

BISCAYAN PLANKTON.

PART IV.—THE THALIACEA.

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(Plates 8 & 9.)

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i. THE CYCLOMYARIA.

THIS suborder was represented only by known species of *Doliolum*, but the collection contained four apparently undescribed phases, two of which I believe to be the blastozooid and trophozooid * of *Doliolum Tritonis*. Of the four polymorphic life-phases of *Doliolum*, the gonozooids alone have been adequately described for most species; in a recent account of the genus, Dr. Borgert † gave a synoptic table which covered the gonozooids of all admitted species, but he did not attempt it for any other of the three forms presented by this remarkable organism. It will be most reasonable, therefore, to begin with the gonozooids; to pass to the phorozoids (since they are stated to be structurally identical with the former, except internally for the absence of the generative organs, and externally for the presence of the ventral outgrowth on which the gonozooid-buds are borne and for the absence of the dorsal outgrowth); and to conclude with the blastozooids and trophozooids.

a. Gonozooids.

DOLIOLUM TRITONIS, Herdman.

This occurred at all depths down to 100 fathoms, but never below that horizon; it is, therefore, epiplanktonic. But it did not occur in sufficient numbers (111), nor on

* Blastozooid = Amme. Phorozoid = Pflgethier. Trophozooid = Nährthier. Gonozooid = Geschlechts-thier.

† A. Borgert: 'Plankton-Expedition. Thaliacea.—C. Vertheilung der Doliolen.' I follow his synonymy.

sufficient occasions (12), for inferences to be drawn as to its habits. Only small specimens were captured ; the largest was about 5 mm. long, and many were less than 2 mm.

DOLIOLUM KROHNI, Herdman.

Two gonozooids only of this species were taken, one in 21 *b*, one in 30 *h*, both in 100-fathom hauls.

DOLIOLUM NATIONALIS, Borgert.

One specimen in 30 *l* (50 fathoms) was apparently referable to this species.

DOLIOLUM sp., Borgert.

Dr. Borgert (*op. cit.*) records specimens from the hauls of the 'National' (coming, with a single exception, "aus etwas grösseren Tiefen," many of them from the closing-net), which showed a marked resemblance to *Krohni*, Herdman, as regarded the formation of the gills and alimentary canal, but recalled *rarum*, Grobben, in the form of the generative organs. To this unnamed species may be referred two specimens from 36 *l* (350 to 0 fathoms). On comparison with *Krohni*, the main differences recognizable were of the character noted by Dr. Borgert:—

<i>Doliolum</i> sp., Borgert.		<i>Doliolum Krohni</i> .	
Endostyle	1st intermuscular space to 5th muscle.	2nd intermuscular space to 4th intermuscular space.	
Gill-plate	4th to about 6th muscle.	5th muscle to 6th intermuscular space.	

But he did not record, what was very noticeable in my specimens, the extreme thinness of the muscle-bands, for they were as thin comparatively as in *Nationalis*, far thinner than in *Krohni*. The gill-slits were not exactly countable, owing to poor preservation, but appeared to be about 16 to 20 in number.

Being unable, in a single case, to find a ripening ovum in this unnamed form, Borgert suggested as a possibility that the specimens were examples of *Krohni* which had failed to reach sexual maturity (supposing them not to constitute a separate species); or, as an alternative, that the differences between them and *Krohni* might be of a pathological nature due to the depth at which they lived. There is, of course, also a third possibility, namely, that these forms are really *Krohni* which, dying before sexual maturity or after sexual exhaustion, are sinking to the bottom, and that the differences in position of some organs are attributable to post-mortem shrinkage and to distortion due to tow-net pressure. Like Borgert, I failed to find ripening ova, the cells of the ovary seemed to be all approximately equal in size; but the whole appearance of this form is so different from *Krohni*, its muscle-bands are so thin, its test so slight, that I believe it to constitute an undescribed mesoplanktonic species. My specimens are hardly good enough to allow of a diagnostic description and figures. I suggest that it is a mesoplanktonic species, not only from the 'National' captures, but also from the distribution of the phorozoid in the closing-net (p. 91).

b. *Phorozoids*.*DOLIOLUM TRITONIS*, Herdman.

