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JOURNAL OF THE COLLEGE OF SCIENCE, TOKYO IMPERIAL UNIVERSITY.
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Fossils from the Upper Musashino of Kazusa and Shimosa.

By

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With 17 Plates.

General Remarks

The Upper Musashino Formation[1] which consists of horizontal interstratified layers of clays, sands and gravels overlaid only by a brown unstratified loam generally believed to be Pleistocene in age, though without any palaeontological evidence, forms a low but extensive plateau around Tokyo whose height above the sea-level varies from a little over ten metres near the sea-coast up to more than a hundred in the interior. This plateau is variously dissected by valleys along whose sides it often shows steep escarpments fairly well exposing the rock-layers of which it is composed. In these escarpments there is frequently a sand-layer more or less filled with fossils which are mainly Mollusca, and therefore usually known under the name of *shell-layer* which is found, not only in and around the city of Tokyo,[2] but also in Kazusa and Shimosa,

1) Explained in my paper entitled "Fossils from the Miura Peninsula and its Immediate North" (Art. 6, Vol. XXXIX, Jour. Coll. Sci., Imp. Univ. Tokyo, 1920).

2) The fossils found in and around Tokyo have already been studied by David Brauns in his "Geology of the Environs of Tokio" (Mem. Sci. Departm. Tokio Daigaku. No. 4, 1885) and S. Tokunaga in his "Fossils from the Environs of Tokyo (Art. 2, Vol. XXI, Jour. Sci. Coll. Imp. Univ. Tokyo, 1906). Brauns described 87 species of Mollusca and Brachiopoda all of which he identified with the living forms and still called them Pliocene. Tokunaga recognized 168 species of Mollusca of which he found a little more than 20 not known to him as living (he says that at least 10 are surely extinct). But unfortunately he ignored many of the small-sized shells, as difficult of determination, whereby the percentage of extinct forms against the living became not quite correct. Consequently his conclusion, drawn from it, that the layer is probably Pleistocene can not be called quite certain. It is here to be noted that most of the shells described by Brauns and Tokunaga are also found among those described by me in this paper.

provinces lying to the east of it. The Mollusca and the Brachiopoda described in the present paper are those obtained from the shell-layer of the latter.

The position which this shell-layer occupies in the Upper Musashino is not far from the overlying loam, though at various distances from it. At Oji, a northern suburb of Tokyo, where Brauns and Tokunaga obtained a great deal of their materials,[1] the shell-layer is given by them as separted from loam by layers of clays, sands and gravels which together make up a thickness of about 4,3 metres, and which, according to Tokunaga, grows to about 6,6 metres at Tabata, a place about 3 kilometres south-east of Oji, and diminishes to about 2,5 metres at Shinagawa[2], a suburb at the southern extremity of Tokyo. At Ōtake, Shimosa, the intervening layer is a sand about 3,6 metres in thickness, while at Shitō, Kazusa, it is between 2 and 4 metres. From these we know that the shell-layer occupies a position very near to the upper boundary of the Upper Musashino Formation.

As to the thickness of the shell-layer itself, it is sometimes considerable. At Ōtake and Takatano-Seki, it attains a thickness of nearly 7 metres in which shells are in such close heaps that the layer is to a greater part made up of them.

The loam and the underlying layers of the Upper Musashino are generally conformable with one another. But at Kido, Tegamura, on the south bank of Tega Swamp in Shimosa, the shell-layer is superposed on a yellowish clay whose surface is full of deep pits and holes, and this clay which is about 1,5 metres thick on an average is again on a blue clay whose surface is very uneven.

The localities from which the fossils have been collected are in all six, viz.:

1. Ōtake, Shimosa.[3] Very near the railway station of Manzaki on the Abiko-Sawara line.

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1) I have been collecting these fossils for more than 15 years, during which time I was assisted by several gentlemen among whom I may mention Messrs, N. Fukuchi, M. Ōyu, T. Ogura, T. Matsumoto and S. Tsuboi, to whom my thanks are due.

2. The shell-layer formerly exposed at Oji, Tabata and Shinagawa is at present not accessible for collection.

3) 下總印旛郡八生村大竹

2. Kioroshi, Shimosa.[1] About 14 kilometres west of Otake and close to the railway station of the same name on the same line as above.

3. Kamenari, Shimosa.[2] About 4 kilometres south-west of Kioroshi.

4. Tega, Shimosa.[3] On the south bank of the swamp of the same name and about 8 kilometres west of Kioroshi. The fossil-layer is exposed at several places of which Kido and Kizaki are the most important.

5. Shisui, Shimosa.[4] About 8 kilometres south of Otake, and in a railway-cutting of the station of the same name on the Narita-line.

6. Shitō, Kazusa.[5] At places from 1,5 to 3,5 kilometres south of the railway-station of Honda on the Bōsō line, which lies about 22 kilometres south of Shisui. The shell-layer is exposed at several places of which three may be mentioned, Semata-no-Seki, Takata and Takatano-Seki.

The number of species of the Mollusca and the Brachiopoda collected in the above named localities amounts to 335 in all, as shown in the following table :

MOLLUSCA	Ōtake	Shisui	Kamenari	Kioroshi	Tega	Shitō	Lower Musashino	LIVING
Gastropoda								
Family Actaeonidae.								
1. Solidula strigosa (Gld.)	+	..	..	..	..	+	..	Central, Western, Southern Japan.
2. Solidula clathrata Yok.	..	..	..	..	..	+	..	
3. Leucotina gigantea (Dkr.)	+	..	..	..	..	+	..	Japan (Dunker).
Family Tornatinidae.								
4. Tornatina exilis Dkr.	+	+	..	..	+	+	..	Western Japan.
5. Tornatina longispirata Yam.	+	..	..	..	+	..	..	
6. Retusa globosa Yam.	+	+	..	..	..	+	..	
7. Retusa truncata Yam.	+	..	..	..	..	+	..	
8. Retusa minima Yam.	+	..	..	..	..	+	+	
9. Volvula angustata (Ad.) var.	+	..	..	..	..	+	..	Northern Japan. Philippines. N. Guinea.

1) 下總印旛郡木下町　2) 同郡大杜村龜成　3) 東葛飾郡手賀村城戸, 木崎　4) 上總
市原郡市東村瀬又ノ堰, 高田, 高田ノ堰

	Otake	Shisui	Kamenari	Kioroshi	Tega	Shito	Lower Musashino	LIVING
10. Volvula acutaeformis Yok.	..	..	..	..	..	+	..	
Family Scaphandridae								
11. Cylichna musashiensis Tok.	+	+	..	..	..	+	+	Central Japan.
Family Philinidae.								
12. Philine scalpta Ad.	..	+	..	..	..	..	..	Central and Western Japan.
13. Philine pygmaea Yok.	..	+	..	..	..	..	..	Central Japan.
14. Philine takatensis Yok.	..	..	..	..	..	+	..	
Family Bullidae.								
15. Bulla multiarata Yok.	..	..	..	..	..	+	..	
16. Bulla ovula Sow.	..	+	..	..	..	..	..	Central and Southern Japan.
Family Ringiculidae.								
17. Ringicula musashinoensis Yok.	+	+	..	+	+	+	+	Central Japan.
Family Terebridae.								
18. Terebra lischkeana Dkr.	+	..	..	..	..	+	+	Central and Western Japan.
19. Terebra gotoensis Smith.	+	..	..	..	..	..	..	Western Japan.
20. Terebra hedleyi Pils.	+	..	..	..	..	..	..	Western Japan.
21. Terebra recticostata Yok.	..	+	..	..	..	..	+	
22. Terebra chibana Yok.	+	..	..	..	..	+	..	
23. Terebra smithi Yok.	+	..	..	..	..	..	..	Central Japan.
24. Terebra quadriarata Yok.	..	..	..	..	..	+	..	
25. Terebra latisulcata Yok.	..	..	..	..	..	+	..	
26. Terebra suavidica Yok.	..	..	..	..	..	+	..	
27. Terebra tsuboiana Yok.	..	..	..	+	..	+	..	Central Japan.
28. Parviterebra raritans Yok.	+	..	..	..	..	..	..	
Family Pleurotomidae.								
29. Pleurotoma vertebrata Smith.	+	+	+	..	..	+	..	Central and Western Japan.
30. Genotia pseudopannus Yok.	+	..	..	..	..	+	..	
31. Genotia ogurana Yok.	+	..	..	..	..	..	+	
32. Drillia principalis Pils.	+	..	..	..	+	..	+	Northern, Central and Western Japan.
33. Drillia subauriformis Smith.	+	..	+	..	..	..	..	Central and Western Japan.
34. Drillia glabriuscula Yok.	..	..	..	..	..	+	..	
35. Mangilia deshayesii Dkr.	+	..	..	..	+	..	+	Central and Western Japan
36. Mangilia ojiensis Tok.	..	..	..	..	..	+	..	
37. Mangilia fukuchiana Yok.	+	..	..	..	..	..	..	Central Japan.
38. Mangilia (Cythara) rugosolabiata Yok.	+	..	..	..	..	..	..	
39. Mangilia (Cythara) oyuana Yok.	..	+	..	..	..	..	..	

	Otake	Shisui	Kamenari	Kioroshi	Tega	Shito	Lower Musashino	LIVING
40. Bela rugulata Tros. var. schneideri Harm.	+	..	..	..	..	..	..	(Fossil in English Crag).
41. Bela recticostulata Yok.	..	..	..	..	..	+	..	
Family Cancellariidae.								
42. Cancellaria spengleriana Desh.	+	..	+	+	+	+	+	From Central Japan to Australia.
43. Cancellaria nodulifera Sow.	+	..	+	..	+	+	..	Central and Western Japan.
44. Cancellaria asperula Lam. var. reeveana Crosse.	+	..	..	..	+	+	..	From Central Japan to Philippines.
Family Olividae.								
45. Olivella fortunei (Ad.)	+	+	+	+	+	+	..	Central Japan, China.
46. Olivella spretoides Yok.	..	..	..	..	..	+	..	
47. Ancilla hinomotoensis Yok.	..	..	..	..	..	+	..	
Family Marginellidae.								
48. Marginella cotamago Yok.	..	..	..	..	..	+	..	Central Japan.
49. Marginella perovulum Yok.	..	..	..	..	..	+	..	
Family Volutidae.								
50. Voluta megaspira Sow.	..	..	..	..	..	+	+	Northern, Central and Western Japan.
Family Mitridae.								
51. Mitra hondana Yok.	..	..	..	..	..	+	..	
52. Mitra pirula Yok.	..	..	..	..	..	+	..	
Family Fasciolariidae.								
53. Fusus perplexus Adams.	+	+	..	..	+	+	+	Northern, Central and Western Japan.
54. Fusus coreanicus Smith.	+	+	..	..	..	+	..	Western Japan.
55. Fusus niponicus Smith.	..	..	..	..	..	+	+	Central Japan (52 fathoms).
Family Buccinidae.								
56. Chrysodomus arthriticus Val.	+	+	+	+	+	+	..	Northern Japan.
57. Chrysodomus schrencki Yok.	..	..	..	..	..	+	+	Northern Japan.
58. Sipho obesiformis Yok.	..	..	..	..	..	+	+	
59. Sipho (Parasipho) nipponicus Yok.	+	..	..	..	..	..	..	(Very close to S. Kroeyeri Möll. of the Arctic).
60. Siphonalia spadicea Rve.	..	..	..	..	..	+	..	Northern and Central Japan.
61. Siphonalia trochulus Rve.	+	+	+	..	+	+	+	Central Japan.
62. Siphonalia kellettii Forbes.	..	..	..	..	..	+	..	Central to Southern Japan. California.
63. Volutharpa perryi Jay.	+	+	..	..	..	+	+	Northern and Central Japan.
64. Eburna japonica Rve.	+	+	..	..	+	..	..	Northern to Southern Japan.

	Otake	Shisui	Kamenari	Kioroshi	Tega	Shito	Lower Musashino	LIVING
Family Nassidae.								
65. Nassa (Hima) japonica Ad.	+	+	+	..	+	+	..	Central and Western Japan.
66. Nassa (Hima) festiva Pow.	+	..	..	..	+	+	+	Northern, Central and Western Japan.
67. Nassa (Hima) fraterculus Dkr.	+	..	..	..	..	..	..	Northern, Central and Western Japan.
Family Columbellidae.								
68. Columbella (Atilia) burchardi Dkr.	..	..	..	..	..	+	+	Western Japan.
69. Columbella (Atilia) smithi Yok.	+	..	+	..	+	..	..	Central Japan.
70. Columbella (Atilia) turriculata Yok.	+	..	..	..	..	..	..	
71. Columbella (Atilia) praecursor Yok.	+	..	..	..	+	+	..	Western Japan.
72. Columbella (Atilia) masakadoi Yok.	+	..	..	..	+	+	..	Central Japan.
73. Columbella (Mitrella) dunkeri Tryon.	+	+	+	..	+	+	+	Northern, Central and Western Japan.
Family Muricidae.								
74. Trophon pachyrhaphe Sm.	..	..	..	..	+	..	..	Western Japan.
75. Trophon subclavatus Yok.	..	..	..	..	+	+	+	(Very close to T. clavatus Sars of boreal seas).
76. Typhis arcuatus Hinds.	..	..	..	..	..	+	..	Western Japan, China, Cape of Good Hope.
77. Ocinebra falcata Sow.	..	..	..	..	+	+	..	Northern, Central and Western Japan.
78. Ocinebra spectata Yok.	+	+	..	..	..	+	..	Central Japan.
79. Rapana bezoar L. v. thomasiana Cr.	+	+	..	+	+	+	..	Northern, Central and Western Japan.
80. Purpura heysiana Dkr.	..	..	..	..	..	+	..	Central Japan.
Family Tritonidae.								
81. Triton tenuiliratus Lke.	..	..	..	..	..	+	..	Central and Western Japan.
82. Priene oregonensis Redf.	..	..	..	..	..	+	+	North. Japan, Alaska, Oregon, Chile, Strait of Magellan.
Family Cassididae.								
83. Cassis strigata Gmel.	+	..	..	..	+	..	..	Central and Western Japan.
Family Doliidae.								
84. Dolium luteostomum Küst.	+	+	..	+	+	+	+	Central and Western Japan, Indian Ocean.
Family Cypraeidae.								
85. Erato callosa Ad. et Rve.	+	..	..	..	..	+	..	Central and Western Japan, China.
Family Strombidae.								
86. Strombus japonicus.	+	..	..	..	..	..	..	Central and Western Japan, Bonins.

	Otake.	Shisui	Kamenari	Kioroshi	Tega	Shito	Lower Musashino	LIVING
Family Cerithiidae.								
87. Cerithium (Clava) kochi Phil.	+	..	..	..	..	..	..	Centr. and West. Japan. East Africa.
88. Potamides (Tympanotonos) fluviatilis Mich. et Post.	+	..	..	..	..	..	+	Centr. and West. Japan, Philippines. Indian Ocean.
89. Potamides (Batillaria) zonalis Brug.	+	..	+	..	..	..	..	North., Centr., West. Japan, Hongkong, Australia.
90. Potamides (Batillaria) multiformis Lke.	..	..	+	..	..	+	+	Northern, Central and Western Japan.
Family Cerithiopsidae.								
91. Cerithiopsis nodosocostatus Yok.	..	..	..	..	..	+	..	
92. Cerithiopsis (Seila) trisulcatus Yok.	..	..	..	..	..	+	..	
Family Triforidae.								
93. Triforis otsuensis Yok.	...	..	..	..	..	+	+	Central Japan.
94. Triforis multigyrata Yok.	..	..	..	..	..	+	..	
Family Trichotropidae.								
95. Trichotropis unicarinata Br. et Sow.	..	..	..	..	..	+	..	Northern to Western Japan.
Family Vermetidae.								
96. Thylacodes medusæ Pils.	+	..	..	..	..	..	+	Central to Southern Japan.
Family Caecidae.								
97. Cæcum vitreum Carp.	..	..	..	..	..	+	..	Central and Western Japan.
Family Melaniidae.								
98. Melania niponica Smith.	+	..	..	..	+	..	..	Central Japan.
Family Solariidae.								
99. Solarium (Philippia) cingulum Kien.	..	..	..	..	..	+	..	Central Japan, Philippines, South Sea.
100. Solarium (Philippia) pseudoperspectivum Broc.	..	..	..	..	..	+	..	Central Japan, Mediterranean Sea. (Pliocene of Italy).
101. Torinia elegantula Yok.	..	..	..	..	..	+	..	
Family Rissoidae.								
102. Rissoa (Cingula) plebeja Yok.	..	..	..	..	..	+	..	
103. Rissoina (Moerchiella) manzakiana Yok.	+	..	..	..	..	..	..	
104. Fenella septentrionalis Tok.	+	..	..	..	+	..	..	Central Japan.
Family Skeneidae.								
105. Skenea nipponica Yok.	..	+	..	..	+	..	+	Central Japan.
106. Skenea planorboides Yok.	..	..	..	..	..	+	..	Central Japan.

	Otake	Shisui	Kamenari	Kioroshi	Tega	Shito	Lower Musashino	LIVING
Family Capulidae.								
107. Capulus badius Dkr.	..	..	+	..	..	..	..	Western Japan.
108. Calyptraea mammilaris Brod,	..	..	..	..	..	+	+	West coast of America (Oregon to Magellan).
109. Crepidula grandis Midd.	..	..	..	..	..	+	..	Northern to Western Japan, Behring Sea.
Family Naticidae.								
110. Natica janthostoma Desh.	+	+	.	..	+	+	+	Northern and Central Japan, Kamchatka.
111. Polinices powisianus Recl.	+	..	..	..	..	..	..	Central and Western Japan, Philippines.
112. Polinices (Neverita) ampla Phil.	+	+	+	+	+	+	+	Northern and Central Japan, China, Australia.
113. Sigaretus (Eunaticina) papilla. Gm.	+	+	+	..	+	+	..	Central and Western Japan, Philippines.
114. Sigaretus (Eunaticina) oblongus Rve.	..	..	..	..	..	+	..	Habitat unknown.
Family Scalariidae.								
115. Scalaria aurita Sow.	+	..	..	+	..	..	..	Central Japan.
116. Scalaria maculosa Ad. et Rve.	+	..	..	..	..	..	..	Western Japan, China Sea.
117. Scalaria azumana Yok.	+	..	..	..	+	+	..	Central Japan.
118. Scalaria kazusensis Yok.	..	..	..	..	..	+	..	Central Japan.
119. Scalaria yamakawai Yok.	+	..	..	..	..	..	..	Central Japan.
120. Scalaria conjuncta Yok.	..	..	..	..	+	+	..	
121. Scalaria subfrondicula Yok.	..	..	..	..	..	+	..	
122. Scalaria picturata Yok.	..	..	..	..	..	+	..	Central Japan.
Family Eulimidae.								
123. Eulima (Leiostraca) unicincta Yok.	+	..	..	..	..	+	..	
124. Eulima (Leiostraca) tokunagai Yok.	+	..	..	..	+	..	..	
125. Eulima (Leiostraca) glabroides Yok.	..	..	..	..	..	+	..	
126. Eulima (Leiostraca) krishna Yok.	..	..	..	..	..	+	..	
Family Pyramidellidae.								
127. Pyramidella (Tiberia) pulchella Ad.	+	..	+	..	+	..	..	Central and Western Japan.
128. Pyramidella (Agatha) virgo Ad. var. brevis Yok.	+	+	+	..	+	+	..	P. virgo lives in Central Japan.
129. Pyramidella (Syrnola) cinnamomea Ad.	+	..	..	..	..	..	..	Western Japan.
130. Pyramidella (Iphiana) mira Yok.	..	..	..	..	..	+	..	

	Otake	Shisui	Kamenari	Kioroshi	Tega	Shito	Lower Musashino	LIVING
131. Pyramidella (Iphiana) siva Yok.	..	..	..	..	..	+	..	
132. Pyramidella (Actæopyramis) eximia Lke.	+	+	..	..	+	+	..	Central and Western Japan.
133. Odostomia sublimpida Yok.	+	..	..	..	..	..	+	
134. Odostomia gordonis Yok.	+	+	..	+	+	+	..	Central Japan.
135. Odostomia shimosen is Yok.	+	..	..	+	..	..	..	Central Japan.
136. Odostomia limpida D. et B.	+	..	..	..	..	+	..	Western Japan.
137. Odostomia desimana D. et B.	+	+	..	..	..	+	..	Central and Western Japan.
138. Odostomia kizakiensis Yok.	..	..	..	..	+	..	..	
139. Odostomia venusta Yok.	+	+	..	+	..	+	..	
140. Odostomia toneana Yok.	+	..	..	..	+	..	..	
141. Odostomia suboxia Yok.	+	..	..	..	..	..	..	Central Japan.
142. Odostomia (Odetta) neofelix Yok.	..	+	..	..	..	..	..	Central Japan.
143. Odostomia (Egilina) marielloides Yok.	+	..	..	..	+	..	..	
144. Turbonilla (Ptycheulimella) misella Yok.	+	..	..	..	+	..	..	
145. Turbonilla (Chemnitzia) imbana Yok.	..	+	..	..	+	+	..	Central Japan.
146. Turbonilla (Mormula) paucicostulata Yok.	+	..	..	..	..	+	..	
147. Turbonilla (Mormula) scrobiculata Yok.	+	..	..	..	..	..	..	Central Japan
148. Turbonilla (Chemnitzia) kidoensis Yok.	..	..	..	..	+	..	..	Central Japan.
149. Turbonilla (Chemnitzia) teganumana Yok.	..	..	..	..	+	..	..	Central Japan.
150. Turbonilla (Chemnitzia) sematana Yok.	..	..	..	..	..	+	..	
151. Turbonilla (Pyrgolampros) planicostata Yok.	..	+	..	..	..	..	..	Central Japan.
152. Turbonilla (Strioturbonilla) sagamiana Yok.	+	..	..	..	..	..	..	Central Japan.
153. Turbonilla (Strioturbonilla) pacifica Yok.	..	..	..	..	..	+	..	Central Japan.
154. Turbonilla (Cingulina) triarata Pils.	+	+	..	..	..	..	..	Western Japan.
155. Turbonilla (Careliopsis) obscura Yok.	..	..	..	..	..	+	..	
156. Turbonilla (Careliopsis) angulifera Yok.	..	..	..	..	..	+	..	

	Otake.	Shisui	Kamenari	Kioroshi	Tega	Shito	Lower Musashino	LIVING
Family Turbinidae.								
157. Turbo (Marmorostoma) granulatus Gm.	+	..	..	..	..	..	..	Central and Western Japan, China, Indian Ocean.
158. Leptothyra purpurescens Dkr.	+	+	..	..	+	+	+	Japan (Dunker).
159. Leptothyra pygmaea Yok.	..	..	..	..	+	..	..	Central Japan.
160. Leptothyra crassilirata Yok.	..	..	..	..	+	..	..	Central Japan.
Family Trochidae.								
161. Trochus spinigera Yok.	..	..	..	..	..	+	..	
162. Minolia tasmanica Tenison Wood.	+	..	..	..	..	+	..	Tasmania.
163. Solariella philippensis Wats.	+	..	..	..	+	+	..	Central Japan, Southern Australia.
164. Solariella angulata Tok.	..	..	..	..	..	+	..	
165. Turcica imperialis A.Ad.	..	..	..	..	..	+	+	Northern, Central and Western Japan.
166. Calliostoma unicum Dkr. var. shinagawensis Tok.	+	+	..	..	+	+	..	C. unicum lives in N.-W. Japan
167. Basilissa ? laeviuscula Yok.	..	..	..	..	..	+	..	
168. Umbonium giganteum Les.	..	..	..	..	+	..	+	Central and Western Japan.
169. Umbonium costatum Val.	+	+	..	+	+	+	+	Northern, Central and Western Japan.
Family Cyclostrematidae.								
170. Cyclostrema stillicidiatum Yok.	..	..	..	..	..	+	..	
Family Stomatellidae.								
171. Stomatella lyrata Pils.	+	..	..	..	+	..	..	Northern, Central and Western Japan.
Family Fissurellidae.								
172. Macroschisma sinensis Ad. var. laevis Yok.	+	..	..	..	+	..	+	Central Japan, China Singapore.
173. Puncturella nobilis Ad.	..	..	..	..	..	+	..	Northern Japan.
174. Emarginula vadososinuata Yok.	..	..	..	..	..	+	..	
Family Patellidae.								
175. Helcioniscus pallidus Gld.	..	..	..	..	..	+	+	Northern and Central Japan.
Scaphopoda								
Family Dentaliidae.								
176. Dentalium weinkauffi Dkr.	+	+	..	+	+	+	+	Central Japan.
177. Dentalium octogonum Lam.	+	..	..	..	..	+	..	Central to Southern Japan, China, Australia, Ceylon.
178. Dentalium edoense Tok.	+	+	..	..	+	+	..	

	Otake	Shisui	Kamenari	Kioroshi	Tega	Shito	Lower Musashino	LIVING
179. Dentalium (Fustiaria) nipponicus Yok.	..	..	..	..	..	+	..	
Lamellibranchiata.								
Family Pholadidae.								
180. Pholas fragilis Sow.	+	..	..	..	..	..	+	Northern to Western Japan, Philippines.
181. Jouannetia kamakurensis Yok.	..	..	..	..	..	+	..	Central Japan.
Family Saxicavidae.								
182. Panope generosa Gld.	+	..	..	..	+	+	..	Northern Japan, Washington to California. (Fossil in Miocene to Pleistocene of the West.)
183. Saxicava orientalis Yok.	..	..	..	..	..	+	+	
Family Corbulidae.								
184. Corbula erythrodon Lam.	+	..	..	+	..	..	..	Central and Western Japan
185. Corbula venusta Gld.	+	+	+	..	+	+	+	Northern Japan.
186. Corbula frequens Yok.	+	+	..	..	+	+	..	
187. Corbula pustulosa Yok.	+	+	..	..	..	..	..	
188. Corbula sematensis Yok.	..	..	..	..	..	+	..	
189. Corbula pygmæa Yok.	+	..	..	+	+	..	..	
190. Corbula substricta Yok.	..	..	..	..	..	+	..	
Family Myacidae.								
191. Cryptomya busoensis Yok.	+	..	+	..	..	..	..	Central Japan.
Family Mactridae.								
192. Mactra sulcataria Desh.	+	+	+	+	+	+	..	Northern to Southern Japan. North China, Possiet Bay.
193. Mactra veneriformis Desh.	+	..	..	..	+	..	+	Northern to Western Japan, North China.
194. Mactra ovalina Lam.	+	+	..	..	+	..	..	Central Japan, Puget Sound in British Columbia.
195. Mactra dunkeri Yok.	..	+	..	..	+	..	..	Central Japan.
196. Mactra sachalinensis Schr. var. imperialis Yok.	+	+	..	..	..	+	..	Typical form lives in North. and Cent. Japan.
197. Spisula grayana Schr.	..	..	..	..	..	+	..	North. Japan, Behring Sea, Massachusetts.
198. Spisula bernardi Pils.	..	..	..	+	..	+	..	Western Japan.
199. Raeta yokohamensis Pils.	+	+	+	..	+	..	..	Central Japan.
200. Raeta pellicula Desh.	+	..	..	..	..	..	..	Japan (Reeve).
201. Raeta elliptica Yok.	..	..	+	+	+	..	..	
202. Raeta magnifica Yok.	..	..	..	..	+	..	..	
203. Tresus nuttalli Conr.	+	+	..	..	+	+	..	North. to West. Japan, Alaska to San Diego. (Pliocene and Pleistocene of California).
204. Lutraria maxima Jon.	+	..	..	+	..	+	..	Western Japan.

	Otake.	Shisui	Kamenari	Kioroshi	Tega	Shito	Lower Musashino	LIVING
Family Solenidae.								
205. Solen grandis Dkr.	+	..	..	..	+	..	..	Central and Western Japan, Philippines.
206. Solen krusensternii Sch.	+	+	+	..	+	+	..	Northern Japan.
207. Siliqua pulchella Dkr.	+	..	..	..	+	..	..	Central and Western Japan.
208. Solecurtus divaricatus Lke.	+	..	..	..	+	+	..	Central and Western Japan.
Family Donacidae.								
209. Donax introradiatus Rve.	..	..	..	..	+	..	..	Central Japan.
Family Psammobiidae.								
210. Psammobia kazusensis Yok.	..	..	..	..	..	+	..	
211. Soletellina violacea Lam.	+	..	+	+	..	..	..	Northern to Western Japan. Philippines.
212. Soletellina olivacea Jay.	+	+	..	..	..	+	..	Northern to Western Japan, Cheefoo.
Family Tellinidae.								
213. Tellina jedoensis Lke.	+	..	..	..	+	..	..	Central and Western Japan.
214. Tellina venulosa Schr.	+	..	..	+	+	+	..	Northern Japan, Okhotsk Sea.
215. Tellina nitidula Dkr.	+	+	+	..	+	+	+	Central and Western Japan.
216. Tellina alternata Say. var. chibana Yok.	+	..	+	..	..	+	..	Central Japan.
217. Tellina ojiensis Tok.	+	..	..	..	..	..	+	Northern and Central Japan.
218. Tellina miyatensis Yok.	+	...	+	+	+	+	+	
219. Tellina delta Yok.	+	..	+	+	+	..	..	Central Japan.
220. Macoma prætexta Mart.	+	+	..	..	+	+	..	Central and Western Japan.
221. Macoma nipponica Tok.	+	+	+	..	+	+	..	Northern Japan.
222. Macoma inquinata Desh.	..	..	+	..	..	..	+	Okhotsk Sea to W. Japan, Alaska to San Diego. (Pliocene and Pleistocene of California).
223. Macoma dissimilis Mart.	+	..	..	..	+	..	..	Central Japan.
224. Macoma secta Conr.	+	..	..	..	+	..	..	Centr. and West. Japan, California. (Pliocene and Pleistocene of California.)
Family Veneridae.								
225. Dosinia troscheli Lke.	+	+	+	+	+	+	+	Central and Western Japan.
226. Dosinia bilunulata Gray.	+	..	..	..	..	..	..	Central Japan.
227. Cyclina chinensis Chem.	+	..	..	..	+	..	+	North. to West. Japan, Cochin China.
228. Lucinopsis divaricata Lke.	..	..	..	..	..	+	..	Central and Western Japan.
229. Meretrix meretrix Linné.	+	..	+	+	+	..	..	North. Japan to Moluccas.
230. Meretix chinensis Chem.	+	+	+	..	+	+	+	North. to West. Japan, China Sea, Australia.
231. Sunetta excavata Hanl.	+	..	+	+	+	..	..	N. to W. Japan, South Australia

	Otake	Shisui	Kamenari	Kioroshi	Tega	Shito	Lower Musashino	LIVING
232. Venus (Mercenaria) stimpsoni Gld.	+	+	..	..	..	+	..	Northern to Western Japan.
233. Venus jedoensis Lke.	+	..	..	+	+	..	+	Northern, Central and Western Japan.
234. Venus neastartoides Yok.	+	..	+	+	+	+	..	Central Japan.
235. Chione isabellina Phil.	+	+	..	..	+	..	+	Japan (Dunker), China Sea.
236. Chione mindanensis Sm.	..	..	..	..	..	+	..	Philippines (in depth of 52 fathoms).
237. Venerupis semipurpurea Dkr.	+	..	+	+	..	..	..	Northern to Western Japan.
238. Tapes euglyptus Phil.	..	..	..	+	..	..	..	Central and Western Japan.
239. Tapes philippinarum Ad. et Rve.	+	..	..	..	..	+	+	North. to West. Japan, Philippines.
240. Tap s variegatus Haul.	+	+	+	+	+	..	+	Central and Western Japan. Philippenes.
241. Saxidomus purpuratus Sow.	+	+	..	+	..	+	+	North. to West. Japan, Bonin I. Sitka to California, Chile.
Family Cardiidae.								
242. Cardium burchardi Dkr.	..	..	+	..	+	..	..	Central and Western Japan.
243. Cardium californiense Desh.	+	+	..	..	+	+	+	North. to West. Japan, Behring Sea. British Columbia. California.
244. Cardium muticum Rve.	+	+	+	..	+	..	+	Northern to Western Japan. Philippines, East Indies.
345. Cardium modestum Ad. et Rve.	..	..	..	..	..	+	+	C ntral Japan.
246. Cardium braunsi Tok.	+	..	..	..	+	+	+	
247. Cardium tokunagai Yok.	+	+	..	..	+	+	..	
Family Leptonidae.								
248. Montacuta japonica Yok.	+	+	..	..	..	+	..	Central Japan.
249. Montacuta oblongata Yok.	..	..	..	..	..	+	..	
250. Montacuta yamakawai Yok.	..	+	..	..	..	..	..	
251. Thyasira trigonata Yok.	..	..	..	..	..	+	..	
Family Diplodontidae.								
252. Diplodonta usta Gld.	+	+	..	+	+	+	+	Northern and Central Japan.
253. Diplodonta japonica Phil.	+	..	+	+	..	..	+	Central Japan.
254. Diplodonta semiaspera Phil.	+	+	..	..	+	+	+	Centr. and West. Japan, Mazatlan, West Indies, Patagonia.
Family Lucinidae.								
255. Lucina pisidium Dkr.	+	+	..	..	+	..	+	North. to South. Japan. New South Wales.
256. Lucina borealis L.	+	+	..	..	+	+	+	Centr. Japan. Iceland to Mediterranean. (Miocene to Glacial of Europe).
257. Lucina contraria Dkr.	+	..	+	+	+	..	+	Central Japan.

	Otake	Shisui	Kamenari	Kioroshi	Tega	Shito	Lower Musashino	LIVING
Family Chamidae.								
258. Chama semipurpurata Lke.	+	..	..	..	..	+	+	Central to Southern Japan.
Family Carditidae.								
259. Venericardia cipangoana Yok.	+	+	+	+	+	+	+	Central and Western Japan. (Fossil in Miocene of Hokkaido).
260. Venericardia ferruginea Ad.	+	..	+	..	..	+	+	Central Japan.
261. Venericardia toneana Yok.	+	..	..	..	+	+	..	
Family Astartidae								
262. Astarte borealis Chem.	..	..	..	..	..	+	..	North. Japan. Arctic Seas. Britain.(Fossil in English Crag.)
263. Astarte hakodatensis Yok.	..	..	..	..	..	+	..	Northern Japan.
Family Crassatellidae.								
264. Crassatella oblongata Yok.	..	..	..	..	..	+	+	
265. Crassatella kioroshiana Yok.	..	..	..	+	..	..	..	
266. Crassatella heteroglypta Pils.	..	..	..	+	..	..	..	Central and Western Japan.
Family Cyrenidae.								
267. Corbicula sandaiformis Yok.	+	..	+	..	..	+	..	Central Japan.
268. Corbicula kobelti Yok.	+	..	..	..	..	+	..	Central Japan.
Family Pleurophoridae.								
269. Coralliophaga corallicphaga Chem.	..	..	..	..	..	+	..	Central and Western Japan. Red Sea. W. Indies.
270. Trapezium nipponicum Yok.	+	..	..	..	..	..	..	Central and Western Japan.
271. Trapezium ventricosum Yok.	+	..	..	..	..	..	..	
272. Trapezium liratum Rve.	+	..	..	..	..	..	..	Central Japan.
Family Cuspidariidae.								
273. Cuspidaria ligula Yok.	..	..	..	..	..	+	..	
Family Lyonsiidae.								
274. Lyonsia prætenuis Dkr.	+	..	..	..	..	..	..	Western Japan.
275. Entodesma naviculoides Yok.	..	..	..	..	..	+	..	
Family Myochamidae.								
276. Myodora fluctuosa Gld.	+	+	+	+	+	+	..	Western Japan.
277. Myodora reeviana Sm.	+	+	..	..	..	+	+	Western Japan, China.
Family Thraciidae.								
278. Thracia papyracea Poli.	+	..	+	..	..	..	..	Norway to Mediterranean.

	Otake	Shisui	Kamenari	Kioroshi	Tega	Shito	Lower Musashino	LIVING
279. Thracia transmontana Yok.	+	..	+	..	+	+	..	Central Japan.
280. Thracia sematana Yok.	..	..	..	..	..	+	..	
Family Poromyidae.								
281. Poromya flexuosa Yok.	..	..	..	..	..	+	..	
Family Mytilidae.								
282. Modiola barbata L.	+	..	..	..	+	+	..	Northern to Western Japan. Mediterranean Sea. (Fossil in English Crag).
283. Modiola modiolus L.	..	..	..	..	..	+	+	Northern to Western Japan. North Atlantic. (Pliocene of Europe).
284. Lithophaga zitteliana Dkr.	+	..	..	..	..	..	..	Western Japan.
285. Crenella divaricata Yok.	..	..	..	..	.	+	..	Central Japan.
Family Anomiidae.								
286. Anomia nipponensis Yok.	+	..	+	+	+	+	+	Northern, Central and Western Japan.
287. Anomia lunula Yok.	+	..	..	+	..	+	..	
288. Anomia sematana Yok.	..	..	..	..	..	+	..	
Family Limidae.								
289. Lima angulata Sow.	+	+	..	..	+	+	+	Northern and Central Japan. Philippines, Panama, New South Wales.
290. Lima subauriculata Mont.	+	+	..	..	+	+	+	Greenland to Mediterranean Sea. (Fossil in Miocene and Pliocene of Europe.)
291. Lima quantoensis Yok.	..	..	..	..	..	+	+	Central Japan.
292. Lima vulgatula Yok.	..	..	..	..	..	+	..	
Family Spondylidae.								
293. Spondylus cruentus Lke.	+	..	..	..	..	..	..	Central and Western Japan.
294. Plicatula cuneata Dkr.	..	..	+	..	..	..	..	Central and Western Japan.
Family Pectinidae.								
295. Pecten squamatus Gm.	+	..	..	..	+	..	+	Central and Western Japan. Philippines.
296. Pecten lætus Gould.	+	..	..	..	+	+	+	Northern, Central and Western Japan.
297. Pecten subplicatus Sow.	..	..	..	+	..	..	..	Western Japan. Philippines, Moluccas.
298. Pecten crassicostatus Sow.	..	..	..	..	..	+	+	Central to Southern Japan.
299. Pecten vesiculosus Dkr.	..	..	..	..	..	+	+	Central Japan.

	Otake	Shisui	Kamenari	Kioroshi	Tega	Shito	Lower Musashino	LIVING
300. Pecten intuscostatus Yok.	..	..	..	..	..	+	+	
301. Pecten tokyoensis Tok.	+	..	..	..	..	+	+	
302. Pecten tissoti Bern.	..	..	..	..	..	+	..	Japan (Dunker).
303. Pecten laqueatus Sow.	+	+	+	+	+	+	+	Northern, Central and Western Japan.
304. Pecten excavatus Ant.	+	..	..	..	+	+	..	North. and Centr. Japan, China Sea.
305. Pecten tenuicostulatus Yok.	..	..	..	..	..	+	..	
Family Ostreidae.								
306. Ostrea gigas Thunb.	+	+	+	+	+	+	+	Northern, Central and Western Japan. Coast of Manchuria and Shantung
307. Ostrea denselamellosa Lke.	+	..	..	..	..	..	+	Northern to Southern Japan.
308. Ostrea musashiana Yok.	+	..	..	..	..	+	+	
Family Pinnidae.								
309. Pinna japonica Hanl.	..	..	..	..	..	+	..	Central and Western Japan.
Family Arcidae.								
310. Arca kobeltiana Pils.	+	..	..	..	..	+	+	Northern and Central Japan.
311. Arca symmetrica Rve.	+	..	..	..	..	..	+	Central Japan to Philippines.
312. Arca (Anomalocardia) granosa L.	+	+	+	..	+	+	..	Central Japan to Philippines.
313. Arca (Anomalocardia) inflata Rve.	+	+	..	..	..	+	..	Northern Japan to Philippines.
314. Arca (Scapharca) subcrenata Lke.	+	+	+	+	+	+	..	Central, Western and Southern Japan.
315. Pectunculus albolineatus Lke.	+	..	..	..	..	..	..	Central Japan.
316. Pectunculus vestitus Dkr.	+	..	+	+	+	..	+	Central Japan.
317. Pectunculus yessoensis Sow.	+	+	+	+	+	+	+	Northern Japan.
318. Pectunculus pilsbryi Yok.	..	..	..	..	..	+	+	
319. Pectunculus yamakawai Yok.	..	..	..	..	..	+	..	Central Japan.
Family Parallelodontidae.								
320. Parallelodon obliquatus Yok.	..	..	..	..	..	+	+	Northern and Central Japan.
321. Cucullaria orientalis Yok.	..	..	..	..	..	+	..	
Family Limopsidae.								
322. Limopsis woodwardi Ad.	+	..	..	..	+	..	..	Central Japan.
323. Limopsis crenata Ad.	+	..	..	..	..	..	+	Northern, Central and Western Japan.
324 Limopsis azumana Yok.	+	..	..	..	..	+	+	

	Otake	Shisui	Kamenari	Kioroshi	Tega	Shito	Lower Musashino	LIVING
325. Limopsis adamsiana Yok.	..	..	..	..	..	+	+	
326. Limopsis areolata Yok.	..	..	..	..	..	+	..	
327. Limopsis nipponica Yok.	..	..	..	+	..	+	..	
Family Ledidæ.								
328. Leda confusa Hanl.	..	+	+	..	+	+	..	Central Japan.
329. Leda ramsayi Sm.	..	..	..	..	..	+	+	New South Wales (at 950 fath.)
330. Yoldia notabilis Yok.	+	+	..	..	..	..	..	
Family Nuculidæ.								
331. Nucula insignis Ad.	+	+	..	..	..	+	+	Northern Japan.
MOLLUSCOIDEA.								
Brachiopoda.								
Family Terebratulidæ.								
332. Terebratella coreanica A. et R.	..	..	..	..	..	+	+	Northern, Central and Western Japan.
333. Terebratella pulvinata Gld.	..	..	..	..	..	+	+	Puget Sound, Washington.
334. Eudesia grayi Dav.	..	..	..	..	..	+	..	Northern, Central and Western Japan, California.
Family Rhynchonellidæ.								
335. Rhynchonella psittacea Chem. var. woodwardi Ad.	..	..	..	..	..	+	..	Northern to Western Japan.

The number of species yielded by each locality is as follows :

Ōtake	196 of which	164 or 83.6% are found in one or more of the other localities.
Shisui	81 of which	74 or 91.0% are found in one or more of the other localities.
Kamenari	56 of which	52 or 93.0% are found in one or more of the other localities.
Kioroshi	49 of which	44 or 90.0% are found in one or more of the other localities.
Tega	117 of which	99 or 84.6% are found in one or more of the other localities.
Shito	218 of which	192 or 88.0% are found in one or more of the other localities.

From this it is quite clear that the faunae of all the localities are very similar to one another. And this is what might be expected from the position of the shell-layer in which they were collected and which, seen from a geological point of view, can not be considered as representing more than a single horizon. And this horizon I propose to call *Manzakian* from the railway station of Manzaki[1] close to which the fossil locality of Ōtake lies.

1) Written Matsuzaki (松崎), but read *Manzaki.*

In the first place, the number of species which are not yet known to be living now, amount to 103, which make 30.7% of the whole fauna. But if we take into account 16 Pteropoda[1] already described by Yamakawa and Ishikawa from Semata-no-Seki in Shitō and which are all living, the above percentage becomes 29.3, which is a little more than one-fourth of the whole fauna. This percentage, though somewhat lower than that of the Lower Musashino (about 37%), must still be called a tolerably high one, if the overlying loam is really *Pleistocene* as is believed by many. Of course, as I have stated in the case of the Lower Musashino, also in this case, there is a possibility of the reduction of the above percentage by the discovery of so-called non-living forms as living. How far this reduction goes, it is at present impossible to say. Admitting, however, that it goes down to one-half which is very improbable, there still remain about 14.6% of non-living forms, making about one-seventh of the whole fauna. When we compare this percentage with those of the Crags of England, for instance with the 7% of the Norwich Crag and the 10% of the Red Crag which are both considered as Pliocene, I can not ascribe to the *Manzakian* an age younger than the *Uppermost Pliocene*. Sometimes the occurrence of *Elephas namadicus* Falc. et Cautl. is adduced against the Pliocene age of the layer. It is true that this elephant which was first discovered in the Narbada bed of India and subsequently also in China is usually considered Pleistocene.[2] But it must be remembered that it is still uncertain whether it is really distinct from *El. antiquus* Falc., a species which in Europe is not only *Lower Pleistocene*, but also *Upper Pliocene*. By so saying, however, I am far from denying the possibility of the layer being younger. I am only viewing the matter from the present

1) Some Pteropoda from the Neogene of Semata (Jour. Geol. Soc. Tokyo, vol. XIX, 1912). The described species are *Limacina inflata* (d'Orb.), Clio (Crescis) acicula Rang., *Clio (Crescis) virgula* Rang., *Clio (Styliola) subulata* Q. et G., *Clio pyramidata* L., *Clio cuspidata* (Bosc), *Clio balantium* (Rang.), *Curieria columella* (Rang.), *Cavolinia (Diacria) trispinosa* (Les.), *Cavolinia (Diacria) quadridentata* (Les.), *Cavolinia longirostris* (Les.), *Cavolinia globosa* (Rang.), *Carolinia gibbosa* (Rang.), *Cavolinia tridentata* (Foxsk.), *Cavolinia uncinata* (Rang.) and *Carolinia inflexa* (Les.), all found in Japanese waters except *Clio balantium* which occurs only more south.

2) Osborn seems to consider the Narbada bed Upper Pliocene. The Age of Mammals, p. 335.

state of our knowledge of its Molluscan fauna. For the layer to be *Pleistocene*, there must be some unmistakable evidence, and until that evidence is found, I deem it most expedient to assign to the layer a place in the *Upper Pliocene*.

Be the age as it may, there is an important fact which deserves our fullest attention. It is the general character of the fauna in relation to that of the recent as well as of the Lower Musashino from a climatic point of view. If we divide the living species, 232[1] in all, according to their habitat, we get the following result :

(1) Species now living only near the fossil localities (Central Japan)[2] or in about the same latitudes (Western Japan).........114.
Percentage of the whole fauna 49.1

(2) Species now living in Central or Western Japan as well as north of it (Northern Japan).......................................45.
Percentage of the whole fauna 19.4

(3) Species now living in Central or Western Japan as well as south of it (Southern Japan) ....29.
Percentage of the whole fauna 12.5

(4) Species now living in whole Japan (Northern-Southern) ....16.
Percentage of the whole fauna 6.9

(5) Species now living only in Northern Japan............14.
Percentage of the whole fauna 6.0

(6) Species now living only outside of Japan .... 8.
Percentage of the whole fauna 3.5

(7) Species whose habitat is not accurately known...... 6.
Percentage of the whole fauna 3.6

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1) The species which, though living, have been separated as varieties are not counted in this number. They are *Bela rugulata* Tr. var. *schneideri* Harm., *Pyramidella virgo* Ad. var. *brevis* Yok., *Macroschisma chinensis* Ad. var. *laevis* Yok., *Calliostoma unicum* Dkr. var. *shinagawensis* Tok. and *Mactra sachalinensis* Schr, var. *imperialis* Yok.

2) Japan, as in my previous paper, has been divided into four parts viz.: Northern, Central, Western, and Southern Japan. Northern Japan is that part of the country lying north of the 38th parallel north latitude, while Central Japan is the part lying south of the same parallel and east of 136° east longitude. Western Japan is the part west of the same longitude, including Chugoku, Shikoku, and Kyushu. Southern Japan is south of Kyushu including the Ryukyu Islands, Formosa and the Ogasawaras or Bonins.

It will be seen from the above that the species which form the main mass of the fauna are still living either near the fossil localities (Central Japan) or in the same latitudes more to the west (Western Japan). But among these forms, we have to distinguish those which live exclusively in Central or Western Japan from those which at the same time live either north (in Northern Japan) or south (in Southern Japan) of it. As might be expected, the forms which live exclusively in Central or Western Japan amount to about one-half (114 or about 50%), while those which live at the same time either north or south are much less (74 or 32%). But if we compare the forms which at the same time live north with those which at the same time live south, the former are considerably more in number (45 or 19.4%) than the latter (29 or 12.5%). Moreover, we must note that there are, besides, 14 species which at present are known only from Northern Japan. They are the following :

1. *Chrysodomus arthriticus* Val.
2. *Chrysodomus schrencki* Yok.
3. *Priene oregonensis* Redf.
4. *Puncturella nobilis* Ad.
5. *Panope generosa* Gld.
6. *Corbula venusta* Gld.
7. *Spisula grayana* Schr.
8. *Solen krusensternii* Schr.
9. *Tellina venulosa* Schr.
10. *Macoma nipponica* Tok.
11. *Astarte borealis* Chem.
12. *Astarte hakodatensis* Yok.
13. *Pectunculus yessoensis* Sow.
14. *Nucula insignis* Ad.

And among the foreign forms, there are also two which may be counted among the northern ones. They are *Terebratella pulvinata* Gld, of Puget Sound in Washington and *Leda ramsayi* Smith[1] of New South Wales, found at a depth of 950 fathoms. It

1) I was recently told that a form which is either identical with, or close to, this bivalve is found in Northern Japan.

is true that there are also two forms which are hitherto known only from tropical regions, namely : *Chione mindanensis* Smith of the Philippines and *Crassatella nana* Ad. et Rve. of Borneo. But these two can hardly have any weight on the sixteen northern forms which constitute about 7% of the whole fauna. From this we are obliged to infer that the waters on the Pacific side of Central Japan during the *Manzakian* time were somewhat *cooler* than at present. However, when we compare the northerly character of the Manzakian fauna with that of the Lower Musashino,[1] it is decidedly *less* marked, for the latter contains some 20% of the exclusively northern forms, and not a single one of the southern. This shows to a certainty that the waters of the Musashino Epoch which at one time[2] were tolerably *cold* became *less so* toward its end. And this must be called truly remarkable,[3] as in Europe just the opposite was the case. There, as is well known, the climate of the Pliocene time which on the whole was quite temperate became gradually cold toward its end, and in the succeeding Pleistocene it became so cold as to cause the so-called Ice-age.

What I have stated above are plain facts as revealed by the study of the Musashino fossils. Why things were so is at present difficult to say. But an opinion I have, and this opinion has already been advanced in my paper entitled "Climatic Changes in Japan since the Pliocene Epoch."[4]

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1) Fossils from the Miura Peninsula, p. 22.

2) Koshiba zone, Ibid. p. 24.

3) Still more remarkable is the occurrence of the so-called Coral-bed of Awa which I take for younger than the Upper Musashino, and perhaps also younger than the overlying loam. In this bed, as already pointed out in my "Climatic Changes," are found, besides large reef-building corals, Molluscan remains which contain several exclusively tropical forms together with several others not yet known to be living. These remains will form the subject of my next paper.

4) Jour. Sci. Coll., Imp. Univ. Tokyo, Vol. XXXII, Art. 5, 1911.

Description of the Species

Phylum **Mollusca.**

Class **GASTROPODA.**

Family **Actæonidæ.**

Genus **SOLIDULA.** Fischer von Waldheim.

1. ***Solidula strigosa*** (Gould).

Pl. I. Fig. 1.

Solidula strigosa. Pilsbry, Cat. Mar. Moll. Japan, p. 6. Tryon, Man. Conch., vol. XV, p. 137, pl. XXA, figs. 60, 61.
Buccinulus strigosus. Gould, Proc. Bost. Soc. Nat. Hist., VII, p. 141. Otia Conchologica, p. 114.
Tornatella strigosa. Lischke, Jap. Meeresconch., II, p. 104, pl. V, figs. 12, 13.
Buccinulus fraterculus. Dunker, Ind. Moll. Mar. Japon., p. 161, pl. XIII, figs. 21–23.
Solidula fratercula. Pilsbry, Cat. Mar. Moll. Jap., p. 6.

A small rather solid shell, ellipsoidal in form, and with whorls which number between five and six. The spire is short, being less than one-fourth the height of the shell. The surface-sculpture consists of fine, impressed and punctured, spiral lines which number four on the penultimate and about twenty-five on the ultimate whorl. A fine interstitial line is also present, most conspicuons on the lower half of the last whorl. Of the two columella-folds which are present, the upper is weak and simple, while the lower is strong and bilobed, the lobes being generally nearly equal in size.

All of the four specimens which were obtained are a trifle broader than those described by the above authors. The largest measures 11.7 millim. in height and 5 millim. in diameter.

The shell described by Dunker as *Buccinulus fraterculus* is surely identical with Gould's species.

Fossil occurrence :—Otake and Shito.

Living :—Central, Western and Southern Japan.

2. *Solidula clathrata*, Yokoyama.

Pl. I. Fig. 2.

Shell moderate in size, solid, ovately oblong. Whorls about seven, somewhat convex. Spire short and pointed, the body-whorl occupying about four-fifths the height of the shell. The sculpture consists of spiral sulci which number usually five on the upper whorls and twenty or more on the body-whorl. These sulci which are almost always narrower than the flat interspaces are finely latticed by raised lines of growth which, though prominent on the front-side of the body-whorl, are either indistinct or obsolete on its back-side and also on the upper whorls. Aperture long, equalling to almost two-thirds the height of the shell, widened and rounded in front, narrowed and acuminate behind. Columella-folds two; the upper weak and not prominent, the lower strong and bilobed, the lower lobe being weaker than the upper. Sutures subchanneled. Height 19.3 millim. Diameter 9.5 millim. Height of body-whorl 16 millim. Length of aperture 13 millim.

This species is closely related to the preceding, but it grows larger, and the sulci are latticed and not punctured. Also the aperture is not so produced, and the two lobes of the lower columella-fold are unequal in size.

Fossil occurrence:—Shito (only three specimens).

Genus **LEUCOTINA**, A. Adams.

3. *Leucotina gigantea*. (Dunker).

Pl. I. Fig. 3.

Leucotina gigantea. Pilsbry, Cat. Mar. Moll. Jap., p. 7. Tryon, Man. Conch., vol. XV, p. 167, pl. XVIII, figs. 92, 93.

Actæon giganteus. Dunker, Index Moll. Mar. Jap., p. 160, pl. II, fig. 59.

Tornatella gigantea. Tokunaga, Foss. Env. Tokyo, p. 31, pl. II, fig. 10.

Many specimens. The largest measures 29 millim. in height and 13 millim. in diameter. The whorls number eight with flat spiral ribs on them, ten on the penultimate and twenty two on the ultimate whorl. Under a lens the interspaces appear cross-striated, the direction of the striae coinciding with that of incremental lines. The outer lip is thin and sulcate within. The margin is crenulate.

Fossil occurrence :—Frequent at Shito, rarer at Otake. Also found at Oji and Shinagawa in Musashi.

Living.—Japan (Dunker).

Family **Tornatinidæ**.

Genur **TORNATINA**, A. Adams.

4. ***Tornatina exilis.*** Dunker.

Pl. I. Fig. 4.

Tornatina exilis. Dunker, Moll. Jap., p. 25, pl. II, fig. 14. Pilsbry, Cat. Mar. Moll. Jap., p. 7. Tryon, Man. Conch., XV, p. 190, pl, XXII, fig. 25. Tokunaga, Foss. Env. Tokyo, p. 31, pl. II, fig. 9. Brauns, Geol. Env. Tokio, p. 34. Yamakawa, Foss. Opisthobr. Diluv. Depos. Japan. (Journ. Geol. Soc. Tokyo. vol. XVIII) p. 40, pl. X, figs. 4–7.

This small shell has already been figured by Tokunaga and Yamakawa in the works above cited, the latter giving, morover, a full description of it.

Fossil occurrence.—Very frequent at Otake, rarer at Shisui, Tega and Shito. Also found at Oji and Shinagawa in Musashi.

Living.—Western Japan.

5. ***Tornatina longispirata.*** Yamakawa.

Pl. I. Fig. 5.

Tornatina longispirata. Yamakawa, Foss. Opisthobr. Dil. Dep. Jap. (Jour. Geol. Soc. Tokyo, vol, XVIII), p. 41, pl. X, figs. 8, 9, 10.

Tornatina longispirata var. otakensis. Yamakawa, loc. cit., p. 42, pl. X, figs. 11, 12, 13.

A full description of this species is found in the work of Yamakawa who distinguished a typical form and a variety, the former having five whorls and the latter four. Besides, he says that the spire in the variety is *more* pointed, which seems to be a mistake for *less* pointed. Anyhow I deem the separation unnecessary.

Fossil occurrence.—Rarely found at Otake and Tega.

Genus **RETUSA**, Broun.

6. ***Retusa globosa***, Yamakawa.

Pl. I. Fig. 6.

Retusa globosa. Yamakawa, Foss. Opisthobr. Dil. Dep. Jap., p. 43, pl. X, figs. 14–16.

Yamakawa gives the diagnosis of this species as follows :

"Shell small, subcylindrical, rather solid, mucronate above and obtuse below. Spire very short. Whorls four, the first one the most prominent, the second generally the shortest. Body-whorl long, almost as long as the shell. Surface with fine, almost obsolete lines of growth. Aperture narrow, linear, dilated below into an oval spathulate form without any fold on the columella. Lip curved forward. Wall of the aperture callous."

Some of our specimens have the aperture more produced in front than in the figure of Yamakawa. The height of the shell is about twice its diameter, or a little less. The largest specimen is only 3.5 millim. in height.

Fossil occurrence.—Rarely found at Otake, Shisui and Shito, and so also at Oji and Kurumacho (Shiba-quarter, Tokyō).

7. ***Retusa truncata***, Yamakawa.

Pl. I. Fig. 7.

Retusa truncata. Yamakawa, Foss. Opisthobr. (Jour. Geol. Soc. Tokyo, vol. XVIII). p. 44, pl. X, figs. 17–20.

This is a quite cylindrical shell, more slender than the preceding. The spire is hidden in a sunken pit, so that the shell-top appears truncated when seen sidewise. The whorls number four, with the surface smooth. The largest specimen measures 4.3 millim. in height and 2 millim. in diameter.

Fossil occurrence.—Rarely found at Otake and Shito. Yamakawa mentions it also from Oji in Musashi.

8. ***Retusa minima***, Yamakawa.

Retusa minima. Yamakawa, Foss. Opisthobr., p. 47, pl. XI, figs. 21–25. Yokoyama, Foss. Miura Penin., p. 26, pl. I, fig. 1.

This shell like the foregoing has its top truncate and the spire hidden in a pit. The diameter increases towards below or front, being smallest at about one-third the shell-height from the top and greatest near the middle or a little above it. The surface where the diameter is smallest appears slightly concave. The height of the largest specimen is 3 millim.

Fossil occurrence.—Otake and Shito (rare at both). Oji. Lower Musashino of Miyata and Naganuma Zones.

9. ***Volvula angustata.*** (A. Adams), var.

Pl. I. Fig. 8.

Volvula angustata. Pilsbry, Catalogue, p. 8. Tryon, Manual Conch., XV, p. 240, pl. XXVI, fig. 67.

Bulla angustata. A. Adams in Sowerby's Thes. Conch., II, p. 596, pl. CXXV, fig. 153.

A few specimens. The shape agrees well with the above mentioned species of Adams except the apex which is somewhat blunter in our fossil. This difference, however, can hardly be considered as more than a varietal one. The general shape of the shell is cylindrical, tapering slightly towards behind. The aperture is linear and much dilated in front. The outer lip is somewhat contracted in the middle.

Fossil occurrence.—Otake and Shito.

Living.—Northern Japan. Philippines. New Guinea.

10. ***Volvula acutæformis,*** Yokoyama.

Pl. I. Fig. 9.

Shell rather small, thin, fusiform, with apex ending in a blunt spine. The greatest diameter is in the middle of the shell. Aperture long, linear, dilated below and bordered on the inner side by an elevated margin somewhat bent outward. Height twice the diameter, or a trifle less. The largest specimen measures 5.5 millim. in height.

This species is quite like *Volvula minuta* Bush (Tryon, Man. Conch., XV, p. 237, pl. XXII, fig. 20, pl. XXVI, fig. 57) which is considered by Dall as identical with *Volvula acuta* d'Orbigny (not *Volvula acuta* Tokunaga, a species which I unite with *V. acuminata* Brug.). But the presence of the raised margin on the inner side of the apertural end and the larger size of the shell distinguish the Japanese fossil from the above mentioned living shell from America. *Volvula oxytata* Bush (Man. Conch., pl. XXVI, fig. 63), also a living American shell and allied to our fossil, is somewhat more slender.

Fossil occurrence.—Shito (frequent).

Family Scaphandridæ.

Genus CYLICHNA, Loven.

11. *Cylichna musashiensis*, Tokunaga.

Pl. I. Fig. 10.

Cylichna musashiensis. Tokunaga, Foss. Env. Tokyo, p. 32, pl. II, fig. 12. Yokoyama, Foss. Miura Penin., p. 27, pl. I, fig. 4.

Bulla cylindracea. Brauns, Geol. Env. Tokio, p. 35.

Although the shell-form is generally cylindrical, with the greatest diameter in its middle portion, there are rarely specimens which somewhat taper above. The height varies between 2.2 and 2.5 times the diameter. The transverse striations which Tokunaga omitted to mention are sometimes very distinct, especially on the lower portion of the shell. The largest example measures 16 millim. in height.

Fossil occurrence.—Otake, Shisui and Shito. Oji and Tabata in Musashi. Lower Musashino of Koshiba.

Living.—Central Japan.

Family Philinidæ.

Genus PHILINE. Ascanius.

12. *Philine scalpta*, A. Adams.

Pl. I. Fig. 11, 12.

Philine scalpta. A. Adams, Ann. Mag. Nat. Hist., 1862, vol. IX, p. 160. Lischke, Jap. Meeresconch., III, p. 76, pl. V, figs. 15, 16.

A thin shell oblong-ovate in form and longitudinally subplicate, with distant impressed spiral lines and a large aperture. It agrees quite well with the figures and descriptions given of Adams' species by Lischke.

We possess two specimens, about one (fig. 12) of which we are still in doubt whether it belongs here or not, on account of its bad state of preservation.

Fossil occurrence.—Shisui and Kioroshi (?).

Living.—Central and Western Japan.

13. *Philine pygmæa.* Yokoyama.

Pl. I. Fig 13.

Shell small, thin, roundly quadrate in outline. Spire none, the apex being somewhat sunken. Body-whorl large with its middle portion slightly excavated. Incremental lines distinct, crossing the dense, wavy punctate, impressed spiral lines. Height 4 millim. Breadth 3.5 millim.

This species is readily recognized by its small size and subquadrate shape.

Fossil occurrence.—Shisui (rare).

Living.—Central Japan.

14. *Philine takatensis.* Yokoyama.

Pl. V. Fig. 4.

Shell rather small, thin, swollen, oval in outline, with the anterior end sharper than the posterior. About fifteen distant elevated spiral riblets ornament the surface. Lines of growth numerous and distinct. Aperture very large, oval, with a broad and shallow notch at the place where it touches the coiled portion of the shell.

A single specimen measuring 8.4 millim. in height and 7.4 millim. in apertural breadth.

Fossil occurrence.—Shito.

Family **Bullidæ.**

Genus **BULLA**, Linne.

15. ***Bulla multiarata***, Yokoyama.

Pl. I. Fig. 14.

Shell small, moderately thick, oval. Spire sunken and with a small hole. Body-whorl inflated, ornamented with over thirty equidistant puncticulate impressed spiral lines. Aperture a little longer than the shell-height, narrowed above, dilated and rounded below. Umbilicus open as a small hole. Outer lip thin, the greater part running vertically downward, with only a slight curvature. Height 4 millim. Diameter 2 millim.

This is a nice little shell easily known by its puncticulate spiral lines.

Fossil occurrence.—Shito (rare).

16. ***Bulla ovula***, Sowerby.

Pl. I. Fig. 15.

Bulla ovula. Sowerby, Reeve's Conch. Icon., Bulla fig. 5.

Bulla vernicosa Gould var. *ovula.* Tryon, Man. Conch., XV, p. 349, pl. XXXVI, figs. 34, 35.

Bulla (*vernicosa* var ?) *ovulum.* Pilsbry, Catalogue, p. 10.

A single but perfect specimen.

The shell is oval in outline and smooth on surface. It measures 11 millim. in height and 7.5 millim. in diameter. In Tryon's Manual of Conchology above quoted, weak spiral grooves are mentioned as present on the inner side of the outer lip which, however, are absent in our fossil specimen.

Fossil occurrence.—Shisui.

Living.—Central, Western and Southern Japan (Ryukyu).

Family **Ringiculidæ**.

Genus **RINGICULA**, Deshayes.

17. ***Ringicula musashinoensis***. Yokoyama.

Pl. I. Figs. 16, 17.

Ringicula musashinoensis. Yokoyama, Foss. Miura Penin., p. 30, pl. I. Figs, 3. 8.
Ringicula arctata. Brauns, Geol. Env. Tokio, p. 30. Tokunaga, Foss. Env. Tokyo, p. 32, pl. II, fig. 11.

That this shell is not *Ringicula arctata* Gould as asserted by Brauns and Tokunaga has already been explained in my work above cited. I have here to add that there are specimens (pl. I. figs. 16, 17) which have the outer lip not so thickened as in the typical ones, so that they approach in this respect *Ringicula doliaris* Gould living in our seas, (Tryon's Manual, XV, p. 403. pl. VII. figs, 82, 83). But these are connected with the typical form by intermediate forms and differ from *R. doliaris* by the more abruptly sloping body-whorl below the suture. The spiral lines of the surface which are generally distinct may often become obsolete.

Fossil occurrence.—Otake (very numerous), Shisui, Tega, Kioroshi, Shito (numerous). Also Oji, Shinagawa and Tabata in Musashi. Lower Musashino of Miyata, Yokosuka and Naganuma.

Living.—Central Japan.

Family **Terebridæ**.

Genus **TEREBRA**, Adanson.

18. ***Terebra lischkeana***. Dunker.

Terebra lischkeana. Dunker, Index Moll. Mar. Jap., p. 71, pl. V. figs. 13–16. Pilsbry, Catalogue, p. 12. Tryon, Man. Conch., VII, p. 37, pl. XII, fig. 22. Yokoyama, Foss. Miura Penin., p. 31, pl. I, fig. 10.

A few young specimens, the largest of which attains the height of 30 millim.

Fossil occurrence.—Otake and Shito. Lower Musashino of Miyata.

Living.—Central and Western Japan.

19. *Terebra gotoensis*, Smith.

Pl. I. Fig. 18.

Terebra gotoensis. Smith, Proc. Zool. Soc. London, 1879, p. 183, pl. XIX, figs. 1, 1a. Pilsbry, Catalogue, p. 12. Dunker, Index Moll., p. 73.

Terebra alveolata Hinds var. *gotoensis*, Tryon, Man. Conch., vol. VII, p. 23, pl. V, figs. 85, 91.

Shell subulate. Whorls about seventeen, flat, slightly concave on the upper third, longitudinally weakly plicate. Plicae numerous, close together, about twenty-six on the body-whorl, somewhat sinuous, vertical at the upper end, then bending backward and then forward, the lower end being directed obliquely forward. Periphery obtusely angulate, with the base abruptly contracted, the angle formed at the periphery being about 130°. Base smooth, with coarse lines of growth only. Aperture subrhombic. Canal short and curved.

There are two specimens, both of which are not quite perfect. The height is about 20 millim. and the diameter 5 millim.

Tryon's opinion that *Terebra gotoensis* is only a variety of *Terebra alveolata* Hinds, a species living in the Strait of Malacca, I am at present unable to confirm. What Tokunaga calls *Terebra alveolata* Hinds (Foss. Env. Tokyo, pl. I, fig. 17) seems to be a quite different shell.

Fossil occurrence.—Otake.

Living.—Western Japan.

20. *Terebra hedleyi*, Pilsbry.

Pl. I. Fig. 19.

Terebra hedleyi. Pilsbry, New Jap. Mar. Moll., Gastropoda (Proc. Acad. Nat. Sci. Philad., Jan., 1904) p. 3, pl. I, figs. 1, 1a.

The shell is subulate with about fifteen flat whorls of which one and a half are embryonal and smooth ; the remaining whorls are ornamented with flat spiral cords whose first or uppermost is the broadest, occupying about one-third of a whorl and is tuberculate, the tubercles being distinct on the upper whorls and indistinct or obsolete on the lower. The second cord is somewhat narrower than the first and weakly tuberculate only on the upper whorls. The third cord is about as broad as the second, and on the whorls near the body-whorl often splits into two by an impressed spiral line which appears in the middle of the cord. The three further cords which are still present are narrower. The impressed spiral lines separating the above cords are punctate. The base of the shell is contracted quite abruptly, giving rise to a bluntly anguiate periphery.

Pilsbry in describing his specimens states that the height is more than five times the diameter. In the four examples which were obtained, it is only four times and a half. The largest example measures 30 millim. in height.

Fossil occurrence.—Otake.

Living.—Central and Western Japan.

21. ***Terebra recticostata***, Yokoyama.

Terebra recticostata. Yokoyama, Foss. Miura Penin., p, 32, pl. I. fig. 11.

A single specimen, 23 millim. in height and 5.5 millim. in diameter. The ribs are not so sharp and strong as in the specimens found in the Lower Musashino.

Fossil occurrence.—Shisui. Lower Musashino of Naganuma.

22. ***Terebra chibana***. Yokoyama.

Pl. I. Fig. 20.

Shell subulate. Whorls about fifteen, slightly concave on the upper third and a trifle convex on the lower two-thirds, longitudinally plicate and spirally striated. Plicæ often weak and indistinct, about twelve on the penultimate whorl and somewhat curved with the concave side towards front. Spiral striae about six in number, with the uppermost at a little distance from the suture and provided with a small tubercle at the point of intersection with the plicae and separated from others by a wide smooth space occupying the concave portion of the whorls. Of the remaining five striae, the third is the most conspicuous, being found on the most convex portion of the whorls ; the lowest one is close to the suture. These striae are often very indistinct on the upper whorls. Periphery rounded. Base rather abruptly narrowed below, usually with two spiral striae on its surface. Aperture subrhombic. Canal short, bent a little backward. Height 24 millim. Diameter 5.5 millim. Length of aperture 5.5 millim.

Fossil occurrence.—Shito (numerous) and Otake.

23. ***Terebra smithi*** Yokoyama.

Pl. I. Fig. 21.

Shell subulate. Whorls about seventeen, flattish, longitudinally costulate and spirally striate. Costulae about twenty on the penultimate whorl, more or less roof-shaped, interrupted by a shallow spiral groove running a little above the middle of the whorls, the part above the groove being somewhat in advance of the part below the same. The groove is more or less indistinct on the upper whorls. The interspaces between the costulae are furnished with very fine spiral striations, some of which on the lower whorls may grow into coarser ones. These coarser ones in crossing the costulae make them tubercular. On the penultimate whorl there are two such coarser threads above the groove and three below it, while on the body-whorl there are four between the groove and the periphery, and about as many on the base. Periphery rounded. Aperture subrhombic. Outer lip thin and sharp. Canal very short, somewhat recurved. Height 36 millim. Diameter 8 millim.

Only a single specimen. This species is still living in our seas, attaining a height of 80 millim. It is brown-coloured when fresh.

I doubt if this is not the shell called *Terebra granulosa* by Smith in the Annals and Magazines of Natural History of 1873 (p. 268), a name afterwards changed by the author himself into *Terebra pustulosa* (Proc. Zool. Soc. London, 1879, p. 186). Unfortunately the shell has never been figured.

Fossil occurrence.—Otake.

Living.—Central Japan.

24. ***Terebra quadriarata***, Yokoyama.

Pl. I. Fig. 22.

Shell subulate, tolerably solid. Whorls many (more than thirteen), nearly flat, ornamented with four impressed spiral lines. The uppermost line is found at some distance from the upper suture, equalling about one-third of a whorl, while the second is nearly in its middle. The two remaining ones are on the lower half of the whorls, the distance between the second and the third being generally greater than that between the third and the fourth. Periphery rounded. Base abruptly narrowed. Canal short and recurved. The apex as well as the outer lip is broken. The shell, if perfect, would measure about 30 millim. in height. The diameter is 6.5 millim.

Fossil.—Shito (rare).

25. ***Terebra latisulcata***, Yokoyama.

Pl. I. Fig. 23.

Shell subulate. Whorls about thirteen, with a subsutural row of weak distant tubercles numbering about twelve on the penultimate whorl. Below this row of tubercles there is a broad shallow groove with a deeply impressed line at its bottom which, however, may be either indistinct or wholly obsolete. Below the groove the surface is somewhat convex and longitudinally weakly plicate, the number of plicae being generally equal to that of the tubercles above the groove. Each of these plicae begins at the top with the tubercle just mentioned, is flatly roof-shaped, often so flat as to become indistinct or even obsolete. Periphery rounded. Base abruptly narrowed, with faint indications of longitudinal plicae only. Sutures deep. Aperture subrhombic. Canal short, bent somewhat backward. Height 30 millim. Diameter 6 millim.

Fossil occurrence.—Shito (rare).

26. *Terebra suaridica*, Yokoyama.

Pl. I. Fig. 24.

Shell turrete. Whorls about eleven, the first two smooth and rounded, the following slightly convex and longitudinally weakly plicate on the upper whorls, the plicae generally disappearing on the lower ones. Usually there is a somewhat depressed spiral area in the upper part of the whorls dividing the plicae into two very unequal parts, of which the upper often looks like an elongated tubercle (found just below the suture). Periphery rounded. Base rather abruptly narrowed, convex, generally only with coarse flexuous lines of growth. Inner lip broadly angulate, making the aperture look four-sided. Canal very short, somewhat recurved. Height 22 millim. Diameter 6 millim.

This shell resembles the preceding in sculpture, but is not so subulate in shape.

Fossil occurrence.—Shito (frequent).

27. *Terebra tsuboiana*, Yokoyama.

Pl. XIII. Fig. 12, 13.

Shell subulate, large. Whorls about sixteen, the upper two-fifths flat, the lower three-fifths slightly convex, longitudinally plicate and spirally threaded. Plicae generally weak, numerous, equal or unequal, sometimes indistinct, oblique on the flat portion of the whorls, nearly vertical below, varying in number (up to thirty on the body-whorl). Spiral threads more or less unequal, often fine and indistinct, also varying in number ; but there is invariably a coarse one at the boundary between the flat and convex portions of the whorls. Above this thread there are two, the one just below the suture and the other midway between it and the boundary one. The latter is somewhat elevated, the surface above as well as below it appearing a trifle excavated. Below the boundary-thread, there are several finer ones which may be close and many, or distant and few. The intersection-points between the threads and plicae are always more or less tuberculous. The body-whorl has the periphery rounded, and the base quickly narrowed and covered with several spiral tubercular threads down to near the caudal end where there is a sharp spiral ridge bounded behind by a broad groove. Aperture elongated, angulate behind and widened in front. Canal very short, recurved. The largest of the three specimens obtained measures 62.5 millim. in height and 13.5 millim. in diameter.

This species is still living, the specimens obtained near Kamakura attaining a somewhat larger size than the fossil. Contrary to the great inconstancy of the surface-sculpture, the shape seems to be tolerably fixed. The colour is dusky brown.

Fossil occurrence.—Kioroshi, Shito.

Living.—Central Japan.

Genus **PARVITEREBRA**, Pilsbry.

28. ***Parviterebra varitans***, Yokoyama.

Pl. I. Fig. 25.

Shell small, solid, lanceolate. Whorls about seven, the first two smooth and rounded, the remaining very little convex and longitudinally weakly plicate. Plicae nearly straight, numerous about twenty on the penultimate whorl, indistinct or obsolete on the body-whorl. There are also impressed spiral lines numbering a little over ten on the penultimate whorl. Body-whorl very large higher than the spire and with the spiral lines down to the caudal end. Aperture elongated, acuminate behind and truncate in front. Inner lip covered with a callus. Outer lip rather sharp. Height 8 millim. Diameter 2.2 millim. Height of body-whorl 4 millim. Length of aperture 2.3 millim.

Parviterebra paucivolvis Pilsbry (New Jap. Mar. Moll., Gastr., Proc. Acad. Nat. Sci. Philad., Jan., 1904, p. 5, pl. I, fig. 4) from Southern Kyushu is somewhat like the present species. But in the former the shell as well as the aperture is longer and the callus of the inner lip absent.

Fossil occurrence.—Otake (rare).

Family Pleurotomidæ.

Genus **PLEUROTOMA**, Lamarck.

29. ***Pleurotoma vertebrata***, Smith.

Pl. I. Fig. 26.

Pleurotoma vertebrata. Smith, Ann. Mag. Nat. Hist., 1875. p. 416. Proc. Zool. Soc. London, 1879, p. 186, pl. XIX, fig. 6a. Pilsbry, Catalogue, p. 15. Tokunaga, Foss. Env. Tokyo, p. 13, pl. I, fig. 22. Chemnitz and Martini, Conch. Cab., IV, pt. 3, p. 31.

The shell is quite characteristic by its fusiform shape and angulate whorls, the angle being a little below their middle. The sculpture consists only of spiral threads large and small, the large ones being one at the angle, one above the suture and one below it. The sinus is somewhat distant from the suture, deep, very wide at mouth, and much narrowed and rounded at bottom. The largest specimen obtained is 32 millim. high and 10 millim. broad. Tryon unites this species with *Pleurotoma violacea* Hinds (Man. Conch., vol. VI, p. 169) of the South Sea.

Fossil occurrence.—Otake, Shisui, Kamenari and Shito. Rather rare at all the above localities, though frequent at Oji in Musashi.

Living.—Central and Western Japan.

Genus **GENOTIA**, H. and A. Adams.

30. ***Genotia pseudopannus***, Yokoyama.

Pl. I. Figs. 27, 28?

Shell moderately thick, subfusiform. Whorls seven and a half, the first two and a half smooth and rounded, the remaining somewhat shouldered, the surface above the shoulder steeply sloping and slightly excavated, below vertical and a little convex. The sculpture consists of longitudinal plicæ and spiral grooves. The plicae are obtuse and broad, wider than the interspaces and about twenty on the penultimate whorl, while on the body-whorl they are almost obsolete. As to the spiral grooves, there are two of them below the shoulder, one of which is close to it and the other near the lower suture. Besides the grooves, there are also very fine impressed spiral lines on other parts of the whorls. Body-whorl somewhat higher than the spire, convex (the shoulder indistinct) and furnished with more than ten grooves below the two above mentioned, their breadth gradually growing as they get downward. Aperture longly oval, pointed behind. Inner lip with a thin callus, distinctly bounded toward outside and with a faint indication of an oblique fold. Outer lip thin, with a wide and shallow notch at a little distance from the suture. Height 17 millim. Diameter 6 millim.

This shell is not unlike the one described as *Oligotoma pannus* (Basterot) (Harmer, Plioc. Moll. Grt. Brit., II, Pal. Soc., vol. LXVIII, p. 215, pl. XXVII, figs. 8-11) from the English Crag and also from the French and Italian Miocene, but the whorls in the latter are nearly flat, with a columellar fold on the inner lip.

Fossil occurrence.—Otake (only a single specimen). There is a specimen (fig. 28) from Semata, Shito showing a similar sculpture, but more slender in form. It may possibly be only a variety to which I intend to give the name of var. *sematensis*, if it should prove hereafter to be such.

31. ***Genotia ogurana***, Yokoyama.

Pl. I. Fig. 29.

Shell moderately thick, fusiform. Whorls about seven and a half, the first two embryonal, smooth and rounded, the remaining somewhat concave on the upper half and slightly convex on the lower, and ornamented with longitudinal as well as with spiral sculptures. The longitudinal sculpture consists of plicae bent in the middle with the concave side toward the front; these plicae are about twenty-seven in number on the penultimate whorl, broad and obtuse, not quite equidistant and more or less unequal, though generally wider than the interspaces, and on the last two whorls interrupted by a concave surface below the suture. The spiral sculpture is divisible into striae and sulci., the former being on the upper half of the whorls and the latter on their lower half. The striae are many, fine and close, while the sulci are generally very narrow and line-like, number three as a rule and are rather distant. Body-whorl about twice as long as spire. Periphery rounded. Base gradually tapering toward its caudal end. The plicae on the body-whorl become evanescent on the base, while the spiral sulci are many, cover the whole surface and are broadest near the middle of the base where they are wider than the interspaces. Sutures subchannelled. Aperture elongated, angular behind. Inner lip with a thin callus. Outer lip sharp, receding both above and below with the sinus shallow and wide, and distant from the suture. Canal short, straight. Height 15 millim. Diameter 6 millim.

A single specimen.

This shell looks very much like the preceding, but on a closer examination, there are many minor distinctions, especially in the sculpture.

Fossil occurrence.—Otake.

Genus **DRILLIA**, Gray.

32. ***Drillia principalis***, Pilsbry.

Drillia principalis. Pilsbry, Catalogue p. 17, pl. II, figs. 9, 10.

Pleurotoma (Drillia) principalis. Tokunaga, Foss. Env. Tokyo, p. 14, pl. I, fig. 13. Yokoyama, Foss. Miura Penin., p. 36, pl. I. fig. 20.

This species has already been described by Tokunaga and myself in the works above quoted, the fuller description, however, being found in Pilsbry's catalogue also above mentioned. It is not found at many places, but where found, it is rather frequent.

Fossil occurrence.—Otake and Tega. Also Oji and Shinagawa in Musashi. Lower Musashino of Koshiba and Naganuma.

Living.—Northern, Central and Western Japan.

33. ***Drillia subauriformis***, Smith.

Pl. I. Fig. 30.

Drillia subauriformis. Pilsbry, Cat., p. 18. Tryon, Man. Conch., VI, p. 207, pl. 12, fig. 35. Dunker, Index Moll., p. 24, pl. IV, figs. 5-7. Smith, Proc. Zool. Soc. London, 1879, p. 195, pl. XIX, fig. 23.

Pleurotoma (*Drillia*) *subauriformis.* Tokunaga, Foss. Env. Tokyo, p. 14, pl. I, fig. 24.

This is a pretty little shell with about ten convex whorls, longitudinally ribbed and spirally striate. The ribs are about eighteen on the penultimate whorl, although sometimes less. The spiral striae are six on the penultimate and one less on a whorl preceding it. The outer lip is thickened by the last rib. Height 12 millim. Diameter 3.6 millim. Rare.

Fossil occurrence.—Otake and Kamenari. Also Oji in Musashi.

Living.—Central and Western Japan.

34. ***Drillia glabriuscula***, Yokoyama.

Pl. I. Figs. 31, 32.

Shell small, turrete. Whorls about nine, the first smooth and mammillated, the second also smooth and rounded, the remaining a little concave just below the sutures and somewhat convex on the lower portion. The sculpture is made up of longitudinal costulae and spiral striae. The costulae are generally present only on the upper whorls, about twelve on the whorl preceding the penultimate, broad, low, rounded, oblique and wider than the intervals. The spiral striae are about four in number, equally distributed and often indistinct. Now and then there is an interstitial stria. Periphery rounded. Base gradually tapering downward, covered with spiral threads. Aperture elongated, narrow, with a short straight canal. Outer lip thin, with a deep and rather wide sinus just below the suture. Inner lip with a thin callus.

The sculpture is often indistinct, and there are even specimens in which the lower whorls are entirely devoid of it. Sometimes the base narrows rather abruptly downward.

Frequent. The largest specimen measures 18 millim. in height and 4.8 millim. in diameter.

Besides the typical form just described, there is a shorter one (fig. 32) with a less number of whorls and the canal usually somewhat wider. I consider this merely as a variety, for which I propose the name of *brevis*.

Fossil occurrence.—Shito.

Genus **MANGILIA**, Risso.

35. ***Mangilia deshayesii***, Dunker.

Mangilia deshayesii. Dunker, Moll. Japon., p 3, pl. I, fig. 3. Pilsbry, Catalogue, p. 19. Tryon, Man. Conch., VI, p. 256, pl. XXII, fig. 71.

Pleurotoma (Mangilia) deshayesii. Yokoyama, Foss. Miura Penin., p. 41, pl. I, fig. 24.

A few specimens. The description of the shell is given in my work above referred to.

Fossil occurrence.—Otake and Tega. Oji (frequent). Lower Musashino of Koshiba.

Living.—Central and Western Japan.

36. ***Mangilia ojiensis***, (Tokunaga).

Pl. I. Fig. 33.

Pleurotoma ojiensis. Tokunaga, Foss. Env. Tokyo, p. 15, pl. I, fig. 28.

Shell small, rather solid. Whorls seven of which five are post-nuclear, convex, somewhat angulate a little above the middle, with the surface above the angle steeply sloping. The sculpture consists of longitudinal ribs and spiral striae. The ribs are about fifteen on the penultimate whorl, perpendicular to the suture above the angle, somewhat oblique below with the upper end directed somewhat forward, obtuse, much narrower than the interspaces. Spiral striae fine, numerous, more or less unequal, often indistinct. On the body-whorl the longitudinal ribs vanish toward the base, while the spiral striae are quite distinct. Periphery rounded. Aperture fusiform, pointed behind, truncate in front, with a very short straight canal. Outer lip varicose without. Sinus very shallow, obtuse-angled at bottom. Height 10 millim. Diameter 5.5 millim.

In general, the shoulder-angle is most conspicuous in the specimens with sharp sculptures, while in those with fainter ones it is more or less rounded. A few specimens found at Shito show the latter character.

Fossil occurrence.—Shito. Oji (numerous).

37. ***Mangilia fukuchiana***, Yokoyama.

Pl. I. Fig. 34.

Shell small, tolerably solid, subfusiform. Whorls about eight, the first two smooth and rounded, the remaining obtusely subangulate a little below the middle with the surface above the angle flat and obliquely sloping, below nearly vertical. The sculpture consists of longitudinal ribs and spiral striae. Ribs about eight in number, rounded, oblique, somewhat curved with the concave side towards the front, separated by intervals of a nearly equal breadth. Spiral striae fine, numerous, close together, rather indistinct (seen only with a lens). Body-whorl somewhat longer than spire, rounded, rather gradually tapering anteriorly, with the ribs evanescent on the base. Aperture ovate, posteriorly acute, anteriorly truncate, with a broad, hardly developed canal. Inner lip varicose without. Lip-sinus moderate in depth. A single specimen, 65 millim. in height and 4 millim. in diameter.

Fossil occurrence.—Otake.

Living.—Central Japan.

38. ***Mangilia (Cythara) rugosolabiata***, Yokoyama.

Pl. I. Fig. 35.

Shell small, rather solid, fusiform. Whorls eight and a half, the first two and a half smooth and rounded, the remaining bluntly angulate a little below the middle, with the surface above the angle slightly concave and steeply sloping, below flat and nearly vertical. Longitudinally ribbed and spirally striate. Ribs eight on the penultimate whorl, coarse, blunt, somewhat curved above the angle, straight and vertical below, separated by much wider interspaces, sometimes indistinct or obsolete on the body-whorl. Spiral striae very fine, only visible with a lens by a good reflection of light. Body-whorl longer than spire. Periphery rounded. Base gradually tapering towards the front and usually with the whorl-ribs continuing into it. Aperture elongated, acute behind. Canal short, straight. Inner lip with a reflexed callus on which there are seven to nine unequal, distant, transverse striae or ridges which are most distinct on the lower half of the lip. Outer lip varicose without, transversely dentate within. Lip-sinus rather shallow, cut into the concave surface above the angle and a little below the suture. Height 12 millim. Diameter 3.5 millim. Rather rare.

Fossil occurrence.—Otake.

39. ***Mangilia* (*Cythara*) *oyuana*,** Yokoyama.

Pl. I. Fig. 36.

Shell small, subfusiform. Whorls eight, the first two smooth and rounded ; of the remaining ones, the younger are subangulate, while the older are convex. The sculpture consists of longitudinal ribs and spiral striae. Ribs eleven on the penultimate whorl, strong, somewhat oblique and curved, obtuse, a little narrower than interspaces. Spiral striae three, the uppermost in the middle of the whorls, the lowest close to the suture and indistinct on the whorls preceding the penultimate. Besides these striae there are also many very fine spiral lines on the upper half of the whorls, only visible with a strong lens. Body-whorl a little longer than spire, with periphery rounded and furnished with more than ten spiral striae. The ribs on the base are nearly vertical. Aperture elongated with a short straight canal. Inner lip with a callus on which there are three teeth, the one which is blunt near the posterior end and the other two (the upper coarse and the lower not so conspicuous) in the middle part. Outer lip thickened, varicose without and with a few coarse teeth within. Lip-sinus moderately deep, rounded and wide-mouthed. Height 8.5 millim. Diameter 3 millim.

Fossil occurrence.—A single specimen from Shisui.

Genus **BELA** (Leach), Gray.

10. *Bela rugulata, Troschel, var. schneideri*, Harmer.

Pl. I. Fig. 37.

Bela rugulata var. schneideri. Harmer, Plioc. Moll. Grt. Brit., part II, p. 284, pl. XXXI, figs. 15, 16. Palaeontogr. Soc. LXVIII.

The shell is rather small, ovato-fusiform in shape, with the spire about half as long as the body-whorl. The whorls number between six and seven and are angulate a little above the middle, the surface above the angle forming a sloping shelf. The sculpture consists of longitudinal ribs and spiral threads, the former being about sixteen on the body-whorl, somewhat narrower than the interspaces and nodulous at the angle. The spiral threads number five, one at, and four below, the angle and slightly tuberculous at their points of intersection with the ribs. Above the angle there are several fine spiral striae. On the body-whorl the spiral threads increase in number to about twenty, are rather unequal and often at unequal distances. Aperture longly obovate. Height 9 millim. Diameter 4 millim.

The two specimens which were obtained are most like the above species of the English Crag with which I do not hesitate to unite them.

The typical form of *Bela rugulata* Tr. is now living in the boreal seas.

Fossil occurrence in Japan.—Otake.

Fossil occurrence in foreign countries.—Coralline Crag, Waltonian, Newbournian, Butleyan and Icenian of England.

11. *Bela recticostulata*, Yokoyama.

Pl. I. Fig. 38.

Shell fusiform. Whorls convex, longitudinally ribbed and spirally striate. Ribs about seventeen on the penultimate whorl.

flatly rounded, wider than interspaces, somewhat oblique, nearly straight, curving slightly toward the front at the upper end. Spiral striae about twelve on the penultimate whorl, alternately large and small. Body-whorl higher than spire with ribs gradually weakening on its base, while spiral striae are numerous and conspicuous down to the caudal end. Aperture rhomboidal, pointed behind. Inner lip with a thin callus. Outer lip thin. Sinus shallow, rounded, close to suture. Canal short, wide, a little bent.

In the single specimen obtained, the apex and the lips are broken. The diameter is about 6 millim. The height, if the shell is perfect, would be about 16 millim.

This shell is closely related to *Bela pyramidalis* Stroem (Mart. u. Chemn., Syst. Conch. Cab., IV, part 3, p. 159, pl. 32, fig. 14) of Polar Seas in which, however, the ribs are sigmoidal.

Fossil occurrence.—Shito.

Family Cancellariidæ.

Genus CANCELLARIA, Lamarck.

42. *Cancellaria spengleriana*, Deshayes.

Cancellaria spengleriana. Sowerby, Thes. Conch., vol. II, p. 439, pl. 93, fig. 29. Dunker, Ind. Moll., p. 103. Pilsbry, Catalogue, p. 21. Watson, Challenger Gastropoda, p. 273. Tokunaga, Foss Env. Tokyo, p. 11, pl. I, fig. 15. Yokoyama, Foss. Miura Penin., p. 44, pl. II, figs. 2, 3.

Although not always in great numbers, this shell is found at several localities.

Fossil occurrence.—Otake, Tega, Kioroshi, Kamenari, Narita, Shito. Shinagawa and Oji in Musashi. Lower Musashino of Yokosuka.

Living.—Central and Western Japan. Philippines. Australia.

43. *Cancellaria nodulifera*, Sowerby.

Pl. II. Fig. 1.

Cancellaria nodulifera. Sowerby, Thes. Conch., II, p. 440, pl. 94, fig. 57. Lischke, Jap. Meeresconch., II, p. 55. Dunker, Ind. Moll. p. 103, pl. VI, figs. 24, 25. Pilsbry, Cat., p. 22. Tokunaga, Foss. Env. Tokyo, p. 12, pl. I, fig. 16.

This species is distinguished from the foregoing by its shorter and more ventricose form and also by broadly channelled sutures. The three folds of the columella-lip mentioned by Sowerby are more or less indistinct in our fossils, the two lower ones being somewhat distant from the uppermost. The shoulder-tubercles are more or less spiny in the fossil specimens as may be seen in our figure and also in that of Tokunaga.

Fossil occurrence.—Otake, Kamenari, Tega, Shito, Oji in Musashi. Rare at all the above places.

Living.—Central and Western Japan.

44. *Cancellaria asperella*, *Lamarck*, *var. reeviana*, Crosse.

Pl. II. Fig. 2.

Cancellaria asperella var. reeviana. Pilsbry, Cat., p. 22.

Cancellaria reeviana. Dunker, Index Moll., p. 104. Lischke, Jap. Meeresconch., II, p. 56. Mart. u. Chemn., Syst. Conch. Cab., IV, part 3, p. 12, pl. II, figs. 7–9. Crosse, Jour. de Conch., IX, p. 237.

Cancellaria elegans. Sowerby, Thes. Conch., II, p. 446, pl. 93, fig. 36, pl. 96, fig. 104. Reeve, Conch. Icon., X, pl. III, fig. 12. (Not C. elegans Desh.).

This is a very variable species. In some specimens the shell is thick, while in others it is rather thin. The whorls are somewhat angulate a little above the middle and not convex throughout as shown in the figures given in the "Systematischen Conchylien-Cabinet." But the general appearance is alike. The ribs number sixteen or seventeen on the penultimate whorl. The spiral threads number about four above the angle and five below it. The inter-section-points of ribs and threads are more or less tuberculous. Columella folds three, strong and oblique. On some specimens there is a thin callus. The outer lip is either dentate or smooth within.

The specimens are all young, the largest measuring 19 millim. in height and 10 millim. in diameter. Rare.

Fossil occurrence.—Otake, Tega and Shito.

Living.—Central and Western Japan. Philippines.

Family Olividæ.

Genus OLIVELLA, Swainson.

45. *Olivella fortunei*, (A. Adams).

Pl. II. Fig. 3.

Olivella fortunei. Pilsbry, Cat., p. 23, pl. II, fig. 11. Tryon, Man. Conch., V. p. 69, pl. XVI, figs. 12–15.

Oliva fortunei. Marrat in Sowerby's Thes. Conch., IV, p. 36, pl. XXIII (Oliva), figs. 422, 423.

Olivella consobrina. Tokunaga, Foss. Env. Tokyo, p. 10, pl. I. fig. 13. Brauns, Geol. Env. Tokio, p. 29. (Not *O. consobrina* Lke.).

This species has been taken by Tokunaga and Brauns for *Olivella consobrina* Lischke which is identical with *O. fulgurata* Adams and Reeve, and possibly also with *O. fabula* Marrat. Compared with *O. consobrina*, *O. fortunei* grows larger and is broader in form. A fine figure of a recent shell is given by Pilsbry in his Catalogue above referred to. Of the three oblique columella-folds present, the uppermost is usually indistinct, while the middle is broad and mostly obliquely striated.

Very frequent. The largest specimen measures 19 millim. in height and 8 millim. in diameter, while the smaller ones are generally a little more slender.

Fossil occurrence.—Otake, Shisui, Tega, Kamenari, Kioroshi, Shito. Oji in Musashi.

Living.—Central Japan. China.

46. *Olivella spretoides*, Yokoyama.

Pl. II. Fig. 4.

Shell small, longly oval, shining. Whorls about four and a half, the first one and a half embryonal and rounded, the succeeding sloping, only a little convex, smooth. Body-whorl very large, broadly rounded, somewhat tapering below toward the caudal end, the greatest diameter being nearly in the middle of the shell. Sutures channelled, the channel-end being distinctly impressed on the body-whorl as a broad, shallow, transverse depression above the posterior end of the aperture which is elongated and angular behind. Columella-lip covered with a thin translucent glaze whose lower end is furnished with an oblique bifid fold. Outer lip thin, the margin being nearly straight. Height 5.5 millim. Diameter 2.5 millim.

This shell which is rather frequent is very much like the one taken by Smith (Proc. Zool. Soc. Lond., 1879, p. 216, pl. XX, fig. 55) for *Olivella spreta* Gould (never figured): but our fossil has the body-whorl more curved and a little more tapering downward.

Fossil occurrence.—Shito.

Genus **ANCILLA**, Lamarck.

47. ***Ancilla hinomotoensis***, Yokoyama.

Pl. II. Fig. 5.

Shell solid, subfusiform. Spire obtuse, entirely covered with spirally indistinctly striated callus which on the lateral side (right from the aperture) of the shell overlaps each other with the left end above. The sutural portion of the body-whorl is also concealed by the callus, while its exposed portion is covered with coarse lines of growth as well as with fine, rather indistinct, spiral ones. Spiral sulcus broad. Basal area with a spiral ridge in the middle, dividing it into two nearly equal parts. Aperture fusiform, pointed behind, truncate in front. Inner lip covered with a portion of the callus extending from above and with the caudal end obliquely grooved; grooves four or five in number. Outer lip thin, its upper portion being also covered with the callus. Height 33 millim. Diameter 9 millim. Length of aperture about 20 millim.

This fossil is not unlike *Ancilla montrouzieri* Souv. (Syst. Conch. Cab., V, *Ancillaria*, p. 17, pl. V, figs. 5, 6) from the South Sea. But in the former the callus on the apertural side of the shell extends more downward, and the acute embryonal end found in the latter is absent.

Fossil occurrence.—Shito (frequent).

Family **Marginellidæ**.

Genus **MARGINELLA**, Lamarck.

48. ***Marginella cotamago***, Yokoyama.

Pl. II. Fig. 6.

Shell minute, rather solid, ovoid, the greatest diameter being a little above the middle of the shell, smooth. Spire concealed. Apex rather rounded. Aperture as long as the shell, narrow. Inner lip with four plaits of which the lowest is the strongest and most oblique ; the next upper one is also prominent but more horizontal, while the two uppermost which are nearly horizontal are thin and often indistinct. Outer lip thickened, receding both above and below, smooth within. Rare. The largest example measures 2 millim. in height and 1.5 millim. in diameter.

This shell looks like *Marginella minuta* Pfr. (Tryon, Man. Conch., V, pl. XII, figs. 60–63) of the Atlantic which, however, has the outer lip denticulate within.

Fossil occurrence.—Shito.

Living.—Central Japan.

49. ***Marginella perovulum***, Yokoyama.

Pl. II. Fig. 7.

Shell small, ovoid, rather thin. Spire hidden. Apex very obtusely pointed. Body-whorl smooth, broadest a little above the middle. Aperture as long as the shell, somewhat dilated in front. Inner lip with four plaits of which the lowest is the strongest, while the other three are nearly equal in size and all quite distinct. Outer lip not thickened, sharp, smooth within. Height 2 millim. Diameter 1.2 millim.

This shell closely resembles *Marginella ovulum* Sow. (Thes. Conch., I, pl. 78, fig. 188) from Australia which, however, tapers more sharply downward.

Fossil occurrence.—At Shito, but rather rare.

Family Volutidæ.

Genus **VOLUTA**, Linné.

50. ***Voluta megaspira***, Sowerby.

Voluta megaspira. Sowerby, Thes. Conch., I, p. 208, pl. 48, figs. 31, 32. Dunker, Index Moll., p. 49. Lischke, Jap. Meeresconch., II, p 167, III, p. 43. Pilsbry, Cat., p. 24. Yokoyama. Foss. Miura Penin., p. 46, pl. II, fig. 18.

Several large specimens, though all more or less broken.

Fossil occurrence.—Shito. Lower Musashino of Miyata, Kamakura, Kanazawa. Koshiba and Naganuma.

Living.—Northern, Central and Western Japan.

Family Mitridæ.

Genus **MITRA**, Lamarck.

51. ***Mitra hondana***, Yokoyama.

Pl. II. Fig. 8.

Shell small, thick, fusiform. Whorls six, the first two smooth and rounded, the remaining convex, with a slightly excavated area at some distance from the upper suture, longitudinally weakly plicate. Plicæ very obtuse, vertical, separated by interspaces of a narrower breadth, about twenty on the penultimate whorl and indistinct or obsolete on the ultimate one which is very large and twice as high as the spire. Sutures margined below by a weak spiral cord which is, however, often indistinct. Aperture longly fusiform. Columella-plaits four, somewhat oblique, the two upper ones nearly equal in size, the third more oblique and smaller, the fourth the smallest and most oblique. Outer lip thin, simple, smooth within. Canal short, straight. Height 10 millim. Diameter 4.2 millim.

This species resembles *Mitra albina* Adams (Tryon, Man. Conch., IV, p. 129, pl. 37, fig. 97) from Luzon which, however, is larger, with the aperture more parallel-sided. Also *Mitra lachryma* Reeve (Man. Conch., loc. cit., pl. 37, ffg. 93) seems to be an allied form.

Fossil occurrence.—Shito (rare).

52. ***Mitra pirula***, Yokoyama.

Pl. II. Fig. 9.

Shell small, thick, shortly fusiform. Whorls about four and a half, the first one and a half smooth and rounded rendering the apex blunt and mammillated, the remaining indistinctly shouldered with the surface above the shoulder slightly excavated, longitudinally plicate. Plicæ coarse, more or less unequal, indistinct or obsolete on the body-whorl which is very large and about three times as high as the spire. Periphery rounded. Base rather abruptly tapering downward into a short straight canal. Aperture subsemilunar. Columella-folds four, somewhat oblique, the upper three nearly equal in size and more or less parallel, the lowest smaller and more oblique. Outer lip thin and simple, broadly arcuate. Height 4 millim. Diameter 25 millim.

A single specimen. It looks somewhat like the preceding species, but is shorter and more inflated.

Fossil occurrence.—Shito.

Family **Fasciolariidæ**.

Genus **FUSUS**, Lamarck.

53. ***Fusus perplexus***, A. Adams.

Fusus perplexus. A. Adams, Journ. Linn. Soc., 1864, VII, p. 106. Pilsbry, Catalogue, p. 26. Tryon, Man. Conch., III, p. 54, pl. 33, figs. 102–107. Tokunaga, Foss. Env. Tokyo, p. 6, pl. I, fig. 6. Yokoyama, Foss. Miura Penin., p. 50, pl. II, fig. 17.

Fusus inconstans. Lischke, Jap. Meeresconch., I, p. 34, pl. II, figs. 1–6, II, p. 26, pl. III, figs. 1–5. Brauns, Geol. Env. Tokio, p. 55.

Although not numerous, there are several fine specimens of this shell so common among the living ones hitherto collected in Central Japan.

Fossil occurrence. — Otake, Tega, Shisui, Shito. Lower Musashino of Naganuma.

Living.—Northern, Central and Western Japan.

54. ***Fusus coreanicus***, Smith.

Pl. II. Fig. 10.

Fusus coreanicus. Smith, Proc. Zool. Soc. London, 1879, p. 204, pl. XX, fig. 36. Pilsbry, Catalogue p. 27.
Ptychatractus coreanicus. Tryon, Man. Conch., III, p. 72, pl. 40, fig. 186.

The three specimens which were collected all lack the apex. The shell is fusiform with whorls convex in general, but flat or slightly concave just below the sutures. The sculpture consists of longitudinal ribs and spiral threads. Longitudinal ribs coarse, rounded, slightly oblique, wider than interspaces, about twenty on the penultimate whorls, generally indistinct on the body-whorl and quite obsolete on its base; spiral threads many, close, unequal, every third usually larger. Aperture oval. Canal short, bent sideward as well as a little backward. Inner lip covered with a smooth callus and devoid of plaits. Outer lip thin, crenulate at margin, with distant transverse striae within corresponding in position to larger threads without.

Smith seems to have had a young shell. He gives the height as 22 millim, and the diameter as 8 millim. Among our specimens there is one with the height about 30 millim. and the diameter 12 to 13 millim.

Tryon in his Manual of Conchology brings this shell under the genus *Ptychatractus*. But as it has no columella-plaits, I deem it more proper to let it remain under *Fusus*.

Fossil occurrence.—Otake, Shisui, Shito. Rather rare at all places.

Living.—Western Japan.

55. ***Fusus niponicus***, Smith.

Pl. II. Fig. 11.

Fusus niponicus. Smith, Proc. Zool. Soc. London, 1879, p. 203, pl. XX, fig. 12. Sowerby, Thes. Conch., IV, Fusus, p. 79, pl. 411 (7), fig. 70. Pilsbry, Catalogue, p. 26. Tryon, Man. Conch., III, p. 65, pl. 39, fig. 169. Yokoyama, Foss. Miura Penin., p. 49, pl. II, fig. 7.
Fusus suboblitus. Pilsbry, New Jap. Mar. Moll., Gastr., Proc. Acad. Nat. Sci., Philad., 1904, p. 18, pl. I, fig. 5.

This species already described from the Lower Musashino is represented by better preserved specimens some of which are larger than that figured by Smith.

The fossil is up to 33 millim. in height and 11 millim. in diameter, moderate in thickness, and quite fusiform. The whorls number about seven and a half, of which the first one and a half are embryonal, smooth and mammillary, the remaining sloping above and convex below, somewhat contracted at the lower suture, longitudinally plicate and spirally striate. The plicae are obtuse, broad, wider than intervals and rather indistinct on the last part of the body-whorl. The number is variable, but in a specimen of 30 millim. in height it is between twelve and fifteen. The spiral striae are equal, there being generally three coarse ones on the convex part of the whorl which on crossing the plicae elevate themselves into transversely elongated tubercles, a character most distinct in adult specimens. The finer striae which cover the sloping shelf and the interspaces between the coarser ones are often unequal, especially on the body-whorl which is provided with more than ten tuberculated striae, the tubercles becoming indistinct and finally obsolete toward the caudal end of the base. The aperture is ovate with the inner lip covered with a thin glaze. Outer lip thin, crenate at margin. Canal long, somewhat oblique.

Fusus suboblitus Pilsbry is undoubtedly a species founded on a specimen of *Fusus niponicus* more grown (the height is given as 36.5 millim.) than the present fossil.

Not rare.

Fossil occurrence.—Shito. Lower Musashino of Miyata and Koshiba.

Living.—Central Japan (Smith gives the locality as south of Honshu at 52 fathoms).

Family **Buccinidæ.**

Genus **CHRYSODOMUS**, Swainson.

56. ***Chrysodomus arthriticus***, (Valenciennes) Bernardi.

Pl. II. Fig. 12.

Chrysodomus arthriticus. Pilsbry, Catalogue, p. 28.

Neptunea arthritica. Dunker, Index Moll., p. 14. Lischke, Jap. Meeresconch., I, p. 37. Brauns, Geol. Env. Tokio, p. 28, pl. II, fig. 1.

Fusus arthriticus. Valenciennes, Comptes Rendues, tome 46, p. 761. Bernardi, Jour. Conch., 1857, p. 386, pl. XII, fig. 3.
Tritonium arthriticum. Schrenck, Moll. Amurl, u. d. nordjap. Meeres, p. 421.
Neptunea despecta. Tokunaga, Foss. Env. Tokyo, p. 7.

This is a very variable shell. But the greater part of the fossils belongs to a form with keeled and nodulous shoulders, although occasionally those with rounded ones are met with. The longitudinal ribs may be distinct or not.

If this is really identical with *Chrysodomus* (*Neptunea*) *despectus* Linné as mentioned in Tryon's Manual of Conchology (vol. III, p. 116), then its distribution becomes circumpolar.

Fossil occurrence.—Otake, Tega, Kioroshi, Shisui, Kamenari, Shito. Oji and Shinagawa in Musashi. More or less frequent in all the localities.

Living. — Northern Japan (from Rikuzen northward). Northern Sakhalin. Strait of Mamiya (Tartary).

57. *Chrysodomus schrencki*, Yokoyama.

Pl. II. Fig. 13.

Chrysodomus schrencki. Yokoyama, Foss. Miura Penin., p. 51, pl. III, fig. 1.

A few bad fragments.

This species is very closely akin to *C. pericochlion* Schrenck of Northern Japan and probably a mere variation of the latter.

Fossil occurrence.—Shito.

Living.—Northern Japan (according to Prof. Yabe).

Genus SIPHO, Klein.

58. *Sipho obesiformis*, Yokoyama.

Sipho obesiformis. Yokoyama, Foss. Miura Penin., p. 52, pl. II, fig. 13.

This species which I founded on a few specimens from the Lower Musashino is rather frequent in the Upper. All the examples which I have show the longitudinal plicae only on the uppermost whorls, so that its resemblance to *Sipho obesus* Sow. already alluded to in my work above mentioned becomes stronger. But the Japanese species does not grow to such a great size as the European (Tryon figures a specimen 60 millim. in height, while the Japanese hardly attains 15 millim. in height) and its canal is shorter.

Fossil occurrence.—Shito, Shinagawa. Lower Musashino of Naganuma.

59. *Sipho* (***Parasipho***) ***nipponicus***, Yokoyama.

Pl. II. Fig. 14.

An imperfect specimen probably belonging to a young shell. But it exactly coincides in form with the figure of *Sipho kroeyeri* Möller described as *Parasipho kroeyeri* by Harmer in his Pliocene Mollusca of Great Britain (part 1, p. 148, pl. XV, figs. 4, 5. Palaeontogr. Soc., vol. LVII, 1913), the only difference being the presence of two spiral threads dividing the surface of the whorls into three nearly equal parts. These threads are distinctly visible on the interspaces of the longitudinal plicae, while on the plicae themselves they are obsolete. The body-whorl is without any plicae. The fine spiral threads are also present, though only seen with a lens.

This shell may possibly be a mere variety of the well known Arctic species above mentioned. But until more specimens are obtained, it seems to be prudent to treat it as a separate species.

Fossil occurrence.—Otake.

Genus **SIPHONALIA**, (Swainson).

60. ***Siphonalia spadicea***, (Reeve).

Siphonalia spadicea. A. Adams, Ann. Mag. Nat. Hist., 1863, XI, p. 203. Smith, Proc. Zool. Soc. London, 1879, p. 205, pl. 20, fig. 38. Dunker, Ind. Moll., p. 16. Yokoyama, Foss. Miura Penin., p. 53, pl. III, figs. 8–11.

Buccinum spadiceum. Reeve, Conch. Icon., Buccinum Index.

Buccinum fusoides. Reeve, Conch. Icon., spec. 64 (not spec. 9).

Neptunea (*Siphonalia*) *spadicea.* Mart. u. Chem., Syst. Conch. Cab., III, pt. 3, p. 130. pl. 42, fig. 8.

A fine perfect specimen 40 millim. in height, but with the canal a little more bent than usual, and several fragments.

Fossil occurrence.—Shito.

Living.—Northern and Central Japan.

61. *Siphonalia trochulus*, (Reeve).

Pl. II. Fig. 15–18.

Siphonalia trochulus. Dunker, Index Moll., p. 16. Pilsbry, Catalogue, p. 30. Tryon, Man. Conch., III, p. 136, pl. 55, fig. 373. Yokoyama, Foss. Miura Penin., p. 54, pl. III, fig. 14.

Buccinum trochulus. Reeve, Conch. Icon., spec. 7.

Neptunea (*Siphonalia*) *trochulus*. Kobelt in Mart. u. Chem. Syst. Conch. Cab., III, pt. 3, p. 128, pl. 42, figs. 2, 3.

The great variability of this shell is well shown by numerous examples, both young and adult, brought from several localities.

A greater part of the examples shows either no longitudinal plicae or very weak ones only on the body-whorl. But occasionally specimens are met with which possess such, though weak, also on the penultimate whorl. The canal is generally more or less bent. The inside of the outer lip is usually smooth, but now and then transversely ridged, in which case the lip is thicker.

Siphonalia stearnsii, a species founded by Pilsbry (Catalogue, p. 29. pl. II, figs. 1, 2) on a shell closely resembling the present one in shape, but having the upper whorls longitudinally plicate may possibly be one of the many forms of *S. trochulus*.

Fossil occurrence. — Otake (frequent), Kamenari, Shisui (frequent), Tega, Shito (very frequent). Oji and Shinagawa in Musashi. Lower Musashino of Naganuma.

Living. — Central Japan.

62. *Siphonalia kellettii*, (Forbes).

Pl. V. Fig. 1.

Siphonalia kellettii. Pilsbry, Cat., pp. 30 and 168. Tryon, Man. Conch., III, p. 134, pl. 54, fi. 352. Lischke, Jap. Meeres conchl., I, p. 38, pl. III, figs. 3, 4. Carpenter, Report II, p. 663.

Fusus kellettii. Forbes, Proc. Zool. Soc. Lond., 1850, p. 274, pl. IX, figs. 9, 10.

A large specimen 140 millim. in height, though not quite well preserved. The species is readily recognized by the fusiform shape, the long bent canal, and the angulate whorls with coarse nodules at the angle and many unequal spiral threads. In the present specimen the nodules are in many places double, that is to say, a second somewhat smaller nodule is found below the principal one. Lischke figures a specimen measuring about 120 millim. in height, while Carpenter mentions one which is 160 millim. high.

Fossil occurrence.—Shito.

Living.—Central, Western and Southern Japan. California. Lower California.

Genus **VOLUTHARPA**, Fischer.

63. ***Volutharpa perryi***, (Jay).

Pl. II. Fig. 19.

Volutharpa perryi. Dunker, Index Moll., p. 33. Pilsbry, Catalongue, p. 32. Tokunaga, Foss. Env. Tokyo, p. 8, pl. I, fig. 11. Yokoyama, Foss. Miura Penin., p. 55, pl. III, fig. 12.

Bullia perryi. Jay, Report on Shells coll. by Jap. Exped. under Comm. Perry, 1856, p. 295, pl. V, figs. 13–15.

Tritonium (*Volutharpa*) *perryi.* Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 347.

Numerous examples, though mostly broken. The whorls which are generally smooth are occasionally ornamented with spiral striations, excepting the last one. Moreover, just beneath the sutures the whorls do not immediately slope but somewhat bulge, so that the sutures become more or less channelled. The figured specimen shows such a character.

Fossil occurrence.— Otake, Shisui, Shito. Also Oji. Lower Musashino of Miyata.

Living.—Northern and Central Japan.

Genus **EBURNA**, Lamarck.

64. ***Eburna japonica***, Reeve.

Pl. II. Fig. 20.

Eburna japonica. Reeve, Conch. Icon., Eburna spec. 3. Sowerby, Thes. Conch., III, p. 70, pl. 215, fig. 11. Schrenck. Moll. Amurl. u. d. nordjapan. Meeres, p. 440. Lischke, Jap. Meeresconch., I, p. 67, pl. II, p. 58. Dunker, Moll. Jap., p. 8. Index Moll., p.

34. Pilsbry, Cat., p. 34. Tryon, Man. Conch., III, p. 211, pl. 82, fig. 463. Brauns, Geol. Env. Tokio, p. 64. Tokunaga, Foss. Env. Tokyo, p. 9.

This shell so common among the living ones near Tokyo is also not infrequently found as a fossil.

Fossil occurrence.—Otake. Shisui. Tega. Oji (frequent) and Shinagawa according to Tokunaga.

Living.—Northern. Central, Western and Southern Japan.

Family **Nassidæ**.

Genus **NASSA**, Lamarck.

65. ***Nassa (Hima) japonica***, A. Adams.

Nassa (Hima) japonica. Pilsbry, Catalogue, p. 86. Yokoyama, Foss. Miura Penins., p. 56, III. fig. 5.

Nassa japonica. A. Adams, Proc. Zool. Soc. Lond., 1851, p. 110. Lischke, Jap. Meeresconch., III, p. 37, pl. II, figs 20–23. Brauns, Geol. Env. Tokio, p. 29, Tokunaga, Foss. Env. Tokyo, p. 9.

Nassa tenuis. Smith, Ann. Mag. Nat. Hist., 1875, p. 423, Proc. Zool. Soc. Lond., 1879, p. 211.

This species which has been fully described in my work above cited is very frequent at some localities. It is easily distinguished from the following species by its finer sculpture, the number of the longitudinal costae being more than twenty on the body-whorl.

Fossil occurence.—Otake (abundant), Shisui, Kamenari, Tega, Shito. Oji, Tabata and Shinagawa (abundant) in Musashi.

Living.—Central and Western Japan.

66. ***Nassa (Hima) festiva***, Powis.

Nassa (Hima) festiva. Pilsbry, Catalogue, p. 35. Yokoyama, Foss. Miura Penin., p. 57, pl. IV, fig. 6.

Nassa festiva. Powis, Proc, Zool. Soc. London, 1835, p. 95, Lischke, Jap. Meeresconch., II, p. 53. Dunker, Index Moll. p. 37. Tryon, Man. Conch., IV, p. 46, pl. 14, figs. 239–242.

Nassa lirata. Dunker, Moll. Jap., p. 7, pl. I, fig. 22.

Several examples. The shell which in its sculpture resembles *Nassa fraterculus* mentioned below is easily distinguished by its larger and more inflated form with a shorter spire. The tuberculated longitudinal plicae number about eleven on the last whorl. The largest specimen measures about 20 millim. in height and 10 millim. in diameter.

Fossil occurrence.—Otake, Tega, Shito, Oji, Shinagawa, Tabata and Dokwanyama in Musashi. Lower Musashino of Miyata and Naganuma.

Living.—Northern, Central and Western Japan.

67. *Nassa* (*Hima*) *fraterculus*, Dunker.

Pl. II. Fig. 21.

Nassa (*Hima*) *fraterculus*. Pilsbry, Catalogue, p. 36.
Nassa fraterculus. Dunker, Moll. Jap., p. 7, pl. I, fig. 15. Index Moll. Mar. Jap., p. 37. Lischke, Jap. Meeresconch., I, p. 60, II, p. 54, pl. IV, figs. 7, 8.
Tritonium (*Nassa*) *fraterculum*. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 435.

A single example. The shell is rather thick and consists of about seven volutions and a half of which the first one and a half are embryonal and smooth ; the remaining whorls are convex, separated by deep sutures, longitudinally ribbed and spirally corded. The ribs are strong, convex, narrower than interspaces, eleven or twelve on the last whorl. There is also a varix at the end of the penultimate whorl as well as on the outer lip which is consequently thickened. The spiral cords are usually four in number, broad and flat ; of these four cords, the lower three are quite close together, being separated only by an impressed line between, while the uppermost is situated midway between the upper suture and the second cord and is comparatively distant from both. The impressed lines above-mentioned cut the ribs on crossing them, so that the latter appear tuberculous. Their number on the body-whorl is about seven. Height 11 millim. Diameter 5 millim.

Fossil occurrence.—Otake.

Living.—Northern, Central and Western Japan.

Family Columbellidæ.

Genus COLUMBELLA, Lamarck.

68. *Columbella* (*Atilia*) *burchardi*, (Dunker).

Columbella (*Atilia*) *burchardi*. Yokoyama, Foss. Miura Penin., p. 59, pl. III, fig. 17.
Columbella (*Mitrella*) *burchardi*. Tryon, Man. Conch., V. p. 129, pl. 49, fig. 17.

