

1968

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Limnological Society

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Annual Conference **NEWSLETTER No. 3**

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EDITORIAL

Certain Cabinet ministers have been calling for the training of more biologists in the universities and for more research of direct economic importance to be carried out, although one can't help feeling that if the Government were to employ more of the already trained biologists so that their scientists were spread less thinly on the ground more might be achieved. However, I do not want to go into the political aspects of this question but rather to point out that there does exist within this country a more or less untapped reservoir of potential workers who could be used to provide much valuable and badly needed information. By this I mean the large number of students doing ecological field work for theses for Honours degrees, Ph.D.s etc. These are people prepared to work long, hard hours and to make all sorts of sacrifices to carry out their research, and yet who are often limited in the kinds of topics or habitats they can study by their inability to afford the

cost of travelling more than a few miles to their study area. It is one thing for them to drive 100 miles or so on a single visit for collecting purposes, but quite another to maintain a regular programme of such visits for a year or more. The universities are unable and unwilling to support student travel but with increasing demands from the public for something to be done about the numerous biological problems that we face it seems to me that for a very small expenditure Governments departments could subsidise much useful work merely by paying the costs of petrol and oil needed for field work. Most students have some sort of bursary or grant, so that it is not a question of providing complete support for them, and many have some form of transport. Although it is iniquitous to capitalise on their enthusiasm the fact remains that it would not be difficult to find students willing to undertake long term field work at some distance from their university for this minimal subsidy. Thus, to quote a local example, it would take only \$125 a year to help a student travel to Rotorua once a fortnight, and less than this to support work on the Waikato River or on some of the dune-lakes suggested for trout farming or the introduction of large-mouth bass. I expect I am an innocent in such matters but it seems very simple to me.

PROTECTION OF LAKES AND RIVERS - "PROJECT AQUA"

"Project Aqua" is an international programme planned originally as a joint undertaking by the International Union for Conservation of Nature and Natural Resources (IUCN) and the Societas Internationalis Limnologiae (SIL). It has now been taken over by the freshwater section of the International Biological Programme (IBP). It attempts to list, describe and propose for conservation aquatic sites such as lakes, rivers and other water bodies, selected for their scientific importance. Criteria for selection are:

- a. significance of water bodies as types characteristic for a specific part of the world;

- b. waters distinguished by research performed on them already, or in progress, which is of importance for hydrobiology in general".

The only New Zealand lakes so far submitted to this programme is Lake Okataina, near Rotorua.

The freshwater committee of the New Zealand IBP programme aims to produce a list of lakes and rivers suitable for this special conservation and would welcome suggestions from members of the Society. Information about each site should be given under the following headings: - name; situation; latitude and longitude; altitude; area; depth (max. and mean); Origin; status in limnological classification (e.g. trophic status of lakes, type of river); special scientific interest; degree of scientific research (including major references to literature); conservation status (e.g. ownership); national recognition (e.g. as part of a National Park or reserve); present usage (e.g. for water supply, fishery, recreation, disposal of waters); threats from possible or proposed developments; other information.

Any suggestions should be forwarded to me as soon as possible.

V.M. Stout.

PARROT'S FEATHER - Have you seen this in the wild?

Myriophyllum brasiliense, Parrot's feather, a water milfoil from Brazil, in the last year or two has been causing considerable trouble in lagoons and drainage channels of the Lower Manawatu, and this summer it has been reported as occurring over a considerable length of the Aka Aka Stream which drains from the north into the Lower Waikato. A patch was found in the Ohau Channel, Rotorua, in 1963.

This is a highly undesirable plant in ponds and water channels where the bottom is a few inches of silt, as it there grows quickly and densely as a tall, robust plant which chokes the waterways. It can also grow as a short, mossy plant among grass and rushes on damp silt, and even grows well in this form where there is little likelihood of inundation on the dredgings dumped on banks during the cleaning of drainage channels. Although the mossy plants themselves cause no trouble, they can be a source for further troublesome infestations.

M. brasiliense can be controlled by spraying, but it takes early persistent effort to eradicate it. It is therefore highly desirable to check infestations early before they grow to a major problem and a perennial expense. As in other countries, where the plant is adventive, only female plants are present so spreading by seed is not a worry.

If you find this plant growing wild, would you please send specimens of it to the Botany Division, D.S.I.R. with the exact locality, date of collection, habitat and degree of infestation. And would you please impress on anyone who you know that cultivates it, how important it is NOT to throw it or place any fragment of it where it can be washed downstream at any time.

Well-established robust, densely growing plants in a drain may have stems up to 8 mm. thick and 3 m. long and over, with 20 cm. of the stem upright above the water. Leaves may be 40 mm. long, almost always five in a whorl and have 12-15 flat, narrow leaflets of fairly uniform length (up to 5 mm. long) on either side. When growth is less dense, leaf stems may lie along the surface with 4-5 cm. upright at the tip and with roots up to 25 cm. hanging from the nodes. In smaller plants, the leaves are shorter but still show the uniform width and numerous leaflets. Usually, the underwater leaves are similar to the emergent but, on occasion, apparently when water is not particularly clear, the underwater leaves are much larger, up to 60 mm. long with rather few, very fine leaflets up to 30 mm. long. So far as is observed, the change from the submerged to the normal form of leaf is abrupt. Normally leaves are pale green, quite different from the dark green of M. elatinoides or M. propinquum. The special form of submerged leaves are reddish brown.

The only plant in New Zealand that M. brasiliense is likely to be confused with is the native M. robustum. but in M. robustum the upper flowers at least are hermaphrodite. There are usually red and brownish shades in the emergent foliage and the species apparently grows in water rich in breakdown products of plant organic matter, besides other minute but definite differences.

Any help you may give would be much appreciated.

Ruth Mason,
Botany Division, D.S.I.R., Private Bag
Christchurch

Requests for material

Dr E.A. Flint (Botany Department, University of Canterbury) would welcome freshwater red algae, preserved in 4 - 5% formalin. These often grow as tufts of branched filaments, sometimes articulated, and often very mucilaginous. They may be greenish brown, purplish red, or black and up to 10 cm long. The algae may be attached to stones, to aquatic plants or on snails, in streams and lakes. Please note the colour of the living thallus and the nature of the substrate to which it was attached.

Dr V.M. Stout (Zoology Department, University of Canterbury) would be interested to see any collections of freshwater mites from standing waters.

RESEARCH NOTES

ZOOLOGY DEPARTMENT, UNIVERSITY OF OTAGO

Dr D. Scott went on sabbatical leave in March. After a few weeks in Canada he is now in Britain, continuing his work on speciation in trout. He will return in November.

Dr S.F. Mitchell is continuing his work on phytoplankton productivity in Lake Mahinerangi and Tomahawk Lagoon. L. Mahinerangi was sampled from 1963-5, during which period the catchment consisted of undeveloped tussock grassland. Since 1966 a large land-development scheme has been continuing around the shores of the lake. To date over 1000 acres have been ploughed, fertilized with lime and superphosphate and sown in turnips or grass. In an effort to determine the effects of this on the lake, sampling was started again in November, 1968, and will be continued throughout 1969. This work is being done in conjunction with Dr Elizabeth Flint of Christchurch, who is working on the species composition of the phytoplankton.

Preliminary results suggest that there has been an increase in phytoplankton productivity as estimated by the ^{14}C method. Several of the values obtained have been higher than the highest recorded during 1963-5 by 30-40%. Changes in the concentration of soluble reactive phosphate have been slight. All of the values obtained in the earlier sampling were less than 3 mg P/m^3 . Subsequently a few have been between 3 and 4 mg/m^3 , but none higher, although values as high as 41 mg/m^3 have been obtained from the inflowing streams. Bicarbonate alkalinity, pH and chlorophyll a all appear to have increased slightly, and one rather puzzling result is that the transparency also appears to have increased. Zooplankton samples are being taken, but have not yet been examined.

