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CONTENTS

	Page
Editorial	1
Eels: Exploitation & Farming	1
Freshwater Research in the D.S.I.R.	3
N.Z.L.S. Bibliographies	5
N.Z.L.S. Conference, 1969	5
Minutes of General Meeting	11.
Abstracts of Conference Papers	13
Research Notes : Student Theses	23
Forthcoming Conferences	27
Notes and News	28
Bibliography of Recent Papers	29

EDITORIAL

We include in this issue some notes on the present trends towards eel farming, and also an article on the proposed work of the new freshwater unit of the D.S.I.R. There has been great interest recently in the possibilities for commercial exploitation of our freshwaters and as Mr Burnet points out active steps are being taken to encourage the farming of eels. The pros and cons of trout farming continue to be hotly debated. N.Z. Limnologists have also been pleased at the increased Government interest in the more basic aspects of freshwater work, as shown by the proposal to study eutrophication problems by the D.S.I.R. It is to be hoped that this step will be accompanied by a more rational and efficient organisation of Government research groups.

EELS: EXPLOITATION AND FARMING

A.M.R. Burnet

The exploitation of wild eels has been increasing steadily, and to assist the industry, the Fishing Industry Board held a seminar on the 17th of September at which the invited speakers outlined our present state of knowledge. A number of processors are successfully using wild eels, but there are problems. Because the growth rates are slow it is easy to deplete an eel population in an area. Wild eels vary in size and the quality differs from place to place making it difficult to produce the uniform product required for overseas markets without quite a lot of wastage.

Recently Mr J.S. Campbell, of the Fishing Industry Board, and Mr G. Duncan Waugh, Director of the Marine Department Research Division have been to Japan, and seen the high level of efficiency attained by eel farming there.

Eel farming offers prospects of controlling the size and quality of the eels, and thus we can produce eels suited to the various markets. In Japan eel farming now supplies the greater part of the 20,000 metric tons of eels processed. (Valued at US\$36,000,000).

The prospects for eel farming in New Zealand look attractive and the Fishing Industry Board arranged for Prof. Dr Iaso Matsui of the Shimonseki University of Fisheries to visit N.Z., and report on the possibilities.

Marine Department scientists assisted Dr Matsui, and I accompanied him on the South Island trip, when possible sites were inspected.

Throughout the discussion with Dr Matsui, the main problem, (and one common to all our fisheries), was lack of the basic knowledge of the biology. For example, my own investigations on the growth rates of wild eels pose more questions than they answer. The age of the glass eels when they enter our rivers is a subject of debate, and the times of arrival and behaviour on entering freshwater has been examined in only a few streams. So far attempts to catch glass eels in quantity have not been successful. This is important as the whole success of eel farming would depend on an assured supply of glass eels of the species which proves to be the most suitable.

What is known of the behaviour of the 2 N.Z. species indicates that experiments will have to be done before we can be sure of success. The economics of eel farming depend largely on the use of cheap protein such as unsaleable fish, crayfish bodies, freezing works offal etc.. However, despite the problems eel farming has great possibilities and could be easier to promote than trout farming.

FRESHWATER RESEARCH IN THE D.S.I.R.R.H. Thornton

Consequent upon the recommendations of the National research Advisory Council and a Cabinet Committee the Minister of Science has approved the establishment within DSIR of a Freshwater Research Unit. Steps were taken in August of this year to form such a section in the present Animal Ecology Division, DSIR, in line with proposals to expand the activities of this Division which are to be increased to include environmental research.

The main terms of reference of this Freshwater Unit are to investigate the principles, causes and effects of eutrophication and it is anticipated that the main work of the Unit will be concerned with examining the chemical, physical, and biological changes in freshwater bodies consequent upon the enrichment resulting from run-off from agricultural land and other forms of nutrient additions. Results from these investigations are expected to provide basic information on the processes taking place in New Zealand waters which, in the long term, will provide new methods and approaches for abating these pollution problems and maintaining waters of acceptable quality.

The headquarters of the Unit is at Soil Bureau, Taita Experimental Station, Lower Hutt, and this location was chosen to provide the necessary multidisciplinary "atmosphere" needed to foster the development of this new unit which will involve the application of chemistry, physics, botany, zoology, microbiology and biochemistry to investigations of enriched and unenriched waters. Eventually it is planned to re-locate Animal Ecology Division, or Ecology Division, as it is to be known from April next, at the Taita Experimental Station to be closely associated with Soil Bureau in the development of environmental research.

While the headquarters of the Unit will be at Lower Hutt many of the present problems resulting from nutrient enrichment are in

the central North Island area and it is therefore necessary to establish a suitably located field station in this region.

The initial research programme includes investigations of a number of selected lakes in the Rotorua area which provide natural experimental material for examining changes consequent upon eutrophication. These investigations will provide this young team with valuable experience and background in a number of different aspects of the enrichment problem while it is building up equipment, staff, techniques and facilities for broader activities.

Rotorua has been chosen as the location for a field station because it provides a base for these initial investigations and because of its geographical location in relation to other problem areas and its convenient transport facilities. The Fisheries Research Division of Marine Department already have a base at Rotorua and as the work of these two Divisions will be complementary it will be to mutual advantage if they are both alongside one another to maintain close and continuing liaison and collaboration with one another. Consequently DSIR is seeking to acquire an area of land adjacent to the Marine Dept. Station on which to locate laboratory, office and storage accommodation for a freshwater field station.

