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Neogene and Quaternary lacustrine diatomaceous deposits are numerous in the western United States, particularly in the Great Basin. Some of these sediments are interbedded with volcanic rocks that have been dated radiometrically or by the fission track method. Fossil lacustrine diatom floras can thus be arranged in geochronological order. By this means, a biochronological pattern of lacustrine diatom evolution has emerged: obligate non-marine Actinocyclus *Ehrenberg (Family Hemidiscaceae) appeared in the early Miocene and attained maximum diversity in the middle middle Miocene. A single species of non-marine* Actinocyclus *persisted to the end of the middle Miocene. Only two species of marine* Actinocyclus *survive in freshwater today. Genera belonging to the Family Thalassiosiraceae typify the late Miocene to Holocene lacustrine diatom biochronology.* Mesodictyon *Theriot et Bradbury nom. prov. is restricted to the late Miocene.* Cyclotella *(Kützing) Brébisson probably first appeared during the middle Miocene and diversified rapidly during the Pliocene.* Stephanodiscus *Ehrenberg and* Cyclostephanos *Round appeared during the latest Miocene and species radiated in the Pliocene and Pleistocene. These forms are often abundant, well-preserved, easily identifiable, and widespread, and can be used to correlate and date lacustrine diatomaceous sediment in the western United States.*

INTRODUCTION

Remarkable progress since the early 1970s has established marine diatom biochronologies for the Neogene and Quaternary (e.g., Burckle, 1972; Koizumi, 1973; Schrader, 1973; McCollum, 1975; Barron, 1980, 1982–83, 1985; Weaver and Gombos, 1981) and Paleogene (e.g., Gombos, 1976, Hajós, 1976; Schrader and Fenner, 1976; Gombos and Ciesielski, 1983; Fenner, 1984a, 1984b, 1985). The results of the Deep Sea Drilling Project (DSDP) have been crucial in these efforts. Core material obtained during these voyages has furnished scientists with a unique opportunity to study long, continuous, undisturbed sections from the world's oceans. These cores often span considerable geologic time and thus facilitate the comparison of successional patterns of marine diatoms in different ocean basins. Also, the presence of other microfossils in these cores, as well as paleomagnetic and radiometric data, have provided the age control necessary to establish marine diatom biochronologies.

The biochronology of lacustrine diatoms, by comparison, is poorly understood (Bradbury and Krebs, 1982), because 1) there are few specialists in lacustrine fossil diatoms, 2) past research has dealt mainly with taxonomy and/or paleoecology, 3) non-marine deposits are "thin" and only represent brief periods of geologic time, 4) patterns of diatom succession are difficult to compare because lacustrine diatomaceous sediments are of limited areal extent and often represent different limnological conditions, 5) lacustrine sediments may be poorly dated because of the lack of associated fossils, and 6) there is much taxonomic confusion. Fortunately, however, a significant number of lacustrine diatomaceous deposits in the western United States are interbedded with volcanic rocks that have been quantitatively dated. These absolute ages permit the associated diatom floras to be arranged in geochronological order.

From these geochronologically stacked fossil lacustrine diatom floras, we have selected several important genera that appear to be most useful for biostratigraphy. Our criteria are those typical of other index or guide fossils, i.e., they are abundant, well-preserved, identifiable, and widespread forms that evolved rapidly. More detailed descriptions and range charts will be provided at a later date. For this paper, we wish to document a general pattern of diatom evolution that is a useful biostratigraphic tool.

MATERIALS

Several hundred samples of lacustrine diatomaceous sediment of Miocene or younger age were examined in this study. These samples were obtained from 82 localities in the western United States, mostly from the Great Basin (Fig. 1 and Appendix 1). The localities include stratigraphic sections as thick as 130 m as well as isolated outcrops exemplified by one sample.

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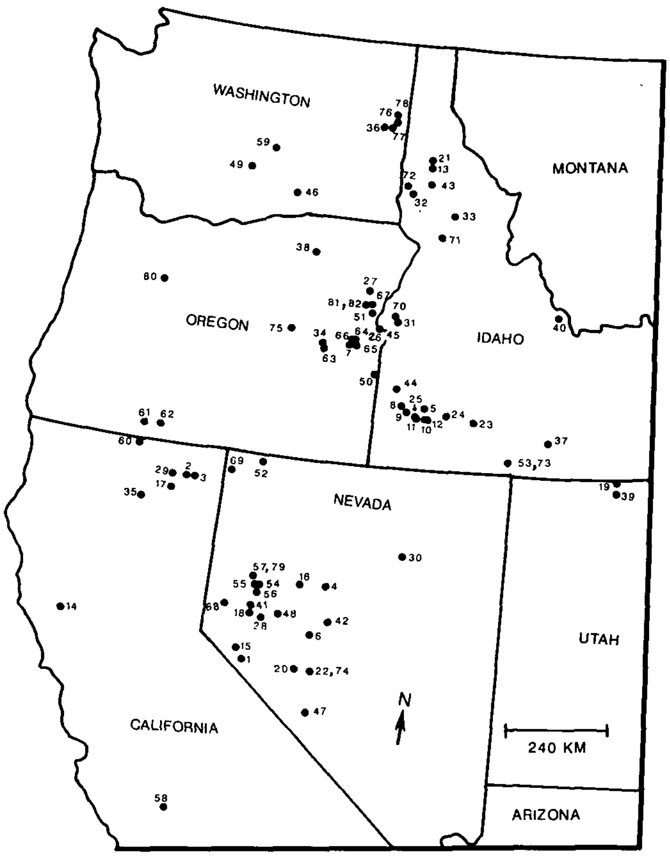

FIGURE 1—Location of sample sites (see Appendix).

