DISTRIBUTION OF SPERM WHALE CATCHES IN THE SOUTHERN INDIAN OCEAN

SABURO MACHIDA*

Whales Research Institute, Tokyo

ABSTRACT

Over 6,000 sperm whales were caught by Japanese antarctic whaling expeditions in the southern Indian Ocean bounded by latitude 30°—50°S and longitude 20°—145°E on the way to and from the antarctic whaling grounds in the seasons of 1957/58–1972/73. Most catches were made intensively in November and December before the baleen whale seasons.

The distribution of the species in the area concerned is discussed in relation to the surface temperature field. The relationship between the heavy catches of the animals and the Subtropical Convergence was found. Sperm whale concentrations are restricted in the convergence region and in temperate waters north of it. They are distributed up to about 41°S in the southwestern, southcentral, and southeastern Indian Ocean and about 47°S south of Australia. Virtually no females occur in colder waters south of the convergence region.

INTRODUCTION

Sperm whales have been caught by Japanese antarctic whaling expeditions in middle latitudes in the southern Indian Ocean on the way to and from the antarctic region in the Antarctic Ocean since the 1957/58 season.

There are very few reports about the distribution of sperm whales in pelagic waters in the Indian Ocean. Especially in the southern part of the ocean only very small catches of the species were made by the American whaleships mainly in nineteenth century (Townsend, 1937) and only a few animals were observed by research and merchant vesseles (Brown, 1957; Slijper *et al.*, 1964). On the other hand we can see the distribution of the species in the area concerned in the charts by Kasuya (1964), Ohsumi and Nasu (1968), and Berzin (1972), which were mapped based on the materials from Japanese and Soviet antarctic whaling expeditions respectively. However, the practical study of the sperm whale distribution and the grounds for the species in relation to the oceanographic conditions is rather scarce.

In any programme of whale research aimed at the reasonable exploitation of a population a knowledge of the distribution of the animals concerned is invaluable. In this present report the distribution of the sperm whale catches in the southern Indian Ocean bounded by latitude 30°–50°S and longitude 20°–145°E has been

* Present address: *Japan Marine Fishery Resource Research Center, Tokyo.*

Sci. Rep. Whales Res. Inst.,
No. 27, 1975, 141–157.

described in relation to the surface temperature field, using the materials from Japanese antarctic whaling expeditions in the seasons of 1957/58–1972/73.

RESULTS

Japanese antarctic whaling expeditions had caught sperm whales heavily in middle latitudes in the southern Indian Ocean from 1957/58 to 1972/73 (Table 1). Though the sperm whale catches were made during the warmer months of November–April, most animals were actually caught in November before the baleen whale seasons. A few catches of the animals were also made at the beginning of December and from the end of March to April again after carrying out catching for baleen whales. During the mid summer (January–February), at the height of catching for baleen whales, only very few sperm whales were caught.

TABLE 1. THE SEASONAL AND MONTHLY CATCHES OF SPERM WHALES BY THE JAPANESE ANTARCTIC WHALING EXPEDITIONS IN THE SOUTHERN INDIAN OCEAN FROM 1957/58 TO 1972/73. RIGHT FIGURES: FEMALES

Season	Nov.		Dec.		Jan.		Feb.		Mar.		Apr.		Total	
1957/58	25	—	—		—		—		—		—		25	—
58/59	—		—		—		—		—		—		—	
59/60	—		—		—		—		29		—		29	—
60/61	—		—		—		—		1	—	29	—	20	—
61/62	62	7	1	—	—		—		64	—	76	—	203	7
62/63	391	187	18	—	46	—	10	—	60	—	105	36	630	223
63/64	1,750	960	—		—		—		48	2	—		1,798	962
64/65	1,194	684	—		—		—		5	—	—		1,199	684
65/66	254	7	—		1	—	—		159	—	—		414	7
66/67	309	47	8	5	3	—	14	—	83	—	—		417	52
67/68	20	—	22	—	27	—	—		—		—		69	—
68/69	—		—		—		—		—		—		—	
69/70	302	137	13	—	—		—		—		—		315	137
70/71	458	305	211	74	—		18	—	—		—		687	379
71/72	45	9	394	206	—		—		—		—		439	215
72/73	—		71	19	—		—		—		—		71	19
Total	4,810	2,343	738	304	77	—	42	—	449	2	210	36	6,326	2,685

Fig. 1 shows the relation between the number of sperm whales and surface temperatures. It can be readily seen from the figure that the catches of the animals in November, when most catches were made, have relations with temperature. A large quantity of catches were made in the relatively limited range from 12° to 16°C with a peak at 14°C though the whales occur in the wide range of −1° to 23°C. On the other hand, in other months, when few sperm whales were caught, the relationship between the catch and temperature can not be seen as well as that in November.

Fig. 2 shows the distribution of sperm whale catches in the southern Indian Ocean from November to April in the seasons of 1957/58–1972/73. Most of the

catches were made in the central part of the area in November. The southern half of the favorite grounds is located in shallow waters around Newamsterdam Island (about 37°50′S and 77°30′E) and Saint Paul Island (about 38°40′S and 77°35′E). The second large catches of the species, which were almost carried out at the beginning of December, are made off southwestern Australia. In the western part of the area, the distribution of the catches are widely scattered and the extent of the favorite haunts were hardly encountered though the total number of sperm whale catches in the area concerned are rather large. In general a large quantity of catches of sperm whales was distributed in the warmer waters north of 40° to 41°S.

It is well known that the sperm whale has some social schools. We can not, of course, find out the accurate composition of the schools caught from the catch records but the catches of females, with which some large-scale social schools are composed, are available. As females have been also caught by Japanese antarctic whaling fleets in middle latitudes in the southern Indian Ocean the catch location are presented here.

The relationship between the nature of female sperm whales and oceanographic condition is shown in Fig. 3, which gives the one between the monthly catch of females and the surface temperatures. Though females were frequently encountered in 10°–23°C, the catches increased abruptly (from 19 to 277 animals) in temperate waters from 11° to 12°C. A large number of the female catches were made in November, and they occurred in waters between 12° and 19°C with a peak at 14°C. During December, probably at the beginning of the month, several females were caught was made in warmer waters (14° to 20°C) than during November. In addition only a few females were caught in warmer temperatures than 17°C in March–April.

Fig. 4 shows the distribution of the female catches, most of which were also captured in November to the beginning of December and a slight catch again in March to April. Furthermore most females were caught in the southcentral Indian Ocean and some animals also caught off southwestern Australia. No females were caught south of 42°S in the southern Indian Ocean except in the eastern extremity south of southeastern Australia, where several females were encountered as far south as about 47°S.