Amycla burchardi. Dunker, Ind. Moll., p. 55, pl. IV, figs. 3, 4. Pilsbry, Catalogue, p. 40.

Many specimens which invariably belong to the form with a shorter spire like those found in the Lower Musashino. The longitudinal plicae found on the younger or upper whorls are more conspicuous than those on the older. The outer lip is more or less dentate within. The largest specimen obtained measures 17 millim. in height and 8 millim. in diameter.

Fossil occurrence.—Shito. Lower Musashino of Miyata and Yokosuka.

69. *Columbella* (*Atilia*) *smithi*, Yokoyama.

Pl. II. Fig. 24.

Shell small, subfusiform. Whorls nine, the apical ones smooth and rounded, the following somewhat convex with the upper ones more or less longitudinally plicate and the lower ones smooth. Plicae usually about fourteen, straight, obtuse, as broad as interspaces, gradually becoming indistinct and obsolete on the lower whorls, though sometimes more or less visible even on the penultimate whorl. The whorls having no plicae are smooth except near the upper suture where a spiral thread margins it. This thread is also found at the periphery of the body-whorl which is distinctly angulate. Base suddenly contracted, smooth except near the caudal portion which is furnished with several oblique sulci. Aperture subquadrangular, more or less resembling a rhombic form. Columella lip bent in the middle, with the lower half vertical. Outer lip thin, smooth within. Canal short, recurved. Height 11 millim. Diameter 4.5 millim. Height of body-whorl 6.5 millim.

This shell is somewhat like *Columbella* (*Atilia*) *lischkei* Smith (Proc. Zool. Soc. Lond., 1879, p. 207, pl. XX, fig. 41.) which, however, has the outer lip varicose without and subtuberculate within.

Fossil occurrence.—Otake (numerous), Kamenari, Tega.

Living.—Central Japan.

70. *Columbella* (*Atilia*) *turriculata*, Yokoyama.

Pl. II. Fig. 22.

Shell turrete. Whorls about ten, the two apical ones smooth and rounded, the following flatly convex with the two uppermost longitudinally weakly plicate and the rest apparently smooth, though by a good reflection of light fine spiral striae are visible. Sutures with a raised margin below, so that they look somewhat channelled. Body-whorl a little shorter than spire. Periphery subangulate. Base suddenly narrowed into a rostrum which is obliquely grooved. Aperture rhombic. Outer lip thin, smooth within. Canal short, well defined, almost straight. A single example which measures 14.5 millim. in height and 5 millim. in diameter.

The species is much like the preceding, but somewhat larger, though more slender, with the whorls a little more convex and the periphery not so sharply angulate.

Fossil occurrence.—Otake.

71. *Columbella* (*Atilia*) *praecursor*, Yokoyama.

Pl. II. Fig. 24.

A few specimens.

The shell is subfusiform with about eight whorls, of which the apical ones are smooth, the one or two following longitudinally weakly costate and the remaining smooth, only a little convex and separated by deep subchannelled sutures. The body-whorl is somewhat higher than the spire and abruptly narrowed below into the base whose caudal portion is furnished with more than ten oblique grooves. Periphery rounded. Aperture four-sided with the posterior angle acute. Columella-lip bent in the middle, the upper half obliquely sloping and the lower half vertical. Outer lip varicose without, smooth within. Canal short, well defined, curved a little sideward as well as backward. Height 12 millim. Diameter 5 millim.

This species is closely akin to *Columbella* (*Atilia*) *niveomarginata*

Smith (Proc. Zool. Soc. Lond., 1879, p. 208, pl. XX, fig. 42) which, however, has the outer lip tuberculated within and the canal broader.

Fossil occurrence.—Shito, Tega, Otake. Also Tabata and Shinagawa in Musashi.

Living.—Western Japan.

72. *Columbella (Atilia) masakadoi*, Yokoyama.

Pl. II. Fig. 23.

Shell small, shortly fusiform. Whorls about eight with apex pointed, only slightly convex, smooth excepting the uppermost ones which are more or less longitudinally plicate. Sutures deep with the raised margin. Body-whorl about twice as high as spire, suddenly narrowed below into the base. Periphery rounded. Caudal portion of the base with several oblique furrows. Aperture rhomboidal with columella-lip bent in the middle. Outer lip thin, smooth within, or as is rarely the case, somewhat thickened and subtuberculate within. Canal short, a little bent. Height 10 millim. Diamer 4.5 millim. Several specimens.

The longitudinal plicae of the upper whorls are more or less distinct, if the specimens are not too much worn. In one young example, they are distinct even on the penultimate whorl.

Columbulla (Mitrella) aurantiaca Dall (Tryon, Man. Conch., V, pl. 50, fig. 39) of California is nearly like the present shell in form. But it is devoid of the longitudinal plicae as well as of the caudal furrows.

Fossil occurrence.—Otake, Tega, Shito. Oji and Dokwanyama in Musashi.

Living.—Central Japan.

73. *Columbulla (Mitrella) dunkeri*, Tryon.

Pl. II. Fig. 26.

Columbella (Mitrella) dunkeri. Tryon, Man. Conch., V, p. 129, pl. 49, fig. 15. Yokoyama, Foss. Miura Penin., p. 59, pl. III, fig. 15.

Amycla varians. Dunker, Malak. Blätt., 1860, p. 231, Moll. Jap., p. 6, pl. I, fig. 17.

Ind. Moll., p. 55. Smith, Proc. Zool. Soc. Lond., 1879, p. 210, pl. XX, fig. 44. Pilsbry, Catalogue, p. 40.

This well known shell is quite frequent, especially at Otake. The two specimens collected at Shito, one of which is represented in the above figure, is more slender than usual, with the end of the aperture more contracted and narrower. The transverse ridges on the inner side of the outer lip is also obsolete in one of them.

Fossil occurrence.—Otake, Shisui, Tega, Kamenari, Shito. Also Tabata and Shinagawa in Musashi. Lower Musashino of Miyata and Yokosuka.

Living.—Northern, Central and Western Japan.

Family **Muricidæ.**

Genus **TROPHON**, Montfort.

74. ***Trophon pachyrhaphe***, (Smith.)

Pl. III. Fig. 1.

Trophon pachyrhaphe. Pilsbry, Catalogue, p. 40. Dunker, Ind. Moll., p. 10.
Coralliophila pachyrhaphe. Tryon, Man. Conch., II, p. 209, pl. 70, figs. 441, 442.
Fusus pachyrhaphe. Smith, Proc. Zool. Soc. London, 1879, p. 205, pl. XX, figs. 37, 37a. Kobelt, Mart. u. Chem. Syst. Conche Cab., p. 202, figs. 10, 11.

A single example. The shell is fusiform with about eight shouldered whorls which are flat and sloping above the shoulder and vertical below it. The sculpture consists of longitudinal ribs and spiral cords. The ribs on the penultimate whorl are nine in number, coarse, and rounded, while they are more or less flattened on the body-whorl. The spiral cords are close together and alternately large and small. Incremental lines scaly on crossing the cords. Aperture obovate. Outer lip crenate at margin and furnished within with a few faint transverse striae which do not attain the margin. Canal short, bent somewhat sideward as well as backward. Height 19 millim. Diameter 9 millim.

Fossil occurrence.—Tega.

Living.—Western Japan.

75. ***Trophon subclavatus***, Yokoyama.

Pl. III. Fig. 2.

Trophon subclavatus. Yokoyama, Foss. Miura Penin., p. 60, pl. III, fig. 2, pl. VI, figs. 13, 14.

There are several examples of this species which is closely related to, if not quite identical with, the North European *Trophon clavatus* Sars. The long canal is bent as in those already described in the work above cited.

Fossil occurrence.—Shito, Tega. Oji in Musashi. Lower Musashino of Miyata.

Genus **TYPHIS**, Montfort.

76. ***Typhis arcuatus***, Hinds.

Pl. III. Fig. 3.

Typhis arcuatus. Pilsbry, Catalogue, p. 41. Hinds, Voy. Sulph., Moll., p. 10, pl. III, figs. 1, 2. Dunker, Ind. Moll., p. 9. Sowerby, Thes. Conch., III, p. 320, pl. 284, figs. 3, 4, 5. Reeve, Conch. Icon., XIX, pl. III, fig. 10 abc. Tryon, Man. Conch., II, p. 136, pl. 30, figs. 293, 297.

Typhis japonicus. A. Adams, Proc. Zool. Soc. London, 1862, p. 374.

This neat little shell is short-fusiform in shape. It has six whorls of which the apical ones are smooth and mammillary, while the succeeding ones are shouldered and furnished with varices numbering ten on the body-whorl, every two of which approach at the shoulders and form a tubular spine. Of these two varices, the anterior one is more bent than the posterior. Canal long and bent.

Several specimens, all with tubular spines broken. They are smaller than those figured by Sowerby, the largest (only 77 millim. in height) being not quite one-half as large.

Fossil occurrence.—Shito.

Living.—Western Japan. China. Cape of Good Hope.

Genus **OCINEBRA**, Leach.

77. ***Ocinebra falcata***, (Sowerby).

Pl. III. Fig. 4.

Ocinebra falcata. Pilsbry, Cat., p. 42. Tryon, Man. Conch., II, p. 127, pl. 38, fig. 457.
Murex falcatus. Sowerby, Thes. Conch., IV, p. 44, pl. 394, fig. 149. Dunker, Ind. Moll., p. 6. Lischke, Jap. Meeresconch., II, p. 30. Tokunaga, Foss. Env. Tokyo, p. 4, pl. I, fig. 1. Schrenck, Moll. Amurl. u. d. nord-jap. Meeres, p. 410.

This characteristic shell already described by Tokunaga from Shinagawa is more or less variable in shape. The number of varices is usually five to seven, but rarely four. The spines born on the shoulders of the varices are sometimes long and acute, sometimes short and blunt.

Fossil occurrence.—Shito (frequent). Tega. Shinagawa in Musashi.

Living.—Northern, Central and Western Japan.

78. ***Ocinebra spectata***, Yokoyama.

Pl. III. Fig. 5.

Shell pyriform. Spire short. Body-whorl very large, occupying about four-fifths the total height of the shell. Whorls about seven, shouldered. Shoulders angulate, the surface above the shoulders being flat and nearly horizontal, below flat and vertical. The sculpture consists of longitudinal varices and spiral threads. Varices twelve on the penultimate whorl, thirteen on the preceding one and only eight on the last, straight, rib-like, rounded, somewhat narrower than interspaces, spiny at shoulders. Spiral threads very flat, weak, distinct only below the shoulders where they number three on the penultimate whorl and the preceding one with an interstitial thread in the former. Of these three threads, the uppermost is just on the shoulder and the lowest near the lower suture, while the middle one is just midway between the two. The spines of the body-whorl are first directed upward and then somewhat inward, hollow and canal-like, the opening being at the anterior side.

The body-whorl tapers quickly downward and is furnished on its lateral surface with numerous, close, unequal spiral threads which are scaly where crossed by incremental lines. Aperture oval, thickened, uneven at margin and with some blunt tubercles at some distance from it. Canal long, straight, closed.

Several specimens. The largest measures 30 millim. in height, and 16 millim. in diameter.

Fossil occurrence.—Otake, Shisui, Shito.

Living.—Central Japan.

Genus **RAPANA**, Schumacher.

79. ***Rapana bezoar*, *Linné*, *var. thomasiana***, Crosse.

Pl. III. Fig. 6.

Rapana bezoar var. thomasiana. Pilsbry, Cat. Mar. Moll, Jap., p. 44.

Rapana bezoar. Lischke, Jap. Meeresconch., I, p. 51. Brauns, Geol. Env. Tokio, p.51. Tokunaga, Foss. Env. Tokyo, p. 5.

Rapana thomasiana. Crosse, Jour. de Conch., vol. IX, pp. 178, 268, pl. IX, X.

Rapana bezoar var. japonica. Dunker, Ind. Moll., p. 42.

Pyrula bezoar var. japonica. Dunker, Moll. Jap., p. 4.

This is a very frequent fossil in the neighbourhood of Tokyo. But all the specimens hitherto found belong to a smoother form without any strong spiral ribs, known under the name of var. *thomasiana*.

Fossil occurrence.—Otake, Kioroshi, Shisui, Tega, Shito. Oji, Tabata and Shinagawa in Musashi.

Living.—Northern, Central and Western Japan.

Genus **PURPURA**, Bruguière.

80. ***Purpura heyseana***, Dunker.

Pl. III. Fig. 7.

Purpura heyseana. Dunker, Ind. Moll., p. 40, pl. XIII, figs. 10, 11. Pilsbry, Catalogue, p. 44.

Dunker founded his species on a single specimen of a young shell. The adult shells have the spire a little more elevated than in Dunker's figure.

As a fossil, a single mutilated example was found with the greater part of the spire lacking. It is about 25 millim. in diameter.

Fossil occurrence.—Shito.

Living.—Central Japan.

Family **Tritonidæ**.

Genus **TRITON**, Montfort.

81. ***Triton tenuiliratus***, Lischke.

Pl. III. Fig. 8.

Triton tenuiliratus. Lischke, Jap. Meeresconch., III, p. 30, pl. II, figs. 18, 19. Tryon, Man. Conch., III, p. 22, pl. XII, fig. 105.

Tritonium tenuiliratum. Pilsbry, Cat., p. 47.

An adult and a young specimen.

The shell is fusiform with large body-whorl. The whorls are generally more or less angulate a little above the middle. The surface above the angle is flat and gently sloping, while below it is more or less vertical and somewhat contracted toward the lower suture. The varices number three on the last two whorls with the fourth one at the boundary between the penultimate whorl and the one preceding it. Between the varices there are many close longitudinal threads, some of which are coarser than others and often assume the appearance of small ribs. Spiral threads about eight on the penultimate whorl, three above the angle, one upon it and usually double (divided into two by an impressed line), and the rest on the vertical wall and unequal in size. The body-whorl possesses many spiral threads, of which the three above the angle are equal-sized, while those below the same are alternately large and small, although sometimes there are two smaller ones between the larger. Periphery rounded, Aperture obovate. Outer lip with a varix without and sulcate within. The canal in our specimens is broken, but it is evidently long, narrow, and somewhat bent. Height about 36 millim. Diameter 13.5 millim.

Fossil occurrence.—Shito.

Living.—Central and Western Japan.

Genus **PRIENE**, H. et A. Adams.

82. ***Priene oregonensis***, (Redfield).

Priene oregonensis. Pilsbry, Catal., p. 47. A Adams in Proc. Zool. Soc. Lond., 1864, vol. VII, p. 106.

Triton oregonensis. Redfield, Ann. Lyc. Nat. Hist. New York, 1846, vol. IV, p. 165, pl. XI, fig. 2 ab. Küster in Syst. Conch. Cab. Mart. u. Chem., p. 247, pl. 66, fig. 2.

Tritonium oregonense. Martins, Mal. Blätt., XIX, 1872, p. 30.

Tritonium cancellatum. Schrenck, Moll. Amurl, p. 431.

Triton (Priene) oregonensis. Yokoyama, Foss. Miura Penin., p. 64, pl. III. figs. 19, 20.

Only some fragments.

Fossil occurrence.—Shito. Lower Musashino of Kamakura, Yokosuka and Koshiba.

Living.—Northern Japan. Alaska, Oregon, Chile, Strait of Magellan.

Family **Cassididæ.**

Genus **CASSIS**, Lamarck.

83. ***Cassis strigata***, (Gmelin).

Pl. III. Fig. 9.

Cassis strigata. Dunker, Ind. Moll., p. 65. Pilsbry, Cat., p. 48. Tryon, Man. Conch., VII, p. 276, pl. 7, fig. 85. Reeve, Conch. Icon., V, fig. 26.

Cassis undata. Küster in Mart. u. Chem. Syst. Conch. Cab., III, part 1, p. 59, pl. 52, figs. 1, 2.

Buccinum strigatum. Gmelin, Linne, Syst. Nat. ed. 13, p. 3477.

Cassis zebra. Lamarck, Anim. sans Vert. X, p. 28.

Of the four examples obtained, two are entirely devoid of varices. The spiral grooves of the body-whorl in one of the specimens are only distinct on the lower two-thirds of the surface. The largest specimen measures 65 millim. in height, while the figured one is not quite 60 millim. high.

Fossil occurrence.—Otake, Tega.

Living.—Central and Western Japan.

Family **Coliidæ.**

Genus **DOLIUM**, Lamarck.

84. *Dolium luteostomum*, Küster.

Pl. III. Fig. 10.

Dolium luteostomum. Küster in Syst. Conch. Cab., vol. III, part 1, B, p. 66, pl. 58, fig. 2. Lischke, Jap. Meeresconch., I, p. 65, II, p. 57. Pilsbry, Catal., p. 49. Brauns Geol. Env. Tokio, p. 60. Tokunaga, Foss. Env. Tokyo, p. 17, pl. I. fig. 30. Yokoyama, Foss. Miura Penin., p. 66, pl. IV, fig. 2.

Dolium japonicum. Dunker, Nov. Conch., p. 104, pl. 35, fig. 36.

Dolium variegatum. Schrenck, Moll. Amurl., p. 408.

Very frequent at some of the localities.

Fossil occurrence.—Otake, Kioroshi, Shisui, Tega and Shito. Shinagawa in Musashi. Lower Musashino of Miyata, Yokosuka and Naganuma.

Living.—Northern, Central and Western Japan. Indian Ocean (Küster).

Family **Cypræidæ.**

Genus **ERATO**, Risso.

85. *Erato callosa*, A. Adams et Reeve.

Pl. III. Fig. 11.

Erato callosa. Adams and Reeve, Zool. Voy. Samarang, p. 25, pl. 10, fig. 32. Sowerby, Thes. Conch., III, p. 82, pl. 219, figs. 35-37. Lischke, Jap. Meeresconch., II, p. 68. Dunker, Moll. Jap., p. 9. Ind. Moll., p. 56. Tryon, Man. Conch., V, p. 9, pl. 4, figs. 38, 39. Pilsbry, Cat., p. 52. Tokunaga, Foss. Env. Tokyo, p. 10, pl. I, fig. 12.

This shell is characterized by A. Adams and Reeve as follows: "Shell pyriform, strong, thickly enamelled, callous; spire subobtuse columella excavated, outer lip distinctly denticulate"

A few specimens of an *Erato* obtained agree very well with the above description and are, therefore, to be assigned to the same species.

In Sowerby's Thesaurus Conchyliorum there is a species called *Erato lachryma* Gray (vol. III. pl. 219, figs. 4, 5, 6) described also from Japan. It is said to have "the crenulations of the outer lip not very perceptible," but in shape it is hardly distinguishable from *Erato callosa*. Moreover, the specimens of the latter have occasionally the denticulations indistinct. Therefore it is possible that the two forms belong to the same species.

Tokunaga's figure of *Erato callosa* must be said to be not quite correct.

Fossil occurrence.—Otake (rare), Shito (not rare). Shinagawa.

Living.—Central and Western Japan. China.

Family Strombidæ.

Genus STROMBUS, Linné.

86. *Strombus japonicus*, Reeve.

Pl. III. Fig. 12.

Strombus japonicus. Reeve, Conch. Icon., fig. 42. Lischke, Jap. Meeresconch., I, p. 30, pl. V, fig. 7. Tryon, Man. Conch., VII, p. 115, pl. 5, fig. 48. Pilsbry, Cat., p. 55.
Strombus vittatus Linne, *var.* Dunker, Index Moll., p. 95.

Two specimens, one of which is young. The adult specimen agrees quite well with the figure of Lischke, except in the upward prolongation of the expanded outer lip which in the present specimen does not go up higher than the shoulder of the body-whorl, while in Lischke's figure it goes much higher, reaching the third whorl from the last.

The younger specimen which is about 20 millim. high has the outer lip thin and not expanded, the shell thereby assuming the appearance of a *Hemifusus*. Such is also the case with young specimens of the living shell.

Fossil occurrence.—Otake.

Living.—Central and Western Japan. Bonins or Ogasawara-jima.

Family Cerithiidæ.

Genus **CERITHIUM**, Adanson.

87. ***Cerithium*, (*Clava*) *kochi***, Philippi.

Pl. III. Fig. 13.

Cerithium kochi. Philippi, Abbild. u. Beschr., III, Cerithium, p. 2 (14), pl. I, fig. 3. Lischke, Jap. Meeresconch., I, p. 76, III, p. 49. Tokunaga, Foss. Env. Tokio, p. 24, pl. I, fig. 49.

Cerithium (Vertagus) kochi. Tryon, Man. Conch., IX, pl. 28, figs. 48, 49.

Vertagus kochii. Dunker, Ind. Moll., p. 108.

Clava kochi. Pilsbry, Cat., p. 56.

Two specimens of a narrowly turrete shell. The whorls are flat and ornamented with seven close, flat, spiral ribs which are alternately large and small. The uppermost rib which is a smaller one is often rather indistinct, being close to the suture. The larger ribs are all tuberculate, while the smaller are either smooth or only indistinctly tuberculate. Columella-fold single, weak, and oblique, but towards the interior high and strong. Height 35 millim. Diameter 10 millim.

Fossil occurrence.—Otake. Shinagawa in Musashi.

Living.—Central and Western Japan. East Coast of Africa.

Genus **POTAMIDES**, Brongniart.

88. ***Potamides* (*Tympanotonos*) *fluviatilis***, (Postiez et Michand).

Potamides (Tympanotonos) fluviatilis. Pilsbry, Cat., p. 57. Tokunaga, Foss. Env. Tokyo, p. 25, pl. I, fig. 52. Yokoyama, Foss. Miura Penin., p. 68, pl. IV, fig. 14.

Potamides fluviatilis. Lischke, Jap. Meeresconch., I, p. 76, II, p. 69.

Tympanotonos fluviatilis. Dunker, Ind. Moll., p. 110.

Cerithium fluviatile. Postiez et Michaud, Cat. Moll. Douai, p. 363, pl. 31, figs. 19, 20. Sowerby, Thes. Conch., II, p. 891, pl. 186, figs. 295, 298.

Potamides cf. incisus. Tokunaga, Foss. Env. Tokyo, p. 26, pl. I, fig. 53.

This shell is characterized by flat whorls on which there are three flat distant ribs. These ribs are furnished with tubercles which form longitudinal rows linked together by a thread.

Fossil occurrence.—Otake (rather frequent). Tabata. Lower Musashino of Yokosuka.

Living.—Central and Western Japan. Philippines. Indian Ocean.

89. *Potamides (Batillaria) zonalis*, Bruguiere.

Potamides (Batillaria) zonalis. Pilsbry, Catalogue, p. 67.

Potamides (Lampania) zonalis. Tryon, Man. Conch. IX, p. 167, pl. 34, figs. 3, 4, pl. 35. fig. 14. Tokunaga, Foss. Env. Tokyo, p. 25.

Lampania zonalis. Liscke, Jap. Meeresconch., I, p. 73, pl. VI, figs. 15, 16, II, p. 69. Dunker, Ind. Moll., p. 109.

Like the living shell described by Lischke, the fossil one too has longitudinally plicate and spirally striate whorls. The longitudinal plicae which number eleven on the penultimate whorl are somewhat oblique and are usually severed into two, sometimes into three, tubercles by spiral grooves. The peristome is continuous except at the anterior end where it is cut by a deep canal. The outer lip is markedly produced near this canal.

Several examples, though more or less broken.

Fossil occurrence.—Otake, Kamenari. Oji and Tabata.

Living.—Northern, Central and Western Japan. Hongkong. Australia.

90. *Potamides (Batillaria) multiformis*, (Lischke.)

Potamides (Batillaria) multiformis. Pilsbry, Catalogue, p. 57. Yokoyama, Foss. Miura Penin., p. 69, pl. IV, fig. 9.

Lampania multiformis. Lischke, Jap. Meeresconch., I, p. 74, pl. VII, figs. 1–10, II, p. 69. Dunker Ind. Moll., p. 109. Tryon, Man. Conch., IX, p. 167, pl. 35, fig. 13, pl. 34, fig. 6, 8.

Lampania zonalis. Brauns, Geol, Env. Tokio, p. 52, pl. II, fig. 12. (non *L. zonalis* Brug.).

The typical form of this shell is characterized by its short shape, a specimen from Kamenari being such a one. Among those from Semata, however, there are also more slender forms which may be considered as a variety.

What Brauns described as *Lampania zonalis* from Surugadai, Tokyo is evidently this variety, his figure clearly showing it.

Fossil occurrence.—Kamenari, Shito (not rare). Surugadai (Tokyo) and Dokwanyama in Musashi. Lower Musashino of Yokosuka.

Living.—Northern, Central and Western Japan.

Family **Cerithiopsidæ.**

Genus **CERITHIOPSIS**, Forbes et Hanley.

91. ***Cerithiopsis nodosocostatus***, Yokoyama.

Pl. III. Fig. 14.

Shell small, turrete. Whorls about thirteen, the first three embryonal, smooth and rounded, the succeeding flat, shouldered, with a narrow sloping shelf above the shoulder and somewhat contracted near the lower suture where there is a suprasutural spiral thread. The sculpture consists of longitudinal riblets, sixteen or seventeen on the penultimate whorl, straight, vertical, usually made up of two nodules placed one above the other and linked together by a low ridge. Of these two nodules the lower may become obsolete, in which case the whorls appear to be furnished with a single spiral row of nodules at the shoulder. Interspaces equal to, or slightly broader than riblets, and furnished with a few faint spiral striae. Periphery angulate, with the suprasutural thread elevated and sharp. Below the peripheral thread there is a second angle marked by a thread and quite obtuse. Base flat, smooth or with faint spiral lines. Aperture squarish. Canal short, narrow, a little bent. Height 6.5 millim. Diameter 2 millim.

Of the three specimens obtained, one has a single spiral row of nodules on lower whorls.

Fossil occurrence.—Shito.

92. ***Cerithiopsis (Seila) trisulcatus***, Yokoyama.

Pl. III. Fig. 15.

Shell small, subulate. Whorls about seventeen, the first two smooth and rounded, the succeeding flat in the upper third and somewhat convex in the lower two-thirds, spirally grooved; grooves three, dividing the surface of the whorls into four parts of which the upper three are nearly equal in breadth, while the lowest is a little narrower. Periphery subangulate. Base with two spiral grooves near the periphery. Aperture rhomboidal. Outer lip thin Canal short, narrow, bent sideward as well as backward. Height 11.5 millim. Diameter 2.5 millim.

In one of the specimens, which are not at all rare, the upper portion of the spire is slightly curved, and in young ones the whorls may be all nearly flat.

Fossil occurrence.—Shito.

Family **Triforidæ.**

Genus **TRIFORIS**, Deshayes.

93. ***Triforis otsuensis***, Yokoyama.

Pl. III. Fig. 16.

Triforis otsuensis. Yokoyama, Foss. Miura Penin., p. 69, pl. IV, fig. 11.

This species which I founded on a single specimen from the Lower Musashino of Yokosuka is represented by four specimens, in two of which the apex is not preserved. The whorls number about twelve, the first three being embryonal. The middle spiral rib of the body-whorl which is equal in size to the other two in the specimens of Yokosuka is in the present ones always more or less weak, as on the preceding whorls. The aperture is a rounded square. Height about 5.5 millim. Diameter 1.5 millim.

Fossil occurrence.—Shito. Lower Musashino of Yokosuka.

Living.—Central Japan.

94. ***Triforis multigyrata***, Yokoyama.

Pl. V. Fig. 5.

A single specimen of a small, subulate, subcylindric shell with the apex a little broken, but still with eighteen whorls preserved. Its height is 13 millim. and its diameter 2.8 millim. The whorls are flat and triseriately granose with interspaces narrower than the grains which are round, close, more or less contiguous either directly or by a short prolongation sent off from their lateral sides. These grains are also linked vertically by a short, somewhat oblique riblet. On the last part of the body-whorl there is an interstitial spiral thread also granose at the extreme end (near the aperture). Aperture squarely rhombic. Canal bent sideward and also backward.

Fossil occurrence.—Shito.

Family **Trichotropidæ**.

Genus **TRICHOTROPIS**, Broderip et Sowerby.

95. ***Trichotropis unicarinata***, Broderip et Sowerby.

Pl. XIII. Fig. 11.

Trichotropis unicarinata. Sowerby, Thes. Conch , III, p. 323, pl. 285, fig. 10. Dunker, Index Moll., p. 105, pl. I, figs. 11, 12. Tryon, Man. Conch., IX, p. 44, pl. 7, fig. 56. Pilsbry, Cat., p. 59. Tokunaga, Foss. Env. Tokyo, p. 20, pl. I, fig. 38.

Trichotropis coronata. Brauns, Geol. Env. Tokio, p. 34 (not *T. coronata* Gould).

This is a very characteristic shell easily recognized by its tabularly shouldered whorls with an elevated and crenulate keel on the shoulder, a large umbilicus surrounded by a sharp and elevated margin, ovate aperture and a very short straight canal. The sculpture is almost absent save some faint spiral striae or threads sometimes visible on the body-whorl below the shoulder.

Fossil occurrence.—Shito (frequent). Oji and Shinagawa in Musashi.

Living.—Northern to Western Japan.

Family **Vermetidæ**.

Genus **THYLACODES**, Guttard.

96. ***Thylacodes medusae***, Pilsbry.

Pl. III. Fig. 17.

Thylacodes medusae. Pilsbry, Proc. Acad. Nat. Sci. Phil., 1891, p. 471, pls. 17, 18. Catalogue, p. 59, pls IV, V. Yokoyama, Foss. Miura Penin., p. 71, pl. IV, fig. 7.

Only a single fragment.

Fossil occurrence.—Otake. Lower Musashino of Miyata and Yokosuka.

Living.—Central to Southern Japan.

Family **Cæcidæ.**

Genus **CÆCUM**, Fleming.

97. ***Cæcum vitreum***, Carpenter.

Pl. III. Fig. 18.

Caecum vitreum. Carpenter, Monogr. Caecidae, Proc. Zool. Soc. Lond., 1858, p. 432, spec. 29. A. Adams, Ann. Mag. Nat. Hist., 1868, p. 364. Tryon, Man. Conch., VIII, p. 215, pl. 66, fig. 54.

A single specimen of a small arched smooth shell, 2 millim. in length and about 0.5 millim. in diameter. The tube is somewhat larger near the anterior end where it is more sharply curved than in the other parts.

A shell like this, having neither characteristic form nor markings is extremely difficult to determine, especially when it is a fossil. But as the presence of this species in the Japanese waters has been already noted by A. Adams, I believe, I am justified in assigning this to the same species.

Fossil occurrence.—Shito.

Living.—Central and Western Japan.

Family **Melaniidæ.**

Genus **MELANIA**, Lamarck.

98. ***Melania niponica***, Smith.

Pl. IV. Fig. 1.

Melania niponica. Smith, Descript. Some New Spec. Land a. Freshw. Shells a. Rem. on Other Spec. found in Japan, Quart. Journ. Conchol., I, p. 118 (1876). Kobelt, Fauna Moll. Extramar. Japon., p. 131, pl. 19, figs. 5–7, 10–14.

Two decollated specimens, both with the upper whorls broken. The whorls grow rather rapidly and are ornamented with slightly curved longitudinal costae, numbering sixteen on the penultimate whorl and crossed by distant spiral cords (six on the penultimate), the intersection-points being tubercular. On the base there are only spiral cords, the longitudinal costae ending at the periphery.

The specimens belong to the so-called short forms of the species like fig. 6 of Kobelt.

Fossil occurrence.—Otake. Tega.

Living.—Central Japan (both in lakes and near sea-coasts).

Family **Solariidæ.**

Genus **SOLARIUM**, Lamarck.

99. ***Solarium (Philippia) cingulum***, Kiener.

Pl. III. Fig. 19.

Solarium (Philippia) cingulum. Sowerby, Thes. Conch., III, Solarium, p. 237, pl. 253 (IV), figs. 55, 56. Tryon, Man. Conch., IX, p. 15 pl. V, figs. 63, 64.

Solarium cingulum. Kiener, Coq. viv., Solarium, p. 6, 6a. Pilsbry, Cat., p. 65.

Shell conical. Whorls five, very little convex, spirally striate and with two suprasutural cords, the lower of which is at the suture and stronger than the upper which is immediately above. Base somewhat convex with a spiral cord below, and close to the corded periphery, and also several spiral striae on the whole surface. Umbilicus about one-fourth the shell-diameter, with margin broadly crenate and divided into two unequal parts by a deep, narrow, spiral groove, the inner being broader than the outer. Aperture triangular with sides somewhat curved. Height 12 millim. Diameter 19 millim. Diameter of umbilicus 5 millim.

Fossil occurrence.—Shito (rare).

Living.—Central Japan. Bonin Islands. Philippines. South Sea.

100. ***Solarium (Philippia) pseudoperspectivum***, (Brocchi).

Pl. III. Fig. 20,

Solarium (Philippia) pseudoperspectivum. Tryon, Man. Conch., IX, p. 15, pl. 5, figs. 67, 68.

Solarium perspectivum. Weinkauff, Moll. Mittelm., p. 260. Sowerby, Thes. Conch., III. Solarium, p. 235, pl. 254 (V), figs. 83, 84. Sacco, Moll. Terr. Tert. Piem. et Lig., pt. 12, p. 48, pl. I, figs. 60–65.

Trochus pseudoperspectivus. Brocchi, Conch. Foss. Subap., II, p. 359, pl. V, fig. 18.

Three examples. one of which, though the smallest, is excellently preserved.

Shell flatly conical. Whorls five, slightly convex to nearly flat, spirally banded both above and below the suture. The infrasutural band or cord is single, followed by a sulcus, while the suprasutural one is double, having a groove in the middle. A narrower groove is also found just above the band. Incremental lines very conspicuous, regular, looking like striae and causing the band to appear crenulate. Periphery angular, formed by the lower half of the double band. Base somewhat convex with the peripheral portion flattened and with two spiral grooves of which the one next to the periphery is the broadest. The base is ornamented with incremental striae radiating from the umbilicus which is comparatively small with margin coarsely crenate and encircled by a deep spiral impressed line. Aperture trapezoidal. Height 7 millim. Diameter 14 millim. Umbilical diameter 3.5 millim. The largest specimen is 21 millim. in diameter.

Very probably this is only one form of *Solarium pseudoperspectivum* of the Mediterranean which has separated into several varieties. Comparing the Japanese fossil with the figures and descriptions of the above species given by Sacco, it seems to come nearest to a variety called *suprastriatula* (fig. 65 of Sacco).

Fossil occurrence.—Shito. Pliocene of Italy.

Living.—Central Japan (hitherto not mentioned in conchological works relating to Japan, but a specimen is at hand brought from Awa (Boshu). Mediterranean.

Genus **TORINIA**, Gray.

101. ***Torinia elegantula***, Yokoyama.

Pl. IV. Fig. 2.

Shell small, almost discoidal, with spire very low. Whorls four, flat, ornamented with six unequal spiral threads of which the uppermost (subsutural) and the two lowest are stronger than the others, and of the two lowest the upper is somewhat stronger than the lower. Crossing these threads are incremental striae which are close and elevated with a bead at the point of intersection. Periphery formed by a cord and angulate. Base angulate in the middle, also with a cord at the angle; the surface between this angle and the periphery is flat with spiral threads on it, while that between the same and the umbilical margin is somewhat convex and furnished with two spiral threads. All these threads together with the angle-cords are crossed by incremental striae, the points of intersection being bead-like. Umbilicus large with margin crenate. Aperture quadratic. Height 1.5 millim. Diameter of shell 3.5 millim. Diameter of umbilicus 1.2 millim.

A single specimen.

Fossil occurrence.—Shito.

Family **Rissoidæ.**

Genus **RISSOA**, Freminville.

120. ***Rissoa (Cingula) plebeja***, Yokoyama.

Pl. IV. Fig. 3.

Shell small, turrete. Whorls about nine, the first three embryonal and very small, the succeeding more or less angulate at about one-third distance from the lower suture, the surface both above and below the angle being a little convex. Sometimes the angle may be rather indistinct in which case the whorls appear strongly convex. The sculpture consists of very faint spiral striae only visible with a magnifier under a good reflection of light. Periphery rounded. Base abruptly narrowed, convex, smooth. Aperture ovate. Inner lip covered with a thin glaze. Outer lip thin, sharp. Height 5 millim. Diameter 2 millim.

The specimens are frequent, but none of them has the outer lip perfect, owing to its thin and fragile nature.

Fossil occurrence.—Shito.

Genus **RISSOINA**, d'Orbigny.

103. ***Rissoina (Moerchiella) manzakiana***, Yokoyama.

Pl. IV. Fig. 4.

Shell small, ovately fusiform, rather solid. Whorls six, the first two smooth and rounded, the succeeding somewhat convex, longitudinally plicate. Plicae straight, vertical, blunt, narrower than interspaces, about twenty in number, very weak on the penultimate whorl and almost obsolete on the ultimate, which latter is higher than the spire. Base spirally striate. Periphery broadly rounded. Aperture ovately semilunar, pointed behind, rounded in front, with peristome continuous. Height 4.5 millim. Diameter 1.8 millim.

Fossil occurrence.—Otake (frequent).

Genus **FENELLA**, A. Adams.

104. ***Fenella septentrionalis***, (Tokunaga).

Pl. IV. Fig. 5, 6.

Rissoa septentrionalis. Tokunaga, Foss. Env Tokyo, p. 26, pl. I, fig. 55.

Shell small, turriculate, pupoidal. Whorls nine, the first two smooth and rounded, the remaining convex, usually with two prominent spiral cords, the one on the upper and the other on the lower half of the whorl, making its surface often subangulate at these places. Besides these two cords, there are also two spiral threads less prominent than the cords and situated just above and below the suture. Sometimes there is a third thread between the cords. These cords and threads may sometimes become nearly equal in size on the body-whorl. The longitudinal sculpture consists of rigid, vertical, distant riblets nearly equal in size to the cords. The riblets, however, are often indistinct and obsolete. Intersection-points of spiral and longitudinal sculptures more or less tubercular. Periphery rounded with a spiral thread on it, which is a continuation of the suprasutural one of the preceding whorls. Base convex with several spiral threads. Umbilicus sometimes furnished with a small narrow chink. Aperture oval, bluntly angulate behind.

The shells are very variable in shape, some being long and slender (height 4.9 millim and diameter 1.4 millim.), while others are short and more pyramidal (height 2.6 millim. and diameter 1.2 millim.). These, however, are connected by intermediate forms. In several specimens, one of the upper whorls is specially large, which is generally the case with the whorl preceding the penultimate. The subsutural chestnut band found in the living specimens is often preserved also in the fossil ones. Rather rare.

Fossil occurrence.—Otake. Tega. Tabata (according to Tokunaga).

Living.—Central Japan.

Family **Skeneidæ**.

Genus **SKENEA**, Fleming.

105. ***Skenea nipponica***, Yokoyama.

Pl. IV. Fig. 7.

Skenea nipponica. Yokoyama, Foss. Miura Penin., p. 75, pl. V. fig. 1.

Two specimens, one of which is somewhat larger than that described from the Lower Musashino, being 2.2 millim. in diameter.

Fossil occurrence. — Shisui. Tega. Lower Musashino of Yokosuka.

Living.—Central Japan.

106. ***Skenea planorboides***, Yokoyama.

Pl. IV. Fig. 8.

Shell small, thin, almost discoidal, broadly umbilicated, Whorls four and a half, rapidly growing, smooth, convex, separated by deep sutures. Periphery roundly angulate. Base somewhat convex. Umbilical margin angulate. Umbilical wall nearly vertical. Aperture roundly triangular, one of the angles being in the middle portion of the outer lip at the extreme end of the periphery. A single specimen which is 2.5 millim. in height and 4.5 millim. in diameter.

This species is closely akin to *Skenea planorbis* Fabr. (Tryon. Man. Conch., IX, pl. 60, fig. 100) of northern seas from which it is distinguished by its angulate periphery.

The living specimens of this shell obtained in the Sea of Sagami (Central Japan) are milk-white and translucent, and ornamented with very fine spiral striae which are almost obliterated in the fossil.

Fossil occurrence.—Shito.

Living.—Central Japan.

Family **Capulidæ.**

Genus **CAPULUS**, Montfort.

107. ***Capulus badius***, Dunker.

Pl. IV. Fig. 9.

Capulus badius. Dunker, Index Moll., p. 124, pl. XIII, figs. 15–17. Pilsbry, Catalogue, p. 69. Tryon, Man. Conch., vol. VIII, p. 132, pl. 39, figs. 77, 78.

A single specimen.

The thick capuliform shell is laterally somewhat compressed with the spirally coiled vertex extending beyond the anterior margin of the aperture. The position of the vertex is not quite in the median line of the shell owing to a distortion by pressure. Surface radiately costellate. Aperture ovate and posteriorly dilated.

Fossil occurrence.—Kamenari.

Living.—Western Japan.

Genus **CALYPTRÆA**, Lamarck.

108. ***Calyptræa mammilaris***, (Broderip).

Calyptræa mammilaris. Tryon, Man. Conch., VIII, p. 120, pl. 34, figs. 64–75, 78–81. Yokoyama, Foss. Miura Penin., p. 75, pl. IV, fig. 5.

Trochita mammilaris. Sowerby, Thes. Conch., V, p. 65, pl. 450, figs. 69–71.

Many examples, but all below 10 millim. in diameter.

Fossil occurrence.—Shito. Lower Musashino of Miyata.

Living.—West Coast of America from Puget Sound down to the Strait of Magellan.

Genus **CREPIDULA**, Lamarck.

109. ***Crepidula grandis***, Middendorff.

Pl. IV. Fig. 10.

Crepidula grandis. Middendorff, Beitr. zu einer Malak. Ross., II, p. 101, pl. XI, figs. 8–10. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 382. Dunker, Ind. Mo[illegible] 123, pl. VI, figs. 1, 2. Pilsbry, Catalogue, p. 70.

A single worn specimen with the longer diameter of the elliptical aperture about 35 millim. It agrees well with the figures and descriptions given in the works above mentioned.

Tryon considers this species as identical with *Crepidula dilatata* Lam. (Man. Conch., IX, p. 127) which lives along the west coast of America from Alaska down to Patagonia.

Fossil occurrence.—Shito.

Living.—Northern, Central and Western Japan. Behring Sea.

Family **Naticidæ.**

Genus **NATICA**, Adanson.

110. ***Natica janthostoma***, Deshayes

Natica janthostoma. Deshayes, Revue Zool., p. 361. Philippi in Syst. Conch. Cab. Mart. u. Chemn., II, part 1, Natica und Amaura, p. 53, pl. VIII, fig. 8. Lischke, Jap. Meeresconch., I, p. 81. Dunker, Index Moll., p. 61. Pilsbry, Cat., p. 71. Yokoyama, Foss. Miura Penin., p. 77, pl. V, figs. 3, 4.

Natica clausa. Tokunaga, Foss. Env. Tokyo, p. 17, pl. I, fig. 31.

Natica clausa var. janthostoma. Middendorff, Mal. Ross., II, p. 209. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 373. Tryon, Man. Conch., VIII, p. 31, pl. 19, fig. 89.

Very frequent.

Fossil occurrence.—Otake (numerous), Shisui (do). Tega, Shito (abundant). Shinagawa, Oji and Tabata in Musashi. Lower Musashino of Miyata, Yokosuka, Kamakura, Koshiba and Naganuma.

Living.—Northern and Central Japan. Kamchatka.

Genus **POLINICES**, Montfort.

111. ***Polinices powisianus***, (Recluz).

Pl. IV. Fig. 12.

Polinices powisianus. Pilsbry, Catalogue, p. 72.

Natica powisiana. Recluz, Proc. Zool. Soc. London, 1843, p. 210. Philippi in Syst. Conch. Cab. Mart. u. Chem., II, part 1. 46, pl. VII, fig. 4.

Natica (Mamma) powisiana. Tryon, Man. Conch., VIII, p. 42, pl. 15, fig. 42, pl. 19, fig. 92, pl. 20, figs. 99, 100.

Uber powisianum. Dunker, Ind. Moll., p. 62.

Characterized by the large umbilicus which in form of a deep and broad channel surrounds the callous process of the columella, the so-called funiculum, in a semicircle.

Fossil occurrence.—Otake (rare).

Living.—Central and Western Japan. Philippines. Moluccas.

112. *Polinices* (*Neverita*) *ampla*, (Philippi).

Polinices (*Neverita*) *ampla*. Pilsbry, Catalogue, p. 72. Yokoyama, Foss. Miura Penin., p. 78, pl. V, figs. 5, 6.

Natica ampla. Philippi, Zeitschr. Malak. 1845, p. 156. Tokunaga, Foss. Env. Tokyo, p. 18, pl. I, fig. 32.

Natica (*Neverita*) *ampla*. Tryon, Man. Conch., VIII, p. 32, pl. 10, figs. 81–83, 85, 86, pl. 1, figs. 91–95, pl. 12, fig. 6.

Neverita vesicalis. Dunker, Ind. Moll., p. 61.

Natica bicolor. Schrenck (non Philippi), Moll. Amurl. u. d. nordjap. Meeres, p. 378.

Natica robusta. Dunker, Moll. Jap., p. 13, pl. II, fig. 24.

Natica lamarckiana. Brauns, Geol. Env. Tokio, p. 30. Lischke, Jap. Meeresconch., I, p. 80.

Natica papyracea. Tokunaga, Foss. Env. Tokyo, p. 19, pl. I. fig. 33.

The specimens of this species are usually thick-shelled, but now and then there are thin-shelled ones which Tokunaga separated under the name of *Natica papyracea* Bush. But as it is quite certain that the latter is only an abnormal form of the former. such a separation is unnecessary. Whether *Natica papyracea* of Bush belongs to the same species or not, I am now unable to decide.

Fossil occurrence. — Otake (numerous). Shisui, Kioroshi. Kamenari. Tega. Shito (numerous). Shinagawa and Tabata in Musashi. Lower Musashino of Miyata, Yokosuka and Naganuma.

Living.—Northern and Central Japan. China, Australia. Indian Ocean.

Genus **SIGARETUS**, Lamarck.

113. *Sigaretus* (*Eunaticina*) *papilla*, (Gmelin).

Pl. V. Fig. 8.

Sigaretus (*Eunaticina*) *papilla*. Pilsbry, Catalogue, p. 73. Tryon, Man. Conch., VIII, p. 58, pl. 25, figs. 78, 79, 87, 88.

Sigaretua papilla. Lischke, Jap. Meersconch., III, p. 54.

Naticina papilla. Dunker, Ind. Moll., p. 63.

Natica papilla. Philippi in Syst. Conch. Cab. Mart. u. Chem., II, pt. 1, p. 36, pl. IV, fig. 18.
Nerita papilla. Gmelin, Syst. Nat. ed. 13, p. 3675.

A longly oval shell, rather thin and consisting of only four whorls and a half which grow very rapidly and are covered with numerons spiral grooves. Umbilicus narrow. Aperture ovate or pear-shaped.

Fossil occurrence.—Shito (rare), Otake (do), Shisui, Kamenari and Tega. Shinagawa in Musashi.

Living.—Central and Western Japan. Phillppines and Moluccas.

114. *Sigaretus (Eunaticina) oblongus*, Reeve.

Pl. IV. Fig. 11.

Sigaretus (Eunaticina) oblongus. Tryon, Man. Conch., VIII, p. 58, pl. 25, fig. 83.

This species is distinguished from the foregoing only by its sculpture which consists not of spiral grooves but of spiral striations. Tryon doubts whether it is really a distinct species, an opinion with which I quite concur.

Several specimens were obtained, some of which, however, are apparently quite smooth on the surface.

Fossil occurrence.—Shito.

Living.—Habitat unknown.

Family Scalariidæ.

Genus **SCALARIA**, Lamarck.

115. *Scalaria aurita*, Sowerby.

Pl. IV. Fig. 13.

Scalaria aurita. Sowerby, Thes. Conch., I, Scalaria, p. 92, pl. XXXIII, fig. 62. Tryon, Man. Conch., IX, p. 59, pl. 12, fig. 84. Dunker, Ind. Moll., p. 67.
Scala aurita. Pilsbry, Cat., p. 75.

Shell moderately thick, turriculate, Whorls nine, the first two smooth and rounded, the succeeding convex with distant decumbent varices which are mostly thin, thirteen on the body-whorl, the last one being situated at the outer margin of the aperture. In one of the specimens, there are three broad varices on the whole shell, two on the body-whorl and one at the end of the penultimate. Umbilicus open, narrow. The three spiral chestnut-bands found on the body-whorl of recent specimens can still be seen also on the fossil. The largest example measures 11 millim. in height and 5 millim. in diameter.

Fossil occurrence.—Otake (rare) and Kioroshi (do).

Living.—Central Japan.

116. *Scalaria maculosa*, A. Adams et Reeve.

Pl. IV. Fig. 14.

Scalaria maculosa. A. Adams and Reeve, Voy. Samarang, p. 51, pl. XI, fig. 14. Tryon, Man. Conch., IX, p. 59, pl. 12, fig. 86.

A. Adams and Reeve give the diagnosis of this species as follows :

"Shell longly turrete, hardly umbilicate. Whorls ten, rounded, smooth, polished. Ribs annular, subdistant, thin, broader and flexuous near the suture. Colour bluish white with dark spots (two between annular ribs)."

There are several specimens of this nice shell which measure up to 20 millim. in height and 9 millim. in diameter. The ribs number nine on the ultimate as well as on the penultimate whorl. In one specimen the original dark dots are preserved as brown ones placed one above the other.

Fossil occurrence.—Otake (not rare).

Living.—Western Japan (according to Iwakawa). China Sea.

117. *Scalaria azumana*, Yokoyama.

Pl. IV. Fig. 15.

Shell turriculate. Whorls many (about ten ?), very convex, longitudinally costellate and spirally striate. Costellæ about seventeen on the body-whorl, thin, lamellar, erect, aculeate at shoulders, generally equal in size in young specimens, though in adult ones some may grow larger and become varix-like. Spiral striae found only between the costellæ, many, equidistant, with one or more finer ones between. Aperture subcircular, surrounded by a broad peristome. Umbilicus imperforate.

Many specimens, all of which, however, lack the apex. The one with eight whorls is 11 millim. in height and 4 millim. in diameter. A large specimen with only three whorls preserved and measuring 7 millim. in diameter shows three or four costellae on each whorl stronger than others.

Specimens from Oji where they are quite frequent show the lamellar costellae higher and more prominent and the shoulder-spines more acute.

This species is closely related to *Scalaria eximia* Adams and Reeve (Voy. Samarang. p. 51, pl. XI, fig. 16), but longer.

Fossil occurrence.—Otake (rare), Tega (do), Shito (do) Oji, in Musashi.

Living.—Central Japan (Sagami).

118. ***Scalaria kazusensis***, Yokoyama.

Pl. IV. Fig. 16.

Shell small, turriculate. Whorls many (about eight ?), convex, longitudinally costellate and spirally striate. Costellae rather thick, lamellar, straight, equal, about twenty on the body-whorl. Spiral striae between costellae fine, equal, distant. Aperture subcircular, surrounded by a somewhat broad peristome. Height 9 millim. Diameter 3,5 millim.

This species resembles the preceding, but is shorter and without the shoulder-spine on the costellae which are also somewhat greater in number.

Fossil occurrence.—Shito (rare).

Living.—Central Japan (Sagami).

119. ***Scalaria yamakawai***, Yokoyama.

Pl. IV. Fig. 17.

Shell small, ovately turrete. Whorls convex, with rather thick, lamellar, erect, equal riblets aculeate at shoulders and numbering thirteen on the body-whorl. Spaces between riblets finely and indistinctly spirally striate. Aperture subcircular with a broad peristome. Height 5.5 millim. Diameter 3 millim.

A single specimen lacking the apex. The number of whorls seems to be about eight. The apical angle of the shell is about 35°.

This species looks like *Scalaria denticulata* Sow. (Thes. Conch., I, pl. 32, figs. 25, 26) from the Philippines which, however, has a less number of riblets.

Fossil occurrence.—Otake.

Living.—Central Japan.

120. *Scalaria conjuncta*, Yokoyama.

Pl. IV. Fig. 18.

Shell turriculate. Whorls convex. longitudinally costellate. Costellae lamellar, erect, low, equal, about twenty-five on the body-whorl, occasionally continuous from one whorl to the other. Interspaces smooth. Aperture subcircular, surrounded by a somewhat broad peristome. Height about 13 millim. Diameter 4.5 millim.

A single specimen lacking the apex. The whorls preserved are eight in number.

A very small specimen only 4 millim. high from Shito seems to be a young of this species. The number of whorls is seven.

Fossil occurrence.—Tega, Shito(?)

121. *Scalaria subfrondicula*, Yokoyama.

Pl. IV. Fig. 19.

Shell turriculate, many-whorled. Whorls convex, with about fourteen longitudinal, somewhat oblique, lamellar, equal riblets aculeate at shoulders. Interspaces between riblets smooth. Aperture roundly elliptical.

A single specimen lacking the apex. The whorls preserved are eight, measuring 20 millim. in height and 7 millim. in diameter.

This species is very much like *Scalaria frondicula* Wood (Crag

Moll., I, Univalves, p. 92, pl. VIII, fig. 16) of the Coralline Crag of England in which, however, the ribs are less in number (generally twelve).

Fossil occurrence.—Shito.

122. *Scalaria picturata*, Yokoyama.

Pl. IV. Fig. 20.

Shell turriculate. Whorls about twelve, the first two smooth, the succeeding convex, longitudinally finely costellate and spirally striate. Costellae very fine, filiform, much narrower than interspaces, about sixty on the body-whorl. Spiral striae equally fine, found only on the lower three-fifths of the whorls, about eight in number on the penultimate, quite as distant as the riblets themselves and crossing them, so that the surface appears cancellated. Periphery angulate. Aperture suborbicular. Base somewhat convex, with longitudinal striae only.

Two specimens. The larger seems to be worn. It shows the riblets obtuse and the spiral striae nearly obsolete. Its height is 20 millim. with the diameter 5.5 millim. The figured specimen is the smaller one which is 13 millim. in height and 5 millim. in diameter.

This species has some resemblance to *Scalaria scaberrima* Micht. (Bellardi et Sacco, Moll. Piem., IX, p. 57. pl. II, figs. 45–47) of the Italian Pliocene, although different in details.

What Tokunaga figured as *Scalaria acuminata* Sow. (Foss. Env. Tokyo, pl. I, fig. 37) seems to be this species. Sowerby's species, however, is more slender and has no spiral striae.

Fossil occurrence.—Shito. Oji in Musashi.

Living.—Central Japan.

Family Eulimidæ.

Genus EULIMA, Risso.

123. *Eulima (Leiostraca) unicincta*, Yokoyama.

Pl. IV. Fig. 21.

Shell small, subulate, polished. Whorls about ten, somewhat convex, separated by indistinct sutures, with an interstitial impressed spiral line a little below the suture, perfectly smooth elsewhere. Body-whorl very large, a trifle higher than one-half the shell-height. Periphery broadly rounded. Aperture elongated, acute behind, rounded in front. Inner lip with a narrow reflexed margin covering lower two-thirds of it. Height 6 millim. Diameter 1.5 millim. Length of aperture 2.5 millim.

This species looks somewhat like *Eulima psila* Watson (Challenger Gastr., pl. 35, fig. 1) from the West Indies which, however, has no spiral line below the suture, and moreover, has the body-whorl as well as aperture comparatively shorter.

Fossil occurrence.—Otake (rare), Shito (do).

124. *Eulima* (*Leiostraca*) *tokunagai*, Yokoyama.

Pl. IV. Fig. 22.

Shell small, subulate, polished. Apical portion sometimes slightly curved sidewise. Whorls about eleven, flat, smooth, with sutures indistinct. Body-whorl shorter than one-half the height of the shell. Periphery broadly rounded. Aperture ovately conic, acute behind, rounded in front. Inner as well as outer lip very obtusely angulate in the middle. Height 6 millim. Diameter 1.5 millim. Length of aperture 1.5 millim.

The living shells which can be compared with the present are *Eulima acerrima* Watson (Challenger Gastr., pl. 36, fig. 1) and *Eulima sarissa* Watson (loc, cit., pl. 36, fig. 2). The former, however, has the shape of the body-whorl as well as of the aperture different, while the latter is in general more subulate in form.

Fossil occurrence.—Otake (frequent), Tege.

125. *Eulima* (*Leiostraca*) *glabroides*, Yokoyama.

Pl. IV. Fig. 23.

Shell small, high-pyramidal. Apex blunt. Whorls about nine, nearly flat, with more or less distinct sutures. Body-whorl a little lower than one-half the shell-height. Periphery rounded. Base rather abruptly narrowed. Aperture ovate, pointed behind, somewhat produced and rounded in front. Margin of inner lip reflexed outward. Height 6.5 millim. Diameter 2 millim. There is also a specimen which measures 3 millim. in diameter, but lacking a greater part of the spire.

This species is not unlike *Eulima glabra* Jeffreys (Tryon, Man. Conch., VIII, pl. 69, fig. 61), a form living in the Atlantic. But the shape of the aperture is different.

Fossil occurrence.—Shito (rare).

126. *Eulima (Leiostraca) krishna*, Yokoyama.

Pl. IV. Fig. 24.

Shell very small, pyramidal. Apex obtuse, with the upper part of the spire somewhat curved. Whorls six, nearly flat, smooth, with sutures more or less indistinct. Body-whorl a little higher than half the shell-height. Periphery sharply rounded. Aperture ovate, posteriorly pointed, anteriorly somewhat produced and bluntly pointed. A single example present measures 1.7 millim. in height and 0.6 millim. in diameter.

This shell looks like *Eulima yokoskensis* Yok. (Foss. Miura Penin., p. 79, pl. V, fig. 7) from Yokosuka, but is smaller and less acute.

Fossil occurrence.—Shito.

Family **Pyramidellidæ.**

Genus **PYRAMIDELLA**, Lamarck.

127. *Pyramidella (Tiberia) pulchella*, (A. Adams).

Pl. V. Fig. 6.

Pyramidella (Tiberia) pulchella. Dall and Bartsch, Notes on Jap., Indopac. a. Amer. Pyramidellidae, Proc. U. S. Nat. Mus., vol. XXX, p. 323, pl. XXV, fig. 4.

Pyramidella pulchella. Tryon, Man. Conch., VIII. p. 301, pl. 72, fig. 75. Pilsbry, Cat. Mar. Moll. Jap., p. 79.

Obeliscus pulchellus. A. Adams, Proc. Zool. Soc. London, 1862, p. 232. Sowerby, Thes. Conch., II, p. 807, pl. 171, fig. 20. Dunker, Index Moll., p. 74.

A longly conical pyramidal shell with flat whorls shouldered at the summit, and when fresh, ornamented with a spiral chestnut band just at the lower sutures which appears on the body-whorl at the subangulate periphery. Aperture subovate. Outer lip thin. Columella straight, biplicate with the posterior fold larger. The largest specimen measures 13 millim. in height. The diameter somewhat varies according as the specimen belongs to a broader or a narrower form. In the former it is a little over (36%), and in the latter a little less (30%) than one-third the shell-height.

The chestnut band is also more or less preserved in all the fossil specimens.

Fossil occurrence.—Otake (frequent), Tega, Kamenari. Oji, Tabata and Dokwanyama in Musashi.

Living.—Central and Western Japan.

128. *Pyramidella* (*Agatha*) *virgo* (*Adams*), *var. brevis* Yokoyama.

Pl. V. Fig. 3.

Dall and Bartsch give the description of *Pyramidella virgo* in their "Japanese, Indopacific and American Pyramidellidae," p. 335 as follows:

"Shell elongate-conic, subturrited, milk-white. Nuclear whorls two, small, well rounded, obliquely about one-half immersed in the first post-nuclear whorl. Post-nuclear whorls rather high between the sutures, inflated, well rounded, shouldered, marked by irregular lines of growth which lend the surface a somewhat uneven appearance and many fine, closely placed, wavy spiral striations; sutures strongly marked. Periphery of the last whorl with a faint suggestion of an angulation. Base prolonged, gently rounded, marked like the spaces between the sutures. Aperture elongate-ovate, posterior angle obtuse, somewhat effuse at the junction of the lip and columella; outer lip thin without internal lirations; columella short, curved, with a very strong, acute, oblique fold near its insertion which fuses directly and is continuous with the anterior reflected portion of the columella; parietal wall covered by a very thin callus."

Numerous specimens. But they are invariably more or less shorter than the specimen figured by Dall and Bartsch (loc. cit. pl. XVIII, fig. 2). The number of post-nuclear whorls is about seven and not ten as the authors say.

The largest example measures 13 millim. in height with the diameter varying from 4.3 millim. to 4.9 millim. (Dall gives: Length 13.7 millim. Diameter 4.4 millim.).

Fossil occurrence.—Otake, Shisui, Kamenari, Tega, Shito. Shinagawa, Oji, Tabata and Dokwanyama in Musashi.

Living.—Central Japan.

129. *Pyramidella (Syrnola) cinnamomea*, (A. Adams).

Pl. V. Fig. 2.

Pyramidella (Syrnola) cinnamomea. Dall and Bartsch, Notes on Jap., Indopac. and Amer. Pyramidellidae, p. 332, pl. XXVI, fig. 1.

Pyramidella (Elusa) cinnamomea. Pilsbry, Cat., p. 82.

Elusa cinnamomea. A. Adams, Proc. Zool. Soc. London, 1862, p. 237.

A single specimen. A long slender apically blunt shell with about eight post-nuclear whorls which are perfectly flat and apparently smooth. Periphery and base rounded. Aperture ovate, pointed behind. Columella-fold indistinct. Height 4.8 millim. Diameter 1.3 millim.

The specimen agrees quite well with the figure and the description of the above species, save in the absence of minute spiral striations which are said to be found in the living one examined by Dall and Bartsch.

Fossil occurrence.—Otake.

Living.—Western Japan.

130. *Pyramidella (Iphiana) mira*, Yokoyama.

Pl. IV. Fig. 25.

Shell medium-sized, slender, *Terebra*-like. Whorls many (eleven preserved), slightly convex, separated by well-marked somewhat channel-like sutures, very finely spirally striate (only visible with a lens). Periphery rounded. Base abruptly narrowed, convex. Aperture subquadrate with a strong oblique columella-fold. Height about 15 millim. Diameter 3 millim.

Two specimens both broken at apex. In a fresh state the shell seems to have been provided with a coloured band close to the lower suture.

A close ally of this species is *Pyramidella tenuiscripta* Lke. (Dall and Bartsch, Notes on Jap. Pyram. already cited, p. 334, pl. XXVI, fig. 3) which Lischke himself has described as *Obeliscus tenuiscriptus* (Jap. Meeresconch., III, pp. 58, 59, pl. III, figs. 7, 8). But the present species is more slender, has the body-whorl more rounded, the columella-fold more oblique and the antero-inner corner of the aperture more obtuse.

Fossil occurrence.—Shito. Oji in Musashi.

131. *Pyramidella* (*Iphiana*) *sira*, Yokoyama.

Pl. IV. Fig. 26.

Shell medium-sized, subulate. Nuclear whorls helicoid, standing on edge but partly immersed in the first post-nuclear whorl, Post-nuclear whorls about eight in number with surface slightly convex, somewhat shouldered at the summit so that the sutures appear subchannelled, finely spirally striate, the striae usually visible only with a lens. Periphery rounded. Base convex. Aperture partly broken but seems to have been longly subquadrate. Columella-fold very oblique. Height 8 millim. Diameter 1.8 millim. A single specimen.

Fossil occurrence.—Shito.

132. *Pyramidella* (*Actaeopyramis*) *eximia*, (Lischke).

Pl. VI. Fig. 1.

Pyramidella (*Actaeopyramis*) *eximia*. Dall and Bartsch, Jap., Indopac. a. Americ. Pyramid., p. 327, pl. XXIII, fig. 1. Pilsbry, Cat., p. 84.
Pyramidella eximia. Tokunaga, Foss. Env. Tokyo, p. 23, pl. I. fig. 46.
Monoptygma eximium. Lischke, Jap. Meeresconch., III, p. 59, pl. III, figs. 4–6.
Monoptygma puncticulata. Brauns, Geol. Env. Tokio, p, 31.

This is a large species with many somewhat convex, spirally incised whorls shouldered at the summit. Spiral striations about seven on the penultimate, and about twelve on the ultimate whorl including those of the base. Columella fold only weakly indicated.

The largest example measures 25 millim. in height and 7 millim. in diameter.

Fossil occurrence.—Otake (frequent), Shisui (do), Tega, Shito (do). Oji in Musashi.

Living.—Central and Western Japan.

Genus **Odostomia**, Fleming.

133. ***Odostomia (Odostomia) sublimpida***, Yokoyama.

Odostomia (Odotomia) sublimpida. Yokoyama, Foss. Miura Penin., p. 82, pl. V, fig. 13.

A single specimen. It is a little larger and broader than the one described from the Lower Musashino. Height 3.5 millim. Diameter 1.8 millim.

Fossil occurrence.—Otake. Oji in Musashi. Lower Musashino of Miyata.

134. ***Odostomia (Odostomia) gordonis***, Yokoyama.

Pl. IV. Fig. 27.

Shell small, elongately ovate. Post-nuclear whorls five or six, slightly convex, somewhat shouldered near the upper suture with a narrow sloping shelf above the shoulder which shows only a faint suggestion of angulation, covered with almost microscopic spiral striae. Incremental lines also very fine. Body-whorl large, nearly as high as the spire or a little higher. Periphery rounded. Base convex. Aperture ovate, pointed behind and rounded in front. Inner lip with a thin narrow coating of glaze. Columella-fold strong, oblique. Height 5 millim. Diameter 2.5 millim.

This shell is characterized by its more or less subtabulated form.

What Tokunaga described from Oji as *Odostomia plana* Gould (Foss. Env. Tokyo, p. 22) may possibly be this species, as it is quite common at that place. But Gould's species whose habitat is given as Hongkong seems to be quite different.

Fossil occurrence.—Otake (frequent), Shisui, Kioroshi, Tega, Shito. Oji in Musashi.

Living.—Central Japan.

135. *Odostomia* (*Odostomia*) *shimosensis*, Yokoyama.

Pl. IV. Fig. 28.

Shell small, elongate-conic. Post-nuclear whorls six, slightly convex, somewhat shouldered at the summit so that the sutures appear subchannelled, smooth. Body-whorl about as high as spire. Periphery subangulate. Aperture longly ovate, acute behind, produced and sharply rounded in front. Columella-fold strong, oblique. Height 5 millim. Diameter 2 millim. Rare.

This shell resembles *Odostomia limpida* Dall and Bartsch (Notes on Jap., Indopac. a. Amer. Pyamidellidae, p. 346, pl. XXVI, Fig. 7) living in our seas; but the fossil is somewhat more slender.

Fossil occurrence.—Otake, Kioroshi.

Living.—Central Japan.

136. *Odostomia* (*Odostomia*) *limpida*, Dall et Bartsch.

Pl. XIV. Fig. 1.

Odostomia (*Odostomia*) *limpida*. Dall and Bartsch, Notes on Jap., Indopac. a. Amer. Pyram, p. 364, pl. XXV, fig. 7.

A small elongate-conic shell with the nuclear whorls to a greater part obliquely immersed in the first post-nuclear one. Post-nuclear whorls about five, only slightly convex, smooth. Body-whorl a trifle longer than one-half the shell-height. Periphery feebly angulate. Aperture subovate, with posterior angle acute and anterior end somewhat produced and rounded. Columella with a distinct lamellar fold. Height 3 millim. Diameter 1.5 millim.

Fossil occurrence.—Shito, Otake.

Living.—Western Japan.

137. *Odostomia* (*Odostomia*) *desimana*, Dall et Bartsch.

Pl. V. Fig. 7.

Odostomia (*Odostomia*) *desimana*. Dall and Bartsch, Jap., Indopac. a. Amer. Pyram., Proc. U. S. Nat. Mus., XXX, p. 362, pl. XXV, fig. 3, pl. XXVI, fig. 2.

Odostomia lactea. Dunker, Moll. Jap., p. 17, pl. II, fig. 4. Pilsbry, Catalogue, p. 84.

Shell small, elongate-conic. Nuclear whorls almost completely immersed in the first post-nuclear one. Post-nuclear whorls about six in a specimen 5.5 millim. high, slightly convex and apparently smooth, though with a strong lens fine spiral lines are visible. Periphery rounded. Aperture subovate, acute behind, produced and rounded in front. Columella-fold strong and oblique.

Dall and Bartsch figure a young as well as an adult specimen in which the anterior end of the aperture is somewhat different. Such a difference, though not so strong, is also found in our fossil.

Perfect specimens do not exceed 5.5 millim. in height with diameter 2 millim. But there is an imperfect one with the last three whorls preserved. It is 6 millim. in height and 3 millim. in diameter.

Fossil occurrence.—Otake (rare), Tega (do), Shito (not very rare).

Living.—Central and Western Japan.

138. ***Odostomia* (*Odostomia*) *kizakiensis***, Yokoyama.

Pl. IV. Fig. 29.

Shell small, elongate-conic. Post-nuclear whorls five, smooth, only a little convex and shouldered at the summit, so that the shell appears subtabulated. Body-whorl a little higher than one-half the height of the shell. Periphery broadly rounded, Base convex, Aperture ovate, pointed behind, a little produced and rounded in front. Lamellar plait distinct, oblique. Height 4 millim. Diameter 1.8 millim. A few specimens

Fossil occurrence.—Tega.

139. ***Odostomia* (*Odostomia*) *venusta***, Yokoyama.

Pl. IV. Fig. 30.

Shell small, elongate-oval. Post-nuclear whorls about four, somewhat convex, shouldered at the summit. Body-whorl very large, the height being more than double that of the spire. Periphery very broadly rounded. Aperture longly ovate, acute behind, much produced and rounded in front. Columella-fold very strong and oblique, its anterior portion forming the inner peristome of the anterior part of the aperture. Outer lip thin and simple. Umbilicus closed. Height 4 millim. Diameter 2 millim.

A. Adams describes a species found living at Awashima under the name of *Odostomia ovoidea* (Ann. Mag. Nat. Hist., 1860 p. 416) which seems to resemble the present fossil in form. But he says that the aperture is oblong and the fold small.

Fossil occurrence.—Otake, Shisui, Kioroshi, Shito (rather frequent). Oji in Musashi.

140. *Odostomia (Odostomia) toneana*, Yokoyama.

Pl. IV. Fig. 31.

Shell small, ovate-conic, rather solid. Post-nuclear whorls about five, smooth, convex with sutures very distinct. Body-whorl very large, a little higher than spire. Periphery rounded. Base convex. Aperture ovate, acute behind, produced and rounded in front. Columella-fold very strong, oblique, its anterior elongation forming the inner peristome of the anterior part of the aperture. Height 4 millim., of which the body-whorl seen from the apertural side occupies 2.6 millim. Diameter 2 millim.

In shape this species is like *Odostomia culta* Dall and Bartsch (Notes on Pyramidellidæ before quoted, p. 361, pl. XXVI, fig. 9), but it is shorter and has the whorls more convex.

Fossil occurrence.—Otake, Tega (not rare). Oji in Musashi.

141. *Odostomia (Odostomia) suboxia*, Yokoyama.

Pl. IV. Fig. 32.

A single specimen.

Shell small, ovate-conic. Whorls few, post-nuclear four, slightly convex, smooth. Sutures well marked. Body-whorl a little shorter than two-thirds the height of the shell. Aperture ovate, pointed behind, produced and rounded in front. Fold oblique, strong. Height 3 millim. Diameter 1.4 millim.

This shell is extremely like *Odostomia oxia* Watson (Challenger Gastr., p. 484, pl. XXXI, fig. 4) from North-East Australia, and if not for the faint spiral lines said to be found in the latter. I would unite the two.

Fossil occurrence.—Otake.

Living.—Central Japan.

142. *Odostomia (Odetta) neofelix*, Yokoyama.

Pl. IV. Fig. 33.

Shell small, ovate-conic. Whorls about five and a half, of which one and a half are nuclear. Post-nuclear ones convex, shouldered a little below the sutures giving the shell a tabulated appearance, spirally ribbed. Ribs flatly rounded, a trifle broader than the interspaces which are finely longitudinally striate, three on the first post-nuclear whorl, four on the next one, six on the penultimate and more than ten on the ultimate. Of the four ribs of the second post-nuclear whorl, the uppermost is much narrower than the others. Of the six ribs of the penultimate whorl, the uppermost is very faint and close to the suture, the next one rather distinct, but weak, the succeeding three larger and nearly equal in size, while the lowest one is somewhat weaker, though strong when compared with the second. On the body-whorl, the first subsutural rib is very weak, the next one somewhat stronger, the following still stronger and nearly equal in size, though they again diminish in size and get closer toward the caudal end of the shell. Periphery rounded. Base convex. Umbilicus open. Aperture oval, with posterior corner blunt and anterior rounded. Tooth weak but distinct, on the some level as the umbilical hole, the peristome anterior to it being a little reflexed outward. Height 3.2 millim. Diameter 1.6 millim. Height of body-whorl seen from apertural side 1.6 millim.

The species is closely related to *Odostomia felix* Dall and Bartsch (Notes on Pyramidellidæ before cited, p. 358, pl. XXI, fig. 2) now living in Japan. But the latter has fewer ribs and the umbilicus closed.

Fossil occurrence.—Shisui (very rare). Oji in Musashi.

Living,—Central Japan.

143. ***Odostomia (Egilina) marielloides***, Yokoyama.

Pl. IV. Fig. 34.

Shell small, ovate-conic. Post-nuclear whorls five, nearly flat, somewhat shouldered at the summit, so that the shell appears more or less tabulated, longitudinally costulate. Costulæ numerous, broadly rounded, close, broader than interspaces, somewhat oblique and flexuous, the lower end being more posterior than the upper. Body-whorl somewhat higher than spire. Periphery subangulate, bounded below by a puncticulate spiral groove which is on the same level as the suture of the last part of the body-whorl. Below this groove there are still a few more grooves of the same nature. Base abruptly narrowed. Aperture ovate, posteriorly pointed, anteriorly produced and rounded, with the margin somewhat reflexed outward. Outer lip thin, sharp. Columella-tooth weak, but distinct. Height 4 millim. Diameter 1.8 millim.

This shell resembles *Odostomia mariella* Dall and Bartsch (Notes on Pyram., p. 354, pl. XXII, fig. 4) in which, however, the apex is truncate and the costulæ oblique in the opposite sense, that is to say, with the lower end more anterior than the upper.

Fossil occurrence.—Otake (rare), Tega (do). Oji in Musashi.

Genus **TURBONILLA**, Risso.

144. ***Turbonilla (Ptycheulimella) misella***, Yokoyama.

Pl. IV. Fig. 36.

Shell small, elongate-conic. Nuclear whorls standing on edge at the summit. Post-nuclear whorls about seven only slightly convex, longitudinally plicate. Plicæ about sixteen on the whorl preceding the penultimate, flattened, with narrower interspaces, very weak and faint on the penultimate and obsolete on the body-whorl, so that the latter appears quite smooth. Periphery rounded. Aperture ovate, acute behind. Outer lip thin. Height 3.6 millim. Diameter 1.2 millim. A single specimen.

Fossil occurrence.—Otake, Tega.

145. ***Turbonilla (Chemnitzia) imbana***, Yokoyama.

Pl. IV. Fig. 35.

Shell small, elongate-conic, gradually tapering posteriorly. Nuclear whorls helicoid, standing on edge at the summit. Post-nuclear whorls about nine, somewhat convex, separated by deep sutures, longitudinally plicate. Plicæ twenty on the penultimate whorls, very obtuse, slightly curved, oblique, the lower end being more anterior than the upper. Interspaces between plicæ very narrow, much narrower than plicæ themselves which are free at both ends. Periphery somewhat angulate. Base abruptly narrowed, with only faint indications of plicæ. Aperture sub-quadrate, obtuse behind. Height 5 millim. Diameter 1.5 millim. Rare.

This is somewhat like *Turbonilla dunkeri* Clessin (Dall and Bartsch, Pyramidellidæ loc. cit., p. 336, pl. XX, fig. 3) in which, however, the interspaces between the plicæ are wider and the plicæ fuse with one another at the periphery.

Fossil occurrence.—Shisui (rare), Tega (do), Shito (do). Oji in Musashi.

Living.—Central Japan.

146. ***Turbonilla (Mormula) paucicostulata***, Tokunaga.

Pl. IV. Fig. 37.

Turbonilla paucicostulata. Tokunaga, Foss. Env. Tokyo, p. 22.

Tokunaga in the above work gives neither the description nor the figure of this species, but simply says that it is like *Turbonilla elegantissima* Mont., the only difference being in the number of whorls and ribs. The following description is based on the specimens left by him in the museum of the the Imperial University of Tokyo.

Shell medium-sized, elongate-conic. Nuclear whorls helicoid, standing on edge at the summit. Post-nuclear whorls eleven or twelve, flatly convex, longitudinally costellate and finely spirally striate. Costellæ rounded, about twenty on the penultimate whorl, slightly curved and oblique, the lower end being more forward than the upper, with broader interspaces, fused with one another at the lower suture. Occasionally two or three costellæ unite together to form a broad flat varix. Spiral striations very faint, visible only on interspaces which are provided at the lower end with a transverse pit. Periphery bluntly angulate. Base abruptly narrowed, with only faint indications of costellæ, besides a few feeble spiral threads. Aperture squarish, the inner lip being bent into an angle somewhat greater than a right angle Outer lip thin, nearly straight. Anterior margin of the aperture broadly rounded. Height 11.5 millim. Diameter 3.2 millim.

Fossil occurrence.—Otake, Shito. Oji in Musashi (frequent).

147. ***Turbonilla* (*Mormula?*) *scrobiculata*,** Yokoyama.

Pl. IV. Fig. 38.

Shell medium-sized, elongate-conic. Nuclear whorls three with the axis at right angles to that of the shell. Post-nuclear whorls about fourteen, moderately convex, longitudinally costellate. Costellæ blunt, generally straight though rarely somewhat flexuous or curved, nearly vertical, slightly narrower than interspaces, separate above, fused below at the suture, with a pit at the lower end of each interspace, occasionally forming a broad flat varix (by fusion of two or three costellae). The number of costellae is about twenty-three on the body-whorl on which they end at the subangulate periphery which is marked by a spiral cord formed by the fusion of the lower ends of the costellae. Base only with coarse lines of growth, rather flat, the convexity being very slight. Sutures deep. Aperture subquadrate. Inner lip bent at an obtuse angle in the middle. Outer lip thin. Height 11 millim. Diameter 2 millim.

This shell is like the preceding, but the whorls are more numerous and have no spiral striations.

Fossil occurrence.—Otake (rare). Oji in Musashi.

Living.—Central Japan.

148. *Turbonilla (Chemnitzia) kidoensis*, Yokoyama.

Pl. IV. Fig. 39.

Shell rather small, elongate-conic. Nuclear whorls decollated. Post-nuclear whorls many (ten ?), convex, longitudinally costellate. Costellæ numerous, about twenty-eight on the body-whorl, obtuse, slightly oblique and somewhat flexuous, broader than interspaces, ending at the rounded periphery of the body-whorl. Base convex, smooth. Aperture subquadrate, the inner lip being bent at an angle which is a little greater than a right angle. Height 11 millim.(?) Diameter 2.5 millim. A single specimen.

Fossil occurrence.—Tega.

Living.—Central Japan.

149. *Turbonilla (Chemnitzia) teganumana*, Yokoyama.

Pl. IV. Fig. 40.

Shell rather small, elongate-conic. Nuclear whorls standing on edge at the summit, post-nuclear whorls about eight, nearly flat, somewhat shouldered at the upper margin, longitudinally costellate. Costellæ rounded, broader than interspaces, nearly straight, slightly oblique with the upper end more forward than the lower, about twenty on the penultimate, nearly obsolete on the body-whorl. Periphery rounded. Base convex, smooth. Aperture pear-shaped, the posterior angle being a little less than a right angle. while the angle in the middle of the inner lip is much greater. Height 6,5 millim. Diameter 2 millim.

Two specimens. In the smaller one (only 4.5 millim. high) the number of post-nuclear whorls are seven and the costellæ are also distinct on the body-whorl, but they vanish near the periphery.

Fossil occurrence.—Tega.

Living.—Central Japan.

150. *Turbonilla (Chemnitzia) sematana*, Yokoyama.

Pl. IV. Fig. 41.

Shell small, elongate-conic. Nuclear whorls standing on edge at the summit. Post-nuclear whorls six, a little convex, longitudinally ribbed. Ribs broad, flatly rounded, separated by much narrower interspaces, slightly flexuous and oblique, about sixteen on the body-whorl in which they end at the periphery without fusing with one another. Periphery subangulate. Base convex, smooth. Aperture subquadrate, the inner lip bending in the middle at a broad angle. Height 4 millim. Diameter 1.3 millim. Rare.

Fossil occurrence.—Shito.

151. ***Turbonilla*** (***Pyrgolampros***) ***planicostata***, Yokoyama.

Pl. V. Fig. 11.

Shell small, elongate-conic. Nuclear whorls two, smooth, rounded, standing on edge at the summit. Post-nuclear whorls about nine, moderately convex, straight, nearly vertical, twenty-one on the penultimate and twenty-three on the ultimate whorl, separated by much narrower interspaces which are finely spirally striate. On the body-whorl the costellæ continue a little into the convex base and then vanish, leaving the place near the umbilicus smooth. Periphery rounded. Aperture oval, the bending of the inner lip in its middle being slight. Height 7.3 millim. Diameter 2 millim. A single specimen.

This species is still living, and the shell, when fresh, is ornamented with two chestnut spiral bands, the one in the middle of the whorls and the other near the lower suture. In the fossil the upper band is distinctly preserved.

Fossil occurrence.—Shisui.

Living.—Central Japan.

152. ***Turbonilla*** (***Strioturbonilla***) ***sagamiana***, Yokoyama.

Pl. V. Fig. 12.

Shell small to medium-sized, elongate-conic. Nuclear whorls one and a half, immersed to a greater part in the first post-nuclear whorl. Post-nuclear whorls nine, flat, somewhat shouldered at the summit and contracted near the lower suture. The sculpture consists of longitudinal costellæ and spiral threads and striae. Costellæ numerous (over thirty on the body-whorl), weak. obtuse, flexuous, oblique, wider than interspaces, very indistinct on the last part of the body-whorl, united a little above the lower suture by a spiral thread followed below by a suprasutural spiral one. Just above the upper thread there is a faint impressed spiral line crossing the costellæ. Intervals between costellæ furnished with very fine spiral striations intersecting growth-lines. Periphery obtusely angulate. Base convex, with fine spiral line cutting those of growth. Umbilicus with a small chink. Aperture ovate, somewhat pointed behind. produced and rounded in front. Inner lip bent in the middle at a very broad angle. Outer lip thin. Height 8 millim. Diameter 2. 5 millim.

Fossil occurrence.—Rarely at Otake.

Living.—Central Japan.

153. ***Turbonilla*** (***Strioturbonilla***) ***pacifica***, Yokoyama.

Pl. V. Fig. 13.

Shell small, elongate-conic. Nuclear whorls standing on edge at the summit. Post-nuclear whorls eight, somewhat convex, longitudinally costellate. Costellæ flatly rounded, very slightly curved or sometimes even a little flexuous, somewhat oblique, about eighteen on the body-whorl. Interspaces very narrow, much narrower than costellæ themselves, very finely spirally striate. Periphery subangulate, the costellæ ending at this place. Base convex, smooth. Aperture subquadrate. Inner lip oblique in the upper half, vertical in the lower. Outer lip nearly vertical. Anterior margin of the aperture rounded. Height 9.5 millim. Diameter 1.2 millim. Rare.

Fossil occurrence.—Shito.

Living.—Central Japan.

154. ***Turbonilla*** (***Cingulina***) ***triarata***, Pilsbry.

Pl. V. Fig. 14.

Turbonilla (*Cingulina*) *triarata*. Pilsbry, New Jap. Mar. Moll., Gastr., Proc. Acad. Nat. Sci. Philad., Jan. 1904, p. 31, pl. V, fig. 48.

A slender shell with flat whorls (post-nuclear thirteen) ornamented with three spiral grooves. Sutures channelled. The largest specimen measures nearly 8 millim. in height and 2 millim. in diameter. Not rare.

Fossil occurrence.—Otake, Shisui.

Living.—Western Japan.

155. *Turbonilla* (*Careliopsis?*) *obscura*, Yokoyama.

Pl. V. Fig. 15.

A single specimen.

Shell small, elongate-conic. Nuclear whorls standing on edge at the summit. Post-nuclear whorls six, convex, very finely spirally striate, the striæ crossing the growth-lines and giving the surface a reticulate appearance which, however, can only be seen with a strong lens. Body-whorl comparatively large, about one-fifth the shell-height. Periphery rounded. Aperture ovate, produced and rounded in front. Inner lip describing a broad curve. Outer lip fractured. Height 5 millim. Diameter 1.5 millim.

Fossil occurrence.—Shito.

156. *Turbonilla* (*Careliopsis?*) *angulifera*, Yokoyama.

Pl. V. Fig. 16.

Shell small, elongate-conic. Whorls about ten, of which one and a half are nuclear and smooth. Post-nuclear whorls angulate in the middle, the angle becoming gradually obtuse as the whorls grow, on the penultimate and ultimate whorls almost obsolete, so that they look quite convex. Spirally striate; striæ about ten, close, separated only by fine impressed lines. Periphery angulate. Base flatly convex, smooth. Aperture subquadrate, the inner lip being bent at an angle a little greater than a right angle. Outer lip thin. Height 6 millim. Diameter 1.8 millim. Only two specimens, one of which lacks the body-whorl.

Fossil occurrence.—Shito.

Family Turbinidæ.

Genus **TURBO**, Linné.

157. *Turbo (Marmorostoma) granulatus*, Gmelin.

Pl. V. Fig. 10.

Turbo (Marmorostoma) granulatus. Pilsbry, Catalogue, p. 89.

Turbo granulatus. Lischke, Jap. Meeresconch., I, p. 87. Tokunaga, Foss. Env. Tokyo, p. 28, pl. I, fig. 59.

Turbo coronatus var. granulata. Tryon, Man. Conch., vol. X, p. 27, pl. 46, fig. 18.

Lunella granulata var. minor. Dunker, Ind. Moll., p. 128.

Putting aside the question whether *Turbo granulatus* is an independent species or merely a variety of *Turbo coronatus* Gm. as asserted by some, a single specimen obtained is a depressed-turbinate shell with about five whorls ornamented with a spiral series of nodules and granules of which the sub-and supra-sutural series are the most prominent. On the body-whorl there are four such prominent series; the uppermost is subsutural, the next is in the continuation of the suprasutural of the penultimate whorl, the third is at the periphery and the fourth is somewhat below the periphery on the base, the place where the last three are present being more or less angulate. Umbilicus open.

Fossil occurrance.—Narita near Otake.

Living.—Central and Western Japan. China. Indian Ocean.

Genus **Leptothyra**, Carpented.

158. *Leptothyra purpurescens*, (Dunkar).

Leptothyra purpurescens. Pilsbry, Catalogue, p. 90. Tryon, Man. Conch., X, p. 251, pl, 69, fig. 24. Yokoyama, Foss. Miura Penin., p. 86, pl. v, fig. 22.

Collonia purpurescens. Dunker Ind. Moll., p. 129, pl. XII, figs. 1—3.

This shell already described by me from the Lower Musashino of Miyata is very numerous wherever it is found. Yet even the largest specimen is not larger than that found in the above formation, being only about 11 millim. in height and diameter.

Fossil occurrence.—Otake, Shisui, Tega, Shito (most numerous). Lower Musashino of Miyata.

Living.—Japan (Dunker)

159. ***Leptothyra pygmaea***, Yokoyama.

Pl. V. Fig. 17.

Shell small, turbinate. Whorls four, rapidly growing, shouldered, the surface above the shoulder a little sloping and below angulate in the middle. The sculpture consists of spiral threads which are commonly alternately large and small. The shoulders are marked with a large thread above which, that is to say, on the sloping shelf, there are two larger ones. The angle below the shoulder is also marked with a coarse thread. On the body-whorl, between the shoulder and the angle, there is another coarse thread, though somewhat weaker, and between the latter and the angulate periphery there is also a similar one. Between the coarser threads there is generally found a weaker one as stated above. The base is flatly convex with several spiral threads. Growth-lines generally distinct between the threads and looking like minute striations. Umbilicus perforate, rather small but deep. Aperture circular. Height and diameter 4 millim.

Fossil occurrence.—Tega (frequent).

Living.—Central Japan.

160. ***Leptothyra crassilirata***, Yokoyama.

Pl. V. Fig. 22.

Shell small, turbinate. Whorls about four, angulate in the middle with the surface above the angle flat and gently sloping, below vertical, spirally ornamented with threads and cords which are altogether five on the penultimate whorl, one at the angle and two both above and below the same, the two above being weaker than the other three. On the body-whorl there is another strong cord at the periphery which makes it angulate. The spaces between the cords are longitudinally finely striated by incremental lines. Base abruptly narrowed, rather flattened, with several spiral threads which gradually diminish in size toward the narrowly perforate umbilicus. Aperture circular. Height and diameter 3.5 millim.

Fossil occurrence.—Tega (rare)
Living.—Central Japan.

Family Trochidæ.

Genus **TROCHUS**, Linné,

161. ***Trochus spinigera***, Yokoyama.

Pl. V. Fig. 18.

Shell small, conical. Whorls about six, slightly convex, furnished with unequal spiral threads set with numerous, close, pointed, spine-like tubercles. Each whorl has two main threads which divide it into three nearly equal parts with a finer thread on each. Periphery angulate, with a smooth thread on it. Base flattened, spirally grooved; grooves several, the outermost the broadest, the other ones being more like impressed lines, although the innermost one or two are somewhat stronger. Aperture (outer lip fractured) roundly quadrate. Height 5 millim. Diameter 4 millim.

A single specimen, but very characteristic by its spinose tubercles.

Fossil occurrence.—Shito.

Genus **MINOLIA**, A. Adams.

162. ***Minolia tasmanica***, Tenison-Woods.

Pl. V. Fig. 19.

Minolia tasmanica. Tryon, Man. Conch., XI, p. 263, pl. 61, figs. 38—40.
Margarita (*Minolia*) *tasmanica.* Tenison-Woods, Proc. Roy. Soc. Tasm., 1876, p. 143 (1877)

Shell small, thin, depressed, with a low-conoidal spire. Whorls about five, terraced above, convex below. Terraces horizontal, flat or even somewhat concave, with very fine spiral lines. Convex surface spirally striate; striæ equal, close, six on the penultimate whorl. Periphery rounded. Base convex with several close spiral striæ. Umbilicus open, with walls funnel-like and outer margin rounded. The walls may be very steep or not; in the first case the hole at the bottom is comparatively large, while in the second it is comparatively small. Aperture subcircular. Columella-lip covered with a thin callus. Outer lip thin. Height 3.5 millim. Diameter of shell 4.5 millim. Diameter of umbilical margin about 1.5 millim.

A few specimens, all of which are smaller than those described by Tryon and Tenison-Woods.

Fossil occurrence.—Otake, Shito.

Living.—Tasmania.

Genus **SOLARIELLA**, Woods.

163. ***Solariella philippensis***, Watson.

Pl. V. Fig. 21.

Solariella philippensis. Watson, Challenger Gastr., p. 73, pl. VI, fig. 10.

Shell small, turbinate-conic, thin. Whorls about five, sharply angulate a little above the middle. Surface above the angle flat, nearly horizontal or a little sloping, below very steep, flat or very slightly convex. The sculpture consists generally of two spiral threads, the one forming the angle and the other situated near the lower suture. Between these two, there are often one or two fainter threads which sometimes may become rather coarse. Besides the spiral threads, oblique lines of growth are everywhere conspicuous, giving the shell a longitudinally striated appearance. Periphery angulate with a thread upon it, striated by the above mentioned lines of growth. Base slightly convex, with a few spiral threads either on the whole surface or only near the large open umbilicus. Umbilical margin bluntly angulate. Umbilical wall very steep and ornamented with spiral striæ crossed by lines of growth. Bottom-hole tolerably large. Aperture subcircular, with peristome discontinuous. Outer lip thin. Height and Diameter 4 millim.

The original colour of the shell is preserved in many specimens. On the terrace above, there are several lathe-shaped dark purplish blotches in a spiral row. Such blotches are also found on the steep lateral surface near the suture. On the base there is a row of rectangular patches of the same colour.

Specimens are all smaller than those described by Watson.

Fossil occurrence.—Otake (not rare), Tega (rare), Shito (do). Oji (numerous).

Living.—Central Japan. Off Port Phillip, South Australia.

164. ***Solariella angulata***, (Tokunaga).

Pl. V. Fig. 20.

Trochus (*Minolia*) *angulatus*. Tokunaga, Foss. Env. Tokyo, p. 36, pl. II, fig. 5.

Shell medium-sized, turbinate-conic, rather thin. Whorls about six, shouldered; shoulders furnished with a spiral cord, the surface above the cord being slightly excavated (a character not distinct in younger whorls), below somewhat convex with four narrow spiral grooves. These grooves make the interspaces look like broad flattish spiral cords of which the third from above is some what broader and more elevated than the others. Lines of growth elevated and prominent on the younger whorls, looking like longitudinal striations. On the body-whorl these lines are not so prominent, though quite coarse. Periphery rounded. Base convex with several inequidistant spiral grooves. Umbilical margin rounded. Umbilical wall with several spiral grooves, the spaces being convex, cord-like and often made crenate by coarse lines of growth. Aperture circular with thin continuous peristome. Height 11 millim. Diameter 12 millim.

The original colour of the shell is present on many specimens as brown longitudinal streaks.

Fossil occurrence.—Shito (very frequent). Oji in Musashi.

Genus **TURCICA**, A. Adams.

165. ***Turcica imperialis***, A. Adams.

Pl. V. Fig. 23.

Turcica imperialis. A. Adams, Proc. Zool, Soc. Lond., 1863, p. 507. Pilsbry, Catalogue, p. 98, in Tryon's Man. Conch., XI, p. 414, pl. 63, figs. 30, 31. Yokoyama, Foss. Miura Penin., 10. 91, pl. V. fig. 31.

Trochus imperialis. Lischke, Jap. Meeresconch., III, p. 67, pl. IV, figs. 5,6. Tokunaga, Foss. Env. Tokyo, p. 28 pl. I, fig. 60.
Trochus adamsianus. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 358, pl. XVI, fig. 3.

A few specimens.

Fossil occurrence.—Shito. Shinagawa in Musashi. Lower Musashino of Miyata.

Living.—Northern, Central and Western Japan.

Genus **CALLIOSTOMA**, Swainson.

166. ***Calliostoma unicum* (*Dunker*), *var. shinagawensis***, Tokunaga.

Pl. V. Fig. 25.

Trochus (*Calliostoma*) *shinagawensis.* Tokunaga, Foss. Env. Tokyo, p. 29, pl. II, fig. 4.

Shell turbinate-conic, pretty solid. Whorls eight, first two nuclear, smooth and rounded. Post-nuclear whorls shouldered a little above the middle; surface above shoulder flat. somewhat sloping, below steep with a slight angulation a little above the middle. Sculpture: Shoulders as well as angles with a coarse spiral cord on them; flat surfaces with spiral threads which are mostly alternately large and small. Of the larger threads, the subsutural one is coarse, somewhat weaker than, or nearly as strong as, the shoulder-cord, consisting of a series of more or less transversely elongated grains. The coarser threads found on the shelf above may likewise become granulate, especially on the older whorls. Body-whorl angulate, with a strong cord on the angle. Base convex, with many unequal spiral threads which are often made graniferous by incremental lines. Umbilicus closed, though in some specimens it is excavated. Aperture roundly quadrate. the breadth being a little greater than the height. Outer lip thin. Height 21 millim. Diameter 22 millim. In younger specimens, the cords as well as the threads are much sharper and all granulate. The figure given by Tokunaga is that of such a specimen.

Tokunaga considered this as a new species, but it is so closely allied to *Calliostoma unicum* Dunker (Moll. Jap., p. 23, pl. III, fig.

3) living in Northern to Western Japan that it can not be considered as more than a variety. The chief difference of the fossil is in the angulation of the whorls being sharp and distinct, while it is less sharp or even indistinct in the living form. Besides, the fossil shows on its base spiral threads instead of distant spiral grooves.

Fossil occurrence.—Otake (frequent), Shisui, Tega, Shito (frequent). Shinagawa (rare).

Genus **BASILISSA**, Watson.

167. ***Basilissa? læviuscula***, Yokoyama.

Pl. V. Fig. 24.

Shell thin, turbinate-conic. Whorls about six of which the first two are nuclear and rounded. Post-nuclear whorls convex, with two faint angulations dividing the surface into three nearly equal parts. Each angulation marked by a fine spiral stria. Surface between angulations very finely spirally striate, the striæ being visible only with a magnifier. Periphery sharply angulate and somewhat projecting above the general surface of the body-whorl. Base convex with very fine spiral lines. Umbilicus provided with a chink. Aperture irregularly and roundly four-sided. Outer lip very thin. Height 8 millim. Diameter 7 millim.

A single specimen. The nuclear whorls are coloured dark brown, while the remaining part is dirty light green. These colours may be the remains of some original coloration.

Fossil occurrence.—Shito.

Genus **UMBONIUM**, Link.

168. ***Umbonium giganteum***, (Lesson).

Umbonium giganteum. Pilsbry in Tryon's Man. Conch., XI, p. 454, pl. 58, figs. 17–19. Catalogue, p. 100. Dunker, Ind. Moll., p. 134. Yokoyama, Foss. Miura Penin., p. 94, pl., VI, fig. 5.

Rotella gigantea. Lesson, Illustr. de Zool., tome 17, 1831. Kiener, Spec. et Icon. Coq. Viv., p. 16, Pl. 3, fig. 7. Sowerby, Thes. Conch., V, p. 136, pl. 472, figs. 15, 16.

Globulus giganteus. Lischke, Jap. Meeresconch., III, p. 63.

A single specimen, but readily recognized by its smooth whorls.

Fossil occurrence.—Tega. Lower Musashino of Naganuma.

Living.—Central and Western Japan.

169. *Umbonium costatum*, (Valenciennes).

Umbonium costatum. Pilsbry in Tryon's Man. Conch., XI, p. 454, pl. 59, figs. 34, 35. Dunker, Ind. Moll., p. 134. Yokoyama, Foss. Miura Penin., p. 95, pl. VI, fig. 6.
Rotella costata. Valenciennes in Kiener's Spec. et Icon. Coq. Viv., p. 10, pl. II, fig. 2.
Globulus costatus. Lischke, Jap. Meeresconchylien, I, p. 91. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 367.

Many specimens of which one is nearly as large as the preceding species.

Pilsbry in his Catalogue p. 101 mentions *Umbonium superbum* Gould as a mere variety of *Umbonium costatum.* I should go a step further and make no distinction between the two, as it is impossible to distinguish them when they are present in numerous specimens. Pilsbry himself says that the only difference is in size, but even this character fails to be applicable in many cases.

I leave the question open as to whether *Umbonium moniliferum* Lam. which is often like *U. superbum* is a good species or not.

Fossil occurrence.—Otake (frequent), Shisui (do), Kioroshi, Tega, Shito. Lower Musashino of Naganuma.

Living.—Northern, Central and Western Japan.

Family **Cyclostrematidæ.**

Genus **CYCLOSTREMA**, Marryatt.

170. *Cyclostrema stillicidiatum*, Yokoyama.

Pl. V. Fig. 26.

Shell small, depressed-globose, thick. Whorls three. smooth, rounded. Body-whorl with a blunt keel a little below the upper suture, the surface between being shallowly excavate. Periphery rounded. Base convex, with distinct lines of growth. Umbilicus open, large, with margin bluntly angulate and wall nearly vertical. Aperture oval, with the longer axis slightly oblique, sharply rounded behind, broadly in front. Peristome continuous, thick. Height 25 millim. Diameter 2 millim. A single specimen.

This is somewhat like *Cyclostrema sulcatum*, Watson (Challenger Gastr., pl. VIII, fig. 11) which, however, has the umbilicus much larger.

Fossil occurrence.—Shito.

Family Stomatellidæ.

Genus **STOMATELLA**, Lamarck.

171. ***Stomatella lyrata***, Pilsbry.

Pl. VI. Fig. 2.

Stomatella lyrata. Pilsbry in Tryon's Man. Conch., XII., p. 12, pl. 2, figs. 3–5. Catalogue, p. 104.

A depressed-globose shell with a short spire and three convex, rapidly growing whorls. The sculpture consists of distant spiral threads with interspaces latticed by oblique raised striæ.

Only three specimens, the largest measuring 6 millim. in height and 8.5 millim. in diameter.

Fossil occurrence.—Otake, Tega.

Living.—Northern, Central and Western Japan.

Family Fissurellidæ.

Genus **MACROSCHISMA**, Swainson.

172. ***Macroschisma sinensis***, A. Adams, ***var. brevis***, Yokoyama.

Pl. VI. Fig. 3.

Shell oblong with the length a little less than twice the breadth. Lateral margins straight (or very slightly concave), parallel. Anterior margin rounded, posterior also in general rounded, but truncated in its middle portion. Anterior slope somewhat convex and a little longer than half the length of the shell. Lateral slopes straight and flat. Posterior slope very short, a trifle longer than the eroded portion behind the hole, broad and shallowly excavated like a gutter. Hole wedge-shaped with nearly straight sides, very narrow in front, gradually becoming broader toward behind where it is broadly rounded, having the length a little greater than one-third that of the shell. Peristome horizontal laterally, curved up both in front and behind, less so in the former than in the latter.

Two specimens. The larger shows the following dimensions: Length 15.5 millim.; breadth 8 millim.; height 4.2 millim.; length of hole 5.5 millim. By comparing it with the typical specimens of this species (Pilsbry's Cat., p. 107 and Tryon's Man. Conch., XII, p. 190, pl. 59, figs. 56–59), the shell is somewhat shorter, and in outline more like *Macroschisma lischkei* Pilsbry (Cat., p. 108, pl. VI, figs. 1–5) which, however, differs from the fossil in many minor points.

Fossil occurrence.—Otake, Tega. Lower Musashino of Yokosuka (typical form).

Living.—The typical form of the species lives in Central Japan, China, and Singapore.

Genus **PUNCTURELLA**, Lowe.

173. ***Puncturella nobilis***, (A. Adams).

Pl. VI. Fig. 4.

Puncturella nobilis. Pilsbry, Catalogue, p. 109. In Tryon's Man. Conch., XII, p. 231, pl. 63, figs. 34–37.

Cemoria nobilis, A. Adams in Sowerby's Thes. Conch., III, p. 208, figs. 6–9. Sowerby in Reeve's Conch. Icon., XIX, fig. 6. Dunker, Index Moll., p. 154.

A. Adams gives the description of this species as follows: "Elevated-conical, vertex acuminate, inclined, acute; radiating ribs strong, equidistant; interstices concentrically striated. Fissure narrow, lanceolate. Margin deeply crenulated. Resembling *Cemoria cucullata* Gould, but with the ribs stronger, wider apart and equal; the apex moreover is considerably more elevated and acute."

Two specimens, the larger of which is only a fragment. The other which is 7 millim. long, 6 millim. broad and 5 millim. high, has about nineteen radiating ribs between which there is always a weaker interstitial not attaining the apex.

Fossil occurrence.—Shito.
Living.—Northern Japan.

Genus **EMARGINULA**, Lamarck.

174. ***Emarginula radososinuata***, Yokoyama.

Pl. VI. Fig. 5.

Shell low-conic, thick, the apex recurved, situated at a little less than the posterior third of the length of the shell. Sculpture consisting of numerous riblets latticed by elevated lines of growth. Riblets unequal especially on the posterior slope where they are alternately large and small. The riblets of the anterior portion of the shell are more equal, although occasionally with a fine thread between. Aperture somewhat elongate-oval, tapering in front. Slit very shallow, looking like a slight notch. Slit-fasciole a little elevated, ornamented with raised lamellæ. Height 8 millim. Length 23 millim. Breadth 15 millim. Rare.

This shell is like *Subemarginula* in having the slit shallow, but the slit-band is elevated and distinct as in *Emarginula*.

Fossil occurrence.—Shito.

Family **Patellidæ**.

Genus **HELCIONISCUS**, Dall.

175. ***Helcioniscus pallidus***, (Gould).

Helcioniscus pallidus. Pilsbry in Tryon's Man. Conch , XIII, p. 133, pl. 67, figs. 9, 10. Catalogue, p. 112. Yokoyama, Foss Miura Penin., p. 101, pl. VI, figs. 16,17.

Patella pallida. Gould, Proc. Bost. Soc. Nat. Hist., VII, p. 162. Dunker, Ind. Moll., p. 156. Lischke, Jap. Meeresconch., I, p. 112.

Patella lamanonii. Schrenck, Moll. d. Amurl. u. d. nordjap. Meeres, p. 303, pl. XIV, figs. 6–9.

A single specimen. This species has already been described from the Lower Musashino in my work above quoted.

Fossil occurrence.—Shito. Lower Musashino of Miyata and Koshiba.

Living.—Northern and Central Japan.

Class SCAPHOPODA.

Family Dentalinidæ.

Genus DENTALIUM, Linné.

176. ***Dentalium weinkauffii***, Dunker.

Pl. VI. Fig. 6.

Dentalium weinkauffii. Dunker, Ind. Moll , p. 153, pl. V, fig. 1. Pilsbry, Catalogue, p. 116. In Tryon's Man. Conch., XVII, p. 40, pl. II, fig. 26. Yokoyama, Foss. Miura Penin., p. 102, pl. VI, fig. 19–21.

Dentalium cf. weinkauffii. Tokunaga, Foss. Env. Tokyo, p. 33, pl. II, fig. 16.

The ribs which are present only on the apical portion of the shell are often unequal, being then alternately large and small.

Specimens are very frequent at some places, as at Otake and Shito.

Fossil occurrence.—Otake, Shisui. Kioroshi, Tega, Shito. Shinagawa in Musashi. Lower Musashino of Naganuma, Koshiba, Kanagawa. and Miyata.

Living.—Central Japan.

177. ***Dentalium octogonum***, Lamarck.

Dentalium octogonum. Lamarck, Anim. sans Vert., V, p. 344. Lischke, Jap. Meeresconch , II, p. 103, III, p. 75, pl. V, figs. 1–3. Dunker, Ind. Moll., p. 153. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 381. Brauns, Geol. Env. Tokio, p. 95. Tokunaga, Foss. Env. Tokyo, p 33, pl. II, fig. 15. Yokoyama, Foss. Miura Penin., p. 103, pl. VI, figs. 22–24.

This Dentalium already known by the names of *D. octangulatum*, *D. hexagonum* and *D. sexcostatum* is represented by a few fragments which are either six-, eight-, or nine-sided. The angles are ribbed in some specimens, having several finer riblets between.

Fossil occurrence.—Otake and Shito. Oji and Shinagawa. Lower Musashino of Miyata, Yokosuka and Naganuma.

Living.—Northern. Central and Western Japan. China, Australia. Ceylon.

178. *Dentalium edoense*, Tokunaga.

Dentalium edoense. Tokunaga, Foss. Env. Tokyo, p. 34. pl. II, fig. 17. Yokoyama, Foss. Miura Penin., p. 103, pl. VI, fig. 28.

This apparently smooth-shelled form is very frequent at some places, although mostly in fragments.

Fossil occurrence.—Otake, Shisui, Tega, Shito. Oji and Shinagawa in Musashi. Lower Musashino of Miyata, Yokosuka and Naganuma.

Living.—Central and Western Japan.

179. *Dentalium (Fustiaria) nipponicum*, Yokoyama.

Pl. VI. Fig. 7.

Shell rather small, slightly curved, pretty rapidly growing smooth, circular in section, provided with a deep narrow slit not quite straight and often with the sides not strictly parallel, some parts swelling in breadth. Posterior opening narrowed, longly ovate.

The specimens, though numerous, are more or less broken at the larger end. The largest measures 27 millim. in length, and 3 millim. in diameter (larger end) with the slit 4 millim. in length.

Fossil occurrence.—Shito.

Class LAMELLIBRANCHIATA.

Order Teleodesmacea.

Family Pholadidæ.

Genus PHOLAS, Linné.

180. *Pholas fragilis*, Sowerby.

Pholas fragilis. Sowerby, Thes. Conch., vol. II, p. 488, pl. 108, figs. 92, 93. Lischke, Jap. Meeresconch., I, p. 143. Yokoyama, Foss. Miura Penin., p. 104, pl. VI, fig. 29.

Barnea fragilis. Dunker, Ind. Moll., p. 170.

A right valve not quite perfect. Its anterior end is obtusely pointed.

Fossil occurrence.—Otake. Lower Musashino of Yokosuka.

Living.—Northern and Western Japan. Philippines.

Genus **JOUANNETIA**, Desmoulins.

181. ***Jouannetia kamakurensis***, Yokoyama.

Pl. VI. Fig. 10.

A single fractured right valve which, however, agrees exactly with a living shell picked up on the coast of Kamakura.

Shell small, roughly four-sided in outline, with surface divided into two parts by a mesial groove. The anterior half is very convex with the dorsal margin very short and slightly concave, and the ventral margin steeply ascending, almost twice as long as the dorsal, and at first straight, but excavated near the upper end, so that the front border of the shell becomes pointed, though blunt at apex. The sculpture consists of concentric and radiating riblets. The radiating riblets are unequal, rather distant, about ten in number, alternately large and small in the middle portion of the surface and quite absent in a small space immediately bordering the mesial groove. The concentric riblets are close, rounded and going over the radiating ones, giving them a crenate appearance. The margin is also crenate. The dorsal margin of the posterior half of the shell is double the length of that of the anterior half, scarcely convex, sloping, the meeting point with the ascending, somewhat undulatory ventral margin being subtruncate. Margin smooth.

The fossil specimen is only 4.5 millim. in length and 3.6 millim. in height, while a recent one from Kamakura is 7.6 millim by 5.2 millim.

Allied to *Jouannetia japonica* Yokoyama (Fossils from Miura Peninsula, p. 105, pl. VII. Fig. 5) from the Lower Musashino which, however, shows a coarser sculpture.

Fossil occurrence.—Shito.

Living.—Central Japan.

Family Saxicavidæ.

Genus **PANOPE**, Menard.[1]

182. ***Panope generosa*** (Gould).

Pl. VI. Fig. 14, 15.

Panopæa generosa. Gould, Proc. Bost. Soc. Nat. Hist., vol. III, p. 215. Wilke's Expedition, p. 385, pl. XXXIV, fig. 507. Otia Conch., p. 165. Brauns, Geol. Env. Tokio, p. 36, pl. III, fig. 14. Tokunaga, Foss. Env. Tokyo, p. 38. Dall, Tert. Fauna Florida, pt. IV, p. 830. Arnold, Pal. & Strat. Mar. Plioc. a. Pleist. San Pedro, California, p. 182.

Glycimeris generosa. H. and A. Adams, Gen. Rec. Moll., p. 350. Gabb, Pal. Cal., II, 89. Keep, West Coast Shells, p. 209, fig. 178. Pilsbry, Cat. Mar. Moll. Jap., p. 117.

This shell excellently figured by Brauns in his work above cited is very variable in shape as well as in thickness. The typical form is rather thin-shelled, nearly equilateral, transversely oblong, anteriorly rounded, posteriorly subtruncate, with the proportion of length to height equal to about 10 to 6.6 on an average. But there is also a more elongated arcuate form characterized by a thick and solid shell with the length nearly twice the height.

Dall in his ,,Tertiary Fauna of Florida'' p. 831, mentions two varieties of the species which he calls *solida* and *globosa*, of which var. *solida* seems to correspond to our longer form, although I can not assert it with certainty, as he does not give figures of his so-called varieties.

In our plate, the typical as well as the longer form is figured.

Fossil occurrence in Japan.—Otake (frequent), Tega, Semata. Also Oji and Shinagawa.

Fossil occurrence in America.—Miocene, Pliocene and Pleistocene of California.

Living.—Northern Japan. West Coast of N. America from Puget Sound to San Diego.

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1) Often written erroneously *Panopæa* (Zittel's Text-book of Palæontology edited by Eastman 1913, p. 500).

Genus **SAXICAVA**, Fleuriau de Bellevue.

183. ***Saxicava orientalis***, Yokoyama.

Saxicava orientalis. Yokoyama, Foss. Miura Penin., p. 106, pl. VII, fig. 2, 3.

A left valve much larger than the specimens hitherto obtained, but not quite perfect. The general shape and the thin state of the shell are, however, alike.

Fossil occurrence.—Shito. Lower Musashino of Yokosuka.

Family **Corbulidæ**.

Genus **CORBULA**, Bruguière.

184. ***Corbula erythrodon***, Lamarck.

Pl. VI. Figs. 8, 9.

Corbula erythrodon. Lamarck, Anim. sans Vert., VI, p. 138. Lischke, Jap. Meeresconch., I, p. 136. Dunker, Ind. Moll., p. 176. Pilsbry, Catalogue, p. 117. Reeve, Conch. Icon., Corbula, pl. I, fig. 4.

This species is easily recognized by its thick, ovate, nearly equilateral, carinated shell which is concentrically grooved on the surface. A perfect specimen with both valves preserved measures 25 millim. in length, 14 millim. in height and 9 millim. in thickness.

Together with the typical specimens, there occur several which are rather thin-shelled, but without any marked difference in shape. Such thin-shelled ones occur also among the living, the two being bridged over by intermediate forms.

Fossil occurrence.—Otake (rare). Kioroshi (do).

Living.—Central and Western Japan.

185. ***Corbula venusta***, Gould.

Corbula venusta. Gould, Bost. Soc. Nat. Hist., vol. VIII, p. 25. Otia Conchologica, p. 164. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 505, pl. XXV, figs. 1–4. Dunker, Index Moll., p. 177. Tokunaga, Foss. Env. Tokyo, p. 39, pl. II, fig. 22. Yokoyama, Foss. Miura Penin., p. 107, pl. VII, figs. 4–6. Pilsbry, Catalogue, p. 117.

This species which is now living in Northern Japan is frequent at some localities.

Fossil occurrence.—Otake, Shisui, Kamenari, Tega, Shito. Oji in Musashi. Lower Musashino of Miyata, Yokosuka, Koshiba and Naganuma.

186. ***Corbula frequens***, Yokoyama.

Pl. VI. Fig. 16. 17.

Shell rather thick and solid, triangular in outline, moderately swollen, inequivalve, subequilateral, anterior side a little longer than posterior, anterior margin broadly rounded, posterior obliquely truncate (the obliquity being very variable; when it is very great, the truncation becomes indistinct and the posterior end appears more or less beaked), ventral margin arcuate. Surface with rough lines of growth making it more or less concentrically undulate. A blunt keel runs from the beak to the postero-ventral corner of the shell. Tooth of the right valve strong and triangular, that of the left smaller and divided into two lobes by a groove running longitudinally. Pallial line distinct, with sinus very shallow. Anterior muscular impression elongated, with the lower half broader than the upper, posterior ovate.

The following are some of the measurements:

	Length.	Height.	Depth.
Right valve (very obliquely truncate).	31.4 millim.	23.2 millim.	9.4 millim.
,, ,, (less ,, ,,).	22.8 ,,	16.8 ,,	6.5 ,,
,, ,, (least ,, ,,).	22.1 ,,	16.3 ,,	7.5 ,,
Left ,, (very obliquely ,,).	22.6 ,,	17.2 ,,	6.7 ,,

Although the outline is rather variable, the proportion of length to height is tolerably constant, being 10 to 7.3–7.6.

Fossil occurrence.—Otake, Shisui, Tega, Shito (abundant).

187. ***Corbula pustulosa***, Yokoyama.

Pl. VI. Fig. 18.

Shell moderately thick, transversely ovate, inequivalve, nearly inequilateral, the beaks being only a little in front of the middle; anterior margin more or less rounded, posterior obliquely subtruncate, postero-dorsal convex, antero-dorsal straight, ventral broadly arcuate; postero-ventral corner bluntly pointed. Surface with a blunt edge running from beak to postero-ventral angle, smooth in general, though incremental lines are more or less rough. Tooth of right valve triangular, with a large fossa behind it. Pallial line rather indistinct. Anterior muscular impression elongated and pear-shaped, posterior more rounded, though with a short pointed process above. The interior of the shell is marked with irregularly distributed pits which may be due to the formation of pearls.

In general outline this shell resembles the preceding, but it is thinner, less triangular, and always provided with the pits above mentioned which are absent in the other species described in this paper.

The following are some of the measurements:

	Length.	Height.	Depth.
Right valve	17.9 millim.	12.6 millim.	5.3 millim.
,, ,,	17.5 ,,	12.0 ,,	4.4 ,,
Left ,,	14.3 ,,	9.2 ,,	4.0 ,,
,, ,,	15.3 ,,	10.0 ,,	4.3 ,,

Fossil occurrence.—Otake (rare), Shisui (do).

188. *Corbula sematensis*, Yokoyama.

Pl. VI. Figs. 19, 20.

Shell rather thin, moderately ventricose, transversely oblong, nearly equilateral. Right valve a little longer than left, rounded at both ends, but more sharply so behind, while the left valve has the posterior border obliquely subtruncate. Surface with faint radiating striae near the ventral border. An obtuse edge runs from the beak to the postero-ventral angle, and in the left valve there is a shallow depression running from the beak to the antero-ventral corner. Pallial line indistinct. Anterior muscular impression elongated, posterior more triangular.

The measurements of three valves are as follows:

	Length.	Height.	Depth.
Left valve	14.3 millim.	10.2 millim.	4.1 millim
Right ,,	9.3 ,,	6.0 ,,	2.1 ,,
,, ,,	7.5 ,,	5.2 ,,	1.9 ,,

Fossil occurrence.—Shito (rare).

189. ***Corbula pygmaea***, Yokoyama.

Pl. VII. Figs. 4, 5.

Several specimens, but mostly right valves.

Shell small, thick, swollen, high triangular, somewhat oblique, inequivalve, inequilateral; anterior side a little longer than posterior, anterior border rounded, posterior truncate, postero-ventral angle roundly angular, ventral border broadly arcuate. Surface ornamented with regular concentric grooves. Beaks inflated, with an obtuse edge running to postero-ventral corner. Anterior muscular impression curved and pear-shaped, posterior ovate. Pallial line very shallowly indented, the sinus looking only like a broad crescent.

A specimen with both valves perfect measures 4.3 millim. in length, 3.6 millim. in height and 2.7 millim. in thickness.

Some of the specimens have the surface rather smooth, a phenomenon probably due to friction.

Fossil occurrence.—Otake (rather frequent), Kioroshi, Tega.

190. ***Corbula substriata***, Yokoyama.

Pl. VII. Fig. 3.

A single right valve. It is small, thick, ventricose, subquadrate, inequilateral, with anterior side shorter than posterior, rounded in front and quite truncate behind. The postero-dorsal angle is obtuse, while the postero-ventral is roundly right-angled. Ventral margin broadly arcuate. Surface with coarse irregular concentric grooves. Beaks large and swollen, a sharp edge running from them to the postero-ventral corner with a second but weaker one near the hinge-margin. Between these edges the surface is somewhat excavated. Tooth bluntly pointed. Pallial line distinct, simple. Length 4 millim. Height 3.6 millim. Depth 2 millim.

