FORAMINIFERAL ASSEMBLAGES IN THE VICINITY OF THE SETO MARINE BIOLOGICAL LABORATORY, SHIRAHAMA-CHO, WAKAYAMA-KEN, JAPAN (PART 1)[1]

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With 1 Text-figure and 5 Tables

Introduction

In a previous report (UCHIO, 1962), the writer discussed Recent nearshore foraminiferal thanatocoenoses along the coast of Wakayama-ken, and their bearing on the hydrography. Among the localities of the samples mentioned in the paper, two samples were from Seto and Ezura near the Seto Marine Biological Laboratory, and four samples from Mori Harbour, Tanabe-shi, about six km northeast of the laboratory (Fig. 1). Recently, Prof. T. TOKIOKA of the laboratory collected a few samples in the same area, and asked the writer to analyze their foraminiferal assemblages, suggesting that he writes this short article. As only six samples from four stations were available for study, no detailed discussion of them can be made, and the main object of this study is to record the species and their relative abundances. However, the foraminiferal assemblages of the middle and lower parts of the continental shelf in this region are almost unknown; general features were reported by ASANO (1937) and ISHIWADA (1964) from Tosa Bay, Shikoku, Japan (see Index Map of Fig. 1). Therefore, the writer thinks it useful to report this short but detailed analysis of the foraminiferal faunas.

The writer wishes to thank Prof. TAKASI TOKIOKA of the Seto Marine Biological Laboratory, Kyoto University, for his kindness in allowing the writer to analyze the foraminiferal faunas and to publish the results in the Publications of the Seto Marine Biological Laboratory. Thanks are also due to Prof. FRED B PHLEGER and Miss FRANCES L. PARKER of the Scripps Institution of Oceanography, University of California, La Jolla, California for their constant encouragement and for reading the manuscript. Most of the foraminiferal specimens studied are deposited in the collections of the Seto Marine Biological Laboratory, Shirahama-cho, Wakayama-ken, Japan.

1) Contributions from the Seto Marine Biological Laboratory, No. 481 and Studies of Meiobenthos by Dragonet, No. 3.

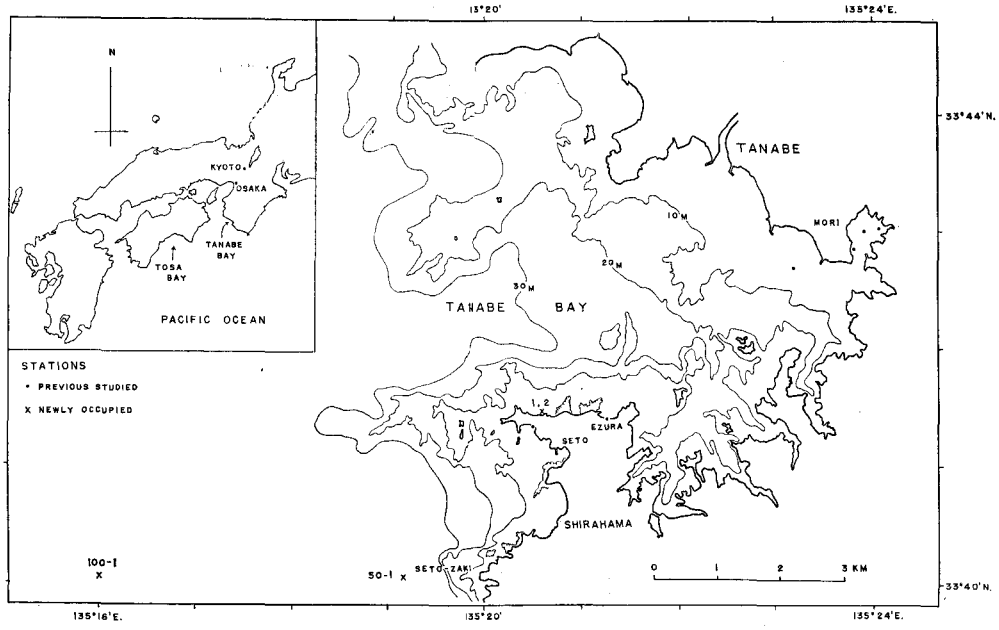

Fig. 1. Locations of stations and submarine topography.

Method of study

Samples were obtained by means of "Dragonet" devised by Drs. BIERI and TOKIOKA, consisting of an iron sled on which a bottom-net and top-net are fixed. The size of the mouth of each net is 1,500 cm^2 (width 75 cm, height 20 cm) and the aperture of the mesh is 0.3 mm. The details of the "Dragonet" is described by BIERI and TOKIOKA (1968) in a separate paper. The Dragonet was lowered to the sea floor from the deck of a ship, and was dragged for about 60 m along the floor in a direction parallel to the shoreline at Stations 1 and 2. The bottom-net scratched and obtained surface sediments and some algae, and the suspended part of the bottom sediment were trapped in the top-net. Thus, two samples were obtained at Stations 1 and 2, respectively, 1-a and 2-a being bottom-net samples, and 1-b and 2-b top-net samples. However, at Stations 50–1 (50 m) and 100–1 (97.5 m) only bottom-net samples were collected. The sediment type is fine sand. These facts suggest that the bottom is relatively smooth around the two stations.

Dr. TOKIOKA made a preliminary sorting of various organisms for detailed analyses. He picked out all specimens (including fragments) contained in the sediment samples, stored them in vials with alcohol as the preservative, and delivered the Foraminifera to the writer for analysis. The writer added a small amount of Rose Bengal solution to the samples to separate the living tests (when collected) from

STATION NO.	1	2	50–1	100–1
DEPTH (m)	1.5	1.8	50	97.5
N. LAT.	33°41′25.8″	33°41′25.8″	33°40′03″	33°40′03″
E. LONG.	135°20′35.8″	135°20′35.8″	135°19′09″	135°15′59″
DISTANCE FROM BEACH	7 m	10 m	1.2k m	6 km
DRAG-DISTANCE	60 m	60 m	60 m	60 m
SEDIMENT TYPE	gravel	sand	fine sand	fine sand
DATES OF COLLECTIONS	March 12, 1966		June 13, 1966	Oct. 24, 1966

the dead ones. However, most specimens were empty (dead). Living specimens of *Operculina ammonoides* and *Hanzawaia nipponica* were common in sample 50–1. Locations of these samples are shown in Fig. 1 together with those of the six samples previously studied.

