Biological Studies on Ecosystems in the Yukidori Valley, Langhovde, East Antarctica

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ラングホブデ雪鳥沢における生態系研究の調査報告

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要旨: 南極陸上生物の研究プロジェクト「陸上生態系構造の研究」は 1986 年から 1990 年 (JARE-27～31) の 4 カ年計画で，沿岸露岩域のラングホブデ雪鳥沢と内陸露岩域のセールロンダーネ山地の 2 地域で進められた．雪鳥沢の生態系の研究計画は越冬観測を含め，1986 年より 3 年間実施され，1989 年 2 月に終了した．この計画には主に次のような調査項目が含められ，研究が進められた．

1) 雪鳥沢水系に広がる植生と環境要因との関係を明らかにするために，生物気象観測を行う．

2) 植生と環境変化の長期的監視のため，永久方形区を設置し，調査する．

3) 雪鳥沢水系の地衣類，蘚類，藻類，微小動物の分類，生態，およびそれらの相互関係を明らかにし，生態系を総合的に理解する．

雪鳥沢を含む 3 km^2 の地域は豊かな植生と海鳥の営巣地があり，その生物学的価値が評価され，1987 年，南極条約協議会議で特別科学的関心地区 (SSSI) として指定された．また，現在進行している国際研究計画「南極陸上生態系の研究」(BIOTAS) を背景に，雪鳥沢の研究は機を得た計画であった．

本報告は雪鳥沢の生態系に関する研究の目的，計画の立案，経過，成果，将来の展望についての概略をまとめたものである．

Abstract: The studies on the mechanism of Antarctic terrestrial ecosystems was planned as a four-year research project from 1986 to 1990 (JARE-27～31) within major projects of JARE. This was undertaken in two different regions of East Antarctica; the coastal ice-free Syowa Station area in Enderby Land and the Sør Rondane Mountains in Queen Maud Land. The study on ecosystems of the Yukidori Valley, Langhovde, located in the Syowa Station area and approved as Sites of Special Scientific Interest (SSSI) in 1987, was carried out with the following main subjects: 1) observation of biological meteorology to know relationships between vegetation and environmental factors, 2) establishment of small sites or quadrats for a long-term monitoring of vegetational changes and 3) synthetic biological studies on ecosystems along streams and lakes between the coast and the end of ice cap. The study also suits the purposes of the inter-

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national project "Biological Investigations of Terrestrial Antarctic Systems (BIOTAS)".

The present report is to summarize and introduce the general accounts of the biological activities in the Yukidori Valley program.

1. Introduction

The Japanese Antarctic Research Expedition (JARE) planned a project in the Syowa Station area in 1972, laying stress on terrestrial biology and geochemistry under the background of increasing human impacts on Antarctic natural environments. The comprehensive ecological study of cryptogamic vegetation composed of mosses,

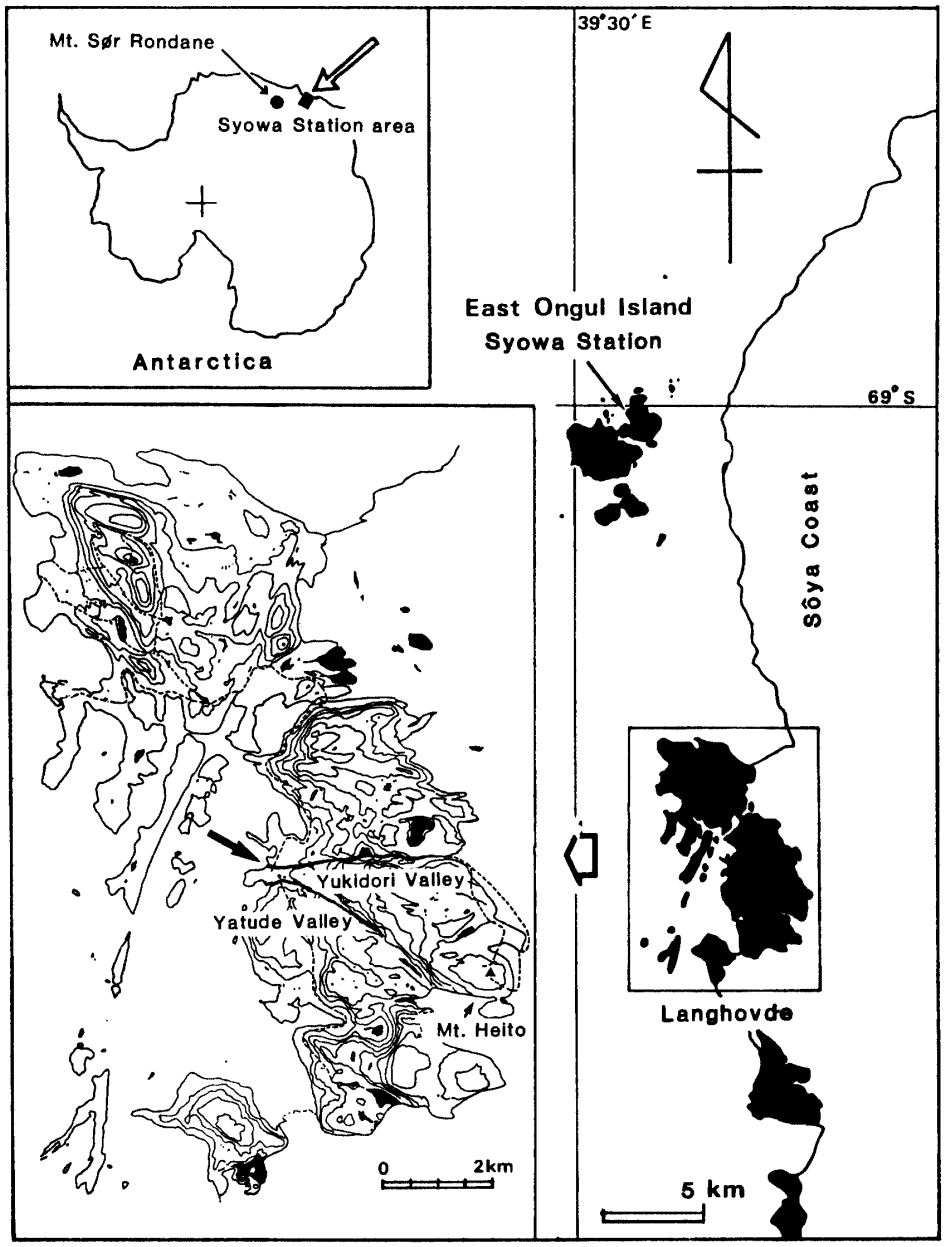

Fig. 1. Maps of the Yukidori Valley, Langhovde.

