shape and the broadly rounded termini are also consistent with an interpretation as body-fossil casts. A wormlike animal with a general organization resembling that of *Marywadea* Glaessner and *Palaeoplatoda* Fedonkin are candidates, but the lack of identifiable anterior-posterior polarity and the absence of strong segmentation preclude closer comparison with these genera. The affinities of our Early Cambrian specimens are thus as yet undetermined.

The new medusoid finds increase the total number of known Late Precambrian metazoan genera in the Canadian Cordillera from two to four. The fauna now comprises the coelenterate taxa *Inkrylovia* sp., *S. excentrica*, *B. brunsae*, and *C. davidi?* and the originators of the trace fossils *Gordia* sp. and *Torrowangea* sp. In addition, several problematic structures have been described.

Correlation of the fossiliferous Late Precambrian beds in northwestern Canada with units containing the Ediacaran fauna in South Australia and the White Sea area is strengthened by the new finds, particularly since they include the most widely distributed Ediacaran medusoid, *Cyclomedusa* (*10*). The data also support the case for the recognition of a formal period based on the Ediacaran fauna (*1, 2*). We expect that continued work in the Canadian Cordillera in general, and in the Wernecke and Mackenzie mountains in particular, will further this concept, although progess may be slower in these remote areas than it would be in more readily accessible regions.

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Lessons from the Silica "Decline" in Lake Michigan

Abstract. *A new analysis of data obtained from water treatment plants on Lake Michigan fails to support published contentions, based on such data, that the silica content of the lake has declined during the last five decades. The purported silica decline appears to have been due to changes in analytical methods and laboratories. Had such changes been avoided, an invaluable record of the silica content of the lake could have been obtained.*

In 1967, Powers and Ayers suggested that the silica (SiO_2) content in Lake Michigan had been declining since 1926 (*1*). Schelske and Stoermer (*2*) then hypothesized that this long-term decline in SiO_2 would lead to changes in the composition of the algal flora from diatoms to less desirable blue-green or green algae. They suggested that the SiO_2 decline resulted from the withdrawal of dissolved SiO_2 by diatoms because of increasing rates of phosphorus input to Lake Michigan and subsequent sedimentation of the diatom remains (*2, 3*). Their hypothesis has been repeatedly cited by one or both of the authors until recently, and it has been incorporated into textbooks of limnology (*4*) and a review of SiO_2 dynamics (*5*). It has even played a role in recent litigation between Milwaukee and Illinois (*6*).

The Schelske-Stoermer hypothesis was based on two sets of observations: (i) increasing rates of phosphorus inputs to Lake Michigan and (ii) the data summarized by Powers and Ayers (*1*) showing an apparent decrease in the average annual SiO_2 concentrations in influents to drinking-water treatment plants in Chicago, Milwaukee, and Grand Rapids between 1926 and 1962. There can be little argument with the notion of increasing phosphorus supplies to Lake Michigan. However, our analysis of the data on which the SiO_2 decline suggested by Powers and Ayers was based, and of data gathered since then, provides little support for the Schelske-Stoermer hypothesis.

At first glance, the evidence appears incontrovertible. The change in the SiO_2 content of the lake with time was particularly striking at Chicago (Fig. 1A), and a regression analysis of the 1926–1962 Chicago data yields a highly significant (see Table 1) decline of 0.10 part per million (ppm) of SiO_2 per year; or, as expressed by Schelske and Stoermer, a decrease of "at least 4 mg/liter in the last 44 years" (*2*, p. 423)—about a 60 percent decrease overall. Nonetheless, a more careful analysis reveals that the Chicago data fall into at least two groups, data for the years from 1926 to 1948 with an average SiO_2 concentration of about 3.9 ppm and those from 1949 to 1962 with an average of about 2.0 ppm (Fig. 1B). This drop in SiO_2 is an abrupt one; across the 1948–1949 transition all earlier points are higher than all later points. Slopes computed from the 1926–1948 data yield an average SiO_2 decline of 0.08 ppm per year, in good agreement with the overall 1926–1962 decline of 0.10 ppm per year. However, if the 1926 and 1927 data are not included, the slope is reduced to -0.04 and the regression is not statistically significant. Remarkably, regression analysis of the post-1949 data also reveals no statistically significant overall SiO_2 decline (Table 1).

