THE STRUCTURE OF THE OPERCULUM OF THE SPECIES OF ATLANTIDAE (GASTROPODA: HETEROPODA) AS A TAXONOMIC CRITERION, WITH RECORDS OF SOME PELAGIC MOLLUSKS IN THE NORTH PACIFIC[1)]

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With 42 Text-figures and 22 Tables

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1) Contributions from the Seto Marine Biological Laboratory, No. 371.

Introduction

The toxonomic criteria for the species of the Family Atlantidae of Heteropoda (Gastropoda) have been based chiefly on structures or features of the shell. Indeed, these criteria are distinct for a few species: *Atlanta lesueuri*, *A. fusca*, *A. turriculata*, *A. inclinata*, and *Oxygylus keraudreni*; but they are so exact for other species, including their jeveniles and those of some of the above-mentioned species, that sometimes the identification is made only provisionally without any confidence. Especially, the juveniles of Atlantidae are mostly left without any

definite identification. To improve such a circumstance even a little, I tried to show a part of the morphological characters of the shell by means of numerical representations (1955 a). This is, however, still insufficient, and moreover it cannot be applied for specimens, the shells of which are softened in some inadequate states of preservation.

While I was examining many plankton samples, especially of the Shellback Expedition, at the Scripps Institution of Oceanography in 1956–1957, I found so many softened shells of Atlantidae in those samples and was urged to find out some way to identify them to record the occurrences of respective species. Examining these softened shells under the binocular, I found that the operculum could be removed rather easily off these specimens and began to study the morphology of the operculum in a hope to get any definite criterion for identification. Evidently, some species are provided respectively with a quite unique operculum, while the operculum structures in others are related one another rather closely, although they seem to be helpful for identification. It was found that *Atlanta inflata* can be identified very easily and distinctly by the structure of the operculum. For other species, it is very effective to examine the operculum to ascertain the identification. An effort was made to support the validity of *Atlanta pacifica*, which I separated from *A. gaudichaudi* on the basis of the difference found in the whorl formula, by examining closely the operculum, but this was not successful. I am unhappy but have to admit that the validity of my *A. pacifica* is doubtful.

In addition to the descriptions of the operculum of respective species of Atlantidae, occurrences of some pteropods and heteropods other than Atlantidae in the North Pacific are recorded in this paper together with some brief morphological notes.

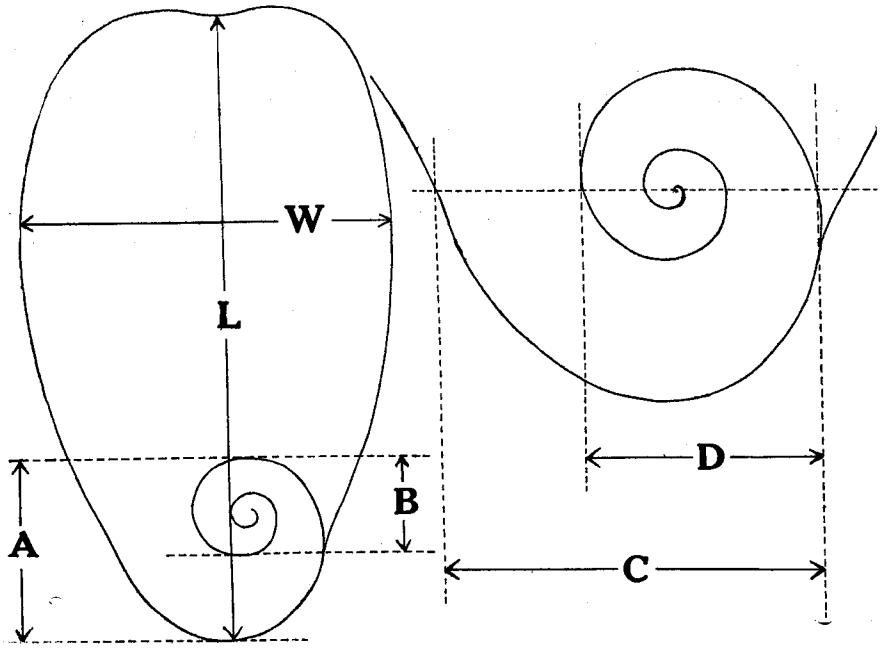
Before going further, I want to express my hearty thanks to the staff of the Scripps Institution of Oceanography, who granted me a favour to have a seat at the laboratory for a year, especially to Prof. W. M. JOHNSON for his kindness in providing all kinds of facilities, and also to the ROCKEFELLER Foundation for the postdoctoral grant.

I. General structure of the operculum in Atlantidae

The operculum is an oval plate, quite colourless, transparent and very thin in most species. The outline of the operculum shows approximately the shape of the shell aperture. They are usually so thin that they can be examined with some difficulties under the usual microscope as in *A. lesueuri*, *A. inclinata* and some others; in such specimens, the staining by rose bengal is somewhat helpful for examination. *A. turriculata* and *A. fusca* have rather thick operculum.

The operculum shows a spiral structure coiled sinistrally, the distal portion

of which is remarkably widened and forms the major part of the operculum on the axial side, while the initial part of the spiral remains as a smaller gyre on the peripheral side of the operculum.



Text-fig. 1. Schemata showing the measurements referred in this paper. For captions see the text on this page. The operculum is figured as seen from the attachment surface. Top shows the axial side and bottom indicates the peripheral side. The right side corresponds to the lower or anterior side of the shell aperture, while the left fits to the upper or posterior side of the aperture.

The proportional size of the gyre and the situation of the centre of the gyre seem to differ specifically. And, in order to show these features exactly, the following measurements were made on nearly the whole opercula examined:

L···long diameter, or length (lateral) of operculum

W···short diameter, or width (antero-posterior) of operculum

A···length of gyre, or the distance between the outer (peripheral) edge of the operculum and the inner (axial) margin of the gyre

B···longitudinal diameter of the central part of the gyre, or the distance between the inner (axial) margin of the gyre and the outer margin of the penultimate whorl of the gyre

C···width (antero-posterior) of the gyre at the level of its centre

D···width of the gyre excluding the last whorl at the same level as in C.

Evidently, both W/L and A/L decrease with growth. Originally, the gyre is considered to grow a little with age, but the lower (peripheral) margin of

this portion seems to wear away more rapidly in adults than it grows. Resultantly, B/A shows generally a slight trend towards the increase with age. The surface of the operculum is usually plain, although there are a spiral series of craw-like sculptures in *A. inflata* and a number of dots in *A. turriculata.* The attachment places of foot muscles to the operculum are defined rather clearly in *A. turriculata* and *A. fusca,* both have somewhat thicker operculum. Growth lines on the major part of the operculum are very clear in some specimens, but they may be quite obscure in some others. The distinctness seems to differ individually and evidently this is of no taxonomic significance.

II. Descriptions of opercula of the species that can be identified easily and distinctly by shell characters

1. *Oxygyrus keraudreni* (LESUEUR)

(Text-figs. 2 and 2a)

Very wide; i.e. much elongate in the antero-posterior direction. The axial margin is nearly straight. Gyre is very small and wholly taken in the antero-inner portion of the last whorl. Centre of the gyre very small, situated in the antero-peripheral part of the operculum.

The keel of the shell seems to appear from the stage with 0.98–1 mm diameter. The surface of the shell is furnished wholly with undulating lines, two of which join to build up the keel, while 10–14 lines are distributed on the surface of the apical half of the shell and 9–10 ones on the surface of the other half.

Occurrences:

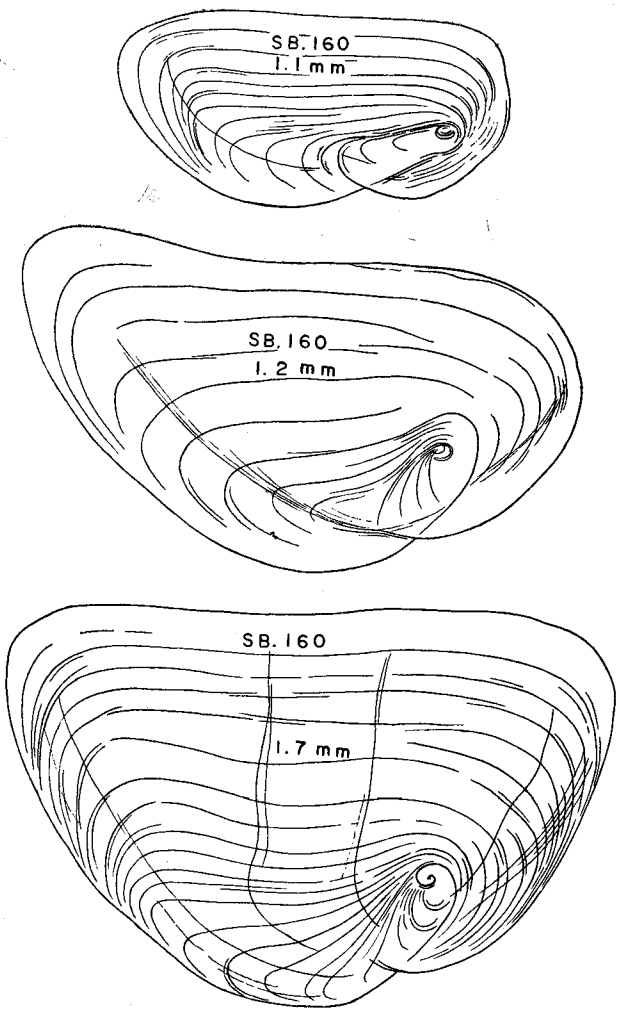
SB 160 (23 shells)	SB 187 (3)	EQPH 7 (2)
SB 175 (2)	SB 200 (3)	EQPH 17 (4)

SB···Shellback Stations, EQPH···Horizon Stations during the Equapac Expedition.

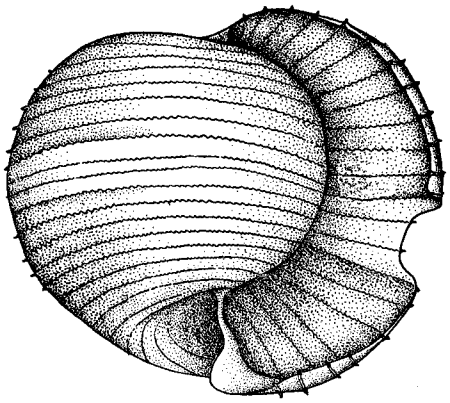
2. *Atlanta turriculata* D'ORBIGNY

(Text-fig. 3)

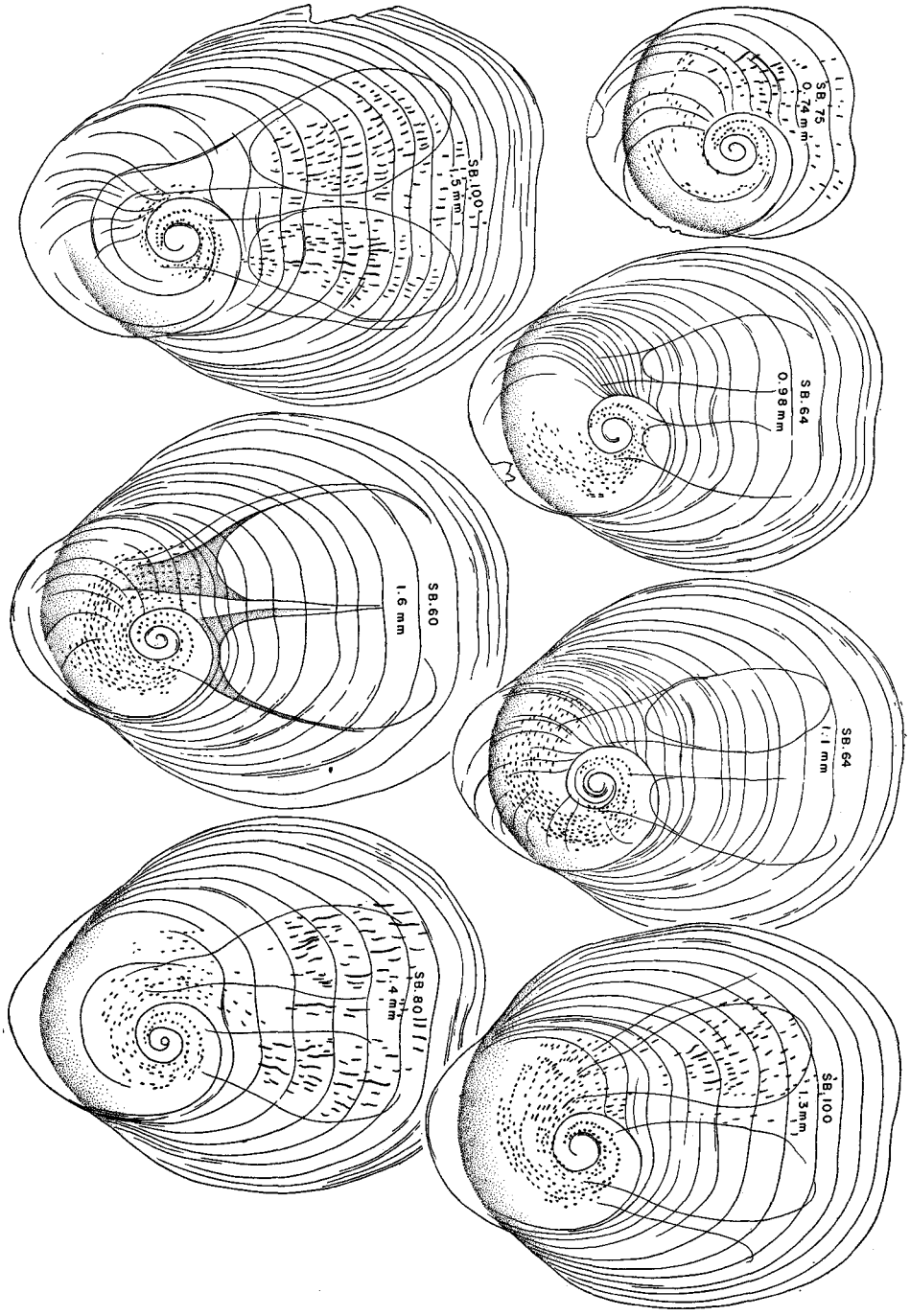
Nearly roundish in outline, W/L very large. The axial margin is rounded, or frequently obtuse. Gyre is comparatively large, but the central portion is rather small and situated in the upper (axial or inner) half of the gyre as is shown by B/A smaller than 0.50, being slightly displaced to the right (anterior) side from the middle as is indicated by D/C ranging from 0.45–0.52. The operculum is pretty thick, but the lower (peripheral) marginal portion of the gyre which is very thin and quite transparent. The gyre is always furnished with a number of dots which are arranged roughly in two rows in the central portion



Text-fig. 2. *Oxygyrus keraudreni* (LESUEUR). Opercula of three shells from Shellback Station 160, respectively 1.1, 1.2 and 1.7 mm in diameter; seen from the attachment surface. ×127.



Text-fig. 2a. *Oxygyrus keraudreni* (LESUEUR). A young shell with a 0.77 mm long diameter, from SB 160. ×73.



Text-fig. 3. *Atlanta turriculata* D'ORBIGNY. Opercula of 0.74~1.6 mm shells from Shellback Stations, seen from the attachment surface. ×86.

of the gyre. Such dots may extend to the major part of the operculum in some specimens, where they become somewhat elongate into dashes. The attachment places of foot muscles are marked very clearly.

Table 1. *A. turriculata* D'ORBIGNY. Whorl formulae.

No. of specimen	Long diameter	Whorl formula	Locality
1	0.74 mm		SB 75
2	1.1	1 : 0.27 : 0.15	SB 80
3	1.2	1 : 0.25 : 0.14	SB 80
4	1.2	1 : 0.24 : 0.15	SB 80
5	1.3	1 : 0.24 : 0.14	SB 80
6	1.3	1 : 0.28 : —	SB 100
7	1.4	1 : 0.28 : 0.14	SB 80
8	1.5	1 : 0.24 : 0.13	SB 80
9	1.5	1 : 0.27 : 0.12	SB 80
10	1.5	1 : 0.25 : —	SB 100

Table 2. A. *turriculata* D'ORBIGNY. Measurements on opercula.

No. of specimen	Long. dia. of shell	L	A	W/L	A/L	B/A	D/C
1	0.74 mm	421 μ	321 μ	0.88	0.76	0.43	0.49
	0.98	647	326	0.80	0.50	0.40	0.48
	1.1	711	332	0.73	0.47	0.44	0.52
6	1.3	758	347	0.81	0.46	0.41	0.45
7	1.4	758	347	0.79	0.46	0.41	0.47
10	1.5	789	326	0.79	0.41	0.42	0.46
	1.6	842	358	0.76	0.43	0.43	0.52

Perfect shells can be identified very easily by the characteristic feature of the spire remarkably heightened and usually coloured in purplish brown. Imperfectly preserved shells, in which the spires are completely torn off, can be identified distinctly by the feature of the operculum.

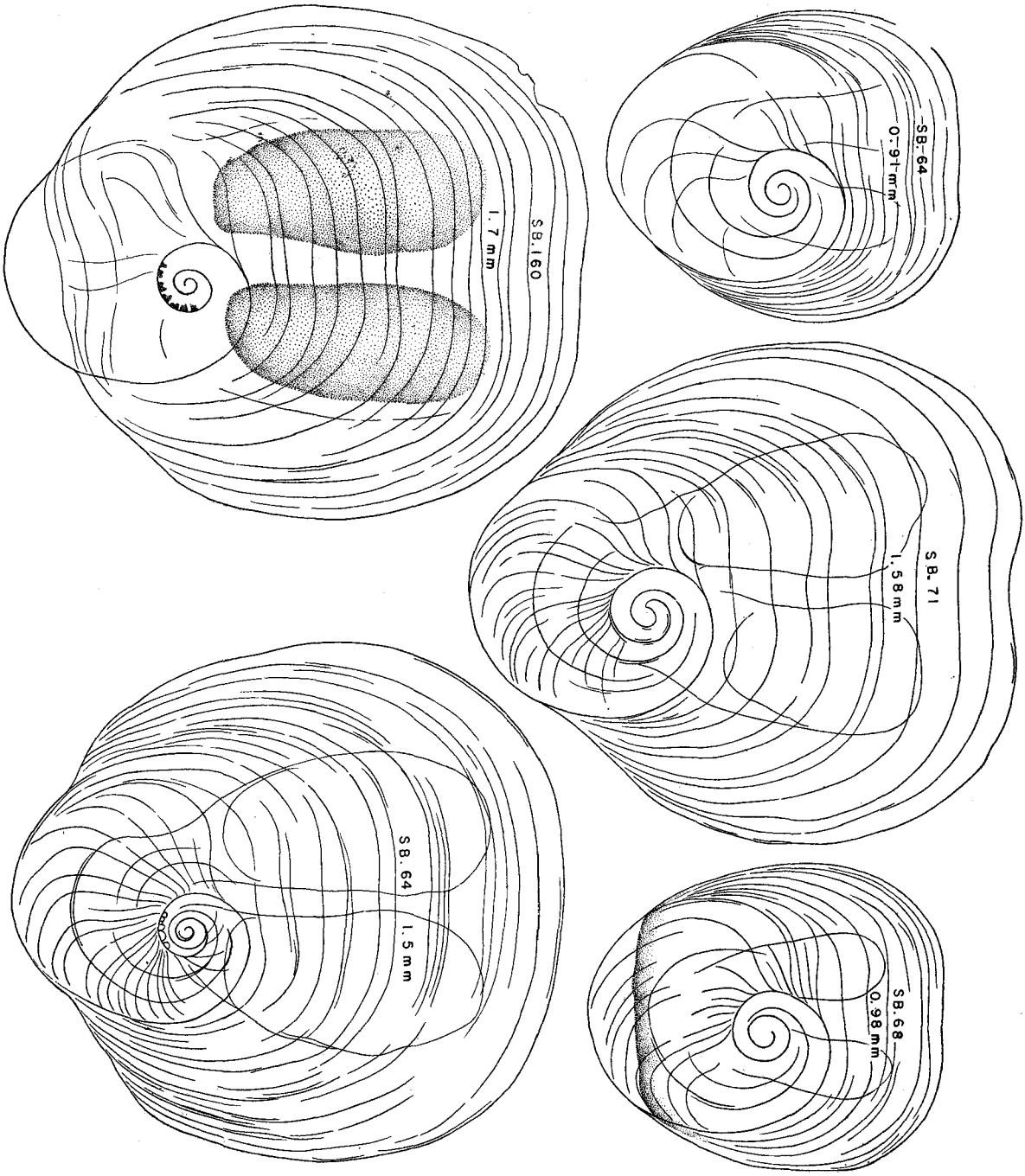
Occurrences:

SB 15 (+) SB 125 (1) SB 181 (1)
SB 60 (1) SB 137 (2) SB 187 (15)
SB 64 (2) SB 145 (3) SB 195 (2)
SB 75 (1) SB 150 (1) SB 200 (21)
SB 80 (7) SB 155 (1) SB 210 (1)
SB 100 (2) SB 160 (12) EQPH 7 (7)
SB 118 (1) SB 175 (7) EQPH 11 (2)

3. *Atlanta fusca* SOULEYET

(Text-fig. 4)

Opercula of very young shells are roughly oval, but those of grown ups are much widened, W/L being 0.87–0.96 in examined specimens. The axial margin



Text-fig. 4. *Atlanta fusca* SOULEYET. Opercula of 0.91~1.7 mm shells from Shellback Stations, seen from the attachment surface. ×107.

is usually obtuse, nearly straight. Gyre is large, but the central portion is comparatively small, situated in the upper axial half and displaced a little from the middle to the anterior side. Very thick throughout. There are several (from 1 to 6) small thickenings in the central portion of the gyre in larger specimens as seen in 1.5 and 1.7 mm shells shown in fig. 4. A pair of traces of pedal muscles are printed very clearly as elongate thinner areas and sometimes marked distinctly by dark pigments remained there.

The general feature of the thick operculum of this species resembles closely that of *A. turriculata*, but it is evidently wider in *fusca* than in *turriculata*.

Table 3. *A. fusca* SOULEYET. Whorl formulae.

No. of specimen	Long diameter	Whorl formula	Number of whorls	Number of whorls on underside	Locality
1	0.89 mm	1 : 0.32 : 0.15			SB 68
2	0.91	1 : 0.36 : 0.21	3-3/4?		SB 64
3	1.5	1 : 0.31 : 0.14	ca. 3?		SB 64
4	1.58	1 : 0.32 : 0.15			SB 71
5	1.7	1 : 0.29 : 0.15	4-1/4	2	SB 160

Table 4. *A. fusca* SOULEYET. Measurements on opercula.

No. of specimen	Long dia. of shell	L	A	W/L	A/L	B/A	D/C
2	0.91 mm	484 μ	337 μ	0.90	0.70	0.41	0.46
	0.98	489	337	0.87	0.69	0.41	0.46
3	1.5	758	337	0.96	0.44	0.38	0.40
4	1.58	768	342	0.91	0.45	0.42	0.46
5	1.7	805	347	0.89	0.43	0.38	0.43

The perfectly preserved specimens of grown up shells of the present species are easily distinguished from others by its characteristic fuscous colouration with a yellowish tint on the whorls and a whitish keel and also by whorl formula with larger middle and last terms. Spire is usually paler in colouration, but never coloured purplish. A pair of dark pigment flecks frequently found at the attachment points of the pedal muscles to the operculum are very helpful for identification, too. The eyes are pale orange, much paler than in other species in preserved state. Juvenile shells resemble those of *A. inclinata* which are also fuscous, but the whorls are more numerous and the spire is higher in *inclinata* than in *fusca*. The differences between juvenile opercula of *fusca* and *inclinata* are given in the descriptions of *inclinata*.

