CONTRIBUTIONS FROM THE CUSHMAN FOUNDATION FOR FORAMINIFERAL RESEARCH

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FOR FORAMINIFERAL RESEARCH

Editor
Alfred R. Loeblich, Jr.

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logic column indicating correlation of the Tertiary formations of Cuba with those of the eastern United States, Mexico, and the Dominican Republic is included.

Hiltermann, H. and **W. Koch.** Taxonomie und Vertikalverbreitung von *Bolivinoides*-Arten im Senon Nordwestdeutschlands.—Geol. Jahrb. für 1943-1948, vol. 64, 1950, pp. 595-632, text figs. 1-7, tables 1-7.—Charts show visually the evolutionary change in size and shape throughout the Senonian of 3 species and 2 varieties, both new. Three species and 3 varieties are described and figured.

Cederstrom, D. J. Geology and Ground-Water Resources of St. Croix, Virgin Islands.—U. S. Geol. Survey Water-Supply Paper 1067, 1950, pp. 1-117, pls. 1-6, text figs. 1-11, tables 1-13.—Foraminifera are listed.

Cole, W. Storrs. Larger Foraminifera from the Palau Islands.—U. S. Geol. Survey Prof. Paper 221-B, 1950, pp. 21-31, pls. 5, 6, text fig. 1 (map).—Six species, one new and one undeterminable, and one variety are described and figured from the Miocene and Eocene.

Accordi, Bruno. Esame Geologico-Paleontologico della Campionatura di un Pozzo Terebrato a Cartura (Padova).—Mem. Istit. Geol. Univ. Padova, vol. 16, 1950, pp. 1-19, 1 pl., 1 text fig.—The occurrence and frequency of 76 species and varieties in the well are shown in a chart, and 15 of the forms are figured.

Esame Geologico-Paleontologico della Campionatura di un Pozzo Terebrato a ca' Capello (Rovigo).—L. c., pp. 1-17, 1 pl., 1 text fig.—Many foraminifera are listed.

R. T.

6. NEW NAMES AND HOMONYMS IN FORAMINIFERA

HANS E. THALMANN
Pasadena, California

ABSTRACT—Twenty-four new names, replacing homonyms, are recorded by their respective authors, and twenty-three additional homonyms a e listed, of which four are herewith renamed.

INTRODUCTION

In order that all homonyms in Foraminifera be replaced whenever they are discovered as primary (objective) or secondary (subjective) pairs of identical names, the writer has listed them since 1933 in his annual "Bibliography and Index to new Foraminifera" in the Journal of Paeontology, or in the "Contributions from the Cushman Laboratory for Foraminiferal Research" and, in most cases, informed the author of the homonym by personal letter. In several cases the authors reacted promptly, publishing new names for their homonyms but in many other instances no correction was made and the aim to avoid the future confusion to which homonyms may give rise was not reached. For this reason a fresh approach was made, inviting authors of homonyms to submit for publication new names under their own authorship, and in this way the following twenty-four new names are herewith formally introduced as permanent names.

For four homonyms, not previously renamed, the writer has substituted new names because their respective authors are deceased. The remaining nineteen unnamed homonyms listed below should be renamed by their authors *immediately*, in order to comply with Articles 34, 35, and 36 of the International Rules of Zoological Nomenclature. It should be emphasized that an author of a homonym, duly informed by the detector of the homonymy in accordance with the "Code of Ethics" (Decision of the International Zoological Congress, Monaco 1913), who does not immediately and without delay correct his nomenclaturial error by proposing and publishing a substitute *nomen novum* or authorizing another scientist to do so in his behalf, renounces through his silence or inactivity all rights to the authorship of the genus, species, or subspecies found to be homonymous.

It is perhaps opportune to call the attention of all foraminiferologists who deal with systematic descriptions of new Foraminifera to the specified time (Midnight, Greenwich Mean Time, 31st December 1950/1st January 1951), set by the International Commission on Zoological Nomenclature at its session held in Paris in July 1948 for important changes of Rules of Zoological Nomenclature, to take effect and to urge them to read carefully and become acquainted with "Status of names proposed for forms of less than subspecific rank" (Reference 1) regarding "subspecies" and "infra-subspecific form," and "Articles 35 and 36: problem of specific homonyms" etc. (Reference 2). R. Richter's excellent introduction to zoological nomenclature, in explanation of the international rules, should, moreover, be familiar to anyone connected with the taxonomy and nomenclature of fossil or recent Foraminifera (Reference 3).

The writer wishes to express his sincere thanks to all the authors for their cooperation in his aim to remove the onerous burden of homonymy, and for their authorization to publish the substitute names in their behalf.

NEW NAMES

Ammodiscus diminutivus Dunn, n. name

For: *Ammodiscus minutus* Dunn, 1942, Jour. Paleon., vol. 16, p. 339, pl. 44, fig. 28. Upper Silurian, Missouri, U. S. A.; not: *Ammodiscus minutus* Paalzow, 1932, Vaterl. Ver. Naturk. Württemberg, Verhandl., Jahresber., vol. 88, p. 93, pl. 4, figs. 10, 11. Argovian, Germany; and not: *Ammodiscus exertus* Cushman, 1910, var. *minutus* Ireland, 1939, Jour. Paleon., vol. 13, figs. B-20, B-21. Silurian, Oklahoma. (Publication of new name authorized in letter of August 21, 1950, by Paul H. Dunn).

Bathysiphon neapolitanum Hofker, n. name

For: *Bathysiphon minutum* Hofker, 1932, Pubbl. Staz. Zool. Napoli, vol. 12, p. 70, text fig. 4. Recent, Gulf of Naples; not: *Bathysiphon minuta* Pearcey, 1900, Millport Marine Sta. Glasgow, Comm. No. 1, p. 39, pl. 2, figs. 1-5, Recent, off Scotland, 40 fathoms.

Bolivina dentilineata Bandy, n. name

For: *Bolivina denticulata* Bandy, 1949, Bull. Amer. Paleon., vol. 32, No. 131, p. 126, pl. 25, fig. 3. Eocene (Claiborne), Alabama, U. S. A., not: *Bolivina granti* Rankin, 1934, var. *denticulata* Cushman and Stevenson, 1948, Cushman Lab. Foram. Research, Contr., vol. 24, p. 59, pl. 9, fig. 37. Miocene, Ecuador. (Publication of new name authorized in letter of August 7, 1950 by O. L. Bandy).

Bolivina polonica Bieda, n. name

For: *Bolivina hirsuta* Bieda, 1936, Soc. géol. Pologne, Ann., vol. 12, p. 264, pl. 8, figs. 1, 2. Miocene, Poland; not: *Bolivina hirsuta* Rhumbler, 1911, Foram. Plankton-Exped., Teil I, Plankton-Exped. Humboldt-Stiftg., Ergebn. vol. 3, p. 65, and 104, pl. 16, figs. 23, 24; pl. 17, figs. 1, 2; pl. 19, fig. 10. Recent. (Publication of new name authorized in letter of September 1, 1950, by F. Bieda).

Bolivina robusta Brady, 1881, subsp. **indonesiensis** Boomgaart, n. name

For: *Bolivina robusta* Brady, 1881, var. *pacifica* Boomgaart, 1949, Proefschr. (Thesis) Rijks-Univ. Utrecht, p. 112, pl. 12, fig. 3. Pliocene, East Java; not: *Bolivina acerosa* Cushman, 1936, var. *pacifica* Cushman and McCulloch, 1942, Allan Hancock Pacific Exped., vol. 6, No. 4, p. 185, pl. 21, figs. 2, 3. Recent, Gulf of California, off Mexico. (Publication of new name authorized in letter of September 1, 1950, by L. Boomgaart).

Bolivina rukasi Hussey, n. name

For: *Bolivina striata* Hussey, 1949, Jour. Paleon., vol. 23, p. 134, pl. 27, figs. 18, 19. Middle Eocene, Louisiana, U. S. A.; not: *Bolivina (Bifarina) hungarica* (Vadász), 1910, var. *striata* (Vadász), 1910, Res. wiss. Erforschg. Balaton-See, vol. I, pt. 1, Pal. Anhang, p. 16, pl. 1, fig. 10. (Publication of new name authorized in letter of July 31, 1950, by K. M. Hussey).

Cibicides subtenuissimus (Nuttall, 1928) subsp. **nipeensis Keijzer**, n. name

For: *Cibicides subtenuissimus* (Nuttall, 1928) var. *concava* Keijzer, 1945, Proefschr. (Thesis), Rijks-Univ. Utrecht, p. 208, pl. 4, fig. 61. Oligo-Miocene, Cuba; not: *Cibicides concavus* Tolmachoff, 1934, Carnegie Mus. Ann., vol. 23, p. 339, pl. 42, figs. 22-24, Miocene, Colombia; and not: *Cibicides concavus* Dorn (MS) in: LeRoy, 1941, Colorado School Mines, Quart., vol. 36, p. 47, pl. 2, figs. 82-84, Mio-Pliocene, East Borneo. (Publication of new name authorized in letter of July 31, 1950, by F. G. Keijzer).

Dorothia javana Boomgaart, n. name

For: *Dorothia rotunda* Boomgaart, 1949, Proefschr. (Thesis), Rijks-Univ. Utrecht, p. 60, pl. 5, fig. 4. Mio-Pliocene, East Java; not: *Dorothia (Gaudryina) rotunda* (Chapman), 1902, Jour. Linn. Soc. London, Zool., vol. 28, p. 409, pl. 36, fig. 11. Recent, Funafuti Atoll. (Publication of new name authorized in letter of September 1st, 1950, by L. Boomgaart).

Entosolenia bodjonegoroensis Boomgaart, n. name

For: *Entosolenia iota* Boomgaart, 1949, Proefschr. (Thesis), Rijks-Univ. Utrecht, p. 109, pl. 9, fig. 7. Mio-Pliocene, East Java; not: *Entosolenia iota* Cushman, 1923, U. S. Nat. Mus., Bull. 104, pt. 4, p. 27 (figured in Cushman and F. L. Parker, 1931, U. S. Nat. Mus., Proc. vol. 80, Art. 3, p. 15, pl. 3, fig. 17. Recent, off Falklands Islands. (Publication of new name authorized in letter of September 1, 1950, by L. Boomgaart).

Globorotalia dominicana Bermudez, n. name

For: *Globorotalia lobata* Bermudez, 1949, Cushman Lab. Foram. Research, Spec. Publ. 25, p. 286, pl. 22, figs. 15-17. Upper Oligocene, Dominican Republic; not: *Globorotalia lobata* Brotzen, 1948, Sverig. geol. Unders., Series C, No. 493, Arsbok 42, No. 2, p. 91, pl. 17, fig. 3. Paleocene, Sweden. (Publication of new name authorized in letter of August 2, 1950, by P. J. Bermudez).

Nodosaria balaniformis Hussey, n. name

For: *Nodosaria primitiva* Hussey, 1943, Jour. Paleon., vol. 17, p. 165, pl. 26, fig. 1. Eocene, Louisiana, U. S. A.; not: *Nodosaria primitiva* Kübler and Zwingli, 1866, Neujahrsblatt Burger-Bibl. Winterthur, p. 7, pl. 1, fig. 16. Jurassic, Switzerland. (Publication of new name authorized in letter of July 31, 1950, by K. M. Hussey).

Nodosaria bermudezi Payard, n. name

For: *Nodosaria tenuistriata* Payard, 1947, Foram. Lias sup. Détroit Poitevin, (Thesis Univ. Paris), p. 169, pl. 2, fig. 13. Upper Liassic, France; not: *Nodosaria tenuistriata* Franke, 1925, Univ. Greifswald, Geol. Pal. Inst., Abhandl., vol. 6, p. 40, pl. 3, fig. 33. Upper Cretaceous, Germany; not: *Nodosaria (Glandulina) tenuistriata* Franke, 1927, Danmarks Geol. Unders., series 2, No. 46, p. 18, pl. 1, fig. 25. Paleocene, Denmark; and not: *Nodosaria tenuistriata* Eichenberg, 1935, Niedersächs. Geol. Vereinig., Jahresber., p. 172, pl. 11, fig. 13. Lower Cretaceous, Germany. (Publication of new name authorized in letter of August 22, 1950, by J. M. Payard).

Nodosaria lamnulifera Boomgaart, n. name

For: *Nodosaria bradyi* Boomgaart, 1949, Proefschr. (Thesis), Rijks-Univ. Utrecht, p. 79, pl. 6, fig. 11. Pliocene, East Java; not: *Nodosaria (Dentalina) bradyi* (Spandel), 1901, Festschr. Säcular-Feier Naturf. Ges. Nürnberg, p. 179, text fig. 9. Permo-Carboniferous, Kansas, U. S. A. [Cave: *Nodosaria inornata* (d'Orbigny), 1846 var. *bradyana* Dervieux, 1893]. (Publication of new name authorized in letter of September 1, 1950, by L. Boomgaart).

Nodosaria mitis (Terquem and Berthelin, 1875) subsp. **pictaviensis** Payard, n. name

For: *Nodosaria mitis* (Terquem and Berthelin, 1875) var. *conica* Payard, 1947, Foram. Lias sup. Détroit poitevin (Thesis, Univ. Paris), p. 171, pl. 2, fig. 19. Upper Liassic, France; not: *Nodosaria conica* (Soldani) in: O. Silvestri, 1872, Atti Accad. Gioenia Sci. Nat. Catania, n. ser. 3, vol. 7, p. 39, pl. 3, figs. 52-56. Pliocene, Italy; and not: *Nodosaria conica* Neugeboren, 1852, Siebenbürg. Ver. Naturwiss., Verh., Mitth., vol. 3, p. 54, pl. 1, fig. 4. Miocene, Siebenbürgen. (Publication of new name authorized in letter of August 22, 1950, by J. M. Payard).

Nodosaria thalmanni Payard, n. name

For: *Nodosaria paucicosta* Payard, 1947, Foram. Lias sup. Détroit poitevin (Thesis, Univ. Paris), p. 169, pl. 2, fig. 16. Upper Liassic, France; not: *Nodosaria pauci-*

costa Roemer, 1841, Verstein. norddeutsch. Kreidegeb., p. 95, pl. 15, fig. 7. Upper Cretaceous, Germany. (Note: *Nodosaria subscalaris* Cushman, 1917, var. *paucicostata* Cushman, 1917 should most probably also be renamed). (Publication of new name authorized in letter of August 22, 1950, by J. M. Payard).

Nummulites (Nummulites) caraibensis de Cizancourt, n. name

For: *Nummulites (Nummulites) antillea* (Hanzawa), 1937, in: de Cizancourt, 1948, Soc. géol. France, Bull., series 5, vol. 18, p. 667 (published September 1949); not: *Nummulites antillea* Cushman, 1919, Carnegie Inst. Washington Publ. 291, p. 51, pl. 4, figs. 1, 2. Upper Eocene, Leeward Islands. (Note: Mrs. de Cizancourt places into synonymy with this species: *Pellatispirella antillea* Hanzawa, 1937, Jour. Paleont., vol. 11, p. 116, pl. 20, figs. 8-10; pl. 21, fig. 1. Eocene, Haiti; and *Camerina pellatispiroides* Barker, 1939, U. S. Nat. Mus., Proc., vol. 86, No. 3052, p. 325, pl. 20, fig. 10; pl. 22, fig. 4. Basal Eocene, East Mexico). (Publication of new name authorized in letter of August 30, 1950, by Mrs. M. de Cizancourt).

Pealerina Lalicker, n. name

For: *Ellisina* Lalicker, 1950, Univ. Kansas Paleont. Contr., Protozoa, Art. 2, p. 18, (Polymorphinidae). Genotype: *Ellisina spatula* Lalicker, 1950, Univ. Kansas Paleont. Contr., Protozoa, Art. 2, p. 19, pl. 4, fig. 3; text fig. 5. Upper Jurassic, Montana, U. S. A. (Cushman Coll. No. 59750, U. S. Nat. Mus., Washington, D. C.; not: *Ellisina* Norman, 1903, Ann. Mag. Nat. Hist., ser. 7, vol. 11, p. 596 (Bryozoa). (Letter from C. G. Lalicker, dated September 14, 1950).

Proteonina ? devexa Dunn, n. name

For: *Proteonina ? ovata* Dunn, 1942, Jour. Paleon., vol. 16, p. 327, pl. 43, fig. 6. Lower Silurian, Illinois, U. S. A.; not: *Proteonina ovata* Cushman, 1910, U. S. Nat. Mus. Bull. 71, p. 43, text fig. 43. Recent, Pacific. (Publication of new name authorized by P. H. Dunn in letter of August 21, 1950).

Psammosphaera compressa Dunn, n. name

For: *Psammosphaera subsphaerica* Dunn, 1942, Jour. Paleon., vol. 16, p. 321, pl. 42, fig. 13. Upper Silurian, Mississippi, U. S. A.; not: *Psammosphaera subsphaerica* Stewart and Priddy, 1941, Jour. Paleon., vol. 15, p. 371, pl. 49, fig. 10. Silurian, Ohio. (Publication of new name authorized in letter of August 21, 1950, by P. H. Dunn).

Pseudocitharina fasciata Payard, 1947, subsp. **pictaviensis** Payard, n. name

For: *Pseudocitharina fasciata* Payard, 1947, var. *aalense* Payard, 1947, Foram. Lias sup. Détroit poitevin (Thesis, Univ. Paris), p. 142, pl. 5, figs. 11, 12. Upper Liassic, France; not: *Pseudocitharina longuemari* (Terquem, 1863) var. *aalense* Payard, 1947, ibid., p. 136, pl. 4, figs. 12, 13. Upper Liassic, France. (Publication of new name authorized in letter of August 22, 1950, by J. M. Payard).

Quinqueloculina adelaidensis Howchin and Parr, 1938, subsp. **nipeensis** Keijzer, n. name

For: *Quinqueloculina adelaidensis* Howchin and Parr, 1938, var. *minuta* Keijzer, 1945, Proefschr. (Thesis), Rijks-Univ. Utrecht, p. 193, pl. 2, fig. 21. Oligo-Miocene, Cuba; not: *Quinqueloculina minuta* Beck, 1943, Jour. Paleon., vol. 17, p. 593, pl. 99, figs. 5-7. Eocene, Washington, U. S. A. (Publication of new name authorized in letter of July 31, 1950, by F. G. Keijzer).

Siphonina obesa van Bellen, n. name

For: *Siphonina cubensis* van Bellen, 1941, Nederl. Akad. Wetensch., Proc., vol. 44, p. 1144, pl. figs. 1-3. Lower Oligocene, Cuba; not: *Siphonina advena* Cushman, 1922, var. *cubensis* Cushman and Bermudez, 1937, Cushman Lab. Foram. Research, Contr., vol. 13, p. 24, pl. 2, figs. 19, 20. Eocene, Cuba. (Note: This species was placed in synonymy with *Siphonina nuda* Cushman and Bermudez, 1936, by Keijzer, 1942, Nederl. Akad. Wetensch., Proc., vol. 45, p. 608). (Publication of new name authorized in letter of August 26, 1950, by R. C. van Bellen).

Thurammina elegans Dunn, n. name

For: *Thurammina splendens* Dunn, 1942, Jour. Paleon., vol. 16, p. 334, pl. 43, fig. 30. Upper Silurian, Mississippi, U. S. A.; not: *Thurammina splendens* Egger, 1899, K. Bayer. Akad. Wiss., Abhandl., II Cl., vol. 21, 1. Abth., p. 15, pl. 2, figs. 14-16. Upper Cretaceous, Bavaria. (Publication of new name authorized in letter of August 21, 1950, by P. H. Dunn).

Tritaxia jongmansi Schijfsma, n. name

For: *Tritaxia compressa* Schijfsma, 1946, Geol. Sticht. Haarlem, Mededeel., series C, V, No. 7, p. 33, pl. 1, fig. 5. Campanian, Netherlands; not: *Tritaxia compressa* Egger, 1899, K. Bayer. Akad. Wissensch., Abhandl., II Cl., vol. 21, 1. Abth., p. 41, pl. 4, figs. 29-31. Upper Cretaceous, Germany. (Publication of new name authorized by E. Schijfsma in letter of August 29, 1950).

HOMONYMS

The following primary and secondary homonyms in Foraminifera have not yet been renamed by their respective authors in spite of the fact that the writer has, in most cases, informed the homonymist of their existence:

Anomalina berthelini ten Dam, 1944, Soc. géol. France, Comptes-rendus, fasc. 10, p. 105 from the Albian of the Netherlands, is preoccupied by *Anomalina berthelini* Keller, 1935, Soc. Natural. Moscou, Bull.,

n. s., vol. 43, sect. géol. vol. 13, p. 552, pl. 3, figs. 25-27, from the Cenomanian of the Dniepr-Donetz Basin, U. S. S. R. [Note: This is one of the rare cases of a synonymous homonym because both authors erected the trivial name for: *Anomalina complanata* Reuss in Berthelin, 1880, Soc. géol. France, Mém., (3), vol. I, p. 66, pl. 4, figs. 12, 13 from the Albian of France].

Carpenterella Bermudez, 1949, Cushman Lab. Foram. Res., Spec. Publ. 25, p. 313, with *Carpenterella truncata* Bermudez, 1949, as genotype, is preoccupied by: *Carpenterella* Collenette, 1933, Ent. mon. Mag., vol. 69, p. 258 (Lepidoptera).

Cassidulina laevigata d'Orbigny, 1826, var. *carinata* Cushman, 1922, U. S. Nat. Mus. Bull. 104, pt. 3, p. 124, pl. 25, figs. 6, 7, Recent, Florida, so often refigured (Kleinpell, 1938, Mioc. Strat. Calif., p. 33, pl. 8, fig. 11; Ellisor, 1940, Bull. Amer. Assoc. Petr. Geol., vol. 24, p. 474, pl. 6, fig. 4; Cushman and Todd, 1945, Cushman Lab. Foram. Research, Spec. Publ. 15, p. 62, pl. 10, fig. 11; Bermudez, 1949, ibid., Spec. Publ. 25, p. 268, pl. 20, figs. 22-24, etc.) is preoccupied by exactly the same name: *Cassidulina laevigata* d'Orbigny, 1826, var. *carinata* Silvestri, 1896, Accad. Pont. N. Lincei, Mem. 12, p. 104, pl. 2, fig. 10, from the Lower Pliocene of Italy. Cushman's original variety (description and figures, as cited above) is herewith renamed: **Cassidulina neocarinata**, n. name, and elevated to specific rank.

Cibicides dutemplei (d'Orbigny, 1846) var. *oligocenicus* Samoilova, 1947, Soc. Natural. Moscou, Bull., vol. 52 n. s., sect. géol. vol. 22, p. 96, text figs. 34-36, from the Lower Oligocene of the Crimea, U. S. S. R., is preoccupied by: *Cibicides (Anomalina) oligocaenica* (Herrmann, 1917), Geol. Landes-Anst. Elsass-Lothr., Mitt., vol. 10, No. 3, p. 278, pl. 2, fig. 2, from the Alsacian Oligocene.

Cibicides formosa Brotzen, 1945, Sver. geol. Unders., series C, No. 465, Arsbok 38, No. 7, p. 55, pl. 2, fig. 3, from the Cenomanian of Sweden, is preoccupied by: *Cibicides (Anomalina) formosus* (Seguenza, 1880), R. Accad. Lincei, Atti, (3), vol. 6, p. 149, pl. 14, fig. 6 (error for fig. 5) from the Italian Tertiary.

Elphidium granulosum (Galloway and Wissler, 1927) (olim: *Themeon granulosus*) Jour. Paleon., vol. 1, p. 193 from the Pleistocene of California, is preoccupied by: *Elphidium (Polystomella) macellum* (Fichtel and Moll, 1798) var. *granulosa* Sidebottom, 1909, Manchester Lit. Phil. Soc., Mem. and Proc., vol. 43, p. 16, pl. 5, fig. 5, Recent off Delos Island, Greece.

Elphidium incertum (Williamson, 1858) var. *obscura* Voloshinova, 1939, Oil Geol. Prosp. Inst., Trans., Leningrad-Moscow, series A, fasc. 125, p. 16, pl. 1, figs. 9, 10, Recent, Okhotzk Sea, is preoccupied by: *Elphidium (Polystomella) obscurum* (Schwager, 1883), Palaeontogr., vol. 30, Pal. Theil, p. 138, pl. 27, fig. 2, from the Eocene, Libyan Desert, Egypt.

Elphidium sagrai (d'Orbigny, 1839) var. *crassum* Galloway and Heminway, 1941, New York Acad. Sci., Sci. Surv. Porto Rico etc., vol. 3, No. 4, p. 366, pl. 15, fig. 1, from the Middle Oligocene of Puerto Rico, is preoccupied by: *Elphidium (Polystomella) crispum* (Linne, 1758) var. *crassa* (Möbius, 1880), Beitr. Meeresfauna Mauritius, etc., p. 101, pl. 11, figs. 4-7, pl. 12, Recent, off Mauritius Island.

Flabellina deltoidea Wedekind, 1940, N. Jahrb. Min. etc., Beil-Bd., 84, Abt. B, p. 186, text fig. 6, from the lower Campanian of Westphalia, Germany (with its varieties *millepunctata* Wedekind, 1940, and *pachydisca* Wedekind, 1940) is preoccupied by: *Flabellina reticulata* Reuss, 1851, var. *deltoidea* Franke, 1928, Preuss. geol. Landes-Anst., Abhandl., N. F. 111, p. 93, from the Upper Cretaceous of North Germany.

Gaudryina glabrata Cushman, 1937, var. *maxima* Galloway and Heminway, 1941, New York Acad. Sci., Sci. Surv. Porto Rico etc., vol. 3, No. 4, p. 323, pl. 7, fig. 2, from the Upper Oligocene of Puerto Rico, is preoccupied by: *Gaudryina baccata* Schwager, 1866, var. *maxima* Egger, 1893, K. Bayer. Akad. Wiss., Abhandl., vol. 18, p. 86, pl. 7, fig. 7, Recent.

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Lituotuba eocenica Cushman and H. H. Renz, 1948, Cushman Lab. Foram. Research, Spec. Publ. 24, p. 7, pl. 1, figs. 20, 21, from Eocene of Trinidad, B. W. I., is preoccupied by: *Lituotuba* (?) *eocenica* Yabe, 1921, Tohoku Imp. Univ., Sci. Rep., Geol. Ser., vol. 5, No. 4, p. 100, pl. 16, fig. 9, from Eocene of Bonin Island.

Nonion multicameratum van der Sluis and de Vletter, 1942, Nederl. Akad. Wetensch., Proc., vol. 45, p. 1010, text fig. 3, Pliocene, East Java, is preoccupied by: *Nonion pizarrensis* W. Berry, 1928, var. *multicameratum* Cushman and Kleinpell, 1934, Cushman Lab. Foram. Research, Contr., vol. 10, p. 4, pl. 1, fig. 10, Miocene, California.

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Quinqueloculina striatula Cushman, 1932, U. S. Nat. Mus., Bull. 161, p. 27, pl. 7, figs. 3, 4, Recent, recently refigured in Said, 1950, Cushman Foundation Foram. Research, Contr., vol. 1, p. 5, pl. 1, fig. 9 from the northern Red Sea, is preoccupied by: *Quinqueloculina striatula* Deshayes, 1831, Descript. Coquilles Charact., p. 252, pl. 3, figs. 1, 2. Cushman's homonym (reference as above), is herewith renamed: **Quinqueloculina neostriatula**, n. name.

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Streblus ketienziensis Ishizaki, 1948, Acta Geol. Taiwanica, vol. 2, p. 59, pl. 1, fig. 2, from Lower Pliocene of Japan, is not identical with, and, therefore, a possible homonym of: *Streblus ketienziensis* Ishizaki, 1943, Taiwan Tigaku Kizi, vol. 14, p. 59, pl. 1 (error for pl. 2), fig. 5, Pliocene of Taiwan (Formosa).

Textularia rugosa (Reuss) in: Said, 1950, Contr. Cushman Foundation Foram. Research, vol. 1, p. 5, pl. 1, fig. 5, Recent, northern Red Sea, and in: Lalicker and McCulloch, 1940, Allan Hancock Pacific Exped., vol. 6, No. 2, p. 138, pl. 16, fig. 21, to cite only a few recent redescriptions and refigurations, is preoccupied by *Textularia rugosa* d'Orbigny, 1826, Ann. Sci. Nat., vol. 7, p. 262, No. 10, figured in Fornasini, 1901, Riv. Ital. Paleont., vol. 7, p. 105, pl. 3, fig. 3; and also by *Textularia rugosa* Costa, 1856, Atti Accad. Pont., vol. 7, fasc. 2, pl. 15, fig. 7 (not described). Reuss' original species, *Plecanium rugosum,* 1869, Akad. Wiss. Wien, Sitz-Ber., vol. 59, p. 453, pl. 1, fig. 3, the *Textularia rugosa* (Reuss) auctorum (not d'Orbigny, 1826), is herewith renamed: **Textularia neorugosa**, n. name.

Uvigerina bradyana Cushman, 1925, (see Bandy, 1950, Jour. Paleon., vol. 24, p. 280, pl. 42, fig. 11, Pleistocene, Oregon, U. S. A.) originally published as *Uvigerina peregrina* Cushman, 1923, var. *bradyana* Cushman, 1925, U. S. Nat. Mus., Bull. 100, pt. 4, p. 168, pl. 42, fig. 12, Recent, Atlantic, is preoccupied by *Uvigerina bradyana* Fornasini, 1900, Accad. Sci. Ist. Bologna, Mem., vol. 8, p. 390, text fig. 40. Cushman's original description and figure for the variety *bradyana,* is herewith given specific rank and renamed: **Uvigerina hollicki**, n. name in honor of the artist, A. T. Hollick, who illustrated so masterfully H. B. Brady's Challenger-Report on the Foraminifera (1884).

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Manuscript received September 20, 1950

7. A NEW NAME FOR AN EOCENE FORAMINIFER FROM TRINIDAD, BRITISH WEST INDIES

H. H. Renz
Caracas, Venezuela

Hans E. Thalmann kindly drew my attention to the fact that *Lituotuba eocenica* Cushman and Renz from Trinidad, British West Indies was preoccupied by *Lituotuba* (?) *eocenica* Yabe described in 1921 from the

Eocene of the Bonin group (Sci. Reports Tohoku Imp. Univ., Geol., Ser. 2, vol. V, No. 4, p. 100, pl. 16, fig. 9) and therefore the following new name is proposed for the Trinidad species:

Lituotuba navetensis Cushman and Renz, n. name

This new name is proposed for the species previously named *Lituotuba eocenica* Cushman and Renz (Cushman Coll. No. 57197) from the Eocene, Navet formation, Navet River marl, Navet River, Eastern Central Range, Trinidad, British West Indies (Cushman Lab. Foram. Res., Spec. Publ. No. 24, 1948, p. 7, pl. 1, figs. 20, 21).

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8. MIDDLE AND UPPER PERMIAN FUSULINIDS OF WASHINGTON AND BRITISH COLUMBIA

M. L. Thompson
University of Wisconsin, Madison
H. E. Wheeler
University of Washington, Seattle
AND
W. R. Danner
Wooster College, Ohio

ABSTRACT—Fusulinid foraminiferal faunas described and illustrated in this paper were obtained from seventeen collections of the Permian of northern Washington and five collections of the Permian of southern British Columbia. These include one new species each of **Boultonia** Lee, **Codonofusiella** Dunbar and Skinner, **Verbeekina** Staff, **Pseudodoliolina** Yabe and Hanzawa, two new and one previously described species of **Schwagerina** Möller, two new species of **Neoschwagerina** Yabe, and three previously described species and one unnamed new form of **Yabeina** Deprat. This is the first time that fusulinids typical of the faunal Zone of **Verbeekina-Neoschwagerina** have been described and illustrated from North America.

INTRODUCTION AND ACKNOWLEDGMENTS

The Permian of northwestern North America is represented by many thousands of feet of rocks, of which several thousand feet are limestones containing abundant faunas of fusulinid foraminifers. In some areas, at least, other types of fossils are relatively scarce. Although fusulinids are especially abundant and widespread in Washington, British Columbia and parts of Alaska, only seven distinct species and three additional indeterminate forms, representing five genera, have been described from there.

During the past four years we have obtained seventeen rather large collections from the Permian of northern Washington and southern British Columbia, that contain large faunas of fusulinids. Many of these fusulinids represent biologic groups not previously recorded from North America. They are of special importance because other types of fossils are rather scarce in these areas. Furthermore, fusulinids have been found to be among the most reliable index fossils for age determinations of Permian rocks.

The Permian of northwestern North America contains in its lower part a fusulinid fauna composed almost entirely of members of the subfamily Schwagerininae and in its upper part a fauna composed largely of members of the subfamilies Verbeekininae and Neoschwagerininae. The fusulinids from both parts of the Permian are unlike those in most other Permian areas in America. In fact, no species has been found common to the northwestern faunas and those in other American regions. However, the faunas, especially those from the upper part, of the northwestern Permian are closely similar in many respects to those widely recognized in the Eastern Hemisphere, particularly those from the Middle and Upper Permian of Japan, China, French Indo-China, Sumatra, Crimea, and Tunis, and from the Middle Permian of Caracorum, the Pamirs, Afghanistan, Turkey, Greece, and Sicily.

The Middle and Upper Permian rocks of the Eastern Hemisphere seemingly were deposited in a seaway, often called the Permian Tethys, that extended from the Mediterranean region as far as the region of the Japanese Islands. Tethyan fusulinid faunas of the Orient contain abundant members of the subfamilies Verbeekininae and Neoschwagerininae and relatively scarce members of the subfamily Schwagerininae. In contrast to the Tethyan faunas, the abundant and widespread Permian fusulinid faunas of the south-central United States, California, northern Mexico, central America, and Venezuela are dominated by prolific members of the subfamily Schwagerininae and few if any members of the verbeekinids and neoschwagerinids.

The fusulinid faunas of the middle and upper parts of the Permian in the northwestern region of America contain abundant faunas of verbeekinids and neoschwagerinids and relatively few other types of fusulinids. The Tethyan faunas of Japan, China, and French Indo-China contain elements so closely similar to those of northwestern America that the two areas can be assumed almost surely to have been connected across or around the Pacific Ocean by shallow seas that probably were continuations of the oriental Tethys. Accordingly, these northwestern American Permian faunas are referred to as the American Tethyan faunas.

American Tethyan fusulinids have been described in four papers. Dawson (1879) described the first American Tethyan fusulinid as *Loftusia columbiana* Dawson from talus of the Marble Canyon limestone of the Cache Creek group (or series) collected from talus in Marble Canyon, British Columbia. Dunbar (1932) later restudied Dawson's collection and described this form as *Neoschwagerina columbiana* (Dawson). Thompson and Wheeler (1942) studied a fusulinid fauna obtained from limestone talus collected by Wheeler from the north shore of the middle of the three Pavilion lakes near the central part of Marble Canyon, and they referred Dawson's form to *Yabeina columbiana* (Dawson) and described associated fusulinids as *Yabeina minuta* Thompson and Wheeler, *Schwagerina pavilionensis* Thompson and Wheeler, *S. pavilionensis* subsp. *acris* Thompson and Wheeler, *Staffella*? sp., and *Nankinella*? sp. They referred the Marble Canyon limestone to the Upper Permian and considered it to be probably younger than the American upper Guadalupian faunas of the fusulinid faunal Zone of *Polydiexodina*. At the same time, they described *Yabeina packardi* Thompson and Wheeler from Cenozoic conglomerates of central Oregon. During the final preparation of their paper on the British Columbia and Oregon fusulinids, they received from Dr. R. L. Lupher rather extensive collections of fusulinids from a limestone quarry near Granite Falls, Washington, that were being described by Anderson (1941) as *Neoschwagerina cascadensis* Anderson and *Leeina* sp. They identified Anderson's forms as *Yabeina cascadensis* (Anderson) and *Schwagerina* sp. Dunbar (1946) described *Parafusulina alaskensis* Dunbar from an unnamed limestone on Kuiu Island of southern Alaska that he considers Leonardian in age. *P. alaskensis* evidently is a primitive form of the genus and seems to be more closely similar to lower Middle Permian forms of the Orient than to other American forms. Staff (1912) described and illustrated a form from somewhere in Alaska as *Fusulina* cf. *F. verneuili* Möller. This species probably is a primitive form of *Parafusulina* and is of Leonardian or slightly younger age. The above include all of the upper Permian Tethyan fusulinids previously described from North America, known to the writers.