Eventually a base will be established in the South Island for work in Southern waters.

Present staff includes Dr. R. McColl, a botanist with research experience on the chemistry of bog and mire waters in relation to plant distribution; Dr. D. Forsyth, an invertebrate zoologist with several year's experience on the Mangere oxidation pond midge problem. Dr. Elizabeth Flint, a freshwater algologist of wide experience is associated with the Unit on a research grant. A similar grant is being sought which will enable Dr. Hilary Jolly, an experienced limnologist to work in collaboration with the Unit.

Additional specialist and technical staff will be recruited to form a viable team covering the major disciplines needed to invest-

igate the basic processes of the eutrophication problem.

An important aim of the Unit will be to establish liaison and collaborate with other workers in the freshwater field and where possible to initiate and take part in joint projects.

Urgent attentions is being given to the recruitment of an experienced leader for this Unit and until a suitable appointment is made Dr. R.H. Thornton, Head Office, DSIR is acting as interim section leader of the Freshwater Research Unit.

N.Z.L.S. BIBLIOGRAPHIES

At the formation of the N.Z.L.S. it was urged that bibliographies of the N.Z. literature on the freshwater flora and fauna be prepared as soon as possible, as a valuable aid to research workers. The Committee invited experts in each group to prepare bibliographies and the first three lists, on the Molluscs, Diptera and Fungi, are being circulated with this newsletter. In the interests of speedy issue it was suggested that the bibliographies need not be complete lists of all relevant literature but rather should concentrate on recent and review papers from which earlier work could be traced. Eventually it is hoped that more permanent publication of the complete series, fully edited and annotated, will be possible.

N.Z.L.S. CONFERENCE, 1969

The second conference was held at Christchurch on the 25th and 26th of August. Forty people attended on the first day when a variety of papers were presented (abstracts given below), and the

committee was pleased at the number of members from all parts of the country - over one third of those attending being from outside Christchurch. A general meeting was held in the evening and on the next day 22 members took part in the field trip to the Selwyn River and to Lakes Ellesmere and Forsythe. The excursion guide is reprinted below.

1. Coe's Ford, Selwyn River

The Selwyn River rises in the foothills and flows in a shingle bed across the Canterbury plains to Lake Ellesmere. The river is influenced chiefly by rain from the S.W. and S.E. The upper and lower reaches usually have water flowing, but much water runs underground and for several months of the year about 15 to 20 miles of the middle portion of the river bed may be dry, with the water level well below the surface. In years of high rainfall, the river may be more or less continuous along its length throughout the year. The gradient is not steep, with little overturning of stones but chiefly sliding, producing flattened rather than ovoid stones on the river bed. Floods are quite frequent and there is considerable movement of the shingle. Although this movement is not as severe as in many Canterbury rivers, such as the Ashley River, it has a considerable effect on the invertebrate fauna.

The invertebrate fauna of part of the Selwyn River slightly upstream from Coe's Ford was studied for a B.Sc. Honours project in Zoology in 1968. The project surveyed a small stretch of the river before, and at several times after, the Easter (Wahine) floods. Before the floods the dominant invertebrate members of the fauna were the caddisfly larvae (Paroxyethira, Pycnocentroides), the mayfly Deleatidium, chironomid (midge) larvae and elmids (beetle) larvae, with lesser numbers of amphipods, snails and other invertebrates. A similar fauna occurs at Coe's Ford. As a result

of the floods, there was a marked decrease in numbers of all the invertebrates, especially the chironomids, elmids and caddis, together with the amphipods and snails. Least affected were the mayflies. Recovery after the floods was most rapid in the case of Deleatidium, followed by the caddis larvae.

Fish found in the river include abundant bullies (most species), several species of galaxiads, smelts, both species of eels, juvenile lampreys, occasional Quinnat salmon and brown trout. The trout stock varies throughout the year. A resident population occupies the available water while Lake Ellesmere also contains moderate numbers of adults. Beginning soon after new year, an immigrant population comes in to the river from the lake in increasing numbers and undergoes maturity. The beds of shingle rivers such as the Selwyn are excellent spawning grounds for the trout, and during the winter thousands of fish spawn in the gravel along the available length of the river, beginning at the end of April and finishing at the beginning of August. The height of the spawning activity is in June and July. Percival studied the trout run in the Selwyn and estimated that up to 60,000 fish use the river to spawn. From a census taken in 1941 he estimated that 62,000,000 eggs were available for deposition in the lower 9 miles. Fertilisation is normally almost complete and the yield of fry very high. After spawning, great numbers of adults go to the lake in freshets. Frequently the river bed dries up in the summer leaving the small fish stranded in pools from which they are transferred by the Acclimatisation Society to more permanent water. The resident trout are smaller in size than those in the lake and the numbers are restricted by lack of suitable cover and shortage of permanent pools. Electric fishing for eels and trout was demonstrated, and also methods of handling and tagging trout.

2. Lake Ellesmere at the Selwyn River mouth

Lake Ellesmere is a large body of brackish water retained by the shingle fans of the Rakaia, Selwyn and Waimakariri rivers, the volcanic rocks of Banks Peninsula and a long shingle bar, the Ellesmere (Kaitorete) spit. Water flows into the lake from several streams, from artesian springs in the bed of the lake and at times from the sea when the outlet is open or when heavy seas break over the western end of the spit. About three to five times a year, the lake is artificially opened at this end of the spit remaining open on an average for about six weeks each time. The maximum depth is about six feet below mean sea level and normally the lake is not allowed to rise more than three and a half feet above mean sea level. The area of the lake at mean sea level is 38,000 acres and at four feet above mean sea level, 54,000 acres. The maximum depth is in the southwest end. The salinity varies principally according to how recently the lake has been open to the sea. After the lake had been open for a period of 13 weeks it was found to be approximately 56% sea water; whereas after eight months closed the proportion was approximately 30% sea water.