Occurrences:

SB 64 (2) SB 75 (?1) SB 160 (1)
SB 68 (1) SB 80 (1) SB 175 (?1)
SB 71 (1) SB 137 (1) SB 181 (1)

4. *Atlanta lesueuri* SOULEYET

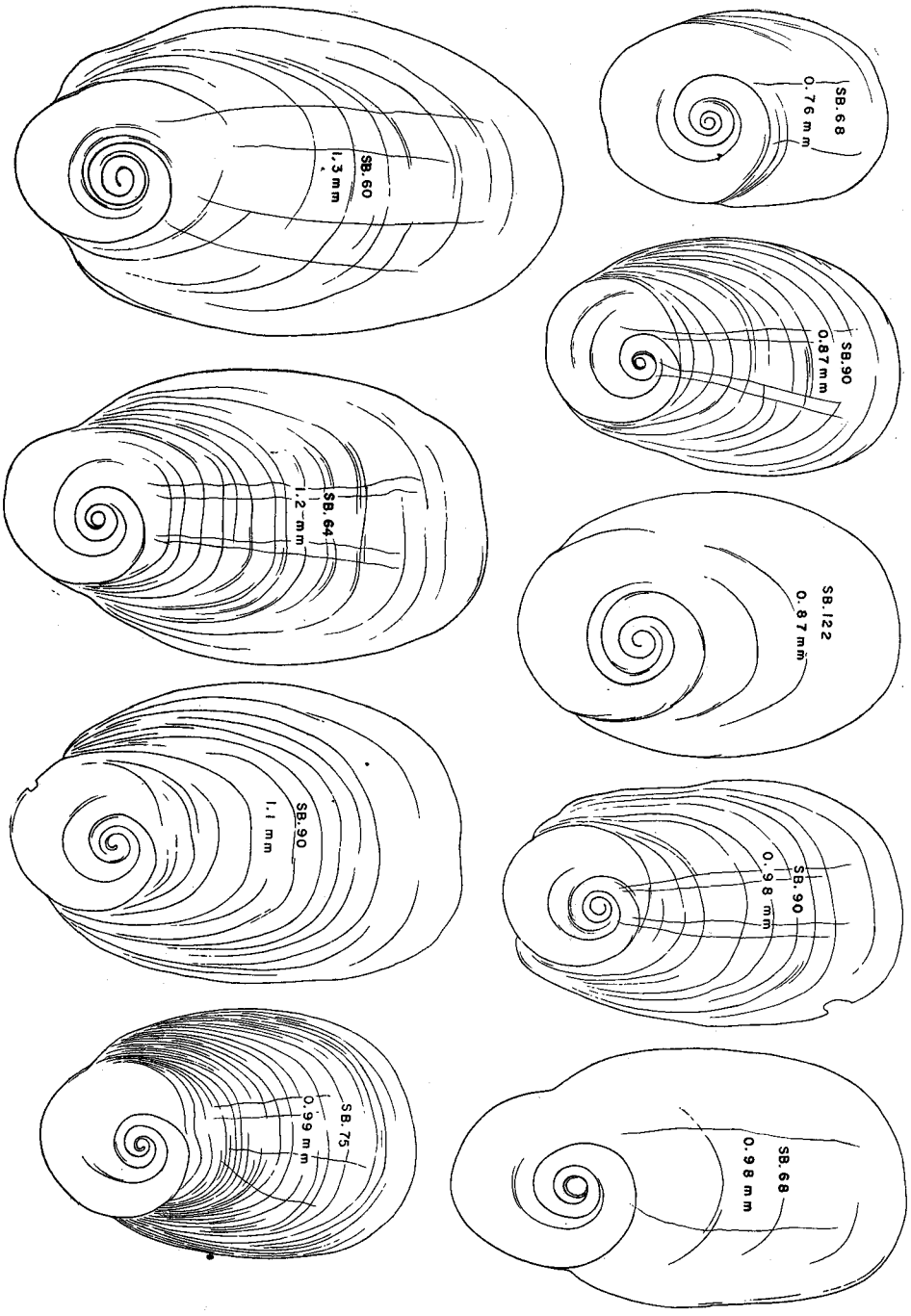
(Text-figs. 5–6)

Elongate oval in outline, W/L being rather small. The axial margin is usually rounded. Gyre relatively small, with rather large central portion located nearly at the centre, the accurate situation is, however, very slightly displaced towards the axial side. The whole operculum is extremely thin.

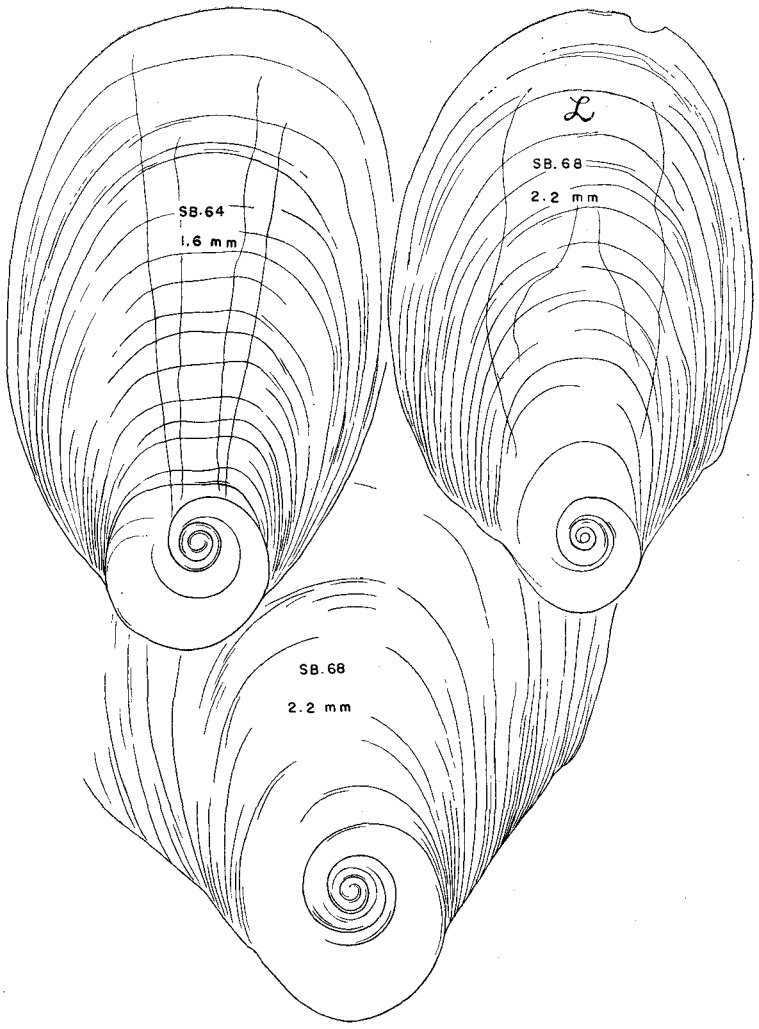
The shells of this species can be easily identified by their unusually large body whorl and by the feature of the spire with much fewer whorls than in any other species. Specimens whose spires are torn off may be identified exactly by the feature of the operculum. Eyes are coloured pale orange to red; of the thirteen examined specimens seven have eyes coloured pale orange, three with reddish orange eyes and other three with red ones.

Table 5. *Atlanta lesueuri* SOULEYET. Whorl formulae.

No. of specimen	Long diameter	Whorl formula	Number of whorls	Number of whorls on underside	Locality
1	0.76 mm	1 : 0.29 : —	2-1/2		SB 68
2	0.8	1 : 0.21 : 0.13	3		SB 80
3	0.87	1 : 0.25 : 0.10	2-1/2		SB 90
4	0.87	1 : 0.30 : 0.13	3	1-1/4	SB 122
5	0.9	1 : 0.24 : 0.12	3		SB 80
6	0.91	1 : 0.24 : —			SB 100
7	0.98	1 : 0.22 : 0.09	3		SB 68
8	0.98	1 : 0.22 : 0.11	2-3/4		SB 90
9	0.99	1 : 0.22 : 0.11	2-1/2		SB 75
10	1.00	1 : 0.26 : 0.13	3–		SB 105
11	1.10	1 : 0.23 : 0.13	3		SB 105
12	1.10	1 : 0.23 : 0.12	3		SB 130
13	1.10	1 : 0.22 : 0.10	2-3/4		SB 90
14	1.10	1 : 0.20 : —			SB 100
15	1.10	1 : 0.20 : 0.10	3		SB 80
16	1.2	1 : 0.20 : 0.09	2-3/4		SB 64
17	1.2	1 : 0.26 : 0.13	3-1/4		SB 130
18	1.3	1 : 0.21 : —			SB 100
19	1.3	1 : 0.20 : 0.10	3-1/4		SB 80
20	1.3	1 : 0.20 : 0.10	3	1-1/2	SB 145
21	1.4	1 : 0.25 : 0.12	3-1/2		SB 105
22	1.41	1 : 0.20 : 0.08	3		SB 75
23	1.5	1 : 0.16 : 0.09	3-1/4		SB 80
24	1.6	1 : 0.19 : 0.08	3		SB 64
25	1.6	1 : 0.19 : 0.07	3-1/4		SB 75
26	1.6	1 : 0.19 : 0.08	?3		SB 100
27	1.7	1 : 0.19 : 0.08	2-1/2		SB 100
28	1.7	1 : 0.19 : —			SB 100
29	1.7	1 : 0.20 : 0.09	3-1/4		SB 130
30	1.8	1 : 0.19 : 0.09	3-1/4		SB 130
31	1.9	1 : 0.18 : 0.09	3-1/4		SB 130
32	2.2	1 : 0.16 : 0.07	3-1/2		SB 68
33	2.7	1 : 0.17 : 0.07	3-1/2		SB 130
34	2.9	1 : 0.18 : 0.08			SB 118



Text-fig. 5. *Atlanta lesueuri* SOULEYET. Opercula of 0.76~1.3 mm shells from Shellback Stations, seen from the attachment surface. ×93.



Text-fig. 6. *Atlanta lesueuri* SOULEYET. Opercula of 1.6 and 2.2 mm shells from Shellback Stations, seen from the attachment surface. L···×55, others···×95.

Table 6. *Atlanta lesueuri* SOULEYET. Measurements on opercula.

No. of specimen	Long dia. of shell	L	A	W/L	A/L	B/A	D/C
1	0.76 mm	426 μ	247 μ	0.68	0.58	0.55	0.68
3	0.87	521	200	0.67	0.38	0.45	0.51
4	0.87	563	274	0.69	0.49	0.56	0.59
7	0.98	668	274	0.57	0.41	0.56	0.67
8	0.98	589	216	0.62	0.37	0.54	0.54
9	0.99	547	221	0.67	0.40	0.50	0.58
13	1.1	653	221	0.68	0.34	0.48	0.53
16	1.2	705	211	0.62	0.30	0.50	0.59
	1.3	800	232	0.61	0.29	0.52	0.58
24	1.6	895	216	0.59	0.24	0.49	0.55
32	2.2	1455	282	0.59	0.19	0.56	0.65

Occurrences:

SB 50 (1)
SB 55 (23)
SB 60 (11)
SB 64 (6)
SB 68 (12)
SB 75 (3)
SB 80 (5)
SB 90 (9)
SB 95 (8)
SB 100 (13)
SB 105 (3)
SB 109 (13)
SB 112 (2)
SB 115 (1)
SB 118 (1)
SB 122 (1)
SB 130 (6)
SB 132 (4)
SB 137 (64)
SB 142 (5)
SB 145 (5)
SB 150 (5)
SB 155 (18)
SB 160 (29)
SB 175 (20)
SB 180 (26)
SB 181 (28)
SB 187 (7)
SB 195 (2)
SB 200 (32)
SB 210 (7)
SB 215 (1)
EQPH 7 (3)
EQPH 11 (19)

5. *Atlanta inclinata* SOULEYET

(Text-figs. 7–10)

Opercula of young shells are nearly roundish to oval and with the axial margin straight or obtuse, while those of grown ups are much elongate and the axial margin is always rounded. Gyre is large and nearly roundish in outline, its central portion is of a moderate size and situated near the middle in the axial half of the gyre. The operculum itself is extremely thin. The structure of gyre resembles somewhat that of *A. fusca*, but in the latter, the operculum is much thicker, W/L is much larger in grown ups and D/C is somewhat smaller than in the present species.

The perfectly preserved shells are easily identified exactly, but the identification of imperfect specimens in which the spires are torn off is rather exact. In such a case, the feature of the operculum, for instance, the size of the gyre and the accurate situation of the central portion shown by B/A and D/C are useful for identification, although some confusions are inevitable between this and some of other species as mentioned later. Eyes were always coloured red in preserved specimens examined.

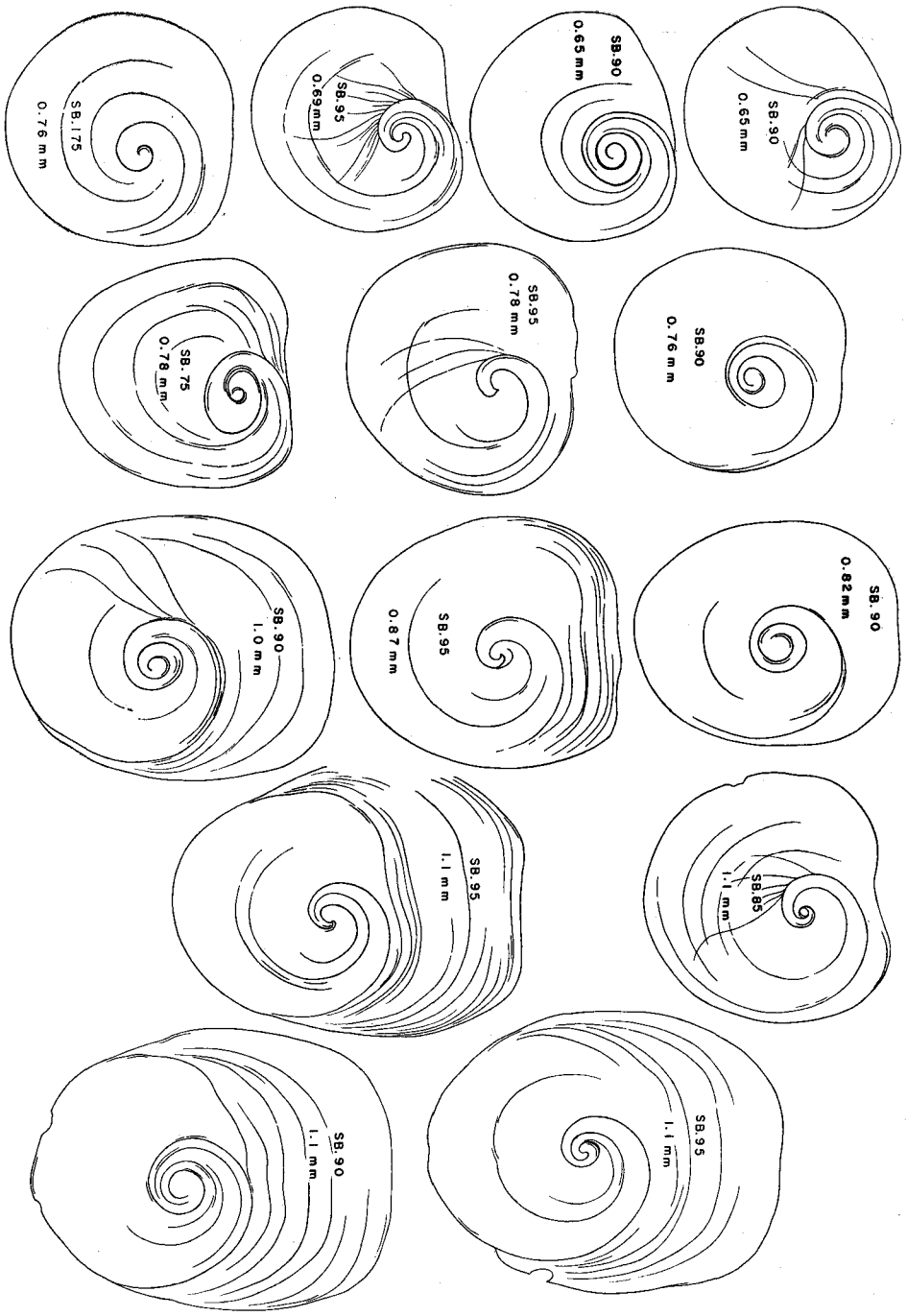
Table 7. *Atlanta inclinata* SOULEYET. Whorl formulae.

No. of specimen	Long diameter	Whorl formula	Number of whorls	Locality
1	0.65 mm	1 : 0.50 : 0.32	3-1/2	SB 90
2	0.65	1 : 0.43 : —		SB 90
3	0.69	1 : 0.56 : —		SB 95
4	0.76	1 : 0.43 : —		SB 90
5	0.76	1 : 0.46 : 0.26	3-1/2	SB 175
6	0.78	1 : 0.53 : —		SB 95
7	0.78	1 : 0.56 : —	4-3/4	SB 75
8	0.82	1 : 0.45 : 0.26		SB 90
9	0.82	1 : 0.39 : —		SB 90
10	0.87	1 : 0.50 : —		SB 95
12	1.00	1 : 0.39 : 0.22	4	SB 90
13	1.1	1 : 0.41 : 0.27	5	SB 85
14	1.1	1 : 0.35 : 0.19	4	SB 90
15	1.1	1 : 0.38 : —		SB 95
16	1.1	1 : 0.40 : —		SB 95
17	1.1	1 : 0.40 : —	5	SB 95
18	1.3	1 : 0.34 : —		SB 90
19	1.3	1 : 0.37 : —		SB 95
20	1.6	1 : 0.34 : 0.19	4-1/2	SB 90
21	1.7	1 : 0.34 : —		SB 90
22	1.7	1 : 0.35 : 0.25	5-1/2*	SB 118
23	2.0	1 : 0.31 : 0.19	5-1/4	SB 80
24	2.0	1 : 0.31 : 0.19		SB 85
25	2.2			SB 175
26	2.4	1 : 0.27 : —		SB 90
27	3.4	1 : 0.28 : 0.13	5+	SB 95
28	3.4			SB 115

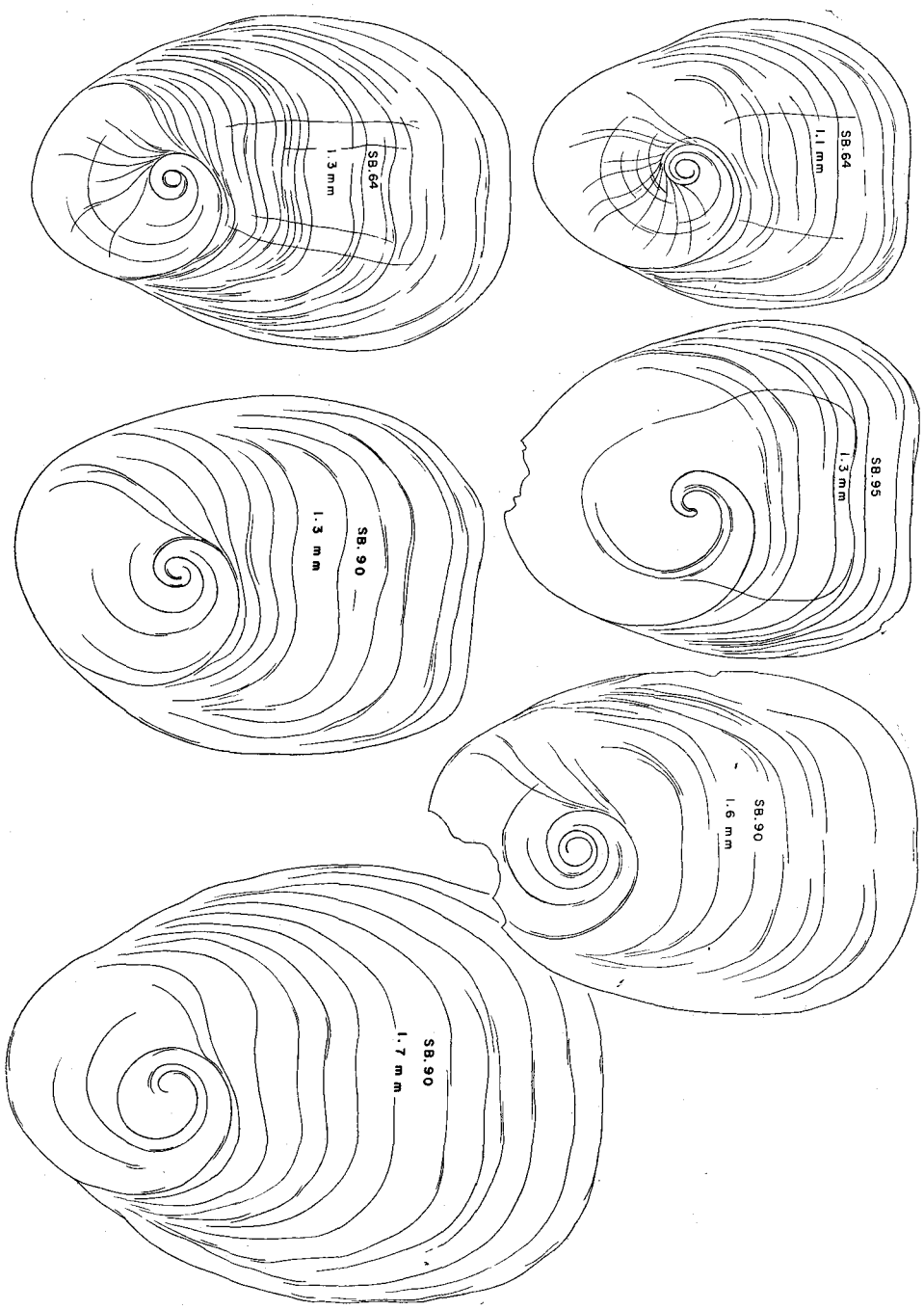
* ca. 2 whorls on the underside.

Table 8. *Atlanta inclinata* SOULEYET. Measurements on opercula.

