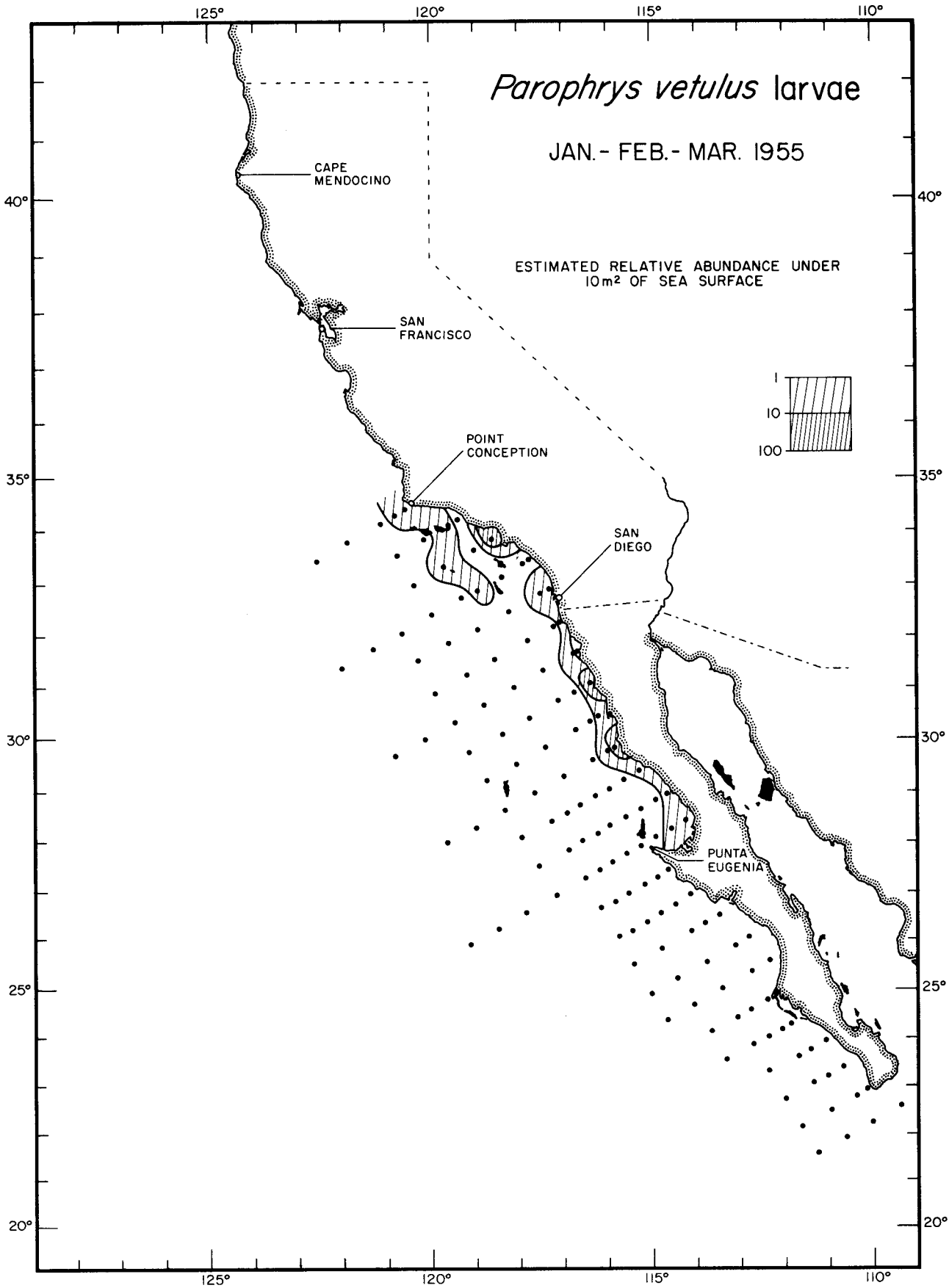
Paralichthys californicus larvae

APR. - MAY - JUN. 1960

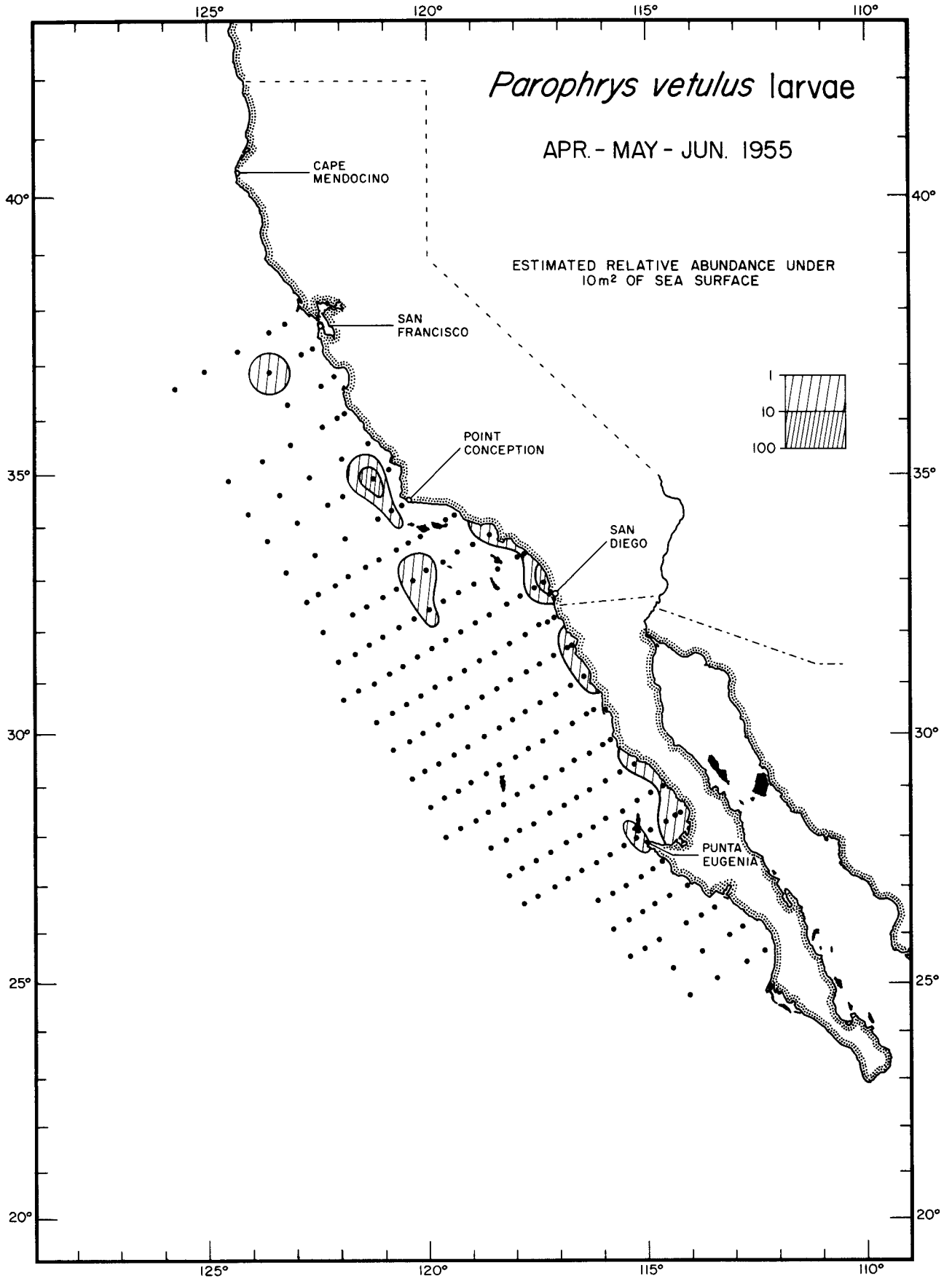


Paralichthys californicus larvae

JUL. - AUG. - SEP. 1960

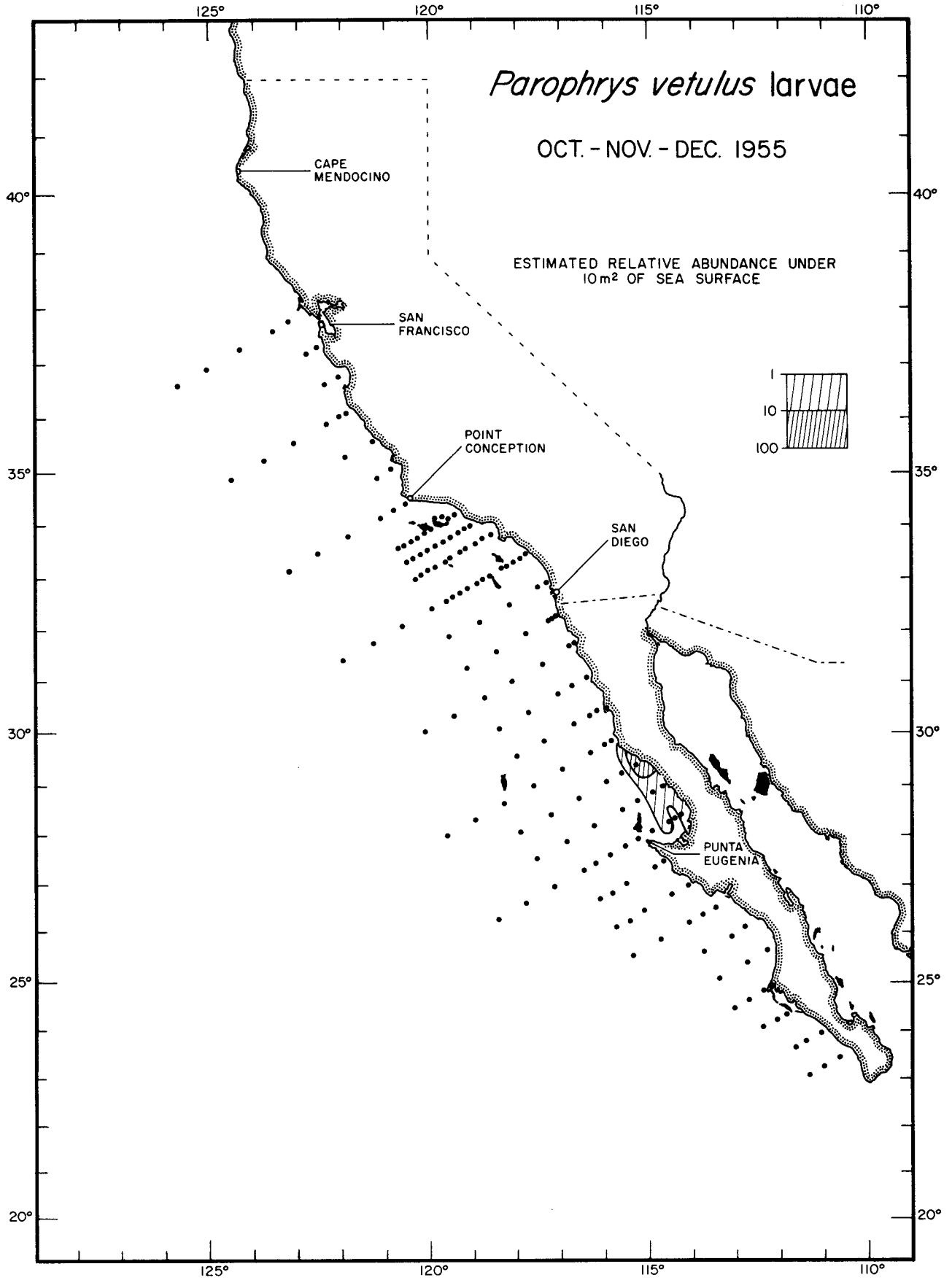


Parophrys vetulus larvae
JAN. - FEB. - MAR. 1955

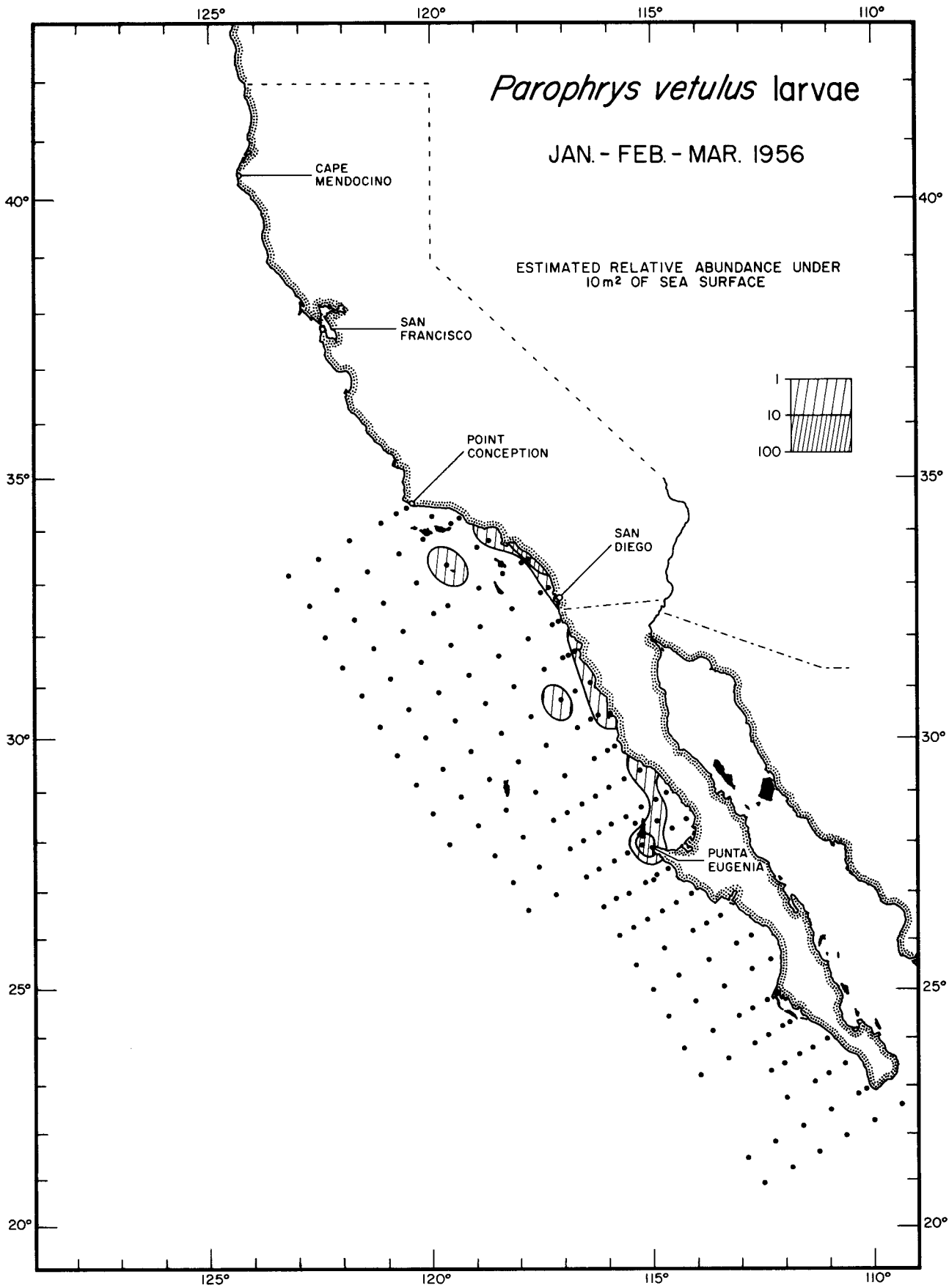


Parophrys vetulus larvae

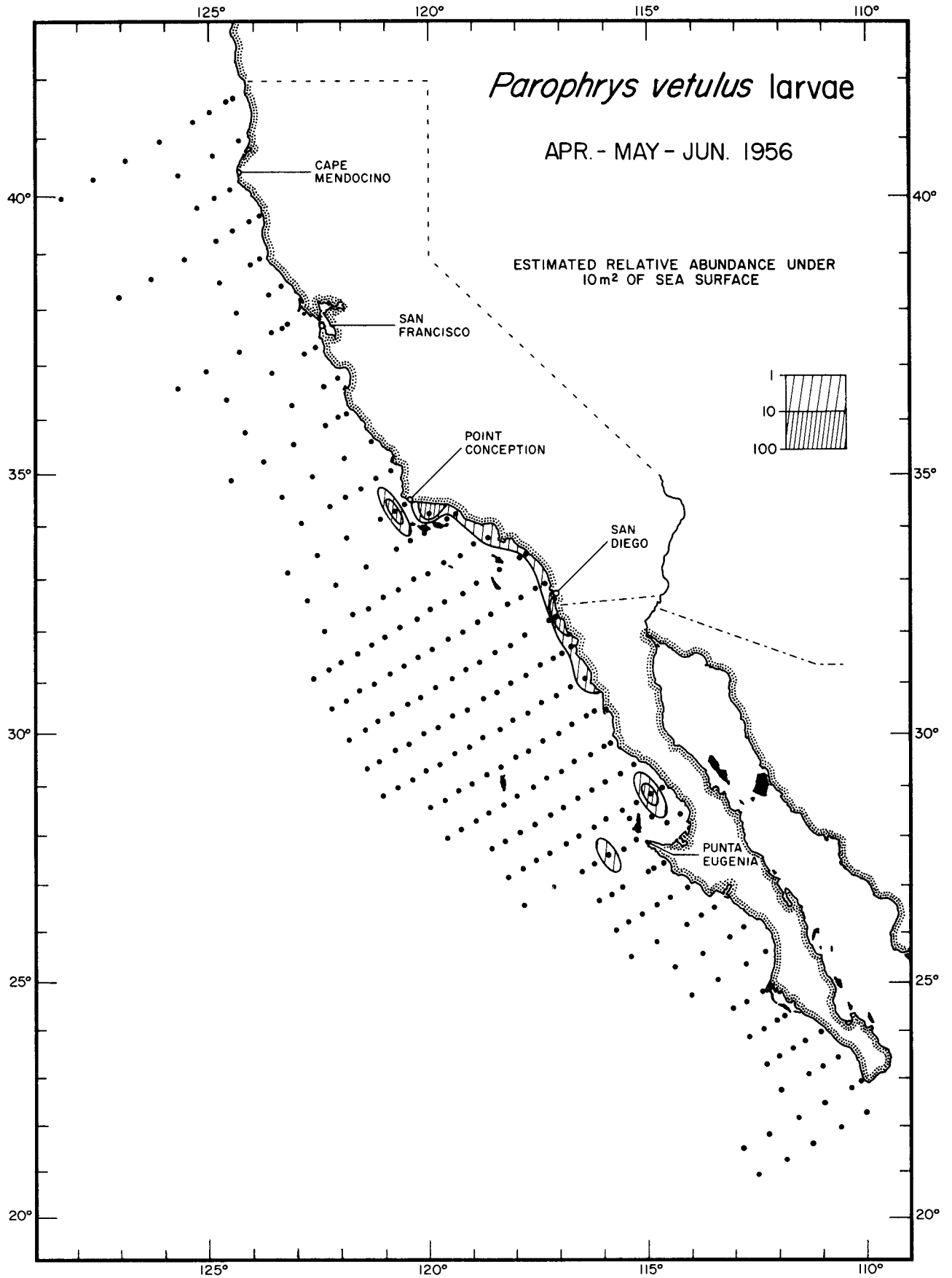
APR. - MAY - JUN. 1955



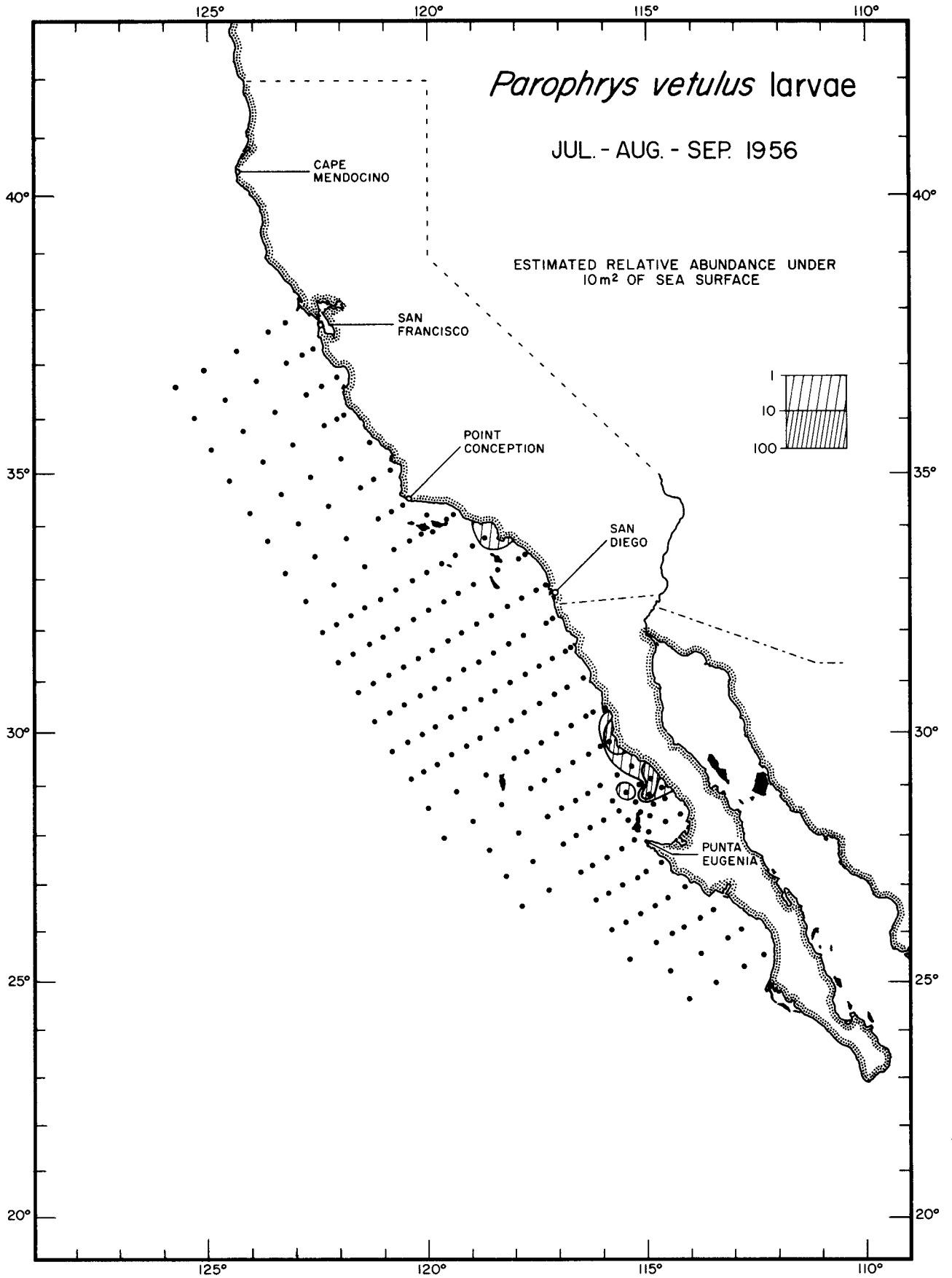
Parophrys vetulus larvae
OCT. - NOV. - DEC. 1955