The bed of the lake is mostly silty loam. The deeper waters of the lake are free of all vegetation and no plants grow on the soft muds, sands and pure shingles. On the silts where the water is neither too deep nor too turbid there are extensive beds of Ruppia spiralis. A discontinuous band of submerged vegetation, some distance offshore, occurs particularly along the inland edge of the lake. It is broken where freshwater enters the lake. Besides Ruppia, the species present include Potamogeton pectinatus, Lepilaena bilocularis, Zannichellia palustris, and the charophytes Chara globularis and Lamprothamnion macropogon. This band of aquatic vegetation has in the past been very dense, then disappeared for a few years from about 1935, and

later gradually returned but not to its previous density. During storms large quantities are washed ashore. Grazing by ducks, black swans and Canada geese is an important factor influencing the vegetation and the swans may nest on the Ruppia.

The lake and its margins has a rich bird fauna. Prominent are the swans, Canada geese, grey duck, mallard, shoveller and paradise, together with the pukeko and various wading birds, such as pied stilts, oyster catchers, and white-faced herons. Many of the birds breed round the lake and the lake is visited in summer by northern hemisphere migrants (knots, sandpipers, godwits).

Lake Ellesmere has a small number of species of aquatic invertebrates but many of them are of considerable interest. They include forms both of marine and of freshwater affinities. Two species of mysids (a predominantly marine group), Tenagomysis chiltoni and T. novae-zealandiae, are often found in large numbers in the water at the edge of the lake. Also of interest are the larvae and pupae of the moth, Nymphula nitens, living on the rooted aquatic vegetation especially at the western side of the lake. The most abundant macroscopic invertebrates are the amphipod Paracalliope fluviatilis and the snail Potamopyrgus antipodum, both of which occur in large numbers on the vegetation and on the surface of the mud. The vegetation supports a number of other invertebrates, including the amphipod Paracorophium lucasi; several species of caddisfly larvae (Pycnocentria, Pycnocentroides, Paroxyethira and Olinga), water boatman (Sigara and Diaprepocoris); and damselfly nymphs (Xanthocnemis). The mud has both oligochaetes and polychaetes, together with midge larvae, the adults of which sometime form vast swarms in the vicinity of the lake. The zooplankton includes both Gladioferens pectinatus and Boeckella hamata.

At the Selwyn river mouth the invertebrate fauna consists principally of Paracalliope, Nymphula and the snails Physastra variabilis and Potamopyrgus, with lesser numbers of Sigara, Anisopa, Tenagomysis and Planorbis coronna.

Fish form an important element of the lake fauna. There is commercial fishing in the lake for flounder, of which three species are present, for yellow-eyed mullet and for eels. Other permanent residents of the lake include galaxiads, bullies, brown trout and Quinnat salmon. Sprat, Maugaclupea antipodum and Retropinna have also been reported. Temporary visitors when the lake is open to the sea have included a common sole, kahawai, elephant fish, red cod, dogfish, skate and one basking shark. In the autumn sexually maturing eels congregate at the southwest corner in their endeavour to reach the sea. Many pass over the shingle bar in southerly weather when the waves break on and over the narrow end of the spit. The opening of the lake at a suitable time is essential for them.

Besides the commercial fishing, the lake is used for recreation - power boating, water skiing, trout fishing and duck shooting being the main activities.

3. Lake Forsyth

Lake Forsyth occupies part of the largest valley on Banks Peninsula and is about 5 km long and one km wide. The lake is shallow, being deepest at the southern end where the depth reaches about 4 m. There is no outlet except during floods when a channel is cut through the bank of shingle separating the lake from the sea. The fertile catchment area is covered by soils of the Pawson series, which are derived from loess or a mixture of loess and volcanic material. The catchment is drained by the Okana and Okuti rivers which join before creating a delta at the head of the lake. The forest in the valley had been replaced by 1890 by cocksfoot and pasture for the thriving dairy industry, and later by grassland which

is now grazed by sheep and cattle. More than a third of the annual precipitation (about 45 inches) falls in winter and drought often occurs in the summer. The water is brackish and its chemical content varies horizontally, the open water at the head of the lake having the lowest salt content. The chemical content of the littoral zone is not only greater than that of the open water but also the amount of calcium present is disproportionally higher as compared with sea water. During 1969 the most common blue-green algae have been species of Coelosphaerium, Merismopedia, and Nodularia (the cause of an obnoxious water bloom); the common green algae have been Chlorella, Dictyosphaerium, Enteromorpha and Scenedesmus. Cladophora has been common in the littoral zone. Most interesting of the rooted vegetation is the occurrence of the charophyte Tolypella.

The invertebrate fauna appears to be poor in number of species Potamopyrgus antipodum and Paracalliope fluviatilis are found in moderate numbers, together with smaller numbers of Sigara arguta. The zooplankton in autumn and winter has consisted principally of rotifers (Keratella, Brachionus, Synchaeta, Euchlanis) with ciliates dominant in March.

