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アカイカ資源調査航海報告書

Cruise report of flying squid survey by the Wakatori Maru
in July/August, 1989

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要 約
1989年7～8月北太平洋の38～44°N、172°E～177°Wの17定点において、流し網によりアカイカ及び混獲生物の調査と海洋観測を行った。1回の操業では非選択性調査網（目合48～157mmの10種類の網各5反）と商業網（目合115mm）50反の計100反を使用した。流し網による漁獲は14定点で日没から夜間にかけてと、夜間に日出にかけての異なった時刻帯に行われ、他の3定点では日没から夜間に行われた。さらに14定点の内2定点では日中に投揚網が行われた。合計33回の操業による漁獲個体数はアカイカ2,057、シマガツオ8,271、等合計11,093であった。その他サケ科魚類、海産哺乳類及び海鳥類の漁獲個体数は、シロザケ127、ギンザケ4、カマイルカ2、オットセイ4、海鳥類12であった。サケ科魚類とアカイカの分布は表面水温13°Cを境界としてほぼ分離していた。アカイカでは時刻帯による差は見られなかったが、シマガツオでは夕刻から夜間にかけての漁獲尾数が夜間から明け方にかけてより多いうように見えた。日中に投揚網を行った定点では漁獲は極めて少なく、アカイカは漁獲されなかった。アカイカの外縁長範囲は調査網で15～48cm、商業網で29～50cmにあり、調査網による外縁長モードは定点により異なるが、18cm付近と40～45cmの2カ所にみられた。前者にモードを持つ群れは主に40°30'/N以南に、後者にモードを持つ群れは主に41°30'/N以北に分布していた。

1. はじめに
遠洋水産研究所は、1989年に4隻の科学調査船を用いてアカイカの資源調査を北太平洋において行った（早瀬ほか、1989）。このうち若鳥丸による調査の目的は、（1）いか流し網による漁獲時刻による漁獲量の変化の調査及び、（2）7～8月のいか流し網漁場西部北限線付近におけるアカイカの分布及びサケ科魚類、海産哺乳類、海鳥類の混獲状況の調査であった。ここでは若鳥丸航海の結果の概要を報告する。

—1—
2. 調査方法

1) 調査船
若鳥丸（鳥取県立水産高校漁業実習船） 総トン数 273 トン、全長 48 m

2) 調査員
谷津明彦（遠洋水産研究所）

3) 乗組員
高田俊悦船長ほか 18 名

4) 期間
函館出港：7 月 11 日、漁獲調査及び海洋観測：7 月 18 日～8 月 5 日、函館入港：8 月 12 日

5) 海域
北太平洋（39° 30'N～43° 30'N，172° 30'E～177° 30'W）（図 1）

6) 調査項目

(1) 海洋観測
海表面から水深 300 m まで水温と塩分を観測した。さらに、透明度、海上気象及び毎時航走表面水温を記録した。

(2) 流し網調査
調査定点数は 17 (図 1)。漁具は非選択性いか流し網調査網（以下、調査網）10 種目合各 5 反及び商業網（目合 115 mm）50 反、合計 100 反を使用した。その目合別配列は次の通り：115 mm（5 反）- 93 mm - 115 mm（40 反）- 106 mm - 48 mm - 63 mm - 121 mm - 72 mm - 138 mm - 82 mm - 55 mm - 157 mm - 115 mm（5 反）。揚網方向は「入れ放し」であるため、常に上記の順で揚網され、その逆の順で揚網された。

操業は各定点につき原則的に 2 回行ったが、定点 9 及び 16 では 3 回、定点 2、6、12 では 1 回であった。1 回目の揚網は日没前、揚網は夜間、2 回目の揚網は夜間、揚網は日出後、3 回目の揚網は日出後、揚網は日中とし、漁具の浸漬時間は約 5 時間とした。揚網には約 20 分、揚網には約 2 時間を要したので、1 定点につき 2 回以上操業した場合の各々の投揚網時刻（現地時間）は次の通りであった。

