TABLE 2 PHYSICO-CHEMICAL PROPERTIES OF WATERS FROM CONTWOYTO LAKE AND FROM NEIGHBOURING WATERCOURSES. All values are arithmetic means in g/m^3 (±95% confidence limits), unless otherwise indicated.

PARAMETER	CONTWOYTO LAKE & LAKES A THROUGH I	STREAM A
Specific Conductance (μmho/cm)	5.8	6.2
Turbidity (JTU)	1.5	1.9
Alkalinity (total)	<1.0	5.9
Hardness (Total)	<5.0	8.1
Calcium (Dissolved)	<2.0	2.2
Potassium (Dissolved)	0.4±0.0	0.4
Sodium (Dissolved)	0.4±0.05	0.8
Silica (Reactive)	0.00±0.00	2.30
Phosphorus (Dissolved)	<0.005	<0.005
Chromium (Extractable)	<0.001	<0.001
Cobalt (Extractable)	<0.001	<0.001
Copper (Extractable)	<0.002	<0.002
Lead (Extractable)	<0.005	<0.005
Manganese (Extractable)	<0.01	<0.01
Moybdenum (Extractable)	<0.05	<0.05
Nickel (Extractable)	<0.005	<0.005
Zinc (Extractable)	<0.001	<0.001
Iron (Extractable)	<0.05	<0.05

TABLE 3 CONCENTRATIONS OF DISSOLVED NITROGEN AND TOTAL PHOSPHORUS IN CONTWOYTO LAKE AND NEIGHBOURING WATERCOURSES. Nitrogen was measured as nitrate-nitrogen. All values are arithmetic means in g/m^3 (±95% confidence limits).

LAKE	DISSOLVED NITROGEN	TOTAL PHOSPHORUS
Contwoyto	0.03±0.015	0.005±0.001
Lake A	<0.01	<0.005
Lake B	0.079	<0.005
Lake C	0.020	<0.005
Lake D	0.052	<0.005
Lake E	<0.01	0.005
Lake F	<0.01	0.005
Lake G	<0.01	0.005
Lake H	0.079	0.007
Lake I	0.179	0.010

3.2 Phytoplankton

Although there were a few notable exceptions, the species composition of the planktonic algal assemblages exhibited a considerable degree of homogeneity among the 10 lakes (Figure 3). Members of the Chrysophyta occurred abundantly, the most common species being *Dinobryon bavaricum* and *D. sociale*. The Bacillariophyta were well-represented by *Cyclotella glomerata* while *Cyclotella ocellata* occurred abundantly in the larger lakes. Although the predominant cyanophyte, *Lyngbya limnetica* frequently achieved dominance, it was almost absent from the plankton of certain lakes. On the other hand, another common species, *Ankistrodesmus falcatus*, maintained dominance in only one lake.

The total standing crop of the algal flora in Contwoyto Lake ranged from $0.73 \times 10^{11} \mu m^3/m^3$ to $0.08 \times 10^{11} \mu m^3/m^3$ (Table 4). About 93 percent of this variation could be explained in terms of depth, while temperature and the nutrient concentration were of little importance (Table 5). Although only slightly higher densities were recorded in the smaller lakes, the quantity of phytoplankton in Lake I was significantly greater than all other areas ($P<0.05$). Differences in nutrient and temperature regime accounted for 60 percent of the density variation (Table 5).

As pointed out by Provasoli (37), *Dinobryon* spp. characteristically occur in areas where phosphorus is limited, and thus *D. bavaricum* seems to occur throughout the north. *Cyclotella glomerata* and *C. ocellata* are also a frequent component of the plankton in subarctic regions (20), while the scarcity of other diatoms such as *Asterionella formosa* is undoubtedly related to the low silica levels (23).

An interesting feature of this investigation was the similarity of the planktonic assemblages of the different lakes. Such distribution has been noted on a number of other occasions for lakes on the Shield (7, 8, 20), and is undoubtedly related to the similarity of several physicochemical parameters, as observed in this study. It should be noted, however, that in more temperate areas, considerable variability exists in planktonic assemblages, despite apparently comparable environmental regimes (31-33).

The standing crop of the flora was generally similar to the values recorded during the summer for lakes in the vicinity of Yellowknife (10) and in Labrador (7). In more alkaline areas of the subarctic, densities are higher (19, 50) as is also the case for lakes lying in the southern edge of the shield (3, 4, 20). Since algal densities were not correlated with

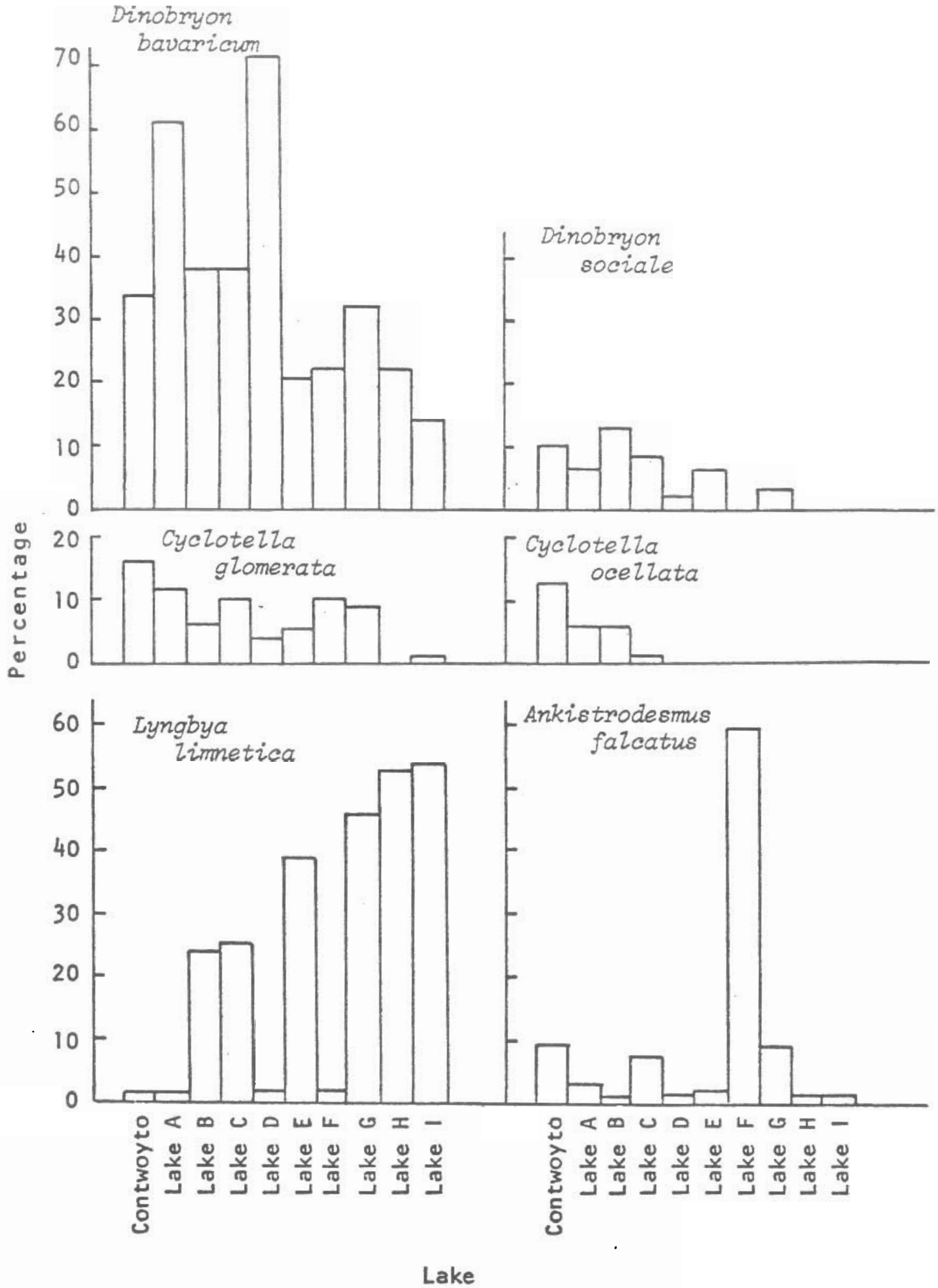

FIGURE 3 RELATIVE ABUNDANCE OF COMMON PLANKTONIC ALGAE.