Regular sampling of Tomahawk Lagoon was also restarted in November, 1968. A few samples taken during the winter of 1968 had revealed high phytoplankton productivities, but as in some other summers, the phytoplankton declined markedly with the development of large crops of macrophytes in November-December. From January-April phytoplankton productivity has been barely detectable, even with the sensitive ^{14}C method. Significant assimilation of ^{14}C has been found in samples containing filaments of Spirogyra, which is brought into the water from the bottom by turbulence. It appears that these and detritus

derived from the weeds may well be the base of the plankton food-chain, as very large concentrations of Daphnia carinata have been present from January - April, in spite of the very low phytoplankton productivity.

It is planned to start quantitative sampling for macrophytes as soon as a suitable sampling method is found, and attempts will later be made to measure the photosynthetic rates of macrophytes using a modified ^{14}C method. Fertilisation experiments using water columns isolated by polyethylene cylinders are planned for next summer, and experimental work on the effects of weed extracts on plankton algae will be continued.

Dr Carolyn W. Burns, a Canterbury graduate, joined the staff in February after completing a Ph.D. at Toronto, and two years post-doctoral work at Yale.

While in Canada, Dr Burns examined the effects of food concentration, temperature and body size on the filtering rates of a population of Daphnia rosea in a small lake. Filtering rates of adult Daphnia, as measured by a radioisotope-labelling technique, were found to be very much lower in summer than they were in spring, despite the higher lake water temperatures in summer.

Direct observations of feeding behaviour of Daphnia rosea and measurements of rates of thoracic appendage movement creating the feeding current (by means of a photoelectric device) suggested that a possible cause of the lower filtering rates was the presence of Anabaena filaments which had developed in the lake in dense concentrations and which were interfering with the normal, rhythmic functioning of the thoracic appendages.

Techniques developed during this study were used at Yale to examine the relationships between filtering rate temperature and body size in 4 species of Daphnia. The filtering rates of all species examined increased with increasing body size of the Daphnia. However, the

occurrence of higher filtering rates at 20°C than at 15°C for two of the species suggests that optimal filtration for these species may occur at temperatures several degrees below the temperature characteristic of the epilimnion of many North American lakes for several months over summer.

The relationship between body size of Bosmina longirostris and 6 species of Daphnia, and the maximum size of particle which they are capable of ingesting was examined using inert plastic microspheres ranging in diameter from 1 - 80 μ as the experimental particle. Direct measurement of the diameters of the ingested spheres revealed a good correlation between the size of an animal and the maximum size of particle it could ingest, the importance of which being that the mathematical expression describing the relationship might be of use in predicting which members of a phytoplankton community would be available, on morphological grounds, as food for different-sized species of filter-feeding Cladocera in nature.

A comparison of the size distribution of microspheres ingested by 2 species of Daphnia similar in body size and frequently coexistent in nature, was also carried out. Under all experimental conditions, Daphnia pulex ingested more spheres than Daphnia galeata under identical circumstances. When some sedimentation of spheres was allowed to occur, D. pulex ingested spheres of a larger size range than did D. galeata. The results suggest that the possible existence of selective feeding by different species of Daphnia in nature should be examined more closely.

Other work at Yale included an 8 month study of the population dynamics and diurnal vertical migration patterns of Daphnia galeata in a small Connecticut lake. One interesting facet of this work was the discovery that in mid-July, the Daphnia were migrating through the mixolimnion from a daytime depth of 8 - 12M where the temperatures

were 5 - 7°C to an evening depth of 2 - 5M where temperatures were 21 - 25°C. Since migration was accomplished within 3 hours one wonders what physiological adjustments to such large temperature differences were occurring at this time.

In Dunedin, Dr Burns intends to extend some of her techniques to an examination of feeding behaviour and assimilation in New Zealand Cladocera, especially members of the genus Daphnia. In addition, she is interested in population dynamics and vertical migration patterns of New Zealand Cladocera, and in the occurrence of parasitism among Daphnia. She would greatly appreciate receiving any parasitized Cladocerans from field collections.

Mr T.W. Shuttleworth has joined the staff as a teaching fellow from Queen Mary College, London, and will be doing research for Ph.D. on osmoregulation in eels.

Ph.D. Students

Mr I.K. Latta is continuing his work on the influence of willows on streams. Various aspects of this include: The influence of willows on the distribution of bottom fauna, bottom flora and trout, estimates of the amount of leaf-fall into streams, the chemical composition of leaves, including pigments, and the influence of willows on the primary productivity of streams, using 24 hour oxygen sampling. Work has recently been started on the growth of bacteria on fallen leaves, and the feeding of bottom fauna on the leaves and their associated bacterial flora, using techniques involving the labelling of these with ^{14}C , wet combustion of the samples to CO_2 , and liquid scintillation counting.

Mr T.M. Wong is continuing research done last year for B.Sc. Honours on osmoregulation in the freshwater crayfish. Differences in osmoregulatory ability were found between animals taken from the very soft waters of L. Mahinerangi and the harder waters of the

Taieri Plain, and research is being continued in an attempt to find out whether these are distinct physiological races.

Mr B.P.K. Nayar is working on filtering and feeding rates in Daphnia carinata using ^{14}C -labelled food and liquid scintillation counting. The influence of food concentrations and temperature is being investigated for the different instars.

B.Sc. Honours, Part 3 Students

Miss B.J. Costello is doing research on cyclomorphosis in Daphnia carinata. Attempts are being made to induce helmet formation experimentally, and seasonal changes in animals from Tomahawk Lagoon are being investigated.

Miss S.F. Barnes is working on feeding and assimilation in Potamopyrgus, using ^{14}C -labelled food and liquid scintillation counting techniques.

UNIVERSITY OF CANTERBURY

BOTANY DEPARTMENT

Dr E.A. Flint is working on a water bloom of Nodularia spumigena var. vacuolaria which was found in Lake Forsyth during the summer of 1968-9 and persisted through the autumn. The structure, ecology and methods of culturing this alga are being studied.

ZOOLOGY DEPARTMENT

Mrs F.R. Allison is describing a number of new species of fresh water flatworms. She is at present on leave until the end of the year.

Dr V.L. Benzie has returned from a year's leave of absence in England and is continuing work on the life-cycle and behaviour of Galaxias.

Professor G.A. Knox is undertaking a study of the biology of the Avon and Heathcote rivers and their estuary. A more detailed account of this work is given later in the newsletter.

Professor R.L.C. Pilgrim continues work on the life history of the mecopteran Choristella philpotti, with regular monthly collections.

Dr V.M. Stout is now in the second year of work on Lake Grasmer in the Canterbury high country. There has also been a preliminary investigation of several of the West Coast lakes particularly Mapourika and Matheson, which revealed some interesting comparisons with Canterbury lakes. A report on several visits to Lake Manapouri during 1968 is being completed for publication.

Dr E.C. Young is finishing a paper on "The changes occurring over a season in populations of Corixidae and Notonectidae" to be submitted to the Trans. R. Soc. N.Z. This is a study in New Zealand, of the development of new populations of two species with emphasis on the flight muscle polymorphism.

A Ph.D. student, D.J. Staples, is working on the production biology of the upland bully, Philypnodon breviceps in a small Canterbury lake.

New theses:-Ph.D.

T.K. Crosby: "The ecology of South Island Simuliidae, with the population dynamics of a common species".

W.J. Crumpton: "The biology and ecology of three species of Odonata".

A. Ramsay: "Studies on the microflora of Canterbury lakes".

M.Sc.

J.A. Neild: "The effect of environmental factors on Potamopyrga

B.Sc. Hons. projects

C. Fowles: "A study of the Avon river as it passes through the Ilam campus".

J. Johnston: "The production of four small ponds".

D. Smith: "The fauna of a small thermal stream".

ENTOMOLOGY DIVISION, D.S.I.R., LINCOLN

L.J. Dumbleton has published a synopsis of the N.Z. mosquitoes and a key to larvae in Tuatara, 16(3) Dec., 1968.

