

Canadian Technical Report of  
Fisheries and Aquatic Sciences 1666

July 1989

RANGE OF VARIATION IN ESTIMATES OF  
DRY WEIGHT FOR PLANKTONIC  
CRUSTACEA AND ROTIFERA  
FROM TEMPERATE NORTH AMERICAN LAKES

by

D.F. Matley, S.G. Lawrence, M.A. MacIver,  
and W.J. Findlay

Central and Arctic Region  
Department of Fisheries and Oceans  
Winnipeg, Manitoba R3T 2N6

This is the 21st Technical Report  
from the Central and Arctic Region, Winnipeg

© Minister of Supply and Services Canada 1989

Cat. no. Fs 97-6/1666E ISSN 0706-6457

Correct citation for this publication is:

Malley, D.F., S.G. Lawrence, M.A. MacIver, and W.J. Findlay. 1989. Range  
of variation in estimates of dry weight for planktonic Crustacea and  
Rotifera from temperate North American lakes. Can. Tech. Rep. Fish.  
Aquat. Sci. 1666: iv + 49 p.

## TABLE OF CONTENTS

	Page
ABSTRACT/RÉSUMÉ . . . . .	iv
INTRODUCTION . . . . .	1
MATERIALS AND METHODS . . . . .	1
Sites and methods of sampling. . . . .	1
Measurements and calculation of dry weight	2
Effect of preservative on calculated dry weight . . . . .	2
Comparison of measurements between workers	3
Statistical analysis . . . . .	3
RESULTS . . . . .	3
Copepods . . . . .	3
Estimated dry weights of individual life stages . . . . .	3
Variation in dry weight with lake stratum and season . . . . .	4
Length-weight relationships . . . . .	4
Cladocerans . . . . .	4
Length-weight relationships . . . . .	4
Rotifers . . . . .	5
Eggs . . . . .	5
DISCUSSION . . . . .	5
Methods of dry weight determination . . . . .	5
Variation in individual dry weight estimates . . . . .	5
Copepods . . . . .	5
Cladocerans . . . . .	5
Rotifers . . . . .	5
Length-weight relationships . . . . .	6
Copepods . . . . .	6
Cladocerans . . . . .	6
Factors affecting dry weight of individuals . . . . .	7
ACKNOWLEDGMENTS . . . . .	7
REFERENCES . . . . .	7

## LIST OF TABLES

Table		Page
1	Physical and chemical parameters of study lakes. . . . .	11
2	Geometric figures and their formulae used to calculate volumes of zooplankters. . . . .	12
3	Rotifer dry weights calculated using formulae given in this paper and those of Ruttner-Kolisko. . . . .	13
4	The effects of two preservatives on two body dimensions and calculated dry weights of cladocerans. . . . .	14
5	Comparison of measurements and calculated dry weights by two workers on adult female <i>Cyclops bicuspidatus thomasi</i> and of <i>Holopedium gibberum</i> . . . . .	16
6	Dimensions and calculated dry weights of life stages of species of calanoid copepods from six lakes. . . . .	17
7	Dimensions and calculated dry weights of life stages of species of cyclopoid copepods from six lakes. . . . .	20

## Table

Table		Page
8	Dimensions and calculated dry weights of Lake 223 organisms sampled from different lake strata or seasons. . . . .	23
9	Length-weight regressions for calanoid and cyclopoid copepods of six lakes . . . . .	24
10	Length-weight regressions for cladocerans of six lakes. . . . .	27
11	Dimensions and calculated dry weights of rotifers from five lakes. . . . .	28
12	Dimensions and calculated dry weights of eggs of copepods, cladocerans and rotifers from several lakes in ELA. . . . .	30
13	Comparisons of dry weights of individuals and eggs of copepods found in temperate North American lakes. . . . .	31
14	Comparisons of dry weights of individuals of cladocerans in temperate North American lakes. . . . .	35
15	Comparisons of dry weights of individuals of rotifers from various sources. . . . .	37
16	Dry weights calculated using regression equations for copepods of representative lengths. . . . .	39
17	Dry weights calculated using regression equations for cladocerans of representative lengths. . . . .	42

## LIST OF FIGURES

Figure		Page
1	Axes of measurements on copepods, cladocerans and rotifers . . . . .	43
2	Length-weight regressions for life stages and groups of life stages of <i>Cyclops bicuspidatus thomasi</i> of ELA Lake 223. . . . .	44

## LIST OF APPENDICES

Appendix		Page
1	Length categories and their average dry weight for cladocerans from two lakes . . . . .	46
2	Individual mean dry weights of crustacean zooplankton species of three Great Lakes . . . . .	48

## ABSTRACT

Malley, D.F., S.G. Lawrence, M.A. MacIver, and W.J. Findlay. 1989. Range of variation in estimates of dry weight for planktonic Crustacea and Rotifera from temperate North American lakes. Can. Tech. Rep. Fish. Aquat. Sci. 1666: iv + 49 p.

Dry weights of individual zooplankters are known to vary from lake to lake, with season, with variability in abundance of food, or from predation and competition. Furthermore, methodological differences in determining weights probably contribute to the variation.

Dry weights calculated from measurements of three body dimensions are reported here for crustaceans and rotifers from four Precambrian Shield lakes in the Experimental Lakes Area in northwestern Ontario, from Clay Lake near Dryden, Ontario and from a prairie pothole lake near Erickson, Manitoba. As well, directly-obtained dry weights are presented for planktonic crustaceans from three Laurentian Great Lakes. Length-weight regressions are presented for copepods and cladocerans. Some new data on the effects of season, lake depth, method of preservation, and on variability of application of our method among technicians are presented.

Ranges of variation in dry weight of individual zooplankters are examined by drawing on these data and on those in the published literature. For each of several cladoceran species, different authors report as large as 10-fold range in weight for individuals of a given length. For copepods, the corresponding range is as high as three-fold.

**Key words:** Cladocera; Copepoda; Calanoida; Cyclopoida; Rotifera; Experimental Lakes Area; Erickson-Elphinstone District; Clay Lake; Lake Huron; Lake Ontario; Lake Superior.

## RÉSUMÉ

Malley, D.F., S.G. Lawrence, M.A. MacIver, and W.J. Findlay. 1989. Range of variation in estimates of dry weight for planktonic Crustacea and Rotifera from temperate North American lakes. Can. Tech. Rep. Fish. Aquat. Sci. 1666: iv + 49 p.

On sait que le poids sec des organismes zooplanctoniques varie d'un lac à l'autre, d'une saison à l'autre, et ce à cause de la variabilité de l'abondance des aliments, ou à cause de la préation et de la compétition. De plus, des différences dans les méthodes de détermination du poids contribuent probablement à cette variation.

On donne dans le présent rapport le poids sec calculé à partir des trois dimensions corporelles pour des crustacés et de rotifères

provenant de quatre lacs du Bouclier précambrien, dans la Région des Lacs Expérimentaux situés dans le nord-ouest de l'Ontario, du lac Clay près de Dryden, dans l'Ontario, et d'une mare de prairie près d'Erickson, au Manitoba. Des poids secs obtenus directement pour des crustacés provenant de trois Grands lacs laurentiens sont aussi présentés. On présente des régressions de longeur-poids pour des copépodes et des cladocères. Le rapport renferme quelques données sur les effets saisonniers, les effets de la profondeur des lacs, la méthode de préservation, ainsi que sur la variabilité de l'application de notre méthode par les techniciens.

Les gammes de variation du poids sec des organismes zooplanctoniques sont établies à partir de ces données et de celles de la documentation publiée. Pour chacune des nombreuses espèces de cladocères, différents auteurs signalent que pour une longueur donnée, le poids varie de 1 à 10 d'un individu à l'autre, alors que pour les copépodes, le poids varie de 1 à 3.

**Mots-clés:** Cladocères; Copépodes; Calanidés; Cyclopidés; Rotifères; Région des Lacs Expérimentaux; District d'Erickson-Elphinstone; lac Clay; lac Huron; lac Ontario; lac Superior.

## INTRODUCTION

Understanding of zooplankton community structure and trophic relationships requires that we know the biomass of individuals at various points in the life cycle. For crustaceans, growth and development can produce large changes in body size over the life cycle. In cladocerans, growth is associated with small developmental changes such that individuals of various ages are not morphologically distinct (direct development). Nevertheless, the oldest individuals weigh 10-20 times as much as neonates. On the other hand, growth in copepods is associated with large developmental changes (indirect development) such that 12 life stages of increasing body size are distinguishable. In rotifers, growth and development produce much less change in body size and morphology.

Our studies therefore focus on instar stage in copepods, body length in cladocerans and at the species level in rotifers. Although growth and development are primary influences on individual biomass, body size at given ages or life stages is influenced by a number of factors including season (Hawkins and Evans 1979; Reed and Aronson 1989), food (Makarewicz and Likens 1979), competition (Hall et al. 1970), lake trophy (Dumont et al. 1975; Bottrell et al. 1976; Yan and Mackie 1987), and fecundity and body fat content (Yan and Mackie 1987).

We examine here the range of variation measured in the dry weights of life stages of zooplankton taxa from freshwater lakes of central and eastern Canada from 1) estimations of dry weight biomass of individual crustaceans from Experimental Lakes Area (ELA) Lakes 224, 227, and 302; from Clay Lake, near Dryden, Ontario; and from Lake 885, near Erickson, Manitoba using the indirect method of Lawrence et al. (1987); 2) from estimations of biomass of individual rotifers from five lakes; 3) examination of unpublished data on biomass of crustaceans from the Laurentian Great Lakes; and 4) reference to the published literature. The ELA data presented are based on material preserved in a final concentration of 4% formalin. We report effects of two preservatives on estimates of the dry weight biomass of cladocerans of ELA lakes 224 and 239 and we present preliminary data on the effects of season and of lake depth on the dry weight biomass of copepods.

## MATERIALS AND METHODS

### SITES AND METHODS OF SAMPLING

Naturally oligotrophic Lakes 223, 224, 226, 227, 239 and 302 are located on the Precambrian Shield in the ELA, northwestern Ontario (Table 1). Lake 223 has been experimentally acidified beginning in 1976. Although trace amounts of six radioactive metals were added to Lake 224 in 1976, it has not otherwise been chemically altered. It serves as a reference lake for whole lake experiments. Lake 226 is a double-basin lake divided by a sea curtain

into northeast and southwest basins. The northeast basin received additions of P, N and C, and the southwest basin, N and C, from 1973 to 1980. Lake 227 has been artificially enriched with N and P each year since 1969. The watershed of unmanipulated reference Lake 239 has been affected by forest fire and blowdown. The two basins of Lake 302 were separated by a curtain. The north basin (302N) was then subjected to additions of C, N and P for several years (Schindler et al. 1980b). When the barrier between north and south basins was removed, chemical variables of the north basin returned to pre-manipulation values within two years. In 1980, the basins were again separated by a curtain, and sulphuric acid was added to 302S from 1982 to the present. Nitric acid was added to 302N from 1982 to 1987 and, subsequently, hydrochloric acid was added from 1987 to the present.

Clay Lake, a riverine lake in the English-Wabigoon River system of northwestern Ontario, was industrially contaminated with mercury (Table 1). Lake 885 is a saline, hypereutrophic prairie pothole lake, without inflow or outflow located south of Riding Mountain National Park in southwestern Manitoba (Table 1). It contains no endogenous fish but was stocked with rainbow trout fingerlings annually from 1974 to 1979.

Zooplankton sampling methods for ELA lakes are described by Chang et al. (1980, 1981, 1983) and Lawrence and Holoka (1987). Impoundments in Lake 223 (10 m diameter, 2 m depth) were sampled by net (Lawrence 1980). Clay Lake and large impoundments in that lake were sampled by Patalas-Schindler trap as described in Lawrence and Holoka (1983). Lake 885 was sampled using a modified Pennak sampler as described in Salki (1981). Unless otherwise indicated, zooplankton samples used in this study from Lakes 223, 224, 226, 227, 239, 302, Clay Lake, and Lake 885 were preserved in a final concentration of 4% formalin.

Zooplankton samples from Lake 223 for measurement of individuals were selected from those taken during the ice-free season from the open lake, prior to acidification in 1974, and during acidification, 1978 and 1980. Impoundments in Lake 223 were sampled only in summer, 1978 (Lawrence 1980). The zooplankton measured from Lake 224 were sampled during 1975 to 1978. Zooplankton from Lake 227 were selected randomly with respect to season, depth and year, 1974 to 1978, in order that single average dry weight estimates could be applied to a given species or life stage uniformly over all sampling dates and locations. Zooplankton taken from Lake 302 and 40 L impoundment vessels incubated in Lake 302 were from the ice-free seasons of 1981 and 1983 (Lawrence and Holoka 1987). Measurements were made on the zooplankton of Clay Lake taken from populations inside and outside of impoundments between May and September 1978 (Lawrence and Holoka 1983). Specimens from Lake 885 were collected from the lake and from populations impounded in 20 L semi-continuously flowing systems between 6 and 21 June 1979. Since the time span was narrow, certain life phases did not appear.

Species composition of the zooplankton communities of Lakes 223, 224, 226, 227, and 239 were described by Patalas (1971), Malley and Chang (1980), Malley et al. (1982), Chang et al. (1983) and Malley et al. (1988). The crustacean zooplankton communities of Lake 302, Clay Lake and Lake 885 were described by Ramsey (1985), Lawrence and Holoka (1983) and Salki (1981), respectively. Rotifers were identified using Chengalath et al. (1971), Ruttner-Kolisko (1974) and Ward and Whipple (1959). Rotifers were rare in Lake 885 at the time of sampling and were not measured.

#### MEASUREMENTS AND CALCULATION OF DRY WEIGHT

Measurements were made to the nearest 0.008 mm with an ocular micrometer along the three principal axes of individuals, i.e. length (anterior-posterior), width (lateral), and depth (dorsoventral) (Fig. 1) using a Zeiss binocular microscope at magnifications of 31 to 200X (Lawrence et al. 1987). In general, appendages such as setae or spikes were not measured but formulae were adjusted to take bulky appendages into account. Individual species of cladocerans and rotifers were measured. Copepod life stages were each measured separately for the various species. Eggs of some species were measured.

A simple geometric figure (Table 2) was judged to approximate the shape of each species or life stage as observed under the microscope. The volumes of these shapes for crustaceans and rotifers were calculated using measured dimensions, converted to wet weight by assuming that 1 mm<sup>3</sup> weighs 1 mg, and thence to dry weight assuming the latter to be 7% of live weight for all species, except for Asplanchna sp., for which the conversion factor was 4% (Dumont et al. 1975).

Measurements were taken on up to 150 randomly-selected organisms of a species or life stage and the biomass of each organism was calculated using the geometric formulae. As described by Lawrence et al. (1987), the formulae were adjusted, if necessary, to agree with directly determined dry weights of adult copepods and cladocerans. For example, Daphnia longiremis, from Lake 302, not discussed in Lawrence et al. (1987), was assigned an initial formula of  $4/3\pi abc$ . This resulted in a ratio of actual dry weight to calculated dry weight of 0.66. The agreement was improved to a ratio of 0.94 by modifying the formula for this organism to  $4/3\pi a0.7bc$ . The formulae in Table 2 include the adjusted formulae (B to I).

Expression of body shape as a geometric figure was previously done by Ruttner-Kolisko (1977) for rotifers. The formulae we use to calculate rotifer biomass are generally less complex than those of Ruttner-Kolisko in that they do not include separate calculations for appendages. In Table 3 we show that the dry weights we calculate using our formulae are very similar to those calculated from Ruttner-Kolisko's formulae excluding the calculations of the volumes of appendages.

#### EFFECT OF PRESERVATIVE ON CALCULATED DRY WEIGHT

Lawrence et al. (1987) hypothesized that the discrepancy between calculated dry weight and measured dry weight for cladocerans was due to distortion upon preservation. Haney and Hall (1973) showed that Daphnia preserved in sugar-formalin were significantly less wide than those preserved in formalin.

To test the effect of two preservatives on body dimensions of cladocerans, some zooplankton samples taken from Lake 226 (NE and SW basins) and Lake 239 were preserved in the field in a final concentration of 5 to 10% formalin while others were preserved in sugar-formalin (final concentration 26-50 g · L<sup>-1</sup> sugar in 5 to 10% formalin). Length, width and depth were measured on individuals of three cladoceran species and weight was calculated according to formula H (Table 2). To examine if width, depth, or calculated dry weights were affected by the preservative, we used analysis of covariance to test for differences between preservatives in length-width, length-depth and length-weight relationships. We assumed that organism length was not differentially altered by the two preservatives. Mean lengths of organisms in the two treatments were compared by analyses of variance to determine whether the populations of organisms sampled differed in mean length.

The width and, consequently, the calculated weights for D. retrocurva were lower by 14 to 24% in sugar-formalin than in formalin alone (Table 4). The difference in weight due to preservative was greater for the small D. retrocurva (36% lower) than for the large (13% lower). For D. galeata mendotae both widths and depths were lower in sugar-formalin resulting in 28% lower overall weight in the latter preservative. Again the difference was greatest for the smaller organisms.

Generally, the dimensions of Diaphanosoma birgei and the calculated weights were not affected by preservative. Bosmina longirostris had lower width and depth in sugar-formalin and this generally resulted in lower calculated weight in this preservative.

Thus, our data confirm the finding of Haney and Hall (1973) that sugar-formalin significantly reduces the width dimension of daphnids. The gaping of the carapace, associated with preservation in formalin, causes the volume and the calculated weight to be overestimated (Lawrence et al. 1987). However, the decrease in volume associated with reduced gaping in sugar-formalin is not sufficient to reduce calculated dry weights to the observed dry weight. The empirical correction factors used by Lawrence et al. (1987) are generally larger than the proportion attributable to gaping alone. It is important to note that the formulae reported in Table 2 are valid for formalin-preserved Daphnia and Bosmina and not for those preserved in sugar-formalin.

## COMPARISON OF MEASUREMENTS BETWEEN WORKERS

Since calculated biomass is dependent upon the accuracy of measurement, measurements made on the same specimens by two workers were compared. The two workers measured the same 10 specimens of each of *Cyclops bicuspidatus thomasi* and *Holopedium gibberum* (Table 5). There were few significant differences in average measurements and calculated dry weight between the two workers. The measurements of one worker were not consistently larger or smaller than those of the other. There appears to be variability in weight estimates due to inaccuracies in the process of measuring but little worker bias.

## STATISTICAL ANALYSIS

Dimensional data were analyzed by standard statistical methods. To compare dry weights of organisms taken from different lake depth strata or season, we used analysis of variance.

Lengths and calculated weights were transformed by using natural logarithms to normalize the distributions and reduce inequality among variances (Persson and Ekbohm 1980; Prepas 1984).  $\ln w$  dry weight of the zooplankters was regressed against  $\ln L$  length according to the equation:

$$\ln w = \ln a + b \ln L$$

where  $\ln w$  is the natural logarithm of the dry weight in  $\mu\text{g}$ ;  $\ln a$  is an estimate of the y-intercept;  $b$  is an estimate of the slope; and  $\ln L$  is the log-transformed length measurement in mm. Confidence limits around the slope, residual mean squares, and the variance of  $\ln L$  were calculated according to standard linear regression methods. Slopes of regressions were considered to be significantly different if their confidence intervals did not overlap.

Once the regression equation has been prepared for a species or life stage, it can in turn be used to calculate average dry weight from a mean of log-transformed length ( $\bar{\ln} L$ ) according to McCauley (1984):

$$\ln w = \ln a + b \bar{\ln} L$$

To do this, Persson and Ekbohm (1980) and McCauley (1984) suggest using calculations to avoid the bias which accompanies the conversion of the average  $\ln w$  to weight in arithmetic units. Bird and Prairie (1985), however, evaluated this use of  $\bar{\ln} L$  and found that weight may be significantly underestimated. They suggest that the  $\ln w$  of each  $\ln L$  be obtained, that these values be transformed to arithmetic units using their equation to avoid bias, and that the arithmetic weight be averaged to obtain a mean weight.

Statistical significance was accepted at the  $P = 0.05$  level.

## RESULTS

### COPEPODS

#### Estimated dry weights individual life stages

The dimensions and calculated weights of calanoid copepods of the genus *Diaptomus* and of *Epischura lacustris* are reported in Table 6. *Diaptomus minutus* occurred in five of the six lakes whereas *D. oregonensis* occurred only in Clay Lake, *D. sicilis* only in Lake 224, and *D. siciloides* only in Lake 885. Where adults of only one species of calanoid were present in a sample, nauplii in that sample were designated as that species. However, most samples contained more than one species of calanoid, including occasionally the large predator, *E. lacustris*. Therefore, in Table 6, nauplii from Lake 224 represent more than one *Diaptomus* species and from Lake 227 are *D. minutus* with a few *E. lacustris*.

For all life cycle stages, weights of *D. minutus* from Lakes 223 and 302 are approximately the same. The copepodid stages of *D. minutus* from Lake 227 are generally heavier than those from Lakes 223 and 302. For all life stages, the weight estimates for *D. oregonensis* of Clay Lake and *D. siciloides* of Lake 885 are similar to each other. The calculated weight estimates for *E. lacustris* from Lakes 227 and 302 (though based on relatively few organisms) are generally similar. With the exception of one life stage, however, *E. lacustris* of Lake 223 are much heavier than those in the other lakes.

The dimensions and calculated weights of cyclopoid copepods are presented in Table 7. *Cyclops bicuspidatus thomasi* occurred in all study lakes. *Tropocyclops prasinus mexicanus*, the smallest of the copepods, occurred in all except Lake 885 and *Mesocyclops edax* occurred in all lakes except Lake 224. *Cyclops vernalis* occurred in Lake 302, Clay Lake and rarely in Lake 885. As for calanoids, where possible, the nauplii in Table 7 are identified to species. Variability between the weights of unspecified cyclopoid nauplii and copepodids reflects different mixtures of species. A large difference in size is always evident between female and male (F,M) adults. F:M biomass ratios range from 5.2 in *M. edax* (Clay Lake) to 1.7 in *T. p. mexicanus* (Lake 224) (Table 7). With the exception of adult females, the estimated weights for *C. b. thomasi* of Lakes 223 and 885 are similar. The weights of adult *C. b. thomasi* of Clay Lake are very similar to those of Lake 223. The mature and immature copepodids of *C. b. thomasi* from Lakes 224 and 227 are similar in weight. The weights of adults of this species from Lake 302 are very much lower than those from the other study lakes. All life stages of *T. p. mexicanus* found in Clay Lake are heavier than these organisms in ELA lakes. The copepodids of this species in Lakes 223 and 227 are similar in weight to each other but heavier than those in Lakes 224 and 302, which, in turn, are similar to each other. The weights of mature and immature copepodids of *M. edax* are not always similar among lakes. The adults of this species in Clay Lake and Lake 885 are up to four times heavier than those in ELA lakes.

### Variation in dry weight with lake stratum and season

Dimensions and calculated weight of D. minutus in Lake 223 varied with the depth stratum from which the organism was sampled (Table 8). Organisms sampled from the epilimnion always weighed significantly less than those sampled at the same time from the hypolimnion.

The weight of C. b. thomasi varied greatly with season, particularly for females (Table 8). Similarly, D. minutus taken in May weighed less than those taken in October (Table 8).

### Length-weight relationships

Generally, copepods have length:weight regressions with slopes between 2 and 3, as expected. Exceptions are those for some adult cyclopoids where slopes were between 4 and 5, and for adult D. minutus of some lakes, where slopes are below 2 (Table 9). Figure 2 shows length-weight regressions for each life stage and for combinations of life stages of C. b. thomasi. As seen in Fig. 2A showing each naupliar stage, the regression coefficients based on organisms over a short length range are variable (1.2 to 4.1). However, the regression equation based on combined N1 to N6, has a slope of 2.2, within the range of expected values. This effect of range of length is seen also in Fig. 2B for copepodids C1 to C5. Figure 2C shows that slopes above 3 for cyclopoid adults are due to an artifact from calculating a single regression through weights of both female and male organisms. As indicated in Fig. 2C, the slopes for each of females and males are lower than for the two sexes together. In Fig. 2D, the relationship for copepodids C1 to C6 has a slope of 2.5 compared with that for C1 to C5 of 2.6 and for adults of 4.1. The overall slope for N1 to C6 (Fig. 2E) is only 1.95. This low slope is an artifact of forcing a single regression line through two distinct data sets, separated by a gap in organism length. The separation is due to the metamorphosis from N6 to C1 which involves a rapid increase in organism length without a proportionate increase in weight.

The length-weight regression equations for some species, e.g. M. edax and C. b. thomasi, do not vary among lakes. Regressions calculated for some stages of T. p. mexicanus, are similar among lakes, but for other stages are very different. For example, regressions for the nauplii of T. p. mexicanus, and for copepodids are very similar between Lakes 227 and Clay Lake, but those of adults and other life stage combinations are different between the two lakes. Regressions for different cyclopoid species are not generally similar to one another.

The regression equations for D. minutus are similar among lakes for immature copepodids, immature copepodids plus adults and for all stages together, but not for nauplii or adults alone. The regressions for D. oregonensis and D. siciloides are similar to each other, but different from those for D. minutus. The equations for E. lacustris differ from those of other calanoids and from lake to lake.

### CLADOCERANS

Of the twelve cladoceran species in the lakes examined, Diaphanosoma birgei (D. brachyurum in Chang et al. 1980, 1981, 1983) and Bosmina longirostris occurred in all except Lake 885. In the latter lake, the only prominent cladoceran was Daphnia schoedleri. Daphnia galatea mendotae, from Lake 223 in our study, may be a mixture of D. g. mendotae and D. dubia. Chydorus sphaericus (actually a mixture of littoral chydorid species) occurred sporadically in pelagic samples from Lake 227 (Chang et al. 1980), 224 (Chang et al. 1983) and 302 (Lawrence and Holoka 1987).

### Length-weight relationships

Length-weight relationships calculated for species of cladocerans from the three geographical areas are given in Table 10. The slopes of these regressions are near 3 except for Holopedium gibberum in Lakes 223 and 302 for which slopes are more variable.

A regression based on 70 D. g. mendotae of Lake 223 in 1978 including neonates, females, males, and egg or embryo-bearing females is not different from the regression for 43 females excluding neonates and egg-bearing individuals (Table 10). A regression based on 76 D. g. mendotae in Lake 223 in 1974 of mixed age, sex and reproductive status is virtually identical with the latter two. Thus, presence of eggs and males has little influence on the regression. The slopes of the regressions for this species are similar regardless of lake, but the y-intercepts for organisms from Lake 224 and Clay Lake differ from each other and from those of Lake 223.

