Observations of Snow Accumulation and Sea Ice at Syowa Station, Antarctica

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南極昭和基地における積雪と海氷観測

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要　旨

第8次（1967年），第9次（1968年），第10次南極地域観測隊（1969年）において実施された昭和基地周辺の海氷上（北の浦およびオングル海峡）における，積雪量と海氷厚の観測結果をまとめて報告する。

北の浦海氷上における積雪量は，場所による大きな相違があるが，おおむね卓越風向の風上地域では非常に少なく，風下の東オングル島に近い地域では多いという傾向が見られた。最も積雪量の多い所では，積雪深が9月から10月頃に120cmを越え，最も少ない所では，年間を通してほとんど積雪がなかった。北の浦全域の平均積雪深は，1968年，69年とも最大約30cmで，11月末から急激に消耗を始め，年間を通じてはほぼゼロとなった。

昭和基地周辺の一冬氷は，9月から11月頃まで成長を続け，最大氷厚は110～140cmであった。

1. Introduction

This report summarizes the results of observations of snow accumulation and sea ice at Syowa Station from March 1967 to January 1970, carried out by the wintering members of the 8th, 9th and 10th Japanese Antarctic Research Expeditions (JARE).

The amount of snow accumulation differed remarkably among various stakes set near Syowa Station, East Ongul Island. Heavy snow accumulation of about 1 m deep in maximum was observed in the vicinity of the shore of East Ongul Island, whereas very little accumulation in the northern windward region. Observations showed that the maximum thickness of winter ice near Ongul Island was 110 ～140 cm.

2. Observations

Observation site viewed from Syowa Station is shown in Fig. 1.

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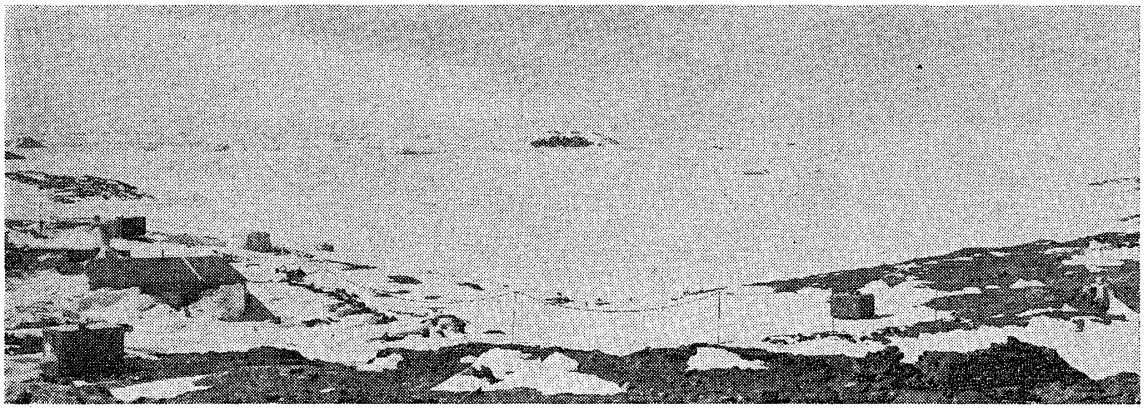

Fig. 1. A view of observation site from Syowa Station in East Ongul Island. The Ongul Strait (about 4 km wide) runs between East Ongul Island and the Antarctic Continent to the right (November 1968).

Snow accumulation was measured by means of stakes every week or every month throughout the year. Measurements were made at one stake in 1967, at fifteen stakes in 1968, and thirteen stakes in 1969–70. The locations of these stakes are indicated in Fig. 2.