Although the stratigraphic relationships among the rather widely separated areas of American Tethyan faunas have not been determined on purely physical stratigraphic studies, Thompson and Wheeler considered on the basis of assumed relative degree of evolutionary development within the genus *Yabeina* that the Granite Falls limestone with *Yabeina cascadensis* is older than the Marble Canyon limestone with *Y. columbiana* and *Y. minuta,* and furthermore that both probably contain the youngest known American fusulinid faunas. It seems probable that the Marble Canyon limestone is considerably younger than the Granite Falls limestone.

The geographic distribution of fusulinids in British Columbia has become much better understood in recent years from studies made by geologists of the Canadian Geological Survey and the British Columbia Department of Mines. Collections of typical Tethyan fusulinid faunas have been obtained by them at various localities in British Columbia from the Ashcroft area on the south to the Teslin Lake area on the north (Armstrong, 1942a, 1942b, 1949; Watson and Mathews, 1944; Duffell and McTaggert, 1947). Fusulinids identified by C. O. Dunbar as *Schubertella, Rugosofusulina, Schwagerina, Pseudoschwagerina,* and *Parafusulina,* that probably are of Lower Permian age, have been reported from great thicknesses of rocks in several places in British Columbia, including the McConnell Creek area (Lord, 1948) and the Fort St. James Map Area (Armstrong, 1949). Armstrong (1942a, 1942b, 1949) collected fusulinids in the Stuart Lake region that were identified by C. O. Dunbar as *Neoschwagerina, Verbeekina, Cancellina, Misellina,* and *Parafusulina.* This is the first report of *Verbeekina, Cancellina,* and *Misellina* in North America. None of these forms have been described as yet. Watson and Mathews (1944) collected fusulinids in the Teslin Lake area that were identified by R. T. D. Wickenden as *Yabeina*? and *Schwagerina.* Mathews (1947) mentions *Yabeina* in the Cowell Quarry on San Juan Island. The Permian rocks of the Northwest contain Tethyan fusulinids probably throughout central British Columbia and well down into the northwestern United States.

We wish to express our thanks to Professor R. L. Lupher who sent us the collections from Granite Falls, from which we are describing and illustrating topotype specimens of *Yabeina cascadensis* (Anderson) and are describing *Schwagerina andersoni,* n. sp. Financial assistance for the technical work in preparing these numerous collections for study was granted by the Research Committee of the University of Wisconsin from funds furnished by the Wisconsin Alumni Research Foundation.

PRESENT INVESTIGATION

Washington—Danner and Wheeler have been studying the Permian rocks of northern Washington and adjacent island areas for several years. In addition to the quarry near Granite Falls from which Anderson obtained the fusulinids he described in 1941, fusulinid-bearing Permian limestones have been found at numerous localities in a belt extending from the central Cascades of Washington northwestward across northwestern Washington to San Juan Island.

Fusulinids have been obtained from many of the limestone exposures and quarries of this area, as shown on the accompanying outline map (Fig. 1), and the limestone exposures at five of them are shown diagrammatically on the accompanying illustration (Fig. 2). The localities in Washington from which fusulinids described or discussed in this paper were obtained are outlined below.

(1) Univ. Wash. Loc. 3482 — Canyon Creek limestone quarry; three and one-half miles northeast of Granite Falls, Snohomish County; E½ sec. 5, T. 30 N., R. 7 E. Fossils collected at the southeast corner of deposit near contact with underlying tuffaceous sediments. *Collection W-1 (Anderson), W-6A.* The Canyon Creek quarry is on a low hill protruding from glacial drift three miles due south of South Twin Lake. The limestone is underlain by tuffaceous argillites and cherty breccias and is at least 150 feet thick, and it dips seemingly about 60 degrees to the southwest. The fusulinids occur near the contact with the underlying tuffaceous argillites and are so abundant as to almost comprise the entire deposit. A dike about 2 feet wide cuts the limestone in a northeast direction. *Yabeina cascadensis* (Anderson), *Schwagerina andersoni,* n. sp., and *Codonofusiella duffelli,* n. sp. (?).

(2) Univ. Wash. Loc. 3483 — Old Granite Falls limestone quarry; four miles northeast of Granite Falls, Snohomish County; on south side of South Fork of the Stillaguamish River; NE¼ sec. 9, T. 30 N., R. 7 E. *Collections W-2A, W-2B.* The old Granite Falls quarry is a mile southeast of the Canyon Creek quarry and is on the south side of the South Fork of the Stillaguamish River. It is overgrown with underbrush, and no limestone was found in place but it is abundant around an old kiln. The country rock is argillite, in places quite quartzitic. *Yabeina cascadensis* (Anderson) and *Schwagerina andersoni,* n. sp.

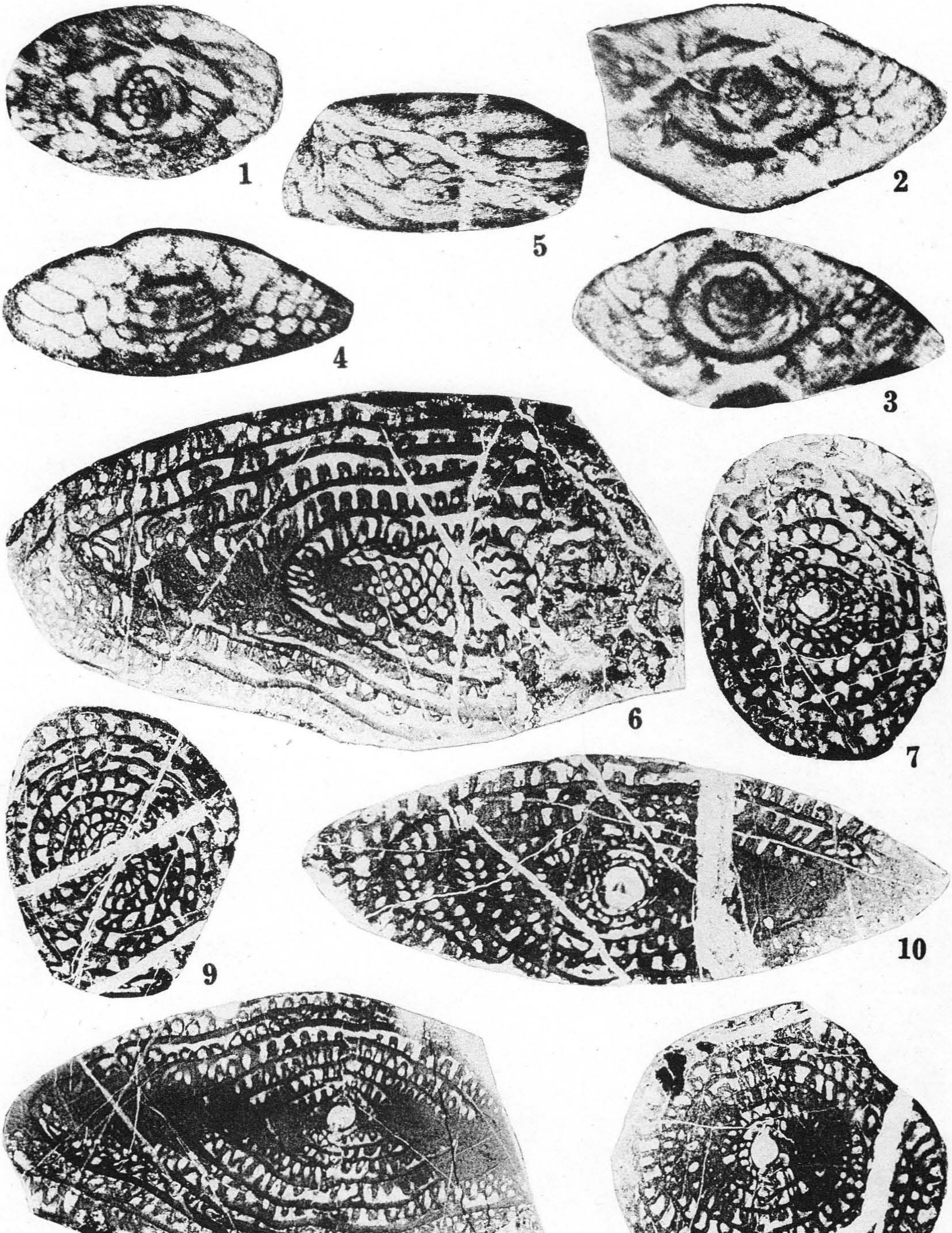
(3) Univ. Wash. Loc. 3484 — Twin Lakes limestone deposit; Morcrop Lime Company quarry; six miles east of Arlington, Snohomish County; center of sec. 2, T. 31 N., R. 6 E.; most northerly of three large limestone outcrops. *Collections W-1A, W-1B, W-1C, W-1D, W-1E, W-1F, W-1G, W-1J.* The Twin Lakes deposit consists of three outcrops that are more or less continuous for nearly three quarters of a mile. Two of them contain two beds of limestone that pinch out in argillite and chert, then reappear. The fusulinids are common only in the northern of the three outcrops where the limestone forms one continuous body about 100 feet thick at the greatest width—about 200 feet of its length has been uncovered and it pinches out at one end. *Neoschwagerina morcropensis,* n. sp., is especially abundant near the bottom of the sequence in the main limestone body, and *Verbeekina americana,* n. sp., is abundant about half way up the sequence. A few small crinoid stems occur just below the top. The predominant dip is to the northeast in the Twin Lakes deposit and ranges from 45 to 80 degrees. Only a few poorly preserved fusulinids have been found in the other two outcrops. The only volcanics observed consist of a small amount of dense greenish basaltic flow interbedded with some limestone at the extreme southwest end of the deposit. *Neoschwagerina morcropensis,* n. sp., *N. brevis,* n. sp., *Verbeekina americana,* n. sp., *Schwagerina* sp., *Pseudodoliolina oliviformis,* n. sp., and *Boultonia cascadensis,* n. sp.

(4) Univ. Wash. Loc. 3485 — Skagit Power Line limestone deposit; located along City of Seattle Skagit Power Line right-of-way four and one-half miles east of Arlington, Snohomish County; center of sec. 10, T. 31 N., R. 6 E. *Collection W-7A.* The Skagit Power Line outcrop is about one mile southwest of the most northerly of the Twin Lakes outcrops. The limestone is exposed as small weathered masses in a body about 50 feet wide and 100 feet long across the power line right-of-way. To the southwest and apparently conformable with the limestone are a few feet of conglomerate, breccia and sandstone, followed by several hundred feet of argillite. To the east alluvium covers the contact for about 200 feet, then argillite and ribbon chert crop out in a few scattered places. The dip is almost vertical with a slight tendency to be northeasterly. However, the ribbon cherts are quite contorted and although they give the best dips, are not too reliable. *Neoschwagerina brevis,* n. sp., and *Pseudodoliolina oliviformis,* n. sp.

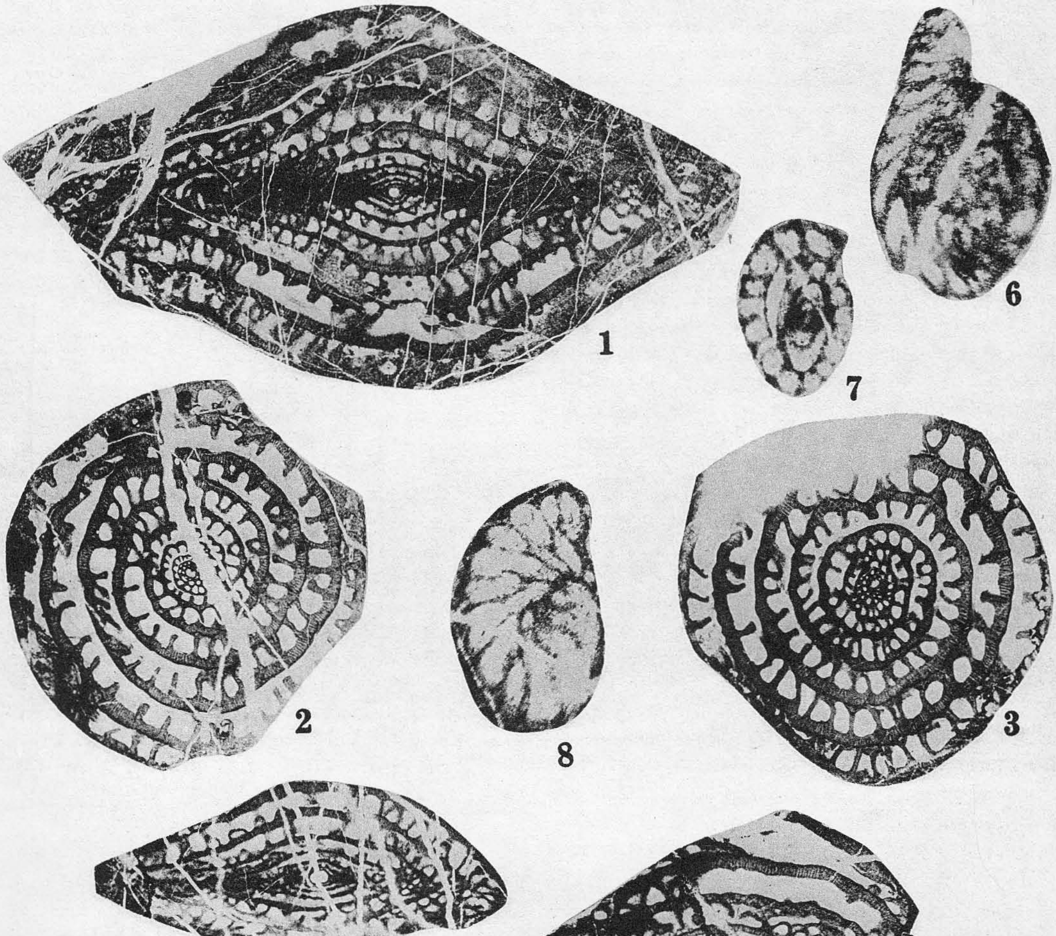
(5) Univ. Wash. Loc. 3486 — Cowell Limestone Quarry; southwest coast of San Juan Island, San Juan County; NE¼ sec. 23, T. 34 N., R. 4 W. *Collections W-3A, W-3B.* The limestone in the Cowell quarry is

EXPLANATION OF PLATE 3

Figs.	All illustrations on this plate are unretouched photographs.	Page
1-5.	*Boultonia cascadensis* Thompson, Wheeler and Danner, n. sp. 1, Oblique section; 2, slightly oblique axial section; 3, slightly tangential axial section; 4, tangential section; 5, oblique tangential section; all × 50. 2 is the holotype, and all others are paratypes. 1, 2, and 5 are from Collection W-1J, 3 is from the Twin Lakes deposit, and 4 is from Collection W-1F.	53
6-11.	*Schwagerina caurus* Thompson, Wheeler and Danner, n. sp. 6, Tangential section; 7-9, sagittal sections; 10, 11, axial sections; all × 10. 11 is the holotype, and all others are paratypes. All are from Collection W-4A.	55



Thompson, Wheeler and Danner, Permian Fusulinids



Thompson, Wheeler and Danner, Permian Fusulinids

very complexly folded and the actual relative position of the fossils is not known, but our collections are from the east end of a series of limestone lenses that seem to be near the top of the sequence. Greenstones occur both above and below the limestone, and some quite small limestone bodies can be found in them. A slight amount of ribbon chert seems to underlie the limestone in several outcrops. The limestone contains flint and some magnesium rich portions. In an early report on the geology of San Juan Island the greenstones were thought to have intruded the limestones, but from the field relations and pillow structure in the greenstone, it seems that they were deposited simultaneously. *Neoschwagerina morcropensis,* n. sp.

(6) Univ. Wash. Loc. 3487 — South Twin Lakes limestone deposit; the most northerly of five limestone outcrops exposed along the logging road northeast of Granite Falls and on the southwest side of South Twin Lakes; SE¼ sec. 18, T. 31 N., R. 7 E. *Collection W-4A.* The South Twin Lakes deposit is about two miles southeast of the Twin Lakes deposit and consists of five outcrops of limestone on the west side of South Twin Lakes. Only the most northerly is fossiliferous. The limestone is lenticular and occurs in a bed of argillite. The argillite is tuffaceous, but no definite volcanic rocks have been found in the vicinity. Ribbon chert underlies the limestone zone and probably occurs above it. *Schwagerina caurus,* n. sp.

(7) Univ. Wash. Loc. 3488 — Palmer Mountain limestone deposit; Grotto Area, King County, northeast side of Palmer Mountain, three miles northeast of Grotto; NW¼ sec. 13, T. 26 N., R. 10 E. *Collection W-5A.* The Palmer Mountain limestone deposits are about 25 miles southeast of Granite Falls. The fusulinids came from a float boulder of highly metamorphosed limestone on the north slope of Palmer Mountain. The outcrop itself occurs higher on the cliffs but could not be reached. However, several lenses of crystalline limestone occur in an almost exact north-south line over a three mile area to the north and to the south. They are nearly vertical and probably continuous with the limestones on the cliffs of Palmer Mountain. The limestones of the lenses are nearly all coarsely crystalline and several of them are intruded on the east by medium-grained diorite. Several basic dikes cut the limestone. Unknown thicknesses of ribbon chert, chert breccia, argillites, and purplish colored meta-volcanics occur to the west and are probably above the limestones. *Neoschwagerina* (large), sp. ind., and *Schwagerina* (large), sp. ind.

British Columbia—Thompson visited the type area of the Cache Creek group of southern British Columbia during the summer of 1949 in search of additional fusulinid faunas, and especially in search of fusulinids *in situ* in the Marble Canyon region. Highly prolific fusulinid faunas were obtained from the steeply dipping Marble Canyon limestone on the road up Hat Creek between Cache Creek and the southeastern entrance to Marble Canyon. The most abundant and best preserved of these faunas were obtained from the lower 300 to 400 feet of the steeply north-dipping limestones exposed in the cliffs 0.3 miles northeast of the mouth of Marble Canyon on the road to Cache Creek (Collection BC-2, BC-3, BC-4) and at the exposure of limestone on the road about 2.65 miles farther down Hat Creek toward Cache Creek (Collection BC-5). The fusulinids from the exposure near the mouth of Marble Canyon are much better preserved and less highly metamorphosed than those 2.65 miles northeastward.

The Marble Canyon fusulinids described by Dawson (1879) and those described by Thompson and Wheeler (1942) were from float obtained in Marble Canyon. Fusulinids were obtained in place by Duffell and McTaggart (1947) from the Marble Canyon limestone probably at the same locality mentioned above from northeast of the Marble Canyon entrance, but they seemingly have not yet been described or illustrated.

As all of the fusulinids formerly described from British Columbia are from talus, we are illustrating *Yabeina columbiana, Y. minuta, Y.?,* n. sp., and *Schwagerina acris* and are describing *Codonofusiella duffelli,* n. sp., from the Hat Creek collections.

Paul Adams and Richard Markley, then students at the University of Kansas, undertook a field problem in 1946 to measure and collect from the Paleozoic rocks exposed on the north side of the South Thompson River east of Kamloops and across the river from Campbell Creek. They obtained numerous collections of fusulinids throughout the great thickness of the lower Cache Creek rocks exposed in the upper part of the section in that area, but most of these were not well enough preserved for identification. These collections have since been studied by Thompson and Verville and are described in Contribution No. 11.

EXPLANATION OF PLATE 4

Figs.	All illustrations on this plate are unretouched photographs.	Page
1-5.	*Schwagerina andersoni* Thompson, Wheeler and Danner, n. sp. 1, Axial section; 2, 3, sagittal sections; 4, 5, axial sections; all × 10. 1 is of the holotype, and all others are of paratypes. All from Collection W-1. (*See, also,* Plate 8)	55
6, 9-12; (?) 7, 8.	*Codonofusiella duffelli* Thompson, Wheeler and Danner, n. sp. 6, Sagittal section; 7, sagittal section referred with question to this species; 8, parallel section referred with question to this form; 9, 11, 12, axial sections; 10, sagittal section; all × 50. 10 is of the holotype; and 6, 9, 11, and 12 are of paratypes. 6 is from Collection BC-4, 7 is from Collection W-6A, 8 is from Collection W-1, and 9-12 are from Collection BC-3.	54

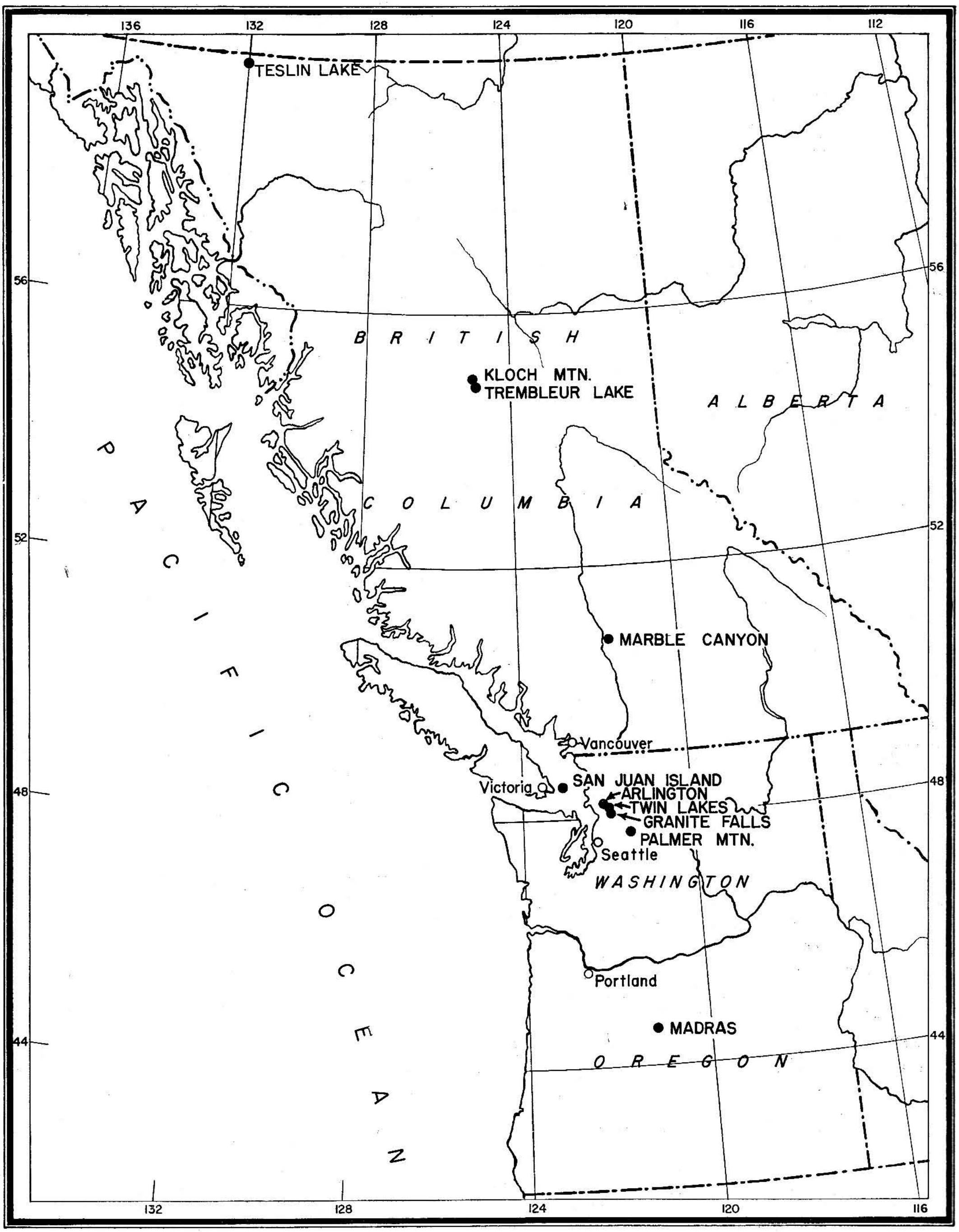


FIGURE 1: Localities of North American Tethyan fusulinid faunas.

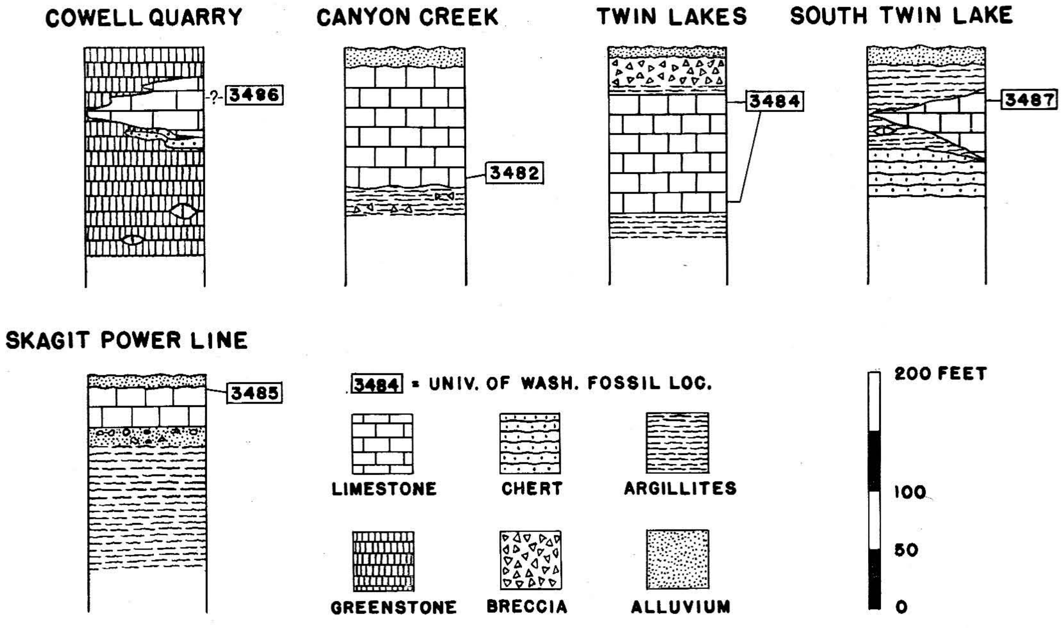


FIGURE 2: Diagrammatic illustration of rocks in quarries and exposures in Washington.

PALEONTOLOGICAL SUMMARY

General Considerations—Much information is needed concerning the stratigraphic distribution of Tethyan fusulinids in the Eastern Hemisphere. By far a majority of the prolific Tethyan faunas that have been described from Europe and Asia were obtained from isolated exposures or from exposures of Permian limestone in thick and complexly deformed sequences, the exact stratigraphic order of which has not been definitely ascertained. As a result, the stratigraphic distribution of Tethyan fusulinids in the Eastern Hemisphere is incompletely known. Some of the best known and largest oriental fusulinid faunas are from Japan and French Indo-China where the Permian is structurally complex. However, the evolution of many biologic groups of the Tethyan fusulinids has been determined from the best available interpretations of the stratigraphy and the presumed evolutionary changes of shell features.

Available evidence indicates that the Wolfcampian fusulinid faunas of both hemispheres are closely similar, and so far as determined, do not contain representatives of the subfamilies Verbeekininae and Neoschwagerininae. Chen (1934) reports verbeekinids and primitive neoschwagerinids in South China in strata which he correlates with the Chihsia limestone from which prolific *Parafusulina* faunas have been described. Verbeekinids and neoschwagerinids are associated with *Polydiexodina* in the Bamian limestone of Afghanistan, but neoschwagerinids and verbeekinids are present in the Sosio beds of Sicily from which ammonoids considered to be lower Guadalupian in age have been obtained (Miller, 1933). It therefore seems possible that the Tethyan fusulinid faunal Zone of *Verbeekina-Neoschwagerina* is equivalent in age to part of the Zone of *Parafusulina* and to the Zone of *Polydiexodina* in America. All available evidence indicates that the highest of the Tethyan fusulinid faunas are dominated by representatives of the genera *Yabeina* and *Lepidolina* and that furthermore they are younger than the Zone of *Verbeekina-Neoschwagerina.*

Washington—The Permian of Washington is exposed in a number of small isolated outcrops over a wide area of the northwestern part of the state. The numerous samples of limestone collected by Danner from Grotto on the south to San Juan Island on the north contain the largest fauna of Tethyan fusulinids known in the Western Hemisphere, and they include representatives of *Boultonia, Codonofusiella, Schwagerina, Pseudodoliolina, Verbeekina, Neoschwagerina,* and *Yabeina.* However, not all of these genera are associated in the same limestone outcrop, and some of the exposures are thought to be considerably different in age. The fusulinids from Washington described below were obtained from the general areas discussed above and indicated on the accompanying illustrations (Figs. 1 and 2).

The South Twin Lakes deposit (Collection W-4A) contains abundant specimens of *Schwagerina caurus,* n. sp., but no representatives of verbeekinids or neoschwagerinids. This form is of the same general type as many known among Tethyan faunas of the Orient, but none of them has been found to be highly diagnostic. This deposit may be equivalent in age to the early part of the Zone of *Verbeekina-Neoschwagerina,* or may be even older.

The Twin Lakes deposits (Collection W-1A to W-1J) contain abundant faunas of *Neoschwagerina morcropensis,* n. sp., *N. brevis,* n. sp., and *Verbeekina americana,* n. sp., and less abundant specimens of *Pseudodoliolina oliviformis,* n. sp., *Schwagerina* sp., and *Boultonia cascadensis,* n. sp. The exposures on the Skagit Power Line (Collection W-7A) contain abundant *Pseudodoliolina oliviformis,* n. sp., and scarce *Neoschwagerina brevis,* n. sp.

Neoschwagerina morcropensis is a rather advanced form of the genus and is associated with *Verbeekina americana,* indicating that the Twin Lakes beds belong to the Zone of *Verbeekina-Neoschwagerina. Pseudodoliolina* is also common in this faunal zone in many areas of Asia. The stratigraphic range of the genus *Boultonia* is not completely known. The genotype, *B. willsi* Lee, and the only previously described form of the genus, is from the Taiyuan series of North China.

The limestones exposed in the Cowell Quarry on San Juan Island are rather highly metamorphosed, but pockets in the samples we have studied from there contain abundant perfectly preserved specimens of *Neoschwagerina morcropensis,* n. sp.

The poorly preserved fusulinids found in the talus samples from the slopes of Palmer Mountain are referable to *Schwagerina* and *Neoschwagerina.* Although too poorly preserved for definite specific recognition, the latter seemingly are closely similar to *Neoschwagerina morcropensis,* n. sp.

The fauna of the Canyon Creek limestone quarry contains *Yabeina cascadensis* (Anderson), *Schwagerina andersoni,* n. sp., and *Codonofusiella duffelli,* n. sp. (?). This fauna is rather typical of the Zone of *Yabeina.*

Although it has not been possible so far to determine the stratigraphic relationships among these numerous exposures, their fusulinid faunas indicate that the South Twin Lakes deposits with abundant *Schwagerina caurus,* n. sp., may be the oldest. The beds at Twin Lakes, Skagit Power Line, Palmer Mountain, and Cowell quarry deposits on San Juan Island seemingly are all of about the same age and are next youngest. All four of the last named deposits are referred to the fusulinid faunal Zone of *Verbeekina-Neoschwagerina.* The deposits exposed at the Canyon Creek limestone quarry and at the old Granite Falls limestone quarry contain abundant *Yabeina* and an associated fusulinid fauna similar to that found with *Yabeina* in the Marble Canyon limestone of British Columbia. They are considered the youngest of the Washington deposits studied.

British Columbia—The Cache Creek was first defined as a rock unit by Selwyn (1872) and was based on exposures between Cache Creek and Marble Canyon, British Columbia, in the general region of the Ashcroft Map Area. Rocks of similar lithologies and age have since been recognized over very wide areas in British Columbia, and they have been described in general as the Cache Creek group or "series." The entire unit is estimated to be more than 20,000 feet in thickness. The lower part is exposed along the north side of the South Thompson River just east of Kamloops. Both the lower and upper parts possibly are exposed in the Ashcroft Map Area along Hat Creek, from its junction with the Bonaparte River to and including Marble Canyon and over a large surrounding area (Duffell and McTaggart, 1947). In general, it seems that Marble Canyon is near the center of a large syncline, the northeastern margin of which is in the vicinity of the mouth of Hat Creek. Dawson (1895) interpreted as the upper part of the Cache Creek the rocks exposed in the area of the headwaters of Hat Creek and in Marble Canyon (Marble Canyon limestone). He was of the opinion that the lower part of the series is represented by the many thousands of feet of rocks exposed along the northern valley walls of the South Thompson River east of Kamloops. The general stratigraphy and distribution of the Cache Creek in British Columbia was summarized recently by Armstrong (1949) and further discussion seems unnecessary here.

Miller and Warren (1933) and Miller and Crockford (1936) described the cephalopods from the upper massive limestone of the section exposed east of Kamloops, including *Propinacoceras americanum* Miller and Warren. The genus *Propinacoceras* has been described from Middle and Upper Permian of many areas, especially from Middle Permian deposits of the Eastern Hemisphere (Miller and Furnish, 1940). Miller and Warren considered the upper limestone bed of the Cache Creek, exposed east of Kamloops and from which *P. americanum* was collected, to be lower Guadalupian in age and correlative with the Word of Texas and the Socio beds in Sicily. Fusulinids are described from the same stratigraphic unit by Thompson and Verville (see following paper) and are referred with question to *Parafusulina, Neofusulinella,* and *Codonofusiella.*

Crockford and Warren (1935) described the megafauna of the Cache Creek rocks exposed east of Kamloops and concluded that the upper unit of the Kamloops section is of Permian age and that its fauna is more closely similar to that of the Permian in the Orient than to that of central and southern United States, northern Mexico, and California. It should be noted that lists of fossils or unnamed faunas from the Permian of British Columbia and Alaska have been published by numerous workers. A majority of these workers have indicated a Tethyan aspect of the Northwest Permian.

The absence of close affinity between the American Tethyan faunas and the marine Permian of California may be more apparent than real. The undescribed megafaunas of the McCloud and Nosoni formations of northern California have a distinct Oriental aspect and the fusulinids of the McCloud are in part similar to those of the lower portion of the Cache Creek group. The absence of the higher American Tethyan fusulinids to the south may be because these faunas are entirely post-Nosoni, and no marine environment was present in northern California so late in Permian time.

The most primitive fusulinids we have studied from the Northwest are from the upper part of steeply dipping limestones with interbedded volcanics exposed on the north side of the South Thompson River east of Kamloops. Daly (1915) measured the entire Cache Creek exposed there as about 13,700 feet thick. Adams and Markley[1] measured more than 9,000 feet thick. However, they measured only the upper part of the section.

Thompson and Verville are describing in Contribution No. 11 two species of *Parafusulina* and an unnamed form referred with question to *Neofusulinella,* from about 150 feet below the top of the uppermost massive limestone of this section, and one of these same species of *Parafusulina* from about 2,300 feet lower in the sequence. Both of these forms of *Parafusulina* are small and may actually be late forms of *Schwagerina.* They are associated at both stratigraphic levels with numerous indeterminate minute fusulinids, possibly referable to *Codonofusiella* Dunbar and Skinner or to *Boultonia* Lee, that are too poorly preserved for identification. The lower part of the massive limestones in the Kamloops section contains rare fusulinids that are poorly preserved and are not highly diagnostic. Although conspecific forms have not been found in the south-central area of the United States, the primitive forms referred with question to *Parafusulina* and the associated *Neofusulinella*? are similar in development to fusulinids in the McCloud limestone of California.

The *Parafusulinas* from the upper part of the Kamloops section are very similar to species of *Parafusulina* from the Permian of Netherlands Timor (Schubert, 1915; Thompson, 1949), the Lower *Productus* limestone of India (Dunbar, 1933), Permian limestone of Caracorum (Reichel, 1940), and from the Permian on the Kuiu Island of Alaska (Dunbar, 1946). It seems to us probable that this part of the Cache Creek was connected with the Oriental Permian by shallow seas across or around the Pacific. It seems possible also that these earlier Cache Creek seas were connected by seaways with the Permian seas of California. The upper part of the Kamloops section is considered to be Leonardian or slightly younger in age. The lower part of the section is possibly Wolfcampian in age, or even older.

