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ARAUCANIAN LAKES

PLANKTON STUDIES IN NORTH PATAGONIA, WITH NOTES ON TERRESTRIAL VEGETATION

BY

KUNO THOMASSON

UPPSALA 1963

ALMQVIST & WIKSELLS BOKTRYCKERI AB

SVENSKA VÄXTGEOGRAFISKA SÄLLSKAPET

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The present paper constitutes no. 5 of the Studies on South American Fresh-Water Plankton by the author, and no. 6 of the Reports of the Swedish Limnological Expedition to South America in 1953–54.

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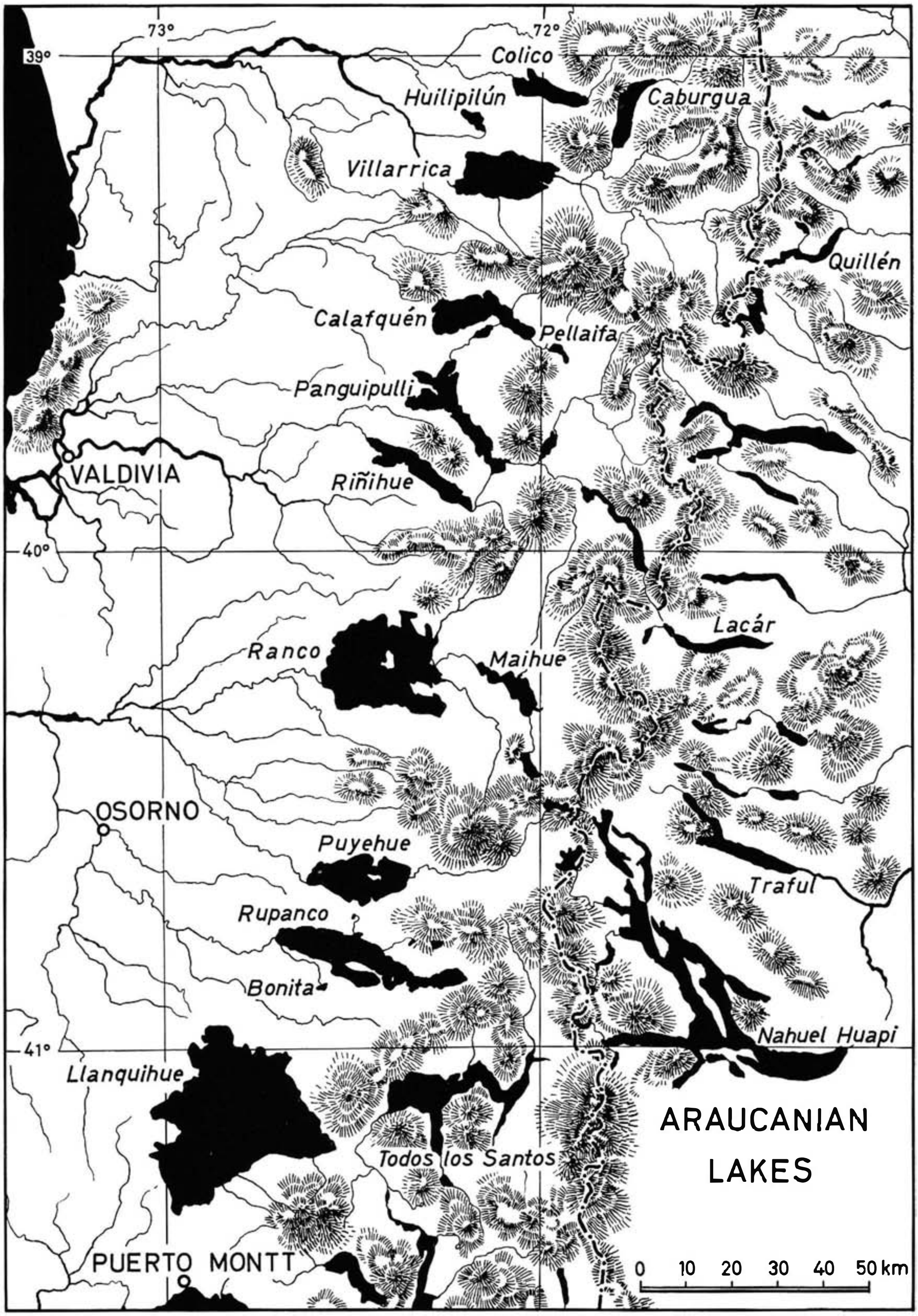
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I. PREFACE

The story of the Swedish Limnological Expedition to South America goes back to 1950. It was then that I began planning an expedition to the tropical parts of South America. Simultaneously Prof. Lars Brundin became interested in the bottom fauna of temperate lakes of the southern hemisphere. His idea was to investigate some lakes in New Zealand or in the temperate part of South America. During a field trip to Jotunheimen in 1952, we had the opportunity to discuss and co-ordinate our plans. For the destination of our journey we chose the Chilean lake district, which extends between 39° 00′ and 41° 30′ south latitude, and 71° 30′ and 73° 30′ west longitude.

We also realized the importance of having somebody well acquainted with limnographical methods among us, so the expedition was completed by a third member, Dr. Heinz Löffler, then working in Sweden. Besides limnography (Löffler, 1960) the zooplankton (Löffler, 1962) became his responsibility.

We arrived at the shores of Lake Villarrica on October 15, 1953, and established our headquarters in Mr. Roth's summer residence which lies on the northern shore of the lake. It is situated only a few kilometers from the small town of Villarrica, one of the oldest towns in Chile, founded in 1555 by Gerónimo de Alderete, who was one of the companions of the conqueror, Pedro de Valdivia. Due to the kindness of Mr. K. Roth, we had good space for laboratory work, and opportunity to use his boats for sampling in the lake. The surroundings of the lake are greatly influenced by the activities of man, but on our side of the lake one could still find large patches of virgin rainforest giving an impression of the ancient landscape which once surrounded the lake.

From our headquarters it was only a short walk to the shallow Lake Pichilafquen which was frequently visited. During our stay on the shores of Lake Villarrica we also made trips to some other lakes in the vicinity, viz. Lake Huilipilún, and Lake Quillehue.

At the beginning of December we spent several days in the country-cottage of Mr. C. Weber on the shores of Lake Pellaifa. On the same occasion Lake Calafquén was also studied.

On the 20th of December 1953 we left our headquarters at Lake Villarrica and a few days later established our new headquarters on the shores of Lake Llanquihue. Here a house of Estacion Experimental "Centinela" was placed at our disposal. This station lies on the peninsula of Centinela, close to the small town of Puerto Octay. The director of this station Mr. C. Conchas did everything possible to assist our investigations. During our stay short trips were made to Lake Ranco, Lake Rupanco, Lake Todos los Santos, and a 10-days trip to Nahuel Huapi National Park in Argentina (Thomasson, 1959).

In the middle of February we left the shores of Lake Llanquihue and once more established ourselves at Lake Villarrica for a while. At the end of February 1954 our field-work in the Chilean lake district was concluded and we left the Araucanian lakes. Then, in April, our work was continued in Peru where we studied high mountain lakes. They will be treated in a subsequent paper.

The aim of our journey was to get some information about the lenitic freshwater biota in the temperate parts of South America. There are only very sparse records on the freshwater fauna and flora in the temperate parts of South America available in the literature. They are quite insufficient for forming a clear conception of the nature of these lakes and their inhabitants. Therefore, more information was necessary for comparison between temperate lakes in the northern and southern hemi-

Fig. 1. Map of the Chilean lake district.

spheres, and also for the elucidation of some biogeographical problems. Of course our studies were of a very preliminary character and they ought to be considered as a beginning only.

The time at our disposal was too short, and an essential part of it was lost on unessential things. The South American way of life is often not very efficient, but in spite of this our work resulted in large collections from different freshwater habitats and we took with us unforgettable impressions of South American scenery. Some notes concerning Araucanian lakes are gathered in the following paragraphs. Naturally all the samples collected in the Chilean lake district have not been studied yet. There are many collections of benthic algae and some other samples of freshwater algae left for future study. But it is my hope that the following paragraphs will give some information, although very limited, about the composition of planktic algal vegetation. The scattered glimpses of benthic algae from different habitats, like ditches, pools, precipices, are incomplete, but may also be of interest.

Incidentally I have added a few notes on the nature of the country bordering the lakes in order to give an idea of the scenery of this remote area. I am afraid that much in this lovely landscape has been altered since our visit, due to the terrible earthquake catastrophe in 1960 which severely hit the Chilean lake district.

II. INTRODUCTION

The territory of Chile is a ribbon of land lying between the lofty peaks of the Andes and the Pacific. It extends from 17° 10′ of south latitude down to 35° 10′, a distance of some 4300 kilometers. It is, on the average, no more than 180 km broad; the Andes and a coastal range of highland take up from a third to a half of this width. Down the whole length of the land, between the towering Andes and the coastal range, there runs a valley. This, however, is not well defined in the north.

The tremendous extension of Chile between the Tropic and the Subantarctic contains within itself wide variations of soil and vast differences of climate; these are markedly reflected in the biogeography of Chile. From Arica in the north, to Cape Horn in the south the climatic vegetation regions of Chile range from semi-tropical desert to subantarctic rain forest and heath. Schmithüsen (1956) even writes about tundra areas, but it is hardly appropriate to use this term, which implies the occurrence of perpetually frozen subsoil, to describe the zone of oceanic humid dwarf-shrub heaths and bogs.

It is superfluous to give here a general survey of the biogeography of Chile, since there are already many detailed presentations of this subject, e.g. Reiche (1907), Hellmich (1933), Schmithüsen (1956), and Oberdorfer (1960). Moreover, from the literature quoted in these publications, one may easily find information about various aspects of Chilean nature.

From north to south the country falls into the following five rather sharply contrasted regions:

1. Atacama region, from the Peruvian frontier to Copiapó, at about 27° S. lat., is a rainless hot desert. It is one of the driest and most desolate of deserts.

2. The region of semi-desert, from Copiapó to Illapel, at about 32° S. lat., is characterized by xerophytic communities of succulents and desert shrubs. They have a highly characteristic "spaced" distribution in which individual plants are scattered thinly throughout large bare areas. Valley bottoms are here cultivated under irrigation.

3. The region of sclerophyllous woodlands and scrublands extends from Illapel to Concepción, at about 37° S. lat. Here there is abundant rainfall in the winter, but the summers are completely dry. Maquis-like scrub is widespread and gives way, inland, to slopes of sclerophyllous woodlands. The valleys are very fertile and intensively cultivated, and the dry slopes are very often overgrazed.

4. The region of deciduous broad-leaved forests extends from about 37° to about 40° S. lat., and along the central valley as far as Lake Llanquihue due to the pattern of distribution of precipitation. It is a country of summergreen forests, characterized not only by the deciduous southern beeches *Nothofagus obliqua* and *N. procera*, but also by evergreen trees, such as *Laurelia sempervirens* and *Persea lingue* which often form a lower tier. It is a landscape of large lakes and many rivers with heavy rainfall during several months of the year. Cleared and cultivated land alternates here with primeval forests and mountains.

5. The region of temperate rain forest stretches south from the previous one down to the Straits of Magellan. This is archipelagic Chile, a region of virgin hygrophilous forests and mountains, glaciers, fiords, islands and channels. Rainfall is torrential, and in the southern part of this region the climate is cold and stormy. The northernmost part of this region is often designated as Valdivian rain forest. It is composed of broad-leafed evergreen trees, among which *Nothofagus dombeyi* is predominant. The forests are rich in species, and they show a dense undergrowth and a considerable variety of climbers and epiphytes. Southwards from this luxuriant Valdivian rain forest a successive de-

pauperation of the vegetation is evident, both in floristic abundance and luxuriance of development. This is the Patagonian rain forest.

The regions mentioned above include several sub-regions and altitudinal belts. For the present study, only the area containing the southern part of the region of deciduous summer forests and the northern part of the region of temperate rain forest, the Valdivian rain forest, is of interest. Within this area lie the lakes studied by us.

There are many designations for the area under consideration, e.g. South Chile, Forest Chile, Chilean lake district, Chilean Switzerland (Suiza Chilena), Valdivian region, etc. I prefer the old name Araucania which alludes to the native inhabitants of this area, the Araucanians or Mapuches as they are called in their own land.

The lake district covers the land between the Andean watershed and the Pacific, from 39° to 41° 30′ S. lat. at the Bay of Reloncavi. It extends about 280 km from the north to the south and 150 km from the west to the east. The area is 4.8 million hectares, of which 1,762,000 hectares is forest. It is a marvellous country, one of the most picturesque lake regions in the world. There are some 14 large lakes, some set high on the Cordillera slopes, others in the central valley southwards from Temuco to Puerto Montt. They differ in the colour of their water: some are crystal clear and others change from a deep blue to an emerald green. Here, too, are imposing waterfalls and rivers.

The lake district, which comprises four provinces, Cautin, Valdivia, Osorno, and Llanquihue, has only been heavily colonised for the last hundred years. The population is about 1 million. 100,000 of them are pure blooded Araucanian Indians and there are possibly 200,000 more of slightly mixed blood. Signs of German colonisation are very marked in these provinces. About 20 per cent of the land is used for food crops, mainly wheat. The central valley especially is characterized by large open areas and an active agriculture. Thus the entire area around Lake Llanquihue is under cultivation or used for pasture. So is the country around Lake Ranco and the surroundings of Lake Villarrica. One can still find some forests of restricted area, but these are mostly wasted by fire and lumbering. The primeval vegetation has been to a great extent destroyed; introduced plants of foreign provenance are widespread. Accordingly the central valley is rather uninteresting from a floristic point of view, with the exception of some places of difficult access or unavailable for farming.

Because of the moderate use of fertilizers and the absence of sewage in any amounts worth mentioning, the biocoenoses of the lakes are still rather uninfluenced by the activity of man. Of course the naturalization of salmon-fishes has somewhat altered the original fish-population. The leaching of forest soils after the frequent fires which often devastate large areas does not seem to have any influence on the large lakes. Probably the inflow of nutrients is insignificant in relation to the large bodies of water. The main tributary streams receive water from the Andean range and have low mineral content, e.g. the conductivity ($\varkappa_{18} \cdot 10^{-6}$) of Rio Minetué was on November 23, 26.2, and that of Lake Villarrica 42. The lakes studied by us have a conductance range of about 12 to 76, see Löffler (1960, p. 229). Doubtless these values do not represent the complete range, since only relatively few values are available.

III. LANDFORMS AND SCENERY

The region, of which this paper will give some glimpses, comprises three distinct orographic elements: the Andes to the east, the coastal range to the west, and in between the longitudinal valley. The Andes and the passes over them are not so high here as in the north, and the snowline is lower. The coastal range is also lower, and the longitudinal valley is not so continuous as from Concepción to Santiago.

COASTAL RANGE
(CORDILLERA DE LA COSTA)

This is a rather low range of hills and plateaus along the Pacific coast, its greatest heights being at Queulue, 792 m, and southwest of Valdivia, 1500 m. The range is built up mainly of Pre-Cambrian sediments, but younger sediments also occur. It has been considered as a last remnant of Burckhardt land, but Brüggen (1934, p. 36) is undecided about such an interpretation of the coastal range as a relict of an ancient Pacific continent. He emphasizes the features which the geology of the Andean mountain mass and the coastal range have in common. There is no recent volcanic activity within this mountain range, but earthquakes are frequent, most of them being of tectonic origin. Several rivers rising in the Andes sweep across the longitudinal valley and through gaps carved by them in the coastal range, into the Pacific. The most important ones are from north to south: Rio Toltén which has a drainage area of 7520 km^2, Rio Valdivia, drainage area about 11,280 km^2, and Rio Bueno with a drainage area of 14,810 km^2.

LONGITUDINAL VALLEY
(VALLE LONGITUDINAL)

This long depression is of tectonic origin. Within the present area the sinking process is still in progress, to which the drowned forests in the archipelago of Chiloe bear witness. In Central Chile, however, an uplift of land is going on. This is well illustrated by the raised beaches at Valparaíso which indicate an uplift of 6 m during the last 400 years.

The width of the longitudinal valley varies between 50 and 100 kilometers. Its broadest part is situated at Osorno. The bottom of this valley, which is crossed by the rivers and their terraces, lies in the northern part of the lake district at about 200 m above sea level, and slopes gradually southwards where its continuation is formed by the bays of Reloncavi, once a freshwater lake, Ancud, and Corcovado. Of course, the bottom of the longitudinal valley is by no means flat; there are some ridges connecting the ranges bordering the valley. At Lake Villarrica, the ridge of Afquintué runs between the volcano Villarrica and Mt. Puralco in the coastal range. South-east of Lanco lies a hilly landscape with its highest point, 823 m, at Punillahue. A second range of hills is situated just south of the river Calle-Calle, the highest point being Mt. Pan de Azucar, 670 m.

The bottom of the longitudinal valley is filled by fluvio-glacial sediments which are often covered by aeolian deposits. Important for the farming are the red-coloured soils of sandy-clayish texture, and the dark-brown soils of rich humus content. The latter soils usually have a pH of 5.6–5.8. The cultivated soils often show deficiency in some important trace elements, like B, Cu, Zn, Mn, Co, F, and I. The whole area is poor in calcium.

ANDEAN CHAIN
(CORDILLERA DE LOS ANDES)

The great mountain chain of the Andes is, southward from latitude 38°, divided into a labyrinth of heights and valleys pierced in many places by rivers which wind in zigzag courses, now toward one ocean, now toward the other. It constitutes a broad mountain zone, 60–100 km in width, of confused geographic features. The summits of angular peaks surmounting a broad common base of granite have an average altitude of about 2000 m. Few of them are less than 1800 m, and only here and there do individual summits exceed 2300 m. The summits, the altitudes of which most closely approach uniformity, have been sculptured by erosion from the broad formerly plateau-like mass of the older rocks of the Andes, whereas most of the isolated peaks which rise more than 2000 m are volcanic cones. Besides granite, beds of diorite, diabase and porphyrite and also cretaceous and jurassic beds are found; tertiary and later deposits of volcanic origin are important. A geological map of the area between Santiago and Chiloe is reproduced in Oberdorfer (1960, p. 11).

Along the western slopes of the Andean chain stand the snow-capped volcanoes which, together with the large lakes, are the most conspicuous features in the landscape of the Araucanian lake area. Practically every large lake is overlooked by a volcano. From north to south, the following volcanoes are most prominent. Villarrica (2840 m) is situated between Lake Villarrica and Lake Calafquén. Further towards the south-east rise Quetrupillan (2360 m) and Lanin (3774 m), the latter the highest peak in this region. On the eastern shore of lakes Panquipulli and Riñihue are located Choshuenco (2360 m) and El Mocho (2430 m). Puyehue (2240 m) towers above the eastern shores of Lake Puyehue. It had its latest eruption during the great earthquake catastrophe of 1960, see Sellevold (1961). At the eastern end of Lake Rupanco lies the sharp peak of Puntiagudo (2490 m), the "Chilean Matterhorn", which is a fragment of a former crater. East of lakes Puyehue and Rupanco extends Antillanca, a veritable moon landscape dominated by the volcano Casablanca (1990 m). The largest of the lakes, Llanquihue, is flanked by two volcanoes: on the north-eastern shore the famous Osorno (2660 m), which is said to surpass Fujiyama in its beauty, and on the south-eastern shore, Calbuco (2015 m). Finally, east of Lake Todos los Santos, the mighty peak of Tronador (3470 m) commands the scene. Like Lanin, Tronador is located within the Andean range, not on the western slopes as are the other volcanoes mentioned above.

Moreover, there are a lot of hot springs, in several of which the temperature reaches 95°. Many of these hot springs are used for thermal baths.

LAKES

The lake district contains a series of great lakes and numerous small ones spread along the foot of the Andes. The eastern ends of most of these large lakes lie between the foothills of the Andean chain. Their western ends are filled by boulders and gravel deposited by the shrinking glaciers. The water is clear, deep blue, sometimes lashed into white froth by the region's high winds, sometimes so still that the white cones of snow-capped volcanoes are sharply mirrored in them.

The largest of the lakes within the lake district are tabulated below; see also the map fig. 1. Information about altitude and area has been kindly supplied by the Instituto Geográfico Militar in Santiago de Chile.

The Araucanian lakes occupy basins excavated by valley glaciers during the last glacial period. The location of the lakes in relation to the Andean chain shows that the glaciers extended farther into the longitudinal valley in the southern part of the lake district than in the northern part. During the maximum of the last glaciation, the Andean ice

TABLE 1. *Araucanian lakes.*

Present name	Ancient name	Year of discovery	Altitude m	Area km²
Colico				57.2
Caburgua				53.0
Villarrica	Mallalauquen	1550	230	172.2
Calafquén		1576	240	121.3
Panguipulli	Vitalauquen	1576	140	114.6
Riñihue		1576	117	82.8
Ranco	Arcalauquen	1552	70	407.7
Puyehue			212	153.3
Rupanco	Llauquihue	1553	172	224.1
Llanquihue	Guañauca	1552	51	851.1
Todos los Santos	Quechocabi		184	180.7

formed a continuous sheet above which only the highest peaks projected. The ice flowed down the mountain flanks, deepening the valleys, and was separated into many parallel ice tongues near the mountain toe. Beyond this, some of them widened to form piedmont glaciers in the longitudinal valley. These glaciers scooped out the deep lake basins, leaving behind rows of ridges of moraine around the west ends of the lakes to join the slopes of the mountains which rise along the eastern shores. To the west of these terminal moraines extend fluvio-glacial sediments, forming broad sand and gravel terraces along the streams. Some of the lake basins continue towards the east as U-shaped valleys which extend far into the Cordillera, often ramifying. On the slopes of these deep valleys one often notes hanging tributary valleys. For the Pleistocene history of Fuego-Patagonia the reader is referred to Auer (1956–58).

The lakes Colico, Huilipilún and Calafquén are located in the longitudinal valley and surrounded by moraines. The terminal moraines bordering the western shores of the latter lake and Lake Panguipulli are so high that both these lakes have their discharge to the south. The eastern ends of the lakes Riñihue and Panguipulli cut deeply into the mountains. The small lakes Pellaifa and Quillehue are surrounded by the slopes of the Cordillera. Likewise within the mountains is located Lake Todos los Santos which is very irregular in shape; long arms of water, which look like fiords, stretch far into the Andean range. It has been dammed by an ancient lava flow from the volcano Osorno which cut off the old course of Rio Petrohué, and forced it to find its way into the Fiord of Reloncavi. Earlier Rio Petrohué discharged into Lake Llanquihue which now has readopted its ancient outflow, Rio Maullin, into the Pacific. The interim outflow into the Bay of Reloncavi was dammed by the eruption of the volcano Calbuco. Before the volcano Osorno was built up, the lakes Llanquihue and Todos los Santos formed one large lake, a counterpart to Lake Nahuel Huapi which lies just east of the watershed.

The lakes Colico, Caburgua and Villarrica belong to the catchment basin of Rio Toltén. To the drainage area of Rio Valdivia belong the lakes Calafquén, Panguipulli and Riñihue. The drainage area of Rio Bueno includes the lakes Ranco, Puyehue and Rupanco. Most of the Araucanian lakes receive a considerable influx from the Andean chain. Their water balance is to a large extent correlated with an abundant supply of water from mountain streams in spring, from the melting ice and snow in the mountains. Also the ample precipitation during this season contributes to the supply of water. This is clearly seen from the following figures illustrating the amount of effluence for two lakes:

Villarrica:	March	127 m^3/sec.,	July	560 m^3/sec.
Rupanco:	March	53 m^3/sec.,	August	162.5 m^3/sec.

The violence of the spring flood was experienced when our expedition was delayed a couple of weeks because many of the roads in the longitudinal valley had been washed away. Even the main road from Santiago towards the south was impassable for traffic.

IV. CLIMATE

The southern hemisphere, with its limited landmasses, has only small regions with a typical west coast maritime climate. Only southern Chile, western Tasmania and south-western New Zealand have climates similar to those of north-pacific North America and north-western Europe, although the similar areas are at higher latitudes in the northern hemisphere. The Chilean lake district is situated at the same latitudes as Portugal or northernmost California but its summer climate equals that of coastal British Columbia. In winter, the climate is mild, because South America is principally a warm-climate continent, and nowhere do large cold air masses develop. The mildness of winter climate in the southern temperate latitudes also results from the narrowness and small extension towards the south of the continent. Of great importance is also the influence from the vast areas of open sea around the southernmost point of the continent, see Troll (1948, pp. 75 ff.). In consequence, the annual temperature range is small.

The vegetation of the Chilean lake district is to a large degree a direct reflection of the climate. Our own fragmentary meteorological observations during the Swedish Limnological Expedition are presented by Löffler (1960), but they cover only a few months; the following brief outline is drawn from the literature.

A general survey of the climate of South Chile is given by Berninger (1929, pp. 24–34). Lauer has recently (1960) drawn an interesting map illustrating the ombrothermic climates of Chile. He also presents diagrams showing the course of precipitation and temperature throughout the year. According to the paper on the division of Chile into climatic zones written by Fuenzalida Villegas in the *Geografia Economica de Chile*, the major part of the lake country belongs to the zone of oceanic west coast climate with some touches of Mediterranean influence, especially in the north (Cfsb). South of this zone, viz. south of the Bay of Reloncavi, extends the zone of cold temperate maritime climate (Cfb). In the north the lake country borders the zone of warm temperate climate (Csb_3). Finally, the zone of steppe climate extends east of the Andean chain. Of course great microclimatic differences appear, often due to the influence of human activity on the physical environment. This aspect has recently been exemplified by Schwabe (1956) and Kunkel (1956) through climatological investigations in Mininco, situated about 100 km north of the lake district.

PRECIPITATION

The climate of southern Chile is influenced by polar Pacific and tropical Pacific air masses in connection with the cyclones that originate on the Pacific polar front. Because of the northward displacement of the polar front in winter and the southward displacement of the subtropical anticyclone in summer, there is a marked maximum of precipitation in the lake district during the winter, and a rather dry summer. The frontal precipitation over southern Chile is generally of the warm-front type, with polar Pacific air in lower levels, and tropical Pacific air aloft. With the passage of the cyclones across the Andes, orographical lifting intensifies the precipitation (see below). Snowfall seldom occurs in the lowlands, for example at Lake Llanquihue only five times in 8 years (Bauer, 1958, p. 57).

The pattern of yearly rainfall in the lake district is a striking illustration of the effect of mountain ranges on climate. Westerly winds, blowing from the ocean, deposit part of their moisture along the coastal mountain range, and about twice as much on the western slopes of the Andes. (However, a similar distribution of precipitation may be found, in summer, also along a flat coast, where the first peak of precipitation is due to increased friction at the coast, and the second one to increased thermal convection caused by the gradual heating and instabilization of the air farther inland.)

The central valley has about the same cloudiness and humidity during the winter as the mountains, but the summer months are sunny and rather dry. The influence of orography on the distribution of precipitation is illustrated by the following rainfall section across Chile in latitude 41°, based on Jefferson (1921), and Ljungner (1959). It shows heavy rain on the coastal range, diminished rain in the valley, and increasing rain toward the crest of the Andes.

The basin of Osorno and La Union (Los Llanos) lies in the rain shadow of a rather elevated stretch of the coastal range between Valdivia and Rio Maullin, called Cordillera Pellada. Such less humid patches situated within the area of Nothofago-Perseetum are often characterized by the Boldo-Cryptocaryetum, if there is any primary vegetation left at all.

TABLE 2. *Rainfall section across Chile in latitude 41°.*

Station	Jeffersen	Ljungner
Punta Corona, at the Pacific coast (48 m)	1986 mm	2179 mm
San Juan de la Costa, in the coastal range (500 m?)	1524	—
Osorno, in the longitudinal valley (24 m)	1328	—
Frutillar, on the western shore of Lake Llanquihue (149 m)	1758	1626
Los Riscos, on the eastern shore of Lake Llanquihue (51 m)	2298	—
Bahia Volcán, on the eastern shore of Lake Llanquihue (51 m)	2112	1917
Peulla, on the eastern shore of Lake Todos los Santos (190 m)	3263	3377
Casa Pangue, at the frontier (320 m)	4110	3354
Puerto Blest, at Lake Frias (764 m)	3590	4026
Bariloche, at Lake Nahuel Huapi (786 m)	—	1009

A few more values add to the picture of rainfall in the lake district. For comparison, values from a few other stations, also representing humid maritime climate, are given (table 3).

TABLE 3. *Mean temperatures (C°) and precipitation (mm).*

Station	Annual		June		January	
Pucón	—	2315	—	314	—	68
Valdivia	19.9	2489	8.0	414	16.9	65
Osorno	—	1343	—	—	—	—
Pto Montt	11.1	1946	8.0	257	15.2	90
Ensenada	10.0	2460	6.3	274	14.3	152
Auckland, N. Z.	14.8	1140	11.9	128	18.7	65
Seattle, Wash.	10.2	864	14.7	34	3.9	123
Vancouver, B. C.	9.5	1387	15.0	57	2.0	202
Bergen, Norway	7.1	2145	13.0	106	1.3	224

It ought to be mentioned that about 120 km south of Pto Montt, in the Fiord of Reñihue, an average amount of 5387 mm/year has been recorded.

DIURNAL VARIATION OF TEMPERATURE

Another important factor for plant life is the occurrence of frosty nights, which are not rare during the winter. Berninger (1929) gives as average annual number for Puerto Montt 12.3, and for Rio Bueno 24.5. Also in Mininco slight spells of cold occur according to Schwabe and Kunkel (*op. cit.*) who report a minimum temperature of −2.3°, see also Kunkel (1959, p. 63). Bauer (1958) who has carried out meteorological observations at La Ensenada, situated on the eastern shore of Lake Llanquihue, has noted a regular occurrence of frosty nights during the winter, most frequently in August, with an average of 15 frosty nights and a total frost duration of 150 hours. The lowest temperature recorded during 6 years was −6.0°. Frosty nights also occur in spring, but seldom in summer and autumn. The lowest night temperature observed by us during our short stay was +0.7° which was noted twice in the first fortnight of November. Inversion of temperature is a common phenomenon in mountainous areas, due to cold air masses descending from the high mountains and influencing the temperature in those basins that are surrounded by mountains, e.g. the basin of La Ensenada.

Insolation and eradiation are of great ecological importance, not only for the thermal stratification in the lakes and vertical distribution of plankters, but also for the terrestrial biota. The diurnal variation of air temperature is considerable during the summer, when sunny weather prevails in the longitudinal valley. The effect of insolation is increased through reduced cloudiness and relatively high transparency of atmosphere, but these factors also promote eradiation. During the winter the diurnal variation of temperature is smaller. The amplitude of the variation of temperature in air and soil has recently been presented in a very instructive way by Schwabe (1956, fig. 9). The diurnal range of air temperature in La Ensenada is also given by Bauer (1958, table 3). For water bodies the diurnal temperature amplitude for different months is illustrated by Kunkel (1956, table 12). It is also interesting to note that he reports soil surface temperatures exceeding 70°C. Temperatures of about 60°C are frequently observed in bare soils. During the winter such areas without vegetation cover often freeze, see Bauer (*op. cit.*, p. 60).

WIND

Wind is a climatic element of considerable importance, both for terrestrial and lacustrine biota. Forel, who defined the range of limnology, recognized the importance of wind conditions for lake studies, see e.g. Forel (1901). The influence of wind on the stratification in Chilean lakes has been studied by Löffler (1960). The winds blowing over the extensive surfaces of the large lakes often attain high velocities. The waters run high, making work on the lakes impossible. For the growth of hydrolittoral life along the Chilean lake shores the surging of the waves is of great importance. The shores of these lakes lie for the most part quite unsheltered from wave action, which is accentuated by considerable fluctuations of the lake level. These shores consist to a great extent of relatively coarse and hard material, such as cobble stones and coarse gravel, and support a very sparse and scattered vegetation. Only in sheltered bays, and also in small lakes, can one find ample littoral vegetation. In such places the shores consist of relatively soft materials.

The wind conditions of Patagonia, including the Chilean lake district, have been elucidated by Ljungner (1959, pp. 34–50). In this important treatise on the Nahuel Huapi area an instructive presentation of the frequency of surface wind directions is also given (fig. 9).

Theoretically, during the summer, S.W. winds are expected to prevail, and N.W. winds during the winter. But due to the orography, the surface winds are deflected towards south and north respectively. Therefore, along the coast of South Chile the winds from the South Pacific high pressure centre move nearly parallel to the coast. During the summer the most frequent winds are southern, e.g. in January at Punta Galera, 54 % from the south and only 22 % from the northern direction. During the winter the direction of prevailing surface winds is reversed, e.g. at Punta Galera the frequency of winds in July is 35 % from N. and 22 % from N.W. The stations in the longitudinal valley also show the same alternation between the prevailing winds: from south during the summer and from north in winter.

Besides the seasonal alternations of wind direction there occurs also a diurnal change. During the summer the prevailing night-winds in the longitudinal valley are from the north, and the day-winds from the south. Winds from the east and west are not frequent; they occur as sea and land breezes on the coast, and also on the shores of large lakes. They also occur in the valleys of the Cordilleras because of the orography. Of importance for the thermal stratification of the lakes are occasional strong east winds which blow down the slopes of the Andean chain (see Löffler, 1960, p. 194). Such winds of föhn-type occur rather infrequently in spring and autumn, and are called "puelche", after an Indian tribe residing on the eastern slopes of the Andes (see Tarras, 1845, and Ljungner, 1959, pp. 234 ff.).

SNOW LINE AND GLACIERS

Snow falls in the Andean mountains during all seasons of the year. At lower altitudes the duration of the snow cover is short, at least during the summer. In winter snow covers the mountains down to 1000 m above sea level. The altitude of the snow line, i.e. the lower limit of perennial snow, depends largely on exposure and the gradient of the slope. The average altitude of the snowline in the lake district is about 1700 m, for further information see Lliboutry (1956).

As a result of heavy precipitation and low summer temperatures there are many glaciers in the high mountains. The most prominent glaciers are situated on the volcano El Tronador (the Thunderer); the one on the northwestern slope reaches as far down as 370 m above sea level, see Lliboutry (1956, p. 345). All the glaciers on the volcanoes of South Chile, e.g. those on Lanin, Villarrica, and Osorno, are retreating, see Frödin (1953, p. 85). Frödin describes the ice-caps on the volcanoes Villarrica and Osorno as stagnant and devoid of further flow.

V. FLORA AND VEGETATION

1. GENERAL REMARKS

The following brief notes on the exotic and interesting plant world in the Chilean lake district are intended to give only a broad outline. They are included because the landscape in which the lakes are an integral part should be described in connection with any lake study (see the programmes by Forel, 1886, and Imhof, 1892). The notes may also be helpful for those who wish to eludicate biogeographical problems concerned with the origin and distribution of the fauna and flora of the southern hemisphere. A discussion about the biology of the southern cold temperate zone was recently (1959) carried on in the Royal Society of London. The Chilean lake district belongs to a transitional zone between the cold and warm temperate zones, but many of the biogeographical problems are largely identical with those of the cooler zone.

The present sketch is based on notes and collections made during our excursions in South Chile. The geographical term "South Chile" is used in the present paper in its conventional extent; i.e. it embraces the area south of the Bio-Bio river to the Bay of Reloncavi, but not West Patagonia and the territory of Magellanes, which make up the southernmost third of Chile. The major part of the studies and collections were made in the surroundings of our base at Lake Villarrica, and during our trips to neighbouring lakes. Driving along the longitudinal valley in the lake district we got a general picture of this mostly cultivated landscape. Random collections were made from different habitats. Together with my friend Benkt Sparre, then professor of botany at the University of Concepción, I had the pleasure of a trip from our base at Puerto Octay across the Coastal Cordillera to Pucatrihue on the shores of the Pacific. On this occasion a rich collection of plants was made. The Andine vegetation was studied along the valley of Rio Trancura, on the way up to Lake Quillehue, which is located north of Volcano Lanin, and also along the international route between the lakes Todos los Santos and Nahuel Huapi via Paso Pérez Rosales, situated just north of Mt. Tronador.

Our studies were concentrated on lakes and their biota; the notes on terrestrial communities are consequently of a random character. For further information, the reader will find ample and detailed descriptions, particularly in the frequently quoted books by Reiche (1907) and Oberdorfer (1960).

The plants which are mentioned in the present chapter are probably rather unfamiliar to most readers. For the taxonomic relationships of the plants reference is made to Reiche (1907 or 1934–1938) and Muñioz (1959). Many of the plants are also listed, with their family, in Thomasson (1959, pp. 30 ff.).

According to an estimate given by Reiche (1938), the flora of Chile comprises about 5000–5500 vascular plants. (The largest family is *Compositae* which contains 118 genera, of which the genus *Senecio* is represented by more than 210 species.) Even though only a fraction of this huge number of vascular plants grow within the lake district they are numerous enough to cause a lot of trouble, not least to the writer, being a phycologist. Some of the plants could only be identified thanks to generous help by kind colleagues (see p. 12 in Thomasson, 1959). A considerable number of mosses were kindly determined by Drs. E. B. Bartram (Pike Co., Pa.) and P.-O. Nyman (Uppsala). The few lichens were identified by Dr. R. Santesson (Uppsala). Because there are many taxa still waiting for a definite interpretation, the author cannot warrant the correctness of every name used, although the nomenclature has been checked as far as practicable.

For the few plant communities of different rank which are mentioned below I have tried to apply the denominations introduced by Oberdorfer (1960). He has given an outline of the most prominent plant communities based on 300 analyses of the vegetation in Central and South Chile.

For a general distribution of Chilean vegetation, see e.g. map 4 in *Geografia Economica del Chile.* A map covering South Chile has been drawn by Berninger (1929, map 2). Longitudinal profiles showing the vegetation belts on the western slopes of the Andean chain are presented e.g. by Ørsted (1861, p. 217), Berninger (1929, fig. 3), Hellmich (1933, fig. 23), Schmithüsen (1956, fig. 3 and 1960, fig. 2), and Oberdorfer (1960, fig. 28). Latitudinal transects across the longitudinal valley are drawn e.g. by Schmithüsen (1956, fig. 2) and Oberdorfer (1960, fig. 27). An interesting representation showing the interrelation of climate and vegetational formations is given by Schmithüsen (1956, fig. 9).

The climax vegetation of the longitudinal valley down to Lake Llanquihue is deciduous broad-leaved forest. The condition of equilibrium is of course never reached, and climax vegetation should, therefore, be understood only in a broad and approximate sense. Over great areas this primary forest has been destroyed by cultivation or replaced by secondary communities. The changes during historical time and their most important causes have been thoroughly discussed by Berninger (1929). His map 2, showing the extension of utilized land, is now very likely out of date. The more recent map, fig. 18 in Oberdorfer (1960), gives a good representation of the current situation, and, incidentally, matches well our impressions.

2. VILLARRICA AREA

PRIMARY FOREST

In the longitudinal valley only a few stands of primary forest were seen. In most of the small woods the vegetation has been changed through grazing, lumbering and forest fires. Most fortunately, however, quite a small area of virgin forest grew close to our base at Lake Villarrica and may serve as an illustration of the deciduous summer forest. The physiognomy of this forest appears from illustrations in the present paper, e.g. figs. 2–4. The forest shows two separable tree layers, the upper one formed by the deciduous *Nothofagus obliqua*, and the lower layer by various evergreen sclerophyllous trees. Shrubs are not frequent, and the field layer of low phanerogams is rather open. It reminds somewhat of the ground-vegetation of Central European beech forest. At the end of October the white flowering orchid *Codonorchis lessonii* is predominant. After a week or two it is

Fig. 2. Bamboo (*Chusquea*) thriving in the glades and forest edges at Lake Villarrica. Photograph by L. Brundin.

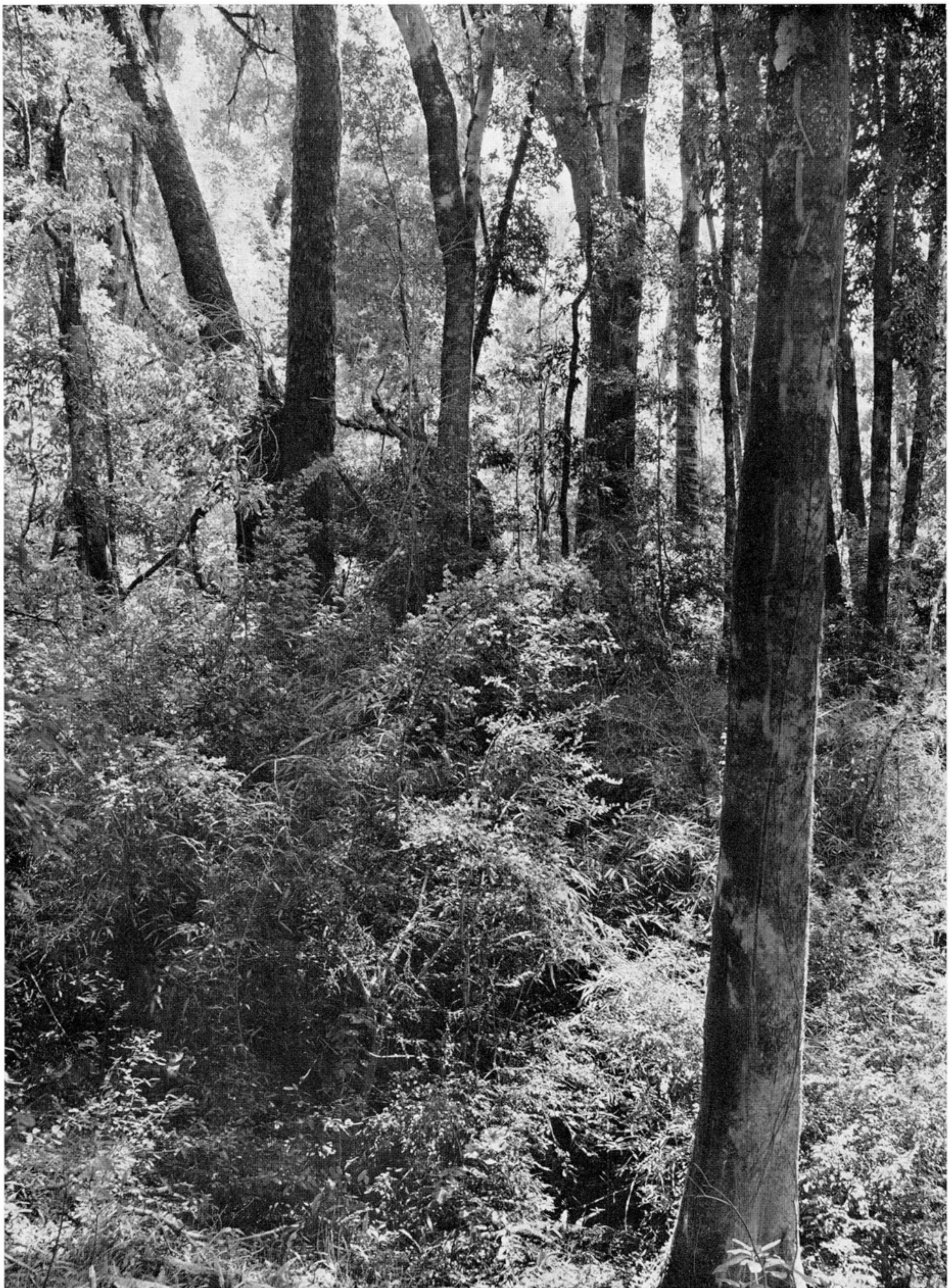


Fig. 5. *Arachnites uniflora* (*Corsiaceae*) in the forest at Lake Villarrica. Photograph by L. Brundin, November 14, 1953.

replaced by one of the *Corsiaceae*, the strange-looking, fleshy-brown coloured (rarely white), *Arachnites uniflora* (fig. 5), being not so common as the *Codonorchis*. The bottom layer is often made up of a luxuriant moss cover.

Very striking is the abundance of lianes; some of them, like *Hydrangea serratifolia*, attain considerable dimensions, see fig. 14. Among the lianes we find many plants with beautiful flowers, such as *Lapageria rosea*, the Chilean national flower (named after Joséphine Beauharnais de la Pagerie, Napoleon Bonaparte's first wife). It belongs to the *Philesiaceae*, a south hemispheric family, see fig. 9 in Good (1953).

Mosses amply cover the trunks of trees, together with lichens. The synusiae of epiphytes which grow

Fig. 3. Moss-covered *Nothofagus* trunks in the forest at Lake Villarrica. Note the luxuriant growth of *Hymenophyllum* on the trunks, and the clinging *Lapageria* in the middle of picture. Photograph by L. Brundin.

Fig. 4. Some parts of the forest at Lake Villarrica with tangled vegetation bear strong resemblance to a jungle. In the foreground *Lophosoria*. Photograph by L. Brundin.

attached to the trunks and branches of trees, shrubs and lianes, even on the surface of living leaves, also include algae, ferns, and a few flowering plants, e.g., *Sarmienta repens* and *Phrygilanthus tetrandus*.

In many places in the forest the ground is bare and even the thin humus layer is lacking. The pH of the surface soil is about 6.

The following list, which is by no means complete, gives an idea of the composition of this forest which occupies a restricted area on the shores of Lake Villarrica. However, some of the plants listed below are obviously intruders from adjoining communities.

ARBORESCENT STRATUM
(tree layer)

Nothofagus dombeyi
N. obliqua
Gevuina avellana
Lomatia dentata
L. obliqua
Drimys winteri
Peumus boldus
Laurelia philippiana
L. sempervirens
Persea lingue
Cryptocarya alba
Caldcluvia paniculata
Sophora cassioides[1]
Aextoxicon punctatum
Eucryphia cordifolia

FRUTESCENT STRATUM
(shrub layer)

Gevuina avellana
Lomatia dentata
L. hirsuta
Drimys winteri
Caldcluvia paniculata
Sophora cassioides
Aextoxicon punctatum
Maytenus boaria
Rhamnus diffusa
Aristotelia chilensis
Eucryphia cordifolia
Azara serrata
Myrceugenella apiculata
Myrceugenia planipes
Rhaphithamnus spinosus

CLIMBERS

Chusquea quila
Luzuriaga radicans
Lapageria rosea
Boquila trifoliata
Hydrangea serratifolia
Cissus striata
Pseudopanax valdiviense
Mitraria coccinea
Proustia pyrifolia

PARASITES

Phrygilanthus tetrandus
Myzodendron spp.

EPIPHYTES

Flowering
Sarmienta repens

Ferns
Hymenophyllum dentatum
H. plicatum
Asplenium dareoides
A. trilobum
Polypodium feuillei

Bryophytes
Plagiochila bispinosa
P. chilensis
P. chiloënsis
Lophocolea muricata
Lepicolea ochroleuca
Chiloscyphus integrifolius
Radula plumosa
Porella chilensis
Frullania chilensis
F. crassa
F. magellanica
Trichocolea verticillata
Lejeunea globosiflora
Strepsilejeunea jackii
S. obtruncata
Aphanolejeunea mamillata
Microlejeunea grandistipula

Camptodontium cryptodon
Dicranoloma setosum
Triquetrella patagonica
Calyptopogon mnioides
Tortula costesii
T. prostrata
Bryum argenteum
B. lechleri
Rhizogonium mnioides
Bartramia aristata
Zygodon pentastichus
Drummondia obtusifolia
Lepyrodon implexus
Cryphaea consimilis
Leptodon smithii
Weymouthia cochlearifolia
W. mollis
Neckera chilensis
Porothamnium leucocaulon
Lamprophyllum splendidissimum
Lopidium plumarium
Hypopterygium thouinii
Thuidium furfurosum
T. rhaphidostegium
Thuidiopsis filaria
Sematophyllum callidum

Lichens
Sticta caulescens
Pseudocyphellaria nitida

HERBACEOUS STRATUM
(field layer)

Flowering
Chusquea quila
Uncinia erinacea
U. phleoides
Arachnites uniflora
Codonorchis lessonii
Urtica magellanica
Oxalis rosea
Dysopsis glechomoides
Hydrocotyle poeppigii
Osmorrhiza chilensis
Nertera granadensis

Ferns
Lophosoria quadripinnata
Adianthum chilense
Polystichum chilense
P. aculeatum
Blechnum auriculatum
B. valdiviense
Asplenium dareoides

CRYPTOGAMIC STRATUM
(ground layer)

Bryophytes
Jamesoniella grandiflora
Plagiochila chilensis
Schistochila stratosa
Lophocolea attenuata
L. minor
Lepicolea ochroleuca
Frullania chilensis

Fissidens asplenioides
Ceratodon purpureus
Aongstroemia gayana
Campylopus modestus
Amphidium cyathicarpum
Barbula pilifera
B. purpurascens
Grimmia consobrina
G. imberbis
Bryum argenteum
Eustichia poepigii
Rhizogonium mnioides
Bartramia ambigua
B. aristata
Zygodon bartramioides
Z. pentastichus
Lepyrodon implexus
Glyptothecium gracile
Weymouthia orbiculata
Porothamnium pandurifolium
P. valdiviae
Rigodium arborescens
R. brachypodium
R. implexum
Lamprophyllum splendidissimum
Hypopterygium thouinii
Hygroamblystegium filum
Sematophyllum callidum
Dendroligotrichum dendroides

According to Oberdorfer (*op. cit.*), this forest of *Nothofagus obliqua – Persea lingue – Laurelia sempervirens* should be characterized as Nothofago-

[1] *Sophora cassioides* (Phil.) Sparre, n. comb. (*Edwardsia cass.* Phil., *Bot. Zeit.* 31: 741, 1873; *S. tetraptera*, sensu Reiche, *Fl. Chile* 2: 53, 1898, non J. Mill., nec Aiton.

Fig. 6. The shore of Lake Villarrica. To the right flowering *Embothrium coccineum.* Photograph by K. Thomasson, November 14, 1953.

Perseetum. Some divergent types occur, e.g. the one growing on moist soil where the ground is covered with a luxuriant mat of mosses (a habitat preferred by the famous little frog *Rhinoderma darwini*). Here *Drimys winteri* (el canelo) is frequent, together with *Lomatia obliqua*, *Azara microphylla*, *Berberis buxifolia*, *Nothofagus antarctica*, and *Embothrium coccineum*. *Drimys winteri* is the sacred tree of the Araucanians, and it has an important place in their religious rites. The Winter's bark, Cortex Winterianus, is a drug still used for stomach-complaints and bladder diseases. Boldin is extracted from the leaves of the above-mentioned boldo (*Peumus boldus*).

The bird life in the forest is poor. One notes *Scelorchilus r. rubecula*, *Troglodytes musculus chilensis*, and now and then the silence is interrupted by the drumming of the Magellanic woodpecker *Ipocrantor magellanicus*, or by the screeching of green parrots on their flights over the forest. Of these the commonest species is *Enicognathus leptorhynchus*. The cooing of the large Chilean pigeon *Columba araucana* can also be heard. Moreover, the occurrence of *Zenaidura a. auriculata*, *Microsittace ferruginea minor*, *Pygarrhicus albogularis*, *Spizitornis p. parulus*, and *Pezites m. militaris* should be mentioned. Probably the bird life is richer in the upper canopy where the birds are difficult to discern.

FOREST – SHORE ECOTONE

More interesting than the forest, from the floristic point of view, is the forest edge along the shore of Lake Villarrica. The forest edge may be defined as an ecotone between the forest and shore communities. Since well developed ecotonal communities may contain organisms characteristic of each of the overlapping communities and, in addition, organisms which are characteristic of and often restricted to the ecotone zone, plants and animals occur more densely and in greater variety than in the communities flanking it. This is known as the edge effect. Oberdorfer (*op. cit.*) has included this ecotonal community in his Boldo-Cryptocaryetum nothofagetosum (based on a single vegetation analysis).

At the end of October the *Sophora cassioides* and *Embothrium coccineum* trees growing along the shore were full of blossom. The former was covered with yellow clusters, the latter with bunches of red flowers. This floral splendour along the shore stood in lovely profusion against the dark green wall of the forest. Characteristic of the ecotonal zone is the abundance of shrubs, and in many places bamboo forms an impenetrable tangle. Among the shrubs, *Aristotelia chilensis* is frequent, reminding of hazel. The following is a list of the plants which were noted along the forest edge bordering Lake Villarrica.

ARBORESCENT STRATUM

Nothofagus obliqua
Lomatia ferruginea
Embothrium coccineum
Peumus boldus
Persea lingue
Cryptocarya alba
Caldcluvia paniculata
Sophora cassioides
Myrceugenia cf. *planipes*
Ugni molinae

FRUTESCENT STRATUM

Nothofagus obliqua
Peumus boldus
Cryptocarya alba
Escallonia sp.
Rubus ulmifolius
Coriaria ruscifolia
Aristotelia chilensis
Azara integrifolia
Ugni molinae
Fuchsia magellanica
Pernettya mucronata v. *angustifolia*
Buddleja globosa
Baccharis marginalis
B. salicifolia
Leptocarpa rivularis

CLIMBERS

Chusquea quila
Lapageria rosea
Muehlenbeckia hastulata
Boquila trifoliata
Lardizabala biternata
Cissus striata
Mitraria coccinea
Proustia pyrifolia

EPIPHYTES

Bryophytes
Frullania crassa
Lophocolea muricata

Bryum argenteum
Bartramia aristata
Leptodon smithii
Zygodon pentastichus
Lepyrodon implexus
Fabronia andina
Weymouthia cochlearifolia
W. mollis
Neckera scabridens
Hygroamblystegium filum

Lichen
Pseudocyphellaria nitida

HERBACEOUS STRATUM

Ferns
Adiantum glanduliferum
Blechnum auriculatum

Flowering
Uncinia phleoides
Alstroemeria aurantiaca
Francoa sonchifolia
Vicia angustifolia
Lathyrus cabrerianus
Loasa acerifolia
Gunnera chilensis
Hydrocotyle poeppigii
Solanum brevidens
Relbunium hypocarpium
Nertera granadensis
Sonchus oleraceus

Bird life is also of greater interest here than in the forest. We are surrounded by a great variety of birds, like *Aphrastura s. spinicauda*, *Colaptes pitius*, *Diuca d. diuca*, *Elaenia albiceps chilensis*, *Nothoprocta perdicaria sandborni*, *Notiopsar c. curaeus*, *Pezites m. militaris*, *Phrygilus a. alaudinus*, *Phrygilus u. unicolor*, *Polyborus p. plancus*, *Spizitornis p. parulus*, *Upucerthia dumetaria*

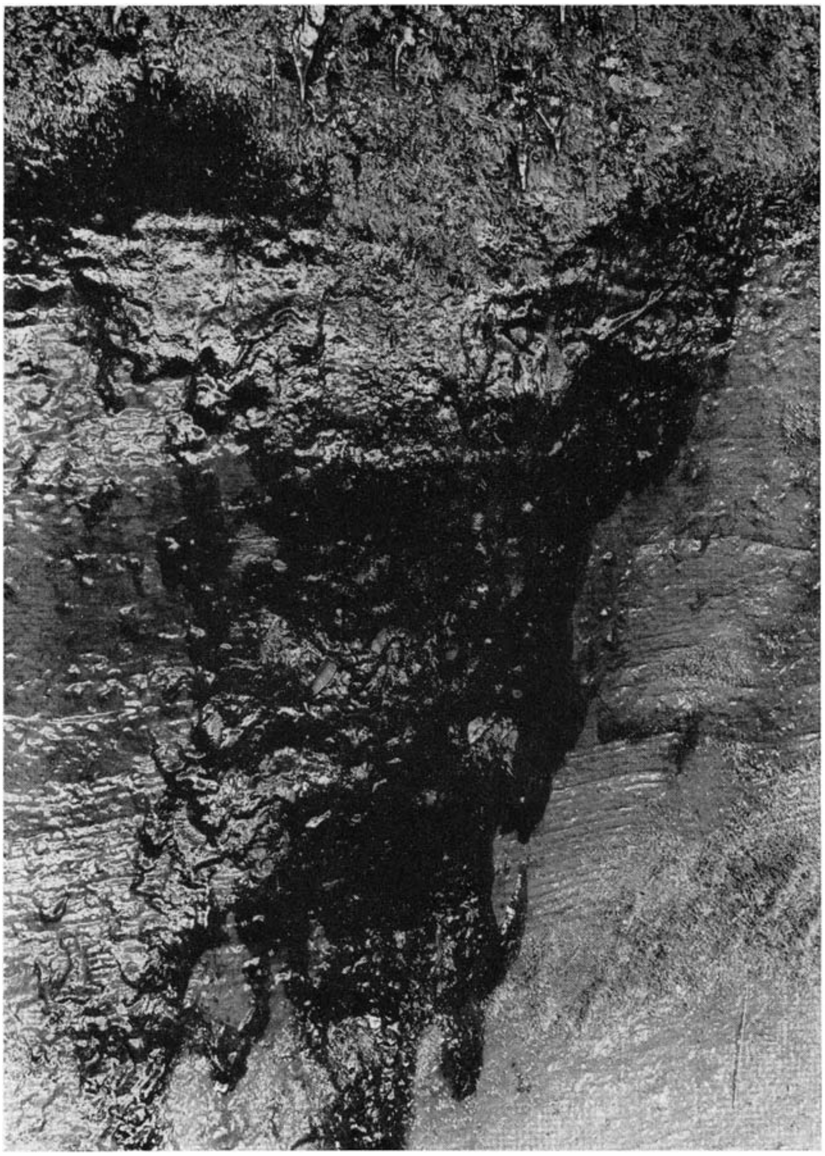


Fig. 7. Hygropetric community of *Cylindrospermum maius* on a precipice of volcanic tuff at Lake Villarrica. Photograph by L. Brundin, November **14**, **1953**.

saturatior, *Zonotricha capensis australis*, and also *Troglodytes musculus chilensis*, *Eugralla paradoxa*, *Turdus falcklandii magellanicus*, *Muscisaxicola macloviana mentalis*, and large flocks of *Spinus barbatus*. The flowering shrubs of fuchsia are often visited by humming birds (*Sephanoides sephanoides*), which also visit the flowers of *Sarmienta repens*.

The ecotonal vegetation which has been cursorily outlined above occupies the lowest of the lake terraces which in some places is replaced by a precipice of volcanic tuff. This precipice is often wet due to streams running down from the forest, or small springs trickling out from the precipice. Growing on this precipice I have noted *Sonchus oleraceus*, *Mimulus luteus*, *Acaena* sp., and the liverworts *Marchantia polymorpha* coll., *Jamesoniella grandiflora*, and *Monoclea forsteri*, together with the mosses *Hygroamblystegium filum*, *Phaeoceros* sp., *Mniobryum albicans*, *Bryum valparaisense*, *Aongstroemia gayana*, and *Rhacomitrium lanuginosum*.

In shady and moist places there occurs an interesting hygropetric algal community dominated by the *Cylindrospermum maius* (*Nostocaceae*), which covers the rock, see fig. 7. Intermingled in the gelatinous masses of *Cylindrospermum maius* occur *Aphanothece stagnina*, *Gloeothece rupestris*, *Melosira varians*, *Rhopalodia gibba*, many small benthic naviculoids, and sterile threads of *Spirogyra*. This jelly mass harbours numerous molluscs, amphipods, ostracods, harpacticids, and larvae of chironomids, a fauna which is closely related to that of small streams.