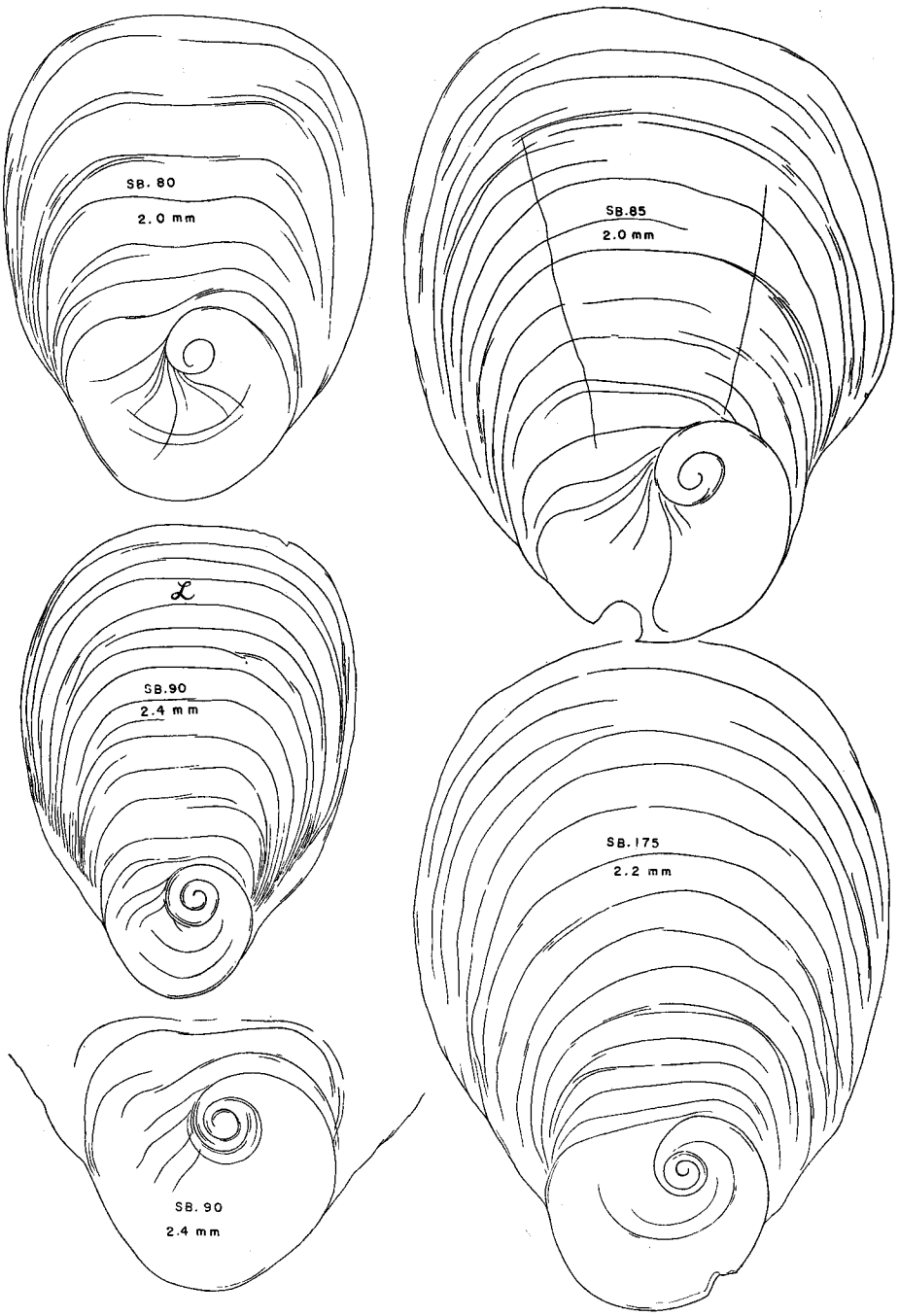
No. of specimen	Long dia. of shell	L	A	W/L	A/L	B/A	D/C
1	0.65 mm	353 μ	353 μ	0.99	1.00	0.43	0.55
2	0.65	337	337	1.08	1.00	0.45	0.51
3	0.69	337	337	1.05	1.00	0.39	0.51
4	0.76	358	316	0.99	0.88	0.42	0.48
5	0.76	358	321	1.00	0.90	0.43	0.48
6	0.78	363	321	1.09	0.88	0.36	0.43
7	0.78	368	368	0.97	1.00	0.37	0.49
8	0.82	416	332	0.85	0.80	0.44	0.53
10	0.87	421	332	0.94	0.79	0.40	0.49
12	1.0	500	332	0.83	0.66	0.46	0.51
13	1.1	384	347	1.03	0.90	0.38	0.46
14	1.1	563	347	0.79	0.62	0.47	0.54
15	1.1	542	337	0.81	0.62	0.36	0.47
16	1.1	553	342	0.80	0.62	0.38	0.52
	1.1	584	316	0.78	0.54	0.38	0.52
	1.3	742	295	0.70	0.40	0.36	0.46
18	1.3	716	363	0.79	0.51	0.39	0.48
19	1.3	632	384	0.84	0.61	0.32	0.48
20	1.6	758	332	0.71	0.44	0.43	0.50
21	1.7	926	358	0.74	0.39	0.49	0.52
23	2.0	768	311	0.75	0.40	0.34	0.47
24	2.0	1010	358	0.76	0.35	0.38	0.43
25	2.2	1060	305	0.70	0.29	0.41	0.48
26	2.4	1290	373	0.70	0.29	0.42	0.51
27	3.4	1710	364	0.64	0.21	0.40	0.52
28	3.4	1460	416	0.67	0.29	0.37	0.46



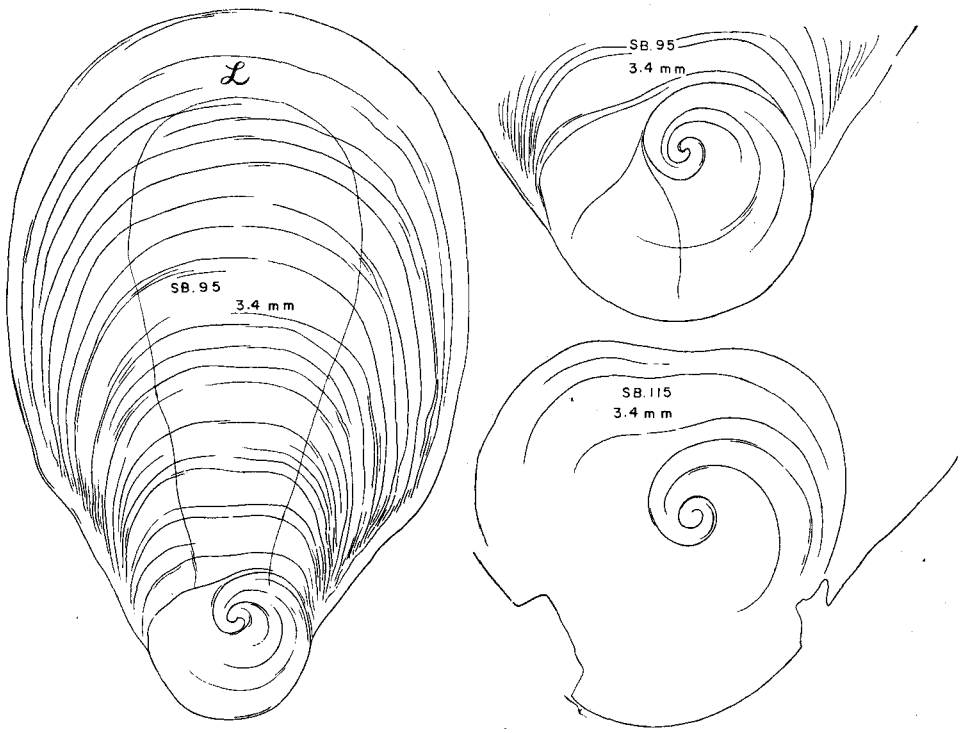
Text-fig. 7. *Atlanta inclinata* SOULEYET. Opercula of 0.65~1.1 mm shells from Shellback Stations, seen from the attachment surface. ×86.



Text-fig. 8. *Atlanta inclinata* SOULEYET. Opercula of 1.1~1.7 mm shells from Shellback Stations, seen from the attachment surface. ×86.



Text-fig. 9. *Atlanta inclinata* SOULEYET. Opercula of 2.0~2.4 mm shells from Shellback Stations, seen from the attachment surface. L···×50, others···×85.



Text-fig. 10. *Atlanta inclinata* SOULEYET. Opercula of 3.4 mm shells from Shellback Stations, seen from the attachment surface. L···×55, others···×95.

Occurrences:

SB 55 (10)	SB 118 (5)	SB 187 (6)
SB 60 (2)	SB 137 (2)	SB 195 (3)
SB 64 (2)	SB 145 (1)	SB 200 (8)
SB 75 (2)	SB 150 (3)	SB 210 (1)
SB 80 (2)	SB 155 (2)	EQPH 3 (2)
SB 85 (2)	SB 160 (11)	EQPH 7 (4)
SB 90 (12)	SB 175 (15)	EQPH 11 (6)
SB 95 (8)	SB 180 (8)	EQPH 17 (12)
SB 115 (8)	SB 181 (8)	EQPS 28 (1)

EQPS···Stranger Station during the Equapac Expedition.

III. Description of the operculum, by which the species can be identified distinctly.

6. *Atlanta inflata* SOULEYET

(Text-figs. 11–12)

There was found a series of opercula which were distinguished very distinctly

from others by possessing a row of craw-like sculptures around the central portion of the gyre. Whorl formulae of the shells having such an operculum are given on Table 9 and they conform well to those of *A. inflata* shown in my previous papers (1955 a and b). Very probably, these shells may be identified safely as *A. inflata*.

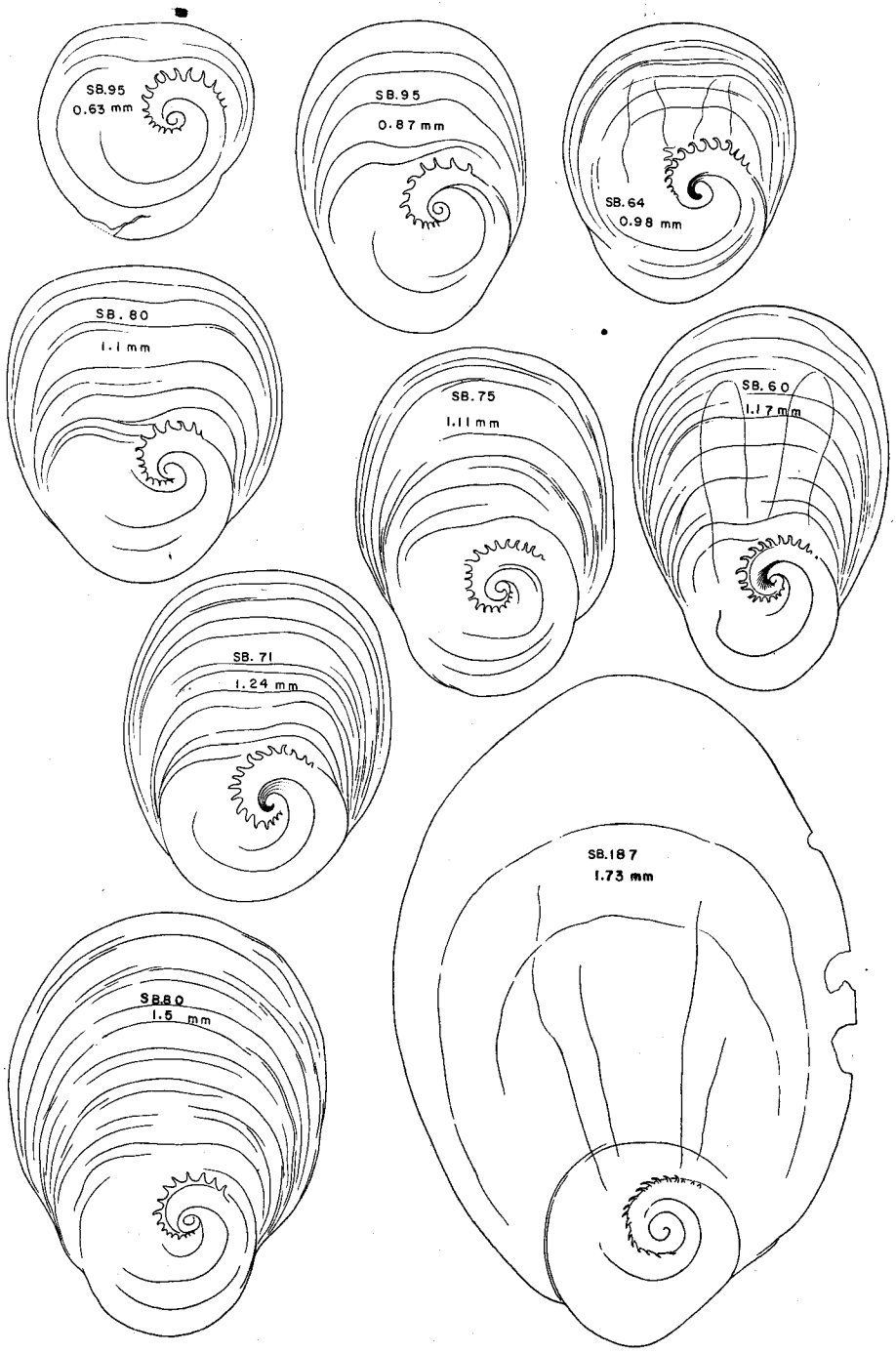
Table 9. *Atlanta inflata* SOULEYET. Whorl formulae.

No. of specimen	Long diameter	Whorl formula	Number of whorls	Number of whorls on underside	Locality
1	0.63 mm	1 : 0.45 : —	?		SB 95
2	0.87	1 : 0.33 : 0.20	4		SB 95
3	0.89	1 : 0.34 : 0.22	4+		SB 160
4	0.98	1 : 0.27 : 0.20	4-1/2		SB 55
5	0.98	1 : 0.33 : 0.20	3-3/4		SB 64
6	1.08	1 : 0.28 : 0.16	4-1/2		SB 60
7	1.1	1 : 0.30 : 0.18	5		SB 55
8	1.1	1 : 0.29 : 0.19	4-1/4		SB 80
9	1.11	1 : 0.29 : 0.18	4		SB 75
10	1.17	1 : 0.30 : 0.18	4-1/2		SB 60
11	1.24	1 : 0.33 : 0.18	4-1/4	2	SB 71
12	1.3	1 : 0.31 : 0.19	4-1/4		SB 160
13	1.3	1 : 0.31 : 0.18	4-1/4		SB 160
14	1.3	1 : 0.30 : 0.17	4-1/4	2-1/4	SB 160
15	1.3	1 : 0.30 : 0.17	4-1/4	2	SB 160
16	1.3	1 : 0.26 : 0.16	4-1/4	2-1/4	SB 160
17	1.4	1 : 0.29 : 0.15	4-1/4		SB 55
18	1.5	1 : 0.31 : 0.16	4-3/4		SB 80
19	1.5	1 : 0.33 : 0.17	4-1/2	2-1/4	SB 80
20	1.5	1 : 0.29 : 0.17	ca. 4	2-1/4	SB 145
21	1.73	1 : 0.28 : 0.11	4-1/4	2-1/4	SB 187
22	1.95	1 : 0.29 : 0.11	5	2-1/4	EQPS 28
23	2.00				SB 180
24	2.6	1 : 0.28 : —	?	2-1/4	SB 155

Table 10. *Atlanta inflata* SOULEYET. Measurements on opercula.

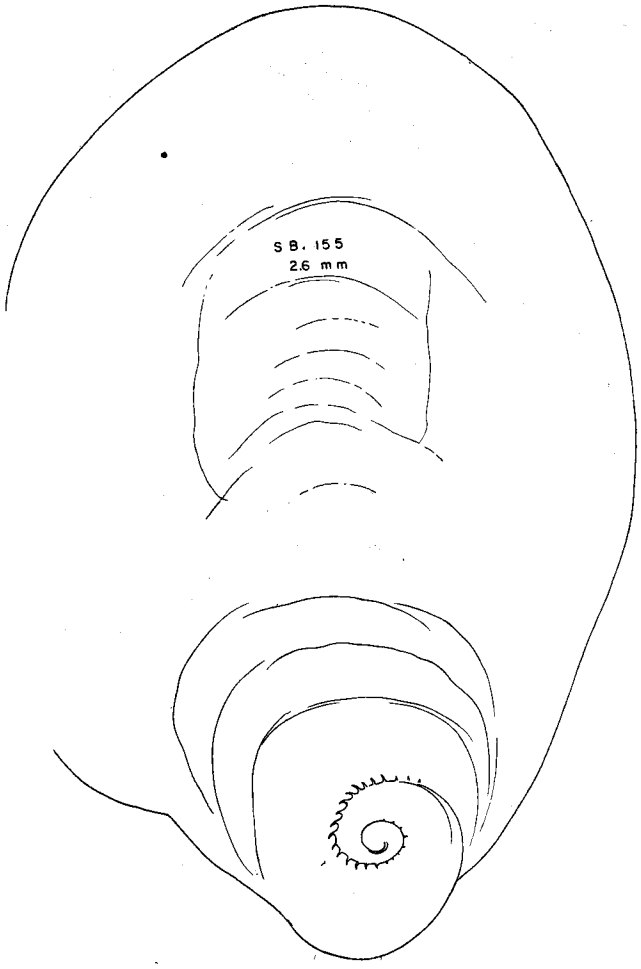
No. of specimen	Long dia. of shell	L	A	W/L	A/L	B/A	D/C
1	0.63 mm	332 μ	247 μ	0.98	0.75	0.32	0.41
2	0.87	479	253	0.73	0.53	0.35	0.48
5	0.98	432	242	0.82	0.56	0.40	0.45
8	1.10	489	237	0.85	0.48	0.34	0.39
9	1.11	537	226	0.73	0.42	0.41	0.56
10	1.17	589	226	0.66	0.38	0.37	0.53
11	1.24	511	226	0.79	0.44	0.47	0.48
18	1.5	653	237	0.74	0.36	0.36	0.49
21	1.73	1031	263	0.68	0.25	0.45	0.50
24	2.6	1321	247	0.68	0.19	0.46	0.54

Operculum is roundish to oval in young shells, but oval in grown ups. The axial margin is usually roundish, excepting the shells of very young stages. Gyre is not so large, A being always less than 270 μ; the central portion is of a moderate size and furnished with 13–26 craw-like sculptures along the suture



Text-fig. 11. *Atlanta inflata* SOULEYET. Opercula of 0.63~1.73 mm shells from Shellback Stations, seen from the attachment surface. ×86.

between it and the last whorl. The central portion is situated wholly in the axial half of the gyre, but near the middle of the antero-posterior axis. The operculum itself is rather thick, especially at the central portion of the gyre where it is somewhat horny.



Text-fig. 12. *Atlanta inflata* SOULEYET. Operculum of a 2.6 mm shell from Shellback Station 155. ×95.

Although the whorl formula of this species differs from those of *A. peroni* and *A. gaudichaudi*, it is rather exact to separate these three species definitely from one another, especially this is the case when young shells are treated or the sculptures on the shell surface are wholly disappeared. The characteristic feature of the operculum, however, makes the identification very easy and distinct.

Throughout the whole specimens identified definitely by using the operculum,

the characteristics of the shell of *A. inflata* are shown by whorl formulae given on Table 9; the formulae are characteristic in that the penultimate whorl looks rather wider than in other species; C/A seems to decrease abruptly between Nos. 20 and 21 (1.5 and 1.73 mm specimens shown on the same table). The spire is relatively tall, but this is not always the case, for it may be rather low as in No. 20 specimen. It is usually purplish, and this colouration may extend over the whole shell in a deep tone as in No. 17 specimen. The base of the keel is brownish. Eyes are pale orange in preserved specimens.

Occurrences:

SB 55 (3)	SB 145 (1)	SB 187 (1)
SB 60 (2)	SB 155 (1)	SB 195 (1)
SB 64 (1)	SB 160 (7)	SB 200 (15)
SB 71 (1)	SB 175 (3)	SB 210 (2)
SB 80 (3)	SB 180 (1)	EQPH 11 (17)
SB 95 (2)	SB 181 (1)	EQPS 28 (1)

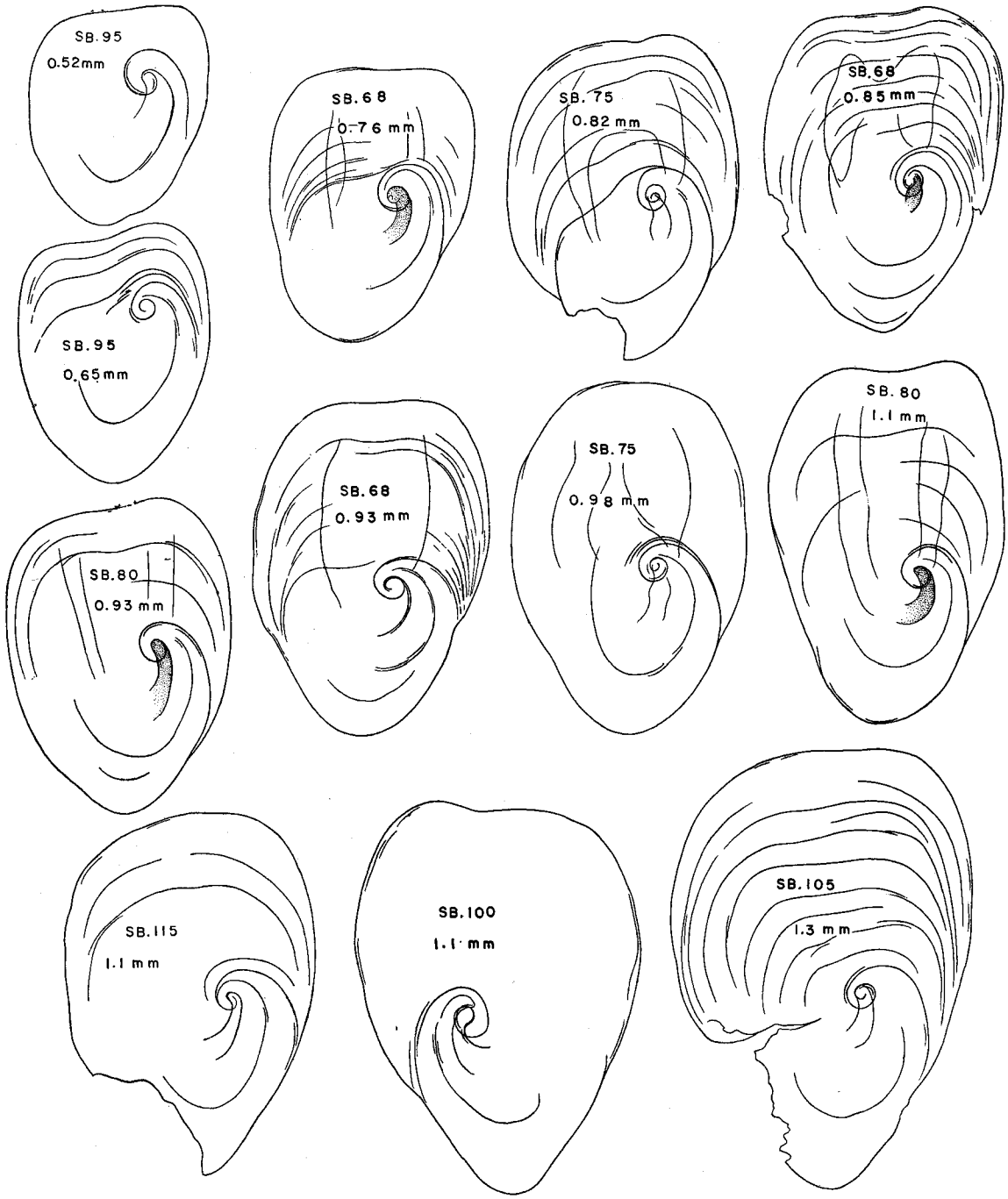
IV. Descriptions of opercula of the species, shells of which resemble one another rather closely.

7. *Atlanta gaudichaudi* SOULEYET

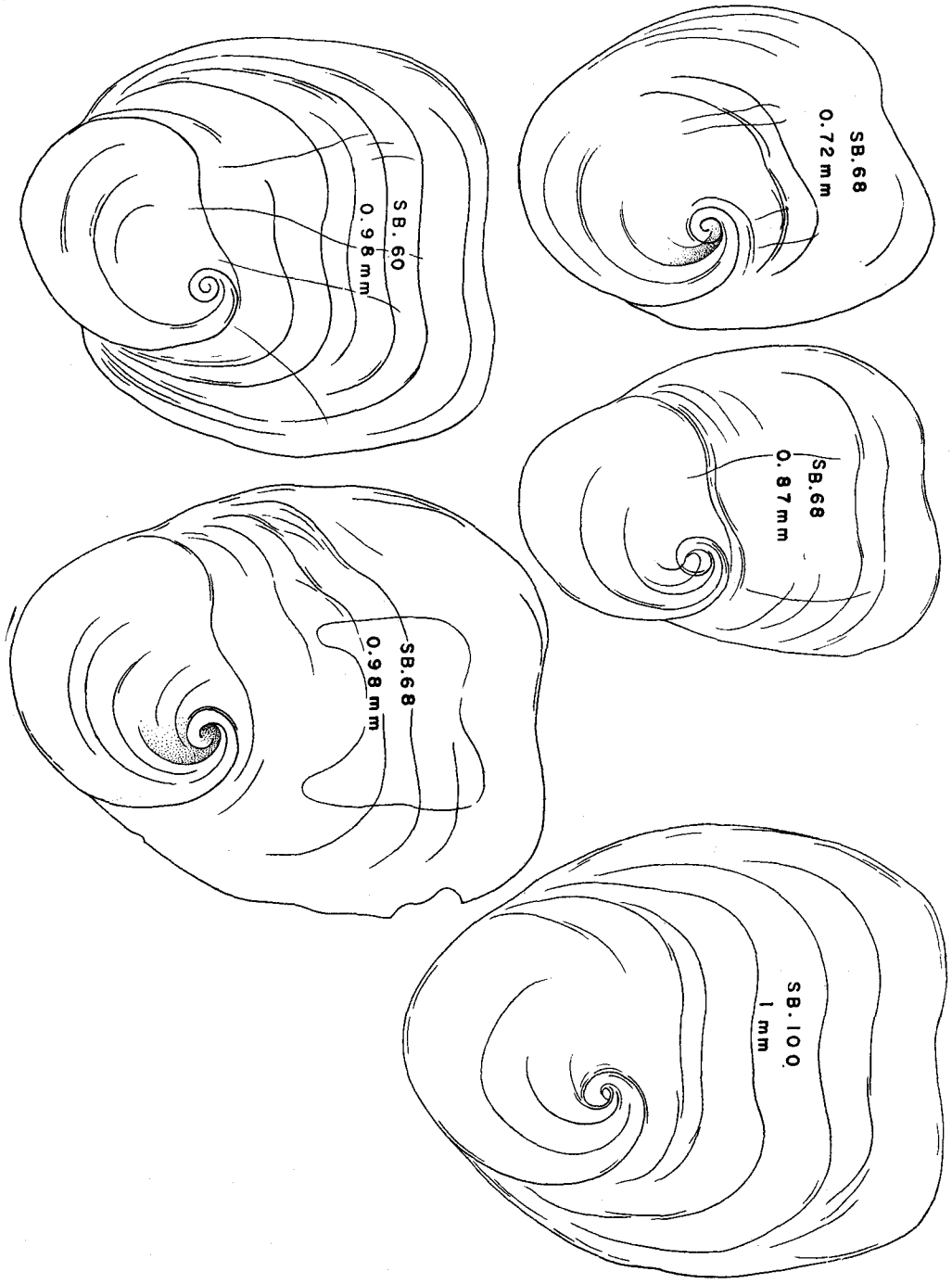
(Text-figs. 13–24)

There are two series of opercula which have each a relatively narrow gyre with the very small central portion situated near its anteroaxial corner. One of them, Series N, consists of opercula having the gyre 242–311 μ in length and smaller B/A and D/C, while opercula of the other series, Series W, have the 295–418 μ long gyre and larger B/A and D/C.

