that have been calibrated to the paleomagnetic time scale, the oxygen isotope record, or both.

2) The integration of paleontology, paleomagnetic stratigraphy, and oxygen isotope analysis in the relatively complete and continuous deep-sea record is providing a chronologic framework within which glacial-interglacial cycles can be accurately delimited. Within this framework it is now becoming possible to make an approximate correlation between the climatic record of the deep sea and the classic glacial-interglacial record in terrestrial sequences.
3) With minor adjustments and calibration to a uniform time scale there is a remarkable degree of correspondence in the climatostratigraphic curves of various authors from various parts of the world in the Northern and Southern hemispheres, which suggests essentially synchronous response over a large part of the earth to major climatic changes. The global correlation of paleoclimatic cycles is shown in Fig. 11.
4) As pointed out in the introductory paragraph to this chapter, the Quaternary is a unique time in earth history, even by the most conservative standard of comparison. In the relatively short time span of the last 1.5 Ma the earth has witnessed such diverse events as:
   a) repeated (perhaps as many as 30 or more) glaciations at high and mid-latitudes in the Northern Hemisphere, which have drastically altered the biogeographic distribution patterns of marine and terrestrial plants and animals alike;
   b) repeated and drastic latitudinal displacement of climatic zones by as much as 20 to 30 degrees;
   c) dramatic changes in oceanographic circulation patterns in the oceans and Mediterranean Sea; dramatic oscillations in circulation between the Mediterranean and Black Sea; repeated isolation of, and increased salinity in, the Red Sea; repeated subaerial exposure of the Bering shelf and subaerial connection between North American and Siberian land areas.
5) Integrated geophysical, geochemical, and paleontologic studies on the deep-sea stratigraphic record are leading to a better understanding of the history of global climate over the past million years. These studies may be expected to lead to a more precise construction of past global climatic conditions at specific "moments" in time (McIntyre *et al.*, 1976), which can, in turn, serve as boundary conditions for modeling general atmospheric circulation patterns in the Pleistocene (Gates, 1976).

   Just as the present has been amply demonstrated to be a reliable guide in reconstructing the past, so the past is seen to be a reliable guide to predicting the future.
6) Having shown uncharacteristic restraint above, we here feel constrained to point out, in passing only, that this same interval has witnessed the passage from East African "stone-pebble culture," through the development of intricate and perfect bifacial implements, to the paleolithic tool industries (which began about 0.5 Ma), through the artistic inspiration of Altamira, Lascaux, and other caves in southwestern France and Spain, to the genius of Leonardo. Although hominid evolution has recently been pushed back into the Pliocene Epoch (*ca.* 3-4 Ma) it seems fair to say that, in general terms, Man is a child of the Quaternary.

REFERENCES

Agassiz, Louis, 1838, *Notes sur les glaciers:* Soc. Géol. France, Bull., ser. 1, v. 9, p. 443-450 (observations on p. 407-410, 435-438).

Ager, D. V., 1973, *The nature of the stratigraphic record:* 113 p., MacMillan (London).

Ambrosetti, Pierluigi, Azzaroli, Augusto, Bonadonna, F. P., & Follieri, Maria, 1972, *A scheme of Pleistocene chronology for the Tyrrhenian side of central Italy:* Soc. Geol. Italiana, Boll., v. 91, p. 169-184.

Arrhenius, Gustav, 1952, *Sediment cores from the east Pacific:* Rept. Swedish Deep Sea Expedition (1947-1948), v. 5, no. 1, p. 1-89.

Azzaroli, Augusto, 1970, *Villafranchian correla-*

tions based on large mammals: Jour. Geology, v. 35, no. 2, p. 111-131.

Bandy, O. L., Casey, R. E., & Wright, R. C., 1971, *Late Neogene planktonic zonation, magnetic reversals, and radiometric dates, Antarctic to the tropics:* Am. Geophys. Union, Antarctic Res. Ser. (Antarctic oceanology, 1), v. 15, p. 1-26.

———, **& Wilcoxon, J. A.,** 1970, *The Pliocene-Pleistocene boundary, Italy and California:* Geol. Soc. America, Bull., v. 81, p. 2939-2948.

Banner, F. T., & Blow, W. H., 1965, *Progress in the planktonic foraminiferal biostratigraphy of the Neogene:* Nature, v. 208, p. 1164-1166.

Bayliss, D. D., 1969, *The distribution of Hyalinea balthica and Globorotalia truncatulinoides in the type Calabrian:* Lethaia, v. 2, p. 133-143.

Bé, A. W. H., & Tolderlund, D. S., 1971, *Distribution and ecology of living planktonic foraminifera in the surface waters of the Atlantic and Indian oceans:* in Micropaleontology of oceans, B. M. Furnell, & W. R. Ridel (eds.), p. 105-149, Cambridge Univ. Press (Cambridge, Mass.).

Beard, J. H., 1969, *Pleistocene paleotemperature records based on planktonic foraminifera, Gulf of Mexico:* Geol. Soc. America, Abstr. with Programs for 1969, pt. 7, p. 256.

