











SMITHSONIAN INSTITUTION  
UNITED STATES NATIONAL MUSEUM  
Bulletin 71

---

A MONOGRAPH OF THE FORAMINIFERA  
OF THE NORTH PACIFIC OCEAN

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PART II. TEXTULARIIDÆ

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BY

JOSEPH AUGUSTINE CUSHMAN

*Of the Boston Society of Natural History*



DEC 23 1912

WASHINGTON  
GOVERNMENT PRINTING OFFICE

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## INTRODUCTION.

The present volume is the second of a series dealing with the Foraminifera of the North Pacific Ocean. It contains the Foraminifera included in the family Textulariidae. The first part, issued in 1910, included the families Astrorhizidae and Lituolidae. The third part, on which work is now actively being done, will be devoted to the Lagenidae, and further volumes will take up the remaining families of the Foraminifera as they are represented in the North Pacific.

JOSEPH AUGUSTINE CUSHMAN.





## TABLE OF CONTENTS.

	Page.
List of illustrations.....	ix
Introduction.....	1
Family 4. Textulariidae.....	2
Subfamily 1. Spiroplectinae.....	4
Genus Spiroplecta.....	4
<i>bulbosa</i> .....	5
Subfamily 2. Textulariinae.....	5
Genus <i>Textularia</i> .....	5
<i>sagittula</i> , var. <i>atrata</i> .....	7
<i>gramen</i> .....	8
<i>agglutinans</i> .....	9
var. <i>fistula</i> .....	10
<i>horrida</i> .....	10
<i>stricta</i> .....	11
<i>candeiana</i> .....	12
<i>milletti</i> .....	13
<i>abbreviata</i> .....	14
<i>aspera</i> .....	14
<i>goësii</i> .....	15
<i>rhomboidalis</i> .....	16
<i>carinata</i> .....	17
<i>siphonifera</i> .....	17
<i>inconspicua</i> .....	18
<i>folium</i> .....	19
<i>aperturalis</i> .....	20
<i>flintii</i> .....	21
<i>cresecentiformis</i> .....	21
<i>concava</i> .....	22
<i>catenata</i> .....	23
<i>crassisepta</i> .....	24
<i>quadrilatera</i> .....	24
Genus <i>Textularioides</i> .....	26
<i>inflata</i> .....	26
Genus <i>Bigenerina</i> .....	27
<i>nodosaria</i> .....	27
<i>digitata</i> .....	28
<i>arenacea</i> .....	29
Genus <i>Pavonina</i> .....	30
<i>flabelliformis</i> .....	30
Genus <i>Bolivina</i> .....	31
<i>punctata</i> .....	32
<i>dilatata</i> .....	33
<i>seminuda</i> .....	34
<i>beyrichi</i> .....	34
var. <i>alata</i> .....	35

## Family 4. Textulariidae—Continued.

## Subfamily 2 Textulariinae—Continued.

Page.

Genus *Bolivina*—Continued.

<i>compacta</i> .....	36
<i>robusta</i> .....	36
<i>semialata</i> .....	37
<i>schwageriana</i> .....	38
<i>nobilis</i> .....	39
<i>karreriana</i> .....	40
var. <i>carinata</i> .....	41
<i>pusilla</i> .....	41
<i>hantkeniana</i> .....	42
<i>amygdalakeformis</i> .....	42
<i>plicata</i> .....	43
<i>semicostata</i> .....	43
<i>ænariensis</i> .....	44
<i>subangularis</i> .....	45
<i>lobata</i> .....	46
<i>spinescens</i> .....	46
<i>decussata</i> .....	47
<i>limbata</i> .....	47
( <i>Bifarina</i> ) <i>porrecta</i> .....	48
( <i>Bifarina</i> ) <i>strigosa</i> .....	49

Genus *Pleurostomella*.....

<i>alternans</i> .....	49
<i>subnodosa</i> .....	50
<i>spinosa</i> .....	51

## Subfamily 3. Verneuulininae.....

Genus *Verneuilina*.....

<i>polystropha</i> .....	52
<i>propinqua</i> .....	53
<i>bradyi</i> .....	53
<i>spinulosa</i> .....	54
<i>affixa</i> .....	55
<i>pusilla</i> .....	56

Genus *Valvulina*.....

<i>conica</i> .....	58
<i>fusca</i> .....	59

Genus *Chrysalidina*.....

<i>dimorpha</i> .....	60
-----------------------	----

Genus *Tritaxia*.....

<i>tricarinata</i> .....	61
--------------------------	----

Genus *Gaudryina*.....

<i>scabra</i> .....	62
<i>flintii</i> .....	63
<i>quadrangularis</i> .....	64
<i>triangularis</i> .....	65
<i>convexa</i> .....	66
<i>paupercula</i> .....	66
<i>bradyi</i> .....	67
<i>baccata</i> .....	68
<i>chilostoma</i> .....	69
<i>apicularis</i> .....	69
<i>pseudofiliformis</i> .....	70

## Family 4. Textulariidae—Continued.

## Subfamily 3. Verneulininae—Continued.

Page.

Genus <i>Tritaxilina</i> .....	71
<i>caperata</i> .....	71
Genus <i>Clavulina</i> .....	72
<i>communis</i> .....	72
<i>bradyi</i> .....	73
<i>angularis</i> .....	74
<i>parisiensis</i> .....	75
Subfamily 4. <i>Bulimininae</i> .....	76
Genus <i>Bulimina</i> .....	76
<i>ovata</i> .....	77
<i>pyrula</i> .....	78
var. <i>spinescens</i> .....	78
<i>affinis</i> .....	79
<i>elongata</i> .....	79
<i>pupoides</i> .....	80
<i>torta</i> .....	81
<i>elegans</i> .....	82
var. <i>exilis</i> .....	82
<i>marginata</i> .....	83
<i>inflata</i> .....	84
<i>buchiana</i> .....	85
<i>aculeata</i> .....	86
<i>rostrata</i> .....	87
<i>subornata</i> .....	88
Genus <i>Buliminella</i> .....	88
<i>subteres</i> .....	89
<i>contraria</i> .....	89
Genus <i>Buliminoides</i> .....	90
<i>williamsoniana</i> .....	90
Genus <i>Virgulina</i> .....	91
<i>squamosa</i> .....	91
<i>subsquamosa</i> .....	92
var. <i>striata</i> .....	93
<i>subdepressa</i> .....	93
<i>schreibersiana</i> .....	94
<i>texturata</i> .....	95
Subfamily 5. <i>Cassidulininae</i> .....	95
Genus <i>Cassidulina</i> .....	95
<i>laevigata</i> .....	96
<i>crassa</i> .....	97
<i>subglobosa</i> .....	98
<i>elegans</i> .....	99
<i>bradyi</i> .....	99
<i>parkeriana</i> .....	100
Genus <i>Ehrenbergina</i> .....	101
<i>serrata</i> .....	101
<i>hystrix</i> .....	102
Index .....	105



## LIST OF ILLUSTRATIONS.

FIG.	Page.
1. Spiroplecta bulbosa. <i>a</i> , view from exterior, showing large proportion of the circular part of the test. $\times 120$ . <i>b</i> , optical section of the test, showing the complete evolution made by the coiled chambers about the proloculum. $\times 200$ .....	5
2-5. Textularia sagittula, var. atrata. 2, front view. $\times 60$ . 3, end view of another specimen. $\times 60$ . 4, view of microspheric proloculum and succeeding chambers by transmitted light, the early chambers forming a coiled series about the proloculum, the later chambers assuming the biserial condition. $\times 75$ . 5, view of megalospheric proloculum and succeeding chambers by transmitted light, the early chambers following the proloculum immediately assuming the biserial condition. $\times 75$ .....	7
6-8. Textularia gramen. 6, <i>a</i> , side view; <i>b</i> , end view. $\times 60$ . 7, microspheric proloculum and succeeding chambers viewed by transmitted light, the early chambers forming a coiled group half way around the proloculum. $\times 150$ . 8, megalospheric proloculum and succeeding chambers, the chambers following the proloculum assuming the biserial form at once without trace of coiling. Specimen viewed by transmitted light. $\times 75$ .....	8
9. Textularia gramen. <i>a</i> , side view, showing the peculiarly modified chambers in the later growth; <i>b</i> , end view. $\times 60$ .....	9
10. Textularia agglutinans. $\times 40$ . <i>a</i> , front view; <i>b</i> , end view.....	9
11. Textularia agglutinans, var. fistula. $\times 40$ .....	10
12. Textularia horrida. $\times 60$ . <i>a</i> , front view; <i>b</i> , end view.....	11
13. Textularia stricta. $\times 15$ . <i>a</i> , front view; <i>b</i> , end view.....	11
14-17. Textularia candejana. 14, specimen from Hawaiian Islands. $\times 60$ . <i>a</i> , apertural view; <i>b</i> , front view. 15, specimen from Gaspar Strait. $\times 60$ . <i>a</i> , apertural view; <i>b</i> , front view. 16, microspheric proloculum and early coiled chambers. $\times 115$ . 17, megalospheric proloculum and following chambers of megalospheric form. $\times 115$ .....	12
18-19. Textularia milletti. 18, <i>a</i> , end view; <i>b</i> , front view. $\times 50$ . 19, optical section by transmitted light. $\times 40$ .....	13
20. Textularia abbreviata. $\times 60$ . <i>a</i> , apertural view; <i>b</i> , front view.	14
21-23. Textularia aspera. 21, specimens growing attached to a fragment of Rhabdammina. $\times 20$ . 22, front view of specimen detached. $\times 25$ . 23, end view of another specimen. $\times 25$ (after Brady) ..	14
24. Textularia goësii. $\times 35$ . <i>a</i> , front view; <i>b</i> , apertural view (after Brady).....	15
25. Textularia rhomboidalis. $\times 75$ . <i>a</i> , apertural view; <i>b</i> , front view..	16
26-27. Textularia carinata. $\times 30$ . 26, front view. 27, <i>a</i> , front view of another specimen; <i>b</i> , end view (after Brady).....	17
28-29. Textularia siphonifera. 28, <i>a</i> , front view of specimen with three projections on each of the adult chambers; <i>b</i> , side view; <i>c</i> , end view. $\times 40$ . 29, proloculum and early chambers by transmitted light. $\times 300$ .....	18

	Page.
FIG. 30. <i>Textularia inconspicua</i> . × 70. <i>a</i> , front view; <i>b</i> , apertural view; <i>c</i> , apical view (after Brady).....	19
31-33. <i>Textularia folium</i> . 31, front view. × 125. 32, early chambers viewed by transmitted light, showing broadly oval proloculum with a spine. × 125. 33, specimen with spherical proloculum, by transmitted light. × 175 .....	19
34-35. <i>Textularia aperturalis</i> . 34. × 30. 35, <i>a</i> , front view; <i>b</i> , side view; <i>c</i> , end view. × 20?. (Fig. 35, after Goës) .....	20
36. <i>Textularia flintii</i> . × 40. <i>a</i> , front view; <i>b</i> , apertural view.....	21
37. <i>Textularia crescentiformis</i> . × 75. <i>a</i> , front view; <i>b</i> , side view showing the distinct curvature of the test; <i>c</i> , apertural view....	22
38. <i>Textularia concava</i> . × 60. <i>a</i> , front view; <i>b</i> , apertural view.....	22
39-40. <i>Textularia catenata</i> . 39, <i>a</i> , front view; <i>b</i> , apertural view. × 60. 40, another specimen, microspheric, by transmitted light, showing the microspheric proloculum followed by four chambers in a coil before the biserial condition is taken on. × 120. ....	23
41. <i>Textularia crassisepta</i> . × 60. <i>a</i> , front view; <i>b</i> , apertural view..	24
42-44. <i>Textularia quadrilatera</i> . 42, megalospheric form; <i>a</i> , front view; <i>b</i> , side view; <i>c</i> , apertural view. × 60. 43, optical section through the early chambers of a megalospheric specimen. × 60. 44, optical section through the early chambers of a microspheric specimen. × 275 .....	25
45. <i>Textularioides inflata</i> . × 30. <i>a</i> , front view; <i>b</i> , end view.....	26
46-48. <i>Bigenerina nodosaria</i> . × 35. 46, <i>a</i> , front view; <i>b</i> , end view. 47, <i>a</i> , front view; <i>b</i> , end view. 48, longitudinal section of the test (after Brady).....	28
49. <i>Bigenerina digitata</i> . × 30. <i>a</i> , front view; <i>b</i> , apertural view.....	28
50. <i>Bigenerina arenacea</i> . × 30. <i>a</i> , front view; <i>b</i> , apertural view....	29
51. <i>Pavonina flabelliformis</i> . <i>a</i> , front view; <i>b</i> , apertural view. × 75..	30
52. <i>Pavonina flabelliformis</i> . Young specimen viewed by transmitted light. × 150 .....	31
53. <i>Bolivina punctata</i> . × 100. <i>a</i> , apertural view; <i>b</i> , front view...	32
54. <i>Bolivina dilatata</i> . × 60. <i>a</i> , apertural view; <i>b</i> , front view.....	33
55. <i>Bolivina seminuda</i> . × 60.....	34
56. <i>Bolivina beyrichi</i> . × 50 (after Brady).....	35
57. <i>Bolivina beyrichi</i> , var. <i>alata</i> . × 60. <i>a</i> , apertural view; <i>b</i> , front view.....	35
58. <i>Bolivina compacta</i> . × 120. <i>a</i> , front view; <i>b</i> , end view.....	36
59-60. <i>Bolivina robusta</i> . 59, spineless variety with deeply lobed chamber margin. × 100. 60, typical specimen with apical spine and less deeply lobed margin. × 70.....	37
61-62. <i>Bolivina semialata</i> . × 75. 61, type-specimen. 62, another more regular specimen from the same region.....	38
63. <i>Bolivina schwageriana</i> . × 65. <i>a</i> , apertural view; <i>b</i> , front view..	38
64. <i>Bolivina nobilis</i> . × 40. <i>a</i> , apertural view; <i>b</i> , front view.....	39
65. <i>Bolivina karreriana</i> . × 80. <i>a</i> , apertural view; <i>b</i> , front view....	40
66. <i>Bolivina karreriana</i> , var. <i>carinata</i> . × 60. <i>a</i> , front view; <i>b</i> , apertural view (after Millett).....	41
67. <i>Bolivina pusilla</i> . × 60. <i>a</i> , front view; <i>b</i> , apertural view.....	41
68. <i>Bolivina hantkeniana</i> . × 60. <i>a</i> , apertural view; <i>b</i> , front view..	42
69. <i>Bolivina amygdaleformis</i> . × 75. <i>a</i> , apertural view; <i>b</i> , front view.....	43
70. <i>Bolivina semicostata</i> . × 75. <i>a</i> , apertural view; <i>b</i> , front view...	44

	Page.
Fig. 71. <i>Bolivina aenariensis</i> . × 40. <i>a</i> , apertural view; <i>b</i> , front view. Specimen without the long median costæ .....	45
72-73. <i>Bolivina subangularis</i> . × 60. 72, <i>a</i> , front view; <i>b</i> , apertural view. 73, front view of another specimen (after Brady) .....	45
74-75. <i>Bolivina lobata</i> . × 80. 74, <i>a</i> , front view; <i>b</i> , apertural view (after Brady) .....	46
76. <i>Bolivina spinescens</i> . × 75. <i>a</i> , apertural view; <i>b</i> , front view ....	47
77. <i>Bolivina decussata</i> . × 120 .....	47
78. <i>Bolivina limbata</i> . × 125. <i>a</i> , front view; <i>b</i> , same specimen from opposite side; <i>c</i> , end view .....	48
79. <i>Bolivina (Bifarina) porrecta</i> . × 60. <i>a</i> , apertural view; <i>b</i> , front view .....	48
80. <i>Bolivina (Bifarina) strigosa</i> . × 120. <i>a</i> , apertural view; <i>b</i> , front view .....	49
81. <i>Pleurostomella alternans</i> . × 60. <i>a</i> , front view; <i>b</i> , view showing aperture .....	50
82. <i>Pleurostomella subnodosa</i> . <i>a</i> , aperture, × 150; <i>b</i> , front view; <i>c</i> , side view, × 75 .....	51
83-84. <i>Pleurostomella spinosa</i> . × 75. 83, <i>a</i> , front view; <i>b</i> , apertural view with the upper end of the chamber slightly broken and jagged. 84, front view of another more inflated specimen ....	52
85. <i>Verneuilina polystropha</i> . × 30. <i>a</i> , apertural view; <i>b</i> , front view.	53
86. <i>Verneuilina propinqua</i> . × 35. <i>a</i> , apertural view; <i>b</i> , front view.	54
87. <i>Verneuilina bradyi</i> . × 40. <i>a</i> , front view; <i>b</i> , apertural view ....	55
88. <i>Verneuilina spinulosa</i> . × 60. <i>a</i> , front view; <i>b</i> , apertural view..	56
89. <i>Verneuilina spinulosa</i> (?). × 60. Specimen with coiled young..	56
90-91. <i>Verneuilina affixa</i> . × 15. 90, specimen attached to <i>Rhabdam-</i> <i>mina</i> . 91, apertural view of detached specimen .....	57
92. <i>Verneuilina pusilla</i> (after Goës) .....	57
93. <i>Valvulina conica</i> . × 40. <i>a</i> , front view; <i>b</i> , from above; <i>c</i> , from below .....	58
94-95. <i>Valvulina fusca</i> . 94, attached specimen. × 40. 95, <i>a</i> , dorsal view; <i>b</i> , ventral view; <i>c</i> , side view, × 50 (after Brady) .....	59
96-97. <i>Chrysalidina dimorpha</i> . × 70. 97, <i>a</i> , front view; <i>b</i> , apertural view (after Brady) .....	60
98-99. <i>Tritaxia tricarinata</i> . × 35. 98, <i>a</i> , apertural view (after Brady)..	61
100. <i>Gaudryina scabra</i> . × 45. <i>a</i> , apertural view; <i>b</i> , front view .....	63
101. <i>Gaudryina scabra</i> . × 30. Specimen with wall containing sponge spicules .....	63
102. <i>Gaudryina flintii</i> . × 20. <i>a</i> , front view; <i>b</i> , apertural view; <i>c</i> , side view .....	64
103. <i>Gaudryina quadrangularis</i> . × 30. <i>a</i> , front view; <i>b</i> , end view ...	65
104. <i>Gaudryina triangularis</i> . × 40. <i>a</i> , end view; <i>b</i> , side view; <i>c</i> , front view .....	65
105. <i>Gaudryina convexa</i> . × 60. <i>a</i> , end view; <i>b</i> , dorsal view; <i>c</i> , ven- tral view .....	66
106. <i>Gaudryina paupercula</i> . × 15. <i>a</i> , front view; <i>b</i> , apertural view.	67
107. <i>Gaudryina bradyi</i> . × 25. <i>a</i> , end view; <i>b</i> , front view; <i>c</i> , side view .....	67
108. <i>Gaudryina baccata</i> . × 20. <i>a</i> , side view; <i>b</i> , front view (after Brady) .....	68
109. <i>Gaudryina chilostoma</i> . × 25. <i>a</i> , front view; <i>b</i> , side view (after Brady) .....	69
110. <i>Gaudryina apicularis</i> . × 60. <i>a</i> , front view; <i>b</i> , apertural view...	70



	Page.
FIG. 111. <i>Gaudryina pseudofiliformis</i> . × 60. <i>a</i> , front view; <i>b</i> , end view, showing outline and ridge above the aperture.....	70
112-114. <i>Tritaxilina caperata</i> . × 16. 112, <i>a</i> , apertural view. 114, specimen cut longitudinally showing labyrinthic interior (after Brady)...	71
115-117. <i>Clavulina communis</i> . × 30. 115, young specimen with but two of the second series of chambers developed. 116, <i>a</i> , front view of medium-sized specimen; <i>b</i> , end view of the same. 117, adult specimen in front view.....	73
118-119. <i>Clavulina bradyi</i> . × 30. 118, <i>a</i> , end view, without tooth. <i>b</i> , front view of typical specimen; 119, front view of a peculiarly roughened specimen.....	74
120-122. <i>Clavulina angularis</i> . × 35. 122, <i>a</i> , front view; <i>b</i> , apertural view (after Brady).....	75
123-124. <i>Clavulina parisiensis</i> . × 30. 123, <i>a</i> , apertural view; <i>b</i> , front view (after Brady).....	75
125. <i>Bulimina ovata</i> . × 40. <i>a</i> , front view; <i>b</i> , end view; <i>c</i> , view showing aperture.....	77
126. <i>Bulimina pyrula</i> . × 60. <i>a</i> , side view; <i>b</i> , view showing aperture; <i>c</i> , end view.....	78
127. <i>Bulimina pyrula</i> . × 75. Details of the aperture.....	78
128. <i>Bulimina pyrula</i> , var. <i>spinescens</i> . × 80. <i>a</i> , front view; <i>b</i> , end view; <i>c</i> , side view.....	79
129. <i>Bulimina pyrula</i> , var. <i>spinescens</i> . × 175. Young specimen, outlines of first five chambers.....	79
130. <i>Bulimina affinis</i> . × 50 (after Brady).....	79
131. <i>Bulimina elongata</i> . <i>a</i> , ventral view; <i>b</i> , dorsal view; <i>c</i> , end view. × 60; <i>d</i> , view of apertural region. × 120.....	80
132. <i>Bulimina pupoides</i> . × 40. <i>a</i> , dorsal view; <i>b</i> , end view; <i>c</i> , ventral view.....	81
133. <i>Bulimina torta</i> . × 60. <i>a</i> , dorsal view; <i>b</i> , ventral view; <i>c</i> , end view.....	81
134. <i>Bulimina elegans</i> . × 60. <i>a</i> , apertural view; <i>b</i> , ventral view; <i>c</i> , dorsal view.....	82
135. <i>Bulimina elegans</i> , var. <i>exilis</i> . × 60. <i>a</i> , apertural view; <i>b</i> , side view; <i>c</i> , front view (after Brady).....	82
136. <i>Bulimina marginata</i> . × 150. <i>a</i> , front view; <i>b</i> , apertural view....	83
137. <i>Bulimina inflata</i> . × 60. <i>a</i> , front view; <i>b</i> , apertural view.....	84
138. <i>Bulimina buchiana</i> . × 150. <i>a</i> , front view; <i>b</i> , apertural view....	85
139. <i>Bulimina aculeata</i> . × 75. <i>a</i> , front view; <i>b</i> , apertural view.....	87
140. <i>Bulimina rostrata</i> . × 150. <i>a</i> , front view; <i>b</i> , apertural view.....	87
141. <i>Bulimina subornata</i> . × 80. <i>a</i> , front view; <i>b</i> , side view (after Brady).....	88
142. <i>Buliminella subteres</i> . × 80. <i>a</i> , apertural view; <i>b</i> , side view....	89
143. <i>Buliminella contraria</i> . × 60. <i>a</i> , dorsal view; <i>b</i> , ventral view; <i>c</i> , peripheral view (after Brady).....	90
144. <i>Bulminoides williamsoniana</i> . × 60. <i>a</i> , apertural view; <i>b</i> , front view.....	91
145. <i>Virgulina squamosa</i> , modified from the original; <i>a</i> , apertural view, <i>b</i> , front view.....	92
146. <i>Virgulina subsquamosa</i> . × 120. <i>a</i> , front view; <i>b</i> , side view; <i>c</i> , apertural view.....	92
147. <i>Virgulina subdepressa</i> . × 50. <i>a</i> , apertural view; <i>b</i> , front view..	93
148. <i>Virgulina schreibersiana</i> . × 60. <i>a</i> , apertural view; <i>b</i> , front view	94
149. <i>Virgulina texturata</i> . × 35. <i>a</i> , front view; <i>b</i> , apertural view....	95



FIG.		Page.
150.	<i>Cassidulina lævigata</i> . × 30. <i>a</i> , apertural view; <i>b</i> , front view..	96
151.	<i>Cassidulina crassa</i> . × 30. <i>a</i> , apertural view; <i>b</i> , dorsal view; <i>c</i> , ventral view .....	97
152.	<i>Cassidulina subglobosa</i> . × 30. <i>a</i> , ventral view; <i>b</i> , side view; <i>c</i> , dorsal view .....	98
153.	<i>Cassidulina bradyi</i> . × 60. <i>a</i> , view from dorsal side; <i>b</i> , apertural view; <i>c</i> , side view .....	99
154.	<i>Cassidulina parkeriana</i> . × 50. <i>a</i> , apertural view; <i>b</i> , ventral view; <i>c</i> , dorsal view .....	100
155.	<i>Ehrenbergina serrata</i> . × 75. <i>a</i> , ventral view; <i>b</i> , dorsal view; <i>c</i> , side view; <i>d</i> , apertural view .....	102
156.	<i>Ehrenbergina hystrix</i> . × 40. <i>a</i> , ventral view; <i>b</i> , dorsal view; <i>c</i> , side view; <i>d</i> , apertural view .....	103



# A MONOGRAPH OF THE FORAMINIFERA OF THE NORTH PACIFIC OCEAN.

TEXTULARIIDÆ.

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## INTRODUCTION.

This second part of the work on the North Pacific Foraminifera deals entirely with the Textulariidae, a family following in natural sequence those families already considered in the first part. The same arrangement of data is here followed.

In addition to the material mentioned in the previous part there has been available a considerable amount dredged by U. S. S. *Tuscarora* in various parts of the North Pacific. This consists of mounted slides of Foraminifera from the various stations. It adds some species and a considerable number of records of distribution for many species.

It has been found necessary to describe several new species and to erect a few new genera, but the number of these has been kept as small as possible. The genus *Textularia*, as will be noted, contains several more or less distinct groups of species, but no attempt is here made to give these groups generic standing. The species of certain genera, such as *Bulimina* for example, are in an unsatisfactory state, and without large series of specimens it is impossible to satisfactorily delimit the various species. Figures referred to the same species by different authors are often very unlike and the synonymy thus becomes very difficult to work out satisfactorily.

Reference to the figures and descriptions of types has shown the necessity of separating our recent forms from the fossil species in a number of cases. Where this is necessary and no names are available, new names have of necessity been given to the recent species.

More strikingly perhaps than in the first part the various faunal areas are shown by the species of the Textulariidae. Many of the species occurring in the Indo-Pacific region extend southward

to the region of Torres Strait. In the North Pacific, however, these species are, as a rule, confined to the western portion from southern Japan southward. The rediscovery of some of the species described by Brady, from almost the exact locality at which they were dredged by the *Challenger*, is very interesting and tends to show the restricted distribution of certain forms.

A systematic presentation of the various groups of the family follows:

#### Family 4. TEXTULARIIDÆ.

Test either arenaceous or calcareous, perforate, the chambers usually numerous, essentially biserial or triserial, or in some genera spirally arranged.

The family Textulariidæ is apparently the most primitive, after the Lituolidæ. A number of the genera are wholly or in part composed of species with arenaceous tests, which is in itself a primitive character in the group. In many species both the microspheric and megalospheric forms are known. In the microspheric form, which repeats most completely the phylogenetic characters, a coiled early development succeeding the proloculum is commonly found. This stage may be compared to the entire development of such a genus as *Haplophragmoides* in the Lituolidæ.

In the most primitive subfamily, the Spiroplectinæ, the coiled development is continued for a fairly long period, and makes up a considerable portion of the test. This coiled stage also occurs in both the microspheric and megalospheric forms, showing that this subfamily is decidedly primitive, and has not as yet become so specialized as to lose the coiled stage in the megalospheric form. In *Spiroplecta*, the only genus of this subfamily, the coiled development is followed by a series of more or less numerous chambers arranged biserially. *Spiroplecta* in its stages of development recapitulates the essential features of the Textulariidæ; a proloculum, followed by a closely coiled series of chambers, in turn followed by a biserially arranged group. This sequence is the basis of the development throughout the family, as will be shown, and is not an exceptional character.

In the Textulariinæ, the typical genus of which, *Textularia*, may be taken as an example, the same stages are shown, but are modified by specialization and acceleration of development. The earlier stages are either much reduced or are entirely skipped. In the case of *Textularia candei*ana d'Orbigny, for example (figs. 14-17), in the microspheric form the small proloculum is followed by a series of chambers, few in number compared with those of *Spiroplecta*, but just as distinctly coiled (fig. 16). The later chambers, which in this

case make up the greater part of the test, are biserially arranged. The stages in the development are exactly the same, but there is a difference in the proportion of each as usually occurs in the upward step in the scale, the earlier stages being shortened and the later stages coincidentally shoved back and taking their place. In the megalospheric form of the species, however (fig. 17), there is a larger proloculum, followed at once by the biserially arranged chambers, the coiled stage being entirely skipped. Microspheric forms of such species of *Textularia* have been referred by many later writers to *Spiroplecta*, but in the type species of *Textularia* both of these forms occur, and if such a procedure were adhered to, the genus *Textularia* would have to be made synonymous with *Spiroplecta* and the former used as the older name, the latter being dropped. As used here, however, *Spiroplecta* includes simply those species which have a very considerable coiled stage, and in which it usually occurs in both forms, microspheric and megalospheric.

In *Textularia*, it is only very rarely, so far as observed, that a coiled stage occurs in the megalospheric form, and then in but a very few chambers. It is obvious, therefore, that the microspheric form of many species of *Textularia* has a coiled development in the young. In the more specialized species, such as *Textularia quadrilatera*, which should perhaps be removed from the genus *Textularia*, there has been observed no coiled young in either the microspheric or the megalospheric form, though the number of available specimens of each form has been large.

In this same subfamily have been included those other genera which have essentially a biserial arrangement of the chambers, such as *Bolivina* and *Pavonina*, and a biserial development followed by a uniserial, as in *Bigenerina*. In this last genus there is a coiled development in the microspheric form of at least one species.

In the subfamily Verneulininæ, the typical arrangement of the adult chambers is triserial instead of biserial, but here again there is in the microspheric form of some species a coiled series of chambers in the young. The specimens are much more difficult to manipulate, and the coiled series may be more common than may at first appear. The expected modification, the return to the biserial condition of the previous subfamily, takes place in *Gaudryina*, in some species only in the last-formed chambers, in other species appearing by acceleration of development early in the life history, the triserial portion much reduced. In *Clavulina* there is a complete return to the uniserial condition, but with the triserial character present in the young.

The subfamily Bulimininæ, as here considered, includes the spiral forms with a loop-shaped aperture, such as *Bulimina* and *Virgulina*,

the latter tending to assume a biserial arrangement. The test here is hyaline and perforate. Two new genera have been separated from the typical *Bulimina* to include species considerably different in their characters from the genus in its restricted sense.

The subfamily Cassidulininæ includes species which are like the Bulimininæ in their aperture, but which have a peculiar arrangement of the chambers. These are biserial, but are secondarily coiled in a helicoid spiral. In *Cassidulina* the species are either completely involute, or in late growth are somewhat uncoiled. In *Ehrenbergina* the uncoiling takes place early, and little of the involute character is seen.

The Textulariidae as a whole are much more rich in ornamentation and complicated forms than are any of the preceding families. In *Bolivina* and in some species of *Bulimina*, *Ehrenbergina*, and *Virgulina* there is a considerable range of ornamentation, punctæ, limbate sutures, knobs or bosses, costæ and spines being the most common forms. On the whole, however, the ornamentation is simple and uninteresting compared with that seen in the Lagenidae.

#### Subfamily 1. SPIROPLECTINÆ.

Test either coarsely arenaceous or calcareous, or even hyaline, the early chambers following the proloculum closely coiled, the later chambers biserial, occasionally tending to become uniserial in the last developed chambers.

This subfamily includes the single genus *Spiroplecta*, which in its developmental stages connects the Textulariidae with the Lituolidæ. Its development is primitive in that the stages are seen in both the microspheric and megalospheric forms of the species, and are of comparatively long duration.

#### Genus SPIROPLECTA Ehrenberg, 1844.

*Spiroplecta* EHRENBURG (type, *S. americana* Ehrenberg), Monatsber. d. k. preuss. Akad. Wiss., Berlin, 1844, p. 75.

The characters are given above under the description of the subfamily. The name *Heterohelix* was used by Ehrenberg in 1843, but it is not clear whether it is entirely synonymous or not, and the type-species is not clearly characterized.

As noted above, many recent writers are referring to *Spiroplecta* species of *Textularia* which show a coiled arrangement of the chambers in the early development, especially in the microspheric form. Such a treatment of these species seems to be incorrect, as previously stated. Although Brady records two species of this genus from Torres Strait, neither of them has been found in the material from the North Pacific which I have examined.



## SPIROPLECTA BULBOSA, new species.

*Description*.—Test compressed, the early portion nearly circular, the later portion elongate, narrower, rectilinear; the chambers numerous, those of the early portion coiled, involute, the later biserial; wall calcareous, perforate, smooth; color white.

Length about 0.40 mm.

*Type-specimen*.—Cat. No. 8328, U.S. N.M., from *Albatross* station D4957 in 437 fathoms off the coast of Japan.

This species is small, and has a remarkably large portion of the test made up by the spirally coiled chambers. Fig. 1, *b*, shows the arrangement of the chambers in the megalospheric form, making a complete volution about the proloculum.

## Subfamily 2. TEXTULARIINÆ.

Test typically biserial, wholly or in part, the early portion in the microspheric form often with a few coiled chambers, followed by the biserial chambers; later chambers

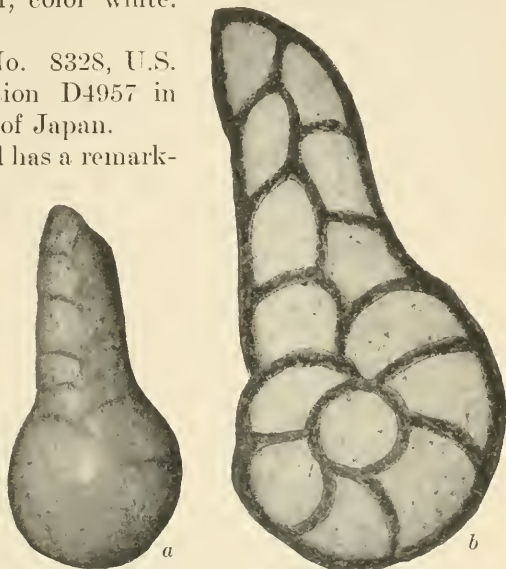


FIG. 1.—SPIROPLECTA BULBOSA. *a*, VIEW FROM EXTERIOR, SHOWING LARGE PROPORTION OF THE CIRCULAR PART OF THE TEST.  $\times 120$ . *b*, OPTICAL SECTION OF THE TEST, SHOWING THE COMPLETE VOLUTION MADE BY THE COILED CHAMBERS ABOUT THE PROLOCULUM.  $\times 200$ .

variously modified in the different genera, uniserial, broadly extended, etc.; wall either arenaceous or calcareous and hyaline, perforate; aperture single, or in a few cases, many present in a single chamber.

This subfamily includes those forms which are essentially biserial in their development, not having reached the triserial stage anywhere in their stages of development. The stages in the simpler genera are like those of *Spiroplecta*, except in duration, the biserial condition being taken on much earlier than in that genus. Various modified forms occur as in the uniserial arrangement in *Bigenerina*, the broadly flaring later growth of *Pavonina*, and the peculiarly modified aperture in *Pleurostomella*.

## Genus TEXTULARIA DeFrance, 1824.

*Textularia* DEFRANCE (type, *T. sagittula* DeFrance) Dict. des Sci. Nat., vol. 32, 1824, p. 177; vol. 53, 1828, p. 344; Atlas Conch., pl. 13, fig. 5.

*Textularia* EHRENBERG, Abh. d. k. preuss. Akad. Wiss., Berlin, 1839, p. 135.

*Grammostomum* EHRENBERG (part), Abh. d. k. preuss. Akad. Wiss., Berlin, 1839, p. 129.

*Plecanium* REUSS, Sitz. kön. Akad. Wiss., Wien, vol. 44, 1861 (1862), p. 383.

*Description*.—Test elongate, tapering, composed of two series of alternating chambers; wall calcareous, in the young, hyaline and per-

porate, occasionally so throughout the test, often with an external coating of siliceous or calcareous sand, or in some species nearly the whole test arenaceous; aperture typically an arched slit at the inner margin of the chamber close to its line of attachment to the preceding chamber; occasionally with the aperture surrounded by a raised lip, or in some species with the aperture circular and terminal.

The genus *Textularia* as usually considered includes species of several different sorts which might perhaps be placed in separate genera, as has been done by some authors. All have the same general type of test in that the chambers, at least in the adult, are arranged biserially, each chamber alternating with the immediately preceding and succeeding chamber of the opposite side and connecting with them, so that typically no chambers of the same series are connected with one another except indirectly through the chambers of the opposite series. In many species where a large series of specimens can be obtained from a single dredging both the microspheric and megalospheric forms of the species may be found. Here again there is a considerable difference in the various groups. In the typical arenaceous species the microspheric form has a definitely coiled series of chambers about the small proloculum before the biserial condition is taken on. This shows its relation to *Spiroplecta* and to the coiled forms of the Lituolidæ. In the megalospheric form of the same species the biserial condition is usually taken on by the two chambers immediately succeeding the large proloculum. As a rule the megalospheric form is the more common, as is usually the case in other groups.

Other species, as *T. quadrilatera*, for example, may be found in the two forms, but the difference is mainly in the size of the proloculum and the number of succeeding chambers, in both cases the biserial condition being taken on with the two chambers following the proloculum.

Usually in species of *Textularia* there is a regular increase in the diameter of the test with the addition of new chambers, but in some individuals there is a definite senescence, in which the chambers of the later portion are smaller and the diameter of the test actually reduced.