Two other facts also raise significant questions about the validity of the SiO_2 decline. First, the abrupt change in SiO_2 concentrations is correlated with a change in laboratories performing the analyses (*7*). Second, dissolved SiO_2 was measured through 1948 but total SiO_2 afterward. The latter change should have produced an abrupt increase rather than the observed decrease; this finding suggests that serious analytical error must have occurred, thus invalidating use of the data for establishing long-term trends.

These observations thus contradict the view that the Chicago data document a progressive decline in Lake Michigan's SiO_2 concentration and suggest rather that the 1926–1963 "decline" (*1, 2*) depends solely upon the joining of the two sets of data (1926–1948 and 1949–1962), which have different means (*8*).

What about data from other cities? Powers and Ayers compared Chicago's SiO_2 data with what they assumed were

Table 1. Summary of the rates of change (parts per million per year) for municipal-intake SiO_2, Cl^-, and SO_4^{2-} data at Chicago (C), Milwaukee (M), or Grand Rapids (G). The Chicago data are from the Harrison and Dever intakes only, as described in the text (*11*). The letter "a" indicates that the rate cannot be calculated because four different analysis techniques were used, alternating between dissolved and total SiO_2; NS = $P > 0.05$ (not significant); * = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$. All statistics are two-tailed *t*-tests.

Data set	SiO_2			Cl^-			SO_4^{2-}		
	C	M	G	C	M	G	C	M	G
1926–1962, data analyzed by Powers and Ayers (*1*)	−0.10***	-0.04^{NS}	-0.12^{NS}	0.08***	0.14***	0.06*	0.14***	0.00^{NS}	0.49***
1926–1948, data up to the change in laboratories at Chicago	−0.08**	0.22*	0.47^{NS}	0.03*	0.14**	-0.13^{NS}	−0.10*	-0.14^{NS}	0.96*
1949–1962, data after the laboratory change to the end of Powers and Ayers's (*1*) analysis	-0.03^{NS}	−0.25***	-0.33^{NS}	0.10*	0.17***	0.11*	0.28***	0.20**	0.65*
1949–1980, data after the laboratory change to 1980	a	−0.19***	-0.06^{NS}	0.15***	0.16***	0.16***	0.21***	0.22***	0.38***
1949–1967, longest post-1948 period of consistent SiO_2 analysis at Chicago	0.05^{NS}	−0.24***	−0.30*						
1971–1978, next-longest post-1948 period of consistent SiO_2 analysis at Chicago	-0.17^{NS}	-0.13^{NS}	0.18^{NS}						

dissolved SiO_2 data (but were in fact total SiO_2) from Grand Rapids and Milwaukee. They concluded that, "The trends for the period 1948–1962 are decidedly negative at all three plants" (*1*, p. 156). Partitioning the data at the time of the change in laboratories at Chicago yields the conclusion that the SiO_2 content declined at Milwaukee. But that decline merely negated an equivalent rise from 1939 to 1948, and we find no significant trends in the before- or after-1949 Grand Rapids data (Table 1). In sum, the evidence for a SiO_2 decline in Lake Michigan up to 1962 is very weak at Chicago and Milwaukee and is nonexistent at Grand Rapids.