Berggren, W. A., 1969, *Micropaleontologic investigations of Red Sea cores—summation and synthesis of results:* in Hot brines and recent heavy metal deposits in the Red Sea, E. T. Degens, & D. A. Ross (eds.), p. 329-335, Springer-Verlag (New York, N.Y.).——1972, *Late Pliocene-Pleistocene glaciation:* in Preliminary reports of the Deep Sea Drilling Project, v. 12, A. S. Laughton *et al.,* p. 953-963, U.S. Government Printing Office (Washington, D.C.).——1977, *The Pliocene/Pleistocene boundary in deep-sea sediments:* Giorn. Geol. (in press).

———, **& Boersma, Anne,** 1969, *Late Pleistocene and Holocene planktonic Foraminifera from the Red Sea:* in Hot brines and recent heavy metal deposits in the Red Sea, E. T. Degens & D. A. Ross (eds.), p. 282-298, 1 pl., Springer-Verlag (New York, N.Y.).

———, **& Haq, Bil-al,** 1976, *Biostratigraphy and biochronology of the Pliocene/Pleistocene boundary: calcareous plankton:* First Internatl. Congress Pacific Neogene Stratigraphy, Tokyo (1976) (Abstract).

———, **& Van Couvering, J. A.,** 1974, *The Late Neogene: Biostratigraphy, geochronology and paleoclimatology of the last 15 million years in marine and continental sequences:* Palaeogeography, Palaeoclimatology, Palaeoecology, v. 16 (1/2), p. 1-216.

Blow, W. H., 1969, *Late middle Eocene to recent planktonic foraminiferal biostratigraphy:* in Proc. 1st Internatl. Conf. Planktonic Microfossils, Geneva (1967), 1, P. Brönnimann & H. H. Renz (eds.), p. 199-421, 54 pl., E. J. Brill (Leiden).

Bremer, Mary, Briskin, Madeleine, & Berggren, W. A., 1977, *Qualitative paleoecology and paleobathymetry of the late Pliocene-early Pleistocene foraminifera of the Le Castella (Calabria, Italy):* Abstr. 10th INQUA Congress, p. 53.

Briskin, Madeleine, & Berggren, W. A., 1975, *Pleistocene stratigraphy and qualitative paleooceanography of tropical North Atlantic core V16-205:* in Late Neogene epoch boundaries, T. Saito & L. H. Burckle (eds.), Micropaleontology, Spec. Publ. 1, p. 167-198.

Brock, Andrew, & Hay, R. L., 1976, *The Olduvai event at Olduvai Gorge:* Earth and Planet. Sci. Lett., v. 29 (1976), p. 126-130.

Broecker, W. S., Thurber, D. L., Goddard, J., Ku, T., Mathews, R. K., & Mesolella, K. J., 1968, *Milankovich hypothesis supported by precise dating of coral reefs and deep-sea sediments:* Science, v. 159, p. 297-300.

———, **& Van Donk, Jan,** 1970, *Insolation changes, ice volumes, and the O^{18} record in deep-sea cores:* Rev. Geophys. Space Phys., v. 8, no. 1, p. 169-198.

Buteux, D., 1843, *Esquisse géologique du Département de la Somme:* Acad. Sci. Agric., Mém., Dépt. de la Somme, p. 187-322.

Ciaranfi, N., & Cita, M. B., 1973, *Paleontological evidence of changes in the Pliocene climates:* in Initial reports of the Deep Sea Drilling Project, W. B. F. Ryan, K. J. Hsu *et al.,* v. 13, no. 2, p. 1387-1399, U.S. Government Printing Office (Washington D.C.).

Cita, M. B., 1973, *Pliocene biostratigraphy and chronostratigraphy:* in Initial reports of Deep Sea Drilling Project, W. B. F. Ryan, K. J. Hsu *et al.,* v. 13, no. 2, p. 1343-1379, U.S. Government Printing Office (Washington, D.C.).

———, **Chierici, M. A., Ciampo, G., Moncharmont Zei, M., d'Onofrio, Sara, Ryan, W. B. F., & Scorziello, R.,** 1973, *The Quaternary record in the Tyrrhenian and Ionian basins of the Mediterranean Sea:* in Initial reports of the Deep Sea Drilling Project, W. B. F. Ryan *et al.,* v. 13, no. 2, p. 1263-1339, U.S. Government Printing Office (Washington, D.C.).

Clark, D. L., 1971, *Arctic Ocean ice cover and its late Cenozoic history:* Geol. Soc. America, Bull., v. 82, p. 3313-3324.

———, **Larson, J. A., Root, R. E., & Fagerlin, S. C.,** 1975, *Foraminiferal patterns of the Arctic Ocean Pliocene and Pleistocene:* Univ. Wisconsin-Madison Arctic Ocean Sedim. Studies Progr. no. 18, Tech. Rept., 94 p.

Cooke, H. B. S., 1973, *Pleistocene chronology: long or short?:* Quaternary Res., v. 3, p. 206-220.

Cox, Allan, 1969, *Geomagnetic reversals:* Science, v. 163, no. 3864, p. 237-245.