1 回目投揚網開始：16 時 18 分～16 時 39 分
1 回目揚網開始：21 時 43 分～22 時 30 分
2 回目投揚網開始：00 時 06 分～01 時 15 分
2 回目揚網開始：05 時 30 分～06 時 30 分
3 回目投揚網開始：03 時 53 分、08 時 13 分
3 回目揚網開始：09 時 00 分、13 時 30 分

A
B
C
本報告では、これらの時刻帯を順に A、B、C と略し、定点番号と組合せても用いることとする。例えば、ST. 9A とは定点 9 の 1 回目の操業を意味する。

漁獲量は船上に引き上げられたもので尾数であり、網にかかったが目で見える範囲で脱落したものは脱落尾数として記録した。なお、イルカ類で 1 頭船上に収容できなかったものがあったが、種を明確に判別できたので漁獲として扱った。漁獲尾数、脱落尾数とも目合別に（商業網では前後の 5 反と南部の 40 反の 3 部に分け）記録した。

（3）標本探集

アカイカは、各操業から漁獲の一部を冷凍標本として北海道大学水産学部及び遠洋水産研究所へ持ち帰った。海鳥は、死亡したもの全てを冷凍標本として北海道大学水産学部へ持ち帰った。イルカ類は、歯、肝臓、筋肉、生殖腺を冷凍あるいはホルマリン標本として遠洋水産研究所へ持ち帰った。サケ科魚類の鰭を遠洋水産研究所へ持ち帰った。

（4）魚体測定

アカイカは、各目合から最大約 100 尾を無作為に抽出し、外観長を性別に記録した。サケ科魚類は、尾叉長、性別、生殖腺重量を測定し、採鰭した。その他の魚類は目合別に最大 30 尾の体長を測定した。イルカ類は、体長、性別、泌乳の有無を観察記録し、写真撮影を行った後、上記の標本を採集した。生きた揚げられたイルカ類は、体長と性別記録後写真撮影を行い放流する予定であったが、この例は無かった。オッセイは、体長・性別（死んで揚げられた場合）、髪色、標識の有無を観察記録し、写真撮影を行った。

3. 結 果

1）海洋観測

各定点の表面水温は最低 11.4℃（ST.13）、最高 21.7℃（ST.5）であった。表面水温の水平分布（図 2）を見ると、等温線はほぼ東西に走っているが、同じ経度でも東ほどやや高温であった。水温の鉛直断面（図 3）によると、水深 10～30 m 付近に水温約 15～18℃の躍層が見られ、南方からの暖水がどこか表層に分布していることが分かる。一方、43°30′N 付近では水温 10℃以下の冷水が水深 20 m 付近まで達しており、それ以南の水温鉛直分布とは異なっていた。

2）漁獲結果

網種別の合計漁獲尾数を表 1 に示した。漁獲尾数において最も優占したのはシマガツオ（エチュオビア）、次いでアカイカであり、これら 2 種で全漁獲尾数の 93％を占めた。

3）アカイカとサケ科魚類の分布

アカイカは ST.13 を除く全ての定点で漁獲され、その CPUE（50 反当り漁獲尾数（脱落を含む））は、調査網では南で高く、商業網では中間の幅で高かった（図 4、5）。サケ科魚類は、定点 1、11、13、14 で漁獲された（図 6、7）。魚種の内訳はシロザケ 127 尾、ギンザケ 4 尾であった。

—3—
表面水温とCPUEの関係を図8、9に示した。調査網、商業網ともアカイカとサケ科魚類とは13°Cを境界にほぼ分離していた。アカイカの調査網のCPUEは水温11〜22°Cの範囲で高温域ほど高く、商業網のCPUEは14〜16°Cで高かった。この原因は、アカイカの体長が北方（低水温域）ほど大きく南方ほど小さいため（後述）と、商業網の目合では外套長30 cm以下の個体を漁獲する効率が極めて低いからである。

