## APPENDIX I: TIME STRATIGRAPHIC FRAMEWORK

Because a large number of paleontologists with different views are participating in the work leading to the initial core descriptions, the JOIDES Advisory Panel on Paleontology and Biostratigraphy recommended a scheme of period/system, epoch/series, age/stage classifications for uniform application in this work. It is probable that no worker will be happy with all of the details of this scheme–indeed, there was not unanimity among the members of the panel that formulated it. But it has been necessary to apply such a scheme uniformly in order that the contributions of diverse authors can be integrated into a coherent whole.

### TIME-STRATIGRAPHIC FRAMEWORK

| | | | | Stage | Bibliographic reference to the concept of the stratotype being applied for the purposes of this manual. |
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| CENOZOIC | QUATERNARY | PLEISTOCENE-RECENT | | Calabrian | Gignoux, M., 1910. *Compt. Rend. Acad. Sci. Paris.* **150**, 841.<br>Gignoux, M., 1913. *Ann. Univ. Lyon.* **36**.<br>Gignoux, M., 1948. *Intern. Geol. Congr. 18th* (Report published 1950).<br>Gignoux, M., 1952. *Congr. Geol. Intern. Compt. Rend. 19th* (Report published 1954).<br>Gignoux, M., 1954. *Congr. Geol. Intern. Compt. Rend. 19th.* p. 249.<br>Selli, R., 1962. *Quaternaria.* **6**, 391. |
| | TERTIARY | PLIOCENE | Upper | Astian / Piacenzian | Astian:<br>de Rouville, P. G., 1853. *Description geologique des environs de Montpellier.* Boehm (Montpellier), 185.<br>Piacenzian:<br>Mayer-Eymar, C., 1858. *Verhandl. Schweig. Naturforsch. Ges.* 17-19 Aug., 1857.<br>Pareto, L., 1865. *Bull. Soc. Geol. France.* (2) **22**, 209.<br>Gignoux, M., 1915. *Bull. Soc. Geol. France.* (4) **14**, 338.<br>Gignoux, M., 1924. *Boll. Soc. Geol. Ital.* **42**, 368.<br>di Napoli-Alliata, 1954. *Congr. Geol. Intern. Compt. Rend. 19th.* p. 229-234. |
| | | | Lower | Zanclian (A)* | Seguenza, G., 1868. *Bull. Soc. Geol. France.* (2) **25**, 465.<br>Baldacci, L., 1886. *Mem. Descrit. Carta Geol. Ital.* **1**, 1.<br>Ogniben, L., 1954. *Mem. 1st Geol. Mineral. Univ. Padova.* **18**.<br>Wezel, F. C., 1964. *Riv. Ital. Pal. Strat.* **70**, 307. |
| | | MIOCENE | Upper | Messinian<br>Tortonian (B) | Mayer-Eymar, C., 1867. *Catologue systématique et descriptif des fossiles des terrains tertiariris qui se trouvent au musée fédéral de Zurich.* (Zurich) **2**, 13.<br>Selli, R., 1960. *Giorn. Geol. Ann. Museo. Geol. Bologna.* (2) **28**, 1.<br>d'Onofrio, S., 1964. *Giorn. Geol. Ann. Museo. Geol. Bologna.* (2) **32**, 409.<br>Mayer-Eymar, C., 1858. *Verhandl. Schweiz. Naturforsch. Ges.* 17-19 Aug., 1857.<br>Gino. G. F. *et al.*, 1953. *Riv. Ital. Paleont., Mem.* 6. 7.<br>Giannoti, A., 1953. *Riv. Ital. Pal. Strat.* Mem. VI, 168.<br>Cita, M. B. *et al.*, 1965. *Riv. Ital. Pal. Strat.* **71**, 217. |

*Capital letters in parentheses refer to "Notes on Concepts of Stages and Other Boundaries".

