FOOD HABITS AND PREY DISTRIBUTIONS OF THREE RORQUAL SPECIES IN THE NORTH PACIFIC OCEAN

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ABSTRACT

Stomach conditions and a total of 1675 stomach samples of fin, sei and Bryde's whales caught in the North Pacific during the seasons of 1969–1979 were examined. The percent of filled stomach to all animals examined was about 60% with varying fullness; and this figure was considered to be very high notwithstanding the fact that large number of whales were caught in the subartic to subtropical waters where the zooplankton distribution is poorer than the northern North Pacific region. Due to southerly shifted whaling ground there found many warm water prey species in the stomach samples. Of more than 40 prey species occurred, however, very few number of the species actually comprised principal prey items, *i.e.*, *Calanus cristatus*, *C. plumchrus*, *C. pacificus*, *Euphausia pacifica*, *E. similis*, *Thysanoessa longipes*, *T. spinifera*, *T. inermis*, *Nematoscelis difficilis*, *Sergestes similis*, *Vinciguerria nimbaria*, *Scomber japonicus*, *Cololabis saira* and *Pseudopentaceros richardsoni*. The composition of stomach contents by whale species revealed that the fin, sei and Bryde's whales eat mainly euphausiid, copepods, and small gregarious fish species in this order. From the characteristics of geographical distributions of the major prey items by each whale species, it was suggested that the North Pacific rorqual whales share a possible food species among them by selecting different prey items. There also suggested that the feeding conditions in the pelagic waters of the North Pacific region differ from those in the marginal sea regions such as the Kurile Islands and/or the Bering Sea in the composition of prey fish species.

INTRODUCTION

Since the establishment of the Whales Research Institute in 1947, one of main study areas was to know the food habits of baleen whales of both northern and southern species. In the North Pacific region including Japanese coastal waters, Mizue (1951) was the first who dealt with the food habits of larger whales caught by the land-based whaling around Japanese waters during 1946–1948, and pointed out an extreme importance of krill for fin whales, whilst squid and/or Japanese sardine may contribute as main food items in sei whales. In accordance with the development of the North Pacific pelagic whaling since 1952, the whaling ground geographically expanded year after year towards more northern latitudes of the Bering Sea (Omura, 1955; Nasu, 1957; Nemoto, 1957), which caused the shift of main study area from the coastal regions to the pelagic catches of whales. Studies of the food habits of baleen whales by Nemoto (1957, 1959, 1963) con-

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tributed to clarify the feeding conditions of baleen whales over the North Pacific and Bering Sea, and the prey items of baleen whales by whale species bacame clear in detail, although some more earlier Russian works in this field have been reported (e.g. Zenkovitch, 1937). Nemoto (1959) finally compiled large amount of data that came from a total of 9,270 animals caught in the North Pacific, Bering Sea, and Okhotsk Sea during 1952–1958. Later, Nemoto (1963) discussed distribution characteristics and importance of two major *Calanus* species as the prey of whales using additional materials obtained up to the 1961 season.

After a pause of effort to collect the stomach contents of the North Pacific baleen whales during the 1962–1968 seasons, activity of material collection by the Whales Research Institute was restored again in 1969, and the effort was continued until 1979 except 1978 season, while the geographical occupation of whaling ground along with the composition of exploitable whale species changed considerably during these periods. However, stomach samples of whales covering last 10 years have not been examined nor reported todate except several short articles of limited subjects (Omori *et al.*, 1972; Kawamura, 1973; Nemoto & Kawamura, 1977; Kawamura, 1978; Kawamura & Hamaoka, 1981; Kawaguchi & Kawamura, 1981). Among these reports, Omori *et al.* (1972) reported the mass occurrence of the sergestiid shrimp, *Sergestes similis* Hansen, and pointed out its importance as whales food particularly in the eastern half of the northern North Pacific, while Kawamura (1973) focussed his discussion on the food conditions of whales in the southern part of the subarctic North Pacific region, and he (Kawamura, 1973) pointed out a possible significant ecological role of several commercially important fish species as food of sei whales.

The long-lasted Japanese activity in the North Pacific pelagic whaling ceased its 18-year operations in 1979 as it was the final expedition. This report aims to provide a knowledge about the food habits of the North Pacific baleen whales, fin, sei, and Bryde's that were caught largely in the southern waters from subarctic to subtropical regions. In this point of view, this report can be regarded as a supplement of our earlier knowledge that was obtained in the boreal to arctic regions.

MATERIALS AND METHODS

The stomach contents of whales were collected randomly from the cut opened first stomach that was found to be containing fresh enough food for the identification of each prey item. Usually, several hundred grams (wet weight) of stomach contents were collected, and they were preserved in plastic bottles with 10% formalin solution. The number of samples should be collected by each season and by the fleet was basically guide lined to take one stomach sample per every ten animals processed, but actually it varied considerably by situations in the field and by the fleet participated. However, being independent of the sampling scheme above mentioned, the materials were collected to meet with the necessity of data analysis, *i.e.*, to collect the materials so as to totally represent the geographical expansion of whaling ground and the month (=season) occupied. Sampling was

TABLE 1. NUMBER OF STOMACH SAMPLES COLLECTED IN THE NORTH PACIFIC AND BERING SEA WHALING DURING THE SEASONS OF 1969—1979.*

( ): Number of whales caught

Season	Fin	Sei	Bryde's
1969	56	316	—
	(576)	(3,591)	—
1970	32	258	—
	(518)	(3,235)	—
1971	62	181	1
	(542)	(2,431)	(98)
1972	14	70	—
	(426)	(2,041)	(5)
1973	24	98**	—
	(256)	(1,710)	(2)
1974	46	100	46
	(216)	(1,190)	(522)
1975	31	52	51
	(118)	(454)	(688)
1976	—	—	56
	—	—	(578)
1977	—	—	97
	—	—	(424)
1978	No sampling		(200)
1979	—	—	94
	—	—	(175)
Total	265	1,075	345
	(2,652)	(14,641)	(2,694)

* A catch of ten minke whales in 1970 was excluded

** One unknown stomach sample probably belongs to sei whale stomach was included

also conducted whenever the species of prey items seemed to have changed by a visual observations. Several number of stomach samples were damaged by a leakage and evaporation of preserving solution under an unfavourable conditions of storage during the past 13 years.

During the summer period of 1969–1979 a total of 19,992 baleen whales were harvested by the Japanese pelagic whaling in the North Pacific and Bering Sea regions. The number of materials actually examined in this study was 1,685 stomachs in all as given in Table 1. The whale species treated were fin, sei and Bryde's. During the study period there were several number of pelagic catches of minke whales but they were excluded in this study due to small number in the available amount of materials.

The traditional catch records (*Geirui Hokaku Daicho*) on each animal processed along with some results of biological observations *in situ* by fleet and whaling season that were compiled by the Far Seas Fisheries Research Laboratory of the Fisheries Agency were available, and these statistical data were referred or quoted whenever it was felt necessary. To construct an approximate expansion of the whaling ground occupied in the past seasons, I consulted a report series (The

reports on the biological investigations of the North Pacific whale stocks) published by the Japan Whaling Association or the Whales Research Institute, Tokyo. Since the general methods and items of observations in recording the stomach conditions of whales in the field have been reported elsewhere (*e.g.* Nemoto, 1957; Kawamura, 1974), no details were mentioned in this report.

RESULT

1. Whaling ground

Geographical occupation

As it was reported earlier (*e.g.* Nemoto, 1957, 1959), the fin whales occur more larger numbers in the Bering Sea and higher latitudes of the northern North Pacific regions from May to August. Due to reduced catch quotas for fin whales year after year the catches of this whale species during study period were confined in small local areas closer to the Pribilof Islands, whereas in the North Pacific the majority of fin whales were caught in the southeast region off Kamchatka and in the Gulf of Alaska. However, the trends of their catches on the whole were somewhat sporadic during the 1960's. In contrast to fin, the sei whales, a major exploitable species during the study period, were found to be distributed over a wide range of the subarctic North Pacific region of north of 40°N. With the change in exploitable whale species from sei to Bryde's along with the opening of warmer temperate/subtropical region down to 20°N as a possible whaling ground in the western North Pacific, the Bryde's became a major species of pelagic whaling since 1971 (Kawamura, 1973).

In order to show approximate trend of the changes in geographical occupations of whaling ground, Fig. 1 was constructed by selecting several representative whaling seasons. During the 1950's the expansion of whaling ground was confined in geographically smaller area of higher latitudes of the North Pacific. The major whaling ground was established both in the eastern/southeastern waters off Kamchatka Penninsula and in the eastern North Pacific/Bering Sea regions. With the developments of whaling activity along with the change in exploitable whale species from fin to sei the whaling ground during the first half of the 1970's became wide ranged occupation where the southern most whaling ground extended to 40°N such the case as shown in 1971. The trend of more southerly shift of whaling ground in 1972 indicates that the movements of whaling fleet were intense in pursuit of more profitable whaling ground in accordance with lifting of the banned area, and this along with covering the catch quotas for fin and sei resulted a largest occupation of whaling ground during the first half of the 1970's throughout the whole North Pacific whaling.

Since the close of hunting fin and sei whales in 1976, there left the Bryde's alone, a warm water species that inhabits widely the temperate to subtropical waters in the North Pacific (Omura & Nemoto, 1955; Kawamura & Satake, 1976). In order to catch the Bryde's whales there found a new whaling ground in far southern waters down to 20°N particularly in the western North Pacific. The