SHORE VEGETATION

The annual fluctuation of the water level is considerable, and we estimated a lowering of the water table of about 70 cm between October and February. Due to the heavy wave action, the shores of Lake Villarrica for the most part consist of coarse gravel, cobble stones, and boulders. Only locally, small, sheltered beaches occur, being built up of fine gravel and sand, mingled with detritus.

The vegetation on the stony shore is on the whole very sparse. Only along the upper geolittoral, viz. that part which is washed by waves only during the most violent storms, or at times of highest water levels, could one find vascular plants in any quantity. The most conspicuous plant among the cobble stones is *Lotus uliginosus*. On the large boulders the following mosses were noted: *Barbula pilifera*, *Grimmia alpicola*, *Rhacomitrium didymum*, and *Tortula prostrata*. There were also lichens, like *Stereocaulon implexum* and *Pseudocyphellaria gilva*.

Such stony beaches are the hunting-ground of lizards and the large hairy spider *Mygale rosea* which has its refuge under driftwood.

The major part of the shore at our base was just a "stony desert"; only one little sandy plot occurred a few kilometers west of our laboratory. Here grew *Scirpus americanus*, *Lathyrus magellanicus*, and a little clump of *Phragmites communis*. This was the only locality for *Phragmites* in the neighbourhood of our base. Probably due to heavy wave action, considerable fluctuations of water level, unsuitable bottom material, and the rather steep sides of the lake basin, *Phragmites* cannot establish itself in aquatic habitats.

In places small streams running from the forest have brought down, especially during the rainy season, considerable amounts of silt and detritus which are deposited on the beach as miniature deltas. On this favourable soil grows frequently the magnificent *Gunnera chilensis* (*Haloragaceae*) with its gigantic leaves with a diameter up to 1.8 m, and pillar-like red inflorescences with a height up to 1.5 m (see fig. 8). The petioles are edible, although containing an ample supply of tannin. Sedges (*Carex aematorryncha*, *C. fuscula*, *C. fuscula* var. *hieronymii*) often grow in a dense carpet, as do *Aster vahlii* and *Trifolium crosnieri*. The small streams are often bordered by yellow flowering *Mimulus parviflorus* and *Ranunculus minutiflorus*. Here we also meet some cosmopolitans, like *Plantago lanceolata*, *Ranunculus repens*, and *Veronica anagallis-aquatica*. During the excursions I noted the following additional plants:

Polystichum adiantiforme	*Sisyrinchum* sp.
Scirpus americanus	*Geum magellanicum*
Cyperus eragrostris	*Viola buchtienii*
C. laetus ssp. *oostachyus* v. *conceptionis*	*Epilobium puberulum* (?)
Juncus balticus	*Eryngium pseudojunceum*
Nothoscordum striatum	*Anagallis alternifolia*
Libertia elegans	*Plantago hirtella*
	Gnaphalium spicatum

Shores of finely textured soil (absent in the neighbourhood of our base) were seen, e.g., on the sheltered bay of Pucón, and along the western reach of the lake at the town of Villarrica. As a rule such places are grazed, and inhabited by secondary plant communities. Oberdorfer (1960, pp. 149 and 151) gives a description of some characteristic hydroseral communities on the southern shore of Lake Villarrica; see also his fig. 39. His classification seems a little vague, however.

AQUATIC MACRO-VEGETATION AND WATERFOWL

The aquatic vegetation of Lake Villarrica is very sparse. Only in the bay at Pucón grow some thin stands of *Scirpus californicus* var. *tereticulmis*.

The bird life on the lake is also poor. The following birds were observed: great grebe (*Aechmophorus maior*), Chilean grebe (*Colymbus rolland chilensis*), flying steamer duck (*Trachyeres patachonicus*), kelp gull (*Larus dominicanus*), *Podilymbus podiceps antarcticus*, *Phalacrocorax o. olivaceus*, and *Colymbus o. occipitalis*.

Fig. 8. *Gunnera chilensis* on the shore of Lake Villarrica. Photograph by L. Brundin.

STREAM LIFE

The bottom of the small streams flowing rapidly through the forest consists of stones and boulders with occasional patches of finer material in which a small number of higher plants, like *Cyperus xanthostachyus*, *Carex pseudocyperus* var. *haenkeana*, and *Uncinia phleoides* can gain a foothold. On the stones and boulders there are liverworts and mosses, e.g. *Hypopterygium thouinii*, *Lamprophyllum splendidissimum*, and *Rigodium arborescens*. There are also green hemispheric colonies of *Chaetophora elegans*, see fig. 39:12. Another alga frequently noted on submerged stones was *Tetraspora lubrica*.

Small black stream-dwelling flatworms were common in the shady forest streams. Much more imposing is the large (10–15 cm) black-brown terrestrial species, *Polycladus gayi*, which is one of the largest flatworms in the world.

LAKE PICHILAFQUEN

Just a short walk to the north from our laboratory at Lake Villarrica a little woodland lake is situated. This lake, aptly called Pichilafquen, is a small body of shallow water with a maximum depth of about 4.5 m. With the exception of the southern side where two crofters had their pasture, the lake was surrounded by a forest of *Nothofagus obliqua – Persea lingue – Laurelia sempervirens*. The forest was open in many places due to clearing, and in such places often grew impenetrable stands of bamboo and bramble.

The woodland borders directly onto the lake, the water level obviously being kept raised by a dam across the outflow. This has brought about submersion of the forest at the border of the lake, judging by the numerous waterlogged trunks of dead trees. These often border the water line in a tangled heap and make the lake inaccessible in most places. The water table of this lake was considerably lower, by about 50–70 cm, in February than at the end of October.

The colour of Lake Pichilafquen was about 15–17, according to the Forel-Ule scale; that of Lake Villarrica about 7. The bottom deposit is rich in organic matter; it consists of undecomposed plant fragments, and even small amounts of sawdust and fragments of timber. This bottom material in Lake Pichilafquen is largely of allochthonous origin. The abundance of small leeches in the bottom samples was especially noticeable.

The composition of the bottom deposit in this shallow little lake makes it a favourable habitat for aquatic vegetation, which is comparatively luxuriant. The shores are bordered with clumps of rushes (*Scirpus californicus* var. *tereticulmis*). Reiche and Oberdorfer have identified the *Scirpus* species growing in South Chile as *S. riparius* but the taxon under consideration is probably better placed under *californicus*, see also Luther (1955, p. 5). A rich growth of *Phragmites communis* occurs along that shore which borders the holdings of the crofters. The lake probably receives some amounts of nutrients from the pasture and settlement. *Potamogeton linguatus* grows between the beds of rushes, and along the shore in shallow water *Juncus inundatus* and *Sagittaria chilensis* are plentiful.

Waterfowl were also abundant. At the end of October two pairs of *Aechmophorus maior* were observed, and also numerous white-winged coots (*Fulica leucoptera*), and a flock of displaying *Oxyura ferruginea* which showed a special curiosity about my plankton net. A white tern, probably *Sterna troudeaui*, was observed in flight. On February 21, the grebes had laid their eggs. Lake Pichilafquen is also the favourite spawning-ground for the large frogs *Calyptocephalus gayi*. During the spawning-season in the middle of November they are very vociferous, and their croaking, or better perhaps their lowing, is audible far around. These frogs are said to be edible. On December 10, some large tadpoles were caught. They were about 10–15 cm long.

LAKE HUILIPILÚN

The second lake in the neighbourhood of Villarrica which was visited by us was Lake Huilipilún. It lies about 5 kilometers north of our laboratory, in a hilly landscape, and is surrounded by fields and pastures. The hillsides slope sheerly down to the sandy beach which is continuous with a shelving bottom. The shores are bordered by shrubs, like *Drimys winteri*, *Lomatia ferruginea*, *Aristotelia chilensis*, *Sophora cassioides*, *Nothofagus antarctica*, *Solanum gayanum*, *Buddleja globosa*, *Leptocarpa rivularis*, *Fuchsia magellanica*, *Lophosoria quadripinnata*, and naturally bamboo. Moreover there grow scattered trees of *Nothofagus obliqua*, *Weinmannia trichosperma*, and *Lomatia ferruginea*. Amongst the herbs growing on the beach only *Carex fuscula* var. *hieronymii*, *Carex pseudocyperus* var. *haenkeana*, *Acaena* sp., and *Aster vahlii* were noted.

In spite of the gentle slope around the margin of the lake, the emergent aquatic vegetation is poor, consisting only of sparse beds of *Scirpus californicus* var. *tereticulmis*. Probably due to the very restricted drainage area, the lake is poor in nutrients and this is reflected in its macro- as well as micro-vegetation.

SEMI-CULTURAL VEGETATION

In the vegetation of the longitudinal valley the changes wrought by man are very extensive, because of lumbering, clearing, burning, grazing, and the cultivation of crops. Such ousting of the native

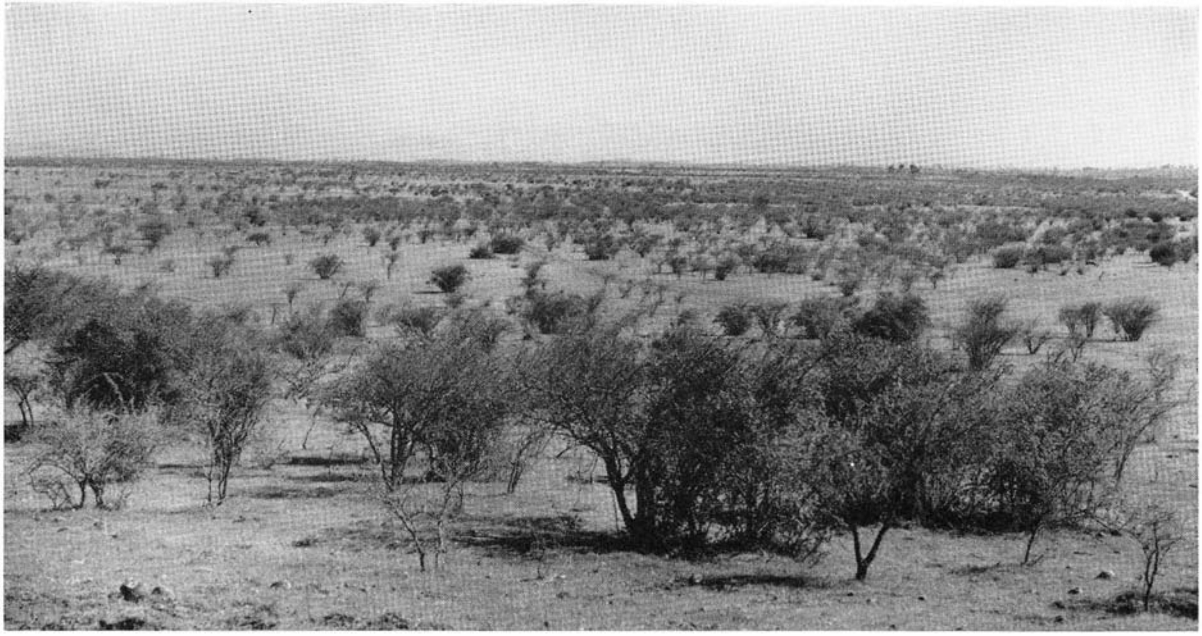


Fig. 9. Central Chilean *Acacia cavenia* espinal (thorn woodland) in Province Bio-Bio. Photograph by L. Brundin.

flora gives ample chances to spread to the adventives, among which introduced plants are numerous. Some of the latter have so thoroughly established themselves in the native environment that they are distinguishable from the indigenous flora only by their known history. But most aliens are limited almost entirely to burned-over or otherwise cleared areas, such as waysides, fields, settlements, etc. Various aspects of human influence on the vegetation and flora have been dealt with in many papers (e.g., Reiche, 1907, pp. 320–345, and 1938, pp. 82–118). Moreover Oberdorfer (1960) has devoted considerable space to the vegetation influenced by man, and to the secondary communities. Several minor contributions may also be of interest, e.g. Kunkel (1956) who gives a summary of some weed communities at Mininco (p. 42), and outlines the vegetation and flora of the forest and eroded slopes there. Mininco is situated within the broad transitional zone between the Central Chilean *Acacia cavenia* espinal (thorn woodland, see fig. 9) and the South Chilean deciduous summer forest.

Just east of our base at Lake Villarrica was an extensive area of pasture. It was rather attractive, because there was a little stream and a patch of inundated ground, both of which were of some phycological interest. Trunks of dead trees gave evidence that once this area was occupied by forest. Shrubs were abundant, the most frequent being *Aristotelia chilensis*. In addition, the following shrubs were noted: *Fuchsia magellanica*, *Rubus ulmifolius*, *Berberis darwinii*, *B. congestiflora*, *Proustia pyrifolia*, *Azara serrata*, *Pernettya mucronata* var. *angustifolia*, *Sambucus nigra*, *Gevuina avellana*, *Buddleja globosa*, *Solanum valdiviense*, *Raphithamnus spinosus*, *Muehlenbeckia hastulata*, and *Discaria discolor*.

The following herbs were noted: *Taraxacum atrovirens*, *Senecio cymosus*, *Hypochoeris radicata*, *Plantago lanceolata* (a weed which was introduced about 1860, and is now one of the most widespread of all flowering plants in Chile), *Stipa mucronata*, *Sisyrinchum chilense*, *Silene gallica*, *Rumex acetosella*, *Cynoglossum creticum*, *Libertia elegans*, *Fragaria chiloensis*, *Daucus pusilla*, *Modiola caroliniana*, *Linum usitatissimum*, *Veronica arvensis*, and *Digitalis purpurea* (often visited by the large humblebee, *Bombus dahlbomi*, which also pollinates clover).

In inundated places tufts of *Juncus procerus* were predominant. Among these the following plants

Fig. 10. *Libertia elegans*, Villarrica. Photograph by K. Thomasson.

grew: *Juncus dichotomus*, *J. involucratus*, *Cyperus reflexus* var. *fraternus*, *Heleocharis melanostachys*, *Ranunculus repens*, *Veronica anagallis-aquatica*, and *Mimulus luteus*. In the warm water a rich algal vegetation occurred which will be described below. Oberdorfer called this plant community Juncetum proceri. Large areas of well developed Juncetum proceri were seen in several grazed marshy places between Valdivia and Osorno.

Such wet rush-meadows and also pastures are the favourite habitats for the Chilean lapwing (*Belonopterus c. chilensis*), Magellanic snipe (*Capella paraquaiae magellanica*), and for the beautiful black-faced ibis (*Theristicus caudatus melanopsis*).

Around the settlements, and here and there in the fields, clumps of *Nothofagus obliqua*, *Persea lingue*, *Acacia melanoxylon*, and *Laurelia sempervirens* have been left. These clumps are often intertwined by bamboo which serves as winter-food for the cattle.

The wood of many Chilean native trees is of a high quality, but unfortunately these trees grow very slowly. Therefore many fast-growing foreign trees have been introduced into Chilean silviculture. In the lake district the most suitable tree for rational forestry is *Pinus radiata* (see Bauer, 1958, pp. 64 and 101), which is also often used in an attempt to control the devastating erosion, especially in the northern part of the lake district. This conifer, and *Eucalyptus globulus* are planted everywhere, always looking out of place. Around the settlements are large groves of *Castanea sativa* or *Populus nigra* var. *italica*. Even birches have been planted, but less successfully. At Christmas-time, lindens were in blossom, and the fields shone white, not with snow, but with millions of flowering *Chrysanthemum leucanthemum*.

Road-side scrub usually consists of *Aristotelia chilensis*, *Fuchsia magellanica*, *Ulex europaeus*, *Acacia melanoxylon*, *Salix viminalis*, and last but not least *Rubus ulmifolius* (zarzamora). It was introduced into Valparaiso in 1847 by Francisco Chabary and was distributed by Sociedad de Agricultura for cultivation all over the country. Soon escapes spread over the country-side, becoming established everywhere. The naturalized alien *Rubus ulmifolius* is nowadays a great plague. It forms impenetrable thorny thickets, and has infiltrated even many native plant communities.

Among the conspicuous herbs growing along the roadsides one notes, e.g., *Libertia elegans* and *Alstroemeria aurantiaca. Digitalis purpurea* was very abundant on the road cuttings at Valdivia, and from a distance was suggestive of fireweed which is met with in similar habitats in Europe and North America. Concerning ruderal plant communities, the reader is referred to Oberdorfer (1960, pp. 183 ff.).

LAKE PELLAIFA

The eastern parts of the pre-andine lakes were once surrounded by a type of forest which, with respect to its flora and vegetation, formed a link between the deciduous summer forest (touched upon above), and the evergreen forest in the mountains, in which *Nothofagus dombeyi* is of great importance. But even here untouched vegetation is now rare along the shores, roads, and streams.

The little lake Pellaifa belongs to this transitional zone, being situated about 5 kilometers south-east of the eastern end of Lake Calafquén. It is surrounded by forest-crowned mountains which, in places, drop sheerly down into the lake (see fig. 27). The forest has partly been lumbered, and burnt areas are common. From the precipices comes a glinting light of the large yellow flowers of *Senecio yegua* var. *depilis.* The western shore of the lake is shelved and covered with greyish sand. In the shallow water a sparse growth of *Scirpus californicus* var. *tereticulmis* occurs. The bottom of the lake is rather even; repeated soundings in the central part of the lake gave depths varying between 80–90 meters. Only 150 meters lakewards from the shelved western shore depths of about 40 m were recorded.

In Lake Pellaifa, as in Lake Villarrica, introduced lake trout and *Percichtys trucha* are abundant. Crayfishes (*Aegla*) occur in enormous quantities.

Along the western shore grow *Nothofagus dombeyi, Laurelia sempervirens, Myrceugenia* cf. *planipes*, and *Austrocedrus chilensis*, the liana *Hydrangea serratifolia*, the epiphyte *Mitraria coccinea*, and shrubs of *Colletia spinosa* and *Aristotelia chilensis* with the climber *Vicia nigricans. Carex macloviana* and *Equisetum bogotense* grow on the sandy beach. *Gunnera* seems to be rather rare here and also to the east of Lake Pellaifa, around the Termas de Malihue. *Digitalis purpurea* is abundant all over on burnt forest ground. Most of the flowers are red; only a few white ones were seen.

Lake Pellaifa discharges into Lake Calafquén by a stream which begins in a shallow bay at the western end of the former lake. The vegetation of this bay is rich; *Scirpus californicus* var. *tereticulmis* grows over a considerable area. In the innermost end of this bay *Phragmites communis* also grows, with a bed of rushes on the lakeward side. From the water's edge down to a depth of 1 m *Littorella australis* forms extensive and compact swards (fig. 11). At a depth of 23 cm, on a soft mud bottom of 11 cm thickness, the mat of *Littorella* was densest, and 5000 specimens per square meter were counted. On a bottom with a thinner mud cover, or on a sandy bottom the rosettes are more thinly dispersed. *Scirpus californicus* var. *tereticulmis* first occurs in about 40 cm deep water; at a depth of 45 cm, 110 stalks per square meter were counted. A few plants of *Potamogeton linguatus* were noted here and there among the rushes. A different zonation occurs elsewhere. Below the zone of *Littorella australis* along the water's edge and in shallow water, a dense mat of *Sagittaria chilensis* occurs at 1 m depth. A few scattered specimens also grow in shallower places, up to only 20 cm depth. The rosettes of *Sagittaria chilensis* are larger and coarser than those of *Littorella australis.* The long flowerstalk with white flowers reaches the surface of the water. The lakeworth (*Littorella*), which has its northernmost localities in the northern part of the lake district, also grows on the shore in large quantities and was flowering in the beginning of December. *Heleocharis pachycarpa, Juncus involucratus, Navaretia involucrata, Hedyotis thesiifolia*, and *Gratiola peruviana* were also noted, growing on the beach.

Water-fowl are more numerous in this bay than on the rest of the lake. Besides the great grebe (*Aechmophorus maior*) which was observed on all of the lakes visited by us, the following birds were noted: several pairs of *Anas specularis*, two pairs of *Belanopterus c. chilensis*, eight specimens of *Theristicus caudatus melanopsis*, and the large southern ringed kingfisher (*Megaceryle torquata stellata*). The common sparrow

Fig. 11. Mat of *Littorella australis* growing along the water's edge on the shore of Lake Pellaifa. Photograph by K. Thomasson, December 5, 1953.

hawk (*Falco sparverius cinnamominus*) and the carancho carrion-hawk (*Polyborus p. plancus*) were observed in flight.

MACRO-VEGETATION OF PONDS

Permanent small bodies of stagnant water like ponds, tarns, and dams, were absent in the places visited by us, except for three ponds along the western shore of Lake Pellaifa. The largest one, called by us the *Potamogeton* pond, had a thick growth of *Potamogeton linguatus*, its water was brown, and the bottom was covered by a thick layer of mud. Beside the pondweeds, *Scirpus californicus* var. *tereticulmis*, *Cyperus xanthostachyus*, and *Carex pseudocyperus* var. *haenkeana* also occurred. During the wet season there is probably a stream flowing through this pond.

The second body of water was merely a pool, only 5 cm deep. On the muddy bottom grew a few specimens of *Nitella*.

The third pond was somewhat deeper, about 50 cm, and filled with a dense growth of *Myriophyllum verticillatum* rooted in the muddy bottom. The surface of this pond was covered with glistening neuston. The algal flora of these small bodies of water will be treated below.

ALTITUDINAL BELTS

During the eruption in 1948 the vegetation on Volcano Villarrica was to a great extent destroyed by flows of lava, volcanic ashes and fires. Therefore, the altitudinal difference in the composition of vegetation is better illustrated by our observations during a trip to Lake Quillehue, through the area situated between Lake Villarrica and Volcano Lanin.

The first phytogeographical survey of this area was made by Neger (1900; first published in Spanish, 1899). He travelled in the summer 1896–97 in the Cordillera Villarrica and crossed the Andean range. During a trip to Volcano Quetrupillan (2360 m), Oberdorfer (1960) studied the plant communities, and arranged them into his system of Chilean plant communities.

As already mentioned (p. 28), the eastern ends of the preandine lakes are surrounded by remnants of forest transitional between the largely deciduous Nothofago-Perseetum (Formación de *Nothofagus obliqua* y *Laurelia philippiana*) and the evergreen Dombeyo-Eucryphietum (Selva valdiviana andina).

The temperate rain forest (Dombeyo-Eucryphietum), which has its northern border at about 37° S., extends on the Andean slopes from about 400 m upwards, forming the subandine temperate rain forest. Besides the evergreen *Nothofagus dombeyi*, which forms the upper tree storey, *Eucryphia cordifolia* and *Laurelia philippiana* are prominent members of this forest community, forming the lower tree storey. This type of forest is closely related to the coastal temperate rain forest (Selva valdiviana de la costa) which covers the slopes of the Coastal Cordillera (see also Neger, 1900, p. 233).

Forest fires are very frequent. At the end of February the sky over Lake Villarrica was covered by clouds of smoke from forest fires in the mountains.

The floristic composition of the Andean *Nothofagus dombeyi – Eucryphia cordifolia – Laurelia philippiana* forest is illustrated by the following list based on our notes and collections, which are fragmentary, in particular with regard to cryptogams.

ARBORESCENT STRATUM
Saxegothaea conspicua
Nothofagus dombeyi
Lomatia obliqua
Drimys winteri
Laurelia philippiana
Persea lingue
Weinmannia trichosperma
Eucryphia cordifolia

FRUTESCENT STRATUM
Saxegothaea conspicua
Gevuina avellana
Lomatia ferruginea
Berberis darwinii
Drimys winteri
Laurelia philippiana
Ribes magellanicum
R. punctatum
Caldcluvia paniculata
Weinmannia trichosperma
Sophora macrocarpa
S. cassioides
Aristotelia chilensis
Eucryphia cordifolia
Azara lanceolata
A. microphylla
Ovidia pillopillo
Myrceugenella apiculata
Ugni molinae
Fuchsia coccinea
Gaultheria myrtilloides
Pernettya mucronata
Rhaphithamnus spinulosus

CLIMBERS
Chusquea coleu
C. quila
Luzuriaga radicans
Hydrangea integerrima
Cissus striata
Elytropus chilensis
Mitraria coccinea

EPIPHYTES
Herbs
Hymenophyllum pectinatum
Asplenium dareoides
Pseudopanax laetevirens

Bryophytes
Dicranoloma robustum
Rhizogonium mnioides
Hypopterygium thouinii

HERBACEOUS STRATUM
Lycopodium paniculatum
Lophosoria quadripinnata
Adiantum chilense
Dryopteris spectabilis
Polystichum aculeatum
Blechnum valdiviense

Chusquea coleu
C. quila
Uncinia phleoides
Codonorchis lessonii
Viola reichei
Loasa acanthifolia
Osmorrhiza chilensis
Nertera granadensis
Lagenophora hirsuta

CRYPTOGAMIC STRATUM
Conspicuous bryophyte
Dendroligotrichum dendroides

At an altitude of about 600–700 m, the flora of the temperate rain forest becomes impoverished, even though the forest is still very tall (30–40 m). *Eucryphia cordifolia*, *Persea lingue*, and many other plants disappear (cf. Neger, 1900, p. 234). In their place appear *Nothofagus procera*, *N. pumilio*, and *Podocarpus andinus*. The most abundant of them is *Nothofagus procera* which gives its name to the present forest community, the Nothofagetum procerae. *Saxegothaea conspicua*, *Laurelia philippiana*, and *Nothofagus dombeyi* are also frequent. In the ground vegetation, bamboo is abundant and grows in enormous quantities in fire-clearings, for this forest belt is also heavily ravaged by forest fires (see fig. 12). The following list is intended to give an idea of the floristic composition of the *Nothofagus procera* forest around Puesco Bajo.

ARBORESCENT STRATUM
Saxegothaea conspicua
Nothofagus dombeyi
N. procera
Lomatia obliqua
Laurelia philippiana

FRUTESCENT STRATUM
Myoschilos oblongum
Berberis buxifolia
B. darwinii
B. linearifolia
Drimys winteri v. *andina*
Ribes magellanicum
Azara lanceolata
Myrceugenia nanophylla
M. chrysocarpa
Amomyrtus luma

CLIMBERS
Luzuriaga radicans
Dioscorea brachybotrya
Hydrangea serratifolia
Griselinia ruscifolia
Asteranthera ovata
Mitraria coccinea

PARASITE
Myzodendron punctulatum

EPIPHYTES
Ferns
Hymenophyllum tortuosum
Asplenium dareoides

Bryophytes
Lepidozia chordulifera

Rhizogonium mnioides
Porothamnium arbusculans

Lichen
Nephroma antarcticum

HERBACEOUS STRATUM
Lycopodium paniculatum
Polystichum mohrioides v. *elegans*
Dryopteris spectabilis
Blechnum valdiviense

Chusquea quila
Uncinia tenuis
Asarca odoratissima
Chrysosplenium valdivianum
Acaena ovalifolia
Trifolium repens
Dysopsis glechomoides
Viola maculata
Osmorrhiza berteroi
O. chilensis
Ourisia coccinea v. *elegans*
Nertera granadensis
Lagenophora hirsuta
Adenocaulon chilense

CRYPTOGAMIC STRATUM
Chiloscyphus integrifolius
Hypnum lechleri
Sticta damaecornis

Fig. 12. The present status of considerable forest areas is shown in this picture from Puesco Bajo, Province Cautin. This is a too common sight in Chilean lake district. Photograph by K. Thomasson, November 21, 1953.

Above the altitude of 1000 m *Nothofagus pumilio* gains ground in many places at the expense of *Nothofagus procera.* On dry, penetrable soils the undergrowth is often a *Pernettya mucronata* heath.

Lake Quillehue, which lies at about 1200 m, is also surrounded by forests of *Nothofagus dombeyi* and *N. pumilio,* which are, however, cleared to a great extent. The flowering shrubs of *Berberis linearifolia* glow like fire in the clearings. On the branches of the southern beeches the parasite *Myzodendron punctulatum* and the epiphyte *Fascicularia bicolor* (*Bromeliaceae*) are of common occurrence. The latter also grows on the rocky precipices around the shores. Along tracks near the lake grow *Ourisia ruelloides, Ranunculus minutiflorus, Calceolaria biflora, Osmorrhiza chilensis, Lathyrus cabrerianus, Viola buchtienii, Vicia nigricans, Sisyrinchium junceum, Senecio acanthifolius, S. hieracium,* and also *Digitalis purpurea.*

The little Lake Quillehue has a very sparse vegetation, except for its shallow western end from where Rio Trancura flows out. Here a luxuriant growth of *Scirpus californicus* var. *tereticulmis* occurs, and the subaquatic vegetation is made up of *Myriophyllum verticillatum.*

Aquatic birds are frequent: on November 22, 1953, seven pairs of great grebes were sitting on eggs; besides these there were a few bald coots, probably *Fulica armillata,* some *Tachyeres patachonicus,* and a goose with goslings, very likely *Chloëphaga polyocephala.*

Around Puesco Bajo the mountain ridges were crowned by trees of *Araucaria araucana.* These trees on the cloud-enshrouded crests have an air of a dim and distant past. This ancient family is represented in South America by two species, viz. *Araucaria angustifolia* which grows in southern Brazil and extends into the Territory of Misiones in Argentina; and *A. araucana* in the Cordillera de los Andes between 34° 40′ and 40° 10′ S., and in the Cordillera de Nahuelbuta between 37° 30′ and 38° 40′ S. (see Croizat, 1952, fig. 94). While on the western shore of Lake Quillehue grow just a few trees of *Araucaria araucana,* it covers the entire valley east of the lake. It is an open forest which has been lumbered here and there. On the trunks of some large trees of *Araucaria araucana* obvious marks of forest fires were observed. The trunks are often covered with hanging tufts of *Usnea magellanica*. Moreover, *Cetraria glauca* and *Cornicularia epiphorella* were noted. The dry soil originates from the nearby volcano Lanin (3774 m). The regeneration of the forest is good, and young trees and seedlings are abundant.

Between the scattered trees of *Araucaria araucana* grows a lower storey (10–15 m) of *Nothofagus pumilio* and *N. procera* (both deciduous). The shrub layer is composed of *Berberis darwinii*, *B. linearifolia*, *Nothofagus pumilio*, *Embothrium coccineum*, *Ribes magellanicum*, *Myoschilus oblongus*, and the low grown var. *andina* of *Drimys winteri*. Among the herbs and dwarf-shrubs were noted: *Anemone antucensis*, *Alstroemeria aurantiaca*, *Lagenophora hirsuta*, *Adenocaulon chilense*, *Viola maculata*, *Geranium sessiliflorum*, *Acaena ovalifolia*, *Pernettya pumila*, *P. mucronata*, *Empetrum rubrum*, *Rubus geoides*, *Fragaria chiloensis*, and *Festuca subandina*.

Higher up on the slopes *Nothofagus pumilio* gains ground and at about 1400 m it occurs in almost pure stands. The timber-line lies at about 1500–1600 m and is formed by *Nothofagus pumilio*. Above the timber-line there is an elfin wood, and ultimately "Krummholz" of the deciduous *Nothofagus antarctica*. This "Krummholz" is intermingled with *Escallonia rubra* and patches of xeric grassland of *Festuca subandina*. Above this belt increasingly limited areas of xeric grassland with prevailing *Festuca subandina* (Festucetum subandinae) reach the altitude of about 2000 m. In areas irrigated from snow-beds, mats of *Caltha appendiculata* are especially characteristic. Heathlands of *Pernettya poeppigii* var. *nana* may develop in particularly favourable, sheltered situations. Further details about this vegetation may be obtained from Neger (1896, pp. 399–402), Reiche (1907, p. 233), and Oberdorfer (1960, pp. 143–146).

3. COASTAL CORDILLERA

Detailed information of the vegetation in the coastal range may be obtained from Reiche (1907). His description of Cordillera Pelada (p. 237) also covers the area visited by us. In 1958 Oberdorfer made a journey to Pucatrihue along the same route as we took. The results of his plant sociological studies are published in the paper frequently quoted above (1960). In the following a few notes, made during a short trip to Pucatrihue, will serve as a brief outline but can scarcely do justice to this luxuriant vegetation.

The Cordillera Pelada lies like a green wall between the longitudinal valley and the Pacific. Our excursion on January 3, 1954, followed the valley of the river Trufún, which forces its way through the mountain range, as far as Estuario Trufún, and continued further to Punta Pucatrihue (see fig. 16).

The vegetation belts of the coastal range lie somewhat lower than the corresponding belts on the western slopes of the Andean range, due to the more accentuated maritime character of the climate. The lower eastern slopes are covered with the same deciduous summer forest that has been dealt with above (p. 16). The upper tree storey, reaching about 40 m, is composed of *Nothofagus obliqua*, *N. dombeyi*, and *Eucryphia cordifolia*. The lower storey, about 30 m high, is made up of *Laurelia sempervirens* and *Persea lingue*. On the whole, the flora and vegetation seem to be quite similar to the deciduous summer forest on the shores of Lake Villarrica. Higher up, at the intermediate level, on both sides of the coastal range extends a belt of *Nothofagus dombeyi – Eucryphia cordifolia – Laurelia philippiana* forest. This forest also has two tree storeys, the upper one of *Nothofagus dombeyi*, *Eucryphia cordifolia*, and *Laurelia philippiana*, and the lower one of *Saxegothaea*, *Podocarpus*, and *Amomyrtus*. The following list gives an idea of the composition of the flora.

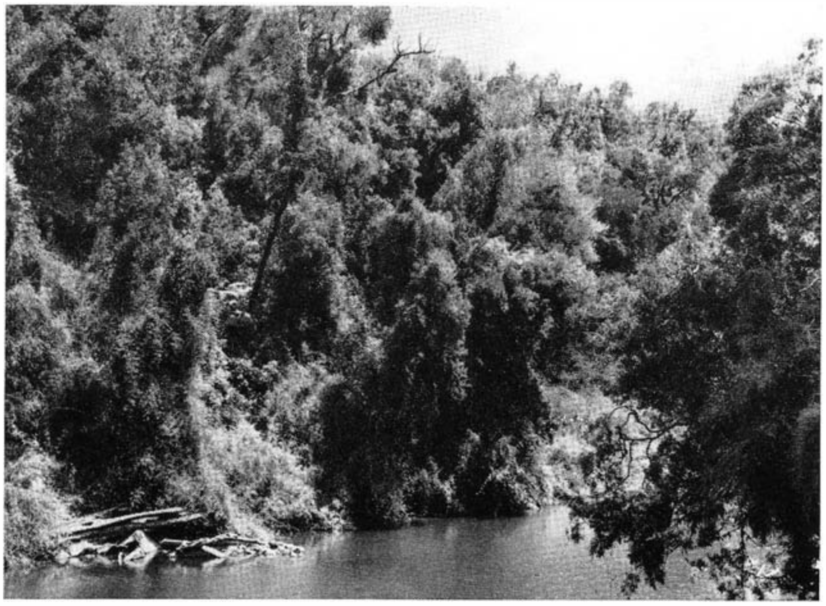


Fig. 13. Bamboo (*Chusquea*) growing luxuriantly along the shores of Rio Trufún in a well exposed situation. Photograph by L. Brundin, January 3, 1954.

ARBORESCENT STRATUM

Podocarpus nubigena
Saxegothaea conspicua
Nothofagus dombeyi
Drimys winteri
Laurelia philippiana
Weinmannia trichosperma
Aextoxicon punctatum
Eucryphia cordifolia
Amomyrtus luma

FRUTESCENT STRATUM

Saxegothaea conspicua
Nothofagus dombeyi
Gevuina avellana
Lomatia ferruginea
Drimys winteri
Laurelia philippiana
Weinmannia trichosperma
Aextoxicon punctulatum
Eucryphia cordifolia
Myrceugenia planipes
Amomyrtus luma

CLIMBERS

Luzuriaga erecta
L. radicans
Lapageria rosea
Hydrangea serratifolia
Mitraria coccinea

EPIPHYTES

Fascicularia bicolor
Hymenophyllum caudiculatum
H. tortuosum

HERBACEOUS STRATUM

Blechnum valdiviense
Anemone hepaticifolia
Nertera granadensis

It is evident that the present forest community is practically identical with the Andean *Nothofagus dombeyi – Eucryphia cordifolia – Laurelia philippiana* forest. Both have been united by Oberdorfer under the Dombeyo-Eucryphietum.

Along the river Trufún grows brushwood of *Fuchsia magellanica*, *Aristotelia chilensis*, and *Rubus ulmifolius*. On the sides of ditches, shrubs of *Abutilon vitifolium*, *Senecio cymosus*, *Buddleja globosa*, *Aristotelia chilensis*, and *Rubus ulmifolius* were noted. Shrubs of *Latua pubiflora* (*Solanaceae*) were also noted, although rare. This is an interesting plant which has been used by Araucanian medicine-men for producing hallucinations.

Among the herbs on the roadside were noted: *Lobelia tupa* var. *bicalcarata*, *Dioscorea* sp., *Loasa acanthifolia*, *L. martinii*, *Anemone hepaticifolia*, *Cirsium vulgare*, *Osmorhiza chilensis*, *Hydrocotyle poeppigii*, *Stellaria cuspidata*, and of course *Digitalis purpurea*.

Amongst the birds the little Magellanic babbler (*Syctalopus m. magellanicus*) should be named.

In a roadside ditch, not far from the seashore, a community of *Spirogyra* sp. ster. and *Pinnularia spathulata* (length 185–305 μ, see Cleve-Euler, 1948, p. 46) occurred. Also an *Oscillatoria* species, close to *O. anguina*, was abundant. Moreover, the occurrence of *Hyalotheca dissiliens*, *Micrasterias conferta*, *Cosmarium subspeciosum* var. *validius*, and *Cylindrocapsa geminella* var. *minor* was noted.

We never had an opportunity to visit the most elevated parts of the coastal range. According to Reiche (1907), above an altitude of about 500 m on both sides of the Coastal Cordillera grows a forest of *Weinmannia trichosperma*, *Laurelia philippiana*, and *Nothofagus dombeyi*. The conifers *Saxegothaea conspicua* and *Podocarpus nubigena* are very important. Above an altitude of 800 m coniferous forests of *Fitzroya patagonica* and *Pilgerodendron uviferum* grow on damp soil. This belt, with patches of *Fitzroya patagonica*, reaches the flat summit area which is, to a large extent, treeless. The vegetation of these treeless areas has been described by Reiche (1907, p. 237). Here extensive communities of subantarctic plants are found, e.g., *Donatia fascicularis*, *Astelia pumila*, *Dacrydium fonckii*, *Tribeles australis*, and *Sphagnum magellanicum*. These occurrences have been explained as relicts from the ice age. No corresponding communities occur in the Andean chain due east, on the other side of the longitudinal valley (see Reiche, 1938, p. 24). Unlike the Andean chain the Coastal Cordillera of Valdivia was not glacier covered during the ice age, although the glaciers from the Andean chain reached the longitudinal valley.

At the western foot of the coastal range, above the seashore, a forest of *Aextoxicum punctatum* grows. *Laurelia philippiana*, *Flotowia diacanthoides*, *Eucryphia cordifolia*, and *Podocarpus saligna* occur intermixed. The lower synusiae are made up of:

SHRUBS

Gevuina avellana
Drimys winteri
Caldcluvia paniculata
Eucryphia cordifolia
Azara lanceolata
Myrceugenella apiculata
Myrceugenia ovata
M. planipes
Amomyrtus luma
Rhaphithamnus spinosus

CLIMBERS

Luzuriaga errecta
Hydrangea serratifolia
Griselina scandens
Elytropus chilensis

GROUND HERBS

Lophosoria quadripinnata
Blechnum valdiviense
Dryopteris spectabilis
Dysopsis glechomoides
Hydrocotyle poeppigii
Osmorrhiza chilensis
Nertera granadensis

Epiphytes are abundant, especially ferns. On the trunks of trees the following epiphytes were noted:

Hymenophyllum caudiculatum
H. dicranotrichum
H. krauseanum
H. plicatum
H. tortuosum
Hymenoglossum cruentum
Polypodium feuillei
Fascicularia bicolor
Pseudopanax laetevirens
Sarmienta repens
Rhizogonium mnioides
Weymouthia mollis
Porothamnium arbusculans
Lamprophyllum splendidissimum
Hypoptrygium thouinii
Lopidium plumarium
Pseudocyphelaria freycinetii

The seashore between Estuario Trufún and Punta Pucatrihue is on the whole a sandy beach, with the exception of basaltic rocks, see fig. 16. Here grow *Scirpus nodosus*, *Juncus planifolius*, *Loasa acanthifolia*, *Rumex maricola*, *Franseria bipinnatifida*, *Francoa sonchifolia*, *Cotula coronopifolia*, *Acaena* sp., *Empetrum rubrum*, *Euphorbia chilensis*, *Tetragonia expansa*, *Hypochoeris* sp., *Calystegia soldanella*, and *Nolana paradoxa*. Along the forest edge grow *Myrceugenia ovata*, *M. planipes*, *Ugni molinae*, *Elytropus chilensis*, *Griselina jodinifolia*, and *Gunnera chilensis*. The Punta Pucatrihue is a rocky point. Here grow *Mesembryanthemum aequilaterale*, *Apium australe*, *Valeriana virescens*, *Fascicularia bicolor*, *Crassula moschata*, *Eryngium paniculatum*, and *Asplenium obtusatum*.

The littoral rocks have a dense cover of large algae, e.g. *Durvillea antarctica* (edible), *Lessonia nigrescens*, *Macrocystis pyrifera*.

On the shore of Punta Pucatrihue a Magellanic penguin (*Spheniscus magellanicus*) was observed. This points to important biogeographical relationships of the area dealt with above.

4. LLANQUIHUE AREA

The third area into which our wanderings brought us was the landscape around Lake Llanquihue and the region between that lake and the Argentinean border. This area is connected with Nahuel Huapi National Park to the east (see Thomasson, 1959, and Dimitri, 1962).

Fig. 14. Lianas have often imposing dimensions like *Hydrangea* in the forest at Lake Villarrica. Photograph by L. Brundin.

LAKE LLANQUIHUE AND VICINITY

The landscape around the western shores of Lake Llanquihue is diversified with low hills, and terminal moraines; it is a pronounced agricultural district. Nothing is left of the primeval vegetation. Groves and copses of *Populus nigra* var. *italica* and *Eucalyptus globulus*, and also of *Nothofagus dombeyi*, break the sweeping lines of the landscape. The ground vegetation in such groves contains many weeds, but also indigenous plants, like *Uncinia erinacea* and *Arachnites uniflora*. A common bird in such places is the huet-huet (*Pteroptochos tarnii*).

The shores of the peninsula Centinela, where we had our base, were bordered by *Sophora cassioides*, *Populus nigra* var. *italica*, *Ugni molinae*, *Caldcluvia paniculata*, and *Eucryphia cordifolia*, the latter covered with charming large, white flowers in the middle of February. The occurrence of the parasitic *Myzodendron brachystachyum* on *Caldcluvia paniculata*, and *Phrygilanthus tetrandus* on *Populus nigra* var. *italica*, ought to be pointed out. Both hosts are rather uncommon. Of climbers only *Mitraria coccinea* was noted.

The brushwood along the shores is composed of *Sophora cassioides*, *Myrceugenella apiculata* var. *australis*, *Rubus ulmifolius*, *Ulex europaeus*, *Coriaria ruscifolia*, *Fuchsia magellanica*, and *Lomatia ferruginea*; the latter was flowering in the middle of January. Among the shrubs the climbing *Mutisia retusa* var. *glaberrima* grows, along with the bamboo. Close to a garden the occurrence of *Ruta chalepensis* was noted.

Along the shores the following birds were noted: *Elaenia albiceps chilensis*, *Patagona g. gigas*, *Spizitornis p. parulus*, *Cinclodes patagonicus chilensis*, *Ortygonax rytirhynchos landbecki*, *Pteroptochos tarnii*, *Pezites m. militaris*, *Spinus barbatus*, *Zonotrichia capensis chilensis*.

On the shore grew *Juncus bufonius*, *J. llanquihuensis*, *J. leersii*, *J. andicola*, *J. cyperoides*, *Scirpus cernuus*, *Littorella australis*, *Gnaphalium spicatum*, *G. cheiranthifolium*, *Silene gallica*, *Potentilla anserina*, *Trifolium repens*, *Prunella vulgaris*, *Valeriana polemonifolia*, and an *Epilobium* sp. not unlike *E. brasiliense*. In a small spring by the shore *Cyperus xanthostachyus* occurred; the mud surface in between was carpeted by *Azolla filiculoides*.

Lake Llanquihue is the largest of the Chilean lakes. Due to the great expanse of water over which the wind blows, the waves may become formidable in size and action. Therefore, the open shores lack emergent hydrophytes. Beds of *Scirpus californicus* var. *tereticulmis* occur only in the more protected marginal regions, such as the Bay of Puerto Octay which lies sheltered behind the peninsula of Centinela. *Myriophyllum verticillatum* also occurs there.

The maximum depth of the Bay of Puerto Octay is about 43–48 m according to our random soundings. Consequently the whole bay is an epilimnic body of water. The thermocline of Lake Llanquihue was located on January 1, 1954, at about 50 m depth. The submerged vegetation of the Bay of Puerto Octay is made up of dense mats of *Nitella* which covers the bottom from a depth of 9 m down to 21 m where the growth is still dense. No samplings from greater depths were made. The transparency was 25–26 m. This luxuriant *Nitella* vegetation grows on muddy bottoms. Between 8 and 9 m only scattered plants of *Nitella* grow. Along the shore the bottom material is sand and stones down to a depth of 1 m. Between 1 and 2 m depth the bottom is covered with brownish incrustations which contain iron oxide and support a thin growth of mosses here and there.

The following waterfowl were noted: *Larus dominicanus*, *L. maculipennis* (not unlike *L. ridibundus*), *Fulica leucoptera*, *Aechmophorus maior* (breeding), and *Podilymbus podiceps antarcticus*.

Between the southern shore of Lake Llanquihue and the Bay of Reloncavi, where nowadays the land

Fig. 15. Dombeyo-Eucryphietum on the shores of Rio Trufún, Province Osorno. Photograph by L. Brundin.
Fig. 16. Coastal dunes at Pucatrihue covered with *Franseria bipinnatifida* and *Euphorbia chilensis*. The tufts are *Juncus planifolius*. Photograph by L. Brundin, January 3, 1954.

is made up of fields and pastures, the early explorers had great difficulties in penetrating the extensive morasses and alerzales, see Ljungner (1959, pp. 199–203). The German settlers who colonized here in the early eighteen fifties have given vivid descriptions of the area. Nothing is left of these once so imposing forests of *Fitzroya patagonica.* Only a few huge stumps between Puerto Varas and Puerto Montt give evidence that these early descriptions are not exaggerated. The largest of the old stumps, the "Silla del Presidente" has a diameter of more than 3 meters (see also Berninger, 1929, p. 51). On a tour of the little lake La Poza, situated close to the south-eastern shore of Lake Llanquihue, one can get a slight idea of the luxuriance of the vegetation which once occupied the area south of Lake Llanquihue.

The road from Puerto Octay to Ensenada passes first over sandy areas on the northern side of Lake Llanquihue, and then over the ashes and lavas of Volcano Osorno. In many places the road is bordered by shrubs of *Rubus ulmifolius* and beautiful flowering stands of *Alstroemeria aurantiaca,* an Alstroemerio-Aristotelietum association according to Oberdorfer (1960, p. 126). The laval fields are covered with *Pernettya poeppigii* heath. The shrubs of *Pernettya* are about 50 cm high. The heath is further composed of *Drimys winteri, Berberis darwinii, Escallonia rubra, Baccharis umbelliformis, Ugni molinae,* and scattered trees of *Nothofagus dombeyi.* The ground is covered with a *Rhacomitrium lanuginosum* mat with *Jamesoniella grandiflora* and some *Cladonia* species interspersed. A description of the natural features of the surroundings of Ensenada has recently been published by Bauer (1958).

The eastern shores of Lake Llanquihue are unavailable for farming, and only grazing occurs. These shores are to a great extent made out of volcanic material of different ages. This material originates from the activity of the volcanoes Osorno (2661 m) and Calbuco (2015 m) which tower on both sides of the eastern end of Lake Llanquihue, just a few kilometers from its shores. Darwin has left us a vivid description of the last eruption of Osorno in 1835. The last eruption of Calbuco was in 1929.

There exist already many descriptions of the vegetation of the area extending eastward from Lake Llanquihue, because this area lies along a very popular tourist route with well arranged transport facilities. The latest studies from this area are to be found in Oberdorfer (*op. cit.*). Here is situated the most charming of the Araucanian lakes, Lake Todos los Santos. This area adjoins the Nahuel Huapi National Park which I have dealt with in an earlier paper, see Thomasson (1959), and also Dimitri (1962).

Pernettya heath covers considerable areas at lake level between the lakes Llanquihue and Todos los Santos. Higher up on the slopes of the volcanoes Osorno and Calbuco heath vegetation also occurs. The following notes from the old lava fields by the road between Ensenada and Petrohué (see fig. 17) give some idea of the flora:

Agrostis montevidensis	*Eucryphia cordifolia*
Chlorea lutea	*Viola maculata*
Nothofagus dombeyi	*Ugni molinae*
Gevuina avellana	*Tepualia stipularis*
Lomatia hirsuta	*Pseudopanax laetevirens*
Myzodendron gayanum	*Pernettya mucronata* v. *angustifolia*
M. punctulatum	*P. poeppigii*
Drimys winteri	*Calceolaria integrifolia*
Laurelia philippiana	*C. tenella*
Weinmannia trichosperma	*Haplopappus glutinosus*
Adesmia retusa	*Baccharis racemosa*
Aextoxicon punctatum	*Senecio chilensis*

The ground is often covered with large patches of *Rhacomitrium lanuginosum* (the predominant lava moss also on Iceland). Moreover *Jamesoniella grandiflora, Ditrichum conicum, Bryum pseudotriquetrum, Dicranoloma billardierii, Rhizogonium mnioides,* and *Cladonia pycnoclada* were noted in the ground layer.

A description of the vegetation on the slopes of Volcano Osorno is given by Reiche (1907, p. 242). The distribution of the vegetation on the slopes is rather irregular. The timber-line lies at 1100–1300 m. Below the timber-line, low-grown copses of *Austrocedrus chilensis, Nothofagus dombeyi, N. betuloides,* and *N. pumilio* are prevalent. Above the timber-line extends the heath of *Pernettya mucronata* which covers large areas; the lower edge of the cap of ice and snow lies at the altitude of 1700–1800 m.

Fig. 17. Volcano Osorno (2660 m). In the foreground an old lava field covered with *Rhacomitrium lanuginosum* and *Cladonia pycnoclada*. The trees to the left are *Nothofagus dombeyi*. Photograph by L. Brundin.

LAKE TODOS LOS SANTOS AND VICINITY

The emergent aquatic vegetation of Lake Todos los Santos is sparse. In its easternmost, fiord-like end, the inflow of the river Peulla has built up a large delta. The river is heavily laden with material originating from the glaciers on Mt. Tronador, and consequently there is a very rapid accumulation in the delta. So, for instance, the little harbour of Peulla, which 30 years ago was situated at the hotel, has been removed about 2 kilometers lakewards because the old harbour was filled up with the material swept down by Rio Peulla. The rushes have established themselves on beds of silt in shallow water, and their gradual spread has impeded the inflowing current and resulted in further deposition of silt. Thus the rushes have increased the area in which conditions are suitable for them, and now cover considerable areas at Peulla. This process is probably accelerated by auxotrophication due to sewage discharge from the large hotel at Peulla.

The shores of Lake Todos los Santos are covered with a luxuriant rain forest, with the exception of the western shore where soils of volcanic origin occur. Here the vegetation is of the same appearance as mentioned above. The clearings along the shores of Lake Todos los Santos are quite limited, and never disrupt the beautiful and varied fiord-like scenery which met us on our boating trips between Petrohué and Peulla.

On the shores of this emerald green lake grows the temperate rain forest, the Dombeyo-Eucryphietum. In the survey of Chilean vegetation by Edmundo Pisano in the *Geografia Economica del Chile*, the area around Lake Todos los Santos has been included in the Selva de Chiloe. The forest around Lake Todos los Santos has the following composition (undergrowth not recorded):

ARBORESCENT STRATUM

Saxegothaea conspicua
Nothofagus dombeyi
Drimys winteri
Laurelia philippiana
Weimannia trichosperma
Aextoxicon punctatum
Eucryphia cordifolia

FRUTESCENT STRATUM

Nothofagus dombeyi
Gevuina avellana
Caldcluvia paniculata
Eucryphia cordifolia
Azara lanceolata
Myrceugenella apiculata
Myrceugenia planipes

CLIMBERS

Luzuriaga erecta
L. radicans
Hydrangea serratifolia
Mitraria coccinea
Sarmienta repens

EPIPHYTES

Hymenophyllum pectinatum
Asplenium dareoides
Chiloscyphus valdiviensis
Weymouthia mollis
Hypopterygium thouinii
Zygodon pentastichus
Ulota fuegiana
Macromitrium krausei

This evergreen temperate rain forest, dominated by *Nothofagus dombeyi*, extends through the pass of Pérez Rosales into the Nahuel Huapi area on the eastern slopes of the Andes. The mountain streams are often bordered with a dense thicket of bamboo (*Chusquea*). One of the most impressive bamboo thickets grows at the Cascada de los Novios, close to Peulla. Magnificent stands of *Gunnera chilensis* are also common in wet places.

On the rocks in the cascade the following algae were noted: *Cylindrocapsa conferta, Gloeocapsa sanguinea, Tolypothrix limbata* (cells 9–10 μ in diameter, filaments 25 μ wide, see Prescott, 1951, pl. 126, figs. 1 and 2), *Nostoc verrucosum* (the verrucose character does not seem to be a very good one, there are colonies with smooth, and also with partly verrucose and partly smooth integument). In addition, sterile threads of *Spirogyra* and *Zygnema* were observed.

Above the Dombeyo-Eucryphietum which covers the shores of Lake Todos los Santos, there is a belt of Laurelio-Weinmannietum on the sides of the mountains (see Oberdorfer, 1960, p. 105). Here, too, *Nothofagus dombeyi* is predominant among the trees, but *Weinmannia trichosperma* should also be mentioned. (In Dombeyo-Eucryphietum it is of minor importance.) The lower tree-storey is formed by the conifers *Saxegothaea conspicua*, and *Podocarpus nubigena*; in addition there are *Drimys winteri* and *Laurelia philippiana*. The following shrubs were noted: *Desfontainea spinosa*, *Amomyrtus luma*, *Lomatia ferruginea*, and *Tepualia stipularis*. The bamboo is abundant in this belt, and also in the following one.

At an altitude of about 1000 m, close to the timber-line, we find here and there *Fitzroya patagonica* forest. It grows also at lower altitudes but then as a rule only on damp soil or in localities where there is no competition from *Nothofagus dombeyi*. The lower tree layer in the *Fitzroya* forest at the timber-line is composed of *Saxegothaea conspicua*, *Podocarpus nubigena*, and of low growing specimens of *Nothofagus dombeyi*. In the shrub layer are *Desfontainea spinosa*, *Myrceugenia chrysocarpa*, *Drimys winteri* var. *andina*, and *Gaultheria phillyreaefolia*. The upper edge of Fitzroyetum is bordered by a brush of *Nothofagus pumilio*.

5. PHYTOGEOGRAPHICAL RELATIONS

Concluding these notes on the flora and vegetation of the country around the Araucanian lakes, a few words about the phytogeographical relations ought to be added, although the literature on this subject is already very comprehensive.

One of the earliest analyses of the floristic relations of Patagonia and adjacent areas was presented by Neger (1900, pp. 244–248). Transantarctic relations, later so much discussed, were not mentioned by him. A few years later (1907) Reiche gave a survey of the floristic relations of Chile to California, New Zealand, and Argentine. The history of the Chilean plant world was also presented by Reiche (1907 pp. 305–310) in his fundamental treatise on Chilean flora and vegetation. See also Skottsberg (1915), Schmithüsen (1956, pp. 72 ff.), Auer (1960), and Couper (1960). Most of the papers on the origin and relations of Chilean flora are listed by Du Rietz

(1940), with his usual thoroughness; only some of the more recent papers will be quoted below. Other sources for information about the literature on biogeographical problems in the southern hemisphere are the bulky books by Croizat (1952 and 1958), which are written in a very personal manner.

The native flora of South Chile and Patagonia is naturally intimately related to the flora of adjacent parts of the South American continent (see Schmithüsen, 1956, p. 70). Representatives of northern hemispheric genera occur, e.g. *Empetrum rubrum*, which is closely related to our crow-berry (see fig. 38, in Good, 1953), or *Littorella australis*, which has its only relative, *L. uniflora*, in North America and Europe. The holarctic genus *Ribes* has also extended its range along the Andean chain to the southernmost point of the South American continent (see fig. 18 in Good, 1953). A similar pattern of distribution is shown by a number of holarctic genera, e.g. *Berberis*, *Draba*, *Saxifraga* (fig. 7 in Du Rietz, 1940), *Lathyrus*, *Vicia*, *Menyanthes*, and *Pinguicula*. See also van Steenis (1962, p. 261). A few conspecific cases attract special attention. The distribution of *Carex magellanica* (in a wide sense) and *C. macloviana* is shown by Du Rietz (1940, figs. 3 and 5).

However, it is not so much the biogeographical relations of temperate South America to the north which have puzzled scientists. In this direction there is a more or less continuous land connection which even includes different climatic belts. But the occurrence of floristic elements of Australian-Antarctic origin and distribution in temperate South America has provoked intense biogeographical discussion. Examples: *Lapageria rosea* (*Philesiaceae*, map by Good, 1953, fig. 9); *Sophora cassioides* (series *Tetraptera*, Good, fig. 34), *Drimys winteri* (*Winteraceae*, Good, fig. 5), genus *Weinmannia* (*Cunoniaceae*, Good, fig. 7), and the genus *Nothofagus* (Du Rietz, 1940, fig. 13; later finds in New Guinea and New Caledonia). See also Good (pp. 106 ff.), and van Steenis (1962, pp. 256 ff.). The land masses around the Antarctic continent are widely separated by the southern ocean, which today seems to be a nearly complete barrier to the distribution of most plants. To explain the present distribution of terrestrial organisms, the oceans ought to have been almost filled up by land bridges (see the instructive map in Handlirsch, 1913, and also van Steenis, 1962, pp. 322 ff.). An alternative is the drifting about of the continents (see van Steenis, 1962, pp. 314 ff.).

The problems of bipolar plant distribution and transantarctic connections have been profoundly elucidated by Du Rietz (1940), and in the papers presented and discussions held at the conference on the biology of the southern cold temperate zone in the Royal Society of London (1960). These papers give a many-sided and suggestive exposition of current opinions. A discussion on the biogeographical position of the Araucanian lakes will be given below (p. 128).