TABLE 4 STANDING CROP OF ALGAE AT DIFFERENT DEPTHS IN CONTWOYTO LAKE AND NEIGHBOURING BODIES OF WATER DURING AUGUST. Where the sample size is greater than 3, 95% confidence limits are given.

LAKE	DEPTH	NUMBERS ($10^8/m^3$)	VOLUME ($\mu m^3 \times 10^{11}/m^3$)
Contwoyto	0	1.45±0.2	0.73±0.11
	5	1.3±0.2	0.65±0.10
	10	0.95±0.15	0.50±0.07
	15	0.95±0.15	0.50±0.07
	20	0.3±0.1	0.16±0.05
	25	0.15±0.05	0.08±0.02
Lake A	0	1.3±0.2	1.17±0.18
	5	1.3±0.3	1.17±0.23
Lake B	0	1.45	0.89
Lake C	0	1.5±0.3	0.95±0.23
	5	1.5±0.1	0.95±0.10
Lake D	0	1.1	0.90
Lake E	0	2.0	1.21
Lake F	0	2.1	1.20
Lake G	0	1.7	0.98
Lake H	0	1.45	0.98
Lake I	0	4.9±1.2	1.96±0.45

quantity of nitrogen and phosphorus in the water, these parameters are not primarily responsible for limiting standing crop.

Tabellaria flocculosa was predominant in the planktonic assemblage of Stream A, representing 50-80 percent of numbers of the community depending on site. Although both *Oscillatoria* cf. *planktonica* and *Dinobryon cylindricum* v. *alpinum* also occurred abundantly, the relative abundance of other species seldom exceeded two percent by numbers of flora. In terms of numbers, the standing crop of the algae ranged from 1.05×10^8 to 3.9×10^8 cells/m^3 while the corresponding range in terms of cell volume was 1.3×10^8 to $4.2 \times 10^8 \mu m^3/m^3$.

Although *D. cylindricum* v. *alpinum* and *T. flocculosa* were predominant in the pools situated along the shore of Contwoyto Lake, large numbers of desmids representing approximately 30 percent of the flora were also encountered. The standing crop of the community remained high averaging 1.2×10^8 cells/m^3.

3.3 Attached Algae

The predominant epilithic species in most lakes, *Tabellaria flocculosa,* represented from 27 to 49 percent by numbers of the flora (Figure 4). It was followed in order of descending importance by *Phormidium corium, Nitzschia frustulum* v. *perpusilla* and *Anomoeonsis serians* v. *brachysira*. Although the composition of the epipelic communities was virtually identical to that outlined above, several species of desmids (especially *Cylindrocystis brebissonii* v. *minor*) occasionally attained some importance (7-9%) in Contwoyto Lake.

The standing crop of epilithic flora varied a great deal depending on collection site and lake. In Contwoyto, for example, values ranged from 0.05×10^6 to 2.5×10^6 cells/m^2 ($0.05 \times 10^9 - 2.6 \times 10^9 \mu m^3/cm^2$) with the highest densities occurring in protected bays. Precisely the same type of pattern was observed in other lakes, but algal densities tended to vary considerably from the values recorded in the main lake (Figure 5). Epipelic algae usually occurred more abundantly than the preceeding forms, particularly in Contwoyto Lake (Figure 5). The abundance of the attached flora was not correlated ($P<0.05$) with the concentration of nutrients in the water or the standing crop of phytoplankton.

The epilithic and epipelic flora occuring in Stream A were, in most instances, identical to those observed in the lakes. However,

TABLE 5 MULTIPLE REGRESSION ANALYSES OF VARIOUS DEPENDENT AND INDEPENDENT VARIABLES AFFECTING THE DENSITIES OF PHYTOPLANKTON, ZOOPLANKTON AND ZOOBENTHOS, r= correlation coefficient, MR^2 = accumulated variation of the dependent variable accounted for by the step-wise addition of each independent variable.

INDEPENDENT VARIABLE	RANK	r	MR^2
a) Dependent variable - Phytoplankton density in Contwoyto Lake.			
Depth	1	0.97	93.2
Temperature	2	0.97	94.1
TP	3	0.21	94.1
NO_3-N	4	-0.05	95.0
SiO_2	5	0.15	95.1
b) Dependent variable - phytoplankton density in Lakes (A-1).			
Temperature	1	0.73	33.0
TP	2	0.61	50.3
SiO_2	3	0.41	59.8
Lake Area	4	0.37	60.0
NO_3-N	5	0.39	60.2
c) Dependent variable - rotifer density.			
Temperature	1	0.40	34.1
Predators (<u>Cyclops scutifer</u>)	2	-0.30	42.1
Phytoplankton density	3	-0.25	43.1
Lake Area	4	-0.18	44.0
d) Dependent variable - crustacean density.			
Temperature	1	-0.20	6.3
Phytoplankton density	2	0.18	7.2
Lake Area	3	0.20	8.0
e) Dependent variable - benthos density.			
Phytoplankton density	1	0.70	66.7
Lake Area	2	-0.03	67.1
Temperature	3	0.03	68.0