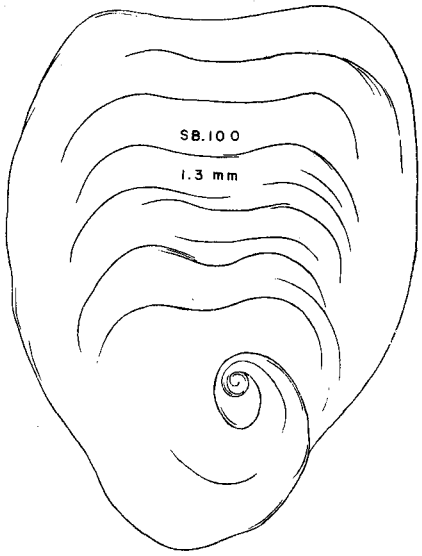
Series N: Opercula of this series were found only in young shells smaller than 1.3 mm in diameter. The typical ones are shown in Text-fig. 13. They are rather elongate, the axial margin in usually truncate and the peripheral end is most frequently acute bluntly. Gyre is short and narrow, the central portion extremely small and situated approximately at the level of the upper (axial) one-fourth and very near the right (anterior) margin. The operculum itself is very thin. Opercula shown in Text-figs. 14–15 are slightly larger than those of Text-fig. 13 and comparatively wider. Gyre is short but rather wide and the lower (peripheral) end is rounded. In spite of the existence of such differences between these and those shown in Text-fig. 13, both opercula seem to be continuous to each other as the close resemblance is shown between the 0.93 mm long specimen from SB 68 (fig. 13) and the 0.87 mm long specimen from SB 68 (fig. 14). Very probably the characteristic feature of the opercula shown in figs. 14–15 is caused by a slight inclination of the axis of the gyre towards the anterior side.



Text-fig. 13. *Atlanta gaudichaudi* SOULEYET, narrow type. Opercula of 0.52~1.3 mm shells from Shellback Stations, seen from the attachment surface, excepting the 1.1 mm shell from SB 100. ×107.



Text-fig. 14. *Atlanta gaudichaudi* SOULEYET, narrow type. Opercula of 0.72~1 mm shells from Shellback Stations, seen from the attachment surface. ×127.



Text-fig. 15. *Altanta gaudichaudi* SOULEYET, narrow type. Operculum of 1.3 mm shell from Shellback Station 100. ×95.

Table 11. *Atlanta gaudichaudi* SOULEYET, Series N. Whorl formulae.

No. of specimen	Long diameter	Whorl formula	Number of whorls	Number of whorls on underside	Locality
1	0.52 mm	1 : 0.46 : —	?		SB 95
2	0.61	1 : 0.39 : —			SB 100
3	0.65	1 : 0.40 : 0.23	4		SB 95
4	0.72	1 : 0.39 : 0.18	3-1/2		SB 68
5	0.76	1 : 0.34 : 0.20	3-1/4		SB 68
6	0.78	1 : 0.36 : 0.22			SB 100
7	0.82	1 : 0.34 : 0.21	3-1/2		SB 75
8	0.85	1 : 0.28 : 0.18	3-1/2		SB 68
9	0.87	1 : 0.32 : 0.20	4-1/2		SB 100
10	0.87	1 : 0.35 : 0.20	4-1/2		SB 100
11	0.87	1 : 0.30 : 0.18	3-3/4		SB 68
12	0.87	1 : 0.35 : 0.22	4-1/2		SB 95
13	0.91	1 : 0.36 : 0.19	4	1-3/4	SB 145
14	0.91	1 : 0.36 : 0.22	4-1/4		SB 60
15	0.91	1 : 0.33 : —			SB 90
16	0.93	1 : 0.35 : 0.21	4-3/4	1-3/4	SB 80
17	0.93	1 : 0.28 : 0.17	3-3/4		SB 68
18	0.93	1 : 0.33 : 0.21	4-3/4		SB 95
19	0.93	1 : 0.35 : 0.21	5		SB 95
20	0.95	1 : 0.32 : 0.18	4-1/2		SB 100
21	0.98	1 : 0.31 : 0.18	4-1/2		SB 100
22	0.98	1 : 0.31 : 0.20	4-1/2		SB 100
23	0.98	1 : 0.31 : 0.18	4-1/4		SB 160
24	0.98	1 : 0.31 : 0.18	4		SB 75
25	0.98	1 : 0.33 : 0.21	4-1/2		SB 60

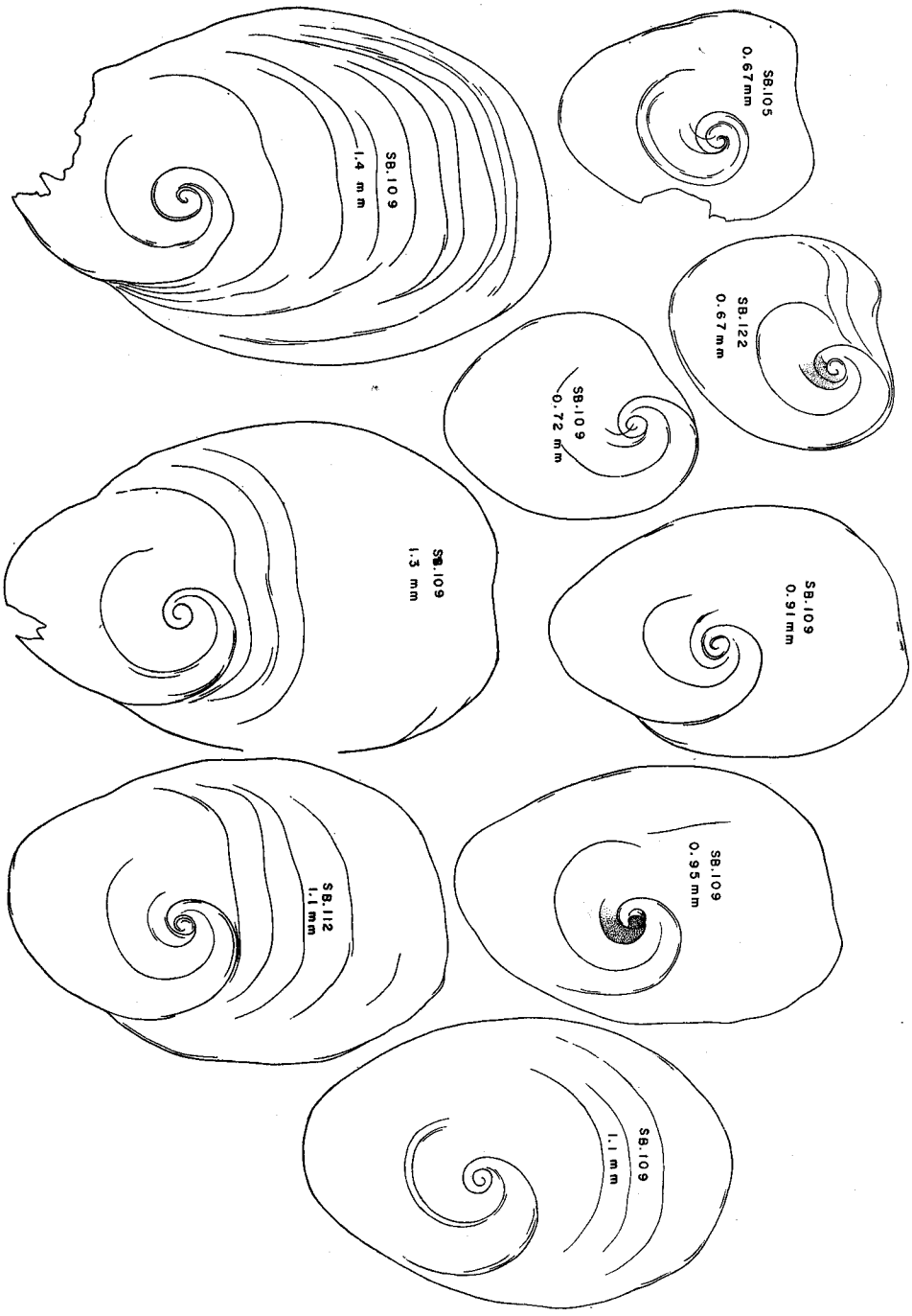
Table 11. (Continued)

No. of specimen	Long diameter	Whorl formula	Number of whorls	Number of whorls on underside	Locality
26	0.98	1 : 0.33 : 0.20	3+		SB 68
27	1.00	1 : 0.34 : 0.21	5		SB 100
28	1.00	1 : 0.33 : 0.22	4+		SB 90
29	1.1	1 : 0.28 : 0.19	4-1/4		SB 90
30	1.1	1 : 0.30 : 0.16	4-1/2		SB 100
31	1.1	1 : 0.34 : 0.20	5		SB 115
32	1.1	1 : 0.31 : 0.19	5+	1-1/2	SB 145
33	1.1	1 : 0.31 : 0.18	4-3/4	1-3/4	SB 80
34	1.2	1 : 0.29 : 0.18	5+	1-1/2	SB 145
35	1.2	1 : 0.39 : 0.21	4?		SB 145
36	1.2	1 : 0.33 : 0.20	5		SB 80
37	1.3	1 : 0.30 : 0.17	5		SB 105
38	1.3	1 : 0.28 : 0.17	4-3/4		SB 100

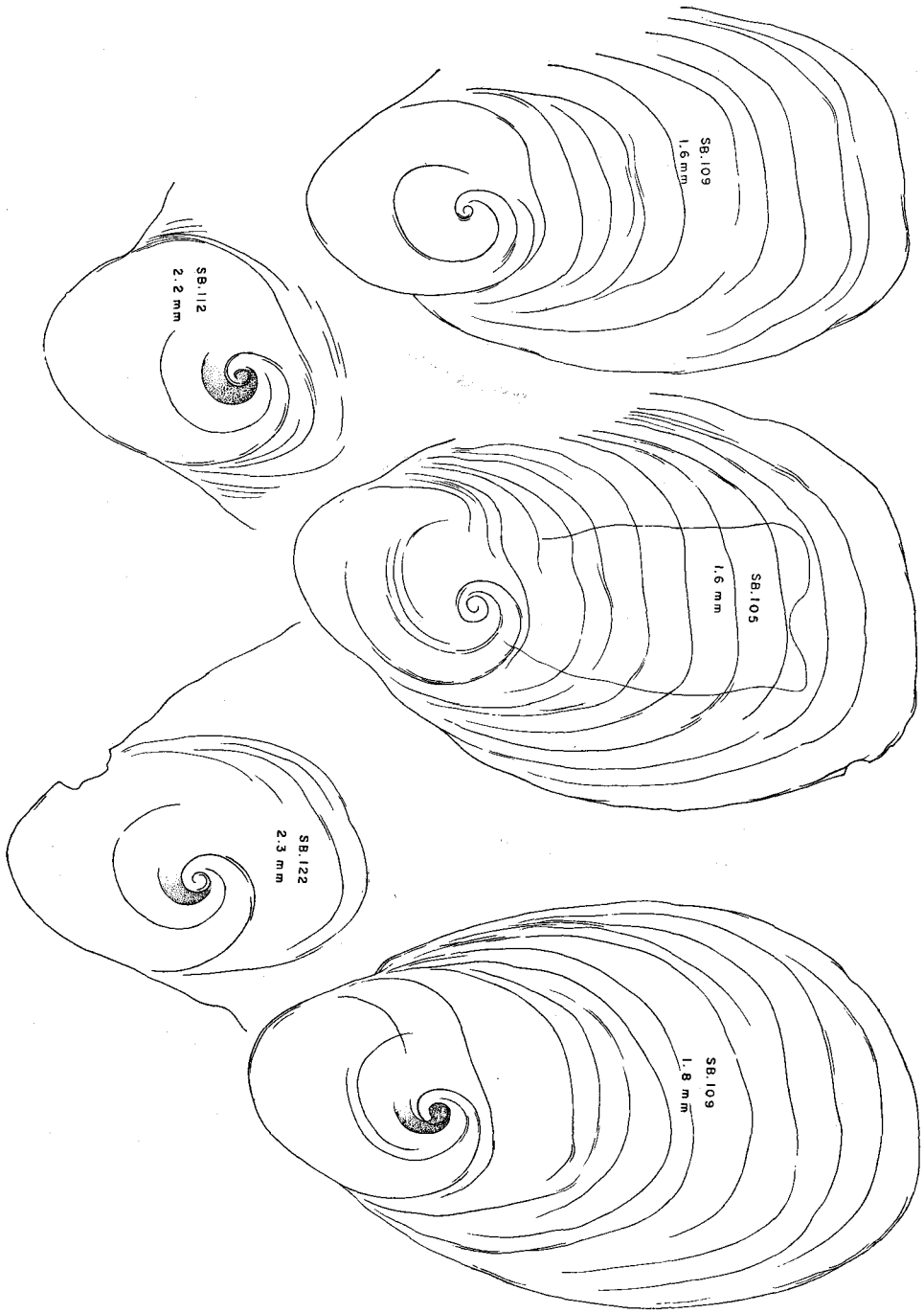
Table 12. *Atlanta gaudichaudi* SOULEYET, Series N. Measurements on opercula.

No. of specimen	Long dia. of shell	L	A	W/L	A/L	B/A	D/C
Opercula shown in text-fig. 13.							
1	0.52 mm	311 μ	253 μ	0.78	0.81	0.25	0.35
3	0.65	358	279	0.74	0.78	0.19	0.30
5	0.76	379	258	0.72	0.68	0.27	0.34
7	0.82	437	268	0.72	0.61	0.22	0.29
8	0.85	437	258	0.73	0.59	0.27	0.34
16	0.93	437	268	0.70	0.61	0.20	0.28
17	0.93	458	247	0.70	0.54	0.22	0.33
24	0.98	479	263	0.67	0.55	0.20	0.30
30	1.1	484	253	0.66	0.52	0.23	0.29
31	1.1	500	284	0.68	0.57	0.20	0.28
33	1.1	553	295	0.70	0.53	0.25	0.33
37	1.3	600	311	0.68	0.52	0.19	0.32
Opercula shown in text-figs. 14 and 15.							
4	0.72	453	247	0.79	0.55	0.21	0.27
11	0.87	463	242	0.74	0.52	0.24	0.30
25	0.98	542	258	0.85	0.48	0.22	0.23
26	0.98	589	268	0.80	0.46	0.22	0.27
27	1.00	605	279	0.83	0.46	0.25	0.29
38	1.3	758	289	0.74	0.38	0.35	0.33

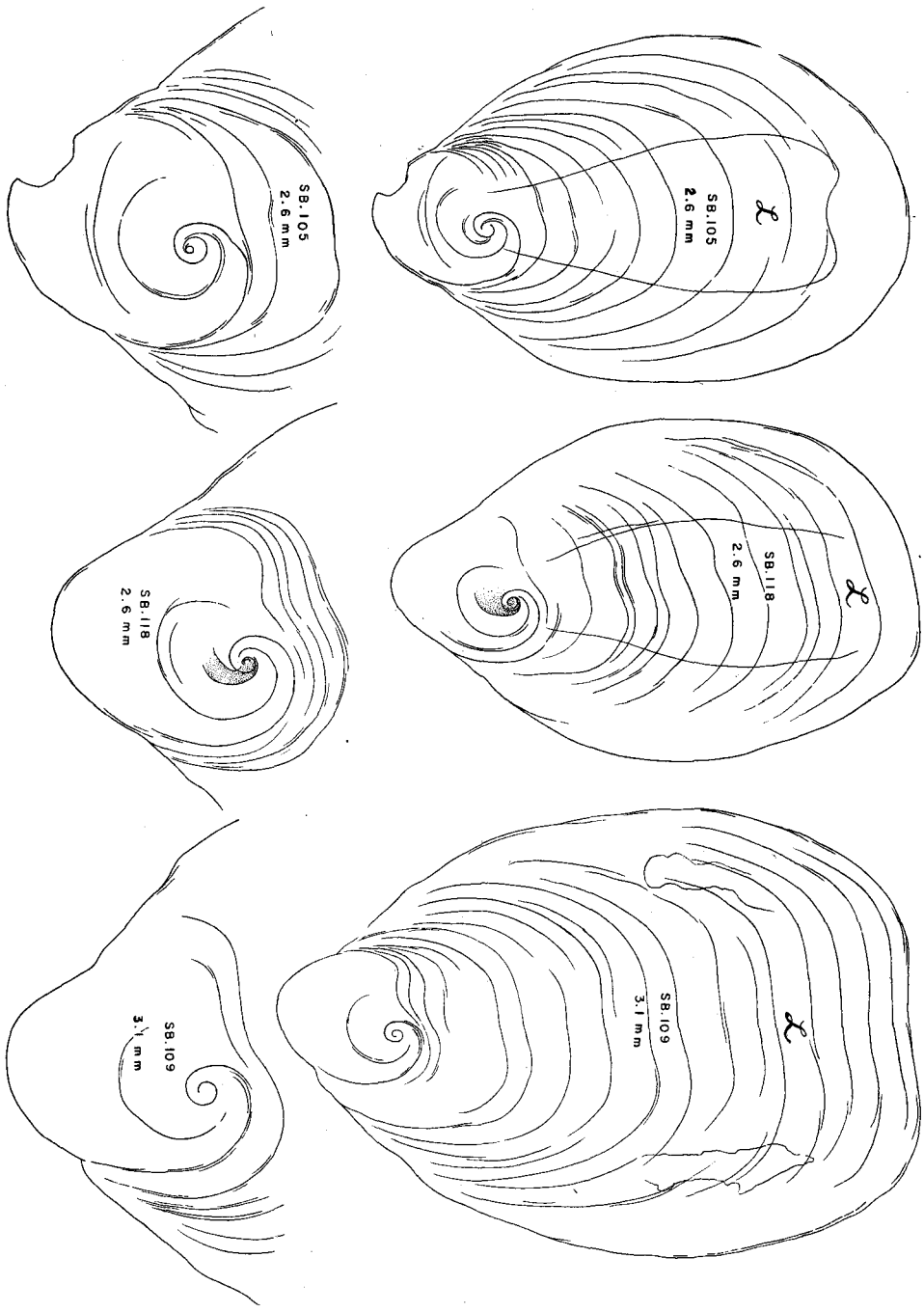
Series W: The operculum is oval, with the axial margin usually rounded in those of the shells larger than 1 mm in diameter and the peripheral (lower) edge most frequently rounded. Gyre is narrow, but longer than in Ser. N; the central portion is still small, although it is evidently larger than in Ser. N. The situation of the central portion is nearer to the centre of the gyre as shown by larger B/A and D/C. The operculum may seem slightly thicker than in Ser. N in some specimens.



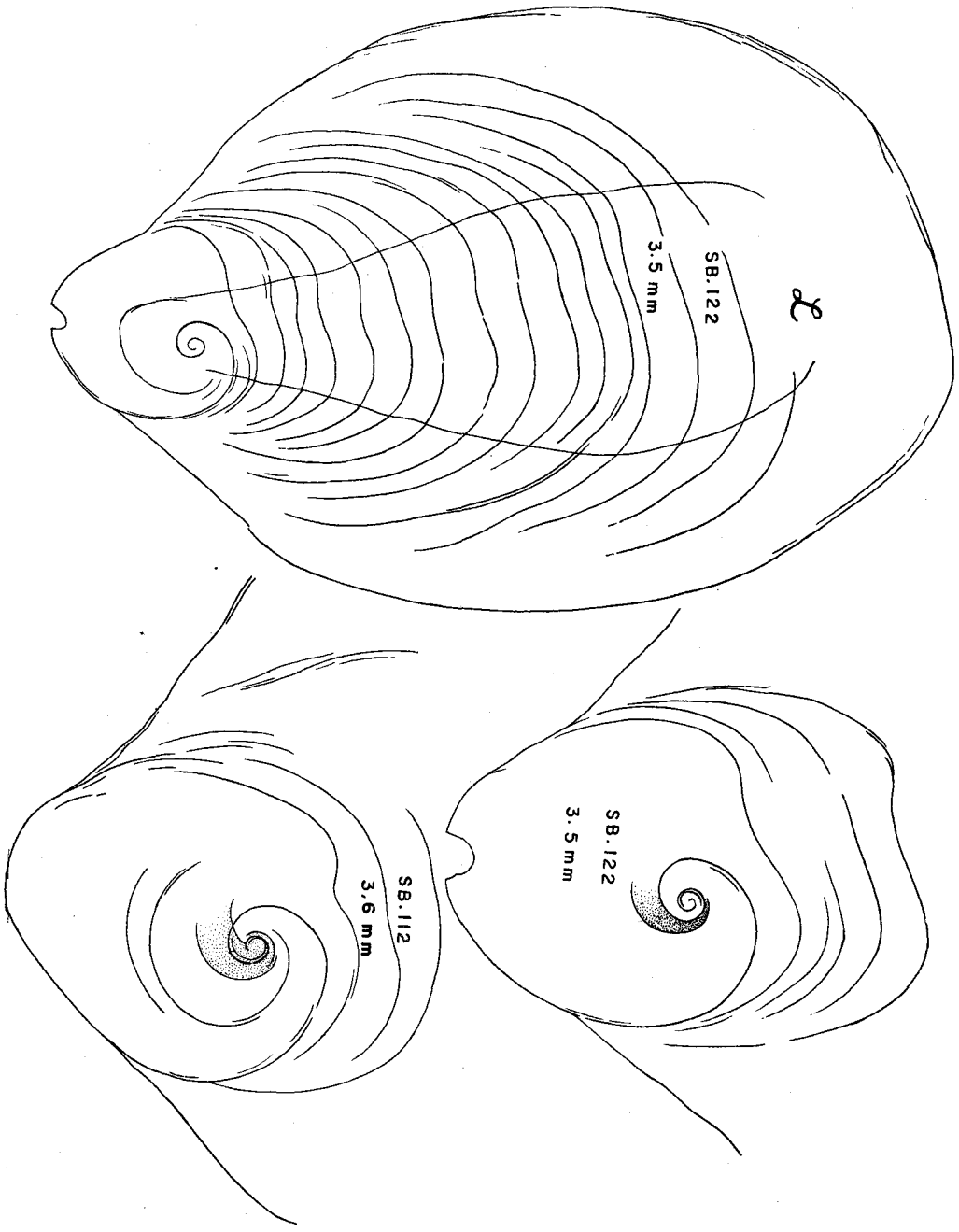
Text-fig. 16. *Atlanta gaudichaudi* SOULEYET, wide type. Opercula of 0.67～1.4 mm shells from Shellback Stations, seen from the attachment surface. ×86.



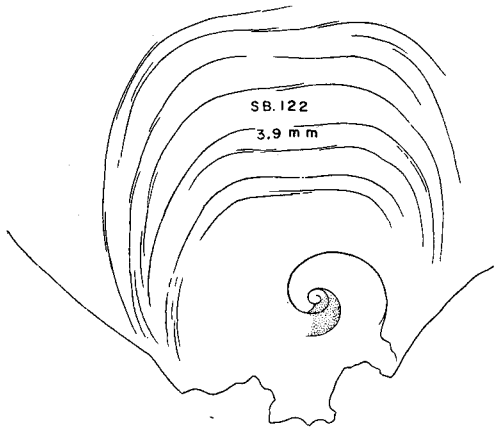
Text-fig. 17. *Atlanta gaudichaudi* SOULEYET, wide type. Opercula of 1.6~2.3 mm shells from Shellback Stations, seen from the attachment surface. ×86.