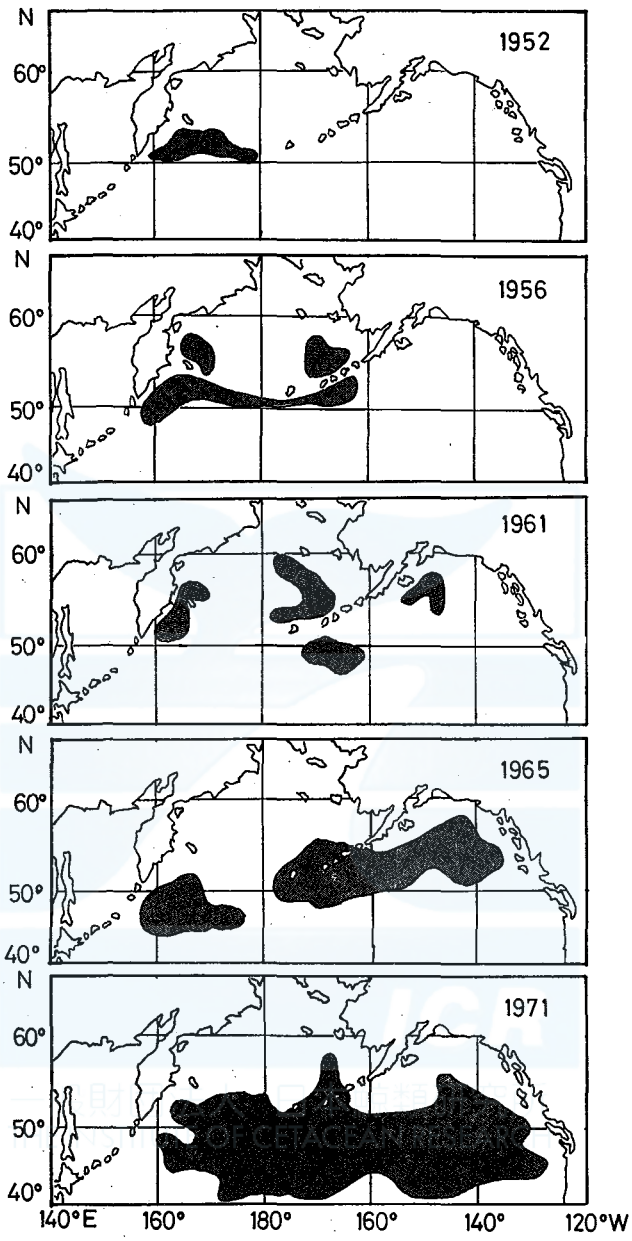
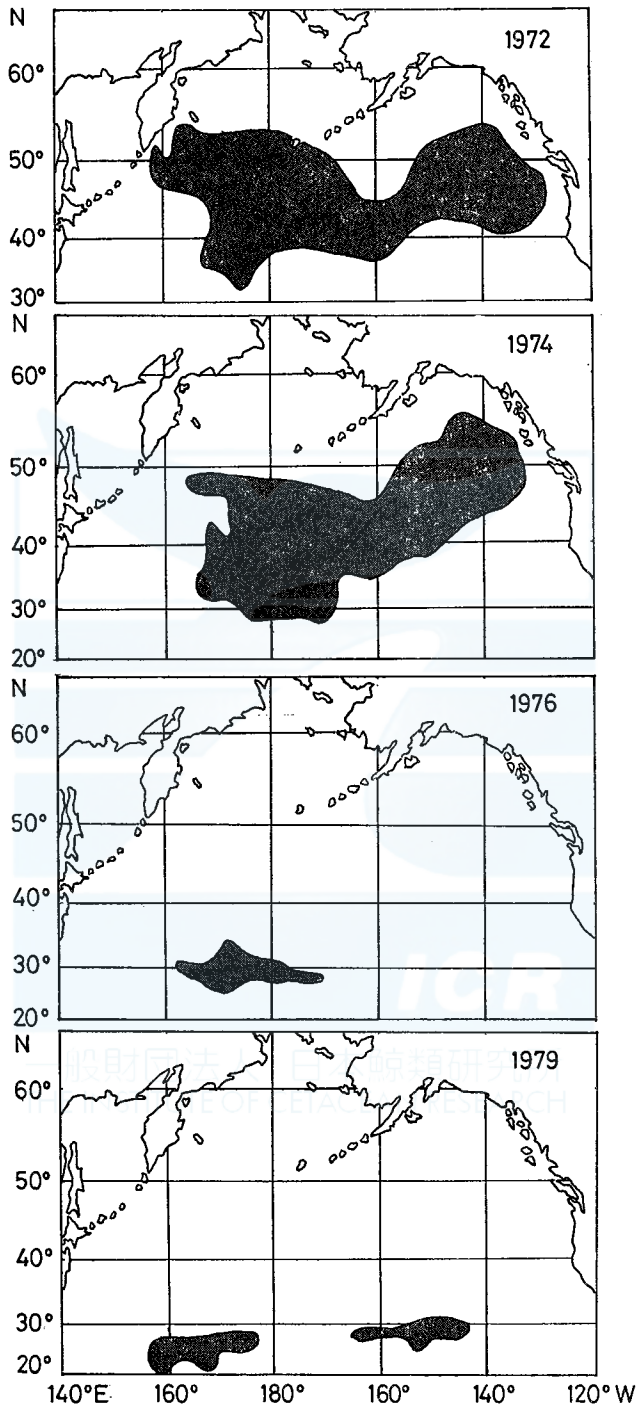


Fig. 1. Geographical occupations of the North Pacific whaling grounds in the past nine seasons.

geographical changes in the occupation of whaling ground can be comparable with the changes in the composition of exploited whale species; the fin and blue were the main species during 1952–1962 when they were hunted in somewhat geographically

(Fig. 1 continued)



smaller local regions. With larger increase in the number of sei whale catch from the 1962–1963 seasons onwards (*e.g.* 4–945 animals in 1955 vs 1398–3819 animals in 1963–1975, IWS, 1967–1972), the whaling ground began to occupy more larger sea area into all horizontal directions until 1975. The very small geographical occupation of whaling ground in the southern North Pacific came from hunting a relatively smaller number of Bryde's whales since 1976, and similar situation continued until 1979, the final whaling season of the long-lasted pelagic whaling in the North Pacific Ocean.

Monthly changes in geographical occupation

Since pelagic whaling in the North Pacific is usually operated for four months or more, the main whaling ground changes in its geographical occupation in accordance with the proceeding of seasons and catch conditions by whale species. Fig. 2 demonstrates such example of changes as shown by monthly occupation through the whaling years of 1969–1973. To see the figures, there observed different monthly occupations from one year to another. In some years such the case as in August of 1970, there were two or more geographically separated whaling grounds occupied within the same month due to difference in accomplished catch conditions by each whaling fleet.

2. Stomach conditions of whales in general

Monthly changes in prey item

Examination of stomach conditions of whales that were processed on the factory ship is one of the items of biological observations in the field. Due to visual observations on the ship each prey item was recorded by the larger taxonomical groups such as the Euphausiacea, Copepoda, Amphipoda, Pisces, and Cephalopoda. One of these available data is found in the catch records of whales by the Fisheries Agency, and a related part of the records were modified to show a monthly changes of prey items in Figs. 3–4, and in appended table, where all data obtained during the 1969–1979 seasons were combined altogether.

It is observed in Figs. 3–4 that there were no significant monthly changes in the percent figure of animals with filled stomach to the total catches, where about 60% of stomachs were found to be filled with variable amount of food over the three whale species and whaling seasons. In the prey items, however, there observed a considerable difference between each whale species. More than 65% of fin whales feed on the Euphausiacea from May through August without notable monthly changes in percent figures. The Euphausiacea along with the Copepoda comprise major food items of the North Pacific fin whales. Towards mid summer, however, the Cephalopoda (=squid) become to share a similar percent to the Copepoda. Sei whales, on the other hand, feed almost exclusively on the Copepoda, and this prey alone accounts for about 75.8% of the animals with filled stomach. Different from the case found in fin whales, relative importance of the Pisces and Euphausiacea is a characteristic food habits of sei whales. In both fin and sei whales the major prey item showed a quite high and less varibale percent fugures

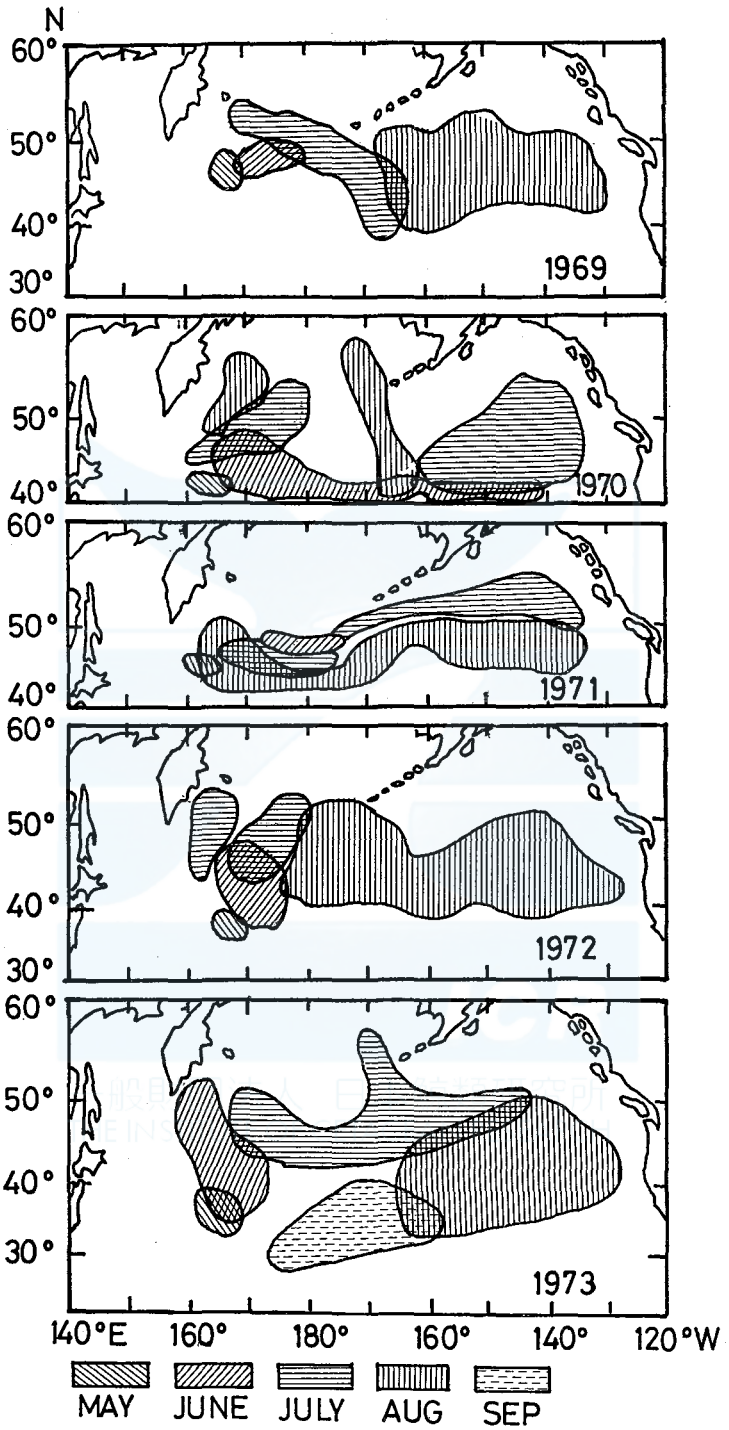


Fig. 2. Monthly occupation of the whaling grounds.