The regressions for D. longiremis of Lake 302 and D. g. mendotae of Clay Lake are similar. The slopes of regressions for D. retrocurva of Lake 227 and Clay Lake are the same, but the y-intercepts differ. The regressions for D. retrocurva of Lake 227 and D. g. mendotae of Lake 224 are very similar to each other. The regression for D. schoedleri of Lake 885 does not resemble that for any other daphnid. The regressions for D. birgei of Lake 223 and for directly weighed D. birgei are the same. The slopes of the regressions for D. birgei from all the lakes are similar to each other and resemble those of the Daphnia species, but the y-intercepts may vary.

Regressions for B. longirostris of Lakes 224, 227 and Clay Lake and for C. sphaericus of Lake 223 are very similar. The regressions for B. longirostris of the two year classes of Lake 302 are similar, but they do not resemble any of the other regressions for this organism.

Regressions for H. gibberum are based on several different geometric formulae (Table 10). The two regressions for Lake 302 are similar and resemble that for Lake 223 organisms < 1 mm long. Regressions for Lake 223 organisms do not resemble those from Lake 227.

## ROTIFERS

Dimensions, formulae and calculated dry weights of rotifers of ELA Lakes 223, 224, 227, and 302 and of Clay Lake are presented in Table 11. *Keratella cochlearis* from Clay Lake are estimated to be four times heavier than those taken from the ELA lakes. Otherwise, individual species vary very little in biomass from lake to lake, except for *Synchaeta*, *Ascomorpha* and *Asplanchna*, where the differences among lakes could be due to the presence of different species.

## EGGS

The average dimensions and calculated biomass of eggs of organisms taken from several ELA lakes are given in Table 12. The eggs of rotifers weigh 25-35% of the adult body weight. Eggs of copepods are 1% or less of adult female weight. The eggs of calanoids are larger than those of cyclopoids even for equal-sized females. The eggs of cladocerans are approximately 10% of the estimated weight of mature females except for those of *H. gibberum* which are only about 1% of the body weight of the female.

## DISCUSSION

### METHODS OF DRY WEIGHT DETERMINATION

Several techniques have been used for the determination of dry weight biomass of zooplankton individuals. The first is drying and direct weighing of organisms, individually or in groups (Richman 1958; Burns 1969; Doohan and Rainbow 1971; Dumont et al. 1975; Pederson et al. 1976; Persson and Ekbohm 1980). Frequently, the organisms are measured (usually the length) before drying in order to calculate dry weight-length regressions (reviewed in Bottrell et al. 1976 and McCauley 1984) which subsequently can be used to estimate the biomass of organisms of known length. Occasionally, the dry weights of large numbers of organisms are averaged. This may be satisfactory for copepods of like life stage and sex or for rotifers but is not useful for cladocerans.

Secondly, volume of organisms may be estimated and converted to wet- or dry-weight biomass (Nauwerck 1963; Ruttner-Kolisko 1977; Bottrell et al. 1976; Pace and Orcutt 1981; Lawrence et al. 1987). Usually volume is estimated by equating the organism to a common geometric shape, the volume of which is calculated using measured axial dimensions. These weight estimates also may be regressed against length. Calculation of volume from geometric shapes had been used primarily for rotifers until it was extended to crustaceans by Pace and Orcutt (1981). In a third method, volume is measured by displacement of scale models of zooplankton individuals (Lewis 1979).

## VARIATION IN INDIVIDUAL DRY WEIGHT ESTIMATES

### Copepods

Our directly-obtained and calculated dry weights for species of copepods are generally within the range of values found by other workers for these organisms from other temperate North American lakes (Table 13). There are some exceptions. Our estimates for naupliar *D. minutus* are an order of magnitude less than those for organisms from Clear Lake, Ontario (Schindler and Novén 1971). Adult male and female *D. sicalis* from Lake 224 are only one-quarter and one-half the weight, respectively, of weights reported in the literature. Male and female *C. b. thomasi* from Lake 302 are very much smaller and lighter in weight than those from other ELA lakes and from the literature. The *M. edax* of Lake 885 appear to be much larger than reported elsewhere except for those found in a pond in New York State by Hall et al. (1970). The weights for *D. minutus* reported by Roff and Kwiatkowski (1977) are about 2 to 5 times greater than our values or those of other workers.

### Cladocerans

The calculated biomass estimates of species of cladocerans from our lakes fall, with a few exceptions, within ranges found for these organisms in other North American temperate lakes (Table 14). The calculated weights for our very small *B. longirostris* are below the range of other published estimates for this organism, although the upper end of our range is generally similar to that of others. The lower limit of the weight range for *D. retrocurva* in our lakes is much lower than those for Lake Erie (Culver et al. 1985) or Lake Michigan (Hawkins and Evans 1979). The upper limit of our weight range of calculated values for *D. birgei* is much greater than reported ranges. Five organisms out of 408 were greater than 1.2 mm in length. If these five are omitted, the range of weight is reduced to 0.56 to 9.5 µg, closer to other published ranges.

### Rotifers

Biomass of rotifers is most often calculated from geometric values but occasionally rotifers are dried and weighed. Our calculated values generally fall within the ranges of values published by other workers (Table 15). There are some exceptions. *Gastopus stylifer*, *Kellicottia bostoniensis* and *K. taurcephala* in ELA lakes are lighter than those in other lakes. *Keratella hiemalis* and *Trichocerca cylindrica* in ELA lakes are much heavier than in other lakes. Rotifer biomass may be affected by the trophy of the lakes from which they are taken. Lake Erken in Sweden is described as naturally eutrophic (Nauwerck 1963) and Clay Lake in Ontario is mesotrophic (J. Rudd, Freshwater Institute, pers. comm.). The rotifers from these lakes tend to be larger than those from the oligotrophic lakes of ELA, e.g., comparison between *G. stylifer* and *A. priodonta* in Lake Erken and ELA lakes; *K. cochlearis* in Clay Lake and ELA lakes (Table 15).

## LENGTH-WEIGHT RELATIONSHIPS

### Copepods

As animals grow, weight increases approximately as the length cubed (Peters 1983). Furthermore, length-weight regressions calculated for a population of a species are expected to have a slope of about 3. The average slope of length-weight regressions for a wide variety of animal species reported by Peters (1983) is 2.83 ( $N = 21$ ,  $S.D. = 0.81$ , median = 2.98, range = 2.0 to 3.45).

Several factors can cause the slope of the regression to deviate from the theoretical maximum value of 3. Nauplii and copepodids show different patterns of growth (Lawrence et al. 1987). With development, nauplii tend to elongate faster than they grow in the other two dimensions and therefore have lower regression slopes than do copepodids which tend to grow more or less proportionately in three dimensions (Table 9, Regressions 39, 40 vs 51 to 55). This is also shown in Fig. 2A vs 2B.

A second feature of copepod growth is a dramatic elongation at the metamorphosis from N6 to C1. This can be seen in Fig. 2E. As a consequence, the regression equations calculated for nauplii and copepodids together have a lower slope than for either nauplii or copepodids alone (Table 9, Regressions 106 to 108).

Figure 2C shows an increase in slope with combining of the sexes. Females and males exhibit different growth rates. The slope of the regression for combined sexes (Table 9, Regression No. 69) is greater than that for either sex (Fig. 2, C6F, C6M). The large slope of C5 (Fig. 2B) is also the result of combining females and males.

Spurious deviations from a slope of 3 occur when the length range is very small. Figure 2 shows highly variable regression slopes for individual naupliar and copepodid stages.

Therefore, to use the equations in Table 9 to calculate dry weight for organisms of known length and life stage, we recommend that either the equations for "nauplii" (Regression No. 1 to 6, and 39 to 50) and for "copepodids + adults" (Nos. 27 to 34; 89 to 105) be used. However, if organisms have only been measured and have not been identified to life stage, then the "all life stages" (No. 35 to 38; 106 to 115) may be used.

Table 16 shows the results of using various equations from Table 9 for organisms of selected lengths. For example, weight of *D. minutus* of Lake 223 of 0.7 mm length is calculated to be 1.098  $\mu\text{g}$  using the "copepodids" regression (No. 7), 1.118  $\mu\text{g}$  using the "adults" regression (No. 16), 1.086  $\mu\text{g}$  using the "copepodids + adults" regression (No. 27), or 1.191  $\mu\text{g}$  using "all life phases" regression (No. 35). The range of these estimates is 9% of their mean. For *C. b. thomasi* of Lake 223, the range of estimates using various life stage regressions for an organism of 1.0 mm length is 25% depending upon the regression equation used (Table 16).

There are differences for a species depending upon the lake for which the regression was calculated (Table 16). For example, weights of *C. b. thomasi* of 1.0 mm length calculated from "copepodid + adult" regressions varied from 2.2 to 2.3  $\mu\text{g}$  in ELA lakes to 2.5  $\mu\text{g}$  in Lake 885 and to 5.7  $\mu\text{g}$  in Lake Erie.

From Table 16, the differences in body size among species are clearly seen. *Tropocyclops mexicanus* adults are short and lightweight, whereas *E. lacustris* are longer and heavier. Effects of variation in body shape among species can also be seen on weight estimates. For example, weights calculated from the "copepodid + adult" regressions for *C. b. thomasi* of 0.5 mm length, are lighter than *E. lacustris*, *D. siciloides* and *M. edax*.

Pace and Orcutt (1981) obtained a regression for *D. siciloides* from eutrophic Lake Oglethorpe which is virtually identical to the one we obtained for that species from hypereutrophic Lake 885. Weight estimates for *C. b. thomasi* copepodids of a given length from Lake Erie using the equations of Culver et al. (1985), are up to three times higher than ours. Of the equations generated by Culver et al. (1985) for copepods of Lake Erie, only that for *C. vernalis* resembles those formed for organisms from our lakes. Those workers usually calculated regressions for female copepodids whereas ours are based on male and female organisms.

### Cladocerans

Regression equations for some cladoceran species are similar; however, not all equations for a given species are the same from lake to lake (Table 10). Organisms from Lake 224 are slightly lighter, and those of Clay Lake two times heavier, for a given length, than those of Lake 223 (Table 17).

In general, *D. birgei* have similar regressions to *D. g. mendotae* and within the common length ranges produce similar weight estimates (Table 17). Culver et al. (1985) observed similarity between these two species in a study of Lake Ontario and Lake Erie organisms. The equation for *D. schoedleri* of Lake 885 resembles that for organisms of Lake Danard (Hayward and Gallup 1976); the weights produced for common lengths (Table 17) are 23-27% different. The range for *D. schoedleri* of Lake 885 is larger on both upper and lower ends than that from Lake Danard (Hayward and Gallup 1976), although, within the common range of lengths, the weights are in general agreement (Table 17). The equation for *D. schoedleri* of Lake Danard more closely resembles that of *D. longiremis* of Lake 302. If weights are estimated for *C. sphaericus*, *B. longirostris*, *D. g. mendotae* and *D. birgei*, using the regressions reported by Culver et al. (1985), the resulting weights are up to 10 times higher than the weights we calculate for individuals of the same lengths using our regressions (Table 17).

The regressions for *B. longirostris* fall into four groups: Lake 223, Lake 223 impoundments, Lake 302 (which resembles that of *D. g. mendotae* of Clay Lake), and Lakes 224, 227 and

and Clay Lake (which resemble those of C. sphaericus of Lake 223 and small H. gibberum of Lake 227).

Equations for H. gibberum are generally different from one another. Intercomparisons of regressions for Holopedium produce weight estimates for a common series of lengths which differ by more than two times (Table 17). Equations produced by Yan and Mackie (1987) for this species resemble those for Lake 223 organisms (using formula E, Table 2, for weight calculations). However, as seen in Table 17, the weight estimates for individuals of a given length vary greatly depending upon the length-weight regression used. Yan and Mackie (1987) have shown that simple length-weight regressions can predict the weights of Holopedium on a lake-to-lake basis, but that consideration of clutch size and a body fat index significantly improved estimates of dry weight.

#### FACTORS AFFECTING DRY WEIGHT OF INDIVIDUALS

Adult C. b. thomasi of six lakes provide an example of large variation in average dimensions and dry weight with life stage within a single species (Table 7). Part of this variation is the result of seasonal variation as seen in C. b. thomasi from Lake 223 (Table 8) and from Lake Michigan (Hawkins and Evans 1979). According to Warren et al. (1986), seasonal change in copepod size is governed primarily by temperature, and secondly by seasonal predation by young-of-the-year fish. Reed and Aronson (1989) also found that total lengths of copepodids of C. b. thomasi varied with water temperature. Diaptomus minutus males and females of Lake 223 undergo a less pronounced variation in size with season (Table 8). As Hawkins and Evans (1979) found in Lake Michigan organisms, weight is high in early spring and late fall, and low in summer.

There are also lake to lake differences not attributable to season. Samples of C. b. thomasi from both Lakes 302 and 885 were taken in late spring but are very different in mean size and weight. Lake trophy may be a factor. Lake 302 is oligotrophic, and Lake 885 is hyper-eutrophic. Carter et al. (1983) reported an influence on body length of adult female D. minutus of Secchi depth and true water colour of the lake water. They hypothesized that less transparent waters provide a measure of protection against visually feeding fish predators, thereby favouring slightly larger adults.

Lake trophy and manipulation affect the weight per unit length of cladocerans (Table 17). The B. longirostris of 0.4 mm length from experimentally eutrophied Lake 227, and mesotrophic Clay Lake are about twice as heavy as those of oligotrophic Lakes 223 and 302. Organisms obtained from an impoundment in Lake 223 are about 50% heavier than those taken from the open lake at the same time. The D. g. mendotae in mesotrophic Clay Lake are about two times heavier than those found in oligotrophic ELA lakes. The same trend is seen in H. gibberum of oligotrophic Lake 223 and eutrophic Lake 227.

In summary, though we do not understand well the basis of body size variation in organisms within and between lakes, several factors can be invoked, e.g., climate, food source, predation, competition, season and lake morphometry and trophy. As well there may be genetic variation in life history parameters. Wyngaard (1986) has reported that there is a genetic component in the variation in body size of M. edax from two geographical locations.

#### ACKNOWLEDGMENTS

Zooplankton samples from Lakes 302 and 885 as well as some from Lake 223 were obtained by Morris Holoka. Samples from Clay Lake were collected by Bruce Townsend and Morris Holoka. The field personnel of ELA have collected samples from various lakes for more than 20 years, and we are grateful for their assistance, especially that of John Penny and Dana Cruikshank. Measurements of some organisms were done by Irene Delbaere. We are grateful to Ves Blouw for preparing the figures, and to Phyllis Cassidy for her patience in preparing a complicated manuscript for publication.

#### REFERENCES

- ARMSTRONG, F.A.J., and A.L. HAMILTON. 1973. Pathways of mercury in a polluted northwestern Ontario lake, p. 131-156. In P.C. Singer (ed.) Trace metals and metal-organic interactions in natural waters. Ann Arbor Science Publishers, Ann Arbor, MI.
- ARMSTRONG, F.A.J., and D.W. SCHINDLER. 1971. Preliminary chemical characterization of waters in the Experimental Lakes Areas, northwestern Ontario. J. Fish Res. Board Can. 28: 171-187.
- BARICA, J. 1975. Geochemistry and nutrient regime of saline eutrophic lakes in the Erickson-Elphinstone District of southwestern Manitoba. Can. Fish. Mar. Serv. Tech. Rep. 511: 82 p.
- BERMAN, T., U. POLLINGHER, and M. GOPHEN. 1972. Lake Kinneret: planktonic populations during seasons of high and low phosphorus availability. Int. ver. theor. angew. Limnol. Verh. 18: 588-598.
- BIRD, D.F., and Y.T. PRAIRIE. 1985. Practical zooplankton length-weight regression equations. J. Plank. Res. 7: 955-960.
- BOTTRELL, H.H., A. DUNCAN, Z.M. GLIWICZ, E. GRYGIEREK, A. HERZIG, A. HILLBRICHT-ILKOWSKA, H. KURASAWA, P. LARSSON, and T. WEGLENSKA. 1976. A review of some problems in zooplankton production studies. Norw. J. Zool. 24: 419-456.

- BRUNSKILL, G.J., and D.W. SCHINDLER. 1971. Geography and bathymetry of selected lake basins, Experimental Lakes Area, northwestern Ontario. *J. Fish. Res. Board Can.* 28: 139-155.
- BURNS, C.W. 1969. Relation between filtering rate, temperature, and body size in four species of *Daphnia*. *Limnol. Oceanogr.* 14: 693-700.
- CARTER, J.C.H., W.G. SPRULES, M.J. DADSWELL, and J.C. ROFF. 1983. Factors governing geographical variation in body size of *Diaptomus minutus* (Copepoda, Calanoida). *Can. J. Fish. Aquat. Sci.* 40: 1303-1307.
- CHANG, P.S.S., D.F. MALLEY, I.L. DELBAERE, and G. MUELLER. 1981. Species composition and seasonal abundance of zooplankton in Lake 223, Experimental Lakes Area, northwestern Ontario: before and during acidification, 1974-1979. *Can. Data Rep. Fish. Aquat. Sci.* 290: iv + 42 p.
- CHANG, P.S.S., D.F. MALLEY, W.J. FINDLAY, G. MUELLER, and R.T. BARNES. 1980. Species composition and seasonal abundance of zooplankton in Lake 227, Experimental Lakes Area, northwestern Ontario, 1969-1978. *Can. Data Rep. Fish. Aquat. Sci.* 182: iv + 101 p.
- CHANG, P.S.S., D.F. MALLEY, W.J. FINDLAY, and G. MUELLER. 1983. Species composition and seasonal abundance of zooplankton in Lake 224, Experimental Lakes Area, northwestern Ontario, 1974-1978. *Can. Manuscr. Rep. Fish. Aquat. Sci.* 1720: iv + 51 p.
- CHENGALATH, R., C.H. FERNANDO, and M.G. GEORGE. 1971. The planktonic Rotifera of Ontario with keys to genera and species. *Univ. Waterloo Biol. Ser.* 2: 40 p.
- CLEUGH, T.R., and B.W. HAUSER. 1971. Results of the initial survey of the Experimental Lakes Area, northwestern Ontario. *J. Fish. Res. Board Can.* 28: 129-137.
- COMITA, G.W. 1972. The seasonal zooplankton cycles, production and transformations of energy in Severson Lake, Minnesota. *Arch. Hydrobiol.* 70: 14-66.
- COMITA, G.W., and S.J. MCNETT. 1976. The postembryonic developmental instars of *Diaptomus oregonensis* Lilljeborg, 1889 (Copepoda). *Crustaceana* 30: 123-163.
- CRUIKSHANK, D.R. 1984. Whole lake chemical additions in the Experimental Lakes Area, 1969-1983. *Can. Data Rep. Fish. Aquat. Sci.* 449: iv + 23 p.
- CULVER, D.A., M.M. BOUCHERLE, D.J. BEAN, and J.W. FLETCHER. 1985. Biomass of freshwater crustacean zooplankton from length-weight regressions. *Can. J. Fish. Aquat. Sci.* 42: 1380-1390.
- DOOHAN, M. 1973. Energetics of plankton rotifers applied to populations in reservoirs. Ph.D. thesis, Univ. London, London, England. 226 p.
- DOOHAN, M., and V. RAINBOW. 1971. Determination of dry weights of small Aschelminthes. *Oecologia* 6: 380-383.
- DUMONT, H.J., I. VAN DE VELDE, and S. DUMONT. 1975. The dry weight estimate of biomass in a selection of Cladocera, Copepoda and Rotifera from the plankton, periphyton and benthos of continental waters. *Oecologia* 19: 75-97.
- FEE, E.J., D. HAYWARD, and J.A. SHEARER. 1982. Annual primary production in lakes of the Experimental Lakes Area, northwestern Ontario; 1976-1980 results. *Can. Data Rep. Fish. Aquat. Sci.* 327: iv + 33 p.
- HALL, D.J., W.E. COOPER, and E.E. WERNER. 1970. An experimental approach to the production dynamics and structure of freshwater animal communities. *Limnol. Oceanogr.* 15: 839-928.
- HANEY, J.F., and D.J. HALL. 1973. Sugar-coated *Daphnia*: a preservation technique for Cladocera. *Limnol. Oceanogr.* 18: 331-333.
- HAWKINS, B.E., and M.S. EVANS. 1979. Seasonal cycles of zooplankton biomass in southeastern Lake Michigan. *J. Great Lakes Res.* 5: 256-263.
- HAYWARD, R.S. and D.N. GALLUP. 1976. Feeding, filtering and assimilation in *Daphnia schoedleri* Sars as affected by environmental conditions. *Arch. Hydrobiol.* 77: 139-163.
- HESSLEIN, R.H., W.S. BROECKER, and D.W. SCHINDLER. 1980. Fates of metal radio-tracers added to a whole lake: sediment-water interactions. *Can. J. Fish. Aquat. Sci.* 37: 378-386.
- HITCHIN, G.G., and N.D. YAN. 1983. Crustacean zooplankton communities of the Muskoka-Haliburton study lakes: methods and 1976-1979 data. *Ont. Minist. Environ. Data Rep.* 83/9.
- LAWRENCE, S.G. 1980. The effects of acid and cadmium on impounded zooplankton in a Canadian Shield lake, p. 81-90. In J.F. Klaverkamp, S.L. Leonhard and K.E. Marshall (ed.). *Proceedings of the Sixth Annual Aquatic Toxicity Workshop*. Can. Tech. Rep. Fish. Aquat. Sci. 975: 291 p.
- LAWRENCE, S.G., and M.H. HOLOKA. 1983. Effect of selenium on impounded zooplankton in a mercury contaminated lake, p. 83-92. In N.K. Kaushik and K.R. Solomon (ed.) *Proceedings of the Eighth Annual Aquatic Toxicity Workshop*. Can. Tech. Rep. Fish. Aquat. Sci. 115: 250 p.

- LAWRENCE, S.G., and M.H. HOLOKA. 1987. Effects of low concentrations of cadmium on the crustacean zooplankton community of an artificially acidified lake. *Can. J. Fish. Aquat. Sci.* 44(Suppl. 1): 163-172.
- LAWRENCE, S.G., D.F. MALLEY, W.J. FINDLAY, M.A. MACIVER, and I.L. DELBAERE. 1987. Method for estimating dry weight of freshwater planktonic crustaceans from measures of length and shape. *Can. J. Fish. Aquat. Sci.* 44(Suppl. 1): 264-274.
- LEWIS, W.M. 1979. Zooplankton community analysis: studies on a tropical system. Springer-Verlag, New York. 163 p.
- LINSEY, G.A., and J. BRAUND. 1984. Water chemistry data from Lake 223 of the Experimental Lakes Area, northwestern Ontario, 1974 to 1982. *Can. Data Rep. Fish Aquat. Sci.* 487: iv + 121 p.
- LINSEY, G.A., J. BRAUND, M.P. STANTON, and J. PROKOPOWICH. 1985. Water chemistry data from the north and south basins of Lake 302 in the Experimental Lakes Area, northwestern Ontario, 1968 to 1983. *Can. Data Rep. Fish. Aquat. Sci.* 509: iv + 307 p.
- MAKAREWICZ, J.C., and G.E. LIKENS. 1979. Structure and function of the zooplankton community of Mirror Lake, New Hampshire. *Ecol. Monogr.* 49: 109-127.
- MALLEY, D.F., and P.S.S. CHANG. 1980. Response of zooplankton in Precambrian Shield lakes to whole-lake chemical modifications causing pH change, p. 108-114. In *Restoration of lakes and inland waters*. U.S. Environ. Prot. Agency EPA 440/5-81-010.
- MALLEY, D.F., P.S.S. CHANG, D.L. FINDLAY, and G.A. LINSEY. 1988. Extreme perturbation of the zooplankton community of a small Precambrian Shield lake by the addition of nutrients. *Int. ver. theor. angew. Limnol. Verh.* 23: 2237-2247.
- MALLEY, D.F., D.L. FINDLAY, and P.S.S. CHANG. 1982. Ecological effects of acid precipitation on zooplankton, p. 297-327. In F.M. D'Itri (ed.) *Acid precipitation. Effects on ecological systems*. Ann Arbor Science Publishers, Ann Arbor, MI.
- MC CAULEY, E. 1984. The estimation of the abundance and biomass of zooplankton in samples, p. 228-261. In J.A. Downing and F.H. Rigler (ed.) *A manual on methods for the assessment of secondary productivity in fresh waters*. 2nd ed. Blackwell Scientific Publications, Oxford.
- NAUWERCK, A. 1963. Die Beziehungen zwischen Zooplankton und Phytoplankton im See Erken. *Symb. Bot. Ups.* 17: 163 p.
- PACE, M.L., and J.D. ORCUTT. 1981. The relative importance of protozoans, rotifers, and crustaceans in a freshwater zooplankton community. *Limnol. Oceanogr.* 26: 822-830.
- PATALAS, K. 1971. Crustacean plankton communities in forty-five lakes in the Experimental Lakes Area, northwestern Ontario. *J. Fish. Res. Board Can.* 28: 231-244.
- PEDERSON, G.L., E.B. WELCH, and A.H. LITT. 1976. Plankton secondary productivity and biomass: their relation to lake trophic state. *Hydrobiologia* 50: 129-144.
- PERSSON, G., and G. EKBOHM. 1980. Estimation of dry weight in zooplankton populations: methods applied to crustacean populations from lakes in the Kuokkel Area, northern Sweden. *Arch. Hydrobiol.* 89: 225-246.
- PETERS, R.H. 1983. *Ecological implications of body size*. Cambridge University Press, New York. 329 p.
- PREPAS, E.E. 1984. Some statistical methods for the design of experiments and analysis of samples, p. 266-335. In J.A. Downing and F.H. Rigler (ed.) *A manual on methods for the assessment of secondary productivity in fresh waters*. 2nd ed. Blackwell Scientific Publications, Oxford.
- PROKOPOWICH, J. 1979. Chemical characterization of epilimnion waters in the Experimental Lakes Area, northwestern Ontario. *Can. Fish. Mar. Serv. Tech. Rep.* 873: iv + 41 p.
- RAMSEY, D.J. 1985. The response of plankton crustacean communities in large enclosures to experimental acidification. M.Sc. thesis, Univ. Manitoba, Winnipeg, MB. xvii + 203 p.
- REED, E.B., and J.G. ARONSON. 1989. Seasonal variation in length of copepodids and adults of *Diacyclops thomasi* (Forbes) in two Colorado montane reservoirs (Copepoda). *J. Crust. Biol.* 9: 67-76.
- RICHMAN, S. 1958. The transformation of energy by *Daphnia pulex*. *Ecol. Monogr.* 28: 273-291.
- ROFF, J.C., and R.E. KWIATKOWSKI. 1977. Zooplankton and zoobenthos of selected north-eastern Ontario lakes of different acidities. *Can. J. Zool.* 55: 899-911.
- RUDD, J.W.M., M.A. TURNER, B.E. TOWNSEND, A. SWICK, and A. FURUTANI. 1980. Dynamics of selenium in mercury-contaminated experimental freshwater ecosystems. *Can. J. Fish. Aquat. Sci.* 37: 848-857.
- RUTTNER-KOLISKO, A. 1974. Plankton rotifers: biology and taxonomy (translated by G. Kolisko). *Die Binnengewässer* 26: 1-146.
- RUTTNER-KOLISKO, A. 1977. Suggestions for biomass calculation of plankton rotifers. *Ergebn. Limnol.* 8: 71-76.
- SALKI, A.G. 1981. The crustacean zooplankton communities of three prairie lakes subject to varying degrees of anoxia. M.Sc.