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| CENOZOIC | TERTIARY | MIOCENE | Middle | | Langhian (C) | | Pareto, L., 1865. *Bull. Soc. Geol. France.* (2) **22**, 229.<br>Cita, M. B. and Silva, I. P., 1960. *Intern. Geol. Congr. 21st, Copenhagen, 1960, Rep. Session, Norden.* **22**, 39.<br>Cita, M. B. and Elter, G., 1960. *Accad. Nazl. dei Lincei.* Ser. 8 (5), **29**, 360. |
| | | | Lower | Girondian | Burdigalian | Girondian: Vigneaux, M., Magne, A., Veillon, M. and Moyes, J., 1954. *Compt. Rend. Acad. Sci. Paris.* **239**, 818. Caralp, M. and Vigneaux, M., 1961. *Compt. Rend. Soc. Geol. France.* 140. Drooger, C. W., 1958. *83rd Congr. Soc. Sav., Sect. Sci.* p. 171. | Burdigalian:<br>Depéret, C., 1892. *Compt. Rend. Soc. Geol. France.* (11), 145.<br>Deperet, C., 1893. *Bull. Soc. Géol. France.* (3) **21**, 263.<br>Dollfus, 1909. *Bull. Serv. Carte Géol. France.* (124) **19**, 380.<br>Drooger, C. *et al.*, 1955. *Koninkl. Ned. Akad. Wetenschap. Verslag Gewone Vergader. Afdel. Nat.* Ser. 1 (2), **21**, 1. |
| | | | | | Aquitanian | | Aquitanian:<br>Mayer-Eymar, C., 1858. *Verhandl. Schweiz. Naturforsch. Ges.* 17-19 Aug., 1857, p. 188.<br>Tournouer, R., 1862. *Bull. Soc. Geol. France.* Ser. 2, **19**, 1035.<br>Drooger, C. W. *et al.*, 1955. *Koninkl. Ned. Akad. Wetenschap. Verslag Gewone Vergader. Afdel. Nat.*<br>Szots, E., 1965. *Bull. Soc. Geol. France.* (7) **7**, 743. |
| | | | | | (E) | | |
| | | OLIGOCENE | | | Bormidian | | Pareto, L., 1865. *Bull. Soc. Geol. France.* (2) **22**, 220.<br>Lorenz, C., 1965. *Bull. Soc. Geol. France.* (7) **6**, 192.<br>Vervloet, C. C., 1966. *Stratigraphical and Micropaleontological Data on the Tertiary of Southern Piemont (Northern Italy).* (Thesis) University Utrecht. Utrecht (Schotanus & Jens).<br>Lorenz, L., 1964. *Bull. Soc. Geol. France.* Ser. 7, **6**, 192. |
| | | | | | Chattian | | Fuchs, T., 1894. *Jahresber. Ungar. Geol. Anstalt.* **10**, 172.<br>Gorgës, J., 1952. *Abhandl. Hess. Landesametes Bodenforsch.* **4**, 1.<br>Hinsch, W., 1958. *Lexique Strat. Intern.* I 5hl.<br>Anderson, H. J., 1961. *Meyniana.* **10**, 118.<br>Hubach, H., 1957. *Ber. Naturhist. Ges. Hannover.* **103**. |
| | | | | | Rupelian | | Dumont, A., 1849. *Bull. Acad. Roy. Med. Belg.* (1) **16**, 370.<br>Batjes, A., 1958. *Inst. Roy. Sci. Nat. Belg. Bull.* Mém. 143. |
| | | | | | Lattorfian | | Mayer-Eymar, C., 1893. *Bull. Soc. Geol. France.* (3) **21**, 8.<br>Munier-Chalmas, E. and de Lapparent, A., 1893. *Bull. Soc. Geol. France.* **21**, 478.<br>von Koenen, A., 1893-1894. *Abhandl. Geol. Spec. Preussen.* **10**, 1005.<br>cf. Krutzsch, W. and Lotsch, D., 1957. *Geologie.* **6**, 476.<br>Krutzsch, W. and Lotsch, D., 1958. *Ber. Deut. Geol. Ges.* **3**, 99. |
| | | EOCENE | Upper | | Priabonian / Bartonian | | Priabonian:<br>Munier-Chalmas, E. P. and de Lapparent, A., 1893. *Bull. Soc. Geol. France.* (3) **21**, 471.<br>Roveda, V., 1961. *Riv. Ital. Pal. Strat.* **67**, 153.<br>Fabiani, R., 1915. *Mem. 1st Geol. Mineral Univ. Padova.* **3**, 1. |