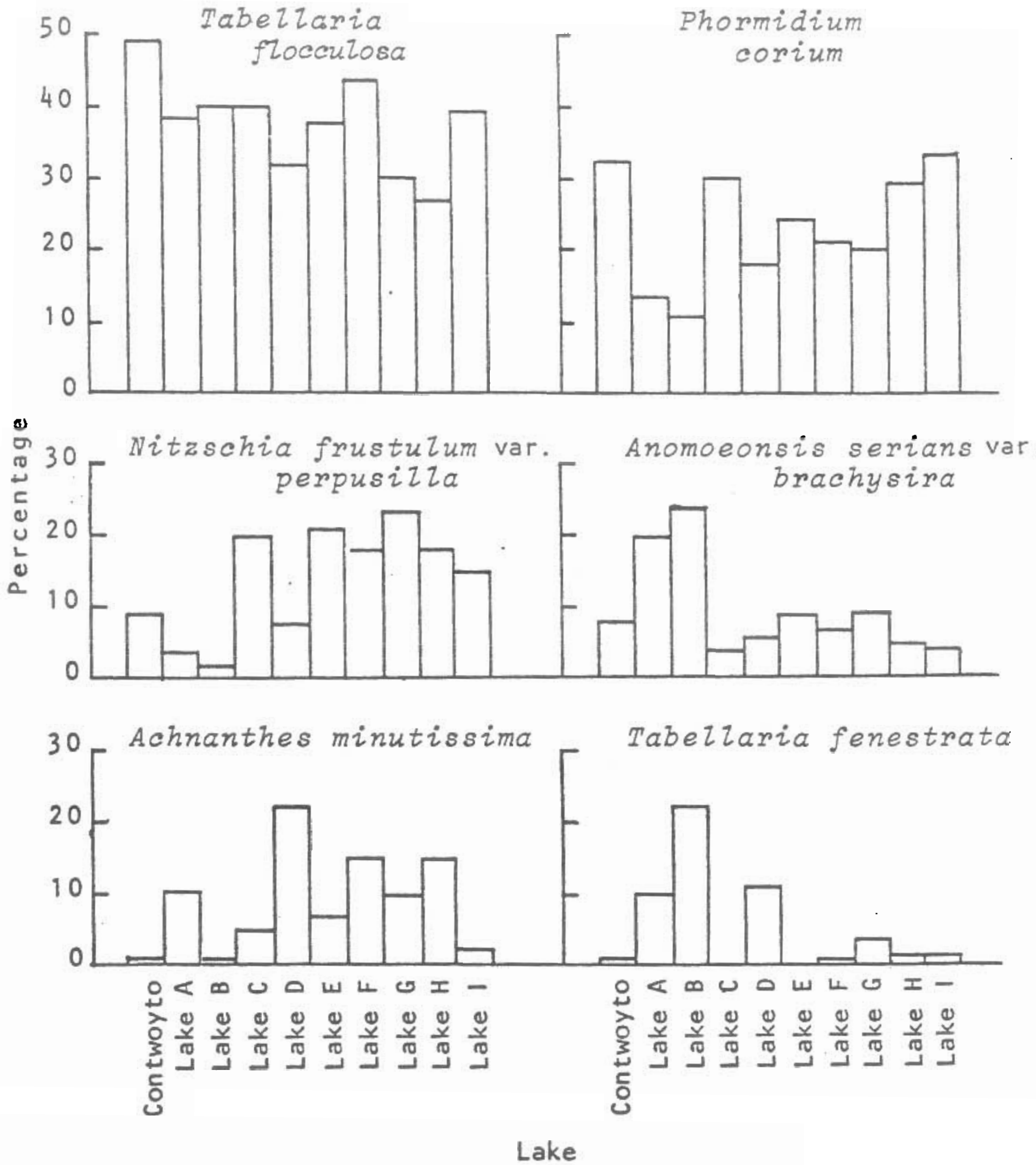

FIGURE 4 RELATIVE ABUNDANCE OF COMMON EPILITHIC ALGAE.

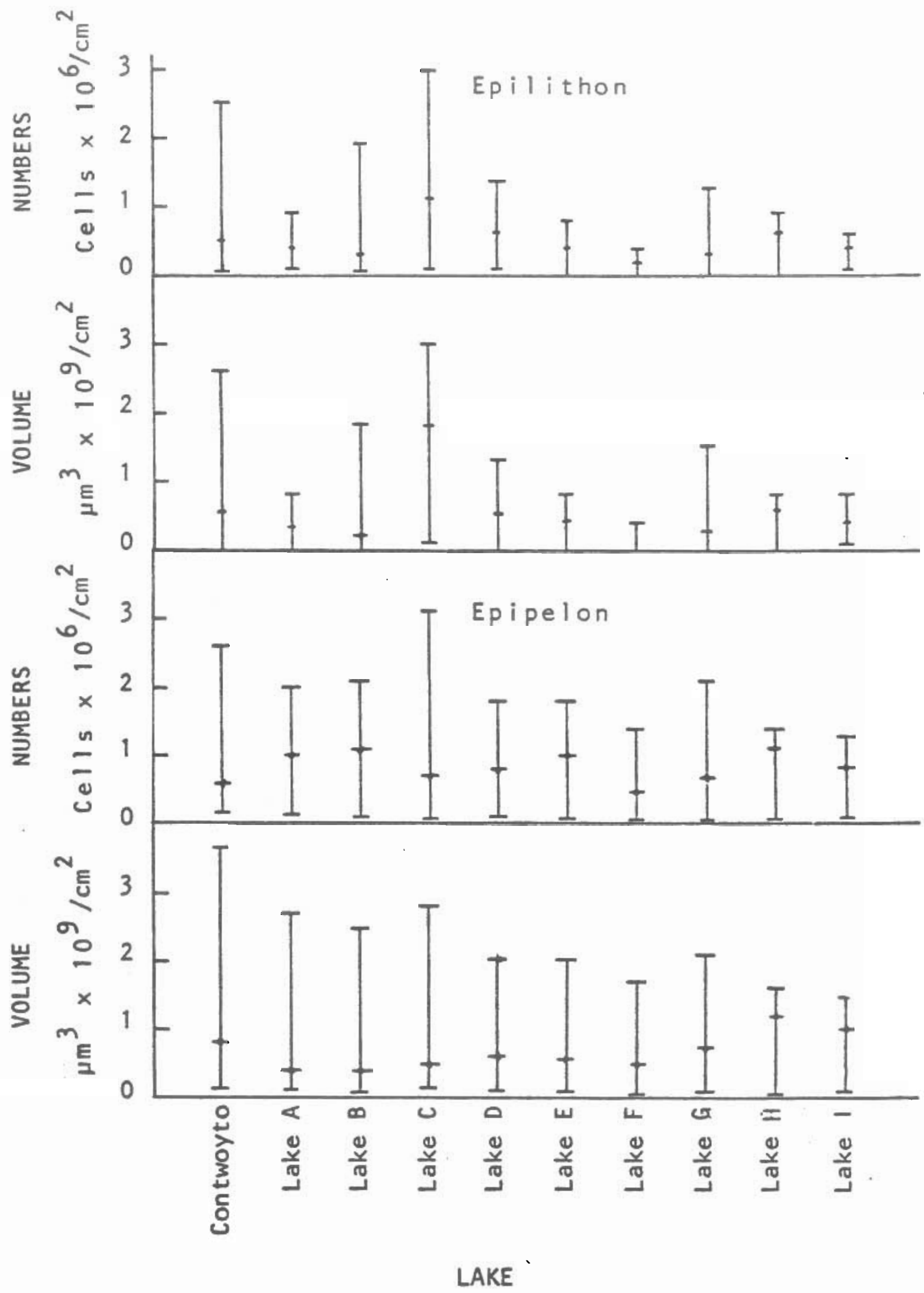

FIGURE 5 STANDING CROP OF EPILITHIC AND EPIPELIC ALGAE.

filamentous algae, particularly sterile *Zygnema* and *Mougeotia* spp., occasionally occurred in large numbers on the sediments, representing up to 90 percent by numbers of the flora. The standing crop of the assemblages was always high, ranging from 0.4×10^6 to 30×10^6 cells/cm^2 ($0.4 \times 10^9 - 5 \times 10^{10}$ µm^3/cm^2).

The predominance of *Tabellaria flocculosa* in the Contwoyto Lake area is similar to the situation on the arctic islands (26, 29, 58). This species is much rarer in the Great Slave Lake region (31) as is also the case in many temperate areas (14, 15, 25). Although *Phormidium corium* has not previously been reported from northern areas (53, 58), *Nitzschia frustulum* and *Anomoeonsis serians* seem to occur frequently in the area (32, 33). Although the standing crop of the epilithic flora exceeded the values recorded in lakes on Baffin Island (29), and in many oligotrophic streams in temperate areas (5, 6), it fell well short of the densities obtained in slow flowing rivers which receive agricultural run-off (29, 30). The epipelic flora, on the other hand, was relatively abundant (12, 25, 30, 34), a feature undoubtedly related to the fact that these forms can usually obtain adequate supplies of nutrients and other substances necessary to grow on from the sediments (26, 27, 41).

3.4 Zooplankton

The predominant rotifer in most lakes, *Kellicottia longispina* Kellicott, occurred at densities of 1×10^3 to 30×10^3 animals/m^3. *Conochiliodes natans* Seligo was normally second in abundance, but occasionally both *Polyarthra remata* (Skoukou) and *Keratella cochlearis* Gosse were also important. The total standing crop of the rotifer fauna ranged from 5×10^3 to 9.0×10^4 animals/m^3 (Figure 6). About 34 percent of this variation could be explained by temperature differences, while the concentration of food and predators was of little importance (Table 5).