- thesis, Univ. Manitoba, Winnipeg, MB. iv + 222 p.
- SCHINDLER, D.W. 1971. Light, temperature, and oxygen regimes of selected lakes in the Experimental Lakes Area, northwestern Ontario. *J. Fish. Res. Board Can.* 28: 157-169.
- SCHINDLER, D.W. 1972. Production of phytoplankton and zooplankton in Canadian shield lakes, p. 311-331. In Z. Kajak and A. Hillbricht-Illkowska (ed.) *Productivity problems of freshwaters*. Proceedings of the IBP-UNESCO Symposium, Kazimierz Dolny, May 1970. Warszawa.
- SCHINDLER, D.W. 1975. Whole-lake eutrophication experiments with phosphorus, nitrogen and carbon. *Int. ver. theor. angew. Limnol. Verh.* 19: 3221-3231.
- SCHINDLER, D.W. 1980. Experimental acidification of a whole lake: a test of the oligotrophication hypothesis, p. 370-374. In *Proceedings of the International Conference on the Ecological Impact of Acid Precipitation*, Sandefjord, Norway, 11-14 March 1980.
- SCHINDLER, D.W., F.A.J. ARMSTRONG, S.K. HOLMGREN, and G.J. BRUNSKILL. 1971. Eutrophication of Lake 227, Experimental Lakes Area, northwestern Ontario, by addition of phosphate and nitrate. *J. Fish. Res. Board Can.* 28: 1763-1782.
- SCHINDLER, D.W., H. KLING, R.V. SCHMIDT, J. PROKOPOWICH, V.E. FROST, R.A. REID, and M. CAPEL. 1973. Eutrophication of Lake 227 by addition of phosphate and nitrate: the second, third and fourth years of enrichment 1970, 1971 and 1972. *J. Fish. Res. Board Can.* 30: 1415-1440.
- SCHINDLER, D.W., R.W. NEWBURY, K.G. BEATY, J. PROKOPOWICH, T. RUSZCZYNSKI and J.A. DALTON. 1980a. Effects of a windstorm and forest fire on chemical losses from forested watersheds and on the quality of receiving streams. *Can. J. Fish. Aquat. Sci.* 37: 328-334.
- SCHINDLER, D.W., and B. NOVÉN. 1971. Vertical distribution and seasonal abundance of zooplankton in two shallow lakes of the Experimental Lakes Area, northwestern Ontario. *J. Fish. Res. Board Can.* 28: 245-256.
- SCHINDLER, D.W., T. RUSZCZYNSKI, and E.J. FEE. 1980b. Hypolimnion injection of nutrient effluents as a method for reducing eutrophication. *Can. J. Fish. Aquat. Sci.* 37: 320-327.
- SCHINDLER, D.W., R. WAGEMANN, R.B. COOK, T. RUSZCZYNSKI, and J. PROKOPOWICH. 1980c. Experimental acidification of Lake 223, Experimental Lakes Area: background data and the first three years of acidification. *Can. J. Fish. Aquat. Sci.* 37: 342-354.
- SHEARER, J.A., E.J. FEE, E.R. DEBRUYN and D.R. DECLERCQ. 1987. Phytoplankton primary production and light attenuation responses to the experimental acidification of a small Canadian shield lake. *Can. J. Fish. Aquat. Sci.* 44(Suppl. 1): 83-90.
- SRISUWANTACH, V. 1978. Nutrients and phytoplankton in six lakes of southwestern Manitoba with particular reference to seasonal anoxic conditions. M.Sc. thesis, Univ. Manitoba, Winnipeg, MB. viii + 105 p.
- SUNDE, L.A., and J. BARICA. 1975. Geography and lake morphometry of the aquaculture study area in the Erickson-Elphinstone district of southwestern Manitoba. *Can. Fish. Mar. Serv. Tech. Rep.* 510: 35 p.
- WARD, H.B., and G.C. WHIPPLE. 1959. Freshwater biology. 2nd ed. W.T. Edmondson (ed.) John Wiley and Sons, Inc., New York. 1248 p.
- WARREN, G.J., M.S. EVANS, D.J. JUDE, and J.C. AYERS. 1986. Seasonal variations in copepod size: effects of temperature, food abundance, and vertebrate predation. *J. Plank. Res.* 8: 841-853.
- WILSON, J.B., and J.C. ROFF. 1973. Seasonal vertical distributions and diurnal migration patterns of Lake Ontario crustacean zooplankton. *Proc. Conf. Great Lakes Res.* 16: 190-203.
- WYNGAARD, G.A. 1986. Genetic differentiation of life history traits in populations of *Mesocyclops edax* (Crustacea: Copepoda). *Biol. Bull. (Woods Hole)* 170: 279-295.
- YAN, N.D., and G.L. MACKIE. 1987. Improved estimation of the dry weight of *Holopedium gibberum* (Crustacea, Cladocera) using clutch size, a body fat index, and lake water total phosphorus concentration. *Can. J. Fish. Aquat. Sci.* 44: 382-389.
- YAN, N.D., and R. STRUS. 1980. Crustacean zooplankton communities of acidic, metal-contaminated lakes near Sudbury, Ontario. *Can. J. Fish. Aquat. Sci.* 37: 2282-2293.

Table 1. Physical and chemical parameters of study lakes. For ELA lakes, map coordinates and basic lake characteristics are given by Cleugh and Hauser (1971); morphometry and bathymetry for selected lakes are given by Brunsell and Schindler (1971); chemical and physical characteristics for selected lakes are described by Armstrong and Schindler (1979), Prokopowich (1979), and Schindler (1971); primary production is given in Fee et al. (1982) and experimental chemical additions to lakes are given by Cruikshank (1984).

Lake	Coordinates	Surface area (ha)	Mean depth (m)	Maximum depth (m)	Year	Conductivity (μmo cm⁻¹ at 25°C) epilimnia	Primary production mean daily value (mg C m⁻² day⁻¹) ice-free season	Treatment	References
223	49°42'N 93°42'W	27.3	7.2	14.4	1974 1975 1978 1979 1980	21-24 19-23 26-31 16-21 18-20	188 105 212 301 337	Additions of H <sub>2</sub> SO <sub>4</sub> from 1976 to present	Schindler 1980
224	49°42'N 93°43'W	25.9	12.0	27.0	1974 1975 1976 1977	16-21 16-21 16-21 18-20	117 98 102 161	Addition of trace amounts of radioactive metals, 1976	Hesslein et al. 1980
226NE	49°42'N 93°45'W	8.3	5.7	14.7	1985	24-30	214	N, P + C additions from 1973 to 1980	Schindler 1975
226SW	49°42'N 93°45'W	7.8	6.3	11.6	1985	24-27	185	N + C additions from 1973 to 1980	Schindler 1975
227	49°42'N 93°42'W	5.0	4.4	10.0	1973 1974 1975 1976 1977 1978	33-49 32-50 31-51 35-49 36-51 29-49	1063 856 258 522 733 777	N + P addition from 1969 to present	Schindler et al. 1971, 1973
239	49°39'30"N 93°43'W	56.1	10.5	30.4	1985	31-44	118	Accidental forest fires 1974, 1980	Schindler et al. 1980a
302S	49°40'N 93°46'W	23.7	5.7	13.8	1980 1981 1982 1983	21-24 19-34 22-27 23-30	295 337 287 203	Additions of H <sub>2</sub> SO <sub>4</sub> from 1982 to present	Linsey et al. 1985
Clay	50°03'N 93°20'W	3000	8.0	24.0	1978	100-150	50-125a (Spring)	Hg added to system via paper industry	Armstrong and Hamilton 1973 Rudd et al. 1980
885	50°39'N 100°10'W	2.4	1.9	3.0	1976 (Feb, Aug)	1835, 1350 (July)	2488	Rainbow trout culture	Barica 1975 Sunde and Barica 1975 Srisuwantach 1978

<sup>a</sup> Clay Lake primary production values are estimated. J. Rudd (Freshwater Institute) classifies this lake as mesotrophic. Primary production is probably highest in late summer when filamentous blue-green algae dominate.

Table 2. Geometric figures and their formulae used to calculate volumes of zooplankters. Formulae are for organisms preserved in 4% formalin.

Shape	Formula <sup>e</sup>	Factor for adjustment for appendages/gape	Designation in tables following
General ellipsoid of revolution	$4/3\pi(abc)$		A
	$4/3\pi(abc)$	x 1.25	B
	$4/3\pi(abc)$	x 1.4	C
	$4/3\pi(abc)$	x 1.5	D
	$4/3\pi(abc)$	x 2	E
	$4/3\pi(abc)$	x 3	F
	$4/3\pi(abc)$	x 0.3	G
	$4/3\pi(abc)$	x 0.5	H
	$4/3\pi(abc)$	x 0.7	I
Elliptic cylinder	$\pi(lbc)$		J
Cone	$1/3\pi(lbc)$		K
Rectangular polyhedron	$lwd$		L

<sup>e</sup> a = length/2; b = width/2; c = depth/2; l = length; w = width; d = depth.

Table 3. Rotifer dry weights calculated using formulae given in this paper (Table 11) and those of Ruttner-Kolisko (1977). Both sets of calculations are based on mean lengths, widths and depths given in Table 11.

Species	Ruttner-Kolisko formulae	weight, $\mu\text{g individual}^{-1}$ This paper
<u>Asplanchna priodonta</u>	$0.533$ $4/3\pi(ab^2)$	0.525
<u>Conochilis unicornis</u>	$0.010-0.013$ $\pi(1b^2)/3$	0.021-0.028
<u>Gastropus stylifer</u>	$0.015-0.020$ $\pi(1bc)$	0.015-0.020
<u>Kellicottia longispina</u>	$0.007-0.008$ $\pi(1b^2)/3$	0.014-0.017
<u>Keratella cochlearis</u>	$0.002-0.011$ $\pi(1b^2)/6$	0.009-0.044
<u>K. hiemalis</u>	0.027 lwd	0.027-0.028
<u>Polyarthra major</u>	0.161 lwd	0.127
<u>P. remata</u>	0.012-0.018 lwd	0.010-0.015
<u>P. vulgaris</u>	0.039-0.049 lwd	0.031-0.041

e Formulae for volume of the rotiferan body from Ruttner-Kolisko (1977); appendages not included in calculations. Volumes are converted to dry weights assuming  $1 \text{ mm}^3 = 1 \mu\text{g}$  and dry weight is 7% wet weight (except Asplanchna where dry weight is 4% wet weight). Terms a,b,c,l,w,d as in Table 2.

Table 4. The effects of two preservatives on two body dimensions and calculated dry weights of cladocerans. Width, depth and weight are adjusted Y-means from analysis of covariance, using length as the X-variable. Mean lengths are compared separately by analysis of variance. P is the probability that the adjusted Y-means or means of the lengths are the same.

Treatment	N	Adjusted Y-Means		Observed Mean Length, $\mu\text{m}$		
		Width, $\mu\text{m}$	Depth, $\mu\text{m}$			
<b><u>Daphnia retrocurva</u></b>						
Lake 226 NE (all sizes:lengths 527 to 1597 $\mu\text{m}$ )						
formalin	42	284.0	390.8	2.128		
sugar-formalin	46	233.4	383.4	1.827		
P		0.0001	0.31	0.019		
				921.6		
				952.3		
				0.54		
Lake 226 NE (small:lengths 527 to 853 $\mu\text{m}$ ) <sup>a</sup>						
formalin	16	283.0	294.8	1.088		
sugar-formalin	20	186.7	275.5	0.693		
P		0.0002	0.0668	0.0007		
				681.6		
				720.6		
				0.16		
Lake 226 NE (large:lengths 899 to 1597 $\mu\text{m}$ ) <sup>a</sup>						
formalin	26	291.3	456.2	2.917		
sugar-formalin	26	262.6	460.1	2.550		
P		0.0164	0.70	0.0103		
				1069.3		
				1130.6		
				0.16		
Lake 226 SW (all sizes:lengths 574 to 1395 $\mu\text{m}$ )						
formalin	45	312.9	374.3	1.963		
sugar-formalin	45	222.7	370.3	1.494		
P		<0.0000	0.58	0.0001		
				861.4		
				882.4		
				0.57		

<sup>a</sup> Subsets of Lake 226NE, all sizes.

Table 4. (cont'd.)

Treatment	N	Adjusted Y-Means			Observed Mean Length, $\mu\text{m}$		
		Width, $\mu\text{m}$	Depth, $\mu\text{m}$	Weight, $\mu\text{g}$			
<b><u>Daphnia galeata mendotae</u></b>							
Lake 239 (all sizes: lengths 574 to 1457 $\mu\text{m}$ )							
formalin	70	442.2	491.4	4.042	964.6		
sugar-formalin	82	334.8	471.0	2.950	976.3		
P		<0.0001	0.0045	<0.0001	0.69		
Lake 239 (small: lengths 574 to 946 $\mu\text{m}$ )							
formalin	34	458.0	411.9	2.966	812.6		
sugar-formalin	34	325.7	383.9	1.955	814.9		
P		<0.0001	0.0081	<0.0001	0.92		
Lake 239 (large: lengths 961 to 1457 $\mu\text{m}$ )							
formalin	36	425.9	556.9	4.896	1108.1		
sugar-formalin	48	342.1	539.8	3.776	1090.5		
P		0.0004	0.071	0.0001	0.49		
<b><u>Diaphanosoma birgei</u></b>							
Lake 226 NE, SW							
formalin	32	302.7	300.7	1.469	711.2		
sugar-formalin	33	303.0	292.6	1.623	739.2		
P		0.99	0.49	0.35	0.62		
Lake 239							
formalin	82	262.6	298.7	1.156	743.2		
sugar-formalin	84	264.1	319.5	1.213	696.7		
P		0.85	<0.0001	0.26	0.0386		
<b><u>Bosmina longirostris</u></b>							
Lake 226 NE, SW							
formalin	65	167.8	259.9	0.286	316.9		
sugar-formalin	56	157.9	245.0	0.249	329.1		
P		0.0186	0.0002	0.0002	0.23		
Lake 239, Sample 1							
formalin	34	166.5	267.3	0.293	325.8		
sugar-formalin	35	158.6	251.0	0.258	340.9		
P		0.0391	0.0002	0.0002	0.22		
Lake 239, Sample 2							
formalin	85	144.7	224.9	0.183	285.0		
sugar-formalin	94	136.4	216.0	0.178	286.4		
P		0.0008	0.0016	0.63	0.84		

Table 5. Comparison of measurements and calculated dry weights (means  $\pm$  S.E.) by two workers on adult female Cyclops bicuspidatus thomasi and on Holopedium gibberum.

	Length, $\mu\text{m}$	Width, $\mu\text{m}$	Depth, $\mu\text{m}$	Weight, $\mu\text{g individual}^{-1}$
<u>Cyclops bicuspidatus thomasi, N = 10</u>				
Worker 1	1238.0 $\pm$ 11.7	349.1 $\pm$ 4.6	252.8 $\pm$ 6.2	4.014 $\pm$ 0.187
Worker 2	1224.0 $\pm$ 11.3	351.3 $\pm$ 2.3	273.7 $\pm$ 4.3	4.320 $\pm$ 0.147
Worker 2 as %				
Worker 1	98.9	100.6	108.3	107.6
Difference	N.S.	N.S.	P < 0.05	N.S.
<u>Holopedium gibberum, N = 10</u>				
Worker 1	1184.1 $\pm$ 98.1	345.6 $\pm$ 18.0	462.4 $\pm$ 34.3	7.866 $\pm$ 1.810
Worker 2	1172.0 $\pm$ 88.1	331.2 $\pm$ 18.3	412.8 $\pm$ 24.9	6.460 $\pm$ 1.199
Worker 2 as %				
Worker 1	99.0	95.8	89.3	82.1
Difference	N.S.	N.S.	N.S.	N.S.

Table 6. Dimensions and calculated dry weights (means  $\pm$  S.E.) of life stages of species of calanoid copepods from six lakes. Formulae are defined in Table 2. One  $\text{mm}^3$  volume is assumed to weigh 1 mg (wet weight) and dry weight is assumed to be 7% of wet weight. N is the number of individuals measured. F and M are female and male, respectively. Length is the longest dimension along the anterior-posterior axis, width is the lateral dimension, and depth is the dorso-ventral dimension (Fig. 1). Data for organisms from Lake 223 are taken from Lawrence et al. 1987.

Species/ Life stage/ Sex	Lake	N	Length $\mu\text{m}$	Width $\mu\text{m}$	Depth $\mu\text{m}$	Formula	Dry Weight $\mu\text{g}$
Nauplius 1	223 <sup>a</sup>	10	132.2 $\pm$ 0.9	69.4 $\pm$ 0.6	65.2 $\pm$ 0.8	D	0.033 $\pm$ 0.001
	224 <sup>b</sup>	11	145.6 $\pm$ 4.2	81.7 $\pm$ 2.0	69.7 $\pm$ 1.8		0.046 $\pm$ 0.003
	227	24	131.3 $\pm$ 1.0	71.9 $\pm$ 0.7	64.0 $\pm$ 1.1		0.033 $\pm$ 0.001
	302 <sup>a</sup>	20	141.0 $\pm$ 1.5	72.2 $\pm$ 1.4	68.2 $\pm$ 1.6		0.039 $\pm$ 0.002
	Clay <sup>c</sup>	10	132.9 $\pm$ 1.9	80.8 $\pm$ 1.4	73.0 $\pm$ 0.9		0.043 $\pm$ 0.001
	885 <sup>d</sup>	10	161.9 $\pm$ 2.9	84.3 $\pm$ 1.3	73.0 $\pm$ 1.0		0.055 $\pm$ 0.002
Nauplius 2	223 <sup>a</sup>	10	153.4 $\pm$ 1.9	80.2 $\pm$ 1.1	77.5 $\pm$ 1.3	D	0.053 $\pm$ 0.002
	224 <sup>b</sup>	10	176.0 $\pm$ 3.0	96.1 $\pm$ 1.4	80.2 $\pm$ 1.9		0.075 $\pm$ 0.004
	227	29	157.2 $\pm$ 2.2	85.0 $\pm$ 0.9	77.4 $\pm$ 0.9		0.057 $\pm$ 0.002
	302 <sup>a</sup>	20	152.8 $\pm$ 1.9	77.4 $\pm$ 1.3	74.6 $\pm$ 1.5		0.049 $\pm$ 0.002
	Clay <sup>c</sup>	10	173.1 $\pm$ 2.1	90.5 $\pm$ 1.5	85.3 $\pm$ 1.4		0.074 $\pm$ 0.003
	885 <sup>d</sup>	10	184.7 $\pm$ 5.7	90.4 $\pm$ 0.9	81.8 $\pm$ 1.4		0.075 $\pm$ 0.004
Nauplius 3	223 <sup>a</sup>	10	192.4 $\pm$ 2.8	93.2 $\pm$ 1.1	86.0 $\pm$ 1.0	D	0.085 $\pm$ 0.003
	224 <sup>b</sup>	10	213.7 $\pm$ 3.4	104.3 $\pm$ 1.7	83.9 $\pm$ 0.9		0.103 $\pm$ 0.003
	227	26	189.3 $\pm$ 2.0	97.6 $\pm$ 0.8	88.3 $\pm$ 1.0		0.090 $\pm$ 0.002
	302 <sup>a</sup>	20	181.6 $\pm$ 2.2	88.8 $\pm$ 1.3	84.8 $\pm$ 1.1		0.075 $\pm$ 0.002
	Clay <sup>c</sup>	10	201.1 $\pm$ 1.7	104.4 $\pm$ 1.0	97.0 $\pm$ 1.8		0.112 $\pm$ 0.003
	885 <sup>d</sup>	10	217.4 $\pm$ 4.6	102.0 $\pm$ 0.0	90.4 $\pm$ 0.9		0.110 $\pm$ 0.003
Nauplius 4	223 <sup>a</sup>	10	224.5 $\pm$ 1.1	106.2 $\pm$ 0.9	97.7 $\pm$ 1.4	D	0.128 $\pm$ 0.002
	224 <sup>b</sup>	11	246.9 $\pm$ 2.4	114.3 $\pm$ 1.1	98.8 $\pm$ 0.9		0.154 $\pm$ 0.004
	227	24	226.0 $\pm$ 3.2	110.3 $\pm$ 1.0	98.1 $\pm$ 1.0		0.135 $\pm$ 0.004
	302 <sup>a</sup>	20	212.4 $\pm$ 1.9	97.2 $\pm$ 1.1	96.6 $\pm$ 2.0		0.110 $\pm$ 0.004
	Clay <sup>c</sup>	10	234.6 $\pm$ 3.1	119.9 $\pm$ 1.8	107.0 $\pm$ 1.6		0.166 $\pm$ 0.006
	885 <sup>d</sup>	10	242.1 $\pm$ 4.0	109.4 $\pm$ 0.9	95.9 $\pm$ 1.0		0.140 $\pm$ 0.004
Nauplius 5	223 <sup>a</sup>	10	257.0 $\pm$ 2.6	114.2 $\pm$ 1.2	107.6 $\pm$ 1.5	C	0.163 $\pm$ 0.005
	224 <sup>b</sup>	10	295.0 $\pm$ 6.3	127.4 $\pm$ 1.4	112.3 $\pm$ 1.1		0.223 $\pm$ 0.011
	227	22	269.5 $\pm$ 2.8	118.0 $\pm$ 1.1	104.6 $\pm$ 0.9		0.171 $\pm$ 0.004
	302 <sup>a</sup>	20	246.2 $\pm$ 4.6	109.8 $\pm$ 1.4	103.0 $\pm$ 2.0		0.143 $\pm$ 0.004
	Clay <sup>c</sup>	10	283.3 $\pm$ 2.2	123.8 $\pm$ 1.7	125.0 $\pm$ 2.4		0.226 $\pm$ 0.008
	885 <sup>d</sup>	10	278.7 $\pm$ 2.4	118.5 $\pm$ 1.4	105.0 $\pm$ 1.3		0.168 $\pm$ 0.009
Nauplius 6	223 <sup>a</sup>	10	291.5 $\pm$ 1.9	119.9 $\pm$ 1.3	123.1 $\pm$ 1.1	B	0.197 $\pm$ 0.003
	224 <sup>b</sup>	11	357.4 $\pm$ 6.2	141.6 $\pm$ 2.0	123.4 $\pm$ 1.3		0.287 $\pm$ 0.010
	227	20	331.0 $\pm$ 8.0	128.8 $\pm$ 2.4	119.0 $\pm$ 1.3		0.237 $\pm$ 0.015
	302 <sup>a</sup>	20	275.4 $\pm$ 5.7	107.0 $\pm$ 1.8	105.4 $\pm$ 1.7		0.144 $\pm$ 0.007
	Clay <sup>c</sup>	10	340.1 $\pm$ 6.2	137.1 $\pm$ 1.4	147.4 $\pm$ 2.5		0.316 $\pm$ 0.014
	885 <sup>d</sup>	3	324.0 $\pm$ 9.3	128.0 $\pm$ 0.0	119.0 $\pm$ 2.0		0.226 $\pm$ 0.010

a Diaptomus minutus

b Diaptomus spp

c D. oregonensis

d D. siciloides

Table 6. (cont'd)