DISCUSSION

Sperm whales are caught heavily in lower latitudes north of about 41°S (Fig. 2), especially in November, though the catches are carried out over the area concerned. The southern extremity of the heavy catch area seems to be corresponding with a certain oceanographic condition. In Deacon's (1937) chart the Subtropical Convergence, which is the boundary between the Subtropical and Subantarctic Surface Waters, was drawn between about 39° and 43°S in the southern Indian Ocean and between about 45° and 47°S south of Tasmania Island in the easternmost area of the ocean. According to Orren (1966) the convergence was found to lie at 42°S ±1° in the southwestern part of the ocean. In the southeastern Indian

Ocean the convergence region was shown in latitudes from about 39° to 42°S in Burling's (1961) chart. Rochford (1962) illustrated the South Transitional Zone schematically, that is the transitional zone between the Subtropical and Subantarctic Zones, which locates between about 35° and 40°S in the southeastern Indian Ocean. In addition the Japanese whaling fleet also crossed the convergence region in nearly same latitudes in the southeastern Indian Ocean (Machida, 1974, a, b, unpublished data). On the other hand, in the southcentral part of the ocean, according to Deacon (1937) the surface temperature observations by the rv Valdivia and Gauss show that the convergence lies between 40° and 41°S in about 76°E. The rv Anton Brunn crossed the Subtropical Convergence at about 40°S, 75°E in April (Uda and Nakamura, 1973). Deacon's (1963) examination of mean monthly temperatures of 1-degree squares by Döneke (1938), though little is reported about the seasonal variation of the convergence, suggests that its variations of the position are rather small, of the same order as these of the Antarctic Convergence. Taking account into these knowledge of the Subtropical Convergence it is evident that good catches of sperm whales are related to the convergence region.

According to Fig. 1 the relationship between the good catches of sperm whales and the Subtropical Convergence will be confirmed. A large quantity of the catches were made in the range from 12° to 16°C with a peak at 14°C during November, when is outside the baleen whale seasons. Deacon (1963) described that the Subtropical Convergence is generally given in a close distribution of the surface isotherms of 10°–14°C in winter and 14°–18°C in summer. Though he divided a year into two seasons, winter and summer, November should be rather grouped into the transitional season from winter to summer. There, however, are very few reports on the Subtropical Convergence except the summer season. In the southeastern Indian Ocean (around 40.5°S and 108°E) a Japanese antarctic whaling fleet crossed the convergence region from 13.5° to 10.4°C in the middle of November (Machida, 1974b). The range of temperature may be classified into the winter category according to Deacon's (1963) criterion. November, however, should be grouped into the warmer month or rather into the transitional season from winter to summer, i.e. spring. Simply taking account of the Deacon's (1963) general criterion about the Subtropital Convergence in the transitional season from winter to summer it probably lie in the range between 12° and 16°C, which are the meadian of the range corresponding with the convergence in winter and in summer respectively. In November a large number of sperm whales, as mentioned above, were caught in these temperatures.

On the other hand a slight catch at the beginning of December, of which the great majority of the catches were made off southwestern Australia, appears to be corresponding to warmer waters than 14°C. The warmer temperatures than 14°C are included into the summer category of Deacon's (1963) criterion of the Subtropical Convergence and coincident with the range which corresponds to the convergence region in December (Machida, unpublished data).

Though in the southern Indian Ocean only very small catches of sperm whales were made mainly in the nineteenth century (Townsend, 1937) and only a few animals

were sighted by research and merchant vesseles (Brown, 1957: Slijper *et al.*, 1964), Kasuya (1964) and Ohsumi and Nasu (1968) illustrated the sperm whale distribution in pelagic waters of the southern Indian Ocean from catch records of Japanese antarctic whaling expeditions. In addition Berzin (1972) charted the distribution of the species in the area concerned based on the recent materials from Soviet pelagic whaling expeditions with previous works. In these charts it is evident that the heavy catches of sperm whales are located around the Subtropical Convergence in the southern Indian Ocean during October–March. He described furthermore that large concentrations were noted north of Newamsterdam and Saint Paul Islands. A heavy catch of the animals by Japanese fleets was also made from in shallow waters around both two islands to north. The large catches was also illustrated off southwestern Australia as the favourable grounds in the charts by Townsend (1937), Gilmore (1959), Mackintosh (1965), Berzin (1972), and others.

The southern extremity of the good catches of sperm whales seems to reflect the concentrations of the large-scale schools of the species. According to Gaskin (1970), Ohsumi (1971), and others the sperm whale has the distinct social structure of various types of school, i.e. the nursely schools, the harem schools, the immature mixed sex schools (the juveniel schools), the bachelor schools, the bull school (male pairs) and the lone bull (solitary bull). Of which the nursely, harem and juveniel schools are composed of a large number of females. In the short period before the baleen whale seasons catching for sperm whales will be occupied in waters inhabiting these schools. We can not, of course, find out the accurate category of the social structure of the species from the catch recrods but the females are recorded in the catch logs. It is quite possible to suppose the location of the large-scale schools from that of females, therefore. The distribution of the female catches shown in Fig. 4 may suggest the distribution pattern of the major schools of the species which are restricted in the Subtropical Convergence.

The females and the youngs are generally accepted being limited to the regions between about 40°N and 40°S (Slijper, 1962). Gilmore's (1959) charts show that females are limited by the isotherm of 20°C, which seems to be more or less the range as the convergence. Kasuya (1964), who charted the seasonal distribution of male and female sperm whales in the rectangles by latitude 1° and longitude 5°, using the part of the same materials as that in this report, assumed that the southern limit of the female distribution in the southern Indian Ocean is 40°–45°S in latitude and that the range is roughly corresponding with the Subtropical Convergence. On the other hand Nasu (1969) pointed out that the southern range of females was corresponding with the Australasian Subantarctic Front, which is located in the region between the Subtropical and Antarctic Convergences (Burling, 1961) based on the distribution of female sperm whales by Ohsumi and Nasu (1968). They charted the distribution of the female catches in ten degree squares by using the part of the same materials as that in Kasuya (1964) and in this report. Clarke (1972) studied the stomach contents of sperm whales caught off Durban (South Africa) and reported that few antarctic cephalopod beaks were found from females and small-sized

males though larger males having antarctic cephalopod beaks in large number. From this fact he suggests that females and small-sized males do not go far south through the Subtropical Convergence. I may take that the southern range of female sperm whales in the southern Indian Ocean is corresponding with the Subtropical Convergence as far as I discuss the distribution of the female catches and the surface temperatures in Fig. 3 and 4.