This was taken in 13 hauls, all between 100 fathoms and the surface. Of the 119 specimens which I have assigned to it, a few may have been young gonozoids; but the greater number (31) of minute specimens, which did not clearly show either generative organs or dorsal outgrowth, have not been reckoned as either gonozoid or phorozoid. No specimen exceeded 4 mm. in length. As we do not know at what length the phorozoids become freed, and as so many minute but recognizable gonozoids were captured, it must be left uncertain whether the larger phorozoids had been knocked off the dorsal outgrowth of a blastozoid, or were leading an independent existence; the former was probably the case. Blastozoids which I refer to *Tritonis* were present in all the hauls in which these phorozoids were taken.

DOLIOLUM sp., Borgert.

To this may be referred two specimens (35 *o*, 250–150 fathoms; 35 *k*, 430–300 fathoms); and, with less certainty, on account of imperfect preservation, eleven further specimens (21 *m*, 500–400 fm., 4 specimens; 21 *c*, 300–200 fm., 1 specimen; 31 *d*, 1000–750 fm., 1 specimen; 27 *a*, 1250–0 fm., 5 specimens). No generative organs were seen, and the specimens were therefore probably phorozoids.

c. *Blastozoids*.

Very little is known of the specific characters of blastozoids. From the text and figures of the more recent authorities I have compiled the following table, omitting, however, two characters which are found in some definitions—the thickness of the muscle-bands, because this seems to depend upon age and size; and the shape of the true stolon, which appears (from my specimens, at any rate) to alter in successive phases of maturation and germination.

In the table, to save space, the muscle-bands are represented by i, ii, iii, &c., the intermuscular spaces by i–ii, ii–iii, &c. The authorities, indicated by square brackets in the table, are:—

- A. Borgert: 'Plankton-Expedition. Thaliacea.—C. Vertheilung der Doliolen' (*Krohni*, pl. vi. fig. 13).
- C. Grobben: Arb. Zool. Instit. Wien, iv. 201 (*Mülleri*, pl. iii. figs. 16–18; *denticulatum*, pl. i. figs. 3–5, pl. ii. fig. 7).
- B. Uljanin: Fauna u. Flora d. Golfes v. Neapel, Monographie *Doliolum* (*Mülleri*, pl. vii. fig. 11, pl. ix. fig. 6; *Ehrenbergi*, pl. xii. fig. 8). On p. 128 the anus of *Mülleri* is described as opening in v–vi, but is drawn as lying in vii–viii on pl. vii. fig. 11: this figure seems to be wrong in some other respects—for example, the eighth muscle-band curves into the dorsal stolon and not the seventh.

	<i>Intestine.</i>	<i>Endostyle.</i>	<i>Œsophagus and Stomach.</i>	<i>Anus.</i>	<i>Gill-slits.</i>	<i>Otocyst.</i>
<i>Mülleri</i> , Krohn [Ulj., Gr.].	with U flexure.	ii-iii to iv-v.	under vi [Ulj.], in v-vi [Gr.].	in v-vi.	v-vi to vi-vii, small.	touching iv [Ulj.], on iv [Gr.].
<i>Krohni</i> , Herdman [Borg.].	with U flexure.	ii-iii to iv-v.	æs. under vi, stom. in v-vi.	under vi.	v-vi to vi-vii, small.	touching iv.
<i>denticulatum</i> , Q. & G. [Gr.].	nearly straight.	ii-iii to iv-v.	in v-vi.	under viii.	v to vi-vii, large.	in iii-iv.
<i>Ehrenbergi</i> , Ulj., not Krohn [Ulj.].	nearly straight.	ii to iv-v.	in v-vi.	under viii.	v to vi-vii, large.	in iii-iv.
Blastozoid A (? = <i>Tritonis</i> , Herdman) [G. H. F.].	nearly straight.	ii-iii to v.	in v-vi or under vi.	from under viii to ix.	v-vi to vi-vii, large.	in iii-iv.

Between the first two there is practically no difference, and but little distinction can be drawn between the last three. Although the separating characters are not the same in the two generations, the gonozooids of the first two species similarly belong to one group of gonozooids, those of the last three to another.