Species/ Life stage/ Sex		Lake	N	Length μm	Width μm	Depth μm	Formula	Dry Weight μg
Copepodid 1	223 <sup>a</sup>	20	415.1± 3.2	127.3± 1.3	115.5± 1.5	B	0.279±0.006	
	224 <sup>b</sup>	17	458.0±14.1	142.8± 5.3	105.0± 3.4		0.331±0.031	
	224 <sup>e</sup>	1	564	192	126		0.625	
	227 <sup>a</sup>	13	446.2± 6.0	132.4± 1.9	112.5± 2.0		0.306±0.012	
	227 <sup>e</sup>	5	481.4± 8.9	158.2± 5.5	133.2± 3.4		0.468±0.036	
	302 <sup>a</sup>	20	406.5±10.9	121.0± 3.9	105.6± 2.2		0.225±0.017	
	Clay <sup>c</sup>	10	465.6± 4.8	152.1± 1.9	125.1± 2.5		0.407±0.015	
	885 <sup>d</sup>	1	448	144	120		0.28	
Copepodid 2	223 <sup>a</sup>	20	517.4± 2.3	138.2± 1.8	126.7± 2.0	B	0.416±0.010	
	224 <sup>b</sup>	14	584.6±19.1	163.6± 5.2	132.2± 2.8		0.596±0.046	
	224 <sup>e</sup>	3	664.0± 3.3	194.0± 1.6	154.0± 0.8		0.907±0.012	
	227 <sup>a</sup>	13	567.9± 5.5	151.2± 1.9	137.3± 1.7		0.541±0.015	
	227 <sup>e</sup>	5	681.6± 7.0	208.8± 4.4	185.4± 5.9		1.214±0.066	
	302 <sup>a</sup>	20	528.4± 6.0	150.2± 2.4	128.6± 2.0		0.470±0.015	
	Clay <sup>c</sup>	10	613.4± 4.0	174.2± 1.4	153.9± 1.5		0.754±0.015	
Copepodid 3	223 <sup>a</sup>	30	606.1± 7.7	172.0± 2.1	151.4± 2.9	B	0.730±0.025	
	224 <sup>b</sup>	21	754.9±10.5	211.6± 3.1	170.4± 4.1		1.262±0.056	
	227 <sup>a</sup>	14	702.0± 3.7	186.4± 3.0	161.6± 2.9		0.971±0.031	
	227 <sup>e</sup>	5	844.8±32.6	258.6±12.7	236.0±10.6		2.324±0.280	
	302 <sup>a</sup>	20	636.8± 6.4	174.0± 1.9	153.0± 3.5		0.779±0.025	
	Clay <sup>c</sup>	10	704.8± 7.2	194.9± 1.9	167.2± 1.5		1.052±0.016	
	885 <sup>d</sup>	1	736	208	176		0.99	
Copepodid 4	223 <sup>a</sup>	30	771.7±13.7	214.2± 5.3	192.2± 4.3	B	1.500±0.097	
	224 <sup>b</sup>	11	861.8±38.0	226.9±11.3	192.5± 9.6		1.836±0.238	
	M 224 <sup>e</sup>	2	1116.0±84.0	342.0± 6.0	282.0± 6.0		4.947±0.563	
	227 <sup>a</sup>	16	853.5±11.8	219.0± 1.6	194.3± 2.7		1.666±0.041	
	227 <sup>e</sup>	3	1040.0±21.2	308.0±14.4	254.0±17.1		3.768±0.517	
	302 <sup>a</sup>	20	731.4± 6.0	201.8± 3.5	181.6± 2.4		1.232±0.038	
	302 <sup>e</sup>	7	1092.0±54.7	317.7±18.9	270.9±17.3		4.512±0.739	
	Clay <sup>c</sup>	10	816.0± 9.8	217.9± 2.6	186.6± 2.6		1.525±0.054	
Copepodid F 5	223 <sup>a</sup>	15	878.9±26.7	234.5± 9.0	219.4± 8.0	B	2.174±0.237	
	M 223 <sup>a</sup>	25	836.3±16.8	227.8± 5.8	211.9± 6.0		1.908±0.126	
	F 224 <sup>a</sup>	3	880.0±16.0	236.0± 8.0	206.0± 5.3		1.958±0.070	
	M 224 <sup>a</sup>	2	840.0± 8.5	228.0± 8.5	186.0± 4.2		1.637±0.114	
	M 224 <sup>e</sup>	3	1496.0±17.4	436.0±10.6	356.0± 4.0		10.645±0.412	
	F 224 <sup>f</sup>	8	1254.0±38.6	334.1± 7.0	279.0± 6.3		5.407±0.350	
	M 224 <sup>f</sup>	4	984.0±19.4	273.0± 5.0	240.0± 7.3		2.962±0.166	
	F 227 <sup>a</sup>	6	916.0±14.4	237.0± 4.8	214.8± 3.2		2.140±0.079	
	M 227 <sup>a</sup>	7	907.4± 8.3	238.4± 3.1	211.4± 5.0		2.100±0.084	
	F 227 <sup>e</sup>	2	1404.0± 8.5	390.0± 4.2	318.0± 4.2		7.982±0.241	
	M 227 <sup>e</sup>	2	1320.0±25.5	360.0± 0.0	306.0± 4.2		6.666±0.221	
	302 <sup>a</sup>	20	831.0±16.2	222.8± 4.3	202.4± 3.6		1.740±0.085	
	302 <sup>e</sup>	10	1285.6±24.2	378.4±11.5	325.6±12.6		7.359±0.593	
	Clay <sup>c</sup>	10	982.4±14.5	254.9± 2.0	217.5± 7.1		2.504±0.117	

<sup>a</sup> *Diaptomus minutus*<sup>b</sup> *Diaptomus* spp<sup>c</sup> *D. oregonensis*<sup>d</sup> *D. siciloides*<sup>e</sup> *Epischura lacustris*<sup>f</sup> *D. sicilis*

Table 6. (cont'd)

Species/ Life stage/ Sex	Lake	N	Length μm	Width μm	Depth μm	Formula	Dry weight μg
<b>Adult Copepodids</b>							
<i>Diaptomus minutus</i>							
Female	223	72	945.5± 7.9	255.3± 2.5	224.7± 2.4	B	2.514±0.064
	224	7	953.1±16.7	240.0± 4.5	207.4± 3.4		2.182±0.105
Male	227	17	1031.3±14.9	282.4± 4.6	244.6± 3.5		3.272±0.109
	302	76	967.6± 6.3	254.5± 2.3	229.5± 1.7		2.604±0.047
	Clay	3	889.3±13.1	221.3± 4.3	210.7± 6.7		1.904±0.120
<i>Diaptomus minutus</i>							
Female	223	50	863.0± 5.6	231.0± 2.5	200.5± 2.0	B	1.822±0.040
	224	8	892.5±15.7	227.6± 3.9	198.0± 6.0		1.844±0.080
Male	227	22	925.6±16.8	255.4± 3.3	228.4± 3.4		2.484±0.086
	302	61	880.9± 5.5	234.3± 1.6	206.5± 1.9		1.962±0.037
	Clay	1	800	208	192		1.5
<i>D. oregonensis</i>							
Female	Clay	10	1290.8±25.5	332.0± 7.3	278.8± 5.0	B	5.518±0.298
Male		10	1136.7±17.5	284.9± 2.0	245.0± 3.2		3.642±0.107
<i>D. sicilis</i>							
Female	224	8	1428.0±39.3	372.0± 9.4	309.0±11.1	B	7.639±0.606
Male		7	1028.6±18.3	265.7± 4.1	219.9± 4.6		2.760±0.119
<i>D. sici-</i> <i>loides</i>							
Female	885	11	1261.3± 8.4	328.1± 3.6	291.5± 3.0	B	5.535±0.132
Male		5	1190.0±12.4	294.4± 3.1	273.0± 4.0		4.379±0.054
<i>Epischura lacustris</i>							
Female	223	10	1854.4±49.1	552.0±14.0	449.6± 6.2	B	21.277±1.277
	224	16	1721.9±45.9	470.6±10.0	381.8± 8.8		14.426±0.895
Male	227	20	1615.8±29.9	443.4± 7.0	374.4± 5.8		12.417±0.529
	302	9	1529.3±36.9	446.7±10.6	368.0±10.2		11.535±0.547
<i>Epischura lacustris</i>							
Male	223	10	1636.0±41.8	470.4±10.9	393.6± 7.9	B	13.979±0.754
	224	11	1675.3±38.4	452.7± 9.7	364.4±13.8		12.900±0.958
Male	227	15	1464.3±26.2	390.2± 4.9	330.0± 5.9		8.682±0.325
	302	16	1444.5±21.9	404.2± 6.2	339.8± 7.1		9.140±0.377

Table 7. Dimensions and calculated dry weights (means  $\pm$  S.E.) of life stages of species of cyclopoid copepods from six lakes. Parameters are described in Table 6. Data for organisms from Lake 223 are taken from Lawrence et al. 1987.

Species/ Life stage/ Sex	Lake	N	Length $\mu\text{m}$	Width $\mu\text{m}$	Depth $\mu\text{m}$	Formula	Dry weight $\mu\text{g}$
Nauplius 1	223 <sup>a</sup>	10	89.6 $\pm$ 2.3	49.6 $\pm$ 1.6	36.8 $\pm$ 2.4	D	0.009 $\pm$ 0.001
	223 <sup>b</sup>	10	110.1 $\pm$ 1.1	71.2 $\pm$ 1.7	50.7 $\pm$ 0.3		0.022 $\pm$ 0.001
	224 <sup>c</sup>	11	111.4 $\pm$ 1.8	68.9 $\pm$ 1.4	49.8 $\pm$ 1.3		0.021 $\pm$ 0.001
	227 <sup>c</sup>	13	115.5 $\pm$ 5.4	65.9 $\pm$ 3.0	56.7 $\pm$ 2.3		0.025 $\pm$ 0.003
	302 <sup>c</sup>	20	94.6 $\pm$ 2.0	52.0 $\pm$ 1.7	40.8 $\pm$ 1.1		0.011 $\pm$ 0.001
	Clay <sup>a</sup>	10	81.1 $\pm$ 1.4	56.4 $\pm$ 40.6	48.9 $\pm$ 1.1		0.012 $\pm$ 0.0004
	885 <sup>b</sup>	10	107.5 $\pm$ 1.1	70.0 $\pm$ 0.0	59.1 $\pm$ 1.1		0.024 $\pm$ 0.001
Nauplius 2	223 <sup>a</sup>	10	102.4 $\pm$ 4.3	49.2 $\pm$ 2.4	49.6 $\pm$ 1.6	D	0.017 $\pm$ 0.002
	223 <sup>b</sup>	10	128.4 $\pm$ 1.5	84.4 $\pm$ 1.4	57.8 $\pm$ 1.2		0.035 $\pm$ 0.001
	224 <sup>c</sup>	11	130.4 $\pm$ 2.4	80.1 $\pm$ 2.0	60.1 $\pm$ 1.3		0.035 $\pm$ 0.001
	227 <sup>c</sup>	20	126.1 $\pm$ 3.0	76.3 $\pm$ 2.3	61.1 $\pm$ 1.5		0.033 $\pm$ 0.002
	302 <sup>c</sup>	20	109.4 $\pm$ 4.8	60.4 $\pm$ 2.3	46.4 $\pm$ 2.1		0.018 $\pm$ 0.002
	Clay <sup>a</sup>	8	114.0 $\pm$ 2.4	70.9 $\pm$ 2.3	54.8 $\pm$ 1.1		0.024 $\pm$ 0.001
	885 <sup>b</sup>	8	126.1 $\pm$ 2.4	79.2 $\pm$ 1.7	61.5 $\pm$ 1.7		0.034 $\pm$ 0.002
Nauplius 3	223 <sup>a</sup>	10	126.4 $\pm$ 3.7	68.8 $\pm$ 2.4	64.0 $\pm$ 0.0	D	0.031 $\pm$ 0.002
	223 <sup>b</sup>	10	152.4 $\pm$ 1.6	94.0 $\pm$ 1.4	64.4 $\pm$ 1.5		0.051 $\pm$ 0.002
	224 <sup>c</sup>	10	150.9 $\pm$ 2.0	92.5 $\pm$ 1.7	68.2 $\pm$ 1.7		0.052 $\pm$ 0.002
	227 <sup>c</sup>	25	160.1 $\pm$ 4.9	93.6 $\pm$ 2.6	76.4 $\pm$ 2.2		0.064 $\pm$ 0.005
	302 <sup>c</sup>	27	119.7 $\pm$ 3.6	66.5 $\pm$ 1.9	50.5 $\pm$ 1.4		0.023 $\pm$ 0.002
	Clay <sup>a</sup>	1	140	76	64		0.04
	885 <sup>b</sup>	10	148.8 $\pm$ 2.7	89.1 $\pm$ 1.0	75.5 $\pm$ 1.5		0.055 $\pm$ 0.002
Nauplius 4	223 <sup>a</sup>	10	136.0 $\pm$ 3.6	82.6 $\pm$ 1.8	62.4 $\pm$ 1.6	D	0.039 $\pm$ 0.002
	223 <sup>b</sup>	10	174.2 $\pm$ 1.4	102.6 $\pm$ 1.4	74.2 $\pm$ 1.3		0.073 $\pm$ 0.002
	224 <sup>c</sup>	12	186.5 $\pm$ 4.3	106.7 $\pm$ 1.8	79.4 $\pm$ 1.9		0.088 $\pm$ 0.005
	227 <sup>c</sup>	26	175.5 $\pm$ 4.0	99.7 $\pm$ 2.0	84.5 $\pm$ 2.0		0.084 $\pm$ 0.005
	302 <sup>c</sup>	22	148.0 $\pm$ 4.9	73.8 $\pm$ 1.5	58.2 $\pm$ 1.9		0.036 $\pm$ 0.003
	Clay <sup>a</sup>	10	145.7 $\pm$ 1.8	85.4 $\pm$ 1.0	71.8 $\pm$ 1.0		0.049 $\pm$ 0.002
	885 <sup>b</sup>	10	177.7 $\pm$ 1.3	103.2 $\pm$ 1.2	83.0 $\pm$ 0.0		0.084 $\pm$ 0.001
Nauplius 5	223 <sup>a</sup>	10	152.0 $\pm$ 4.3	84.8 $\pm$ 2.4	65.5 $\pm$ 1.6	C	0.044 $\pm$ 0.003
	223 <sup>b</sup>	10	198.1 $\pm$ 1.9	114.1 $\pm$ 1.5	81.9 $\pm$ 0.8		0.095 $\pm$ 0.002
	224 <sup>c</sup>	10	220.7 $\pm$ 2.8	114.0 $\pm$ 0.9	96.4 $\pm$ 1.2		0.125 $\pm$ 0.003
	227 <sup>c</sup>	26	221.8 $\pm$ 5.3	118.3 $\pm$ 2.5	101.3 $\pm$ 2.3		0.140 $\pm$ 0.008
	302 <sup>c</sup>	21	189.0 $\pm$ 6.0	100.0 $\pm$ 3.5	63.2 $\pm$ 1.3		0.062 $\pm$ 0.004
	Clay <sup>a</sup>	10	169.6 $\pm$ 1.4	98.6 $\pm$ 1.0	81.6 $\pm$ 1.0		0.070 $\pm$ 0.002
	885 <sup>b</sup>	10	202.6 $\pm$ 1.3	112.9 $\pm$ 1.1	92.5 $\pm$ 1.2		0.109 $\pm$ 0.002
Nauplius 6	223 <sup>a</sup>	10	154.4 $\pm$ 2.4	87.0 $\pm$ 2.1	65.0 $\pm$ 0.8	B	0.040 $\pm$ 0.002
	223 <sup>b</sup>	10	242.2 $\pm$ 3.2	126.9 $\pm$ 1.7	89.7 $\pm$ 0.7		0.127 $\pm$ 0.003
	224 <sup>c</sup>	10	260.0 $\pm$ 0.8	131.2 $\pm$ 1.2	109.1 $\pm$ 0.6		0.170 $\pm$ 0.002
	227 <sup>c</sup>	28	250.5 $\pm$ 9.2	122.1 $\pm$ 3.4	106.6 $\pm$ 3.6		0.162 $\pm$ 0.013
	302 <sup>c</sup>	19	240.0 $\pm$ 8.7	110.7 $\pm$ 3.6	77.7 $\pm$ 3.6		0.100 $\pm$ 0.010
	Clay <sup>a</sup>	10	198.2 $\pm$ 1.3	107.9 $\pm$ 1.3	91.8 $\pm$ 1.2		0.090 $\pm$ 0.002
	885 <sup>b</sup>	10	239.7 $\pm$ 1.8	120.5 $\pm$ 1.1	105.6 $\pm$ 1.1		0.140 $\pm$ 0.003

<sup>a</sup> *Tropocyclops prasinus mexicanus*

<sup>b</sup> *Cyclops bicuspidatus thomasi*

<sup>c</sup> Mixed species

Table 7. (cont'd)

Species/ Life stage/ Sex	Lake	N	Length μm	Width μm	Depth μm	Formula	Dry Weight μg	
Copepodid 1	223 <sup>a</sup>	10	228.8± 2.4	83.2± 4.0	68.8± 4.2	B	0.061±0.006	
	223 <sup>b</sup>	35	362.9± 6.7	139.8± 2.6	88.8± 1.7	A	0.177±0.006	
	224 <sup>b</sup>	19	419.9± 5.6	148.7± 1.4	103.6± 1.7	A	0.238±0.007	
	227 <sup>a</sup>	7	262.1± 6.5	99.6± 1.6	79.0± 1.4	B	0.095±0.004	
	227 <sup>b</sup>	10	403.9±13.2	148.7± 1.5	101.4± 4.3	A	0.225±0.015	
	227 <sup>d</sup>	3	432.0±20.8	159.3± 4.5	130.0± 2.0	D	0.491±0.022	
	302 <sup>c</sup>	21	306.7±16.3	111.6± 6.4	76.4± 6.2	B	0.145±0.025	
	Clay <sup>a</sup>	10	308.7± 3.3	112.9± 1.1	85.3± 1.5	B	0.136±0.004	
	885 <sup>b</sup>	10	409.9± 2.8	152.5± 1.8	118.8± 2.6	A	0.273±0.010	
Copepodid 2	223 <sup>a</sup>	10	290.4± 8.4	99.5± 4.1	72.8± 2.5	B	0.098±0.009	
	223 <sup>b</sup>	32	471.1± 9.0	164.4± 2.6	110.1± 2.6	A	0.320±0.017	
	224 <sup>b</sup>	18	537.3± 7.8	175.6± 1.7	128.2± 1.4	A	0.445±0.013	
	227 <sup>a</sup>	7	310.6± 2.3	104.6± 1.3	87.4± 3.1	B	0.130±0.005	
	227 <sup>b</sup>	8	504.1±14.6	170.2± 4.2	131.6± 2.9	A	0.414±0.019	
	227 <sup>d</sup>	5	549.6± 8.8	171.6± 3.2	132.6± 3.8	D	0.688±0.032	
	302 <sup>c</sup>	19	378.4±19.1	135.2± 7.6	86.3± 4.4	B	0.230±0.040	
	Clay <sup>a</sup>	10	362.6± 5.0	121.9± 1.6	94.6± 1.0	B	0.192±0.005	
	885 <sup>b</sup>	10	514.0± 2.5	177.6± 2.0	135.8± 1.6	A	0.455±0.009	
Copepodid 3	223 <sup>a</sup>	10	326.0± 4.6	116.4± 3.2	91.2± 4.6	B	0.158±0.010	
	223 <sup>b</sup>	34	616.6±11.5	203.5± 5.4	136.2± 4.3	A	0.653±0.035	
	224 <sup>a</sup>	1	324	117	96	B	0.17	
	224 <sup>b</sup>	17	706.6± 9.7	216.3± 2.5	153.8± 2.0	A	0.865±0.026	
	227 <sup>a</sup>	4	364.5±14.0	113.5± 4.3	100.0± 2.9	B	0.191±0.020	
	227 <sup>b</sup>	9	627.9±18.6	207.7± 3.2	155.0± 3.8	A	0.746±0.045	
	227 <sup>d</sup>	6	680.0±23.5	216.0± 8.0	161.7± 6.5	D	1.327±0.135	
	302 <sup>a</sup>	16	326.5± 8.6	111.0± 2.4	80.2± 1.1	B	0.134±0.007	
	302 <sup>d</sup>	10	632.0±26.0	215.2±11.3	151.2± 9.4	D	1.187±0.179	
	302 <sup>c</sup>	9	529.3±15.1	206.2±11.2	133.8± 6.5	B	0.684±0.076	
	Clay <sup>a</sup>	10	404.7± 3.6	132.2± 1.6	104.6± 2.1	B	0.257±0.009	
	885 <sup>b</sup>	10	655.3±10.3	214.5± 2.3	152.1± 1.9	A	0.783±0.013	
	223 <sup>a</sup>	10	371.2± 6.7	136.4± 5.4	89.6± 3.5	B	0.211±0.017	
	223 <sup>b</sup>	45	774.0±11.9	246.8± 4.2	183.2± 5.3	A	1.333±0.080	
Copepodid 4	224 <sup>a</sup>	3	414.0± 0.0	174.1± 4.9	105.3± 4.8	B	0.257±0.006	
	224 <sup>b</sup>	17	853.8±10.4	264.6± 4.8	182.1± 2.8	A	1.520±0.063	
	227 <sup>a</sup>	5	411.2± 3.9	128.6± 2.8	115.4± 1.5	B	0.280±0.009	
	227 <sup>b</sup>	11	763.9±16.5	227.2± 5.0	178.6± 3.9	A	1.150±0.068	
	227 <sup>d</sup>	5	832.8±37.9	235.4± 8.9	191.4±15.1	D	2.120±0.338	
	302 <sup>a</sup>	18	418.7±11.0	124.2± 2.4	96.9± 2.9	B	0.233±0.013	
	302 <sup>d</sup>	10	761.2±12.2	246.4± 5.9	167.2± 7.3	D	1.743±0.128	
	302 <sup>c</sup>	16	724.2±12.1	239.0± 7.6	154.2± 4.6	B	1.253±0.098	
	Clay <sup>a</sup>	10	460.9±11.5	142.0± 2.8	112.2± 2.4	B	0.340±0.021	
	885 <sup>b</sup>	10	805.9±16.6	240.9± 5.0	192.7± 3.9	A	1.382±0.081	
	223 <sup>a</sup>	10	457.6±12.7	156.8± 4.0	123.2± 3.4	B	0.411±0.027	
	223 <sup>b</sup>	20	917.2±17.4	280.4± 8.8	211.1± 8.6	A	2.055±0.179	
	224 <sup>a</sup>	3	438.0± 3.0	146.7± 1.3	109.0± 6.1	B	0.320±0.017	
Copepodid 5	F	224 <sup>b</sup>	7	1076.6±16.7	299.1±12.3	242.9± 7.0	A	2.891±0.221
	M	224 <sup>b</sup>	8	961.5±37.6	257.3± 8.0	195.0± 3.0	A	1.776±0.108
	227 <sup>a</sup>	6	447.5± 9.7	140.7± 5.6	109.8± 4.4	B	0.320±0.027	
	227 <sup>b</sup>	6	918.0±10.6	268.0± 5.1	194.2± 4.7	A	1.753±0.068	
	227 <sup>d</sup>	5	986.4±45.3	303.6±19.9	242.4±14.4	D	4.132±0.600	
	302 <sup>a</sup>	18	466.2±12.9	146.7± 3.9	110.0± 5.0	B	0.357±0.029	
	302 <sup>d</sup>	19	969.7±36.9	298.3±14.9	224.2± 9.4	D	3.788±0.372	
	302 <sup>c</sup>	11	746.9± 8.9	221.5± 6.0	171.6± 8.3	B	1.321±0.108	
	Clay <sup>a</sup>	10	488.5±10.0	149.2± 4.9	117.9± 3.6	B	0.400±0.033	

<sup>a</sup> *Tropocyclops prasinus mexicanus*<sup>b</sup> *Cyclops bicuspidatus thomasi*<sup>c</sup> Mixed species<sup>d</sup> *Mesocyclops edax*

Table 7. (cont'd)

Species/ Life stage/ Sex	Lake	N	Length μm	Width μm	Depth μm	Formula	Dry Weight μg
<b>Adult Copepodids</b>							
<u>Cyclops</u>	223	20	1027.6±35.2	331.2±14.5	212.1±10.4	A	2.918±0.334
<u>bicuspidatus</u>	224	18	1199.3± 8.4	372.0± 3.7	277.7± 4.2		4.555±0.122
<u>thomasi</u>	227	14	1231.0±17.4	383.1± 6.6	270.9± 6.9		4.698±0.183
Female	302	28	713.6±10.2	223.9± 4.3	146.9± 3.5		0.871±0.040
Clay	10	1065.5±40.3	319.9±12.5	244.4± 9.4		3.172±0.396	
	885	11	1094.8±12.0	353.3± 3.8	279.4± 3.9		3.967±0.122
<u>Cyclops</u>	223	15	884.7±22.7	239.0± 6.1	149.9± 4.1	A	1.193±0.084
<u>bicuspidatus</u>	224	11	1000.4± 5.2	244.6± 1.8	178.9± 3.8		1.604±0.034
<u>thomasi</u>	227	15	925.6±11.3	254.3± 6.3	185.6± 5.7		1.608±0.092
Male	302	10	664.0± 9.0	207.2± 2.4	114.0± 2.4		0.578±0.025
Clay	10	880.0±11.4	225.3± 4.2	160.4± 2.7		1.165±0.030	
	885	9	894.0± 8.9	233.8± 4.5	168.7± 3.6		1.294±0.048
<u>Cyclops</u>	302	39	1122.2±14.9	403.9± 6.8	252.1± 5.9	B	5.359±0.250
<u>vernalis</u>	Clay	13	1173.3±35.0	433.2±12.2	284.2±11.5		6.825±0.608
Female	885	1	1302	460	384		10.5
<u>Cyclops</u>	302	39	791.3±10.2	249.0± 3.4	160.5± 1.8	B	1.460±0.043
<u>vernalis</u>	Clay	13	816.0±12.1	252.0± 7.6	167.8± 4.3		1.604±0.116
Male							
<u>Mesocyclops</u>	223	10	1309.2±21.4	423.9± 6.2	286.4± 4.9	D	8.785±0.380
<u>edax</u>	227	15	1406.4±17.0	411.7± 3.9	327.5± 4.9		10.469±0.344
Female	302	29	1171.4± 8.4	371.0± 3.9	249.9± 2.7		5.972±0.099
Clay	5	1620.8±65.4	507.6±29.5	422.4±23.0		19.553±2.848	
	885	2	1614 ±17.0	648 ± 5.7	450 ±35.4		25.801±1.535
<u>Mesocyclops</u>	223	9	780.4±14.6	246.6± 3.1	170.2± 1.8	D	1.807±0.070
<u>edax</u>	227	17	855.9± 8.4	241.4± 2.2	185.6± 3.5		2.146±0.064
Male	302	32	795.0± 7.7	233.1± 1.5	165.0± 2.6		1.690±0.049
Clay	5	1025.6± 6.6	295.2± 4.8	226.2± 2.5		3.768±0.118	
	885	1	1094	400	320		7.7
<u>Tropocyclops</u>	223	30	542.1± 5.2	172.5± 1.2	132.5± 1.5	B	0.571±0.014
<u>mexicanus</u>	224	10	517.9±10.8	162.3± 3.2	111.9± 2.1		0.434±0.022
<u>prasinus</u>	227	14	542.8±10.4	179.0± 4.7	129.1± 2.8		0.579±0.029
Female	302	57	508.4± 3.0	168.2± 1.0	116.7± 2.9		0.457±0.014
Clay	10	609.0± 7.1	192.7± 1.6	154.9± 2.4		0.834±0.023	
<u>Tropocyclops</u>	223	30	455.7± 4.9	133.5± 0.6	98.5± 1.7	B	0.276±0.007
<u>prasinus</u>	224	4	441.0±13.2	133.0± 3.5	96.8± 0.8		0.261±0.014
<u>mexicanus</u>	227	16	463.0± 8.0	133.8± 1.7	106.7± 1.0		0.303±0.007
Male	302	48	423.1± 2.8	126.9± 1.0	92.2± 1.8		0.228±0.006
Clay	10	484.2± 5.5	141.0± 2.8	111.5± 1.2		0.350±0.012	

Table 8. Dimensions and calculated dry weights (means  $\pm$  S.E.) of Lake 223 organisms sampled from different lake strata or seasons. Copepodid, female and male are abbreviated C, F and M, respectively. N is number of individuals. Mean dry weights from two strata or two seasons were compared using one-way ANOVA. F-probability is the probability that the values are not different.