On the other hand there is really several records that the female and young sperm whales occurred in higher latitudes beyond the Subtropical and Antarctic Convergences. Salvenson (1915) illustrated one female caught off South Gergia (about 55°S). In the southern Indian Ocean several schools of small-sized sperm whales, which seemed to be composed of females and youngs, were observed at the end of January at 59°S, 65°E and at 58°30'S, 71°E, respectively (Ivanov, 1972). Fourteen females were caught at the end of January south of Herd Island (about 56°S) (Ivashin and Budylenko, 1970). Though these observations and records suggests that some females and youngs are tolerable to cold waters south of the Subtropical Convergence and/or furthermore through the Antarctic Convergence, these are rather scarce and I may regarde them as strugglers.

REFERENCES

Berzin, A. A., 1971. *The sperm whale* (Eng. transl. by A. V. Yablokov, IPST, Jerusalem, 1972, 394 pp.).

Brown, S. G., 1957. Whales observed in the Indian Ocean. *Mar. Obsr.*, 27: 157–165.

Burling, R. W., 1961. Hydrology of circumpolar waters south of New Zealand. *N. Z. Dep. sci. indust. Res. Bull.*, 143 (*N. Z. oceano. Inst. Mem.*, 10), 66 pp.

Caldwell, D. K., Caldwell, M. C., and D. W. Rice, 1966. Behaviour of the sperm whale, *Physeter catodon* L. *Whales, Dolphins, and Porpoises* (*ed. K. S. Norris*), 677–717.

Clarke, M. R., 1972. New technique for the study of sperm whale migration. *Nature*, 238: 405–406.

Deacon, G. E. R., 1937. Hydrology of the Southern Ocean. *Discovery Rep.*, 15: 1–124.

Deacon, G.E.R., 1963. The Southern Ocean. *The Sea* 2 (*ed. M. N. Hill*), 281–296.

Deacon, G.E.R., 1966. Subtropical Convergence. *The Encyclopedia of Oceanography* (*ed. R. W. Fairbridge*), 884–885.

Gaskin, D. E., 1970. Composition of schools of sperm whales *Physeter catodon* Linn. east of New Zealand. *N. Z. Jl. Mar. Freshwat. Res.*, 4(4): 456–471.

Ivanov, A. P., 1972. Small-sized sperm whales in the Anatrctic. (Jap. transl. by H. Sakiura, *Geiken Tsushin*, 282: 14)

Ivashin, M. V., and Budylenko, G. A., 1970. Female sperm whales in the Antarctic? (cited from A. P. Ivanov, 1972)

Kasuya, T., 1964. *Report of biological investigations of whales caught by Japanese antarctic whaling expeditions in the 1963/64 season.* Whales Res. Inst., Tokyo, 79 pp. (in Japanese)

Machida, S., 1974a. Geographical positions of the major oceanographic fronts observed by whale sighting boat in the Australasian Antarctic in the 1972/73 season. *Geiken Tsushin*, 269: 1–5. (in Japanese)

Machida, S., 1974b. Temperature observations by the whaling factory '*Chiyo Maru*' and whale catcher '*Katsu Maru No. 3*' on the way to and from the Antarctic in the 1973/74 season. *Geiken Tsushin*, 275: 51–54. (in Japanese)

Machida, S., (unpublished data) Subtropical Convergence, Subantarctic Front, and Antarctic Convergence observed by Japanese Antarctic Icebreaker 'Fuji'.

Nasu, K., 1969. Oceanography in the southern limit of habitat of southern bluefin tuna. *Bull. Jap. Soci. Fish. Oceano.*, 15: 19–26. (in Japanese)

OHSUMI, S., and NASU, K., 1968. Range of habitat of the female sperm whale with reference to oceanographic structure. (cited from K. Nasu, 1968)

OHSUMI, S., 1971. Some investigations on the school structure of sperm whale. *Sci. Rep. Whales Res. Inst.*, 23: 1–25.

ORREN, M. R., 1966. Hydrology of the south west Indian Ocean. *Invest. Rep. Div. Sea. Fish. S. Afr.*, 55: 1–36.

ROCHFORD, M. R., 1962. Hydrology of the Indian Ocean II. *Aust. J. mar. Freshw. Res.*, 13: 226–251.

SALVESON, T. E., 1915. The whale fisheries of the Falkland Islands and dependencies. (cited from D. K. Caldwell *et al.*, 1966)

SLIJPER, E. J., VAN UTRECHT, W. L., and C. NAAKTGEBOEN, 1964. Remarks on the distribution and migration of whales observations from Netherlands ships. *Bijdr. Dierkunde*, 34, 93 pp.

TOWNSEND, C. H., 1935. The distribution of certain whales as shown by logbook records of American whaleships. *Zoologica*, 19: 1–50.

UDA, M., and NAKAMURA, Y., 1973. Hydrography in relation to tuna fisheries in the Indian Ocean. *Spl. Publ. Mar. Biol. Ass. India*, 1973, 276–292.