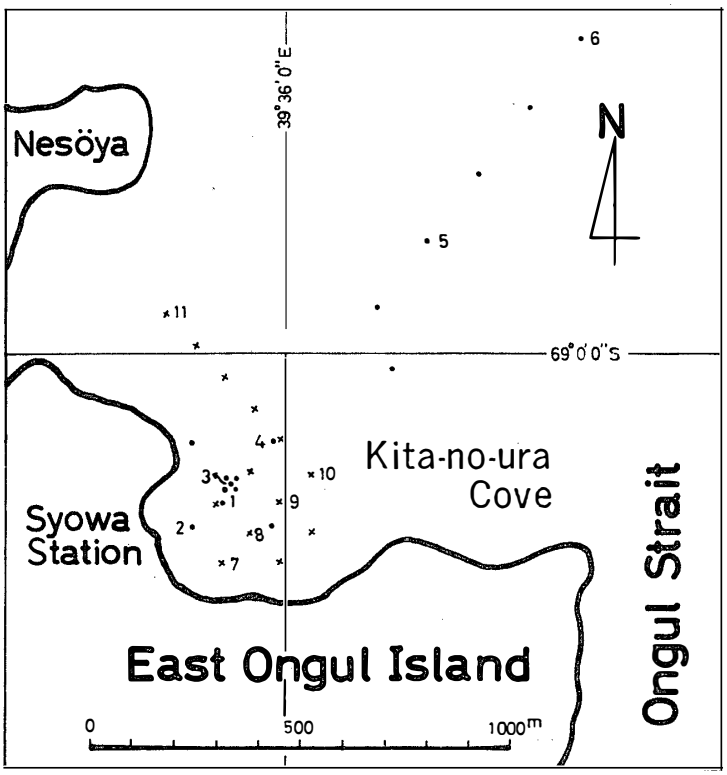

Fig. 2. Locations of accumulation stakes in the Kita-no-ura Cove. Solid circles indicate the stakes set in 1968, and crosses in 1969. Iwa-zima Island is about 250 m northeast of stake No. 6.

Thickness of sea ice was measured in bore holes also every week or every month throughout the year, at the site of stake No. 1 in 1967 and 1968, and at the site of stake No. 10 in 1969–70. Measurements of ice thickness at numerous points along the routes of the oversnow vehicles on sea ice in the Ongul Strait were repeated frequently.

3. Results

3.1. Snow accumulation

The cumulative curves of snow accumulation measured in 1968 and 1969 at each stake near Syowa Station are given in Fig. 3 and Fig. 4, respectively. It is clearly seen from Fig. 3 and Fig. 4 that the amount of accumulation in the southwestern region, at stakes No. 2 and No. 7 near the shore of East Ongul Island, is greater than that in the northeastern region, around stakes No. 5, No. 6, No. 9 and No. 10. This difference should be attributed to the effect of the island in relation to the wind system. The direction of the prevailing wind at Syowa Station, especially almost every strong wind more than 10 m/s, is from northeast

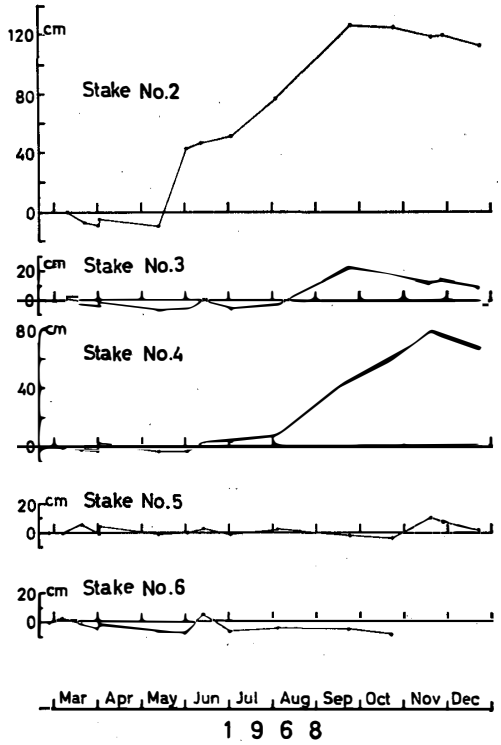

Fig. 3. Cumulative accumulation(cm in snow) at various points near Syowa Station in 1968. Zero-level indicates the snow surface at the biginning of observations in February or March.