			N	Length μm	Width μm	Depth μm	Dry weight μg	F-proba- bility
<b>I. LAKE DEPTH STRATUM</b>								
<b><u>Diaptomus minutus</u></b>								
C1	19Jun74	Epi <sup>a</sup>	10	403.2 $\pm$ 3.2	124.8 $\pm$ 2.1	110.4 $\pm$ 1.6	0.254 $\pm$ 0.005	
		Hypo <sup>a</sup>	9	427.0 $\pm$ 1.6	129.8 $\pm$ 0.9	119.9 $\pm$ 1.3	0.306 $\pm$ 0.003	<0.0001
C2	19Jun74	Epi	10	513.6 $\pm$ 3.7	132.8 $\pm$ 2.4	126.4 $\pm$ 3.7	0.395 $\pm$ 0.015	
		Hypo	10	521.2 $\pm$ 2.1	143.5 $\pm$ 1.2	127.0 $\pm$ 1.8	0.436 $\pm$ 0.010	0.0433
C3	19Jun74	Epi	10	585.6 $\pm$ 17.7	163.2 $\pm$ 4.6	136.0 $\pm$ 6.0	0.603 $\pm$ 0.050	
		Hypo	10	616.0 $\pm$ 9.9	176.0 $\pm$ 2.4	158.4 $\pm$ 1.6	0.788 $\pm$ 0.022	0.0033
C4	19Jun74	Epi	10	739.2 $\pm$ 14.5	195.2 $\pm$ 3.2	177.6 $\pm$ 3.7	1.177 $\pm$ 0.046	
		Hypo	10	812.8 $\pm$ 35.5	241.6 $\pm$ 10.8	208.4 $\pm$ 9.7	1.946 $\pm$ 0.223	0.0034
C5F	19Jun74	Epi	6	797.3 $\pm$ 17.2	203.7 $\pm$ 6.8	197.8 $\pm$ 6.1	1.481 $\pm$ 0.103	
		Hypo	2	960.0 $\pm$ 0.0	256.0 $\pm$ 8.0	240.0 $\pm$ 0.0	2.787 $\pm$ 0.084	0.0005
C5M	19Jun74	Epi	6	728.2 $\pm$ 10.7	193.0 $\pm$ 5.9	184.8 $\pm$ 9.9	1.179 $\pm$ 0.054	
		Hypo	8	884.0 $\pm$ 9.4	240.0 $\pm$ 0.0	218.0 $\pm$ 2.9	2.120 $\pm$ 0.043	<0.0001
C6F	19Jun74	Epi	20	919.4 $\pm$ 19.6	241.8 $\pm$ 2.4	213.6 $\pm$ 3.2	2.181 $\pm$ 0.067	
		Hypo	10	928.1 $\pm$ 22.6	254.2 $\pm$ 4.4	223.4 $\pm$ 1.9	2.417 $\pm$ 0.081	0.0427
C6F	17Jul74	Epi	10	921.6 $\pm$ 9.0	233.4 $\pm$ 3.3	215.2 $\pm$ 2.2	2.123 $\pm$ 0.054	
		Hypo	10	1011.0 $\pm$ 12.1	295.1 $\pm$ 2.9	265.8 $\pm$ 5.3	3.632 $\pm$ 0.085	<0.0001
C6M	19Jul74	Epi	17	833.9 $\pm$ 11.3	220.2 $\pm$ 3.2	201.4 $\pm$ 3.0	1.703 $\pm$ 0.058	
		Hypo	3	875.0 $\pm$ 2.5	237.3 $\pm$ 1.5	217.0 $\pm$ 3.8	2.065 $\pm$ 0.054	0.0203
<b>II. SEASON</b>								
<b><u>Cyclops bicuspidatus thomasi</u></b>								
C6F	May74 <sup>b</sup>	Lake	9	862.9 $\pm$ 10.5	262.1 $\pm$ 4.3	163.9 $\pm$ 4.7	1.366 $\pm$ 0.071	
	Aug74	Lake	10	1164.1 $\pm$ 20.5	390.7 $\pm$ 6.7	253.1 $\pm$ 5.3	4.252 $\pm$ 0.221	<0.0001
C6M	May74 <sup>b</sup>	Lake	7	815.4 $\pm$ 27.3	219.0 $\pm$ 7.1	136.0 $\pm$ 4.9	0.907 $\pm$ 0.098	
	Aug74	Lake	7	946.9 $\pm$ 18.3	253.9 $\pm$ 2.8	161.6 $\pm$ 2.1	1.425 $\pm$ 0.046	0.0004
<b><u>Diaptomus minutus</u></b>								
C6F	May74 <sup>b</sup>	Lake	10	943.6 $\pm$ 8.8	255.7 $\pm$ 3.4	212.2 $\pm$ 2.0	2.348 $\pm$ 0.057	
	Oct74 <sup>c</sup>	Lake	10	962.8 $\pm$ 5.9	262.0 $\pm$ 1.2	226.9 $\pm$ 1.8	2.913 $\pm$ 0.091	<0.0001
C6M	May74 <sup>b</sup>	Lake	10	894.2 $\pm$ 6.8	243.9 $\pm$ 1.8	204.5 $\pm$ 3.4	2.045 $\pm$ 0.049	
	Oct74 <sup>c</sup>	Lake	10	856.0 $\pm$ 5.2	250.7 $\pm$ 2.6	207.4 $\pm$ 1.9	2.407 $\pm$ 0.058	0.0001

<sup>a</sup> Epi = epilimnion; Hypo = hypolimnion.

<sup>b</sup> Before lake temperature strata established.

<sup>c</sup> After fall lake turnover.

Table 9. Length-weight regressions for calanoid and cyclopoid copepods of six lakes. Equations are generated from measured lengths and calculated dry weights. The slope ( $b$ )  $\pm$  the 95% confidence level (C.I.);  $y$ -intercept ( $l_{na}$ ); the average logarithm of the length, ( $\bar{ln}L$ ); estimated variance of  $\bar{ln}L$ , ( $Sx^2$ ); correlation coefficient ( $r$ ); number of observations ( $N$ ); residual mean square (RMS) and range of length measurements are presented for the relationship  $lnw = l_{na} + b\bar{ln}L$ , where  $lnw$  is the logarithm of the dry weight ( $\mu g$ ). Lengths are measured as shown in Fig. 1. Formulae are defined in Table 2. Lake 223 data are taken from Lawrence et al. 1987.

Species	Regres-sion No.	Lake	N	$l_{na}$	$b \pm C.I.$	$\bar{ln}L$	$Sx^2$	RMS	r	Range of length mm	Formula
<b>CALANOID COPEPODS</b>											
<b>NAUPLII (N1-N6)</b>											
<i>Diaptomus minutus</i>	1	223	60	1.2461	$2.2650 \pm 0.0722$	-1.6053	0.0793	0.0061	0.99	0.128-0.300	H1-4 : D
<i>D. oregonensis</i>	2	302	120	0.8700	$2.0669 \pm 0.1152$	-1.6326	0.0623	0.0251	0.96	0.128-0.312	H5 : C
<i>D. oregonensis</i>	3	Clay	60	1.2249	$2.1547 \pm 0.0794$	-1.5284	0.0990	0.0092	0.99	0.121-0.384	N6 : B
<i>D. siciloides</i>	4	885	53	0.9177	$2.0694 \pm 0.0996$	-1.5245	0.0494	0.0063	0.99	0.144-0.339	
Mixed species	5	224	63	0.9475	$2.0676 \pm 0.0656$	-1.4766	0.0989	0.0066	0.99	0.121-0.393	
	6	227	145	0.9926	$2.0997 \pm 0.0694$	-1.6044	0.0970	0.0172	0.98	0.121-0.423	
<b>COPEPODIDS (C1-C5)</b>											
<i>D. minutus</i>	7	223	140	1.0783	$2.7879 \pm 0.0875$	-0.4306	0.0708	0.0196	0.98	0.384-1.120	B
	8	227	71	0.9426	$2.6829 \pm 0.0802$	-0.3787	0.0700	0.0079	0.99	0.405-0.960	
	9	302	100	1.0267	$2.7540 \pm 0.0957$	-0.4998	0.0693	0.0159	0.99	0.336-1.020	
<i>D. oregonensis</i>	10	Clay	50	0.9227	$2.4235 \pm 0.0704$	-0.3654	0.0667	0.0040	1.00	0.435-1.046	
<i>D. siciloides</i>	11	885 <sup>a</sup>	8	0.8713	$2.1912 \pm 0.4756$	-0.6055	0.0416	0.0110	0.98	0.416-0.736	
<i>Epischura</i>	12	224	9	1.1839	$2.9946 \pm 0.1908$	-0.0422	0.1671	0.0087	1.00	0.564-1.524	
<i>Tacustris</i>	13	227	22	0.8655	$2.9373 \pm 0.1285$	-0.0863	0.1079	0.0086	1.00	0.459-1.416	
	14	302 <sup>b</sup>	17	1.1549	$3.2935 \pm 0.5346$	0.1806	0.0144	0.0145	0.96	0.944-1.424	
Mixed species	15	224 <sup>c</sup>	63	0.9799	$2.7765 \pm 0.0922$	-0.4559	0.0706	0.0093	0.98	0.378-1.080	
<b>ADULTS (C6)</b>											
<i>D. minutus</i>	16	223	122	1.0332	$2.6060 \pm 0.2797$	-0.1002	0.0065	0.0157	0.86	0.728-1.104	B
	17	224	15	0.8259	$1.6870 \pm 1.1410$	-0.0840	0.0032	0.0125	0.66	0.840-1.032	
	18	227	39	1.0808	$1.8630 \pm 0.3840$	-0.0328	0.0084	0.0114	0.85	0.816-1.200	
	19	302	147	1.0174	$2.5894 \pm 0.2222$	-0.0757	0.0046	0.0085	0.89	0.784-1.152	
<i>D. oregonensis</i>	20	Clay	20	0.9717	$2.7323 \pm 0.4721$	0.1902	0.0074	0.0071	0.94	1.014-1.430	
<i>D. sicilis</i>	21	224	15	0.9311	$3.0360 \pm 0.1630$	0.2012	0.0326	0.0026	1.00	0.948-1.560	
<i>D. siciloides</i>	22	885	16	0.9608	$3.1588 \pm 0.0484$	0.2137	0.0012	0.0043	0.87	1.142-1.318	
<i>E. lacustris</i>	23	223	20	1.4670	$2.4741 \pm 0.4840$	0.5515	0.0120	0.0121	0.93	1.430-2.044	
	24	224	27	1.2603	$2.5222 \pm 0.4337$	0.5280	0.0092	0.0106	0.92	1.392-2.016	
	25	227	35	1.2702	$2.4850 \pm 0.4071$	0.4347	0.0085	0.0116	0.91	1.272-1.812	
	26	302	25	1.4269	$2.2224 \pm 0.7181$	0.3865	0.0046	0.0133	0.80	1.264-1.648	
<b>COPEPODIDS AND ADULTS (C1-C6)</b>											
<i>D. minutus</i>	27	223	262	1.0542	$2.7482 \pm 0.0621$	-0.2767	0.0679	0.0178	0.98	0.384-1.140	B
	28	227	110	1.0377	$2.8255 \pm 0.0866$	-0.2560	0.0755	0.0157	0.99	0.405-1.200	
	29	302	247	1.0282	$2.7523 \pm 0.0492$	-0.2474	0.0741	0.0115	0.99	0.336-1.152	
<i>D. oregonensis</i>	30	Clay	70	0.9772	$2.5304 \pm 0.0544$	-0.2066	0.1133	0.0058	1.00	0.435-1.430	
<i>D. siciloides</i>	31	885	24	1.0889	$2.5288 \pm 0.0923$	-0.0594	0.1691	0.0077	1.00	0.416-1.318	
<i>E. lacustris</i>	32	224	36	1.1337	$2.7882 \pm 0.1161$	0.3854	0.1077	0.0123	0.99	0.564-2.016	
	33	227	57	1.2014	$2.6465 \pm 0.0651$	0.1777	0.1624	0.0096	1.00	0.459-1.812	
	34	302 <sup>d</sup>	42	1.2333	$2.7561 \pm 0.2894$	0.3031	0.0188	0.0158	0.95	0.944-1.648	
<b>ALL LIFE PHASES (N1-C6)</b>											
<i>D. minutus</i>	35	223	322	0.9212	$2.1497 \pm 0.0376$	-0.5243	0.3383	0.0400	0.92	0.128-1.140	B,C,D
	36	302	367	0.9059	$2.1291 \pm 0.0282$	-0.7003	0.4935	0.0374	0.99	0.128-1.152	
<i>D. oregonensis</i>	37	Clay	130	0.9212	$1.9903 \pm 0.0408$	-0.8167	0.5435	0.0298	0.99	0.121-1.430	
<i>D. siciloides</i>	38	885	77	1.0968	$2.1951 \pm 0.0354$	-1.0678	0.5516	0.0132	1.00	0.144-1.318	

a Copepodid 1-3 only.

b Copepodid 4-5 only.

c Copepodid 1-4 only.

d Copepodid 4-6 only.

Table 9. (cont'd)

Species	Regres-	Lake	N	Ina	b ± C.I.	TnL	Sx <sup>2</sup>	RMS	r	Range of length mm	Formula
No.											
<b>CYCLOPOID COPEPODS</b>											
<b>NAUPLII (N1-N6)</b>											
<i>Cyclops bicuspi-</i>	39	223 <sup>e</sup>	60	1.2290	2.2520±0.1011	-1.8209	0.0716	0.0108	0.99	0.108-0.256	N1-4 : D
<i>datus thomasi</i>	40	885	58	1.3463	2.2569±0.0736	-1.8186	0.0782	0.0060	0.99	0.102-0.243	N5 : C
<i>Mesocyclops edax</i>	41	302 <sup>f</sup>	15	0.8811	2.2034±0.3174	-1.6744	0.0622	0.0188	0.97	0.128-0.296	N6 : B
	42	3029	18	1.1897	2.3724±0.4371	-1.8500	0.0642	0.0464	0.94	0.104-0.288	
<i>Tropocyclops</i>	43	223	60	1.7143	2.5762±0.2718	-2.0883	0.0491	0.0535	0.93	0.080-0.160	
<i>prasinus mexi-</i>	44	227	17	1.4576	2.4529±0.2128	-2.0515	0.0746	0.0119	0.99	0.085-0.198	
<i>canus</i>	45	302 <sup>f</sup>	18	2.1369	2.8069±0.3696	-2.2164	0.0507	0.0262	0.97	0.080-0.168	
	46	3029	29	0.8964	2.2658±0.3697	-2.2478	0.0462	0.0420	0.92	0.076-0.176	
Mixed species	47	Clay	49	1.3581	2.2981±0.0805	-1.9935	0.1033	0.0079	0.99	0.076-0.204	
	48	224	64	1.6235	2.4594±0.0850	-1.7861	0.0897	0.0102	0.99	0.102-0.264	
	49	227	138	1.6388	2.4474±0.0780	-1.7389	0.0920	0.0196	0.98	0.085-0.315	
	50	302	129	1.0145	2.3082±0.0919	-1.9713	0.1192	0.0329	0.98	0.076-0.296	
<b>COPEPODIDS (C1-C5)</b>											
<i>C. b. thomasi</i>	51	223	166	0.9032	2.7307±0.0764	-0.5435	0.1143	0.0287	0.98	0.272-1.120	A
	52	223 <sup>e</sup>	50	0.8601	2.5896±0.0764	-0.4756	0.0791	0.0068	0.99	0.398-0.982	
	53	224	86	0.7719	2.5549±0.0601	-0.4206	0.1049	0.0081	0.99	0.382-1.116	
	54	227	44	0.7674	2.4333±0.1330	-0.5078	0.0897	0.0167	0.98	0.315-0.960	
	55	885 <sup>c</sup>	40	0.7924	2.3468±0.0949	-0.5498	0.0675	0.0058	0.99	0.396-0.896	
Mixed <i>Cyclops</i> sp.	56	302	43	1.0300	2.5050±0.2000	-0.5536	0.1165	0.0479	0.97	0.304-0.800	B
<i>M. edax</i>	57	227	25	1.3205	2.6629±0.2402	-0.3529	0.0847	0.0274	0.98	0.396-1.068	D
	58	302 <sup>f</sup>	19	1.3135	2.9005±0.2094	-0.3379	0.1333	0.0234	0.99	0.412-1.184	
	59	3029	21	1.3506	2.7528±0.2662	-0.4170	0.1088	0.0352	0.98	0.412-1.156	
	60	302	50	1.3424	2.8027±0.1861	-0.3424	0.1015	0.0426	0.98	0.412-1.184	
<i>T. p. mexicanus</i>	61	223	50	1.2298	2.7965±0.2437	-1.1230	0.0591	0.0430	0.96	0.224-0.512	B
	62	224 <sup>h</sup>	7	0.5796	2.1354±0.7518	-0.8928	0.0115	0.0059	0.96	0.324-0.441	
	63	227	29	0.7164	2.3186±0.2049	-1.0653	0.0444	0.0124	0.98	0.234-0.468	
	64	302 <sup>f</sup>	17	0.7921	2.6362±0.3673	-1.0892	0.0728	0.0346	0.97	0.240-0.492	
	65	3029	22	0.8084	2.6215±0.3657	-1.1284	0.0626	0.0404	0.96	0.228-0.488	
	66	302	61	0.9578	2.7323±0.1874	-1.0086	0.0672	0.0354	0.97	0.224-0.544	
	67	Clay	50	0.7323	2.3332±0.1194	-0.9182	0.0301	0.0052	0.98	0.294-0.531	
<b>ADULTS (C6)</b>											
<i>C. b. thomasi</i>	68	223	35	0.7606	3.9145±0.3602	-0.0460	0.0238	0.0257	0.97	0.752-1.238	A
	69	223 <sup>e</sup>	20	0.8066	4.0823±0.3991	-0.0838	0.0223	0.0173	0.98	0.752-1.238	
	70	224	29	0.4925	5.5302±0.4203	0.1126	0.0086	0.0101	0.98	0.984-1.248	
	71	227	29	0.7646	3.6183±0.4063	0.0591	0.0235	0.0258	0.96	0.828-1.344	
	72	302	38	0.9795	3.4802±0.4989	-0.3586	0.0052	0.0116	0.93	0.620-0.816	
	73	Clay	20	0.7652	3.9756±0.7528	-0.0357	0.0164	0.0400	0.93	0.800-1.302	
	74	885	20	0.8772	5.2722±0.5389	-0.0015	0.0116	0.0145	0.98	0.864-1.190	
<i>C. vernalis</i>	75	302	78	1.2177	3.4934±0.1661	-0.0625	0.0372	0.0199	0.98	0.696-1.360	
	76	Clay	26	1.2549	3.8299±0.2566	-0.0249	0.0401	0.0155	0.99	0.752-1.398	
<i>M. edax</i>	77	223	19	1.3472	3.0087±0.1490	0.0229	0.0735	0.0066	1.00	0.704-1.430	D
	78	227	32	1.2487	3.1820±0.1486	0.0763	0.0652	0.0107	0.99	0.792-1.512	
	79	302 <sup>f</sup>	20	1.2321	3.3097±0.2783	-0.0414	0.0369	0.0123	0.99	0.776-1.216	
	80	3029	20	1.2758	3.1546±0.1421	-0.0477	0.0460	0.0040	1.00	0.732-1.252	
	81	302	61	1.2649	3.2053±0.1163	-0.0458	0.0404	0.0082	0.99	0.732-1.252	
<i>T. p. mexicanus</i>	82	223	60	1.6112	3.6336±0.2809	-0.7007	0.0110	0.0128	0.96	0.384-0.582	B
	83	224	14	0.9889	2.8054±0.4361	-0.7057	0.0096	0.0050	0.97	0.405-0.552	
	84	227	30	1.1615	2.9559±0.5726	-0.6983	0.0116	0.0263	0.89	0.405-0.594	
	85	302 <sup>f</sup>	20	1.6122	3.4372±0.4751	-0.7802	0.0096	0.0094	0.96	0.400-0.544	
	86	3029	20	1.0262	3.1726±0.6524	-0.7718	0.0119	0.0218	0.92	0.392-0.524	
	87	302	105	1.5269	3.4806±0.3892	-0.7615	0.0104	0.0415	0.87	0.392-0.552	
	88	Clay	20	1.6255	3.6749±0.3068	-0.6111	0.0158	0.0064	0.98	0.448-0.659	

<sup>c</sup> Copepodid 1-4 only.<sup>e</sup> 50 individuals (C1-C5) selected randomly ( $10 \text{ stage}^{-1}$ ) from 166 and 20 C6 (10 F, 10 M) selected randomly for preparation of Fig. 2.<sup>f</sup> Samples taken in 1981.<sup>g</sup> Samples taken in 1983.<sup>h</sup> Copepodid 3-5 only.

Table 9 (cont'd)

Species	Regres-	Lake	N	Tna	b ± C.I.	TnL	Sx <sup>2</sup>	RMS	r	Range of length mm	Formula
	No.										
<b>COPEPODIDS AND ADULTS (C1-C6)</b>											
<i>C. b. thomasi</i>	89	223	201	0.8370	2.6608±0.0744	-0.4569	0.1341	0.0386	0.98	0.272-1.238	A
	90	223 <sup>e</sup>	70	0.7885	2.5331±0.1264	-0.3637	0.0941	0.0293	0.98	0.398-1.238	
	91	224	115	0.8114	2.6440±0.0832	-0.2861	0.1344	0.0269	0.99	0.382-1.248	
	92	227	73	0.8344	2.5760±0.1103	-0.2826	0.1407	0.0309	0.98	0.315-1.344	
	93	885	60	0.8850	2.5440±0.1492	-0.3670	0.1163	0.0382	0.98	0.396-1.190	
<i>M. edax</i>	94	227	57	1.3169	2.7917±0.1240	-0.1119	0.1185	0.0254	0.99	0.396-1.512	D
	95	302 <sup>f</sup>	39	1.2632	2.9012±0.1522	-0.1858	0.1042	0.0224	0.99	0.412-1.216	
	96	302 <sup>g</sup>	41	1.3046	2.7519±0.1516	-0.2368	0.1112	0.0250	0.99	0.412-1.252	
	97	302	111	1.2931	2.8220±0.1075	-0.1794	0.0901	0.0291	0.98	0.412-1.252	
<i>T. p. mexicanus</i>	98	223	110	0.9246	2.5800±0.1319	-0.8927	0.0771	0.0372	0.97	0.224-0.582	B
	99	224 <sup>i</sup>	21	0.5987	2.2153±0.3253	-0.7681	0.0178	0.0086	0.96	0.324-0.552	
	101	227	59	0.7697	2.3791±0.1538	-0.8787	0.0615	0.0210	0.97	0.234-0.594	
	102	302 <sup>e</sup>	37	1.1881	2.9513±0.2226	-0.9222	0.0618	0.0267	0.98	0.240-0.544	
	103	302 <sup>f</sup>	42	0.4926	2.3951±0.2363	-0.9586	0.0701	0.0393	0.96	0.228-0.524	
	104	302	166	1.0491	2.8400±0.1479	-0.8523	0.0453	0.0420	0.95	0.224-0.552	
	105	Clay	70	0.9412	2.5596±0.1226	-0.8305	0.0450	0.0117	0.98	0.294-0.659	
<b>ALL LIFE PHASES (N1-C6)</b>											
<i>C. b. thomasi</i>	106	223	261	0.6154	2.0340±0.0537	-0.7704	0.4500	0.0877	0.98	0.108-1.238	A,B,C,D
	107	223 <sup>e</sup>	130	0.6268	1.9529±0.0437	-1.0362	0.6149	0.0434	0.99	0.108-1.238	
	108	885	118	0.7303	1.9536±0.0518	-1.0805	0.6279	0.0502	0.99	0.102-1.190	
<i>M. edax</i>	109	302 <sup>f</sup>	54	1.2054	2.4404±0.0747	-0.5993	0.5440	0.0399	0.99	0.128-1.216	B,C,D
	110	302 <sup>g</sup>	58	1.2484	2.4310±0.0652	-0.7201	0.6635	0.0399	1.00	0.104-1.252	
<i>T. p. mexicanus</i>	111	223	170	0.4774	2.0256±0.0625	-1.3146	0.3953	0.0672	0.98	0.080-0.582	B,C,D
	112	227	76	0.4804	2.0204±0.0724	-1.1410	0.3055	0.0302	0.99	0.085-0.594	
	113	302 <sup>f</sup>	55	0.4511	2.0950±0.1102	-1.3457	0.4328	0.0705	0.98	0.080-0.544	
	114	302 <sup>g</sup>	71	0.0706	1.9200±0.0801	-1.4852	0.4668	0.0526	0.98	0.076-0.524	
	115	Clay	119	0.4162	1.8636±0.0541	-1.3094	0.3987	0.0349	0.99	0.076-0.659	

<sup>e</sup> 50 individuals (C1 to C5) selected randomly (10 stage<sup>-1</sup>) from 166 and 20 C6 (10 F, 10 M) selected randomly for preparation of Fig. 2.<sup>f</sup> Samples taken in 1981.<sup>g</sup> Samples taken in 1983.<sup>i</sup> Copepodid 3-6 only.

Table 10. Length-weight regressions for cladocerans of six lakes. Equations are generated from measured lengths and calculated dry weights. Parameters are described in Table 9. Lengths are measured as shown in Fig. 1. Formulae are defined in Table 2.