The density of planktonic Crustacea in Contwoyto Lake during the day was invariably low near the surface, rising sharply at 5-10 m, but tapering gradually in the deeper strata (Figure 7). Although *Cyclops scutifer* Sars was generally the most abundant organism, *Diaptomus sicilis* Forbes attained dominance at some stations (Figures 8 and 9). Most of the *Cyclops scutifer* population consisted of immature CIV and CV forms (80%) with only a few CIII and adults. Most specimens in the latter group were carrying eggs. While the abundance of this species is highly variable during the day, greatest densities were always attained in

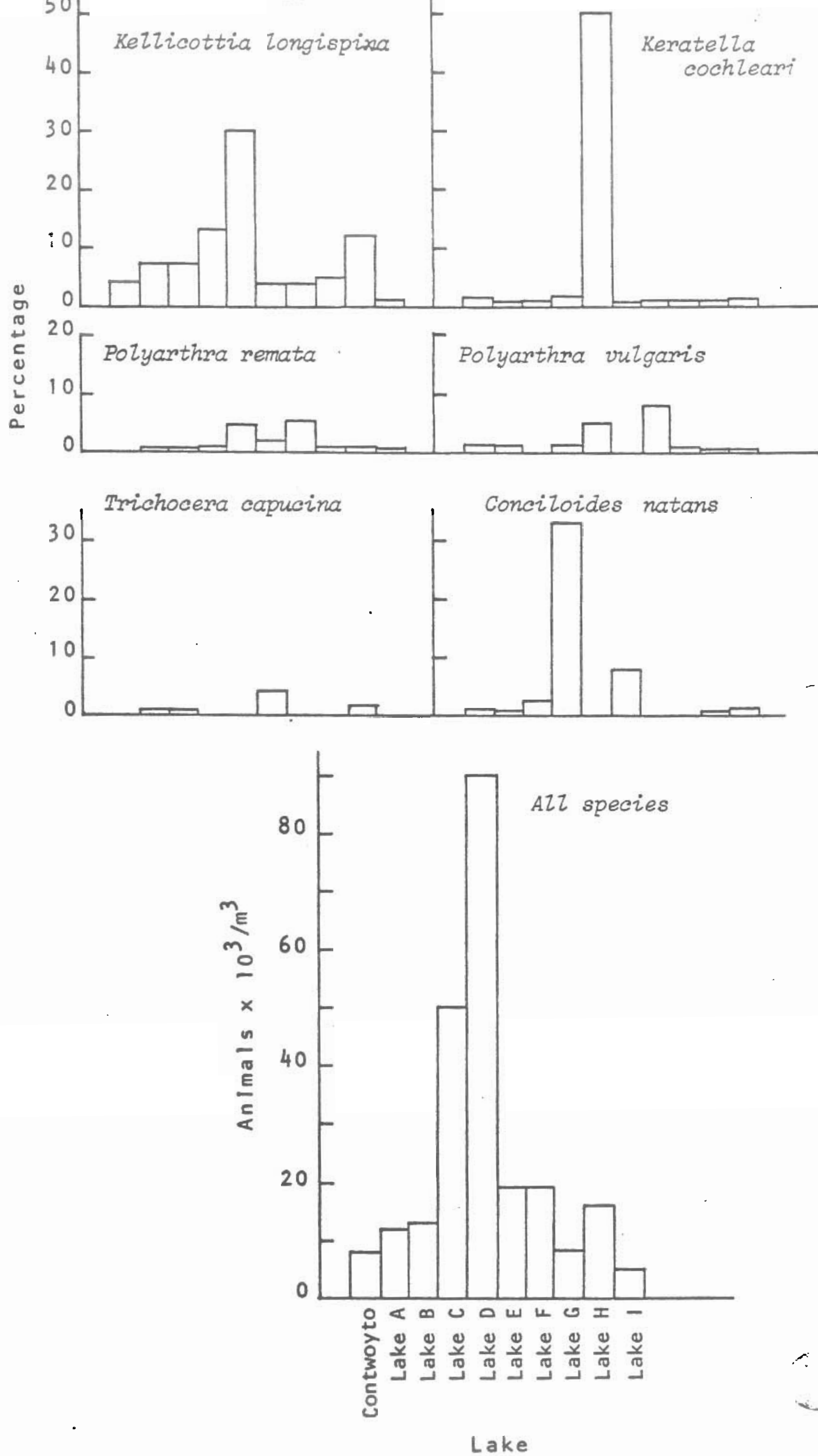

FIGURE 6 STANDING CROP OF COMMON ROTIFERS.

relatively shallow water. Yet, at night, the limited data pointed to a well-defined downward migration (Figure 10). Most of the *Diaptomus sicilis* population also consisted of CV forms with maximum numbers occurring at 5-15 m, irrespective of station or time of day (Figures 9 and 10). While a number of other crustaceans (*Epischura lacustus* Forbes, *Heterocope septentrionalis* Juday and Matt., *Holopedium gibberum* Zadd., *Daphnia galeata mendotae* Birge, *Bosmina coregoni* Baird) were collected, their abundance was always low (<6% of the population).

Diaptomus sicilis (mainly CV) was usually predominant in the smaller lakes reaching high densities even at 0 m (Figure 11). *Cyclops scutifer* customarily achieved secondary importance with adults representing ca 1/3 of the population. *Heterocope sepentrionalis* occurred in all lakes deeper than 5 m, averaging about 200 animals/m^3 (range 50-350). While most other organisms occurred in greatly reduced numbers, *Holopedium gibberum* achieved dominance in Lake E and H with respective surface densities of 7,400 and 5,900 animals/m^3, and was relatively common in Lakes B and I (190,650/m^3). Differences in crustacean density could not be adequately explained in terms of temperature, algal food course, or the surface area of the lake (Table 5).

While the absence of *Limnocalanus macrurus* from the Contwoyto Lake area is surprising, most of the common species encountered during this investigation occur abundantly throughout northern Canada (33). Since *H. gibberum* characteristically reaches greatest abundance in mid-summer, its occurrence in the smaller lakes is undoubtedly related to temperature. *Cyclops scutifer* probably over winters as CIII - CV with only one generation being produced per year. The same pattern was also apparently exhibited by *D. sicilis*, but development seems to be slightly retarded.

3.5 Zoobenthos

The species composition of the Chironomidae varied greatly among the different lakes (Figures 12 and 13). The main lake, for example, contained large numbers of *Heterotrissocladius changi* and *H. oliveri*, but these forms were either rare or absent in the other areas. Similarly, *Corynocera* cf. *ambigua* occurred abundantly only in lakes G and H, while *Psectrocladius calcaratus* was restricted primarily to D, F and H. The standing crop of the entire fauna also varied greatly among the different lakes with maximum and minimum values of 4900 and 140 animal/m^2, respectively.