Thirty-four of these localities have absolute ages that provide geochronological control. In most cases, these absolute ages were obtained from volcanics interbedded with lacustrine diatomaceous sediment. A few are second order age estimates based on stratigraphic relationships with other well-dated units. Fossil mammals and stratigraphy have provided relative geologic ages for most of the remaining 48 localities, and these samples have proven to be useful for morphological comparisons, distribution analysis, and as tests of our biochronological model. Range extensions of species are certain to occur as additional data are accumulated. We are confident, however, that the general outline of lacustrine diatom biochronology presented herein will remain intact. We regard some reported diatom occurrences as likely contamination or misidentification, e.g., *Stephanodiscus* Ehrenberg in the middle Miocene (Van Landingham, 1964). This conclusion is based on our re-examination of samples from the subject localities as well as on our own experience.

RESULTS AND DISCUSSION

We have selected five diatom genera belonging to two families for our lacustrine diatom biochronology (Fig. 2). Of these five genera, three are restricted to non-marine waters: *Mesodictyon* Theriot et Bradbury nom. prov., *Cyclostephanos* Round, and *Stephanodiscus*. *Actinocyclus* Ehrenberg is today confined to coastal marine environments, although two species, *A. normanii* (Gregory) Hasle and *A. ehrenbergii* Ralfs, are occasionally found in non-marine conditions (Yezdani, 1970; Hasle, 1977; Foged, 1978; Belcher and Swale, 1979). There are no known extant obligate non-marine species of *Actinocyclus*, and the Miocene forms that we have found in lacustrine sediments appear to have been restricted to that environment, for they have not yet been reported in marine diatomaceous rock. *Cyclotella* (Kützing) Brébisson, by comparison, is primarily a non-marine genus, although a few species have been reported in coastal marine waters (e.g., Lange and Syvertsen, 1986).

In lacustrine sediments of the western United States, *Actinocyclus* (Fig. 3A, 3B, 3D, and 3E) is restricted to the early and middle Miocene. Its acme occurred between 11 and 13 Ma (middle middle Miocene), and a single species lasted to the end of the middle Miocene. *Mesodictyon* (Fig. 3C, 3F, and 3G) is restricted to the late Miocene and is widespread and diverse in lacustrine sediments of that age. The oldest forms of *Cyclotella* (Fig. 4I, 4J, 4K, and 4L) in lacustrine sediments are of middle Miocene age. The genus diversified during the late Miocene and rapidly evolved during the Pliocene. It is common today in lakes and rivers of North America.

Stephanodiscus (Fig. 4A, 4B, 4C, 4D, 4E, and 4F) and *Cyclostephanos* (Fig. 4G and 4H) first appeared near the Miocene-Pliocene boundary, although both genera probably evolved during the latest Miocene. *Stephanodiscus* evolved rapidly during the Pliocene and Pleistocene and today is a diverse, widespread genus. *Cyclostephanos,* although apparently represented by fewer living species than *Stephanodiscus,* is also extant and widely distributed (Theriot and Kociolek, 1986).

This outline of lacustrine diatom biochronology is, of course, very general in nature. We have described new species (Theriot and Bradbury, in press) and will detail geologic ranges in future publications. The purpose of this paper is to report that lacustrine diatoms have evolved and that this evolution can be used to correlate and date lacustrine rocks in the western United States. We have tested our model on numerous occasions and have had success with both surface and subsurface samples. For example, species of *Actinocyclus* confirm the late Clarendonian age of the middle diatomite member of the Truckee Formation (Fig. 1, locality 55) (MacDonald, 1950, 1956) and a Barstovian age for "Diatomite Ridge," Stewart Valley, Nevada (Fig. 1, loc. 20) (S. Starratt, pers. comm., 1986; 1986). Additionally, our lacustrine diatom biochronology has provided time-stratigraphic control in subsurface wells in Carson Sink, Nevada, the western Snake River Basin of Idaho and Oregon, the Salt Lake Basin of Utah, and in Lemhi Valley, Idaho.

In regions of numerous lacustrine diatomaceous outcrops such as Carson Sink and Walker Lake of Nevada and the Snake River Basin of Idaho and Oregon, reworking of older deposits into younger sediments can pose problems. For example, *Actinocyclus* sp. B (Fig. 4B) appears in the Quaternary and Holocene sediments of Walker Lake, because it has been eroded from Miocene diatomaceous outcrops along the Walker