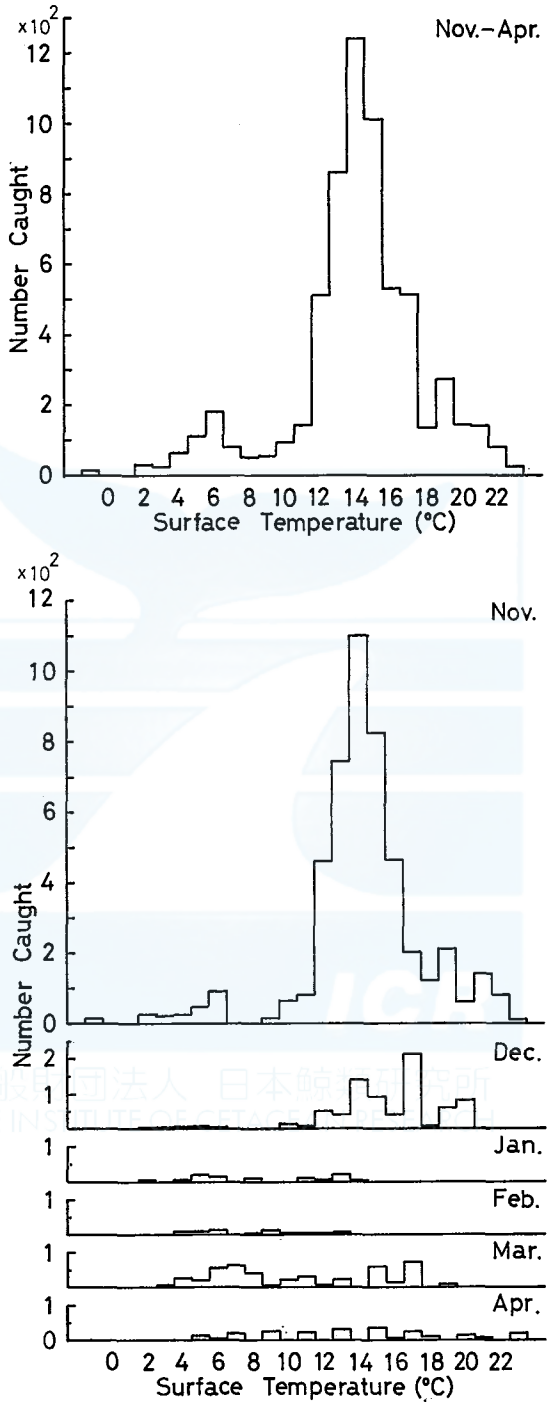
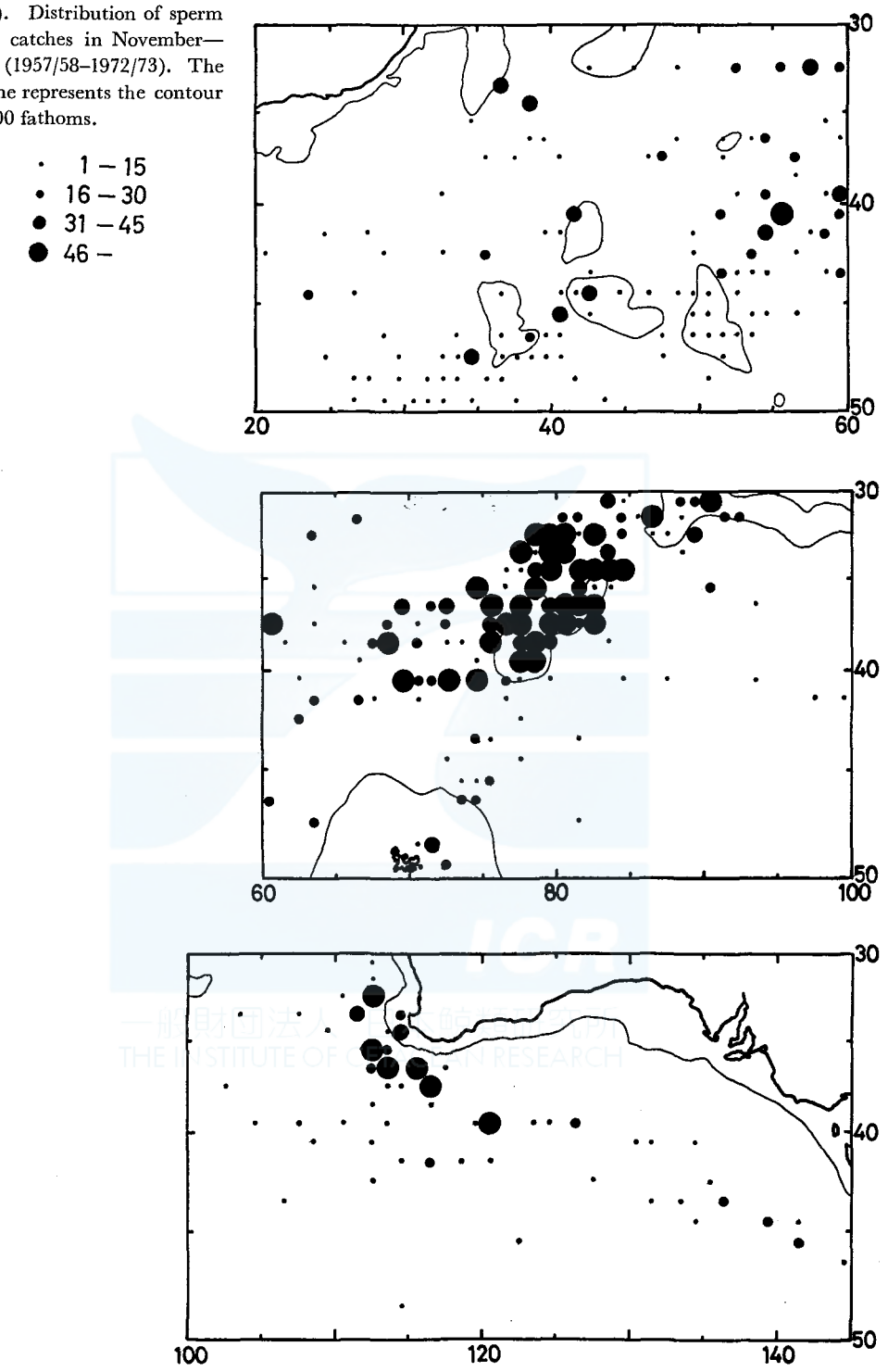


Fig. 1. Catches of sperm whales and surface temperatures in November—April (1957/58–1972/73)

Fig. 2(a). Distribution of sperm whale catches in November—April (1957/58–1972/73). The fine line represents the contour of 1,500 fathoms.