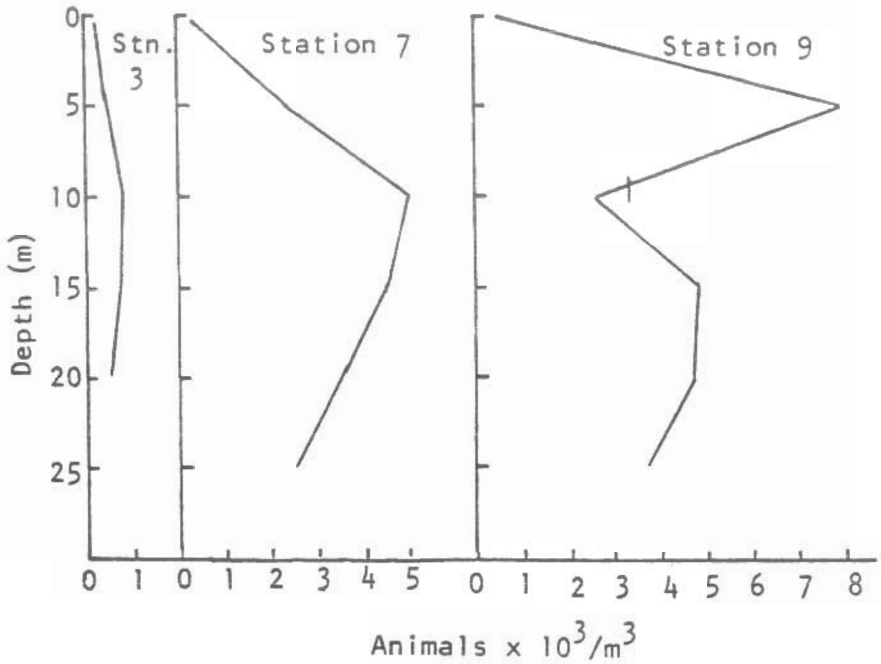

FIGURE 7 STANDING CROP OF PLANKTONIC CRUSTACEANS IN CONTWOYTO LAKE DURING THE DAY.

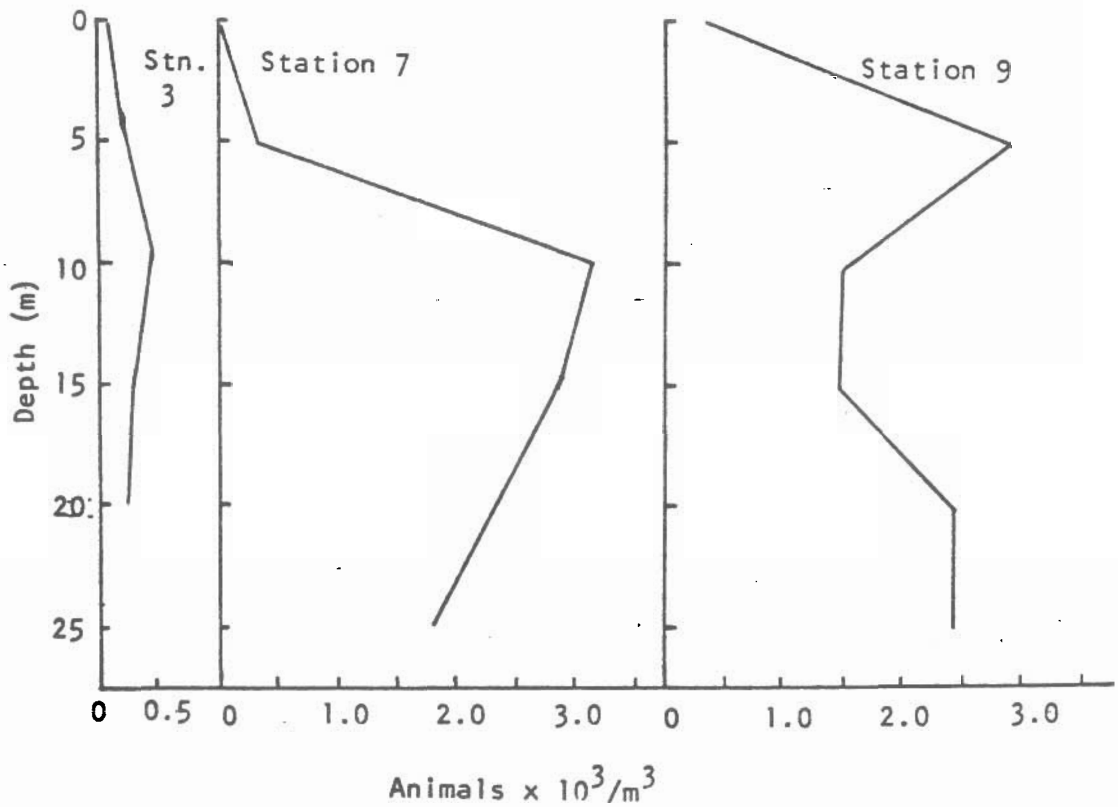

FIGURE 8 STANDING CROP OF *CYCLOPS SCUTIFER* IN CONTWOY LAKE DURING THE DAY.

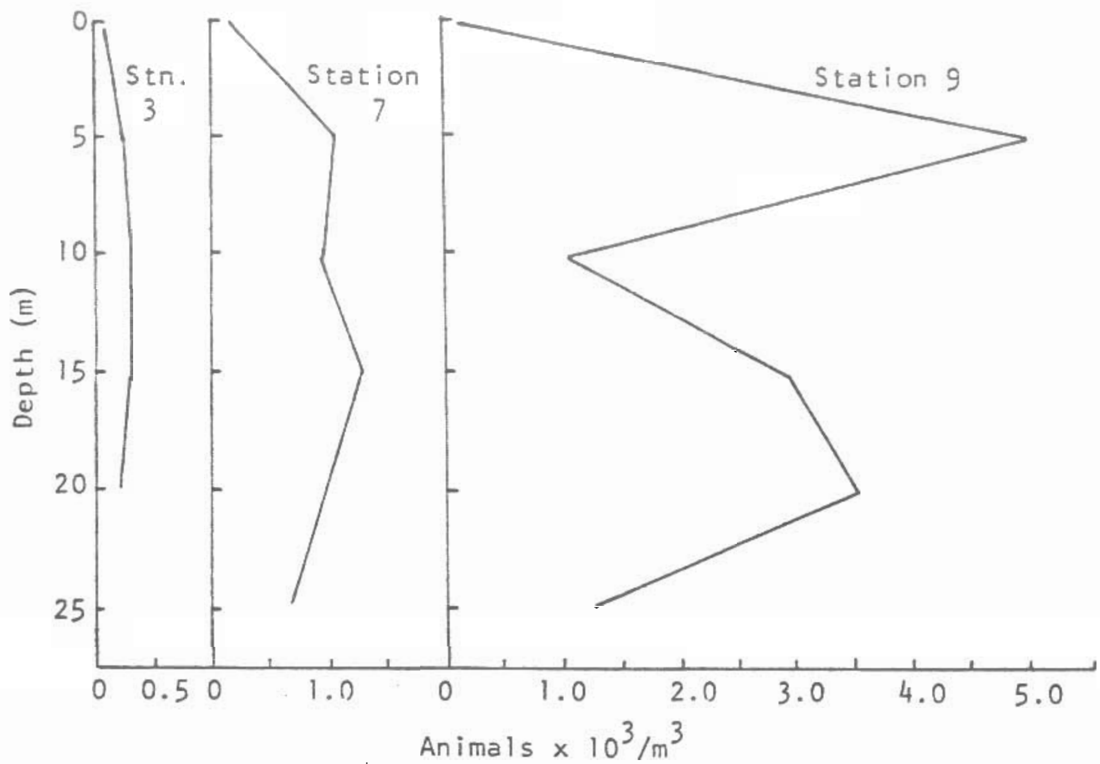

FIGURE 9 STANDING CROP OF *DIAPTOMUS SICILIS* IN CONTWOYTO LAKE DURING THE DAY.