This shell looks like *Corbula striata* Walther and Boys (Wood, Crag Moll., II, Bivalves, p. 274, pl. XXX, fig. 3) from the English Crag, although more quadrate in shape.

Fossil occurrence.—Shito.

Family **Myacidæ**.

Genus **CRYPTOMYA**, Conrad.

191. ***Cryptomya busoensis***, Yokoyama.

Pl. VII. Figs. 1, 2.

Shell small, thin, transversely elliptical, convex, nearly equilateral, rounded in front, obliquely truncate behind, the truncated border forming tolerably sharp angles both above and below. Antero-dorsal margin arched, postero-dorsal nearly straight, ventral broadly arcuate. Surface smooth, with beaks small, a sharp edge running from them to the postero-ventral corner, behind which the surface is slightly concave. Left valve with a triangular ligamental spoon and a tooth behind it. Anterior muscular impression elongated-fusiform, somewhat bent in the middle, posterior short-fusiform. Pallial line simple.

Specimens are rare. The largest we have is a left valve 18.5 millim. in length, 11 millim. in height and 3 millim. in depth. The next largest is a right valve 17.5 millim. in length, 11 millim. in height and 3.5 millim. in depth.

This species is closely akin to *Cryptomya elliptica* Adams (Dunker, Ind. Moll., p. 178, pl. VII, figs. 17–19), but lacks the radial striations of the latter.

Fossil occurrence.—Otake, Kamenari. Oji in Musashi.

Living.—Central Japan.

Family **Mactridæ**.

Genus **MACTRA**, Linné.

192. ***Mactra sulcataria***, Deshayes.

Pl. VII. Fig. 6.

Mactra sulcataria. Deshayes, Proc. Zool. Soc. London, 1855, p. 15. Reeve, Conch. Icon., Mactra, sp. 5. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 570, pl.

XXIII, figs. 1, 2. Lischke, Jap. Meeresconch., I, p. 133. Pilsbry, Cat., p. 118. Tokunaga, Foss. Env. Tokyo, p. 40, pl. II, fig. 26.
Trigonella sulcataria. Dunker, Ind. Moll., p. 182.

This rather thin-shelled species is easily recognized by its ovately triangular shape, longer than high, somewhat equilateral and with both extremities rounded, posterior somewhat more sharply than anterior. Convexity moderate. The surface is concentrically but unequally grooved. Lunula and area hardly developed.

The shell attains a large size, the largest in our collection being 78 millim. in length and 67 millim. in height.

Fossil occurrence.—Otake (in thousands), Kamenari (frequent), Kioroshi (do), Shisui (do), Tega (do), Shito. Oji and Shinagawa in Musashi.

Living.—Northern to Western Japan. North China. Possiet Bay (near Vladivostok).

193. ***Mactra veneriformis***, Deshayes.

Mactra veneriformis. Deshayes, Proc. Zool, Soc. London, 1853, p. 15. Reeve, Conch. Icon., Mactra, pl. IX, fig. 78. Lischke, Jap. Meeresconch., I, p. 133, II, p. 121, pl. IX, figs. 7, 8. Brauns, Geol. Env. Tokio, p. 38, pl. IV, fig. 17. Tokunaga, Foss. Env. Tokyo, p. 40. Yokoyama, Foss. Miura Penin., p. 109, pl. VIII, fig. 10.
Trigonella veneriformis. Dunker, Ind. Moll., p. 182.

This shell, which is found in thousands in the seas near Tokyo, is represented only by two specimens, a left and a right valve. Its rarity as a fossil in general is quite noteworthy. When compared with the preceding species, it is usually somewhat smaller, but higher and more inflated.

Fossil occurrence.—Otake, Tega. Lower Musashino of Yokosuka.

Living.—Northern to Western Japan.

194. ***Mactra ovalina***, Lamarck.

Pl. VII. Fig. 12, 13.

Mactra ovalina. Lamarck, Hist. Nat., 2d. Ed., VI, p. 104. Reeve, Conch. Icon., Mactra, pl. XIV, fig. 66. Mart. Chemn. Syst. Conch. Cab., Mactra, p. 69, pl. XXV, figs. 1, 1a, pl. XXVIII, fig. 3.

The shell is thin, flat, transversely oval, inequilateral with the posterior end somewhat gaping. The area is distinct, bounded in each valve by a sharp edge running from beak to postero-ventral corner. Within the area there is an obtuse ridge dividing the surface into two longitudinal, somewhat concave parts. Lunula present, but indistinct. Beaks very small, approaching. Surface only concentrically striate. Ligamental pit triangular. Pallial sinus large and deep, elliptical, reaching somewhat beyond the beak.

The largest specimen is a broken right valve 43 millim. in height. The length, if perfect, would be about 63 millim. The largest perfect right valve obtained measures 32 millim. in length, 20.6 millim. in height and 5.4 millim. in depth, while the largest left measures 31.7 millim. in length, 20.8 millim. in height and 5.7 millim. in depth. Rare at all the localities.

Fossil occurrence.—Otake, Shisui, Tega. Oji in Musashi.

Living.—Central Japan. Puget Sound in Washington.

195. *Mactra dunkeri*, Yokoyama.

Pl. VII. Fig. 7, 8.

Shell small, rather thin, moderately convex, triangular in general outline, somewhat longer than high, subequilateral, anterior end sharply rounded, posterior bluntly pointed, antero-dorsal border broadly arched, postero-dorsal very convex, somewhat angulate in the middle so as to make the sheli appear obliquely subtruncate behind, ventral broadly arcuate. Surface smooth bluntly carinated. Pallial sinus moderately deep, finger-like.

This shell stands in form between *Mactra straminea* (Ind. Moll, p. 183, pl. VII, figs. 5, 6) and *M. crossei* (Ibid. p. 183, pl. VII, figs. 1–4) of Dunker, being more triangular than the former and higher than the latter. Moreover, it is generally smaller.

The fossil specimens, which are pretty frequent, do not attain more than 7 millim. in length, while the living found in the Sea of Sagami are somewhat larger. There is a left valve measuring

11.3 millim. in length, 10.2 millim. in height and 3 millim. in depth. It is coloured pinkish, especially near the beak.

Fossil occurrence.—Shisui (frequent), Tega.

Living.—Central Japan.

196. *Mactra sachalinensis*, Schrenck *var. imperialis*, Yokoyama.

Pl. VII. Fig. 9, 10.

Mactra sachalinensis. Tokunaga, Foss. Env. Tokyo, p. 39, pl. II, fig. 25.

Shell large, thick, tumid, triangular, anterior side shorter than posterior, rounded at both ends though generally more sharply behind than in front, postero-dorsal slope either straight or only a little arched, ventral margin broadly curved with the anterior half sometimes less curved or even nearly straight, postero-ventral and antero-ventral corners generally indistinctly and obtusely angulate. Surface with very unequal and irregular concentric grooves. Beaks comparatively small, very obtuse, with indistinct edges running both to postero-ventral and antero-ventral corners near which they become more or less distinct. Ligamental pit triangular, protruding downward far out of the hinge-margin. Anterior muscular impression fig-shaped, posterior more squarely oval. Pallial sinus deep, tongue-shaped.

There is a considerable variation in the shape of the shell, some being more ovate than others.

The figured specimens are very large ones, if not the largest. The right valve (fig. 10) measures 119 millim. in length, 90.5 millim. in height and 33 millim. in depth, while the left (fig. 9) which is more triangular in shape is 111 millim. in length, 86,5 millim. in height and 33 millim. in depth. There is also a broken right valve 110 millim. in height.

Tokunaga identified this shell with the above named species of Schrenck. But there are several well-marked distinctions between the two. The fossil shell is more triangular in outline, with the anterior muscular impression shorter and the ligamental pit larger and more protruding downward. The pallial sinus, too, is perhaps a little deeper (Tokunaga figures it as if pointed, which is an error). On these accounts, I separate the fossil as a variety of the living shell.

Fossil occurrence.—Otake (frequent), Shisui, Shito. Oji and Tabata in Masashi.

Genus **SPISULA**, Gray.

197. ***Spisula grayana***, (Schrenck).

Pl. VIII. Fig. 1, 2.

Spisula grayana. Pilsbry, Cat., p. 119.
Mactra (*Spisula*) *grayana.* Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 572.
Mactra ovalis. Reeve, Conch. Icon., Mactra, pl. IX, fig. 36.
Mactra ponderosa. Philippi, Abbild., I, Mactra, p. 1 (165), pl. I, fig, 1.

A rather thin, flatly convex, triangular shell with the anterior side a little longer than the posterior. Both ends rounded, much more sharply in front than behind. Surface smooth, only with lines of growth. Pallial sinus deep, finger-like, subtruncate or rounded at end.

The following are the measurements of the two valves figured:

	Length.	Height.	Depth.
Right valve	63.0 millim.	45.2 millim.	11.9 millim.
Left ,,	52.5 ,,	38.3 ,,	9.3 ,,

Fossil occurrence.—Shito (frequent).

Living.—Northern Japan. Okhotsk Sea. Behring Sea. Massachusetts.

198. ***Spisula bernardi*** Pilsbry.

Pl. VIII. Fig. 3, 4.

Spisula (*Oxyperas*) *bernardi.* Pilsbry, New Jap. Mar. Moll., Pelecypoda, Proc. Acad. Nat. Sci. Phil., July, 1904, p. 550, pl. XXXIX, figs. 4–6.

A transversely elongated triangular shell almost twice as long as high. Surface concentrically grooved, although smooth near the beaks. Lateral teeth normally crenulate.

Although the shell is generally moderately thick, there are occasionally thin shelled specimens among the younger ones.

Fossil occurrence.—Shito (not rare), Kioroshi.

Living.—Western Japan.

Genus **RAETA**, Gray.

199. ***Raeta yokohamensis***, Pilsbry.

Pl. VIII. Fig. 5, 6.

Raeta yokohamensis. Pilsbry, Catalogue, p. 119, pl. III, figs. 4, 5.

A thin, fragile, white, swollen shell ovately triangular in shape, compressed, bluntly pointed and a little gaping behind, with the surface concentrically corrugated.

Fossil occurrence.—Otake (rather frequent). Tega (frequent). Shisui, Kamenari. Oji in Musashi.

Living.—Central Japan (Tokyo Bay).

200. ***Raeta pellicula***, (Deshayes)

Pl. IX. Fig. 6.

Raeta pellicula. Pilsbry, Cat. Mar. Moll. Jap., p. 119.
Mactra pellicula. Deshayes, Proc. Zool. Soc. Lond., 1854, p. 68. Reeve, Conch. Icon., Mactra, pl. XXI, fig. 124.

An imperfect left valve swollen and rounded in front, somewhat flattened and truncate behind. The thin shell shows concentric furrows on the surface. It is 23 (?) millim. long, 18.5 millim. high and 6 millim. deep.

Fossil occurrence.—Otake.

Living.—Japan (according to Reeve).

201. ***Raeta elliptica***, Yokoyama.

Pl. VIII. Fig. 7.

Shell thin, fragile, transversely ovately elliptical, inflated, somewhat flattened near the posterior end, with posterior side a little shorter than anterior, rounded at both ends, though sometimes rather subtruncate behind. Anterior and posterior margins more or less straight, going over into lateral margins without any angulation; ventral margin arcuate, slightly gaping behind. Surface more or less concentrically corrugated, especially so toward lateral margins, somewhat flattened or even excavated a little behind the middle. Pallial line and sinus generally indistinct, the latter large but shallow and rounded.

The largest right valve measures 18.2 millim. in length, 13 millim. in height, 4.1 millim. in depth, while the largest left measures 14.6 millim. in length, 10 millim. in height and 3 millim. in depth.

This shell seems to have been more or less hyaline when fresh, as some of the specimens show such a character and are translucent.

Fossil occurrence.—Tega (very frequent), Kamenari, Kioroshi.

202. *Raeta magnifica*, Yokoyama.

Pl. VIII. Fig. 12, 13.

Shell comparatively large, thin, inquilateral, anterior side somewhat shorter than posterior, transversely oval, swollen and broadly rounded in front, compressed and quickly narrowed behind, with the end truncate and a little gaping. Surface with numerous irregular concentric plications. Main teeth rather small, two in the left valve and one in the right, the posterior one in the former being somewhat deltoid in shape. Posterior lateral tooth very long. Pallial sinus very large and deep, horizontal, finger-like.

A single shell with both valves perfect. Length 42.5 millim. of which about 20 millim. belong to the anterior side. Height 37 millim. Thickness 25.5 millim.

This species is somewhat like *Raeta anatinoides* (Reeve) shown in Conch. Icon., Mactra, pl. XXI, fig. 123 from an unknown locality, which, however, is more pointed behind.

Fossil occurrence.—Tega (Kizaki).

Genus **TRESUS**, Gray.

203. ***Tresus nuttali*** (Conrad).

Pl. VIII. Fig. 8.

Tresus nuttali. Dunker, Ind. Moll., p. 184. Pilsbry, Cat., p. 120. Tokunaga, Foss. Env. Tokyo, p. 42. Arnold, Pal. a. Strat. San Pedro, California, p. 178.

Lutraria nuttali. Conrad, Jour. Acad. Nat. Sci. Phil., vol. VII, 1837, p. 235, pl. XVIII fig. 1. Lischke, Jap. Meeresconch., I, p. 136. Brauns, Geol Env. Tokio, p. 38, pl. IV, fig. 6.

Lutraria maxima. Middendorff, Mal. Ross., III, p. 66, pl. XIX, figs. 1–4. Reeve, Conch. Icon., Lutraria, pl. V, fig. 18. Non *L. maxima* Jonas.

This large shell excellently figured by Brauns is frequent both living and fossil in the neighbourhood of Tokyo.

Although comparatively thin-shelled in general, some of the fossil specimens are rather thick and attain the length of 165 millim. with the height of 120 millim.

Fossil occurrence in Japan.—Otake (quite frequent), Shisui, Tega, Shito (frequent). Oji and Shinagawa in Musashi.

Fossil occurrence in America.—Pliocene and Pleistocene of San Pedro, California.

Living.—Northern, Central and Western Japan. Alaska to San Diego on the west coast of America.

Genus **LUTRARIA**, Lamarck.

204. ***Lutraria maxima***, Jonas.

Pl. VIII, Figs. 9, 10.

Lutraria maxima. Jonas, Zeitschr. f. Malak., 1844, p. 34 (non *L. maxima* Midd.). Reeve, Conch. Icon., Lutraria, pl. III, fig. 11. Lischke, Jap. Meeresconch., I, p. 138. Pilsbry, Cat., p. 120.

Characterized by a transversely elongate-oblong, compressed, very inequilateral shell more than twice as long as high. The surface is smooth.

This shell is somewhat like *Lutraria ovalis* Tokunaga (Foss. Env. Tokyo, p. 41, pl. II, fig. 28) from Shinagawa which is possibly identical with *Lutraria sieboldi* Reeve (no. 15 of his Conch. Icon.), but it is decidedly longer.

	Length.	Height.	Depth.
Left valve	126.7 millim.	61.2 millim.	13.2 millim.
Right ,,	127.2 ,,	64.3 ,,	13.5 ,,

Fossil occurrence.—Otake (frequent), Kioroshi, Shito.

Living.—Western Japan.

Family **Solenidæ**.

Genus **SOLEN**, Linné.

205. ***Solen grandis***, Dunker.

Pl. IX. Fig. 1.

Solen grandis. Dunker, Nov. Conch., II, p. 71, pl. XXIV, fig. 5. Ind. Moll., p. 172 Lischke, Jap. Meeresconch., I, p. 141. Mart. u. Chem., Syst. Conch. Cab., XI, part 3, Solenaceæ, p. 18, pl. VII, fig. 1. Pilsbry, Cat., p. 190.

This splendid shell is either straightly truncate or slightly concave in front, while it is rounded behind. The length is 4.3–4.4 times the height. The largest specimen obtained measures 135 millim. in length, 30 millim. in height and 18.5 millim in thickness.

Brauns in his "Geology of the Environs of Tokio" (p. 56) says that this species is very frequent at Oji, but as not a single specimen has since been found, it is very likely that he mistook the next species for it.

Fossil occurrence.—Otake (very frequent), Tega.

Living.—Western Japan. Philippines.

206. ***Solen krusensternii.*** Schrenck.

Pl. IX. Fig. 5.

Solen krusensternii. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 594, pl. XXV, figs. 9–12. Pilsbry, Catalogue, p. 190. Tokunaga, Foss. Env. Tokyo, p. 36, pl. II, fig. 19.

Ensis krusensternii. Dunker, Ind. Moll., p. 173.

Although smaller in size than the preceding, this species is comparatively longer, and also somewhat longer than the living specimens. Schrenck says that the length is about four times and a half the height. But in the fossil specimens the length is generally five times the height or even a little greater. The upper margin (hinge-margin) is often somewhat concave, though it is usually straight.

The fossil specimens are generally somewhat smaller than the living, the largest measuring 80 millim. in length and 15 millim. in height.

Fossil occurrence.—Otake (very frequent), Shisui (do), Kamenari, Tega, Shito, (very frequent). Oji, Tabata and Shinagawa in Musashi.

Living.—Northern Japan.*

Genus **SILIQUA**, Mühlfeld.

207. ***Siliqua pulchella***, (Dunker).

Pl. IX. Fig 7.

Siliqua pulchella. Pilsbry, Catalogue, p.121.

Aulus pulchellus. Dunker, Zeitschrift für Malakol., 1852, p. 58. Nov. Conch., pt. II, p. 20, pl. VI, figs. 4, 5. Ind. Moll., p. 174. Lischke, Jap. Meeresconch., II, p. 124.

Machæra pulchella. Clessin, Mart. u. Chem Syst. Conch. Cab., vol. XI, pt. 3, Solenacea, p. 65. pl. XX, fig. 6.

The shell is thin, fragile, transversely much elongated, subelliptical, very inequilateral, smooth (in fresh state with fine radiating lines except on the posterior surface), with a strong inner rib which runs from the beak to the ventral margin.

Most of the specimens have the length a little greater than three times the height, but there is one from Tega which is shorter, the length being not quite three times the height. It is probably due to variation.

Fossil occurrence.—Otake (pretty frequent), Tega.

Living.—Central and Western Japan.

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* Pilsbry mentions *Akashi* as one of the habitats of *S. krusensternii* (Catalogue, p. 190) on the authority of Stearns. But it is evidently a mistake for *Akkeshi* (Northern Japan).

Genus **SOLECURTUS**, Blainville.

208. ***Solecurtus divaricatus***, (Lischke).

Solecurtus divaricatus. Clessin in Mart. u. Chem. Syst. Conch. Cab., XI, pt. 3, p. 87, pl. 21, fig. 4. Yokoyama, Foss. Miura Penin., p. 112, pl. VII, fig. 14.
Macha divaricata. Lischke, Jap. Meeresconch., I, p. 142, pl. X, figs. 1, 2. Tokunaga, Foss. Env. Tokyo, p. 36, pl. II, fig. 20.
Solecurtus (*Macha*) *divaricatus.* Pilsbry, Cat., p. 121.

This shell first described and figured by Lischke is pretty frequent as a fossil. It is readily recognized by its transversely elongato-oblong form with distant, impressed, radiating lines on the surface.

Fossil occurrence.—Otake (pretty frequent), Tega, Shito. Oji in Musashi. Lower Musashino of Yokosuka.

Living.—Central and Western Japan.

Genus **DONAX**, Linné.

209. ***Donax introradiatus***, Reeve.

Pl. IX. Fig. 8, 9.

Donax introradiatus. Reeve, Conch. Icon., Donax, pl. IX, fig. 65. Römer in Syst. Conch. Cab., X, part 3, p. 75, pl. XIII, figs. 5-8.

A very young shell with both valves perfect. It is characterized by radiating striæ which are also visible from inside. In the anterior half of the shell, these striæ are rather indistinct. The posterior slope of the shell-margin is convex, with a somewhat wing-like projection. Ventral margin crenulate within. Length 4.2 millim. Height 31 millim. Thickness 2.4 millim.

Fossil occurrence.—Tega.

Living.—Central Japan.

Family **Psammobiidæ**.

Genus **PSAMMOBIA**, Lamarck.

210. ***Psammobia kazusensis***, Yokoyama.

Pl. IX. Fig. 4.

Two left valves which, however, are quite characteristic.

Shell moderately large, rather thin, transversely oblong, pretty tumid, inequilateral, posterior side somewhat more than one and a half times the length of the anterior, rounded in front, obliquely subtruncate behind, antero-and postero-dorsal margins nearly straight and somewhat sloping. Surface with rude lines of growth, pretty uniformly convex except near the postero-dorsal margin where it is somewhat flattened. Beaks small. Teeth two, obliquely directed backward, with the posterior more so than the anterior which is thick and short while the posterior is thin and long. Muscular impressions more or less irregularly ovate, with the posterior broader than the anterior. Pallial sinus large, finger-like, horizontal and deep, reaching almost to below the beak.

The larger of the two specimens measures 80 millim. in length, 45 millim. in height and 13.5 millim. in depth.

This species closely resembles *Psammobia maxima* Desh. (Reeve, Conch. Icon., *Psammobia*, sp. 4) from Panama which, however, is more quadrate and more compressed.

Fossil occurrence.—Shito.

Genus **SOLETELLINA**, Blainville.

211. *Soletellina violacea*, Lamarck.

Pl. IX. Figs. 13, 14.

Soletellina violacea. Lamarck, Hist. Nat., Ed. II, vol. VI, p. 60. Delessert, Recueil, pl. II, fig. 5. Lischke, Jap. Meeresconch., vol. I, p. 131. Pilsbry, Cat, p. 122.
Soletellina cumingiana. Deshayes, MSS. in Mus. Cuming. Reeve, Conch. Icon., Soletellina, pl. I, fig. 4.
Psammobia violacea. Deshayes, in Encycl. Meth. Vers., III, p. 852. Philippi, Abbild., I, p. 97. Psammobia, I, fig. 2.
Solenotellina violacea. Dunker, Moll. Ind., p. 187.

This transversely oblong flat shell rounded in front and somewhat obliquely truncate behind is very numerous at some localities. The violet tint of the living shell is more or less preserved also in the fossil. It must here be remarked that the fossil specimens are somewhat shorter than the living figured by Reeve, the length being not quite double the height.

The largest specimens at hand are left valves, one of which measures 56 millim. in length and 31 millim. in height, while another with the same length shows the height of 35 millim.

Fossil occurrence.—Northern to Western Japan. Philippines. Moluccas

212. *Soletellina olivacea*, Jay.

Pl. VII. Fig. 11. Pl. IX. Fig. 17.

Soletellina olivacea. Jay, Report on Shells coll. by Jap. Exped. of Commodore Perry, 1856, p. 292, pl. I, figs. 8, 9. Lischke, Jap. Meeresconch., I, p. 131, III, p. 98, pl. VIII, figs. 7–12. Pilsbry, Cat., p. 122.

Solenotellina olivacea. Dunker, Ind. Moll., p. 188.

Soletellina japonica. Debeaux, Jour. de Conch., II, pp. 245, 254. Reeve, Conch. Icon., Soletellina, pl. IV, fig. 16.

This shell is shorter and more oval than the preceding. The right valve is almost flat, while the left is somewhat convex.

Fossil occurrence.—Otake (frequent), Shisui, Shito (very frequent).

Living.—Northern to Western Japan. North China (Cheefoo).

Family **Tellinidæ.**

Genus **TELLINA** Linné.

213. *Tellina jedoensis*, Lischke.

Pl. IX. Fig. 15, 16.

Tellina jedoensis. Lischke, Jap. Meeresconch., vol. III, p. 92, pl. IX, figs. 1–3. Dunker, Ind. Moll., p. 190. Pilsbry, Catalogue, p. 124. Brauns, Geol. Env. Tokio, p. 39. Tokunaga, Foss. Env. Tokyo, p. 43, pl. II, fig. 31.

Lischke describes this little species as follows:

"Shell oblong, rather thin, swollen in front, compressed behind. The anterior side is considerably longer than the posterior, the fold being pretty strongly marked. The dorsal margin is straight, passing gradually into the well-rounded anterior margin which also gradually goes over into the ventral; the latter runs at first almost straight or only slightly curved, and then ascends somewhat upward, making an obtuse angle with the steeply descending, broadly curved posterior margin. The sculpture consists of fine incremental lines and some still finer radiating ones which can only be distinguished with a magnifier. The hinge has two cardinal teeth in each valve and two laterals in the right. Of the cardinal teeth, the posterior one in the right valve and the anterior in the left are strong, directed upward and split, while the other is oblique, narrow and simple. The lateral teeth are thin and distant from the beaks. The pallial sinus is very large, almost reaching the anterior muscular impression, its lower border coinciding with the mantle-line for its whole length......"

The fossil specimens agree quite well with this, Lischke's species.

Fossil occurrence.—Otake (rare), Tega. (rather frequent), Oji in Musashi.

Living.—Central and Western Japan.

214. *Tellina venulosa*, Schrenck.

Pl. X. Fig. 1.

Tellina venulosa. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 556, pl. XX, figs. 2–5. Dunker, Ind. Moll., p. 192. Pilsbry, Cat., p. 124.

A moderately thick, compressed, broadly triangular shell with the length a little more than one and a half times the height. The posterior lateral teeth are absent, while the anterior is single.

The largest specimen attains the length of 100.5 millim.

Fossil occurrence.—Otake (frequent), Kioroshi, Tega, Shito (frequent).

Living.—Northern Japan. Sea of Okhotsk.

215. *Tellina nitidula*, Dunker.

Pl. VIII. Fig. 11.

Tellina nitidula. Dunker, Moll. Jap., p. 27, pl. III, fig. 14. Lischke, Jap. Meeresconch., I, p. 129, II, p. 113, pl. X, figs. 10, 11. Brauns, Geol. Env. Tokio, p. 39. Tokunaga, Foss. Env. Tokyo, p. 42, pl. II. figs. 30 abc. Yokoyama, Foss. Miura Penin., p. 112, pl. VII, fig. 15.

This thin-shelled species already described by Brauns and Tokunaga from the environs of Tokyo and by me from the Lower Musashino of the Miura Peninsula is very frequent at some places.

Fossil occurrence.—Otake (frequent), Kamenari, Shisui (frequent), Tega, Shito (very frequent). Oji and Shinagawa in Musashi. Lower Musashino of Miyata and Naganuma.

Living.—Central and Western Japan.

216. *Tellina alternata*, Say *var. chibana*, Yokoyama.

Pl. X. Figs. 5, 6.

Shell rather thin, compressed, transversely elongated, almost twice as long as high, a little inequilateral with posterior side somewhat shorter than anterior, rounded in front, obliquely subtruncate behind. Antero-and postero-dorsal margins nearly straight; ventral margin broadly arched. Surface concentrically grooved; grooves rather fine, pretty regular, although often indistinct through friction. Also fine discontinuous and irregular radiating lines present. A keel runs from the beak to the postero-ventral corner, behind which there is a very shallow depression. Pallial sinus large, deep and oblong. Anterior main tooth in left valve and posterior main tooth in right valve bifid. Lateral teeth two, one in front and one behind. Rather frequent.

The largest example is a right valve measuring 49.4 millim. in length, 26.6 millim. in height and 4.8 millim. in depth. The largest left measures 45.4 millim. in length, 27 millim. in height and 4.5 millim. in depth.

This shell still living near our coast agrees quite well with *Tellina alternata* Say (Philippi, Abbild., vol. II, p. 23, pl. III, fig. 1 and Syst. Conch. Cab., *Tellina*, pl. XXV, figs. 10–15) from the east coast of the United States in form, the only difference being the shallower pallial sinus and the absence of radiating lines in the latter. Therefore I deem it expedient to treat the Japanese form as a variety of the American.

Fossil occurrence,—Otake, Kamenari, Shito.

Living.—Central Japan.

217. *Tellina ojiensis*, Tokunaga.

Tellina ojiensis. Tokunaga, Foss. Env. Tokyo, p. 44, pl. II, fig. 34. Yokoyama, Foss. Miura Penin., p. 113, pl. VII, figs. 16, 17.

A right and a left valve. The former measures 16 millim. in length, 11.5 millim. in height and 3 millim. in depth, the latter 10.5 millim. in length, 7.6 millim. in height and 1.5 millim. in depth.

Fossil occurrence.—Otake. Oji in Musashi. Lower Musashino of Miyata.

Living.—Northern and Central Japan.

218. *Tellina miyatensis*, Yokoyama.

Tellina miyatensis. Yokoyama, Foss. Miura Penin., p. 115, pl. VII, fig. 18.

This small transversely elongated shell already described by me from the Lower Musashino is widely distributed in the Upper.

Fossil occurrence.—Otake (very mumerous), Kioroshi, Kamenari. Tega, Shito. Oji in Musashi. Lower Musashino of Miyata.

219. *Tellina delta*, Yokoyama.

Pl. X. Figs. 8–10.

Shell small, rather thick, ovately and obliquely trigonal, moderately convex, nearly equivalve, strongly inequilateral with posterior side twice as long as anterior, rounded at both ends though more sharply in front than behind. Antero-and postero-dorsal margins nearly straight, meeting at an angle of about 110° at the beak; ventral margin broadly arcuate. Surface uniformly convex and furnished with close, regular, concentric furrows. Cardinal teeth two in each valve, the anterior in the left and the posterior in the right being larger. Lateral teeth two, one on each side of the cardinal ones. Pallial sinus large, with the upper border obliquely ascending and terminating near the anterior muscular impression with a blunt end.

The shell does not attain more than 8 millim. in length, 6.5 millim. in height and 3.2 millim. in thickness.

Fossil occurrence.—Otake (very common), Kioroshi, Kamenari, Tega (frequent).

Living.—Central Japan (Sea of Sagami).

Genus **MACOMA**, Leach.

220. ***Macoma praetexta***, (Martens).

Pl. X. Figs. 2, 3.

Tellina praetexta. Martens, Ann. Mag. Nat. Hist., XVI, p. 430. Lischke, Jap. Meeresconch., vol. I, p. 130, vol. II, p. 113, pl. X, fig. 14. Dunker, Ind. Moll., p. 190. Pilsbry, Cat., p. 125.

This shell somewhat resembling *Tellina nitidula* Dkr. in shape as well as in its thin state is more triangular with the ventral margin more ascending behind, so that the end appears somewhat rostrate. The posterior fold is also more distinct than in Dunker's species. The lateral teeth are wholly wanting. The posterior main tooth of the right valve is thick and bifid.

The largest specimen obtained is 31 millim. in length, 20.5 millim. in height and 7.6 millim. in thickness.

Fossil occurrence.—Otake, Shisui, Tega, Shito (rather rare at all these localities). Dokwanyama in Musashi.

Living.—Central and Western Japan.

221. ***Macoma nipponica***, (Tokunaga).

Macoma nipponica. Yokoyama, Foss. Miura Penin., p. 117, pl. VIII, figs. 3, 4.
Tellina nipponica. Tokunaga, Foss. Env. Tokyo, p. 44, pl. II, fig. 36.

A full description of this species is given in my work above quoted.

Fossil occurrence.—Otake (not rare), Tega, Kamenari, Shisui, Shito (very common). Oji and Tabata in Musashi.

Living.—Northern Japan.

222. ***Macoma inquinata***, (Deshayes).

Macoma inquinata. Pilsbry, Cat., p. 124. Arnold, Pal. Strat. Mar. Plioc. Pleistoc. San Pedro, p. 162, pl. XVI, fig. 4. Yokoyama, Foss. Miura Penin., p. 117, pl. VIII, figs. 1, 2.

Tellina inquinata. Deshayes, Proc. Zool. Soc. Lond., 1854, p. 357. Römer in Syst. Conch. Cab., vol. X, part 4, p. 227, pl. 44, figs. 1–4. Dunker, Ind. Moll., p. 190.

Tellina inquinata var. *incongrua.* Lischke, Jap. Meeresconch., vol. II, p. 117, pl. X, figs. 12, 13.

Tellina incongrua. Martens, Ann. Mag. Nat. Hist., Series III, vol. 16. p. 430. Römer in Syst. Conch. Cab., X. pt. 4, p. 225, pl. 43, fig. 11–13.

Only a small left valve.

Fossil occurrence in Japan.—Kioroshi. Lower Musashino of Yokosuka and Miyata.

Fossil occurrence in America.—Pliocene and Pleistocene of San Pedro, California.

Living.—Northern, Central and Western Japan. Sea of Okhotsk. West coast of America from Alaska to San Diego in California.

223. ***Macoma dissimilis***, (Martens).

Pl. X. Fig. 4.

Macoma dissimilis. Pilsbry, Cat., p. 125. Yokoyama, Foss. Miura Penin., p. 116, pl. VII, figs. 19, 20.

Macoma nasuta. Tokunaga, Foss. Env. Tokyo, p. 45, pl. II, fig. 2.

Tellina dissimilis. Martens, Ann. Mag., Series III, vol. XVI, p. 430.

Tellina nasuta. Brauns, Geol. Env. Tokio, p. 39.

Tellina nasuta var. dissimilis. Lischke, Jap. Meeresconch., II, p. 115, pl. IX, figs. 15–17.

A few examples.

Fossil occurrence.—Otake, Tega. Oji (quite abundant), Tabata (many) and Shinagawa in Musashi. Lower Musashino of Miyata and Yokosuka.

Living.—Central Japan.

224. ***Macoma secta***, (Conrad).

Pl. XI. Fig. 1.

Macoma secta. Pilsbry, Cat., p. 125. Arnold, Pal. Strat. Mar. Plioc. Pleistoc. San Pedro, p. 164, pl. XVI, fig. 5.

Tellina secta. Conrad, Jour. Acad. Nat. Sci. Philad., VII, 1837, p. 257. Philippi, Abbild., II, p. 22, pl. IV, fig. 2. Reeve, Conch. Icon., Tellina, pl. II, fig. 5. Lischke, Jap. Meeresconch., II, p. 173.

The shell is comparatively large, though thin. It is triangular, compressed, rounded in front and bluntly angulate behind. The height is about three-fourths of the length. Surface smooth. Growth-lines distinct.

The examples are all left valves. The largest measures 58.7 millim. in length and 43.8 millim. in height.

Fossil occurrence in Japan.—Otake (rather rare). Tega.

Fossil occurrence in America.—Pliocene and Pleistocene of San Pedro, California.

Living.—Central and Western Japan. California (Bodega Bay to San Diego).

Family **Veneridæ.**

Genus **DOSINIA**, Scopoli.

225. ***Dosinia troscheli***, Lischke.

Dosinia troscheli. Lischke, Jap. Meeresconch., III, p. 89, pl. VIII, figs. 1–3. Dunker, Ind. Moll., p. 203. Yokoyama, Foss. Miura Penin., p. 119, pl. VIII, figs. 5,6.
Dosinia exoleta. Brauns, Geol. Env. Tokio, p. 41, pl. VI, fig. 22. Tokunaga, Foss. Env. Tokyo, p. 47.

This shell so scarce in the Lower Musashino is of a wide distribution in the Upper. That Lischke's species is distinct from its European ally, *Dosinia exoleta* L., was explained in my work above cited.

Fossil occurrence.—Otake, Shisui, Kamenari, Kioroshi, Tega, Shito. Oji (quite numerous), Tabata, Dōkwanyama and Shinagawa in Musashi. Lower Musashino of Miyata and Naganuma.

Living.—Central and Western Japan.

226. ***Dosinia bilunulata***, Gray.

Pl. X. Figs. 12, 13.

Dosinia bilunulata. Gray, Analyst. Quart. Jour., 1838, pars 24, p. 309. Reeve, Conch. Icon., Dosinia, sp. 22. Römer, Monogr. Dosinia in Nov. Conch., p. 83, pl. XVI, fig. 1. Lischke, Jap. Meeresconch., II, p. 172, III, p. 90. Dunker, Ind. Moll., p. 203. Pilsbry, Cat., p. 126.

A large and splendid species easily recognized by its double lunula, one within the other. There are two valves, a right and a left. The former is 83.3 millim. long, 82.3 millim. high and 15.7 millim. deep, while the latter is 74.1 millim. long, 72.6 millim. high and 14.2 millim. deep.

Fossil occurrence.—Otake.

Living.—Central Japan.

Genus ***Cyclina***, Deshayes.

227. *Cyclina chinensis*, (Chemnitz).

Cyclina chinensis. Deshayes, Traité Elément., I, pt. 2, p. 626, pl. 14, figs. 20–22. Pfeiffer in Syst. Conch. Cab., XI, pt. 1, p. 111, pl. II, fig. 5, pl. XXVIII, fig. 1. Lischke, Jap. Meeresconch., I, p. 126. Brauns, Geol. Env. Tokio, p. 53. Tokunaga, Foss. Env. Tokyo, p. 48. Yokoyama, Foss. Miura Penin., p. 119, pl. XI, figs, 7, 8.

Venus chinensis. Chemnitz, Conch. Cab., X, p. 356, pl. 171, fig. 1663.

Only two right valves.

Fossil occurrence.—Otake, Tega. Tabata in Musashi. Lower Musashino of Yokosuka.

Living.—Northern, Central and Western Japan. China Sea. Cochin China.

Genus ***Lucinopsis***, Forbes et Hanley.

228. *Lucinopsis divaricata*, Lischke.

Pl. X. Fig. 7.

Lucinopsis divariata. Lischke, Jap. Meeresconch., III, p. 90, pl. VII, figs. 12–14.

A single left valve. It is rather thin, tolerably inflated, circular in general outline and nearly equilateral. Of the three main teeth, the middle one is very thick and bifid. The surface-sculpture has been obliterated by friction. Pallial sinus deep, ascending, triangular. Length 11.5 millim. Height 10.9 millim. Depth 3.3 millim.

Fossil occurrence.—Shito.

Living.—Central and Western Japan.

Genus **MERETRIX**, Lamarck.

229. ***Meretrix meretrix***, (Linné).

Pl. XI. Fig. 4.

Meretrix meretrix. Pilsbry, Catalogue, p. 126. Römer, in Malak. Blätter, p. 45, Monogr. Venus, p. 27, pl. 8, fig. 1.

Cytherea meretrix. Linné, Syst. Nat., Ed. 10, p. 686. Lischke, Jap. Meeresconch, I, p. 122, II, p. 108. Dunker, Ind. Moll. p. 199. Pfeiffer in Syst. Conch. Cab., vol. XI, pt. 1, p. 15, pl. III, figs, 4–9. Brauns, Geol. Env. Tokio, p. 53. Tokunaga, Foss. Env. Tokyo, p. 47, pl. III, fig. 5.

Venus (*Meretrix*) *meretrix.* Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 545.

This well known tumid triangular shell, so common in the seas around Japan, has already been described by Brauns and Tokunaga from the fossil layers near Tokyo.

The specimen figured is a large left valve about 84 millim. in length, 68 millim. in height and 25 millim, in depth. It is markedly triangular with the curvature of the ventral margin rather small.

Fossil occurrence.—Otake (rather frequent), Kamenari, Kioroshi, Tega (frequent). Shinagawa in Musashi.

Living.—Northern, Central and Western Japan. Philippines. Moluccas. Indian Ocean.

230. ***Meretrix* (*Callista*) *chinensis***, (Chemnitz).

Pl. XI. Fig. 5.

Meretrix (*Callista*) *chinensis.* Pilsbry, Catalogue, p. 127. Yokoyama, Foss. Miura Penin., p. 120, pl. VIII, figs. 9, 10.

Cytherea chinensis. Pfeiffer in Mart. Chemn. Syst. Conch. Cab., XI, pt, 1, p. 31, X, fig. 2. Lischke, Jap. Meeresconch., I, p. 122. Tokunaga, Foss. Env. Tokyo, p. 46, pl. III, fig. 4.

Callista chinensis. Dunker, Ind. Moll., p. 200.

Venus chinensis. Chemnitz, Conch. Cab., XI, p. 227, pl. 202, fig. 1976.

Specimens are quite frequent. The largest is from Shito, measuring 120 millim. in length and 85 millim. in height.

Fossil occurrence.—Otake (common), Tega, Kamenari, Shisui, Shito (rather frequent). Oji and Shinagawa in Musashi. Lower Musashino of Naganuma.

Living.—Northern, Central and Western Japan. China Sea. Australia.

Genus **SUNETTA**, Link.

231. ***Sunetta excavata*** (Hanley).

Pl. XI. Figs. 6, 7, 8.

Sunetta excavata. Adams, Gen. Rec. Moll., II, p. 428. Pfeiffer, Syst. Conch. Cab., XI, pt. 1, p. 83, pl. XXIX, fig. 4. Dunker, Ind. Moll. p. 201. Pilsbry, Cat., p. 127.

Cytherea excavata. Hanley, Proc. Zool. Soc. Lond., 1842, p. 123, Descript. Cat., p. 109, pl. 15, fig. 19.

Meroe excavata. Sowerby, Thes. Conch., II, p. 610, pl. 126, figs. 13, 14. Reeve, Conch. Icon., Meroe, pl. III, fig. 11. Lischke, Jap. Meeresconch., II, p. 110.

Sunetta menstrualis. Römer, Monogr. Venus, II, p. 13, pl. IV, fig. 2. Pfeiffer, Syst. Conch. Cab., XII, pt. 1, p. 85, pl. XXIX, figs. 10, 11, 12. Pilsbry, Cat., p. 127.

Cytherea menstrualis. Menke, Moll. Nov. Holl., sp. 43. Philippi, Abbild., II, p. 96, no. 3, Cytherea, pl. IV, fig. 3.

Meroe menstrualis. Sowerby, Thes. Conch., II, p. 742, no. 8, pl. 163, fig. 17. Reeve, Conch, Icon , Meroe, pl. III, fig. 9.

Meroe magnifica. Reeve, Conch. Icon., Meroe, pl. I, fig. 2.

Lischke unites the two species of *Sunetta excavata* Hanley and *Sunetta menstrualis* Menke into one, and quite rightly. I have a few large specimens which are typical *Sunetta menstrualis* and many small ones which can be assigned to *S. excavata.* The former are up to 57 millim. in length, roundly oval in form, compressed and rounded at both ends, the anterior more sharply than the posterior, while the latter are more oblong or elliptical in shape, with the posterior end mostly truncate or subtruncate and smaller in size, usually being less than 20 miliim. in length. But on examining the young specimens of the living shell. I was convinced that the form gradually passes from the one into the other, so that there is no reason for separating the two.

Pfeiffer in "Systematisches Conchylien-Cabinet" above cited mentions the fine radiating lines of *Sunetta menstrualis* as one of the distinctions from the other species, but as such lines are very indistinct in young specimens, they can not be of much value in distinguishing the two.

The largest left valve measures 57.1 millim. in length, 47.2 millim. in height and 10.5 millim. in depth, while the largest right measures 54.3 millim. in length, 45 millim. in height and 9.5 millim. in depth.

Fossil occurrence.—Otake (numerous), Kioroshi, Kamenari (frequent), Tega.

Living.—Northern, Central and Western Japan. South Australia.

Genus **VENUS**, Linné

232. ***Venus (Mercenaria) stimpsoni***, Gould.

Pl. XI. Figs. 11, 12.

Venus (*Mercenaria*) stimpsoni. Gould, Otia Conch., p. 169. Brauns, Geol. Env. Tokio, p. 40, pl. V, fig. 21. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 604.
Venus stimpsoni. Tokunaga, Foss. Env. Tokyo, p. 46.

Shell solid, rather compressed, ovately triangular, broader than high, bluntly angular behind, very inequilateral, the beaks being near the anterior margin. Surface ornamented with thin, erect, concentric lamellae. Lunula deep, well bounded, longly cordate. Area very long, rather distinctly bounded, taking nearly the whole length of the postero-dorsal slope of the shell. Of the three strong main teeth, the middle one in the left valve is bifid, while in the right the middle as well as the posterior are bifid. Pallial sinus small, shallow, triangular. The inner margin of the shell is finely crenulate, though Gould calls it simple.

The largest specimen obtained is a left valve measuring 95 millim. in length, 80 millim in height and 23 millim. in depth.

Fossil occurrence.—Otake (frequent), Shisui (do), Shito (do). Oji in Musashi.

Living.—Northern to Western Japan.

233. ***Venus jedoensis***, Lischke.

Venus jedoensis. Lischke, Jap. Meeresconch., III, p. 84, pl. VII, figs. 1–9. Dunker, Ind. Moll., p. 196. Pilsbry, Cat., p. 127. Yokoyama, Foss. Miura Penin., p. 120, pl. VIII, figs. 9, 10.

This shell fully described by Lischke is readily known by its rather thick, tumid, transversely and shortly oval, inequilateral form with radiating ribs crossed by concentric lines of growth. Lunula cordate bounded by distinct grooves. Inner margin crenulate. Pallial sinus moderately deep, narrowing towards its end which is bluntly pointed. Of the three main teeth, the middle in the left valve and the middle and the posterior in the right are bifid.

The young specimens of this species are more rounded in outline than the adult.

Fossil occurrence.—Otake (not rare), Kioroshi, Tega. Lower Musashino of Miyata and Yokosuka.

Living.—Northern, Central and Western Japan.

234. ***Venus neastartoides***, Yokoyama.

Pl. XI. Figs. 9, 10.

Shell small, thick, rather compressed, triangular. Anterior side only a little longer than posterior. Anterior end sharply rounded. Antero-dorsal margin nearly straight, sloping. Postero-dorsal and posterior margins together forming a broad curve. Postero-ventral corner obtusely angulate. Surface smooth, only with lines of growth. Beaks small, pointed, curved in. Teeth three in each valve with the middle one thickest. No lunula. Inner margin smooth. Pallial sinus shallow, triangular, blunt at end. The largest right valve measures 20.3 millim. in length, 15.6 millim. in height and 5 millim. in depth, while the largest left measures 19.4 millim, in length, 14.6 millim. in height and 4.3 millim. in depth.

The compressed state of this shell reminds us of the genus *Astarte*, but as the name *astartoides* is already used by Beck, *neastartoides* was chosen as the specific name.

Fossil occurrence.—Otake (frequent), Kamenari (do), Tega (do), Kioroshi (most frequent), Shito (rare).

Living.—Central Japan.

Genus **CHIONE**, Megerle von Mühlfeldt.

235. ***Chione isabellina***, (Philippi).

Chione isabellina. Deshayes, Conch. Brit. Mus., I, p. 124, no. 17. Dunker, Index Moll., p. 198. Yokoyama, Foss. Miura Penin., p. 121, pl. VIII, fig. 13.

Venus isabellina. Philippi, Zeitschr. f. Malak., p. 188, no. 65. Abbild., III, p. 83, no. 5. Venus, pl. X, fig. 5. Pfeiffer in Syst. Conch. Cab., XI, pt. 1, p. 194, pl. 25, fig. 9.

Venus foliacea. Tokunaga, Foss. Env. Tokyo, p. 46, pl. III, fig. 3, (non *V. foliacea* Phil).

Tokunaga mistook this shell for *Chione foliacea* Phil. which has the inner margin crenulate and not smooth as in the present species. The shape is also somewhat different, the height being somewhat greater in *Chione isabellina*.

Fossil occurrence.—Otake (rare), Shisui, Tega. Oji and Shinagawa in Musashi. Lower Musashino of Naganuma.

Living.—Japan (according to Dunker). China Sea.

236. *Chione mindanensis*, Smith.

Pl. XI. Figs. 2, 3.

Venus (*Chione*) *mindanensis.* Smith, Challenger Report, Lamellibr., p. 130, pl. II J, figs. 4, 4 b.

The shell is small, rather thin, moderately convex, inequilateral, subquadrate in outline, the four sides being formed by the postero-dorsal, posterior, anterior and ventral margins, of which the first is the shortest and the last the longest. The antero-dorsal and anterior margins together form a curved line, while the posterior is only slightly arched, meeting with the ventral usually in a rounded right angle. The surface has a blunt edge running from the beak to the postero-ventral corner, the part behind which is slightly depressed in the middle. The sculpture consists of radiating riblets and concentric lamellae. The former are rounded and generally furnished with an interstitial one which is either indistinct or obsolete near the beaks, while the latter are elevated, variable in number, and at unequal distances from one another. Lunula longly ovate, distinctly bordered by grooves and ornamented with a few radiating riblets. Shell-margin finely crenulate. Teeth three in each valve, the middle one being the strongest. As to the laterals, there is only one in the anterior part of the right valve, which is thin and rudimentary. Pallial sinus very shallow, broader than deep, narrowed at end.

	Length.	Height.	Depth.
Right valve	9.2 millim.	7.8 millim.	2.6 millim.
Left ,,	8.1 ,,	7.3 ,,	2.3 ,,

This shell has not yet been reported from Japanese waters.

Fossil occurrence.—Shito (very common).

Living.—Off Mindanao of the Philippines at the depth of 82 fathoms.

Genus **VENERUPIS**, Lamarck.

237. ***Venerupis semipurpurea***, (Dunker).

Pl. XII. Figs. 1, 2.

Venerupis semipurpurea. Pilsbry, Catal., p. 129.
Rupellaria semipurpurea. Dunker, Ind. Moll. p. 208.

This shell which is more or less variable in outline may be described somewhat as follows:

Shell usually rather thin, convex, transversely elongated, oblong, inequilateral, rounded in front, more or less truncate behind. Dorsal margin more or less straight and mostly parallel with ventral margin. Surface with a blunt edge running from beaks to postero-ventral corner. The sculpture consists of numerous, close, flexuous, radiating riblets crossed by rude lines of growth. Of the three teeth present in each valve, the middle one is thick and bifid. Pallial sinus deep, reaching the middle of the valves, with the upper border horizontal and the lower oblique, so that the end becomes bluntly pointed.

The variability of the shell lies in its length (sometimes double, sometimes not quite one and a half times the height), in the degree of the parallel state of the dorsal margin with the ventral as well as of the inequilateral state and depth, in the shape of the anterior end (rarely truncate), etc.

The living specimens of this shell are coloured purplish in the hinder part, while the remaining parts are more or less white. Dunker in describing this species did not give any figure.

The following are some of the measurements:

	Length.	Height.	Depth.
Left valve.	39.2 millim.	22.2 millim	9.6 millim.
,, ,,	29.5 ,,	16.9 ,,	6.3 ,,
Right ,,	34.0 ,,	18.8 ,,	8.6 ,,
,, ,,	34.8 ,,	20.9 ,,	8.2 ,,

Fossil occurrence.—Otake (rather rare), Narita, Kamenari.

Living.—Northern, Central and Western Japan.

Genus **TAPES**, Megerle von Mühlfeldt.

238. ***Tapes euglyptus***, (Philippi).

Pl. XII. Fig. 8.

Tapes euglyptus. Lischke, Jap. Meeresconch., vol. I, 119, III, p. 80, pl. V, figs. 8–10. Dunker, Ind. Moll., p. 206. Pilsbry, Catal., p, 129. Tokunaga, Foss. Env. Tokyo, p. 50, pl. III, fig. 8.

Venus euglypta. Philippi, Abbild., III, p. 76, pl. VII, fig. 3.

A fragment of a left valve. Yet the coarse concentric grooves as well as the general outline leave no doubt of its being the above named species.

Fossil occurrence.—Kioroshi. Shinagawà in Musashi.

Living.—Central and Western Japan.

239. ***Tapes philippinarum***, (Adams et Reeve).

Tapes philippinarum. Lischke, Jap. Meeresconchylien, I, p. 115, II, p. 108, III, p. 78. Pilsbry, Cat., p. 130. Yokoyama, Foss. Miura Penin., p. 125, pl. IX, fig. 6.

Venus philippinarum. Adams and Reeve, Voy. Samarang, Moll., p. 79. pl. XXII. fig. 10.

Venus decussata. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 533.

Tapes decussatus. Brauns, Geol. Env. Tokio, p. 53.

This shell which is closely akin to the following is represented by a few examples.

Fossil occurrence.—Otake, Shito. Tabata and Dokwanyama in Musashi. Lower Musashino of Yokosuka.

Living.—Northern, Central and Western Japan. Philippines. Indian Ocean.

240. *Tapes variegatus*, Hanley.

Tapes variegatus. Sowerby, Thes. Conch., II, p. 696, pl. 151, figs. 133–138. Lischke, Jap. Meeresconch., I, p. 118, II, p. 108, III, p. 79. Dunker, Ind. Moll., p. 209. Pilsbry, Cat., p. 130. Yokoyama, Foss. Miura Penin., p. 125, pl. IX, figs. 4,5.

Very frequent at some localities.

This species is distinguished from the foregoing by its longer and less inflated shell, The radiating riblets of the surface are similar in both. The size attained by fossil specimens is moderate. The largest left valve is 52.5 millim. long, 35.3 millim. high and 12.5 millim. deep.

Fossil occurrence.—Otake (very frequent), Tega (do). Kioroshi, Kamenari, Shisui. Lower Musashino of Miyata.

Living.—Central and Western Japan. Philippines.

Genus **SAXIDOMUS**, Conrad.

241. *Saxidomus purpuratus*, (Sowerby).

Pl. XII. Fig. 9.

Saxidomus purpuratus. Deshayes in Cat. Conch. Brit. Mus., p. 138. Lischke, Jap. Meeresconch., vol. I, p. 127. Dunker, Ind. Moll., p. 206. Brauns, Geol. Env. Tokio, p. 40, pl. V, fig. 20. Yokoyama, Foss. Miura Penin., p. 127, pl. IX, fig. 8.

Saxidomus nuttali. Conrad, Jour. Acad. Sci., Phil, 1887, VII, p. 249, pl. XX, fig. 12. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 253. Tokunaga, Foss. Env. Tokyo, p. 45.

Several splendid examples from several localities.

Fossil occurrence.—Otake, Shisui, Kioroshi, Shito. Oji and Shinagawa in Musashi. Lower Musashino of Yokosuka.

Living.—Northern, Central and Western Japan. Ogasawara-jima or Bonin Islands. Indian Ocean. Sitka, California, Chile.

Family **Cardiidæ.**

Genus **CARDIUM**, Linné.

242. *Cardium burchardi*, Dunker.

Pl. XII. Fig. 3.

Cardium burchardi. Dunker, Ind. Moll., p. 210, pl. XVIII, figs. 4–6. Pilsbry, Catalogue, p. 131.

Two right valves and one left.

The shell is somewhat obliquely ovate, higher than long, moderately convex and ornamented with straight, rounded, radiating ribs separated from one another by deep narrow grooves and numbering a little over forty. The ribs found near the extreme end of the flattened posterior surface are accompanied by fine riblets which are roughly crenate, or even spiny, toward their lower ends.

The larger of the two right valves is 63.3 millim. in height, 59.7 millim. in length and 20.5 millim. in depth, while the smaller has the posterior and postero-dorsal margins more arched and is comparatively higher and less deep, being 20.8 millim. in height 20.6 millim. in length and 5.6 millim. in depth. The left valve is 37 millim. in height, 36 millim. in length and 11.5 millim. in depth.

Fossil occurrence.—Kamenari, Tega.

Living.—Central and Western Japan.

243. *Cardium californiense*, Deshayes.

Cardium californiense. Deshayes, Revue Zool., p. l. Soc. Cuvierienne, p. 360. Middendorff, Sib. Reise, Meeresmollusken, p. 218, pl. XIX, figs. 6–11. Mal. Ross., III, p. 40, pl. XV, figs. 23–25. Schrenck, Moll. Amurl. u. d. nordjap, Meeres, p. 514. Lischke, Jap. Meeresconch., I, p. 144, III, p. 125. Brauns, Geol. Env. Tokio, p. 42. Yokoyama, Foss. Miura Penin., p. 127, pl, IX, fig. 10.

The specimens, though numerous, are mostly small. But there is a broken right valve from Shisui measuring 40 millim. in height.

Fossil occurrence.—Otake (frequent), Shisui, Tega, Shito (frequent). Oji and Shinagawa. Lower Musashino of Miyata and Yokosuka.

Living.—Northern, Central and Western Japan. Behring Sea. British Columbia. California.

244. *Cardium muticum*, Reeve.

Pl. XII. Fig. 7.

Cardium muticum. Reeve, Conch. Icon., Cardium, pl. VI, fig. 32. Lischke, Jap.

Meeresconch., I, p. 144. Brauns, Geol. Env. Tokio, p. 42. Tokunaga, Foss. Env. Tokyo, p. 50, pl. III, fig. 10. Dunker, Ind. Moll., p. 212. Pilsbry, Catalogue, p. 131. Yokoyama, Foss. Miura Penin., p. 128, pl. IX, fig. 11.

Cardium japonicum. Dunker, Moll. Jap., p. 28, pl. III, fig. 16.

Cardium papyraceum. Römer in Syst. Conch. Cab., X, pt. 2, p. 78, pl. III, fig. 4, pl. XII, figs. 19, 20.

The figured specimen is a large right valve 83.5 millim. in length and 72.5 millim. in height.

Fossil occurrence.—Otake (common), Shisui, Kamenari, Tega (frequent). Oji and Shinagawa. Lower Musashino of Miyata, Yokosuka and Naganuma.

Living.—Northern, Central and Western Japan. Philippines. East Indies.

245. ***Cardium modestum***, Adams et Reeve.

Cardium modestum. Adams and Reeve, Voy. Samarang, Zoology, p. 77, pl. XXII, fig. 6. Dunker, Ind. Moll., p. 211. Pilsbry, Catal., p. 131. Yokoyama, Foss. Miura Penin., p. 128, pl. IX, figs. 12, 13.

This shell frequent in the Lower Musashino of Koshiba is rare in the Upper.

Living.—Central Japan.

246. ***Cardium braunsi***, Tokunaga.

Pl. XIII. Fig. 2.

Cardium braunsi. Tokunaga, Foss. Env. Tokyo, p. 51, pl. III, fig, 11, Yokoyama, Foss. Miura Penin., p. 129, pl. X, fig. 1.

That this species is akin to *Cardium tuberculatum* L. and *Cardium nuttali* Reeve has already been mentioned in my work above cited. The specimens which are rather rare are more or less decorticated on the surface. The largest specimen obtained is a right valve measuring about 91 millim. in length and height, and 34 millim. in depth. The ribs number twenty-four on an average and are made crenate near the ventral margin by rude lines of growth, a character which brings the species closer to the species of Reeve as well as of Linné.

Fossil occurrence.—Otake, Tega, Shito. Oji in Musashi. Lower Musashino of Miyata.

247. *Cardium tokunagai*, Yokoyama.

Pl. XII. Figs. 4, 5, 6.

Shell rather thin, tolerably inflated, suborbicular, a little broader than high, anterior border somewhat more broadly rounded than posterior, slightly inequilateral and oblique. The sculpture consists of about twenty-four broad, elevated, rather flatly topped, finely and indistinctly crenate ribs separated by somewhat broader and deep valleys. Beaks small, approaching. Inner margin coarsely crenate.

The following are some of the measurements of isolated valves:

	Length.	Height.	Depth.
Left valve	26.9 millim.	24.4 millim.	8.6 millim.
,, ,,	23.0 ,,	21.7 ,,	7.5 ,,
Right ,,	28.9 ,,	25.2 ,,	10.1 ,,
,, ,,	25.5 ,,	23.7 ,,	8.8 ,,

The surface in most specimens is more or less decorticated, the crenate character of the ribs being most marked in such. As to the shape, there is some variation. In some examples both anterior and posterior ends are equally rounded, while in others the posterior is subtruncate. Fig. 4 represents a right valve with such a subtruncate posterior end. It is ovate in shape and somewhat different in appearance from the typical form. I believe it is only an abnormal one, but should it prove to be constant in character I would propose for it the name of var. *ovata*. The specimen measures 30 millim. in length, 26.5 millim. in height and 10.5 millim. in depth. The ribs number twenty-three and are to a greater part decorticated.

The typical form of the species is allied to *Cardium sinense* Sowerby (Syst. Conch. Cab. Mart. Chem., Cardium, p. 73, pl. XII, figs. 11, 12) in which, however, the lunula as well as the area are well developed.

Tokunaga in his "Fossils from the Environs of Tokyo" seems to have mistaken this shell for *Cardium californiense* Desh., as can be judged from his figure (pl. III, fig. 9). The two species are indeed somewhat alike, but a closer examination shows that *Cardium californiense* is flatter and longer.

Fossil occurrence.—Otake (numerous), Shito, Shisui, Tega. Oji (very frequent).

Family **Leptonidæ.**

Genus **MONTACUTA**, Turton.

248. ***Montacuta japonica***, Yokoyama.

Pl. IX. Figs. 2, 3.

Shell very small, rather thin, moderately inflated, transversely oval, very inequilateral with anterior side only about half as long as posterior. Anterior dorsal margin steeply sloping, slightly excavated, meeting nearly at a right angle with posterior dorsal which is less steep and somewhat convex. Anterior and posterior ends rounded, the former a little more sharply than the latter. Surface only with lines of growth. Beaks small, pointed. Muscular and pallial impressions distinct. Length 3.5 millim. Height 3.1 millim. Depth of each valve about 1.1 millim.

This species closely resembles *Montacuta bidentata* Mont. (Wood, Crag Moll., Biv., p. 126, pl. XII, fig. 17) of the English Crag, which is still living in the British seas. The English species, however, is larger and more rhombic in outline, with the dorsal and ventral margins subparallel.

Fossil occurrence.—Otake, Shisui, Shito. Oji (numerous).

Living.—Central Japan.

249. ***Montacuta oblongata***, Yokoyama.

Pl. XIII. Figs. 9, 10.

Shell very small, thin, compressed, transversely oblong, very inequilateral, rounded at both ends, a little more sharply in front than behind. Dorsal and ventral margins subparallel. Surface smooth. Beaks small and pointed, with an obtuse keel running to postero-ventral corner. Left valve with two diverging teeth which are very distinct. Length 4.5 millim. Height 3.1 millim. Depth of each valve about 1.0 millim. Very rare.

In shape this shell is much like *Montacuta* (?) *donacina* Wood, var. (Crag Moll., Bivalves, p. 131, pl. XI, fig. 3 a.) from the English Coralline Crag.

Fossil occurrence.—Shito. Oji in Musashi.

250. *Montacuta ? yamakawai*, Yokoyama.

Pl. IX. Fig. 10.

A few right valves.

The shell is very small, rather thin, compressed, transversely oblong, with the anterior border more sharply rounded than the posterior, and somewhat inequilateral, the anterior side being a little shorter than the posterior. The ventral margin is generally only slightly arched or straight or even concave, being as a whole subparallel with the very broadly arched dorsal margin. Surface with very faint radiating lines, only visible with a magnifier. Hinge with two diverging teeth and a triangular vacancy between.

One of the specimens measures 4.5 millim. in length, 32 millim. in height, and 0.9 millim. in depth, while another measures 3.6 millim. in length, 2.7 millim. in height and 0.6 millim. in depth.

The shell resembles in form the right valve of *Kellia suborbicularis* Mont. figured in Wood's Crag Mollusca (Bivalves, pl. XII, fig. 8 b), though the hinge is quite different.

Fossil occurrence.—Shisui.

Genus **THYASIRA**, Leach.

251. *Thyasira trigonata*, Yokoyama.

Pl. IX. Figs. 11, 12.

Shell small, rather thin, ovately triangular, moderately swollen, very inequilateral, posterior side being about two and a half times as long as anterior, sharply rounded in front, bluntly pointed behind. Antero-dorsal margin concave, postero-dorsal broadly convex, ventral strongly arcuate. Beaks small but conspicuous, bent forward. Surface with a weak posterior flexure, the furrow being very broad and shallow. The sculpture consists of concentric striæ with fine radiating lines. Lunula ovate, deep and sunken. Muscular as well as pallial impressions obsolete.

One left and two right valves. The former measures 4.7 millim. in length, 3.9 millim. in height, and 1.3 millim. in depth, while one of the latter measures 5.3 millim. in length, 4.9 millim. in height and 1.9 millim. in depth.

Fossil occurrence.—Shito.

Family **Diplodontidæ.**

Genus **DIPLODONTA**, Broun.

252. ***Diplodonta usta***, Gould.

Pl. XIII. Fig. 3.

Diplodonta usta. Pilsbry, Catalogue, p. 133. Yamakawa, On Diplodonta usta Gld. (Japanese), Journ. Geol. Soc. Tokyo, 1909, vol. XVI, p. 482, pl. XIV, figs. 1–10. Yokoyama, Foss. Miura Penin., p. 130, pl. IX, figs. 14, 15. 16.

Mysia (*Felania*) *usta.* Gould, Otia Conch., p. 170.

Mysia pacifica. Tokunaga, Foss. Env. Tokyo, p. 53.

Diplodonta trigonula. Brauns, Geol. Env. Tokio, p. 44, pl. VI, ffg. 25 (non D. trigonula Broun).

This shell has already been described in my work above cited. The specimens are very frequent, much more so than in the Miura Peninsula. There is some variation in form.

Fossil occurrence.—Otake (very frequent), Shisui (do), Kioroshi, Tega, Shito (very frequent). Oji in Musashi. Lower Musashino of Miyata.

Living.—Northern and Central Japan.

253. ***Diplodonta japonica***, Pilsbry.

Diplodonta japonica. Pilsbry, Catalogue, p. 132, pl. III, figs. 6, 7. Yokoyama, Foss. Miura Penin., p. 131, pl. X, fig. 4.

This shell so rare in the Lower Musashino is quite common in the Upper.

Fossil occurrence.—Otake, Kioroshi, Kamenari. Lower Musashino of Naganuma

Living.—Central Japan.

254. *Diplodonta semiaspera*, Philippi.

Pl. XIV. Fig. 2.

Diplodonta semiaspera. Philippi, Archiv. f. Naturgesch., I, 1836, p. 225, pl. VII, fiig. 2. Dunker, Ind. Moll., p. 48. Yokoyama, Foss. Miura Penin., p. 131, pl. X, figs. 2,3.
Mysia aff. semiaspera. Tokunaga, Foss. Env. Tokyo, p. 53, pl. III, fig. 13.

This species which resembles the preceding in outline is thinner, flatter and grows larger with beaks smaller and less swollen. There is a large right valve measuring 34.4 in length. The figured specimen is also a comparatively large one measuring 29.5 millim. in length, 27.2 millim. in height and 10 millim. in depth. Rather frequent.

Fossil occurrence.—Otake, Shisui, Tega, Shito. Oji in Musashi. Lower Musashino of Miyata and Koshiba.

Living.—Central and Western Japan. West Indies. Mazatlan. Patagonia.

Family **Lucinidæ.**

Genus **LUCINA**, Bruguière.

255. *Lucina pisidium*, Dunker.

Lucina pisidium. Dunker, Moll. Jap., p. 28, pl. III, fig. 9. Ind. Moll., p. 216. Lischke, Jap. Meeresconch., vol. II, p. 133. Pilsbry, Cat., p. 133. Yokoyama, Foss. Miura Penin., p. 132, pl. X, fig. 6.
Lucina parvula. Gould, Otia, Conch., p. 174.

Rather rare,

Fossil occurrence.—Otake, Shisui, Tega. Oji. Lower Musashino of Miyata, Yokosuka and Naganuma,

Living,—Northern, Central, Western and Southern Japan, New South Wales.

256. *Lucina borealis*, (Linné).

Lucina borealis. Forbes and Hanley, Brit. Moll., II, p. 46, pl. 35, fig. 5. Wood, Crag Moll., Biv., p. 139, pl. XII, fig. 1. Nyst, Conch. Tert. de la Belgique, p. 176, pl. XIX, fig. 2. Brauns, Geol. Env. Tokio, p. 44. Tokunaga, Foss. Env. Tokyo, p. 52. Yokoyama, Foss. Miura Penin., p. 133, pl. X, fig. 7.
Venus borealis. Linné, Syst. Nat., ed. 12, p. 1134.

This well known Altantic shell not mentioned in any work relating to the recent conchology of Japan hitherto published is frequently met with living in the seas near Sagami (Central Japan). The fossil specimens are also common in the Upper Musashino as already pointed out by Brauns and Tokunaga.

Fossil occurrence in Japan.—Otake (common), Tega, Shisui, Shito. Oji, Tabata and Shinagawa. Lower Musashino of Miyata, Yokosuka and Naganuma.

Fossil occurrence in Europe.—Pliocene and Glacial of England. Pliocene of Belgium and Italy. Miocene of Austria, Poland, Switzerland, Russia, etc.

Living.—Central Japan. Atlantic from Iceland to the Mediterranean Sea.

257. ***Lucina contraria***, Dunker.

Lucina contraria. Dunker, Ind. Moll., p. 215, pl. XIII, figs. 12, 13, 14. Yokoyama, Foss. Miura Penin., p. 134, pl. X, fig. 8.

Lasæa striata. Tokunaga, Foss. Env. Tokyo, p. 53, pl. III, fig. 14.

What Brauns described as *Lasæa rubra* Mont. in his "Geology of the Environs of Tokio" p. 43, without giving any figure, seems to be this species.

Fossil occurrence.—Otake (common), Kioroshi, Kamenari, Tega (frequent). Oji and Shinagawa in Musashi. Lower Musashino of Miyata.

Living.—Central Japan.

Family **Chamidæ.**

Genus **CHAMA**, Linné.

258. ***Chama semipurpurata***, Lischke.

Pl. XIII. Fig. 5.

Chama semipurpurata. Lischke, Jap. Meeresconch., II, p. 130, pl. VIII, fig. 1. Pilsbry, Catalogue, p. 134. Yokoyama, Foss. Miura Penin., p. 136, pl. X, figs. 13, 14.

A single upper and a single lower valve of two young individuals.

The lower valve is nearly elliptical in outline, with coarse corrugated concentric laminæ on the free portion of the shell. The inner margin is finely crenulate up to near the beak at the anterior side. Length 19 millim. Height 25 millim.

The upper valve is suboval in form and very small, only 4.1 millim. in length and 2.7 millim. in height. The sculpture consists of coarse concentric laminæ which in the lower two-thirds of the surface give out tubiform processes or spines.

Fossil occurrence.—Otake, Shito. Lower Musashino of Miyata.

Living.—Central to Southern Japan.

Family **Carditidæ.**

Genus **VENERICARDIA**, Lamarck.

259. ***Venericardia cipangoana***, Yokoyama.

Pl. XIII. Fig. 4.

Venericardia cipangoana. Yokoyama, Foss. Miura Penin., p. 137, pl. XI, Fig. 2.
Venericardia compressa. Yokoyama, Verst. a. d. jap. Kreide, Palæontographica, XXXVI, p. 196, pl. XXV, fig. 4.

A full description of this species was given in my work on the fossils of the Lower Musashino above cited.

The figured specimen is a large left valve from Otake, 34.2 millim. in length, 28.7 millim. in height and 9.7 millim. in depth.

Fossil occurrence.—Otake, Kioroshi. (common), Shisui, Kamenari, Tega, Shito (very common). Lower Musashino of Miyata and Naganuma. Miocene(?) of Poronai in the Hokkaido.

Living.—Central and Western Japan.

260. ***Venericardia ferruginea***, (Adams).

Venericardia ferruginea. Yokoyama, Foss. Miura Penin,, p. 139, pl. XI, figs. 3, 4.
Cardita ferruginea. Clessin, in Syst. Conch. Cab. Mart. Chemn., pt. 1, p. 17, pl. VI, fig. 11. Pilsbry, Cat., p. 135.
Cardita rotunda. Tokunaga, Foss. Env. Tokyo, p. 55, pl. III, fig. 17.

Fossil occurrence.—Otake, Kamenari, Shito (very common). Oji and Shinagawa. Lower Musashino of Miyata, Yokosuka, Koshiba and Naganuma.

Living.—Northern Japan.

261. *Venericardia toneana*, Yokoyama.

Pl. XIII. Figs. 6, 7.

Shell very small, thick, triangularly ovate, moderately convex, somewhat oblique and inequilateral with anterior side shorter than posterior, rounded in front and behind. Antero- and postero-dorsal margins straight, meeting each other at somewhat less than a right angle, so that the beaks appear pointed. Surface radiately ribbed; ribs about thirteen in number, flatly rounded, separated by very narrow valleys, crenulate. Inner margin coarsely crenate. Lunula longly ovate, distinct, smooth. Main teeth accompanied by an anterior lateral. Length 2.2 millim. Height 2.1 millim. Thickness 1.7 millim.

Fossil occurrence.—Otake, Tega, Shito (numerous). Oji.

Family **Astartidæ**.

Genus **ASTARTE**, Sowerby.

262. *Astarte borealis*, (Chemnitz).

Pl. X. Fig. 11.

Astarte borealis. Forbes, Mem. Geol. Surv., vol. I, p. 413, 1846. Wood, Crag Moll., Biv., p. 175, pl. XVI, figs. 3a–d.

Astarte corrugata. Lovén, Ind. Moll. Scand., p. 37. Middendorff, Beitr. z. Malac. Ross., III, p. 46, pl. XVII, figs. 4–9.

Astarte arctica. Möller, Ind. Moll. Greenl., p. 19. Forbes and Hanley, Hist. Brit. Moll., I, p. 461, pl. XIX, fig. 7.

Venus borealis. Chemnitz, Conch. Cab., vol. VII, pl. XXXIV, fig. 42.

A single left valve which, however, undoubtedly belongs to the species above named. It is thick, much compressed, broadly ovate, somewhat longer than high, rounded in front, truncate behind. The surface is smooth and has an indistinct flattened carina behind. Inner margin smooth. Length 15.3 millim. Height 14.1 millim. Depth 2.9 millim. In shape it comes closest to what Middendorff calls var. *lactea* (loc. cit., pl. XVII, figs. 8, 9).

Fossil occurrence in Japan.—Shito.

Fossil occurrence in Europe.—English Crag.

Living.—Northern Japan (Kurile Islands). Behring Strait. Britain (deep water). Arctic seas.

263. ***Astarte hakodatensis***, Yokoyama.

Astarte hakodatensis. Yokoyama, Foss. Miura Penin., p. 140, pl. XI, figs. 5, 6.

This species is smaller and higher in form than the preceding. Its description is found in my work above mentioned.

Fossil occurrence.—Shito.

Living.—Northern Japan.

Family **Crassatellidæ.**

Genus **CRASSATELLA**, Lamarck.

264. ***Crassatella oblongata***, Yokoyama.

Crassatella oblongata. Yokoyama, Foss. Miura Penin., p. 142, pl. XI, figs. 8, 9.

A few young specimens which are somewhat flatter and more coarsely grooved on the surface than the adult ones. The largest obtained is a right valve, 9 millim. long, 6.5 millim. high and 2 millim. deep, with concentric grooves about seventeen in number.

Fossil occurrence.—Shito. Lower Musashino of Miyata and Koshiba.

265. ***Crassatella nana***, Adams et Reeve.

Pl. XIII. Fig. 8.

Crassatella nana. Adams and Reeve, Voy. Samarang. Moll , p. 81, pl. XXIII, fig. 2.

A single right valve. Shell thick, strongly compressed, subequilateral, somewhat pentagonal in outline, longer than high, rounded in front, truncate behind. Postero-dorsal margin straight, sloping, gradually passing into posterior margin with a curve; ventral margin broadly arcuate with inner side crenulate and postero-ventral corner obtusely angulate. Surface with concentric furrows. Beaks small, pointed, with an obtuse edge running to postero-ventral corner. Main teeth two, oblique with lower ends towards front and a triangular ligamental pit behind; anterior lateral tooth distinct, elongated. Anterior muscular impression somewhat pear-shaped, posterior more rounded. Length 15 millim. Height 12.1 millim. Depth 3 millim.

This shell resembles the preceding in general outline; but it is larger, flatter and smooth on the surface.

Fossil occurrence.—Kioroshi.

Living.—Eastern seas (according to Adams and Reeve).

266. *Crassatella heteroglypta*, (Pilsbry).

Crassatella heteroglypta. Yokoyama, Foss. Miura Penin., p. 141, pl. XI, figs. 10, 11.
Crassatellites heteroglypta. Pilsbry, Cat., p. 135.
Crassatella japonica. Sowerby, Jour. Linn. Soc., XX, p. 399, pl. 25, fig. 19.

A single right valve.

Fossil occurrence.—Kioroshi. Lower Musashino of Miyata and Naganuma.

Living.—Central and Western Japan.

Family **Cyrenidæ**.

Genus **CORBICULA**, Mühlfeldt.

267. *Corbicula sandaiformis*, Yokoyama.

Pl. XIII. Figs. 14, 15.

Shell thick, roundly triangular, about as high as long, a little inequilateral, moderately tumid. Anterior border rounded, posterior subtruncate, forming an obtuse angle with broadly curved ventral border; antero-dorsal meeting with postero-dorsal at an angle which is nearly a right angle; ventral less arched in posterior half than in anterior. Surface with a very blunt posterior carina and ornamented throughout with rude, unequal, concentric grooves. Beaks rather large, swollen, prominent. Lunula lanceolate, bounded by a fine impressed line on both sides.

The following are some of the measurements of the normal form:

	Length.	Height.	Depth.
Left valve	26.7 millim.	26.5 millim.	9.0 millim.
,, ,,	28.8 ,,	29.3 ,,	9.5 ,,
Right ,,	31.5 ,,	31.5 ,,	9.9 ,,

Besides, there are also forms which are either shorter or longer. One of the latter measures 21 millim. in length, 19.6 millim. in height and 6.7 millim. in depth, while one of the former measures 32 millim. in length, 33.5 millim. in height and 10.5 millim. in depth.

This shell is closely allied to *Corbicula sandai* Reinhardt (Kobelt, Fauna Moll. Extramar. Jap., p. 153, pl. 20, fig. 3) from which it differs by the presence of a posterior carina.

Fossil occurrence.—Otake, Kamenari, Shito (common).

Living.—Central Japan (coast of Kazusa).

268. ***Corbicula kobelti***, Yokoyama.

Pl. XIII. Figs. 18, 19.

Three left valves. The shell is decidedly longer (lower) than the preceding with beaks smaller and less swollen. The outline is ovato-trigonal, more or less rounded in front and truncate behind. The angle at which the antero- and postero-dorsal margins would meet, when produced, is somewhat greater than a right angle. Convexity of shell moderate. Surface with rude lines of growth which make it unequally grooved.

The measurements of the three valves are as follows:

Length.		Height.		Depth.	
29.4 millim.	(10)	27.0 millim.	(9.0)	8.8 millim	(2.9)
22.8 ,,	(10)	20.5 ,,	(8.9)	7.1 ,,	(3.1)
13.1 ,,	(10)	11.8 ,,	(9.0)	3.7 ,,	(2.9)

The nearest ally of this species seems to be *Corbicula pexata* Prime (Kobelt, loc. cit., p. 157, pl. 20, fig. 2) in which, however, the beaks are more tumid.

Fossil occurrence.—Shito, Otake.

Living.—Central Japan.

Family **Pleurophoridæ**.

Genus **CORALLIOPHAGA**, Blainville.

269. ***Coralliophaga coralliophaga***, (Chemnitz).

Pl. XIV. Fig. 5.

Coralliophaga coralliophaga. Pilsbry, Cat., p. 136. H. and A. Adams, Genera of Recent Mollusca, II, p. 439, pl. 109, figs. 6, 6a.

Coralliophaga lithophagella. Dunker, Ind. Moll., p. 209.

Cypricardia coralliophaga. Lischke, Jap. Meeresconch., II, p. 140.
Chama coralliophaga. Chemnitz, Conch. Cab., X, p. 359, pl. 172, figs. 1673, 1674.

Only a single right valve, 38 millim. in length, 19 millim. in height and 6.3 millim. in depth. It is characterized by a transversely elongated, more or less rectangular or oblong form with beaks near the anterior border and two main teeth accompanied by a posterior lateral. These teeth are more or less horizontal in position. The radiating riblets found in living specimens are not seen in the fossil, a result of friction.

On examining the recent specimens, there is a great variation in shape. The younger ones are generally shorter and often more oblong than the adult.

Fossil occurrence.—Shito.

Living.—Central and Western Japan. South Sea. Red Sea. West Indies.

Genus **TRAPEZIUM**, Mühlfeldt.

270. ***Trapezium nipponicum***, Yokoyama.

Pl. XIII. Fig. 17.

Shell rather thick, transversely elongated, trapezoidal, swollen, very inequilateral, with anterior margin rounded, posterior truncate, ventral somewhat excavated, postero-dorsal sloping and meeting with posterior at an obtuse angle. Surface with a shallow median depression, and coarsely concentrically corrugated. A rounded edge runs from beak to postero-ventral corner. Area lanceolate, bounded by an elevated, rather blunt and irregular ridge on both sides. Beaks large, swollen. Main teeth two in each valve, oblique; posterior lateral single.

One right and three left valves. The former measures 27.5 millim. in length, 18 millim. in height and 8.6 millim. in depth, while the largest of the latter measures 11.2 millim. in length, 8.1 millim. in height and 4.3 millim. in depth.

Fossil occurrence.—Otake, Shito.

Living.—Central and Western Japan.

271. *Trapezium ventricosum*, Yokoyama.

Pl. XIII, Fig. 1.

Shell thick, somewhat higher than long, very inequilateral, much swollen, sharply rounded in front, truncate behind, with ventral margin only slightly arched. Beak very large, swollen, curved forward as well as inward, with two blunt edges, one running to postero-ventral and the other to antero-ventral corner. Space between these two edges flattened. The sculpture consists only of coarse lines of growth. Behind the beak there is a lanceolate area-like space bounded by a blunt ridge in each valve with three longitudinal ribs on it. Pallial line simple.

There is only a single left valve with a large part of the beak broken. The hinge is worn by friction, but so much is certain that there is at least one prominent main tooth. The posterior lateral is indistinct. It is 18.5. millim. long, 20 millim. high and 10 millim. deep.

Fossil occurrence.—Otake.

272. *Trapezium liratum*, (Reeve).

Pl. XIII. Fig. 16.

Trapezium liratum. Pilsbry, Catalogue, p. 136.
Cypricardia lirata. Reeve, Conch. Icon., I. Cypricardia, spec. 1,

Shell moderately thick, rather tumid, transversely elongated, strongly inequilateral, sharply rounded in front, truncate behind. Dorsal and ventral margins nearly straight and parallel. A flat ridge runs from the beak to the rounded postero-ventral corner. Surface with a shallow median depression and rugose concentric folds or ridges. Area lanceolete, bounded by a ridge on each side. Main teeth two, horizontal; laterals indistinct. Pallial line simple. Only a left valve, 20.5 millim. in length, 12 millim. in height and 5.3 millim. in depth.

Fossil occurrence.—Otake.

Living.—Central Japan.

Order Anomalodesmacea.

Family Cuspidariidæ.

Genus CUSPIDARIA, Nardo.

273. *Cuspidaria ligula*, Yokoyama.

Pl. XIV. Figs. 3, 4.

Shell small, thin, moderately convex, transversely piriform, somewhat inequilateral with anterior side a little shorter than posterior, rounded in front, rostrate and truncate behind. Antero-dorsal margin slightly concave, ventral broadly convex except near posterior end where it is somewhat convex. Surface convex in general, being rather compressed only in the rostrum. Beaks very small, directed backward. A long lamellar tooth is present both in front of, and behind, the beaks, parallel with the hinge-margin. Sculpture present only on the area formed by a keel running from each beak to postero-ventral corner, consisting of fine concentric striae crossed and cut by fine impressed lines.

The following are the measurements:

	Length.	Height.	Depth.
Right valve	6.4 millim.	3.6 millim.	1.5 millim.
Left ,,	6.1 ,,	4.0 ,,	1.4 ,,

Fossil occurrence.—Shito (rare).

Family Lyonsiidæ.

Genus LYONSIA, Turton.

274. *Lyonsia prætenuis*, Dunker.

Pl. XIV. Figs. 9, 10.

Lyonsia prætenuis. Dunker, Ind. Moll., p. 180, pl. VII, fig. 12. Pilsbry, Cat., p. 137.

The shell in very thin and fragile, transversely ovate, rather gibbous, rounded in front, produced and obliquely truncate behind. and ornamented with radiating costulae on the surface.

Only three isolated valves, more or less fractured. The least imperfect is a right valve, 14.7 millim. long, 9.3 millim. high and 3 millim. deep.

Fossil occurrence.—Otake.
Living.—Western Japan.

Genus **ENTODESMA**, Philippi.

275. ***Entodesma naviculoides***, Yokoyama.

Pl. VI. Fig. 11.

A single left valve which is moderate in thickness, quadrately oblong, much longer than high, ventricose, strongly inequilateral, rounded in front, subtruncate behind. Ventral margin somewhat excavated, subparallel with equally excavated dorsal margin. Beak swollen. Surface much worn, apparently only with rude lines of growth. Teeth absent. Pallial line distinct with a shallow notch. Length 58 millim. Height 35 millim. Depth 14.6 millim.

The shell is extremely like *Entodesma navicula* Ad. et Rve. (Zool. Samarang, p. 83, pl. 23, fig. 11) and *E. truncatissima* Pilsbry (Catalogue p. 137, pl. III. figs. 11, 12) both of which, however, are described as thin and fragile. But it is not altogether impossible that this fossil may turn out to be an abnormally thick-shelled form of either of the above species.

Fossil occurrence.—Shito.

Family **Myochamidæ.**

Genus **MYODORA**, Gray,

276. ***Myodora fluctuosa***, Gould.

Pl. XIV. Figs. 6, 7.

Myodora fluctuosa. Gould, Otia Conch., p. 161. Smith, Proc. Zool. Soc. London, 1880, p. 583. Brauns, Geol. Env. Tokio, p. 37. Tokunaga, Foss. Env. Tokyo, p. 39, pl. II, fig. 24. Pilsbry, Catal., p. 138.

The shell is generally of a moderate thickness, though sometimes rather thin. It is triangular in outline, somewhat longer than high, and somewhat inequilateral with the anterior side longer than the posterior. Beaks small, pointed, directed backward. The antero-dorsal margin is slightly convex and passes insensibly into the rounded anterior, while the postero-dorsal is somewhat concave and makes an obtuse angle with the truncate p the ventral is broadly arched. The valves are very unequal; while the right is moderately convex, the left is either flat or somewhat concave. Moreover, the right valve has a blunt posterior keel on the surface. The sculpture is the same in both valves, consisting of coarse concentric undulations. Behind the beaks there is an elongated areal excavation bounded by more or less distinct edges. The anterior muscular impression is longly pear-shaped and curved inward, while the posterior is ovate and upright. Pallial sinus shallow, rounded, somewhat ascending. Length 17.2 millim. Height 14.3 millim. Thickness 5.4 millim.

The variation in form lies chiefly in the degree of rotundity of the anterior end.

Fossil occurrence.—Otake (common), Tega (rather common), Shisui, Kamenari, Kioroshi, Shito (very common). Oji and Shinagawa.

Living.—Western Japan.

277. ***Myodora reeviana***, Smith.

Pl. XIV. Figs. 8, 11.

Myodora reeviana. Pilsbry, New Jap. Mar. Moll., Pelecyp., Proc. Acad. Nat. Sci. Phil., July 1904, p, 558, pl. XLI, figs. 7–10. Yokoyama, Foss. Miura Penin., p. 143, pl. XI, figs. 12, 13.

This species has already been described by me from the Lower Musashino in the work above cited.

Fossil occurrence.—Otake, Shisui, Shito (rather common.) Lower Musashino of Miyata and Koshiba.

Living.—Western Japan. China.

Family **Thraciidæ.**

Genus **THRACIA**, Leach.

278. ***Thracia papyracea***, (Poli).

Pl; XIV. Fig. 12.

Thracia papyracea. Hörnes, Foss. Moll. Tert. Beck. v. Wien, II, p. 49, pl. V, fig. 3. Wood, Crag Moll., Biv. Suppl., p. 156. Nyst. Conch. Terr. Tert. Belg., d. 215, pl. XXVII, fig. 6.

Odoncincta papyracea. Da Costa, Cat. Syst. Test. Sicil., p. 23, pl. II, figs. 1–4.

Tellina papyracea. Poli, Test. Utr. Sicil., I, p. 43, pl. XV, figs. 14–18.

Thracia phaseolina. Philippi, Enum. Moll. Sicil., I, p. 19, pl. I, fig. 7, II, p. 16. Wood, Crag Moll., Biv., p. 260, pl. XXVI, fig. 2 abc.

Two right valves and a broken left.

The shell is subquadrate, transverse, thin, convex, with the anterior side a little longer than the posterior, rounded in front and truncate behind. The dorsal margin is only slightly arched and subparallel with the straight ventral. The surface has a posterior carina which is distinct in spite of being rather blunt. The sculpture consists merely of rough lines of growth. Pallial sinus large, deep, rounded.

The larger of the two right valves is 17.4 millim. long, 10.5 millim. high and 4 millim. deep. It looks quite like the specimen figured by Wood in his Crag Mollusca above cited.

Fossil occurrence in Japan.—Otake, Kamenari.

Fossil occurrence in Europe.—Pliocene of England, Belgium and Italy; Miocene of Austria.

Living.—Norway, British seas, Mediterranean Sea.

279. *Thracia transmontana*, Yokoyama.

Pl. XIV. Figs. 13, 14.

Shell small, thin, inequivalve with right valve convex and left rather compressed, transversely elongated, subquadrate, inequilateral with anterior side a little longer than posterior, rounded in front, truncate behind. Antero-dorsal margin slightly excavated, postero-dorsal straight, ventral very little arched. A distinct, though not very sharp, posterior carina is present, behind which the surface is somewhat depressed in the middle. The sculpture is absent save lines of growth. Beaks small, pointed, bent backward. Pallial sinus deep, rounded at end and reaching almost the middle of the shell.

The following are the measurements.

	Length.	Height.	Depth.
Left valve	9.9 millim.	5.0 millim.	1.1 millim.
,, ,,	8.4 ,,	4.0 ,,	1.0 ,,
Right ,,	10.0 ,,	5.4 ,,	2.0 ,,
,, ,,	8.1 ,,	4.3 ,,	1.3 ,,

Fossil occurrence.—Otake, Kamenari, Tega, Shito (frequent). Oji in Musashi.

Living.—Central Japan.

280. *Thracia sematana*, Yokoyama.

Pl. XIV. Figs. 17, 18.

Shell small, thin, longer than high, roundly pentagonal, rather compressed, inequilateral with anterior side a little longer than posterior, rounded in front, truncate behind. Antero-and postero-dorsal margins almost straight and sloping, ventral very little convex, postero-ventral corner roundly angulate. Surface smooth, with an obtuse posterior keel. Beaks small, pointed, directed backward. Lunula longly ovate, bounded on both sides by a blunt edge. Pallial sinus large, deep, broadly rounded, not reaching the middle of the shell. Examples are rare. One of the left valves measures 6.1 millim. in length, 4 millim. in height, and 1.3 millim. in depth, while one of the right measures 6.6 millim. in length, 4.8 millim. in height and 1.7 millim. in depth.

This shell looks like a young *Thracia papyracea*, but the beaks are smaller and more pointed, and the outline is more pentagonal.

Fossil occurrence.—Shito.

Family **Poromyidæ**,

Genus **POROMYA**, Forbes.

281. *Poromya flexuosa*, Yokoyama.

Pl. XIV. Figs. 15, 16.

Shell small, thin, convex, triangularly ovate, longer than high, inequilateral with anterior side somewhat shorter than posterior, rounded in front, somewhat obliquely subtruncate behind, with ventral margin broadly convex. Surface with a blunt posterior carina and a shallow depression in front of it. The sculpture consists of minute granules arranged more or less radially and most distinct on the hinder and ventral parts, those on the other parts being often obliterated by friction. Lunula ovate, distinct. Hinge: In the left valve there are two diverging eminences, with a triangular ligamental pit behind, divided into two parts by a median ridge; the right valve has but one tooth. Pallial sinus shallow, crescentiform. Not rare.

The following are the measurements:

	Length.	Height.	Depth.
Left valve	12.5 millim.	9.3 millim	4.0 millim.
,, ,,	10.2 ,,	7.4 ,,	3.0 ,,
Right ,,	10.3 ,,	7.6 ,,	3.0 ,,
,, ,,	11.0 ,,	8.2 ,,	3.3 ,,

Fossil occurrence.—Shito.

Family **Modiolidæ.**

Genus **MODIOLA**, Lamarck.

282. ***Modiola barbata***, (Linné).

Pl. XIV, Fig. 19.

Modiola barbata. Forbes and Hanley, Brit. Moll., II, p. 190, pl. XLIV, fig. 4. Pilsbry, Catal., p. 140. Wood, Crag Moll., Biv., p, 58, pl. VIII, fig. 2.

Mytilus barbatus. Linné, Syst. Nat., Ed. 12, p. 1156. Jeffreys, Brit. Conch., II, p. 114.

Only young shells. The largest is a left valve still preserving a little of the original reddish brown colour. It is ovately triangular in outline and obtusely pointed at the smaller and, with the ventral margin somewhat excavated. The other specimens which are all younger have a more posteriorly expanded shape, though, compared with the Crag form, the posterior expansion as well as the ventral excavation is less. Anyhow there is a great variation in outline as is evident on examining the specimens of the recent shell.

The greatest extension of the largest specimen above referred to is 11.8 millim., while the dimension across where it is greatest is 6.3 millim. The depth is 2.8 millim. There is also a smaller left valve 7.1 millim. long, 4.8 millim. broad and 2 millim. deep.

Fossil occurrence in Japan.—Tega (very rare), Otake (do), Shito (rare). Oji in Musashi.

Fossil occurrence in Europe.—English Crag.

Living.—Northern, Central and Western Japan. Britain. Mediteranean.

283. *Modiola modiolus*, Linné.

Modiola modiolus. Linné, Syst. Nat., Ed. 10, p. 706. Lischke, Jap. Meeresconch., I, p. 156, II, p. 147, III, 109. Dunker, Ind. Moll., p. 222. Tokunaga, Foss. Env. Tokyo, p. 63. Yokoyama, Foss. Miura Penin., p. 145, pl. XI, fig. 21. Wood, Crag Moll., Biv., p. 57, pl. VIII, fig. 1. Nyst, Conch. Terr. Tert. Belg., p. 163, pl. XVII, fig. 5.

Specimens are all fragmentary, though of a large size.

Fossil occurrence in Japan.—Shito (rare). Lower Musashino of Miyata.

Fossil occurrence in Europe.—English Crag; Pliocene of Belgium and Italy.

Living.—Northern, Central and Western Japan. North Pacific. North Atlantic.

Genus **LITHOPHAGA**, Bolten.

284. *Lithophaga zitteliana*, Dunker.

Pl. XVII. Fig. 14.

Lithophaga zitteliana. Dunker, Ind. Moll., p. 226, pl. XIV, figs. 1, 2, 8, 9. Pilsbry, Cat., p. 140.

A transversely elongated subcylindrical shell, elliptical in cross-section, rounded at both ends, though posteriorly somewhat more expanded. The surface has only lines of growth.

A few small fragments.

Fossil occurrence.—Otake. Tabata in Musashi.

Living.—Western Japan.

Genus **CRENELLA**, Brown.

285. *Crenella divaricata*, Yokoyama.

Pl. XV. Figs. 10, 11.

Shell minute, thin, translucent, longitudinally elongated, roundly oblong, tumid, subequilateral. Anterior and posterior margins broadly rounded, the former perhaps a little more sharply.

Surface with radiately divergent striae, the divergent character being most conspicuous on the anterior as well as on the posterior slope; striae fine, tolerably dense, with an interstitial one towards the ventral margin and cut by fine concentric lines of growth, whereby they become more or less crenulate, though not always distinct. Inner margin of shell crenulate all around. Beaks small, though somewhat inflated.

One of the left valves measures about 2 millim. in length, 2.5 millim. in height and 1 millim. in depth.

A. Adams described several species of *Crenella* from the Japan Sea in the "Annals and Magazines of Natural History" of 1862, without giving any figure. But none agrees exactly with the present one, though it seems to be closely allied to what he called *Crenella spectabilis*.

Compared with *Crenella decussata* Mont. (Forbes and Hanley, British Moll., IV, pl. 45, fig. 2) which lives in the Corea Strait, the fossil form has the cardinal margin more rounded and the beaks less pointed, approaching in these respects *Crenella elegans* Desh. of the Paris Basin (Descrip. Anim. sans Vert., Atlas, pl. 76, figs. 6–9) in which, however, the rounded nature of the cardinal margin is still greater.

Fossil occurrence.—Shito (not rare). Oji.

Living.—Central Japan.

Family **Anomiidæ**.

Genus **ANOMIA**, Linné.

286. ***Anomia nipponensis***, Yokoyama.

Anomia nipponensis. Yokoyama, Foss. Miura Penin., p. 146, pl. XI, figs. 18, 19.

This species still living in Japan has already been described in my work above cited. It is much like *Anomia laqueata* Reeve, though more equilateral and generally provided with more prominent radiating wrinkles which, however, are almost obsolete in some specimens. The colour of the living shell is dull reddish to light copper in the upper valve, and whitish to bluish or even greenish in the lower.

Fossil occurrence.—Otake, Kioroshi (frequent), Kamenari, Tega, Shito (very frequent). Oji, Tabata and Shinagawa in Musashi. Lower Musashino of Miyata, Yokosuka and Naganuma.

Living.—Northern, Central and Western Japan.

287. ***Anomia lunula***, Yokoyama.

Pl. XIV. Figs. 22, 23.

Shell thin, subcircular, with lower or right valve only a little convex and upper or left more or less flat. Surface either quite smooth or radiately and sinuously striated near the margin.

The size of the shell is usually below 20 millim. in diameter, though it is sometimes twice as large.

Fossil occurrence.—Otake (not rare), Kioroshi, Shito.

288. ***Anomia sematana***, Yokoyama.

Pl. XIV. Figs. 20, 21.

Only a few left valves. Shell small, rather thin, roundly elliptical, usually higher than long, swollen, ornamented with many, close, sinuous, granulated, radiating riblets which increase in number towards the shell-margin either by bifurcation or by the intercalation of new ones between.

The largest example measures 9.6 millim. in length, 10.7 millim. in height and 4.1 millim. deep.

Fossil occurrence.—Shito.

Family Limidæ.

Genus LIMA, Bruguière.

289. ***Lima angulata***, Sowerby.

Lima angulata. Sowerby, Thes. Conch., I. p. 86, pl. XXIII, figs. 39, 40. Yokoyama, Foss. Miura Penin., p. 148, pl. XII, fig. 12.

Lima basilanica. Adams and Reeve, Voy. Samarang, Zool., p. 75, XXI, fig. 6.

Lima hakodatensis. Tokunaga, Foss. Env. Tokyo, p. 64, pl. III, fig. 26.

Several examples, though mostly damaged on account of the thin and fragile state of the shell.

Fossil occurrence.—Otake, Shisui, Tega, Shito (rather common). Shinagawa. Lower Musashino of Naganuma.

Fossil occurrence.—Neogene of New Zealand.

Living.—Northern and Central Japan. Philippines. New South Wales. Panama. Bay of Caracas.

290. *Lima subauriculata* (Montagu).

Lima subauriculata. Yokoyama, Foss. Miura Penin., p. 150, pl. XII, fig. 10.
Lima auriculata. Weinkauff, Conch. Mittelm., II, p. 245, no. 7. Forbes and Hanley, Hist. Brit. Moll., II, p. 263, pl. LIII, fig. 45. Wood, Crag. Moll., Biv., p. 47, pl. VII, fig. 3. Hörnes, Moll. Tert. Beck. Wien, II, p. 389, pl. LIV, fig. 6. Nyst, Conch. Terr. Tert. Belg., p. 158, pl. XVIII, fig. 3.
Pecten subauriculatus. Montagu, Test. Brit., Suppl., p. 65, pl. XXIX, fig. 2.

Specimens are quite frequent. The largest obtained is a left valve 8 millim. high, 4.7 millim. long and 2.3 millim. deep. The next largest is a right valve 7.6 millim. high, 4.4 millim. long and 2.4 millim. deep. There seems to be a slight variation in shape. The radiating costellae are distinct only in the median line of the shell toward the ventral margin.

Fossil occurrence in Japan.—Otake, Shisui, Tega, Shito (very common). Oji. Lower Musashino of Miyata.

Fossil occurrence in Europe.—Pliocene of England, Belgium and Italy. Miocene of France, Austria, Hungary, etc.

Living.—Mediterranean Sea, Britain, Norway, Greenland.

291. *Lima quantoensis*, Yokoyama.

Lima quantoensis. Yokoyama, Foss. Miura Penin., p. 150, pl. XII, fig. 11.

This shell first described by me from the Lower Musashino is represented by several specimens which, however, are all young.

Fossil occurrence.—Shito. Lower Musashino of Koshiba.

Living.—Central Japan.

292. ***Lima vulgatula***, Yokoyama.

Pl. XVII. Figs. 18, 19.

A right and a left valve.

The shell is closely related to the preceding in its general shape. It is rather thin, moderately convex and obliquely ovate, with all the margins rounded except the antero-dorsal which is straight or somewhat excavated. The ears are small, especially the anterior. Lunula short-lanceolate in outline, deep, ornamented with a few longitudinal riblets. The surface is covered with radiating ribs which number about twenty-two and are flattish and broader than, or about as broad as, the interspaces. The right valve is 15.3 millim. long, 18.5 millim. high and 4.7 millim. deep, while the left is 14.1 millim. long, 15.9 millim. high and 4.1 millim. deep.

The distinctions of this species from the foregoing are the less number of ribs, a somewhat flatter shell and the subangulate form of the antero-ventral corner.

Fossil occurrence.—Shito.

Family **Spondylidæ.**

Genus ***Spondylus***, Linné.

293. ***Spondylus cruentus***, Lischke.

Pl. XIV. Fig. 24.

Spondylus cruentus. Lischke, Jap. Meeresconch., I. p. 172, pl. XII, figs. 1–5. Dunker, Ind. Moll., p. 246. Pilsbry, Cat., p. 143.

A single upper valve of a young individual. It is irregularly roundish, tolerably compressed and ornamented with distant radiating ribs which are mostly crenate or granular near the hinge-margin and foliaceous or spiny in the ventral. Between these ribs there are also several interstitial riblets. The diameter of the shell is a little greater than 12 millim.

Living.—Central and Western Japan.

Genus **PLICATULA**, Lamarck.

294. *Plicatula cuneata*, Dunker.

Pl. XIV. Fig. 25.

Plicatula cuneata. Dunker, Malak. Bl., vol. 24, p. 73. Index Moll., p. 246, pl. XI, fig. 3.

A much worn right valve, 12.8 millim. long, 15.4 millim. high and 2.6 millim. deep. It is thick, cuneate in shape and has eight strong, flattened, radiating ribs with narrower interspaces. The ribs seem to have been lamellar when fresh.

Fossil occurrence.—Kamenari.

Living.—Central and Western Japan.

Family **Pectinidæ.**

Genus **PECTEN**, Müller.

295. *Pecten squamatus*, (Gmelin).

Pecten squamatus. Sowerby, Thes. Conch., I, Pecten, p. 70, pl. XIII, figs. 57, 58. Reeve, Conch. Icon., Pecten, sp. 82. Dunker, Ind. Moll., p. 240, pl. XI, fig. 14. Küster, in Syst. Conch. Cab., VII, pt. 2, Spondylus and Pecten, p. 113, pl. XXXII, fig. 4. Yokoyama, Foss. Miura Penin., p. 151., pl. XIV, figs. 3, 4.

Ostrea squamata. Gmelin, Syst. Nat., Ed. 13, p. 3329.

A few right valves of young individuals. They are flattish with a long anterior ear and ornamented with unequal radiating ribs whose interspaces are also unequal. The scales on the ribs are almost wholly worn away by friction.

Fossil occurrence.—Otake, Tega. Lower Musashino of Naganuma.

Living.—Central and Western Japan. Philippines.

296. *Pecten lætus*, Gould.

Pl. XIV. Figs. 26.

Pecten lætus. Gould, Otia Conch., p. 177. Lischke, Jap. Meeresconch., I, p. 169, pl. XII, figs. 6, 7, II, p. 157. Dunker, Ind. Moll., p. 241. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 603. Brauns, Geol. Env. Tokio, p. 57. Tokunaga, Foss. Env. Tokyo, p. 65, pl. V, fig. 2. Yokoyama, Foss. Miura Penin., p. 152, pl. XIV, figs. 1, 2.

Very frequent at some localities. The largest obtained has a height of 90 millim.

Fossil occurrence.—Otake, Shito (very common). Tega. Shinagawa and Oji (frequent). Lower Musashino of Miyata, Yokosuka and Naganuma.

Living.—Northern, Central and Western Japan.

297. *Pecten subplicatus*, Sowerby.

Pl. XV. Fig. 3.

Pecten subplicatus. Sowerby, Thes. Conch., I, p. 64, pl. XIII, fig. 37, pl. XIV, figs. 72, 73, 81. Mart. u Chem., Syst. Conchyl. Cab., VII, Pectinacea, p. 157, pl. 44, figs, 3-5. Dunker, Ind. Moll., p. 242.

The right valve of a young individual. It has five radiating folds with a weak one on each side of them. The folds as well as the valleys are radially striated. Length 20.5 millim. Height 22.5 millim. Depth 4 millim.

Fossil occurrence.—Kioroshi.

Living.—Western Japan. Philippines. Moluccas.

298. *Pecten crassicostatus*, Lowerby,

Pecten crassicostatus. Pilsbry, Cat., p. 143. Dunker, Ind. Moll., p. 239, pl. XIII, fig. 28. Lischke, Jap. Meeresconch., I, p. 168. Sowerby, Thes. Conch., I, p. 75, pl. XV, fig. 111, pl. XVII, fig. 152. Yokoyama, Foss. Miura. Penin., p. 153, pl. XII, fig. 7.

Pecten nobilis. Reeve, Conch. Icon., Pecten, pl. I, fig. 3.

A single left valve belonging to a young individual.

Fossil occurrence.—Shito. Lower Musashino of Naganuma.

Living.—Central to Southern Japan.

299. *Pecten vesiculosus*, Dunker.

Pecten vesiculosus. Dunker, Ind. Moll., p. 241, pl. XI, fig. 1. Yokoyama, Foss. Miura Penin., p. 154, pl. XIII, figs. 11, 12, 13.

Very frequent, but most of the specimens are water-worn and lack the ears.

Fossil occurrence.—Shito. Lower Musashino of Koshiba.

Living.—Central Japan.

300. *Pecten intuscostatus*, Yokoyama.

Pecten intuscostatus. Yokoyama, Foss. Miura Penin., p. 156, pl. XIII, figs. 9, 10.

This small shell already described from the Lower Musashino has the outer surface concentrically striated, while within there are coarse distant radiating riblets near the margin.

Fossil occurrence.—Shito (not rare). Lower Musashino of Miyata and Koshiba.

301. *Pecten tokyoensis*, Tokunaga.

Pecten tokyoensis. Tokunaga, Foss. Env. Tokyo, p. 68, pl. V, figs. 1–10. Yokoyama, Foss. Miura Penin., p. 158, pl. XIV, figs. 7, 8.

Pecten plica. Brauns, Geol. Env. Tokio, p. 48, (non Linné).

There are many large specimens, the largest being more than 160 millim. high.

Fossil occurrence.—Otake, Shito (very frequent). Oji (frequent) and Shinagawa. Lower Musashino of Miyata, Yokosuka and Naganuma,

302. *Pecten tissoti*, Bernardi.

Pl. XV. Figs. 1, 2.

Pecten tissoti. Pilsbry, Cat., p. 144. Bernardi in Jour. d. Conch., VII, 1859, p. 91, pl. I, fig. 2. Kobelt in Syst. Conch. Cab., VII, part 2, Spondylus and Pecten, p. 143, pl. XL, fig. 5.

A small neat *Pecten* circular in form and tolerably swollen, with the anterior ear larger than the posterior. About twenty radiating ribs accompanied by a smaller one on both sides ornament the surface. Crossing these ribs, there are fine concentric lamellae which are most distinct in interspaces where there are one or two radiating striae. Inner margin crenate.

Only three valves of which two are right. The larger of the right valves measures 16.8 millim. in height, 16 millim. in breadth and 6.2 millim. in depth.

Fossil occurrence.—Shito.

Living.—Japan (according to Dunker).

303. *Pecten laqueatus*, Sowerby.

Pecten laqueatus. Sowerby, Thes. Conch., I, p. 46, pl. XV, fig. 101. Lischke, Jap. Meeresconch., I, p. 167, II, p. 157, pl. XII, figs. 1, 2. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 482. Brauns, Geol. Env. Tokio, p. 48. Tokunaga, Foss. Env. Tokyo, p. 64. Yokoyama, Foss. Miura Penin., p. 160, pl. XIV, figs. 9, 10.

Very frequent.

Fossil occurrence,—Otake, Shisui, Kioroshi, Kamenari, Tega, Shito. Oji and Shinagawa. Lower Musashino of Miyata and Yokosuka.

Living.—Northern, Central and Western Japan.

304. *Pecten excavatus*, Anton.

Pl. XV. Figs. 6, 7.

Pecten excavatus. Anton, Verzeichniss, p. 19, no. 710. Philippi, Abbild. u. Beschr., I, Pecten, p. 201, pl. II, fig. 1.
Vola excavata. Dunker, Index Moll., p. 243. Pilsbry, Cat., p. 145.
Pecten sinensis. Sowerby, Thes. Conch., I, p. 48, pl. XVI, figs. 120, 121, 134.

This shell which resembles the preceding is smaller and characterized by its valves being very unequal, more unequal than in the latter, for its left valve is markedly concave instead of being flat or only slightly concave, The right valve on the contrary is strongly convex, more so than in *Pecten laqueatus.* The ears are nearly equal, so that the shell appears to be almost equilateral. The radiating ribs of the convex valve are broad and flattened with lateral edges subangular and interspaces much narrower. The number of ribs is over ten, but it is difficult to give them exactly, for, besides the main ribs, there are one or more much weaker ones on both extremities of the shell, and also those in the middle portion often show a tendency to split. Near the beaks the ribs are almost obsolete, so that the surface becomes more or less smooth, Incremental lines very distinct. On the concave valve the ribs are narrower than the interspaces, with concentric growth-lines often somewhat lamellated. When lamellae are absent, the concave valve is often difficult to distinguish from that of *Pecten laqueatus.*

The specimens are all young, the largest being only 22 millim. both in height and length.

Fossil occurrence.—Otake (not rare), Tega, Shito. Oji and Shinagawa.

Living.—Northern and Central Japan. China Sea.

305. *Pecten tenuicostulatus*, Yokoyama.

Pl. XVII. Fig. 15.

Three left valves.

Shell small, thin, flatly convex, nearly circular, almost equilateral. Surface with weak, rounded, scaly, radiating riblets which are rather distant, more or less unequal and at unequal distances from one another; interspaces much broader with one or more interstitial riblets. The number of main ribs is not constant, but usually about twenty or a little more. Ears somewhat unequal with anterior larger than posterior.

The largest specimen measures 8.9 millim. both in length and height and 1.5 millim. in depth.

Fossil occurrence.—Shito.

Family **Ostreidæ.**

Genus **OSTREA**, Linne.

306. *Ostrea gigas*, Thunberg.

Ostrea gigas. Thunberg, Kongl. Vetensk. Akad. nya Handl., XIV, 1793, p. 140, pl. VI. figs. 1–3. Pilsbry, Cat., p. 145. Tokunaga, Foss. Env. Tokyo, p. 68, pl. IV, fig. 5. Brauns, Geol. Env. Tokio; pp. 48, 51, 55. Yokoyama, Foss. Miura Penin, p. 162, pl. XV, figs. 1, 2.

Ostrea laperousii. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 475, pl. XIX.

The elongated as well as the ovate form in numerous examples. Some are rather thin-shelled and even provided with some longitudinal folds.

Fossil occurrence.—Otake, Shisui, Kamenari, Kioroshi, Tega, Shito. Oji and Shinagawa. Lower Musashino of Yokosuka and Koshiba.

Living.—Northern, Central and Western Japan. Coast of Manchuria and Shantung in China.

307. *Ostrea denselamellosa*, Lischke.

Ostrea denselamellosa. Lischke, Jap. Meeresconch., I, p. 79, pl. XIII, pl. IV, fig. 1. Brauns, Geol. Env. Tokio, p. 58. Pilsbry, Cat., p. 146. Tokunaga, Foss. Env. Tokyo, p. 68, pl. IV, fig. 6. Yokoyama, Foss. Miura Penin., p. 162, pl. XVI, fig. 6.

A few but good specimens of the lower valve.

Fossil occurrence.—Otake, Tega. Oji and Shinagawa. Lower Musashino of Yokosuka.

Living.—Northern, Central, Western and Southern Japan.

308. *Ostrea musashiana*, Yokoyama.

Pl. XV. Fig. 5.

Ostrea musashiana. Yokoyama, Foss. Miura Penin., p. 163, pl. XVI, figs. 1–5.

A few specimens. The shell is thin and usually more or less longly ovate, with the lower valve strongly convex.

Fossil occurrence.—Otake, Shito. Lower Musashino of Yokosuka and Koshiba.

Family **Pinnidæ.**

Genus **PINNA**, Linné.

309. *Pinna japonica*, Hanley.

Pl. XV. Fig. 8.

Pinna japonica. Hanley, Proc. Zool. Soc. 1858. p. 136. Reeve, Conch. Icon., fig. 47. Küster in Syst. Conchyl. Cab., VIII, pt. 1, p. 72, pl. 24, fig. 3, pl. 29, fig. 1. Pilsbry, Cat., p. 147.

Only a fragment belonging to the beak-portion. It is, however, easily recognized by its thin shell, distant radiating costulae and concentric corrugations as the above named species.

Fossil occurrence.—Shito. Oji in Musashi.

Living.—Central and Western Japan.

Family **Arcidæ.**

Genus **ARCA**, Lamarck.

310. *Arca kobeltiana*, Pilsbry.

Arca kobeltiana. Pilsbry, New Jap. Mar. Moll., Pelec., Proc. Acad. Nat. Sci. Phil., July, 1904, p. 559, pl. XI, figs. 16–19. Yokoyama, Foss. Miura Penin., p. 163, pl. XVII, fig. 4.

Arca ocellata. Kobelt in Syst. Conch. Cab., vol. VIII, p. 87, pl. 24, figs. 1–4 (non Reeve). Pilsbry, Cat., p. 148.

Arca rectangularis. Tokunaga, Foss. Env. Tokyo, p. 61, pl. III, fig. 28.

This shell has already been described from the Lower Musashino.

Fossil occurrence.—Otake, Shito (frequent). Lower Musashino of Miyata, Yokosuka, Kanazawa and Koshiba.

Living.—Northern and Central Japan.

311. *Arca symmetrica*, Reeve.

Arca symmetrica. Reeve, Conch. Icon., Arca, sp. 117. Yokoyama, Foss, Miura Penin., p. 166, pl. XVII, figs. 7, 8.

A few isolated valves much worn by friction.

Fossil occurrence.—Otake. Lower Musashino of Yokosuka and Naganuma.

Living.—Central and Western Japan. Philippines. Indian Ocean.

312. *Arca (Anomalocardia) granosa*, Linné.

Pl. XV. Fig. 4.

Arca (Anomalocardia) granosa. Pilsbry, Cat., p. 149. Kobelt in Syst. Conch. Cab., VIII, pt. 2, p. 38, pl. III, fig. 7.

Arca granosa. Linné, Syst. Nat., Ed. 12, p. 1142. Reeve, Conch. Icon., Arca, spec. 15. Lischke, Jap. Meeresconch., I, p. 145. Tokunaga, Foss. Env. Tokyo, p. 59, pl. III, fig. 20.

Anomalocardia granosa. Dunker, Ind. Moll., p. 233.

Isolated valves from several localities which are not quite full-grown. The largest is only 55 millim. in length. This species is easily recognized by its thick, solid, swollen, somewhat oblique shell ornamented with coarse granular radiating ribs whose number in the fossil is seventeen or eighteen. It is here to be remarked that the fossil specimens are a little more oblique and the postero-ventral corner more produced than that represented in the figure of Kobelt.

Fossil occurrence.—Otake, Shisui, Kamenari, Tega, Shito. Tokunaga mentions this species from Tabata. Takigashira near Yokohama according to Brauns.

Living.—Central and Western Japan. China. Philippines. Indian Ocean.

313. ***Arca (Anomalocardia) inflata***, Reeve.

Pl. XV. Fig. 9.

Arca (Anomalocardia) inflata. Pilsbry, Cat. p. 149. Kobelt in Syst. Conch. Cab., VIII, pt. 2, p. 30, pl. X, figs. 1, 2.

Arca inflata. Reeve, Conch. Icon., Arca, sp. 30. Yokoyama, Foss. Miura Penin., p. 167, pl. XVII, fig. 9.

Arca broughtonii. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 575, pl. 24, figs. 1–3.

Arca tenuis. Tokunaga, Foss. Env. Tokyo, p. 58, pl. IV, fig. 1.

Some specimens are quite thin-shelled which induced Tokunaga to establish a new species which he called *A. tenuis.* The largest attains a length of more than 110 millim.

Fossil occurrence.—Otake, Shisui (frequent), Shito. Oji, Tabata and Shinagawa. Lower Musashino of Naganuma.

Living.—Northern, Central and Western Japan. Philippines.

314. ***Arca (Scapharca) subcrenata***, Lischke.

Pl. XV. Fig. 12.

Arca (Scapharca) subcrenata. Kobelt in Syst. Conch. Cab., VIII, pt, 2, p. 47, pl. XIII, figs. 5, 6. Pilsbry, Cat., p. 149. Yamakawa, Fossil Scapharca of the Neighbourhood of Tokyo, Jour. Geol. Soc. Tokyo, 1912, vol. XVIII, no. 219, p. 6. pl. III, IV, figs. 1–12.

Arca subcrenata. Lischke, Jap. Meeresconch., I, p. 146, pl. IX, figs. 1–3.

Scapharca subcrenata. Dunker, Ind. Moll., p. 234.

Arca kagoshimensis. Tokunaga, Foss. Env. Tokyo, p. 59, pl. III, fig. 21.

Distinguished from the preceding species by a less number of radiating ribs (twenty-eight to thirty-six, while in *A. inflata* usually over forty) and their subcrenate nature which in the left valve is seen on all the ribs anterior to the posterior carina, and on the right only on those near the anterior end of the shell. A fuller account is found in the work of Yamakawa above cited.

Fossil occurrence.—Otake (very common), Kioroshi, Kamenari, Shisui (common). Tega (very frequent), Shito (rare). Oji.

Living.—Central, Western and Southern Japan.

Genus **PECTUNCULUS**, Lamarck.

315. ***Pectunculus albolineatus***, Lischke.

Pl. XVII. Figs. 1, 2, 3.

Pectunculus albolineatus. Lischke, Jap. Meeresconch., III, p. 108, pl. IX, figs. 11, 12. Dunker, Ind. Moll., p. 236. Brauns, Geol. Env. Tokio, p. 45. Tokunaga, Foss. Env. Tokyo, p. 61. Pilsbry, Cat., p. 150.