Parophrys vetulus larvae
JAN. - FEB. - MAR. 1956

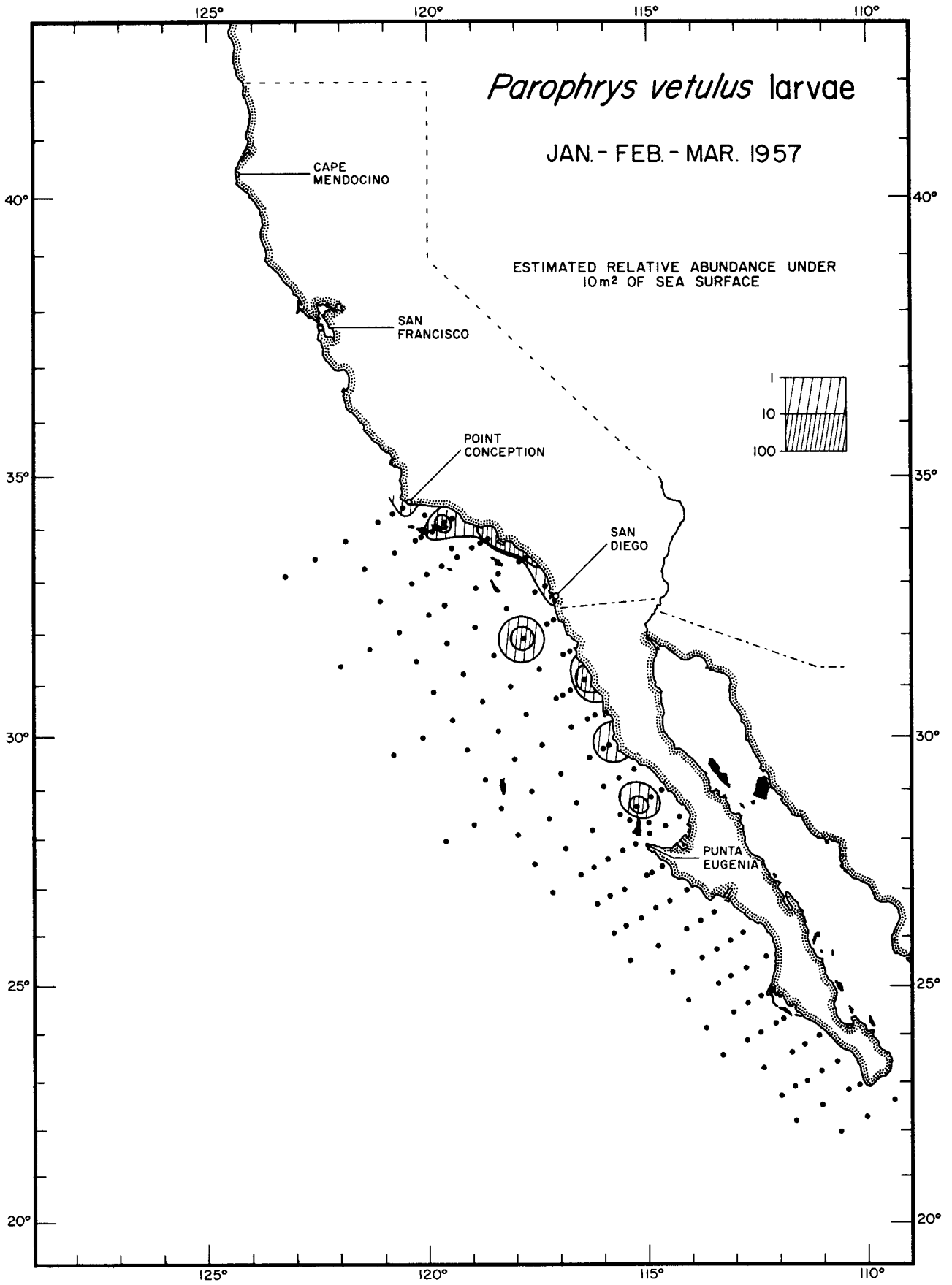


Parophrys vetulus larvae
APR. - MAY - JUN. 1956



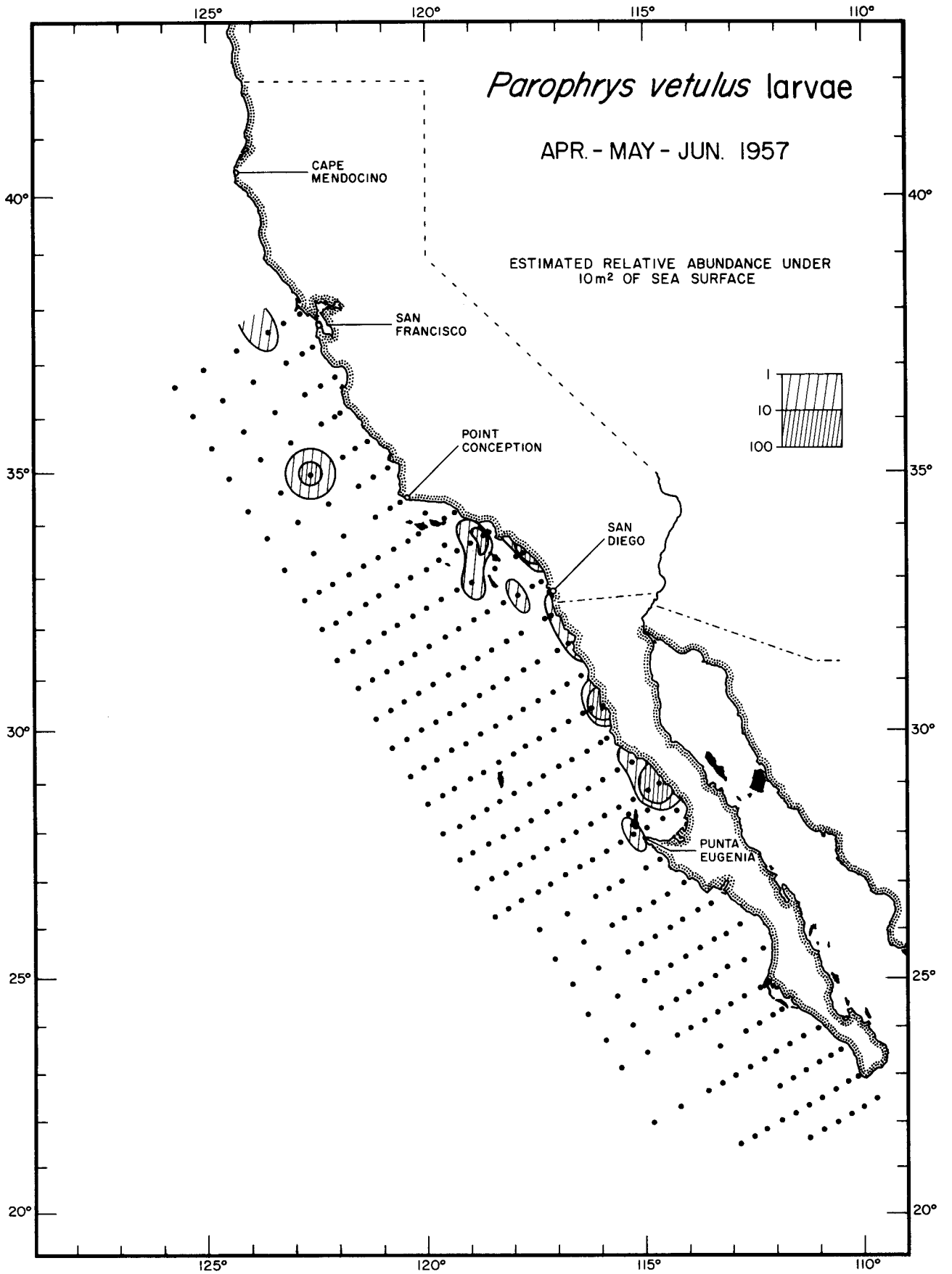
Parophrys vetulus larvae

JUL. - AUG. - SEP. 1956

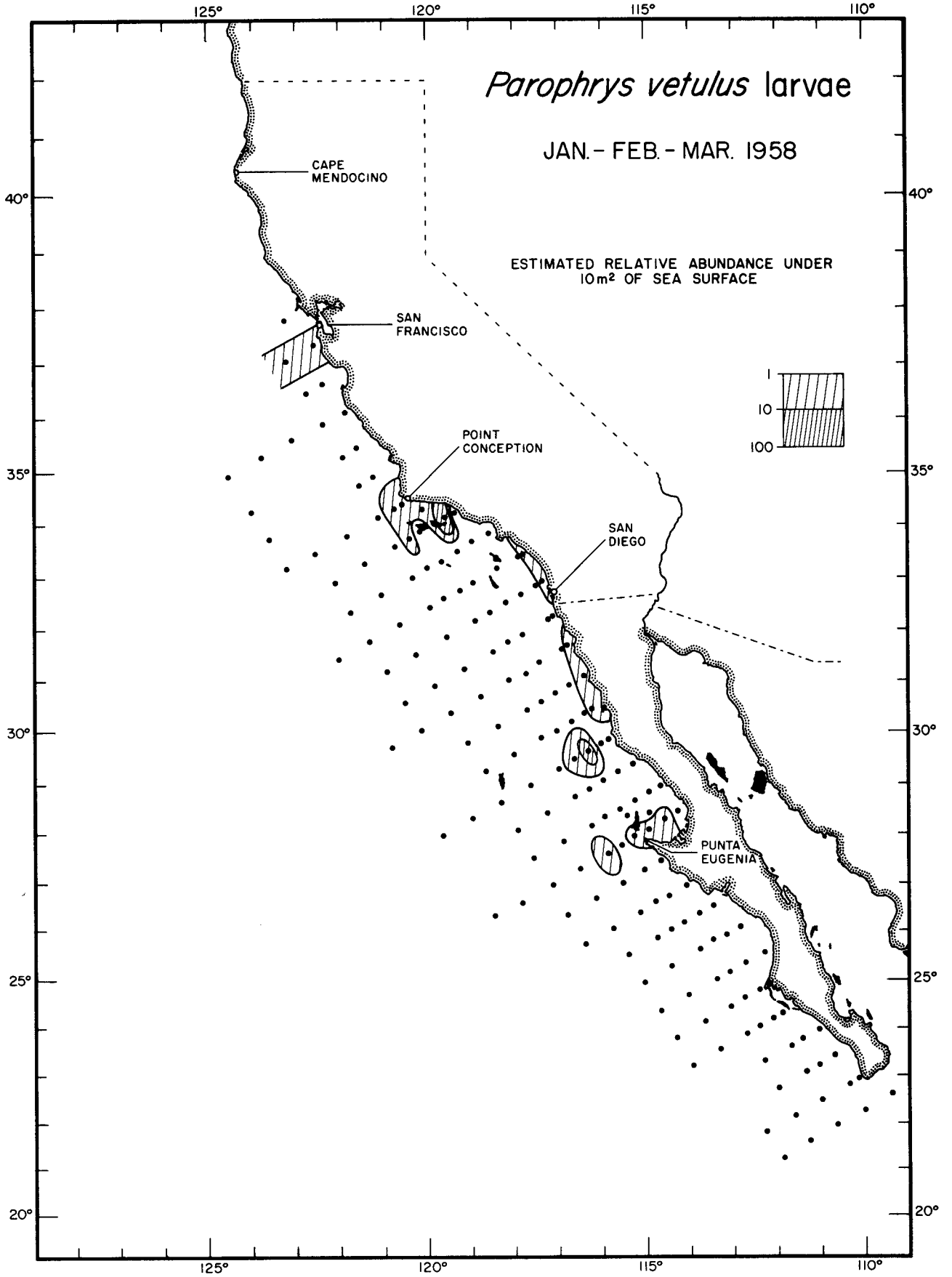


Parophrys vetulus larvae

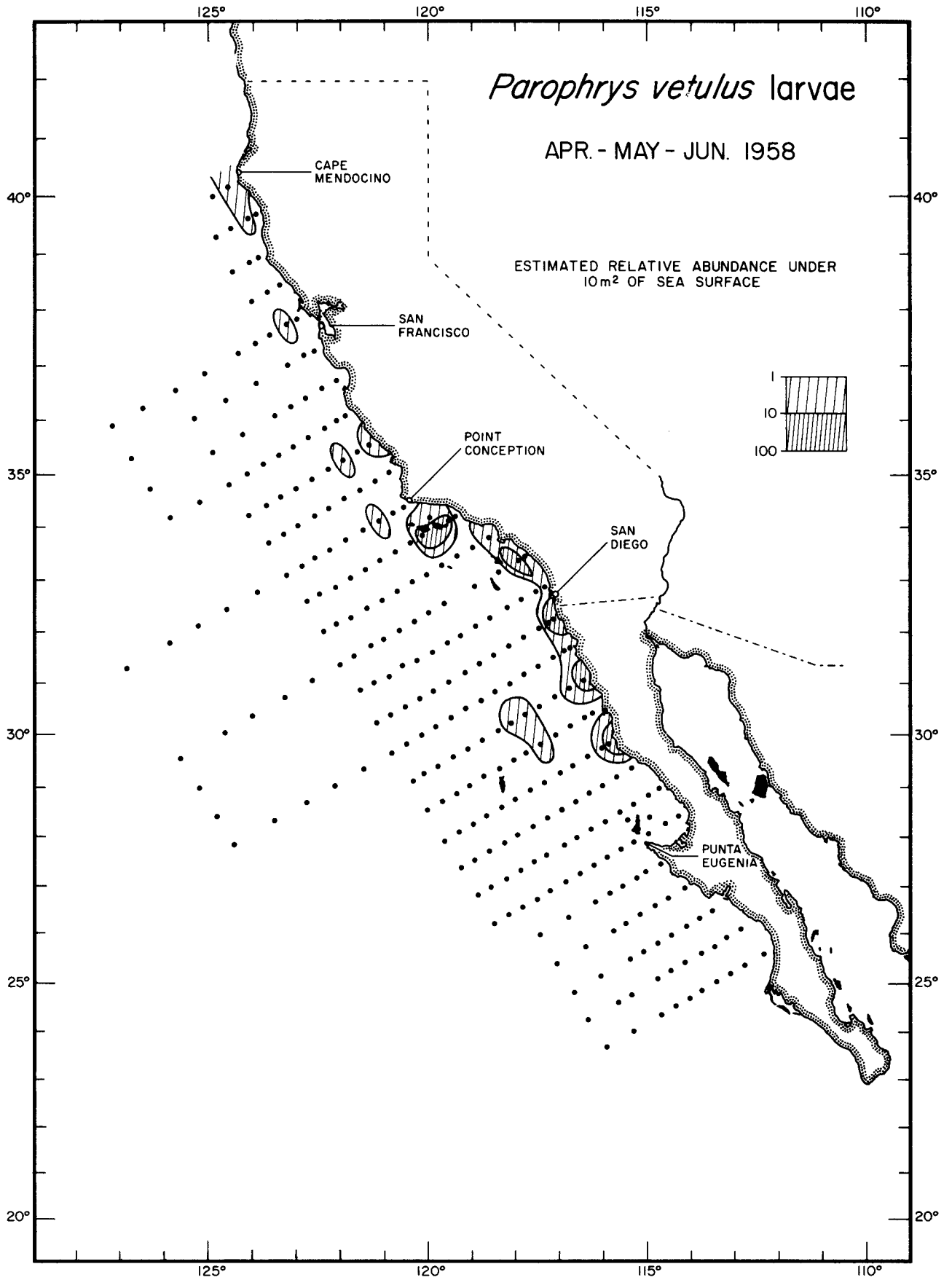
JAN. - FEB. - MAR. 1957



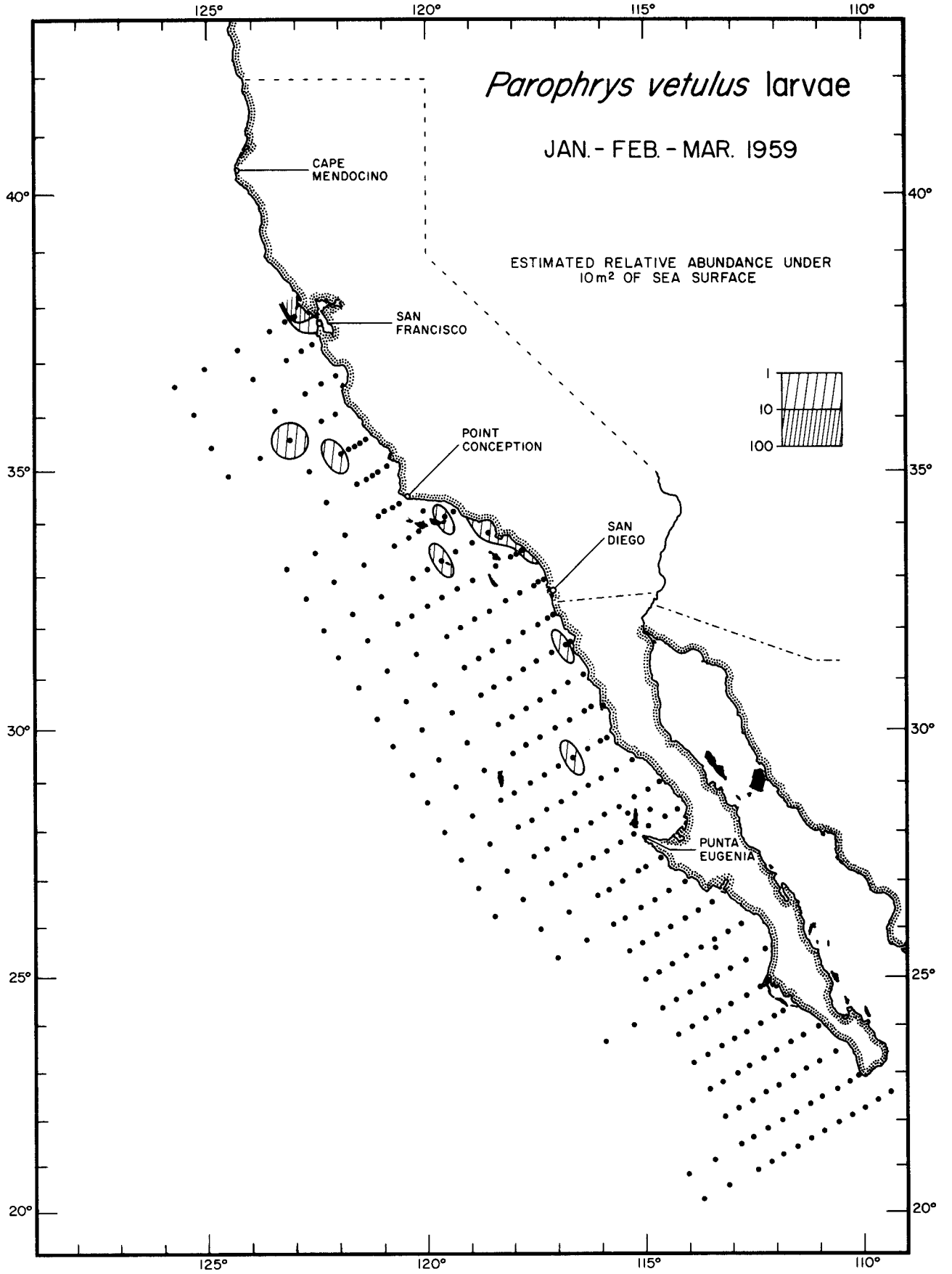
Parophrys vetulus larvae
APR. - MAY - JUN. 1957



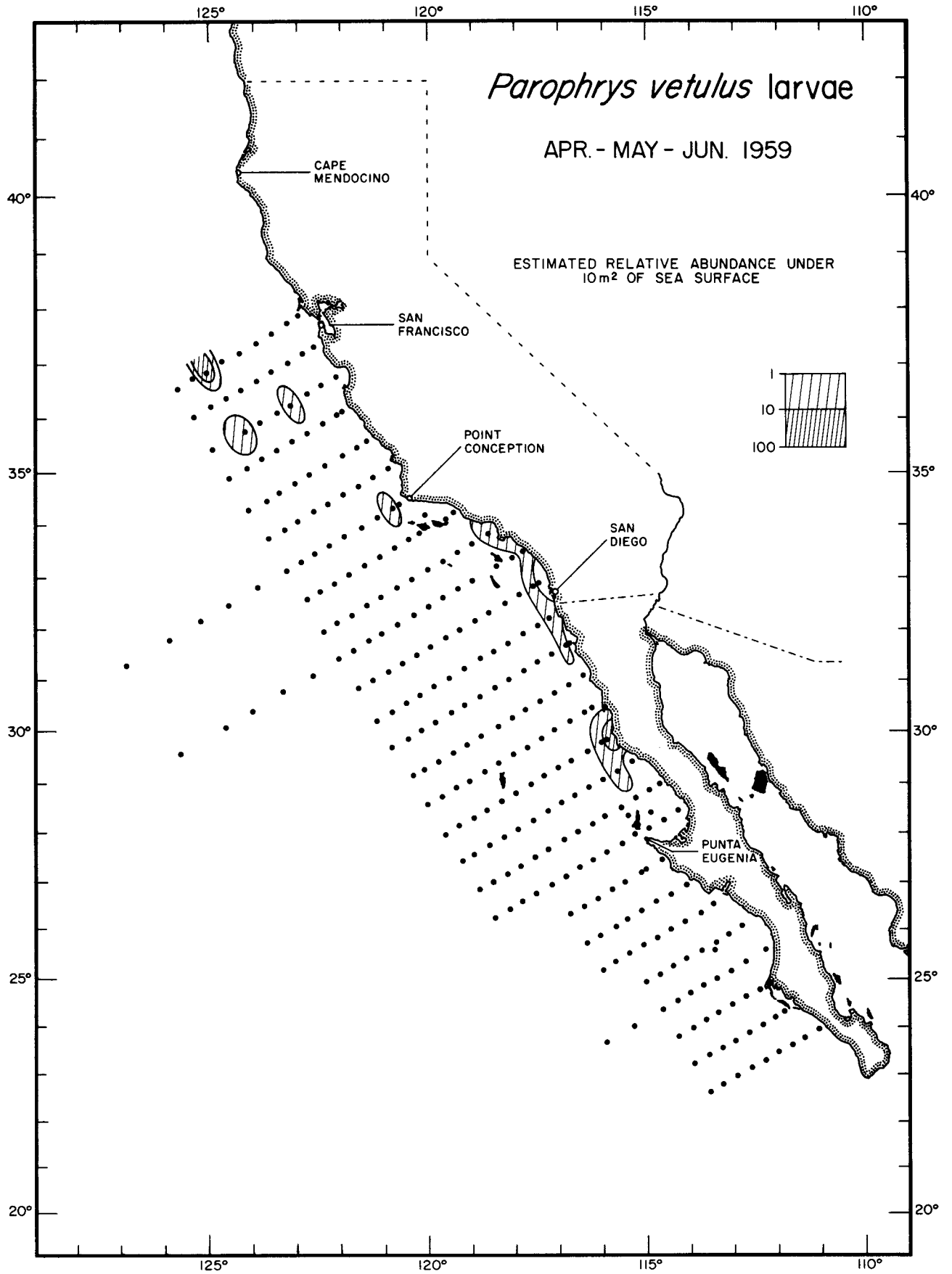
Parophrys vetulus larvae
JAN. - FEB. - MAR. 1958