lichens and fresh water algae was carried out from 1973 to 1975 (JARE-15, -16). Owing to the first synthetic biological surveys in JARE, the project was successful and meaningful with the following results: 1) distributions of mosses, lichens and fresh water algae were clarified and these habitat types were classified, 2) moss and lichen vegetation was investigated with a phytosociological approach, 3) biological and geochemical nature of lake water was analyzed, and colonization changes of soil organisms of algae and bacteria were monitored, and 4) a population census of sea animals such as Adélie penguins and Weddell seals was undertaken.

These results have been hitherto compiled in two proceedings of "The first symposium on the Antarctic environmental sciences", edited by the NATIONAL INSTITUTE OF POLAR RESEARCH (1977) and "The symposium on terrestrial ecosystem in the Syowa Station area", edited by MATSUDA and HOSHIAI (1979). It was quite significant that these results derived from the project encouraged biological scientists for desired studies on ecosystems of the Yukidori Valley, Langhovde.

In the presents report, the authors summarized and introduced the general accounts of biological activities for a three-year research on ecosystems in the Yukidori Valley from 1986 to 1989.

2. Studies on the Mechanism of Antarctic Terrestrial Ecosystems

The studies on the mechanism of Antarctic terrestrial ecosystems were planned as the four-year research program during the period of 1986–1990 (JARE-27 to JARE-31) within the major projects of JARE. This study has two programs in two different

Table 1. Observation schedule of a three-year research on ecosystems in the Yukidori Valley, Langhovde.

Items	JARE-27	JARE-28	JARE-29
1. Biological meteorology			
a) Meteorological observations near the hut	·····	———	———
b) Microclimatic observations along the stream of the valley	———	———	———
c) Unmanned microclimatic observations near the hut			———
2. Long-term monitoring			
a) Lichen vegetation	———	·····	·····
b) Moss vegetation		·····	———
c) Algal vegetation			———
3. Biological research			
a) Distribution and taxonomy of lichens	———	·····	
b) Ecology and physiology of invertebrates		———	
c) Geomorphology and ecology of moss lichen-vegetation		———	
d) Ecophysiology of moss-lichen vegetation			———
e) Ecology and taxonomy of mosses	·····	———	———
f) Ecology and taxonomy of algae			———

Solid lines indicate plans operated, and broken lines indicate plans under way or plans observed occasionally.

regions. One is the study in coastal ice-free Syowa Station area along the Sôya Coast and Prince Olav Coast with special reference to the Yukidori Valley, Langhovde. The other one is the study in the Sør Rondane Mountains among inland nunataks of Queen Maud Land (Fig. 1). The Yukidori Valley program was carried out for three years of 1986–1989 with six biologists comprising five wintering members and one summer member. The Sør Rondane program was conducted by three biologists for two summer seasons of 1989–1990 to be continued until the austral summer of 1990. In the Yukidori Valley program, the following biological articles were planned and operated: 1) observation of biological meteorology to know relationships between vegetation and environmental factors, 2) establishment of small sites or quadrats for a long-term monitoring of vegetational changes, and for evaluation of natural environments affected by human impacts, and 3) synthetic biological studies on ecosystems along streams and lakes between the coast and the end of ice cap (Table 1).

3. SSSI and BIOTAS Program

The Yukidori Valley was approved as the 22nd SSSI (Sites of Special Scientific Interest) by the 14th Antarctic Treaty of Consultative Meeting (ATCM) at Rio De Janeiro in October 1987 (SCAR, 1988). The Yukidori Valley (lat. 69°14′30″S, long. 39°46′00″E) is located in the central part of Langhovde, Lützow-Holm Bay, the Continental Antarctic. The site encompasses an area of 3 km by 0.5–1.5 km, located between a tongue of the ice cap and the sea at the western end of the valley (Figs. 2–4).

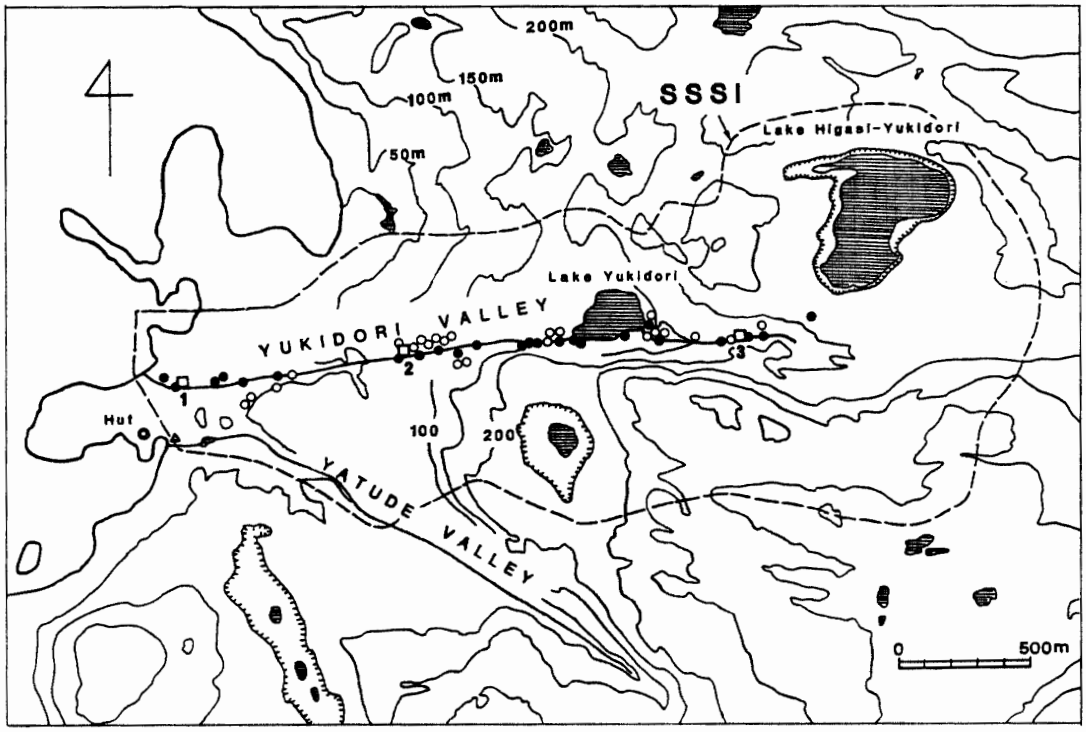

Fig. 2. The SSSI and sites for a long-term monitorng.
● *Moss vegetation*: ○ *Lichen vegetation*: △ *Algal vegetation*: □ *Sites for the microclimatic observation. 1. Lower course, 2. Middle course, 3. Upper course.*