Foraminifera assemblages

The foraminiferal assemblages here dealt with are considered as thanatocoenoses, though they included some living specimens when collected. Altogether 240 species, varieties and subspecies (225 benthonic and 15 planktonic) were distinguished, of which 160 were identical with forms previously known, 46 were questionably referred to known species, and 34 were indeterminate specifically (see Table 1). They are grouped in 115 genera and 44 families according to LOEBLICH and TAPPAN's (1964) classification, though the writer has raised to family status their subfamily Plectofrondicullariinae.

Generally speaking, the faunas here studied are characteristic of the tropical to subtropical Pacific or Indo-Pacific waters. Most of the species identified are known from the South Pacific Islands (CUSHMAN, 1932, 1933, 1942; CUSHMAN, TODD and POST, 1954; TODD, 1957, 1965, 1966), Philippines (CUSHMAN, 1921; GRAHAM and MILITANTE, 1959), Malaya Archipelago (MILLETT, 1898–1904), Kerimba Archipelago off Portuguese East Africa (HERON-ALLEN and EARLAND, 1914–1915), Red Sea (SAID, 1949, 1950), Dry Tortugas, Florida (CUSHMAN, 1922) and West Indian Islands (HOFKER, 1964). As shown in Table 1, 130 and 109 benthonic species of the Shirahama faunas are the same or very closely related to the species of the tropical Pacific and the Philippines (mostly shallow waters), respectively. In other words, about four fifths of all the benthonic species of Shirahama area (excluding indeterminate forms) are known from the tropical Pacific and Philippines.

Tanabe Bay region, of which Shirahama is a part, is well known for a molluscan fauna that is the most diversified in Japan. The number of foraminiferal genera and species present (Tables 3 and 4) are also very large, as is usual in the shallow tropical

Table 1. Occurrences of Foraminifera in percent of total (living plus dead) population. Benthonic and planktonic populations computed separately.

	Group A		Group B				Philippines		Tropical Pacific: Cushman, Todd, etc. 1932–1966
SAMPLE NO.	100–1	50–1	2-a	2-b	1-a	1-b	Graham & Militante 1959	Cushman 1921	
DEPTH (m)	97.5	50	1.8		1.5				
ARENACEOUS BENTHONIC FORAMINIFERA									
Aschemonellidae									
Reophax scorpiurus Montfort	R	0.5	—	—	—	—	×	×	—
Nouriidae									
Nouria polymorphinoides Heron-Allen & Earland	—	R	—	—	—	—	—	—	×
Lituolidae									
Alveolophoragmium jeffreysii (Williamson)	—	R	—	—	—	—	×	×	—
A. sp.	—	R	—	—	—	—	—	—	—
Haplophragmoides (?) sp.	—	R	—	—	—	—	—	—	—
Textulariidae									
Textularia cf. *T. agglutinans* d'Orbigny	—	3	—	—	—	—	×	×	×
T. agglutinans fistula Cushman	0.2	0.4	—	—	—	—	—	×	—
T. conica d'Orbigny (short, smooth surface variety)	0.2	0.5	—	—	—	—	×	×	×
T. foliacea Heron-Allen & Earland	R	0.2	—	—	—	—	×	×	×
T. foliacea oceanica Cushman	—	2	—	—	—	—	×	—	×
T. foliacea oceanica Cushman var.	—	0.2	—	—	—	—	—	—	—
T. kerimbaensis Said	0.6	1	—	—	—	—	×	—	×
T. aff. *T. occidentalis* Cushman	—	0.2	—	—	—	—	—	—	—
T. cf. *T. pseudotrochus* Cush.	R	VR	—	—	—	—	—	×	—
Siphotextularia aff. *S. rolshauseni* Phleger & Parker	0.1	0.2	—	—	—	—	—	—	—
Spiroplectammina atrata (Cushman)	0.9	0.1	—	—	—	—	—	×	—
S. pseudocarinata Cushman	2	1	—	—	—	—	—	×	—
Bigenerina cf. *B. nodosaria* d'Orbigny	R	2	—	—	—	—	—	×	—
Trochamminidae		3							
Trochammina cf. *T. pacifica* Cushman	VR	0.5	—	—	—	—	—	—	—
T. sp.	R	—	—	—	—	—	—	—	—
Ataxophragmiidae									
Gaudryina cf. *G. pacifica* Cushman & McCulloch	0.5	2	—	—	0.2	—	×	—	—
Clavulina yabei akiensis Asano	R	—	—	—	—	—	—	—	—
Pseudocalvulina scabra Cushman	VR	—	—	—	—	—	—	—	—
Carterinidae									

Table 1 (continued)

SAMPLE NO.	Group A		Group B				Philippines		Tropical Pacific: Cushman, Todd, etc. 1932-1966
	100–1	50–1	2-a	2-b	1-a	1-b	Graham & Militante 1959	Cushman 1921	
DEPTH (m)	97.5	50	1.8		1.5				
Carterina spiculotesta (Carter)	—	R	—	—	—	—	—	—	×
Miliolidae (part)									
Quinqueloculina cf. *Q. agglutinans* d'Orbigny	VR	R	—	—	—	—	×	×	×
Sigmoilopsis (?) sp.	R	—	—	—	—	—	—	—	—
CALCAREOUS (PORCELANEOUS) BENTHONIC FORAMINIFERA									
Fischerinidae									
Cyclogyra involvens (Reuss)	R	—	—	—	—	—	×	×	—
C. sp. cf. *Cornuspiroides foliaceus* (Phil.)	R	—	—	—	—	—	—	×	—
Nubeculariidae									
Spiroloculina cf. *S. acescata* Cushman	VR	R	—	—	—	—	×	—	×
S. sp. A	0.1	R	—	0.7	—	0.3	—	—	—
S. communis Cushman & Todd	3	0.4	1	—	0.2	0.3	×	—	×
S. corrugata Cushman & Todd	0.7	0.3	—	0.7	0.8	0.3	×	×	×
S. cf. *S. foveolata* Egger	R	R	—	—	—	0.3	—	—	×
S. hadai Thalmann	—	—	—	—	0.2	—	×	—	×
Nodobacullariella cf. *N. convexiuscula* (Brady)	—	R	—	—	—	—	—	×	—
Nodophthalmidium n. sp. of Barker, 1960	VR	R	—	—	—	—	—	×	—
Vertebralina striata d'Orbigny	0.7	0.5	1	0.7	0.8	0.3	×	×	×
Miliolidae									
Quinqueloculina cf. *Q. badenensis* d'Orbigny	R	R	—	—	—	—	—	—	—
Q. cf. *Q. contorta* d'Orbigny	R	R	—	—	—	—	—	×	×
Q. cf. *Q. costata* d'Orbigny	—	R	—	—	—	—	—	—	×
Q. crassa subcuneata Cushman	R	R	—	—	—	—	×	×	×
Q. sp. cf. *Cribrolinoides curta* (Cushman)	R	R	—	—	—	—	×	×	—
Q. granulocostata Germeraad	0.1	R	—	—	—	—	×	—	—
Q. cf. *Q. laevigata* d'Orbigny	—	R	—	—	—	—	×	—	—
Q. lamarckiana d'Orbigny	0.1	—	—	—	—	—	—	×	×
Q. parkeri (Brady)	R	R	—	—	—	—	×	×	×
Q. subarenaria Cushman	—	0.5	—	—	—	—	—	—	×
Q. cf. *Q. subarenaria* Cushman	—	R	—	—	—	—	—	—	—
Q. cf. *Q. seminula* (Linné)	—	—	—	1	—	—	×	×	×
Q. vulgaris d'Orbigny	1	1	—	—	—	—	×	×	—
Q. cf. *Q. vulgaris* d'Orbigny	—	0.1	—	—	—	—	—	—	—
Q. yabei Asano	—	R	3	—	0.6	—	—	—	—