He also has three papers in press:-

1. The hot springs Ephydrella (Diptera) has been described as a new species and some notes are given on other species from mineralised waters (New Zealand Entomologist).
2. Culicoides mollis (a biting ceratopogonid from Samoa and Fiji is recorded as apparently recently established in Aitutaki (Cook Is). (N.Z. Entomologist).
3. The simuliid genus Austrosimulium does not extend to the islands to the north of N.Z. A single species of Simulium (S. jolyi) is known from Fiji and New Hebrides. A new species of Simulium is described from New Caledonia and a new subspecies of S. ornatipes (an Australian species) from Norfolk Is. (N.Z. Jl. Sci.).

Other occupations are:- completion of writing up work on N.Z. Austrosimulium; investigation as opportunity permits of breeding of the biting ceratopogonid Spiloconops myersi; endeavouring to locate on the roots of aquatic plants the so far undescribed larvae of two species of Coquillettidia (Culicidae).

MARINE DEPARTMENT, FISHERIES LABORATORY, CHRISTCHURCH

Mr M. Flain while writing up his Lake Coleridge investigation is planning a study of the Quinnsat salmon. He has already examined growth rates of the run in the Rakaia river, and is now collecting comparative material from other areas.

As time permits the study will be expanded to include other aspects of the biology. Recent sampling has shown that a high proportion of the salmon parr which remain in the rivers for a full year are sexually mature males. There is little information on the occurrence of these precocious male salmon in New Zealand.

Mr A.M.R. Burnet is continuing a study of the effects of cropping on a brown trout population in a small stream. The population was observed for several years during which there was little or no exploitation. The mean population level for the period was 234lbs per acre. Starting in 1964 the number of 2 year and older fish has reduced to one third of the unexploited level, and a "crop" was been taken each year to keep the numbers to this level. The crop has varied from year to year with a mean of 92lbs/Acre.

The reduction in density has resulted in changes in the growth rate of the trout. Where they took 4 years to reach 28cm, this length is now attained in 3 years. The mean weight of the 2 year and older fish has increased from 99gms to 227 gms. The relationship between growth rate, population density and the food supply is being studied.

The first numerical reduction resulted in a marked decrease in the total weight of trout present. However the increased growth rate which followed the decrease in population numbers has increased the population density again bringing it back close to the unexploited level. Thus we have, by controlled cropping, changed a numerous slow growing population into a smaller population of faster growing fish. While the total density is now only slightly less, the structure of the population has changed significantly.

The Technical Field Service is continuing the investigation on salmon and plan to install electronic counting equipment at the Glenariffe Trap. They are also undertaking a series of lake surveys, starting this year with 3 lakes in the Ashburton valley. The main aim of the investigation is to obtain data on the fish population, together with a general limnological survey.

Samples are being collected for Mr Burnet who is measuring the comparative primary productivity, and the effects of trace elements, etc.

DOMINION MUSEUM

Dr A.N. Baker is principally concerned with marine work at the moment but still has an interest in the ecology and taxonomy of freshwater algae from Victoria Land, Antarctica, and will continue to work up the remainder of his pond and lake collections during the next few years.

N.Z. OCEANOGRAPHIC INSTITUTE, WELLINGTON

Bathymetric surveys have been completed on Lakes Te Anau and Wakatipu and the charts of these and of Lake Manapouri are in preparation. Sufficient temperature data are now available for Lake Wakatipu from recent work and that of Dr V.H. Jolly to enable this to be jointly written up. A preliminary study of the morphology and sedimentation in Lake Wakatipu is under way.

VICTORIA UNIVERSITY, DEPARTMENT OF GEOLOGY

Mr S.H. Eagar has been examining ostracods collected by the Dominion Museum Expedition to the East Cape in 1966, making identifications and building up distribution patterns. The Museum's 1967 Mt Egmont material is now being examined. Last year a mummified ostracod of Nukumarian (Pleistocene) age was found near Gladstone, Wairarapa, and in the same district samples rich in ostracods were collected from a lake deposit of Casteccliffian (Pleistocene) age. Mr Eagar is also completing a survey of the ostracod fauna of Wellington Harbour.

ROTORUA

Dr G.R. Fish (Fisheries Research Division, Marine Dept.)

The limnological survey of Lakes Rotorua and Rotoiti will, by June, have reached a stage when data are available on two complete annual cycles of water temperature and dissolved oxygen fluctuations and of phytoplankton population changes. These data will be used later in the year to estimate heat and oxygen budgets for the lakes. Some preliminary details, including a simple water budget, have been made available for inclusion in the Chairman's Report for 1969 to the Freshwater Fisheries Advisory Council.

Evaluation of the plant nutrient contribution to Lake Rotorua by its inflowing rivers and springs is still in the data-collecting stage. No firm conclusions have yet been reached but the indications are that although agricultural runoff contributes a greater proportion of the phosphorus salts than urban effluents, the reverse is the case for nitrogen salts. Analyses for these nutrient salts will be continued on the lake waters, their influents and effluents for several more months and the study extended to include some small but clearly-defined catchments in order to identify the major sources of nutrients that support the primary production in the lake.

Essential help in this survey is being given by Dr M.A. Chapman (the status of zooplankton populations) and Dr U.V. Cassie (phytoplankton identifications) of Auckland University and by Mr H.J. Freestone (flowrates in rivers) and Mr I. Nairn (catchment analyses) of the M.O.W., Rotorua.

Dr Cassie has published a paper on the results of her first year's work (see bibliography) and a further two are in preparation. Over 60 species of phytoplankton have been identified to date and photographic records of the algal flora are being kept.

Dr Chapman has found that there are slight but consistent differences in the zooplankton populations of Rotorua and Rotoiti, although the same Entomostracan species occur in both lakes. In general Cladocera dominate Rotorua, and changes in the abundance and seasonal dominance of all species are more obvious and more striking than in the calanoid copepod dominated Rotoiti. The Calamoecia

populations have been analysed in some detail and show a complex multi-voltine continuously breeding pattern. The Rotorua work has now been terminated and instead some attention is being paid to the shallow water and littoral populations of Rotoiti.

UNIVERSITY OF AUCKLAND : ZOOLOGY DEPARTMENT

Mr D.R. Cowley is continuing with his study of the systematics and morphology of the larvae and pupae of N.Z. Trichoptera.

Miss M.H. Barclay maintains her interest in pond ecosystems but is principally occupied in preparing an account of N.Z. freshwater and semi-terrestrial harpacticoid copepods.

Dr M.A. Chapman has been making a survey of a varied selection of lakes in the Auckland-Waikato area, with special reference to the zooplankton populations, in which the calanoid copepod species have proved of particular interest.

Boeckella minuta, previously known only from Wellington, has been found in the Waikato hydro dams, whilst a surprising number of lakes in which both Boeckella and Calamoecia occur together are now known. Certain aspects of her work on the zooplankton of Lakes Rotoiti and Rotorua are now being written up, and a start has been made on a survey of the N.Z. cyclopoid copepods.

Dr J.P. Leader is interested in various aspects of the ecological energetics and physiology of freshwater animals.

Three students are jointly studying a sand-dune lake, Rototoa, on the South Kaipara peninsula. J.D. Green (Ph.D.) and W.F. Donovan (M.Sc.) are working on the zooplankton, with particular reference to Calamoecia lucasi and Bosmina meridionalis respectively, and on associated phytoplankton and physico-chemical cycles. Laboratory studies are being planned to supplement the field data. C.S. Hatton (M.Sc.) is studying the productivity of Gobiomorphus sp. and its relation to the standing crops of benthic fauna and of planktonic Entomostraca.

W. Orr (IIIB) is investigating the effects of dehydration, oxygen lack etc. on the production and hatching of eggs in the ostracod Cyprinotus incongruens.

UNIVERSITY OF AUCKLAND : BOTANY DEPARTMENT

Professor V.J. Chapman is at present on sabbatical leave in the United States.