Fig. 3. A landscape of the Yukidori Valley and three sites for microclimatic observations. An arrow indicates the mouth of the Yukidori Valley.

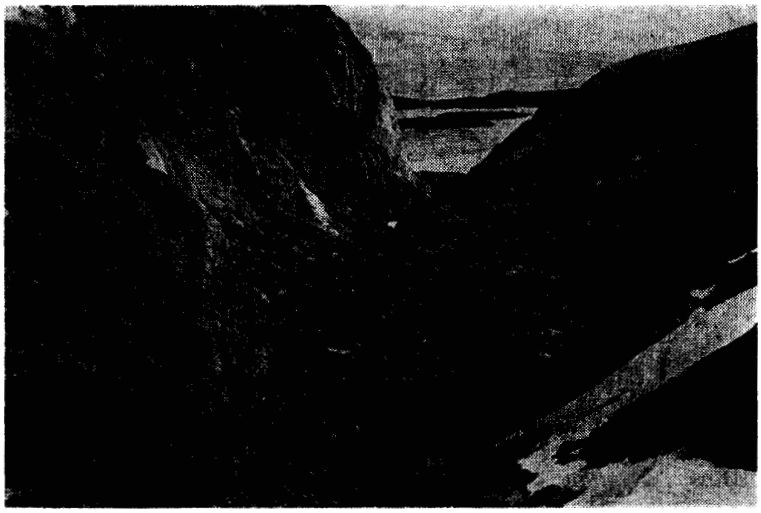

Fig. 4. A view of the valley overlooked from the upper course.

The Yukidori Valley of the Langhovde region is well known as an ice-free area having the most prominent vegetation in the Syowa Station area because almost all of the plant species recorded from the region occur within the Yukidori Valley. It is much contrasted with the Yatude Valley which is adjacent to the Yukidori Valley and has scanty vegetation. Thus, the Yukidori Valley is considered to be the most suitable area for SSSI in the vicinity of Syowa Station.

At the 18th Scientific Committee on Antarctic Research (SCAR) in Bremerhaven, 1984, the working group on biology proposed to organize a group in order to promoto and co-ordinate an international terrestrial and inland water program in the Antarctic and sub-Antarctic. The program "Biological Investigations of Terrestrial Antarctic Systems (BIOTAS)" was supported in 1986 by the 19th SCAR as appropriate. More important purposes of the BIOTAS Program are to encourage research studies to follow a more unified approach and to establish research sites associated with scientific station. When the research sites are established, the national group responsible for their management will be encouraged to designate them as SSSI (SMITH and WYNN-WILLIAMS, 1987).

4. Outline of the Activities Performed in the Three-Year Research (Table 2)

4.1. 1985–86 summer and 1986 winter programs (JARE-27)

1) A hut for biological research was constructed in the neighborhood of the

Table 2. Representative field surveys for biological researches in Langhovde.

Date	Member	Items for biological research
1986	**JARE-27**	
July 28–31	M. INOUE*, S. NAGAMACHI, T. OHWADA	Measurement of the depth of snow cover at nine fixed points between the Yukidori Valley and the Yatude Valley.
Oct. 14–19	M. INOUE*, T. SUGAWARA, T. Oginasa	Collection of lichen specimens in the adjacent islands of Langhovde.
Nov. 10–13	M. INOUE*, S. KIKUCHI, S. KOMURA	Collection of lichen specimens in the adjacent islands of Langhovde.
Nov. 17–Dec. 5	M. INOUE*, T. OHWADA, H. SASAKI	Ecological surveys of terrestrial plants on stressing lichen vegetation around the Yukidori Valley.
Dec. 5–Jan. 9	M. Inoue*, T. OHWADA, M. SAKAJIRI	Observation of biological meteorology at the hut.
1987	**JARE-28**	
Jan. 9–16	Y. MOCHIDA*, H. SUGAWARA, M. INOUE (JARE-27)	1) Cooperative researches with the JARE-27 party.
		2) Geomorphological and ecological surveys of moss vegetation.
		3) Ecological surveys of invertebrates.
Aug. 3–8	Y. MOCHIDA*, M. NAKANISHI, Y. OHYAMA, S. KANETO, K. INAMORI, H. SAITO	The first route survey via continental ice between S16 and Mt. Heito, Langhovde.
Aug. 14	Y. MOCHIDA*, K. SONE, H. SUGAWARA, H. NAKAMURA	Ecological surveys for invertebrates of the Yukidori Valley.
Aug. 18–20	H. MIYAOKA*, Y. MOCHIDA, S. TAIRA, H. AKIMARU	Ecological surveys for plant vegetation.