Table 1 (continued)

SAMPLE NO.	Group A		Group B				Philippines		Tropical Pacific: CUSHMAN, TODD, etc. 1932-1966
	100–1	50–1	2-a	2-b	1-a	1-b	GRAHAM & MILITANTE 1959	CUSHMAN 1921	
DEPTH (m)	97.5	50	1.8		1.5				
Q. sp. A	—	R	—	—	—	—	—	—	—
Q. sp. B	—	R	—	—	—	—	—	—	—
Q. sp. C	—	R	—	—	—	—	—	—	—
Q. sp. D	0.1	—	—	—	—	—	—	—	—
Q. sp. E	R	—	—	—	—	—	—	—	—
Q. sp. F	R	R	—	—	—	—	—	—	—
Q. spp. (fragments)	4	1	—	R	1	2	—	—	—
Triloculina affinis D'ORBIGNY	4	3	3	2	2	2	×	×	×
T. bertheliniana (BRADY)	—	—	—	—	0.2	—	×	×	×
T. irregularis (D'ORBIGNY)	0.1	R	3	1	2	0.3	×	—	×
T. cf. *T. planciana* D'ORBIGNY	0.7	0.5	3	—	0.2	0.6	—	—	—
T. cf. *T. planciana* D'ORBIGNY var.	—	0.2	—	—	—	—	—	—	—
T. striatotrigona PARKER & JONES	R	—	—	—	0.2	—	—	×	×
T. terquemiana (BRADY)	R	—	—	—	0.4	—	×	×	×
T. tricarinata D'ORBIGNY	2	0.8	6	—	1	0.6	×	×	×
Pyrgo ddenticulata (BRADY) var.	0.2	0.3	3	—	0.2	—	×	×	×
P. cf. *P. depressa* (D'ORBIGNY)	0.1	R	—	—	—	—	—	×	—
P. milletti (CUSHMAN)	R	—	—	—	0.2	—	×	×	×
Biloculinella globula (BORNEMANN)	R	—	—	—	—	—	—	×	×
Pyrgoella sphaera (D'ORBIGNY)	R	R	—	—	—	—	—	×	×
Miliolinella circularis (BORNEMANN)	2	0.6	3	—	0.2	0.6	×	×	×
M. oceanica (CUSHMAN)	2	0.5	3	—	1	0.3	×	—	×
M. sublineata (BRADY)	—	R	—	—	—	—	—	—	—
M. suborbicularis (D'ORBIGNY)	0.2	R	—	—	—	0.3	×	—	—
Massilina inaequalis CUSHMAN	VR	—	—	—	0.2	—	×	—	×
Pseudomassilina macilenta (BRADY)	VR	—	—	—	—	—	×	—	—
Hauerina bradyi CUSHMAN	—	R	—	—	1	2	—	×	×
H. fragilissima (BRADY)	0.6	0.3	1	2	2	0.9	×	×	×
H. orientalis CUSHMAN	—	—	—	—	0.2	—	—	—	—
H. pacifica CUSHMAN	0.5	0.4	3	—	3	0.3	×	—	×
H. cf. *H. pacifica* CUSHMAN	—	0.1	—	—	—	—	—	—	—
H. speciosa (KARRER)	—	R	—	—	—	—	—	—	×
Hauerina or *Polysegmentia* sp.	—	—	—	—	—	0.3	—	—	—
Soritidae									
Spirolina arietina (BATSCH)	—	—	—	0.7	0.8	0.3	×	×	×
Solites marginalis (LAMARCK)	0.5	0.2	3	7	4	7	×	×	×

Table 1 (continued)