VI. LAKES LOCATED WEST OF THE ANDES

"An Seen ist Chile sehr reich, doch beanspruchen sie vorläufig, solange die Untersuchung ihres Planktons noch aussteht, ein geringes botanisches Intresse" stated Reiche in 1907 (p. 53). A quarter of a century later Hellmich (1933, p. 198) wrote that the lakes are entirely unknown from a biological point of view. Sparse and scattered notes on freshwater organisms are found in some early botanical papers, and somewhat more in zoological papers. However, before our journey very little investigation of Chilean lakes had been made. With respect to freshwater algae and the plankton of Chilean lakes, only the papers by Krasske, Schwabe, and Thomasson need to be mentioned.

METHODICAL REMARKS

The main object of the present study is the phytoplankton. For zooplankton the reader is referred to Löffler (1962). I have included in the lists below a few zooplankters in order to give an idea about the structure of the prevailing plankton community. This paper deals with net plankton only, and most of the samples were studied in formalin preserved condition. Only a few elucidatory studies were carried out on the spot, on the living material.

For qualitative sampling of the plankton, tow nets made of no. 25 Dufour bolting silk were used. The average aperture size of mesh, according to the standard grade, is 65 μ, but according to my measurements the aperture varies from about 53 to 60 μ. Of course plankters of a considerably smaller size are also retained as the catch accumulates and blocks up the holes in the net. However, plankters below 30 μ in size are generally much under-represented in samples collected with plankton nets. Numerous investigators have attempted to indicate a size limit for plankters which may be collected by means of fine-mesh nets, but with a low degree of certainty. One can accept, with some doubt, the minimum size of about 50–60 μ that has been used by many authors and coincides with the proposed boundary between microplankton and nannoplankton. To set a limit at 100 μ, as done by some authors, seems to mean that a considerable part of the phytoplankters would be excluded, but, on the contrary, phytoplankters, as a rule, are prevalent in fine-mesh net samples. In many papers the division into net plankton and nannoplankton is not at all the result of fractionating by filtration, but is based on measurements of plankters, without regard to the often very voluminous gelatinous, external envelopes.

Studies based on netplankton give a fairly good idea of the occurrence of those phytoplankters that can be readily identified in a preserved state. For a complete list of phytoplankters occurring in the Chilean lakes, preserved samples are of course inadequate, since an examination of the living organisms is essential for the identification of most small protista. It was, however, impossible to carry out investigations of fresh samples during our expedition. At Lake Villarrica the lack of electric light made it impossible to use a microscope in the evenings. The days were mostly spent on field studies. In other places our stay was too short for detailed microscopical studies.

For the time being the net plankton is more suitable for comparative ecological and biogeographical studies than is the nanno- and ultraplankton. Only few studies on these minute organisms have been carried out by experienced phycologists. However, among small flagellates the cosmopolites are also common, e.g. in Hall Tarns (4270 m) on Mt. Kenya (Africa) occur *Anisonema acinus, Bodo nasutus, Katablepharis vulgaris*, and *Menoidium costatum*, species which are frequently noted in Swedish lakes.

For quantitative sampling the large-size sampler of 5 l capacity, that was constructed by Strøm (1931) and has later been improved by Rodhe (1941), was used. The phytoplankton was separated from the water by means of a filter consisting of the finest mesh of phosphorus-bronze. According to the manufacturer the size of mesh should be 55 μ, but my check measurements gave an aperture of about 70–80 μ.

According to our experiences during the Swedish Limnological Expedition this sampler is not quite satisfactory for field work under difficult conditions. The sampler is bulky and hardly suitable for the work and transportation of an expedition. It is especially laborious to handle in a rubber boat.

Due to the abundance of plankton in most of the lakes studied, the filtering process soon became very slow because of clogging of the filter, and the sampling procedure was rather time consuming.

A considerably smaller sampler would have been sufficient for our purpose. By using a large-size sampler, the probability is higher that uncommon plankters will be represented. These species have no quantitative importance, however, and as a rule their number will be too low for comparative ecological conclusions. However, from a statistical point of view an ample material is desirable; therefore we never used our Ruttner sampler for plankton sampling.

A Friedinger winch was used for operating the samplers. It proved to be useful even though this apparatus should preferably have been lighter to ease transportation. Because of the great depths of the Chilean lakes, a considerable length of stranded wire cable was indispensable, though heavy.

For preservation a few drops of 40% formalin were added to the samples. An extremely small amount is to be preferred in order to avoid disagreeable effects from its vapourisation. For some of the quantitative samples a solution of iodine and potassium iodide was used as a preserving fluid.

The two northernmost of the Araucanian lakes, viz. Colico and Caburgua, were not visited by us, nor are any notes on the plankton in these lakes to be found in the literature. There is, however, no reason to assume that the composition of the plankton in these lakes is entirely different in character from the plankton of the other large pre-andine lakes. Nor did we study the lakes Panguipulli and Riñihue, situated between the lakes Calafquén and Ranco. Some information about the plankton in these two lakes is given in Thomasson (1955).

The phytoplankton of the large pre-andine lakes is rather monotonous and not very interesting from the phycological point of view. Therefore, the summing up of the phycological results of our journey has been considerably delayed. But owing to the delay some additional information could be included about the lakes located along the eastern slopes of Andean chain. About the environmental factors only a few notes have been included below. They have been thoroughly treated in no. 3 of the "Reports of the Swedish Limnological Expedition to South-America" by Löffler (1960).

1. LAKE VILLARRICA

QUALITATIVE RESULTS

The large lake Villarrica was the main object of our studies in the Chilean lake district. We spent the days between October 15 and December 19, 1953 on the shores of this lake. During this time, of course, excursions were made to nearby lakes. Later on, in February 1954, we stopped on the way to the north for about a week at Lake Villarrica. Naturally, our stay was too short to get an idea about the development of the different seasonal aspects of the plankton community in that lake. As will be evident from the table reproduced below, we probably covered only the transition from the spring facies to the summer facies which occurred in the middle of November. Further development of the plankton community remains to be studied.

At the beginning of our stay the spring circulation was ceasing (see Löffler, 1960, p. 198). In spite of a heavy storm on October 25 and 26, the formation of thermal stratification had already started on November 1. Due to wave action large quantities of detached tufts of benthic diatoms occurred along the shore. The bulk of the phytoplankton was made up of filaments of a slender species of *Tribonema* (see p. 105), and of threads of *Melosira granulata* and *M. hustedtii*. In visual examination of samples an abundance of small black spots was conspicuous. These proved to be *Stentor* specimens, and were found to be positively phototactic in the vials.

This *Tribonema-Melosira* plankton flourished during the whole period of observation. At about the middle of November, the *Melosira hustedtii* decreased slightly in quantity, as did also *Hexarthra*, and *Philodina*. On the other hand, the number of *Dictyosphaerium* and *Gloeococcus* colonies and *Tribonema* filaments increased as judged from the qualitative samples. The decrease in the *Melosira* population was followed by an increase of silica in the water of the lake (see Löffler, 1960, p. 242).

In the middle of November, the stones in a 30–50 cm broad belt along the entire shore, from the water's edge down to a depth of 20 cm, were coated with an orange-coloured, 0.5–1 mm thick cover of *Stigeoclonium lubricum* (fig. 39 : 11). This had replaced an earlier cover of benthic diatoms, mainly *Cymbella affinis* and *Synedra ulna* var. *danica*, which had been cleared away during gales.

The qualitative composition of the plankton in Lake Villarrica is summarized in table 4. The prevailing taxa have been indicated by ●, ◑, and ◔ according to their decreasing abundance. All samples were collected in the northwestern part of the lake, except the first one which was collected at Pucón. The majority of the samples from February 1954

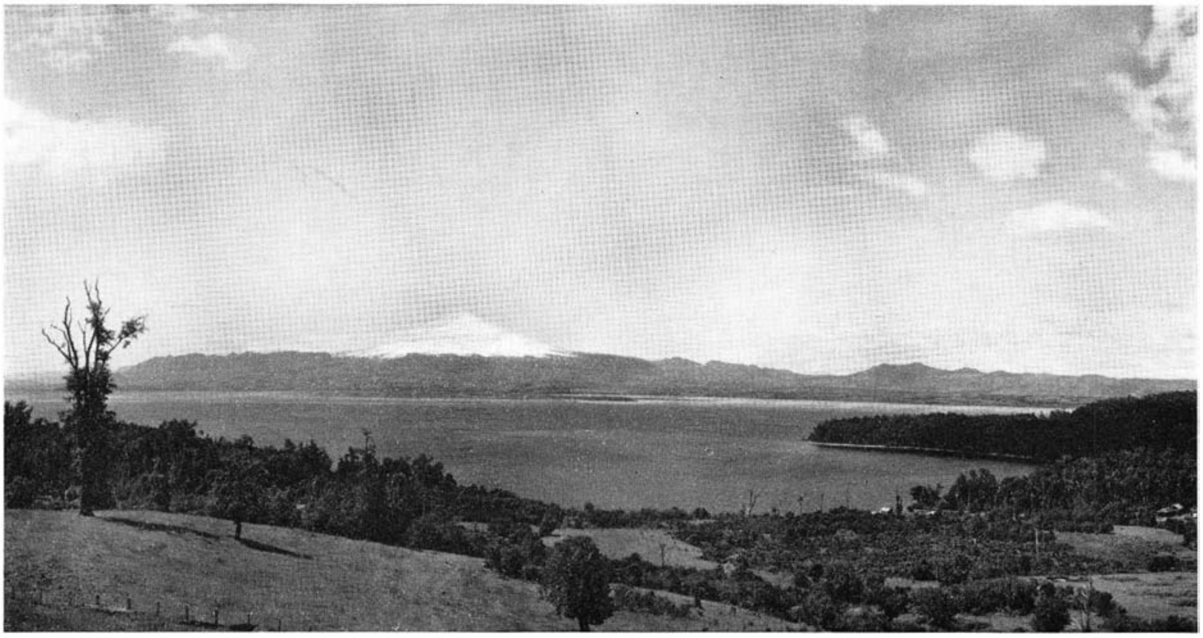


Fig. 18. Panorama of Lake Villarrica with Volcano Villarrica (2840 m) in the background. At the right margin our field laboratory. Photograph by K. Thomasson.

were broken during transport. This reduced our observation period to only two months, which is insufficient for any idea about annual variation.

According to information from several inhabitants, there sometimes occurs in summer a yellow-coloured water-bloom which was said to bring about considerable fish mortality at times.

In 1902 Daday published a paper on the zooplankton of Lake Villarrica which was based on samples collected on March 31, 1899 by Filippo Silvestri. According to this paper *Dinobryon divergens* and *Eudorina elegans* were rather frequent in the plankton. As mentioned above, a *Stentor* sp. was observed by us; Daday reported *Stentor coeruleus*. The *Vagnicola* sp. was identified by him as *Vagnicola* (*Cothurnia*) *crystallina*. The rotifer *Pompholyx complanata* that was reported as common has not been observed by me nor by J. Hauer (in Löffler, 1962), and has apparently been replaced by *P. sulcata*.

The occurrence of *Fragilaria crotonensis* was established in many lakes located east of the Andean range (see chapter 7). Although the peak of abundance of *F. crotonensis* obviously occurred in these lakes during the cold season, there were always at least a few specimens found in samples from the warm season. However, no traces of this species were noted during the first examination, some years ago, of our collections from the Chilean lake district. Therefore, in my earlier paper (Thomasson, 1959, p. 59), the absence of this species in the plankton of South Chilean lakes was considered as an interesting feature of their plankton. Later, a very time-consuming re-examination was made of a number of samples from different lakes in the Chilean lake district. Having spent almost a hundred hours examining that very sample drop by drop, I then managed to find three colonies of *Fragilaria crotonensis* in a surface sample collected from Lake Villarrica on December 2, 1953. It is a rich sample, the result of filtration of some thousands of liters through the plankton net. Very likely *Fragilaria crotonensis* may be more frequent in some other season. If so, it might have been possible to establish its presence by the examination of bottom samples, but these have been left for future studies. During this lengthy search for *Fragilaria crotonensis* only two specimens of *Xanthidium antilopaeum* were seen in the same sample. There is an extremely low probability of getting such sparse species represented, not to speak of the chances to observe them, even after careful qualitative sampling. Considering quantitative samples which, as a rule, are much smaller, the chances of these species being represented are practically non-existent. Rare species, without any importance from the quantitative point of view, may nevertheless have a considerable scientific interest, but their absence can never be stated with full certainty.

TABLE 4.
Plankton of Lake Villarrica

	17.10.1953	30.10.1953	2.11.1953		7.11.1953		9.11.1953	19.11.1953		2.12.1953			15.12.1953			19.2.1954	22.2.1954
	0 m	0 m	0 m	3–4 m	0 m	3–4 m	0 m	0 m	3–4 m	0 m	5 m	10 m	0 m	4 m	20 m	20–30 m	0 m
CYANOPHYTA																	
Aphanocapsa delicatissima	·	+	+	·	·	·	·	+	+	·	+	·	·	·	·	·	·
A. elachista v. *planctonica*	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
Gomphosphaeria lacustris	·	+	+	·	+	+	+	+	·	+	+	+	+	+	+	+	+
Merismopedia glauca – fig. 40: 2	·	+	·	·	·	+	·	+	·	·	·	·	·	·	·	·	·
Oscillatoria bornetii	·	+	·	·	·	·	·	+	+	·	·	+	·	·	·	·	·
Oscillatoria sp.	·	+	·	·	+	·	+	·	·	·	·	·	·	·	·	·	+
PYRROPHYTA																	
Peridinium willei	·	+	+	·	+	+	·	+	+	+	+	·	+	+	+	·	·
P. willei f. *lineatum*	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
P. volzii	·	·	·	·	·	·	+	·	·	+	·	·	·	·	·	·	·
Peridinium sp.	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+
CHRYSOPHYTA																	
XANTHOPHYCEAE																	
Askenasyella chlamydopus?	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
Tribonema elongatum	+	◔	●	◔	●	◑	◔	●	●	●	●	●	●	●	◑	+	●
CHRYSOPHYCEAE																	
Dinobryon cylindricum	·	·	+	·	+	+	·	+	+	+	+	+	+	+	+	·	·
D. cylindricum v. *palustre*	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
D. divergens	·	·	·	·	·	·	·	+	+	+	+	+	◔	+	+	·	·
Mallomonas alpina	·	+	+	·	+	·	+	+	+	+	+	·	·	·	·	·	·
M. elongata	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·
BACILLARIOPHYCEAE																	
Melosira ambigua	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
M. granulata – fig. 39: 1	◔	◑	◑	◑	◔	◑	●	◔	◑	+	◑	◑	◑	◔	◑	◑	◑
M. hustedtii – fig. 39: 2	◑	●	●	●	◑	●	◔	+	+	+	+	+	+	+	+	+	+
M. varians	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
Cyclotella stelligera	·	+	+	·	+	·	·	·	+	+	·	·	+	·	·	·	+
Stephanodiscus astraea	·	+	·	·	+	·	+	+	+	+	+	+	+	+	+	·	·
Rhizosolenia eriensis – fig. 40: 3	·	+	·	·	·	·	·	+	+	◔	◑	+	+	+	·	·	·
Diatoma elongatum	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·
Centronella reicheltii – fig. 33: 7	·	·	·	·	·	·	·	·	+	+	+	·	+	+	·	·	·
Fragilaria crotonensis	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
Synedra ulna	+	+	·	+	·	·	+	+	+	+	+	+	+	+	+	·	+
Nitzschia acicularis	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·
Cymatopleura solea	·	·	·	·	·	·	·	+	·	+	·	·	·	·	·	·	·
Surirella guatimalensis – figs. 33: 2 & 3	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·

Table 4. (*Continued*)

	17.10.1953	30.10.1953	2.11.1953		7.11.1953		9.11.1953	19.11.1953		2.12.1953			15.12.1953			19.2.1954	22.2.1954
	0 m	0 m	0 m	3–4 m	0 m	3–4 m	0 m	0 m	3–4 m	0 m	5 m	10 m	0 m	4 m	20 m	20–30 m	0 m
CHLOROPHYTA																	
VOLVOCALES																	
Eudorina cylindrica	·	·	·	·	·	·	·	·	·	+	·	·	·	+	·	·	·
E. elegans	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	·	+
Volvox aureus – fig. 33: 1	·	+	·	·	·	·	·	+	+	+	·	+	·	+	+	·	·
Gloeococcus schroeteri	+	+	+	+	+	+	+	+	+	+	+	·	+	+	+	·	·
Gloeocystis botryoides	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·
Paulschulzia pseudovolvox	·	·	·	·	·	·	·	+	+	+	+	·	·	+	·	·	·
Phacomyxa sphagnophila?	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·
Tetraspora lacustris	·	·	+	+	+	+	+	+	+	+	◔	+	+	·	·	·	+
Stylosphaeridium stipitatum	·	·	·	·	·	·	·	+	+	·	·	·	·	·	·	·	·
CHLOROCOCCALES																	
Nephrocytium agardhianum	·	·	·	·	·	·	·	+	·	·	·	·	·	+	·	·	·
N. limneticum	·	·	·	·	+	·	·	·	·	+	·	·	+	·	·	·	·
N. lunatum	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·
Oocystis natans	+	·	+	·	+	+	·	+	+	+	+	·	+	+	·	·	+
O. solitaria	·	·	+	·	·	+	·	·	·	·	·	·	·	·	·	·	·
Ankistrodesmus falcatus	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Kirchneriella obesa	+	+	+	+	◔	+	◔	+	◔	+	+	·	+	+	+	·	+
Botryococcus braunii	+	+	+	+	·	+	+	+	+	+	+	+	+	+	+	+	+
B. protuberans	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Dictyosphaerium pulchellum	◑	+	+	+	+	+	+	+	+	◑	+	+	+	+	·	·	+
Coelastrum microporum	·	·	+	·	+	+	+	+	+	+	+	·	+	·	+	·	·
Scenedesmus brevispina	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
ULOTRICHALES																	
Geminella interrupta	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
CONJUGALES																	
Closterium ehrenbergii	·	+	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·
C. moniliferum	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
Cosmarium araucaniensis	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
C. depressum v. *achondrum*	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
C. pseudoprotuberans f.	·	·	·	·	·	·	·	·	·	+	·	·	+	+	·	·	·
Xanthidium antilopaeum – figs. 34:15–17	·	·	·	·	·	·	·	·	·	+	·	·	·	+	·	·	·
Staurodesmus convergens – fig. 34: 14	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·
S. dickiei v. *rhomboideus*	·	·	·	·	·	·	·	·	·	+	·	·	·	+	·	·	·
Staurastrum anatinum f. *denticulatum*	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
S. armigerum v. *furcigerum*	·	+	+	·	·	·	·	·	·	+	·	·	+	+	·	·	·
S. asterias	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·
S. avicula f. – figs. 42: 7 & 8	·	·	+	·	·	+	·	+	+	+	+	·	+	+	·	·	·
S. brachiatum	+	+	+	·	+	+	+	+	+	+	+	·	+	+	·	·	+
S. cingulum v. *obesum*	·	·	+	·	·	·	+	·	·	+	·	·	·	·	·	·	·
S. denticulatum	·	·	·	·	+	·	+	+	·	·	·	·	·	·	·	·	·
S. leptocladum v. *cornutum*	·	·	·	·	·	·	·	·	·	·	·	·	+	+	·	·	·
S. noduliferum	·	·	·	·	·	·	·	+	·	+	·	·	+	·	·	·	·
S. pingue	·	+	+	·	·	·	·	+	·	+	·	·	+	+	·	·	·
S. pseudosebaldi f. – Thomasson (1959, fig. 22: 6)	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·

TABLE 4. (*Continued*)

	17.10.1953 0 m	30.10.1953 0 m	2.11.1953 0 m 3–4m	7.11.1953 0 m 3–4 m	9.11.1953 0 m	19.11.1953 0 m 3–4 m	2.12.1953 0 m 5 m 10 m	15.12.1953 0 m 4 m 20 m	19.2.1954 20–30 m	22.2.1954 0 m
Staurastrum rotula v. *smithii* – figs. 41: 5 & 6	+	+	+ ·	+ +	+	+ +	+ + +	+ + ·	·	+
S. sebaldi v. *ornatum* f. *planctonica*	·	·	· ·	· ·	·	· ·	+ · ·	+ · ·	·	·
S. tetracerum	·	·	· ·	· ·	·	· ·	· · ·	+ · ·	·	·
S. tetracerum v. *evolutum*	·	+	· ·	+ +	+	+ +	+ + +	· + +	·	·
S. urinator v. *brasiliense* – fig. 42: 20	·	·	+ ·	+ ·	·	· ·	+ · ·	· · ·	·	·
S. valdiviense	·	·	· ·	· ·	·	· ·	· · ·	+ · ·	·	·
Hyalotheca dissiliens	·	·	· ·	· ·	·	· ·	+ · ·	· · ·	·	·
PROTOZOA										
Acanthocystis aculeata	·	·	· ·	· ·	·	· ·	+ + +	+ + +	·	+
Ophrydium versatile	·	·	· ·	· ·	+	+ ·	+ + ·	+ + ·	·	·
Stentor sp.	·	·	· ·	◔ +	+	+ +	◔ + ·	· + ·	·	+
Tintinnidium fluviatile	·	+	+ +	· ·	·	· ·	· + +	· · +	·	·
Vagnicola sp. – fig. 40: 5	·	+	+ ·	+ +	+	+ +	+ + +	+ + ·	·	+
Vorticella sp.	·	+	+ +	+ ·	·	+ +	+ · +	· · +	·	·
ROTATORIA										
Collotheca sp.	·	·	· ·	· ·	·	· ·	· · ·	+ + ·	·	·
Colurella obtusa	·	·	· ·	· ·	·	· ·	+ · ·	· · ·	·	·
Colurella sp.	·	·	· ·	· ·	·	· ·	· · ·	· + ·	·	·
Conochilus unicornis	+	+	+ +	+ +	+	+ +	+ + +	+ + +	+	+
Euchlanis dilatata	·	+	· ·	· ·	·	· ·	+ · ·	· · ·	·	·
Filina longiseta – fig. 39: 7	+	+	· ·	+ +	+	· +	· · ·	+ · ·	·	+
F. terminalis	·	·	· ·	· ·	·	· ·	· · ·	+ · ·	·	·
Gastropus minor	·	+	· ·	· ·	·	· ·	· · ·	· · ·	·	·
G. stylifer	+	+	· ·	+ ·	+	+ ·	· · ·	· + ·	·	·
Hexarthra fennica	+	+	+ ·	+ ◔	◔	+ +	+ · ·	· + ·	·	+
Keratella c. cochlearis	+	+	+ ·	+ +	+	+ +	+ + +	+ + +	·	+
Lecane flexilis – fig. 45: 7	·	·	· ·	· ·	·	· ·	+ · ·	· · ·	·	·
L. stichaea	·	·	+ ·	· ·	·	· ·	· · ·	· · ·	·	·
Lepadella ovalis	·	·	· ·	· ·	·	· ·	+ · ·	· · ·	·	·
L. patella	·	·	· ·	· ·	·	· ·	+ · ·	· · ·	·	·
L. triptera	·	+	· ·	· ·	·	· ·	+ · ·	· · ·	·	·
Lepadella sp.	·	·	· ·	· ·	·	+ ·	· · ·	· · ·	·	·
Mytilina sp.	·	+	· ·	· ·	·	· ·	· · ·	· · ·	·	·
Notholca haueri	·	+	· ·	· ·	·	· ·	+ · ·	+ · ·	·	·
N. labis	·	·	· ·	· ·	+	· ·	+ · ·	· · ·	·	·
Philodina roseola	·	+	· ·	· ·	+	· +	· · ·	+ · ·	·	+
Polyarthra vulgaris	+	+	· ·	+ +	·	· +	+ + ·	+ · ·	·	+
Pompholyx sulcata – fig. 45: 4	+	+	+ ·	+ +	◔	+ ·	+ · ·	+ · ·	·	+
Synchaeta longipes	·	+	· ·	· ·	·	· ·	· · ·	· · ·	·	·
S. pectinata	·	+	· ·	· +	+	· +	· · ·	· + ·	·	+
Trichocerca birostris – fig. 45: 10	+	+	· ·	· ·	·	· ·	· · ·	· · ·	·	·
T. dixon-nuttalli	·	·	· ·	· ·	·	· ·	+ · ·	· · ·	·	·
T. inermis	·	·	· ·	· ·	+	· ·	· · ·	· · ·	·	·
T. weberi – fig. 45: 11	·	+	· ·	· ·	·	· ·	+ · ·	· · ·	·	·

Table 4. (*Continued*)

	17.10.1953	30.10.1953	2.11.1953		7.11.1953		9.11.1953	19.11.1953		2.12.1953			15.12.1953			19.2.1954	22.2.1954
	0 m	0 m	0 m	3–4 m	0 m	3–4 m	0 m	0 m	3–4 m	0 m	5 m	10 m	0 m	4 m	20 m	20–30 m	0 m
Trichocerca ruttneri	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
T. stylata	·	·	·	·	·	·	+	·	·	+	·	·	·	·	·	·	·
Trichocerca sp.	·	·	+	·	+	·	·	+	+	+	·	·	+	·	·	·	+
CLADOCERA																	
Alona cf. *poppei*	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Bosmina chilensis	+	·	·	·	·	·	+	+	·	·	·	+	·	·	●	+	+
Ceriodaphnia dubia	+	·	·	+	·	+	+	+	+	+	◔	●	·	+	●	+	+
Daphnia ambigua	·	·	+	·	+	·	·	·	·	·	·	·	·	·	·	·	·
Diaphanosoma excisum chilense – fig. 40: 6	·	+	·	·	+	·	·	·	·	·	·	+	·	·	+	+	+
COPEPODA																	
Boeckella gracilipes	+	+	·	·	·	·	·	·	·	·	+	●	·	·	●	●	+
Diaptomus diabolicus	·	·	·	+	+	·	+	·	·	·	+	·	·	·	·	+	·
Tropocyclops prasinus meridionalis	·	·	·	·	·	·	·	+	·	·	+	·	·	·	+	+	+

SOME QUANTITATIVE ASPECTS

During our stay at Lake Villarrica a considerable number of samples for quantitative study were collected. However, the filter that was used with the sampler proved to be too coarse. Therefore only the largest phytoplankters, viz. threads of *Tribonema* and *Melosira*, were present in numbers large enough to illustrate the vertical distribution. A statistical analysis made on the parallel series of samples that were collected on the same occasion showed that the figures could be used as relative values only. Therefore they are mentioned on the following pages with the distinct reservation that they are intended only to illustrate the vertical distribution with relative numbers. They must not in any case be considered as reflecting the actual standing crop of the plankters.

Only in a few cases are the values of both of the parallel series shown in diagrams, e.g. fig. 19. However, in most cases the true numbers of these plankters are considerably higher than those obtained from the sampler. This is illustrated by the following examples, in which the results of sampling with the sampler are compared with those obtained using a fine mesh plankton net. In both cases a 5 l surface sample was collected. The figures below, and elsewhere, give the number of plant cells, and the number of animals, occurring in one liter of water.

Lake Villarrica, November 4, 1953. Surface, 1 l.

	sampler	net
Tribonema elongatum	20,900	27,000
Melosira granulata	2,400	2,910
M. hustedtii	2,860	3,530
Stentor sp.	4	2
Hexartha fennica	11	18
Keratella c. cochlearis	4	23
Conochilus unicornis	0	5

Lake Villarrica, November 7, 1953. Surface, 1 l.

	sampler	net
Tribonema elongatum	8,750	14,600
Melosira granulata	60	260
M. hustedtii	70	70
Stentor sp.	0	2
Hexartha fennica	4	9

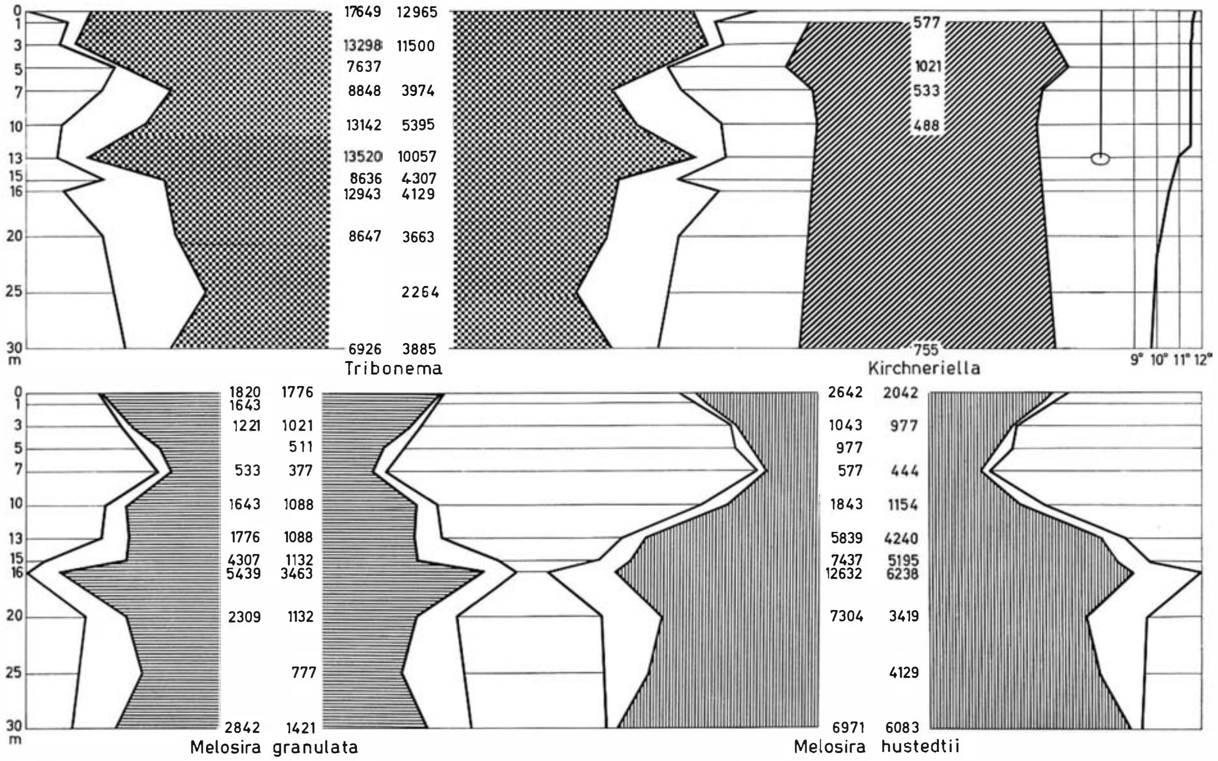


Fig. 19. Diagram showing vertical distribution of some plankters in Lake Villarrica on November 3, 1953, at 9.15–14.15. All quantities of phytoplankters are expressed in numbers of cells, and those of zooplankters in numbers of animals, per liter at that level.

Lake Villarrica, November 7, 1953. Depth 1 m, 1 l.

Tribonema elongatum	18,000	4,750
Melosira granulata	1,350	130
M. hustedtii	750	250
Stentor sp.	12	4
Hexarthra fennica	8	15
Keratella c. cochlearis	2	1

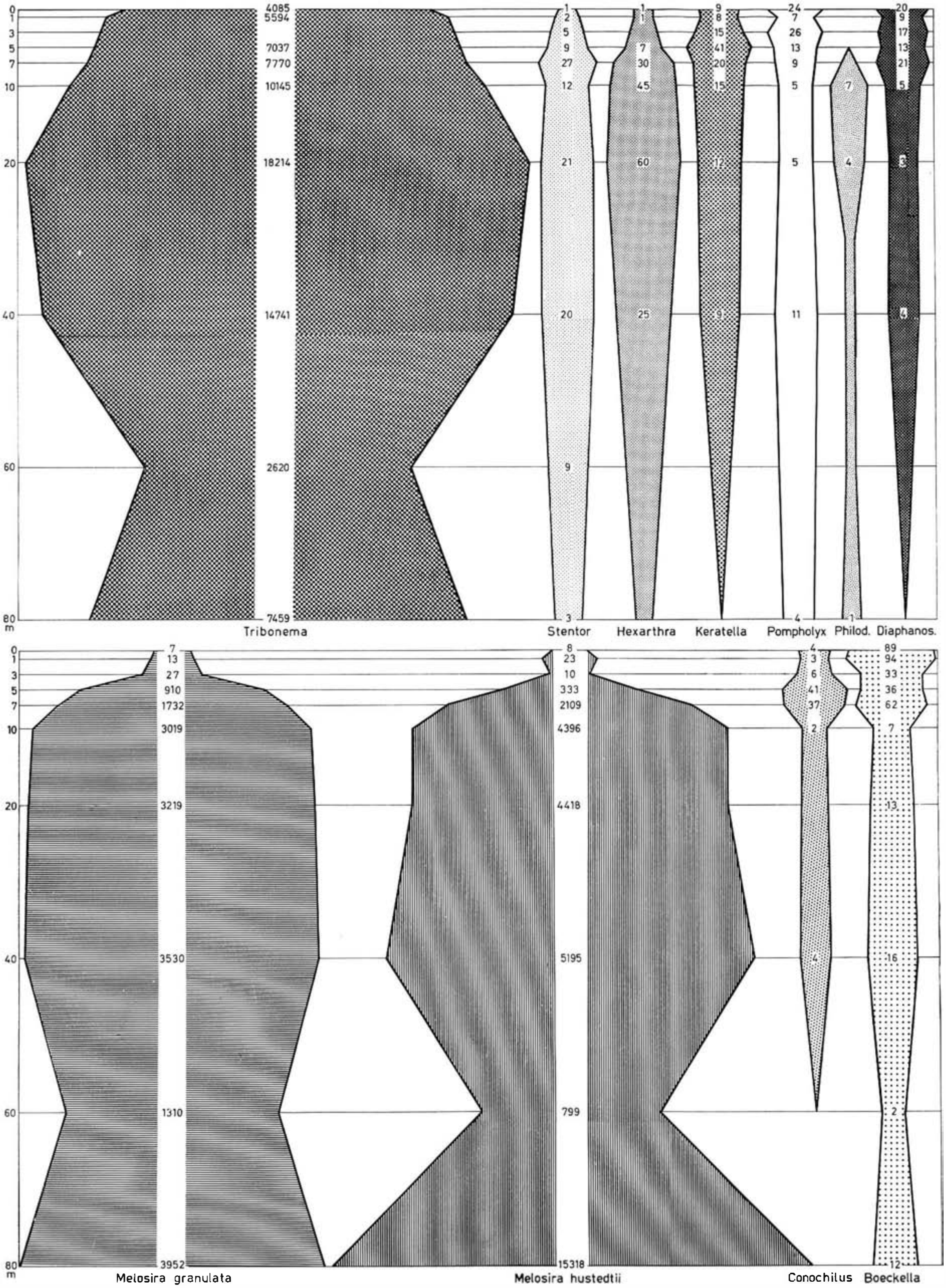
Lake Villarrica, November 12, 1953. Surface, 1 l.

Tribonema elongatum	13,600	6,620
Melosira granulata	550	330
M. hustedtii	70	180
Stentor sp.	12	4
Hexarthra fennica	2	2
Keratella c. cochlearis	1	6

The mesh (70 μ) of the filter that was used for sampling phytoplankters would have been suitable for collecting zooplankton, but for zooplankton a filter with a still larger mesh was used. Consequently, the numbers of zooplankters published by Löffler (1962) are too low.

The samples have been counted by Mrs. I. Kriszán. For zooplankters the whole 5 l catch has been counted, with the aid of a Zeiss inverted plankton microscope.[1] The figures are reduced to show the number of zooplankters in one liter of water. Note that the figures published by Löffler (*op. cit.*) refer to the content of 5 l. The numbers of *Stentor* given are too low because a great many specimens probably burst on passing into the filter. In some cases the whole 5 l catch was counted for phytoplankters; in most cases a fraction of the sample was counted; sometimes both methods were used. The results have been analysed statistically, see Lund, Kipling & Le Cren (1958) and Gillbricht (1962). After the statistical treatment, some series of samples were excluded. Because the filters were too coarse most of the phytoplankters were, from a statistical point of view, too few in numbers.

[1] The earliest inverted microscope is very likely the compound microscope for photographic and chemical work by Philippo Pacini, made by A. Poggiali in the middle of the nineteenth century, now in the Historical Museum of Natural Sciences in Florence.


0
1
3
5
7
10
20
40
60
80
m
4085
5594
7037
7770
10145
18214
14741
2620
7459
Tribonema
Stentor
Hexarthra
Keratella
Pompholyx
Philod.
Diaphanos.
7
13
27
910
1732
3019
3219
3530
1310
3952
Melosira granulata
8
23
10
333
2109
4396
4418
5195
799
15318
Melosira hustedtii
Conochilus
Boeckella

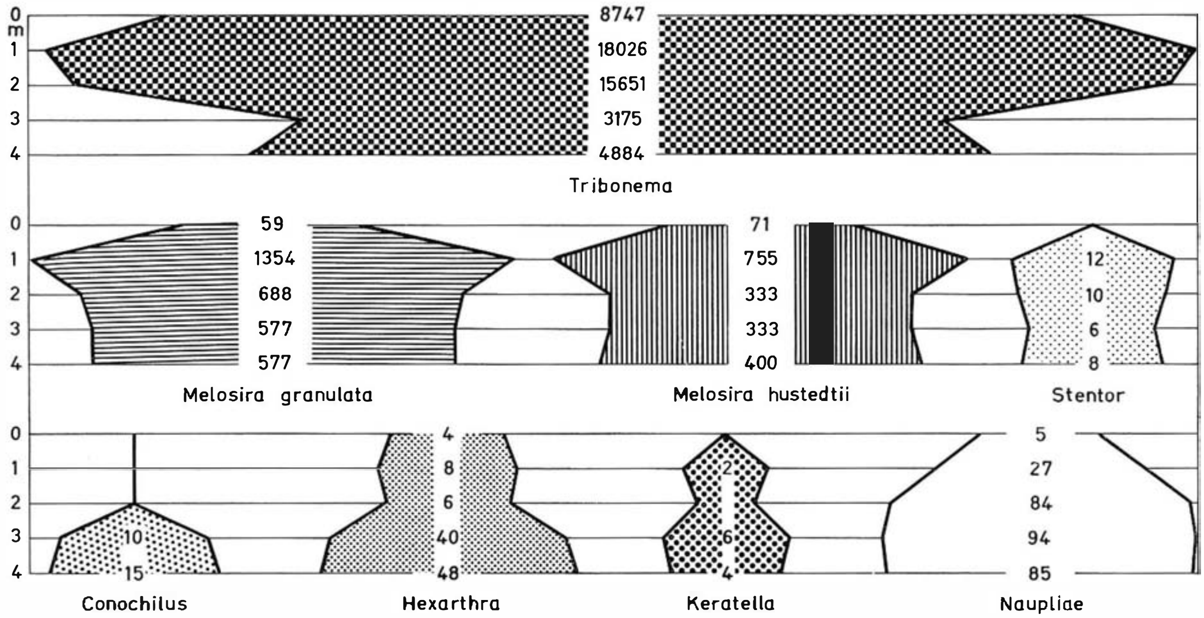


Fig. 21. Diagram showing vertical distribution of some plankters in Lake Villarrica on November 7, 1953, at 13.30–15.30.

Consequently they have not been included in the diagrams.

All the quantitative samples from Lake Villarrica were collected from the north-western part of the lake, not far from our field laboratory. It was impossible to make long collecting trips with our little boat to other parts of the large lake. Sampling from only one station cannot be considered as characteristic for the entire lake; even early students of quantitative relations have pointed out irregularities in horizontal distribution of plankters. Such irregularities may occur in large lakes, but also often in relatively small lakes or parts of lakes; see, e.g. Utermöhl (1925, pp. 218 ff.), Ruttner (1929, pp. 124 ff.), Bērziņš (1958), Rodhe (1958), Štěpánek & Chalupa (1958), and Tonolli (1961 and 1962). Calculations of standing crop and productivity cannot be made without satisfactory information about horizontal distribution of plankton in the body of water under consideration, see Mathiesen (1963).

Another factor of great importance is the often considerable quantitative variations within a short period that make frequent sampling necessary, see e.g. Hortobágyi (1961), Kiss (1951, 1952a and b) and Štěpánek (1958). Our scanty samples from Lake Villarrica also reflect this to some extent. These often considerable variations in plankton density within the epilimnion, especially its uppermost layers, may to some extent be the result of wind-produced epilimnic currents. This is particularly true of large lakes, but may occur also in smaller lakes.

The few profiles showing the vertical distribution of plankters which are reproduced in this paper have been constructed as "Kugelkurven" according to the method introduced by Lohmann in 1908. In constructing such spherical curves the formula for determining the radius (R) in a given instance is:

$$R = k\sqrt[3]{\frac{V}{4.19}}$$

In which k is a scale constant and V equals the volume of the sphere; it may represent the number or the total volume of the individuals to be represented by the sphere. Such spherical type curves introduced in Lohmann's studies on marine plankton are to be found in many standard works on freshwater plankton, e.g.

Fig. 20. Diagram showing vertical distribution of some plankters in Lake Villarrica on November 5, 1953, at 21.00–24.00

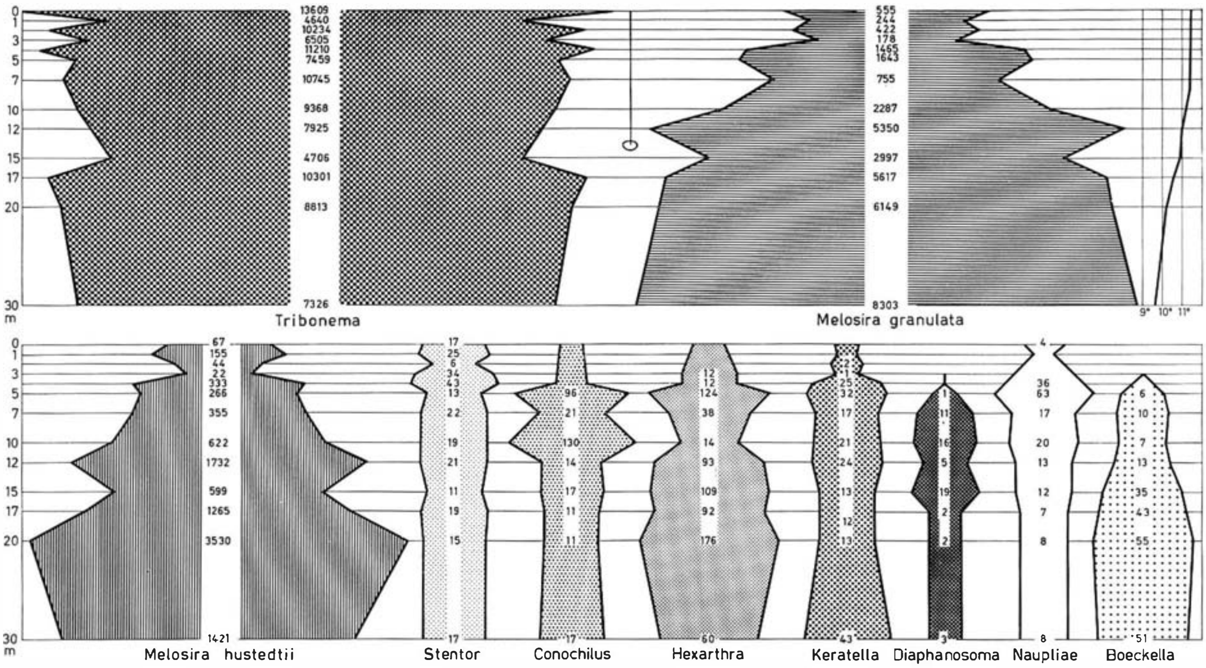


Fig. 22. Diagram showing vertical distribution of some plankters in Lake Villarrica on November 12, 1953, at 14.00–17.00.

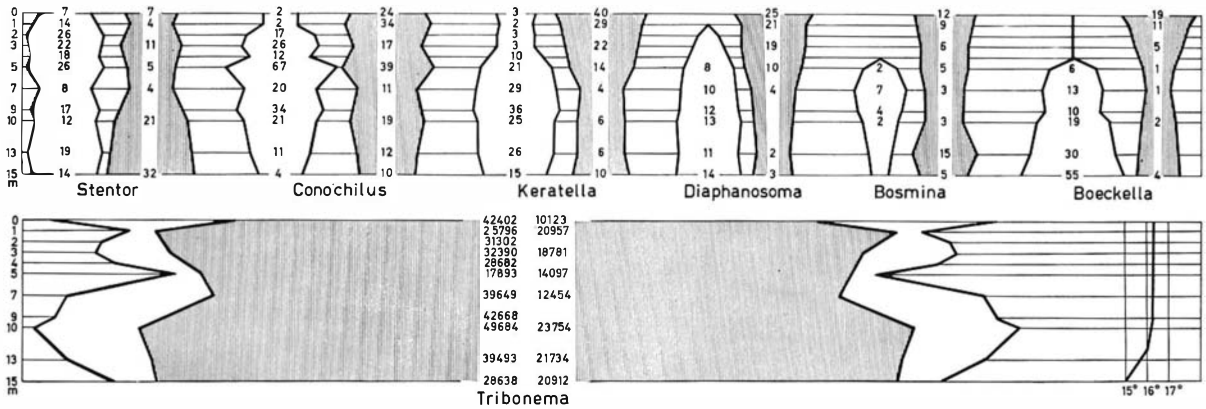


Fig. 23. Diagram showing vertical distribution of some plankters in Lake Villarrica on November 28, 1953, at 14.00–16.00. (open figures), and on November 29, at 21.00–22.20 (striated figures).

Birge & Juday (1922, for construction see pp. 58–59), Naumann (1923, pp. 195–196), and Utermöhl (1925, for construction see pp. 90–96).

The first series of quantitative samples from Lake Villarrica was collected on November 3, 1953, at 9.15–14.15. Fig. 19 shows the vertical distribution of *Tribonema*, *Melosira*, and *Kirchneriella*. For the two former the duplicate samples have also been indicated. At the time of collection of these samples, those from the upper strata had a greenish colour, and those from the deeper layers were somewhat brownish, due to the colours of *Tribonema* and the two *Melosira* species, respectively. The upper layers were only sparsely populated by zooplankters (not shown in fig. 19). According to the counts, most of the zooplankters were densest between

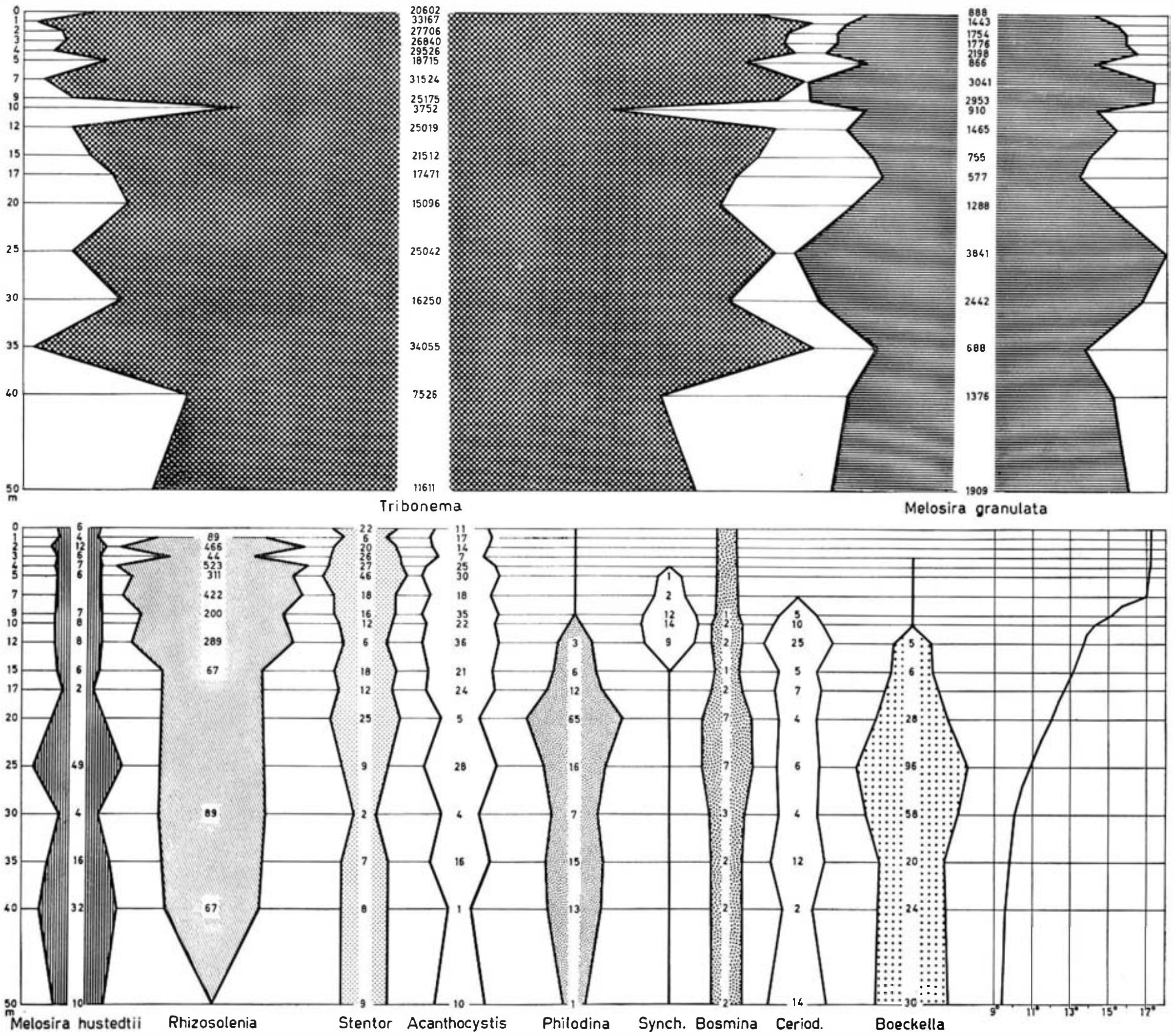


Fig. 24. Diagram showing vertical distribution of some plankters in Lake Villarrica on December 15, 1953, at 14.00–17.00.

10–15 meters, except the naupliae, which preferred the layer between 3–10 meters.

A few days later, on November 5, quantitative sampling was carried out in the evening, at 21.00–24.00. Now the zooplankton proved to be abundant in the upper layers as well, in contrast to the condition in the samples collected in day-time. Threads of *Tribonema* and *Melosira* showed a tendency to increase in frequency with depth, being relatively sparse in the uppermost layers. The distribution of the most frequent plankters is shown in fig. 20.

Another quantitative sampling was carried out on November 7, at 13.30–15.30, during one of the few cloudy days. Only the top 4 meters were sampled. The results are shown in fig. 21.

The next series of accepted samples date from November 28 and 29. The sampling was carried out at 14.00–16.00 on November 28, and at 21.00–22.20 on November 29. With regard to the phytoplankters only the vertical distribution of *Tribonema* has been indicated in fig. 23. It may be added that both species of *Melosira* show their greatest density below 4 m, down to 15 m, and that they

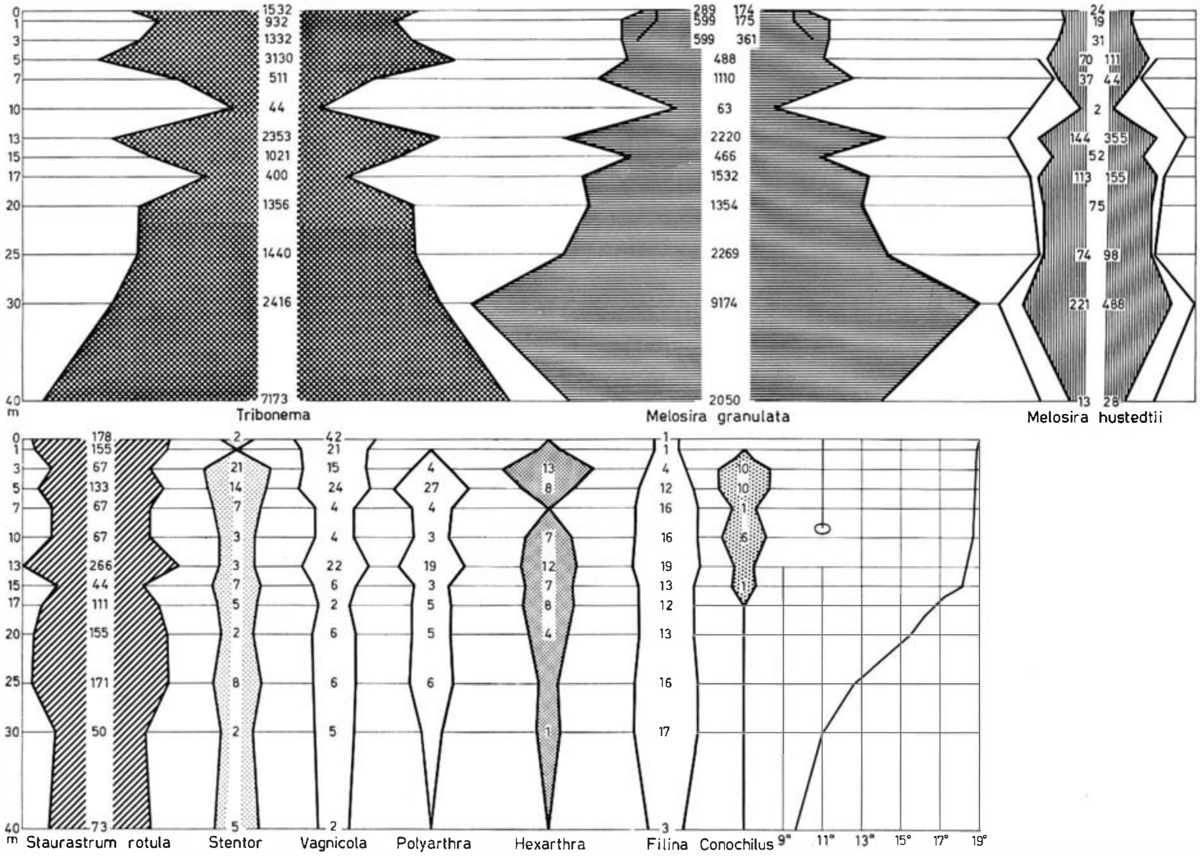


Fig. 25. Diagram showing vertical distribution of some plankters in Lake Villarrica on February 22, 1954, at 11.30–13.30.

are more numerous in the samples collected in day-time than in those collected at night. *Cyclotella* and *Rhizosolenia* also seem to prefer the layers below 4 m. For the vertical distribution of the most frequent zooplankters see fig. 23.

As early as the beginning of December the frequency of *Melosira* threads began to decrease. This was especially marked in the case of *Melosira hustedtii*, and is evident from fig. 24, which is based on the sampling on December 15, at 14.00–17.00. The temperature was about 19.5° C in the surface water, and 8° C at 160 m. The thermocline was located just above 10 m. The bulk of phytoplankters consisted of *Tribonema* threads.

The last of the series of accepted quantitative samples was collected on February 22, 1954, during a short stay at Lake Villarrica on our way to the north. The sampling was made in the same part of the lake as before. The distribution of the major plankton components is shown in fig. 25. *Tribonema* had decreased markedly. *Tribonema* and *Melosira* are remarkably scarce in the 10 meter sample. However, the other plankters that have been included in fig. 25 show no signs of such a tendency, which would have been the case if there had been some error in sampling. For *Melosira* the content of some duplicate samples has also been indicated in the diagram.

As stated above, the method used for sampling was not appropriate. Moreover, the sampling covers only a relatively short period. The results, which would otherwise have been of great interest, should now be interpreted cautiously and only with strong reservations.

Fig. 26. Lake Pichilafquen. Photograph by L. Brundin.

2. LAKE PICHILAFQUEN

The second lake that was studied for about two months is the little shallow woodland lake, Pichilafquen. It is only about 4–5 m deep; the Secchi-disk was visible down to the bottom where it disappeared into soft bottom sediments. The predominant phytoplankter was, on October 31, *Dinobryon cylindricum.* Among the zooplankters, *Conochilus unicornis* and naupliae were most frequent. The composition of the plankton in Lake Pichilafquen is summarized in table 6. It is evident from the table that no essential changes occurred within the plankton community during these two months of observation. The richness of planktic desmids is notable. Among the lakes visited by us, Lake Pichilafquen was the most well-stocked with desmids. According to Löffler (1960) it had one of the lowest calcium concentrations of the lakes investigated by us, viz. 2.1 mg/l.

Only three quantitative samples were collected from Lake Pichilafquen. The major components of the plankton have been tabulated below (table 5). The first sample was collected with the 5 l sampler and the two others by filtering 5 l of water through the plankton net.

On October 31, a visible difference was noted between two quantitative samples which were collected not far from each other. One was rich in copepods, the other had only a few. The copepods obviously occurred in swarms. The former sample

TABLE 5. *Quantitative samples from Lake Pichilafquen.*

	Number of cells or specimens per liter		
	31/10 sampler 2.7 m	13/11 net 0 m	10/12 net 0 m
Oscillatoria sp. µ	—	3108	3557
Dinobryon colonies	70	—	—
D. cylindricum cells	—	1021	6571
D. divergens cells	—	444	2620
Melosira granulata	—	49	96
M. hustedtii	—	6	—
Tribonema elongatum	—	1653	467
Crucigenia rectangularis	648	—	—
Philodina sp.	—	6	—
Conochilus unicornis	22	40	8
Filina longiseta	—	1	27
Polyarthra vulgaris	—	—	39
Keratella c. cochlearis	1	33	116
Bosmina chilensis	2	—	1
Naupliae	24	22	23
Diaptomus diabolicus	4	6	2

was collected from the sunny and shallow part of the lake, the latter from the shaded and deeper part. Both insolation and depth may influence the distribution of zooplankters. I have seen similar irregularities in the distribution of copepods in the Puno Bay of Lake Titicaca. Here the swarms of copepods were clearly visible when the angle of sunlight was favourable.

On November 13, 1953, the surface water of Lake Pichilafquen was rich in *Conochilus unicornis*, while in deeper layers the blue-greenish coloured copepods *Diaptomus diabolicus* were numerous.

On December 10, the surface temperature was 24° C. The dominant plankter was *Dinobryon cylindricum*. Among zooplankters *Keratella c. cochlearis* was abundant.