Table 2. (*Continued*)

Date	Members	Items for biological research
Sep. 14–18	H. NAKANISHI*, H. SAITO, Y. OHYAMA, Y. NAKAYAMA, S. TAIRA, H. AKIMARU	The second route survey via continental ice between S16 and Mt. Heito, Langhovde.
Oct. 5–7	H. SUGAWARA*, K. SONE, T. YAMANOUCHI, A. YAMAMOTO	Check of the biological meteorological instruments near the hut.
Oct. 11–14	Y. MOCHIDA*, M. NAKANISHI, Y. NAKAYAMA, S. TAIRA, H. TAKABE, H. MIYAOKA	1) Deposit of a living caboose. 2) Biological surveys in the Yukidori Valley and the Yatude Valley.
Oct. 30–31	Y. MOCHIDA*, H. SUGAWARA, H. BABA, H. AKIMARU, Hidetoshi SUGAWARA, K. MORIMOTO, Y. MIYATA	Installations of biological meteorological instruments near the hut.
Nov. 18, '87 –Jan. 7, '88	Y. MOCHIDA*, H. SUGAWARA, H. OGIHARA	1) Meteorological observation near the hut. 2) Microclimatic observation of moss-lichen vegetation and soils as habitats of mites. 3) Distribution and ecological surveys of invertebrates. 4) Geomorphological and ecological surveys of moss-lichen vegetation.
1988	**JARE-29**	
Jan. 7–12	H. KANDA*, Y. INO, S. OHTANI, T. HAGIWARA (Observer) Y. MOCHIDA (JARE-28), H. SUGAWARA (JARE-28)	Cooperative researches with the JARE-28 party. Installations of the quadrats of moss vegetation for long-term monitoring.
Jan. 12–19	Y. INO*, S. OHTANI	1) Ecophysiological investigation of mosses and lichens. 2) Collection of algal specimens. 3) Microclimatic investigation along the stream of the Yukidori Valley.
Feb. 3–May 8	H. KANDA*, S. OHTANI, M. DOI, H. MIKAMI	1) Distribution and ecological surveys of mosses and algae in the Langhovde region. 2) Biological meteorological survey. 3) Monitoring of moss and algal vegetation. 4) Limnological surveys and collection of aquatic mosses and algae in Lake Yukidori.
Nov. 1–Dec. 1	H. KANDA*, S. OHTANI, K. YAMAGUCHI	1) Distributional and ecological surveys of mosses and algae in the Yukidori Valley. 2) Monitoring of environmental changes around the vegetation.
Dec. 1, '88– Jan. 3, '89	H. KANDA*, S. OHTANI, K. OKADA	Measurements for biological environments with portable instruments.
1989		
Jan. 3–15	H. KANDA*, S. OHTANI	1) Photograph of fixed sites for long-term monitoring. 2) Observation of moss community as habitats of epiphytic algae. 3) Lichen collection for symbiosis study.

* Leader of the field party.

Yukidori Valley in January 1986. The distribution and taxonomy of lichens and relationships among the vegetation, salt concentration in snow cover and nutrient supply by the excrements of snow petrels increasing in the valley were investigated.

2) Meteorological observations near the hut and microclimatic surveys along the stream in the Yukidori Valley were undertaken.

3) For a long-term monitoring of lichen vegetation, small quadrat sites were selected and surveyed along the stream.

4) Field work was carried out at intervals during winter and was concentrated in spring and summer seasons.

5) Lichenologist M. INOUE and zoologist Y. NAITO (leader of the wintering party) took part in the research with the support of the other JARE-27 members.

4.2. 1986–87 summer and 1987 winter (JARE-28)

1) Distribution of invertebrates, relationships between invertebrates and environmental factors, and physiological study on the cold resistance of invertebrates were investigated.

2) Geomorphological and ecological features around moss and lichen communities were described.

3) Meteorological and microclimatic observations were automatically operated near the hut and along the valley, and these data were compared with those at Syowa Station.

4) Field work was carried out at intervals during winter and concentrated in the spring and summer season. New potential continental routes between S16 on the continental plateau and Mt. Heito in Langhovde were surveyed and one was finally established in the middle of September 1988 for the coming JARE-27 party which was planning to stay in the Yukidori Valley for a long period in the autumn season when routes across the sea-ice would become impassable.

5) Soil zoologist H. SUGAWARA, plant ecologist Y. MOCHIDA and physiologist Y. OHYAMA (leader of the wintering pary) took part in the research with the support of the other JARE-28 members.

4.3. 1987–88 summer and 1988 winter (JARE-29)

1) Ecology, morphology and taxonomy of mosses, fresh water and terrestrial algae were investigated.

2) Meteorological and unmanned microclimatic observations near the hut and microclimatic surveys along the valley were successfully undertaken.

3) For a long-term monitoring of moss vegetation, small quadrats were selected along the stream.

4) Field work was carried out at intervals during winter and concentrated in the autumn, spring and summer seasons. After the autumn surveys (February–May), which have been the first experience in JARE, the party returned to Syowa Station through the continental route from Mt. Heito to S16 on 9th May 1988.

5) Ecophysiologist Y. INO (summer member), bryologist H. KANDA and phycologist S. OHTANI took part in the research with the support of the other JARE-29 members.

5. Construction of a Hut for Biological Researches in the Yukidori Valley, Langhovde (Figs. 5, 6)

Syowa Station is located on East Ongul Island which is completely surrounded by impassable sea-ice from November to February, *i.e.* during the most biologically active season. Biologists and other field workers have therefore been prevented from crossing to other ice-free areas at this time and the construction of a field camp for the summer season in the Yukidori Valley had been under consideration since the time

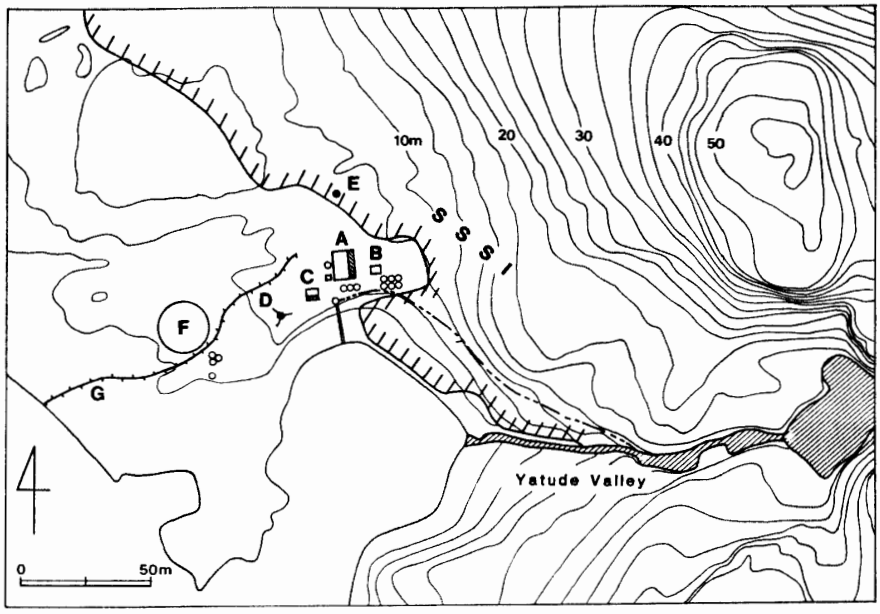

Fig. 5. The living area for biological research near the mouth of the Yatude Valley. A: A main quarter, B: A small hut for power generators, C: A living caboose, D: A pole of 10 m height for meteorological observations near the hut, E: A site for unmanned microclimatic observations, F: A helicopter port, G: A roadway for snow vehicles.