Species	Lake	N	lna	b ± C.I.	TnL	Sx <sup>2</sup>	RMS	r	Ranges			Formula
									Length mm	Calculated dry weight, µg	Length mm	
<u>Alona</u> <u>rectangula</u>	Clay	16	2.2367	2.7418±0.4558	-1.1369	0.0341	0.0231	0.96	0.243-0.409	0.20-	1.01	A
<u>Bosmina</u> <u>longirostris</u>	223 <sup>a</sup>	88	2.4751	3.3614±0.0946	-1.2210	0.0413	0.0083	0.99	0.204-0.492	0.05-	1.13	H
	223 <sup>b,c</sup>	70	2.4198	2.8799±0.1916	-1.1214	0.0373	0.0237	0.96	0.204-0.486	0.11-	1.61	A
	224	12	2.9552	3.3460±0.8784	-1.1870	0.0100	0.0171	0.94	0.252-0.348	0.20-	0.64	A
	227	68	3.1104	3.3500±0.1178	-1.3275	0.0494	0.0115	0.99	0.180-0.414	0.08-	1.16	A
	302 <sup>b,d</sup>	100	1.8747	2.9074±0.1632	-1.2140	0.0470	0.0314	0.96	0.168-0.432	0.03-	0.58	A
	302 <sup>b,e</sup>	78	1.7930	2.7151±0.2556	-1.2543	0.0793	0.1004	0.92	0.112-0.560	0.04-	1.54	A
	Clay <sup>b</sup>	40	3.2245	3.4501±0.1903	-1.2444	0.0353	0.0121	0.99	0.179-0.409	0.07-	1.17	A
<u>Ceriodaphnia</u> <u>lacustris</u>	Clay	15	2.7286	3.3370±0.5188	-0.7782	0.0764	0.0617	0.97	0.275-0.704	0.20-	4.18	A
<u>Chydorus</u> <u>sphaericus</u>	223	8	3.1270	3.3678±0.2938	-1.3382	0.0109	0.0011	1.00	0.230-0.326	0.30-	0.89	A
	Clay	30	3.5035	3.2142±0.2757	-1.4548	0.0196	0.0103	0.98	0.198-0.339	0.18-	0.96	A
<u>Daphnia</u>												
<u>D. catawba</u>	223 <sup>a</sup>	58	0.9455	3.1108±0.0976	-0.1599	0.0833	0.0113	0.99	0.560-1.542	0.41-	10.82	G
<u>D. g. mendotae</u>	223 <sup>a,f</sup>	76	1.0797	2.7108±0.0870	0.2637	0.2433	0.0352	0.99	0.336-2.429	0.23-	43.11	H
	223 <sup>a</sup>	70	1.0956	2.7101±0.0776	0.3799	0.1755	0.0183	0.99	0.464-2.507	0.34-	44.42	H
	223 <sup>a</sup>	43	1.0649	2.7540±0.1059	0.4222	0.1267	0.0146	0.99	0.768-2.507	1.56-	44.42	H
	224	32	0.8989	2.8476±0.2294	0.4524	0.0987	0.0386	0.98	0.852-2.292	1.76-	30.57	I
	Clay <sup>b</sup>	31	1.7533	2.7013±0.2591	-0.2866	0.0407	0.0196	0.97	0.560-1.046	0.96-	6.77	A
<u>D. longiremis</u>	302	40	1.6274	3.3367±0.4511	-0.0205	0.0070	0.0136	0.93	0.816-1.104	2.52-	6.66	I
<u>D. retrocurva</u>	227	37	0.8637	3.1262±0.2333	-0.2154	0.0929	0.0441	0.99	0.540-1.536	0.31-	11.41	H
<u>D. schoedleri</u>	Clay <sup>b</sup>	40	0.6323	2.7034±0.2297	-0.0230	0.0409	0.0206	0.97	0.720-1.590	0.79-	6.34	A
	885 <sup>b</sup>	86	1.3933	3.0114±0.0868	-0.0307	0.2727	0.0440	0.99	0.403-3.201	0.4-	-174.4	H
<u>Diaphanosoma</u> <u>birgei</u>	223 <sup>a</sup>	85	1.2740	3.2454±0.1908	-0.2940	0.1026	0.0800	0.96	0.390-1.318	0.07-	11.13	H
	224	10	0.9638	3.3283±0.6559	-0.2734	0.0640	0.0466	0.97	0.576-1.116	0.56-	4.95	H
	227	54	1.0720	2.9064±0.1993	-0.3344	0.0726	0.0378	0.97	0.384-1.104	0.16-	4.10	H
	302 <sup>b,d</sup>	50	1.0436	2.7318±0.2122	-0.3224	0.1235	0.0674	0.97	0.380-1.760	0.11-	14.98	A
	302 <sup>b,e</sup>	50	0.9740	2.6410±0.1946	-0.3452	0.0582	0.0267	0.97	0.404-1.096	0.30-	3.53	A
	Clay	159	1.0148	2.8321±0.1484	-0.5837	0.0717	0.0640	0.95	0.320-1.126	0.10-	6.47	H
	239,240,382	9h,i	1.1949	3.0073±0.7157	-0.2518	0.0419	0.0307	0.97	0.497-1.043			
<u>Holopedium</u> <u>gibberum</u>	223	56	2.1169	2.6972±0.0478	0.1790	0.1214	0.0038	1.00	0.512-1.967	1.37-	54.81	E
	223	56	2.1202	1.9705±0.1305	0.1790	0.1214	0.0283	0.97	0.512-1.967	2.06-	41.11	D,FJ
	223 <sup>a</sup>	43	1.8135	2.7406±0.1080	0.3418	0.0300	0.0036	0.99	1.030-1.967	7.02-	41.11	D
	223 <sup>a</sup>	13	2.5058	2.6426±0.2123	-0.3593	0.0421	0.0047	0.99	0.512-0.998	2.06-	9.98	F
	227	89	2.7080	3.2102±0.1362	-0.2082	0.1250	0.0515	0.98	0.324-1.440	0.74-	65.94	E
	227	89	2.8522	2.5810±0.1951	-0.2082	0.1250	0.1057	0.94	0.324-1.440	1.11-	49.46	D,FJ
	227	27	2.2752	4.5992±0.7053	0.1615	0.0104	0.0317	0.94	1.032-1.440	11.50-	49.46	D
	227	62	3.1690	3.1429±0.1963	-0.3693	0.0890	0.0523	0.97	0.324-0.984	1.11-	24.19	F
	302 <sup>d</sup>	50	2.2852	2.4328±0.3666	-0.5090	0.0699	0.1138	0.89	0.352-1.028	0.59-	8.46	D,FJ
	302 <sup>e</sup>	52	2.4285	2.5195±0.3396	-0.4477	0.0804	0.1169	0.90	0.320-1.128	0.28-	10.66	D,FJ

<sup>a</sup> Data taken from Lawrence et al. (1987).

<sup>b</sup> Width adjusted at measurement.

<sup>c</sup> Sample taken from experimental enclosure to which 30 µg·L<sup>-1</sup> cadmium had been added (Lawrence 1980).

<sup>d</sup> 1981 samples.

<sup>e</sup> 1983 samples.

<sup>g</sup> data taken from organisms sampled in 1974 (Lawrence et al. 1987), range of length is here corrected to 0.336-2.429 mm.

<sup>g</sup> data taken from organisms sampled in 1978. Group of 70 contains females, males, neonates and egg and embryo bearing females;

<sup>h</sup> group of 43 contains only non-egg/embryo bearing females.

<sup>i</sup> Dried and weighed.

<sup>j</sup> 9 groups of 10-40 individuals.

Depth measurement is multiplied by 3 if organism length is <1000µm,

by 1.5 " " " " " >1000µm.

Table 11. Dimensions and calculated dry weights (means  $\pm$  S.E.) of rotifers from five lakes. Formulae are defined in Table 2. One mm<sup>3</sup> volume is assumed to weigh 1 mg (wet weight) and dry weight is assumed to be 7% of wet weight except for Asplanchna spp. where dry weight is calculated as 4% of wet weight. N is the number of individuals measured.

Species	Lake	N	Length μm	Width μm	Depth μm	Formula	Dry weight μg
<u>Anuraeopsis fissa</u>	224	7	75.6 $\pm$ 1.7	44.0 $\pm$ 1.3	44.0 $\pm$ 1.1	A	0.005 $\pm$ 0.0003
	227	24	76.8 $\pm$ 0.9	42.9 $\pm$ 0.5	40.3 $\pm$ 0.5		0.005 $\pm$ 0.0001
<u>Ascomorpha ecaudis</u>	223	10	81.6 $\pm$ 2.5	67.1 $\pm$ 1.8	66.5 $\pm$ 1.8	A	0.014 $\pm$ 0.001
<u>A. ovalis</u>	223	10	85.3 $\pm$ 1.4	74.4 $\pm$ 0.8	53.9 $\pm$ 1.5	A	0.013 $\pm$ 0.0003
<u>Ascomorpha</u> sp.	224	4	121.2 $\pm$ 2.6	78.8 $\pm$ 2.3	78.8 $\pm$ 2.3	A	0.028 $\pm$ 0.001
	227	9	117.0 $\pm$ 4.2	78.4 $\pm$ 2.3	67.9 $\pm$ 2.1		0.023 $\pm$ 0.002
<u>Asplanchna priodonta</u>	227	27	394.7 $\pm$ 10.2	254.0 $\pm$ 5.8	239.1 $\pm$ 5.5	A	0.525 $\pm$ 0.037
<u>Asplanchna</u> sp.	302	10	538.4 $\pm$ 10.1	364.4 $\pm$ 6.5	364.4 $\pm$ 6.5	A	1.501 $\pm$ 0.061
	Clay	6	303.7 $\pm$ 26.6	243.8 $\pm$ 12.4	228.8 $\pm$ 11.5		0.374 $\pm$ 0.072
<u>Cephalodella gibba</u>	302	10	119.2 $\pm$ 4.6	61.6 $\pm$ 1.4	81.6 $\pm$ 0.7	A	0.022 $\pm$ 0.001
<u>Cephalodella</u> sp.	302	10	62.4 $\pm$ 1.3	33.2 $\pm$ 0.6	33.2 $\pm$ 0.6	A	0.003 $\pm$ 0.0001
<u>Colletheaca</u> sp.	223	20	76.9 $\pm$ 3.8	44.2 $\pm$ 1.8	42.7 $\pm$ 1.7	A	0.006 $\pm$ 0.001
	224	9	101.0 $\pm$ 5.4	42.0 $\pm$ 2.6	42.2 $\pm$ 2.5		0.007 $\pm$ 0.001
	227	13	84.1 $\pm$ 4.2	37.9 $\pm$ 1.5	36.6 $\pm$ 1.5		0.004 $\pm$ 0.001
<u>Conochilis unicornis</u> (contracted)	223	16	89.4 $\pm$ 3.7	78.4 $\pm$ 3.7	73.5 $\pm$ 3.8	A	0.021 $\pm$ 0.003
	224	13	107.9 $\pm$ 3.7	81.5 $\pm$ 3.8	78.2 $\pm$ 3.2		0.026 $\pm$ 0.003
	227	27	107.7 $\pm$ 3.4	82.3 $\pm$ 2.6	80.2 $\pm$ 2.5		0.028 $\pm$ 0.002
<u>Conochilis</u> sp.	227	3	150.0 $\pm$ 6.0	97.3 $\pm$ 1.7	97.3 $\pm$ 1.7	A	0.052 $\pm$ 0.003
<u>Filinia longiseta</u>	227	25	148.7 $\pm$ 3.2	84.2 $\pm$ 2.3	76.7 $\pm$ 2.6	A	0.037 $\pm$ 0.003
	224	1	153	81	81		0.04
<u>Floscularia</u> sp.	302	15	164.3 $\pm$ 4.3	70.9 $\pm$ 1.5	70.9 $\pm$ 1.5	A	0.031 $\pm$ 0.002
<u>Gastropus hyptopus</u>	223	10	88.9 $\pm$ 2.6	80.2 $\pm$ 1.7	73.0 $\pm$ 1.3	A	0.019 $\pm$ 0.001
	224	8	86.0 $\pm$ 3.9	69.1 $\pm$ 4.6	69.1 $\pm$ 4.6		0.016 $\pm$ 0.003
<u>G. stylifer</u>	223	20	87.8 $\pm$ 1.9	70.8 $\pm$ 1.3	44.2 $\pm$ 0.9	J	0.015 $\pm$ 0.001
	227	24	97.0 $\pm$ 2.8	80.2 $\pm$ 2.9	47.3 $\pm$ 0.9		0.020 $\pm$ 0.002
<u>Hexarthra</u> sp.	Clay	10	182.7 $\pm$ 5.7	138.4 $\pm$ 4.2	123.9 $\pm$ 3.2	L	0.223 $\pm$ 0.018
<u>Kellicottia bostoniensis</u>	223	10	112.2 $\pm$ 1.1	57.0 $\pm$ 0.0	39.4 $\pm$ 1.2	B	0.012 $\pm$ 0.0004
	224	3	117.0 $\pm$ 5.2	45.0 $\pm$ 0.0	41.0 $\pm$ 1.0		0.010 $\pm$ 0.001
	227	7	114.4 $\pm$ 3.2	47.6 $\pm$ 1.7	35.3 $\pm$ 1.5		0.009 $\pm$ 0.001
<u>K. longispina</u>	223	20	131.6 $\pm$ 1.1	56.2 $\pm$ 0.7	48.2 $\pm$ 0.8	B	0.016 $\pm$ 0.0004
	224	21	130.0 $\pm$ 2.1	52.7 $\pm$ 1.3	46.8 $\pm$ 1.1		0.015 $\pm$ 0.001
	227	37	122.6 $\pm$ 1.5	55.0 $\pm$ 0.7	46.2 $\pm$ 0.7		0.014 $\pm$ 0.001
	Clay	10	146.1 $\pm$ 1.5	56.4 $\pm$ 0.6	47.5 $\pm$ 1.1		0.017 $\pm$ 0.001

Table 11. (cont'd)

<u>Keratella</u>	223	20	93.3± 0.9	53.8± 0.6	38.3± 0.3	B	0.009±0.0002	
<u>cochlearis</u>	224	15	102.5± 2.1	53.9± 1.3	42.7± 0.6		0.011±0.001	
	227	31	99.0± 1.4	52.2± 0.8	44.8± 0.7		0.011±0.0004	
	Clay	10	192.9±13.0	78.0± 5.6	57.1± 4.2		0.044±0.007	
<u>K. hiemalis</u>	224	4	111.3± 2.1	64.0± 1.0	54.0± 0.0	L	0.027±0.001	
	227	22	110.5± 0.9	64.1± 0.8	55.3± 0.6		0.028±0.001	
<u>K. tauro-</u>	223	14	119.3± 1.2	73.0± 0.8	47.5±1.0	A	0.015±0.0004	
<u>cephala</u>	224	4	112.5± 2.6	61.8± 2.8	47.3±1.3		0.012±0.001	
	227	3	114.0± 3.0	75.0± 6.0	49.3±2.6		0.016±0.002	
<u>Lecane</u>	224	2	108.0± 9.0	85.5± 4.5	44.0±1.0	L	0.028±0.0002	
<u>sp.</u>	227	3	96.0±13.1	78.0± 7.9	69.0±7.9		0.038±0.011	
<u>Lepadella</u>	302	10	80.8± 4.4	58.4± 3.0	28.8±1.4	A	0.005±0.001	
<u>Monommata</u>	302	10	88.4± 3.5	55.2± 1.8	55.2±1.8	A	0.010±0.001	
<u>Ploesoma</u>	223	20	111.4± 4.1	102.6± 3.6	102.0±3.9	A	0.046±0.004	
<u>Tenticulare</u>								
<u>P. truncatum</u>	Clay	10	150.1± 3.0	119.9± 1.6	110.1±1.1	A	0.073±0.003	
<u>Ploesoma</u>	sp.	224	5	109.8± 8.7	97.2± 7.2	91.8±8.2	A	0.038±0.008
		227	9	115.0± 4.9	100.0± 4.4	98.9±3.6		0.043±0.005
<u>Polyarthra</u>	Clay	10	200.6± 2.3	116.1± 2.4	98.9±1.9	J	0.127±0.005	
<u>P. remata</u>	223	20	84.7± 1.7	52.2± 1.1	47.8±1.2	J	0.013±0.001	
	224	9	81.0± 3.4	51.0± 3.4	42.9±1.7		0.010±0.002	
	227	14	82.3± 3.0	56.9± 3.0	55.1±2.8		0.015±0.002	
	Clay	10	80.8± 2.9	54.0± 1.7	51.6±1.5		0.013±0.001	
<u>P. vulgaris</u>	223	20	120.3± 2.2	71.4± 1.9	65.0±1.5	J	0.031±0.002	
	224	19	123.2±13.1	72.9± 2.6	62.6±2.6		0.032±0.003	
	227	48	126.8± 1.5	77.1± 2.6	71.2±1.5		0.041±0.002	
	Clay	10	109.8± 1.8	74.2± 0.9	70.0±0.9		0.031±0.001	
<u>Synchaeta</u>	223	10	74.3± 1.4	70.0± 0.9	65.7±1.4	A	0.013±0.001	
<u>sp.</u>	227	27	193.1± 7.2	145.7± 5.1	139.0±4.7		0.156±0.015	
	302	10	156.0± 4.4	109.6± 3.0	109.6±3.0		0.070±0.006	
	Clay	10	283.7±13.5	184.1± 1.9	191.2±2.0		0.366±0.019	
<u>Testudinella</u>	302	10	102.0± 1.7	87.2± 3.5	30.8±0.9	J	0.015±0.001	
<u>parva</u>								
<u>Trichocerca</u>	223	10	318.5± 5.4	73.8± 1.7	81.0±2.6	A	0.070±0.004	
<u>cylindrica</u>	224	6	368.2±13.4	80.2± 2.5	86.5±1.4		0.094±0.006	
	227	12	314.2±13.8	78.2± 3.3	78.2±3.3		0.074±0.008	
	Clay	10	313.4± 6.8	78.2± 1.4	77.4±0.9		0.070±0.003	
<u>I. multi-</u>	Clay	10	208.1± 1.5	99.6± 1.0	92.5±1.2	A	0.070±0.002	
<u>crinis</u>								
<u>Trichocerca</u>	223	10	95.8± 1.9	41.1± 0.9	38.6±0.6	A	0.006±0.0003	
<u>sp. (small)</u>	224	3	90.0± 0.0	34.7± 1.3	34.7±1.3	A	0.004±0.0002	
	227	5	94.4± 2.0	41.2± 1.7	41.2±1.7	A	0.006±0.001	
	302	10	97.6± 2.5	32.4± 0.4	32.4±0.4	A	0.004±0.0002	
	Clay	10	92.0± 1.5	41.9± 0.9	42.2±0.9	K	0.006±0.0003	

Table 12. Dimensions and calculated dry weights (means  $\pm$  S.E.) of eggs of copepods, cladocerans and rotifers from several lakes in ELA. The formulae used to calculate volume was  $4/3\pi(abc)$  where symbols are as in Table 2. One mm<sup>3</sup> volume is assumed to weigh 1 mg (wet weight), and dry weight is assumed to be 7% of wet weight. N is the number of eggs measured.

Species	Lake	N	Length μm	Width μm	Depth μm	Dry weight/egg μg
<b>COPEPODA</b>						
Calanoid copepods						
<u>Diaptomus minutus</u>	223	8	113.9 $\pm$ 1.9	110.6 $\pm$ 2.4	111.6 $\pm$ 1.8	0.052 $\pm$ 0.002
<u>D. sicilis</u>	223	1	115	115	115	0.06
Cyclopoid copepods						
<u>Cyclops bicuspidatus thomasi</u>	223	26	86.5 $\pm$ 0.9	76.4 $\pm$ 1.0	76.8 $\pm$ 1.2	0.019 $\pm$ 0.001
<u>Mesocyclops edax</u>	223	2	121.5 $\pm$ 6.5	96.0 $\pm$ 0.0	92.5 $\pm$ 3.5	0.040 $\pm$ 0.004
<u>Tropocyclops prasinus mexicanus</u>	223	6	62.2 $\pm$ 1.7	56.7 $\pm$ 0.6	54.5 $\pm$ 1.2	0.007 $\pm$ 0.0004
<b>CLADOCERA</b>						
<u>Bosmina longirostris</u>	223	5	134.2 $\pm$ 3.5	97.2 $\pm$ 1.2	93.2 $\pm$ 1.7	0.045 $\pm$ 0.002
<u>Daphnia galeata mendotae</u>	223	6	241.2 $\pm$ 4.9	195.2 $\pm$ 4.5	190.0 $\pm$ 2.0	0.329 $\pm$ 0.019
<u>D. longiremis</u>	302	10	192.5 $\pm$ 2.1	127.7 $\pm$ 1.7	127.7 $\pm$ 1.7	0.115 $\pm$ 0.004
<u>Diaphanosoma birgei</u>	223	1	256	121	102	0.12
<u>Holopedium gibberum</u>	223	5	155.8 $\pm$ 1.7	155.8 $\pm$ 1.7	155.8 $\pm$ 1.7	0.139 $\pm$ 0.005
	302	4	149.5 $\pm$ 7.3	149.5 $\pm$ 7.3	149.5 $\pm$ 7.3	0.125 $\pm$ 0.018
<b>ROTIFERA</b>						
<u>Anuraeopsis fissa</u>	227	10	58.2 $\pm$ 2.1	34.1 $\pm$ 0.8	33.3 $\pm$ 0.9	0.002 $\pm$ 0.0002
<u>Colletheca sp.</u>	223	5	42.2 $\pm$ 0.8	27.2 $\pm$ 1.3	25.0 $\pm$ 0.0	0.001 $\pm$ 0.0001
<u>Conochilus sp.</u>	223	1	83	51	51	0.01
<u>Kellicottia bostoniensis</u>	223	20	63.2 $\pm$ 0.5	40.2 $\pm$ 0.7	37.7 $\pm$ 0.3	0.004 $\pm$ 0.0001
<u>K. longispina</u>	223	20	84.3 $\pm$ 1.9	45.5 $\pm$ 0.9	43.7 $\pm$ 0.8	0.006 $\pm$ 0.0003
<u>Keratella cochlearis</u>	223	20	55.1 $\pm$ 0.9	41.8 $\pm$ 0.5	37.0 $\pm$ 0.4	0.003 $\pm$ 0.0001
<u>K. hiemalis</u>	223	5	70.2 $\pm$ 0.8	55.0 $\pm$ 1.3	49.0 $\pm$ 1.4	0.007 $\pm$ 0.0004
<u>K. taurocephala</u>	223	16	64 $\pm$ 8 $\pm$ 1.0	48.8 $\pm$ 0.7	45.2 $\pm$ 0.7	0.005 $\pm$ 0.0002
<u>Polyarthra remata</u>	223	5	63.6 $\pm$ 0.4	38.0 $\pm$ 0.0	38.0 $\pm$ 0.0	0.003 $\pm$ 0.0002
	227	10	62.2 $\pm$ 0.3	37.9 $\pm$ 0.3	38.1 $\pm$ 0.5	0.003 $\pm$ 0.0001
<u>P. vulgaris</u>	223	4	83.5 $\pm$ 4.6	50.8 $\pm$ 2.2	49.2 $\pm$ 1.8	0.008 $\pm$ 0.001

Table 13. Comparisons of dry weights of individuals and eggs of copepods found in temperate North American lakes. Where the authors presented biomass as volume or wet weight, a dry weight estimate was calculated assuming 1 mm<sup>3</sup> weighs 1 mg (wet weight) and dry weight is 7% of wet weight. \* indicates weight obtained by drying and weighing of organisms. N is the number of organisms. Copepodid is designated as C.

Species	N	Dry weight μg individual <sup>-1</sup>	Collection Site	Source
<b>CALANOID COPEPODS</b>				
Nauplii	720	0.067-0.45*	Lake Erie	Culver et al. 1985
	501	0.03-0.32	6 Lakes	This paper Table 6
		0.9* (500μm)	Lake Ontario	Wilson and Roff 1973
Immature Copepodids		0.87-1.17*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
	190	0.83-3.23*	Lake Erie	Culver et al. 1985
		3.0	Cornell, NY ponds	Hall et al. 1970
		6.1*	Lake Ontario	Wilson and Roff 1973
	489	0.23-10.64	6 Lakes	This paper Table 6
<u><i>Diaptomus minutus</i></u>				
Adults		4.5*	Clear Lake, Ontario	Schindler and Novén 1971
		2.0-2.24*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		4.9*	Lake Ontario	Wilson and Roff 1973
Females		1.7-4.9*	Lake Michigan	Hawkins and Evans 1979
		11.95-26.9*	6 N.Ontario lakes	Roff & Kwiatkowski 1977
	120	5.0*	Lake Ontario	This paper Table A2
	102	1.97-3.55*	Lake Erie	Culver et al. 1985
	185	1.90-3.27	5 lakes	This paper Table 6
	56	1.96-3.97*	3 ELA lakes	Lawrence et al. 1987
Males		1.8-4.4*	Lake Michigan	Hawkins and Evans 1979
	142	1.5-2.48	5 ELA lakes	This paper Table 6
	105	4.0*	Lake Ontario	This paper Table A2
	15	3.0*	1 ELA lake	Lawrence et al. 1987
Immature Copepodids		1.6	Clear Lake, Ontario	Schindler and Novén 1971
		1.0-3.7a*	Clear Lake, Ontario	Schindler 1972
	30	1.47* (C5)	Lake Erie	Culver et al. 1985
	314	0.22-2.17	4 ELA lakes	This paper Table 6
Nauplii		0.4	Clear Lake, Ontario	Schindler and Novén 1971
		0.1-0.9a*	Clear Lake, Ontario	Schindler 1972
	180	0.03-0.20	2 ELA Lakes	This paper Table 6
Eggs		0.07*	Clear Lake, Ontario	Schindler and Novén 1971
	8	0.052	L223	This paper Table 12
<u><i>Diaptomus oregonensis</i></u>				
Adults		3.55*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		9.0*	Lake Ontario	Wilson and Roff 1973
Females		3.8-10.9*	Lake Michigan	Hawkins and Evans 1979
		2.342*	Silver Lake, Minn.	Comita and McNett 1976
	31	9.9*	Lake Ontario	This paper Table A2
	104	3.84-8.66	Lake Erie	Culver et al. 1985
	10	5.52	Clay Lake, Ontario	This paper Table 6
Males		3.3-10.1*	Lake Michigan	Hawkins and Evans 1979
	31	8.6*	Lake Ontario	This paper Table A2
		3.373*	Silver Lake, Minn.	Comita and McNett 1976
	50	4.33-4.80	Lake Erie	Culver et al. 1985
	10	3.64	Clay Lake, Ontario	This paper Table 6

Table 13. (cont'd)