Table 6. *Plankton of Lake Pichilafquen*

	26.10.1953 0 m	31.10.1953 0 m	13.11.1953 0 m	13.11.1953 3 m	29.11.1953 0 m	10.12.1953 0 m	21.2.1954 0 m	13.11.1953 benthos
CYANOPHYTA								
Microcystis botrys	·	·	·	·	+	·	·	·
Tetrarcus ilsteri	+	·	·	·	·	+	·	·
Lyngbya holsatica	+	·	·	·	·	·	·	·
Oscillatoria bornetii	·	·	·	+	·	·	·	+
O. bornetii f. *tenuis*	+	+	·	·	+	+	+	·
O. splendida	·	·	·	·	·	·	·	◔
Oscillatoria sp.	+	·	·	·	·	·	·	·
EUGLENOPHYTA								
Phacus longicauda	+	·	·	·	·	·	·	·
Petalomonas sp.	·	·	·	·	·	·	·	+
PYRROPHYTA								
Peridinium cinctum	+	+	·	·	·	·	·	·
P. willei	+	+	+	+	+	◔	+	·
Peridinium sp.	·	·	·	·	·	+	+	·
CHRYSOPHYTA								
XANTHOPHYCEAE								
Tribonema elongatum	·	+	+	·	·	·	·	·
CHRYSOPHYCEAE								
Dinobryon acuminatum	·	·	·	·	·	+	·	·
D. cylindricum	+	◔	+	◑	●	●	●	·
D. divergens	+	·	·	+	+	◔	◔	·
Stichogloea doederleinii	·	·	+	◔	+	+	·	·
BACILLARIOPHYCEAE								
Melosira ambigua	·	·	·	·	+	·	·	+
M. granulata	·	+	·	+	·	·	+	·
M. hustedtii	·	+	+	·	+	·	·	·
Synedra acus	·	·	·	·	+	·	·	·
S. ulna	·	·	·	·	·	+	·	·
Surirella guatimalensis	+	·	·	·	+	·	·	·
CHLOROPHYTA								
VOLVOCALES								
Eudorina elegans	+	·	+	·	+	+	·	·

Table 6. (*Continued*)

	26.10.1953 0 m	31.10.1953 0 m	13.11.1953 0 m	13.11.1953 3 m	29.11.1953 0 m	10.12.1953 0 m	21.2.1954 0 m	13.11.1953 benthos
Volvox aureus	+	+	·	·	·	·	·	·
Gloeococcus schroeteri	·	+	+	+	·	+	+	·
CHLOROCOCCALES								
Tetraëdron caudatum v. *longispinum*	·	·	·	·	+	·	·	·
Ankistrodesmus falcatus	+	·	·	·	+	·	·	·
A. spiralis	+	·	·	·	·	·	·	·
Kirchneriella obesa	·	+	·	·	·	+	·	·
Botryococcus braunii	+	+	+	+	+	+	+	·
Dictyosphaerium pulchellum	+	+	·	·	·	+	·	·
Pediastrum araneosum v. *rugulosum*	+	+	·	·	+	·	·	·
P. boryanum – fig. 33: 4	+	·	·	·	+	+	·	·
P. duplex	·	·	·	·	+	·	·	·
Coelastrum cambricum	·	·	·	·	+	·	·	·
C. proboscideum	·	·	·	·	·	+	+	·
Crucigenia rectangularis	+	◔	+	◔	+	+	+	·
Scenedesmus acuminatus	+	·	·	·	·	·	·	·
S. ecornis	·	·	·	·	+	·	+	+
S. falcatus	·	·	·	·	+	+	·	·
S. quadricauda	·	·	·	·	+	·	·	·
CONJUGALES								
Netrium digitus	+	+	·	+	+	·	·	·
N. digitus v. *lamellosum*	+	·	·	·	+	·	·	·
N. digitus f. *rectum* – fig. 38: 16	·	·	·	·	+	·	·	·
Gonatozygon aculeatum	+	·	·	·	·	·	·	·
G. monotaenium	·	·	·	·	+	·	·	·
Penium margaritaceum	·	·	·	·	+	·	·	·
P. spirostriolatum	+	·	·	+	·	·	·	·
Closterium abruptum	·	·	·	·	·	+	·	·
C. archerianum	+	·	·	·	·	·	·	·
C. cynthia	·	·	·	·	+	·	·	·
C. gracile f.	·	·	+	·	·	·	·	·

TABLE 6. (*Continued*)

	26.10.1953 0 m	31.10.1953 0 m	13.11.1953 0 m	13.11.1953 3 m	29.11.1953 0 m	10.12.1953 0 m	21.2.1954 0 m	13.11.1953 benthos
Closterium libellula v. *interruptum*	·	·	·	·	+	·	·	·
C. ralfsii	·	·	·	+	·	·	·	·
C. toxon	+	·	·	·	·	·	·	·
Pleurotaenium ehrenbergii – fig. 38: 19	·	·	+	+	+	·	·	·
P. trabecula	·	·	·	·	+	·	·	·
Euastrum affine	+	·	·	·	+	·	·	·
E. ansatum – fig. 37: 9	·	·	·	·	+	·	·	·
E. dubium v. *ornatum*	+	·	·	·	·	+	·	·
E. insulare v. *silesiacum*	+	·	·	·	·	·	·	·
E. turnerii	·	·	·	·	+	·	·	·
Micrasterias radians	·	+	·	·	·	+	·	·
M. radians v. *bogoriensis*	·	·	·	·	·	+	·	·
M. radiata	+	·	·	·	+	·	·	·
M. rotata – fig. 37: 1	·	·	·	·	+	·	·	·
M. sol v. *elegantior*	·	·	·	·	+	·	·	·
M. sol v. *ornata* – figs. 37: 7–8	+	+	·	+	+	+	·	·
Cosmarium araucaniensis	+	+	+	+	+	+	·	·
C. botrytis	+	·	·	·	·	·	·	·
C. conspersum v. *subrotundatum*	+	·	·	·	·	·	·	·
C. contractum v. *ellipsoideum* – fig. 38: 5	·	+	·	+	+	+	·	·
C. corumbense f. – fig. 35: 9	·	·	·	·	·	+	·	·
C. depressum v. *achondrum* – fig. 38: 2	+	+	+	+	·	·	+	·
C. laeve	·	·	·	·	·	+	·	·
C. nitidulum – fig. 38: 12	·	·	·	·	+	·	·	·
C. phaseolus – fig. 38: 10	·	·	+	·	·	·	·	·
C. portianum	·	·	·	·	·	·	+	·
C. punctulatum v. *subpunctulatum*	·	·	·	+	·	·	·	·
C. pyramidatum	+	·	·	·	·	·	·	·
C. quadrifarium f. *octasticha* – fig. 35: 8	+	+	·	·	·	·	+	·
C. rectangulare f. – fig. 38: 4	·	·	·	·	·	+	·	·
C. regnesii	+	·	·	·	·	·	·	·
C. scorbiculosum – fig. 38: 7	·	·	+	·	·	·	+	·
C. subarctoum	·	·	·	+	·	·	·	·
C. subspeciosum v. *validius* – fig. 38: 8	+	·	+	+	+	·	·	·
C. subtumidum v. *klebsii* – fig. 38: 3	·	·	·	·	·	·	·	+

TABLE 6. (*Continued*)

	26.10.1953 0 m	31.10.1953 0 m	13.11.1953 0 m	13.11.1953 3 m	29.11.1953 0 m	10.12.1953 0 m	21.2.1954 0 m	13.11.1953 benthos
Cosmarium trilobulatum	·	·	·	·	·	+	·	·
Xanthidium antilopaeum	+	+	+	◔	+	◔	+	·
Staurodesmus convergens – fig. 34: 12	·	·	+	·	+	+	·	·
S. convergens f. – Scott & Grönblad (1957, pl. 13, fig. 12)	·	·	·	·	+	·	·	·
S. curvatus	+	·	·	·	·	·	·	·
S. cuspidatus	+	+	+	·	·	+	+	·
S. dejectus	·	·	·	·	·	·	+	·
S. dickiei v. *rhomboideus* fig. 34: 10	·	+	+	·	·	+	·	·
S. joshuae fac. *joshuae*	·	·	·	·	·	+	+	·
S. subulatus – fig. 34: 7	+	+	+	+	+	+	+	·
S. triangularis v. *convergens*	+	+	·	·	·	·	·	·
S. triangularis f. *curvispina*	·	·	·	·	+	·	·	·
S. triangularis v. *parallelus*	·	·	·	+	·	+	·	·
S. triangularis fac. *triangularis*	·	·	·	·	+	·	·	·
Staurastrum anatinum f. *denticulatum* – figs. 41: 3 & 4	+	+	+	+	+	+	+	·
S. arcuatum f. – figs. 42: 12 & 13	·	·	·	+	·	·	·	·
S. armigerum v. *furcigerum* – fig. 42: 17	+	+	+	+	+	◔	+	·
S. asterias – figs. 42: 14 & 15	·	·	·	·	+	+	·	+
S. brachiatum – fig. 41: 9	+	+	+	+	+	+	+	·
S. galpinii	+	·	·	·	+	·	·	·
S. grande v. *rotundatum* – fig. 41: 21	+	+	·	◔	+	+	+	·
S. laeve – fig. 42: 2	+	·	·	·	+	·	·	·
S. leptocladum v. *cornutum* – fig. 42: 18	·	+	+	◔	+	◔	+	·
S. rectangulare f. *minor*	·	·	·	·	·	·	·	+
S. rotula v. *smithii*	+	+	+	·	+	+	+	·
S. sebaldi v. *ornatum* f. *planctonica* – fig. 42: 19	+	+	+	+	+	+	+	·
S. setigerum	+	·	+	+	+	+	+	·
S. subpolymorphum	·	·	·	·	+	·	·	·
S. tetracerum	·	·	·	·	+	·	·	·
S. tohopekaligense	·	·	·	+	·	·	·	·
S. tohopekaligense v. *brevispinum*	+	·	·	·	+	+	+	·

TABLE 6. (*Continued*)

	26.10.1953 0 m	31.10.1953 0 m	13.11.1953 0 m	13.11.1953 3 m	29.11.1953 0 m	10.12.1953 0 m	21.2.1954 0 m	13.11.1953 benthos
Staurastrum trifidum – figs. 42: 12 & 13	·	·	·	·	+	·	·	·
Staurastrum sp. – fig. 42: 6, see p. 125	·	·	·	·	·	+	·	·
Sphaerozosma aubertianum	+	+	·	+	·	·	·	·
Spondylosium panduriforme f. *limneticum*	·	·	·	·	·	+	·	·
S. planum	·	·	·	·	·	+	·	·
Bambusina moniliformis – fig. 38: 20	+	+	+	·	+	·	·	·
Hyalotheca dissiliens	+	+	+	·	+	+	+	·
PROTOZOA								
Acanthocystis longiseta	·	·	·	+	·	·	·	·
Heliozoa sp.	·	+	·	·	·	+	·	·
Podophrya fixa – fig. 40: 4	·	·	·	·	+	·	·	·
Vagnicola sp.	·	·	·	·	·	·	+	·
ROTATORIA								
Collotheca pelagica	·	·	·	·	·	+	·	·
Colurella uncinata bicuspidata	·	·	·	·	·	+	·	·
Conochilus unicornis	+	◑	●	◑	+	+	+	·
Euchlanis dilatata	+	+	·	·	·	·	·	·
E. incisa	·	·	·	·	+	·	·	·
Euchlanis sp.	+	·	·	·	·	·	·	·
Filina longiseta	·	+	+	+	·	·	·	·
F. terminalis	·	·	+	·	·	+	·	·
Gastropus stylifer	·	·	·	·	·	+	·	·
Keratella c. cochlearis	+	+	+	+	◔	+	+	·
Lepadella cristata	+	·	·	·	·	·	·	·
Macrochaetus subquadratus	·	·	+	·	+	+	·	·
Monostyla bulla – fig. 45: 6	·	·	·	·	+	+	·	·
M. lunaris	·	·	·	·	+	+	·	·
Notholca haueri – fig. 45: 14	·	·	·	·	·	·	+	·
Philodina roseola	·	·	·	+	·	+	·	·
Platyias quadricornis	+	·	·	·	·	·	·	·
Polyarthra dolichoptera	·	·	·	·	·	+	+	·
Polyarthra vulgaris	+	·	+	·	+	+	+	·
Pompholyx sulcata	·	+	·	·	·	·	·	·
Ptygura sp.? – fig. 45: 12, see p. 127	·	·	·	·	·	+	·	·
Synchaeta lakowitziana	·	·	·	·	·	·	+	·
Synchaeta sp.	+	·	·	·	·	·	·	·
Trichocerca pusilla	·	·	·	·	·	+	+	·
T. ruttneri	·	·	+	·	·	·	·	·
T. similis	+	·	·	·	·	·	·	·
CLADOCERA								
Alona cf. *affinis*	+	·	·	·	·	·	·	·
A. cf. *pulchella*	·	·	·	·	+	·	·	·
Bosmina chilensis	+	+	+	+	+	+	+	·
Camptocercus rectirostris	+	·	·	·	·	·	·	·
Chydorus sphaericus	+	·	·	·	·	·	·	·
Pleuroxus aduncus	+	·	·	·	+	·	·	·
Scapholeberis spinifera	·	·	·	·	+	·	·	·
COPEPODA								
Boeckella gracilipes	·	◑	·	◑	·	·	+	·
Cyclops sp.	+	·	·	·	+	·	·	·
Diaptomus diabolicus	·	·	+	·	·	◑	◑	·

3. LAKE HUILIPILÚN

The northernmost lake within the Chilean lake district that was visited by us is Lake Huilipilún. It is surrounded by hills which are covered by fields and pastures, and bordered by a fringe of shrubbery.

Among the factors that influence the trophic status of this lake, the following two should be pointed out: 1. The influence of wind on the lake is rather restricted because of the surrounding hills and limited area of the lake. Consequently, wind produced currents have little efficacy. 2. The lake has a small drainage area, and consequently the supply of nutrients from the surroundings is low.

The lake is oligotrophic; it is characterized by a low specific conductivity, $\varkappa_{18} \cdot 10^6 = 21$, and the plankton is very sparse. The bulk of plankton was, on November 17, made up of *Dinobryon* and *Keratella*. For the composition of the prevailing plankton community see table 7, column 1. The predominant zooplankter was *Keratella valdiviensis*. *Melosira* species were of rare occurrence.

On November 17, 1953, a quantitative surface sample was collected from Lake Huilipilún by pouring 5 l water through a fine mesh plankton net. It contained 75 cells of *Dinobryon cylindricum* and 38 cells of *Melosira granulata* per liter, but only 6 cells of *M. hustedtii*. The dominant zooplankter was *Keratella*, with 22 specimens per liter; the subdominant was *Philodina*, with 6 specimens per liter.

4. LAKE QUILLEHUE

The small subalpine lake Quillehue is located in the Andean chain just below the timber line at an altitude of 1196 m (p. 31). It was visited by us on November 22, 1953. The phytoplankton of this lake proved to be rather abundant, while the planktic crustaceans were sparse. Among the phytoplankters *Dinobryon sertularia* was predominant. *Melosira hustedtii*, which in the plankton of low altitude lakes was often represented in great numbers, was very rare in this lake. *M. granulata*, on the other hand, was rather common. For the composition of plankton see table 7.

5. LAKE CALAFQUÉN

The sampling was carried out in the eastern part of the lake on December 6, 1953. (Here the notorious poisonous plant *Conium maculatum* grew; it has obviously been introduced in some way.) The composition of the plankton (see table 7) was similar to that in Lake Villarrica. *Tribonema* filaments were still more numerous than in Lake Villarrica. About 95 per cent of the plankton was made up of *Tribonema*. Next, but far behind in quantity, were *Dinobryon divergens* var. *schauinslandii* and *Melosira granulata*. *Staurastrum valdiviense* was also noted. This species was described from the lakes Panguipulli and Riñihue which receive a considerable inflow from Lake Calafquén.

6. LAKE PELLAIFA

The little lake Pellaifa is located a short distance south-east of Lake Calafquén. It has clear water; the transparency was 14.5 m. For the water chemistry of this lake, consult Löffler (1960). The bulk of surface plankton was, on December 4, 1953, made up of *Dinobryon cylindricum*; among zooplankters *Conochilus unicornis* and *Filina longiseta* were frequent. The qualitative samples from a depth of 3–4 m also showed a dominance of *Dinobryon cylindricum*; among the zooplankters *Boeckella*, *Bosmina*, and *Filina* were numerous. Of a markedly different character were the samples collected in the bay of Lake Pellaifa that has been previously mentioned in chapter 5 (p. 28). Here, too, the predominant phytoplankter was *Dinobryon cylindricum*, but the subdominant species was *Micrasterias truncata*, and, as evident from table 7, many benthic and tychoplanktic organisms occurred among the euplankters. These samples also contained detritus because collections were here made by tossing a plankton net attached to a line out into the water and then pulling the net slowly to shore. For comparison, some notes on the benthic organisms are given below. The sample of benthos was collected from the same bay. The depth of water at the spot of sampling was only about 5 cm. Besides huge quantities of small benthic diatoms the following organisms were present:

Ankistrodesmus falcatus
Pediastrum boryanum v. *longicorne*
P. tetras
Coelastrum cambricum
C. proboscideum
Scenedesmus ovalternus
S. quadricauda

Netrium digitus
Euastrum dubium f.
Micrasterias truncata

Cosmarium araucaniensis
C. connatum
C. portianum
C. pyramidatum
C. subspeciosum v. *validius*
Staurastrum armigerum v. *furcigerum*
S. dilatatum
S. orbiculare

Lecane arcula

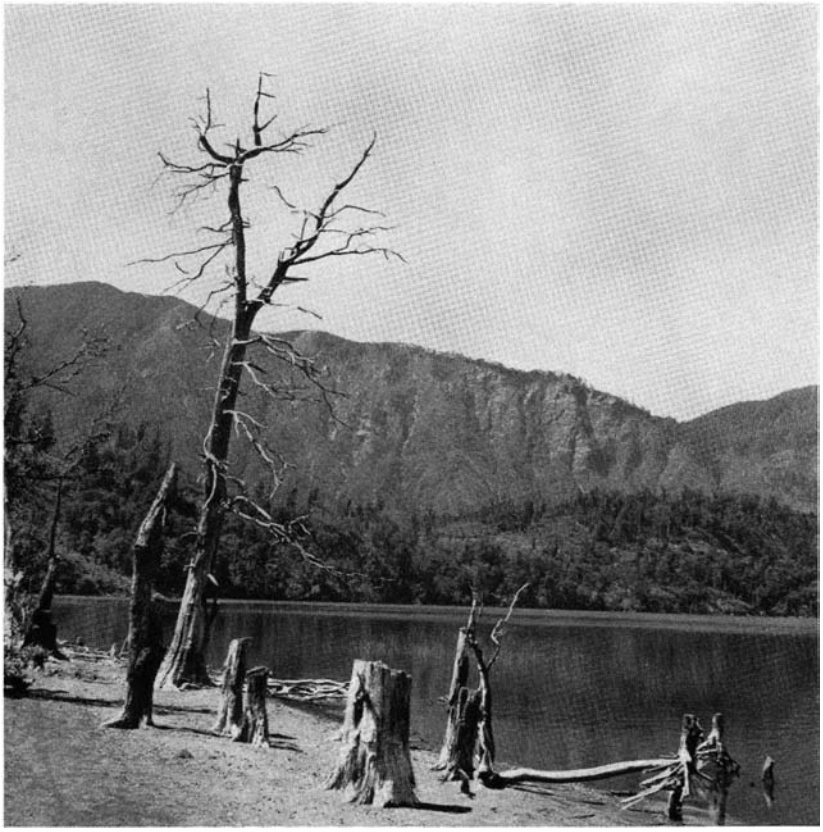


Fig. 27. Lake Pellaifa. Photograph by K. Thomasson, December 3, 1953.

In this connection the algal community that occurs on the submerged parts of *Scirpus* stems may also be of some interest. For this kind of community, Behre (1956, p. 286, see also Behre, 1958, p. 232) has introduced the term metaphyton. Naturally, many of the organisms listed below may accidentally have become tangled with the *Oedogonium* and *Bulbochaete* filaments covering the *Scirpus* stems.

CHRYSOPHYTA

BACILLARIOPHYCEAE

Melosira ambigua

CHLOROPHYTA

CHLOROCOCCALES

Ankistrodesmus falcatus
Pediastrum boryanum
P. duplex
Coelastrum proboscideum
Scenedesmus ovalternus
S. quadricauda
Tetradesmus wisconsinensis

ULOTRICHALES

Uronema africanum – on *Oedogonium*

CHAETOPHORALES

Chaetosphaeridium globosum
Coleochaete orbiculare

OEDOGONIALES

Bulbochaete sp.
Oedogonium spp.

CONJUGALES

Spirogyra sp. ster.
Pleurotaenium ehrenbergii v. *undulatum*
P. trabecula
Euastrum turneri
Micrasterias crux-melitensis – fig. 37: 3
M. radians – resembling fig. 120 in Grönblad & Scott (1958)
M. rotata
M. truncata – frequent
Cosmarium amoenum f.
C. araucaniensis
C. elegantissimum f. *minor*
C. portianum
C. pseudoconnatum
C. pyramidatum
C. subspeciosum v. *validius*
Xanthidium antilopaeum
Staurodesmus dejectus
S. dickiei f. – fig. 34: 4
Staurastrum armigerum v. *furcigerum*
S. bibrachiatum
S. dilatatum
S. furcatum
S. gladiosum
S. muticum
S. proboscideum – fig. 42: 1
S. quadrangulare v. *contectum*
S. subavicula v. *tyrolense* – fig. 42: 3–5
S. tetracerum f. *trigona*
S. valdivianum
Staurastrum sp. – fig. 42: 6, p. 125

PROTOZOA

Epistylis sp.

ROTATORIA

Lepadella quinquecostata
Monostyla bulla
M. lunaris
M. pyriformis

On December 4, 1953, between 17.30 and sunset at 19.00, a number of quantitative samples were collected from Lake Pellaifa. The vertical distribution of some plankters down to 40 m depth is shown in fig. 28. It is notable that *Dinobryon* and *Filina* ceased somewhere between 40 and 60 meters. At 80 m, 24 specimens of *Stentor* per liter were counted in a 5 l sample, so it is not an epilimnic animal as was supposed by Löffler (1961). Living cells of *Melosira granulata* and a few specimens of *Keratella* were also noted at that depth. The latter, together with *Boeckella*, of which 16 specimens per liter were counted, had their maximum density at 20 m. *Bosmina chilensis* showed two maxima, one at 5 m with 18 specimens per liter, and another at 20 m with 17 specimens per liter. The thermocline was located at about 10 m.

However, all statements as to the number of specimens or cells per liter that have been given above and in fig. 28, are too low due to the coarse filter used. This is evident from the following figures which are based on a 5 l surface sample filtered through a fine mesh plankton net, and calculated per liter.

Dinobryon cylindricum	92,500
Tribonema elongatum	2,600
Gloeococcus schroeteri	475
Stentor sp.	37
Filina longiseta	32
Conochilus unicornis	15

If a sedimentation technique had been used, still higher figures would have been expected.

7. LAKE RANCO

This lake is the second largest in the Chilean lake district. I did not personally visit Lago Ranco, nor the following three bodies of water which have been included in table 7, viz. Puyehue, Rupanco, and Bonita. The sampling of these lakes was carried out by Dr. Löffler when I was on my trip to Nahuel Huapi National Park in Argentina. The collections

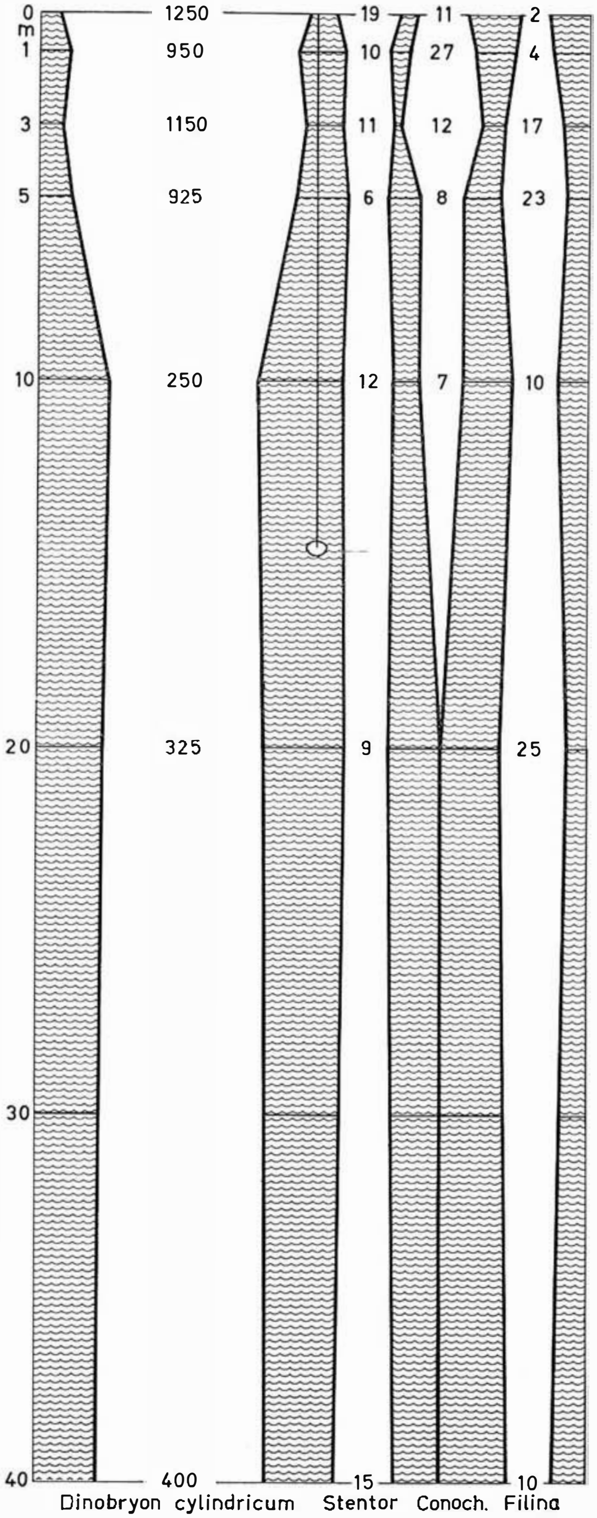


Fig. 28. Diagram showing vertical distribution of some plankters in Lake Pellaifa on December 4, 1953, at 17.30–19.00.

were made with too coarse a plankton net, therefore the information on the phytoplankton composition is inadequate.

In Lake Ranco sterile *Oedogonium* filaments preponderated; there were two taxa among them, judging from the breadth of the filaments. On January 30, 1954, *Melosira granulata, M. hustedtii,* and *Dinobryon divergens* were of frequent occurrence. Among zooplankters *Diaptomus diabolicus* dominated.

8. LAKE PUYEHUE

The phytoplankton of Lake Puyehue was, on February 3, 1954, as far as can be judged from the sample at my disposal, dominated by *Melosira granulata*. The subdominant plant was *Dinobryon divergens* which was represented by an interesting population. The shape of the colonies is suggestive of *D. cylindricum* var. *palustre*, and the receptacles are very much elongated. However, as has been shown by Ahlstrom (1937), the length of the receptacles has no taxonomic value. The abundance of finely divided peaty matter in the sample is notable. The few plankters noted in this sample have been listed in table 7 on p. 65.

9. LAKE RUPANCO

The sample from this lake was collected on January 8, 1954, by Dr. Löffler. Remarkably, nearly one hundred per cent of the plankton consists of the colonies of an as yet unidentified ciliate (see figs. 40:1 & 3), most likely an *Ophrydium* sp. *Melosira granulata* is represented in the present sample by two forms, viz. one with straight threads, and the other with curved threads. Both were also met with in the plankton of Lake Llanquihue. *Melosira hustedtii* is rare in the Rupanco sample.

10. LAKE BONITA

The plankton of the little Laguna Bonita which is situated just south of Lake Rupanco was also of quite curious character. The sample, which was collected on January 5, 1954, was predominantly made up of one large solitary *Chlamydomonas* sp. and of another colonial one. The oblong solitary cells, which have a prominent anterior papilla, measure about 30–31 $\times$ 12–16 μ. The colonial species resembles *C. siderogloea* Pascher & Jahoda and *C. passiva* Skuja, according to kind information by Prof. Skuja. I am inclined to consider it as *C. siderogloea*. Among these two dominating plankters only a few other species were found; they are listed in table 7. Noteworthy is the occurrence of *Brachionus quadridentatus*. I observed only two specimens, the only representatives of this genus which I have found in the Chilean lake district. However, Hauer, in Löffler (1962), has noted *B. calyciflorus* in the plankton of Lake Quillehue. As a rule, *Brachionus* species prefer ponds and eutrophic lakes.

11. LAKE LLANQUIHUE

The southernmost and largest of the lakes in the Chilean lake district is the huge Lake Llanquihue. Sampling from this lake was carried out in its northern part, at Puerto Octay. Here behind the peninsula Centinela lies a sheltered bay which was suitable for sampling from a rowing boat. On the open lake it was risky to work in a little boat because of the sudden storms.

On December 28, 1953, the predominant phytoplankter was *Dinobryon divergens*; among the zooplankters *Vagnicola* and *Stentor* were most frequent. The diatoms *Rhizosolenia eriensis, Melosira hustedtii,* and *Diatoma elongatum* were sparsely represented. As mentioned above the population of *Melosira granulata* was made up of both straight and curved filaments. The lack of *Tribonema* threads is noticeable. The frequent occurrence of an unknown organism requires mentioning. It is equipped with long setae, see fig. 40: 8, and resembles *Dasydytidae*. According to Dr. Å. Franzén (Uppsala) it is a larva of a freshwater polychaete. I have never seen anything like this creature in any plankton sample; it ought to be studied living. Five weeks later this creature was not to be found in the plankton.

On February 8, 1954, the composition of the plankton was entirely changed. Only sparse colonies

Fig. 29. Lake Llanquihue, the Bay of Puerto Octay and Peninsula Centinela. In the background Volcano Osorno (2660 m). Photograph by L. Brundin.

of *Dinobryon divergens* remained; the predominant phytoplankter was *Melosira granulata*. Among zooplankters the *Vagnicola* and a ciliate suggestive of *Ophrydium* were predominant.

A list of benthic organisms from Lake Llanquihue may be of some interest for comparison with the plankters which have been listed in table 7, p. 65. The list reproduced here is based on samples from *Nitella* mats at about 10 m depth. Dr. T. Willén (Uppsala) has kindly informed me that this *Nitella* is very likely *N. tenuissima* (Desv.) Kütz., and that there occur also few sterile *Chara* specimens in the samples. The organisms listed below were obtained by rinsing *Nitella* tufts. Besides small benthic diatoms the following organisms were noted:

BACTERIOPHYTA
Achromatium oxaliferum

CYANOPHYTA
Chroococcus turgidus
Merismopedia glauca
Gloeotrichia cf. *natans*

EUGLENOPHYTA
Gyropaigne kosmos

CHRYSOPHYTA

CHRYSOPHYCEAE
Dinobryon divergens
Stipitochrysis monorhiza

BACILLARIOPHYCEAE
Cyclotella meneghiniana
Melosira granulata
M. hustedtii
M. varians
Diatoma elongatum
Synedra ulna
Diatomella balfouriana
Neidium hitchcockii
Rhopalodia gibba
Nitzschia acicularis
Cymatopleura solea
Surirella guatimalensis

CHLOROPHYTA

VOLVOCALES
Schizochlamys gelatinosa fig. 39: 8

CHLOROCOCCALES
Botryococcus braunii
B. protuberans
Dictyosphaerium pulchellum
Pediastrum boryanum

CHAETOPHORALES
Chaetosphaeridium globosum – fig. 39: 10
Coleochaete scutata

OEDOGONIALES
Bulbochaete sp.
Oedogonium undulatum – figs. 39: 4 & 5
Oedogonium sp.

CONJUGALES
Spirogyra sp. ster.
Zygnema sp. ster.
Mougeotia sp. ster.
Pleurotaenium trabecula

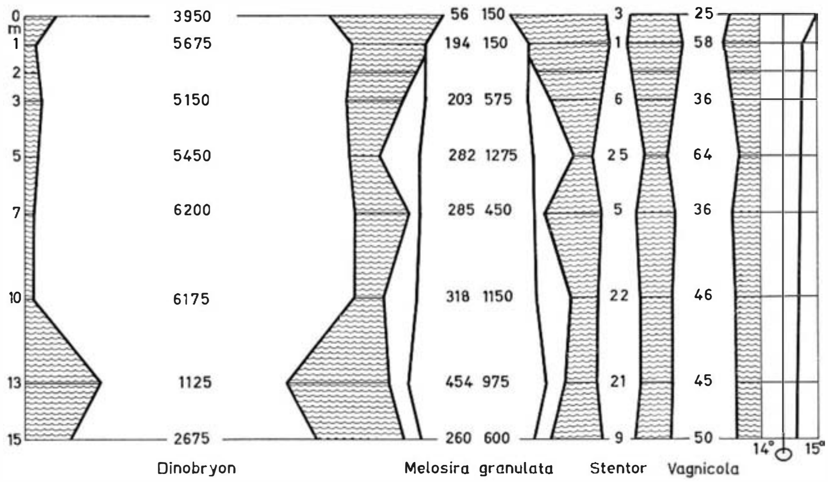


Fig. 30. Diagram showing vertical distribution of some plankters in the Bay of Puerto Octay, Lake Llanquihue, on December 31, 1953, at 8.30–9.30.

Euastrum attenuatum v. *lithuanicum* – fig. 37: 13
Actinotaenium capax v. *minus*
Cosmarium araucaniensis
C. botrytis
C. granatum
C. subspeciosum v. *validius*
C. teilingii
Staurodesmus cuspidatus
Staurastrum rotula v. *smithii*
S. smithii
Sphaerozosma aubertianum
S. aubertianum v. *archeri*
Hyalotheca dissiliens

PROTOZOA
Cyphoderia trochus
Vagnicola sp.

ROTATORIA
Colurella obtusa
Keratella c. cochlearis
Lepadella patella
Monostyla crypta
Trichocerca porcellus
T. weberi

CLADOCERA
Alona cf. *affinis*
Camptocercus rectirostris
Chydorus sp.
Leydigia leydigi
Streblocerus serricaudatus

COPEPODA
Cyclops sp.

The vertical distribution of some of the most abundant plankters in the Bay of Puerto Octay on December 31, 1953, is shown in fig. 30. This bay is epilimnic and about 43–48 m deep. On December 30, the transparency was 23 m and the bay was homothermous. At sampling, which was carried out between 8.30 and 9.30 in the morning, two 5 l samples from each level were collected. The numerals within the curves indicate the numbers of plankters per liter and are based on 5 liter samples. For *Melosira granulata*, the second of the curves, the numbers of cells in both series of samples have been indicated. For the other plankters only one of the series has been shown. The numbers of plankters in fig. 30 are to be considered too low, and only suitable for illustrating the vertical distribution.

12. LAKE TODOS LOS SANTOS

The lake of All Saints or Lago Esmeralda is of a quite different shape compared to the other large Chilean lakes. The shape is very irregular due to glacial scouring and volcanic activities. On February 2, 1954, qualitative collections were made in the easternmost extension of the lake, at Peulla. Here the lake receives a considerable inflow, viz. Rio Tronador or Rio Peulla, which carries glacier water rich in ooze. Another notable but of course different influence comes from the sewage running into the lake from the large hotel. The plankton was very rich in rotifers, the most frequent species being a *Philodina*, which is a common plankter in many Chilean lakes. Probably it is *Philodina roseola*. Furthermore, the following rotifers were amply represented: *Gastropus stylifer*, *Keratella cochlearis*, and *Polyartha vulgaris*.

A few days later, collections were made at Petrohué, located on the western shore of the lake. From Petrohué the outlet of the lake, Rio Petrohué, flows to the Bahía Ralún. On February 5, 1954, the submerged stones along the shore were covered by a dense cover of *Epithemia turgida*, intermixed with *Rhopalodia gibba*. The plankton at Petrohué proved to be quite different in character from that at Peulla. At both places the number of taxa was small. But at Petrohué the population of plankters was mainly made up of *Melosira granulata* and *Acanthocystis aculeata. Eudorina elegans* and *Synedra acus* were also frequent. Samples from both localities are listed in table 7.

The epilimnic distribution of *Melosira granulata* and *Stentor* in the plankton of Lake Todos los Santos is shown in fig. 31. The sampling was carried out on January 19, 1954, at Petrohué. The numerals within the "spherical curves" indicate the numbers of plankters per liter at that level. They are based on 5 liter samples, and are to be considered as being too low, and of relative value only. *Boeckella* and *Hexarthra*, not included in fig. 31, were most abundant at 20 m. On the whole the number of zooplankters is higher in my samples than in those collected by Löffler on the same occasion, see Löffler (1962, p. 212). It is likely that the filter with meshes of about 170 μ used by him was much too coarse. The 70 μ filter used by me was appropriate for zooplankton, but for phytoplankton a filter with still narrower meshes should have been used. For the thermal stratification of Lake Todos los Santos see fig. 10 in Löffler (1960, p. 194).

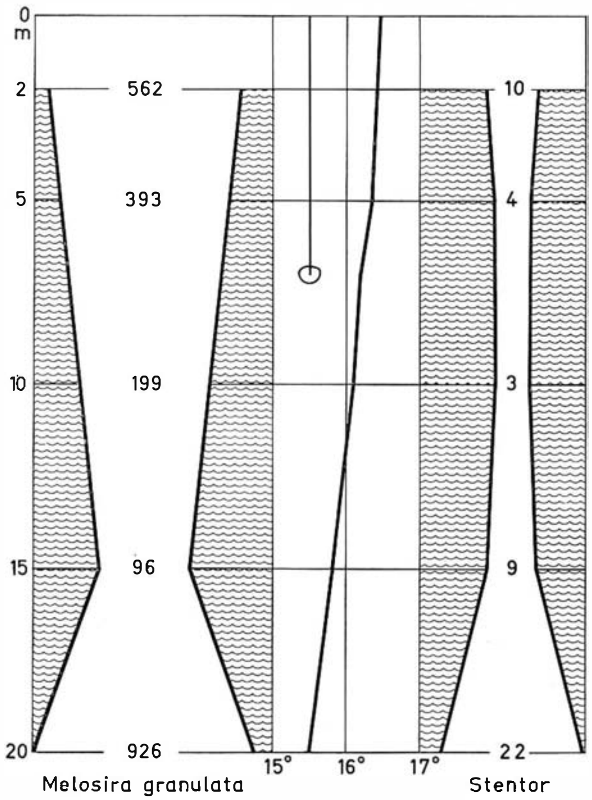


Fig. 31. Diagram showing vertical distribution of some plankters in Lake Todos los Santos at Petrohué, on January 19, 1954.

Table 7.
Plankton of some South Chilean lakes

	Huilipilún 17.11.1953 0 m	Huilipilún 17.11.1953 3–4 m	Quillehue 22.11.1953 0 m	Calafquén 6.12.1953 0 m	Calafquén 6.12.1953 3–4 m	Pellaifa 4.12.1953 0 m	Pellaifa 4.12.1953 3–4 m	Pellaifa 5.12.1953 bay	Ranco 30.1.1954 0 m	Rupanco 8.1.1954 0 m	Puyehue 3.2.1954 0 m	Bonita 5.1.1954 0 m	Llanquihue 28.12.1953 0 m	Llanquihue 8.2.1954 0 m	Llanquihue 25.12.1953 littoral	Llanquihue 16.7.1963 0 m	Todos los Santos Peulla 2.2.1954	Todos los Santos Petrohué 5.2.1954
CYANOPHYTA																		
Aphanocapsa elachista v. *planctonica*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·
Aphanothece nidulans	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Anabaena affinis	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
A. flos-aquae	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
A. solitaria f. *planctonica*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
A. spiroides v. *minima*	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
Chroococcus minutus	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
C. pallidus – fig. 40: 7	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·

TABLE 7. (*Continued*)

	Huilipilún 17.11.1953 0 m	Huilipilún 17.11.1953 3–4 m	Quillehue 22.11.1953 0 m	Calafquén 6.12.1953 0 m	Calafquén 6.12.1953 3–4 m	Pellaifa 4.12.1953 0 m	Pellaifa 4.12.1953 3–4 m	Pellaifa 5.12.1953 bay	Ranco 30.1.1954 0 m	Rupanco 8.1.1954 0 m	Puyehue 3.2.1954 0 m	Bonita 5.1.1954 0 m	Llanquihue 28.12.1953 0 m	Llanquihue 8.2.1954 0 m	Llanquihue 25.12.1953 littoral	Llanquihue 16.7.1963 0 m	Todos los Santos 2.2.1954 Peulla	Todos los Santos 5.2.1954 Petrohué
Chroococcus turgidus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·
Coelosphaerium kuetzingianum	·	+	·	·	+	+	·	·	·	·	·	·	·	·	·	·	·	·
Gomphosphaeria aponina	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
G. lacustris	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	+	·	·
Merismopedia glauca	·	+	·	+	·	·	·	·	·	·	·	·	+	·	·	·	·	·
Nodularia spumigena – fig. 39: 6	·	·	·	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·
Nostoc kihlmanii	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Oscillatoria sp.	·	·	·	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·
EUGLENOPHYTA																		
Colacium vesiculosum	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·
Trachelomonas volvocina	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
PYRROPHYTA																		
Peridinium cinctum	·	·	·	·	·	·	+	+	·	·	·	·	·	·	·	·	·	·
P. inconspicuum	◑	◑	·	·	·	·	·	·	·	·	·	◔	·	·	·	·	·	·
P. lomnickii	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
P. willei	+	+	+	+	+	+	·	·	·	·	·	+	+	+	+	+	+	+
P. volzii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
P. volzii v. *cinctiforme* – fig. 33: 5	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
CHRYSOPHYTA																		
XANTHOPHYCEAE																		
Tribonema elongatum	·	·	+	●	●	·	+	·	·	·	·	·	·	·	·	+	·	·
CHRYSOPHYCEAE																		
Carnegia frenguellii – see p. 104	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Dinobryon cylindricum	◑	+	·	+	+	●	●	●	·	·	·	·	·	·	·	·	·	·
D. cylindricum v. *palustre*	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	+
D. divergens	·	·	+	·	·	·	·	+	◔	+	●	+	●	+	●	+	+	+
D. divergens v. *schauinslandii*	·	·	·	◑	◑	·	·	·	·	·	·	·	·	·	·	·	·	·
D. sertularia	·	·	●	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Mallomonas elongata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·
Mallomonas sp.	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
BACILLARIOPHYCEA																		
Melosira ambigua	+	+	·	+	+	·	·	+	·	·	·	+	·	·	·	·	·	·
M. granulata	·	+	◑	◑	+	·	·	+	◔	+	●	+	+	◑	+	◑	+	●
M. granulata v. *angustissima*	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
M. hustedtii	+	+	+	+	+	+	·	·	◔	+	+	+	+	+	+	◑	·	·
M. italica ssp. *subarctica*	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
Cyclotella meneghiniana	·	·	+	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
C. planctonica	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
C. stelligera	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·
Stephanodiscus astraea	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·

Table 7. (*Continued*)

	Huilipilún 0 m 17.11.1953	Huilipilún 3–4 m 17.11.1953	Quillehue 0 m 22.11.1953	Calafquén 0 m 6.12.1953	Calafquén 3–4 m 6.12.1953	Pellaifa 0 m 4.12.1953	Pellaifa 3–4 m 4.12.1953	Pellaifa bay 5.12.1953	Ranco 0 m 30.1.1954	Rupanco 0 m 8.1.1954	Puyehue 0 m 3.2.1954	Bonita 0 m 5.1.1954	Llanquihue 0 m 28.12.1953	Llanquihue 0 m 8.2.1954	Llanquihue littoral 25.12.1953	Llanquihue 0 m 16.7.1963	Todos los Santos Peulla 2.2.1954	Todos los Santos Petrohué 5.2.1954
Rhizosolenia eriensis	·	·	·	+	+	·	·	·	·	+	·	·	+	+	+	+	·	·
Diatoma elongatum	·	·	+	·	·	·	·	·	·	·	·	+	+	·	+	·	·	·
D. elongatum v. *fuegensis*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
D. hiemale v. *mesodon*	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
D. vulgare	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Fragilaria sp.	·	·	+	·	·	·	·	·	·	·	·	·	+	·	·	+	·	·
Synedra acus	·	·	◔	+	+	·	·	+	·	·	·	·	·	·	·	+	·	◔
S. ulna	·	+	+	+	+	·	·	+	·	·	·	·	·	+	+	·	·	·
S. ulna v. *danica*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·
S. ulna v. *spathulifera*	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Eunotia pectinalis	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Pinnularia polyonca	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
Rhopalodia gibba	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
Nitzschia acicularis	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Cymatopleura solea	·	·	+	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
Surirella guatimalensis	·	·	·	·	+	+	·	+	·	·	·	·	+	·	·	+	·	·
S. robusta	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·
CHLOROPHYTA																		
VOLVOCALES																		
Chalmydomonas dinobryonis	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·
C. siderogloea – see p. 62	·	·	·	·	·	·	·	·	·	·	·	◑	·	·	·	·	·	·
Chlamydomonas sp.	·	·	·	·	·	·	·	·	·	·	·	◔	·	·	·	·	·	·
Eudorina cylindrica	·	·	·	+	+	·	·	·	·	·	·	·	·	·	·	·	·	+
E. elegans	·	·	·	·	·	·	·	·	·	+	·	·	+	+	+	+	+	◔
Pandorina morum	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
Gemellicystis neglecta	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Gloeococcus schroeteri	+	+	+	+	+	+	+	+	·	·	·	·		·	+	+	·	·
Gloeocystis gigas v. *pallida*	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
Paulschulzia pseudovolvox	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
Tetraspora lacustris	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
CHLOROCOCCALES																		
Echinosphaerella limnetica	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Chodatella citriformis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·
Lagerheimia quadriseta	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Oocystis natans	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
O. solitaria	·	·	·	+	+	·	·	·	·	·	·	·	+	·	·	·	·	·
Ankistrodesmus falcatus	·	+	+	·	·	·	+	+	·	·	·	+	·	·	+	·	·	·
Kirchneriella contorta	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
K. obesa	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Botryococcus braunii	+	+	·	+	+	+	+	+	+	+	+	·	+	+	+	+	·	+
B. protuberans	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
Dictyosphaerium ehrenbergianum	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
D. pulchellum	·	·	·	·	·	·	·	+	·	·	·	·	+	+	+	·	·	·

Table 7. (*Continued*)

	Huilipilún		Quillehue	Calafquén		Pellaifa			Ranco	Rupanco	Puyehue	Bonita	Llanquihue				Todos los Santos	
	17.11.1953	17.11.1953	22.11.1953	6.11.1953	6.12.1953	4.12.1953	4.12.1953	5.12.1953	30.1.1954	8.1.1954	3.2.1954	5.1.1954	28.12.1953	8.2.1954	25.12.1953	16.7.1963	2.2.1954	5.2.1954
	0 m	3–4 m	0 m	0 m	3–4 m	0 m	3–4 m	bay	0 m	0 m	0 m	0 m	0 m	0 m	littoral	0 m	Peulla	Petrohué
Pediastrum boryanum	·	·	+	·	+	·	·	+	·	·	·	·	·	·	·	·	·	·
P. boryanum v. *longicorne*	·	·	·	·	·	·	·	+	·	·	·	+	+	·	·	·	·	·
P. duplex	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
P. tetras v. *tetraodon*	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Coelastrum proboscideum	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Scenedesmus bijugatus	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
S. ovalternus	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
S. quadricauda	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
Tetradesmus wisconsinensis	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Tetrastrum elegans	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
ULOTRICHALES																		
Elakatothrix gelatinosa	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
OEDOGONIALES																		
Oedogonium sp. ster.	·	·	·	·	·	·	·	·	●	·	·	·	·	·	·	·	·	·
CONJUGALES																		
Gonatozygon aculeatum	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
Netrium digitus	·	·	·	+	·	·	·	+	·	·	·	+	·	·	·	·	·	·
Penium margaritaceum	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Closterium aciculare	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
C. acutum v. *variabile*	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
C. cynthia	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
C. dianae	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
C. kuetzingii	·	·	·	+	·	·	·	+	·	·	·	·	·	·	·	·	·	·
C. macilentum	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
C. ralfsii v. *immane*	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
C. striolatum	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
C. venus	·	·	·	·	·	·	·	+	·	·	·	·	+	·	·	·	·	·
Pleurotaenium ehrenbergii	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
P. trabecula	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Euastrum dubium	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
E. evolutum v. *integrius*	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Micrasterias denticulata	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
M. radians	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
M. tetraptera v. *longesinuata*	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
M. truncata	·	·	·	+	+	·	·	◑	·	·	·	·	·	·	·	·	·	·
Actinotaenium elongatum – fig. 38: 15	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
Cosmarium araucaniensis	·	·	·	·	+	·	·	+	·	·	·	·	·	·	·	·	·	·
C. blyttii v. *novae-sylvae*	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
C. botrytis	·	·	+	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
C. botrytis v. *tumidum*	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
C. connatum – Krieger (1932, pl. 8, figs. 14 & 15)	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
C. contractum v. *ellipsoideum*	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·

TABLE 7. (*Continued*)

	Huilipilún 0 m 17.11.1953	Huilipilún 3–4 m 17.11.1953	Quillehue 0 m 22.11.1953	Calafquén 0 m 6.12.1953	Calafquén 3–4 m 6.12.1953	Pellaifa 0 m 4.12.1953	Pellaifa 3–4 m 4.12.1953	Pellaifa bay 5.12.1953	Ranco 0 m 30.1.1954	Rupanco 0 m 8.1.1954	Puyehue 0 m 3.2.1954	Bonita 0 m 5.1.6954	Llanquihue 0 m 28.12.1953	Llanquihue 0 m 8.2.1954	Llanquihue littoral 25.12.1953	Llanquihue 0 m 16.7.1963	Todos los Santos Peulla 2.2.1954	Todos los Santos Petrohué 5.2.1954
Cosmarium laeve	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
C. ochtodes v. *amoebum*	·	·	+	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
C. portianum	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
C. pseudoprotuberans f. – fig. 38: 13	·	·	+	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
C. pyramidatum	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
C. pyramidatum v. *transitorium*	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
C. subspeciosum v. *validius*	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
C. subtumidum v. *klebsii*	·	·	·	·	+	·	·	+	·	·	·	·	·	·	·	·	·	·
C. teilingii	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
Xanthidium antilopaeum	·	·	+	+	·	·	+	+	·	·	·	·	·	·	·	·	·	·
Staurodesmus convergens	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
S. cuspidatus	·	·	·	+	+	·	·	·	·	·	·	·	+	+	+	·	·	·
S. cuspidatus v. *acuminatus* – figs. 34: 5 & 6	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
S. dejectus – fig. 34: 8	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·
S. dickiei v. *maximus* – fig. 34: 13	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
S. patens – fig. 34: 9	·	·	·	·	·	·	·	·	·	·	·	·	+	+	+	·	·	·
S. subulatus	·	·	+	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
S. triangularis f. *curvispina*	·	·	·		·	·	+	·	·	·	·	·	·	·	·	·	·	·
Staurastrum anatinum v. *subfloriferum* – fig. 41: 14	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
S. armigerum v. *furcigerum*	·	+	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
S. aspinosum f. – figs. 42: 21 & 22	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
S. brebissonii v. *maximum*	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
S. excavatum v. *minimum*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·
S. gladiosum	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
S. grande v. *parvum* – fig. 41: 15	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
S. muticum	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·	·	·
S. pingue	·	·	◔	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
S. pingue v. *tridentata*	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
S. planctonicum f.	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
S. punctulatum	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
S. rotula v. *smithii*	·	·	+	·	·	·	·	+	·	+	·	+	+	+	+	+	+	+
S. sebaldi v. *ornatum*	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
S. sebaldi v. *ornatum* f. *planctonica*	·	·	·	+	+	·	+	·	·	·	·	·	·	·	·	·	·	·
S. smithii	·	·	·	+	+	·	·	·	·	·	·	·	+	·	·	·	·	·
S. striolatum	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
S. subgrande v. *convexum* – fig. 38: 6	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
S. teracerum v. *evolutum*	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	+	+	+
S. valdiviense – fig. 42: 16	·	·	·	+	+	+	+	·	·	·	·	·	·	·	·	·	·	·
Staurastrum sp. – Thomasson (1955, figs. 2: 8 & 3: 1)	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Sphaerozosma aubertianum	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·	·	·

Table 7. (*Continued*)

	Huillipilún 17.11.1953 0 m	Huillipilún 17.11.1953 3–4 m	Quillehue 22.11.1953 0 m	Calafquén 6.12.1953 0 m	Calafquén 6.12.1953 3–4 m	Pellaifa 4.12.1953 0 m	Pellaifa 4.12.1953 3–4 m	Pellaifa 5.12.1953 bay	Ranco 30.1.1954 0 m	Rupanco 8.1.1954 0 m	Puyehue 3.2.1954 0 m	Bonita 5.1.1954 0 m	Llanquihue 28.12.1953 0 m	Llanquihue 8.2.1954 0 m	Llanquihue 25.12.1953 littoral	Llanquihue 16.7.1963 0 m	Todos los Santos 2.2.1954 Peulla	Todos los Santos 5.2.1954 Petrohué
Hyalotheca dissiliens	·	·	+	·	·	·	+	·	·	·	·	+	+	·	·	·	·	·
H. mucosa	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
PROTOZOA																		
Acanthocystis aculeata	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	+	●
Euglypha brachiata	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Ophrydium sp.	·	·	·	·	·	·	·	·	·	●	·	·	+	●	·	·	·	·
Stentor sp.	·	·	·	·	·	·	·	·	·	+	·	·	◔	·	+	·	·	·
Vagnicola sp.	·	·	·	·	·	·	·	·	·	·	·	·	◔	●	+	+	·	·
Vorticella sp.	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·
ROTATORIA																		
Brachionus quadridentatus	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
Cephalodella sp.	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
Collotheca libera	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
C. mutabilis	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Collotheca sp.	·	·	·	·	·	·	·	·	·	+	·	+	·	·	·	·	·	·
Colurella obtusa	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Colurella sp.	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Conochilus unicornis	+	+	+	+	+	●	+	+	+	+	+	+	+	·	·	·	·	+
Euchlanis dilatata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
Euchlanis sp.	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+
Filina longiseta	+	+	·	+	+	◑	◑	·	·	·	·	+	·	·	·	·	◔	+
F. terminalis	·	·	◔	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Gastropus stylifer	·	·	·	·	·	·	·	·	·	·	·	·	+	+	·	·	◔	+
Hexarthra fennica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+
Keratella c. cochlearis	+	·	+	+	·	·	+	·	+	+	·	+	+	+	+	+	◔	+
K. cochlearis tecta	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
K. tropica	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·
K. valdiviensis	●	●	·	+	+	+	+	·	·	·	·	·	·	·	·	·	·	·
Lecane flexilis	·	·	·	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·
Lepadella patella	·	+	+	+	+	·	·	+	·	·	·	·	·	·	·	·	·	·
Lophocharis najas	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
L. oxysternon	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Monostyla bulla	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
M. closterocerca	·	·	+	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
M. crenata	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·	·	·
M. lunaris	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
M. pyriformis	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Notholca haueri	·	·	◔	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·
Philodina sp.	·	·	+	·	·	·	·	·	·	·	·	·	+	·	·	+	●	+
Polyarthra vulgaris	+	+	·	+	·	+	+	+	·	·	·	·	+	·	+	·	◔	+
Pompholyx sulcata	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	+
Synchaeta pectinata	·	·	+	+	·	·	·	·	·	·	·	·	+	·	·	·	+	+

Table 7. (*Continued*)

	Huilipilún	Huilipilún	Quillehue	Calafquén	Calafquén	Pellaifa	Pellaifa	Pellaifa	Ranco	Rupanco	Puyehue	Bonita	Llanquihue	Llanquihue	Llanquihue	Llanquihue	Todos los Santos	Todos los Santos
	17.11.1953	17.11.1953	22.11.1953	6.12.1953	6.12.1953	4.12.1953	4.12.1953	5.12.1953	30.1.1954	8.1.1954	3.2.1954	5.1.1954	28.12.1953	8.2.1954	25.12.1953	16.7.1963	2.2.1954	5.2.1954
	0 m	3–4 m	0 m	0 m	3–4 m	0 m	3–4 m	bay	0 m	0 m	0 m	0 m	0 m	0 m	littoral	0 m	Peulla	Petrohué
Synchaeta sp.	·	·	·	+	·	+	+	·	·	+	·	·	+	·	·	·	·	·
Trichocerca longiseta	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
T. similis	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·
Trichocerca sp.	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	+	+	·
CLADOCERA																		
Bosmina chilensis	·	+	·	+	+	+	◔	+	+	+	·	+	+	·	+	+	+	+
Chydorus sp.	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
Daphnia ambigua	·	·	·	+	·	+	·	·	·	·	·	·	·	·	·	·	·	·
Diaphanosoma excisum chilense	·	·	·	·	·	+	+	+	◔	·	·	·	·	·	·	·	·	·
Ilyocryptus spinifer	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
Pleuroxus aduncus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
Scapholeberis mucronata intermedia	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·
COPEPODA																		
Boeckella gracilipes	·	·	·	+	·	+	●	·	·	·	·	·	·	·	·	·	·	·
Cyclops sp.	·	·	·	+	+	+	+	+	+	·	·	+	·	·	·	+	+	·
Diaptomus diabolicus	·	·	·	+	·	·	·	·	●	·	·	·	·	+	·	·	·	·

13. LAKE CHICA

This lake, and the following one, are located north of the Chilean lake district. Samples from these lakes were kindly placed at my disposal by Dr. Jorge E. Furet, Concepción.

Laguna Chica de San Pedro, which is the northernmost of the two, is a small body of water located at San Pedro in the province of Ñuble, about 65 km to the east of Concepción.

On December 28, 1962, the main part of the plankton was made up of *Botryococcus braunii*. Noteworthy is the abundant occurrence of *Keratella americana*, a species that has earlier been reported from Brazil by Thomasson (1955), Venezuela by Hauer (1956), and from the province of Buenos Aires by Olivier (1961). Among the bulk of *Botryococcus* only the following organisms were noted:

CYANOPHYTA

Aphanocapsa elachista v. *planctonica*
Gomphosphaeria lacustris

CHRYSOPHYTA

CHRYSOPHYCEAE

Dinobryon divergens

BACILLARIOPHYCEAE

Melosira granulata
Surirella guatimalensis

CHLOROPHYTA

VOLVOCALES

Gloeococcus schroeteri
Tetraspora lacustris

CHLOROCOCCALES

Botryococcus braunii
Pediastrum boryanum

CONJUGALES

Xanthidium antilopaeum
Staurodesmus cuspidatus
S. subulatus
Staurastrum armigerum v. *furcigerum*
S. rotula v. *smithii*
Sphaerozosma aubertianum

ROTATORIA

Keratella americana
Lepadella acuminata

During the cool season *Dinobryon divergens* and *Botryococcus braunii* predominate according a sample collected on July 1, 1963. In addition *Aphanocapsa elachista* var. *planctonica*, *Melosira granulata*, *Surirella guatimalensis*, *Gloeococcus schroeteri*, *Pediastrum araneosum* var. *rugulosum*, *Conochilus unicornis*, *Filina terminalis*, *Keratella americana*, and large numbers of naupliae were noted.

14. LAKE LANALHUE

The third sample supplied by Dr. Furet is from Lake Lanalhue. This is a large lake located in the coastal province of Arauco, about 130 km south of Concepción.