Creuze de Lesser, Henri, 1824, *Statistique du Department de l'Hérault:* 606 p. (Montpélier).

Dansgaard, W., & Tauber, H., 1969, *Glacial oxygen-18 content and Pleistocene ocean temperatures:*

Science, v. 166, no. 3904, p. 499-502.

———, **Johnsen, S. J., Clausen, H. B., & Langway, C. C.,** 1971, *Climatic record revealed by the Camp Century ice core:* in Late Cenozoic glacial ages, K. K. Turekian (ed.), p. 37-56, Yale University Press (New Haven, Conn.).——1972, *Speculations about the next glaciation:* Quaternary Res., v. 2, p. 396-398.

Denizot, G., 1957, *Lexique stratigraphique international:* v. 1, fasc. 4a VII, *Tertiaire: France, Belgique, Pays. Bas, Luxembourg:* Centre Nat. Rech. Sci., Paris, 217 p.

Desnoyers, J., 1829, *Observations sur un ensemble de dépôts marins plus récents que les terrains tertiaires du bassin de la Seine, et constituant une formation géologique distincte; précedées d'un aperçu de la nonsimultanéité des bassins tertiaires:* Ann. Sci. Nat., v. 16, p. 171-214, 402-419.

Deuser, W. G., 1972, *Late Pleistocene and Holocene history of the Black Sea as indicated by stable-isotope studies:* Jour. Geophys. Res., v. 77, no. 6, p. 1071-1077.——1974, *Evolution of anoxic conditions in Black Sea during Holocene:* in The Black Sea—geology, chemistry and biology, E. T. Degens & D. A. Ross (eds.), Am. Assoc. Petrol. Geologists, Mem. 20, p. 133-136.

———, **& Degens, E. T.,** 1969, *O^{18}/O^{16} and C^{13}/C^{12} ratios of fossils from the hot-brine deep area of the central Red Sea:* in Hot brines and recent heavy metal deposits in the Red Sea, E. T. Degens & D. A. Ross (ed.), p. 336-347, Springer-Verlag (New York).

Donn, W. L., & Shaw, D. M., 1967, *The maintenance of an ice-free Arctic Ocean:* in Progress in oceanography, 4, Mary Sears (ed.), p. 105-113, Pergamon (Oxford).

Duplessy, J. C., Labeyrie, J., Lalou, C., & Nguyen, H. V., 1970, *Continental climatic variations between 130,000 and 90,000 years B. P.:* Nature, v. 226, p. 631-633.

Emiliani, Cesare, 1955, *Pleistocene temperatures:* Jour. Geology, v. 63, p. 538-578.——1961, *Cenozoic climatic changes as indicated by the stratigraphy and chronology of deep-sea cores of Globigerina-ooze facies:* New York Acad. Sci., Ann., v. 95, p. 521-536.——1964, *Paleotemperature analysis of the Caribbean cores A254-BR-C and CP-28:* Geol. Soc. America, Bull., v. 75, p. 129-144.——1966a, *Paleotemperature analysis of the Caribbean cores P6304-8 and P6304-9 and a generalized temperature curve for the last 425,000 years:* Jour. Geology, v. 74, p. 109-126.——1966b, *Isotopic paleotemperatures:* Science, v. 154, p. 851-857.——1967, *The Plio-Pleistocene boundary: Reply to G. M. Richmond:* Science, v. 156, no. 3773, p. 410.——1972, *Quaternary paleotemperatures and the duration of the high temperature intervals:* Science, v. 178, p. 398-401.

———, **Mayeda, T., & Selli, Raimondo,** 1961, *Paleotemperature analysis of the Plio-Pleistocene section at Le Castella, Calabria, southern Italy:* Geol. Soc. America, Bull., v. 72, p. 679-688.

Ericson, D. B., Broecker, W. S., Kulp, J. L., & Wollin, Goesta, 1956, *Late Pleistocene climates and deep-sea sediments:* Science, v. 124, no. 3218, p. 385-389.

———, **Ewing, Maurice, & Wollin, Goesta,** 1963, *Pliocene-Pleistocene boundary in deep-sea sediments:* Science, v. 139, no. 3556, p. 727-737.——1964a, *Sediment cores from the Arctic and subarctic seas:* Science, v. 144, p. 1183-1192.——1964b, *The Pleistocene Epoch in deep-sea sediments:* Science, v. 146, p. 723-732.

———, **& Wollin, Goesta,** 1956a, *Correlation of six cores from the equatorial Atlantic and the Caribbean:* Deep-Sea Res., v. 3, p. 104-125.——1956b, *Micropaleontological and isotopic determinations of Pleistocene climates:* Micropaleontology, v. 2, no. 3, p. 257-270.——1968, *Pleistocene climates and chronology in deep-sea sediments:* Science, v. 162, p. 1227-1234.

Ewing, Maurice, & Donn, W. L., 1956, *A theory of ice ages:* Science, v. 123, p. 1061-1066.——1958, *A theory of ice ages, 2:* Science, v. 127, p. 1159-1162.

Fairbridge, R. W., 1972, *Climatology of a glacial cycle:* Quaternary Res., v. 2, no. 3, p. 283-302.