We have studied about a dozen large samples collected from the steeply dipping massive limestones exposed along the Hat Creek road northeast of the southeast entrance of Marble Canyon. Although the total thickness of the Marble Canyon limestone was not determined, it obviously is more than 1,000 feet. Our samples all appear to be from more than 1,000 feet below the top of the formation, and all seem closely similar in age. In addition to *Yabeina columbiana, Y. minuta,* and *Schwagerina acris,* these collections (Collections BC-2, BC-3, BC-4, and BC-5) contain several undescribed neoschwagerinids and the specimens we are describing below as *Codonofusiella duffelli,* n. sp. This fauna is typical of the Upper Permian Zone of *Yabeina.*

1 Personal communication.

SYSTEMATIC PALEONTOLOGY

Family FUSULINIDAE

Subfamily SCHUBERTELLINAE

Genus **Boultonia** Lee, 1927

The genus *Boultonia* was established by Lee in 1927, and *B. willsi* Lee from the Taiyuan series of North China was designated as the genotype. The only other species described at that time, *B. rawi* Lee, is not here considered to be congeneric. *B. willsi* resembles in most respects *Codonofusiella paradoxica* Dunbar and Skinner, the genotype of *Codonofusiella,* from the Capitan limestone of Texas, except that the type specimens do not reveal the uncoiled gerontic stage observed in the latter. It seems possible that these two genotype species may be congeneric, but until more extensive topotype collections of *B. willsi* are studied, both genera are recognized, and distinguished by the uncoiled later stages of *Codonofusiella.*

The genotype species of *Boultonia* seemingly is Lower Permian in age. The form described below as *B. cascadensis* is associated with a fusulinid fauna typical of the Middle Permian faunal Zone of *Verbeekina-Neoschwagerina.*

Boultonia cascadensis Thompson, Wheeler and Danner, n. sp.

Plate 3, figures 1-5.

Shell minute, inflated fusiform; with sharply jointed poles, convex lateral slopes. Specimens of five to five and a half volutions 0.92 to 1.2 mm. long, 0.54 to 0.78 mm. wide. First two to three volutions subdiscoidal in shape, with rounded periphery, axis of coiling at a large angle to that of outer fusiform volutions. Third or fourth volution ellipsoidal in shape, with broadly rounded polar area and strongly rounded central area. As maturity is approached, the poles become elongated and gradually more sharply pointed.

Proloculus minute, spherical in shape, having an outside diameter of about 29 microns. Heights of chambers of first to sixth volution of a typical specimen about 24, 33, 35, 52, 80, and 160 microns, respectively.

Septa rather widely spaced. Those of inner discoidal volutions seemingly plane, those of outer fusiform volutions closely fluted in polar regions and broadly fluted in central part of shell.

Spirotheca relatively thick, structure not determined with certainty, covered above and below by dense deposits seemingly continuous with chomata.

Tunnel narrow, elliptical in cross section in earlier volutions. In last volution, tunnel about one-third as high as chamber and about five times as wide as high. Chomata distinct throughout shell, with lateral slopes about uniform in shape on both sides. Floor of tunnel covered by chomata deposits.

Remarks—*Boultonia cascadensis* is referred with question to this genus. Its asymmetrical early volutions resemble *Schubertella* Staff and Wedekind. However, the fluting of the septa in the outer volutions resembles that found in *Boultonia* and *Codonofusiella*. *Codonofusiella* was distinguished from *Boultonia* principally on the basis of the uncoiled mature stage of its shell, but none of our specimens shows an uncoiled stage. Therefore, our specimens seem more closely similar to *Boultonia willsi* than to any other genotype. It should be pointed out, however, that the septa of *B. cascadensis* are much more broadly fluted than are those of *B. willsi* or those of most species of *Codonofusiella*.

Occurrence—*Boultonia cascadensis* is common in the Morcrop Lime Company quarry in the Twin Lakes deposits about six miles east of Arlington, Snohomish County, Washington (Collection W-1F, W-1J), where it is associated with *Neoschwagerina morcropensis*, n. sp., *Verbeekina americana*, n. sp., *Pseudodoliolina oliviformis*, n. sp., and *Schwagerina* sp.

Genus **Codonofusiella** Dunbar and Skinner, 1937

Codonofusiella was described by Dunbar and Skinner with *C. paradoxica* Dunbar and Skinner from the Capitan limestone as genotype. Since its definition, the genus has been recognized as widely distributed in both hemispheres. Erk (1941) described two forms of *Codonofusiella* from Turkey associated with a fauna typical of the Zone of *Verbeekina-Neoschwagerina*, including the fusulinids *Neoschwagerina* and *Cancellina*. Hanzawa (1944) reports the genus in the Zone of *Yabeina* of Japan. Dunbar and Skinner (1937) report poorly preserved specimens that may be referable to it from the upper part of the lower Cache Creek group near Kamloops, B. C. The form described below as *Codonofusiella duffelli*, n. sp., is associated with abundant forms of *Yabeina* in the Marble Canyon limestone and in the Granite Falls limestone of Washington. The genus apparently has a long range in the Permian, from the Middle Permian to the Zones of *Polydiexodina* and *Yabeina*.

Codonofusiella duffelli Thompson, Wheeler and Danner, n. sp.

Plate 4, figures 6, 9-12, (?) 7, 8.

Shell minute, more or less fusiform at end of third or fourth volutions, distinctly uncoiled in later stages of growth. Fusiform part of shell about 0.5 mm. wide, 0.8 mm. long for specimen of three and a half volutions. Axial length of about 1.0 mm. when shell starts uncoiling. First volution slightly evolute; with axis of coiling about normal to axis of coiling of following two or three volutions. Maximum width across entire shell of our most extended uncoiled specimen about 1.3 mm.

Proloculus minute; with outside diameter of about 60 microns. Height of chambers at end of first volution about 60 microns, at end of second volution about 60 microns, at end of third volution about 100 microns, at end of fourth volution about 325 microns.

Spirotheca and septa composed of thin, dense, seemingly structureless layers. Septa highly but irregularly fluted throughout shell, including uncoiled part. The number of septa in the first volution was not determined. There are about 12 septa in the second volution, 15 in the third, and 26 in the fourth volution. Tunnel present in first three to four volutions.

Remarks—The irregular shells of *Codonofusiella* make it difficult to present measurable data by which forms of the genus can be distinguished. As a result, considerable doubt exists that its different forms will ever be easily recognized.

Codonofusiella duffelli, n. sp. resembles *C. nana* Erk from Turkey in general size, but the former has much more highly and closely fluted septa. *C. duffelli* differs from *C. paradoxica* principally by its shorter and more inflated fusiform early shell.

This form is named in honor of Dr. S. Duffell of the Canada Geological Survey.

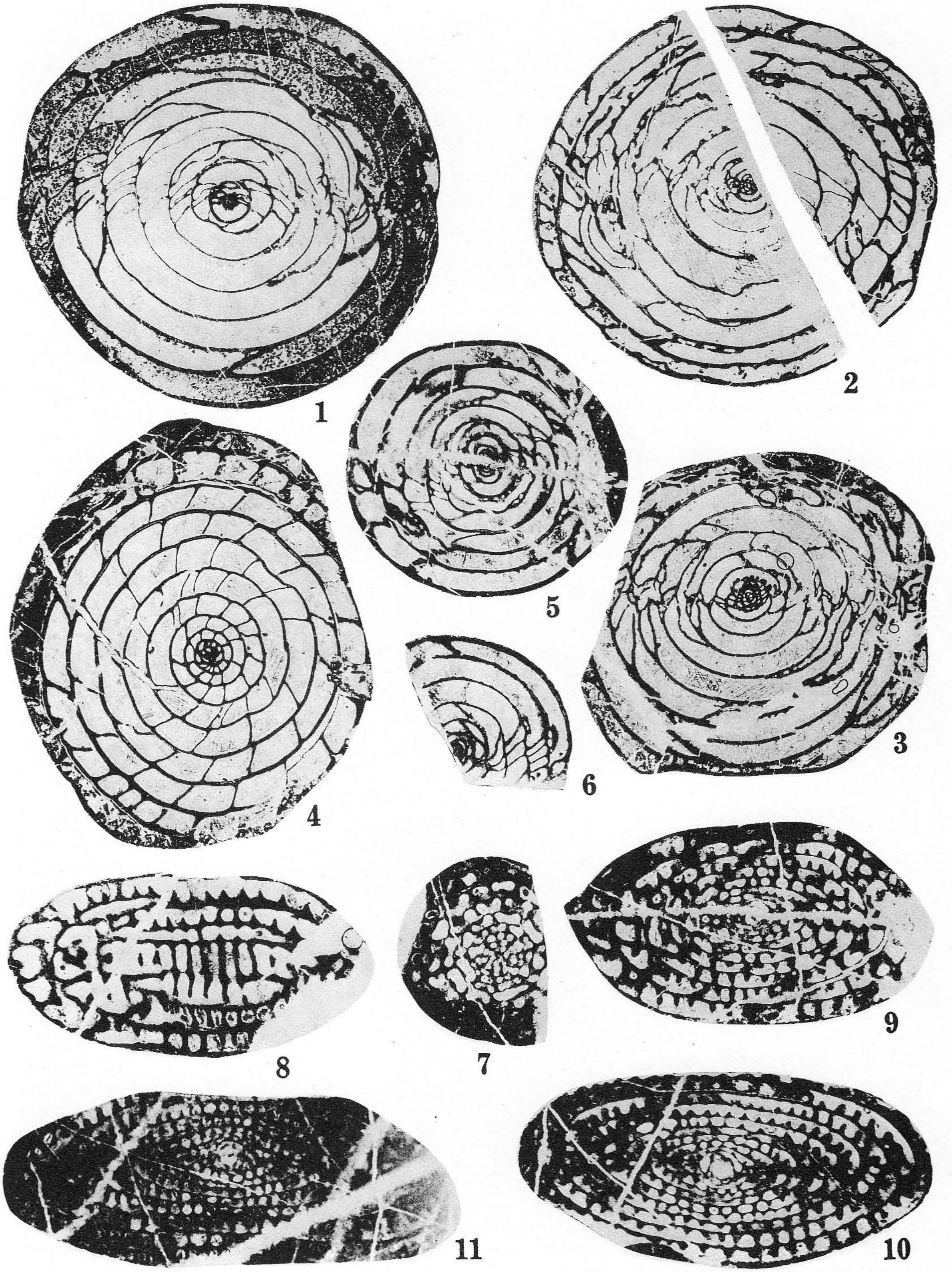
Occurrence—*Codonofusiella duffelli*, n. sp. is common in the lower 100 feet of the steeply dipping limestone exposed on the cliffs 0.3 mile northeast of the road fork at the eastern entrance of Marble Canyon, where it is associated with *Yabeina columbiana* (Daw-

EXPLANATION OF PLATE 5

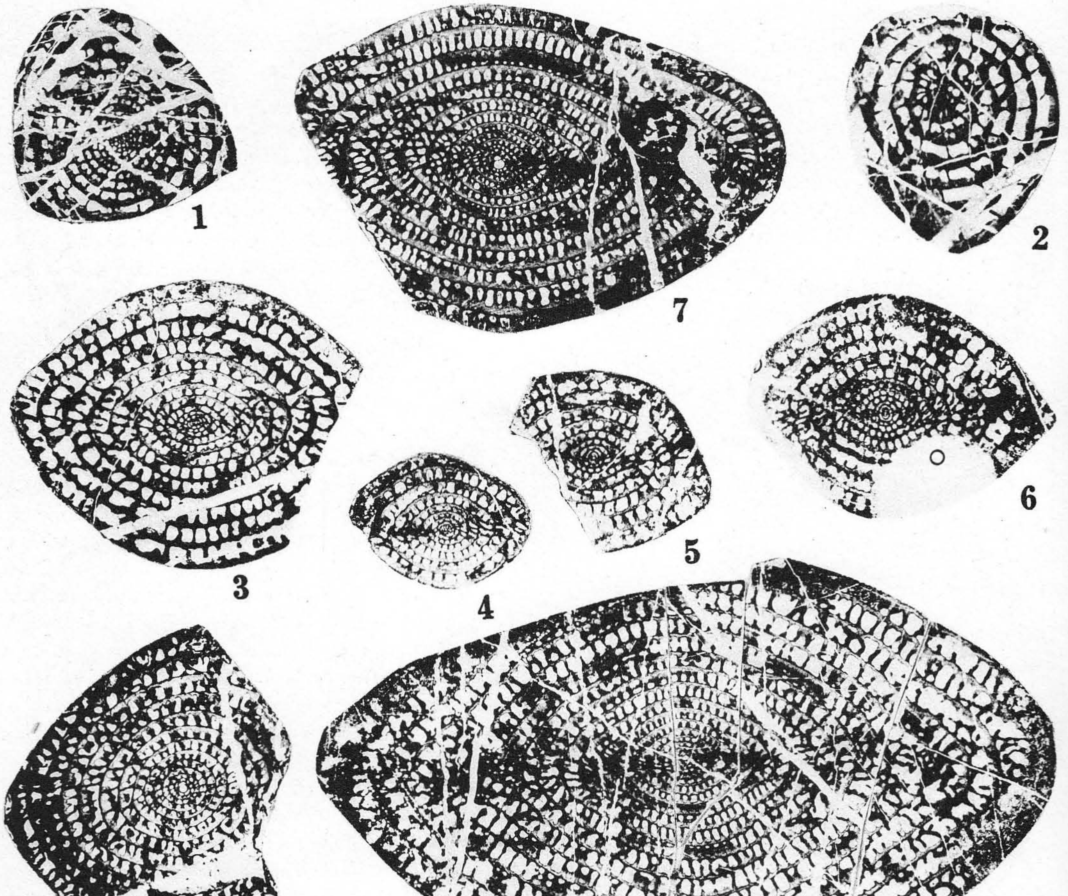
FIGS. All illustrations on this plate are unretouched photographs. PAGE

1-6. *Verbeekina americana* Thompson, Wheeler and Danner, n. sp. 1, Slightly tangential axial section; 2, 3, 5, 6, axial sections; 4, sagittal section; all × 10. 1 is of the holotype, and 2-4 are of paratypes. 1-4 are from Collection W-1J, 5 is from Collection W-1B, and 6 is from Collection W-1D 57

7-11. *Pseudodoliolina oliviformis* Thompson, Wheeler and Danner, n. sp. 7, Parallel section; 8, tangential section; 9, oblique axial section; 10, 11, axial sections; all × 20. 10 is of the holotype, and all others are of paratypes. 7-10 are from Collection W-1G, and 11 is from Collection W-7A. 58



Thompson, Wheeler and Danner, Permian Fusulinids



Thompson, Wheeler and Danner, Permian Fusulinids

son), *Y. minuta* Thompson and Wheeler, *Y.?, n. sp.*, *Schwagerina acris* Thompson and Wheeler, *S. andersoni?*, n. sp., and *S.* sp. Probable conspecific specimens are common in the Granite Falls limestone of Washington associated with *Yabeina cascadensis* (Anderson) and *Schwagerina andersoni,* n. sp.

Subfamily SCHWAGERININAE

Genus **Schwagerina** Möller, 1877, *s. l.*

The genus *Schwagerina* is allowed about the greatest latitude of any genus of the fusulinids. As presently defined, it ranges from the lower Wolfcampian to the highest of the fusulinid-bearing Permian. The Middle and Upper Permian of the Tethys contains a large variety of forms now referred to *Schwagerina* which have heavy axial fillings, intensely fluted septa, large proloculi, and rather highly inflated shells, but which differ considerably from the genotype, *Borelis princeps* Ehrenberg, 1842. The intense fluting of the septa of some of these forms suggest a relationship to *Parafusulina* Dunbar and Skinner, but they are not considered by us as being referable to that genus and perhaps are not closely related biologically to it. As thus defined, *Schwagerina* ranges throughout the Permian. However, forms now referred to *Schwagerina* that are similar to the form described below as *S. caurus,* n. sp., seems to be restricted to the Middle and Upper Permian of the Tethys.

Schwagerina caurus Thompson, Wheeler and Danner, n. sp.

Plate 3, figures 6-11.

Shell large, inflated, fusiform; with rather sharply pointed poles, straight axis of coiling, straight to slightly concave lateral slopes. Our largest specimens of ten or eleven volutions about 6 mm. wide, 14.6 mm. long, giving form ratios of about 2.4. Average form ratios of first to seventh volution of holotype specimen 1.4, 2.0, 2.2, 2.4, 2.4, and 2.6, respectively.

Proloculus very large with outside diameter of 430 to 660 microns, averaging about 535 microns for four specimens. Shell inflated. Heights of chambers in first to ninth volution of a typical specimen about 160, 150, 210, 300, 340, 340, 360, 360, and 430 microns, respectively. Our specimens have been fractured and partly crushed, and the above measurements of the proloculus and of the chambers are only close approximations.

Spirotheca thick and distinctly alveolar. Average thicknesses of spirotheca in second to eighth volution of four specimens 44, 57, 68, 110, 125, 134, and 116 microns, respectively. Proloculus wall thin and apparently structureless, about 25 microns thick.

Septa thin and intensely fluted throughout most of their height. Fluting extends completely to top of spirotheca. Closed chamberlets extend more than two-thirds as high as chambers. Cuneculi narrow and low, best defined in outer volutions. Septal counts in first to seventh volution about 17, 22, 25, 25, 29, 34 and 38, respectively. The septa are so intensely fluted at their lower margins that they develop narrow cuneculi which have not been excavated. However, all tangential sections do not show cuneculi.

Tunnel narrow, low. The specimens are so badly deformed along the area of the tunnel that the tunnel angle cannot be measured accurately. Small chomata present in first one or two volutions but seem to be absent in outer volutions. Very dense deposits occur in axial regions, completely filling chambers along axis of coiling.

Remarks—Schwagerina caurus, n. sp. resembles *S. acris* Thompson and Wheeler from the Marble Canyon limestone of British Columbia more closely than any other American form. However, it can be distinguished from *S. acris* by its larger size, larger proloculus, and more inflated shell.

The septal fluting of *Schwagerina caurus* is closely similar to that found in typical forms of *Parafusulina.* However, the cuneculi are not as high or wide as those of typical *Parafusulina,* and it is not certain that they are completely excavated. This form may be referable to *Parafusulina,* but for the present at least we have placed it in the genus *Schwagerina.*

Occurrence—Schwagerina caurus, n. sp. is exceedingly abundant in the sample obtained from the South Twin Lakes limestone deposit (Collection W-4A). No other fusulinids have been found associated with it.

Schwagerina andersoni Thompson, Wheeler and Danner, n. sp.

Plate 4, figures 1-5; (?) Plate 8, figure 13.

Leeina? sp., ANDERSON, 1941, Washington State College Res. Studies, vol. 9, pp. 194-200, pl. 2, fig. 2.

Schwagerina sp., THOMPSON and WHEELER, 1942, Jour. Paleon., vol. 16, p. 703.

Shell large, highly inflated in central area. Poles acutely pointed, resulting in rather narrowly rounded

EXPLANATION OF PLATE 6

All illustrations on this plate are unretouched photographs, and all of them are magnified × 10.

FIGS.		PAGE
1, 2.	*Neoschwagerina?* sp. 1, Sagittal section; 2, parallel section; both from Collection W-7A.	60
3-6.	*Neoschwagerina brevis* Thompson, Wheeler and Danner, n. sp. 3-5, Axial sections of paratypes; 6, axial section of the holotype. 3-5 are from Collection W-1D, and 6 is from Collection W-1A.	59
7-11.	*Neoschwagerina morcropensis* Thompson, Wheeler and Danner, n. sp. 7, 9, Axial sections of paratypes; 8, 11, sagittal sections of paratypes; 10, axial section of the holotype. 7 and 8 are from Collection W-3B, and 9-11 are from Collection W-1F.	59

surfaces near middle of shell. Lateral slopes concave, low as poles are approached. Holotype of nine volutions about 10.0 mm. long, 5.2 mm. wide, giving form ratio of about 1.9. Shell of same general shape throughout all volutions, except that central part of earlier volutions is not as highly inflated. Form ratios of first to eighth volution of holoytpe 1.5, 2.0, 2.2, 2.4, 2.6, 2.5, 2.5, and 2.0, respectively. Form ratios of paratypes compare favorably with these figures.

Proloculus small; with outside diameter of 150 to 190 microns, that of holotype 156 microns. Heights of chambers in first to ninth volution of holotype 59, 52, 70, 113, 209, 348, 460, 547, and 522 microns, respectively. Thus, first two to three volutions are tightly coiled. Shell expands rapidly between third and fifth volutions. Outermost volutions of closely similar height or become slightly more tightly coiled. Chambers are of their greatest height immediately above the tunnel, but they decrease in height rapidly toward the poles.

Spirotheca thin in first three to four volutions, increases in thickness rapidly from fourth to sixth volutions, remaining thick to maturity. Spirotheca very coarsely alveolar in outer volutions. Alveoli not recognized in inner two volutions. Thicknesses of spirotheca in third to ninth volution of holotype 37, 47, 70, 87, 191, 190, and 220 microns, respectively.

Septa rather thick above tunnel, composed of distinct pycnotheca that extends to base of chambers with very little thinning. Laterally from tunnel, septa become thin rapidly. Septa highly fluted throughout length of chambers in all parts of shell, fluting not extending far anterior of tops of antetheca. Septal counts of first to eight volution of a typical specimen 11, 12, 16, 18, 19, 24, 30, and 34, respectively.

Tunnel narrow, its path about straight, little more than one-third as high as chambers. Rudiments of bases of the septa are present in the middle of the tunnel in the outer three volutions of some shells. Distinct chomata observed in axial sections only in second to fourth volutions. Sagittal sections show presence of thick but discontinuous chomata in sixth to eighth volutions. Dense axial fillings occur in immediate axial region of most parts of shell.

Remarks—Schwagerina andersoni, n. sp. is perhaps the most distinctive American form of the genus. It is not closely similar to any other American forms. It was described briefly by Anderson (1941) and referred by him with question to *Leeina* Galloway. However, the genus *Leeina* is considered synonymous with *Pseudofusulina* Dunbar and Skinner, the genotypes of both differing considerably from the present species.

This form is named in honor of Mr. Roy A. Anderson who was the first to describe Washington fusulinids.

Occurrence—Schwagerina andersoni, n. sp., is abundant in our samples from the Canyon Creek limestone quarry, three and a half miles northeast of Granite Falls, Washington, which are a part of the collections from which Anderson described his fauna in 1941 (Collection W-1) and also in samples collected by Danner in 1949 from the same quarry (Collection W-6A). Specimens are scarce in discarded rocks of the old Granite Falls quarry four miles northeast of Granite Falls (Collections W-2, W-3). It is associated with abundant specimens of *Yabeina cascadensis* (Anderson) and scarce specimens of *Codonofusiella duffelli?*, n. sp. Scarce specimens probably conspecific with the holotype are present in our collections from Hat Creek in British Columbia (Collection BC-4) associated with typical faunas of the Zone of *Yabeina.*

Schwagerina acris Thompson and Wheeler

Plate 8, figures 11, 12.

Schwagerina pavilionensis var. *acris* Thompson and Wheeler, 1942, Jour. Paleon., vol. 16, p. 207, pl. 105, figs. 1, 2.

Specimens here referred to *Schwagerina acris* are rather common in several of our collections from along Hat Creek, northeast of Marble Canyon. Two of these samples from the lower part of the limestone cliff exposed 0.3 mile northeast of the Marble Canyon road fork (Collections BC-3, BC-4) contain a number of specimens that agree in most details with the original types except that they are slightly larger. We have not thus far obtained sufficient well oriented specimens to thoroughly redescribe this form, but we are illustrating two of our better specimens.

The original types of *Schwagerina acris* are about 13.8 mm. long, 3.7 mm. wide. Our largest specimens from Hat Creek are about 16 mm. long and 5.0 mm. wide, giving a slightly smaller form ratio. Other than in gross size, these specimens seem almost identical with the types.

Occurrence—The specimens from Hat Creek here referred to *Schwagerina acris* occur throughout the lower 200 feet of the limestone cliff 0.3 mile northeast of the road fork at the eastern entrance of Marble Canyon on the Hat Creek road and at the small limestone outcrop 2.7 miles down Hat Creek from the road fork. The original types came from talus on the north shore of the middle of the three Pavilion lakes in Marble Canyon.

Schwagerina spp.

Specimens of *Schwagerina* have been observed in nearly all of the samples sectioned from Washington and British Columbia. Many poorly oriented sections occur in the samples from Hat Creek that are not referable to *S. acris,* to *S. pavilionensis,* or to *S. andersoni* but of which we do not have sufficient material for description. Also, a number of sections of forms of *Schwagerina* have been observed associated with *Ver-*

beekina americana, n. sp., and *Neoschwagerina morcropensis,* n. sp., but we do not have sufficient material of these for identification. These specimens, associated with *Verbeekina* and *Neoschwagerina* in our Washington collections (W-1A to W-1J), will not be illustrated or described until additional and better specimens are obtained.

Subfamily VERBEEKININAE

Genus **Verbeekina** Staff, 1909

The genus *Verbeekina* Staff includes a closely similar group of fusulinids, in which specific variations are difficult to recognize, largely because of the absence of complex structural features. Their septa are plane, their wall structures are similar, and their shells are similar in general shape. Size of the shell, wall thickness, degree of development of parachomata, spacing of the foramina, and variations of the profile outline of the shell seem to be among the most reliable features by which species of the genus can be differentiated.

Verbeekina is most closely similar to *Eoverbeekina* Lee, from which it differs by the presence of foramina throughout its shell and more pronounced parachomata. The tunnel system of *Eoverbeekina* begins as a single tunnel in the first volutions, changes to a double tunnel with growth of the shell, and then changes to a multiple series of foramina. Parachomata are absent or are very small in *Eoverbeekina.*

Verbeekina seems to be confined to the Permian fusulinid faunal Zone of *Verbeekina-Neoschwagerina.* Fusulinids of this faunal unit occur in the Sosio beds of Sicily associated with the fusulinid genera *Schwagerina, s. l., Yangchienia,* and *Sumatrina,* and numerous ammonoids which Miller (1933) considers closely equivalent in age to the lower Guadalupian of America. Fusulinids of this faunal zone are widespread in southern Europe, Asia Minor, in southern Asia, and islands of the Indian and Pacific oceans. *Verbeekina* has been reported from Australia.

Verbeekina and *Neoschwagerina* are associated with *Polydiexodina* in Afghanistan, a genus that seems to be confined in America to the upper Guadalupian faunal Zone of *Polydiexodina.* It therefore seems that at least part of this Tethyan fusulinid faunal zone is equivalent in age to the upper Guadalupian of America.

Representatives of *Verbeekina* have been reported or described from Sicily, Greece, Turkey, Caracorum, Pamir, Afghanistan, French Indo-China, Sumatra, Australia, China, and Japan. Dunbar (*In* Armstrong, 1942b) identified *Verbeekina* from central British Columbia.

Verbeekina americana Thompson, Wheeler and Danner, n. sp.

Plate 5, figures 1-6.

Shell spherical, with slightly umbilicate polar regions. Our largest specimens of ten to thirteen volutions 5.0 to 6.3 mm. wide, 5.6 to 6.4 mm. long, giving form ratio of about unit value. Inner two to three volutions very tightly coiled, with short axes of coiling. Beginning with third or fourth volution, shell about spherical and remains so to maturity.

Proloculus minute, spherical, with outside diameter of about 48 microns. Inner volutions tightly coiled. Chambers increase rapidly in height from third to eighth volutions, decrease slightly in eighth to ninth volution, remain of about same height to ninth or tenth volution, and decrease in height slightly as maturity is approached. Heights of chambers in first to twelfth volution of a typical specimen 32, 39, 53, 97, 179, 257, 388, 557, 364, 388, 340, and 250 microns, respectively. Height of chambers in outer volutions about same throughout length, resulting in a spherical shell.

Septa very thin, plane. They extend anteriorly only slightly from normal to spirotheca. Chambers relatively long in inner ten volutions, become short beginning with tenth volution. Septal counts of fourth to eleventh volution of a typical specimen 9, 10, 12, 12, 12, 14, 20, and 32, respectively.

Spirotheca relatively thin, composed of tectum and finely alveolar keriotheca. Spirotheca thickest at its posterior edge where it extends a short distance down anterior side of septum. Spirotheca increases in thickness slowly for first four or five volutions, decreases in thickness for next three or four volutions, then increases in thickness slowly to maturity. Spirotheca 43, 31, 31, 31, 24, 45, 63, 63, and 64 microns thick, respectively, in third to eleventh volution of a typical specimen. That of another specimen 23, 37, 35, 35, 31, 31, 42, 45, 56, and 59 microns, respectively, in second to eleventh volution. Foramina occur throughout shell. There are about 34 foramina in tenth volution and 40 in eleventh volution of holotype. Parachomata only slightly developed, most distinct adjacent to septa of outer volutions of mature specimens, absent or very small immediately adjacent to septa in earlier volutions.

Remarks—*Verbeekina americana,* n. sp., is the first species of the genus to be described from America. Dunbar (*In* Armstrong, 1942b) identified an undescribed form of the genus from the Cache Creek group (seemingly middle Cache Creek) from Trembleur Lake in central British Columbia.

The above description is based entirely on specimens from Collection W-1J obtained from about half way up the sequence exposed in the Morcrop Lime Company quarry about six miles east of Arlington, Washington. Two collections from other parts of the quarry (Collections W-1D and W-1B) contain rare specimens of a form of *Verbeekina* that resemble those described above except that they are much smaller in size and have relatively thicker spirotheca. In both collections these small specimens are associated with rare typical specimens of *V. americana,* n. sp. These small specimens may be small individuals of this form or they may represent a distinct form. We are referring them to *V. americana* with question.

Verbeekina americana resembles *V. verbeeki* (Geinitz), the genotype species from the Padang limestone of Sumatra, very closely in many respects. However, the American form seemingly has fewer volutions at maturity, more highly inflated chambers, less well formed parachomata, thinner spirotheca for corresponding parts of the shell, and more widely spaced septa.

Verbeekina americana is closely similar to *V. heimi* Thompson and Foster from the Yanghsin limestone of western China, a form that is associated with a fusulinid fauna of an over-all aspect very closely similar to that associated with *V. americana.* The major differences between these forms are that *V. heimi* is larger, has more volutions, maintains a thin spirotheca to a larger size, and has larger parachomata. The two species are probably closely related in age.

Occurrence—Verbeekina americana is exceedingly abundant in the Twin Lakes deposits (Collection W-1D to W-1J) where it is associated with *Neoschwagerina morcropensis,* n. sp., *N. brevis,* n. sp., *Pseudodoliolina oliviformis,* n. sp., *Boultonia cascadensis,* n. sp., and *Schwagerina* sp.

Genus **Pseudodoliolina** Yabe and Hanzawa, 1932

Pseudodoliolina seems to be a late member of the subfamily Verbeekininae, for it has very thin walls (possibly as a result of aberrant development) and high and narrow parachomata. In fact, the parachomata of this genus is among the most pronounced of any of the members of the subfamily. It is associated with typical fusulinids of the Zone of *Verbeekina-Neoschwagerina* in most areas where known. Representatives have been described from western China, French Indo-China, Japan, Sumatra, and the Island of Letti. The upper limits of the range of *Pseudodoliolina* is not known with certainty. It may range into the Zone of *Yabeina.*

Pseudodoliolina oliviformis Thompson, Wheeler and Danner, n. sp.

Plate 5, figures 7-11.

Shell small, elongate ellipsoidal, with rounded polar areas, straight axis of coiling, distinctly convex lateral slopes. Specimens of ten volutions about 1.5 mm. wide, 3.2 mm. long, giving form ratios of near 2.0. Poles pointed for first three to four volutions, rounded beyond fourth volution. Form ratios of first to tenth volution of holotype specimen 1.3, 2.0, 2.4, 2.2, 2.2, 2.3, 2.3, and 2.3, respectively.

Proloculus large, with outside diameter of 120 to 208 microns, averaging 155 microns for three specimens. Shell expands slowly and uniformly. Averages of height of first to tenth volution of four specimens 36, 40, 54, 56, 68, 85, 92, 92, and 118 microns, respectively.

Spirotheca very thin, in many specimens apparently composed of a single thin layer. In some specimens a thin clearer layer occurs at base of spirotheca. Total thickness of primary layers of spirotheca in seventh to tenth volution of holotype specimen 13, 12, 17, and 17 microns, respectively. Septal furrows distinct, resulting in a highly scalloped shell surface.

Septa exceedingly thin, composed of a single dense layer. Surfaces of septa and of spirotheca covered by dense layers from parachomata. Lower edges of septa above foramina appear pendant-shaped. Septa plane. Septal counts of fourth to seventh volution about 13, 14, 16, and 18, respectively.

Foramina small, circular to slightly ellipsoidal in cross-section, about 9, 12, 12, 17, 18, 19, 22, and 24, respectively, in third to tenth volution of holotype specimen. Parachomata throughout shell, extending to the tops of chambers in all parts of shell, at least immediately adjacent to septa. Lateral openings above parachomata ellipsoidal, more or less centered in chamber.

Remarks—Pseudodoliolina oliviformis, n. sp. resembles *P. ozawai* Yabe and Hanzawa and *P. lettensis* (Schubert) rather closely. Both of the latter forms have thin walls, massive parachomata, and elongate subcylindrical shells. The shell of *P. oliviformis* is shorter, more inflated, and has more highly convex lateral surfaces than either of them.

Pseudodoliolina oliviformis resembles *P. pseudolepida* (Deprat) closely in general shape, but the latter is much larger, has thicker walls, and has more massive parachomata.

Occurrence—Pseudodoliolina oliviformis is fairly abundant in the limestones from the Twin Lakes deposits where it is associated with *Verbeekina americana,* n. sp., *Neoschwagerina morcropensis,* n. sp., and *Schwagerina* sp. (Collections W-1D, W-1G, and W-1J) and in the Skagit Power Line right-of-way deposit where it is associated with *Neoschwagerina brevis,* n. sp. (Collection W-7A).

Subfamily NEOSCHWAGERININAE

Genus **Neoschwagerina** Yabe, 1903

Neoschwagerina can be distinguished from other members of the subfamily Neoschwagerininae by the rather thick walls, primary transverse septula, and axial septula. *Cancellina* Hayden has transverse septula but no axial septula. *Yabeina* and *Lepidolina* have thinner walls than *Neoschwagerina,* secondary transverse septula located above the foramina, and more numerous axial septula. The thin walls, secondary transverse septula, and more uniformly long transverse and axial septula of *Afghanella* and *Sumatrina* serve to distinguish them from *Neoschwagerina.*

The stratigraphic range of *Neoschwagerina* is not too well known. It is abundant in southern Europe, Asia Minor, southern Asia, the East Indies, and Japan in the Zone of *Verbeekina-Neoschwagerina*. Douvillé (1934) described *Neoschwagerina* from Tunis where it was stratigraphically below *Yabeina*. *Neoschwagerina* has been reported in association with *Yabeina* in many areas, especially in French Indo-China and Japan, but it is most abundant in the Zone of *Verbeekina-Neoschwagerina*.

Although *Neoschwagerina* was reported from British Columbia by Dunbar (1931) and from Washington by Anderson (1941), the species referred by these workers to *Neoschwagerina* are here considered to belong to *Yabeina*. Dunbar (*In* Armstrong, 1942b) reported *Neoschwagerina* in association with *Verbeekina* in central British Columbia, but these have not yet been described or illustrated.

Neoschwagerina brevis Thompson, Wheeler and Danner, n. sp.

Plate 6, figures 3-6.

Shell small, short, inflated, with highly convex lateral slopes, straight axis of coiling, bluntly rounded poles. Our largest specimens of ten to fourteen volutions 4.45 to 6.00 mm. long, 3.07 to 3.88 mm. wide, giving form ratios of 1.4 to 1.5. First two to three volutions have short axes of coiling, beyond third volution the shape closely resembles that of mature shell. Form ratios of first to tenth volution of holotype specimen 0.6, 0.7, 0.8, 1.2, 1.3, 1.5, 1.4, 1.4, 1.5, and 1.5, respectively. First two to three volutions are slightly evolute, have small form ratios, and are coiled at high angles to direction of coiling of outer volutions.

Proloculus minute, with outside diameter of 42 to 57 microns, averaging 49 microns for three specimens. Heights of first to eleventh volutions of holotype specimen 23, 42, 40, 49, 89, 96, 153, 203, 244, and 244 microns, respectively.