Species	N	Dry weight µg individual <sup>-1</sup>	Collection Site	Source
<b><u>Diaptomus oregonensis</u> (cont'd)</b>				
Immature Copepodids	30 50	3.23* (C5) 0.41-2.50	Lake Erie Clay Lake, Ontario	Culver et al. 1985 This paper Table 6
<b><u>Diaptomus sicilis</u></b>				
Adults		13.7*	Muskoka-Haliburton Lakes, Ontario	Hitchin and Yan 1983
		12.6*	Lake Ontario	Wilson and Roff 1973
Females	524 88 8	13.6* 13.4-23.0* 14.1* 7.64	Lake Superior Lake Michigan Lake Ontario Lake 224	This paper Table A2 Hawkins and Evans 1979 This paper Table A2 This paper Table 6
Males	359 95 7	10.9* 8.6-14.5* 10.7* 2.76	Lake Superior Lake Michigan Lake Ontario Lake 224	This paper Table A2 Hawkins and Evans 1979 This paper Table A2 This paper Table 6
<b><u>Diaptomus siciloides</u></b>				
Females	77 11	4.75-10.5* 5.54	Lake Erie Lake 885	Culver et al. 1985 This paper Table 6
Males	110 5	3.45-7.47* 4.38	Lake Erie Lake 885	Culver et al. 1985 This paper Table 6
<b><u>Epischura lacustris</u></b>				
Adults		15.9* 5.9-13.9*	Muskoka-Haliburton Lakes, Ontario Lake Michigan	Yan and Strus 1980 Hawkins and Evans 1979
Females	29 69 55 17	21.6* 23.9* 11.54-21.28 13.8-20.2*	Lake Huron/Georgian Bay Lake Superior 4 ELA lakes 2 ELA lakes	This paper Table A2 This paper Table A2 This paper Table 6 Lawrence et al. 1987
Males	6 61 52 7	15.2* 18.8* 8.68-13.98 11.43*	Lake Huron/Georgian Bay Lake Superior 4 ELA Lakes 1 ELA lake	This paper Table A2 This paper Table A2 This paper Table 6 Lawrence et al. 1987
Immature Copepodids	2 48	7.0* 0.8-3.6* 0.47-10.64	Lake Superior Lake Michigan 3 ELA Lakes	This paper Table A2 Hawkins and Evans 1979 This paper Table 6
<b>CYCLOPOID COPEPODS</b>				
Nauplii		0.34* 0.01 680 558	Clear Lake, Ontario Cornell, NY ponds Lake Erie 6 Lakes	Schindler and Novén 1971 Hall et al. 1970 Culver et al. 1985 This paper Table 7
Immature Copepodids ( <i>Cyclops</i> spp.)		0.78-1.75* 3.0 0.6-2.2* 663	Muskoka-Haliburton Lakes, Ontario Cornell, NY ponds Lake Michigan 6 Lakes	Yan and Strus 1980 Hall et al. 1970 Hawkins and Evans 1979 This paper Table 7

Table 13. (cont'd)

Species	N	Dry weight μg individual <sup>-1</sup>	Collection Site	Source
<u><i>Cyclops bicuspidatus thomasi</i></u>				
Adults		4.05*	Clear Lake, Ontario	Schindler and Novén 1971
		3.24-4.6*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		3.1*	Lake Ontario	Wilson and Roff 1973
Females	194	4.9*	Lake Huron/Georgian Bay	This paper Table A2
	39	4.1*	Lake Superior	This paper Table A2
	297	3.8*	Lake Ontario	This paper Table A2
		1.9-5.6*	Lake Michigan	Hawkins and Evans 1979
	67	3.4-4.9*	Lake Erie	Culver et al. 1985
	101	0.87-4.70	6 lakes	This paper Table 7
	90	2.75-3.52*	3 ELA lakes	Lawrence et al. 1987
Males	21	1.8*	Lake Huron/Georgian Bay	This paper Table A2
	29	2.5*	Lake Superior	This paper Table A2
	309	2.2*	Lake Ontario	This paper Table A2
		1.2-2.9*	Lake Michigan	Hawkins and Evans 1979
	70	0.58-1.61	6 lakes	This paper Table 7
	40	1.85-2.98*	2 ELA lakes	Lawrence et al. 1987
Immature Copepodids	115	1.52*	Clear Lake, Ontario	Schindler and Novén 1971
		1.4*	Lake Huron/Georgian Bay	This paper Table A2
		2.4*	Lake Ontario	Wilson and Roff 1973
	377	1.8*	Lake Superior	This paper Table A2
	323	2.2*	Lake Ontario	This paper Table A2
	127	0.97-2.95*	Lake Erie	Culver et al. 1985
	336	0.18-2.89	4 Lakes	This paper Table 7
Eggs		0.06*	Clear Lake, Ontario	Schindler and Novén 1971
	306	0.168*	Lake Erie	Culver et al. 1985
	26	0.019	Lake 223	This paper Table 12
<u><i>Cyclops vernalis</i></u>				
Adults		3.14*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		8.6*	Cornell, NY ponds	Hall et al. 1970
Females		4.8-6.4*	Lake Michigan	Hawkins and Evans 1979
	127	1.8-8.3*	Lake Erie	Culver et al. 1985
	53	5.4-10.5	3 Lakes	This paper Table 7
Males		2.4-2.6*	Lake Michigan	Hawkins and Evans 1979
	70	1.5-3.1*	Lake Erie	Culver et al. 1985
	52	1.5-1.6	2 Lakes	This paper Table 7
Immature Copepodids	224	0.33-1.43*	Lake Erie	Culver et al. 1985

Table 13. (contd)

Species	N	Dry weight μg individual <sup>-1</sup>	Collection Site	Source
<u>Mesocyclops edax</u>				
Adults		6.46-10.7*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		18.0	Cornell, NY ponds	Hall et al. 1970
Females	23	8.4*	Lake Huron/Georgian Bay	This paper Table A2
	120	3.8-7.2*	Lake Erie	Culver et al. 1985
	61	5.97-25.80	5 Lakes	This paper Table 7
	39	7.33-9.92*	2 ELA lakes	Lawrence et al. 1987
Males	63	1.7-7.7	5 ELA lakes	This paper Table 7
	29	3.36*	1 ELA lake	Lawrence et al. 1987
Immature Copepodids	150	0.97-2.40*	Lake Erie	Culver et al. 1985
	63	0.49-4.13	2 ELA lakes	This paper Table 7
Eggs	300	0.175*	Lake Erie	Culver et al. 1985
	9	0.03-0.04	2 ELA lakes	This paper Table 12
<u>Tropocyclops prasinus mexicanus</u>				
Adults		0.47-0.87*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		1.20±0.057*	Mirror Lake, NH	Makarewicz and Likens 1979
		0.7-1.2*	Lake Michigan	Hawkins and Evans 1979
Females	121	0.43-0.83	5 ELA lakes	This paper Table 7
	45	1.0*	1 ELA lake	S.G. Lawrence, unpublished data
Males	108	0.23-0.35	5 ELA lakes	This paper Table 7
	26	0.38*	1 ELA lake	S.G. Lawrence, unpublished data
Immature Copepodids	188	0.3-0.5*	Lake Michigan	Hawkins and Evans 1979
		0.06-0.41	4 ELA lakes	This paper Table 7

a estimated from graphic material.

Table 14. Comparisons of dry weights of individuals of cladocerans in temperate North American lakes. \* indicates weight obtained by the drying and weighing of individuals or groups of organisms. All other dry weight values were calculated from dimensional data. N is the number of organisms. Length (mm) of organisms are given in parentheses.

Species		Dry weight N $\mu\text{g individual}^{-1}$	Collection Site	Source
<u>Bosmina longirostris</u>		2.0	Clear Lake, Ontario	Schindler and Novén 1971
		0.7-4.0a*	Clear Lake, Ontario	Schindler 1972
		0.54-0.78*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
	295	1.4*	Lake Huron/Georgian Bay	This paper Table A2 Table 1
	102	2.4*	Lake Superior	This paper Table A2
		1.20 (0.26mm)	Lake Severson, MN	Comita 1972
		1.8*	Cornell, NY ponds	Hall et al. 1970
		1.17±0.088*	Mirror Lake, NH	Makarewicz and Likens 1979
		1.0-2.8a*	Lake Erie	Culver et al. 1985
	92	3.0*	Lake Ontario	This paper Table A2
<u>Ceriodaphnia lacustris</u>		0.6-1.8*	Lake Michigan	Hawkins and Evans 1979
	100	0.95-1.04*	Lake 223	Lawrence et al. 1987
	456	0.03-1.54	5 Lakes	This paper Table 10
	60	1.9*	Lake Ontario	This paper Table A2
<u>Chydorus sphaericus</u>	15	0.2-4.18	Clay Lake	This paper Table 10
		0.59-0.9*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
	7	1.1*	Lake Huron/Georgian Bay, Ontario	This paper Table A2
		2.0*	Cornell, NY ponds	Hall et al. 1970
		0.1-1.2a*	Lake Erie	Culver et al. 1985
		0.8-1.2*	Lake Michigan	Hawkins and Evans 1979
	38	0.18-0.96	2 Lakes	This paper Table 10
<u>Daphnia catawba</u>		5.3*	Clear Lake, Ontario	Schindler and Novén 1971
		0.32-19.5a*	Mirror Lake, NH	Makarewicz and Likens 1979
	74	1.91-10.4*	Lake 223	Lawrence et al. 1987
	58	0.41-10.82	Lake 223	This paper Table 10
<u>Daphnia galeata mendotae</u>		10.2*	Clear Lake, Ontario	Schindler and Novén 1971
		8.76*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
	45	4.0*	Lake Huron/Georgian Bay	This paper Table A2
	372	20.3*	Lake Superior	This paper Table A2
		2.5-8.9*	Lake Michigan	Hawkins and Evans 1979
	50	4.6-21.94b*	3 ELA Lakes	Lawrence et al. 1987
	209	0.23-44.42b	3 Lakes	This paper Table 10

Table 14. (cont'd)

Species	N	Dry weight μg individual <sup>-1</sup>	Collection Site	Source
<u>Daphnia</u> <u>retrocurva</u>		3.14*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
	100	4.8*	Lake Huron/Georgian Bay, Ontario	This paper Table A2
		1.6-7.5 <sup>a</sup> *	Lake Erie	Culver et al. 1985
		3.7*	Lake Ontario	Wilson and Roff 1973
		1.2-6.5*	Lake Michigan	Hawkins and Evans 1979
	20	3.85*	Lake 240	This paper
	77	0.31-11.41	2 lakes	This paper Table 10
<u>Daphnia</u> <u>schoedleri</u>		1.4-57 <sup>a</sup> * (0.55-2.05mm)	Lake Denard, Alberta	Hayward and Gallup 1976
	86	0.4-174.4 (0.4-3.2mm)	Lake 885	This paper Table 10
<u>Diaphanosoma</u> <u>birgei</u>	1	4.0*	Lake Huron/Georgian Bay	This paper Table A2
		7.0 c*	Cornell, NY ponds	Hall et al. 1970
	229	0.32-3.26*	3 ELA lakes	Lawrence et al. 1987
	408	0.07-14.98	5 lakes	This paper Table 10
<u>Holopedium</u> <u>gibberum</u>		20.0(4-71 <sup>a</sup> )*	Clear Lake, Ontario	Schindler and Novén 1971, Schindler 1972
		10.94*	Muskoka-Haliburton Lakes, Ontario	Yan and Strus 1980
		2.0-9.4 <sup>a</sup> *	Mirror Lake, NH	Makarewicz and Likens 1979
	98	14.5*	Lake Huron/Georgian Bay	This paper Table A2
	2	12.5*	Lake Ontario	This paper Table A2
	1	33.0*	Lake Superior	This paper Table A2
		1.9-10.9*	Lake Michigan	Hawkins and Evans 1979
		42.69-129.34*	5 N.Ontario lakes	Roff and Kwiatkowski 1977
	98	1.45-83.0*	Plastic Lake, (0.51-2.12mm) Ontario	Yan and Mackie 1987
	134	6.2-146.0*	(0.87-2.18mm) 29 S. Ontario lakes	Yan and Mackie 1987
	79	4.5-21.47*	3 ELA lakes	Lawrence et al. 1987
	247	0.28-65.94d	3 ELA lakes	This paper Table 10

<sup>a</sup> Estimated from published graph<sup>b</sup> Sample may contain Daphnia dubia specimens<sup>c</sup> Designated as D. brachyurum<sup>d</sup> Various formulae are used to arrive at these values (Table 10)

Table 15. Comparisons of dry weights of individuals of rotifers from various sources. Where authors presented biomass as volume or wet weight, dry weight value was calculated assuming 1 mm<sup>3</sup> weighs 1 mg (wet weight), and dry weight is 7% of wet weight. Where available, the number of individuals weighed and average length (mm) is given. \* indicates weight was obtained by drying and weighing of organisms.

Species	N	Dry weight μg individual <sup>-1</sup>	Collection Site	Source
<u>Asplanchna priodonta</u> <sup>a</sup>		1.2-12.0 <sup>a</sup> (30-300x10 <sup>6</sup> μ <sup>3</sup> )	Lake Erken, Sweden	Nauwerck 1963
		8.0 (200x10 <sup>6</sup> μ <sup>3</sup> )	Lake Windermere, Eng.	Ruttner-Kolisko 1977
		1.5 (37.5x10 <sup>6</sup> μ <sup>3</sup> )	Lake Kinneret, Israel	Berman et al. 1972
	550	0.48-0.60*(11x10 <sup>6</sup> μ <sup>3</sup> )	Ghent, Belgium pond	Dumont et al. 1975
	54	1.6*	Lake Superior	B. Wilson (pers. comm.)
		2.0	Cornell, NY ponds	Hall et al. 1970
		0.212±0.003*	Mirror Lake, NH	Makarewicz and Likens 1979
<u>Conochilus unicornis</u>	27	0.525	Lake 227	This paper Table 11
		0.028 (0.4x10 <sup>6</sup> μ <sup>3</sup> )	Lake Erken, Sweden	Nauwerck 1963
		0.082±0.005	Mirror Lake, NH	Makarewicz and Likens 1979
	56	0.021-0.028	3 ELA Lakes	This paper Table 11
<u>Filinia Tongiseta</u>	300	0.42-0.48*	Lake Patan, Nepal	Dumont et al. 1975
		0.028 (L=0.136 μm)	Lake Severson, MN	Comita 1972
	44	0.037	2 ELA Lakes	This paper Table 11
<u>Gastropus stylifer</u>	26	0.0385 (0.55x10 <sup>6</sup> μ <sup>3</sup> )	Lake Erken, Sweden	Nauwerck 1963
		0.015-0.020	2 ELA Lakes	This paper Table 11
<u>Kellicottia bostoniensis</u>		0.063 (0.0009mm <sup>3</sup> )	Clear Lake, Ontario	Schindler and Novén 1971
		0.066±0.012*	Mirror Lake, NH	Makarewicz and Likens 1979
	20	0.009-0.012	3 ELA Lakes	This paper Table 11
<u>K. longispina</u>		0.007 (0.1x10 <sup>6</sup> μ <sup>3</sup> )	Lake Erken, Sweden	Nauwerck 1963
		0.0056 (0.8x10 <sup>6</sup> μ <sup>3</sup> )	Lake Windermere, Eng.	Ruttner-Kolisko 1977
		0.126 (0.0018 mm <sup>3</sup> )	Clear Lake, Ontario	Schindler and Novén 1971
		0.100±0.015*	Mirror Lake, NH	Makarewicz and Likens 1979
	88	0.014-0.017	4 lakes	This paper Table 11
<u>Keratella cochlearis</u>		0.0035 (0.05x10 <sup>6</sup> μ <sup>3</sup> )	Lake Erken, Sweden	Nauwerck 1963
		0.005 (0.070 μg wet weight)	Lake Lanao, Philippines	Lewis 1979
		0.001 (0.015x10 <sup>6</sup> μ <sup>3</sup> )	Lake Kinneret, Israel	Berman et al. 1972
		0.0105 (0.15x10 <sup>6</sup> μ <sup>3</sup> )	Lake Windermere, Eng.	Ruttner-Kolisko 1977
		0.049 (0.0007 mm <sup>3</sup> )	Clear Lake, Ontario	Schindler and Novén 1971
	350	0.11*	Ghent, Belgium pond	Dumont et al. 1975
		0.07	Lake Suwa, Japan	Bottrell et al. 1976
		0.013 (0.108mm)	Lake Severson, MN	Comita 1972
		0.005	Cornell, NY ponds	Hall et al. 1970
		0.070±0.008*	Mirror Lake, NH	Makarewicz and Likens 1979
	76	0.009-0.044	4 lakes	This paper Table 11

Table 15. (cont'd)

Species	N	Dry weight μg individual <sup>-1</sup>	Collection Site	Source
egg		0.003 (0.046 μg wet weight)	Lake Lanao, Philippines	Lewis 1979
	20	0.003 ± 0.001	Lake 223	This paper Table 12
<u>K. hiemalis</u>		0.0035(0.05x10 <sup>6</sup> μ <sup>3</sup> )	Lake Erken, Sweden	Nauwerck 1963
		0.005	Cornell, NY ponds	Hall et al. 1970
	26	0.027-0.028	2 ELA lakes	This paper Table 11
<u>K. taurocephala</u>		0.084 (0.0012 mm <sup>3</sup> )	Clear Lake, Ontario	Schindler and Novén 1971
		0.096±0.007*	Mirror Lake, NH	Makarewicz and Likens 1979
	21	0.012-0.016	3 ELA lakes	This paper Table 11
<u>Polyarthra remata</u>		0.035 (0.5x10 <sup>6</sup> μ <sup>3</sup> )	Lake Erken, Sweden	Nauwerck 1963
		0.0105 (0.15x10 <sup>6</sup> μ <sup>3</sup> )	Lake Kinneret, Israel	Berman et al. 1972
		0.049 (0.0007 mm <sup>3</sup> )	Clear Lake, Ontario	Schindler and Novén 1971
	77	0.012-0.015	4 lakes	This paper Table 11
<u>P. vulgaris</u>		0.0385 (0.55x10 <sup>6</sup> μ <sup>3</sup> )	Lake Erken, Sweden	Nauwerck 1963
		0.020 (0.29ug wet weight) (0.077mm)	Lake Lanao, Philippines	Lewis 1979
		0.098 (0.0014 mm <sup>3</sup> )	Clear Lake, Ontario	Schindler and Novén 1971
		0.043*	London, Eng. reservoir	Doohan 1973
		0.060±0.002*	Mirror Lake, NH	Makarewicz and Likens 1979
	97	0.031-0.041	4 lakes	This paper Table 11
egg		0.0031 (0.044 μg wet)	Lake Lanao, Philippines	Lewis 1979
	4	0.008	Lake 223	This paper Table 12
<u>Trichocerca cylindrica</u>		0.007 (0.0001 mm <sup>3</sup> )	Clear Lake, Ontario	Schindler and Novén 1971
	38	0.070-0.094	4 ELA lakes	This paper Table 11

a Dry weight is calculated as 4% wet weight (Dumont et al. 1975)

Table 16. Dry weights ( $\mu\text{g individual}^{-1}$ ) calculated using regression equations for copepods of representative lengths. The regression equations used are those given in Table 9, except as noted. A dash indicates the length is outside the range of lengths on which the equation was based; a blank indicates no information is available.

Length mm	<u>Diaptomus minutus</u>					<u>D. oregonensis</u> <sup>a</sup>		<u>D. siciloides</u> <sup>a</sup>		<u>Epischura lacustris</u>					
	Lake	223	224	227	302	Erie <sup>a</sup>	Clay	Erie <sup>a</sup>	885	Ogle- <sup>b</sup> thorp	Erie <sup>a</sup>	223	224	227	302
<b>Nauplii</b>															
0.08	-					-			-						
0.15	0.047					0.048	0.057		0.050						
0.25	0.151					0.138	0.172		0.143						
0.3	0.228					0.201	0.255		0.208						
<b>Copepodids</b>															
0.25	-					-	-		-						
0.3	-					-	-		-						
0.4	0.231		0.221	0.226		-	-		-						
0.5	0.430		0.401	0.417		-	-		-						
0.7	1.098		0.990	1.054		0.470	0.526		-		0.412	0.312	-		
1.0	2.969		-	2.814		1.062	1.100		-		1.128	0.837	-		
1.2	-		-	-		2.521	-		-		3.281	2.386	3.197		
1.4	-		-	-		-	-		-		5.665	4.077	5.828		
											8.988	6.412	9.682		
<b>Adults</b>															
0.4	-	-	-	-		-	-		-		-	-	-	-	
0.5	-		-	-		-	-		-		-	-	-	-	
0.7	(1.118) <sup>c</sup>	-	-	(1.206) <sup>c</sup>	(1.869) <sup>c</sup>	-	-		-		-	-	-	-	
1.0	2.832	2.298	2.964	2.778	-	2.651	6.197	-	2.858	5.887	-	-	-	-	
1.2	-	-	4.163	-	-	4.364	8.860	4.659	4.475	11.877	-	-	-	-	
1.4	-	-	-	-	-	6.650	-	-	-	-	-	8.283	8.266	8.858	
2.0	-	-	-	-	-	-	-	-	-	-	24.239	20.366	-	-	
<b>Copepodids + Adults</b>															
0.25	-	-	-	-		-	-		-		-	-	-	-	
0.3	-		-	-		-	-		-		-	-	-	-	
0.4	0.233		(0.214) <sup>c</sup>	0.225		-	-		-		-	-	-	-	
0.5	0.431		0.401	0.417		0.459	-		0.517	0.519	-	-	-	0.534	-
0.7	1.086		1.038	1.054		1.078	-		1.210	1.188	-	-	1.210	1.300	-
1.0	2.895		2.845	2.812		2.665	-		2.982	2.858	-	-	2.982	3.341	3.460
1.2	-		4.762	-	-	4.233	-		4.729	4.475	-	-	5.198	5.413	5.718
1.4	-	-	-	-	-	6.260	-	-	-	-	-	6.984	8.139	8.746	
2.0	-	-	-	-	-	-	-	-	-	-	-	17.211	-	-	
<b>All life stages</b>															
0.08	-		-	-		-	-		-		-	-	-	-	
0.15	0.043			0.044		0.058			0.047						
0.25	0.130			0.132		0.160			0.144						
0.3	0.193			0.194		0.230			0.214						
0.4	0.358			0.358		0.409			0.403						
0.5	0.578			0.576		0.638			0.658						
0.7	1.191			1.180		1.250			1.378						
1.0	2.563			2.521		2.550			3.014						
1.2	-		-	-		3.671			4.498						
1.4	-		-	-		4.995			-						

<sup>a</sup> Equations of Culver et al. (1985)

<sup>b</sup> Equation of Pace and Orcutt (1981); no length range or RMS given

<sup>c</sup> Length is slightly outside of the range over which the regression was calculated

Table 16. (contd)

Length mm	<i>Tropocyclops prasinus mexicanus</i>								<i>Cyclops bicuspidatus thomasi</i>									
	Lake	223	224	227	302	d	e	f	Clay	223	g	h	223	224	227	302	Clay	885
<b>Nauplii</b>																	a	
0.08	0.009	-	-	-	0.007	(0.008) <sup>c</sup>	(0.012) <sup>c</sup>	-	-	-	-	-	-	-	-	-	0.053	
0.15	0.043	-	0.041	-	0.042	0.034	0.050	-	0.048	0.048	-	-	-	-	-	-	-	-
0.25	-	-	-	-	-	-	-	-	0.151	0.151	-	-	-	-	-	-	-	-
0.3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Copepodids</b>																		
0.25	0.072	-	0.083	0.060	0.058	0.060	-	0.126	0.093	-	-	-	-	-	-	-	-	-
0.3	0.121	-	0.126	0.099	0.094	0.098	-	0.246	0.205	0.221	0.209	0.234	-	-	-	-	0.258	-
0.4	0.270	0.101	0.246	0.217	0.201	0.207	-	0.414	0.377	0.394	0.370	0.402	-	-	-	-	0.435	-
0.5	0.503	-	-	-	-	-	-	-	0.945	0.941	0.873	0.912	-	-	-	-	0.959	-
0.7	-	-	-	-	-	-	-	-	2.503	-	2.173	-	-	-	-	-	-	-
1.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Adults</b>																		
0.4	0.181	(0.206) <sup>c</sup>	(0.216) <sup>c</sup>	0.194	0.216	0.154	-	-	-	-	-	-	-	-	-	-	-	-
0.5	0.406	0.386	0.417	0.421	0.465	0.313	0.399	-	-	-	-	-	-	-	-	-	-	-
0.7	-	-	-	-	-	-	-	-	2.167	2.143	1.645	2.176	-	-	-	0.774	-	-
1.0	-	-	-	-	-	-	-	-	4.424	4.412	4.508	4.209	-	-	-	4.527	-	-
1.2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>Copepodids + Adults</b>																		
0.25	0.072	-	0.081	0.057	0.056	0.060	-	-	-	-	-	-	-	-	-	-	-	-
0.3	0.115	-	0.124	0.095	0.095	0.093	0.118	0.096	-	-	-	-	-	-	-	-	0.240	-
0.4	0.242	0.240	0.247	0.216	0.223	0.186	0.247	0.206	0.225	0.202	0.221	-	-	-	-	0.423	-	-
0.5	0.430	0.394	0.419	0.407	0.430	0.317	0.437	0.372	0.392	0.365	0.392	-	-	-	-	0.997	2.854	-
0.7	-	-	-	-	-	-	-	-	0.911	0.906	0.889	0.933	-	-	-	2.470	5.690	-
1.0	-	-	-	-	-	-	-	-	2.354	2.203	2.282	2.339	-	-	-	-	-	-
1.2	-	-	-	-	-	-	-	-	3.824	3.469	3.695	3.742	-	-	-	-	-	-
1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2.0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>All life stages</b>																		
0.08	0.010	-	-	-	0.008	0.009	0.014	-	-	-	-	-	-	-	-	-	0.052	-
0.15	0.036	0.036	-	-	0.031	0.029	0.045	0.041	0.047	-	-	-	-	-	-	0.142	-	-
0.25	0.101	-	0.100	-	0.089	0.077	0.117	0.115	0.128	-	-	-	-	-	-	0.203	-	-
0.3	0.145	-	0.144	-	0.131	0.109	0.164	0.167	0.183	-	-	-	-	-	-	0.355	-	-
0.4	0.261	-	0.258	-	0.239	0.190	0.280	0.300	0.321	-	-	-	-	-	-	0.550	-	-
0.5	0.409	-	0.404	-	0.381	0.291	0.424	0.472	0.497	-	-	-	-	-	-	1.060	-	-
0.7	-	-	-	-	-	-	-	-	0.936	0.959	-	-	-	-	-	-	2.128	-
1.0	-	-	-	-	-	-	-	-	1.933	1.928	-	-	-	-	-	-	-	-
1.2	-	-	-	-	-	-	-	-	2.801	2.754	-	-	-	-	-	-	-	-
1.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

<sup>a</sup> Equations of Culver et al. (1985)<sup>b</sup> Length is slightly outside of the range over which the regression was calculated<sup>c</sup> 1981 and 1983 organisms<sup>d</sup> 1981 organisms<sup>e</sup> 1983 organisms<sup>f</sup> All available organisms used to obtain equation<sup>g</sup> Equal numbers of each stage used to obtain equation

Table 16. (contd)

Length mm	<i>C. vernalis</i>						<i>Mesocyclops edax</i>			
	Lake	302	Clay	Erie <sup>a</sup>	223	227	302 <sup>d</sup>	302 <sup>e</sup>	302 <sup>f</sup>	Erie <sup>a</sup>
<b>Nauplii</b>										
0.08										
0.15							0.037	0.037		
0.25							0.115	0.125		
0.3							-	-		
<b>Copepodids</b>										
0.25							-	-	-	
0.3							-	-	-	
0.4						0.331	-	-	-	
0.5						0.600	0.505	0.504	0.583	
0.7						1.469	1.174	1.337	1.472	
1.0						3.797	2.869	3.763	3.928	
1.2						-	-	-	-	
1.4						-	-	-	-	
<b>Adults</b>										
0.4	-	-			-	-	-	-	-	
0.5	-	-			-	-	-	-	-	
0.7	0.982	-			1.320	-	-	-	-	
1.0	3.413	3.535			3.860	3.505	3.557	3.450	3.589	
1.2	6.453	7.106			6.680	6.260	6.381	6.307	6.379	
1.4	-	-			10.621	10.224	-	-	-	
2.0	-	-			-	-	-	-	-	
<b>Copepodids + Adults</b>										
0.25						-	-	-	-	
0.3						-	-	-	-	
0.4			0.683			0.293	-	-	-	
0.5			1.208			0.546	0.407	0.479	0.554	
0.7			2.855			1.396	1.351	1.271	1.399	2.383
1.0			7.106			3.780	2.916	3.577	3.733	6.692
1.2			11.324			6.288	6.185	6.070	6.165	-
1.4			-			9.669	-	-	-	
2.0			-			-	-	-	-	
<b>All life stages</b>										
0.08							-	-	-	
0.15							0.033	0.035		
0.25							0.116	0.122		
0.3							0.180	0.190		
0.4							0.364	0.383		
0.5							0.627	0.659		
0.7							1.426	1.494		
1.0							3.405	3.555		
1.2							5.314	5.538		
1.4							-	-		

<sup>a</sup> Equations of Culver et al. (1985)<sup>d</sup> 1981 and 1983 organisms<sup>e</sup> 1981 organisms<sup>f</sup> 1983 organisms

Table 17. Dry weights ( $\mu\text{g individual}^{-1}$ ) calculated using regression equations for cladocerans of representative lengths. Equations are listed in Table 10, except as noted. A dash indicates the length is outside the range of lengths on which the equation was based.