Fillon, R. H., 1972, *Evidence from the Ross Sea for widespread submarine erosion:* Nature, Phys. Sci., v. 238, p. 40-42.

Fleck, R. J., Mercer, J. H., Nairn, A. E. M., & Peterson, D. N., 1972, *Chronology of late Pliocene and early Pleistocene glacial and magnetic events in southern Argentina:* Earth Planet. Sci. Lett., v. 16, p. 15-22.

Fleischer, R. L., 1974, *Preliminary report on Late Neogene Red Sea Foraminifera, Deep Sea Drilling Project, Leg 23B:* in Initial reports of the Deep Sea Drilling Project, T. A. Davies, B. P. Luyendyk *et al.*, v. 26, p. 985-1011, 2 pl., U.S. Government Printing Office (Washington, D.C.).

Forbes, Edward, 1846, *On the connexion between the distribution of the existing fauna and flora of the British Isles and the geographical changes which have affected their area, expecially during the epoch of the Northern Drift:* Great Britain Geol. Survey, Mem. v. 1, p. 336-432.

Gates, W. L., 1976, *Modeling the ice-age climate:* Science, v. 191, no. 4232, p. 1138-1144.

Geitzenauer, K. R., 1969, *Coccoliths at late Quaternary paleoclimatic indicators in the subantarctic Pacific Ocean:* Nature, v. 223, p. 170-172.——1972, *The Pleistocene calcareous nannoplankton of the subantarctic Pacific Ocean:* Deep-Sea Res., v. 19, p. 45-60.

Gignoux, Maurice, 1913, *Les formations marines pliocène et quaternaires de l'Italie du Sud et de la Sicile:* Ann. Univ. Lyon, n. sér., v. 36, 693 p.——1950, *Géologie stratigraphique:* 4e édit.

entièrement refondue, 735 p., Masson et cie. (Paris).——1955, *Stratigraphic geology:* 682 p., Freeman & Co. (San Francisco, Calif.).

Hammen, T. van der, Wijmstra, T. A., & Zagwijn, W. H., 1971, *The floral record of the Late Cenozoic of Europe:* in The Late Cenozoic glacial ages, K. K. Turekian (ed.), p. 391-424, Yale Univ. Press (New Haven, Conn.).

Haq, Bilal, Berggren, W. A., & Van Couvering, J. A., 1977, *Corrected age of the Pliocene/Pleistocene boundary:* Nature, v. 269, p. 483-488.

Hays, J. D., 1965, *Radiolaria and Late Tertiary and Quaternary history of Antarctic seas:* Biology of the Antarctic Sea II, Am. Geophys. Union, Antarct. Res., ser. 5, p. 125-184.——1967, *Quaternary sediments of the Antarctic Ocean:* in Progress in oceanography, 4, Mary Sears (ed.), p. 117-131, Pergamon (Oxford).

———, **& Berggren, W. A.,** 1971, *Quaternary boundaries and correlations:* in Micropaleontology of the oceans, B. M. Funnell, & W. R. Riedel (eds.), p. 669-691, Cambridge University Press (Cambridge, Eng.).

———, **Saito, Tsunemasa, Opdyke, N. D., & Burckle, L. H.,** 1969, *Pliocene-Pleistocene sediments of the equatorial Pacific—their paleomagnetic, biostratigraphic and climatic record:* Geol. Soc. America, Bull., v. 80, p. 1481-1514.

Herman, Yvonne, 1969, *Arctic Ocean Quaternary microfauna and its relation to paleoclimatology:* Palaeogeography, Palaeoclimatology, Palaeoecology, v. 6, p. 251-276.——1970, *Arctic paleoceanography in late Cenozoic time:* Science, v. 169, p. 474-477.——1972, *Quaternary Eastern Mediterranean sediments: micropaleontology and climatic record:* in The Mediterranean Sea: A natural sedimentation laboratory, D. J. Stanley (ed.), p. 129-147, Dowden, Hutchinson & Ross (Stroudsburg, Pa.).——1974, *Arctic Ocean sediments, microfauna and the climatic record in Late Cenozoic time:* in Marine geology and oceanography of the Arctic seas, Yvonne Herman (ed.), p. 283-348, Springer-Verlag (New York-Heidelberg-Berlin).

Hoernes, M., 1856, *Die fossilen Mollusken des Tertiär-Beckens von Wien:* K. K. Geol. Reichsanstalt, Abh., v. 3, p. 1-733.

Hopkins, K. M., 1967a, *Quaternary marine transgression in Alaska:* in The Bering land bridge, D. M. Hopkins (ed.), p. 47-86, Stanford University Press (Stanford).——1967b, *The Cenozoic history of Beringia—a synthesis:* in The Bering land bridge, D. M. Hopkins (ed.), p. 451-484, Stanford Univ. Press (Stanford, Calif.).——1972, *The paleogeography and climate history of Beringia during Late Cenozoic time:* Inter-Nord 12, p. 121-150.——1973, *Sea level history in Beringia during the past 250,000 years:* Quaternary Res., v. 3, p. 520-540.——1975, *Time-stratigraphic nomenclature for the Holocene Epoch:* Geology, v. 3, p. 10.