Lischke who first described this species had only young shells of a more or less circular form whose length was below 40 millim. But there are specimens which are 80 millim. long. Such full-grown ones are not circular, but decidedly somewhat obliquely round-squarish, the antero-dorsal corner in front and postero-ventral corner behind being most produced. Such a squarish form we can also find among the young shells in which, if not both corners, at least the antero-dorsal corner is more or less produced. From this it is quite certain that there is a great variation in the outline of the shell. The surface ornamention consists of white radiating lines and fine dots.

The fossil specimens which I deem as belonging to this species are a few isolated valves which are quite grown. They are also in general roundly squarish, but the posterior margin is a little more rounded than in the recent shell, so that the protrusion of the postero-ventral corner is not so obvious. One of the left valves measures 68.6 millim. in length, 59.5 millim. in height and 17.3 millim. in depth, while one of the right measures 68 millim. in length, 56.5 millim. in height and 17.2 millim. in depth.

The surface-dots are obliterated in the fossil and the white radiating lines are present as impressed ones with several finer interstitials between.

Fossil occurrence.—Otake. Oji.

Living.—Central Japan.

316. ***Pectunculus restitus***, Dunker.

Pl. XVI. Figs. 1, 2, 3.

Pectunculus restitus. Dunker, Ind. Moll , p. 236, pl. XVI, figs. 7, 8. Pilsbry, Cat., p. 150.

Pectunculus rotundus. Dunker, Ind. Moll., p. 236, pl. XVI, figs. 7, 8. Pilsbry, Cat., p. 150. Yokoyama, Foss. Miura Penin., p. 167, pl. XVII, figs. 10, 11.

This species shows a great variation in the outline of the shell. The normal form is a rounded oval, slightly oblique, somewhat longer than high and with the beak-portion narrowed. What Dunker gives in his figure (pl. XVI, figs. 7,8) is a less rotund form with the length somewhat greater than in the normal type. Young examples of this shell which can be collected in hundreds at some localities are more circular in form, and it is quite certain that Dunker's *Pectunculus rotundus* is a species founded on such examples. It is here to be noted that among the adult ones there are often forms which possess the more produced and subtruncate posterior end.

The surface in recent specimens is ornamented with white radiating lines as in the preceding species, which are present in the fossil as impressed lines with finer ones between. But the dots of the latter seem to be absent. Therefore the young circular form of the preceding species, when the dots are obliterated, is difficult to distinguish from the present.

The largest specimen in our collection is a right valve 76 millim. long and 68.5 millim. high.

Fossil occurrence.—Otake (numerous), Kioroshi (do), Kamenari, Tega (numerous). Tabata and Shinagawa. Lower Musashino of Miyata and Naganuma.

Living.—Central Japan.

317. ***Pectunculus yessoensis***, Sowerby.

Pl. XVI. Fig. 6, 7.

Pectunculus yessoensis. Sowerby, Descr. Fourt. New Shells fr. China, Jap. a. Andam.

Isl., Proc. Zool. Soc. Lond., 1886, p. 570, pl. XXVIII, fig. 19. Pilsbry, Cat., p. 150. Yokoyama, Foss. Miura Penin., p. 168, pl. XVIII, figs. 1, 2.

The characteristic feature of this shell usually consists in the postero-dorsal margin being a little longer than the antero-dorsal, whereby the rounded or, as is sometimes the case, subangulate corner between the former and the posterior margin becomes more or less conspicuous. But it is here to be remarked that this character is not always obvious, especially in young specimens, so that the distinction from *Pectunculus vestitus* sometimes becomes very difficult, or even impossible.

The largest specimen obtained measures 65 millim. both in length and height.

Fossil occurrence.—Otake (frequent), Shisui, Kioroshi, Tega, Kamenari, Shito (very common). Lower Musashino of Miyata.

Living.—Northern Japan.

318. ***Pectunculus pilsbryi***, Yokoyama.

Pl. XVI. Figs. 8, 9.

Pectunculus pilsbryi. Yokoyama, Foss. Miura Penin., p. 170, pl. XVIII, fig. 8.

This small oblique *Pectunculus* is generally characterized by the subangulate posterior end and the fine, close, unequal, radiating riblets which cover the whole surface. The posterior end, however, may sometimes be subtruncate or so produced as to assume a rostrate appearance as shown in the figure. The granulate nature of the riblets are not always distinct.

The largest example attains a length of 25 millim. and a height of 23 millim. The depth of a valve of such specimens is about 7 millim.

Fossil occurrence.—Shito (very common). Lower Musashino of Miyata (rare).

Living.—Central Japan.

319. ***Pectunculus yamakawai***, Yokoyama.

Pl. XVI. Figs. 4, 5.

A right and a left valve. Both are flattened (right valve being 30.5 millim. long, 28 millim. high and 6 millim. deep), oblique and oval with the sharper end at the posterior ventral corner. Antero- and postero-dorsal margins insensibly passing respectively into anterior and posterior ends which are both rounded, with the latter much more sharply than the former. Ventral margin broadly arcuate, crenate within. Ligamental area comparatively narrow, triangular, with two series of several straight grooves, the one parallel to the anterior and the other parallel to the posterior side of the area, which meet at an obtuse angle below the beak. Beaks small. Surface with fine, straight, radiating, impressed lines.

A shell quite like this fossil was found living on the coast of Awa (Boshu) with the posterior dorsal slope sometimes more straight, so that the posterior end appears more angulate. The surface is coloured brownish yellow with white radiating lines like those of *Pectunculus albolineatus* and *P. vestitus*. Although it is a little more convex than our fossil, there is no doubt of its being the same speceis.

Fossil occurrence.—Shito.

Living.—Central Japan.

Family **Parallelodontidæ.**

Genus **PARALLELODON**, Meek et Worthen.

320. ***Parallelodon obliquatus***, Yokoyama.

Parallelodon obliquatus. Yokoyama, Foss Miura Penin., p. 170, pl. XVIII, figs. 9–11

Only a single left valve.

Fossil occurrence.—Shito. Lower Musashino of Miyata, Yokosuka and Koshiba.

Living.—Northern and Central Japan.

Genus **CUCULLARIA**, Deshayes.

321. ***Cucullaria orientalis***, Yokoyama.

Pl. XVII. Figs. 8, 9.

A few isolated right valves.

Shell very small, rather thick, moderately convex, transversely elongated, narrowed in front, gradually dilated behind, strongly inequilateral, with posterior side four times as long as anterior. Anterior and posterior ends rounded, the former passing insensibly into ventral margin, while the latter is oblique and forms a rounded angle with the same. Hinge nearly straight, with three or four short oblique teeth in front and about seven almost sub-horizontal teeth behind, the space between being either smooth or provided with a few indistinct granules. Area very narrowly triangular. Surface with an obtuse posterior carina and a broad mesial depression which makes ventral margin straight or even somewhat excavated. The sculpture consists of subequal radiating ribs which are flatly rounded, broader than interspaces and number a little more than thirty; some of these ribs show a narrow longitudinal groove and a tendency to split. Occasionally some interspaces are unusually broad in which case there is usually an interstitial riblet, though only near the margin. Length 5.1 millim. Height 3 millim. Depth 1 millim.

The occurrence of this shell is quite noteworthy, as related forms have hitherto been found only in the Eocene, for example, *Cucullaria aldrichi* Dall (Tert. Fauna Florida, IV. pl. 32, fig. 10) in the Eocene of Florida and *Cucullaria gracilis* Desh (Anim sans Vert., I. pl. 69, figs. 22—24) in the Paris Basin.

Fossil occurrence.—Shito.

Family **Limopsidæ.**

Genus **LIMOPSIS.** Sasso.

322. ***Limopsis woodwardi***, A. Adams.

Pl. XVII. Fig. 5.

Limopsis woodwardi. Adams, Proc. Zool. Soc. Lond., 1862, p. 231. Dunker, Ind. Moll., p. 237, pl. XVI, figs. 5, 6. Pilsbry, Catal., p. 150. Tokunaga, Foss. Env. Tokyo, p. 62.

Shell thick, convex, roundly ovate, about as long as high, somewhat oblique, rounded in front, rounded or obliquely subtruncate behind. Surface with numerous, rounded, radiating riblets alternately large and small, separated by broader interspaces and crossed by incremental lines which make them somewhat granular. Hinge curved, with oblique lamellar teeth ten to fourteen on each side of the ligamental pit which is triangular and provided in some with two diverging ridges and a few transverse striae. Beaks small, pointed. Inner margin flattened and smooth.

There is some variation in form, the height being sometimes a little less, sometimes a little greater than the length. The convexity is also somewhat variable.

The largest specimen obtained is a left valve, 17.3 millim. long, 17.5 millim. high and 5.4 millim. deep.

Smith in his Challenger Lamellibranchiata (p. 256) unites *Limopsis woodwardi* with Reeve's *Limopsis cancellata* which lives in Northern Australia, Torres Strait, Singapore, etc. But at present I am not in a position to utter any opinion on it.

Fossil occurrence.—Otake, Tega. Oji (common) and Shinagawa.

Living.—Central Japan.

323. *Limopsis crenata*, A. Adams.

Limopsis crenata. A. Adams, Descript. Limopsis of Cuming. Coll., Proc. Zool. Soc. Lond., 1862, p. 230. Yokoyama, Foss, Miura. Penin., p. 173, pl. XVIII, figs. 17, 18.

A few isolated valves.

Fossil occurrence.—Otake. Lower Musashino of Miyata, Kamakura, Kanazawa, and Koshiba.

Living.—Northern, Central and Western Japan.

324. *Limopsis azumana*, Yokoyama.

Limopsis azumana. Yokoyama, Foss. Miura Penin., p. 174. pl. XVIII, figs. 12–21.

More frequent than the preceding species.

Fossil occurrence.—Shito, Otake. Lower Musashino of Miyata and Koshiba.

325. *Limopsis adamsiana*, Yokoyama.

Limopsis adamsiana. Yokoyama, Foss. Miura Penin., p. 175, pl. XIX, figs. 1, 2.

The species founded on two right valves from the Lower Musashino is somewhat frequent in the Upper. The left valves which were found in the latter have nearly the same shape as the right. As to the surface-sculpture, most of the specimens are water-worn and smooth, but in one or two unequal concentric striae are visible which are crossed by very fine, rather indistinct, radiating lines.

The largest of the left valves is 6.4 millim. long, 5.8 millim. high and 1.9 millim. deep.

Fossil occurrence.—Shito. Lower Musashino of Miyata and Koshiba.

326. ***Limopsis areolata***, Yokoyama.

Pl. XVII. Figs. 6, 7.

Shell small, thick, compressed, obliquely short-oblong, inequilateral, rounded both in front and behind, though somewhat more sharply in the former than in the latter. Surface with fine impressed radiating lines interrupted by unequal concentric grooves. Beaks small and rounded. Hinge bent with teeth thick, lamellar to tubercular, about six in anterior row, somewhat less in posterior, rapidly diminishing in size in both rows from the middle to both sides. Ligamental pit broadly triangular. A deep narrow escutcheon is present just above and behind the posterior row of teeth whereby the hinge-margin behind the teeth is somewhat pushed inward. Beaks small, pointed. Fine radiating lines present just within the pallial line. Inner margin flattened and smooth.

The measurements of four isolated valves are as follows:

	Length.	Height.	Depth.
Left valve	15.0 millim	14.0 millim	3.3 millim.
,, ,,	13.8 ,,	12.5 ,,	2.4 ,,
Right ,,	12.5 ,,	12.2 ,,	2.4 ,,
,, ,,	11.0 ,,	12.4 ,,	2.3 ,,

This shell is easily recognized by its shortly oblong shape and the deep escutcheon behind the beak.

Fossil occurrence.—Shito (rare).

327. *Limopsis nipponica*, Yokoyama.

Pl. XVII, Figs. 16, 17.

Shell very small, moderately thick, longitudinally oblong, somewhat oblique, convex. Anterior and posterior margins only a little curved and subparallel; ventral rounded. Surface radiately striated; striae many, nearly straight, subequal, with equal or broader interspaces and cut by incremental lines, the points of intersection being more or less grain-like. Hinge-line about as long as shell-length, with about three teeth in front of ligamental pit and about five behind. Beaks small, pushed a little forward. Inner surface with fine radiating lines within the pallial line. Inner margin flattened and smooth. Length 2.9 millim. Height 3.5 millim. Depth of each valve 1.3 millim.

Fossil occurrence.—Kioroshi (very rare), Shito (do).

Family **Ledidæ.**

Genus **LEDA,** Schumacher.

328. *Leda confusa*, Hanly.

Pl. XVII. Fig. 4.

Leda confusa. Hanley in Sowerby's Thes. Conch., III, Nuculidæ, p. 119, pl. 228. fig. 85. Lischke, Jap. Meeresconch., III, p. 109. Dunker, Ind. Moll., p. 238. Brauns, Geol. Env. Tokio, p. 45. Pilsbry, Cat., p. 56.

Hanley describes this shell as follows:

"Beaked-oval, convex or subventricose with a shining ash-coloured epidermis, closely, regularly, and concentrically grooved throughout (the dorsal areas excepted); sulci shelving in front, their intervals converted into flattened costæ on the umboes and towards the umbonal ridge which latter is neither elevated nor defined in front. Sides equal, or very nearly so: Anterior extremity rounded; posterior side rather abruptly beaked, the tip, which is either in the middle or just above it, upturned and sharply angular. Front dorsal slope very slight, convex with a sudden terminal retusion. Hinder dorsal slope moderate, at first straightish or plano-convex, eventually rather suddenly incurved. Ventral margin much rising at both ends, arcuated (at the least in front), devoid of retusion. Dorsal areas large pouting, lanceolate; escutcheon carinately defined, sublongitudinally grooved; lunule impressly defined, its sulci finer. Interior bluish white, the front edge, in adult example, most minutely crenulated; hinge-margin broad, its teeth rather numerous on both sides. Cartilage-pit small, triangular."

Although in our specimens the fine crenulations of the innerside of the front edge are not visible, still there is not the least doubt of their belonging to Hanley's species.

The largest example is a right valve measuring 20 millim. in length, 10.8 millim. in height and 3.5 millim. in depth. It is therefore somewhat larger than the one shown in Hanley's figure.

Fossil occurrence.—Shisui (rare). Kamenari, Tega (not rare), Shito (do). Oji and Shinagawa.

Living.—Central Japan. China sea.

329. ***Leda ramsayi***, Smith.

Leda ramsayi. Smith, Report on Lamellibranchiata, Challeng. Exp., p. 241, pl. XX, fig. 3, 3a. Yokoyama, Foss. Miura Penin., p. 176, pl. XIX, fig. 3.

Three left valves, one of which attains 9.4 millm. in length, 5.4 millim. in height and 1.7 millim. in depth. Just as in the Lower Musashino, the specimens are very rare.

Fossil occurrence.—Shito. Lower Musashino of Miyata and Koshiba.

Living.—Off Sydney, New South Wales, in 950 fathoms (Smith). Also Northern Japan (?)

Genus **YOLDIA**, Möller.

330. ***Yoldia notabilis***, Yokoyama.

Pl. XVII. Fig. 10.

Yoldia arctica. Brauns, Geol. Env. Tokio, p. 47. p. VI, fig. 29.
Yoldia lanceolata. Tokunaga, Foss. Env. Tokyo, p. 57, pl. III, fig. 18.

The shell is thin, compressed, transversely elongated, rounded in front, rostrated and pointed behind, inequilateral, the anterior side being much longer than the posterior (about 1.8 times as long). The front dorsal margin is at first somewhat ascending and then very gradually descending, very little arched and going over into the rounded front end. The hinder dorsal margin is sloping, at first straight, but eventually becomes concave, meeting with the convexly ascending posterior margin at about a right angle. The ventral margin is broadly convex, ascending at both ends. The surface is subconcentrically grooved, with grooves narrow, so that the interspaces appear as broad flat ribs. These grooves and ribs, however, are somewhat oblique and not quite parallel with the ventral margin, so that those situated near it end at its posterior half. Teeth numerous, lamellar, outwardly bent in the middle, not quite thirty in number in the anterior and about half as many in the posterior row. Ligamental pit triangular, broader than high, and with a somewhat concave base. Lunula not developed. Area lanceolate, bounded by a sharp carina on both sides and with a high, elevated, very steep carina in the median line, whose lateral faces show only fine sublongitudinal striations. Anterior muscular impression larger than posterior, ovate in shape; posterior transversely oval, bounded within by a strong rounded ridge descending vertically from below the posterior end of the ligamental pit. Sinus large, rounded. The largest specimen is a right valve 36 millim. in length (anterior side 23 millim.), 18.6 millim. in height and 4.1 millim. in depth.

Brauns and Tokunaga took this shell for *Yoldia lanceolata* Sow. (Y. arctica Br. et Sow.) to which, indeed, it has a great resemblance. But the sculpture is quite different in the two. In the present species it consists of subconcentric grooves, while in *Y. lanceolata* of much more oblique striae which vanish toward the posterior end of the shell. Moreover, the Japanese fossil is somewhat more inequilateral, with the posterior end a little sharper.

Anyhow it is very interesting that a species much like *Yoldia lanceolata* was found in the Upper Musashino, as all the living forms of *Yoldia* are hitherto either arctic or at least boreal, *Y. lanceolata* itself being reported also from Kamchatka and Strait of Tartary.

Fossil occurrence.—Shisui (very rare), Otake (do). Oji.

Family **Nuculidæ.**

Genus **NUCULA**, Lamarck.

331. ***Nucula insignis***, Gould.

Nucula insignis. Gould, Otia Conch., p. 175. Tokunaga, Foss. Env. Tokyo, p. 56. Yokoyama, Foss. Miura Penin., p. 179. pl. XIX, figs. 7, 8.

Several specimens, the largest being 20 miliim. in length.

Fossil occurrence.—Otake, Shisui, Shito. Oji, Tabata and Shinagawa. Lower Musashino of Koshiba.

Living.—Northern Japan.

Phylum **Molluscoidea.**

Class **BRACHIOPODA.**

Family **Terebratulidæ.**

Genus **TEREBRATELLA**, d'Orbigny.

332. ***Terebratella coreanica***, Adams et Reeve.

Terebratella coreanica. Davidson, Monogr. Rec. Brach., p. 81, pl. XIII, figs. 3–9. Dall, Amer. Jour. Conch., VI, p. 121. Dunker, Ind. Moll., p. 252. Pilsbry, Cat., p. 151. Yokoyama, Foss. Miura Penin., p. 184, pl. XIX, figs. 25, 28.

Terebratula coreanica. Adams and Reeve, Voy. Samarang, Zool., p. 71, pl. XXI, fig. 3. Schrenck, Moll. Amurl. u. d. nordjap. Meeres, p. 168. Lischke, Jap. Meeres-conch., I, p. 181.

This is a well known living shell in Japan. As stated by Davidson, its outline is very variable. In general, the breadth is somewhat less than the height or length, but there are specimens in which the height is much greater than the breadth. As to the mesial depression of the dorsal valve, it is here to be remarked that it is either very shallow or absent in which latter case the place is only flattish.

The largest of the perfect specimens is 36.5 millim. in height, but there is an isolated dorsal valve nearly as high, therefore the corresponding ventral must have been over 40 millim. in height.

Fossil occurrence.—Shito (frequent). Lower Musashino of Miyata.

Living.—Northern, Central and Western Japan.

333. ***Terebratella pulvinata***, (Gould).

Terebratella pulvinata. Davidson, Monogr. Rec. Brach., p. 90. pl. XVI, fig. 13. Dall. Amer. Jour. Conch., VI, p. 117. Yokoyama, Foss. Miura Penin., p. 185, pl. XIX, fig. 26.

Terebratula (*Waldheimia*) *pulvinata.* Gould, Otia Conch., pp. 97, 255.

A few specimens which are all smaller than the one figured by Davidson. The largest measures 13.5 millim. in height, 125 millim. in breadth and 6 millim. in thickness. The frontal edge of one of the specimens is a little more sharply rounded than in the others, a variation which must be admitted in a group of animals like the Brachiopods.

Fossil occurrence.—Shito. Lower Musashino of Miyata.

Living.—Puget Sound, Washington.

Genus **EUDESIA**, King.

334. ***Eudesia grayi***, (Davidson).

Pl. XVII. Figs. 11, 12.

Eudesia grayi. Pilsbry, Catal., p. 152.

Waldheimia grayi. Davidson, Monogr. Rec. Brach., p. 54, pl. X, figs. 1–4. Dunker, Ind. Moll., p. 252. Brauns, Geol. Env. Tokio, p. 58. Tokunaga, Foss. Env. Tokyo, p. 69, pl. IV, fig. 8.

Terebratula (*Waldheimia*) *grayi.* Schrenck., Moll. Amurl. u. d. nordjap. Meeres, p. 465.

A few isolated valves.

This shell is very variable in outline. The ventral valve which is very convex may be "squarely pentagonal" as Davidson says, or longitudinally oval. The dorsal valve which is only little convex and somewhat depressed in the middle is usually subtriangularly semicircular. Both valves are furnished with strong, angular, radiating ribs which often bifurcate. The strongest ribs are in the middle of the valves.

Fossil occurrence.—Shito. Shinagawa.

Living.—Northern, Central and Western Japan. California.

Family Rhynchonellidæ.

Genus **RHYNCHONELLA**, Fischer.

335. ***Rhynchonella psittacea***, (Chemnitz) ***var. woodwardi***, (Adams).

Pl. XVII. Fig. 13.

Rhynchonella psittacea var. woodwardi. Davidson, Monogr. Rec. Brach., p. 168, pl. XXIV, figs. 12. 13. Pilsbry, Cat., p. 153.

Rhynchonella woodwardi, Adams, Ann. Mag. Nat. Hist., 3d Ser., vol. XI, p. 100.

One perfect specimen and a few isolated valves.

The shell is somewhat triangular in outline, globose, broadest in the middle and laterally rounded. From the typical form of *R. psittacea* it is distinguished by the absence of radiating lines, the smaller and less curved beaks and the rounded ventral margin produced in the middle. The perfect specimen measures 22.3 millim. in height, 22 millim. in breadth and 16.5 millim. in thickness. It is therefore somewhat larger than that figured by Davidson in his monograph.

Fossil occurrence—Shito.

Living.—Northern and Western Japan.

INDEX.

ADDENDA.

On page 167, to the description of Trapezium nipponicum, the following lines should be added :

Two small left valves shown in figs. 12 and 13, plate VI, seem to be the young forms of this species. They are comparatively longer, with the surface-keel very sharp and more or less spiny.

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PLATE I.

Plate I.

Fig. 1. Solidula strigosa Gould. a. Surface enlarged to show punctured lines. Ōtake. P. 22

Fig. 2. Solidula clathrata Yok. Shitō P. 23.

Fig. 3. Leucotina gigantea Dkr. Ōtake. P. 23.

Fig. 4. Tornatina exilis Dkr. a. Apical view. Ōtake. P. 24.

Fig. 5. Tornatina longispirata Yam. Shitō. P. 24.

Fig. 6. Retusa globosa Yam. a. Apical view. Ōtake. P. 25.

Fig. 7. Retusa truncata Yam. a. Apical view. Ōtake. P. 25.

Fig. 8. Volvula angustata Ad. var. a. Apical view. Ōtake. P. 26.

Fig 9. Volvula acutaeformis Yok. Shito. P. 26.

Fig. 10. Cylichna musashiensis Tok. Ōtake. P. 27.

Fig. 11. Philine scalpta Ad. Shisui. P. 27.

Fig. 12. Philine scalpta Ad. (?) Kioroshi. P. 28.

Fig. 13. Philine pygmaea Yok. Ōtake. P 28.

Fig. 14 Bulla multiarata Yok. 14a. Surface enlarged. Shito. P. 29.

Fig. 15. Bulla ovula Sow. Shisui. P. 29.

Fig. 16, 17. Ringicula musashinoensis Yok. 16. Normal form. Shitō. 17. Smooth form. Ōtake. P. 30.

Fig. 18. Terebra gotoensis Smith. 18a. Surface enlarged. Ōtake. P. 31.

Fig. 19. Terebra helleyi Pils. a. Upper whorls enlarged. b. Lower whorls enlarged. Ōtake. P. 31.

Fig. 20. Terebra chibana Yok. Ōtake. P. 32.

Fig. 21. Terebra smithi Yok. Ōtake. P. 33.

Fig. 22. Terebra quadriarata Yok. 22a. Whorls enlarged. Shitō. P. 34.

Fig. 23. Terebra latisulcata Yok. a. Surface enlarged. Shitō. P. 34.

Fig. 24. Terebra suavidica Yok. Shisui. P. 35.

Fig. 25. Parviterebra raritans Yok. Ōtake. P. 36.

Fig. 26. Pleurotoma vertebrata Smith. a shows the slit. Shitō. P. 37.

Fig. 27, 28. Genotia pseudopannus Yok. 27. Ōtake. 28. Var. sematensis. Shitō. P. 37.

Fig. 29. Genotia ogurana Yok. a shows the shallow lip-notch. Ōtaka. P. 38.

Fig. 30. Drillia subauriformis Smith. a shows lip-notch. Kamenari. P. 40.

Fig. 31, 32. Drillia glabriuscula Yok. 31a, 32a show lip-notch. 32. Var. brevis. Shitō. P. 40.

Fig. 33. Mangilia ojiensis Tok. a shows lip-notch. Shitō. P. 41.

Fig. 34. Mangilia fukuchiana Yok. a shows lip-notch. Ōtake. P. 42.

Fig. 35. Mangilia (Cythara) rugoso-labiata Yok. a shows lip-notch. Ōtake.

Fig 36. Mangilia (Cythara) oyuana Yok. Shisui. P. 43.

Fig. 37. Bela rugulata Tros. var. schneideri Harm. Ōtake. P. 44.

Fig. 33. Bela recticostulata Yok. a shows lip-notch. Shitō. P. 44.

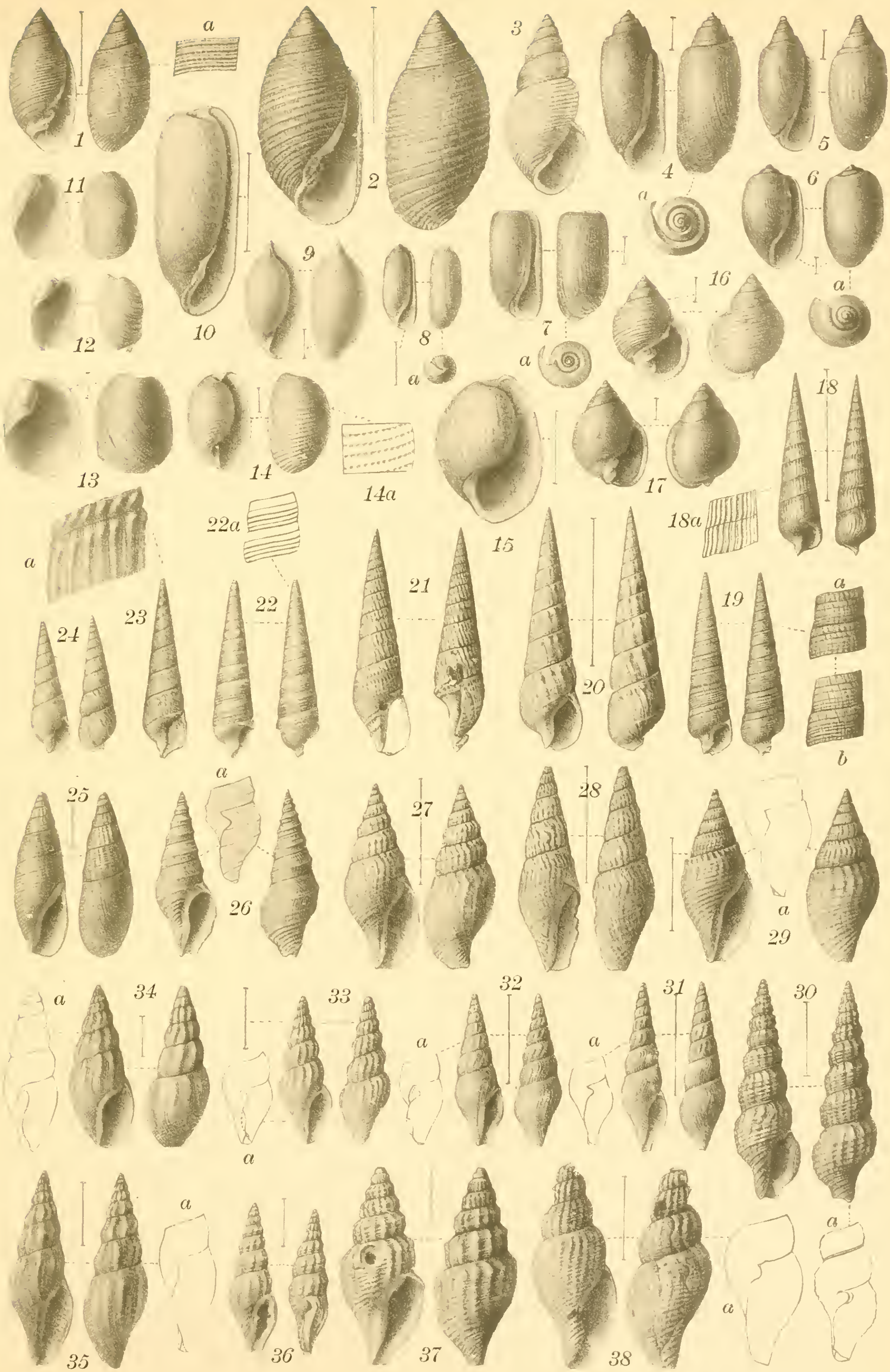

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PLATE II.

Plate II.

Fig. 1. Cancellaria nodulifera Sow. Shitō. P. 45.
Fig. 2. Cancellaria asperella Lam. var. reeviana Cr. Ōtake. P. 46.
Fig. 3. Olivella fortunei Ad. 3a. Basal portion of the shell. Shisui. P. 47.
Fig. 4. Olivella spretoides Yok. Shito. P. 47.
Fig. 5. Ancilla hinomotoensis Yok. a. Lateral view (from left). Shitō. P. 48.
Fig. 6. Marginella cotamago Yok. a. Apical view. Shitō. P. 49.
Fig. 7. Marginella perovulum Yok. a. Apical view Shitō. P. 49.
Fig. 8. Mitra hondana Yok. Shitō. P. 50.
Fig. 9. Mitra pirula Yok. Shitō. P. 51.
Fig. 10. Fusus coreanicus Smith. Shitō. P. 52.
Fig. 11. Fusus niponicus Smith. a. Surface sculpture enlarged. Shitō. P. 52.
Fig. 12. Chrysodomus arthriticus Val. Ōtake. P. 53.
Fig. 13. Chrysodomus schrencki Yok. Shitō. P. 54.
Fig. 14. Sipho (Parasipho) nipponicus Yok. Ōtake. P. 55.
Figs. 15, 16, 17. Siphonalia trochulus Rve. Shitō. P. 56.
Fig. 18. „ „ „ Ōtake. P. 56.
Fig. 19. Volutharpa perryi Jay. Shito. P. 57.
Fig. 20. Eburna japonica Rve. Ōtake. P. 57.
Fig. 21. Nassa (Hima) fraterculus Dkr. Ōtake. P. 59.
Fig 22. Columbella (Atilia) turriculata Yok. Ōtake. P. 61.
Fig. 23. Columbella (Atilia) masakadoi Yok. Ōtake. P. 62.
Fig. 24. Columbella (Atilia) smithi Yok. Ōtake. P. 61.
Fig. 25. Columbella (Atilia) praecursor Yok. Shitō. P. 61.
Fig. 26. Columbella (Mitrella) dunkeri Tryon. Slender form. Shito. P. 62.

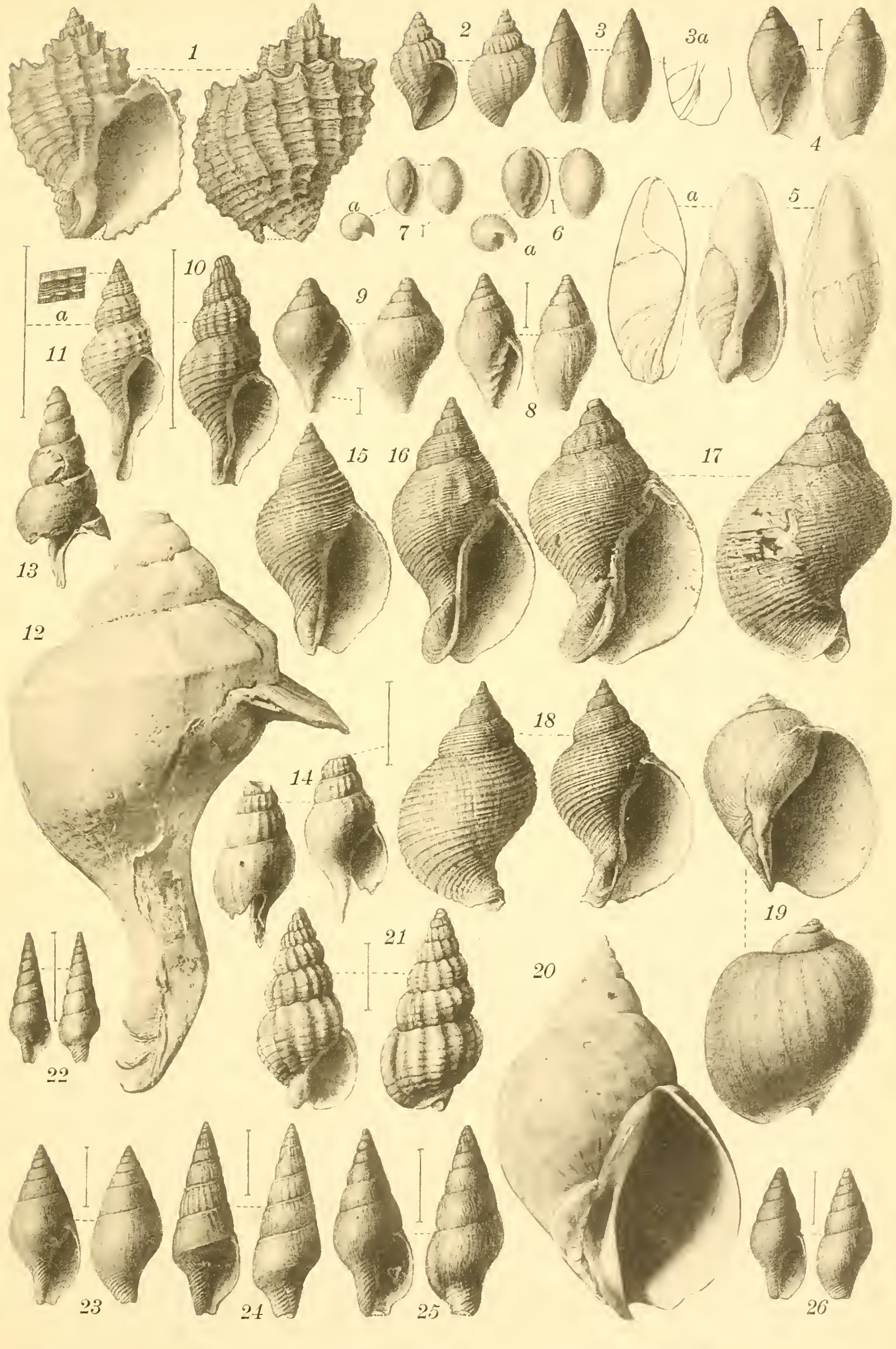

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PLATE III.

Plate III.

Fig. 1. Trophon pachyrhaphe Smith. Tega. P. 63.
Fig. 2. Trophon subclavatus Yok. Shitō. P. 64.
Fig. 3. Typhis arcuatus Hinds. Shitō. P. 64.
Fig. 4. Ocinebra falcata Sow. Shitō. P. 65.
Fig. 5. Ocinebra spectata Yok. Ōtake. P. 65.
Fig. 6. Rapana bezoar L. var. thomasiana Crosse, $\frac{1}{2}$ nat. Size. Ōtake. P. 66.
Fig. 7. Purpura heyseana Dkr. Shitō. P. 66.
Fig. 8. Triton tenuiliratus Lke. Shitō. P. 67.
Fig. 9. Cassis strigata Gm. Ōtake. P. 68.
Fig. 10. Dolium luteostomum Küst. Tega. P. 69.
Fig. 11. Erato callosa Ad. et Rve. a. Apical view. Ōtake. P. 69.
Fig. 12. Strombus japonicus Rve. Ōtake. P. 70.
Fig. 13. Cerithium (Clava) kochi Phil. Ōtake. P. 71.
Fig. 14. Cerithiopsis nodoso-costatus Yok. Shitō. P. 73.
Fig. 15. Cerithiopsis trisulcatus Yok. Shitō. P. 73.
Fig. 16. Triforis otsuensis Yok. Shitō. P. 74.
Fig. 17. Thylacodes medusae Pils. Shitō. P. 75.
Fig. 18. Cæcum vitreum Carp. Shitō. P. 76.
Fig. 19. Solarium cingulum Kien. Shitō. P. 77.
Fig. 20. Solarium pseudoperspectivum Broc. Shitō. P. 77.

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PLATE IV.

Plate IV.

Fig. 1. Melania niponica Smith. Ōtake. P. 76.
Fig. 2. Torinia elegantula Yok. Shitō. P. 78.
Fig. 3. Rissoa (Cingula) plebeja Yok. Shitō. P. 79.
Fig. 4. Rissoina (Moerchiella) manzakiana. Ōtake. P. 79.
Figs. 5, 6. Fenella septentrionalis Tok. 5. Ōtake. Vertical ribs indistinct. 6. Tega. P. 80.
Fig. 7. Skenea nipponica Yok. Tega. P. 81.
Fig. 8. Skenea planorboides Yok. Shito. P. 81.
Fig. 9. Capulus badius Dunk. a. Side-view. Kamenari. P. 82.
Fig. 10. Crepidula grandis Midd. Shitō. P. 82.
Fig. 11. Sigaretus (Eunaticina) oblongus Rve. Shitō. P. 85.
Fig. 12. Polinices powisianus Recl. Ōtake. P. 83.
Fig. 13. Scalaria aurita Sow. Ōtake. P. 85.
Fig. 14. Scalaria maculosa Ad. Ōtake. P. 86.
Fig. 15. Scalaria azumana Yok. Shitō. P. 86.
Fig. 16. Scalaria kazusensis Yok. Shitō. P. 87.
Fig. 17. Scalaria yamakawai Yok. Ōtake. P. 87.
Fig. 18. Scalaria conjuncta Yok. Tega. P. 88.
Fig. 19. Scalaria subfrondicula Yok. Shitō. P. 88.
Fig. 20. Scalaria picturata Yok. Shitō. P. 89.
Fig. 21. Eulima (Leiostraca) unicincta Yok. Ōtake. P. 89.
Fig. 22. Eulima (Leiostraca) tokunagai Yok. Ōtake. P. 90.
Fig. 23. Eulima (Leiostraca) glabroides Yok. Shitō. P. 90.
Fig. 24. Eulima (Leiostraca) krishna Yok. Shitō. P. 91.
Fig. 25. Pyramidella (Iphiana) mira Yok. Shito. P. 93.
Fig. 26. Pyramidella (Iphiana) siva Yok. Shitō. P. 94.
Fig. 27. Odostomia (Odostomia) gordonis Yok. Ōtake. P. 95.
Fig. 28. Odostomia (Odostomia) shimosensis Yok. Ōtake. P. 96.
Fig. 29. Odostomia (Odostomia) kizakiensis Yok. Tega. P. 97.
Fig. 30. Odostomia (Odostomia) venusta Yok. Shitō. P. 97.
Fig. 31. Odostomia (Odostomia) toneana Yok. Ōtake. P. 98.
Fig. 32. Odostomia (Odostomia) suboxia Yok. Ōtake. P. 98.
Fig. 33. Odostomia (Odetta) neofelix Yok. Shisui. P. 99.
Fig. 34. Odostomia (Egilina) marielloides Yok. Tega. P. 100.
Fig. 35. Turbonilla (Chemnitzia) imbana Yok. Shisui. P. 101.
Fig. 36. Turbonilla (Ptycheulimella) misella. Yok. Ōtake. P. 100.
Fig. 37. Turbonilla (Mormula) paucicostulata Tok. Shitō. P. 101.
Fig. 38. Turbonilla (Mormula) scrobiculata Yok. Ōtake. P. 102.
Fig. 39. Turbonilla (Chemnitzia) kidoensis Yok. Tega. P. 103.
Fig. 40. Turbonilla (Chemnitzia) teganumana Yok. Tega. P. 103.
Fig. 41. Turbonilla (Chemnitzia) sematana Yok. Shitō. P. 103.

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PLATE V.

Plate V.

Fig. 1. Siphonalia kellettii Forbes (somewhat reduced). Shito. P. 56.
Fig. 2. Pyramidella (Syrnola) cinnamomea Ad. Ōtake. P. 93.
Fig. 3. Pyramidella (Agatha) virgo Ad. var. brevis Yok. Ōtake. P. 92.
Fig. 4. Philine takatensis Yok. a (the lowest of the three figs., not shaded). Front-view. Shitō. P. 28.
Fig. 5. Triforis multigyrata Yok. Shito. P. 74.
Fig. 6. Pyramidella (Tiberia) pulchella Ad. Ōtake. P. 91.
Fig. 7. Odostomia desimana Dall et Bartsch. Shitō. P. 97.
Fig. 8. Sigaretus (Eunaticina) papilla Gmel. Shisui. P. 84.
Fig. 9. Sigaretus (Eunaticina) oblongus Reeve. Shitō. P. 85.
Fig. 10. Turbo (Marmorostoma) granulatus Gmel. Narita. P. 107.
Fig. 11. Turbonilla (Pyrgolampros) planicostata Yok. Shisui. P. 104.
Fig. 12. Turbonilla (Strioturbonilla) sagamiana Yok. Ōtake. P. 104.
Fig. 13. Turbonilla (Strioturbonilla) pacifica Yok. Shitō. P. 105.
Fig. 14. Turbonilla (Cingulina) triarata Pils. Shisui. P. 105.
Fig. 15. Turbonilla (Careliopsis) obscura Yok. a. Spiral sculpture (growth-lines not shown). Shitō. P. 106.
Fig. 16. Turbonilla (Careliopsis) angulifera Yok. Shitō. P. 106.
Fig. 17. Leptothyra pygmaea Yok. Tega. P. 108.
Fig. 18. Trochus spinigera Yok. Shitō. P. 109.
Fig. 19. Minolia tasmanica Tenison et Wood. Ōtake. P. 109.
Fig. 20. Solariella angulata Tok. Shitō. P. 111.
Fig. 21. Solariella philippensis Wat. Ōtake. P. 110.
Fig. 22. Leptothyra crassilirata Yok. Tega. P. 108.
Fig. 23. Turcica imperialis Ad. Shito. P. 111.
Fig. 24. Basilissa ? laeviuscula Yok. Shito. P. 113.
Fig. 25. Calliostoma unicum Dkr. var. shinagawensis Tok. Ōtake. P. 112.
Fig. 26. Cyclostrema stillicidiatum Yok. Shito. P. 114.

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PLATE VI.

Plate VI.

Fig. 1. Pyramidella (Actaeopyramis) eximia Lke. Ōtake. P. 94.
Fig. 2. Stomatella lyrata Pils. Ōtake. P. 115.
Fig. 3. Macroschisma sinensis Ad. var. laevis Yok. Ōtake. P. 115.
Fig. 4. Puncturella nobilis Ad. Shitō. P. 116.
Fig. 5. Emarginula vadososinuata Yok. Shitō. P. 117.
Fig. 6. Dentalium weinkauffii Dkr. Ōtake. P. 118. (The concave side should have been drawn with a more uniform curve).
Fig. 7. Dentalium (Fustiaria) nipponicum Yok. Shitō. P. 119.
Figs. 8, 9. Corbula erythrodon Lam. $\frac{6}{5}$ nat. size. 8. Right valve. 9. Left valve. Ōtake. P. 122.
Fig. 10. Jouannetia kamakurensis Yok. Shitō. P. 120.
Fig. 11. Entodesma naviculoides Yok. Shitō. P. 170.
Figs. 12, 13. Trapezium nipponicum Yok. (very young specimens)?. Shitō. P. 270.
Figs. 14, 15. Panope generosa Gld. Left valves. 14. Normal form. Tega. 15. Elongated form. $\frac{2}{3}$ nat. size. Ōtake. P. 121.
Figs. 16, 17. Corbula frequens Yok. 16. Left valve. 17. Right valve. Shitō. P. 123.
Fig. 18. Corbula pustulosa Yok. Right valve. Ōtake. P. 123.
Figs. 19, 20. Corbula sematensis Yok. 19. Right valve. 20. Left valve. Shitō. P. 124.

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PLATE VII.

Plate VII.

Figs. 1, 2. Cryptomya busoensis Yok. 1. Right valve. 2. Left valve. a shows depth. Ōtake. P. 126.

Fig. 3. Corbula substriata Yok. Right valve. Shitō. P. 125.

Figs. 4, 5. Corbula pygmaea Yok. 4. Right valve. a shows depth. 5. Left valve Tega. P. 125.

Fig. 6. Mactra sulcataria Desh. Shitō. P. 126.

Figs. 7, 8. Mactra dunkeri Yok. 7. Right valve. 8. Left valve. Shitō. P. 128.

Figs. 9, 10. Mactra sachalinensis Schr. var. imperialis Yok. $\frac{2}{3}$ nat. size. 9. Broad and triangular form. Shito. 10. Higher and more ovate form. Ōtake. P. 129.

Fig. 11. Soletellina olivacea Jay. Left valve. Shitō. P. 138.

Fig. 12, 13. Mactra ovalina Lam. 12. Left valve. Ōtake. 13. Right valve. Tega. P. 127.

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PLATE VIII.

Plate VIII.

Figs. 1, 2. Spisula grayana Schr. Shito. P. 130.
Figs. 3, 4. Spisula bernardi Pils. Kioroshi. P. 130.
Figs. 5, 6. Raeta yokohamensis Pils. Ōtake. P. 131.
Fig. 7. Raeta elliptica Yok. Tega. P. 131.
Fig. 8. Tresus nuttali Conr. ½ nat. size. Ōtake. P. 133.
Figs. 9, 10. Lutraria maxima Jon. ⅔ nat. size. Ōtake. P. 133.
Fig. 11. Tellina nitidula Dkr. Shisui. P. 139.
Figs. 12, 13. Raeta magnifica Yok. Tega. P. 132.

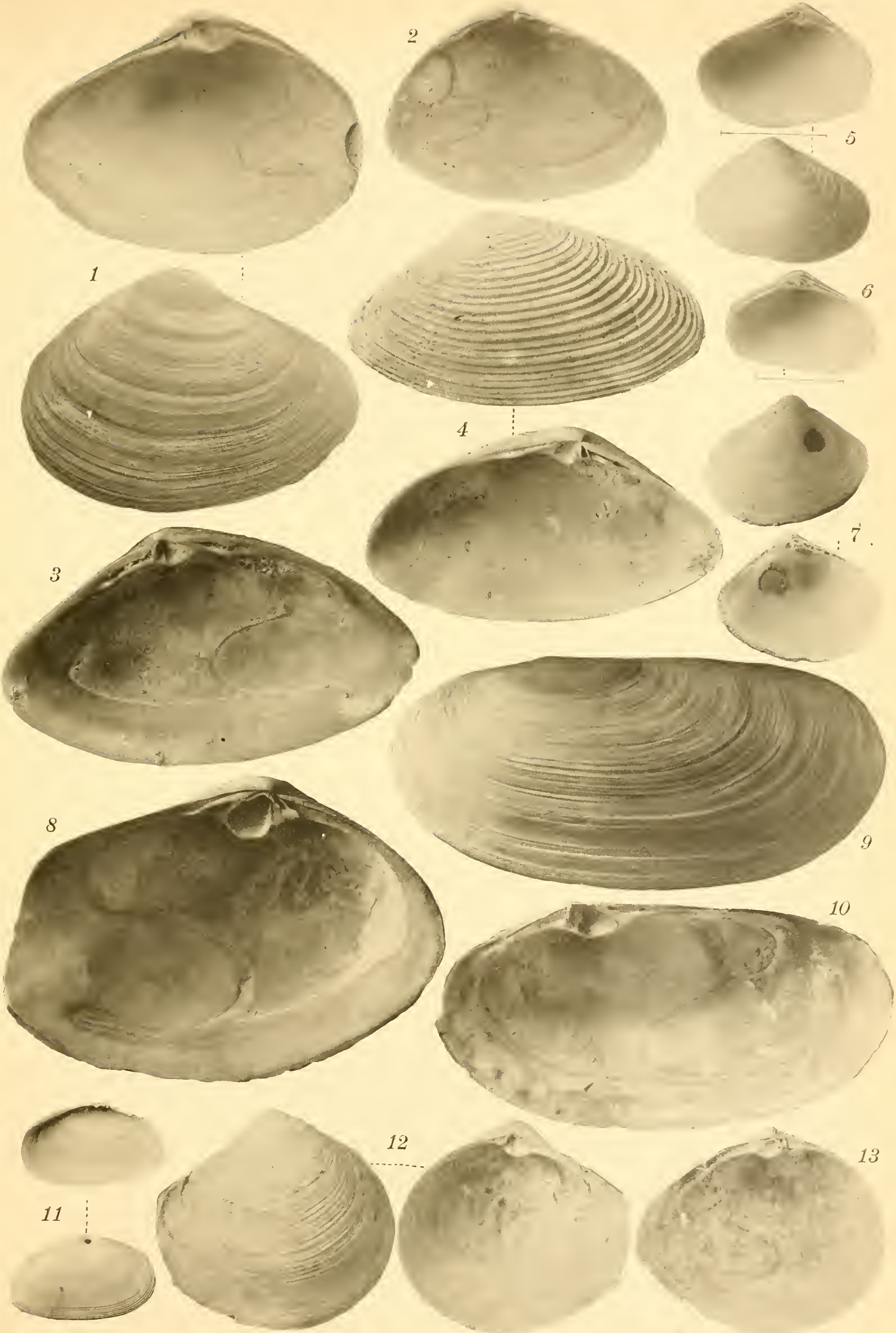

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PLATE IX

Plate IX.

Fig. 1. Solen grandis Dkr. Left valve. Ōtake. P. 134.

Figs. 2, 3. Montacuta japonica Yok. 2 Left valve. 3. Right valve. Ōtake. P. 157.

Fig. 4. Psammobia kazusensis Yok. Left valve. Shitō. P. 136.

Fig. 5. Solen krusensterni. Schrenck. Right valve. Ōtake. P. 134.

Fig. 6. Raeta pellicula Desh. Left valve. Ōtake. P. 131.

Fig. 7. Siliqua pulchella Dkr. Right valve. Ōtake. P. 135.

Figs. 8, 9. Donax introradiatus Reeve. 8. Left valve. 9. Right valve. Tega. P. 136.

Fig. 10. Montacuta yamakawai Yok. Right valve. Shisui. P. 158.

Figs. 11, 12. Thyasira trigonata Yok. 11. Right valve. 12. Left valve. Shitō. P. 158.

Figs. 13, 14. Soletellina violacea Lam. 13. Right valve. 14. Left valve. Ōtake. P. 137.

Figs. 15, 16. Tellina jedoensis Lischke. 15. Left valve. 16. Right valve. Tega. P. 138.

Fig. 17. Soletellena olivacea Jay. Right valve. Shitō. P. 138.

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PLATE X.

Plate X.

Fig. 1. Tellina venulosa Schrenck. Left valve. Ōtake. P. 139.

Figs. 2, 3. Macoma praetexta Mart. 2. Right valve. 3. Left valve. Shisui. P. 142.

Fig. 4. Macoma dissimilis Mart. Left valve. Ōtake. P. 143.

Figs. 5, 6. Tellina alternata Say var. chibana Yok. 5. Left valve from Ōtake. 6. Right valve from Kamenari. P. 140.

Fig. 7. Lucinopsis divaricata Lischke. Left valve. a shows depth. Shitō. P. 145.

Figs. 8, 9, 10. Tellina delta Yok. 8. Right valve. 9. Left valve. 10. Seen from beak-side. Ōtake. P. 141.

Fig. 11. Astarte borealis Chem. Left valve. Somewhat enlarged ($\times 1\frac{1}{3}$). a. Inside. b. Outside. Shito. P. 163.

Figs. 12, 13. Dosinia bilunulata Gray. 12. Left valve. 13. Right valve. Ōtake. P. 144.

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PLATE XI.

Plate XI.

Fig. 1. Macoma secta Conrad. Left valve. Ōtake. P. 143.

Figs. 2, 3. Chione mindanensis Smith. 2. Right valve. 3. Left valve. Shitō. P. 150.

Fig. 4. Meretrix meretrix Linne. Left valve. Ōtake. P. 146.

Fig. 5. Meretrix (Callista) chinensis Chem. Right valve. Shitō. P. 146.

Figs. 6, 7, 8. Sunetta excavata Hanley. 6 ab. Left valve from Kioroshi, formerly considered to be a different species under the name of S. menstrualis Menke. 7. A young left valve from Ōtake (typical S. excavata). 8. A young right valve of menstrualis-type from Ōtake. P. 147.

Figs. 9, 10. Venus neastartoides Yok. Kioroshi. 9 ab. left valve. 10. Right valve. P. 149.

Figs. 11, 12. Venus stimpsoni Gould. Ōtake. 11. Left valve. 12. Right valve. P. 148.

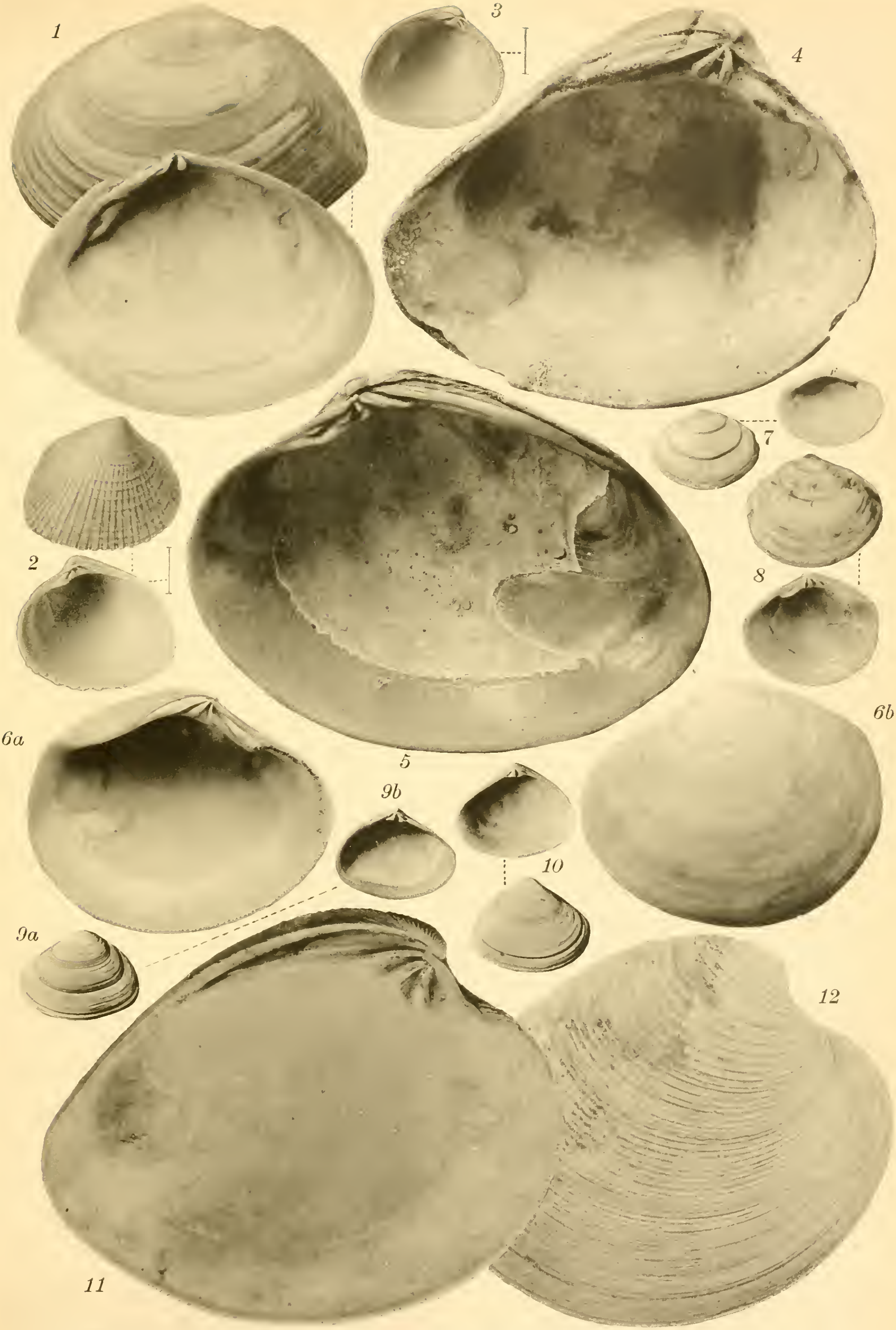

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PLATE XII.

Plate XII.

Figs. 1, 2. Venerupis semipurpurea Dkr. 1. Left valve. 2. Right valve (a form more truncate both in front and behind). Ōtake. P. 151.

Fig. 3. Cardium burchardi Dkr. Right valve. Ōtake. P. 153.

Figs. 4, 5, 6. Cardium tokunagai Yok. 4. Var. ovata. Shisui. 5, 6. Typical forms. Ōtake. P. 156.

Fig. 7. Cardium muticum. Reeve. Right valve. Ōtake. P. 154.

Fig. 8. Tapes euglyptus Phil. Left valve. Kioroshi. P. 152.

Fig. 9. Saxidomus purpuratus Sow. Right valve. Ōtake. P. 153.

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PLATE XIII.

Plate XIII.

Fig. 1 a b. Trapezium ventricosum Yok. Left valve. Ōtake. P. 108.

Fig. 2. Cardium braunsi Tok. Right valve. Ōtake. P. 155.

Fig. 3. Diplodonta usta Gld. Left valve. Ōtake. P. 159.

Fig. 4. Venericardia cipangoana Yok. Left valve. Ōtake. P. 162.

Fig. 5. Chama semipurpurata Lke. Convex valve. Ōtake. P. 161.

Figs. 6, 7. Venericardia toneana Yok. 6. Left valve. 7. Right valve. Shitō. Enlarged about 4 times. P. 163.

Fig. 8. Crassatella nana Ad. et Rve. Right valve. Kioroshi. P. 164.

Figs. 9, 10. Montacuta oblongata Yok. 9. Left valve. 10. Right valve. Drawn after Oji specimens, those from Kazusa and Shimosa being too imperfect for figuring. P. 157.

Fig. 11. Trichotropis unicarinata Brod. Shitō. P. 75.

Figs. 12, 13. Terebra tsuboiana Yok. 12. Kioroshi. 13. A living shell from Sagami Sea for comparison, the sculpture being more distinct. P. 35.

Figs. 14, 15. Corbicula sandaiformis Yok. 14. Left valve. 15. Right valve. Shitō. P. 165.

Fig. 16. Trapezium liratum Reeve. Left valve. Ōtake. P. 168.

Fig. 17. Trapezium nipponicum Yok. Right valve. Ōtake. P. 167. The left valves shown in figs. 12 and 13 of plate VI may be the young forms of this species.

Figs. 18, 19. Corbicula kobelti Yok. 18. Right valve. 19. Left valve. Shitō. P. 166.

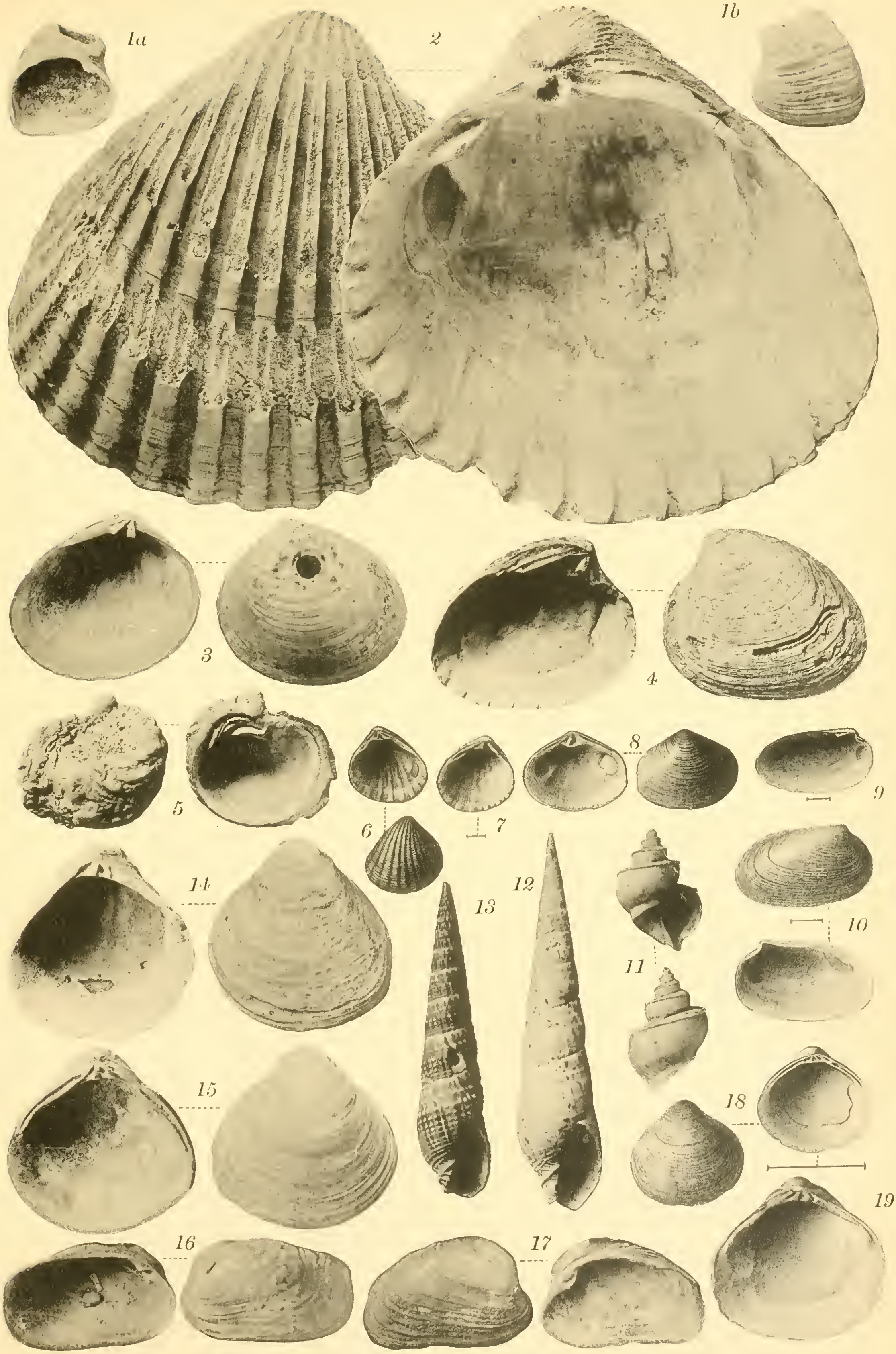

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PLATE XIV.

Plate XIV.

Fig. 1. Odostomia limpida Dall. Ōtake. P. 96.
Fig. 2. Diplodonta semiaspera Phil. Right valve. Shisui. P. 160.
Figs. 3, 4. Cuspidaria ligula Yok. 3. Left valve. 4. Right valve. Shitō. P. 169.
Fig. 5. Coralliophaga coralliophaga Chem. Right valve. Shitō. P. 166.
Figs. 6, 7. Myodora fluctuosa Gld. 6. Left valve. 7. Right valve. Ōtake. P. 170.
Figs. 8, 11. Myodora reeviana Smith. 8. Right valve. a. Front view. 11. Left valve. a. Shows depth. Shito. P. 171.
Figs. 9, 10. Lyonsia praetennis Dkr. 9. Right valve. 10. Left valve. Ōtake. P. 169.
Figs. 12. Thracia papyracea Poli. Right valve. a. Shows depth. Ōtake. P. 171.
Figs. 13, 14. Thracia transmontana Yok. 13. Right valve. a. Shows depth. 14. Left valve. Shitō. P. 172.
Figs. 15, 16. Poromya flexuosa Yok. 15. Left valve. a. Shows depth. 16. Right valve. Shitō. P. 173.
Figs. 17, 18. Thracia sematana Yok. 17. Right valve. a. Shows depth. 18. Left valve. Shitō. P. 173.
Fig. 19. Modiola barbata L. Right valve. Tega. P. 174.
Figs. 20, 21. Anomia sematana Yok. Somewhat enlarged ($\frac{4}{3}$). Convex valves. Shitō. P. 177.
Figs. 22, 23. Anomia lunula Yok. $\frac{4}{3}$. 22. Flat valve. 23. Convex valve. Ōtake. P. 177.
Fig. 24. Spondylus cruentus Lke. $\frac{4}{3}$. Upper valve. Ōtake. P. 179.
Fig. 25. Plicatula cuneata Dkr. $\frac{4}{3}$. Right valve. Kamenari. P. 180.
Fig. 26. Pecten laetus Gld. Shitō. P. 180.

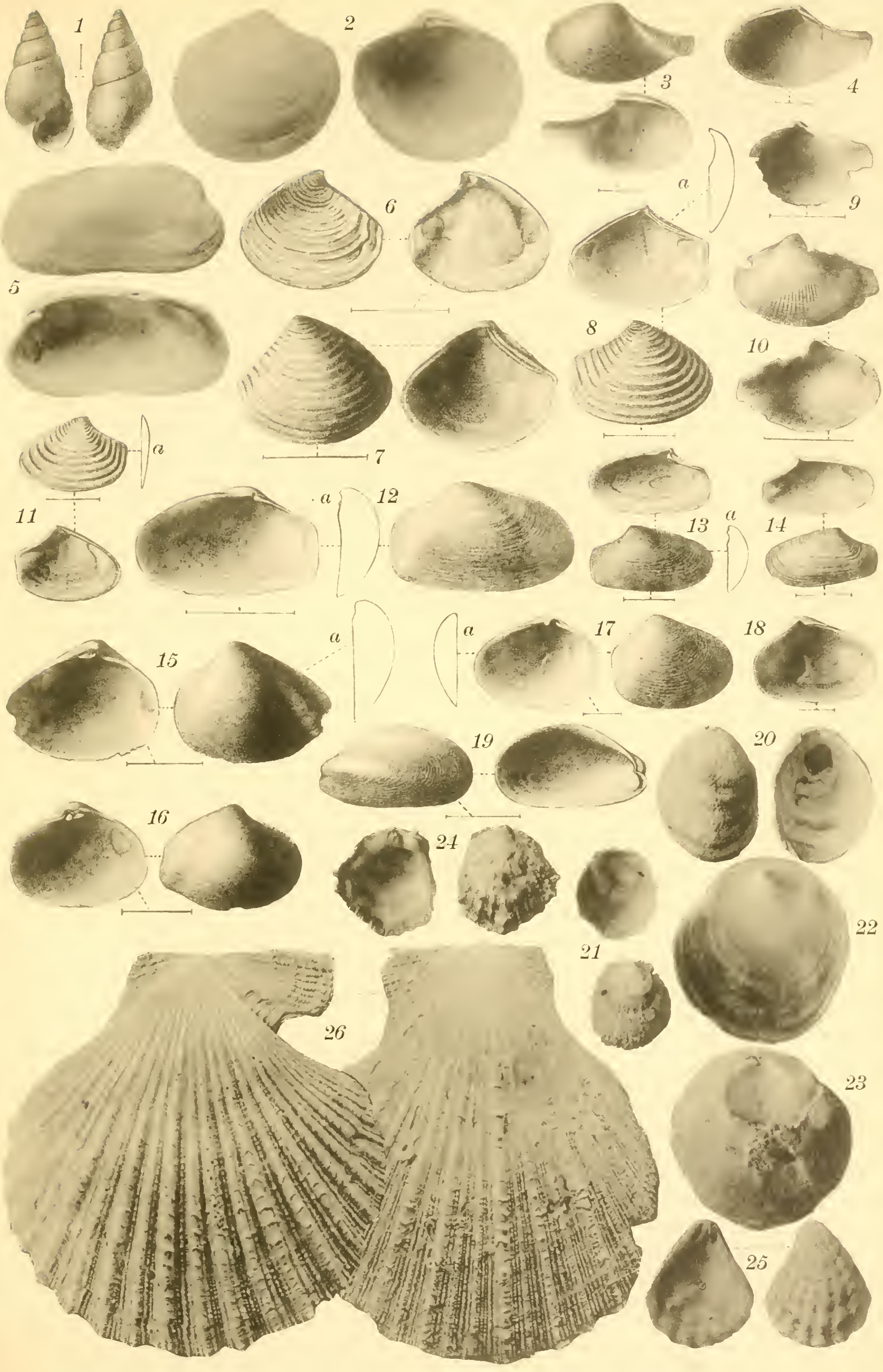

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PLATE XV.

Plate XV.

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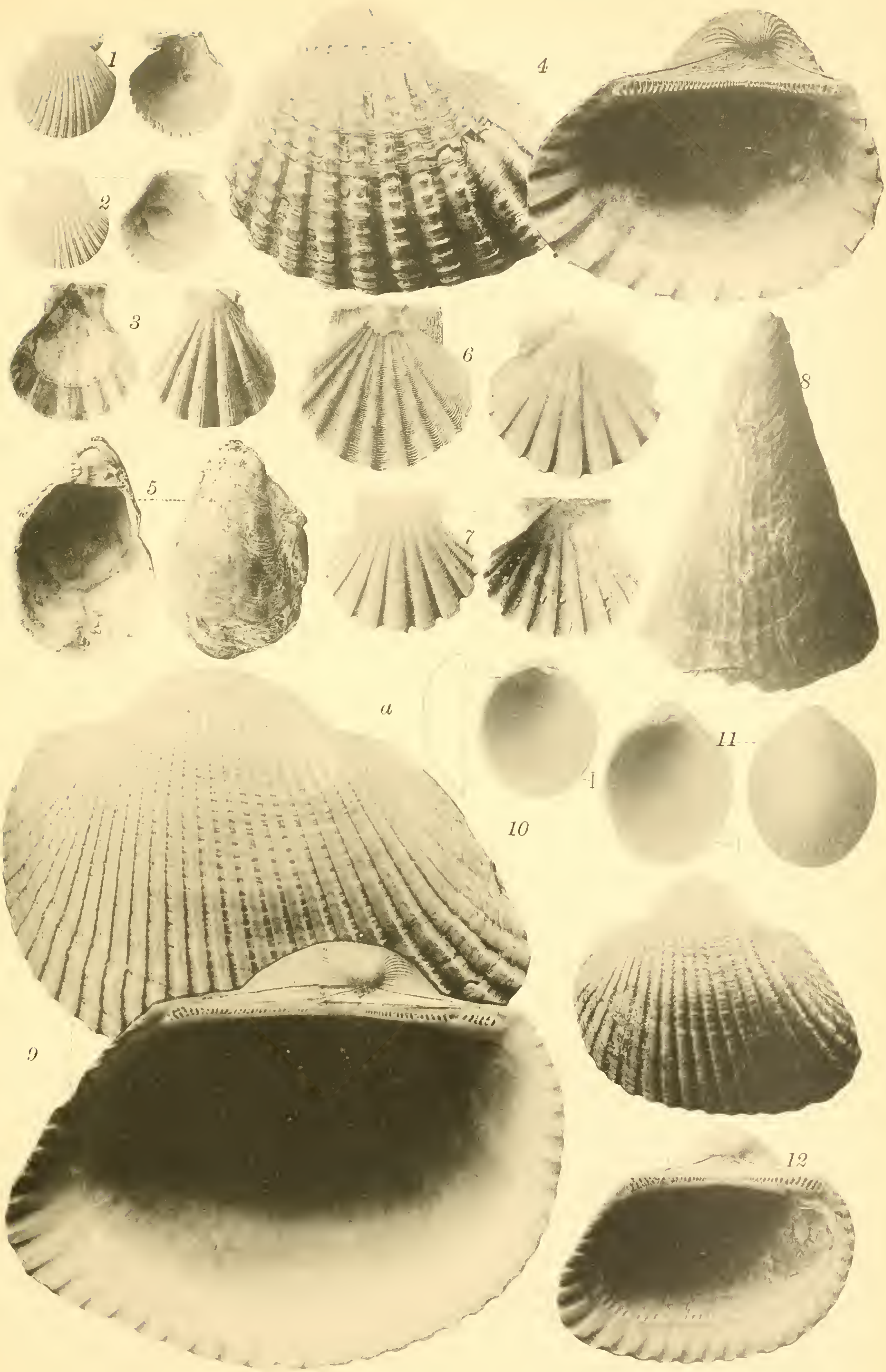

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Plate XVI.

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Plate XVII.

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On some Japanese Freshwater Triclads; with a Note on the Parallelism in their Distribution in Europe and Japan.

By

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With 1 plate and 14 text figures.

A considerable number of the freshwater Triclads have, up to date, been recorded by several investigators as occurring in various parts of the globe. With regard to the systematic classification of them, it should be remarked that the group is now in a very confused condition, so that they require a thorough revision at once. It may be noticed here that the genus *Planaria* hitherto referred to shows a difference in form of sufficient value to separate the two or more groups generically. In the present paper, however, I have intentionally abstained from making any such attempt, leaving the problem to those who may have occasion to study personally a large number of forms and especially to re-examine the species previously described. I have now confined myself to the further report of ten species previously placed on record as occurring in the territories of Japan. But the species described by STIMPSON (75) under the name of *Planaria badia* from Loo Choo and *Pl. cinerea* from Ohshima—both seeming perhaps to stand in conjunction with *Pl. gonocephala*—are left out of consideration in this paper, since they are decidedly meagre in description.

In this communication, in addition to giving an account of the habits, I will make a suggestion with regard to the parallelism in the distribution of the freshwater Triclads in Europe and Japan, with a brief consideration of the causes underlying this distribution in the two regions.

It might particularly be mentioned here that some of the coloured illustrations which are embodied in the present paper were made by the late Professor Isao Ijima from the living worms. To him my hearty thanks are due for much valuable aid rendered me during the work.

The species dealt with in the present paper are shown in the following key:

A. Eyes 2 (rarely 3 or 4).

a[1]. Frontal margin thrown into some adhesive folds on the inferiorly turned swollen edge.

a[2]. Body large; median head lobe strongly arched; lateral lóbes not prominent; colour reddish brown..................... .... 1. *Bdellocephala annandalei* Ij. et Kab.

b[2]. Body moderately large; median head lobe as in the preceding; colour olive-like brown, sometimes velvety black..................... 2. *Bdellocephala brunnea* Ij. et Kab.

b[1]. Frontal margin exhibiting no adhesive folds.

c[2]. With tentacles.

a[3]. Tentacles moderately long, obtusely pointed at tip; body blackish or dark olive-like brown in colour ....3. *Planaria vivida* Ij. et Kab.

b[3]. Tentacles short, rounded at tip; body colourless, translucent.......................4. *Planaria pellucida* Ij. et Kab.

d[2]. Without tentacles.

c[3]. Head triangular, with lateral processes and auricular sense organs slenderly reniform; colour variable, usually olive-like brown .... 5. *Planaria gonocephala* Dugès.

d[3]. Frontal margin subtruncate; body of a grayish colour, with a linear series of small papillae in the mid-dorsal line..................... 6. *Planaria papillifera* Ij. et Kab.

B. Eyes numerous.

a^1. Eyes situated a considerable distance apart from head margin.

Eyes distributed in two longitudinal tracts; tentacles moderately long, obtusely pointed at tip; body colourless or presenting various sorts of hues .... 7. *Sorocelis sapporo* IJ. et KAB.

b^1. Eyes distributed close to head margin.

a^2. Eyes in irregular rows.

Tentacles long, more or less rounded at tip; body generally of a sepia brown colour .... 8. *Polycelis auriculata* IJ. et KAB.

b^2. Eyes in a single row.

a^3. Tentacles moderately short, pointed at tip; body of a dark olive-like brown colour ...9. *Ploycelis ijimai* KAB.

b^3. Tentacles longer, more pointed at tip; body of a dark brown colour, showing two longitudinal ill-defined darker bands .... 10. *Polycelis karafto* IJ. et KAB.

Bdellocephala annandalei IJ. et KAB.

(Pl. I., fig. 1.—Text figs. 1, 2.)

A few specimens of this species were collected by Dr. N. ANNANDALE and Mr. T. KAWAMURA in October, 1915, in Lake Biwa, on a muddy bottom at a depth of 30–45 fathoms.

Form and Dimension.—The body, which is of large size and of a very firm texture, is elongate-oval with the narrow head lobe distinctly marked off from the trunk. When in motion, the breadth of the head lobe is less than one-third that of the broadest part of the trunk. The frontal margin of the head is crenate and strongly arched in the middle parts, spreading on each side into lateral lobes which are not prominent. When viewed from the ventral side, the head lobe exhibits some small adhesive folds on the inferiorly turned swollen edge, as is shown in text fig. 1; close behind that edge there exists a groove-like depression. The trunk, being rounded at the posterior end, is of considerable thickness, rather strongly convex dorsally, but flattening ventrally. Large specimens reach 40 mm. in length and 15 mm. in breadth at the pharyngeal region.

Colouration.—The colour of the dorsal surface is somewhat variable, but usually reddish brown; the positions of the pharynx and the copulatory organs are indicated by almost colourless spaces. The ventral surface is of a much lighter colour than the dorsal.

Text fig. 1. Ventral side of the head end of *Bdellocephala annandalei* IJ. et KAB., showing adhesive folds and groove.

Eyes. — The two crescentic eyes, each surrounded by a small oval colourless space, are situated at the hind border of the head lobe, and are widely separated from each other.

Body Wall.—The epidermis consists of a layer of ciliated columnar cells, which are of a greater height on the dorsal side than on the ventral. Wedged in between the cells are spindle-like rhabdites, which originate from their mother-cells, scattered in sparse numbers in the parenchyma. The basement membrane is fairly thick and distinct. The underlying dermal musculature, which is strongly developed, consists on the dorsal side of three sets of fibres, circular, transverse and longitudinal. The outer circular muscles occur in distinct thick bundles, unlike those of the majority of the Triclads. The longitudinal muscular layer, which is the best developed of all the muscular layers of the body, is of great thickness. Besides, directly inwards to the longitudinal layer there exists a layer of inner circular fibres on the ventral side. In addition there is a well-developed system of parenchyma-muscle, chiefly composed of dorso-ventral fibres. Embedded in the parenchyma are numerous glandular cells, which open to the exterior submarginally on the ventral surface as well as at various points of the entire body-surface, much as in any other forms.

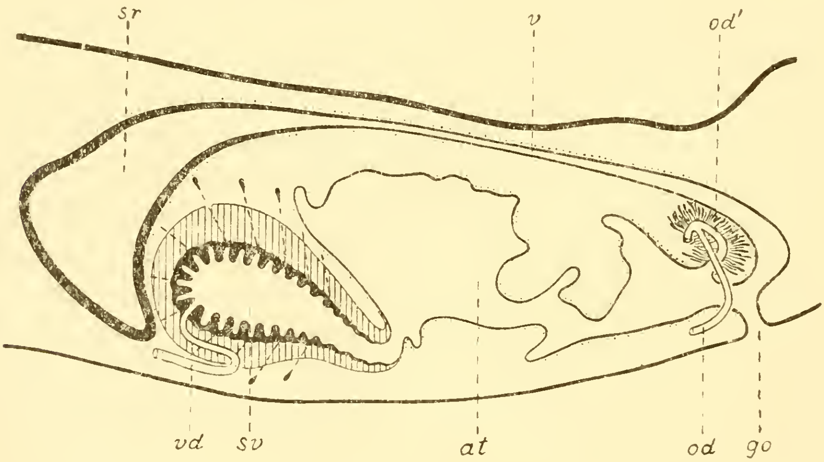
In the region of the adhesive folds numerous glands open to the exterior. The epidermis lining the depression is wholly devoid of cilia and rhabdites. The organ cannot be compared to the sucker of cotyligerous Turbellaria, or to the muscular sucking discs of other Platodes, nor to that of the leech; it lacks the special musculature so often elaborately developed in these. It appears to be comparable, rather, to the frontal organ of the Acoela, and more particularly to the organ existing at the anterior end of *Mesostoma lingua*, as mentioned by WOODWORTH.

Digestive System.—The mouth-opening lies slightly behind the hind end of the middle third of the body. The pharynx, which is cylindrical in shape, is inserted at about the middle of the body and is about one-sixth the length of the entire body. The anterior main trunk of the intestine gives rise to about 11 pairs of lateral branches which are numerously subdivided, while the posterior trunks are each provided with about 18 bifurcated or trifurcated diverticulae. The wall of the gut is composed of an epithelium comprising a number of cells which are known under the name of MINOT'S glands. The general epithelial cells were seen to contain minute spherical droplets or to be vacuolated.

Nervous Sytem.—The brain is a bilobed organ, situated at the anterior end of the body between the ventral wall and the anterior termination of the intestinal trunk. Anteriorly each brain-mass gives off a few sensory nerves and posteriorly is continuous with one of the longitudinal trunks which run nearly parallel to each other and extend to the hind end of the body. Throughout their entire course, the trunks are connected by numerous transverse commissures and also send out lateral branches towards the marginal nerves, usually at points opposite to the union of the trunks with transverse commissures.

Genital Organs.—The common genital opening is placed at a point somewhat in front of the middle between the mouth-opening and the posterior end of the body. It leads into the spacious prolonged atrium, which is provided with an irregularly folded wall, and which may be generally divided into three portions, viz., the anterior, the middle and the posterior. The anterior space extends forward over the penis. The wall is made up of an epithelium of columnar cells, resting upon a basement membrane, external to which is a well-developed muscular coating, varying more or less in thickness in different parts.

Numerous testes occur close together in the dorsal parts of the body, arranged in two longitudinal lateral zones which extend posteriorly from behind the ovaries. Each testis is, as usual, composed of sperm-mother-cells and spermatozoa in several stages of development, enclosed by the tunica propria. They have not been observed to connect with sperm ductules, but the vasa deferentia, on the other hand, are distinctly discernible in the pharyngeal region. The vasa deferentia, proceeding backwards just inside the longitudinal nerve cords on the ventral side, make a forward turn just before entering the penis, and open separately into the cavity of the latter. The wall of the vas deferens, filled with spermatozoa, consists of an epithelium and an outer layer of circular muscles, which is strongly developed in the neighbourhood of the penis.



Text fig. 2. Reproductive organs of *Pd. annandalei* in sagittal section, diagrammatically shown.

at atrium, *go* genital opening, *od* oviduct, *od'* unpaired common oviduct, *sr* seminal receptacle, *sv* seminal vesicle, *v* vagina, *vd* vas deferens.

The penis, which is wholly devoid of intromittent part of any sort, is a pear-shaped, saccular organ with a strongly thick muscular wall and entirely embedded in the parenchyma, the internal cavity opening on the floor of the anterior part of the atrium The cavity of the penis is lined with an epithelium, which projects to a considerable extent into the lumen of the organ in folds, thus producing a large surface. Embedded in the parenchyma directly around the penis are numerous eosinophil penis-glands, which make their way into the cavity.

The paired ovary is placed between the third and fourth pairs of the lateral branches of the anterior gut trunk. It is a small spherical body, showing egg-cells in several stages of development.

The vitelline glands are represented by branched cellular cords with cells arranged in single or double rows. They are extensively distributed almost throughout in the interstices between the gut diverticulae and connected with the oviduct at numerous points. However, the mode of connexion could not be made out clearly. The vitelline cell is of small size and contains an almost spherical nucleus, which is far larger than that of the surrounding tissues and exhibits a closer affinity for haematoxylin.

The oviduct of each side springs from the postero-lateral surface of the ovary as an ampullaceous passage, filled with spermatozoa, which soon assumes the character of a narrow duct, proceeding straight backwards just along the outer side of the longitudinal nerve cord. In the region of the genital opening it suddenly bends inwards, at the same time rising upwards, to unite with its fellow of the opposite side into a short common duct, which curves backwards and downwards to open into the vestibular part of the atrium from above. On one occasion there was observed a curious complete loop of the oviduct, occurring on the right side at the atrial region. The oviduct exhibits a distinct lumen throughout the entire length. With the exception of the unpaired terminal duct the direct wall is composed of a ciliated epithelium, which shows no nuclei at all. The nucleus-containing parts of the epithelium are sunk into the surrounding parenchyma, as recorded by several investigators to be the case in *Planaria gonocephala*, *Pl. polychroa*, *Pl. burmaensis*, *Dendrocoelum lacteum*, etc. Immediately exterior to the layer mentioned, come two layers of internal circular and external longitudinal muscular fibres, surrounded by a number of cells which probably represent the sunken parts of the epithelium. Processes from the cells are occasionally found to extend to, and to join, the epithelium. In the unpaired terminal part of the duct the lining epithelium is made up of normal ciliated columnar cells, and the muscular coating is much better developed than elsewhere.

The seminal receptacle is a large sack-like organ, situated close in front of the penis. The lining epithelium is made up of large columnar cells of a glandular nature, resting upon a delicate basement membrane, beneath which exists a layer of fine muscular fibres. In the specimen examined, the organ appears to have been in high secretory activity, containing enormous quantities of fine granular substance, which becomes stained with eosin and is perhaps secretion from the wall. Further, the cells were observed to contain fine spherical droplets or to be vacuolated.

Posteriorly the receptacle gives rise to the slender vaginal canal, which runs over the entire length of the atrium, and opens into the vestibular part of the atrium behind the unpaired oviduct and just within the genital aperture. The vagina is internally lined with an epithelium made up of cylindrical cells resting upon a fine basement membrane. Just external to this are found the internal circular and the external longitudinal muscular layers in direct succession.

Bdellocephala brunnea IJ. et KAB.

(Pl. I., fig. 2.—Text figs. 3, 4.)

This species is fairly common in the Empire, and numerous specimens have been discovered in cool running brooks at the following places: Yemada and Kanazuchi in Prov. Rikuzen, Koiwai in Prov. Rikuchu, Inawashiro in Prov. Iwashiro and Kyoto.

Form and Dimension.—The body is moderately large and rather slender. The head is indistinctly marked off from the trunk by a gentle neck-like narrowing of the body. The frontal margin is crenate and weakly arched in the median parts, which are thrown into some folds on the inferiorly turned swollen edge, as is shown in text fig. 3. Behind that edge there exists a groove-like depression. The lateral lobes are but little projected. The breadth of the frontal margin in the creeping state is less than half the greatest breadth of the trunk. The trunk, which is dorsally convex and ventrally flat, very gradually broadens posteriorly from the neck to about the region of the sexual organs. In the hind parts it tapers to a rather rounded extremity. The body in the creeping condition measured commonly 20–26 mm. long by 3–4 mm. broad at the broadest part.

Text fig. 3. Ventral side of the anterior end of *Bdellocephala brunnea* IJ. et KAB., showing adhesive folds and groove.

Colouration.—The dorsal surface of the body is of an olive-like brown or sometimes velvety black colour, the parts containing guts being usually darker than elsewhere. The ventral surface is much paler than the dorsal.

Eyes.—The two eyes, each lying in a white space, occupy a position slightly in front of the neck-like constriction, the distance between them being about twice as long as that between either of the eyes and the nearest point in the frontal margin or that in the lateral margin of the head.

Body Wall.—The epidermis resting on a fine basement membrane is somewhat thicker on the dorsal than on the ventral side, and is, as usual, full of minute rhabdites. In the parenchyma immediately beneath the dermal musculature there occur such rhabdites as are still contained in their mother-cells, which exist in wide distribution over various parts of the body. The dermal musculature consists, as usual, of circular, transverse and longitudinal layers. Situated in the parenchyma are eosinophil glandular cells opening submarginally on the ventral surface, much as in the preceding species. The anterior fold receiving the ducts of numerous glands is not a true sucker, nor does the animal employ its anterior end for the purposes of attachment to any greater degree than the posterior or lateral margins of the body, along the ventral surface of which numerous glands have their openings. In truth, it is the margins and posterior end that adhere more firmly to a support; often when the animal is forcibly removed from the side of the aquarium, the parts of the margin or the posterior end will adhere so firmly to the glass that the points of attachment are drawn out into digitate processes.

Digestive System.—The mouth-opening is situated at about the posterior end of the middle third of the body. The pharynx-insertion lies at about the centre of the body. The anterior main gut trunk gives off 7–9 pairs of lateral branches; while each posterior trunk is usually provided with 13 lateral branches and about as many, but very short, inwardly directed branches.

The nervous sytem seems to be in its main features similar to that of the preceding species.

Genital Organs.—The common genital aperture lies nearly in the middle of the posterior third of the body. In structural respects the genital organ are essentially the same as in the preceding species. The opening leads into the atrium which is an irregular prolonged space with its wall thrown into folds, and shows an extensive annular space in front of the junction of the oviduct. The lining epithelium is made up of cuboidal cells, resting upon a delicate basement membrane, beneath which are two layers of circular and longitudinal muscular fibres.

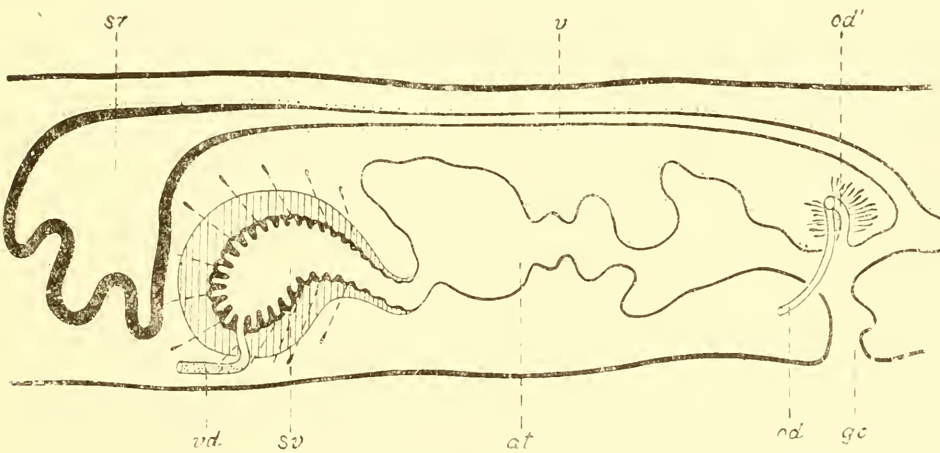
The small follicular testes lie in abündance mostly dorsal to the end of the lateral gut branches and are arranged in two lateral longitudinal zones running along the lateral margin of the body, from behind the ovaries colse to the posterior end of the body. Each testis is, as usual, made up of sperm-mother-cells and spermatozoa in several stages of development.

The vasa deferentia, which proceed backwards inside the longitudinal nerve cords, open into the lumen of the penis separately and without making a turn forwards. The vas deferens is full of spermatozoa.

The penis is entirely destitute of any sort of intromittent part and is represented by an elongate sack-like organ of muscular nature, which opens behind into the anterior part of the atrium on the floor. The wall is thrown into many folds, projecting into its lumen, much as in *Bd. annandalei.* In the parenchyma around the penis there exist numerous eosinophil penis-glands, the ducts of which open into the cavity.

The paired ovary occupies a ventral position behind the first (or second?) pair of the gut branches. It is nearly ovoid in shape and is composed of egg-cells in several stages of development.

The vitelline glands are represented by branched cords of cells arranged in single or double rows. They are widely distributed in the interspaces between the gut branches and connected with the oviduct at numerous points. The mode of connexion has not been brought under observation.



Text fig. 4. Sagittal section of genital organs of *Bd. brunnea*, diagrammatically shown. Index letters as in text fig. 2.

From the postero-lateral aspect of the ovary the oviduct arises as a funnel-like widening, which soon takes the character of a narrow duct, pursuing a backward course just along the outer side of the longitudinal nerve cord. In front of the genital aperture it nears the median line, rising slightly upwards at the same time, and unites with its fellow of the opposite side into a short unpaired duct before opening into the posterior part of the genital atrium behind the annular space from above. The oviduct shows a distinct lumen in its whole length. As in *Bd. annandalei*, its direct wall is of an homogeneous and ciliated epithelium which shows no nuclei. The nucleus containing parts of the epithelium are placed at the outer side of the muscular layers, which come directly beneath the layer mentioned.

The seminal receptacle is a large sack-like organ, lying between the penis and the pharyngeal chamber. Its wall is, as usual, an epithelium made up of columnar cells of a glandular nature, resting on a basement membrane, outside which are thin muscular layers.

At the postero-superior aspect the receptacle gives rise to the slender vaginal canal, which, after traversing behind close under the dorsal body wall, takes a downward course and bends forwards at the end to join the atrium from behind. Internally the canal is lined with a single epithelium, external to which are found circular and longitudinal muscular layers.

Planaria gonocephala Dugès

(Pl. I, figs. 3–6.–Text fig. 5.)

Synonymy. *Planaria gonocephala*, Dugès (22).
Dugesia gonocephaloides, Girard (30).
Planaria gonocephaloides, Stimpson (75).

This species, which is well known from Europe and North America, is also the commonest and the most widely distributed freshwater planarian in Japanese territories. It is usually found beneath stones and other sunken objects in running and standing waters in various regions.

Form and Dimension.—The head in the living state is, as usual, of a triangular shape with a prominent lappet on either side, the sides forming in front a somewhat rounded median angle of approximately 60°. The body is broadest at the cephalic lappets. There thus exists behind the head a somewhat neck-like narrowing. The trunk is elongate, slender, with lateral margins even and nearly parallel for a large part of the length, but in the hind parts gradually tapering to a bluntly pointed posterior extremity. The worms commonly measure 20–33 mm. long by 2·5–4 mm. broad in the pharyngeal region, the ratio of the breadth and length being 1:7–10.

Colouration.—As is shown in figs. 3–6, the ground colour of the body is subject to considerable variation according to both age and individuals. In the dorsal view, full-grown individuals are generally of an olive-like brown colour, sometimes, but not always, with dark longitudinal bands running on either side of the median line from behind the eyes to the posterior parts of the body. Some of the younger individuals are paler and the greater part of the body may present various sorts of hues—not infrequently reddish, brownish, yellowish or greenish—according to varying colourations of the guts. The ventral surface is of a much paler colour than the dorsal.

Eyes.—The two crescentic eyes, each situated at the inner edge of an oval colourless area, exist slightly in front of the line connecting the apices of the cephalic lappets; the distance between them is slightly less than that between either of the eyes and the lateral head-margin of the same side. Besides the usual pair, one or two adventitious eyes may sometimes be seen. The eye consists of a pigment cup and numerous retina cones, as it does in the same species described by HESSE (36), UDE (79) and others.

Auricular sense organs are, as usual, present on each side, as a very distinct, slenderly reniform, non-pigmented area on the cephalic lappet.

Body Wall.—The ciliated epidermis, thickest on the dorsal surface, becomes thinner as it passes round to the ventral. Lying between the epidermic cells are found numerous rhabdites which take place in their mother-cells embedded in the parenchyma. The basement membrane is an homogeneous layer immediately beneath the epidermis, the cells of which are directly connected with it. The underlying dermal musculature consists, as usual, of three layers of circular, transverse and longitudinal muscular fibres. The longitudinal muscles form a thick band just inside the transverse layer, and are much thicker on the ventral side than on the dorsal. Besides, there is found a system of parenchyma-muscle, composed of dorso-ventral fibres. Embedded in the parenchyma are numerous glandular cells which make their way to the exterior chiefly submarginally on the ventral surface.

Digestive System.—The mouth-opening is situated at a point somewhat behind the middle of the body or at about the commencement of the posterior third of the body. The pharynx, which is cylindrical in shape, is inserted a short distance in front of the middle of the body; its length is nearly equal to one-fifth the length of the body.

The unpaired anterior main trunk of the intestine extends to a point in front of the brain and gives rise to 8–12 pairs of lateral branches, which are numerously subdivided before reaching the margin of the body; while the posterior trunks are each provided with 13–18 outer branches and about as many, but much shorter, inner branches. In place of the two posterior trunks, which exist in the ordinary Triclad-type, there are often two parallel trunks on each side of the pharyngeal chamber. The accessory trunks either take their origin at the root of the pharynx, like the two normal posterior trunks, or exist as parallel branches of the latter.

Excretory System.—The exact arrangement of the excretory system could not be ascertained, it seemed to be in accordance with that previously described by Ude (79). Dorsally and ventrally there exist two main vessels on each side of the body, which extend almost throughout the whole body-length and are connected with one another by means of anastomosis. The main vessels give off at several points numerous ducts which open between the epidermic cells.

Nervous Sytem.—The nervous sytem of this species shows no noteworthy variation from that observed by Ude in detail. Each longitudinal nerve trunk passes forward over a well-developed brain mass, those of both sides being connected by a number of commissures. Of all the commissures the foremost is the best developed and traversed by three sets of transverse fibres. From each brain-mass arise five forwardly directed sensory nerves, excluding the optic nerve, as well as some lateral nerves. Posteriorly the longitudinal trunks proceed, running nearly parallel to each other, to the very tail, and are connected by transverse commissures. Lateral nerves are sent out from the trunks usually at points opposite to the union of the latter with transverse commissures.

Genital Organs.—The common genital aperture exists slightly in front of the middle of the posterior third of the body. It leads directly into the simple penis-sheath, much as in *Pl. polychroa.*

Numerous follicular testes are placed close together in the dorsal parts of the body, arranged in two longitudinal lateral zones which extend from behind the ovaries to nearly the posterior end of the body.

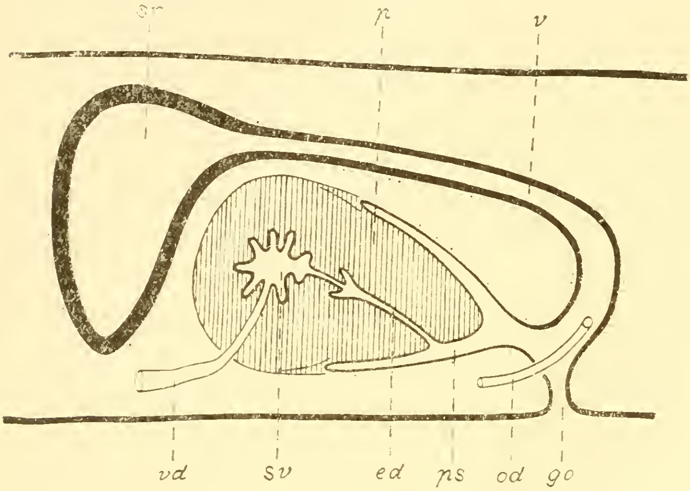
The vasa deferentia, filled with spermatozoa, are distinctly discernible in the pharyngeal region. After running backwards just along the inner side of the longitudinal nerve cords on the ventral side, they rise obliquely upwards to open separately into the lumen of the penis, at the lateral sides of the bulbous part.

The penis consists of two parts, viz., the free, conical and massive intromittent part lying nearly horizontal in the penis-sheath, and the semispherical bulbous part of strongly muscular nature. The latter part encloses a moderately wide and more or less folded cavity, the seminal vesicle; posteriorly this is continuous with the slender ejaculatory duct, which opens into the penis-sheath on the under side of the penis, not at the tip. In its course, the ejaculatory duct shows an oblique, anteriorly directed annular outbulging, as in *Pl. burmaensis* Kab; it consequently brings about a small, conical posteriorly directed process which is surrounded by the said outbulging, and which is axially traversed by the narrow anterior section of the ejacultory duct.

The paired ovary occupies a ventral position between the second and third lateral branches of the anterior trunk of the intestine. It is a spherical mass of egg-cells in several stages of development and is enveloped by the tunica propria.

The vitelline glands are represented by cellular cords with cells arranged in two or more rows; they are very extensively distributed posteriorly from the region of the ovaries and in the interspaces between the gut diverticulae, and stand at many points in connexion with the oviduct by means of a spherical or pyriform giant cell.

The oviduct of each side springs from the lateral aspect of the ovary as an ampullaceous passage, which is filled with spermatozoa. This soon takes the character of a narrow tube, which proceeds straight backwards just along the outer side of the nerver cord. In the region of the genital aperture it nears the median line, to open into the outer end of the rather wide vaginal canal, without uniting with its fellow of the opposite side into a common duct. Its direct wall is made up of an homogeneous layer without nuclei, much as in both the preceding species. Immediately outside this layer come two layers of internal circular and external longitudinal muscular fibres. An inversion in the relative position of these two muscular layers occurs in the terminal parts of the oviduct, as described by STOPPENBRINK (76). External to the muscular layers there exists a cellular coating which probably represents the sunken parts of the lining epithelium.



Text. fig. 5. Diagram of copulatory organs of *Planaria gonocephala* Dugès in sagittal section.
ed ejaculatory duct, *p* penis, *ps* penis-sheath.
Other letters as in text fig. 2.

As already indicated, the oviduct receives the vitelline glands at several points of its course. The mode of connexion is quite similar to that found in *Pl. polychroa*, *Pl. burmaensis*, *Dendrocoelum lacteum* and others. It is effected by means of a spherical giant cell, which usually contains an internal space filled with spermatozoa and probably communicating with the lumen of the oviduct. The cytoplasm of the cell is finely granular and exhibits but little affinity for haematoxylin; the nucleus is far larger than that of surrounding tissue. In sections the cellular cords of the vitelline gland are seen to be attached to the surface of the giant cell, but exactly how the yolk cells reach the oviduct lumen cannot be elucidated. As pointed out by previous authors, the giant cell in question is probably of a glandular nature. It may be that its secretion disperses into the parenchyma and acts as an attractive agent, which may cause the yolk cells to collect at its position. Eventually the cell breaks up and disappears, and then the yolk cells may be said to be in a position to make their way unhindered into the oviduct.

The seminal receptacle is a moderately large sack-like organ situated in front of the penis. Its wall is an epithelium made up of large columnar cells of a glandular nature, beneath which are fine muscular layers of circular and longitudinal fibres.

The receptacle gives rise behind to the vaginal canal, which runs dorsal to the penis, finally opening into the penis-sheath from above and behind. The lining epithelium is made up of cylindrical cells, beneath which is a thick muscular coating composed of an internal circular and an external longitudinal layer. Besides, the vagina is surrounded by a large number of pyriform cells, which appear to represent the unicellular glands.

Planaria papillifera IJ. et KAB.

(Pl. I., figs. 7,8.—Text figs. 6,7.)

This species was first procured by Professor SHISHIDO in November, 1889, in an old unused well in Tokyo (Ichigaya Ward). Subsequently, on several occasions, specimens were obtained by him and given to the late Professor IJIMA. In May, 1890, a number of cocoons apparently belonging to the species were collected in the same well. According to the late Professor IJIMA's note, they contained embryos of about 2 mm. in length.

Form and Dimension.—The frontal margin of the body in the living state is subtruncate and weakly crenate. The gentle median convexity spreads on each side into rounded lateral lobes which are not produced into tentacles. The head gradually merges into the trunk, from which it is indistinctly separated by a slight neck-like narrowing. The trunk is slender, almost uniformly broad down to about the region of the copulatory organs, and gradually tapers to a rounded hind end. The most striking feature is the presence of a linear series of small, low and truncate papillae in the mid-dorsal line, the papillae numbering 20-25 in all. The series of the papillae commences sometimes in front of, and at other times behind, the eyes. Largest specimens measured 7–8 mm. long by 1–1·5 mm. broad, the ratio of the breadth to the length being 1:6–7.

Colouration.—The general colour of the dorsal surface in the larger specimens is somewhat grayish, due to scanty development of pigments, leaving the lighter median zone, in which the dorsal papillae again frequently appear as blackish spots. Younger and smaller indvidiuals are quite or nearly colourless.

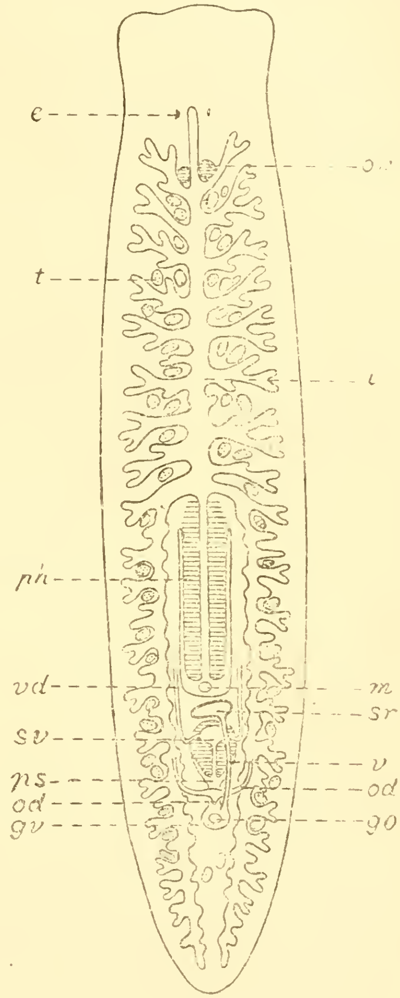
Eyes,—The two eyes, each surrounded by a colourless area, are situated in the region of the neck-like portion; the distance between them is less than that between either of the eyes and the lateral neck-margin, and very much less than that between them and frontal margin.

Body Wall. — The epidermis is somewhat thicker on the dorsal surface than on the ventral. It contains minute rhabdites which occur in greater abundance dorsally than ventrally. Especially the rhabdites are found crowded in the part of the little process or papilla. The epidermis rests, as usual, on a fine basement membrane, beneath which come two layers of circular and longitudinal muscular fibres. The muscles are relatively weakly developed. Below the dermal musculature, in the parenchyma, there occur in wide and scattered distribution such rhabdites as are still contained in their mother-cells. In the tissue of the papilla they are found in great abundance. Besides, embedded in the parenchyma there exist numerous glands, which open out submarginally on the ventral surface as well as at various points of the entire surface of the body.

Digestive System.—The mouth-opening lies at a position between the middle and the posterior thirds of the body. The pharynx, cylindrical in shape, is inserted at about the middle of the body-length. The anterior main gut trunk is provided with 8–9 pairs of lateral branches, while the posterior trunks each send out 14–17 external branches and about as many very small internal branches.

Of the excretory canals I have been able to obtain no more insight than a few loops at some points in the dorso-lateral parts of the body.

Nervous System. — The brain is a bilobed organ, each half of which, besides the optic nerve, gives rise to five forwardly directed sensory nerves, breaking up into branches, and some lateral nerves. Posteriorly each brain-mass is continuous with one of the longitudinal nerve cords which extend, pursuing a parallel course, to the hind end of the body, and are connected by numerous transverse commissures. The cord of either side is also connected with the marginal nerve of the same side by means of a series of lateral nerves given off usually from the cord at points opposite to the union of the latter with transverse commissures.



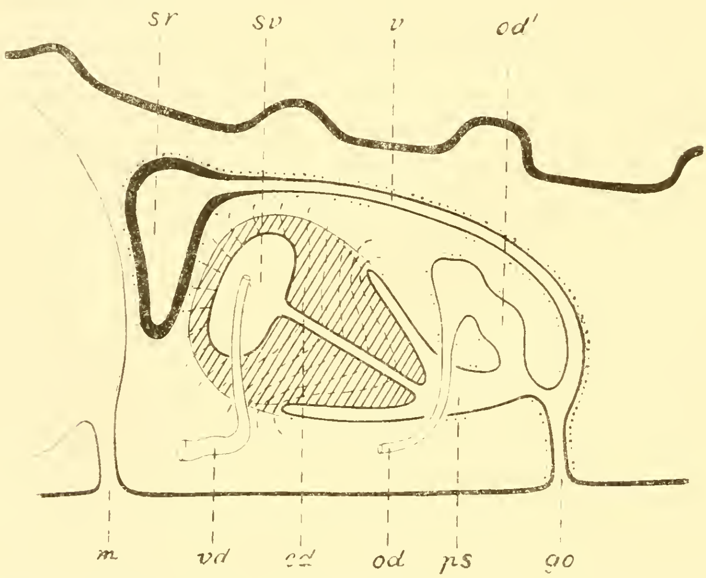
Text fig. 6. Diagrammatic representation of the organization of *Planaria papillifera* IJ. et KAB., as seen from the dorsal side.

e eye, *gr* genital vestibulm, *i* intestine, *m* mouth-opening, *ov* ovary, *ph* pharynx, *t* testis.

Other letters as in text figs. 2 and 5.

Genital Organs. — The common genital aperture is situated at about the middle of the posterior third of the body. It leads into the small vestibulum, which receives the opening of the penis-sheath from the front. The direct wall of the atrium is an epithelium made up of cuboidal cells, beneath which is, as usual, a muscular coating composed of circular and longitudinal fibres.

The testes, which are of an irregular form, occur in abundance mostly in ventral, but some in dorsal, parts of the body, arranged on both sides of the anterior gut trunk and also outside or inside the posterior gut trunks.



Text fig. 7. Diagram of sexual organs of *Pl. papillifera* in sagittal section. Index letters as in text figs. 2, 5 and 6.

The vasa deferentia, after pursuing a sinuous course backwards along the inner side of the longitudinal nerve cords, bend abruptly inwards at the region of the penis, rising upwards at the same time, finally to open into the seminal vesicle separately on the sides of the penis.

The penis consists, as usual, of the semispherical bulb and the conical intromittent part which is almost horizontally disposed in the penis-sheath. The former contains a very wide, smooth-walled lumen, the seminal vesicle, which posteriorly gives rise to the slender ejaculatory duct, opening at the apex of the penis.

The paired ovary occupies a ventral position in front of the first pair of the gut branches. It is of small size and is composed of ova in several stages of development. In front of the ovary there exists a large and lobed cellular mass which may be designated under the name of the paraovary.

The vitelline glands are branching cords of cells which are arranged in two or more rows, and are extensively distributed posteriorly from the ovarian region and in the interstices between the gut diverticulae. The mode of the connexion between them and the oviduct has not come under observation.

The oviduct, which arises from the ovary in the form of a funnel-like passage, soon assumes the character of a narrow tube running backwards just along the outer side of the nerve cord. Slightly in front of the genital aperture the oviduct takes an inward and upward course to unite with its fellow of the opposite side into a wide single duct which opens into an elongate atrial passage between the penis-sheath and the vestibulum on the dorsal side.

Planaria virida IJ. et KAB.

(Pl. I., figs. 9–11.–Text figs. 8, 9.)

This species is widely distributed throughout the mainland of the Empire and commonly found in cool running waters in the hilly districts.

Form and Dimension.—In shape the species closely resembles *Pl. alpina* DANA. The frontal margin of the body in the living condition is subtruncate and gently arched in the middle parts, which laterally pass into the frontal margin of the moderately long, obtusely pointed tentacles. The head is very flat, without being marked off from the trunk by any neck-like narrowing of the body. The trunk is slender, only weakly convex above and almost uniformly broad for the greater part of its length, in the hind parts tapering to an obtusely pointed, or sometimes rounded, extremity. Large specimens may reach 22 mm. in length and 4 mm. in breadth at the pharyngeal region, the ratio of the breath to the length being 1: 8–10. The worms, however, are usually smaller.

Colouration. —The colour of the dorsal surface is usually blackish or dark olive-like brown, especially dark in the median parts. Small individuals, in which the pigments are not greatly developed, may reveal the guts more or less distinctly in various colours. The ventral surface is of a much paler colour than the dorsal.

Eyes.—The two eyes, each lying in a half-moon-shaped colourless spot, are of a crescentic form. The distance between them is equal to about one-fourth their distance from the frontal margin, and somewhat less than the distance of either eye from the lateral margin of the same side.

The eye consists of a pigment cup and some visual cells. The pigment cup is of an ovoidal shape with its opening at the side and is, as usual, formed of very minute closely packed granules, of a dark brown colour. Enclosed in the cup are visual cells which are three in number. Each cell presents a fibrillous structure and contains a large nucleus in the proximal part.

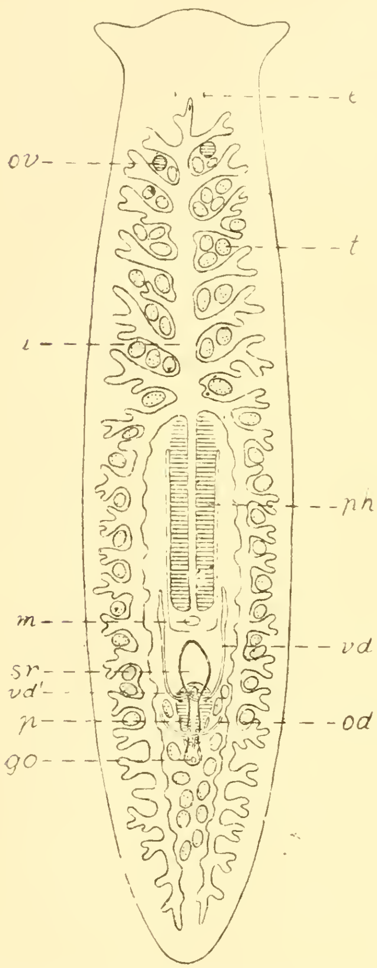
Body Wall.—The epidermis, resting upon a fine basement membrane, is not of the same thickness all over the body, being very much thicker on the dorsal than on the ventral surface, and being richly ciliated on the ventral surface. Numerous rhabdites are found in the epidermis, which is perforated by the ducts of rhabdite-forming cells scattered in sparse numbers in the parenchyma. The epidermic cells, each of a columnar shape, contain an oval or rounded nucleus near the base, the protoplasm being characterised by fine striations which are most prominent at the basal parts of the cells. The dermal musculature consists of three layers of circular, transverse and longitudinal muscular fibres. The circular fibres lie immediately beneath the basement membrane, and form but a very thin layer. The thick longitudinal layer is composed of a series of muscular bands, being rather more strongly developed on the ventral than on the dorsal surface, doubtless in ralation to the movements. In the parenchyma there exist numerous glandular cells, which open out submarginally on the ventral surface as well as at various points of the entire surface of the body. A large accumulation of cells exists at both ends of the body, the deep ends of the anterior being located behind the brain.

Digestive System.—The mouth-opening is situated at about the commencement of the posterior third of the body. The pharynx, which is inserted a short distance in front of the middle of the body, is a cylindrical tube, terminating conically at the free end. The anterior gut trunk gives rise to 4–6 pairs of lateral branches, while the posterior trunk is usually provided with 12–14 lateral branches and about as many inwardly directed very short branches.

Of the excretory canals I could not obtain from any of the sections available more insight than a few loops, which lie in dorso-lateral parts of the body and open out at some points on the dorsal surface.

Nervous System.—The brain conforms to the type observed by MICOLETZKY (53) in *Pl. alpina.* The longitudinal nerve cord of each side forms anteriorly a well-developed brain-mass, those of the two sides being connected by a strong commissure in which there can be distinguished three sets of transverse fibres. From each brain-mass spring some sensory nerves directed forwardly and laterally. The first and second nerves, taking their origin at the anterior corner of the brain-mass, proceed forwards to join the marginal nerve. The third nerve breaks up into branches whilst proceeding towards the body-margin and extends to the tentacular region, associated with the remainder, From the inner lateral region of the "Substanzinsel" arises a nerve extending to the eye. Immediately below the first nerve is a very fine anterior trunk which is connected with its fellow of the opposite side by some transverse commissures. The posterior longitudinal trunks proceed, running parallel to each other, to the hind end of the body and are connected together by about 45 transverse commissures. At points opposite to the union of the said commissures the trunks give off lateral nerves towards the marginal nerves.

Genital Organs.—The common genital aperture lies behind the mouth-opening at a distance equal to about one-third that between the mouth-opening and the posterior end of the body. The opening directly leads into the vestibulum which anteriorly communicates with the penis-sheath.

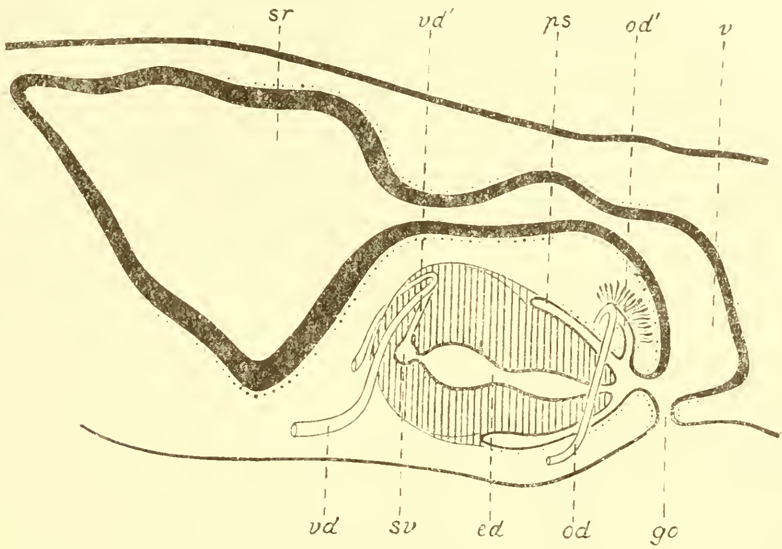


Text fig. 8. Diagrammatic representation of the organization of *Planaria vivida* Ij. et Kab., as seen from the dorsal side.
vd' common vas deferens.
Other letters as in text figs. 2, 5 and 6.

The small testes occur in the ventral parts of the body, averaging about 60 in total number. Sometimes they begin to exist in front of the ovaries. More usually they are found close behind these and occur backwards on both sides of the anterior gut trunk, but laterally to the posterior gut trunks, down to the level of the genital opening, and behind this point between the gut trunks.

The fine testicular canal arising from the testes cannot clearly be made out. The vasa deferentia, swollen at the posterior one-fourth of the pharynx, proceed backwards along the inner side of the longitudinal nerve cords and unite into a short common duct in the antero-superior part of the penis-bulb before opening into the small seminal vesicle. The vas deferens, which is filled with spermatozoa, is lined with a thin epithelium, outside which in the neighbourhood of the penis a layer of muscular fibres occurs tangled to a certain extent.

The penis is composed of the semispherical bulb of muscular nature and the conical and massive intromittent part which is horizontally disposed in the penis-sheath. The seminal vesicle is of small size and soon communicates through a very short slender duct with a relatively wide and smooth-walled lumen, which posteriorly narrows slightly into the ejaculatory duct. Embedded in the parenchyma around the penis-bulb are the eosinophil penis-glands, which open into the lumen of the penis.



Text fig. 9. Sagittal section of genital organs of *Pl. virida*, diagrammatically shown. Index letters as in text figs. 2,4,6 and 8.