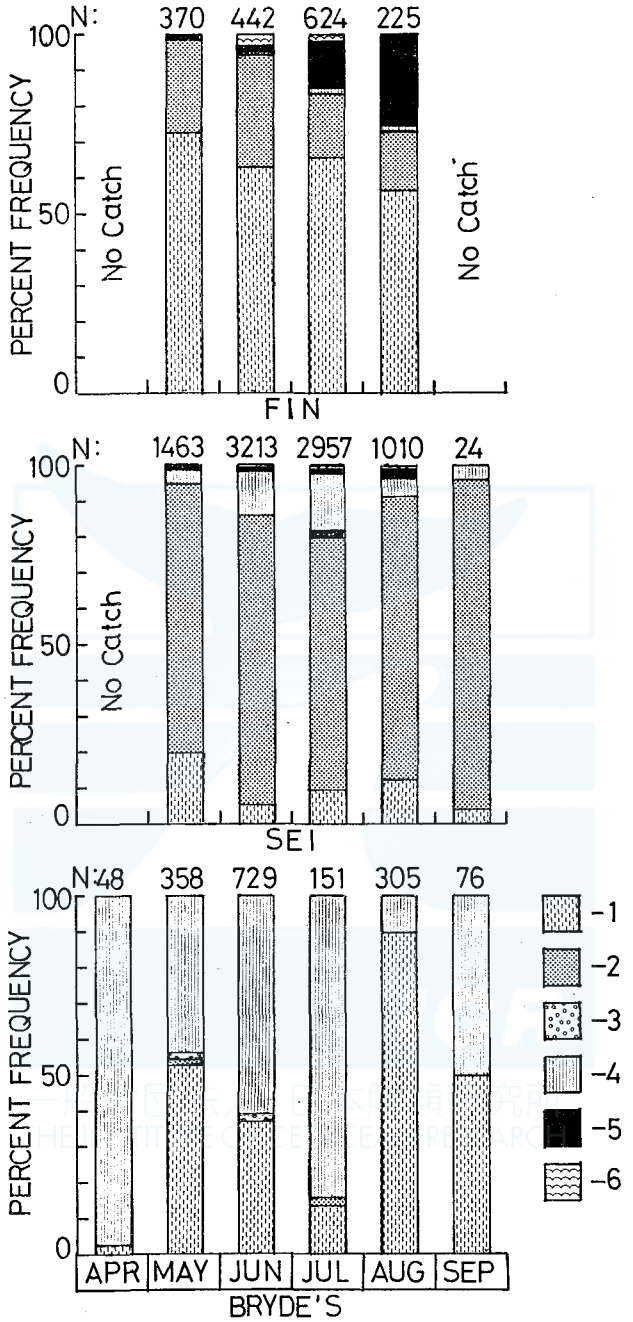


Fig. 3. Composition of stomach contents by the larger prey taxa in fin, sei and Bryde's whales caught during the seasons of 1969–1979.
1-Euphausiacea 2-Copepoda 3-Amphipoda 4-Pisces 5-Cephalopoda(decapoda) 6-Cephalopoda(octopoda)
N: Number of filled stomach

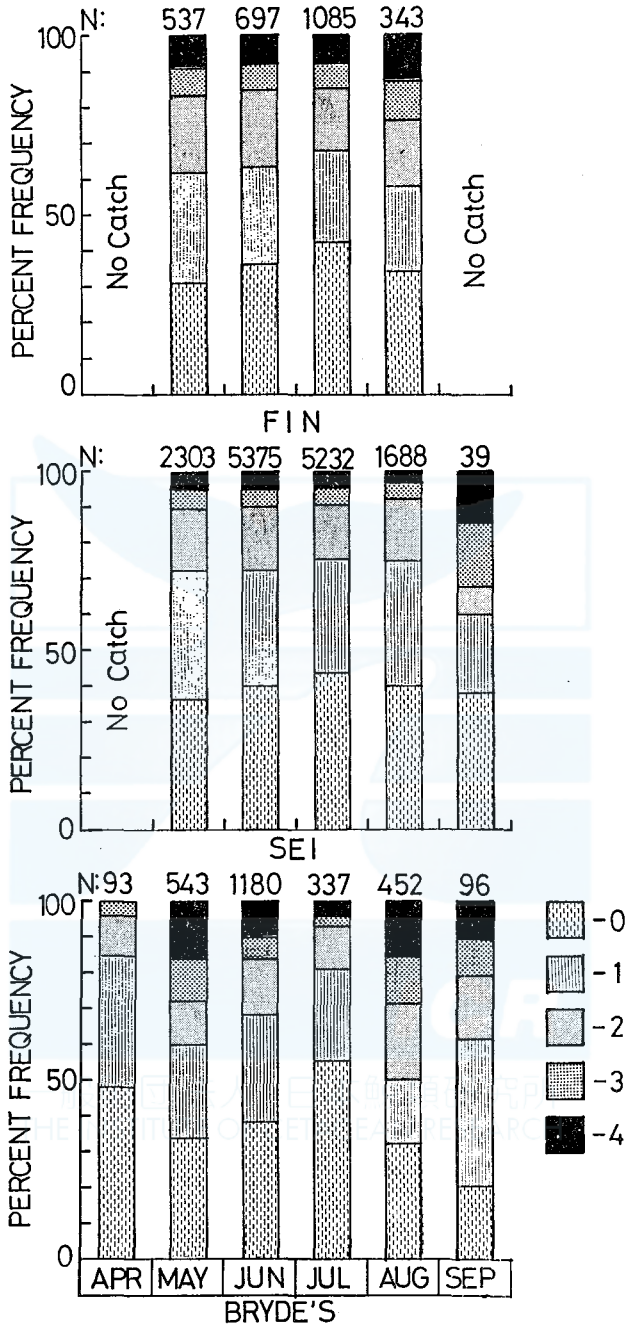


Fig. 4. Stomach fullness in fin, sei and Bryde's whales caught during the seasons of 1969–1979.
0-Empty 1-Few 2-Moderate 3-Rich 4-Full
N: Number of whales

throughout the whaling season. In contrast to this, there observed considerable seasonal changes in the major prey items in Bryde's whales, where both the Euphausiacea and Pisces comprised most important prey items. The Copepoda occurred only in 0.12% of animals with filled stomach, and this prey item along with the Amphipoda and Cephalopoda was unlikely to keep any importance in the food habits of the Bryde's whales. During April the Bryde's feed exclusively on the Pisces, but the Euphausiacea becomes very important food towards mid summer, then fish shares 50% again in September. Although there found the occurrence of ' Octopus ' as one of prey items in the catch records of whales, its occurrence seems to be doubtful since none of this prey was collected as the stomach samples. The overall figures in Fig. 3 clearly show that the major prey items of fin, sei and Bryde's whales in the North Pacific region including a part of the Bering Sea are quite different by each whale species. Dominancy of the Euphausiacea in fin, and the Copepoda in sei whales was seasonally unchanged while that of the Euphausiacea and Pisces in Bryde's whales showed distinct seasonal changes. These characteristics of possible selection in prey items by the whale species have been pointed out elsewhere (*e.g.* Nemoto, 1959; Nemoto & Kawamura, 1977, Kawamura, 1981).

Monthly changes in stomach fullness

The stomach fullness of killed animal was also available in the catch records of whales. Usually, it is recorded in the field by classifying the fullness of stomach into five different categories, being based on approximate volume of stomach contents against a whole stomach volume, *i.e.*, few (less than 25%), moderate (25–50%), rich (50–75%) and full (more than 75%). To see Fig. 4 and appended table the fullness of stomach by each volume category does not seem to change seasonally over the three whale species concerned, but there was slightly higher percent of empty stomach in July. The percentages of empty stomach throughout the whaling months in the order of fin, sei and Bryde's were 31.1–42.5%, 38.5–43.5%, and 20.8–55.2% respectively. Both fin and sei whales showed nearly constant fullness during the whole whaling season whereas the Bryde's alone showed seasonally variable figures. This is probably due to the difference in major prey items of Bryde's whales from fin and sei whales, that is, the Bryde's whales feed mainly on both the Euphausiacea and Pisces, while the latter two feed almost exclusively on one of the Euphausiacea and Copepoda.

The categories of both ' rich ' and ' full ' among filled stomachs were relatively fewer than that of ' few ' and/or ' moderate '. It can be observed over the three whale species that both ' rich ' and ' full ' stomach generally increase in their percentage figures when the ' empty ' stomach decreases, but no clear relationship was observed between the principal prey items and the stomach fullness (Figs. 3–4). An unusual high percentage of filled stomach of Bryde's whales in September came largely from the catches in both the 1974 and 1975 seasons when a vast amount of the gonostomatid fish, *Vinciguerria nimbaria* and euphausiids, *Nematoscelis difficilis* comprised major prey items.

3. Species of prey item

Prey item in general

Because of wider geographical and longer seasonal occupation of whaling ground, there occurred a considerable large number of prey species throughout this study. However, some zooplankton and fish species as whales food known from the animals caught during past seasons in the waters of higher latitudes did not occur completely throughout the present study due to very little effort to catch whales in such regions as reported by Nemoto (1957, 1959). They were: *Metridia lucens*, *Gnathophausia gigas*, cod (*Gadus macrocephalus*), walleye pollock (*Theragra chalcogramma*), Atka mackerel (*Pleurogrammus monopterygius*) Pacific sandlance (*Ammodytes hexapterus hexapterus*), capelin (*Mallotus villosus*), rockfish (*Sebastes polyspinis*), Pacific herring (*Clupea harengus pallasi*) and sea lamprey (*Entosphenus tridentatus*) (Nemoto, 1957).

Instead of these northern fish species there found the occurrence of more variable prey items of warm temperate species in the southern whaling ground. Some of them composed major prey item but some others were considered to be occasional or even accidental occurrence. Table 2 shows all prey items found in the stomach samples taken from fin, sei and Bryde's whales during the 1969–1979 seasons. One of characteristics in the composition of prey items is an occurrence of so variable fish species as whales food, among which a mass occurrence of the gonostomatid fish, *Vinciguerria nimbaria* (see Kawamura & Hamaoka, 1981) and relative importance of the clupeid, scombrid, pentacerotid, scomberesocid, and engraulid fish species are noteworthy. Some of these characteristics found in southerly shifted whaling ground were reported earlier by Kawamura (1973), and he pointed out the ecological significance of the juvenile forms of commercially important fish species for sei whales. The mass occurrence of pelagic armorhead as prey item of sei whales was another interesting evidence that was firstly reported by Chikuni (1970). Although relatively large number of fish species were found in the present study, nine species out of 18 occurred with small number of individuals, and were considered to be an occasional or accidental occurrence.

In crustaceans there occurred four species of calanid copepods, *Calanus plumchrus*, *C. cristatus*, *C. marshallae* and *C. pacificus*, and natantia shrimp, *Sergestes similis* (see Omori *et al.*, 1972). All these five crustacean species were considered very important prey items except *C. marshallae* that was found in one stomach collected in the Alaskan shelf waters in the Bering Sea. In the Euphausiacea, however, the 14 species of euphausiids, which cover such northern temperate species as *Thysanoessa* group to the southern temperate or even subtropical species as *Euphausia similis* and *Nematoscelis difficilis* were found to be another important prey items for fin and Bryde's whales. The luxuarious species composition in euphausiids can be regarded as one of another characteristics that came from the southerly shift of whaling ground during the last decade. It was noticed that there were no other taxonomical groups to be noted as whales food, but locally limited occurrence of the larvae of a squid, *Berryteuthis anonychus*.