Text-fig. 18. *Atlanta gaudichaudi* SOULEYET, wide type. Opercula of 2.6~3.1 mm shells from Shellback Stations, seen from the attachment surface. L···×50, others···×86.



Text-fig. 19. *Atlanta gaudichaudi* SOULEYET, wide type. Opercula of 3.5 and 3.6 mm shells from Shellback Stations, seen from the attachment surface. L···×73, others···×127.



Text-fig. 20. *Atlanta gaudichaudi* SOULEYET, wide type. Operculum of 3.9 mm shell from Shellback Station 122, seen from the attachment surface. ×95.

Table 13. *Atlanta gaudichaudi* SOULEYET, Series W. Whorl formulae.

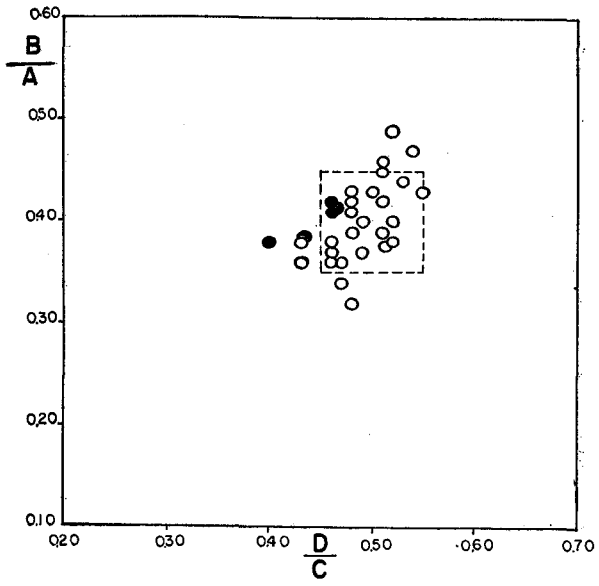
No. of specimen	Long diameter	Whorl formula	Number of whorls	Number of whorls on underside	Locality
1	0.36 mm	1 : 0.44 : 0.25	4-1/4		SB 145
2	0.67	1 : 0.42 : 0.26	4	1-1/4	SB 122
3	0.69	1 : 0.41 : —	3+		SB 105
4	0.69	1 : 0.47 : 0.28	3-3/4		SB 122
5	0.72	1 : 0.45 : —			SB 109
6	0.87	1 : 0.43 : 0.25	4+	1-1/4	SB 122
7	0.89	1 : 0.41 : 0.24	3-1/4		SB 122
8	0.91	1 : 0.43 : —			SB 109
9	0.91	1 : 0.43 : 0.24	4-1/2		SB 122
10	0.95	1 : 0.34 : —	3+		SB 109
11	1.1	1 : 0.33 : —	3+		SB 109
12	1.1	1 : 0.35 : 0.18	3+		SB 112
13	1.1	1 : 0.36 : 0.20	4-1/4	1-1/4	SB 122
14	1.1	1 : 0.33 : —			SB 112
15	1.1	1 : 0.33 : 0.18	3+		SB 109
16	1.2	1 : 0.29 : 0.18	5	2	SB 160
17	1.3	1 : 0.32 : 0.16	ca. 4		SB 109
18	1.3	1 : 0.32 : 0.17			SB 109
19	1.3	1 : 0.27 : 0.15	5		SB 160
20	1.3	1 : 0.31 : 0.17	5+	2	SB 160
21	1.3	1 : 0.33 : 0.18	4-1/4	1-1/4	SB 122
22	1.4	1 : 0.30 : 0.15	4?		SB 109
23	1.4	1 : 0.30 : 0.15	4-1/2	1-1/2	SB 122
24	1.4	1 : 0.29 : —			SB 112
25	1.5	1 : 0.27 : 0.14	ca. 4		SB 112
26	1.5	1 : 0.29 : —			SB 112
27	1.5	1 : 0.27 : 0.14	5	1-3/4	SB 145
28	1.5	1 : 0.30 : 0.18	4-1/2	1-1/2	SB 122
29	1.5	1 : 0.29 : 0.17	4-1/4	1-1/2	SB 122
30	1.5	1 : 0.29 : 0.17	4-1/4	1-1/2	SB 122
31	1.5	1 : 0.29 : 0.17	4-3/4	1-1/2	SB 122
32	1.6	1 : 0.28 : 0.15	ca. 4		SB 109
33	1.6	1 : 0.27 : 0.13	4+		SB 105

34	1.6	1 : 0.28 : 0.15	4-3/4	1-1/2	SB 122
35	1.6	1 : 0.27 : 0.15	4-1/2	1-1/2	SB 122
36	1.6	1 : 0.28 : 0.16	5	1-1/2	SB 122
37	1.6	1 : 0.29 : 0.15	4-3/4	1-1/2	SB 122
38	1.7	1 : 0.25 : 0.15	4-1/2	1-1/2	SB 122
39	1.8	1 : 0.27 : 0.13	ca. 4		SB 109
40	1.8	1 : 0.26 : 0.12	ca. 4		SB 112
41	1.8	1 : 0.24 : 0.14	4-1/2	1-3/4	SB 122
42	1.8	1 : 0.27 : 0.15	5	1-1/2	SB 122
43	1.8	1 : 0.24 : 0.14	4-1/2	1-1/2	SB 122
44	2.0	1 : 0.28 : 0.13	4-3/4	1-1/2	SB 122
45	2.0	1 : 0.27 : 0.14	ca. 5	1-3/4	SB 122
46	2.1	1 : 0.26 : 0.13	5		SB 122
47	2.2	1 : 0.25 : 0.12	ca. 4		SB 112
48	2.2	1 : 0.25 : 0.12			SB 112
49	2.2	1 : 0.25 : 0.14	5-1/4		SB 122
50	2.3	1 : 0.23 : 0.11	5	1-3/4	SB 122
51	2.6	1 : 0.25 : —	4+		SB 105
52	2.6	1 : 0.25 : 0.13	5		SB 118
53	2.6	1 : 0.25 : 0.13	5-1/4	ca. 2	SB 122
54	2.6	1 : 0.25 : 0.13	5-1/4	ca. 2	SB 122
55	2.7	1 : 0.24 : 0.11	5-1/4		SB 122
56	2.9	1 : 0.25 : 0.11	5-1/8	ca. 2	SB 122
57	2.9	1 : 0.27 : 0.11	5-1/4	1-3/4	SB 125
58	2.9	1 : 0.29 : —			SB 109
59	3.0	1 : 0.28 : —			SB 109
60	3.0	1 : 0.26 : 0.11	5+		SB 118
61	3.1	1 : 0.27 : —	?		SB 109
62	3.1	1 : 0.25 : 0.13	5-1/4	2	SB 122
63	3.4	1 : 0.27 : 0.10	5-1/2		SB 80
64	3.5	1 : 0.24 : 0.09	5	2-1/4	SB 122
65	3.6	1 : 0.25 : 0.09	5-1/4		SB 112
66	3.8	1 : 0.26 : 0.09	5-1/2		SB 80
67	3.9	1 : 0.25 : 0.10	5	2-1/4	SB 122
68	4.6	1 : 0.26 : —			SB 80

Table 14. *Atlanta gaudichaudi* SOULEYET, Series W. Measurements on opercula.

No. of specimen	Long dia. of shell	L	A	W/L	A/L	B/A	D/C
2	0.67 mm	395 μ	295 μ	0.84	0.75	0.29	0.41
	0.67	384	374	0.85	0.97	0.35	0.45
5	0.72	395	395	0.83	1.00	0.32	0.44
8	0.91	563	332	0.69	0.59	0.29	0.41
10	0.95	589	368	0.69	0.63	0.29	0.36
11	1.1	668	379	0.68	0.57	0.32	0.41
12	1.1	679	363	0.78	0.53	0.30	0.43
17	1.3	763	363	0.68	0.48	0.32	0.42
22	1.4	837	342	0.67	0.41	0.37	0.44
32	1.6	932	353	0.62	0.38	0.34	0.45
33	1.6	974	384	0.67	0.39	0.32	0.39
39	1.8	1047	374	0.61	0.36	0.28	0.40
47	2.2		395			0.26	0.36
50	2.3		389			0.30	0.40
51	2.6	1427	400	0.65	0.28	0.32	0.43
52	2.6	1400	418	0.65	0.30	0.26	0.37
61	3.1	1673	391	0.72	0.23	0.27	0.35
64	3.5	1709	355	0.68	0.21	0.31	0.44
65	3.6	2000	368	0.75	0.18	0.31	0.35
67	3.9	1800		0.72			0.37

Before the relation between Series N and W is discussed, it seems to be necessary to learn about the range of variations found in respective features of the operculum of some distinctly identified species. Of these features, the length of the gyre and the situation of the central portion indicated by B/A×D/C are considered most important for discussing the relation between Series N and W. The situations of the central portion of the gyre in five well-defined species are shown in text-figs. 21 and 22, and those of Series N and W in text-fig. 23. Even when Series N and W are treated as a single group, the range of variations throughout these two series is never too large as compared with those of some of the five species, as B/A fluctuates for 0.40 as in *A. inclinata* (text-fig. 21) and

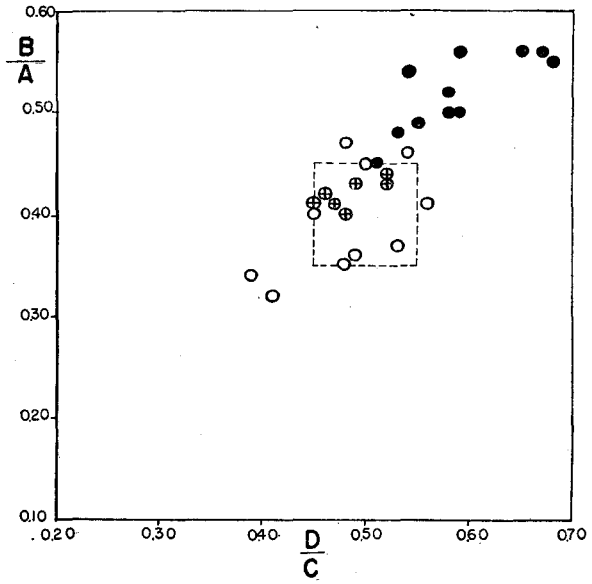


Text-fig. 21. Variations found in the situation of the central portion of gyre in *A. inclinata* (open circle) and *A. fusca* (solid circle). Square shows B/A (0.35–0.45)×D/C (0.45–0.55).

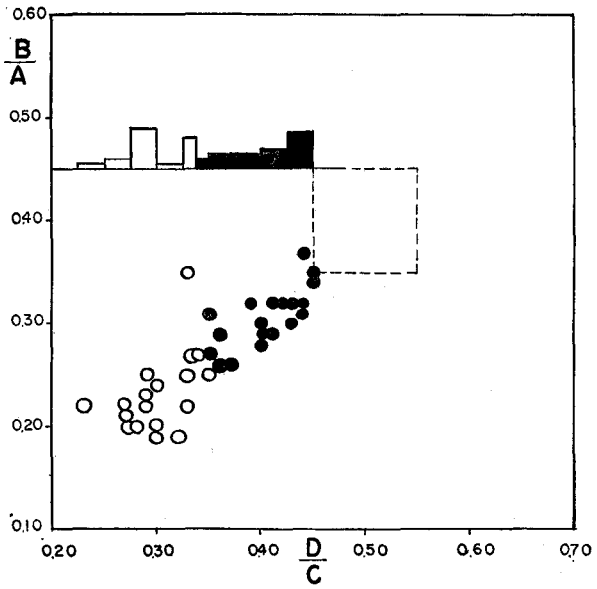
D/C also does for approximately 0.40 as in *A. lesueuri* (text-fig. 22). As to this respect, Series N and W may be considered to be quite continuous to each other. On the other hand, there is a considerable gap between the gyre length of the two series as is seen in text-fig. 24. The gyre length fluctuates in the above-mentioned five species as shown on Table 15.

Table 15. Fluctuations of gyre length in six species.

turriculata	339 ± 18 μ
fusca	342 ± 5
lesueuri	241 ± 41



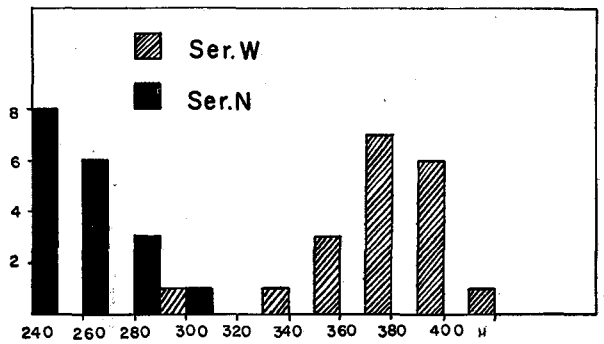
Text-fig. 22. Variations found in the situation of the central portion of gyre in *A. inflata* (open circle), *A. lesueuri* (solid circle) and *A. turriculata* (crossed circle). Square shows B/A (0.35–0.45)×D/C (0.45–0.55).



Text-fig. 23. Variations found in the situation of the central portion of gyre in Series N (open circle) and W (solid circle) of *A. gaudichaudi*. Square shows B/A (0.35–0.45) ×D/C (0.45–0.55).

inclinata	356 ± 60	
inflata	245 ± 18	
Ser. N of *gaudichaudi*	276 ± 34	329 ± 88
Ser. W of *gaudichaudi*	356 ± 61	

When the two series are treated together as a single group, the range of fluctuation of the gyre length seems to be too large for a single species. Usually, however, the more examples are measured, the larger the range of fluctuation becomes. And moreover, it is impossible that the range of fluctuation in a certain species can be accepted as the strict frame for any other species, although it is very helpful to guess the range in other species. The existence of two modes in text-fig. 24 might be caused by the smallness of the examined material. For these reasons, I hesitate to treat Series N and W separately as distinct varieties within a species and expect that these two series may become quite continuous when a large number of specimens are examined.



Text-fig. 24. Variations of the gyre length in two series of *A. gaudichaudi*.

At first, I expected to find out some morphological differences between the shells of these two series in a hope to ascertain the validity of *A. pacifica* which I established. Very unfortunately, however, both series have quite the similar shell which is characterized as follows:—

Shell is flattened and usually with a low spire which may seem rather high on some small shells. It may be quite transparent (No. 57 specimen of Ser. W) or most frequently rather opaque and chalky white in colour; the spire may also be transparent or opaque and coloured purplish-violet, yellowish, or rarely quite colourless. Probably such conditions of the shell and the spire are in accord with the states of preservation of shells rather than to be of any essential significance. Keel insertion is seen rather rarely and in a slight degree, usually it reaches to 1/8–1/4 of the body whorl, although exceptionally it may attain 1/2 (No. 67 specimen of Ser. W). The base of the keel is brownish. Eyes are usually reddish, or rarely orange red in a preserved state. The whorl formula

for this species includes both formulae respectively given previously for *A. gaudichaudi* and *A. pacifica* (Tokioka 1955 a, b). In other words, *A. pacifica* can not be distinguished as a distinct form from *A. gaudichaudi*. Thus, I am quite unhappy, but here withdraw *A. pacifica* by myself. It is very possible, however, that the majority of specimens in a certain sample are apt to show the similar whorl formula of the shell or the appearance of the operculum which may frequently differ somewhat from those seen in specimens in other samples. And such a phenomenon seems to show the existence of some differences according to stocks in a certain species. Very probably, the characters that ever differentiated *pacifica* from *gaudichaudi* are of the nature of the differences according to stocks and also the same is for the differences between Series N and W.

Occurrences:

SB 1 (23)	SB 115 (1)	SB 181 (n4, w4)
SB 68 (1)	SB 118 (2)	SB 187 (n4, w2)
SB 75 (?1)	SB 122 (32)	SB 195 (n 1)
SB 80 (2)	SB 125 (1)	SB 200 (n27, w14)
SB 90 (2)	SB 145 (6)	SB 217 (w 1)
SB 95 (8)	SB 150 (n1, w1)	EQPH 7 (n 1)
SB 100 (1)	SB 155 (n1, w1)	EQPH 11 (n 8)
SB 105 (n1, w3)	SB 160 (n1, w5)	EQPH 17 (n1, w2)
SB 109 (w 15)	SB 175 (n6, w5)	
SB 112 (w 37)	SB 180 (w 5)	

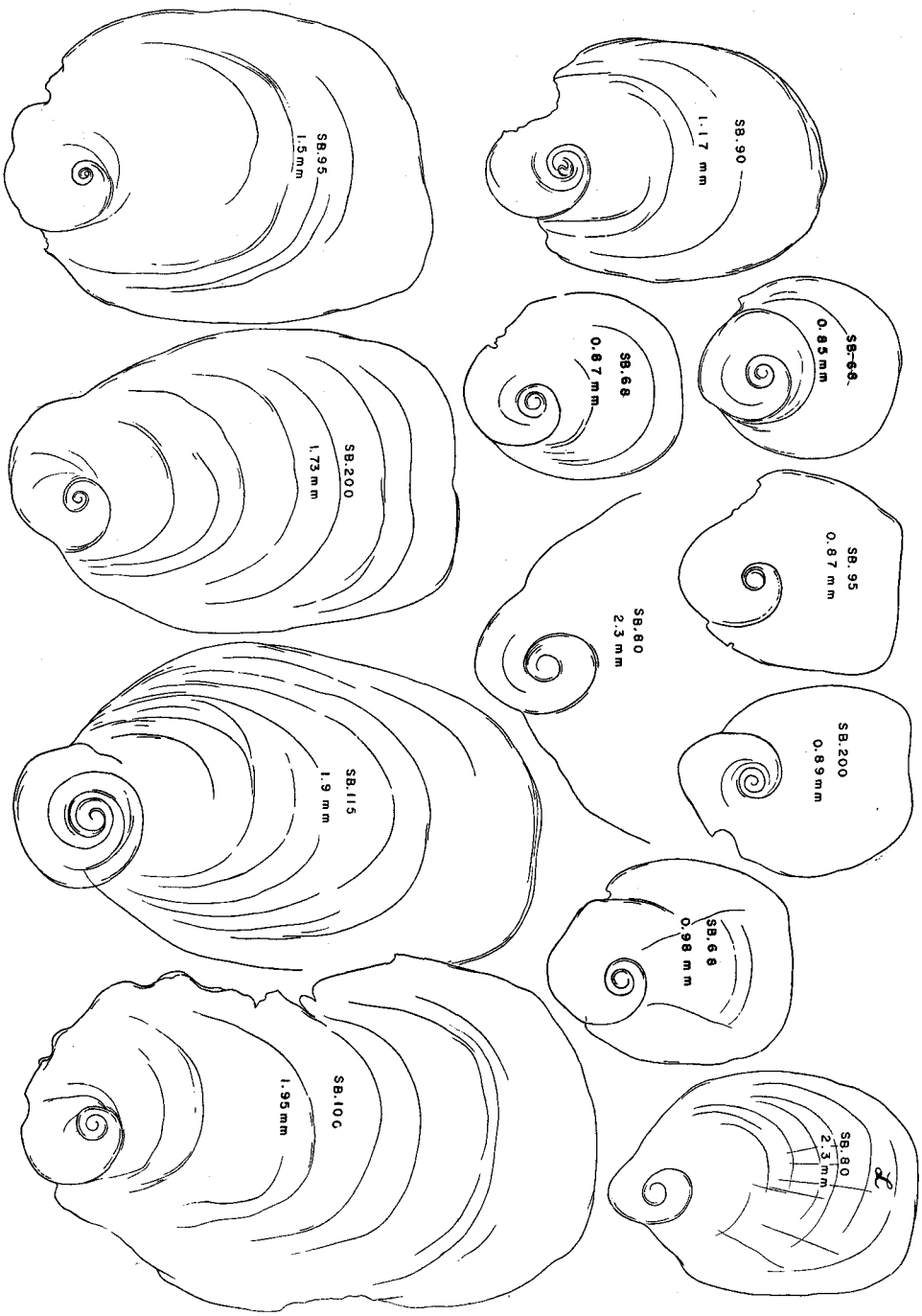
n···Series N, w···Series W.

8. *Atlanta peroni* LESUEUR

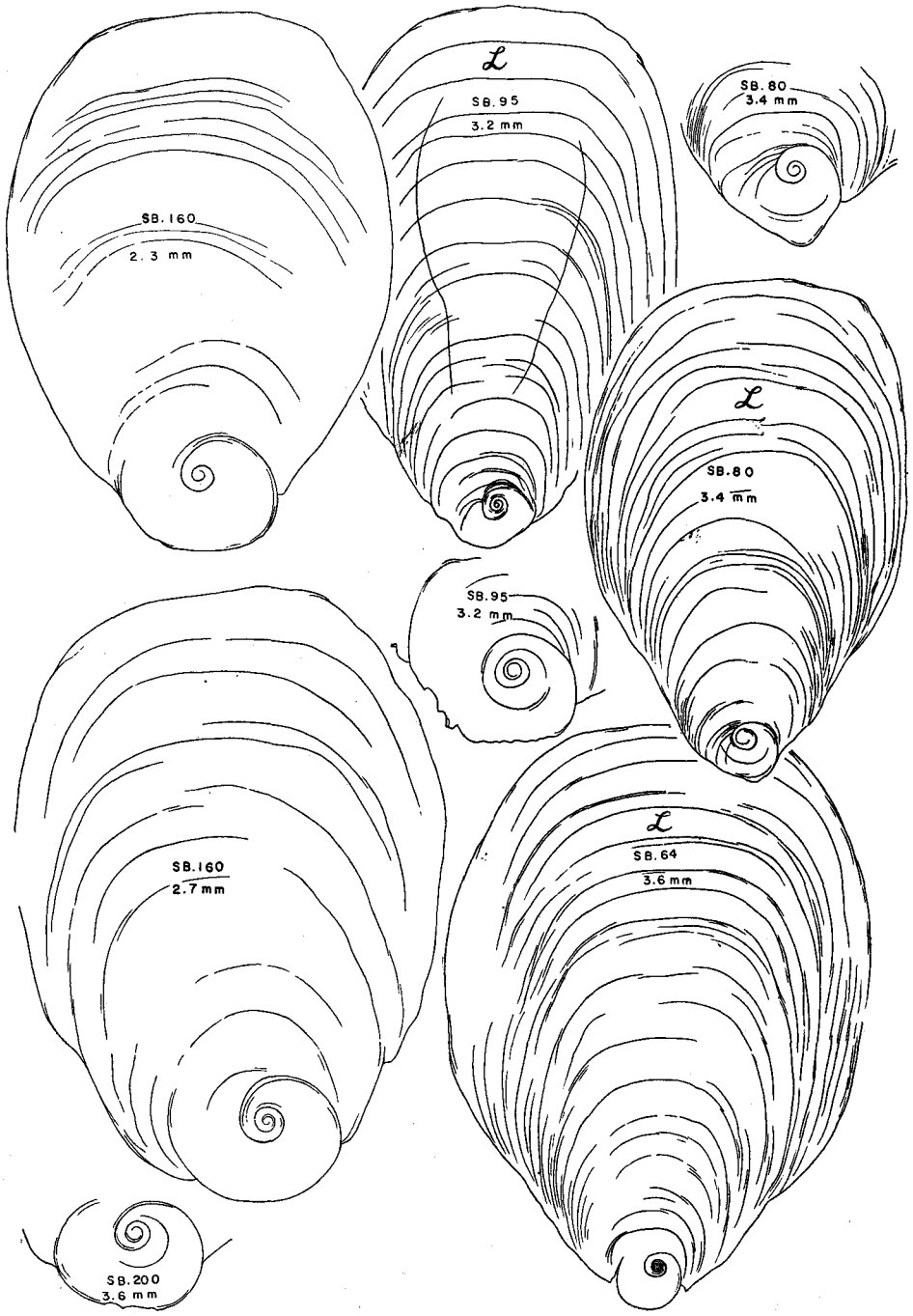
(Text-figs. 25–31)

It is very strange that this best known species is identified with very great difficulty. As noted by TESCH (1949, p. 17), the most remarkable difference between this and the preceding species is found in the breadth of the shell aperture which is comparatively larger in *A. gaudichaudi* than in *A. peroni*. In addition to this, the remarkable insertion of the keel between the whorls in larger shells is noticeable. Thus, at first, enough large shells with the comparatively large second and third terms of the whorl formula and a remarkable penetration of keel were selected out of the samples as the definitely identified specimens of *A. peroni* and then their opercula were examined. Next, by using the features of the operculum as clues for identification, the data for the present species were searched for. Again, here are discriminated two series of opercula, Series S and L.