As was noted in my previous paper (43), it is an interesting fact that a spermatophore, apparently completely formed and ready for ejection by the penis, was found lodged in the terminal swelling of the common vas deferens or the seminal vesicle, completely filling it up and to a degree distending the same. It is of a nearly pyriform shape, bent at the pointed end and measuring 216 μ by 133 μ. The body is so oriented that its pointed end is directed towards, and projects somewhat into, the distal end of the common vas deferens. The capsule is 0·5–3 μ thick, being thickest towards the pointed end. Its substance is not homogeneous but exhibits a porous structure when seen under the high power. Microchemically it shows special affinity for eosin, quite agreeing in this respect with the secretion of the penis-gland.

The spermatophore has hitherto been known from several species of the Triclads, always contained in the cavity of the seminal receptacle or the so-called uterus. Much discussion has arisen as to its formation. MAX SCHULTZE (65) found in the receptacle of *Pl. torva* one or two spermatophores or empty spermatophore capsules, which are of a retort shape and of a brown chitinous nature, and placed on record a view that the spermatophore after being prepared in the penis-lumen, is introduced, by the act of copulation, from one individual into the receptacle of another. Von KENNEL (45), harbouring some suspicion, of this view, commented as follows: "Zur Bildung eines Spermatophores müsste aber dass als männliches individuum bei der Begattung fungirende Thier ein besonderes Organ besitzen, und zwar müsste die Höhlung des Penis, der zweifellos das Sperma überführt, dazu eingerichtet sein, was jedoch nicht der Fall ist." He is inclined to consider that the receptacle secretion enclosing spermatozoa assumes an aspect of spermatophore owing to conservation; while WOODWORTH (100), though having no observation, was of the opinion that the spermatophore is formed beyond boubt within the lumen of the penis. BERGENDAHL (4,5) judging from his observation of the features of the spermatophore capsule in the receptacle of *Pl. torva*, expounded the same view as MAX SCHULTZE.

Subsequently, MICOLETZKEY (53) put forward a view that differs considerably from that of the preceding. He found in some haematoxylin-eosin preparations of *Pl. gonocephala* that the receptacle secretion in immediate contact with the spermatophore capsule stained red—i.e., was eosinophil,—though in more remote parts it was cyanophil, the red and blue grading over each other in the intermediate parts, and was of the opinion that the secretion changes from cyanophil into eosinophil during the process of the capsule formation in that organ.

Later, WEISS (92), after describing the occurrence of some specious spermatophores and canals in the so-called uterus of *Pl. striata* and pointing out that the substance of the canalar wall is very similar in nature to the eosinophil penis secretion found at the tip of the penis in the genital atrium, noted down as follows: "Dass sich bei der Copulation eine (oder einige?) aus dem Secret der Penisdrüsen gebildete, an beiden Enden offene und trichterartig erweiterte Röhre formt, und durch den Uterusgang bis in den Uterus geschoben wird; durch die Röhre wird alsdann das Sperma, das ihr wie ein Beutel anhängt, ebenfalls in den Uterus geleitet worden sein. Durch Kontraktionen der Uterusgangmuskulatur könnte dann, wie ich mir denke, die Röhre selbst in den Uterus getrieben werden, und dementsprechend halte ich jenes Stück der Spermatophore, das mit der Spermakugel in Zusammenhang steht, für das eine, das der Uteruswand angelagerte, etwas anders gestelltete für das andere Ende der wahrscheinlich sehr langen Spermatophore. Die Membran, welche die ganze Spermakugel umschliesst, zeigt nur in jener Partie, die der Röhre zunächst gelegen ist, einen deutlich roten, an den übrigen Stellen aber einen mehr blauen Farbton, und er erscheint mir daher nicht unmöglich, dass dieselbe ein Produkt der cyanophilen Penisdrüsen ist."

Thus, most of the writers named above assumed the formation of the spermatophore in the penis, ascribing the source of the capsule to the penis-glands, as mentioned by LANG (48) in a Polyclad (*Cryptocelis albus*) and by LUTHER (51) and others in some Rhabdocoeles. The discovery of the completely formed spermatophore found lodged in the penis-lumen of one of *Pl. vivida* apparently favours the view that its formation takes place in the penis-lumen, and not in the seminal receptacle. The spermatophore capsule contained either in the penis-lumen or in the receptacle stains deeply with eosin, quite agreeing in this respect with the eosinophil secretion of the penis-glands, which are found abundantly in the parenchyma round the penis-bulb and more sparsely in the wall of the penis itself, and differing from the cyanophil secretion of the receptacle. The spermatozoa, after leaving the testes by the testicular canals, finally pass into the seminal vesicle, which become distended as it receives the spermatozoa. Here the spermatozoa remain stored until enveloped by the spermatophore capsule, the substance of which, in my opinion, appears to originate from the eosinophil secretion of the penis-glands.

Further, it is important to note that the spermatophores occurring either singly or two together at a time in the receptacle are of a shape and size well agreeing with the one described from the seminal vesicle, so far as my observations go. The pyriform shape of the spermatophore of *Pl. vivida* apparently stands in the relation with the shape of the space of its origin, the seminal vesicle, and the adjoining parts of the common vas deferens. In this connexion I may mention that in both *Pl. burmaensis* and *Pl. annandalei* Kab. the spermatophores I have found in the receptacle were also of a shape corresponding to that of the part of the penis-lumen known as the seminal vesicle, as already noted. In the former species the shape was elongate-ovoid, and in the latter tubular.

The eosinophil nature of the substance of the spermatophore capsule decidedly differentiates it from the cyanophil secretion of the glandular cells discharging into the seminal receptacle. As already described, Micoletzky based his observation on the staining property of the receptacle fluid enclosing a spermatophore, using haematoxylin-eosin for the stain, and assumed that the receptacle secretion changes from cyanophil into eosinophil during the process of the capsule formation in that organ. I have obtained a similar result with *Pl. vivida* under the same circumstances of condition and treatment; however, I am inclined to interpret the differential staining as due to the receptacle fluid being in the process of dissolving up the substance of the spermatophore capsule.

The paired ovary is situated ventrally between the first and second branches of the anterior gut trunk. It is of an ovoid shape, the major axis being parallel to that of the worm-body. The ovary is, as usual, made up of ova in several stages of development, surrounded by the tunica propria. No trace of the pigmented tissue could be observed around the ovary.

The vitelline glands are represented by cellular cords with cells arranged in two or more rows. They are very extensively distributed from the ovarian region nearly to the end of the body, filling up the interspaces between the gut diverticulae. They connect with the oviduct at numerous points. The cells of the vitelline glands are comparatively large and of an irregular contour, due to mutual compression. They are found to contain numerous strongly refractive granules.

The oviduct of each side starts from the postero-lateral aspect of the ovary as a funnel-like widening, which is lined with a single layer of columnar cells as has deen shown by MATTIESEN (52) to be the case in *Dendr. lacteum*. This soon assumes the character of a narrow duct which proceeds backwards just along the outer side of the longitudinal nerve cord. In the region of the penis it nears the median line, slightly rising upwards at the same time, and finally unites with its mate of the opposite side into a common duct before opening into the atrium between the penis-sheath and the vestibulum from above. The oviduct exhibits a distinct lumen throughout its entire length, and is found filled up with spermatozoa. As in *Bd. annandalei*, *Bd. brunnea* and *Pl. gonocephala*, its direct wall is an homogeneous and ciliated layer showing no nuclei at all. The nucleus-containing parts are sunk into the surrounding parenchyma beneath the two layers of internal circular and external longitudinal muscular fibres which come directly external to the layer mentioned above. The single duct is supplied with numerous unicellular glands.

The seminal receptacle is a very large sack-like organ which is of an irregular shape and is placed in front of the penis. In structural respects its wall presents no novel feature, and it is an epitheleum made up of large columnar cells of a glandular nature, outside which is a thin muscular layer. In some specimens I have examined, the organ seems to have been in secretory activity, the cells being vacuolated. On some occasions the organ is found to contain one or two well-formed and empty spermatophores of a pyriform shape, enveloped in a coagulum of the secretion.

The receptacle gives rise behind to the wide vagina, which proceeds backwards dorsal to the penis and dips down to open into the vestibulum. In the middle of its course the duct is gently constricted, as is seen in text fig. 9. The lining epithelium is made up of cells of an elongate-pyriform shape, resting on a basement membrane, directly external to which are two layers of internal circular and external longitudinal muscular fibres. Embedded in the parenchyma around the vagina are numerous glands which open into its lumen.

As to the function of the organ usually called the uterus much discussion has arisen up to the present. By some authorities (HALLEZ (34), CHICHKOFF (17), etc.), who observed spermatozoa, egg-cells and yolk-cells contained in the cavity of the organ, it was alleged that the union of the sexual elements takes place in its lumen; while some authorities (IJIMA (38), MATTIESEN (52), etc.) assumed the formation of the cocoon in its cavity, ascribing the source of the capsule to the glandular wall; and the remainder (von KENNEL, BURR (16), WILHELMI (96), etc.) regarded the organ as representing a seminal receptacle. Of the above views the last is now generally accepted. As mentioned above, in some cases the organ contains spermatozoa enveloped in a coagulum of the secretion, while in other cases it contains a well-formed spermatophore, or rather the capsule of an empty spermatophore. In my opinion, they had been introduced by the act of copulation from another individual, as has been mentioned by some previous writers. Thereby I am also of the same view as first expounded by von KENNEL, but I believe that the organ in question is to be shown as the main or primary seminal receptacle. It has perhaps no function in connexion with the fecundation nor with the formation of the cocoon. It may be that the secretion of the uterine wall acts not only as nutrient medium for prolonging the activity of the male element, but also as the agent of dissolving up the substance of the spermatophore capsule, as already mentioned.

As regards the spermatozoa contained in the ampullaceous passage of the oviduct, the tuba, which is in contact with the ovary, I have met with such on several occasions in the species examined by me. How the spermatozoa reach the lumen of the tuba cannot be exactly elucidated. It may be, as stated by BURR, that the spermatozoa transferred by copulation into the so-called uterus, after leaving it, make their way into the oviduct being enticed by a certain chemotactic irritation. As mentioned by

Stoppenbrink, Micoletzky, Burr and others, the tuba of the oviduct appears to have function in connexion with the seminal receptacle, though Burr expounds that "Den Tricladen fehlt eben dann das, was man bei anderen Würmern Receptaculum seminis nennt." To this I am inclined to apply the name accessory or secondary seminal receptacle, in which the union of the sexual elements takes place.

The occurrence of the egg- and yolk-cells together with the spermatozoa in the cavity of the so-called uterus has been placed on record by some previous authorities, who mostly assumed the formation of the cocoon in that organ, ascribing the source of the capsule to its glandular wall. According to some investigators, however, the formation of the cocoon certainly takes place in the genital atrium. As stated by Burr, the cocoon capsule seems to be composed of minute granules, originating from the yolk-cells, as well as of the fluid ground substance, coming from the erythrophil shell-glands. With regard to the formation of the cocoon however, I have no observation to put forward. Upon the entrance of such elements as the spermatozoa, egg- and yolk-cells into the organ Oscar Schmidt (64) assumed that the opening of the oviduct comes into direct communication with the stalk of the uterus, and then the elements appear to finally make their way to the organ by means of the peristaltic movement. Von Kennel was of the opinion that these may enter the uterus, owing to the remarkable contraction which frequently occurs in the region of the genital apparatus during preservation; while Burr said "dass ein normaler Aufenthalt der Eier und Dotterzellen in Uterus überhaupt nicht erklärt werden könnte." To my mind, however, the elements seem to reach the lumen of the uterus, due to the contraction of the worm-body during preservation.

Planaria pellucida Ij. et Kab.

This species occurs beneath stones and fallen leaves in a cold running stream in the wooded hills to the east of Toyohara (Vladimirofka), Saghalin. Some specimens were procured by the late Professor Ijima in June, 1906, together with *Poly. karafto* described later on in the present paper.

Form and Dimension.—In the living state the shape of the body is very similar to that of the preceding. The frontal margin is subtruncate and weakly crenate. The rounded auricular lobes are scarcely prolonged into the tentacles, being anyway shorter than in *Pl. vivida.* Large specimens measured 10 mm. long by 1·5 mm. across in the broadest part.

Colouration.—The translucent body is always colourless, without any trace of pigment. The digestive tracts show themselves in a milky white or somewhat yellowish or a dark colour.

Eyes.—The two crescentic eyes are situated fairly distant behind the frontal margin; the distance between them is shorter than that of either eye from the lateral body-margin of the same side.

Digestive System.—The mouth-opening is situated at about the hind end of the middle third of the body. The pharynx, which is about one-fifth the entire length of the body, is inserted at the middle of the body. The anterior main trunk of the intestine gives off 10–11 pairs of lateral subdivided branches, while the posterior trunks are each provided with about 20 lateral branches.

The genital organs unfortunately were not yet developed in the specimens examined.

Sorocelis sapporo Ij. et Kab.

(Pl. 1., fig. 12.—Text figs. 10, 11.)

This species, which indicates some alliances with the forms recorded from Lake Baikal and Tibet, is common in the clear brook flowing through the grounds of Sapporo Agricultural College in Hokkaido. Numerous specimens were collected by the late Professor Ijima in October, 1913.

Form and Dimension.—The frontal margin is subtruncate and gently arched in the median parts, which spread on each side into the moderately distinct tentacles rounded at the end. The head merges into the trunk, from which it is indistinctly separated by a slight neck-like narrowing. The trunk is slender and for the most part of a nearly uniform breadth, though it tapers behind to a bluntly pointed end. The worm sometimes reaches 17 mm. in lenght and 2 mm. in breadth at the pharyngeal region, but is generally smaller, the breadth and length being in the proportion of 1 to 6–8.

Colouration.—The greater part of the body may present various hues—not infrequently light salmon, light brownish, dark or reddish varying from pink to blood-red or chestnut-red according to varying colouration of the intestine. The head and the body-margin are nearly colourless and translucent. The pharynx and genital organs mày be discerned on the dorsal side in a white colour.

Eyes.—The extremely small eye-spots occur in abundance, increasing in number with the growth of the body, but never quite reaching 100 in total number. They are distributed in two longitudinal zones which converge and meet in front and thus form a horse-shoe-shaped tract, situated a considerable distance apart from the head-margin both anteriorly and laterally. Posteriorly the tract extends to about the third pair of the gut branches of the anterior trunk.

The eye consists simply of a small pigmented cup, partly filled with a peculiar cellular substance, whose true nature could not be ascertained from any of the sections.

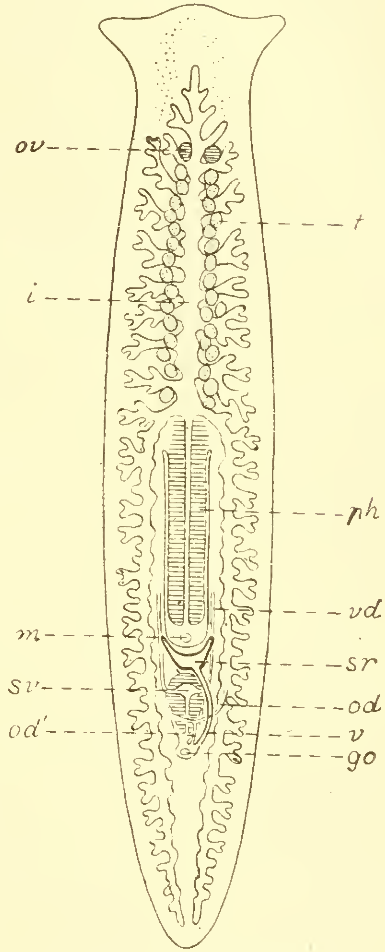
Body Wall.—The epidermis is not of the same thickness all over the body, being much thicker on the dorsal than on the ventral side. As is well known, it is made up of closely packed ciliated columnar or cuboidal cells resting upon a fine basement membrane, each with an oval nucleus at its base. The protoplasm of the cells is generally fibrillated, the course of the fibrillae being in a general way perpendicular to the surface. In the anterior region the epidermis comprises some 12 special sensory cells, which are situated between the general cells and provided with well-developed cilia. The sensory cell is of a spherical or ovoidal shape and is sunk into the surrounding tissue. Where the cilia are inserted in the cell, there exists a deeply staining, finely granular matter which is made up of the fusion of three or more ovoidal bodies. The cell contains a nucleus near the base, the protoplasm being characterized by fine striations. At its base the cell receives the supply of nerve fibres. In the epidermis itself the rhabdites are found in large numbers wedged in between the component cells. They are best developed on the dorsal surface and well on the lateral surfaces, but on the ventral surface they become much fewer in number and smaller in size. Scattered about in the parenchyma just beneath the dermal musculature occur the rhabdites enclosed in their parent cells, which on some occasions are found to continue their way to the surface. In the parenchyma there are numerous glandular cells, which, as is well known, open out submarginally on the ventral surface as well as at various points all over the surface of the body.

The dermal musculature consists of three distinct layers of circular, transverse and longitudinal muscular fibres. The circular fibres lie immediately beneath the basement membrane, and form but a very thin layer, beneath which is a thin layer of transverse fibres. The longitudinal fibres occur in a series of thick bands, each made up of a number of separate fibres.

Digestive System.—The mouth-opening lies about between the middle and the posterior third of the body. It leads into the pharyngeal chamber, in which the cylindrical pharynx is horizontally disposed. The pharynx, which in length is equal to about one-fourth the body-length, is inserted at about the middle of the body or slightly in front of it. In structural respects the organ presents no features calling for special remark. The anterior gut trunk extends to a point in front of the brain and is provided with 8 or 9 pairs of numerously subdivided branches, while each posterior trunk gives off 18–20 lateral branches and about as many, but extremely short, inwardly directed branches. Occasionally there occurs a transverse connexion between the posterior trunks.

Excretory System.—Situated in the dorsal parenchyma are found two main excretory canals on each side of the dody, which especially in the anterior region give off numerous fine ductules, to form an anastomosing system. As is well known, the canals make their way to the exterior at several points of the dorsal surface, between the epidermic cells. Occasionally the two ducts are seen to fuse together just before opening out on the surface.

Nervous System.—The exact arrangement of the nervous system could not clearly be ascertained. The brain is a bilobed organ situated near the anterior end of the body. Each brain-mass gives rise to some five forwardly directed sensory nerves and some lateral nerves. From the dorsal surface of the brain the optic nerves arise and break up into branches, extending to the numerous eye-spots. Each half of the brain is continuous posteriorly with one of the longitudinal nerve cords, which themselves are relatively thick. Throughout their entire course, until they unite with the marginal nerve at the posterior end of the body, the two cords are connected by numerous transverse commissures, averaging about 55 in number. Some of the commissures are better developed than others and these most frequently occur in the neighbourhood of the pharynx-insertion and the copulatory organs. From the cords at points opposite to the union of these with transverse commissures lateral nerves are given off towards the marginal nerves.

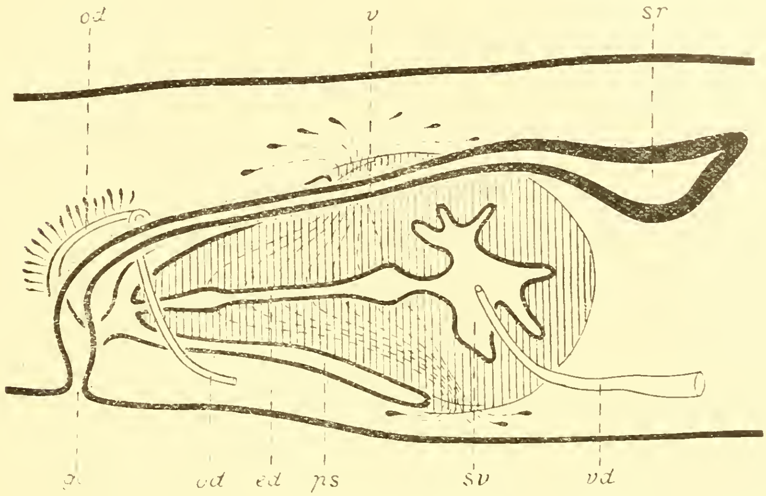


Text fig. 10. Diagrammatic representation of the organization of *Sorocelis sapporo* Ij. et Kab., as seen from the dorsal side.
Index letters as in text figs. 2, 5 and 6.

Genital Organs.—The common genital opening is situated behind the mouth-opening at a distance equal to about one-third that between the mouth-opening and the posterior end of the body. It leads into the narrow vestibulum, which receives from the front the opening of the penis-sheath. Both the vestibulum and the penis-sheath are lined with a single epithelium resting on a fine basement membrane, beneath which lie circular and longitudinal muscular layers moderately well developed. Eosinophil glands occur all round the vestibulum, into which they discharge themselves.

The small testes number about 18–22 on either side, lying ventrally along both sides of the anterior gut trunk and extending from the ovarian region to the insertion of the pharynx. Each testis is, as usual, a follicular body made up of sperm-mother-cells and spermatozoa in several stages of development and surrounded by the tunica propria. Ventrally each testis gives rise to a short testicular canal which soon joins the vas deferens. The vasa deferentia, which proceed backwards along the inner side of the longitudinal nerve cords on the ventral side, gradually make an inward bend, rising upwards at the same time, to open separately into the seminal vesicle on the sides of the penis-bulb. The vas deferens is filled with spermatozoa, but forming no peculiar enlargement of the nature of accessory seminal vesicle.

The penis consists of two parts, viz., the spherical bulbous part of muscular nature and the free, conical intromittent part almost horizontally disposed in the penis-sheath. The former part, being distinguishable from the surrounding parenchyma with ease, is a mass of the parenchyma traversed by several muscular fibres and encloses a moderately wide cavity, the seminal vesicle the wall of which is thrown into irregular folds. The lining epithelium is made up of columnar cells resting upon a delicate basement membrane. Posteriorly this cavity passes into the slender ejaculatory duct which opens at the tip of the penis. In its course the ejaculatory duct makes two expansions, as seen in text fig. 11. In structural respects the penis exhibits nothing peculiar, but the muscular layers of circular and longitudinal fibres, lying beneath the external epithelium, are less developed than those found in *Pl. gonocephala* and *Pl. virida.* Embedded in the parenchyma around the penis-bulb are numerous eosinophil penis-glands, the ducts of which enter the penis at the base and open into the ejaculatory duct throughout, between the expansions mentioned above.



Text fig. 11. Diagram of genital organs of *S. sapporo* in sagittal section. Index letters as in text figs. 2, 5 and 6.

The paired ovary is placed ventrally between the first and second, sometimes between the second and third, branches of the anterior gut trunk. It is a spherical mass of relatively few egg-cells in several stages of development and is enclosed by a distinct delicate membrane. The youngest ova are found in the foremost part and the most mature ones in the central and hind parts, from the postero-lateral surface of which the oviduct starts as an ampullaceous passage. Scattered in between the ova are branching cells which fill the spaces between them. The cells have been considered by some authorities (Moseley (54), von Kennel (45), Lang (48), Woodworth (98), etc.) as resulting from the differentiation of the connective tissue. However, as mentioned by Ijima (38), von Graff (31), Böhmig (9) and others, they appear to be regarded as rudimentary egg-cells, at whose expense the ova develop.

The vitelline glands are represented by branching cellular cords with cells usually arranged in several rows; they are very extensively distributed posteriorly from the region of the ovaries and in the interstices between the gut diverticulae, thus exhibiting little room left for parenchyma. The connexion of the organs with the oviducts takes place at intervals throughout their length. The cells of the vitelline glands are of moderately large size and are pressed against one another, thus presenting an irregular contour. The nucleus is smaller in proportion to the size of the cells. In the cytoplasm lightly refractive granules occur abundantly exhibiting an affinity for eosin.

The ampullaceous part of the oviduct soon takes the character of a narrow tube running backwards just outside the longitudinal nerve cord. In the region of the penis the oviduct gradually nears the median line, rising upwards at the same time, and finally unites with its mate of the opposite side into an unpaired common duct on the dorsal side of the penis-sheath. The common duct opens into the genital vestibulum, supplied with a large number of unicellular glands. The direct wall of the oviduct is an epithelium made up of ciliated and nucleated cells, outside which comes a feeble muscular layer of circular fibres. As already stated, the oviduct receives the vitelline glands at several points. So far as my observation goes, the latter appears to connect with slight projections of the former.

The seminal receptacle is an U-shaped organ lying dorsally just anterior to the penis and clasping from behind the posterior end of the pharyngeal chamber. Its wall is made up of an epithelium of columnar cells of a glandular nature, resting upon a fine basement membrane, external to which lie moderately well-developed muscular layers of circular and longitudinal fibres. The appearance of the cells is subject to variation according to their secretory activity; the protoplasm may be either mostly homogeneous and deeply stainable, or contains some course granules.

From the hind end of the receptacle arises the vaginal canal, which runs backwards over the penis-sheath somewhat to the right of the median line and then dips below to open into the vestibulum. Internally the canal is lined with an epithelium of non-ciliated columnar cells, beneath which is a muscular coating, being continuous with that of the receptacle. Perforating the wall and opening into the lumen are the ducts of a great number of unicellular glands.

Polycelis auriculata IJ. et KAB.

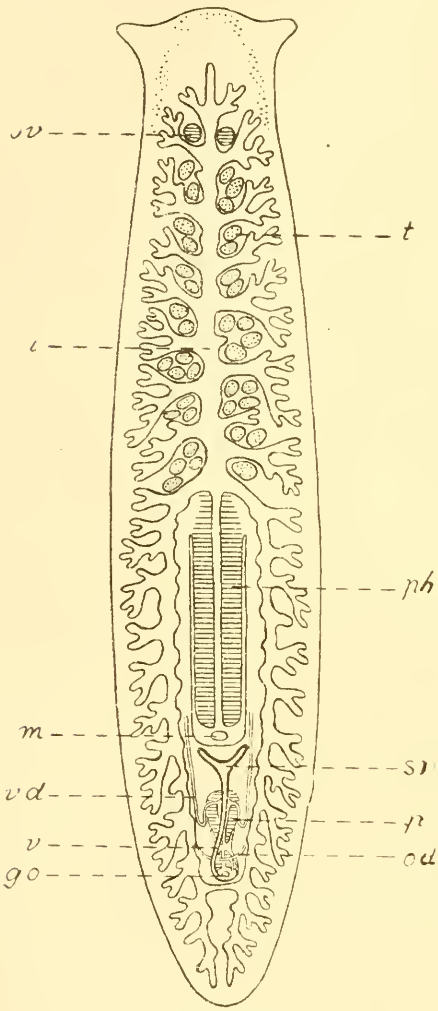
(Pl. I., figs. 13, 14.—Text figs. 12, 13.)

This is a fairly common species in the hilly districts of Japan. Numerous specimens have been captured in both cool running and standing waters at the following localities: Nikko; Mt. Iwate in Prov. Rikuchu; in the neighbourhood of Lake Towada in Prov. Mutsu; Ozawa in Prov Ugo; Mt. Bantai in Prov. Iwashiro.

Form and Dimension.—The frontal margin of the body in the living condition is subtruncate and shows a gentle median convexity which passes laterally into the frontal margin of the moderately distinct tentacles, rounded at the tip and shortly anteriorly directed. The head merges into the trunk, without being marked off by any neck-like narrowing. The trunk, being superiorly convex and inferiorly flat, is slender and presents lateral margins running nearly parallel for the most part. The hind end of the body is rounded rather than obtusely pointed. Exceptionally large forms in the fully extended state reach 25 mm. in length and about 3·5 mm. in breadth, but the species is commonly smaller and measures 10–15 mm. long by 1–1·5 mm. broad in the creeping state, the breadth and length being in the ratio of 1: 7–10.

Colouration.—Dorsally the body is generally of a sepia-brown colour, the guts indistinctly showing themselves in a dark brownish colour or in a variety of other colours incidental to gut contents. The ventral surface is of a paler colour than the dorsal.

Eyes.—The extremely small eye-spots occur in great abundance and number 30–73 on either side, increasing in number with the growth of the body. They are distributed in a horse-shoe-shaped tract close to the head-margin, there commonly existing in the width of that tract more than one eye and only occasionally a single eye. The tract may extend posteriorly for a length equal to about one-eighth or one-sixth the entire length of the body.



Text fig. 12. Diagrammatic representation of the organization of *Polycelis auriculata* IJ. et KAB., as seen from the dorsal side,
Index letters as in text figs. 2, 5 and 6.

Body Wall.—The epidermis consists, as usual, of ciliated cuboidal or cylindrical cells, which are much higher on the dorsal than on the ventral surface. Wedged in between the epidermic cells are minute spindle-like rhabdites, which are derived from their mother-cells, widely scattered in the parenchyma of the body. In addition to the glands opening submarginally on the ventral surface there are some glands which open in scattered distribution all over the entire surface of the body.

The dermal musculature is well developed and composed of three layers of outer circular, middle transverse and inner longitudinal fibres. The innermost layer is the most developed of all the layers and is associated in distinct bands in the usual manner.

Digestive System. — The mouth-opening is situated at about the hind end of the middle third of the body. The pharynx, cylindrical in shape, is inserted at about the middle of the boby-length. The anterior gut trunk gives off 6–9 pairs of lateral branches; each posterior trunk is usually provided with 10–17 branches, those inwardly directed being either very small or, as is frequently the case, joining together the two trunks.

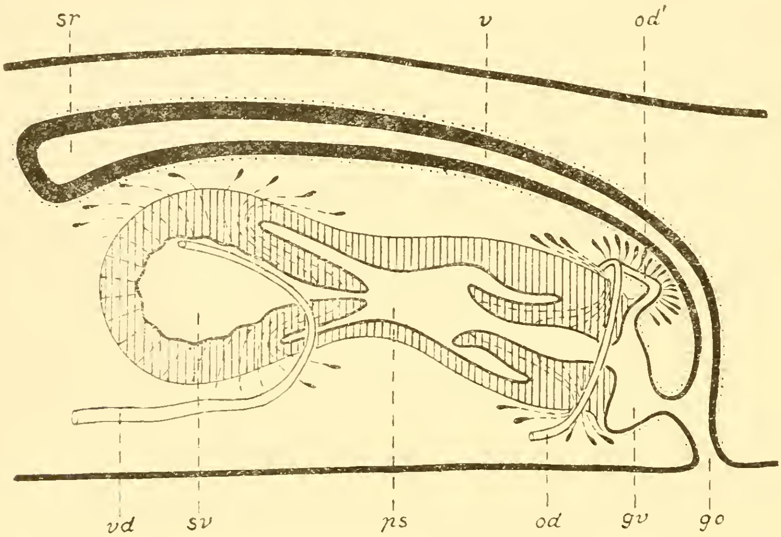
Excretory System.—So far as I have observed, there are two main vessels on the dorsal side of the body, extending almost throughout the whole length. They are connected with each other by means of anastomosis. The canals make their way to the surface in the usual manner.

Nervous System.—Each longitudinal nerve cord passes forward over a well-developed brain-mass, those of both sides being connected by some transverse commissures. The foremost commissure is the most developed of all of them. From each brain-mass arise some five forwardly directed sensory nerves excluding the optic nerve, and some lateral nerves. Throughout their entire course the longitudinal cords are connected by numerous transverse commissures, and give off lateral branches of the same number.

Genital Organs.—The common genital aperture is placed near the middle of the posterior third of the body. It leads into the atrial cavity which is divided into two chambers, the penis-sheath and the vestibulum, separated by a tubular diaphragm of muscular nature. Its free end is retroversed into the penis-sheath. Doubtless the penis appears to extend through the lumen of that body to the exterior. This organ is covered with an epithelium continuous with the lining epithelium of the atrial chamber. The numerous glands, which are embedded in the surrounding parenchyma, open out on the internal surface of the diaphragm and partly on the surface of the vestibulum. The sphincter muscles of the diaphragm consist of three sets of fibres, circular, longitudinal and radial, of which the radial fibres are present in a strongly developed condition. The penis-sheath is provided with a muscular wall continuous with that of the penis and thickest on the dorsal side. There can be distinguished two sorts of circular and longitudinal muscular fibres, of which the longitudinal muscles are developed to an extraordinary degree.

The testes number about 19–21 on either side of the body, occupying a ventral position on each side of the anterior gut trunk and limited in their distribution to between the ovaries and the pharynx-insertion. It is of an irregularly oval or spherical shape and is made up of sperm-mother-cells and spermatozoa in various stages of development, surrounded by the tunica propria.

The vasa deferentia, after proceeding backwards, as usual, inside the longitudinal nerve cords, in the posterior parts take a forward turn, rising upwards at the same time, before they open separately into the lumen of the penis on the dorsal side. The vas deferens is full of spermatozoa throughout its length.



Text fig. 13. Sagittal section of sexual organs of *Poly. auriculata*, diagrammatically shown.
Index letters as in text figs. 2, 5 and 6.

The spherical bulbous part of the penis consists of connective tissue with variously directed muscular fibres, and contains a wide cavity, the seminal vesicle, which is provided with a somewhat folded wall. The cavity passes gradually into the wide ejaculatory duct, opening at the tip of the intromittent part of the penis, which is of a conical shape and is horizontally disposed in the penis-sheath. Embedded in the parenchyma around the penis are present numerous penis-glands which open into the lumen of this organ.

The paired ovary, which is of a spherical shape, is placed ventrally between the first and second pairs of the gut branches.

The vitelline glands, which are represented by branching cords of cells arranged in single or double rows, are extensively distributed almost throughout in the interspaces between the gut branches and communicate with the oviducts by means of the short branches of the latter, which are situated at tolerably regular intereals.

The oviduct starts from the postero-lateral part of the ovary as an ampullaceous passage, which soon narrows and runs backwards just along the outer side of the nerve cord. At the end it unites with its fellow of the opposite side into a short single duct at a point dorsal to the atrial diaphragm, to open into the vestibulum just behind the latter.

The seminal receptacle is simply tubular at an early stage of development. Later, the anterior blind end becomes bent to the right or branches somewhat in the shape of a Y. Its direct wall is an epithelium made up of cylindrical cells of a glandular nature, which are of a greater height on the ventral than on the dorsal side. The cells appear to have been in high secretory activity, and are observed to be vacuolated. Outwardly there exist two layers of internal circular and external longitudinal muscular fibres.

Posteriorly the receptacle passes over into the vaginal canal which opens dorsally into the vestibulum on the left of the median line. This is constructed in the same manner as the receptacle.

Polycelis ijimai Kab.

(Pl. I., fig. 15.—Text fig. 14.)

Some specimens of this species were captured by the late Professor Ijima in the autumn of 1916 from Lake Shikotsuko in Hokkaido. The genital organs were not yet developed in most of them.

Form and Dimension.—In shape the worm conforms to the outline of the preceding species. The frontal margin is subtruncate and presents in the median part a gentle convexity which laterally passes through a slight concavity into the frontal margin of the oblique, forwardly directed tentacles. The tentacles is pointed rather than in the preceding species. The head is distinctly separated by a gentle neck-like constriction from the trunk, which presents lateral margins running nearly parallel for the most part. The greatest breadth is seen behind the middle of the body, in the pharyngeal region, from which the trunk gradually tapers to an obtusely pointed end. The mature worm in the fully extended state usually reaches 18-20 mm. in length and 2–2·5 mm. in breadth.

Colouration.—The dorsal side of the body is generally of a darkish olive-like brown colour, being much darker than in *Poly. auriculata*. At the frontal end, on the lateral margins and in the median line the colour is somewhat lighter than elsewhere. On the outer side the region of the pharynx and copulatory organs may be, as usual, discerned to a certain degree in clear spaces. The ventral side is much paler, revealing even the ovaries, the testes and the longitudinal nerve cords as dark spots or stripes.

Eyes.—Numerous small eye-spots, increasing in number with the growth of the body, are arranged in a single row along and close to the margins of the head, thus forming a horse-shoe-shaped tract which does not extend so far behind as in *Poly. auriculata*. In a few large specimens the eyes number 28–39 on either side.

Body Wall.—The epidermis is composed of a single layer of columnar cells which are much higher on the dorsal side than on the ventral. It contains minute spindle-shaped rhabdites which are situated between the cells. Deep below the epidermis, in the parenchyma, are found such rhabdites as are still enclosed in their mother-cells. Numerous glands, deeply situated in the parenchyma, are seen to open on the ventral surface towards the sides of the body as well as at various points of the entire surface of the body. The dermal musculature consists, as usual, of the outermost circular, the middle transverse and the innermost longitudinal layers. Of these the longitudinal layer is the best developed and appears associated in distinct bundles.

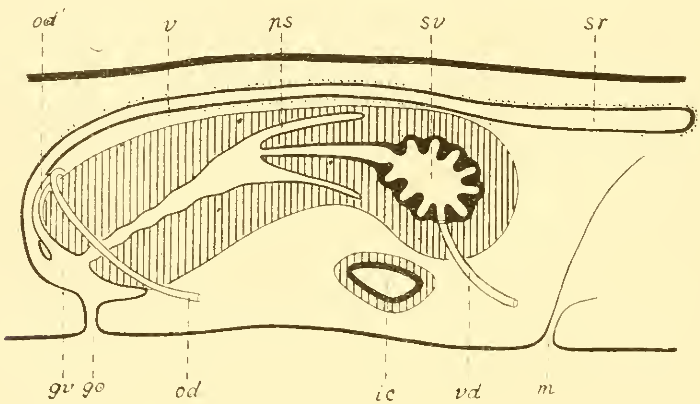
Digestive System—In the fully grown forms the mouth-opening lies slightly behind the hind end of the middle third of the body-length. The pharynx, which is of a cylindrical shape, is inserted at a point in front of the middle of the body, showing an average length in relation to the body-length of 1: 3.5. The unpaired anterior gut trunk generally gives off 5 pairs of subbranched lateral diverticulae, while the posterior trunks are each provided with 15–17 diverticulae outwardly directed. A point of interest is the occurrence of a transverse commissure, joining together the two posterior trunks. Internally, the connecting canal is lined with an epithelium made up of small cylindrical cells of a glandular nature, which shows features apparently differing from the general epithelium of the intestine. Externally there exists a muscular coating of considerable thickness, consisting of circular fibres for the most part. The muscular layer is less developed in the immature than in the mature individual. To me, the connecting canal appears to serve as a glandular organ.

The exact arrangement of the nervous system could not be ascertained, but it seemed to be quite similar to that observed in the preceding species.

Genital Organs.—The genital apparatus is similar in appearance to that of *Poly. auriculata.* The common genital opening lies nearly midway between the mouth-opening and the posterior end of the body, and leads into the vestibulum, which receives the openings of the vagina and the unpaired common oviduct from above, as well as of the penis-sheath from the front. The penis-sheath is provided with a strongly developed muscular layer of circular fibres, which in the living state may be easily discerned as a lighter colour. The muscular layer gradually increases in thickness posteriorly, and is thickest at the end of the sheath. In cross section the muscular layer shows a uniform thickness, unlike that in *Poly. auriculata* in which it is much thinner on the ventral than on the dorsal side. Between the penis-sheath and the vestibulum there exists no sign of the funnel-like body, which is observed in *Poly. auriculata.*

Numerous testes occur close together in the ventral position, arranged on either side of the anterior main trunk of the intestine. They extend from behind the ovaries to the insertion of the pharynx. The vasa deferentia proceed backwards close along the inner side of the longitudinal nerve cords. At the sides of the penis they gradually bend inwards and upwards, finally to open separately into the seminal vesicle.

In the penis there can be distinguished the conical intromittent part, lying horizontally in the penis-sheath, and the spherical bulbous part of muscular nature, which contains a wide lumen of an irregular contour, the seminal vesicle. The vesicle gives rise behind to the moderately wide ejaculatory duct, which opens at the tip of the penis. Embedded in the parenchyma around the penis are numerous eosinophil glands, which make their way into the lumen of the penis.



Text fig. 14. Diagrammatic representation of sexual organs of *Polycelis ijimai* Kab in sagittal section.
ic intestinal commissure.
Other letters as in text figs 2, 5 and 6.

The paired ovary, which is of an irregular shape, is placed behind the brain, one on either side close to the inner side of the longitudinal nerve cord and between the first and second pairs of the gut branches. At the postero-lateral aspect the oviduct leaves the ovary in the form of a funnel-like widening, which soon assumes the character of a slender duct and proceeds backwards just outside the longitudinal nerve cord, receiving the vitelline glands at numerous points. The vitelline glands are represented by branching cellular cords with cells arranged in single or double rows. The mode of the connexion of the glands with the oviduct was not clearly made out. In the region of the penis-sheath the duct bends inwards, rising upwards at the same time, and finally unites with its fellow of the opposite side into a single common duct, which opens into the vestibulum from above.

The seminal receptacle is represented by a slender tubular organ, which extends forward, without forming any widening, up to the dorsal side of the hind end of the pharyngeal chamber. The organ is lined with an epithelium made up of columnar cells of a glandular nature, beneath which comes a thin musclar layer. Posteriorly the receptacle passes into the vaginal canal, which runs dorsal to the penis, finally opening into the vestibulum.

Polycelis karafto IJ. et KAB.

(Pl. I., fig. 16.)

This species was procured by the late Professor IJIMA in June, 1906, together with *Pl. pellucida*, from cool running brooks in the wooded hills to the east of Tayohara (Vladimirofka), Saghalin. It was also found in a spring near Tretia Padi, north of Korsakoff, in the same island.

Form and Dimension.—The head is shaped nearly as in both the preceding *Polycelis*-species, but the tentacles are somewhat longer and more pointed at the end. The trunk is slender, almost uniformly broad for the most part and obtusely pointed at the posterior extremity. In the creeping state a large specimen was 12 mm. in length and 2 mm. in the broadest part. Commonly the worms are smaller, their breadth equalling about one-fifth or one-sixth the length.

Colouration.—The colour of the dorsal surface is dark brown with two longitudinal ill-defined darker bands, which run on either side of the median line posteriorly from the neck-like region. The ventral surface is of a lighter colour, showing the course of the longitudinal nerve-cords as two dark lines.

Eyes.—Numerous small eye-spots are found along and close to the margins of the head, on both sides extending behind to about the second pair of the gut branches. They are arranged in a single row in the smaller specimens; but in the larger ones they may be increased to such a number that several are found in the width of the ocellated zone, especially in the anterior parts of the head. A gap in the zone may occur in the middle of the frontal margin, separating it into the right and left zones.

Body Wall—The epidermis is somewhat thicker on the dorsal than on the ventral surface. Wedged in between the epidermic cells are found spindle-like rhabdites, which take place in the subcutaneous cells, occurring in wide distribution over various parts of the body. Besides the glands opening submarginally on the ventral surface there are some glands which open here and there over the entire surface of the body. The dermal musculature consists, as usual, of circular, transverse and longitudinal layers.

Digestive Syetem.—The mouth-opening is situated at about the hind end of the middle third of the body. The pharynx-insertion is found a short distance in front of the middle of the body. The anterior main trunk of the intestine sends out 5–7 pairs of lateral branches; the posterior trunks are each provided with about 15 of the same.

Genital Organs.—The following is based on a few mature or nearly mature specimens unfit for close study. Nearly midway between the mouth-opening and the hind end of the body is present the common genital aperture, which leads into the long and tubular atrium. As usual, the atrium is internally lined with a single epithelium, without being surrounded by such a thick muscular coating as observed in *Poly. auriculata* and *Poly. ijimai.*

Numerous testes are situated ventrally along both sides of the anterior gut trunk, extending from the ovarian region to the insertion of the pharynx. The vasa deferentia, being full of spermatozoa, pursue a backward course along the inner side of the longitudinal nerve cords, finally to open separately into the moderately wide seminal vesicle, which passes behind into the slender ejaculatory duct. The penis is of small size and horizontally disposed, its muscular wall not being sharply defined from the surrounding parenchyma. The free end projects but little into the widened anterior end of the tubular atrium, the penis-sheath.

The two ovaries are placed each ventrally in front of the first pair of the gut branches. Owing to my careless manipulation while preparing the material, the course of the oviducts could not be distinctly traced from any of the sections available. A short stretch of longitudinal canal, running along the ventral side of the atrium and joining this at a point about midway between the tip of the penis and the junction of the vagina with the atrium, probably represents the unpaired terminal part of the united oviducts. The seminal receptacle is a slender tubular canal, running over the penis and extending a short distance beyond this anteriorly, much as in *Poly. ijimai*. Its direct wall is an epithelium made up of columnar cells of a glandular nature, surrounded by a thin muscular layer. The vaginal canal dips below to open into the atrial passage from above.

Habits.

Occurrence.—The freshwater Triclads inhabiting both running and standing waters are found, for the most part, clinging to the under side of stones or other sunken objects, which project up from the bottom or out into the water, or which lie against each other so that the under side is not buried. The stones are more or less rough, covered with tiny crevices which make good hiding places, the worm being almost below the surface and thoroughly protected but still able to make use of the swift current of fresh water. *Pl. gonocephala*, which is of wide distribution in the northern hemisphere, is very abundant in both standing and running waters, being widely distributed from the mountainous region nearly down to the sea level. *Pl. virida*, *Pl. pellucida*, *Poly. karafto* and *Poly. ijimai* usually inhabit cool running streams, the middle two species being not infrequently found together. *Poly. auriculata*, though sometimes occurring in stagnant water, abounds in cold streams. *Bd. annandalei* occurs on the muddy bottom of the lake, whereas its ally, *Bd. brunnea*, distinguished by the small size of the body, is usually found in running water. *Pl. papillifera* is known as occurring only in an unused well of stagnant water in the Ichigaya Ward of Tokyo.

Of interest is the fact that the *Polycelis*-species exhibit a tendency to live on the body-surface of other large animals. As regards this mode of life, we have met such on few occasions in *Poly. auriculata* and *Poly. karafto.* In one case the former species is found attached in most abundance to the body of *Richardsonius phalacrocorax* (JORDAN and FOWLER), whereas the latter was found living on the carapace of a certain crab as well as on the body-surface of a certain fish and evidently feeding well on the liver of the crab.

Food.—The food of several of the species consists, so far as my observations go, largely of small animals. In their digestive tracts have been found certain Crustacea and others. Probably Protozoa makes ideal food because their protoplasm is generally not so thoroughly covered as to be inaccessible and because they are very common everywhere. Further, the worms make, as already stated, the most vigorous efforts to obtain the flesh of higher animal forms, such as fish. Besides animal food, they also normally, probably to some extent, feed on vegetable matter, which seems, however, to be second in choice, probably because the thick cellulose of its epidermis is too armour-like and is beyond the possibility of even receiving an impression from the delicate and jawless lips of the gentle feeders. These substances frequently impart various sorts of hue to the animal, as is observed in *Pl. gonocephala* and some others. During collection, I have used chiefly crushed pieces of a boiled hen's egg. Further, it is an interesting fact that when hungry, a partially crushed specimen of *Planaria*, even though still able to move about, will be seized upon and eaten as quickly as any other food. I have met with such on several occasions. It is, in fact, possible, with a little patience, to make a specimen eat a small piece cut off the posterior end of its own body. This eating of each other occurs, so far as I have observed, when an individual is bruised so that some of the tissue underlying the epidermis is exposed. Under these conditions juices escape from the body and act as stimuli on the other worms, as has been stated by

Pearl (57). Under normal conditions contact of one individual with another does not start the feeding reaction, which is a purely reflex phenomenon, capable of being started only by a certain set of stimuli.

As regards the obtaining of food, I have made an observation in one case of *Pl. gonocephala.* The worm, on meeting a certain crustacea in its path in the course of movement in a dish, stops an instant, slightly raises the head and lets it drop down till it touches the said minute animal. Owing to currents produced by undulation of the auricular lobes as well as by means of cilia which cover the head-surface, the anterior end closes down over the whole body, and then apparently squeezes it by contraction of the muscles on the ventral surface of the head. While the reaction is taking place the worm as a whole stops its progressive movements and remains quiet. After squeezing the food animal the worm starts gliding ahead on to the food. In the process the mucus, which is secreted at all times over the surface of the body, is considered, as it seems to me, partly to serve as an important factor in securing food. The worm passes forwards up to the point where the opening for the extrusion of the pharynx is located. Then the pharynx is extruded and feeding begins.

Respiration.—It is self-evident that the planarians, although provided with no special organs, are capable of breathing i.e. of taking in oxygen contained in solution in the water and disengaging carbonic acid. The process of respiration is carried on through the epidermis or through the internal organs which stand in direct communication with the surrounding water. They are all very sensitive to the amount of the air (oxygen) contained in solution in the water. In aquarium, when there begins to be only a slight overloading with carbon dioxide, many individuals can be seen making their way to the top, where there exists a layer of fresh water, avoiding the foul depths. Occasionally they prefer to remain near the top for a long time, staying quietly near the edge or creeping about very slightly along the surface film of water. So far as our observations go, the worms find, in general, their most suitable habitation entangled in a mass of algae or creeping over bits of weed, probably as much for the supply of oxygen and consequent purer water as for a hiding place. In balanced aquarium, they are therefore capable of living in the same manner as in nature.

Reactions.—All the planarians are, to some extent, sensitive to light, being definitely and conspicuously negative in their relation both to diffused and localized light. Consequently they ordinarily occupy a position beneath stones or other sunken materials, and move about more by night than by day. If placed in a dish, they investigate very thoroughly every part and invariably come to rest in the situation of greatest shadow in the day time. Their ability to estimate the size and density of the shadow is evidently keen, since they seem able to distinguish even small gradations. The eyes are an aid in distinguishing differences in light intensity as well as the direction from which light comes, but the presence or absence of these organs cannot be taken as the main factor in this respect, for species which are wholly destitute of them may possess the ability to distinguish between light and darkness. Another fact that is perhaps to be correlated with light is the relative amount of colour. The pigments in the epidermis or subcutaneous tissue were regarded as arising from the direct influence of light, and, as a necessary corollary to this view, it was also asserted that the absence of light always prevented the formation of pigments, or destroyed that which was already formed. The fact that *Bd. annandalei*, occurring in the deepest parts of Lake Biwa, is wholly devoid of any trace of pigments appears to afford a striking evidence of the accuracy of this statement.

Locomotor Movement.—As already briefly stated in my paper dealing with the marine Triclads, there can usually be distinguished three sorts of locomotor movements, gliding, crawling and so-called swimming, Gliding is the most usual mode of progressive movement when the animal is not particularly stirred up, while crawling is seen when it is strongly stimulated in certain ways. When the worm starts from a resting condition the nature of the movement, i.e. whether gliding or crawling, depends in a large measure on the intensity of the stimulus which starts it. If the resting animal is rather strongly stimulated, it will start at once into a crawling movement, which changes to gliding after a few contractions. When the worm starts spontaneously into movement, it usually begins at once with the glide. When starting spontaneously, the glide is usually preceded by some of the feeling movements of the head-end as in coming to rest. Among the species which I have examined, *Pl. virida* is capable of performing the progressive movement with greater rapidity than do any others.

The gliding movement is, so far as my observation goes, effected by the action of cilia in mucus which is constantly being secreted in greater or less quantity, and which gives rise to a thin layer between the ventral surface of the body and the surface on which the worm is moving. Immediately after being secreted into the water this mucus is very sticky and is adherent to the substratum. Hereby we can think of the lowest part of this mucus layer, which is of denser consistency than its upper layers which are in contact with the worm. In this upper layer, cilia cause the progression of the worm body owing to their strong beatings backwards. In this case there is, of course, a very slight rhythmical wavy movement of the ventral wall of the body, which assists in the locomotion. In this respect Lehnert (49) considered rhythmical contraction waves passing along the ventral surface of the worm to be a factor in the movement of the freshwater planarians. Pearl (57), however, spoke of unconformation in the forms examined, pointing out that some very slight muscular movement of the ventral wall of the body, if it exists, is very insignificant. After all, the principal factors in producing gliding I give as (1) the action of cilia on the ventral surface of the body, (2) secretion of mucus, and (3) slight rhythmcial wavy motions of the ventral wall of the body.

Furthermore, the gliding movement takes place with the body in contact with the surface film of water, which serves the purpose of a solid body. This I will distinguish from the preceding by the name of the so-called swimming. This movement is slower than that on the bottom, largely on account of the greater flexibility of the surface. The surface film is of an elastic nature and does not give so firm a basis as does a solid body. The mechanism of the movement is exactly the same as that mentioned in the preceding part. Both the Rhabdocoeles and the Polyclads are capable of performing true swimming movements, i.e. movements which are free in the water without contact with my solid body. So far as I can learn in the literature, however, no one has ever placed on record that a freshwater Triclad swims freely through the water, although BARDEEN (2) has spoken of the worms freely making progress through the water. With regard to this I have no observation at present.

A comparison with the movement of land planarians is made. In them the movement, according to MOSELEY (54), is a combined reaction, brought about by ciliary movement on the ventral surface, by secretion of mucus, by rhythmical contraction waves passing longitudinally over the ventral surface and by snake-like movements of the whole body, the muscular factors being more important relatively to the ciliary component than in the freshwater forms. The snake-like movement I am unable to confirm from observation on the forms.

Crawling is to be attributed to a purely muscular movement, and is always caused by a successive alternation of the active muscular contraction and stretching. When starting spontaneously one side of the body at the posterior end attaches with more or less firmness to the substratum and then immediately the posterior half contracts; an instant later the opposite side stretches out far in front, being slightly lifted, and fastens to the substratum. Then according to a longitudinal contraction which begins just at the back of the head and runs posteriorly, the hind end is thrust forwards. Such looping fashion is repeated with great rapidity.

At this point I will proceed briefly to bring out the relation of the movements of the Triclads to those of other Turbellarian groups. Most of the Rhabdocoeles swim through the water by means of cilia covering the whole body, as previously mentioned by a number of investigators. In fact, the movement is not at all or very little dependent upon muscular activity. On the contrary, many of the Polylcads usually perform a gliding movement, largely effected by the rhythmical beating of the margins of the body, aided perhaps very little by the cilia of the ventral surface. Also they are able to make progress through the water by means of muscular movements of the body as a whole, or of undulations of its expanded margins, the ciliary activity taking no necessary part in this form of movement. In the freshwater and marine Triclads, the cilia have become much diminished in comparison with the Rhabdocoeles, and are not numerous and strong enough to support and move the disproportionately heavier body freely through the water. The muscular movements of the body or its lateral extensions are not so highly developed as those of the Polyclads. In consequence, the Triclads are not capable of performing free movements in the water without contact with any solid body. Judging from the above, the Triclads seem to occupy a somewhat intermediate position in respect to locomotor phenomena between the Rhabdocoeles and Polyclads.

Non-locomotor Movements.—Under this description of movements will be included the phenomena of contraction, extension, feeling movements, extrusion of the pharynx, etc.

The feature of the worm when resting or stimulating is quite different from its feature in the active motion. The body grows shorter, wider and thicker. The ordinary contour of the head is almost entirely lost, and the end is evenly rounded like that at the posterior. The lateral margins of the body form a wavy line instead of the straight one of the active condition. This shortening of the body lengthwise is usually designated by the term "Contraction of the body." In the condition most contracted longitudinally after stimulation, many individuals decrease one-half or one-third the body-length in the full extension. This is produced by the contraction of the longitudinal muscular fibres, which are apparently better developed on the ventral than on the dorsal side. In this case all the sets of muscular fibres other than the longitudinal must, of course, be relaxed completely, because as the animal shortens it grows broader and thicker, which would be impossible if the circular, or transverse, or dorso-ventral muscular fibres also contracted.

When the worm passes from the resting or contracted condition into movement, one can see the lengthening of the body, which is meant by extension of the body. Probably the most important sets of muscular fibres for producing the general extension are the circular and dorso-ventral. The contraction of the former must cause the body to lengthen, and the contraction of the latter must bring about the flattening seen in the fully extended, gliding animal. Of course, the transverse muscles assist, by their contraction, in the extension of the body. It is self-evident that contractions of any of the sets of fibres may take place in localized region, producing extensions or contractions of that region, according to the set effected. The feeling movements of the head are effected in this way. The extension and extrusion of the pharynx are brought about by contraction of its well-developed circular muscles.

The animal in the course of gliding raises the anterior part of the body off the bottom so as to form an angle with the rest of the body. The head is in constant though slight feeling movement, without being held in a fixed raised position. Usually the head is moved up and down, and swept from side to side, while at the same time the tentacular or auricular lobes, though slightly undulated, are fully extended and raised. The head region acts in movement as an organ which is constantly testing the environment as the worm proceeds.

Reproduction by Fission.—The light which observations have, up to the present, thrown on the phenomena of fission in the Triclads is considerable; the revision of the literature has been made by Steinmann (72), who divides the normal fission of them into three groups. So far as my observations go, *Pl. vivida* and *Poly. ijimai* very frequently reproduce by fission. In the former the division takes place quite similarly to that known in *Pl. alpina* Dana. First a furrow appears at the place where division is to occur; it deepens, finally leading to separation of the parts. There were not infrequently found cases in which the dividing body-parts were still connected by a narrow band of tissue, which no doubt would soon break off by the motion of crawling.

Pl. gonocephala, as observed by me, seems also to reproduce to a large extent by fission. I have never yet met with individuals which were doubtlessly quite in the process of dividing, except showing a dark pigment spot in the middle of the dorsal surface, but those bearing evident marks of foregone fission are rather common. To judge from these, it seems that this always takes place at a point immediately behind the pharynx or a short distance farther back, much as is known from *Pl. maculata* Curtis. Instances of division in front of the pharynx, known to have taken place in *Pl. albisima* Sekera, was never observed in the species in question. The severed end of the two pieces produced by division presents for some time a transverse and nearly straight edge, exposing the parenchyma in a thin white line. For some time after the healing of the wound there is observed at the end of the body concerned a colourless area of regeneration, which area, bounded off from the old parts by a zone of concentrated pigmentation, is at first of a crescentic, and then more or less of a triangular shape. In the tail piece that area develops into the part of the new head anterior to the auricles, while in the head piece it merely forms the new tail-end. In the former case the regenerated area increases considerably in extent, and the eyes appear as two minute dots close to its border against the pigmented old parts of the body. The points of the auricles begin to show themselves somewhat later.

In all the species mentioned, reproduction by fission takes place most actively during June, July and August, in which period it is exceedingly rare, if at all, to discover individuals with developed sexual organs. So far as my observations go, the fission ceases in the autumn and then the reproductive organs begin to develop. It may therefore be said, in unison with Curtis (20), that the life history of these planarians presents alternate periods of asexual and sexual reproduction. It is rather difficult to understand why the lowering of the temperature in the fall induces an acceleration in the growth of the sexual elements. There are perhaps two theories to be offered in explanation. One is that the planarians which in their primitive habitation lived in cold regions become sexually mature when the temperature comes the nearest to their ancestral condition. The other is that eggs which are able to develop slowly or lie dormant for some time, if deposited in the fall, will be ready to begin a more rapid growth in the spring.

Budding.—That heteromorphosis can be produced experimentally in the planarian has been proved by a number of investigators (see STEINMANN (72)). In nature there also occur various heteromorphic forms with double or more head or tail portions, upon which little has hitherto been observed. During my work I have met with such on several occasions in *S. sapporo*, *Pl. vivida* and *Pl. gonocephala*, as previously noted (43). Among these a very curious case was obtained in a specimen of *S. sapporo* in which the mother-individual bears on the left lateral margin of the body in the pharyngeal region two branch-like buds of considerable size. One of them represents an additional posterior part of the body, and the other an additional anterior part of the body, the latter lying between the former and the posterior part of the mother-individual. The small daughter-individual with the end of the head directed posteriorly in relation to the mother-individual crawled forwards, though at times it made efforts of forward crawling in its own sense. As mentioned by van DUYNE (23), each piece would move away from the other until they had completely torn apart.

On the Parallelism in the Distribution of Freshwater Planarians in Europe and Japan with a Consideration of the Causes underlying this Distribution in the two Regions.

Whether Japan ever underwent a glacial age is the subject of much controversy among geologists. Most interest attaches to the conflicting views of YOKOYAMA and YABE. From the palaeontological point of view, YOKOYAMA[1] puts forward the view that the climate of Central Japan during the Pliocene epoch was on the

(1) YOKOYAMA, M., 1911. Climatic Changes in Japan since the Pliocene Epoch. Journ. Coll. of Sci. Imp. Univ. Tokyo, Vol. XXXII, Art. 5.

whole colder than it is at present but that it was never cold enough to generate glaciers, and that during that period it was colder in the earlier part than in the later. The temperature of the country has gradually increased since the Pliocene epoch, attaining its maximum in the Diluvial period and then again decreasing down to the present time. This state of things is just the reverse of what we find in Europe and America. YABE[2], on the contrary dissenting entirely from YOKOYAMA's view, infers that Japan has undergone climatic changes nearly parallel to those which prevailed in Europe and America. More recently, some authorities (TSUJIMURA, YAMAZAKI, ÔZEKI, OGAWA and others), approaching the question from the geographical point of view, have adduced arguments of considerable weight in favour of the view that this part of the globe has formerly been subjected to a climate cold enough to generate glaciers. As evidence of the recent occurrence of a glacial age, they cite the cirques and moraines found in the Hida mountains, well-known as the Japanese Alps. At present, this view, though still more or less open to obvious objection, appears to be generally accepted.

Drawing attention to YOKOYAMA's opinion, BREHM[3] has mentioned that the freshwater fauna in Japan requires more investigation. In collecting the freshwater Triclads I have paid most attention to the condition of their distributions, upon which the following is based.

Central Japan presents us with four familiar planarians, such as *Bdellocephala brunnea*, *Planaria gonocephala*. *Pl. virida and Polycelis auriculata.* Among them the last mentioned species is, so far as my observation goes, chiefly confined to the northern mountain districts, while *Pl. virida*, which is similar in external feature to *Pl. alpina* in Europe, extends much farther south than *Poly. auriculata.* It is, however, of interest that *Pl. virida* in the southern parts is always found either in cave (Gembudo in province

(2) YABE, Y., 1913. On the Climate in Japan since the Pleistocene Epoch. Gendai no Kagaku (Sci. Gaz.), Vol. I.

(3) BREHM, V., 1913. Die Bedeutung der japanischen Corallin-Age für den europäischen Süsswasserbiologen. Zool. Anz., Bd XLII.

Tajima) or in high mountain regions. In general, it abounds at a higher altitude than *Poly. auriculata*. *Bd. brunnea* is met with in cool running brooks chiefly in the northern mountain districts. The foregoing species are not found in the warmer regions such as Kiu-shu and Shikoku. *Pl. genocephala*, which is of wide distribution in the northern hemisphere, has the greatest range, extending from the mountainous region down to the sea level and usually inhabiting streams or lakes of a higher temperture than the streams, in which *Pl. virida* and *Poly. auriculata* occur. At the high levels *Pl. gonocephala* occurs sporadically, and at the highest levels not at all.

Now, let us consider the conditions affecting the distribution in the Nikko region which includes the town of Nikko, Chuzenji and Yumoto, extending from an altitude of 590 m. to one of 1620 m. above the sea level. The temperature diminishes steadily as we ascend towards Yumoto, where people do not reside in winter. Extensively distributed in this region are found three species, *Pl. gonocephala*, *Pl. virida* and *Poly. auriculata*, the distribution of which shows some interesting features. My investigations show that four distinctly marked sub-regions can be distinguished. The first sub-region is represented by the vicinity of the town of Nikko, which affords positions favourable to *Pl. gonocephala*. This species is very abundant in the streams flowing through this locality. The second sub-region extends from the neighbourhood of Nikko to an altitude of about 833 m., and in it the three species just mentioned are found together. Ascending the mountains we enter the third sub-region in Chuzenji, standing at an altitude of about 1350 m., and here flourishes *Poly. auriculata*. We come next to the last sub-region in the neighbourhood of Yumoto, where *Pl. virida* occurs fairly abundantly in cool running brooks. Here also is to be found *Pl. gonocephala*, but it is confined either to the riveis or to lakes.

Associated with each other the three species, *Pl gonocephala*, *Pl. virida* and *Poly. auriculata* are to be found in the second sub-region mentioned above. Their distribution suggests that there is between them a struggle for existence. But a close observation shows that *Pl. virida* is apt to thrive in the upper parts of the streams, *Poly. auriculata* in the middle courses, and *Pl. gonocephala* in the lower parts. This is a state similar to what we find in Central Europe, where the most familiar species are *Dendrocoelum lacteum*, *Pl. gonocephala*, *Pl. alpina* and *Poly. cornuta*. According to some investigators (VOIGT (81–90), VOLZ (91), ZSCHOKKE (103, 104) WILHELMI (93) and others), *Pl. gonocephala* flourishes in the lower reaches of the stream, *Poly. cornuta* in the middle courses, and *Pl. alpina* in the upper parts. Between each two there is a section, in which the two species are found side by side.

As regards the causes underlying this condition of the distribution we can enumerate six influences to account for this:

(1) food-supply,	(4) nature of the substratum.
(2) struggle for existence,	(5) property of water, and
(3) temperature,	(6) light.

Generally the food of planarians consists of small animals and plants, which will, doubtless, vary in kind and quantity in different localities. Migrations of planarians may be greatly dependent upon the nature of the food-supply, as is the case with several animals. With regard to this subject, however, I have no observation to put forward.

According to observations in a small aquarium, *Pl. virida* and *Poly. auriculata* are apt to shun *Pl. gonocephala* which is rather stoutly built. Sometimes it may be seen that some forms, when they are bruised so that some of the tissues underlying the epidermis is exposed, are seized and eaten by another individual of the same or different species. But to my mind, the struggle for existence does not appear to exercise a paramount influence.

The geological structure of the locality seems to a certain extent to be an important factor in affecting the distribution. So far as my observation goes, a sandy soil seems to be the most favourable substratum for *Pl. virida*, whereas a muddy soil is more favourable to *Poly auriculata*. The latter species is mostly found clinging to the under side of decaying leaves and logs rather than beneath stones, though *Pl. gonocephala* abounds under stones, or under decaying vegetable matter, on both sandy and muddy bottoms. It is also self-evident that the medium in which the planarian lives has an influence on the distribution. *Pl. gonocephala* inhabits both stagnant and running water, while *Poly. auriculata* and especially *Pl. vivida* are found in swiftly flowing streams: *Poly. auriculata* on the other hand, seems to live only in streams with sluggish currents. The chemical property of the water is also a dominating factor in connexion with the distribution of planarians. Though *Poly. auriculata* seems to abound in water containing a considerable quantity of organic substances, the planarian always occurs in clear water and is not found in water containing mineral substances to a certain degree. *Poly. auriculata* is chiefly found in regions covered with dense forests of deciduous trees. It may be stated that as all planarians are considerably negative in their reaction to light, this is not a strong influence on their distribution.

Much has hitherto been written in favour of the view that temperature seems to be a stronger influence than any other. I am of the same opinion. As already mentioned, *Pl. vivida* and *Poly. auriculata* always inhabit cold water in the northern mountain districts, and are not found in the warmer regions such as Kiushu and Shikoku. Of both the species, *Pl. vivida* flourishes at a higher altitude than *Poly. auriculata*, the former finding more security in streams colder than those in which the latter occurs. Even in the region in which they live together, *Pl. vivida* seems to be fitted for life in the upper parts near the sources of streams, where the water is colder than in the lower reaches. *Pl. vivida*, though extending much farther south than *Poly. auriculata*, is confined to cold water either in caves at a low altitude or in higher mountain districts. *Pl. gonocephala* which is very common throughout the Empire inhabits streams of a higher temperature than the streams in which *Pl. vivida* and *Poly. auriculata* exist. In the neighbourhood of Yumoto is to be found this species in greater quantities, but it is confined either to rivers or lakes, where the water was decidedly lukewarm. Thus, it cannot be denied that the temperature appears to exercise a paramount influence upon the distribution of planarians.

As mentioned above, it may be noted that the change of temperature may be considered as representing a paramount cause bringing about the condition of the distribution. In Europe the freshwater Triclad-fauna has just been proved as indicating the association with the conditions of the climate. *Pl. alpina* which inhabits cold streams in various localities, extending from the Alpine regions to Lapland, is generally regarded as the relict of the glacial age. During the height of that period it is supposed to have flourished in the plain of Northern Europe, but retreated to higher altitudes as well as to more northern and colder latitudes on the approach of a genial temperature, leaving the plain for a subsequent immigrant, *Poly. cornuta*, which was followed by *Pl. gonocephala*.

It is an interesting fact that there is a remarkable resemblance in the distribution of the European and Japanese Triclad-faunas. The similarity of physical conditions does not necessarilly result in a similar fauna, and conversely. To me, however, this parallelism seems to be of particular value in suggesting a view that the climate of Japan has been subjected to a certain extent to variations very similar to those ascertained on the European Continent. Perhapes *Pl. virida* occurred in the low-land of Centrai Japan under conditions of climate and temperature similar to those under which *Pl. alpina* flourished in the plain of Northern Europe. On the approach of a milder climate *Pl. virida* retired to higher altitudes as well as to more northern and colder latitudes, giving place to a subsequent immigrant, *Poly. auriculata*. Following the latter, *Pl. gonocephala* made its appearance, extending over almost all the northern hemisphere. In this manner, the parallelism between the European and Japanese Triclad-faunas can be explained.

In conclusion, I have a few words to state as to THIENEMANN's theory (77) in respect of the blindness of certain freshwater animals. He has, judging from the facts that some blind *Niphargus* and *Planaria*-species usually occur in stenothermal water, spawning in winter and revealing their distribution quite parallel to that of *Pl. alpina*, considered them as representing the glacial relicts, and further, he has advanced the view that they are descended from ancestors with eyes, which inhabited drainage water during the glacial age. In the post glacial age, which immediately succeeded the Alpine Daun stage and the Scandinavian Litorina time, the rising of temperature was so great that it rendered the water absolutely unsuitable to the stenothermal animals, and made life possible only in deep caverns or in the deepest parts of lakes, where the daylight cannot penetrate and the temperature is very low. Some characters of abyssal forms therefore reappeared here, and in the course of generations the eyes must have altogether disappeared, according to the law of degeneration, and in consequence of their disuse in darkness, this blindness acquired constancy and became the distinctive character of the species. The great heat, however, gradually diminished as time went on, again giving them the opportunity to progress upon the surface of the water, but the eyes did not reacquire sight.

To such blind examples I am able to add one more which I myself have met with. It is a case of *Microstomum* sp., which occurs fairly abundantly at *Zeze* in the marginal part of Lake Biwa. Another is an interesting species belonging to the Macrostomidae. This latter was discovered by Professor TANABE of the Technical College of Kyoto in the aquarium dish containing a certain freshwater weed (*Cladophora santeri?*), which was carried back by himself from Lake Akan in Hokkaido.

BREHM has, turning his attention to YOKOYAMA's view, placed on record that it would be interesting to know whether in Japan there exist no species of *Niphargus* and *Planaria* wholly destitute of eyes, as this may help us towards the determination of THIENEMANN's theory described above. If in this part of the world there were formerly found no glaciations, as contended by YOKOYAMA, the discovery of such blind planarians as described above would justify us in ignoring THIENEMANN's view. As Japan appears, however, to have undergone climatic changes nearly parallel to those found in Europe, it cannot at present be denied that the blindness of freshwater organisms represents one of the characters of the glacial relicts. The question, however, deserves further investigation.

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Explanation of the Plate.

The asterisk marks the figures made by the late Professor IJIMA.

Fig. 1. *Bdellocephala annandalei* IJ. et KAB., natural size.
Fig. 2.* *Bdellocephala brunnea* IJ. et KAB., about natural size.
Fig. 3.* *Planaria gonocephala* DUGÈS. ×2·5.
Fig. 4.* The same. ×2·5.
Fig. 5.* The sama. In the resting state. ×3.
Fig. 6.* The same. ×3.
Fig. 7.* *Planari i papillifera* IJ. et KAB., about natural size.
Fig. 8. The same. ×5.
Fig. 9.* *Planaria vivida* IJ. et KAB. ×4.
Fig. 10.* The same. ×3.
Fig. 11.* The same. ×3.
Fig. 12. *Sorocelis sapporo* IJ. et KAB. ×4
Fig. 13.* *Polycelis auriculata* IJ. et KAB. ×5.
Fig. 14.* The same. ×3.
Fig. 15. *Polycelis ijimai* KAB. ×4.
Fig. 16 *Polycelis karafto* IJ. et KAB. ×5.

IJIMA et KABURAKI del.

T. KABURAKI: Japanese Freshwater Triclads.

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On some Japanese Tricladida Maricola, with a Note on the Classification of the Group.

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With 1 plate and 6 text figures.

Introduction.

Up to the present, only three species of marine Triclads have been known to occur in Japanese territories, viz., *Procerodes lactea*, *Stummeria trigonocephala* and *Ectoplana limuli*. So far I have not, as yet, been able to obtain any other species. Doubtless more will be discovered in the Empire. In the present paper I shall try to describe the anatomy of these species as fully as I possibly can. Besides, I shall avail myself of the opportunity to propose a new classification of the marine Triclads.

Before proceeding further, I wish to express my sincere gratitude to the late Professor Isao Ijima, under whose kind supervision this investigation has been prosecuted. My best thanks are due to Mr. J. T. Saunders of the Zoological Laboratory, Cambridge University, for looking over my manuscript. Also I gladly take this opportunity of thanking Baron Hamao, former President of the Tokyo Imperial University, for the stipend, without which it would have been difficult for me to carry out the work.

Procerodes lactea Ij. et Kab.

(Pl. I., fig. 1.—Text figs. 1, 4.)

Numerous specimens of this species were captured by the late Professor Ijima beneath stones on the beach between Yukanki and Meleya in the Saghalin in July, 1906.

Form.—The shape of the body in the living condition is closely similar to that of *Pr. ulvae* (Oersted) in the same state. The frontal margin is subtruncate, usually slightly crenate and gently arched in the middle parts which spread on each side into an antero-laterally directed tentacle through a gentle concavity. The tentacles are moderately long and slightly rounded at the end. The head merges into the trunk, from which it is indistinctly separated by a slight neck-like narrowing. When fully extended, the trunk is elongated and slender, and is of a nearly uniform breadth throughout, beginning to taper gradually from the region of the copulatory organs to the rounded hind end.

Size.—The specimens in the preserved condition measure 2–4 mm. in length and about 1 mm. across in the broadest part of the body at the pharyngeal region.

Colour.—The body is almost translucent milky white, due to the entire absence of pigments, much as in *Pr. lobata* (O. Schm.) The intestine and the vitelline glands can be seen with more or less distinctness, being of a reddish or brownish colour. The pharynx and the copulatory organs are also discernible to a certain extent.

Eyes.—The crescentic eyes, two in number, are situated well behind the frontal margin and separated from each other by a space somewhat longer than the distance of either eye from the lateral body-margin of the same side.

Digestive Organs.—The mouth is placed somewhat behind the beginning of the posterior third of the body. The pharynx is inserted at about the end of the anterior third of the body, being somewhat longer than one-third the body-length. The unpaired anterior main trunk of the intestine usually sends out 7 or 8 pairs of lateral branches, while the posterior trunks are provided with 14–18 outwardly directed branches.

Genital Organs.—The genital aperture is placed at a distance behind the mouth equal to about one-fifth that between the latter and the posterior body-end. The genital atrium is divided into the penis-sheath and the vestibulum by a constriction. Numerous testes, of a spherical shape, are dorsally situated in two lateral zones, beginning from the ovarian region and extending behind nearly to the end of the body. The vasa deferentia are united into a slender ejaculatory duct in the bulbous part of penis without showing any sign of vesicula seminalis. The penis is of a small conical shape, being vertically disposed in its sheath. The paired ovary is situated ventrally between the first and second pairs of the lateral branches of the anterior gut trunk. The oviducts open directly into a small outbulging of vagina at the postero-inferior aspect. The receptaculum seminis is a large spherical body, lying behind the penis. The vagina runs anteriorly and obliquely downwards to join the vestibulum from behind.

Remark.—This species seems to be nearly allied to *Pr. ulvae* and *Pr. lobata*, but may be readily distinguished from the former by the entire absence of pigments and the feature of the oviducts opening directly into the vaginal outbulging without uniting into an unpaired terminal duct, and from the latter by the different shape of the head and the absence of the seminal vesicle within the penis.

Stummeria trigonocephala (IJ. et KAB.)

(Pl. I., figs. 2, 4, 5.—Text figs. 2, 5.)

A single specimen of this species previously referred to the genus *Procerodes* was first collected by the late Professor IJIMA in 1887 from the coast of Oginohama, Prov. Rikuzen. Later, numerous specimens were obtained by myself in the estuary of rivulets in the same locality (1915), and in Itsukushima, Prov. Aki (1916).

Form.—The head presents a nearly triangular shape and merges behind into the trunk, being marked off by a gentle neck-like narrowing. The trunk gradually widens backwards to the region of copulatory organs, and then begins to taper to the posterior body-end which is somewhat rounded or bluntly pointed.

Size.—The large specimens are about 4 mm. in length, when alive and fully extended, and 1 mm. across in the widest part of the body.

Colour.—The translucent body is generally of a whitish or light brownish colour, but may present sometimes various sorts of hues—not infrequently smutty yellowish brown, yellow, orange, red, gray or green—according to the varying colouration of intestinal contents. The darkish pigments are well developed along the head-margin and most densely in the region of the eyes, bringing about a central clear space. The pharynx and the copulatory organs may fairly well appear as clear spaces. The ventral surface is of much lighter colour than the dorsal.

Eyes.—The two crescentic eyes are fairly closely approximated, but far removed behind the anterior end of the body, the distance being much larger than that of either eye from the lateral neck-margin of the same side, and the latter being a little longer than double the distance which intervenes between them ; each eye is surrounded by a small, oval, non-pigmented area.

Digestive Organs.—The mouth is situated at about the hind end of the middle third of the body. The insertion of pharynx takes place at a short distance behind the middle of the body. The anterior gut trunk is provided with 7–9 pairs of lateral branches, while the posterior trunks give off each about 10 branches on both sides, those of inner sides being very short.

Genital Organs.—The genital aperture lies nearly half-way between the mouth and the posterior body-end, and leads directly into the simple atrium. Numerous small testes, ventral in position, are arranged on both sides of lateral nerve-cords from close behind the ovaries to the pharynx-insertion, but farther behind only on the outer side of the same, ceasing altogether to exist at about the level of the mouth. The vasa deferentia fuse together in the penis bulb to form a short common duct which soon opens into the moderately wide vesicula seminalis; the latter is narrowed inferiorly into the ejaculatory duct terminating at the tip of the penis, which is of a conical shape and is subvertically disposed. The paired ovary is placed ventrally between the fourth and fifth pairs of the lateral branches of the anterior gut trunk. The oviducts of both sides open separately into the vaginal canal. The receptaculum seminis holds a position posterior to the penis, giving rise at its antero-superior part to the vaginal canal, which runs down to open into the genital atrium from behind.

Remark.—The present species seems to be most nearly allied in the external features to *Pr. graciliceps* from Hongkong and *Pr. trilobata* from Avatscha in Kamtschatka, which were described in 1857 by STIMPSON (56) under the name of *Fovia.* To me it appears, judging from the description, that the worm in question stands somewhat at variance from both the species in a few respects. The head is in *Pr. graciliceps* of a triangular shape, much the same as in the present species, but is wholly devoid of any trace of pigments. In *Pr. trilobata* the head seems to present a similar appearance in shape, but a black transverse line exists at a point behind the eyes, unlike in *St. trigonocephala.*

Ectoplana limuli (IJ. et KAB.)

(Pl. I., figs. 3, 6–8.—Text figs. 3, 6.)

Numerous specimens of this species were collected in 1889 by Professor KISHINOUYE at Ajino, Prov. Bizen, and in 1916 by myself at Yobimatsu in the vicinity of the same place. The worms occur in abundance on *Limulus longispina,* attached mostly on the hard surface of the proximal segments of the cephalothoracic appendages as well as on the gill-books.

Form.—The body in the creeping state is elongate-slender, nearly uniformly broad almost throughout its length, and is narrowed at both its bluntly pointed ends. The tentacles are altogether absent.

Size.—The large specimens measure 4–6 mm. in length by 0·7–1 mm. in the broadest part when fully extended.

Colour.—The living animals are generally of a uniform milky white colour, but sometimes light brown, according to the character of intestinal contents. Any trace of pigments can nowhere be detected. In the hind region there usually exists a light spot which doubtless shows the position of the copulatory organs.

Eyes.—The two crescentic eyes are closely approximated and situated far behind the head end, the distance between them being about half that from the eye to the lateral margin of the head of the same side.

Digestive Organs.—The mouth is situated nearly between the middle and the posterior thirds of the body. The insertion of pharynx takes place at a short distance in front of the middle of the body. The anterior main trunk of the intestine is provided with 8–10 pairs of lateral branches, while the posterior trunks are usually united at the hind end, each giving off at least 16 lateral branches.

Genital Organs.—The genital aperture lies in front of the middle of the posterior third of the body. The genital atrium is divided into two chambers ; the vestibulum presents a vertically ascending and laterally outbulging and wide lumen. Numerous testes are situated ventrally along both sides of the anterior gut trunk, extending from the ovaries to the dividing point of the gut trunks. The vasa deferentia are united in the upper part of the penis bulb before opening into the vesicula seminalis, which is not wide, passing below into the slender ejaculatory duct. The intromittent part of the penis is of a conical shape and is subvertically disposed. The paired ovary is spherical in shape and occupies a ventral position between the first and second pairs of the gut branches. The oviducts open separately into the genital vestibulum at the upper end, where the small receptaculum also opens by a short stalk (vagina) from behind.

Anatomy.

Integument.

The epidermis consists, as usual, of ciliated cuboidal or cylindrical cells which vary in height not only in different species but also in different body parts of the same individual, largely depending upon the condition of expansion or contraction of the worm. It is generally thickest on the dorsal surface, and as it passes over to the ventral surface, gradually becomes thinner as far as the middle line, it measuring in *Pr. lactea* 12 μ dorsally, 8 μ ventrally ; in *St. trigonocephala* 8 μ dorsally, 5 μ ventrally, and in *Ect. limuli* 9 μ dorsally, 7 μ ventrally.

The protoplasm of the cell is generally fibrillated, as observed by a number of investigators. The courses of the fibrillae are more or less irregular, though in a general way perpendicular to the surface. Frequently, but not always, they form a network, in which the spherical or ovoid nucleus, as a rule, lies near the base or the middle of the cell, but not constant. The nucleus appears to contain a distinct chromatic network in a definite membrane. Besides, the epidermal cells are more frequently full of minute rhabdites.

The cilia covering all over the epidermis are much more strongly developed ventrally than elsewhere. In some preserved specimens the dorsal surface is often wholly destitute of them. In fixation, they become matted together to form a tangled mass, in which it is difficult to observe individual cilia. Where they are inserted in the epidermis, the characteristic basal swellings give the appearance of a very thin dense layer at the surface, which has been interpreted by some investigators as a cuticula. Although it is very difficult to determine the precise relation between the cilia and the protoplasmic striations of the epidermal cells, the basal extensions of the former may probably be continuous with the latter striations.

Generally the epidermis comprises a number of interstitial cells, usually known as Böhmig's "Klebzellen," which are characterised by the perforation of the glandular ducts as well as by the complete absence of cilia and rhabdites. The cells are more or less higher than the general epidermal cells, and form a narrow zone completely surrounding the body just within the lower ventral margin. This submarginal zone is broad in the anterior region, distinctly narrower in the tail, and very narrow along either side of the body. The cells are not glandular, but perforated by the ducts of glandular cells which are deeply embedded in the parenchyma below the dermal musculature. Besides, there exist some similar cells here and there in scattered distribution, chiefly over the ventral surface of the body. By means of the secretion the worm is able to adhere with surprising firmness to a smooth surface, quite a strong jet of water being necessary to displace it.

Besides, the epidermis also holds in the tentacular and frontal regions special cells, designated under the name of sensory cells, which are provided with well developed cilia, but completely devoid of rhabdites. In the case of *Ect. limuli* they show no nuclei. As usual, the cells exhibit to a considerable extent a fibrillous structure, the fibrillae appearing to stand in connexion with nurofibrillae. Besides, any special sensory cells, demonstrated by Böhmig (5) in *Pr. ulvae* and *Planaria gonocephala*, could not be brought under observation.

Now as to the epidermis or epithelium of the Plathelminthes in general. In some Triclads there can frequently be recognised a special epidermis, in which no nuclei are present at all, much as in the Trematodes and Cestodes. Some authors [Seidl (55), Sabussow (51) and Böhmig] observed the case in the frontal sensory part of the body in several species (*Sorocelis stummeri*, *S. gracilis*, *S. lactea*, *S. sabussowi*, *S. rosea*, *Planaria wytegrensis* and *Procerodes ohlini*). Especially it is of great interest that in the hitherto known limulus-infesting *Bdelloura*- and *Syncoelidium*-species no trace of nuclei could anywhere be detected in the epidermis which is a homogeneous and ciliated layer, and is also wholly devoid of rhabdites, except in one species of *Bd. propinqua*. The nucleus containing parts are sunk into the parenchyma immediately below the dermal musculature. In vertical sections, it is impossible to distinguish cell-boundaries with ease, but in tangential ones, polygonal spaces are apparent, which probably represent the callular character. So far as my observations go, similarity can be demonstrated in the frontal sensory region only in *Ect. limuli.* In the species examined there occurs no indication of the cuticular wall observed in several forms by WILHELMI (71) and others.

Turning attention to the variations, pointing out the resemblance between the insunken epidermis of the Turbellaria and the 'epidermis' of the Trematodes and Cestodes, the probable descendants of the former group, von GRAFF (24) has stated as follows:—"Berücksichtigt man, dass in der ursprünglichsten Familie (Geoplanidae). . . . . . .ein normales Epithel angetroffen wird, so kann man in den eingesenkten Epithelien überhaupt und speciell in dem der Kriechleiste nur einen secundären Charakter erkennen—einen Charakter, der erst in den beiden am weitesten differenzirten Familien der Rhyncodemidae und Bipaliidae auftritt und bei letzterer seinen höchsten Ausbildungsgrad erreicht hat. Hier ergreift der Process der Einsenkung bei manchen Formen, wie *Plac. kewensis*, das gesammte Körperepithel und man könnte sagen, dass diese Species und die ihr im Bau des Epithels zunächststehenden Bipaliiden im Begriffe sind, die Epithelform der Trematoden und Cestoden zu acquiriren." In the endoparasitic Trematodes and Cestodes the body is generally invested by a cuticular wall, while in the ectoparasitic Trematodes regarding as the probable intermediate group of the former groups and Turbellaria there appear to be found some epidermal variations. The epidermis retains in some cases either the cellular or the cuticular feature over the whole surface of the body. Frequently there occur some species, in which the cuticular wall partly consists of the cells, or contain a number of nuclei at irregular intervals, as for example in the primitive cestode *Amphilina*—SALENSKY (52) as well as in several Trematodes (*Bucephalus*—ZIEGLER (76); *Cercaria*—SCHWARZE (54), HECKERT, 1889; *Monostomum mutabile*, BRAUN (8); *Nemathobothrium molae* and *Distomum*—MACLAREN (42); *Cotylogaster*—NICKERSON (46), etc.) In some specimens it is found that the cuticular wall, in its earliest stage, is composed of the cells which in later stages become the cuticula, the cytoplasma changing its character and the nuclei being obliterated gradually. To judge from the epidermal variations just mentioned, it seems that the Turbellarian epidermis is homologous with the cuticular wall of the Trematodes and Cestodes, as pointed out by Lönnberg (40), Ziegler (77) and others. Further, the fact, which will be set forth in the paragraph concerning the atrium, probably affords a strong support for this view.

Rhabdites.—As is well known, the epidermal cells contain numerous rhabdites as a peculiar content, the rhabdites lying near the free surface of the cells and chiefly occupying the distal half. Some of the rhabdites may sometimes reach the basement membrane. Usually their major axis is approximately perpendicular to the surface and nearly parallel to one another, but they may sometimes assume any angle with one another. In *St. trigonocephala* they are found in a very small number, evidently situated between the epidermal cells. In *Pr. lactea* and *Ect. limuli* the epidermis is full of rhabdites usually within, and rarely between, the cells. Generally the rhabdites occur in great abundance, so that the epidermis appears at one glance to be composed of them, on the dorsal surface, up to the lateral margin of the body, where the body-glands open to the exterior, and where they abruptly cease. They are, however, altogether absent in the sensory regions, and become remarkably fewer in number on the ventral surface, disappearing altogether around the genital aperture.

As stated above, the epidermis is full of the rhabdites which are all of one kind, but vary in size. The variations occur wherever the rhabdites are found. Generally speaking, however, there is an interesting correlation between the thickness of the epidermis and the size of them, as mentioned by Woodworth (74). The rhabdites are invariably longer on the dorsal than on the ventral side. their length measuring on the average in *Pr. lactea* 6 μ dorsally by 4 μ ventrally, and in both *St. trigonocephala* and *Ect. limuli* 4 μ dorsally by 3 μ ventrally. Each is generally of a slightly curved fusiform shape, bluntly pointed at both ends, and more or less slender in the latter two species than in the former. In general, they are deeply stainable with borax-carmine, and when stained with haematoxylin-eosin, they take on a violet colour. They are of a perfectly homogeneous and strongly reflective nature, presenting no peculiar structure.

Of interest is the complete absence of rhabdites in the previously recorded limulus-infesting Bdellourid-species, except one form of *Bd. propinqua*, in which they are but rarely found. However, they are in *Ect. limuli* very abundant on the dorsal side.

The formation of the rhabdites has long been a much debated question. By a number of investigators it was alleged that they originate only in cells, found scattered in the body-parenchyma directly inwards to the dermal musculature; while a few writers [Böhmig (5), Ude (55), Weiss (61)] assumed their formation to be partly in the subcutaneous cells and partly in the epidermal cells. Now I am apt to acknowledge the latter view. In the species examined, the rhabdite-forming cells are scattered in the parenchyma immediately near, or farther inwards to, the epidermis, as observed by some authors. The passage by which the rhabdites reach the epidermis through the parenchyma and the basement membrane could frequently be brought under observation. In both *Pr. lactea* and *Ect. limuli* the subcutaneous cells are found sparsely in the parenchyma, in spite of the abundant occurrence of rhabdites in the epidermis. To my mind, the fact probably stands in favour of the view that the formation of rhabdites takes place partly in the epidermal cells.

The question concerning the physiological meaning of rhabdites has also been long debated on by naturalists. Some writers considered the rhabdites as homologous to the nematocysts of Coelenterates, whereas more recent authors would ascribe them to the equivalents of gland secretions. I entirely concur with the latter opinon. The rhabdites are given off freely on the dorsal as well as on the ventral surface. When they are discharged a sticky gelatinous fluid is poured out with them. If the worm be placed in a dish with a very little water, or irritated in any way, a rapid discharge takes place, and the worm becomes enclosed in a whitish coating to protect itself. It is quite likely that the secretion being perhaps poisonous may have some effect in entangling or disabling the prey. As mentioned by Woodworth, Böhmig and others, the rhabdites are, I believe, of use to the worm in securing food as well as for offensive and defensive purposes.

Basement Membrane.

Immediately inwards to the epidermis comes the basement membrane which is in most place a well marked layer, and varies in thickness according to individuals and to parts of an individual. Generally the membrane is somewhat thicker on the dorsal side than on the ventral and grows thinner as it passes over to the ventral side. Its thickness cannot be measured with any accuracy, the extremes, however, being 1 μ and 4 μ. It seems to be somewhat thicker in *Ect. limuli* than in other two forms, of which I have treated. Judging from the varying reaction to stains the membrane is apparently differentiated microchemically from both the parenchyma and the epidermis. In carmine or haematoxylin preparations it is always much more stainable than the epidermis and the parenchyma, and is distinctly marked off from both. The membrane appears in vertical sections nearly homogeneous, showing no granular feature, but it apparently presents in horizontal sections a fibrillated appearance. The course of the fibrillae, though more or less irregular, is, on the whole, parallel to the body surface and thus at right angles to the fibrillae of the epidermal cells. Externally the basement membrane presents a fine scalloped appearance, which may probably be due to the insertion of the epidermis; internally it is less sharply differentiated from the parenchyma, and fine striations, forming a loose meshwork, run out of the membrane to the latter.

Woodworth (74) believes the basement membrane of *Phagocata gracilis* to be a hypodermal product. However, my own observations of the fibrillous nature of the membrane seem to render more evident its probable continuity with the parenchyma. Genetically therefore it belongs to the parenchyma rather than to the epidermis, as mentioned by several authors.

Musculature.

The dermal musculature presents nothing peculiar, and consists, as is well known, typically of three sets of fibres, viz., the circular, the transverse and the longitudinal. The outermost circular muscles form a very fine layer directly beneath the basement membrane, and appear in sagittal sections of the worms as minute dots. In immediate contact internally with this there can be recognised a delicate layer, in which the fibres are arranged in two ways, one runs from the right to the left backwardly, the other from the left to the right backwardly. They cross perpendicularly with each other, and the fibres in the same ways are nearly parallel to each other with some distance. It is very hard to distinguish those fibres, though we are positively able to demonstrate them in horizontal sections. Inwards to the layer there exists a layer of the longitudinal fibres, which is the most developed of all the muscular layers of the body, and appears associated in distinct and quite regular bundles. The fibres in bundles extend from one end of the body to the other, without or very rarely with anastomosing system, and are much more strongly developed on the ventral than on the dorsal side. In the species examined, the musculature of *Ect. limuli* is much better developed than that of the others.

In our forms the body muscles, also calling parenchyma muscles, exactly coincide for the most part with those of the species studied by Böhmig. As usual, several kinds of fibres can be distinguished, viz., the dorso-ventral, the oblique dorso- and ventro-lateral and the oblique longitudinal. Of these the dorso-ventral muscles are very strongly developed in the species, with which I have dealt. In the lateral portion of the body there are also distributed two kinds of the oblique transverse muscles, the first running dorso-laterally, the second ventro-laterally. As stated by Böhmig, the oblique longitudinal fibres are present, confined to the frontal part of the body, but they are so weakly developed that I have not been easily able to demonstrate them. Besides, some fibres, regarded as the retractor or protractor of the pharynx, pass oblique longitudinally from the root of the latter organ, through the parenchyma to the dermal musculature. The numerous fibres are peculiarly distributed in *Ect. limuli* around the atrial chamber apparently without order, running irregularly and outwardly in the parenchyma (Pl. 1. fig. 8.)

In structural respects the muscle fibres show nothing peculiar, and consist, as usual, of the inner granular and the outer fibrillous layer. The latter is more strongly stainable than the former.

Parenchyma.

The parenchyma constitutes the greater portion of the body-substance, occupying all the interstices between the various organs. It generally consists of two sorts of cells, one of which, subject to considerable variation in form, is usually multipolar. In each there exists an ovoid or rounded nucleus. Processes of these cells come into connexion with one another, giving the appearance of the sponge reticulated fibrous connective tissue. The other is rounded or ovoid cells, the plasma of which is very finely granular and nearly homogeneous. They are usually designated under the name of "stamm" or "formative" cells, and are easily distinguished by a somewhat larger nucleus containing chromatin in noticeable abundance. They lie chiefly in the lateral parts of the body and take part in the regeneration or the formation of the tissue, as mentioned by several authors.

In *St. trigonocephala* the pigments, which are of somewhat coarse granules and of a dirty greenish colour, occur abundantly in the anterior region, as already stated. In the deeper tissue, below the dermal musculature, the granules are intercellular in position, never intracellular, and considerably well developed in the region of eyes. No sign of pigments was detected in the epidermis, unlike *Heterochaerus australis*, and also no special pigment cells are anywhere present.

Body Glands.

Embedded in the parenchyma are numerous glands, in which we are generally able to distinguish three groups of the body-, pharyngeal and genital glands, as I shall call them. As to the glands which stand in intimate relation with the pharynx and the genital organs, I would desire to give a note in the paragraph concerning those organs.

As usual, the body-gland is composed of two kinds, viz., the numerous eosinophil and the sparse cyanophil. The eosinophil glands are very diffusedly but not uniformly distributed in the parenchyma on each side of the body and open externally in the narrow submarginal zone of the ventral surface, as already stated. Of the species examined, in *Ect. limuli* they are most well developed. A large accumulation of the glandular cells exists near the anterior body-end. The deep ends of them are located behind the brain, and in passing over the latter they run downwards and forewards up to making their way to the ventral surface of the head close to its anterior margin. Again, such a similar but smaller cluster of the glandular cells is found at the posterior extremity of the body, and they open out on the posterior edge.

The glandular cells are, as usual, of a rounded or pyriform shape, and contain a homogeneous or finely granular substance. In haematoxylin-eosin preparations they stain violet in *Ect. limuli*, but deeply red in others. Each is prolonged on one side into a long slender duct; the ducts unite often with one another to form larger ones and then again to separate into numerous fine ducts near the dermal musculature just before opening submarginally on the ventral surface.

Between the eosinophil glands there occur the cyanophil, which are but rarely found. They are recognisable with more or less distinctness in *Ect. limuli*, chiefly in the brain region, as compared with those in *Pr. lactea* and *St. trigonocephala*, in which they cannot be found with ease. The shape of the cells varies to a considerable extent, but is, as usual, round or pyriform. In haematoxylin-eosin preparations they usually take on a somewhat deep violet colour. They open to the exterior at various points of the entire body-surface.

The unicellular glands undoubtedly secrete mucus and help to attach the body of the worm more securely to objects or the host, as can be seen when one attempts to displace the worm from the latter. Moreover, it is very allowable to conclude that the mucus is used by the animal as a means of movement. The worms are able to move by the action of the cilia in the mucus layer between the ventral surface of the body and the substratum.

Digestive System.

The digestive system consists of the mouth, the pharyngeal chamber, the pharynx, the glands which come into connexion with the pharynx, and the intestine.

The mouth is a small opening situated on the ventral side nearly between the middle and the posterior thirds of the body, as already noted down, close to the termination of the pharyngeal chamber. It is lined with a definite one-celled layer, being somewhat higher than the epidermis of the ventral surface. The rhabdites are altogether absent around the mouth, and the cilia are confined to the outside of the mouth. Beneath the epithelium comes a basement membrane and layers of circular and longitudinal muscular fibres, of which the layer of circular muscles are remarkably well developed.

The mouth leads into the pharyngeal chamber, the lining of which is very flattened and rests on a very delicate basement membrane, next to which exist feeble muscular layers consisting of outer circular and inner longitudinal fibres. Towards the base of the pharynx these muscular layers gradually increase in thickness to a considerable extent and stand in direct continuation with the circular and longitudinal muscles of the pharynx. Unlike in *Bd. candida*, no evidence of the insunken epithelium was found in my own sections.

Pharynx.—The pharynx, protruding into its chamber, is as usual, a cylindrical body, of which the ratio to the body-length is as follows: in *Pr. lactea* nearly 1: 3, in *St. trigonocephala* 1: 6 and in *Ect. limuli* 1: 4·5.

So far as my observations go, there exists no essential difference in structural respect; nine layers can be clearly made out, as stated by Böhmig. For the sake of convenience they may now be distinguished into three zones, viz., the outer, the middle and the inner.

Outer Zone.—Externally the thin epithelial plate of the pharynx is, as usual, covered by a ciliary layer which disappears on the lip of the organ, where the ducts of the pharyngeal glands open out. Immediately beneath the epithelial plate is a delicate basement membrane and the musculature consisting of two layers of outer longitudinal and inner circular fibres. Generally the musculature is very well developed near the proximal portion of the pharynx and gradually diminishes in thickness towards the tip of the pharynx. The sets of fibres are much better developed in *Ect. limuli* than in the other species examined by me. Directly below the circular muscles there occur numerous nuclei which, in my opinion, seem partly to belong to the epithelium, and partly to be remnants of cells producing muscular fibres.

Middle Zone.—This part consists chiefly of parenchymatous connective tissue traversed lengthwise or crosswise by several elements, such as glandular ducts, nerve plexus and muscular fibres, which predominate generally to an extraordinary degree. Embedded in the parenchyma near the intestinal mouth are numerous pharyngeal glands in which, as is well known, two sorts can be distinguished, viz., the cyanophil and the eosinophil. The latter glands stainable violet with haematoxylin-eosin are abundantly distributed somewhat in front of the former which occur in a sparse number close near the pharynx-insertion and take on a deep red colour. These glandular cells vary in form, being usually pyriform. The efferent ducts of the cyanophil glands are formed into a strong compact bundle on entering the pharynx, and they run, immediately beneath the outer zone, the whole length of the pharynx and finally open into the pharyngeal chamber at the tip of the organ. Besides, they send out some fine efferent ducts, which open here and there in scattered distribution over the external surface of the pharynx. Similarly the ducts of the eosinophil glands, forming a large bundle, proceed nearly parallel to the above with some distance between to open at the tip of the pharynx. Both the bundles of the ducts just mentioned are separated from each other by a zone of connective tissue traversed by plexus forming nerves.

The nerve plexus is much more conspicuous in the posterior half of the pharynx than in the anterior and for the most consists of several nerves connecting almost perpendicularly with one another. The longitudinal nerves run nearly parallel to the external surface of the pharynx. In *St. trigonocephala* there exists a strongly developed nerve ring nearly between the middle and the posterior thirds of the pharynx, much as in *Pr. lobata.* In *Pr. lactea* three fairly well developed nerves are seen, which probably represent the rings, but in *Ect. limuli* I have failed to recognise a similar ring.

Besides, this zone is traversed by numerous radial muscular fibres which run from the inner epithelium to the outer, but never occur in any definite bundle. Between these radial fibres there are a few nuclei which are exactly similar in appearance to those of the general parenchyma. Only in sections of *Ect. limuli* I have also been able to find out a few loops of excretory canals which were already demonstrated by some authors in the pharynx of any other forms.

Inner Zone.—In structural respects this zone is apparently analogous to the outer. The lining epithelium of the pharynx lumen is continuous with the external. In both *Pr. lactea* and *St. trigonocephala* the nuclei are displaced at about anterior one-third in the muscular layer of circular fibres immediately beneath the epithelium, while in *Ect. limuli* they are altogether absent in the whole internal epithelium. This muscular layer is developed to a considerable extent near the middle of the pharynx and is composed of numerous rows of fibres which are much more powerful in both *Pr. lactea* and *Ect. limuli* than in *St. trigonocephala.* Directly below this layer there exist longitudinal fibres in two or more rows. Generally the thichness of the musculature diminishes towards either end of the pharynx. Quite similar to any other forms, retractor and protractor muscles pass from the pharynx through the parenchyma to the muscular layers of the body-wall, as already described.

Intestinal System.—The intestine shows a characteristic differentiation into an unpaired anterior and paired posterior trunks, but it deviates in *Ect. limuli* somewhat from the normal type, as will be described later. In general, the anterior trunk extends to a point in front of the brain and usually sends out some lateral branches on either side, numbering 7 or 8 in *Pr. lactea*, 6–9 in *St. trigonocephala* and 8–10 in *Ect. limuli.* The first branches occur in both *Pr. lactea* and *St. trigonocephala*, sometimes in front of the brain. In *St. trigonocephala* the branches are subdivided before reaching the lateral margins of the body ; while in the others they show little tendency to subdivide, except at their tips, where they are sometimes bi- or trifurcate. The posterior trunks proceed, one on either side of the pharyngeal chamber, towards the posterior body-end, where they unite together only in the case of *Ect. limuli*, but remain separate in others. They are provided with numerous diverticulae which have even less tendency to bifurcate than those of the anterior trunk, their number being 14–18 in *Pr. lactea*, 10–15 in *St. trigonocephala* and 14–16 in *Ect. limuli.*

Among the marine Triclads, *Syncoelidium pelucidum* HALLEZ is known to me as exhibiting a union of the posterior trunks, the trunks fusing behind the vestibulum. From the point of union an unpaired stem possessing a few minute diverticulae on either side proceeds towards the posterior body-end, much as in *Dendrocoelum nausicaæ*, a fresh-water species, in which the fusion is brought about by a confluence of a pair of mesial diverticulae, and not by a fusion of the trunks themselves. Behind the union, however, no unpaired stem is seen in *Ect. limuli*, in which the trunks unite together at the ends. Of course, the fusion is of a most different nature from that found in *Bd. candida*, in which it occurs between mesial diverticulae, thus forming a connection between the trunks, like the horizontal bar which joins the two upright pieces in the letter H. Also the gut branches of *Micropharynx parasitica* Jägerskiöld are numerously subdivided and anastomose, quite similar to the appearance that occurs in some Polyclads (Pseudoceridae, Euryleptidae, etc.). Any sign of such an anastomosis could nowhere be found in *Ect. limuli.*

The intestinal cavity is lined by a continuous epithelium consisting of two sorts of cells, one of which constitutes the greater portion of the lining while the other is glandular. In most species the former cells are always either columnar or nearly conical and appear vacuolated at the distal portion. The nucleus always lies close to the basal portion, where the protoplasm is very finely granular and deeply stainable. Besides, the cells contain numerous granules of small size. In some specimens of *St. trigonocephala* the cells are found to contain various granules but in a sparse number. Between those cells just mentioned there exist the goblet-shaped glandular cells which are well known as Minot's glands. They are full of coarse granules of homogeneous substance, deeply stainable with eosin and orange-G, and having strongly refractive powers. The cells occur more abundantly in the epithelium of the main trunk than elsewhere.

In the planarians digestion is regarded by Ijima (29) and others as taking place intracellularly. According to Arnold (1), however, the food taken in is in all probability inter- and intracellularly digested. As to the intercellular digestion he says as follows: "The intercellular digestion is limited to fat. The fat is broken down in the lumen of the intestine by the secretion of the goblet-cells into fatty-acids, which are then absorbed by the columnar cells and synthesised again into neutral fat.

"Most of the fat is digested in the cytoplasm of the columnar cells, but some of it is extended into the parenchyma at their base, and appears in the yolk cells and in the wandering cells." Concerning this subject I have now little to add to what has been written. The digesting product can pass into the tissue only by osmosis and filtration.

Respiration is regarded as being carried on in these worms by means of the digestive tract. However, the life and growth of the worm piece lacking either the mouth or the pharynx seem to me to suggest that it can breath with the whole extent of the skin.

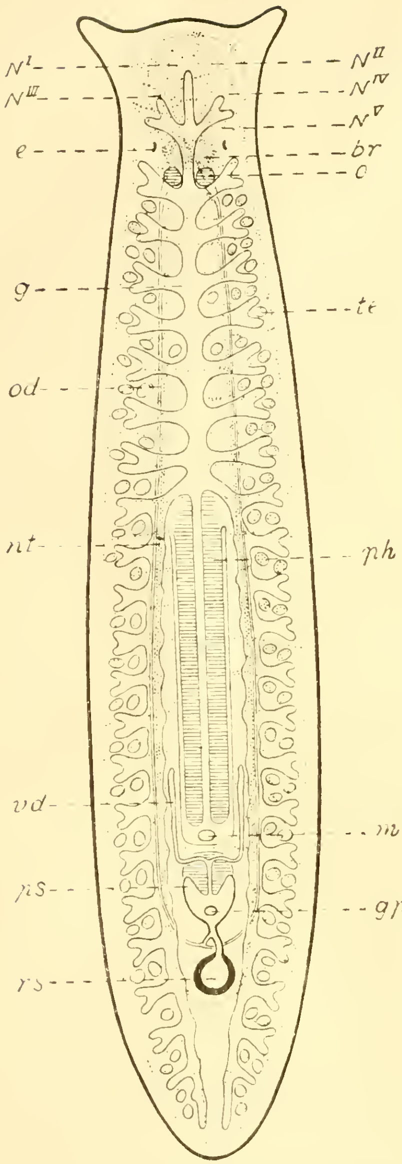
Excretory System.

Of the excretory canals I have been able to obtain no more insight than a few loops at some points in the dorso-lateral parts of body. So far as my observations go, the system in *Pr. lactea* appears to exhibit an arrangement that is generally characteristic of *Procerodes.* Dorsally there exist two main vessels on either side of tho body which are directly connected with one another by means of anastomosis, thus presenting an irregular network. The main vessels send out at various points numerous ducts generally perpendicular to the surface, which open to the exterior at between the epidermal cells. Generally an epithelium seems to be present in the ducts, but in some cases the wall is not sharply differentiated from the surrounding parenchyma. In sections I have seen no evidence of a definite epithlium.

Nervous System.

The nervous system of the species, upon which my observation was based, agrees in the main parts with that of other Triclads and is represented by the central parts consisting of the brain and the longitudinal trunks as well as by the peripheral part.

Each longitudinal nerve trunk gradually widens anteriorly and passes over a brain mass, those of both sides being connected by a number of strong commissures. So far as I have examined, the morphological point of distinction between both the central parts could not be ascertained with ease, but it seems probable that "die Abzweigungsstelle der sog. vorderen Längsnerven" presents such a point, as pointed out by Böhmig. The brain has the same appearance as that of other Triclads, but



Text fig 1. *Procerodes lactea.* Diagrammatic representation of the organization of an entire worm, as seen from the dorsal side.

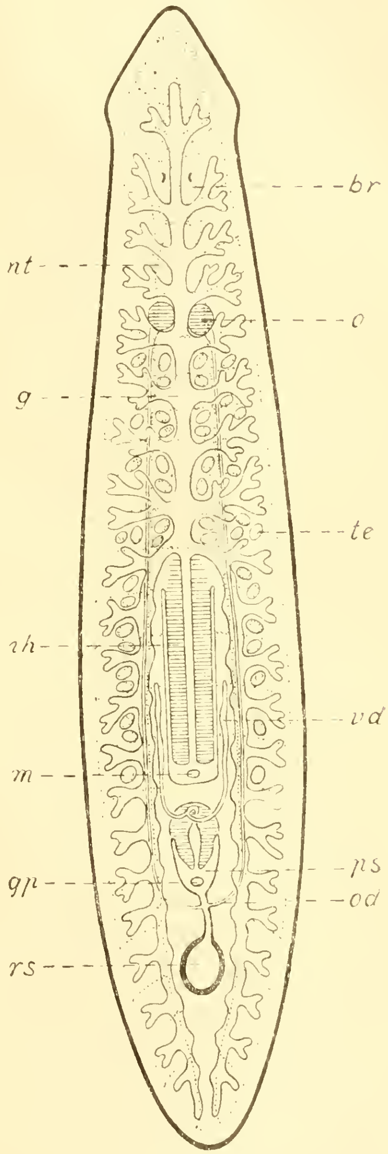
br brain, *e* eye, *g* gut, *gp* genital pore, *m* mouth, N^I–N^V sensory nerves arising from the brain, *nt* longitudinal nerve trunk, *o* ovary, *od* oviduct, *ph* pharynx, *ps* penis-sheath, *rs* receptaculum semins, *te* testis, *vd* vas deferens.

it is subject to variations to some extent in different species and genera.

Brain.—*Pr. lactea* (Text fig. 1). The brain is formed on the same plan as that of *Pr. ulvae.* Each half, connected with its fellow by three strong commissures, is nearly of a pyramidal shape, and consists, as usual, of three ganglia. From each brain mass arise some six sensory nerves directed forwardly and laterally. The innermost nerve (N^I), taking its origin at the anterior corner of the brain mass, proceeds forwards on the ventral side just inside the dermal musculature. Laterally following to this is present the second nerve (N^{II}) which proceeds forwards and appears to stand in connexion with the dorsal longitudinal trunk on the marginal nerve, much as in *Pr. ulvae.* The following third and fourth nerves (N^{III}, N^{IV}) branch repeatedly and extend anteriorly to the tentacular region. Besides, among the other two sensory nerves given off from the lateral part of the brain mass, the anterior (N^V) pursues a course laterally directed, and the posterior reach the eye. Furthermore, immediately below the innermost nerve N^I, so that the definite distinction could not be demonstrated with any satisfaction to myself, there exists the fine anterior longitudinal trunk which is continuous with the posterior trunk. Those of both sides are connected together by three fine transverse commissures in the brain region. Anterior to these there are present at least four transverse commissures between the trunks. Lateral nerves are given off from the points of insertion of the commissures in the longitudinal trunk, and proceed, without branching, to the body-margin, where they join the marginal nerve plexus.

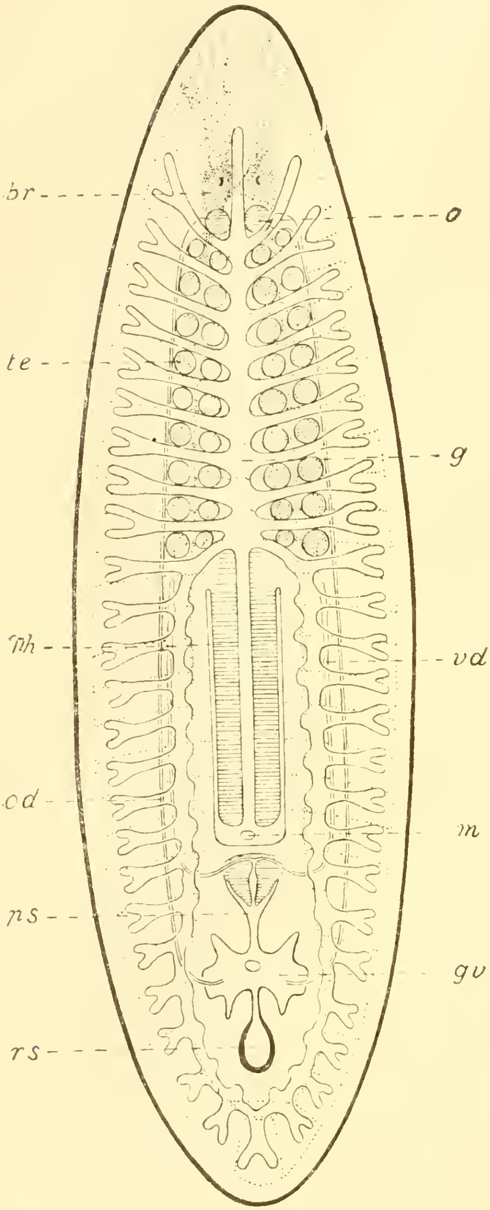
The dorsal nervous system seems to have in the brain region the same appearance as in *Pr. ulvae.* However, nothing more than three lateral nerves could be brought under observation.

St. trigonocephala (Text fig. 2). The material of this species is in a state unfit for close study, hence I will limit myself to a general appearance of the brain. The brain lies fairly far behind the anterior body-margin, unlike the other forms, and has the same appearance as in the preceding species. The right and left halves of the brain are connected by three strong commissures. Each brain mass gives rise to at least



Text fig. 2. *Stummeria trigonocephala.* Diagrammatic representation of the organization of an entire worm, as seen from th dorsal side.
Index letters as in text fig. 1.

five sensory nerves which break up into branches, as they proceed towards the anterior body-margin. Besides, from the postero-lateral region of the "Substanzinsel" arises a nerve extending to the eye. The arrangement of the anterior longitudinal nerve trunk seems to be quite similar to that of the preceding, and some, at least seven, fine transverse commissures occur between the trunks of both sides in front of the three commissures found immediately beneath the brain.



Text fig. 3. *Ectoplana limuli*. Diagrammatic representation of the organization of an entire worm, as seen from the dorsal side.
gv genital vestibulum.
Other letters as in text fig. 1.

Ect. limuli (Text fig. 3; Pl. I., fig. 6). The brain conforms closely to the type found in *Bd. candida*. Of interest is the presence of a fine transverse commissure (*nx*) immediately anterior to the ordinary strong commissures of the brain. From each brain mass arise five sensory nerves, excluding the optic nerve. The anterior longitudinal trunks (*na*) are connected together by a few transverse commissures (*nc*), at least six in number, throughout their whole length, straight from trunk to trunk. Unlike the preceding two species there exist no three special transverse commissures in the brain region. From the main trunks, at points of insertion of the transverse commissures in the trunks, are given off lateral nerves (*nl*), which join the marginal nerve plexus (*nm*). The dorsal longitudinal nerve trunks appear to take their origin from the marginal nerve at points of exit for the ventral anterior longitudinal trunks, and pursue a backward course directly below the sheet of the dermal musculature. They are connected together by a number of transverse commissures and with the marginal nerve by the same number of lateral nerves, quite similar in appearance to the ventral anterior longitudinal nervous system.

Crowded around the fibrillous mass of the brain are numerous large nuclei containing ganglionic cells easily stainable. The cellular coating is generally much thicker on the ventral than on the dorsal side. The sensory nerves are also seen with their setting of ganglionic cells, which are generally either unipolar or more commonly bi- or multipolar. Each brain mass is invaded by a peculiar tissue well known as "Substanzinsel", which consists for the most part of the ganglionic cells beset with connective tissue and is traversed by some dorso-ventral muscular fibres.

Posterior Longitudinal Nervous System.—As usual, there exist three pairs of longitudinal nerve trunks, viz., ventral (*nt*), dorsal and lateral (*nl*). Of these the ventral trunks are the most important and are developed to a considerable extent. Behind the brain they generally proceed, running nearly parallel to each other, until near the copulatory organs and then gradually approach to each other. Only in *Ect. limuli*, however, they are separated in the region of the copulatory organs from each other, because of the remarkable enlargement of the vestibulum. The longitudinal trunks are connected together by a number of transverse commissures, straight from trunk to trunk, sometimes with, sometimes without branching in their passage, much like a rope ladder. Some of the commissures are much more well developed than others and these most frequently occur immediately behind the pharynx and the copulatory organs. The longitudinal trunk of either side is also connected with the marginal nerve of the same side by means of a very regular series of lateral nerves given off usually from the main trunk at points opposite to the union of the latter with transverse commissures. The marginal nerve, forming a plexus, runs all round the body submarginally on the ventral side. Between the transverse commissures and the lateral gut diverticulae there exists no fixed relation in number, so far as my observations go. The number of commissures is, of course, never constant in the different individuals of the same species. In the specimens, from which the figures were taken, the number of commissures, exclusive of those bridging the space between the anterior longitudinal trunks, is shown in the accompanying table.

Species.	Number of commissures.	Length of worms in the preserved state.	Maturity.
Pr. lactea.	26	3.25 mm.	Sexually mature.
St. trigonocephala.	20	3.82 "	" "
Ect. limuli.	28	4.53 "	" "

The dorsal longitudinal nerve trunks, briefly noted down in the section concerning the brain, proceed towards the hind end just underneath the sheet of dermal musculature. Each is connected on the one hand with its fellow by a number of fine transverse commissures and on the other with the marginal nerve of the same side by means of lateral nerves given off from the trunk, quite like the ventral nervous system. Besides, the connexion between both the dorsal and the ventral nervous systems is effected by means of vertical nerves running dorso-ventrally, as was demonstrated in several species by Böhmig.

The nerves show the somewhat reticulated appearance so commonly described by various authors. Now I have little to add to what has been written in detail by Böhmig. Embedded in the nerves are numerous ganglionic cells at various points.

Sensory Organs.

The organs considered to be sensory organs are the tentacles or the corresponding anterior parts which are devoid of rhabdites as well as pigments and the eyes.

Tentacles.—The antero-laterally directed appendages projecting from the frontal margin are generally shown as tentacles, which are found only in *Pr. lactea* among the species examined by me. Unlike *Pr. ohlini*, the epidermis of this part is composed of normal ciliated cells which always contain no rhabdites and pigments. In *St. trigonocephala* also the epidermis has the same appearance at the anterior end of the body ; while in *Ect. limuli* it is wholly devoid of nuclei which have sunk into the parenchyma just beneath the sheet of the dermal musculature. The minute structure of the cells has already been described in the part dealing with epidermis. No peculiar sensory cell has come under my observation at all.