Spirotheca relatively thick, distinctly alveolar. Due to intersection of septula by thin sections, it is difficult to measure the true thickness of the spirotheca. As well as can be determined, thickness of spirotheca in fourth to eleventh volutions of holotype specimen about 16, 26, 33, 40, 52, 56, 64, and 68 microns, respectively.

Septa rather thick. Keriotheca extends down both sides of tectum for a short distance. Septal counts of first to ninth volution of a typical specimen 6, 7, 8, 9, 10, 10, 14, 13, and 17, respectively. Transverse septula extend to tops of parachomata across chambers, except for small lateral openings. Axial septula first appear in third to fourth volution. Two axial septula occur between adjacent septa in outer volutions. Transverse septula and foramina first appear in fourth volution.

Foramina very low and relatively wide, about three times as wide as high. There are 6 foramina in fourth volution, 10 in sixth volution, 21 in tenth volution, and 28 in twelfth volution of holotype specimen. Foramina first recognizable in fourth volution. It is not certain that they occur in earlier volutions.

Remarks—*Neoschwagerina brevis*, n. sp. is the smallest form of the genus known from America. It is shorter, has smaller form ratios for corresponding volutions, has thinner spirotheca in earlier volutions and thicker spirotheca for corresponding later volutions, and has fewer axial septula in corresponding early parts of the shell than *N. morcropensis*, n. sp.

Occurrence—Occasional specimens of *Neoschwagerina brevis* were found in several of our collections from the Twin Lakes deposits at the Morcrop quarry. In some of these they are the only fusulinid present. In others they are associated with *Verbeekina americana*, n. sp., (Collections W-1D, W-1J, W-1B) and *Pseudodoliolina oliviformis*, n. sp., (Collection W-1G).

Neoschwagerina morcropensis Thompson, Wheeler and Danner, n. sp.

Plate 6, figures 7-11.

(?) *Yabeina* sp. Mathews, 1947, British Columbia Dept. Mines, Bull. 23, p. 52.

Shell large, inflated fusiform. Our largest specimens of sixteen to eighteen volutions slightly more than 6 mm. wide and 12.0 mm. long, giving form ratios of about 2.0. First two to three volutions inflated ellipsoidal to subspherical in shape, with very bluntly pointed poles. Beyond fourth volution shell assumes its mature shape. Lateral slopes of all parts of shell distinctly convex. However, as maturity is approached, lateral slopes become almost straight in end zones. Form ratios of first to sixteenth volution of holotype specimen 1.0, 1.0, 1.1, 1.4, 1.5, 1.6, 1.8, 1.8, 1.8, 1.8, 1.8, 1.8, 1.8, 1.8, 1.9, and 2.0, respectively

Proloculus spherical in shape, minute in size, with an outside diameter of 77 to 108 microns, averaging 90 microns for three specimens. Shell expands slowly and uniformly for first nine volutions and expands even more slowly from there to maturity. Heights of chambers in first to sixteenth volution of holotype specimen 38, 54, 78, 78, 108, 148, 164, 198, 238, 229, 253, 306, 330, 325, 330, and 327, respectively.

Spirotheca thick, distinctly alveolar. Alveoli very narrow. All alveoli apparently extend from base of keriotheca or from lower surfaces of septula completely to tops of spirotheca. The true thickness of the spirotheca is difficult to measure because both transverse and axial septula intersect the thin sections at numerous places. Thicknesses of spirotheca at its thinnest point between adjacent septula in first to sixteenth volution of holotype specimen about 14, 17, 21, 24, 33, 37, 26, 40, 35, 40, 57, 70, 87, 87, 87, and 82 microns, respectively.

Septa composed of tectum and posterior and anterior layers of keriotheca. Posterior layer has structure like that of septula, with alveoli that bend sharply to posterior surface. Anterior extension of keriotheca extends downward along septa for only about one-half height of chambers. Septal counts of first to fourteenth volution of two typical specimens average 7, 8, 11, 11, 12, 13, 14, 16, 17, 17, 18, 20, 22, and 26, respectively. Axial septula present in most if not all parts of shell. Axial septula are difficult to recognize in the first two volutions. Some chambers in third volution have two distinct axial septula, other chambers there have only one. Chambers in outer volutions of mature specimens have one or two axial septula. A rudimentary suggestion of a third axial septula is present in the outermost volutions of larger specimens. Axial septula vary considerably in length and shape among different chambers throughout shell. They are formed by pendant ridges of spirotheca that more or less parallel septa, and contain distinct alveoli completely to their bases. Although axial septula are nearly straight throughout shell, some are slightly offset as they cross transverse septula. Primary transverse septula throughout shell, with lower surfaces in contact with tops of parachomata across chambers, except for irregularly shaped lateral passages that penetrate lower areas of transverse septula above parachomata. Details of the shapes and positions of these lateral passages in the transverse septula were not determined with certainty, but they seem to be confined largely to the posterior side of the chambers.

Foramina small, elliptical, with greatest diameter parallel to axis of coiling of shell. Narrow and high parachomata occur between adjacent foramina throughout all volutions, except outer part of last volution. It is not known if the number of foramina is a highly consistent feature in a given species of *Neoschwagerina*. Also, it is not certain that the exact number present can be determined in most thin sections of forms of the genus that have been studied. There are about 12, 16, 16, 20, 22, 26, 30, 34, 34, 36, 40, 48, and 44 foramina, respectively, in the fourth to sixteenth volution of the holotype specimen. Thin axial fillings seemingly occur in extreme polar regions. However, the congestion of chambers in this region may result in crowding of parachomata to give the appearance of axial fillings.

Remarks—*Neoschwagerina morcropensis*, n. sp., can be distinguished from *N. brevis* by its much larger size, relatively thinner spirotheca, narrower and more numerous septula, and larger proloculus.

Although *Neoschwagerina morcropensis* is a typical form of the genus, its huge size suggests that it is an advanced form. However, size alone is not a reliable criterion for the determination of evolutionary advancement.

Occurrence—*Neoschwagerina morcropensis*, n. sp. is abundant in the lower part of the fusulinid-bearing limestone bed (Collection W-1E, W-1F) and less abundant in the middle part of the limestone bed (Collection W-1D) in Morcrop quarry at Twin Lakes where it is associated with exceedingly abundant specimens of *Verbeekina americana*, n. sp., *Pseudodoliolina oliviformis*, n. sp., *Schwagerina* sp., and *Boultonia cascadensis*, n. sp. It is abundant in the Cowell quarry on San Juan Island (Collection W-3B).

Neoschwagerina? sp.

Plate 6, figures 1-2.

Spirotheca unusually thick. One short axial septula in each chamber. Septa plane, without extensions of spirotheca down their surfaces as in most *Neoschwagerina*. The centered sagittal section (Pl. 4, fig. 1) of twelve volutions is 2.9 mm. wide. Outside diameter of proloculus about 30 microns. Heights of chambers in first to tenth volution of one specimen 28, 47, 59, 61, 78, 90, 110, 134, 191, and 183 microns, respectively. Septal counts of first to tenth volution 7, 12, 13, 14, 16, 19, 21, 22, 22, and 24, respectively. Spirotheca measures 19, 19, 35, 35, 52, 57, 70, 75, and 90 microns, respectively, in fourth to twelfth volution. Transverse septula short, broad. Base of parachomata broad. There are about 14 foramina in the eleventh volution.

Remarks—We have only a few specimens of this form, and none of them is a centered axial section. Its axial septula indicate that it is a neoschwagerinid. Its plane thin septa resemble those of the verbeekinids. Its abnormally thick spirotheca resembles closely that of *Cancellina* Hayden. However, *Cancellina* seemingly does not have even rudimentary axial septula as found in this form. It may be intermediate between *Cancellina* and *Neoschwagerina*.

Occurrence—This form has been found only in the Skagit Power Line deposit (Collection W-7A) where it is associated with *Pseudodoliolina oliviformis*, n. sp.

Genus **Yabeina** Deprat, 1914

Yabeina is distinguished from *Neoschwagerina* Yabe by its secondary transverse septula, more numerous axial septula, and a thinner spirotheca. In the more primitive forms, the secondary transverse septula first appear in outer volutions, but secondary transverse septula are found throughout nearly all volutions of the highly advanced forms. The spirotheca of early forms of *Yabeina* is closely similar in thickness to that of *Neoschwagerina*, but in more advanced forms of the genus it is very thin. *Lepidolina* Lee is considered to be a descendent of *Yabeina*. They differ principally by the thinner spirotheca and more numerous axial and transverse septula of *Lepidolina*.

So far as the available evidence indicates, *Yabeina* is present in the highest of the Tethyan fusulinid faunas. It seems to occur in many areas stratigraphically above other types of Tethyan fusulinids that are associated in southern Asia with *Polydiexodina,* the index genus of the highest of the Permian fusulinid faunas of south-central United States and northern Mexico.

Yabeina cascadensis (Anderson)

Plate 7, figures 1-5.

Neoschwagerina cascadensis ANDERSON, 1941, Washington State Coll. Res. Studies, vol. 9, pp. 190-194, pl. 1, figs. 1, 2, pl. 2, fig. 1.

Yabeina cascadensis THOMPSON and WHEELER, 1942, Jour. Paleon. vol. 16, p. 703.

Shell large, highly inflated fusiform. Our largest specimen of twenty-one volutions about 9.6 mm. wide, more than 12.6 mm. long. Axis of coiling about straight, lateral slopes distinctly convex throughout shell. We do not have any specimens of more than seventeen volutions that are well oriented in thin section along the axis of coiling. Average form ratios of first to fourteenth volution in three specimens 0.8, 0.9, 1.1, 1.4, 1.5, 1.6, 1.8, 1.9, 2.0, 2.0, 1.8, 1.8, 1.8, and 2.0, respectively. One specimen has minute proloculus, with first one and a half volutions coiled at high angles to outer fusiform volutions.

Proloculus minute, spherical, with outside diameter of 37 to 104 microns, averaging 67 microns in three specimens. Averages of height of chambers in first to eighteenth volution of three specimens 29, 40, 41, 59, 73, 97, 114, 137, 160, 171, 187, 209, 231, 239, 272, 261, 266, and 252 microns, respectively.

Spirotheca rather thin, distinctly alveolar, 30 to 40 microns thick in outer part of shell. The thickness of the spirotheca can be measured only at points between the septula, and it is difficult to determine such points in thin sections. It is not noticeable that the spirotheca changes in thickness greatly from the seventh volution to maturity. Alveoli of spirotheca very fine, extending completely to base of septula, not recognizable in many parts of shell.

Pycnotheca of septa has extension of keriotheca to its base on posterior side, and short downward extension of keriotheca on anterior side. Transverse primary septula present throughout shell. Secondary transverse septula first become distinct in tenth to twelfth volution. Axial septula throughout shell or at least from third volution to maturity. There are about three axial septula in tenth volution, four to six in fifteenth volution. Total number of axial septula in outer volution seems to vary slightly from chamber to chamber.

Foramina very abundant. More than 70 foramina occur in twenty-third volution. In typical specimens, about 11 foramina occur in fifth volution, 27 in tenth volution, 44 in fifteenth volution. Bases of the parachomata are wide, but they are very narrow where they come in contact with the primary tranverse septula. Axial zone filled with dense calcite that may consist of crowded parachomata.

Remarks—*Yabeina cascadensis* was referred originally to *Neoschwagerina* by Anderson, but he recognized that secondary transverse septula were present in its outer volutions. It can be distinguished from *Y. columbiana* (Dawson) by its thicker spirotheca, the later appearance of secondary transverse septula, and the smaller number of axial septula in corresponding volutions.

Occurrence—*Yabeina cascadensis* (Anderson) is abundant in the Canyon Creek quarry (Collection W-1, W-6A) and less abundant in the old Granite Falls quarry (Collection W-2A, W-2B). It is associated with abundant specimens of *Schwagerina andersoni*, n. sp., and *Codonofusiella duffelli?*, n. sp.

Yabeina columbiana (Dawson)

Plate 8, figures 1-3.

Loftusia columbiana DAWSON, 1879, Quart. Jour. Geol. Soc. London, vol. 35, pp. 69-75, pl. 6, figs. 1-7.

Neoschwagerina cf. *craticulifera* STAFF, 1912, Palaeontographica, vol. 59, p. 161.

Neoschwagerina columbiana DUNBAR, 1932, Royal Soc. Canada Proc. and Trans., 3d ser., vol. 26, Sec. IV, pp. 45-49, pl. 1, figs. 1-4.

Yabeina columbiana THOMPSON and WHEELER, 1942, Jour. Paleon., vol. 16, pp. 708-710, pl. 106, fig. 5, pl. 107, fig. 5, pl. 108, fig. 1, pl. 109, figs. 1-4.

As indicated in the synonymy above, this form has been referred to *Loftusia* Brady, *Neoschwagerina* Yabe, and *Yabeina* Deprat. The original type specimens and all later published specimens were obtained from talus of the Marble Canyon limestone in Marble Canyon. The specimens here illustrated were obtained from the lower part of the limestone cliff about 0.3 mile northeast of the eastern entrance of Marble Canyon on the bluff immediately west of the Hat Creek road. These specimens agree so closely with those described and illustrated by Thompson and Wheeler that further discussion seems unnecessary here.

Occurrence—This form is exceedingly abundant in the limestone bluff 0.3 mile northeast of the eastern entrance of Marble Canyon (Collections BC-2, BC-3, BC-4) where it is associated with *Yabeina minuta* Thompson and Wheeler, *Yabeina?*, n. sp., *Schwagerina acris* Thompson and Wheeler, *S. andersoni?*, n. sp., and *Codonofusiella duffelli,* n. sp. It is less abundant and poorly preserved in samples from 2.7 miles northeast of Marble Canyon on the Hat Creek road, where it is associated with *Schwagerina acris* and *Codonofusiella duffelli,* n. sp. The original types came from talus in Marble Canyon, and the specimens described by Thompson and Wheeler came from talus on the north shore of the middle of the three Pavilion lakes in Marble Canyon.

Yabeina minuta Thompson and Wheeler

Plate 8, figures 4-7.

Yabeina minuta THOMPSON and WHEELER, 1942, Jour. Paleon., vol. 16, pp. 707, 708, pl. 106, figs. 6-10.

The specimens here illustrated are almost identical with the original types from talus on the north shore of the middle of the three Pavilion lakes in Marble Canyon.

Occurrence—The specimens here illustrated are from 0.3 mile northeast of the eastern end of Marble Canyon (Collections BC-2, BC-3, BC-4) where they are associated with *Yabeina columbiana* (Dawson), *Yabeina?*, n. sp., *Schwagerina acris* Thompson and Wheeler, *S. andersoni?*, n. sp., and *Codonofusiella duffelli,* n. sp.

Yabeina? n. sp.

Plate 8, figures 8-10.

Numerous random and variously oriented thin sections have been obtained from one of our Marble Canyon limestone samples, and evidently represent an undescribed form. They are of a large, highly inflated form of at least thirteen volutions, with a very large proloculus, thin spirotheca, very narrow septula, secondary transverse septula in all volutions with as many as two occurring between primary transverse septula in outer volutions, and very numerous foramina. Our largest axial section of only ten and a half volutions is about 6.7 mm. long and 4.0 mm. wide. Its proloculus has a diameter of more than 400 microns. The shell is tightly coiled.

We are not able to determine all of the characters of this form. However, for the sake of completeness, we are illustrating three of our better sections.

The spirotheca of this form is thinner than that of most forms of *Yabeina.* It can be distinguished from *Y. columbiana* by its thinner spirotheca, more closely spaced foramina, more numerous secondary transverse septula, and larger proloculus. It resembles *Y. minuta* in wall thickness, but its proloculus is larger, its axial septula are more highly irregular in length, its shell is more inflated and larger, and apparently it has more numerous secondary transverse septula.

Further study of this form will be necessary before a definite generic assignment can be made.

Occurrence—This form is common in our Collection BC-3 with the same associations as given above for *Yabeina columbiana* (Dawson).

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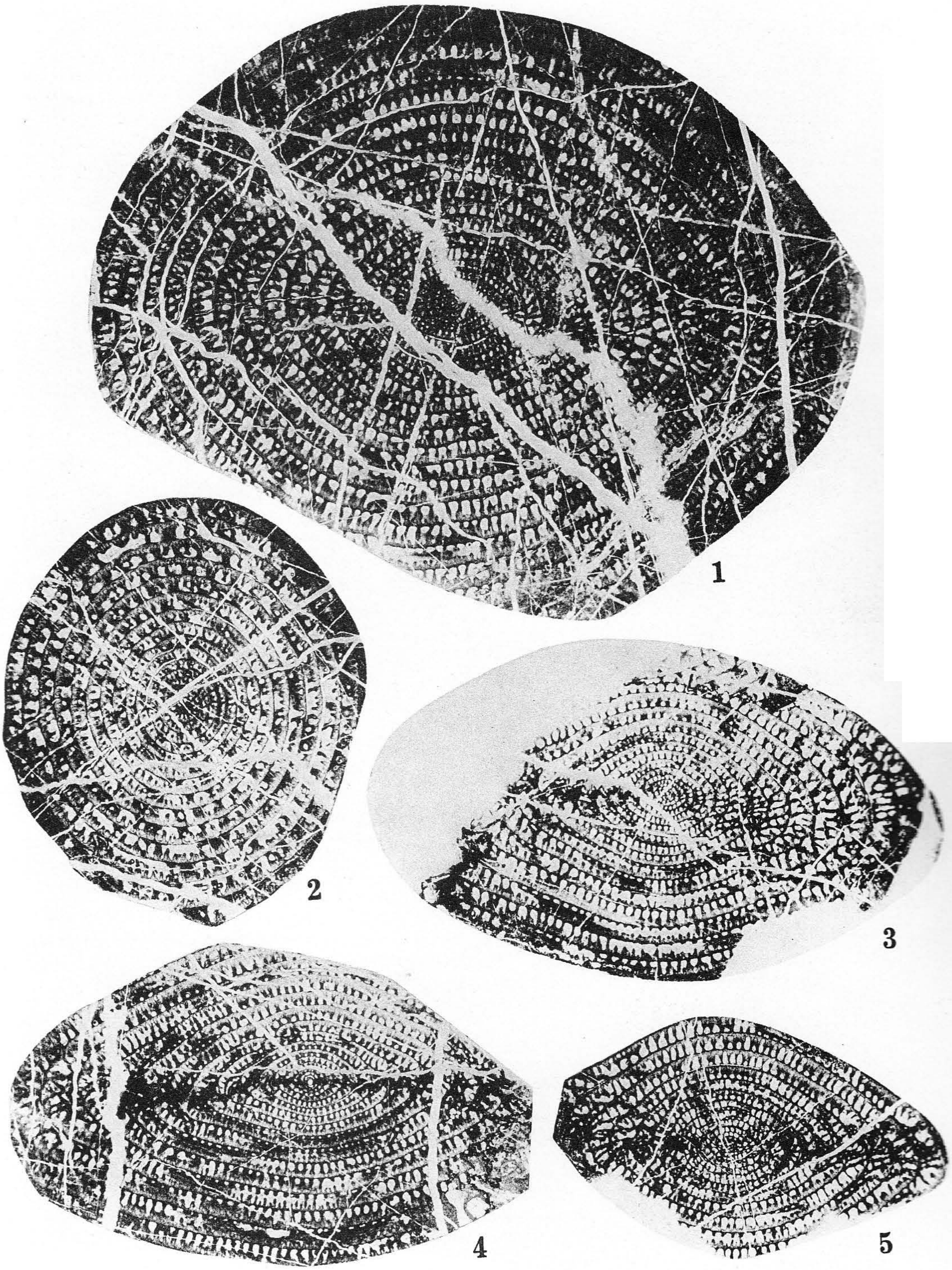
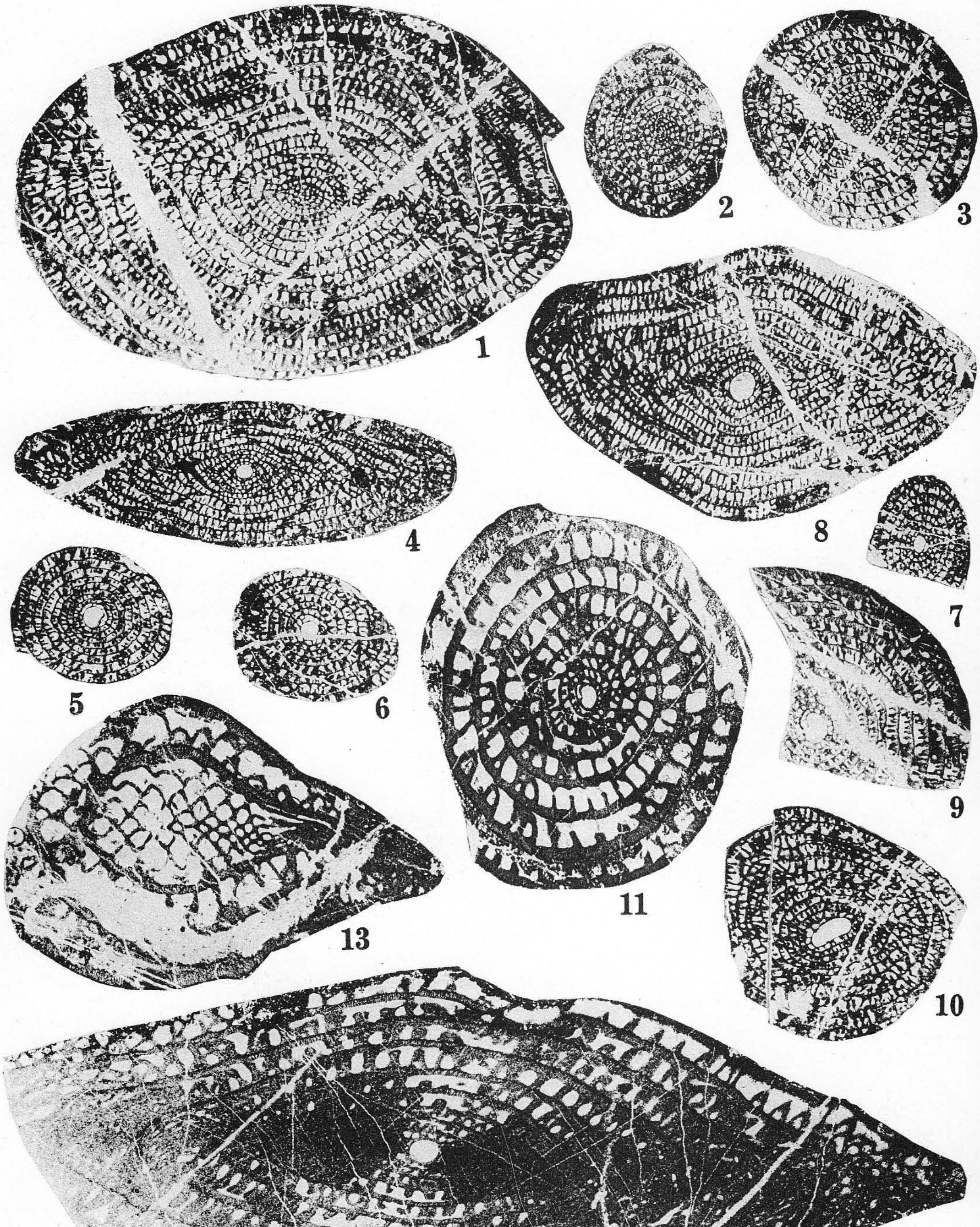
EXPLANATION OF PLATE 7

All illustrations on this plate are unretouched photographs, and all of them are magnified × 10.

FIGS.		PAGE
1-5.	*Yabeina cascadensis* (Anderson). 1, Centered oblique section; 2, sagittal section; 3, 4, axial sections; 5, near-centered tangential section; all topotypes. All from Collection W-1.	61



Thompson, Wheeler and Danner, Permian Fusulinids



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9. RECENT LOSSES TO MICROPALEONTOLOGY: I.

HANS E. THALMANN
Pasadena, California

ADRIANUS JOHANNES COSIJN
(1890-1945)

A. J. Cosijn was born in Zoeterwoude near Leiden, Holland, on November 18th, 1890. He studied under the late Dr. G. A. F. Molengraaff at the Technical University in Delft where he received the degree of mining engineer. After a short time as an employee of the State Central Bureau of Statistics he went to Lausanne (Switzerland) for post-graduate field work under Dr. Maurice Lugeon. In April, 1920, he was employed by the Royal Dutch-Shell Company as a petroleum geologist for field work in Roumania, where he stayed until August, 1923. Although of a strong and healthy constitution, Cosijn apparently became infected with tuberculosis while staying in a Roumanian village, resulting in a complete breakdown of his health. For many years he convalesced in Davos, Switzerland, with the good result that he was able later to move to the good climate at Ronda, Spain, and take up geology again for his own interest.

While in southern Spain, Cosijn became greatly interested in Foraminifera. He assembled large collections of *Cycloclypeus* from the neighborhood of Ronda and Villajoyosa (Oligocene), and *Lepidocyclina* from the Miocene of Jaen, the famous locality where Robert

EXPLANATION OF PLATE 8

All illustrations on this plate are unretouched photographs, magnified × 10, and all of them are from Collection BC-3, except those of figs. 12 and 13, which are from Collection BC-4.

FIGS.		PAGE
1-3.	*Yabeina columbiana* (Dawson). 1, Oblique section; 2, 3, sagittal sections	61
4-7.	*Yabeina minuta* Thompson and Wheeler. 4, Axial section; 5-7, sagittal sections	62
8-10.	*Yabeina?* n. sp. 8, Axial section; 9, 10, sagittal sections.	62
11, 12.	*Schwagerina acris* Thompson and Wheeler. 11, Sagittal section; 12, axial section.	56
13.	*Schwagerina andersoni*? Thompson, Wheeler and Danner, n. sp. Oblique tangential section of a specimen questionably referred to this form. (*See, also,* Plate 4)	55

Douville assembled the materials for his thesis on the Subbetic Prealps in 1906.

After his return to Holland in 1937, and as he was unable to get a position as geologist abroad, Cosijn studied the assemblages of larger Foraminifera in the geological laboratories of the Technical University at Delft under the guidance of Dr. Umbgrove, and at the University of Leiden under Dr. Van der Vlerk. Based on his excellent thesis "Statistical Studies on the Phylogeny of some Foraminifera: *Cycloclypeus* and *Lepidocyclina* from Spain, *Globorotalia* from the East-Indies," he received his Ph.D. at Delft in 1938. In this paper he gave us rich information as to the development of the operculinoid apparatus in *Cycloclypeus,* the development of the size of the proloculus and its relation to the relative age of the *Cycloclypeus*-group, a critical discussion of Tan Sin Hok's results on the same group as geo-chronological indicators in the Neogene of Indonesia, on the morphogenesis of the protoconch in *Lepidocyclina,* and on biometrical examination of *Globorotalia* from the Indonesian Neogene.

For two short periods he again worked for the Royal Dutch-Shell Company on Foraminifera and heavy minerals, and was employed as consulting geologist for a private group in northern Spain. A second highly important and interesting paper was published in 1942, concerning the "Phylogeny of the embryonic apparatus of some Foraminifera" — a short monograph which is a "must" for anyone interested in biometrical analysis and phylogeny of the Foraminifera.

The years of the German occupation of the Netherlands proved fatal for the health of Dr. Cosijn. During the terrible winter famine of 1944-45 his health broke down completely, and the man and scientist, who would have been capable of enhancing and widening our knowledge of the Foraminifera, passed away on February 28th, 1945. He has, however, set himself a lasting monument through his two important papers.

The writer is greatly indebted to Mrs. A. J. Cosijn, Oegstgeest, Holland, for biographical information, and wishes to express, in the name of the fraternity of foraminiferologists, the highest regard for her husband's achievements.

ADOLF FRANKE
(1860-1942)

Dr. h. c. Adolf Franke died during an excursion in Arnstadt, Thuringia, on June 19th, 1942. He was born on August 17, 1860 at Ettischleben near Arnstadt. He successfully passed the teacher's examination in Sondershausen in 1880 and served as teacher in Arnstadt until 1885, then for three semesters studied natural sciences, mathematics, and pedagogy at the University of Jena. From then until his retirement as "Studienrat" in 1925 he taught at different schools and finally in Dortmund at the Woman's Teacher College. After 1925 he lived in Arnstadt, where he assembled and exhibited his large collections of smaller Foraminifera, which he had been collecting since his first publication devoted to Foraminifera and Ostracoda in 1910. Arnstadt became the Mecca of the foraminiferologists, where Dr. Franke put his collections of Foraminifera at the disposal of anyone who wished to obtain first-hand acquaintance with the foraminiferal assemblages of the German Liassic, Jurassic, Cretaceous and Eocene. He was technically skilled in picking and mounting Foraminifera, and was the inventor of the so-called "Franke-slide," which was later on manufactured commercially by Hugo Weise at Kornhochheim.

It is impossible to give here an adequate and well-deserved review of all his foraminiferal publications, and their immense practical value and application. Franke's important papers are listed in the "Catalogue of Foraminifera," vol. 30, 1940. Reference may, however, be made to his classic monographs on the Lower Oligocene Foraminifera of northern Germany (1925), on those of the Pommeranian Cretaceous (1925), his emendations of Beissel-Holzapfel's "Foraminiferen der Aachener Kreide" (1927); on the Paleocene Foraminifera of Denmark (1927); the handbook of the Foraminifera of the Upper Cretaceous of northern and middle Germany (1928); and on the Foraminifera of the German Liassic (1936). His publications on methods, collecting, and preparation of Foraminifera are widely known amongst workers on Foraminifera and Ostracoda. It is to be regretted that his last work on the Foraminifera of the Lower Cretaceous of northern and middle Germany never went to press because of the recent war.

For his splendid pioneer work on the fossil Foraminifera of Germany, Adolf Franke received on May 30th, 1939, the well-deserved Ph.D. honoris causa from the Faculty of Natural Sciences of the University of Jena, at the age of 79.

When paying full tribute to Dr. Franke's scientific achievements in the field of micropaleontology, it should not be overlooked that his foraminiferal studies were done chiefly in his spare-time as a teacher and conrector. For many years he patiently pursued his beloved studies at a time when most of the paleontologists neglected or completely disregarded the Foraminifera, and even believed these fossils to be unfit and valueless for practical stratigraphical purposes.

Besides being an authority on the Foraminifera, Dr. Franke was an excellent teacher, conservator and curator of geological and paleontological collections. He was an expert in museology and his advice was sought by many provincial museums. Moreover, he was highly active in promoting geology as a subject of great educational value in schools and local scientific societies.

The writer deeply regrets the loss of many fine letters received from Dr. Franke while stationed in Palembang (Sumatra). In those letters Dr. Franke had revealed his human character, his love for the Foraminifera and Ostracoda. How happy he was when he was visited by Dr. J. A. Cushman, Dr. Y. Ozawa, Dr. J. Bonnema and others, and what touching words he found when he announced that he had received the honorary doctor's degree from Jena University. Dr. Franke lives forth in his published works, and he may well serve as a excellent example that perseverance and patience afford one of the few ways which lead to great scientific results.

Dr. Franke's name will be recalled to micropaleontologists by the genus *Frankeina* Cushman and Alexander, by the many new species and varieties which he himself erected, and by his two genera, *Saracenella,* 1936, and *Glomerina,* 1929.

ADALBERT LIEBUS
(1876-1945)

I have been unable to ascertain the exact dates of Professor Adalbert Liebus' birth and death. The following biographical data have been assembled with the help of my friend, Dr. Heinrich Hiltermann, Hannover, to whom I herewith express my cordial thanks.

Born in 1876 in a village in Hungary, Adalbert Liebus studied at the German University in Prague, where he became assistant under Prof. G. Laube. He served for many years as teacher, then entered the academic career and about 1929 became a full professor of paleontology at his alma mater. After graduating from the German University in Prague he was for some time connected with the Austrian Geological Survey, where he came into contact with the late Dr. Richard J. Schubert with whom he started work on fossil Foraminifera.

For nearly forty-five years Adalbert Liebus was highly active in the field of micropaleontology, and throughout his life was also interested in the Pleistocene vertebrate paleontology of Slovakia and Bohemia. During and after the First World War he was a prisoner of the Russians in Siberia from where he was released in 1920. During this time he was very active in arranging concerts, lectures and entertainment for his fellow-prisoners in Chabarowsk and Krasnaja Rjecke, and also learned the Russian language which he spoke nearly as fluently as Czechoslovakian.

We micropaleontologists are grateful to Prof. Liebus for his excellent foraminiferal studies of the Miocene of Bavaria (1902), of the Priabonian of Biarritz (1906), the middle Eocene of Dalmatia (1911), Eocene of Carinthia (1927), Tertiary of Albania (1928), lower Carboniferous of Germany (1932), for his notes on the Foraminifera of the Flysch and the Neogene of Moravia, Vienna region, Trieste area, and, most of all, for his excellent and original handbook on the fossil Foraminifera (1931).

Together with R. J. Schubert he published the monograph on the Upper Cretaceous Foraminifera of Hungary (1902), and with H. E. Thalmann compiled the literature on Foraminifera to 1930, which was published as several volumes of the "Fossilium Catalogus," 1933. His last paper on the Triassic Foraminifera of Eberstein was published in the Pal. Zeitschr., vol. 23, 1942. All his papers show painstaking exactness in description of foraminiferal assemblages in relation to their stratigraphic occurrence.

A few years before his death, Dr. Liebus suffered from a bladder ailment, which necessitated his confinement to a hospital in Prague (1943-44). His last year of life must have been unbearable: he lost his wife, was himself gravely ill, had to leave his home and library in the days of revolution shortly after termination of the Second World War, and finally died in great misery.

With Prof. Liebus' passing, Czechoslovakia lost her best authority in the field of micropaleontology. It is to be deplored that nothing is known about the disposition of the excellent private collection of Foraminifera which Liebus brought together in his nearly half a century of devotion to his profession and avocation. All of us who had the fortune to be in contact with this fine scientist and man, or who have used his publications on Foraminifera, will keep a lasting memory of Adalbert Liebus, whom Fate treated so cruelly during his last years of life.

The name of Dr. Liebus will always be recalled by the genus *Liebusella* Cushman, 1933, and by the new species and varieties which he erected, as well as the genera *Plectofrondicularia,* 1903, and *Ellipsodentalina,* 1928.

VICTOR MADSEN
(1865-1947)

Dr. Victor Madsen, born March 2, 1865, and who was intimately connected for 48 years with the Geological Survey of Denmark, first as State Geologist, and then as its Director, died in Kopenhagen on July 16th, 1947. He will be remembered by the micropaleontologists for his studies of Pleistocene Foraminifera.

After studying paleontology at Berlin (1891-92), and Munich (1895-96), he received his Ph.D. degree in 1895. His dissertation was a monograph on the Danish Pleistocene Foraminifera, in which he stressed the value of these microfossils for the age determination of the marine Pleistocene beds, a quarter of a century before the accepted beginning of applied micropaleontology.

Two additional papers on Pleistocene Foraminifera, one in 1896 on the German Pleistocene, and the other in 1900 on the Foraminifera of the Pleistocene of Schleswig-Holstein greatly furthered our knowledge, and thus can be regarded as forerunners of the present day study of Pleistocene Foraminifera in Holland, England, Scandinavia, and Germany.

His other achievements in the fields of glaciology, Pleistocene stratigraphy, geology and morphology of Denmark, his work as cartographer and popularizer of geology throughout Denmark, his interest in literature and languages, and his activity as an organizer of the first systematic geophysical survey of Denmark and as a promoter of test-borings, may only briefly be recorded here. He was endowed with a fine sense of humor, was an excellent speaker at scientific meetings, and a warm friend of the younger generation of Danish geologists who found him ready at any time for counsel and advice. With the passing of Dr. Madsen, Denmark has lost her leading geologist.

(The writer wishes to acknowledge gratefully the assistance of Dr. Th. Sorgenfrei, Copenhague, who kindly furnished biographical data.)

JAROSLAV PERNER
(1869-1947)

Dr. Jaroslav Perner, born at Tynec-nad-Labem in Central Bohemia on April 28th, 1869, was a student at the Charles University at Prague under Prof. O. Novak. He was later for many years keeper of the famous J. Barrande Collection at the National Museum in Prague, and then professor of paleontology at the Charles University, where he received the title of Dr. rer. nat. honoris causa on December 18th, 1937. When he died in Prague on June 9th, 1947, Czechoslovakia lost her leading paleontologist, who, during his long life, was eminently interested first in the Foraminifera, and then in the Graptolites and Gastropods of the Bohemian Silurian and Devonian.