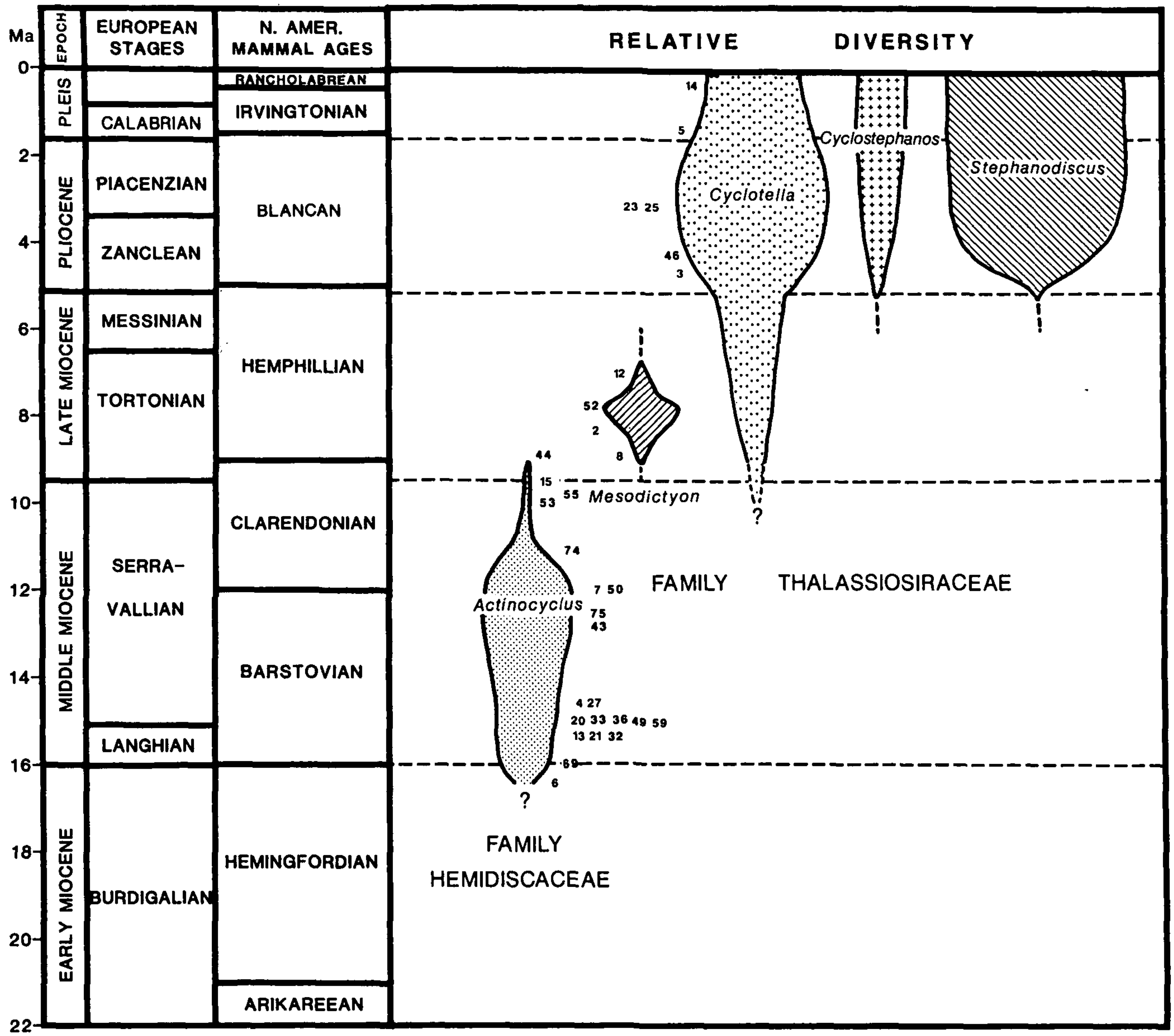

FIGURE 2—Biochronology and relative diversities of five lacustrine diatom genera, western USA. The numbers represent localities with absolute ages. Diversity patterns are generalized and are not comparable between genera. Time scale from Berggren et al. (1985) and Barron et al. (1985).

River. These reworking problems are not, however, any greater than those frequently encountered by marine diatom biostratigraphers.

We have found that these forms are widely distributed in the western United States and that the western Snake River Basin, with its Neogene and Quaternary lacustrine diatomaceous sediments, accurately records the biochronological pattern herein presented. The modes of lacustrine diatom transportation are varied and include interconnected drainages, airborne, insect, and bird dispersal (Darwin, 1859; Wutrich and Matthey, 1980). Assuming that during the Miocene and Pliocene western North American presented fewer obstacles to lacustrine diatom dispersal than today, it is not surprising that these fossil forms are so widely distributed. In fact, the modern ubiquitous distribution of *Stephanodiscus niagarae* Ehrenberg provides an analog for non-marine diatom distribution that is consistent with the geographic range of Neogene lacustrine planktonic diatoms (Theriot and Stoermer, 1984). Furthermore, we have noted that fossil lacustrine *Actinocyclus* and *Mesodictyon* occur elsewhere in the world in rocks of possible equivalent age (Bradbury, 1984; Qi, 1986; Servant-Vildary, 1986; K. Serieyssol, pers. comm., 1986; E. Fourtanier, pers.