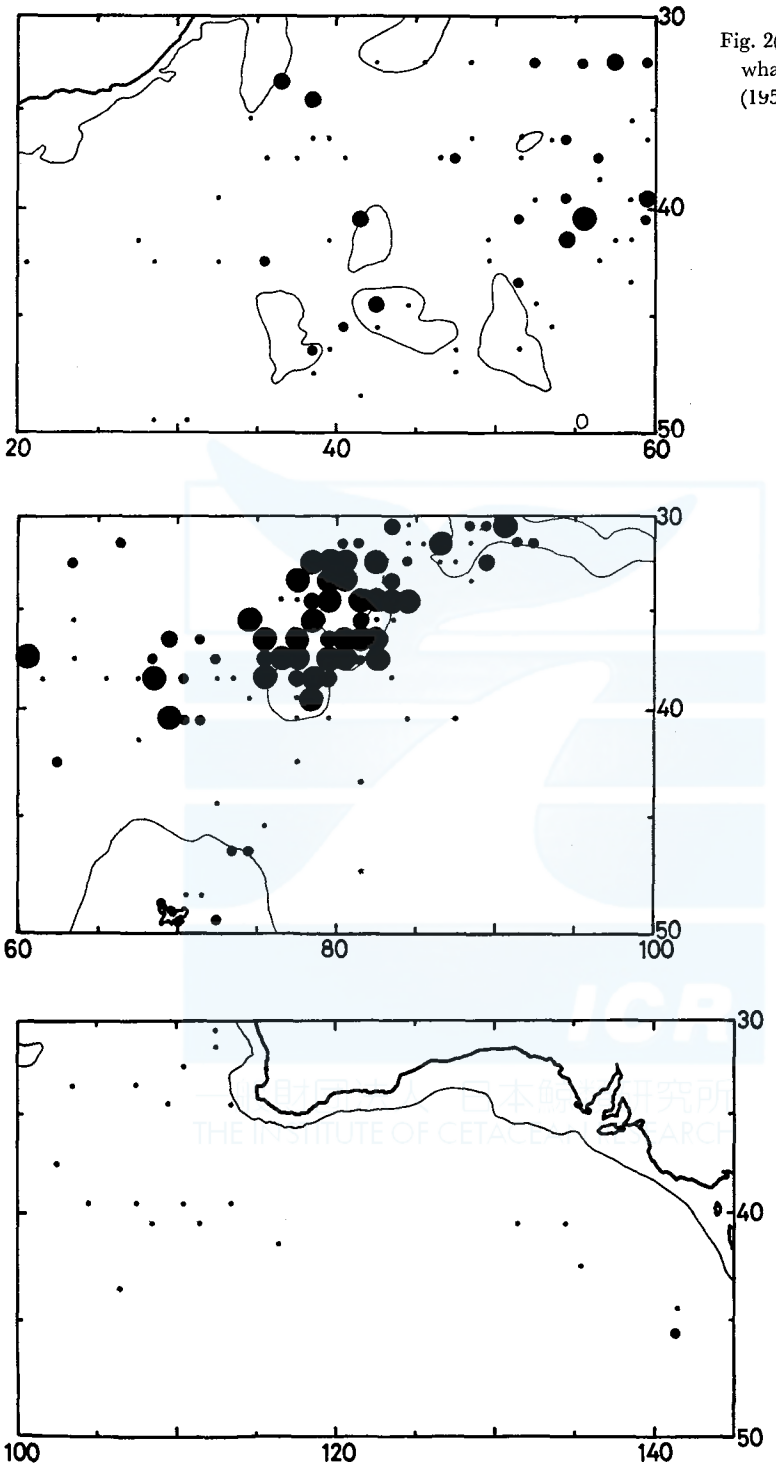
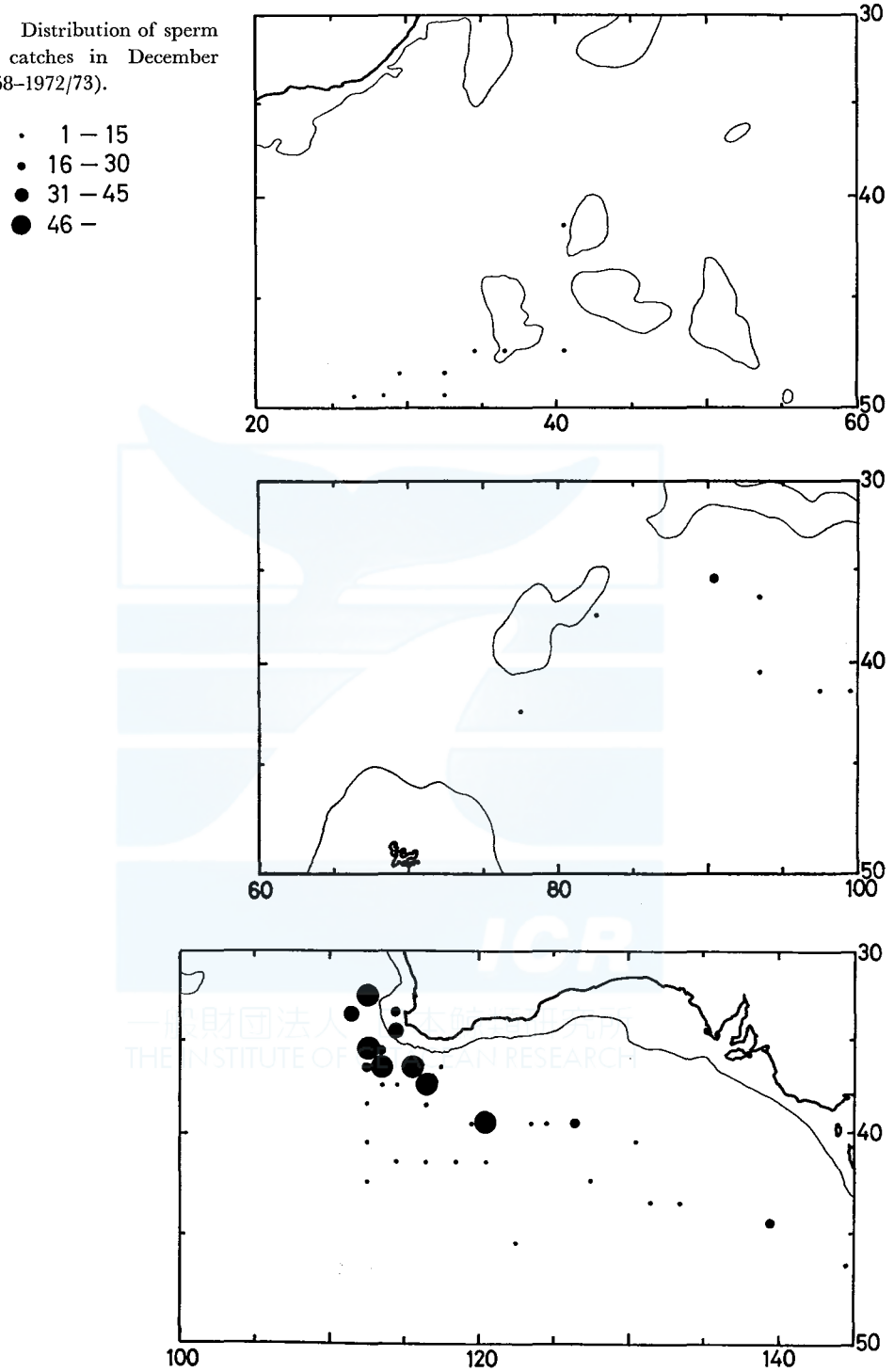


Fig. 2(b) Distribution of sperm whale catches in November (1957/88–1972/73).

· 1 – 15
• 16 – 30
● 31 – 45
● 46 –

Fig. 2(c). Distribution of sperm whale catches in December (1957/58–1972/73).