The sample which was collected on December 31, 1962, contains much detritus. *Harpacticidae* are frequent and indicate the benthic character of the sample. The predominant plankter is *Microcystis aeruginosa.* The large, handsome *Cosmarium denticulatum* var. *perspinosum* is present. This plant was described by Grönblad (1942) from Brazil, where *C. denticulatum* is represented in multifarious forms.

Among the large amounts of detritus particles the following organisms were noted:

CYANOPHYTA

Anabaena sp.
Merismopedia glauca
Microcystis aeruginosa

PYRROPHYTA

Peridinium sp.

CHRYSOPHYTA

XANTHOPHYCEAE

Tribonema sp.

CHRYSOPHYCEAE

Dinobryon divergens
Mallomonas sp.

BACILLARIOPHYCEAE

Melosira ambigua
M. granulata
M. hustedtii
Surirella guatimalensis

CHLOROPHYTA

VOLVOCALES

Gloeococcus schroeteri

CHLOROCOCCALES

Ankistrodesmus falcatus
Botryococcus braunii
Dictyosphaerium pulchellum
Dimorphococcus lunatus
Pediastrum boryanum
P. boryanum v. *longicorne*
P. tetras
Scenedesmus sp.

CHAETOPHORALES

Aphanochaete repens – on *Oedogonium*

CONJUGALES

Netrium digitus
Penium margaritaceum
Pleurotaenium trabecula
Micrasterias truncata
Cosmarium denticulatum v. *perspinosum*
Cosmarium ochthodes
C. pseudoconnatum
C. pseudoprotuberans
C. subspeciosum v. *validius*
Staurodesmus triangularis v. *subparallelus*
Staurastrum sp.
Hyalotheca mucosa

ROTATORIA

Brachionus calyciflorus anuraeiformis
Euchlanis dilatata
Filina terminalis
Keratella americana
K. cochlearis tecta
Lecane sp.
Macrochaetus collinsi
Pompholyx sulcata
Trichocerca sp.

CLADOCERA

Bosmina chilensis
Ceriodaphnia dubia

CONCLUDING REMARKS

It is very hazardous to draw any general conclusions from such material of random samples as has been presented above. However, it is possible to discern two main types of phytoplankton occurring in the subtropical (cf. Thomasson, 1959, pp. 37–38) lakes in the Chilean lake district. A type characterized by the abundant occurrence of *Dinobryon* spp. is found in lakes which are obviously poor in available dissolved nutritive material, e.g. Huilipilún, Pichilafquen, and Pellaifa. All these lakes are rather small and have a small drainage area. The second type of plankton is characterized by a rich growth of *Melosira granulata,* and occurs in lakes with a more favourable supply of nutritive substances. To this group of lakes, all of which have a considerable drainage area, belong Villarrica, Calafquén, Panguipulli, Riñihue, Ranco, Puyehue, Todos los Santos, etc. Of course, *Dinobryon* spp. may occur in considerable quantities in these lakes as well. During the summer a rich growth of *Tribonema* occurs in many of these lakes. A factor of importance for biota in the lakes of this type may be a rapid turnover of nutrient material due to the high epilimnic temperatures and considerable wind-produced currents. The large Lake Llanquihue seems to be intermediate in character but more closely related to the *Dinobryon*-lakes than to the *Melosira*-lakes. The material at my disposal from lakes Rupanco and Bonita does not allow classification of these two lakes.

It is noteworthy that the *Cyanophyta* are only sparsely represented in the plankton of the lakes in the Chilean lake district. There is no evidence of water-bloom. However, in other Chilean lakes water-bloom of *Cyanophyta* occurs; our expedition encountered water-bloom in Central Chile, viz. in Lake Huehún located about 30 km north of Santiago. Here the water-bloom was made up of *Anabaena solitaria* f. *planctonica*. In addition only *Synedra acus* and *Moina* cf. *macrophthalmum* were noted in a sample collected with a coarse net by Dr. Löffler. More interesting is a sample of neuston from the water's edge. Here an *Euglena* sp., most likely *Euglena tuba* (see Hortobágyi, 1960), occurred in large numbers. A lot of floatoblasts were intermingled. According to kind information by Dr. Mary D. Rogick, they belong to the following taxa: the majority are of *Plumatella emarginata* type; a fair number belong to *Plumatella fruticosa*; moreover, there are a few which may be *Plumatella repens* or *P. fungosa*, and possibly also some attributable to *Hyalinella punctata*. In addition the following organisms were noted in this sample: *Spirulina maior*, *Cymatopleura solea*, *Pteromonas limnetica*, *Pandorina morum*, *Colurella obtusa*, *Lepadella patella*, *Lecane luna*, *L. nana*, *L. ohioensis* – fig. 45:3, *Monostyla bulla*, *M. closterocerca*, *M. furcata*, *M. hamata*, and a few species of *Cyclops* and some cladocers.

The proportion of *Chlorococcales* in the plankton of the Chilean lake district is relatively small. Only in Lake Villarrica *Dictyosphaerium* and *Kirchneriella*, and in Lake Pichilafquen *Crucigenia*, were found in noteworthy quantities. The number of taxa is also rather small.

Among the desmids the constant occurrence of *Staurastrum rotula* var. *smithii* in the plankton of the majority of the lakes is notable.

Such familiar plankters as *Asterionella*, *Tabellaria*, *Ceratium*, *Kellicottia*, and *Keratella quadrata* are apparently lacking in this region. However, considering the latter two plankters this statement ought to be somewhat modified. In fact I have never seen any specimens which were alive at the time of sampling, but in a sample from Lake Pichilafquen I found a deformed lorica of *Kellicottia longispina*, and in a sample from the *Potamogeton* pond at Lake Pellaifa two lorica of *Keratella quadrata* were observed. For the present I am inclined not to assign too much significance to these finds until it has been shown clearly that the species occur living at the sampling stations. The possibility of passive transport cannot be ignored. Neither of them is reported in the list of rotifers reproduced in Löffler (1962, pp. 214 and 215).

The occurrence of *Centronella*, see fig. 33: 7, in the plankton of Lake Villarrica is noteworthy. This species probably has a much wider distribution than is indicated by the sparse reports (Krieger, 1927; Wysocka, 1959); it is likely to be overlooked because of its very fine texture.

Summing up I would like to point out that these notes only give some glimpses of the Chilean freshwater plankton. During these studies many questions arose that can only be elucidated by further collections from these lakes, some even demanding investigations on the spot. An exploration in unfamiliar regions, not least in the present case, often results in some elucidatory information that might be useful for planning future investigations.

VII. LAKES LOCATED EAST OF THE ANDES

During our stay in the Chilean lake district I made a short journey to the National Park of Nahuel Huapi, which is located east of the Andean range. Some glimpses from this area were gathered in Thomasson (1959). As is evident from that paper further information from the lakes in this National Park is very desirable. Therefore, when my Swedish friend Dr. Åke Vinterbäck was going to spend some time at Instituto di Fisica in Bariloche I asked him to collect a few plankton samples from the lakes in the Nahuel Huapi area. My request was granted above all expectations. During his stay in Bariloche, Dr. Vinterbäck kindly made collections not only from nearby waters, but in spite of his research work at Instituto di Fisica, he also found time to make long and arduous journeys to distant lakes. To him and to his assistants in the field, Dr. Juan Carlos Lerman and Don Diego Niel, I give my most sincere thanks. Dr. Lerman has most kindly continued sampling in 1962–63.

1. LAKE QUILLÉN

This lake is located in the National Territory of Neuquén within the eastern slopes of the Andean range at 39° 30′ S lat., see the map in fig. 1. It drains through Rio Quillén, Rio Aluminé, and Rio Negro to the Atlantic. On the shores of Lake Quillén are forests of *Nothofagus obliqua* and *N. procera*. East of the Andean range *N. procera* has its main distribution in the area located approximately between the lakes Quillén and Lacár. The vegetation of the present area, the National Park of Lanin which is located between 39° and 40° 30′ of south latitude, has been described by Dimitri (1959). The sampling was carried out on March 5, 1962, near the Estancia La Ofelia, which is situated at the eastern end of the lake. The altitude of the lake is 980 m. The temperature of the water at sampling was 18° C.

The main bulk of plankters consisted of *Stentor*. The large quantities of this protozoan gave the sample a silty appearance. Among the phytoplankters, *Dinobryon divergens* is predominant. *Fragilaria crotonensis* and *Dictyosphaerium pulchellum* were rare in the sample. The following plankters were noted:

CYANOPHYTA

Anabaena solitaria f. *planctonica*

PYRROPHYTA

Peridinium volzii

CHRYSOPHYTA

CHRYSOPHYCEAE

Chrysosphaerella brevispina
Dinobryon divergens – abundant

BACILLARIOPHYCEAE

Melosira granulata
Rhizosolenia eriensis
Fragilaria crotonensis
Synedra ulna v. *danica*
Surirella guatimalensis

CHLOROPHYTA

CHLOROCOCCALES

Dictyosphaerium pulchellum

CONJUGALES

Staurastrum tetracerum v. *evolutum*

PROTOZOA

Acanthocystis aculeata
Rhaphidiocystis sp.
Stentor sp. – predominant
Vagnicola sp.

ROTATORIA

Ascomorpha saltans
Gastropus stylifer
Keratella c. cochlearis
Monostyla lunaris
Polyarthra vulgaris
Trichocerca pusilla
T. stylata

CLADOCERA

Bosmina chilensis

COPEPODA

Boeckella gracilipes
Cyclops sp.

2. LAKE LACÁR

Lake Lacár is located in the National Territory of Neuquén, within the National Park of Lanin which has an area of 395,000 ha. Lake Lacár lies at latitude 40° 10′ S. It is located deeper below the mountain ridges of the Andes than the adjacent lakes; its altitude is only 711 m, according to other sources 645 m. The lake therefore seems narrower than it actually is, see pl. 13 in Willis (1914). It is 26.5 km long, its width is in general about 2 km, and the surface area of the water is 52 km². The area of the drainage basin is about 980.5 km². Immediately above the outlet, that is, above the west end of the lake, Cerro Malo (2060 m) rises to the north and Cerro Queñi (2070 m) to the south. To the south of the lake there are heights rising to more than 1900 m above sea level. The northern shore of Lake Lacár is not so high. The range of Cerro Malo (1770 m), and the Cerro Quinalahué (1754 m) mark a height which is interrupted by transverse valleys. The shores of Lago Lacár are steep; here and there rocky and precipitous cliffs rise 500 m above the lake directly from the shores. At Lake Lacár are the southernmost forests of *Nothofagus obliqua*. They have a somewhat wider distribution than those of *N. procera*, which are also found here. While the forests of *N. procera* extend only to Lake Quillén in the north, forests of *N. obliqua* reach as far as Lake Aluminé.

Lake Lacár is the only one of the lakes north of Nahuel Huapi which discharges its waters to the Pacific side. On the eastern boundary the basin is enclosed by a moraine which is about 950 m above sea level. The Rio Hua-Hún, issuing from the west end of the lake, takes a north-westerly course to Lake Pirehueico, in Chile. Its waters eventually reach the Pacific via Rio Calle-Calle at Valdivia. The basins of Lake Lacár, Rio Hua-Hún, and Lake Pirehueico form a continuous valley, with no elevation to be surmounted, and this has always been found the most convenient way by which to cross the range. It was used by Indians already before the conquest of Chile, and is nowadays an important international route.

The sample from Lake Lacár was collected on March 6, 1962, at San Martin de los Andes, which lies at the eastern end of the lake. The temperature of the water at sampling was about 18°C.

The plankton proved to be rich. The predominant plankter is *Aphanocapsa elachista* var. *planctonica*. *Staurastrum rotula* var. *smithii* is frequent. The occurrence of *Melosira hustedtii* is noteworthy. This is a plant which has only seldom been met with in the lakes located along the eastern slopes of the Andean range. In the Chilean lake district it is common. The following plankters were noted in the sample from Lake Lacár:

CYANOPHYTA
Aphanocapsa elachista v. *planctonica* – abundant

PYRROPHYTA
Peridinium inconspicuum
P. willei
P. volzii v. *cinctiforme*

CHRYSOPHYTA
CHRYSOPHYCEAE
Dinobryon cylindricum
Mallomonas elongata
M. alpina

BACILLARIOPHYCEAE
Melosira granulata
M. hustedtii
M. varians
Rhizosolenia eriensis
Synedra ulna v. *danica*
S. ulna v. *contracta*

CHLOROPHYTA
VOLVOCALES
Eudorina elegans
Gloeococcus schroeteri
Paulschulzia pseudovolvox

CHLOROCOCCALES
Botryococcus braunii
Dictyosphaerium pulchellum
Quadrigula closteroides

CONJUGALES
Staurastrum arachne v. *curvatum* f. – fig. 46: 1
S. rotula v. *smithii* – frequent
Staurodesmus cuspidatus v. *acuminatus*

PROTOZOA
Acanthocystis aculeata
Ophrydium versatile
Stentor sp.
Vagnicola sp.

ROTATORIA
Asplanchna silvestrii
Collotheca sp.
Conochilus unicornis
Euchlanis dilatata
Hexarthra fennica
Keratella c. cochlearis
Lepadella patella
Philodina sp.
Polyarthra vulgaris
Synchaeta sp.
Trichocerca stylata

CLADOCERA
Bosmina chilensis
Ceriodaphnia sp.

3. LAKE TRAFUL

Lake Traful is located in the Nahuel Huapi National Park, in its northern part, which forms the southernmost extension of the Territorio Nacional del Neuquén. (The southern area of the Nahuel Huapi National Park forms the westernmost part of Territorio Nacional del Rio Negro.)

Lake Traful is a very deep and narrow body of water completely enclosed by high ranges except at the east end, where the river flows out. Excellent photographs of the scenery at Lake Traful, and of many other lakes in the Nahuel Huapi National Park are reproduced by Agostini (1949). The altitude of Lake Traful is 790 m, and the area is 70 km². The lake has two arms, a long northern one, and a much shorter one on the west. The longer arm lies immediately below the cliffs of Cerro Falkner (2350 m), thence eastward there is a succession of summits ending at Cerro Tres Fralles. From the summits to the lake are precipices of 1000 m or more. The heights south of Lago Traful are equal to those of the northern range, but the slopes are not so precipitous. The highest point is Cerro Cuyin Manzano (2220 m), see the map fig. 1 in Thomasson (1959). This is the highest peak on the divide between Lake Traful and Lake Nahuel Huapi. The drainage basin of the Traful is rather restricted, its area being 535.2 km².

The sampling was carried out at Villa Traful, which is located on the southern shore of the lake, about halfway between the east and the west ends of the lake.

On May 20, 1961, the temperature of the water was about 8°C. The predominant plankter was *Acanthocystis aculeata*, but *Melosira granulata* was also well represented. In this population of *Melosira granulata*, besides the cells of normal breadth, there were cells of 25 μ diameter intermingled. The composition of plankton will be evident from table 8. I have seen only one injured specimen of *Ceratium hirundinella*.

On January 9, 1962, another sample was collected from Lake Traful. The water temperature was about 14°C. *Keratella cochlearis* made up the major part, about 90 per cent, of the plankton community. Also in this sample, the above-mentioned broad threads of *Melosira granulata* occur. As will be evident from table 8, the number of taxa is rather small. It ought to be pointed out that only 3 cells of *Asterionella gracillima* and only 8 cells of *Melosira hustedtii* were noted.

4. LAKE ESPEJO

Lake Espejo is located a few kilometers north of Lake Nahuel Huapi, see the map fig. 1 in Thomasson (1959). It has an area of 38.2 km², the area of its drainage basin is 237.8 km², and according to Auer (1959, p. 186), the altitude of the lake is 772 m. The statements about the altitude are, as usual, vague, in the present case they vary between 748 and 816 meters. Lake Espejo drains into Lake Correntoso. Its western shore is precipitous; here the Cerro Campana reaches an altitude of 1652 m. Dr. Vinterbäck's impression is that Lake Espejo is one of the most transparent of the lakes visited by him in the Nahuel Huapi area. The sampling was carried out at the southern end of the lake.

The first samples were collected on May 20, 1961. The temperature of the water was about 7–8°C. The predominant plankter was *Dinobryon divergens*. *Eudorina elegans* and *Rhizosolenia eriensis* are also amply represented in the sample. The occurrence of *Fragilaria crotonensis* is noteworthy.

On January 11, 1962, there were only a few colonies of *Eudorina elegans* left. The sample proved to be almost a pure culture of *Rhizosolenia eriensis*, which occurred in copious quantities. *Vagnicola* was frequent. Most of the other plankters, which have been listed in the table 8, were sparsely represented. The temperature of the water was about 13°C.

On March 6, the plankton community was again characterized by the rich growth of *Dinobryon divergens*. The *Vagnicola* was more abundant than in the above-mentioned samples. Only one specimen of *Ceratium hirundinella* was observed, and a short zigzag chain of *Tabellaria quadriseptata*. *Anabaena solitaria* f. *planctonica* was extremely rare. The temperature of the surface water was at sampling about 18°C.

5. LAKE CORRENTOSO

Connecting on to the northern arm of Lake Nahuel Huapi is Lake Correntoso. It is an independent lake, yet it is separated from Lago Nahuel Huapi only by a narrow strip of gravel and boulders. The area of the lake is 25.9 km², and of its drainage basin 157.8 km². The figures for the altitude of the lake vary between 748 and 811 m above sea level. According to Auer (1959, p. 184) the altitude is only 711 m. Along the eastern shore of Lake Correntoso rise the stony summits of Cerro M.A. Montes de Oca (1850 m), Cerro Betveder (1992 m), and Cerro Bayo (1782 m). The western shore is considerably lower, here the highest point is Cerro Coligüe (1201 m). The main inflow comes from Lake Espejo, the outflow runs into Lake Nahuel Huapi.

The first samples from Lake Correntoso were collected on May 20, 1961. After a night's frost the temperature of the surface water was about 7°C. The predominant plankter was *Anabaena solitaria* f. *planctonica*. The relation between the length and breadth of its spores is 2 : 1. *Eudorina elegans* and *Dinobryon cylindricum* were also frequent. The occurrence of *Fragilaria crotonensis* should be pointed out.

On January 11, 1962, the water temperature was about 14°C. The most abundant plankter was *Dinobryon divergens*. *Rhizosolenia eriensis* and *Polyarthra vulgaris* were second in quantity. *Anabaena solitaria* f. *planctonica* was abundant, its threads were without spores.

On March 7, 1962, *Dinobryon divergens* was predominant in the plankton community. The number of plankters was small; *Anabaena* was absent. For the composition of the plankton see table 8. The water temperature was 18°C at sampling.

6. LAKE LOS CÁNTAROS

This little lake is located just a short distance, about 880 m, north of Puerto Blest. It has very transparent water. The plankton of Laguna Los Cántaros was rather sparse on February 28, 1961. The predominant plankter was *Dinobryon cylindricum*. *Polyarthra vulgaris* was numerous. The lake is one of the few among the North Patagonian lakes where *Ceratium cornutum* has been observed. It is also one of the bodies of water where *Keratella quadrata* has been observed, but here, as in the other bodies of water, only a single lorica was noted. Curiously enough I have never seen any living specimens, only just a few loricas.

7. LAKE BAGUALES

This is a little lake located near the southern end of the large Isla Victoria, the largest island in Lake Nahuel Huapi, lying in the central section of the lake. Laguna Baguales is surrounded by trees that have fallen down and by swampy ground. Access is difficult. The dimensions of the lake are about 200 × 800 m. The temperature of the water was about 13°C at the time of sampling on April 15, 1961. The dominants in the prevailing plankton community were *Keratella cochlearis* and a sterile *Mougeotia* species 6 μ broad. *Dinobryon divergens* was also abundant. Among the plankters listed in table 8 the occurrence of *Brachionus calyciflorus* and *Ceratium hirundinella* should be pointed out. The first, a rotifer, is characteristic of minor waters rich in nutrients. Only few such bodies of water have been studied, and therefore the representatives of that genus have been extremely rarely recorded. The second plankter, viz. *Ceratium hirundinella*, belongs to those which are very sparse in North Patagonian lakes.

TABLE 8. *Plankton of some lakes located in the northern part of Nahuel Huapi National Park*

	Traful		Espejo			Correntoso			Cántaros		Bagualcs
	20.5.1961	9.1.1962	20.5.1961	11.1.1962	6.3.1962	20.5.1961	11.1.1962	7.3.1962	28.2.1961	26.2.1963	15.4.1961
CYANOPHYTA											
Anabaena solitaria f. *planctonica*	+	·	+	·	+	●	◔	·	·	·	+
Anabaena sp.	·	·	·	·	·	·	·	·	+	·	+
Aphanocapsa elachista v. *planctonica*	·	·	·	·	+	·	·	·	·	·	·
Merismopedia glauca	·	·	·	·	·	·	·	+	·	·	·
EUGLENOPHYTA											
Trachelomonas volvocina	·	·	·	·	·	·	·	·	·	·	+
PYRROPHYTA											
Ceratium cornutum	·	·	·	·	·	·	·	·	+	·	·
C. hirundinella f. *austriacum*	+	·	·	·	+	·	·	·	·	·	+
Glenodinium dinobryonis	·	·	·	·	+	·	+	+	·	·	·
Peridinium cinctum	·	·	·	·	·	·	·	+	·	·	·
P. willei	+	+	+	+	+	+	+	+	+	·	·
P. volzii	·	·	+	·	·	·	·	·	·	+	·
Peridinium sp.	·	·	·	+	·	+	·	·	·	·	·
CHRYSOPHYTA											
CHRYSOPHYCEAE											
Chrysosphaerella brevispina	·	·	+	+	+	+	·	·	·	·	·
Dinobryon cylindricum	·	·	·	·	·	◔	·	·	●	+	·
D. divergens	+	·	●	+	●	+	●	●	·	·	◔
Mallomonas alpina	·	·	·	·	·	·	·	·	+	·	·
M. bourrellyi	·	·	·	·	·	·	·	·	·	+	·
M. elongata	·	·	·	·	·	·	·	·	·	·	+
Mallomonas sp.	+	·	·	·	·	·	·	·	·	·	·
Bicoeca lacustris v. *longipes*	·	·	+	·	·	·	·	·	·	·	·
Monosiga ovata	·	·	+	+	+	·	·	·	·	·	·
M. varians	·	·	+	·	·	·	·	+	·	·	·
Salpingoeca frequentissima	·	·	·	·	·	+	+	·	·	·	·
Stichogloea doederleinii	·	·	·	·	·	·	·	·	·	+	·
Synura uvella	·	·	·	·	·	·	·	·	·	·	+
BACILLARIOPHYCEAE											
Melosira ambigua	·	·	·	·	·	·	+	+	·	·	·
M. distans	·	·	·	·	·	·	·	·	·	·	+
M. granulata	◔	+	+	+	+	·	+	+	·	·	+
M. hustedtii	·	+	·	·	·	·	·	·	·	·	·
M. patagonica	·	·	·	+	·	·	·	·	·	·	·
M. varians	·	·	·	·	+	·	·	·	·	·	·
Cyclotella stelligera	·	+	·	·	·	·	·	·	·	·	·
Rhizosolenia eriensis	+	·	◑	●	+	+	◑	+	·	·	·
Tabellaria quadriseptata	·	·	·	·	+	·	·	·	·	·	+
Diatoma elongatum	·	·	·	+	+	·	+	·	·	·	·
D. vulgare	+	·	·	·	·	·	·	·	·	·	·
Fragilaria crotonensis	+	·	+	·	·	+	·	·	·	·	·
Asterionella gracillima	·	+	+	·	·	·	·	·	·	·	·
Synedra ulna v. *danica*	·	·	·	+	+	·	+	+	·	·	·
Surirella guatimalensis	·	+	·	·	·	·	·	·	·	·	·
CHLOROPHYTA											
VOLVOCALES											
Eudorina elegans	+	·	◑	+	+	◑	+	·	·	·	+
Pandorina morum	·	·	·	·	·	+	+	·	·	·	·
Volvox aureus	·	·	·	·	·	+	·	·	·	·	·
Coenocystis subcylindrica	·	·	·	·	·	·	·	·	·	·	+
Gloeococcus schroeteri	·	·	·	·	·	+	·	·	·	·	·
CHLOROCOCCALES											
Nephrocytium lunatum	·	·	·	·	+	·	+	·	·	·	·
Kirchneriella contorta	·	·	·	·	·	·	·	·	·	·	+
Selenastrum westii	·	·	·	·	·	·	·	·	·	·	+
Botryococcus braunii	+	+	+	·	·	+	+	·	+	+	+
Dictyosphaerium pulchellum	·	·	·	·	+	+	·	·	·	·	·
Pediastrum tetras	·	·	·	·	·	·	·	·	·	·	+

Table 8. (*Continued*)

	Traful		Espejo			Correntoso			Cántaros		Baguales
	20.5.1961	9.1.1962	20.5.1961	11.1.1962	6.3.1962	20.5.1961	11.1.1962	7.3.1962	28.2.1961	26.2.1963	15.4.1961
Crucigenia tetrapedia	·	·	·	·	·	·	·	·	·	·	+
Scenedesmus bicaudatus	·	·	·	·	·	·	·	·	·	·	+
S. ecornis	·	·	·	·	·	·	·	·	·	·	+
S. quadricauda	·	·	·	·	·	·	·	·	·	·	+
CONJUGALES											
Mougeotia sp. ster.	·	·	·	·	·	·	·	·	·	·	◑
Gonatozygon kinahani	·	·	+	·	·	·	+	·	·	·	·
G. monotaenium	·	·	+	·	·	·	·	·	·	·	·
Closterium aciculare	·	·	·	·	·	·	·	·	·	·	+
Pleurotaenium ehrenbergii	·	·	·	·	·	·	·	·	·	·	+
P. trabecula	·	·	·	·	·	·	·	·	·	·	+
Cosmarium regnesii	·	·	·	·	·	·	·	·	·	·	+
C. subspeciosum v. *validius*	·	·	·	·	·	·	·	+	·	·	·
Staurodesmus cuspidatus	+	+	·	·	·	·	·	·	·	·	·
S. megacanthus f. – Thomasson (1959, fig. 21: 23)	·	·	+	·	+	·	·	·	·	·	·
S. sellatus fac. *sellatus*	·	·	+	·	+	·	+	·	+	·	·
S. triangularis fac. *stroemii*	+	·	·	+	+	·	+	·	·	·	·
Staurastrum brebissonii	+	·	·	·	·	·	·	·	·	·	·
S. rotula v. *smithii*	·	·	·	·	+	·	·	+	·	·	·
S. sebaldi v. *ornatum* f. *planctonica*	+	+	·	·	·	·	·	·	·	·	·
S. tetracerum v. *evolutum*	·	·	·	·	·	·	·	·	·	·	+
Staurastrum sp. – Smith (1924, pl. 73, figs. 7–11)	·	·	·	·	·	·	·	·	·	·	+
Desmidium baileyi f. *tetragona*	·	·	·	·	·	·	+	·	·	·	·
PROTOZOA											
Acanthocystis aculeata	●	+	·	·	+	·	+	·	·	·	·
Rhaphidiophrys sp.	·	·	+	·	·	·	·	·	·	·	·
Stentor sp.	+	+	+	·	+	+	·	·	+	+	·
Vagnicola sp.	·	·	+	◔	◑	·	+	+	·	+	·

Table 8. (*Continued*)

	Traful		Espejo			Correntoso			Cántaros		Baguales
	20.5.1961	9.1.1962	20.5.1961	11.1.1962	6.3.1962	20.5.1961	11.1.1962	7.3.1962	28.2.1961	26.2.1963	15.4.1961
ROTATORIA											
Ascomorpha saltans	·	·	+	·	·	·	·	·	·	·	·
Asplanchna sp.	·	·	·	+	·	·	+	·	·	·	·
Brachionus calyciflorus	·	·	·	·	·	·	·	·	·	·	+
Collotheca sp.	+	·	·	·	·	·	+	·	·	·	·
Conochilus unicornis	·	·	+	·	+	+	+	·	+	·	·
Filina longiseta	·	·	+	·	+	+	·	·	·	·	·
F. terminalis	·	·	+	·	·	·	·	·	·	·	·
Gastropus stylifer	+	+	+	·	+	+	+	·	·	·	·
Keratella c. cochlearis	+	●	+	+	+	+	+	+	+	·	+
K. cochlearis tecta	·	·	+	·	+	·	·	·	·	·	·
Keratella tropica	·	·	·	·	·	·	·	·	·	·	+
Monostyla sp.	·	+	·	·	·	·	·	·	·	·	·
Notholca haueri	·	·	+	·	·	·	·	·	·	·	·
Philodina roseola	+	·	+	·	+	+	+	·	·	+	·
Polyarthra dolichoptera	·	·	+	·	·	·	·	·	·	·	·
P. vulgaris	◑	+	+	+	+	+	◑	+	◔	+	◑
Pompholyx sulcata	·	·	+	+	+	+	·	·	·	·	+
Synchaeta sp.	+	·	·	·	·	·	+	·	·	+	+
Trichocerca birostris	·	·	·	·	·	+	·	·	+	·	·
T. chattoni	·	·	·	·	·	·	·	·	+	·	·
T. r. rattus	·	·	·	·	·	·	·	·	·	+	·
T. similis	·	·	·	·	·	·	·	·	·	+	·
T. stylata	·	·	·	·	·	·	·	·	·	·	+
Trichocerca sp.	·	+	·	·	+	·	+	·	·	+	·
CLADOCERA											
Bosmina chilensis	·	+	·	·	+	·	·	·	·	·	·
Ceriodaphnia dubia	·	·	·	·	+	·	·	·	·	·	·
Ceriodaphnia sp.	·	·	+	·	·	·	·	·	·	·	·
Diaphanosoma excisum chilense	·	·	·	·	·	·	·	·	·	+	·
Scapholeberis spinifera	·	·	·	+	+	·	·	·	·	·	·
COPEPODA											
Boeckella gracilipes	·	·	+	·	·	+	+	·	·	·	·
Cyclops sp.	·	·	·	·	+	·	·	·	+	·	+

8. LAKE NAHUEL HUAPI

The large Lake Nahuel Huapi lies in the centre of the National Park. Its basin is a wide branching valley with the head in the main range of the Cordillera and, descending past high mountains, reaching beyond the Andes into the relatively lower lands that lie between the Andes and the high plateaux of western Rio Negro. The main body of the lake is a long fiord which curves northward in the eastern lower part and ends at its north-eastern outlet nearly at right angles to the general trend. From its central section, where the Isla Victoria lies, several arms diverge and penetrate the mountains to the north and west, and the main body of the lower lake opens out eastward. The Brazo Huemul extends south-eastward. The Brazo Puerto Blest reaches directly westward to the foot of some high granite domes that are the counterforts of the main range of the Andes. The Brazo de la Tristeza winds south-westward. The total area of the drainage basin of Lake Nahuel Huapi is 2758.4 km^2. For a general description of Lake Nahuel Huapi see Thomasson (1959).

The colour of Lake Nahuel Huapi is usually blue. After the great earthquake catastrophe in Chile on May 22, 1960, when all lakes within the National Park were deluged with great quantities of ashes the colour of the lake turned green. In February 1961, the whole lake was still green, according to the information kindly given by Dr. Vinterbäck. The green colour of Brazo Puerto Blest was, naturally, the most dense. It is a pity that no chemical analyses have been made so that the influence of precipitating volcanic ashes could have been studied.

Naturally, as will be evident from the following paragraphs, the composition of plankton in such a large and complicated basin is not homogeneous, cf. the samples from April 15, 1961, in table 9.

The first column in table 9 is for the sample from 1954, which has also been reproduced in Thomasson (1959).

The second column is for the sample collected on February 4, 1961, at Centro Atomico, just a few kilometers to the west from Bariloche. The temperature of the surface water was 16°C. The predominant plankter was *Melosira granulata*; subdominants were *Rhizosolenia eriensis* and *Synedra ulna*. *Dictyosphaerium* was fourth in quantity. Note the occurrence of *Ceratium cornutum*.

On March 13, 1961, a sample was collected from the same spot. The temperature of water was about 14°C. Due to a volcanic eruption in Chile on March 10, the sample contains large amounts of detritus. The number of plankters is small. The most abundant plankter is *Rhizosolenia eriensis*, and the second is *Melosira granulata*. It is interesting that *Dictyosphaerium* is absent in this sample.

On April 15, 1961, a sample was collected at the east side of Isla Victoria, at Puerto Gober. The water temperature was 12°C. The composition of the prevailing plankton community is given in table 9, the first column under 15.4.1961. The predominant plankter is *Dictyosphaerium pulchellum*, the subdominant *Melosira granulata*. The second column under 15.4.1961 gives the composition of plankton at the west side of Isla Victoria. The sampling was carried out at Puerto Anchorena which lies about 30 km from Bariloche. About 99 per cent of plankton was made up of *Dinobryon cylindricum*. *Dinobryon divergens* was also common.

On April 23, 1961, samples were collected in Brazo de la Tristeza. Here the bulk of plankton, about 80 per cent, was made up of *Dictyosphaerium pulchellum*. *Rhizosolenia eriensis* was amply present. Only 5 cells of *Asterionella gracillima* were noted.

On May 20, 1961, sampling was carried out at Villa Angostura which is located on the northernmost part of the lake, about 48 km by water from Bariloche, 94.5 km by road. Up to 60 per cent of the samples consisted of *Dictyosphaerium*. *Melosira granulata* was next in abundance. A few short colonies of *Fragilaria crotonensis* were encountered, and only one cell of *Asterionella gracillima*. Besides the plants of ordinary breadth, I have also found in these samples broad plants, 25 μ, of *Rhizosolenia* *eriensis.* The temperature of surface water was about 6°C.

One week later, on May 27, 1961, a sample was collected at Puerto Ciprés, located 11 km west of Bariloche. About 70 per cent of plankton was made up of *Dictyosphaerium pulchellum*, the second most frequent species was *Melosira granulata.* There is no record of the water temperature, but on June 3 it was 9.5°C.

At the beginning of October the spring begins. On October 22, 1961, *Dictyosphaerium pulchellum* was still the most frequent plankter, followed by *Melosira granulata.* Both narrow and broad plants of *Rhizosolenia* were present. This sample was collected from Brazo Campanario, at Hosteria Querencia, about 14 km west of Bariloche. The water temperature was about 11°C. Brazo Campanario is the arm of Lake Nahuel Huapi where the sampling was made in 1954. It lies in the shelter of Peninsula San Pedro, the site of the ancient mission.

On December 25, 1961, another sample was collected from the same arm of Lake Nahuel Huapi. The temperature of the surface water was about 17°C. The predominant plankter was *Dinobryon divergens*; *Rhizosolenia eriensis* and *Dictyosphaerium pulchellum* were also abundant.

About one month later, on January 28, 1962, a sample was collected at Playa Bonita. This is located 8 km west of Bariloche. The temperature of the water was 18°C. *Rhizosolenia* had become more abundant than *Dinobryon.* It occurred in narrow as well as broad forms. Second in quantity were *Dinobryon divergens* and *D. cylindricum.*

The last samples were collected at Villa Angostura on March 7, 1962. The temperature of water was 15°C. *Dinobryon divergens* was the most abundant plankter, but its dominance was not very strong. *Rhizosolenia* was also frequent. *Tabellaria flocculosa* var. *asterionelloides* was of very rare occurrence.

It is not easy to establish the annual succession of the plankton community of Lake Nahuel Huapi from these samples. This is partly because the observation period is too short, and partly because the different parts of the complicated lake basin were not all covered by sampling. In spite of these shortcomings, it seems evident that during the winter half-year the predominant plankter is *Dictyosphaerium pulchellum.* During the summer half-year the *Bacillariophyceae* and *Chrysophyceae* predominate. One would be likely to expect the reverse. *Rhizosolenia eriensis* flourishes during the summer, and also *Dinobryon* which, however, is also abundant during the autumn. *Melosira granulata* seems to have two maxima, viz. one in the spring, and one more extended during the late summer and autumn. The small number of samples covering the winter and spring seasons makes this effort to outline the development of the plankton community open to discussion. With no records of physical and chemical conditions in Lake Nahuel Huapi, except the water temperature, one can only make the tentative suggestion that during the rainy cool season large quantities of essential nutritive material are washed from the drainage basin into the lake and bring about the luxuriant growth of *Dictyosphaerium pulchellum.*

TABLE 9.
Plankton of Lake Nahuel Huapi

	25.1.1954	4.2.1961	13.3.1961	15.4.1961	23.4.1961	20.5.1961	27.5.1961	22.10.1961	25.12.1961	28.1.1962	7.3.1962	25.2.1963
CYANOPHYTA												
Aphanocapsa elachista v. *planctonica*	·	·	·	· ·	·	·	·	·	·	·	+	·
Chroococcus minutus	+	·	·	· ·	·	·	·	·	·	·	·	·
Dactylococcopsis ellipsoideus	+	·	·	· ·	·	·	·	·	·	·	·	·
Gomphosphaeria lacustris	+	·	·	· ·	·	·	·	·	·	·	·	·
Merismopedia glauca	+	·	·	· ·	·	·	·	·	·	·	+	·

TABLE 9. (*Continued*)

	25.1.1954	4.2.1961	13.3.1961	15.4.1961	23.4.1961	20.5.1961	27.5.1961	22.10.1961	25.12.1961	28.1.1962	7.3.1962	25.2.1963
Oscillatoria limosa	·	·	·	· ·	·	·	·	+	+	·	·	·
Oscillatoria sp.	·	·	·	· ·	·	·	·	·	·	+	·	·
PYRROPHYTA												
Ceratium cornutum	·	+	+	· ·	·	·	·	·	·	·	·	·
Peridinium bipes	·	+	·	· ·	·	·	·	·	·	·	·	·
P. cinctum	·	·	·	· +	·	+	·	·	·	+	·	·
P. willei	+	+	·	+ ·	+	·	+	·	·	+	+	·
P. volzii	·	·	·	· ·	·	·	·	·	·	·	·	+
CHRYSOPHYTA												
CHRYSOPHYCEAE												
Chrysosphaerella brevispina	·	·	·	· +	+	+	·	+	·	+	+	·
Dinobryon cylindricum	+	+	+	+ ●	+	+	+	·	·	◔	+	·
D. cylindricum v. *alpinum*	·	·	·	· ·	·	·	·	·	·	+	·	·
D. cylindricum v. *palustre*	+	·	·	· ·	+	·	·	·	·	·	·	·
D. divergens	●	+	+	+ ◔	+	+	+	·	●	◔	◔	+
D. divergens v. *schauinslandii*	+	·	·	· ·	·	·	·	·	·	·	·	·
D. sertularia	◔	·	·	· ·	·	·	·	·	·	·	·	·
Mallomonas alpina	·	·	·	· +	·	+	+	·	·	·	·	·
M. elongata	·	·	·	· +	·	·	·	·	·	·	·	·
Salpingoeca elegans	+	·	·	· ·	·	·	·	·	·	·	·	·
S. frequentissima	·	+	+	+ +	+	+	+	·	+	·	+	·
BACILLARIOPHYCEAE												
Melosira ambigua	+	·	·	· ·	·	·	·	·	·	·	·	·
M. granulata	+	●	◑	◑ +	+	◑	◑	◑	+	·	+	+
Cyclotella stelligera	·	·	·	· ·	·	·	·	·	+	·	·	·
C. stelligera v. *elliptica*	+	+	·	· ·	·	·	+	·	+	+	·	·
Rhizosolenia eriensis	◑	◑	●	+ +	◔	+	+	+	◑	●	+	+
Tabellaria flocculosa f. *asterionelloides*	·	·	·	· ·	·	·	·	·	·	·	+	·
Diatoma elongatum	+	+	+	· ·	+	+	·	+	+	·	·	·
Asterionella gracillima	·	·	·	· ·	+	+	·	·	·	·	·	·
Fragilaria crotonensis	·	·	·	· ·	·	+	·	+	+	·	·	·
Synedra acus	·	+	+	· ·	+	·	·	·	+	·	·	·
S. ulna	·	◑	+	· +	+	·	+	+	+	+	+	·
S. ulna v. *danica*	+	·	·	· ·	·	·	·	·	·	·	·	+
Surirella guatimalensis	·	·	+	· +	·	·	+	+	+	·	·	+
CHLOROPHYTA												
VOLVOCALES												
Eudorina cylindrica	·	·	·	· ·	+	+	·	·	·	·	·	·
E. elegans	+	+	·	+ +	+	+	+	+	·	+	+	·
Pandorina morum	·	·	·	· +	·	·	·	+	·	·	·	·
Gemellicystis neglecta	·	·	·	· ·	·	·	·	·	·	+	+	·
Gloeococcus schroeteri	+	·	+	· ·	+	+	+	+	+	+	+	·
Paulschulzia pseudovolvox	+	·	·	· ·	·	+	+	+	+	+	·	·
Tetraspora lacustris	+	·	·	· ·	·	·	·	·	·	+	+	·
CHLOROCOCCALES												
Micractinium sp.	+	·	·	· ·	·	·	·	·	·	·	·	·
Nephrocytium limneticum	·	·	·	· ·	·	·	·	·	+	+	·	·

TABLE 9. (*Continued*)

	25.1.1954	4.2.1961	13.3.1961	15.4.1961	23.4.1961	20.5.1961	27.5.1961	22.10.1961	25.12.1961	28.1.1962	7.3.1962	25.2.1963
Oocystis solitaria	+	·	·	· ·	·	·	·	·	·	·	·	·
O. submarina v. *variabilis*	+	·	·	· ·	·	·	·	·	·	·	·	·
Kirchneriella obesa	+	·	·	· ·	·	·	·	·	·	·	·	·
Botryococcus braunii	+	+	·	+ +	+	+	+	·	·	+	+	·
Dictyosphaerium pulchellum	+	◔	·	● +	●	●	●	●	◑	+	·	·
Coelastrum proboscideum	+	·	·	· ·	·	·	·	·	·	·	·	·
Crucigenia rectangularis	+	·	·	· ·	·	·	·	·	·	·	·	·
Hofmania lauterbornii	+	·	·	· ·	·	·	·	·	·	·	·	·
Pediastrum boryanum	+	·	·	· ·	·	·	·	·	·	·	·	·
ULOTRICHALES												
Elakatothrix biplex	·	·	·	· ·	·	·	·	·	·	+	+	·
Geminella minor	·	+	·	· ·	+	+	+	+	+	+	·	·
CONJUGALES												
Gonatozygon kinahani	·	·	·	+ +	+	+	·	·	·	·	·	·
G. monotaenium	·	·	·	· ·	·	·	·	+	·	·	·	·
Closterium leibleinii	·	·	·	· ·	·	·	·	+	·	·	·	·
Cosmarium botrytis	+	·	·	· ·	·	·	·	·	·	·	·	·
C. connatum	+	·	·	· ·	·	·	·	·	·	·	·	·
C. contractum v. *ellipsoideum*	+	·	·	· ·	·	·	·	·	·	·	·	·
C. subspeciosum v. *validius*	·	·	·	· ·	·	·	·	·	·	·	+	·
Staurodesmus megacanthus	+	·	·	· ·	·	·	·	·	·	·	·	·
S. patens f. – figs. 46: 2–5	·	·	·	+ +	+	+	+	+	+	+	·	·
S. sellatus fac. *jacobsenii*	+	·	·	· ·	·	·	·	·	·	·	·	·
S. sellatus fac. *sellatus*	·	·	·	· ·	+	·	·	+	·	·	·	·
Staurastrum avicula	+	·	·	· ·	·	+	·	+	+	+	+	·
S. hexacerum	·	·	·	· ·	·	·	·	·	+	·	·	·
S. planctonicum v. *ornatum* – Thomasson (1959, fig. 22: 11)	+	·	+	+ +	+	+	+	+	+	+	·	·
S. rotula v. *smithii*	+	·	·	· ·	+	+	+	·	·	·	+	+
S. sebaldi v. *ornatum* f. *planctonica*	+	·	·	· ·	·	·	·	·	·	·	·	·
S. tetracerum v. *evolutum*	+	·	·	· ·	·	+	·	+	+	·	·	·
S. trachytithophorum	+	·	·	· ·	·	·	·	·	·	·	·	·
Sphaerozosma aubertianum	·	·	·	· ·	·	·	+	+	·	·	·	·
S. vertebratum	+	·	·	· ·	·	·	·	·	·	·	·	·
Hyalotheca dissiliens	·	·	·	· ·	·	·	·	+	·	·	·	·
Desmidium swartzii	·	·	·	· ·	+	·	·	·	·	·	·	·
PROTOZOA												
Acanthocystis aculeata	·	·	·	· ·	·	·	·	·	·	·	+	+
Heliozoa spp.	·	·	·	· +	·	+	·	+	·	·	·	+
Rhaphidiocystis tubifera	+	·	·	· ·	·	·	·	·	·	·	+	·
Rhaphidiophrys sp.	+	·	·	· ·	·	·	·	·	·	·	·	·
Stentor sp.	·	·	·	· +	·	+	·	+	+	+	+	·
Tokophrya quadripartita	·	·	·	· ·	·	·	·	·	·	+	·	·
Vagnicola sp.	·	·	·	· ·	·	·	·	·	+	+	+	+
ROTATORIA												
Argonotholca foliacea	·	·	·	· ·	·	+	·	+	·	·	·	·
Collotheca mutabilis	·	·	·	· +	·	·	·	·	·	·	·	·
Collotheca sp.	+	·	·	· ·	·	+	·	·	·	·	·	·

Table 9. (*Continued*)

	25.1.1954	4.2.1961	13.3.1961	15.4.1961	23.4.1961	20.5.1961	27.5.1961	22.10.1961	25.12.1961	28.1.1962	7.3.1962	25.2.1963
Conochilus unicornis	+	·	·	+ ·	·	+	+	·	·	·	·	·
Filina longiseta	·	·	·	+ +	+	+	+	·	·	·	·	·
Gastropus stylifer	◔	+	+	· ·	+	+	+	·	·	·	+	·
Hexarthra fennica	·	·	·	· ·	·	+	·	·	·	·	·	·
Keratella c. cochlearis	◔	+	+	· +	+	+	+	·	+	+	+	+
Lecane flexilis	·	·	·	· +	·	·	·	·	·	·	·	·
L. luna	·	·	·	· ·	·	·	·	·	·	·	·	+
Lepadella patella	·	·	·	· ·	·	·	·	+	+	·	·	·
Monostyla lunaris	+	·	·	· ·	·	·	·	·	·	·	·	·
Philodina sp.	+	·	·	· ·	·	·	+	·	·	·	·	·
Polyarthra vulgaris	+	+	+	+ +	+	+	+	+	+	+	+	+
Pompholyx sulcata	+	+	·	+ +	+	+	+	·	·	·	+	·
Synchaeta pectinata	+	·	·	· ·	·	·	·	·	·	·	·	·
Synchaeta sp.	+	·	·	· ·	·	+	·	·	·	·	·	·
Testudinella coeca lermaensis	+	·	·	· ·	·	·	·	·	·	·	·	·
Trichocerca birostris	+	·	·	· ·	·	·	·	·	·	·	·	·
T. brachyura	+	·	·	· ·	·	·	·	·	·	·	·	·
Trichotria tetractis	·	·	·	· ·	·	·	·	·	·	·	·	+
CLADOCERA												
Alonella sp.	+	·	·	· ·	·	·	·	·	·	·	·	·
Bosmina chilensis	+	·	·	· ·	·	·	·	·	·	·	+	·
Diaphanosoma excisum chilense	·	·	·	· +	·	·	+	·	·	·	·	·
COPEPODA												
Boeckella gracilipes	◑	·	+	+ +	+	·	+	+	·	·	·	·
Cyclops sp.	·	+	·	· +	·	·	·	·	·	·	·	·

9. LAKE FRIAS

This little lake, with an area of about 5 km², lies at an altitude of 770 m on the international route between Argentina and Chile. It is located close to the Chilean frontier, see the map fig. 1, and pl. 12 and 13 in Thomasson (1959). Lake Frias, like the lakes mentioned below, lies in the southern half of Nahuel Huapi National Park which forms the westernmost part of Territorio Nacional del Rio Negro.

For the composition of plankton in Lake Frias, see table 10. The temperature of water was 14°C on February 28, 1961, and about 10°C on April 2, 1961. The samples collected at Hotel Lago Frias were rich in detritus due to the inflow of Rio Frias into this part of the lake. On the other hand, in the samples collected at Puerto Alegre, located at the north end of the lake, the amount of detritus was considerably smaller. The plankton of Lake Frias is sparse both from a quantitative and a qualitative point of view. Noteworthy is the occurrence of *Ceratium cornutum*, and of a form of *Keratella cochlearis* with an extremely long posterior spine, like the one figured in Ahlstrom (1943, pl. 35, fig. 1), or the one in Thomasson (1957 a, fig. e). Lake Frias is the only one of the North Patagonian lakes where I have found this form. In the sample collected on February 25, 1963 a lorica of *Kellicottia longispina* was observed.

10. LOS CAUQUENES

Paso Vuriloche is located at the head of the upper Rio Manso valley. It is the pass by which Friar Menéndez crossed the range when searching for the lost road of Vuriloche. The old path of Vuriloche passes a number of small lakes called Lagunitas Los Cauquenes (Canquenes). They are located close to the boundary between Argentina and Chile. One can also discern them on the map, fig. 1 in Thomasson (1959), lying just about 5 km north of the westernmost end of Lake Fonck. The altitude of these small lakes is from 1380 to 1460 m. Some of them drain to the west, the others to the east. From one of these lakes a sample was collected on March 30, 1961. The water temperature was about 7°C.

The sample proved to consist of almost a pure culture of *Peridinium volzii*; about 99 per cent of the plankton was made up of this species. It is noteworthy that *Ceratium hirundinella* was encountered in this sample.

On the next day a sample was collected from a little pond located close to the tree-line just a little below the "Observatory" on Mt. Tronador. The "Observatory" is situated between the glaciers Alerces and Castaño Overo at an altitude of about 1800 m. This sample is rather poor. *Cylindocystis brebissonii* is the most abundant organism. In addition *Peridinium willei*, *P. volzii*, *Staurastrum spongiosum*, and *Boeckella gracilis* (*schwabei*) were noted.

11. LAKE FREY

One can find this small lake on the map, fig. 1 in Thomasson (1959), located just a little south-west of Brazo de la Tristeza, the south-western arm of Lake Nahuel Huapi. Here in the shadow of Cerro Capitán (1944 m) and Cerro Frey, lies Lake Frey. It is a clear and deep lake; the shores are precipitous, in some places they slope steeply toward the lake in precipices of 400 meters or more. The area of Lago Frey is about 1 km², and that of its drainage basin roughly 5.4 km². The altitude is approximately 800 m above sea level.

The plankton proved to be rather sparse, according to the sample which was collected on April 24, 1961. Predominant plankter was *Dinobryon divergens*. The temperature of the water was about 10°C. In the sample collected on February 17, 1963 by Dr. Lerman a lorica of *Kellicottia longispina* was noted.

12. LAKE MORALES

The little Laguna Morales lies close to the north-eastern shore of Lake Perito Moreno, near Hotel El Trébol, 21 km from Bariloche. It lies in a region of hills and hollows, of attractive meadows, of charming lakelets, and of rich verdure.

On December 24, 1961, a sample was collected from this lake. The temperature of the water was about 19°C, and the air temperature 22°C. Approximately 80 per cent of the prevailing plankton community was made up of *Dinobryon divergens*. *Dinobryon cylindricum* and *Rhizosolenia eriensis* were also abundant. For the composition of the plankton community see table 10.

13. LAKE PERITO MORENO ESTE

The western arm of peninsula Llao-Llao encloses in the north the twin lakes known as Lagos Perito Moreno. They lie about 20 km west of Bariloche. South-west of these lakes tower the mighty peaks of Cerro Lopez (2075 m). Along the shores here and there are luxuriant patches of *Scirpus californicus* var. *tereticulmis*.

On February 11, 1962, a sample was collected from the eastern of the twin lakes. The water in this lake was clear and bluish; temperature 19°C. The plankton of Lago Perito Moreno Este was abundant. The predominant plankter was *Rhizosolenia eriensis*, followed by *Dinobryon divergens* and *Polyarthra vulgaris*.

14. LAKE GUTIÉRREZ

Lake Gutiérrez lies in a deep glacial trough between Sierra de la Ventana and El Catedral. Its shores are steep. To the west rise the pinnacles of

El Catedral up to 2388 m, a ridge whose gigantic spires, slenderer than the lightest gothic towers, at once suggest and justify its name. To the east the Sierra de la Ventana exceeds 2000 meters in altitude. The valley between these ridges continues southwards, as if through a gateway in the range. In passing through this valley one observes no dividing ridge, yet one crosses from the Atlantic to the Pacific watershed beyond the Continental Divide, see the map fig. 1 in Thomasson (1959). From the north end of Lake Gutiérrez the Arroyo Gutiérrez flows out across a gravel plain and enters Lago Nahuel Huapi near Puerto Moreno. The altitude of Lake Gutiérrez is 800 meters above sea level. The area is about 18 km², and that of its drainage basin about 38.4 km².

On March 25, 1961, a sample of plankton was collected at the north end of the lake. It proved to be rather sparse. The predominant plankter was *Dinobryon divergens*; *Stentor* and *Polyarthra* were also abundant. The plankters which were present in this sample are listed in table 10. Only a broken theca of *Ceratium hirundinella* was found. The temperature of the water was 14°C.

15. LAKE MASCARDI

The horseshoe-shaped Lake Mascardi occupies a section of the valley that contains also Lake Gutiérrez, from which it is separated only by a gravel plain which hardly separates the two lakes, yet which divides the waters of the eastern and western oceans. The altitude of Lake Mascardi is 796 m, the area of the lake is about 36 km². Lake Mascardi is a link in the curious chain of rivers and lakes that make up the Rio Manso. The main stream rises in the glaciers on the slopes of Mt. Tronador and enters the western arm of Lake Mascardi. Leaving the lake at the south-west the river runs westward to Lago Hess, thus doubling back on itself.

On March 29, 1961, two samples were collected from Lake Mascardi. The first one was from Brazo Este, and the second one was taken at Hotel Tronador. At the first station the temperature of the surface water was about 13°C, and at the second one 8–10°C. These samples proved to be very similar. In both samples *Dinobryon divergens* was the predominant plankter, and the other plankters were also the same. Therefore, the results of the planktological analyses are given in one column in table 10.

On April 12, 1961, sampling was carried out at Estación de Servicio del A.C.A. The composition of the plankton can be seen in table 10. The water temperature was 14°C.

16. LAKE GUILLELMO

Lake Guillelmo is located south of Lake Mascardi at an altitude of 826 meters. It is a small valley lake.

The sample from March 29, 1961, is characterized by the abundance of *Boeckella gracilipes*. In addition, *Dinobryon divergens* is frequent. The temperature of water at sampling was about 10°C. For the composition of the plankton see table 10.

17. LAKE HESS

Among the lakes situated in the southern part of Nahuel Huapi National Park is also Lake Hess. This lake, like some of the others, has been mentioned briefly in Thomasson (1959).

Lake Hess lies just south of latitude 41° 20′ within an extensive basin which gathers the waters of the upper Rio Manso, and those of several streams that flow from the western Cordillera. The altitude of Lake Hess is something between 730 and 750 meters, and the area about 4 km². The shores are in part low, in part higher gravel terraces.

As in 1954, the sample which was collected on March 29, 1961, was rich in plankters and tychoplankters. The temperature of water at sampling was about 9°C. The predominant plankter was *Dinobryon divergens*. The occurrence of *Euastrum attenuatum* var. *splendens* is noteworthy, a plant which as far as I know has hitherto only been found in Africa.