TABLE 2. PREY ITEMS OCCURRED IN THE STOMACHS OF FIN, SEI AND BRYDE'S WHALES

COPEPODA
Calanus plumchrus MARUKAWA
Calanus cristatus KRÖYER
Calanus pacificus BRODSKY*
Calanus marshallae FROST
EUPHAUSIACEA
Euphausia pacifica HANSEN
Euphausia similis G. O. SARS
Euphausia recurva HANSEN
Euphausia tenera HANSEN
Euphausia gibboides ORTMANN
Euphausia diomedeae ORTMANN
Thysanoessa inermis (KRÖYER)
Thysanoessa raschii (M. SARS)
Thysanoessa longipes BRANDT
Thysanoessa gregaria G. O. SARS
Thysanoessa spinifera HOLMES
Nematoscelis difficilis HANSEN
Nematoscelis gracilis HANSEN
Thysanopoda monacantha ORTMANN
DECAPODA
Sergestes similis HANSEN
AMPHIPODA
Themisto sp.
MOLLUSCA
Berryteuthis anonychus (PEARCY & VOSS)**
Gonatus sp.**
Limacina helicina helicina (PHIPPS)
COELENTHELATA
Velella sp.
PISCES
Scomber japonicus HOUTTUYN
Maurolicus muelleri (GMERIN)
Tarletonbeania taylori MEAD
Sardinops melanosticta (TEMMINCK & SCHLEGEL)
Engraulis japonica HOUTTUYN
Cololabis saira (BREVOORT)
Pseudopentaceros richardsoni (SMITH)
Exocoetus volitans LINNAEUS***
Decapterus lajang BLEEKER
Argyropelecus aculeatus CUVIER ET VALENCINNES****
Myctophum asperum (RICHARDSON)****
Diaphus bertelseni NAFPAKTITIS*****
Polypnus matsubarai SCHLUTZ****
Ranzania laevis makua JENKINS
Pleurogrammus azonus JORDAN & METZ
Gasterosteus aculeatus LINNAEUS
Sebastes sp.
Vinciguerria nimbaria (JORDAN & WILLIAMS)

* During discussions about this result with Dr A. Fleminger of the Scripps Institute of Oceanography, it was suggested that there must be some occurrence of *Calanus orientalis* among *C. pacificus* occurred in the northern waters.
** Identified by T. Kubodera
*** „ „ K. Amaoka
**** „ „ H. Nakaya
***** „ „ K. Kawaguchi

Some biological notes of the major prey species

Copepoda

C. cristatus: Occurrence of copepodid stage V (CV) alone. The body length was recorded up to 7.7 mm.

C. plumchrus: Occurrence of CV with occasional occurrence of CIV. The former was 41–50 mm with major body size of 41–43 mm, and the latter was about 30 mm.

C. pacificus: CIII-CV, and both adult male and female. Usually CV of 33–36 mm was predominated among all. The prey composition by the developmental stages was usually CV alone, but there were also the case of adult male and female with a dominancy of male, CV+male+female, CV+female, CV+male+female, and CIII+CIV+CV+female. CIII was about 25 mm.

Euphausiacea

E. pacificus: Both adult male and female of 21–22 mm with occasional occurrence of juveniles of 12–17 mm and 6.8–9.3 mm size classes. There was no clear trend in the dominancy of one of two sexes. Some male and female carried a single spermatophore.

E. similis: Adult female alone or juveniles of 17–21 mm.

T. longipes: Both male and female of ordinal and spine forms (12–13 mm) were found. Most example of prey comprised female alone, but sometimes mixture of very few number of adolescent males, or juveniles of furcilia stages. No spermatophore was observed.

T. inermis: Both male and female of ordinal and 2-spined forms. Very strongly biassed in sex composition. Usually, male or female predominates from another.

T. spinifera: Female alone, but occassional mixture with very few number of males. Body size was 23–30 mm. Two spermatophores were found in both sexes.

T. raschii: Male alone or both sexes with considerable predominancy in females.

T. gregaria: Male and female of about equal number. Sometimes juveniles of 9–10 mm were found among adult forms, but lesser extent in quantity. Some adults of both sexes carried one spermatophore.

N. difficilis: Both male and female with variable predominancy of one of two sexes.

T'poda monacantha: Recorded in one sample collected in the northern waters of Hawaii Islands in April 9, 1979.

Decapoda

S. similis: Usually matured adult forms (49–50 mm) and juveniles composed the prey. Occasionally, adolescent forms of 27–35 mm formed the principal prey composition. (see also Omori *et al.*, 1972).

Amphipoda

Only unidentifiable small hyperiids including *Themisto* sp. (4–5 mm). There was no occurrence of adult forms of any amphipod species.

Pisces

V. nimbaria: Most individual was 46–60 mm (T.L.). Details of this fish and its food habits were reported by Kawamura and Hamaoka (1981).

T. taylori: Recorded body length (T.L.) was 46–75 mm. The prey item found in 6 individuals (49–60 mm) was very small hyperiids, Ostracoda, young euphausiids and Copepoda including *Euchirella* sp.

M. muelleri: Recorded body length was 34–58 mm (T.L.) with dominancy of 42–48 mm individuals. Prey items found in 42–58 mm individuals were hyperiids, *Conchoecia* sp., *Pareuchaeta* sp., *Candacia* sp. and micro-calanoida.

G. aculeatus: 36–48 mm (T.L.)

P. azonus: 83–115 mm (T.L.).

E. japonica: 60–125 mm (T.L.), but 60–70 mm was the main body length. Prey item of this fish in June were CV and adult female of *C. pacificus*, furcilia of eupahusiids, *Oikopleura* sp. and micro-calanoida.

S. japonicus: 99–188 mm (T.L.). Very variable prey items were found; *C. pacificus* (CV), *Candacia bipinnata*, *Candacia* sp. *Pseudocalanus* sp., *Oncaea* sp., unidentifiable micro-calanoida, *Phronima pacifica*, *Salpa* sp., *Muggiaea* sp. and fish scale.

S. melanosticta: 75–106 mm (T.L.). Prey item was furcilia of euphausiids, *Clausocalanus arcuicornis*, *Corycaeus* sp. and other micro-calanoida.

C. saira: 98–133 mm (T.L.). Prey item was simply composed of CV of *C. plumchrus*.

*R. laevis makua**: 89–147 mm (T.L.)

*E. monicirrhus**: 98 mm (T.L.)

*D. lajang**: 118 mm (T.L.)

*A. aculeatus**: 56 mm (T.L.)

*D. bertelseni**: 100.5 mm (S.L.) Very rare occurrence as reported by Kawaguchi and Kawamura (1981).

Cephalopoda

B. anonychus: 10–52 mm

4. Geographical distribution of prey organisms

Copepoda

Figure 5 demonstrates the distribution of three copepod species that were preyed upon by fin, sei and Bryde's whales during the summer seasons of 1969–1977 and 1979. Since the stomach samples collected were combined together all through the fishing season and month, the geographical distribution of prey organisms by species showed somewhat complicated features. For example, northern boundaries of *Calanus pacificus* distributions in the eastern half of the North Pacific showed local irregularity, that is, there were several tongue like intrusions of distribution range and/or even an isolated patches in the region occupied by another prey species. The southern boundaries of *C. plumchrus* was the case of similar pattern to *C. pacificus*. As it was mentioned in Table 2, copepods were

* The number of specimens was single or very few, and their occurrence in whale stomachs was considered to be accidental.

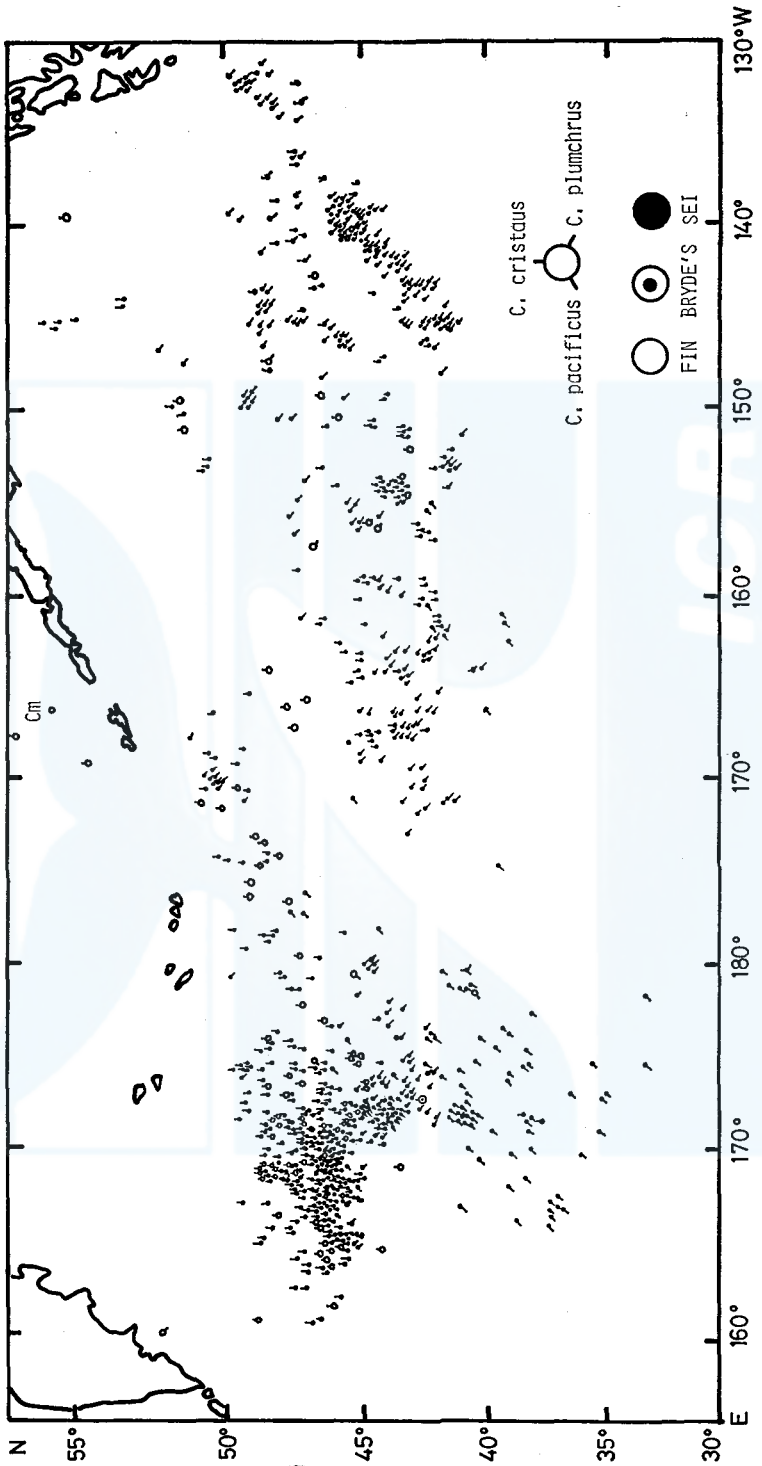


Fig. 5. Distributions of prey copepods. Cm: *Calanus marshallae*.

largely preyed upon by the sei whales, and this resulted to show an absence of any copepod food in the Bering Sea, because the sei usually does not enter this region (Nemoto, 1959). One of copepod samples collected at the slope region of the Alaskan Continental Shelf consisted of *Calanus marshallae*. This evidence is perhaps the first record of the species as whales food from this region. To see the general distribution pattern over the whole North Pacific, it is clearly observed that the major occurrence region of *Calanus pacificus* is concentrated in the western half of the subarctic North Pacific with two eastern most occurrences in 155°W. *C. cristatus*, one of another major prey item was found to be the most important food copepods both for fin and sei whales in the western half region. *C. cristatus*, however, may possibly become important prey item in the northern latitudes in the Gulf of Alaska.