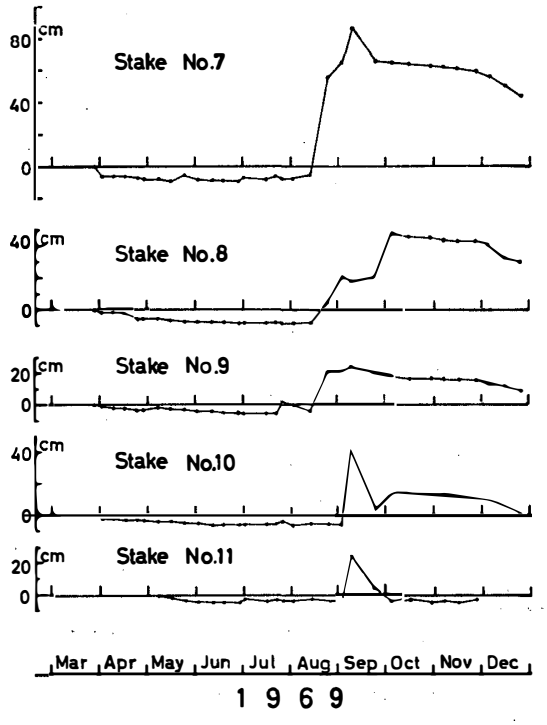

Fig. 4. Cumulative accumulation(cm in snow) at various points near Syowa Station in 1969. Zero-level indicates the snow surface at the biginning of observations.

(MORITA, 1968). Furthermore, as noticed in Fig. 3 and Fig. 4, there is considerable irregularity in the amount of accumulation among various stakes. It may be ascribed to the following fact: in some parts of this region, the surface of sea ice in winter was composed of pure and glazy ice after the puddle was frozen, so that the snow was scarecely accumulated on this glazy ice surface.

The maximum values of snow accumulation were 125 cm at stake No. 2 in September 1968 and 86 cm at stake No. 7 in September 1969. Annual net accumulation at stakes No. 5, No. 6, No. 10 and No. 11 was almost nil or negative.

The cumulative curve of the mean accumulation for all the fifteen stakes measured in 1968 and that for all the thirteen stakes in 1969 are given in Fig. 5.

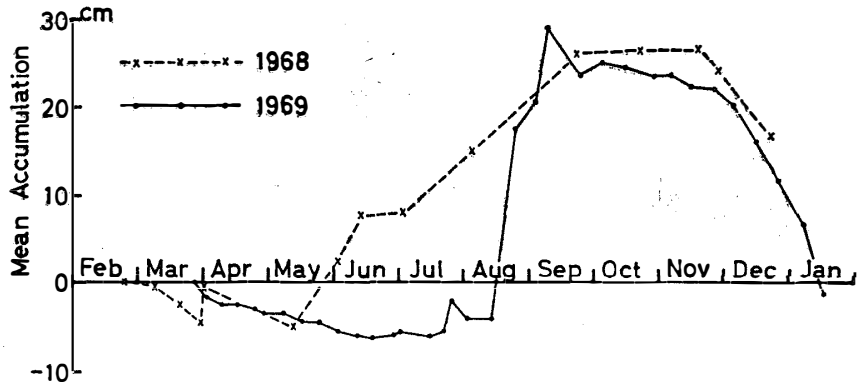

Fig. 5. Mean cumulative accumulation (cm in snow) for all stakes near Syowa Station. Broken line shows mean accumulation measured by 15 stakes in 1968, and solid line shows mean accumulation by 13 stakes in 1969. Zero-level indicates the snow surface at the biginning of observation.

Until May 1968 and July 1969, ablation of 5~6 cm due to sublimation and wind erosion was observed. From May to September 1968, snow accumulated gradually. In 1969, the most amount of snow accumulated in the latter part of August and the early part of September. The maximum values were about 30 cm in both years*. In the daytime of December and January, a large amount of snow melted, consequently ablation occurred rapidly through these months. The mean annual net accumulation for all stakes was almost zero in both years.

3.2. Growth and decay of sea ice

Seasonal variations of ice thickness and depth of snow cover were measured at stake No. 1 in 1967 and 1968, as shown in Fig. 6. It is clearly noticed that the submergence of sea ice below the sea level took place under the weight of snow

* In 1966, the wintering members of 7th JARE measured snow accumulation in the Ongul Strait. The maximum mean thickness of 70 cm at the end of October was obtained by 8 stakes set in the vicinity of East Ongul Island (SEINO, 1967), and that of 44 cm at the end of September by 14 stakes set in the sea ice across most of the Ongul Strait (MAEGOYA, 1969).