In an end view it is usually seen that the lateral portions of the newly added chamber extend beyond the aperture on either side so that the aperture in the end view seems to be in an indentation of the inner margin of the chamber. This is especially true of those species that have the aperture a slitlike opening on the inner margin close to the line of meeting with the previous chamber. In those species in which the aperture is not so elongate and is farther from the previous chamber, this indentation is much less marked or wanting,



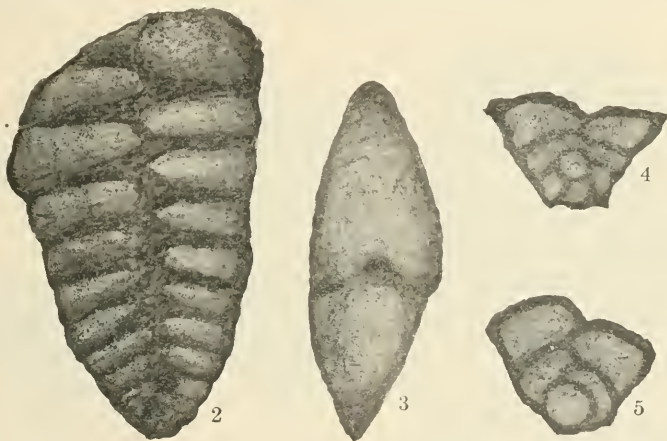
and where the aperture is circular and terminal there is no trace of an indentation.

As a whole the genus *Textularia* shows little trace of ornamentation of the test, except in the thickening of the wall at the junction of the chambers and occasionally spines at the earlier end. In a few species there are signs of raised lines of ornamentation. In one group of species there is a tendency to form proliferations at the sides of the chambers, carried to its extreme in *T. siphonifera* H. B. Brady. These are peculiar modifications of the test and occur in several species.

The largest and best-developed species of *Textularia* are from shallow water in tropical or subtropical seas, but the various species are widely distributed, both as to depth and latitude, and the geological history of the genus is apparently a long one.

**TEXTULARIA SAGITTULA** DeFrance, var. **ATRATA**, new variety.

*Description.*—Test as a rule broader than in the typical form, the initial end broad and rounded in both the microspheric and megalospheric



FIGS. 2-5.—*TEXTULARIA SAGITTULA*, VAR. *ATRATA*. 2, FRONT VIEW.  $\times 60$ . 3, END VIEW OF ANOTHER SPECIMEN.  $\times 60$ . 4, VIEW OF MICROSPHERIC PROLOCULUM AND SUCCEEDING CHAMBERS BY TRANSMITTED LIGHT, THE EARLY CHAMBERS FORMING A COILED SERIES ABOUT THE PROLOCULUM. THE LATER CHAMBERS ASSUMING THE BISERIAL CONDITION.  $\times 75$ . 5, VIEW OF MEGALOSPHERIC PROLOCULUM AND SUCCEEDING CHAMBERS BY TRANSMITTED LIGHT, THE EARLY CHAMBERS FOLLOWING THE PROLOCULUM IMMEDIATELY ASSUMING THE BISERIAL CONDITION.  $\times 75$ .

forms; sutures between the chambers covered by a dark material much darker than the rest of the test; test otherwise unornamented.

Length 1 mm., microspheric proloculum 0.04 mm., megalospheric proloculum 0.07 mm.

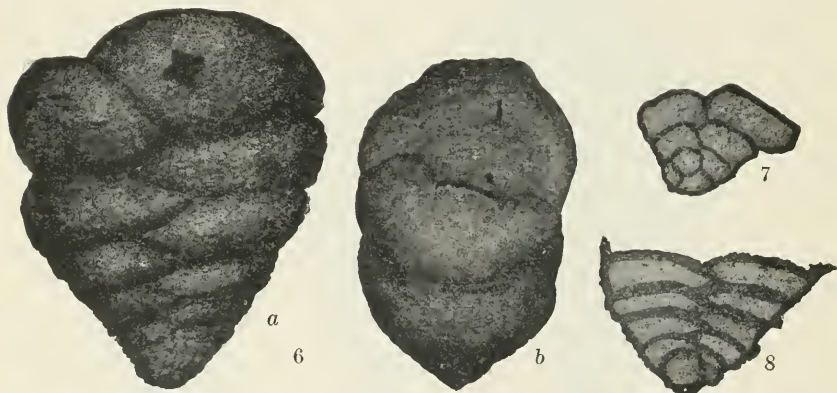
*Distribution.*—This variety occurred in some numbers at *Albatross* station D4875, in the eastern channel of the Korean Straits, in 59 fathoms. (Type, Cat. No. S329, U.S.N.M.)

The peculiar dark condition of the material above the sutures was noted in all the specimens from this region.

## TEXTULARIA GRAMEN d'Orbigny.

*Textularia gramen* d'ORBIGNY, For. Foss. Vienne, 1846, p. 248, pl. 15, figs. 4, 6.—H. B. BRADY, Rep. Voy. *Challenger*, Zoölogy, vol. 9, 1884, p. 365, pl. 43, figs. 9, 10.—BALKWILL and WRIGHT, Trans. Roy. Irish Acad., vol. 28, 1885, p. 332, pl. 13, figs. 13, 14.—FORNASINI, Boll. Soc. Geol. Ital., vol. 6, 1887, p. 399, pl. 11, figs. 4a, b.—TERRIGI, Mem. R. Acc. Lincei, ser. 4, vol. 6, 1889, p. 109, pl. 5, figs. 1, 2.—HÆSLER, Abh. Schweiz. Pal. Ges., vol. 17, 1890, p. 71, pl. 11, figs. 26, 27, 37.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 470.—FORNASINI, For. Plioc. Pont. Savena, 1891, pl. 2, fig. 6.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 272, pl. 6, figs. 24–26.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 19.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 284, pl. 29, fig. 5.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 563.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 7.—CHAPMAN, Journ. Linn. Soc. (Zool.), vol. 30, 1907, p. 25, pl. 3, fig. 53.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 30.

*Description*.—Test rather short and broad, thick, subconical, increasing rapidly in diameter; chambers broad and low, the lateral borders acutely angled, the early chambers compressed, the sutures often



FIGS. 6-8.—TEXTULARIA GRAMEN. 6, a, SIDE VIEW; b, END VIEW.  $\times 60$ . 7, MICROSPHERIC PROLOCULUM AND SUCCEEDING CHAMBERS VIEWED BY TRANSMITTED LIGHT, THE EARLY CHAMBERS FORMING A COILED GROUP HALFWAY AROUND THE PROLOCULUM.  $\times 150$ . 8, MEGALOSPHERIC PROLOCULUM AND SUCCEEDING CHAMBERS, THE CHAMBERS FOLLOWING THE PROLOCULUM ASSUMING THE BISERIAL FORM AT ONCE WITHOUT TRACE OF COILING. SPECIMEN VIEWED BY TRANSMITTED LIGHT.  $\times 75$ .

indistinct; wall arenaceous, sometimes rough; aperture elongate, slitlike, in the indentation near the base of the inner border of the chamber.

Length 1 to 1.5 mm., microspheric proloculum 0.014 mm., megalospheric proloculum 0.05 mm.

*Distribution*.—This species is widely distributed. It is recorded by Bagg from seven *Albatross* stations in the vicinity of the Hawaiian Islands, in from 275–865 fathoms. From the Western Pacific I have seen specimens from Hongkong and from Gaspar Strait. One from the latter locality occurring with the typical form is shown in fig. 9, where the irregularity of the last-formed chambers gives a very different appearance to the test. Both microspheric and megalospheric

spheric specimens were found in the material from Gaspar Strait, figs. 7 and 8. In the specimen of the microspheric form but few



FIG. 9.—*TEXTULARIA GRAMEN*. *a*, SIDE VIEW, SHOWING THE PECULIARLY MODIFIED CHAMBERS IN THE LATER GROWTH; *b*, END VIEW.  $\times 60$ .

chambers were included in the early coiled portion. The megalospheric form was, as usual, much the more common of the two.

#### *TEXTULARIA AGGLUTINANS* d'Orbigny.

*Textularia agglutinans* D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 136, pl. 1, figs. 17, 18, 32-34.—PARKER and JONES, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 369.—MÆBIUS, Beitr. Meeresfauna d. Insel Mauritius, 1880, p. 93, pl. 9, figs. 1-8.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 363, pl. 43, figs. 1, 2.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 267, pl. 6, figs. 1, 2.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 1, 1894, p. 35, pl. 7, figs. 300, 301; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 41.—MILLET, Journ. Roy. Micr. Soc., 1899, p. 562.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 7.

*Description*.—Test large and stout, somewhat elongate, the chambers high, rotund; wall coarsely arenaceous in surface view, with a calcareous base as seen

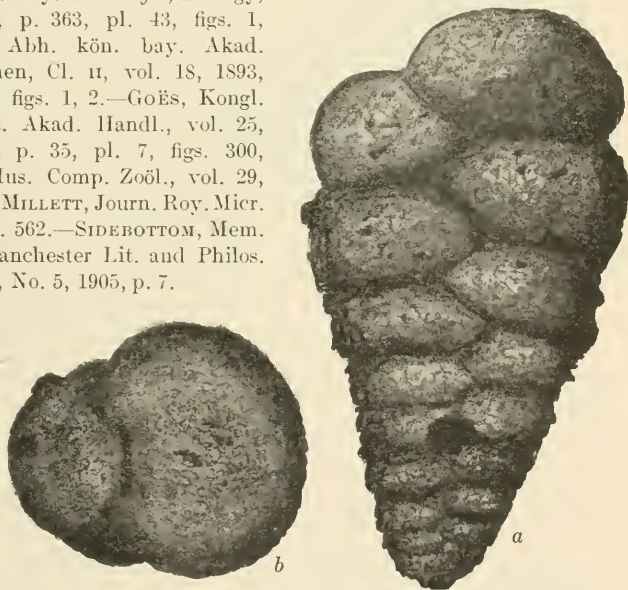


FIG. 10.—*TEXTULARIA AGGLUTINANS*.  $\times 40$ . *a*, FRONT VIEW; *b*, END VIEW.

in section, the early chambers somewhat compressed, in end view somewhat rounded; aperture in a well-marked depression of the inner border of the chamber, slitlike; surface roughened; last-formed chamber often more smooth.

Length 1-3 mm.



*Distribution.*—The species seems to have a wide range both in depth and latitude. Brady records it from *Challenger* station 253, in 3,125 fathoms, in the North Pacific. It is more often found in rather shallow water. Bagg records it from four *Albatross* stations near the Hawaiian Islands, in from 104–1,342 fathoms. The most typical specimens are from *Nero* station 2071, in 271 fathoms, off the Hawaiian Islands.

The various figures of specimens assigned to this species show the great variety of forms which have been grouped under this specific name.

TEXTULARIA AGGLUTINANS d'Orbigny, var. FISTULA, new variety.

*Description.*—In general similar to the typical form, but with lateral fistulose projections on the early chambers, these in the later chambers becoming extended into a projecting peripheral border; the early chambers are somewhat compressed, the later rotund as in typical *T. agglutinans*.

Length 1–2 mm.

*Distribution.*—Numerous specimens of this variety were found in material from *Albatross* station H3007, in 323 fathoms, and *Nero* station 2071 (type), in 271 fathoms, both near the Hawaiian Islands; also from Blake Reef, Vincennes Strait, off southern Japan, in 248 fathoms. (Type, Cat. No. 8330, U.S.N.M.)



FIG. 11.—TEXTULARIA AGGLUTINANS,  
VAR. FISTULA.  $\times 40$ .

The specimens occur with the typical form, and are apparently a fistulose variety of it. In the form and appearance of the extended rim on the later chamber it is very different from *T. sagittula*, var. *fistulosa* H. B. Brady, which it otherwise in some ways resembles.

TEXTULARIA HORRIDA Egger.

*Textularia horrida* EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 270, pl. 6, figs. 11, 12 [*T. horroida* on explanation of plate].

*Description.*—Test broad, short, compressed, composed of a few low chambers directed backward, each extending outward into an elongated process; walls rough, made up of cemented particles of calcareous sand; aperture a curved slit in an indentation of the inner margin of the chamber.

Length 0.37–0.80 mm.

*Distribution.*—Egger's specimens were from Mauritius. The specimen figured here is from the Hawaiian Islands, *Nero* station 2071, in 271 fathoms.

The semilunar form of the last-formed chambers, the backward direction of the outer portions of the chambers and their prolongations serve to distinguish the species.

**TEXTULARIA STRICTA, new species.**

*Description.*—Test long and narrow, composed of numerous high chambers, the early portion somewhat compressed, the later portions nearly circular in cross section, the later chambers inflated, giving a lobular outline to the test; wall arenaceous but rather smoothly finished; sutures deep; apertural end somewhat acute; aperture an elongated slit near the base of the inner border of the chamber.

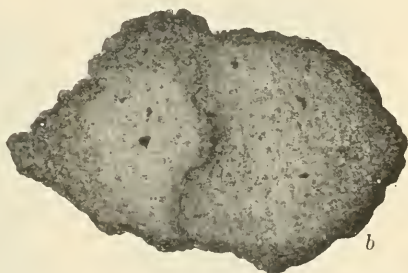
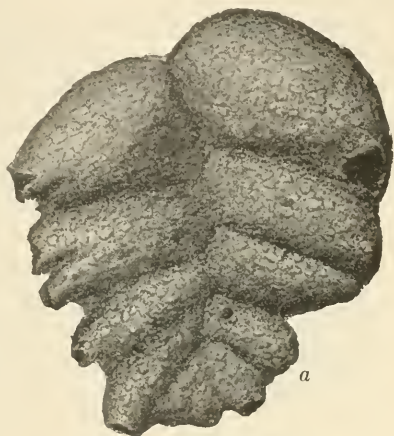


FIG. 12.—*TEXTULARIA HORRIPA*.  $\times 60$ . *a*, FRONT VIEW; *b*, END VIEW.



FIG. 13.—*TEXTULARIA STRICTA*.  $\times 15$ . *a*, FRONT VIEW; *b*, END VIEW.

Length up to 6 mm.

*Distribution.*—Specimens of this species were very common in material from *Albatross* station D4900 in the Eastern Sea off southwestern Japan, in 139 fathoms. (Type, Cat. No. 8331, U.S.N.M.)

This is one of the largest species of *Textularia* I have met with, and seems to differ from the other described species in form and size, and in the form of its apertural end. Some of the specimens had 40 or more chambers.

## TEXTULARIA CANDEIANA d'Orbigny.

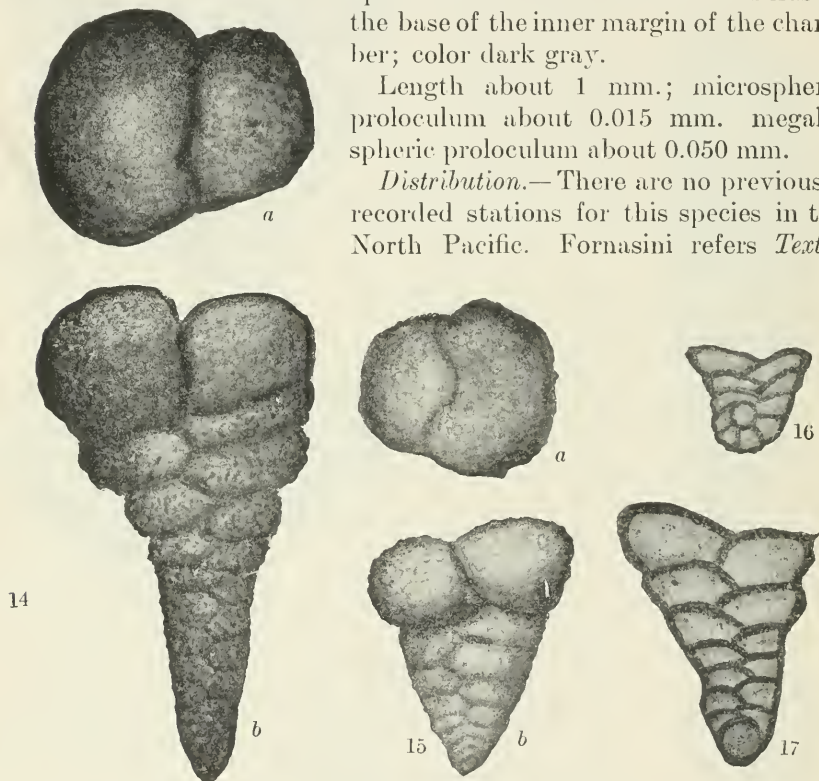
*Textularia candeiana* D'ORBIGNY, in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 143, pl. 1, figs. 25-27.—FORNASINI, Mem. Accad. Sci. Bologna, ser. 5, vol. 10, 1902-1904, p. 137, pl., fig. 8.

*Textularia sagittula*, var. *candeiana* MILLETT, Journ. Roy. Micr. Soc., 1899, p. 562, pl. 7, fig. 12.

*Description*.—Test elongate, club-shaped, the early portion narrow, much compressed, the edges almost carinate, slightly tapering to the round-pointed apex, the later chambers enlarging rapidly, much inflated; chambers numerous; wall rather coarsely arenaceous; aperture in a broad but shallow sinus at the base of the inner margin of the chamber; color dark gray.

Length about 1 mm.; microspheric proloculum about 0.015 mm. megalo-spheric proloculum about 0.050 mm.

*Distribution*.—There are no previously recorded stations for this species in the North Pacific. Fornasini refers *Textu-*



FIGS. 14-17.—TEXTULARIA CANDEIANA. 14, SPECIMEN FROM HAWAIIAN ISLANDS.  $\times 60$ . *a*, APERTURAL VIEW; *b*, FRONT VIEW. 15, SPECIMEN FROM GASPAR STRAIT.  $\times 60$ . *a*, APERTURAL VIEW; *b*, FRONT VIEW. 16, MICROSPHERIC PROLOCULUM AND EARLY COILED CHAMBERS.  $\times 115$ . 17, MEGALOSPHERIC PROLOCULUM AND FOLLOWING CHAMBERS OF MEGALOSPHERIC FORM.  $\times 115$ .

*laria polita* Schwager, var. *inflata* Goës to this species. If such were really the relationship of this form, Goës's specimens would provide records for this area, but an examination of Goës's material shows it to be very different.

The species was found to be abundant in the region of the Hawaiian Islands in comparatively shallow water, at *Nero* stations 2042

and 2043, in 55 and 58 fathoms. Specimens, less elongate, were also found in material from Gaspar Strait (fig. 15).

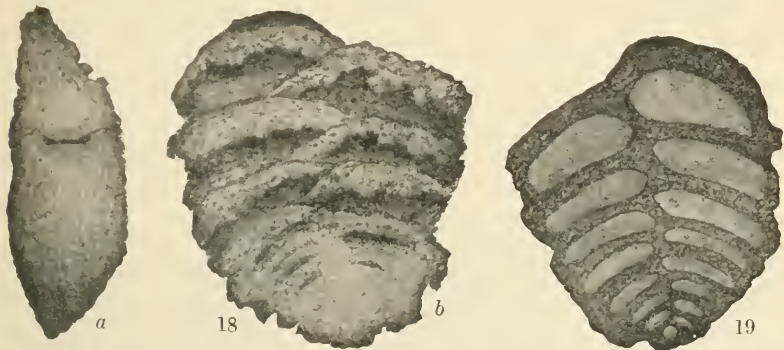
Some of the Hawaiian specimens are very much expanded at the apertural end, even more so than the figured specimen. This is especially accentuated when they are viewed laterally so that the thin edge of the early portion is seen.

Both megalospheric and microspheric forms were found in the material examined. In the microspheric form the early portion is coiled as in this form in other species. The coiling is not apparent in the megalospheric form.

**TEXTULARIA MILETTI, new species.**

*Tertularia sagittula*, var. *jugosa* MILLETT, Journ. Roy. Micr. Soc., 1899, p. 561, pl. 7. fig. 8.

*Description*.—Test free, compressed, composed of numerous broad, low chambers, rapidly increasing in breadth in the earlier chambers, in end view narrow, acutely pointed at the lateral margins; wall coarsely arenaceous; distal and inner walls of chambers much thick-



FIGS. 18-19.—TEXTULARIA MILETTI. 18, *a*, END VIEW; *b*, FRONT VIEW.  $\times 50$ . 19, OPTICAL SECTION BY TRANSMITTED LIGHT.  $\times 40$ .

ened, forming a raised ridge, often with irregular portions extending from the proximal edge; peripheral margin thin; chambers of earlier portions often obscure in external view.

Length 1 mm., megalospheric proloculum 0.055 mm. (in one specimen).

*Distribution*.—Specimens referred to this species were obtained at four North Pacific stations, *Nero* stations 990 (type), in 859 fathoms, and 1464, in 891 fathoms, both near Guam; also *Nero* station 1205, in 737 fathoms, south of Yokohama, and *Albatross* station H3007, in 323 fathoms, near the Hawaiian Islands.

*Type*.—Cat. No. 8332, U.S.N.M. Apparently the recent form figured by Millett from the Malay Archipelago is the same species.

The form and ornamentation of the test will distinguish this species from others of the genus.



## TEXTULARIA ABBREVIATA d'Orbigny.

*Textularia abbreviata* D'ORBIGNY, For. Foss. Vienne, 1846, p. 249, pl. 15, figs. 9-12 (7-12).—EGGER, Neues Jahrb., 1857, p. 293, pl. 12, figs. 17, 18.—FORNASINI, Boll. Soc. Geol. Ital., vol. 6, 1887, p. 399, pl. 11, figs. 1a, b, 3a, b.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 219, pl. 42, figs. 4, 5.—TERRIZI, Mem. Accad. Lincei, ser. 4, vol. 6, 1889, p. 109, pl. 5, fig. 3.—FORNASINI, Mem. Accad. Sci. Bologna, ser. 5, vol. 10, 1902-1904, p. 139, pl., fig. 10.

*Description*.—Test short and broad, somewhat compressed, the apical end bluntly and the apertural end broadly rounded; chambers few, broad and low; sutures indistinct; wall arenaceous, fairly smooth; aperture at the inner border of the chamber rather narrow and deep; color gray.

Length about 0.50 mm., breadth 0.65 mm.



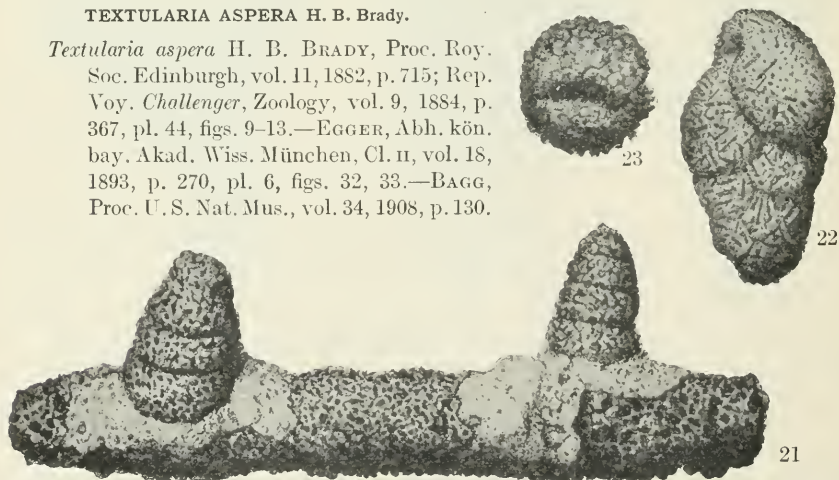
FIG. 20.—TEXTULARIA ABBREVIATA.  $\times 60$ . a, APERTURAL VIEW; b, FRONT VIEW.

*Distribution*.—Ap-

parently not previously recorded from the North Pacific. The figured specimen is from the coast of Japan, *Albatross* station D4968, in 253 fathoms.

## TEXTULARIA ASPERA H. B. Brady.

*Textularia aspera* H. B. BRADY, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 715; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 367, pl. 44, figs. 9-13.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 270, pl. 6, figs. 32, 33.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 130.



FIGS. 21-23.—TEXTULARIA ASPERA. 21, SPECIMENS GROWING ATTACHED TO A FRAGMENT OF RHABDAMMINA.  $\times 20$ . 22, FRONT VIEW OF SPECIMEN DETACHED.  $\times 25$ . 23, END VIEW OF ANOTHER SPECIMEN.  $\times 25$ . (AFTER BRADY.)

*Description*.—Test free or adherent, rather broad, slightly tapering, somewhat compressed, in end view broadly rounded, composed of



few chambers, which are inflated, with distinctly depressed sutures; chambers high; wall coarsely arenaceous, somewhat roughened; aperture a subelliptical opening at the base of the inner margin of the chamber.

Length 1.26–2.25 mm.

*Distribution*.—The only North Pacific record for this species is that given by Bagg, from the vicinity of the Hawaiian Islands, *Albatross* station D4000, in 104–213 fathoms.

Brady figures specimens growing attached to the surface of the test of *Rhabdammina*. They are surrounded at their attachment by a light-colored material, probably related to the attached condition. This habit would tend to separate the species from true *Textularia*, which is typically free.

In some respects the species is not so greatly removed from certain species of *Verneuilina*.

**TEXTULARIA GOËSII, new name.**

*Textularia sagittula* DEFRANCE, var., GOËS. Königl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, 1882, pl. 5, figs. 150–158.

*Textularia trochus* H. B. BRADY (part). Rep. Voy. *Challenger*. Zoology, vol. 9, 1884, p. 366, pl. 43, fig. 17 [not 15, 16, 18, 19]; pl. 44, figs. 1–3 [not *T. trochus* d'Orbigny].

*Description*.—Test broadly triangular in front view, subcircular in end view; in front view tapering abruptly to the apex, margins convex; chambers low and broad, sutures distinct, limbate, but not deep; wall more or less coarsely arenaceous but usually rather smoothly finished; aperture linear, in a depression at the base of the inner margin of the chamber.

Length 0.85–2.25 mm.

*Distribution*.—This species occurs in rather shallow water in various parts of the North Pacific. Bagg records it from *Albatross* station D4000, in 104–213 fathoms, in the vicinity of the Hawaiian Islands, as *T. trochus*.

The synonymy of *Textularia trochus* illustrates well the rather interesting confusion that has arisen through the desire to unite fossil and recent species under the same name. Brady carried this union to an extreme, and the majority of later writers have been willing to follow the *Challenger* report blindly. The figure and description given by d'Orbigny of his typical *Textularia trochus* from the cretaceous

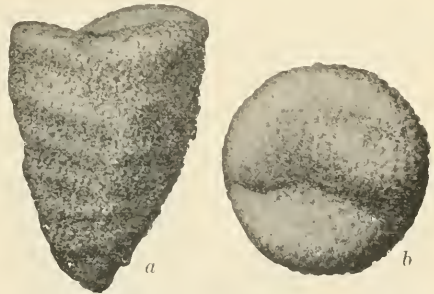


FIG. 24.—*TEXTULARIA GOËSII*.  $\times 35$ . a. FRONT VIEW; b. APERTURAL VIEW (AFTER BRADY).

of France both call for an entirely different form of test from the recent species usually passing under that name. In d'Orbigny's species the test is distinctly flaring with concave sides, the sutures flush and not limbate, and the broader apertural end of the test concave.

The common recent species has a tapering test, but instead of a broadly flaring later growth tends to increase in diameter less rapidly as it approaches the adult condition. As a result the sides, instead of becoming very concave are really convex, and rather strongly so. The sutures as a rule are limbate and the chambers typically overlap slightly, giving a test of greatly different appearance from d'Orbigny's figure.

After a study of a considerable series of foraminiferal material from various European Tertiary and other deposits, especially from France, I have been struck with the very considerable differences that appear between the species of these fossil faunas and recent material. The resemblances are for the most part small, and to unite any considerable number of these fossil species with the recent ones would mean ignoring the very real differences that exist. To unite them on the plea of great variation is not a position strengthened by a study of large series of recent material. Therefore, it has seemed to me best to call attention to certain of the apparent discrepancies that have originated in this way and to try to correct them.

**TEXTULARIA RHOMBOIDALIS** Millett.

*Textularia rhomboidalis* MILLETT, Journ. Roy. Micr. Soc., 1899, p. 559, pl. 7, fig. 4.

*Description.*—Test elongate, tapering, apical end rounded, apertural end broadly rounded, in end view quadrangular or rhomboidal, the sides slightly concave, the sutures distinct, somewhat depressed, curved; wall calcareous, hyaline, coarsely perforate; aperture a deep rounded opening; color white.

Length 0.34–0.60 mm.

*Distribution.*—Not hitherto recorded from the North Pacific. One specimen was found at *Nero* station 2042, in 55 fathoms, near the Hawaiian Islands. From what

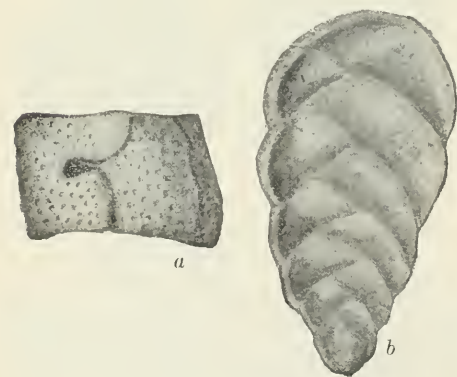


FIG. 25.—*TEXTULARIA RHOMBOIDALIS*.  $\times 75$ .  
a, APERTURAL VIEW; b, FRONT VIEW.

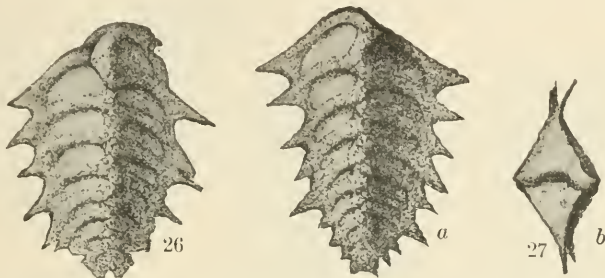
may be learned of the distribution of this species, it is apparently confined to tropical and subtropical waters.

## TEXTULARIA CARINATA d'Orbigny.

*Textularia carinata* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 263, No. 23; For. Foss. Vienne, 1846, p. 247, pl. 14, figs. 32-34.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 360, pl. 42, figs. 15, 16.—EGGER, Abh. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 270, pl. 6, figs. 39-41.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 284, pl. 29, fig. 1.

*Plectanium carinatum* SCHWAGER, Boll. R. Com. Geol. Ital., vol. 8, 1877, p. 26, pl., fig. 97.

*Description*.—Test somewhat elongate, fairly broad, much compressed toward the edges, sharply rhombic in end view; chambers low and broad, the sutures strongly limbate, running out into acutely



FIGS. 26-27.—TEXTULARIA CARINATA.  $\times 30$ . 26, FRONT VIEW. 27, a, FRONT VIEW OF ANOTHER SPECIMEN; b, END VIEW (AFTER BRADY).

pointed spines; wall coarsely arenaceous; aperture an elongate slit at the base of the inner margin of the chamber.

Length 1-1.5 mm.

*Distribution*.—The only North Pacific record for this species is that of the *Challenger* station 209, in 95 fathoms off the Philippines, where it is recorded by Brady as "tolerably abundant."

## TEXTULARIA SIPHONIFERA H. B. Brady.

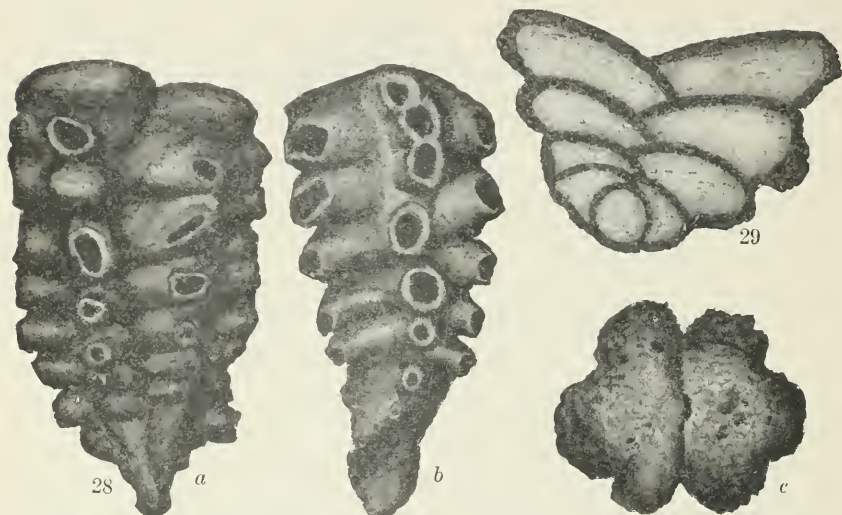
*Textularia siphonifera* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 53; Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 362, pl. 42, figs. 25-29.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 130.

*Spiroplecta siphonifera* CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 272, pl. 3, fig. 1.

*Description*.—Test free, elongate, subcylindrical, tapering toward the initial end, where it is often somewhat twisted and flattened; end view broadly oval with six or eight projecting portions; chambers low and broad, the earlier flattened and produced into fistulae, the later with three or four projections, forming vertical rows with those of the chambers directly above and below; ends of the projections usually open, occasionally closed and bluntly rounded; wall arenaceous, of medium thickness; surface slightly roughened.

Length 1-2.5 mm.; megalospheric proloculum in one specimen 0.04 mm.

*Distribution.*—This species seems to be limited to the Indo-Pacific region and is best developed in shallow water in the vicinity of coral reefs. Brady records it from 40 fathoms on the coral reefs of Honolulu, Hawaiian Islands, and Bagg records it from a single *Albatross* station, H4567, in 1,307 fathoms off the same islands. This is probably a case similar to those already mentioned where currents have carried the tests of shallow water forms into the deeper water outside the reefs. I have noted the species at *Nero* station 2042 in 55 fathoms and *Albatross* station H3007 in 323 fathoms, both near the Hawaiian Islands, and *Albatross* station H4881 off Blake Reef, southern Japan,



FIGS. 28-29.—TEXTULARIA SIPHONIFERA. 28, *a*, FRONT VIEW OF SPECIMEN WITH THREE PROJECTIONS ON EACH OF THE ADULT CHAMBERS; *b*, SIDE VIEW; *c*, END VIEW.  $\times 40$ . 29, PROLOCULUM AND EARLY CHAMBERS BY TRANSMITTED LIGHT.  $\times 300$ .

in 316 fathoms. This last station is the one already noted at which there is developed a decidedly southern coral reef fauna.

Chapman has found specimens of this species in which the megaspheric proloculum was followed by a short spiral, and refers the species to the genus *Spiroplecta*.

TEXTULARIA INCONSPICUA H. B. Brady.

*Textularia inconspicua* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 357, pl. 42, figs. 6a-c.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 557, pl. 7, fig. 1.

*Description.*—“Test short, subconical, compressed laterally; distal end broadly elliptical, truncate or somewhat concave; apex rounded. Segments few, about six in each series, placed transversely; sutures flush externally. Walls thin, hyaline, perforate.

“Length  $\frac{1}{100}$  inch (0.25 mm.)”



*Distribution.*—Brady recorded this species from three Pacific stations, one of which is in the North Pacific, *Challenger* station 232, in 345 fathoms on the *Hyalonema*-ground south of Japan. Millett records the species from the Malay Archipelago. I have not found the species in the material I have examined. The above description and figures are from Brady.



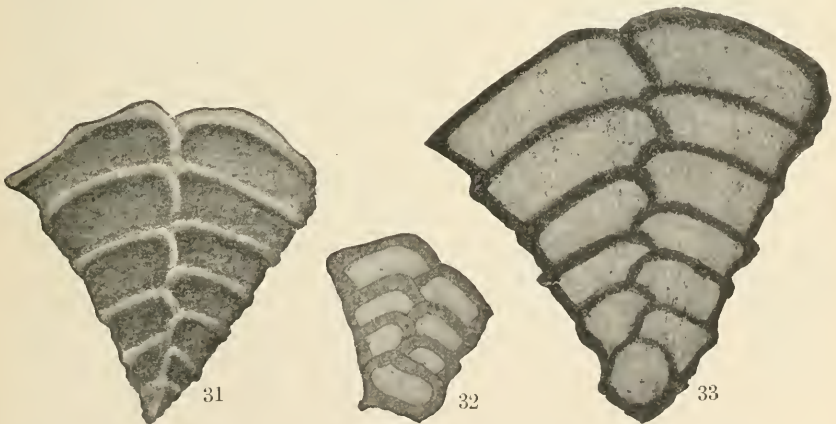
FIG. 30.—*TEXTULARIA INCONSPICUA*.  $\times 70$ . *a*, FRONT VIEW; *b*, APERTURAL VIEW; *c*, APICAL VIEW (AFTER BRADY).

As noted by Millett this species has certain characters more like some of the Rotalidæ than like any of the other species of *Textularia*. In its aperture, also as figured both by Brady and by Millett, this same resemblance is noticed. It may be a *Discorbina*, with chambers extending half way about the circumference of the test, but a study of the apical characters and the arrangement of the early chambers should determine this.

*TEXTULARIA FOLIUM* Parker and Jones.

*Textularia folium* PARKER and JONES, Philos. Trans. Roy. Soc. vol. 155, 1865, pp. 370, 420, pl. 18, fig. 19.—MÖBIUS, Beitr. Meeresfauna Insel Mauritius, 1880, p. 92, pl. 8, figs. 16–17.—BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 357, pl. 42, figs. 1–5.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 272, pl. 6, figs. 27, 28.—RHUMBLER, Zool. Jahrb., Abteil. Syst., vol. 24, 1906, p. 59, pl. 5, figs. 51, 52.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 130.