	Group A		Group B				Philippines		Tropical Pacific: Cushman, Todd, etc. 1932-1966
SAMPLE NO.	100–1	50–1	2-a	2-b	1-a	1-b	Graham & Militante 1959	Cushman 1921	
DEPTH (m)	97.5	50	1.8		1.5				
Amphisorus hemprichii Ehrenberg	—	—	—	0.7	—	1	×	—	×
CALCAREOUS (HYALINE) BENTHONIC FORAMINIFERA									
Nodosariidae									
Lagena cf. *L. amphora* Reuss	VR	—	—	—	—	—	—	—	—
L. plicoenica Cushman & Gray	VR	—	—	—	—	—	—	—	—
L. striata strumosa Reuss	VR	—	—	—	—	—	—	×	—
Nodosaria albatrossi Cushman	VR	—	—	—	—	—	—	×	—
N. pauciloculata Cushman	VR	—	—	—	—	—	—	×	×
Dentalina cf. *D. communis* d'Orbigny	—	R	—	—	—	—	—	—	—
D. cf. "*D. jogusa* Williamson" of Cushman & McCulloch	0.1	—	—	—	—	—	—	—	—
D. sidebottomi Cushman	0.2	—	—	—	—	—	—	—	×
D. californica Cushman & Gray	0.1	VR	—	—	—	—	—	—	—
D. subemaciata Parr	VR	—	—	—	—	—	—	×	—
D. intorta (Dervieux)	—	R	—	—	—	—	—	×	×
Pseudonodosaria sp.	VR	—	—	—	—	—	—	—	—
Amphicoryna scalaris (Batsch)	0.9	R	—	—	—	—	—	×	×
Robulus calcar (Linné)	2	0.9	—	—	—	—	—	×	×
R. sp. A	VR	R	—	—	—	—	—	—	—
R. sp. B	R	R	—	—	—	—	—	—	—
R. sp. C	VR	—	—	—	—	—	—	—	—
R. sp. D	VR	—	—	—	—	—	—	—	—
R. sp. E of Todd, 1957	VR	—	—	—	—	—	—	—	×
"*Planularia tricarinella* Reuss" of Brady	0.1	—	—	—	—	—	—	×	—
Vaginulinopsis tenuis (Bornemann)	VR	—	—	—	—	—	—	—	—
V. sp.	VR	—	—	—	—	—	—	—	—
Astacolus hanzawai (Asano)	—	R	—	—	—	—	—	—	—
A. vaginulinaeformis (Cushman & Hanzawa)	R	—	—	—	—	—	—	×	×
Saracenaria angulata Natland	VR	—	—	—	—	—	—	—	—
S. cf. *S. italica* Defrance	R	—	—	—	—	—	—	×	—
Plectofrondiculariidae									
Bolivinella folia (Parker & Jones)	VR	—	—	0.7	2	—	×	—	×
Polymorphinidae									
Polymorphina (?) sp.	R	—	—	—		—	—	—	—
Pseudopolymorphina sp.	—	R	—	—		—	—	—	—

Table 1 (continued)

SAMPLE NO.	Group A		Group B				Philippines		Tropical Pacific: CUSHMAN, TODD, etc. 1932-1966
	100–1	50–1	2-a	2-b	1-a	1-b	GRAHAM & MILITANTE 1959	CUSHMAN 1921	
DEPTH (m)	97.5	50	1.8		1.5				
Sigmomorphina sp.	—	R	—	—	—	—	—	—	—
Sigmoidella kagaensis CUSHMAN & OZAWA	0.1	0.2	—	—	—	—	—	—	—
Guttulina aff. *G. regina* (BRADY, PARKER & JONES)	—	R	—	—	—	—	—	×	—
G. sp.	R	R	—	—	—	—	—	—	—
Fissurina cf. *F. lacunata* (BURROWS & HOLLAND)	VR	—	—	—	—	—	—	—	—
F. marginata (MONTAGU) var.	—	R	—	—	—	—	×	×	—
Sphaeroidinidae									
Sphaeroidina cf. *S. compressa* CUSHMAN & TODD	0.3	R	—	—	—	—	—	×	×
Turrilinidae									
Buliminella elegantissima D'ORBIGNY	VR	—	—	—	—	—	—	×	×
Bolivinitidae									
Bolivina kiiensis ASANO	VR	—	—	—	—	—	—	—	—
B. rhomboidalis (MILLETT)	VR	—	—	—	—	—	—	—	×
B. cf. B. robusta BRADY	VR	R	—	—	—	—	—	×	×
B. semicostata CUSHMAN	VR	—	—	—	—	—	×	×	×
Loxostomoides (?) *amygdalaeformis* (BRADY)	VR	—	—	—	—	—	—	×	—
L. (?) *karrerianum* (BRADY)	3	1	—	—	—	—	×	×	×
L. (?) *mayori* (CUSHMAN)	—	—	—	—	0.2	—	×	×	×
Rectobolivina raphana (PARKER & JONES)	2	R	—	—	—	—	×	×	×
Buliminidae									
Bulimina marginata D'ORBIGNY	VR	R	—	—	—	—	—	×	—
Pavonina flavelliformis D'ORBIGNY	R	R	—	—	—	—	×	—	×
Chrysalidinella dimorpha (BRADY)	VR	—	—	—	—	—	—	×	×
Reussella cf. *R. aculeata* CUSHMAN	VR	—	—	—	—	—	×	—	×
R. simplex CUSHMAN	2	1	4	1	3	1	—	×	×
Uvigerinidae									
Uvigerina sp.	R	—	—	—	—	—	—	—	—
Discorbidae (including Glabratellidae)									
Discorbinella (?) cf. *D. bertheloti* (D'ORBIGNY)	0.1	R	—	—	—	—	—	×	—
Epistominella (?) *tubulifera* (HERON-ALLEN & EARLAND)	R	0.1	—	—	—	—	×	—	×
Gavelinopsis praegeri (HERON-ALLEN & EARLAND)	0.2	0.2	—	0.7	0.4	0.3	—	—	×

Table 1 (continued)

	Group A		Group B				Philippines		Tropical Pacific: Cushman, Todd, etc. 1932-1966
SAMPLE NO.	100–1	50–1	2-a	2-b	1-a	1-b	Graham & Militante 1959	Cushman 1921	
DEPTH (m)	97.5	50	1.8		1.5				
Neoconorbina crustata (Cushman)	0.1	0.3	4	—	2	0.9	—	—	×
N. opercularis (d'Orbigny)	0.3	1	—	1	2	2	—	—	—
N. opercularis nakamurai (Asano)	0.6	0.8	—	2	2	0.6	—	—	—
N. opercularis subopercularis (Asano)	—	0.3	—	1	—	—	—	—	—
N. terquemi stachi (Asano)	0.2	R	1	5	3	1	×	×	×
N. patelliformis (Brady)	0.7	0.7	1	2	1	—	×	—	×
Augulodiscorbis quardrangularis Uchio	—	R	—	—	—	—	—	—	×
Rotorbinella mira (Cushman)	R	0.3	1	0.7	0.2	1	×	—	×
Hanzawaia nipponica Asano	3	2	—	—	—	—	—	—	—
Patellinella hanzawai Asano	VR	—	—	—	—	—	×	—	—
Glabratella pulvinata makinoi (Uchio)	R	R	—	—	—	—	×	—	—
G. tabernacularis (Brady)	—	0.3	—	—	—	—	—	—	×
Planodiscorbis circularis (Sidebottom)	0.1	—	—	—	—	—	—	—	—
Rosalina cf. *R. australis* Parr	—	—	—	—	0.8	0.6	—	—	—
R. globularis d'Orbigny	1	0.7	—	1	2	1	×	—	×
R. sp. A	—	—	—	—	0.4	—	—	—	—
R. cf. *R. vilardeboana* d'Orbigny	—	—	3	—	0.6	0.6	—	×	×
R. (?) sp.	—	R	—	—	—	—	—	—	—
Tretomphalus bulloides (d'Orbigny)	R	—	—	—	—	—	×	×	×
Cancris auriculus (Fichtel & Moll)	VR	0.5	—	—	—	—	×	×	×
Valvulineria sp.	—	R	—	—	—	—	—	—	—
Siphoninidae									
Siphoninoides echinatus (Brady)	R	—	—	—	—	—	×	—	×
S. glabra (Heron-Allen & Earland)	—	0.1	—	—	0.2	—	—	—	×
Epistomariidae									
Epistomaroides polystomelloides (Parker & Jones)	—	R	—	—	0.4	0.3	×	—	×
Spirillinidae									
Spirillina limbata papillosa Cushman	—	R	—	—	—	—	—	—	—
S. vivipara densepunctata Cushman	—	R	—	—	—	—	—	—	×
Rotaliidae									
Ammonia beccarii (Linné)	R	0.2	—	—	0.4	—	×	×	×