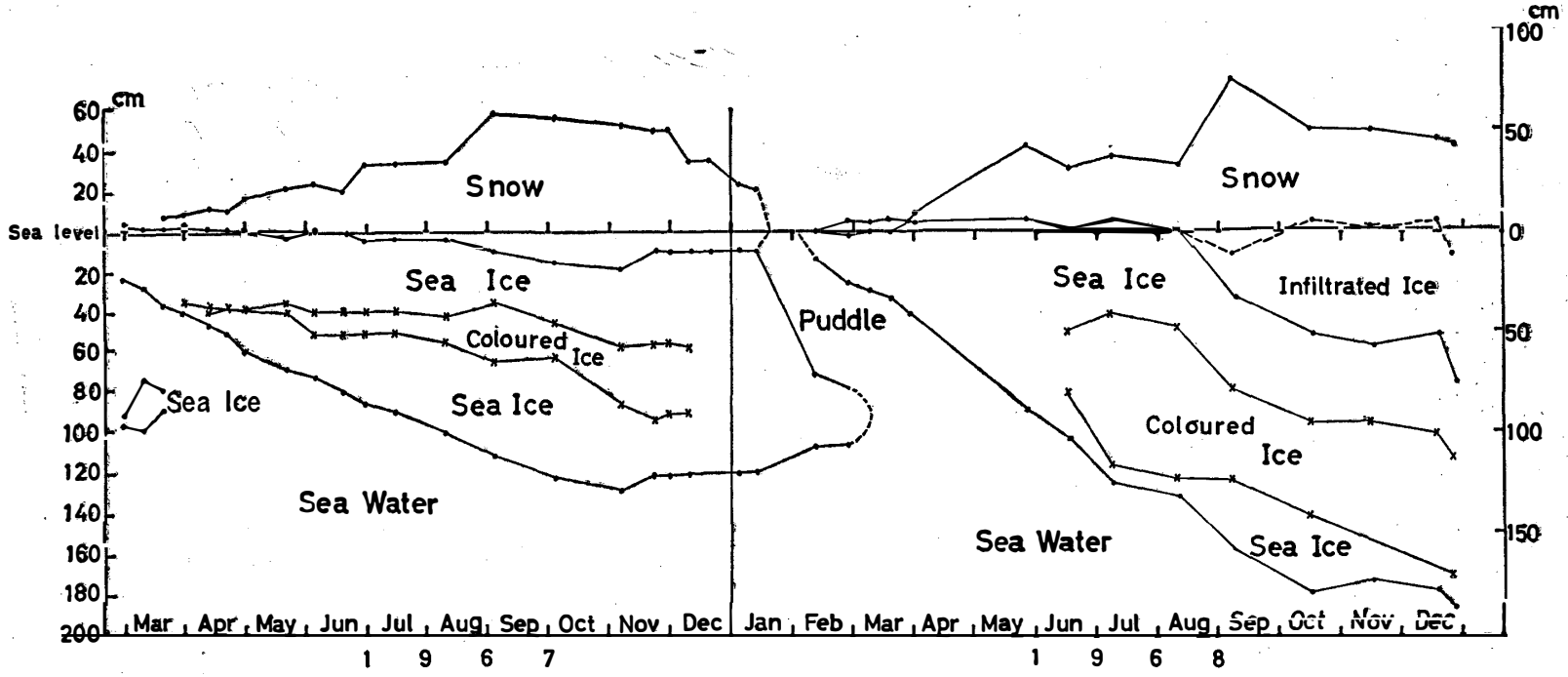

Fig. 6. Growth and decay of sea ice at stake No. 1 in 1967 and 1968.
Snow depth and ice thickness are measured from the sea level. Infiltrated ice means ice formed from snow by freezing of permeated sea water. Coloured ice means a brown layer coloured by flora.

cover. Consequently the sea water permeated into the snow cover through the cracks of sea ice, so that "infiltrated ice" was formed by freezing of sea water. It is also noticed that coloured ice (brown) grew to several tens of centimeters and faded away with the lapse of time. This vicissitude in 1967 was observed in detail by HOSHIAI (1969).