*Description.*—Test free, much flattened, broad, triangular in front view, in end view narrow, tapering toward the rather acute lateral



FIGS. 31-33.—*TEXTULARIA FOLIUM*. 31, FRONT VIEW.  $\times 125$ . 32, EARLY CHAMBERS VIEWED BY TRANSMITTED LIGHT, SHOWING BROADLY OVAL PROLOCULUM WITH A SPINE.  $\times 125$ . 33, SPECIMEN WITH SPHERICAL PROLOCULUM, BY TRANSMITTED LIGHT.  $\times 175$ .

margins; chambers broad and low in later development, earlier the less broad, the inner and distal margins thickened to form a raised ridge;

peripheral margin thin, surface smooth; wall fairly thick, clearly perforate, proloculum rounded or often somewhat quadrangular.

Length 0.18–0.54 mm., proloculum in rounded form 0.024–0.030 mm. in diameter, in quadrangular form 0.027–0.036 mm. high and 0.055–0.066 mm. in breadth.

*Distribution.*—The distribution of this species is again in the Indo-Pacific region, although it was not found by Millett in the Malay Archipelago. It has been recorded from the Australian region, from about the Fiji and Admiralty Islands, and from Mauritius. From the Hawaiian Islands it was recorded on the coral reefs of Honolulu, 40 fathoms, by Brady, and from *Albatross* station H4017, in 305 fathoms, by Bagg. Rhumbler records it from shallow water at Laysan Island. I have noted specimens from two *Nero* stations off the Hawaiian Islands, 2033 and 2071, in 249 and 271 fathoms, respectively.

This in its form and ornamentation is in many ways a rather unique species. The occurrence of double tests has been noted by several writers.

**TEXTULARIA APERTURALIS, new name.**

*Textularia solita* (SCHWAGER), var. *inflata* GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 42, pl. 5, figs. 1–3.

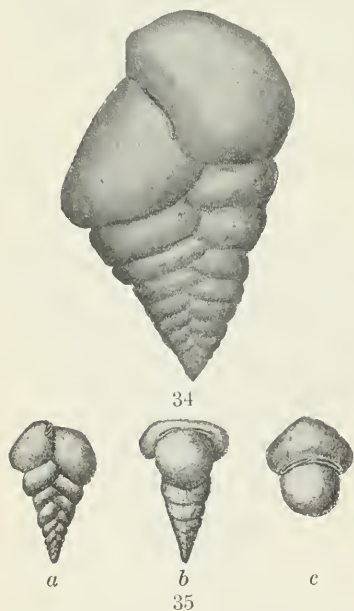
*Description.*—Test tapering, triangular in front view, the initial end acute and compressed, the later portion inflated, with high chambers; the end view broadly oval; wall composed of very fine almost amorphous material, smooth; aperture a much elongated slit slightly above the base of the inner margin of the chamber, in adult specimens divided in the median plane to form two apertures; aperture often bordered by a slightly projecting raised rim; color white.

Length 1.45 mm.

*Distribution.*—Goës described this species from *Albatross* station D3375 in 1,201 fathoms off the west coast of America.

An examination of Goës's original material does not seem to show the reason for uniting this species with *Textularia solita* (Schwager) even as a varietal form. With its peculiar inflated adult chambers and its tendency to divide the aperture, it seems

to be a very distinctive species, and as *inflata* has already been used in this genus, I propose the above name for this species.



FIGS. 34–35.—TEXTULARIA APERTURALIS.  
34.  $\times 30$ . 35, a, FRONT VIEW; b, SIDE VIEW; c, END VIEW.  $\times 20?$  (FIG. 35, AFTER GOËS.)

## TEXTULARIA FLINTII, new species.

*Textularia agglutinans* FLINT (part), Rep. U. S. Nat. Mus., 1897 (1899), p. 284, pl. 29, fig. 4 (in part) [not *T. agglutinans* d'Orbigny].

*Textularia rugosa* BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 131 [not *T. rugosa* (Reuss)].

*Description*.—Test triangular in front view, irregularly rhombic in end view, rapidly increasing in size from the early portion, rather thick, but somewhat compressed laterally; chambers numerous, low and broad, inflated, separated by rather deep sutures; wall very finely arenaceous but smooth and shining; aperture an elongated slit slightly above the inner base of the chamber, often with a slightly raised lip.

Length about 1 mm.

*Distribution*.—Specimens referred to this species were found at *Albatross* station H2899, 1,531 fathoms, east of the Hawaiian Islands, and at *Nero* stations 1294, 1,417 fathoms, off the Bonin Islands, and 1464 (type), in 891 fathoms, near Guam; also at *Tuscarora* station 58, in 814 fathoms, near the Bonin Islands. Bagg records this species under the name of *Textularia rugosa*, as a study of his selected material shows. The figured specimens were from *Albatross* station H4568, in 1,274 fathoms, near the Hawaiian Islands.

*Type*.—Cat. No. 8333, U.S.N.M.

In the figures given by Flint this species is confused with *Textularia agglutinans*. This species differs much from typical *T. agglutinans* in the greater lateral compression, the broader, more triangular form, the low broad chambers, the rhombic or almost quadrangular outline in end view and the broad aperture with its raised border above the base of the chamber, as well as in the much smoother and polished surface.

This species may be found to be rather common if it is carefully distinguished from the others with which it has been confused.

## TEXTULARIA CRESCENTIFORMIS, new species.

*Description*.—Test elongate, slender, tapering, the initial end subacute, in side view crescentiform, gradually increasing in size from the initial end, in end view broadly rounded; chambers numerous, the

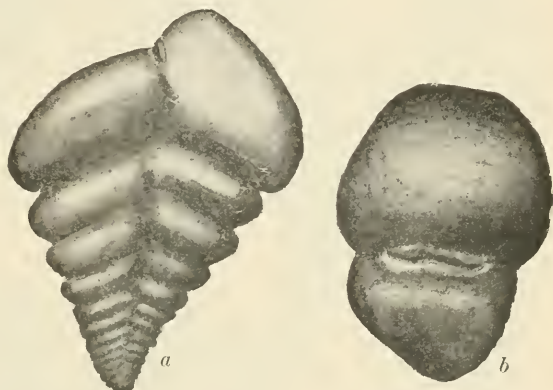


FIG. 36.—TEXTULARIA FLINTII.  $\times 40$ . a, FRONT VIEW; b, APERTURAL VIEW.

earlier broad and low, becoming higher in later development and the last formed chambers higher than broad; sutures depressed and, with the somewhat tumid chambers, giving a sinuous outline to the test; wall arenaceous but of fine material and smoothly finished; aperture narrow, slightly above the base of the inner border of the chamber.

Length about 1 mm.

*Distribution*.—This species was found near the Hawaiian Islands at *Nero* station 2034, in 175 fathoms.

*Type*.—Cat. No. 8334, U.S.N.M.

This species in some respects resembles *Bolivina* but in most characters is a *Textularia*. The curvature of the test in side view is marked.

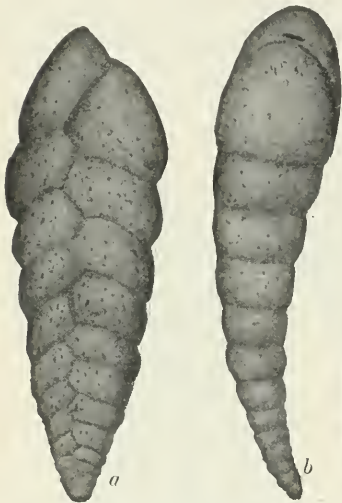


FIG. 37.—*TEXTULARIA CRESCENTIFORMIS*.  $\times 75$ . a, FRONT VIEW; b, SIDE VIEW, SHOWING THE DISTINCT CURVATURE OF THE TEST; c, APERTURAL VIEW.

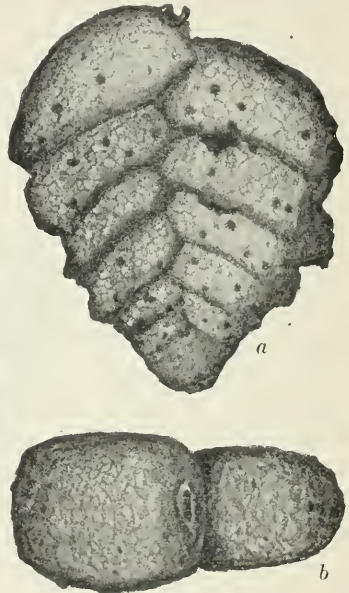


FIG. 38.—*TEXTULARIA CONCAVA*.  $\times 60$ . a, FRONT VIEW; b, APERTURAL VIEW.

*TEXTULARIA CONCAVA* (Karrer).

*Plecanium concavum* KARRER, Sitz. kais. Akad. Wiss., Wien, vol. 58, 1868, p. 129, pl. 1, fig. 3.

*Textularia concava* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 360, pl. 42, figs. 11, 12 [not pl. 43, fig. 11].—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 471.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 271, pl. 6, figs. 3, 4 [?].—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 42.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 283, pl. 28, fig. 5.—MILLET, Journ. Roy. Micr. Soc., 1899, p. 559, pl. 7, fig. 5.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 7, pl. 1, fig. 11.

*Description*.—Test tapering, becoming broad in the adult, compressed, broad faces often distinctly concave; chambers low and broad, squarely truncated laterally; wall arenaceous; aperture a narrowly



elliptical opening, surrounded by a raised lip, somewhat above the base of the inner wall of the chamber.

Length 0.5-1.0 mm.

*Distribution.*—This species is apparently not common in the North Pacific. It has been noted occasionally in the material from about the Hawaiian Islands.

**TEXTULARIA CATENATA, new species.**

*Description.*—Test elongate, rounded in end view, composed of inflated chambers separated by rather deep sutures, making the outline of the test sinuate; wall somewhat coarsely arenaceous; aperture in the early chambers slit-like at the ventral border of the inner margin, in later chambers gradually moving away from the margin and in the last-formed chamber subterminal and rounded.

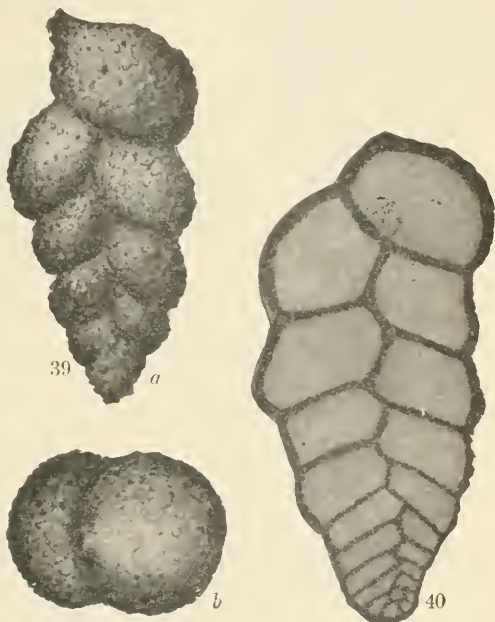
Length about 1 mm.; microspheric proloculum 0.022 mm.

*Distribution.*—This species was obtained from two *Nero* stations in the western North Pacific, station 1160 (type), in 1,907 fathoms and station 1320, in 2,048 fathoms. These stations are between Yokohama and Guam, one occupied on the northern voyage, the other on the return. They are but a few miles apart and the difference in depth is unimportant.

*Type.*—Cat. No. 8335, U.S.N.M.

The microspheric form of the species which is here figured has several small chambers in a coil about the proloculum. Then follows a series of broad low chambers, arranged biserially (fig. 40.)

Such species as this, with the terminal rounded aperture, have clearly essential characters different from the typical species of *Textularia* with the elongated aperture at the base of the inner border, yet these forms here described are evidently directly related to typical *Textularia* as is shown in their early development.



FIGS. 39-40.—*TEXTULARIA CATENATA*. 39, *a*, FRONT VIEW; *b*, APERTURAL VIEW.  $\times 60$ . 40, ANOTHER SPECIMEN, MICROSPHERIC, BY TRANSMITTED LIGHT, SHOWING THE MICROSPHERIC PROLOCULUM FOLLOWED BY FOUR CHAMBERS IN A COIL BEFORE THE BISERIAL CONDITION IS TAKEN ON.  $\times 120$ .

This species has a slight resemblance in its last chambers to *Gaudryina siphonella* Reuss, but is not a *Gaudryina*, having the biserial arrangement developed directly after the coiled series of chambers in the young.

**TEXTULARIA CRASSISEPTA**, new species.

*Description*.—Test broad, much compressed, in end view quadrangular, composed of rather few chambers, the earlier low and broad, the later shorter and comparatively high; walls coarsely arenaceous; borders of chambers much thickened and appearing as raised portions with depressed areas between; aperture becoming terminal some distance from the inner border of the chamber in the adult.

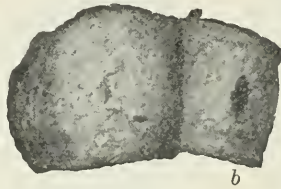


FIG. 41.—*TEXTULARIA CRASSISEPTA*.  $\times 60$ . a, FRONT VIEW; b, APERTURAL VIEW.

Length 0.8–1.0 mm.

*Distribution*.—This species was found at Albatross station H3007, in 323 fathoms, near the Hawaiian Islands.

*Type*.—Cat. No. 8336, U.S.N.M.

In some respects this species suggests *Textularia concava*, but is readily distinguishable.

**TEXTULARIA QUADRILATERA** Schwager.

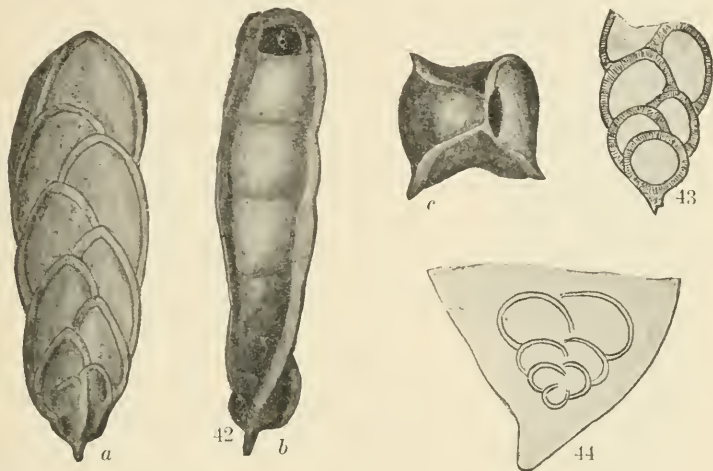
*Textularia quadrilatera* SCHWAGER, *Novara* Exped., Geol. Theil, vol. 2, 1866, p. 253, pl. 7, fig. 10.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 358, pl. 42, figs. 8–12.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 283, pl. 28, fig. 3.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 559, pl. 7, fig. 3.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 131.

*Bolivina quadrilatera* WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 475.

*Description*.—Test elongated, slender, very slightly tapering, in end view quadrilateral, the angles usually carinate; chambers high and narrow, running back obliquely on the outer border, compressed; the initial end of the test often with a stout spine, occasionally with several small spines or smooth and broadly rounded, the early chambers sometimes with one or more longitudinal raised costæ for a short distance; wall hyaline, distinctly perforate; aperture at one side near the distal end of the chamber, sometimes obliquely elongate, but somewhat variable.

Length up to 1.2 mm., megalospheric proloculum 0.076–0.115 mm., microspheric proloculum 0.012–0.023 mm.

*Distribution.*—The distribution of this species is very interesting. According to the *Challenger* report, it was found once in the South Atlantic and at a number of stations in the South Pacific, in from 410 to 1,350 fathoms. Flint records it from near Colon, Canal Zone, in 896 fathoms. Bagg records it from two stations near the Hawaiian Islands, station H4430, in 1,544 fathoms, and station H4568, in 1,274 fathoms. In the material I have examined it has occurred very frequently in the western North Pacific. Off the coast of Japan it was often noted in the *Albatross* material, and also in the *Nero* material from the line of soundings between Yokohama and Guam. The depths range from 191 to 891 fathoms, with a single record from 1,599 fathoms.



FIGS. 42-44.—*TEXTULARIA QUADRILATERA*. 42, MEGALOSPHERIC FORM; *a*, FRONT VIEW; *b*, SIDE VIEW; *c*, APERTURAL VIEW.  $\times 60$ . 43, OPTICAL SECTION THROUGH THE EARLY CHAMBERS OF A MEGALOSPHERIC SPECIMEN.  $\times 60$ . 44, OPTICAL SECTION THROUGH THE EARLY CHAMBERS OF A MICROSPHERIC SPECIMEN.  $\times 275$ .

Both microspheric and megalospheric forms occurred in the material examined. In the microspheric form, which is not common, the proloculum is very small and the initial end of the test very tapering, the full width of the test not being attained until near its completion. The microspheric proloculum in the specimens examined varied from 0.012 to 0.023 mm. in diameter. In the megalospheric form the proloculum is much larger, often of nearly as great a diameter as that of the completed test and greater than the thickness of any other portion of the test. This form is therefore usually less tapering, with nearly parallel sides. The megalospheric proloculum varied from 0.076 to 0.115 mm. In the record kept the ratio of frequency of the megalospheric to the microspheric form was about 6 to 1.

This species, as has been suggested by various authors, is more like *Bolivina* in some respects than like the other species of *Textularia*. I have left it in the latter genus for the present, not without some doubts.

Both forms of the species are, so far as has been noted, without a coiled series of chambers in the early development of the test, a character which seems characteristic of the microspheric form in most species of *Textularia*. This would tend to place the species as a highly specialized one which in its acceleration of development had skipped this stage in its ontogeny even in the microspheric form.

#### TEXTULARIOIDES, new genus.

*Description*.—Test attached, consisting of a *Textularia*-like series of chambers, arranged in two series, the chambers of one series alternating with those of the other; wall arenaceous; aperture an elongated slit in a depression at the base of the inner margin of the chamber.

*Type of the genus*.—*Textularioides inflata*, new species.

This genus is closely related to *Textularia*, being mainly distinguished by the attached habit and the consequent changes in the structure of the test.

#### TEXTULARIOIDES INFLATA, new species.

*Description*.—Test attached, elongate, slender, biserial, composed of alternating series of chambers, each slightly wider than high; sutures fairly distinct; chambers inflated, margin sinuous; wall coarsely arenaceous;

aperture an elongated slit in a depression at the ventral border of the inner margin of the chamber.

Length 2.5 mm.

*Distribution*.—This species was found attached to a fragment of shell dredged by the *Albatross* at station D4900, in 139 fathoms, off the coast of Japan.

*Type*.—Cat. No. 8337, U.S.N.M.



FIG. 45.—TEXTULARIOIDES INFLATA.  $\times 30$ .  
a, FRONT VIEW; b, END VIEW.



Apparently this specimen is megalospheric, as the chambers immediately succeeding the proloculum are arranged biserially, with no trace of a coiled series of chambers. The species is a large and striking one.

Genus *BIGENERINA* d'Orbigny, 1826.

*Bigenerina* d'ORBIGNY (Type, *B. nodosaria* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 261.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 368.

*Description*.—Test free, elongate, composed of a series of biserial chambers in the early portion, followed by several chambers uniserially arranged; aperture typically an oval or rounded opening near the middle of the terminal face; walls fairly thick, arenaceous, usually fairly coarse, but sometimes of fine material and smooth.

The specimen figured originally by d'Orbigny is rather characteristic. It has twelve biserially arranged chambers followed by a uniserial series of four chambers. In his sectional figure d'Orbigny shows the apertures of the early portion as truly textularian on the border of the inner margin of the apertural face, between it and the preceding chamber, while in the uniserial chambers it becomes a central opening in the middle of the terminal face of the chamber.

Later authors have included in this genus a great variety of species with characters not in accord with those established by d'Orbigny. Brady, in his synonymy, gives a long list of genera which he places wholly or in part in this genus.

As shown in *B. arenacea* Bagg, there are apparently both megalospheric and microspheric forms present. In the microspheric form the early chambers following the proloculum are coiled, as in the microspheric form of various species of *Textularia*, and like both forms in *Spiroplecta*. Later chambers are biserially arranged, as in *Textularia*, and those of the last formed group are arranged uniserially, giving the generic character. In the megalospheric form the coiled chambers may be wanting. As in other types, the microspheric form of the species attains the larger size.

*BIGENERINA NODOSARIA* d'Orbigny.

*Bigenerina nodosaria* d'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 261, pl. 11, figs. 9-11; Modèles, 1826, No. 57.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 28, pl. 2, fig. 62.—TERRIGI, Atti. Acc. Pont. Nuovi Lincei, vol. 33, 1880, p. 192, pl. 2, fig. 28.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 369, pl. 44, figs. 14-18.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 471.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 37, pl. 7, figs. 313-315 [316-323?]; Bull. Mus. Comp. Zool., vol. 29, 1896, p. 44.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 286, pl. 31, fig. 4.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 564, pl. 7, fig. 13.

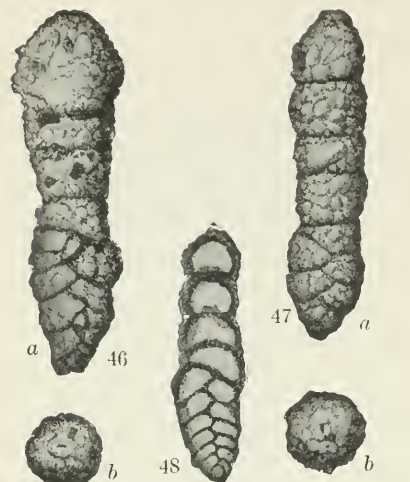
*Textularia agglutinans*, var. *nodosaria* PARKER and JONES, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 371, pl. 15, fig. 25; pl. 17, fig. 80.

*Clavulina elegans* KARRER, *Norara* Exped., Geol. Theil, vol. 1, 1864, p. 80, pl. 16, fig. 11.

*Description*.—Test elongate, the early portion composed of a biserial group of chambers, considerably flattened and with the sutures clearly marked externally; chambers progressively broader; later portion composed of a uniserial group of chambers, rounded, usually less in width than the biserial portion; wall usually coarsely arenaceous, sometimes of fine material and nearly smooth; aperture in the early portion as in *Textularia*, an elongate slit between the base of the inner margin of the chamber and the adjacent wall of the preceding chamber, in the later portion rounded and in the middle of the terminal face of the chamber; color white or light gray.

Length about 1 mm.

*Distribution*.—In the North Pacific this species is recorded by Brady in shallow water from three localities: China Sea; Hongkong Harbor,



FIGS. 46-48.—BIGENERINA NODOSARIA.  $\times 35$ . 46, a, FRONT VIEW; b, END VIEW. 47, a, FRONT VIEW; b, END VIEW. 48, LONGITUDINAL SECTION OF THE TEST (AFTER BRADY).

7-10 fathoms; Inland Sea, Japan, 15 fathoms.

Outside the North Pacific it is widely distributed.

#### BIGENERINA DIGITATA d'Orbigny.

*Bigenerina digitata* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 262; Modèles, 1826, No. 58.—H. B. BRADY, Trans. Linn. Soc., London, vol. 24, 1864, p. 468, pl. 48, fig. 8; Nat. Hist. Trans. Northumberland, vol. 1, 1865-67 (1867), p. 102, pl. 12, fig. 7.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 28, pl. 2, fig. 61.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 370, pl. 44, figs. 19-24.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 471.

*Textularia agglutinans*, var. *digitata* PARKER and JONES, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 371, pl. 17, fig. 81.

*Description*.—Test fusiform or cylindrical, elongate, rounded in cross section, the early portion consisting of a number of chambers arranged biserially, but circular in cross section; sutures somewhat indistinct; apex bluntly rounded; later portion consisting of a number of chambers arranged uniserially; division between the two portions not marked by a difference in size; wall rather coarsely arenaceous, but the particles neatly cemented with a reddish brown cement to form



FIG. 49.—BIGENERINA DIGITATA.  $\times 30$ . a, FRONT VIEW; b, APERTURAL VIEW.

a nearly smooth surface; aperture rounded, small, usually in the middle of the apertural face.

Length 1-1.6 mm.

*Distribution.*—Although this species has not heretofore been recorded from the Pacific, specimens from *Albatross* station D4949, in 110 fathoms on the coast of Japan, seem to belong to it. It occurs with numerous other species of the colder water area, which are similar to or identical with those of the northern Atlantic.

This species at first sight might be taken for a *Clavulina*, but the early chambers are biserial instead of triserial, as is the case in the early development of *Clavulina*. The species differs from the preceding in the early portion, which is here rounded, in *B. nodosaria*, being much flattened, and in the union between the biserial and uniserial portions, which are clearly distinguished in *B. nodosaria* by the difference in diameter of the test at that point, while in *B. digitata* the point of union is hardly distinguishable, except by the sutures.

BIGENERINA ARENACEA Bagg.

*Bigenarina arenacea* BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 132, pl. 5, figs. 4-6.

*Description.*—Test flattened, fairly large, composed of a series of chambers arranged biserially, followed by a later portion made up of broad, somewhat arched chambers arranged uniserially, both portions much compressed; in cross section elongate oval; sides well rounded, not at all carinate; wall arenaceous, varying in coarseness, smoothly finished; aperture in the later portion an oval opening in the middle of the apertural face.

Length up to 3 mm.

*Distribution.*—This species was described by Doctor Bagg from several *Albatross* stations in the vicinity of the Hawaiian Islands. I have examined the type and other specimens returned to the National Museum, and have found



FIG. 50.—BIGENERINA ARENACEA.  $\times 30$ . a, FRONT VIEW; b, APERTURAL VIEW.

two other *Albatross* stations, station H2999, in 549 fathoms, and station H2986, in 271 fathoms. A specimen from *Nero* station 990, in 859 fathoms, off Guam, apparently belongs to this species. It is somewhat more smooth and of finer material than usual, but this is probably due to local conditions of the bottom.



One additional feature not noted by the author is the tendency in the larger specimens to have the earliest chambers in a coil. Apparently this genus is related, as is *Textularia* and certain other genera, to an ancestral coiled form, as is indicated by the coiled arrangement of the earliest chambers in several genera of the family. This repetition of characters usually occurs only in the microspheric form of the species, which in this case as in many others seems to attain the larger size.

Genus PAVONINA d'Orbigny, 1826.

*Pavonina* d'ORBIGNY (type, *P. flabelliformis* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 260.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 374.

*Description*.—Test calcareous, hyaline, perforate, many chambered, the early chambers biserial, the later embracing, each embracing portion composed of one or more chambers; apertures numerous at the peripheral margin of the chamber.

There seems to be but a single well-defined living species, which is rather widely distributed.

PAVONINA FLABELLIFORMIS d'Orbigny.

*Pavonina flabelliformis* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 260, pl. 10, figs. 10, 11; For. Foss. Vienne, 1846, p. 72, pl. 21, figs. 9, 10.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 27, pl. 1, fig. 22.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 19, 1879, p. 282, pl. 8, figs. 29, 30.—MÖBIUS, Beitr. Meeresfauna Insel Mauritius, 1880, p. 91, pl. 8, figs. 13–15.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 374, pl. 45, figs. 17–22.—BASSET, Ann. Soc. Sci. Charente-Inf., 1884 (1885), p. 161, fig. in text.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 132.

*Pavonina flabelloides* BRONN, Klassen und Ordnungen Thier-Reichs, vol. 1, 1859, p. 72, pl. 6, figs. 13a, b.—BÜTSCHLI, in Bronn, Klassen und Ordnungen Thier-Reichs, vol. 1, 1880, p. 204, pl. 18, fig. 13.

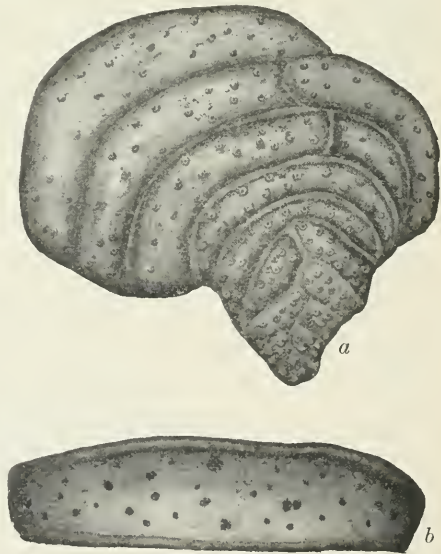


FIG. 51.—PAVONINA FLABELLIFORMIS. a, FRONT VIEW; b, APERTURAL VIEW.  $\times 75$ .

*Description*.—Test free, many chambered, much compressed, the early portion consisting of chambers arranged biserially, the later portion spreading; chambers in a single series, elongated, forming a fan-

shaped test; wall thin and transparent; apertures numerous on the peripheral wall, varying in size, and irregularly placed; wall porous, with numerous pores of good size more or less disposed in linear series, each with the wall immediately about it thickened and often slightly raised; color white, hyaline.

The diameter of the test rarely exceeds 1 mm.

*Distribution.*—This species seems to be rather rare, yet widely distributed throughout the warmer waters of the oceans. From the Pacific it has been recorded by Brady from the coast of Korea and from the coral reefs of Honolulu, in 40 fathoms; Bagg records it from *Albatross* station D4174, near the Hawaiian Islands, in 735–865 fathoms. I have seen specimens from three *Nero* stations, station 2042, in 55 fathoms, near the Hawaiian Islands, station 201, in 1,033 fathoms, near Midway Island, and station 1310, in 518 fathoms, near the Bonin Islands.

D'Orbigny's original figure shows the whole test without the biserial condition usually observed. Since the rediscovery by Möbius of the species in Madagascar sand, where d'Orbigny's type material was collected, it is clear that this is the species meant by d'Orbigny. The early portion was either obscure in his specimen or else it represents a megalospheric specimen without the biserial early stages. The later developed elongated chambers may run entirely across the periphery of the test or it may take two or even three chambers to complete the distance.



FIG. 52.—PAVONINA FLABELLIFORMIS.  
YOUNG SPECIMEN VIEWED BY TRANSMITTED LIGHT.  $\times 150$ .

#### Genus BOLIVINA d'Orbigny, 1839.

*Bolivina* D'ORBIGNY, (type, *B. plicata* d'Orbigny) Voyage Amér. Mérid., vol. 5, pt. 5, 1839, p. 61.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 416.

*Description.*—Test elongate, distinctly biserial throughout; wall usually thin and hyaline in the young, but becoming thickened with age in many species, ornamented by punctæ, striæ, costæ, knobs and spines, with carinæ developed in some species; aperture elongate, usually wider at one end, usually symmetrical.

This genus includes a large number of species, most of which are of small size. In many cases the species seem to be very local in their distribution, as shown by the work of the *Challenger* and again in the present material. This is especially true of the species occurring in fairly shallow water in the tropical and subtropical seas.

Although resembling *Bulimina* in some ways, its affinities seem closer to *Textularia* and related genera. The aperture is not usually asymmetrical to any extent, as claimed by Brady.

A study of the microspheric and megalospheric forms in the different species should be made to determine whether or not there are coiled chambers in the early development of the microspheric form.

The species which exhibit a tendency toward a uniserial condition have been referred by some authors to *Bifarina*. The last two species in the present series may be so placed.

**BOLIVINA PUNCTATA d'Orbigny.**

*Bolivina punctata* D'ORBIGNY, Voyage Amér. Mérid., vol. 5, pt. 5, "Foraminifères," 1839, p. 63, pl. 8, figs. 10-12.—H. B. BRADY, Trans. Linn. Soc., London, vol. 24, 1864, p. 468, pl. 48, figs. 9, *a, b*; Nat. Hist. Trans. Northumberland and Durham, vol. 1, 1865-67 (1867), p. 103, pl. 12, figs. 8 *a, b*.—MÖBIUS, Beitr. Meeresfauna Insel Mauritius, 1880, p. 94, pl. 9, figs. 9, 10.—TERRIGI, Atti Acc. Pont. Nuovi Lincei, vol. 33, 1880, p. 197, pl. 2, fig. 41.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 417, pl. 52, figs. 18, 19.—WOODWARD and THOMAS, 13th Ann. Rep. Geol. Nat. Hist. Surv. Minnesota for 1884 (1885), p. 169, pl. 3, fig. 12.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1886, p. 743, pl. 14, figs. 10 *a, b*.—MALAGOLI, Boll. Soc. Geol. Ital., vol. 7, 1889, p. 375, pl. 14, figs. 1-4.—TERRIGI, Mem. Com. Geol. d'Italia, vol. 4, 1891, p. 74, pl. 1, figs. 26-28.—WOODWARD and THOMAS, Geol. Nat. Hist. Surv. Minnesota, vol. 3, 1893, p. 34, pl. c, figs. 27, 28.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 298, pl. 8, figs. 1-3.—GOËS, Kongl. Svensk. Vet. Akad. Handl, vol. 25, No. 9, 1894, p. 49, pl. 9, figs. 475-478, 480.—EGGER, Jahr. 16, naturhist. Ver. Passau, 1895, p. 12, pl. 1, fig. 11.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 47.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 292, pl. 38, fig. 1.—WRIGHT, Geol. Mag. Dec. 4, vol. 7, 1900, p. 100, pl. 5, fig. 10.—MILLETT, Journ. Roy. Micr. Soc. 1900, p. 540.—SIDEBOTTOM, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 14.—CHAPMAN, Journ. Linn. Soc. Zoology, vol. 30, 1907, p. 32, pl. 4, fig. 80.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 138.—CUSHMAN, Proc. Boston Soc. Nat. Hist., vol. 34, 1908, p. 28, pl. 5, fig. 13.—CHAPMAN, Proc. Roy. Soc. Victoria, vol. 22, 1910, p. 274.

*Bulimina presli*, var. (*Bolivina*) *punctata* PARKER and JONES, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 376, pl. 17, fig. 74.

*Description*.—Test much elongated, straight or slightly curved, the apical end bluntly pointed, tapering very gradually to the apertural end; chambers numerous, somewhat compressed, the sutures slightly depressed, the chambers increasing in height as added; wall smooth, conspicuously but finely punctate; aperture an elongated slit, widest at the inner end; color white, brownish when living.

Length 0.40-0.85 mm.



FIG. 53.—*BOLIVINA PUNCTATA*. X 100. *a*, APERTURAL VIEW; *b*, FRONT VIEW.

*Distribution.*—Generally recorded from the North Pacific by Brady. Goës records it from several stations in the eastern Pacific in 695–1,882 fathoms, and Bagg records it at a number of stations in the vicinity of the Hawaiian Islands, in 104–1,544 fathoms. I have found the species well scattered in the North Pacific material that I have examined. The deepest record is *Nero* station 2049, in 2,226 fathoms, off the Hawaiian Islands.

A considerable variety of smooth forms have been assigned to this species, as a study of the references quoted will show. That there are several species or varieties present seems most likely. The variety with a portion of each chamber smooth, without punctæ, as noted by Millett, was found off the southern coast of Japan, and there may be other varieties with a definite distribution were sufficient material available from the different oceans.

The elongate form is not greatly removed from some forms of *B. nobilis*, except for the striations of the latter.

#### BOLIVINA DILATATA Reuss.

*Bolivina dilatata* REUSS, Denkschr. Akad. Wiss., Wien, vol. 1, 1850, p. 381, pl. 48, fig. 15.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 33, 1880, p. 197, pl. 2, fig. 42.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 418, pl. 52, figs. 20, 21.—MALAGOLI, Boll. Soc. Geol. Ital., ser. 4, vol. 6, 1887, p. 520, pl. 13, fig. 3.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 221, pl. 43, figs. 3, 6.—TERRIGI, Mem. Com. Geol. d'Ital., vol. 4, 1891, p. 75, pl. 1, fig. 29.—WOODWARD and THOMAS, Geol. Nat. Hist. Surv. Minnesota, vol. 3, 1893, p. 33, pl. e, fig. 26.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 294, pl. 8, figs. 17–20.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 50, pl. 9, figs. 482–486, pl. 14, figs. 5–10.—EGGER, Jahr. 16, naturhist. Ver. Passau, 1895, p. 10, pl. 1, fig. 6.—Goës, Bull. Mus. Comp. Zool., vol. 29, 1896, p. 47.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 542.



FIG. 54.—*BOLIVINA DILATATA*.  $\times 60$ . *a*, APERTURAL VIEW; *b*, FRONT VIEW.

*Description.*—Test cuneate, broadening rapidly toward the apertural end, the apical end small, blunt, much compressed, the edges thin; chambers numerous, broad and low, little inflated; sutures very distinct but hardly depressed; wall smooth, punctate; aperture elongate, narrow, ending at the edge of the inner border of the chamber; color white.

Length 0.3–0.6 mm.



*Distribution.*—Recorded by Goës from the eastern portion of the North Pacific in 695–1,832 fathoms, and by Bagg from the Hawaiian Islands, in 275–1,544 fathoms, with the average depth below 400 fathoms.

I have had material from *Nero* station 990, in 859 fathoms, near Guam, and from stations about Japan, in the Inland Sea, and in Bering Sea, from depths ranging between 120 fathoms and 898 fathoms. Specimens were nowhere common.

Although Reuss' name has been used for all the broader forms which could not well be included under *B. punctata* d'Orbigny by various writers, there is, as is seen from a study of the present material, a definite species with the characters given above. It is apparently very distinct from *B. punctata*, with chambers of a very different form.

**BOLIVINA SEMINUDA, new species.**

*Description.*—Test elongate, subcylindrical, very slightly compressed, the apical end rounded; chambers numerous, high, very slightly inflated, sutures nearly flush; wall hyaline, finely punctate except the lower half of each which has coarse foramina, otherwise smooth; aperture elongate, loop-shaped; color transparent and whitish about the lower half of each chamber.

Length up to 1 mm.

*Distribution.*—Specimens of this species were fairly common at two *Albatross* stations in Bering Sea, station H4025, in 536 fathoms, and station D4775 (type), on Bowers Bank, in 584 fathoms.

*Type.*—Cat. No. 8338, U.S.N.M.