Table 1 (continued)

SAMPLE NO.	Group A		Group B				Philippines		Tropical Pacific: CUSHMAN, TODD, etc. 1932-1966
	100–1	50–1	2-a	2-b	1-a	1-b	GRAHAM & MILITANTE 1959	CUSHMAN 1921	
DEPTH (m)	97.5	50	1.8		1.5				
A. angulata (KUWANO)	VR	—	—	—	—	—	—	—	—
A. cf. *A. inflata* (SEGUENZA)	VR	—	—	—	—	—	—	—	—
Pararotalia nipponica (ASANO)	2	2	—	—	0.6	0.9	×	—	—
P. nipponica var. *ozawai* (ASANO)	—	—	—	0.7	—	0.1	×	—	×
Pseudorotalia gaimardii (D'ORBIGNY)	3	3	—	—	—	—	×	×	—
Calcarinidae									
"*Calcarina defrancii* D'ORBIGNY" of BRADY	—	R	—	—	—	—	×	×	×
Elphidiidae									
Elphidium advena (CUSHMAN) var.	VR	—	—	—	0.8	—	×	×	×
E. craticulatum (FICHTEL & MOLL)	—	0.2	1	0.7	—	1	×	×	—
E. crispum (LINNÉ)	5	4	7	10	12	19	×	×	×
E. cf. *E. hokkaidoense* ASANO	VR	R	—	0.7	—	—	×	—	×
E. jenseni (CUSHMAN)	0.5	0.7	4	3	4	2	—	—	×
E. cf. *E. kusiroense* ASANO	—	—	—	—	0.2	—	—	—	—
E. subincertum ASANO	VR	—	—	—	—	—	—	—	—
E. cf. *E. simplex* CUSHMAN	R	R	—	—	—	—	—	—	×
Nummulitidae									
Operculina ammonoides (GRONOVIUS)	2	7	—	—	0.8	—	×	×	×
Heterostegina suborbicularis D'ORBIGNY	R	0.4	—	0.7	0.2	0.6	×	×	×
Eponididae									
Neoeponides antillarum (D'ORBIGNY)	0.2	0.3	—	—	—	—	—	×	—
Poroeponides cribrorepandus ASANO & UCHIO	1	1	—	0.7	0.4	0.3	×	×	×
Amphisteginidae									
Amphistegina lessoni D'ORBIGNY	3	21	1	11	3	9	×	×	×
Cibicididae									
Cibicides lobatulus (WALKER & JACOB)	1	1	—	—	—	—	—	×	×
C. margaritiferus (BRADY)	0.2	—	—	—	—	—	—	×	—
C. cf. *C. pseudoungerianus* (CUSHMAN)	4	3	—	0.7	0.2	1	—	×	×
C. refulgens MONTFORT	9	6	3	10	7	8	—	×	×
C. tenuimargo (BRADY)	VR	—	—	—	—	—	—	×	—
Caribbeanella katasensis (UJIIE)	—	R	—	0.7	—	—	—	—	—
C. ogiensis (MATSUNAGA)	1	0.5	—	—	0.8	0.3	—	—	—

Table 1 (continued)

SAMPLE NO.	Group A		Group B				Philippines		Tropical Pacific: Cushman, Todd, etc. 1932-1966
	100–1	50–1	2-a	2-b	1-a	1-b	Graham & Militante 1959	Cushman 1921	
DEPTH (m)	97.5	50	1.8		1.5				
Dyocibicides biserialis Cushman & Valentine	R	R	—	—	—	—	—	—	—
Planulina wuellerstorfi (Schwager)	R	—	—	—	—	—	—	×	×
Planorbulinidae									
Planorbulina acervalis Brady	6	1	12	14	8	15	×	×	×
P. (?) *rubra* d'Orbigny	VR	R	—	—	—	—	—	—	×
Acervulinidae									
Acervulina inhaerens Schultze	4	1	10	10	6	7	×	—	×
Gypsina globula (Reuss)	VR	—	—	—	—	—	×	×	×
G. vesicularis (Parker & Jonres)	VR	—	—	—	—	—	×	—	×
Cymbaloporidae									
Cymbaloporetta bradyi (Cushman)	2	0.6	9	2	9	3	×	×	×
C. cf. *C. squammosa* (d'Orbigny)	—	—	—	—	—	0.3	×	×	×
Delosinidae									
Delosina (?) cf. *D. complexs* (Sidebottom)	R	R	—	—	—	—	—	—	—
Cassidulinidae									
Cassidulina depressa Asano & Nakamura	—	R	—	—	—	—	—	—	—
C. subglobosa Brady	VR	—	—	—	—	—	—	×	×
C. sp. nov.	VR	—	—	—	—	—	—	—	—
C. orientale Cushman	VR	—	—	—	—	0.3	—	—	—
C. (*Islandiella* ?) cf. *I. yabei* Asano & Nakamura	VR	R	—	—	—	—	×	×	—
Nonionidae									
Nonion manpukujiensis Otuka	0.1	R	—	—	—	—	×	×	×
N. subturgidus Cushman	0.4	R	—	—	—	—	×	—	×
Pseudononion japonicus Asano	VR	R	—	—	—	—	—	—	—
Chilostomellina ovoidea (Reuss)	VR	—	—	—	—	—	—	×	×
Alabaminidae									
Gyroidina cf. *G. soldanii* d'Orbigny	0.2	R	—	—	—	—	—	×	×
Oridorsalis umbonatus (Reuss)	VR	—	—	—	—	—	—	×	×
Anomalinidae									
Anomalina glabrata Cushman	0.5	—	—	—	—	—	×	—	×
A. (?) sp.	—	R	—	—	—	—	—	—	—
Anomalinoides sp. nov.	—	0.1	—	—	—	—	—	—	—
Heterolepa dutemplei (d'Orbigny)	5	4	—	—	—	—	—	×	—
Karreria nipponica (Uchio)	0.1	R	—	—	—	—	—	—	—