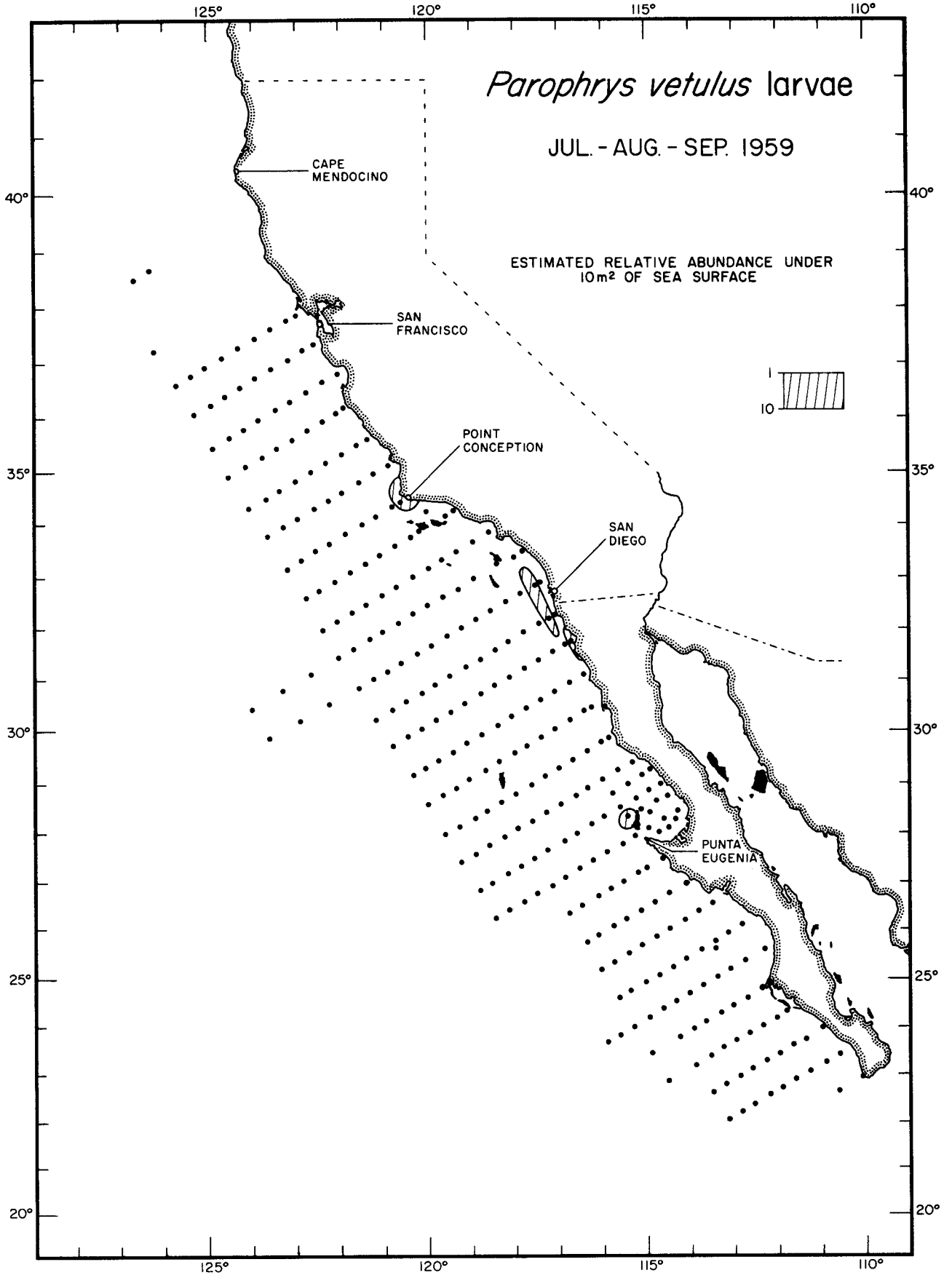
Parophrys vetulus larvae
APR. - MAY - JUN. 1958



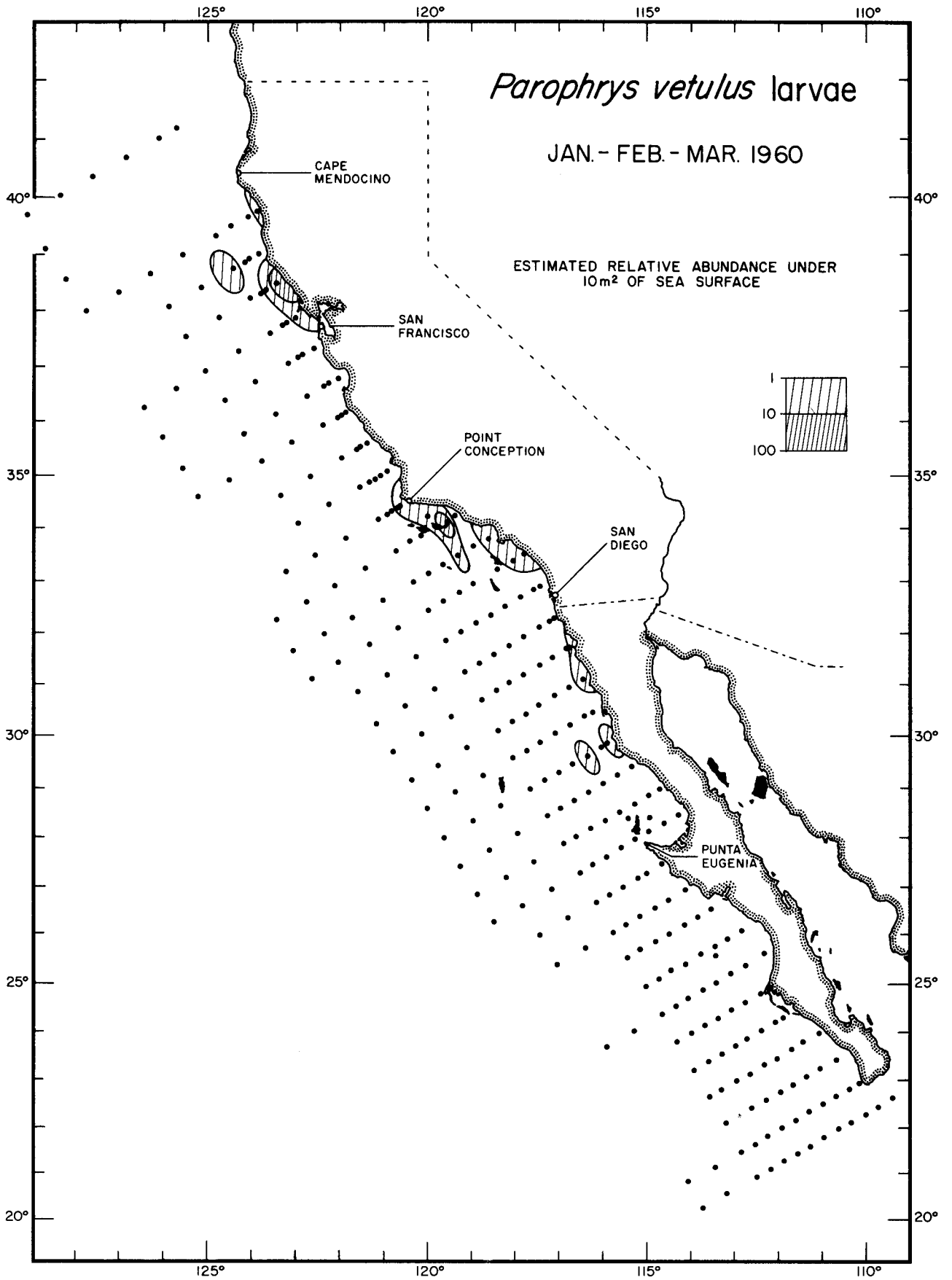
Parophrys vetulus larvae
JAN. - FEB. - MAR. 1959



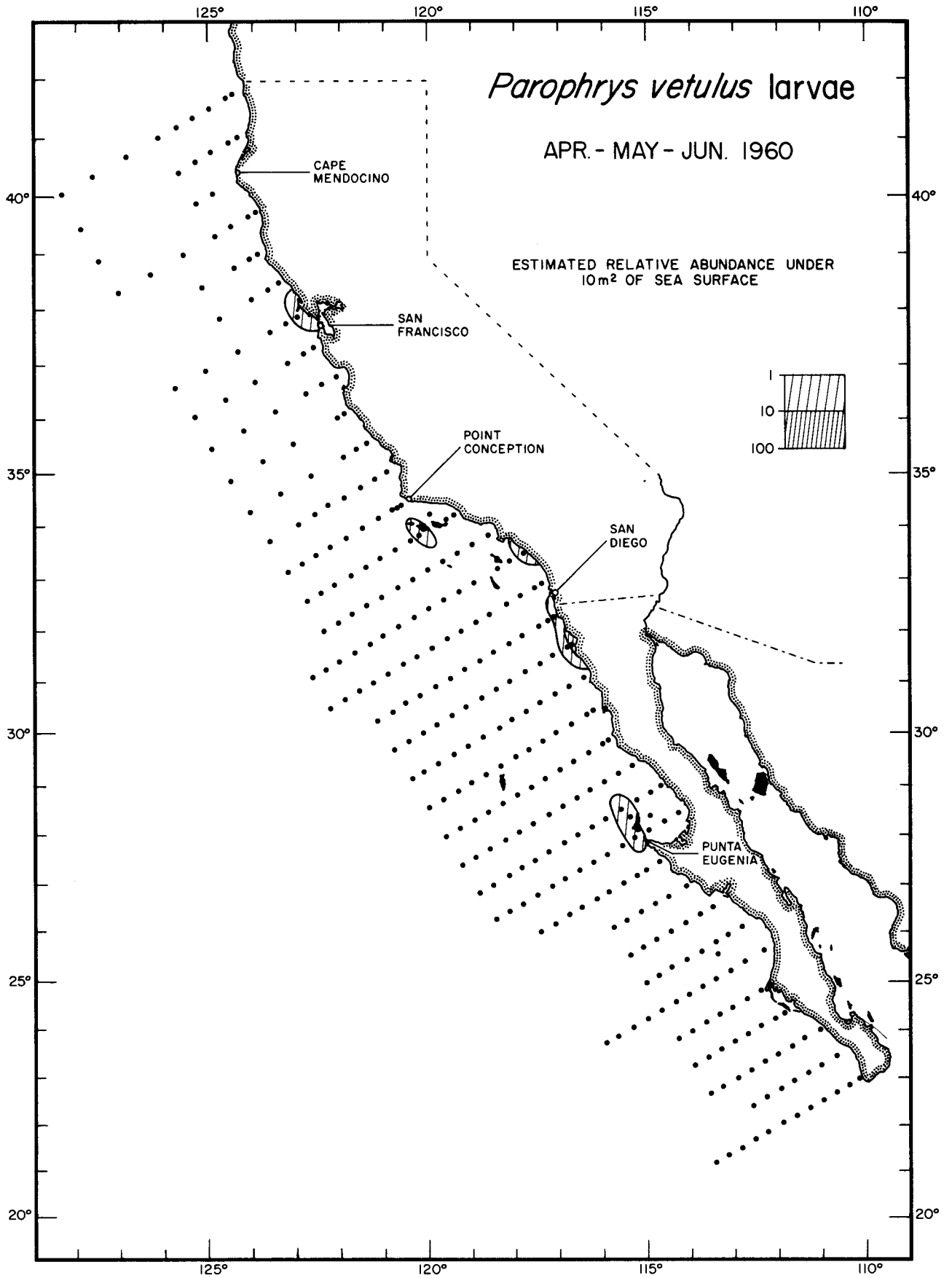
Parophrys vetulus larvae
APR. - MAY - JUN. 1959



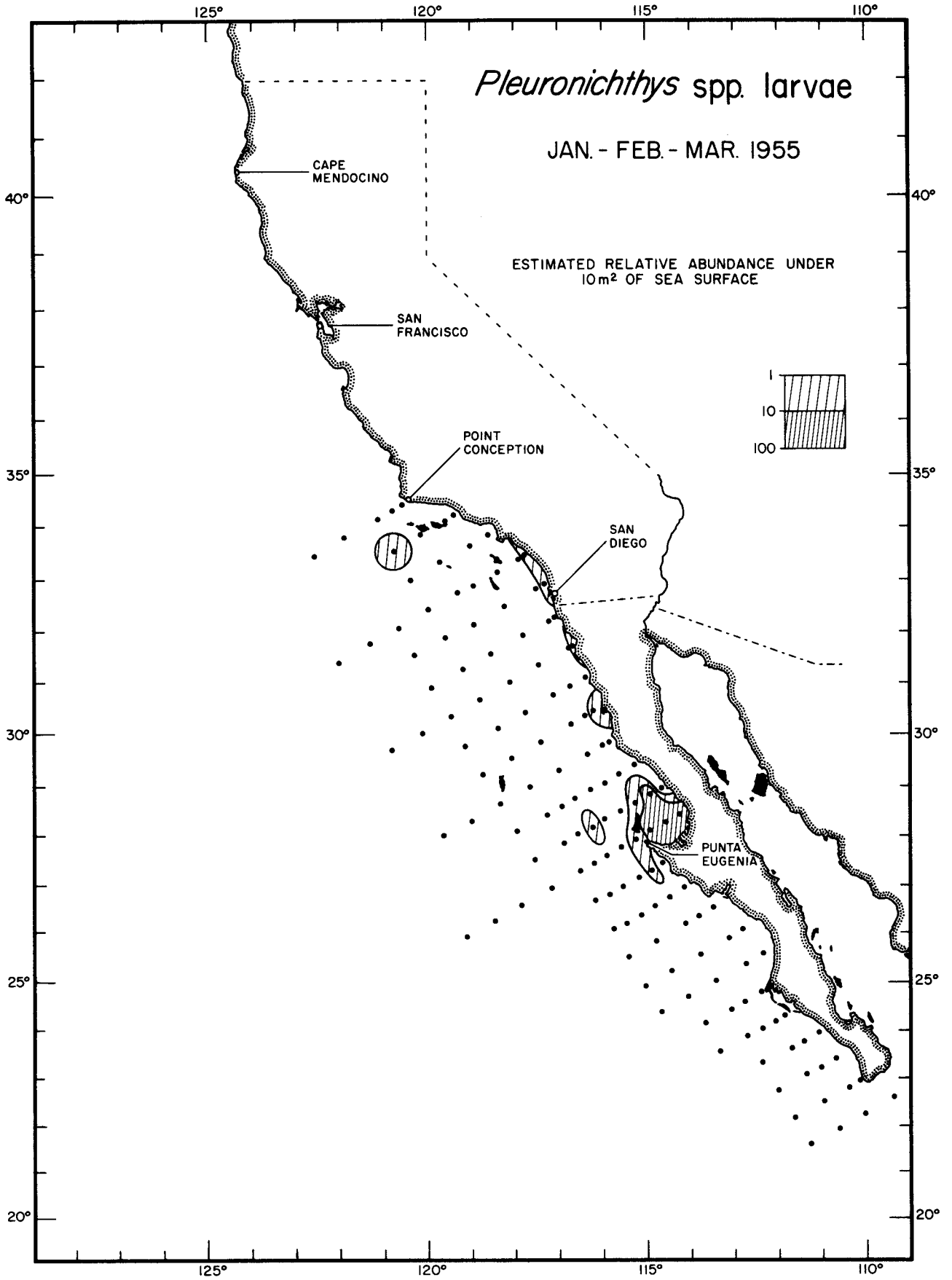
Parophrys vetulus larvae
JUL. - AUG. - SEP. 1959



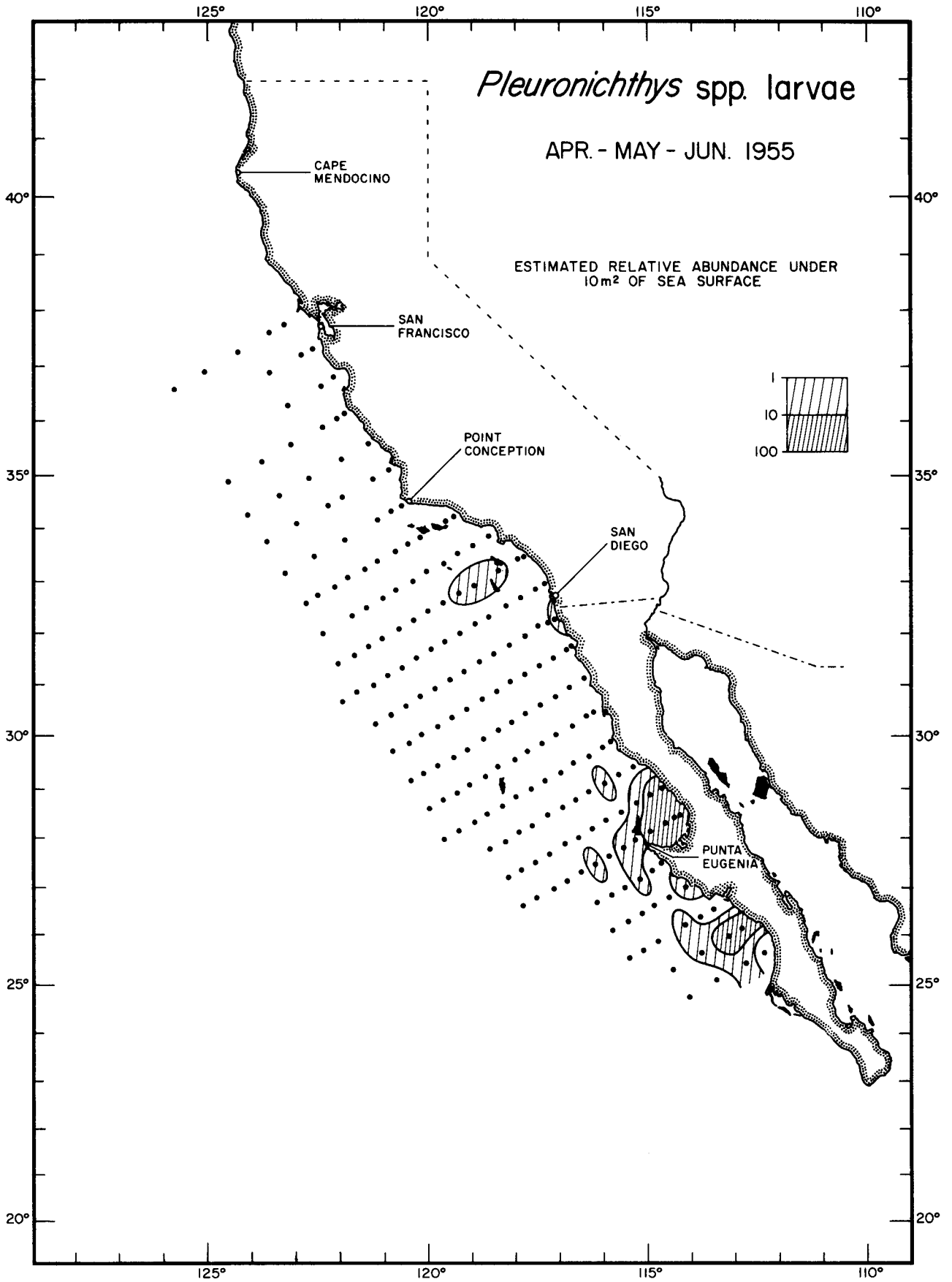
Parophrys vetulus larvae
JAN. - FEB. - MAR. 1960



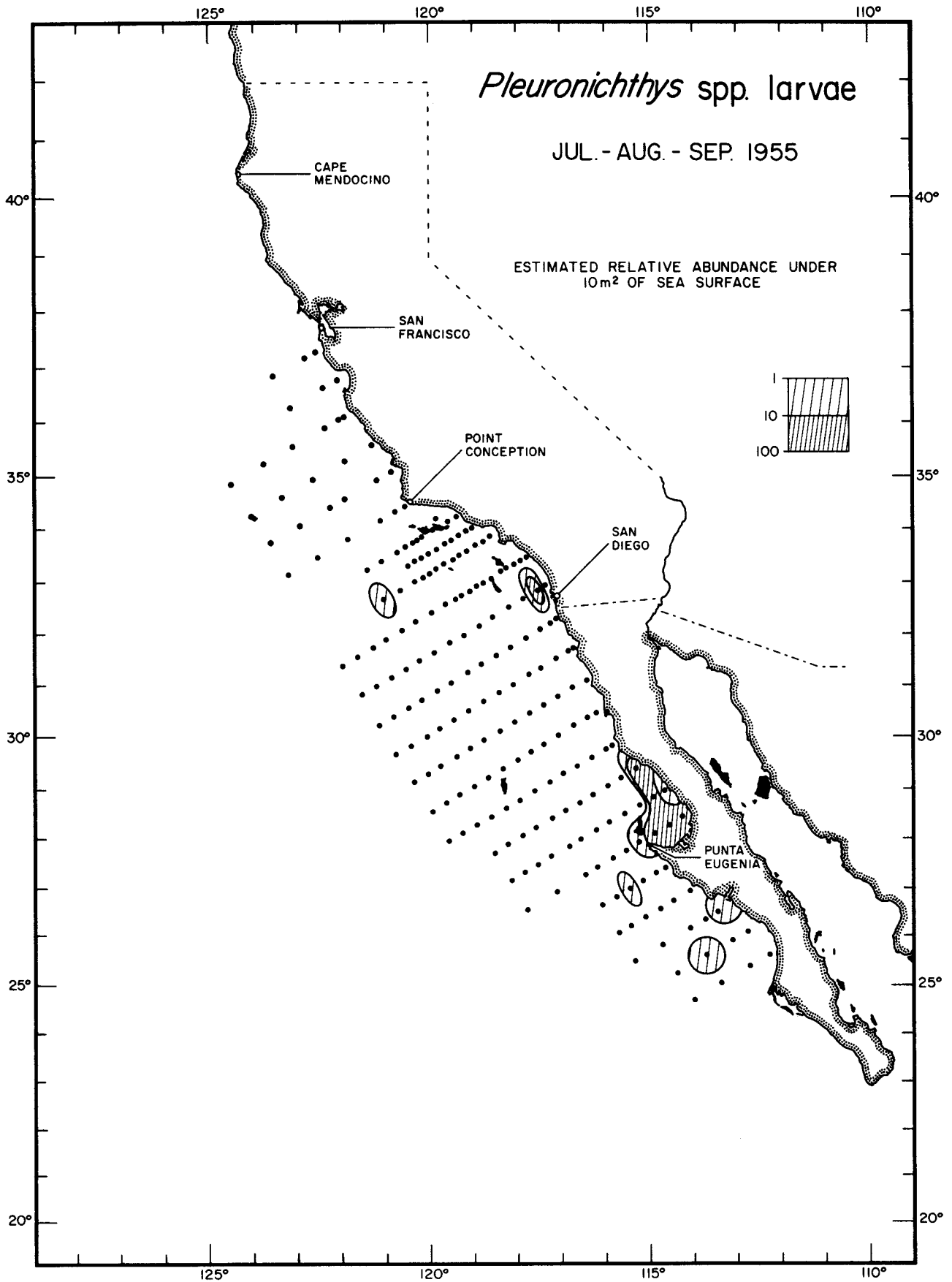
Parophrys vetulus larvae
APR. - MAY - JUN. 1960