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| CENOZOIC | TERTIARY | EOCENE | UPPER | Priabonian / Bartonian (F) | Bartonian:<br>Mayer-Eymar, C., 1858. *Verhandl. Schweiz. Naturforsch. Ges.* 178.<br>Prestwich, J., 1847. *Quart. J. Geol. Soc., London.* **3**, 354.<br>Prestwich, J., 1857. *Quart. J. Geol. Soc., London.* **13**, 108.<br>Curry, D., 1958. *Lexique Strat. Intern.* I 3a 12. |
| | | | Middle | Lutetian | de Lapparent, A., 1883. *Traite de Geologie.* 1st Ed., p. 989.<br>Blondeau, A. and Curry, D., 1964. *Bull. Soc. Geol. France.* (7) **5**, 275.<br>Blondeau, A. *et al.*, 1966. *Bull. Soc. Geol. France.* (7) **7**, 200.<br>Blondeau, A., 1964. *Mem. Bur. Rech. Geol. Min. No. 28.* 21. |
| | | | Lower | Ypresian | Dumont, A., 1849. *Bull. Acad. Roy. Med. Belg.* (1) **16**, 368.<br>Kaasschieter, J. P. H., 1961. *Inst. Roy. Sci. Nat. Belg. Bull.* Mem. 147. |
| | | PALEOCENE | UPPER | Thanetian | Renèvier, E., 1873. *Tableau des terraines sédimentaires (in 4°) et un texte explicatif.* Lausanne (G. Bridel).<br>Renèvier, E., 1897. *Chronogr. Geol.*<br>Prestwich, J., 1852. *Quart. J. Geol. Soc., London.* **8**, 235.<br>Barr, F. T. and Berggren, W. A., 1965. *Stockholm Contrib. Geol.* (2) **13**, 9. |
| | | | LOWER | Montian | Dewalque, G., 1868. *Prodrome d'une description geologique de la Belgique.* p. 185.<br>Cornet and Briart, 1866. *Bull. Acad. Roy. Med. Belg.* (2) **20**, 757.<br>Briart and Cornet, 1880. *Ann. Soc. Geol. Belg.* **7**, 139.<br>Rutot, A. and von den Broeck, E., 1885. *Ann. Soc. Roy. Malac. Belg.* **20**, 108.<br>Rutot, A. and von den Broeck, E., 1886. *Ann. Soc. Geol. Belg.* **13**, 94.<br>Rutot, A. and von den Broeck, E., 1887. *Bull. Soc. Geol. France.* (3) **15**, 157.<br>Marlière, R., 1955. *Ann. Soc. Geol. Belg.* **78**, 297.<br>Berggren, W. A., 1964. *Stockholm Contrib. Geol.* (5) **11**, 135. |
| Tertiary / Cretaceous | | | | Danian | Tertiary:<br>de Grossovure, A., 1897. *Bull. Soc. Geol. France.* Ser. 3, **25**, 57.<br>Loeblich, A. R., Jr. and Tappan, H., 1957. *U. S. Nat. Museum Bull.* **215**, 173.<br>Troelsen, J., 1957. *U. S. Nat. Museum Bull.* 125.<br>Berggren, W. A., 1962. *Stockholm Contrib. Geol.* (2) **9**, 103.<br>Berggren, W. A., 1964. *Stockholm Contrib. Geol.* (5) **11**, 103.<br>Cretaceous:<br>Eames, F. E. (in press), 1968. *J. Geol. Soc. India.*<br>Desor, E., 1847. *Bull. Soc. Geol. France.* Ser. 2, **4**, 179.<br>Brotzen, F., 1959. *Sveriges Geol. Undersokn Arsbok, Ser. C.* (571), 81 pp.<br>Rasmussen, H. W., 1965. *Mededel. Geol. Sticht.* N. S., (17), 33. (Supplemented by M. Meijer, *loc. cit.*, pp. 21-25). |
| MESOZOIC | CRETACEOUS | Upper | | Maestrichtian | Dumont, A., 1849. *Bull. Acad. Roy. Sci.* Lettres, Beaux-Arts, Belgique, 351.<br>Hofker, J., 1966. *Paleontographica.* Supplement-Band 10, Atlas of Foraminifera, 5.<br>Jeletzsky, J., 1951. *Beih. Geol. Jahrb.* (1), 1. |
| | | | | Campanian (G) | Coquand. H., 1857. *Bull. Soc. Geol. France.* 749.<br>Van Hinte, J., 1965. *Koninkl. Ned. Akad. Wetenschap. Proc., Ser. B.* (1) **68**, 14.<br>Marie, P., 1941. *Mem. Museum Nat. Hist. Nat. (Paris).* **12**, 1. |