Eyes.—Generally two eyes lie on either side of the median line on the dorsal surface in the anterior region. They are embedded in the parenchyma. In *Pr. lactea* the eyes are situated at a little distance from the brain mass, but in *St. trigonocephala* and *Ect. limuli* either near or close to it. They are usually of an ovoid or crescentic shape. So far as my observations go, the structure shows no differenee in essential respects from that observed in *Pr. ulvae* by Hesse (28). We can distinguish two elements of which a single eye is formed, viz., the pigment cup and inside the pigment cup the retina cell (Pl. I., fig. 4, *rc*). The pigment cup is composed of only a single cell which shows a crescentic appearance, as recorded by Hesse. On the lateral side of it there exists an ellipsoidal, homogeneous or finely granular plasmic lens layer (*l*). This, in *Pr. lactea* and *St. triganocephala*, is developed to a considerable extent. The nucleus does not occur in the lens layer, but lying just outside the pigment layer, as is shown in fig. 4 (*n*).

In structural respests the retina cell has very nearly the same appearance as that previously observed in several species. Close to the pigment cup there exist some ganglionic cells, the processes of which on one side proceed towards the brain and on the other pursue a course to connect with the retina cells. The cells number three or four? in *Pr. lactea* and *St. trigonocephala*, but two only in *Ect. limuli*. As stated by several authors, they exhibit generally the fibrillous structure. In the proximal part of the retina cones are seen very weakly stainable fibres, which show a decreasing affinity for stains as we recede from the proximal part. The fibres are at length connected with "Stiftchen" which is deeply stainable.

Reproductive System.

Male Organs.

The male organs are composed of the testes, the vasa deferentia and the penis.

Testis.—In the marine Triclads there is a wide degree of variation in the number of testes. Böhmig describes in *Pr. ohlini* and *Bd. candida* 100–150 on either side of the body: while Wilhelmi (71) records in *Cerbussowia cerruti* only a single pair of them, the smallest number of which I have found any record. Among the species examined, *Pr. lactea* bears 58 testes on either side, *St. trigonocephala* 30–35, the average number being 32, and *Ect. limuli* 18.

The testes show a considerable variation in position and arrangements. In *Pr. lactea* they are situated in the dorsal part of the body-parenchyma and are arranged in two lateral zones extending from the ovarian region backwards nearly to the body-end. In *St. trigonocephala* they are found lying ventrally not only on both sides of the longitudinal nerve trunks from close behind the ovaries to the insertion of the pharynx, but also posteriorly only on the outer side of the same, ceasing altogether to exist at about the level of the mouth. In *Ect. limuli* they are placed in the ventral part along both sides of the anterior unpaired gut trunk, extending backwards up to the dividing point of the gut trunks. Generally the testes are situated on either dorsal or ventral side of the body between the successive gut diverticulae, presenting a somewhat metameric appearance.

The testes are usually ovoid or round in form, but sometimes polygonal or lobate, as the case may be, they being subjected to more or less pressure against one another. The fully grown testes are in every way like the typical follicles of the Triclads. In *St. trigonocephala* they are comparatively small. Each testis is bounded directly by a thin layer, the tunica propria, which assumes the character of fibrous tissue, and is beyond doubt to be differentiated from the parenchyma, as mentioned by Böhmig. In the first stage of development the testes appear as spherical clusters of cells, which by division increase in number and arrange themselves in the form of the follicles, normally packed full of sperm-mother-cells and spermatozoa in all stages of development. Numerous cells, each containing a large nucleus, are arranged in a single layer on the wall of the testis; they are loosely opposed to the parenchyma.

Vas Deferens.—The wall of the capsular testis gives rise to the epithelium of the fine duct, by which the spermatozoa reach the vas deferens. Generally two types may be distinguished in the mode of communication of the testes with the vasa deferentia, according to the position and arrangement of the testes. In the first type, the testes communicate almost directly with the vasa deferentia; while in the second type, they open into the latter by means of fine testicular canals.

In *Pr. lactea* each testis, occupying a dorsal position in the body, gives rise, on its lower side, to a fine testicular canal or vas efferens. The vasa efferentia proceed between the gut branches, frequently uniting together to form somewhat wider ducts, and then take a course directed towards either of the vasa deferentia. They are more or less distinctly visible only when filled up with spermatozoa. In *St. trigonocephala* and *Ect. limuli*. from each testis lying ventrally arises a short vas efferens which soon unites with its fellow of the opposite side to form vasa deferentia.

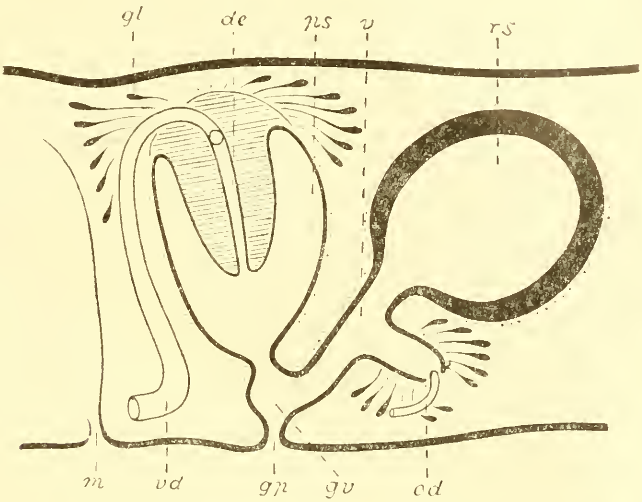
The vasa deferentia proceed backwards in *Pr. lactea* and *St. trigonocephala*, along the inner side of the longitudinal nerve trunks on the ventral side, while they run in *Ect. limuli* just outside the latter. Generally the two vasa deferentia pursue a somewhat winding course, gradually widening as they proceed, and finally uniting in the upper part of the penis-bulb. In their course they are always filled up with spermatozoa and thus are sharply marked off from the surrounding tissues.

The inner wall of the vas efferens and deferens is formed by a single layer of definite epithelial cells which are usually cubic or flattened, and the protoplasm of which is very finely granular, but not vacuolated. As usual, the epithelium exhibits at intervals some ovoid nuclei deeply stainable. No trace of cilia could be detected at points of exit for the vas efferens from the testis. Directly external to the epithelium is a delicate layer of circular muscular fibres.

Penis.—The penis consists of the bulbous part and the conical intromittent part which is vertically or subvertically disposed in the penis-sheath. No chitinous stylet is present at all. The bulb is comparatively less developed in the species examined than in any freshwater planarians.

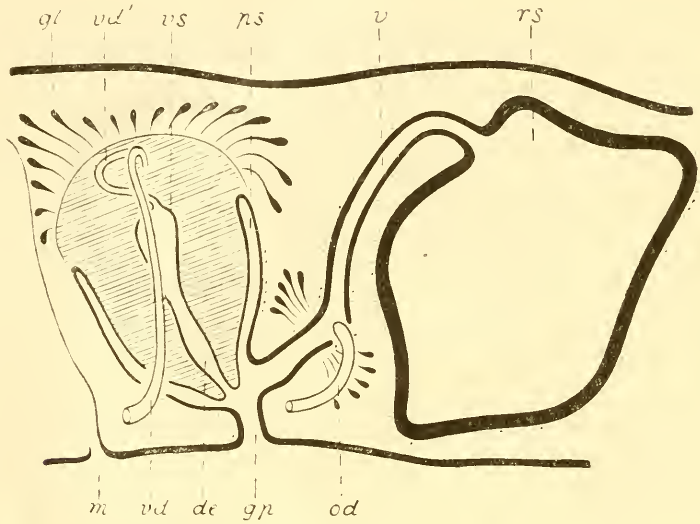
In *Pr. lactea* (Text figs. 1, 4.) the vasa deferentia unite in the penis bulb into a slender duct, the ejaculatory duct, which opens at the tip of the penis, without assuming the character of widening, much as in *Pr. ulvae.* In *St. trigonocephala* (Text fig. 2, 5) they fuse in the blub to form a single slender duct, the vas deferens impar, which stands in connexion, as in *Pr. jaqueti*, with a moderately distended and smooth-walled vesicula; the vesicula gradually narrows into the ejaculatory duct as it proceeds towards the apex of the penis. Such similar feature are also found in *Ect. limuli.* Beyond the point of union of the vasa deferentia, a short common duct enters at once into a wide lumen which is, however, more or less narrow as compared with that of the preceding species.

The lining of the penis lumen is an epithelium composed of cuboidal or cylindrical cells. As is well known, embedded in the parenchyma around the penis are a number of the glands which open into the penis-sheath over the surface. Directly external to it there exists a muscular layer of circular fibres which are more well developed in the part of the ejaculatory duct than in the part



Text fig. 4. Diagrammatic copulatory organs of *Procerodes lactea* in sagittal section.
de ductus ejaculatorius, *gl* gland, *v* vagina.
Other letters as in text figs. 1 and 3.

of the vas deferens impar. Besides, the minute structure of the intromittent part shows no difference in any essential respects, from what has hitherto been described. As usual, the penis is externally covered with a thin layer of normal cells, which is continuous with the lining epithelium of the penis-sheath, while in *Ect. limuli* the epithelium is devoid of nucleus at all. Immediately beneath the epithelium there exist two muscular layers of strongly developed circular and longitudinal fibres. Between the external and the internal muscular layer there is a zone of a mass of the connective tissue, which is traversed by feeble radial muscular fibres. A number of nuclei regarding as either myoblasts or nuclei of the connective tissue lie arranged directly below the external muscles. These, I believe, for the most part, to be cells that have produced the muscular fibres. The penis bulb consists generally of a reticulated, fibrous connective tissue which is traversed by variously directed muscular fibres. Embedded in



Text fig. 5. Copulatory organs of *Stummeria trigonocephala* in sagittal section, diagrammatically shown.
vd' vas deferens impar, *vs* vesicula seminalis.
Other letters as in text figs. 1 and 4.

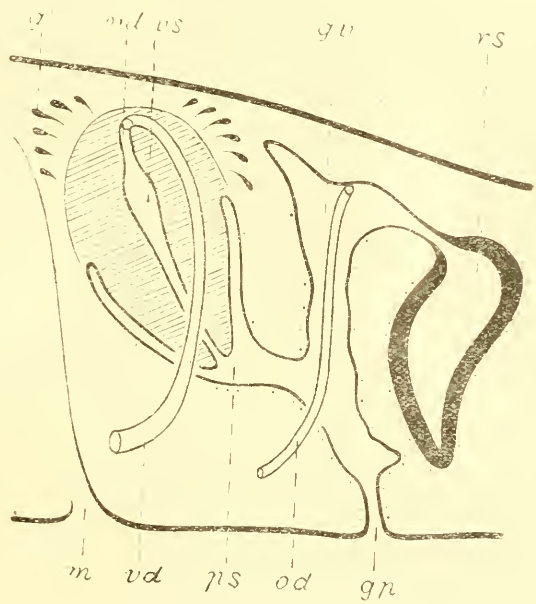
the body-parenchyma around the penis are numerous penis glands which enter the penis at the base to open its cavity.

Female Organs

The female reproductive organs are composed of the ovaries, the oviducts, the vitelline glands, the receptaculum seminis and the vagina.

Ovary.—The paired ovary is of a rounded or ovoidal shape, and is placed in *Pr. lactea* between the first and the second anterior lateral branch, in *St. trigonocephala* between the fourth and the fifth diverticula and in *Ect. limuli* usually immediately in front of the first branches. In both the first and the last named species they are closely opposed to the brain, while in *St. trigonocephala* they are situated a little farther behind the brain. Besides, no special organ known as paraovarium is present.

The ovary is a solid mass of germ cells in several stages of development and is enclosed by a delicate membranous capsule of connective tissue. the tunica propria, which exhibits no sign of cellular structure or of distinct epithelium; the unripe ova are found in the anterior part and the more developed ones in the postero-lateral part, whence the oviduct takes its rise. Between the ova there exists a mass of protoplasm in which small nuclei are embedded. As was mentioned by IJIMA (29), CHICHKOFF (11), v. GRAFF (24), BÖHMIG and others, these protoplasmic masses probably represent undeveloped germ-cells. It may be that these act as nutritive cells, the products of which pass into the ova. Judging from the relative size, the ova become gradually larger and larger in all the dimensions. The nuclei become remarkably large and vesicular, the chromation granules become more and more undefined, and a distinct nucleolus makes its appearance in each nucleus. In the mature state the protoplasm is very finely granular and very conspicuous around the nucleus.



Text fig. 6. Copulatory organs of *Ectoplana limuli* in sagittal section. Diagrammatic.
Index letters as in text figs. 1, 3, 4 and 5.

Vitelline Gland.—The vitelline glands are represented by cellular cords with the cells arranged in one or more rows: they are very extensively distributed posteriorly from the region of the ovaries and in the interstices between the gut diverticulae medially to the testes, so that there seems little room left for parenchyma. The cell cords stand in connexion with the oviduct at numerous points throughout the whole length.

In structural respects the vitelline gland is in all the species quite similar and is very simple. Unlike the ovary the organs are not surrounded by a definite membrane, the tunica propria. The vitelline cells are arranged close together, and in sections the cell-boundaries can be clearly made out with ease. The cell in the fully grown state is very large, and contains an ovoid or spherical nucleus, the latter being small in proportion to the size of the cell. There exist numerous highly refractive granules in the protoplasm, increasing in number as the growth of the cells proceeds, till eventually, when the cells have attained their full size; they form a relatively large proportion of the cell mass.

As to the function of the gland I am not in a position to make any assertion, but as is well known, they furnish in all probability not only the necessary nutriment for the embryo but also the substance of the cocoon.

Oviduct.—In *Procerodes* the oviduct generally starts on either side from the postero-lateral surface of the ovary. They proceed straight backwards along and just outside the longitudinal nerve cords, turning towards the median line in the region of the vagina and, finally, in *Pr. lactea* (Text figs. 1, 4), opening directly into a small outbulging of the vagina at the postero-inferior aspect and, in *St. trigonocephala* (Text figs. 2, 5), opening immediately into the vaginal canal at the postero-inferior portion. But in *Ect. limuli* the course of the oviduct and its relation to the ovary are very different, (Text figs. 3, 6; Pl. I., fig. 7). After leaving the ovaries at the outer-lateral part, they proceed backwards at a considerable distance outside the longitudinal nerve trunks, and then, in the region of the genital vestibulum, are directed towards the median line mounting dorsally at the same time and open into the vestibulum at the supero-lateral portion.

As at first described by STOPPENBRINK (57), three portions can generally be distinguished in the oviduct, viz., a foremost swollen portion designated by the name of the tuba, a middle portion receiving the vitelline glands at numerous points and a hindmost portion.

As is well known, the oviduct of each side starts from the postero-lateral aspect of the ovary as an ampullaceous passage filled with spermatozoa. There exists no direct communication on the boundary between the oviduct and the tuba, where "Schlussplatte" in the sense of BÖHMIG is formed. It always presents a well defined lumen and is, as in most species, lined with an epithelium of cylindrical cells, each of which shows at the base an ovoid nucleus. Internally the epithelium is seen to be uniformly covered with cilia. A large number of spermatozoa completely fill up its lumen. So far as my observations go, however, no trace of spermatozoa could anywhere be detected in the ovary.

The occurrence of sperm-masses in the tuba has convinced me that the spermatozoa introduced by the act of copulation from one individual into the receptaculum of another may perhaps be enticed by a certain chemotactic stimulus into the tuba, after leaving the receptaculum. As mentioned by STOPPENBRINK, MICOLETZKY, BURR and others, the tuba appears to function as a kind of the receptaculum. It is beyond doubt within the lumen of the tuba that fertilization takes place.

The tuba soon assumes the character of a narrow tube, which stands in connexion with the vitelline glands at many points through the whole length. The mode of their connexion presents no difference from that observed by BÖHMIG, and the vitelline glands are connected by means of a short funnel-like stalk with the oviduct.

In *Pr. lactea* the oviducts open behind the vagina into a common root, like in *Pr. lobata*, which presents the appearance of a small outbulging of the vagina, being directly marked by numerous eosinophil glands. In *St. trigonocephala*, although in some cases a tendency to such outbulging is observable, they generally open separately into the vagina, and are lined by an insunken epithelium for a short distance before the opening (Pl. I, fig. 5). Numerous glands make their passage to the lumen of the vagina just inferior to the point where the latter receives the oviducts. In *Ect. limuli* the hindmost part of the latter receives the openings of the glands before opening into the vestibulum.

The lining epithelium of the oviduct is generally composed of normal ciliated cells with the exception of the proximal part of the same in *St. trigonocephala*, as described just above. Immediately outwards to the epithelium there exists a feeble muscular layer of circular and longitudinal fibres.

Receptaculum Seminis (*Uterus*). In one receptaculum-bearing marine Triclads, except *Uteriporus*, the receptaculum always lies behind the male organ. In *Pr. lactea* it is a spherical sac-like organ lying dorsally in the parenchyma, and it is lined with an epithelium of large cuboidal cells, which usually possess an avoid nucleus closs to the base. The appearance of the cells varies much with the state of their secretory activity; at the basal portion the protoplasm is usually homogeneous and deeply stainable, while at the distal portion it is vacuolated in consequence of the discharge of the secretory product. The cells rest upon a delicate basement membrane, beneath which are fine circular and longitudinal muscles. In *St. trigonocephala* the receptaculum is a large sac-like organ which is lined with a relatively thin epithelium, showing either uniformly homogeneous or very finely granular appearance. The nuclei are present near the base. In immediate contact with the epithelium is a fine basement membrane outwards to which comes a muscular layer, quite similar to that of the preceding. In *Ect. limuli* this organ is moderately large, of a somewhat conical shape, and the fairly thick wall presents an aspect closely similar in structure to that of the preceding species.

Upon the nature of the so-called uterus different views have been held by different authors. The latest view is that the organ is a seminal receptacle. In a few cases in *Pr. lactea* this organ contains spermatozoa in considerable quantity, which are enclosed by coarse granules. In the case of the other species it was found to be filled with a granular substance, evidently the secretory product of the uterine wall. Besides, I have nowhere been able to find out ova and yolk cells. In my opinion, this organ has perhaps no functions in connexion with the union of the sexual elements and also with the formation of the cocoon, but it seems doubtless to act as a seminal receptacle. As already stated, it seems beyond doubt probable that fertilization takes place in the lumen of the tuba of the oviduct. I think, therefore, I am justified in showing the organ in question as the primary seminal receptacle against the tuba. As to the function of secretion of the uterine wall, it is difficult to account for the presence of a secretion in the uterus unless it serves as a nutrient medium for prolonging the activity of the male elements.

Vagina.—In *Pr. lactea* the vagina arising from the anterior part of the receptaculum runs anteriorly and obliquely downwards to join the vestibular part of the genital atrium from behind, and undergoes a small outbulging at the postero-inferior part. Its wall is of cuboidal cells resting upon a fine basement membrane, just outside which there exist internal circular and external longitudinal muscular layers. As I have already stated, the wall of the outbulging is perforated by the efferent ducts of the eosinophil glands, which are scattered in sparse numbers in the parenchyma around the same.

In *St. trigonocephala* the receptaculum give rise at its antero-superior part to the vaginal canal which runs down to open into the genital atrium from behind. As is shown in fig. 5 (Pl. I), the vagina has special epithelial cells in the wall, each being wholly destitute of nucleus. In sections the cell-boundaries can be clearly made out, being cuboidal. The epithelium rests upon a delicate basement membrane, exterior to which are distinctly seen the strong circular and weak longitudinal muscles. Moreover, outside the muscular layers there exists a cellular coating which probably partly represents the insunken parts of the lining epithelium. Processes from the cells are occasionally seen to extend to, and to join the epithelium. The vaginal part just inferior to the point where it receives the openings of the oviducts is always distinctly marked by numerous eosinophil glands which open into its lumen.

So far as I have observed, the vagina is not very conspicuous in *Ect. limuli*, and the uterus opens almost directly into the postero-superior part of the vestibulum by a very short, narrow stalk, which may perhaps represent the vagina.

Genital Atrium.—Before proceeding further, I shall in the first place proceed to state as to the genital aperture. As already noted down, it in *Pr. lactea* is situated at a distance behind the mouth equal to about one-fifth that between the latter and the posterior body-end, in *St. trigonocephala* a little in front of the middle between them and in *Ect. limuli* in front of the middle of the posterior third of the body. The opening is lined by a ciliated epithelium continuous with that of the body. In *St. trigonocephala* and *Ect. limuli* some eosinophil glands open out on the ventral body-surface around the genital opening.

The aperture leads into an atrial cavity, which may be distinguished into two portions, viz., a penis-sheath and a vestibulum, the general structure of which it will be necessary to describe here, beginning with the penis-sheath.

Penis Sheath.—The lining epithelium of this is continuous with that of the penis ; in *Ect. limuli* it shows no nuclei, which are apparently displaced just beneath the muscular layer. Usually the epithelium rests upon a delicate basement membrane, outwards to which come two muscular layers of internal circular and external longitudinal fibres. In *St. trigonocephala* the cavity soon opens to the exterior by way of the minute aperture; while in *Pr. lactea* and *Ect. limuli* it communicates with the vestibulum.

Vestibulum.—In *Pr. lactea* this is a moderately distended cavity situated just inferior to the penis-sheath, and apparently separated from it by a constriction. The wall presents quite or almost the same appearance with that of the penis-sheath. *St. trigonocephala* shows an aspect quite like *Pr. ohlini*, and no special vestibular part is present in it.

The vestibulum presents in *Ect. limuli* the most peculiar aspects. It is a deep and wide cavity, which ascends vertically up to immediately below the dorsal body-wall and undergoes laterally very irregular and complicated outbulgings, but always showing a bilateral symmetry, as is shown in figs. 7, 8 (Pl. I). I regret I am not able to demonstrate its form with adequate thoroughness.

The wall presents nothing peculiar. The inner wall is, except near the genital aperture, formed of a single layer, with wide variations in thickness in different parts, and exhibiting no nuclei at all. In certain portions the lining may be sufficiently distended to cause a virtual disappearance of the epithelium so that the underlying basement membrane or muscles abut directly on the cavity. A similar condition has been demonstrated by Lang (37) in the penis of *Yungia aurantiaca* and by Luther (41) in the atrium copulatorium of *Castrada segne*, in the bursa copulatrix of the Mesostomidae, etc. Immediately external to the epithelium there is a strongly developed muscular layer which also varies in thickness in different parts, and seems to be much thicker on the hind wall than elsewhere. It is, although I am not able strictly to say the kinds of the muscular fibres, for the most part composed of three sets of fibres, viz., internal circular, middle longitudinal and outermost circular, of which the middle circular layer is developed to a considerable degree. Externally the muscular coat is surrounded by numerous pyriform cells which perhaps represent partly the insunken parts of the lining epithelium and partly unicellular glands. Moreover, around the vestibulum muscles are developed to a considerable extent, which leave the wall in various directions, passing through the body-parenchyma (Pl. I, fig. 8). Now, from the morphological point of view I have come at length to the conclusion that the vestibulum of *Ect. limuli* is quite homologous with the vagina of *St. trigonocephala*.

In the Turbellaria we thus find an epithelial transformation leading to the condition in the Trematodes and Cestodes, in which the epithelium has been replaced by a thin refractive membrane or a cuticula. This fact, I believe, points out beyond doubt the probable homology between the Turbellarian epithelium or epidermis and the Cestode cuticula.

Biology.

Habitat.—Among the species examined, *St. trigonocephala* always occurs beneath stones or other sunken materials in the estuary of rivulets, where the water is entirely fresh, during ebb tide. The resting position of the worms, with their ventral surface uppermost, would seem to indicate a negative response to gravity, since when moving they may be in any position, depending upon the particular surface over which they happen to be gliding. The worms are very sensitive even to a slight irritation. The specimens contained in a glass dish, when jarred even very slightly, instantly stop, contract and remain immovable. They usually wander to a dark place. It is due perhaps to this property that the parasitic planarians never willingly leave their host animal.

In the course of the past year six parasitic species were recorded, which may be divided into two categories according to their relations to the host, viz., permanent parasitism and commensalism (pseudoparasitism). The species brought under the category of true parasitism is *Micropharynx parasitica* JÄGERSKIÖLD (32), which lives attached to the dorsal surface of the body of *Raja clavata* and *batis*. Regarding the habits of this species, however, no further report has, up to the present, appeared. The species brought under the category of commensalism are the worms which attach themselves firmly to the cephalothoracic appendages or to the gill-books of *Limulus*, such are *Bd. candida*, *Bd. wheeleri*, *Bd. propinqua*, *Syncoelidium pellucidum* and *Ect. limuli*. In general, these worms have long been regarded as true parasities which bring about the fall of the cephalothoracic appendages as well as of the gill-leaves, injuring the skin of the articulation. WILHELMI (69), however, has considered the question from a purely experimental point of view, and has come to the conclusion that these worms are not true parasites of *Limulus*. They do not apparently feed on any part of the host's body. So far as I have examined, any trace of injury caused by the parasites could nowhere be found on the skin of the articulation of *Limulus*.

They seem undoubtedly to content with the crushed remnants of food which may be floating in the water, or remaining between the spines of the segments, after feeding of the host animal. On the whole they are, as mentioned by WILHELMI, best regarded as commensal form.

Over 50% of *Limulus longispina* are always infested with a large number of *Ect. limuli* which lives attached chiefly to the proximal segments of the cephalothoracic appendages and to the gill-books, much as does the other ectoparasitic Bdellourid-species. According to Professor KISHINOUYE's statement they occur in large numbers confined to the three hindermost pairs of the cephalothoracic appendages, without wandering to the gills. However, my own observation, which is based upon *Limulus* collected by myself at Yobimatsu, in the province Bizen, shows beyond doubt the occurrence of the worms on the gill-books and other parts. They are not confined to the legs only. When present, they are very abundant, numbering more than one hundred in two specimens of *Limulus* examined.

Bdelloura and *Syncoelidium* all deposit their cocoons on the gill-lamillae of their host, *Limulus*. *Bd. candida* seems to show no preference for a particular region of the gill-books, but scatters its cocoon over the whole ventral surface. *Bd. propinqua* selects the basal, or proximal region of the leaf, while *Syn. pellucidum* prefers a small area near the edge, just lateral to a small marginal callosity which forms a brown line with the callosities of the adjacent leaves when the gill-book is closed. These Limulus-infesting worms also differ in their time of breeding. *Bd. candida* oviposits during May and early June, *Syncoelidium* in the later part of July; *Bd. propinqua* appears to breed at the same time as the latter. I have not been able to discover the breeding time of *Ect. limuli*, but egg-laying seems to take place on the gill-lamellae of the host during July, because I have found the half-grown young of the parasites in abundance on the gills in the early part of August.

As stated by WILHELMI (69, 70, 71), it seems probable that the passage of the parasites from one crab to another can occur only during copulation. The limulus deposits its eggs chiefly in August. On calm nights during that month, males and females, the former on the abdominal shield of the latter, return with the rising tide from the deep water towards sandy shores to breed; egg-laying taking place between the tide marks. This meeting of the sexes doubtless affords the parasites a good opportunity to shift from one host to another.

I will now give some general remarks of the parasitism of these animals. *Micropharynx* is regarded as a true parasite and is wholly destitute of eyes. The body-shape is that of the blade of an ovate leaf, the posterior end being often obliquely truncated and exhibiting some small folds on the inferiorly turned edge, which is more or less distinctly marked off, but shows a great variation in appearance. The worms are very firmly attached to their host's body by means of the caudal disc. In the limulus-infesting Bdellourids the body is generally lanceolate, the posterior end being truncated. The posterior portion known as the caudal adhesive disc is generally distinctly marked off by a constriction of the body from the anterior. While *Ect. limuli* is of a slender body which is entirely devoid of any such distinct part or organ as the special caudal disc mentioned just above. The worms, however, are able to adhere with surprising firmness to the surface of the host's body by means of slime which is being constantly secreted on the ventral surface of the body, especially on a narrow zone completely surrounding the body just within the lower ventral edge. Quite a considerable effort is required to displace them. When removed by means of a spatula together with the mud which is usually present on the ventral surface of *Limulus*, they adhere to the spatula so firmly that they cannot be washed away with ease. Their movement is rather ponderous, due to the powerful nature of their slime, as compared with that of the other species. They never leave the host of their own accord.

Among the limulus-infesting species, *Bd. propinqua* contains but a few rhabdites in the epidermis, while in the case of *Bd. candida*, *Bd. wheeleri* and *Syn. pellucidum* the epidermis is wholly destitute of them. Hence WILHELMI (70) has come to the conclusion that such a reduction of the rhabdites is a special adaptation; I shall now quote his own words. He says, "Die Rückbildung der Rhabditen korrespondiert mit meiner Annahme, dass die Rhabditen Schutzorgane sind, die auf Druck aus dem Epithel heraustreten. Offenbar sind sie bei den Bdellouriden, die geschützt auf der konkaven Bauchfläche und zwischen den Kiemenblättern des Limulus leben, infolge Funktionslösigkeit zurückgebildet worden." However, the fact that the epidermis is in *Ectoplana* and *Micropharynx* always full of minute rhabdites lends probability, in my opinion, to the view that his hypothesis cannot be regarded as a perfect truth. Of course, I believe that the rhabdites are of use to the animal for protection.

Locomotion.—Like the other planarians, the freely living or parasitic worm is very active in its movements, creeping with steady, rapid motion over smooth surfaces, crawling after the manner of geometer caterpillars, or swimming on the surface of the water.

Gliding is the most usual mode of progressive movement when the worm is not disturbed, and so far as I have been able to observe, it is a combined reaction, brought about partly by muscular rhythmic, wavy motion of the ventral body-wall and partly by the action of the cilia in the mucus layer between the ventral surface of the body and the surface of which they are moving, the thin layer of mucus being secreted constantly.

Crawling is induced only when the animal is stimulated in certain ways, and of course, takes place by a successive alternation of the active muscular contraction and stretching. The ventral surfaces of the anterior and posterior regions of the body act like suckers as the worm loops. While the anterior end holds, the posterior is freed and then drawn up. Such looping fashion was particularly well observed in *Ect. limuli*.

Although certain species of Rhabdocoele can freely move by the ciliary reaction through the water, such a swimming is never seen in the Triclads. However, our forms, with their ventral surface uppermost, are able to creep along the water surface. This sort of movement seems to be brought about by the action of the cilia, turning to account a large amount of mucus and the surface tension of the water. The mechanism may perhaps be equal to that of gliding, and the surface tension of the water serves for the purpose of a substratum. The movements of the parasitic worm seem to be slower in comparison than those of the freely living forms. This is, I think, due to a great amount of powerful mucus.

Note on the Classification of the Maricola.

Böhmig (5) was the first who founded a more rational classification of the marine Triclads in general. According to the features of the genital organs, he has at length distinguished seven well-established genera into two families and five subfamilies as follows:—

1. Fam. Procerodidæ.
    - i. Subfam. Euprocerodinæ, *Procerodes*.
    - ii. Subfam. Cercyrinæ, *Subussowia*. *Cercyra*.
    - iii. Subfam. Micropharynginæ, *Micropharynx*.
2. Fam. Bdellouridae.
    - i. Subfam. Uteriporinæ, *Uteriporus*.
    - ii. Subfam. Eubdellourinæ, *Bdelloura*. *Syncoelidium*.

Later, he (6) brought under the Procerodidae a new subfamily Stummerinæ for receiving a new genus *Stummeria*.

Then, Wilhelmi (71, 73) published an important paper on the marine Triclads, in which he classifies them according to a new system as in the following:—

1. Fam. Procerodidæ. *Procerodes*. *Stummeria*.
2. Fam. Uteriporidæ, *Uteriporus*.
3. Fam. Cercyridæ, *Cercyra*, *Cerbussowia*, *Sabussowia*.
4. Fam. Bdellouridæ, *Bdelloura*, *Syncoelidium*.
5. Fam. Micropharyngidæ. *Micropharynx*.

As is seen above, the Procerodid-subfamilies instituted by Böhmig were raised by Wilhelmi to the rank of distinct families, making use of some distinctive characters which do not appear to me to be of more than subfamily value. Now, casting a glance at the features of the genital apparatus, it is brought out clearly that they agree with one another in some respects. The procedure of Böhmig, in my opinion, seems to me far more rational than that of Wilhelmi, so that I do not hesitate to abide by the scheme which divides the Procerodidæ of Böhmig further into three subfamilies—Euprocerodinæ, Cercyrinæ and Micropharynginæ—for convenience' sake.

Now then, as already recorded, an attempt was made by Böhmig to divide the Bdellouridæ into two subfamilies, making use of distinctive characters which, to my mind, appear to be of sufficient magnitude to isolate those subfamilies as distinct families —Uteriporidæ and Bdellouridæ—co-ordinate with the Procerodidæ. In this respect the procedure of Wilhelmi seems to me very reasonable. As an arrangement of all the previously recorded genera, subject, of course, to modification in the future, I would propose for the present to classify them according to a new system as follows:—

1. Fam. Procerodidæ.
    i. Subfam. Euprocerodinæ Böhmig.
        Procerodes Girard.
        Stummeria Böhmig.
        Ectoplana Kaburaki.[1)]
    ii. Subfam. Cercyrinæ Böhmig.
        Cercyra O. Schmidt.
        Cerbussowia Wilhelmi.
        Sabussowia Böhmig.
    iii. Subfam. Micropharynginæ Böhmig.
        Micropharynx Jägerskiöld.
2. Fam. Uteriporidæ.
        Uteriporus Bergendal.
3. Fam. Bdellouridæ.
        Bdelloura Leidy.
        Syncoelidium Wilhelmi.
        Synsiphonium Hallez.

Some principal characters of distinction between all the above

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1) As to the systematic position of the genus *Ectoplana* I have already stated in detail in my fo mer paper (33).

groups may be mentioned as in the accompanying diagnostic table:—

I. Receptaculum seminis single.

A. A single genital aperture. Receptaculum seminis situated posterior to the penis . . . . Fam. Procerodidæ.

a^1. Penis unarmed.

a^2. Vasa deferentia not fusing together to form a common duct before entering the base of the penis. Intestine showing no sign of anastomosis . . . . Subfam. Euprocerodinæ.

a^3. Freely living.

a^4. Oviducts opening into the vagina by a distinct duct . . . . Genus *Procerodes*.

b^4. Oviducts opening separately into the vagina . . Genus *Stummeria*.

b^3. Ectoparasitic on *Limulus*.

Oviducts opening separately into the extremely wide, dorsally prolonged vestibulum . . . . Genus *Ectoplana*.

b^2. Vasa deferentia united together into a single ductus deferens before entering the base of the penis. Intestinal branches anastomose . . . . Subfam. Micropharynginæ.

Ectoparasitic on *Raja* . . . . Genus *Micropharynx*.

b^1. Penis pointed or provided with stylet.

Vasa deferentia united together into a common duct before entering the penis, or not united. Oviducts opening separately into the vagina. . . . . Subfam. Cercyrinae.

c^2. Vasa deferentia fusing together to form a single ductus deferens in front of the penis.

c^3. Penis with long stylet. Ovaries placed closely in front of the pharynx-insertion . . . . Genus *Cercyra*.

d^3. Penis pointed, without stylet. Ovaries situated behind the brain. Adhesive cells lying dorsally at the anterior end . . Genus *Sabussowia*.

d^2. Vasa deferentia or ejaculatory ducts opening separately very near the tip of the penis.

Paired testis placed in front of the insertion of the pharynx. Penis with long stylet. Ovaries nearly midway between the eyes and the pharynx-insertion. Adhesive cells lying dorsally at the anterior end. . . . . Genus *Cerbussowia*.

B. Two genital apertures. Receptaculum seminis situated between the pharynx and the penis . . . . Fam. Uteriporidæ.

Receptaculum seminis connected by two canals with the oviducts which unite into an unpaired oviduct, before opening into the penis-sheath . . . . Genus *Uteriporus*.

II. Receptaculum seminis double.

Three genital apertures. Receptaculum seminis opening by distinct ostia lateral to the longitudinal nerves in front of the penis . . . . . . Fam, Bdellouridæ.

A. Ectoparasitic on *Limulus*. Body with a distinct adhesive disc at the head end.

a. Receptaculum seminis saccular; duct arising from its anterior edge. Intestinal branches numbering 24–32. . . . . Genus *Bdelloura*.

b. Receptaculum seminis closely similar in appearance to the preceding; duct arising from its posterior inner surface. Posterior gut trunks uniting soon after hatching and forming an unpaired stem. . . . . Genus *Syncoelidium*.

B. Freely living. Body without any sign of adhesive disc. Receptaculum seminis tubular. . . . . Genus *Synsiphonium*.

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Abbreviations used in the Explanation of Plate.

br.	brain.
e.	eye.
g.	gut.
gl.	gland.
gp.	genital pore.
gv.	genital vestibulum.
l.	lens.
m.	mouth.
n.	nucleus.
N^{I}—N^{V}	Sensory nerves arising from the brain.
na.	anterior longitudinal nerve trunk.
nc.	transverse nerve commissure.
nl.	lateral nerve.
nm.	marginal nerve.
no.	optic nerve.
nt	longitudinal nerve trunk.
nx.	brain commissure.
o.	ovary.
od	oviduct.
rc.	retina cell.
rs.	receptaculum seminis (uterus).
si.	'Substanzinsel.'
tu.	tuba.
v.	vagina.
vd.	vas deferens.

Contents.

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PLATE I.

Plate I.

Fig. 1. *Procerodes lactea.* Outline of body in the living state (after the late Professor IJIMA's sketch), about 17×.

Fig. 2. *Stummeria trigonocephala* in the living condition, 10×.

Fig. 3. *Ectoplana limuli* in the living state, 6×.

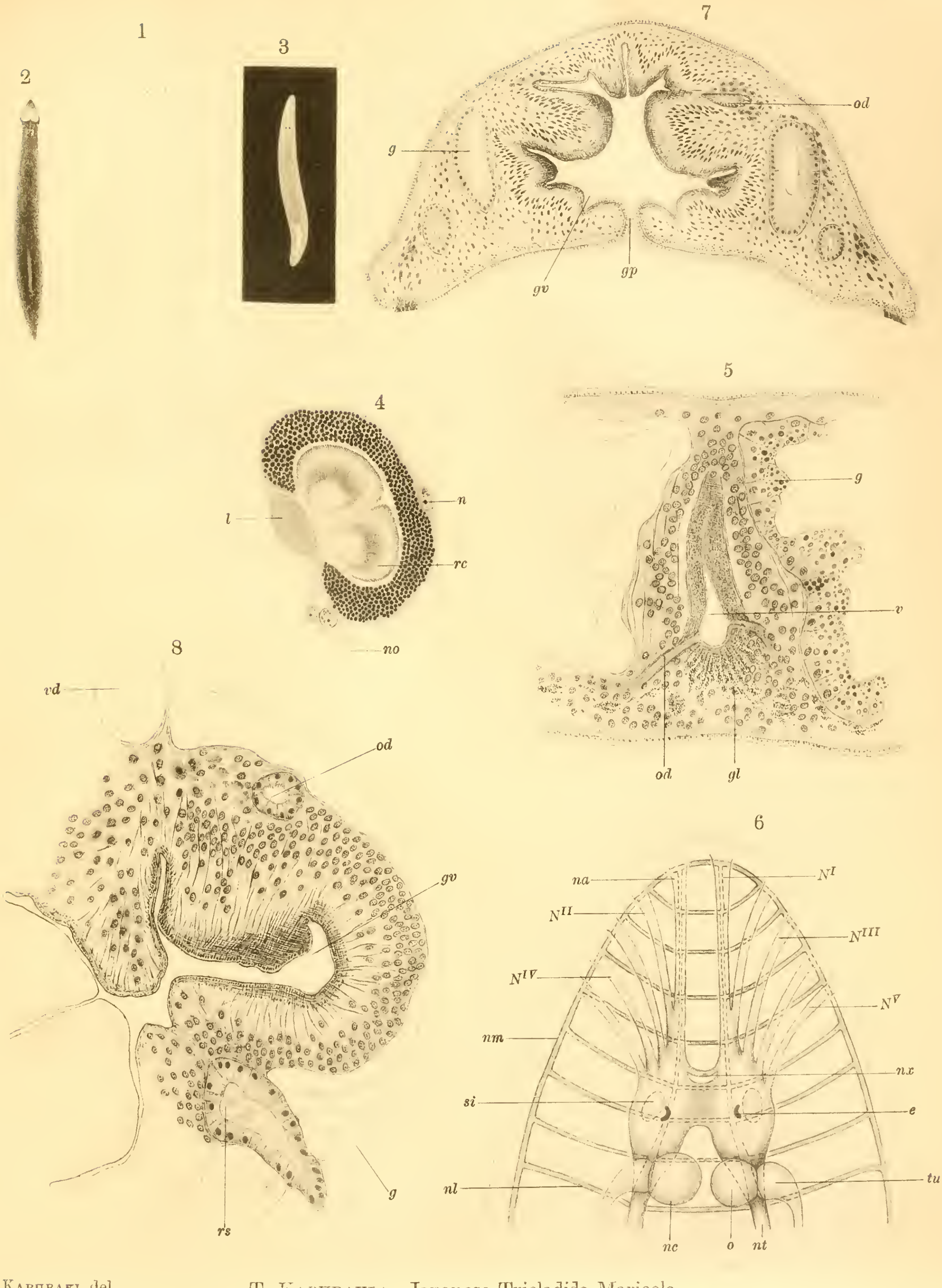
Fig. 4. *Stummeria trigonocephala.* Cross section of the eye, about 900×.

Fig. 5. Ditto. Cross section of body through the opening point of the oviducts into the vagina, 250×.

Fig. 6. *Ectoplana limuli.* Diagrammatic representation of the brain, as seen from the dorsal side, 150×.

Fig. 7. Ditto. Cross section of body through the vestibulum, 150×.

Fig. 8. Ditto. Horizontal section through the sexual organs, 300×.



KABURAKI, del.

T. KABURAKI: Japanese Tricladida Maricola.

JOURNAL OF THE COLLEGE OF SCIENCE, TOKYO IMPERIAL UNIVERSITY.
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On the Terrestrial Planarians from Japanese Territories.

By

Tokio KABURAKI.

Zoological Institute, Science College, Imperial University, Tokyo.

With 1 plate and 23 text figures.

Since the appearance of STIMPSON's report (62), the terrestrial planarians of Japan have been largely neglected, though von GRAFF (25) recorded one more species later.

The material upon which the present report is based was collected chiefly by the late Professor ISAO IJIMA and by myself in several localities. Consignment of some specimens were received from Professor S. WATASÉ, Dr. S. HÔZWA, Mr. S. KINOSHITA, the late Mr. M. TAKESHITA and the late Mr. YASUDA. To the gentlemen named I desire to express my thanks for the opportunity of working at these forms.

Here I deem it my duty to acknowledge my indebtedness to the University of Cambridge for the use of their tables at the Zoological Laboratory, which made it possible for me to prosecute the present investigation. It should also be mentioned that some of the coloured illustrations given in the plate acompanying this paper were made by the late Professor IJIMA from living examples. To him are due my warmest thanks for his kindness in allowing me the use of those excellent figures as well as in placing at my disposal a series of notes and sketches taken by him.

The classification here adopted is that laid down by von GRAFF in his well-known monograph.

List of the species embodied in this paper.

Family Geoplanidæ Stimpson.

1. *Geoplana bimaculata*, n. sp.
2.* ,, *lapidicola* Stimpson.
3. *Artioposthia japonica*, n. sp.

Family Bipaliidæ von Graff.

4. *Perocephalus fulvus*, n. sp.
5. *Bipalium venosum*, n. sp.
6. ,, *ruteofulvum*, n. sp.
7. ,, *ochroleucum*, n. sp.
8. ,, *kisoensis*, n. sp.
9. ,, *fuscolineatum*, n. sp.
10. ,, *hilgendorfi* (von Graff).
11. ,, *fuscocephalum*, n. sp.
12. ,, *monolineatum*, n. sp.
13.* ,, *maculatum* Stimpson.
14. ,, *trifuscostriatum*, n. p.
15. ,, *trilineatum* Stimpson.
16. *Placocephalus fuscatus* (Stimpson).
17. ,, *glaucus*, n. sp.
18. ,, *virgatus* (Stimpson).

Family Rhynchodemidæ von Graff.

19. *Rhynchodemus ijimai*, n. sp.
20. *Microplana ruteocephala*, n. sp.

Family Geoplanidæ Stimpson.

Genus **Geoplana** Müller.

1. ***Geoplana bimaculata***, n. sp.

(Pl. I., Fig. 1.)

This new species is based on the late Professor Ijima's notes and sketches taken from a single individual, which was obtained by himself in July, 1886, in Nikko.

*) The species indicated by asterisks are those which could not be brought under my direct examination.

The body, when the worm was living, was slender and had the lateral margins even and nearly parallel for a large part of their length, but was tapering at both the anterior and posterior ends, which were bluntly pointed. The ventral surface is made up of the slightly raised sole, extending over the whole surface. The specimen was 24 mm. in length and 1·5 mm. across the widest part of the body.

The ground colour of the dorsal surface is of a dark olive-like brown colour and medially marked with a slender dark stripe which loses itself in the anterior parts. There occur two pairs of colourless spots at the lateral sides of the body, a short distance behind the anterior extremity which is dark. Ventrally, the dark olive brown colour is continued from the dorsal surface, except for the mid-ventral surface which is pale.

The eye-spots, numbering about twelve on either side, are arranged round the anterior tip in a single row interrupted by a gap in the middle.

2. *Geoplana lapidicola* STIMPSON.

Geoplana lapidicola, STIMPSON (62), pp. 23, 30.—DIESING (16), pp. 510.—VON GRAFF (25), pp. 370, 371.

This species was first recorded by STIMPSON from Loo Choo. No specimen came under my examination.

"Elongata, subconvex, post medium parum latior, lateribus fere parallelis, extremitatibus rotundatis; supra grisea, fascia mediana fulva, marginibus pallidis. Ocelli vix numerosi in lateribus extremitatis anterioris sparsi, majores utrinque 3–4 laterofrontales. Long. 1·2 (30·5 mm.); lat. 0·1 (2·5 mm.) poll".

Genus **Artioposthia** VON GRAFF.

3. *Artioposthia japonica*, n. sp.

(Pl. I., Fig. 2.—Text Fig. 1.)

This new species is one of the commonest forms in Central Japan; it was procured in fair abundance in Nikko, at Itaya in Prov. Iwashiro and in the neighbourhoods of Tokyo and Kyoto.

The body in the living state is slender and nearly uniformly broad for the most part of its length, though it tapers off considerably in front. Both the anterior and posterior extremities are bluntly pointed or rounded. Extending almost throughout the whole length, in the mid-ventral line, is a slightly raised ridge, the sole, which is not less than one-fifth the width of the body. Well-grown specimens measure 40–60 mm. in length and 2–4 mm. in breadth.

The ground colour of the dorsal surface is uniformly yellow or yellowish brown with a fine black stripe, which medially extends over the whole surface. As it approaches the anterior tip it gradually assumes a darker tone. The ventral surface is a somewhat paler shade of the same colour as the dorsal, except for the surface of the sole which is nearly white.

The eye-spots are arranged in one or two rows round the anterior tip and continued, without any grouping, for a few mm. down the sides.

The mouth-opening which leads into the peripharyngeal pocket is situated near the middle of the body.

The common genital aperture is placed half-way between the mouth-opening and the posterior end of the body.

The epidermis consists of a single layer of columnar cells which are about equally high on the dorsal and the ventral surface. The sole possesses a ciliated epithelium, but the cilia appear to be confined to this part of the ventral surface. Except on the surface of the sole, the epidermis contains enormous quantities of minute spindle-like rhabdites, evidently wedged in between the cells. As is well known, the rhabdites arise from their mother-cells, scattered in fair abundance in the parenchyme beneath the epidermis, and sometimes are seen to be in connexion with the latter. Scattered in sparse numbers in the parenchyme are unicellular glands, which open out at various points of the body-surface. Besides this, there are enormous quantities of glands which occur deeply embedded in the parenchyme and make their way to the surface of the sole.

The musculature of the body is differentiated into two systems, superficial and deep. The superficial system, immediately underneath the fine basement membrane, is made up of two layers of the outer circular and the inner longitudinal fibres. Separated from this by a zone of tissue is the deep muscular system which forms a layer thicker than the superficial and consists principally of two sets of fibres, longitudinal and circular; these fibres occurring intermingled in the same mass without being arranged in definite layers. Besides, dorso-ventral fibres are well developed, running between the intestinal branches.

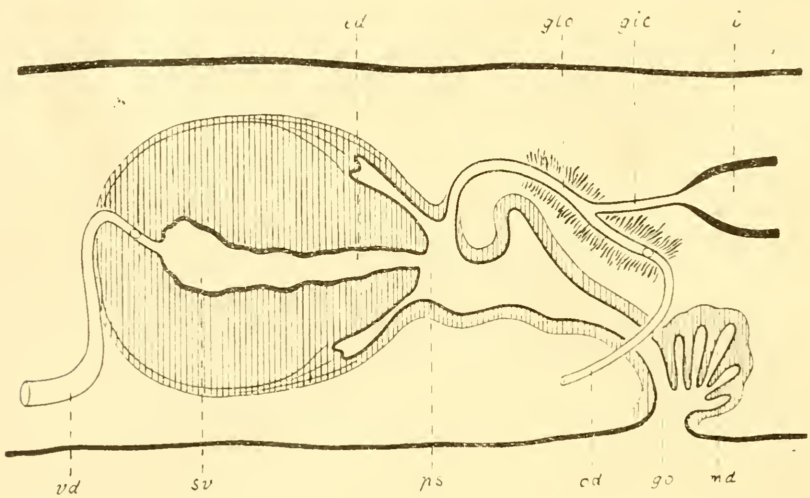
The mouth-opening lies near the centre of the peripharyngeal cavity, in which the pharynx is horizontally disposed. The pharynx is of a short cylindrical shape, terminating conically at the free end. The three main trunks of the intestine are provided with numerous lateral branches which are sometimes bifurcated and sometimes trifurcated. Their direct wall is a single layer made up of high cylindrical cells, each af which contains a great number of coarse, highly refractive granules in the finely granular protoplasm. Sometimes the cells were observed to be vacuolated in their distal portion.

Situated near the anterior end of the body is the brain, which is a bilobed organ, sending out numerous nerves. Posteriorly each half of the brain-mass is continuous with one of the longitudinal nerve cords which proceed straight backwards, until finally they extend to the posterior end of the body. The nerve cords are connected throughout their entire course by numerous transverse commisures and give off numerous lateral nerves towards the nerve plexus, which lies beneath the outer longitudinal muscles of the body and extends completely round the body.

The genital opening leads anteriorly into the penis-sheath and posteriorly into the "muskulösen Drüsenorgan", provided with a wall which projects into the lumen in folds. Embedded in the parenchyme around the said organ are numerons glands which make their way into its lumen.

Numerous testes, ventral in position, are arranged in a single row just outside the longitudinal nerve cords, beginning from behind the ovary and ceasing altogether to exist at the level of the pharynx-insertion. The vasa deferentia, filled with spermatozoa, proceed straight backwards just along the dorsal side of the longitudinal nerve cords, and in front of the penis make an inward bend, rising at the same time, to enter the penis-bulb and then to unite into a common duct, which communicates with the seminal vesicle, after receiving numerous glands.

The penis divided into two parts of the bulbous basal part of muscular nature and the free conical intromittent part lying horizontally in the penis-sheath, which opens to the exterior through a narrow passage. Enclosed in the penis-bulb is the relatively narrow and somewhat folded seminal vesicle, which passes behind into the ejaculatory duct terminating at the tip of the penis. The cavity is lined with a single layer of columnar cells.



Text fig. 1. Genital organs of *Artioposthia japonica*, n. sp. in sagittal section, diagrammatically shown.

ed ejaculatory duct, *gic* genito-intestinal canal, *glo* glandular organ, *go* genital opening, *i* intestine, *md* "muskulöse Drüsenorgan", *od* oviduct, *ps* penis-sheath *sv* seminal vesicle, *vd* vas deferens.

Behind the brain occurs the paired ovary, occupying a ventral position. At the postero-lateral aspect the oviduct springs from the ovary in the form of a funnel-like widening, which soon assumes the character of a narrow duct, pursuing a backward course just along the outer side of the longitudinal nerve cords and receiving in its course the vitelline glands at several points. The vitelline glands are composed of closely packed, large cells, extensively filling up the interspaces between the branches of the intestine. The mode of their connexion with the oviduct is effected by means of the short branches of the latter. In the neighbourhood of the genital opening the oviduct nears the median line, rising upwards at the same time, to unite into a common canal, the glandular canal, which pursues a forward course, finally opening from behind into the penis-sheath. The wall of the oviduct is made up of a ciliated epithelium, external to which is a thin muscular coating.

In its course the glandular canal gives off a branch which stands in communication with the right posterior trunk of the intestine, so that there is, as in some land planarians,[1] a genito-intestinal canal. The canal is constructed in the same manner as the glandular canal, and is lined with an epithelium made up of ciliated columnar cells, outside this is a muscular coating.

Family Bipaliidæ von GRAFF.

Genus **Perocephalus** von GRAFF.

4. ***Perocephalus fulvus***, n. sp.

(Pl. I., Fig. 3.)

Only a single specimen representing this new species was procured by the late Professor IJIMA in July, 1886, on the stone wall covered with the moss in Nikko.

According to the late Professor IJIMA's notes and sketches taken from the living worm, the head presented a lunar shape and merged into the trunk, from which it was speparated by a slight neck-like narrowing. In the preserved state, the head lobes make it very difficult to distinguish. The trunk is nearly oval in cross section and almost uniformly broad for the most part of its length, but is tapering in the hind parts down to the bluntly pointed extremity. Along the mid-ventral line runs the slender sole from

1) See the author's report "On the Terrestrial Planarians from the Islands of Mauritius and Rodrigues, with a Note upon the Canal connecting the Female Genital Organ with the Intestine." (32).

the neck to the posterior extremity, which is scarcely raised above the general level. When fully extended the worm measured 20 mm. in length and 0·75 mm. in breadth.

The animal is, dorsally, of a bright orange colour, except the head which is more or less reddish. Ventrally, the colour is much lighter than that of the dorsal surface.

Numerous eye-spots are present in a row or rows all round the margin of the head.

The mouth-opening is situated nearly at the hind end of the second third of the body, opening into the peripharyngeal cavity with the pharynx plicated.

The sexual organs were not yet developed in the specimen examind.

The epidermis consists of a layer of columnar cells, which are much higher on the dorsal side than on the ventral, and contains small spindle-like rhabdites in sparse numbers, wedged in between the cells. Deep below the epidermis, in the parenchyme, are found such rhabdites as are still contained in their mother-cells. There are numerous glands, situated in the parenchyme, opening to the exterior on the surface of the sole.

The superficial muscular system underlying the basement membrane is composed of two layers, outer circular and inner longitudinal. The deep muscular system is well developed all round in the parenchyme as a thick and continuous sheet, consisting of two principal sets of longitudinal and circular fibres.

The mouth-opening is situated near the centre of the peripharyngeal chamber, in which is hanging the plicated pharynx from above. The gut trunks are provided with numerous branches which are bifurcated.

The brain forms a meshwork, from which posteriorly start two longitudinal nerve cords, connected together by numerous transverse commissures and giving off numerous lateral branches.

Genus **Bipalium** Stimpson.

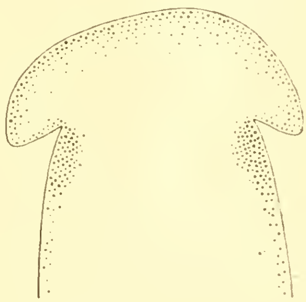
5. ***Bipalium venosum***, n. sp.

(Pl. I., Fig. 12.—Text Figs. 2, 3.)

Two specimens of this species were obtained by me in July, 1916, on the stone wall of the Mii Temple in Ôtsu.

The head, which is semi-lunar in shape, presents a somewhat recurrent lappet on either side and is not less than twice the breadth of the body, from which it is separated by a neck-like narrowing. The frontal margin of the head in the creeping state shows a serrated appearance. The trunk is almost uniformly broad for the most part, but gradually tapering in the hind parts to the bluntly pointed extremity. Dorsally it is slightly convex and ventrally nearly flat, the sole on the mid-ventral surface forms a slightly raised ridge, rather less than one-third the width of the body, and extending from the base of the head to the posterior end. The large specimen measures 90 mm. long by 5 mm. broad, while the small is 50 mm. long by 2·5 mm. broad; the head in both measures 7 mm. across.

The dorsal surface is of a uniform dark brownish colour, which anteriorly gets more or less lighter. Ventrally, the colour is much lighter than that of the dorsal surface, except on the sole which presents a pale tone.



Text fig. 2. Distribution of eye-spots in *Bipalium venosum*. n. sp.

The eye-spots are thickly distributed all round the margin of the head and also occur sparingly scattered over the entire length of the body, sub-marginally on the ventral side. At the sides of the neck, they are especially densely packed.

The mouth-opening is placed slightly in front of the centre of the body, leading into the peripharyngeal chamber. In the preserved specimens the pharynx is protruded through the mouth-opening.

The common genital aperture is situated near the centre of the second fourth of the distance between the mouth-opening and the posterior extremity of the body.

The epidermis consists of a layer of columnar cells which are a great deal higher on the dorsal than on the ventral surface. Widely distributed almost over the entire surface of the body, except on the sole, are enormous quantities of vermiform rhabdites situated between the epidermic cells. Directly below the superficial muscular system, there occur such rhabdites as are still contained in their mother-cells. There are enormous quantities of slime glands which are deeply situated in the parenchyme along the median zone of the body and open out on the surface of the sole.

The superficial muscular system is composed of the outer circular and the inner longitudinal layer. The deep muscular system, which chiefly consists of longitudinal fibres, is well developed all round in the parenchyme as a continuous sheet. In addition to these, dorso-ventral muscles are found, running between the branches of the intestine.

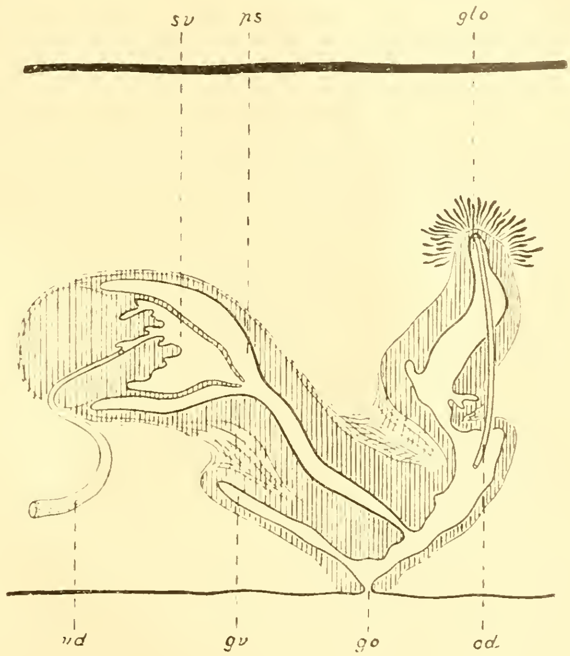
The mouth-opening is situated near the centre of the peripharyngeal chamber with the plicated pharynx hanging from above. The three main gut trunks are provided with numerous outwardly directed, lateral branches which are sometimes bifurcated and sometimes multifurcated. The lining epithelium of the intestine is made up of high cylindrical cells which contain a great number of coarse, highly refractive granules in the finely granular protoplasm. In some cases the cells were seen to be vacuolated in the distal portion of the cell.

The cerebral nervous system has the appearance of meshwork which is continuous with two longitudinal nerve cords, running on either side of the median line. Throughout their entire course, the cords are connected by very numerous transverse commissures. Laterally they give off numerous branches towards the nerve plexus, lying beneath the outer longitudinal muscles of the body and extending completely round the body.

The common genital aperture leads into the vestibulum which forms an oblique, upwardly directed, annular outbulging; consequently there is formed in the cavity a downwardly directed, conical process surrounded by the said outbulging. The cavity is lined with a single epithelium, beneath which is a muscular coating composed of circular and longitudinal fibres.

Numerous small testes, each made up of sperm-mother-cells and spermatozoa in several stages of development, are arranged in two lateral zones, which extend from somewhat behind the ovary to the insertion of the pharynx. The vasa deferentia, proceeding straight backwards, make an abrupt forward bend at the sides of the penis, to enter the base of the penis and then finally to unite into a common duct just before opening into the lumen of the penis.

In the penis there can be distinguished the bulbous part of muscular nature and the conical intromittent part, lying almost horizontally in the penis-sheath. Enclosed in the latter part is the wide seminal vesicle with an anterior wall which projects into the lumen in folds. The cavity directly opens into the penis-sheath at the tip of the intromittent part, without passing through the ejaculatory duct. Posteriorly the penis-sheath is continuous with the narrow passage which opens into the posterior outbulging of the vestibulum, near the tip of the conical process. Its actual wall is formed by a single layer of columnar cells, beneath which comes a muscular coating.



Text fig. 3. Copulatory organs of *P. venosum* in sagittal section, diagrammatically shown.
gv genital vestibulum.
Other letters as in text fig. 1.

At a short distance behind the meshwork of the brain is seen the paired ovary which is nearly oval in shape and consists of ova in several stages of development. The oviduct leaves the ovary in the form of a funnel-like widening, which soon assumes the character of a narrow duct, running outside the nerve cords and receiving in its course the vitelline glands at numerous points. The vitelline glands are represented by branching cellular masses, which are distributed in the interspaces between the diverticulae of the intestine. The mode of their connexion of the glands with the oviduct is effected by means of the short branches of the latter. In the region of the genital opening the oviduct rises upwards and unites with its fellow of the opposite side, to form the glandular organ. The oviduct is lined with a nonciliated epithelium, external to which comes a feeble muscular layer of circular fibres.

The glandular organ, which is supplied with numerous unicellular glands, opens into the posterior outbulging of the vestibulum from above. It shows a definite wall consisting of a single layer of columnar epithelial cells and a thick muscular coating.

6. ***Bipalium rufeofulvum***, n. sp.

(Pl. I., Fig. 10.—Text fig. 4.)

A single representative of this new species was obtained by Professor Watasé, Dr. Hôzawa and the late Mr. Yasuda in May, 1911, near Taihoku in Formosa.

The head in the preserved state presents a semi-lunar outline with a recurrent lappet on either side, which curves so far inwards as to meet the sides of the neck. The trunk is almost uniformly broad for the greater part of its length, though it gradually tapers off in the hind parts towards the bluntly pointed posterior extremity. From the base of the head to the posterior body end, in the mid-ventral line, is the sole, forming a slightly raised ridge and not a great deal wider than one-fifth the breadth of the body. The specimen measures about 45 mm. long by 6 mm. broad.

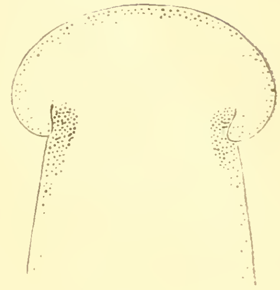
Dorsally, the body, in spirit, is of a uniform dark reddish brown colour, which on the head gets more or less light towards the frontal margin. Ventrally, the colour is nearly similar to that of the dorsal side, except for the surface of the sole which is pale.

Numerous eye-spots surround the entire fringe of the head and are continued round to the sides of the neck where they are more ventral than dorsal, forming a crowded patch. Further, they are present sparsely scattered over the whole length of the body, submarginally on the ventral surface.

The mouth-opening is situated near the middle of the body, leading into the peripharyngeal pocket.

The genital organs were not yet developed in the individual examined.

Note:— The present species seems to resemble *Bipalium venosum* previously described as well as *B. giganteum* WHITEHOUSE and *B. claparèdei* von GRAFF, but may be distinguished from any of them by the differences in the appearance of the head and the colouration of the body.



Text fig. 4. Distribution of eye-spots in *Bipalium ruteofulvum*, n. sp.

7. *Bipalium ochroleucum*, n. sp.

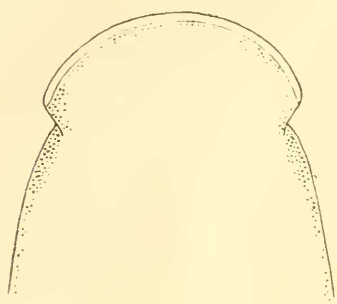
(Pl. I., Fig. 13.—Text figs. 5, 6.)

A single representative of this new species was captured by Mr. YERI in January, 1916, in Nara.

The head in the preserved state presents a very small, semilunar shape and is a great deal narrower than the width of the trunk, from which it is only separated by a slight constriction. The trunk, which is nearly oval in cross section, is almost uniformly broad for the most part of its length and gradually tapers in the hind parts to the rounded posterior extremity. Extending from the base of the head to the posterior extremity is the sole, which is raised into a prominent ridge and less than one-fourth the width of the body. The body measures 50 mm. in length and 3·5 mm. in breadth.

The dorsal surface, in spirit, is of a dirty yellowish colour with a fairly thick black stripe which medially extends almost throughout the whole length of the body. On the ventral surface the colour is much paler than on the dorsal, except for the creeping area which is nearly white.

Numerous eye-spots are distributed all round the margin of the head and continued round to the sides of the neck, where they are more ventral than dorsal and form a crowded cluster. Further, the eye-spots are arranged in sparse numbers almost throughout the whole length of the body along the sides.



Text fig. 5. Distribution of eye-spots in *Bipalium ochroleucum*, n. sp.

The mouth-opening is situated between the first and second thirds of the body, leading into the peripharyngeal chamber. The pharynx was protruded through the mouth-opening as a creamy frill.

The common genital aperture occurs at a short distance behind the centre of the body.

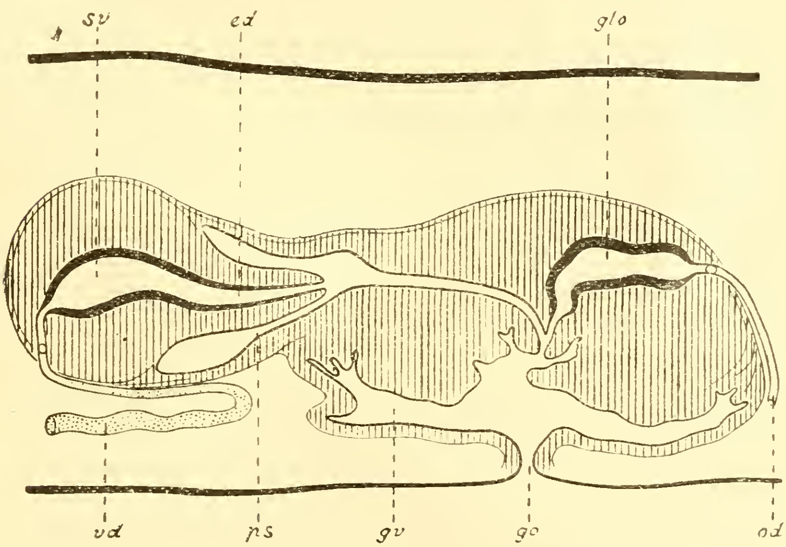
The epidermis consists of a layer of columnar cells, which are of a greater height on the dorsal than on the ventral side. The cilia are present on the surface of the sole only. Situated between these cells, except for the surface of the sole, are spindle-shaped rhabdites which are derived from their mother-cells, scattered in the parenchyme deep below the epidermis. In addition to the glands opening to the exterior on the surface of the sole, there are some glands which open in scattered distribution all over the surface of the body.

The superficial muscular system underlying the fine basement membrane is composed of the outer circular and the inner longitudinal layer. The deep muscular system, which consists of longitudinal and circular fibres, is well developed all round in the parenchyme as a thick and continuous sheet. Besides these, there are well-developed dorso-ventral muscles which run between the gut branches.

The mouth-opening is situated near the centre of the peripharyngeal chamber, in which is hanging the plicated pharynx from above. The gut trunks give off numerous lateral branches which are mostly bifurcated.

The common genital opening leads into the wide, annularly outbulged vestibulum which is provided with a wall composed of a ciliated epithelium and a muscular coating, thickest on the dorsal side.

The vas deferens, filled up with spermatozoa, proceeds backwards and at the sides of the penis makes an abrupt forward bend, to enter the base of the penis and to unite with its fellow of the opposite side into a short common duct which joins the seminal vesicle.



Text fig. 6. Diagrammatic genital organs of *B. ochroleucum* in sagittal section. Index letters as in text figs. 1 and 3.

The penis consists of the spherical bulbous part of muscular nature and the conical intromittent part lying horizontally in its sheath. The bulb encloses a relatively narrow seminal vesicle with its smooth wall, which posteriorly narrows gradually into the ejaculatory duct, opening at the tip of the penis. The penis-sheath opens, through the ciliated tubular passage, at the tip of a small conical and downwardly directed process projecting into the vestibulum.

The vitelline glands are represented by cellular cords with the cells closely packed; they extensively fill up the interspaces between the gut branches and are in connexion with the oviduct at numerous points by means of the short branches. Slightly behind the genital aperture, the oviduct nears the median line, rising upwards at the same time, and finally unites with its mate of the opposite side on the dorsal side of the vestibulum, to form a short common duct which soon communicates with the glandular organ from behind. The oviduct is lined with a ciliated epithelium. external to which comes a muscular layer of circular fibres,

The glandular organ is a body, embedded in the muscular sheath of the vestibulum, and is lined with an epithelium made up of high columnar cells of a glandular nature. Anteriorly it communicates with the tubular passage of the penis-sheath, just before opening into the vestibulum.

Note :— The present species is nearly allied to *B. simplex* von Graff recorded from the island of Sunda, but may be distinguished from this in the colouration of the head.

8. *Bipalium kisoensis*, n. sp.

(Pl. I., Fig. 11.—Text figs. 7, 8.)

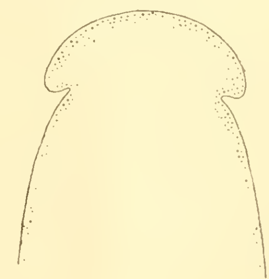
This new species is founded on seven individuals which were procured by the late Professor Ijima in 1889 in Kiso.

The head in the preserved state presents a small semi-lunar shape and is less than the width of the trunk, from which it is only marked off by a neck-like constriction. The trunk is nearly oval in cross section and has the lateral margins even and nearly parallel for a large part of the body-length, but is tapering in the hind parts to the rounded hind end of the body. The ventral surface is made up of a slightly raised sole, extending almost throughout the entire length of the body and rather less than one-third the breadth of the body. Well-grown specimens measure 30–35 mm. in length and 5 mm. in breadth.

The dorsal surface, in spirit, is of a dark colour with a touch of olive-like brown and marked with a black median stripe, extending over almost the whole length of the body. Ventrally, the colour is nearly similar to that of the dorsal surface, except for the surface of the sole which is nearly white.

The eye-spots are thickly set along all the margin of the head and also occur sparsely scattered over the whole length of the body. At the sides of the neck they are somewhat closely packed.

The mouth-opening which leads into the peripharyngeal chamber lies slightly behind the middle of the body. In some preserved specimens examined the pharynx was protruded through the mouth-opening as a frill.



Text fig. 7. Distribution of eye-spots in *Bipalium kisoensis*, n. sp.

The common genital aperture is placed slightly in front of the middle of the distance between the mouth-opening and the posterior end of the body.

The epidermis is somewhat thicker on the dorsal surface than on the ventral and full of minute spindle-shaped rhabdites, evidently situated between the epidermic cells, except on the sole-surface. Deep below the epidermis, in the parenchyme, are found the rhabdites enclosed in their mother-cells. Numerous glands, deeply situated in the median plane of the body, make their way to the surface of the sole.

The superficial muscular system consists of the outer circular and the inner longitudinal layer. Separated from this by a zone of tissue is the deep muscular system which is composed of two sets of fibres, longitudinal and circular, these two sets occurring intermingled in the same sheet.

The mouth-opening lies near the centre of the peripharyngeal pocket with the plicated pharynx. The gut trunks are provided with numerous subdivided lateral branches, which consist, as usual, of high columnar cells.

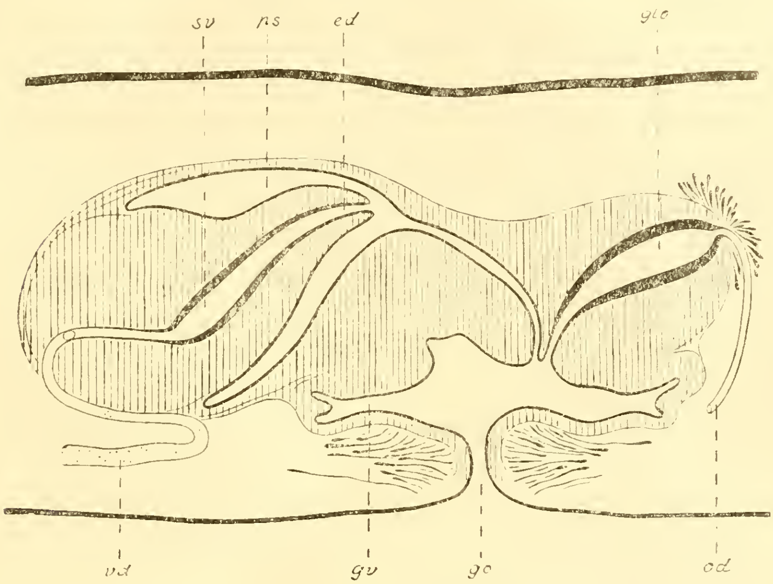
In the region of the head the nervous system forms a mesh-work which passes behind into two longitudinal nerve cords, connected in their course by numerous transverse commissures and giving off numerous lateral branches towards the marginal nerve plexus.

The copulatory organs are constructed in similar manner to those in *Bipalium ochroleucum* previously described, and embedded in the muscular sheath. The common genital opening leads into the wide vestibulum of an irregular contour, which receives the openings of the penis-sheath and the glandular organ from above. The vestibulum is lined with a single epithelium, beneath which are found circular and longitudinal muscular layers. Numerous glands are found all round the genital aperture, into which they open.

Numerous testes are arranged in a single row just outside the longitudinal nerve cords, beginning from some distance behind the ovary and ceasing altogether to exist at the level of the pharynx-insertion. As is well known, each testis is made up of sperm-mother-cells and spermatozoa in all stages of development. The vasa deferentia, which are filled with spermatozoa, pursue a backwardly directed, sinuous course along the outer side of the nerve cords, and at the sides of the penis make an abrupt turn upwards and forwards. After entering the penis-bulb, they fuse together to form a common duct which opens into the seminal vesicle.

The penis is composed of the bulbous basal part of strongly muscular nature and the free conical intromittent part, being almost horizontally disposed in the penis-sheath. The latter part encloses a relatively narrow seminal vesicle lined with a layer of high columnar cells of a glandular nature. The vesicle passes behind into the ejaculatory duct, opening into the penis-sheath at the tip of the penis. The sheath communicates with the vestibulum through the narrow passage.

The paired ovary, ventral in position, is situated at a short distance behind the meshwork of the brain, and at the postero-lateral aspect gives rise to the oviduct in the form of a funnel-like widening which soon passes into the narrow duct, proceeding backwards just above the nerve cords and receiving the vitelline glands at numerous points. The vitelline glands are represented by branching cellular masses, extensively filling up the interspaces between the branches of the intestine. Behind the genital opening the oviducts bend inwards, rising upwards at the same time, and finally enter, each separately, the glandular organ at the posterior end. The wall of the oviduct is, as usual, composed of a ciliated epithelium and a thin muscular layer.



Text fig. 8. Copulatory organs of *B. kisoensis* in sagittal section, diagrammatically shown.
Index letters as in text figs. 1 and 3.

The glandular organ, embedded in the muscular sheath, presents a fairly wide lumen lined with a thick ciliated epithelium of a glandular nature, and opens in front into the vestibulum close to the opening of the penis-sheath. At the opening point of the oviducts the organ is supplied with numerous glands.

9. *Bipalium fuscolineatum*, n. sp.

(Pl. I., Figs. 4, 5.—Text fig. 9.)

A few representatives of this new species were caught by the late Professor Ijima in July, 1886, on the stone wall or under stones in Nikko.

According to the late Professor IJIMA's notes and sketches taken when the worms were living, the head, which was dorso-ventrally depressed, was semi-lunar or oval in shape, a great deal wider than the trunk, and marked off from the trunk by a neck-like narrowing. In the creeping state the frontal margin of the head gave rise to numerous serrated processes. The trunk in the preserved state is elongate, slender and of a uniform breadth for the greater part, though it tapers extremely gradually in the hind parts, to end with a blunt point at the posterior extremity. Dorsally, the body is slightly convex and ventrally nearly flat. From the base of the head to the posterior end of the body, in the mid-ventral line, is the slender sole, forming a prominently raised ridge, rather less than one-fourth the breadth of the body. Large worms may reach 50 mm. in length and 3 mm. in breadth, while one of the smallest measured 9 mm. long by 2 mm. broad.

The ground colour of the dorsal surface is very dark mixed with a slight olive tint and marked with a fine black mid-longitudinal line, extending almost throughout the whole length of the body. Anteriorly the line loses itself gradually in the general colour of the head, which is much lighter than that of the body. The ventral surface is of a gray colour, except on the sole where the colour is pale.

The eye-spots thickly surround the entire fringe of the head, continuing sparsely along the sides of the body. At the sides of the neck they form, as usual, a crowded cluster.

The mouth-opening which leads into the peripharyngeal chamber lies somewhat behind the middle of the body on the sole.

The common genital aperture is placed at the hind end of the first third of the distance between the mouth-opening and the posterior extremity of the body.

The epidermis consists of a single layer of columnar cells resting upon a fine basement membrane and contains numerous spindle-shaped rhabdites, evidently situated between the cells. The rhabdites enclosed in the subcutaneous cells occur in wide distribution over various parts of the body. In addition to the glands opening on the surface of the sole, there are some glands which open in scattered distribution over the surface of the body.

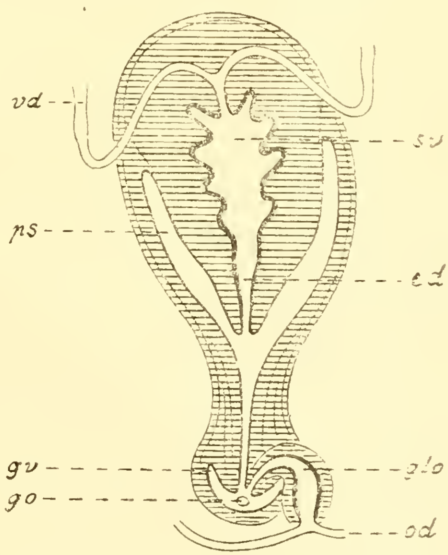
The superficial muscular system consists of the outer circular and the inner longitudinal layer. The deep muscular system, which is composed of longitudinal and circular fibres, is well developed all round in the parenchyme as a thick and continuous sheet.

The mouth-opening lies near the centre of the peripharyngeal chamber, in which is laid the pharynx plicated. The gut trunks give off a large number of lateral branches, the walls of which are composed of single epithelium of high cylindrical cells.

The cerebral-nervous system exhibits an appearance of meshwork which gives rise behind to two longitudinal nerve cords, connected throughout by very numerous transverse commissures and laterally giving off numerous nerves towards the nerve plexus.

The common genital opening leads into the vestibulum which makes an oblique, upwardly directed, annular outbulging; consequently there is formed in the cavity a small conical and downwardly directed process surrounded by the said outbulging.

Numerous testes are arranged in a single row just along the lateral side of the longitudinal nerve cords, extending from behind the ovary to about the level of the mouth. The vasa deferentia, proceeding straight backwards, turn abruptly upwards and forwards to enter the bulbous part of the penis, and unite into a short common duct, which soon opens into the seminal vesicle.



Text fig. 9. Diagrammatic representation of the genital organs of *Bipalium fuscolineatum*, n. sp., as seen from the dorsal side.
Index letters as in text figs. 1 and 3.

The penis consists of the small semi-spherical bulbous part of muscular nature and the free, conical intromittent part lying almost horizontally in its sheath, which communicates with the vestibulum, through a narrow ciliated passage, at the tip of the conical process. Enclosed in the penis is the seminal vesicle, which is provided with a folded wall and continuous posteriorly with the ejaculatory duct, opening into the penis-sheath at the tip of the penis.

The paired ovary is situated somewhat behind the cerebral meshwork and gives rise to the oviduct on each side, which receives the vitelline glands at numerous points. Behind the genital aperture the oviduct bends mediad, at the same time rising upwards, to unite with its fellow of the opposite side into a fairly wide common canal, the glanduar organ, which gradually narrows and opens into the vestibulum close behind the opening of the penis-sheath.

10. *Bipalium hilgendorfi* (von Graff).

(Pl. I., Fig. 6.—Text figs. 10, 11.)

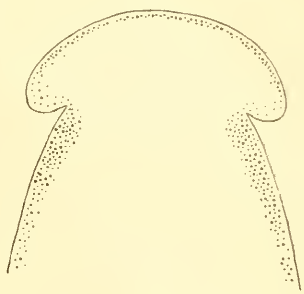
Perocephalus hilgendorfi, von Graff (25), p. 415.

A single specimen of this species, which I identify with *Perocephalus hilgendorfi*, described by von Graff from "Yeddo", an old name of Tokio, was obtained by Mr. Kinoshita and the late Mr. Takeshita in October, 1916, at Takao near Tokyo.

The head in the preserved state presents a semi-lunar shape and is not a great deal wider than the breadth of the trunk. There thus exists behind the head a neck-like constriction. The trunk, which is nearly oval in cross section, is almost uniformly broad for the most part, but gradually tapering in the hind parts to the bluntly pointed extremity. From the neck to the extreme posterior is the sole, which forms a prominently raised ridge, about one-third the width of the body. The worm in the fully extended state measures 70 mm. in length and 2·5 mm. in breadth.

The dorsal surface is of a uniform umber brown colour with a fine black line which extends almost throughout the whole length of the body along the median line. Anteriorly the line merges into the ground colour of the head, which is much darker than the rest of the dorsal surface. The ventral surface is much lighter than the dorsal, except on the sole, where the colour is nearly white.

The eye-sopts are arranged in one or two rows along the margin of the head, except on the lappets, where they occur in loosely scattered distribution. In addition there are present the eye-spots around the body, at the sides of the neck they are especially dense, extending over more ventral than dorsal.



Text fig. 10. Distribution of eye-spots in *Bipalium hilgendorfi* (von Graff).

The mouth-opening lies somewhat behind the centre of the body, opening into the peripharyngeal chamber. In the preserved specimen the pharynx was protruded through the mouth-opening as a frill.

The common genital aperture is situated at the commencement of the second third of the distance between the mouth-opening and the hind end of the body.

The epidermis consists of a layer of columnar cells, which are a great deal higher on the dorsal than on the ventral side. The cilia are present on the surface of the sole only. Evidently wedged in between the cells, except on the sole, are spindle-shaped rhabdites, which arise from their mother-cells, embedded in the parenchyme below the superficial muscular system. Numerous glands, deeply situated in the body along the median line, make their way to the surface of the sole.

Directly below the fine basement membrane is the superficial muscular system composed of two layers, outer circular and inner longitudinal. The deep muscular system, separated from the superficial by a zone of tissue, forms a thick and continuous sheet, and consist of two distinct sets of fibres, longitudinal and circular, which occur intermingled in the same sheet, without being arranged in definite layers. The longitudinal fibres are more strongly developed than the circular.

The mouth-opening is situated near the centre of the peripharyngeal chamber, in which is disposed the plicated pharynx. The gut trunks are provided with numerous bifurcated branches, the epithelium of which is made up, as usual, of higher columnar cells.

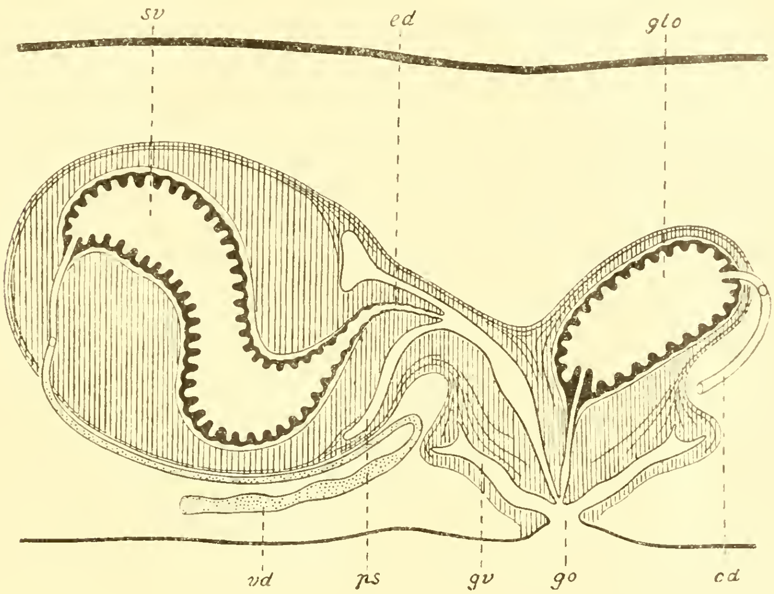
The structure of the genital apparatus is in accord with that described by von Graff. The common genital opening leads into the vestibulum, which forms a wide, annular, oblique, upwardly directed outbulging, and which receives the openings of the penis-sheath as well as of the glandular organ. The vestibulum is lined with a single epithelium, beneath which is a muscular coating composed of circular and longitudinal fibres.

Numerous testes are arranged on either side of the anterior gut trunk, extending from behind the ovary to the insertion of the pharynx. The vasa deferentia, proceeding backwards just along the upper side of the longitudinal nerve cords, turn abruptly round at the sides of the penis and then pursue a directly opposite course, to enter the penis-bulb at its anterior end. Within the bulbous part they unite into a common duct before opening into the seminal vesicle. The vas deferens, which is filled with spermatozoa, shows a definite wall consisting of a thin epithelium and a feeble muscular layer of circular fibres.

The penis is composed of the spherical bulbous part of muscular nature and the small, conical intromittent part which is nearly horizontally disposed in the penis-sheath. Enclosed in the former part is a wide cavity, the seminal vesicle, which is lined with an epithelium of a glandular nature, projecting to a considerable extent into its lumen in folds. Posteriorly the vesicle is continuous with the ejaculatory duct which opens into the penis-sheath at the tip of the penis. Externally the penis is covered with a thin epithelium. The muscular fibres of which the penis is composed are arranged in two principal sets, circular and longitudinal, the fibres of the two sets occurring intermingled with one another.

The penis-sheath leads into the vestibulum, through the tubular passage which is richly ciliated. The wall of the sheath consists of a non-ciliated epithelium and a thick muscular coating, much as observed in the vestibulum.

The paired ovary, situated behind the brain, gives rise to the oviduct on each side, which proceeds backwards just outside the longitudinal nerve cord receiving the vitelline glands at numerous points. The vitelline glands are represented by branching cellular



Text fig. 11. Genital organs of *B. hilgendorfi* in sagittal section, diagrammatically shown. Index letters as in text figs. 1 and 3.

cords, extensively distributed in the interstices between the gut diverticulae. Behind the genital opening the oviduct, supplied with numerous unicellular glands, nears the median line, rising obliquely upwards at the same time, and finally unites with its fellow of the opposite side, to form a short common duct, which soon enters the glandular organ at the posterior end. The duct shows a distinct lumen throughout its entire length. Its direct wall is formed by a richly ciliated epithelium, outside which is a muscular layer of circular fibres.

The glandular organ, situated dorsal to the vestibulum, is an oblong muscular organ, which anteriorly communicates with the vestibulum, through the ciliated narrow passage, at a point close to the opening of the penis-sheath. It is internally lined with a ciliated epithelium of a glandular nature, which is thrown into many folds, projecting into its lumen. The formation of the cocoon takes place in this organ, as mentioned by von GRAFF.

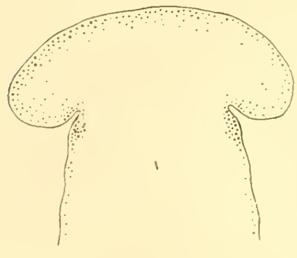
11. *Bipalium fuscocephalum*, n. sp.

(Pl. I., Fig. 7.—Text fig. 12.)

A single immature specimen of this species was taken by myself in August. 1915, on the stone wall in the vicinity of Innai in Prov. Ugo.

The head, which is semi-lunar in shape, has somewhat recurrent lappet pointed at the apex on either side, and is wider than the trunk, which is of a uniform breadth for the greater part, though it gradually tapers in the hind parts down to the bluntly pointed extremity. The ventral surface is made up of the median, slightly raised sole, which extends over almost the whole length of the body and is about one-fourth the width of the body. When in motion the worm may reach 35 mm. long by 3 mm. broad; the head measures about 4 mm. across the apices.

The ground colour of the dorsal surface is uniformly brown with a slight gray tint and marked with a fine black line which medially extends over nearly the entire length of the body. Anteriorly the line merges into the ground colour of the head, which is of a brownish black colour. The ventral surface is much lighter than the dorsal, except for the surface of the sole, which is somewhat paler.



Text fig. 12. Distribution of eye-spots in *Bipalium fuscocephalum*, n. sp.

The eye-spots are exceedingly numerous, and occur, not only surrounding the entire fringe of the head and lobes, but also continuing sparsely for a considerable distance along the sides of the body. At the sides of the neck, they are somewhat more ventral than dorsal, forming a crowded cluster.

The mouth-opening lies slightly behind the middle of the body, leading into the peripharyngeal cavity.

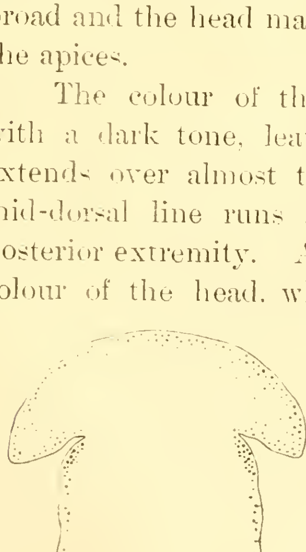
12. *Bipalium monolineatum*, n. sp.

(Pl. I., Fig. 14.—Text figs. 13, 14.)

This new species is represented by two specimens which were captured by me in July, 1916, on the stone wall of Chionin, a Buddhist temple, in Kyoto, and also at Mt. Hiyei. According to the late Professor IJIMA's notes he also obtained a specimen referable to this species in the former situation.

The head presents a semi-lunar shape and is more or less wider than the width of the trunk, from which it is distinctly separated by a neck-like constriction. The frontal margin of the head in the creeping state gives rise to numerous serrated processes. In the hind parts the sides of the trunk converge backwards to a pointed extremity. The ventral surface is marked with the slightly raised sole, which is rather less than one-third the width of the body and extends almost throughout the entire length of the body. When fully extended the body measures 35 mm. long by 2 mm. broad and the head may reach twice the width of the body, across the apices.

The colour of the dorsal surface is brownish orange mixed with a dark tone, leaving a light coloured, median zone which extends over almost the entire length of the body. Along the mid-dorsal line runs a fine black stripe from the head to the posterior extremity. Anteriorly the stripe merges into the general colour of the head, which is much darker than the rest of the dorsal surface. Ventrally, the colour is similar to that of the dorsal side, though usually paler; the surface of the sole is pale yellow, and on each side of it is a diffused black line.



Text fig. 13. Distribution of eye-spots in *Bipalium monolineatum*, n. sp.

The eye-spots are numerous and extend all round the head to the sides of the neck, where they are densely set. Further, the eye-spots are present sparingly scattered over the entire length of the body along the sides.

The mouth-opening which leads into the peripharyngeal chamber is situated near the centre of the body.

The genital aperture is placed at the hind end of the second third of the distance between the mouth-opening and the posterior end of the body.

The epidermis is composed of a layer of columnar cells, which are very much higher on the dorsal than on the ventral side. The cilia are confined to the surface of the sole only. Evidently situated between the cells are minute rhabdites which take place in the subcutaneous cells. Besides the glands opening medially on the surface of the sole, there are some unicellular glands which open in scattered distribution all over the surface of the body.

Directly below the basement membrane comes a muscular system which consists, as usual, of the outer circular and the inner longitudinal layer. Deep below these layers, in the parenchyme, is a thick and continuous sheet composed of two distinct sets of fibres, longitudinal and circular, which occur intermingled in the same sheet. In addition to these are found the dorso-ventral muscles which run between the gut diverticulae.

The mouth-opening is situated in the middle of the peripharyngeal pocket, from the dorsal wall of which arises the plicated pharynx. The intestinal trunks are provided with numerous branches which are sometimes bifurcated and sometimes trifurcated. Their walls are a single epithelium made up of high cylindrical cells which are placed very closely together and contain numerous coarse, highly-refractive granules in the finely granular protoplasm.

The brain has the appearance of meshwork, widely spread at the anterior end of the body. Posteriorly from the meshwork spring two longitudinal nerve cords which proceed backwards, running nearly parallel to each other, to the hind end of the body, and are connected by numerous transverse commissures. Laterally they give off numerous branches.

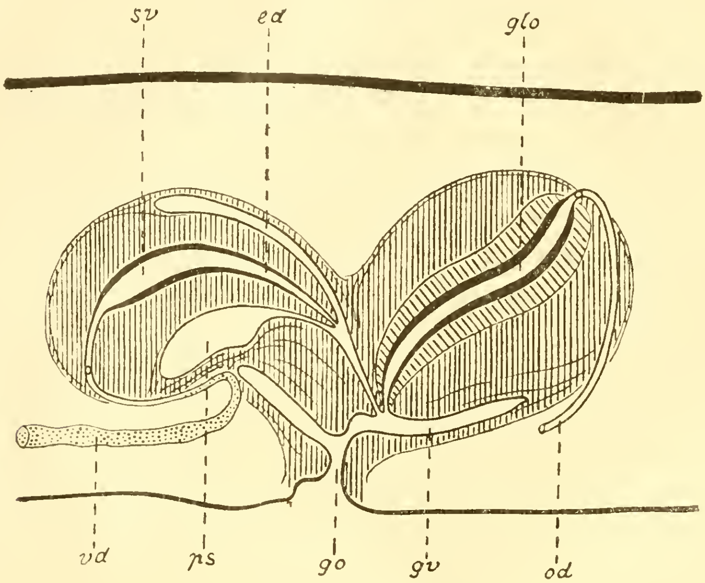
The eye consists simply of a pigment cup, filled with a cellular substance, which is a faintly staining, very slightly granular body and very little differentiated from the general cell-contents.

The common genital opening leads into the vestibulum which receives the openings of the penis-sheath and the glandular organ. The actual wall of the vestibulum is an epithelium made up of ciliated columnr cells, beneath which are a muscular coating composed of circular and longitudinal fibres.

Numerous testes, each nearly spherical in shape and made up of sperm-mother-cells and spermatozoa in several stages of development, are placed colosely together in the ventral portion of the body, arranged in a single row just outside the longitudinal nerve cords, which extend from somewhat behind the ovary to the insertion of the pharynx. The vasa deferentia, filled up with spermatozoa, proceed backwards along the outer side of the nerve cords and form a loop at the sides of the penis, to pursue a forward course. After entering the base of the penis, they unite into a single duct which joins the seminal vesicle from the front.

The penis consists of the semi-spherical bulb of muscular nature and the conical intromittent part which is horizontally disposed in the penis-sheath. The bulb contains a relatively narrow and smooth-walled seminal vesicle, which posteriorly narrows gradually into the ejaculatory duct, opening into the penis-sheath at the tip of the penis. The penis-sheath communicates with the vestibulum through the ciliated tubular passage.

The ovaries are nearly oval in shape and are present in a pair somewhat behind the brain, one on the lateral side of the nerve cord. From the inner lateral aspect of the ovary starts the oviduct as an ampullaceous passage, which soon assumes the character of a narrow tube, proceeding straight backwards just along the inner side of the vas deferens and receiving the vitelline glands at several points of its course. The vitelline glands are represented by irregularly ramified, cellular cords, extensively distributed in the interstices between the gut branches. The mode of their connexion with the oviduct is effected by means of the short branches of the latter, which are situated at fairly regular intervals. Behind the common genital aperture the oviduct, supplied with numerous unicellular glands, bends inwards, at the same time rising upwards, to fuse with its fellow of the opposite side into a very short common duct, which soon joins the glandular organ from behind. The wall of the oviduct is composed of a ciliated epithelium and a muscular layer of circular fibres.



Text fig. 14. Reproductive organs of *B. monolineatum* in sagittal section, diagrammatically shown.
Index letters as in text figs. 1 and 3.

The glandular organ, situated dorsal to the vestibulum, is a nearly spherical body with a sheath of parenchyme including numerous muscular fibres, and anteriorly opens into the vestibulum at a point close behind the opening of the penis-sheath. Its direct wall is formed by an unfolded epithelium made up of non-ciliated columnar cells of a glandular nature, which are placed very closely together. Immediately external to the layer mentioned is a fairly thick layer of nearly homogeneous tissue.

Note:—The parasitic nematode has long been known to occur in the bodies of some land planarians. Embedded in the parenchyme of the specimen at present under examination are found a few individuals of a small nematode parasitic, which appear making their way through the body-wall.

13. *Bipalium maculatum* Stimpson.

Bipalium maculatum, Stimpson (62) pp. 25, 30—Diesing (16), p. 514.—Moseley (45), p. 108 and (46), p. 290.—*Loman* (40), p. 64.—von Graff (25), p. 446.

This species was first described by Stimpson from the island of Oshima. No specimen came under my observation.

"Subdepressum; capite auriculis sat brevibus, fronte arcuata. Corpus supra fulvum, maculis nigris confertis, fascia mediana pallida nigro-marginata; auricularum marginibus posterioribus nigris. Ocelli valde numerosi in acervum arcuatum frontalem submarginalem. Long. 3 poll. (76 mm.); corporis lat. 0·2 poll (5 mm.); capitis lat. 0·3 poll. (7·6 mm.)"

The present species seems to be nearly allied to *B. ceres* Moseley (45) from Ceylon, as described by von Graff.

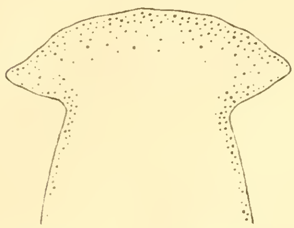
14. *Bipalium trifuscostriatum*, n. sp.

(Pl. I., Fig. 15.—Text fig. 15.)

This new species is represented by two individuals, one of which was secured by the late Professor Ijima in 1890 at Sakata, Prov. Ohmi, and the other by myself in July, 1916, on the stone wall of the Mii Temple in Ôtsu.

The head in the living state is of a semi-lunar shape and a great deal wider than the trunk, from which it is distinctly marked off by a neck-like narrowing. The trunk is almost uniformly broad in the greater part of its length, but gradually tapering in the hind parts down to the bluntly pointed posterior extremity. Extending from the neck to the hind end of the body, in the mid-ventral surface, is the sole, which is scarcely raised above the general level and rather less than one-third the width of the trunk. The specimen is 50 mm. long, the greatest breadth, at about the middle of the trunk, is 2 mm., and the head measures 6 mm. across.

The ground colour of the dorsal surface is a bluish gray with a touch of black. Medially are three black stripes which run throughout the whole length of the body. Of those the median stripe extends over the head and loses itself gradually in the general colour of the head, which is characterized by a touch of brown colour. The ventral surface is similar in colouring to the dorsal, but the surface of the sole is more or less pale than the rest of the ventral surface.



Text fig. 15. Distribution of eye-spots in *Bipalium trifuscostriatum*, n. sp.

Except on the apex of the lappets the eye-sports are distributed all round the margin of the head, where they are exceedingly numerous, and also sparingly present over the entire length of the body to the posterior extremity.

The mouth-opening which leads into the peripharyngeal chamber is situated at nearly the centre of the body. The genital aperture is placed at a distance behind the mouth-opening equal to about one-third that between the latter and the posterior end of the body.

The epidermis is much thicker on the dorsal side than on the ventral and contains numerous spindle-like rhabdites, evidently wedged in between the epidermic cells. Numerous glands, embedded in the parenchyme along the median plane of the body, open out on the surface of the sole.

The superficial muscular system is composed of the external circular and the internal longitudinal layer. Separated from this by a zone of tissue the deep muscular system is found, forming a thick and continuous sheet which consists of two sets of fibres, longitudinal and circular, occurring intermingled in the same mass.

The mouth-opening lies near the centre of the peripharyngeal pocket with the plicated pharynx. The gut trunks are provided with numerous subdivided lateral branches, which are lined with an epithelium of high cylindrical cells, each full of coarse, highly refractive granules.

The genital organs were, unfortunately, not yet well developed in the specimen examined. The genital opening leads into the tubular atrium, which divides into two parts, anterior and posterior. The former passes into a vesicle, the penis-sheath, which is wholly devoid of any intromittent part of the penis. The muscular fibres of which the penis-bulb is composed are found occurring intermingled with one another. The latter leads into a muscular-walled blind vesicle, doubtless representing the glandular organ.

15. ***Bipalium trilineatum*** STIMPSON.

(Pl. I., Fig. 16.—Text fig. 16.)

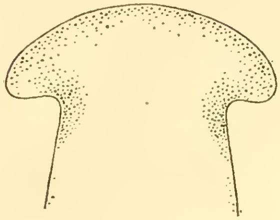
Bipalium trilineatum, STIMPSON (62) pp. 25, 31.—*Diesing* (16) p. 516.—MOSELEY (45), p. 108 and (46), p. 290.—*Loman* (40), p. 64.—von GRAFF (25), p. 443.

Two specimens, which I identify with STIMPSON'S *Bipalium trilineatum*, described by that author from Hokkaido, were collected by the late Professor IJIMA, 1889, at the foot of Mt. Hanaoka, near Kumamoto, in Prov. Higo.

This worm is possessed of a broadly spread semi-lunar head, which presents somewhat recurrent lobes and is distinctly separated from the trunk by a neck-like narrowing. The trunk gradually widens backwards to the pharyngeal region and then begins to taper gradually, to end with a point at the posterior end of the body. The dorsal surface is slightly convex and the ventral nearly flat; the sole forms a slightly raised ridge, rather less than one-fifth the width of the body, and extending from the base of the head to the posterior extremity. The large specimen was 54 mm. long by 4 mm. broad, at the pharyngeal region, while the small was 39 mm. long by 3 mm. broad; the head in both measured 5 mm. across.

The dorsal surface in the living state is of a dirty yellowish orange colour with three well-defined black stripes, which extend almost throughout the whole length of the body. The median stripe extends to a point on the head and loses itself gradually in the general colour of the head, which is much lighter than that of the trunk. Ventrally, the colour is similar to that of the dorsal side, though usually paler, except for the surface of the sole which is nearly white.

Exceedingly numerous eye-spots surround almost the entire fringe of the head and lappets, and are continued round to the sides of the neck where they are more ventral than dorsal and form a dense cluster. Besides this, the eye-spots occur sparingly scattered over almost the whole length of the body, on the ventral side along and just within the margin of the body; there existing two or three eye-spots in width.



Text fig. 16. Distribution of eye-spots in *Bipalium trilineatum* STIMPSON.

The mouth-opening which leads into the peripharyngeal pocket is situated near the middle of the body, in the mid-ventral line.

In the specimens examined the genital organs were not yet developed at all.

Genus **Placocephalus** von GRAFF.

16. ***Placocephalus fuscatus*** (STIMPSON).

(Pl. I., Figs. 8, 9.—Text figs. 17–19.)

Bipalium fuscatum, STIMPSON (62), pp. 25, 31.—DIESING (16), p. 515.—MOSELEY (45), p. 108 and (46), p. 290.—LOMAN (40), p. 64.

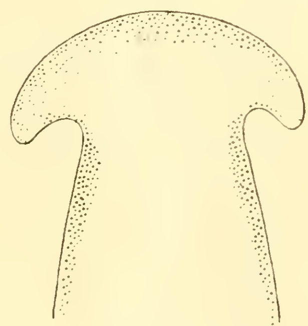
Placocephalus fuscatus, von GRAFF (24), p. 121 and (25), pp. 461, 462.

This species, known as occurring in the Indo-Malay Archipelago, is exceedingly common in Japanese territories. Numerous specimens came under my observation.

The head in the preserved state is much depressed dorsoventrally, of a semi-lunar shape with a round prominent lappet on either side, and only a little wider than the trunk, from which it is distinctly separated by a neck-like constriction. The fronta margin of the head in the creeping state gives rise to numerous serrated processes. The greater part of the trunk is of similar breanth, though it graddally tapers in the hind parts down to the bluntly pointed posterior extremity. The dorsal surface is slightly convex and the ventral nearly flat, but forming a slightly raised, median ridge almost throughout the whole length of the body. Large worms may reach 12 cm. in length and about 4 mm. in breadth, while one of the smallest measured only 13 mm. long by 1·5 mm. broad.

The dorsal surface is of a uniform velvety black, except on the head, which reveals a dark rusty brownish tone. Ventrally, the colour is somewhat paler than that of the dorsal side, except for the surface of the sole which is, as usual, of a plae gray colour and anteriorly presents nearly the form of an arrow-head by reason of the shade of colour. On either side there exists a longitudinal zone much paler than the rest of the ventral surface.

Numerous eye-spots are densely set, surrounding the entire fringe of the head lobe, and are continued round to the sides of the neck, where they are more ventral than dorsal and form a closely crowded cluster. Further, the eye-spots are arranged in sparse numbers almost throughout the whole length of the body, on the ventral side along and just within the margin of the body.



Text fig. 17. Distribution of eye-spots in *Placocephalus fuscatus* (STIMPSON).

The mouth-opening which leads into the peripharyngeal chamber is placed slightly behind the centre of the body in the mid-ventral line.

The common genital aperture is situated at the hind end of the anterior third between the mouth-opening and the posterior end of the body.

The epidermis made up of columnar cells is much higher on the dorsal surface than on the ventral and provided with cilia on the surface of the sole only. Situated between the epidermic cells, except those that are on the sole-surface, are found minute and slender rhabdites, which originate from their mother-cells, scattered in fair abundance in the parenchyme farther inwards to the epidermis. Deeply embedded in the parenchyme along the median zone of the body are enormous quantities of slime glands which open out on the sole-surface.

Immediately beneath the basement membrane comes the superficial muscular system composed of two layers of outer circular and inner longitudinal fibres. The deep muscular system, separated from this by a zone of tissue, forms a thick layer which consists of two sets of fibres, longitudinal and circular, occurring intermingled without being arranged in a definite layer.

The mouth is a small opening situated near the centre of the peripharyngeal cavity, into which the plicated pharynx is protruded from above. The intestinal trunks give off numerous bifurcated lateral branches. Their direct walls are composed of a single epithelium made up of high cylindrical cells which are placed very closely together.

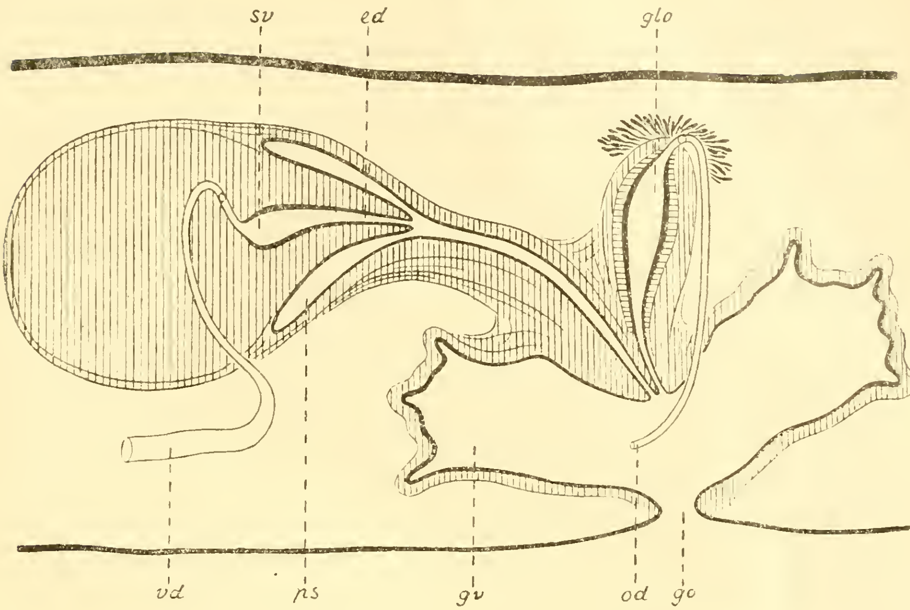
In the anterior region the nervous system presents a feature of meshwork which passes behind into two longitudinal cords, connected throughout by numerous commissures and provided with lateral nerves towards the nerve plexus.

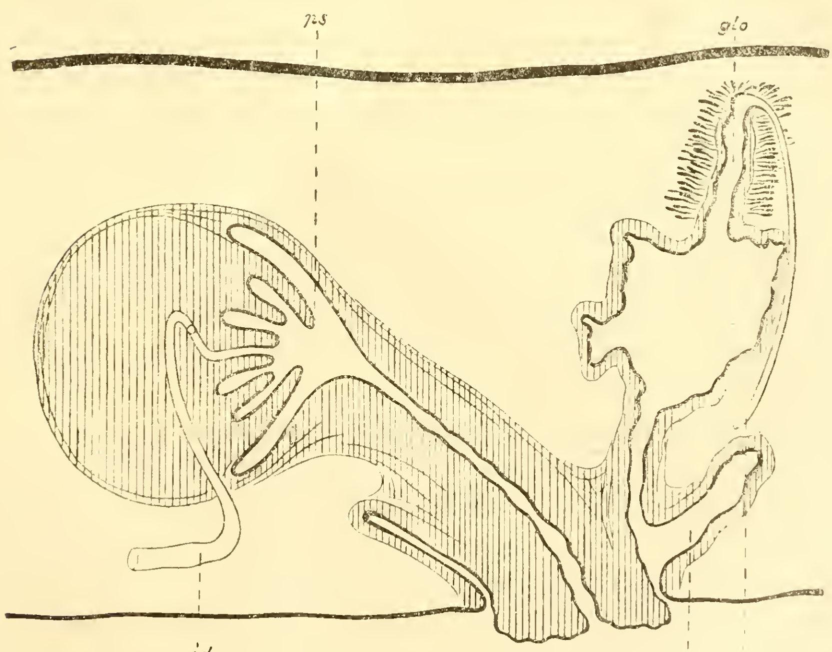
The general feature of the copulatory organs in the normal state stands somewhat at variance from that described by von Graff, but the difference may be regarded as depending upon different individuals and the condition of expansion or contraction of the worm. A similar feature to that of von Graff I have obtained with an individual, as shown in Text fig. 19.

The genital aperture leads into the widely outbulged vestibulum, which at the bottom is lined with an epithelium made up of high columnar cells. The vestibulum receives the communications of the penis-sheath and the glandular organ.

Numerous testes are ventrally arranged in a row on each side of the body just outside the nerve cords, extending from behind the ovary to the insertion of the pharynx. The vasa deferentia, proceeding backwards, make an abrupt upward bend at the sides of the penis to enter the penis-bulb and to fuse into a common duct which soon communicates with the seminal vesicle.

The penis is divided into two parts, viz., the bulbous basal part of strongly muscular nature and the conical intromittent part lying almost horizontally in the penis-sheath. Enclosed in the latter part is a relatively narrow, smooth-walled seminal vesicle, which narrows behind into the ejaculatory duct, terminating at the tip of the penis. In one case the wall of the vesicle projects into





Text figs. 18 and 19. Sagittal sections of the copulatory organs of *Plac. fuscatus*, diagrammatically shown.
Index letters as in text figs. 1 and 3.

the lumen in folds, as stated by von GRAFF. The penis-sheath passes behind into the narrow passage which dips below to open into the vestibulum from above.

The paired ovary is nearly oval in shape and occupies a ventral position somewhat behind the cerebral meshwork. At the postero-lateral aspect the oviduct leaves the ovary as an ampullaceous passage which soon assumes the character of a narrow duct, proceeding backwards above the longitudinal nerve cords and receiving the vitelline glands at several points of its course. In the region of the genital aperture the oviduct bends mediad, rising upwards at the same time, and finally unites with its fellow of the opposite side to form the glandular organ. The oviduct has its wall formed by a ciliated epithelium and a thin muscular layer.

The glandular organ, which is embedded in the muscular sheath, presents a fairly wide lumen, internally lined with an unfolded epithelium and externally with a layer of parenchyme including muscular fibres, and opens into the vestibulum close behind the opening of the penis-sheath. Sometimes the organ is distended into a wide space with a plicated wall. Near the communicating point of the oviducts the organ is supplied with numerous glands.

17. *Placocephalus glaucus*, n. sp.

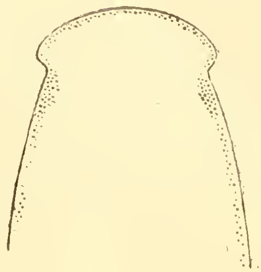
(Pl. I., Fig. 17.—Text figs. 20, 21.)

This planarian, of which four specimens were collected by myself in July, 1916, on the stone wall in Yoshino, is remarkably handsome and occurred in pairs, one individual followed by the other.

The head presents a small semi-lunar shape and is as broad as the trunk, from which it is only marked off by a slight necklike constriction. The trunk is exceedingly elongate, slender and of similar breadth for the greater part, though it gradually tapers some little distance from the posterior end to a bluntly pointed extremity. Extending from the neck to the posterior end of the body, in the mid-ventral line, is a slightly raised ridge, the sole, rather less than one-third the breadth of the body. In length they range from 120 mm. to 200 mm., measuring 3·5–4 mm. in breadth.

The worm has, dorsally, a uniform deep green colour, except on the head, where the colour is grayish brown. The ventral surface is of a much lighter colour than the dorsal, except for the surface of the sole which is pale.

The eye-spots are arranged in one or two rows all round the margin of the head and continue sparingly for a considerable distance along the sides of the body. At the sides of the neck they are somewhat closely packed.



Text fig. 20. Distribution of eye-spots in *Placocephalus glaucus*, n. sp.

The mouth-opening is placed at about the hind end of the first third of the length of the body, leading into the peripharyngeal chamber.

The common genital aperture is situated at a short distance behind the mouth-opening.

The epidermis is made up of a layer of columnar cells which are of a greater height on the dorsal than on the ventral side. The cilia are present on the surface of the sole only. Wedged in between these cells, except on the sole, are numerous rhabdites of a spindle-like shape. Deep below the epidermis, in the parenchyme, exist such rhabdites as are still contained in their mother-cells. Besides the glands, deeply situated in the median line of the body and opening out on the sole-surface, there occur some glands which open in scattered distribution all over the surface of the body.

Directly inwards to the basement membrane is the superficial muscular system composed of the outer circular and the inner longitudinal layer. The deep muscular system is well developed all round in the parenchyme as a thick and continuous sheet, chiefly consisting of longitudinal fibres.

The mouth-opening lies near the middle of the peripharyngeal chamber, in which is disposed the plicated pharynx from above. The gut trunks give off numerous subdivided lateral branches, the epithelium of which shows no noteworthy features, consisting, as it does, of high columnar cells.

The nervous system consists, as usual, of two longitudinal cords which anteriorly join the cerebral meshwork. The cords are connected throughout their course by numerous fine transverse commissures. Laterally they send out numerous branches towards the nerve plexus.

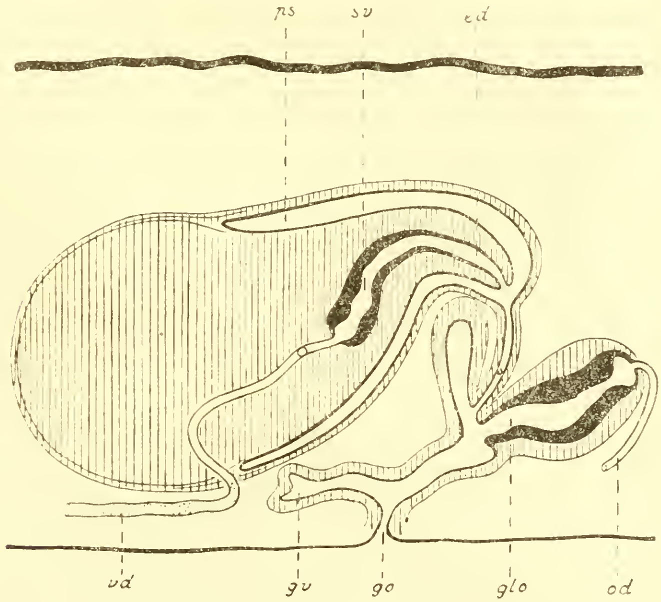
The common genital opening leads into the vestibulum of an irregular contour, which receives the openings of the penis-sheath and the glandular organ from behind. The cavity is lined with a thin ciliated epithelium, external to which is a fairly well developed muscular coating composed of circular and longitudinal fibres.

Numerous testes, each consisting of sperm-mother-cells and spermatozoa in several stages of development, occur close together in the ventral position of the body and are arranged in a single row along the outer side of the nerve cords, beginning from somewhat behind the ovary and extending behind to the insertion of the pharynx. The vasa deferentia, filled with spermatozoa, proceed straight backwards, just outside the nerve cords, and turn abruptly forwards and upwards, to enter the penis-bulb at the sides, and finally to unite into a common duct which communicates with the seminal vesicle.

In the penis there can be distinguished the semi-spherical bulbous part of muscular nature and the free conical intromittent part which is nearly horizontally disposed in the penis-sheath. Enclosed in the intromittent part is a relatively narrow seminal vesicle, which is lined with high columnar cells of a glandular nature. Posteriorly the vesicle is continuous with the ejaculatory duct, opening into the penis-sheath at the tip of the penis. The muscular fibres of which the penis is composed are arranged in two sets, circular and longitudinal, the fibres of the two sets occurring intermingled with one another.

The penis-sheath is in communication with the vestibulum through the narrow passage lined with a ciliated epithelium.

At some distance behind the cerebral meshwork is found the paired ovary which is of an oval shape and made up of ova in various stages of development. From its inner lateral aspect the oviduct springs in the form of a funnel-like widening which soon takes the character of a narrow duct and pursues a backward course just above the nerve cords, receiving the vitelline glands at numerous points. The vitelline glands present an appearance of branching cellular masses, extensively distributed in the interspaces between the gut branches. Behind the common genital aperture the oviduct rises obliquely upwards, to open into the glandular organ from behind, without uniting with its fellow of the opposite side into a common duct. The oviduct shows a distinct lumen in its entire length. Its actual wall is formed by a richly ciliated epithelium, directly below which is a thin muscular layer.



Text fig. 21. Copulatory organs of *Plac. glaucus* in sagittal section. Diagrammatic. Index letters as in text figs. 1 and 3.

The glandular organ is a nearly oblong body with a thick muscular sheath, opening into the vestibulum at a point below the opening of the penis-sheath. The cavity is lined with an epithelium made up of high columnar cells of a glandular nature.

The vestibulum is supplied with an upwardly directed outbulging, which appears to serve as a seminal receptacle during copulation.