4) 時刻帯による漁獲量の差

時刻帯C（日中仕網、日中揚網）は2定点で行われ、それらの漁獲は極端に少なかったので（サンマ3尾、ビンナガ2尾、ヨシキリザメ12尾、トピウオ2科の1種1尾、イボダイ科（Centrolophidae）の1種1尾、ハシポソミズナギドリ1羽のみ）、時刻帯AとBのみを比較した（図10、11）。アカイカでは時刻帯AとBの間に差があるようには見えず、シマグツオでは時刻帯AがBより漁獲尾数が多いように見える（統計的検定は未だになされていない）。アカイカのCPUEの日変化も検討したが、CPUEの明瞭な周期性は見られなかった（図12）。

5) アカイカの体長組成

アカイカの網種類別時刻帯別の外套長組成を図13、14に示した。調査網での組成は、その網目の選択性から流し網の設置された水深の外套長約18〜50 cmのアカイカの自然の組成をほぼ反映していると考えられるのに対し（Kubodera and Yoshida, 1981）、商業網のそれは大型のイカを選択性に漁獲していることが分かる。時刻帯による体長組成では、調査網、商業網とも40 cm以上のイカが時刻帯AよりBでやや多いように見えるが、統計的検定はなされていない。また、調査網の時刻帯Aで17〜20 cmのイカが非常に多いが、これは定点5 Aでの450尾という特別に多い漁獲の組成を反映したものである。

各定点における外套長組成を時刻帯A、Bを込みにして図15に示した。外套長組成は緯度と密接な関係がみられ、35 cm以上の大型個体は北方に、15〜25 cmの小型個体は南方に多かった。25〜30 cmの個体は非常に少なく定点16で若干見られたのみであった。172°30' Eでは緯度に関わらず大型イカは極めて少なかった。

4. 文献


<table>
<thead>
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<th>Species name</th>
<th>Scientific name</th>
<th>Catch in number</th>
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<tr>
<td><strong>Flying squid</strong></td>
<td><em>Ommastrephes bartrami</em></td>
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</tr>
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<td><strong>Boreal clubhook squid</strong></td>
<td><em>Onychoteuthis boreali japonica</em></td>
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<td><strong>Eight-armed squid</strong></td>
<td><em>Gonatopsis borealis</em></td>
<td>62.0</td>
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<tr>
<td><strong>Other squids</strong></td>
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<tr>
<td><strong>Pomfret</strong></td>
<td><em>Brama japonica</em></td>
<td>5,290.5</td>
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<td><strong>Saury</strong></td>
<td><em>Cololabis saira</em></td>
<td>127.0</td>
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<tr>
<td><strong>Flyingfishes</strong></td>
<td><em>Exocoetidae</em></td>
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<td><strong>Albacore</strong></td>
<td><em>Thunnus alalunga</em></td>
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<td><em>Euthynnus pelamis</em></td>
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<td><em>Seriola aurovittata</em></td>
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<td><strong>Great blue shark</strong></td>
<td><em>Prionace glauca</em></td>
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<td><strong>Chum salmon</strong></td>
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<td><strong>Coho salmon</strong></td>
<td><em>Oncorhynchus kisuch</em></td>
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<td><strong>Pacific striped dolphin</strong></td>
<td><em>Lagenorhynchus obliquidens</em></td>
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<tr>
<td><strong>Northern fur seal</strong></td>
<td><em>Callorhinus ursinus</em></td>
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<td><strong>Black-footed albatross</strong></td>
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<td><strong>Laysan albatross</strong></td>
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<td><strong>Slender-billed shearwater</strong></td>
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<tr>
<td><strong>Unidentified shearwater</strong></td>
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<tr>
<td><strong>Marine turtles</strong></td>
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<tr>
<td><strong>Total</strong></td>
<td></td>
<td>7,391.0</td>
</tr>
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*Calculated catch in number by species.*
Fig. 1. Location of research stations.
Fig. 2. Horizontal distribution of surface water temperature (°C).
Fig. 3. Vertical distribution of water temperature (°C) and salinity (‰) at longitudes 172°30'E, 177°30'E, and 177°30′W.
Fig. 4. Distribution of CPUE (catch in number per 50 tans) of flying squid by time zone by non-selective research gillnet. CPUE at each station is composed of those at time zone "A" (top) and those at time zone "B" (bottom).
Fig. 5. Distribution of CPUE (catch in number per 50 tons) of flying squid by commercial gillnet. For other legends, see Fig. 4.
Fig. 6. Distribution of CPUE (catch in number per 50 tans) of salmonids by non-selective gillnet. For other legends, see Fig. 4.
Fig. 7. Distribution of CPUE (catch in number per 50 tans) of salmonids by commercial gillnet. For other legends, see Fig. 4.
Fig. 8. Relationship between surface water temperature (°C) and CPUE (catch in number per 50 tans) of flying squid (top) and salmonids (bottom) by non-selective research gillnet.
Fig. 9. Relationship between surface water temperature (°C) and CPUE (catch in number per 50 tans) of flying squid (top) and salmonids (bottom) by commercial gillnet.
Fig. 10. Comparison of log-transformed CPUE of flying squid by time zone. Top, non-selective research gill net; bottom, commercial gillnet.
Fig. 11. Comparison of log-transformed CPUE of pomfret by time zone. Top, non-selective research gillnet; bottom, commercial gillnet.
Fig. 12. Daily variation in difference between CPUE of flying squid at time zone "A" and those at time zone "B". Top, non-selective research gillnet; bottom, commercial gillnet.
Fig. 13. Overall size compositions of flying squid by non-selective research gillnet. Top, time zone "A"; bottom, time zone "B". Only data from stations with both time zones were used.
Fig. 14. Overall size compositions of flying squid by commercial gillnet. Top, time zone "A"; bottom, time zone "B". Only data from stations with both time zones were used.
Fig. 15. Size composition of flying squid by non-selective research gillnet at each station except for stations 6 and 12. N.B.: different scales on y-axis.
CRUISE REPORT OF FLYING SQUID SURVEY BY THE