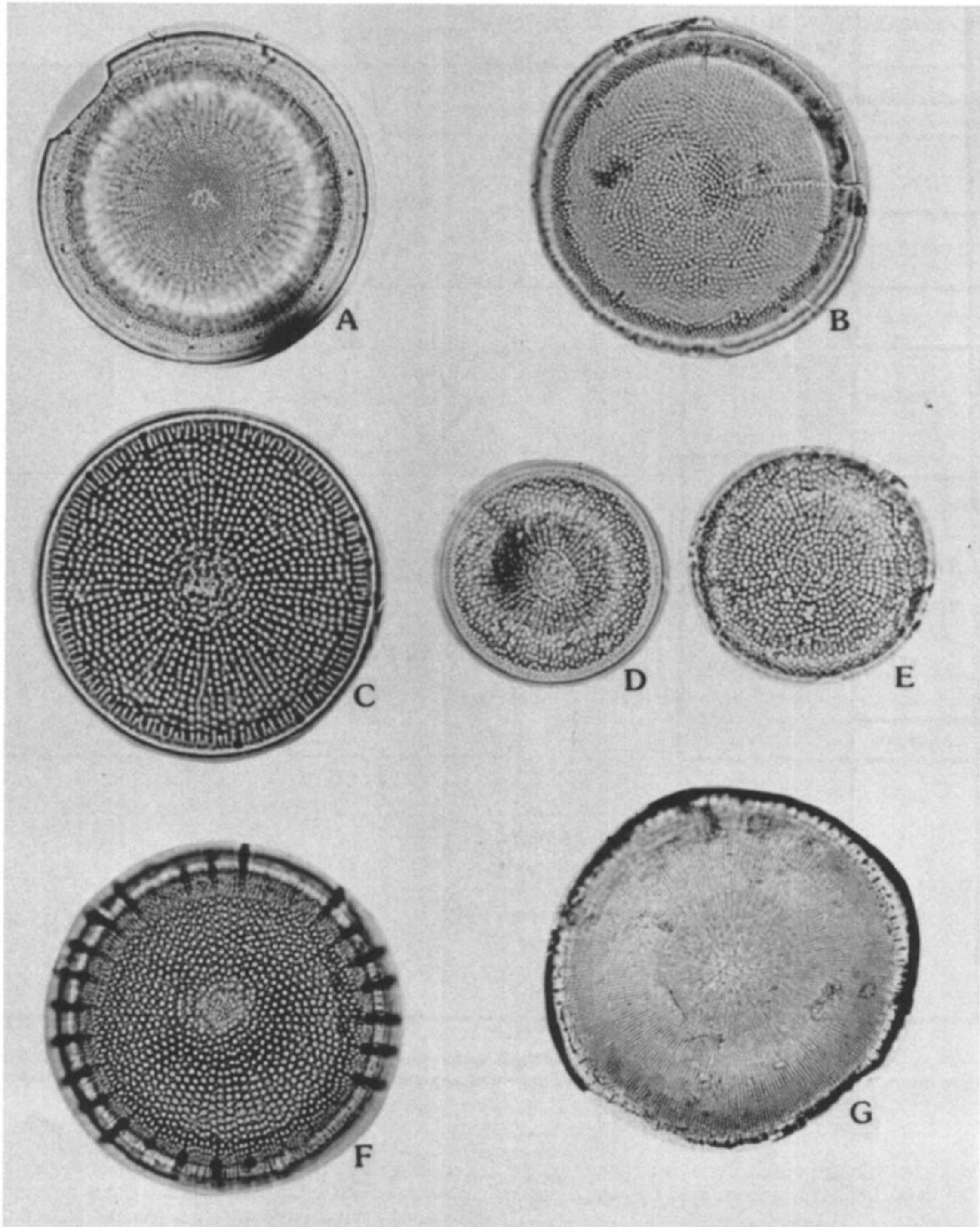

FIGURE 3—*Actinocyclus* and *Mesodictyon* species. **A)** *Actinocyclus* sp. A, Bully Creek Fromation, Malheur Co., Oregon (locality 7). Diameter = 69 μm. **B)** *Actinocyclus* sp. B, Juntura(?) Formation, Otis Creek, Harney Co., Oregon (locality 34). Diameter = 68 μm. **C)** *Mesodictyon fovis* Theriot, Bradbury, et Krebs nom. prov., Chalk Hills Formation, Castle Creek, Owyhee Co., Idaho (locality 9). Diameter = 42 μm. **D)** *Actinocyclus* sp. C, unnamed unit, Arrow Junction, Nez Perce Co., Idaho (locality 72). Diameter = 27 μm. **E)** *Actinocyclus* sp. D, unnamed unit, Juliaetta, Nez Perce Co., Idaho (locality 32). Diameter = 29 μm. **F)** *Mesodictyon fovis*, Chalk Hills Formation, Castle Creek, Owyhee Co., Idaho (locality 9). Diameter = 65 μm. **G)** *Mesodictyon magnum* Theriot, Bradbury, et Krebs nom. prov., Chalk Hills Formation, West Browns Creek, Owyhee Co., Idaho (locality 8). Diameter = 132 μm.