The lake is visited by many of the species of birds which are found on Lake Ellesmere.

GENERAL MEETING

A General Meeting was held in the Seminar Room, Zoology Department, University of Canterbury, at 8 p.m. on the 25th August 1969.

Apologies for absence were received from:

Dr V.H. Jolly, Mr G. Duncan Waugh, Dr R.M. McDowall, Prof. J.G. Pendergrast, Miss M. Barclay, Dr J. McLellan, Mr P.J. Burstall, Mr J. McLean.

Constitution

The form of constitution which had been previously circulated to members was proposed for acceptance. The Secretary reported

that most members who replied agreed to the constitution, and that the few minor suggestions were on the wording and form. It was put to the meeting that the constitution as modified to meet the written suggestions of members be adopted. This was carried.

The Chairman then explained that while the Society now had a constitution the rules precluded an immediate election of officers, and it was decided to hold elections next year.

Subscription

The Chairman proposed that the subscription be increased to \$1.00 for ordinary members, and 50 cents for student members. She pointed out that the present subscription does not cover the cost of paper etc., used in the preparation of the Newsletter and the circulars. The meeting adopted the new subscription rates.

Next Meeting

In discussion, Dr Mitchell suggested a longer conference and Dr Chapman suggested that a dinner be part of the programme. It was agreed that August is the best time, and that the next conference be held at Rotorua.

General Business

The Chairman outlined Project Aqua (an IBP project - see last newsletter).

The only site so far submitted was Lake Okataina. It is requested that any further suggestions be sent to Dr Stout as soon as possible. The Committee will then consult with the Ecological Society.

The Chairman read out a letter from the International Society of Limnology recruiting members. It was explained that there must be 50 members in N.Z., to qualify for a national representative. It was suggested that we explore the possibility of combining with Australia to have a shared representative.

Dr Chapman put forward the recommendation of the Committee that Dr V.H. Jolly be elected an honorary member. This was adopted by the meeting.

The meeting closed at 9.15 p.m.

A.M.R. Burnet

Secretary

ABSTRACTS OF CONFERENCE PAPERS

Eutrophication in Lake Rotorua

G.R. Fish

(Marine Dept. Rotorua)

Some causes of eutrophication were briefly discussed to support the hypothesis that certain aspects of present land development have led to excessive erosion and rapid runn-off. These two factors have supplied high concentrations of dissolved plant nutrients to drainage waters which in turn created eutrophication and consequent high production in the larger receiving waters. A correlation between catchment development and eutrophication was shown for Lakes Okaro and Okataina in the North Island.

It was tentatively established that Lake Rotorua had become eutrophic during the last twenty years and preliminary phosphate and nitrogen budgets for the period June 1967-8 were examined.

The largest supply of phosphate to the lake was provided by the Hamurana Springs. Another large cold-water spring at the Awahou provided most of the nitrate and the small Waiohewa River carried the largest proportion of the total ammonia supplied to the lake. Town sewage, although providing an important contribution of phosphate and ammonia, did not seem to be the most important supplier of these nutrient salts and so its part in causing eutrophication of the lake may have been exaggerated in the past. Drainage from developed land appeared to be the most important factor during the period of investigation and water analyses of streams following aerial topdressing and floods provided further evidence to support the initial hypothesis.

Algal Diversity in the North Island Lakes
Rotoiti and Rotorua

U.V. Cassie

(Botany Dept., Auckland University)

Phytoplankton samples, and a few aufwuchs and benthos samples, from these lakes have been examined for the last 3 years. So far 118 species have been identified, of which only 14 were restricted to L. Rotorua, and 7 to Rotoiti (although this lake has been sampled less intensively). Diatoms (particularly Melosira granulata, M. distans and Asterionella formosa) predominate in numbers of cells and colonies though not in numbers of species, except in the aufwuchs and benthos. In the open water the Chlorophyceae are the best represented class.

During the three year period there was relatively little change in the seasonal patterns of dominance and relative abundance of the various species, except that a very big increase in Asterionella colonies was recorded in the 1967-68 spring-summer period, with nearly 12 million cells per litre in mid-November in Rotorua. A marked decrease in the numbers of cells and filaments of Melosira granulata (monotonously dominant in Rotorua except during Asterionella peaks) was found during the 1967-68 summer in L. Rotoiti.

The occurrence of algal species regarded as pollution tolerant by Palmer (1969 J. Phycol. 5 : 78-82) was discussed but the samples provided little evidence of pollution. It was also pointed out that nitrogen-fixing forms of blue-green algae are not well represented in these two lakes.

The importance of more intensive studies on the aufwuchs and the benthic flora was emphasised, and in particular on the oscillatoria community which appears to dominate the oozy mud inshore.

Water-blooms of blue-green algae

E. Flint

(Soil Bureau, D.S.I.R.)

Water-blooms of Anabaena circinalis Rabenh., A. flos-aquae

(Lyngb.) Bréb., A. spiroides Kleb., *Anacystis cyanea (Kuetz.) Dr. & Dail., Coelosphaerium kuetszingianum Næg. and *Nodularia spumigena Mertens var. vacuolata Fritsch & Rich have been recorded in New Zealand. *Aphanizomenon flos-aquae (L.) Ralfs and Oscillatoria lacustris (Kleb.) Geitler form water-blooms elsewhere but they are still uncommon here (species marked with * contain strains that are poisonous to animals). Some of their characteristics seem to give the blue-green algae biological advantages and may account for their success in eutrophic waters (Fogg, 1969; Holm-Hansen, 1968). Many species produce resting spores and fix atmospheric nitrogen, the latter process being more rapid when the amount of oxygen in the water is depleted. Gas vacuoles, usually present, and produced more abundantly in dim than in bright light, increase the buoyancy of the algae, which, accumulating and decaying at the water's edge are repulsive and evil-smelling.