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| MESOZOIC | CRETACEOUS | UPPER | Santonian S.S. (H) | Coquand, H., 1857. *Bull. Soc. Geol. France*, 749.<br>Seronie-Vivien, M., 1959. *Colloque sur le Crétacé Supérieur Francais rendus de Congrès des Societes Savantes de Paris et des Depártments, Comité des Travaux historiques et scientifiques, section des sciences, sous-section de géologie, tenu a Dijon.* Paris (Gauthier-Villars). 581. |
| | | | Lower Santonian – Coniacian (I) | Coquand, H., 1857. *Bull. Soc. Geol. France.* 748.<br>Seronie-Vivien, M., 1959. *Colloque sur le Crétacé Supérieur Francais rendus de Congrès des Societes Savantes de Paris et des Depártments, Comité des Travaux historiques et scientifiques, section des sciences sous-section de geologie, tenu a Dijon.* Paris (Gauthier-Villars). p. 581.<br>Schijsfma, E., 1946. *Mededel. Geol. Sticht.* Ser. C-V (7), 1. |
| | | | Turonian | D'Orbigny, 1842. *Les Cephalopodes.* (Published by author) 622 pp.<br>D'Orbigny, 1842. *Les Animaux Mollusques et Raronnes.* (Published by author) 456 pp.<br>Lacointre, 1959. *Colloque sur le Crétacé Supérieur Francais rendus de Congrès des Societes Savantes de Paris et des Depártments, Comité des Travaux historiques et scientifiques, section des sciences, sous-section de géologie, tenu a Dijon.* Paris (Gauthier-Villars). 415.<br>Butt, A. A., 1966. *Micropaleontology.* (2) **12**, 168. |
| | | | Cenomanian | D'Orbigny, 1842. *Les Cephalopodes.* (Published by author) 622 pp.<br>D'Orbigny, 1842. *Les Animaux Mollusques et Raronnes.* (Published by author) 456 pp.<br>Marks, P., 1967. *Koninkl. Ned. Akad. Wetenschap., Proc., Ser. B* (3), **70**, 264. |
| | | LOWER | Albian | Collignon, 1965. Rapport sur L'Etage Albian. **In** Colloque sur le Crétacé Inferiéur, Lyon. *Mem. Bur. Rech. Geol. Min.* (34) (Lyon), 313.<br>Casey, 1961. The stratigraphical paleontology of the Lower Greensand. *Paleontology.* **3**, 487. |
| | | | Aptian | Fabre-Taxy, S., Moullade, M. and Thomel, G., 1965. A-Les stratotypes de l'Aptien. **In** Colloque sur le Crétacé Inferiéur, Lyon. *Mem. Bur. Rech. Geol. Min.* (34), 173.<br>Casey, R., 1961. The stratigraphical paleontology of the Lower Greensand. *Paleontology.* **3**, 487. |
| | | | Barremian | Busnardo, R. 1965. Le stratotype de Barremien. **In** Colloque sur le Crétacé Inferiéur, Lyon. *Mem. Bur. Rech. Geol. Min.* (34) (Lyon), 101. |
| | | | Hauterivian | Debelmas, J. and Thieuloy, J., 1965. E'tage Hauterivian. **In** Colloque sur le Crétacé Inferiéur, Lyon. *Mem. Bur. Rech. Geol. Min.* (34), 85. |
| | | | Valanginian | Barbier, R. and Thieuloy, J., 1965. E'tage Valanginien. **In** Colloque sur le Crétacé Inferiéur, Lyon. *Mem. Bur. Rech. Geol. Min.* (34), 79. |
| | | | Berriasian | Busnardo, R., Hegaret, G. L. and Magne, J., 1965. Le stratotype du Berriasien. **In** Colloque sur le Crétacé Inferiéur, Lyon. *Mem. Bur. Rech. Geol. Min.* (34) (Lyon), 5. |