WAKATORI MARU IN JULY/AUGUST 1989

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ABSTRACT

The surveys on flying squid and species which were caught incidentally were conducted using driftnets at 17 stations from 38°N to 44°N and 172°E to 177°W in the North Pacific Ocean in July and August, 1989. Oceanographic observations were also made. A total of 100 tans, 50 tans of the non-selective research gillnet (5 tans each of 10 different mesh sizes from 48 mm to 157 mm) and 50 tans of the commercial net (115 mm in mesh size) were used for each operation. Fishing by driftnet was conducted at 14 stations in different time zones from sunset to night and from night to sunrise and fishing in the other 3 stations was conducted from sunset to night. In addition, at 2 stations out of 14 stations, nets were set and hauled during the daytime. In a total of 33 fishing operations, a total of 11,093 individuals was caught; 2,057 flying squid and 8,271 Pacific pomfret, etc. Of the total catch, the number of salmonids, marine mammals, and seabirds caught were 127 chum salmon, 4 coho salmon, 2 Pacific white sided dolphin, 4 northern fur seals, and 12 seabirds. The distribution of salmonids and flying squid was almost separated at the border of surface temperature of 13°C. Although no difference was observed in the catch of flying squid with time of day, the catch of Pacific pomfret from sunset to night seemed to be greater than that from night to sunrise. The catch was extremely low at the stations where nets were set and hauled during the daytime and no flying squid were caught. The mantle length range of flying squid was 15-48 cm by the research gillnet and 29-50 cm by the commercial net. Although the mode of mantle length obtained by the research gillnet varied by station, two length modes were observed, around 18 cm and 40-45 cm. Groups with the smaller mode were distributed mainly in waters south of 40°30'N and those with the larger mode were distributed mainly in waters north of 41°30'N.
1. Introduction

The Far Seas Fisheries Research Laboratory conducted surveys on flying squid using four scientific research vessels in the North Pacific Ocean in 1989 (Hayase et al. 1989). Among them, the objectives of the survey by the Wakatori maru were as follows: (1) survey of the fluctuation of the catch by squid driftnet by fishing time, and (2) surveys on the distribution of flying squid and the conditions of incidental take of salmonids, marine mammals and seabirds around the northern boundary of the regulatory area for the Japanese squid driftnet fishery in July and August. The summary of survey results obtained by the cruise of Wakatori maru are reported here.