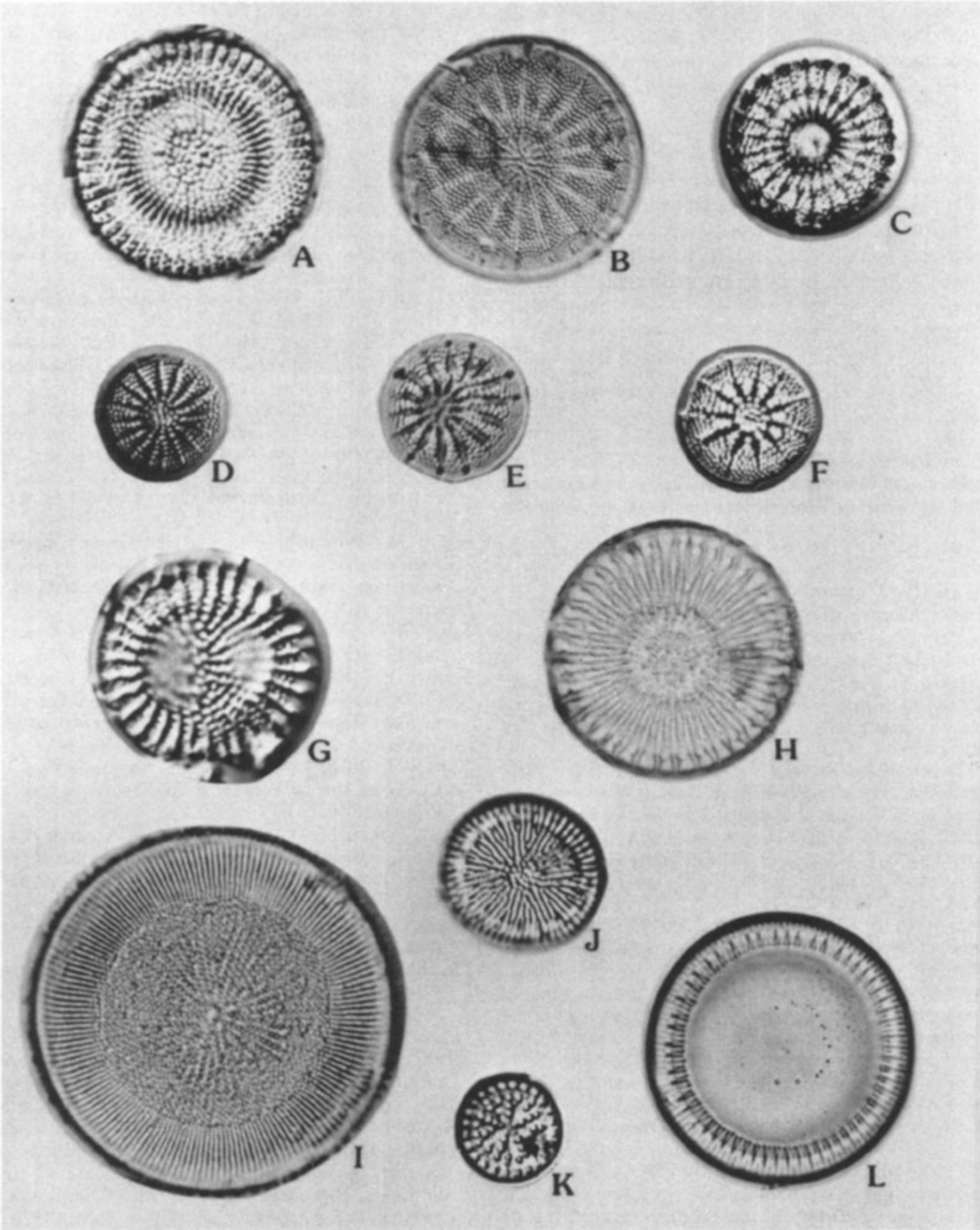

FIGURE 4—*Stephanodiscus, Cyclostephanos,* and *Cyclotella* species. **A)** *Stephanodiscus* sp. A, Ringold Formation, White Bluffs, Franklin Co., Washington (locality 46). Diameter = 17 μm. **B)** *Stephanodiscus carconensis* Grunow, Kelseyville Formation, Clear Lake, Lake County, California (locality 14). Diameter = 35 μm. **C)** *Stephanodiscus carconensis* var. *pusillus* Grunow, "Yonna" formation, Merrill, Klamath Co., Oregon. Diameter = 17 μm. **D)** *Stephanodiscus carconensis* var. *pusillus,* "Yonna" Formation, Fairhaven, Klamath Co., Oregon. Diameter = 11 μm. **E)** *Stephanodiscus* sp. B, Kelseyville Formation, Clear Lake, Lake Co., California (locality 14). Diameter = 23 μm. **F)** *Stephanodiscus carconensis,* "Yonna" Formation, Lower Klamath Lake, Siskiyou Co., California. Diameter = 10 μm. **G)** *Cyclostephanos undatus* Theriot et Kociolek, Idaho Group, West Weiser Flats, Malheur Co., Oregon. Diameter = 11 μm. **H)** *Cyclostephanos* sp. A, Pleistocene, Lake Atitlan, Guatemala. Diameter = 57 μm. **I)** *Cyclotella elgeri* Hustedt, "Yonna" Formation, Dorris, Siskiyou Co., California. Diameter = 46 μm. **J)** *Cyclotella andancensis* Ehrlich, "Yonna" Formation, Sprague River, Klamath Co., Oregon. Diameter = 16 μm. **K)** *Cyclotella pygmaea* Pantocsek, "Yonna" Formation, Lost River, Klamath Co., Oregon. Diameter = 10 μm. **L)** *Cyclotella* cf. *C. stylorum* Brightwell, Holocene, Pyramid Lake, Washoe Co., Nevada. Diameter = 50 μm.

comm., 1986), as do *Cyclotella, Cyclostephanos,* and *Stephanodiscus.* Although the lacustrine diatom biochronology that we have described may be provincial to the western United States, it may have broader geographic significance.

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APPENDIX I

List of Diatom Sample Localities

For each locality number (shown in Figure 1) there is a corresponding U.S.G.S. Diatom Locality Number as well as information regarding collector, date, locality description, stratigraphic and age assignment, or absolute age if known (and marked with an asterisk).