Professor Perner spent some time in the 'Nineties at Mason College, now University of Birmingham, England, under the late Prof. Charles Lapworth, and it is very likely that it was here that he became interested in the fossil Foraminifera. Between 1892 and 1898 he published four very important monographs: the Foraminifera of the Bohemian Cenomanian (1892), a critical list of the Foraminifera of the Priesen-beds of the Bohemian Cretaceous (1893), the Foraminifera of the Weissenburg-beds (1897), and the Foraminifera of the Tithonian of Stramberg (1898).

Perner's name will be recalled to students of Foraminifera by the foraminiferal genus *Pernerina* Cushman, 1933.

The writer is greatly indebted to Dr. Ferdinand Prantl, Prague, for biographical information.

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10. ORIENTED THIN-SECTIONING OF MICROFOSSILS

ROBERT H. CUMMINGS
University of Glasgow, Scotland

The numerous difficulties in preparing accurately oriented thin-sections of the smaller types of microfossils are known to all workers in this field. During research work on the smaller Foraminifera of the Scottish Carboniferous, a method of preparation was evolved which allows for the production of such sections with comparative ease, so much so that nearly all the material handled was accurately cut in the required section. The method may be applied to all branches of micropaleontology.

The procedure adopted in the preparation of the thin-sections of the Foraminifera is summarized below.

1. Moulds, consisting of cardboard boxes, approximately two inches square and of a depth of one inch are prepared. The interior of these boxes should be lined with cellophane paper, which is fastened by gum-tape so that it fits closely to the sides of the boxes.

2. A sufficient quantity of Marco Resin to fill these moulds to the depth of one-half inch is prepared. This "Marco Resin" is manufactured by Messrs Scott Bader and Co., Ltd., 109 Kingsway, London, W. C. 2, and its preparation and uses are fully described in that company's Technical Pamphlet No. 31. This thickness of one-half inch provided rigidity and ease of handling during grinding. After the resin is poured into the moulds, these are covered to prevent dust settling.

3. When the surface of the resin becomes tacky, approximately one hour after preparation, the specimens are placed on the surface, using a low power binocular microscope for their orientation. They may be pressed slightly into the resin. It must be emphasized that the specimens must always be dry. Coating with polyvinol alcohol may be done, but this is not necessary.

4. After the specimens are placed in position and while the surface of the mould is still tacky, a sufficient quantity of resin is poured over the specimens so that they are submerged to a depth of at least one quarter of an inch.

5. After 12 hours the cardboard boxes are broken away from the sides of the master block which is then washed in acetone. The master block is then cut with a small saw so that each specimen is contained separately in a small block of the hard transparent plastic.

6. The surfaces of these specimen blocks are polished, using a high speed lap, to determine accurately the orientation of the contained specimen. The upper surface of the specimen-block, that nearest to the specimen, is ground down until the required plane in the

fossil is reached. For this process the normal agents of fine carborundum and glass plate, followed by glycerine and soft hone, may be used. At this stage it is often advantageous to fill the interior of the specimen with Marco Resin and allow it to harden before the final plane is reached, so that the delicate internal structures can be preserved.

7. The specimen block is trimmed so that the surface for attachment to the glass slide is greater in area than the sides. This has been found to be helpful during the second grinding process. Cleaning with amyl acetate before mounting helps toward perfection in the completed slide.

8. The specimen-block is mounted on the glass slide using Canada Balsam, and is ground down to the required thickness in the usual manner.

9. Staining techniques may be employed at this point.

10. Normal covering of the slide concludes the operation.

The advantages of this method over those normally used are readily discernible. The preparation of the master block in two layers and the time lapse between the first becoming tacky and the pouring of the second, allows for a careful and controlled mounting of the specimens. As the plastic, upon hardening, is transparent, the preliminary plane of grinding of the specimen block can be easily worked out and observed throughout the whole process. In this manner the required section is readily obtained. The thin layer of plastic around the section acts as an indicator of thickness during the second grinding process. Furthermore, the thin layer of plastic binds the specimen and prevents its disruption when the slide is being covered.

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11. CACHE CREEK FUSULINIDS FROM KAMLOOPS, BRITISH COLUMBIA

M. L. THOMPSON AND G. J. VERVILLE
University of Wisconsin, Madison

ABSTRACT—Four species of fusulinids from the upper massive limestone of the Cache Creek section exposed east of Kamloops are described and illustrated as **Parafusulina armstrongi**, n. sp., **P.** sp. A, **Neofusulinella?** sp., and **Codonofusiella?** sp. A. These fusulinids indicate that the upper part of the Cache Creek near Kamloops is of Leonardian or lower Guadulupian age.

INTRODUCTION AND ACKNOWLEDGMENTS

Steeply dipping massive Permian limestones and interbedded volcanic rocks are exposed for about twelve miles on the bluffs above the gravel terraces on the north side of the South Thompson River, east of Kamloops, British Columbia. Although close folding has been observed in these rocks at a number of places (Daly, 1915), the sequence seems to dip eastward at high angles almost continuously for the entire distance. The top of the sequence seems to be at the east edge of the outcrop belt across the South Thompson River from Campbell Creek. The amount of repetition of section due to folding or faulting has not been determined. The majority of workers who have done the stratigraphic work there consider that a large percentage of the section exposed is not repeated by faulting or folding. Dawson (1896) and Daly (1915) have interpreted a great thickness for the entire sequence near Kamloops. Daly estimated from his measurements that it is at least 13,700 feet in thickness.

The highest of our samples came from about 150 feet below the top of the upper massive limestone of the Kamloops section. They contain four fusulinids described and illustrated below as *Parafusulina armstrongi*, n. sp., *P.* sp. A., *Neofusulinella*? sp., and *Codonofusiella*? sp. A. A sample from about 2,450 feet below the top of the sequence contains common specimens of *Parafusulina armstrongi* and abundant specimens of *Codonofusiella*? sp. A. Collections obtained from about 3,150 feet below the top of the sequence contain abundant *Codonofusiella*? sp. A, and another small fusulinid that we are describing as *Staffella* sp.

The genus *Parafusulina* Dunbar and Skinner typifies the fusulinid faunal Zone of *Parafusulina*. One of the most primitive forms of the genus, *P. gracilis* (Meek), is from the lower McCloud limestone of California where it is associated with *Pseudoschwagerina, Schwagerina, Neofusulinella*?, and *Schubertella*. The lower McCloud limestone is considered Wolfcampian in age, and it is probably uppermost Wolfcampian. *P. gracilis* evidently is a primitive form of the genus, for it has thick spirotheca and narrow cuneculi. The upper limit of *Parafusulina* in America seems to correspond to the base of the Guadalupian Zone of *Polydiexodina*.

The species of *Parafusulina* in the Cache Creek group at Kamloops, *P. armstrongi*, n. sp., and *P.* sp. A have thin spirotheca, tightly coiled shells, and heavy axial fillings. Their shell features compare favorably with those of forms from America and China that are considered to be Leonardian or slightly younger in age.

Parafusulina armstrongi and *P.* sp. A resemble in the general shell features *P. wanneri* (Schubert) from the Permian of Timor, *P. kattaensis* (Schwager) from the Lower *Productus* limestone of India, and *P. caracorumensis* (Merla) from Caracorum. They possibly are closely equivalent in age. *P. caracorumensis* occurs in the middle fusulinid-bearing beds of Caracorum and below the upper white limestones that contain a primitive verbeekinid fauna. Reichel (1940) considers *P. caracorumensis* as lower Artinskian in age.

The form here referred with question to *Neofusulinella,* from about 150 feet below the top of the Kamloops section, is congeneric with *N.? occidentalis* Thompson and Wheeler from the lower part of the McCloud limestone of California and *N.? montis* Thompson and Wheeler from the upper part of the McCloud. The former is associated with fusulinids typical of the Wolfcampian. However, the latter form is associated with large forms of *Pseudofusulina* that are considered to be probably of Leonardian age. The generic group to which these forms belong may have a long stratigraphic range.

The small fusulinid from 3,150 feet below the top of the Kamloops section here illustrated as *Staffella* sp. resembles forms that have been described from the lower part of the Oklan Series of Texas as *S. expansa* Thompson, from rocks of the same general age in New Mexico as *S. depressa* Thompson and *S. powwowensis* Thompson; from lower Leonardian rocks of Chiapas as *S. centralis* Thompson and Miller, and from rocks possibly of Guadalupian age in Venezuela as *S.* sp. Thus it is evident that *Staffella* has a very long stratigraphic range in America. None of its forms has been found to be of much value for detailed age determinations.

A very minute and extremely abundant fusulinid was obtained from 150, 2,450, and 3,150 feet below the top of the Kamloops section and is here referred with question to *Codonofusiella.* Its generic affinities are uncertain, and it has no value at this time for age determinations.

All of the samples used in the preparation of this report were collected in 1946 by Paul Adams and Richard Markley to whom we wish to express our sincere thanks. Financial support for the completion of this study was given by the University of Wisconsin Research Committee from funds furnished by the Wisconsin Alumni Research Foundation.

SYSTEMATIC PALEONTOLOGY

Family FUSULINIDAE

Subfamily OZAWAINELLINAE

Genus **Staffella** Ozawa, 1925

Staffella sp.

Plate 9, figure 12

We have several small samples collected from about 3,150 feet below the top of the section east of Kamloops that contain abundant specimens of a small subspherical to subdiscoidal fusulinid that is similar in many respects to the genotype species of *Staffella* Ozawa. All our specimens seem to be largely mineralized and replaced.

We have two axial sections that contain five volutions and are about 0.37 mm. long and 0.83 mm. wide, giving a form ratio of about 0.44. The axial areas of all volutions are slightly umbilicate, and the central surfaces of all volutions are narrowly rounded. The detailed structures of the spirotheca and septa were not determined, but the spirotheca seems to contain a rather thick layer in which no structures were observed. The septa are plane.

Proloculus about 43 microns in outside diameter. Heights of chambers in first to fifth volution of one specimen about 30, 50, 90, 90, and 100 microns, respectively. Tunnel wide. Massive chomata occur in all volutions of our sections. Tunnel side of chomata steep, lateral slopes low. Chomata extend about half the distance from tunnel to axis of coiling.

Remarks—The specimens here referred with questions to *Staffella* are smaller than most forms referred to this genus. In general shape they resemble *S. expansa* Thompson from the Marble Falls limestone of Texas and *S. powwowensis* Thompson from the Apodaca formation of New Mexico. Both of these forms are much larger than our specimens.

Forms of *Staffella* have not been recognized as diagnostic stratigraphic markers. The genus seems to range throughout most of the Pennsylvanian and Permian.

Occurrence—*Staffella* sp. is abundant about 3,150 feet below the top of the massive limestone of the Cache Creek group east of Kamloops where it is associated with abundant specimens referred below to *Codonofusiella?* sp.

Subfamily SCHUBERTELLINAE

Genus **Codonofusiella** Dunbar and Skinner, 1937

Codonofusiella? sp. A

Plate 9, figures 16-19

A large number of specimens of a very minute fusulinid occur in samples from 150, 2,450, and 3,150 feet below the top of the Cache Creek at Kamloops, which are too poorly preserved for definite generic identification. These specimens obviously contain three to four volutions and are at least 0.25 to 0.43 mm. long and 0.14 to 0.23 mm. wide. Seemingly the first few volutions are coiled at a large angle to the outer volutions. Our largest shells are fusiform in shape. The septa are intensely fluted.

Remarks—This form is referred to Codonofusiella with considerable question. Its fluted septa eliminate the possibility that it belongs to *Schubertella.* An uncoiled late stage as found in *Codonofusiella* has not been observed. It may be referable to *Boultonia* Lee.

Occurrence—This form is associated with *Parafusulina armstrongi*, n. sp., *P*. sp. A, and *Neofusulinella*? sp. about 150 feet below the top of the section east of Kamloops, with *P. armstrongi* 2,450 feet below the top, and with *Staffella* sp. 3,150 feet below the top of the Cache Creek limestone east of Kamloops.

Genus **Neofusulinella** Deprat, 1912

Neofusulinella? sp.

Plate 9, figures 13-15

We have obtained only two sections of *Neofusulinella* sp. that pass through the proloculus, and they are both only partly preserved. In addition to these two sections, several sections are oriented obliquely and show the septal fluting and general shape. The following description is based on all our material. Shell small, elongate fusiform; with sharply pointed poles, highly inflated central area, concave lateral slopes, straight axis of coiling. One of our largest specimens of eight and a half volutions is 6.4 mm. long, 1.9 mm. wide, giving a form ratio of 3.4. Form ratios of first to sixth volution of same specimen about 2.3, 2.0, 2.2, 2.5, 2.3, and 2.0, respectively. The other section that passes through the proloculus seems to be more highly inflated than the one from which the above ratios were obtained.

Proloculus small, with outside diameter of 135 microns. Heights of chambers of first to seventh volution about 27, 43, 44, 76, 120, 122, and 143 microns, respectively.

Spirotheca thin, composed of a tectum and a less dense lower layer. Alveoli have not been observed. Poleward from tunnel, tectum covered by a thick layer that is similar in density to the chomata. Spirotheca of first to seventh volution of one specimen measures about 10, 16, 18, 20, 23, 26, 30, 35, and 40 microns, respectively.

Septa closely spaced, almost plane in central part of the shell, rather broadly fluted almost to tops of chambers in polar areas.

Tunnel almost circular in cross section in inner three to four volutions, broad and low in outer volutions. Chomata very high, massive. Tunnel sides of chomata steep, poleward slopes somewhat lower, more than half as high as chambers.

Remarks—The specimens described above as *Neofusulinella*? sp. resemble *N.*? *occidentalis* Thompson and Wheeler more closely than any other form. However, they are more elongated than that species, are larger for corresponding volutions, have less massive chomata in the inner volutions, and have wider tunnel angles.

Occurrence—The specimens here referred to *Neofusulinella*? sp. are from about 150 feet below the top of the Cache Creek rocks exposed on the north side of the South Thompson River east of Kamloops, where they are associated with *Parafusulina armstrongi*, n. sp., *P*. sp. A, and *Codonofusiella*? sp. A.

Subfamily SCHWAGERININAE

Genus **Parafusulina** Dunbar and Skinner, 1931

Parafusulina amstrongi Thompson and Verville, n. sp.

Plate 9, figures 1-7

Shell small, highly elongate subcylindrical; with bluntly rounded poles, straight to broadly curving axis of coiling. Our largest specimen, the holotype, of seven volutions about 5.9 mm. long, 2.0 mm. wide, giving form ratio of about 3.0. Shell elongate and slender throughout growth. Form ratios of first to seventh volution of holotype about 2.5, 2.9, 3.4, 3.5, 3.7, 3.6, and 3.6, respectively.

Proloculus small, ellipsoidal, with outside diameter of about 115 microns. Shell tightly coiled for first three to four volutions. Chambers increase in height rather rapidly in fourth to sixth volution, increase in height slowly from sixth volution to maturity. Heights of chambers in first to seventh volution of holotype and of a typical sagittal section about 30, 45, 55, 80, 110, 165, and 215 microns, respectively.

Spirotheca very thin in inner three volutions and apparently composed of a structureless layer. In outer volutions it is composed of a tectum and a distinctly alveolar layer. Thickness of spirotheca in first to seventh volution about 8, 18, 19, 27, 28, 36, and 40 microns, respectively. Proloculus wall too thin to measure accurately.

Septa thin, closely spaced, fluted throughout length but most sharply fluted in lower surfaces. Although fluting extends to tops of septa, closed chamberlets extend only about one-third height of chambers. Tangential sections do not display cuneculi. Septal counts of first to fifth volution 11, 14, 17, 21, and 23, respectively.

Tunnel wide, low. Our specimens are all crushed or faulted through the tunnel, and tunnel angle cannot be measured accurately. Axial areas filled with dense calcite for about one-third distance from axis of coiling to borders of tunnel, except in last volution. Small irregular chomata occur in inner six volutions.

Remarks—*Parafusulina armstrongi*, n. sp. can be distinguished from *P*. sp. A by its thinner spirotheca, more slender shell, more tightly coiled shell, and thinner proloculus wall.

This form is somewhat questionably assigned to *Parafusulina*. The shell shape, spirothecal thickness and structure, axial fillings, and septal fluting resemble those of typical forms of *Parafusulina* more closely than those of other genera.

The species is named in honor of Dr. J. E. Armstrong who has contributed much to a better understanding of the Permian of British Columbia.

Occurrence—*Parafusulina armstrongi*, n. sp., is common in our samples from the upper massive limestone of the section across the river from Campbell Creek and about twelve miles east of Kamloops where it is associated with *Parafusulina* sp. A, *Codonofusiella*? sp. A, and *Neofusulinella*? sp. 150 feet below the top of the limestone and with *Codonofusiella*? sp. A 2,450 feet below the top of the limestone.

Parafusulina sp. A

Plate 9, figures 8-11

All the specimens here referred to *Parafusulina* sp. A are either submature or were nearly destroyed during the preparation of the thin sections. Larger specimens of at least seven volutions at least 2.5 mm wide, 10 mm long. Form ratio of first to fourth volution of one specimen 3.1, 2.9, 3.3, and 4.7, respectively.

Proloculus large, spherical, with outside diameter of 185 to 250 microns. Heights of chambers in first to seventh volution about 40, 60, 90, 125, 220, 225, and 365 microns, respectively.

Spirotheca distinctly alveolar. Thickness in first to seventh volution about 15, 24, 30, 42, 52, 75, and 94 microns, respectively. Proloculus wall structureless, about 30 microns thick.

Septa very narrowly and highly fluted throughout length. Closed chamberlets extend at least half the height of chambers. Regular fluting pronounced, even to tops of septa.

Tunnel relatively wide. Its angle cannot be determined in our specimens. Axial areas filled with dense calcite for at least one-fourth the distance from poles to tunnel.

Remarks—Not enough information is available from our specimens of *Parafusulina* sp. A for specific comparison with previously described forms. However, they differ considerably from *P. armstrongi*, n. sp., in having a thicker proloculus wall, thicker septa, more inflated chambers, thicker spirotheca, shorter axis of coiling in the inner volutions, and more highly fluted septa.

Occurrence—*Parafusulina* sp. A is from about 150 feet below the top of the upper massive limestone of the Cache Creek group exposed on the north bluff of the South Thompson River east of Kamloops where it is associated with *Parafusulina armstrongi*, n. sp., *Neofusulinella*? sp., and *Codonofusiella*? sp. A.

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12. SOME TERTIARY FORAMINIFERA FROM VICTORIA, AUSTRALIA[1]

IRENE CRESPIN
Bureau of Mineral Resources
Canberra, Australia

A detailed stratigraphic and micropalaeontologic investigation of the cliff sections along the southern coastline of Victoria between Torquay, 60 miles southwest of Melbourne and Anglesea, nine miles southwest of Torquay, has been completed by H. G. Raggatt and the writer and the results will be published shortly.

1. Published with the permission of the Director of the Bureau of Mineral Resources, Geology and Geophysics.

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FIGS.	All illustrations on this plate are unretouched photographs.	PAGE
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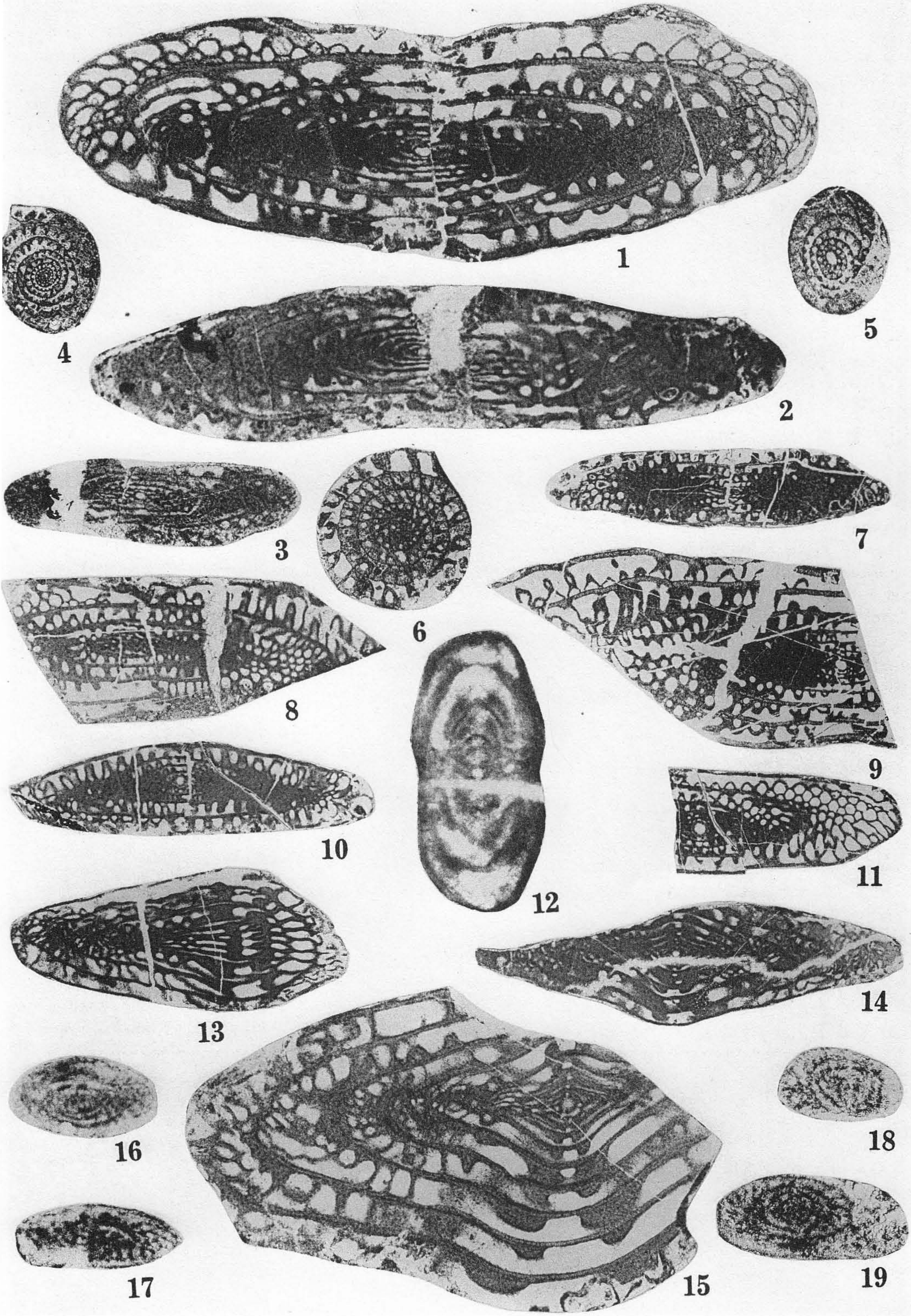
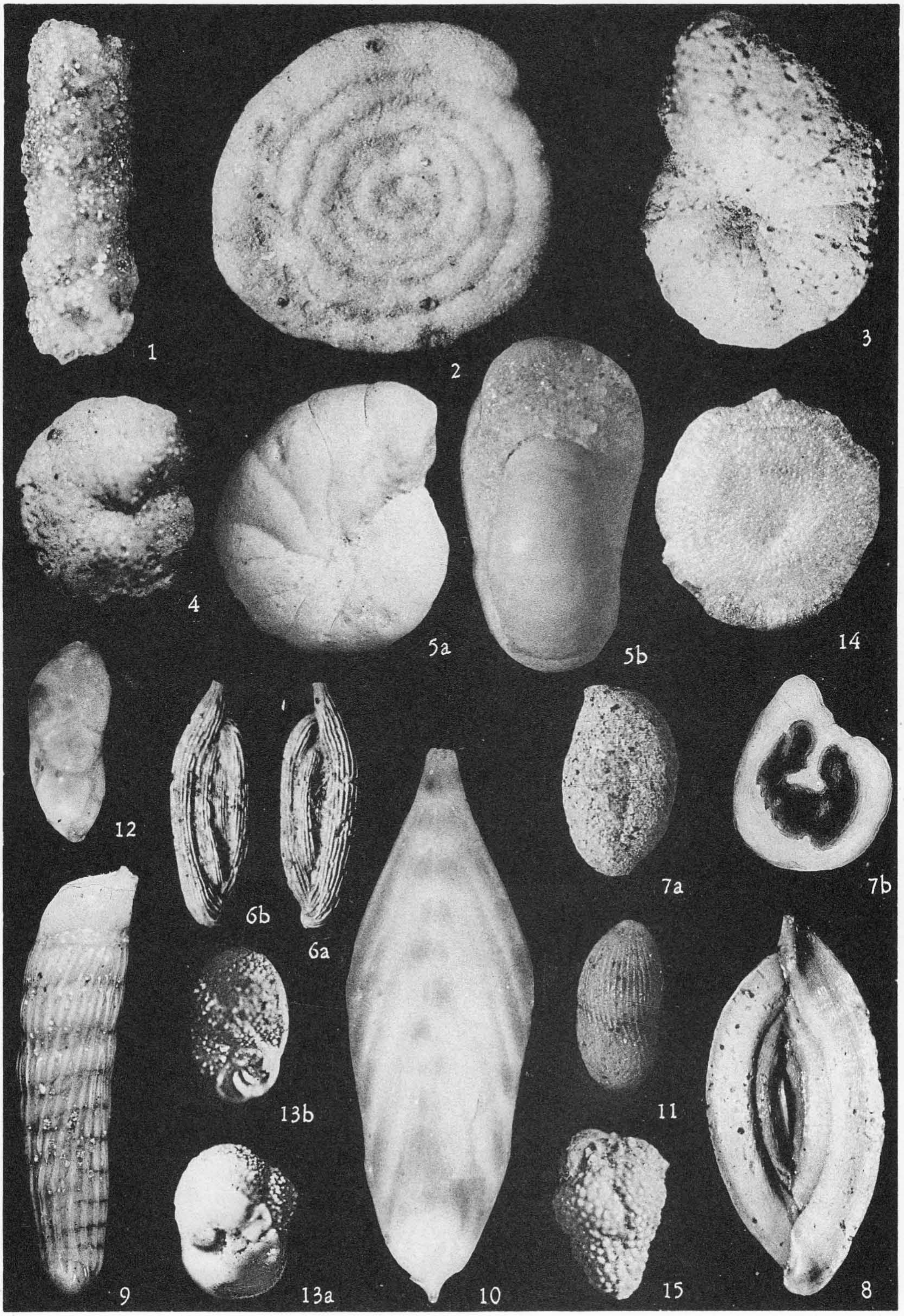


Thompson and Verville, Cache Creek Fusulinids



Crespin, Australian Tertiary Foraminifera

The study of the microfaunas in the sediments has yielded considerable information about the stratigraphic range of the foraminiferal species and it has been possible to determine the restricted vertical range of certain species. The area studied includes the type locality for the Anglesean Stage at Demon's Bluff, two miles east of Anglesea and the overlying Janjukian Stage which has its type locality in the basal portion of the Bird Rock cliffs, one and a half miles southwest of Torquay. The Anglesean Stage is considered to be Oligocene and the Janjukian, Lower Miocene.

The Foraminifera vary considerably both generically and specifically in the Janjukian. However, a small group of species including some new forms have been found to have a restricted vertical range and these are herein described.

In Anglesean times, conditions of sedimentation were uniform over a wide area of southern Victoria and the distinctive dark brown to grey and purplish lignitic siltstones and sandy clays can be readily recognized. The genus *Cyclammina* dominates the Anglesean assemblage; this form alone occurs in the majority of samples examined.

The late F. Chapman was the first to publish any detailed description of the Foraminifera from the Janjukian and Anglesean deposits. The Anglesean Foraminifera were described by him in 1904 from Brown's Creek, west of Anglesea and in 1921 he described Janjukian species from a bore at Torquay which was drilled at the base of the Bird Rock Cliff. Some of the species recognized by Chapman have important zonal significance. The late Dr. J. A. Cushman also described some small forms from the Torquay area (1936).

Six new species are described below, namely *Bathysiphon angleseaensis* from the Anglesean Stage at Demon's Bluff, *Quinqueloculina singletoni, Quinqueloculina ornithopetra, Frondicularia victoriae* and *Dimorphina janjukensis* from the Janjukian Stage in the vicinity of Bird Rock, Parish of Jan Juc, and one species *Ammodiscus parri* from the Janjukian in a bore in Gippsland, south-eastern Victoria. Although described from the Janjukian, this last species occurs in the Anglesean at Demon's Bluff. Eight other species are discussed and figured because of their importance in the Anglesean and Janjukian assemblages, and because some of them have not been figured elsewhere since they were originally described.

All types are in the Commonwealth Paleontological Collection at Canberra. The excellent photographs were taken at the Bureau of Mineral Resources by Stuart Edgell and the manuscript was kindly checked by Mr. A. C. Collins.

SYSTEMATIC DESCRIPTIONS

Genus **Bathysiphon** M. Sars, 1872

Bathysiphon angleseaensis Crespin, n. sp.

Plate 10, figure 1.

Test slender, elongate, cylindrical; wall coarse, rough, composed of clear sand grains and amorphous material; aperture large, at ends of test. Length 2.7 mm; breadth 0.9 mm.

Holotype (Comm. Pal. Coll. No. 656) from Oligocene (Anglesean) lignitic siltstone at Demon's Bluff, Anglesea, Victoria.

All specimens of this species appear as fragments. It is usually associated with numerous tests of *Cyclammina* at the type locality and elsewhere in the Anglesean.

Genus **Ammodiscus** Reuss, 1862

Ammodiscus parri Crespin, n. sp.

Plate 10, figure 2.

Test free, consisting of a small proloculum and a long undivided second chamber wound in five regular convolutions; all closely coiled, the last coil being rather broader than the others; periphery rounded; central portion of each face slightly depressed; sutures distinct, depressed; wall thick, arenaceous, white, smooth; aperture semicircular, depressed. Diameter 3.8 mm.

Holotype (Comm. Pal. Coll. No. 643) from Lower Miocene (Janjukian) siltstones in No. 1 Bore, Parish

EXPLANATION OF PLATE 10

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of Bengworden South, Gippsland, Victoria at 2,538 feet.

This species is common in the lower part of the Janjukian and in the upper part of the Anglesean Stages in a group of deep bores in Gippsland, southeastern Victoria and the broken specimens in the Anglesean beds at Demon's Bluff seem to be referable to it. Parr collected this species from the Balcombian marls overlying the *Lepidocyclina* limestone in the Batesford Quarry near Geelong. The tests are frequently large but the majority of them are slightly distorted. *A. parri* has some relationships with *A. finlayi* described by Parr from the Awamoan beds of New Zealand. The present species is more closely and more evenly coiled than the New Zealand form.

The species is named in honor of the late W. J. Parr who suggested to the author some years ago that the Victorian form was possibly a new species.

Genus **Cyclammina** H. B. Brady, 1876

Cyclammina incisa (Stache)

Plate 10, figure 3.

Haplophragmium incisum STACHE, 1864, Novara Exped. Geol. Theil, vol. 1, p. 165, pl. 21, fig. 1.

Cyclammina incisa CHAPMAN, 1926, Geol. Surv. N. Z. Pal. Bull., No. 11, p. 29, pl. 2, fig. 1; Chapman and Crespin, 1932, Bur. Min. Res. Bull. No. 1, pl. 1, fig. 6.

This species, described by Stache from the Eocene of New Zealand, is common in the Oligocene siltstones at Demon's Bluff, Anglesea. It is apparently a widespread species in the Oligocene and Lower Miocene rocks throughout the world; it is common in the Anglesean Stage in southeastern Australia and in some Janjukian beds especially in deep bores in Gippsland. Some specimens from the siltstones at a headland southwest of Point Addis and east of Anglesean measure up to 5 mm in diameter. Diameter of figured specimen, 2.8 mm.

Plesiotype (Comm. Pal. Coll. No. 644) from the Oligocene (Anglesean) siltstones at Demon's Bluff, Anglesea, Victoria.

Cyclammina paupera Chapman

Plate 10, figure 4.

Cyclammina paupera CHAPMAN, 1904, Rec. Geol. Surv. Vict., vol. 1, pt. 2, p. 229, pl. 22, fig. 6.

Chapman described this species from brown siltstones at Brown's Creek, west of Anglesea, which are Anglesean in age. The species is moderately common at Demon's Bluff and the size is similar to that of the type, which is 1.6 mm.

Plesiotype (Comm. Pal. Coll. No. 645) from the Oligocene (Anglesean) siltstones at Demon's Bluff, Anglesea, Victoria.

Cyclammina rotundata Chapman and Crespin

Plate 10, figures 5, 5a.

Haplophragmium latidorsatum CHAPMAN (non Brady), 1904, Rec. Geol. Surv. Vict., vol. 1, pt. 2, p. 227, pl. 22, fig. 1.

Cyclammina rotundata CHAPMAN and CRESPIN, 1930, Proc. Roy. Soc. Vict., vol. 43, pt. 1, (n. s.) p. 96, pl. 5, figs. 1, 2.

Cyclammina rotundata was described from Janjukian marls in No. 1 Bore, Parish of Bumberrah, Gippsland, at the depth of 1,295 feet. The specimen figured herein is from the type locality for the Anglesean Stage where it is moderately common. The test is slightly more rotund than the type and the sutures are more distinct. Diameter of figured specimen 2.3 mm; thickness 1.0 mm.

Plesiotype (Comm. Pal. Coll. No. 646) from the Oligocene (Anglesean) siltstone, Demon's Bluff, Anglesea, Victoria.

Genus **Quinqueloculina** d'Orbigny, 1826

Quinqueloculina singletoni Crespin, n. sp.

Plate 10, figures 6, 6a.

Test elongate, fusiform, slender, rounded on end view, both ends of the chambers extending beyond the previous ones; three times as long as broad; chambers distinct, very elongate, semicircular in transverse section; periphery rounded; wall ornamented with fine longitudinal costae running parallel for the entire length of chambers; fourteen shown on last chamber; deep grooves between costae: four chambers visible on dorsal surface; aperture circular at the end of a projecting neck. Length 2.0 mm; greatest width 0.7 mm.

Holotype (Comm. Pal. Coll. No. 648) from Lower Miocene (Janjukian) grey marls at base of Bird Rock Cliff, Torquay, Victoria.

Chapman apparently referred this beautiful species to *Spiroloculina grata* Terquem in his paper of the Torquay Bore (1921) but it differs from that species in many respects. The closest resemblance is with *Triloculina mississippiensis* described by Cushman (1935) from the Lower Oligocene at Pearl River, Byram, Miss. *Q. singletoni* lacks the fine rectangular pits in the grooves between the costae in *T. mississippiensis* but the general features are similar. This species is restricted to the type locality for the Janjukian Stage and is a good index form for the marly beds at Bird Rock, Fisherman's Steps and Deadman's Gully, two localities west of Bird Rock.

Q. singletoni is named in honor of the late Professor F. A. Singleton who, at the time of his death, was actively engaged in a detailed study of the megafossils at Bird Rock, Torquay.

Quinqueloculina ornithopetra Crespin, n. sp.

Plate 10, figures 7a, b.

Test elongate ovate, twice as long as broad; periphery chiefly rounded but slightly keeled towards posterior end; three chambers visible on the slightly convex dorsal surface and two on the flat ventral side; sutures indistinct; wall covered with outer layer of moderately coarse sand grains with a smooth finish; inner layer calcareous; aperture moderately large, rounded, with a strong bifid tooth. Length 2.1 mm; greatest width 1.3 mm.

Holotype (Comm. Pal. Coll. No. 647) from Lower Miocene (Janjukian) grey marl at the base of Bird Rock Cliff, Torquay, Victoria.

Q. ornithopetra is a distinctive form among the Victorian Tertiary Foraminifera. However, it shows a general resemblance to *Triloculina garretti* Howe (1939) from the Eocene of Cook Mountain, Louisiana, but differs from that species in the presence of a strong bifid tooth in the Victorian form.

Genus **Massilina** Schlumberger, 1893

Massilina torquayensis (Chapman)

Plate 10, figure 8.

Spiroloculina torquayensis CHAPMAN, 1921, Rec. Geol. Surv. Vict., vol. 4, pt. 3, p. 320, pl. 51, figs. 1, 2.
Massilina torquayensis CRESPIN, 1943, Bur. Min. Res. Bull. No. 4, in lists.
Spiroloculina torquayensis CUSHMAN, 1944, Cushman Lab. Foram. Res., Spec. Publ. No. 11, p. 26, pl. 4, fig. 27.