———, **Mathews, J. V., Wolfe, J. A., & Silberman, M. L.,** 1971, *A Pliocene flora and insect fauna from the Bering Strait region:* Palaeogeography, Palaeoclimatology, Palaeoecology, v. 9, p. 211-231.

———, **Rowland, R. W., Echols, R. E., & Valentine, P. C.,** 1974, *An Anvilian (early Pleistocene) marine fauna from Western Seward Peninsula, Alaska:* Quaternary Res., v. 4, p. 441-470.

Huene, Roland von, et al., 1971, *Deep Sea Drilling Project Leg 18:* Geotimes, v. 16, no. 10, p. 12-15.

Hunkins, K., Bé, A. W. H., Opdyke, N. D., & Mathieu, G., 1971, *The Late Cenozoic history of the Arctic Ocean:* in Late Cenozoic glacial ages, K. K. Turekian (ed.), p. 215-237, Yale University Press (New Haven, Conn.).

Iaccarino, Silvia, 1975, *Planktonic and significant benthonic Foraminifera of the proposed Plio-Pleistocene boundary type-section of Le Castella:* L'Ateneo Parmense, Acta Nat., v. 11, no. 3, p. 449-465.

Imbrie, John, 1972, *Correlation of the climatic record of the Camp Century ice core (Greenland) with foraminiferal paleotemperature curves from North Atlantic deep sea cores:* Geol. Soc. America, Abstr. Programs, v. 4, no. 7, p. 550.

———, **& Kipp, N. D.,** 1969, *Quantitative interpretations of late Pleistocene climate based on planktonic foraminiferal assemblages in Atlantic cores:* Geol. Soc. America, Abstr. Ann. Mtg., 1969, Part 7, p. 113.——1971, *A new micropaleontological method for quantitative paleoclimatology: application to a late Pleistocene Caribbean core:* in Late Cenozoic glacial ages, K. K. Turekian (ed.), p. 73-181, Yale University Press (New Haven, Conn.).

———, **Van Donk, J., & Kipp, N. D.,** 1973, *Paleoclimatic investigation of a late Pleistocene Caribbean deep-sea core: comparison of isotopic and faunal methods:* Quaternary Res., v. 3, no. 1, p. 10-38.

Ingle, J. C., Jr., 1973, *Summary comments on Neogene biostratigraphy, physical stratigraphy, and paleooceanography in the marginal northeast Pacific Ocean:* in Initial reports of the Deep Sea Drilling Project, L. D. Kulm, R. von Huene *et al.,* v. 18, p. 949-960, U.S. Government Printing Office (Washington, D.C.).——1975, *Pleistocene and Pliocene Foraminifera from the Sea of Japan, Leg 31, Deep Sea Drilling Project:* in Initial reports of the Deep Sea Drilling Project, Leg 31, D. E. Karig *et al.,* p. 693-701, U.S. Government Printing Office (Washington, D.C.).

Johnsen, S. J., Dansgaard, W., Clausen, H. B., & Langway, C. C., 1972, *Oxygen isotope profiles through the Antarctic and Greenland ice sheets:* Nature, v. 235, p. 429-434.

Keany, John, & Kennett, J. P., 1973, *Pliocene-early Pleistocene paleoclimatic history recorded in Antarctic-subantarctic deep-sea cores:* Deep-Sea Res., v. 17, p. 529-548.

Kellogg, T. B., 1972, *Late Pleistocene climates in the Norwegian and Greenland seas:* Geol. Soc. America, Abstr. Programs, v. 4, no. 7, p. 560.

Kennett, J. P., 1970, *Pleistocene paleoclimates and foraminiferal biostratigraphy in subantarctic deep-sea cores:* Deep-Sea Res., v. 17, p. 125-140.

———, **& Brunner, C.,** 1973, *Antarctic Late Cenozoic glaciation: evidence for initiation of ice-rafting and inferred increased bottom water activity:* Geol. Soc. America, Bull., v. 84, no. 6, p. 2043-2052.

———, **& Huddlestun, Paul,** 1972, *Abrupt climatic change at 90,000 Yr BP: faunal evidence from Gulf of Mexico cores:* Quaternary Res., v. 2, no. 3, p. 384-395.

———, **& Shackleton, N. J.,** 1975, *Laurentide ice sheet meltwater recorded in Gulf of Mexico deep-sea cores:* Science, v. 188, p. 147-150.

———, **Watkins, N. D., & Vella, Paul,** 1971, *Paleomagnetic chronology of Pliocene-early Pleistocene climates and the Plio-Pleistocene boundary in New Zealand:* Science, v. 171, p. 276-279.

Kent, D., Opdyke, N. D., & Ewing, Maurice, 1971, *Climatic change in the North Pacific using ice-rafted detritus as a climatic indicator:* Geol. Soc. America, Bull., v. 82, p. 2741-2754.