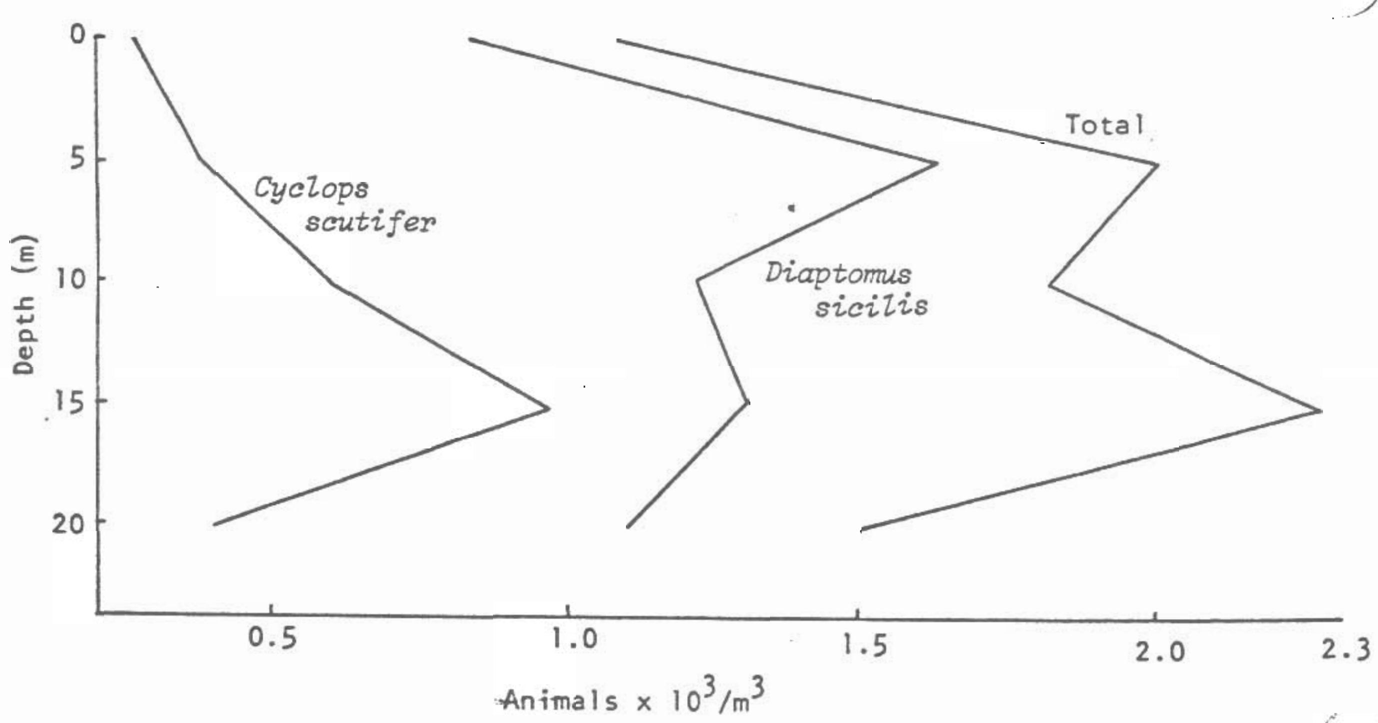

FIGURE 10 STANDING CROP OF PLANKTON CRUSTACEANS IN CONTWOYTO LAKE AT 2230 H.

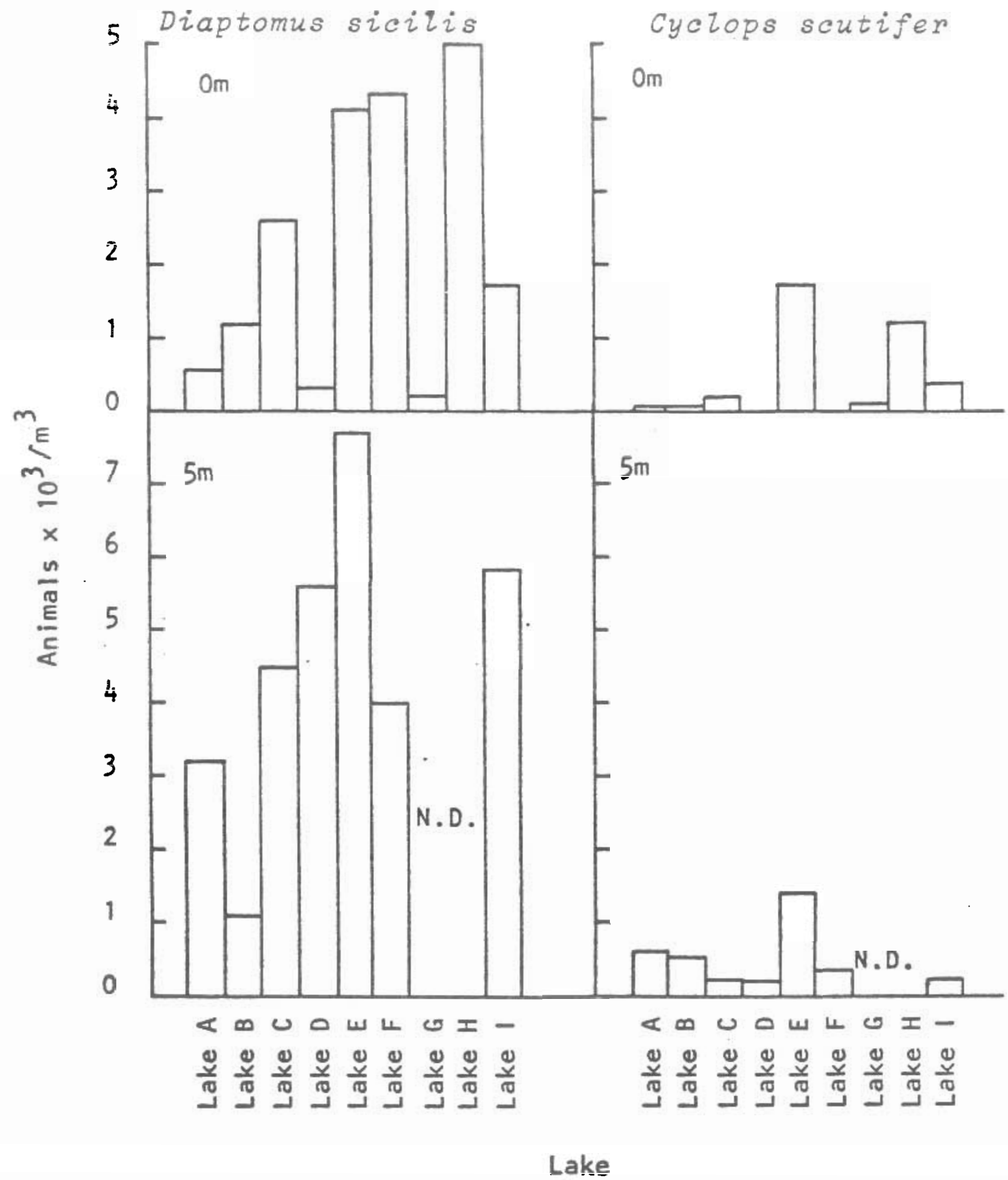

FIGURE 11 STANDING CROP OF *DIAPTOMUS SICILIS* AND *CYCLOPS SCUTIFER* IN LAKES A - I DURING THE DAY.