TABLE 10.
Plankton of some lakes in the southern part of Nahuel Huapi National Park

	Frias				Caquenes	Frey		Morales	Moreno	Gutiérrez		Mascardi			Guillelmo		Hess	
	1.2.1954	28.2.1961	2.4.1961	25.2.1963	30.3.1961	24.4.1961	17.2.1963	24.12.1961	11.2.1961	22.1.1954	25.3.1961	23.1.1954	29.3.1961	12.4.1961	23.1.1954	29.3.1961	26.1.1954	29.3.1961
CYANOPHYTA																		
Aphanocapsa elachista v. *planctonica*	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
A. pulchra	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
A. roseana	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
Aphanothece microspora	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
Chroococcus limneticus	·	·	·	·	·	·	·	·	·	·	+	+	·	·	+	·	·	·
Coelosphaerium kuetzingianum	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
Gomphosphaeria lacustris	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	+	·
Merismopedia glauca	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
M. tenuissima	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
Anabaena solitaria f. *planctonica*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Anabaena sp.	·	·	·	·	+	·	·	·	·	·	·	+	·	·	+	·	+	·
Nostoc coeruleum	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·
Nostoc sp.	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·
Lyngbya putealis	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Lyngbya sp.	·	·	·	·	·	·	·	·	·	+	·	·	·	·	+	·	·	·
Oscillatoria lacustris	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
O. tenuis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Oscillatoria sp.	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·
EUGLENOPHYTA																		
Euglena sp.	+	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
PYRROPHYTA																		
Ceratium cornutum	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
C. hirundinella f. *austriacum*	·	·	·	·	+	·	+	·	·	·	+	·	·	·	·	·	+	·
Gymnodinium sp.	·	·	·	·	·	·	·		·	+	·	·	·	·	·	·	+	·
Peridinium cinctum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·
P. cinctum f.	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·
P. willei	·	·	+	·	+	·	·	·	+	+	+	◔	+	+	+	·	+	·
P. volzii	·	·	·	·	●	·	+	+	·	·	·	·	+	·	·	+	+	·
Peridinium sp.	·	·	+	·	·	·	·	·	·	+	·	+	+	·	+	+	·	·
CHRYSOPHYTA																		
CHRYSOPHYCEAE																		
Chrysosphaerella brevispina	·	·	·	·	·	+	+	·	·	·	·	·	·	·	·	·	+	+
Dinobryon cylindricum	+	·	·	·	+	·	·	◔	+	◔	+	+	+	·	·	+	·	+
D. divergens	·	·	+	·	+	◔	·	●	◑	●	●	●	●	+	●	◔	+	●
D. divergens v. *schauinslandii*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
D. sertularia	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	+	·
D. sociale v. *americanum*	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·
Diploeca flava	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Mallomonas acaroides	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
M. alpina	+	·	+	·	+	·	·	·	·	·	·	·	·	·	·	+	+	+
M. elliptica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
M. elongata	·	·	·	·	+	·	·	+	·	·	·	+	+	+	·	·	·	+
Monosiga ovata	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·

Table 10. (*Continued*)

	Frias				Cauquenes	Frey		Morales	Moreno	Gutiérrez		Mascardi			Guillelmo		Hess	
	1.2.1954	28.2.1961	2.4.1961	25.2.1963	30.3.1961	24.4.1961	17.2.1963	24.12.1961	11.2.1961	22.1.1954	25.3.1961	23.1.1954	29.3.1961	12.4.1961	23.1.1954	29.3.1961	26.1.1954	29.3.1961
Salpingoeca buetschlii	·	·	·	·	·	·	·	·	·	·	·	+	·	·	+	·	+	·
S. frequentissima	·	·	·	·	·	·	·	+	·	·	+	·	·	+	·	+	·	·
Stichogloea doederleinii	·	·	·	·	·	·	·	+	·	+	·	·	·	·	·	·	·	·
BACILLARIOPHYCEAE																		
Melosira ambigua	·	+	+	·	·	·	·	·	·	+	·	·	·	·	·	·	+	·
M. distans	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
M. granulata	·	·	·	·	+	·	·	+	+	+	+	+	+	·	+	+	+	+
M. italica	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
M. patagonica	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
Cyclotella stelligera	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
C. stelligera v. *elliptica*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Rhizosolenia eriensis	·	·	·	·	·	·	·	◔	●	+	+	◔	+	+	+	+	+	+
Tabellaria flocculosa f. *asterionelloides*	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·
Tetracyclus ellipticus v. *lancea* f. *chilensis*	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diatoma elongatum	+	+	+	·	·	·	·	·	·	+	·	·	·	·	+	·	+	+
D. elongatum v. *fuegensis*	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
D. hiemale	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
D. hiemale v. *mesodon*	+	+	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
D. vulgare v. *producta*	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Fragilaria sp.	+	·	·	+	·	·	·	·	·	+	·	·	·	·	+	·	+	·
Synedra acus	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	+	·
S. ulna	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	+	·
S. ulna v. *amphirhynchus*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
S. ulna v. *danica*	+	·	·	·	·	·	·	·	·	·	·	+	+	+	+	·	+	+
Neidium hitchcockii	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Gomphonema acuminatum v. *coronata*	+	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	+	·
Nitzschia vermicularis	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Cymatopleura solea	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
Surirella guatimalensis	+	+	·	·	·	·	·	+	+	+	·	·	+	+	·	·	+	·
S. robusta	+	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
S. tenera	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
Surirella spp.	+	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·
CHLOROPHYTA																		
VOLVOCALES																		
Eudorina elegans	·	·	·	·	+	·	·	·	·	+	·	◔	+	+	·	·	+	·
Pandorina morum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
Asterococcus superbus	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
Gemellicystis neglecta	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
Gloeococcus schroeteri	·	·	·	·	·	·	·	·	·	+	·	+	·	·	·	·	·	·
Paulschulzia pseudovolvox	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·
Schizochlamys sp.	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
Tetraspora lacustris	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	+
CHLOROCOCCALES																		
Oocystis crassa	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
O. elliptica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·

Table 10. (*Continued*)

	Frias 1.2.1954	Frias 28.2.1961	Frias 2.4.1961	Frias 25.2.1963	Cauquenes 30.3.1961	Frey 24.4.1961	Frey 17.2.1963	Morales 24.12.1961	Moreno 11.2.1961	Gutiérrez 22.1.1954	Gutiérrez 25.3.1961	Mascardi 23.1.1954	Mascardi 29.3.1961	Mascardi 12.4.1961	Guillelmo 23.1.1954	Guillelmo 29.3.1961	Hess 26.1.1954	Hess 29.3.1961
Oocystis lacustris	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
O. solitaria	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	+	·
Nephrocytium limneticum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
N. lunatum	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	+	·
Ankistrodesmus falcatus	+	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·
A. spiralis	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Quadrigula closteroides	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Botryococcus braunii	·	·	·	·	·	·	·	+	+	◑	+	◔	+	·	+	+	+	·
Dictyosphaerium pulchellum	·	·	·	·	·	+	+	·	+	·	+	+	·	·	·	·	+	·
Pediastrum araneosum v. *rugulosum*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
P. boryanum	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	+	·
P. boryanum v. *longicorne*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
P. duplex	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	+	·
P. integrum f. *granulata*	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
P. integrum v. *scutum*	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
Crucigenia quadrata	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
C. rectangularis	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
Scenedesmus quadricauda	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
ULOTRICHALES																		
Elakatothrix biplex	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
Geminella mutabilis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
CONJUGALES																		
Cylindrocystis brebissonii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Netrium digitus v. *naegelii*	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Gonatozygon aculeatum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	+
G. kinahani	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·
G. monotaenium	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	+	·
G. pilosum	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
Closterium acerosum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
C. aciculare	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	+	·
C. kuetzingii	+	·	·	·	+	+	·	·	·	+	·	·	+	·	·	·	+	·
C. leibleinii	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	+	·
C. setaceum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Pleurotaenium coronatum v. *nodulosum*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
P. ehrenbergii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
P. trabecula	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Euastrum attenuatum v. *splendens*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+
E. pinnatum	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
E. verrucosum v. *alatum*	·	·	+	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
Micrasterias denticulata?	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
M. radians	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
M. sol	·	·	·	·	+	·	·	·	·	·	·	·	+	·	·	·	·	+
M. sol v. *elegantior*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+
M. sol v. *ornata*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
M. truncata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Cosmarium abbreviatum v. *planctonicum*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·

Table 10. (*Continued*)

	Frias 1.2.1954	Frias 28.2.1961	Frias 2.4.1961	Frias 25.2.1963	Cauquenes 30.3.1961	Frey 24.4.1961	Frey 17.2.1963	Morales 24.12.1961	Moreno 11.2.1961	Gutiérrez 22.1.1954	Gutiérrez 25.3.1961	Mascardi 23.1.1954	Mascardi 29.3.1961	Mascardi 12.4.1961	Guillelmo 23.1.1954	Guillelmo 29.3.1961	Hess 26.1.1944	Hess 29.3.1961
Cosmarium botrytis	+	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	+	·
C. botrytis v. *gemmiferum*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
C. brebissonii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
C. contractum v. *ellipsoideum*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+
C. depressum v. *achondrum*	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	+	·
C. margaritatum v. *subtumidum*	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
C. moniliforme	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
C. portianum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
C. pseudoconnatum v. *ellipsoideum*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
C. quadrifarium	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
C. quadrifarium f.	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
C. quadrum	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
C. subcucumis	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
C. subdanicum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
C. subspeciosum v. *validius*	+	·	·	·	·	+	·	+	·	+	·	+	·	·	+	·	+	+
C. subtumidum v. *pachydermum*	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
C. tetraophthalmum	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
Xanthidium antilopaeum	+	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	+	+
Staurodesmus convergens	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
S. cuspidatus	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
S. dickiei	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
S. megacanthus	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
S. megacanthus f. – Thomasson (1959, fig. 21: 23)	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+
S. mucronatus v. *subtriangulare*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
S. phimus	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
S. subulatus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
S. triangularis fac. *stroemii*	·	·	·	·	·	·	·	·	·	·	·	+	·	·	+	·	+	·
Staurastrum arcuatum f. – figs. 42: 12 & 13	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
S. armigerum v. *furcigerum*	·	·	·	·	+	·	·	·	·	+	·	+	·	·	+	·	+	·
S. avicula v. *subarcuatum*	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	+	·
S. brachiatum	·	·	·	·	·	+	+	·	·	·	·	·	·	·	·	·	+	·
S. brebissonii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
S. dilatatum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
S. dispar	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
S. excavatum v. *minimum*	·	·	·	·	·	·	·	·	·	·	·	+	·	·	+	·	+	·
S. laeve	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
S. manfeldtii f.	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
S. margaritaceum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
S. planctonicum v. *ornatum*	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
S. pseudonanum f.	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
S. pseudosebaldi f.	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
S. punctulatum v. *ellipticum*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
S. rotula v. *smithii*	·	·	·	·	·	+	+	·	+	·	·	·	·	·	·	·	+	+
S. sebaldi v. *brasiliense*	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
S. sebaldi v. *orientale* f.	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·

Table 10. (*Continued*)

	Frias				Cauquenes	Frey		Morales	Moreno	Gutiérrez		Mascardi			Guillelmo		Hess	
	1.2.1954	28.2.1961	2.4.1961	25.2.1963	30.3.1961	24.4.1961	17.2.1963	24.12.1961	11.2.1961	22.1.1954	25.3.1961	23.1.1954	29.3.1961	12.4.1961	23.1.1954	29.3.1961	26.1.1954	29.3.1961
Staurastrum sebaldi v. *ornatum* f. *planctonica*	·	·	·	·	+	·	·	·	·	+	+	·	·	·	·	·	·	·
S. tetracerum v. *biverruciferum*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
S. tetracerum v. *evolutum* – Thomasson (1959, figs. 23: 10 & 11)	·	·	·	·	+	·	+	·	·	·	·	+	+	+	+	+	+	+
S. tohopekaligense v. *brevispinum*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Staurastrum sp. – Thomasson (1959, fig. 21: 3)	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+
Sphaerozosma aubertianum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
S. granulatum	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·
Spondylosium panduriforme f. *limneticum*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Hyalotheca dissiliens	·	·	·	·	·	+	·	·	·	·	·	+	+	·	·	·	+	+
H. neglecta	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·
Desmidium cylindricum	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
D. quadratum	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·
Bambusina moniliformis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
PROTOZOA																		
Acanthocystis aculeata	·	·	·	·	·	·	·	+	+	·	+	+	+	+	◔	·	+	+
Arcella discoides	·	·	·	·	·	·	·	·	·	+	·	·	·	·	+	·	+	·
A. hemisphaerica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Astrodiscus laciniatus	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Euglypha brachiata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·
Heliozoa sp.	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·
Ophrydium versatile	·	·	·	·	·	·	·	·	·	·	◔	·	+	·	·	+	·	·
Stentor sp.	·	·	·	·	·	·	+	·	+	+	◔	+	+	·	◔	+	·	·
Vagnicola sp.	+	·	·	·	·	·	·	·	+	·	·	+	+	+	●	+	●	·
ROTATORIA																		
Ascomorpha saltans	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·
Asplanchna sp.	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
Cephalodella sp.	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
Collotheca atrochoides	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
C. clava	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
C. mutabilis	·	·	·	·	·	·	·	+	·	+	·	·	·	·	·	·	·	·
Collotheca sp.	·	·	·	·	·	+	·	·	·	·	+	·	·	·	·	·	+	·
Colurella adriatica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
C. obtusa aperta	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
C. oxycauda	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
C. tesselata	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
C. uncinata	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
C. uncinata bicuspidata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+
Conochilus unicornis	+	·	+	·	·	·	·	·	+	+	·	+	+	·	+	+	+	+
Euchlanis dilatata	·	·	·	·	+	·	·	·	·	+	·	·	·	·	·	·	·	·
E. incisa	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
E. cf. *meneta*	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Euchlanis sp.	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	+

TABLE 10. (*Continued*)

	Frias 1.2.1954	Frias 28.2.1961	Frias 2.4.1961	Frias 25.2.1963	Cauquenes 30.3.1961	Frey 24.4.1961	Frey 17.2.1963	Morales 24.12.1961	Moreno 11.2.1961	Gutiérrez 22.1.1954	Gutiérrez 25.3.1961	Mascardi 23.1.1954	Mascardi 29.3.1961	Mascardi 12.4.1961	Guillelmo 23.1.1954	Guillelmo 29.3.1961	Hess 26.1.1954	Hess 29.3.1961
Filina longiseta	·	·	·	·	·	·	·	·	·	+	+	·	+	·	+	·	·	·
F. terminalis	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	+	·	·
Gastropus stylifer	·	·	·	·	·	·	·	·	+	·	·	+	+	·	+	·	+	+
Hexarthra fennica	·	·	·	·	·	·	·	·	+	+	+	·	·	·	·	·	·	·
Keratella c. cochlearis	+	·	+	·	+	+	+	+	+	◑	+	◔	+	+	+	+	+	+
K. cochlearis tecta	+	+	+	+	+	·	·	·	·	+	·	·	+	·	+	·	·	·
Lecane flexilis	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
L. glypta	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
L. hornemanni	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
L. luna	+	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	+	·
Lepadella acuminata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+
L. patella	·	·	·	·	+	·	·	·	·	·	·	·	+	·	·	·	+	·
Macrochaetus subquadratus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Monommata longiseta	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
Monostyla constricta	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
M. hamata	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
M. lunaris	+	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	+	·
Monostyla sp.	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Mytilina ventralis	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
Notholca haueri	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
Notommata copeus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+
Philodina roseola	·	·	·	·	·	·	·	·	·	·	·	+	·	·	+	+	·	·
Ploeosoma sp.	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Polyarthra dolichoptera	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
P. vulgaris	+	+	+	·	·	+	+	·	◑	+	◔	+	+	+	·	+	+	+
Pompholyx sulcata	·	·	·	·	·	·	·	+	·	·	·	·	+	·	·	+	·	·
Synchaeta oblonga	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
S. pectinata	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
Synchaeta sp.	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	+	·	·
Trichocerca cavia	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
T. cylindrica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·
T. insignis	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	+	·
T. longiseta	+	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	+
T. porcellus	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+
T. stylata	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·
T. tigris	+	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
Trichocerca sp.	·	·	·	·	·	·	+	·	·	·	·	+	·	·	·	·	·	·
Trichotria tetractis	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+	·
CLADOCERA																		
Alona sp.	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	+	·
Bosmina chilensis	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	+	+	+
Ceriodaphnia sp.	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	+	·	+
Chydorus sphaericus	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
Daphnia sp.	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diaphanosoma excisum chilense	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+

Table 10. (*Continued*)

	Frias 1.2.1954	Frias 28.2.1961	Frias 2.4.1961	Frias 25.2.1963	Cauquenes 30.3.1961	Frey 24.4.1961	Frey 17.2.1963	Morales 25.12.1961	Moreno 11.2.1961	Gutiérrez 22.1.1954	Gutiérrez 25.3.1961	Mascardi 23.1.1954	Mascardi 29.3.1961	Mascardi 12.4.1961	Guillelmo 23.1.1954	Guillelmo 29.3.1961	Hess 26.1.1954	Hess 29.3.1961
Macrothrix sp.	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+
Scapholeberis spinifera	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
COPEPODA																		
Boeckella gracilipes	·	·	·	·	·	·	·	·	·	·	·	+	+	·	·	●	·	·
B. gracilis (schwabei)	·	·	·	·	+	·	·	·	·	+	·	·	·	·	+	·	·	·
Cyclops sp.	·	·	·	·	+	·	·	·	·	·	·	·	·	·	+	+	·	·
Mesocyclops annulatus	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·

18. LAKE MENÉNDEZ

The National Park Los Alerces lies in the north-eastern part of Territorio Nacional del Chubut between 42° and 43° southern latitude. It has an area of 263,000 ha. This national park includes many large and beautiful lakes. There are three principal lakes, Rivadavia, Menéndez, and Futalaufquen, which have a total area of about 142 km². The irregular branching forms of the lakes and their situation among high, serrate, and often snow-covered mountains mark them as strikingly beautiful even in the Andean lake country, which is one of the most beautiful in the world.

Lake Menéndez lies in the very heart of the Andes, narrowly enclosed by ranges which rise more than 1700 meters above it. The lake bears the name of Friar Menéndez who was the first European to traverse the region in 1783 and 1787. The rocky shores of the lake are exceedingly sheer, descending straight into the dark-green waters. The lake has three arms; between the north-western and south-western arms stand the bold peaks of Las Torrecillas (2240 m), a precipitous group which dominates the view westward from the lake. Between the south-western and south-eastern arms rise the cliffs of Cerro Solo. Lake Menéndez has an area of approximately 66 km², and its drainage basin has an area of about 675 km². The altitude is 523 m above sea level. From its south-eastern arm the lake discharges into Rio Futaleufú. On the western shores of Lake Menéndez grow woods of more than one-thousand-year-old trees of *Fitzroya patagonica* which have given the name to this National Park.

The first sample dates from April 30, 1961. The water temperature was 11°C. The predominant plankters were *Rhizosolenia eriensis* and *Keratella cochlearis*. The composition of the prevailing plankton community can be seen from table 11.

On November 27, 1961, about 98 per cent of the plankton consisted of *Rhizosolenia eriensis*. *Polyarthra vulgaris* was also common. It is interesting that *Melosira* is absent from this sample. The water temperature was about 8°C.

In the sample collected on April 10, 1962, the phytoplankton proved to be sparse, but there was an abundance of zooplankters. *Keratella cochlearis* was dominant. *Acanthocystis* was also abundant. *Melosira granulata* was of rare occurrence. The temperature of the water was 12°C.

On December 30, 1962 about 98 per cent of the plankton was made up of *Rhizosolenia eriensis*. The temperature of the water was 13° C, and that of the air 19° C.

19. LAKE FUTALAUFQUEN

Lake Futalaufquen (Fetalaufquen) lies in the extension of the canyon of Lago Menéndez. This lake also has three arms. The northern arm of the lake which receives the Rio Futaleufú is nearly enclosed at its south end by mountain spurs, beyond which opens the broad, irregular body of the lake. The outlet lies in the south-western arm and leads directly into the little Lake Krügger. The shores of Lake Futalaufquen are in general rocky, and in many places there is no beach at the base of the cliffs, but they are not so precipitous as those of Lake Menéndez. The surrounding forests are made up mainly of *Nothofagus dombeyi* with considerable interspersion of *Austrocedrus chilensis*. The area of Lake Futalaufquen is about 66 km^2; its drainage basin is approximately 242.1 km^2. The altitude is 518 m above sea level.

On April 29, 1961 a sample was collected near the Intendencia Parque Nacional Los Alerces, which is situated close to the shore of the lake. The temperature of the water was 12°C. Surprisingly about 90 per cent of the plankton was made up of *Fragilaria crotonensis* which occurred in beautiful large colonies. Besides the *Melosira* threads of normal breadth broad ones, as mentioned above, also occurred. For the composition of the plankton community see table 11.

The lake was next sampled on November 27, 1961 from the same spot as before. The water temperature was about 8–10°C. The dominating plankters were *Dinobryon divergens*, *Melosira granulata*, *Asterionella gracillima*, and *Polyarthra vulgaris*. It is curious that I have never seen star-shaped colonies of *Asterionella* in North Patagonian lakes; the colonies were always either zigzag formed or chains. *Melosira* also occurred in the present sample in semicircular or even ring-shaped filaments. Both broad and narrow plants of *Rhizosolenia* were noted. *Fragilaria crotonensis* was sparse in this sample.

The last sample dates from April 10, 1962. It was collected somewhere in the centre of this star-shaped lake. The temperature of the water was 13°C. The predominant plankters were *Fragilaria crotonensis* and *Keratella cochlearis*. *Fragilaria* was far less abundant than in the previous year.

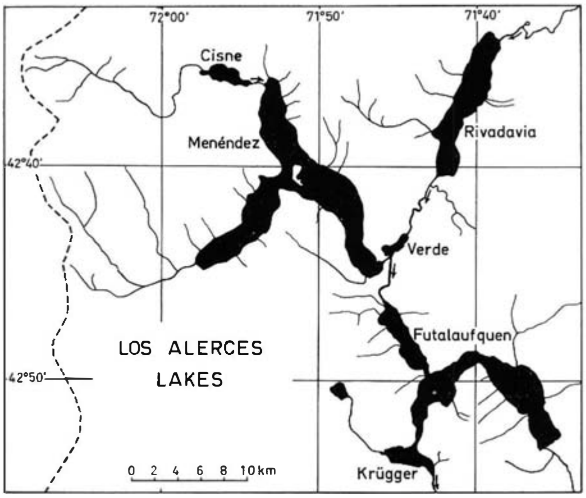


Fig. 32. Sketch-map showing the location of the lakes in Los Alerces National Park which have been discussed in this paper.

20. LAKE VERDE

This lake is located further up the valley from Lake Futalaufquen at an altitude of 518–19 m.

On April 29, 1961 *Fragilaria crotonensis* and *Keratella cochlearis* predominated. The sample also contained large amounts of detritus. Only six cells of *Melosira hustedtii* were noted; it is seldom found east of the Andean range. The temperature of the water was 12°C.

On November 27, 1961 *Rhizosolenia eriensis* and *Dinobryon divergens* predominated. Moreover, a *Synchaeta* was frequent, but undeterminable in the preserved state. This sample also contained a lot of detritus. Like the previous sample it had a high number of species, see table 11. The specimens of *Rhizosolenia* and *Mallomonas* were often seen with cysts. Water temperature was about 10°C.

On April 10, 1962 the dominants were, as in the previous year, *Fragilaria crotonensis* and *Keratella cochlearis*. *Rhizosolenia* occurred rarely. The amount of detritus was high. Water temperature was 13°C.

21. LAKE KRÜGGER

Lake Krügger (Kruger) is a little lake located south-west of the south-western arm of Lago Futalaufquen. It not only receives the waters of that lake but also those of a considerable tributary which enters from the north-west. The valley of Lake Krügger, like the other valleys of this system, has a broad flat bottom from which steep or precipitous slopes rise to the mountain summits. Lake Krügger lies at an altitude of 518 m; its area is about 6.4 km², and that of its drainage basin 146.8 km². The Rio Futaleufú flows southward from the south-eastern end of the lake through a very deep canyon, which it has cut as a result of glacial diversion. In this canyon the Rio Futaleufú (Rio Grande) has developed one of the greatest cataracts of the Andes.

The sample from Lake Krügger, collected on April 30, 1961, was, like the one from Lake Futalaufquen, characterized by abundance of *Fragilaria crotonensis*. This diatom accounted for up to 90–95 per cent of the biomass. *Dinobryon divergens* and *Rhizosolenia eriensis* were also frequent.

22. LAKE CISNE

Lake Cisne is located in the Los Alerces National Park, at an altitude of 548 m in a broad valley which extends from the head of the north-western arm of Lake Menéndez. Beyond Lake Cisne extend deep canyons between the spurs of Cerro Negro and Cerro Trepado. The summits of the range are here covered with extensive glaciers which discharge streams into Lago Cisne and further on, into Lake Menéndez, Lake Futalaufquen, and Lake Krügger.

The plankton of Lake Cisne is sparse as is evident from table 11. On November 26, 1961, the predominant plankter was *Dinobryon cylindricum*. The sample contained much detritus brought in by the inflowing streams carrying water from the glaciers in the west. The temperature of the water was ca 6–8°C at sampling.

On April 7, 1962, another sample from this lake was collected near Rio de los Palos. The water temperature was 10.5°C. The plankton was sparse, as at the previous sampling. *Dinobryon cylindricum* was still predominant. *Mallomonas bourrellyi* was frequent; an electron micrograph of its beautiful scales made by Dr. Berit Asmund has been kindly placed at my disposal (see figs. 43: 1, 2 and 4).

Table 11.
Plankton of some lakes in Los Alerces National Park

	Menéndez					Futalaufquen			Verde				Krügger	Cisne		
	30.4.1961	27.11.1961	10.4.1962	23.9.1962	30.12.1962	29.4.1961	27.11.1961	10.4.1962	29.4.1961	27.11.1961	10.4.1962	23.9.1962	30.4.1961	26.11.1961	7.4.1962	23.9.1962
CYANOPHYTA																
Anabaena solitaria f. *planctonica*	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·
Anabaena sp.	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
Gomphosphaeria lacustris	·	·	·	·	+	·	+	·	+	·	+	·	·	·	·	·
Oscillatoria bornetii	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·
EUGLENOPHYTA																
Colacium vesiculosum	·	·	·	·	·	·	·	+	·	·	·	·	+	·	·	·
PYRROPHYTA																
Ceratium hirundinella f. *austriacum*	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Peridinium cinctum	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
P. inconspicuum	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·
P. willei	·	+	·	·	·	+	+	+	+	+	·	·	+	·	·	·
P. volzii	+	+	+	·	+	·	·	+	+	·	+	·	+	·	+	·
Peridinium sp.	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·

TABLE 11. (*Continued*)

	Menéndez					Futalaufquen			Verde				Krügger	Cisne		
	30.4.1961	27.11.1961	10.4.1962	23.9.1962	30.12.1962	29.4.1961	27.11.1961	10.4.1962	29.4.1961	27.11.1961	10.4.1962	23.9.1962	30.4.1961	26.11.1961	7.4.1962	23.9.1962
CHRYSOPHYTA																
CHRYSOPHYCEAE																
Chrysosphaerella brevispina	+	·	·	+	+	+	+	+	+	+	·	·	+	·	·	·
Dinobryon cylindricum	+	·	+	+	+	·	+	·	·	+	·	·	·	◔	◑	+
D. divergens	+	+	+	·	+	+	◑	+	+	◑	+	·	◔	·	+	·
D. suecicum	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Epipyxis ramosa	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+
Mallomonas alpina	·	·	·	·	·	+	+	+	+	+	+	·	+	·	·	·
M. bourrellyi – figs. 43: 1–4	·	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
M. elongata – fig. 43: 5	·	·	·	·	·	·	·	·	+	+	+	·	·	·	+	·
Mallomonas sp.	·	·	+	·	+	·	·	·	·	·	·	·	·	·	·	·
Salpingoeca buetschlii	·	·	·	·	·	·	·	+	+	·	+	·	·	·	·	·
S. frequentissima	·	·	·	·	·	+	·	·	·	·	+	·	+	·	·	·
BACILLARIOPHYCEAE																
Melosira dickiei	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
M. distans v. *alpigena*	+	+	+	·	·	·	·	·	+	+	+	·	·	·	·	·
M. granulata	·	·	+	·	·	+	◑	+	+	+	·	+	+	·	·	·
M. hustedtii	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
M. varians	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
Cyclotella stelligera	·	·	·	·	·	·	+	·	·	+	·	·	·	·	·	·
C. stelligera v. *elliptica*	+	·	·	·	+	·	·	·	+	·	·	·	·	·	·	·
Rhizosolenia eriensis	◑	●	+	+	●	+	+	+	+	◑	+	·	◔	·	·	·
Tabellaria quadriseptata	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Diatoma elongatum	·	+	·	·	·	+	·	·	+	+	·	·	·	·	·	·
D. elongatum v. *fuegensis*	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
D. vulgare	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
Fragilaria crotonensis	+	·	·	·	·	●	+	◔	◑	+	◑	·	●	·	·	·
Asterionella gracillima	·	+	+	·	·	+	◑	·	+	·	·	·	+	·	+	·
Synedra ulna	·	·	·	·	·	·	·	+	+	·	·	·	·	·	·	·
S. ulna v. *danica*	·	·	+	·	·	·	·	·	·	+	+	+	+	·	·	·
Eunotia flexuosa	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·
Surirella guatimalensis	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
CHLOROPHYTA																
VOLVOCALES																
Eudorina elegans	·	·	·	·	·	+	+	·	+	·	+	·	·	·	·	·
Pandorina morum	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
Coenocystis subcylindrica	·	·	·	·	·	+	·	·	·	·	·	·	+	·	·	·
Gloeococcus schroeteri	·	+	+	·	+	+	·	+	+	+	+	·	+	·	·	·
CHLOROCOCCALES																
Oocystis sp.	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·
Nephrocytium lunatum	·	+	+	·	+	+	·	·	·	·	+	·	·	·	·	·
Ankistrodesmus arcuatus	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Kirchneriella obesa	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·
Botryococcus braunii	+	+	+	+	+	+	+	+	+	+	+	·	+	·	·	·
Dictyosphaerium pulchellum	+	+	·	·	+	·	+	·	·	+	·	·	·	·	·	·

TABLE 11. (*Continued*)

	Menéndez					Futalaufquen			Verde				Krügger	Cisne		
	30.4.1961	27.11.1961	10.4.1962	23.9.1962	30.12.1962	29.4.1961	27.11.1961	10.4.1962	29.4.1961	27.11.1961	10.4.1962	23.9.1962	30.4.1961	26.11.1961	7.4.1962	23.9.1962
Pediastrum boryanum	·	·	·	·	·	·	+	·	+	·	·	·	·	·	·	·
P. boryanum v. *longicorne*	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
CONJUGALES																
Gonatozygon aculeatum	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Closterium aciculare	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
C. aciculare v. *subpronum*	·	·	·	·	·	·	·	·	·	·	·	+	·	·	·	·
C. kuetzingii	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
C. parvulum	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
C. rostratum	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
C. setaceum	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·
Cosmarium subspeciosum v. *validius*	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·
Staurodesmus convergens	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
S. glabrus fac. *glabrus* f. *limnophilus*	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·
Staurastrum planctonicum v. *ornatum*	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
S. proboscideum	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·	·
S. tetracerum v. *evolutum*	+	·	·	·	·	+	+	+	+	+	+	+	+	·	·	·
Sphaerozosma aubertianum	·	·	+	·	·	+	·	·	·	·	·	·	·	·	·	·
Hyalotheca mucosa	+	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
PROTOZOA																
Acanthocystis aculeata	+	+	◔	+	+	+	+	+	+	+	+	·	+	·	·	·
Arcella vulgaris	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
Heliozoa sp.	·	·	·	·	·	+	·	·	·	·	·	·	·	+	·	+
Rhaphidiophrys sp.	·	·	·	·	·	·	·	·	+	·	+	·	·	·	·	·
Stentor sp.	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Vagnicola sp.	·	·	·	·	·	+	·	+	·	+	+	·	+	·	·	·
ROTATORIA																
Collotheca libera	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
C. mutabilis	+	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
Collotheca sp.	·	·	+	·	+	·	·	+	·	·	·	·	·	·	·	·
Conochilus unicornis	+	·	·	·	·	·	+	·	+	·	·	·	·	·	+	+
Euchlanis dilatata	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	+
Filina longiseta	·	·	·	·	·	·	+	·	+	·	·	·	·	·	·	·
F. terminalis	+	·	·	·	·	·	·	·	+	+	·	·	·	·	+	·
Gastropus stylifer	+	+	+	·	+	·	+	+	+	·	+	·	·	+	+	·
Hexarthra fennica	+	·	·	·	+	·	·	+	·	·	·	·	·	·	·	·
Keratella c. cochlearis	◑	+	◑	+	+	+	+	◔	◑	+	◔	+	+	+	+	+
K. cochlearis tecta	+	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·
Lepadella patella	·	·	·	·	·	·	·	+	·	+	·	·	·	·	·	·
L. quinquecostata	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
Mytilina m. mucronata	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	·
Notholca haueri	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	+
N. labis	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·
N. squamula	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
Philodina roseola	+	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·

TABLE 11. (*Continued*)

	Menéndez					Futalaufquen			Verde				Krügger	Cisne		
	30.4.1961	27.11.1961	10.4.1962	23.9.1962	30.12.1962	20.4.1961	27.11.1961	10.4.1962	29.4.1961	27.11.1961	10.4.1962	23.9.1962	30.4.1961	26.11.1961	7.4.1962	23.9.1962
Philodina **sp.**	·	·	·	·	·	·	·	·	·	·	·	·	·	+	·	+
Polyarthra dolichoptera	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	+
P. vulgaris	+	◔	+	·	+	+	◑	+	+	+	+	·	+	·	+	·
Pompholyx sulcata	+	·	·	·	·	+	+	+	+	·	·	·	+	·	·	·
Synchaeta **sp.**	+	+	·	·	·	·	+	+	+	◔	+	·	·	·	·	·
Trichocerca birostris	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
T. porcellus	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
T. similis	·	·	+	·	·	·	·	·	·	·	·	·	·	·	·	·
T. stylata	+	·	+	·	·	·	·	·	·	·	·	·	+	·	·	·
T. tenuior	+	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
Trichocerca **sp.**	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·	·
Trichotria tetractis	·	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·
CLADOCERA																
Bosmina chilensis	·	·	·	+	+	+	·	+	+	·	+	·	·	·	·	·
Ceriodaphnia dubia	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Ceriodaphnia **sp.**	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Daphnia **sp.**	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Diaphanosoma excisum chilense	·	·	·	·	·	+	·	·	·	·	·	·	·	·	·	·
Ilyocryptus agilis	·	·	·	·	·	·	·	·	+	·	·	·	·	·	·	·
COPEPODA																
Boeckella gracilipes	·	·	·	·	·	+	+	+	·	+	·	·	·	+	·	·
Cyclops **sp.**	·	·	+	·	·	+	+	+	+	·	·	·	·	+	·	·

CONCLUDING REMARKS

Unlike the samples from the Chilean lake district, which cover only a short period, the material from the Argentine lakes represents a considerably longer period. Consequently a few comments on the seasonal development sequence of the various plankters can be made, even though the intervals between samples are long, and from some of the lakes only one or two samples are available. Moreover, some of the lakes are of a complicated configuration; in such lakes frequent sampling from different parts would have been desirable. The present material from the North Patagonian lakes consists of net plankton only. As has been demonstrated, e.g. by Birge & Juday (1922), the seasonal distribution of nannoplankters may give quite a different picture, not least from the quantitative point of view (see figs. 34 and 35 in Birge & Juday, 1922). Other reservations considering the interpretation of the present material could also be made.

Some features of the seasonal periodicity of plankters in Lake Nahuel Huapi have been indicated above. During the warm and dry season the plankton is characterized by rich development of *Dinobryon*, *Rhizosolenia*, and *Melosira*. During the cold and rainy season, *Dictyosphaerium* colonies make up a considerable part of the plankton community. This is the reverse of the generally accepted rule, that the green algae virtually disappear during the winter. For instance, for Argentina Guarrera (1948) reported that *Chlorophyta* and *Cyanophyta* flourish in the plankton of Lake San Roque in Provincia de Córdoba during the summer, and *Chrysophyceae* had their maximum in August.

Concerning the other lakes mentioned above, one notes many common features, see the tables 9, 10, and 11. Lake Lacár and most of the lakes in the southern part of Nahuel Huapi National Park have the maximum during the warm season obviously produced by *Dinobryon*. In Lake Moreno *Rhizosolenia* is predominant, and in the small Lagunita Cauquenes, *Peridinium volzii*. In the lakes located in the northern part of the Nahuel Huapi park the plankton during the summer and autumn is also characterized by the abundance of *Dinobryon* and *Rhizosolenia*. The samples collected during the autumn from lakes Espejo and Correntoso contained large quantities of *Eudorina*. The plankton in Lake Correntoso was characterized by the abundance of *Anabaena*, which was the dominant plankter, and probably predominates during the winter.

Passing on southwards, the plankton in many of the lakes located in Los Alerces National Park, according to the few samples available, seems to be characterized during the summer by abundant occurrence of *Dinobryon*, *Rhizosolenia*, *Melosira*, and *Asterionella*. In the autumn there is an abundant growth of *Fragilaria crotonensis*, except in Lake Menéndez, where *Rhizosolenia* is also frequent in the autumn. Lake Cisne, which is fed by glacier waters, lacks *Fragilaria crotonensis*. The abundant autumnal growth of *Fragilaria crotonensis* in lakes Futalaufquen, Verde, and Krügger probably lasts through the winter.

The occurrence of *Fragilaria crotonensis* is one of the surprises from the samples collected from the lakes situated along the eastern slopes of the Andes. In the northernmost of these lakes this plankter is rare. In the lakes of Nahuel Huapi National Park it is not very abundant, but occurs regularly. *Fragilaria crotonensis* is often abundant during the warm season in lakes in the northern hemisphere, e.g., I have noted it as predominant in Lake Storsjön, Jämtland, Sweden, on August 8, 1948 (Thomasson, 1951). Furthermore, in many of the lakes studied by Florin (1957) it is predominant during the summer. From Denmark, Wesenberg-Lund (1904) reports it as a common plankter which is especially abundant during the warm season, showing often a maximum in May–June, and a second one in September when the water temperature is about 13°–16°C. On the other hand, in many Central European lakes, it has its maximum development in late autumn, in October–December, or, in other Central European lakes, in January–May. The time for maximal growth of *Fragilaria crotonensis* apparently varies from one lake to another, and even from one year to another.

Another noteworthy point is the occurrence of the genus *Ceratium* in North Patagonian lakes. There were two taxa, viz. *Ceratium cornutum* and *C. hirundinella*. Both of them were extremely rare. They never attain such numbers as in many temperate lakes in the northern hemisphere, where representatives of the genus *Ceratium* are often present in copious quantities. For instance the plankton of Grosser Plöner See was on September 15, 1950, wholly dominated by *Ceratium furcoides* and the subdominant plankter was *Ceratium hirundinella*. In the lakes west of the Andean range I have hitherto not managed to find any *Ceratium* species. Further southwards, from Tierra del Fuego, Borge (1901) reported the rare occurrence of a *Ceratium* sp. in Lago Maravilla. I have not managed to refind it in his samples. In my own Fuegian material I have seen a single theca, obviously of marine origin (Thomasson, 1955, p. 223). Once I recorded a theca of the characteristic marine species *Ceratium tripos*, in a little lake in the Scandean range far from any marine deposits and at an altitude of about 525 m, viz. in Åtjärn, Jämtland, Sweden (see fig. 1 in Thomasson, 1952).

Asterionella gracillima occurs in some of the lakes located along and within the eastern slopes of the Andean range. It is rather sparse; only in Lake Futalaufquen was it frequent. It is noteworthy that it grows in zigzag chains, never in star-shaped colonies, see also Huber-Pestalozzi (1942, pp. 450–452). In the southernmost part of the continent, in Tierra del Fuego, I have noted it in Lake Fagnano, and Cleve (in Borge, 1901) reports it as common in Lake Maravilla.

Moreover, the occurrence of *Tabellaria* in these lakes should be pointed out. This is the plant which, according to the taxonomy introduced by Knudson (1952–53), should be labelled as *T. quadriseptata. T. flocculosa* var. *asterionelloides* has also been observed. According to the nomenclature adopted, e.g. by Hustedt (1931–59), these plants should be classified as *T. fenestrata* and *T. fenestrata* var. *asterionelloides*, respectively. No true *T. flocculosa* var. *flocculosa* has been seen. Krasske has reported subfossile *Tabellaria flocculosa* from mires at lakes Correntoso and Espejo, see Krasske (1949, pp. 15 and 18) and Auer (1958, pp. 94–95). This diatom was of rare occurrence. He has also reported the occurrence of *Tabellaria fenestrata* and *Asterionella gracillima*. It is noteworthy that *Melosira hustedtii* has been recorded only once, viz. in a sample collected at Villa Angostura, see Krasske (1949 p. 20) and Auer (1958, p. 93). Krasske did not observe *Fragilaria crotonensis*.

Melosira hustedtii, which is a common plankter in the Chilean lake district, has but seldom been encountered east of the Andean range.

Considering the characteristic features of the rotifer fauna, one notes that representatives of the genus *Brachionus* have seldom been encountered. This is probably because there are no habitats suitable to this genus among the sampling stations. Otherwise in Argentina, e.g. in the water bodies of the province of Buenos Aires, the representatives of the genus are frequent, see Olivier (1955 and 1959). [It is most probable that *Brachionus dimidiatus* var. *inermis* Schmarda listed by that author is, according to the drawing in Olivier (1961, pl. 1, fig. 3), *Pompholyx sulcata* Hudson, an animal frequently noted in North Patagonian waters.] *Kellicottia longispina* and *Keratella quadrata* seem to be almost absent in the plankton of North Patagonian lakes, along both slopes of the Andean chain. Of *Kellicottia longispina* I have seen only one lorica in a sample collected in the Chilean lake district, and two in the samples collected from Nahuel Huapi National Park. Only a single lorica of *Keratella quadrata* was observed in the Argentinean and two in the Chilean lake district. I have never seen any living specimens of these rotifers, so the two species seem to have a very concealed existence. The nearest locality for *Kellicottia longispina* where living animals have been observed is probably the Rio Chagres at Bohio, Panama, see Harring (1914). *Keratella quadrata* is common in many lakes on the Altiplano, in Peru.

Curiously enough not one *Diaptomus* specimen was observed in the samples collected east of the Andean range. This may be due to the fine-mesh net which was used. On the whole the crustacea are sparse in the samples.

For the periodicity of plankters in North Patagonian lakes the change between dry and rainy seasons may be of importance. During the rainy season large quantities of nutrients are probably brought from the surroundings into the lakes. In many lakes the winter is also the time for the full circulation, which e.g. in Lake Nahuel Huapi occurs in July–August. On the other hand, during the dry and warm season the nutrients are more completely absorbed by plankters, and there is little addition from the drainage basin. Furthermore, the nutrients in the deeper strata of the lake are inaccessible because of the thermal stratification. Insolation is extraordinarily strong in the present region during the summer when most of the lakes are very transparent; for instance the transparency of Lake Llanquihue is about 25 m. For more convincing information about the environmental factors and their influence on plankton communities intense local studies are necessary. It is to be hoped that the plan for a limnological station at Bariloche, which was proposed by Popovici & Riggi (1948, p. 114), will be realized. Bariloche is an excellent starting-point for biological investigations of the many terrestrial and aquatic biota that are found within easy reach.

In previous papers I have pointed out some features of the composition of plankton communities in North Patagonian lakes. After the study of the present collections it is obvious that some of these points ought to be modified. It is always risky to base statements about the distribution of plankters on a few random samples. For convincing conclusions intense sampling for some years would be necessary, but this is difficult to realize in remote areas.

VIII. POOLS AND PONDS

Pools and ponds were scarce in the places visited by us. Consequently the subsequent notes on algae in such bodies of water are rather casual. Sampling was carried out in a few lake-side pools, in some ponds, and in an inundation pool. The flora and fauna in some of these collections proved to be very rich and of considerable interest.

1. INUNDATION POOL

This pool, which has been mentioned on p. 26, is located a short walk from our base at Lake Villarrica. The algal flora in the warm and shallow water beneath the Juncetum proceri proved to be rich. There grew *Aphanocapsa grevillei* in gelatinous aggregates, tufts of sterile *Oedogonium* spp., threads of *Zygnema*, and *Desmidium swartzii*. Moreover, *Euastrum pinnatum, Cosmarium tetragonum* var. *lundellii*, and diatoms like *Pinnularia, Rhopalodia, et. al.* were frequent. The following list gives some information about this *Euastrum pinnatum – Cosmarium tetragonum* community, except for the major part of the rich material of benthic diatoms which has been left for future studies.

CYANOPHYTA

Aphanocapsa grevillei – abundant
Nostoc sp.

EUGLENOPHYTA

Phacus curvicauda

CHRYSOPHYTA

CHRYSOPHYCEAE

Dinobryon sertularia

BACILLARIOPHYCEAE

Diatoma elongatum v. *fuegensis*
Diatoma vulgare
Rhopalodia gibba
R. gibba v. *ventricosa*
Pinnularia spp.

CHLOROPHYTA

CHLOROCOCCALES

Oocystis sp.
Ankistrodesmus falcatus
Dictyosphaerium pulchellum
Pediastrum tetras
Scenedesmus ecornis

CONJUGALES

Netrium digitus
Zygnema sp. ster.
Closterium cynthia
C. pseudolunula
Euastrum dubium v. *ornatum*
E. insulare v. *silesiacum*
E. pinnatum – frequent
E. turneri
Micrasterias truncata
Cosmarium connatum
C. difficile
C. difficile v. *dilatatum*
C. elegantissimum f. *minor*
C. meneghinii
C. portianum v. *maius* – length 65 μ
C. pseudoconnatum
C. pseudopyramidatum
C. punctulatum
C. pyramidatum
C. pyramidatum v. *transitorium*
C. quadrum
C. regnesii v. *montanum* – Wests' *Monograph* (pl. 68, fig. 32)
C. subprotumidum f. – fig. 38: 11
C. subspeciosum v. *validius*
C. subtumidum
Cosmarium tetragonum v. *lundellii* – fig. 38: 14
C. tinctum v. *intermedium*
C. trilobulatum
Staurastrum bidentulum f. *maior* – fig. 41: 16, see p. 114
S. dilatatum f. – figs. 41: 17 & 18
S. dispar f. – Wests' *Monograph* (pl. 127, fig. 7)
S. proboscideum f. – fig. 42: 9
Desmidium swartzii

OEDOGONIALES

Bulbochaete sp.
Oedogonium sp. – abundant

PROTOZOA

Euglypha filifera
Operculum superior
Quadrula symmetrica – fig. 45: 15

ROTATORIA

Cephalodella sp.
Monostyla bulla
M. crenata
M. lunaris

During the rainy season this pool is drained by a ditch which contained, on November 6, 1953, only a little stagnant water. The algal vegetation was mainly made up of sterile filaments of *Mougeotia* and *Zygnema*. Intermingled were noted: *Cylindrocapsa* sp., *Dinobryon cylindricum, Synedra ulna, Closterium ehrenbergii, Cosmarium amoenum, Euastrum dubium* var. *ornatum, Staurastrum punctulatum,* and *S. suborbiculare* (length 37.5 μ).

2. LAKE-SIDE POOLS

All the lake-side pools that were studied to some extent were located on the shores of Lake Villarrica. Some of them were obviously left by high water, the others were fed by trickling water from the precipice which borders the beach. These small bodies of water showed considerable differences.

From the chemical point of view, the pools coloured by lake ochre are of great interest. Löffler (1960, p. 238) has reported a Fe concentration of about 4.4 mg/l in one such pool. Naturally in this unbalanced environment only a few organisms live. On November 6, 1953, I noted only *Leptothrix ochracea*, a sterile *Oedogonium*, and *Synedra ulna* in one of the most strongly orange coloured pools. The gold-gleaming neuston film was made up of the following *Chlamydobacteriales*: *Leptothrix discophora*, *L. ochracea*, and *L. sideropus*.

Pools which have obviously been left by the high water of the lake are of a different type. The algal vegetation in such a pool was, on November 11, 1953, characterized by a rich occurrence of *Pandorina morum*. Furthermore, sterile threads of *Bulbochaete*, *Mougeotia*, and *Spirogyra* occurred. Among the clusters of these filaments the following algae were noted: *Gomphosphaeria lacustris*, *Melosira hustedtii*, *Synedra ulna*, *Coelastrum microporum*, *C. proboscideum*, *Dictyosphaerium pulchellum*, *Staurastrum rotula* var. *smithii*.

Simultaneously a sample was collected from a nearby pool which had a rich growth of *Spirogyra bellis* and *S. teodoresci*. According to information from Dr. W. Bock the last mentioned species cannot be distinguished from *S. varians*; they ought to be united. In addition an *Oscillatoria* sp., *Synedra acus*, *S. ulna*, *Closterium ehrenbergii*, *C. pritchardianum*, and *Hyalotheca dissiliens* were noted.

In another pool, which had a rich growth of sterile filaments of *Spirogyra* and *Oedogonium* intermingled with *Zygnema* filaments, and large quantities of *Anabaena catenula*, a rich algal flora was noted on February 24, 1954. Besides plentiful benthic diatoms the following plants were noted: *Pandorina morum*, *Ankistrodesmus falcatus*, *Pediastrum duplex*, *P. tetras*, *Closterium moniliferum*, *C. venus*, *Cosmarium botrytis*, *C. laeve*, *C. lundellii* var. *ellipticum*, *C. quadrum*. Among the rotifers *Lepadella patella* was the most frequent; *Colurella obtusa*, *Lepadella acuminata*, and a *Cephalodella* sp. were also recorded.

The high water which had submerged the small lake-side meadow, see p. 23, left behind a few little pools which contained threads of *Ulothrix* and *Vaucheria*, and a lot of diatoms, such as *Cyclotella meneghiniana*, *C. stelligera* var. *subglabra* (?) – diam. 30 μ, *Melosira fennoscandica* var. *baccata*, *Diatoma elongatum* var. *fuegensis*, *Synedra ulna*, *Gomphonema acuminatum* var. *coronata*. *Tetracladium marchallianum* was also noted. In the small stream which ran through this meadow were found great quantities of *Spirogyra*, intermingled with *Melosira varians* and *Synedra ulna*.

It is interesting to note that small pools in the forest were very sparsely populated. I noted only a *Surirella* sp., *Cosmarium pyramidatum*, and some rotifers such as *Colurella adriatica*, and hitherto unidentified species of *Lepadella*, *Mytilina*, and *Squatinella*. *Harpacticoida* were also represented.

3. PONDS

Only two small ponds were studied to any extent. Both are located close to Lake Pellaifa. These ponds have already been mentioned (p. 29).

The heleoplankton of the *Myriophyllum* pond was, on December 5, 1953, characterized by a large amount of *Peridinium cinctum*. The algal flora on the whole was rich as evident from the list below.

CYANOPHYTA
Merismopedia glauca

EUGLENOPHYTA
Euglena spirogyra
Phacus acuminatus
Phacus sp.
Trachelomonas elliptica
T. hispida v. *punctata*
T. volvocina

PYRROPHYTA
Glenodinium oculatum
Gymnodinium sp.
Peridinium cinctum – abundant
Peridinium inconspicuum
P. volzii f. *compressum*

CHRYSOPHYTA

XANTHOPHYCEAE
Stipitococcus vas

CHRYSOPHYCEAE
Dinobryon divergens

BACILLARIOPHYCEAE
Melosira distans
Gomphonema acuminatum v. *coronata*
Surirella guatimalensis

CHLOROPHYTA

VOLVOCALES

Helikotropis okteres? – fig. 33: 10

CHLOROCOCCALES

Selenastrum bibraianum
S. minutum
S. westii
Dictyosphaerium pulchellum
Pediastrum duplex
P. tetras
Scenedesmus acutiformis
S. armatus v. *bicaudatus*
S. ecornis
S. quadricauda

CONJUGALES

Pleurotaenium ehrenbergii
Euastrium ansatum v. *attenuatum*
E. evolutum v. *integrius* – figs. 37: 11 & 12
Micrasterias radians – fig. 37: 2
M. tetraptera v. *longesinuata*
M. truncata
Xanthidium antilopaeum
Staurodesmus joshuae v. *extensus*
Staurastrum armigerum v. *furcigerum*
S. subpolymorphum – figs. 42: 10 & 11
S. tetracerum

PROTOZOA

Paulinella chromatophora

ROTATORIA

Anuaeropsis f. fissa
Colurella uncinata bicuspidata – fig. 45: 9
Keratella tropica
Monostyla bulla
Trichocerca similis
Trichocerca sp.

In the nearby *Potamogeton* pond, at the same time, *Dinobryon divergens* was the preponderant phytoplankter. *Micrasterias truncata* was also frequent, as was also the case in the samples collected from the bay of Lake Pellaifa, see p. 59. Among the zooplankters *Keratella tropica* and *Anuaeropsis fissa* occurred in great numbers. Moreover, this pond was inhabited by numerous cladocers, of which only a few have been identified. This sample, like the previous one, contains many benthic diatoms which have as yet not been identified.

CYANOPHYTA

Aphanocapsa elachista
Coelosphaerium kuetzingianum
Merismopedia tenuissima
Nostoc sp.

EUGLENOPHYTA

Euglena fusca
Trachelomonas volvocina

CHRYSOPHYTA

CHRYSOPHYCEAE

Bicoeca lacustris
Dinobryon divergens – abundant

BACILLARIOPHYCEAE

Melosira varians
Gomphonema acuminatum v. *coronata*

CHLOROPHYTA

VOLVOCALES

Schizochlamys gelatinosa

CHLOROCOCCALES

Treubaria triappendiculata
Ankistrodesmus falcatus
A. falcatus v. *spirilliformis*
Kirchneriella obesa
Selenastrum bibraianum
S. westii
Botryococcus braunii
Dictyosphaerium pulchellum
Dimorphococcus lunatus
Pediastrum boryanum
P. duplex
Scenedesmus abundans
S. bicaudatus
S. carinatus
S. ecornis
S. ecornis v. *disciformis*
S. ovalternus

CONJUGALES

Closterium malmei
C. setaceum
C. venus
Pleurotaenium ehrenbergii
P. trabecula
Micrasterias truncata – frequent
Cosmarium botrytis v. *depressum*
C. regnesii
C. subspeciosum v. *validius*
Xanthidium antilopaeum
X. variabile
Staurodesmus convergens
Staurodesmus crassus
S. dejectus
S. dickiei
S. joshuae
S. phimus – fig. 34: 11
Staurastrum alternans – figs. 41: 19 & 20
S. gladiosum
S. iotanum
S. perundulatum
S. quadrangulare v. *contectum* – figs. 41: 7&8
S. setigerum
S. subavicula v. *tyrolense*
Sphaerozosma excavatum v. *subquadratum*
S. granulatum
Hyalotheca dissiliens
Desmidium swartzii

PROTOZOA

Arcella vulgaris

ROTATORIA

Anuaeropsis f. fissa – fig. 45: 13, frequent
Keratella tropica – frequent
Lepadella patella
Macrochaetus collinsi
Monostyla bulla
Scaridium longicaudum
Trichocerca bicristata – fig. 45: 8
Trichotria tetractis

CLADOCERA

Alona sp.
Ilyocryptus spinifer
Scapholeberis spinifera

COPEPODA

Cyclops sp.

These two ponds are the sole habitats noted within the lake district for many freshwater organisms, including the plankter *Anuaeropsis fissa*, a species typical of ponds and small eutrophic lakes.

IX. TAXONOMIC COMMENTS

During the studies of my South American collections many taxonomic notes accumulated, some of which are gathered in the following pages. They are intended to stimulate further taxonomic discussions or have been included in order to elucidate some of the problems that were met with in the present study. Numerous taxa have been illustrated by microphotographs which serve to support the identifications, to promote taxonomic discussion, and to facilitate future investigation.

For many taxa the material has been too sparse for a convincing identification. Thus it may be impossible to classify a particular specimen, although after a study of numerous specimens a solution may be reached. The alpha and omega of phycological work is to use the existing literature fully but critically. No manual is complete, and many are out of date, being sometimes completely antiquated as regards some groups of algae, and even dangerous to use for identification. The phycological literature is increasing rapidly. One can never get along only with manuals; considerable studies of the original literature are indispensable for the identification of many algae. However, no one knows of all phycological papers that have been published, and very likely there exist papers which ought to have been quoted below but have been overlooked. Naturally, the selection of taxa commented on is highly individual; hence the notes on desmids take up much space.

1. MICROPHYTA

Chroococcaceae

For this group the old-world nomenclature, used for example by Geitler, Huber-Pestalozzi, Skuja, Teiling, *et al.*, has been used in the present paper. I have not bothered to prepare dried herbarium specimens which could be compared with those of Drouet & Daily (1956). There is no doubt that the taxonomy of the *Chroococcaceae* should be based on fresh specimens or at least on liquid preserved ones, e.g. samples preserved in formalin, and on published illustrations of good quality. As a rule, dried specimens are of little value for taxonomic work and can rarely be employed as types for taxa of algae. They would even lead to two kinds of taxonomy, one working with fresh material and natural populations, and another with blue-green spots on herbarium sheets. Unfortunately, the nomenclature introduced by Drouet & Daily (l. c.) has come very much into vogue. Thus, people who used to call the common waterbloom *Microcystis* sp. have accepted the synonym, *Anacystis cyanea.*

Cylindrospermum maius Kütz.

Fig. 7. Hygropetrica, Villarrica.

This plant occurred in large quantities on the moist surface of the precipice at intervals bordering the shore of Lake Villarrica (see p. 22). It was often noted as forming spores, and in this connection it should be pointed out that the cell-division occurring at germination in mature spores is contrary to what has been stated by Glade (1914).

Carnegia frenguellii (Cler.) Defl.

In a sample collected from Lake Quillehue on November 22, 1953, a specimen of this *Chrysostomatacea* was noted. The breadth of the envelope was about 10 μ. A good drawing of this plant is given by Frenguelli (1936, p. 267, figs. 5a–c), compare also Conrad (1938b, figs. 6 and 10). The shape of the envelope closely resembles the silicious cysts produced by some *Chrysophyta*, compare Nygaard (1956, pl. 12, figs. 9–11). The similarity between *Carnegia frenguellii* and the cysts of *Uroglena soniaca*, described by Conrad (1938a, pl. 3), is striking. As to the taxonomic status of *Chrysostomataceae* see Conrad (1938b) and Bourrelly (1957a, pp. 72–75, 101, 122–123).

Tribonema elongatum n. sp.

In many Chilean lakes a *Tribonema* sp. was noted. It was compared with *T. ambiguum* Skuja (1948, p. 342) which, however, has slightly fusiform cells. The cells of my specimens are cylindrical in shape. Cell breadth is very similar to that of *T. taeniatum* Pascher figured by Nygaard (1949, fig. 21), but the cells are considerably longer. The measurements of my plants are: breadth 3.75 μ, length of the cells 40–43.5–49–54–59–60 μ. A cell usually contains a single chromatophore, but sometimes there seem to be two of them. The membrane is very thin.

Trichomata cylindracea, recta vel irregulariter flexuosa. Cellulae elongatae, long. cellularum 40–60 μ, latitudo 3.75 μ.

Melosira granulata (Ehrenb.) Ralfs

Fig. 39: 1. Lake Villarrica.

I have studied a large amount of material of this species which is frequent in many Chilean lakes, and is of some taxonomic interest, as has been pointed out earlier (Thomasson, 1959, p. 65). Cells with striae arranged parallel to the pervalvar axis are frequent, but a careful examination of the present material has shown that in other cases there is a discernible or even distinct slightly oblique striation. There is little reason to maintain *M. pseudogranulata* which was described by A. Cleve-Euler (1948); this taxon fits well within the variation range of *M. granulata*. Similar populations were obviously observed even earlier, e.g. by A. Cleve, in Borge (1901, p. 5), here denoted as *M. granulata β australiensis*, and by O. Müller (1909) who called it *M. granulata* var.

Chlorococcales

Among the *Chlorococcales* two plants which puzzled me a great deal were noted in the plankton of Lake Villarrica.

One was rather frequent; the coenobia were generally 4-celled, the cells 14.4 μ long, see fig. 33: 11. It resembles some figures of *Crucigenia irregularis* Wille, e.g. that in Korschikov (1953, p. 359, fig. 339a). However, it occurs also in large aggregates, see fig. 33: 12. Similar coenobia are often noted in cultures of *Scenedesmus*, but these observations can scarcely be applied to the taxonomy of natural populations. Relationship may possibly exist between this plankter and among others *Lobocystis* Thompson, *Tetrachlorella alternans* (Smith) Korschikov (*Crucigenia alternans* Smith), and *Didymocystis* Korschikov. However, I have not managed to arrive at an understanding of the taxonomic position of this plant, which was also noted in the plankton of Lake Llanquihue. Some information about its reproduction is necessary.

The other confusing plant is seen in fig. 39: 9. The cells are 23.5 μ long. It has some resemblance to *Nephrocytium*, and also to the plant called *Quadricoccus laevis* v. *giganteus* by Thomasson (1957c). For this plant also, further investigations, on fresh material, are required.

Euastrum attenuatum var. *lithuanicum* Wolosz.

Fig. 37: 13. Lake Llanquihue, benthos.

Compare the plant depicted by Borge (1901, pl. 1, fig. 10) which belongs to *E. attenuatum* according to Krieger's *Flora*. A plant which I consider as representing *E. attenuatum* v. *lithuanicum* is reproduced in Thomasson (1959, fig. 22: 8). See also *E. attenuatum* v. *lithuanicum* f. *pulchellum* Prescott & Scott (1945, pl. 4, fig. 10). Because of the somewhat dubious figure of v. *lithuanicum* which was given by Woloszynska (Krieger's *Flora*, pl. 73, figs. 18–19) the interpretation of this variety is still unsettled. Additional material is wanted that may elucidate the taxonomic value of this variety, and its relation to *E. attenuatum* Wolle (1892, p. 113, pl. 30, fig. 17).