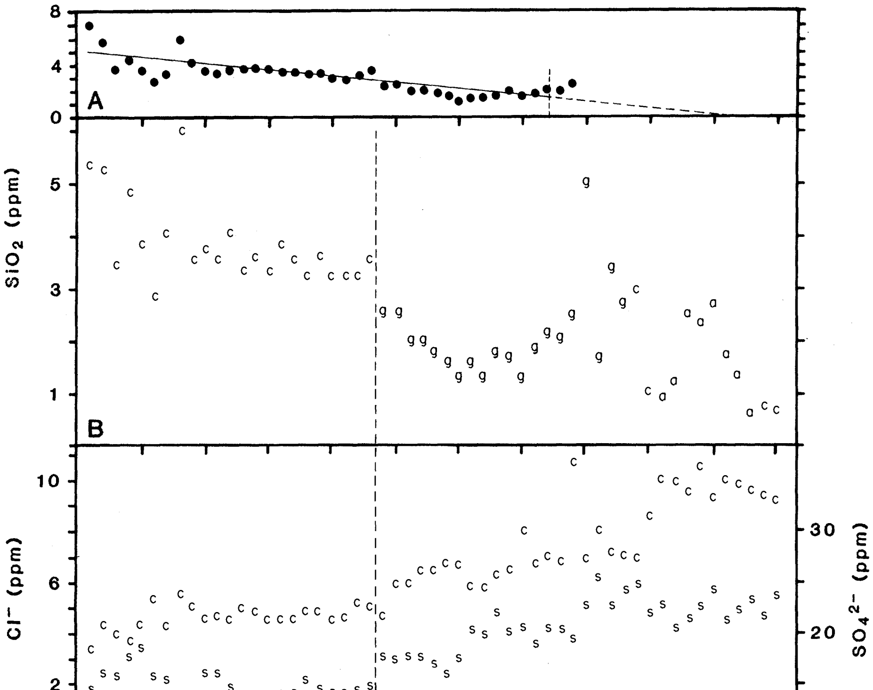

Fig. 1. Chemical parameters measured in Lake Michigan water at Chicago. The vertical dashed line between 1948 and 1949 marks the time of the change in laboratories performing the analyses. (A) Annual SiO_2 averages with declining trend as originally published by Powers and Ayers (*1*) and republished by Schelske and Stoermer (*3*) [redrawn from (*3*)]. (B) Annual SiO_2 averages calculated with data from only the Harrison and Dever intakes, as described in the text (*11*). Methods of analysis are as follows: *c* = colorimetric, *g* = gravimetric, *a* = atomic absorption. (C) Annual averages for Cl^- (*c*) and SO_4^{2-} (*s*); SO_4^{2-} increased abruptly in 1949, but for some unknown reason there was a 1-year lag in the increase for Cl^-.

Other data support our contention that the 1948–1949 SiO_2 change was probably "in the laboratory" and not in the lake. Beeton (*9*) presented evidence that the concentrations of Cl^- and SO_4^{2-} increased over the years 1885 to 1961 in Lake Michigan. The Chicago water intake data generally confirm this but exhibit a statistically significant abrupt increase for each of these ions at the same time as a sudden decrease in SiO_2 (Fig. 1C) (*10*).

We have obtained and analyzed treatment plant data collected since 1962 to see if a trend could be documented. Analysis of the gravimetrically determined SiO_2 data from Milwaukee and Grand Rapids is straightforward, but the situation at Chicago is much more complicated (*11*). To circumvent the problems of periodic changes in methods of analyzing SiO_2, we first restricted our analysis to the longest post-1948 periods of consistent SiO_2 analyses at Chicago, 1949 to 1967 and 1971 to 1978, during which total SiO_2 was measured, albeit by different methods (Fig. 1B). Neither data set exhibited a significant slope.

The only consistent evidence that we know of, based on water intakes, for a SiO_2 decline in Lake Michigan from 1926 to 1980 comes from the 1949 to 1980 Milwaukee measurements (Table 1), but this is for total and not dissolved SiO_2. It is difficult to know how to interpret these data, in view of the fact that Parker and Edgington have concluded (*12*) that the sediments of Lake Michigan are not acting as a major SiO_2 sink, which would be necessary if the Milwaukee trend were real.

Interestingly, in contrast to the case for SiO_2, the Cl^- and SO_4^{2-} trends at the three cities from 1949 to 1980 are, with one understandable exception, consistent with each other (Table 1). There was an increase in Cl^- from 0.15 to 0.16 ppm per year at Chicago, Milwaukee, and Grand Rapids. There was an increase in SO_4^{2-} of 0.21 ppm per year at Chicago and 0.22 ppm per year at Milwaukee, but 0.38 ppm per year at Grand Rapids; the difference is probably due to a change in methods that resulted in an overestimate of 57 percent.

Thus municipal water analyses appear to document some trends, but the results continue to be equivocal on the question of whether Lake Michigan is experiencing progressive change in SiO_2, dissolved or total. (One must also question whether water samples collected in the nearshore zone can ever be representative of the water quality of the lake as a whole.) This is not to say that the Schelske-Stoermer hypothesis is wrong, but clearly it is undemonstrable in Lake Michigan, although it may have been demonstrated elsewhere (*13*).

