Microfauna of Schirmacher Oasis, Antarctica: I. Water-Moss Communities

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ABSTRACT

Ten limnetic lakes at Schirmacher Oasis, Antarctica were surveyed during the austral summer (Jan-Feb. 1985). Distribution and abundance of microfauna with the associated algal and moss communities were studied. Population density and biomass were greater in the sediment covered with moss turf. The fauna was mainly comprised of seven taxonomic groups, dominated by nematodes (22.13%), followed by protozoans (19.77%), turbellarians (15.47%) and tardigrades (09.23%). Other faunal components were oligochaetes (01.38%), rotifers (00.94%) and acarides (00.71%). Numerous invertebrate cysts were also recorded (27.27%) in all the samples. The maximum faunal density of 304 numbers/10 cm^2 and minimum of 45 numbers/10 cm^2 (x = 95.4) were recorded in the moss turf and moss carpet respectively. Algal communities associated with microfauna were belonging to the genus *Oscillatoria, Synechocystis, Desmidium* and *Choococcus* of the blue-green algae. Estimated faunal standing crop seem to be related to the sediment characteristics.

INTRODUCTION

The freshwater lakes of Antarctica represent a biological integration of particularly attractive ecological units for basic study (Priddle and Heywood, 1980). Being mostly isolated, unaltered, unpolluted and despite of the hazardous climatic conditions, such polar ecosystems have been investigated by many workers. Available information indicates that major emphasis has so far been placed on their territorial environments (Strong, 1967; Smith, 1978; Jenning, 1979; Maslen, 1980 and Block, 1984). Consequently, information about the faunistic aspects on the limnetic and glacial biotopes is rather insufficient to permit any general interpretation.

Although the Schirmacher Oasis was discovered in 1938-39 by an earlier German Expedition, (Die Deutsche Anterctische expedition, 1942) the published records of ecological aspect are very few. The earliest account is by Bardin and Leflat (1965) on the chemical characteristics, followed by Komarker and Ruzickal (1966) on the algal production in an ice covered lake. The present investigations were carried out during the austral summer of 1984-85 and the microfaunal components of the freshwater habitat in relation to the environmental oscillations have been reported here. Faunal distribution, relative abundance and standing crop were studied and an attempt has been made to compare and discuss the data with the pubhshed information from comparable ecosystems of the other regions.

MATERIAL AND METHODS

Study area: The Schirmacher Oasis, forming a part of Dronning Maud Land, is about 70 km south of the Princess Astrid coast of Antarctica (Lat. 70°43' to 70°77'S; Long. 11°22' to 11°55'E). It covers an area of about 72 km^2 (Fig. 1) of which about 3% is always free from snow cover. The remaining area, normally covered with some snow, in the winter largely melts off in the summer. This melted water, along with the melted glacier water get accumulated in the depression between the hills forming small pools. About 30 such fresh water ponds or pools exist in the Schirmacher Oasis. These small lakes were visited twice (on 21 Jan. and 23 Feb. 1985) during the 4th Indian Scientific Expedition to Antarctica (1984-85) and the material for present study was collected from 10 different lakes of the Schirmacher Oasis.

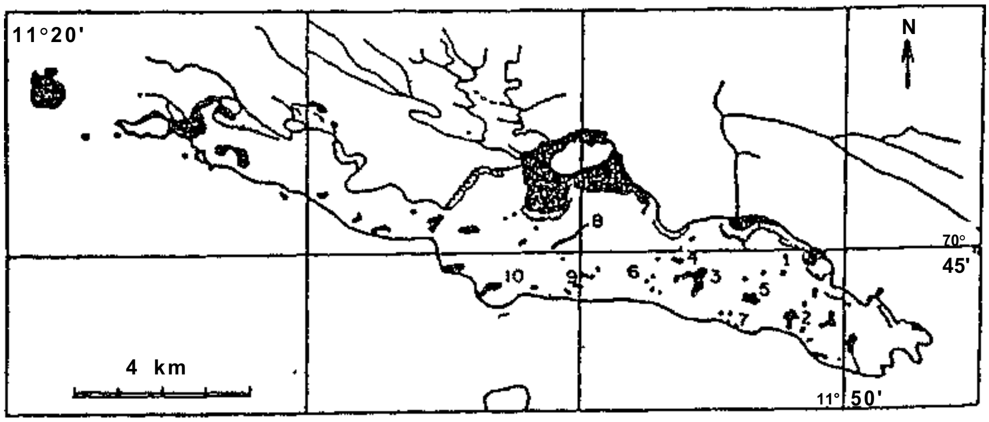

Fig.1. Study area showing the observation points (L-1 to L-10 in Table I) in Schirmacher Oasis, Antarctica.