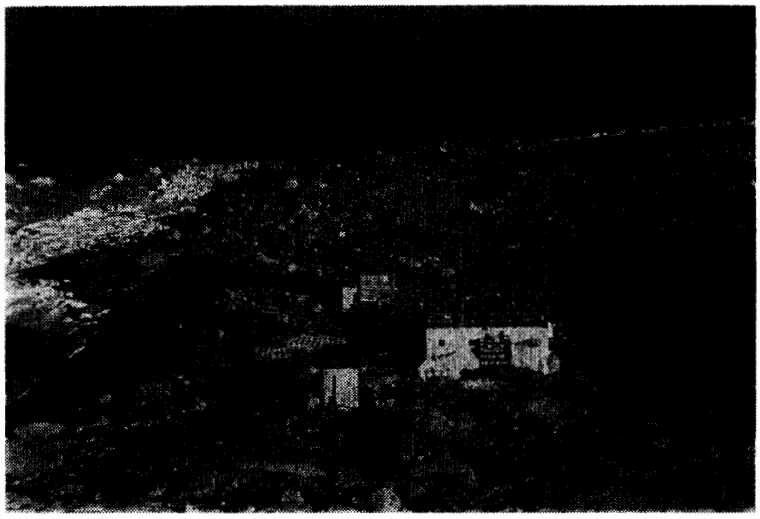

Fig. 6. Living quarters at the mouth of the Yatude Valley.

of JARE-24 (1983–1984).

In the summer operation from 15th to 21st January 1986, the party built the living quarters of about 26 m^2 (3.6 m × 7.2 m) and the small hut for power generators of about 5 m^2 (1.8 m × 2.7 m) near the beach at the mouth of the Yukidori Valley. Interior finish work of these constructions was completed by two jobs on 7–10th and 10–14th June. For the communications with Syowa Station, tranceivers of VHF (25W), HF (10W) and their antenna were installed. In addition, a second-hand living caboose was brought from Syowa Station during the winter of JARE-28 and it was used mainly as an experimental laboratory.

6. Surveys for Biological Meteorology around the Yukidori Valley (Figs. 2, 5, 7; Table 3)

6.1. Observations in JARE-27

Meteorological observations were carried out near the biological hut for two months from mid-November 1986 to January 1987. The elements measured by automatic and partially hand-operated observations and sensor specifications are shown in Table 3. This was the first meteorological observation in the Langhovde region. Almost all of the observations were operated by members of the Meteorological Agency of Japan.

In the lower course of the stream of the Yukidori Valley, microclimatic observations were conducted by biologists examining environmental conditions around moss and lichen communities. The data were recorded by an 8-channel data logger (Koito Kogyo Co., MES-801) and transferred to microcassette, and afterwards processed by a host computer. Temperatures at moss and lichen levels were measured by the thermocouple sensor at intervals of 30 min from spring to early summer, and of 15 min to late summer.

6.2. Observations in JARE-28

In the summer operation of JARE-28, some meteorological instruments were installed on a pole of 10 m height set up 30 m west from the hut in order to compare the data with those of Syowa Station. For this system, a term "mesoclimatic" may be suitable toward "microclimatic", but we use merely "meteorological" here.

The microclimatic observation was commenced in the lower, middle and upper courses of the Yukidori Valley. The three sites for the observation were selected to investigate the relationships between the moss vegetation and the environmental condition, and were operated by the system using a solar cell battery (Kyosera Co., LD361C22A) and a lead-acid gel battery (Nihon Denki Co., PE24-12r), along with the data logger. These systems partially followed those of JARE-27. In order to compare the environmental conditions at the sites, simultaneous measurements of the same elements were undertaken. The operation commenced from 24th November 1987, but the observations stopped owing to a trouble of the data logger in the upper and middle courses. Probably static electricity caused the damage. The measurements at the lower site were successful for about one month until 8th January 1988. The damaged data loggers were replaced by new ones brought by JARE-29.

Table 3. Sensor specification of meteorological instruments used in the vicinity of Yukidori Valley, Langhovde.

Elements	Type	Range	Accuracy	Height (m)	Date	Intervals
I. Automatically operated						
1. Meteorological observation near the hut[1)]					JARE-28 XII. 1, '87～	30 min
a) air temperature	E-732, E-831 (Nakaasa Keiki)	−50～+150°C	±0.2°C	1.5	I. 10, '88	
b) wind direction	KE-500 (Koshin Denki)	0～540°	±5°	10.0		
c) wind speed	ditto	0～70 m/s	±0.5 m/s	10.0	JARE-29	
d) atmospheric humidity	HMP31UT (Vaisala)	0～100%RH	±2～3%RH	1.5	II. 3～	30 min
e) solar radiation	Li-200SB (Li-cor)	0～3000 $W \cdot m^{-2}$	±5%	1.5	V. 8, '88	
f) photosynthetically active radiation	Li-190SB (Li-cor)	0～10000 $\mu mol \cdot s^{-1} \cdot m^{-2}$	±5%	1.5	XI. 1, '88～ I. 10, '89	
g) temperatures at moss lichen and soil levels	T-CC					
2. Microclimatic observation along the stream[2)]					JARE-27 XI. 21～30, '86	30 min
a) air temperature	PT-150-7-150 (Ohyo Denki Kogyo)	−40～+80°C	±0.1°C	1.5	XI. 30, '86～	15 min
b) wind derection	N162-P (Nihon Electr. Inst.)	0～360°	±5°	3.0	I. 14, '87	
c) wind speed	ditto	0～45 m/s	±0.5 m/s	3.0		
d) atmospheric humidity	HMP31UT11 (Vaisala)	0～100% RH	±2～3%RH	1.5	JARE-28	
e) solar radiation	A-2 (Nihon Electr. Inst.)	0～1.429 $kW \cdot m^{-2}$		2.0	XI. 24, '87～	15 min
f) photosynthetically active radiation	IKS-25 (Koito Kogyo)	0～3000 $\mu mol \cdot s^{-1} \cdot m^{-2}$	±5%	2.0	I. 8, '88	
g) temperatures at moss, lichen and soil levels	MES-1103 (Koito Kogyo)	−20～+80°C	±0.2%		JARE-29 II. 9～ IV. 29, '88 XI. 6, '88～ I. 10, '89	15 min