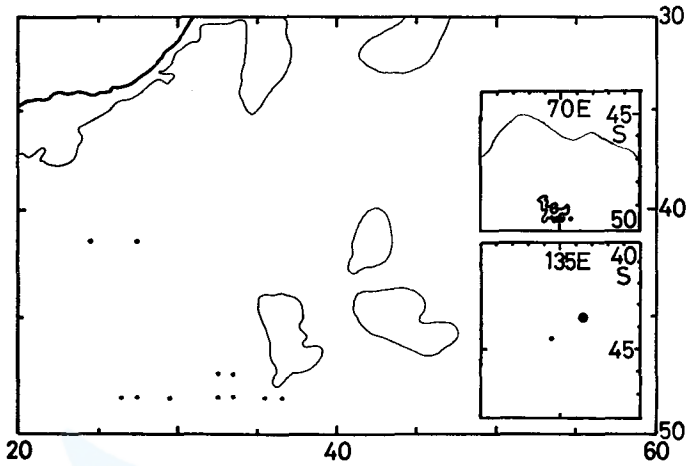
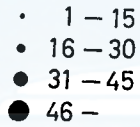


Fig. 2(d). Distribution of sperm whale catches in January (1957/58–1972/73).



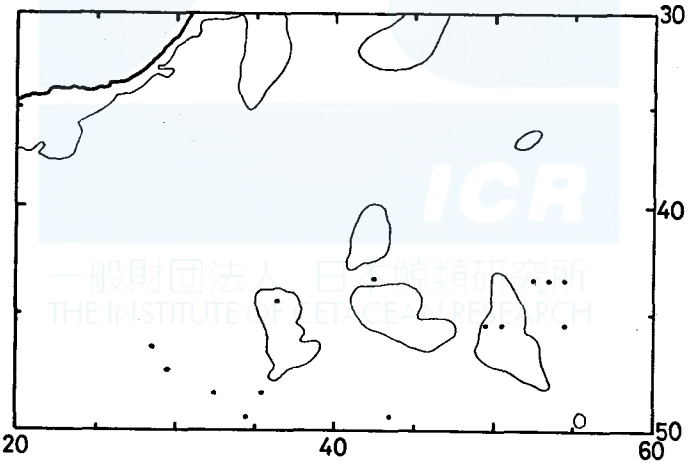


Fig. 2(e). Distribution of sperm whale catches in February (1957/58–1972/73).

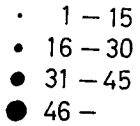


Fig. 2(f). Distribution of sperm whale catches in March (1957/58–1972/73).

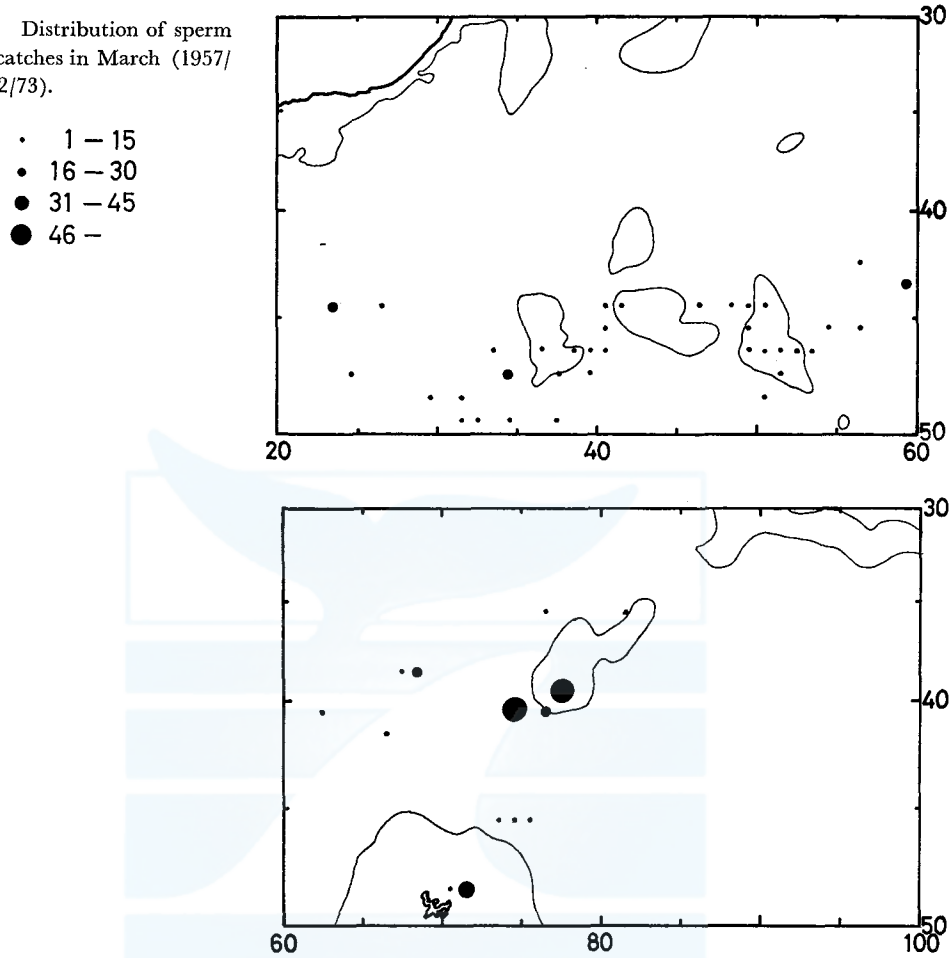
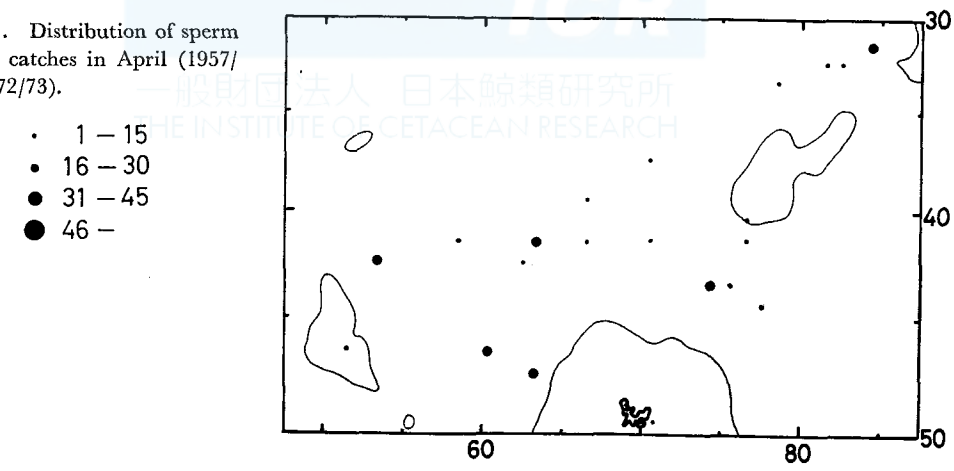


Fig. 2(g). Distribution of sperm whale catches in April (1957/58–1972/73).