The specimen figured here is a gerontic form but the characteristic sulcated dorsal and ventral surfaces, square but slightly concave edges and the finely striated surfaces are clearly shown. This species is restricted to the Janjukian Stage throughout southeastern Australia. It is moderately common in the basal beds at Bird Rock but it is rare elsewhere. The holotype came from the depth of 13-14 feet in the Torquay Bore near Bird Rock. Length of test 3.3 mm; greatest width 1.4 mm.

Plesiotype (Comm. Pal. Coll. No. 649) from Lower Miocene (Janjukian) marls at the base of Bird Rock Cliff, Torquay, Victoria.

Genus **Vaginulinopsis** Silvestri, 1904

Vaginulinopsis gippslandicus (Chapman and Crespin)

Plate 10, figure 9.

Vaginulina gippslandica CHAPMAN and CRESPIN, 1930, Proc. Roy. Soc. Vict., vol. 43, pt. 1, pl. 5, fig. 5; CRESPIN, 1943, Bur. Min. Res. Bull. No. 4, in lists.

The type specimen of this handsome species is refigured here. It was described from a bore in Gippsland. It is typical of the Janjukian deposits in that area but is rare in the beds at the type locality for the Stage. It has been found in deep bores in southwestern Victoria.

Holotype (Comm. Pal. Coll. No. 19) from Lower Miocene (Janjukian) marls at the depth of 180 feet in No. 3 Bore, Parish of Glencoe, Gippsland, Victoria.

Genus **Frondicularia** Defrance, 1824

Frondicularia victoriae Crespin, n. sp.

Plate 10, figure 10.

Test typically elongate, small, compressed; periphery truncate; initial end with a single short spine attached to the rounded proloculum; early portion increasing in width until about the upper third of the test where it tapers rapidly towards the apical end; chambers eight, distinct, uniform in length; sutures distinct, thickened especially towards the median line but not raised; wall smooth, except for four strong costae on the proloculum; aperture small, at the end of a slender neck. Length 1.2 mm; greatest width 0.42 mm.

Holotype (Comm. Pal. Coll. No. 651) from Lower Miocene (Janjukian) marls in cliff section between Fisherman's Steps and Bird Rock, Torquay, Victoria.

F. victoriae is quite distinct from *F. lorifera* described by Chapman (1913) from the Middle Miocene beds in the Mallee Bores, Victoria. The sutures in *F. victoriae* are not raised and the test is not ovate in shape. Its shape, type of sutures and costate proloculum, however, are similar to *F. verneuiliana* d'Orbigny of the Upper Cretaceous of Europe and elsewhere.

Genus **Dimorphina** d'Orbigny, 1826

Dimorphina janjukensis Crespin, n. sp.

Plate 10, figure 11.

Test subcylindrical, short, initial portion triserial, rather indistinct, later two chambers uniserial; almost circular in transverse section; test covered with fine longitudinal but slightly oblique costae which radiate from the center of the rounded initial portion; sutures indistinct, at right angles to the axis; aperture radiate, central. Length 1.4 mm; greatest width 1.7 mm.

Holotype (Comm. Pal. Coll. No. 650) from Lower Miocene (Janjukian) grey marl at base of Bird Rock Cliff, Torquay, Victoria.

This species is most probably the one referred to by Chapman (1921) as *Nodosaria comata* Batsch in his description of the Foraminifera from the Torquay Bore. The triserial arrangement of the initial chambers followed by two uniserial chambers place it in the comparatively rare genus *Dimorphina*. It has been difficult to obtain a section of a test as most of them are filled with glauconite. There does not seem to be any described species of the genus with which *D. janjukensis* can be compared. The species is restricted to the Janjukian Stage.

Genus **Bulimina** d'Orbigny, 1826

Bulimina pupula Stache

Plate 10, figure 12.

Bulimina pupula STACHE, 1864, Novara Exped., Geol. Theil, vol. 1, p. 265, pl. 24, fig. 13 (non d'Orbigny).
Bulimina ovata CHAPMAN, 1926, Geol. Surv. N. Z. Pal. Bull., No. 11, p. 39, pl. 5, figs. 13, 14.
Bulimina pupula CRESPIN, 1943, Bur. Min. Res. Bull. No. 4, in lists.

This species is restricted to the Janjukian rocks in southeastern Australia and is fairly common in the Torquay section. Stache's figure of his New Zealand species seems to be distinct from *B. ovata* d'Orbigny in that the chambers are less inflated than in that species. Parr also agreed that these two species are distinct. Length 1.1 mm; width 0.45 mm.

Plesiotypes (Comm. Pal. Coll. No. 652) from Lower Miocene (Janjukian) marls in the cliff section between Fisherman's Steps and Bird Rock, Torquay, Victoria.

Genus **Lamarckina** Berthelin, 1881

Lamarckina glencoensis Chapman and Crespin

Plate 10, figures 13a, b.

Lamarckina glencoensis CHAPMAN and CRESPIN, 1930, Proc. Roy. Soc. Vict., vol. 43, pt. 1, (n. s.) p. 99, pl. 5, figs. 11, 12; CRESPIN, 1943, Bur. Min. Res. Bull. No. 4, in lists.

This species is characteristic of the Janjukian assemblages and is restricted to that Stage. The holotype is refigured here. Greatest length 0.95 mm; width 0.77 mm; greatest thickness, 0.68 mm.

Holotype (Comm. Pal. Coll. No. 23) from Lower Miocene in No. 3 Bore, Parish of Glencoe, Gippsland, Victoria at the depth of 100 feet.

Genus **Sherbornina** Chapman, 1922

Sherbornina atkinsoni Chapman

Plate 10, figure 14.

Sherbornina atkinsoni CHAPMAN, 1922, Journ. Linn. Soc. Zool., vol. 34, p. 501, pl. 32, figs. 1-5; CRESPIN, 1946, Trans. Roy. Soc. S. Aust., vol. 70, pt. 2, p. 300.

Some workers are inclined to place the genus *Sherbornina* in the synonomy of *Cycloloculina* but recent investigations by the author support Chapman's type description in which he gives the distinction between *Sherbornina* and *Cycloloculina*. *S. atkinsoni* was originally described from the Janjukian beds at Table Cape, Tasmania and it is restricted to the Janjukian in southeastern Australia. It is exceedingly rare in Gippsland but it is common at localities west of the type section for that Stage at Bird Rock, Torquay. With *Victoriella plecte,* which is described below, it is a valuable zonal species as it persists in both argillaceous and calcareous sediments. It is commoner in the calcareous sediments where the tests are usually larger and more numerous. Diameter of figured specimen, 1.2 mm.

Plesiotype (Comm. Pal. Coll. No. 654) from Lower Miocene (Janjukian) at Bell's Headland west of Torquay, Victoria.

Genus **Victoriella** Chapman and Crespin, 1930

Victoriella plecte (Chapman)

Plate 10, figure 15.

Carpenteria proteiformis Goes var. *plecte* CHAPMAN, 1921, Rec. Geol. Surv. Vict., vol. 4, pt. 3, p. 300, pl. 51, fig. 3.
Victoriella plecte CHAPMAN and CRESPIN, 1930, Proc. Roy. Soc. Vict., vol. 42, pt. 2, p. 110, pl. 7, figs. 1-4.

Victoriella plecte is characteristic of the beds throughout southeastern Australia which are regarded as belonging to the Janjukian Stage. It is an invaluable zonal species because of its adaptability to facies changes. It thrived equally well in calcareous and argillaceous sediments. The figured specimen comes from the basal beds at Bird Rock Cliff, close to the site of the Torquay Bore from which Chapman (1921) described *Carpenteria proteiformis* var. *plecte. V. plecte* has been found at considerable depths in bores in southeastern and southwestern Victoria. Length of figured specimen 2.1 mm; greatest width 1.6 mm.

Plesiotype (Comm. Pal. Coll. No. 655) from Lower Miocene (Janjukian) marls in basal bed, Bird Rock Cliff, Torquay, Victoria.

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13. SOME LITUOLIDAE FROM THE TERTIARY OF JAPAN

KIYOSHI ASANO
Institute of Geology and Paleontology,
Tôhoku University, Sendai, Japan

ABSTRACT.—Some species of the Family Lituolidae are described; they are characteristic of the Oligocene and Middle or Lower Miocene formations of Japan, but absent in the Pliocene. **Haplophragmoides renzi, Cribrostomoides kyushuense** and **Cyclammina japonica** are described as new.

INTRODUCTION

In a previous paper (Asano, 1949a), attention was drawn to the stratigraphic distribution of the genus *Cyclammina* in the oil-fields of Japan. Since then, additional records of the genus in other regions of Japan have accumulated, and together with a revision of Japanese forms they are herein reported. Several species of *Haplophragmoides* and *Cribrostomoides,* which occur in association with *Cyclammina* are here recorded.

The above mentioned Foraminifera are characteristic Oligocene and Miocene forms of Japan, and do not occur in the Pliocene. The same limited occurrence is recognized in New Zealand (Stache, Chapman, Finlay), Java, Sumatra (LeRoy), Venezuela (Renz), the Dominican Republic (Bermudez) and in the Pacific regions of North America (Kleinpell).

Cyclammina incisa (Stache) is a common Oligo-Miocene species of the Circum-Pacific region and occurs abundantly in the Tertiary formations of Japan. The Poronai Shale formation in Hokkaidô and the Asagai Sandstone formation in the Jôban Coal-field contain many typical specimens of this species and are considered to be Zemorrian in age from their foraminiferal assemblage (Asano, 1949b). Other records of *C. incisa* in Japan belong to the Middle or Lower Miocene, and it is associated with *Desmostylus* or *Miogypsina* and *Operculina.* The Masuhoro formation of Chishiya in Hokkaidô, the Shiiya and Teradomari formations of the Niigata Oil-field, the Hon-ya Shale in the Jôban Coal-field, the Tsuyama formation in the Tsuyama Basin of Okayama Prefecture and the Tsuma formation of Miyazaki Prefecture comprise the most dominant zone of this species in the Miocene of Japan.

Cyclammina japonica n. sp., which often is as large as 6.0 mm in diameter, is very characteristic of the horizon of *Desmostylus* in Japan, occurring from the Masuhoro formation in Hokkaidô, Hon-ya and Kameno-o formations in the Jôban Coal-field, Funakawa and Teradomari formations in the Oil-fields of the Japan Sea coast area, Gembi formation of Iwate Prefecture, Kuzumine formation of Miyagi Prefecture and in the Kozu formation of Fukushima Prefecture. Other species of the Lituolidae are also usually present with *Cyclammina* but do not seem to be as important in bio-stratigraphy as *Cyclammina,* as their specimens are usually deformed and of comparatively smaller size.

The writer wishes to offer his thanks to Dr. K. Hatai of the Institute of Geology and Paleontology, Tôhoku University, for his cooperation concerning the manuscript. Thanks are also due to Messrs. S. Hanzawa, W. Hashimoto, K. Suyari, T. Kano, K. Ishikawa, N. Kitamura, Y. Kamada, S. Murata and T. Arakawa for kindly donating material for this study.

LOCALITIES OF LITUOLIDAE IN THE TERTIARY OF JAPAN

HOKKAIDÔ

Chishiya, Soya-gun; Masuhoro formation, Miocene. Coll. by W. Hashimoto.

Ikushumbetsu, Mikasayama-mura, Sorachi-gun; Poronai Shale, Oligocene. Coll. by K. Asano.

Momijiyama, Yubari-machi, Yubari-gun; Momijiyama formation, Oligocene. Coll. by K. Asano.

Shimizu-zawa, Yubari-machi, Yubari-gun; Poronai Shale, Oligocene. Coll. by K. Asano.

Penkeobiraruka-zawa, Hobetsu-gawa, Yufutsu-gun; Poronai Shale, Oligocene. Coll. K. Asano.

HONSHŪ

1. *Akita Prefecture.*

Masukawa, Minami-Isokawa-mura, Minami-Akita-gun; Funakawa formation, Miocene. Coll. S. Hanzawa.

2. *Yamagata Prefecture.*

Minami-Hirata, Akumi-gun; Funakawa formation, Miocene. Coll. S. Hanzawa.

3. *Niigata Prefecture.*

Ochiai, Ishiguro-mura, Kariha-gun; Teradomari formation, Miocene. Coll. by K. Ishikawa.

Shimizu, Matsudai-mura, Higashi-Kubiki-gun; Shiiya formation, Miocene. Coll. by T. Kano.

Fudôson, Asahi-mura, Higashi-Kubiki-gun; Shiiya formation, Miocene. Coll. by T. Kano.

Tanahiro, Maki-mura, Higashi-Kubiki-gun; Teradomari formation, Miocene. Coll. by T. Kano.

Han-irizawa, Minamoto-mura, Naka-Kubiki-gun; Shiiya formation, Miocene. Coll. by T. Kano.

Hotaruba, Minamoto-mura, Naka-Kubiki-gun; Shiiya formation, Miocene. Coll. by T. Kano.

Kawaya, Minamoto-mura Naka-Kubiki-gun; Shiiya formation, Miocene. Coll. by T. Kano.

Izumiya, Yoshikawa-mura, Naka-Kubiki-gun; Shiiya formation, Miocene. Coll. by T. Kano.

Oshimizu, Yoneyama-mura, Naka-Kubiki-gun; Shiiya formation, Miocene. Coll. T. Kano.

4. *Iwate Prefecture.*

Zuizan, Gembi-mura, Nishi-Iwai-gun; Gembi formation, Miocene. Coll. N. Kitamura.

5. *Miyagi Prefecture.*

Miyanokuchi, Monji-mura, Kurihara-gun; Kuzumine formation, Miocene. Coll. N. Kitamura.

6. *Fukushima Prefecture.*

Kozu, Kozu-mura, Azumi-gun; Kozu formation, Miocene. Coll. by T. Arakawa.

Yagawase, Iino-mura, Ishiki-gun; Hon-ya formation, Miocene. Coll. Y. Kamada.

Yumoto-machi, Ishiki-gun; Mizunoya formation, Miocene. Coll. K. Asano.

North of the Yumoto Railway-station, Yumoto-machi, Ishiki-gun; Asagai formation, Oligocene. Coll. K. Asano.

7. *Okayama Prefecture.*

Usai-dani, Tsuyama City; Tsuyama formation, Miocene. Coll. K. Suyari.

Yoshino Primary School, Katta-gun; Tsuyama formation, Miocene. Coll. K. Suyari.

KYŪSHŪ

Nakao, Takaoka-machi, Higashi-Morogata-gun, Miyazaki Prefecture; Tsuma formation, Miocene. Coll. S. Murata.

SYSTEMATIC DESCRIPTIONS

Family LITUOLIDAE

Genus **Haplophragmoides** Cushman, 1910

Haplophragmoides compressa LeRoy

Plate 12, figures 7a, b.

Haplophragmoides compressa LeRoy, 1939, Nat. Tijd. Ned. Indies, Dl. 99, p. 227, pl. 5, figs. 24, 25.

Test circular, compressed, often distorted, somewhat umbilicate, periphery subround; chambers indistinct, six to eight in the last coil, usually collapsed; sutures indistinct, more or less radial; wall fine to medium textured; aperture peripheral, at the base of the last chamber. Diameter up to 0.7 mm.

Hypotype.—Yagawase, Iino-mura, Ishiki-gun, Fukushima Prefecture (Lat. 37° 2′ 40″ N., Long. 140° 54′ E.). Hon-ya formation, Miocene.

Remarks.—Very common in the Hon-ya formation, Jôban Coal-field; rare in the Teradomari and Shiiya formations, Niigata Oil-field.

Haplophragmoides cf. **emaciatum** (Brady)

Plate 12, figure 5.

Haplophragmium emaciatum Brady, 1884, Challenger Foraminifera, vol. 9, p. 305, pl. 33, figs. 26-28.

Test planispiral, both sides concave, composed of two or more coils, of which the outer one consists of about seven inflated chambers, often distorted, periphery rounded; wall constructed of sand grains; sutures depressed, sometimes indistinct; aperture at the base of the apertural face of the last formed chamber. Diameter up to 0.6 mm.

Hypotype.—Fudôson, Asahi-mura, Higashi-Kubiki-gun, Niigata Prefecture (Lat. 37° 10′ N., Long. 138° 31′ E.). Shiiya formation, Miocene.

Remarks.—Rare in the Shiiya formation, Niigata Oil-field; and Funakawa formation, Akita Oil-field. Rare in the Hon-ya formation, Jôban Coal-field. The present specimens are usually distorted and are not thus strictly identifiable with Brady's species, but they are very similar to the specimens from the Oligocene and Miocene of Venezuela figured by H. H. Renz.

Haplophragmoides renzi Asano, n. sp.

Plate 12, figures 3a-c.

Haplophragmoides coronatum RENZ (not Brady), 1948, Geol. Soc. America, Mem. 32, p. 141, pl. 1, fig. 5.

Test planispiral, close coiled, compressed, involute, periphery rounded but somewhat lobulate, umbilical region covered; seven to eight chambers in the last coil, slightly inflated; sutures nearly radial, often indistinct; wall thick with much quartz sand; aperture a curved slit at the base of the apertural face. Diameter up to 1.0 mm.

Holotype.—IGPS loc. no. Ni-19, Kawaya, Minamoto-mura, Naka-Kubiki-gun, Niigata Prefecture (Lat. 57° 12′ N., Long. 138° 31′ E.). Shiiya formation, Miocene. IGPS coll. cat. no. 66195.

Remarks.—Common in the Teradomari and Shiiya formations, Niigata Oil-field; scarce in the Tsuyama formation, Okayama Prefecture, and in the Masuhoro formation, Soya-gun, Hokkaidô. The Venezuelan specimen figured by Renz under the name of *H. coronatum* (Brady) is apparently similar to the present species which differs from Brady's *coronatum* in the completely involute test. The specific name is given in honor of Dr. H. H. Renz, in recognition of his work on smaller Foraminifera.

Haplophragmoides cf. **trullissatum** (Brady)

Plate 12, figures 4a, b.

Trochammina trullissata BRADY, 1879, Quart. Jour. Micr. Soc., vol. 19, p. 56, pl. 5, figs. 10, 11.
Haplophragmoides trullissata CUSHMAN, 1910, Bull. 71, U. S. Nat. Mus., pt. 1, p. 100, text-figs. 148a, b.

Test subglobular, planispiral, not completely involute, umbilical region usually depressed, periphery slightly lobulate, rounded, sometimes subacute when depressed; chambers numerous, seven to nine in the last coil, somewhat inflated; sutures distinct, slightly depressed; wall finely arenaceous; aperture at the base of the apertural face of the last chamber. Diameter up to 0.7 mm.

Hypotype.—Tanahiro, Maki-mura, Higashi-Kubiki-gun, Niigata Prefecture (Lat. 37° 3′ 12″ N., Long. 138° 24′ 20″ E.). Teradomari formation, Miocene.

Remarks.—Common in the Teradomari and Shiiya formations, Niigata Oil-field; scarce in the Funakawa formations of the Akita and Yamagata Oil-fields and in the Masuhoro formation, Hokkaidô. Most of the present specimens are depressed or distorted, but resemble Brady's *trullissatum* in the sutures and subglobular chambers.

Genus **Cribrostomoides** Cushman, 1910

Cribrostomoides kyushuense Asano, n. sp.

Plate 12, figures 1a-c.

Test comparatively large, planispiral, slightly umbilicate, periphery broadly rounded, not lobulate; chambers five or six in the last coil, low and broad; sutures distinct, slightly depressed; wall coarsely arenaceous, but smoothly finished; aperture a curved slit with distinct projections at the base of the apertural face, but undivided by tooth-like processes. Diameter up to 2.0 mm.

Holotype.—IGPS loc. no. My-1, Nakao, Takaoka-machi, Higashi-Morogata-gun, Miyazaki Prefecture (Lat. 31° 50′ N., Long. 138° 17′ E.). Tsuma formation, Miocene. IGPS coll. cat. no. 66194. Differs from the Recent *C. bradyi* Cushman from Japan in the apertural characters.

Cribrostomoides (?) sp.

Plate 12, figures 2a, b.

Hypotype.—Fudôson, Asahi-mura, Higashi-Kubiki-gun, Niigata Prefecture (Lat. 37° 10′ N., Long. 138° 31′ E.). Shiiya formation, Miocene.

Remarks.—Scarce in the Shiiya formation, Niigata Oil-field. The present form has an apertural projection at the base of the septal face, as seen in young *Cribrostomoides,* but is distinguishable from *C. kyushuense* by the lobulate margin and more depressed sutures.

Genus **Cyclammina** Brady, 1876

Cyclammina incisa (Stache)

Plate 12, figures 8a-9b.

Haplophragmium incisum STACHE, 1864, Novara-Exp., Geol. Theil, Bd. 1, p. 165, pl. 21, figs. 1, 2.
Cyclammina incisa CUSHMAN and LAIMING, 1931, Jour. Paleon., vol. 5, no. 2, p. 93, pl. 9, figs. 6a, b.

Test compressed, umbilicate; eight to eleven chambers in the last coil, periphery somewhat lobulate; sutures slightly depressed, nearly radial; wall finely arenaceous, smoothly finished. Diameter up to 1.8 mm.

Hypotype (Fig. 8a, b).—Usaidani, Tsuyama City (Lat. 35° 4′ N., Long. 134° 2′ 10″ E.). Tsuyama formation, Miocene.

Hypotype (Fig. 9a, b).—Yagawase, Iino-mura, Ishiki-gun, Fukushima Prefecture (Lat. 37° 2′ 40″ N., Long. 140° 54′ E.). Hon-ya formation, Miocene.

Remarks.—Abundant in the Hon-ya and rare in the Mizunoya formations, Jôban Coal-field. Common in the Tsuyama formation of Okayama Prefecture, Tsuma formation of Miyazaki Prefecture, the Poronai Shale and Masuhoro formations of Hokkaidô, scarce in the

Teradomari and Shiiya formations, Niigata Prefecture; and in the Funakawa formation of Akita Prefecture.

Cyclammina japonica Asano, n. sp.

Plate 11, figures 3a-8.

Test large, lenticular, compressed, periphery subacute, umbilicus often excavated; 15 to 19 chambers in the last coil, usually 18 or 19; sutures distinctly depressed, slightly curved, subangular near umbilical region; aperture a curved slit at the base of the apertural face, supplementary pores indistinct. Diameter up to 6.0 mm.

Holotype.—IGPS loc. no. Ni-19, Kawaya, Minamoto-mura, Naka-Kubiki-gun, Niigata Prefecture (Lat. 37° 12′ N., Long. 138° 31′ E.). Shiiya formation, Miocene. IGPS coll. cat. no. 66193.

Remarks.—Common in the Shiiya and Teradomari formations of the Niigata Oil-field, Funakawa formation of the Akita and Yamagata Oil-fields, and in the Masuhoro formation of Hokkaidô. Scarce in the Kuzumine formation of Miyagi Prefecture, Gembi formation of Iwate Prefecture, and in the Kozu formation of Fukushima Prefecture. Differs from *C. compressa* Cushman in the much larger test and greater number of chambers.

Cyclammina orbicularis Brady

Plate 11, figures 9-12.

Cyclammina orbicularis BRADY, 1884, Challenger Foraminifera, vol. 9, p. 353, pl. 37, figs. 17-19.

Test subglobose, completely involute, planispiral, nearly as broad as high; 11 to 13 chambers in the last coil, much broader than high; sutures somewhat depressed; wall finely arenaceous; aperture a curved slit at the base of the apertural face. Diameter up to 1.5 mm.

Hypotype.—Chishiya, Soya-gun, Hokkaidô (Lat. 45° 30′ N., Long. 141° 58′ E.). Masuhoro formation, Miocene.

Remarks.—Common in the Masuhoro formation of Hokkaidô, but scarce in the Shiiya formation of the Niigata Oil-field.

Cyclammina pusilla Brady

Plate 12, figures 6a, b.

Cyclammina pusilla BRADY, 1881, Quart. Jour. Micro. Soc., vol. 21, p. 53; CUSHMAN, 1910, Bull. 71, U. S. Nat. Mus., Pt. 1, p. 111, text-fig. 172.

Test small, much compressed, planispiral, periphery sharply angled, lobulate, umbilicate; 14 to 15 chambers in the last coil; sutures distinct, slightly depressed; wall finely arenaceous; aperture a slit at base of apertural face. Diameter up to 0.7 mm.

Holotype.—Tanahira, Maki-mura, Higashi-Kubiki-gun, Niigata Prefecture (Lat. 37° 3′ 12″ N., Long. 138° 24′ 20″ E.). Teradomari formation, Miocene.

Remarks.—Common in the Teradomari and Shiiya formations of Niigata Oil-field, and in the Funakawa formation of the Akita Oil-field.

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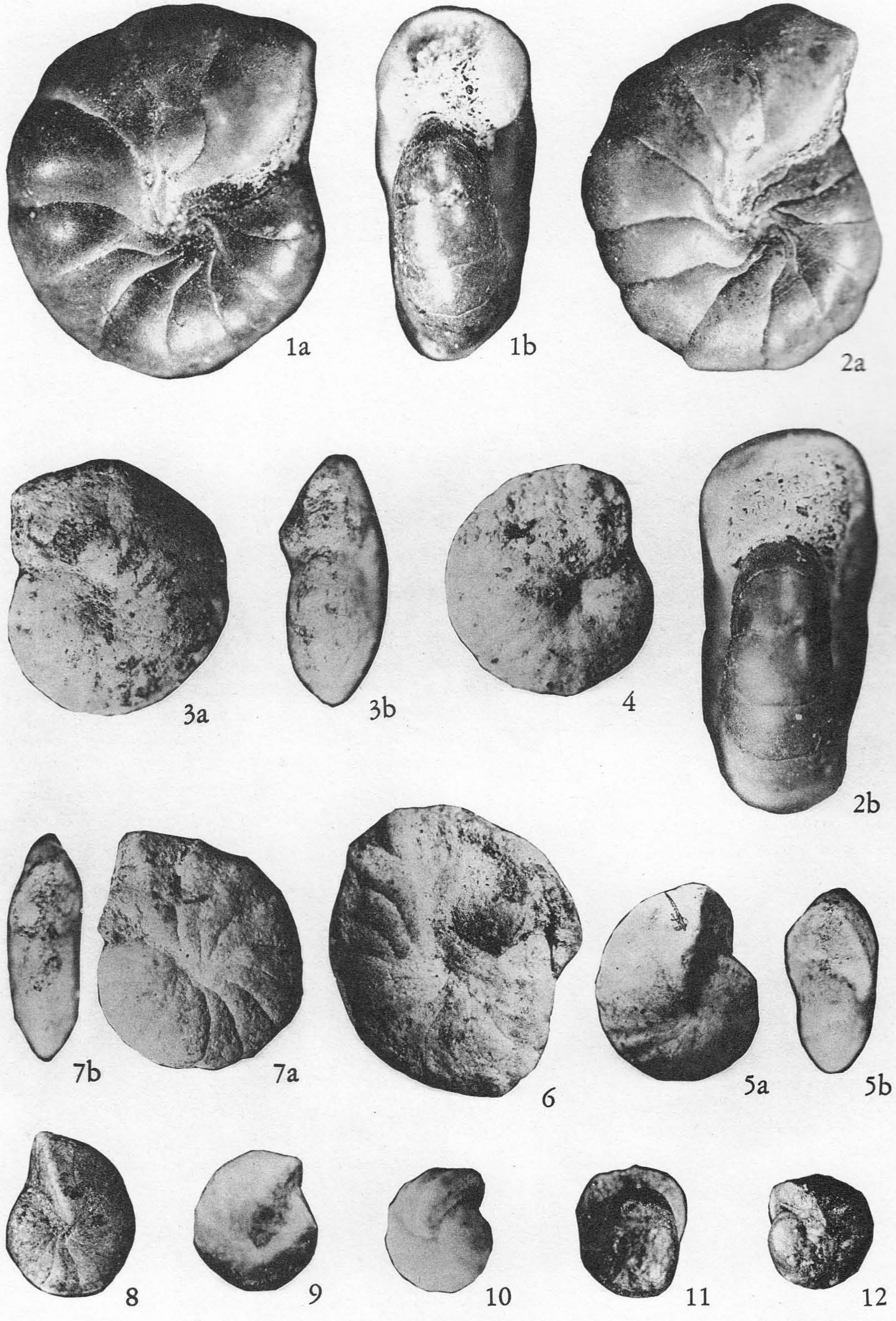
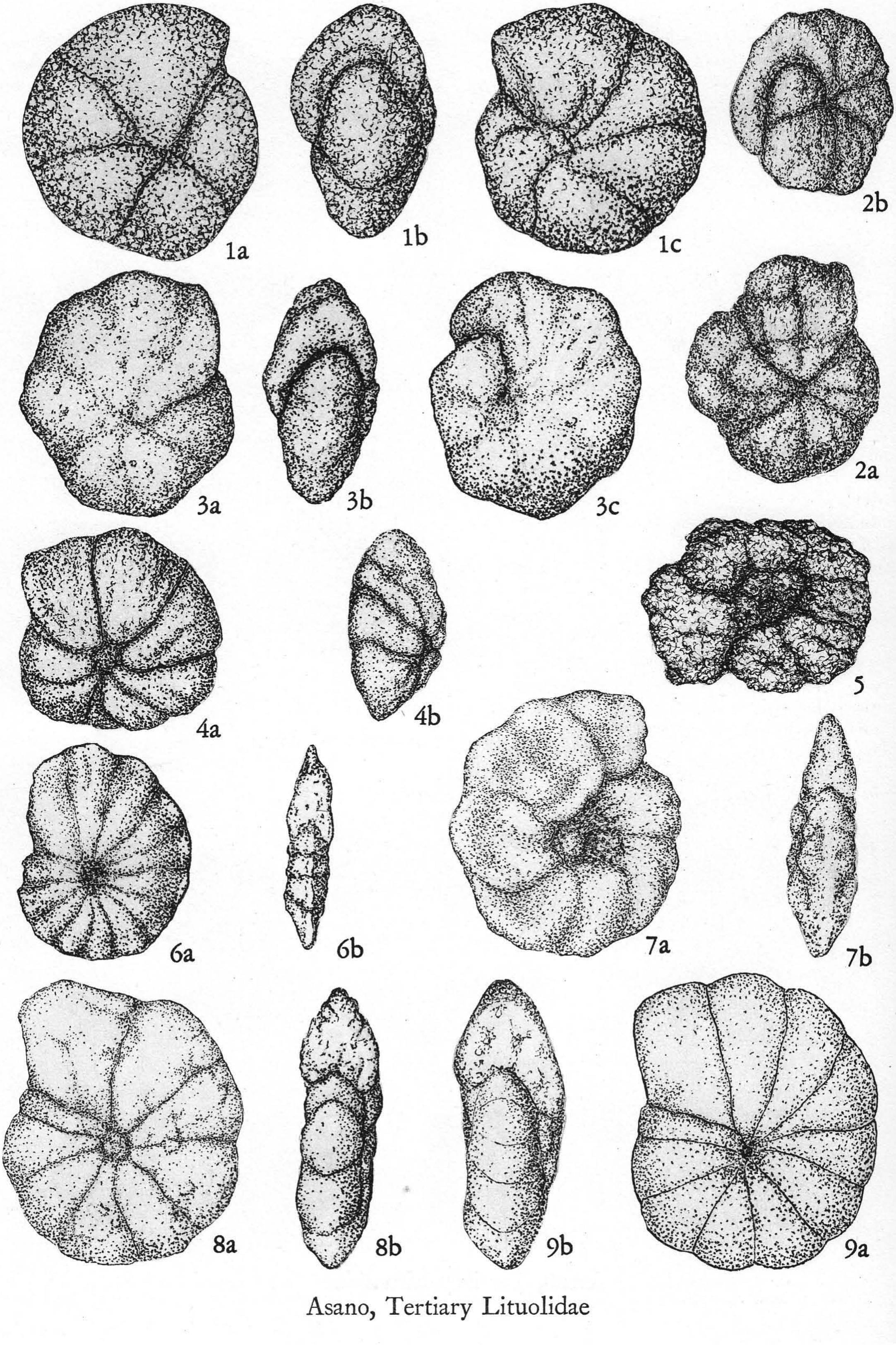
EXPLANATION OF PLATE 11

FIGS.		PAGE
1a-2b.	*Cyclammina cancellata* Brady, × 10. Recent. Off Chiba Prefecture, 196 meters depth.	
3a, b.	*Cyclammina japonica* Asano, n. sp., × 10. Holotype, IGPS coll. cat. no. 66193.	78
4-8.	*Cyclammina japonica* Asano, n. sp., Paratypes.	78
9-12.	*Cyclammina orbicularis* Brady, × 15. Hypotypes.	78



Asano, Tertiary Lituolidae



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Manuscript received August 22, 1950

14. DO THE SPECIFIC NAMES OF THE FORAMINIFERA ACCORD WITH THE RULES OF NOMENCLATURE?

HELMUT BARTENSTEIN
Celle, Germany

In recent American foraminiferal literature, one notices an inconsistency in the usage of the gender of the various genera, and that consequently the termination of the trivial name varies within a genus. The root of this evil is well known: it lies in the frequent incorrect use of the Latin language. Could not, however, a way be found to prevent the additional labor of later correcting such errors? Such a proposal was made by Rudolf Richter, 1942, ("Ist eine unveränderliche Form des Art— Namens möglich?", Senckenbergiana, vol. 25, pp. 340-356) by the use of which a clear and consistent nomenclature might be evolved.

In explanation of this problem, I have given below several examples from recent American literature, where in some cases inconsistent usage has been followed in a single paper by the same author, and even adjacent within the text. As I am here concerned only with examples to explain my general thesis, no criticism is implied, and the author and citations are not given.

Bolivinoides decorata (Jones)
— *Trochamminoides coronus* Loeblich & Tappan

Ammodiscoides conica Cushman & Waters
— *Elphidioides americanus* Cushman

Textularioides inflata Cushman
— *Recurvoides contortus* Earland

Orbitoides media (Archiac)
— *Coskinolinoides texanus* Keijzer

Siphoninoides echinata (Brady)
— *Cornuspiroides striolatus* (Brady)

Some of the genera with the ending —ides are therefore used as masculine and others as feminine.

Eponides tenera Brady
— *Eponides repandus* (Fichtel & Moll)

Vagocibicides maoria Finlay
— *Cibicides lobatulus* (Walker & Jacob)

Haplophragmoides rugosa Cushman & Waters
— *Haplophragmoides rotulatus* (Brady)

These genera have been used interchangeably as both masculine and feminine.

Tristix liasina (Berthelin)
— *Tristix acutangulum* (Reuss)

This genus should be feminine.

Ammobaculites torosus Loeblich & Tappan
— *Ammobaculites stenomeca* Cushman & Waters

This genus should be masculine.

Ophthalmidium orbiculare Burbach
— *Ophthalmidium minima* Tappan

Nodophthalmidium pyriformis (Tappan)
— *Lecythium hyalina* (Ehrenberg)

These genera with the ending —ium must be neuter.

Bathysiphon filiformis M. Sars
— *Arenosiphon gigantea* Grubbs
Diaphoropodon mobile Archer

The ending —on is of masculine gender.

Dentalinopsis subquadrata Tappan
— *Dentalinopsis tricarinatum* (Reuss)

Bolivinopsis papillata (Cushman)
— *Virgulopsis pustulata* Finlay

EXPLANATION OF PLATE 12

FIGS.		PAGE
1a-c.	*Cribrostomoides kyushuense* Asano, n. sp., × 30. Holotype, IGPS coll. cat. no. 66194.	77
2a, b.	*Cribrostomoides* (?) sp., × 30. Hypotype.	77
3a-c.	*Haplophragmoides renzi* Asano, n. sp., × 40. Holotype, IGPS coll. cat. no. 66195.	77
4a, b.	*Haplophragmoides* cf. *trullissatum* (Brady), × 40. Hypotype.	77
5.	*Haplophragmoides* cf. *emaciatum* (Brady), × 40. Hypotype.	76
6a, b.	*Cyclammina pusilla* Brady, × 50. Hypotype.	78
7a, b.	*Haplophragmoides compressa* LeRoy, × 40. Hypotype.	76
8a-9b.	*Cyclammina incisa* (Stache), × 50. Hypotypes.	77

The genera with the ending —opsis must be masculine.