Table 3. (Continued)

Elements	Type	Range	Accuracy	Height (m)	Date	Intervals
3. Unmanned microclimatic observation[3]					JARE-29 I. 10, '88～	30 min
a) air temperature	HMP31UT (Vaisala)	−40～+80°C	±0.1°C	1.2	I. 10, '89	
b) wind direction	Dyna Vane 111-T (Ota Keiki)	0～540°	±5°	1.5		
c) wind speed	ditto	0～70 m/s	±0.5 m/s	1.5		
d) atmospheric humidity	HMP31UT, HMK11 (Vaisala)	0～100%RH	±2%RH	1.2		
e) photosyntheticall active radiation	Li-190SB (Li-cor)	0～10000 μmol·s^{-1}·m^{-2}	±5%	1.2		
f) temperatures at moss and soil levels	THE 6 (Takara Kogyo)	−50～+50°C	±0.2%			
II. Hand-operated						
					JARE-27	once
a) air pressure	portable aneloid			1.5	XI. 18, '86～	a day
b) air temperature	thermometer			1.5	I. 9, '87	0800
c) wind direction				1.5		
d) wind speed	cup anemometer			1.5	JARE-29	twice
e) atmospheric humidity	psychrometer (Assmann)			1.5	II. 10～	a day
f) weather					V. 5, '88	0900,
g) cloud						2100
h) visibility						

Power supply
1) Alternating current by a generator (Yanmar, YDG 3000, 2.7 kVA).
2) Lead-acid gel batteries (Nihon Denki Co.).
3) Lead-acid cyclon batteries (Bridgestone Co.).

Fig. 7. The system for microclimatic observations in the upper course of the Yukidori Valley.

6.3. Observations in JARE-29

JARE-29 operated three systems for biological meteorology, namely the meteorological and microclimatic observations continued from the previous parties and an additional new system, unmanned microclimatic observation. Air temperature and atmospheric humidity were measured simultaneously by hand-operated observation near the hut at intervals of 12 hours for a calibration and comparison with Syowa Station by a meteorologist.

Comparative observations at the three sites were carried out successfully for the two months of February and March, 1988, but the data logger at the lower sites was so erroneously operated that the subsequent observations were conducted only at the upper and middle sites. The data given by the observations were much significant to realize the activity of the organisms vigorously increasing under the Antarctic environmental condition during the summer season. The microclimatic data measured from 1988 to 1989 by JARE-29 were compiled in a series of data report (OHTANI *et al.*, 1990).

Furthermore, the party of JARE-29 operated an unmanned system for measurements for a year. The system was set up at 30 m north of the hut. The measurements were made at intervals of 30 min all year round from January with the different data loggers (Kona Co., KADEC-U) composed of seven 1-channel instruments using the batteries which can work under low temperature condition below −50°C (Bridgestone Co., Cyclone).

7. A Long-term Monitoring Using a Quadrat Method for a Change of the Vegetation and its Environments (Figs. 2, 8a, b)

The study of the terrestrial ecosystems of the Yukidori Valley was charged with the long-term monitoring for the vegetational and environmental changes which are considered to be caused by global or local climatic changes, or human impacts. The