Microfauna samples were collected from the periphery of all the ten lakes using a hand plastic corer (10 cm length; 4.5 cm inner diameter). Duplicate samples, upto 6 cm sediment depth, were fixed in 4% formaldehyde solution to which 1% rose-bengal solution was added. Samples were also collected separately from each site for the determination of organic content and particle size analysis. Dissolved oxygen in the overlying water was measured following the method of Strickland and Parsons (1968). A systronic digital pH meter (Model, 333) was used to measure the hydrogen ion concentration. Temperatures (air, water and sediment) and sediment types were recorded during the sampling time.

Faunal samples were washed through 500 mm and 0.063 mm sieves in filtered freshwater on board M.V. *Finnpolaris* and the contents of the 0.063 mm sieve were then preserved in 4% buffered fbrmaldehyde solution. All animals were sorted, counted and identified to the possible taxon under a Projectina microscope. Biomass (dry weight) of nematodes, turbellarians, tardigrades, oligochaetes and acarides was determined according to the method given by Dye and Furstenberg (1977) and dry mass of protozoans (ciliates), rotifers and cysts (resting eggs) was calculated following the method of Sarojini and Nagbhushanam (1967). Particle size analysis of the sediments was carried out following the method of Holme and McIntyre (1971) and organic content was estimated by the wet oxidation method of E1 Wakeel and Riley (1956).

RESULTS

Environmental characteristics

Table I summarizes the data on the physical characteristics of the environment. The surface water temperatures ranged from + 1.0° to+3.7°C with a mean of +2.42°C during the sampling period. The air temperature fluctuated widely and the values ranged from -3.0° to +1.0°C with a mean of - 0.8°C. Sediment temperatures in all ten lakes were invariably in the range of +4.0° to +8.1°C (x= 5.9°C). The lake waters were generally transparent with extremely low salinity and high phytoplankton growth. However, water in the lake 6 was found to be slightly saline (1.93‰ salinity). Dissolved oxygen in the overlying water of all the 10 lakes varied from7.27-8.27 ml/1, with a mean of 7.85 ml/1. The pH values oscillated between 7.55-8.75 with a mean of 8.24.

Sediment texture

Sediments at all the sampling sites were either covered with a moss turf or moss carpet with filamentous blue-green algae (Fig. 2a, b). The average percentage of sand, silt and clay along with the type of substrate at each sampling station are presented in Table II. The substrate was rich in coarse sand, poor in crystalline particles and was dominated by pebbles. Higher percentages of sand and pebbles were observed in all the samples. The values for the coarse sand particles ranged from 82.80%-97.58% with a mean of 91.26%. Sediment covered with moss carpet was very coarse and poor in silt-clay fractions as compared to the sediment covered with the moss turf. The values for silt-clay percentage varied from 02.42-17.20% (x= 8.74).

Organic carbon

The organic carbon input from the vegetation in the catchment area ranged from 0.05-1.80% (Table II). Generally the sediment covered with vegetation (moss and algae) showed more carbon

TABLE I

Comparison of Environmental factors recorded at 10 freshwater habitats of Schirmacher Oasis, Antarctica.

St.No.	Air	Temperature °C Surface water	Sediment	pH	O_2 ml/l	Salinity %o
L-1	-3.0	1.5	+4.7	8.70	7.6	0.1310
L-2	+0.5	2.0	+6.8	8.75	7.6	0.0885
L-3	-2.14	3.3	+4.3	8.10	7.35	0.0885
L-4	-1.0	2.5	+5.5	8.00	7.93	0.0885
L-5	-1.5	2.8	+5.5	8.00	7.93	0.0885
L-5	-1.5	2.8	+5.8	8.65	8.27	0.0885
L-6	-3.0	1.7	+4.9	7.55	8.10	1.9340
L-7	-2.0	1.0	+4.0	8.34	8.13	0.0885
L-8	+1.0	3.7	+8.1	7.95	7.27	0.0885
L-9	+1.5	3.7	+8.1	8.50	7.93	0.0885
L-10	+1.0	3.7	+8.1	7.92	8.16	0.0885

TABLE II

Comparison of sediment characteristis and faunal standing crops of 10 freshwater habitats.