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| MESOZOIC | JURASSIC | UPPER | Tithonian | Enay, R., 1964. L'etage Tithonique. **In** Colloq. du Jurassique (Luxembourg, 1962). *Compt. Rend. Mem., Luxembourg.* 355. |
| | | | Kimmeridgian | Ziegler, B., 1964. Das Untere Kimeridgien in Europa. **In** Colloque du Jurassic (Luxembourg, 1962). *Compt. Rend. Mem., Luxembourg.* 345. |
| | | | Oxfordian | Callomon, J. H., 1964. Notes on the Callovian and Oxfordian Stages. **In** Colloque du Jurassique (Luxembourg, 1962). *Compt. Rend. Mem., Luxembourg.* 269.<br>Enay, R. *et al.* (in press). Les Faunes Oxfordiennes d'Europe Meridionale. Essai de Zonation. **In** *Colloque International du Jurassique (Luxembourg, 1967).* |
| | | MIDDLE | Callovian | Callomon, J. H., 1964. Notes on the Callovian and Oxfordian Stages. **In** Colloque du Jurassique (Luxembourg, 1962). *Compt. Rend. Mem., Luxembourg.* 269. |
| | | | Bathonian | Cox, L. R. 1964. The type Bathonian. **In** Colloque du Jurassique (Luxembourg, 1962). *Compt. Rend. Mem., Luxembourg.* 265.<br>Torrens, H. S. (in press). Standard zones of the Bathonian. **In** *Colloque International de Jurassique (Luxembourg, 1967).*<br>Elmi, S., 1964. Précisions stratigraphieques sur la Bathonien supérieur du nord de l'Ardèche. **In** Colloque du Jurassique (Luxembourg, 1962). *Compt. Rend. Mem., Luxembourg.* 535. |
| | | | Bajocian | Elmi, S., Enay, R. and Mangold, C., 1964. La stratigraphie et les variations de faciès du Bajocien de l'Ile Crémieu (Jura meridional tabulaire). **In** Colloque du Jurassique (Luxembourg, 1962). *Compt. Rend. Mem., Luxembourg.* 539. |
| | | LOWER | Aalénian | Enay, R. and Elmi, S., 1964. Précision sur la stratigraphie de l'Aalénien dans le Bugey occidental. **In** Colloque du Jurassique (Luxembourg, 1962). *Compt. Rend. Mem., Luxembourg.* 559.<br>Maubeuge, P. L., 1963. La position stratigraphique du gisement Ferrifère Lorrain (Le problème de l'Aalénien). *Bull. Tech. Chambre Syndicale Min. Fer France.* (72). |
| | | | Toarcian | Elmi, S. *et al.* (in press). L'etage Toarcien. Zones et Sous-Zones d'Ammonites. **In** *Colloque International de Jurassique (Luxembourg, 1967).*<br>Howarth, M. K., 1964. Whilbian and Yeovilian Substages. **In** Colloque du Jurassique (Luxembourg, 1962). *Compt. Rend. Mem., Luxembourg.* 189. |
| | | | Pleinsbachian | Geyer, O. F., 1964. Die typuslokalitat des Pleinsbachian in Württemburg (Südwer deutchland). **In** Colloque du Jurassique (Luxembourg, 1962). *Compt. Rend. Mem., Luxembourg.* 161. |
| | | | Sinemurian | Maubeuge, P. L., 1964. Quelques remarquès a propos de l'Hettangien du Sinemurien et du Lotharingien. **In** Colloque du Jurassique (Luxembourg, 1962). *Compt. Rend. Mem., Luxembourg.* 127. |
| | | | Hettangian | Elmi, S. *et al.* (in press). Les Subdivisions biostratigraphiques de l'Hettangien en France. **In** *Colloque International du Jurassique (Luxembourg, 1967).* |

## NOTES ON CONCEPTS OF STAGE– AND OTHER BOUNDARIES

(A) Zanclian is used in preference to Tabianian because the former has been shown to contain a better and more diverse marine fauna which can be used in regional stratigraphic correlation.