The cylindrical form and the very peculiar ornamentation of the test distinguish this species. The test is hyaline and the lower half of the chamber, instead of being spinose or granular as in *B. spinescens*, is characterized by coarse foramina. No specimens

FIG. 55.—*BOLIVINA SEMINUDA*. × 60.



were found except in Bering Sea.

**BOLIVINA BEYRICHI Reuss.**

*Bolivina beyrichi* REUSS, Zeitschr. deutsch. geol. Gesellsch., vol. 3, 1851, p. 83, pl. 6, fig. 51.—HANTKEN, Mitth. Jahrb. Ung. geol. Anstalt, vol. 4, 1875 (1881), p. 64, pl. 7, fig. 11.—TERRIGI, Atti Accad. Pont. Nuovi Lincei, vol. 33, 1880, p. 198, pl. 2, figs. 43–45; vol. 35, 1883, p. 191, pl. 3, fig. 33.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 422, pl. 53, fig. 1.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 296, pl. 8, figs. 24–26.

*Description.*—Test elongate, rather narrow, much compressed, slightly tapering to the round-pointed apical end, apertural end

evenly rounded, the chambers numerous, high at the posterior outer edge each projecting backward in a spinose projection; wall smooth, punctate; aperture elongate; color white.

Length slightly less than 1 mm.

*Distribution*.—The only records in the North Pacific for this species are the two *Challenger* stations from which it was recorded by Brady, off the Philippines, in 95 fathoms, and on the *Hyalonema*-ground south of Japan, in 345 fathoms.

The figures of this species are very different, that of Hantken showing little if any of the posterior projections, and Egger's figure being very different from the usual form assigned to this species. From a study of the published figures and descriptions it seems very possible that our recent species may be found upon careful study to be different from the fossil.



FIG. 56.—*BOLIVINA BEYRICHI*.  $\times 50$  (AFTER BRADY).

*BOLIVINA BEYRICHI* Reuss, var. *ALATA* (Seguenza).

*Vulvulina alata* SEGUENZA, Atti Accad. Gioenia Sci. Nat., ser. 2, vol. 18, 1862, p. 115, pl. 2, figs. 5, 5a.

*Bolivina alata* EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 296, pl. 8, fig. 27.

*Bolivina beyrichi*, var. *alata* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 422, pl. 53, figs. 2-4.

*Bolivina beyrichi*, var. *carinata* HANTKEN, Magy. kir. földt. int. évkönyve, vol. 4, 1875 (1876), pl. 7, fig. 12; Mitth. Jahrb. Ung. geol. Anstalt, vol. 4, 1875 (1881), pl. 7, fig. 12.

*Description*.—Test differing from that of the typical form of the species by the wide peripheral flange; it is also broader and much more tapering.

Length about 1 mm.

*Distribution*.—Brady records this variety from one North Pacific *Challenger* station off the Philippines, in 95 fathoms. There is a specimen (figured) in the material which I have examined from *Albatross* station H4025, in 536 fathoms, near the Aleutian Islands, which seems to belong here and is not unlike the specimen figured by Brady in pl. 53, fig. 2, of the *Challenger* report.

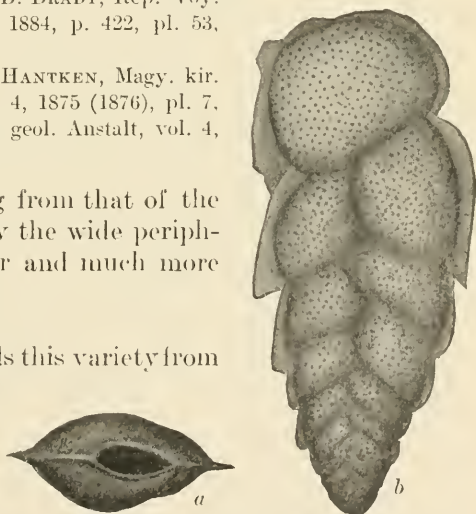


FIG. 57.—*BOLIVINA BEYRICHI*, var. *ALATA*.  $\times 60$ . *a*, APERTURAL VIEW; *b*, FRONT VIEW.

**BOLIVINA COMPACTA** (Sidebottom).

*Bolivina robusta* H. B. BRADY, var. *compacta* SIDEBOTTOM, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 15, pl. 3, fig. 7.

*Description*.—Test elongate, tapering, the apex blunt-pointed, compressed, the edges rounded, the chambers numerous, somewhat inflated; sutures slightly depressed; surface areolated by the coalescence of the raised edges of the rather coarse punctæ; aperture elongate, with a slightly raised border; color silvery white.

Length about 0.60 mm.

*Distribution*.—Specimens which agree well with the figure and description given by Sidebottom have been found at various stations in the North Pacific. The relation to *Bolivina robusta* does not seem to be close enough to make it a variety of that species, and so I have raised it to specific rank.

It was secured near the Hawaiian Islands at *Albatross* station H3007, in 323 fathoms, and at two *Nero* stations in the same region, from Guam, and from a *Nero* station near the Philippines.



FIG. 58.—*BOLIVINA COMPACTA*.  $\times 120$ . *a*, FRONT VIEW; *b*, END VIEW.

**BOLIVINA ROBUSTA** H. B. Brady.

*Bolivina robusta* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 57; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 421, pl. 53, figs. 7-9.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 294, pl. 8, figs. 31, 32.—MILLET, Journ. Roy. Micr. Soc., 1900, p. 543.—(?)CHAPMAN, Journ. Linn. Soc. Zool., vol. 30, 1907, p. 32, pl. 4, fig. 82.—(?)BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 138.

*Bolivina acaulis* EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 295, pl. 8, figs. 28-30.

*Description*.—Test roughly triangular, tapering gradually to the apical end, which is either bluntly rounded or with a long, stout spine; apertural end very broadly rounded, almost obliquely truncate; test thickest at the median line, from which it slopes away to the fairly thin but rounded lateral edges; chambers numerous, longer than high, curved, in the later often crenulate with fairly deep reëntnants on the posterior margin; sutures scarcely depressed, limbate, curved; wall calcareous, thickly set with rather coarse perforations; aperture oval with a slightly raised lip; color white or gray,

Length about 0.50 mm.; microspheric proloculum 0.011-0.012 mm.; megalospheric proloculum 0.047-0.050 mm.

*Distribution*.—From the North Pacific, Brady records this species as occurring at three stations in from 7-345 fathoms, the last being on



the *Hyalonema*-ground south of Japan. Bagg records it from the vicinity of the Hawaiian Islands, but not all of his selected set are of this species, and none of them are at all typical.

From the 1906 cruise of the *Albatross* there is a large number of specimens representing many stations ranging in depth from 59 to 500 fathoms, mostly off the southern coast of Japan, from the region from which some of Brady's material was obtained, with one or two stations in the Eastern Sea. From the *Nero* material the species is represented from stations south of Yokohama in 660 to 2,119 fathoms, the latter being at the only station in this area from which the species has been obtained from more than 1,500 fathoms. There are a few specimens from *Albatross* station II3007, near the Hawaiian Islands, in 323 fathoms, and from *Tuscarora* station 58, in 814 fathoms, south of the Bonin Islands.

In the material, microspheric and megalospheric specimens have been found at the same station, and the measurement of the proloculum in several cases has been obtained. There seems to be no tendency toward coiled young in the microspheric form, so far as seen.

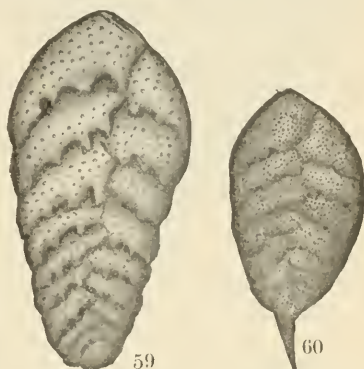
There is a considerable variation in the character of the lobulation of the posterior border of the chambers and in the presence or absence of the apical spine. Egger has described a species, *B. acaulis*, which seems to include those forms which lack the spine and have the lobulated margins of the chambers, but these characters are somewhat variable. The microspheric form is the more tapering of the two.

The figures show the extreme forms as made out in the material. The spineless form with the deeper lobulations is that called *B. acaulis* by Egger.

#### BOLIVINA SEMIALATA Bagg.

*Bolivina semi-alata* Bagg, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 139, pl. 5, fig. 3.

*Description*.—Test broad, very much compressed, the early chambers in a conical, little compressed test, the later chambers broadening out, very much compressed, with a broad thin flange about the periphery; apical end acuminate, with a short, rather stout, spine; apertural margin very broadly rounded; posterior margin of the flange with short, posteriorly directed tooth-like projections; wall calcareous, thin, perforated with rather coarse perforations,



FIGS. 59-60.—*BOLIVINA ROBUSTA*. 59, SPINELESS VARIETY WITH DEEPLY LOBED CHAMBER MARGIN.  $\times 100$ . 60, TYPICAL SPECIMEN WITH APICAL SPINE AND LESS DEEPLY LOBED MARGIN.  $\times 70$ .

smooth except for the apical end which may be slightly costate; aperture long and narrow, bordered by a raised lip formed by the flange bordering the chamber; color white.

Length 0.75–1.00 mm.

*Distribution.*—Bagg described this species from two specimens from *Albatross* station H4555, in 1,398 fathoms, near the Hawaiian Islands. The type-specimen is figured here; the other was not seen.

I have had a single specimen from *Nero* station 2034, in 175

fathoms, also off the Hawaiian Islands. It is figured here. Apparently it is a younger and less developed specimen of this same species, with the apical portion slightly costate.

*BOLIVINA SCHWAGERIANA* H. B. Brady.

*Bolivina schwageriana* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 58; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 425, pl. 53, figs. 24, 25.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 547, pl. 4, fig. 10.

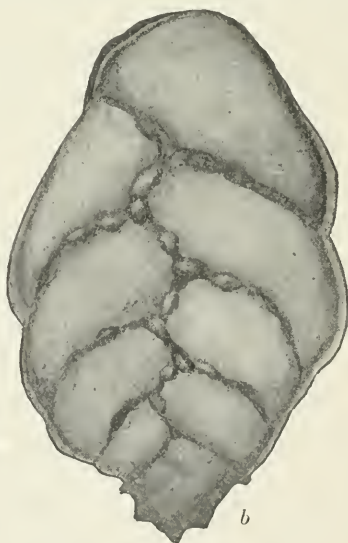
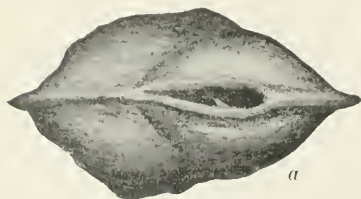


FIG. 63.—*BOLIVINA SCHWAGERIANA*.  $\times 65$ . a, APERTURAL VIEW; b, FRONT VIEW.

*Description.*—Test broad, a little longer than wide, compressed, thickest in the median line, thence curving gently to the carinate mar-



FIGS. 61-62.—*BOLIVINA SEMIALATA*.  $\times 75$ . 61, TYPE-SPECIMEN. 62, ANOTHER MORE REGULAR SPECIMEN FROM THE SAME REGION.

gins; apical end blunt, rounded; no keel developed on the early chambers, but in the later prominent though rather narrow; chambers well rounded; sutures limbate with raised beads near the junction with the chambers of the opposite series; wall calcareous, smooth except for the sutures and occasional costæ near the border of the test; aperture rather large, somewhat elongate, with an oblique projecting tooth; color white.

Length 0.50–0.65 mm.

*Distribution.*—This species has not previously been recorded from the North Pacific. Brady described it from specimens from Humboldt Bay, New Guinea, in 37 fathoms, and doubtful specimens from Torres Strait, in 155 fathoms. Millett records the species from the Malay Archipelago.

There are typical specimens from *Nero* station 1472, in 1,000 fathoms, near Guam. These are the only ones I have seen from the North Pacific. Apparently the species is limited to the Australasian region and the East Indian archipelago.

#### BOLIVINA NOBILIS Hantken.

*Bolivina nobilis* HANTKEN, Magy. kir. földt. int. évkönyve, vol. 4, 1875 (1876), p. 56, pl. 15, fig. 4, Mitth. Jahrb. Ung. geol. Anstalt, vol. 4, 1875 (1881), p. 65, pl. 15, fig. 4.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 424, pl. 53, figs. 14, 15.—CHAPMAN, Quart. Journ. Geol. Soc., vol. 48, 1892, p. 516, pl. 15, fig. 11.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 541, pl. 4, fig. 4.—CHAPMAN, Journ. Linn. Soc. Zool., vol. 30, 1907, p. 32, pl. 4, fig. 81.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 138.

*Description.*—Test much elongated, slender, somewhat compressed; sides nearly parallel but tapering rather quickly to a blunt point at the apical end, apertural end obliquely truncate; chambers numerous, high, somewhat inflated; sutures slightly depressed; wall calcareous, the apical portion with fine longitudinal costæ, the apertural end smooth; aperture oval, in some specimens, where a uniserial condition is attained, remote from the border and subterminal, otherwise reaching to the preceding chamber as also in the young; color white.

Length up to 1.20 mm.

*Distribution.*—All the *Challenger* stations for this species are in comparatively shallow water in the South Pacific. Bagg's records for the species are from *Albatross* station H4567, in 1,307 fathoms, and station H4696, in 367 fathoms, near the Hawaiian Islands. I have examined the specimens from these two stations and find that they are of the long slender type with finely costate apical ends.



FIG. 64.—*BOLIVINA NOBILIS*.  $\times 40$ .  
a, APERTURAL VIEW; b, FRONT VIEW.

I have specimens from five stations, *Albatross* station H2922, in 268 fathoms, station H3007 in 323 fathoms, *Nero* stations 2037 in 55 fathoms, 2064 in 1,355 fathoms and 2071 in 271 fathoms. All these five stations are close to the Hawaiian Islands.

These specimens as well as those which have been described by others are not very distinct from *B. punctata* except in the striations of the early chambers.

**BOLIVINA KARRERIANA H. B. Brady.**

*Bolivina karreriana* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 58; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 424, pl. 53, figs. 19-21.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 299, pl. 8, figs. 38, 39.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 546.

*Description*.—Test elongate, tapering, the apical end occasionally rounded, but usually pointed with one large spine or two or more small ones; chambers comparatively few, inflated; sutures much depressed; wall calcareous, ornamented by longitudinal raised costæ, occasionally branching or anastomosing, continued even on the last-formed chamber; aperture broadly oval, subterminal, occasionally with a small tooth projecting into the orifice, bordered with a raised lip; color, white.

Length 0.50-0.80 mm.

*Distribution*.—Brady found this species abundant in material from the *Hyalonema*-ground south of Japan, in 345 fathoms. I have examined material from more than twenty stations, all in the region about Japan or to the southward. At some of these stations specimens are fairly common. The *Albatross* material from near the southern coast of Japan in most of stations from D4965 to D4975 contained this species. These stations are in the same region as the *Challenger* station mentioned above. They vary in depth from 191 to 905 fathoms. The species is well represented in the *Nero* material, mostly from the line of soundings between Guam and Yokohama. In depth these soundings range within the limits just given for the *Albatross* stations. In the *Tuscarora* material lately come under notice there is a single mounted specimen from station 2, which is south of the Hawaiian Islands, in 1,468 fathoms. The specimen is typical in all its characters.

FIG. 65.—*BOLIVINA KARRERIANA*.  $\times 80$ .  
a, APERTURAL VIEW;  
b, FRONT VIEW.



The specimen recorded by Doctor Bagg from the vicinity of the Hawaiian Islands proves upon examination to be *Bulimina buchiana* d'Orbigny.



## BOLIVINA KARRERIANA H. B. Brady, var. CARINATA Millett.

*Bolivina karreriana* H. B. BRADY, var. *carinata* MILLETT, Journ. Roy. Micr. Soc., 1900, p. 546, pl. 4, fig. 8.

*Description*.—This variety has the test more compressed and larger than in the typical form, the aperture reaching to the preceding chamber instead of remote from it, and with the lateral borders distinctly carinate; the aperture is more elongate with a long tooth-like projection.

Length 0.75–0.80 mm.

*Distribution*.—Rare in the North Pacific, occurring but once, at *Nero* station 1472, in 1,000 fathoms, near Guam. Millett described this variety from the Malay Archipelago where it occurred at several stations.

Millett remarks upon the similarity of the variety to *B. hantkeniana* as well as to *B. karreriana*, and it may be that it is a distinct species. With but little available material I am leaving it as Millett has described it.



FIG. 66.—BOLIVINA KARRERIANA, VAR. CARINATA.  $\times 60$ . *a*, FRONT VIEW; *b*, APERTURAL VIEW (AFTER MILLETT).

## BOLIVINA PUSILLA Schwager.

*Bolivina pusilla* SCHWAGER, *Norara-Exped.*, Geol. Theil, pt. 2, 1866, p. 254, pl. 7, fig. 101.

*Description*.—Test elongate, tapering, composed of numerous rather low broad chambers, the apical end often with a very short spine, mucronate; wall ornamented with slightly raised longitudinal costæ, except at the apertural end where the chambers are usually smooth; aperture elongate, symmetrical; color, white.

Length about 0.40–0.60 mm.

*Distribution*.—This species is well distributed in the North Pacific in fairly deep water. It occurred at a large number of *Nero* stations from the Hawaiian Islands westward and along the coast of Japan. The shallowest record is near Japan, at *Albatross* station H4878, in 84 fathoms, and the deepest, *Nero* station 2049, in 2,226 fathoms, near the Hawaiian Islands. The larger number of records are from depths between 1,000 and 1,500 fathoms.

These specimens seem to be identical with the species described by Schwager from the fossil deposits of Kar Nicobar. The loss of ornamentation in the later chambers of adult specimens is interesting.



FIG. 67.—BOLIVINA PUSILLA.  $\times 60$ . *a*, FRONT VIEW; *b*, APERTURAL VIEW.

## BOLIVINA HANTKENIANA H. B. Brady.

*Bolivina hantkeniana* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 58; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 424, pl. 53, figs. 16-18.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 296, pl. 8, figs. 40-42.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 546, pl. 4, fig. 9.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 137.

*Description*.—Test broad, much compressed, usually completely surrounded except at the aperture by a broad wing-like flange, either entire or variously lobed; chambers inflated somewhat; sutures very distinct, slightly depressed; wall calcareous, with a few short longitudinal costæ, usually confined to the limits of the chamber on which they originate; aperture narrow, oval, with a single tooth-like projection in the orifice; color, white.

Length 0.60-0.84 mm.

*Distribution*.—This species is recorded by Bagg from several *Albatross* stations in the vicinity of the Hawaiian Islands. While some of these specimens have the characters of this species, others I should refer to *B. beyrichi*, var. *alata*, and to *B. semialata*.

The only specimen I have which can without doubt be this species is from *Albatross* station D4970, in 500 fathoms, off the southern coast of Japan.

Brady's specimens were all from the Indo-Pacific region, and apparently this is a species limited to the warmer region from Australia northward, including the oceanic islands. This is the range of a large number of our species.



FIG. 68.—BOLIVINA HANTKENIANA.  
× 60. a, APERTURAL VIEW; b,  
FRONT VIEW.

## BOLIVINA AMYGDALÆFORMIS H. B. Brady.

*Bolivina amygdalæformis* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 59; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 426, pl. 53, figs. 28, 29.

*Description*.—Test oval, compressed, the apical end round-pointed, the apertural end broadly rounded; chambers few, the sutures mostly hidden by the exterior ornamentation of the test, but showing slightly as darker lines; wall calcareous, ornamented by longitudinal costæ variously branching and anastomosing; terminal chamber, or sometimes the last two, nearly smooth, except for slight costæ at the lower border of the chamber, conspicuously and rather coarsely

perforate; aperture terminal, in end view nearly central, long-oval, slightly constricted near the middle, bordered by a rounded raised lip; color, white or gray.

Length about 0.75 mm.

*Distribution.*—In the North Pacific, Brady records this species from *Challenger* station 209, in 95 fathoms, off the Philippines. I have seen specimens from two *Albatross* stations, D4875, in 59 fathoms, eastern channel of Korea Strait, and D4964, in 37 fathoms, off the southern coast of Japan. Brady also records the species from off the north coast of New Guinea, 1,070 fathoms, and in Torres Strait, in 155 fathoms.

The specimens I have had for study are of the same form and with the same details as those figured by Brady. The specimen figured by Egger<sup>a</sup> does not seem to be of this species and is referred elsewhere

**BOLIVINA PLICATA** d'Orbigny.

*Bolivina plicata* D'ORBIGNY, Voyage Amér. Mérid., vol. 5, pt. 5, "Foraminifères," 1839, p. 62, pl. 8, figs. 4-7.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 138.

This species is recorded by Goës from *Albatross* station D3395, in 730 fathoms, but an examination of the selected material mounted by Goës from this station shows it to be a new species, later described.

Brady records *B. plicata* from a single station near the Hawaiian Islands, but his mounted specimen is unfortunately difficult to study, and dismounting was not attempted.

I have found no material in the North Pacific referable to this species.

**BOLIVINA SEMICOSTATA**, new name.

*Bolivina costata* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 426, pl. 53, figs. 26, 27 (not *B. costata* d'Orbigny, 1839).

*Description.*—Test broadly oval, two-thirds as broad as long, the ends obtusely rounded, somewhat compressed; chambers few, the sutures distinct, somewhat depressed; wall calcareous, ornamented with a number of raised rounded costæ running lengthwise of the test,



FIG. 69.—*BOLIVINA AMYGDALIFORMIS*. X 75. *a*, APERTURAL VIEW; *b*, FRONT VIEW.

<sup>a</sup> Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 299, pl. 8, fig. 45.



somewhat irregular; last one or two chambers usually smooth, carinate; aperture, in end view, central, terminal, broadly oval, with a raised, rounded border; color white.

Length 0.60–0.75 mm.

*Distribution.*—I have specimens of this species from *Nero* station 990, in 859 fathoms, off Guam. The oval specimens of Brady referred to above were from off Raine Island, Torres Strait, in 155 fathoms; in Humboldt Bay, off New Guinea, in 37 fathoms; and off Amboina, in 15–20 fathoms. Goës's specimen<sup>a</sup> does not belong here.

This species differs in several important characters from the typical form described by d'Orbigny. From the available records the species seems to be limited to tropical or subtropical waters.

**BOLIVINA ÆNARIENSIS (Costa).**

*Bricalina aenariensis* COSTA, Atti Acad. Pontaniana, vol. 7, 1856, p. 297, pl. 15, fig. 1, A. B

*Bolivina aenariensis* H. B. BRADY, Proc. Roy. Soc. Edinburgh, vol. 11, 1882, p. 711, table; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 423, pl. 53, figs. 10, 11.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 221, pl. 43, figs. 2, 4, 5.—MALAGOLI, Boll. Soc. Geol. Ital., vol. 7, 1889, p. 377, pl. 14, figs. 11, 12.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 50.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 292, pl. 37, fig. 8.—MILLET, Journ. Roy. Micr. Soc., 1900, p. 544.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 137 (part).

*Bulimina punctata* Goës?, Kongl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, 1882, pl. 4, figs. 114, 115 (not *Bolivina punctata* d'Orbigny).

*Description.*—Test elongate, slightly tapering, much compressed, the edges carinate; apical end broadly rounded, often with a stout spine; apertural end rounded; chambers numerous, slightly inflated, the sutures curved, very slightly depressed; wall calcareous, smooth and punctate except for two or more longitudinal costæ, usually two long costæ extending well forward near the middle of the test, with shorter accessory ones near the apical end; aperture elongate-oval, with a continuation of the carina of the chamber forming a smooth raised lip about the opening; color white or gray.

Length up to 1.25 mm.



FIG. 70.—*BOLIVINA SEMICOSTATA*.  
× 75. *a*, APERTURAL VIEW; *b*,  
FRONT VIEW.

<sup>a</sup> Bull. Mus. Comp. Zool., vol. 29, 1896, p. 48.

*Distribution.*—The species has been recorded by Brady at two North Pacific stations, off the Philippines, in 95 fathoms, and from the south coast of Japan, in 15 fathoms. Bagg records it from a number of *Albatross* stations near the Hawaiian Islands, but an examination of his material shows most of his specimens to belong to another species.

Typical specimens were found at a number of stations off the coast of Japan, in from 39–584 fathoms; also at three *Albatross* stations in Bering Sea, H4025, in 536 fathoms; D4781, in 482 fathoms; and D3608, in 276 fathoms. Specimens were abundant and large at station H2768, in 373 fathoms, near the coast of California. Specimens were also found at *Tuscarora* stations 32, in 309 fathoms, from the Californian coast; and 79, in 799 fathoms, near the Aleutian Islands.

The figured specimen did not have the typical long median costæ which are shown in Brady's figures and in the photographed specimens of Flint.

**BOLIVINA SUBANGULARIS H. B. Brady.**

*Bolivina subangularis* H. B. BRADY. Quart. Journ. Micr.

Sci., vol. 21, 1881, p. 59; Rep. Voy. *Challenger*,

Zoology, vol. 9, 1884, p. 427, pl. 53, figs. 32, 33.—MILLETT, Journ. Roy. Micr.

Soc., 1900, p. 545.



FIG. 71.—*BOLIVINA ENARIENSIS*.  $\times 40$ . *a*, APERTURAL VIEW; *b*, FRONT VIEW. SPECIMEN WITHOUT THE LONG MEDIAN COSTÆ.



FIGS. 72-73.—*BOLIVINA SUBANGULARIS*.  $\times 60$ . 72, *a*, FRONT VIEW; *b*, APERTURAL VIEW. 73. FRONT VIEW OF ANOTHER SPECIMEN (AFTER BRADY).

down each face of the test. Aperture comma-shaped."

Length 0.5 mm. or less.

*Distribution.*—Recorded by Brady from *Challenger* station 209, in 95 fathoms, off the Philippines. I have not found specimens referable to this species. The description and figures are from Brady.

*Description.*—"Test oblong, tapering, stoutly built, more or less angular, somewhat concave or excavated on both sides; aboral extremity obtusely pointed. The angular contour of the transverse section is determined by the prominence of superficial costæ, the principal of which, six in number, are placed, one down each lateral margin, and two

## BOLIVINA LOBATA H. B. Brady.

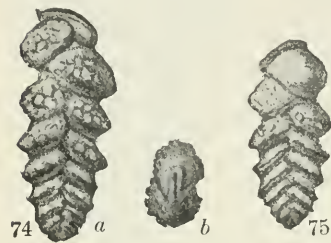
*Bolivina lobata* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 58; Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 425, pl. 53, figs. 22, 23.

*Description*.—"Test elongate, depressed, digitate; distal end obliquely truncate or rounded, aboral extremity obtuse, peripheral margin lobulated. Segments inflated, their outer margins projecting and subangular; sutures thickened, and deeply sunk; surface, especially of the later chambers, more or less granulated. Aperture a long oval slit contracted at the middle; nearly central."

Length 0.40 mm.

*Distribution*.—This species was described by Brady from the region about New Guinea. I have found it at a single station, *Nero* station

1583, in 777 fathoms, between Guam and Midway Island. The granulations of the surface and the form are similar. Egger's figures<sup>a</sup> do not seem to represent this species, but it is hard to judge from the quality of the figures in that work. Millett's figure<sup>b</sup> closely resembles *B. lobata*, but its connection with the young of *Bigennerina fimbriata* Millett makes it certain that it is a young of that species. If *B. lobata* had such a uniserial development, it seems that



FIGS. 74-75.—*BOLIVINA LOBATA*.  $\times 80$ .  
74, a, FRONT VIEW; b, APERTURAL VIEW (AFTER BRADY).

Brady's material would have shown it. Therefore, for the present, it seems best not to unite it, but to keep it with the species as described by Millett. The resemblance is, however, so striking that it may be that the uniserial form was present but overlooked or placed elsewhere. The question remains as to whether the figured specimen given by Millett is really the same as the type of *Bolivina lobata* H. B. Brady. If it is, then Brady's name should be used, although the genus would necessarily be changed.

The description and figures are from Brady.

## BOLIVINA SPINESCENS, new name.

*Bolivina textularioides* H. B. BRADY (part), Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 419, pl. 52, figs. 24, 25 (not *Bolivina textularioides* Reuss, 1862).—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 542, pl. 4, fig. 5.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 139.

*Description*.—Test elongate, subcylindrical, the apex bluntly pointed; chambers numerous, inflated, the sutures fairly deep, the surface smooth except the portion at and just above the sutures, which is minutely spinose or granular; aperture large, loop-shaped, with a slightly raised border; color white or gray.

Length 0.50-0.75 mm.

<sup>a</sup> Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, pl. 8, figs. 55, 56.

<sup>b</sup> Journ. Roy. Micr. Soc., 1900, pl. 1, fig. 4.

*Distribution.*—It is impossible to determine which of the two forms figured by Brady was obtained from the one North Pacific station given by him, Honolulu Reefs, 40 fathoms. However, an examination of Bagg's material labeled *B. textularioides* shows the rough bordered form here described. In the *Nero* material I have had specimens from stations 2068, 2071, and 2074 in 307, 271, and 22 fathoms, respectively, the last being at Honolulu. Therefore Brady's specimens were probably of this species. There are also numerous specimens from the southern coast of Japan and from the area between Yokohama and Guam.

Millett recognized two distinct forms in the Malayan material. This spinose or granular form, at least in the North Pacific, seems to be the more common, no specimens which could be assigned to Reuss's species being seen.

**BOLIVINA DECUSSATA H. B. Brady.**

*Bolivina decussata* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 58; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 423, pl. 53, figs. 12, 13.

*Description.*—Test broad, tapering to the rounded apical end; apertural end obliquely truncate, compressed, the edges thick and square, or somewhat rounded; chambers numerous, the sutures indistinct,

the surface ornamented with a series of rounded bosses, arranged more or less in vertical rows and also in oblique rows across the test; aperture rounded, with a raised border; color white.

Length 0.50 mm.

*Distribution.*—The only records for this species are those given by Brady from off Juan Fernandez in the South Pacific. What certainly seems to be this species has occurred at *Albatross* station D4839, in 140 fathoms, off Japan. The form is similar and the surface has the peculiar raised ornamentation shown in Brady's figures.

**BOLIVINA LIMBATA H. B. Brady.**

*Bolivina limbata* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 57; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 419, pl. 52, figs. 26-28.—HOWCHIN, Trans. Roy. Soc. South Australia, vol. 12, 1889, p. 8.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 300, pl. 8, figs. 10-12.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 543.—SIDEBOTTOM, Mem. and Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 15.—CHAPMAN, Journ. Linn. Soc., Zool., vol. 30, 1907, p. 32, pl. 4, fig. 83.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 138.



a



b

FIG. 76.—*BOLIVINA SPINESCENS*.  $\times 75$ .  
a, APERTURAL VIEW; b, FRONT VIEW.



FIG. 77.—*BOLIVINA DECUSSATA*.  $\times 120$ .



*Description.*—Test elongate, much compressed, gradually tapering to the rather bluntly-rounded apical end, often somewhat twisted, thickest along the median line, thinning toward the lateral margins, which are slightly rounded; chambers usually about as high as wide, slightly tumid, the sutures very distinct, irregularly curved, limbate, especially along the median portion of the face; wall calcareous, smooth, punctate; aperture elongate-oval, in some specimens somewhat remote

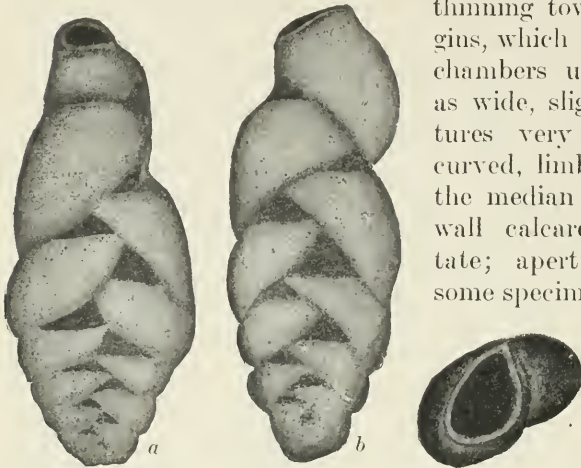


FIG. 78.—*BOLIVINA LIMBATA*.  $\times 125$ . *a*, FRONT VIEW; *b*, SAME SPECIMEN FROM OPPOSITE SIDE; *c*, END VIEW.

from the border and terminal; color white.

Length 0.50–0.75 mm.

*Distribution.*—

Brady records the

species from the following three stations in the North Pacific, off the Hawaiian Islands, in 40 fathoms, south shore of Japan, 15 fathoms, and in Hongkong Harbor, 7 fathoms. Bagg's specimen is from *Albatross* station H4694, in 865 fathoms, off the Hawaiian Islands.

In the material I have examined the species has been noted from the following stations: *Albatross* station D4965, in 191 fathoms, off the coast of Japan, and *Nero* station 1466, in 234 fathoms, near Guam.

There is a tendency in adult specimens to assume a uniserial development with a terminal aperture. From the other published records the species seems to be confined to fairly shallow tropical and subtropical waters.

***BOLIVINA (BIFARINA) PORRECTA* H. B. Brady.**

*Bolivina porrecta* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 57; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 418, pl. 52, fig. 22, *a*, *b*, *c*.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 300, pl. 8, figs. 7–9, 46, 47.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 292, pl. 38, fig. 2.

*Bifarina porrecta* MILLETT, Journ. Roy. Micr. Soc., 1900, p. 540, pl. 4, fig. 3.

*Description.*—Test elongate, slightly tapering, the apex rounded; apertural end truncate, compressed, the edges rounded, the chambers



FIG. 79.—*BOLIVINA (BIFARINA) PORRECTA*.  $\times 60$ . *a*, APERTURAL VIEW; *b*, FRONT VIEW.



high, the later triangular, the sutures in later growth passing entirely across the test and forming an almost uniserial stage; wall smooth, perforate; aperture subterminal, removed from the inner edge of the chamber, elongate, with a raised border; color white.

Length 0.75–0.84 mm.

*Distribution*.—Not previously recorded from the North Pacific, but known from off Tahiti, the north coast of New Guinea, and from the Malay Archipelago. The only North Pacific station at which I have found the species is *Albatross* station D4875, in 59 fathoms, eastern channel of Korea Strait. This material is typical.

This species is referred to *Bifarina* by Millett, and if that genus be recognized that is its logical position.

**BOLIVINA (BIFARINA) STRIGOSA (H. B. Brady).**

*Bolivina lobata*, var. *strigosa* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 425, pl. 113, fig. 7.

*Description*.—Test elongate, slightly tapering, compressed; chambers triangular, the outer posterior angle extending outward, giving a very lobulated margin to the test; wall perfectly hyaline, except at the border, where it is partially white and opaque; sutures distinct, extending across the test in the later chambers; aperture elongate, subterminal, removed from the inner border of the chamber, surrounded by a raised lip; color transparent, white.

Length 0.40 mm.

*Distribution*.—Brady described this as a variety of *B. lobata* from Torres Strait. The figured specimen from *Nero* station 1310, in 518 fathoms, between Yokohama and Guam, is in every respect identical with Brady's specimen. The resemblance to *B. lobata* seems to be remote, and it is here considered as a distinct species.

In this same region and at corresponding depths many of the other species described from Torres Strait are found, and it is not surprising to find this rare form here also. The arrangement of the last-formed chambers strongly suggests *Bifarina*.

**Genus PLEUROS TOMELLA Reuss, 1860.**

*Nodosaria* (part) REUSS, Verst. Böhm. Kreid., pt. 1, 1845, p. 28.

*Dentalina* (part) REUSS, Haidinger's Nat. Abhandl., vol. 4, 1850, p. 24.

*Pleurostomella* REUSS (type, *P. subnodosa* Reuss.), Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 203.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 410.

*Description*.—Test elongate, somewhat compressed, composed of numerous chambers, usually biserially arranged; wall calcareous,



FIG. 80.—*BOLIVINA (BIFARINA) STRIGOSA*.  
× 120. *a*, APERTURAL VIEW; *b*,  
FRONT VIEW.

perforate, smooth or ornamented; aperture distinctive, an arched opening with a vertical notch or slit in the middle of the lower edge, usually with tooth-like projections upward at either side.

The aperture is really the distinguishing character of this genus. It differs much from that of the other genera of the family, and there are considerable differences in the various species, some having a simple vertical slit without teeth, others a broad notch with a well developed tooth at each side. This wall containing the slit or notch is usually well within the arched space, and is not always easy to see when examining material. There are several described species, but none of them seem to be at all common. None of the species have previously been recorded from the North Pacific.



FIG. 81.—PLEUROSATOMELLA ALTERNANS.  $\times 60$ . *a*, FRONT VIEW; *b*, VIEW SHOWING APERTURE.

PLEUROSATOMELLA ALTERNANS Schwager.

*Pleurostomella alternans* SCHWAGER, *Novara* Exped., geol. Theil, vol. 2, 1866, p. 238, pl. 6, figs. 79, 80.—TERRIGI, Atti. dell' Accad. Pont., ann. 33, 1880, p. 199, pl. 2, fig. 46.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 412, pl. 51, figs. 22, 23.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 25.

*Description*.—Test elongated, compressed, very gradually tapering from the subacute base; apertural end acute in front view, in side view broadly rounded; chambers numerous, longer than wide; sutures slightly depressed; aperture broadly arched; notch of the lower wall broad, almost semicircular, with an acutely

pointed tooth projecting forward on each side; wall smooth and polished; color white.

Length 0.60–0.85 mm.

*Distribution*.—There is a single specimen in the collection from *Albatross* station D2806, in 1,379 fathoms, off the Galapagos Islands. It has not been met with in material from any other part of the North Pacific.

Whether or not this species is really *P. alternans* Schwager may be open to question. That species, as the original figures show, has a very high vertical wall in which the aperture is seen near the top as a relatively small opening. In the recent specimens figured this opening is much larger and broader.