Out of the numerous well-preserved blastozoids in the collection, not one had retained on its dorsal outgrowth phorozoids of sufficient size to be identified specifically. The experience of the 'National' was similar; the older buds become very easily detached. It is only, therefore, through indirect evidence that the blastozoids and trophozooids can be linked with their proper species. Such evidence I propose now to attempt.

In 14 out of the 50 hauls at 100 fathoms or less which contained *Doliolum* of any kind, occurred either gonozooids or phorozoids, or both, referable to *Tritonis*, amounting in all to 111 * gonozooids and 119 * phorozoids. In 2 out of these 50 hauls were found gonozooids referable to *Krohni*; in 1 only a gonozooid belonging to *Nationalis*. Expressed in a comparative table, of the total gonozooids captured:

97.3	per cent.	were referable to	<i>Tritonis</i> ,
1.7	"	"	<i>Krohni</i> ,
.8	"	"	<i>Nationalis</i> ;

and there occurred gonozooids of:

<i>Tritonis</i>	in	28	p.c. of hauls containing	<i>Doliolum</i> ,
<i>Krohni</i>	in	4	"	"
<i>Nationalis</i>	in	2	"	"

In every one of the 50 hauls at 100 fathoms or less which contained *Doliolum* of any kind occurred blastozoids, amounting to 922 specimens. In about sixteen of these

* Actual numbers, not multiplied by time-factor; all nets at 100 fm. or less.

cases occurred small specimens, some 400 in number, which had not begun or had not completed their degeneration, and therefore showed their characteristic structure: they were demonstrably of a type hitherto undescribed. The remaining blastozooids (excepting four, possibly five, specimens to be dealt with later) appeared to pass by easy gradation into this type, though altered by the usual metamorphosis and degeneration. In every case in which phorozoids of *Tritonis* were captured this blastozooid occurred.

The presumption is that this undescribed blastozooid belongs to one of the species already captured in the North-eastern Atlantic, namely, to *denticulatum*, *Nationalis*, *Krohnii*, *Tritonis*, or *sp.*, Borgert*. Of these, *denticulatum* is known only as a warm-water form, and has not been taken north of 42° N.; *D. sp.*, Borgert, is apparently a deep-water form, and I did not take it above 250–150 fathoms; the blastozooid of *Krohnii* has been well figured and described, and does not agree with the one before us; there remain *Nationalis* and *Tritonis*. As between these two, the presumption is enormously in favour of the one to which belong 97 per cent. of the gonozooids and all the phorozoids. In default, therefore, of characters which enable older blastozooids to be specifically differentiated, I refer all blastozooids from the epiplankton (except the five already referred to) to

BLASTOZOOID A (? = *DOLIOLUM TRITONIS*, Herdman).

The table (p. 92) and the drawing (Pl. 8. fig. 1) sufficiently show the diagnostic characters.

In the case of the Thaliacea, as in that of the Chaetognatha, I have endeavoured to sort out every specimen in the collection. That this is practically impossible, especially when dealing with minute specimens, I know well; even if every particle of the catch were sorted out into its respective Order (which has not in every case been done), there would remain, in rich hauls from 100 fathoms particularly, specimens tangled together in clots from which they can only be freed by tearing them. In such hauls the error in minute specimens may perhaps be as much as 10 per cent.†; in the poorer hauls it drops proportionately, till it becomes zero. But I believe the approximation to accuracy to be close enough to allow one to handle the resulting statistics of population (compare Methods and Data, p. 7, *supra*), and in any case the conclusions based on counted specimens can only be put forward provisionally for confirmation or refutation by future observers.

The hauls used for statistics may be regarded as fairly comparable, except for the varying rate of the ship's drift: for this factor no proper correction can be made. Hauls made with a small-mouthed net of 180 meshes per linear inch have been neglected, as in the case of Chaetognatha, because the catching-power was obviously so slight (simultaneously, 180 meshes caught none, 60 meshes caught 68 specimens; 180 meshes caught none, 60 meshes caught 10 specimens). Hauls with a net of about 18 meshes per linear inch, and a diagonal of the mesh-aperture about 1.5 mm., have also been omitted (but not in the case of the larger Chaetognatha), as allowing small specimens to slip through.