Water in Lake Forsyth (near Christchurch) has been poisonous to stock intermittently for over 40 years but the probable cause was unknown until a water-bloom of Nodularia spumigena var. vacuolata was reported in summer 1968/69. Problems associated with the alga are being studied in several Departments and the preliminary results show that the alga persists through the winter as spores and as vegetative threads, that the water in the lake is more saline and its algal activity is greater at the southern (seaward) end than at the northern where a delta has been formed by the incoming stream. Lake Forsyth is land-locked except during flooding when a channel is cut through the shingle bank but other factors contributing to the eutrophic state of the water include the felling and burning of the forest, flood waters draining rich dairy pasture, effluents from dairy factories (all streams flow into the lake) top-dressing in the catchment area and large flocks of aquatic birds that feed at the northern end of the lake.

References

- Fogg, G.E. 1969: "The Physiology of an algal nuisance" Proc. roy. Soc. 173, 175-189
- Holm-Hansen, O. 1968: "Ecology, Physiology and Biochemistry of blue-green algae". Ann. Rev. Microbiol. 22, 47-70.

The influence of land development on phytoplankton
productivity in Lake Mahinerangi - a preliminary report.

S. Mitchell

(Zoology Dept., Otago University)

Lake Mahinerangi is a rather oligotrophic power-supply reservoir 40 miles south-west of Dunedin. It has an area of about 7 square miles, a mean depth of 6.2m, and a mean retention-time for the water of 8-9 months. An initial investigation of the phytoplankton productivity was made between September 1964 and January 1966, using the ^{14}C method. The range of values obtained was 0.58 - 5.61 mg of Carbon. $\text{m}^{-3} \cdot \text{hr}^{-1}$, and 20-200 mg of Carbon. $\text{m}^{-2} \cdot \text{day}^{-1}$. During this period the whole of the catchment area was undeveloped tussock grass land, apart from an area of exotic forest. Since then, about 4500 acres of land have been developed for agricultural use. This amounts to about 5 per cent of the Catchment area of the lake.

In November 1968 an investigation was started to find whether the phytoplankton productivity has been influenced by the land development. The productivity for this month was more than twice as high as in November 1964 or November 1965. Between December 1968 and February 1969 values were similar to those obtained in the earlier investigation, but since then there has been a striking increase, and from February-August the phytoplankton productivity has been consistently 3-4 times as high as in 1965.

By means of multiple regression analysis it was found that about 80 per cent of the variation in hourly production at near-optimal light intensity during 1964-66 could be accounted for by variations in temperature, water-level and day length. Temperature was slightly more important than water level (which varied through a range of 7m), and day length was relatively unimportant. Water-levels this year have been consistently higher than in 1964-66. When allowance was made for this, by substituting this year's water levels and temperatures into the multiple regression equation, there was good agreement between the

calculated values and those determined experimentally for the period December - March. Since then the productivity has been consistently higher than the values calculated from the equation by a factor of 2 - 3, and it appears that this may represent the real increase resulting from the land development. This increase occurred immediately after a high concentration of phosphate had been recorded in the stream which drains much of the newly developed land, following topdressing ($42 \text{ mg PC}_4 - \text{P/m}^3$).

There has been a slight tendency for phosphate concentrations in the lake to be higher this year. All of the samples analysed in 1964-66 had less than $3 \text{ mg PO}_4 - \text{P/m}^3$, whereas several of this year's samples have contained 3-4 mg/m^3 , and the August sample had 12.6 mg/m^3 . The increased productivity has been accompanied by an increase in the concentrations of chlorophyll, although the two curves differ in some details. There has been little change in the bicarbonate alkalinity, which is about 0.13 meq/l . pH levels have been consistently higher this year than in 1965.

It is postulated that the high productivity in November 1968 was a residual effect from topdressing during the previous Spring, and that this effect disappeared during the Summer as a result of the phosphate being lost in the outflow, bound in the sediments, or incorporated in stable organic phosphates. There was a further stimulus from the Autumn topdressing, which persisted until August, when further topdressing was carried out.

Lake Mahinerangi, being oligotrophic, is sensitive to outside influence, and although the phytoplankton productivity has been increased by a factor of 2-3, the increase, in absolute terms, is small.

Feeding Behaviour of North American Daphnia

Carolyn W. Burns

(Zoology Dept., Otago University)

Evidence from three lines of investigation - 1. direct observation, 2. analysis of the size composition of microspheres

ingested by Daphnia, and 3. measurements of filtering rate at different temperatures - suggests that different species of Daphnia may differ slightly in their feeding behaviour.