1	23 I 81-4	Stewart, J. H., 1980, 38.84°N, 119.06°W, Lyon Co., Nevada. East Walker River, Aldrich Station (?) Formation, Miocene
2*	16 VI 81-2	Laws, R., 1981, Sec. 27, T42N, R15E, Modoc Co., California. Howards Gulch, Alturas Formation, 8.1 Ma (Evernden and James, 1964) = 8.3 Ma (corrected).
3*	17 X 77-1	Hanna, G. D., California Academy of Sciences locality 36805. 3.5 miles W. of Alturas, Modoc Co., California. Alturas Formation, 4.8 Ma (Repenning, in press).
4*		Krebs, W. N., 1982, Sec. 31, T24N, R39E, Augusta Mountains, Churchill Co., Nevada. Unnamed unit, 14.6 Ma (Amoco, unpublished).
5*	12 VI 78-3	Bradbury J. P., 1978, Sec. 27, T5S,R4E, Elmore Co., Idaho. W. Snake River Plain, Bruneau Formation, 1.36 Ma (Evernden et al., 1964), 1.41 Ma (Armstrong et al., 1975).
6*	1 VII 75-52	Axelrod, D. I., Sec. 2, T15N, R37E, Churchill Co., Nevada. Buffalo Canyon Formation, about 16 Ma (Smedman, 1969) = 16.4 Ma (corrected).
7*		Krebs, W. N., 1980, Sec. 11, T19S, R41E, Malheur Co., Oregon. Harper Basin, Bully Creek Formation, middle Miocene (about 12 Ma, estimated) (Van Landingham, unpublished).
8*		Krebs, W. N., 1980, Sec. 2, T5S, R1W, Owyhee Co., Idaho. West Browns Creek, base of Chalk Hills Formation, about 9 Ma (Kimmel, 1979).
9*		Krebs, W. N., 1980, Sec. 9, T6S, R1E, Owyhee Co., Idaho. Castle Creek, Chalk Hills Formation, 9-7 Ma (Kimmel, 1979).
10*		Krebs, W. N., 1980, Sec. 20, T7S, R4E, Owyhee Co., Idaho. Chalk Hills, Chalk Hills Formation, 9-7 Ma (Kimmel, 1979).
11*		Evetts, M. J., 1979, Sec. 9, T7S, R3E, Owyhee Co., Idaho. Shoofly Creek, Chalk Hills Formation, lower Horse Hill ash, 7 Ma (Kimmel, 1979).
12*		Evetts, M. J., 1979, Sec. 25, T7S, R4E, Owyhee Co., Idaho. Type section, Chalk Hills Formation, lower Horse Hills ash, 7 Ma (Kimmel, 1979).
13*	13 IV 78-3	Smiley, C. J., Sec. 13, T42N, R1E, Shoshone Co., Idaho. Clarkia basin, unnamed unit, 15.3 Ma (Bradbury et al., 1985).
14*	21 X 81-4	Rymer, M. J., 1978, Sec. 27, T13N, R9W, Lake Co., California. Clear Lake, Kelseyville Formation, 0.4 Ma (Rymer, 1981).
15*	12 X 83-1	Stewart, J. H., 1983, Sec. 2, T9N, R26E, Lyon Co., Nevada. Pine Grove Hill, Coal Valley Formation, 9.3 Ma (Evernden et al., 1964) = 9.5 Ma (corrected).
16		Krebs, W. N., 1982, Sec. 26, T24N, R34E, Churchill Co., Nevada. Copper Kettle Canyon, unnamed unit, Miocene.
17	13 VII 85-6	Bradbury, J. P., 1985, Sec.