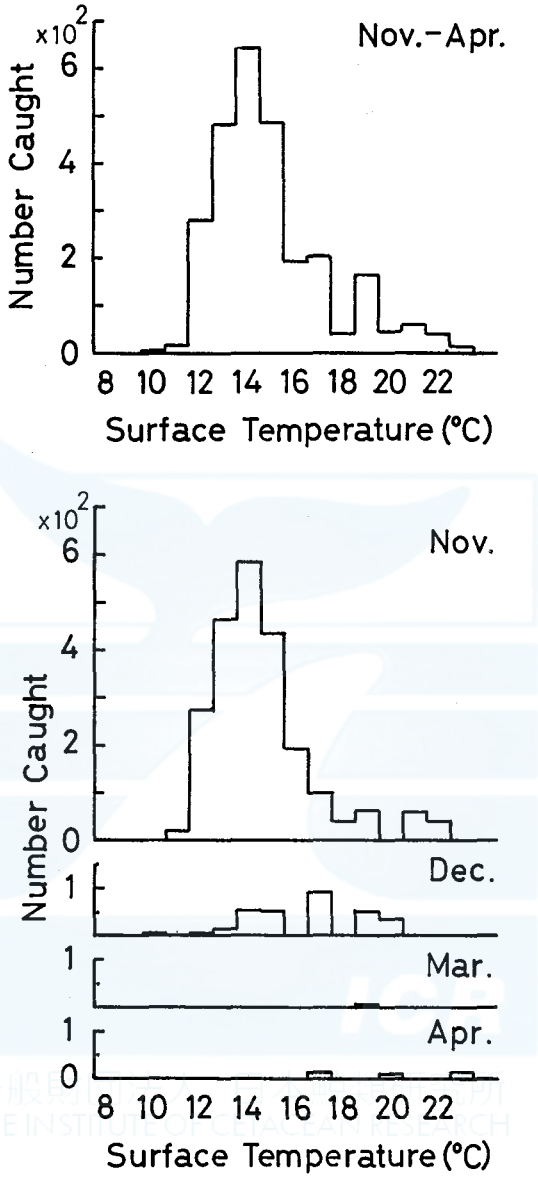
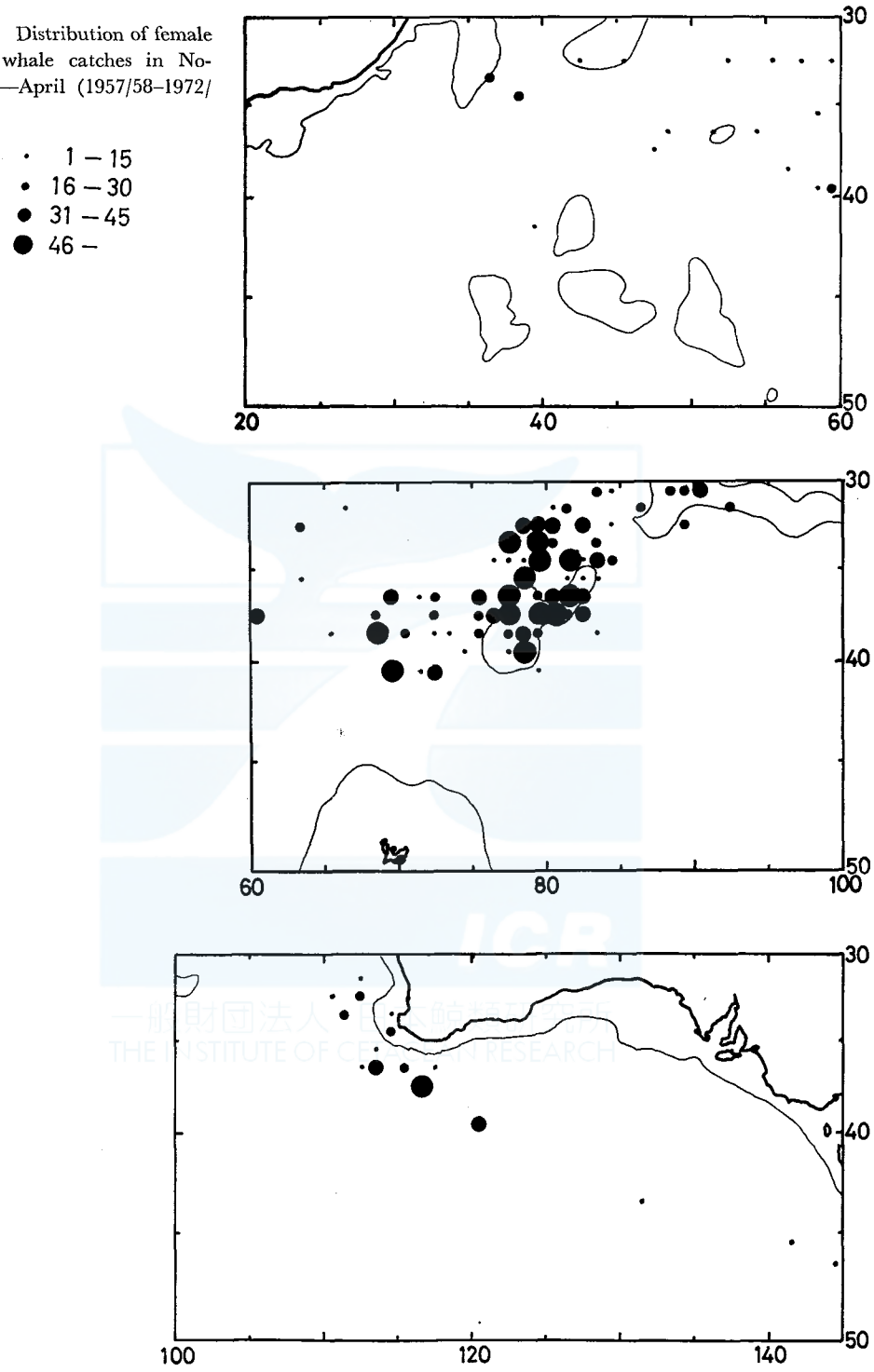


Fig. 3. Monthly catches of female sperm whales and the surface temperatures (1957/58–1972/73).