In December and January, a number of puddles were found on the surface of

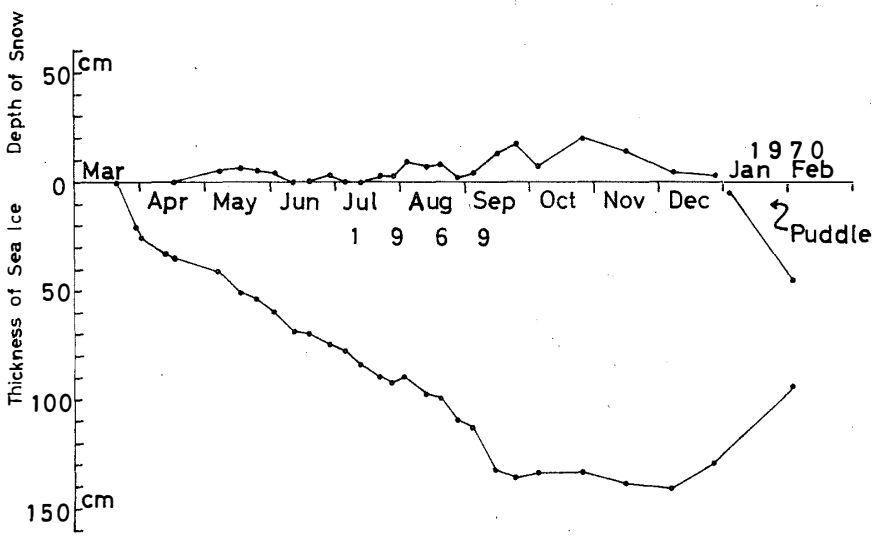

Fig. 7.
Growth and decay of sea ice at stake No. 10 in 1969–70.
Thickness of sea ice excludes that of infiltrated ice.

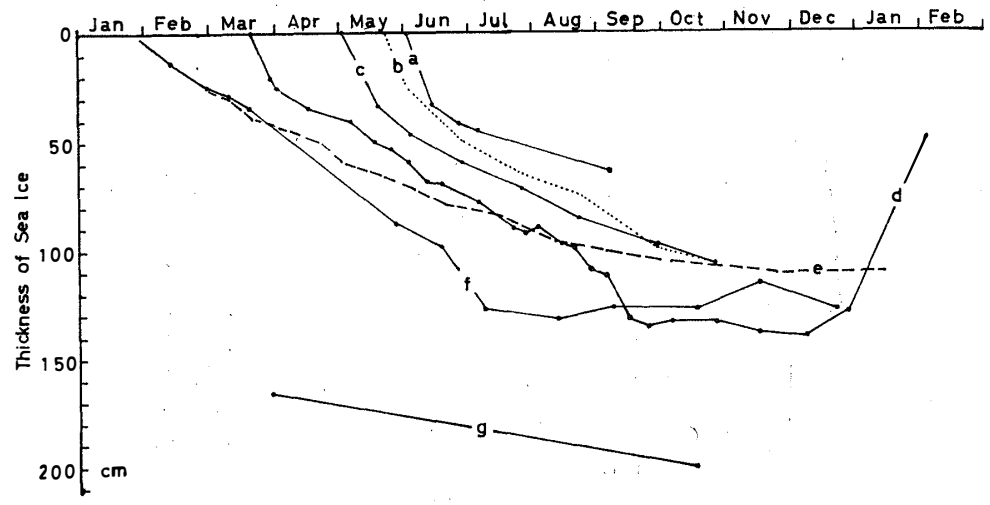

Fig. 8. Growth of sea ice at various points near East Ongul Island.

a) At a central part of the Ongul Strait where the new ice formed in the early part of June, measured in 1968.

b) At a central part of the Ongul Strait where the new ice formed in the middle of May, in 1969.

c) At a central part of the Ongul Strait where the new ice formed at the end of April, in 1969.

d) At stake No. 10 where the new ice formed in the middle of March, in 1969.

e) At stake No. 1, in 1967.

f) At stake No. 1, in 1968.

g) At stake No. 9, in 1969. Young polar ice.