## PLEUROSATOMELLA SUBNODOSA (Reuss).

*Nodosaria nodosa* REUSS (part), Verst. Böhm. Kreid., pt. 1, 1845, p. 28, pl. 13, fig. 22.

*Dentalina subnodosa* REUSS (part), Haidinger's Nat. Abhandl., vol. 4, 1850, p. 24, pl. 1, fig. 9.

*Pleurostomella subnodosa* REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 204, pl. 8, fig. 2a, b.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 412, pl. 52, figs. 12, 13.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 25.

*Description.*—Test much elongated, very slightly compressed, nearly cylindrical, hardly tapering, the apical end broadly rounded, the apertural end subacute in front view, rounded in side view; chambers several, the very early ones biserial, the later uniserial, but with oblique sutures showing the traces of the biserial condition; aperture fairly broad; sinus broad with slight projections at each side; color white.

Length 0.65–0.90 mm.

*Distribution.*—Apparently this species is more common in the North Pacific than the preceding. It was found in material from *Tuscarora* station 2, in 1,468 fathoms, in the southwestern Pacific, *Nero* station 842, in 1,330 fathoms, off the coast of Luzon, Philippine Islands, and at *Nero* stations 1294 and 1299, in 1,417 and 1,817 fathoms, south of Japan.

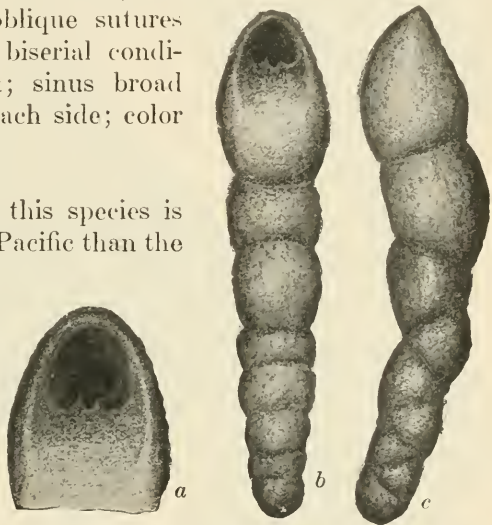


FIG. 82.—PLEUROSATOMELLA SUBNODOSA. a, APERTURE.  $\times 150$ ; b, FRONT VIEW; c, SIDE VIEW.  $\times 75$ .

The early portions of the test show biserially arranged chambers and the later ones while uniserial are really a biserial series, which shove one another apart, as is seen by the arrangement of the sutures and the wedge-shaped chambers alternating from side to side as added.

## PLEUROSATOMELLA SPINOSA, new species.

*Description.*—Test broad, abruptly tapering to the acute spinose apical end; chambers several, greatly increasing in size in the adult, broad and much inflated, the sutures deep; surface with numerous very short subacute spines, either over all the chambers or limited to the earlier ones; aperture with the sinus a narrow slit with bluntly rounded short teeth at the sides; color white.

Length 0.50–0.70 mm.

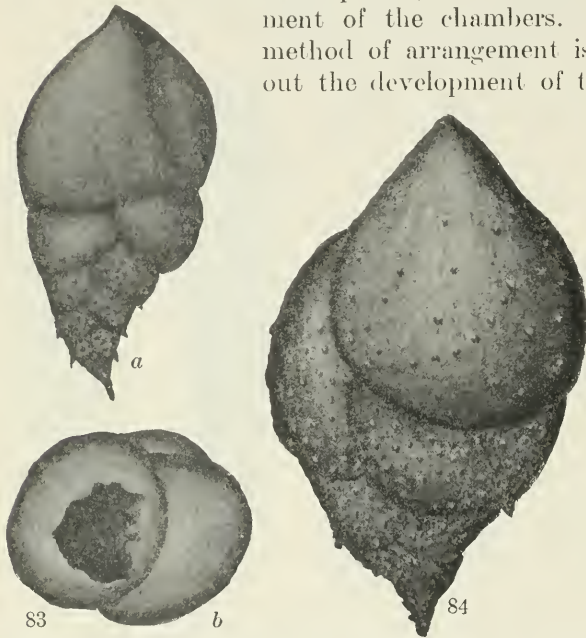
*Distribution.*—Type-specimen (Cat. No. 8339, U.S.N.M.) from Albatross station D4970, in 500 fathoms, off Japan. Two other specimens were found at this station.

This species differs from the other abruptly tapering species of the genus by its more depressed sutures and its spinose surface.

### Subfamily 3, VERNEUILININÆ.

This subfamily includes those genera which, at least in their early development, have a distinctly triserial arrangement of the chambers. In *Verneuilina* this method of arrangement is continued throughout the development of the test, but in other

genera becomes variously modified. In *Gaudryina* the early portion of the test is triserial and the adult arrangement is biserial and comparable to *Textularia*. In *Clavulina* there is still another regressive step and the young are triserial, while the adult arrangement is uniserial with a central aperture.



FIGS. 83-84.—PLEUROSATOMELLA SPINOSA.  $\times 75$ . 83, *a*, FRONT VIEW; *b*, APERTURAL VIEW WITH THE UPPER END OF THE CHAMBER SLIGHTLY BROKEN AND JAGGED. 84, FRONT VIEW OF ANOTHER MORE INFLATED SPECIMEN.

### Genus VERNEUILINA d'Orbigny, 1840.

*Verneuilina* D'ORBIGNY (type, *V. tricarinata* d'Orbigny), Mém. Soc. Géol. France, ser. 1, vol. 4, 1840, p. 38.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 382.

*Bulimina* (part), REUSS, Verst. Böhm. Kreid., pt. 2, 1845, p. 109, and other authors.

*Polymorphina* (part), SCHULTZE, Organ. Polyth., 1854, p. 61.

*Textularia* (part), PARKER and JONES, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 371 and other authors.

*Description.*—Test free, more or less elongate, tapering, in cross section rounded or triangular, composed of a series of chambers spirally arranged, but in three vertical columns; walls variable, arenaceous or hyaline; aperture a slit at or near the base of the inner margin of the chamber.



In general the genus *Verneuilina* may be used to include all the definitely triserial species which have a slit-like aperture at the base of the inner margin of the chamber. This is apparently the primitive genus from which have developed such genera as *Gaudryina*, and in its relations to *Textularia*, *Verneuilina* may be taken as the simplest member of the subfamily *Verneulinina*. It includes a number of well characterized species, some of them rather common and of wide distribution.

**VERNEUILINA POLYSTROPHA (Reuss).**

*Bulimina polystropha* REUSS, Verst. Böhm.

Kreid., pt. 2, 1845, p. 109, pl. 24, fig. 53.

*Verneuilina polystropha* PARKER and JONES,

Introd. Foram., 1862, p. 311.—H. B.

BRADY, Ann. Mag. Nat. Hist., ser. 5, vol.

1, 1878, p. 436, pl. 20, figs 9a-c.

*Description*.—Test elongate, conical, triserial, the apical end bluntly rounded, the chambers somewhat inflated; wall coarsely arenaceous, the surface rough; aperture at the base of the inner margin of the chamber, in a depression formed at the junction of the three chambers, rounded or oval; vertical columns of chambers usually spirally twisted; color reddish brown.

Length 0.50-1.0 mm.

*Distribution*.—This shallow water species has heretofore not been recorded from the North Pacific. Specimens from two *Albatross* stations, H2681, in 486 fathoms, and H2772, in 343 fathoms, off the western coast of the United States, seem referable to it as figured by Brady. Whether this is really the species described by Reuss from the cretaceous is very doubtful, but for the present it is so considered.



FIG. 85.—VERNEUILINA POLYSTROPHA. X 30. a, APERTURAL VIEW; b, FRONT VIEW.

**VERNEUILINA PROPINQUA H. B. Brady.**

*Verneuilina propinqua* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884,

p. 387, pl. 47, figs. 8-12 [not 13, 14].—Goës, Kongl. Svensk. Vet. Akad. Handl.,

vol. 25, No. 9, 1894, p. 33, pl. 7, figs. 264-266.—FLINT, Rep. U. S. Nat. Mus.,

1897 (1899), p. 285, pl. 31, fig. 2.

*Description*.—Test free, pyramidal, triserial, the apical end bluntly rounded; chambers well inflated but closely set; wall coarsely arena-



ceous, the surface somewhat rough or nearly smooth; aperture elongate at the base of the inner margin of the chamber; color brown.

Length up to 3.6 mm.

*Distribution.*—Brady records this species from three *Challenger* stations in the southwestern portion of the North Pacific, in 95, 2,050, and 2,900 fathoms. Goës records the species, but his Pacific material belongs to the following species, and his Atlantic is *V. bradyi*. In the *Albatross*, *Nero*, and *Tuscarora* soundings the species has occurred at a number of stations from off California to the coast of Japan.

Its most shallow occurrence is 905 fathoms and the deepest 2,086 fathoms.

The vertical columns of chambers are straight as in *V. bradyi* and show no tendency toward the spiral form as in *V. polystropha*.

**VERNEULINA BRADYI, new name.**

*Verneulina pygmæa* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 385, pl. 47, figs. 4-7 (not *Bulimina pygmæa* Egger).—FLINT, Rept. U. S. Nat. Mus., 1897 (1899), p. 285, pl. 31, fig. 1.

*Verneulina propinqua* Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 38 (part).

*Description.*—Test pyramidal, the triserial chambers inflated, the wall finely arenaceous; about five visible chambers in each vertical series; surface smooth, but not usually polished; aperture an elongated slit near the base of the inner margin of the chamber, occasionally with a thickened lip; color light gray.

Length 0.60-1.50 mm.

*Distribution.*—Apparently this species is widely distributed in the deeper water of all the oceans.

The only North Pacific records are those of Brady, who found the species in material from six *Challenger* stations in this area ranging in depth from 1,850-3,125 fathoms. In the material which I have examined the species has occurred many times. No station with a depth of less than 1,000 fathoms gave specimens of this species. This accords with Brady's observations on the *Challenger* material, where but 8 out of 42 stations at which this species occurred were of a depth of less than a thousand fathoms, and 14 were greater than 2,000. Only one of our stations is below the 2,000 fathom mark, though several are close to it. The shallowest station from which I have seen specimens had a depth of 1,040 fathoms. In general the stations are well scattered over the area of the North Pacific where dredging has been done, except



FIG. 86.—VERNEULINA PROPINQUA.  $\times 35$ . a, APERTURAL VIEW; b, FRONT VIEW.

that it did not occur in the 1906 soundings from about Japan. Most of the work done here, however, was in more shallow water.

There has been considerable doubt in the minds of various authors as to the correctness of assigning our recent species to the somewhat incomplete figure of *Bulimina pygmæa* given by Egger.<sup>a</sup> Brady remarks upon the doubtfulness of using Egger's name for this species. Goës also is inclined to question the identity.

From a study of the available data it seems to me very unwise to refer our well characterized recent species to the very doubtful and ill characterized fossil species. Egger's figure does not at all represent our common recent species nor does the later figure given by Goës.<sup>b</sup> Neither *Textilaria triseriata* Terquem nor *Verneuilina rotundata* Karrer are clearly this species, certainly not the former, although both are included by Brady under *V. pygmæa*. In such a case it seems best to use a new name for our recent species, and from the clear description and excellent figures given by Brady his name is used here for the species.

An examination of the series selected by Goës shows that a part of his specimens referred to *V. propinqua* are in reality *V. bradyi* and not *V. propinqua* H. B. Brady.

#### VERNEUILINA SPINULOSA Reuss.

*Verneuilina spinulosa* REUSS, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 374, pl. 47, fig. 12.—EGGER, Neues Jahrb., 1857, p. 292, pl. 9, figs. 17, 18.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 384, pl. 47, figs. 1-3.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 219, pl. 42, fig. 15 (not fig. 14).—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 472.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 11.—SIDE-BOTTOM, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 10, pl. 2, fig. 5.—RHUMBLER, Zool. Jahrb., Abth. Syst., vol. 24, 1906, p. 61, pl. 5, fig. 53.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 132.

*Description*.—Test pyramidal, three-sided, triangular in transverse section, the sides flat or slightly concave, the initial end acutely

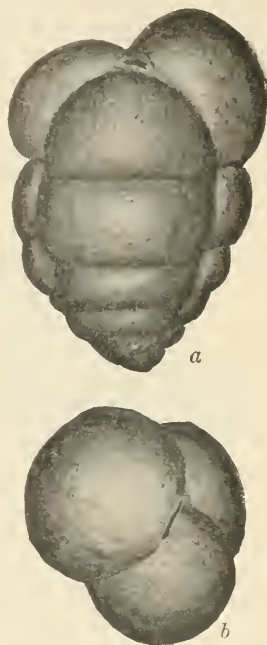


FIG. 87.—VERNEUILINA BRADYI.  
× 40. a, FRONT VIEW; b, APERTURAL VIEW.

<sup>a</sup> Neues Jahrb. für Min., 1857, p. 284, pl. 12, figs. 10, 11.

<sup>b</sup> Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 33, pl. 7, figs. 262, 263.

pointed; initial end and angles of chambers often with sharp spines; walls of medium thickness, hyaline, or in some cases thickened and rough, perforate, smooth or granular; apertural end of test bluntly angled, the edges of the chambers thickened; aperture a curved slit at the base of the inner edge of the chamber.

Length 0.25–0.75 mm.

*Distribution.*—This species seems to be widely distributed in the North Pacific. Brady records it from four *Challenger* stations in this area, the extremes of depth being 7 and 2,300 fathoms. Rhumbler notes its occurrence at Laysan Island, and Bagg records it from five *Albatross* stations near the Hawaiian Islands in from 275 to 865 fathoms.

I have had material from a considerable number of stations in the North Pacific, all but two of which were from depths greater than 100 fathoms. Brady found that but 7 of his 24 stations for this species were in depths greater than 100 fathoms. The greatest depth at which material was taken in-

cluding this species was 1,355 fathoms in the *Nero* soundings near the Hawaiian Islands. Nearly all the specimens examined were from south of 30° north.

*VERNEULINA AFFIXA*, new name.

*Verneulina propinqua* H. B. BRADY (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 387, pl. 47, figs. 13, 14 [not figs. 8–12].—Goës (part), Bull. Mus. Comp. Zool., vol. 29, 1896, p. 38.

*Description.*—Test affixed, pyramidal, tapering to a rather acute point at the apical end, triserial except at the attached end, which may be biserial in the attached chambers; test usually somewhat curved; wall coarsely arenaceous, but only slightly roughened on the surface; aperture at the base of the inner margin of the chamber in an elongated depression formed by the last formed whorl of chambers, rounded or somewhat elongate; color reddish brown, except the attached chambers and the area of attachment about the chambers, which are light gray.

Length up to 4 mm.

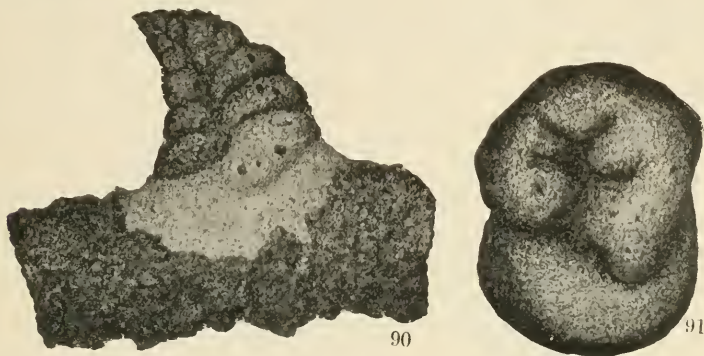


FIG. 88.—*VERNEULINA SPINULOSA*.  $\times 60$ . *a*, FRONT VIEW; *b*, APERTURAL VIEW.



FIG. 89.—*VERNEULINA SPINULOSA* (?).  $\times 60$ . SPECIMEN WITH COILED YOUNG.

*Distribution.*—As Brady includes this under *Verneuilina propinqua*, it is impossible to know at which stations this species occurred without consulting his material. Goës's specimens, one of which is figured here, were from *Albatross* station D3419, in 772 fathoms, off the west coast of Mexico, attached to tubes of *Rhabdammina irregularis* W. B. Carpenter.



FIGS. 90-91.—VERNEUILINA AFFIXA.  $\times 25$ . 90, SPECIMEN ATTACHED TO RHABDAMMINA. 91, APERTURAL VIEW OF DETACHED SPECIMEN.

This species is different in every way from typical *V. propinqua* H. B. Brady. It is higher and more tapering, and is usually distinctly bent toward the tip. The chambers are more numerous and less inflated, the later with a tendency to become biserial; and it differs also in the attached habit with its consequent modifications of the apertural portion of the test.

The light gray or white border of loose material about the area of attachment appears to be common to a large number of attached forms which are not at all related.

#### VERNEUILINA PUSILLA Goës.

*Verneuilina pusilla* Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 39, pl. 5, figs. 6-8.

*Description.*—“Short, often nearly cylindrical, with very little inflated segments, or sometimes ovoid with inflated segments; aperture a sutural slit or an obliquely set comma-formed fissure. Pale yellow or whitish.”

Length 0.50–0.66 mm.

*Distribution.*—This species was described by Goës from *Albatross* station D3431, in 995 fathoms, at the entrance of the Gulf of California.



FIG. 92.—VERNEUILINA PUSILLA (AFTER GOËS).

I have carefully examined the mounted set returned to the U. S. National Museum by Goës from the above station and labeled *Verneuilina pusilla* Goës on the original label. The specimens do not fit the description or figures at all well, but many of the figures



of the paper quoted are very poor when compared with the specimens. I should place these specimens under *V. polystropha* Reuss, as they seem to have all the characteristics of Brady's figures of that species.

The above description is taken from Goës.

Genus VALVULINA d'Orbigny, 1826.

*Valvulina* d'ORBIGNY (type, *V. triangularis* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 270.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 391.  
*Rotalina* (part) WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 55.

*Description*.—Test spiral, conical, with three chambers in a whorl, umbilicate, usually attached; wall arenaceous, fairly smooth; aperture provided with a valvular tooth; color usually reddish brown, area of fixation white or light gray.

The genus *Valvulina* as designated by d'Orbigny includes various fossil forms which differ somewhat in shape from our recent species but only in minor points. Typically the test is attached but it is not always found in place. The area of fixation is large.

The genus is best represented by fossil species, the recent ones being few and specimens rare.

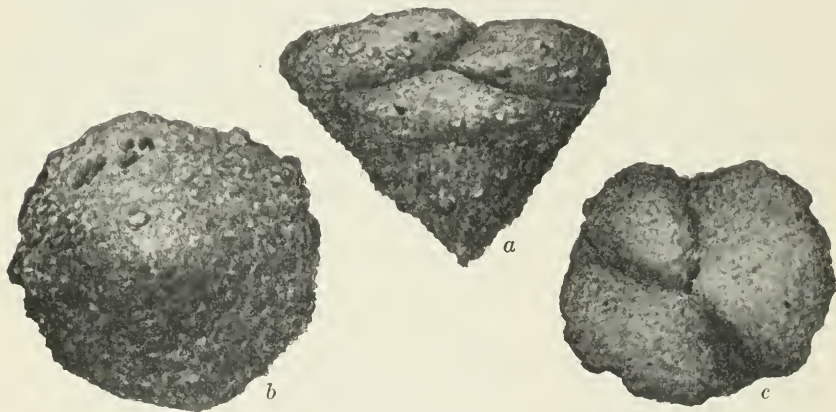


FIG. 93.—VALVULINA CONICA.  $\times 40$ . a, FRONT VIEW; b, FROM ABOVE; c, FROM BELOW.

VALVULINA CONICA (Parker and Jones).

*Valvulina triangularis* PARKER and JONES, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 295, pl. 11, figs. 15, 16 (not *Valvulina triangularis* d'Orbigny).

*Valvulina triangularis*, var. *conica* PARKER and JONES, Philos. Trans. Roy Soc., vol. 155, 1865, p. 406, pl. 15, fig. 27.

*Valvulina conica* M. SARS, Vid. Selsk. Forh., 1868, p. 249.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 392, pl. 49, figs. 15, 16.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 220, pl. 41, fig. 21; pl. 42, figs. 16, 17.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 39, pl. 8, figs. 342-352.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 286, pl. 31, fig. 3.

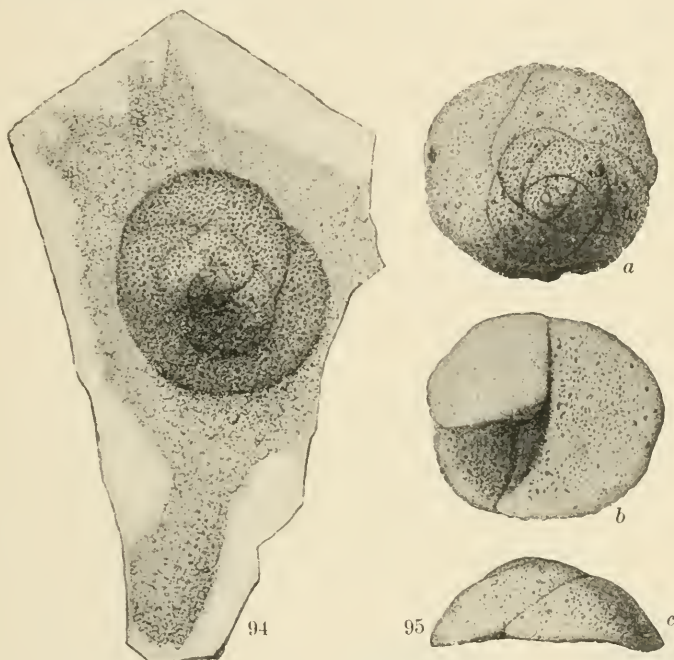
*Description*.—Test typically attached, conical, often with the axis somewhat curved, the apical end bluntly pointed, the affixed end flat and truncate, even concave; chambers arranged spirally, but so



as to form a triserial test; wall coarsely arenaceous, rough or fairly smooth on the surface; aperture slit-like, at the inner basal margin of the chamber, protected by a valvular lip; early chambers dark reddish brown, the later becoming lighter; area of attachment light gray.

Diameter about 0.50 mm.

*Distribution.*—There are no previously published records for this species in the North Pacific. The only specimens obtained from the material examined were from *Albatross* station H2922, in 268 fathoms, near the Hawaiian Islands.



FIGS. 94-95.—VALVULINA FUSCA. 94, ATTACHED SPECIMEN.  $\times 40$ . 95, a, DORSAL VIEW; b, VENTRAL VIEW; c, SIDE VIEW.  $\times 50$  (AFTER BRADY).

VALVULINA FUSCA (Williamson).

*Rotalina fusca* WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 55, pl. 5, figs. 114, 115.—TERQUEM, Ess. Anim. Plage Dunkerque, 1875, p. 26, pl. 2, figs. 6, a, b.

*Valvulina fusca* M. SARS, Vid. Selsk. Forh., 1868, p. 249.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 392, pl. 49, figs. 13, 14.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 39, pl. 8, figs. 353-355.

*Valvulina triangularis*, var. *austriaca* PARKER and JONES, Introd. Foram., 1862, p. 311.

*Valvulina austriaca* H. B. BRADY, Trans. Linn. Soc. London, vol. 24, 1864, p. 472.

*Description.*—Test typically attached, low conical, depressed, rounded, the affixed end concave; chambers spirally arranged, with only three chambers in each whorl; wall finely arenaceous, smooth;

aperture slit-like, at the inner basal margin of the chamber, protected by a valvular lip; early chambers reddish brown, the later yellowish brown; area of attachment light gray.

Diameter 0.50–0.65 mm.

*Distribution.*—The only record for this species in the North Pacific is that given by Brady from near the Philippines, in 95 fathoms. I have not met with the species in the material which I have examined.

#### Genus CHRYSALIDINA d'Orbigny, 1846.

*Chrysalidina* d'ORBIGNY (type, *C. gradata* d'Orbigny), For. Foss. Vienne, 1846, p. 194.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 387.

*Description.*—Test many chambered, triserial, at least in the early portion, tapering; apertures numerous, scattered over the terminal wall of the chamber; other walls also porous.

This genus includes two species, one a fossil from the cretaceous of the Vienna basin, the other a very rare recent species occurring in shallow water in the warmer portion of the Pacific and Indian Oceans.

It is rather probable that these two species are not generically related, but until more is known about them they may be considered as belonging to one genus.

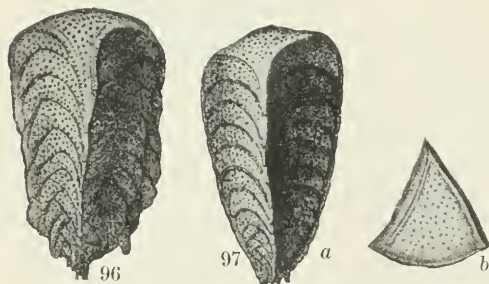
#### CHRYSALIDINA DIMORPHA H. B. Brady.

*Chrysalidina dimorpha* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 54; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 388, pl. 46, figs. 20, 21.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 274, pl. 6, figs. 47, 51, 52.—MILLET, Journ. Roy. Micr. Soc., 1900, p. 12, pl. 1, fig. 14.

*Description.*—Test free, elongate, tapering, triangular in cross section, the sides nearly equal, somewhat concave, the edges slightly carinate; early portion acute, consisting of chambers arranged triserially, the later portion composed of chambers arranged in a single series; wall hyaline, perforate; apertures numerous on the broadened terminal face of the chamber.

Length about 0.50 mm., diameter about 0.25 mm.

*Distribution.*—This species is known from the warmer portions of the Pacific and Indian Oceans, almost entirely from shallow water or from shore sands. The only published North Pacific records are given by Brady: Coral reef of Honolulu, in 40 fathoms; Hongkong Harbor, in 7 fathoms.



FIGS. 96-97.—CHRYSALIDINA DIMORPHA.  $\times 70$ . 97, a, FRONT VIEW; b, APERTURAL VIEW (AFTER BRADY).

## Genus TRITAXIA Reuss, 1860.

*Textularia* (part) REUSS, Verst. Böhm. Kreid., pt. 1, 1845, p. 39.

*Tritaxia* REUSS (type, *T. tricarinata* (Reuss) = *Textularia tricarinata* Reuss), Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 228.—H. B. BRADY (part), Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 388.

*Description*.—Test triserial, at least in the earlier portion, usually triangular in cross section; aperture central and terminal with or without a distinct neck and lip, rounded; wall usually arenaceous.

This genus, as defined by Reuss and employed by Brady, includes those triserial forms which in their earlier development are like *Verneuilina* and have a textularian aperture, later changing their plan of development so that the newly added chamber occupies nearly or quite the whole of the apertural end of the test. With this change in the chamber comes a change in the aperture to a terminal position and a corresponding change in shape to a circular opening, usually with a raised lip, and in some species with a definite tubular neck as well.

A new genus has been erected for *T. caperata* H. B. Brady, which is in many ways different from other species of *Tritaxia*.

## TRITAXIA TRICARINATA (Reuss).

*Textularia tricarinata* REUSS, Verst. Böhm. Kreid., pt. 1, 1845, p. 39, pl. 8, fig. 60.

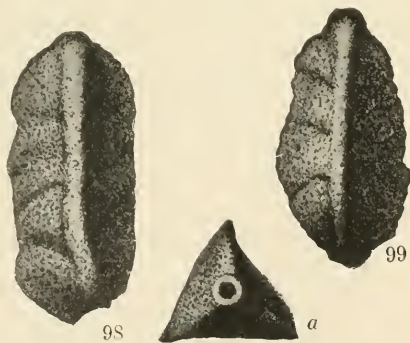
*Tritaxia tricarinata* REUSS, Sitz. Akad. Wiss. Wien, vol. 40, 1860, p. 228, pl. 12, figs. 1, 2.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 389, pl. 49, figs. 8, 9.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 39.

*Description*.—Test elongate, triangular in cross section, the edges carinate, the apical end bluntly rounded, the sides slightly concave; apertural aspect triangular; wall rather coarsely arenaceous, fairly smooth, the sutures rather indistinct; aperture in adult specimens rounded, central, terminal, often with a short neck; color brown.

Length about 1 mm.

*Distribution*.—Goës records this species as rare in the Pacific (referring to the southeastern portion of the North Pacific), in 900 fathoms. None of the Pacific stations from which Goës had material is exactly 900 fathoms in depth, although several

are near it. Under the lists by stations this species does not occur from the Pacific list, and there are no specimens in the lot returned by Goës. Therefore the record rests solely upon the published work of Goës.



FIGS. 98-99.—TRITAXIA TRICARINATA.  $\times 35$ .  
98, a, APERTURAL VIEW (AFTER BRADY).

It is a question whether Brady was correct in assigning the recent form which occurred only off Torres Strait to the cretaceous species described by Reuss. In the absence of material this point can simply be suggested as open to question.

Genus GAUDRYINA d'Orbigny, 1839.

*Gaudryina* d'ORBIGNY (type, *G. rugosa* d'Orbigny), in De la Sagra, Hist. Fis. Pol. Nat. Cuba, 1839, "Foraminifères," p. 109; Mém. Soc. Géol. France, ser. 1, vol. 4, 1840, p. 43; For. Foss. Vienne, 1846, p. 197.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 377.

*Heterostomella* REUSS, Sitz. Akad. Wiss. Wien, vol. 52, pt. 1, 1865, p. 448.

*Description*.—Test free, composed of two distinct portions, the earlier consisting of a series of chambers arranged triserially, followed by a later consisting of a series arranged biserially; wall arenaceous, varying much in coarseness in the different species; aperture variable as in the various species of *Textularia*, either an opening at the base of the inner margin of the chamber, between it and the wall of the preceding chamber, or a perforation near the base of the inner margin, often with a raised border, or in some species a terminal more or less circular opening.

This species, while related to *Textularia*, is by its development a genus derived through triserial forms, such as *Verneuilina*, and its resemblance to *Textularia* is due to a reversion in its later development to the biserial condition. There has been some attempt on the part of certain authors to split the genus on the basis of the apertural characters. While this seems reasonable, it is not followed out here, as already mentioned in connection with *Textularia*.

This genus has a considerable geological range, but after a study of certain forms it has not seemed wise to unite the recent species with the cretaceous ones described by d'Orbigny. The differences are great enough to be of good specific value, and a discussion of the characters involved will be found under the various species. Most of the recent species are rather constant in their characters, the variations being limited to unimportant details.

GAUDRYINA SCABRA H. B. Brady.

*Gaudryina pupoides* H. B. BRADY (not *G. pupoides* d'Orbigny 1840), Ann. Mag. Nat. Hist., ser. 4, vol. 6, 1870, p. 300, pl. 8, fig. 5.

*Gaudryina scabra* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 381, pl. 46, fig. 7.—Goës, Bull. Mus. Comp. Zool., vol. 29, 1896, p. 40.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 288, pl. 34, fig. 1.

*Description*.—Test elongate, gradually tapering to the initial end, which is broadly rounded; cross section rounded; early triserial portion composed of but few chambers, the later biserial portion forming the greater part of the test, chambers rotund; sutures distinct; wall



coarsely arenaceous, but rather neatly cemented with a reddish-brown cement; aperture elongate, situated between the inner border of the chamber and the adjacent wall of the preceding chamber; color reddish-brown, the last formed chamber often being light gray.

Length up to 2 mm.

*Distribution.*—The only published records for this species in the North Pacific are those given by Goës from off the west coast of America, *Albatross* stations D3419, in 772 fathoms, D3431, in 995 fathoms, and D3418, in 660 fathoms. I have examined the specimens of this species returned by Goës to the National Museum and they appear to be typical. In the further material I have examined the species has been noted but twice, from *Albatross* station H2922, in 268



FIG. 100.—GAUDRYINA SCABRA.  
× 45. a, APERTURAL VIEW;  
b, FRONT VIEW.



FIG. 101.—GAUDRYINA SCABRA. × 30  
SPECIMEN WITH WALL CONTAINING  
SPONGE SPICULES.

fathoms, off the Hawaiian Islands and from *Tuscarora* station 126, in 500 fathoms, just south of the Aleutian Islands.

#### GAUDRYINA FLINTII, new name.

*Gaudryina subrotundata* FLINT (not *G. subrotundata* Schwager, 1866), Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 287, pl. 33, fig. 1.

*Gaudryina rugosa* Goës (not *G. rugosa* d'Orbigny, 1840), Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 39.

*Description.*—Test subcylindrical, gradually tapering to the initial end, the early triserial portion forming but a small part of the test, the later biserial portion making up fully three-fourths; chambers of the later portion well rounded, nearly circular in cross section; sutures well marked; wall arenaceous, usually rather coarse, but in some cases finer and more smoothly finished; aperture in the biserial portion a



subcircular opening near, but somewhat away from, the inner border of the chamber; color gray.

Length 1-5 mm.

*Distribution.*—The specimens recorded by Flint and figured by him as *G. subrotundata* Schwager were from the Atlantic. The specimens recorded by Goës from the eastern Pacific as *G. rugosa* d'Orbigny, prove upon examination to belong to this new species. Specimens were also common in material from *Nero* station 990, in 859 fathoms, off Guam.

It is possible that the *Challenger* specimens referred to *G. subrotundata* by Brady may also belong to this species, especially those from the West Indies. The specimens recorded by Goës seem to be

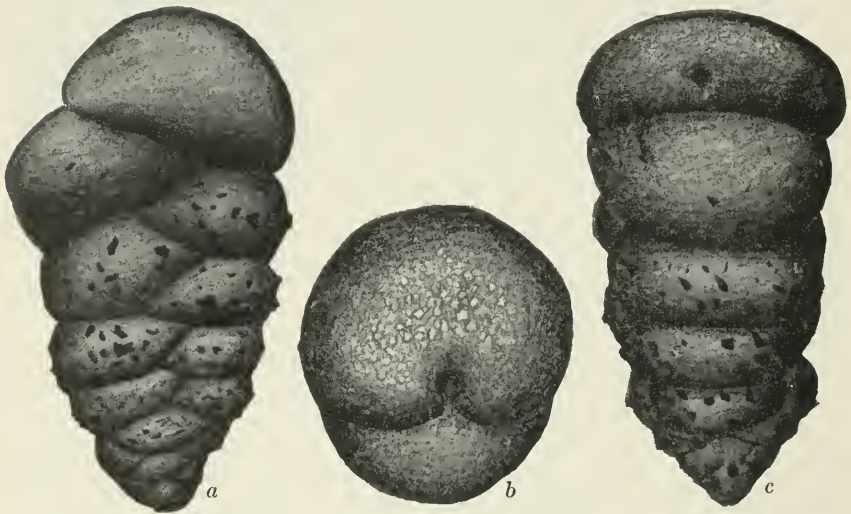


FIG. 102.—GAUDRYINA FLINTII.  $\times 20$ . a, FRONT VIEW; b, APERTURAL VIEW; c, SIDE VIEW.

neither the *G. rugosa* of d'Orbigny nor the recent species referred to *G. rugosa* by Brady. This species differs from *G. subrotundata* in the large size, more circular form in cross section, in the general tapering form, and in having the aperture circular and in the end wall.

**GAUDRYINA QUADRANGULARIS** Bagg.

*Gaudryina quadrangularis* BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 133, pl. 5, fig. 1.

*Description.*—Test elongate, tapering abruptly at the initial end, composed of an early trihedral portion with acute angles made up of a triserial group of chambers, and a later more or less quadrangular portion composed of chambers biserially arranged; wall coarsely arenaceous and rather roughly cemented; aperture an elongate orifice between the inner border of the chamber and the adjacent

wall of the preceding chamber, with in end view a sort of rounded lip above and a depression at either side; in side view the aperture is in a depression of the abruptly truncated end of the test.

Length up to 3 mm.

*Distribution*.—The type-specimen (which I have examined) is from *Albatross* station D4000, in 104–213 fathoms, off the Hawaiian Islands. The only other specimens I have seen were obtained at *Nero* station 2071, in 271 fathoms, and *Albatross* station H2922, in 268 fathoms, also near the Hawaiian Islands.

The species is a large one, with a distinctly textularian aperture.

**GAUDRYINA TRIANGULARIS**, new species.

*Description*.—Test slightly longer than broad, for the most part triangular, the angles rather acute, composed of a series of chambers triserially arranged, the later chambers rotund, biserially arranged, few in number; walls coarsely arenaceous, more or less smoothly finished; sutures plainly visible on the exterior;

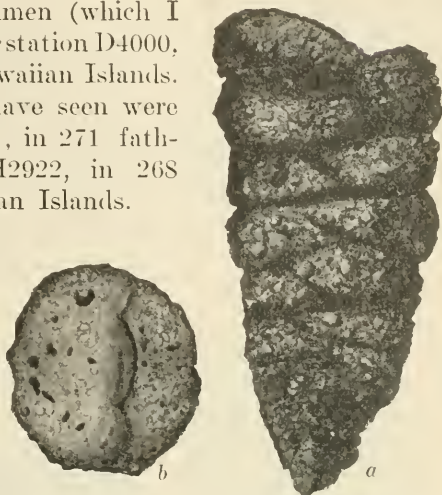


FIG. 103.—GAUDRYINA QUADRANGULARIS.  $\times 30$ .  
a, FRONT VIEW; b, END VIEW.



FIG. 104.—GAUDRYINA TRIANGULARIS.  $\times 40$ . a, END VIEW; b, SIDE VIEW; c, FRONT VIEW.

aperture narrow, between the inner border of the chamber and the preceding chamber; color gray.

Length about 1 mm.

*Distribution*.—Type-specimen from *Albatross* station H2922, in 268 fathoms, near the Hawaiian Islands (Cat. No. 8342, U.S.N.M.).

It occurred also at *Nero* station 1254, in 264 fathoms, near the Bonin Islands in the western Pacific.