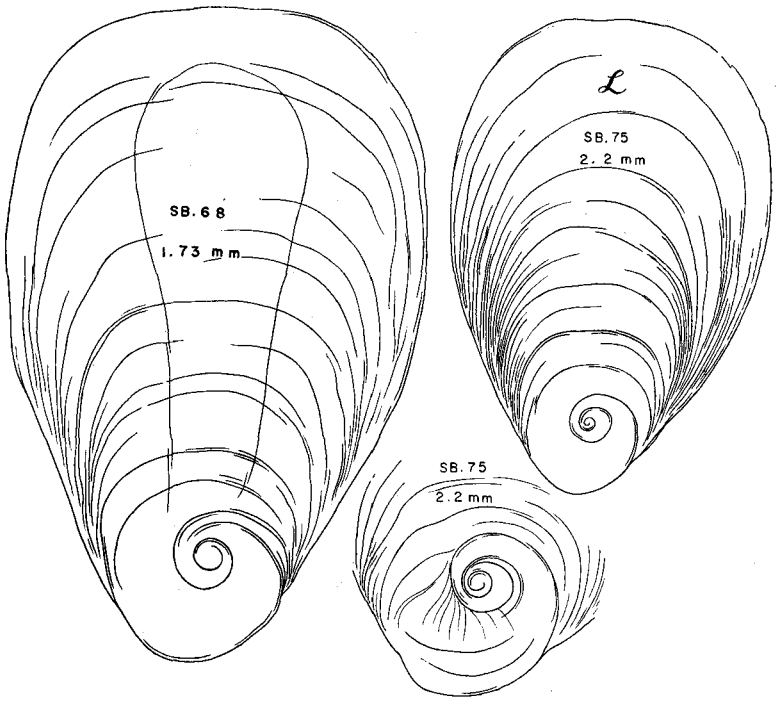
Series S (Text-figs. 25–27): Operculum oval, gyre is very small, most frequently less than 200μ in length. The axial margin is obtuse to round, while the lower (peripheral) edge of gyre is rounded or rarely slightly narrowed as



Text-fig. 25. *Atlanta peroni* LESUEUR, Series S. Opercula of 0.85~2.3 mm shells from Shellback Stations, seen from the attachment surface, excepting the operculum of the 0.89 mm shell from SB 200. L···×50, others···×86.



Text-fig. 26. *Atlanta peroni* LESUEUR, Series S. Opercula of 2.3~3.6 mm shells from Shellback Stations, seen from the attachment surface. L···×50, others···×86.

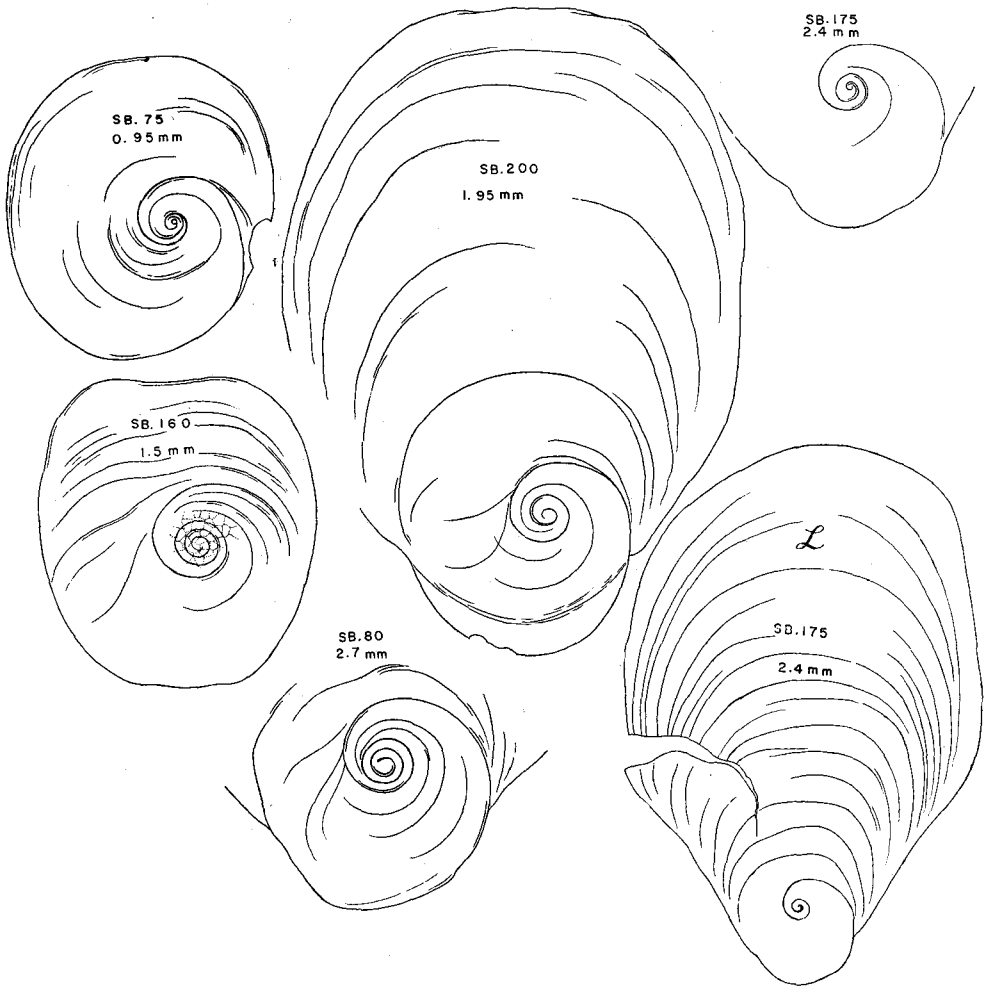


Text-fig. 27. *Atlanta peroni* LESUEUR, Series S. Opercula of 1.73 and 2.2 mm shells from Shellback Stations, seen from the attachment surface. L···×55, others···×95.

seen in 0.89 (SB 200), 2.3 (SB 80) and 3.4 mm (SB 80) shells. Gyre is most frequently very wide (antero-posteriorly) and with the peripheral margin often worn away. The central portion of gyre is rather small, but sometimes it may be of a considerable size in some specimens. It is usually situated near the middle of the axial half of the gyre, though it may be somewhat displaced to the right (anterior) side in some specimens. The operculum itself is extremely thin.

Evidently, terms B/A and C/A of the whorl formula are slightly larger in *A. peroni* than in *A. gaudichaudi*, although these values of smaller shells are quite similar in both species. Mostly, the shell is coloured yellowish white, pale yellowish, or light brownish and the spire is often quite uncoloured. The base of the keel may be brownish in some specimens. Eyes are reddish in preserved specimens.

Series L (Text-figs. 28–29): The axial margin of the operculum is obtuse in younger stages, but roundish in grown ups. The gyre in much larger than in Ser. S, being always longer than 250 μ. It is very wide and the peripheral edge is rounded. The central portion is of a considerable size and situated near the middle of the axial half. The operculum itself seems to be slightly thicker than in Ser. S.



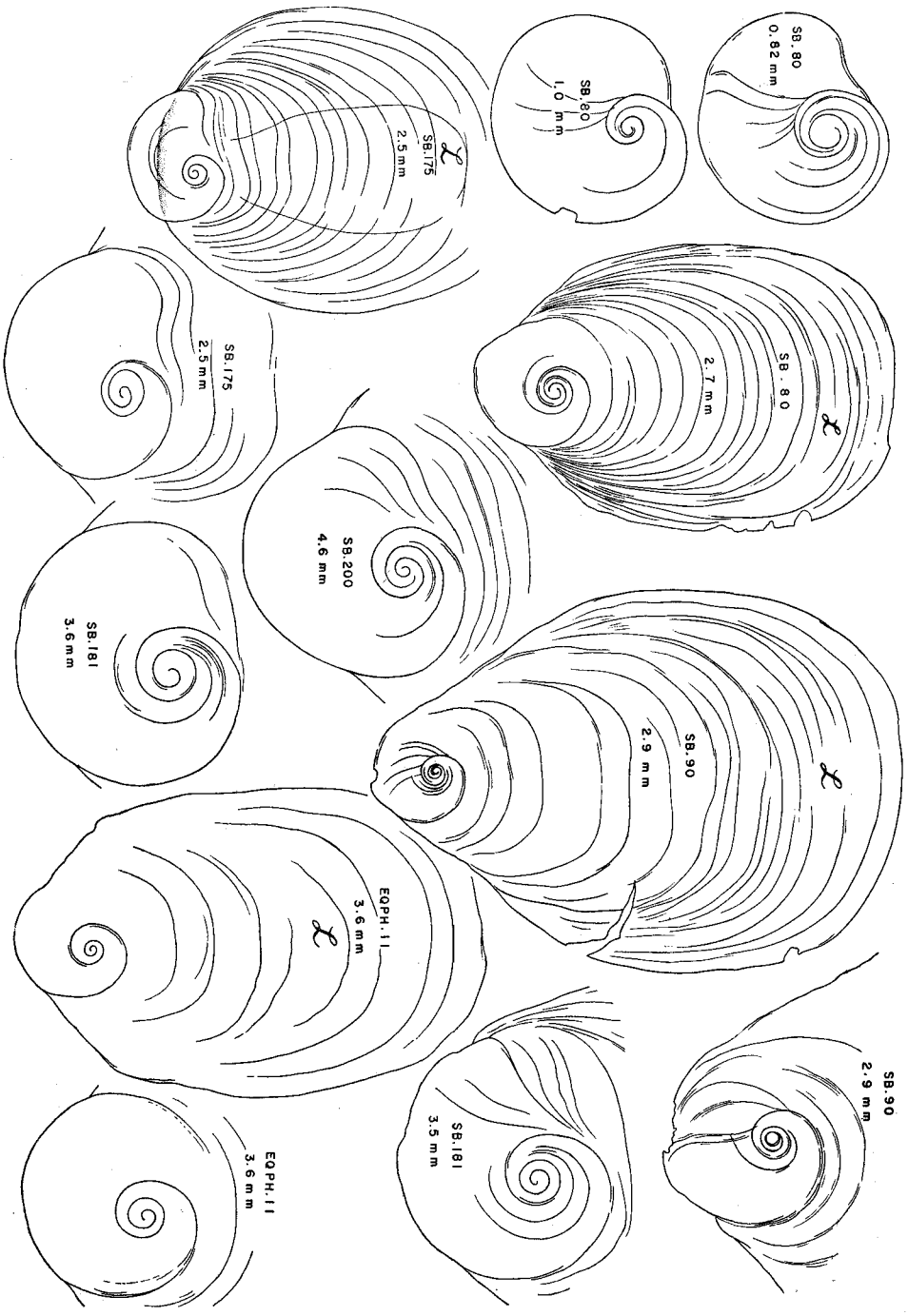
Text-fig. 28. *Atlanta peroni* LESUEUR, Series L. Opercula of 0.95~2.7 mm shells from Shellback Stations, seen from the attachment surface. L···×71, others···×122.

Table 16. *Atlanta peroni* LESUEUR, Series S. Whorl formulae.

No. of specimen	Long diameter	Whorl formula	Number of whorls	Number of whorls on underside	Locality
1	0.87 mm	1 : 0.50 : —			SB 95
2	0.89	1 : 0.44 : 0.27	3-1/4		SB 200
3	1.17	1 : 0.37 : —			SB 90
4	1.5	1 : 0.35 : —	5	2	SB 95
5	1.73	1 : 0.33 : 0.18	4-3/4		SB 200
6	1.73	1 : 0.33 : —			SB 68
7	1.84	1 : 0.31 : 0.16	4-1/4	2	EQPH 7
8	1.9	1 : 0.34 : 0.17	5		SB 115
9	1.95	1 : 0.33 : 0.16	3-1/4?		SB 100
10	2.2	1 : 0.34 : 0.16	4-1/2	2-1/4	EQPH 17
11	2.2	1 : 0.31 : —			SB 75
12	2.3	1 : 0.28 : 0.12	4-3/4		SB 80
13	2.3	1 : 0.31 : 0.13	5-1/4	2-1/4	SB 160
14	2.3	1 : 0.31 : 0.14	4-1/4		SB 50
15	2.7	1 : 0.29 : 0.12	5-1/4	2-1/4	SB 160
17	3.2				SB 95
18	3.6	1 : 0.29 : —			SB 64
19	3.6	1 : 0.25 : 0.14	5-1/2	2-1/4	SB 200
20	4.6	1 : 0.31 : 0.11	5	ca. 3	EQPH 17

Table 17. *Atlanta peroni* LESUEUR, Series S. Measurements on opercula.

No. of specimen	Long dia. of shell	L	A	W/L	A/L	B/A	D/C
	Opercula shown in text-figs. 25 and 26.						
	0.85 mm	274 μ	142 μ	1.06	0.52	0.46	0.55
1	0.87	347	153	0.86	0.44	0.45	0.50
	0.87	363	163	0.86	0.45	0.37	0.50
2	0.89	374	163	0.80	0.44	0.42	0.52
	0.98	389	157	0.84	0.41	0.40	0.45
3	1.17	537	163	0.72	0.30	0.42	0.48
4	1.5	663	163	0.75	0.25	0.35	0.39
5	1.73	705	157	0.69	0.22	0.47	0.48
8	1.9	832	211	0.61	0.25	0.73	0.78
9	1.95	911	157	0.64	0.17	0.47	0.49
12	2.3	855	227	0.72	0.27	0.60	0.56
13	2.3	842	179	0.71	0.21	0.45	0.56
15	2.7	953	195	0.70	0.20	0.51	0.55
17	3.2	1464	173	0.65	0.12	0.69	0.56
	3.4	1355	164	0.64	0.12	0.37	0.48
18	3.6	1582	155	0.72	0.10	0.41	0.48
19	3.6		163			0.45	0.52
	Opercula shown in text-fig. 27.						
6	1.73	911	215	0.64	0.24	0.51	0.58
11	2.2	1136	245	0.66	0.22	0.47	0.50



Text-fig. 29. *Atlanta peroni* LESUEUR, Series L. Opercula of 0.82~4.6 mm shells from Shellback (SB) and Equapac (EQPH) Stations, seen from the attachment surface. L···×50, others···×86.

Table 18. *Atlanta peroni* LESUEUR, Series L. Whorl formulae.

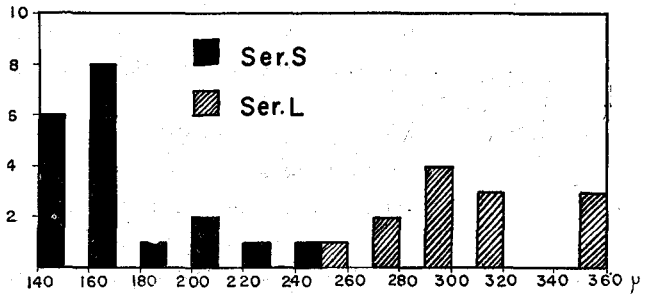
No. of specimen	Long diameter	Whorl formula	Number of whorls	Number of whorls on underside	Locality
1	0.82 mm	1 : 0.42 : 0.26	4		SB 80
2	0.95	1 : 0.36 : 0.23	3-3/4		SB 75
3	1.00	1 : 0.43 : —	4-1/2		SB 80
4	1.5	1 : 0.33 : 0.18	4-1/4	1-3/4	SB 160
5	1.95		4-1/4	2-1/4	SB 200
6	2.4				SB 175
7	2.5	1 : 0.32 : 0.13	4-1/4		SB 175
8	2.7	1 : 0.31 : 0.12	5		SB 80
9	2.9	1 : 0.31 : —			SB 90
10	3.5	1 : 0.28 : 0.11	5+		SB 181
11	3.6	1 : 0.29 : 0.14	5	2-1/4+	SB 181
12	3.6	1 : 0.29 : 0.11	5+	2-1/2	EQPH 11
13	4.6	1 : 0.31 : 0.14	5-1/4	2-1/2	SB 200

Table 19. *Atlanta peroni* LESUEUR, Series L. Measurements on opercula.

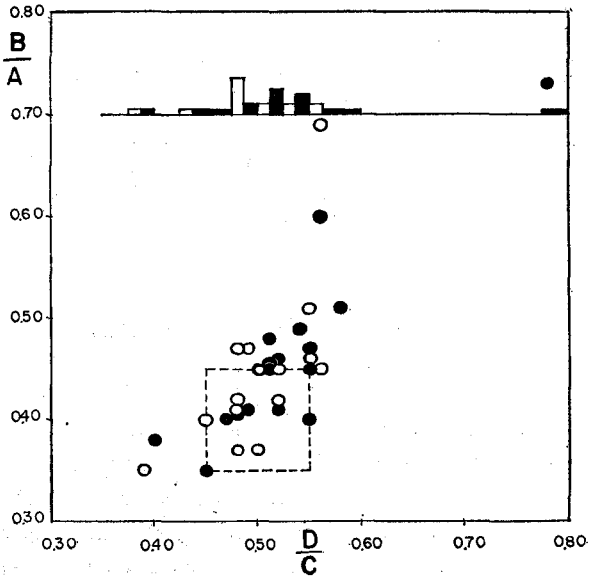
No. of specimen	Long dia. of shell	L	A	W/L	A/L	B/A	D/C
1	0.82 mm	295 μ	295 μ	1.13	1.00	0.48	0.51
2	0.95	453	295	0.86	0.65	0.38	0.40
3	1.0	305	305	1.09	1.00	0.40	0.47
4	1.5	447	295	0.89	0.66	0.45	0.51
5	1.95	953	284	0.70	0.30	0.41	0.49
6	2.4	1364	264	0.65	0.19	0.35	0.45
7	2.5	1027	264	0.82	0.26	0.41	0.48
8	2.7	1145	318	0.68	0.28	0.46	0.56
9	2.9	1445	255	0.72	0.18	0.40	0.55
10	3.5		342			0.49	0.54
11	3.6	1273	309	0.66	0.24	0.45	0.51
12	3.6		353			0.46	0.52
13	4.6		347			0.41	0.52

The most perplexing is the identification of young shells; for instance, that of the 0.95 mm and 1.5 mm shells shown in text-fig. 28 and the 0.82 mm and 1.00 mm ones shown in text-fig. 29. If the development of the operculum of Series L is completely parallel to that of Series S, then the 0.82 mm and 1.00 mm shells of Ser. L should have some well-defined major part. If the 0.82 mm and 1.00 mm shells shown in text-fig. 29 are really the young shells of Series L, then the 0.95 mm shell shown in text-fig. 28 is too large for Ser. L; and moreover it is rather strange that the 1.00 mm shell of Series L has the operculum smaller than that of the shell of the corresponding size in Series S. On the other hand, the gyre of Ser. L resembles very closely that of *A. inclinata*. Evidently, however, opercula of the 0.82 mm and 1.00 mm shells shown in text-fig. 29 are too small for *inclinata*. Especially, the operculum of the 1.5 mm shell shown in text-fig. 28 is related closely to that of *inclinata*, but even this is somewhat small for *inclinata*. Moreover, the whorl formulae of these young shells are not differentiated clearly

from those of young *inclinata.* Thus, these shells are arranged here under Series L of *A. peroni,* only because the shape and size of gyres of their opercula resemble most closely those of the typical ones of Series L. I cannot identify them with confidence; it is not impossible that some of them might belong to *A. inclinata.*



Text-fig. 30. Variations of the gyre length in two series of *A. peroni.*



Text-fig. 31. Variations found in the situation of the central portion of gyre in Series S (open circle) and L (solid circle) of *A. peroni.* Square shows B/A (0.35–045)×D/C (0.45–0.55).

The shells of Ser. L are quite the same as those of Ser. S. As the operculum length is nearly the same in the two series for shells of the same diameter, it is quite natural that there is no difference between the whorl formulae of the two series.

The difference between Series S and L is confined to the size or the length of the gyre of the operculum as shown in text-fig. 30. The feature of the central portion shown by B/A and D/C is quite common to the opercula of both series as seen in text-fig. 31. It is hardly possible, at present, to mention definitely about the significance of the difference between the two series. I can only repeat here the same comment expressed upon the Series N and W of the preceding species. The two specimens shown in text-fig. 27 were separated from others, as they were considered to represent some intermediate states between the two series.

Some opercula of Series L resemble superficially some of Ser. W of *A. gaudichaudi*. However, the situation of the central portion of the gyre indicated by B/A and D/C seems to differ definitely between the two (text-fig. 31 v. 23). Moreover, the gyre length of Ser. L (240~360 μ) is smaller than that of Ser. W (280~420 μ). And further, as the gyre length, the situation of the central portion of the gyre, and the whorl formula of the shell are correlated one another in respective series, it is impossible that some significant close relationship is proved between Series W and L.