2. Method of survey

1) Research vessel

Wakatori maru (Tottori Prefectural Sakai Fisheries High School, Fishery Training Vessel) 273 GT, 48 m in length.

2) Researcher

Akihiko Yatsu (Far Seas Fisheries Research Laboratory).

3) Crew

Captain Shun-etsu Takada and 18 others.

4) Period

Departure from Hakodate: July 11th. Fishing survey and oceanographic observation: July 18 to August 5. Arrival in Hakodate: August 12.

5) Area

North Pacific Ocean (39°30'N to 43°30'N and 172°30'E to 177°30'W)(Fig. 1).

6) Survey items

(1) Oceanographic observation

Water temperatures and salinities from surface to depth of 300 m were observed. Furthermore, transparency and weather conditions at sea, and cruising surface water temperature by every hour were recorded.

(2) Driftnet survey

The number of survey stations was 17 (Fig. 1). As the fishing gear, a total of 100 tans, 5 tans each of 10 different mesh sizes of non-selective squid research gillnet (hereafter referred to as the research net) and 50 tans
of commercial net (115 mm in mesh size) were used. Arrangement of a net by mesh is as follows: 115 mm (5 tans) - 93 mm - 115 mm (40 tans) - 106 mm - 48 mm - 63 mm - 121 mm - 72 mm - 138 mm - 82 mm - 55 mm - 157 mm - 115 mm (5 tans). The nets are always cast in the above mentioned order and are hauled in the reverse order.

Although the fishing operation was conducted principally twice at each station, the fishing was conducted three times at the stations 9 and 16, and once at the stations 2, 6 and 12. The first cast was made before sunset and the net was hauled at night, and the second cast was made at night and the haul was made after sunrise, and the third cast was made after sunrise and the haul was made at daylight, and soaking time of the gear was about 5 hours. As we spent about 20 minutes for casting and about 2 hours for hauling, each casting time when two or more operations were conducted at one station is as follows (local time):

1st commencement of casting: 1618 hrs. - 1639 hrs.  
1st commencement of hauling: 2143 hrs. - 2230 hrs.  
2nd commencement of casting: 0006 hrs. - 0115 hrs.  
2nd commencement of hauling: 0530 hrs. - 0630 hrs.  
3rd commencement of casting: 0353 hrs. or 0813 hrs.  
3rd commencement of hauling: 0900 hrs. or 1330 hrs.

In this report, these time zones are simplified as A, B, and C, in order, and were combined with the station number. For instance, St. 9A means the first operation at station 9.

The number in the catch was reported as the number of animals landed on the vessel. Animals entangled in the nets, but dropped out from the net in visible range were recorded as the number of dropout animals. In addition, there was a porpoise which was not landed on the vessel, but as we could identify the species clearly, dealt with that porpoise as a catch. The numbers caught and number of dropouts were recorded by mesh (the commercial net is divided into 5 tans of front and back and 40 tans of middle part).

(3) Sampling

We brought back a frozen sample of flying squid which was collected from a part of the catch of each operation to the Faculty of Fisheries, Hokkaido University and Far Seas Fisheries Research Laboratory. All dead seabirds were brought back to the Faculty of Fisheries, Hokkaido University as a frozen sample. We brought back teeth, liver, muscle, and gonad of a porpoise as frozen or formalin samples to the Far Seas Fisheries Research Laboratory. Scales of salmonids were also brought back to the Far Seas Fisheries Research Laboratory.
(4) **Body measurement**

A maximum of about 100 flying squid were sampled randomly from each mesh and the mantle length was recorded by sex. For salmonids, fork length, sex and gonad weight were measured, and scales were collected. For other species, body-lengths of maximum 30 fish were measured by mesh. For porpoises, body length, sex, and existence of lactation was observed and recorded, and pictures were taken and the above samples were collected. For porpoises landed alive, we intended to record body length and sex and take pictures, and release them to the sea, but we did not have such an incident. For northern fur seal, body length, sex (in the case of northern fur seal landed dead), color of whiskers and existence of tags were observed and recorded, and pictures were taken.