(B) Tortonian is placed in the Upper Miocene because:
1) This was its original placement.
2) Although subsequently placed in Middle Miocene, it has now been returned to its original position because the Langhian has been moved up from the top of the Lower Miocene into the Middle Miocene. The type Tortonian is subsequent to beds called "Elveziano" or "Tortonian of Vienna basin", from which many species of Mollusca, especially, have been described as typical of the Middle Miocene. These "Vienna beds" are within the same stratigraphic interval as the beds of the Langhian (=Serravallian of Vervloet, 1966).

(C) The Langhian is restricted, for the purposes of this Manual, to the beds included in the Cessole Formation, and excludes the older horizons included in the Langhian by Cita and Elter.

This essentially follows the usage of Pareto (1865), who directly referred only to the section north of Cessole, which commences with the Cessole Formation. This is in accordance with the results of the work carried out by Drooger and colleagues, who recommended that the first evolutionary appearance of the genus *Orbulina* occurs from the base of the Middle Miocene, which is a few meters above the base of the exposed Cessole Formation at Cessole.

This is supported by the fact that the base of the French stage Sallomacian (which falls within the Langhian Stage) has always been regarded by the French as the commencement of the Middle Miocene. (The name "Sallomacina" has two years' priority over the term "Vindobonian".) The beds included in the Langhian and Sallomacian Stages are also equivalent to the Badenian Stage of Reiss and Gvirtzman, which covers beds included in the Vindobonian from which virtually all the typical Middle Miocene molluscs were obtained.

(D) The Girondian Stage (Vigneaux *et al.*, 1954) is coextensive with the Aquitanian and Burdigalian, and forms a stratigraphic unit well defined in terms of larger Foraminifera and Mollusca.

(E) Regarding the position of the Oligocene-Miocene boundary, for the purposes of this Manual, the panel has accepted (by majority opinion) the base of the stratotype Aquitanian to represent the base of the Neogene (Oligocene-Miocene boundary), as recommended by the Comité du Néogène Mediterranéen in 1959 (published 1960), 1961 (published 1964), 1964 (published 1966) and 1967 (in press), but not yet formally approved by the IUGS.

There is a radical dichotomy of opinion represented among the panel members, and the two viewpoints are explained below, labelled 1 and 2.

1. It has been recommended that the base of the stratotype Aquitanian should be taken as the base of the Miocene (and, therefore, the base of the Neogene). The following points apply:
   (1) When originally proposed, the Bormidian was regarded as Miocene, and one of the latest publications (Lorenz, 1964), also regarded it as Miocene.
   (2) The Bormidian is highly conglomeratic and rests directly upon the Triassic; normally it would not be considered suitable for a stratotype for a standard stage. There has been no indication whether any of the fossils recorded are derived or not (the pebbles of phyllites, schists, etc. obviously are derived). Some fossils were believed later to be Oligocene, but some have been found elsewhere *only* in beds of Miocene age. To the east of the area the Bormidian is cut out, and the overlying Aquitanian rests directly on nummulitic Oligocene (not present to the west) so that there is an unconformity at the base of the Bormidian–the Triassic underlying it in one area, and nummulitic Oligocene underlying it in another area.
   (3) The European stage names on the Tertiary Chart prepared by this panel were all based upon marine megafossil faunas such as Mollusca, Echinoidea, larger Foraminifera, etc. (except for the Paleocene, which originally was based upon plant evidence). The evidence of planktonic foraminifera, however important an asset it may be in the refinement of zonation within and correlation of these stages, did *not* enter into the primary definitions. It seems quite wrong ***arbitrarily*** to select one level of planktonic foraminiferal zonation to define the Miocene-Oligocene boundary; it remains but one part of a much larger field for synthesis. In any case, terms such as "Miocene" and "Oligocene" are time-stratigraphic units, and cannot be stratotypified. Consequently, the evidence of megafossils should be considered when

attempting to find a suitable position for the Miocene-Oligocene boundary.