Table 1 (continued)

	Group A		Group B				Philippines		Tropical Pacfiic: CUSHMAN, TODD, etc. 1932-1966
SAMPLE NO.	100–1	50–1	2-a	2-b	1-a	1-b	GRAHAM & MILITANTE 1959	CUSHMAN 1921	
DEPTH (m)	97.5	50	1.8		1.5				
CALCAREOUS (ARAGONITIC) BENTHONIC FORAMINIFERA									
Ceratobuliminidae									
Lamarcknia ventricosa (BRADY)	R	—	—	—	—	—	—	—	—
Hoeglundina elegans (D'ORBIGNY)	1	—	—	—	—	—	—	×	×
Mississippina concentrica (PARKER & JONES)	VR	R	—	—	—	—	—	×	×
Robertinidae									
Robertinoides murotoensis (ASANO)	VR	—	—	—	—	—	—	—	—
PLANKTONIC FORAMINIFERA									
Globigerinidae									
Globigerina cf. *G. bulloides* D'ORBIGNY	1	4	—	—	(33.3)	—	×	×	×
G. sp.	0.1	0.7	—	—	—	—	—	—	—
Globigerinella aequilateralis (BRADY)	4	2	(50)	—	—	—	×	×	×
Globigerinoides conglobatus (BRADY)	3	4	—	—	—	—	—	×	×
G. ruber (D'ORBIGNY)	10	7	—	—	(33.3)	—	×	×	×
G. sacculifer (BRADY)	2	0.7	—	—	—	—	×	×	×
G. trilobus (REUSS)	16	16	(50)	—	—	—	—	×	×
G. sp.	0.5	—	—	—	—	—	—	—	—
Orbulina universa D'ORBIGNY	1	VR	—	—	—	—	×	×	×
Catapsydracidae									
Globoquadrina dutertrei (D'ORBIGNY)	22	20	—	—	—	—	—	×	×
Pulleniatina obliquiloculata (PARKER & JONES)	20	33	—	—	(33.3)	—	×	×	×
Globorotaliidae									
Gioborotalia hirsuta (D'ORBIGNY)	VR	—	—	—	—	—	—	—	×
G. inflata (D'ORBIGNY)	17	11	—	—	—	(100)	—	×	—
G. menardii (D'ORBIGNY)	2	2	—	—	—	—	×	×	×
G. truncatulinoides (D'ORBIGNY)	1	—	—	—	—	—	—	×	×
TOTAL POPULATION (counted)	2495	3361	71	151	517	332			
PLANKTONIC POPULATION	804	135	2	0	3	1			
BENTHONIC POPULATION	1691	3226	69	151	514	331			
PLANKTONIC/BENTHONIC RATIO (%)	47	4.2	2.9	0	0.6	0.3			

Table 2. Main features of the foraminiferal assemblages

SAMPLE NO.	100–1	50–1	2–a	2–b	1–a	1–b
TOTAL POPULATION (counted)	2495	3361	71	151	517	332
PLANKTONIC POPULATION	804	135	2	0	3	1
BENTHONIC POPULATION	1691	3226	69	151	514	331
ARENACEOUS (%)	5.2	14.2	0	0	0.2	0
CALCAREOUS (PORCELANEOUS) (%)	22.7	12.9	36.2	18.6	22.3	18.8
CALCAREOUS (HYALINE) (%)	71.0	72.7	63.8	81.4	77.5	81.2
Nodosariidae (%)	4.1	1.3	0	0	0	0
Plectofrondicullariidae (%)	VR	0	0	0.7	2	0
Polymorphinidae (%)	0.2	0.4	0	0	0	0
Sphaeroidinidae (%)	0.3	R	0	0	0	0
Bolivinitidae (%)	5.0	1.4	0	0.7	2.1	0
Buliminidae (%)	1.7	1.1	4.3	1.3	2.6	1.2
Uvigeinidae (%)	R	0	0	0	0	0
Discorbidae (including Glabratellidae) (%)	6.8	8.0	11.6	14.0	14.0	9.1
Siphoninidae (%)	R	0.1	0	0	0.2	0
Epistomariidae (%)	0	R	0	0	0.4	0.3
Spirillinidae (%)	0	R	0	0	0	0
Rotaliidae (%)	5.0	5.5	0	0.7	1.0	1.2
Calcarinidae (%)	0	R	0	0	0	0
Elphidiidae (%)	5.9	5.2	14.5	14.6	17.3	22.6
Nummulitidae (%)	2.0	7.4	0	0.7	1.0	0.6
Eponididae (%)	1.2	1.6	0	0.7	0.4	0.3
Amphisteginidae (%)	2.8	21.3	1.5	11.3	2.5	8.8
Cibicididae (%)	16.6	11.6	2.9	10.7	7.9	9.4
Planorbulinidae (%)	6.2	1.2	11.6	13.9	7.8	14.6
Acervulinidae (%)	3.8	1.1	10.0	10.0	5.8	7.0
Cymbaloporidae (%)	2.3	0.6	8.7	2.0	8.9	3.3
Cassidulinidae (%)	0	0.1	0	0	0	0.3
Nonionidae (%)	0.5	0.1	0	0	0	0
Alabaminidae (%)	0.2	R	0	0	0	0
Anomalinidae (%)	5.8	4.5	0	0	0	0
CALCAREOUS (ARAGONITIC) (%)	R	R	0	0	0	0

Sample Nos. 2–a and 2–b, bottom- and top-net samples at Station 2 respectively; the same applies for Sample Nos. 1–a and 1–b at Station 1. R: rare.

Table 3. Numbers of species (including varieties and subspecies).