3. **Results**

1) **Oceanographic observations**

Surface water temperature at each station was a minimum of 11.4°C (St. 13) and a maximum 21.7°C (St. 5). Judging from the horizontal distribution of surface water temperature (Fig. 2), an isothermal line tends almost from the east to the west, but even in the same latitude, it was somewhat higher temperature, as it goes toward the east. According to the vertical section of water temperature (Fig. 3), thermoclines of about 15° to 18°C were observed in depths of near 10 m to 30 m, and it was recognized that warm water which flowed from the south was distributed in the surface layer. On the other hand, cold water of 10°C and colder reached to depths of about 20 m at around 43°30'N and it differed from the vertical distribution of water temperature in waters south of that area.

2) **Results of catch**

Table 1 shows the total number caught. Of the numbers caught, Pacific pomfret was dominant, followed by flying squid and these two species accounted for 93% of the total number of animals.

3) **Distribution between flying squid and salmonids**

Flying squid were caught in all stations except St. 13. CPUE values (the catch number per 50 tan, including dropouts) were high in the southern latitudes for the research net, and were high in the interim latitudes for the commercial net (Figs. 4 and 5). Salmonids were caught at Stations 1, 11, 13 and 14 (Figs. 6 and 7). There were 127 chum salmon and 4 coho salmon.

Relationship between surface water temperature and CPUE was shown in Figs. 8 and 9. For both the research and commercial nets, flying squid and salmonids were distributed separately almost to the border of water temperature of 13°C. CPUE values of the research net for flying squid in the temperature range of 11-22°C were high in the higher temperature areas, and CPUE value of the commercial net was high in water temperatures of 14°C to 16°C. This was caused by the fact that the body length of flying squid was
large in the northern areas (colder water temperature areas) and was small in the southern areas, as mentioned later, and the mesh size of the commercial net had a very low effectiveness to catch the individuals which were smaller than 30 cm in mantle length.

4) Differences of catch by time zone

Survey on the fishing time zone C (daytime casting, and daytime hauling) was conducted at 2 stations, however, as the catch was extremely low (3 Pacific saury, 2 albacore, 12 blue shark, 1 fish of a species of flying fish, 1 fish of a species of the Centrolophidae, and 1 slender-billed shearwater, only time zones A and B were compared (Figs. 10 and 11). For flying squid, differences between the fishing time zone A and B were not observed, and for Pacific pomfret, the number of catch from fishing time zone A seemed to be higher than that of fishing time zone B (statistical tests are not completed yet). Although we considered the daily variation of CPUE of flying squid, we could not observe any obvious periodic variations of CPUE (Fig. 12).

5) Length composition of flying squid

Figs. 13 and 14 show the mantle length composition of flying squid by kind of net and by fishing time zone. Judging from the selectivity of driftnets mesh, it is considered that the mantle length composition of flying squid which were caught by the research net reflects nearly the natural composition of flying squid of about 18 cm to 50 cm in mantle length at depths where nets were set (Kubodera and Yoshida 1981), while it is recognized that the mantle length composition of flying squid which were caught by the commercial net are selective for catches of the large-sized squid. Although it is observed that flying squid of 40 cm and greater in mantle length composition in the fishing time zone A seemed to be somewhat greater than that in fishing time zone B for both the research and commercial nets, it has not yet been tested statistically. In addition, flying squid of 17 cm to 20 cm in mantle length were abundant in the fishing time zone A by the research net, this was caused by the extensively high catch in Station 5A (450 individuals) where squid of the above length range were dominant.

Fig. 15 showed the combined mantle length composition of flying squid at each station of the fishing time zones A and B. Close relationship between the mantle length composition and latitude was observed, and the large-sized individuals of 35 cm and larger in mantle length were dominant in the northern areas and the small-sized individuals of 15 cm to 25 cm in mantle length were dominant in the southern areas. The individuals of flying squid of 25 cm to 30 cm in mantle length were scarce, and a few individuals were observed at St. 16. Large-sized squid were extremely scarce at 172°30'E, regardless of latitude.

References, Table 1 and Figs. 1 to 15 are in English in the Japanese document.