Mr F. Hill is at present continuing work done on the Waikato hydro-electric lakes for his Ph.D. and will, over the next few months, be looking at nutrients, plankton and weed regrowth in the various lakes. Most of these have been lowered substantially (e.g. 30 feet in Maraetai) in an effort to control the weed growth and the effects of this will be looked at during the coming year.

Dr U.V. Cassie is continuing her work on the phytoplankton of the Rotorua lakes and elsewhere.

Dr J.M.A. Brown, Mr F. Drumgoole and Mr B.T. Coffey (M.Sc. student) are preparing vegetation maps of Lakes Rotoiti and Tarawera, and of the Blue and Green Lakes. Mr Coffey has begun a study of the autecology of Lagarosiphon major, particularly in Rotoiti which is the only lake where this species is dominant. Growth and regeneration experiments are being carried out in the field by diving, and a three month series were carried out last summer which provided interesting data in relation to competition with Elodea canadensis. A winter series is now being set up. Laboratory experiments in an artificial stream are being made to assess the effects of light quality and intensity, current, temperature, daylength, etc. Attention is also being paid to control by herbivorous snails and grass carp, and their food preferences and rates of consumption are being investigated.

In view of proposals to crop the aquatic plants of the Rotorua lakes Dr Brown and a student are following up a report of Fish (1963) of high arsenic contents and are making more extensive analyses.

Mr M.B. Starling (M.Sc. student) is continuing his work on Nitella hookeri. He has found that culturing on agar (as mentioned in the last Newsletter) is unsatisfactory, because, due to the number of ions present in agar, it was impossible to decide whether the results obtained were due to the ions in the media, or ions in the agar, or both.

Previous experiments had shown that it was impossible to obtain growth in a substrate-free inorganic media. Furthermore, the addition of an inert substrate (ground glass) gave negative results. However, it was possible to obtain reasonable growth with soil or mud extracts and diatomaceous earth.

A large experiment is being set up involving approximately 4000 vegetative propagules, and nearly 300 different combinations of inorganic media, vitamins, amino-acids, and growth hormones in an endeavour to obtain a definable media capable of producing a growth rate of sufficient rapidity to enable quantitative measurements to be made of growth under different chemical and physical environments.

Mr I.M. Johnstone (M.Sc. student) is writing up his thesis on Salvinia herzogii. His aim was to find a suitable control for this heterosporous water-fern, and to elucidate what effects its control would impose on the Western Springs ecosystem. Western Springs is a small natural impoundment in Auckland city and is fed by an underground river system whose watershed drains some of the earliest and most extensively settled areas of the city. A 12 month limnological study of the Springs was carried out and the Springs were found to be eutrophic, with dense beds of macrophytes such as Egeria densa, Elodea canadensis, Potamogeton ochreatus etc, as well as the extensive floating population of Salvinia. Nutrient levels were high; there was much

nannoplankton with Melosira varians dominating those phytoplankters of larger size, and the amphipod, Paracalliope fluviatilis, the pond type zooplankton. In the summer marked diurnal fluctuations in oxygen content were found. The effects of cutting down but not removing the weeds are discussed, and included a marked lowering of the oxygen content of the water, followed later by extensive growth of Spirogyra. Particular attention was paid to the taxonomy, morphology and general biology of Salvinia, and both laboratory and field experiments were carried out on its physiology. The effects of various herbicides were tested, two of which were found to be suitable, and other means of control and of commercial use are discussed.

ABSTRACTS OF RECENT AUCKLAND THESES

Lake Ohakuri - its limnology and aquatic vegetation (C.F. Hill, Botany Dept., Ph.D.)

The eight hydro-electric lakes on the Waikato river were created in order that a head of water could be obtained for electricity generation. A subsidiary function was to provide a means of water storage, although the naturally formed and oligotrophic lake Taupo has the greatest storage capacity and provides much of the water required for Power Station operation.

The limnology of the Waikato lake chain is dominated by the following physical features:

- (1) The rate and volume of water flow through the system.
- (2) The fact that the source water for the river derives from an entirely oligotrophic source.
- (3) The river in its southernmost half receives virtually no industrial pollution but only agricultural drainage plus a very small amount of sewage from non-industrial sources.

Certain aspects of the limnology of the Waikato lakes, and in particular Lake Ohakuri, have been investigated and the following is a summary of the results obtained.

Physico-chemical conditions

Free phosphate ions reach their lowest level in water being discharged from Lake Taupo. At this point the ion is frequently not detectable. The level of the ion rises in the southern Hydro-electric lakes rather rapidly but north from Ohakuri average s-phosphate levels change only slightly. In Ohakuri an extreme range of 20 to 1070 ug/l PO_4^{3-} was recorded from 1966-1968. It is obvious in this latter lake that agricultural fertilizer is a major phosphate source. As water passes northwards from Taupo into each succeeding Hydro-electric impoundment its t-phosphate level increases. Taupo has very low t-phosphate levels, 0.06 mg/l, and the river at Meremere contains the highest levels, 2.80 mg/l. Like t-phosphate, nitrate accumulates down river from Lake Taupo. Taupo water contains little nitrate (< 50ug/l) and Karapiro appreciable quantities (winter maximum 1000 ug/l). The level of the ion in the river develops a very strong seasonal fluctuation.

Ammonia shows none of the seasonal changes in levels characteristic for nitrate, though it is still likely to be an important nutrient especially when and where nitrate levels are low. Geothermal water is a major source of this ion in the southern lakes (Ohakuri and Aratiatia). Levels of the ion vary from a mean of 82 ug/l for Taupo, 132 ug/l for Ohakuri, and 420 ug/l for Meremere. Ferrous ion was not detected with certainty in any open water away from the lake sediments. "Available" iron levels increase downstream from Taupo. Water from Taupo contains very little amounts of iron and this is a possible factor keeping the water in its present unproductive state. Chloride is present in moderate quantities in the Waikato lakes. The amount however is less than the bicarbonate content. Calcium levels in Lake Ohakuri (approx. 3.5 - 5.5 mg/l) and alkalinity values (approx. 0.8 - 1.5 meq/l) are typical for the whole lake system and undoubtedly play an important role in maintaining pH and the level of carboxyanions in the water at a level which allows the biota to reach a high degree of productivity. Silica reaches high levels throughout the lakes (12 - 38 mg/l in Lake Ohakuri), much in excess of that required to maintain continued high productivity in diatom species. Potassium, being present in milligram quantities, is not likely to be a limiting nutrient in the Waikato drainage system.

Due to the large scale movement and flow of water in the Hydro-electric impoundments, the great amount of aeration which the water receives on passing through each power station, and the lack of pronounced thermal stratification, no oxygen deficiency or oxygen stratification was found to develop in Lake Ohakuri. In Ohakuri oxygen levels ranged between 4.5 and 11 mg/l with a mean value of 8.3 mg/l. In a tributary stream absolute values, and % saturation values, exceeded the range found in the open lake.

Seasonal water temperatures on the surface range from 9° to 22°C. Lake Ohakuri, and presumably the other Waikato impoundments, are essentially homothermous and there is little temperature difference between top and bottom waters even in mid-summer (up to 4°C).

The change in the light transmitting quality of Taupo water as it flows through Aratiatia, Ohakuri and other northern lakes is very pronounced. The greatest change occurs in the northern half of Ohakuri where large scale phytoplankton development completely alters the character of the water. On the basis of water colour, and light transmission the Waikato lakes fall into two groups:

- (1) (Taupo) - Aratiatia - southern half of Ohakuri, with very transparent, blue coloured water.
- (2) Northern section of Ohakuri and lakes to the north, very turbid water, yellow-brown colour, improving to yellow-green in the winter period.

Plankton

North of the Orakei Korako area on Lake Ohakuri the plankton present in the Waikato is definitely of an "eutrophic" type. Dominated by Melosira.

South of Orakei Korako it is sparse, clearly oligotrophic, and dominated by Melosira, although the variety present here is different to that above.