Occurrences:

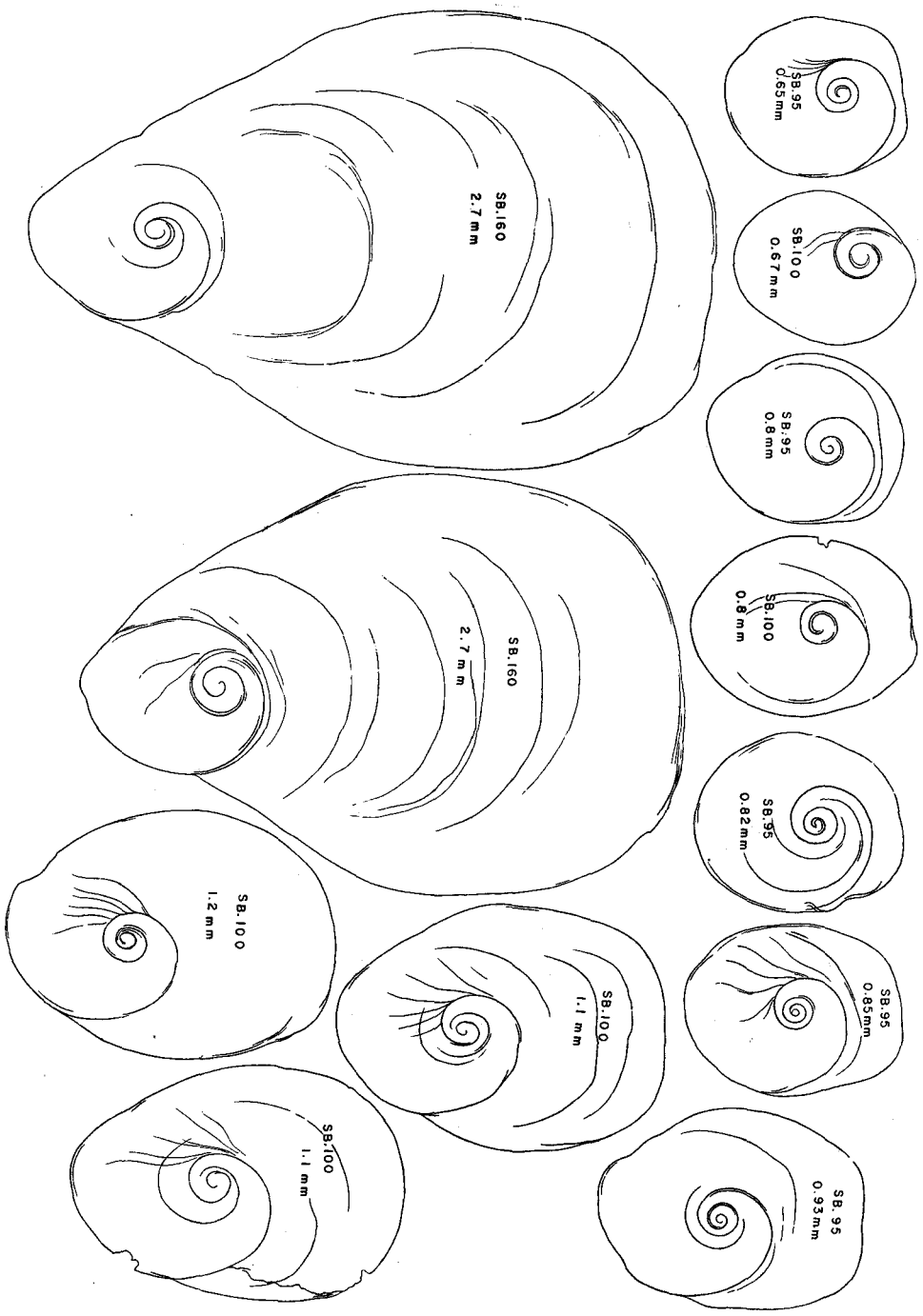
SB 50 (3)	SB 95 (5)	SB 187 (1)
SB 60 (2)	SB 100 (10)	SB 200 (5)
SB 64 (1)	SB 112 (2)	EQPH 7 (3)
SB 68 (1)	SB 115 (1)	EQPH 11 (15)
SB 75 (2)	SB 160 (3)	EQPH 17 (8)
SB 80 (6)	SB 175 (2)	
SB 90 (7)	SB 181 (2)	

9. *Atlanta helicinoides* SOULEYET

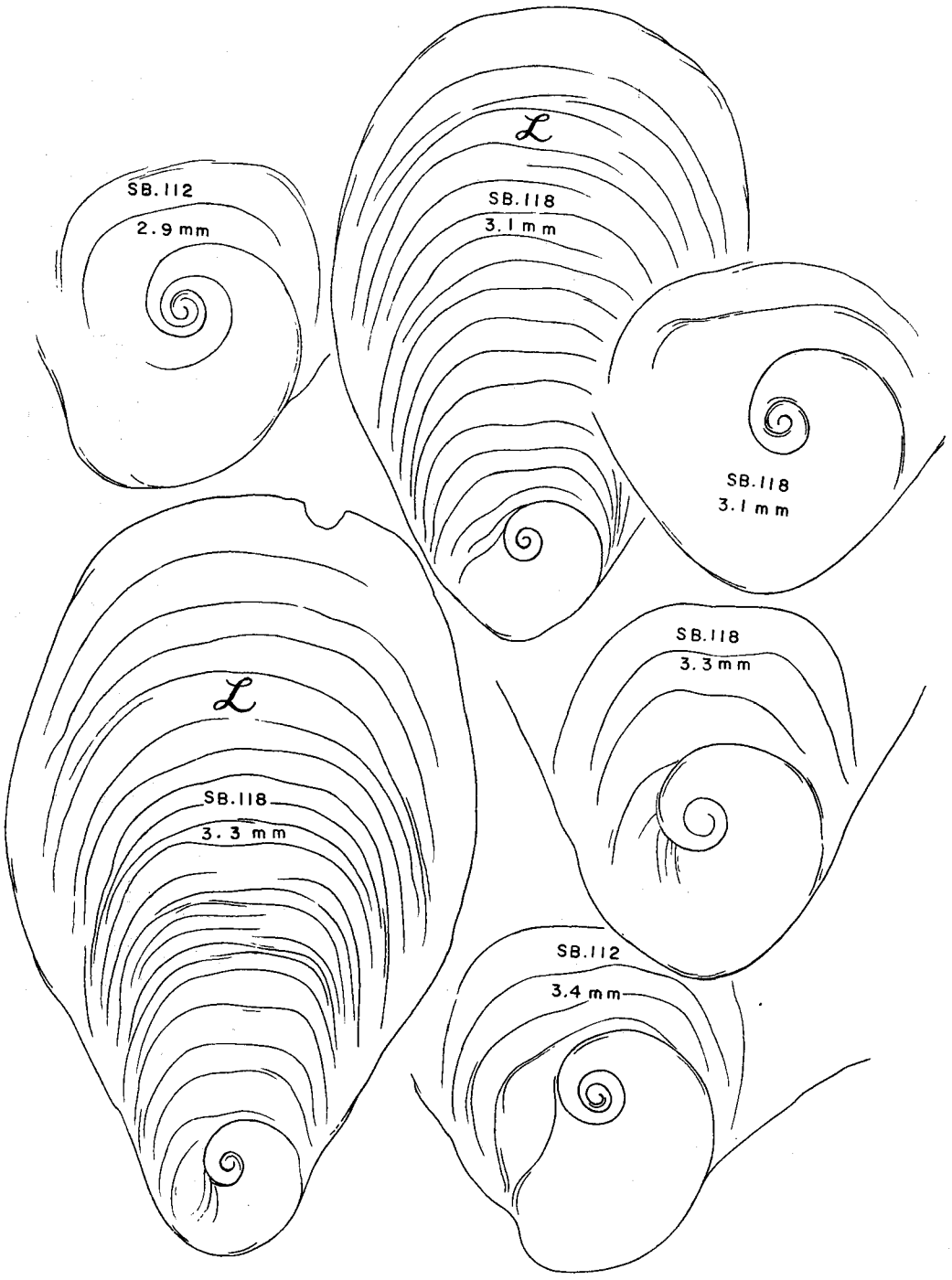
(Text-figs. 32-34)

It is very difficult to identify this species on young shells in which the sculpture has disappeared. As a whole, the state of preservation is not satisfactory for the specimens of Atlantidae in the present material, most shells are more or less softened and the sculpture on the spire has become quite obscure. So, at first, some enough large shells which can be identified as *A. helicinoides* which a certainty because of the larger spire (or the larger second term of the whorl formula) and the presence of many whorls* on the spire were selected out and

* Apart from the appearance of the sculpture on the spire, *A. helicinoides* differs from *A. inflata*, the most closely related species, in that the spire is much larger or somewhat broader (TESCH 1908, p. 23; 1949, p. 19). Number of whorls on the spire was described fewer (5) than in *inflata* (5-7) by TESCH in 1908 when he treated *A. depressa* SOULEYET as a distinct species. However, in his paper of 1949 *A. depressa* is considered to be *helicinoides* in which the sculpture of the spire has disappeared. If *A. depressa* is really a synonym of *A. helicinoides*, then the number of whorls on the spire should be raised a little more for *helicinoides*.



Text-fig. 32. *Atlanta helicinoides* SOULEYET. Opercula of 0.65～2.7 mm shells from Shellback Stations, seen from the attachment surface. ×86.



Text-fig. 33. *Atlanta helicinoides* SOULEYET. Opercula of 2.9~3.4 mm shells from Shellback Stations, seen from the attachment surface. L···×73, others···×127.

their opercula were examined carefully. Then, by using the feature of the operculum as the clue, some other shells referable to the present species were taken out of the samples.

Table 20. *Atlanta helicinoides* SOULEYET. Whorl formulae.

No. of specimen	Long diameter	Whorl formula	Number of whorls	Number of whorls on underside	Locality
1	0.65 mm	1 : 0.67 : —			SB 95
2	0.67	1 : 0.68 : —			SB 100
3	0.80	1 : 0.65 : —			SB 100
4	0.80	1 : 0.65 : —			SB 95
5	0.82	1 : 0.66 : —			SB 95
6	0.85	1 : 0.49 : 0.26	3-1/2		SB 68
7	0.85	1 : 0.57 : —			SB 95
8	0.87	1 : 0.50 : 0.25	3-1/4		SB 68
9	0.92	1 : 0.39 : 0.23	3-1/4		SB 80
10	0.93	1 : 0.58 : —			SB 95
11	0.98	1 : 0.42 : 0.22	3-1/2		SB 68
12	1.1	1 : 0.52 : —			SB 100
13	1.1	1 : 0.56 : —			SB 100
14	1.2	1 : 0.51 : —			SB 100
15	2.7	1 : 0.34 : 0.22	7-1/2	3+	SB 160
16	2.9	1 : 0.30 : —			SB 112
17	3.1	1 : 0.29 : 0.19	7-1/2	ca. 3	SB 118
18	3.3	1 : 0.28 : 0.14	8	ca. 4	SB 118
19	3.4	1 : 0.29 : —			SB 112

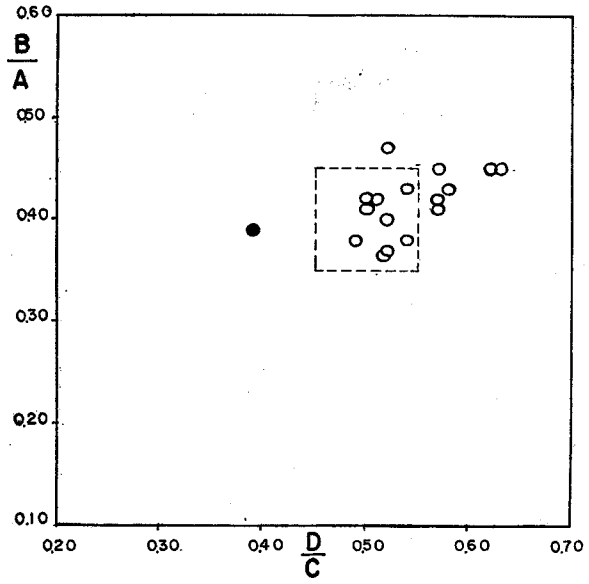
Table 21. *Atlanta helicinoides* SOULEYET. Measurements on opercula.

No. of specimen	Long dia. of shell	L	A	W/L	A/L	B/A	D/C
1	0.65 mm	279 μ	268 μ	0.91	0.96	0.47	0.52
2	0.67	284	284	0.85	1.00	0.43	0.58
3	0.80	311	268	0.87	0.86	0.41	0.50
4	0.80	358	274	0.79	0.76	0.37	0.52
5	0.82	326	279	0.87	0.85	0.45	0.62
6	0.85	342	258	0.80	0.75	0.45	0.57
10	0.93	416	284	0.76	0.68	0.43	0.54
12	1.1	511	289	0.76	0.57	0.42	0.57
13	1.1	526	316	0.71	0.60	0.38	0.54
14	1.2	516	274	0.77	0.53	0.42	0.50
15	2.7	947	289	0.71	0.31	0.40	0.52
	2.7	1079	284	0.67	0.26	0.41	0.57
16	2.9	1500	284	0.60	0.19	0.37	0.52
17	3.1	1236	273	0.64	0.22	0.42	0.51
18	3.3	1482	264	0.61	0.18	0.45	0.63
19	3.4	1500	274	0.73	0.18	0.38	0.49

The operculum is oval in younger specimens, but somewhat elongate in adults. The axial margin is usually rounded in grown ups. The gyre is oval and relatively small. It is a little larger than that of Ser. S of *A. peroni* and nearly as long as that of Series L of the same species. It is, however, never so wide as in both types of *A. peroni*; it is always longer than wide in the present species, while

it is wider than long in *A. peroni*. The central portion is situated at the middle of the axial half of the gyre. D/C seems to be a little larger than in *A. peroni*. The operculum itself is extremely thin.

The existence of 7–8 whorls on shells with ca. 3 mm diameter is unique for the present specimens. Large shells are usually brownish, rather thin and sometimes translucent or transparent. The surface of the body whorl may be slightly undulating as in the shell of *Carinaria*. The spire is high, may incline a little to the plane of the body whorl and usually it is not coloured specially. The umbilicus is large and deep; up to 4 whorls are observed on the underside. The

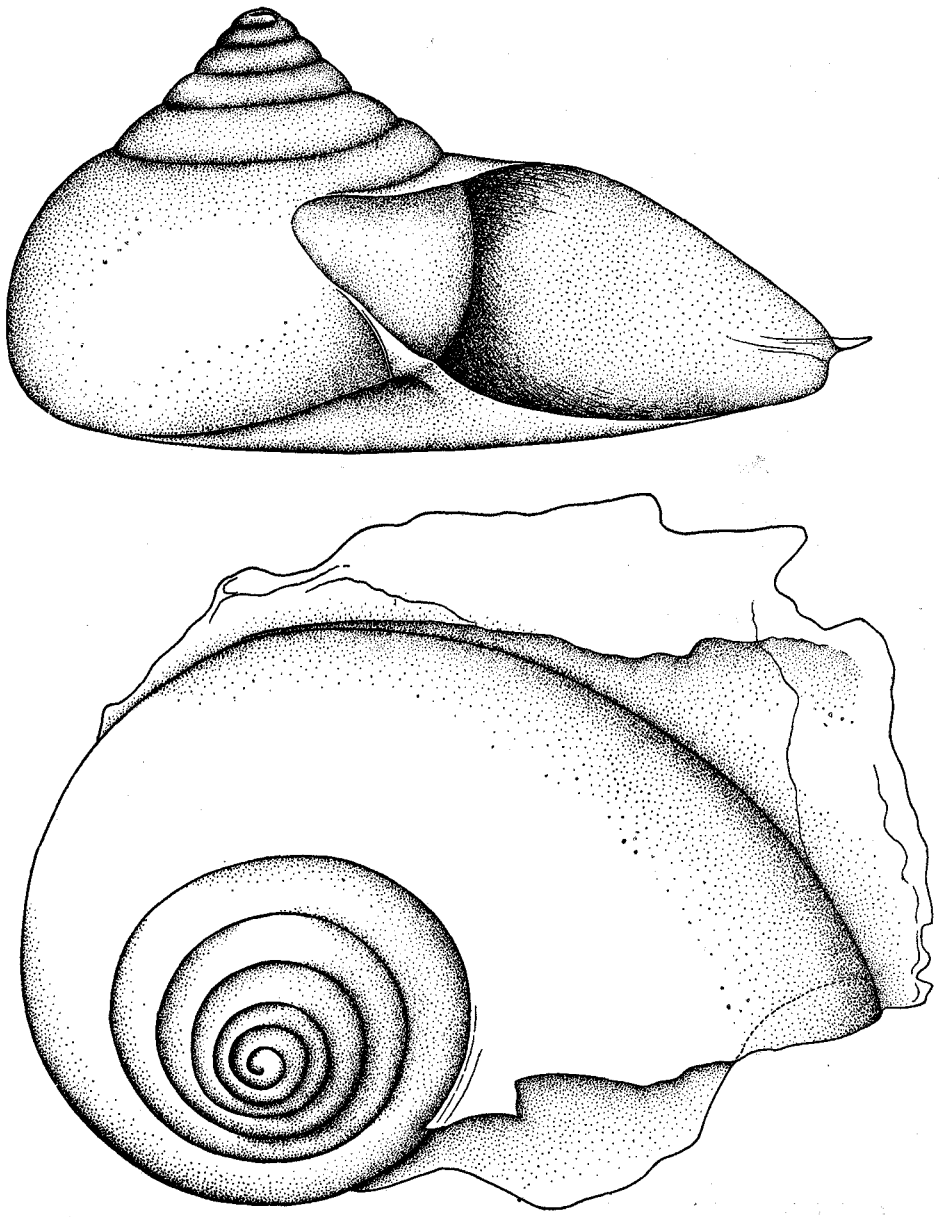


Text-fig. 34. Variations found in the situation of the central portion of gyre in *A. helicinoides* (open circle) and *P. souleyeti* (solid circle). Square shows B/A (0.35–0.45)×D/C (0.45–0.55).

keel may be very high and its insertion reaches to 1/4 of the suture between the body whorl and the spire in examined specimens. The eyes are usually reddish in the preserved specimens. Young shells might be confused with those of *A. inclinata*, as the spire is large and high and provided with rather numerous whorls as compared with those of other species. However, the operculum of *A. inclinata* has usually the gyre larger than that of *A. helicinoides*.

Occurrences:

SB 68 (3)	SB 115 (1)	SB 155 (?1)
SB 80 (1)	SB 118 (2)	SB 160 (2)
SB 100 (5)	SB 145 (1)	



Text-fig. 35. ?*Protatlanta souleyeti* (E. A. SMITH). Shell with a 1.5 mm long diameter. ×73.

10. ? *Protatlanta souleyeti* (EDG. A. SMITH)

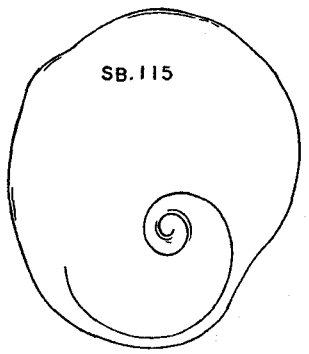
(Text-figs. 34–36)

A single shell referable to this species was found in the sample from SB 115.

Table 22. ? *Protatlanta souleyeti* (E. A. SMITH). Whorl formula (above) and measurements on operculum (below).

Long diameter	Whorl formula		Number of whorls	Number of whorls on underside		Locality
1.5 mm	1 : 0.42 : 0.29		6-1/2	2		SB 115
Long dia. of shell	L	A	W/L	A/L	B/A	D/C
1.5 mm	347 μ	163 μ	0.85	0.47	0.39	0.39

It is a small shell with a 1.5 mm diameter, which is thin, somewhat horny in consistency and yellowish brown in colour. Six and a half whorls are observed. The spire is very large and high, but distinctly differs in shape from that of *A. inclinata.* Rather it resembles that of *A. helicinoides,* especially that of *A. depressa* figured by TESCH (1908). The underside is rather flat, not so convex as



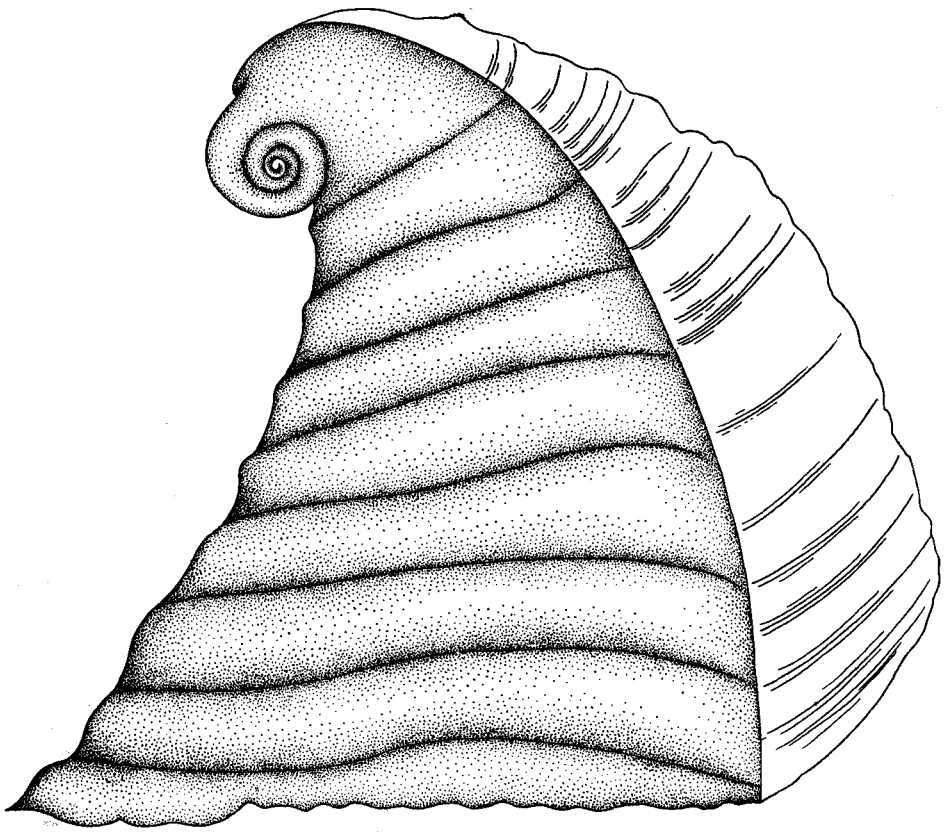
Text-fig. 36. ? *Protatlanta souleyeti* (E. A. SMITH). Operculum of the 1.5 mm shell from SB 115, seen from the attachment surface. ×127.

in *A. inclinata.* The umbilicus is large and deep. Most parts of the keel is quite transparent. This shell resembles most closely *A. helicinoides.* However, the operculum of this shell seems to be too small for *helicinoides,* much smaller than opercula of 1.1 mm shells of *helicinoides.* The gyre length is similar to that of Series S of *A. peroni,* but the length of the whole operculum is still much

smaller than in *A. peroni*. Moreover, the feature of the shell differs distinctly between this and *A. peroni*; the spire is larger and more whorls are present in the present specimen. As the operculum of *A. inclinata* is much larger and has much larger gyre, the comparison between this and *A. inclinata* is quite out of the question. I am inclined to consider this specimen to be a form of *A. helicinoides*, but at the same time, the resemblance between this and *P. souleyeti* cannot be denied completely. At present, on account of the existence of so remarkable difference between the opercula of the present specimen and *A. helicinoides*, I want to treat this provisionally as *P. souleyeti*. Future examinations on many definitely identified specimens of *Protatlanta* will settle this question.

Occurrences of some Atlanta shells unidentified:

SB 55 (2)	SB 68 (1)	SB 180 (1)
SB 60 (6)	SB 80 (1)	SB 181 (1)
SB 64 (1)	SB 109 (27)	SB 200 (2)



Text-fig. 37. *Carinaria galea* BENSON. A 5.9 mm high shell from EQPH 17, ×20.

V. Records of other Heteropods, with some brief notes

11. *Carinaria galea* BENSON

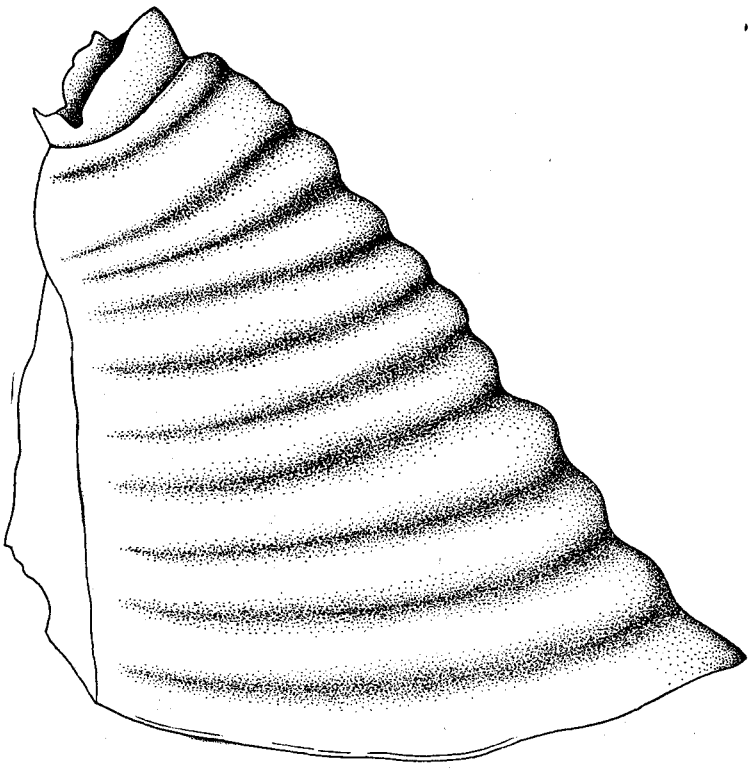
(Text-fig. 37)

A single specimen with a shell finely preserved, but had become very brittle, was found in the sample from EQPH 17. The shell is 5.9 mm high and with a very tall keel. The spire or the embryonic shell is 0.98 mm in long diameter, yellowish brown in colour, and coils three and a half times; the whorl formula is 1 : 0.47 : 0.22 as it is measured as in atlantids.

Occurrences: EQPH 11 (?1), EQPH 17 (1)

12. *Carinaria cithara* var. *procumbens* TESCH

(Text-fig. 38)



Text-fig. 38. *Carinaria cithara* var. *procumbens* TESCH. A 2.9 mm high shell from SB 118, ×20.

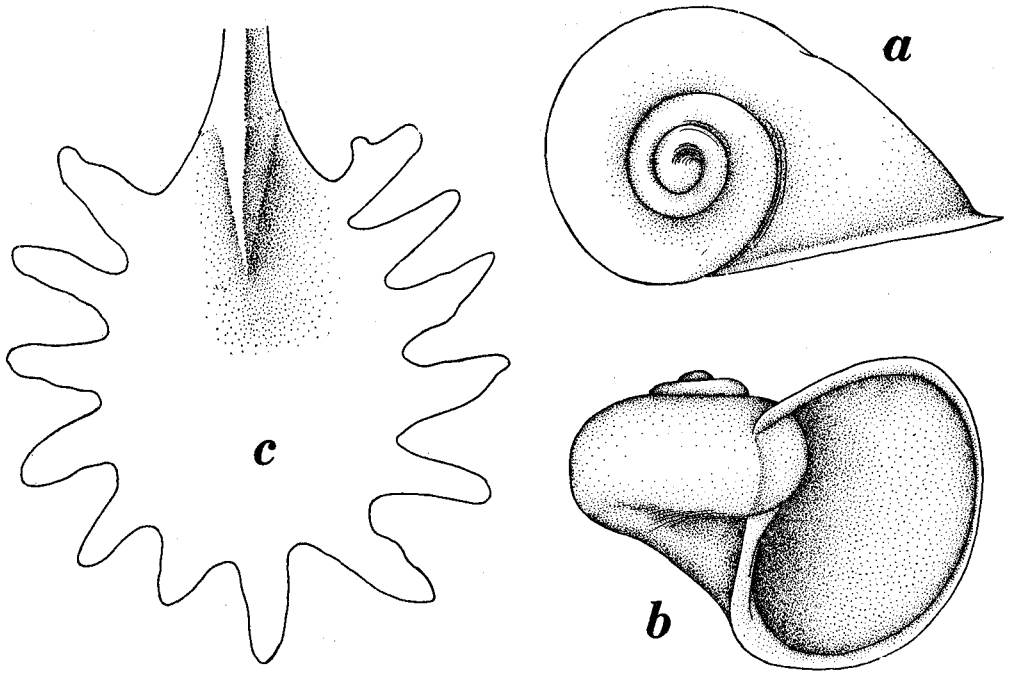
A small 2.9 mm high shell from SB 118. The embryonic shell is torn off. As the anterior side furnished with the keel is nearly straight, or rather it is slightly concave, it is very evident that this belongs to the variety *procumbens* described by TESCH (1949, p. 29).