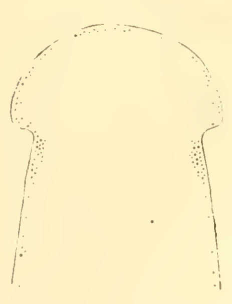
18. *Placocephalus virgatus* (Stimpson.)

(Pl. I., Fig. 18.—Text fig. 22.)

Bipalium virgatum, Stimpson (62), pp. 25, 30.—Diesing (16), p. 514.—Moseley (45), p. 51 and (46), p. 290.—Loman (40), p. 64.—von. Graff (25), p. 445.

Two specimens of the species, which seems to be identical with Stimpson's *Bipalium virgatum*, described by that author from the Loo Choo Islands, were collected by Professor Watasé, Dr. Hôzawa and the late Mr. Yasuda in May, 1911, in the neighbourhood of Taihoku, Formosa.

The head in the preserved condition is of a small semi-lunar shape and less than the width of the body, from which it is only separated by a neck-like constriction. The elongate and slender trunk presents the lateral margins even and nearly parallel for the greater part of its length, though it tapers gradually in the hind parts to the bluntly pointed extremity. Extending over almost the entire length of the body is a slightly raised ridge, the sole, which is rather less than one-fifth the breadth of the body. The large specimen attains a length of about 150 mm. and a breadth of 4 mm., while the small measures 60 mm. long by 3 mm. broad.



Text fig. 22. Distribution of eye-spots in *Placocephalus virgatus* (Stimpson

The ground colour of the dorsal surface, in spirit, is buff with five dark stripes, a median and two pairs of lateral, which extend over almost the entire length of the body; in this respect the present species seems to be allied to *Placocephalus kewensis* Moseley, so that it may be referable to this species. The median stripe is very fine and loses itself on reaching a point somewhat behind the head. The inner pair are much the strongest of all, and the outer pair at the edge of the body become indistinct as they approach the hind end; on either side both coalesce at the neck into a small dusky patch. The ventral surface is similar in colour to the dorsal, except on the sole which is pale.

The eye-spots are arranged in one or more rows along the entire margin of the head and continue round to the sides of the neck, where they are somewhat closely packed. Besides this, the eye-spots are present sparsely scattered over the whole length of the body to the very tail.

The mouth-opening is placed at about the hind end of the first third of the body, leading into the peripharyngeal cavity.

The genital organs were not yet developed in the specimens examined.

Family Rhynchodemidæ von GRAFF.

Genus **Rhynchodemus** LEIDY.

19. ***Rhynchodemus Ijimai***, n. sp.

(Pl. I., Figs. 19, 20.—Text fig. 23.)

Some specimens representing this new species were obtained by the late Professor IJIMA in July, 1886, on the mossy stone wall under stones in Nikko and its vicinity.

The body in the living state is nearly circular in cross section, slender, and almost uniformly broad for its greater length, though it tapers more gradually to the rounded or somewhat truncated anterior extremity than to the posterior, which is bluntly pointed. On the ventral side of the anterior body-part, indistinctly marked off from the trunk by a gentle constriction, there is a depression, which is shallow but well-defined and is thrown into a series of wavy folds, lying just in front of the anterior termination of the sole and occupying about one-fifth the whole length of the body. Anteriorly and laterally the depression is bordered by a prominent ridge of a horseshoe shape, while posteriorly it gradually merges into the general ventral surface. Extending almost throughout the whole length of the body, from behind the said ventral depression, is the slightly raised sole, rather less than one-fifth the breadth of the body. In length the specimens range from 8 mm. to 14 mm., measuring 1–1·5 mm. in breadth.

The dorsal surface is of a dark olive-like brown colour, with a dark median zone, which medially encloses a light space nearly in front of the middle of the body. The ventral surface is a somewhat paler shade of the same colour as the dorsal, except for the surface of the sole which is pale.

At a little distance behind the anterior end there are present two eyes, one on each side.

The mouth-opening is situated near the middle of the body, leading into the peripharyngeal chamber, in which is disposed the pharynx of a cylindrical shape.

The common genital aperture occupies a position behind the mouth-opening equal to about one-third the distance between the latter and the posterior end of the body.

The body is coated with a single epidermis made up of columnar cells, which are of a greater height on the dorsal side than on the ventral and possess cilia, but confined to the latter surface only. Situated between these cells, except on the ventral surface, are spindle-shaped rhabdites, which originate from their mother-cells, scattered in the parenchyme below the dermal musculature. On some occasions the rhabdites are seen to be in connexion with their mother-cells. Embedded in the parenchyme are enormous quantities of glands, opening out on the surface of the sole.

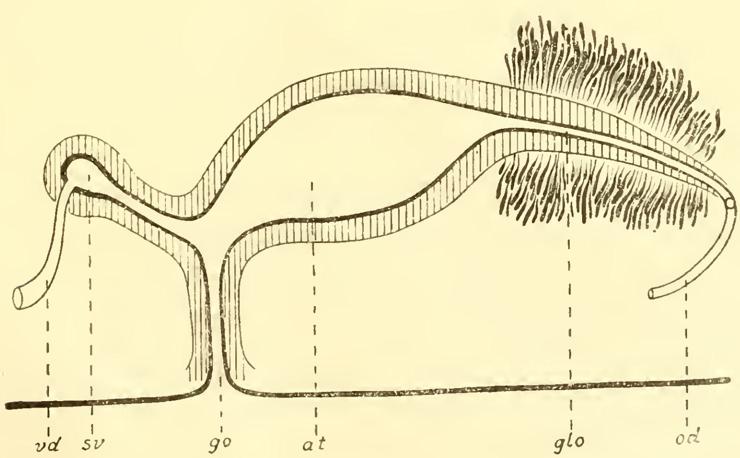
The musculature of the body presents no noteworthy features, consisting, as it does, of two systems, superficial and deep, which are rather more strongly developed on the ventral than on the dorsal side, doubtless in relation to the movements. Besides, dorso-ventral muscles occur, running between the intestinal branches.

The mouth-opening is placed at about the centre of the peripharyngeal chamber with the pharynx horizontally disposed. The pharynx is a short cylindrical body, terminating conically at the free end. The gut trunks are provided with numerous bifurcated lateral branches, the epithelium of which consists of high cylindrical cells, each full of coarse, highly refractive granules.

The brain is a bilobed organ, situated at the anterior part of the body. Posteriorly each half of the brain-mass gives rise to one of the longitudinal nerve cords, which proceed straight backwards, running parallel to each other. Throughout their entire course, the cords are connected by very numerous transverse commissures, and laterally give off numerous branches towards the nerve plexus, lying below the superficial muscular system.

The common genital opening leads into the moderately wide atrium with a wall composed of an epithelium of high columnar cells and a muscular coating. Anteriorly the atrium is in communication with the seminal vesicle and posteriorly with the glandular canal.

Numerous testes are ventrally arranged in a single row on each side of the body just outside the nerve cords, beginning from behind the ovary and extending posteriorly nearly to the insertion of the pharynx. The vasa deferentia, filled with spermatozoa, extend backwards to a point in front of the genital opening, where they bend inwards slightly rising upwards at the same time, and finally open, each separately, into the relatively narrow seminal vesicle. The vesicle shows a definite wall consisting of a single epithelium of columnar cells and a muscular coating, passing behind into a tubular passage which soon communicates with the atrium. In the species examined the male organ is wholly devoid of intromittent part of any sort.



Text fig. 23. Sagittal section of the copulatory organs of *Rhynchodemus ijimai*, diagrammatically shown.
at atrium.
Other letters as in text fig. 1.

The paired ovary, which is of a spherical shape, is placed nearly half-way between the anterior end of the body and the pharynx-insertion, one on either side close to the outer side of the longitudinal nerve cord. At the posterior aspect the oviduct leaves the ovary in the form of a funnel-like widening, which soon assumes the character of a narrow duct, proceeding straight backwards. Behind the genital opening it nears the median line, slightly rising at the same time, and finally unites with its fellow of the opposite side to form a common duct, the glandular canal. The direct wall of the oviduct is made up of a ciliated epithelium, beneath which comes a muscular layer. The vitelline glands, made up of closely-packed, large cells, extensively fill up the interspaces between the gut branches. They are in connexion with the oviduct at numerous points.

The glandular canal opens from behind into the atrium, after receiving enormous quantities of unicellular glands. The canal is internally lined with an epithelium of columnar cells and externally with a layer of parenchyme, including muscular fibres, and perforated by the ducts of the glands.

Genus **Microplana** Vejdoský.

20. ***Microplana ruteocephala***, n. sp.

(Pl. figs. 21–23.)

Three representatives of this new species were captured by the late Professor Ijima in July, 1886, in Nikko.

According to the collector's notes and sketches taken when the animals were living, the body was nearly circular in cross section, elongate, slender and for the most part uniformly broad, though it tapered more gradually to the rounded anterior than to the posterior end which was pointed. The present species is wholly deviod of sensory grooves as well as of creeping sole. The largest specimen measured 22 mm. in length and 1·5 mm. in breadth, while smallest was 9 mm. long by 0·8 mm. broad.

The ground colour of the dorsal surface is uniformly light black with a slight touch of reddish tint, in front grading over into a red or yellow tone at the tip of the body. Extending over the surface is a fine black median stripe, which loses itself in front. The dark tone is carried to the ventral side with little difference in shade except for the mid-ventral surface which is pale.

The small eyes, which are two in number, occur on either side at the anterior tip of the body.

The mouth-opening is situated near the middle of the body, leading into the peripharyngeal pocket with the cylindrical pharynx.

Key to Species of the Terrestrial Planarians embodied in this Paper.

1. Eyes numerous.

A. Without head-lappets

a^1. Dark in colour.

a^2. Dorsal surface of a dark olive-like brown colour, marked with a dark median stripe. Two pairs of colourless spots at the lateral sides near the anterior tip of body . . . . *Geoplana bimaculata*. p. 2.

b^2. Body pale gray in colour, marked with a dark brown median stripe . . . . *Geoplana lapidicola* p. 3.

b^1. Light yellow in ground colour.
Body marked with a dark median stripe . . . *Artioposthia japonica*. p. 3.

B. With head-lappets.

a^1. Without longitudinal stripe.

a^2. Head small lunar in shape.
Body of a bright orange colour . . . . . . *Perocephalus fulvus*. p. 7.

b^2. Head broad semi-lunar in shape.

a^3. Ground colour brownish.

a^4. Dorsal surface uniformly of a dark brownish colour . . . . *Bipalium venosum*. p. 8.

b^4. Dorsal surface dark reddish brown in colour . . . . *Bipalium ruteofulvum*. p. 12.

b^3. Ground colour dark.

c^4. Dorsal surface uniformly velvety black . . . . *Placocephalus fuscatus*. p. 34.

d^4. Body of a deep green colour . . . . . *Placocephalus glaucus*. p. 38.

b^1. With longitudinal stripe.

c^2. Longitudinal stripe unpaired.

c^3. With one stripe.

e^4. Head without pattern.

a^5. Ground colour yellow or brown.

a^6. Body of a dirty yellowish colour . *Bipalium ochroleucum*. p. 13.

b^6. Colour brownish orange mixed with a slight dark tone . . . . *Bipalium monolineatum*. p. 27.

c^6. Body of a uniform umber brown colour . . . . *Bipalium hilgendorfi*. p. 22.

b^5. Ground colour dark.

d^6. Colour black mixed with a slight olive tint . . . . *Bipalium fuscolineatum*. p. 19.

e^6. Colour dark with a touch of olive-like brown . . . . *Bipalium kisoensis*. p. 16.

f^4. Head with pattern.

Body uniformly brown with a slight touch of gray tint . . . . *Bipalium fuscocephalum*. p. 26.

d^3. With three or more stripes.

g^4. Stripes three.

c^5. Body of a dirty yellowish orange colour . . . . *Bipalium trilineatum*. p. 33.

e^5. Ground colour bluish gray with a touch of black . . . . *Bipalium trifuscostriatum*. p. 31.

h_4. Stripes five.

Dorsal surface buff in colour . . . . *Placocephalus virgatus*. p. 42.

d^2. Longitudinal stripes paired.

Ground colour brown . . . . *Bipalium maculatum*. p. 31.

II. Eyes two in number.

A. With a groove on the ventral surface of the anterior body-end.

Body of a dark olive-like colour with a dark median zone, enclosing a light space in front of the middle . . . . *Rhynchodemus ijimai*. p. 43.

B. Without groove.

Ground colour uniformly light black with a slight touch of reddish tint, marked with a black median line . . . . *Micropalana ruteocephala*. p. 46.

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Explanation of the Plate.

The figures indicated by affixing asterisks are those which were made by the late Professor Ijima.

Fig. 1.* *Geoplana bimaculata*, n. sp. in the living state, seen from the dorsal side, × 2·5.

Fig. 2.* *Artioposthia japonica*, n. sp. in the living state, dorsal aspect, × 1·5.

Fig. 3.* *Perocephalus fulvus*, n. sp. in the living state, dorsal view, × 5.

Fig. 4. *Bipalium fuscolineatum*, n. sp. in the creeping state, dorsal aspect, × about 2.

Fig. 5.* The same. × about 3.

Fig. 6. *Bipalium hilgendorfi* (von Graff) in the living state, nearly natural size, dorsal aspect.

Fig. 7. *Bipalium fuscocephalum*, n. sp. in the living state, seen from the dorsal side, × 2.

Fig. 8.* *Placocephalus fuscatus* (Stimpson) in the living state, natural size, dorsal aspect.

Fig. 9.* The same. Ventral aspect.

Fig. 10. *Bipalium ruteofulvum*, n. sp. in the preserved state, seen from the dorsal side, natural size.

Fig. 11. *Bipalium kisoensis*, n. sp. in the preserved state, natural size, dorsal aspect.

Fig. 12. *Bipalium venosum*, n. sp. in the creeping state, natural size, dorsal aspect.

Fig. 13. *Bipalium ochroleucum*, n. sp. in the preserved state, dorsal view, × 1·2.

Fig. 14. *Bipalium monolineatum*, n. sp. in the living state, dorsal aspect, × about 2.

Fig. 15. *Bipalium trifuscostriatum*, n. sp. in the creeping state, nearly natural size, dorsal view.

Fig. 16. *Bipalium trilineatum* Stimpson in the living state, natural size, dorsal aspect.

Fig. 17. *Placocephalus glaucus*, n. sp. in the living state, natural size, dorsal view.

Fig. 18. *Placocephalus virgatus* (Stimpson), in the preserved state, natural size, dorsal view.

Fig. 19.* *Rhynchodemus ijimai*, n. sp. in the living state, seen from the dorsal side, × about 3.

Fig. 20. The same. Ventral side of the anterior body-part, showing the depression. × about 20.

Fig. 21.* *Microplana ruteocephala*, n. sp. in the creeping state, seen from the dorsal side, × 3.

Fig. 22.* The same. Anterior part of the body, seen from the lateral side.

Fig. 23.* The same. Anterior part of the body, dorsal aspect.

IJIMA et KABURAKI del.

T. KABURAKI : Terrestrial Planarians from Japanese Territories.

Berichtigung

zu meiner Arbeit: Ueber eine Theorie des relativ Abel'schen Zahlkörpers,

dieses Journal, Vol. XLI, Art. 9.

S. 16, Z. 7 v. u. lies ξ_1' statt ξ.

S. 33, Z. 4 v. o. „ $\mathfrak{L}^{\nu+1}$ „ $\mathfrak{l}^{\nu+1}$.

S. 34, Z. 11 v. o. „ $\mathfrak{L}^{\nu+1}$ „ $\mathfrak{l}^{\nu+1}$.

S. 45, Z. 15 v. o. „ lv_0 „ v_0.

S. 47, Z. 5 v. u. (auf der rechten Seite der Gleichung)
lies 2 statt l.

S. 74, Z. 6 v. o. „ r_ν „ t_ν.

S. 100, Z. 8 v. o. „ $\mathfrak{m}_0$ „ m_0.

S. 114, Satz 35, den aufgezählten Ausnahmefällen hinzuzufügen:

$$\Delta \equiv 1 \pmod 8, \quad m = 2m', \quad m' \text{ ungerade};$$

in diesem Falle ist der Führer m', die Relativdiscriminante somit prim zu 2.

S. 118, Z. 3 v. o. lies *vier* statt *drei*, entsprechened der Berichtigung zu S. 114, Satz 35. Die Fussnote bezieht sich auf den von Herrn Fueter a. a. O. übersehenen Fall:

$$\Delta = -3, \quad m = 2.$$

T. TAKAGI.

JOURNAL OF THE COLLEGE OF SCIENCE, TOKYO IMPERIAL UNIVERSITY.
VOL. XLIV., ART. 5.

Ueber das Reciprocitätsgesetz in einem beliebigen algebraischen Zahlkörper.

Von

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Dieser Aufsatz ist als Fortsetzung meiner unten citirten Arbeit gedacht: es wird eine andere Methode befolgt als in den Abhandlungen des Hrn. Furtwänglers. Nachdem nämlich in jener Arbeit ein wesentlicher Teil des Reciprocitätsgesetzes in einer sehr allgemeinen Fassung erledigt worden ist, gestaltet sich der Beweis des allgemeinen Reciprocitätsgesetzes nunmehr verhältnismässig einfach.

Der erste Teil (§§ 3–11) enthält den vollständigen Beweis des Reciprocitätsgesetzes für einen ungeraden Primzahlgrad l. Dieser Beweis geschieht in drei Schritten. Zuerst wird das Reciprocitätsgesetz zwischen einer primären Zahl und einer zu l primen Zahl in § 6. erledigt. Hierbei erwies sich als unentbehrliches Mittel das sogenannte Eisenstein'sche Reciprocitätsgesetz, welches, dank eines allgemeinen Satzes über die Beziehung zwischen den Potenzcharacteren in verschieden Körpern (§ 2) sofort auf einen beliebigen algebraischen Körper zu übertragen ist. Dieser Specialfall des Reciprocitätsgesetzes vertritt bei unserem Beweise gewissermassen die Stelle der Definition des Legendre-Kummer'schen Symbols, an die nachher nicht mehr direct appellirt wird. Ein Ausnahmefall, der bei dem Beweise zunächst auftritt, wird durch einen einfachen Kunstgriff leicht in die allgemeine Regel subsumirt (§ 7), während Hr. Furtwängler zum analogen Zwecke eine complizirte Betrachtung anstellt.

Durch die zweite Schritt wird derjenige Fall bewiesen, wobei eine der beiden in Betracht kommenden Zahlen beliebig, die andere aber sowohl zur ersten als auch zu l prim ist (§§ 9. 10). Hierbei konnte ich mich auf einen allgemeinen Satz über die Normenreste des relativ cyclischen Körpers stützen. der in meiner früheren Arbeit bewiesen worden ist—im Gegensatz zu der Hilbert-Furtwängler'schen Methode, wobei derselbe Satz aus dem Reciprocitätsgesetz erschlossen wird. Zu einer grossen Vereinfachung des Beweises diente auch der Existenzsatz der Primideale in beliebigen Idealclassen im allgemeinen Sinne. Das Hauptergebnis lautet: *Der Wert des Symbols* $\left(\frac{\mu}{\mathfrak{r}}\right)$ *hängt nur von der Classe mod* $\mathfrak{f}$ *ab, welcher das Ideal* $\mathfrak{r}$ *angehört, wo* $\mathfrak{f}$ *der Führer der dem Körper* $K=k(\sqrt[l]{\mu})$ *zugeordneten Classengruppe im Grundkörper* k *bedeutet.* Hierin erblicke ich den wesentlichen Inhalt des allgemeinen Reciprocitätsgesetzes.

Um den Gang des Beweises möglichst übersichtlich darzutun, habe ich es vermieden, das Hilbert'sche Normenrestsymbol an die Spitze zu stellen. Will man aber das Reciprocitätsgesetz in jener von Hilbert aufgestellten allgemeinsten und eleganten Form zu erhalten, wobei zwei ganz beliebige Zahlen des Körpers in Betracht gezogen werden, so hat man die dritte und die letzte Schritt zu tun. Hierbei handelt es sich jedoch um eine Betrachtung mehr formaler Natur, und der Beweis erledigt sich schnell durch Heranziehung des vorher erhaltenen Resultats. In § 11 bin ich nur kurz auf den Gegenstand eingegangen.

Im zweiten Teile (§§ 12–14) wird das quadratische Reciprocitätsgesetz behandelt. Es genügte, kurz die Modification anzugeben, die nötig wird wegen der Vorzeichenbedingungen, den die in Betracht gezogenen Zahlen in den mit dem gegebenen conjugirten reellen Körpern zu genügen haben.

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Einleitung.

Bezeichnungen.

In diesem Aufsatz werden die folgenden Bezeichnungen durchgehends beibehalten:

l, eine rationale Primzahl.

ζ, die primitive l-te Einheitswurzel: $\zeta = e^{\frac{2\pi i}{l}}$.

k, ein algebraischer Zahlkörper, welcher die Zahl ζ enthält.

m, der Grad von k.

r, die Anzahl der Grundeinheiten von k.

In k gelte die Zerlegung in Primfactoren:

$$l = \mathfrak{l}_1^{s_1} \mathfrak{l}_2^{s_2} \cdots \mathfrak{l}_z^{s_z},$$

$$1-\zeta = \mathfrak{l}_1^{\sigma_1} \mathfrak{l}_2^{\sigma_2} \cdots \mathfrak{l}_z^{\sigma_z}, \quad \sigma_i (l-1) = s_i,$$

$$L = (1-\zeta)^l = \mathfrak{l}_1^{\sigma_1 l} \mathfrak{l}_1^{\sigma_2 l} \cdots \mathfrak{l}_z^{\sigma_z l},$$

$$\bar{L} = \mathfrak{l}_1^{\sigma_1 l + 1} \mathfrak{l}_2^{\sigma_2 l + 1} \cdots \mathfrak{l}_z^{\sigma_z l + 1}.$$

§ 1.

Allgemeine Sätze über relativ Abel'sche Zahlkörper.

Wir stellen in diesem Artikel einige der wichtigsten allgemeinen Sätze zusammenfassend dar, um später bequem darauf Bezug nehmen zu können; es sind Sätze, die ich in der Abhandlung R. A. ausführlich dargelegt habe, und die ich in einer dem Zweck dieses Aufsatzes gemäss specialisirten Fassung wiedergebe.

(1) *Rang der Classengruppe.* Der Classeneinteilung im Grundkörper sei das Idealmodul $\mathfrak{m}$ zugrunde gelegt, und die sämtlichen l-ten Potenzen in die Hauptclasse zusammengefasst. Die Hauptclasse besteht also aus der Gesamtheit der ganzen und gebrochenen zu $\mathfrak{m}$ primen Ideale von der Form $\alpha\mathfrak{j}^l$, wo α ein l-ter Potenzrest von $\mathfrak{m}$ ist. Die Classengruppe G ist dann von der Ordnung l^h, wo h der Rang von G ist. Um diesen Rang darzustellen, bezeichnen wir mit h_0 den Rang der absoluten Classengruppe, d. h. die Anzahl der von einander unabhängigen Idealclassen im absoluten Sinne, deren Ordnungen Potenzen von l sind. Wir betrachten ausserdem den Rang der entsprechenden Zahlengruppe, d. h. die Anzahl der unabhängigen Nichtreste nach $\mathfrak{m}$. Dieselbe ist offenbar gleich 1, wenn $\mathfrak{m}=\mathfrak{p}^e$ eine zu l prime Primidealpotenz von k ist. Dagegen ist, wenn $\mathfrak{m}=\mathfrak{l}^g$ Potenz eines in l aufgehenden Primideals $\mathfrak{l}$ ist, dieser Rang gleich

$$R(g)=\left[g-\frac{g}{l}\right].f, \qquad \text{wenn} \quad g\leqq\sigma l,$$

oder

$$= \quad sf+1, \qquad \text{wenn} \quad g>\sigma l,$$

wenn $\mathfrak{l}$ genau zur $s=\sigma(l-1)$-ten Potenz in l aufgeht und vom Grade f ist(¹). Gehen daher in

$$\mathfrak{m}=\Pi\mathfrak{p}^e.\Pi\mathfrak{l}^g$$

d von einander verschiedene zu l prime Primideale $\mathfrak{p}$ auf, dann ist der Rang der Zahlengruppe:

$$N=d+\Sigma R(g), \tag{1}$$

wo sich die Summe auf alle in $\mathfrak{m}$ aufgehenden Potenzen $\mathfrak{l}^g$ bezieht.

(¹) R.A. S. 64.

Ferner gebe es unter den r Grundeinheiten, den Einheitswurzeln in k, und den h_0 unabhängigen Zahlen, welche l-te Potenzen der Ideale von k sind, insgesamt N' unabhängige Nichtreste nach $\mathfrak{m}$:

$$\eta_1, \quad \eta_2, \cdot \cdot \cdot \cdot \eta_{N'} \tag{2}$$

sodass $N' \leqq N$, und eine Zahl von der Form

$$\eta_1^{u_1}\, \eta_2^{u_2} \cdot \cdot \cdot \cdot \eta_{N'}^{u_{N'}} \qquad (0 \leqq u_1, u_2, \cdot \cdot \cdot < l)$$

nie anders ein l-ter Rest nach $\mathfrak{m}$ sein kann, als wenn die sämtlichen Exponenten $u_1, u_2, \cdots$ verschwinden. Alsdann ist der Rang der Classengruppe G durch die Formel gegeben:

$$h = h_0 + N - N'. \tag{3}$$

Wenn $l=2$ und wenn unter den mit k conjugirten Körpern $r_1 (r_1 > 0)$ reelle vorhanden sind, dann ist notwendig, den Classenbegriff dadurch enger zu fassen, dass zur Definition der Aequivalenz zweier Ideale: $\mathfrak{j}_1 = \alpha \mathfrak{j}_2$ nur der Zahlenfactor α zugelassen wird, welche ausser der Congruenzbedingung mod. $\mathfrak{m}$ noch die Vorzeichenbedingung befriedigt, *total positiv* zu sein. Zufolge dieser Festsetzung, erfährt die Rangzahl h der Classengruppe G die Modification, indem zunächst der Rang N der Zahlengruppe um r_1 vermehrt wird, sodann zu dem System der N' Zahlen (2) noch $N''-N'$ quadratische Reste nach $\mathfrak{m}$ hinzugenommen werden, die sich unter den $r+1+h_0$ unabhängigen Einheiten und Idealpotenzen befinden, und welche von einander unabhängige Vorzeichencombinationen in den r_1 reellen mit k conjugirten Körpern aufweisen mögen, sodass nunmehr an Stelle von (2) ein System von N'' Zahlen $(N'' \geqq N')$:

$$\eta_1, \cdot \cdot \cdot \cdot \eta_{N'}, \eta_{N'+1}, \cdot \cdot \cdot \cdot \eta_{N''} \tag{2*}$$

auftritt, von der Beschaffenheit, dass eine Zahl von der Form:

$$\eta_1^{u_1} \cdot \cdot \cdot \eta_{N''}^{u_{N''}} \qquad (u=0,\ 1)$$

niemals quadratischer Rest nach $\mathfrak{m}$ und zugleich total positiv sein kann, ausser wenn alle Exponenten $u_1, \cdot \cdot \cdot u_{N''}$ verschwinden. Demnach wird in diesem Falle

$$h = h_0 + N + r_1 - N''. \tag{3*}$$

Wir stellen nun die Systeme der Gruppencharactere für G. Seien

$$\mathfrak{r}_1,\ \mathfrak{r}_2,\ \cdots\ \mathfrak{r}_{h_0}$$

ein System von h_0 zu $\mathfrak{m}$ primen Idealen von k, welche die h_0 unabhängigen Basisclassen im absoluten Sinne repräsentiren, sodass für jedes Ideal $\mathfrak{r}$ von k eine Gleichung von der Form gilt :

$$\alpha=\mathfrak{r}\,\mathfrak{r}_1^{e_1}\,\mathfrak{r}_2^{e_2}\cdots\mathfrak{r}_{h_0}^{e_{h_0}}\mathfrak{j}^l, \qquad (4)$$

wo $e_1, e_2, \cdots e_{h_0}$ für jedes $\mathfrak{r}$ eindeutig bestimmtes Exponentensystem aus der Reihe $0, 1, 2, \cdots l-1$ sind. Dann haben wir zunächst h_0 *absolute Classencharactere* für $\mathfrak{r}$:

$$\chi_i(\mathfrak{r})=\zeta^{e_i} \qquad (i=1, 2, \cdots h_0)$$

Sodann kommen N *Potenzcharactere*, von denen die d, welche den zu l primen Primfactoren $\mathfrak{p}$ von $\mathfrak{m}$ entsprechen, durch die Legendre'schen Symbole gegeben werden können:

$$\chi'_\delta(\mathfrak{r})=\left(\frac{\alpha}{\mathfrak{p}}\right), \qquad (\delta=1,\ 2,\ \cdots\ d)$$

wo α die in (4) angegebene Bedeutung hat. Die $R(g)$ Potenzcharactere, welche einer in $\mathfrak{m}$ enthaltenen Potenz $\mathfrak{l}^g$ entsprechen, sind

$$\chi''_\rho(\mathfrak{r})=\zeta^{a_\rho} \qquad [\rho=1,\ 2,\ \cdots\ R(g)]$$

wenn

$$\alpha\equiv\gamma_1^{a_1}\gamma_2^{a_2}\cdots\gamma_R^{a_R}\zeta^l \pmod{\mathfrak{l}^g},$$

wo $\gamma_1, \gamma_2, \cdots \gamma_R$ ein System der $R=R(g)$ unabhängigen Nichtreste nach $\mathfrak{l}^g$ bedeuten.

Endlich kommen, wenn $l=2$, noch r_1 *Vorzeichencharactere* :

$$\chi'''_j(\mathfrak{r})=\mathrm{Sg}_j(\alpha), \qquad (j=1,\ 2,\ \cdots\ r_1)$$

wo $\mathrm{Sg}_j(\alpha)=\pm1$, jenachdem die mit α conjugirte Zahl in dem reellen Körper k_j positiv oder negativ ausfällt.

Aus diesen elementaren Characteren setzen wir nun den allgemeinen Character $X(\mathfrak{r})$ zusammen:

$$X(\mathfrak{r})=\zeta^{\sum\limits^{i} c_i u_i}\prod^{\mathfrak{p}}\left(\frac{\alpha}{\mathfrak{p}}\right)^{v}\prod^{\mathfrak{l}}\zeta^{\sum\limits^{\rho} a_\rho v'_\rho}\prod^{j}\mathrm{Sg}_j(\alpha)^{w_j},$$

indem wir die Exponenten v, v', w den N' bez. N'' Bedingungen unterwerfen, dass für die Zahlen (2) bez. (2*)

$$X(\eta_i)=1 \qquad (i=1,\ 2,\ \cdots\ N' \text{ bez. } N'')$$

ausfallen soll.

Auf diese Weise entstehen $l^h=l^{h_0+N-N''}$ bez. $2^h=2^{h_0+N+r_1-N''}$ Charactersysteme, die sich aus den h unabhängigen durch Multiplication zusammensetzen lassen. Die Gesamtheit der Ideale $\mathfrak{r}$, für welche

$$X(\mathfrak{r})=1$$

ausfällt, bildet dann eine Classengruppe vom Index l; umgekehrt aber lässt sich jede Classengruppe vom Index l auf diese Weise characterisiren.

(2) *Existenz der Classenkörper*(2). Zu jeder Untergruppe H der Classengruppe G von k existirt ein und nur ein Classenkörper $K(H)$; derselbe ist relativ Abel'sch in Bezug auf k. Die Galois'sche Gruppe des Relativkörpers K/k ist holoedrisch ismorph mit der complementären Gruppe G/H. Die Relativdiscriminante von K/k enthält nur und alle Primideale von k als Factor, welche in den Führer der Classengruppe H aufgehen.

Wir heben den folgenden speciellen Fall dieses Satzes hervor, welcher den Fall: $\mathfrak{m}=1$, also die *absoluten* Classenkörper betrifft.

Satz 1. (Satz von Furtwängler) *Ist h der Rang der absoluten Classengruppe von k, dann existiren h unabhängige relativ cyclische unverzweigte Körper vom Relativgrade l über k, folglich h unabhängige "singuläre Primärzahlen" in k:*

$$\omega_1,\ \omega_2,\ \cdots\ \omega_h,$$

so nennen wir nach Furtwängler die primären Zahlen, welche entweder Einheiten oder l-te Potenzen der Ideale sind; diese h Zahlen sind von der Art, dass jede Zahl ω von derselben Beschaffenheit auf eine und nur auf eine Weise in der Form

$$\omega=\omega_1^{u_1}\cdots\omega_h^{u_h}\xi^l$$

(2) E.A. S. 62.

darstellbar ist, wo die Exponenten $u_1, \cdots u_h$ Zahlen aus der Reihe $0, 1, 2, \cdots l-1$ sind, und ξ eine Zahl in k bedeutet.

Ferner ist, wenn $l=2$ und die Classen im gewöhnlichen Sinne genommen werden, die h singulären Primärzahlen total positiv. Wenn aber die Classen nach total positiven Zahlen definirt werden, und erfährt dabei der Rang der Classengruppe einen Zuwachs um h', dann kommen noch h' unabhängige singuläre Primärzahlen $\omega'_1 \cdots \omega'_{h'}$ hinzu, die aber nicht total positiv sind und unabhängige Vorzeichencombinationen in den mit k conjugirten reellen Körpern aufweisen(3).

Eine wichtige Folgerung aus der Existenz des allgemeinen Classenkörpers ist der folgende

Satz 2. *In jeder Classe von k nach einem beliebigen Modul $\mathfrak{m}$ und mit einer beliebigen Vorzeichenbedingung existiren stets unendlich-viele Primideale ersten Grades.*

(3) *Die Normenreste des relativ cyclischen Oberkörpers*(4). Eine Zahl α in k heisst ein *Normenrest* des Oberkörpers K nach einem Idealmodul $\mathfrak{j}$ von k, wenn es eine Zahl A in K gibt, derart dass

$$N(A) \equiv \alpha \pmod{\mathfrak{j}},$$

wo mit N die Relativnorm in Bezug auf k angedeutet wird.

Satz 3. *Wenn $\mathfrak{p}$ ein zu l primes Primideal von k ist, welches in die Relativdiscriminante des relativ cyclischen Oberkörpers K/k vom Relativgrade l aufgeht, dann ist von den $\varphi(\mathfrak{p})$ reducirten Zahlclassen mod $\mathfrak{p}$ genau der l-te Teil Normenrest des Körpers K nach dem Modul $\mathfrak{p}$, nämlich die Zahlen α, für welche*

$$\left(\frac{\alpha}{\mathfrak{p}}\right)=1$$

ausfällt.

Wenn $\mathfrak{l}$ ein Primfactor von l ist, welcher zur $(v+1)(l-1)$-ten Potenz in die Relativdiscriminante von K/k aufgeht, dann ist jede zu $\mathfrak{l}$ prime Zahl von k Normenrest nach $\mathfrak{l}^e$, wenn $e \leqq v$. Ist dagegen $e>v$, dann ist genau der l-te Teil eines reducirten Systems der Zahlclassen mod $\mathfrak{l}^e$ Normenrest des Körpers K nach $\mathfrak{l}^e$. Es gibt in k eine Zahl $1+\lambda_v$, wo λ_v eine genau durch $\mathfrak{l}^v$ (nicht mehr durch $\mathfrak{l}^{v+1}$) teilbare Zahl ist,

(3) R.A. S. 84. (4) R.A. S. 27—35.

welche Normennichtrest nach $\mathfrak{l}^e$ ist, derart, dass jede zu $\mathfrak{l}$ prime Zahl α von k in der Form dargestellt werden kann:

$$\alpha \equiv \nu(1+\lambda_e)^n \pmod{\mathfrak{l}^e},$$

wo ν ein Normenrest nach $\mathfrak{l}^e$, und n eine Zahl aus der Reihe 0, 1, 2, $\cdots$ $l-1$ bedeutet.

(4) *Der Zerlegungssatz*(5).

Satz 4. *Ist* $K=k(\sqrt[l]{\mu})$ *Classenkörper zu der Classengruppe von* k, *welche durch den Character* $X(\mathfrak{r})=1$ *characterisirt wird, dann ist für ein Primideal* $\mathfrak{p}$ *von* k

$$\left(\frac{\mu}{\mathfrak{p}}\right)=1,$$

dann und nur dann, wenn

$$\chi(\mathfrak{p})=1$$

ausfällt.

In diesem Satze ist schon ein wesentlicher Teil des Reciprocitätsgesetzes enthalten. Unser weiteres Ziel wird nun das sein, zu jeder gegebenen Zahl μ von k, den zugehörigen Character X genauer zu bestimmen. Von diesem Standpunct aus kann aber X nur bis auf einen zu l primen Exponenten bestimmt werden, denn mit X ist jeder Character X^n ($n\not\equiv 0$, mod l) geeignet, die dem Körper $K=k(\sqrt[l]{\mu})$ zugeordnete Classengruppe zu characterisiren. Wie es sich herausstellen wird, lässt sich dieser Exponent so bestimmen, dass allemal

$$\left(\frac{\mu}{\mathfrak{r}}\right)=\chi(\mathfrak{r})$$

ausfällt, auch für solche Primideale $\mathfrak{r}$, für welche $\left(\frac{\mu}{\mathfrak{r}}\right)\neq 1$, sogar für jedes beliebige zu μ und l prime Ideal von k.

§ 2.

Beziehung zwischen den Potenzcharactern in Oberkörper und Unterkörper.

Satz 5. *Es sei K ein beliebiger Oberkörper von* k. *Ist dann* α

(5) R. A. S. 96.

eine Zahl von k, $\mathfrak{J}$ *ein zu* α *und zu* l *primes Ideal von* K. $\mathfrak{j}=N(\mathfrak{J})$ *die Relativnorm von* $\mathfrak{J}$ *in Bezug auf* k. *dann ist*

$$\left\{\frac{\alpha}{\mathfrak{J}}\right\}=\left(\frac{\alpha}{\mathfrak{j}}\right),$$

wo der Potenzcharacter in K *durch gekrümmte Klammer gekennzeichnet wird*(6).

Satz 6. *Es sei* K *ein beliebiger Oberkörper von* k. *Ist dann* A *eine Zahl von* K, $\alpha=N(A)$ *die Relativnorm von* A *in Bezug auf* k, *und* $\mathfrak{j}$ *ein zu* α *und zu* l *primes Ideal von* k, *dann ist* (7)

$$\left\{\frac{A}{\mathfrak{j}}\right\}=\left(\frac{\alpha}{\mathfrak{j}}\right).$$

Beweis. Es genügt, den Satz für ein Primideal $\mathfrak{j}=\mathfrak{p}$ zu beweisen. Sei K^* ein relativ normaler Oberkörper von k, welcher K enthält, G die Galois'sche Gruppe von K^* in Bezug auf den Grundkörper k, H die Untergruppe von G, welche die Zahlen von K unverändert lässt, sodass der Gruppenindex $(G:H)=M$, dem Relativgrade von K/k. Sei G nach der Untergruppe H in die M Complexe zerlegt:

$$G=\sum^{i} HS_i, \qquad (i=1, 2, \cdots M) \qquad (1)$$

Dann ist

$$\alpha=\prod^{i} A|S_i, \qquad (i=1, 2, \cdots M) \qquad (2)$$

wenn mit $A|S$ die durch die Substitution S von G aus A hervorgehende Zahl bezeichnet wird.

In K gelte die Zerlegung in Primfactoren:

$$\mathfrak{p}=\mathfrak{P}_1^{g_1}\mathfrak{P}_2^{g_2}\cdots\mathfrak{P}_e^{g_e}, \qquad (3)$$

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(6) Vgl. Ph. Furtwängler, Math. Annalen **58**, S. 24.

(7) Herr Furtwängler hat a.a. O. diesen Satz für den Fall bewiesen, wo K relativ normal in Bezug auf k ist. Für einen beliebigen Oberkörper habe ich einen Beweis publicirt in den Proceedings of the Tokyo Math. Phys. Soc. 2 Ser., **9**. S. 166–169, den ich im Text in wesentlich unveränderter Form wiedergebe.

und es sei f_i der Relativgrad des Primideals $\mathfrak{P}_i$ in Bezug auf k. Ist dann P die Norm von $\mathfrak{p}$ in k, so ist

$$\left(\frac{a}{\mathfrak{p}}\right)\equiv a^{\frac{P-1}{l}} \pmod{\mathfrak{p}}, \qquad \left\{\frac{A}{\mathfrak{P}_i}\right\}\equiv A^{\frac{P^{f_i}-1}{l}} \pmod{\mathfrak{P}_i}. \tag{4}$$

Ferner sei $\mathfrak{P}^*$ ein Primideal von K^*, welches in $\mathfrak{P}_1$ aufgeht, G_z und G_t die Zerlegungs- und die Trägheitsgruppe von $\mathfrak{P}^*$ in Bezug auf k. Zerlegt man die Gruppe G in die Complexe der Form HSG_z:

$$G=\sum^{i} HS_iG_z, \qquad (i=1,\ 2,\ \cdots e) \tag{5}$$

dann ist bekanntlich die Anzahl dieser Complexe gleich der Anzahl der von einander verschiedenen in $\mathfrak{p}$ aufgehenden Primideale von K, und diese Complexe und die Primideale sind in der Weise aufeinander bezogen, dass in K^* die Zerlegung gilt:

$$\mathfrak{P}_i=(\Pi\mathfrak{P}^*\,|\,S_i^{-1}H)^{\gamma_i},$$

wo sich das Product auf alle von einander verschiedenen Primideale von K^* bezieht, welche durch die Substitutionen des Complexes $S_i^{-1}H$ aus $\mathfrak{P}^*$ hervorgehen[8].

Setzt man nun

$$\mathfrak{P}'=\mathfrak{P}_i\,|\,S_i,$$

dann ist $\mathfrak{P}'$ das durch $\mathfrak{P}^*$ teilbares Primideal in dem mit K conjugirten Körper $K'=K\,|\,S_i$, und es ist

$$\left\{\frac{A}{\mathfrak{P}_i}\right\}=\left\{\frac{A\,|\,S_i}{\mathfrak{P}'}\right\}',$$

wo mit dem angesetzten Strich der Potenzcharacter in K' angedeutet wird. Demnach ist nach (3)

$$\left\{\frac{A}{\mathfrak{p}}\right\}=\prod^{i}\left\{\frac{A}{\mathfrak{P}_i}\right\}^{g_i}=\prod^{i}\left\{\frac{A\,|\,S_i}{\mathfrak{P}'}\right\}'^{\,g_i}, \quad (i=1,\ 2,\ \cdots e) \tag{6}$$

wo in jedem Factor des letzten, auf die e Complexe (5) bezogenen Productes S_i durch jede Substitution des Complexes HS_iG_z ersetzt werden kann: dadurch wird wohl K' aber nicht $\mathfrak{P}'$ verändert.

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(8) H. Weber, Lehrbuch der Algebra, **2**.(2. Aufl.) § 179; G. Landsberg, über Reduction von Gleichungen durch Adjunction, Crelles Jour. **132**, S. 1. (insbesondere S. 11–20).

Nun sei, indem wir den Index bei S einfachheitshalber weglassen,

$$HSG_z = HS + HS' + \cdots + HS^{(\nu-1)}, \qquad (7)$$

sodass nach (1) $\Sigma\nu = M$ wird, wenn über alle e Complexe (5) summirt wird.

Ist dann wie früher $K' = K|S$, und $H' = S^{-1}HS$ die entsprechende Untergruppe von G, ferner H_z', H_t' die Durchschnitte von H' und G_z bez. G_t, dann sind H_z', H_t' die Zerlegungs- und die Trägheitsgruppe von $\mathfrak{P}^*$ im Relativkörper K'/k. Die Zahl ν in (7) ist aber gleich dem Gruppenindex $(G_z : H'_z)$, also

$$\nu = fg,$$

wenn f der Relativgrad von $\mathfrak{P}'$ in Bezug auf k, und g der Exponent der höchsten in $\mathfrak{p}$ aufgehenden Potenz von $\mathfrak{P}'$ bedeutet. (Daher ist $g = g_i$, wenn wie früher $\mathfrak{P}' = \mathfrak{P}_i | S$ ist).

Sei nun Z eine derjenigen Substitutionen von G_z, für welche jede ganze Zahl Ω von K^* die Congruenz:

$$\Omega | Z \equiv \Omega^P \pmod{\mathfrak{P}^*}$$

befriedigt; und es sei Z^t die niedrigste Potenz von Z, die in H' also in H_z' vorkommt. Da dann

$$\Omega | Z^t \equiv \Omega^{P^t} \pmod{\mathfrak{P}^*},$$

so muss t durch f teilbar sein, weil die Norm von $\mathfrak{P}^*$ in K' gleich P^f und H_z' die Zerlegungsgruppe von $\mathfrak{P}^*$ in Bezug auf K' ist. Umgekehrt muss aber in H'_z eine Substitution Z_0 enthalten sein, von der Art, dass

$$\Omega | Z_0 \equiv \Omega^{P^f} \pmod{\mathfrak{P}^*}.$$

Demnach ist

$$\Omega | Z_0 \equiv \Omega | Z^f \pmod{\mathfrak{P}^*},$$

also $Z^f Z_0^{-1}$ in H'_t, folglich in H'_z enthalten, sodass Z^f in H_z', folglich in H' vorkommt.

Ist also S eine beliebige Substitution des Complexes HSG_z, dann sind die f Complexe

$$HS,\ HSZ,\ \cdots\ HSZ^{f-1} \qquad (8)$$

in dem Complexe (7) enthalten, und diese f Complexe sind von einander verschieden. Ist ferner S' eine Substitution desselben

Complexes (7), die in keinem der Complexe (8) enthalten ist, dann sind die weiteren f Complexe

$$HS', HS'Z, \cdots HS'Z^{f-1}$$

in (7) enthalten, welche sowohl von einander als auch von (8) verschieden sind. So fortfahrend zerlegt man den Complex HSG in g Systeme von je f Complexe wie (8).

Nun ist

$$A \mid SZ^n \equiv (A \mid S)^{P^n} \pmod{\mathfrak{P}^*}.$$

Daher

$$\left(\prod_{0,f-1}^{n} A \mid SZ^n\right)^{\frac{P-1}{l}} \equiv (A \mid S)^{(1+P+\cdots+P^{f-1})\frac{P-1}{l}}$$

$$\equiv (A \mid S)^{\frac{P^f-1}{l}}$$

$$\equiv \left\{\frac{A \mid S}{\mathfrak{P}'}\right\}' \pmod{\mathfrak{P}^*}$$

$$= \left\{\frac{A}{\mathfrak{P}_i}\right\},$$

wenn $S = S_i$ dem Complexe HS_iG_z in (5) angehört; folglich ist

$$\left(\prod^{n} A \mid S^{(n)}\right)^{\frac{P-1}{l}} \equiv \left\{\frac{A}{\mathfrak{P}_i}\right\}^{g_i} \pmod{\mathfrak{P}^*},$$

wenn das Product links über die ν Substitutionen $S^{(n)}$ in (7) erstreckt wird. Endlich ist nach (6)

$$\left(\prod_{1,M}^{i} A \mid S_i\right)^{\frac{P-1}{l}} \equiv \prod_{1,e}^{i} \left\{\frac{A}{\mathfrak{P}_i}\right\}^{g_i}$$

$$\equiv \left\{\frac{A}{\mathfrak{p}}\right\} \pmod{\mathfrak{P}^*},$$

wenn links das Product über alle $\Sigma\nu = M$ Substitutionen S_i in (1) erstreckt wird. Nach (2) ist also

$$\alpha^{\frac{P-1}{l}} \equiv \left\{\frac{A}{\mathfrak{p}}\right\} \pmod{\mathfrak{P}^*}.$$

Daher nach (4)

$$\left(\frac{\alpha}{\mathfrak{p}}\right) \equiv \left\{\frac{A}{\mathfrak{p}}\right\} \pmod{\mathfrak{P}^*},$$

woraus, da $\mathfrak{P}^*$ prim zu l ist,

$$\left(\frac{\alpha}{\mathfrak{p}}\right) = \left\{\frac{A}{\mathfrak{p}}\right\},$$

w. z. b. w.

I. Das Reciprocitätsgesetz für die Potenzcharactere eines ungeraden Primzahlgrades.

§ 3.

Kennzeichen für das Repräsentantensystem der Basisclassen.

In diesem I. Teil bedeutet l eine ungerade Primzahl. Ist ferner r die Anzahl der unabhängigen Grundeinheiten, h der Rang der absoluten Classengruppe von k, dann existiren nach Satz 1 h unabhängige singuläre Primärzahlen, sodass jede Zahl von k, welche eine Einheit oder eine l-te Potenz des Ideals von k ist, auf eine und nur eine Weise in der Form

$$\eta_1^{u_1} \cdots \eta_{r+1}^{u_{r+1}} \omega_1^{v_1} \cdots \omega_h^{v_h} \xi^l \tag{1}$$

darstellbar ist, wenn die Exponenten $u_1, \cdots v_1, \cdots$ Zahlen aus der Reihe $0, 1, \cdots l-1$ sind und ξ eine Zahl von k ist; hierbei bedeuten $\omega_1, \cdots \omega_h$ die singulären Primärzahlen, und $\eta_1, \cdots \eta_{r+1}$ Einheiten oder Idealpotenzen, die nicht primär sind; eine Bezeichnung, die in der Folge durchgehends beibehalten werden soll.

Satz 7. *Die h Primideale $\mathfrak{i}_1, \cdots \mathfrak{i}_h$, für welche*

$$\left(\frac{\omega_a}{\mathfrak{i}_a}\right) \neq 1, \quad \left(\frac{\omega_a}{\mathfrak{i}_b}\right) = 1, \quad (a \neq b)$$

ausfällt (9), *repräsentiren die h Basisclassen von k in dem Sinne, dass für jedes Ideal $\mathfrak{r}$ von k eine Gleichung der Form*

(9) Bekanntlich existiren stets solche Primideale, vgl. Hilbert, Bericht, Satz 152, auch R. A. S. 16.

$$(\rho)=\mathfrak{r}\,\mathfrak{i}_1^{e_1}\cdots\mathfrak{i}_h^{e_h}\,\mathfrak{j}^l$$

gilt, wo ρ *eine Zahl,* $\mathfrak{j}$ *ein Ideal von* k *ist und* $e_1,\cdots e_h$ *das mit* $\mathfrak{r}$ *eindeutig bestimmte Exponentensystem aus der Reihe* 0, 1, $\cdots l-1$ *sind*(10).

Beweis. Setzt man

$$L=(1-\zeta)^l=\prod^{i}\mathfrak{l}_i^{\gamma_i l}$$

dann ist der Rang der Classengruppe von k nach dem Modul L offenbar gleich $r+1+h$. Ebenso gross beträgt aber der Rang der Classengruppe nach dem Modul $L\,\mathfrak{i}_1\cdots\mathfrak{i}_h$ (11). Dies hat zur Folge, dass für eine Zahl α von k nur dann

$$(\alpha)=\mathfrak{i}_1^{e_1}\cdots\mathfrak{i}_h^{e_h}\,\mathfrak{j}^l, \qquad (0\leqq e<l)$$

wenn die sämtlichen Exponenten $e_1,\cdots e_h$ verschwinden. Hiermit ist aber der Satz bewiesen.

Es sei noch bemerkt, dass wenn μ nicht singülar primär, auch nicht eine l-te Potenz in k ist, die h Ideale $\mathfrak{i}_1,\cdots\mathfrak{i}_h$ des obigen Satzes so gewählt werden kann, dass

$$\left(\frac{\mu}{\mathfrak{i}_a}\right)=1 \qquad (a=1,\ 2,\ \cdots h)$$

ausfällt; $\mathfrak{i}_1,\cdots\mathfrak{i}_h$ heissen dann *gegen* μ *normirt.*

§ 4.

Kennzeichen für das primäre Primideal.

Ein Ideal $\mathfrak{a}$ von k, für welches

$$\left(\frac{\eta_i}{\mathfrak{a}}\right)=1, \qquad (i=1,\ 2,\ \cdots r+1)$$

$$\left(\frac{\omega_i}{\mathfrak{a}}\right)=1 \qquad (i=1,\ 2,\ \cdots h)$$

ausfällt, heisst ein *primäres* Ideal.

(10) Tatsächlich brauchen die Ideale $\mathfrak{i}$ nicht prim zu sein, wie in der Folge einleuchten wird.

(11) § 1, (1).

Satz 8. *Ist $\mathfrak{p}$ ein primäres Primideal, dann gibt es eine primäre Zahl ϖ* [12] *in k von der Art, dass*

$$(\varpi)=\mathfrak{p}\mathfrak{j}^l,$$

wo $\mathfrak{j}$ ein Ideal von k bedeutet.

Beweis. Nach Voraussetzung ist der Rang der Classengruppe nach dem Modul $\mathfrak{p}$ gleich $h+1$. Es gibt folglich eine primäre Zahl ϖ, wie der Satz verlangt.

Dieser Satz kann auch auf der folgenden Weise bewiesen werden. Nach dem Modul $L=(1-\zeta)^l$ ist der Rang der Classengruppe $r+1+h$. Der Classenkörper für die Hauptclasse ist offenbar

$$K=k\left(\sqrt[l]{\eta_1}\cdots\sqrt[l]{\eta_{r+1}},\ \sqrt[l]{\omega_1},\cdots\sqrt[l]{\omega_h}\right)$$

Da nach Voraussetzung $\mathfrak{p}$ in K in die Primideale ersten Relativgrades zerfällt, so gehört $\mathfrak{p}$ der Hauptclasse an (Satz 4); folglich gibt es eine Zahl ϖ derart, dass

$$(\varpi)=\mathfrak{p}\,\mathfrak{j}^l, \qquad \varpi\equiv\xi^l \pmod{L},$$

w. z. b. w.

Die Zahl ϖ heisst eine *Primärzahl des primären Primideals* $\mathfrak{p}$. Für ein gegebenes $\mathfrak{p}$ wird ϖ nur bis auf einen singulären primären Factor bestimmt. Man kann daher ϖ so wählen, dass sie gegen ein vorgeschriebenes Repräsentantensystem der Basisclassen normirt ist.

§ 5.

Kennzeichen für das hyperprimäre Primideal.

Die h unabhängigen singulären Primärzahlen $\omega_1,\cdots\omega_h$ seien so gewählt, dass sie prim zu l sind, und in dem System der l^h Zahlen:

$$\omega_1^{u_1}\cdots\omega_h^{u_h} \qquad (0\leqq u<l)$$

seien l^n hyperprimäre [13]. Der Rang der Classengruppe nach dem Modul

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(12) Primär heisst eine zu l prime Zahl von k, welche l-ter Rest nach dem Modul L ist. Die Relativdiscriminante von $K=k(\sqrt[l]{\mu})$ ist dann und nur dann prim zu l, wenn μ primär ist.

(13) Hyperprimär heisst eine zu l prime Zahl von k, wenn sie l-ter Rest mod $\overline{L}$ ist.

$$\bar{L} = \prod^{i} \mathfrak{l}_i^{\sigma_i l+1} \qquad (i=1,\ 2,\ \cdots z)$$

beträgt dann $r+1+h+z_0$, wenn

$$z_0 = z-(h-n)$$

gesetzt wird. Daher gibt es z_0 Zahlen

$$\lambda_1,\ \cdots\ \lambda_{z_0},$$

welche ausser durch die l-ten Potenzen der Ideale nur noch durch die Ideale $\mathfrak{l}_1, \cdots \mathfrak{l}_z$ teilbar sind, und so beschaffen, dass erstens jede Zahl λ von der gesagten Eigenschaft in der Form

$$\lambda = \lambda_1^{u_1} \cdots \lambda_{z_0}^{u_{z_0}} [\eta,\ \omega,\ \xi^l] \tag{1}$$

darstellbar ist, wo $u_1, \cdots u_{z_0}$ Zahlen aus der Reihe $0, 1, \cdots l-1$ sind und das Zeichen $[\eta, \omega, \xi^l]$ in allgemeiner Weise eine Zahl von der Form

$$\eta_1^{v_1} \cdots \eta_{r+1}^{v_{r+1}} \omega_1^{w_1} \cdots \omega_h^{w_h} \xi^l$$

bedeutet, und dass zweitens eine Zahl von der Form (1) nur dann gleich 1 sein kann, wenn die sämtlichen Exponenten $u_1, \cdots u_{z_0}$ verschwinden.

Ein Ideal $\mathfrak{a}$ von k heisst *hyperprimär*, wenn für jede Zahl λ in (1)

$$\left(\frac{\lambda}{\mathfrak{a}}\right) = 1$$

ausfällt, d.h. wenn $\mathfrak{a}$ primär ist und ausserdem noch

$$\left(\frac{\lambda_i}{\mathfrak{a}}\right) = 1. \quad (i=1,\ 2,\ \cdots\ z_0)$$

Satz 9. *Ist $\mathfrak{p}$ ein hyperprimäres Primideal, dann gibt es eine hyperprimäre Zahl ϖ von der Art, dass*

$$(\varpi) = \mathfrak{p}\mathfrak{j}^l.$$

Beweis. Der Classenkörper für die Hauptclasse nach dem Modul $\bar{L}$ ist

$$K = k\left(\sqrt[l]{\eta_1},\ \cdots\ \sqrt[l]{\omega_1},\ \cdots\ \sqrt[l]{\lambda_1},\ \cdots\ \right)$$

vom Relativgrade $r+1+h+z_0$. Da nach Voraussetzung $\mathfrak{p}$ in die Primideale des ersten Relativgrades in K zerfällt, so ist $\mathfrak{p}$ in der Hauptclasse enthalten. Folglich gibt es eine Zahl ϖ von der Art, dass

$$(\varpi)=\mathfrak{p}\mathfrak{j}^l, \qquad \varpi\equiv\xi^l \pmod{\bar{L}},$$

w. z. b. w (14).

§ 6

Das Reciprocitätsgesetz zwischen einer primären Zahl und einer beliebigen zu l primen Zahl.

Hülfssatz 1. *Es sei ϖ eine Primärzahl eines primären Primideals $\mathfrak{p}$; $\mathfrak{i}_1, \cdots \mathfrak{i}_h$ ein Repräsentantensystem der Basisclassen, welches gegen ϖ normirt ist; ferner sei $\bar{\mathfrak{r}}$ ein zu ϖ und zu l primes Primideal und*

$$\rho=\mathfrak{r}\mathfrak{i}_1^{e_1}\cdots\mathfrak{i}_h^{e_h}\mathfrak{j}^l,$$

wo ρ eine Zahl, $\mathfrak{j}$ ein Ideal von k bedeutet, beides prim zu l angenommen. Dann ist

$$\left(\frac{\varpi}{\mathfrak{r}}\right)=\left(\frac{\varpi}{\rho}\right)=1,$$

dann und nur dann, wenn

$$\left(\frac{\rho}{\mathfrak{p}}\right)=\left(\frac{\rho}{\varpi}\right)=1$$

ausfällt.

Beweis. Da die Relativdiscriminante von $K=k(\sqrt[l]{\varpi})$ gleich $\mathfrak{p}^{l-1}$ ist, so wird die zugehörige Classengruppe von k durch eine Character-gleichung

$$\chi(\mathfrak{r})=\zeta^{e_1u_1+\cdots e_hu_h}\left(\frac{\rho}{\mathfrak{p}}\right)^v=1$$

definirt sein, wo $v\neq0$, weil K kein unverzweigter Körper ist (15). Da nach Voraussetzung

$$\left(\frac{\varpi}{\mathfrak{i}_a}\right)=1, \qquad (a=1,\ 2,\ \cdots h)$$

so folgt aus

$$\chi(\mathfrak{i}_a)=1,$$

(14) Satz 8 und Satz 9 gelten auch für nicht primes Ideal, wie in der Folge einleuchten wird.

(15) § 1. (4).

dass $u_1 = \cdots = u_h = 0$ sein muss. Daher folgt nach Satz 4 der zu beweisende Hülfssatz. (Es ist vorausgesetzt, was erlaubt ist, dass $\mathfrak{i}_1, \cdots \mathfrak{i}_z$ Primideale sind).

Hülfssatz 2. *Ist ϖ eine Primärzahl eines primären Primideals $\mathfrak{p}$, und q eine zu ϖ und zu l prime rationale Primzahl, dann ist*

$$\left(\frac{\varpi}{q}\right) = \left(\frac{q}{\varpi}\right).$$

Beweis. Sei

$$\varpi_0 = \mathfrak{n}(\varpi),$$

wo $\mathfrak{n}$ die Relativnorm in Bezug auf den durch ζ definirten Kreiskörper bedeutet. Da dann ϖ_0 primär ist, so folgt aus dem sogenannten Eisenstein'schen Reciprocitätsgesetz [16]

$$\left[\frac{\varpi_0}{q}\right] = \left[\frac{q}{\varpi_0}\right],$$

wo die eckigen Klammern Potenzcharactere im Kreiskörper bedeuten. Da nach Satz 5 und 6

$$\left(\frac{q}{\varpi}\right) = \left[\frac{q}{\varpi_0}\right], \quad \left(\frac{\varpi}{q}\right) = \left[\frac{\varpi}{q_0}\right],$$

so folgt

$$\left(\frac{\varpi}{q}\right) = \left(\frac{q}{\varpi}\right).$$

Hülfssatz 3. *Seien $\mathfrak{a}$, $\mathfrak{b}$ Primideale,*

$$\alpha = \mathfrak{a}\,[\mathfrak{i}], \qquad \beta = \mathfrak{b}\,[\mathfrak{i}],$$

wo α, β Zahlen von k sind, und das Zeichen $[\mathfrak{i}]$ allgemein ein Idealproduct von der Form

$$\mathfrak{i}_1^{e_1} \cdots \mathfrak{i}_h^{e_h}\, \mathfrak{j}^l$$

bedeutet, unter $\mathfrak{i}_1, \cdots \mathfrak{i}_h$ ein Repräsentantensystem der Basisclassen verstanden. Dann gibt es unendlichviele primäre Primideale $\mathfrak{p}_0$ mit den zugehörigen, gegen $[\mathfrak{i}]$ normirten Primärzahlen ϖ_0 von der Art, dass, wenn ζ_1, ζ_2 beliebige l-te Einheitswurzeln sind,

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[16] Vgl. Hilbert, Bericht, Satz 140.

$$\left(\frac{\alpha}{\varpi_0}\right)=\left(\frac{\varpi_0}{\alpha}\right)=\zeta_1^n,$$
$$\left(\frac{\beta}{\varpi_0}\right)=\left(\frac{\varpi_0}{\beta}\right)=\zeta_2^n, \qquad n\not\equiv 0 \pmod{l}$$

ausfällt.

Beweis. Seien a, b bez. die durch $\mathfrak{a}$, $\mathfrak{b}$ teilbaren rationalen Primzahlen, und es sei in Primfactoren zerlegt,

$$a=\mathfrak{a}^u\mathfrak{a}'^{u'}\ldots, \quad b=\mathfrak{b}^v\mathfrak{b}'^{v'}\ldots \tag{1}$$

Wir nehmen an, es sei

$$u\not\equiv 0, \quad v\not\equiv 0 \pmod{l}, \tag{2}$$
$$a\neq b, \tag{3}$$

denn wir benutzen diesen Hülfssatz nur in dem Falle, wo diese Bedingungen erfüllt sind. Ferner sei

$$\alpha'=\mathfrak{a}'[\mathrm{i}], \cdots; \quad \beta'=\mathfrak{b}'[\mathrm{i}], \cdots$$

sodass

$$\left.\begin{aligned} \alpha^u\alpha'^{u'}\cdots &= a\,[\eta,\ \omega,\ \xi^l] \\ \beta^v\beta'^{v'}\cdots &= b\,[\eta,\ \omega,\ \xi^l] \end{aligned}\right\} \tag{4}$$

Nun sei $\mathfrak{p}_0$ ein Primideal (ersten Grades), für welches

$$\left\{\begin{aligned} &\left(\frac{\alpha}{\mathfrak{p}_0}\right)=\zeta_1^n, \left(\frac{\alpha'}{\mathfrak{p}_0}\right)=1, \cdots && (5) \\ &\left(\frac{\beta}{\mathfrak{p}_0}\right)=\zeta_2^n, \left(\frac{\beta'}{\mathfrak{p}_0}\right)=1, \cdots && (6) \\ &\left(\frac{\eta}{\mathfrak{p}_0}\right)=1, \cdots \left(\frac{\omega}{\mathfrak{p}_0}\right)=1, \cdots && (7) \end{aligned}\right.$$

ausfällt. Ist dann ϖ_0 die gegen $[\mathrm{i}]$ normirte Primärzahl dieses primären Primideals $\mathfrak{p}_0$, so folgt aus (4), (5), (6), (7)

$$\left(\frac{\alpha^u\alpha'^{u'}\cdots}{\mathfrak{p}_0}\right)=\left(\frac{a}{\mathfrak{p}_0}\right)=\zeta_1^{nu},$$
$$\left(\frac{\beta^v\beta'^{v'}\cdots}{\mathfrak{p}_0}\right)=\left(\frac{b}{\mathfrak{p}_0}\right)=\zeta_2^{nv}.$$

Folglich ist nach Hülfssatz 2

$$\left(\frac{\varpi_0}{a}\right)=\zeta_1^{nu}, \quad \left(\frac{\varpi_0}{b}\right)=\zeta_2^{nv}. \tag{8}$$

Aus (5), (6) folgt anderseits nach Hülfssatz 1

$$\left(\frac{\varpi_0}{\alpha'}\right)=1, \;\cdot\;\cdot\;\cdot\; \left(\frac{\varpi_0}{\beta'}\right)=1. \;\cdot\;\cdot \tag{9}$$

Daher ist, nach (4), (8), (9)

$$\left(\frac{\varpi_0}{\alpha}\right)^u=\zeta_1^{nu}, \quad \left(\frac{\varpi_0}{\beta}\right)=\zeta_2^{nv},$$

folglich nach (2)

$$\left(\frac{\varpi_0}{\alpha}\right)=\zeta_1^n, \quad \left(\frac{\varpi_0}{\beta}\right)=\zeta_2^n.$$

Hülfssatz 4. *Es seien α, β gegen das System* [i] *normirte Primärzahlen der primären Primideale* $\mathfrak{a}$, $\mathfrak{b}$; $\mathfrak{r}$ *ein zu* α, β *und* l *primes Primideal und* $\rho=\mathfrak{r}[\mathfrak{i}]$, *dann ist für einen ganzzahligen Exponenten e*

$$\left(\frac{\alpha\beta^e}{\mathfrak{r}}\right)=1,$$

dann und nur dann, wenn

$$\left(\frac{\rho}{\alpha\beta^e}\right)=1.$$

Beweis. Wir machen dieselbe Annahme (2), (3) wie bei dem Beweise von Hülfssatz 3. Da $\alpha\beta^e$ primär und gegen [i] normirt ist, so folgt, wie beim Beweise von Hülfssatz 1, dass die Classengruppe mod $\mathfrak{a}\mathfrak{b}$, welche dem Körper $K=k(\sqrt[l]{\alpha\beta^e})$ zugeordnet ist, durch eine Character-gleichung

$$\chi(\mathfrak{r})=\left(\frac{\rho}{\mathfrak{a}}\right)^v\left(\frac{\rho}{\mathfrak{b}}\right)^{v'}=1 \tag{10}$$

definirt wird. Es handelt sich darum, zu zeigen, dass

$$v\not\equiv 0, \quad v'\equiv ve \pmod{l}$$

sein muss.

Es seien ζ_1, ζ_2 l-te Einheitswurzeln, welche die Bedingungen

$$\zeta_1\zeta_2^e=1, \quad \zeta_2\neq 1 \tag{11}$$

befriedigen, und $\mathfrak{p}_0$, ϖ_0 das primäre Primideal und die zugehörige Primärzahl wie sie in Hülfssatz 3 erklärt worden sind. Da dann nach (11)

$$\left(\frac{\alpha\beta^e}{\mathfrak{p}_0}\right)=1$$

ausfällt, so folgt nach (10)

$$\left(\frac{\varpi_0}{\mathfrak{a}}\right)^{r}\left(\frac{\varpi_0}{\mathfrak{b}}\right)^{r'}=1. \tag{12}$$

Anderseits ist nach Hülfssatz 3

$$\left.\begin{aligned}\left(\frac{\varpi_0}{\mathfrak{a}}\right)&=\left(\frac{\varpi_0}{\alpha}\right)=\zeta_1^n,\\ \left(\frac{\varpi_0}{\mathfrak{b}}\right)&=\left(\frac{\varpi_0}{\beta}\right)=\zeta_2^n,\end{aligned}\right\} \quad n\not\equiv 0 \pmod{l}.$$

Daher folgt aus (12)

$$\zeta_1^{r}\zeta_2^{r'}=1.$$

Dies in Verbindung mit (11) ergibt

$$v'\equiv ve \pmod{l}.$$

Sodann folgt, dass notwendig $v\not\equiv 0 \pmod{l}$ sein muss, weil sonst für jedes $\mathfrak{r}$, $\chi(\mathfrak{r})=1$ ausfiele.

Hülfssatz 5. *Wenn ϖ eine Primärzahl eines primären Primideals $\mathfrak{p}$ ist, und ν eine beliebige zu ϖ und zu l prime Zahl, dann gilt die Reciprocitätsgleichung:*

$$\left(\frac{\varpi}{\nu}\right)=\left(\frac{\nu}{\varpi}\right).$$

Beweis. Wir nehmen das Repräsentantensystem $[i]$ der Basisclassen gegen ϖ normirt an. Es sei dann $\mathfrak{r}$ ein beliebiges zu ϖ und zu l primes Primideal und $\rho=\mathfrak{r}[i]$. Wir beweisen zunächst den Satz für $\nu=\rho$.

Da nach Hülfssatz 1 der Satz richtig ist, wenn $\left(\frac{\varpi}{\mathfrak{r}}\right)=1$, so nehmen wir an: es sei

$$\left(\frac{\varpi}{\mathfrak{r}}\right)=\zeta_1\neq 1. \tag{13}$$

Wir bestimmen dann nach Hülfssatz 3 ein primäres Primideal $\mathfrak{p}_0$ und die gegen $[i]$ normirte Primärzahl ϖ_0 desselben, von der Art, dass

$$\left(\frac{\varpi_0}{\mathfrak{r}}\right)=\left(\frac{\rho}{\varpi_0}\right)=\zeta_2\neq 1. \tag{14}$$

Ist dann

$$\zeta_1 \zeta_2^e = 1, \tag{15}$$

dann folgt aus (13), (14)

$$\left(\frac{\varpi\, \varpi_0^e}{\mathfrak{r}}\right) = 1.$$

Daher ist nach Hülfssatz 4

$$\left(\frac{\rho}{\varpi\, \varpi_0^e}\right) = 1,$$

woraus nach (14) und (15)

$$\left(\frac{\rho}{\varpi}\right) \equiv \zeta_1$$

oder nach (13)

$$\left(\frac{\varpi}{\rho}\right) = \left(\frac{\rho}{\varpi}\right).$$

Nunmehr sei ν eine beliebige zu ϖ und zu l prime Zahl von k, und

$$(\nu) = \mathfrak{r}_1^{a_1}\, \mathfrak{r}_2^{a_2} \cdots \mathfrak{j}^l,$$

wo $\mathfrak{r}_1, \mathfrak{r}_2, \cdots$ von einander verschiedene Primideale von k und die Exponenten $a_1, a_2, \cdots$ nicht durch l teilbar sind.

Setzt man dann

$$\rho_1 = \mathfrak{r}_1[\mathfrak{i}], \quad \rho_2 = \mathfrak{r}_2[\mathfrak{i}], \cdots$$

so wird

$$\nu = \rho_1^{a_1}\, \rho_2^{a_1} \cdots [\eta, \omega, \xi^l],$$

wo $[\mathfrak{i}]$ und folglich $[\eta, \omega, \xi^l]$ prim zu ϖ und l angenommen werden können. Es ist dann nach dem vorhin bewiesenen

$$\begin{aligned}\left(\frac{\varpi}{\nu}\right) = \left(\frac{\varpi}{\rho_1}\right)^{a_1}\left(\frac{\varpi}{\rho_2}\right)^{a_2} \cdots &= \left(\frac{\rho_1}{\varpi}\right)^{a_1}\left(\frac{\rho_2}{\varpi}\right)^{a_2} \cdots \\ &= \left(\frac{\rho_1^{a_1}\rho_2^{a_2}\cdots}{\varpi}\right) \\ &= \left(\frac{\nu}{\varpi}\right),\end{aligned}$$

da $\mathfrak{p}$ primär und folglich

$$\left(\frac{[\eta, \omega, \xi^l]}{\varpi}\right) = 1.$$

Satz 10. *Ist μ primär, ν prim zu μ und l, dann besteht die Reciprocitätsgleichung:*

$$\left(\frac{\mu}{\nu}\right)=\left(\frac{\nu}{\mu}\right).$$

Beweis. Es sei

$$(\mu)=\mathfrak{p}_1^{a_1}\,\mathfrak{p}_2^{a_2}\cdots\mathfrak{p}_t^{a_t}\,\mathfrak{i}^l, \tag{16}$$

wo $\mathfrak{p}_1, \mathfrak{p}_2, \cdots \mathfrak{p}_t$ von einander verschiedene Primideale und die Exponenten $a_1, a_2, \cdots a_t$ nicht durch l teilbar sind.

Sei $\mathfrak{r}$ ein zu μ und l primes Primideal, und

$$\rho=\mathfrak{r}[\mathfrak{i}],$$

wo $[\mathfrak{i}]$ gegen μ normirt ist. Dann ist, wie beim Beweise von Hülfssatz 4

$$\left(\frac{\mu}{\mathfrak{r}}\right)=1,$$

dann und nur dann, wenn

$$\left(\frac{\rho}{\mathfrak{p}_1}\right)^{v_1}\left(\frac{\rho}{\mathfrak{p}_1}\right)^{v_2}\cdots\left(\frac{\rho}{\mathfrak{p}_t}\right)^{v_t}=1, \tag{17}$$

wo die Exponenten v von $\mathfrak{r}$ unabhängig sind. Es handelt sich darum, zu zeigen, dass

$$v_1:v_2:\cdots:v_t\equiv a_1:a_2:\cdots:a_t \pmod{l}.$$

Man bestimme zu diesem Behuf ein primäres Primideal $\mathfrak{p}_0$ und die zugehörige Primärzahl ϖ_0 so, dass

$$\left(\frac{\varpi_1}{\mathfrak{p}_0}\right)=\zeta^{na_2},\quad \left(\frac{\varpi_2}{\mathfrak{p}_0}\right)=\zeta^{-na_1},\quad \left(\frac{\varpi_3}{\mathfrak{p}_0}\right)=\cdots\left(\frac{\varpi_t}{\mathfrak{p}_0}\right)=1,$$

$$n\not\equiv 0 \pmod{l},$$

wo

$$\varpi_i=\mathfrak{p}_i[\mathfrak{i}] \qquad (i=1,\ 2,\ \cdots\ t)$$

(vgl. Hülfsstaz 3). Dann folgt nach Hülfssatz 5

$$\left(\frac{\varpi_0}{\mathfrak{p}_1}\right)=\zeta^{na_2},\ \left(\frac{\varpi_0}{\mathfrak{p}_2}\right)=\zeta^{-na_1},\ \left(\frac{\varpi_0}{\mathfrak{p}_3}\right)=\cdots=\left(\frac{\varpi_0}{\mathfrak{p}_t}\right)=1, \tag{18}$$

woraus nach (16)

$$\left(\frac{\varpi_0}{\mu}\right)=1,$$

also nach Hülfssatz 5

$$\left(\frac{\mu}{\varpi_0}\right)=\left(\frac{\mu}{\mathfrak{p}_0}\right)=1.$$

Daher muss nach (17)

$$\left(\frac{\varpi_0}{\mathfrak{p}_1}\right)^{v_1}\left(\frac{\varpi_0}{\mathfrak{p}_2}\right)^{v_2}\cdots\left(\frac{\varpi_0}{\mathfrak{p}_t}\right)^{v_t}=1,$$

oder nach (18)

$$\zeta^{n(a_2 v_1-a_1 v_2)}=1,$$

und weil $n\not\equiv 0 \pmod{l}$,

$$a_2 v_1-a_1 v_2\equiv 0 \pmod{l}.$$

Ebenso folgt

$$a_i v_1-a_1 v_i\equiv 0 \pmod{l}. \quad (i=1, 2, \cdots t)$$

Da offenbar nicht alle v verschwinden können, so erhält man

$$v_i\equiv a_i w \pmod{l},$$

wo $w\not\equiv 0 \pmod{l}$, w. z. b. w.

Fernerhin verläuft der Beweis genau wie bei Hülfssatz 5.

Oben haben wir angenommen, dass $t>1$. Ist $t=1$, also

$$(\mu)=\mathfrak{p}^a\mathfrak{j}^l, \quad a\not\equiv 0 \pmod{l},$$

dann kann man genau wie bei Hülfssatz 5 verfahren (Tatsächlich ist $\mathfrak{p}$ ein primäres Primideal). Man kann auch ebenso wie im folgenden Falle: $t=0$ verfahren.

Wenn $t=0$, also $\mu=\omega$ singulär primär ist, dann sei μ_0 eine beliebige nicht singuläre zu ν prime primäre Zahl; dann ist

$$\left(\frac{\omega\mu_0}{\nu}\right)=\left(\frac{\nu}{\omega\mu_0}\right).$$

Da aber

$$\left(\frac{\mu_0}{\nu}\right)=\left(\frac{\nu}{\mu_0}\right),$$

so folgt

$$\left(\frac{\omega}{\nu}\right)=\left(\frac{\nu}{\omega}\right)=1.$$

Diesen Specialfall von Satz 10 sprechen wir noch als einen besonderen Satz aus.

Satz 11. *Wenn ω eine singuläre Primärzahl ist, so gilt für jede zu ω und zu l prime Zahl ν die Beziehung:*

$$\left(\frac{\omega}{\nu}\right)=1.$$

Es ist zu bemerken, dass Satz 10 nur unter der Voraussetzung bewiesen worden ist, dass alle in μ und ν aufgehenden Primideale die zu Beginn des Beweises von Hülfssatz 3 gestellte Bedingung (2) erfüllen: es sollen nämlich diese Primideale in eine rationale Primzahl zu einer Potenz aufgehen, deren Exponent nicht durch l teilbar ist. Es werden also eine gewisse endliche Anzahl Primideale, die in die Discriminante von k aufgehen, ausser Betracht gelassen. Diese beschränkende Voraussetzung soll nun im folgenden Artikel beseitigt werden ([17]).

§ 7.

Beseitigung der beschränkenden Annahme.

Alle Primideale von k, für welche die im Hülfssatze 3 des vorhergehenden Artikels gestellte Forderung erfüllt werden können, wollen wir vorübergehend als *regulär* bezeichnen. Ebenso wollen wir eine Zahl oder ein Ideal von k regulär nennen, wenn darin ein nicht reguläres Primideal gar nicht oder nur zu einer Potenz mit einem durch l teilbaren Exponenten als Factor enthalten ist.

Ein nicht reguläres Primideal geht zu einer Potenz mit einem durch l teilbaren Exponenten in eine rationale Primzahl auf. Es kann daher in jedem Körper nur eine endliche Anzahl nicht regulärer Primideale geben. Zweck dieses Artikels ist aber nachzuweisen, dass überhaupt jedes zu l prime Primideal regulär ist.

(I) Sei μ eine reguläre primäre Zahl, $\mathfrak{r}_1, \mathfrak{r}_2, \cdots \mathfrak{r}_h$ ein gegen μ normirtes Repräsentantensystem der Basisclassen von k, $\mathfrak{q}$ ein Primideal, $\varkappa=\mathfrak{q}[\mathfrak{r}, \mathfrak{j}^l]$. Ist dann

$$\left(\frac{\mu}{\mathfrak{q}}\right)=1.$$

([17]) Die zweite Annahme (3): $a \neq b$ bei Hülfssatz 3 ist ohne Belang, weil wir bei dem Beweis von Hülfssatz 5 den Hülfssatz 4 nur in dem Falle zu benutzen haben, wo diese Bedingung erfüllt ist.

dann ist, wie aus dem Beweise von Satz 10. zu entnehmen ist, notwendig

$$\left(\frac{\varkappa}{\mu}\right)=1,$$

auch dann noch, wenn $\mathfrak{q}$ nicht regulär wäre.

Ist aber

$$\left(\frac{\mu}{\mathfrak{q}}\right)\neq 1,$$

dann sei $\mathfrak{p}$ ein reguläres primäres Primideal von der Art, dass

$$\left(\frac{\varkappa}{\mathfrak{p}}\right)\neq 1.$$

Wenn dann ϖ die gegen $\mathfrak{r}_1, \mathfrak{r}_2, \cdots \mathfrak{r}_h$ normirte Primärzahl von $\mathfrak{p}$ ist, so ist notwendig nach Hülfssatz 1

$$\left(\frac{\varpi}{\mathfrak{q}}\right)\neq 1.$$

Wir setzen

$$\left(\frac{\varkappa}{\varpi}\right)=\left(\frac{\varkappa}{\mathfrak{p}}\right)=\left(\frac{\varpi}{\mathfrak{q}}\right)^e, \qquad e\not\equiv 0 \pmod{l}. \tag{1}$$

Sei nun eine natürliche Zahl n so bestimmt, dass

$$\left(\frac{\mu\varpi^n}{\mathfrak{q}}\right)=1 \tag{2}$$

ausfällt. Da dann $\mu\varpi^n$ regulär und primär ist, so folgt

$$\left(\frac{\varkappa}{\mu\varpi^n}\right)=1. \tag{3}$$

Aus (1), (2), (3) erhält man

$$\left(\frac{\varkappa}{\mu}\right)=\left(\frac{\mu}{\mathfrak{q}}\right)^e$$

Der Exponent e ist also dem Primideal $\mathfrak{q}$ eigen; er hängt nicht von μ ab; und $\mathfrak{q}$ ist regulär, wenn der zugehörige Exponent $e=1$ ist.

Ist aber μ regulär primär, ν durch $\mathfrak{q}^a$, sonst durch kein nicht reguläres Primideal teilbar, dann ist

$$\left(\frac{\mu}{\nu}\right)\left(\frac{\mu}{\mathfrak{q}}\right)^{a(e-1)}=\left(\frac{\nu}{\mu}\right).$$

Wenn daher $a\not\equiv 0 \pmod{l}$, $\left(\frac{\mu}{\mathfrak{q}}\right)\neq 1$ und zugleich $\left(\frac{\mu}{\nu}\right)=\left(\frac{\nu}{\mu}\right)$, dann ist notwendig $\mathfrak{q}$ regulär.

(II) Es sei K ein Oberkörper von k, $\mathfrak{Q}$ ein Primideal von K, welches in $\mathfrak{q}$ aufgeht und vom Relativgrade f ist, der nicht durch l teilbar ist:

$$N(\mathfrak{Q})=\mathfrak{q}^f, \qquad f\not\equiv 0 \pmod{l}.$$

Ist dann $\mathfrak{q}$ regulär in k, dann ist $\mathfrak{Q}$ regulär in K, und umgekehrt.

Denn sei A eine Zahl in K von der Art, dass

$$A=\mathfrak{Q}\mathfrak{A},$$
$$\alpha=N(A)=\mathfrak{q}^f\mathfrak{a},$$

wo $\mathfrak{A}$ und $\mathfrak{a}=N(\mathfrak{A})$ prim zu $\mathfrak{q}$ und regulär in K und k angenommen werden können. Ferner sei μ regulär und primär sowohl in k als in K, und

$$\left(\frac{\mu}{\mathfrak{q}}\right)\neq 1. \tag{4}$$

Nach Satz 5 und 6 ist dann

$$\left\{\frac{\mu}{A}\right\}=\left(\frac{\mu}{\alpha}\right), \quad \left\{\frac{A}{\mu}\right\}=\left(\frac{\alpha}{\mu}\right).$$

Ist daher $\mathfrak{q}$ regulär in k, sodass

$$\left(\frac{\mu}{\alpha}\right)=\left(\frac{\alpha}{\mu}\right), \tag{5}$$

dann ist

$$\left\{\frac{\mu}{A}\right\}=\left\{\frac{A}{\mu}\right\}, \tag{6}$$

und weil nach Annahme A nur durch die erste Potenz von $\mathfrak{q}$ teilbar, und

$$\left\{\frac{\mu}{\mathfrak{Q}}\right\}=\left(\frac{\mu}{\mathfrak{q}}\right)^f\neq 1$$

ist, so folgt nach (1), dass $\mathfrak{Q}$ regulär in K ist.

Ist umgekehrt $\mathfrak{Q}$ regulär in K, dann gilt zunächst (6), demnach auch (5), welches in Verbindung mit (4) zeigt, dass $\mathfrak{q}$ regulär in k sein muss.

(III) Im Oberkörper K von k bleibe $\mathfrak{q}=\mathfrak{Q}$ prim, oder es werde $\mathfrak{q}=\mathfrak{Q}^g$, $g\not\equiv 0 \pmod{l}$, wo $\mathfrak{Q}$ Primideal von K bedeutet. Ist dann $\mathfrak{q}$ regulär in k, dann ist $\mathfrak{Q}$ regulär in K, und umgekehrt.

Denn sei α eine Zahl in k von der Art, dass $\alpha=\mathfrak{q}\mathfrak{a}$, wo $\mathfrak{a}$ prim zu $\mathfrak{q}$ und regulär sowohl in k als auch in K ist. Ferner sei M eine primäre Zahl von K, sodass $\mu=N(M)$ primär ist. Wir nehmen, wie erlaubt, M so gewählt an, dass M und μ regulär in K und k sind, und dass

$$\left\{\frac{M}{\mathfrak{q}}\right\}=\left(\frac{\mu}{\mathfrak{q}}\right)\neq 1 \tag{7}$$

ausfällt.

Ist dann $\mathfrak{q}$ regulär in k, dann ist

$$\left(\frac{\mu}{\alpha}\right)=\left(\frac{\alpha}{\mu}\right), \tag{8}$$

folglich

$$\left\{\frac{M}{\alpha}\right\}=\left\{\frac{\alpha}{M}\right\}. \tag{9}$$

Da $\left\{\frac{M}{\mathfrak{q}}\right\}=\left\{\frac{M}{\mathfrak{Q}}\right\}^{g}\neq 1$, also $\left\{\frac{M}{\mathfrak{Q}}\right\}\neq 1$, so folgt nach (I), dass $\mathfrak{Q}$ regulär in K ist.

Umgekehrt, wenn $\mathfrak{Q}$ regulär in K ist, so gilt zunächst (9), folglich auch (8), woraus mit Hülfe von (7) zu schliessen ist, dass $\mathfrak{q}$ regulär in k ist.

(IV) Es sei nun q die durch das Primideal $\mathfrak{q}$ von k teilbare rationale Primzahl und

$$q=\mathfrak{q}^{a}\mathfrak{n}, \qquad a\equiv 0 \pmod{l},$$

wo $\mathfrak{n}$ prim zu $\mathfrak{q}$ ist. Ferner sei K ein Normalkörper, welcher k enthält, $\mathfrak{Q}$ ein in $\mathfrak{q}$ aufgehendes Primideal von K, und zwar seien $\mathfrak{Q}^{g}$, $\mathfrak{Q}^{\gamma}$ $(g=a\gamma)$ die höchsten in q bez. $\mathfrak{q}$ aufgehenden Potenzen von $\mathfrak{Q}$.

Sei K_t der Trägheitskörper von $\mathfrak{Q}$. Da dann $\mathfrak{Q}_0=\mathfrak{Q}^{g}$ Primideal von K_t ist, welches nur zur ersten Potenz in die rationale Primzahl q aufgeht, so ist $\mathfrak{Q}_0$ regulär in K_t.

Im Relativkörper K/K_t ist aber $\mathfrak{Q}$ vom ersten Relativgrade. Daher ist nach (II) $\mathfrak{Q}$ regulär in K.

Nunmehr seien k_z, k_t der Zerlegungs- und der Trägheitskörper von $\mathfrak{Q}$ in Bezug auf k, sodass $\mathfrak{q}^{*}=\mathfrak{Q}^{\gamma}$ Primideal in k_z und k_t ist.

Da $\mathfrak{Q}$ regulär in K, und vom ersten Relativgrade im Relativkörper K/k_t, so ist nach (II) $\mathfrak{q}^{*}$ regülar in k_t

Da ferner $\mathfrak{q}^{*}$ nicht im Relativkörper k_t/k_z zerfällt, so ist nach (III) $\mathfrak{q}^{*}$ regulär in k_z.

Endlich ist $\mathfrak{q}^*$ vom ersten Relativgrade im Relativkörper k_z/k, sodass nach (II) $\mathfrak{q}$ regulär in k sein muss.

Hiermit ist nachgewiesen, dass jedes zu l primes Primideal von k regulär, und somit Satz 10 ausnahmslos gültig ist.

§ 8

Das erste und das zweite Ergänzungssatz.

Satz 12. (*Das erste Ergänzungssatz*). *Wenn ε eine Einheit oder l-te Potenz eines Ideals von k ist, und wenn α eine zu ε prime primäre Zahl ist, dann gilt die Relation:*

$$\left(\frac{\varepsilon}{\alpha}\right)=1.$$

Satz 13. (*Das zweite Ergänzungssatz*). *Wenn λ eine Zahl ist, die ausser durch die l-ten Potenzen der Ideale nur noch durch die in l aufgehenden Primideale von k teilbar ist, und wenn α eine zu λ prime hyperprimäre Zahl ist, dann gilt die Relation:*

$$\left(\frac{\lambda}{\alpha}\right)=1.$$

Satz 12 ist ein Specialfall von Satz 10, und Satz 13 von den folgenden

Satz 14. *Wenn μ eine Zahl von k ist, und*

$$(\mu)=\mathfrak{m}\prod_i^i \mathfrak{l}_i^{a_i}, \qquad (a_i\geqq 0,\ i=1,\ 2,\ \cdots z) \tag{1}$$

wo $\mathfrak{m}$ zu l prim ist, und wenn ν eine zu μ prime primäre Zahl ist, für welche überdies, wenn a_i nicht durch l teilbar, die Congruenz

$$\nu\equiv\xi^l \quad \left(\operatorname{mod} \mathfrak{l}_i^{\sigma_i l+1}\right) \tag{2}$$

in k besteht, wo σ_i die in S. 3. angegebene Bedeutung hat, dann gilt die Relation:

$$\left(\frac{\mu}{\nu}\right)=\left(\frac{\nu}{\mathfrak{m}}\right).$$

Beweis. Wir legen ein gegen ν normirtes Repräsentantensystem der Basisclassen zu Grunde. Ist dann $\mathfrak{r}$ ein beliebiges zu ν primes Ideal von k, und

$$\rho = \mathfrak{r}[\mathfrak{i}],$$

dann ist die dem Körper $K = k(\sqrt[l]{\nu})$ zugeordnete Classengruppe von k nach Satz 10 durch

$$\chi(\mathfrak{r}) = \left(\frac{\rho}{\nu}\right) = 1$$

characterisirt. Wenn nun a_i nicht durch l teilbar ist, dann zerfällt nach (2) das Primideal $\mathfrak{l}_i$ in K. Folglich ist nach Satz 4

$$\left(\frac{\lambda_i}{\nu}\right) = 1, \qquad (3)$$

wo

$$\lambda_i = \mathfrak{l}_i[\mathfrak{i}]. \qquad (i = 1, 2, \cdots z)$$

Wenn ferner

$$\mu_0 = \mathfrak{m}[\mathfrak{i}]$$

gesetzt wird, dann folgt nach (1)

$$\mu_0 \overset{i}{\Pi} \lambda_i^{a_i} = \mu[\chi, \omega, \xi].$$

Daher ist nach (3)

$$\left(\frac{\mu}{\nu}\right) = \left(\frac{\mu_0}{\nu}\right) \overset{i}{\Pi} \left(\frac{\lambda_i}{\nu}\right)^{a_i} = \left(\frac{\mu_0}{\nu}\right).$$

Da anderseits nach Satz 10

$$\left(\frac{\mu_0}{\nu}\right) = \left(\frac{\nu}{\mu_0}\right) = \left(\frac{\nu}{\mathfrak{m}}\right),$$

so folgt die zu beweisende Gleichheit.

§ 9

Das allgemeine Reciprocitätsgesetz.

Es sei μ eine beliebige Zahl von k, und

$$(\mu) = \mathfrak{m} \overset{i}{\Pi} \mathfrak{l}_i^{a_i}, \qquad (1)$$

wo $\mathfrak{m}$ zu l prim ist. Um das allgemeine Reciprocitätsgesetz bequem ausdrücken zu können, führen wir das Symbol (μ, ν) durch die folgende Definition ein:

$$(\mu, \nu)=\left(\frac{\mu}{\nu}\right)\left(\frac{\nu}{\mathfrak{m}}\right)^{-1}, \tag{2}$$

wo unter ν, wie immer, eine zu μ und zu l prime Zahl von k zu verstehen ist.

Aus dieser Definition folgt

$$(\mu\mu', \nu)=(\mu, \nu)(\mu', \nu), \tag{3}$$

$$(\mu, \nu\nu')=(\mu, \nu)(\mu, \nu'). \tag{4}$$

Ferner ist nach Satz 10, wenn μ primär ist,

$$(\mu, \nu)=1. \tag{5}$$

Wenn allgemeiner $\frac{\mu'}{\mu}$ primär ist, d.h. wenn $\frac{\mu'}{\mu}$ gleich einem Bruch $\frac{\mu_0'}{\mu_0}$ ist, wo μ_0, μ_0' prim zu l sind und eine Congruenz

$$\mu_0' \equiv \mu_0 \xi^l \pmod{L}$$

in k befriedigen, dann ist

$$(\mu, \nu)=(\mu', \nu). \tag{6}$$

Denn setzt man

$$\frac{\mu'}{\mu}=\frac{\mu_0'}{\mu_0}=\frac{\mathfrak{m}'}{\mathfrak{m}},$$

wo $\mathfrak{m}$ für μ die in (1) angegebene, und $\mathfrak{m}'$ für μ' die entsprechende Bedeutung haben soll, so folgt

$$\left(\frac{\mu'}{\nu}\right)\left(\frac{\mu_0}{\nu}\right)=\left(\frac{\mu}{\nu}\right)\left(\frac{\mu_0'}{\nu}\right),$$

$$\left(\frac{\nu}{\mu_0}\right)\left(\frac{\nu}{\mathfrak{m}'}\right)=\left(\frac{\nu}{\mu_0'}\right)\left(\frac{\nu}{\mathfrak{m}}\right)$$

und durch Division

$$(\mu', \nu)(\mu_0, \nu)=(\mu, \nu)(\mu_0', \nu).$$

Sei nun $\mu_0\mu^*$ primär und prim zu ν, dann ist es auch $\mu'_0\mu^*$, sodass nach (5)

$$(\mu_0\mu^*, \nu)=(\mu_0'\mu^*, \nu)=1,$$

folglich

$$(\mu_0, \nu)=(\mu_0', \nu)$$

und somit

$$(\mu, \nu)=(\mu', \nu).$$

Nach dieser Vorbemerkung führen wir das zweite Symbol $Z_i(\mu, \nu)$ durch die folgende Festsetzung ein.

Es sei μ eine beliebige Zahl von k und wie in (1)

$$(\mu)=\mathfrak{m}\prod^{i}\mathfrak{l}_i^{a_i},$$

Wir bestimmen dann ein System von z Zahlen

$$\mu_1,\ \mu_2,\ \cdots\ \mu_z$$

gemäss den Congruenzen:

$$\left.\begin{aligned}\mu_i&\equiv\mu\ \left(\mathrm{mod}\ \mathfrak{l}_i^{\sigma_i l+a_i}\right),\\ &\equiv 1\ \left(\mathrm{mod}\ \frac{L}{\mathfrak{l}_i^{\sigma_i l}}\right),\end{aligned}\right\}(i=1,\ 2,\ \cdots\ z) \qquad (7)$$

und wir setzen, wenn ν eine zu μ, l und zu $\mu_1, \mu_2, \cdots \mu_z$ prime Zahl von k ist,

$$Z_i(\mu,\nu)=(\mu_i,\nu). \quad (i=1,\ 2,\ \cdots\ z) \qquad (8)$$

In der Tat wird das Symbol $Z_i(\mu,\nu)$ durch diese Festsetzung unzweideutig bestimmt, denn wenn μ_i' eine andere Zahl ist, die den Congruenzen (7) genügt, dann ist offenbar $\frac{\mu_i'}{\mu_i}$ primär, also wie vorhin bemerkt

$$(\mu_i,\nu)=(\mu_i',\nu),$$

wenn nur μ_i' prim zu ν ist [18].

Das allgemine Reciprocitätsgesetz lässt sich nun in der folgenden Form ausdrücken:

Satz 15. **(Das allgemeine Reciprocitätsgesetz)** *Wenn ν zu μ und zu l prim ist, dann gilt die Relation:*

$$(\mu,\nu)=Z_1(\mu,\nu)Z_2(\mu,\nu)\cdots Z(\mu,\nu). \qquad (9)$$

Beweis. Formel ist dieser Satz eine unmittelbare Folge der Definition des Symbols $Z(\mu,\nu)$. Denn setzt man

$$\frac{\mu_1\mu_2\cdots\mu_z}{\mu}=\frac{\alpha}{\beta},$$

wo α, β zu l prime Zahlen von k sind, dann folgt aus der Gleichung

$$\mu\alpha=\mu_1\mu_2\cdots\mu_z\beta,$$

(18) Diese Beschränkung, sowie die, welche oben der Zahl ν auferlegt worden ist, prim zu $\mu_1, \mu_2, \cdots$ zu sein, ist nicht wesentlich, weil wir eben durch eine andere Wahl des Systems $\mu_1, \mu_2, \cdots$ entkommen.

indem man sie als eine Congruenz nach dem Modul $\mathfrak{l}_i^{\sigma_i l + a_i}$ auffasst, nach (7)

$$\alpha \equiv \beta \pmod{\mathfrak{l}_i^{\sigma_i l}}. \qquad (i=1,\ 2,\ \cdots z)$$

Daher ist $\frac{\alpha}{\beta}$ primär, folglich nach (6)

$$(\mu,\ \nu)=(\mu_1\mu_2 \cdots \mu_z,\ \nu)$$
$$=(\mu_1,\ \nu)\,(\mu_2,\ \nu) \cdots (\mu_z,\ \nu),$$

woraus nach (8) die zu beweisende Gleichung (9) folgt.

Der sachliche Inhalt des Satzes 15 wird aber erst durch die Ausführungen im folgenden Artikel aufgeklärt werden.

§ 10

Das Normenrestsymbol $Z(\mu,\ \nu)$.

Das im vorhergehenden Artikel definirte Symbol $Z_i(\mu,\ \nu)$ ist das *Normenrestsymbol* in Bezug auf dem Oberkörper $K=k(\sqrt[l]{\mu})$ und das Primideal $\mathfrak{l}_i$ von k; es ist nämlich das Bestehen der Beziehung $Z_i(\mu,\ \nu)=1$ das Criterium dafür, dass ν ein Normenrest des Körpers K nach dem Modul $\mathfrak{l}_i^{v_i+1}$ ist, wo v_i in Bezug auf $\mathfrak{l}_i$ die in Satz 3 erklärte Bedeutung hat. Einfachheitshalber wollen wir zuvörderst einen Teil dieser Behauptung als einen besonderen Satz formuliren, der wie folgt lautet.

Satz. 16. *Wenn die Relativdiscriminante des Körpers $K=k(\sqrt[l]{\mu})$ prim zu $\mathfrak{l}$ ist, dann ist für jede zu μ und zu l prime Zahl ν von k*

$$Z(\mu,\ \nu)=1\,;$$

wenn dagegen $\mathfrak{l}$ in die Relativdiscriminante von K aufgeht, und wenn

$$\nu \equiv \xi^l \pmod{\mathfrak{l}^{v+1}}$$

in k, dann ist

$$Z(\mu,\ \nu)=1,$$

oder allgemeiner, wenn

$$\nu' \equiv \nu\xi^l \pmod{\mathfrak{l}^{v+1}},$$

dann ist

$$Z(\mu,\ \nu)=Z(\mu,\ \nu').$$

Hierbei haben $\mathfrak{l}$, Z, v die bisherige Bedeutung von $\mathfrak{l}_i$, Z_i, v_i; die Indices sind einfachheitshalber weggelassen worden.

Beweis. Die dem Primideal $\mathfrak{l}=\mathfrak{l}_i$ entsprechende Zahl μ_i wollen wir einfach mit μ, und demgemäss $Z(\mu, \nu)=(\mu_i, \nu)$ mit (μ, ν) bezeichnen. Der erste Teil des Satzes ist evident, weil für denselben μ primär ausfällt. Wir nehmen daher an, dass $\mathfrak{l}$ in die Relativdiscriminante von $K=k(\sqrt[l]{\mu})$ aufgeht, und zwar zunächst dass $\mu=\mathfrak{l}^a\mathfrak{m}$, wo $\mathfrak{m}$ zu $\mathfrak{l}$ prim und $a \not\equiv 0 \pmod{l}$, sodass $v=\sigma l$ ausfällt (19). Ferner sei, wie vorausgesetzt

$$\nu' \equiv \nu\xi^l \pmod{\mathfrak{l}^{\sigma l+1}}, \tag{1}$$

Wir appelliren an den Satz der Existenz unendlichvieler Primideale in jeder Classe von k nach einem beliebigen Modul (Satz 2). Es sei demnach (ρ) ein Primideal von k von der Art, dass

$$\rho \equiv 1 \pmod{\mathfrak{l}^{\sigma l+1}\mathfrak{m}}, \tag{2}$$

$$\nu\rho \equiv \nu' \left(\mathrm{mod}\ \frac{L}{\mathfrak{l}^{\sigma l}}\right). \tag{3}$$

Da die Relativdiscriminante von K ausser der in $\mathfrak{m}$ aufgehenden nur noch das Primideal $\mathfrak{l}$ als Factor enthält, so folgt aus (2), dass (ρ) in K zerfallen muss (Satz 4), sodass

$$\left(\frac{\mu}{\rho}\right)=1.$$

Anderseits folgt aus eben derselben Congruenz (2)

$$\left(\frac{\rho}{\mathfrak{m}}\right)=1,$$

folglich ist

$$(\mu, \rho)=1 \tag{4}$$

Es sei nun eine zu μ prime Zahl von k aus der Congruenz

$$\nu\rho\beta \equiv 1 \pmod{\mathfrak{l}L} \tag{5}$$

bestimmt. Dann ist nach (3), (5)

$$\nu'\beta \equiv 1 \left(\mathrm{mod}\ \frac{L}{\mathfrak{l}^{\sigma l}}\right),$$

und nach (1), (2), (5)

$$\nu'\beta \equiv \xi^l \pmod{\mathfrak{l}^{\sigma l+1}}.$$

(19) Vgl. R.A. S. 26–27.

Daher ist

$$\nu'_l\beta \equiv \xi'' \pmod{lL} \qquad (6)$$

in k. Aus (5), (6) erhält man nach Satz 14

$$(\mu, \nu\rho_l\beta)=1,$$

$$(\mu, \nu'_l\beta)=1,$$

woraus mit Rücksicht auf (4) folgt

$$(\mu, \nu)=(\mu, \nu').$$

Wenn μ zu l prim, oder wenn $\mu=\mathfrak{l}^a\mathfrak{m}$, aber a durch l teilbar ist dann ist $v<\sigma l$ (10). Dann ist in (1) der Modul $\mathfrak{l}^{v+1}\,\mathfrak{m}$, und in (5) der Modul L zu setzen, und zuletzt Satz 10 statt Satz 14 heranzuziehen.

Satz 17. *Geht $\mathfrak{l}_i$ zur $(v_i+1)(l-1)$ ten Potenz in die Relativdiscriminante des Körpers $K=k(\sqrt[l]{\mu})$ auf, so ist $Z_i(\mu, \nu)$ dann und nur dann gleich 1, wenn ν Normenrest des Körpers K nach dem Modul $\mathfrak{l}_i^{v_i+1}$ ist.*

Beweis. Wir setzen

$$(\mu)=\mathfrak{m}\prod^{i}\mathfrak{l}_i^{a_i},$$

wo $\mathfrak{m}$ zu l prim ist, und führen den Beweis für $\mathfrak{l}_i=\mathfrak{l}_1$. Es sei zunächst ν Normenrest des Körpers K nach $\mathfrak{l}_1^{v_1+1}$. Wir bestimmen dann ein Primideal (ρ) von k von der Art, dass

$$\left.\begin{aligned} \rho &\equiv \nu \left(\mathrm{mod}\ \mathfrak{l}_1^{v_1+1}\right), && (7)\\ &\equiv 1 \left(\mathrm{mod}\ \mathfrak{m}\,\mathfrak{l}_2^{v_2+1}\cdots\mathfrak{l}_z^{v_z+1}\right). && (8) \end{aligned}\right\}$$

Ist $\mathfrak{f}^{l-1}$ die Relativdiscriminante des Körpers K, dann ist nach (7), (8) ρ Normenrest des Körpers K nach $\mathfrak{f}$, infolgedessen (ρ) in K zerfällt (Satz 4), sodass

$$\left(\frac{\mu}{\rho}\right)=1.$$

Da anderseits nach (8)

$$\left(\frac{\rho}{\mathfrak{m}}\right)=1,$$

so folgt

$$(\mu, \rho)=1. \qquad (9)$$

Nach Satz 16 ist aber in Rücksicht auf (8)

$$Z_2(\mu, \rho) = \cdots = Z_z(\mu, \rho) = 1,$$

sodass nach (9)

$$Z_1(\mu, \rho) = 1,$$

(vgl. Satz 15). Aus (7) folgt daher nach Satz 16

$$Z_1(\mu, \nu) = 1.$$

Es bleibt übrig, nachzuweisen, dass wenn ν Normennichtrest nach $\mathfrak{l}_1^{v_1+1}$ ist, notwendig $Z_1(\mu, \nu) \neq 1$ ausfallen muss. Wenn $\mathfrak{l}_1$ nicht in die Relativdiscriminante von K aufgeht, dann ist nach Satz 16 $Z_1(\mu, \nu) = 1$ für jedes zu μ primes ν; in diesem Falle ist aber auch jede zu $\mathfrak{l}_1$ prime Zahl von k Normenrest nach $\mathfrak{l}_1$ (R. A., S. 28). Wenn dagegen $\mathfrak{l}_1$ in die Relativdiscriminante von K aufgeht, dann ist genau der l-te Teil von den zu $\mathfrak{l}_1$ primen Zahlclassen mod $\mathfrak{l}_1^{v_1+1}$ Normenrest von K nach $\mathfrak{l}_1^{v_1+1}$. Nach dem oben bewiesenen, genügt es daher nachzuweisen, dass $Z_1(\mu, \nu)$ nicht für jedes zu $\mathfrak{l}_1$ primes ν gleich 1 ausfallen kann. Dies folgt aber schon daraus, dass $\mathfrak{l}_1$ ein Factor des *Führers* $\mathfrak{f}$ der Classengruppe ist, welche dem Körper K zugeordnet ist, wenn man beachtet, dass nach Satz 16 der Wert des Symbols $Z_i(\mu, \nu)$ nur von der Zahlclassen mod $\mathfrak{l}_i^{v_i+1}$ abhängt, welcher die Zahl ν angehört. Wäre nämlich $Z_1(\mu, \nu) = 1$ für jedes ν so folgte

$$\left(\frac{\mu}{\nu}\right) = \left(\frac{\nu}{\mathfrak{m}}\right) Z_2(\mu, \nu) \cdots Z_z(\mu, \nu),$$

das heisse aber dass die gesagte Classengruppe nach dem Modul $\mathfrak{m}\,\mathfrak{l}_2^{v_2+1} \cdots \mathfrak{l}_z^{v_z+1}$ definirt werden könnte, was ausgeschlossen ist.

Als eine Anwendung des vorhergehenden Satzes wollen wir noch einen Satz beweisen, welcher eine Verallgemeinerung des Eisenstein'schen Reciprocitätsgesetzes ist.

Satz 18. *Ist a eine nicht durch l teilbare rationale Zahl, ν eine zu a und zu l prime Zahl von k, für welche*

$$\nu \equiv r \left(\operatorname{mod} \prod_i \mathfrak{l}_i^{n_i}\right), \quad n_i > \sigma_i, \ (i = 1, 2, \cdots z)$$

wo r eine rationale Zahl bedeutet, dann ist $(a, \nu) = 1$.

Beweis. Für den Oberkörper $K=k(\sqrt[l]{a})$ fällt $v_i \leqq \sigma_i$ aus, oder es ist a primär in Bezug auf $\mathfrak{l}_i$ (19). Da anderseits nach Voraussetzung

$$\nu \equiv r^l \left(\bmod\ \mathfrak{l}_i^{\sigma_i+1}\right),$$

weil $r^l \equiv r \left(\bmod\ \mathfrak{l}_i^{s_i}\right)$ und $s_i > \sigma_i$, so ist nach Satz 16

$$Z_i(a, \nu)=1, \quad (i=1, 2, \cdots z)$$

woraus nach Satz 15 die zu beweisende Gleichung folgt.

Dieser Satz ist ein Specialfall eines allgemeineren Satzes, der auf genau derselben Weise zu beweisen ist:

Satz 19. *Wenn μ, ν zu einander und zu l prim sind, und wenn in k*

$$\mu \equiv \alpha^l \left(\bmod\ \prod^i \mathfrak{l}_i^{m_i}\right),$$

$$\nu \equiv \beta^l \left(\bmod\ \prod^i \mathfrak{l}_i^{n_i}\right),$$

wo

$$m_i + n_i > \sigma_i l, \quad (i=1, 2, \cdots z)$$

dann gilt die Relation :

$$(\mu, \nu)=1.$$

Das Ergebnis der bisherigen Betrachtungen fassen wir kurz wie folgt zusammen:

Es sei μ eine beliebige Zahl von k,

$$(\mu)=\mathfrak{m} \prod^i \mathfrak{l}_i^{a_i} \quad (a_i \geqq 0, i=1, 2, \cdots z)$$

wo $\mathfrak{l}_i$ die Primfactoren von l, und $\mathfrak{m}$ ein zu l primes Ideal von k ist; ferner seien $\mathfrak{i}_1, \mathfrak{i}_2, \cdots \mathfrak{i}_h$ als ein System der Repräsentanten der Basisclassen von k prim zu μ und zu l angenommen. Wenn dann $\mathfrak{r}$ ein beliebiges zu μ und zu l primes Ideal von k ist, und

$$(\rho)=\mathfrak{r}\mathfrak{i}_1^{e_1}\mathfrak{i}_2^{e_2} \cdots \mathfrak{i}_h^{e_h}\mathfrak{j}^l, \quad (0 \leqq e < l)$$

wo $\mathfrak{j}$ ein Ideal, ρ eine Zahl von k ist, beides prim zu μ und l angenommen, dann ist

$$\left(\frac{\mu}{\mathfrak{r}}\right)=\left(\frac{\mu}{\mathfrak{i}_1}\right)^{-e_1} \cdots \left(\frac{\mu}{\mathfrak{i}_h}\right)^{-e_h}\left(\frac{\rho}{\mathfrak{m}}\right)Z_1(\mu, \rho) \cdots Z_z(\mu, \rho).$$

Das heisst: der Wert des Symbols $\left(\frac{\mu}{\mathfrak{r}}\right)$ *hängt nur von der Idealclasse nach dem Modul* $\mathfrak{f}$ *ab, welcher das Ideal* $\mathfrak{r}$ *angehört, wo* $\mathfrak{f}^{l-1}$ *die Relativdiscriminante des Körpers* $K=k\sqrt[l]{\mu}$ *ist.* Hierin erblicken wir den wesentlichen Inhalt des Reciprocitätsgesetzes.

§ 11.

Das Hilbert sche Normenrestsymbol.

Wir erinnern an die Definition des *Hilbert'schen Symols*

$$\left(\frac{\nu,\mu}{\mathfrak{w}}\right),$$

wo μ, ν zwei beliebige von 0 verschiedene ganze Zahlen und $\mathfrak{w}$ ein beliebiges Primideal des Körpers k ist.

Es sei zunächst $\mathfrak{w}$ ein zu l primes Primideal. Wenn dann μ genau durch $\mathfrak{w}^a$, ν genau durch $\mathfrak{w}^b$ teilbar $(a, b \geqq 0)$, dann kann man die Zahl

$$\varkappa=\frac{\nu^a}{\mu^b}=\frac{\rho}{\sigma}$$

in einer zu $\mathfrak{w}$ teilerfremden Bruchform darstellen. Alsdann soll

$$\left(\frac{\nu,\mu}{\mathfrak{w}}\right)=\left(\frac{\varkappa}{\mathfrak{w}}\right)=\left(\frac{\rho}{\mathfrak{w}}\right)\left(\frac{\sigma}{\mathfrak{w}}\right)^{-1}$$

gesetzt werden [20].

Sodann sei $\mathfrak{w}=\mathfrak{l}_i$ ein Primfactor von l. Wenn dann

$$\begin{aligned} \mu &= \mathfrak{m} \prod^{i} \mathfrak{l}_i^{a_i}, \quad a_i \geqq 0, \\ \nu &= \mathfrak{n} \prod^{i} \mathfrak{l}_i^{b_i}, \quad b_i \geqq 0, \end{aligned} \qquad (i=1, 2, \cdots z)$$

wo $\mathfrak{m}$ und $\mathfrak{n}$ zu l prim sind, so sei die Zahl μ_i durch die folgenden Congruenzen definirt:

$$\mu_i \equiv \mu \left(\text{mod } \mathfrak{l}_i^{\sigma_i l+1+a_i}\right),$$

$$\equiv 1 \left(\text{mod } \frac{\overline{L}}{\mathfrak{l}_i^{\sigma_i l+1}}\right).$$

(20) Hilbert, *Bericht*, S. 411.

Es ist alsdann

$$\left(\frac{\nu,\mu}{\mathfrak{l}_i}\right)=\Pi'\left(\frac{\nu,\mu_i}{\mathfrak{w}}\right),$$

wo das Product Π' über alle (in μ_i oder in ν aufgehenden) zu l primen Primideale von k zu erstrecken ist ([21]).

Mit Hülfe dieser Symbole kann man das Reciprocitätsgestz in der folgenden sehr eleganten Form darstellen:

$$\Pi\left(\frac{\nu,\mu}{\mathfrak{w}}\right)=1,$$

wo das Product über die sämtlichen (in μ, in ν oder in l aufgehenden) Primideale von k zu erstrecken ist.

Wenn ν zu μ und zu l prim ist, dann reducirt sich diese Formel auf unsere Gleichung (9) in § 9.

Die characteristische Eigenschaft des Symbols $\left(\frac{\nu,\mu}{\mathfrak{w}}\right)$ *besteht darin, dass das Symbol dann und nur dann den Wert 1 hat, wenn* ν *Normenrest des Körpers* $K=k(\sqrt[l]{\mu})$ *nach jeder beliebigen Potenz von* $\mathfrak{w}$ *ist.*

Hiefür wollen wir noch kurz den Beweis führen für den Fall, wo $\mathfrak{w}=\mathfrak{l}_1$. Hierbei genügt es, den ersten Teil der Behauptung zu beweisen; der zweite Teil, die Umkehrung der ersten, folgt dann wie bei Satz 17.

Es sei also ν Normenrest des Körpers $K=k(\sqrt[l]{\mu})$ nach Potenzen von $\mathfrak{l}_1$, und zwar zunächst

$$\nu=\mathfrak{l}_1^{b_1}\mathfrak{n}, \tag{1}$$

wo $\mathfrak{n}$ prim zu l ist. Wenn $\mathfrak{l}_1$ in K zerfällt, dann gibt es in k eine Zahl λ, welche Relativnorm einer ganzen Zahl von K, und genau durch die erste Potenz von $\mathfrak{l}_1$ teilbar ist, doch so, dass, wenn

$$\lambda=\mathfrak{l}_1\mathfrak{a} \tag{2}$$

gesetzt wird, $\mathfrak{a}$ prim zu μ und $\mu_i (i=1,2,\cdots z)$ ausfällt. Wenn aber $\mathfrak{l}_1$ in K prim bleibt, dann soll

$$\lambda=\mathfrak{l}_1^{l}\mathfrak{a} \tag{2*}$$

(21) Hilbert, Math. Annalen, **51**. S. 108.

genau durch die l-te Potenz von $\mathfrak{l}_1$ teilbar, im übrigen aber genau ebenso beschaffen sein, wie im ersten Falle. In desem zweiten Falle ist nun der Exponent b_1 der höchsten in ν aufgehenden Potenz von $\mathfrak{l}_1$ in (1) notwendig durch l teilbar, sodass wir denselben durch $b_1 l$ ersetzen wollen.