Tributary streams running into the Hydro-electric lakes often have an extreme development of plankton species and a succession of blooms of Cyanophytes, Diatoms and Chlorophyceae. The through-flow of water in the main lake areas undoubtedly prevents the development of such bloom conditions in the open lake, except on odd occasions.

The zooplankton is very sparse in the southern parts of Ohakuri, but becomes denser in the northern section of Ohakuri and northwards from there. Many of the species present are also common in the Taupo-Rotorua lakes, and in this respect they are similar to the phytoplankton populations.

The following data have been collected upon Ceratophyllum demersum, the principal plant species in Lake Ohakuri. The plant is essentially a sub-surface species and appears capable of year round growth. Maximum growth rates occur in the December to January period in the lake proper, and the plant is apparently capable of growing in very deep water (circ. 8 metres) and thus under very low light intensities.

The growth form of the plant is extremely variable and it is thought that such criteria as internode length, number of leaves to node, and leaf dimensions are influenced mainly by changes in absolute light intensity, day length, and light quality.

No evidence was found that Ceratophyllum set viable seed, or that new seedlings arose each year. The plant is very quickly reproduced by vegetative means from any piece of stem bearing a nodal portion.

In situ growth experiments show that Ceratophyllum is apparently more productive than Lagarosiphon in shallow waters.

Biomass estimations of Ceratophyllum stands in shallow water 1 to 1.5 metres deep showed that the weight of material present exceeded biomass figures obtained for Lagarosiphon in Lake Rotoiti, and were slightly below those recorded for Ceratophyllum in a Swedish lake.

The photosynthetic oxygen output with increasing depth was estimated for Ceratophyllum and Lagarosiphon and the former species proved the most efficient under low light intensities.

The Limnology of Lake Pupuke (M.H. Barker, University of Auckland, M.Sc., 1967)

Lake Pupuke is a circular maar lake with a maximum depth of 55m. Stable thermal stratification develops over the summer and there is a marked oxygen deficiency in the hypolimnion. Nutrient levels and pHs are high (see abstract of paper given at 1968 Conference in Newsletter 2). Phytoplankton was dominated by desmids, and the zooplankton by Calamoecia lucasi which bred continuously throughout the year.

Limnological Studies on a Waitakere Reservoir (J.D. Green, University of Auckland, M.Sc., 1968)

The Auxilliary Nihotupu Reservoir is a small storage dam in the Waitakere Range, which is not generally used for water drawoff now, although it was emptied for three weeks during this study. Stable thermal stratification and oxygen deficiencies develop during the summer. The seasonal cycles of the phytoplankton (mainly flagellates) and of the zooplankton (dominated by Cladocera) are discussed with particular emphasis on Boeckella propinqua. The effects of the drainage of the dam are considered. (See also abstract of Boeckella work in Newsletter 2).

The Limnology of a Farm Pond (G.V. Cowley, University of Auckland, M.Sc., 1969)

A 12 month study of a farm pond at Papatoetoe was made, with particular reference to the physico-chemical conditions and the zooplankton. Chlorophyll analyses were also made. Marked horizontal and vertical micro-stratification patterns were found. The zooplankton was largely made up of Boeckella symmetrica and the populations of this multivoltine cop pod were analysed in some detail.

Flight Activity of Aquatic Insects (P.H. Norrie, University of Auckland, M.Sc., 1969)

A year's study of the flight activity of the aquatic insects of the Cascades Kauri Park in the Waitakere Ranges near Auckland was made, mainly using a Robinson light trap, for which a mechanism which automatically separated hourly samples was designed.

At least 16 species of mayflies (the individual species of Deleatidium were not separated), and 43 species of caddisflies were taken. Catches of insects of other orders were not analysed. Light trap records showed that Deleatidium spp. made up more than half of the mayfly catch, although Zephlebia cruentata and Coloburiscus humeralis were also important. The five most important caddisflies, in descending order, were Pycnocentroides aureola, Hydropsyche colonica, H. philpotti, Olinga feredayi and Hydrobiosus parumbripennis.

During the latter part of 1968 a suction trap was used and in these catches Zephlebia sp.A was the most abundant mayfly with Deleatidium spp., Coloburiscus humeralis and Zephlebia scita also important. The same caddisfly species

were found as in the light trap catches but there was a shift in emphasis towards the smaller sericostomatid species. In both traps the sex ratios were similar but the ratio of imaginal : subimaginal mayflies was much higher (77% cf. 15%).

Comparisons of the catches taken by a light trap 9 metres above the stream bed with those from a trap at stream level show that smaller catches with a greater proportion of caddisflies were taken from the upper trap, and some conclusions concerning the vertical stratification of flight activity of some species were possible after a detailed comparison of the results from these two traps. Stratification of imaginal swarming activity was observed in Zephlebia sp.A and Z. scita.

The flight season for most species was of 7 - 10 months duration, although occasional specimens could be collected on warm evenings throughout the winter. This long flight season fits a world-wide pattern in which longer flight seasons are found at lower altitudes. Ichthyotus hudsoni was the only species with a short (2½ month) flight season.

The nocturnal pattern of light trap catches was unimodal with maximum numbers occurring shortly after sunset. No dawn peak was found. In Hydrobiosis parumbripennis there were peaks at 4 hourly intervals throughout the night. The catches in the suction trap confirmed the results of the nocturnal samples of the light trap, but also showed that flight could occur during the day. Favourable conditions for daylight swarming include high humidity or an overcast sky. The drop in temperature and in light intensity associated with the onset of a rainshower may have acted as releasing stimuli, and rainfall may also be important.

Emergence times for three species of mayflies and five species of caddisflies were recorded. With the exception of Zephlebia scita which emerged during the day, all species emerged at night and most showed a distinct peak of emergence activity immediately after sunset. 75% of the emerging subimagos were captured in the first 40 minutes after sunset.

Air temperature was found to be the most important component of the weather in controlling flight activity. There was a threshold point at 9.5 - 11.0°C (depending on species) above which catch size was linearly related to temperature. Humidity, rainfall and wind had no detectable effect within the range encountered. Cloud cover probably exerted an effect through temperature since overcast evenings were generally warmer than clear evenings. Light appeared to function as a time signal.

THE BIOLOGY OF THE AVON AND HEATHCOTE RIVERS AND THE AVON-HEATHCOTE ESTUARY Prof. G.A. Knox and Mrs J. Cameron
(Department of Zoology, University of Canterbury)

Objectives

1. To review the research work carried out in the estuary during the past 40 years.
2. To assess the present status of the estuary flora and fauna with special reference to the effects of pollution.
3. To endeavour to forecast the likely effects on the flora and fauna of any changes in the drainage patterns, increase in pollution and the changes in the character of the estuary if a barrage were erected at the mouth.

This research is supported by grants from the Christchurch Drainage Board.

Fieldwork

Over the past year the following work has been carried out.

1. A survey of the distribution of the flora and fauna (on a grid pattern of sampling) of the area of a former starch factory effluent. The effects of this pollution on the flora and fauna can be clearly seen in the low number of species and the abundance of pollution tolerant species such as the flagellate *Euglena*. This survey will enable the recovery which should take place to be followed.
2. A similar survey which is still in progress is being carried out in the area of the outflow from the Drainage Board oxidation ponds. Again, certain species combinations and densities indicate the extent of pollution. When completed this survey will enable the effects of any further increase in the outflow from the treatment ponds to be assessed.
3. A start has been made on a study of the quantitative distribution of the fauna along a series of accurately surveyed transects, representative of the different parts of the estuary. These transects will serve as reference points against which future changes on the estuary can be checked.
4. A survey of the Avon River along the lines of that conducted by Mrs Cameron last summer in the Heathcote has been carried out. The distribution of the flora and fauna at a series of 20 stations from Fitzgerald Avenue to Pleasant Point has been determined. Water analyses for O₂, BOD, NH₃, Album. N₂, nitrate, suspended solids and chlorinity have been carried out. There are marked contrasts between the distribution of the flora and fauna in the two rivers, indicative of the much greater degree of pollution of the Heathcote.