1. Microscopic observation of Daphnia from a Canadian lake revealed that D. galeata mendotae ingested a colonial chrysophycean alga present in the water in Spring, whereas D. rosea did not. During a midsummer bloom of Anabaena, D. galeata occasionally ingested single cells or short fragments of the algal filaments. In D. rosea, the presence of a single Anabaena cell in the food groove caused a violent rejection of the entire food mass.
2. D. pulex and D. galeata mendotae are similar in size and often occur in the same lake. Representatives of each species were allowed to feed together in suspensions of plastic microspheres (1-30 μ diam. size range) under a variety of experimental conditions. Microscopic examination of gut contents showed that when the microspheres were kept in suspension by continuous rotation of the feeding vessel, the size composition of the microspheres ingested by each species was the same. Under conditions in which partial sedimentation of microspheres occurred, D. pulex ingested proportionally more large spheres ($> 14 \mu$) than D. galeata did. In all experiments the total number of beads ingested by D. pulex was always larger than it was for D. galeata.
3. Filtering rates of 5 species of Daphnia were measured by allowing juveniles and adults to feed in dilute suspensions of ^{32}P -labelled yeast cells at 15° , 20° and 25°C - a temperature range characteristic of the epilimnion of North American lakes in Summer. In D. galeata mendotae and D. magna, filtering rates increased with increasing temperature and were higher at 25°C than at 15°C or 20°C . Filtering rates of D. pulex, D. schöddleri and D. rosea were higher at 20°C than at 15°C or 25°C . These results are supported by the observed ecology and distribution of the species in North America. A survey of the literature reveals that the question of possible differences between species of Daphnia as a factor affecting feeding rates has been largely neglected or overlooked, especially in English-speaking countries.

Although evidence in support of the existence of species - specific differences in feeding behaviour is scanty, and much more work needs to be done, the implications of the observations are important:

- (1) In measuring secondary productivity of a lake, care should be exercised before extrapolating to the field, filtering rates and feeding rates of another species of Daphnia measured in the Laboratory.
- (2) Where several species of Daphnia coexist in a lake, subtle differences in feeding behaviour, might lessen interspecific competition for food in an otherwise comparatively homogeneous environment.

Utilization of Food Resources in a Population of Freshwater

Fish

C.L. Hopkins

(Marine Dept., Wellington)

Data obtained from a stream system in the Wairarapa district were used to calculate the daily food consumption of a fish population consisting of juvenile trout, eels and bullies (Philypnodon breviceps).

The major food source of all fish was the mayfly nymph Deleatidium which formed 54% of all food organisms found in fish stomachs and was present in 75% of all fish. There were small differences in the diet of the different fish species. Small animals such as Chironomid larvae were eaten by bullies; hardcased animals such as caddis larvae and snails were eaten by trout and eels but not by bullies; Coloburiscus, Hydropsyche and Rhyacophilidae were eaten more by bullies and eels than by trout. There were also food differences between different ages of the same fish species. Both young bullies and trout fry ate large numbers of Chironomid larvae, these organisms being largely replaced by mayfly nymphs in the older fish. There was also an increase in the variety of food eaten as the fish grew larger.

For calculation of total food eaten per day, it was assumed for bullies and trout that the ration eaten for maintenance purposes equalled 1.2% of the body weight of the fish, while food contributing to growth equalled 4.2 times the daily growth rate of the fish. Summation of these two rations yielded the total daily food intake. A different method of calculating food intake was used for the eels. For these fish, maintenance and growth food conversion factors were combined to produce a figure for the total daily ration in terms of percentage of body weight. The percentage varied with weight of the eels from 2.18% to 2.30%.

A table was shown illustrating the estimated daily food consumption of the fish population at different times of year. The figures indicated that the fish ate some 2 - 6% by weight of the benthos every day.

Aspects of the Production Biology of the Upland Bully *Phlypnodon*
breviceps (Stokell) in a small Canterbury Lake

D.J. Staples
(Zoology Department, Canterbury Univer

A study is in progress aimed at estimating the net production of a population of bullies. Monthly production estimates are being computed from mortality and growth rate data for each age group.

A combination of two methods is being used to distinguish age groups. Fish below 40mm. in total length are aged simply by size using length frequency analysis. At greater lengths scales are needed to provide a satisfactory method of age determination.

The growth rate is estimated from the monthly change in mean weight of each age group. The mean length is first calculated and then converted to weight from length-weight relationships established each month. Results so far show marked seasonal variation in growth rates of all age groups, with males growing faster than females.

The mortality rate is calculated from the change in the total number of fish present in each age group as estimated bi-monthly. Juvenile fish are estimated by sampling a unit volume of water, while the remaining population is being estimated by a capture-recapture method using fin clips for marking. The two interesting features of these results so far are the high number of bullies present and their high mortality rate. A population peak was recorded in February, 1969 when approximately 1 million juveniles and 275 thousand adult fish were present (total density of approx. $150 / m^2$.) The maximum life span is four years with an average annual mortality rate for adults of 95%.

Net production estimation incorporates these population parameters to give the total elaboration of fish tissue during any given time interval. Using a graphical method of computation the net production of male fish was $52 \text{ gms.} / m^2 / \text{year}$. This figure is comparatively high. However, at this stage of the study it is based only on annual growth and mortality data rather than on monthly figures. These will be soon available to determine more accurately the seasonal changes in biomass and net production of the species.

(This work is being done for a Ph.D. thesis - Editor)

Pattern and process in a submerged shallow water plant community
in Lake Rotoiti

B.J. Coffey, V.J. Chapman, J.M.A. Brown &
F.J. Dromgoole

(Botany Dept., University of Auckland)

On shallowly sloping sandy substrates in Lake Rotoiti which are protected from the prevailing westerly winds a plant community of vegetation islands develops which appears to show pattern and process. This "Low Mixed Community" occurs in water up to 1.8m deep.