In the course of the second day's work (July 8) we struck a "swarm" of *Doliolum*, a remarkable feature of which was that, unlike the swarms of gonozooids hitherto described,

* *Vide* Chart, Pl. 9.

† Mr. J. J. Lister, testing this in *Hastigerina*, found in rich hauls an error in my sorting of 5 to 6 per cent.

it consisted almost entirely of blastozooids. For example, haul 21 *h* at 100 fathoms yielded the following determinable and measurable specimens * in half an hour :—

Blastozooids :	2 mm. and less in length	.	.	.	.	.	369
	3	„	„	.	.	.	43
	4	„	„	.	.	.	16
	5	„	„	.	.	.	10
	6	„	„	.	.	.	10
	7	„	„	.	.	.	4
	9	„	„	.	.	.	1
Gonozooids :	2	„	„	.	.	.	2
	3	„	„	.	.	.	1

This puzzling appearance of numerous specimens of the same generation termed a “swarm” has been discussed at some length by Dr. Borgert. He refers the swarming to the more or less seasonal occurrence of optimal conditions, such as food and temperature (*op. cit.* pp. 61-63); but he rejects (*op. cit.* pp. 49, 50) the idea that species of *Doliolum* have regularly recurrent periods of reproduction, on the following grounds :—(1) that all the eggs of the gonozooid do not ripen simultaneously, and therefore the resulting blastozooids will be of different ages and sizes; (2) that the blastozooids and phorozooids are productive for a considerable time, and their successive “progeny” therefore will be even more markedly of different sizes and ages: thus the effect of a swarm produced under optimal conditions will be dissipated and untraceable in the course of a complete cycle of reproduction.

On the other hand, the presence of such large numbers of minute blastozooids as were taken on July 8 certainly seems to me to demand the pre-existence of a “swarm” of gonozooids, since the ovary of the specimens examined contained generally only one large ovum, although plenty of smaller ova.

The swarm was apparently confined to a small space; on the next day, July 9, at a distance varying from 8 to 20 miles away in a N.W. direction, it was not certainly recognizable. On July 11 we were again 8 miles from the original position, this time a little N. of E.; the average catch per haul that day was 2·6 instead of 314. On July 12, 9 miles S.E. of the original position, the average catch † per haul was 4·5. Yet the whole area covered by our stations was so small that the conditions of food and temperature were presumably uniform throughout, and, if optimal at one point, ought, on Dr. Borgert’s theory, to have affected the whole area, and to have produced a uniform swarming: this was obviously not the case.

But though the “swarm” was apparently local, yet sporadic sexual reproduction appeared to have taken place simultaneously over, at any rate, a large part of the area under observation. This would appear from the following table ‡ :—

* Actual numbers, not multiplied by a time-factor.

† The daily average catches per haul have been plotted on the chart of positions, but yielded no obvious result.

‡ Days of 24 hours, midnight to midnight. The specimens were roughly measured as 2 mm. or less; 3 mm. or less, but more than 2; 4 mm. or less, but more than 3, &c.; and the average length struck on these measurements. They seem to show the comparative daily lengths, but would not be accurate enough to determine (say) rate of growth.

Day.	Average length of specimens. (mm.)	Length of smallest specimens. (mm.)	Length of largest number of specimens. (mm.)
July 8	2.3	2.0	2.0
9	2.8	2.0	2.0
10	4.8	2.0	2.0
11	5.5	3.0	5.0
12	5.6	4.0	5.0
13	6.2	4.0	7.0

After this there was a break of five days in the observations, due to deep-water work and to our running into Brest for coal; except on the 19th and 20th we caught few specimens, and the figures, both of average specimens per haul per day and of average and actual lengths per day, are orderless. That sporadic sexual reproduction had occurred subsequently to the first "swarm" is, however, seen from the fact that specimens of 2 mm. and less were caught (for the last time) on the 19th.

We may conclude from the above: that a swarm of blastozoids may be formed, as well as a swarm of gonozoids; that it seems to demand the previous occurrence of a swarm of gonozoids; that some further explanation of the production of the swarm is required than mere optimal conditions of food and temperature, because the swarm is so local, even when sporadic reproduction is going on in the surrounding area.