Pleuronichthys spp. larvae
JAN. - FEB. - MAR. 1955

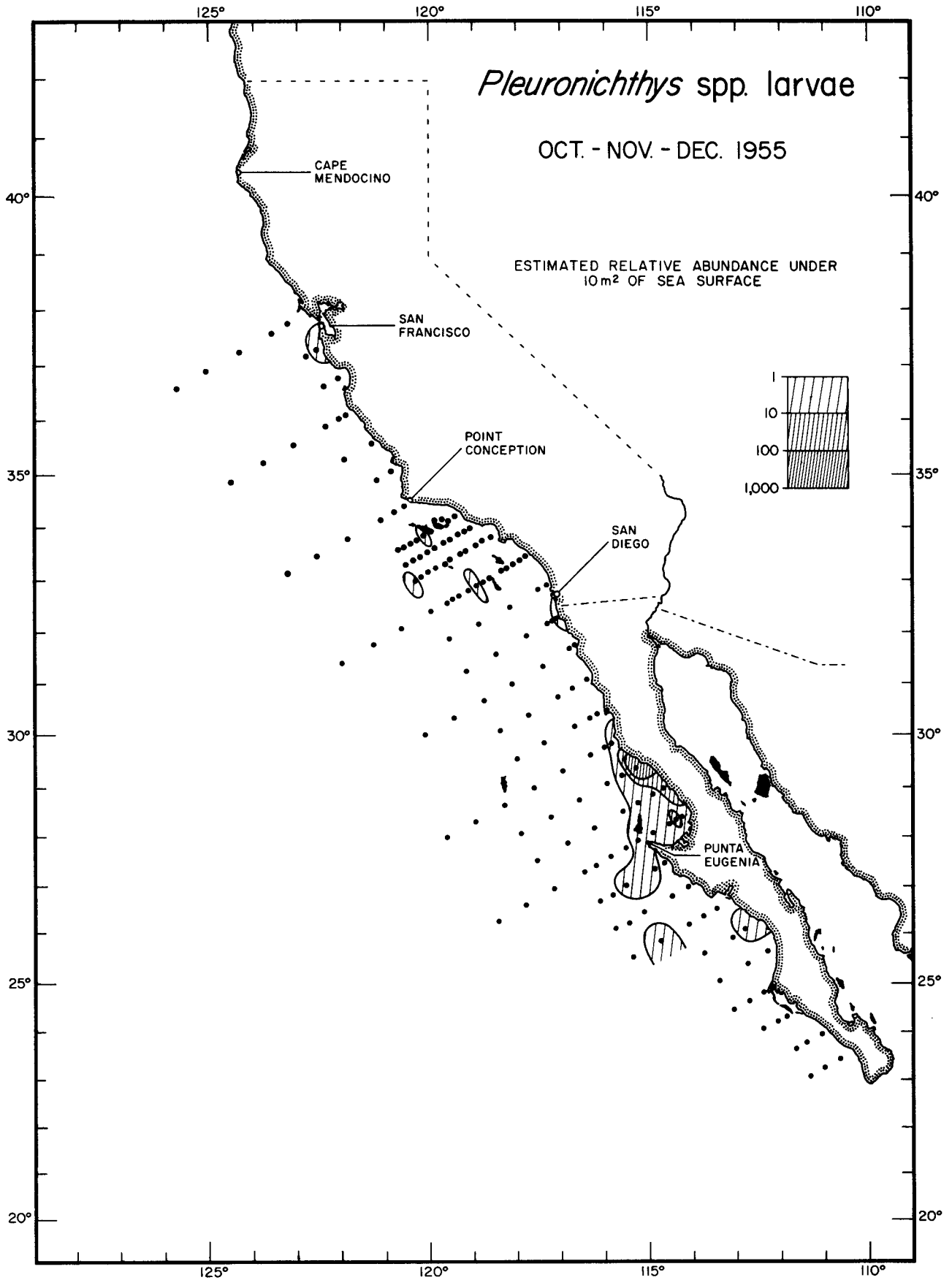


Pleuronichthys spp. larvae
APR. - MAY - JUN. 1955



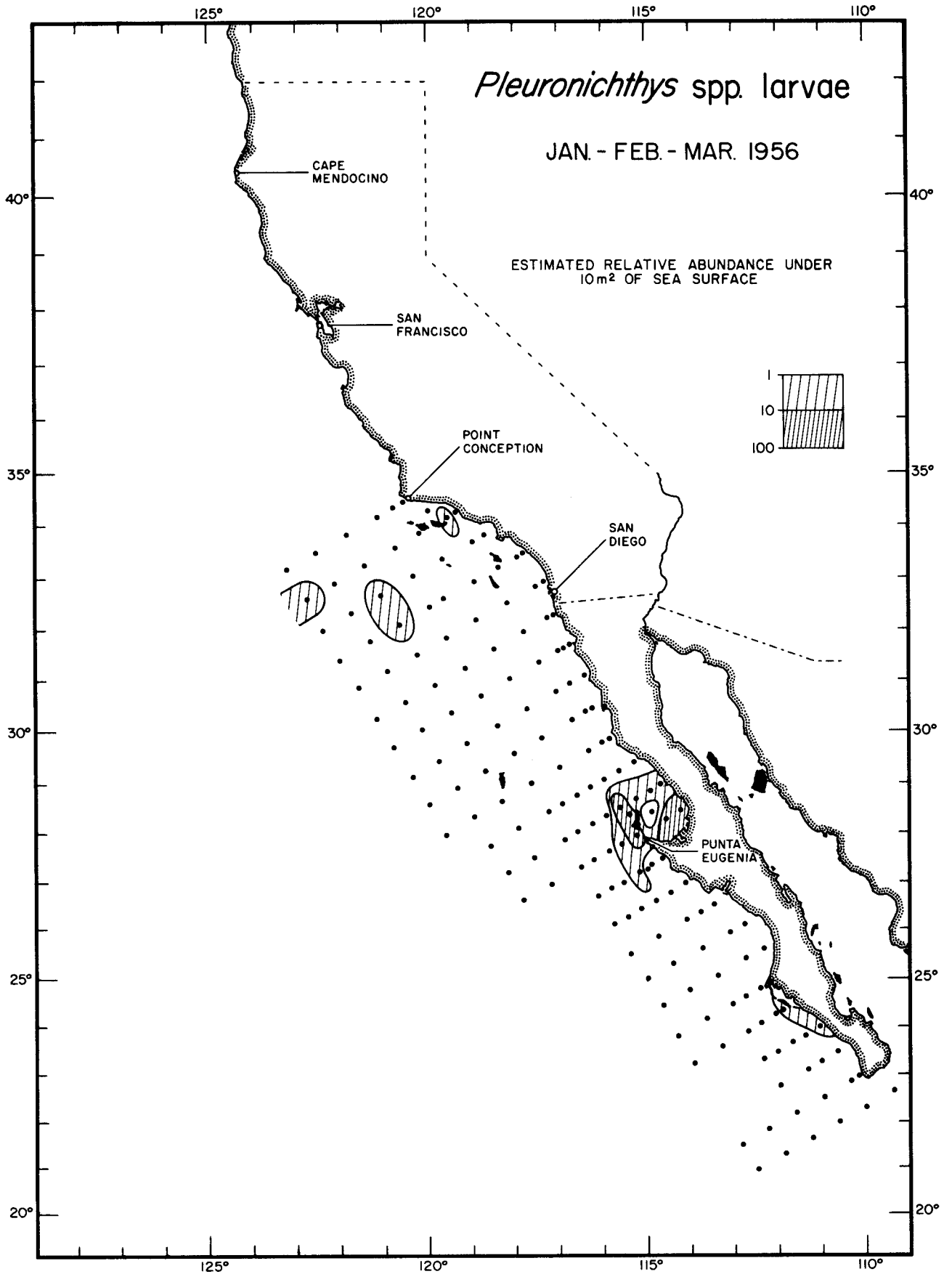
Pleuronichthys spp. larvae

JUL. - AUG. - SEP. 1955



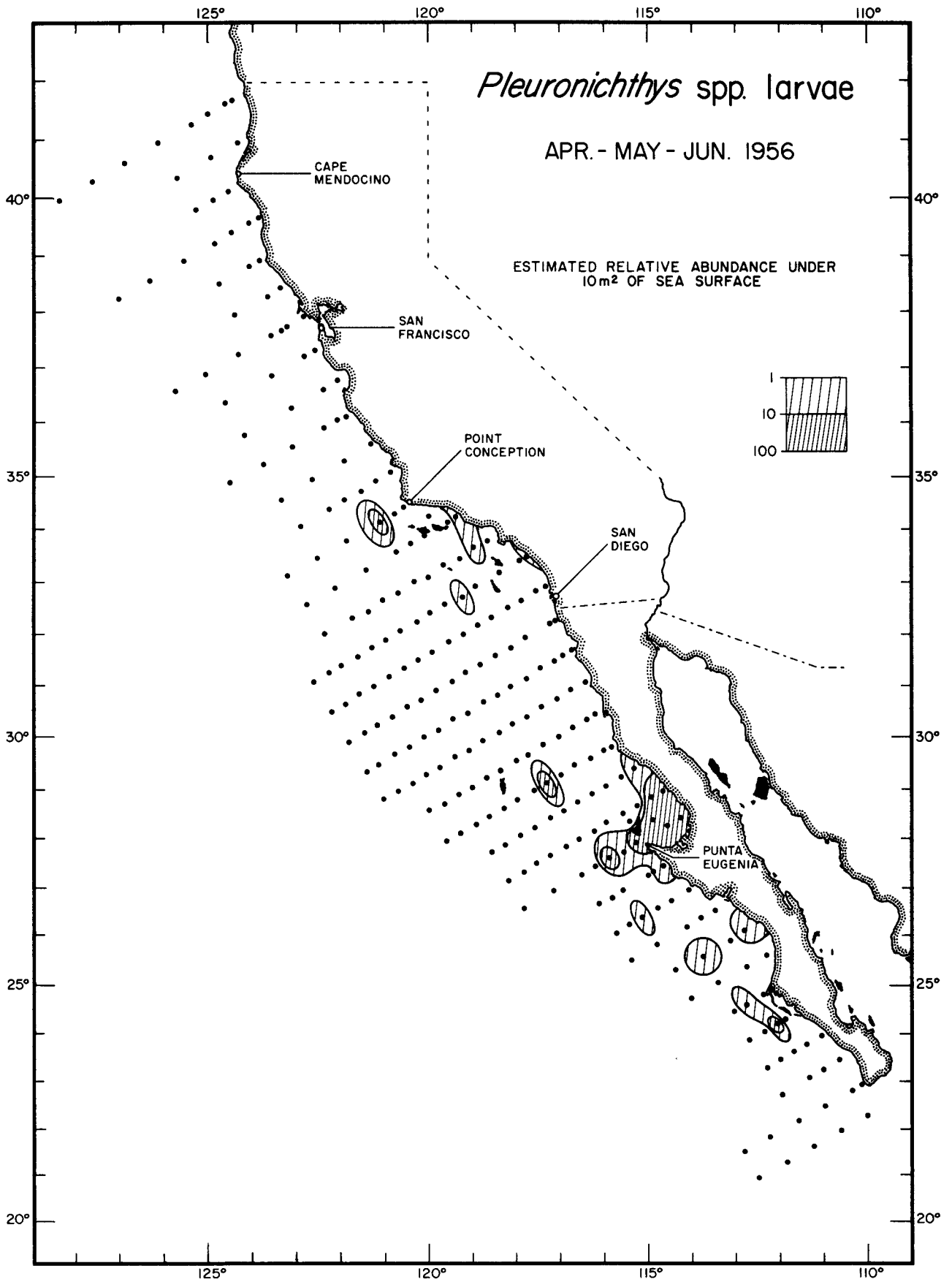
Pleuronichthys spp. larvae

OCT. - NOV. - DEC. 1955



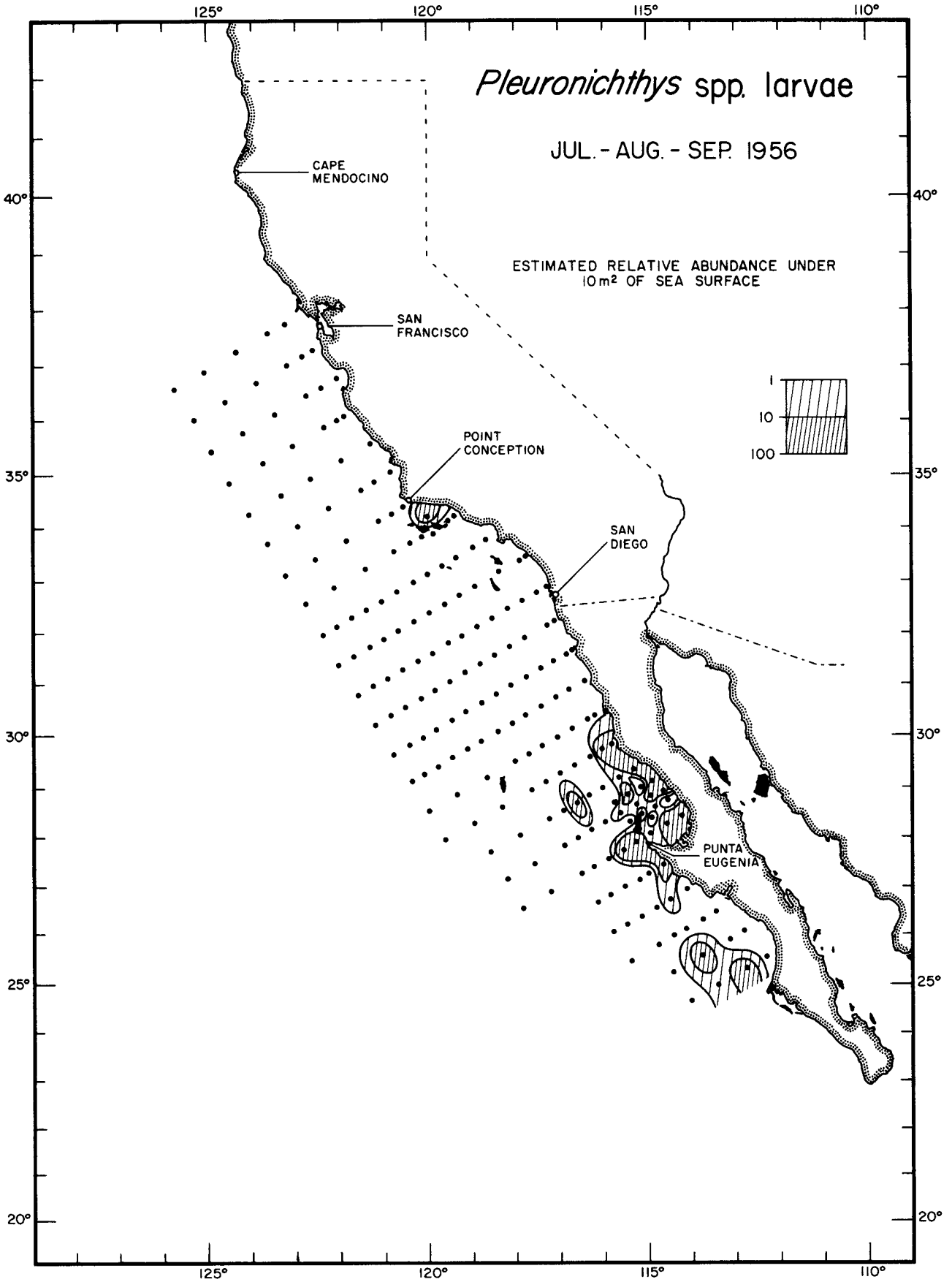
Pleuronichthys spp. larvae

JAN. - FEB. - MAR. 1956



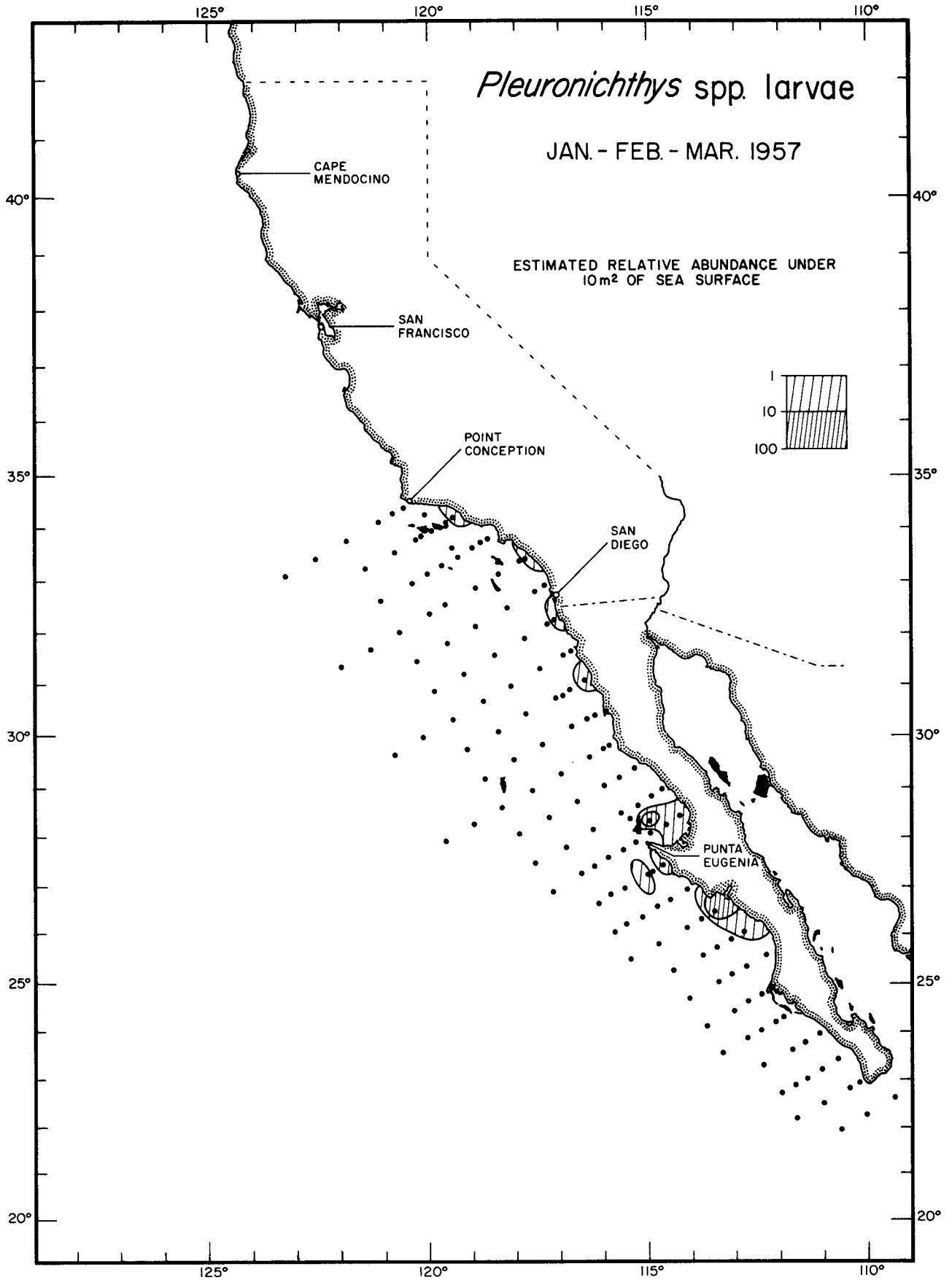
Pleuronichthys spp. larvae