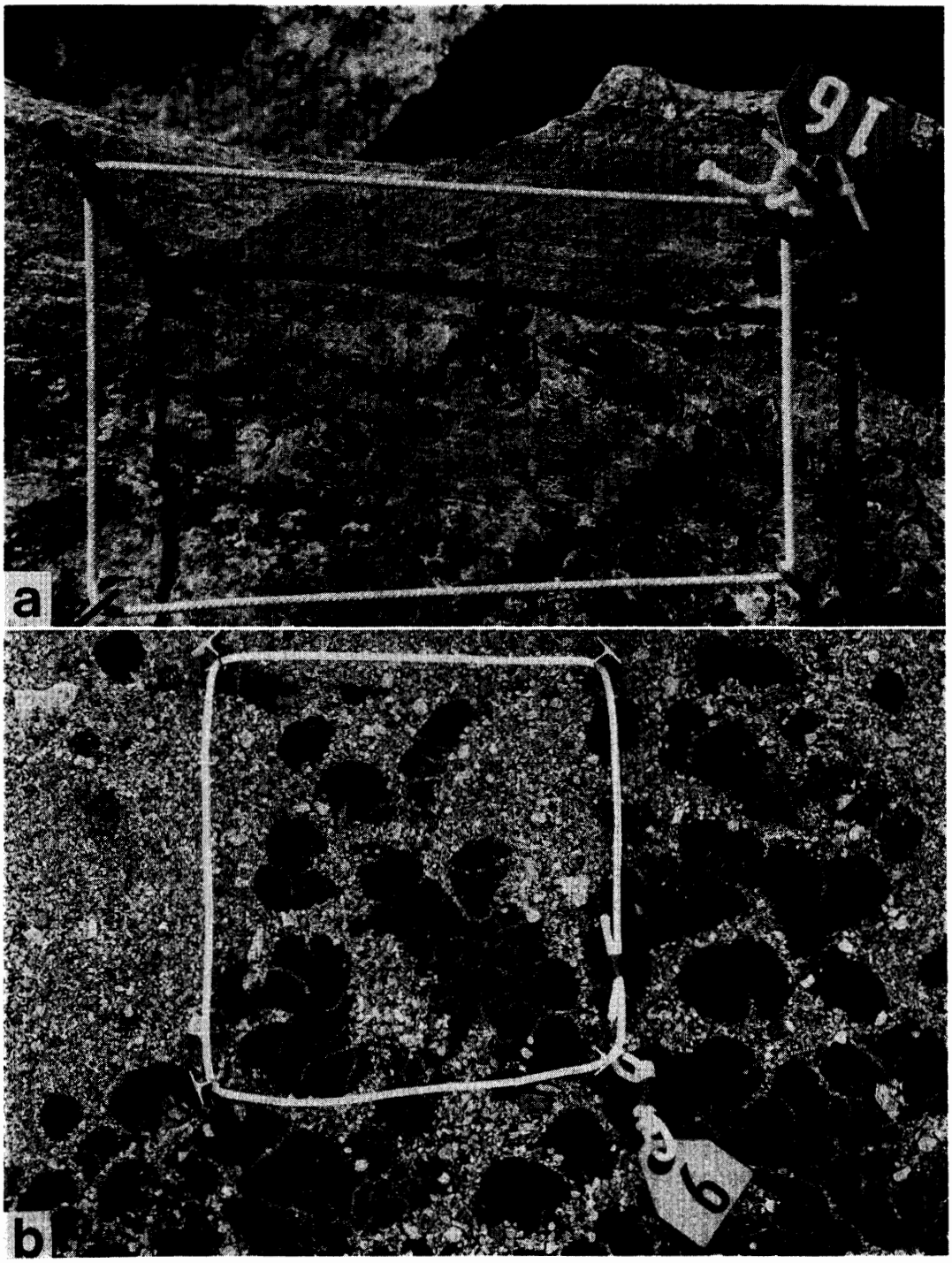

Fig. 8. Quadrats and vegetation for a long-term monitoring.
a. A lichen community of Buellia frigida.
b. A moss community of Ceratodon purpureus.

work related to the long-term monitoring has been commenced at Langhovde in 1974 by a plant ecologist, the late Dr. S. NAKANISHI who had joined the summer party of JARE-16 and set up a photographic site for the change of crustose lichen colonies near the mouth of the Yatude Valley. Twelve years later, another lichenologist, M.

INOUE of JARE-27 took photographs of the vegetation at the same site and analyzed the changes through the past years.

The long-term monitoring of the lichen vegetation by the quadrat method was made at 23 sites along the valley. The shape of each quadrat was mostly square of 30×30 cm, but sometimes rectangular depending on the condition of the lichen community. *Buellia frigida*, which is one of the most common lichen species around the Yukidori Valley, was chosen at 29 fixed points for a lichenometrical study measuring the growth and its relationships to the habitats for a year. On the other hand, 24 monitoring sites of moss vegetation were set up by JARE-29 along the valley with the same method as JARE-27. The vegetational and environmental changes of moss communities such as *Ceratodon purpureus*, *Bryum pseudotriquetrum* and these mixed comunity for a year were observed occasionally and the photographs were taken.

The monitoring site for microorganisms such as algae, mites, rotifer and tardigrades were not set up during the project, excepting one algal site at the mouth of the Yatude Valley.

The voucher specimens, photographs and maps used in the long-term monitoring are preserved in the National Institute of Polar Research, Tokyo (NIPR).

8. Field Surveys for Taxonomy and Ecology of Lichens, Mosses, Algae and Invertebrates

8.1. Lichens

The studies of distribution and taxonomy of lichens were carried out mainly along the Sôya Coast and the Prince Olav Coast by the party of JARE-27, of which M. INOUE was charged with the field survey. Some lichen collections were occasionally made in the Yukidori Valley on the way to other ice-free areas during the winter season until 17th November 1986 from when the party started intensive studies there until 16th January 1987.

To facilitate the field work along the valley, a stream area of about 2.5 km between the end of ice cap and the mouth of the stream was divided into 23 zones at intervals of 100 m. Each zone was marked by a bamboo pole.

The surveys related to the change and depth of snow cover were occasionally conducted at nine fixed points in the coastal area between the Yukidori Valley and the Yatude Valley for a year from 19–20th January 1986. A mapping of the lichen distribution was also prepared. One of environmental factors influencing the lichen distribution is considered to be salt concentration in snow cover near lichen vegetation. To measure the value of the electric conductivity of snow, a lump of snow of 1.5 kg was collected at each site of 57 points. Phytogeographical and phytosociological data related to lichen vegetation were taken at 183 points throughout the Langhovde region. Study area for each data is basically in quadrat of 20×20 cm. The associating species were sampled, and the coverage percentage was counted, and the data form was filled out.

8.2. Mosses

During the project, the first research of mosses was carried out by Y. MOCHIDA of JARE-28. The major work was ecological survey relevant to habitats and vegeta-

tion, with special emphasis on microscale topography of the surface soils. The following articles were studied at 26 fixed points: 1) phytosociological study of moss vegetation along the valley and a mapping based on the communities classified, 2) geomorphological profile of vegetation beds by level surveyings, 3) relative water contents of mosses and soils and particle property of soils, 4) description of moss habitats composed of the valley bank (meltwater streams), steps and cliffs (glacial denudation), and flat places (fluvioglacial deposition), and 5) measurements of soil temperature, moisture, and movement for relationships between the vegetation and the surface movements on it.

An ecophysiological survey of mosses was carried out by Y. INO of the summer party of JARE-29. Photosynthetic study was carried out by using mosses under natural condition near the hut. This survey was continued during the summer from 7th to 17th January 1988.

Ecological studies on mosses, including water relations, phytosociology and interrelations between algae and mosses were carried out by H. KANDA of the winter party of JARE-29. More important work during the summer was to measure the water content of mosses and to set up small quadrats of the moss vegetation for the long-term monitoring. The moss vegetation was chosen at 24 fixed points for measurement of water contents, and vegetational and environmental changes such as movement of sand cover, accumulation of snow drift and epiphytic organisms. These studies were continued at intervals of about ten days for a year excepting the winter from May to September. The moss distribution in the Langhovde region was plotted in detail within meshed grids of 500×500 m. Furthermore, the SSSI area of approximately 3 km^2 including the Yukidori Valley was sectioned into 50×50 m meshes and the located mosses were plotted on distribution maps. In the three zones of the upper, middle and lower courses of the stream, the moss vegetation was classified using phytosociological methods and the essential data were used to make vegetation maps of the valley. Microclimatic observations were carried out in the environments around the moss colonies in each course of the stream.