This species may be the same as that from the Atlantic referred by various authors to *G. rugosa* d'Orbigny. A glance at the original figure given by d'Orbigny, however, shows the great difference between this recent species and d'Orbigny's cretaceous fossil species. In true *G. rugosa*, according to d'Orbigny's figure and description, the triangular portion is the smaller part, and the biserial portion the greater, the whole appearance of the test being very different. Here the triserial condition is maintained well toward the end of the test, where the biserial condition is taken on. Our recent species seems to me to have little in common with the cretaceous species.

GAUDRYINA CONVEXA, new species.

*Description*.—Test triangular in front view, broad at the apertural and rather rapidly tapering to the initial end, one face nearly flat, the other strongly convex and with deeper sutures; apertural



FIG. 105.—GAUDRYINA CONVEXA.  $\times 60$ . a, END VIEW; b, DORSAL VIEW; c, VENTRAL VIEW.

end obliquely truncate, in end view roughly semicircular; wall rather coarsely arenaceous; aperture elongate, between the inner border of the chamber and the adjacent wall of the preceding chamber, in a distinct depression of the inner border of the chamber; color gray.

Length 0.60 mm.

*Distribution*.—Type from *Albatross* station D4878, in 59 fathoms, eastern channel of the Korean Strait (Cat. No. 8343, U.S.N.M.).

This species suggests somewhat *G. wrightiana* Millett, but both faces in our species in the biserial portion are convex, one of them, however, only slightly so. It also somewhat resembles *G. jonesiana* Wright.

GAUDRYINA PAUPERCULA, new species.

*Description*.—Test short and broad, abruptly tapering to the broadly rounded initial end, the early portion triserial, the last developed chambers biserial; chambers inflated; sutures distinct; end view broadly rounded; walls arenaceous, but with a

smooth exterior; aperture elongate, situated in a depression of the inner border of the chamber, between it and the adjacent wall of the preceding chamber; color gray or slightly brownish.

Length 2 mm.

*Distribution*.—This species was very abundant in material from *Albatross* station D4900, in 139 fathoms, Eastern Sea (type, Cat. No. 8340, U.S.N.M.).

This species seems at first glance to be very similar to *Verneuilina propinqua* H. B. Brady, but it is a *Gaudryina*, as the last formed chambers are decidedly biserial. It is a very short species and differs in general appearance from the others of its genus.

**GAUDRYINA BRADYI, new name.**

*Gaudryina pupoides* H. B. BRADY (not *G. pupoides* d'Orbigny), Rep. Voy. *Challenger*, Zoölogy, vol. 9, 1884, p. 378, pl. 46, figs. 1-4.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 219, pl. 43, figs. 7, 8.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 471.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 20.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 40.—FLINT, Ann. Rep. U.S. Nat. Mus., 1897 (1899), p. 287, pl. 32, fig. 4.

*Description*.—Test stout, somewhat elongate, tapering slightly until near the initial end where it tapers abruptly to the somewhat blunt end; triserial portion nearly circular in cross section, of few chambers, the later biserial portion making up about three-fourths of the test, slightly compressed; chambers overlapping and appearing crowded, broadly elliptical in cross section, inflated; sutures deep and distinct; end strongly convex; wall of fine arenaceous material or calcareous shell, smooth; aperture oval, slightly back from the inner margin of the chamber

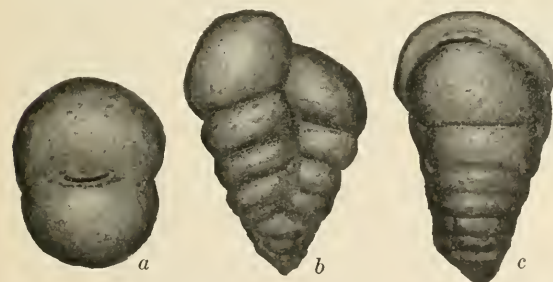


FIG. 107.—GAUDRYINA BRADYI.  $\times 25$ . a, END VIEW; b, FRONT VIEW; c, SIDE VIEW.

and with the border raised somewhat and thickened; color light gray.

Length 0.38 to 0.90 mm.

*Distribution*.—Under the name of *Gaudryina pupoides* this species has been recorded as follows from the North Pacific: Brady records



FIG. 106.—GAUDRYINA PAUPER-  
CULA.  $\times 15$ . a, FRONT VIEW;  
b, APERTURAL VIEW.



it at two *Challenger* stations in 1,850 and 2,050 fathoms; Goës records it from two *Albatross* stations, D3375, in 1,201 fathoms, and D3376, in 1,132 fathoms; Bagg records it from four *Albatross* stations near the Hawaiian Islands, H4430, in 1,544 fathoms, H4555, in 1,398 fathoms, H4568, in 1,274 fathoms, and H4571, in 384 fathoms; Flint records it<sup>a</sup> from *Nero* station 613, in 1,072 fathoms.

In the material I have examined, the species has been frequently found in the vicinity of the Hawaiian and Galapagos Islands, Guam, off Japan, etc. The average depth of the stations is about 1,000 fathoms.

From an examination of the original figure and description given by d'Orbigny, it seems clear that our rather common recent form is not the same as his cretaceous species. Goës came to the conclusion that Brady's union of the two was incorrect. However, to unite both this species and *G. chilostoma* as Goës has done, both under the latter name, does not seem to me to be a solution of the matter, as the two seem to be very distinct. As no other name is available, a new name is here proposed. This is one of the cases where it would seem to have been better if Brady had proposed a new name instead of uniting different things, as the *Challenger* Report has been looked to so long as a standard that Brady's distinctions in regard to original figures and descriptions have not always been investigated by later authors. A new name at that time and a recognition of the existing differences would have cleared the synonymy greatly.

GAUDRYINA BACCATA Schwager.

*Gaudryina baccata* SCHWAGER, *Novara* Exp., Geol. Theil, p. 2, 1866, p. 200, pl. 4, figs. 12a, b.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 379, pl. 46, figs. 8-11.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 20.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 287, pl. 32, fig. 5.

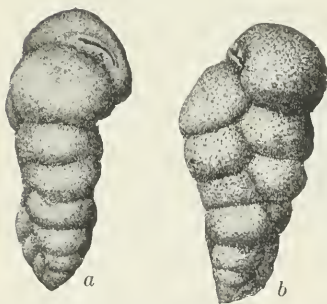


FIG. 108.—GAUDRYINA BACCATA.  $\times 20$ .  
a, SIDE VIEW; b, FRONT VIEW (AFTER BRADY).

*Description*.—Test elongate, tapering gradually to the somewhat acute initial end; early portion composed of triserially arranged chambers with rounded angles and forming the lesser portion of the test; later portion biserial, often somewhat irregular; wall arenaceous, of fine material and smoothly finished; aperture elongate, somewhat back from the inner border of the chamber and often with a raised border; color gray.

Length about 2 mm.

*Distribution*.—The only records for this species in the North Pacific are the specimens recorded by Brady from *Challenger* station 206, in 2,100 fathoms, between China and the Philippines.

<sup>a</sup> Bull. 55, U. S. Nat. Mus., 1905, p. 20.



This species is characterized by an irregular form in the biserial portion, one or more of the chambers breaking the alignment somewhat and causing the following to be less regular than they would be otherwise.

**GAUDRYINA CHILOSTOMA (Reuss).**

*Textilaria chilostoma* REUSS, Zeitschr. deutsch. geol. Ges., vol. 4, 1852, p. 18.

*Gaudryina chilostoma* REUSS, Denkschr. Akad. Wiss. Wien, vol. 25, 1866, p. 120, pl. 1, fig. 5.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 34, pl. 7, figs. 278–280; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 41.

*Gaudryina pupoides*, var. *chilostoma* H. B. BRADY, Rep. Voy. *Challenger*, Zoölogy, vol. 9, 1884, p. 379, pl. 46, figs. 5, 6.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 219, pl. 42, fig. 9.

*Gaudryina pupoides*, var. *chilostomella* EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 278, pl. 7, fig. 6 [?].

*Description*.—Test compressed, broad, gradually tapering to the broadly rounded initial end; triserial portion consisting of but few chambers; biserial portion compressed, making up most of the test; chambers rounded; wall of fine arenaceous material; the surface smoothly finished; aperture an elongate slit slightly in from the inner edge of the chamber, surrounded by a slightly thickened and raised lip; color gray.

Length about 1 mm.

*Distribution*.—Goës records this species from *Albatross* station D3407, in 885 fathoms, off the Galapagos Islands.

One at least of the two specimens selected by Goës from this station appears to be this species upon examination. Egger's figure and description are apparently meant for this species, but do not fit it very closely. I have seen but one specimen which I can refer to this species, from the coast of Japan, *Albatross* station D4916, in 361 fathoms.

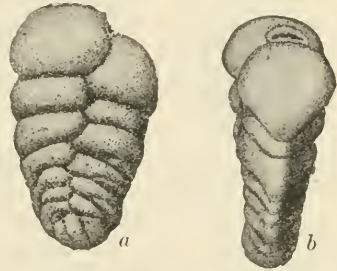


FIG. 109.—GAUDRYINA CHILOSTOMA.  $\times 25$ .  
a. FRONT VIEW; b. SIDE VIEW (AFTER BRADY).

**GAUDRYINA APICULARIS, new name.**

*Gaudryina siphonella* H. B. BRADY (not *G. siphonella* Reuss, 1851), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 382, pl. 46, figs. 17–19.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 288, pl. 34, fig. 2.

*Description*.—Test elongate; triserial portion consisting of few chambers, forming usually somewhat less than half the test; later portion biserial, the chambers inflated and distinct, the later chambers with a forward extension, at the end of which is the aperture; wall rather coarsely arenaceous and slightly rough; aperture nearly circular, at the end of the elongate chamber; color reddish brown.

Length up to 1 mm.

*Distribution.*—As *G. siphonella*, Brady has recorded this species from three *Challenger* stations in the North Pacific, in from 2,100–3,950 fathoms. I have noted the species but once, in 2,141 fathoms, *Nero* station 1293, between Yokohama and Guam.

An examination of the original description of *Gaudryina siphonella* Reuss,<sup>a</sup> and especially the figures, shows that the recent species described here is very different from that fossil. Fig. 42 of Reuss shows a test with five vertical rows of chambers, and need not be further considered here. Of the others, each has the final chamber very convex and extending much higher on the outer side than on any other part, and the aperture at the end of a small, much lower projection. This curious form occurs in both figs. 40 and 41 and is noted in the description. The recent species is very different, the apertural portion forming the highest part of the chamber, which on its peripheral portion is lower than elsewhere, while the fossil species is highest there.



FIG. 110.—GAUDRYINA APICULARIS.  $\times 60$ . a, FRONT VIEW; b, APERTURAL VIEW.

**GAUDRYINA PSEUDOFILIFORMIS, new name.**

*Gaudryina filiformis* H. B. BRADY (not *G. filiformis* Berthelin), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 380, pl. 46, figs. 12a-c.

*Description.*—Test much elongate, composed of numerous chambers; early portion triserial with indistinct sutures; later portion, including nearly the entire test, biserial with the sutures deep and well marked; cross section elliptical, showing some compression; walls arenaceous, but usually smooth; aperture small, in adults back a little way from the inner margin of the chamber, slightly elongate, the edges thickened and raised to form a rim about it, appearing nearly tooth-like in end view; color gray.

Length 1 mm.

*Distribution.*—*G. filiformis* has been recorded from the North Pacific only once, by Bagg, at *Albatross* station H4568, in 1,274 fathoms, off the Hawaiian Islands. I have the species also from *Albatross* station H2923, in 392 fathoms, off the same islands. These are the only records for the species in this area.



FIG. 111.—GAUDRYINA PSEUDOFILIFORMIS.  $\times 60$ . a, FRONT VIEW; b, END VIEW, SHOWING OUTLINE AND RIDGE ABOVE THE APERTURE.

<sup>a</sup>Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 78, pl. 5, figs. 40–42.

Although Brady referred the recent species to the cretaceous *G. filiformis*, it seems from a comparison of the material obtained with the original description and figure, that the two species are not the same, and the recent species is therefore differentiated under another name. It is smooth and has the aperture somewhat in from the edge, surrounded by a raised ridge.

TRITAXILINA, new genus.

*Clavulina* (part) H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 54.

*Tritaxia* (part) H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 390.

*Description*.—Test in the early portion triserial, later becoming biserial or uniserial; wall arenaceous; aperture in the adult, central and terminal, in the young like *Textularia* or *Verneuilina*, in adult condition with peripheral teeth projecting into the apertural opening; interior labyrinthic.

This genus includes a single species, *T. caperata* (H. B. Brady), which differs from the species of *Tritaxia* in the form of the test, the aperture, and the labyrinthic interior of the test.

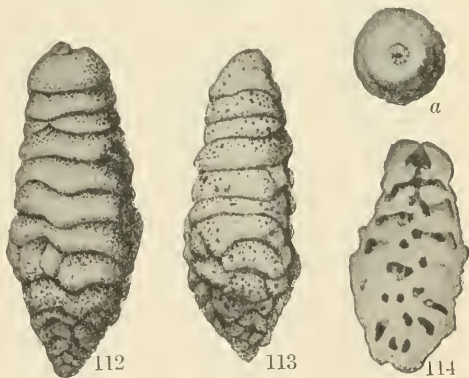
TRITAXILINA CAPERATA (H. B. Brady).

*Clavulina caperata* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 54.

*Tritaxia caperata* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 390, pl. 49, figs. 1-7.

*Description*.—Test fusiform, the early portion triserial, roughly triangular in cross section but with well rounded angles, the later portion becoming biserial or uniserial and circular in cross section; apical end rather acutely pointed; apertural end truncate or broadly rounded, chambers numerous; wall thick, composed of fine arenaceous material, in part traversed by long pore canals leading from the chamber to the exterior; interior of test labyrinthic; outer part of wall with a wrinkled appearance due to the thickening of the chamber wall just above the sutures; sutures distinct; aperture in the young like *Verneuilina*, in the adult becoming terminal and central with a peripheral border of inwardly projecting teeth; color gray.

Length up to 2.5 mm.



FIGS. 112-114.—TRITAXILINA CAPERATA.  $\times 16$ . 112, *a*, APERTURAL VIEW. 114, SPECIMEN CUT LONGITUDINALLY, SHOWING LABYRINTHIC INTERIOR (AFTER BRADY).

*Distribution.*—Brady records this species from but one North Pacific station, in 95 fathoms, near the Philippines. The other stations from which he records it are off Kandavu, Fiji, in 250 fathoms, and off Sombrero, West Indies, in 450 fathoms.

There are two specimens in the *Albatross* material from station D4781, in 482 fathoms, near the Aleutian Islands, which certainly seem to be this species. If this is the case the distribution is a very peculiar one. Except that the final stages are not entirely complete, the two specimens fit the figure and description excellently.

#### Genus CLAVULINA d'Orbigny, 1826.

- Clavulina* d'ORBIGNY (type, *C. parisiensis* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 268.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 393.  
*Verneulina* (part) PARKER and JONES, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 303.—BROECK, Ann. Soc. Belgique Micr., vol. 2, 1876, p. 136.  
*Valvulina* (part) PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 35.

*Description.*—Test free, elongate, cylindrical, or angled; early portion consisting of a number of chambers arranged triserially; later portion consisting of numerous chambers arranged uniserially; walls arenaceous, usually smooth; aperture in early chambers with a valvular tooth; in the later portion aperture central or nearly so, rounded, and with or without a tooth.

This genus includes those species of Textulariidae which have a triserial early portion and the adult portion uniserial. Such species are clearly related to such forms as *Valvulina* and have added to the characters of that genus the uniserial condition. By acceleration of development the triserial stage has become very short in comparison to the entire test and is only seen at the beginning of the development; the uniserial stage has come to occupy most of the test. The genus is known in the Tertiary and from that period to the recent seas.

There are a few widely scattered species, for the most part best developed about the shores of oceanic tropical islands, such as the West Indies. Other species are characteristic of rather deep water and are widely distributed.

#### CLAVULINA COMMUNIS d'Orbigny.

- Clavulina communis* d'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 268; For. Foss. Vienne, 1846, p. 196, pl. 12, figs. 1, 2.—BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 394, pl. 48, figs. 1–13.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 220, pl. 42, fig. 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 275, pl. 6, figs. 42, 43.—GOËS, Kong. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 40; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 36, pl. 4, figs. 9–15.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 288, pl. 34, fig. 3.—MILLET, Journ. Roy. Micr. Soc., 1900, p. 12.—CHAPMAN, Journ. Linn. Soc. New South Wales, vol. 30, 1907, p. 29, pl. 3, fig. 66.  
*Verneulina communis* JONES and PARKER, Quart. Jour. Geol. Soc., vol. 16, 1860, p. 303.—BROECK, Ann. Soc. Belgique Micr., vol. 2, 1876, p. 136, pl. 3, fig. 14.



*Description*.—Test elongate, cylindrical, the early portion consisting of chambers arranged triserially, rounded in cross section; chambers almost indistinct from the exterior, the sutures not depressed; later portion consisting of chambers arranged uniserially, distinct, but the sutures only slightly excavated, circular in cross section; wall composed of sand, usually fine in texture, with the surface smoothly finished; aperture in the middle of the terminal wall of the chamber in the uniserial portion, usually with a short but very distinct neck; aperture with a single tooth; color gray.

Length up to 5 mm.

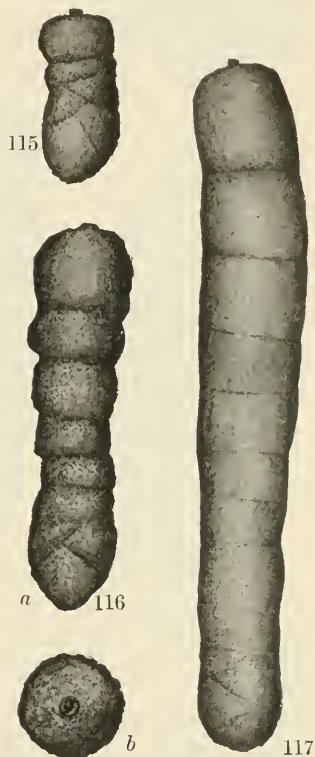
*Distribution*.—In the North Pacific this species was recorded by Brady from two *Challenger* stations, in 345 fathoms off Japan, and in 2,300 fathoms in the region east of Japan; Goës records it from several *Albatross* stations off the west coast of America in depths from 772–1,471 fathoms; Flint records it from 51 fathoms in Panama Bay. I have found it frequently in the North Pacific material which I have examined, most frequently in globigerina ooze and muds from a medium depth. It has occurred near the Galapagos Islands, and at scattered stations in the *Nero* material from the line of soundings across the Pacific, and in the material from the *Albatross* (1906) cruise it is common from about Japan. It occurs also in the collections from south of the Aleutian Islands, Tuscarora station 126, in 500 fathoms.

This, as far as the North Pacific is concerned, is by far the most common species. As shown by Brady's figures in the *Challenger* report, there are two rather different forms, but the material is not sufficient to establish definite varieties at this time.

**CLAVULINA BRADYI, new name.**

*Clavulina cylindrica* H. B. BRADY (not *C. cylindrica* d'Orbigny, 1826), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 396, pl. 48, figs. 32–38.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 134.

*Description*.—Test stout, cylindrical, the early triserial portion not well shown exteriorly, the later uniserial portion of few



FIGS. 115–117.—CLAVULINA COMMUNIS.  $\times 30$ . 115, YOUNG SPECIMEN WITH BUT TWO OF THE SECOND SERIES OF CHAMBERS DEVELOPED. 116, a, FRONT VIEW OF MEDIUM-SIZED SPECIMEN; b, END VIEW OF THE SAME. 117, ADULT SPECIMEN IN FRONT VIEW.

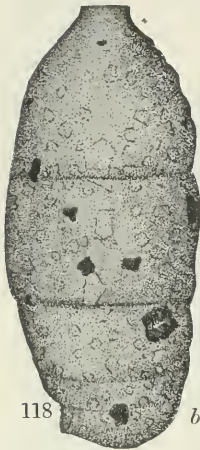


chambers, large, distinct, with well-defined, depressed sutures; wall arenaceous, composed of a mixture of coarse and fine material, but usually with a smooth exterior; aperture circular, often at the end of a short neck, usually with a single valvular tooth; color light gray.

Length up to 5 mm.



a



118

b



119

FIGS. 118-119.—*CLAVULINA BRADYI*.  $\times 30$ . 118, *a*, END VIEW, WITHOUT TOOTH; *b*, FRONT VIEW OF TYPICAL SPECIMEN. 119, FRONT VIEW OF A PECULIARLY ROUGHENED SPECIMEN.

roughened surface and a longer and more slender neck, but is associated with the species at the same station.

#### *CLAVULINA ANGULARIS* d'Orbigny.

*Clavulina angularis* D'ORBIGNY, ANN. SCI. NAT., vol. 7, 1826, p. 268, pl. 12, fig. 7.—H. B. BRADY, REP. VOY. CHALLENGER, Zoology, vol. 9, 1884, p. 396, pl. 48, figs. 22-24.—GOËS, BULL. MUS. COMP. ZOÏL., vol. 29, 1896, p. 37.—FLINT, ANN. REP. U. S. NAT. MUS., 1897 (1899), p. 289, pl. 36, fig. 2.—MILLETT, JOURN. ROY. MICR. SOC., 1900, p. 13.—CHAPMAN, JOURN. LINN. SOC., Zool., vol. 30, 1907, p. 29, pl. 4, figs. 68, 69 [70], [not 71-73].—BAGG, PROC. U. S. NAT. MUS., vol. 34, 1908, p. 133.

*Valvulina angularis* JONES and PARKER, Quart. Journ. Geol. Soc., vol. 16, 1860, p. 305.

*Valvulina triangularis* D'ORBIGNY, forma *clavulina* GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, p. 86, pl. 11, figs. 387-389.

*Description*.—Test elongate, triangular in cross section, the early triserial portion limited to a few chambers, followed by a few chambers

*Distribution*.—The only previously recorded station for this species is that given by Bagg: *Albatross* station D4000 in 104-213 fathoms, off the Hawaiian Islands. I have seen the species in material from *Nero* station 2037, in 55 fathoms, and 2071, in 271 fathoms, both in the vicinity of the Hawaiian Islands.

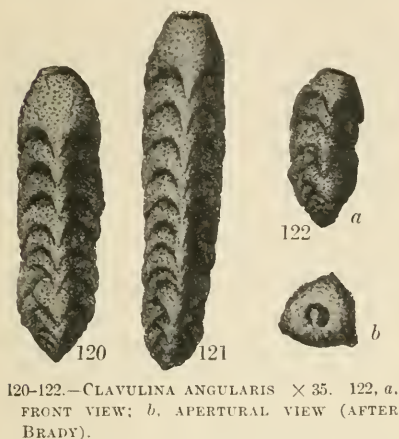
There is much exterior resemblance between this species and *Haplostiche dubia*, but the specimens of *Clavulina bradyi* having the single valvular tooth or sometimes none. Fig. 119 shows a specimen somewhat different from the usual form shown in fig. 118.

It has a more distinctly

biserial in character; finally the main portion of the test, which is uniserial, the chambers extending back along the angles of the test, arched upward across the faces, leaving a slight hollow below; wall arenaceous but smoothly finished on the exterior; aperture in the uniserial portion circular, in the middle of the apertural face, with a single valvular tooth.

Length up to 1.25 mm.

*Distribution.*—There is but one record for this species in the North Pacific, that given by Bagg, from *Albatross* station D4017, in 305 fathoms, off the Hawaiian Islands. I have examined Bagg's specimen and it seems without doubt to be



120-122.—*CLAVULINA ANGULARIS*  $\times 35$ . 122, *a*, FRONT VIEW; *b*, APERTURAL VIEW (AFTER BRADY).

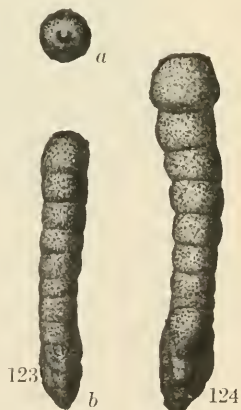
this species, although the test is not entire. It has been found in various parts of the other oceans, usually in rather shallow water.

#### *CLAVULINA PARIISIENSIS* d'Orbigny.

*Clavulina parisiensis* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 268; Modèles, 1826, No. 66.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 29, pl. 1, fig. 26.—TERQUEM, Mém. Soc. Géol. France, ser. 3, vol. 2, 1882, p. 121, pl. 12 (20), figs. 34*a*, *b*.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 395, pl. 48, figs. 14-18.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 220, pl. 42, figs. 10, 12.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1889, p. 485, pl. 11, fig. 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 274, pl. 6, fig. 44.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 41, pl. 8, figs. 378-386.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 21.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 37.—FLINT, Ann. Rep. U. S. Nat. Mus., 1897 (1899), p. 289, pl. 35, figs. 2, 3.

*Valvulina parisiensis* PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, pp. 29, 35, pl. 1, fig. 26.

*Description.*—Test elongate, slender, the early triserial portion decidedly angled, pyramidal, the upper end usually wider than the early part of the following uniserial portion which is cylindrical; chambers of this portion inflated, often well separated by deep sutures, sometimes moniliform; walls arenaceous,



FIGS. 123-124.—*CLAVULINA PARIISIENSIS*.  $\times 30$ . 123, *a*, APERTURAL VIEW; *b*, FRONT VIEW (AFTER BRADY).

usually rather coarsely so, and the exterior more or less rough; aperture in the uniserial portion circular, central, partially closed with a broad valvular tooth.

Length up to 3 mm.

*Distribution.*—The only published records for this species from the North Pacific are those given by Brady from two *Challenger* stations, one off the Philippines, in 95 fathoms, the other in the deep water of the Pacific, in 3,125 fathoms. This latter seems all the more peculiar, as the species as a rule has been found in comparatively shallow water.

#### Subfamily 4. BULIMININÆ.

Included in this subfamily are those forms which are typified by *Bulimina*. In typical species the arrangement of the chambers is an elongate spiral. The aperture is elongate, loop-shaped, usually in an oblique position, and in some species there is a tooth, flange, or other structure which partially closes the opening. The test is calcareous, often hyaline in the young, but may be considerably thickened and opaque in the adult; is always perforate.

Two new genera have been segregated from *Bulimina*, the differences in structure and development appearing to be worthy of more than specific rank.

#### Genus BULIMINA d'Orbigny, 1826.

*Bulimina* D'ORBIGNY (type, *Bulimina marginata* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 269.—H. B. BRADY (part), Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 397.

*Description.*—Test usually fusiform or tapering, free, composed of numerous chambers arranged typically in a spiral, each chamber situated above the third preceding one, making a triserial arrangement, not always visible from the surface except in the last convolution; wall calcareous, perforate, usually thin and transparent but thickening somewhat with age; smooth or ornamented with raised costæ, spines, etc.; aperture typically a comma-shaped slit broadest above and tapering obliquely to a point below, usually with a raised rim and often partly closed by a tooth-like rim at one side.

The genus *Bulimina* as it has come to be used includes several distinct groups of species as noted by Brady in the *Challenger* report upon the Foraminifera. If these groups are closely examined it will be noted that their differences are really morphological and essential characters, too distinct to be accounted for on the basis of variation and seem to be of generic significance. I have therefore divided the genus into several genera which show distinctive characters, and have limited the name *Bulimina* to those species which show a triserial arrangement of the chambers. Such an arrangement is seen in the typical *Bulimina marginata*, the only species figured by d'Orbigny of those given under the genus in the original description.

The groups of species which have numerous chambers in each coil and a definite umbilicus, with other accompanying characteristics, are grouped under the new genus *Buliminella*, and the single species *Bulimina williamsonii* H. B. Brady, which has the chambers hidden at the surface by the ornamentation, but nevertheless spiral, and the aperture central and terminal, has been made the type of the new genus *Buliminoides*.

There is a considerable range of species characters in the species of *Bulimina* as restricted, the chambers in certain forms becoming rapidly larger, and in the adult hiding the earlier or becoming larger with an accompanying extension of the axis of the spire forming a long tapering test with the triserial arrangement visible throughout.

From the difficulty of examining the proloculum and early chambers, little is known concerning the occurrence of the microspheric and megalospheric forms in the species of this genus.

*BULIMINA OVATA* d'Orbigny.

*Bulimina ovata* D'ORBIGNY, For. Foss. Vienne, 1846, p. 185, pl. II, figs. 13, 14.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 400, pl. 50, figs. 13a, b.

*Description*.—Test ovate in front view, circular or nearly so in end view, the apex broadly rounded; visible chambers several, little



FIG. 125.—*BULIMINA OVATA*.  $\times 40$ . a, FRONT VIEW; b, END VIEW; c, VIEW SHOWING APERTURE.

inflated; sutures but slightly compressed; wall smooth; aperture rather narrow with a plate-like tooth; color white.

Length 0.75–1.20 mm.

*Distribution*.—Rather common throughout the area, except in very deep water.

The smooth species of *Bulimina* are in an extremely confused state, and as the material I have examined is insufficient to determine definitely the interrelationships of all the forms, they are referred to certain general species, usually taking the figures given by Brady as a broad basis for distinguishing the forms.

Brady's figure of *Bulimina ovata* is referred by Goës to *B. ellipsoides* Costa.



## BULIMINA PYRULA d'Orbigny.

*Bulimina pyrula* D'ORBIGNY, For. Foss. Vienne, 1846, p. 184, pl. 11, figs. 9, 10.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 399, pl. 50, figs. 7-10.

*Description*.—Test ovate in front view, broadest usually near the base, nearly circular in end view, the apex rounded; visible chambers

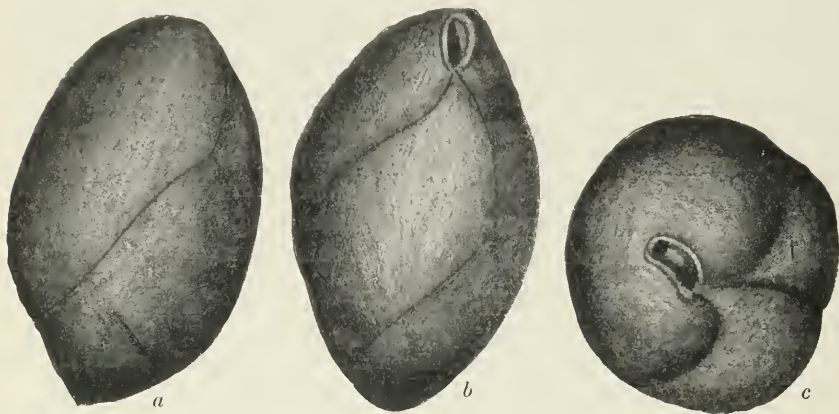


FIG. 126.—BULIMINA PYRULA.  $\times 60$ . a, SIDE VIEW; b, VIEW SHOWING APERTURE; c, END VIEW.

few, very little inflated; sutures flush with the surface or very slightly depressed; wall smooth; aperture short and broad with a broad plate-like tooth partially closing the opening; color white.

Length 0.50-0.85 mm.

*Distribution*.—Strangely enough all the material which I have selected as belonging to this form has come from the coast of Japan, in from 134 to 437 fathoms.

This species has fewer visible chambers with a broader and shorter aperture than the preceding. The details of the aperture are shown in the enlarged figure.

## BULIMINA PYRULA d'Orbigny, var. SPINESCENS H. B. Brady.

*Bulimina pyrula* D'ORBIGNY, var. *spinescens* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 400, pl. 50, figs. 11, 12.

*Description*.—Similar to the typical form of the species but with the broad apical end of the test beset with short spines.

*Distribution*.—Specimens were found at *Albatross* station D4972, in 440 fathoms, off Japan. All have the same spinose apex.

The specimens figured here are much more elongate and of somewhat different form from those figured by Brady, but they have a similar spinose apex.



FIG. 127.—BULIMINA PYRULA.  $\times 75$ . DETAILS OF THE APERTURE.



## BULIMINA AFFINIS d'Orbigny.

*Bulimina affinis* D'ORBIGNY, Foram. Cuba, 1839, p. 109, pl. 2, figs. 25, 26.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 400, pl. 50, fig. 14a, b.—SHERBORN and CHAPMAN, Journ. Roy. Micr. Soc., 1886, p. 743, pl. 16, fig. 1.—BURROWS, SHERBORN, and BAILEY, Journ. Roy. Micr. Soc., 1890, p. 554, pl. 8, fig. 23.—CHAPMAN, Journ. Roy. Micr. Soc., 1892, p. 756, pl. 12, fig. 10.—EGGER, Abh. kön. bay. Acad. Wiss. München, Cl. II, vol. 18, 1893, p. 285, pl. 8, fig. 71.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 290, pl. 37, fig. 2.—MILLET, Journ. Roy. Micr. Soc., 1900, p. 274.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 134.

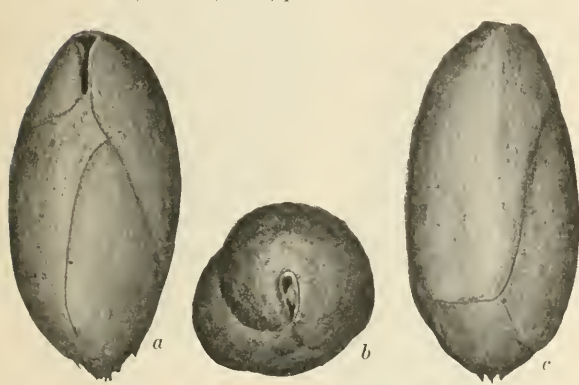


FIG. 128.—*BULIMINA PYRULA*, VAR. *SPINESCENS*.  $\times 80$ . a, FRONT VIEW; b, END VIEW; c, SIDE VIEW.

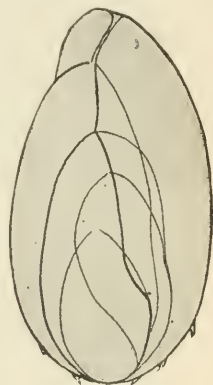


FIG. 129.—*BULIMINA PYRULA*, VAR. *SPINESCENS*.  $\times 175$ . YOUNG SPECIMEN, OUTLINES OF FIRST FIVE CHAMBERS.

*Description*.—Test conical, tapering from the broadly rounded apertural end to the acutely pointed apical end; chambers numerous, inflated; sutures somewhat depressed; wall calcareous, smooth; aperture loop-shaped, rather short; color white.

Length about 0.75 mm.

*Distribution*.—Brady records this species from one station in the deeper part of the North Pacific, in 3,125 fathoms, and Bagg records its occurrence at three *Albatross* stations, D4017, D4025, and D4174, in 305–865 fathoms, off the Hawaiian Islands. I have not noted specimens which could be determined as this species.

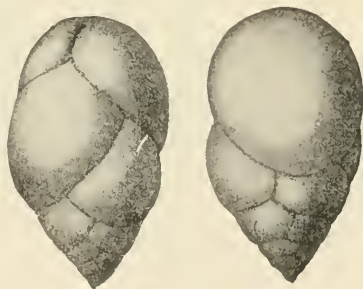


FIG. 130.—*BULIMINA AFFINIS*.  $\times 50$  (AFTER BRADY).

## BULIMINA ELONGATA d'Orbigny.

*Bulimina elongata* D'ORBIGNY, For. Foss. Vienne, 1846, p. 187, pl. 11, figs. 19, 20.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 401, pl. 51, figs. 1, and 2?

*Description*.—Test elongate, subcylindrical, nearly circular in cross section, the chambers numerous, inflated, short, sutures much

depressed, apical end rounded, occasionally with minute spines; wall calcareous, smooth; aperture broad and rounded, with a broad plate-like tooth, partially filling the opening; color white.

Length 0.50–1.00 mm.

*Distribution*.—A few specimens from the western North Pacific seem referable to this species, at least to the form figured by Brady, which is stouter than the type. These were from *Nero* station 1299, in 1,817 fathoms, south of Japan, and *Albatross* station H4891, in 756 fathoms, in Yezo Strait.

The form of the apertural tooth in the specimen figured is a peculiar one. It is broad, but instead of being like the one figured by

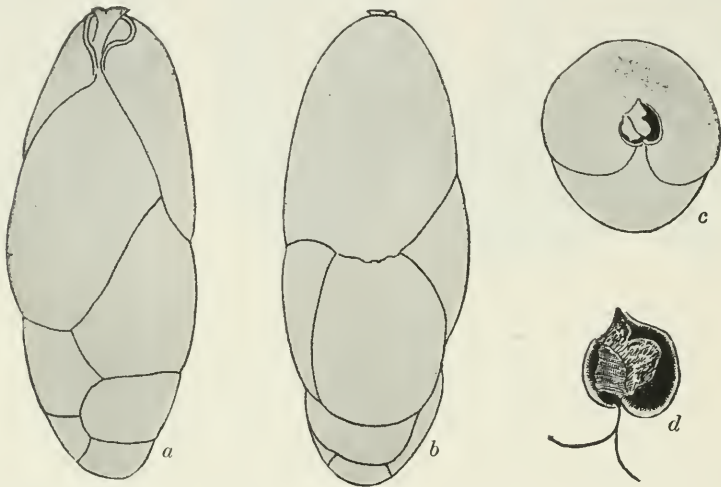


FIG. 131.—*BULIMINA ELONGATA*. *a*, VENTRAL VIEW; *b*, DORSAL VIEW; *c*, END VIEW.  $\times 60$ . *d*, VIEW OF APERTURAL REGION.  $\times 120$ .

Brady is slightly bifurcate, with a median ridge from which the two sides gradually slope away, as shown in the figure. This is a rather peculiar type of apertural tooth for this family.

#### *BULIMINA PUPOIDES* d'Orbigny.

*Bulimina pupoides* D'ORBIGNY, For. Foss. Vienne, 1846, p. 185, pl. 11, figs. 13, 14.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 400, pl. 50, figs. 15a, b.