Ku, T. L., & Broecker, W. S., 1967, *Rates of sedimentation in the Arctic Ocean:* in Progress in occanography, 4, Mary Sears (ed.), p. 95-104, Pergamon (Oxford).

Kukla, G. J., Mathews, R. K., & Mitchell, M. J. (eds.), 1972, *The present interglacial: How and when will it end?:* Quaternary Res., v. 2, no. 3, p. 261-445.

Lamb, J. L., 1969, *Planktonic foraminiferal datums and Late Neogene epoch boundaries in the Mediterranean, Caribbean and Gulf of Mexico:* Geol. Soc. America, Abstr. with Programs for 1969, pt. 7, p. 280.——1971, *Planktonic foraminiferal biostratigraphy and paleomagnetics of late Pliocene and early Pleistocene strata at Le Castella, Italy:* Gulf Coast Assoc. Geol. Soc., Trans., v. 21, p. 411-418.

———, **& Beard, J. H.,** 1972, *Late Neogene planktonic foraminifers in the Caribbean, Gulf of Mexico and Italian stratotypes:* Univ. Kansas Paleont. Contrib., Art. 57 (Protozoa 8), 67 p., 25 text-fig., 36 pl.

Larson, J. A., 1975, *Arctic Ocean Foraminifera abundance and its relationship to equatorial Pacific Ocean solution cycles:* Geology, v. 3, no. 9, p. 491-492.

Laughton, A. S., et al., 1970, *Deep-Sea Drilling Project, Leg 12:* Geotimes, v. 15, no. 9, p. 10-14. ——1972, *Initial reports of the Deep Sea Drilling Project, XII:* p. iv-xxi + 3-1243, U.S. Government Printing Office (Washington, D.C.).

Lyell, Charles, 1833, *Principles of geology:* v. 3, 398 p. (plus 109 p.), Murray (London).—— 1839, *Nouveaux éléments de géologie:* 648 p. Pitois-Levrault (Paris).

McIntyre, Andrew, Bé, A. W. H., Biscaye, Pierre, Burckle, Lloyd, Gardner, James, Geitzenauer, K. R., Roche, Michael, Imbrie, John, Kipp, Nilva, Ruddiman, W. F., Moore, T. C., & Heath, Ross, 1972, *The glacial North Atlantic 17,000 years ago: paleoisotherm and oceanographic maps derived from floral-faunal parameters by CLIMAP:* Geol. Soc. America, Abstr. Programs, v. 4, no. 7, p. 590.

———, **et al.,** 1976, *The surface of the Ice-Age earth:* Science, v. 191, no. 4232, p. 1131-1137.

———, **Ruddiman, W. F., & Jantzen, R.,** 1972, *Southward penetration of the North Atlantic polar front: faunal and floral evidence of large-scale surface water mass movements over the last 225,000 years:* Deep-Sea Res., v. 19, p. 61-77.

Margolis, S. V., & Kennett, J. P., 1970, *Antarctic glaciation during the Tertiary recorded in sub-Antarctic deep-sea cores:* Science, v. 170, p. 1085-1087.——1971, *Cenozoic paleoglacial history of Antarctica recorded in sub-Antarctic deep-sea cores:* Am. Jour. Sci., v. 271, p. 1-36.

Mercer, J. H., 1973, *Cainozoic temperature trends in the Southern Hemisphere: Antarctic and Andean glacial evidence:* in Palaeoecology of Africa, E. M. van Zinderen Bakker (ed.), v. 8, p. 87-114, A. A. Balkema (Capetown-Rotterdam).

Mercey, A. de, 1874-77, *Sur la classification de la période Quaternaire en Picardie:* Soc. Linn. Nord France, Mém., v. 4, p. 18-29.

Mesolella, K. J., Mathews, R. K., Broecker, W. S., & Thurber, D. L., 1969, *The astronomical theory of climatic change: Barbados data:* Jour. Geology, v. 77, no. 3, p. 250-274.

Meunier, E. S., 1908, *Géologie:* 989 p., 152 text-fig., Vuibert et Nony (Paris).

Muratov, V. M., Ostrovsky, A. B., & Fridenberg, E. O., 1974, *Quaternary stratigraphy and paleogeography on the Black Sea coast of Western Caucasus:* Boreas, v. 3, p. 49-60.

Nakagawa, Hisao, Niitsuma, Nobuaki & Hayasaka, I., 1969, *Late Cenozoic geomagnetic chronology of the Boso Peninsula:* Geol. Soc. Japan, Jour., v. 75, no. 5, p. 267-280.

Nelson, C. H., Hopkins, D. M., & Scholl, D. W., 1974a, *Cenozoic sedimentary and tectonic history of the Bering Sea:* in Oceanography of the Bering Sea, D. W. Hood & E. J. Kelley (eds.), Inst. Mar. Sci., Univ. Alaska, Fairbanks, p. 485-516.——1974b, *Tectonic setting and Cenozoic sedimentary history of the Bering Sea:* in Marine geology and oceanography of the Arctic seas, Y. Herman (ed.), p. 119-140, Springer-Verlag (New York-Heidelberg, Berlin).