Two fruiting species, *Pottia heimii* and *Bryum amblyodon* are known along the valley. The developmental processes in moss sporophytes are more easily distinguished in comparison with those in vegetative plants. Sampling for measuremens of the growth of shoots, development of sexual organs and capsules, and length of setae was carried out at intervals of several weeks. Moreover, core material of mosses and soils was collected using a line transect method. Furthermore, moss samples showing the growth profile in longitudinal cross section were made. An additional study was to sample aquatic mosses in Lake Yukidori and on its banks. The moss habitats on the lake bottom were observed and they seem to be closely related to the algal coverage.

8.3. Fresh water algae

The wintering studies of fresh water algae are carried out by S. OHTANI of JARE-29. The algal surveys are mainly to collect samples at some kinds of habitats such as surfaces of soils, rocks and moss cushions, bottoms of cherty boulders, rock crevice, lake margins and bottoms, and rookery of sea birds. The existence and composition of epiphytic algae on moss cushions are unique phenomena different from aquatic

habitats in the Antarctic. The algal coverage on mosses is probably depending upon microscale structures of the uneven surface which seems to be caused by the changes of the water content or sand accumulation. At two stands along the stream (wet type) and snow drift (dry type), the relationships among the temperature regimes, photosynthetically photon flux density (PPFD) and water content were observed at intervals of one week from the middle of November 1988 to early January 1989. Furthermore, in order to clarify the relation between the water content of soil surface and the algal vegetation, samples of algae were collected at 25 fixed points at intervals of 100 m along the Yukidori Valley and water contents of soils were measured. In this summer season an upper half of the stream had usual stream water, but almost of all the algae dried in at the lower stream because of little water. An additional work was to collect lichen samples from which associated algae and fungi could be experimentally isolated under the aspetic condition. The samples are preserved in the condition of −20°C and are supposed to be cultured. One of the very interesting items of algal study is algal mats growing on the bottom of Lake Yukidori. In early February 1988, algal mats on the lake bottom 100 m off the beach were observed and collected. The surface water was taken by a water sampler (Kitahara type) and algal mats were gathered. Simultaneously the water depth, water temperature, conductivity and pH were measured at intervals of 10 m over a distance of 100 m from the lake edge towards the central part of lake.

8.4. Invertebrates

The studies on the taxonomy and ecology of invertebrates such as mites, tardigrades, nematodes, rotifers, were carried out by H. SUGAWARA of JARE-28 from January 9–16th 1987 in the Yukidori Valley. In the upper and middle courses of the valley, a cryptostigmatic mite, *Antarcticola meyeri* was found newly to the Syowa Station area. This is the third record from Antarctica; the previous two being from Molodezhnaya Station, Enderby Land and Prince Charles Mountains, Mac. Robertson Land in East Antarctica.

The intensive ecological survey and with a life history of the mites was carried out from the middle of August to early January. The change of the composition on each developmental stage was monthly observed. Furthermore, the samples were obtained at 18 fixed points with different microhabitats, and environmental preference and vertical distribution of invertebrates in moss cushions were examined, and the soils and mosses were sampled transversely at the different gradients of water condition. A tolerance of mites against the low temperature was experimentally examined under the three conditions from −16.0°C to −32.5°C for six hours and afterwards the living population was counted. Reversely they were exposed under the high temperature condition of 30°–40°C. An additional study was to realize the relationships between the invertebrates population and the microclimatic condition such as air temperature, atmospheric humidity, soil temperature, water contents of soils and mosses and particle property of soils. Some samples of mosses and soils were vertically and horizontally made for extracting the aquatic microfauna such as tardigrades, nematodes, rotifers, and so on. These samples were preserved in the frozen and stuffed condition for subsequent experimental studies.

9. Consideration for Future Surveys

The survey in the inland ice-free area, the Sør Rondane program, continues for each summer season from 1989 to 1990. After the program is accomplished, the whole project (Studies on the mechanism of Antarctic terrestrial ecosystems) performed in the inland and coastal ice-free areas will be finished. We consider that the results derived from the study will prove significant in comparing floras and faunas, habitats, microclimatic and edaphic conditions between the two different areas. In the case of the Yukidori Valley program, the biological and environmental changes should be monitored at long intervals of five or ten years. Some studies on terrestrial biology are being designed for the five year plan in the fourth phase of JARE which should be in progress between 1991 and 1996. The study would be undertaken from the ecological aspect previously conducted in the Yukidori Valley area toward the ecophysiological aspect.

The Japan-China cooperative project began at Great Wall Station, King George Island in 1988 and is planned to continue for each summer season until 1990. The major object of this project is to compare the terrestrial floras and faunas between the Great Wall Station area and the Syowa Station area. In order to add further interest in the cooperative study, it is fundamental and important to compile and analyze the meteorological data and biological samples accumulated from the Syowa Station area.

These data and samples will not only be used in ecosystem studies of the Antarctic environments, but also in ecological and taxonomical studies about the relationships between polar ecosystems, and other ecosystems of the world.

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References

MATSUDA, T. and HOSHIAI, T., ed. (1979): Proceedings of the Symposium on Terrestrial Ecosystem in th Syowa Station Area. Mem. Natl Inst. Polar Res., Spec. Issue, **11**, 152p.

NATIONAL INSTITUTE of POLAR RESEARCH, ed. (1977): Proceedings of the First Symposium on the Antarctic Environmental Sciences, September 27, 1976. Nankyoku Shiryô (Antarct. Rec.), **59**, 1–148.

OHTANI, S., KANDA, H. and INO, Y. (1990): Microclimate data measured at the Yukidori Valley, Langhovde, Antarctica in 1988–1989. JARE Data Rep., **152** (Terr. Biol. 1), 216 p.

SCAR, ed. (1988): Recommendations from the 14th Antarctic Treaty Consultative Meeting, Rio De Janeiro 5–26 October 1987. Annex. Sites of Special Scientific Interest No. 22: Yukidori Valley, Langhovde, Lützow-Holm Bay. SCAR Bull., **89**, 3–4.

SMITH, R. I. L. and WYNN-WILLIAMS, D. D., ed. (1987): Biological Investigations of Terrestrial Antarctic Ecosystems. BIOTAS Newsl., **1**, 1–10.

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