(4) In the Marnes Blanches de Bernachon, which immediately and conformably underlie the stratotype Aquitanian, there are 7 species of Gastropoda, 9 species of bivalvia, and 20 species and 1 subspecies of Ostracoda, all of which occurred in the overlying Miocene faunas, but have not been found anywhere else in beds regarded as being of Oligocene age. There were a few Ostracoda having known long ranges, but *not a single* mollusc or ostracod previously known only from the Oligocene or from Oligocene and older beds. This fauna is to be regarded as Neogene and Miocene. In the same beds are found Miogypsina at a more advanced stage of evolution than those of the Eochattian of Bunde. These beds rest unconformably upon nummulitic Middle Oligocene.

(5) In the Nordic Province of Northwestern Europe, the fauna of the Vierländer Stage, although originally regarded as Aquitanian, was later regarded by Kautsky (1925) as being of Burdigalian or even younger age. Consequently, in this Nordic province, there are *no* basal Miocene megafossil faunas at all available for comparison with the megafossil faunas of the stratotypes of the Chattian, Eochattian and Neochattian. Furthermore, it is evident that the top ends of the ranges of the megafossils in the stratotype Chattian are completely unknown since some of them may well (and probably do) range up into basal Miocene age of much of the Eochattian-Neochattian succession were not realized, such extensions of ranges would never come to light.

(6) With regard to the Eochattian-Neochattian succession it is perhaps significant that: (a) there are several common molluscan species in the Neochattian of which there is no sign in the Eochattian, and (b) there are three levels in. the Eochattian at which derived Liassic ammonites occur.

(7) The fauna of the Escornebéou beds as published by Butt (1966) was regarded by him (and Drooger) as late Oligocene ("Chattian"). Not only does this material contain derived material from at least two older levels, and not only do the beds in the area rest unconformably on the Cretaceous, but the faunas include good *Globigerinoides* which correlate the material with material *within* the type Aquitanian at the *oldest.* This material is therefore *younger* than the Neochattian.

(8) Conclusions: The terms "Miocene" and "Oligocene" are time-stratigraphic units and cannot be stratotypified. Miocene faunas occur *beneath* the stratotype Aquitanian, and at Escornebéou (where they were called Oligocene). Much of the Eochattian-Neochattian succession can reasonably be regarded as basal Miocene. Useful levels of changes in planktonic foraminiferal faunas are certainly to be used to refine the time-limits within which successions of megafossil faunas occur, but any single one of these *alone* should *not* be taken to define a boundary such as "Miocene-Oligocene" without synthesizing the planktonic foraminiferal faunal evidence with that of the megafossils. Any attempt to take the "Miocene-Oligocene" boundary at the incoming of *Globigerinoides* (i.e., base of stratotype Aquitanian) would result in a large number of molluscan, echinoid, larger foraminiferal, etc. faunas having their ranges extended a very short distance down into the "Oligocene" (*sic*), at which level there is not only a very noticeable faunal change in many groups of fossils (justifiably taken as the Neogene-Palaeogene boundary) but very often evidence of unconformity in the Alpine-Himalayan region (used in a broad sense). It seems to be highly undesirable to have a major faunal change occurring a short distance below one of relatively minor significance, and to use the latter rather than the former as a "Miocene-Oligocene" boundary.