5. The green algal problem

This summer has seen quite a spectacular increase in the quantity of green algae growing in the estuary. In his 1928 survey Thompson did not refer to either of the species Ulva or Enteromorpha. Ulva was certainly present in the estuary in 1946 and Bruce commented on its abundance in 1951. The appearance of Enteromorpha was noted in 1951 and Williams in 1959 found them to be equally abundant. While the condition improved for a while following the installation of the new treatment plant the algal growth is now in the increase.

A comparison has been made of the wet weights of algae from approximately the same area over the period 1951 to 1958.

A summary of the results of this summer's survey follows:

- (a) Av. density for 37 samples is 3.525 Kgm/M² wet weight, 0.296 Kgm/M² dry weight. Average % weight of water is 90.9%.
- (b) Av. density of Ulva is 1.063 Kgm/M² wet weight, 0.092 Kgm/M² dry weight. Average % weight of water is 81.7%.
- (c) Av. density of Enteromorpha is 2.434 Kgm/M² wet weight, 0.195 Kgm/M² dry weight. Average % weight of water is 85.8%.
- (d) Ulva and Enteromorpha are present in the Estuary in a ratio of U : E = 1 : 2.25. Enteromorpha has a slightly higher water content than Ulva. The reasons for the change from Ulva dominance to Enteromorpha dominance are not clear. Further work is needed before an answer can be given.
- (e) The Enteromorpha found in McCormack's Bay and by the Dyers Road Bridge is a different form (E. intestinalis) to that found over the rest of the estuary (E. ramulosa var. acanthophora).
- (f) Approximately 25% of the Estuary has a green alga cover greater than 75%. Most of this area is about the channels in the south - south western sector. About 60% of the Estuary has less than 25% cover and the majority of this area is the Brighton Spit sector.
- (g) Both species are absent from a considerable area adjacent to the sewage pond outlets. This may be due to a direct prohibiting effect by the effluent or to an indirect effect whereby the effluent is responsible for the absence of suitable molluscs to provide shells for the algae to attach to.

Five final year B.Sc.(Hons.) students are carrying out research projects on the estuary.

A.R. Kilner. The quantitative distribution of the snails Amphibola crenata and Zediloma.

D.A. Steffensen. The distribution of the euglenoid Euglena obtusa with reference to pollution.

K.J. Graham. The distribution of the flora and fauna in an impounded area in McCormack's Bay.

P.R. Kettle. A preliminary survey of the distribution of nematodes in relation to pollution.

R.W. Voller. The quantitative distribution of the fauna along the estuary side of the Brighton Spit.

ANNUAL CONFERENCE

The annual conference of the society will take place in Christchurch on August 25-26. There will be a day of papers and a day's excursion, probably to Lake Forsythe and the lower reaches of the Selwyn River. Members should by now have (and returned!) their notices of this meeting.

LIMNOLOGICAL THESES FROM N.Z. UNIVERSITIES

We have endeavoured to list all M.Sc., Ph.D. and B.Sc. Hons. theses submitted before May, 1969, and have also included, where possible, any publications arising out of them. This latter list may not be complete since such data are less readily assembled than are the thesis titles, most of which are given in the Union List of N.Z. Theses.

UNIVERSITY OF AUCKLAND

(These are all M.Sc. theses unless otherwise stated.)

BOTANY DEPARTMENT

- Haughey, A.W.H. (1965) The planktonic algae of Auckland sewage treatment ponds.
 Paper of same title in N.Z. Jl. mar. Freshwat. Res. 2: 721-766
- Carr, Julie L. (1967) The primary productivity and physiology of Ceratophyllum demersum.
 Two papers on this work are in press in the Aust. J. mar. Freshwat. Res.
- Hill, C.F. (1969) Lake Ohakuri : Its Limnology and Aquatic Vegetation. (Ph.D.; just submitted).

ZOOLOGY DEPARTMENT

- Bayly, I.A.E. (1959) Ecological studies on limnetic Entomostraca, with special reference to Boeckella propinqua Sars on Mayor Island.
 Publ: Ecological studies on N.Z. lacustrine zooplankton with special reference to Boeckella propinqua Sars. Aust.J.mar.Freshwat.Res. 13: 143-197; (1962).
- Tan, J.S. (1961) The ecology and life-history of Coloburiscus humeralis (Ephemeroptera, Siphonuridae).
- Winterbourne, M.J. (1964) Studies of the larval taxonomy, ecology, life-history and distribution of N.Z. stoneflies (Plecoptera).
 Publ: Studies on N.Z. Stoneflies. I. Taxonomy of larvae and adults. N.Z.Jl.Sc. 8: 253-84; (1965).
 2. The ecology and life-history of Zelandoperla maculata (Hare), and Aucklandobius trivacuatus (Tillyard) - (Gripopterygidae). N.Z.Jl.Sc. 9: 312-23; (1966).
- Barclay, M.H. (1965) An investigation of the fauna of a temporary pond with particular reference to the Crustacea.
 Publ: An ecological study of a temporary pond near Auckland, New Zealand. Aust.J.mar.Freshwat.Res. 17: 239-58; (1966).

- McLean, J.A. (1967) Studies on the biology of Oniscigaster wakefieldi McLachlan.
- Barker, M.A. (1967) The limnology of Lake Pupuke.
- Green, J.D. (1968) Limnological studies on a Waitakere Reservoir.
- Wilcocks, C.R. (1968) The physiological ecology of Triplectides obsoleta (McLachlan).
- Cherry, I. (1969) Studies on the osteology, musculature and behaviour of Galaxias basalis. (Just submitted).

UNIVERSITY OF CANTERBURY

(These are M.Sc. theses unless noted otherwise.)

BOTANY DEPARTMENT

- Opie, A.R.T. (1925) An ecological study of a Canterbury swamp. (No copy available.)
- Flint, E.A. (1935) The periodicity of the Phytoplankton in Lake Sarah with a consideration of some ecological factors.
 Publ: A preliminary study of the phytoplankton in Lake Sarah (New Zealand). J.Ecol.XXCI, 353-8; (1938).
- Arthur, E.F. (1936) The vegetation of the Grasmere stream.

ZOOLOGY DEPARTMENT

- Hamilton, A. (1931) An account of the morphology, life history and bionomics of Archichauliodes dubitatus Walker.
 Publ: The New Zealand dobson-fly (Archichauliodes diversus Walk.): life-history and bionomics. N.Z.J.Sci.Technol. 22(1A): 44A-55A; (1940).
- Helson, G.A.H. (1932) The cionomics, morphology, etc. of Stenoperla prasina.
 Publ: The Bionomics and Anatomy of Stenoperla prasina (Newman). Trans.R.Soc.N.Z. 64: 214-48; (1934).
 The hatching and early instars of Stenoperla prasina Newman. Ibid, 65: 11-14; (1935).
- Thomson, M.S. (1933) An account of the systematics, anatomy and bionomics of Austroperla cyrene Newman.