Station No.	Sand %	Silt & clay (%)	Texture	Organic carbon (%)	Standing crops Density nos./m^2	Biomass g/m^2
Lake 1	82.80	17.20	Silty sand covered with moss turf	0.85	1460	2.609
Lake 2	96.05	03.94	Coarse sand with pebbles	0.08	860	1.870
Lake 3	84.57	15.43	Silty sand covered with moss turf and algae	1.73	900	2.404
Lake 4	93.01	06.99	Coarse sand covered with moss turf	1.15	1610	5.376
Lake 5	87.83	12.17	Silty sand covered with moss turf	1.80	1920	5.525
Lake 6	97.58	02.42	Coarse sand with pebbles	0.01	510	0.960
Lake 7	91.67	08.33	Coarse sand with pebbles covered with moss carpet	0.01	450	1.491
Lake 8	96.18	03.82	Coarse sand with pebbles	0.05	490	2.517
Lake 9	86.53	13.47	Silty sand covered with moss carpet	0.85	1200	2.597
Lake 10	96.37	3.62	Coarse sand with moss carpet	0.05	450	1.225

Fig. 2(a). **Sediment covered with moss carpet (L-3B) (115 X 167 cm^2**

Fig. 2(b). **Sediment covered with moss turf (115 X 167 cm^2).**

content than the uncovered (bare) sediment. Maximum and minimum of 1.80% and 0.01% of organic carbon content was recorded in the covered and uncovered sediments respectively.

Faunal density

Fauna in the upper 6 cm layer of the sediments is comprised of seven taxonomic groups (Fig. 3). Maximum faunal density of 304 numbers/10 cm^2 was recorded in the lake 5 and minimum density of 45 numbers/10 cm^2 in the lake 7 (Table III). The fauna was dominated by cysts (resting stages (eggs) of micro-invertebrates, Fig. 4) which comprised 27.27% of the total fauna. Maximum and minimum density of 79 cysts/10 cm^2 and 05 cysts/10 cm^2 were recorded at the lake 5 and lake 3, respectively. Nematodes comprised 22.13% of the total fauna with maximum and minimum density of 127 and 06 numbers/10 cm^2 ($\bar{x}$=23.08). Turbellarians were next in the order of abundance (15.47%) and ranged between 03-74 numbers/10 cm^2 ($\bar{x}$= 15.03). Generally nematodes (*Teratacephalus* sp.) and turbellarians (*Neorhabdocolid* sp. and *Kalyptorhynchia* sp.) were abundant in the lake edge, where benthic algae (species of *Oscillatoria; Synechacystics; Desmidium* and *Choococcus*) were also abundant. Other faunal components were tardigrades (02-32 numbers/10 cm^2, $\bar{x}$= 9.25); protozoa (03-32 numbers/ 10 cm^2, $\bar{x}$= 9.16) and ciliates (03-24 numbers/10 cm^2, $\bar{x}$= 10.55). Acarids and oligochaetes were maximum in the moss carpet with a density of 06 and 06 numbers/10 cm^2.

Faunal distribution

Random distribution of microfauna was observed and animals were abundant where plant materials were found, as most of these animals are directly plant feeders. Morisita's Index (IS) of dispersion was calculated for the spatial distribution of numerically abundant faunal groups (Table IV). The values for the nematodes were significantly higher than 1, indicating an aggregated or contagious dispersion (x^2, P <0.01, n-1 degree of freedom). Rotigers were distributed contageously and the maximum were found in the lake 2. IS values for the other groups were less than 1 showing their spatial distribution.