Length mm	<i>Bosmina longirostris</i>						<i>Ceriodaphnia lacustris</i>						<i>Cydorus sphaericus</i>								
	Lake	223 <sup>a</sup>	223 <sup>b</sup>	224	227	302 <sup>c</sup>	302 <sup>d</sup>	Clay	Erie <sup>e</sup>	Clay	Ontario <sup>e</sup>	223	Clay	Ontario <sup>e</sup>	223	Clay	Ontario <sup>e</sup>	223	Clay	Ontario <sup>e</sup>	
0.2	0.053	0.110	-	0.103	0.061	0.080	0.098	-	-	-	0.284	-	-	-	0.190	-	0.240	0.239	0.213	1.946	
0.3	0.209	0.355	0.345	0.400	0.200	0.240	0.397	1.213	-	-	0.396	0.697	1.299	-	0.332	-	0.397	0.442	0.430	0.417	
0.4	0.548	0.813	-	1.048	0.461	0.525	1.072	2.302	0.742	0.660	-	-	-	0.511	-	1.277	1.557	1.596	1.489	1.514	
0.5	-	-	-	-	-	0.962	-	-	1.563	1.025	-	-	-	0.592	2.103	1.803	5.070	3.685	3.927	3.731	
														227	Clay	Erie <sup>e</sup>	223	Clay	Ontario <sup>e</sup>		
<i>Daphnia catenata</i>	<i>D. galeata mendotae</i>						<i>D. longiremis</i>						<i>D. retrocurva</i>						<i>Diaphanosoma birgei</i>		
	Lake	223	223 <sup>f</sup>	223 <sup>g</sup>	223 <sup>h</sup>	224	227	224	Clay	Erie <sup>e</sup>	302	302	227	Clay	Erie <sup>e</sup>	223	Clay	Ontario <sup>e</sup>	223	Clay	Ontario <sup>e</sup>
0.4	-	0.248	-	0.461	-	-	-	-	2.550	-	-	-	0.325	-	-	0.190	-	0.240	0.239	0.213	1.946
0.5	-	0.455	-	1.649	1.580	-	-	3.191	5.319	-	-	0.511	-	-	0.332	-	0.397	0.442	0.430	0.417	
0.8	1.293	1.633	1.649	1.580	-	3.286	-	8.754	7.044	3.266	2.460	2.086	2.103	2.729	1.803	1.277	1.557	1.596	1.489	1.514	
1.1	3.482	3.882	3.908	3.799	-	6.530	-	12.766	-	6.942	4.722	9.349	11.096	15.003	-	-	-	7.363	-	-	
1.4	7.373	7.479	7.513	7.391	-	17.156	17.188	17.113	15.579	-	20.584	-	-	-	27.832	38.028	-	-	-	-	-
1.9	-	32.379	32.374	32.565	-	-	-	-	-	-	-	-	-	-	57.474	-	-	-	-	-	
2.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	
<i>Holopedium gibberum</i>																					
	Lake	223 <sup>j</sup>	223 <sup>k</sup>	223	223 <sup>l</sup>	223 <sup>m</sup>	227 <sup>j</sup>	227 <sup>k</sup>	227 <sup>l</sup>	227 <sup>m</sup>	227 <sup>n</sup>	227 <sup>o</sup>	227 <sup>p</sup>	227 <sup>q</sup>	227 <sup>r</sup>	227 <sup>s</sup>	227 <sup>t</sup>	227 <sup>u</sup>	227 <sup>v</sup>	227 <sup>w</sup>	
0.4	-	-	-	-	-	-	0.880	1.716	1.371	-	1.120	1.195	-	-	-	-	-	-	-	-	
0.5	-	-	-	-	-	-	1.801	3.053	2.764	-	1.927	2.097	-	-	-	-	-	-	-	-	
0.8	4.558	5.445	6.810	-	-	8.145	10.269	12.108	-	6.045	6.853	4.304	-	-	-	-	-	-	3.820	-	
1.1	10.760	10.198	-	7.977	22.640	23.360	-	-	15.324	-	15.288	11.047	9.498	-	-	-	-	-	-	-	
1.4	20.621	16.401	-	15.447	49.102	43.531	-	-	46.458	-	-	22.555	18.931	-	-	-	-	-	-	-	
1.9	46.993	29.938	-	35.672	-	-	-	-	-	-	-	55.695	-	-	-	-	-	-	-	-	

<sup>a</sup> N = 88, lake organisms

<sup>b</sup> N = 70, impounded organisms

<sup>c</sup> 1981 organisms

<sup>d</sup> 1983 organisms

<sup>e</sup> Equations of Culver et al. 1985

including *D. leuchtenbergianum*

<sup>f</sup> 1974 organisms

<sup>g</sup> 1978 organisms, all inclusive

<sup>h</sup> 1978 organisms, no young, male or egg bearing females

<sup>i</sup> Equation obtained from graphed data in Hayward and Gallup (1976)

<sup>j</sup> b = 3.0456  $R^2 = 1.634$   $R_{NS} = 0.099$

<sup>k</sup> Formula E

<sup>l</sup> Formula D, F

<sup>m</sup> Formula F

<sup>n</sup> Formula D

<sup>o</sup> Yan and Mackie 1987

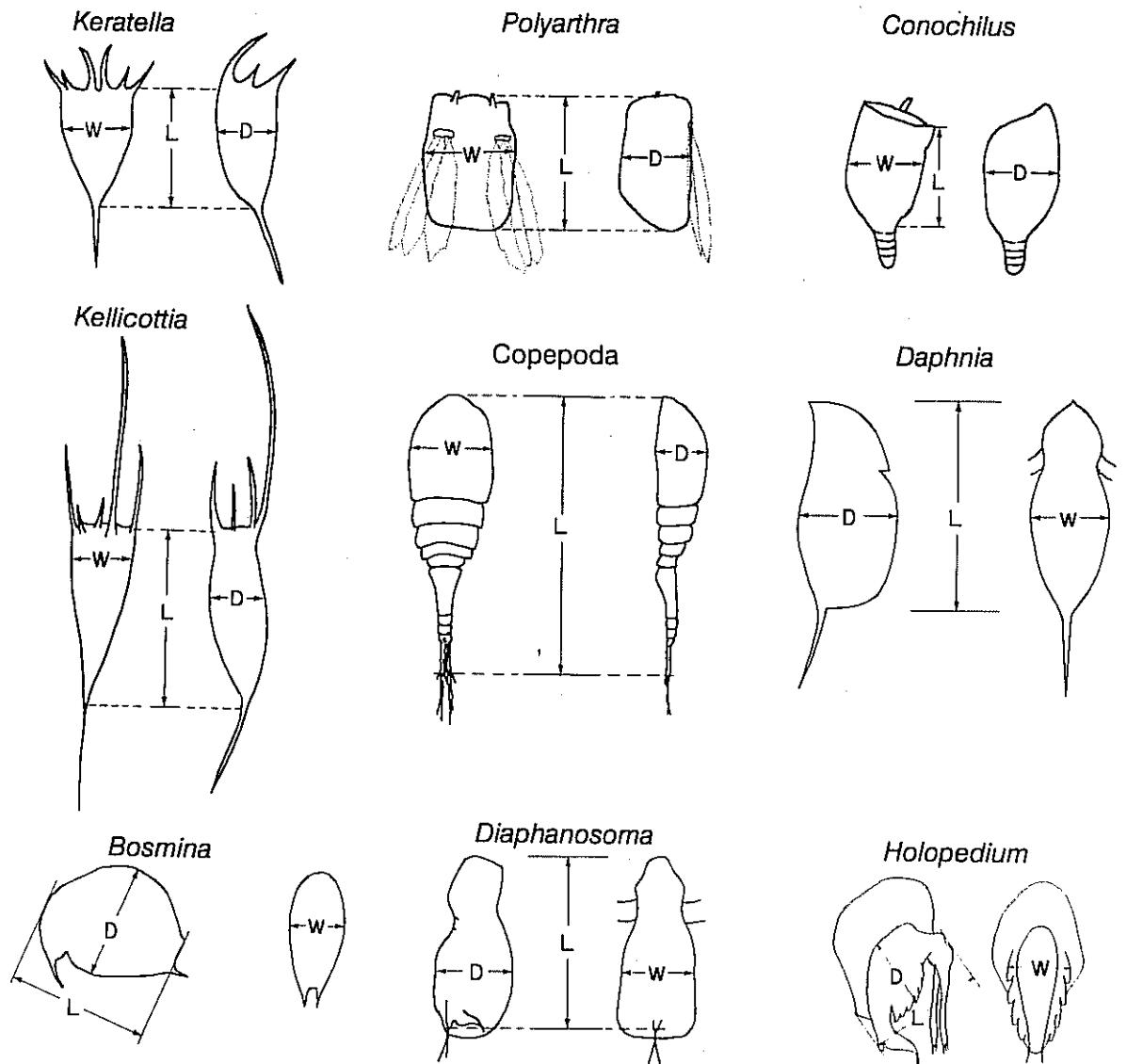


Figure 1. Axes of measurements on copepods, cladocerans and rotifers.  
L is length, D is depth, and W is width.

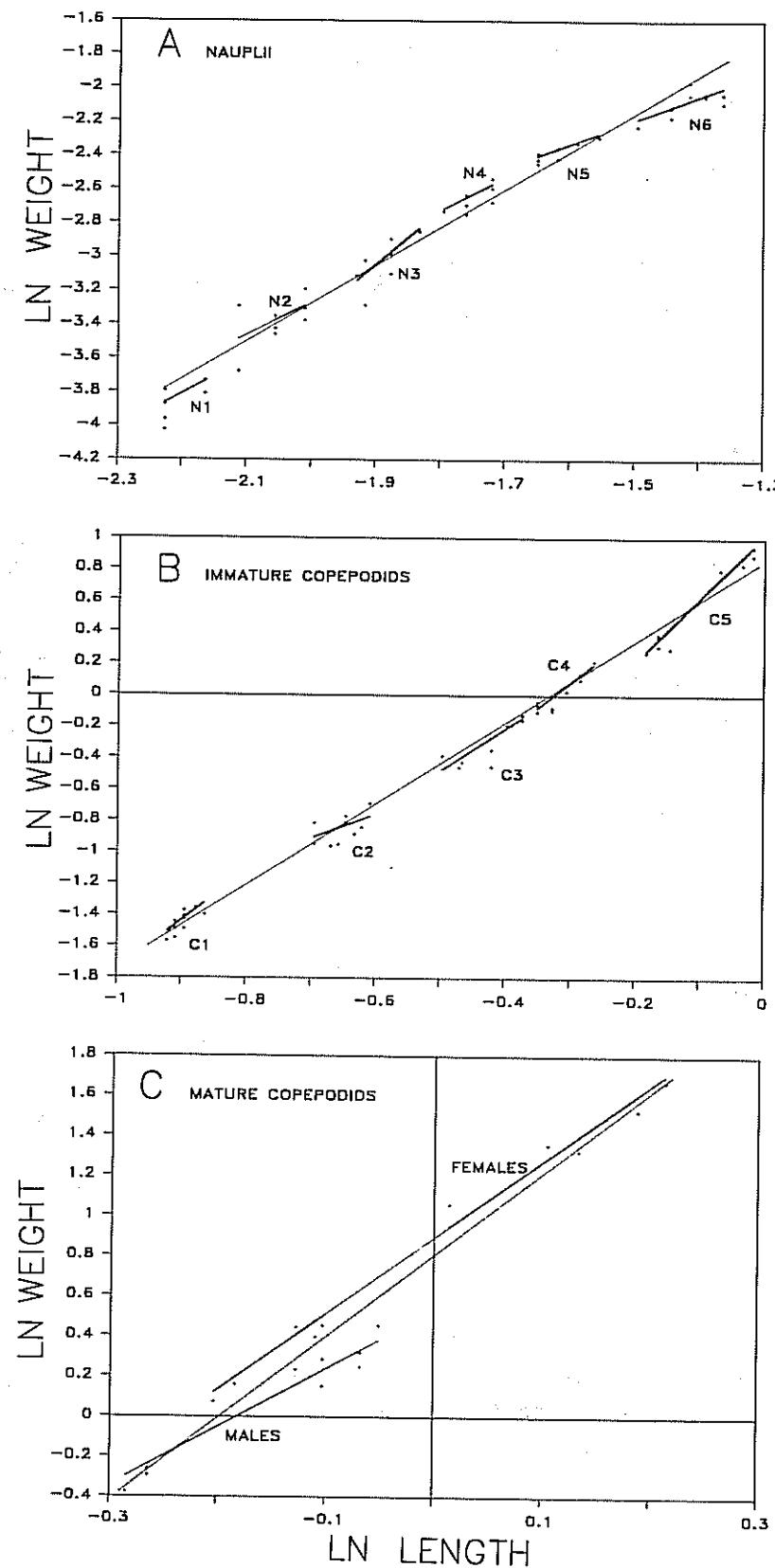


Figure 2. Length-weight regressions for life stages and groups of life stages of Cyclops bicuspidatus thomasi of ELA Lake 223.

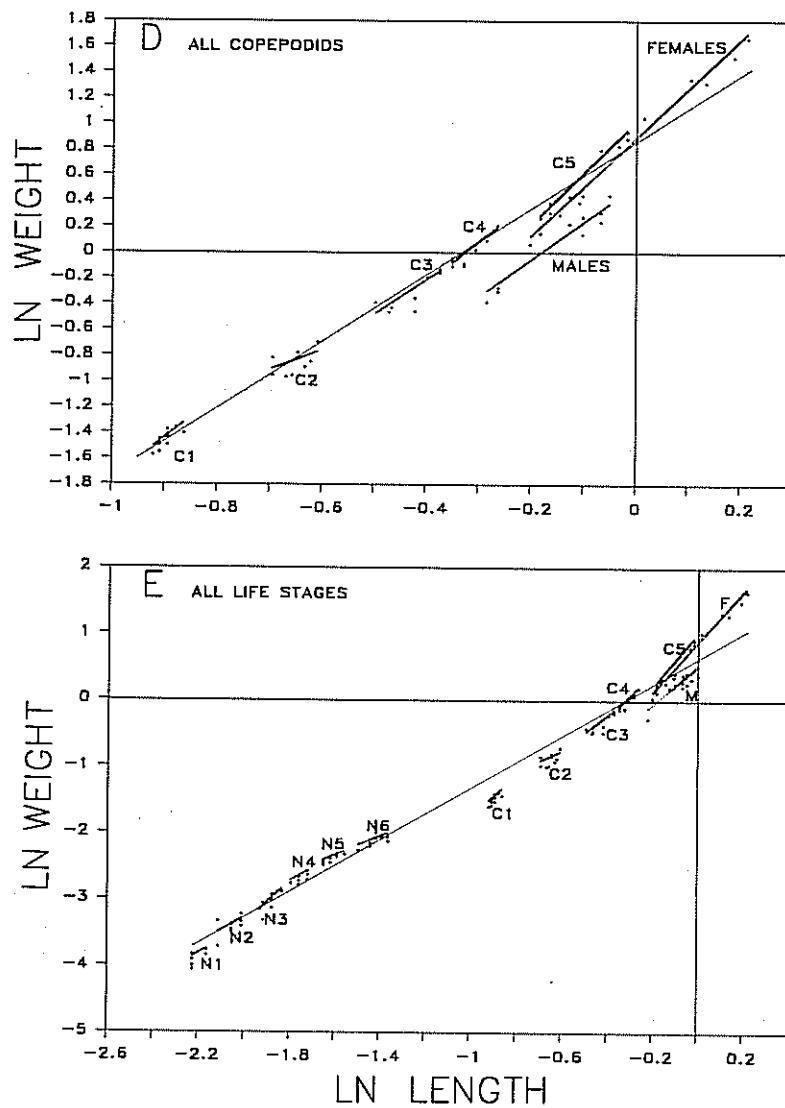


Figure Panel	Stages	n	ln a	b ± C.I.	r	Range Length (mm)
A,E	N1	10	0.7407	2.0698 ± 2.0827	0.60	0.108-0.115
A,E	N2	10	0.6207	1.9446 ± 2.1542	0.57	0.121-0.114
A,E	N3	10	3.0265	3.1949 ± 1.8860	0.79	0.145-0.160
A,E	N4	10	0.8439	1.9824 ± 1.4980	0.71	0.166-0.179
A,E	N5	10	-0.0671	1.4132 ± 0.7128	0.83	0.192-0.211
A,E	N6	10	-0.1259	1.3716 ± 1.0147	0.72	0.224-0.256
B,D,E	C1	10	1.4416	3.2025 ± 2.0787	0.76	0.398-0.422
B,D,E	C2	10	0.1700	1.5429 ± 1.9702	0.51	0.499-0.544
B,D,E	C3	10	0.4679	2.6975 ± 1.1094	0.86	0.608-0.688
B,D,E	C4	10	1.0541	3.2314 ± 0.9980	0.93	0.704-0.768
B,D,E	C5	10	1.0238	4.0253 ± 0.5661	0.98	0.032-0.982
C,D,E	C6F	10	0.8938	3.8076 ± 0.3190	0.99	0.816-1.238
C,D,E	C6M	10	0.5305	2.9169 ± 1.1755	0.90	0.752-0.950
A	N1 to N6	60	see Table 9, Regression No. 39.			
B	C1 to C5	50	see Table 9, Regression No. 52.			
C	C6F + C6M	20	see Table 9, Regression No. 69.			
D	C1 to C6	70	see Table 9, Regression No. 90.			
E	N1 to C6	130	see Table 9, Regression No. 107.			

Figure 2. continued

## APPENDIX 1

In two publications (Lawrence 1980; Lawrence and Holoka 1983) estimates of individual cladoceran biomass were made by assigning a value to a length interval. The length intervals were established by measuring 40 - 200 organisms as described in the text, calculating a dry weight for each and then ordering the data by length and identifying discontinuous groups. The calculated weights within each group were averaged to obtain the assigned biomass (Table A1).

This size-class method for measuring cladocerans gives rise to inaccurate biomass estimates since animals within a size class include a wide range of weights. For example, Daphnia galeata mendotae 900-1399  $\mu\text{m}$  in length are assigned a value of 7.31  $\mu\text{g}$  individual $^{-1}$ . Using the Lake 223 regression (Table 10), an organism 900  $\mu\text{m}$  in length weighs 4.37  $\mu\text{g}$  and one 1399  $\mu\text{m}$  long weighs 14.58  $\mu\text{g}$ . Biomass values can be over- or under-estimated depending on the distribution of lengths in the sample examined. This method is no longer used in our laboratories.

Table A1. Length categories and their average dry weight for cladocerans from two lakes.  
N is the number measured in each category.

	Lake 223			Clay Lake		
	Length category μm	N	Average dry weight μg ± S.E.	Length category μm	N	Average dry weight μg ± S.E.
<u><i>Alona rectangula</i></u>				190-329 330-410	7 6	0.287 ± 0.08 0.708 ± 0.18
<u><i>Bosmina</i></u>	200-250	25	0.358 ± 0.014	200-249	9	0.175 ± 0.03
<u><i>Tongirostris</i></u>	250-300	26	0.523 ± 0.030	250-299	11	0.256 ± 0.04
	300-350	15	1.019 ± 0.093	300-349	10	0.502 ± 0.09
	350-400	15	1.393 ± 0.091	350-399	6	0.839 ± 0.14
	>400	7	2.877 ± 0.351	>400	1	1.2
<u><i>Chydorus sphaericus</i></u>	as in Clay Lake			180-229 230-269 >270	15 10 5	0.224 ± 0.035 0.334 ± 0.055 0.741 ± 0.140
<u><i>Daphnia galeata mendotae</i></u>	300-499	5	0.72 ± 0.21	500-899	24	2.32 ± 0.99
	500-899	14	3.35 ± 0.81	900-1399	7	5.78 ± 0.57
	900-1399	20	7.31 ± 2.29			
	1400-1799	10	20.51 ± 6.43			
	1800-2299	17	43.34 ± 12.63			
	>2300	10	67.60 ± 14.67			
<u><i>Daphnia retrocurva</i></u>				700-899 900-1099 1100-1299 1300-1499	18 11 7 3	1.11 ± 0.19 1.40 ± 0.07 1.87 ± 0.58 4.6
<u><i>Diaphanosoma brachyurum</i></u>	300-499	3	0.48	300-449	39	0.416 ± 0.111
	500-699	9	1.28	450-590	47	0.874 ± 0.221
	700-899	7	4.17	591-749	39	1.700 ± 0.516
	900-1099	5	7.07	750-890	19	3.278 ± 0.898
<u><i>Sida crystallina</i></u>	600-899	5	4.6			
	900-1099	3	7.7			
	>1100	2	25			

## APPENDIX 2

In several cruises on three of the Great Lakes, B. Wilson<sup>a</sup>, N. Watson<sup>a</sup> and J. Roff<sup>b</sup> collected samples of zooplankton. Selected specimens were dried and weighed by B. Wilson as described in Wilson and Roff (1973).

On Lake Ontario, a single station was sampled eight times during 1972 (Wilson and Roff 1973), in Georgian Bay of Lake Huron, eight stations were sampled once by Watson and Wilson during a single cruise, and on Lake Superior, 19 stations were sampled by Wilson during a single cruise. Samples from each lake were pooled and a single dry weight value produced for each species. Some of the Lake Ontario values appear in Wilson and Roff (1973) in somewhat different form. Mean dry weights of species from Lakes Huron and Superior (Table A2) are published here for the first time.

<sup>a</sup> Great Lakes Laboratories of Fisheries and Aquatic Sciences, Burlington, Ontario.

<sup>b</sup> Department of Zoology, Guelph University, Guelph, Ontario.

Table A2. Individual mean dry weights ( $\mu\text{g}$ ) of crustacean zooplankton species of three Great Lakes. N is the number of individuals dried and weighed. F is female, M is male, C indicates immature copepodids.

Species	Lake Ontario			Lake Huron (Georgian Bay)		Lake Superior	
	Sex	N	$\mu\text{g}$	N	$\mu\text{g}$	N	$\mu\text{g}$
<b>CLADOCERA</b>							
<u>Bosmina longirostris</u>	F	92	3.0	295	1.4	102	2.4
<u>Ceriodaphnia lacustris</u>	F	60	1.9				
<u>Chydorus sphaericus</u>	F			7	1.1		
<u>Daphnia galeata mendotae</u>	F			45	4.0	372	20.3
<u>D. retrocurva</u>	F	67	3.3	100	4.8		
<u>Daphnia species</u>				580	4.0		
<u>Diaphanosoma leuchtenbergianum</u>	F			1	4.0		
<u>Eubosmina coregoni</u>	F			161	2.2		
<u>Holopedium gibberum</u>	F	2	12.5	98	14.5	1	33.0
<u>Leptodora kindtii</u>	F	4	12.0	2	20.5		
<u>Polyphemus</u>	F			4	28.0		
<b>COPEPODA</b>							
<u>Cyclops bicuspidatus thomasi</u>	F	297	3.8	194	4.9	39	4.1
	M	309	2.2	21	1.8	29	2.5
	C1-5	323	2.2	115	1.4	377	1.8
<u>Diaptomus ashlandi</u>	F					216	4.4
	M					165	3.8
<u>D. minutus</u>	F	120	5.0				
	M	105	4.0				
<u>D. oregonensis</u>	F	31	9.9				
	M	31	8.6				
<u>D. sicilis</u>	F	88	14.1			524	13.6
	M	95	10.7			359	10.9
<u>Epischura lacustris</u>	F			29	21.6	69	23.9
	M			6	15.2	61	18.8
	C1-5					2	7.0
<u>Eurytemora affinis</u>	F	16	7.7				
	M	25	5.4				
	C1-5	18	5.1				
<u>Limnocalanus macrurus</u>	F	110	53.2	62	53.1	221	56.3
	M	120	38.4	9	56.8	203	45.5
	C1	20	1.8				
	C2	28	2.3				
	C3	41	4.2				
	C4	38	7.9	4	11.5		
	C5	29	20.2	5	21.6		
<u>Mesocyclops edax</u>	F			23	8.4		
	C1-5			49	3.4		
<u>Senecella calanoides</u>	F					105	82.0
	M					85	68.9
	C1-5					2	56.0