APR. - MAY - JUN. 1956

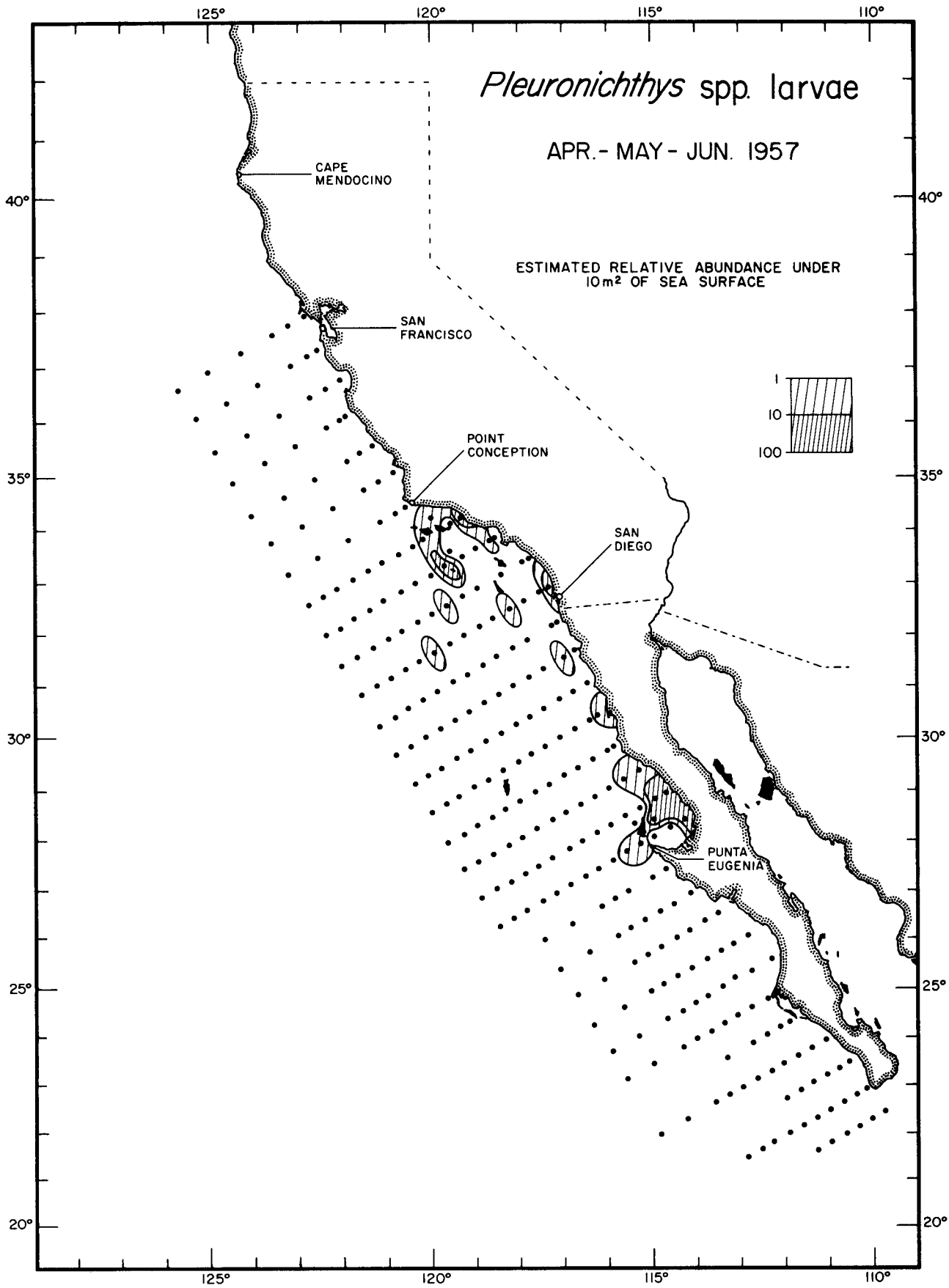


Pleuronichthys spp. larvae

JUL. - AUG. - SEP. 1956

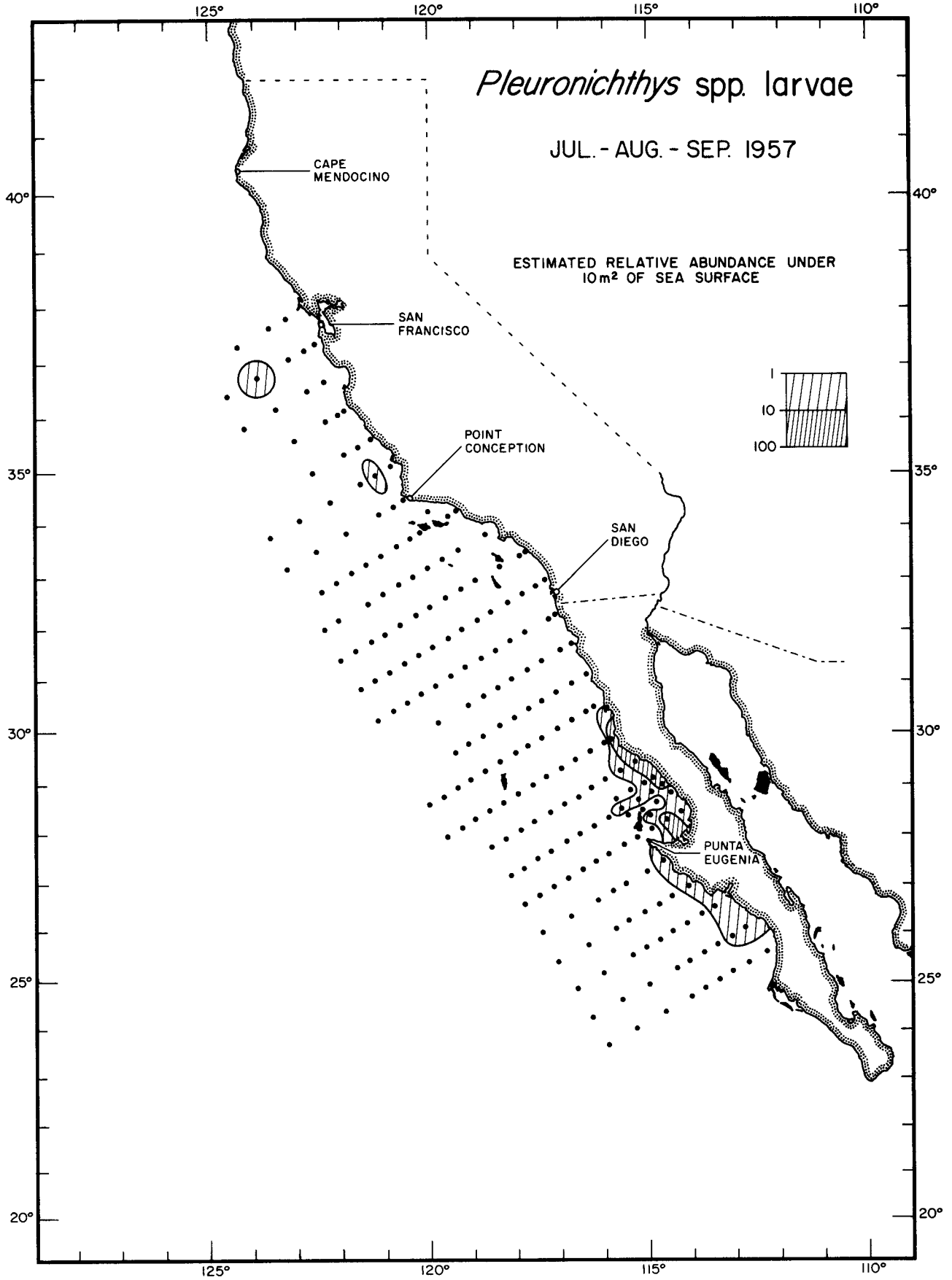


Pleuronichthys spp. larvae
JAN. - FEB. - MAR. 1957



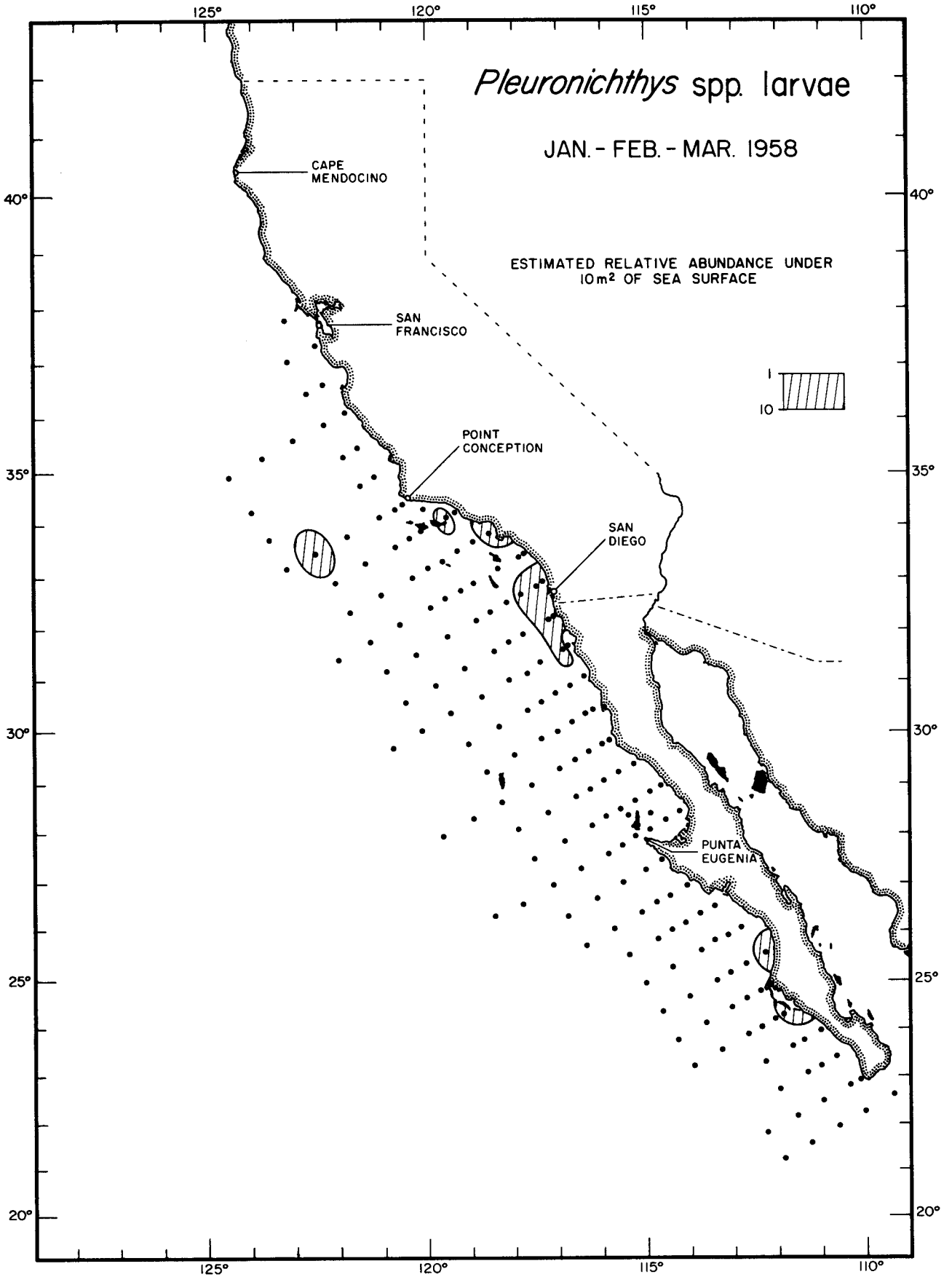
Pleuronichthys spp. larvae

APR. - MAY - JUN. 1957

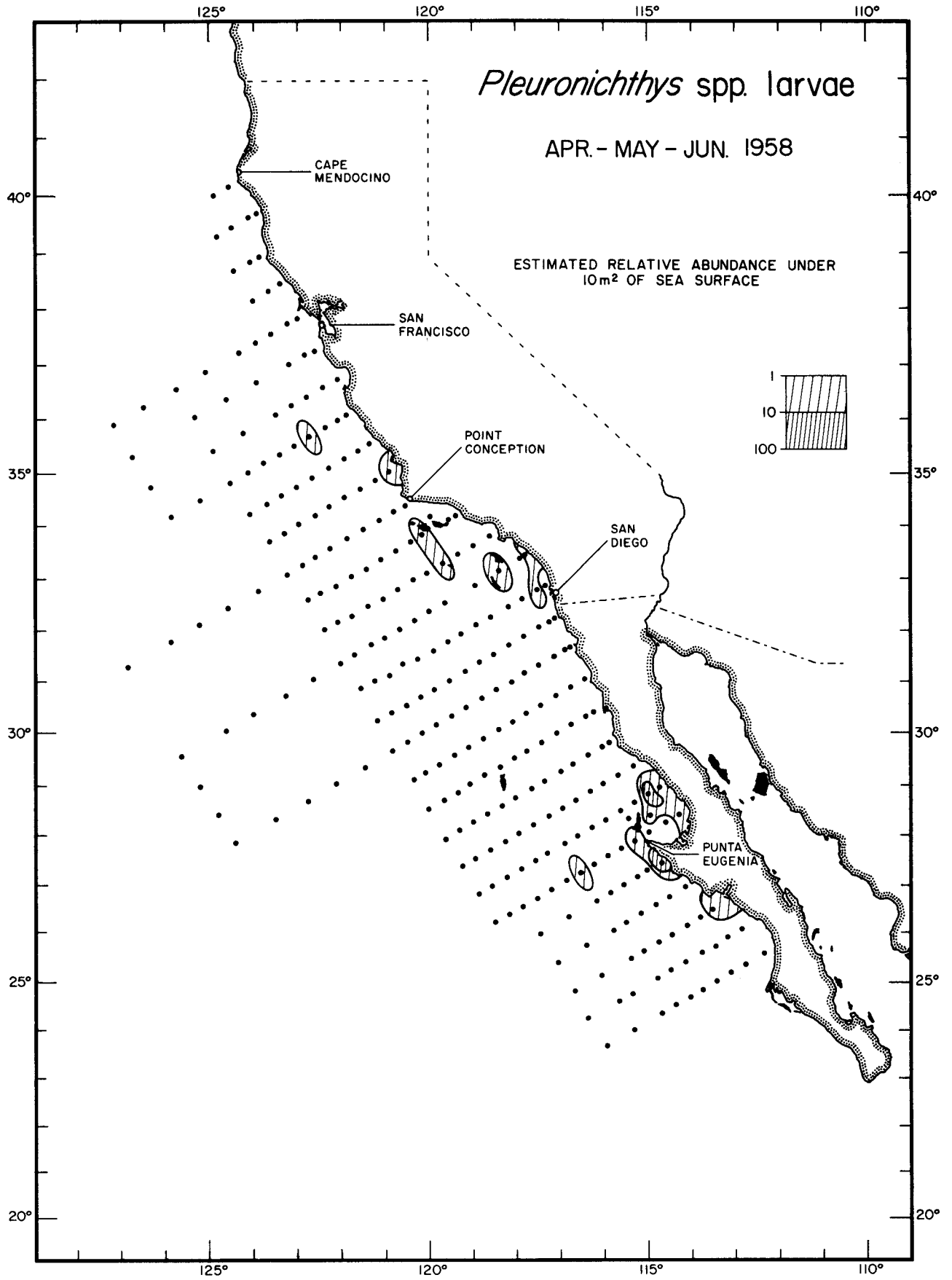


Pleuronichthys spp. larvae

JUL. - AUG. - SEP. 1957



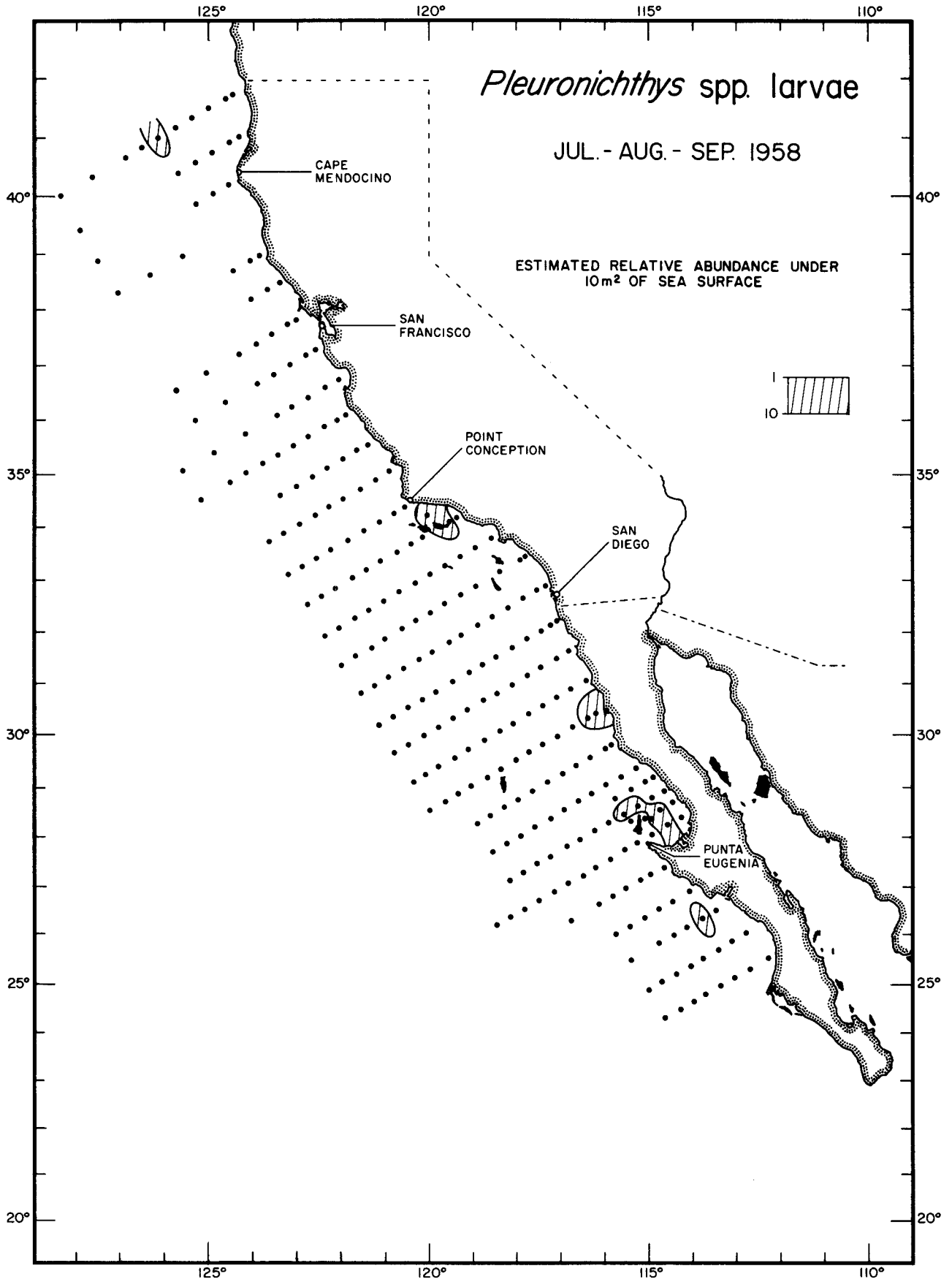
Pleuronichthys spp. larvae
JAN. - FEB. - MAR. 1958