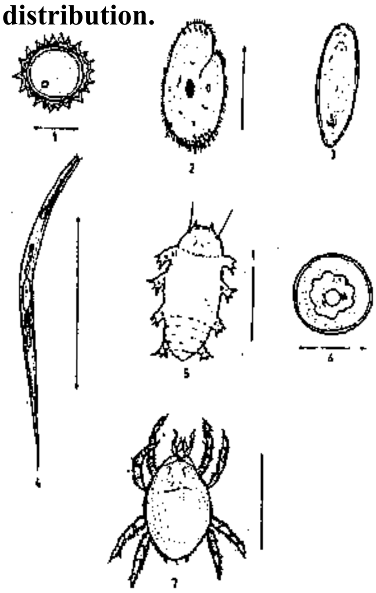

Fig. 3. **Freshwater fauna of Schirmacher Oasis, Antarctica, representing the major groups: 1. Tardigrade egg (d.0.09 mm), 2. Ciliate (L.0.12 mm), 3. Turbellaria (L.0.42 mm), 4. Nematoda (L.1.15 mm), 5. Tardigrade (*Echiniscus* sp. L.0.68 mm), 6. Cyst (d.0.12 mm), 7. Acarina (L.0.38 mm).**

Fig. 4. **Cyst (resting egg) of micro-invertebrate, (d.0.09 mm) recorded from lake periphery, Schirmacher Oasis, Antarctica.**

Standing crop

The standing crop of benthic fauna was estimated by direct count (dry weight method) from the preserved samples. Population density and biomass values are illustrated in Fig. 5. Mean density of 985 numbers/m^2 was estimated for the entire austral summer (Jan-Feb 1985) with a mean biomass of 2.657 g/m^2. Maximum density of 3040 numbers/m^2 and minimum of 450 numbers/m^2 was recorded

TABLE III

Faunal density, per 10 cm^2 in ten freshwater habitats at Schirmacher Oasis, Antarctica (Values in parenthtesis are biomass in µg dry weight 10 cm^2).

Localities (Date of collection)	Nematoda	Turbellaria	Ciliata	Tardigrada	Egg capsules	Rotifera	Protozoa	Acarina	Oligochaeta	Unidentified	Total
Like 1 (19 Ian '85)	24	21	06	06	59	-	24	-	06	-	146
	(10.8)	(9.45)	(0.03)	(2. 70)	(0.295)	-	(0.12)	-	(2.70)	-	(26.09)
Lake 2 (-„-)	15	09	21	05	24	07	05	-	-	-	086
	(6.75)	(4.05)	(0.105)	(2.25)	(0.12)	(3.45)	(0.025)	-	-	-	(16,44)
Lake 3A (21 Jan '85)	09	10	06	02	10	-	03	-	03	02	045
	(4.05)	(4.50)	(0.03)	(0.9)	(0.05)	-	(0.015)	-	(1.35)	(0.9)	(11.88)
Lake 3B (-„-)	32	19	19	09	10	-	-	05	02	03	099
	(14.4)	(8.55)	(0.095)	(4.095)	(4.05)	-	-	(2.25)	(0.9)	(1.35)	(31.64)
Lake 3C (-„-)	41	27	19	21	31	03	-	-	-	07	149
	(18.45)	(12.15)	(0.095)	(9.45)	(0.155)	(135)	-	-	-	(3.15)	(44.79)
Lake 3D (-„-)	27	05	10	24	05	-	05	-	-	05	081
	(12.15)	(2.25)	(0.05)	(10.8)	(0.025)	-	(0.025)	-	-	(2.25)	(27.54)
Lake 3A (23 Feb '85)	09	06	06	03	20	-	-	-	03	-	047
	(4.05)	(2.7)	(0.03)	(1.35)	(0.10)	-	-	-	(1.35)	-	(09.58)
Lake 3B (-„-)	38	13	06	05	40	-	32	-	-	03	137
	(17.1)	(5.85)	(0.03)	(2.25)	(0.20)	-	(0.16)	-	-	(135)	(26.94)
Lake 3C (-„-)	19	10	13	06	10	-	05	-	-	-	063
	(8.55)	(4.50)	(0.065)	(2.70)	(0.05)	-	(0.025)	-	-	-	(15.88)
Lake 3D (-„-)	07	10	18	07	22	03	09	-	-	06	082
	(3.15)	(4.50)	(0.09)	(3.15)	(0.11)	(1.35)	(0.045)	-	-	(2.70)	(15.09)
Lake 4 (21 Jan '85)	44	24	06	03	27	-	03	03	03	-	113
	(19.8)	(10.8)	(0.03)	(1.35)	(0.135)	-	(0.015)	(1.35)	(1.35)	-	(34.82)
Lake 4 (23 Feb '85)	127	09	12	09	29	03	06	-	-	09	204
	(57.5)	(4.05)	(0.06)	(4.05)	(0.14)	(1.35)	(0.03)	-	-	(4.09)	(67.92)
Lake 5 (21 Ian '85)	38	03	05	22	07	-	-	-	-	-	075
	(17.1)	(1.35)	(0.025)	(9.9)	(0.35)	-	-	-	-	-	(28.4)
Lake 5 (23 Feb '85)	58	74	24	32	79	03	24	06	03	-	304
	(26.10)	(33.30)	(0.12)	(14.4)	(0.39)	(1.35)	(0.12)	(2.70)	(1.35)	-	(79.85)
Lake 6 (21 Jan '85)	06	12	09	03	18	-	03	-	-	-	051
	(2.70)	(5.40)	(0.04)	(135)	(0.09)	-	(0.01)	-	-	-	(09.59)
Lake 7 (-„-)	06	21	03	-	09	-	03	-	03	-	045
	(2.70)	(9.45)	(0.01)	-	(0.04)	-	(0.01)	-	(1.35)	-	(13.56)
Lake 8 (18 Jan '85)	07	10	05	-	18	-	07	-	-	02	49
	(3.15)	(2.50)	(0.02)	-	(0.09)	-	(0.03)	-	-	(0.90)	(8.69)
Lake 9 (18 Jan '85)	09	18	24	15	30	-	09	-	06	09	120
	(4.05)	(8.10)	(0.12)	(6.75)	(0.15)	-	(0.04)	-	(2.70)	(4.09)	(26.00)
Lake 10 (18 Jan '85)	09	15	03	03	15	-	-	-	-	-	045
	(4.05)	(6.75)	(0.01)	(1.35)	(0.07)	-	-	-	-	-	(12.23)