		1, T41N, R8E, Modoc Co., California. Turner Creek, unnamed unit, late Barstovian to Clarendonian (J. A. Wolfe, personal communication, 1985).
18		Krebs, W. N., 1981, Sec. 24, T18N, R26E, Churchill Co., Nevada. Dead Camel Mountains, unnamed unit, Miocene.
19		Krebs, W. N., 1983, Sec. 19, T14N, R1E, Cache Co., Utah. Delta Stephan Szot Well, unnamed unit, Pliocene(?) and Pleistocene.
20*		Starratt, S., 1986, 38° 37'02"N, 117°56'35"W, Mineral Co., Nevada. "Diatomite Ridge," "Esmeralda" Formation in Stewart Valley, 15.1 Ma (S. Starratt, personal communication, 1986).
21*	5 XII 80-4	Smiley, C. J., 1978, Sec. 33, T43N, R1E, Shoshone Co., Idaho. Clarkia basin, Emerald Creek, unnamed unit, 15.3 Ma (Bradbury et al., 1985).
22	23 I 81-10	Stewart, J. H., 1980, 38.5°N, 44.75°W, Mineral Co., Nevada. Cedar Mountain, Esmeralda(?) Formation, Miocene.
23*	11 VI 79-1	Bradbury, J. P., 1979, Sec. 16, T7S, R13E, Twin Falls Co., Idaho. Snake River, below Hagerman Horse Quarry, Glenns Ferry Formation, about 3.2 Ma (Neville et al., 1979).
24		Evetts, M. J., 1979, Sec. 1, T6S, R8E, Owyhee Co., Idaho. Malde's (1972) section no. 55, Glenns Ferry Formation, Pliocene.
25*		Evetts, M. J., 1979, Sec. 6, T7S, R3E, Owyhee Co., Idaho. Shoofly Creek, Glenns Ferry Formation, 3.3-3.0 Ma (M. Porter, personal communication, 1985).
26		Evetts, M. J., 1979, Sec. 35, T15S, R46E, Washington Co., Idaho. Weiser, Glenns Ferry(?) Formation, Pliocene (?).
27*	10 VI 78-2	Bradbury, J. P., 1978, Sec. 29, T8S, R43E, Baker Co., Oregon. Goose Creek, unnamed unit, 14.5 Ma (Fiebelkorn et al., 1983).
28		Krebs, W. N., 1982, Sec. 14, T17N, R28E, Churchill Co., Nevada. Halbouty Federal Well, unnamed unit, Pliocene and Pleistocene.
29	13 VII 85-5	Bradbury, J. P., 1985, Sec. 22, T42N, R9E, Modoc Co., California. Howards Gulch, Alturas Formation, late Miocene.
30		Laule, S., 1980, Sec. 31, T31N, R52E, Eureka Co., Nevada. Humboldt Formation, Miocene.
31		Evetts, M. J., 1979, Sec. 34, T12N, R4W, Washington Co., Idaho. Idaho Group, Neogene.
32*	5 XII 80-3	Smiley, C. J., Sec. 20, T37N, R3W, Nez Perce Co., Idaho. Juliaetta, unnamed unit, 15.3 Ma (Bradbury et al., 1985).
33*	5 XII 80-7	Smiley, C. J., Sec. 15, T33N, R6E, Idaho Co., Idaho. Jungle Point, unnamed unit, 14.5-15.4 Ma (Smiley and Rember, 1979).
34	14 VI 78-4	Bradbury, J. P., 1978, Sec. 32, T19S, R36E, Harney Co., Oregon. Otis Creek, Juntura(?) Formation, Miocene.
35	16 VI 81-1	Laws, R., 1981, Sec. 29, T37N, R3E, Shasta Co., California. Lake Britton, unnamed unit, Pliocene(?).
36*	5 VI 79-1	Bradbury, J. P., 1979, Sec. 6, T24N, R43E, Spokane Co., Washington. Hangman Valley, Latah (?) Formation, 14.5 Ma (Evernden and James, 1964) = 14.9 Ma (corrected).
37	10 VI 79-2	Bradbury, J. P., 1979, Sec. 35, T10S, R27E, Cassia Co., Idaho. Burley, Raft River Formation, Pleistocene.
38		Evetts, M. J., 1979, Sec. 19, T2S, R33E, Umatilla Co., Oregon. Seven Mile Creek, the lower(?) part of the Columbia River Basalt Group, Miocene.
39		Krebs, W. N., 1983, Sec. 17, T12N, R1E, Cache Co., Utah. Lynn Reese Well, unnamed unit, Pliocene(?) and Pleistocene.
40		Krebs, W. N., 1983, Sec. 19, T15N, R27E, Lemhi Co., Idaho. Milford Federal Well, unnamed unit, Miocene.
41		Krebs, W. N., 1981, Sec. 8, T19N, R26E, Churchill Co., Nevada. Fernley, Truckee Formation (middle member), Miocene.
42	14 VII 85-4	Bradbury, J. P., 1985, unsurveyed, T19N, R40E, Lander Co., Nevada. New Pass, unnamed unit, Miocene.
43*	5 XII 80-1	Smiley, C. J., Sec. 12, T39N, R1E, Clearwater Co., Idaho. Oviatt Creek, unnamed unit, 12.8 Ma (Smiley and Rember, 1979).
44*		Krebs, W. N., 1980, Sec. 2, T2S, R3W, Owyhee Co., Idaho. Reynolds Creek, Poison Creek Formation, minimum age 8.9 Ma (Amoco, unpublished).
45		Evetts, M. J., 1979, Sec. 17, T11N, R6W, Washington Co., Idaho. Poison Creek Formation, Miocene.
46*	9 VI 78-1	Bradbury, J. P., 1978, Sec. 1, T10N, R28E, Franklin Co., Washington. White Cliffs, Columbia River, Ringold Formation, 4.3 Ma (Repenning, in press).
47	3 VI 84-5	Bradbury, J. P., 1984, unsurveyed, T2N, R38E, Esmeralda Co., Nevada. Big Smokey Valley, unnamed unit, Miocene.
48		Krebs, W. N., 1981, Sec. 22, T18N, R31E, Churchill Co., Nevada. Southern Stillwater Mountains, unnamed unit, Miocene.
49*	26 II 79-1	Bradbury, J. P., 1979, Sec. 9, T14N, R19E, Yakima Co., Washington. Squaw Creek Member, Ellensburg Formation, 14.5-15.5 Ma (Beeson et al., 1985).
50*		Evetts, M. J., 1979, Sec. 28, T24S, R46E, Malheur Co., Oregon. Leslie Gulch, Sucker Creek Formation, 12 Ma estimated (Fields, 1983).
51	10 VI 78-4	Bradbury, J. P., 1978, Sec. 6, T12S, R44E, Baker Co., Oregon. Swayze Creek, Durkee, unnamed unit, late Miocene.
52*	12 VII 85-1	Bradbury, J. P., 1985, unsurveyed, T46N, R25E, Humboldt Co., Nevada. Thousand Creek Formation, Hemphillian (Wood et al., 1941), estimated 7.8 Ma (Van Landingham, unpublished).
53*	5 XII 80-6	Smiley, C. J., Sec. 2, T15S, R20E, Cassia Co.,