- Glasgow, J.P. (1934) The bionomics and anatomy of Hydropsyche colonica MacLachlan (Trichoptera, Hydropsychidae) and descriptions of larvae of H. philpotti Tillyard and H. fimbriata MacLachlan.
 Publ: The bionomics of Hydropsyche colonica MacLachlan and H. philpotti Tillyard (Trichoptera).
 Proc.Roy.ent.Soc.Lond., A, 11: 122-8; (1936).
- Macfarlane, W.V. (1936) Life cycles of four N.Z. trematodes: bionomics of Opechona, Telogaster, Catocaecum and Fasciola.
 Publ: The life cycle of the heteropyoid trematode Telogaster opistorchis. Trans.R.Soc.N.Z. 75: 218-230; (1945).
 Bionomics of two trematode parasites of N.Z. eels. J.Parasit. 38: 391-7; (1952).
- McFarlane, A.G. (1937) Life histories and biology of N.Z. Rhyacophilidae, Order Trichoptera.
 Publ: Additions to N.Z. Rhyacophilidae - Part 1. Trans.R.Soc.N.Z. 69: 330-340; (1939).
- Pilgrim, R.L.C. (1947) Studies on a freshwater mussel belonging to the genus Diplodon Spix.
- Wolfe, L.S. (1949) Studies on the genus Uropetala Selys (Odonata, Petaluridae) from N.Z.
 Publ: A study of the genus Uropetala Selys (Order Odonata) from New Zealand. Trans.R.Soc.N.Z. 80: 245-75; (1953).
- McMillan, H.M. (1951) The osteology and relationships of the family Retropinnidae Gill; including studies on life history, systematics and ecology, with particular reference to Retropinna anisodon (Stokell, 1941).
 Publ: An addition to the knowledge of the fish Retropinna anisodon Stokell (Retropinnidae). Trans.R.Soc.N.Z., Zool. 1: 139-44; (1961).
- Wisely, H.B. (1952) Some aspects of the life history, ecology, distribution and anatomy of a mayfly.
 Publ: Studies on Ephemeroptera. I. Coloburiscus humeralis (Walker); Early life history and nymph. Trans.R.Soc.N.Z.Zool. 1: 249-57; (1961).
 Studies on Ephemeroptera. II. Coloburiscus humeralis (Walker); Ecology and distribution of the nymphs. Ibid, 2: 209-20; (1962).
 Studies on Ephemeroptera. III. Coloburiscus humeralis (Walker); Morphology and anatomy of the winged stages. N.Z.Jl.Sci. 8: 398-415; (1965).

- Burnet, A.M.R. (1955) A study of the ecology of the N.Z. freshwater eels (Anguilla dieffenbachii and A. australis schmidtii Phillips).
 Publ: Studies on the ecology of the New Zealand long-finned eel, Anguilla dieffenbachii Gray.
 Aust.J.mar.Freshwat.Res. 3: 32-63; (1952).
- Bullivant, J.S. (1958) The growth rates and the respiration rates of young quinnat salmon (Oncorhynchus tschawytscha).
 N.Z.Jl.Sci. 4: 381-91; (1961).
- Young, E.C. (1959) Studies on the Corixidae (waterboatmen).
 Publ: The Corixidae and Notonectidae of New Zealand.
 Rec.Canterbury Museum, 7, 5: 327-74; (1962).
- Benzie, V.L. (1961) A comparison of the life history and variation in two species of Galaxias, G. attenuatus and G. vulgaris.
 Publ: The life history of Galaxias vulgaris Stokell, with a comparison with G. maculatus attenuatus.
 N.Z.Jl.mar. Freshwat.Res. 3, 4: 628-653; (1968).
 Some ecological aspects of the spawning behaviour and early development of the common whitebait, Galaxias maculatus attenuatus (Jenyns).
 Proc.N.Z.Ecol.Soc. 15: 31-39; (1968).
- Cranfield, H.J. (1962) Studies on the systematics of Gobiomorphus breviceps (Stokell) and G. gobioides (Cuvier and Valenciennes).
- Rowley-Smith, D.M. (1962) Studies on the biology and functional morphology of Triplectides obsoleta.
- Craig, D.A. (1966) The biology of some N.Z. Blepharoceridae (Diptera, Nematocera). (Ph.D.)
 Publ: The eggs and embryology of some N.Z. Blepharoceridae (Diptera, Nematocera) with reference to the embryology of other Nematocera.
 Trans.R.Soc.N.Z.Zool. 8: 191-206; (1967).
- Robb, J.A. (1966) A study of the influence of selected environmental factors on the egg and larval instars of the midge Chironomus zealandicus Hudson.
- Woods, C.S. (1967) A systematic study of Gobiomorphus (Pisces, Eleotridae) with supporting studies of Retropinna and Galaxias. (Ph.D.)
 Publ: Species composition of whitebait (Galaxias spp.)
 Rec.Canterbury (N.Z.) Mus. 8: 177-179; (1966).
 Growth characteristics, pigmentation, and the identification of whitebait (Galaxias spp., Salmonoidea). N.Z.Jl.mar.Freshwat.Res.2: 162-82; (1968).
 Variation and taxonomic changes in the family Retropinnidae (Salmonoidea). Ibid, 2: 398-425; (1968).

UNIVERSITY OF OTAGO

ZOOLOGY DEPARTMENT

- Parr, P.J. (1949) Observations of Rotatoria in Otago.
(M.Sc.)
- Jolly, V.H. (1955) A Review of freshwater Cladocera in New Zealand. (M.Sc.)
Publ: Observations on the genus Bosmina in New Zealand. *Hydrobiologia*, 5: 309-313; (1953).
- Thompson, J.A. (1955) Saddle Hill Pond. (M.Sc.)
Publ: J.A. Byars - A freshwater pond in New Zealand. *Aust.J.mar.Freshwat.Res.* 11: 222-240; (1960).
- Jolly, V.H. (1959) A limnological study of some New Zealand lakes. (Ph.D.)
Publ: A preliminary study of the limnology of Lake Hayes. *Aust.J.mar.Freshwat.Res.* 3: 74-91; (1952).
Thermal stratification in some N.Z. lakes. *Proc.N.Z.Ecol.Soc.* 4: 43-44; (1957).
Diurnal surface concentrations of zooplankton in Lake Taupo, New Zealand. *Hydrobiologia*, 25: 466-472; (1965).
The comparative limnology of some N.Z. lakes.
1. Physical and chemical. *N.Z.Jl.mar.Freshwat.Res.* 2: 149-161; (1968).
- Chapman, M.A. (1960) Studies on Freshwater Ecology.
Part 1: The ecology of some brackish ponds. Part 2: Freshwater and Terrestrial Ostracods of N.Z.
Publ: The Terrestrial Ostracod of N.Z., Mesocypris audax sp.nov. *Crustaceana* 2: 255-261; (1961).
A Review of the Freshwater Ostracods of N.Z. *Hydrobiologia* 22: 1-40; (1963).
- Marples, T.G. (1962) The plankton of Ardlui Dam. (M.Sc.)
Publ: An interval plankton sampler for use in small ponds. *Ecology* 43: 323-324.
- Duncan, K.W. (1963) The food of the black shag in Otago. (B.Sc.Hons)
Publ: The food and population structure of perch (Perca fluviatilis L.) in Lake Mahinerangi. *Trans.R.Soc.N.Z., Zool.* 9: 45-52; (1967).
The food of the black shag (Phalacrocorax carbo novaehollandiae) in Otago inland waters. *Ibid, Biol.Sci.* 11: 9-23; (1968).
- Don, A.W. (1964) Observations on the life history and linear growth of Microvelia macgregori Kirkaldy (Heteroptera, Veliidae). (M.Sc.)
Publ: Aspects of the biology of Microvelia macgregori Kirkaldy (Heteroptera: Veliidae). *Proc.R.ent.Soc.Lond.(A)*, 42: 171-179; (1967).

- Latta, I.K. (1965) The effect of cover on the trout population of the Waitati River. (B.Sc.Hons.)
- McLay, C.L. (1965) A study of drift in rivers. (B.Sc.Hons.)
 Publ: A study of drift in the Kakanui River.
 Aust.J.mar.Freshwat.Res. 19: 139-150; (1968).
- James, G.D. (1967) The distribution of the fish fauna in the Shag River. (Dip.Sci.)
- Merrilees, M.J. (1967) A study of electivity values of three species of fish. (B.Sc.Hons.)
- Mitchell, S.F. (1967) Primary productivity in Lake Mahinerangi, Lake Waipori and Tomahawk Lagoon. (Ph.D.)
- Barr, G.A.M. (1968) Summer food and feeding habits of trout (Salmo trutta L.) and perch (Perca fluviatilis L.) in Lake Mahinerangi. (B.Sc.Hons.)
- Wong, T.M. (1968) A study of chloride and osmotic regulation in Paranephrops zealandicus (White) in relation to environmental solute concentration. (B.Sc.Hons.)
- Grimmond, N.M. (1968) Observations on growth and age in Hyridella menziesi (Mollusca : Bivalvia) in a freshwater tidal lake. (M.Sc.)
- Nayar, P.K.B. (1968) Zooplankton of Tomahawk Lagoon No. 2. (Dip.Sci.)
- Clark, W.G.D. (1968) Some experiments on the oxygen consumption of brown trout (B.Sc.Hons.)