C. plumchrus, on the other hand, began to occur frequently towards the eastern half region with most prominent occurrence in the pelagic region of the mid latitudes in the east of 150°W. In the central region of the North Pacific the distributions of *C. plumchrus* became very scarce or almost absent between 180° and 170°W, but this species occurred at 37°N as the southern most record throughout this study. Due to somewhat sporadic whaling effort in the Gulf of Alaska, information of this region is very limited but suggesting a possible importance of *C. cristatus* both for fin and sei whales.

In general the characteristics of copepod prey in its distributions are summerized as that *C. cristatus*+*C. pacificus* dominate in the western half but they change to *C. cristatus* alone or *C. cristatus*+*C. plumchrus* community in the middle. Towards more east, *C. cristatus* occurs again but it finally changes to *C. plumchrus*.

Euphausiacea

In contrast to copepod, the prey species of the Euphausiacea comprised at least 14 species (Fig. 6). Due to smaller number in the catch of fin whales that feed mainly on euphausiids, spots of distributions in Fig. 6 showed more dispersed occurrence than the copepod food. In the northern waters north of 50°N there occurred only fin whales except a very few sei whales, but the fin also occurred considerably in the southern waters down to 35°N in the western half region. In the shelf region of the Bering Sea there were five collections from fin whales, and *Thysanoessa rashii* was the major prey item. In the higher latitudes of the North Pacific, *T. spinifera*, *T. inermis* and *T. longipes* were found to be the most important prey items, of which *T. spinifera* showed its importance in the offshore region of British Columbia, while the latter two species frequented in the pelagic regions. In the middle latitudes between 40°–50°N, *Euphausia pacifica* was exceptionally occurred both in fin and sei whales along with two *Thysanoessa* species. Towards southern waters, however, the composition of prey became to show more complexity by the local and sporadic occurrence of many rare species such as *Thysanopoda monacantha*, *Nematoscelis difficilis*, *Euphausia gibboides*, *E. tenera*, *E. recurva* and *E. diomedeae*. Apart from fin and sei whales, the catch of Bryde's whales was clearly confined in the southwestern region down to 25°N, where *E. similis*, *N. difficilis* and *T. gregaria* were found to be most important as the prey items.

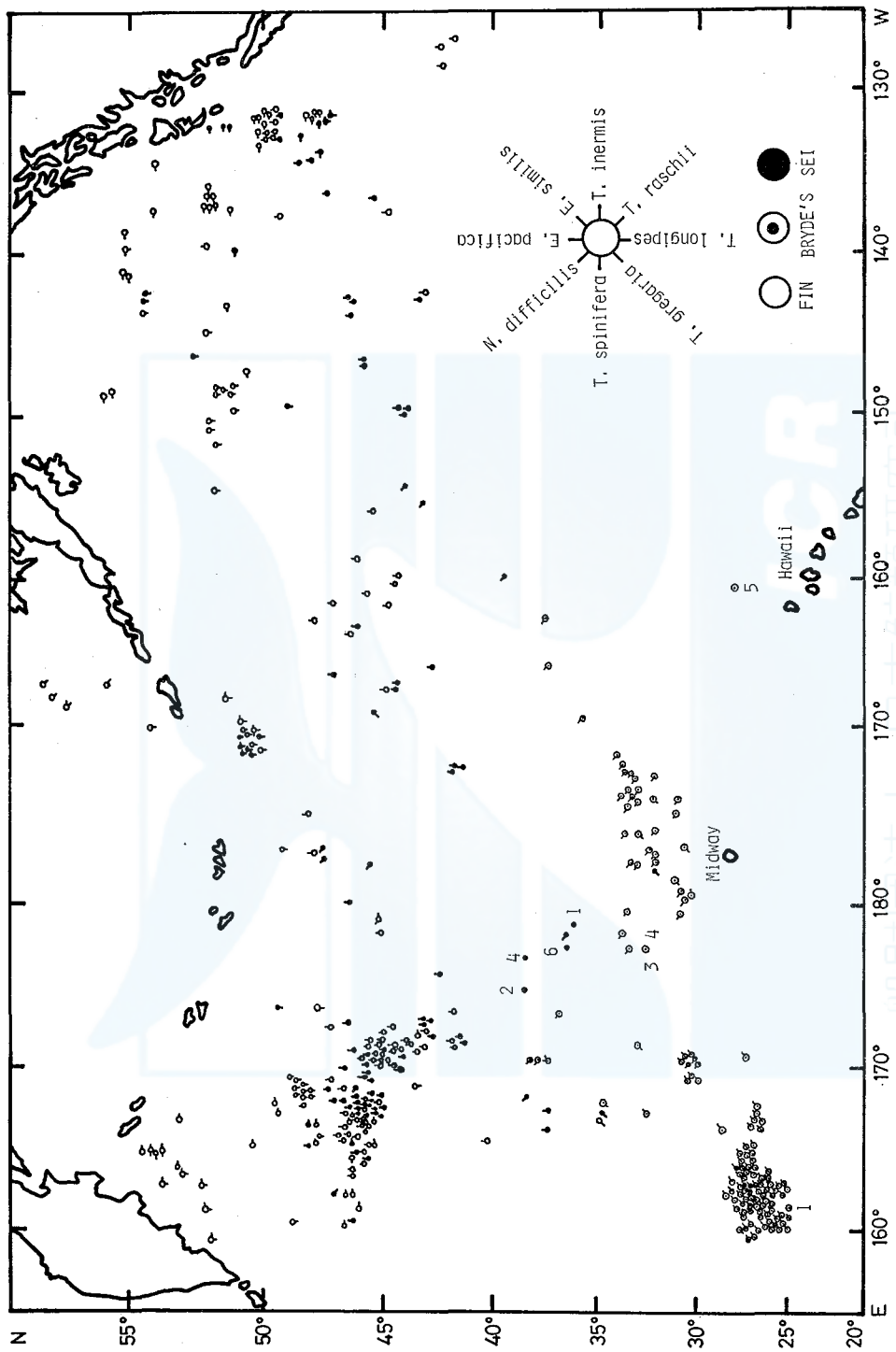


Fig. 6. Distributions of prey euphausiids.
1-*Euphausia recurva* 2-*Euphausia similis* 3-*Euphausia gibboides* 4-*Nematoscelis gracilis* 5-*Thysanopoda monacantha* 6-*Euphausia diomedeae*

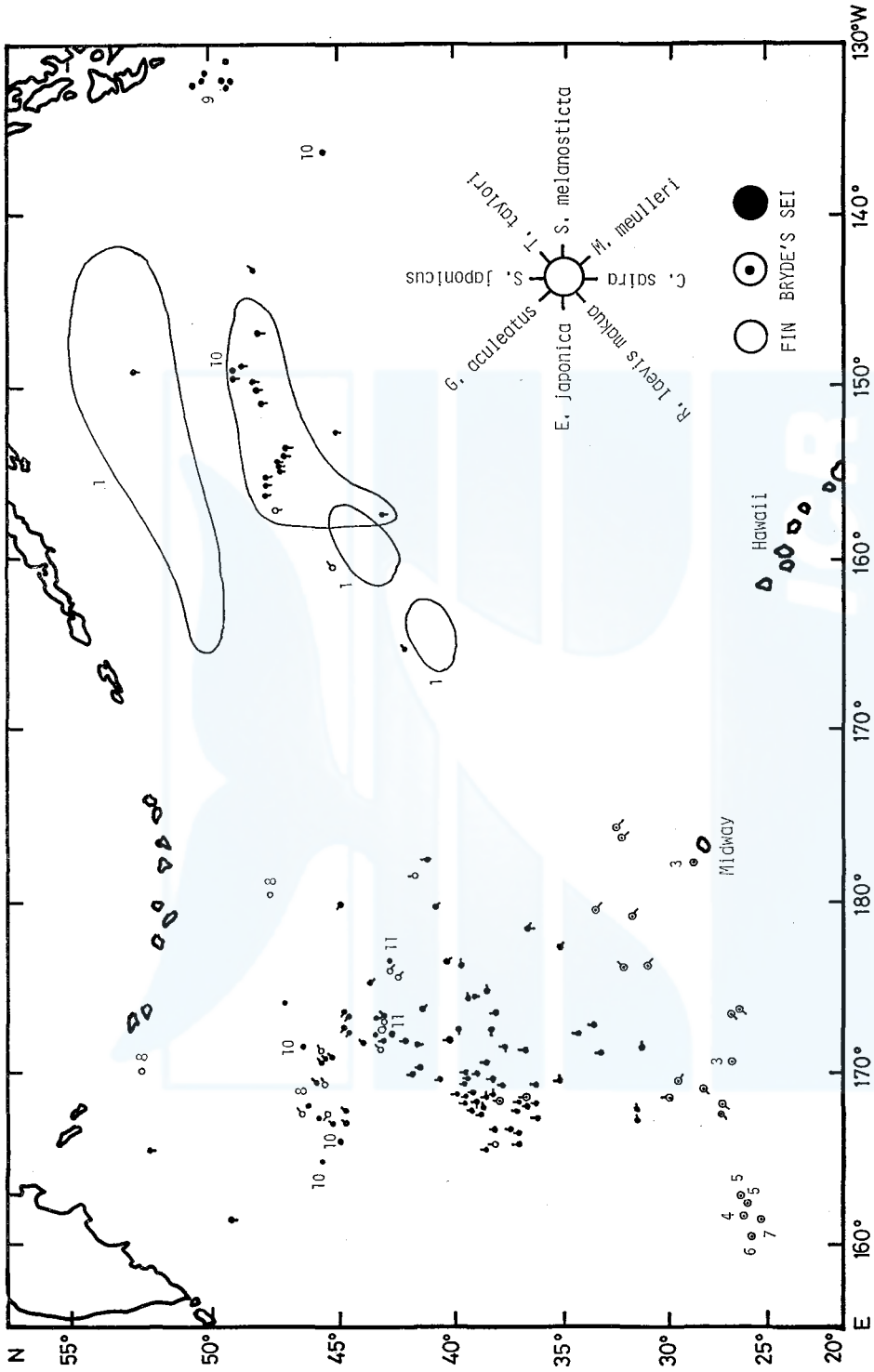


Fig. 7. Distributions of prey fish. The encircled areas show approximate range of the occurrences of pelagic armorhead and Pacific saury that found in the catch records of whales compiled by the Fisheries Agency.
1-*Pseudopentaceros richardsoni* 2-*Exocoetus volitans* 3-*Decapterus lajang* 4-*Argyropelecus aculeatus* 5-*Myctophum asperum* 6-*Diaphus bertelseni* 7-*Polyipnus matsubarai* 8-*Pleurogrammus azonus* 9-*Sebastes* sp. 10-Myctophids(unidentified) 11-Trigger fish(unidentified)