I had hoped that these blastozoids were present in sufficient numbers and occurred on sufficient occasions to enable a test to be made of their reaction to light by the method used for *Sagitta serratodentata* (Part III. pp. 60-61, above). But the attempts at this were invalidated by the presence of the "swarm," which sent up the values of the depths (50 and 100 fathoms) at which it occurred in a manner quite disproportionate to those obtained for the remainder of the cruise. For example, the average specimens* per hour haul at 100 fathoms between 3.0 A.M. and 7.0 P.M. were 93.5 if the swarm-haul 21 *h* was included, but 3.2 if it was omitted! I therefore separated the swarm-hauls 21 *e* to 21 *i*, and although they by themselves seemed to indicate a movement of the swarm to the surface at night, yet the placing of the remaining hauls on day-and-night tables gave no satisfactory result: it neither confirmed nor denied any vertical oscillation, either because both specimens and observations were too few, or, more probably, because no such vertical oscillation exists in this species. But the contrasting of hauls in dry weather, irrespective of time of day, with those made during or after rain

* In this section the actual numbers caught have been treated with the time-factor; nets 18 and 180 omitted; and averages struck over all hauls, not merely those in which the blastozoid occurred.

markedly showed much the same avoidance of the surface as was noticeable with *Sagitta serratodentata* (p. 61, *supra*). Both sets of figures include day and night hauls; the swarm-hauls 21 *e* to *h* (21 *i* was with net 18) are also included :—

At 0	} fathoms in	10	} hauls in dry weather the average catch per hour was	9.4	} specimens, but in	3	} hauls during or after rain the average catch per hour was	0	} specimens.
25		9		0.6		3		7.3	
50		10		10.4		3		22.0	
75		10		2.8		1		3.0	
100		19		49.8		2		7.0	

Were the swarm-hauls omitted, the dry-weather values for 0, 50, and 100 fathoms would be 10.4, 6.8, and 2.1; and the contrast would be even more marked.

In the following table the swarm-hauls have been omitted, in order to get an idea of the vertical distribution of these blastozoids irrespective of swarms :—

At 0	} fathoms they occurred in	41	} per cent. of	12	} hauls, yielding	7.8	} average specimens per hour haul.
25		58		12		2.3	
50		83		12		10.3	
75		72		11		2.8	
100		55		20		2.6	

Both percentages of hauls and average specimens per hour indicated that 50 fathoms was the optimal horizon*.

Average lengths per depth, when tabled, did not show that older specimens sought a different level from the younger specimens.

We may summarize the foregoing paragraphs as follows :—The captures, as a whole, yielded no evidence for or against a day and night oscillation; but they markedly indicated an avoidance of the surface during or after rain, the species becoming most plentiful at 25 and 50 fathoms; the average expectation of specimens is highest at 50 fathoms, which may be taken to have been the optimal horizon for the date and area studied.

In epiplankton hauls at or above 100 fathoms these blastozoids occurred in 65 per cent. of the total hauls; below 100 fathoms they vanished; on three occasions only (*cf.* Table, pp. 100–101) there were taken in the mesoplankton net from considerable depths fragments of very large specimens of a blastozoid, mostly larger than any of the epiplankton specimens. These may have been dead specimens of Blastozoid A, or may even possibly belong to a deep-water species. But there can be no doubt that Blastozoid A is epiplanktonic.

* It is curious that, on whatever principles such statistics are arranged, the average specimens at 50 fathoms always have much higher values than at 75 and 25 fathoms. The same was observed in *Sagitta serratodentata*.

BLASTOZOOID B.

A single specimen, which had completely degenerated and was in very bad condition, exhibited muscle-bands thinner than in those attributed to *Tritonis* at a corresponding length. It would not have been recorded here, but for the fact that it occurred in the same haul as some trophozooids to be described (p. 98).

DOLIOLUM KROHNI, Herdman.

Specimens which seemed to agree with Borgert's figures and description occurred in 32 *h* (50 fm., 1 specimen) and 34 *c* (75 fm., 3 specimens).