13. *Carinaria* sp.

A single mutilated juvenile specimen from SB 20.

14. *Cardiapoda placenta* (LESSON)

(Text-fig. 39)



Text-fig. 39. *Cardiapoda placenta* LESSON from SB 125. a···apical view of shell, b···front view of shell, c···dorsal view of tail fin; ×20.

Here is described an individual from SB 125. The shell is 3 mm in long diameter and 2 mm in height. It is quite transparent and yet without any keel nor winglets described by TESCH (1949, p. 36). The umbilicus is deep. The apical side of the spire is nearly flat. The horizontal tail fin is pigmented in purplish brown.

Occurrences: SB 125 (1), SB 187 (1), EQPH 11 (4)

15. *Cardiapoda* sp.

All the specimens are in unsatisfactory condition for identification, although many of them are considered to be *C. richardi* VEYSSIÈRE.

Occurrences:

SB 55 (1)	SB 150 (1)	SB 210 (1)
SB 95 (1)	SB 160 (2)	TP 109 (1)
SB 100 (1)	SB 175 (1)	
SB 137 (1)	SB 180 (1)	

TP···Transpac Stations.

16. *Pterosoma planum* LESSON

Occurrences: SB 35 (1), SB 187 (1), MP 14 (1). MP···Midpac Stations.

17. *Pterotrachea coronata* FORSKÅL

Occurrences:

SB 105 (1)	SB 181 (2)	SB 217 (1)
SB 118 (1)	SB 187 (2)	

18. *Pterotrachea* spp.

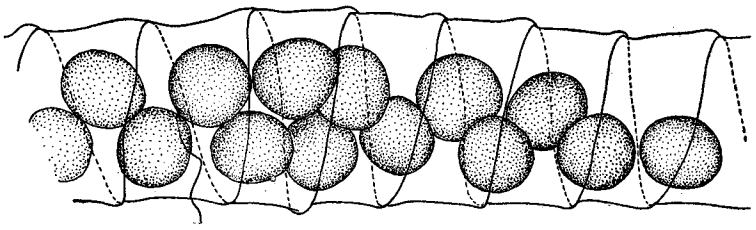
Very probably most of these mutilated juvenile specimens are belonging to *P. coronata.*

Occurrences:

SB 35 (1)	SB 112 (5)	SB 180 (4)
SB 80 (1)	SB 142 (3)	EQPH 11 (1)
SB 90 (1)	SB 150 (1)	EQPH 17 (9)
SB 109 (1)	SB 155 (4)	MP 20 (1)

19. *Firoloida desmaresti* LESUEUR

(Text-fig. 40)



Text-fig. 40. *Firoloida desmaresti* LESUEUR. A part of egg string showing the existence of a low spiral ridge winding clockwise, ×73.

Occurrences:

SB 10 (1)	SB 150 (7)	EQPH 7 (1)
SB 15 (3)	SB 155 (19)	EQPH 11 (5)
SB 30 (3)	SB 160 (5)	EQPH 17 (1)
SB 35 (1)	SB 166 (6)	MP 5 (1)
SB 44 (16)	SB 170 (4)	MP 8 (1)
SB 50 (1)	SB 175 (2)	MP 10 (2)
SB 55 (3)	SB 180 (2)	MP 10A (1)
SB 80 (2)	SB 181 (10)	MP 14 (28)
SB 90 (5)	SB 187 (9)	MP 16 (1)
SB 100 (5)	SB 195 (1)	MP 35 (1)
SB 105 (2)	SB 200 (2)	
SB 145 (2)	EQPH 3 (1)	

VI. Records of some Pteropods, with some brief notes.

1. *Limacina helicina* (PHIPPS)

Occurrences: TP 20 (7), TP 21 (1), TP 27 (15)

2. *Limacina trochiformis* (D'ORBIGNY)

Occurrences:

SB 80 (7)	SB 132 (5)	SB 187 (40)
SB 85 (1)	SB 137 (39)	SB 195 (2)
SB 100 (3)	SB 142 (2)	SB 200 (33)
SB 105 (7)	SB 145 (29)	SB 215 (2)
SB 109 (10)	SB 150 (8)	SB 217 (756)
SB 112 (1)	SB 155 (13)	EQPH 7 (1)
SB 115 (2)	SB 160 (10)	EQPH 11 (20)
SB 122 (1)	SB 180 (9)	EQPH 17 (30)
SB 130 (1)	SB 181 (64)	

3. *Limacina inflata* (D'ORBIGNY)

Occurrences:

SB 5 (+)	SB 100 (1)	SB 195 (1)
BS 10 (+)	SB 105 (1)	SB 200 (406)
SB 15 (+)	SB 115 (6)	SB 215 (4)
SB 50 (4)	SB 150 (8)	SB 217 (1)
SB 55 (3)	SB 155 (2)	EQPH 3 (58)
SB 75 (3)	SB 160 (51)	EQPH 7 (23)
SB 80 (24)	SB 175 (19)	EQPH 11 (181)
SB 85 (1)	SB 180 (1)	EQPH 17 (8)
SB 90 (5)	SB 181 (19)	EQPS 28 (2)
SB 95 (13)	SB 187 (94)	

4. *Limacina lesueuri* (D'ORBIGNY)

Occurrences: SB 1 (?1), SB 10 (+)

5. *Limacina bulimoides* (D'ORBIGNY)

Occurrences:

SB 80 (1)	SB 181 (8)	EQPH 7 (3)
SB 145 (1)	SB 187 (2)	EQPH 11 (44)
SB 160 (9)	SB 200 (6)	EQPH 17 (19)
SB 180 (4)	EQPH 3 (4)	MP 41 (2)

6. *Euclio pyramidata* (LINNÉ)

Occurrences:

SB 10 (+)	SB 105 (2)	SB 160 (5)
SB 50 (3)	SB 112 (17)	SB 181 (47)
SB 80 (4)	SB 137 (?4)	EQPH 3 (juv. 1)
SB 85 (2)	SB 142 (3)	D-6-109 (Aug. 13, '49) abundant
SB 90 (1)	SB 150 (2)	

7. *Euclio cuspidata* (BOSC)

(Text-fig. 41, *f–h*)

Embryonic shell is somewhat roundish and with a solid and acutely pointed prominence at the tip which is curved towards the dorsal side. The shell is devoid of any distinct ridges along the lateral side in younger stages and the section shows a triangular outline with rounded corners.

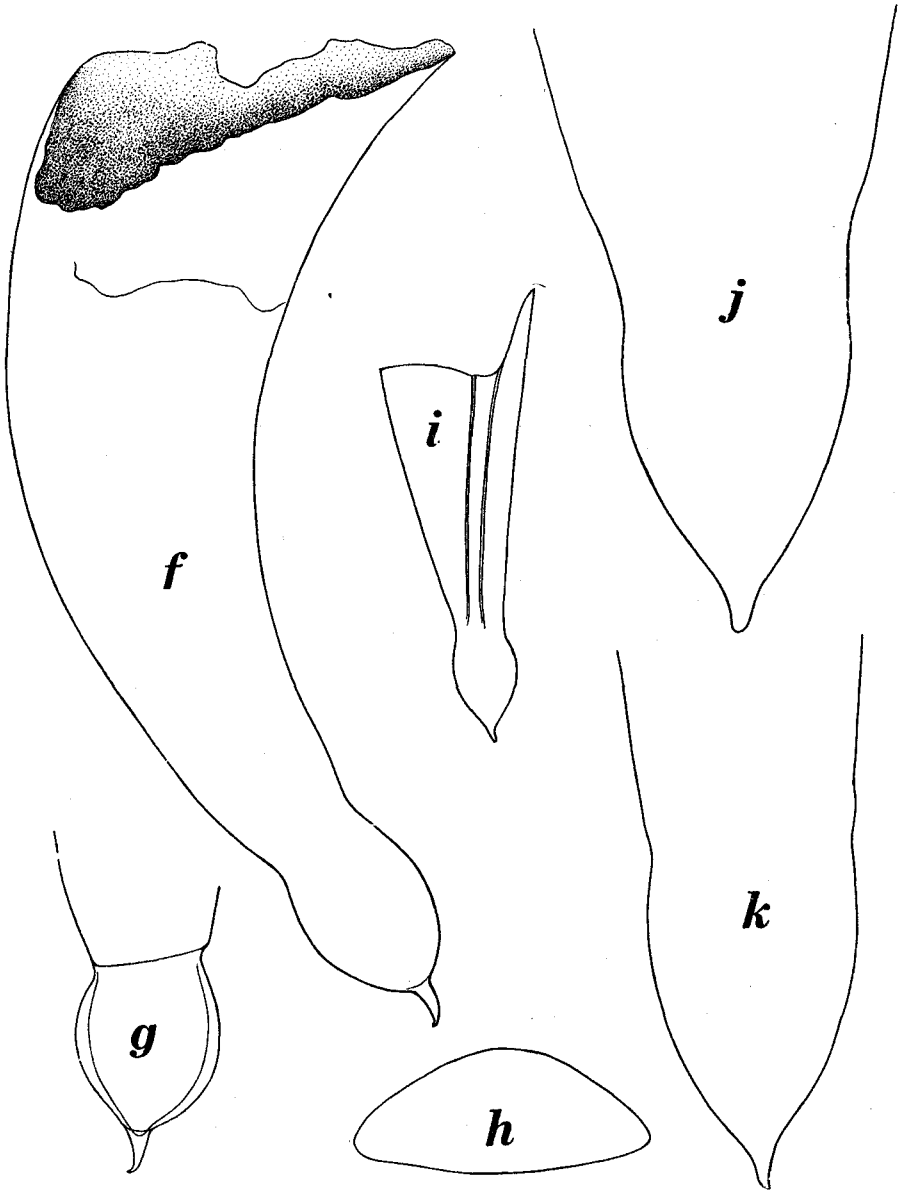
Occurrences:

SB 100 (51)	SB 175 (3)	SB 210 (2)
SB 105 (1)	SB 180 (4)	SB 215 (13)
SB 115 (2)	SB 187 (19)	EQPH 3 (1)

8. *Euclio balantium* (RANG)

(Text-fig. 41, *i–k*)

Two brownish crests on the lateral side. Embryonic shell resembles closely that of *Euclio cuspidata* in a somewhat swollen appearance with a small pointed prominence very slightly curved towards the dorsal side, but it may become like that of *Euclio pyramidata* in some adults.



Text-fig. 41. f–h. *Euclio cuspidata* (BOSC). A young shell from EQPH 3. f···lateral view of the shell, g··· embryonic shell, h···section of the shell, all ×127.
i–k. *Euclio balantium* (RANG). Young shells from SB 115. i···lateral view of the shell, j and k···embryonic shells, ×127.

Occurrences:

SB 115 (+)	SB 145 (2)	EQPH 11 (5)
SB 118 (7)	SB 160 (2)	EQPH 17 (3)
SB 122 (3)	EQPH 7 (5)	

9. *Creseis acicula acicula* RANG

Occurrences:

SB 15 (+)	SB 109 (2)	SB 187 (10)
SB 55 (4)	SB 142 (10)	SB 200 (9)
SB 60 (3)	SB 145 (5)	SB 210 (4)
SB 64 (3)	SB 155 (8)	SB 217 (?1)
SB 68 (1)	SB 160 (45)	EQPH 7 (3)
SB 71 (1)	SB 175 (62)	EQPH 11 (8)
SB 75 (4)	SB 180 (4)	TP 74 (abundant)
SB 80 (7)	SB 181 (22)	

9a. *Creseis acicula clava* RANG

Occurrences: SB 80 (1), SB 109 (1), SB 112 (1), EQPH 17 (2)

10. *Creseis virgula virgula* RANG

Occurrences:

SB 10 (+)	SB 71 (6)	SB 175 (5)
SB 50 (1)	SB 75 (3)	SB 210 (6)
SB 55 (5)	SB 85 (2)	SB 217 (7)
SB 60 (5)	SB 90 (2)	EQPH 7 (5)
SB 64 (2)	SB 95 (1)	EQPH 11 (57)
SB 68 (3)	SB 100 (2)	EQPH 17 (2)

10a. *Creseis virgula conica* (ESCHSCHOLTZ)

Occurrences:

SB 15 (+)	SB 125 (2)	SB 187 (34)
SB 68 (1)	SB 137 (27)	SB 195 (3)
SB 75 (2)	SB 142 (7)	SB 200 (39)
SB 80 (3)	SB 145 (7)	EQPH 3 (2)
SB 100 (14)	SB 150 (8)	EQPH 7 (1)
SB 105 (7)	SB 155 (26)	EQPH 11 (8)
SB 109 (14)	SB 160 (9)	EQPH 17 (9)
SB 112 (7)	SB 175 (6)	EQPS 28 (1)
SB 115 (12)	SB 180 (11)	
SB 118 (5)	SB 181 (76)	

11. *Creseis* sp.

A mutilated specimen unidentified from SB 217.

12. *Styliola subula* (QUOY et GAIMARD)

Occurrences:

SB 15 (+)	EQPH 7 (1)	EQPH 17 (40)
EQPH 3 (25)	EQPH 11 (1)	

13. *Hyalocylis striata* (RANG)

Occurrences:

SB 15 (+)	SB 112 (3)	SB 187 (5)
SB 55 (5)	SB 150 (?2)	SB 200 (7)
SB 60 (3)	SB 155 (11)	EQPH 3 (4)
SB 68 (3)	SB 160 (2)	EQPH 7 (8)
SB 71 (6)	SB 175 (14)	EQPH 11 (8)
SB 75 (1)	SB 180 (3)	EQPH 17 (1)
SB 80 (8)	SB 181 (7)	

14. *Diacria trispinosa trispinosa* (LESUEUR)

Occurrences:

SB 55 (juv. 15)	SB 195 (?1)	EQPH 17 (juv. 4)
SB 125 (juv. 1)	EQPH 7 (2)	
SB 145 (juv. 1)	EQPH 11 (juv. 4, ad. 2)	

15. *Diacria quadridentata quadridentata* (LESUEUR)

Of the twenty shells from EQPH 11, eight were of the usual type, whitish and with some brownish flecks at some parts of the shell, while other twelve were smaller, wholly brownish in colour, and with the five longitudinal ridges on the dorsal side of the shell which were marked much more clearly; probably the latter belongs to the subspecies *costata* (PFEFFER).

Occurrences:

SB 15 (juv. +)	SB 145 (juv. 3)	SB 200 (juv. 2, ad. 12)
SB 55 (juv. 7)	SB 150 (juv. 1)	SB 210 (juv. 2)
SB 60 (4)	SB 160 (juv. 6, ad. 10)	SB 217 (juv. 1)
SB 64 (2)	SB 166 (1)	EQPH 3 (2)
SB 68 (juv. 1, ad. 1)	SB 175 (juv. 6, ad. 7)	EQPH 7 (juv. 2, ad. 8)
SB 75 (juv. 1)	SB 180 (1)	EQPH 11 (juv. 5, ad. 20)
SB 80 (juv. 1, ad. 2)	SB 181 (1)	EQPH 17 (juv. 5, ad. 6)
SB 100 (juv. +)	SB 187 (juv. 1)	
SB 142 (juv. 1)	SB 195 (1)	

16. *Cavolinia tridentata* FORSKÅL

Occurrences:

SB 60 (juv. 1)
SB 64 (juv. 2)
SB 80 (juv. 2)
SB 95 (juv. 4)
SB 100 (juv. 1)
SB 195 (?4)
EQPH 11 (1)
TP 81 (1, enclosed in a gelatinous envelope)

17. *Cavolinia longirostris longirostris* (LESUEUR)

Occurrences:

SB 15 (+)
SB 80 (1)
SB 109 (3)
SB 130 (1)
SB 137 (2)
SB 145 (3)
SB 150 (2)
SB 155 (1)
SB 160 (12)
SB 166 (2)
SB 187 (1)
SB 210 (1)
SB 217 (1)
EQPH 7 (juv. 3, ad. 1)
EQPH 11 (13)
EQPH 17 (8)

17a. *Cavolinia longirostris angulata* (SOULEYET)

Occurrences: EQPH 7 (1), EQPH 11 (13).

17b. *Cavolinia longirostris strangulata* HEDLEY

Three shells from EQPH 11.

18. *Cavolinia gibbosa* (RANG)

A single shell from EQPH 17.

19. *Cavolinia uncinata* (RANG)

Occurrences: SB 71 (1), SB 181 (2)

20. *Cavolinia globulosa* (RANG)

Occurrences:

SB 55 (1)
SB 100 (13)
SB 210 (1)
EQPH 11 (juv. 1, ad. 5)
EQPH 17 (juv. 1)

21. *Cavolinia inflexa* (RANG)

Occurrences:

SB 10 (juv. +)
SB 71 (juv. 1)
SB 80 (juv. 1)
SB 175 (juv. 4)
SB 200 (juv. 1)
EQPH 3 (7)
EQPH 7 (3)
EQPH 11 (juv. 4)
EQPH 17 (12)
EQPS 28 (1)

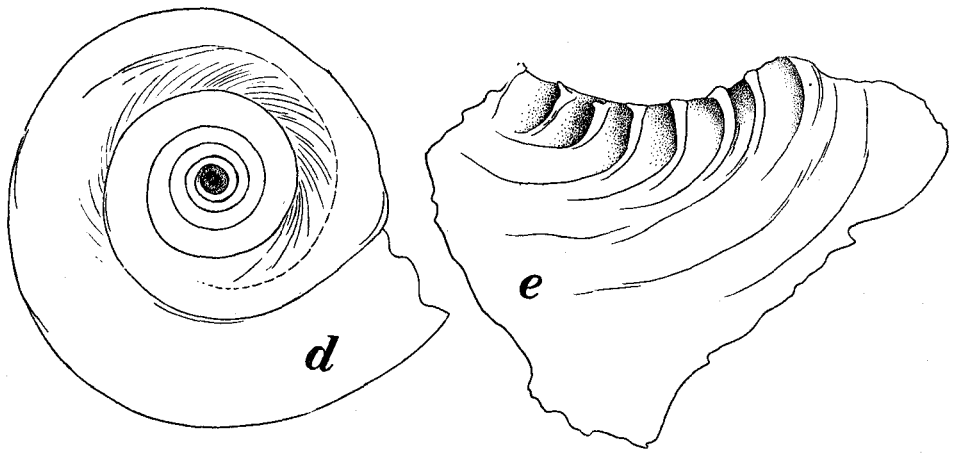
22. *Cavolinia* spp.

Mutilated and unidentified specimens occurred as SB 175 (2), SB 195 (1), and EQPH 7 (juv. 1).

23. *Peraclis reticulata* (D'ORBIGNY)

(Text-fig. 42d)

Occurrences: EQPH 7 (1), EQPH 11 (1), EQPH 17 (6), MP 41 (+)



Text-fig. 42. Operculum of *Peraclis reticulata* (D'ORBIGNY) (d, ×73) and a part of the body whorl of *Peraclis apicifulva* MEISENHEIMER showing the sculptures along the suture (e, ×127).

24. *Peraclis apicifulva* MEISENHEIMER

(Text-fig. 42e)

This species can be distinguished by the smoothly surfaced feature of the shell, which is, however, furnished with a number of short radially arranged crests found along the suture between the body whorl and the spire (Text-fig. 42e). The shell from SB 80 with a 1.1 mm long diameter and coiled two and a quarter times shows the whorl formula 1 : 0.30 : 0.10.

Occurrences: SB 80 (2)

25. *Peraclis* spp.

Mutilated and unidentified specimens occurred as:

SB 60 (1)	SB 142 (1)	SB 210 (2)
SB 80 (2)	SB 155 (1)	MP 41 (1)
SB 85 (1)	SB 175 (6)	
SB 100 (1)	SB 181 (1)	

26. *Cymbulia sibogae* TESCH

The dorsal part of the pseudoconcha tapers rather abruptly and in some specimens it is prolonged for a considerable length and ends acutely. The ventral part is never narrowed. The median and two ventro-lateral ridges are defined clearly on the aboral side, the former is shorter than the latter. In addition to these, one or two ridges are formed on each lateral~latero-oral side; these and the ventro-lateral ridges on the aboral side may be forked into two branches ventrally (specimens from SB 160). And the inner branch of the oral-most ridge is often furnished with 3–4 prominent teeth along the aperture (specimens from SB 175 and EQPH 11).

Occurrences:

SB 100 (12, 18, 19 mm inds.)	SB 181 (28.5 mm ind.)
SB 112 (15.5 mm ind.)	SB 187 (3)
SB 115 (12.5 mm ind.)	SB 195 (+)
SB 160 (24.5, 25 mm inds.)	SB 200 (2)
SB 175 (18, 22 mm inds. and 3)	EQPH 11 (25 mm ind. and 3)
SB 180 (17 mm ind.)	

27. *Corolla ovata* (QUOY et GAIMARD)

A considerable number of pseudochonchs were found in the sample from SB 1.

28. *Corolla* sp.

Pseudochoncha is oval, rounded at both ends, and about 30 mm long and 17 mm wide. Aperture is nearly one half as long as the pseudoconcha. The distribution of spinules on the surface is very regular as is found on *Corolla* sp. from the Atlantic described by TESCH (1946; p. 38, Pl. V figs. 29 a–b). A single pseudoconch from SB 85.

29. *Desmopterus papilio* CHUN

Occurrences:

SB 1 (3)	SB 35 (1)	SB 55 (8)
SB 25 (2)	SB 50 (1)	SB 60 (7)

SB 75 (1)	SB 187 (6)	TP 70 (1)
SP 80 (3)	SB 195 (5)	MP 8 (4)
SB 95 (1)	SB 215 (7)	MP 15 (1)
SB 112 (4)	SB 217 (8)	MP 20 (1)
SB 122 (1)	EQPH 3 (1)	MP 41 (1)
SB 155 (1)	EQPH 7 (1)	J 5 (1)
SB 170 (5)	EQPH 11 (10)	J 6 (2)
SB 180 (9)	EQPH 17 (4)	

J···Stations in the north-eastern waters off Japan.

30. *Hydromyles globulosa* (RANG)

Occurrences: EQPH 3 (6), EQPH 7 (2)

31. *Thliptodon akatsukai* TOKIOKA

A single specimen from SB 50.

32. *Thliptodon* spp.

Although they can't be identified exactly on account of their so strongly contracted condition, some of large individuals (for instance, those from SB 125 and SB 132) might belong to *T. diaphanus* (MEISENHEIMER) and the individual from SB 130 might be *T. gegenbauri* BOAS as the anterior part of the body having a pair of anterior tentacles looks like that of the species.

Occurrences:

SB 44 (1)	SB 125 (1)	SB 160 (1)
SB 68 (1)	SB 130 (1)	SB 180 (?1)
SB 95 (1)	SB 132 (5)	SB 187 (1)
SB 105 (1)	SB 145 (1)	
SB 118 (1)	SB 155 (1)	

33. ?*Pneumodermopsis* sp.

Occurrences: SB 64 (1), SB 130 (1), EQPH 11 (2)

34. Gymnosomata unidentified

Occurrences:

SB 30 (1)	SB 142 (1)	SB 195 (1)
SB 68 (1)	SB 175 (1)	SB 200 (5)
SB 71 (1)	SB 180 (1)	SB 95 (1, probably
SB 100 (4)	SB 181 (1)	*Notobranchaea* sp.)

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