Micrasterias rotata (Grev.) Ralfs

Fig. 37: 1. Lake Pichilafquen.

This plant is closely related to *M. rotata* v. *japonica* Fujis. Properly speaking it is an intermediate between *M. rotata* s. str. and its v. *japonica*. There is also some resemblance between my plant and *M. tetraptera* v. *longesinuata* Krieger, a taxon which probably has nothing to do with *M. tetraptera* W. & W. In the samples from Lake Pellaifa I encountered specimens similar to the plant under discussion, but having ultimate lateral lobes with broad truncate ends. They are very similar to the plant figured by Thomasson (1959, fig. 21: 20) under the name of *M. denticulata* Bréb. See also *M. denticulata* v. *japonica* (Fujis.) Okada in Hinode (1959, pl. 8, fig. 6).

Micrasterias sol var. *ornata* Nordst.

Figs. 37: 7 and 8. Lake Pichilafquen.

At the first glance it seems to be a simple matter to classify these plants, but when comparing different published figures of related plants one becomes rather confused. Just compare the following: *M. radiosa* Ralfs in Taylor (1935, pl. 48); *M. radiosa* v. *extensa* (Prescott & Scott) Irénée-Marie (1952, pl. 15, figs. 6 and 7); *M. radiosa* v. *ornata* Nordstedt (1869, pl. 2, fig. 11); *M. sol* f. *ornata* (Nordst.) Kossinskaja (1960, pl. 74, fig. 4, and pl. 75, figs. 1–6); *M. sol* v. *murrayi* (W. & W.) Allorge in Krieger (1939, pl. 132, fig. 1); *M. murrayi* W. & W. in Grönblad (1921, pl. 1, fig. 13); *M. papillifera* Bréb. formae in Kossinskaja (1936, pl. 1); *M. speciosa* Wolle in Irénée-Marie (1952, pl. 15, figs. 9–11); *M. novae-terrae* v. *speciosa* (Wolle) Krieger & Bourrelly (1956, p. 152); and also *M. hamata* f. *brasiliensis* Børgesen (1890, pl. 2, fig. 11).

M. radiosa is to be considered as synonymous with *M. sol*; *M. murrayi* and *M. sol* v. *murrayi* probably belong to *M. papillifera*, cf. Kossinskaja (1960, p. 463). *M. speciosa* has been united by Krieger in 1939 with *M. papillifera* as v. *speciosa*, but transferred later on in Krieger & Bourrelly (1956) to *M. novae-terrae*. I am not convinced as to the possible relationship between *M. hamata* f. *brasiliensis* Børgesen and *M. borgei* (cf. Krieger, 1939, p. 116), I think that Børgesen's plant is better to be placed with *M. novae-terrae*.

The varied taxonomic life-times of the plants listed above are not surprising as they resemble each other closely. Considering my plants from Lake Pichilafquen, I think that the slender lobes, especially the slender polar lobe, the ornamentation of the membrane, and the size indicate their relationship to *M. sol.* v. *ornata*.

Cosmarium amoenum Bréb. forma

Fig. 38: 9. Length 57 μ, breadth 36 μ. Lake Pellaifa.

This rather large *Cosmarium* is puzzling particularly with respect to the shape of the isthmus part. My plant resembles the following taxa: *C. amoenum* Bréb. in Skuja (1949, pl. 27, fig. 4), *C. isthmium* f. *hibernica* W. West in Irénée-Marie (1939, pl. 26, fig. 8), *C. excavatum* f. *duplo-maior* Lund. in Grönblad (1934, fig. 4: 8), and in Taylor (1934, pl. 52, fig. 3). Moreover, *C. bisphaericum* Printz (1916) figured by Croasdale (1956, pl. 13, fig. 1), ought to be considered.

Cosmarium araucaniensis n. sp.

Fig. 35: 6. Length 40–45 μ, breadth 35–47.5 μ. Lake Pellaifa.

This *Cosmarium* has a very characteristic ornamentation of the cell wall. It is granulated, and besides the granulation there are three longitudinal rows of large papillae on the front of the semicells. The structure of ornamentation is evident from microphotograph 35: 6. In vertical view, three conspicuous undulations indicate the rows of papillae. The sinus is expanded in its outer part. I have observed single specimens of this plant in the plankton of the lakes Pellaifa and Pichilafquen. It resembles slightly some forms of *C. monomazum* and *C. cyclicum* in its outlines. Compare also *C. cuneatum* Joshua in Skuja (1949, pl. 31, figs. 3 and 4). However, I consider the plant from the Chilean lake district to be a new species.

Cellulae mediocres, tam latae quam longae. Long. 40–45 μ, lat. 35–47.5 μ. Isthmus modice latus, sinus ad extremitatem interiorem angustus rectusque. Membrana verrucis in series regulares ordinatis.

Cosmarium corumbense Borge forma

Fig. 35: 9. Length 50 μ. Lake Pichilafquen.

I have identified this plant as a forma of *C. corumbense* Borge (1903, pl. 2, fig. 27). The plant described by Borge is smaller, only 39–41 μ long, but considering the shape they are very similar. There are also some forms of *C. obtusatum* which resemble my plant, e.g. *C. obtusatum* v. *glabrum* Borge (1903), but that plant has a smooth apex. *C. didymochondrum* v. *novae-guineae* Bernard (1909) also seems to be closely related to my plant.

Cosmarium depressum var. *achondrum* (Boldt) W. & W.

Fig. 38: 2. Length 50–54 μ, breadth 54 μ. Lake Pichilafquen.

This plant should be compared with *C. subtumidum* v. *klebsii*, see fig. 38: 3. It also resembles *C. contractum* v. *retusum* (W. & W.) Krieger & Gerloff, 1962.

Cosmarium nitidulum De Not.

Fig. 38: 12. Length 30 μ. Lake Pichilafquen.

Compare *C. nitidulum* in Krieger (1950, p. 40, fig. 2) which has a length of 33–35 μ. The similar *C. nitidulum* v. *pseudorectangulare* described by Messikommer (1938, p. 172, pl. 3, fig. 26) is larger; the length is 40–50 μ. My plant should be compared with *C. granatum* v. *rotundatum* Krieger (1932, pl. 10, fig. 21) which is similar in shape but not identical.

Cosmarium phaseolus Bréb.

Fig. 38: 10. Length 32.5 μ, breadth 26 μ. Lake Pichilafquen.

This plant is similar to *C. phaseolus* Bréb. in Croasdale (1956, p. 45, pl. 4, fig. 6), and in Thomasson (1959, fig. 21: 19). *C. subtumidum* v. *pachydermum* Prescott & Scott (1952, pl. 1, fig. 18) is a plant of very similar shape but smaller.

Cosmarium portianum var. *maius* Scott & Prescott

Fig. 35: 7. Length 64–68 μ, breadth 48 μ. Villarrica, inundation pool.

I have identified this plant with the variety described by Scott & Prescott (1961, p. 65, pl. 28, fig. 9), but as no measurements were given, I am not quite sure about the identity.

Cosmarium pseudoprotuberans Kirch. forma

Fig. 38: 13. Length 20.5–25 μ. Lake Llanquihue.

A plant similar in shape, but larger is *C. pseudoprotuberans* v. *inapertum* Messik. (1957, pl. 1, fig. 16).

Cosmarium pyramidatum Bréb.

Fig. 35: 1. Length 96 μ, breadth 66 μ. Inundation pool, Villarrica.

Figures to be compared: *C. pyramidatum* in Seckt

(1929, pl. 3, fig. 55); *C. pyramidatum* in Taylor (1934, pl. 48, fig. 17); and *C. pyramidatum* v. *transitorium* Heimerl. in Irénée-Marie (1939, pl. 30, figs. 2 and 3, and pl. 22, fig. 2). Similar in shape but considerably larger is *C. pseudopachydermum* Nordst. (1888). Smaller, about 72 μ long, is *C. pachydermum* v. *schmidlei* Printz (1916, p. 18, pl. 2, fig. 14). My specimen also somewhat resembles *C. gayanum* Bréb. in Oye (1943, pl. 2, fig. 5).

Cosmarium quadrifarium f. *octasticha* Nordst.

Fig. 35: 8. Lake Pichilafquen.

Very similar to the present plant, and possibly synonymous is *C. pulcherrimum* Nordst. (1869, p. 175, pl. 3, fig. 24).

Cosmarium rectangulare Grun. forma

Fig. 38: 4. Length 35 μ, breadth 25 μ. Lake Pichilafquen.

This small alga belongs to the *Cosmarium* species that are difficult to identify. I have seen only one specimen, and have no idea about the variation. It is similar in size and shape to the plant obviously wrongly identified as *C. galeritum* v. *minus* Wille (1884) by Hirano (1957, pl. 20, fig. 40). *C. pseudoprotuberans* v. *borgei* Insam & Krieger is similar in shape but smaller than my plant. Among the Cosmaria of similar shape but of larger dimensions one notes: *C. nitidulum* v. *pseudorectangulare* Messik., and *C. pseudonitidulum* v. *validum* W. & W. I have considered, with great doubt, the plant under discussion as belonging to *C. rectangulare* as figured by Messikommer (1938, pl. 3, figs. 29–31), but being a little smaller.

Cosmarium scorbiculosum Borge

Fig. 38: 7. Length 90 μ, breadth 65–67 μ. Lake Pichilafquen.

I presume that this plant belongs to *C. scorbiculosum* Borge (1903). There are also some forms of *C. margaritaceum* which are very similar to my plant, e.g. *C. margaritaceum* (Lund.) Roy & Biss. in Skuja (1949, pl. 32, fig. 2), and *C. margaritaceum* v. *pseudoconspersum* Dick (1926) depicted by Croasdale (1956, pl. 17, fig. 16).

Cosmarium subprotumidum Nordst. forma

Fig. 38: 11. Length 20.5 μ. Villarrica, inundation pool.

This little *Cosmarium* was of rather frequent occurrence among the algae growing in the inundation pool near our laboratory at Villarrica. The identification is somewhat doubtful, cf. Grönblad (1960, fig. 129). There is also some superficial resemblance to *C. calcareum* Wittrock, and to *C. blyttii* Wille figured by Carlson (1913, p. 41, fig. 10).

Cosmarium subtumidum var. *klebsii* (Gutw.) W. & W.

Fig. 38: 3. Length 52 μ, breadth 54 μ. Lake Pichilafquen.

In *C. subtumidum* v. *klebsii* the broadest part of the semicell is located close to the isthmus, while in the similar *C. depressum* v. *achondrum* (Boldt) W. & W. the semicell is broadest just below the centre. This plant from Lake Pichilafquen is exceptionally large. Considering its size it could be placed between *C. subtumidum* v. *klebsii* and *C. lundellii* Delp.

Cosmarium teilingii n. sp.

Figs. 35: 2–5, Length 105–109 μ. Lake Llanquihue.

The shape and the ornamentation of the membrane of this large triradiate desmid indicate that it is a *Cosmarium* and not a *Staurastrum*. It has semicircular semicells, a triangular vertical view, convex sides of the cell body in vertical view, and angles broadly rounded. The characteristic ornamentation of the cell wall is evident from the microphotographs. In vertical view it resembles *C. amplum* f. *trigona* Nordstedt (1888, p. 63, pl. 6, fig. 21) but has a much coarser texture. I have named this new taxon in honour of my good friend, the well known planktologist, Dr. Einar Teiling.

Cellulae magnae, non plane duplo longiores quam latae, in medio incisura lineari constrictae. Semicellulae e vertice visae triangulares, angulis rotundatis; latere visae subcirculares. Membrana granulis magnis regulariter ordinatis, inter granula poris quincuncialiter dispositis ornata. Long. 105–109 μ.

Cosmarium tetragonum var. *lundellii* Cooke

Fig. 38: 14. Inundation pool, Villarrica.

Figures of *C. tetragonum* v. *lundellii* which should be compared with this specimen: Deflandre (1925, p. 383, figs. 28–31); Insam & Krieger (1936, p. 109, pl. 3, fig. 20); Grönblad (1942, pl. 3, figs. 22 and 23). See also *C. tetragonum* v. *lundellii* f. *schmidlei* Gutw. (1897) in Ružička (1955, p. 599, fig. 28), and in Rybníček (1960, p. 146, fig. 56). For *C. tetragonum* see the *Euastrum tetragonum* in Nägeli (1849, pl. 7, fig. 5c). *C. tetragonum* v. *lundellii* could at a hasty glance be mistaken for *Euastrum doliforme* W. & W. (1897, p. 289, pl. 16, fig. 12). See also the variety of that species depicted by Taylor (1935, pl. 39, fig. 7). My plant also somewhat resembles *Euastrum simpliciforme* Fritsch & Stephens (1921, p. 28, fig. 9).

Staurastrum alternans Bréb.

Figs. 41: 19 and 20. Length 27.5 μ. *Potamogeton* pond at Lake Pellaifa.

This *Staurastrum* shows a considerable resemblance to *S. alternans* figured in Grönblad (1960, pl. 10, figs. 215 and 216). It is a plant of about the same size and shape as the plant depicted by Grönblad. The apical margin is in both plants nearly flat. The plant from *Potamogeton* pond agrees also well in shape and ornamentation with the plant figured as *S. dilatatum* Ehrenb. in Thomasson (1959) which, however, is larger and quadriradiate. As was pointed out in Thomasson (1959, p. 67) the *alternans-dilatatum-striolatum*-group is in need of revision. There is one more taxon to be considered, viz. *S. lapponicum* (Schmidle) Grönblad (1926, p. 29, figs. 106 and 107) which has elliptical semicells and convex apical margin. See also the forma of *S. lapponicum* figured in Krieger & Bourrelly (1956, pl. 11, fig. 117). The latter agrees almost exactly in shape and ornamentation with *S. dilatatum* v. *obtusilobum* De Not. depicted by Nordstedt (1888, p. 41, pl. 4, fig. 19), a variety which has been discarded in Wests' *Monograph.* Of similar shape are the specimens of *S. punctulatum* v. *ellipticum* Levin figured in Krieger (1932, pl. 15, fig. 10), and in Skuja (1949, pl. 35, fig. 7). Both have probably nothing to do with the taxon described by Levin (1888, p. 9, pl. 1, fig. 16) because her plant has, in top-view, straight sides. They may be considered as closely related to *S. lapponicum.* The plant from *Potamogeton* pond should also be compared with *S. illusum* G. S. West, and with its v. *maior* which has been described by Irénée-Marie (1949, p. 144, pl. 1, fig. 12). Both these plants are somewhat larger than my plant.

Staurastrum anatinum var. *subfloriferum* n. var.
Figs. 41: 14. Lake Llanquihue.

This variety is characterized by its inclined processes which have a well developed dorsal ornamentation. It should be compared with *S. floriferum* W. & W. (1896, pl. 18, fig. 1). My plant also resembles somewhat *S. saltator*, figured in Grönblad (1938), and the plant which has been described under the name *S. planctonicum* v. *laeviceps* by Grönblad (1960). I think that the last mentioned combination is somewhat dubious, the plant depicted being scarcely related to *S. planctonicum.*

Varietas a species differens processibus convergentibus.

Staurastrum arachne var. *curvatum* W. & W. forma
Fig. 46: 1. Length without processes 26 μ, with processes 47 μ, breadth 64 μ. Lake Lacár.

This quinqueradiate plant from Lake Lacár is considered a form of *S. arachne* v. *curvatum*, see Wests' *Monograph* (p. 152, pl. 150, fig. 2). It has slightly stouter processes than the variety figured by the Wests. See also the plant depicted by Hirano (1959, pl. 17, fig. 12). There is also some resemblance to *S. asteroideum* W. & W. which, however, is much smaller, and to *S. radians* v. *divergens* Scott & Grönblad which is a considerably larger plant.

Staurastrum arcuatum Nordst. forma
Figs. 42: 12 and 13. Lake Pichilafquen.

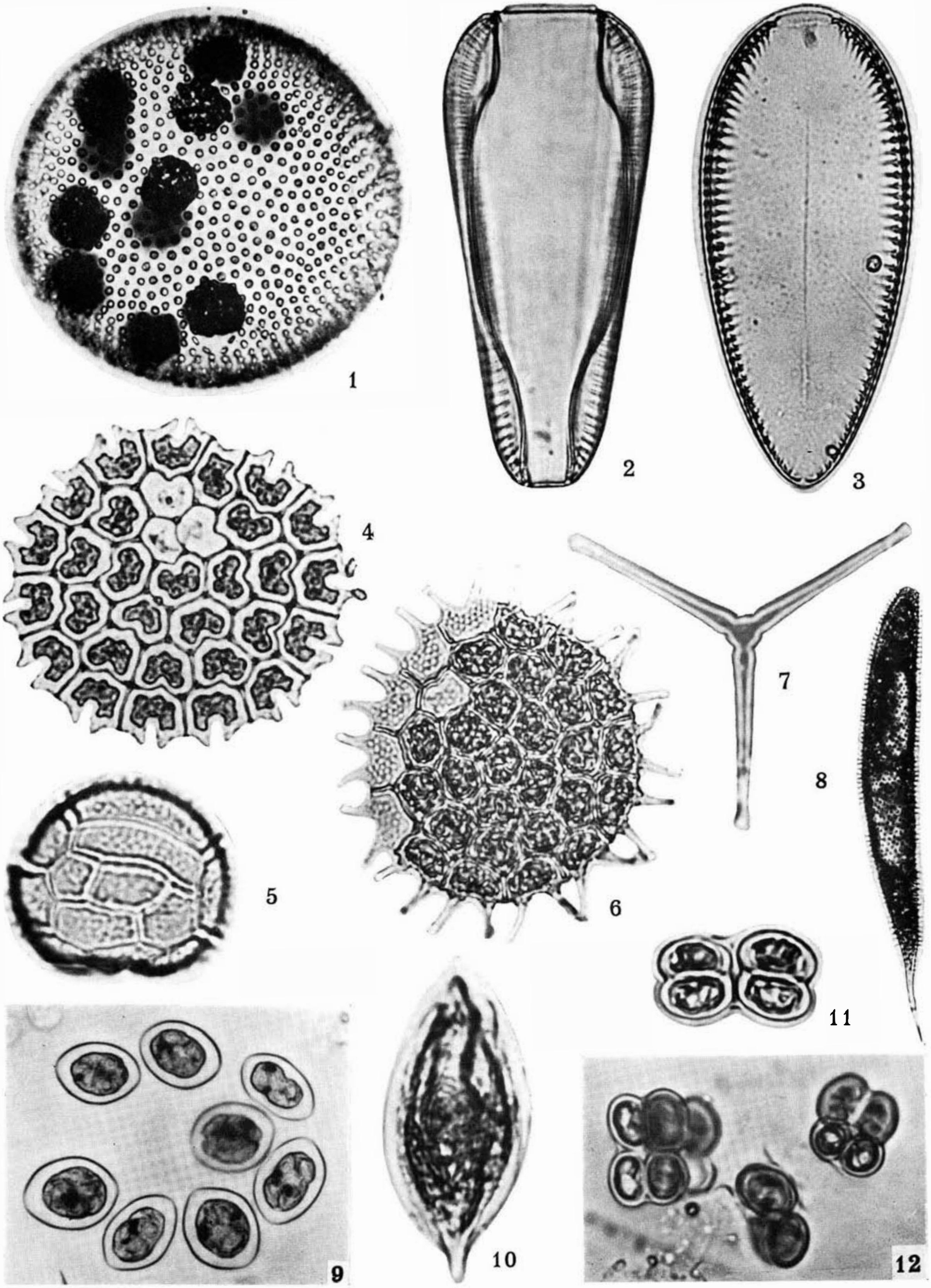
This plant is almost identical with *S. arcuatum*, except that the processes terminate in three spines instead of the usual two. This difference makes its identity uncertain. The position of the apical processes on the central part of the apex is characteristic of *S. arcuatum.* In addition, my plant should be compared with forms of *S. furcatum* and *S. subavicula.*

Staurastrum aspinosum Wolle forma
Figs. 42: 21 and 22. Length 24 μ, breadth 68 μ. Lake Llanquihue.

This plant was a rare plankter; only a few specimens were observed. I have identified it as a form of *S. aspinosum* Wolle (1892, p. 157, pl. 62, figs. 22 and 23). It differs from the plant described by Wolle in having less diverging processes, and in being quadriradiate; the semicells are not twisted. The v. *annulosum* W. & W. (1896) is similar, but I have studied it in the plankton of some lakes in North Carolina and found it not to be identical. Compare also *S. platycerum* Joshua depicted in Thomasson (1960), a desmid that closely resembles the plant from Chile. However, that taxon was identified by means of the vertical view as given by Joshua (1886, pl. 24, fig. 1) and I now regard the determination as dubious. If my plant had been larger, a relationship to *S. anatinum* v. *longibrachiatum* W. & W. in Wests' *Monograph* (pl. 147, fig. 5) would have had to be considered. On the other hand it also resembles the following smaller plants: *S. gracile* v. *tenuissima* Boldt in Wests' *Monograph*, and in Irénée-Marie (1939, pl. 49, fig. 21), and *S. gracile* v. *subtenuissimum* Woronichin f. in Messikommer (1949, fig. 16).

Fig. 33.
1. *Volvox aureus* Ehrenb., Villarrica.
2–3. *Surirella guatimalensis* Ehrenb., Villarrica.
4. *Pediastrum boryanum* Menegh., Pichilafquen.
5. *Peridinium volzii* var. *cinctiforme* Lef. tab. 1 a simplex, Llanquihue.
6. *Pediastrum boryanum* var. *longicorne* Reinsch, Pellaifa.
7. *Centronella reicheltii* Voigt, Villarrica.
8. *Euglena fusca* (Klebs) Lemm., Pellaifa pond.
9. *Oocystis natans* (Lemm.) Wille, Villarrica.
10. *Helikotropis okteres* Pochm.?, Pellaifa pond.
11–12. *Chlorococcales*, see p. 105, Villarrica.

Photographs by K. Thomasson.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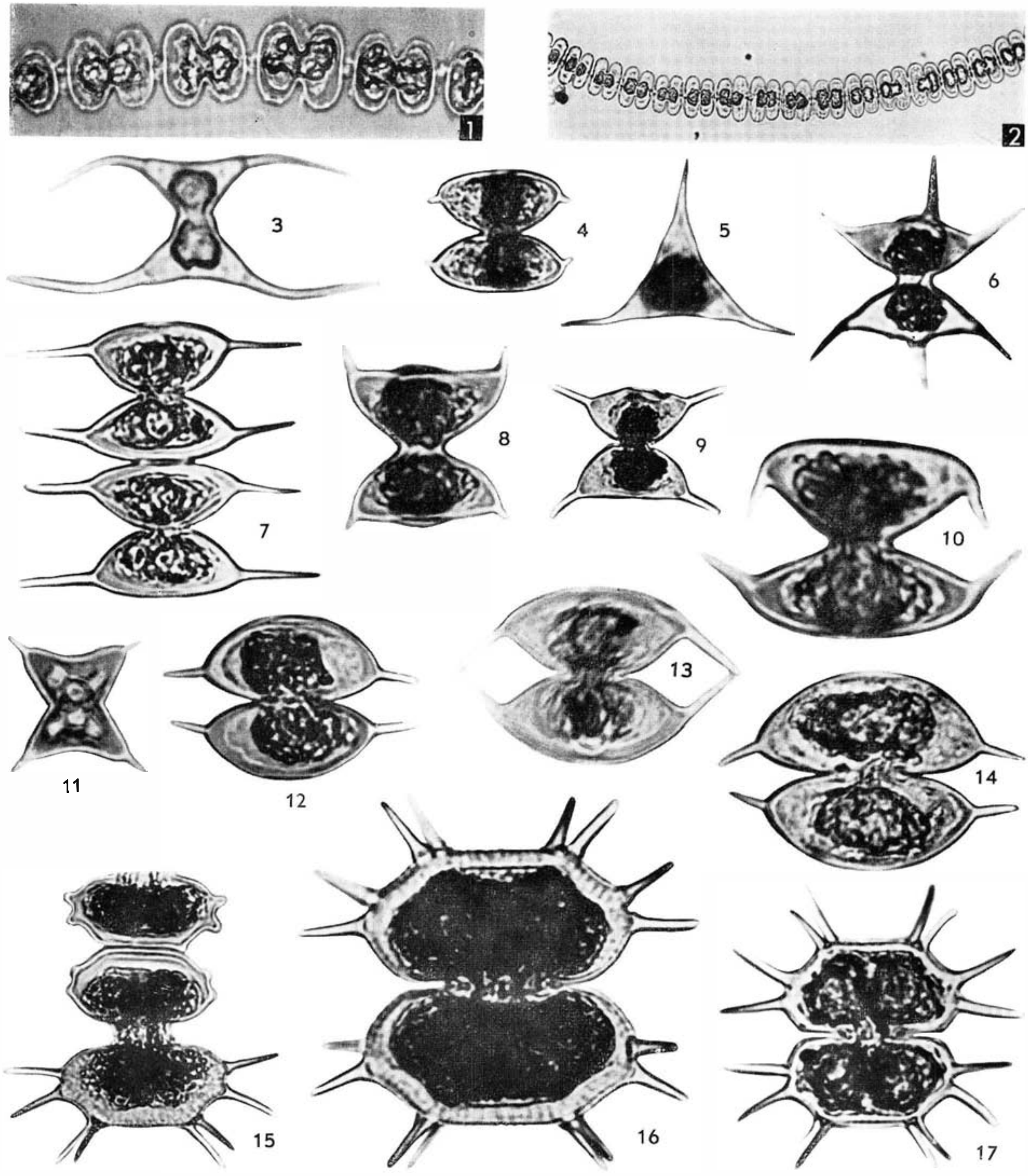


Fig. 34.

1–2. *Sphaerozosma aubertianum* W. West, Pichilafquen, Llanquihue.
3. *Staurodesmus triangularis* f. *curvispina* Thom., Pellaifa.
4. *S. dickiei* (Ralfs) Lillier. forma, Pellaifa.
5–6. *S. cuspidatus* var. *acuminatus* (Nygaard) Florin, Llanquihue.
7. *S. subulatus* (Kütz.) Croasdale, Pichilafquen.
8. *S. dejectus* (Bréb.) Teiling, Pellaifa.
9. *S. patens* (Nordst.) Croasdale, Llanquihue.
10. *Staurodesmus dickiei* var. *rhomboideus* (West & West) Lillier., Pichilafquen.
11. *S. phimus* (Turner) Thom., Pellaifa pond.
12. *S. convergens* (Ehrenb.) Teiling, Pichilafquen.
13. *S. dickiei* var. *maximus* (West & West) Thom. Pellaifa.
14. *S. convergens* (Ehrenb.) Teiling, Villarrica.
15–17. *Xanthidium antilopaeum* (Bréb.) Kütz., Villarrica.

Photographs by K. Thomasson.

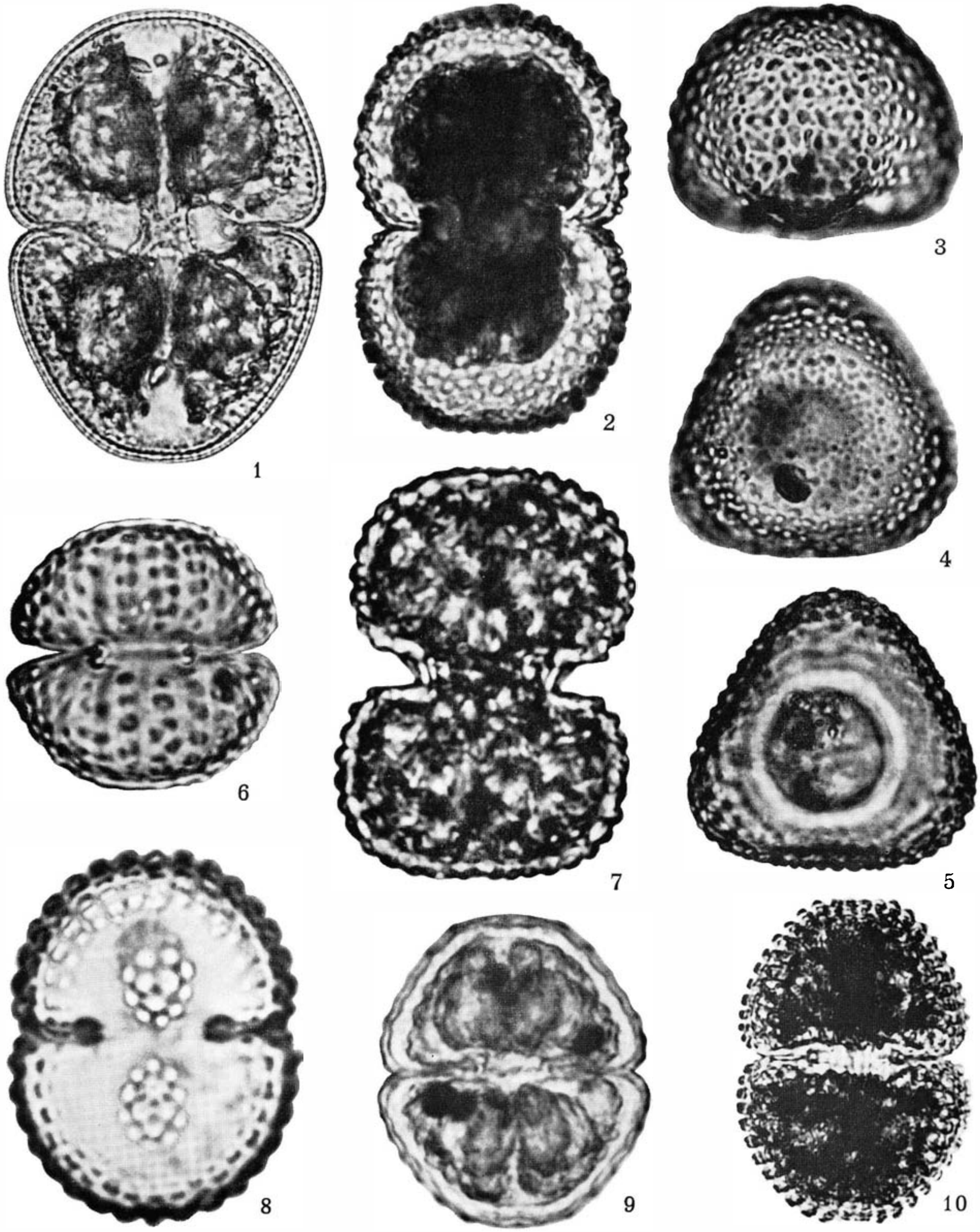


Fig. 35.

1. *Cosmarium pyramidatum* Bréb., Villarrica.
2–5. *C. teilingii* Thom., Llanquihue.
6. *C. araucaniensis* Thom., Pellaifa.
7. *C. portianum* var. *maius* Prescott & Scott, Villarrica.
8. *Cosmarium quadrifarium* f. *octasticha* Nordst., Pichilafquen.
9. *C. corumbense* Borge forma, Pichilafquen.
10. *C. ochthodes* var. *amoebum* W. West, Laguna Bonita.

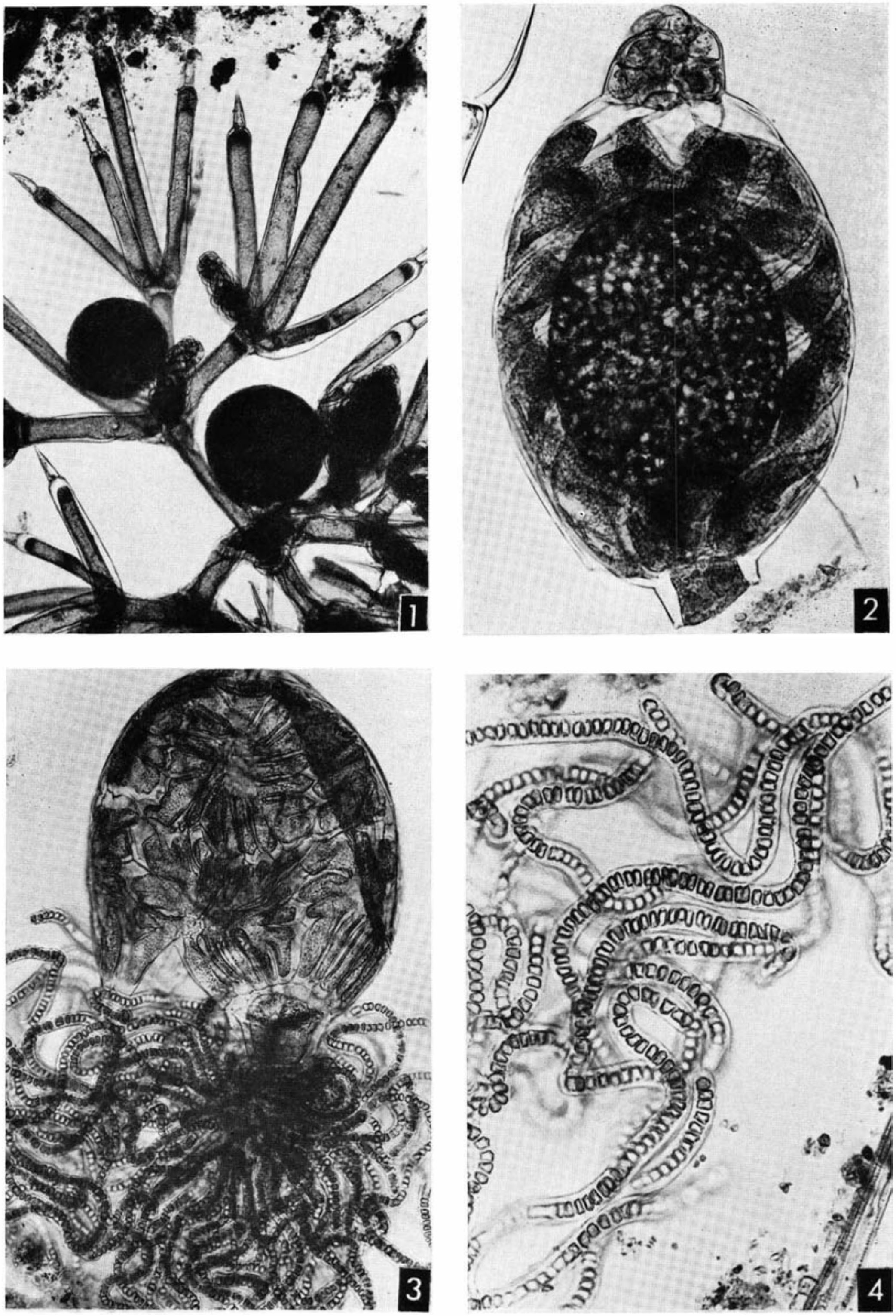


Fig. 36.

1. *Nitella* with antheridia and oogonia, see p. 63.
2. Almost mature fruit.
3. Mature oogonium with spermatogenous threads.
4. The spermatogenous threads that were noted in benthos samples were puzzling until they were traced to the oogonia of *Nitella*, Llanquihue.

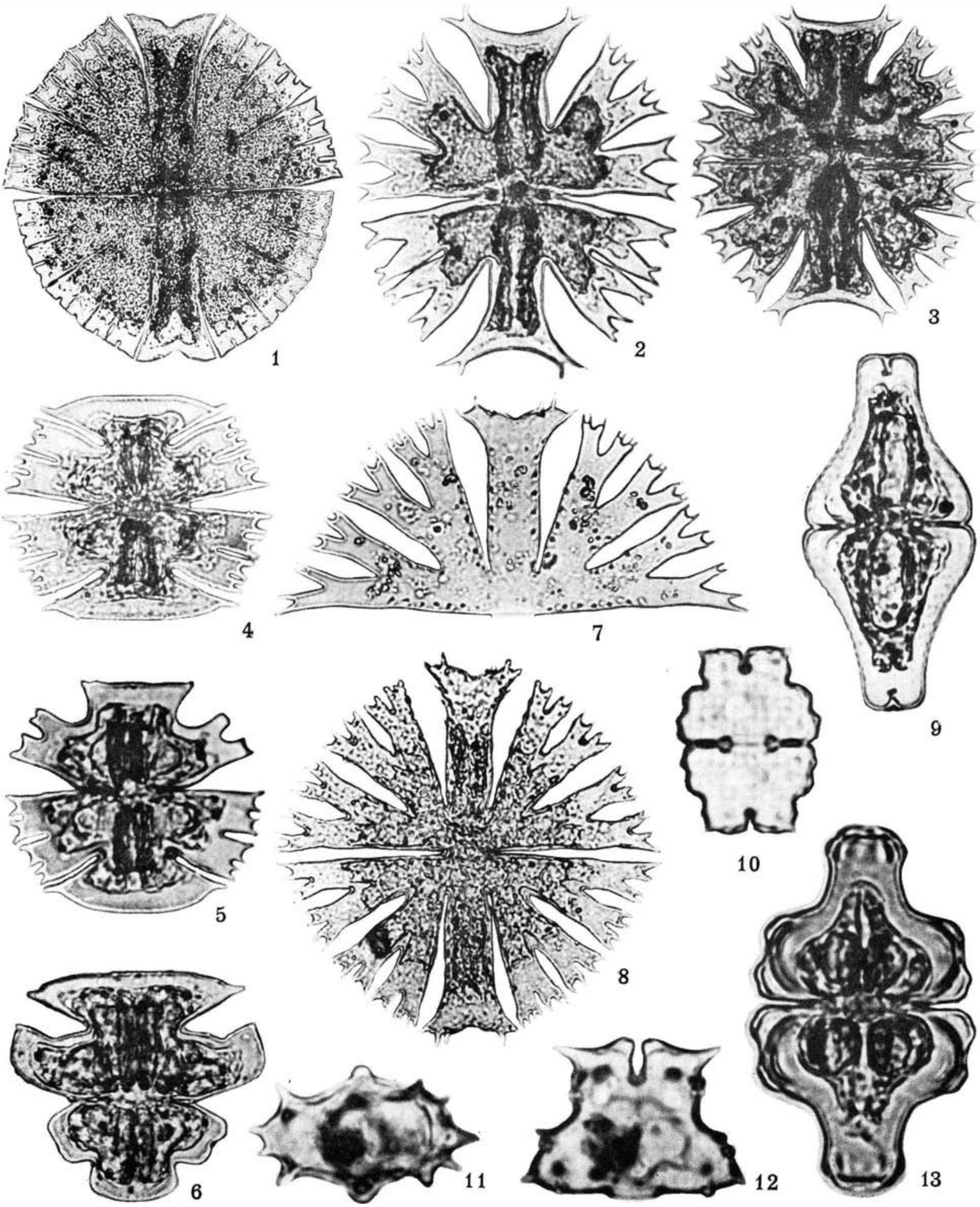


Fig. 37.

1. *Micrasterias rotata* (Grev.) Ralfs, Pichilafquen.
2. *M. radians* Turner, Pellaifa pond.
3. *M. crux melitensis* (Ehrenb.) Hass., Pellaifa.
4–6. *M. truncata* (Corda) Bréb., Pellaifa.
7–8. *Micrasterias sol* var. *ornata* Nordst., Pichilafquen.
9. *Euastrum ansatum* Ehrenb., Pichilafquen.
10. *E. turneri* W. West, Villarrica pool.
11–12. *E. evolutum* var. *integrius* West & West, Pellaifa pond.
13. *E. attenuatum* var. *lithuanicum* Wolosz., Llanquihue.

Staurastrum avicula Bréb. forma

Figs. 42: 7 and 8. Lake Villarrica.

I have considered this plant as belonging under *S. avicula*. It resembles in shape the *S. avicula* figured in Cook's *British Desmids*, and also *S. subcruciatum* in Hirano's *Flora*. The latter plant is scarcely identical with the plant which was described by Cook (*op. cit.*) under the name of *S. subcruciatum*. My plant from Lake Villarrica may possibly be considered as a separate forma of *S. avicula*. It was noted in several samples from North Patagonia.

Staurastrum bidentulum f. *maior* n. f.

Fig. 41: 16. Length and breadth 66 μ. Villarrica, inundation pool.

This large *Staurastrum* greatly resembles *S. orbiculare* v. *denticulatum* Nordst. (1869, pl. 4, fig. 42) which, however, is a somewhat smaller plant. In 1945 Grönblad renamed the taxon described by Nordstedt as *S. bidentulum*. The specimen depicted by Bourrelly (1957 b, cf. *S. bidentulum* f. fig. 119) is also smaller, length 40 μ, breadth 37 μ, as are the plants of Scott & Prescott (1961, pl. 49, figs. 7 and 8) which are 48–54 μ long, and 44–46 μ broad. In spite of its larger size, my plant is obviously related to these plants and may be considered as f. *maior* of *S. bidentulum*. Compare also *S. dickiei* v. *circulare* f. *inerme* Irénée-Marie in Irénée-Marie & Hilliard (1963, p. 115, pl. 1, fig. 4).

Staurastrum brachiatum Ralfs

Fig. 41: 9. Lake Pichilafquen.

This plant was frequently noted in many of the Chilean lakes studied. I am rather doubtful as to its proper taxonomic position. It has relatively long processes which, as a rule, are tipped by two stout spines. Rarely, the spines are short or absent. The apex is convex. The decision has been between *S. brachiatum* or *S. subnudibrachiatum*. After a study of the original drawings by Brébisson, I think my plants can be considered as *S. brachiatum*. See also Tarnogradsky (1960, pl. 1, figs. 15 and 16).

Staurastrum dilatatum Ehrenb. forma

Figs. 41: 17 and 18. Length 40 μ. Inundation pool, Villarrica.

The identification has been made with some doubt, because of the obscure character of *S. dilatatum*, see Wests' *Monograph*. The present specimen should be compared with the figures in Nordstedt (1888, p. 41, pl. 4, fig. 19b) and Grönblad (1960, p. 46, pl. 10, figs. 219 and 220). The latter differs from the South American plant in the widely open sinus. The ventral margin is in my plant only slightly inflated in the median part. In typical *S. dilatatum* the ventral margin is, according to Wests' *Monograph*, greatly inflated in the median part, so that the greater portion of the semicell is raised up on a smaller ventral piece.

Staurastrum grande var. *parvum* W. West forma

Fig. 41: 15. Length 50 μ. Lake Llanquihue.

The plant figured is triradiate. It resembles some forms of *S. orbiculare*, e.g. v. *hibernicum* and v. *depressum*, cf. Borge (1913, p. 26, pl. 2, fig. 24). However, the sinus of *S. orbiculare* is closed. An open sinus is to be found in *S. grande* Bulnh., and in its various forms. See *S. grande* in Smith (1924, p. 66, pl. 67, fig. 8). My plant is similar in shape but much smaller. There is a fitting variety, viz. v. *parvum* W. West only about 60 μ long, but it differs somewhat in shape from my plant. I consider my plant as a form of *S. grande* v. *parvum*.

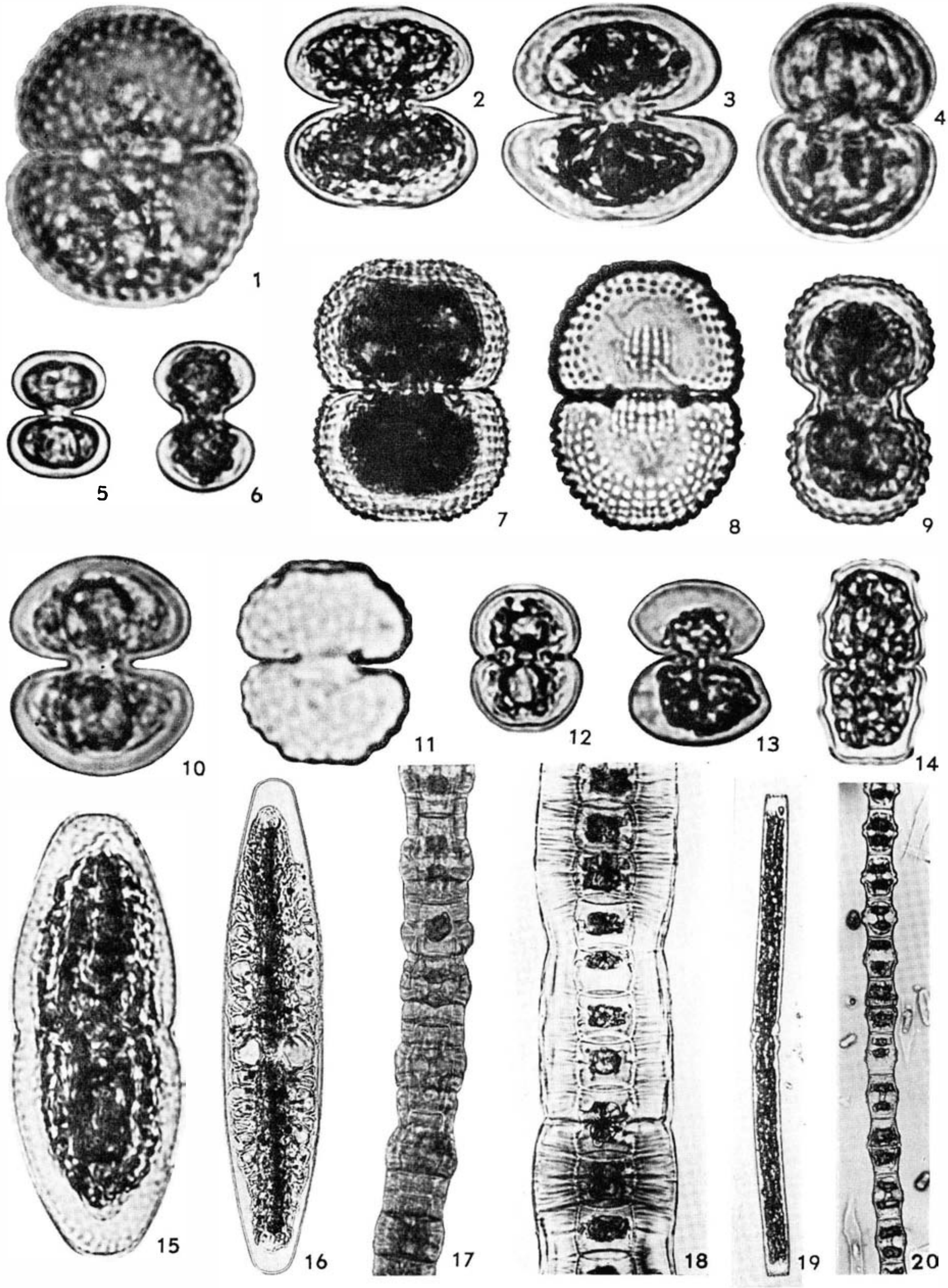
Staurastrum grande var. *rotundatum* W. & W.

Fig. 41: 21. Length 60–66 μ, breadth 50 μ. Lake Pichilafquen.

Fig. 38.

1. *Cosmarium punctulatum* var. *subpunctulatum* (Nordst.) Børges., Pichilafquen.
2. *C. depressum* var. *achondrum* (Boldt) West & West, Pichilafquen.
3. *C. subtumidum* var. *klebsii* (Gutw.) West & West, Pichilafquen.
4. *C. rectangulare* Grun. forma, Pichilafquen.
5. *C. contractum* var. *ellipsoideum* (Elfv.) West & West, Pichilafquen.
6. *Staurastrum subgrande* var. *convexum* Prescott & Scott, Llanquihue.
7. *Cosmarium scorbiculosum* Borge, Pichilafquen.
8. *C. subspeciosum* var. *validius* Nordst., Pichilafquen.
9. *C. amoenum* Bréb. forma, Pellaifa.
10. *Cosmarium phaseolus* Bréb., Pichilafquen.
11. *C. subprotumidum* Nordst. forma, Villarrica pool.
12. *C. nitidulum* De Not., Pichilafquen.
13. *C. pseudoprotuberans* Kirchner forma, Llanquihue.
14. *C. tetragonum* var. *lundellii* Cooke, Villarrica pool.
15. *Actinotaenium elongatum* (Racib.) Teiling, Llanquihue.
16. *Netrium digitus* f. *rectum* (Turner) Kossinskaja, Pichilafquen.
17. *Bambusina borreri* (Ralfs) Croasdale, Pucuro.
18. *Hyalotheca dissiliens* (Sm.) Bréb., Pucuro.
19. *Pleurotaenium ehrenbergii* (Bréb.) de Bary, Pichilafquen.
20. *Bambusina moniliformis* (Ehrenb.) Thom., Pichilafquen.

Photographs by K. Thomasson.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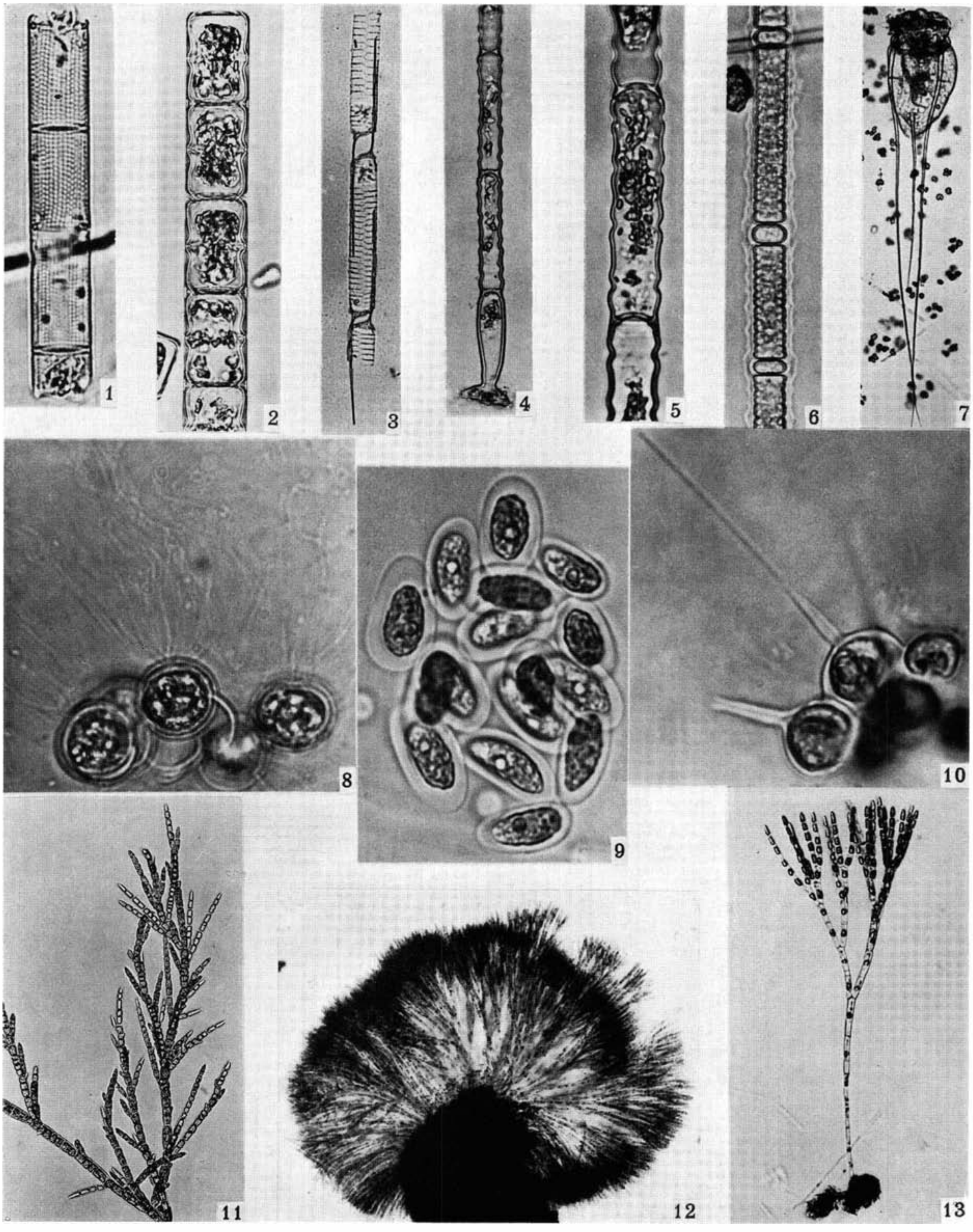


Fig. 39.

1. *Melosira granulata* (Ehrenb.) Ralfs, Villarrica.
2. *M. hustedtii* Krasske, Villarrica.
3. *Rhizosolenia eriensis* H. L. Smith, Villarrica.
4–5. *Oedogonium undulatum* (Bréb.) A. Braun, Llanquihue.
6. *Nodularia spumigena* Mertens, Calafquén.
7. *Filina longiseta* (Ehrenb.), Villarrica.
8. *Schizochlamys gelatinosa* A. Braun, Llanquihue.
9. *Chlorococcales*, see p. 105, Villarrica.
10. *Chaetosphaeridium globosum* (Nordst.) Klebahn, Llanquihue.
11. *Stigeoclonium lubricum* (Dillw.) Kütz., Villarrica.
12–13. *Chaetophora elegans* (Roth) C. A. Agardh, Villarrica.

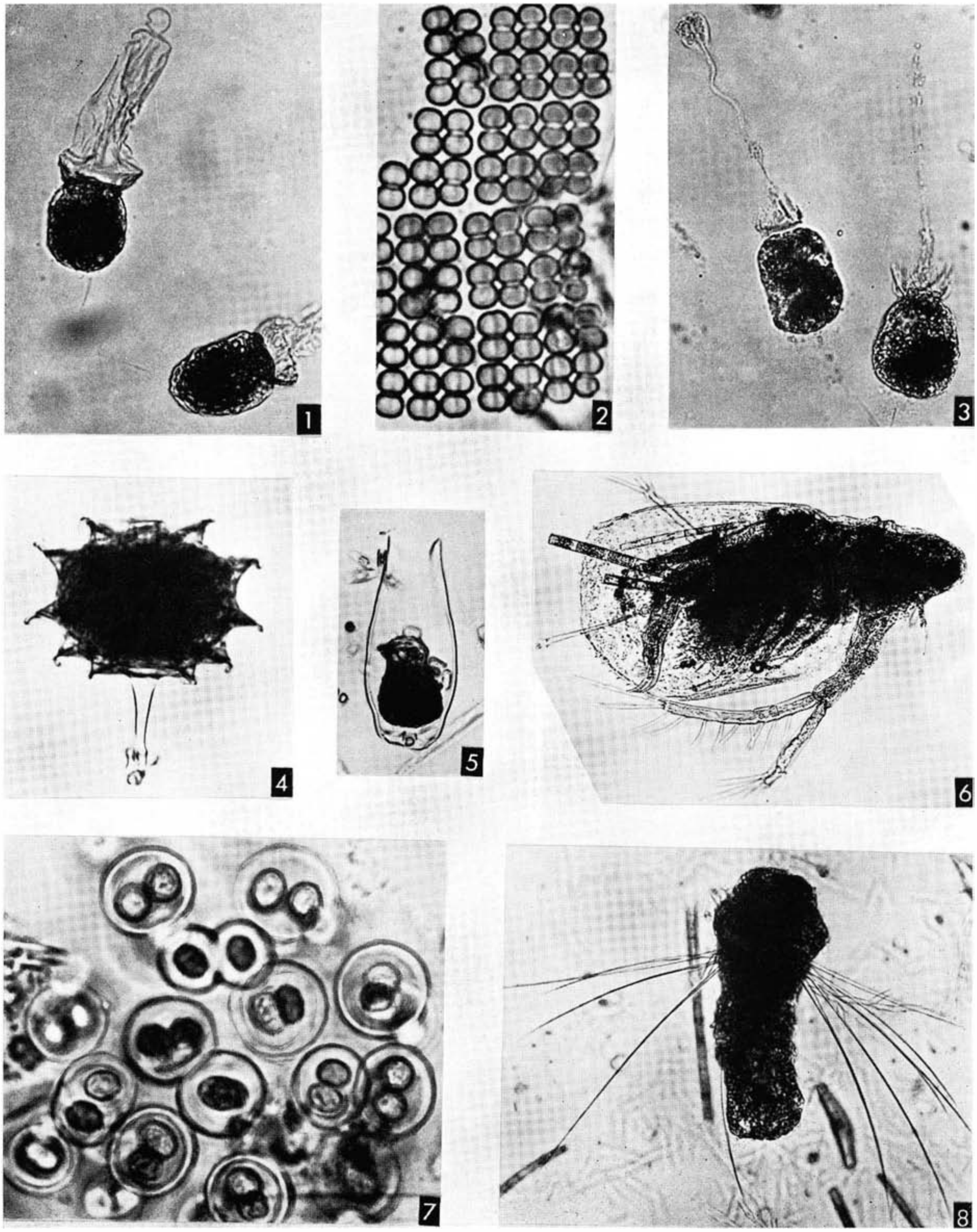


Fig. 40.
1 and 3. *Ophrydium* sp.?, Rupanco.
2. *Merismopedia glauca* (Ehrenb.) Näg., Villarrica.
4. *Podophrya fixa* (O.F.M.), Pichilafquen.
5. *Vagnicola* sp., see p. 44, Villarrica.
6. *Diaphanosoma excisum chilense* (Daday), Villarrica.
7. *Chroococcus pallidus* Näg., Pellaifa.
8. Larva of a freshwater polychaete, Llanquihue.
Photographs by K. Thomasson.

This plant is somewhat smaller than the variety described by W. & G. S. West, but in spite of that I am inclined to consider it as belonging to v. *rotundatum.*

Staurastrum noduliferum Grönbl. forma

In the plankton of Lake Villarrica a small thin *Staurastrum* was repeatedly noted. Length 17 μ, breadth 40 μ. I have identified it as *S. noduliferum* Grönblad (1945, p. 28, fig. 238). In shape it also resembles *S. gracile* in Nygaard (1949, fig. 38g), and in Grönblad (1942, pl. 4, fig. 22). The plant called *S. longiradiatum* W. & W. in Grönblad (1956, pl. 1, fig. 22) is similar in shape, and most probably is not identical with the taxon described by the Wests. I think the taxonomic position, relations, and value of the taxa mentioned above need further investigations.

Staurastrum proboscideum (Bréb.) Arch.

Fig. 42: 9. Length 35–44 μ. Inundation pool, Villarrica.

The plant under consideration is very much like *S. proboscideum* f. in Wests' *Monograph* (pl. 143, fig. 14). It has some resemblance to *S. cyrtocerum* v. *compactum* W. & W., and the specimens of *S. margaritaceum* (Ehrenb.) Menegh. figured by Borge (1923, pl. 2, fig. 24) and by Kossinskaja (1953, pl. 3, fig. 16). The latter is a small plant. In the population of the Inundation pool were also plants with cup-shaped semicells. Such specimens resemble, except for their short processes, the plant discussed below.