Pisces

There were very few stomach samples of fin that preyed upon fish, but both sei and Bryde's whales fed largely on such various kind of fish species as pointed out by Nemoto & Kawamura (1977). To see Fig. 7 there observed very clear difference in major prey items between western and eastern halves of the North Pacific. The fin and sei occurring in the western half region of the mid latitudes ate pre-

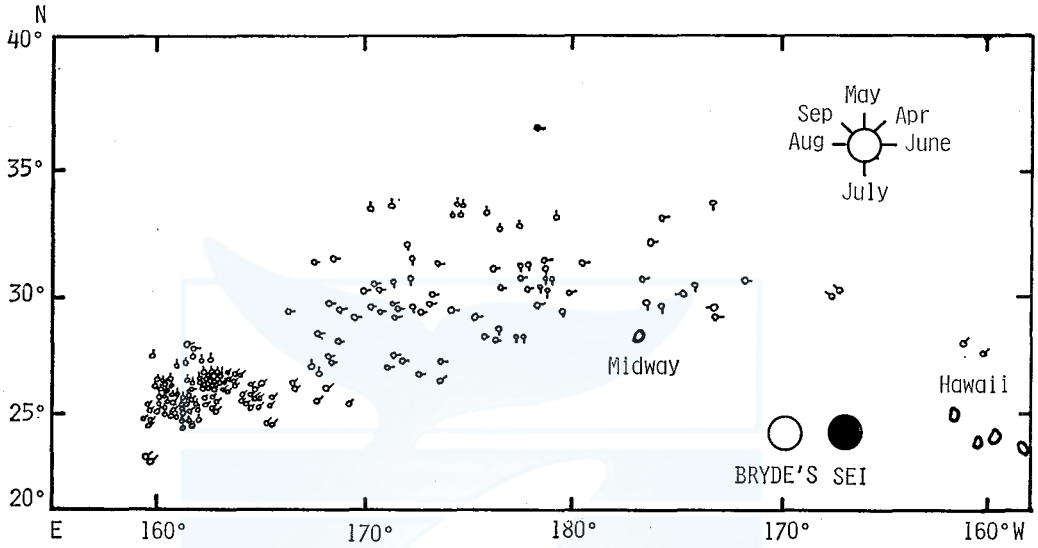


Fig. 8. Monthly distribution of *Vinciguerria nimbaria* eaten by the sei and Bryde's whales.

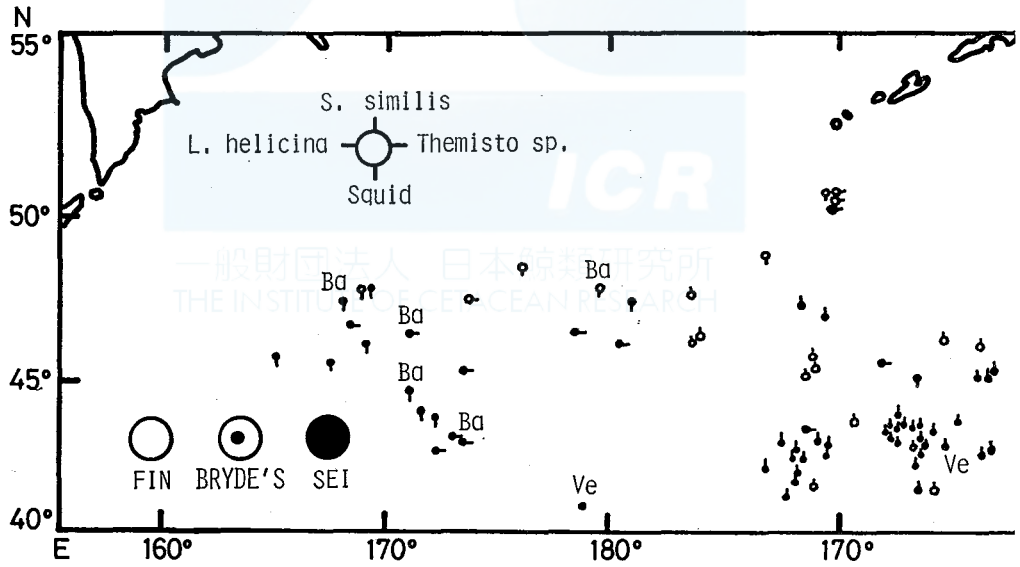


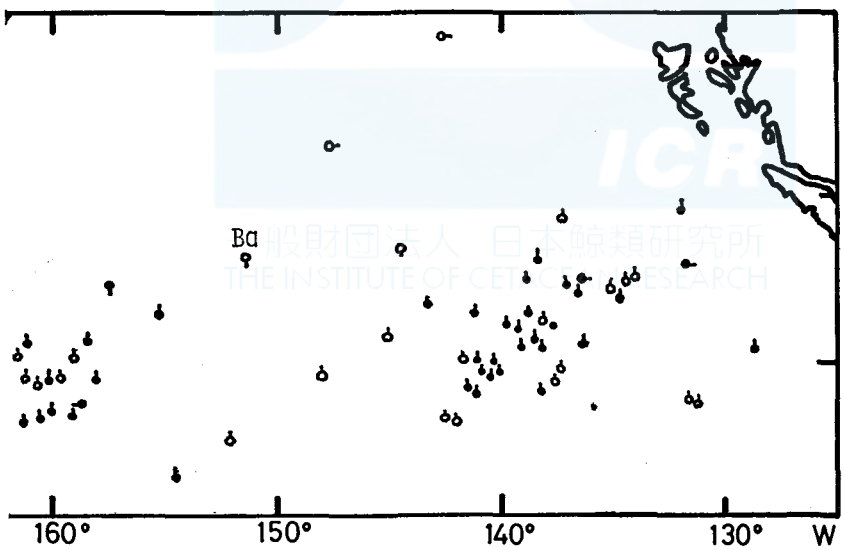
Fig. 9. Distribution of shrimp, *Sergestes*
Ba: *Berryteuthis*

dominantly on mackerel (*S. japonicus*) among all and both anchovy (*E. japonica*) and Japanese sardine (*S. melanosticta*) came to the next. Towards more northern waters, however, the major prey item changed to a myctophid fish (*T. taylori*) and three spine stickleback (*G. aculeatus*) while gonostomatid fish (*V. nimbaria*), *M. muelleri*, *R. laevis makua* and myctophids (*M. asperum* and *Diaphus bertelseni*) may become important prey for the Bryde's whales (see also Fig. 8, and Kawamura & Hamaoka, 1981). Among various species of fish prey *V. nimbaria* is considered most important item for the Bryde's whales occurring in the subtropical regions of the North Pacific during April through September (Fig. 8).

In the eastern North Pacific the collection of stomach samples was fewer than the western region due to difficulty in collecting and preserving such large-sized fish prey as the pelagic armorhead (*P. richardsoni*). Being based on the catch records of whales by the Fisheries Agency, it was proved that the sei eat mainly Pacific saury (*C. saira*) during July to August in the pelagic waters of the eastern half region. One of another important fish species was pelagic armorhead in the Gulf of Alaska region. Because of its large-sized body length and easiness in identification in the field, no *P. richardsoni* was collected as stomach samples, but their occurrence in the catch records of whales was indicated by the encircles in Fig. 7. Closer to waters off Vancouver Island, there were another possible important prey item, the larval forms of rock fish (*Sebastes* sp.).

Others

Among several other prey items the sergestid shrimp, *S. similis* was most important prey both for fin and sei whales in the midst towards eastern region of the northern latitudes between 40°–50°N as it was reported previously (Omori *et al.*, 1972). To see Fig. 9 along with Figs 5–7 it can be observed that *S. similis* was



similis and other prey species.
anonychus, Ve: *Vellela*

one of very few prey items that was available in the midst of the northern North Pacific. Towards west, however, larval forms of squid (*B. anonychus* and *Gonatus* sp.) and hyperiid amphipods were considered to be moderately important. However, amphipods represented largely by *Themisto* sp. never showed such importance of appreciable extent as the case known in the southern counter part, *Parathemisto gaudichaudii* (Kawamura, 1970, 1974).

5. Species composition of stomach contents

Fin whales

It was indicated in Table 3 that the euphausiids were relatively more important than the copepods as food of fin whales. However, the detailed composition of prey species being based on the collected material shows that very limited number of euphausiid species actually comprise a major food of fin whales. The matrix of prey composition clearly shows a predominant occurrence of three euphausiid species, *i.e.*, *E. pacifica*, *T. longipes*, *T. spinifera*, and *T. inermis* (Table 3). Although there were several examples of mixture with other prey species in both the case of *E. pacifica* and *T. inermis*, most stomach contents were found to be monospecific in the composition.

In copepods, *C. cristatus* was a major prey item, and this species along with sergestid shrimp, *S. similis* formed additional important prey items. The very clear monospecific composition in *T. spinifera* was noteworthy, while there were many examples of mixed composition in *T. inermis*. The major prey species that composed a stomach contents was usually monospecific. In three examples, however, there found mixed compositon of food with three species such as *C. cristatus*+*T. longipes*+*T. spinifera*, *T. inermis*+*N. difficilis*+*C. pacificus* and *T. inermis*+*T. longipes*+*C. cristatus*. There were only four stomachs that were filled with fish. Although there occurred a considerable number of prey species on the whole, it can be said that the fin whales in the North Pacific region mainly live on by eating six species of crustaceans where euphausiids account for a largest part of the prey composition.