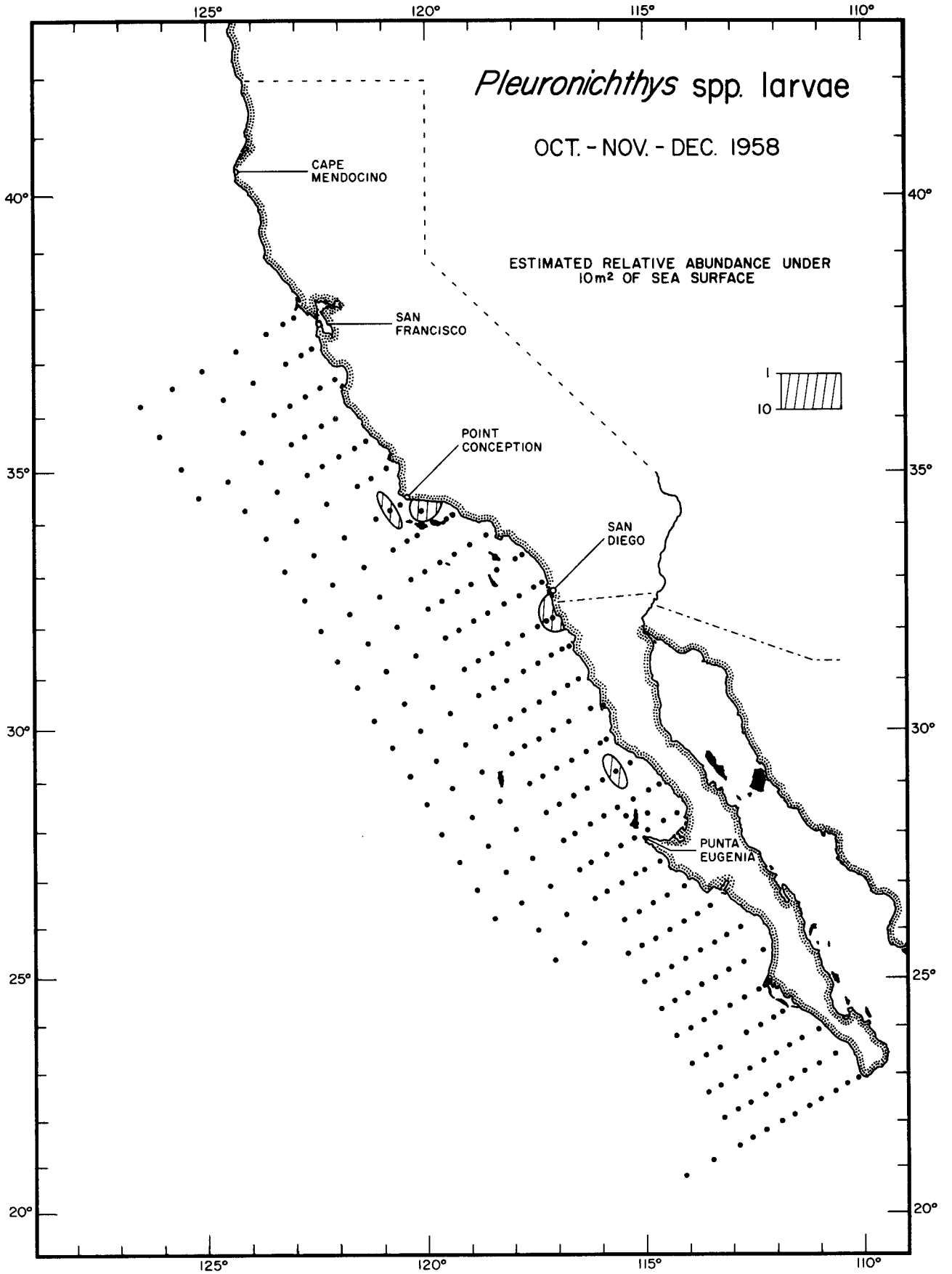
Pleuronichthys spp. larvae

APR. - MAY - JUN. 1958

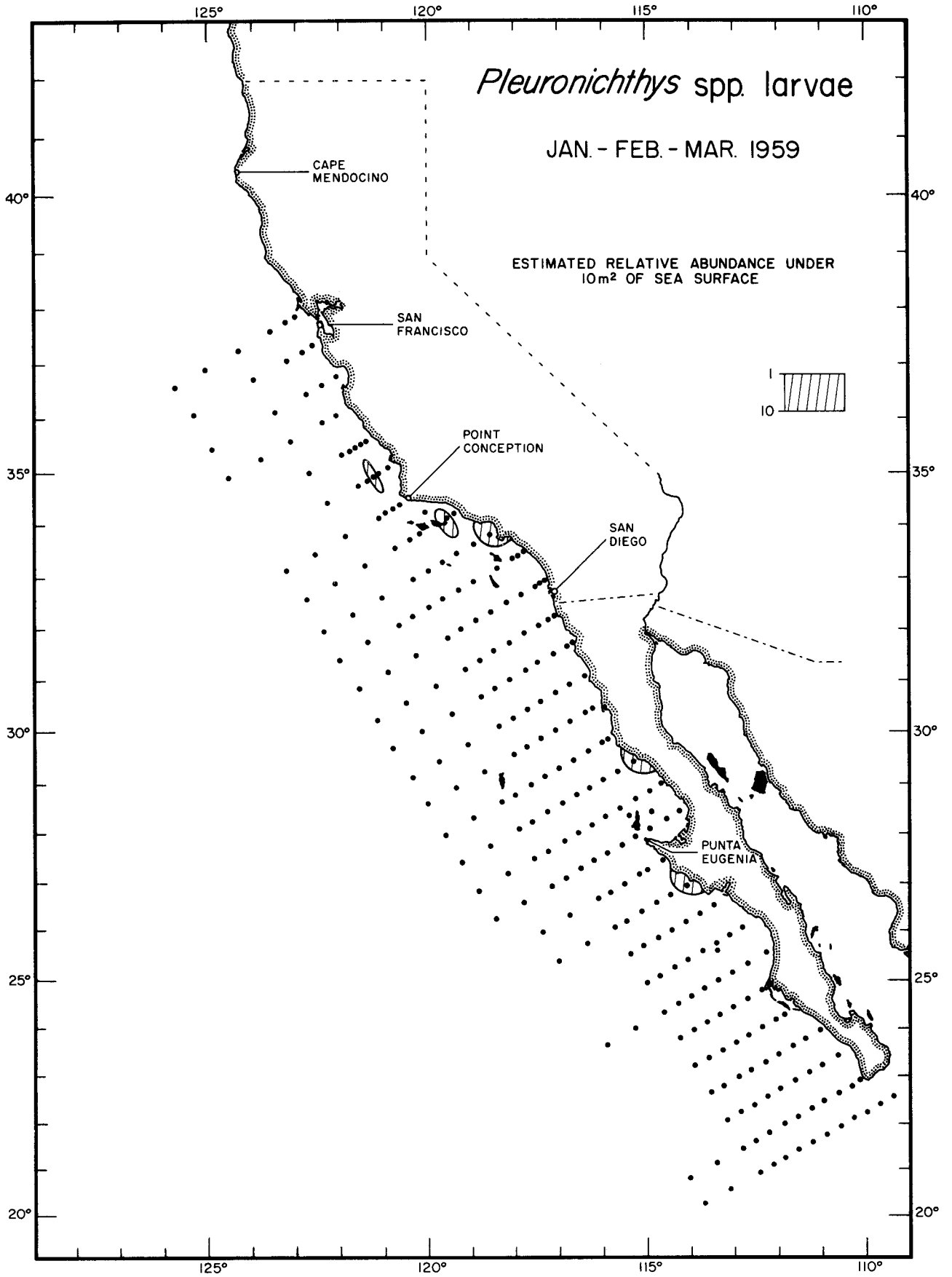




Pleuronichthys spp. larvae
JUL. - AUG. - SEP. 1958

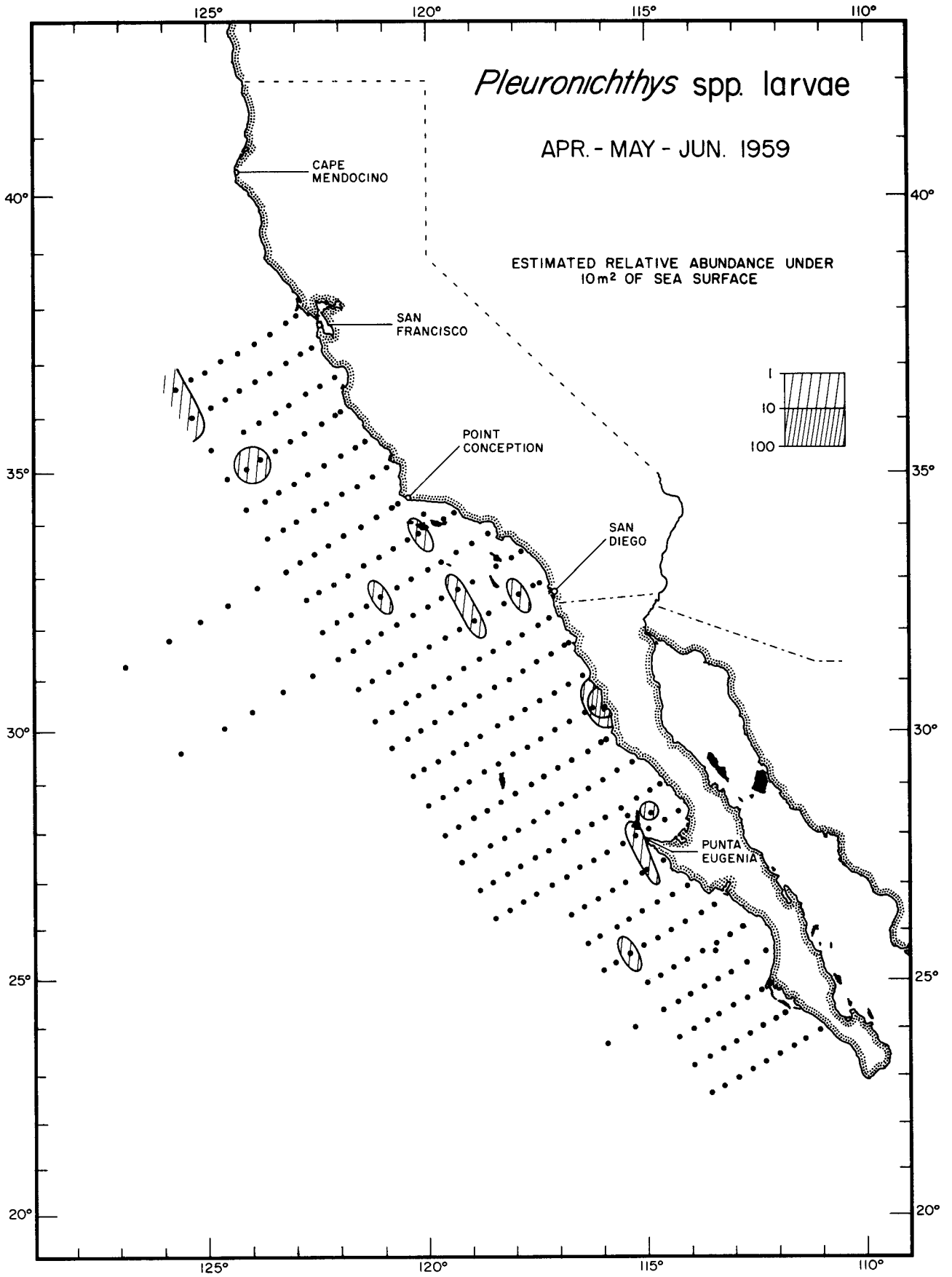


Pleuronichthys spp. larvae
OCT. - NOV. - DEC. 1958



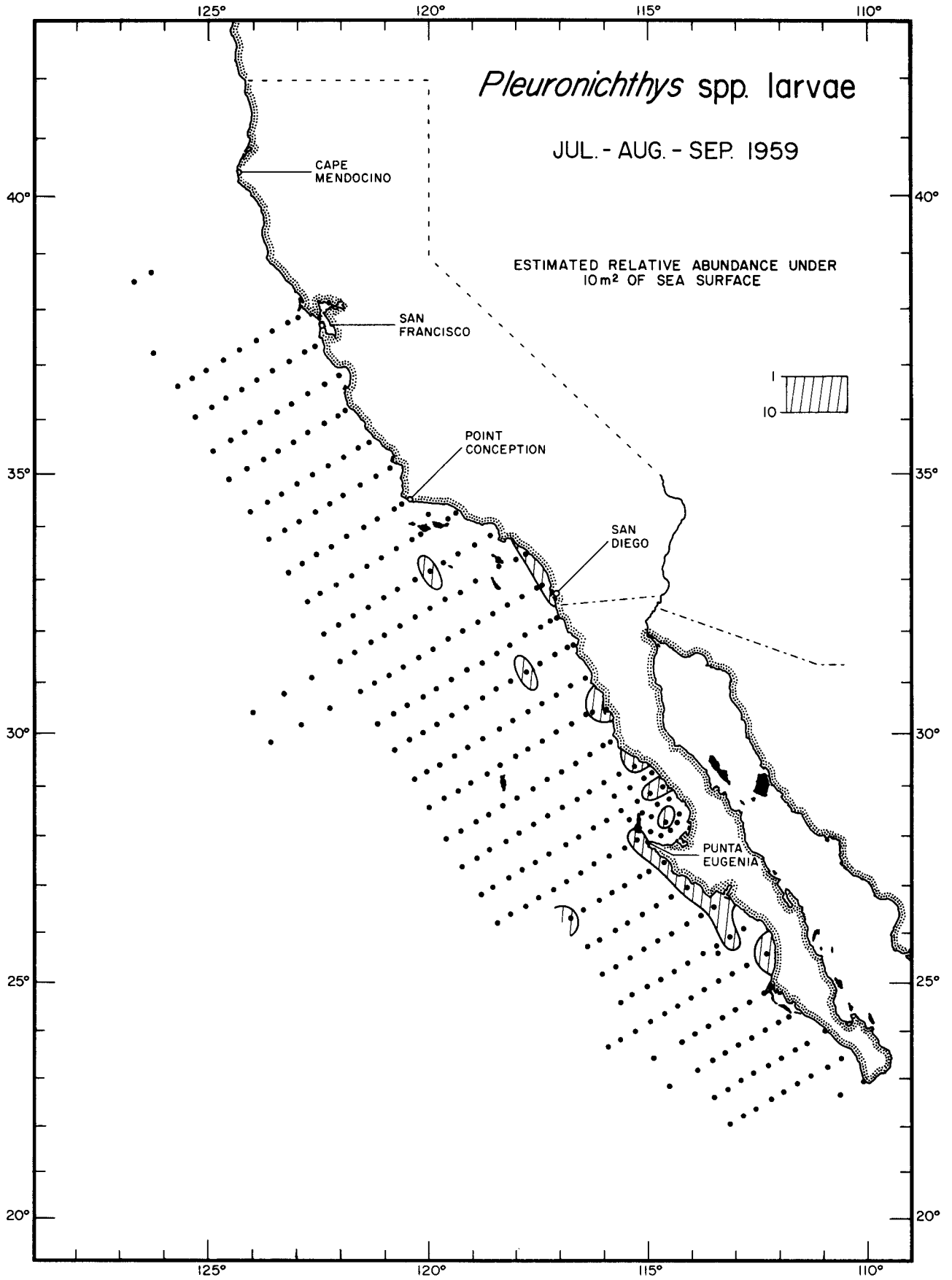
Pleuronichthys spp. larvae

JAN. - FEB. - MAR. 1959



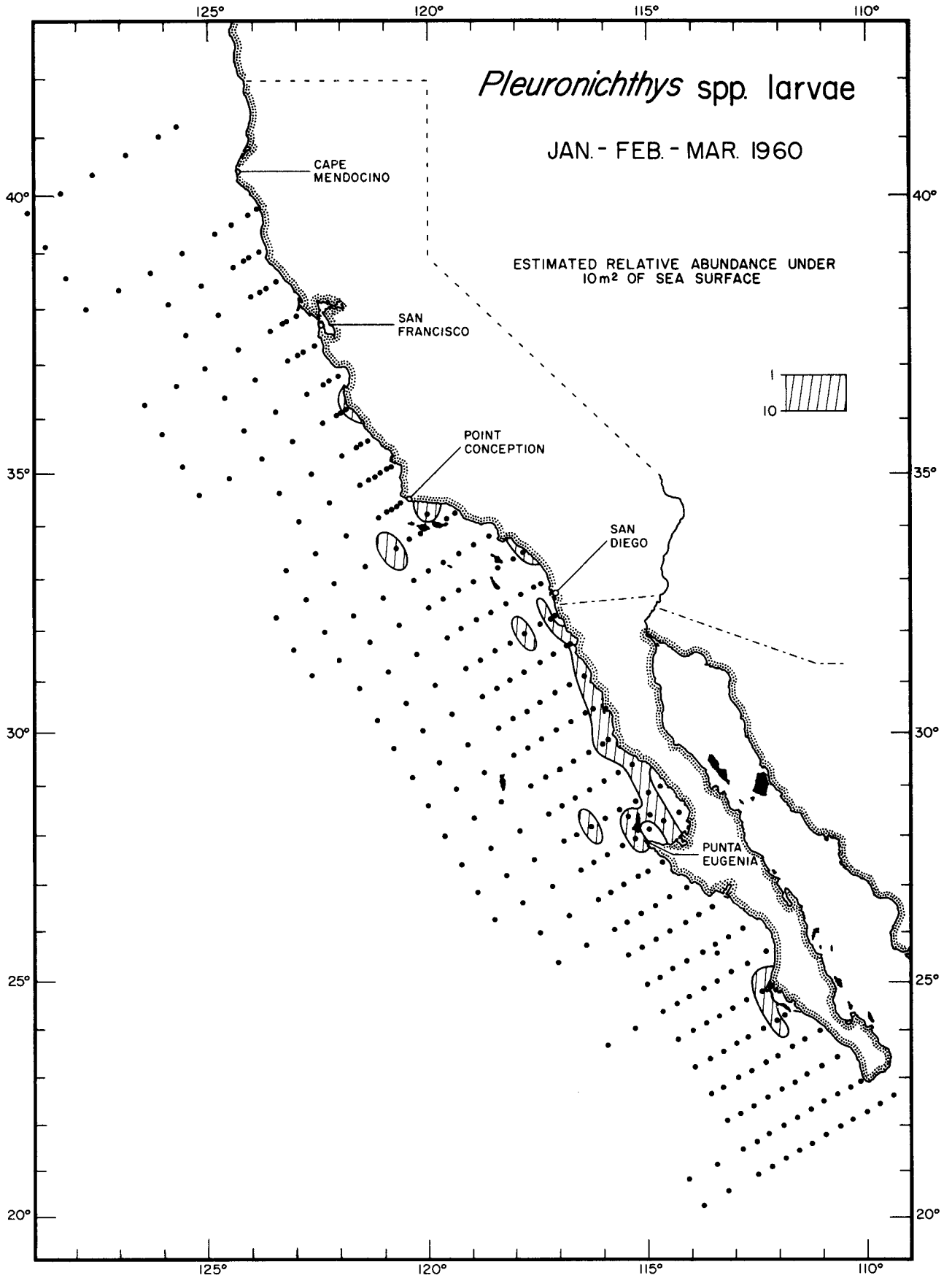
Pleuronichthys spp. larvae

APR. - MAY - JUN. 1959



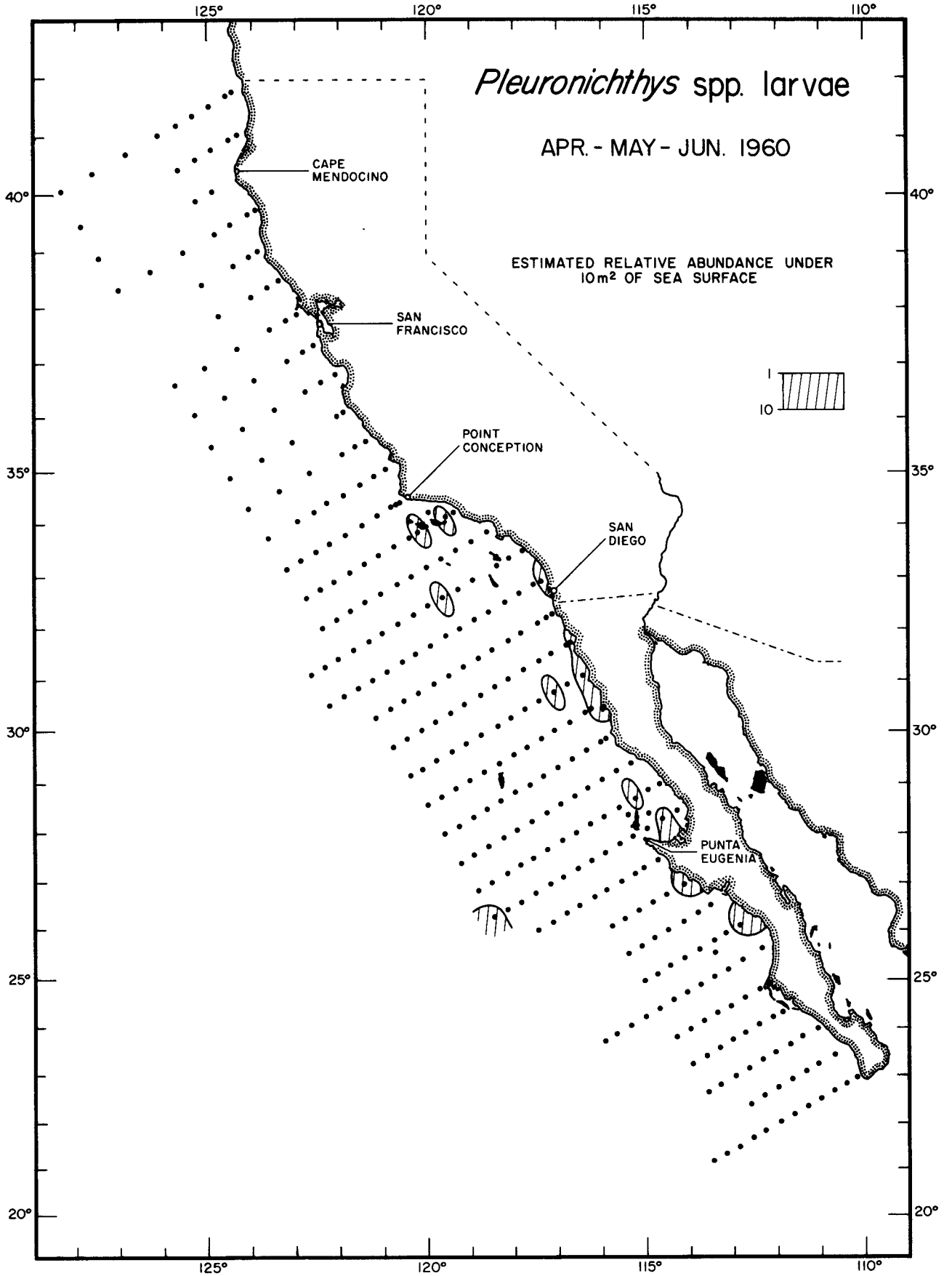
Pleuronichthys spp. larvae

JUL. - AUG. - SEP. 1959

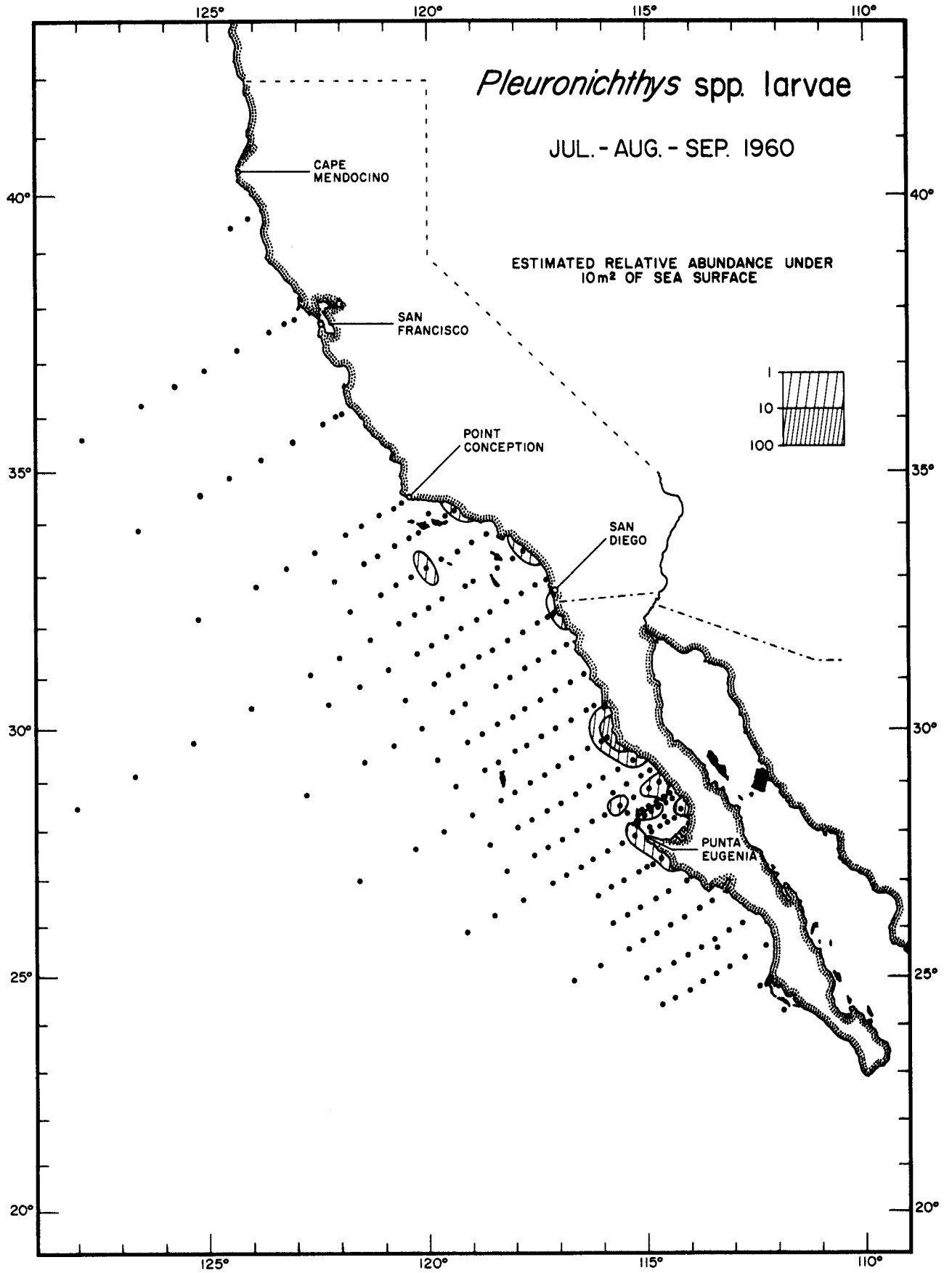


Pleuronichthys spp. larvae

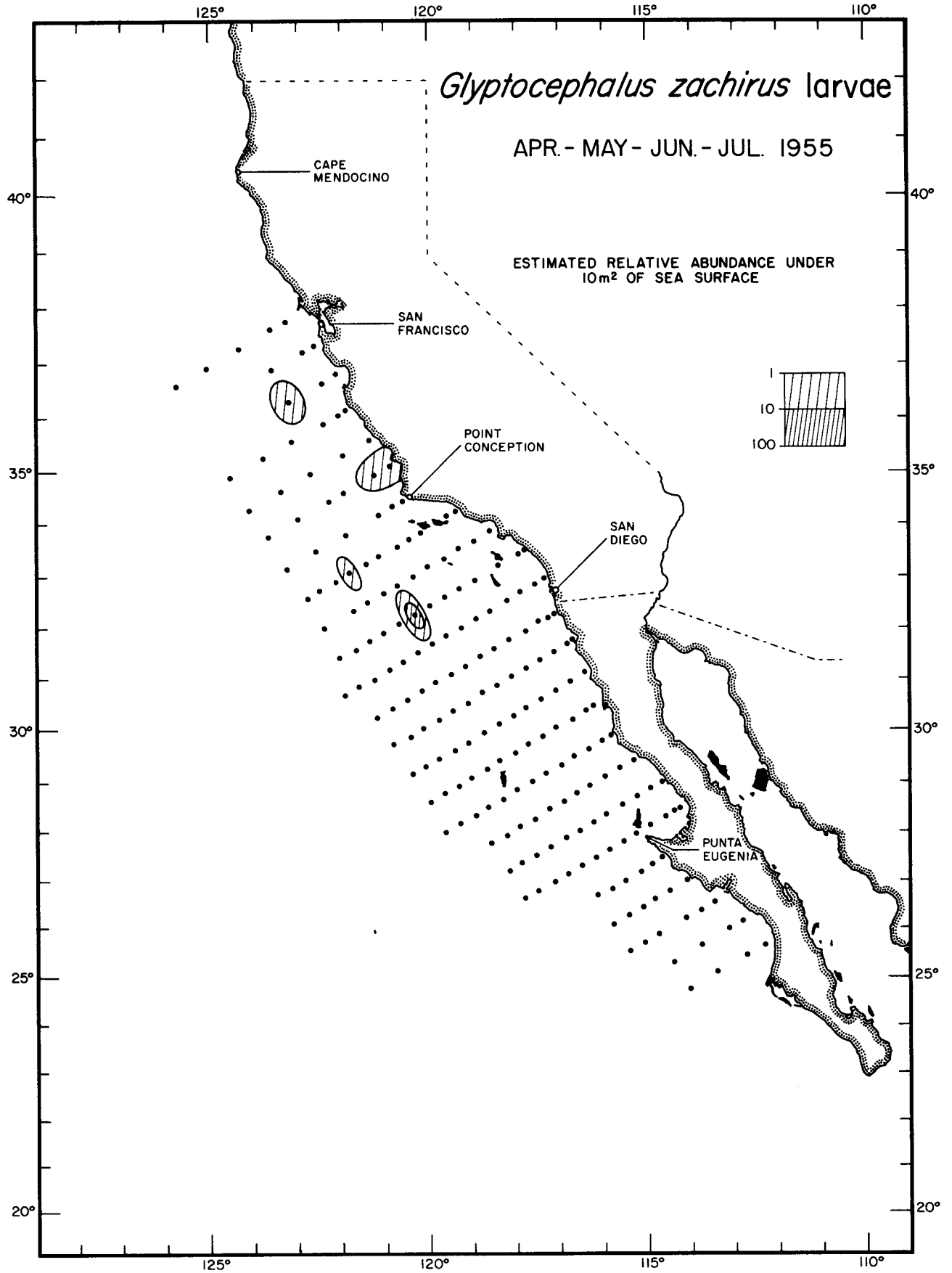
JAN. - FEB. - MAR. 1960



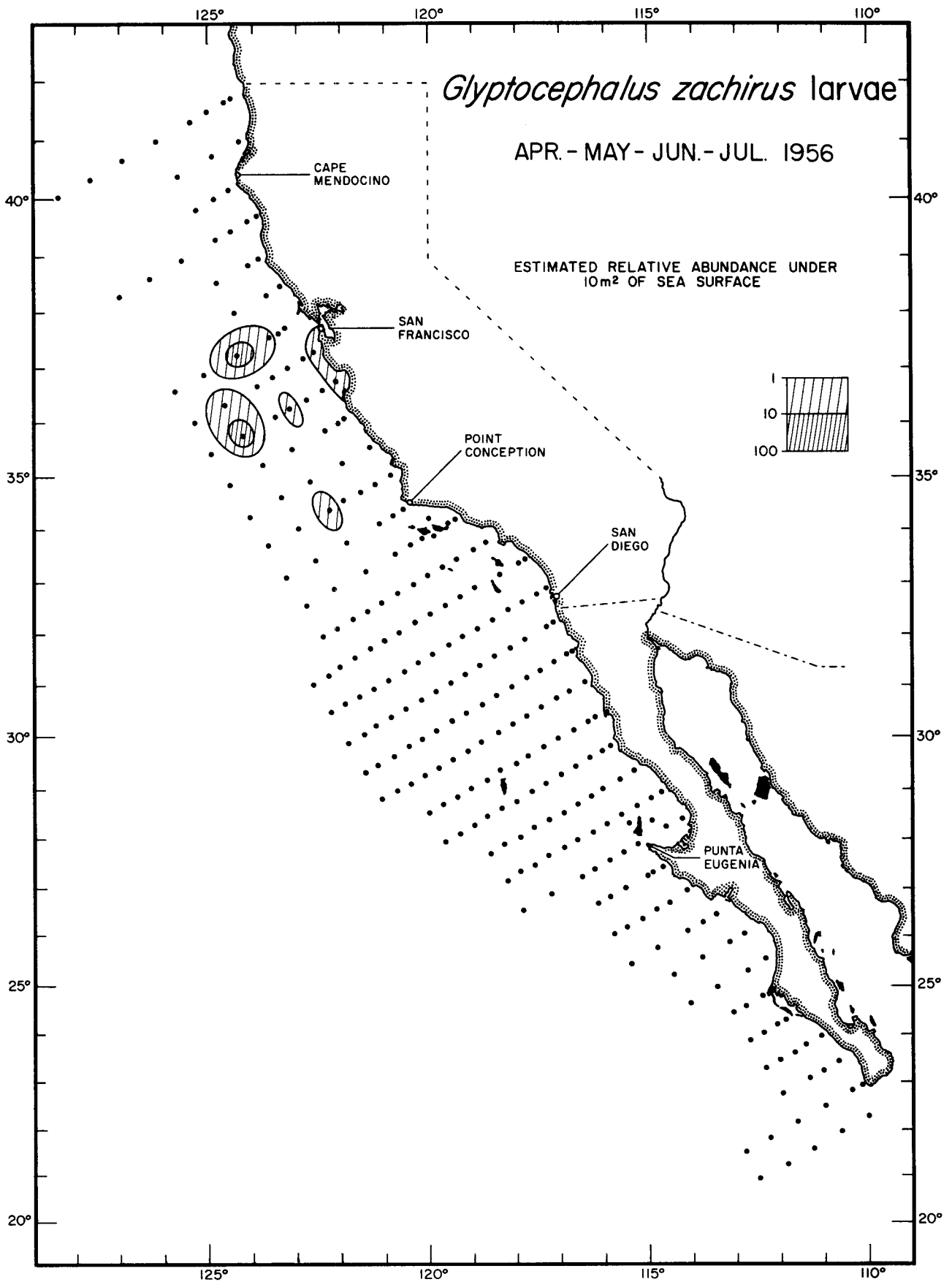
Pleuronichthys spp. larvae
APR. - MAY - JUN. 1960