SAMPLE NO.	100–1	50–1	2–a	2–b	2–T	1–a	1–b	1–T
PLANKTONIC	15	12	2	0	2	3	1	4
BENTHONIC	165	144	27	35	45	57	47	66
ARENACEOUS	17	22	0	0	0	1	0	1
CALCAREOUS (PORCELANEOUS)	40	44	13	11	19	24	20	29
CALCAREOUS (HYALINE)	104	77	14	24	26	32	27	36
Nodosariidae	23	8	0	0	0	0	0	0
Plectofrondiculaiidae	1	0	0	1	1	1	0	1
Polymorphinidae	4	6	0	0	0	0	0	0
Sphaeroidinidae	1	1	0	0	0	0	0	0
Turrilinidae	1	0	0	0	0	0	0	0
Bolivinitidae	7	3	0	0	0	1	0	1
Buliminidae	5	3	1	1	1	1	1	1
Uvigerinidae	1	0	0	0	0	0	0	0
Discorbidae (including Glabratellidae)	16	18	5	8	10	11	9	11
Siphoninidae	1	1	0	0	0	1	0	1
Epistomariidae	0	1	0	0	0	1	1	1
Spirillinidae	0	2	0	0	0	0	0	0
Rotaliidae	5	3	0	1	1	2	2	3
Calcarinidae	0	1	0	0	0	0	0	0
Elphidiidae	6	5	3	4	4	4	3	5
Nummulitidae	2	2	0	1	1	2	1	2
Eponididae	2	2	0	1	1	1	1	1
Amphisteginidae	1	1	1	1	1	1	1	1
Cibicididae	8	6	1	3	3	3	3	3
Planorbulinidae	2	2	1	1	1	1	1	1
Acervulinidae	3	1	1	1	1	1	1	1
Cymbaloporidae	1	1	1	1	1	1	2	2
Delosinidae	1	1	0	0	0	0	0	0
Cassidulinidae	4	2	0	0	0	0	1	1
Nonionidae	4	3	0	0	0	0	0	0
Alabaminidae	2	1	0	0	0	0	0	0
Anomalinidae	3	4	0	0	0	0	0	0
CALCAREOUS (ARAGONITIC)	4	1	0	0	0	0	0	0

Sample Nos. 1–a and 2–a, bottom-net samples at Stations 1 and 2, respectively.
Sample Nos. 1–b and 2–b, top-net samples at Stations 1 and 2, respectizely.
Sample Nos. 1–T and 2–T, combination of 1–a and 1–b; 2–a and 2–b, respectively.
R: rare.

Table 4. Number of genera at each station.

STATION NO.	100–1	50–1	2	1
BENTHONIC FORAMINIFERA	93	79	26	33
Arenaceous *	9	11	0	1
Calcareous (Poreclaneous)	15	11	10	10
Calcareous (Hyaline)	65	56	16	22
Calcareous (Aragonitic)	4	1	0	0
PLANKTONIC FORAMINIFERA	7	7	2	3
TOTAL (Benthonic plus Planktonic)	94	87	28	36

*Number of arenaceous miliolid species is 1 and 2 at Stations 50–1 and 100–1, respectively. They are not included in arenaceous but in porcelaneous group.

Table 5. Number* of main constituent species having a frequency of more than 1% at each station.

STATION NO.	100–1	50–1	2	1	WHOLE SAMPLES
BENTHONIC FORAMINIFERA	27	24	32	27	55
Arenaceous	1	6	0	0	6
Calcareous (Porcelaneous)	6	2	14	9	17
Calcareous (Hyaline)	20	16	18	18	32
Calcareous (Aragonitic)	0	0	0	0	0
PLANKTONIC FORAMINIFERA	12	6	(2)	(4)	12

*Number in parentheses is not dependable. The numbers at Stations 1 and 2 are relatively large compared with those at Stations 100–1 and 50–1, and this seems to be owing to small number of specimens counted (for instance, in the case of Sample 2–a, occurrence of a single specimen means frequency of more than 1%).

and subtropical regions of the other parts of the world.

As can be understood from the sampling method used, each assemblage does not represent the entire fauna. The absence of certain small species, such as species of *Lagena, Bolivina*, etc., which from the reports of others should be commonly found in this region, is perhaps owing to the loss of the finer fraction of the sediments through the mesh (0.3 mm) of the sampling net. Nevertheless, the assemblages show the general features of the faunas at respective depths. This fact, together with the small number of samples available, though they were analyzed quantitatively for Foraminifera, suggests that a detailed discussion of the results is to be avoid. The main features of the assemblages to be discussed are inferred from Tables 1–5. According to TOKIOKA (personal communication), foraminiferal populations at Stations 50–1 and 100–1 listed in Table 1 are from 3.2 cc of sand plus 1 cc of detritus and 16.2 cc of sand plus 1 cc of detritus, respectively. The total population of the samples could not be compared because of the unknown amount of original sediment analyzed.

BENTHONIC FORAMINIFERA: The following two groups can be distinguished, Group A (Stations 100–1 and 50–1) and Group B (Stations 2 and 1). De-

tailed features of the groups are as follows:

1. *Arenaceous Foraminifera* are absent or negligible in Group B. This seems to be due to coarseness of the sediment. This is a local phenomenon, as they are not necessarily rare in shallow waters of other regions, for instance, the beach sand at Kushimoto, Wakayama-ken (UCHIO, 1962).

2. *Porcelaneous Foraminifera* are generally more abundant in Group B than in Group A. The relatively high porcelaneous content at Station 100–1 may be due to secondary displacement from the shallow sea bottom. The number of porcelaneous species is larger in Group A than in Group B (Table 3), and this seems to be owing to the higher probability of finding rare species in the much larger population in Group A than in Group B. The general distribution of the Miliolidae is the same in Group A and B, except that *Hauerina* is much richer in Group B. This may indicate displacement of sediment from shallower to deeper water. In the Solitidae, both *Solites* and *Amphisorus*, which are large and discoidal, are rare in Group A, but relatively abundant in Group B.