Fig. 4(a). Distribution of female sperm whale catches in November—April (1957/58–1972/73).



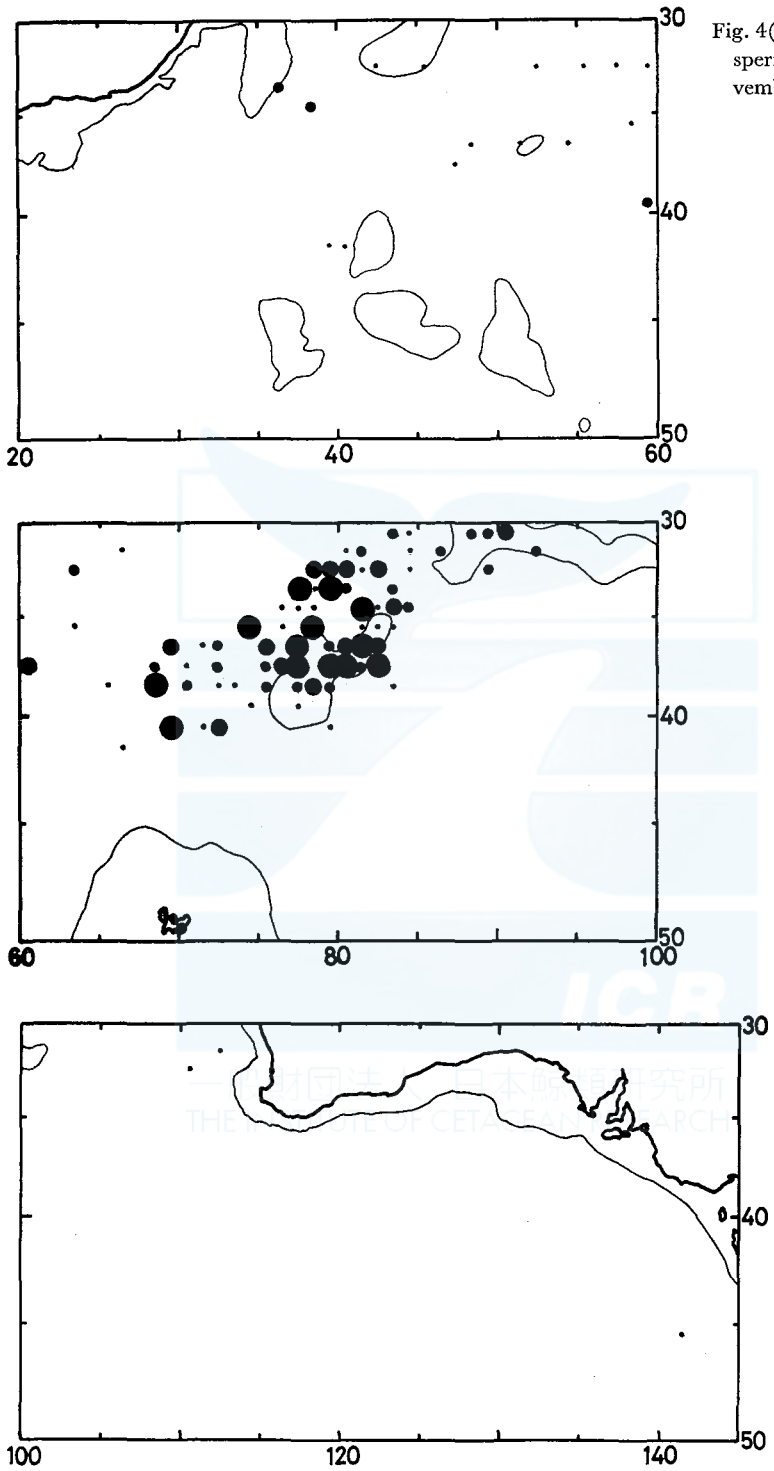


Fig. 4(b). Distribution of female sperm whale catches in November (1957/58–1972/73).

· 1 — 15
• 16 — 30
● 31 — 45
● 46 —

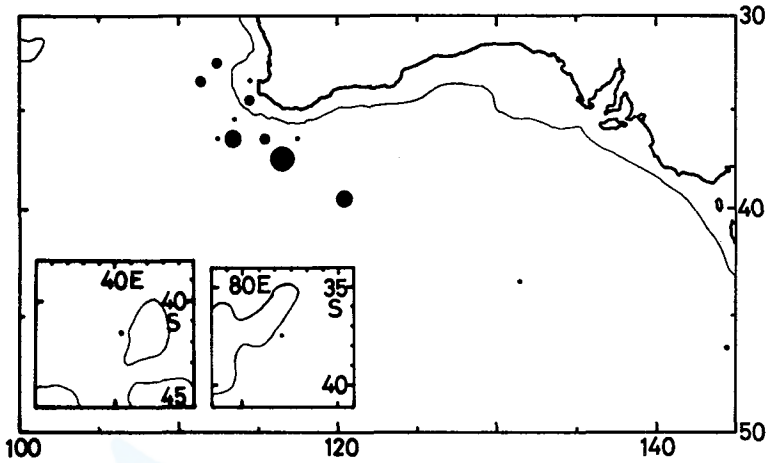
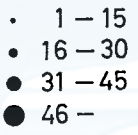


Fig. 4(c). Distribution of female sperm whale catches in December (1957/58–1972/73).



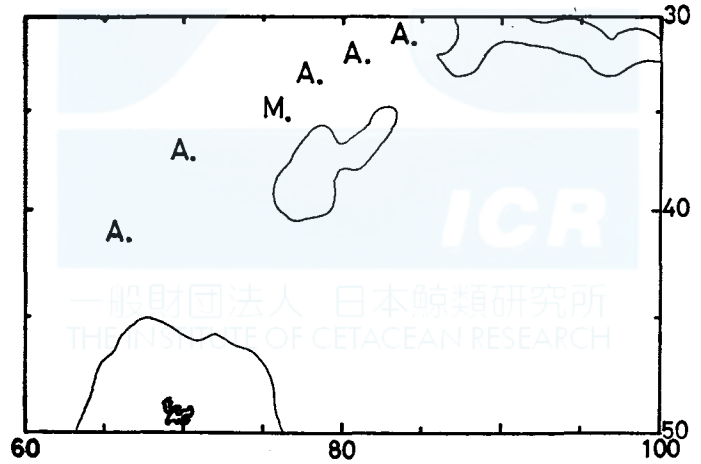


Fig. 4(d). Distribution of female sperm whale catches in March and April (1957/58–1972/73). M: March A: April