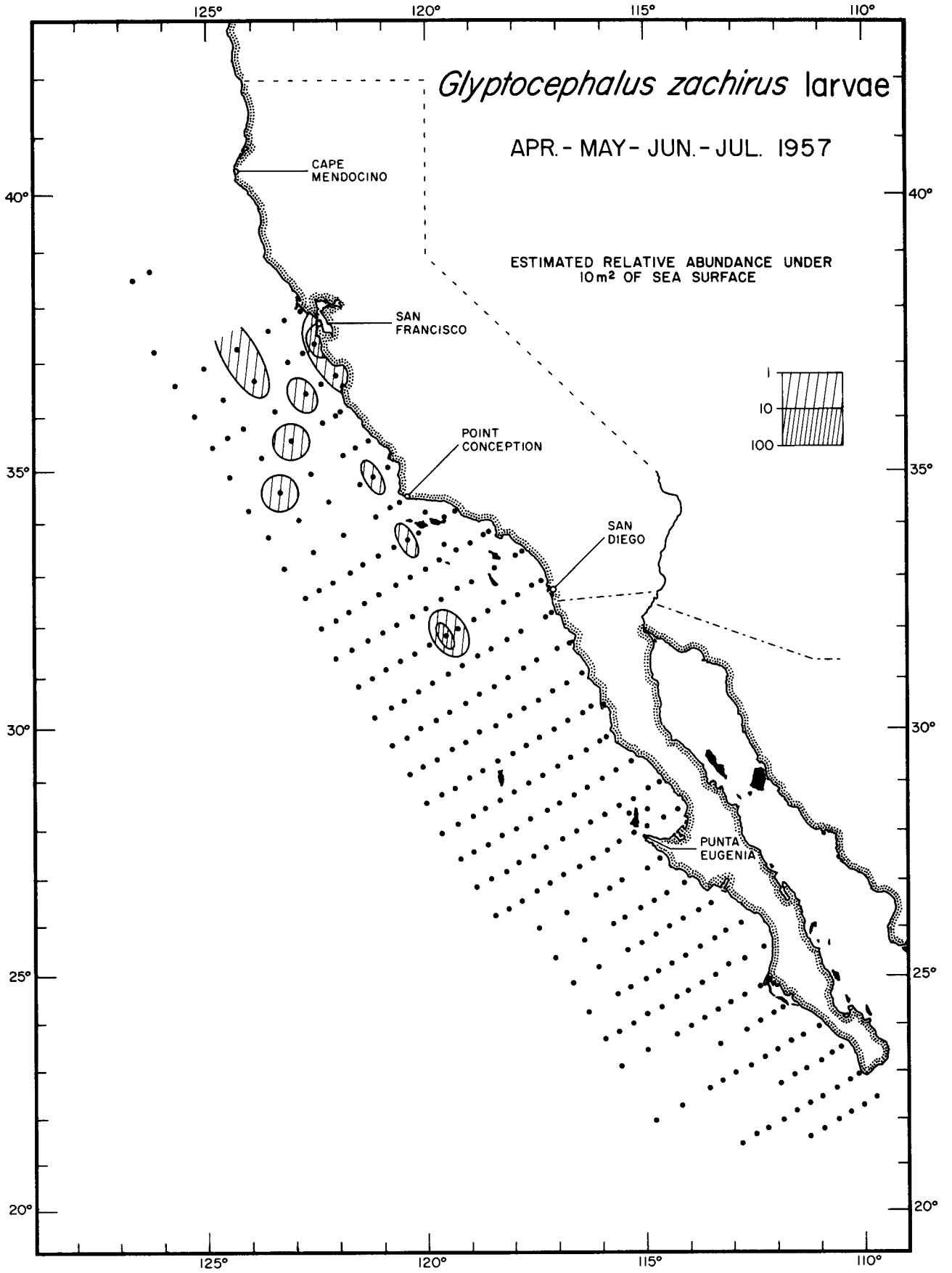
Pleuronichthys spp. larvae
JUL. - AUG. - SEP. 1960



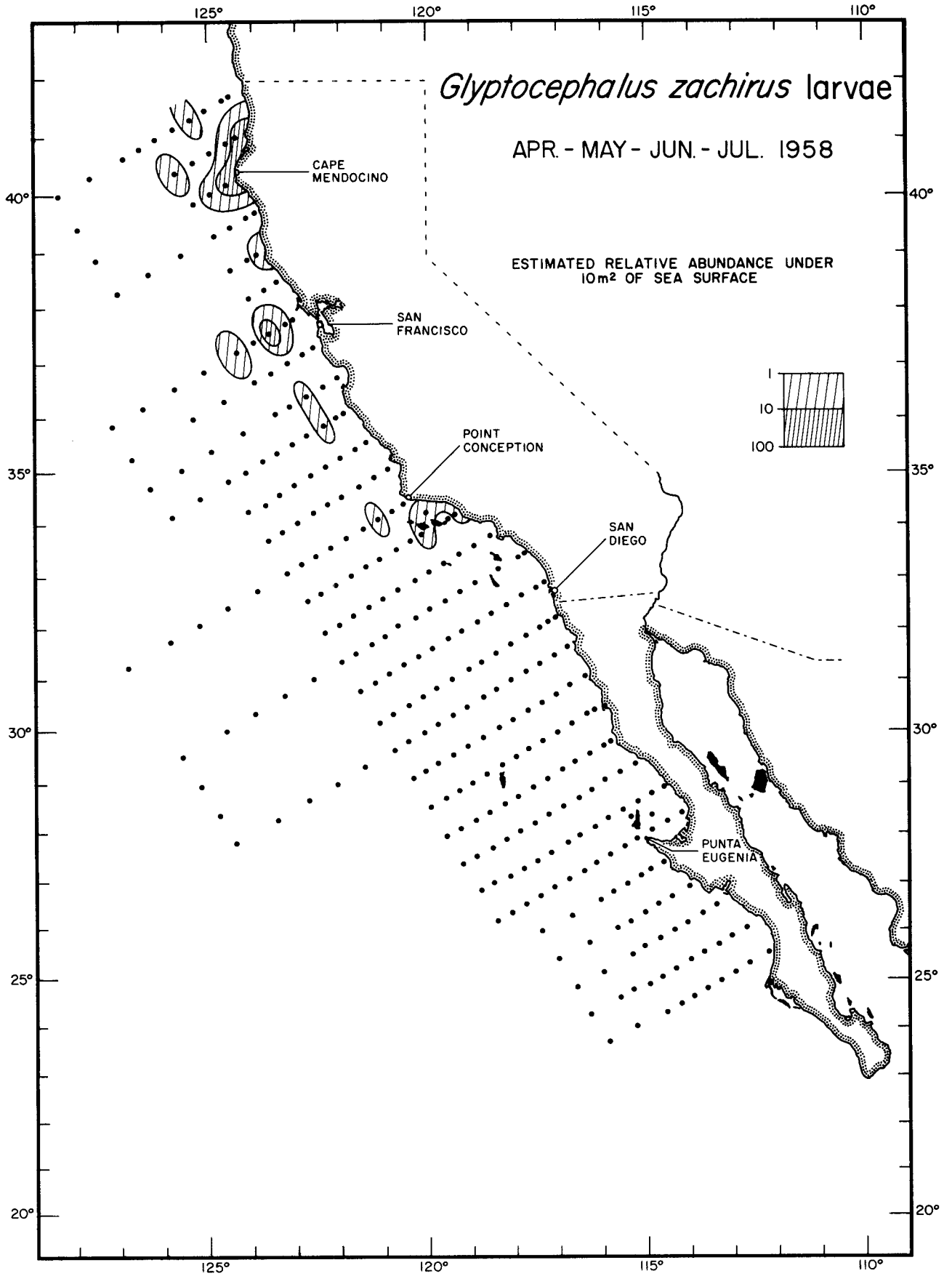
Glyptocephalus zachirus larvae
APR. - MAY - JUN. - JUL. 1955



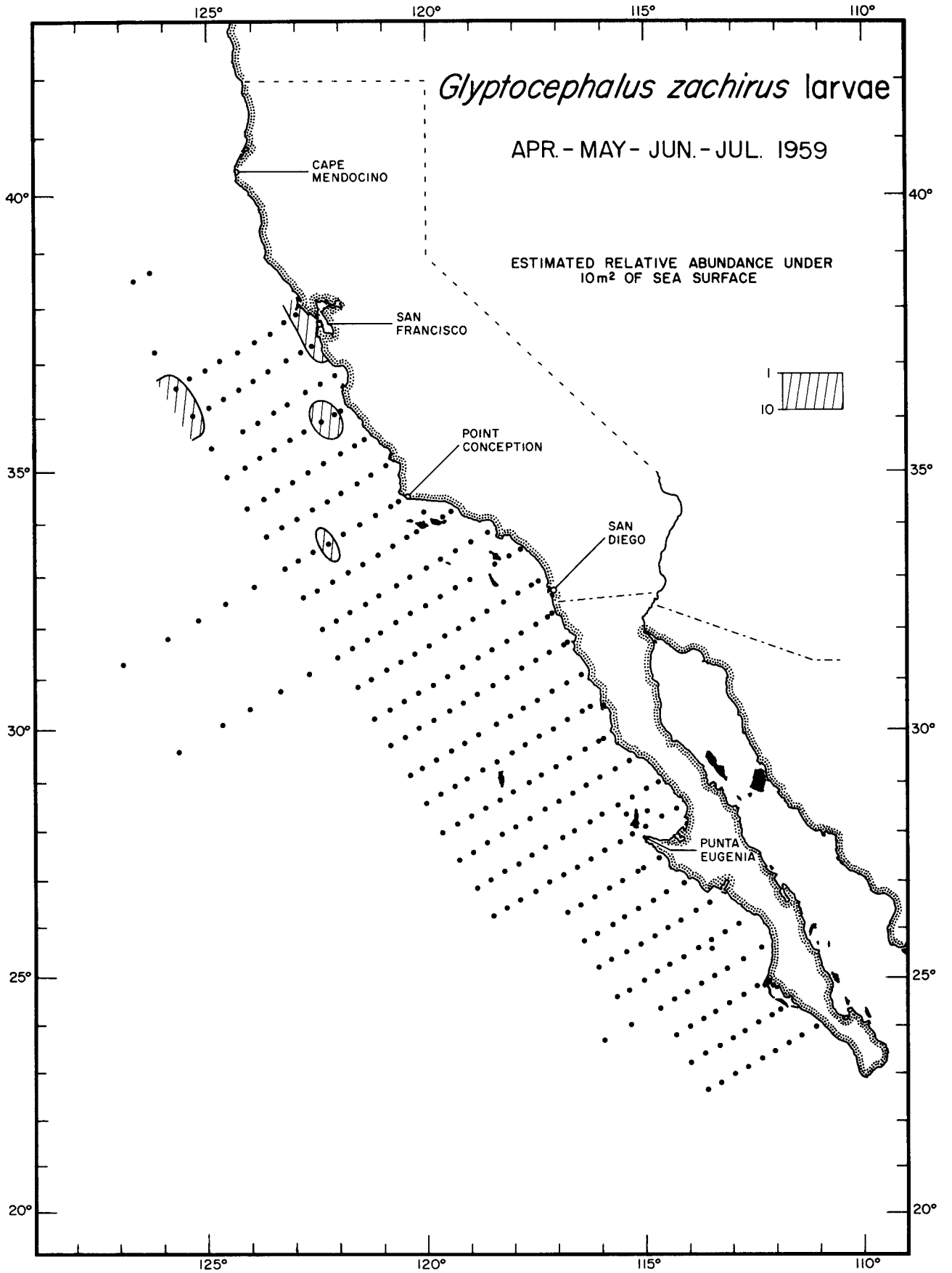
Glyptocephalus zachirus larvae
APR. - MAY - JUN. - JUL. 1956



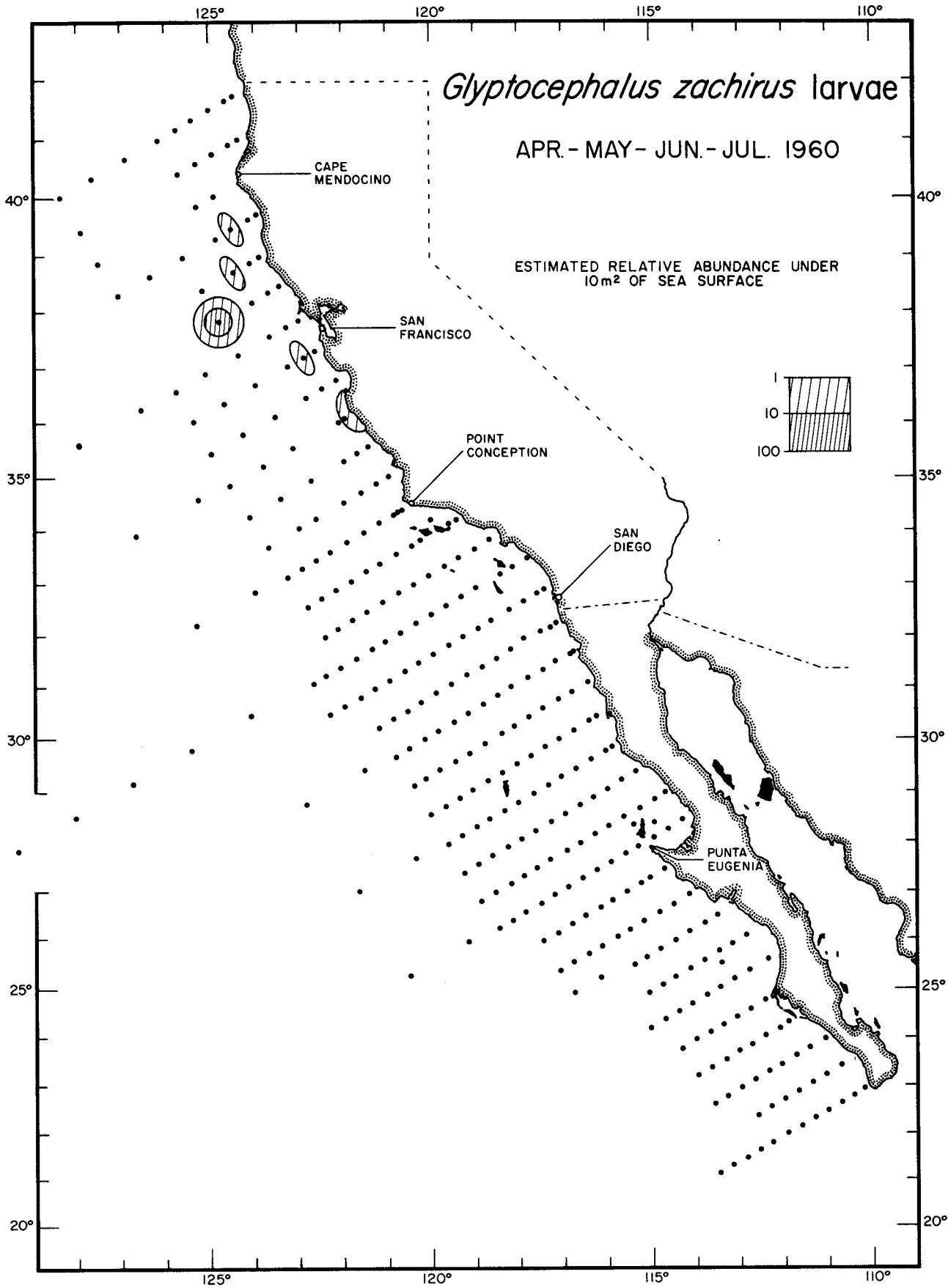
Glyptocephalus zachirus larvae
APR. - MAY - JUN. - JUL. 1957



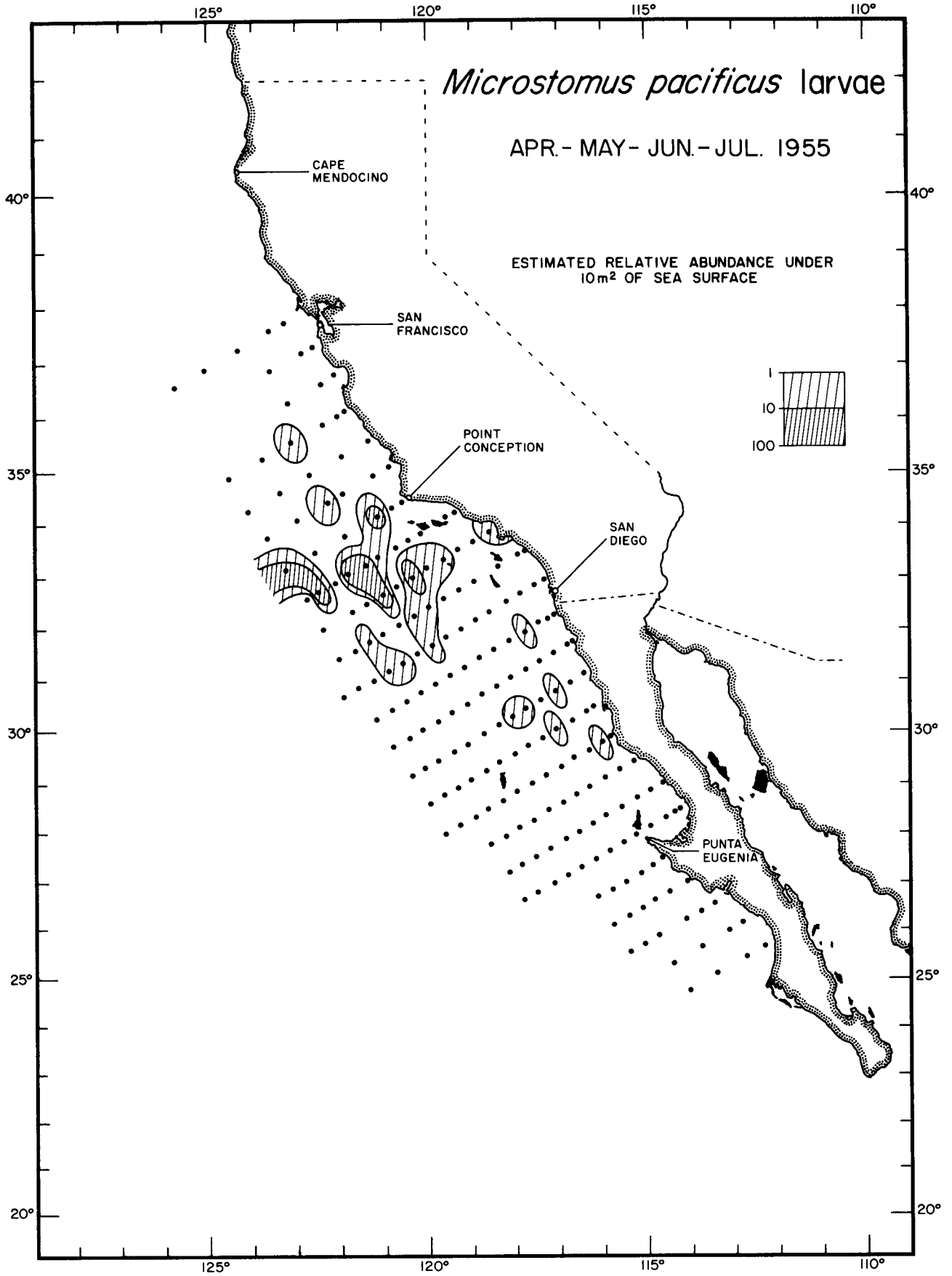
Glyptocephalus zachirus larvae
APR. - MAY - JUN. - JUL. 1958