Niitsuma, Nobuaki, 1970, *Some geomagnetic stratigraphical problems in Japan and Italy:* Mar. Geology, v. 6, no. 2, p. 99-112.

Olausson, Eric, 1961, *Remarks on Tertiary sequences of two cores from the Pacific:* Geol. Inst. Uppsala, Bull., v. 40, p. 299-303.——1965, *Evidence of climatic changes in North Atlantic*

deep-sea cores with remarks on isotopic paleotemperature analysis: in Progress in oceanography, 3, Mary Sears (ed.), p. 221-252, Pergamon (Oxford).

Opdyke, N. D., Glass, B. P., Hays, J. D., & Foster, J. H., 1966, *Paleomagnetic study of Antarctic deep-sea cores:* Science, v. 154, p. 349-357.

Parker, F. L., 1958, *Sediment cores from the Mediterranean Sea and the Red Sea: No. 4. Eastern Mediterranean Foraminifera:* Rept. Swedish Deep-Sea Expedition, v. 8, p. 219-283.

Parkin, D. W., & Shackleton, N. J., 1973, *Trade wind and temperature correlations from a deep-sea core off the Saharan Coast:* Nature, v. 245, no. 5426, p. 455-457.

Parmenter, C., & Folger, D. W., 1974, *Eolian biogenic detritus in deep sea sediments: a possible index of equatorial ice age acidity:* Science, v. 185, p. 695-697.

Phleger, F. B., 1961, *Ecology and distribution of recent Foraminifera:* 297 p., Johns Hopkins Press (Baltimore, Md.).

Reboul, Henri, 1833, *Géologie de la période Quaternaire, et introduction à l'histoire ancienne:* 222 p., F.-G. Levrault (Paris).

Repenning, C. A., 1967, *Paleartic-Nearctic mammalian dispersal in the late Cenozoic:* in The Bering land bridge, D. M. Hopkins (ed.), p. 288-311, Stanford University Press (Stanford, Calif.).

Richmond, G. M., 1970, *Comparison of the Quaternary stratigraphy of the Alps and Rocky Mountains:* Quaternary Res., v. 1, no. 1, p. 3-28.

Rio, Domenico, 1974, *Remarks on late Pliocene-early Pleistocene calcareous nannofossil stratigraphy in Italy:* Ateneo Parmense, Acta Natur., v. 10 (1974), p. 409-449.

Ross, D., Neprochonov, Y., Hsu, K. J., Muhitten, S., Stoffers, P., Supko, P., Trimonis, E. A., Percival, S., Traverse, A., Ericson, A. J., Degens, E. T., Hunt, J. M., & Manheim, F., 1975, *Glomar Challenger drills the Black Sea:* Geotimes, v. 20, no. 10, p. 18-20.

Ruddiman, W. F., 1971, *Pleistocene sedimentation in the equatorial Atlantic: stratigraphy and faunal climatology:* Geol. Soc. America, Bull., v. 82, p. 283-302.

———, **& McIntyre, Andrew,** 1976, *Northeast Atlantic paleoclimatic changes over the past 600,000 years:* Geol. Soc. America, Mem. 145, p. 111-146.

Ruggieri, Giuliano, 1971, *Calabriano e Siciliano nei dintorni di Palermo, Part 1:* Rivista Min. Sicil., v. 22(130-132), p. 160-171.——1972, *Alcune considerazioni sulla definizione del piano Calabriano:* Soc. Geol. Italiana, Boll., v. 91 (1972), p. 639-645.

———, **Buccheri, Giuseppe, Greco, Antonio, & Sprovieri, Rodolfo,** 1976, *Un affioramento di Siciliano nel quaero della revisione della stratigrafia del Pleistocene inferiore:* Soc. Geol. Italiana, Boll., v. 94, p. 889-914.

Ryan, W. B. F., 1972, *Stratigraphy of Late Quaternary sediments in the Eastern Mediterranean:* in The Mediterranean Sea, D. J. Stanley (ed.), p. 149-169, Dowden, Hutchinson & Ross, Inc. (Stroudsburg, Pa.).

Saito, Tsunemasa, 1969a, *The Miocene-Pliocene and Pliocene-Pleistocene boundaries in deep-sea sediments:* Congr. INQUA 8e, Paris 1969, Résumés des Communication, sec. 2, 72 bis (abstract). ——1969b, *Late Cenozoic stage boundaries in deep-sea sediments:* Geol. Soc. America, Ann. Mtg., Abstr., v. 82, pt. 7, p. 289-290.

Savage, D. E., & Curtis, G. H., 1970, *The Villafranchian Stage—Age and its radiometric dating:* in Radiometric dating and paleontologic zonation, O. L. Bandy (ed.), Geol. Soc. America, Spec. Paper 124, p. 207-231.

Scholl, D. W., et al., 1971, *Deep Sea Drilling Project, Leg 19:* Geotimes, v. 16, no. 11, p. 12-15.

Selli, Raimondo, 1967, *The Pliocene-Pleistocene boundary in Italian marine sections and its relationship to continental stratigraphies:* in Progress in oceanography, 4, Mary Sears (ed.), p. 67-82, Pergamon (Oxford).——1971, *Calabrian:* Giorn. Geol., ser. 2, v. 37, no. 2, p. 55-64.——1977, *The Neogene/Quaternary boundary in the Italian marine formations:* Giorn. Geol. (in press).