*Description*.—Test ovate, broadest near the apertural end; apical end bluntly pointed, tapering; end view nearly circular; visible chambers numerous, much inflated; sutures rather deeply depressed; wall smooth; aperture long and narrow, with a narrow plate-like tooth; color white.

Length about 1 mm.

*Distribution.*—Bagg records this species from two *Albatross* stations, D4174 and D4025, in 275–865 fathoms, near the Hawaiian Islands. The only specimens I have seen were from near the Galapagos Islands, in 1,379 fathoms.

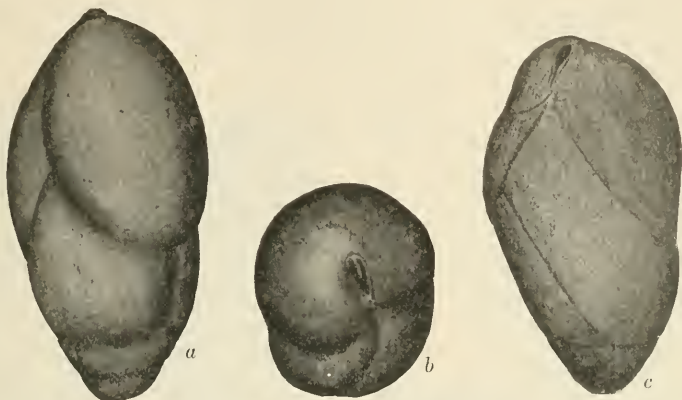


FIG. 132.—*BULIMINA PUPOIDES*.  $\times 40$ . *a*, DORSAL VIEW; *b*, END VIEW; *c*, VENTRAL VIEW.

*BULIMINA TORTA*, new species.

*Description.*—Test elongate, broadest near the apertural end, tapering to the subacute apical end; apertural end broadly rounded; early portion slightly compressed; later portion circular in cross section; chambers several, somewhat inflated; sutures depressed; wall calcareous, perforate, smooth; aperture very long and narrow, curved, broadest at the upper end; color white.

Length 0.65 mm.

*Type-specimen.*—Cat. No. 8341, U.S.N.M., from *Albatross* station H2902, in 1,783 fathoms, northeast of the Hawaiian Islands.

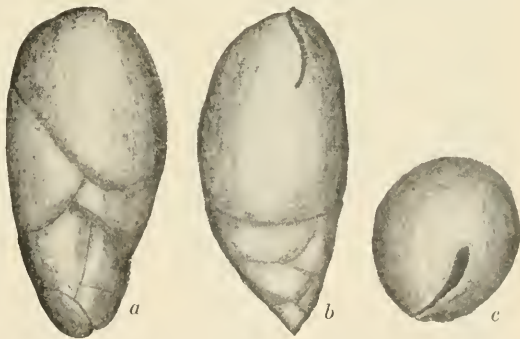


FIG. 133.—*BULIMINA TORTA*.  $\times 60$ . *a*, DORSAL VIEW; *b*, VENTRAL VIEW; *c*, END VIEW.

The aperture of this species is very elongate, with no apertural tooth present in this specimen. The chambers in dorsal view have an irregular arrangement, becoming regularly placed in ventral view.

## BULIMINA ELEGANS d'Orbigny.

*Bulimina elegans* d'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 270, No. 10; Modèles, 1826, No. 9.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 20, pl. 2, fig. 64.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 398, pl. 50, figs. 1-4.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 284, pl. 8, figs. 66, 67.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 290, pl. 36, fig. 3.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 274, pl. 2, fig. 1.

*Description*.—Test elongate, conical, tapering to the acutely pointed, sometimes mucronate, apical end; chambers numerous, inflated; sutures deeply depressed; wall calcareous, smooth; aperture short, broad, and rounded; color, white.

Length 0.50-0.85 mm.

*Distribution*.—

The species has not previously been recorded from the North Pacific. The specimens I have examined were from various

stations off the coast of Japan, in 282-584 fathoms, and from Bering Sea, in 536 fathoms.

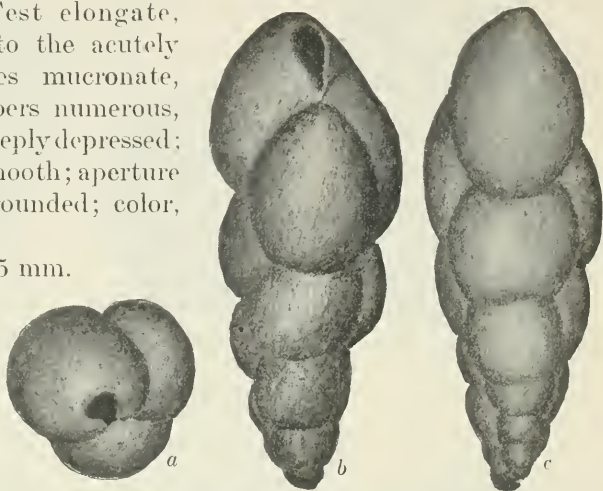


FIG. 134.—*BULIMINA ELEGANS*.  $\times 60$ . a, APERTURAL VIEW; b, VENTRAL VIEW; c, DORSAL VIEW.

*BULIMINA ELEGANS* d'Orbigny, var. *EXILIS*  
H. B. Brady.

*Bulimina elegans* d'ORBIGNY, var. *exilis*  
H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 399, pl. 50, figs. 5, 6.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 275.—SIDEBOTTOM, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 54, No. 16, 1910, p. 12, pl. 1, fig. 11.

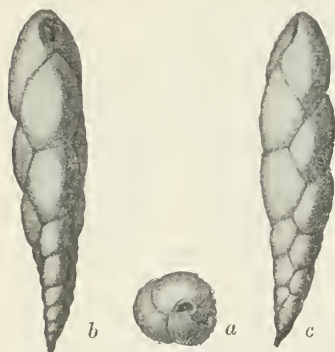


FIG. 135.—*BULIMINA ELEGANS*, VAR. *EXILIS*.  $\times 60$ . a, APERTURAL VIEW; b, SIDE VIEW; c, FRONT VIEW (AFTER BRADY).

*Description*.—"Test much elongated, slender, tapering, more or less compressed on three sides; oral end subacute or rounded, aboral extremity acuminate. Segments numerous, oblique, somewhat inflated, arranged in a regular triserial spire."

Length 0.75 mm.

*Distribution*.—Brady records this variety from the North Pacific at *Challenger* station 232, in 345 fathoms, on the *Hyalonema*



ground south of Japan. I have not found any specimen sufficiently elongated to warrant their being placed in this variety. The figure and description are from Brady.

**BULIMINA MARGINATA** d'Orbigny.

*Bulimina marginata* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 269, No. 4, pl. 12, figs. 10-12.—PARKER and JONES, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 296, pl. 11, figs. 35-40.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 405, pl. 51, figs. 3-5.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 220, pl. 43, figs. 7, 10.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 474.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 287, pl. 8, figs. 69, 70.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 46, pl. 9, figs. 439-444.—MILLETT, Journ. Roy. Micr. Soc., 1899, p. 277.

*Bulimina pupoides*, var. *marginata* WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 62, pl. 5, figs. 126, 127.

*Bulimina presli*, var. *marginata* PARKER and JONES, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 372, pl. 15, fig. 10; pl. 17, fig. 70.

*Description.*—Test ovate or tapering; chambers numerous, inflated, all visible from the exterior; sutures deep; lower margins of the chambers extending back with a free edge which is serrate, or may be only crenulate, or even spinose; remaining portion of chamber smooth and unornamented; wall thin and transparent, or in older specimens thickened, white, and nearly opaque; aperture a comma-shaped slit in a slight depression of the inner face of the chamber, with a slightly raised border.

Length usually under 1 mm., but some specimens slightly larger.

*Distribution.*—This species has been recorded once from the North Pacific. It occurred at *Challenger* station 232 on the *Hyalonema*-ground south of Japan, in 345 fathoms. In the present collection I have seen specimens from two *Albatross* stations off Japan, D4972, in 440 fathoms, and D5056, in 258 fathoms. Specimens were also found in the *Nero* material from three stations near the Bonin Islands, south from Japan, in 1,208-1,760 fathoms. All the records for this species in the North Pacific are therefore from the faunal region of Japan, and adjacent waters. The recorded distribution of the species elsewhere is very wide, both as to geographical and bathymetrical range.



FIG. 136.—*BULIMINA MARGINATA*.  
X 150. a, FRONT VIEW; b, APERTURAL VIEW.



The species may be confused on one hand with *Bulimina inflata*, which, however, has ribs running up on the face of the chambers, these in *B. marginata* being smooth, and with *B. aculeata* on the other hand, which has long spines over the chamber wall on the early chambers, in adult specimens the last formed chambers being smooth. In *B. marginata* the lower margins of all chambers are serrate with little difference in the earlier and later formed in this respect.

BULIMINA INFLATA Seguenza.

*Bulimina inflata* SEGUENZA, Atti Accad. Gioenia Sci. Nat., ser. 2, vol. 18, 1862, p. 109, pl. 1, fig. 10.—SCHWAGER, *Novara* Exped. geol. Theil, vol. 2, 1866, p. 246, pl. 7, fig. 91.—H. B. BRADY, Rep. Voy. *Challenger*, Zoölogy, vol. 9, 1884, p. 406, pl. 51, figs. 10–13.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 220, pl. 43, fig. 9.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 474.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 288, pl. 8, fig. 85.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 22.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 46.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 291, pl. 37, fig. 5.—MILLET, Journ. Roy. Micr. Soc., 1899, p. 279.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 135.

*Description*.—Test short, ovate, composed of overlapping chambers, triserial, the sutures deep; edge of chamber extending out into a free winglike expansion with a crenulated border extending outward into short spines, from which raised costæ extend back into the outer surface of the chambers; upper portions of the chambers smooth and unornamented; wall transparent and thin in the young, becoming thickened and white in the adult; aperture an obliquely placed slit, elongated, widest near the upper end, usually with a raised border, and often with a lip extending in on the concave side.

Length, 0.4–1.0 mm.

*Distribution*.—This species seems to be widely distributed in the North Pacific. It was recorded by Brady from *Challenger* station 209, in 95 fathoms, near the Philippine Islands. Goës records it from two *Albatross* stations in the eastern part of the tropical Pacific, in 695 and 995 fathoms. Bagg found it in material from four *Albatross* stations near the Hawaiian Islands, in 384–1,307 fathoms. In my



FIG. 137.—BULIMINA INFLATA.  $\times 60$ .  
a, FRONT VIEW; b, APERTURAL VIEW.

own work I have found specimens from a large number of stations, especially in the Western Pacific about Japan, and southward, and also in the deeper water in various places. It has occurred also in material from between Hawaii and the western coast of America. Of these various stations the shallowest at which I have found the species is 181 fathoms, and the deepest 1,417 fathoms.

The species, although widely distributed, has not been met with in any considerable numbers at any one station.

Brady speaks of this species as a transition form connecting *Bulimina aculeata* and *B. buchiana*, but it has always been easily distinguished from either of these two species in the material I have examined. In a large list of stations the two species *B. inflata* and *B. buchiana* occurred at the same station but twice.

As far as the North Pacific is concerned *Bulimina inflata* seems to be the most common species of the genus.

**BULIMINA BUCHIANA d'Orbigny.**

*Bulimina buchiana* D'ORBIGNY, FOR. FOSS. VIENNE, 1846, p. 186, pl. 11, figs. 15-18.—REUSS, Sitz. kais. Akad. Wiss. Wien, vol. 55, 1867, p. 95, pl. 4, figs. 10a, b.—TERRIGI, Atti Acc. Pont. Nuovi Lincei, vol. 33, 1880, p. 195, pl. 2, fig. 37.—H. B. BRADY, Rep. Voy. Challenger, Zoölogy, vol. 9, 1884, p. 407, pl. 51, figs. 18, 19.—WRIGHT, Proc. Roy. Irish Acad., ser. 3, vol. 1, 1891, p. 474.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 286, pl. 8, figs. 68, 77.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 22.—BAGG, Bull. U. S. Nat. Mus., vol. 34, 1908, p. 135.

*Bulimina presli*, var. *buchiana* PARKER AND JONES, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 374, pl. 17, fig. 71.

*Bulimina karreriana* BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 138 (not *B. karreriana* H. B. Brady).

*Description.*—Test ovate, short, composed of numerous inflated chambers; sutures fairly deep, triserial; chambers visible from base to apex; ornamentation consisting of a series of raised costæ, usually three to five on each chamber, and becoming confluent with those on the chambers directly above and below, so that the test has the appearance of bearing longitudinal costæ from the early chambers to the basal portion of those last formed; wall thin and transparent in young specimens, in adults becoming thickened, white, and opaque,



FIG. 138.—BULIMINA BUCHIANA.  
× 150. a, FRONT VIEW; b,  
APERTURAL VIEW.

perforate; final series of chambers smooth above; aperture a looplike opening on the inner margin of the chamber.

Length, 0.3-0.8 mm.

*Distribution.*—The only previous records for this species in the North Pacific are those of Bagg from near the Hawaiian Islands, at *Albatross* stations H4568, in 1,274 fathoms, and H4585, in 689 fathoms. His selected specimens appear to be typical. Brady did not find the species in the *Challenger* material from the North Pacific. In the *Albatross* and *Nero* material that I have examined this species has occurred at numerous stations. These are for the most part in the western portion of the area. As a rule the depths at which this species has been taken correspond well with the observations of Brady on the *Challenger* material. All of our stations come within the range given by Brady. The shallowest occurrence of the species in this material is 440 fathoms and the deepest 2,086 fathoms. The great majority of the stations are in water between 1,000 and 2,000 fathoms in depth.

The figured specimen is not an adult, the costæ on all but the last-formed chamber reaching well up toward the upper end, while in the adult, as a rule, the three chambers last formed are comparatively smooth. The overlapping appearance is seen in profile at the sides.

An examination of Bagg's specimen recorded as *Bolivina karreriana* shows it to be a young specimen of *Bulimina buchiana*.

#### BULIMINA ACULEATA d'Orbigny.

*Polymorpha pinciformis* SOLDANI, Testaceographia, vol. 1, pt. 2, 1791, p. 118, pl. 127, fig. 1, pl. 130, fig. vv.

*Bulimina aculeata* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 269.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 406, pl. 51, figs. 7-9.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., vol. 12, 1888, p. 220, pl. 43, fig. 8.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 287, pl. 8, figs. 72, 78.—CHAPMAN, Proc. Zool. Soc., London, 1895, p. 22.—GOËS, Bull. Mus. Comp. Zool., vol. 29, 1896, p. 45.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 291, pl. 37, fig. 4.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 134.

*Bulimina pupoides*, var. *spinulosa* WILLIAMSON, Rec. For. Great Britain, 1858, p. 62, pl. 5, fig. 128.

*Bulimina presli*, var. *aculeata* PARKER and JONES, Intr. Foram., 1862, Appendix, p. 311.

*Description.*—Test elongate, tapering, triserial, the early chambers with rather stout aculeate spines, in part from the projecting border of the chamber and in part from its outer surface above the projecting portion; later chambers in adult specimens typically smooth and inflated, with depressed sutures; wall calcareous, perforate, in adult specimens white and opaque; aperture a slightly curved looplike opening at the lower inner border of the chamber.

Length, 0.4-0.8 mm.

*Distribution.*—This species is very widely distributed in the various ocean basins. In the North Pacific it is recorded by Brady from one *Challenger* station, 232, in 345 fathoms, on the *Hyalonema*-ground south of Japan. Bagg records it from a single *Albatross* station, H4567, in 1,307 fathoms, near the Hawaiian Islands. Goëss did not note the species in the eastern Pacific material examined by him, and I have failed to find it in material from the same region. Just east of the Hawaiian Islands it has been noted in material from a few stations, in 1,424–2,615 fathoms. I have found it also at one station just off the Hawaiian Islands, in 392 fathoms. It has occurred at a great number of stations in the Western Pacific, about Japan and in the region to the south. The depth of the stations at which it was taken range from 76 to 1,299 fathoms, with the average depth between 500 and 1,000 fathoms.

From a study of the various figures of specimens assigned to this species it would seem as though there were two or more distinct forms confused under this name. The most common and typical form seems to be that figured here and in the *Challenger* report on plate 51, fig. 8. In the North Pacific this is the common form.



FIG. 139.—*BULIMINA ACULEATA*.  $\times 75$ . *a*, FRONT VIEW; *b*, APERTURAL VIEW.

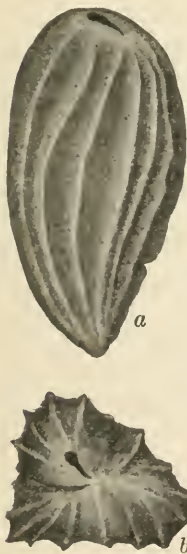


FIG. 140.—*BULIMINA ROSTRATA*.  $\times 150$ . *a*, FRONT VIEW; *b*, APERTURAL VIEW.

*BULIMINA ROSTRATA* H. B. Brady.

*Bulimina rostrata* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 408, pl. 51, figs. 14, 15.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 287, pl. 8, figs. 96, 97.

*Description.*—Test ovoid, tapering to an acute point, sometimes with a distinct apical spine; chambers arranged triserially, but indistinct in front view; surface with a series of raised costæ running from the apical end to the last-formed whorl, concealing the sutures; end view showing the sutures; wall punctate, opaque, white; aperture elongate, comma-shaped.

Length 0.3–0.5 mm.

*Distribution.*—Brady found this species in material from four *Challenger* stations in rather deep water in the South Atlantic and



Southern Ocean, between the Cape of Good Hope and Kerguelen Island, and off the Ki Islands. Egger in the *Gazelle* report records it once from West Australia; but his figures do not indicate typical specimens. It has not previously been recorded from the North Pacific. I have specimens of this species from six stations widely scattered in this area, as follows: *Albatross* station H2899, in 1,531 fathoms, near the Hawaiian Islands; *Nero* stations 170, east of Midway Island, in 1,990 fathoms; 1123, 1185, and 1208, near the Bonin Islands, in the Western Pacific in 1,877, 1,491, and 665 fathoms, respectively; and *Albatross* station D4957, in 437 fathoms, off Japan.

This seems to be a small species, distinct from *Bulimina buchiana*, with continuous costæ of sufficient strength to obscure the sutures of the test.

**BULIMINA SUBORNATA** H. B. Brady.

*Bulimina subornata* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 402, pl. 51, figs. 6a, b.

*Description*.—"Test oblong-ovate; resembling that of *Bulimina pupoides* in general form and segmentation; the earlier chambers ornamented externally with raised longitudinal costæ; the aboral extremity generally armed with a stout spine. Shell-wall conspicuously ornamented."

Length 0.5 mm.

*Distribution*.—This species was described by Brady from material dredged by the *Challenger* on the *Hyalonema*-ground, south of Japan, in 345 fathoms. It is very interesting to note that the only specimen of this species obtained from the North Pacific material examined was from

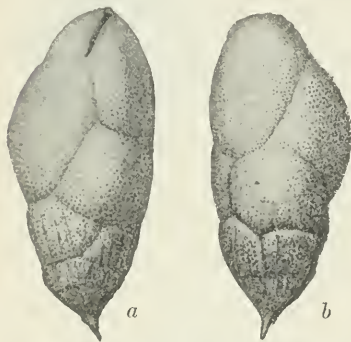


FIG. 141.—*BULIMINA SUBORNATA*.  $\times 50$ .  
a FRONT VIEW; b, SIDE VIEW. (AFTER BRADY).

*Albatross* station D5090, in 200 fathoms, but a few miles from the spot where this species was obtained by the *Challenger*. This specimen might have been used for Brady's figure, so exactly is it like the figure in the *Challenger* report in its details. The description and figure are from Brady.

**BULIMINELLA**, new genus.

*Bulimina* (part) D'ORBIGNY, Foram. Amér. Méri., 1839, p. 51.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 397.

*Description*.—Test composed of chambers triseriately arranged, but in later development becoming involute and spirally coiled, the aperture being in the umbilicus thus formed; wall calcareous, perforate; aperture in the species but little twisted spirally, long and narrow, nearly vertical, in the closely spiral species becoming rounded in the middle of the concave umbilical area.



This genus contains species such as *Buliminella elegantissima* (d'Orbigny), where the spiral form of the test is very marked, and others which show a lesser tendency toward the spire, such as *Buliminella subteres* (H. B. Brady), *B. declivis* (Reuss) and *B. contraria* (Reuss). It is very different from typical *Bulimina*, with its simple triserial arrangement of the chambers.

*Type-species.*—*Buliminella elegantissima* (d'Orbigny).

**BULIMINELLA SUBTERES (H. B. Brady).**

*Bulimina presli*, var. *elegantissima* PARKER and JONES, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 374, pl. 15, figs. 12-17.

*Bulimina elegantissima* (var.) H. B. BRADY, Ann. Mag. Nat. Hist., ser. 5, vol. 1, 1878, p. 436, pl. 21, fig. 12.

*Bulimina subteres* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 55.—WRIGHT, Proc. Belfast Nat. Field Club, 1880-81, App. p. 180, pl. 8, figs 2, 2a.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 403, pl. 50, figs. 17, 18.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 289, pl. 8, figs. 73, 74.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 46, pl. 9, figs. 445-453.—SIDEBOTTOM, Mem. Proc. Manchester Lit. and Philos. Soc., vol. 49, No. 5, 1905, p. 10.

*Description.*—"Test elongate-ovate, tapering to a blunt point at the initial extremity, rounded at the distal end; consisting of from two to three more or less regular, oblique convolutions. Chambers relatively large and only slightly ventricose externally; sutural lines very distinct. Aperture a curved slit near the inferior umbilical margin of the terminal chamber, considerably removed from the distal end of the test."

Length 0.4-0.6 mm.

*Distribution.*—A single specimen of this species was found in material from *Nero* station 1254, in 264 fathoms, south of Japan. It appears to be the only record for this region, although Brady records it from eight stations in the South Pacific.

The *Nero* specimen matched exactly the figure given by Brady and reproduced here. The description is from Brady.

**BULIMINELLA CONTRARIA (Reuss).**

*Rotalina contraria* REUSS, Zeitschr. deutsch. geol. Ges., vol. 3, 1851, p. 76, pl. 5, fig. 37.

*Bulimina contraria* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 409, pl. 54, fig. 18a, b, c.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 288, pl. 8, figs. 81, 82.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 135.

*Cassidulina jonesiana* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 59.

*Description.*—Test coiled in a depressed spire, umbilicate, the chambers numerous, slightly inflated; sutures distinct, slightly depressed;



FIG. 142. *BULIMINELLA SUBTERES*.  $\times 80$ .  
a, APERTURAL VIEW; b, SIDE VIEW.

wall smooth, calcareous; aperture distinctly bulimine, loop-like, rather long and narrow, extending to the umbilicus: color white.

Diameter about 0.75 mm.

*Distribution*.—Recorded by Brady from the *Hyalonema*-ground, south of Japan, in 345 fathoms, and by Bagg from three *Albatross* stations near the Hawaiian Islands, D4000, H4430, and H4555, in 104–1,544 fathoms.

This is a rather anomalous species, but seems to be related to the other species of the *Bulimina* group by its aperture, and to *Buliminella* by its spirally coiled form.

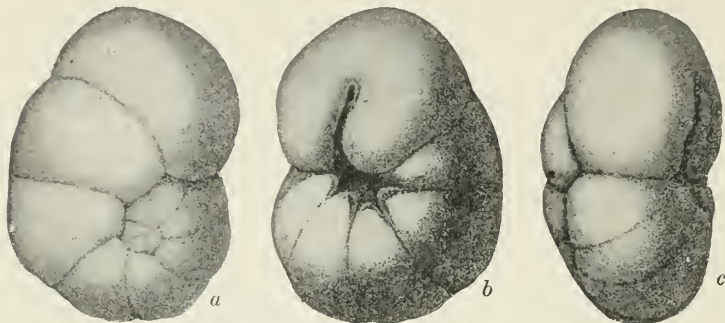


FIG. 143.—*BULIMINELLA CONTRARIA*.  $\times 60$ . *a*, DORSAL VIEW; *b*, VENTRAL VIEW; *c*, PERIPHERAL VIEW (AFTER BRADY).

#### BULIMINOIDES, new genus.

*Description*.—Test triserial, spiral, elongate, subcylindrical; wall calcareous, perforate; aperture nearly circular, terminal, in a depression of the truncated apertural end.

This genus differs from true *Bulimina* in its spiral cylindrical form and its central, circular, terminal aperture. It contains but one species, *B. williamsoniana* (H. B. Brady).

*Type-species*.—*Buliminoides williamsoniana* (H. B. Brady).

#### BULIMINOIDES WILLIAMSONIANA (H. B. Brady).

*Bulimina williamsoniana* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 56; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 408, pl. 51, figs. 16, 17.—MILLET, Journ. Roy. Micr. Soc., 1900, p. 279, pl. 2, fig. 8.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 136.

*Description*.—Test subcylindrical, elongate, spirally twisted, triserial, slightly tapering, the apical end broadly rounded, the apertural end obliquely truncated, depressed; chambers numerous, long and narrow, obliquely placed; sutures not clearly marked, being hidden by the surface ornamentation; wall calcareous, perforate, ornamented with a series of longitudinal costæ, somewhat twisted, following over the apertural end and continuing to the edge of the aperture, occa-

sionally bifurcating; aperture terminal, central, circular, situated in the center of the depression at the apertural end; color, white.

Length 0.50–0.80 mm.

*Distribution.*—The only North Pacific record for this species is given by Bagg, *Albatross* station H4694, in 865 fathoms, off the Hawaiian Islands. I have had material from *Albatross* station H2922 in 268 fathoms, also off the Hawaiian Islands.

The species seems to be a tropical or subtropical one, being found in the area from northern Australia through the South Pacific and Malay Islands, a not uncommon distribution for other species found in the Hawaiian waters.

### Genus VIRGULINA d'Orbigny, 1826.

*Virgulina* d'ORBIGNY (type, *V. squamosa* d'Orbigny). Ann. Sci. Nat., vol. 7, 1826, p. 267.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 413.

*Bulimina* (part) BAILEY, Smiths. Contr. Knowledge, vol. 2, 1851, p. 12.—PARKER and JONES, Ann. Mag. Nat. Hist., ser. 2, vol. 19, 1857, p. 296; Philos. Trans. Roy Soc., vol. 155, 1865, p. 375.—WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 63.

*Description.*—Test elongate, made up of chambers from one side biserial, from the other more or less spiral or irregular; wall calcareous, perforate; aperture large, comma-shaped, on the inner portion of the chamber; color, white.

This genus, including but a few species, has a wide distribution in the present seas and is found fossil especially in the later tertiary. On the one hand it is related to *Bulimina*, and on the other hand many of its characters are not unlike *Bolivina*, especially the aperture.

### VIRGULINA SQUAMOSA d'Orbigny.

*Virgulina squamosa* d'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 267; Modèles, No. 64.—PARKER, JONES, and H. B. BRADY, Ann. Mag. Nat. Hist., ser. 3, vol. 16, 1865, p. 29, pl. 2, fig. 66; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 415.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 291, pl. 8, figs. 98, 104.—Goës, Kongl. Svensk. Vet. Akad. Handl., vol. 25, pt. 9, 1894, p. 47, pl. 9, figs. 454, 456, 460; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 46.—SIDEBOTTOM, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, No. 5, 1905, p. 13, pl. 3, fig. 5.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 136.

*Description.*—Test elongate, tapering, the chambers oblique, longer than wide; test becoming much wider toward the apertural end, thin;



FIG. 144.—BULIMNOIDES WILLIAMSONIANA.  $\times 60$ .  
a, APERTURAL VIEW; b, FRONT VIEW.

walls calcareous, smooth, and polished; sutures clearly marked, but not deep; aperture elongate, narrow, comma-shaped; color, white.

Length about 0.50 mm.

*Distribution*.—This species is well distributed over the North Pacific in water of medium depths, few stations being less than a thousand fathoms.

There is some confusion as to the application of d'Orbigny's name, but it is here applied to the rather thin, broad, tapering form with oblique chambers, such as is shown by d'Orbigny's model. With such an application it may be rather easily distinguished from the more rotund, less tapering *V. subsquamosa* Egger.

**VIRGULINA SUBSQUAMOSA** Egger.

*Virgulina subsquamosa* EGGER, Neues Jahrb., 1857, p. 295, pl. 12, figs. 19–21.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 415, pl. 52, figs. 9–11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 291, pl. 8, figs. 89, 90, 109.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, pt. 9, 1894, p. 49, pl. 9, figs. 473–474; Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 46.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 291, pl. 37, fig. 7.—SIDEBOTTOM, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, No. 5, 1905, p. 13.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 136.



FIG. 145.—*VIRGULINA SQUAMOSA*, MODIFIED FROM THE ORIGINAL. *a*, APERTURAL VIEW; *b*, FRONT VIEW.

*Description*.—Test elongate, tapering, the chambers somewhat oblique, with slightly depressed sutures, slightly inflated in the narrower forms; test in side view somewhat curved; walls calcareous, smooth and polished; aperture elongate, fairly broad, comma-shaped; color, white.

Length 0.40–0.65 mm.

*Distribution*.—This species has been recorded by Brady, Goës, and Bagg from the North Pacific; from the *Hyalonema*-ground, 345 fathoms, off Japan by Brady; from the eastern Pacific in 1,132 fathoms by Goës; and from about the Hawaiian

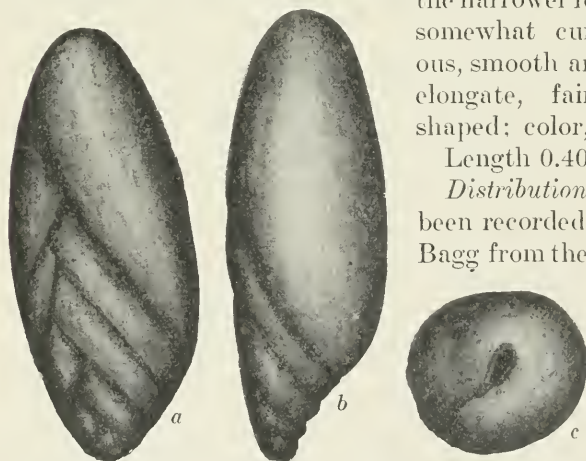


FIG. 146.—*VIRGULINA SUBSQUAMOSA*.  $\times 120$ . *a*, FRONT VIEW; *b*, SIDE VIEW; *c*, APERTURAL VIEW.

Islands by Bagg, in 275–1,544 fathoms. I have found specimens referable to this species from many stations well scattered over the North Pacific.



That there is a decided confusion in regard to this and the foregoing species is evident from a study of the original descriptions and figures and a comparison with later figures. The originals are much closer than later authors have made their diagnoses of the two, and it is now difficult, without a large series of specimens, to determine clearly the limits of the species as they exist at present. Unfortunately, although the material studied from the North Pacific is from many stations, the number of specimens from any one station is too small to admit of a comparative study of variation. A large series would probably show that there are definite species with more or less clearly defined distribution, as has been elsewhere found to be the case when conditions were favorable for such a study.

*VIRGULINA SUBSQUAMOSA* Egger, var. *STRIATA* Bagg.

*Virgulina squamosa striata* BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 137, pl. 5, fig. 7.

*Description*.—Test elongate, slightly tapering, bluntly rounded at the apical end, obliquely truncate at the apertural end; the chambers about as broad as high, somewhat rotund; the sutures distinct; wall calcareous, polished, ornamented with longitudinal costæ; color, white.

Length about 0.50 mm.

*Distribution*.—Described from *Albatross* station D4025, in 275–368 fathoms, near the Hawaiian Islands.

A study of the type specimen seems to place the species rather as related to *V. subsquamosa* Egger rather than to *V. squamosa* d'Orbigny as here considered. It may be a good species, but further material is desirable for study before this can be determined.

*VIRGULINA SUBDEPRESSA* H. B. Brady.

*Virgulina subdepressa* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 416, pl. 52, figs. 14–17.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 291, pl. 8, fig. 103.—Goës, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 47.

*Description*.—Test elongate, subcylindrical, slightly compressed; the chambers fully as high as broad, inflated, the sutures deep; outline distinctly crenulate; apical end of test broadly rounded; wall calcareous, smooth and polished; aperture fairly broad, comma-shaped; color, white.

Length about 1 mm.

*Distribution*.—Goës records this species from a single station off the western coast of America, in 730 fathoms. I have seen material from four stations, *Albatross* station

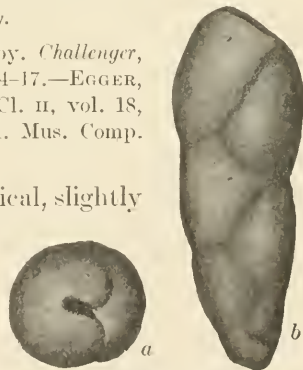


FIG. 147.—*VIRGULINA SUBDEPRESSA*.  
× 50. *a*, APERTURAL VIEW; *b*, FRONT VIEW.



H4856, 898 fathoms, Bering Sea, *Nero* station 170 in 1,990 fathoms near Midway Island, and *Nero* stations 1128 and 1123 in 1,418 and 2,049 fathoms in the Western Pacific.

From the material examined the characters of this species seem to be well defined. It is more cylindrical in form than any of the other recent species, and its shape, with the triangular outline of the inflated chambers, distinguishes it from the other species.

The original stations given by Brady are all in deep water, as are also the *Gazelle* stations, from which the species is recorded by Egger.

VIRGULINA SCHREIBERSIANA Czjzek.

*Virgulina schreibersiana* CZJZEK, Haidinger's Nat. Abhandl., vol. 2, 1848, p. 147, pl. 13, figs. 18-21.—EGGER, Neues Jahrb., 1857, p. 295, pl. 12, figs. 12-14.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 414, pl. 52, figs. 1-3.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 290, pl. 8, figs. 93, 95.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 48, pl. 9, figs. 459, 461-472.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 291, pl. 37, fig. 6.—FORNASINI, Mem. Accad. Sci. Instit. Bologna, ser. 5, vol. 7, 1898, p. 206, pl., fig. 6.—MILLETT, Journ. Roy. Micr. Soc., 1900, p. 280, pl. 2, fig. 13.—SIDEBOTTOM, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, No. 5, 1905, p. 13, pl. 3, fig. 4.

*Bulimina presli* var. (*Virgulina*) *schreibersii* PARKER and JONES, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 375, pl. 15, fig. 18; pl. 17, figs. 72, 73.

*Description*.—Test much elongated, narrow, tapering, compressed, slightly curved in side view, the apical end tapering to a blunt point; the chambers much longer than wide, oblique; the sutures distinct, slightly compressed; wall calcareous, smooth and polished; aperture rather broad and widely open, loop-shaped; color white.

Length 0.30-0.50 mm.

*Distribution*.—Recorded by Brady from two *Challenger* stations in the North Pacific in deep water, in 2,425 and 3,125 fathoms. I have had material from a number of stations, all in the western Pacific, two stations, in 891 fathoms and 1,331 fathoms, being the only two in less than 1,500 fathoms, more than half the stations being in water more than 2,000 fathoms in depth.

This is another of the species in which there is great confusion, as a study of published figures will show. From the material at hand there seem to be rather definite groupings into two or more distinct forms, but more of a series is necessary to define these with certainty.



FIG. 148.—VIRGULINA SCHREIBERSIANA. X 60. a, APERTURAL VIEW; b, FRONT VIEW.

## VIRGULINA TEXTURATA H. B. Brady.

*Virgulina texturata* H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 415, pl. 52, figs. 6, *a*, *b*.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 292, pl. 8, fig. 99.

*Description*.—Test elongate, subcylindrical, gradually tapering to the subacute apical end, somewhat compressed; chambers numerous, inflated, about as broad as high, the sutures distinctly depressed; wall calcareous, smooth and polished; aperture elongate, loop-shaped; color white.

Length 1.0–1.3 mm.

*Distribution*.—Although not previously recorded from the North Pacific, this species has occurred at three stations, *Albatross* station H2902, in 1,783 fathoms, and *Nero* stations 166 and 170, in 1,850 and 1,990 fathoms.

The specimens from *Nero* station 166 were very smooth and somewhat different from the typical ones found at the other stations.

## Subfamily 4. CASSIDULININÆ.

This subfamily includes forms which are peculiarly constructed in that there is a combination of two distinct modes of growth. One of these, so usual in this family, is the biserial, which is here combined with a spiral or volute method. The combination of the two makes a complex test.

Two genera are common in the North Pacific, *Cassidulina* and *Ehrenbergina*, both of which are represented by more than one species.

## Genus CASSIDULINA, d'Orbigny, 1826.

*Cassidulina* D'ORBIGNY (type, *C. lavigata* d'Orbigny), Ann. Sci. Nat., vol. 7, 1826, p. 282.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 427.

*Description*.—Test coiled, at least the earlier portion, and the chambers biserially arranged on the sides of the axis of coiling; wall calcareous, perforate, usually smooth; the chambers numerous, with distinct sutures; aperture loop-like, variously modified in the different species.

The most lucid description of the arrangement of the chambers in this genus is that given by Brady, as follows: "The arrangement of the test in *Cassidulina* is in some respects more complex than that of any other type of Foraminifera, inasmuch as it combines two distinct modes of growth, the biserial and the convoluted. This may

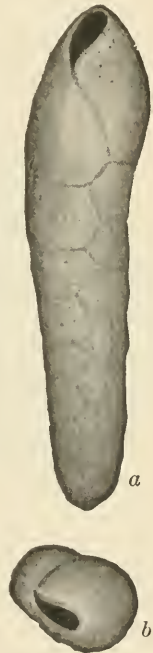


FIG. 149.—VIRGULINA TEXTURATA.  $\times 35$ . *a*, FRONT VIEW; *b*, APERTURAL VIEW.

be best understood by its analogy, in the typical condition, to a broad Textularian or Bolivine shell, doubled or folded longitudinally on the median line, and then rolled in the crease so formed from the narrow to the broad end. The flaps of each convolution extend nearly or quite to the umbilicus, and completely enclose the previous whorls."