respectively in the sediment covered with moss turf and moss carpets. Respective values for biomass were 5.525 g/m^2 and 0.960 g/m^2.

DISCUSSION

The term 'Oasis' was first used by 'Stephenson' (a member of the British Grahamland Expedition, 1934-37) to cover both dry and wet snow free areas on the Antarctic continent. Oases are warmer than the surrounding areas covered with ice and snow since bare rocks and soil have a much lower albedo than snow. Walton (1984) has identified the three types of bare grounds on the Antarctic continents as (1) areas permanently free from snow, (2) areas normally with some snow cover in the winter and (3) exposed areas of rocks associated with mountains. The Schirmacher oasis comes under the second type, where the area normally is covered with some snow in the winter which largely melts off in the summer to provide an ice or water-free zone. This water-free zone at least for a part of the summer is very necessary because with long photo-periods and high temperature, maximum phytoplankton production takes place. It allows the micro-organisms to develop, grow and reproduce.

TABLE IV

Morisita's Index (IDdd) for dispersion in the case of dominant groups.

Total fauna	1.3665
Nematoda	2.5435
Turbellaria	1.8143
Ciliata	1.3976

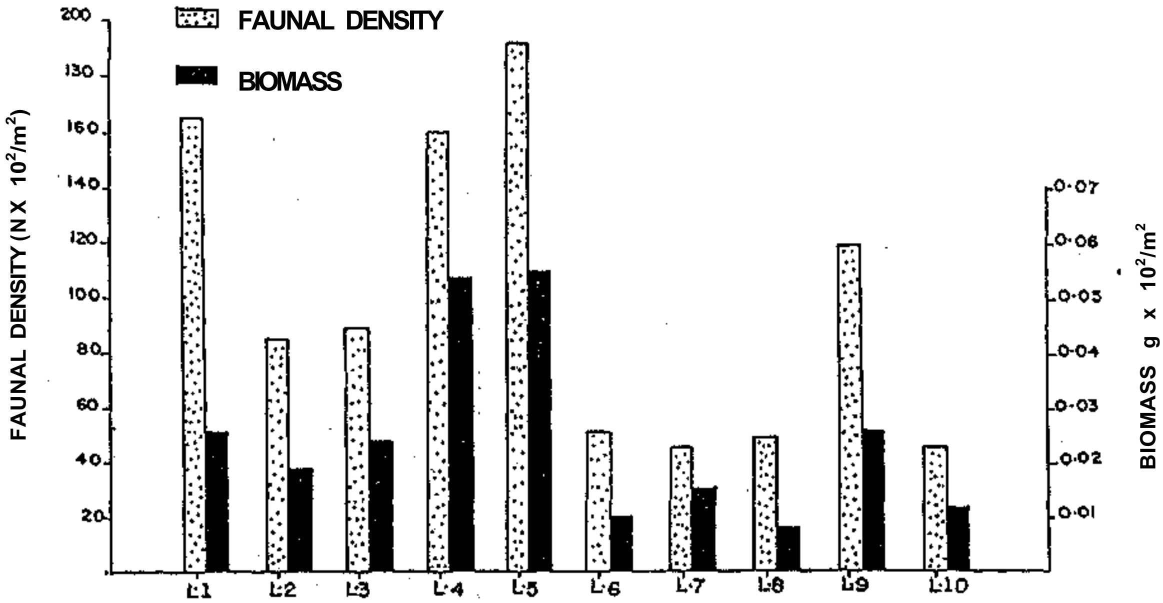

Fig.5. Micro-faunal standing crop from 10 freshwater habitats in the Schirmacher Oasis, Antarctica.

Air temperature at the Schirmacher Oasis increases from -6.0° to -1.0°C from November to February (Desa et al., 1983). During this period, the lakes are completely or partly melted and support a surprisingly high and diverse biological activity (Matondkar and Gomes, 1983). As recorded during the present study, surface water temperature ranged from +1° to +4°C during January-February 1985. The metabolic activities of living organisms in the Antarctic ecosystems, depend on the quantity and quality of incoming radiation and resulting thermal conditions (Block, 1984). The luxuriant growth of benthic vegetation and the surrounding algal matter, especially the loosely packed moss and turf moss carpets along the lake side support diverse invertebrate fauna. The vegetation, not only serves as a food source in the summer but also provides protection giving insulation during the severe winter (Goldman et al., 1972).