The initial colonisation of bare sand may be started in shallow water (0 to 60 cm) by several plants whose buried runners bind sand

and give rise to elevated mounds (10 to 25 cm high) e.g. Elodea canadensis, Limosella lineata, Lilaeopsis lacustris, Myriophyllum propinquum. Other plants may invade the mounds but such chance complementation leads to mounds which are floristically very variable both in respect to the density of individual species and the numbers of each.

In the deeper zones of the community (60 to 180 cm) the vegetation islands are larger and contain several additional species e.g. Myriophyllum elatinoides, Potamogeton spp., Triglochin striata, Isoetes kirkii. Some of the species present show a decreasing density with water depth whilst others become less frequent. The lower limit of the community is determined by the dense beds of Lagarosiphon major found in the lake.

Pattern and process with a movement of the mounds into deeper water has been observed at depths from 0 to 60 cm. Wave backwash when easterly winds are blowing leads to an erosion at the shoreward end and the sides parallel to the wind. Provided growth at the offshore edge is faster than shoreward erosion, this results in an elongated mound which gradually moves into deeper water. Other possible causes of mound erosion in the deeper water are still under investigation.

The arsenic content of some water weeds from the Rotorua and
Waikato Lakes

J.H.A. Brown

(Botany Dept. Auckland University)

Following proposals that control of waterweeds in these lakes might be accomplished by harvesting them and processing for commercial use an earlier report by Fish that considerable quantities of arsenic may be present in the weeds has been followed up. Arsenic levels in dried plant material were determined by the relatively subjective Gutzeit techniques. The results were variable, varying from 25 to 500 ppm arsenic content, but showed that all samples contained con-

siderable amounts of arsenic when compared with similar weeds from non-volcanic waters.

Analyses of water from the Waikato chain (Dr C.F. Hill) show that arsenic levels near thermal discharges are relatively high but decrease progressively down river.

The Culturing of *Nitella hookeri*

M.B. Starling

(Botany Dept., Auckland University)

Attempts are being made to get a definable medium capable of inducing rapid growth in Nitella. So far vitamins B₁₂ and nicotinamide have been shown to have a positive effect when added in large amounts. Other vitamins used with moderate success are thymine, pyridoxine, pyridoxamine, p-amino-benzoic acid and riboflavine. Confirmatory experiments on these results are now in progress. Similarly initial experiments tend to suggest that indole-acetic acid (above 1 ppm concentration) and biotin (1 ppm and above) inhibit growth. The effects of kinetins remain somewhat obscure. It is hoped that experiments varying the concentrations of vitamins and inorganic components will give a medium which is reasonably adequate. However, the plant is proving very difficult to culture satisfactorily, as well as being very irregular and inconsistent in many of its responses.

RESEARCH NOTES : STUDENT THESES

The available abstracts of student theses or of work in progress are printed below.

UNIVERSITY OF CANTERBURY

Miss J. Crumpton is making a general ecological study of two species of damselfly, Austrolestes colensonis and Xanthocnemis

zealandica (Ph.D. thesis). She hopes eventually to be able to outline the life histories and biology of these insects, comparing their niches; and to present some data on the productivity and energetics of selected populations. Study areas include a series of farm ponds near the Waimakariri River, and a high country kettle hole lake. She is sampling these habitats regularly to obtain general information on the environment, and specific information on the growth rates and biology of the damselflies. The diet of the nymphs is being examined, a series of experiments has been designed to determine their food consumption and respiration rates. It is already apparent that these two species have distinctly different niches.

Trevor Crosby is doing a Ph.D. on simuliids. The main work will be a population dynamics study with the ultimate aim of attempting to construct a life table for one species, Austrosimulium tillyardi. The principal study area will be in the Wainui Valley on Banks' Peninsula, where there are extensive populations, but observations will also be made in the Canterbury high country and in Westland. Some experimental work has already been done, for example on still water survival at various temperatures, and analyses of larval gut contents commenced. Some work has also begun on simuliid parasites.

Philip Cadwallader has recently arrived from England to study for a Ph.D. thesis on the rare Canterbury mudfish, Galaxias burrowsius. This thesis is to be supported by the Marine Department and will involve a general study of the habitat, habits and behaviour of the species.

A. Ramsay is working on the microflora of Lake Grasmere, Canterbury. Emphasis is on factors causing variations in the numbers of bacteria in the lake and on classification of the main types of bacteria present (Ph.D. thesis).

Janet M. Holder is studying (for an M.Sc. thesis) certain aspects of the physiology of Potamopyrgus antipodum with emphasis on measuring

oxygen consumption (using the micro-Winkler technique) in relation to body weight, starvation periods, temperature, salinity, oxygen concentration in the water, and in running and still water. It is hoped that a comparative study can be made between P. antipodum and either one or both of the other two New Zealand species of Potamopyrgus. Additional studies which may be carried out are (1) feeding and assimilation and (2) osmotic regulation, using the microcryoscopic method of Ramsay & Brown (1955) to measure the freezing point of small samples.

J.A. Staples is working on zooplankton in Lake Grasmere, and this work will probably be submitted for an M.Sc. thesis. Emphasis is on zooplankton production, with particular reference to the Cladocera.

B.Sc. Hons. projects in Zoology (1969)

C.R. Fowles: A study of substrate - fauna relationships in the Ilam stream.