Microcometes paludosa Cienkowski

This genus can only belong to the masculine gender.

These comparisons could be continued indefinitely, and show the uncertainty in determining the gender of the various genera and even the impossibility of determining definitely the gender of artificially formed names, even on the basis of the Latin language. Furthermore, the use of trivial names is made additionally difficult through the two possibilities of using them in the form of adjectives or as substantives (for example: *Verneuilina favūs* Bartenstein, but not *Verneuilina fava* Bartenstein; similarly *pilus, pilūs; pugnus, pugnūs,* etc.).

In order to finally abolish such difficulties for the foraminiferal nomenclature (and indeed for all zoological nomenclature) and to make a single correction of all generic and trivial names, which would be easily and freely usable for all later work, let me again quote the proposals of Richter (1942, p. 355):

1. Adjectival trivial names must appear in the feminine gender without regard to the gender of the generic name (as an unspoken complement to the word species).

2. The substantive-appositional trivial name must, in so far as it has the endings —us (—er), —a, —um, be used as a Latin adjective: these names must therefore appear, as are the adjectival trivial names, only in the feminine gender (following proposal 1).

In order to arrive at a binding international agreement, a discussion of these proposals as related to the field of micropaleontology would be very desirable. I am indebted to Professor Rudolf Richter for his assistance on this problem.

Manuscript received March 29, 1950

EDITOR'S NOTE: Since this manuscript was received, a lengthy review and summary of Prof. Richter's article was published by J. Marvin Weller. For the benefit of readers who may not have seen the original, the reference follows: Jour. Paleon., vol. 24, no. 4, pp. 507-512, July, 1950.

15. OCCURRENCE AND ONTOGENY OF GLOBIGERINATELLA INSUETA CUSHMAN AND STAINFORTH FROM THE OLIGOCENE OF TRINIDAD, B. W. I.

By

P. Bronnimann

Trinidad Leaseholds Ltd.

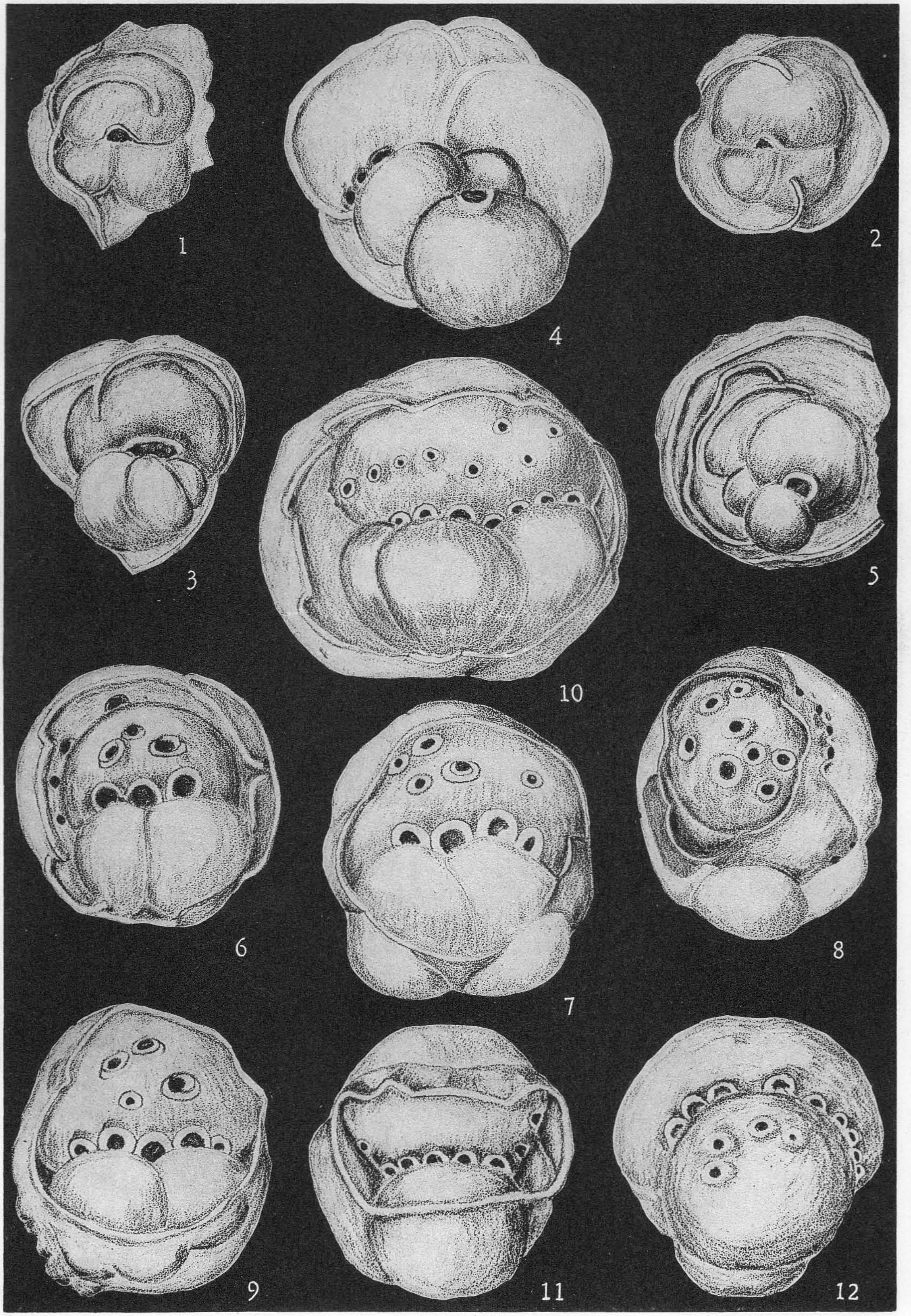
Pointe-a-Pierre, Trinidad, B. W. I.

The planktonic foraminifer, *Globigerinatella insueta* Cushman and Stainforth (1945, p. 68-69, pl. 13, figs. 7-9, holotype fig. 7) originally described from the Oligocene Cipero marl formation of Trinidad, B. W. I., is diagnostic for Zone II of Cushman and Stainforth. This zone is found between the Upper Oligocene *Globorotalia fohsi* zone and the Middle Oligocene *Globigerina dissimilis* zone (Cushman and Renz 1947, p. 3). At the Cipero Coast type section (Cushman and Stainforth 1945, p. 7), the *Globigerinatella insueta* zone overlies the "Bamboo silt" or Flat Rock silt tongue, which is not younger than early Middle Oligocene as identified by the presence of *Globigerina* cf. *concinna* Reuss and the absence of the genus *Halkyardia* (Stainforth 1948b, p. 1299). However a recent re-examination of the *Globigerina* assemblages from this locality failed to contain any indisputable specimens of *Globigerina* cf. *concinna,* but proved the presence of numerous *Globigerina apertura* Cushman and a few specimens of *Globigerina dissimilis* Cushman and Bermudez, an association which suggests basal Oligocene. This age difference obviously implies the existence of a fault between the Flat Rock silt tongue and the adjacent *Globigerinatella insueta* zone.

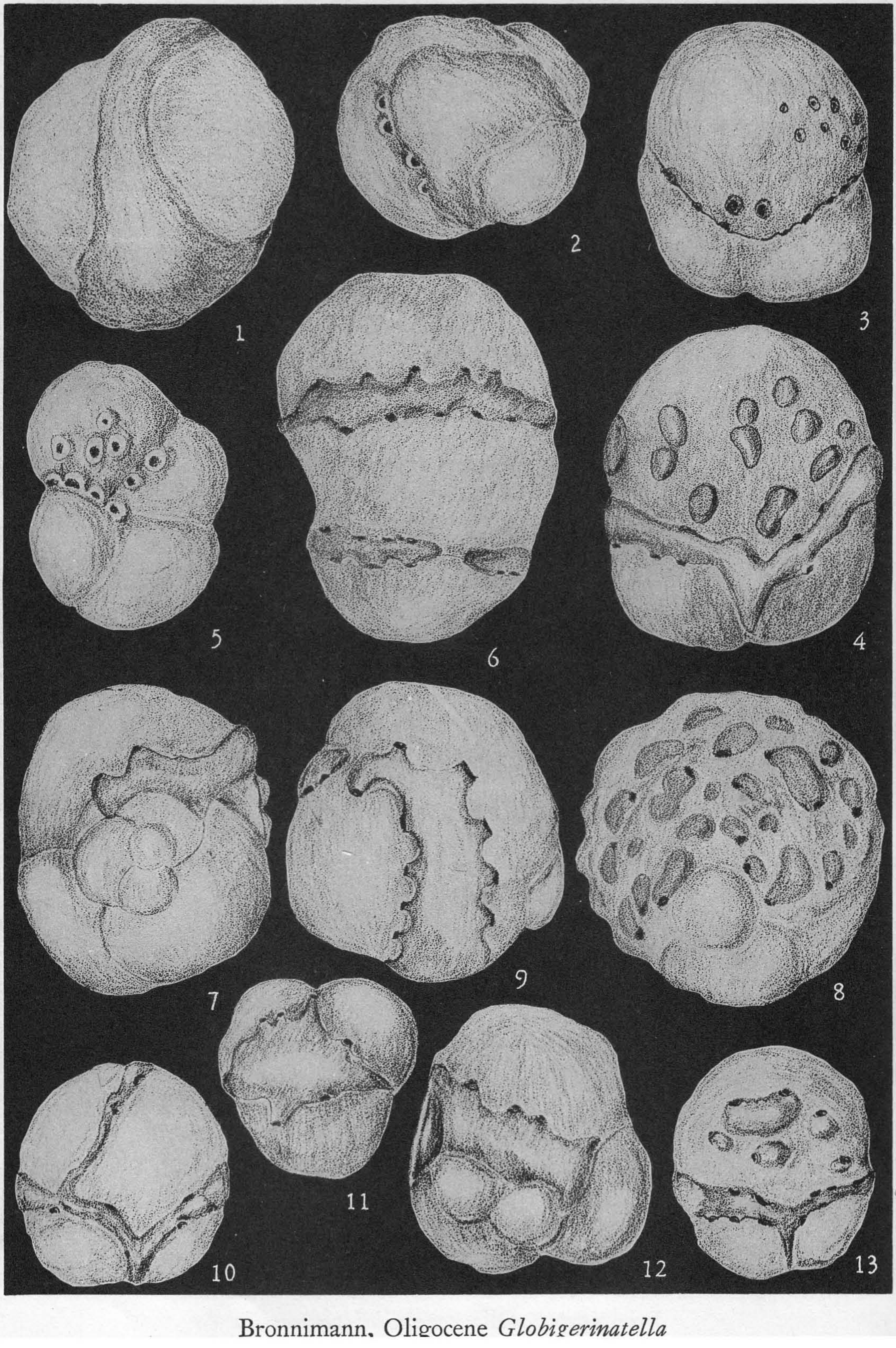
Stainforth (1948a, p. 120, 1948b, p. 1327, 1328) reported *G. insueta* from the Upper Oligocene of the Oceanic formation of Barbados and from the late Middle and early Upper Oligocene of Ecuador. H. H. Renz (1948, p. 136) recorded *G. insueta* in the lower part of the upper Acostian of the Agua Salada Group, State of Falcon, Venezuela, and Cushman and Renz (1947, p. 41) in the type locality of the Trinidad Point cal-

EXPLANATION OF PLATE 13

Figs. 1-12. *Globigerinatella insueta* Cushman and Stainforth. Trinidad, B.W.I.; Upper Oligocene. 1-5, *Globigerina*-stage with single aperture. 6-12, *Globigerina*-stage with multiple aperture. All figures approximately × 120.



Bronnimann, Oligocene *Globigerinatella*



Bronnimann, Oligocene *Globigerinatella* careous clay at Trinidad Point, Oropouche Lagoon, southern Trinidad. *G. insueta* has recently been observed in the yellow silty calcareous clay and hard yellowish-grey limestone of the old Ste. Croix Quarry at Lothians Estate, south of Princes Town, Trinidad, which is the type locality of the Ste. Croix calcareous clay. Hence the Ste. Croix Quarry does not belong to the Upper Oligocene *Globorotalia fohsi* zone as suggested by Cushman and Renz (1947, p. 2). From the occurrence of *Globorotalia barisanensis* LeRoy, *Globorotalia mayeri* Cushman and Ellisor, rare *Globigerina dissimilis* Cushman and Bermudez and some as yet undescribed species related to *G. dissimilis*, it is believed that the Ste. Croix Quarry fauna is equivalent to the basal portion of the *Globigerinatella insueta* zone or is transitional between the *Globigerina dissimilis* and the *Globigerinatella insueta* zones.

From these records it appears that *Globigerinatella insueta* is geographically widely distributed, very restricted in time, and little affected by facies variations. As a rule this species is easily recognizable. All these qualities make *Globigerinatella insueta* an excellent marker fossil for the lower part of the Upper Oligocene of the Caribbean region.

The morphologic features of adult specimens of *G. insueta* vary considerably (pl. 14, figs. 1, 2, 4, 6-10, 12, 13) so that specific determinations based on Cushman and Stainforth's condensed description (1945, p. 68) are sometimes open to doubt. In order to arrive at more reliable determinations and at the same time reach a better understanding of the complex morphology and the variability of the adult test, the ontogeny of numerous specimens of *G. insueta* from various Trinidad localities was analyzed. The true stratigraphic position of these localities was known only where the fauna indicated a transitional position either to the *Globorotalia fohsi* zone above or to the *Globigerina dissimilis* zone below.

The ontogeny of typical representatives of *G. insueta* can be subdivided into three successive stages: (a) *Globigerina*-stage with single aperture; (b) *Globigerina*-stage with multiple aperture, and (c) *Globigerinatella*-stage.

It was not possible to isolate the small subglobular proloculus or initial chamber, which as a rule, and when not masked by supplementary chambers of the *Globigerinatella*-stage can be observed on the surface of well preserved specimens (pl. 14, fig. 7).

The *Globigerina-stage with single aperture* is composed of three to four, in some specimens possibly five subglobular chambers, including the proloculus, which are arranged in a distinct trochoidal spire. The chambers increase rapidly in size and the last formed is usually larger than the complete preceding spire. Each chamber has a single large semi-circular aperture with a distinct lip, situated in the suture. Broken specimens display three chambered (pl. 13, figs. 1, 2) and four chambered (pl. 13, figs. 3, 4, and 5) *Globigerina*-stages with single apertures. At this stage, the later chambers do not yet tend to envelop the preceding ones.

The first chamber of the more complicated *Globigerina-stage with multiple aperture,* as shown in pl. 13, fig. 6, is perforated by three semicircular sutural and by three additional, circular non-sutural apertures, all fairly large and with distinct lips. This stage probably includes three to four subglobular chambers, trochoidally arranged as in the foregoing stage and tending to become somewhat enveloping in the last phase of growth (pl. 13, figs. 6-12, pl. 14, fig. 3).

The number of sutural and non-sutural apertures increases with the size of the chambers. From broken specimens of this cribrate *Globigerina*-stage (pl. 13, figs. 6-12) it can be seen that the surface of the last formed chamber is rather rough whereas the inner face appears quite smooth. The specimens on pl. 13, fig. 12 and pl. 14, figs. 3, 5 are representative of a growth stage prior to the development of the characteristic supplementary *Globigerinatella*-chambers.

The *Globigerinatella*-stage is typified by one or more irregularly formed and generally rather small, thin walled supplementary chambers or chamber like growths produced by the protoplasm flowing through the sutural and non-sutural apertures. The shape and distribution of these rudimentary chambers are apparently governed by the position of the apertures and possibly also by the amount of protoplasm. The following types are recognizable:

(a) a single large supplementary chamber, embracing the test completely, or incompletely in the form of a collar of irregular outlines. The supplementary chamber essentially follows the sutural depressions. Occasionally it overlaps the adjacent chamber surface (pl. 14, figs. 1, 2, 9, and 12).

(b) one or more narrow, often inter-connected supplementary chambers, filling the sutural depressions (pl. 14, figs. 6, 10).

(c) numerous small, irregularly shaped supplementary chambers, scattered over the anterior portion of the surface of the last formed chamber (pl. 14, fig. 8).

(d) supplementary chambers, occurring as a com-

EXPLANATION OF PLATE 14

FIGS. 1-10, 12, 13. *Globigerinatella insueta* Cushman and Stainforth. Trinidad, B.W.I.; Upper Oligocene. 3, 5, *Globigerina*-stage with multiple aperture. 1, 2, 4, 6-10, 12, 13, *Globigerinatella*-stage showing the various types of supplementary chambers.

FIG. 11. *Globigerinatella* aff. *insueta* Cushman and Stainforth. Trinidad, B.W.I.; Miocene (?reworked). Aberrant form with plate-like supplementary chamber. All figures approximately × 120.

bination of the types (b) and (c) (pl. 14, figs. 4, 13).

(e) a single irregularly shaped supplementary chamber, covering the umbilical portion of the test and branching out into the sutural grooves (pl. 14, fig. 11). The adult test is distinctly trochoidal, three chambered and considerably smaller than that of the typical *G. insueta*. The ontogeny of this form could not be studied in detail and it is possible that the stratigraphic range of this aberrant type and that of *G. insueta* differ. At present it has been included in the genus *Globigerinatella* as *G.* aff. *insueta*. Future work will decide whether it is a true *Globigerinatella*.

In the *Globigerinatella*-stage the apertures are numerous, rather small and semicircular, with lips. They are situated along the margins of the supplementary chambers and often at the end of short lateral processes (pl. 14, fig. 9). Supplementary chambers of type (c) usually have a single fairly large semicircular aperture.

The relative stratigraphic position of the scattered localities from which the present specimens were obtained is not sufficiently well known to permit a study of the phylogenetic development of *Globigerinatella insueta*. This species seems to have appeared suddenly and no source is known at present from which this monotypic genus might have originated, although Cushman and Stainforth (1945, p. 69) make reference to the genera *Candorbulina* and *Globigerinoides*. *Candorbulina* can be excluded as a possible ancestor, for this highly developed genus first appeared in Trinidad at approximately the time *G. insueta* became extinct. Furthermore, the ontogenetic stages of *Candorbulina universa* Jedlitschka differ from those of *G. insueta*. The genus *Globigerinoides* likewise includes highly specialized Globigerinae and thus can not be regarded as the potential ancestor of *Globigerinatella*. Based on the ontogeny, it can be assumed that the ancestor of *G. insueta* resembles a small trochoidal *Globigerina*, with a large single semicircular aperture, as represented by the first ontogenetic stage. Typical and well developed representatives of *G. insueta* existed at the time *Globigerina dissimilis* became extinct and no distinct morphologic differences have been observed between the geologically oldest and youngest specimens. But it is to be expected that a detailed investigation of the ontogeny of specimens from localities of known stratigraphic position will reveal phylogenetically significant changes in morphologic features such as (a) reduction of the number of chambers with primitive *Globigerina* features, (b) changes in the arrangement and distribution of the apertures and supplementary chambers, (c) differences in the development of the pores, etc.

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Manuscript received September 6, 1950

16. THE DIRECTION OF COILING IN THE EVOLUTION OF SOME GLOBOROTALIIDAE

HANS BOLLI
Trinidad Leaseholds Ltd.
Pointe-a-Pierre, Trinidad, B. W. I.

ABSTRACT—The direction of coiling of various species of **Globorotalia** and **Globotruncana** throughout their vertical range is discussed. It is found that random coiling is usually restricted to the early representatives of a species or group of related species, whereas the stratigraphically younger ones prefer a single direction, almost to the exclusion of the other, which may be either sinistral (left) or dextral (right), according to the species concerned.

INTRODUCTION

Most gastropods, some cephalopods and many families of the Foraminifera possess tests which show trochoidal coiling with well recognizable dorsal and umbilical sides, thus a direction of coiling is defined. With the exception of a few genera most of the gastropods coil dextrally, i. e. clockwise, when viewed from the dorsal side. Only very rarely does an individual coil in a direction opposite to that which is characteristic for the species.

Little attention has been paid thus far to the direction of coiling in Foraminifera, even when it can be easily recognized under normal magnification, e. g. in the Globorotaliidae, Anomalinidae, Rotaliidae, Globigerinidae etc. The probable reason for this is the fact that many species of these families seem to have no apparent preference for either direction of coiling.

A few workers however, dealing in particular with *Globotruncana* and *Globorotalia,* have made observations which show that the direction of coiling in at least some foraminiferal genera appears to follow certain rules.

Tschachtli (1941) suggests that apart from the morphological features one can distinguish *Globotruncana* from *Globorotalia* by the fact that the former always coils dextrally whereas coiling in both directions can be found in the latter. This might prove to be correct when only a portion of the vertical range of the respective forms is considered. So simple a solution to distinguish these two genera cannot be maintained, however, when the complete vertical range of a certain species is known. Gandolfi (1942) made some valuable observations on the coiling of Globotruncanas of Cenomanian and Turonian age (see below). To the writer's knowledge he is also the first author to mention the direction of coiling in the species he described. Cita (1948) also refers to the direction of coiling for a number of species of *Globotruncana.* Her results, as well as those of Gandolfi will be discussed in a subsequent portion of this paper.

The interest of the writer was attracted to the problem of coiling of the Foraminifera while studying the evolution of some species of *Globorotalia* from Trinidad, B. W. I. It was found that in one rock sample a certain form might provide specimens in which both directions of coiling were more or less equally common, while in other samples one direction was predominant or even exclusive. An investigation of the relationship of this phenomenon with the stratigraphic position of a selected species resulted in the observation that the occurrence of an approximately equal number of right coiled or dextral and left coiled or sinistral tests appears to be restricted to the stratigraphically older, i. e. earlier types of a species or group of related species, whereas the stratigraphically younger ones apparently prefer one direction almost to the exclusion of the other.

A similar observation has been made by Gandolfi (1942) on Globotruncanas from a Cenomanian-Turonian section in the southern part of Switzerland. Without drawing any conclusions therefrom, he states under the description of *Globotruncana apenninica* O. Renz (free translation from the Italian): "It is a remarkable fact, that in the older beds the sinistral specimens are very frequent, nearly as numerous as the dextral ones, but in ascending stratigraphically, they gradually diminish in number until they represent only sporadic exceptions, so that it seems that coiling specializes in favour of dextral coiling." Figure 1 attempts to show the frequency of occurrence of the preferred direction of coiling in a species of *Globorotalia* or *Globotruncana* throughout its stratigraphic range.

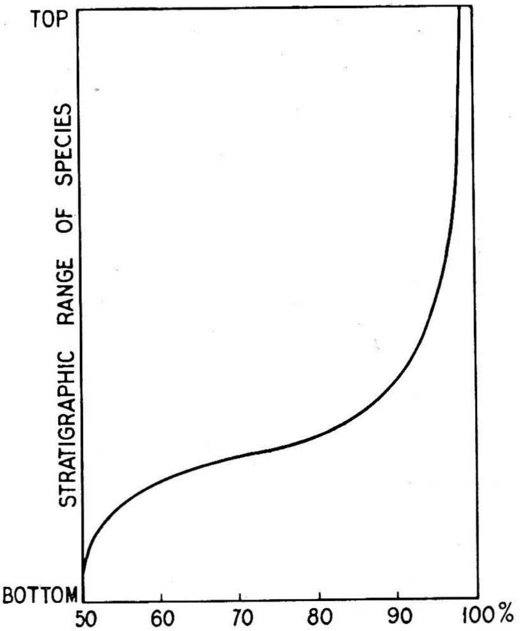

FIGURE 1: Percentage of specimens coiling in one direction throughout the stratigraphic range (sinistral or dextral according to the species).

From Gandolfi's and the writer's observations it appears probable that the evolution of the trend of coiling as shown in this figure is typical for at least a number of species of *Globorotalia* and *Globotruncana,* but there are indications that the curves for some Globorotalias are of a more complex nature than the one given in Figure 1. This applies to *Globorotalia praemenardii* Cushman and Stainforth, *Globorotalia menardii* (d'Orbigny) and to *Globorotalia aragonensis* Nuttall, which will be considered later.

For studies on the evolution of the direction of coiling during the range of a certain species complete and undisturbed stratigraphic sections are desirable. Trinidad, to which the present observations had to be restricted, is not very favourable from this point of view. Well exposed and tectonically undisturbed sections are practically non-existent. However a number of subsurface sections cored at close intervals have given some satisfactory and seemingly reliable results. Whether the trend of the direction of coiling, as shown in Figure 1 is of world-wide persistence needs further investigation.

Genus **Globorotalia** Cushman, 1927

Oligocene-Miocene Globorotalias

A number of subsurface sections of the Oligocene Cipero formation of Trinidad are apparently complete and without major unconformities or tectonic disturbance. The foraminiferal fauna of this formation and its subdivision into biostratigraphic zones, based on micropaleontological evidence has previously been published by Cushman and Stainforth (1945). They distinguished 3 zones: Zone I (*Globigerina concinna*), Zone II (*Globigerinatella insueta*), Zone III (*Globorotalia fohsi*). An additional zone (*Globigerina dissimilis*) has since been added to this subdivision (Cushman and Renz, 1947) and its position is between Zones I and II of Cushman and Stainforth.

Fortunately a number of species of *Globorotalia* are restricted to this comparatively uniform Cipero formation. In the writer's opinion some of these species are closely related. Among this group are the species *Globorotalia fohsi* Cushman and Ellisor, *Globorotalia barisanensis* LeRoy, *Globorotalia lobata* Bermudez and a previously undescribed species. Before discussing the behaviour of the direction of coiling in these species it is necessary to define them more exactly inasmuch as the published descriptions are not always in complete agreement.

For the sake of simplification of nomenclature and for the purpose of grouping phylogenetically related species a trinominal nomenclature such as has been successfully applied to various *Globotruncana* and other species, is here proposed.

Globorotalia fohsi Cushman and Ellisor, which is diagnostic for the Trinidad Upper Oligocene, was the first described species of this group and is therefore selected as the central type of the superspecies with the name *Globorotalia fohsi fohsi* Cushman and Ellisor. The whole group of the *fohsi* subspecies will then read (in descending stratigraphic order):

Globorotalia fohsi robusta Bolli, n. subsp.
Globorotalia fohsi lobata Bermudez
Globorotalia fohsi fohsi Cushman and Ellisor
Globorotalia fohsi barisanensis LeRoy

For description of these species see appendix.

Observations on a number of subsurface sections showed that the early *Globorotalia fohsi barisanensis* LeRoy coils in both directions with approximately equal frequency. A sharp change takes place, however, with the incoming of *Globorotalia fohsi fohsi* Cushman and Ellisor, rising quickly to over 90% in favor of sinistral coiling. This persists throughout the range of the younger *Globorotalia fohsi lobata* Bermudez and *robusta* Bolli n. subsp. until the extinction of the latter.

Globorotalia mayeri Cushman and Ellisor, which has a stratigraphic range comparable to that of the *Globorotalia fohsi* group, appears to have a similar curve. Early specimens of *Globorotalia mayeri* in the *Globigerina dissimilis* and *Globigerinatella insueta* zones show sinistral and dextral coiling in about equal proportion whereas a rapid change towards 95% or more of sinistral coiling has been observed in the higher subzones of the *Globorotalia fohsi* group.

Globorotalia praemenardii is another species occurring in the Oligocene at approximately the same time as *Globorotalia fohsi barisanensis* LeRoy. It was first described by Cushman and Stainforth (1945) and sub-

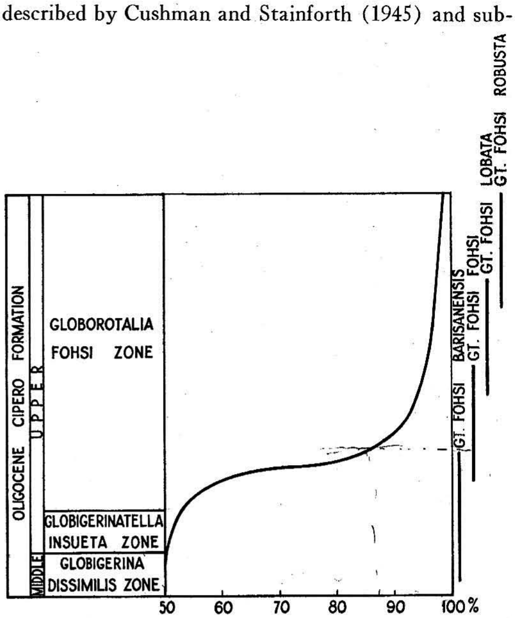

FIGURE 2: Percentage of sinistral specimens of the **Globorotalia fohsi** group in the Oligocene Cipero formation of Trinidad.

sequently mentioned and figured in various papers (Cushman and Bermudez, 1949; Bermudez, 1949). It is believed that *Globorotalia praemenardii* is an early form of *Globorotalia menardii* (d'Orbigny) which ranges up to Recent. *Globorotalia menardii* shows very much the same morphology as its ancestor, but is usually more massive and larger, has a more accentuated peripheral keel, with sutures somewhat less lobate and the dorsal side is less convex.

The first part of the frequency curve of the direction of coiling of *Globorotalia praemenardii* Cushman and Stainforth and *Globorotalia menardii* (d'Orbigny) is very much the same as the one obtained for the *Globorotalia fohsi* group. The *Globorotalia praemenardii* forms at first show no preference for any direction but higher in the section sinistral coiling becomes dominant. This trend continues and is even more pronounced in the Miocene Lengua beds of Trinidad. It has been observed in several subsurface sections, that a sharp and unexpected change takes place in the transitional beds between the Lengua (open sea, clear water, calcareous fauna) and the next younger Cruse beds (shallow water, muddy and sandy, mainly arenaceous fauna). The sinistral coiling changes suddenly and with hardly any transition to a practically entirely dextral one. However these conditions do not last long. After a certain interval and in most cases before reaching the Cruse beds proper, the coiling again becomes sinistral and continues so, as far as can be observed in Trinidad, up to the present time. The percentage curve of Figure 3 illustrates the trend of coiling in the *Globorotalia praemenardii* - *Globorotalia menardii* group.

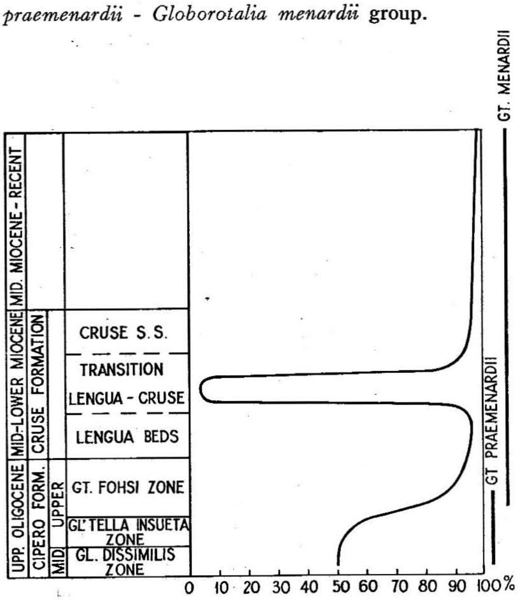

FIGURE 3: Percentage of sinistral specimens of the **Globorotalia praemenardii - menardii** group from the Oligocene to Recent in Trinidad.

Paleocene-Eocene Globorotalias

Globorotalia aragonensis Nuttall seems to show a frequency curve similar to that of *Globorotalia praemenardii* Cushman and Stainforth - *Globorotalia menardii* (d'Orbigny). This species occurs in the Paleocene Lizard Springs and Middle to Lower Eocene Navet formations in Trinidad. The foraminiferal faunas described from these two formations by Cushman and Jarvis (1932) and Cushman and Renz (1946, 1948) came from various isolated outcrops of Central and South Trinidad. Due to tectonic complications and perhaps due to contemporaneous erosion or non-deposition no continuous sections of these formations are known.

The Navet faunas have been placed by Cushman and Renz (1948) into the following stratigraphic sequence (from top to bottom):

Penitence Hill Marl
Fitt Trace - Navet River - Nariva River Marls
Friendship Quarry - Dunmore Hill Marls
Ramdat Marl

Globorotalia aragonensis Nuttall is recorded from the Nariva River, Friendship Quarry - Dunmore Hill, and Ramdat Marls. Its first occurrence is in the Lizard Springs formation which was originally described by Cushman and Jarvis (1932) and placed in the Upper Cretaceous. *Globorotalia aragonensis* Nuttall is described by Cushman and Jarvis under the name of *Globotruncana arca* (Cushman). Cushman and Renz (1948) divided the formation into an Upper and Lower Lizard Springs formation and considered the age of the fauna as transitional between the Upper Cretaceous and Paleocene. *Globorotalia aragonensis* Nuttall is not mentioned but it is possibly included under *Globorotalia lacerti* Cushman and Renz. A Paleocene age for the Lizard Springs, as suggested by Grimsdale (1947), is favoured today by Trinidad paleontologists.

Examination of a number of type locality samples showed that *Globorotalia aragonensis* Nuttall appears in general to be restricted to the Upper Zone. *Globorotalia wilcoxensis* Cushman and Ponton var. *acuta* Toulmin and *Globorotalia crassata* (Cushman) var. *aequa* Cushman and Renz, two other Globorotalias from the Lizard Springs formation, appear on the other hand to be mainly confined to the Lower Zone. A few of the samples, which probably represent transitional beds, contained all three species in association.

Counts made of *Globorotalia aragonensis* Nuttall, over its range from the Lizard Springs formation to the Nariva River beds and *Globorotalia wilcoxensis* Cushman and Ponton var. *acuta* Toulmin and *Globorotalia crassata* (Cushman) var. *aequa* Cushman and Renz in the Lizard Springs formation, yielded the results given in Table 1 (from top to bottom):

TABLE 1

	Number of Specimens					
	Globorotalia aragonensis		**Globorotalia crassata** var. **aequa**		**Globorotalia wilcoxensis** var. **acuta**	
	dextral	sinistral	dextral	sinistral	dextral	sinistral
Nariva River Marl	—	4				
Dunmore Hill Marl	—	8				
Friendship Quarry Marl	1	40				
Ramdat Marl	12	88				
Upper Lizard Springs	90 86 84	10 14 16				
Probable	40	40	13	—	—	7
Transitional beds between Upper and Lower Lizard Springs	4	—	21	1	—	11
Lower Lizard Springs			50 42	— 1	4 —	96 20

The figures of Table 1 and the curves of Figure 4 indicate a similar trend in the direction of coiling throughout the range of *Globorotalia aragonensis* Nuttall as was found for *Globorotalia praemenardii* Cushman and Stainforth - *menardii* (d'Orbigny). These results are based, however, on a stratigraphic sequence which is not yet fully established due to the above mentioned structural complications.

If the rules of coiling in the various species of *Globorotalia* should prove valid from evidence elsewhere, they may serve to assist in recognizing the correct stratigraphic position of isolated outcrops. Provided the early stages of a species or its ancestral form do

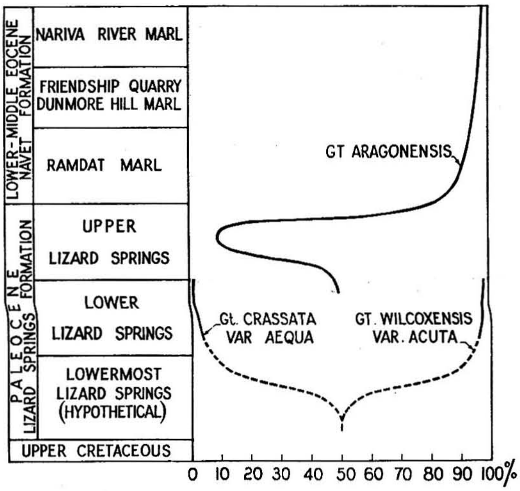

FIGURE 4: Percentage of sinistral specimens of **Globorotalia aragonensis** in the Lizard Springs and Navet formations and of **Globorotalia wilcoxensis** var. **acuta** and **Globorotalia crassata** var. **aequa** in the Lizard Springs formation of Trinidad. The Lowermost Lizard Springs and the dotted curves are hypothetical.

have a disposition to coil to the same degree in both directions, one may then assume that *Globorotalia wilcoxensis* var. *acuta* and *Globorotalia crassata* var. *aequa* of the Lizard Springs formation, with their very distinct sinistral and dextral coiling respectively are advanced representatives of the two species. As no early forms of the species coiling both ways are known thus far from Trinidad, one could then go a step further and assume that part of a Lowermost Paleocene Lizard Springs formation is missing between the Lower Lizard Springs and Upper Cretaceous s. s.