This is an unfortunate conclusion in view of the fact that a few precautions could have rendered the Lake Michigan analyses an unparalleled environmental record. Although the changes in method at Chicago were made in a search for greater accuracy, had the analytical methods not changed in 1949 or had the methods used been calibrated against each other for a year (as was done for SO_4^{2-} at Grand Rapids), the record would now be of much greater value.

Although we have used these municipal data to evaluate claims for long-term trends in the limnology of Lake Michigan, the data were collected not for that purpose but rather to demonstrate compliance with water quality criteria. The difference is not trivial. These data demonstrate that there was no continuing concern over measurement control, which involves cross-calibration of techniques, evaluation of error, use of appropriate standards, and interlaboratory comparison. There was also no apparent effort made to maintain consistent sampling and laboratory procedures (*11*).

Because of the laboratory change in Chicago in 1948, it was incorrect initially to fit lines to those data, and, in fact, because of the obvious lack of measurement control, it is incorrect to search for long-term trends in any of the data. Furthermore, if the data are examined closely, there seem to be a number of discontinuities in addition to the 1948 changes (Fig. 1): (i) an abrupt reduction in SiO_2, SO_4^{2-}, and Cl^- data variability starting in 1935; (ii) abrupt shifts in Cl^- and SO_4^{2-} values in 1956; (iii) an abrupt increase in SO_4^{2-} values starting in 1965, coincident with an increase in the variability of the SiO_2 values; and (iv) an abrupt increase in Cl^- values in 1971. In one of these cases the discontinuity correlates with a known change in measurement procedure: in 1965, a new laboratory began performing the analyses (*11*). Because for many years no records were kept on changes in analytical procedures, we do not know whether the other discontinuities are so correlated. Therefore, because the 1948 and 1965 changes were in the laboratory and not in the lake, we believe that it is not safe to conclude anything about long-term trends in Lake Michigan from these data.

Those agencies doing analyses on any environmental parameter, year after year, for whatever reason, have a largely unrecognized obligation (and opportunity) to carry out long-term monitoring. This obligation includes a responsibility for measurement control. Analytical methods should not be changed unnecessarily, and any necessary changes should be cross-calibrated.

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11. From 1926 to 1980 six different water intakes at various depths and distances from shore were used. The South District Filtration Plant conducted the analyses until November 1964, at which time the Jardine Plant took over; the filtration plants occasionally took in water directly at the plant, a "shore intake"; from August 1956 to August 1963 approximately 1 mg of fluoride per liter of water was added (as H_2SiF_6) at one pumping station, Chicago Avenue, before analyses were made; and since 1926, at least five different methods of SiO_2 analysis have been used, alternating between measurements of dissolved and total SiO_2. To circumvent some of these problems, we analyzed just the data from the Chicago Avenue pumping station, which used the Harrison intake until 1936 when it was replaced by the Dever intake, 100 feet away. We corrected for the SiO_2 that accompanied the F^- additions by subtracting 0.5 ppm SiO_2 from those data.
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The Cheetah Is Depauperate in Genetic Variation

Abstract. *A sample of 55 South African cheetahs (*Acinonyx jubatus jubatus*) from two geographically isolated populations in South Africa were found to be genetically monomorphic at each of 47 allozyme (allelic isozyme) loci. Two-dimensional gel electrophoresis of 155 abundant soluble proteins from cheetah fibroblasts also revealed a low frequency of polymorphism (average heterozygosity, 0.013). Both estimates are dramatically lower than levels of variation reported in other cats and mammals in general. The extreme monomorphism may be a consequence of a demographic contraction of the cheetah (a population bottleneck) in association with a reduced rate of increase in the recent natural history of this endangered species.*

The cheetah (*Acinonyx jubatus*) is the world's fastest mammal (achieving speeds of up to 112 km per hour) (*1*) and probably the most specialized of felids. Unlike other feline species, the cheetah has semiretractile claws, a long slender skeleton, and a number of derived anatomical characters related to its adaptations as a high-speed sprinter. Cheetahs are highly successful predators whose primary interference competitors are species such as the spotted hyena (*Crocuta crocuta*), the lion (*Panthera leo*), and the African wild dog (*Lycaon pictus*) (*2–4*). Their numbers are sparse (estimates range between 1500 and 25,000 in