2. The stratigraphic extent of the Bormidian can be shown in terms of planktonic foraminiferal zones to include much of the interval ascribed to the Eochattian and Neochattian of Northern Germany. The uppermost part of the Bormidian is approximately at the same level as the middle part of the Neochattian, and both are prior to the *Globigerinoides* datum which can be recognized at the base of the stratotype Aquitanian. This *Globigerinoides* datum, as expressed in the stratotype Aquitanian, was recommended in 1959 and reaffirmed in 1963 and 1967, by the Neogene Commission on Mediterranean Neogene as the horizon to be taken to mark the base of the Miocene. The base of the Bormidian falls within the upper part of the Eochattian succession, while the lower part of Eochattian succession, has been correlated, Hubach

(1957), and Anderson (1961) with the type Kassel Sands representing the type Chattian. Therefore, there is a *prima* facie case for regarding the Bormidian as post-Chattian, but pre-Aquitanian. German workers have long regarded the successions seen at Kassel, Doberg and Astrup as being a single major lithological unit, and have considered them as Oligocene. However, where Beyrich (1854 and 1858) did not discuss the present exposure at Astrup, he did discuss the beds at Doberg which include both Eochattian and Neochattian. Therefore, in Beyrich's terminology, the term "Oligocene" should be applied, not only to the Kassel Sands, but also to the succession at Doberg. *Miogypsina septentrionalis* occurs from near the exposed base of the succession at Doberg (Bed Number 10 of Hubach). This horizon is referable to Zone P.19 of Blow, and also was correlated by Hubach and Anderson to be within the interval of the type Kassel Sands. Furthermore, the latest horizon recognized within the Boom Clay of Belgium (type Rupelian) is also within Zone P. 19. Thus, in agreement with the work of Batjes (1958), there is a reasonable case for considering the Chattian as part equivalent, at least, of the later parts of the Rupelian. The range of *Miogypsina* ss. must include a part of the Oligocene, and, therefore, cannot be used to decide Neogene or Paleogene affinities.

(F) The Biarritzian Stage has been shown to be partly upper Lutetian and partly lower Auversian. Curry (1967) has suggested that the term "Auversian" covers a recognizable and useful sequence, although it is not quite as extensive stratigraphically as suggested by its usage by some previous French workers. Since the terms Biarritzian and Auversian are provincial in nature they are not used in this manual.

(G) Van Hinte (1965) erected a neostratotype for the Campanian which contains planktonic foraminiferal faunas in the lower part and orbitoids in the higher part. The Campanian planktonic foraminiferal faunas are, from analysis of Van Hinte's figured forms (by Pessagno and Blow), an assemblage which is long-ranging in the broad concept of Campanian, but is not likely to be that which occurs in immediately pre-Maestrichtian horizons. There is no justification for accepting Van Hinte's supposition that *G. calcarata* bearing beds (his Unit G), immediately overlie the neostratotype G of Van Hinte. In support of this, Blow (unpublished) has observed a single broken specimen of *G. calcarata* presumably from the same Unit G from which Van Hinte recorded his planktonic faunas. In view of the fact that the occurrence of *G. calcarata* is sporadic and the fauna from the neostratotype is very much restricted in diversity and in number of species, it appears that Van Hinte's Unit G is in part, at least, representative of the *G. calcarata* zone. However, there is an interval between the top of Unit G and the first horizon of occurrence of undoubted orbitoids (e.g. *Orbitoides media*) which have been accepted by many authors as characteristic of Maestrichtian.

It should be noted that many small *"Orbitoides"* occur in the interval between the first occurrence of *O. media* and the top of the planktonic foraminiferal fauna of Bed G. These forms (e.g. *Schlumbergeria*) have been accepted as Campanian forms by many authors; therefore, at least the lower half of Van Hinte's Unit F must be considered as Campanian, whereas the upper half of Unit F and the younger horizons should be ascribed to Maestrichtian. Because of this, this manual shows *G. calcarata* disappearing just prior to the Campanian-Maestrichtian boundary and *G. ventricosa* disappearing at or very near the Campanian-Maestrichtian boundary.

(H) Santonian s.s. is that part of the Santonian represented by the stratotype.

(I) Beneath the exposed beds of the stratotype Santonian is an interval, part of which is undoubtedly Coniacian as represented in its "stratotype", but between the two there are both beds and faunas which have not been unambiguously differentiated.

(J) The Vraconian of certain Continental authors is here artibrarily included as low Cenomanian.

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