Serres, Michael de, 1830, *De la simultanéité des terrains de sediments supérieurs:* in La Géographie Physique de l'Encyclopédie Méthodique, v. 5, 125 p., 1 pl.——1855, *Des caractères et de l'importance de la période Quaternaire:* Soc. Géol. France, Bull., sér. 2, v. 12, no. 1, p. 257-263.

Shackleton, N. J., 1967, *Oxygen isotope analyses and Pleistocene temperatures re-assessed:* Nature, v. 215, no. 5096, p. 15-17.

———, **& Kennett, J. P.,** 1975a, *Paleotemperature history of the Cenozoic and the initiation of Antarctic glaciation: oxygen and carbon isotope analyses in DSDP sites 277, 279, and 281:* in Initial reports of the Deep Sea Drilling Project, v. 19, J. P. Kennett, R. E. Houtz *et al.*, p. 743-755, U.S. Government Printing Office (Washington, D.C.).——1975b, *Late Cenozoic oxygen and carbon isotopic changes at DSDP Site 284; implications for glacial history of the Northern Hemisphere and Antarctic:* in Initial reports of the Deep Sea Drilling Project, v. 19, J. P. Kennett, R. E. Houtz *et al.*, p. 801-807, U.S. Government Printing Office (Washington, D.C.).

———, **& Opdyke, N. D.,** 1973, *Oxygen isotope and palaeomagnetic stratigraphy of equatorial Pacific core V28-238: oxygen isotope temperature and ice volumes on a 10^5 year scale:* Quaternary Res., v. 3, no. 1, p. 39-55.——1976, *Oxygen-isotope and paleomagnetic stratigraphy of Pacific core V28-239: Late Pliocene to latest*

Pleistocene: Geol. Soc. America, Mem. 145, p. 449-464.

Smith, L. A., 1969, *Pleistocene discoasters from the stratotype of the Calabrian Stage (Santa Maria di Catanzaro) and the section at Le Castella, Italy:* Gulf Coast Assoc. Geol. Soc., Trans., v. 19, p. 579-583.

Sprovieri, Rodolfo, d'Agostino, Salvatore, & Di Stefano, Enrico, 1973, *Giacitura del Calabriano nei dintorni di Catanzaro:* Riv. Italiana Paleont. Stratigr., v. 79, no. 1, p. 127-140 (incl. Eng. summ.).

Takayama, T., 1970, *The Pliocene-Pleistocene boundary in the Lamont core V21-98 and at Le Castella, Italy:* Jour. Marine Geology, v. 7, no. 2, p. 70-77.

Van Montfrans, H. M., 1971, *Paleomagnetic dating in the North Sea basin:* Earth Planet. Sci. Lett., v. 11, p. 226-235.

Van Straaten, L. M. J. U., 1972, *Holocene stages of oxygen depletion in deep waters of the Adriatic Sea:* in The Mediterranean Sea: a natural sedimentation laboratory, D. J. Stanley (ed.), p. 631-643, Dowden, Hutchinson & Ross, Inc. (Stroudsburg, Pa.).

Van Voorthuysen, J. H., Toering, K., & Zagwijn, W. H., 1972, *The Plio-Pleistocene boundary in the North Sea basin: revision of its position in the marine beds:* Geol. Mijnb., v. 6, p. 627-640.

Vezian, Alexandre, 1865, *Prodrome de Géologie:* v. 3, F. Savy (Paris).

Watkins, N. D., & Kennett, J. P., 1971, *Antarctic bottom water: major change in velocity during the late Cenozoic between Australia and Antarctica:* Science, v. 173, p. 873.——1972, *Regional sedimentary disconformities and upper Cenozoic changes in bottom water velocities between Australia and Antarctica:* in Antarctic Res. Ser. 19, Antarctic oceanology 2: The Australian-New Zealand sector, D. E. Hayes (ed.), p. 273-293, American Geophysical Union (Washington, D.C.).

———, **Kester, D. R., & Kennett, J. P.,** 1974, *Paleomagnetism of the type Pliocene/Pleistocene boundary section at Santa Maria di Catanzaro, Italy, and the problem of post-depositional precipitation of magnetic minerals:* Earth and Planet. Sci. Lett., v. 24, p. 113-119.

———, **Kristjansson, L., & McDougall, I.,** 1976, *A detailed paleomagnetic survey of the type location for the Gilsa geomagnetic polarity event:* Earth and Planet. Sci. Lett., v. 27, p. 436-444.

Zagwign, W. H., 1974, *The Pliocene-Pleistocene boundary in western and southern Europe:* Boreas, v. 3, p. 75-97.

———, **Van Montfrans, H. M., & Zandstra, J. G.,** 1971, *Subdivision of the "Cromerian" in the Netherlands: pollen-analysis, palaeomagnetism and sedimentary petrology:* Geol. Mijnb., v. 50, p. 41-58.

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