Sei whales

In contrast to somewhat simple or poor composition of prey species in fin whales, a total of 27 prey items were found to be important in sei whales. As mentioned before, copepod food was found in quite large part of the sei whale stomachs, and *C. cristatus*, *C. plumchrus* and *C. pacificus* accounted for more than 79% among all stomachs examined (Table 4). One of the characteristics in the copepod food was a frequent occurrence of mixed composition with different prey items such as with euphausiids particularly the case in *C. plumchrus*. To see the frequency in the number of stomachs, relative importance of euphausiid food reduced largely in sei whales except the case in *E. pacifica*, but sergestid shrimp, *S. similis* that was a very important prey item in fin whales also showed considerable importance again in sei whales. One of characteristic compositions was the relative importance of commercially important fish species as a major prey com-

TABLE 3. COMPOSITION OF THE STOMACH CONTENTS IN FIN WHALES (NUMBER OF STOMACHS)

Major components \ Minor components	*C. cristatus*	*C. plumchrus*	*C. marshallae*	*C. pacificus*	*E. pacifica*	*T. longipes*	*T. spinifera*	*T. inermis*	*T. raschii*	*T. gregaria*	*N. difficilis*	*S. similis*	*V. nimbaria*	*S. japonicus*	*G. aculeatus*	*P. azonus*	*T. taylori*	Squid	*C. pacificus* + *N. difficilis*	*C. cristatus* + *T. raschii*	*C. cristatus* + *T. longipes*	*T. longipes* + *T. spinifera*	*T. inermis* + *T. spinifera*	Total	Percent
C. cristatus	52	1			3	5										1	1	3				1		67	25.9
C. plumchrus	1	7																						8	3.08
C. marshallae			1																					1	0.39
E. pacifica	8				40		1					1					2							52	20.07
T. longipes	7					19		2															1	29	11.20
T. spinifera							29																	29	11.20
T. inermis	1					4	2	18											1	1	1			28	10.81
T. raschii	1			1					1															3	1.16
T. gregaria										1			1											2	0.77
N. difficilis											1													1	0.39
S. similis					2							25					2							29	11.20
M. muelleri													1											1	0.39
S. japonicus														2										2	0.77
G. aculeatus															1									1	0.39
Squid																		5						5	1.93

TABLE 4. COMPOSITION OF THE STOMACH

Minor

Major components	*C. cristatus*	*C. plumchrus*	*C. pacificus*	*E. pacifica*	*E. diomedeae*	*E. recurva*	*E. tenera*	*T. longipes*	*T. spinifera*	*T. inermis*	*T. gregaria*	*N. difficilis*	*N. glacilis*	*S. similis*	*G. aculeatus*	*P. azonus*	*C. saira*	*S. japonicus*	*S. melanosticta*	*E. japonica*	*Sebastes* sp.	*M. muelleri*
C. cristatus	398	3		9						1		1		1								
C. plumchrus	10	270	3	5				3		1				11	3		1				1	
C. pacificus		3	89	2		1				2	1	4										
E. pacifica	5	5	4	37					1									1				
E. diomedeae					1																	
E. recurva						1																
E. tenera							1															
T. longipes								4		3												
T. spinifera									7													
T. inermis										1												
T. gregaria											2											
N. difficilis												2										
N. glacilis													1									
S. similis		4												48								
G. aculeatus															2							
P. azonus																1						
C. saira																	5					
S. japonicus		1	2															33	2	1		
S. melanosticta																			5			
E. japonica																				3		
Sebastes sp.																	1				5	
M. muelleri																						5
T. taylori																						
myctophido																						
P. richardsoni (?)																						
Squid				1																		
L. helicina																						

* Since the occurrence of the pelagic armorhead, *P. richardsoni* was based on the catch records of whales excluded from this table.

ponent. They were, Japanese mackerel, *Sebastes* sp., Pacific saury, Japanese sardine, Japanese anchovy, and lanternfish, *M. muelleri*. These greater variety of prey composition in sei whales is the reflexion of larger geographical occupation of whaling ground along with longer duration in sei whale catches. There were several records of mixed stomachs composed of more than three prey items; they were, *E. pacifica*+*C. cristatus*+*T. taylori*, *E. pacifica*+*S. similis*+*Vellela* sp., *T. longipes*+*C. plumchrus*+*T. inermis*, *T. longipes*+*T. inermis*+*T. spinifera*, *E. pacifica*+*C. pacificus*+*C. cristatus*, *C. plumchrus*+*C. pacificus*+*C. cristatus*, and *S. similis*+*C. plumchrus*+*C. cristatus*. Although prey composition showed greater variety in sei whales, but it can be said that the sei in general feeds largely on three species of copepods, one species of euphausiids, sergestid shrimp, and scombrid fish.

CONTENTS IN SEI WHALES* (NUMBER OF STOMACHS)

components

T. taylori	myctophids	*P. richardsoni* (?)	Squid	*L. helicina*	hyperiids	*C. pacificus* + *C. plumchrus*	*C. pacificus* + *C. cristatus*	*C. plumchrus* + *C. cristatus*	*C. cristatus* + *T. taylori*	*T. inermis* + *T. spinifera*	*C. plumchrus* + *T. inermis*	*S. similis* + myctophids	*T. taylori* + myctophids	*S. similis* + *Velella* sp.	*C. saira* + squid	*Velella* sp.	Total	Percent
6	2		5		5								1				427	39.8
1	1		2				1										318	29.7
																1	103	9.6
3						1			1			1		1			60	5.6
																	1	0.09
																	1	0.09
																	1	0.09
					2					1	1						12	1.1
																	7	0.6
																	1	0.09
																	2	0.18
																	2	0.18
																	1	0.09
								1									53	4.9
																	2	0.18
																	1	0.09
																	5	0.47
																	39	3.6
																	5	0.47
																	3	0.28
																	6	0.56
																1	6	0.56
1																	1	0.09
	1																1	0.09
		1															1	0.09
3			8														12	1.11
				1													1	0.09

alone, the actual composition of stomach contents was unknown, and consequently this fish species was

Bryde's whales

Due to different geographical occupation of whaling ground in the case of the Bryde's whales, the composition of major prey item for this whale species was far different from that in fin and sei whales (Table 5). Most important prey item was a gonostomatid fish, *V. nimbaria* which accounted for more than 55% among all instance, and *E. similis* came to the next (25.2%). *N. difficilis* was also important member of the prey composition (10.8%). Except a single record of multispecific prey composition (*V. nimbaria*+*E. gibboides*+*N. gracilis*), the food of Bryde's whales can be considered quite monospecific with stronger trends of eating small and gregarious fish species in the pelagic waters.

TABLE 5. COMPOSITION OF THE STOMACH CONTENTS IN BRYDE'S WHALES (NUMBER OF STOMACHS)

Major components \ Minor components	*C. cristatus*	*E. similis*	*E. recurva*	*T. gregaria*	*T. inermis*	*N. difficilis*	*E. gibbosides* + *N. glacilis*	*S. similis*	*V. nimbaria*	*M. muelleri*	*S. japonicus*	*S. melanosticta*	*T. taylori*	*L. laevis makua*	*E. volitans*	*D. lajang*	*P. matsubarai*	*A. aculeatus*	*M. asperum*	*D. bertelseni*	Fish bones	Total	Percent
C. cristatus	1																					1	0.03
E. pacifica		1																				1	0.03
E. similis		80							2										2			84	25.2
E. recurva			1																			1	0.03
T. gregaria				5																		5	1.5
T. inermis					1																	1	0.03
Thysanoessa sp.		1																				1	0.03
N. difficilis						35			1													36	10.8
T'da monacantha									1													1	0.03
S. similis								1														1	0.03
V. nimbaria		3		1			1		175			1					1	1		1		184	55.1
M. muelleri									1	3												4	1.2
S. japonicus											4											4	1.2
S. melanosticta												1										1	0.03
T. taylori													1									1	0.03
L. laevis makua									1					4								5	1.5
E. volitans															1							1	0.03
D. lajang																1						1	0.03
Fish bones																					1	1	0.03
																						334	

DISCUSSION

The whaling ground during the seasons of 1969–1979 was occupied in the more southern sea regions than that occupied during the 1950's to early 1960's. This geographical difference along with somewhat seasonally longer whaling operation resulted to show a wide ranged variety in the taxon of prey items, particularly in species composition of the Euphausiacea and Pisces. The conditions of surface sea temperature in general over the whaling ground is considered to be somewhere between about 26°C and 10°C in August (Sverdrup *et al.* 1942), and from the zoogeographical point of view in zooplankton communities, the whaling ground of under consideration includes the region of boreal complex, zone of mixing and even tropical complex (Zenkevitch, 1963).

The stomach condition of whales in general revealed that about 60% or more stomachs of fin, sei and Bryde's were filled with variable amount of food without showing any notable seasonal changes in the percent figures of filled stomach. According to Nemoto (1957), 52% of fin and 44% of sei caught in the northern North Pacific during the 1952–1956 seasons were found to be filled stomachs. These percentages seem to be considerably lower than the above mentioned figures (ca.

60%) found in this study. During the years of 1952–1971 when the whaling ground began to expand southwards, the corresponding percentages for fin and sei were 60% and 55.5% respectively (Nemoto & Kawamura, 1977), while it was 94% and 81% respectively in the Kurile region (after Sleptsov, 1955). These figures seem to be high enough when it is compared with that found in the present study and also in the Antarctic feeding grounds (Kawamura, 1978). Usually the distribution of zooplankton biomass in the boreal region of the northwestern North Pacific decreases to about 1/5 or 20% towards the tropical region (Zenkevitch, 1963). According to Odate (1966), the wet zooplankton biomass in the south of 40°N of the western North Pacific was 20–30 gr/1000 m^3 while it was 200–400 gr/1000 m^3 in the boreal regions of the North Pacific and Bering Sea. Notwithstanding these facts the comparisons mentioned above strongly suggest that the boreal or subarctic North Pacific to the subtropical or even tropical regions may provide very important feeding ground for the baleen whales as well as the northern North Pacific region. One of possible, but important explanations for this is the local and extremely biassed patchy distributions of prey species (e.g. Brodie et al. 1978; Kawamura, 1979). The occurrence of fish prey in the southwestern North Pacific may come from the scarceness of patch-forming zooplankton species in this region since those fish species can eat and survive on such variable zoo plankton species as studied in *Vinciguerria nimbaria* (Kawamura & Hamaoka, 1981).

As it was shown in Fig. 4 the stomach fullness by the quantity of contents did not change seasonally in its general pattern over the three whale species. However, stomachs combined both ' full ' and ' rich ' showed relatively higher figures in fin and Bryde's than sei whales. This evidence seems to be related to the difference of major prey items between whale species as shown in Fig. 3, where it was suggested that the larger the size of prey organisms, the larger percent of well filled stomachs were expected (Nemoto, 1963). Similarly, the smaller percent figures of ' full ' and ' rich ' stomach in sei whales that feeds mainly on copepods are resulted from more smaller size of prey, since the biomass of prey organisms may become smaller in accordance with the reduction of their body size (Nemoto & Kawamura, 1977). The prey items which occurred in boreal regions of the North Pacific were agreed on the whole to those known previously in the pelagic waters (e.g. Nemoto, 1959), and distributions of *Thysanoessa* species and copepods were agreed well to that found in the Olyutorsky and Commandorsky regions (Ponomareva, 1949). However, when each prey item is compared with the case found in marginal seas such as the Kuril or Bering Sea regions, there were considerable difference in the composition of prey fish species. As mentioned before, there occurred no common fish species between the results from the Bering Sea and the present study (see Kawamura, 1980, Table 17), while only two species, Pacific saury and anchovy were common with the Kurile region (Betesheva, 1954, 1955). In the Far Eastern Seas, of 14 prey fish species only Pacific sardine and Pacific saury were common with the present study (Sleptsov, 1955; Tomilin, 1967). These characteristics in the prey composition suggest that the feeding conditions of whales in the North Pacific may differ considerably from place to place especially in the marginal sea

regions, but they also differ in several prey taxa even in the pelagic waters.