Two recent species from Barbados, B. W. I., were examined in addition to the fossil Globorotalias. *Globorotalia tumida* (H. B. Brady) which is closely related to *Globorotalia menardii* (d'Orbigny) favors sinistral coiling in the ratio of 35:1 of the counted specimens. This would fit in the evolution curve given for *Globorotalia menardii* (d'Orbigny) (Figure 3). The other species, *Globorotalia truncatulinoides* (d'Orbigny) is dextral in the ratio of 26:4.

Genus **Globotruncana** Cushman, 1927

Tschachtli's statement (1941) that Globotruncanas always coil dextrally is understandable insofar as it applies to the majority of the species encountered. But that a number of species coil both dextrally and sinistrally in their earliest occurrences was shown by Gandolfi (1942). It can therefore be assumed that the trend of the direction of coiling of these forms is similar or identical to that of a number of *Globorotalia* (e. g. *Globorotalia fohsi* group, Figure 2).

Observations made by Gandolfi (1942) and Cita (1948) on the coiling of a number of species of *Globotruncana* are of interest. Concerning *Globotruncana ticinensis* Gandolfi (?Albian-Cenomanian) Gandolfi states: "The coiling is indiscriminately sinistral and dextral" and Cita mentions for the same species: "Coiling is in general dextral, sinistral specimens are frequent however." Gandolfi's notes on *Globotruncana apenninica* O. Renz (Cenomanian - Lower Turonian) have been mentioned previously. Cita states in her description of *Globotruncana apenninica* O. Renz: "One notes sinistral specimens" and for *Globotruncana stephani* Gandolfi of similar range she states: "Dextral coiling; in the lower beds frequent sinistral specimens." Dextral coiling was observed by Cita in *Globotruncana stuarti* (de Lapparent) (Campanian - Maestrichtian), the double keeled *Globotruncana lapparenti lapparenti* Bolli (Turonian - Maestrichtian) and *Globotruncana lapparenti coronata* Bolli (Turonian - Santonian).

Random coiling appears to be restricted mainly to some early Cenomanian species such as *Globotruncana ticinensis* Gandolfi, the *Globotruncana apenninica* group with its subspecies, and some others. It is believed by some workers (Gandolfi 1942, Bolli, 1944) that the double keeled *Globotruncana lapparenti* Brotzen group (*Globotruncana linnei* (d'Orbigny), *canaliculata* (Reuss), *marginata* (Reuss) etc.) evolves via the transitional form, *Globotruncana renzi* Thalmann and Gandolfi, from single keeled Cenomanian forms. As-

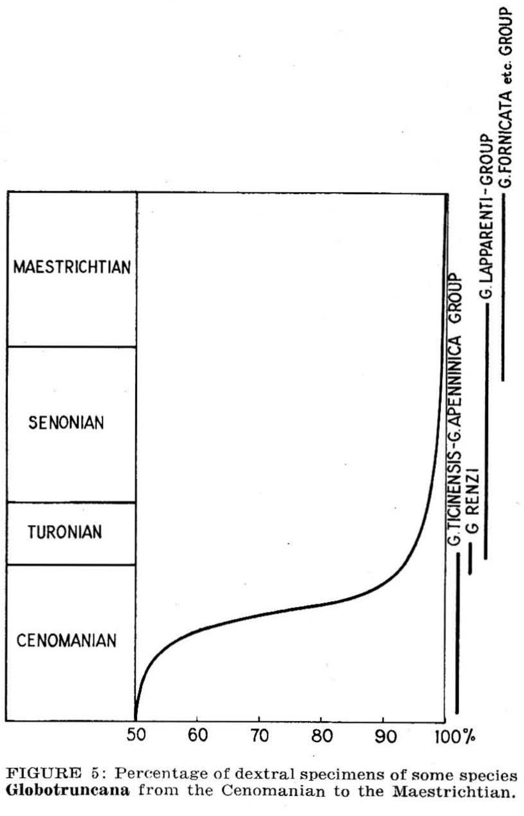

FIGURE 5: Percentage of dextral specimens of some species **Globotruncana** from the Cenomanian to the Maestrichtian.

suming a similar trend of evolution as was observed in the *Globorotalia fohsi* group, these species would then be expected to be dextral from their first appearance or divergence from the ancestral forms. Such an evolution is shown in Figure 5.

This would also explain why so many species of *Globotruncana* appear to have no evolutionary stage showing coiling in both directions. This feature applies to all the species of the *Globotruncana lapparenti* group, probably to *Globotruncana renzi* Thalmann and Gandolfi and in addition to all those Campanian-Maestrichtian forms, which seem to be related to *Globotruncana lapparenti* Brotzen, such as *Globotruncana fornicata* Plummer, *Globotruncana contusa* White, *Globotruncana caliciformis* (de Lapparent), *Globotruncana cretacea* Cushman, etc. In consequence of the above, one would expect them to be predominantly dextral throughout their range.

Counts of some of these species from incomplete sections in Trinidad and some figured Cenomanian species (Gandolfi, 1942) give the following results which seem to confirm this:

TABLE 2

	Number of specimens dextral	sinistral
1) Cenomanian		
G. ticinensis Gandolfi	3	3 (from Gandolfi 1942)
G. stephani Gandolfi	7	5 (from Gandolfi 1942)
G. apenninica group. O. Renz	15	5 (from Gandolfi 1942)
G. apenninica O. Renz	2	1 (Trinidad)
2) Turonian-Maestrichtian		
G. lapparenti lapparenti Bolli } **G. lapparenti bulloides** Bolli }	147	7 (Trinidad)
G. lapparenti tricarinata (Quereau)	152	2 (Trinidad)
G. fornicata Plummer	103	2 (Trinidad)
G. caliciformis (de Lapparent)	303	11 (Trinidad)
3) Some Campanian-Maestrichtian species apparently not related to species of 1) and 2)		
G. stuarti (de Lapparent)	100	— (Trinidad)
G. gansseri Bolli	344	8 (Trinidad)

One group of apparently related species occurring in the Campanian-Maestrichtian of Trinidad may be cited as a final example of the change of direction of coiling during evolution. They are three new species of *Globotruncana,* described by the writer (The genus *Globotruncana* in Trinidad, B. W. I., in press, Jour. Paleon.). Sinistral coiling is not uncommon in the phylogenetically oldest form of this group; of 48 specimens, 13 are sinistral. The intermediate form already shows a pronounced dextral coiling (41:1) and the species considered to be phylogenetically the youngest of the group, favors dextral coiling in the ratio of 78:1.

CONCLUSIONS

The examples given showing changes in coiling in a number of species of *Globorotalia* and *Globotruncana* during their vertical range are sufficient evidence to show that certain rules may govern the evolution of these species insofar as the nature of coiling is concerned. Those specimens which coil in either direction in approximately equal numbers are usually the earlier representatives of a species or of a group of related species. The stratigraphically younger representatives of a species appear to change abruptly to almost entirely a sinistral or dextral coiling, which is then usually retained until their extinction (Figures 1, 3, 5). More complex conditions of coiling are found in some species of *Globorotalia* (Figures 2, 4). Once a preferred direction of coiling has been selected, this direction usually persists to a very marked degree (90-100% of the specimens).

After the early stage, in which some species coil about equally in either direction, practically all of the species of *Globotruncana* examined become dextral and remain so until their extinction. On the other hand many of the *Globorotalia* species seem to prefer sinistral coiling in their later stage (e. g. group of *Globorotalia fohsi* Cushman and Ellisor, *Globorotalia wilcoxensis* Cushman and Ponton var. *acuta* Toulmin, *Globorotalia tumida* (H. B. Brady) etc.). The coiling of *Globorotalia menardii* (d'Orbigny) and *Globorotalia aragonensis* Nuttall also follows this pattern, interrupted by only a short but decided swing to dextral coiling. *Globorotalia crassata* (Cushman) var. *aequa* Cushman and Renz and *Globorotalia truncatulinoides* (d'Orbigny) and probably others apparently favor dextral coiling.

It is hoped that the present note throws some light on a feature which has been thus far neglected, but which may be of importance not only for evolutionary and phylogenetic studies, but also in its application to stratigraphy. Observations have been restricted to species of *Globorotalia* and *Globotruncana.* There are indications that other Globorotaliidae and at least some species of *Globigerina* also follow certain rules in the direction of coiling.

It would also be of interest to know whether or not other rotaliid Foraminifera follow a pattern in their trend of coiling during the geologic range of a species.

Further investigations should be undertaken if possible in areas of undisturbed stratigraphic sequence, and of homeotypic sediments, where the evolution of the species can be reliably followed.

ACKNOWLEDGMENTS

For the reading and criticizing of this paper, the writer is gratefully indebted to Dr. H. G. Kugler, Consulting Geologist to Central Mining Investment

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APPENDIX

The subspecies of *Globorotalia fohsi* Cushman and Ellisor

Genus **Globorotalia** Cushman, 1927

Globorotalia fohsi barisanensis LeRoy

Plate 15, figures 5-6c.

Globorotalia barisanensis LEROY, 1939, Natuurk. Tijdschr. Nederl.-Indië, vol. 99, p. 265, pl. 1, figs. 8-10; STAINFORTH, 1948, Jour. Paleon., vol. 22, p. 120, pl. 26, figs. 24-26.

The test is usually longer than broad, the dorsal side slightly convex to nearly flat, the ventral one convex. About two whorls are visible from the dorsal side, the last with five or six rather inflated chambers, increasing moderately in size as added and slightly lobate. The peripheral margin is rounded, sometimes subacute in the adult chambers. Random coiling is observed in the early forms; later, sinistral tests become more frequent. The sutures on the ventral side are radial to slightly curved and depressed in the later chambers, dorsally they are depressed and distinctly curved. The umbilicus is small; the wall perforate. The elongate aperture on the ventral side of the margin of the last chamber (interiomarginal) extends from the umbilicus nearly to the periphery and has a lip.

Average dimensions.—Length: 0.2 to 0.4 mm; breadth: 0.15 to 0.3 mm; thickness: 0.13 to 0.2 mm.

Remarks.—Specimens transitional to *Globorotalia fohsi fohsi* Cushman and Ellisor are frequently encountered.

Occurrence.—This subspecies occurs in the middle and lower portion of the upper Cipero formation (Oligocene) of Trinidad.

Globorotalia fohsi fohsi Cushman and Ellisor

Plate 15, figures 4a-c.

Globorotalia fohsi CUSHMAN and ELLISOR, 1939, Contr. Cushman Lab. Foram. Research, vol. 15, p. 12, pl. 2, figs. 6a-c; CUSHMAN and BERMUDEZ, 1949, Contr. Cushman Lab. Foram. Research, vol. 25, p. 30, pl. 5, figs. 14-16; BERMUDEZ, 1949, Special Pub. 25, Cushman Lab. Foram. Research, p. 285, pl. 22, figs. 18-20.
Globorotalia barisanensis LeRoy, CUSHMAN and STAINFORTH, 1945, Special Pub. 14, Cushman Lab. Foram. Research, p. 70, pl. 13, figs. 15a-c.

The test is usually longer than broad, the dorsal side slightly convex to nearly flat, the ventral one distinctly convex. About two whorls are visible from the dorsal side, the early one closely coiled; the latter has six to seven chambers which increase rapidly in size. The later chambers of adult specimens are occasionally slightly lobate. The periphery is slightly rounded to subacute in the early chambers and becomes acute but usually not keeled in the mature specimen. Sinistral tests are usually strongly dominant (over 90% of the specimens encountered). The sutures are radial or slightly curved ventrally, depressed in the latter portion. Dorsally they are curved and slightly depressed. The umbilicus is small; the wall finely perforate. The aperture, an elongate opening on the ventral side of the margin of the last chamber (interiomarginal), extends from the umbilicus nearly to the periphery and has a distinct lip.

Average dimensions.—Length: 0.25 to 0.5 mm; breadth: 0.2 to 0.4 mm; thickness: 0.15 to 0.25 mm.

Remarks.—Specimens transitional to *Globorotalia fohsi lobata* Bermudez are frequently encountered.

Occurrence.—This subspecies occurs in the upper part of the Oligocene Cipero formation of Trinidad.

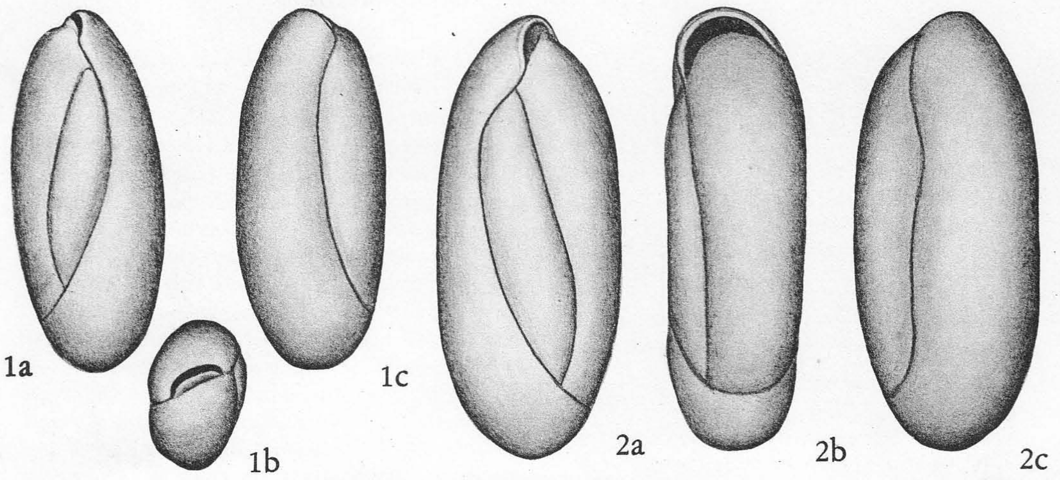
Globorotalia fohsi lobata Bermudez

Plate 15, Figures 7-8c.

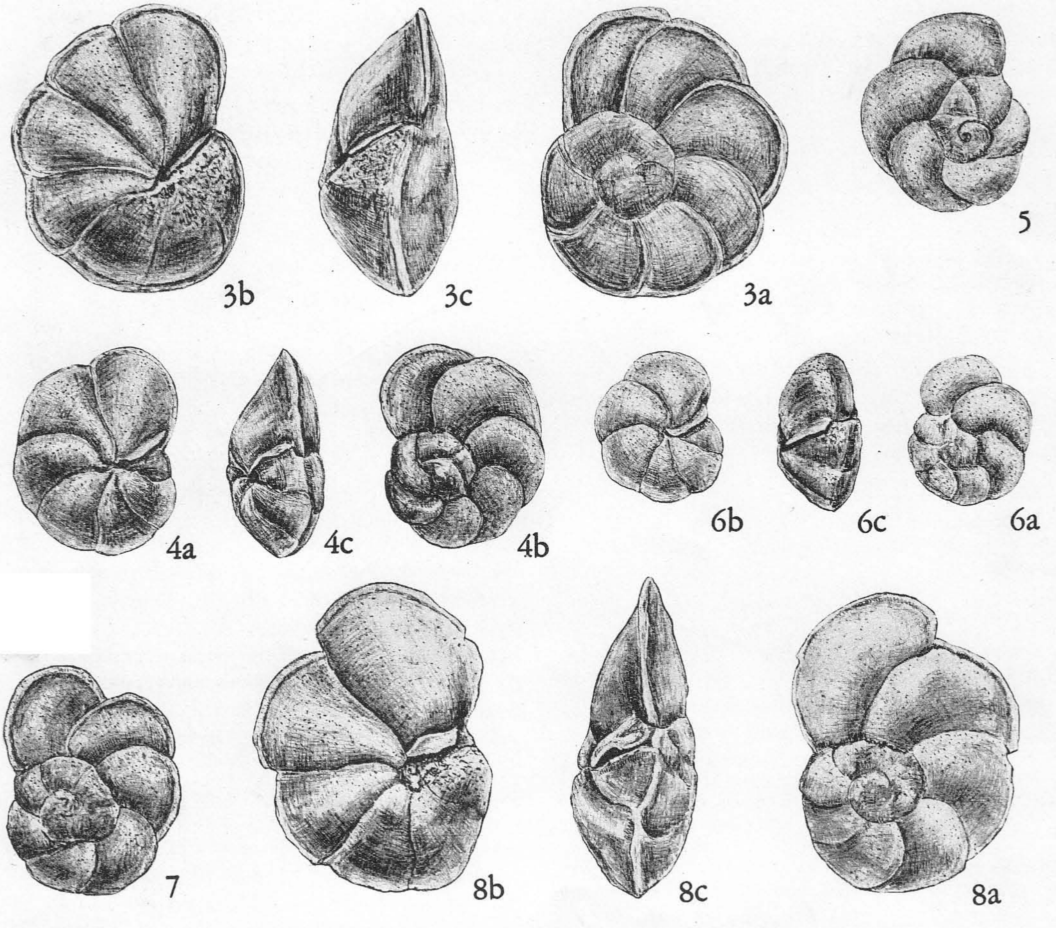
Globorotalia lobata BERMUDEZ, 1949, Special Pub. 25, Cushman Lab. Foram. Research, p. 286, pl. 22, figs. 9-11.
Globorotalia fohsi Cushman and Ellisor, CUSHMAN and

EXPLANATION OF PLATE 15

FIGS.		PAGE
1-2.	*Triloculinella obliquinodus* Riccio, n. sp. 1a, Side view of holotype; 1b, apertural view, showing oblique aperture mostly covered by semi-circular flap; 1c, side view, × 94. 2a, Side view of paratype; 2b, front view, showing broken-out semi-circular flap; 2c, side view, × 52.	90
3a-c.	*Globorotalia fohsi robusta* Bolli, n. subsp. 3a, Dorsal view of holotype; 3b, side view; 3c, ventral view, × 63.	89
4a-c.	*Globorotalia fohsi fohsi* Cushman and Ellisor. 4a, Dorsal view; 4b, side view; 4c, ventral view, × 63	88
5-6c.	*Globorotalia fohsi barisanensis* LeRoy. 5, Dorsal view of dextral specimen. 6a, Dorsal view of another specimen; 6b, side view; 6c, ventral view. × 63.	88
7-8c.	*Globorotalia fohsi lobata* Bermudez. 7, Dorsal view. 8a, Dorsal view of another specimen; 8b, side view; 8c, ventral view, × 63.	88



Riccio, *Triloculinella*, n. gen.



Bolli, Subspecies of *Globorotalia fohsi*

STAINFORTH, 1945, Special Pub. 14, Cushman Lab. Foram. Research, p. 70, pl. 13, figs. 13a-c.

The test is much compressed, longer than broad, often distinctly biconvex, although specimens with rather a flat dorsal side are not uncommon. Two whorls are usually visible from the dorsal side, the early one is closely coiled, the latter shows six to eight chambers increasing rapidly in size. Characteristic of the species are the strongly lobate "cockscomb"-like adult chambers. The peripheral margin is acute, the last chambers often with a faint keel. Sinistral tests are strongly dominant (over 90% of the specimens encountered. The ventral sutures are more or less radial, slightly depressed, especially those of the later chambers. On the dorsal side the sutures are curved, in the early part often faintly depressed, later somewhat limbate. The umbilicus is small; the wall finely perforate and in the early chambers often of a granular aspect ventrally. The aperture is elongate, on the ventral side of the margin of the last formed chamber (interiomarginal), extending from the umbilicus nearly to the periphery and with a distinct protecting lip.

Average dimensions.—Length: 0.4 to 0.7 mm; breadth: 0.3 to 0.5 mm; thickness 0.15 to 0.25 mm.

Remarks.—Specimens transitional to *Globorotalia fohsi robusta* Bolli, n. subsp. are frequently encountered.

Occurrence.—This subspecies occurs in the upper part of the Oligocene Cipero formation of Trinidad.

Globorotalia fohsi robusta Bolli, n. subsp.

Plate 15, figures 3a-c.

The test is often longer than broad, the dorsal side nearly flat to slightly convex, the ventral side strongly convex. About two whorls are visible from the dorsal side, the last with seven or eight gradually enlarging chambers. The adult chambers often have a slight lobation. The peripheral margin shows a distinct keel throughout. Sinistral tests dominate the species (over 90% of the specimens encountered). The ventral sutures are radial and slightly depressed, the dorsal ones oblique or slightly curved and often limbate. The umbilicus is small; the wall finely perforate, the ventral side of the early chambers often of a granular aspect. The aperture, an elongate slit on the ventral side of the margin of the last chamber (interiomarginal) extends from the umbilicus nearly to the periphery and has a small lip.

Average dimensions.—Length: 0.45 to 0.7 mm; breadth: 0.3 to 0.6 mm; thickness: 0.25 to 0.3 mm.

Occurrence.—This subspecies occurs in the upper part of the ~~Oligocene~~ Cipero formation of Trinidad.

The holotype is deposited in the Cushman Collection (No. 64136), United States National Museum, Washington, D. C.

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Manuscript received September 12, 1950

17. TRILOCULINELLA, A NEW GENUS OF FORAMINIFERA

JOSEPH F. RICCIO
University of Southern California

INTRODUCTION

In the course of study of the Timms Point silt, Timms Point, San Pedro, California, a species of Foraminifera was noted that did not fall within existing specific and generic categories.

Additional study revealed much taxonomic confusion between closely related forms and the genus herein described. It was considered desirable therefore to erect a new genus for this form.

The writer is indebted to Dr. O. L. Bandy, professor of geology at the University of Southern California for his guidance and helpful criticism in the preparation of this paper.

SYSTEMATIC DESCRIPTIONS

ORDER FORAMINIFERA

Family MILIOLIDAE d'Orbigny, 1839

Genus **Triloculinella**, n. gen.

Genotype.—Triloculinella obliquinodus Riccio, n. sp.

Diagnosis.—Test imperforate, calcareous, triloculine in adult; large semicircular flap covering most of the aperture.

This genus is erected to embrace those triloculine forms assigned to *Miliolinella*. The genus *Miliolinella* is quinqueloculine as indicated by its genotype, *Quinqueloculina lamellidens* Reuss (Deutsche Sudpolar-Exped., vol. XX, Zool., 1931, p. 65), an unquestioned quinqueloculine form with a broad flap covering the aperture. The genus *Triloculinella* differs from *Triloculina,* whose type is *"Miliolites" trigonula* Lamarck, 1804, in having a large semicircular flap covering the aperture (figure 1).

Triloculinella obliquinodus Riccio, n. sp.

Plate 15, figures 1a-2c.

Triloculina oblonga, CUSHMAN and VALENTINE (not Montagu), 1930, Contr. Dept. Geol., Stanford University, vol. 1, no. 1, p. 16, pl. 4, figs. 6a-c.

Description.—Test imperforate, calcareous, elongate, ovate, slightly compressed; with three visible chambers, inflated, last-formed chamber broadest at initial end, longer than preceding ones; edge broadly rounded in end view; sutures distinct, arcuate, somewhat depressed; wall smooth; aperture oblique with large semicircular flap covering most of the aperture.

Holotype.—Length 0.51 mm, breadth 0.21 mm, thickness 0.13 mm, plate 15, figures 1a-c.

Paratype.—Length 1.1 mm, breadth 0.5 mm, thickness 0.36 mm, plate 15, figures 2 a-c.

Locality.—San Pedro, California; Timms Point silt, Lower Pleistocene; U. S. Geol. Surv. Prof. Paper 207, locality 32e.

Depository.—Paleontological collection, University of Southern California, Los Angeles, California.

Remarks.—Montagu, in 1803, erected the species *Vermiculum oblongum,* (Testacea Britannica, 1803, p. 552, fig. 9). In 1826 d'Orbigny placed *V. oblongum* in the genus *Triloculina.* Subsequently, Cushman placed *T. oblonga* in the genus *Miliolinella,* (Cushman, Foraminifera, 1948, pl. 15, figs. 6a-c). Cushman's *M. oblonga* differs from Montagu's type in the following respects: 1. *V. oblongum* possesses a distinct neck. 2. *V. oblongum* does not have a semicircular flap covering an oblique aperture, and 3. Sutures of *V. oblongum* are parallel to the long axis.

In the Contr. Dept. Geol., Stanford University, 1930, vol. 1, no. 1, pl. 4, Cushman and Valentine show two groups of figures, 5a-c and 6a-c; and they refer these to *Triloculina oblonga.* Cushman refers figure 5a-c of the above reference to *Miliolinella oblonga,* (Foraminifera, 1948, pl. 15, fig. 6a-c). Both figures 5a-c and 6a-c of Cushman and Valentine are triloculine forms with a large semicircular flap covering most of the aperture. Figure 5a-c (Cushman and Valentine) however, does not have an oblique aperture, and possesses an angled instead of an arcuate suture as shown by figure 6a-c of the same reference.

The paratype has had the tooth broken out in order to see the size and shape of the aperture. Length of the specimens range from 0.5 mm to 1.1 mm.

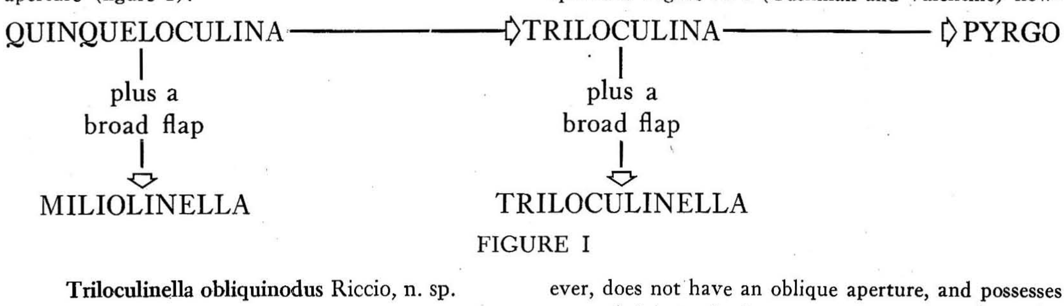

FIGURE I

Manuscript received June 26, 1950

RECENT LITERATURE ON THE FORAMINIFERA

Below are given some of the more recent works on the foraminifera that have come to hand:

Mikhailov, A. To the characteristics of the genera of Lower Carboniferous Foraminifera on the territory of the Union S. S. R., in, The Lower Carboniferous Deposits of the North-western limb of Moscow Basin.—Leningrad Geological Administration, Symposium No. 3, 1939, pp. 47-62, pls. 1-4. (English Summary)—Numerous species, several new, are described and figured. They belong in 23 genera, of which the following are, or had previously been, erected by the author: *Brunsia* Mikhailov, 1935-36 (genotype *Spirillina irregularae* Möller), *Forschia* Mikhailov, 1935 (genotype *Spirillina subangulata* Möller), *Forschiella* Mikhailov, 1935 (genotype *F. prisca* Mikhailov), *Mstinia* Mikhailov, 1935-6 (genotype *M. bulloides* Mikhailov), *Endothyrina* Mikhailov 1935 (genotype *E. typica* Mikhailov), *Yanischewskina* Mikhailov, 1935 (genotype *Y. typica* Mikhailov), *Pseudoendothyra* n. gen. (genotype *Fusulinella struvii* Möller). Wall structure of the Lower Carboniferous foraminifera is discussed.

Of the paleozoic Ammodiscidae.—L. c., pp. 63-69, text figs. 1-5. (English Summary)—A discussion of the family relationships of the Ammodiscidae, including five of the genera mentioned in the preceding paper: *Brunsia, Endothyrina, Forschia, Forschiella,* and *Mstinia.*

Vogler, J. Ober-Jura und Kreide von Misol (Niederländisch-Ostindien).—Palaeontographica, 1941, Suppl. 4, pt. 4, pp. 243-293, pls. 19-24, text figs. 1-13, tables 1, 2.—The work includes chiefly thin-section studies of Globotruncanas (of which one is new, and there are two new names), and the two families: (1) Cadosinidae Wanner (single-chambered globular porcellanous forms with one or two or no apertures) including the genera, *Cadosina* Wanner, 1940, with 10 species, of which 7 are new; *Pithonella* Lorenz, 1902, with one species; and *Cadosinella,* n. gen. (genotype *C. gracillimoides* n. sp.); and (2) Stomiosphaeridae Wanner (single-chambered globular hyaline, perforate forms with or without an aperture) including 6 species, of which 3 are new, in the genus *Stomiosphaera* Wanner, 1940.

Crespin, Irene. Foraminifera in Australian Stratigraphy.—International Geol. Congress "Report of the Eighteenth Session, Great Britain, 1948," Part XV, pp. 1-8, fig. 1 [map].—Large and small foraminifera are mentioned in discussing assemblages useful in correlation.

Ovey, C. D. The stratigraphical value of Foraminifera in New Zealand (based on correspondence and literature from Dr. H. J. Finlay).—L. c., pp. 1-4.—An interesting account of the development and present state of usefulness of foraminifera in stratigraphic correlation and age determination in New Zealand.

Phleger, Fred. B. The Foraminifera (Contr. No. 484 from the Woods Hole Oceanographic Institution and No. 1 from the Marine Foraminifera Laboratory), Papers from the Robert S. Peabody Foundation for Archeology, vol. 4, No. 1, 1949, pp. 99-108, pl. 14, tables 13, 14.—The few species found in the clay beds exposed in excavations in the Boston Basin are studied as to their ecologic significance.

Maync, Wolf. The foraminiferal genus *Choffatella* Schlumberger in the Lower Cretaceous (Urgonian) of the Caribbean Region (Venezuela, Cuba, Mexico, and Florida).—Eclogae geol. Helvetiae, vol. 42, No. 2, 1949, pp. 529-547, pls. 11, 12, text fig. 1 [map], table.—Correlation between *Choffatella-Pseudocyclammina*-bearing beds in the Caribbean region is discussed, and the geographical distribution of the genus within the Tethyan areas is described. The phyllogenetic relations of *Choffatella* and related genera are discussed and the new subfamily Spirocyclininae is proposed to contain the lituolid group of genera that show a reticulate subepidermal layer of diagnostic value. Numerous specimens of *C. decipiens* are illustrated in section and an emended diagnosis is given. Two other species of the genus are briefly discussed.

Uchio, Takayasu. Foraminiferal study of Tertiary Formation near Otaki Gas-Field, Chiba Prefecture (Series I), in Natural Gas in the Vicinity of Otaki, Chiba-ken, by K. Kawai, T. Uchio, M. Ueno, and M. Hozuki.—Journ. Assoc. Petr. Technologists, vol. 15, No. 4, June 1950, pp. 151-219, text figs. 1-25 (including maps and sections), tables 1-6. (English Summaries)—A new genus, *Pseudoeponides* (genoholotype *P. japonica* n. sp.) and 4 new species are described and figured.

Asano, Kiyoshi. Upper Cretaceous Foraminifera from Japan.—Pacific Science, vol. 4, no. 2, April 1950, pp. 158-163, pl. 1.—In this first Upper Cretaceous foraminiferal fauna from Japan, 15 species are described and figured, of which 4 are new and 4 unidentifiable.

Illustrated Catalogue of Japanese Tertiary Smaller Foraminifera. Part I: Nonionidae. (compiled and edited by Leo. W. Stach)—Tokyo, Japan, July 21, 1950, pp. 1-12, text figs. 1-73.—Thirty-four species and varieties, of which 7 are new, in the 9 genera of this family are formally described and illustrated, those originally from elsewhere than Japan being illustrated by a Japanese hypotype.

Japanese Tertiary Species of *Gaudryina* and *Gaudryinella*. Short Papers from the Institute of Geology and Paleontology, Tôhoku Univ., Sendai, No. 1, July 5, 1950, pp. 5-10, pl. 2.—Ten species of *Gaudryina,* 2 new, and 2 of *Gaudryinella,* both new, are recorded and figured.

Hanzawa, Shoshiro. Eocene Foraminifera from Hahajima (Hillsborough Island) (2).—L. c., pp. 1-4, pl. 1.—Formal description and illustration of *Alveolina javana* Verbeek, var. *boninensis,* n. var.

Bronnimann, P. The genus *Hantkenina* Cushman in Trinidad and Barbados, B. W. I.—Journ. Pal., vol. 24, No. 4, July 1950, pp. 397-420, pls. 55, 56, text figs. 1, 2, tables 1-3.—Thirteen species, 3 new, are described in detail and figured. They are included in 5 subgenera, one of which, *Hantkeninella* (subgenotype *H. primitiva* Cushman and Jarvis), is new. Morphological distinctions are discussed and shown in a table. Stratigraphic distribution is shown in other tables.

Crespin, Irene. Australian Tertiary Microfaunas and their relationships to assemblages elsewhere in the Pacific region.—L. c., pp. 421-429, text fig. 1 (map).—Genera and species of both larger and smaller foraminifera are mentioned in discussing the "letter" classification in two provinces: Austral-Indo-Pacific and Bass Strait.

Thompson, M. L., G. J. Verville, and **H. J. Bissell.** Pennsylvanian Fusulinids of the South-Central Wasatch Mountains, Utah.—L. c., pp. 430-465, pls. 57-64, text figs. 1, 2.—Fifteen species and varieties, 5 new, are described and illustrated.

Hussey, Keith M., and **Charles L. McNulty, Jr.** *Planularia planotrochiformis,* a new species showing variation in the genus.—L. c., pp. 472, 473, text figs. 1-9.—The species shows a change from planispiral to trochoid coiling.

Applin, Esther R., and **Louise Jordan.** *"Lockhartia" cushmani* Applin and Jordan and notes on two previously described foraminifera from Tertiary rocks in Florida.—L. c., pp. 474-478, pl. 66.—Discussion of changes made in the names of *Lockhartia cushmani, Elphidium leonensis,* and *Miscellanea nassauensis.*

Bursch, J. H. The Range Chart as an Aid in Foraminiferal Correlation.—L. c., pp. 479-484, text fig. 1, table. 1.

Stainforth, R. M. Types of *Pullenia duplicata* Stainforth.—L. c., p. 502.

Garrett, J. B., Jr. New Name for a Texas Miocene Foraminifer.—L. c., p. 506.—*Planulina palmerana* for *P. palmerae* Garrett (not van Bellen).

Natland, M. L. Report on the Pleistocene and Pliocene Foraminifera. Part IV in 1940 E. W. Scripps Cruise to the Gulf of California, Geol. Soc. Amer., Mem. 43, August 10, 1950, pp. i-v, 1-55, pls. 1-11. —One hundred thirty-two species and varieties, 5 new, 13 indeterminable, and 2 with new names, are recorded and illustrated from 16 outcrop samples. Ecologic significance of the faunas is described.

Wiseman, J. D. H. and **C. D. Ovey.** Recent Investigations on the Deep-Sea Floor.—Proc. Geol. Assoc., vol. 61, pt. 1, 1950, pp. 28-84, pls. 2, 3, text figs. 1-3, tables 1-3.—A statistical study based on actual counts of 19 species in 9 widely separated, deep, bottom samples confirms the validity of certain planktonic species as indicators of surface water temperatures. The 19 species, grouped as to cold, temperate, and warm indicators, are figured. An historical survey of the field of deep-sea investigations is included in the paper.

van Voorthuysen, J. H. Recent Indigenous and Upper-Cretaceous Derived Foraminifera of the Netherlands Tidal Flats (Wadden).—Waddensymposium, Geol. Instit. Groningen, Nederland, Melkweg 1, Publ. 53, 1950, pp. 89-93, pl.—The meager fauna is studied as to percentage distribution and ecology. The derived foraminifera are believed to be sea-transported. Nineteen species are figured.

Hagn, Herbert. Über Umlagerungsvorgänge in der subalpinen Molasse Oberbayerns und ihre Bedeutung für die alpine Tektonik.—Geologica Bavarica, No. 5, 1950, pp. 1-45, pls. 1-5.—Numerous foraminifera are mentioned and figured, none new.

Barnard, T. Foraminifera from the Lower Lias of the Dorset Coast.—Quart. Journ. Geol. Soc. London, vol. 105, pt. 3, Sept. 5, 1950, pp. 347-391, text figs. 1-11, chart.—Forty-seven species and varieties, 8 new, are described and illustrated and their distribution plotted in a carefully collected section. Certain shorter-range species are noted as useful markers, and the first appearances of other species are used as zone markers. The *Lenticulina* "plexus" is discussed with the aid of a diagram.

RUTH TODD