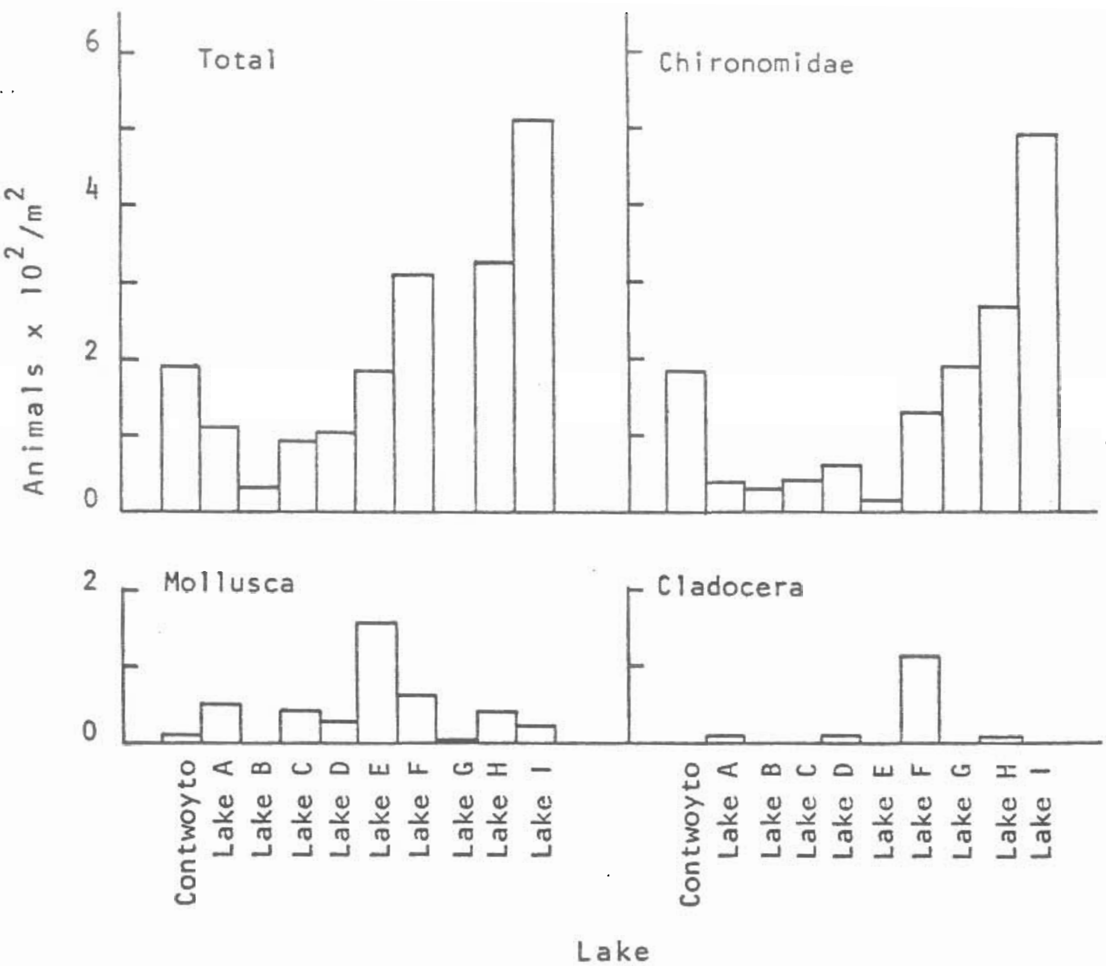

FIGURE 12 STANDING CROP OF MAJOR GROUPS OF ZOOBENTHIC ORGANISMS.

The most important factor controlling densities was the algal food source (Table 5). Descriptions of the predominant chironomids collected in this study are outlined in Moore (24).

A main feature of this investigation was the relatively large numbers of *Heterotrissocladius changi* and *H. oliveri* present in Contwoyto Lake. Since the latter species is strongly cold steno-thermic, (37, 38, 47), its restricted distribution is undoubtedly related to temperature. This animal was absent from all the study lakes (A-I) where bottom water temperatures were above 11°C. The distribution of *Heterotrissocladius changi*, on the other hand, is relatively independent of temperature (1, 9, 45). This species also occurred in relatively shallow (1-2 m) lakes. In temperate areas, *H. changi* is restricted to sublittoral and profundal areas (1).

Although *Protanypus ramosus* seems to occur abundantly in oligotrophic lakes in the more southern areas of Canada, this species is probably rare in the north (46). Its absence from Contwoyto Lake is probably due to the low water temperatures. Although an additional species of *Protanypus* occurred at low densities in the smaller lakes, it also was absent from the main body of water.

While it was not possible to identify the larval forms of *Psectrocladius*, considerable numbers of adult *P. calcaratus* were collected along the shore of the study lakes. *P. calcaratus* has been previously reported in Canada only from Alberta (43), while its Palearctic distribution includes Norway and Sweden (51). *Stictochironomus rosenscholdi* also has a circumpolar distribution, and since both species characteristically occur in moderately oligotrophic to mesotrophic lakes (47), they are absent from Contwoyto Lake.

One of the major problems associated with the collection of a single series of insect samples is that, depending on the period of emergence, species densities will fluctuate widely over a relatively short time period. Thus for example, while *Coryneura* spp. were always rare in the benthic samples, immense numbers of adults were found along the shore. Similarly, while the trend was not nearly so apparent, adults of *Polypedilum* sp. also occurred near the shore. Other species, however, were invariably rare (<0.1%) in the adult collections. Although considerable variability existed, density values for the Contwoyto Lake area generally exceeded those reported in more southern locales (1, 44, 48).