		Idaho. Trapper Creek, Beaverdam Formation, 10 Ma estimated (Armstrong et al., 1975).
54		Krebs, W. N., 1981, Sec. 21, T23N, R27E, Churchill Co., Nevada. Bradys Hot Springs, Truckee Formation (middle member), Miocene.
55*		Krebs, W. N., 1981, Sec. 33, T23N, R27E, Churchill Co., Nevada. Browns Hill, Truckee Formation (middle member), 9.8 Ma (Amoco, unpublished).
56		Krebs, W. N., 1981, Sec. 36, T22N, R27E, Churchill Co., Nevada. Hot Springs Mountains, Truckee Formation (lower member), Miocene.
57		Krebs, W. N., 1981, Sec. 18, T24N, R26E, Churchill Co., Nevada. Nightingale, Truckee Formation (middle member), Miocene.
58	17 I 81-1	Secs. 26/35, T21S, R17E, Kings Co., California. La Ceja Ridge, Kettleman Hills, Tulare Formation, Pliocene to Pleistocene.
59*	27 II 79-1	Bradbury, J. P., 1979, Sec. 17, T18N, R23E, Grant Co., Washington. Vantage, Ellensburg Formation, 14.5-15.5 Ma (Beeson et al., 1985).
60	6 VI 78-1	Bradbury, J. P., 1978, Sec. 11, T47N, R1E, Siskiyou Co., California. Dorris, "Yonna" Formation, Pliocene.
61	12 VII 80-2	O'Brian, M., 1980, Sec. 23, T38S, R8E, Klamath Co., Oregon. Klamath Falls, "Yonna" Formation, Pliocene.
62	6 VI 78-7	Bradbury, J. P., 1978, Sec. 23, T38S, R11.5E., Klamath Co., Oregon. Yonna Valley, "Yonna" Formation, Pliocene.
63	USGS 1019	Moore, B. N., 1931, Sec. 14, T20S, R36E, Harney Co., Oregon. Drewsey,
	USGS 1020	unnamed unit, late Miocene.
64	USGS 1022	Moore, B. N., 1931, Sec. 15, T18S, R41E, Malheur Co., Oregon. Harper Basin, Westfall, Bully Creek Formation, Miocene.
65	USGS 1023	Moore, B. N., 1931, Sec. 34, T19S, R42E, Malheur Co., Oregon. Harper Basin, Bully Creek Formation, Miocene.
66	USGS 1024	Moore, B. N., 1931, Sec. 34, T18S, R41E, Malheur Co., Oregon. Harper Basin, Bully Creek Formation, Miocene.
67	USGS 1030	Moore, B. N., 1931, Sec. 11, T11S, R43E, Baker Co., Oregon. Swayze Creek, lake beds of Burnt River, Miocene.
68	USGS 1187	Gianella, V. P., 1932, 10 miles N. of Virginia City, Storey Co., Nevada. Virginia Range, "Truckee" lake beds, Miocene.
69*	USGS 1690	LaMotte, R. S., 1933, 17 miles E. of N. of Cedarville, Modoc Co., California. Forty-nine Camp, Nevada, upper part of the Cedarville Formation, 15.6 Ma (Axelrod, 1966) = 16.0 Ma (corrected).
70	USGS 2280	Brown, R. W., 1934, 15 miles N.E. of Whitebird, Idaho Co., Idaho. Unnamed unit, no age information.
71	USGS 2281	Brown, R. W., 1934, 2.5 miles N.E. of Whitebird, Idaho Co., Idaho. On road to Grangeville, unnamed unit, no age information.
72	USGS 2289	Brown, R. W., 1934, about 2.5 miles N.E. of Arrow Junction, Nez Perce Co., Idaho. On road to Juliaetta, unnamed unit, no age information.
73	USGS 3707	Gill, J. R., 1951, Sec. 35, T14S, R20E, Cassia Co., Idaho. Goose Creek, unnamed unit, no age information.
74*	USGS 3394	Lohman, K. E., 1938, T8N, R38E, Nye Co., Nevada.
	USGS 3397	Cedar Mountain section, Esmeralda Formation, about 11.4 Ma (corrected average) (Evernden et al., 1964).
75*	USGS 4213	Wallace, R. E., 1955, Sec. 36, T17S, R31E, Grant Co., Oregon. Silvies Valley, unnamed unit, 12.5 Ma (Fiebelkorn et al., 1983).
76	USGS 5678	Hosterman, J. W., 1963, Sec. 24, T25N, R44E, Spokane Co., Washington. Shelly Lake, Latah Formation, Micoene.
77	USGS 5679	Hosterman, J. W., 1963, Sec. 15, T24N, R43E, Spokane Co., Washington. Latah Formation, Miocene.
78	USGS 5681	Hosterman, J. W., 1963, Sec. 27, T26N, R44E, Spokane Co., Washington. Peone, Latah(?) Formation, no age information.
79	USGS 6007	Willden, R., 1966, Sec. 20, T24N, R26E, Churchill Co., Nevada. Unnamed unit, no age information.
80	USGS 6035	Wheeler, H., 1967, T11S, R7E, Linn Co., Oregon. Marion Forks, N. Santiam River, unnamed unit, no age information.
81	USGS 6364 USGS 6371 USGS 6373	Sheppard, R. A., 1970, Sec. 23, T11S, R43E, Baker Co., Oregon. Durkee, unnamed unit, no age information.
82	USGS 6368	Sheppard, R. A., 1970, Sec. 20, T11S, R43E, Baker Co., Oregon. Durkee, unnamed unit, no age information.

I want to stress the fact that discussion of human population groups has emotional and social significance to humans and that in dealing with this topic the scientist is responsible for the affective as well as the technical significance of his terminology.

—G. G. Simpson