In some species there is the tendency to uncoil as in so many other genera which are close coiled. The various species appear to be widely distributed.

CASSIDULINA LÆVIGATA d'Orbigny.

*Cassidulina lævigata* D'ORBIGNY, Ann. Sci. Nat., vol. 7, 1826, p. 282, pl. 15, figs. 4, 5; Modèles, 1826, No. 41.—WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 68, pl. 6, figs. 141, 142.—PARKER and JONES, Philos. Trans., vol. 155, 1865, p. 377, pl. 15, figs. 1-4; pl. 17, fig. 64, *a*, *b*, *c*.—H. B. BRADY, Rep. Voy. Challenger, Zoology, vol. 9, 1884, p. 428, pl. 54, figs. 1-3.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc. London, vol. 12, 1888, p. 221, pl. 43, fig. 11.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 302, pl. 7, figs. 47, 48, 54-56.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 43, pl. 8, figs. 418-320.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 12, 1896, p. 103, pl. 2, fig. 10.—MILLET, Journ. Roy. Micr. Soc., 1901, p. 1.—SIDEBOTTOM, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, No. 5, 1905, p. 16.—RHUMBLER, Zool. Jahrb., Abth. Syst., vol. 24, 1906, p. 62.

*Description.*—Nearly circular in outline, lenticular or biconvex with a thin, carinate, peripheral border; chambers numerous, long and narrow, curved, the surface nearly smooth; sutures distinct but hardly depressed; wall calcareous, perforate, smooth; aperture a long narrow slit just below and nearly parallel to the periphery of the test; color white.

Diameter 0.50-0.90 mm.

*Distribution.*—Brady records this species as occurring at three stations in the North Pacific. I have material of this keeled form from but one station, *Albatross* station D4822, in 130 fathoms, off Japan. The other species are all more common in the material from this region, but from the colder waters of Bering Sea as well as on the northern coast of western America this species is common. Rhumbler records a very small specimen measuring 0.234 mm. from Chatham Island.

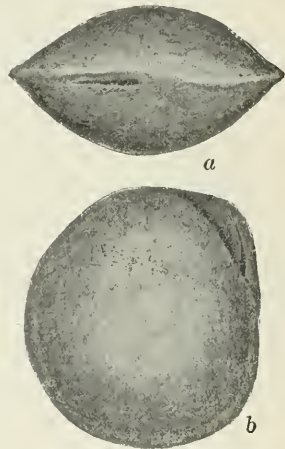


FIG. 150.—CASSIDULINA LÆVIGATA.  $\times 30$ . *a*, APERTURAL VIEW; *b*, FRONT VIEW.

## CASSIDULINA CRASSA d'Orbigny.

*Cassidulina crassa* D'ORBIGNY, Foram. Amér. Mérid., 1839, p. 56, pl. 7, figs. 18-20; For. Foss. Vienne, 1846, p. 213, pl. 21, figs. 42, 43.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 303, pl. 7, figs. 35, 36.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 43, pl. 8, figs. 421, 422.—EGGER, Nat. Ver. Passau, Jahr. 16, 1895, p. 19, pl. 9, fig. 19.—SILVESTRI, Mem. Pont. Accad. Nuovi Lincei, vol. 12, 1896, p. 104, pl. 2, figs. 11, 12.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 292, pl. 38, fig. 3.—MILLETT, Journ. Roy. Micr. Soc., 1901, p. 2.—SIDEBOTTOM, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, No. 5, 1905, p. 17.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 139.

*Cassidulina levigata*, var. *crassa* PARKER and JONES, Philos. Trans. Roy. Soc., vol. 155, 1865, p. 377, pl. 15, figs. 5-7; pl. 17, fig. 64d.

*Cassidulina obtusa* WILLIAMSON, Rec. Foram. Great Britain, 1858, p. 69, pl. 6, figs. 143, 144.

*Description*.—Outline subcircular or oval, biconvex, with a broadly rounded peripheral border; chambers rather few, short, and inflated, the surface depressed at the sutures; wall calcareous, perforate,

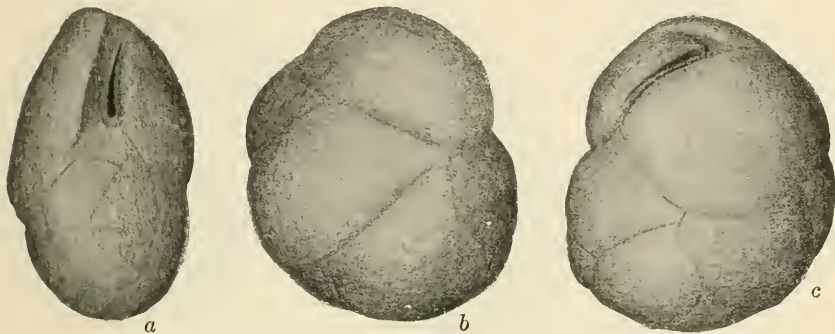


FIG. 151.—CASSIDULINA CRASSA.  $\times 30$ . a, APERTURAL VIEW; b, DORSAL VIEW; c, VENTRAL VIEW.

smooth; aperture a long narrow slit just below and nearly parallel to the periphery of the test, with a long tooth partially filling the aperture; color, white.

Diameter, 0.60-1.00 mm.

*Distribution*.—Brady records this species from five stations in the North Pacific at depths varying from 40 to 2,475 fathoms. Bagg records it from *Albatross* stations H4440 and H4694, in 1,259 and 865 fathoms, respectively, off the Hawaiian Islands. I have had material from three stations off Japan, in 120-142 fathoms, from the Okhotsk Sea in 100 fathoms, from the vicinity of the Aleutian Islands, in 500 fathoms, and from off California, in 65 fathoms. This gives a rather general distribution for the area, and specimens are usually in considerable numbers when found. The broadly rounded periphery will distinguish this species from *C. levigata*, and its more narrow and elongate aperture and more numerous chambers from *C. subglobosa*. When



the aperture is viewed from above there is visible a broad tooth-like plate partially filling the aperture except at the upper end. This gives the aperture a very narrow appearance in some views.

In this region at least *C. crassa* seems to be much more common and more widely distributed than *C. lævigata*.

CASSIDULINA SUBGLOBOSA H. B. Brady.

*Cassidulina subglobosa* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 60; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 430, pl. 54, figs. 17, a-c.—H. B. BRADY, PARKER, and JONES, Trans. Zool. Soc., London, vol. 12, 1888, p. 221, pl. 43, figs. 12-14.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 304, pl. 7, figs. 41, 42, 52, 53.—GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 49.—FLINT, Rep. U. S. Nat. Mus., 1897 (1899), p. 293, pl. 38, figs. 4.—CHAPMAN, Journ. Linn. Soc., vol. 30, 1907, p. 33, pl. 4, fig. 84.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 140.

*Description*.—Test with an oval outline, subglobular, inequilateral, somewhat compressed on the two faces, the peripheral border broadly

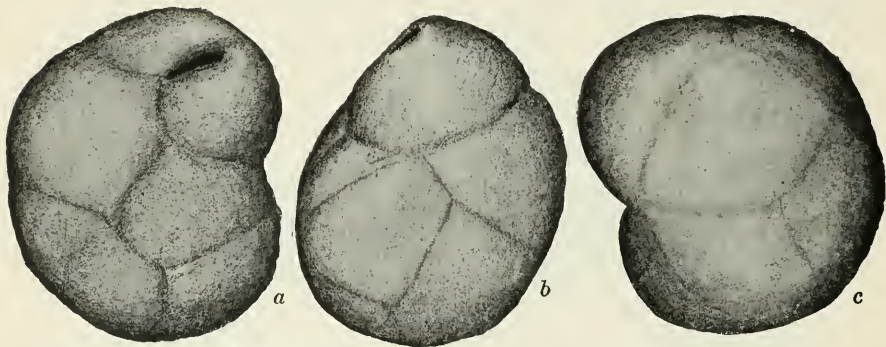


FIG. 152.—CASSIDULINA SUBGLOBOSA. X 30. a, VENTRAL VIEW; b, SIDE VIEW; c, DORSAL VIEW.

rounded; chambers few, somewhat inflated; sutures slightly depressed, wall calcareous, perforate, smooth; aperture fairly broad and short, looplike or oval; color, white.

Diameter, 0.50-1.00 mm.

*Distribution*.—The two stations in the Northwest Pacific from which Brady records this species are in 2,300 and 2,950 fathoms. Goës records the species from the southeastern part of the area in 770-1,201 fathoms, and Bagg found it in material from three *Albatross* stations near the Hawaiian Islands, H4430, H4571, and H4585, in 384-1,259 fathoms. In the *Nero* material this species was very common in the area between Guam and Japan at an average depth of about 1,500 fathoms. Specimens from the *Albatross* material from off the coast of Japan were dredged in 130 and 200 fathoms. In the *Tuscarora* material this species occurred at several stations: station 2, in 1,468 fathoms, near the Hawaiian Islands; station 13, in 190 fathoms, off the coast of California; station 23, in



1,964 fathoms, in the middle of the Pacific, south of Midway Island; station 41, in 530 fathoms, off California; and station 83, in 282 fathoms, off the western Aleutian Islands. Taken with the other records these give a rather broad distribution, including most parts of the North Pacific, as well as rather wide ranges in depth.

The species is very distinct from the others of the genus, the sub-globose form, and the short oval or loop-like aperture serving to distinguish it at once.

**CASSIDULINA ELEGANS** Sidebottom.

*Cassidulina elegans* SIDEBOTTOM, Journ. Queckett Mic. Club, ser. 2, vol. 11, 1910, p. 106, pl. 4, figs. 1, b, c.

*Description*.—Test somewhat globular, somewhat compressed laterally; chambers numerous, distinct; sutures fairly deep; wall of the distal border of the chambers often raised into a well-marked keel; surface somewhat roughened; aperture a curved loop-like slit, oblique, with a raised border.

Diameter, 0.40–0.60 mm.

*Distribution*.—This species, recently described by Sidebottom from the Southwest Pacific, occurred at four *Nero* stations between Guam and Japan as follows, 1301, in 1,088 fathoms, 1308, in 1,040 fathoms, 1309, 891 fathoms, and 1464, in 891 fathoms.

This species is ornate with raised ridges and is at once distinguished from all other species of the genus.

**CASSIDULINA BRADYI** Norman.

*Cassidulina bradyi* (Norman, MS.) WRIGHT, Proc. Belfast Nat. Field Club, App., 1880, p. 152.—H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 59; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 431, pl. 54, figs. 6–10.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 304, pl. 7, figs. 38–40.—GÖES, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 44, pl. 8, figs. 423–426; Bull. Mus. Comp. Zool., vol. 29, 1896, p. 49.—SIDEBOTTOM, Mem. Proc. Manchester Lit. Philos. Soc., vol. 49, No. 5, 1905, p. 17, pl. 3, fig. 10.

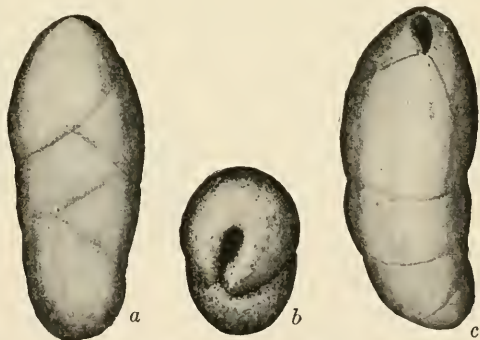


FIG. 153.—CASSIDULINA BRADYI.  $\times 60$ . a, VIEW FROM DORSAL SIDE; b, APERTURAL VIEW; c, SIDE VIEW.

*Description*.—Test elongate, compressed, the early portion spirally coiled, the later chambers forming an uncoiled biserial series; lateral faces convex; peripheral border thin, either acute or (usually) somewhat rounded; chambers fairly long, very slightly inflated; suture very slightly

depressed; wall calcareous, smooth; aperture broad and short, loop-like or oval on the inner face of the chamber; color, white.

Length, 0.40–0.80 mm.

*Distribution.*—Brady records this species from two North Pacific stations, in 95 fathoms, off the Philippines and, in 345 fathoms, on the *Hyalonema*-ground south of Japan. I have had specimens from *Nero* station 1464, in 891 fathoms, near Guam; station 170, in 1,990 fathoms, off Midway Island, and station 2049, in 2,226 fathoms, near the Hawaiian Islands. There is a single specimen of this species from *Tuscarora* station 47, in 1,499 fathoms, in the Western Pacific. This species is interesting in showing the development of an uncoiled form, a process which is carried still farther by the following.

CASSIDULINA PARKERIANA H. B. Brady.

*Cassidulina parkeriana* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 59; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 432, pl. 54, figs. 11–16.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, p. 304, pl. 7, fig. 37.

*Description.*—Test elongate, cylindrical, the very early portion spirally coiled, the later chambers forming an uncoiled biserial series, making up the larger part of the test, circular in cross section; chambers broad and high, considerably inflated; sutures much depressed; wall calcareous, smooth; aperture very broad and short, occasionally sub-circular, often with a broad tooth-like plate nearly filling the opening; color, white.

Length, 0.50–0.65 mm.

*Distribution.*—This species has not been previously recorded from the North Pacific. Brady's specimens were dredged by the *Challenger* among the islands on the west coast of Patagonia, and our specimens are from the same coast of the Pacific. Single specimens were obtained at *Albatross* stations D2806, in 1,379 fathoms, near the Galapagos, and D3608, in 276 fathoms, in the Bering Sea.

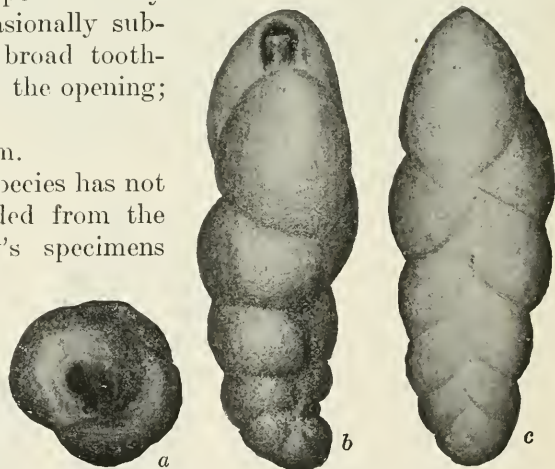


FIG. 154.—CASSIDULINA PARKERIANA.  $\times 50$ . a, APERTURAL VIEW; b, VENTRAL VIEW; c, DORSAL VIEW.

The species carries the uncoiling to an extreme and develops a cylindrical test with the aperture nearly terminal and rounded, but keeps to the biserial condition, although in some specimens the chambers nearly separate those adjacent.

## Genus EHRENBURGINA Reuss, 1850.

*Ehrenbergina* REUSS (type, *E. serrata* Reuss), Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 377.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 433.

*Cassidulina* (part) D'ORBIGNY, Foram. Amér. Mérid., 1839, p. 57.

*Description*.—Test free, composed of numerous chambers arranged biserially about an elongate axis, evenly united on the dorsal border but forming a deep groove on the ventral border, generally triangular in cross section; wall calcareous; aperture elongate, nearly at right angles to the edge of the chamber, smooth or ornamented with spines or ridges.

Brady, in the *Challenger* Report, speaks of this genus as almost confined to the southern hemisphere. This has been largely due to lack of material, in the Pacific at least, for in the present work it has been found at a great many stations and often in very considerable numbers.

## EHRENBURGINA SERRATA Reuss.

*Ehrenbergina serrata* REUSS, Denkschr. Akad. Wiss. Wien, vol. 1, 1850, p. 377, pl. 48, fig. 7.—BRONN, Leth. Geog., ed. 3, vol. 3, 1853-6, p. 231, pl. 35, figs. 25 *a-c*.—SCHWAGER, Boll. Roy. Com. Geol. Ital., vol. 8, 1877, p. 26, pl. 68.—H. B. BRADY, Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 434, pl. 55, figs. 2-7.—EGGER, Abh. kön. bay. Akad. Wiss. München, Cl. II, vol. 18, 1893, pl. 7, figs. 30-32.—GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 25, No. 9, 1894, p. 44, pl. 8, figs. 428-430.—CHAPMAN, Proc. Zool. Soc. London, 1895, p. 26.—BAGG, Proc. U. S. Nat. Mus., vol. 34, 1908, p. 140.

*Ehrenbergina serrata*, var. *trigona* GOËS, Bull. Mus. Comp. Zoöl., vol. 29, 1896, p. 49.

*Textularia triquetra* MÜNSTER, var., GOËS, Kongl. Svensk. Vet. Akad. Handl., vol. 19, No. 4, 1882, p. 83, pl. 6, figs. 181, 182.

*Description*.—Test longer than wide, of several chambers, arranged biserially about a central axis, on the dorsal side meeting evenly to form a smooth surface, on the ventral often leaving a deep groove between the two adjacent series of chambers, or smooth; test triangular, ovoid, or biconvex in transverse section; angles of the test carinate, often produced into short spines; wall calcareous, finely perforate; aperture an elongate, somewhat curved slit; color white.

Length about 0.5 mm.

*Distribution*.—There are a number of records published for this species in the North Pacific. Brady, in the *Challenger* Report, records it from but one station, in 2,340 fathoms. Goës found it in material from two stations, off the west coast of America, *Albatross* stations 3375 and 3400, in 1,201 and 1,322 fathoms; Bagg records it from five *Albatross* stations in the vicinity of the Hawaiian Islands, varying in depth from 367-1,544 fathoms. I have had material from thirty or more stations in the North Pacific. It was found in material from *Albatross* station D2806 in 1,379 fathoms near the Galapagos Islands; it occurred several times in the line of soundings from San Francisco

to the Hawaiian Islands, in 392-2,615 fathoms, and in the *Nero* material from about the Hawaiian Islands and Guam, and is common between Guam and Japan at many stations. Among variously scattered *Tuscarora* stations it occurs in 500 fathoms just south of the Aleutian Islands. It is a fairly common constituent of globigerina-ooze and volcanic muds in a number of areas of the North Pacific, according to the data available.

There seems to be some variation in the shape and the amount of spinosity developed. In general the more triangular forms are most spinose and the

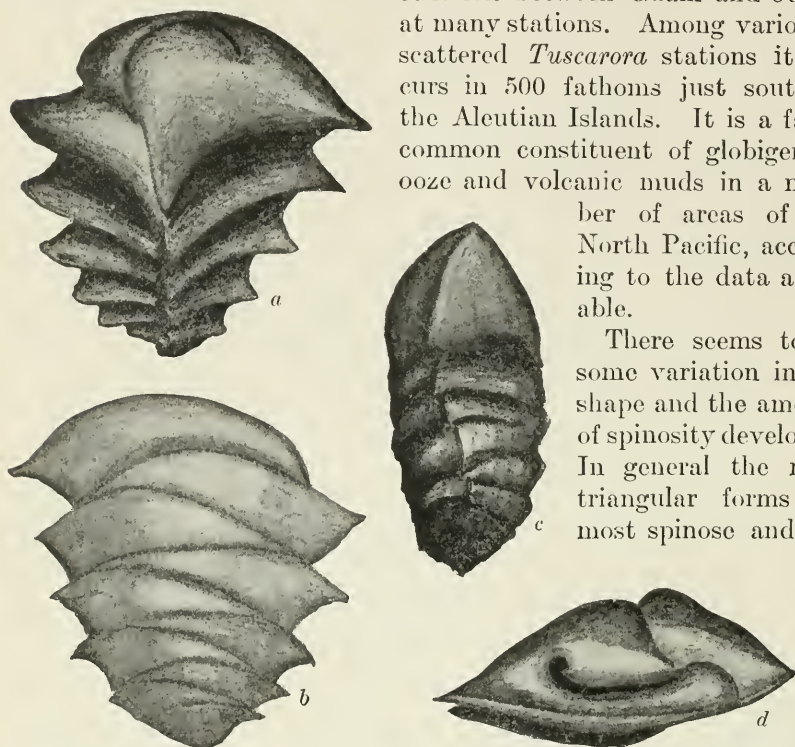


FIG. 155.—*EIRENBERGINA SERRATA*.  $\times 75$ . *a*, VENTRAL VIEW; *b*, DORSAL VIEW; *c*, SIDE VIEW; *d*, APERTURAL VIEW.

biconvex forms often almost smooth and frequently with the long axis of the test considerably curved.

#### *EHRENBURGINA HYSTRIX* H. B. Brady.

*Ehrenbergina hystrix* H. B. BRADY, Quart. Journ. Micr. Sci., vol. 21, 1881, p. 60; Rep. Voy. *Challenger*, Zoology, vol. 9, 1884, p. 434, pl. 55, figs. 8-11.—FLINT, Bull. 55, U. S. Nat. Mus., 1905, pp. 16, 19.

*Description*.—Test free, biserial, nearly as broad as long, stout; dorsal border with spines often coalescing laterally to make a fringe-like projection, later chambers smooth dorsally, the lateral margins and ventral portion with large stout spines, the last developed chamber often smooth and somewhat inflated, marked with fine raised lines running radially outward from the aperture; wall fairly thick, calcareous; aperture elongate, rounded at the inner end; color white.

Length up to 1 mm.



*Distribution.*—The only published records for the North Pacific are those of Flint, who found it in the *Nero* material from three stations. I have found it in material from two of these same stations and from a number of others, most of them northwest of the Hawaiian Islands. It occurred also near the Bonin Islands and at one *Albatross* station, H2902, east of the Hawaiian Islands. All of these records are from

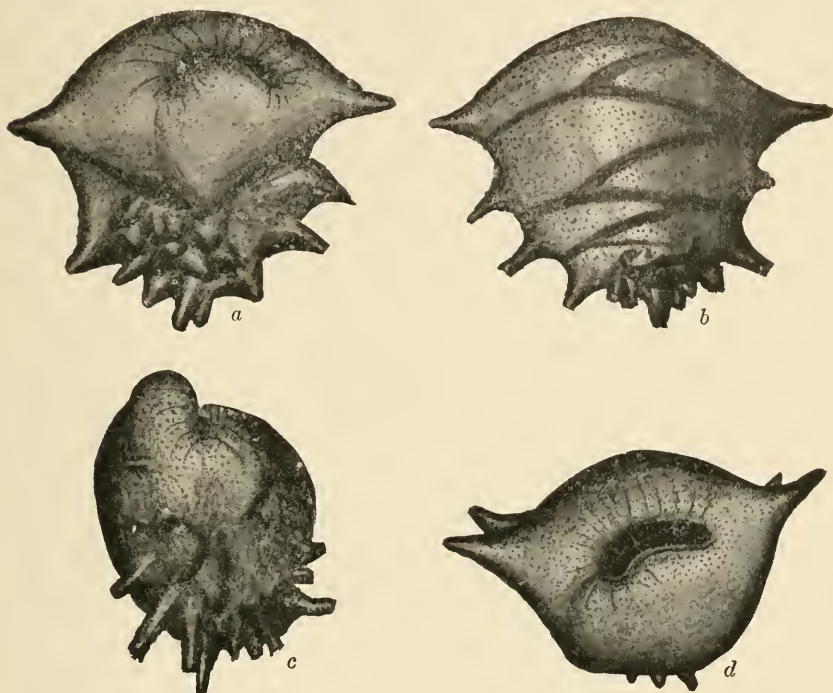


FIG. 156.—EHRENBERGINA HYSTRIX.  $\times 40$ . *a*, VENTRAL VIEW; *b*, DORSAL VIEW; *c*, SIDE VIEW; *d*, APERTURAL VIEW.

rather deep water, ranging from 1,321–2,203 fathoms, mostly from globigerina ooze.

The *Challenger* records for this species are all from the South Pacific, in rather deep water. This species is much more robust than the preceding; the shorter and stouter spines and the broad last formed chamber with its ornamentation of radial lines and the shape of the aperture are all very different from the conditions seen in *E. serrata*.





# I D N E X.

	Page.		Page.
abbreviata Textularia.....	14	Bolivina lobata.....	46, 49
acaulis, Bolivina.....	36	strigosa.....	49
aculeata, Bulimina.....	84, 86	nobilis.....	39
presli.....	86	plicata.....	43
ænariensis, Bolivina.....	44	porrecta.....	48
Brizalina.....	44	punctata.....	32, 40, 44
affinis, Bulimina.....	78	quadrilatera.....	24
affixa, Verneuilina.....	56	robusta.....	36
agglutinans, Textularia.....	9, 21	compacta.....	36
digitata, Textularia.....	28	schwageriana.....	38
fistula, Textularia.....	10	semialata.....	37, 42
fistulosa, Textularia.....	10	semicostata.....	43
nodosaria, Textularia.....	10	semituda.....	34
alata, Bolivina.....	27	spinescens.....	46
Vulvulina.....	35	subangularis.....	45
alternans, Pleurostomella.....	50	textularioides.....	46
amygdalæformis, Bolivina.....	42	bradyi, Cassidulina.....	99
angularis, Clavulina.....	74	Clavulina.....	73
Valvulina.....	74	Gaudryina.....	67
aperturalis, Textularia.....	20	Verneuilina.....	54
apicularis, Gaudryina.....	69	Brizalina ænariensis.....	44
arenacea, Bigenerina.....	29	buchiana, Bulimina.....	40, 85, 88
aspera, Textularia.....	14	bulbosa, Spiroplecta.....	5
atrata, Textularia sagittula.....	7	presli.....	85
austriaca, Valvulina.....	59	Bulimina.....	52, 76, 88
triangularis.....	59	aculeata.....	84, 86
baccata, Gaudryina.....	68	affinis.....	78
beyrichi, Bolivina.....	34	buchiana.....	40, 85, 88
alata, Bolivina.....	35, 42	contraria.....	89
Bifarina porrecta.....	48	elegans.....	82
(Bifarina) porrecta, Bolivina.....	48	exilis.....	82
strigosa, Bolivina.....	49	elegantissima (var.).....	89
Bigenerina.....	27	ellipsoides.....	77
arenacea.....	29	elongata.....	79
digitata.....	28	inflata.....	84
fimbriata.....	46	marginata.....	76, 83
nodosaria.....	27	ovata.....	77
Bolivina.....	31	polystropha.....	53
acaulis.....	36	presli aculeata.....	86
ænariensis.....	44	buchiana.....	85
alata.....	35	elegantissima.....	89
amygdalæformis.....	42	marginata.....	83
beyrichi.....	34	punctata.....	32
alata.....	35, 42	schreibersii.....	94
carinata.....	35	punctata.....	44
(Bifarina) porrecta.....	48	pupoides.....	80, 88
strigosa.....	49	marginata.....	83
compacta.....	36	spinulosa.....	86
costata.....	43	pygmæa.....	54
decussata.....	47	pyrula.....	78
dilatata.....	33	spinescens.....	78
hantkeniana.....	41, 42	rostrata.....	87
karreriana.....	40, 41, 85, 86	subornata.....	88
carinata.....	41	subteres.....	89
limbata.....	47	torta.....	81

	Page.		Page.
Bulimina williamsoniana.....	77, 90	dilatata, Bolivina.....	33
Buliminella.....	77, 88	dimorpha, Chrysalidina.....	60
contraria.....	89	dubia, Haplostiche.....	74
declivis.....	89	Ehrenbergina.....	101
elegantissima.....	89	hystrix.....	102
subteres.....	89	serrata.....	101, 103
Buliminine.....	76	trigona.....	101
Buliminoides.....	90	elegans, Bulimina.....	82
williamsoniana.....	90	exilis, Bulimina.....	82
candeiana, Textularia.....	12	elegantissima, Bulimina var.....	89
sagittula.....	12	presli.....	89
caperata, Clavulina.....	71	ellipsoides, Bulimina.....	77
Tritaxia.....	61, 71	elongata, Bulimina.....	79
carinata, Bolivina beyrichi.....	35	exilis, Bulimina, elegans.....	82
karreriana.....	41	filiformis, Gaudryina.....	70
Textularia.....	17	fimbriata, Bigenerina.....	46
carinatum, Plecanium.....	17	fistula, Textularia agglutinans.....	10
Cassidulina.....	95, 101	fistulosa, Textularia agglutinans.....	10
bradyi.....	99	flabelliformis, Pavonina.....	30
crassa.....	97	flabelloides, Pavonina.....	30
elegans.....	99	flintii, Gaudryina.....	63
jonesiana.....	89	Textularia.....	21
laevigata.....	95, 96	folium, Textularia.....	19
crassa.....	97	fusca, Rotalina.....	59
obtusa.....	97	Valvulina.....	59
parkeriana.....	100	Gaudryina.....	69
subglobosa.....	97, 98	apicularis.....	69
Cassidulininae.....	95	baccata.....	68
catenata, Textularia.....	23	bradyi.....	67
chilostoma, Gaudryina.....	68, 69	chilostoma.....	68, 69
Textularia.....	69	convexa.....	66
Chrysalidina.....	60	filiformis.....	70
dimorpha.....	60	flintii.....	63
gradata.....	60	jonesiana.....	66
Clavulina.....	71, 72	paupercula.....	66
angularis.....	74	pseudofiliformis.....	70
bradyi.....	73	pupoides.....	62, 67
caperata.....	71	chilostoma.....	69
communis.....	72	chilostomella.....	69
cylindrica.....	73	quadrangularis.....	65
elegans.....	27	rugosa.....	62, 63, 64, 66
parisiensis.....	72, 75	seabra.....	62
clavulina, Valvulina triangularis.....	74	siphonella.....	69, 70
communis, Clavulina.....	72	subrotundata.....	63, 64
Verneuilina.....	72	triangularis.....	65
compacta, Bolivina.....	36	wrightiana.....	66
robusta.....	36	göesü, Textularia.....	15
conca, Textularia.....	22	gradata, Chrysalidina.....	60
conca, Plecanium.....	22	gramen, Textularia.....	8
conica, Valvulina.....	58	Grammostomum.....	5
triangularis.....	58	hantkeniana, Bolivina.....	41, 42
contraria, Bulimina.....	89	Haplostiche dubia.....	74
Bulminella.....	89	Heterostomella.....	62
Rotalina.....	89	horrida, Textularia.....	10
convexa, Gaudryina.....	66	hystrix, Ehrenbergina.....	102
costata, Bolivina.....	43	inconspicua, Textularia.....	18
crassa, Cassidulina.....	97	inflata, Bulimina.....	84
laevigata.....	97	Textularia solita.....	20
crassisepta, Textularia.....	24	Textularioides.....	26
erescentiformis, Textularia.....	21	irregularis, Rhabdammina.....	57
cylindrica, Clavulina.....	73	jonesiana, Cassidulina.....	89
decussata, Bolivina.....	47	Gaudryina.....	66
Dentalina.....	49	jugosa, Textularia sagittula.....	13
subnodosa.....	51	karreriana, Bolivina.....	40, 41, 85, 86
digitata, Bigenerina.....	28	carinata, Bolivina.....	41
Textularia agglutinans.....	28	laevigata, Cassidulina.....	95, 96

	Page.		Page.
laevigata, crassa, Cassidulina .....	97	rostrata, Bulimina .....	87
limbata, Bolivina.....	47	Rotalina.....	58
lobata, Bolivina.....	46, 49	contraria.....	89
strigosa, Bolivina.....	49	fusca.....	59
marginata, Bulimina.....	76, 83	rotundata, Verneuilina.....	55
presli.....	83	rugosa, Gaudryina.....	62, 63, 64, 66
pupoides.....	83	Textularia.....	21
milletti, Textularia.....	13	sagittula atrata, Textularia.....	7
nobilis, Bolivina.....	39	candeiana, Textularia.....	12
nodosa, Nodosaria.....	51	jugosa, Textularia.....	13
Nodosaria.....	49	scabra, Gaudryina.....	62
nodosaria, Bigenerina.....	27	schriebersiana, Virgulina.....	94
Nodosaria nodosa.....	51	schriebersii, Bulimina preslii.....	94
nodosaria, Textularia agglutinans.....	27	schwageriana, Bolivina.....	38
obtusa, Cassidulina.....	97	semialata, Bolivina.....	37, 42
parisiensis, Clavulina.....	72, 75	semicostata, Bolivina.....	43
Valvulina.....	75	seminuda, Bolivina.....	34
parkeriana, Cassidulina.....	100	serrata, Ehrenbergina.....	101, 103
paupercula, Gaudryina.....	66	trigona, Ehrenbergina.....	101
Pavovina.....	30	siphonella, Gaudryina.....	69, 70
flabelliformis.....	30	siphonifera, Spiroplecta.....	17
flabelloides.....	30	Textularia.....	17
pineiformis, Polymorpha.....	86	solita inflata, Textularia.....	20
Plecanium.....	5	spinescens, Bolivina.....	46
carinatum.....	17	Bulimina pyrula.....	78
conconvum.....	22	spinosa, Pleurostomella.....	51
Pleurostomella.....	49	spinulosa, Bulimina pupoides.....	86
alternans.....	50	Verneuilina.....	52
spinosa.....	51	Spiroplecta.....	4
subnodosa.....	51	bulbosa.....	5
plicata, Bolivina.....	43	siphonifera.....	17
Polymorpha pineiformis.....	86	Spiroplectinae.....	4
Polymorphina.....	52	squamosa, Virgulina.....	91
polystropha, Bulimina.....	53	striata, Virgulina subsquamosa.....	93
Verneuilina.....	53	stricta, Textularia.....	11
porrecta, Bifarina.....	48	strigosa, Bolivina (Bifarina).....	49
Bolivina.....	48	lobata.....	49
(Bifarina).....	48	subangularis, Bolivina.....	45
presli aculeata, Bulimina.....	86	subdepressa, Virgulina.....	93
buchiana, Bulimina.....	85	subglobosa, Cassidulina.....	97, 98
Bulimina.....	40, 85, 88	subnodosa, Dentalina.....	51
elegantissima, Bulimina.....	89	Pleurostomella.....	51
marginata, Bulimina.....	83	subornata, Bulimina.....	88
punctata, Bulimina.....	32	subrotundata, Gaudryina.....	63, 64
schriebersii, Bulimina.....	94	subsquamosa striata, Virgulina.....	93
propinqua, Verneuilina.....	53, 57, 67	Virgulina.....	92
pseudofiliformis, Gaudryina.....	70	subteres, Bulimina.....	89
punctata, Bolivina.....	32, 40, 44	Buliminella.....	89
Bulimina.....	44	Textilaria.....	5
pupoides, Bulimina.....	80, 88	chilostoma.....	69
chilostoma, Gaudryina.....	69	triseriata.....	55
chilostomella, Gaudryina.....	69	textilarioides, Bolivina.....	46
Gaudryina.....	62, 67	Textularia.....	5, 52, 61
marginata, Bulimina.....	83	abbreviata.....	14
spinulosa, Bulimina.....	86	agglutinans.....	9, 21
pusilla, Verneuilina.....	57	digitata.....	28
pygmaea, Bulimina.....	54	fistula.....	10
Verneuilina.....	54, 55	fistulosa.....	10
pyrula, Bulimina.....	78	nodosaria.....	27
spinescens, Bulimina.....	78	aperturalis.....	20
quadrangularis, Gaudryina.....	65	aspera.....	14
quadrilatera, Bolivina.....	24	candeiana.....	12
Textularia.....	24	carinata.....	17
Rhabdammina irregularis.....	57	catenata.....	23
rhomboidalis, Textularia.....	16	concaeva.....	22
robusta, Bolivina.....	36	crassisepta.....	24
compacta, Bolivina.....	36	crescentiformis.....	21



	Page.		Page.
Textularia flintii.....	21	Tritaxia tricarinata.....	61
folium.....	19	Tritaxilina.....	71
goësi.....	15	caperata.....	71
gramen.....	8	trochus, Textularia.....	15
horrida.....	10	Valvulina.....	58, 72
inconspicua.....	18	angularis.....	74
milletii.....	13	austriaca.....	59
quadrilatera.....	24	conica.....	58
rhomboidalis.....	16	fusca.....	59
rugosa.....	21	parisiensis.....	75
sagittula atrata.....	7	triangularis.....	58
candeiana.....	12	austriaca.....	59
jugosa.....	13	clavulina.....	74
var.....	15	conica.....	58
siphonifera.....	17	Verneuilina.....	52, 72
solita inflata.....	20	affixa.....	56
stricta.....	11	bradyi.....	54
tricarinata.....	61	communis.....	72
triquetra var.....	101	polystropha.....	53
trochus.....	15	propinqua.....	53, 57, 67
Textulariidae.....	2	pusilla.....	57
Textulariinae.....	5	pygmaea.....	54, 55
Textularioides.....	26	rotundata.....	55
inflata.....	26	spinulosa.....	55
texturata, Virgulina.....	95	tricarinata.....	52
triangularis, austriaca, Valvulina.....	59	Verneulininae.....	52
clavulina, Valvulina.....	74	Virgulina.....	91
conica, Valvulina.....	58	schreibersiana.....	94
Gaudryina.....	65	squamosa.....	91
Valvulina.....	58	subdepressa.....	93
tricarinata, Textularia.....	61	subsquamosa.....	92
Tritaxia.....	61	striata.....	93
Verneuilina.....	52	texturata.....	95
trigona, Ehrenbergina serrata.....	101	Vulvulina alata.....	35
triquetra, var. Textularia.....	101	williamsoniana, Bulimina.....	77, 90
triseriata, Textularia.....	55	Buliminoides.....	90
Tritaxia.....	61, 71	wrightiana, Gaudryina.....	66
caperata.....	61, 71		