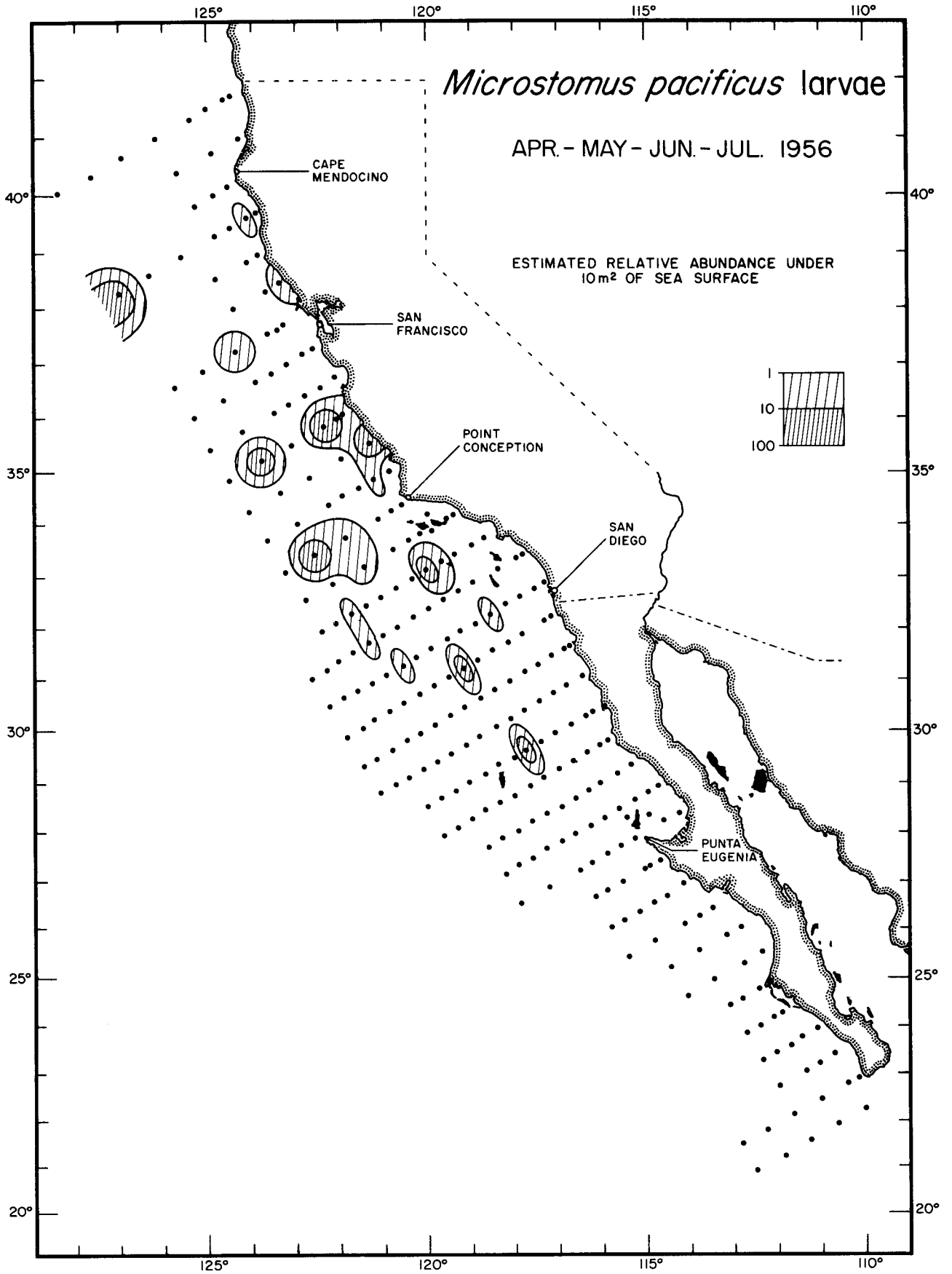
Glyptocephalus zachirus larvae
APR. - MAY - JUN. - JUL. 1959



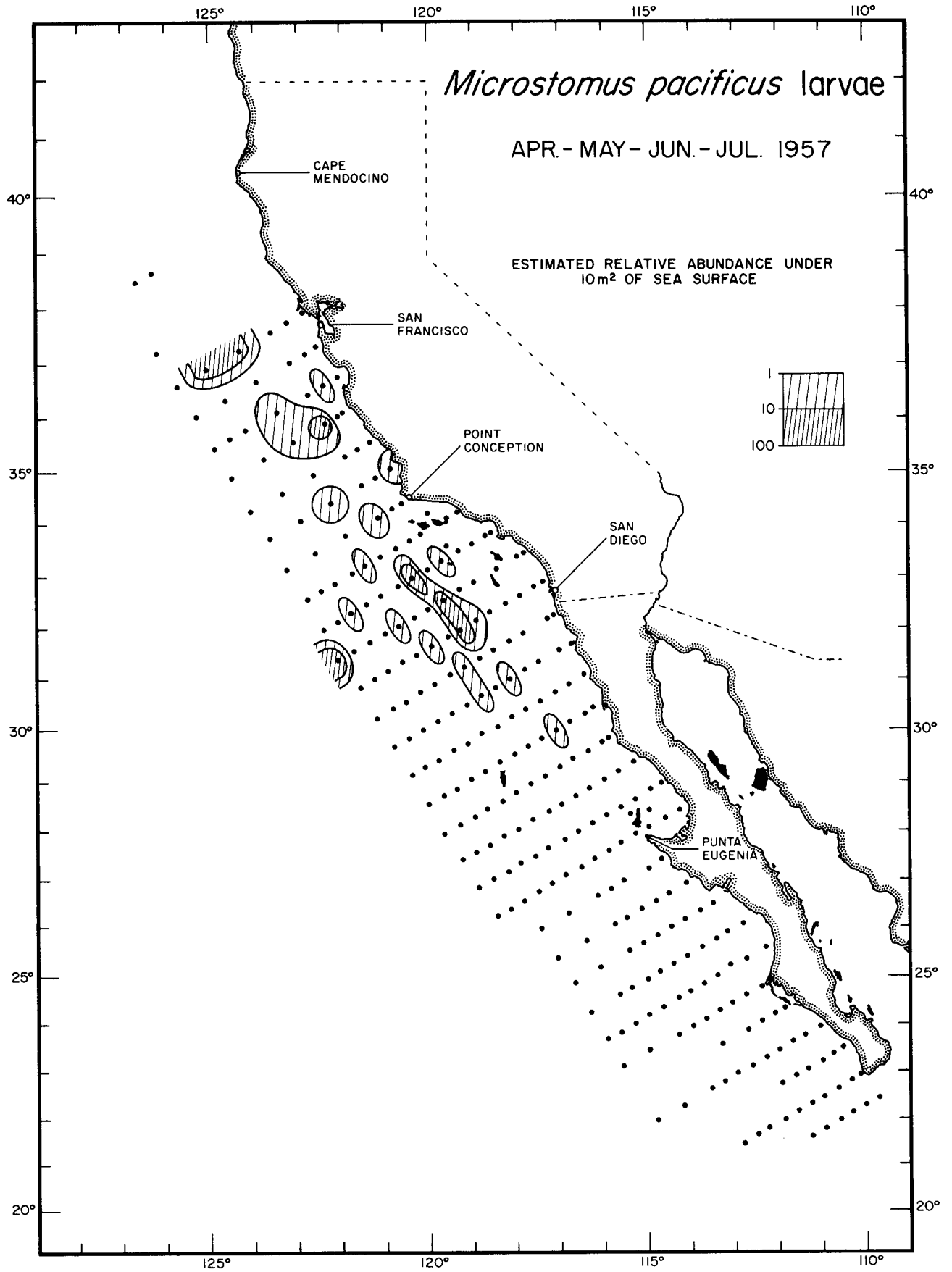
Glyptocephalus zachirus larvae
APR. - MAY - JUN. - JUL. 1960



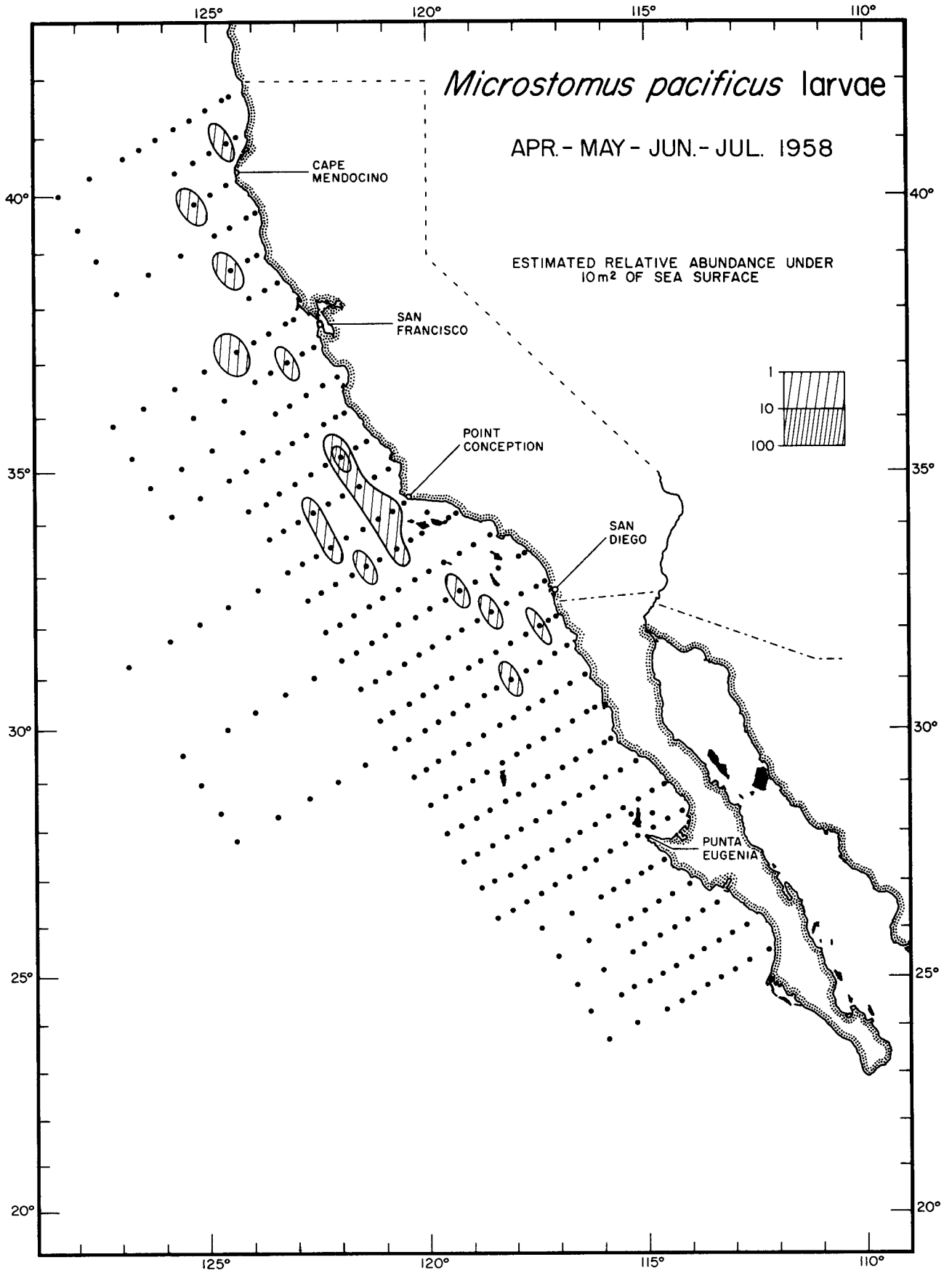
Microstomus pacificus larvae
APR. - MAY - JUN. - JUL. 1955



Microstomus pacificus larvae
APR. - MAY - JUN - JUL. 1956

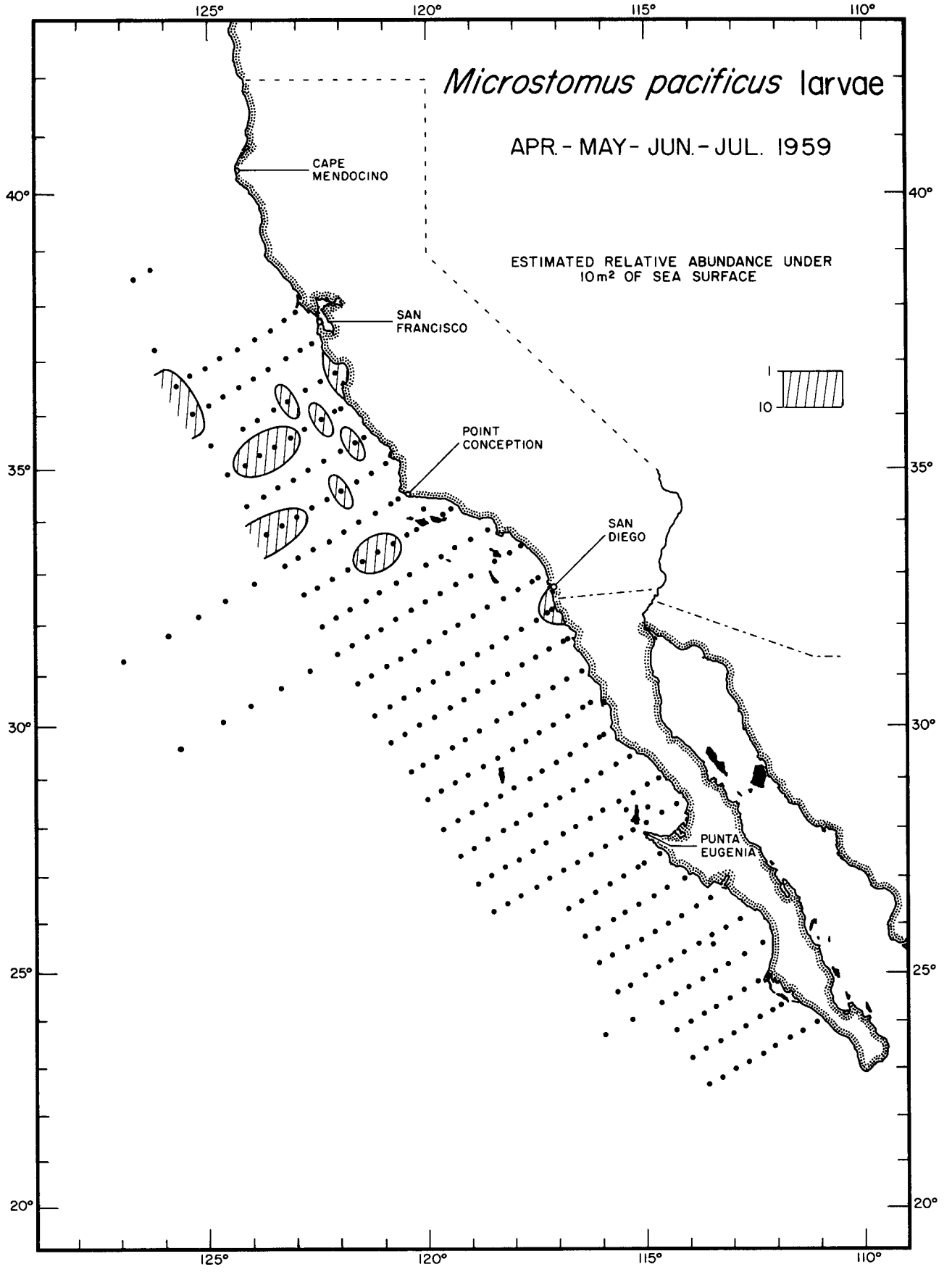


Microstomus pacificus larvae
APR. - MAY - JUN. - JUL. 1957

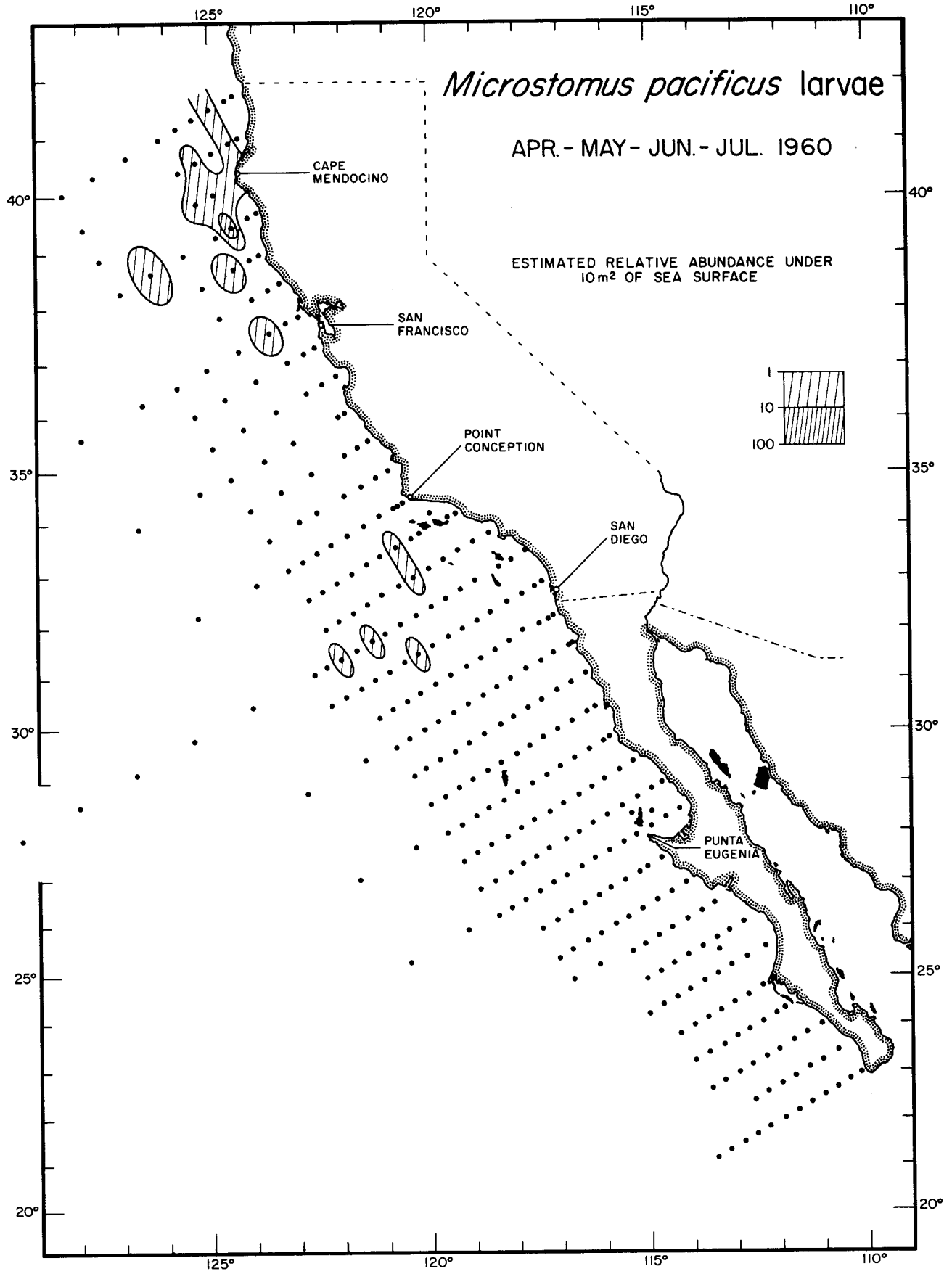


Microstomus pacificus larvae

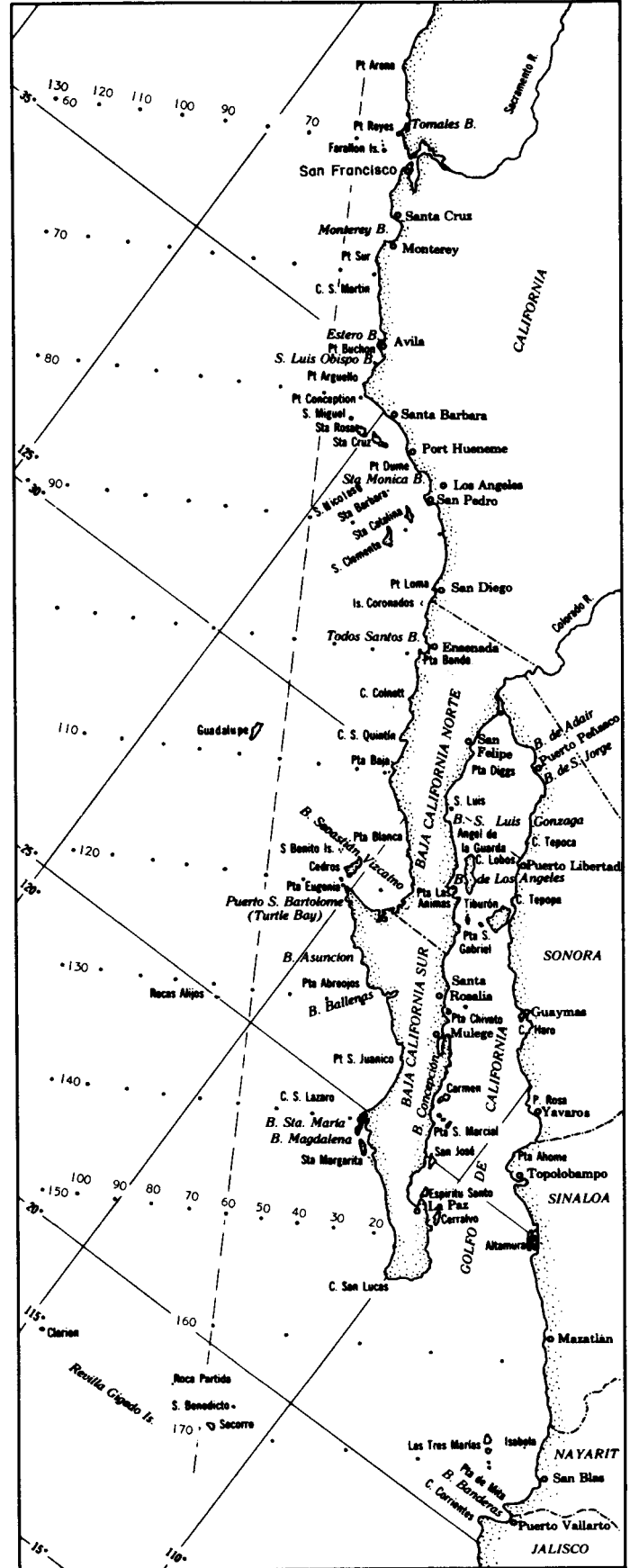
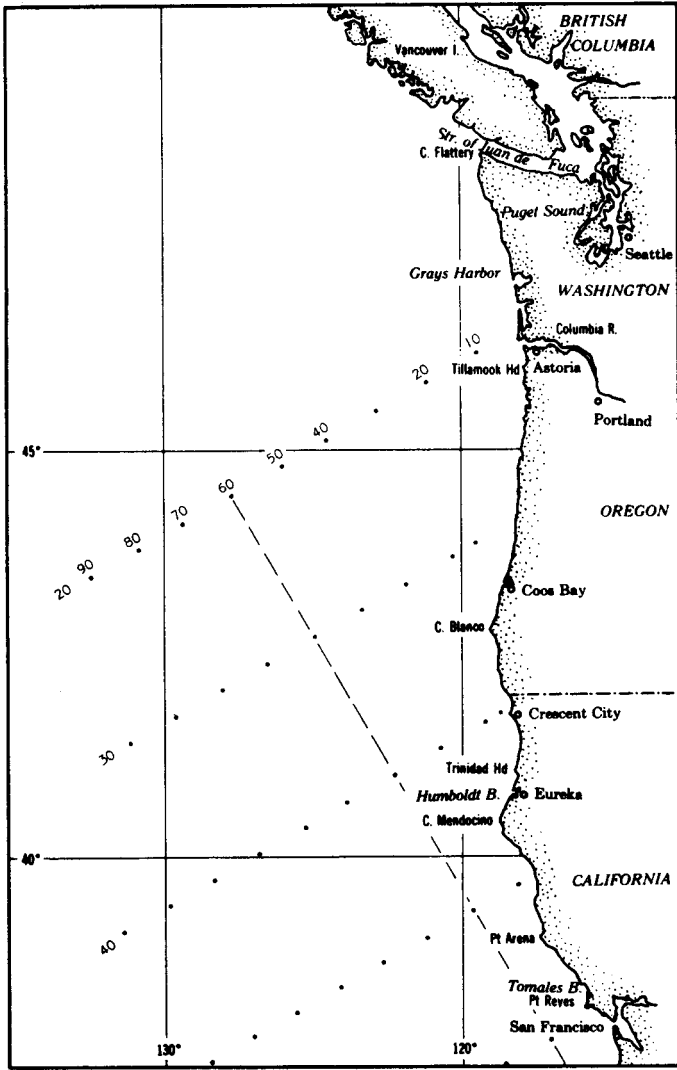
APR. - MAY - JUN. - JUL. 1958



Microstomus pacificus larvae
APR. - MAY - JUN. - JUL. 1959



Microstomus pacificus larvae
APR. - MAY - JUN. - JUL. 1960



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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