VICTORIA UNIVERSITY OF WELLINGTON

(These are all M.Sc. theses)

BOTANY DEPARTMENT

- Mather, W.M. (1927) Freshwater algae of the Hutt Valley.
- Moar, N.T. (1949) A study of some mires in the southwest of Wellington Province.
 Publ: Gollans Valley swamp. Bull.Wgtn.Bot.Soc. 23: 10-15; (1950).

ZOOLOGY DEPARTMENT

- McKenzie, M.K. (1937) Embryonic and larval structures of Galaxias attenuatus.

- Stout, V.M. (1952) Hydracarina from Wellington Province.
 Publ: Eylais waikawae n.sp. (Hydracarina) and some features of its life history and anatomy.
 Trans.R.Soc.N.Z. 81: 389-416; (1953).
 New species of Hydracarina with a description of the life-history of two. Ibid, 81: 417-466; (1953).
- McDowall, R.M. (1962) Studies on the biology of the New Zealand freshwater red-finned bully Gobiomorphus huttoni (Ogilby), (Eleotridae).
 Publ: Studies on the biology of the red-finned bully Gobiomorphus huttoni (Ogilby). Part I. Habitat and species interrelationships. Trans.R.Soc.N.Z. Zool. 4: 175-182; (1964).
 Part II. Breeding and life history. Ibid, 5: 177-196; (1965).
 Part III. Food studies. Ibid, 5: 233-254; (1965).
- Mason, J.M. (1963) Studies on the freshwater and terrestrial leeches (Hirudinea) of New Zealand.
- Babington, A.M. (1967) The systematics and ecology of three species of caddis fly larvae in Lake Rotorua.
- Moore, S.G. (1968) A systematic revision of the mayfly genus Deleatidium Eaton (Leptophlebiidae).

BIBLIOGRAPHY OF RECENT LIMNOLOGICAL PAPERS

- Bayly, I.A.E. (1967) The fauna and chemical composition of some athalassic saline waters in New Zealand. N.Z.Jl.mar.Freshwat.Res. 1: 105-117.
- Benzie, V.L. (1968) Consideration of the whitebait stage of Galaxias maculatus attenuatus (Jenyns). N.Z.Jl.mar.Freshwat.Res. 2: 559-573.
- (1968) Stages in the normal development of Galaxias maculatus attenuatus (Jenyns). Ibid, 2: 606-627.
- (1968) The life history of Galaxias vulgaris Stokell, with a comparison with G. maculatus attenuatus. Ibid, 2: 628-653.
- Burnet, A.M.R. (1968) A Study of the Relationships between Brown Trout and Eels in a New Zealand Stream. Fisheries Technical Report No. 26.
- Burnet, A.M.R., Cranfield, H.J. and V.L. Benzie (1969) The Freshwater Fishes, in The Natural History of Canterbury, ed. G.A. Knox: 498-508.
- Dix, T.G. (1968) Helminth parasites of brown trout (Salmo trutta L.) in Canterbury, New Zealand. N.Z.Jl.mar.Freshwat.Res. 2: 363-374.
- Edgar, E. (1968) The New Zealand species of Leptocarpus (Restionaceae). N.Z.J.Botany 6: 467-469.
- Fish, G.R. (1968) An examination of the trout population of five lakes near Rotorua, New Zealand. N.Z.Jl.mar.Freshwat.Res. 2: 333-358.
- Hardy, C.J. (1968) Freshwater Fisheries Field Techniques. Tagging; Transportation; Mortality and Drift Sampling. Fisheries Technical Report No. 27.
- Haughey, A. (1968) The planktonic algae of Auckland sewage treatment ponds. N.Z.Jl.mar.Freshwat.Res. 2: 721-766.
- Hopkins, C.L. (1967) Growth rate in a population of the freshwater crayfish, Paranephrops planifrons White. N.Z.Jl.mar.Freshwat.Res. 1: 464-474.
- Irwin, J. (1968) Observations of temperatures in some Rotorua district lakes. N.Z.Jl.mar.Freshwat.Res. 2: 591-605.
- Jolly, V.H. (1968) The comparative limnology of some New Zealand lakes. I. Physical and chemical. N.Z.Jl.mar.Freshwat.Res. 2: 214-259.
- McDowall, R.M. (1968) The proposed introduction of the large-mouth black bass Micropterus salmoides (Lacépède) into New Zealand. N.Z.Jl.mar.Freshwat.Res. 2: 149-161.
- (1968) Galaxias maculatus (Jenyns), the New Zealand whitebait. Fisheries Research Bulletin No. 2 (New Series).

- McDowall, R.M. (1968) The application of the terms anadromous and catadromous to the Southern Hemisphere Salmonid Fishes. *Copeia*, 1968, No. 1: 176-8.
- (1968) The Status of Nesoglauxias neocaledonicus (Weber & de Beaufort) (Pisces, Galaxiidae). *Breviora*, 5th April 1968, No. 286: 1-8.
- McLay, C.L. (1968) A study of drift in the Kakanui River, New Zealand. *Aust.J.mar.Freshwat.Res.* 19: 139-150.
- Mason, R. (1969) The Vegetation of Freshwaters, in *The Natural History of Canterbury*, ed. G.A. Knox: 452-457.
- Pilgrim, R.L.C. (1967) Argulus japonicus Thiele, 1900 (Crustacea: Branchiura) - a new record for New Zealand (Note). *N.Z.Jl.mar.Freshwat.Res.* 1: 395-398.
- Scott, D. & K.W. Duncan (1967) The function of freshwater crayfish gastroliths and their occurrence in perch, trout, and shag stomachs. *N.Z.Jl.mar.Freshwat.Res.* 1: 99-104.
- Skrzynski, W. (1967) Freshwater fishes of the Chatham Islands. *N.Z.Jl.mar.Freshwat.Res.* 1: 89-98.
- (1968) The Canterbury mudfish, Galaxias burrowsius Phillips, a vanishing species. *N.Z.Jl.mar.Freshwat.Res.* 2: 688-697.
- Stout, V.M. (1969) Life in lakes and ponds, in *The Natural History of Canterbury*, ed. G.A. Knox: 458-470.
- (1969) The invertebrate fauna of the rivers and streams, in *The Natural History of Canterbury*, ed. G.A. Knox: 471-497.
- Vidal, I.L. (1968) An addition to the genus Boeckella (Copepoda) in New Zealand. *N.Z.Jl.mar.Freshwat.Res.* 2: 684-687.
- Woods, C.S. (1968) Growth characteristics, pigmentation, and the identification of whitebait (Galaxias spp., Salmonoidea). *N.Z.Jl.mar.Freshwat.Res.* 2: 162-182.
- (1968) Variation and taxonomic changes in the family Retropinnidae (Salmonoidea). *N.Z.Jl.mar.Freshwat.Res.* 2: 398-425.
- (1968) An improved fish measuring board. *N.Z.Jl.mar.Freshwat.Res.* 2: 678-683.

Correction

We apologise for the incorrect citation of the paper by Winterbourn & Brown (1967) in the bibliography in Newsletter No. 1, which should have read:

Winterbourn, M.J. & T.J. Brown (1967) Observations on the faunas of two warm streams in the Taupo thermal region. *N.Z.Jl.mar.Freshwat.Res.* 1: 38-50.