3. *Calcareous (Hyaline) Foraminifera*: The most noticeable thing is the almost complete absence from Group B of the Nodosariidae, Polymorphinidae, Sphaeroidinidae, Cassidulinidae, Nonionidae, Alabaminidae and Anomalinidae (not in CUSHMAN's sense). The same can be said of the Bolivinitidae, Buliminidae (except *Reussella*) and Uvigerinidae. The species of these families present in Group A are low in percentage frequency, and this fact shows that Group A is not a true deep water fauna. Except for these foraminifers, almost all of the dominant species are present in both groups, which also shows that Group A is not true deep water fauna. *Pseudorotalia gaimardii, Cibicides margaritiferus, C.* cf. *C. pseudoungerianus, Heterolepa dutemplei* and *Operculina ammonoides* are more abundant in Group A than in Group B. On the contrary, *Neoconorbina, Rotorbinella,* and *Rosalina,* namely, the "*Discorbis*" group, *Planorbulina acervalis, Acervulina inhaerens* and *Cymbaloporetta* are more abundant in Group B than in Group A. *Elphidium* (particularly *E. jenseni* and *E. craticulatum*) is also more abundant in Group B. It is to be noticed that *Operculina ammonoides,* which is supposed to be a typically shallow, tropical species, is more abundant in Group A as in the Philippines (CUSHIMAN, 1921, p. 382). Living tests of *Operculina ammonoides* is common at Station 50–1. This species is also present rarely in beach sands at Ezura and Seto (UCHIO, 1962). *Amphistegina* is more abundant at Station 50–1 (21%) than in Group B. The relatively low frequency of *Amphistegina* in Group B seems to be due to the method of collecting mateiral, because it is found at much higher frequencies in beach sands at Ezura (65%) and Seto (71%).

4. *Calcareous (Aragonitic) Foraminifera*: These foraminifers are found only in Group A. However, *Lamarckina ventricosa* and *Mississippina concentrica* were found in beach sands of the Izu Peninsula and Hachijo Island (UCHIO, 1952 a, b). *Hoeglundina*

and *Robertinoides* are deep-water inhabitants.

5. A subdivision of Group A may be made by benthonic characteristics, as follows: Assemblage A_1 (Station 100–1) shows more diversity in Nodosariidae than Assemblage A_2 (Station 50–1), namely, 23 species in A_1 and 6 species in A_2. Furthermore, *Cibicides margaritiferus, Planulina wuellerstorfi, Chilostomellina ovoidea, Oridorsalis umbonatus* and *Hoeglundina elegans* are deep-water inhabitants and are found only in A_1. This subdivision is supported more definitely by the character of the planktonic Foraminifera.

6. Foraminiferal characteristics of the bottom-net sample do not differ significantly from those of the top-net sample at each station, as is to be expected. However, some differences are noted. *Cymbaloporetta bradyi,* and *Reussella simplex* to a lesser extent, are more abundant in bottom-net samples, while *Amphistegina lessoni, Elphidium crispum, Solites marginalis* and *Planorbulina acervalis* are more abundant in top-net samples. These differences may be due to size, shape, or thickness of test, but these factors do not yield consistent tendencies, as follows:

Amphistegina lessoni (lenticular)...may be easily moved....more abundant in top-net sample.
Elphidium crispum (lenticular)...more abundant in top-net sample.
Elphidium jenseni (very flat, discoidal, thin)...may be difficult to move.....slightly more abundant in top-net sample.
Acervulina inhaerens (large, flat)...about the same frequency in both type samples.
Solites marginalis (discoidal, large, flat)...more abundant in top-net samples.
Amphisorus hemprichii (large, flat, discoidal, thick)...none in bottom-net samples but some in top-net samples.
Cymbaloporetta bradyi (plano-convex or concavo-convex)...more abundant in bottom-net samples.
Cibicides refulgens (plano-convex, thick)...slightly more in top-net samples.
Miliolids (thick-test)...slightly more in bottom-net samples.

PLANKTONIC FORAMINIFERA: The ratio of planktonic to benthonic populations, expressed in percent, shows that a sudden increase takes place between Stations 50–1 and 100–1. This means that Stations 1, 2 and 50–1 are in coastal waters, and the influence of oceanic waters becomes strong at point where the distance from shore is more than *ca.* 6 km and the depth more than *ca.* 100 m. Recently, in analyzing paleoecological factors, the planktonic/benthonic ratio is sometimes used. However, the minimum distance from shore and the depth of water for planktonic predominance is not fixed generally, depending upon the oceanographic conditions. The result here obtained shows an example of this kind. So far as number of species and percentage frequency of the planktonic Foraminifera are concerned, Stations 50–1 and 100–1 have the same characteristics. Considering all the features mentioned

above, Station 50–1 can be considered to be transitional from the nearshore group (Stations 1 and 2) to the offshore one (Station 100–1). The coiling direction of tests of some planktonic Foraminifera have become an important criterion for geologic correlation. So far as is known, the ratio of left and right coiling of a species changes geographically. It is of use to give the ratio of some species in this area.

	Sta. 100–1			Sta. 50–1		
	no. of specimens		% of L.	no. of specimens		% of L.
	Left	Right		Left	Right	
Pulleniatina obliquiloculata	4	155	0.3	0	45	0
Globoquadrina dutertrei	1	171	0.6	1	26	3
Globorotalia hirsuta	0	3	0			
G. truncatulinoides	1	29	3.3			
G. inflata	132	0	100	15	0	100
G. menardii	49	0	100	2	0	100

According to F.L. PARKER (personal communication), *Pulleniatina obliquiloculata* and *Globoquadrina dutertrei* are always right-coiling, and *Globorotalia inflata* and *G. menardii* left-coiling at the present time regardless of location.

INTRODUCTION TO TAXONOMY: The interpretation of species varies among authors. Some species are so characteristic that their identification is easy, wheras some, particularly those described in early stages of foraminiferal study such as those by D'ORBIGNY, etc., are very difficult to identify correctly. Therefore, it is desirable for each author to figure the species they mentioned. However, this is laborious, time-consuming, and very expensive. The writer usually does not figure the species he mentions in his papers except for new species or those of special interest, but he always has compared his specimens with reliable hypotypes and/or topotypes (s.s. or s.l.). In the present study, he used as comparative material specimens from Recent sediments of the Dry Tortugas (Florida), Bermuda, Jamaica, Andros Island (Bahamas), Hawaii, New Zealand, Australia, Okinawa (Japan), Red Sea, off San Diego (California), Gulf of Mexico, various parts of the Japanese coast, and fossils from Japan. Most of the Recent material mentioned above consists of cuts of the samples from which CUSHMAN described those of his new species referred to here. This material was given to the late Dr. YOSHIAKI OZAWA. Sometimes there are contradictory statements in CUSHMAN's description and figures, but these are usually settled by examining the detailed redescriptions and excellent figures of various type specimens by FRANCES L. PARKER, RUTH TODD and ALFRED R. LOEBLICH, in various papers. There seem to be a few new genera or, at least, emendation of genera, several new species, details to be noted on the ranges of variation of many species and relationships among species. These things will be published on another occasion (Part 2).

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