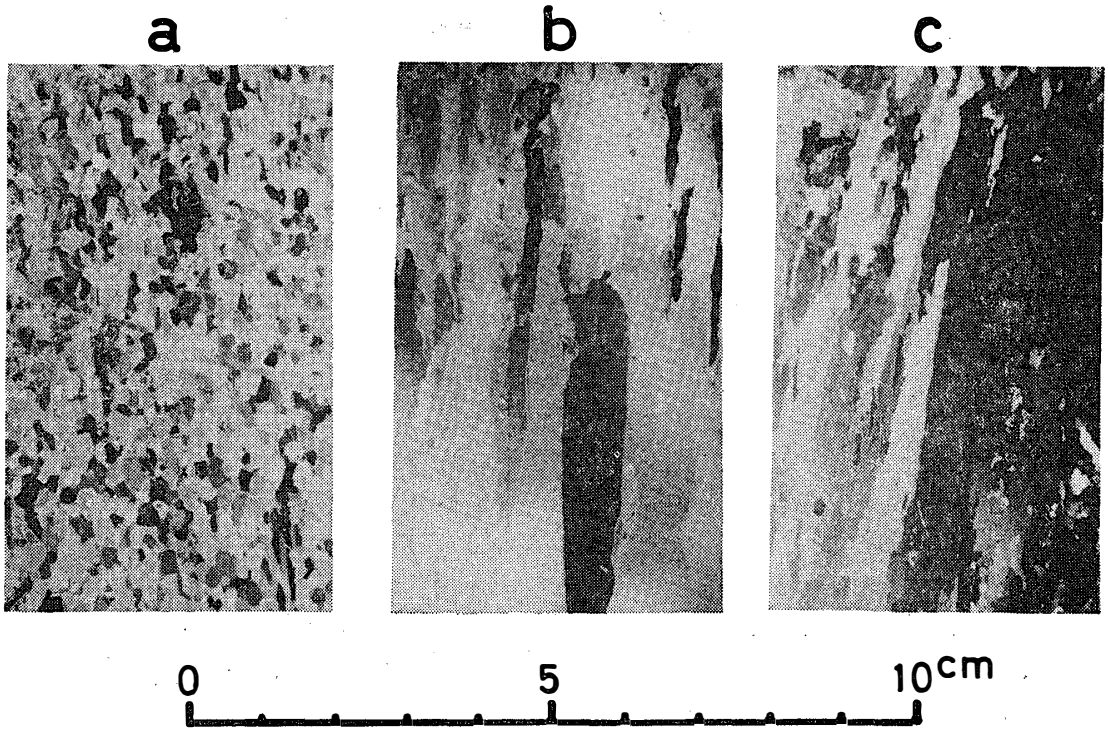

Fig. 9. Photographs of vertical thin sections.
a) Infiltrated ice.
b) Puddle ice.
c) Sea ice.

the sea ice. The depth of some puddles was several tens of centimeters (ENDO, 1970). After February, the surface of the puddle started to freeze, but the melting at the bottom of the puddle was still in progress and finally the bottom layers disappeared (see Fig 6).

Seasonal variations of ice thickness and depth of snow cover at stake No. 10 in 1969 are shown in Fig. 7. Until September, sea ice grew continuously. In October and November ice thickness was almost unchanged, and after December the sea ice was melted both from the surface and the bottom.

Growth and decay of sea ice measured at various points near East Ongul Island are summarized in Fig. 8. In the Ongul Strait, young winter ice was swept many times by the strong blizzards. In the Kita-no-ura Cove, the maximum thickness of winter ice was 110–140 cm*.

Photographs of vertical thin sections of infiltrated ice, puddle ice, and sea ice are shown in Fig. 9.

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* KUSUNOKI and others reported that the maximum thickness of annual sea ice near Syowa Station was deduced to be about 150 cm from the measurements in 1966 and 1967 (KUSUNOKI, YOSHIDA and ISHIDA, 1970).

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