A study was made of the fauna of different substrates in the stream running through the Ilam campus, and of the effect of clearance of the weeds at the sides of the stream on the stream fauna. The main species present were members of the Tubificidae, Potamopyrgus antipodum and Paracalliope fluviatilis, with to a lesser extent Cura pinguis, Physastra variabilis and Oxyethira albiceps. Altogether nineteen species of invertebrates and two fish were found. Clearance of the weeds in general caused a reduction in the numbers of species and in the total fauna present, with a later period, of approximately six weeks, of recovery leading to recolonization. General trends and detailed descriptions for each substrate are given.

J.R. Johnson: An ecological study of temporary ponds in Canterbury.

The plankton of three farm ponds which dry up in summer was investigated from April until June, 1969. Lists of organisms are

given, and cycles of chlorophyll and oxygen concentrations and zooplankton weights are described. The fauna can be divided into three groups according to their method of overcoming the dry phase. Oxygen production and consumption experiments, as well as chlorophyll analysis, were used as the basis for an estimate of the production by the plankton. The effects of certain environmental factors were examined. In all the ponds, light and temperature bore a direct relation to gross production.

D.J. Smith: The distribution of the fauna of a warm stream at Hamner Springs, with particular reference to temperature.

A study was made of a small length of stream affected by a hot water discharge. The distribution of the fauna, mainly in relation to temperature but also to substrate, is given. The fauna consists principally of oligochaetes, gastropods and rhabdocoeles.

University of Auckland

W.S. Orr (IIIB project) examined the effects of dessiccation on ostracod eggs. For Cyprinotus incongruens it was found that the eggs would hatch with or without prior dessiccation at room temperature and at 30°C, except that eggs dried at 30° failed to hatch. It appeared that dessiccation for 2 weeks or longer slightly decreased the time taken to hatch. A more extensive analysis of the effects of various dessiccation and hatching temperatures was made on Herpetocypris pascheri eggs. For this species it was found that the eggs would hatch with or without prior dessiccation except after drying at 0° and 30°, or for longer than 2-3 days at 2.5°. (Direct hatching without drying was not tested below 15°). The effects of the various drying and hatching temperatures and the duration of exposure to them on hatching times and hatching success were analysed.

ANNUAL CONFERENCE, AUGUST, 1970

It was decided during our last conference in Christchurch to hold the next one in Rotorua. This is an excellent centre from which to study some of the North Island lakes and the Marine Department, which, with the help of the Department of Internal Affairs, will be the host organisation, hopes to be able to arrange plenty of field trips for those members interested in visiting the local waters.

A circular will be sent out to members early next year with further information. The date will probably be in the last week of August and it is hoped that the conference centre will be at the Forest Research Institute, Rotorua. If this is confirmed, not only will we have extremely pleasant surroundings for our meetings but also good cafeteria facilities and low-cost accommodation for those members who wish to use the quarters at the permanent camp in the Institute grounds.

G.R. Fish

N.Z. WATER CONFERENCE, 1970

This conference is being organised jointly by the N.Z. Institution of Engineers and the Royal Society of N.Z. to provide an opportunity for a general and comprehensive discussion of national problems of water resources, management and development. It will be held on May 12-14 at the University of Auckland. Enquiries about the Conference should be sent to Mr H.S. Bunby, Conference Secretary, P.O. Box 1017, Auckland 1.

INTERNATIONAL ASSOCIATION ON WATER POLLUTION RESEARCH

The 5th International Conference and Exhibition will be held in San Francisco, California from July 26 - August 1, 1970 and there will

be a reconvened session in Honolulu, Hawaii from August 1, 1970. There are a number of technical and cultural tours associated with the conference.

Further information may be obtained from Mr Ron Hicks, Auckland Regional Authority, Private Bag, Auckland 1.

FIRST INTERNATIONAL CONFERENCE ON EPHEMEROPTERA

The first international conference on Ephemeroptera will be held on August 17 - 20, 1970 at Florida A & M University, Tallahassee, Florida. Submitted and invited papers will be given on various fields of research concerning Ephemeroptera, and it is hoped that the conference will have an informal atmosphere centred around discussion. Symposia are also planned. Research facilities will be provided for interested persons in the university's Laboratory of Aquatic Entomology. The laboratory includes an extensive collection of Ephemeroptera collected from various areas of the world.

Immediately after the conference an excursion is planned to the Blackwater River in NW Florida. The excursion will leave Tallahassee on August 21 and return on the evening of August 23.

Those interested in attending the conference should register on or before February 1, 1970. Forms may be obtained from: Dr William L. Peters, University P.O. Box 111, Florida A & M University, Tallahassee, Florida 32307, U.S.A.

NOTES AND NEWS

Professor V.J. Chapman of the Botany Department, University of Auckland, has returned after 9 months sabbatical leave in the U.S.A.

A new School of Science at the University of Waikato, Hamilton, is being formed, and with the appointments of Professor J.G. Pendergrast (as Professor of Biological Sciences), Dr M.A. Chapman and

Professor A.T. Wilson (as Professor of Chemistry and Dean of the School, with a keen interest in Antarctic limnology) to the staff limnology and entomology will be emphasised. Teaching at the first year and research student levels commences next year, Teaching Fellowships being available for the support of the latter.

Dr V.H. Jolly on her retirement from the Sydney Water Board has returned to N.Z. and is now attached to the Zoology Department, University of Auckland. She has also been invited to participate in the Freshwater Research Unit of the D.S.I.R.

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