Distributions of each prey species showed very interesting results (Figs. 5–9). Since stomach samples obtained during 1969–1977 and 1979 seasons were plotted altogether simply by separating each major prey species, the number of plots do not agree with the number of stomachs sampled because there were many examples of mixed stomach composition of two or more species. Figures 5–9 however, demonstrate a zoogeographical pattern of ditribution of each prey item during April to September, where variable density of plot distribution suggests relative abundance of whale distribution by sea regions. To see through Figs. 5–9 the overall distribution pattern of each prey species agrees well with the generally known zoogeography of planktonic animals such as the distribution boundary of *Calanus* species (e.g. Minoda, 1958; Omori, 1965 Frost, 1974), euphausiids (e.g. Boden *et al.*, 1955; Mauchline and Fisher, 1969) and lanternfishes (e.g. Wisner, 1974; Gjosaeter and Kawaguchi, 1980). However, important evidence is that the plotted region indicates more possible area of frequent occurrence of plankton aggregations that are preferable food condition for baleen whales, and a vacancy of the plots never means negative distribution of each corresponding prey species. In this connection, the lack of amphipods as whales food in the North Pacific must be noteworthy, while *Parathemisto gaudichaudii* constitutes important prey item in the southern sei whales (Kawamura, 1974). Actually several number of *Themisto* species are known to form dense swarms, but they were not eaten by the whales.

The characteristic of the stomach contents as shown in Tables 3–5 is such an extremely predominant occurrence of monospecific composition over the stomachs of three whale species as it was reported by Kawamura (1974, 1980) for the southern sei and Bryde's whales. Although data on the freshness of stomach contents by each prey species were not shown in this study, it was observed that the freshness of prey species which occurred together in a stomach such as the case of *C. plumchrus* and *C. pacificus*, was different from one to another. Similarly the different freshness can be observed in many stomachs when their contents were composed of more than two prey species. As it was discussed on the mixed prey with *C. cristatus* and *C. plumchrus* (Nemoto, 1963), these phenomenon was perhaps caused by the time-lag in picking up each prey species due to horizontal and vertical differences in the distribution of prey organisms. Occurrence of the Siphonophora, *Velella* sp., however, indicates that the whales often feed in the very surface waters. The plot in Figs. 5–9 consequently, suggests that how frequently each prey organism occurs patchily in the region by forming dense monospecific swarms, aggregations, and/or schools. After analysing a small scale of distributions of whales and their stomach contents observed within a short enough period, Kawamura (1978) estimated a spacial scale of patchiness of prey species as less than 5–6 km as an estimated diameter of patches in *C. cristatus*, *C. plumchrus* and *C. pacificus* complex whereas it was slightly larger in *E. pacifica*, *T. inermis*, *T. raschii*, *T. longipes*, *T. spinifera* and possibly in *N. difficilis*.

To conclude the geographical distributions of prey species that form dense swarms or aggregations, it can be summerized that the North Pacific fin, sei and

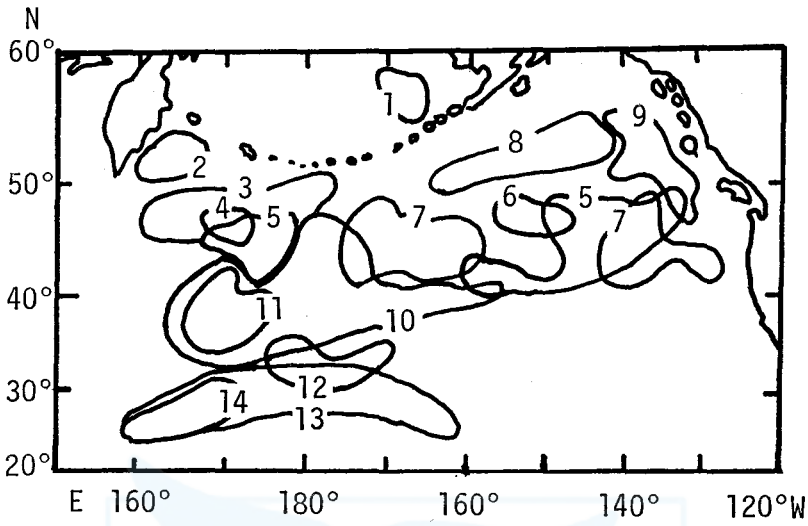


Fig. 10. Approximate geographical occupations of the principal prey species. 1-*Calanus marshallae* 2-*Thysanoessa inermis* / *T. longipes* 3-*Calanus cristatus* 4-*Tarletonbeania taylori* 5-*Calanus plumchrus* 6-*Cololabis saira* 7-*Sergestes similis* 8-*Pseudopentaceros richardsoni* 9-*Thysanoessa spinifera* 10-*Euphausia pacifica* 11-*Calanus pacificus* 12-*Nematoscelis difficilis* 13-*Vinciguerria nimbaria* 14-*Euphausia similis*

Bryde's whales share a possible prey species each other by selecting euphausiids, copepods and fish communities respectively. Among so many variable prey items, the distribution ranges of major prey species over the whole North Pacific can be demonstrated in schema (Fig. 10). Although *C. cristatus*, *C. plumchrus* and *C. pacificus* are known to distribute widely over the whole North Pacific, the main occurrence of their patchy swarms show different geographical distributions, i.e., both *C. cristatus* and *C. pacificus* predominantly form their patches more frequently or intensively in the northwestern to western North Pacific whereas *C. plumchrus* does in the eastern North Pacific. Although physical and chemical conditions of the sea surface in the northern North Pacific shows very homogeneous features from the west to the east in general, the distributions of many prey species on the whole suggest that there seems to exist geographically discontinuous region somewehere between 160°–170°W where the variety of prey species is very poor.

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APPENDIX I. STOMACH CONDITIONS OF FIN, SEI AND BRYDE'S WHALES CATCH RECORDS OF WHALES COMPILED BY THE FAR SEAS

		Catch	Food item				
			Euphausiacea	Copepoda	Amphipoda	Pisces	Squid
Fin	May	537	268 (72.4)	101 (27.3)	—	—	1 (0.3)
	June	697	281 (63.6)	139 (31.4)	—	6 (1.4)	1 (0.2)
	July	1,085	410 (65.7)	115 (18.4)	—	5 (0.8)	92 (14.7)
	August	343	128 (56.9)	35 (15.6)	—	1 (0.4)	61 (27.1)
	Total	2,662	1,080	388	—	12	154
	% to total		65.4	23.5	—	0.7	9.32
Sei	May	2,303	293 (20.0)	1,092 (74.6)	—	69 (4.7)	9 (0.6)
	June	5,375	169 (5.3)	2,574 (80.1)	—	456 (14.2)	8 (0.3)
	July	5,232	278 (9.4)	2,080 (70.3)	2 (0.07)	523 (17.7)	65 (2.2)
	August	1,688	123 (12.2)	800 (79.2)	—	48 (4.8)	38 (3.8)
	September	39	1 (4.2)	22 (91.7)	—	1 (4.2)	—
	Total	14,637	864	6,568	—	1,097	120
	% to total		9.97	75.8	—	12.66	1.38
Bryde's	April	93	1 (2.1)	—	—	47 (97.9)	—
	May	543	191 (53.4)	1 (0.3)	1 (0.3)	165 (46.1)	—
	June	1,180	274 (37.6)	—	1 (0.3)	454 (62.3)	—
	July	337	22 (14.6)	1 (0.7)	—	128 (84.8)	—
	August	452	274 (89.8)	—	—	31 (10.2)	—
	September	96	38 (50.0)	—	—	38 (50.0)	—
	Total	2,703*	800	2	2	863	—
	% to total		47.99	0.12	0.12	51.76	—

* Two Bryde's whales that were unknown their catch month were excluded

CAUGHT DURING THE SEASONS OF 1969–1979. (CONSTRUCTED USING FISHERIES RESEARCH LABORATORY OF THE FISHERIES AGENCY)

Octopus	Total of filled stomach	% of filled stomach to total	Stomach fullness				
			Few	Moderate	Rich	Full	Empty
—	370	68.90	167 (31.1)	115 (21.4)	39 (7.3)	49 (9.1)	167 (31.1)
15 (3.4)	442	63.41	188 (27.0)	146 (20.9)	55 (7.9)	53 (7.6)	255 (36.6)
2 (0.3)	624	57.51	265 (24.4)	190 (17.5)	84 (7.7)	85 (7.8)	461 (42.5)
—	225	65.60	83 (24.2)	64 (18.7)	35(10.2)	43(12.5)	118 (34.4)
17	1,661	62.39	703 (26.4)	515 (19.3)	213 (8.0)	230 (8.6)	1,001 (37.6)
1.02	62.39						
—	1,463	63.53	824 (35.8)	393 (17.1)	128 (5.6)	118 (5.1)	840 (36.5)
6 (0.2)	3,213	59.78	1,731 (32.2)	974 (18.1)	265 (4.9)	243 (4.5)	2,162 (40.2)
9 (0.3)	2,957	56.52	1,625 (31.1)	834 (15.9)	254 (4.9)	244 (4.7)	2,275 (43.5)
1 (0.1)	1,010	59.83	587 (34.8)	297 (17.6)	72 (4.3)	54 (3.2)	678 (40.2)
—	24	61.54	8 (20.5)	3 (7.7)	7(17.9)	6(15.4)	15 (38.5)
16	8,667	59.21	4,775 (32.6)	2,501 (17.1)	726 (4.9)	665 (4.5)	5,970 (40.8)
0.18	59.21						
—	48	51.61	34 (36.6)	10 (10.8)	4 (4.3)	—	45 (48.4)
—	358	65.93	141 (26.0)	66 (12.2)	66(12.2)	85 (15.7)	185 (34.1)
—	729	61.78	361 (30.6)	181 (15.3)	68 (5.8)	119 (10.1)	451 (38.2)
—	151	44.81	88 (26.1)	43 (12.8)	7 (2.1)	13 (3.9)	186 (55.2)
—	305	67.48	80 (17.7)	99 (21.9)	57(12.6)	69 (15.3)	147 (32.5)
—	76	79.17	39 (40.6)	17 (17.7)	10(10.4)	10 (10.4)	20 (20.8)
—	1,667	61.67	743 (27.5)	416 (15.4)	212 (7.8)	296 (11.0)	1,034 (38.3)
—							