The second plant which has been figured here under the name of *S. proboscideum* f., see fig. 42: 1, is also benthic. The length of this plant from Lake Pellaifa is 44 μ. It has longer processes than the previous one, but intermediate forms occurred. Because of the poor figure given by Ralfs, *S. proboscideum* has become a rubbish dump for Staurastra like *gracile, paradoxum, polymorphum* and some others. Earlier I have depicted a similar plant from Lake Guillelmo, see Thomasson (1959, fig. 23: 8). It should be compared with *S. proboscideum* (Bréb.) Arch. figured by Ružička (1955, p. 601, fig. 40) which is similar in shape and size. Some plants which have been grouped around *S. manfeldtii*, e.g. the plant in Grönblad (1960, p. 38, pl. 12, fig. 238) and *S. manfeldtii* v. *planctonicum* Lütkem. in Messikommer (1963, p. 65, pl. 2, fig. 42), are similar to the plant under discussion which, however, has slightly converging processes. Moreover, similar plants are to be found among many taxa; compare *S. oxyacantha* v. *patagonicum* Borge (1901), *S. cunningtonii* G. S. West figured by Nayal (1935, fig. 93), and *S. pseudosebaldi* v. *simplicius* W. & W. in Wests' *Monograph* (pl. 149, fig. 13). All these plants are smaller than the plant from Lake Pellaifa.

Staurastrum quadrangulare var. *contectum* (Turner) Grönbl.

Figs. 41: 7 and 8. Length 44 μ. Lake Pellaifa.

Synonyms are *S. contectum* v. *inevolutum* Turner in West & West (1896, pl. 16, fig. 19), and *S. quadrangulare* v. *armatum* W. & W. (1896, pl. 16, fig. 18). It seems to me that *S. quadrangulare* belongs to those species which have been over-loaded with varieties and forms of questionable taxonomic value.

Staurastrum rotula var. *smithii* (G. M. Smith) Thom.

Figs. 41: 5 and 6. Lake Villarrica.

This plant is very characteristic for the plankton of the North Patagonian lakes. Note the prominent apical ornamentation, and also the ornamentation on the processes. However, the ornamentation shows rather great variation. In a sample collected from Lake Espejo on March 7, 1962, I have even observed specimens with a smooth apex. Such specimens resemble *S. ostenfeldii* which was described from Gatun Lake in Panama by Nygaard (Ostenfeld & Nygaard, 1925, p. 15). For comparison see the microphotographs 41: 1 and 2 of *S. ostenfeldii* from a sample from Gatun Lake which I collected on June 20, 1959.

Staurastrum sebaldi var. *ornatum* f. *planctonica* (Lütkem.) Teiling

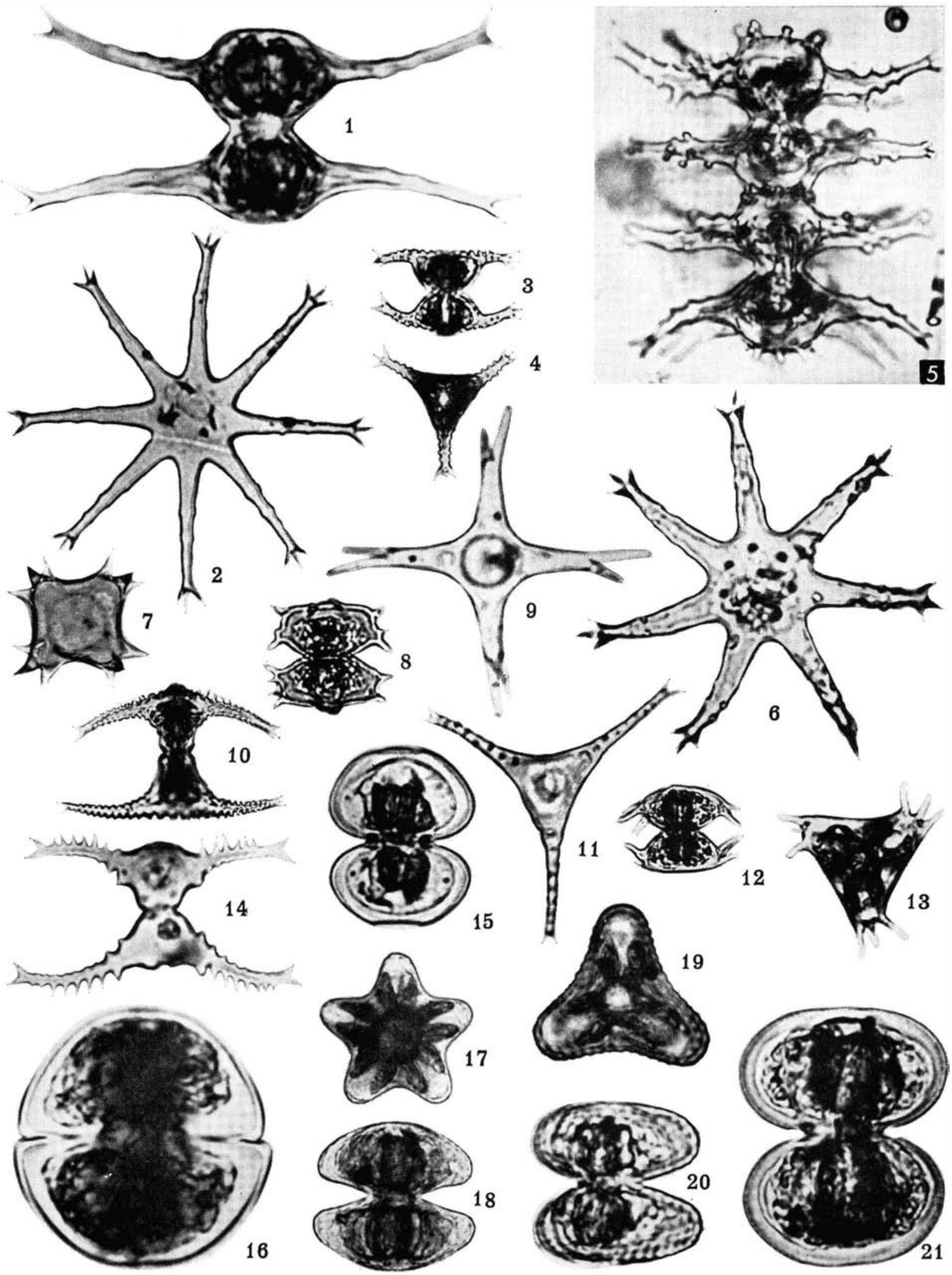
Figs. 41: 10 and 42: 19. Lake Pichilafquen.

S. sebaldi is a stout benthic plant; v. *ornatum* is,

Fig. 41.

1–2. *Staurastrum ostenfeldii* Nygaard, Gatun Lake, Panama.
3–4. *S. anatinum* f. *denticulatum* (G. M. Smith) Brook, Pichilafquen.
5–6. *S. rotula* var. *smithii* (G. M. Smith) Thom., Villarrica.
7–8. *S. quadrangulare* var. *contectum* (Turner) Grönblad, Pellaifa.
9. *S. brachiatum* Ralfs, Pichilafquen.
10. *S. sebaldi* var. *ornatum* f. *planctonica* (Lütkem.) Teiling, Pichilafquen.
11. *Staurastrum anatinum* var. *subfloriferum* Thom., Llanquihue.
12–13. *S. trifidum* Nordst., Pichilafquen.
14. *S. anatinum* var. *subfloriferum* Thom., Llanquihue.
15. *S. grande* var. *parvum* W. West forma, Llanquihue.
16. *S. bidentulum* f. *maior* Thom., Villarrica pool.
17–18. *S. dilatatum* Ehrenb. forma, Villarrica pool.
19–20. *S. alternans* Bréb., Pellaifa pond.
21. *S. grande* var. *rotundatum* West & West, Pichilafquen.

Photographs by K. Thomasson.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however, more slender with very conspicuous apical ornamentation. It is instructive to look at Nordstedt's drawing of *S. sebaldi* v. *ornatum*, Nordstedt (1873, fig. 15) also reproduced by Teiling (1947, fig. 11), before making any identifications with that variety. The f. *planctonica* of v. *ornatum* is a still more slender plant and the apical ornamentation is less prominent than in v. *ornatum*. It is transitional to the plants grouped around *S. planctonicum*. The difference between *S. sebaldi* v. *ornatum* f. *planctonica* and some forms of *S. planctonicum* is subtle. I consider my plants from Lake Pichilafquen as belonging to *S. sebaldi* v. *ornatum* f. *planctonica*. The semicells are long and slender with a slight basal swelling. The sub-brachial ornamentation is prominent, likewise also the isthmal ornamentation on the basal swelling. The processes are subparallel or somewhat converging. The outstanding feature of the population is that most of the plants bear horn-like processes on the apex, one on every corner. These "horns" are the enlarged proximal spines of the row of stout dorsal spines on the processes. My plants should be compared with *S. sebaldi* v. *ornatum* f. in Bourrelly (1957b, p. 1087, fig. 140). They are very similar indeed.

In the plankton of Lake Villarrica an interesting population occurred. These plants had semicells of the same shape as the plants from Lake Pichilafquen. The ornamentation was identical; even the apical "horns" occurred on some of the plants, sometimes only on one of the semicells. The characteristic feature was the strongly converging processes. These plants remind one of *S. cerastes* in shape, but not in size. The plants from Lake Villarrica were about 66 μ long, and 90 μ broad. *S. cerastes*, as described by Lundell, is a stout species. Some of its varieties approach the specimens under discussion, e.g. v. *triradiatum* G. M. Smith (1922, pl. 12, figs. 16–18), and the variety depicted by Scott (Scott & Prescott, 1961, pl. 56, figs. 6 and 7). My plants, with strongly convergent processes, also have some features in common with *S. pseudosebaldi* v. *unguiculatum* Borge (1925, p. 41, pl. 3, fig. 19), and with *S. approximatum* W. & W. (1902, pl. 22, fig. 5).

Staurastrum subavicula var. *tyrolense* Schmidle

Figs. 42: 3–5. Length 21–24 μ. Pond at Lake Pellaifa.

I have called this plant *S. subavicula* v. *tyrolense*, see Messikommer (1935, f. 22), Irénée-Marie (1939, pl. 55, fig. 5), and the *S. subavicula* of Grönblad (1960, figs. 163 and 164). Some plants in the population bear six short bifid processes on the apex. My plant may well be a small form of *S. diplacanthum* v. *anglicum* Turner, but Turner's drawing of that variety is very poor. My plants also have some remote similarity to some forms of *S. simonyi* Heimerl.

Staurastrum subgrande var. *convexum* Prescott & Scott

Fig. 38: 6. Lake Llanquihue.

I have identified this triradiate plant with *S. subgrande* v. *convexum* Scott & Prescott (1958, p. 66, pl. 22, fig. 4). It should also be compared with *S. subgrande* which was described by Borge. Actually the identification has been made with some doubt. There are many taxa to choose between. A few with which it may be compared are: *S. ellipticum* in Wests' *Monograph* (pl. 119, fig. 7) which also has an open sinus but an acuminate apex, *S. coarctatum* v. *subcurtum* Nordst. in Scott & Prescott (1961, p. 87, pl. 52, fig. 15) and *S. muticum* v. *victoriense* G. S. West (1909, pl. 5, fig. 8).

Staurastrum tetracerum var. *evolutum* W. & W.

This plant has been reported from a great many North Patagonian lakes. It is a little larger than the plants described by West & West (1905, pl. 2, fig. 31). The measurements of the plants from Lake Verde are: length without processes 14.4–16 μ, length with processes 40–52 μ, breadth with processes 48–56 μ. Sometimes the semicells are somewhat twisted in relation to each other. They have longer processes than the plants figured in Thomasson (1959, figs. 23: 10 and 11). I have also observed quadriradiate plants. My plants seem to be identical with the plants denoted as *S. subgracillimum* W. & W. by Thomasson (1960, p. 238, fig. 37). Very likely the difference between these two taxa is subtle or non-existent. It

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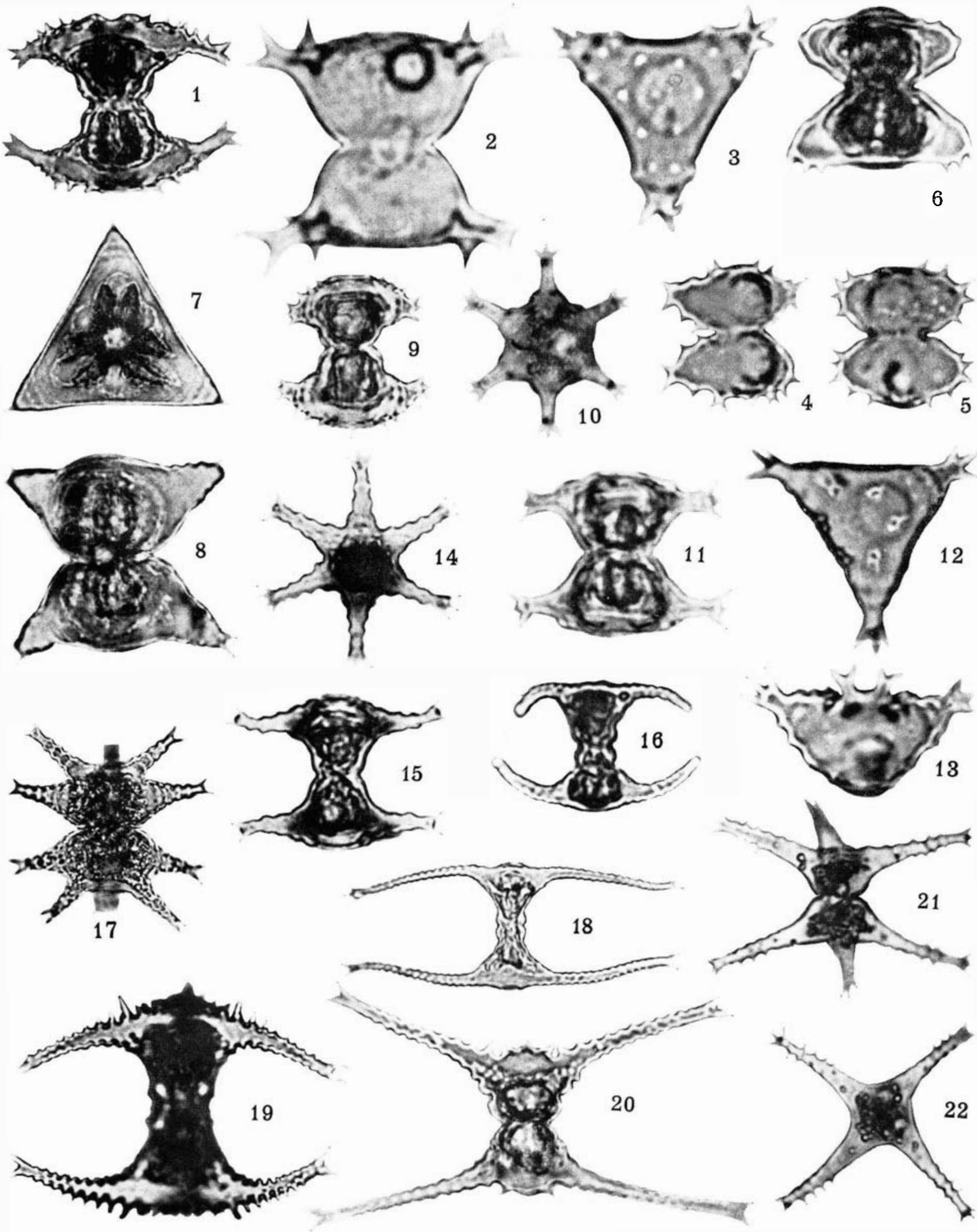
Fig. 42.

1. *Staurastrum proboscideum* (Bréb.) Arch., Pellaifa.
2. *S. laeve* Ralfs, Pichilafquen.
3–5. *S. subavicula* var. *tyrolense* Schmidle, Pellaifa pond.
6. *Staurastrum* sp., see p. 125, Pichilafquen.
7–8. *S. avicula* Bréb. forma, Villarrica.
9. *S. proboscideum* (Bréb.) Arch. forma, Villarrica pool.
10–11. *S. subpolymorphum* Borge, Pellaifa pond.
12–13. *S. arcuatum* Nordst. forma, Pichilafquen.
14–15. *S. asterias* Nygaard, Pichilafquen.
16. *Staurastrum valdiviense* Thom., Pellaifa.
17. *S. armigerum* var. *furcigerum* (Bréb.) Teiling, Pichilafquen.
18. *S. leptocladum* var. *cornutum* Wille, Pichilafquen.
19. *S. sebaldi* var. *ornatum* f. *planctonica* (Lütkem.) Teiling, Pichilafquen.
20. *S. urinator* var. *brasiliense* Grönblad, Villarrica.
21–22. *S. aspinosum* Wolle forma, Llanquihue.

Photographs by K. Thomasson.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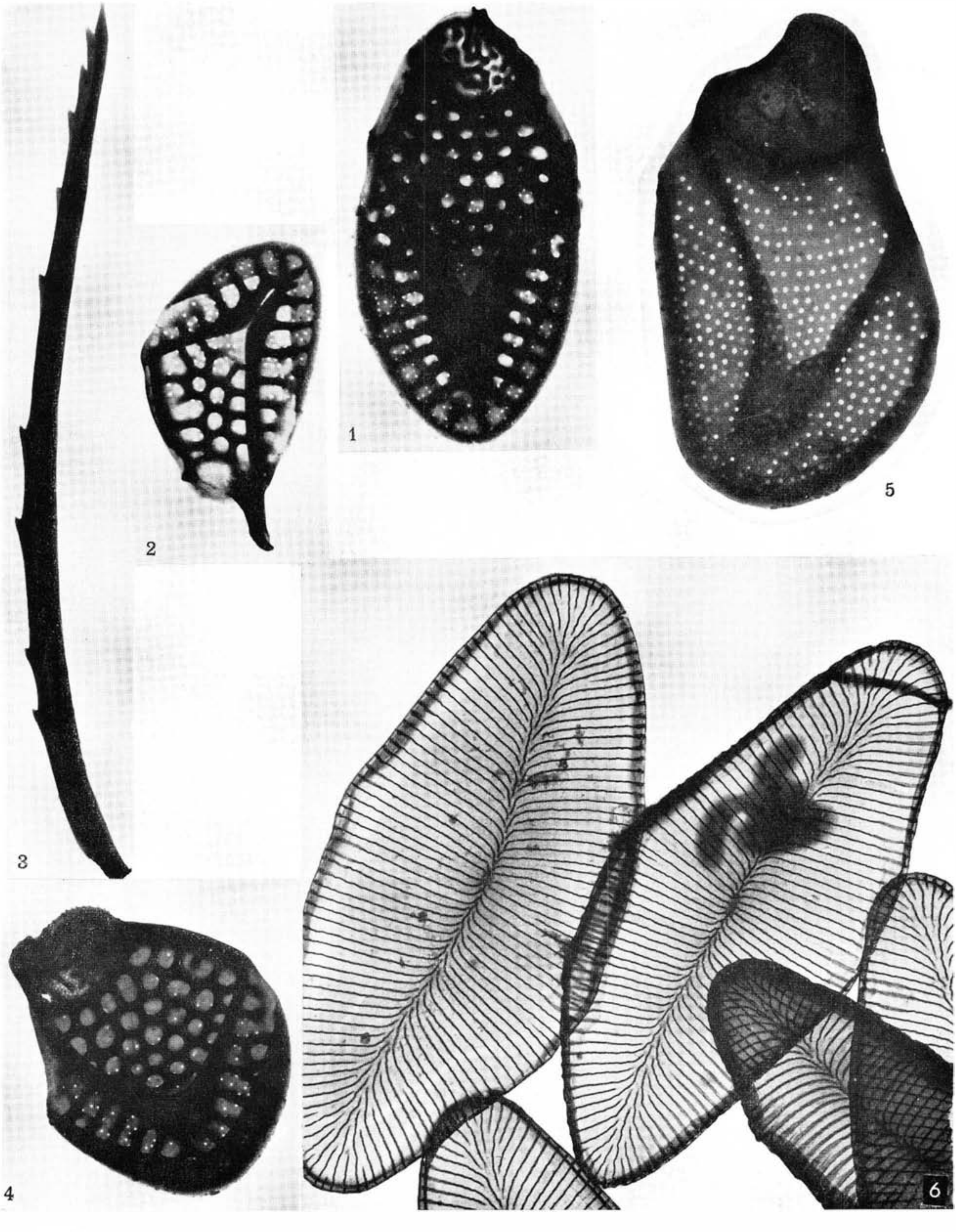


Fig. 43.

1–4. *Mallomonas bourrellyi* Teiling; 1. body scale, 2. posterior scale, 3. bristle, 4. anterior scale, Cisne.

5. *Mallomonas elongata* Reverdin; anterior scale, Verde.
6. *Rhaphidiophrys* sp., scales, Cisne.
Photographs by B. Asmund, × 12.900.

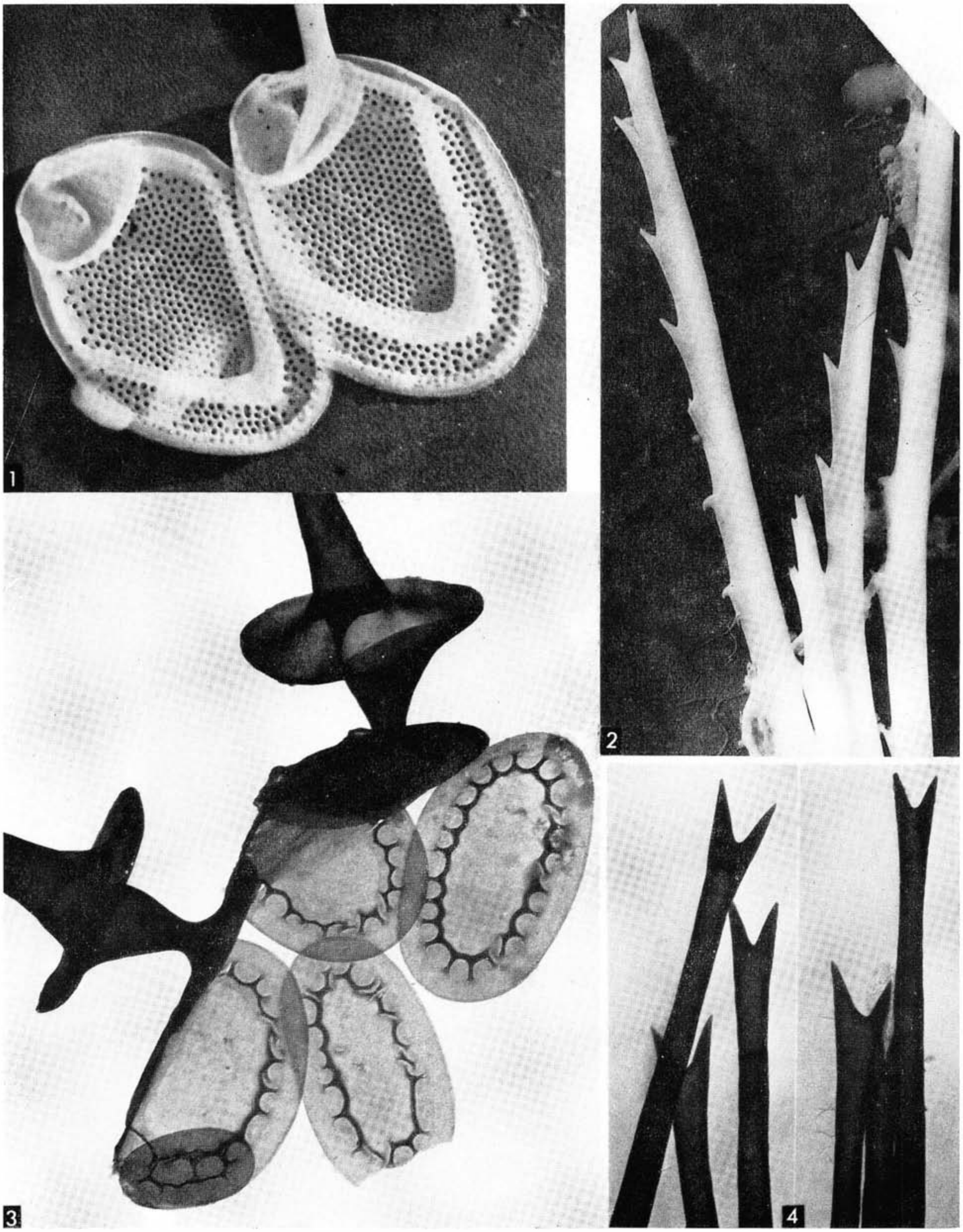
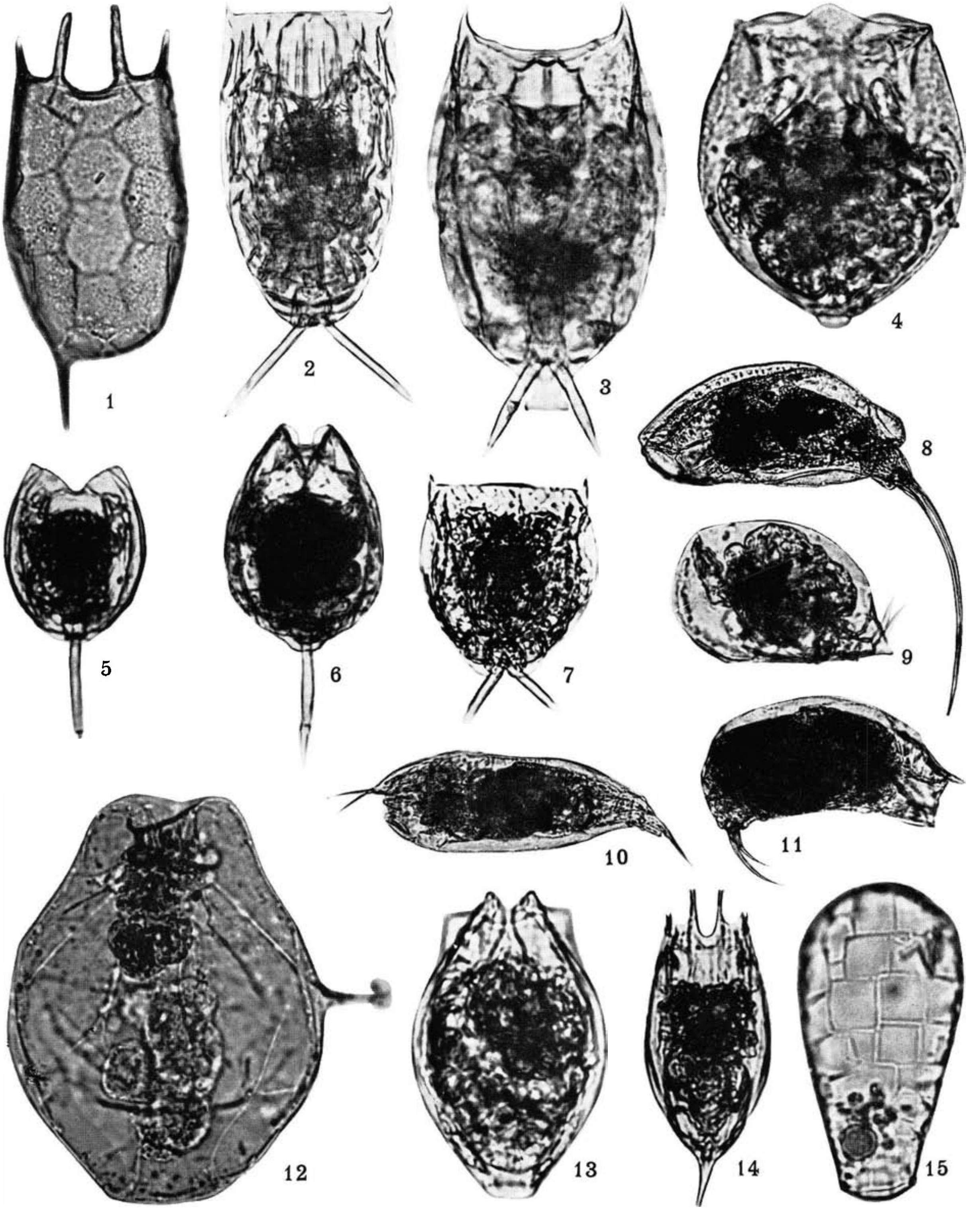


Fig. 44.

1–2. *Mallomonas alpina* Pascher & Ruttner [*M. tonsurata* var. *alpina* (Pascher & Ruttner) Krieger] anterior scales and bristles, Verde.

3–4. *Chrysosphaerella brevispina* Korsch. scales and bristles. Note the bobbin-like base of the bristle. Figs. 1–3. ×12.900, 4. ×15.900. Photographs by B. Asmund.



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may be questioned whether there is any taxonomic relationship between *S. tetracerum* and its v. *evolutum*.

Staurastrum urinator var. *brasiliense* Grönbl.
Fig. 42: 20. Length 53.5 μ, breadth 92.5 μ. Lake Pichilafquen.

This plant was frequently observed in the plankton of Lake Pichilafquen. Only a few specimens were noted in the plankton of Lake Villarrica. The present taxon should be compared with *S. urinator* Smith f. as figured in Krieger (1950, fig. 35).

Staurastrum sp.
Fig. 42: 6. Length 25 μ, breadth 52.5 μ. Lake Pichilafquen.

Initially I identified this plant as a form of *S. subpygmaeum* v. *spiniferum* with the guidance of Scott & Grönblad (1957, pl. 31, fig. 18). My plant differs from that variety in having three spines at each angle instead of only two. The apex of my plant is plane. As has been emphasized by these authors their variety may consist of plants which could represent several taxa. In my opinion their figs. 17 and 18 may be considered as representatives of a different taxon, which even scarcely seems to be related to *S. subpygmaeum*. However, the plane apex in my plant, and the occurrence of three spines at the angles indicate that the relationship with the plants discussed above is very vague. I have seen only few specimens, and hence cannot define its taxonomic position. It ought also to be compared with *S. curvimarginatum*, Scott & Grönblad (1957, pl. 19, fig. 16) and with the form depicted by Thomasson (1962, fig. 2). Both these plants are somewhat larger.

Staurodesmus dickiei (Ralfs) Lillieroth forma
Fig. 34: 4. Length 28.6 μ. Lake Pellaifa.

This little specimen can be considered as *S. dickiei*, or as a small form of that taxon. In shape it resembles some drawings of *S. dickiei* v. *maximum*, e.g. West & West (1896, pl. 18, fig. 18) which is, however, considerably larger. The small forms of *S. dickiei*, e.g. v. *circulare* and v. *minutum*, have a more rounded apex than my plant.

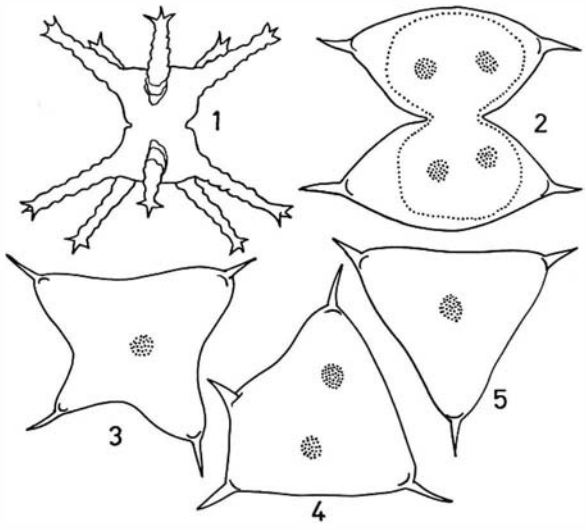

Fig. 46. 1. *Staurastrum arachne* var. *curvatum* West & West forma, Lake Lacár. 2–5. *Staurodesmus patens* (Nordst.) Croasdale forma, Lake Nahuel Huapi.

Staurodesmus dickiei var. *rhomboideus* (W. & W.) Lillieroth
Fig. 34: 10. Length 32.5 μ. Lake Pichilafquen.

This taxon was frequently met with in the plankton of many lakes. My plant should be compared with the figure given by West & West (1903, pl. 16, fig. 9) and with the plant depicted by Croasdale (1957, p. 130, pl. 3, fig. 43).

Staurodesmus patens (Nordst.) Croasdale
Fig. 34: 9. Length 40 μ Lake Llanquihue.

This plant is very similar to the triradiate plants

Fig. 45.

1. *Keratella tropica* (Apstein), Pellaifa.
2. *Lecane ploenensis* (Voigt), Songwe River, S:n Rhodesia.
3. *L. ohioensis* (Herrick), Huechún.
4. *Pompholyx sulcata* Hudson, Villarrica.
5. *Monostyla (Lecane) lunaris* (Ehrenb.), Llanquihue.
6. *M. bulla* Gosse, Pichilafquen.
7. *Lecane flexilis* (Gosse), Villarrica.
8. *Trichocerca bicristata* (Gosse), Pellaifa pond.
9. *Colurella uncinata bicuspidata* (Ehrenb.), Pellaifa.
10. *Trichocerca birostris* (Minkiewicz), Villarrica.
11. *T. weberi* (Jennings), Villarrica.
12. *Ptygura* sp.?, see p. 127, Pichilafquen.
13. *Anuraeopsis fissa* (Gosse), Pellaifa pond.
14. *Notholca haueri* Thom., Pichilafquen.
15. *Quadrula symmetrica* F. E. Schulze, Villarrica pool.

Photographs by K. Thomasson.

labelled as *S. subulatus* by Scott & Grönblad (1957, pl. 12, figs. 11–13). Moreover, the plant depicted by Holsinger (1955, fig. 5c and d) is similar in shape, but only half as large as my plants from Lake Llanquihue. Dr. Teiling has suggested *S. patens* as the proper name for my plant.

Another similar triradiate plant from the plankton of Lake Nahuel Huapi is shown in figs. 46: 2–5. It is a little larger than the previous one; the length is 50 μ, and breadth 62.5 μ. The length of the spines varies. Besides short-spined specimens, like the depicted ones, long-spined cells are common. Some of the specimens have one, others two pyrenoids. The facies 3 + 4 is frequent; it was especially abundant on April 23, 1961. I have also observed facies 3 + 5. In most cases the semicells with supernumerary spines give the impression of being developmental defects. I have not managed to find any 4 + 4 or 5 + 5 cells, so one of the semicells is always triradiate. In shape of the semicells the present plant resembles some forms of *S. mucronatus* v. *subtriangularis*; see the plant figured in Wests' *Monograph* (pl. 130, fig. 13). However, the latter plants are always short-spined. Moreover, the recently described *S. tripyrenoideus*, Scott & Prescott (1961, pl. 49, fig. 6) is similar in shape and size, but differs in having three pyrenoids. While waiting for the monograph of the genus *Staurodesmus* by Teiling, I have regarded the plant from Lake Nahuel Huapi as a form of *S. patens*.

2. MICROZOA

Heliozoa

Many different taxa of *Heliozoa* were noted in the samples. In only a few cases was an attempt made to identify them. I am convinced that the future taxonomy of the *Heliozoa* ought to be based on the fine structure of the cells, i.e. that of the scales and spines, as seen with the electron microscope. A good beginning has been made by Petersen & Hansen (1960). However, there will be many difficulties, similar to those met with in the genus *Mallomonas* when trying to identify taxa described using a conventional microscope with those studied with an electron microscope, cf. Fott (1962).

I hope that the scales from Lake Cisne which have been photographed with an electron microscope can be used for future identification. This photograph, reproduced in fig. 43: 6, was most kindly placed at my disposal by Dr. Berit Asmund. These scales very likely belong to some *Rhaphidiophrys* species.

Keratella tropica (Apstein)

Fig. 45: 1. Pellaifa.

Keratella tropica was considered by early authors as a form or variety of *Keratella valga*. It was first established as an independent species by the Latvian limnologist Bērzinš (1955). *Keratella tropica* is characterized by the occurrence of a quadrangular postero-median remnant, a plaque which is lacking in *Keratella valga*.

In my collections from Araucanian lakes, e.g. in Lake Pellaifa and in the *Potamogeton* pond near that lake, *Keratella tropica* was rather common. This gave me an opportunity to study the variation in shape of the postero-median remnant which in the majority of specimens was trigonal; as a consequence their postero-median plaque was pentagonal. Only few specimens were noted with a quadrangular postero-median remnant and, when so, it was as a rule rather narrow. In the plankton of Lake Pellaifa a specimen was noted in which this remnant was lacking, and the pattern of the dorsum was similar to the pattern in *K. procurva* (Thorpe), viz. the postero-median plaque was pentagonal and terminated in a short median line. According to Bērzinš (*op. cit.*) this short median line forms a wedge in *K. procurva*; that is not the case in my specimen. It should be pointed out that Ahlstrom (1943) has noted *K. procurva* occurring together with *K. tropica*. In his monograph he says nothing about the presence of a wedge.

Notholca haueri n.sp.

The figures 47: 1–5 show a *Notholca* species which is similar in shape to *N. caudata* Carlin. It has an acuminate posterior spine which is rather well set off from the lorica. However, my specimens from Lake Quillehue are only 184–200 μ long. The length of the stout *N. caudata* varies according to Carlin (1943, p. 71, fig. 11) from 300 μ to 400 μ. Because of the significant difference in size, I am inclined to consider these South American specimens as representatives of a distinct taxon which I have named in honour of the rotatorian expert Dr. J. Hauer. This species was called *N. caudata* by Thomasson (1955 and 1957b) and also by Hauer, in Löffler (1962).

For comparison I show here a drawing in the same scale of a 389 μ long specimen of *N. caudata* from Lake Storsjön, Jämtland,[1] Sweden, cf. fig. 47: 6.

Ptygura sp.

Fig. 45: 12. Lake Pichilafquen.

The identification of the present specimen is very problematic. It has very conspicuous lateral antennae like the *Ptygura* sp. (?) from Venezuela which has been depicted by Hauer (1956, p. 304, fig. 21).

Trichocerca bicristata (Gosse)

Fig. 45: 8. Length of body 200–243 μ, toe 170–186 μ. *Potamogeton* pond.

This species is similar in shape to *Trichocerca* (*Rattulus*) *braziliensis* Murray (1913, p. 244, pl. 10, fig. 16), which was described from Rio de Janeiro, but is considerably smaller.

Ceriodaphnia lacustris Birge forma

In a sample collected from Lake Hess on March 29, 1961, an interesting *Ceriodaphnia* was encountered. It is characterized by very large fornices which have blunt apices armed with two small teeth. The caudal claw is without a pecten. I have considered it a form of *C. lacustris* Birge (1893, p. 294, pl. 12, figs. 6–9). My specimens have none of the spines on the head characteristic of the true *C. lacustris.* The vertex and the valves lack any reticulations. The valves are covered with minute scattered spines. There is no prominent posterior spine.

Diaphanosoma excisum chilense (Daday)

Animals observed in North Patagonian waters were assigned to this taxon because of the relative length of their anal teeth, i.e. the most distal one is at least twice as long as the proximal two, see fig. 1–3 in Löffler (1962, p. 151). Animals figured by Olivier (1961, pl. 2, fig. 16, and 1962, pl. 1, fig. 2) also possess this character.

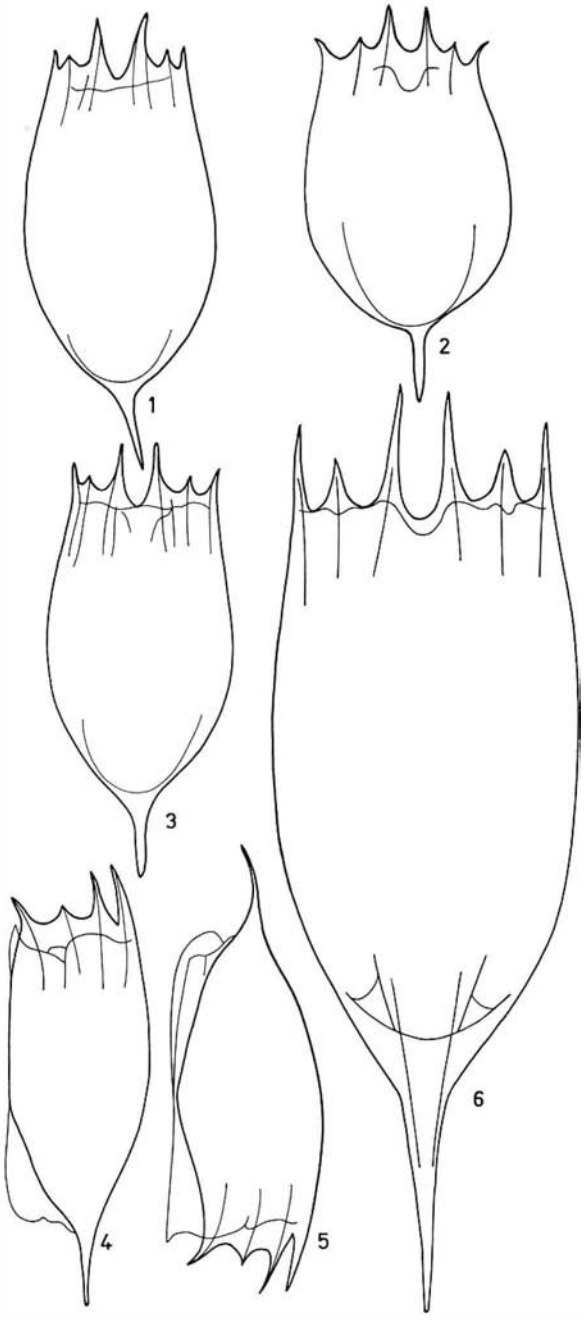

Fig. 47. 1–5. *Notholca haueri* Thom., Lake Quillehue. 6. *Notholca caudata* Carlin, Lake Storsjön, Sweden.

[1] Lake Storsjön is one of the localities which have recently been doubted by Pejler (1962) because they do not fit his theory that *N. caudata* should be considered as a marine relict. Due to the peculiar history of the Baltic there are some well-known animals of marine origin in some of the lowland lakes in the Baltic area; see, e.g., Thienemann (1950). One can even find rotifers which are characteristic for brackish water in freshwater lakes, see Thomasson (1949). However, *Notholca caudata* can in no way be established as a marine relict because it also occurs above the highest Littorina level, see Thomasson (1951 and 1952), although infrequent. Lake Storsjön, mentioned above, is located at a height of 292 m above sea level, a good distance above the highest Littorina level.

X. BIOGEOGRAPHICAL NOTES

When we set out in 1953 to study inland waters in the southern temperate zone, in Northern Patagonia, the study of plankton was one of the main objects in our programme. At that time practically nothing was known about these lakes. During the field work some notes on the terrestrial life were also made. The first thing that strikes a European student on comparing the composition of aquatic and terrestrial communities is that in the latter we notice mostly genera foreign to us; hardly any are familiar from home. In the water, however, are a number of familiar genera of vascular plants, e.g. *Scirpus*, *Littorella*, *Myriophyllum*, *Potamogeton*. Among the algae there are partly the same species which we find at home, partly closely related ones. The phytoplankton consists almost entirely of plants widespread in temperate waters in the northern hemisphere; the strangers are few and not frequent. The same applies for rotifers, but definitely not for most of the crustaceans occurring in the plankton of these lakes.

One of the most fascinating biogeographical problems is the relationship of southern South America to Australia and New Zealand. Some features considering the phytogeographical relations have been indicated in chapter 5. Possibly of still greater significance are the indications of a relationship between these two distant areas in the freshwater fauna. The zoogeographical framing of the problem has been discussed by Brehm (1936). The distribution of *Boeckellidae* is of special interest. In some other groups of freshwater animals there is also evidence for an ancient transantarctic connection between these distant parts of the world, e.g., in the fauna of the lotic environments. In the mountain streams of North Patagonia a number of plecopteres and chironomids occur which seem to have their nearest relatives in Australia and/or New Zealand. For the affinities among the plecopteres see the recent papers of Illies (1960 and 1961). The fauna of chironomids in North Patagonian mountain streams is much more exciting than that of the lakes. The working up of chironomids from North Patagonian waters by Brundin is well under way. Here I will only point out that among the stream-dwelling chironomids are many primitive types, and that there is good biogeographical evidence for an ancient transantarctic connection to be found within this group. With regard to the faunistic relations between the northern temperate zone (the holarctic region) and the southern temperate zone, as reflected through studies in North Patagonia and Peru, I would like to quote Brundin (1956, p. 214): "Wenn wir die hochandine Chironomidenfauna von Peru mit jener der Holarktis und der Südanden vergleichen, muss der Schluss gezogen werden, dass die Anden als Verbindungsglied zwischen den temperierten Faunen des Nord- und Südhalbkugel niemals von Bedeutung gewesen sind". Incidentally, the Andean chain has been considered by many biogeographers as the main thoroughfare between the northern and southern temperate zones.

With regard to the copepods, the only species of *Diaptomus* which has been observed in the Chilean lake district is *Diaptomus diabolicus*. It is a common plankter in many lakes, and very likely endemic in that area. Dr. B. F. Osorio Tafall (Cairo) has kindly informed me that the genus *Diaptomus* is represented in Chile at least by four different species including *D. diabolicus*, they all are fairly abundant. According to Wright (1927, p. 100) all South American species of *Diaptomus* are endemic for the continent, with the exception of *D. marshi* which has also been found in Central America. The bulk of *Diaptomus* species occur north of Wallace's line, which divides South America into the Brazilian and Chilean regions. South of Wallace's line only few species have hitherto been found, e.g. *D. bergi*, *D.*

michaelseni, *D. incompositus*, and *D. diabolicus*. *D.* (*Notodiaptomus*) *incompositus* has also been reported by Ringuelet (1958) from the Creek Valcheta in Territorio Nacional del Rio Negro. The Chilean region is characterized by the abundance of *Boeckella* and *Pseudoboeckella* species. Both genera have a distribution restricted to southern continents. The only exception is *Boeckella orientalis*, which was described by Sars from River Kerulen in Mongolia. It has also been reported by Rylov (1928 and 1930) from Lake Khanka north of Vladivostok, where together with *Epischura chankensis* it was a predominant zooplankter. Moreover, according to Borutzky (1960), *Boeckella orientalis* has also been reported from River Amur and its tributaries. It is closely related to the Australian *B. oblonga*. With regard to the manner in which these animals are distributed, Marsh (1924) says that while it is not impossible that birds carry them in mud on their feet, there is little evidence that this actually occurs, and observed facts seem to indicate that the ordinary means of distribution of freshwater copepods is by water transportation. It seems most probable, according to Marsh, that the genera travelled from the Antarctic continent, and the species have become differentiated in the various localities. However, *Boeckella orientalis* provokes some doubt.

Another group of freshwater crustaceans which is characteristic of North Patagonian lakes is the unique, endemic South American genus, *Aegla*. Its nearest relatives probably belong among the marine galatheids. There are no freshwater *Crustacea* similar to *Aegla* anywhere else in the world. This genus is distributed throughout the southern half of South America, where more than 20 taxa occur (see the map fig. 40 in Schmitt, 1942). *Aegla denticulata* was extremely abundant in the Chilean lake district, e.g., in lakes Villarrica and Pellaifa, where huge amounts of it were caught by our fishing nets. Löffler (1962) has erroneously indicated *Parastacus* instead of *Aegla* as abundant in Araucanian lakes. According to Schmitt (1942) *Aegla abto* also occurs in the Chilean lake district; the Nahuel Huapi area is characterized by the occurrence of the related *A. riolimayana*. Moreover, in Lake Nahuel Huapi, *A. neuquensis* has also been recorded, see Ringuelet (1956). For the distribution see the map on pl. 25 in Ringuelet (1956).

The third group of interesting freshwater crustaceans is the family *Parastacidae*. Only a few representatives of this family, belonging to the South American genus *Parastacus*, were observed by us, in lakes Huilipilún and Pellaifa. They probably belonged to *Parastacus agassizi*. The family of *Parastacidae*, according to Ortmann (1902), is divided between four completely isolated areas in the southern hemisphere. Within each of these areas are peculiar genera: in Australia, *Cheraps*, *Astacopsis*, *Engaeus*; in New Zealand, *Paranephrops*; in South America, *Parastacus*; in Madagascar, *Astacoides*. The latter is rather distant morphologically from the other genera, which are more or less closely related to each other. The somewhat out-of-date, but still fascinating paper by Ortmann (1902) gives a very interesting analysis on the geographical distribution of the family, and on freshwater decapods as a whole.

The faunistic relationships, as reflected by terrestrial animals, have recently been touched upon by Kuschel (1960, p. 548). See also the interesting paper by Darlington (1960); note the very instructive map, fig. 82, showing the distribution of carabid beetles of the tribe *Migadopini*. Most of these beetles are flightless.

When talking about the ancient transantarctic connections it should be emphasized that these are really very ancient—perhaps as early as the Tertiary, or still earlier. The distributional pattern of many components in this ancient biogeographical element in southern South America has been greatly altered during the glacial epoch. In this connection the distribution of the above-mentioned torrential chironomids which live in cold mountain streams is of great interest.

Summing up the biogeographical evidence for an ancient transantarctic connection, we must admit that it is supported by facts of phytogeography, and what seems to me still more important, also by the geographical and phylogenetical relations of the freshwater fauna. Attempts to explain the biogeographical relationships by means of random dispersal seem often to be rather far-fetched, see Thienemann (1950, pp. 160–165). But, on the other hand, many biogeographers and most oceanographers refuse to believe in vertical movements of the ocean bottom sufficient to establish land connections.

Concerning the geographical distribution of freshwater algae, we are still stock-taking, and a great deal of work remains to be done. In some algal groups we can figure out some distinct distributional features with a fair degree of probability. However, for most of the freshwater algae we can only discern a few trends. There can be little doubt that algae have existed from the earliest geological epochs. In consequence, a considerable proportion of freshwater algae have a world-wide distribution, and are to be found in every suitable locality.

Many maps have been published of the distribution of freshwater algae. Most of them are of little significance. For example, those published by Donat (1927–31) of the distribution of desmids virtually show only how restricted is our information about the distribution of these algae. Other maps of the distribution of desmids, recently published by Kossinskaja (1960), could in many cases be interpreted as reflecting the oceanic tendency in the distribution of desmids which has been emphasized by some early phycologists. However, the accumulation of localities in the westernmost part of the Soviet Union is to some extent due to the fact that these areas include formerly independent countries, where intense scientific work was done between the two world wars. In this connection one ought also to remember the words of Kusnezov (1900, p. 227). Summing up, we could state that most of the maps of the geographical distribution of freshwater algae reflect only the intensity of phycological research. It seems to be too early to draw any conclusions about the distribution from these maps.

The only way to obtain available information about the distribution of freshwater algae is of course to study the very extensive phycological literature. However, the interpretation of many sources is often open to discussion. In many cases, one first has to assess the reliability of the identifications. This may be a difficult problem, especially when no figures have been published, only lists of names. In this connection I would like to quote Pringsheim (1962, p. 190): "Besonders in ökologischen Arbeiten findet man gewöhnlich lange Listen von Namen, deren Richtigkeit nicht ersichtlich ist. Wenn man weiss, wie schwer oft die Bestimmung ist und wie weit in manchen Gruppen die Modifizierbarkeit durch die Aussenbedingungen geht, so kann man solche Listen nicht als Grundlage der Forschung hinnehmen". For many groups of algae the literature is so extensive and widely scattered that it is practically impossible to survey all relevant papers. Some publications must be disregarded because of difficulty of access, and many others are no doubt overlooked.

Moreover, when comparing the algal flora of different areas one often faces the problem that the information refers to habitats of entirely different character. That makes all comparison rather difficult.

These are some of the restrictions and reservations which one should bear in mind when considering the following discussion of the distribution of freshwater algae.

During the quaternary glaciations, the ice covered a considerable part of North Patagonia to the west and to the east of the Andean chain; see the appendix 5 in Auer (1956), or appendix 1 in Auer (1958). The lakes on both sides of the range have been formed by glaciers. The only exceptions may be the basins of lakes Nahuel Huapi and Todos los Santos which may partly originate from the pre-glacial epoch. Not only were the lake basins created during the glacial epoch but also a considerable proportion of the biota was eliminated. For the recolonisation of the Chilean area, the Andean chain and the deserts in the north form an important barrier. This is reflected in the composition of so many terrestrial biota that one could talk about the insular features of Chile; for instance there are no poisonous snakes there. From the biogeographical point of view the Argentine lake district also belongs here. It is connected by many passes with its Chilean counterpart, and forms a striking contrast to the arid areas which extend to the north and east of it.

The freshwater biota in North Patagonia seem also to be somewhat impoverished, e.g. a richer variety of planktic desmids would have been expected. The Andean range seems to form an insurmountable barrier for the genus *Ceratium*, nor has it apparently managed to gain any ground worth mentioning in the Argentine preandine lakes. On the other hand, such a common and abundant plankter in the Chilean lake district as *Melosira hustedtii* has been found only occasionally east of the Andean range. This taxon seems to be endemic in the North Patagonian lake district. From a biogeographical point of view it is interesting that it is closely related to the marine *Melosira juergensii*, which also occurs in brackish waters. According to Krasske (1939, p. 352), *Melosira juergensii* grows in masses in the littoral zone along the Pacific coast. One may wonder whether the population of *Melosira hustedtii* has been isolated in freshwater during some of the changes of level which have occurred in this unsettled area.

It is also noteworthy that *Cyanophyta* seem to be of no importance in the Chilean lake district, nor in its Argentine counterpart, with the exception of Lake Correntoso in Nahuel Huapi National Park. Abundant growth of planktic *Cyanophyta* has been encountered in Tierra del Fuego as well as in the Santiago area, see Thomasson (1955), in water bodies where conditions are favourable.

On the whole, however, the phytoplankton communities in North Patagonian lakes are similar to those occurring in temperate lakes everywhere. Judged from the composition of the algal flora, especially that of desmids, there is no obvious relationship to the flora of tropical South America. Of course there is only limited information about the algal flora in tropical South America, mainly based on the work of Borge and Grönblad. The tropical character is, however, unmistakable.

With regard to the above-mentioned biogeographical relations between southern South America and Australia-New Zealand, we must admit that there is no support for the theory of ancient connections to be found in the distribution of phytoplankters. The Australian flora of freshwater algae, especially in the northern part of that continent, shows strong affinities to the Indo-Malayan area. The flora of desmids is a rich one, probably far richer than that of Europe. It includes a number of species which are common in the Indo-Malayan region, and its general character is tropical; see West (1909), Scott & Prescott (1958), and the numerous publications of Playfair. Information about the phytoplankters in New Zealand lakes is sparse. According to Thomasson (1960), the phytoplankton seems to be of temperate character. There are no features which could be interpreted in favour of transantarctic connections. The *Chrysophyta* make up a considerable quantitative proportion of the phytoplankton in many of the lakes on North Island. Curiously enough *Tabellaria*, *Fragilaria crotonensis* and *Rhizosolenia* are absent from these random samples. *Ceratium* is predominant in some of the lakes. The New Zealand and Australian flora of benthic freshwater algae have much in common with regard to the desmids. This is obvious if the information given by Nordstedt (1888) is compared with the available Australian records. The flora of desmids in New Zealand is, on the whole, considerably richer than that of Patagonia.

With regard to the planktic rotifers of New Zealand, it is apparent that *Kellicottia longispina* is absent (see Russell, 1960) as in the Patagonian lakes. But there are many observations of the occurrence of *Keratella q. quadrata*. The available information on Australian rotifers is sparse, and Bērziņš (1953) does not mention the occurrence of these rotifers. *Keratella quadrata* is represented in Australia by subsp. *australis* Bērziņš (1963).

Summing up, we may say that the phytoplankton communities of North Patagonian lakes, with the exception of a few peculiarities which have been mentioned above, are not more related to those of New Zealand lakes than, e.g., to those in the lakes in North American mountainous areas (Thomasson, 1962), or in some European lakes.

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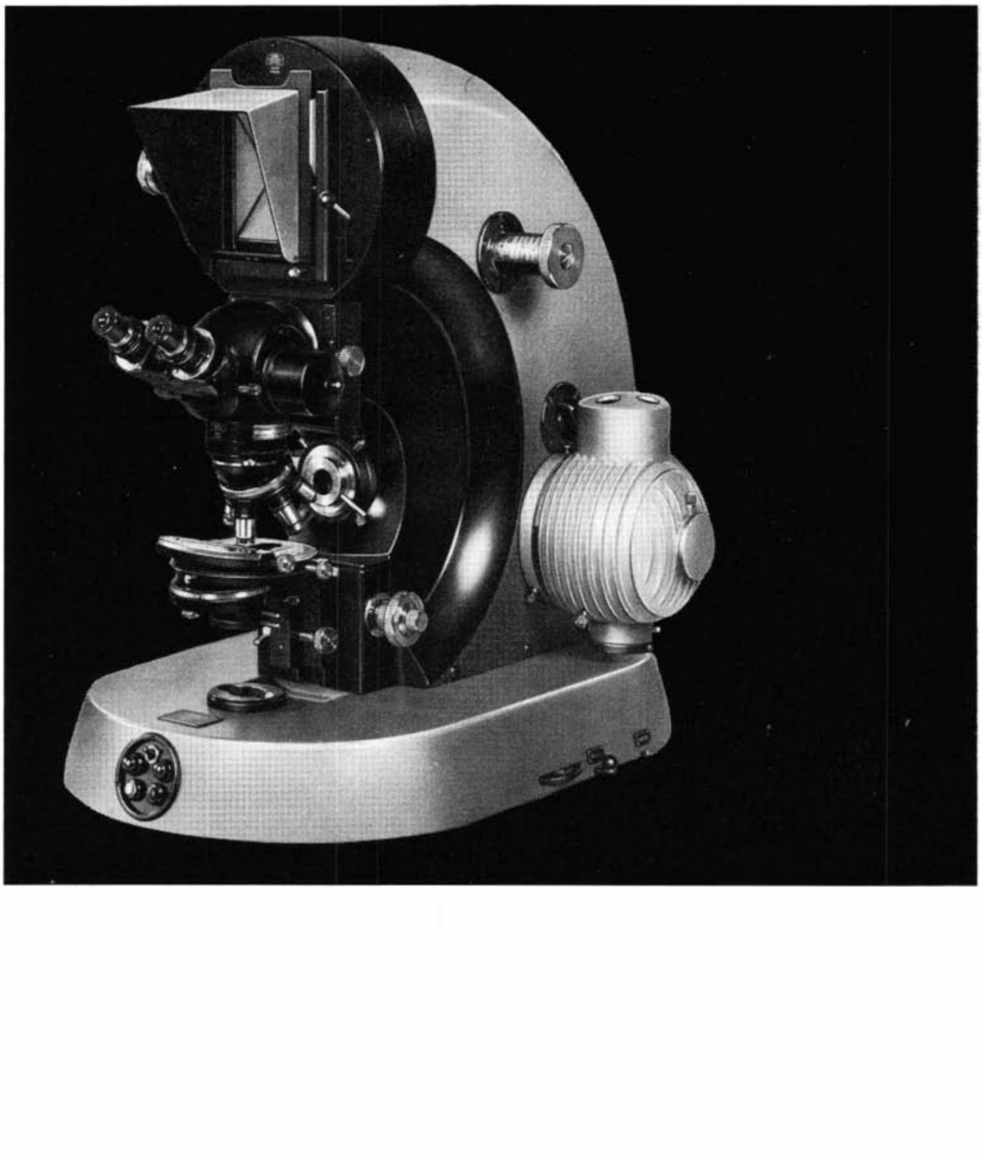

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