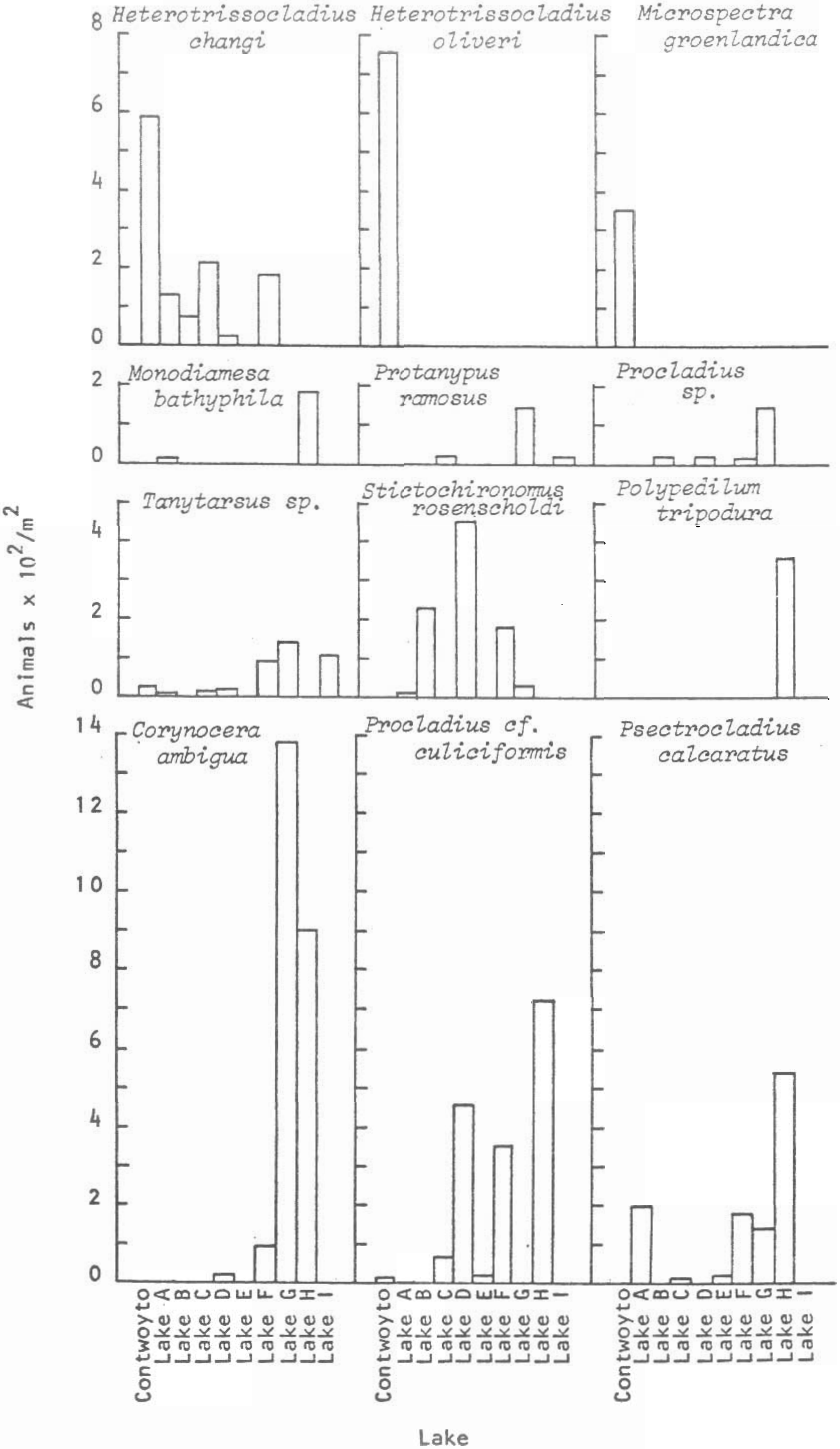

FIGURE 13 STANDING CROP OF PREDOMINANT CHIRONOMIDS.

The Mollusca were well-represented in most lakes, the predominant species being *Pisidium casertanum* *P. Idahoensis* and probably *P.* cf. *subtruncatum* (Figure 14). Although the density of the fauna exceeded 1500 animals/m^2 in some bodies of water, values of less than 50/m^2 were recorded for Contwoyto Lake and Lake B. Unidentified oligochaetes occurred in all lakes with the density of these organisms ranging from 30 to 250 animals/m^2.

Most of the molluscs found in the Contwoyto Lake area occur widely throughout the arctic and subarctic. Since the presence of vegetation seems to regulate the abundance of these organisms (2, 21), the low standing crop recorded for the main lake is probably related to this factor. The density of the fauna was generally similar to that reported for Great Slave Lake (39).

While benthic cladocerans were generally absent from the study area, *Eurycerus glacialis* Lilljeborg did occur abundantly in Lake F, reaching densities in excess of 1,100/m^2. The population consisted entirely of females, most (90%) of which were carrying eggs. The stomach contents consisted of attached algae (*Frustulia rhomboides, Synedra acus, Oedogonium* sp. *Pinnularia* spp., *Achnanthes* spp., and *Navicula* spp.), detritus and sand grains. The average number of algal cells in the gut was 1,400 ± 300 (95% confidence limits) with maximum and minimum values of 2,100 and 300, respectively.

Although only a few ($<1/m^2$) insects were found in littoral regions of the lakes, the presence of large numbers of empty caddisfly cases is an indication that the area was heavily populated earlier in the year. Adults of *Apatania zonella* (Zetterstedt), *Asynarchus aldinum* (Ross), *Asynarchus curtus* (Banks) and *Limnephilus picturatus* (McLachlan) were captured during this investigation.

3.6 Fishes

Only two species of fish were captured using a gill net in both Contwoyto and Lake C. Lake trout (*Salvelinus namaycush* (Walb) occurred most abundantly in the catches with only three arctic char (S. *alpinus* L.) being caught. Although slimy sculpins (*Cottus cognatus* Rich.) were abundant in the littoral areas of Contwoyto Lake, none were captured in Lake C. Young arctic grayling (*Thymallus arcticus* Pall.) frequently occurred in Stream A, while identified salmonids were observed in nearly all the lakes surrounding the study area. A single specimen of burbot (*Lota lota* L.) was found in Contwoyto Lake.

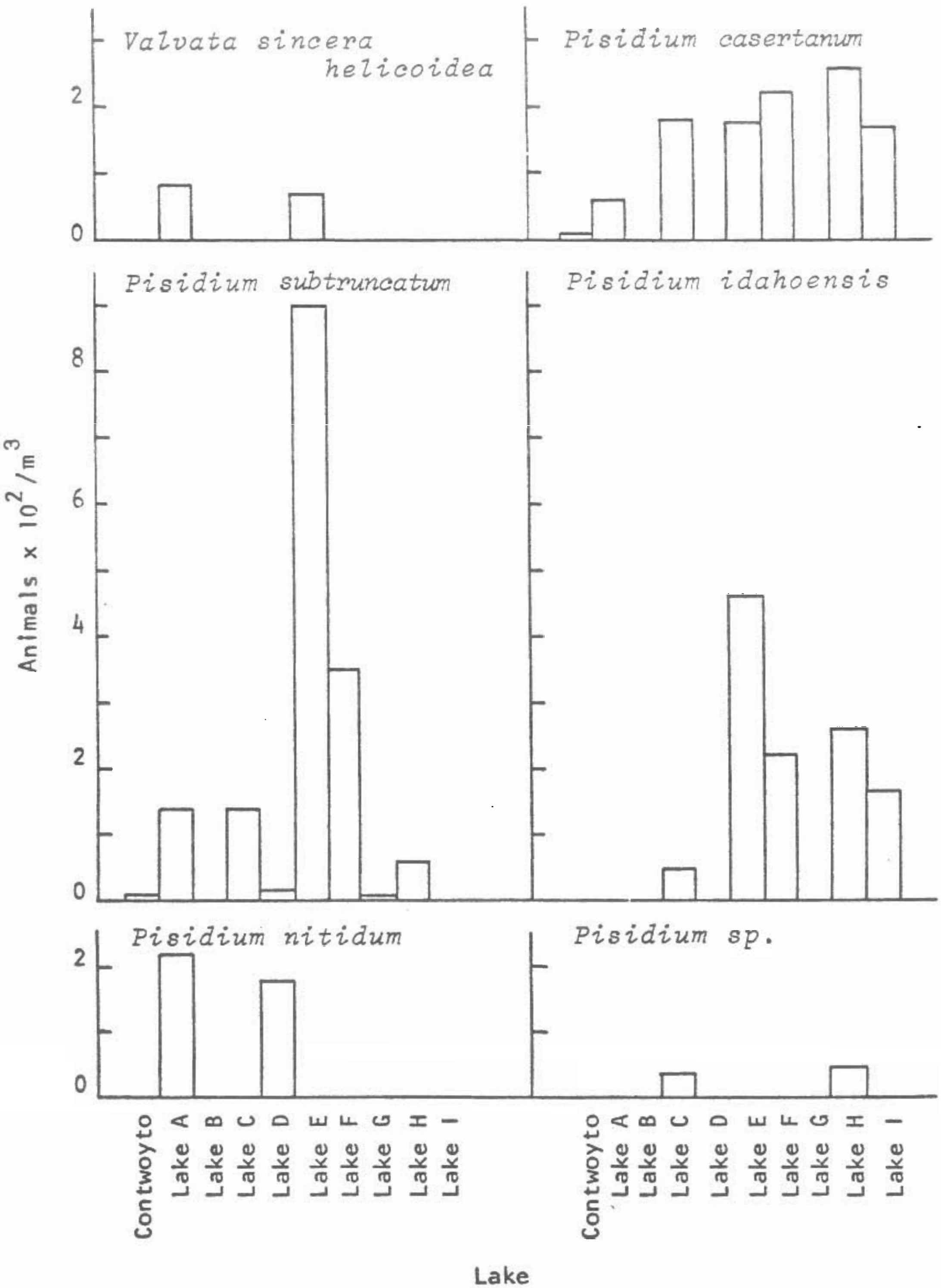

FIGURE 14 STANDING CROP OF PREDOMINANT MOLLUSCS.