In general, much of the invertebrates are plant feeders (Heywood et al., 1979) and accordingly, maximum faunal density was associated with the distribution and abundance of plant material. Free living turbellarians and nematodes were abundant at the lake edge where dead plant material was high. However, an increase in the microfaunal population with the decline in microbial population was observed during the present study. It indicates that the fauna of Schirmacher Oasis is opportunistic feeder (feeds on algae, detritus and associated bacteria). While reporting the microflora and microfauna interaction in the mass-peat, Wynn-William (1982) reported that the microflora are a major food source for protozoa and nematoda. Davis (1981) suggested that protozoans play an important role in the moss community under the littoral Antarctic conditions.

The role of the benthic organisms in modifying the sediment habitat, both physically and chemically, has been discussed by Bloom et al. (1972) and Gray (1974).

Inspite of the common faunal communities in all the ten freshwater habitats at the Schirmacher Oasis, the values for standing crops ranged widely. The main reason for this fluctuations in the standing crop is the sediment texture as some of the lakes are surrounded by moss carpet and some with thick moss turf. Davis (1980) has discussed the dead organic matter (DOM) decomposition and standing crop in the moss turf and moss carpet and reported a higher standing crop in the moss turf as compared to the moss carpet. The analysis of organic carbon in the sediments during the present study also indicated a higher organic content in the moss turf than in the moss carpet. The particle size analysis of the sediment showed an increasing percentage of silt-clay fractions in the moss turf than in the moss carpet, which may be due to the higher decomposition rate of organic matter in the moss turf (Davis, 1980).

It is thus concluded that the abundant algal and moss flora all around the water bodies, support rich invertebrate fauna. This fauna appears to be an opportunistic feeder rather than selective feeder, which is due to the marked seasonal fluctuations in phytoplankton growth. Periodicity is the most important characteristic of the species in physically unstable areas (Carriker, 1967).

The animals also have the ability to produce cysts (resting eggs) when conditions become too severe. Secondly, this fauna may be an important food source for birds, especially for the wintering birds. It has been further confirmed from the insect skeleton and frustules of micro-organisms found in the faecal pellets and in the undigested food of the Antarctic Skua (personal observation). Burger (1978) has reported oligochaetes as an important component of the diet of two bird species at the Marion Island.

Long term studies on the physiological and ecological factors in relation to adaptations in the environment will certainly provide further knowledge of as to how colonization of these animal communities in an oasis far removed from any other land area, takes place.

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