In beiden Fällen kann man daher eine zu μ_1 und zu l prime Zahl ρ aus der Congruenz bestimmen:

$$\lambda^{b_1}\rho \equiv \nu \left(\text{mod } \mathfrak{l}_1^{\sigma_1 l+1+b_1}\right), \qquad (3)$$

sodass ρ Normenrest von K nach $\mathfrak{l}_1$ wird. Infolgedessen ist nach Satz 17

$$Z_1(\mu,\rho) = \left(\frac{\rho,\,\mu}{\mathfrak{l}_1}\right) = 1.$$

Anderseits folgt aus dieser Congruenz, wie leicht mit Hülfe von Satz 16 nachzuweisen ist,

$$\left(\frac{\nu,\,\mu}{\mathfrak{l}_1}\right) = \left(\frac{\lambda^{b_1}\rho,\,\mu}{\mathfrak{l}_1}\right) \qquad (4)$$

$$= \left(\frac{\lambda,\,\mu}{\mathfrak{l}_1}\right)^{b_1}\left(\frac{\rho,\,\mu}{\mathfrak{l}_1}\right) = \left(\frac{\lambda,\,\mu}{\mathfrak{l}_1}\right)^{b_1}.$$

Daher bleibt nur übrig nachzuweisen, dass

$$\left(\frac{\lambda,\,\mu}{\mathfrak{l}_1}\right) = 1.$$

Nun folgt nach Annahme

$$\left(\frac{\mu}{\mathfrak{a}}\right) = 1, \quad \left(\frac{\lambda}{\mathfrak{m}}\right) = 1,$$

also

$$1 = \left(\frac{\mu}{\mathfrak{a}}\right)\left(\frac{\lambda}{\mathfrak{m}}\right)^{-1} = \Pi\left(\frac{\lambda,\,\mu}{\mathfrak{l}_i}\right), \quad (i=1,\,2,\,\ldots\,z) \qquad (5)$$

wo

$$\left(\frac{\lambda,\,\mu}{\mathfrak{l}}\right) = \left(\frac{\mu_i}{\mathfrak{a}}\right)\left(\frac{\lambda}{\mathfrak{m}_i}\right)^{-1},$$

$$\mu_i = \mathfrak{l}_i^{a_i}\,\mathfrak{m}_i,$$

und, wie oben festgesetzt, $\mathfrak{m}_i$ prim zu λ ist. Wir bestimmen nun, indem wir $i \neq 1$ annehmen, eine zu l prime Zahl α in k gemäss den Congruenzen:

$$\left.\begin{aligned} \alpha &\equiv 0 \pmod{\mathfrak{a}}, \\ &\equiv \lambda \pmod{\mathfrak{l}_i^{\sigma_i l+1}\mathfrak{m}_i}, \end{aligned}\right\} \tag{6}$$

sodass, wenn

$$\alpha = \mathfrak{a}\,\mathfrak{b} \tag{7}$$

gesetzt wird, nach (2) bez. (2*)

$$\mathfrak{b} \sim \mathfrak{l}_1 \text{ bez. } \mathfrak{l}_1^l \pmod{\mathfrak{l}_i^{\sigma_i l+1}\,\mathfrak{m}_i} \tag{8}$$

ausfällt. Da μ_i hyperprimär in Bezug auf $\mathfrak{l}_1$ ist, so zerfällt $\mathfrak{l}_1$ im Körper $k(\sqrt[l]{\mu_i})$, folglich ist nach (8)

$$\left(\frac{\mu_i}{\mathfrak{b}}\right) = 1,$$

daher nach (7)

$$\left(\frac{\mu_i}{\mathfrak{a}}\right) = \left(\frac{\mu_i}{\alpha}\right).$$

Anderseits folgt aus (6):

$$\left(\frac{\lambda}{\mathfrak{m}_i}\right) = \left(\frac{\alpha}{\mathfrak{m}_i}\right).$$

Folglich

$$\begin{aligned} \left(\frac{\lambda,\,\mu}{\mathfrak{l}_i}\right) &= \left(\frac{\mu_i}{\mathfrak{a}}\right)\left(\frac{\lambda}{\mathfrak{m}_i}\right)^{-1} = \left(\frac{\mu_i}{\alpha}\right)\left(\frac{\alpha}{\mathfrak{m}_i}\right)^{-1} = Z_i(\mu,\alpha) \\ &= 1, \quad (i \neq 1) \end{aligned} \tag{9}$$

weil nach (6) α Normenrest des Körpers K nach $\mathfrak{l}^{\sigma_i l+1}$ ist (Satz 17). Aus (5) folgt daher, wie nachzuweisen war,

$$\left(\frac{\lambda,\,\mu}{\mathfrak{l}_1}\right) = 1.$$

Wenn zweitens

$$\nu = \mathfrak{n}/\mathfrak{l}_i^b$$

durch $\mathfrak{l}_i (i \neq 1)$ teilbar ist, dann bestimme man eine genau durch die erste Potenz von $\mathfrak{l}_i$ teilbare, sonst zu μ und zu μ_1 prime Zahl λ_i von k, die der Congruenz:

$$\lambda_i \equiv 1 \left(\operatorname{mod} \mathfrak{l}_1^{\sigma_1 l+1}\right)$$

genügt, sodann eine zu μ_1 und zu l prime Zahl ρ aus der Congruenz

$$\lambda^{b_1} \ldots \lambda_i^{b_i} \ldots \rho \equiv \nu \left(\operatorname{mod} \mathfrak{l}_1^{\sigma_1 l+1+b_1} \ldots \mathfrak{l}_i^{b_i} \ldots\right),$$

die an Stelle von (3) tritt, dann erhält man analog zu (4)

$$\left(\frac{\nu, \mu}{\mathfrak{l}_1}\right) = \left(\frac{\lambda, \mu}{\mathfrak{l}_1}\right)^{b_1} \ldots \left(\frac{\lambda_i, \mu}{\mathfrak{l}_1}\right)^{b_i} \ldots$$

und es ist nunmehr zu zeigen, dass

$$\left(\frac{\lambda_i, \mu}{\mathfrak{l}_1}\right) = 1.$$

Dies ist aber genau die Relation (9), nur haben die beiden Indices 1 und i ihre Rolle miteinander getauscht. Bemerkt sei noch, dass zum Nachweis von (9) nur die Voraussetzung, dass λ Normenrest von K nach $\mathfrak{l}_i^{\sigma_i l+1}$ ist, aber nicht die, dass λ wirkliche Relativnorm einer Zahl von K ist, erforderlich war. Hiermit ist unsere Aufgabe erledigt.

II. Das quadratische Reciprocitätsgesetz.

§ 12.

Das primäre und das hyperprimäre Primideal.

Es sei k ein beliebiger algebraischer Körper vom Grade m. Unter den mit k conjugirten Körpern gebe es r_1 reelle, die wir mit $k_1, k_2 \cdots k_{r_1}$ bezeichnen. Ist also r wie bisher die Anzahl der Grundeinheiten von k, dann ist

$$m + r_1 = 2(r+1).$$

Ferner sei h bez. $h+h'$ der Rang der absoluten Classengruppe im weiteren oder engeren Sinne, wenn alle Idealquadrate zur Hauptclasse gerechnet werden. Es gibt alsdann in k nach Satz 1. $h+h'$ unabhängige singuläre Primärzahlen, darunter h total positive, sodass jede Zahl ε von k, welche eine Einheit oder ein Idealquadrat ist, auf eine und nur auf eine Weise in der Gestalt:

$$\varepsilon = \eta_1^{u_1} \ldots \eta_n^{u_n} \, \omega_1^{v_1} \ldots \omega_h^{v_h} \, \omega_1'^{v_1'} \ldots \omega_{h'}^{v'_{h'}} \, \xi^2 \qquad (1)$$

darstellbar ist, wo die Exponenten u, v, v' die Zahlen 0 oder 1 sind, und ξ eine Zahl von k bedeutet. Hierbei bezeichnen wir mit $\omega_1 \cdots \omega_h$ die total positiven, mit $\omega_1' \cdots \omega'_{h'}$ die nicht total positiven singulären Primärzahlen, und mit $\eta_1, \cdots \eta_n$ die $n=r+1-h'$ nicht primären Einheiten und Idealquadrate, worunter die n_0 ersten total positiv sein mögen, sodass $\eta_1, \eta_2, \cdots \eta_n$ unabhängige quadratische Nichtreste mod 4 sind, und $\eta_{n_0+1}, \cdots \eta_n, \omega_1' \cdots \omega_{h'}'$ unabhängige Vorzeichencombinationen aufweisen. Es ist dann nach § 1. (1)

$$h'=\frac{r_1-(n-n_0)}{2}=n_0-\frac{m-r_1}{2}.$$

Satz 20. *Die h Primideale* [10] $\mathfrak{i}_1, \cdots \mathfrak{i}_h$, *für welche*

$$\left(\frac{\omega_a}{\mathfrak{i}_a}\right)=-1, \quad \left(\frac{\omega_a}{\mathfrak{i}_b}\right)=1, \quad (a \neq b)$$

bilden ein System von Repräsentanten der Basisclassen von k im weiteren Sinne.

Wenn ausserdem für die h' Primideale $\mathfrak{i}'_1, \cdots \mathfrak{i}'_{h'}$

$$\left(\frac{\omega}{\mathfrak{i}'_a}\right)=1, \quad \left(\frac{\omega'_a}{\mathfrak{i}'_a}\right)=-1, \quad \left(\frac{\omega'_a}{\mathfrak{i}'_b}\right)=1, \quad (a \neq b)$$

dann bilden die $h+h'$ Ideale $\mathfrak{i}, \mathfrak{i}'$ *zusammen ein Repräsentantensystem der Basisclassen von k im engeren Sinne.*

Beweis. Genau wie bei Satz 7. Man überzeugt sich leicht von der Übereinstimmung der Rangzahlen der Classengruppen im engeren Sinne nach den Moduln $L=(4)$ und $L\mathfrak{i}_1 \cdots \mathfrak{i}_h$, bez. der Rangzahlen im weiteren Sinne nach L und $L\mathfrak{i}_1 \cdots \mathfrak{i}_h \mathfrak{i}'_1 \cdots \mathfrak{i}'_{h'}$. (nach §1, (1)): sodann hat man Satz 27 von R. A. zu Hülfe zu nehmen.

Die Bedingungen $\left(\frac{\omega}{\mathfrak{i}'}\right)=1$ haben, nach dem ersten Teile, zur Folge, dass die Ideale $\mathfrak{i}_a'$ von der Form $\iota_a \mathfrak{j}_a^2$ $(a=1, 2 \cdots h')$ sind, wo ι_a Zahlen von k sind, sodass man als Repräsentanten der Classen $\mathfrak{i}_a'$ durch ι_a ersetzen kann.

Satz 21. *Wenn $\mathfrak{p}$ ein Primideal von der Art ist, dass für die $n+h+h'$ Zahlen in* (1)

$$\left(\frac{\eta}{\mathfrak{p}}\right)=1, \quad \left(\frac{\omega}{\mathfrak{p}}\right)=1, \quad \left(\frac{\omega'}{\mathfrak{p}}\right)=1 \qquad (2)$$

ausfällt, dann gibt es eine total positive primäre Zahl ϖ in k, sodass

$$(\varpi)=\mathfrak{p}\,\mathfrak{j}^2,$$

wo $\mathfrak{j}$ ein Ideal in k bedeutet.

Wenn die Gleichungen (2) *nur für die* n_0+h *total positiven Zahlen* $\chi_1 \cdots \chi_{n_0}$, $\omega_1 \cdots \omega_h$ *gelten, dann wird* ϖ *noch primär sein, aber nicht mehr total positiv* ([14]).

Beweis. Genau wie bei Satz 8.

Ferner sei wie früher

$$\bar{L} = \overset{i}{\Pi} \mathfrak{l}_i^{2s_i+1} \quad (i=1,\ 2,\ \cdots z)$$

gesetzt, wobei $(2) = \overset{i}{\Pi} \mathfrak{l}_i^{s_i}$ die Primfactorzerlegung von der Zahl 2 in k ist. Unter den Zahlensystemen:

$$\omega_1^{u_1} \cdots \omega_h^{u_h},$$

bez.

$$\omega_1^{u_1} \cdots \omega_h^{u_h}\ \omega'^{u'_1}_1 \cdots \omega'^{u'_{h'}}_{h'},$$

wo die Exponenten u, u' die Werte 0, 1 haben, gebe es $2^{h-\nu}$ bez. $2^{h-\nu+h'-\nu'}$ hyperprimäre Zahlen, sodass die Zahlensysteme bez. ν und $\nu+\nu'$ unabhängige quadratische Nichtreste nach dem Modul $\bar{L}$ aufweisen.

Der Rang der Classengruppe von k nach dem Modul $\bar{L}$ ist dann im weiteren Sinne

$$[\bar{L}] = h + n_0 + z_0 = [L] + z_0,$$

im engeren Sinne:

$$[\bar{L}^+] = h + r + 1 + z_0 + \nu' = [L^+] + z_0 + \nu',$$

wo

$$z_0 = z - (\nu + \nu')$$

und $[L]$, $[L^+]$ die entsprechenden Rangzahlen für den Modul $L=(4)$ bedeuten. Daher gibt es $z_0+\nu'$ Zahlen

$$\lambda_1,\ \lambda_2,\ \cdots\ \lambda_{z_0+\nu'}, \tag{3}$$

worunter die z_0 ersten total positiv sind, welche ausser durch die Idealquadrate nur durch die in 2 aufgehenden Primideale teilbar, und von der in § 5 erklärten Beschaffenheit sind.

Nunmehr stellen wir einen Satz 9 analogen Satz auf, welcher in ähnlicher Weise wie jener zu beweisen ist.

Satz 22. *Wenn* $\mathfrak{p}$ *ein Primideal von der Art ist, dass für die* $n+h+h'$ *Zahlen in* (1) *und die* $z_0+\nu'$ *Zahlen in* (3)

$$\left(\frac{\eta}{\mathfrak{p}}\right)=1,\ \left(\frac{\omega}{\mathfrak{p}}\right)=1,\ \left(\frac{\omega'}{\mathfrak{p}}\right)=1,\ \left(\frac{\lambda}{\mathfrak{p}}\right)=1 \qquad (4)$$

ausfällt, dann gibt es eine total positive hyperprimäre Zahl ϖ von der Art, dass

$$(\varpi)=\mathfrak{p}\,\mathfrak{j}^2.$$

Wenn die Gleichungen (4) *nur für die n_0+h+z_0 total positiven Zahlen in* (1) *und* (3) *gelten, dann wird ϖ wohl hyperprimär, aber nicht mehr total positiv sein* ([14]).

§ 13.

Das quadratische Reciprocitätsgesetz zwischen einer primären und einer beliebigen ungeraden Zahl.

Das quadratische Reciprocitätsgesetz ist im Wesentlichen in Satz 4 enthalten. Wir wollen uns daher kurz fassen und beginnen mit einem Satz 10 analogen Satz, der sich ohne Umstände erledigen lässt.

Satz 23. *Wenn μ primär und ν prim zu μ und zu 2 ist, dann besteht die Gleichung:*

$$\left(\frac{\mu}{\nu}\right)\left(\frac{\nu}{\mu}\right)=\prod^{i}\mathrm{Sg}_i(\mu,\nu), \quad (i=1,\ 2,\ \cdots\ r_1)$$

wo $\mathrm{Sg}_i(\mu,\nu)=1$, wenn wenigstens eine der beiden mit μ und ν conjugirten Zahlen in dem reellen Körper k_i positiv ist, dagegen $\mathrm{Sg}_i(\mu,\nu)=-1$, wenn jene Zahlen beide negativ sind.

Beweis. Es sei

$$(\mu)=\mathfrak{p}_1\cdots\mathfrak{p}_e\mathfrak{j}^2,$$

wo $\mathfrak{p}_1,\cdots\mathfrak{p}_e$ die von einander verschiedenen in μ aufgehenden Primideale und $\mathfrak{j}$ ein gewisses Ideal von k ist. Ferner seien $\mathfrak{i}_1,\cdots\mathfrak{i}_h$ ein System der Repräsentanten der Basisclassen von k, welches gegen μ normirt ist, $\mathfrak{r}$ ein zu μ und zu 2 primes Primideal und

$$(\rho)=\mathfrak{r}\,[\mathfrak{i}],$$

wo ρ eine Zahl von k, die ebenfalls prim zu μ und zu 2 angenommen wird.

Da μ primär ist, so ist die Relativdiscriminante von $K=k(\sqrt{\mu})$ gleich $\mathfrak{f}=\mathfrak{p}_1\cdots\mathfrak{p}_e$. Wir führen nun den Beweis in drei Schritten.

1. Es sei zunächst μ total positiv. Dann ist die dem Körper K zugeordnete Classengruppe von k eine solche, welche ohne Vorzeichenbedingung nach dem Modul $\mathfrak{f}$ definirt werden kann [22]. Nach Satz 4 gibt es daher einen Character $\chi(\mathfrak{r})$ von der Form

$$\chi(\mathfrak{r})=\left(\frac{\rho}{\mathfrak{p}_1}\right)^{v_1}\cdots\left(\frac{\rho}{\mathfrak{p}_e}\right)^{v_e}, \quad (v=0,\ 1)$$

derart, dass für das Primideal $\mathfrak{r}$

$$\left(\frac{\mu}{\mathfrak{r}}\right)=\chi(\mathfrak{r}).$$

Da aber $\mathfrak{f}$ der Führer der Classengruppe ist, so folgt, dass keiner der Exponenten $v_1, \cdots v_e$ verschwinden kann, so-dass

$$\left(\frac{\mu}{\mathfrak{r}}\right)=\left(\frac{\mu}{\rho}\right)=\left(\frac{\rho}{\mu}\right).$$

Dass nunmehr für jede zu μ und zu 2 prime Zahl ν die Gleichheit gilt:

$$\left(\frac{\mu}{\nu}\right)=\left(\frac{\nu}{\mu}\right),$$

beweist man genau wie bei Hülfssatz 5 von § 6.

2. Es sei nun μ nicht total positiv und zwar fürs erste möge μ nur eine einzige negative conjugirte in k_1 besitzen. Dann ist zur Characterisirung der entsprechenden Classengruppe die Vorzeichenbedingung unentbehrlich [22]. Aus dieser Tatsache folgert man wie oben die Richtigkeit der Gleichung

$$\left(\frac{\mu}{\nu}\right)\left(\frac{\nu}{\mu}\right)=\mathrm{Sg}_1(\mu,\nu),$$

da hier $\mathrm{Sg}_i(\mu,\nu)=1\,(i=2, 3, \cdots r_1)$.

3. Wenn allgemein die Conjugirten von μ in den t reellen Körpern $k_1, \cdots k_t$ negativ sind, dann bestimmen wir entsprechend t primäre Zahlen $\mu_1, \cdots \mu_t$ in k die bez. nur in einem jener t Körpern negative Conjugirten aufweisen, und die sämtlich zu ν prim sind. Da dann $\mu\,\mu_1 \cdots \mu_t$ primär und total positiv sind, so ist nach 1

$$\left(\frac{\mu\,\mu_1\cdots\mu_t}{\nu}\right)=\left(\frac{\nu}{\mu\,\mu_1\cdots\mu_t}\right),$$

(22) R.A., S. 84.

woraus mit Rücksicht auf 2.

$$\left(\frac{\mu}{\nu}\right)\left(\frac{\nu}{\mu}\right)=\overset{i}{\Pi}\,\mathrm{Sg}_i(\mu_i,\nu). \quad (i=1,\ 2,\ \cdots t)$$

Also, da $\mathrm{Sg}_i(\mu_i\,\nu)=\mathrm{Sg}_i(\mu,\nu)$ für $i=1,2,\cdots t$, und $\mathrm{Sg}_i(\mu,\nu)=1$, für $i=t+1,\cdots r_1$,

$$\left(\frac{\mu}{\nu}\right)\left(\frac{\nu}{\mu}\right)=\overset{i}{\Pi}\,\mathrm{Sg}_i(\mu,\nu), \quad (i=1,\ 2,\ \cdots r_1)$$

w. z. b. w.

Dieser Beweis gilt offenbar auch dann, wenn $\mu=\omega$ singulär primär ist. Für diese erhält man speciell

$$\left(\frac{\omega}{\nu}\right)=\overset{i}{\Pi}\,\mathrm{Sg}_i(\omega,\nu). \quad (i=1,\ 2,\ \cdots r_1)$$

§ 14

Das allgemeine Reciprocitätsgesetz für die quadratische Reste.

Wenn μ nicht primär oder auch nicht prim zu 2 ist, und

$$(\mu)=\mathfrak{m}\overset{i}{\Pi}\mathfrak{l}_i^{a_i} \quad (a_i\geqq 0\,;\ i=1,2,\ \cdots z)$$

wo $\mathfrak{l}_i$ die Primfactoren von 2, und $\mathfrak{m}$ ein zu 2 primes Ideal von k ist, dann setzen wir wie in § 9

$$(\mu,\nu)=\left(\frac{\mu}{\nu}\right)\left(\frac{\nu}{\mathfrak{m}}\right)$$

worin, wenn μ zu 2 prim ist, $\mathfrak{m}=\mu$ zu setzen ist.

Anderseits bestimmen wir ein System von z *total positiven* Zahlen $\mu_1\cdots\mu_z$ aus den Congruenzen:

$$\left.\begin{aligned}\mu_i&\equiv\mu\left(\mathrm{mod}\ \mathfrak{l}_i^{2s_i+a_i}\right),\\ &\equiv 1\left(\mathrm{mod}\ \frac{4}{\mathfrak{l}_i^{2s_i}}\right),\end{aligned}\right\}\quad (i=1,\ 2,\ \cdots z)$$

wo s_i den Exponenten der höchsten in 2 aufgehenden Potenz von $\mathfrak{l}_i$ bedeutet. Wir definiren dann, wenn ν eine zu 2, μ (und $\mu_1\cdots\mu_z$) prime Zahl von k ist [18], die z Symbole $Z(\mu,\nu)$ durch die Gleichungen

$$Z_i(\mu, \nu)=(\mu_i, \nu). \quad (i=1, 2, \cdots z)$$

Wir können dann das **allgemeine quadratische Reciprocitätsgesetz** wie folgt aussprechen.

Satz 24. *Wenn ν zu μ und zu 2 prim ist, dann besteht die Reciprocitätsgleichung:*

$$(\mu, \nu)=\prod^{i} \mathrm{Sg}_i(\mu, \nu) \prod^{j} Z_j(\mu, \nu). \quad \left(\begin{matrix} i=1, 2, \cdots r_1, \\ j=1, 2, \cdots z \end{matrix}\right)$$

Beweis. Genau wie bei Satz 15, indem Satz 23 zu Hilfe herangezogen wird.

Satz 25. *Es ist $Z_i(\mu, \nu)$ das Normenrestsymbol in Bezug auf den relativ quadratischen Körper $K=k(\sqrt{\mu})$ und das Primideal $\mathfrak{l}_i$: es ist stets $Z_i(\mu, \nu)=1$, wenn $\mathfrak{l}_i$ nicht in die Relativdiscriminante von K aufgeht; wenn aber $\mathfrak{l}_i$ zur v_i+1 ten Potenz in die Relativdiscriminante aufgeht, dann ist $Z_i(\mu, \nu)=1$ oder -1, jenachdem ν Normenrest des Körpers K nach dem Modul $\mathfrak{l}_i^{v_i+1}$ ist oder nicht.*

Beweis. Genau wie bei Satz 17, indem die dort mit ρ bezeichnete Zahl hier total positiv angenommen wird, was ja erlaubt ist (Satz 2).

Unter Beibehaltung der am Ende von § 10 benutzten Bezeichnungen erhält man das Resultat:

$$\left(\frac{\mu}{\mathfrak{r}}\right)=\left(\frac{\rho}{\mathfrak{m}}\right) \left(\frac{\mu}{\mathfrak{i}_\alpha}\right)^{e_\alpha} \prod^{\beta} Z_\beta(\mu, \rho) \prod^{\gamma} \mathrm{Sg}_\gamma(\mu, \rho),$$

$$(\alpha=1, 2, \cdots h; \quad \beta=1, 2, \cdots z; \quad \gamma=1, 2, \cdots r_1)$$

d.h. *der Wert des Symbols $\left(\frac{\mu}{\mathfrak{r}}\right)$ hängt nur von der Classe ab, welcher das Ideal $\mathfrak{r}$ angehört, wenn die Classen von k nach der Relativdiscriminante des Körpers $K=k(\sqrt{\mu})$ als Modul und im engeren Sinne (nach total positiven Zahlen) definirt werden.*

(Abgeschlossen im Juni, 1920.)

Inhaltsübersicht.

Einleitung.

I. Das Reciprocitätsgesetz für die Potenzcharactere eines ungeraden Primzahlgrades.

II. Das quadratische Reciprocitätsgesetz.

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On Some Remarkable Relations between the Yearly Variations of Terrestrial Phenomena and Solar Activities.

By

Torahiko TERADA,

With 17 text figures.

I. Frequency of Earthquakes.

In a previous communication[1], it was shown that the distribution of the barometric pressure in our region is apparently influenced, not only by the total area of faculæ passing the central meridian of the sun's disc, but also by the difference of the areas of those situated on the northern and southern solar hemispheres respectively. On the other hand, the present author has been long since engaged with the investigation of the barometric gradient as one of the important secondary causes determining the seismic frequency and already published some results obtained[2]. If the solar activities affect the barometric condition to a sensible degree, we will not be surprised, if they also would show some correlations with the frequency of occurrence of earthquakes. As a first step for testing this idea, the yearly frequency of earthquakes observed in different Japanese stations, were compared with the areas of sunspots and faculæ for an interval of thirty years, 1886–1916.

1) Japanese Journal of Astronomy and Geophysics, **1** (1922), No. 2; also in Papers dedicated to Prof. H. Nagaoka to commemorate the twenty-fifth anniversary of his professorship.

2) Proc. Tôkyô Phys.-Math. Soc., [1] 5, p. 454. See also H. Nagaoka, *ibid.* **6**, p. 208; K. Hasegawa, *ibid.* **7**, p. 181; Saem. Nakamura, *ibid.* **8**, p. 69; T. Terada and S. Masuzawa, *ibid.* [2] **1**, p. 343.

The latter data were taken from Maunder's paper in the Monthly Notices of the Royal Astronomical Society, Vol. 80, 1920, in which the areas for the both hemispheres are separately tabulated. The seismological data were kindly placed at my disposal by Prof. Okada and Prof. Saem. Nakamura of the Central Meteorological Observatory, for which my best thanks are due. The materials consist of the records of the number of earthquakes observed in the chief meteorological observatories of Japan[1]. The shocks are generally classified into two kinds, i. e. those 'felt' and instrumentally recorded. The 'total' number, therefore, shows often a sudden increase after the introduction of the seismograph. Beside this apparent circumstance, it must be assumed that the said number is affected by many uncontrollable causes apart from the actual variation of the seismic activity. Hence, it was considered most plausible to take the following procedure for studying the actual influences of the secondary cause upon earthquakes.

The successive yearly numbers were plotted as the ordinates on a diagram with the years as abscissæ and the successive points were connected into a broken line or curve. Among the other irregularities presented by the diagram, one may worth special mention, i.e. when a destructive earthquake occurs in a district, the aftershocks are felt often during several years after it. In such case, the small variation of frequency due to the secondary cause may be entirely overlooked, if we pay our attention only to the absolute magnitude of the number. Hence, for the present purpose, the maxima and minima of the curve were determined by comparing each year only with the few neighbouring years. Any year at the top of a convex part, or at the bottom of a concave part of the graph was respectively called a 'maximum' or a 'minimum'. On the slope of frequency curve following a destructive earthquake, it may therefore happen that a 'minimum' is followed by a 'maximum' which is decidedly less in actual magnitude than the former. In short, the maxima and minima were judged by the *second difference* of the frequencies.

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1) Number of the years available varies from 18 to 30 for different stations. For sixteen stations, the observations of thirty years are at hand.

In the following, the 'total' number of the shocks was generally taken, except for a few stations for which the 'felt' ones were only available. In the former case, the number shows discontinuous increase at the introduction of the instrument as already mentioned. This will, however, scarcely affect the general results here concerned, even if we count a false minimum on this account.

After determining the years of maxima and minima for each station, the next procedure was to see if these years were associated with some peculiarities in the distribution of the solar activities upon the two hemispheres. For this purpose, it was considered most suitable to construct a diagram in which the abscissæ x and the ordinates y gave the areas of spot on the northern and the southern hemispheres respectively, N_s and S_s say. Each year is then represented by a point on the diagram with the coordinates $x=N_s$, $y=S_s$. Call this, for simplicity's sake, the *spots-diagram* to distinguish it from a similar one in which the area of faculæ on the two hemispheres, N_f and S_f say, stand for x and y respectively, i.e. the *faculæ-diagram*. Taking a given station, the points for the years corresponding to the maxima and the minima of the seismic frequency are marked with suitable signs, say ○ and × respectively. If there exists any systematic relation between the distribution of the solar activities and the earthquake, we may expect that the points with the same mark would be arranged in a definite portion or portions of the area of this diagram. On carrying out the plotting, it was found that such is actually the case. For a great number of stations the years with minimum frequencies are crowded in a narrow zone lying along the both sides of the straight line $x=y$, bisecting the angle between the axes of coordinates, while the years of maxima are arranged on both sides of the zone. For some other stations, the contrary was the case, the years of maxima being distributed near the line $x=y$.

Since the number of years taken was not great, the points of maxima and minima on the diagram were often too sparsely distributed to enable us to draw the line of demarcation separating the areas of maxima and minima. Hence, it was considered convenient to superpose the spot-diagram upon the faculæ-diagram, by choosing suitable scales of the coordinates such that the ranges of variation on the diagrams were nearly equal for the two diagrams. This was approximately effected by taking the areas of faculæ as equivalent to twice the areas of the spots. On the *spots-faculæ-diagram* thus obtained, the lines of demarcation were drawn separating the areas with ○ and × respectively. Though the results are not quite simple, we may classify the different stations into the following three classes, according to the distribution of the years of maxima and minima, or the situation of the lines of demarcation upon the diagram:

Class I. Frequency is minimum when $|N_s-S_s|$ or $|N_f-S_f|$, or briefly $|N-S|$ is small. The stations belonging to this class are Tainan*[1], Taityû*, Naha, Kagosima, Nagasaki, Kumamoto, Hukuoka, Matuyama, Kôti, Tadotu, Tokusima, Wakayama, Hirosima, Hamada, Okayama, Hikone, Nagoya, Hukui, Kanazawa, Yagi*, Matumoto, Nagano, Kôhu, Utunomiya, Maebasi, Kumagae, Tyôsi, Mito, Mera*, Hukusima, Kanayama, Miyako, Yamagata, Aomori, Hakodate and Nemuro*.

Fig. 1. Hirosima.

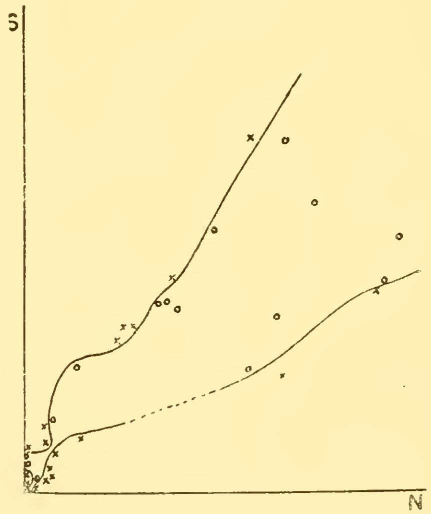

Fig. 2. Simonoseki.

1) The stations marked with * are those for which the 'felt' earthquakes only were taken.

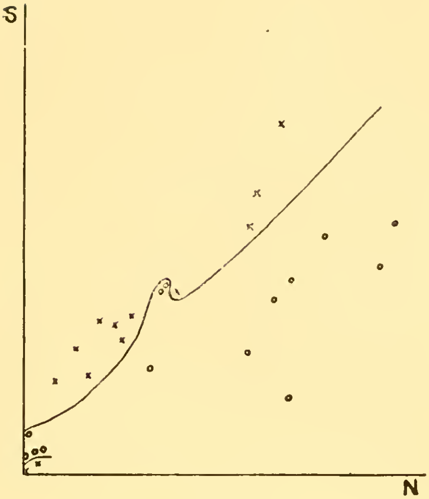

Fig. 3. Kyôto.

Class II. Frequency is maximum when $|N-S|$ is small and minimum when it is large. The stations of this class are Nase, Simonoseki, Ôsaka, Sakai, Niigata, Akita, Sapporo and Kusiro.

Class II′. For not very small value of N and S, the frequency of earthquakes is maximum when $N>S$ and minimum when $N<S$. For small values of $N+S$, the contrary is often the case, or the relation is similar to Class I. The stations of this type are Miyazaki, Ooita, Saga, Kôbe, Kyôto, Tu, Gihu, Husiki*, Hamamatu and Tôkyô.

The most typical examples of these classes are illustrated in figs. 1, 2 and 3.

Taking together all stations belonging to the same class, the number of stations with maximum or minimum of frequency in

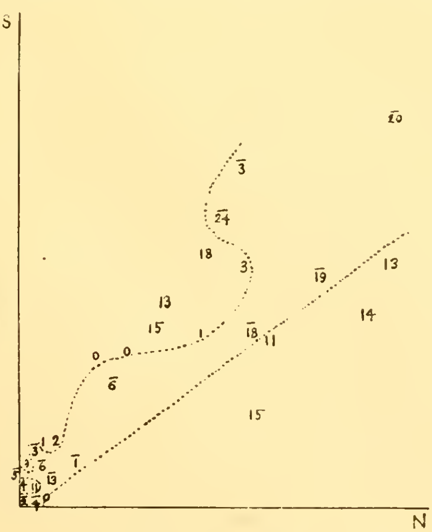

Fig. 4. Class I.

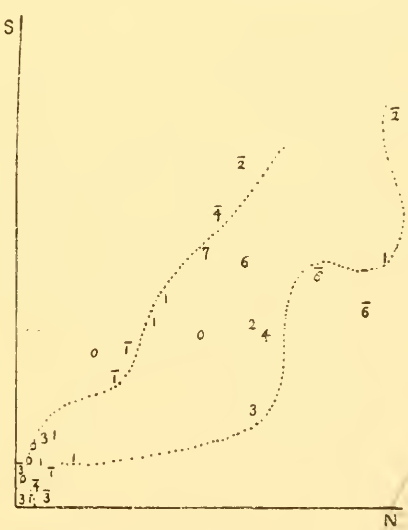

Fig. 5. Class II.

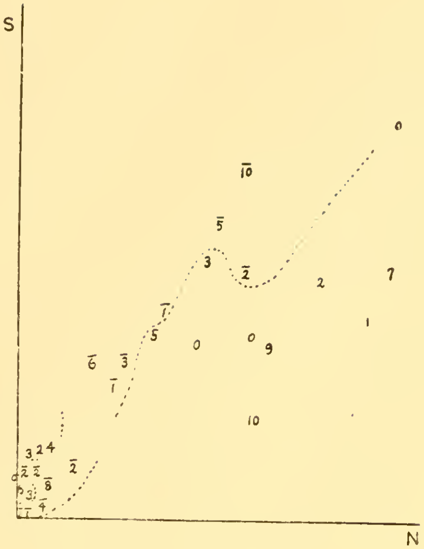

Fig. 6. Class II′.

each year was counted. The difference of the number of the maxima minus that of the minimum was then plotted on figs. 4, 5, 6 which refer to faculae. Similar diagrams referred to spots show quite similar aspects. It was seen that the Class II′ is similar to Class I for the small value of $N+S$ and rather resembles Class II for the large value of it, suggesting that Class II′ is a mixed type of I and II.

On the other hand, the yearly deviations from the mean of the number of stations of each class showing maximum or minimum were treated similarly. For Class I and II, the results are such as could be expected from the above. For Class

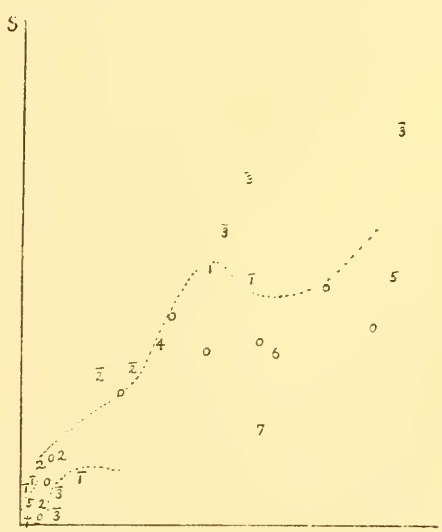

Fig. 7. Number of stations with maximum frequency.

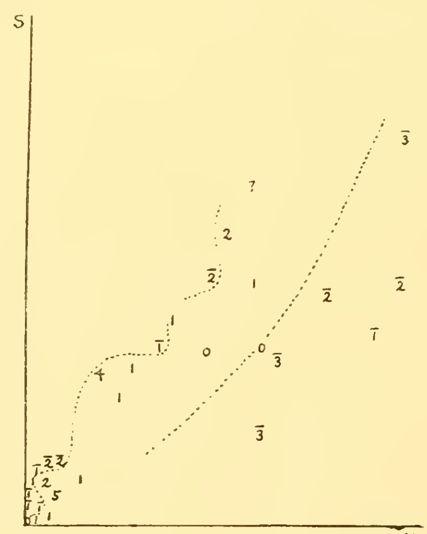

Fig. 8. Number of stations with minimum frequency.

II′, however, it may be remarked (figs. 7 and 8) that the number of minimum is of the type similar to Class I, while the number of maximum shows a distribution proper to Class II, especially for not very large value of $N+S$.

It must be remarked in passing that some stations show anomalous behaviour in changing the class to which they belong, by the choice whether the felt shocks only or the total numbers are taken. For example, Tôkyô belongs to Class II′ for the total frequency, but if the 'felt' only is taken, it belongs to I. Again, Maebasi and Aomori which belong to Class I for the total frequency, are transferred into Class II when the felt earthquakes are taken. It will be seen later that these stations are near the boundary of the areas separating the different classes.

Plotting the stations of different types on a suitable map of Japan (Fig. 9), we see that Class I and II shows a distinct geographical distribution, the latter class decidedly predominating on the Japan Sea coast. The region belonging to Class II′ appears

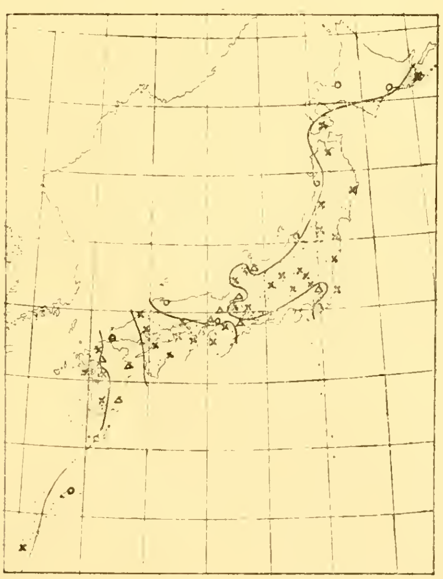

Fig. 9. × : Class I. ○: Class II. △: Class II′.

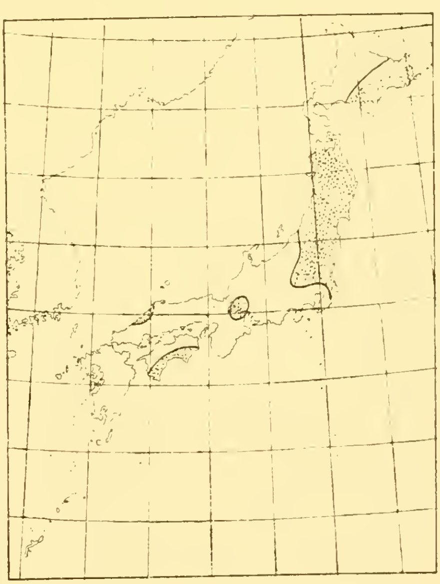

Fig. 10. Area dotted over shows maximum frequency in summer, while the remaining land area shows maxima in winter. (Corea and Manchuria are excluded).

intruding between the areas of Class I, as if it were the branches of the area for II. It may be noticed that the latter branched areas coincide nearly with the tectonic depression of Bungo Channel and a chain of depression formed by the Bay of Ise, Lake Biwa and the Bay of Wakasa.

Prof. Omori[1] has investigated, early in 1902, the seasonal variation of seismic frequency in different stations of Japan and distinguished two groups of districts according to the season in which the frequency is maximum. Those districts in which it is maximum in winter or in summer were called respectively Group A and B. Comparing his map reproduced in fig. 8, with fig. 7, a certain similarity of the distribution may easily be discerned. If in fig. 7, the areas for Class II and II′ be allowed to encroach upon that for Class I in the western and central part of Japan, while it be made to shrink back in northern Japan, the result may become quite similar to fig. 8. If this comparison is legitimate, the conclusions follow: The districts for which the seismic frequency is greater in summer correspond to those for which it is maximum when the 'hemispherical difference' of the solar activity $|N-S|$ is large, while those with the greater frequency in winter are those for which it is maximum when $|N-S|$ is small. If the yearly seismic frequency be chiefly influenced by the distribution of barometric pressure as it seems probable, we may therefore be justified to conjecture that the years with small hemispherical difference would probably correspond to those in which the continental pressure is relatively high and the oceanic one is relatively low, while the years with large difference would be characterized by relatively higher oceanic and lower continental pressure.

Referring to Table IV, B of the previous paper, it may be observed that the small $|n'-s'|$ is generally associated with the gradients with the western side higher. This may be regarded as a partial verification of the above conjecture.

Next, the yearly mean values of barometric pressure for different oriental stations were taken from Walker's memoir[2] and

1) F. Omori, Publications of the Earthq. Inv. Comm. in Foreign Language, No. 8.

2) G. T. Walker: "Sunspots and Pressure," Memoirs of the Indian Met. Dep., **21**, Part 12.

the years of maxima and minima of pressure were plotted on the spots-faculæ diagrams in exactly same manner as described above for the case of the seismic frequency. The result showed a remarkable fact that all stations may be divided into two distinct classes according as the maxima or minima of the pressure are associated with the small hemispherical difference $|N-S|$[1]. Among the stations investigated, Jakutsk, Irkutsk, Nicolaevsk, Ley, Zikawei etc. show maxima, while Tôkyô, Hongkong, Manila, Langoon and all Indian stations show minima of pressure for small $|N-S|$. This remarkable fact harmonizes well with the above conjecture that the small hemispherical difference is associated with the higher continental and lower oceanic pressure.

The above results confirm the undeniable influences of the difference of activities on the two hemispheres of the sun upon the terrestrial weather and at the same time emphasize the importance of the barometric distribution as the actual cause of earthquakes.

On the other hand, the number of earthquakes in Jamaica was taken from Maxwell Hall's paper[2] and plotted on a similar diagram. It was found that this district belongs to Class I, i. e. the maximum frequency is met with in the years with small hemispherical difference of the solar activities. According to Hall, the seasonal distribution of frequency shows a maximum in winter. Hence it may be supposed that the small $|N-S|$ tends to give winterly character to the barometric distribution. According to Berghaus's Meteorological Atlas, the winter gradient in this district is generally greater than the summer one. The yearly pressure at Florida, Texas and Mexico was found to show maxima in the years with small $|N-S|$, while Newcastle in Jamaica shows minima for the same. This relation therefore corroborates the above results for the Japanese earthquakes.

Next, yearly numbers of the earthquakes in different parts of the world which were reported in the 'London Times' and quoted by R. W. Sayles in his note on 'Earthquake and Rainfall,[3] were

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1) The results of these investigations will be given in the next chapter.

2) Maxwell Hall: Earthquakes in Jamaica, from 1688 to 1919.

3) R. W. Sayles, Bull. Seism. Soc. America, **3** (1913).

treated in a similar manner. The diagram obtained seems to belong to Class I. This shows probably that the Class I predominates in the entire seismic zones of the world. This point deserves a more detailed study with respect to sufficient materials.

II. Pressure and Temperature.

In the preceding chapter, I have shown that the yearly frequencies of earthquakes in Japan and Jamaica are closely associated with the absolute value of the difference of the spots or faculae area on the northern and southern solar hemispheres in the corresponding year, which we may call the 'hemispherical difference' and denote by $|N-S|$, or more properly with the quantity $|N-S|/(N+S)$ which we may denote by δ and call the 'specific hemispherical difference'. For the discussion of the results, it became necessary to investigate the similar relation with respect to the yearly mean pressure and temperature in different parts of the world. For this purpose, the most convenient materials near at hand was afforded by Walker's fifth and sixth memoirs on the 'Correlation in Seasonal Variations of Weather', frequently cited in my previous papers. The data given there were adopted without any reduction. Since the solar data available[1] were limited to the epoch 1886–1916, the terrestrial data before 1886 could not be utilized. Besides, the weather data do not extend beyond 1913 so that the epoch here treated refers at most to 1886–1912.[2] For a number of stations the data are missing still further. Notwithstanding the want of homogeneity, the whole data were subjected o the similar treatment, as it seemed most practical for the present preliminary investigation. Besides, the pressure and temperature data of Apia, Samoa, recently published by Angenheister[3] were untilized, since they are valuable in filling up the want of stations in the Pacific region.

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1) E. W. Maunder: Note on the Distribution of Solar Faculae, Monthly Notices of the Royal Astronomical Society, **80** (1920), p. 728.

2) For Nagasaki and Tôkyô, the pressure and temperature data were available up to 1916.

3) From the abstract given in Meteor. ZS., 1922.

The method of investigation is quite similar to the previous one with regard to the frequency of earthquakes. The years of maximum and mininum pressure or temperature were distinguished according as the year is situated at the top of a convex part or at the bottom of a concave part of the pressure-or temperature-time curve. Next, a diagram was constructed for each station in which the abscissae and the ordinates represent the area of faculae or twice the area of spots upon the northern and southern solar hemisphere respectively. Each point on the diagram representing a year was marked with ○ or × according as the year corresponded to a maximum or minimum of the meteorological element. After superposing the faculae and spots diagrams thus obtained, the lines of demarcation were drawn such that they divide the area of the diagram into definite parts in which the marks ○ or × are grouped.

The results of the above investigations may be summarized as follows:

1) *Pressure.*

In the case of the mean pressure, the results were quite similar as in the case of the earthquake frequency. The different stations could be classified into two distinct classes or types:

Type I. in which the years of maximum pressure marked with ○ are crowded in a narrow strip of area along the line $x=y$ or $N=S$, bisecting the angle between the axes of coordinates. A pair of the lines of demarcation could be drawn which may more or less approximately be represented by two straight lines passing the origin and making certain angles with the bisector, or in other words by two line $x=(1+\varepsilon_1)y$ and $x=(1-\varepsilon_2)y$. Beyond these lines of demarcation, years with the mark × are scattered.

Type II. which is complementary to Type I, the years with minimum pressure, i. e. the points marked with × being distributed between the similar lines of demarcation.

Of course, the above classification refers to the most general features of the diagrams, disregarding many irregularities in detail. The lines of demarcation are indeed generally not straight, but

Fig. 11.

show often marked sinuousity. Still, it is possible in most cases to divide the area of the diagram into three sectors of which the middle one extending along the line $x=y$ is crowded with either ○ or ×.

The distribution of the stations belonging to each class on the earth's surface is shown in Fig. 11. Stations of Types I and II are distinguished by the marks ○ and × respectively. Though the density of the station is small, especially in the southern hemisphere, I have tried to draw a series of lines dividing the entire earth's surface into a number of hypothetical zones alternately belonging to Types I and II. The boundary lines of the zones thus assumed are shown in Fig. 11 with thick lines. It will be noticed that one of the poles of the zones falls somewhere near the northern part of Siberia. It is interesting to observe on the other hand that, if we suppose the distributions of land and water on the earth's surface were to be roughly represented by means of the zonal harmonics of the fourth order, the most suitable solution seems to conform roughly with the division above obtained. This suggests that the relation of the means annual pressure with the solar activity has something to do with the distribution of land and water and arouses the suspicion that the relation may be brought about by the fluctuation of the *heat* radiation of the sun. In order to advance the investigation in this line, it is necessary to consult the following results with respect to the temperature.

2) *Temperature.*

In the case of temperature, the results were generally similar as in the previous cases, but somewhat more complicated such that it was found in some cases difficult to divide the area of the diagram into three sectors by two lines of demarcations with no considerable sinuousity. It seemed more suitable to distinguish four types, instead of two, in the case of temperature:

Type I. in which the years of maximum temperature correspond to the small values of the specific hemispherical difference, $\delta=|N-S|/(N+S)$, in analogy with Type I in the case of pressure.

Type II. in which the years of minimum temperature are

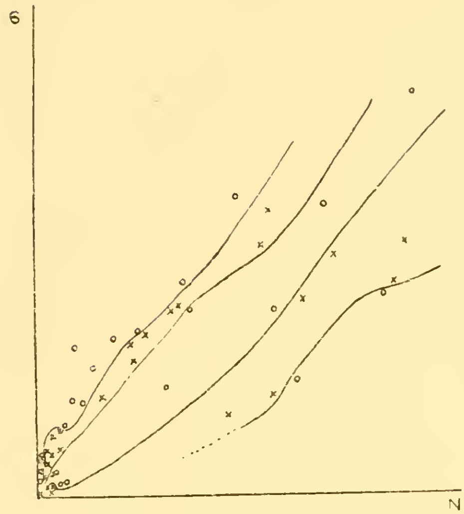

Fig. 12. Leh.

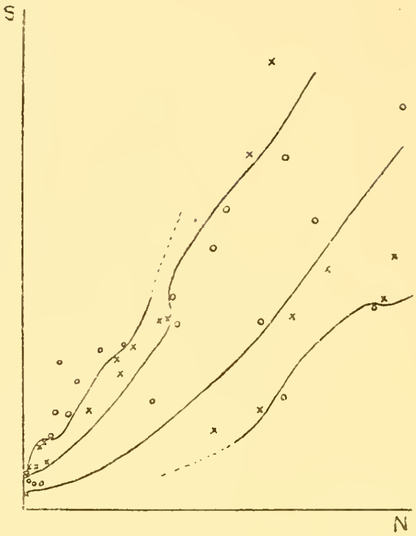

Fig. 13. 25 continental stations.

associated with the small values of δ, in analogy with Type II in the case of pressure.

Fig. 14. Jacobshavn.

Type III. in which the area of the diagram may conveniently be divided into five sectors of which the middle and the outermost sectors contain the years with maximum temperature, or in other words, the maximum of temperature occurs in the years with small or large values of δ and the minimum occurs in those with the intermediate values of this solar quantity.[1] An example of this type is shown in Fig. 12.

Type IV. which is comple-

1) The yearly fluctuations of mean temperature for 17 American, 7 European and 1 Indian stations, given in p. 593 of Humphrey's "Physics of the Air", treated in the similar manner, show a very typical diagram of this Type III (Fig. 13). Since these stations are all continental, it may be said that this type is that characteristic for the land area.

mentary to Type III, the middle and the external sectors being occupied with the years of minimum temperature. An example is given in Fig. 14.

These results led me to revise the pressure diagrams and to examine if a similar quadruple classification is not possible also in that case. It was found that the marked sinuousity of the lines of demarcation could be avoided in some cases if we allow the existence of the four analogous types. On carrying out the revision, it was found however that the new classification affects the zonal distribution of the Map of Fig. 1 in no considerable way, if we take Types III and IV as the general cases of Types I and II respectively, as is quite natural, and denote them by the same mark ○ and × respectively.

3) *Relation between Pressure and Temperature.*

The relation between the pressure types and the temperature types is of the paramount importance for the investigation of the cause of the fact disclosed above. It is especially interesting to see whether high pressures correspond to high or low temperatures. For this purpose, the correspondence of pressure and temperature types was examined for all stations for which the determination of the type was possible for the both elements. Among the eighty seven stations available, fourteen were put aside, as the classification was more or less ambiguous. In forty six[1] among the remaining seventy three stations, I or II pressure type is associated with II or I temperature type respectively, while in twenty seven stations[2] the contrary relation is found. It may be observed that of the latter twenty seven stations, eighteen are those belonging

1) These are: Algier, Alice Spring, Apia, Archangelsk, Astrachan, Bagdad, Bahia, Barbados, Barnaul, Basel, Bermuda, Blumenau, Bombay, Bordeaux, Brisbane, Bushire, Calcutta, Carnarvon, Colombo, Cordoba, Cristiansund, Eniseisk, Helena (Montana), Hongkong, Honolulu, Irkutsk, Jacobshavn, Jakutsk, Lisbon, Lugansk, Madras, Mexico. Moscou, Nikolaevsk, Pelotas, Petrograd, Port Louis, Rio de Janeiro, San Diego, Scutari, Seychelles, Tokyô, Vardö, Victoria B.C., Winnipeg, Zikawei.

2) These are: Adelaide, Aden, Agra, Albany N. Y., Buenos Aires,* Derby, Ekaterinburg*, Galveston*, Greenwich, Hamburg, Keywest*, Ley*, Nagasaki, Ponta Delgada, Punta Arenas*, Rangoon, Recife, Santiago, Stykkisholm, Sydney (Austr.), Sydney N.S., Tashkent*, Tiflis, Valencia, Vienna*, Washington, Zanzibar*.

to the pressure type II and IV, i.e. to the 'water zone', while of the remaining nine stations[1], eight are situated near the boundary of ○ or the 'land zone'.

The above relation suggests that the zonal distribution of the yearly pressure is chiefly determined by the zonal distribution of the atmospheric temperature caused by some unknown mechanism of the solar influence. It is no wonder that the temperature distribution is not so simple as the pressure distribution, since the temperature observed at the surface of the earth are considerably affected by the local factors such as cloudiness, precipitations, the directions of wind etc. which are governed in their turn by the pressure distribution. The fact that the fluctuation of the pressure shows nevertheless a regular distribution seems therefore to indicate that the temperature of the air is affected up to the higher layer by the influence of the sun, in such a manner as to produce the above zonal distribution.

The above way of regarding the relation between the temperature and pressure is interesting inasmuch as it promises to explain in some measure the peculiar correlation often found between the pressure of a certain station with the temperature of another station situated in quite remote part of the earth[2]. If the yearly variations of pressure and temperature are related to the variation of solar activity as considered above, it is quite natural that these elements in different parts of the earth show positive or negative correlation as the case may be. The fact that the actual correlations are by no means so universal and also that remarkable relations are often found between one element in a certain month of a certain station and another element in another month of a distant station, is not surprising, if we consider that numerous local influences are always present tending to drown the general effect of the solar activity. Farther discussions on these lines will

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1) Those marked with * in foot note (2) of the previous page.

2) For example, April and August pressure of Toronto is closely associated with the August temperature at Erimo, Hokkaidō (See T. Okada, Journ. Met. Soc. Jap., **36**, No. 6.) It may be remarked that yearly pressure of Toronto and yearly temperature of Tôkyô belongs to Type III.

however be better postponed till the similar investigations have been made with respect to the *monthly* variations of pressure and temperature.

From the results of the present investigation, we may suggest the followings at least as a kind of working hypothesis:

1) The yearly mean temperature of atmosphere, averaged throughout the entire air column above the surface, represented as a function of the geographical position and of the solar activity, contains a leading term of the form $F(\varphi)D(\delta)$, where F is a periodic function of the angular distance φ from a pole situated somewhere in the northern part of Siberia, and D is also a periodic function of the specific hemispherical difference of solar activity, denoted here by $\delta=|N-S|/(N+S)$. F expanded in terms of zonal harmonics will contain a term of the fourth order as a conspicuous member. D seems to be an even function of δ.

2) The pressure is chiefly determined by the temperature of the entire air column.

3) If $F(\varphi)$ is sheerly determined by the distribution of land and water on the earth's surface, we may regard D as an expression of the solar radiation as a function of δ. This idea harmonizes with the fact that most of those stations in which low pressure corresponds to the low temperature lie in the 'water-zone' while the contrary is the case in the 'land-zone'. It seems that the radiation is minimum for $\delta=0$, increases at first with δ and attains a maximum for a moderate value of that quantity, beyond which it again decreases.

These ideas which seem to be so far plausible for explaining the facts found, may be useful for planning a farther researches. If the above conjecture be confirmed by future studies, the physical interpretation of the function $D(\delta)$ will not fail to form a problem of some significance in the domain of the solar physics in general.

III. Other Meteorological Elements.

After the remarkable relations between the atmospheric pressure and temperature and the solar activity has been disclosed, we will not be surprised if similar relations were found with

Fig. 15.

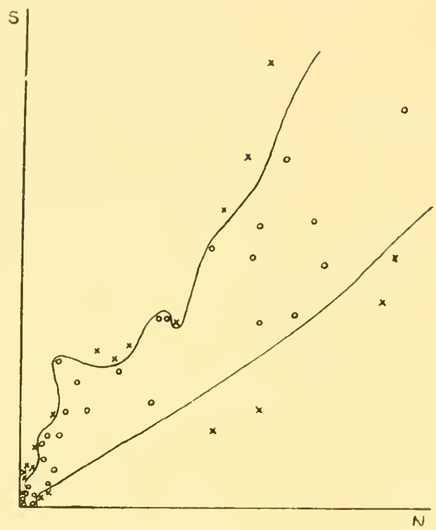

Fig. 16.

respect to widely varying classes of meteorological phenomena. For instances, we may cite the following fragmentary results:

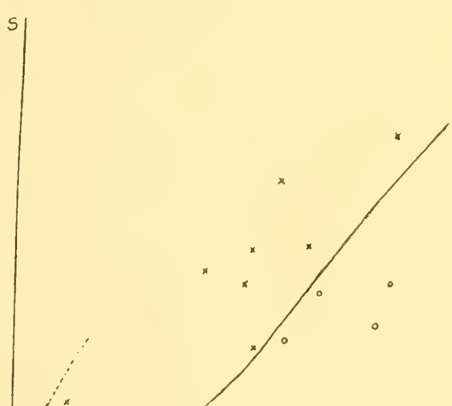

Fig. 17.

Number of typhoons. The number of conspicuous typhoons recorded in the Central Meteorological Observatory of Tôkyô[1] during 1887–1916 was treated similarly. A very conspicuous result was obtained that the maxima of the number occurs when δ is small, except for the years with very small solar activity, $N+S$, in which case the minima seem to prevail (Fig. 15).

Ice in Greenland Sea.

1) The data were kindly placed at my disposal by Mr. K. Saki of the Central Met. Obs., to whom my best thanks are due.

The ice-covered area in the Greenland Sea[1] shows a relation just contrary or complementary to the case of Japanese typhoon.

Rice crops in NE. Japan and Hokkaidô. With these crops[2] the relation is quite similar to the case of the typhoon The dependence upon δ is very simple and conspicuous (Fig. 16).

Wheat crop in Ohio, U. S. A. This crop[3] shows generally minima in the years with small δ, contrary to the case of Japanese rice.

Monsoon rain in India and Nile flood.[4] These shows a similar relation to each other and the division of the area of the spots-faculae diagrams belongs to Type III.

Number of fires due to lightenings, in Prussia. This number[5] is minimum for the years with small δ (Fig. 17).

Frequency of trade wind in Apia, Samoa.[6] This also shows minima for small δ.

The examples may be added still further. It seems probable that most of the periodicities of weather elements with the periods of 3–5 years, hitherto investigated by many meteorologists, are related to the rather irregular fluctuation of the solar quantity δ here called the specific hemispherical difference of activities.

In conclusion, it must be remembered with an emphasis that the years referred to in this paper as corresponding to the maxima or minima of the meteorological element in question were determined sheerly with regard to the convexity or concavity of the small portion of the time curve in the neighbourhood of the very year, so that it may occurs ometimes that the absolute value of a minimum is greater than that of a maximum in other parts of the curve. The irregular fluctuations treated in the present investigation which show so remarkable dependence on the quantity δ are

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1) Met. Zs., 1917, p. 320.

2) The data were taken from Prof. Okada's paper 'On the the possibility of forecasting the approximate yield of rice-crop for northern Japan, Journ. Met. Soc., **36**, No. 11. The epoch here utilized is 1886–1913.

3) From T. A. Blair's paper in Monthly Weather Review, **47** (1919), No. 12.

4) From the abstract given in Met. ZS., 1911.

5) *Ibid.*

6) Angenheister. *loc. cit.*

therefore those short period fluctuations which appear superposed on those variations with 11 years or still longer periods. What seems most remarkable to me is the fact that the correspondence of this short period waves with the variations of δ is so conspicuous that it seems to remove at least a greater part of the difficulties hitherto felt in correlating many terrestrial phenomena with the simple solar cycle of 11 years.

The results of further investigations now in progress will follow in due time.

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On Some Fossil Shells from the Island of Saishū in the Strait of Tsushima.

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With 1 Plate.

Several years ago, Prof. Shintaro Nakamura of the Imperial University of Kyoto, then a geologist of the Geological Survey of Korea, sent me some fossil shells for examination, which he had collected on Saishū, an island at the western entrance of the Tsushima Strait, generally known under the name of Quelpart among Westerners.

The fossil locality is a sea-cliff near the brook flowing at the western end of Seikiho,* a small anchorage on the southern coast of the island. According to a note attached to the fossils, the rock-layers composing the cliff seem to be nearly horizontal and three in number which, counted from below, are as follows:

1. Sand. About 100 feet in thickness and containing some argillaceous layers in the upper part and having two shell-layers, one at about 50 feet, the other at about 60 feet above the level of the sea. The lower layer is 3–6 feet thick and entombs Mollusca, while the upper is somewhat less in thickness and rich in Brachiopoda.
2. Volcanic agglomerate. About 20 feet thick.
3. Trachytic lava. About 60 feet thick and occupying the highest part of the cliff.

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* 濟州島西歸浦

The fossils which I obtained appear to have been collected from both shell-layers, since though they consist mostly of Mollusks there are also some Brachiopods. Besides these two groups of shells, there are also some remains of Echinoids, Cirripedes, Bryozoans and Tubicolous Annelids.

The Mollusca and Brachiopoda which I have been able to determine are the following:

1. Turritella saishuensis n. sp.
2. Natica sp.
3. Dentalium weinkauffi Dkr.
4. Pholas fragilis Sow.
5. Dosinia sp.
6. Meretrix (Callista) chinensis Chem.
7. Saxidomus purpuratus Sow.
8. Cardium sp.
9. Diplodonta semiaspera Phil.
10. Lucina borealis L.
11. Venericardia cipangoana Yok.
12. Venericardia ferruginea Ad.
13. Venericardia nakamurai n. sp.
14. Myodora fluctuosa Gld.
15. Thracia pubescens Pult.
16. Mytilus sp.
17. Anomia lunula Yok.
18. Pecten laqueatus Sow.
19. Pecten laetus Gld.
20. Pecten tokyoensis Tok.
21. Pecten cosibensis Yok.
22. Pectunculus vestitus Dkr.
23. Nucula insignis Gld.
24. Terebratella coreanica Ad.
25. Terebratella? excelsa n. sp.
26. Terebratella? sp.
27. Endesia? sp.

Putting aside the forms not specifically determined there are 21 species of which 6 are not yet known to be living. Of these one-half or 3 are quite new, while the other half has already been found in the Musashino formation near Tokyo. The former are *Turritella saishuensis*, *Venericardia nakamurai* and *Terebratella? excelsa*, and the latter *Anomia lunula*, *Pecten tokyoensis* and *Pecten cosibensis*. The remaining 15 are all recent as well as fossil and found in Japan, save one, *Thracia pubescens*, which was hitherto known only from Europe where it is living and also fossil in the English Crag. The formation in which the other 14 are fossil is the *Musashino* found in the region surrounding Tokyo Bay.

From these considerations I deem the shell-layers of Seikiho as of the *Musashino* Age, that is to say, *Upper Pliocene*.

Description of the Species.

1. ***Turritella saishuensis*** n. sp.

(Pl. I., Fig. 2.).

Shell turrete. Whorls numerous, somewhat convex, weakly angulate a little above the suture, three-ridged. Ridges elevated, more or less sharp on the younger whorls, and flattened on the older; the lowest occupies the angle and is the largest, the middle is nearly as large and in the middle of the whorl, while the upper is the weakest of all and somewhat more distant from the middle one than the middle one is from the lower. There is also a fourth ridge close to the lower suture which, though usually small and inconspicuous, is on the body-whorl nearly as large as the others and forms the angulate periphery. The spaces between the ridges are usually provided with a few unequal spiral striae. Base flattened, with about two spiral ridges near the periphery and diminishing in size toward the caudal end. Spiral striae also present not only between the ridges, but also beyond the last one. Aperture roundly subquadrate. Outer lip thin, sinuous, with a broad and shallow notch below the suture.

There are only a few specimens, all lacking the apex. The entire number of the whorls may be about eighteen. Apical angle about 18°. The largest specimen measures some 56 millimetres in height and 15 millim. in diameter.

This species is not unlike *Turritella trisulcata* Lam. (Tryon's Conchology, vol. 8, pl. 63, fig. 75) living in the Red Sea, in which, however, the arrangement of the three upper ridges is somewhat different.

A form close to this species was found in the Tertiary of Gōtsu, Echigo.

2. ***Natica*** sp.

A single imperfect fragment of a young shell resembling that of *Natica janthostoma* Desh. (Yokoyama, Foss. Miura Penin., pl. v, figs. 3, 4.).

3. ***Dentalium weinkauffi***, DUNKER.

Dentalium weinkauffi. Yokoyama, Foss. Miura Pen., p. 102, pl. VI, figs. 19–21. Foss. Up. Musashino, p. 118, pl. VI, fig. 6.

Only some fragments.

4. ***Pholas fragilis***, SOWERBY.

Pholas fragilis. Yokoyama, Foss. Miura Penin., p. 104, pl. VI, fig. 29. Foss. Up. Musashino, p. 119.

A right valve not quite perfect.

5. ***Dosinia*** sp.

A fragment not quite determinable.

6. ***Meretrix*** (CALLISTA) ***chinensis***, (CHEMNITZ).

Meretrix (*Callista*) *chinensis*. Yokoyama, Foss. Miura Penin., p. 120, pl. VIII, figs. 9, 10. Foss. Upper Musashino, p. 146, pl. XI, fig. 6.

A small imperfect right valve.

7. ***Saxidomus purparatus***, (SOWERBY).

Saxidomus purpuratus. Yokoyama, Foss. Miura Penin., p. 127, pl. IX, fig. 8. Foss. Up. Musashino, p. 153, pl. IX, figs. 4, 5.

Two large specimens, though merely casts.

8. ***Cardium*** sp.

Two casts of a large *Cardium* showing on its surface about eighteen rather weak and distant radiating ribs.

9. ***Diplodonta semiaspera***, (PHILIPPI).

Diplodonta semiaspera. Yokoyama, Foss. Miura Penin., p. 131, pl. X, figs, 2, 3. Foss. Up. Musashino, p. 160, pl. XIV, fig. 2.

An internal cast of a medium-sized shell.

10. ***Lucina borealis***, (LINNÉ).

Lucina borealis. Yokoyama, Foss. Miura Penin., p. 133, pl. X, fig. 7, Foss. Up. Musashino, p. 160.

Only some fragments.

11. ***Venericardia cipangoana***, YOKOYAMA.

Venericardia cipangoana. Yokoyama, Foss. Miura Penin., p. 137, pl. X, fig. 2. Foss. Up. Musashino, p. 162, pl. XIII, fig. 4.

A tolerably large right valve.

12. ***Venericardia ferruginea***, (ADAMS).

(Pl. I., Fig. 6.).

Venericardia ferruginea. Yokoyama, Foss. Miura Penin., p. 139, pl. XI, figs. 3, 4. Foss. Up. Musashino, p. 162.

Two right valves. The one is small and normal in form, the length somewhat exceeding the height. The other (figured) is large and abnormally high, being 18.2 millim. long and 19.5 millim. high, so that it may be provisionally treated as a variety under the name of var. *orbicularis*.

13. ***Venericardia nakamurai***, YOKOYAMA.

(Pl. I., Fig. 9.).

A single right valve.

Shell small, rather thick, compressed, subequilateral. Anterior and posterior margins rounded, both passing without any angle into the broadly arcuate ventral margin; anterior dorsal nearly straight, posterior somewhat excavated. Surface ornamented with ten coarse, flatly rounded, radiating ribs separated by very narrow valleys. Beak pointed. Lunula present, though not very distinct, short. Hinge with an anterior lateral tooth. Height 5.4 millim. Breadth 5 millim. Depth 1.5 millim.

The specimen is worn, but very characteristic in form. It is somewhat like *Venericardia toneana* Yok. (Foss. Up. Musashino, p. 163, pl. XIII, figs. 6, 7.), but it is higher and more pointed, with a less number of ribs.

14. ***Myodora fluctuosa***, GOULD.

Myodora fluctuosa. Yokoyama, Foss. Up. Musashino, p. 170, pl. XIV, figs. 6, 7.

A single right valve.

15. ***Thracia pubescens***, PULTENY.

(Pl. I., Fig. 1.).

Thracia pubescens. Wood, Crag Mollusca, Bivalves III, p. 259, pl. XXVI, fig. 1.

A specimen with both valves preserved, though the left valve is much broken. It is 60 millim. long, 42 millim. high, and about 25 millim. thick, and is almost exactly like that figured by Wood in his Crag Mollusca above cited. Hanley and Forbes describes the ventral margin as somewhat retuse on the posterior side (British Moll,, I. p. 226). But it is uniformly convex as in the Crag specimen. The posterior end of ours is a little fractured.

This species is still living in the British seas as well as in the Mediterranean, but up to this time, it has never been found living in the seas around Japan.

16. ***Mytilus*** sp.

A cast of a right valve looking somewhat like that of *Mytilus grayanus* Dkr. living in our seas.

17. ***Anomia lunula***, YOKOYAMA.

Anomia lunula. Yokoyama, Foss. Up. Musashino. p. 177, pl. XIV, figs. 22, 23.

A single flat valve.

18. *Pecten laqueatus*, SOWERBY.

Pecten laqueatus. Yokoyama, Foss. Miura Penin., p. 160, pl. XIV, figs. 9, 10. Foss, Up. Musashino, p. 183.

A single flat or left valve.

19. *Pecten lætus*, GOULDS.

Pecten laetus. Yokoyama, Foss. Miura Penin., p. 152, pl. XIV, figs. 1, 2. Foss. Up. Musashino, p. 180, pl. XIV, fig. 26.

Some fragments.

20. *Pecten tokyoensis*, TOKUNAGA.

Pecten tokyoensis. Yokoyama, Foss. Miura Penin., p. 158, pl. XIV, figs. 7, 8. Foss. Up. Musashino, p. 182.

Two right and three left valves,

21. *Pecten cosibensis*, YOKOYAMA.

(Pl. I., Fig. 5.).

Pecten cosibensis. Yokoyama, Foss. Miura Penin., p. 156, pl. XIII, figs. 7, 8.

A right valve 50 millim. high. The ribs are four in number, if we except the last one on each side of the shell which is indistinct. The two middle ones consist of three and the two lateral ones of two unequal riblets. The interspaces are narrow, and radiately and unequally costellated.

22. *Pectunculus vestitus*, DUNKER.

Pectunculus vestitus. Yokoyama, Foss. Miura Penin., p. 167, pl. XVII, figs 10, 11. Foss. Up. Musashino, p. 189, pl. XVI, figs. 1–3.

A right and a left valve.

23. *Nucula insignis*, GOULD.

Nucula insignis. Yokoyama, Foss. Miura Penin., p. 179, pl. XIX, figs. 7, 8. Foss. Up. Musashino, p. 198.

A single right valve.

24. *Terebratella coreanica*, Adams et Reeve.

Terebratella coreanica. Yokoyama, Foss. Miura Penin., p. 184, pl. XIX, figs. 25, 28. Foss. Up. Musashino, p. 198.

A single large specimen with both valves preserved, though a little broken.

25. *Terebratella*(?) *excelsa*, Yokoyama.

(Pl. I., Fig. 3, 4.).

Shell tolerably large, either suborbicular or elongate-oval, broadest near the middle, moderately inflated. Ventral valve somewhat deeper than the dorsal one. Mesial fold hardly developed, the ventral valve being rather uniformly convex and the place where the dorsal sinus should be being simply flattened, or at utmost only very slightly concave. Beak moderately produced, incurved and truncated by a large round foramen almost reaching the hinge-line and separated from it by a deltidium in two small separate pieces. Beak-ridges sharp. Surface with numerous sharp roof-like ridges which increase in number toward the front by the interpolation of new ones, especially in the front-half of the shell, the size of the new ones near the margin being weaker. Lines of growth distinct, crossing the ridges and occasionally forming constrictions. Shell-structure punctate.

There are two examples. The one is perfect with both valves preserved and larger. It is 43.8 millim. high, 38.2 millim, broad and 25.3 millim. thick. The other is a ventral valve nearly as broad as high, being 32.6 millim. high, 32.4 millim. broad, and 11.3 millim. deep.

The generic determination is at present impossible, but the surface-sculpture shows some resemblance to that of *Terebratella dorsata* (Gmelin), described and figured in Davidson's ,,Monograph of Recent Brachiopoda'' (p. 75, pl. XIV, figs. 9–19).

26. *Terebratella*(?) sp.

(Pl. I., Fig. 10.).

Two specimens. The shell is elongate-oval in shape, inflated, smooth on surface, punctate in structure and with the dorsal valve only a little shallower than the ventral. The beak is produced, incurved and truncated by a small round foramen separated from the hinge-line by a deltidium consisting of two pieces. Height 25.5 millim. Breadth 19 millim. Thickness 5.3 millim.

This shell looks like an elongated form of *Terebratella coreanica* (Davidson's Monograph, pl. XIII, fig. 8), though thicker with the beak more pointed and the foramen smaller. It is also not unlike a fossil which I described from the Lower Musashino of Koshiba (Foss. Miura Penin., pl. XIX, fig. 27) under the name of *T. nipponensis*, though the foramen is smaller.

On account of the extreme difficulty in determining this class of shells from a few examples, especially when we are not able to disclose the internal characters, I leave the shell unnamed. And so also the next one.

27. *Eudesia*(?) sp.

(Pl. I., Figs. 7, 8.).

This is a more roundish form than the preceding, although in itself it is somewhat longer than broad. There are three specimens, two of which have been figured. These seem to belong to the same species in spite of the smaller one being more pointed behind. The surface is perfectly smooth, the magnifying-glass, however, revealing its punctate structure. Mesial fold hardly developed. The beak is much produced, incurved and provided with a small foramen at the summit. Deltidium consisting of two pieces.

The larger of the figured specimens measures 27.6 millim. in height 24.7 millim. in breadth and 16 millim. in thickness, while the smaller is 23 millim. high, 20.5 millim. broad and 11 millim. thick.

The shell shows some distant resemblance to *Eudesia lenticularis* (Deshayes) living and fossil (Pleistocene) in New Zealand (Davidson's Monograph, p. 52, pl. IX, figs. 2–13).

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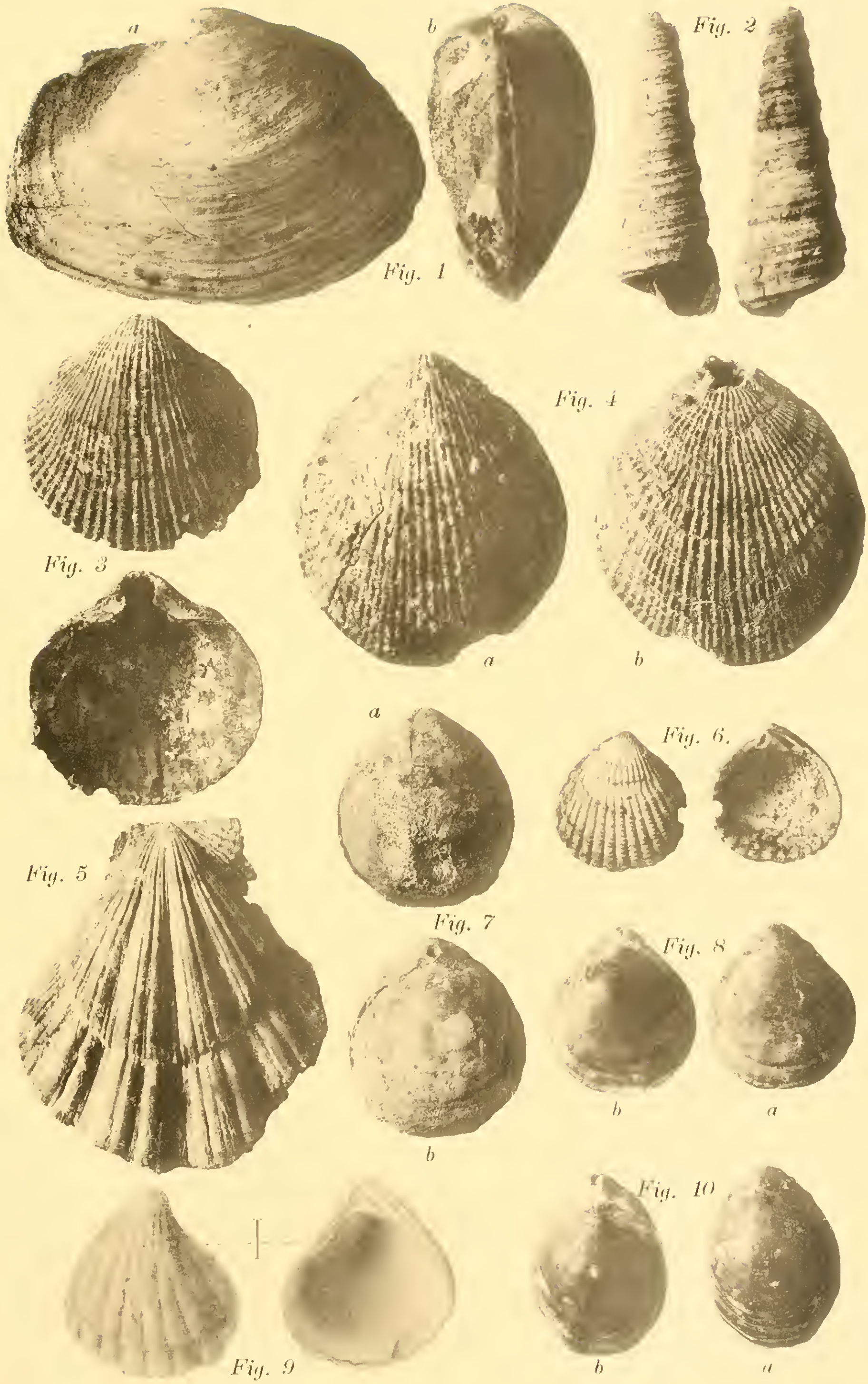
PLATE I.

Plate I.

Fossils from Quelpart.

Fig. 1. Thracia pubescens Pult. a. View from right side. b. View from behind.
Fig. 2. Turritella saishuensis Yok.
Figs. 3, 4. Terebratella ? excelsa Yok. 3. Ventral valve seen from outside and inside. 4 a. Ventral view. 4 b. Dorsal view.
Fig. 5. Pecten cosibensis Yok. Right valve.
Fig. 6. Venericardia ferruginea var. orbicularis Yok. Right valve.
Figs. 7, 8. Eudesia ? sp. a. Ventral views. b. Dorsal views.
Fig. 9. Venericardia nakamurai Yok. Right valve, much enlarged.
Fig. 10. Terebratella ? sp. a. Ventral view. b. Dorsal view.



M. Yokoyama: Fossil Shells from Saishu.

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Die Hydroidenfauna der Japanischen Region.

Von Prof. Dr E. STECHOW
in München.

Die nachfolgende Zusammenstellung umfasst die gesamte Hydroidenfauna, die bisher aus dem Gebiet zwischen Formosa im Süden und den Kurilen im Norden bekannt geworden ist, einschliesslich der Bonin-Inseln; sie umfasst zugleich auch alle die Species, die an den gegenüberliegenden Küsten des Asiatischen Festlandes gefunden worden sind. Diese Abgrenzung des Gebietes bringt es mit sich, dass im Süden zahlreiche tropische Formen, im Norden mannigfache arktische Species mit in die Liste hineinfallen, ein Umstand, der auch durch eine andere Abgrenzung des Gebietes nicht zu vermeiden gewesen wäre; denn das Japanische Gebiet stellt eine Mischfauna aus nördlichen und südlichen Bestandteilen dar, ohne dass man an irgend einem Punkte eine scharfe Grenze zwischen beiden feststellen könnte. In dem so eingehend erforschten Gebiet Mittel-Japans, in der Sagamibai, überwiegt jedenfalls das südliche Faunenelement noch ganz bedeutend und es finden sich hier nur ganz wenige nordische Formen.

Eine Zusammenstellung der gesamten bisher bekannten Hydroidenfauna des tropischen Indopacifischen Gebietes, die für die weitere Erforschung der Japanischen Region von der grössten Bedeutung ist und jetzt bereits fast 600 bekannte Species umfasst, hoffe ich dieser Mitteilung folgen lassen zu können. Denn es ist klar, dass ein grosser Teil derselben noch in Japan, bis hinauf zur Sagami-Bai, gefunden werden wird.

Die eingehende Revision des Systems und der ganzen Nomenklatur, die in den letzten 10 Jahren durchgeführt worden ist, bringt gegenüber meiner Zusammenstellung der Japanischen Hydroidenfauna vom Jahre 1913 eine beträchtliche Anzahl unvermeidlicher Namensänderungen mit sich, auf die im Folgenden stets verwiesen worden ist.

Zu meiner besonderen Freude bin ich in der Lage, hier auch die erste Beschreibung einer neuen, noch unbekannten Species, *Cuspidella gigantea*, beifügen zu können.

ATHECATA.

Corynidae.

1. *Coryne pusilla* GAERTNER 1774.
   Sagamibai (INABA Nr. 1, STECHOW 1907, 1909, 1913b).
2. *Hydrichthella epigorgia* STECHOW 1909.
   Sagamibai (STECHOW 1909, 1913b).
3. *Halocharis gemmosa* (MC CRADY 1859).
   Sagamibai (STECHOW 1909 als ,,*Gemmaria gemmosa*").
4. *Halocharis indopacifica* STECHOW 1919.
   Sagamibai (STECHOW 1919a).
5. *Cladocoryne pelagica* ALLMAN 1874.
   Sagamibai (Inaba Nr. 2, STECHOW 1913b).
6. *Hydrocoryne miurensis* STECHOW 1907.
   Sagamibai (STECHOW 1907, 1909).
7. *Dendrocoryne secunda* INABA 1892.
   Sagamibai und Bonin-Inseln (INABA Nr 38, GOTO 1897); Japan (JÄDERHOLM 1896); Sagamibai (STECHOW 1909).
8. *Dendrocoryne misakinensis* INABA 1892.
   Sagamibai (INABA Nr. 37, GOTO 1897, STECHOW 1909), JÄDERHOLM 1919); Hirado-Strasse (JÄDERHOLM 1896).
9. *Dendrocoryne* (*Solanderia*) *leuckarti* MARSHALL 1892.
   ?Japan (MARSHALL 1892).
10. *Solanderia* sp. WELTNER 1893.
    Enoshima und Hakodate, nördliches Japan (WELTNER 1893, p. 18).

Halocordylidae (=Pennariidae).

11. *Halocordyle disticha* (GOLDFUSS 1820)=*Pennaria carolinii* EHRENBERG 1834.

Sagamibai (INABA Nr. 32, STECHOW 1913b); Bonin-Inseln (JÄDERHOLM 1919).

Tubulariidae.

12. *Tubularia mesembryanthemum* ALLMAN 1872.
Sagamibai (INABA Nr. 33, STECHOW 1913b).
13. *Tubularia sagamina* STECHOW 1907.
Sagamibai (STECHOW 1907, 1909).
14. *Corymorpha tomoensis* IKEDA 1910.
Tomo, Provinz Bingo (IKEDA 1910); Kiushiu (JÄDERHOLM 1919).
15. *Corymorpha carnea* (CLARKE 1876).
Sagamibai (STECHOW 1909, 1913b).
16. *Branchiaria mirabilis* STECHOW 1921c.
Sagamibai (STECHOW 1913b als „*Branchiocerianthus* n. sp.", STECHOW 1921c; STECHOW 1908 und 1909 als „*Branchiocerianthus imperator*" pro parte, nämlich nur=Nr. 343 der Sammlung DOFLEIN).
17. *Branchiocerianthus imperator* (ALLMAN 1885).
Bei Yokohama (ALLMAN 1888); Sagamibai (MIYAJIMA 1900, STECHOW 1908, 1909, 1913b, 1919a, JÄDERHOLM 1919); Sunosaki (STECHOW 1909).

Clavidae.

18. *Campaniclava clionis* VANHÖFFEN 1910.
China-See (VANHÖFFEN 1910).
19. *Balella mirabilis* (NUTTING 1905).
Bonin-Inseln (JÄDERHOLM 1919 als „*Balea mirabilis*").

Bougainvilliidae.

20. *Podocorella minoi* (ALCOCK 1892).
Sagamibai (FRANZ und STECHOW 1908, STECHOW 1909, 1913b, 1921c).

21. *Hydractinia epiconcha* Stechow 1907.
Sagamibai (Inaba Nr. 3 als „*Podocoryne* sp.", Stechow 1907, 1909, 1913b, Jäderholm 1919); Kiushiu (Jäderholm 1919).
22. *Hydractinia spiralis* Goto 1910.
Sagamibai, Tokiobai (Goto 1910).
23. *Hydrissa sodalis* (Stimpson 1859-Stechow 1907).
Hakodate-Bai auf Jesso (Stimpson 1859); Sagamibai und Tokiobai (Inaba Nr. 36 als „*Podocoryne* sp.?", Döderlein-Ortmann 1892, Stechow 1907, 1909, 1913b, 1921b, 1921c als „*Hydractinia*", Goto 1910); Japan (Dollfus 1906).
24. *Leuckartiara pusilla* (Wright 1857)=*Perigonimus repens* (Wright 1858).
Sagamibai (Stechow 1909); Kiushiu (Jäderholm 1919 als „*Perigonimus*").
25. *Bougainvillia ramosa* (van Beneden 1844).
Sagamibai (Inaba Nr. 31, Stechow 1909, 1913b); Uraga-Kanal (Stechow 1909).

Eudendriidae.

26. *Eudendrium capillare* Alder 1856.
Sagamibai (Inaba Nr. 35, Stechow 1909, 1913b).
27. *Eudendrium vaginatum* Allman 1863.
Sagamibai (Inaba Nr. 34, Stechow 1913b).
28. *Eudendrium armstrongi* Stechow 1909.
Sagamibai (Stechow 1909)=„*Eudendrium ramosum*" Armstrong 1879, nec aut.!
29. *Eudendrium rameum* (Pallas 1766).
Sagamibai (Stechow 1909); Kiushiu (Jäderholm 1919).
30. *Eudendrium racemosum* (Gmelin 1791).
Sagamibai (Stechow 1913b).

THECATA.

Haleciidae.

31. *Halecium repens* Jäderholm 1907.

Sagamibai (STECHOW 1913b).

32. *Halecium delicatulum* COUGHTREY 1876.
Sagamibai (STECHOW 1913b).

33. *Halecium crinis* STECHOW 1913.
Sagamibai (STECHOW 1913, 1913b).

34. *Halecium tenellum* HINCKS 1861.
Sagamibai und Bonin-Inseln (JADERHOLM 1919).

35. *Halecium mediterraneum* WEISMANN 1883-STECHOW 1919.
Sagamibai (INABA Nr. 16, STECHOW 1913b, JÄDERHOLM 1919); Kiushiu und Bonin-Inseln (JÄDERHOLM 1919); Ost-Sachalin (LINKO 1911, p. 42, als „*Halecium parvulum* BALE".—Es sind *Halecium tenellum* var. *mediterranea* WEISMANN 1883=*Halecium flexile* ALLMAN 1888=*Halecium gracile* BALE 1888=*Halecium parvulum* BALE 1888 (s. STECHOW 1919a, p. 34).

36. ?*Halecium cymiforme* ALLMAN 1888.
Sagamibai (INABA Nr. 46, STECHOW 1913b).

37. *Halecium beani* (JOHNSTON 1838).
Sagamibai (STECHOW 1913b).

38. *Halecium sessile* NORMAN 1867.
Sagamibai (INABA Nr. 15, STECHOW 1913b).

39. *Halecium reversum* NUTTING 1901.
Sachalin (LINKO 1911).

40. *Halecium muricatum* (ELLIS et SOLANDER 1786).
Ochotskisches Meer (LINKO 1911, p. 56–60).

41. *Halecium ochotense* LINKO 1911.
Ochotskisches Meer (LINKO 1911, p. 44).

42. *Halecium halecinum* (LINNÉ 1758).
Ochotskisches Meer (LINKO 1911, p. 40).

43. *Halecium speciosum* NUTTING 1901.
Ochotskisches Meer, Sachalin-Golf (LINKO 1911, p. 19).

44. *Halecium labrosum* ALDER 1859.
Ost-Sachalin (LINKO 1911, p. 37).

45. *Halecium brashnikowi* LINKO 1911.
Ochotskisches Meer (LINKO 1911, p. 71).

46. *Ophiodissa arborea* (ALLMAN 1888).

Sagamibai (Stechow 1913b, Jäderholm 1919); Kiushiu (Jäderholm 1919).

Campanulariidae.

47. *Campanularia gracilis* Allman 1876.
Japan (Allman 1876a).
48. *Campanularia tincta* Hincks 1861.
Sagamibai und Bonin-Inseln (Jäderholm 1919).
49. *Campanularia indopacifica* Stechow 1919.
Sagamibai (Stechow 1919a).
50. *Campanularia hincksi* Alder 1856 var. *grandis* Billard 1907.
Sagamibai (Stechow 1913b); Bonin-Inseln (Jäderholm 1919).
51. *Campanularia urceolata* Clarke 1876.
Kurilen (Linko 1911, p. 162).
52. *Campanularia volubilis* (Linné 1758).
Sachalin (Linko 1911, p. 157).
53. *Campanularia sulcata* Jäderholm 1896.
Hirado-Strasse (Jäderholm 1896).
54. *Campanularia groenlandica* Levinsen 1893.
Sagamibai (Stechow 1913b); Ochotskisches Meer (Linko 1911, p. 179).
55. *Campanularia* sp. (*groenlandica* aff.).
Sachalin (Linko 1911, p. 183).
56. *Rhizocaulus chinensis* (Marktanner 1890).
Sagamibai und Bonin-Inseln (Jäderholm 1919); Tschifu (Marktanner 1890 als „*Campanularia*"); Sachalin und Ochotskisches Meer (Linko 1911, p. 200).
57. *Rhizocaulus verticillatus* (Linné 1758).
Sachalin,sches Ochotski Meer, Kamtschatka (Linko 1911, p. 195, 197 als „*Campanularia*").
58. *Tulpa speciosa* (Clarke 1876) = *Campanularia crenata* Allman 1876.
Japan (Allman 1876a); Ochotskisches Meer (Linko 1911, p. 185 als „*Campanularia*").

59. *?Campanularia integra* Macgillivray 1842.
Kishu (Inaba Nr. 40, Stechow 1913b); Sachalin (Linko 1911, p. 165).

60. *Orthopyxis caliculata* (Hincks 1853).
Sagamibai und Kishu (Inaba Nr. 39, Stechow 1913b als „*Campanularia integra*" pro parte).

61. *Orthopyxis compressa* (Clarke 1876).
Sachalin (Linko 1911, p. 172).

62. *Thaumantias raridentata* (Alder 1862).
Sagamibai (Inaba Nr. 45, Stechow 1913b als „*Campanularia*"); Shima (Inaba).

63. *Clytia delicatula* (Thornely 1900).
Sagamibai (Inaba Nr. 13, Stechow 1913b); Hirado-Strasse (Jäderholm 1902b).

64. *Clytia edwardsi* (Nutting 1901).
Sagamibai (Stechow 1913b).

65. *Clytia linearis* (Thornely 1900).
Sagamibai (Inaba Nr. 14, Stechow 1913b, Jäderholm 1919); Bonin-Inseln (Jäderholm 1919).

66. *Clytia gracilis* (M. Sars 1851) = *Gonothyraea gracilis* aut.
Sagamibai (Stechow, Hydroiden des Mittelmeers, Amerikas usw., 2. Teil).

67. *Obelia geniculata* (Linné 1758).
Sagamibai (Inaba Nr. 7 und Nr. 8, Stechow 1913b).

68. *Obelia plana* (M. Sars 1835) = *Obelia flabellata* (Hincks 1866).
Kap Sesuro bei Wladiwostok (v. Marenzeller 1902).

69. *Obelia longissima* (Pallas 1766).
Japanisches Meer, Wladiwostok, Sachalin, Ochotskisches Meer (Linko 1911, p. 234–236).

70. *Obelia* (?) *chinensis* Marktanner 1890.
Gelbes Meer (Marktanner 1890).

71. *Gonothyraea bicuspidata* (Clarke 1875).
Sagamibai (Stechow 1913b als „*Gonothyraea longicyatha*", Jäderholm 1919).

Campanulinidae.

72. *Campanulina chilensis* HARTLAUB 1905.
Sagamibai (STECHOW 1913b und STECHOW, Hydroiden des Mittelmeers, Amerikas usw., 2. Teil).

73 *Campanulina denticulata* CLARKE 1907.
Sagamibai (STECHOW 1913b).

74. *?Opercularella hispida* NUTTING 1896.
Sagamibai (STECHOW 1913b).

75. *Stegopoma fastigiatum* (ALDER 1860).
Sagamibai (STECHOW 1913b als „*Stegopoma gilberti*"); Bonin-Inseln (JÄDERHOLM 1919); vgl. STECHOW 1914, Zool. Anzeiger, Vol. 45, p. 135, fig. 9.

76. *Stegopoma plicatile* (M. SARS 1863).
Kap Sesuro bei Wladiwostok (v. MARENZELLER 1902); Ost-Sachalin (LINKO 1912, p. 45).

77. *Cuspidella gigantea n. sp.*
Fundort. Bei Misaki, Sagamibai, Japan. An der Hydrorhiza von *Gonothyraea* sp., die auf dem Rücken der Krabbe *Halimus diacanthus* (DE HAAN) sass.

Das Genus *Cuspidella* ist für die Fauna Japans neu.

Trophosom. Hydrocaulus fehlt. Theken teils halbsessil und dann aufgerichtet wie bei *Filellum*, teils stehend wie bei den schon bekannten *Cuspidella*-Arten, cylindrisch, lang, etwa 5mal so lang als breit, meist glatt, selten mit einigen Zuwachsrändern wie bei *Cuspidella costata*. Oben ein conisches Operculum, aus etwa 15 Stücken bestehend. Länge der Theken 0.700–1.100 mm, Breite 0.120–0.240 mm.

Gonosom fehlt.

Das vorliegende Material erinnert besonders an *Cuspidella costata*, weniger an *Cuspidella grandis;* von beiden liegt mir Vergleichsmaterial vor. Es unterscheidet sich von beiden durch das Vorkommen riesiger Theken; RITCHIE (1910b) findet bei *Cuspidella costata* nur eine Thekenbreite von 0.100–0.140 mm, STECHOW (1919a) nur eine solche von 0.110–0.160 mm, an neuerem Material aus Neapel sogar nur eine Breite von 0.080–0.110 mm. Von *Cuspidella costata* unterscheidet es sich auch darin, dass nur sehr selten einmal einzelne Theken Zuwachsränder zeigen, während gerade dies bei *Cuspidella costata* die Regel ist.

Bei *Cuspidella grandis* andererseits sind die Theken relativ länger, röhrenförmiger; nach den Figuren von Hartlaub (1897, Taf. 20 Fig. 18–19) und Hincks (1868, tab. 40 fig. 4) sind sie fast 10mal so lang als weit.

Möglicherweise stellt diese Japanische Species nur eine riesige Wachstumsform von *Cuspidella costata* Hincks dar.

78. *Eupoma maximum* (Levinsen 1893).
Ost-Sachalin (Linko 1912, p. 75 als „*Lafoeina*").

79. *Calicella syringa* (Linné 1767).
Gelbes Meer (Marktanner 1890); Kap Sesuro bei Wladiwostok (v. Marenzeller 1902).

80. *Calicella pygmaea* (Hincks 1868).
Sagamibai (Stechow 1913b als „*Calycella syringa*").

Lafoeidae.

81. *Hebella parasitica* (Ciamician 1880).
Sagamibai (Inaba Nr. 30 als „*Lafoea* sp.?", Stechow 1913b).

82. *Hebellopsis calcarata* (A. Agassiz 1865).
Sagamibai (Stechow 1913b als „*Hebella calcarata*").

83. *Croatella corrugata* (Thornely 1904).
Sagamibai (Stechow 1913b, Jäderholm 1919; Stechow, Hydroiden des Mittelmeers, Amerikas usw., 2. Teil).

84. *Croatella neglecta* (Stechow 1913).
Sagamibai (Stechow 1913, 1913b); Bonin-Inseln (Jäderholm 1919 als „*Hebella*").

85. *Bonneviella grandis* (Allman 1874).
Tsugor-Strasse, Japan (Allman 1876a; genauer Fundort nach Broch 1909, p. 200); Ochotskisches Meer (Linko 1911, p. 150).

86. *Bonneviella regia* (Nutting 1901).
Japanisches Meer (Nutting 1915).

87. *Hebomma ingens* (Nutting 1915).
Kurilen (Nutting 1915 als „*Bonneviella ingens*").
88. *Lictorella stechowi* Jäderholm 1919.
Sagamibai (Jäderholm 1919).
89. *Zygophylax biarmata* Billard 1905.
Bonin-Inseln (Jäderholm 1919).
90. *Zygophylax curvitheca* Stechow 1913.
Sagamibai (Stechow 1913, 1913b, Jäderholm 1919).
91. *Zygophylax tizardensis* Kirkpatrick 1890.
Sagamibai (Stechow 1913b, Jäderholm 1919); Bonin-Inseln (Jäderholm 1919).
92. *Zygophylax brevitheca* Jäderholm 1919.
Bonin-Inseln (Jäderholm 1919).
93. *Zygophylax cervicornis* (Nutting 1905).
Bonin-Inseln (Jäderholm 1919).
94. *Zygophylax pacifica* Stechow 1920.
Sagamibai (Stechow 1913b als „*Zygophylax biarmata*", Stechow 1920).
95. *Acryptolaria exserta* (Johnson 1858).
Sagamibai (Stechow 1913b, Jäderholm 1919 als „*Perisiphonia*"); Kiushiu und Bonin-Inseln (Jäderholm 1919).
96. *Lafoea tenellula* Allman 1877.
Sagamibai (Stechow 1913b).
97. *Lafoea dumosa* (Fleming 1820).
Ost-Sachalin (Linko 1911, p. 95).
98. *Lafoea fruticosa* (M. Sars 1851).
Sagamibai (Inaba Nr. 6, Stechow 1913b, Jäderholm 1919); Shima (Inaba); Kiushiu (Jäderholm 1919); Japanisches Meer (Linko 1911, p. 100); Kap Sesuro bei Wladiwostok (v. Marenzeller 1902).
99. *Lafoea gracillima* (Alder 1856).
Bonin-Inseln (Jäderholm 1919); Gelbes Meer (Marktanner 1890).
100. *Filellum contortum* (Nutting 1905).
Sagamibai (Stechow 1913b).

101. *Filellum serratum* (CLARKE 1879).
Sagamibai (STECHOW 1913b); Bonin-Inseln (JÄDERHOLM 1919).

102. *Oswaldaria pulchella* (ALLMAN 1888).
Sagamibai (STECHOW 1913b als „*Cryptolaria pulchella*").

103. *Oswaldaria symmetrica* (NUTTING 1905).
Sagamibai (STECHOW 1913b als „*Cryptolaria symmetrica*").

104. *Oswaldaria crassicaulis* (ALLMAN 1888).
Sagamibai (STECHOW 1913b als „*Cryptolaria crassicaulis*"); Kiushiu (JÄDERHOLM 1919).

105. *Oswaldaria conferta* (ALLMAN 1877) var. *australis* RITCHIE 1911.
Sagamibai (JÄDERHOLM 1919 als „*Cryptolaria*").

106. *Grammaria scandens* STECHOW 1913.
Sagamibai (STECHOW 1913, 1913b, JÄDERHOLM 1919); Ochotskisches und Japanisches Meer (LINKO 1911, p. 140, als „*Grammaria stentor*").

107. *Grammaria immersa* NUTTING 1901.
Uraga-Kanal (STECHOW 1913b).

Syntheciidae.

108. *Synthecium campylocarpum* ALLMAN 1888.
Sagamibai (INABA Nr. 19 als „*Sertularia* sp.", STECHOW 1913b, JÄDERHOLM 1919); Kiushiu (JÄDERHOLM 1919).

109. *Synthecium orthogonium* (BUSK 1852).
Süd-Japan (JÄDERHOLM 1903).

110. *Synthecium tubithecum* (ALLMAN 1877).
Sagamibai (STECHOW 1913b); Hirado-Strasse (JÄDERHOLM 1902b); Kiushiu (JÄDERHOLM 1919); Bonin-Inseln (JÄDERHOLM 1919).

Sertulariidae.

111. *Tetrapoma quadridentatum* (HINCKS 1874).
Sachalin (LINKO 1912, p. 80 als „*Lovenella*").

112. *Nigellastrum nuttingi* (Stechow 1913).
Sagamibai (Stechow 1913, 1913b als ,,*Diphasia nuttingi*").

113. *Nigellastrum palmatum* (Nutting 1905).
Sagamibai (Stechow 1913b als ,,*Diphasia palmata*"); Kiushiu (Jäderholm 1919).

114. *Nigellastrum scalariforme* (Kirkpatrick 1890).
Süd-Japan (Jäderholm 1903 als ,,*Diphasia*").

115. *Nigellastrum digitale* (Busk 1852).
Bonin-Inseln (Jäderholm 1919 als ,,*Diphasia*").

116. *Nigellastrum thornelyae* (Ritchie 1909).
Kiushiu (Jäderholm 1919 als "*Diphasia thornelyi*").

117. *Nigellastrum derbeki* (Kudelin 1913).
Ochotskisches Meer (Kudelin 1913 als ,,*Diphasia*").

118. *Idiella pristis* (Lamouroux 1816).
Hirado-Strasse (Stechow 1913b als ,,*Idia pristis*"); Formosa (Marktanner 1890); Bonin-Inseln (Jäderholm 1919).

119. *Dynamena distans* Lamouroux 1816.
Sagamibai (Inaba Nr. 22, Stechow 1913b, Jaderholm 1919); Bonin-Inseln (Jäderholm 1919 als ,,*Sertularia*").

120. *Dynamena japonica* Stechow 1920.
Sagamibai (Inaba Nr. 18 als ,,*Sertularia* sp.", Stechow 1913b als ,,*Thuiaria articulata*", Stechow 1920).

121. *Dynamena tubuliformis* Marktanner 1890.
Sagamibai und Bonin-Inseln (Jäderholm 1919 als ,,*Sertularia tubuliformis*").

122. *Pasya nodosa* (Hargitt 1908).
Sagamibai (Inaba Nr. 42, Stechow 1913b als ,,*Pasythea*"); Kishu (Inaba).

123. *Symplectoscyphus indivisus* (Bale 1882).
Sagamibai (Inaba Nr. 10, Stechow 1913b als ,,*Sertularella solidula* Bale").

124. *Symplectoscyphus turgidus* (Trask 1857).
Sagamibai (Inaba Nr. 12 als ,,*Diphasia* sp.?", Stechow 1913b als ,,*Sertularella*"); Japan (Nutting 1904).

125. *Symplectoscyphus gotoi* STECHOW 1913.
Sagamibai (STECHOW 1913, 1913b).

126. *Symplectoscyphus tricuspidatus* (ALDER 1856).
Hirado-Strasse (JÄDERHOLM 1896); Sagamibai (JÄDERHOLM 1919); Ost-Sachalin (LINKO 1912, p. 109).

127. *Symplectoscyphus tricuspidatus* var. *acuminata* (KIRCHENPAUER 1884).
West-Sachalin (LINKO 1912, p. 112).

128. *Symplectoscyphus tropicus* (HARTLAUB 1901).
Sagamibai (STECHOW 1913b als ,,*Sertularella* sp.?", JADERHOLM 1919); Kiushiu und Bonin-Inseln (JÄDERHOLM 1919).

129. *Symplectoscyphus cumberlandicus* (JÄDERHOLM 1905).
Sagamibai (STECHOW 1913b als ,,*Sertularella cumberlandica*").

130. *Symplectoscyphus rubellus* (TILESIUS-KIRCHENPAUER 1884).
Kamtschatka (KIRCHENPAUER 1884).

131. *Symplectoscyphus pinnatus* (CLARKE 1876).
Kamtschatka (KIRCHENPAUER 1884 als ,,*Sertularella fruticulosa* PÖPPIG-KIRCHENPAUER", LINKO 1912, p. 117).

132. *Serta mirabilis* (JÄDERHOLM 1896).
Hirado-Strasse (JÄDERHOLM 1896); Süd-Japan (JÄDERHOLM 1903); Sagamibai und Kiushiu (JÄDERHOLM 1919).

133. *Sertularella areyi* NUTTING 1904.
Sagamibai (STECHOW 1913b); Kiushiu und Bonin-Inseln (JÄDERHOLM 1919).

134. *Sertularella miurensis* STECHOW 1921.
Sagamibai (INABA Nr. 9, STECHOW 1913b als ,,*Sertularella indivisa*", STECHOW 1921c); Kishu (INABA).

135. *Sertularella sagamina* STECHOW 1921.
Sagamibai (STECHOW 1921c).

136. *Sertularella tenella* (ALDER 1856).
Bonin-Inseln (JÄDERHOLM 1919).

137. *Sertularella sinensis* JÄDERHOLM 1896.
Sagamibai (INABA Nr. 47, STECHOW 1913b, JÄDERHOLM 1919); Süd-Japan (JÄDERHOLM 1903); Formosa-Strasse

(JÄDERHOLM 1896); Kiushiu und Bonin-Inseln (JÄDERHOLM 1919).

138. *Sertularella inabai* STECHOW 1913.
Sagamibai (STECHOW 1913, 1913b, INABA Nr. 11 als „*Diphasia* sp.?", JÄDERHOLM 1919).

139. *?Sertularella lata* (BALE 1882).
Sagamibai (INABA Nr. 17 als „*Thuiaria* sp.", STECHOW 1913b als „*Sertularella tridentata*").

140. *Sertularella gayi* (LAMOUROUX 1821) var. *gracilescens* JÄDERHOLM 1919.
Kiushiu (JÄDERHOLM 1919).

141. *Sertularella spinosa* KIRCHENPAUER 1884.
Yokohama und Nagasaki (KIRCHENPAUER 1884); Goto und Nagasaki (JÄDERHOLM 1902b).

142. *Sertularella gigantea* MERESCHKOWSKY 1878.
Korea-Strasse (JÄDERHOLM 1896); Kamtschatka (KIRCHENPAUER 1884); Krestowaja, Tatarsky Golf, Japanisches Meer, Sachalin und Ochotskisches Meer (LINKO 1912, p. 132).

143. *Sertularella brandti* LINKO 1912.
Kamtschatka (LINKO 1912, p. 119).

144. *Sertularella albida* KIRCHENPAUER 1884.
Kamtschatka (KIRCHENPAUER 1884)=*Sertularella robusta* CLARKE 1876 praeocc.

145. *Abietinaria traski* (TORREY 1902).
Sagamibai (STECHOW 1913b).

146. *Abietinaria variabilis* (CLARKE 1876).
Sagamibai (STECHOW 1913b).

147. *Abietinaria juniperus* KIRCHENPAUER 1884.
Kurilen (KIRCHENPAUER 1884).

148. *Abietinaria melo* KIRCHENPAUER 1884.
Kurilen (KIRCHENPAUER 1884).

149. *Abietinaria abietina* (LINNÉ 1758).
Kamtschatka (KIRCHENPAUER 1884).

150. *Abietinaria filicula* (ELLIS et SOLANDER 1786).
Kamtschatka (KIRCHENPAUER 1884).

151. *Abietinaria tilesii* Kirchenpauer 1884.
Kamtschatka (Kirchenpauer 1884).
152. *Abietinaria merki* Kirchenpauer 1884.
Kamtschatka (Kirchenpauer 1884).
153. *Abacella* (?) *purpurea* (Linné 1758).
Kamtschatka (Kirchenpauer 1884 als „*Selaginopsis*").
154. *Lagenitheca compressa* (Mereschkowsky 1878).
Port Ajan, Ochotskisches Meer (Mereschkowsky 1878b als „*Sertularia*").
155. *Amphisbetia furcata* (Trask 1857).
Kishu (Inaba Nr. 41, Stechow 1913b als „*Sertularia furcata*").
156. *Amphisbetia nasonowi* (Kudelin 1913).
Ochotskisches Meer (Kudelin 1913 als „*Sertularia nasonowi*").
157. *Tridentata gracilis* (Hassall 1848).
Sagamibai (Inaba Nr. 20, Stechow 1913b als „*Sertularia gracilis*").
158. *Tridentata turbinata* (Lamouroux 1816).
Sagamibai (Inaba Nr. 21, Stechow 1913b als „*Sertularia turbinata*", Jäderholm 1919); Bonin-Inseln (Jäderholm 1919).
159. *Tridentata rugosissima* (Thornely 1904).
Bonin-Inseln (Jäderholm 1919 als „*Sertularia rugosissima*").
160. *Sertularia suensoni* Levinsen 1913.
Nordost-Korea bei Kap Sisuro (Levinsen 1913).
161. *Sertularia nuttingi* Levinsen 1913.
Westspitze von Kiushiu, Korea-Strasse (Levinsen 1913).
162. *Sertularia intermedia* Levinsen 1913.
Korea-Strasse (Levinsen 1913).
163. *Sertularia tenera* G. O. Sars 1874.
Kiushiu (Jäderholm 1919).
164. *Sertularia heteroclada* (Jäderholm 1902).
Hirado-Strasse (Jäderholm 1902b als „*Thuiaria heteroclada*").

165. *Pericladium bidentatum* ALLMAN 1876.
Japan (ALLMAN 1876a, MERESCHKOWSKY 1878b, KIRCHENPAUER 1884 als ,,*Selaginopsis*'').
166. *Pericladium tataricum* (KUDELIN 1913).
Tatarische Meerenge (KUDELIN 1913 als ,,*Sertularia*'').
167. *Pericladium ochotense* (MERESCHKOWSKY 1878).
Ochotskisches Meer (MERESCHKOWSKY 1878b als ,,*Selaginopsis*'').
168. *Salacia lonchitis* (ELLIS et SOLANDER 1786).
Süd-Japan (JÄDERHOLM 1903 als ,,*Thuiaria*'').
169. *Salacia crassicaulis* (ALLMAN 1876).
Japan (ALLMAN 1876a als ,,*Thuiaria*'').
170. *Salacia coronata* (ALLMAN 1874)=*Salacia coronifera* (ALLMAN 1876).
Japan (ALLMAN 1876a als ,,*Thuiaria*'').
171. *Salacia marktanneri* (STECHOW 1913).
Gelbes Meer (MARKTANNER 1890 als ,,*Monopoma variabilis*'' praeocc., STECHOW 1913b als ,,*Thuiaria marktanneri*'').
172. *Salacia acutiloba* (PÖPPIG-KIRCHENPAUER 1884).
Wahrscheinlich Kurilen (KIRCHENPAUER 1884 als ,,*Thuiaria*'').
173. *Salacia stelleri* (TILESIUS-KIRCHENPAUER 1884).
Kamtschatka (KIRCHENPAUER 1884 als ,,*Thuiaria*'').
174. *Salacia lichenastrum* (PALLAS 1766).
Kamtschatka (KIRCHENPAUER 1884 als ,,*Thuiaria*'').
175. *Salacia cartilaginea* (KIRCHENPAUER 1884).
Kamtschatka? (KIRCHENPAUER 1884 als ,,*Thuiaria*'').
176. *Selaginopsis allmani* NORMAN 1878.
Japan (ALLMAN 1876a als ,,*Selaginopsis fusca*'' ALLMAN, nec aut.!, KIRCHENPAUER 1884).
177. *Selaginopsis pinnata* MERESCHKOWSKY 1878.
Port Ajan, Ochotskisches Meer (MERESCHKOWSKY 1878b).
178. *Selaginopsis decemserialis* MERESCHKOWSKY 1878.
Nördlicher Pacific, Küste von Pallana (MERESCHKOWSKY 1878b).
179. *Selaginopsis thuja* MERESCHKOWSKY 1878.

Nördlicher Pacific (MERESCHKOWSKY 1878b).

180. *Selaginopsis cedrina* (LINNÉ 1758).
Kamtschatka (KIRCHENPAUER 1884).

181. *Selaginopsis* (?) *triserialis* MERESCHKOWSKY 1878.
Kamtschatka (MERESCHKOWSKY 1878b), vgl. NUTTING 1904, p. 129, und STECHOW 1920, p. 38.

Plumulariidae.

182. *Kirchenpaueria curvata* (JÄDERHOLM 1904).
Wladiwostok (LINKO 1911, p. 15, als ,,*Halecium magellanicum,*'' HARTLAUB 1905).

183. *Pycnotheca mirabilis* (ALLMAN 1883).
Sagamibai (INABA Nr. 25 als ,,*Plumularia producta*'', STECHOW 1907, 1909, 1913b als ,,*Diplocheilus*'', JÄDERHOLM 1919); Shima (INABA); Kiushiu und Bonin-Inseln (JÄDERHOLM 1919).

184. *Antenella secundaria* (GMELIN 1791).
Sagamibai (INABA Nr. 23 als ,,*Plumularia* sp.'', STECHOW 1907, 1909, 1913b, JÄDERHOLM 1919); Uraga-Kanal (STECHOW 1907, 1909); Shima (INABA); Bonin-Inseln (JÄDERHOLM 1919).

185. *Antenella sucnsoni* JÄDERHOLM 1896.
Hirado-Strasse (JÄDERHOLM 1896).

186. *Monotheca obliqua* (THOMPSON 1844).
Sagamibai (JÄDERHOLM 1919).

187. *Monotheca spinulosa* (BALE 1882).
Sagamibai (STECHOW 1921c; STECHOW, Hydroiden des Mittelmeers, Amerikas usw., 2. Teil).

188. *Plumularia setacea* (LINNÉ 1758).
Sagamibai (INABA Nr. 4, STECHOW 1909, 1913b, JÄDERHOLM 1919); Hirado-Strasse (JÄDERHOLM 1896); Kiushiu und Bonin-Inseln (JÄDERHOLM 1919).

189. *Plumularia caliculata* BALE 1888.
Sagamibai (INABA Nr. 5, STECHOW 1913b als ,,*Plumularia lagenifera*'').

190. *Plumularia filicaulis* Kirchenpauer 1876 var. *japonica* Jäderholm 1919.
Kiushiu (Jäderholm 1919).

191. *Plumularia spiralis* Billard 1911.
Bonin-Inseln (Jäderholm 1919).

192. *Dentitheca habereri* (Stechow 1909).
Sagamibai (Inaba Nr. 44, Stechow 1909, 1913b als „*Plumularia habereri*"); Shima (Inaba).

193. *Dentitheca hertwigi* (Stechow 1907).
Sagamibai (Inaba Nr. 24, Stechow 1907, 1909, 1913b, 1919a, als „*Plumularia*").

194. *Thecocaulus plagiocampus* (Pictet 1893).
Bonin-Inseln (Jäderholm 1919 als „*Plumularia*").

195. *Monostaechas quadridens* (Mc Crady 1859).
Süd-Japan (Jäderholm 1903); Sagamibai und Uraga-Kanal (Stechow 1907, 1909); Kiushiu (Jäderholm 1919).

196. *Nemertesia minor* Kirchenpauer 1876.
Hirado-Strasse (Jäderholm 1896 als „*Antennularia octoseriata*"); Sagamibai (Stechow 1907, 1909 als „*Antennularia perrieri*", 1913b als „*Nemertesia irregularis*"); Bonin-Inseln (Jäderholm 1919 als „*Nemertesia irregularis*").

197. *Nemertesia japonica* Stechow 1907.
Sagamibai (Stechow 1907, 1909, 1919a).

198. *Nemertesia ciliata* Bale 1914.
Sagamibai und Kiushiu (Jäderholm 1919).

199. *Antennellopsis integerrima* Jäderholm 1896.
Hirado-Strasse (Jäderholm 1896); Sagamibai und Uraga-Kanal (Stechow 1907, 1909 als „*Antennellopsis dofleini*"); Sagamibai und Kiushiu (Jäderholm 1919).

200. *Heterotheca campanula* (Busk 1852).
Kiushiu und Bonin-Inseln (Jäderholm 1919 als „*Plumularia*").

201. *Haliaria vegae* (Jäderholm 1903).
Süd-Japan (Jäderholm 1903 als „*Halicornaria*"); Kiushiu (Jäderholm 1919).

202. *Halicetta expansa* (Jäderholm 1903).
Süd-Japan (Jäderholm 1903 als „*Halicornaria*"); Sagamibai (Stechow 1907, 1909, Jäderholm 1919); Bonin-Inseln (Jäderholm 1919).

203. *Halicetta gracilicaulis* (Jäderholm 1903).
Süd-Japan (Jäderholm 1903); Bonin-Inseln (Jaderholm 1919 als „*Halicornaria*").

204. *Gymnangium hians* (Busk 1852).
Sagamibai (Inaba Nr. 26, Stechow 1907, 1909, 1913b als „*Halicornaria*"); Kiushiu (Jäderholm 1919).

205. *Gymnangium* (?) *ishikawai* (Stechow 1907).
Suruga-Bai und Uraga-Kanal (Stechow 1907, 1909, 1913b als „*Halicornaria*").

206. *Gymnangium* (?) *roretzi* (Marktanner 1890).
Japan (Marktanner 1890 als „*Aglaophenia*"); Sagamibai (Stechow 1907, 1909 als „*Halicornaria*").

207. *Macrorhynchia balei* (Nutting 1905).
Sagamibai (Stechow 1907, 1909 als „*Lytocarpus balei*" pro parte).

208. *Macrorhynchia singularis* (Billard 1913).
Sagamibai (Stechow 1909 als „*Lytocarpus balei*" Nr. 360 Sammlung Doflein, Stechow 1919a als „*Lytocarpia singularis*").

209. *Macrorhynchia phoenicea* (Busk 1852).
Japan (Marktanner 1890); Insel Amoy, Formosa-Strasse (Marktanner 1890); Sagamibai (Inaba Nr. 43, Stechow 1907, 1909, 1913b als „*Lytocarpus*"); Shima (Inaba); Kiushiu (Jäderholm 1919); Sagamibai (Jäderholm 1919); Hirado-Strasse (Jäderholm 1896 als „*Lytocarpus spectabilis*").

210. *Cladocarpus crenatus* (Fewkes 1881) var. *allmani* Ritchie 1909a = *Cladocarpus formosus* Allman 1883, nec Allman 1874.
Sagamibai (Allman 1883, 1888 als „*Cladocarpus formosus*").

211. *Cladocarpus* (?) *bocki* Jäderholm 1919.

Kiushiu (JÄDERHOLM 1919).

212. *Hemicarpus pennarius* (LINNÉ 1758).
Süd-Japan (JÄDERHOLM 1903); Kiushiu (JÄDERHOLM 1919 als „*Lytocarpus*"); Korea-Strasse (JÄDERHOLM 1896 als „*Lytocarpus secundus*"); China-See (KIRCHENPAUER 1872 als „*Aglaophenia secunda*"); Formosa (KIRCHENPAUER 1872 als „*Aglaophenia crispata*". HINCKS 1887 als „*Aglaophenia crispata*").

213. *Lytocarpia nigra* (NUTTING 1905).
Sagamibai (INABA Nr. 29, STECHOW 1907, 1909, 1913b als „*Thecocarpus*"; STECHOW, Hydroiden des Mittelmeers, Amerikas usw., 2. Teil); Kishu und Shima (INABA).

214. *Lytocarpia myriophyllum* (LINNÉ 1758) var. *orientalis* BILLARD 1908.
Kiushiu (JÄDERHOLM 1919 als „*Thecocarpus*").

215. *Aglaophenia bilobidentata* STECHOW 1907.
Sagamibai (STECHOW 1907, 1909, 1913b, 1919a).

216. *Aglaophenia whiteleggei* BALE 1888.
Sagamibai (INABA Nr. 28, STECHOW 1907, 1909 als *Aglaophenia laxa*", 1913b); Bonin-Inseln (JÄDERHOLM 1919).

217. *Aglaophenia suensoni* JÄDERHOLM 1896.
Sagamibai (INABA Nr. 27 als „*Aglaophenia pluma*", STECHOW 1907 als „*Aglaophenia ijimai*", STECHOW 1909, 1913b, JÄDERHOLM 1919); Shima (INABA); Hirado-Strasse (JÄDERHOLM 1896).

218. *?Aglaophenia simplex* (D'ORBIGNY 1839).
Chinesisches Meer (KIRCHENPAUER 1872).

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