As all blastozooids are so much alike after degeneration (which in Blastozooid A sets in generally at about 2.50 or 2.75 mm. of total length), it is a little difficult to see what criterion can ever be applied to their specific determination, the organs ordinarily used in diagnosis having disappeared. As an experiment in this direction, which I hope may be repeated by someone else in another species, I have measured the width of the fourth muscle-band in fifty specimens of various lengths, and give in the following table the means (not averaged) at those lengths:—

Total length.				Mean width of muscle-band iv in μ .	
3 or more,	less than	4 mm.	. . . . .	270	
4	„	5	„	502	
5	„	6	„	575	
6	„	7	„	810	
7	„	8	„	880	
8 and more	. . . . .			1012	

d. *Trophozooids*.

TROPHOZOOID A (? = DOLIOLUM TRITONIS, Herdman). (Pl. 8. figs. 2, 3.)

In 8 out of the 50 hauls between 100 fathoms and the surface, which contained *Doliolum* of any kind, occurred an undescribed but characteristic trophozooid, amounting to 106 specimens. It is stated that trophozooids are unable to lead an independent existence; we may therefore expect to find the corresponding blastozooid in the collection. The mere numbers captured indicate a very great probability that this form belongs to the Blastozooid A, which I have provisionally assigned to *Tritonis*.

The only trophozooids hitherto figured and described with any approach to specific certainty are those of *Mülleri*, Krohn, *Ehrenbergi*, Uljanin non Krohn, and *denticulatum*, Quoy and Gaimard. At the outset we are met by the difficulty that the figures of the trophozooid of *Mülleri* given by Grobben (pl. ii. fig. 9) and Uljanin (pl. xi. fig. 9) do not

agree together ; and I incline to doubt that they are really of the same species : in the synoptic table below * I have kept them separate from one another :—

	<i>Intestine.</i>	<i>Anus.</i>	<i>Endostyle.</i>
<i>denticulatum</i> [Grobben].	widely apart from stomach.	anterior to œsophagus.	short, posterior, on level with stomach.
<i>Mülleri</i> [Grobben].	fairly close to stomach.	posterior to œsophagus.	short, far posterior, behind stomach.
<i>Mülleri</i> [Uljanin].	fairly close to stomach.	on level with œsophagus.	fairly long, from level of œsophagus to that of stomach.
<i>Ehrenbergi</i> [Uljanin].	widely apart from stomach.	posterior to œsophagus.	long, from well in front of œsophagus to behind stomach.
Trophozooid A (? = <i>Tritonis</i>) [G. H. F.].	tightly coiled with stom. and œsoph.	anterior to œsophagus.	short, posterior, on level with stomach.
Trophozooid B [G. H. F.].	fairly close to stomach.	posterior to œsophagus.	long, from far in front of œsophagus to well behind stomach.

These Trophozooids A, which I refer provisionally to *Tritonis*, differ in one point or another from all those yet described, notably and from all in the fact that the whole alimentary canal is tightly compressed together, almost like a *Salpa* “nucleus.” Many of the specimens were in very good condition, and the points of difference are therefore not likely to be due to preservation.

As regards the scale-like projections figured by both Grobben and Uljanin, some of my specimens had two, some one, some none. It is probable that they belong rather to the dorsal outgrowth of the blastozooid than to the trophozooid, and that their presence, like the length of the stalk, depends on how and where the trophozooid is broken off. The specimen in Pl. 8. fig. 2 had no scale, that in fig. 3 showed two, folded over : they react to hæmatoxylin like the test. The long sense-processes figured by Grobben had generally been knocked off, but were observed in some specimens.

TROPHOZOOID B. (Pl. 8. figs. 4, 5.)

In 3 out of the 50 hauls between 100 fathoms and the surface occurred trophozooids of another character—in all four specimens. In only one of these hauls was there caught a blastozooid † not obviously like Blastozooid A ; this has already been mentioned in Blastozooid B (p. 97).

* As with the blastozooid, the authority for the description and figure has been enclosed in square brackets.

† Of course, the presence of these trophozooids, although only 3·6 p.c. of the total number, renders less assured my reference to *Tritonis* of all the 917 blastozooids quoted as A. But if this reference be not accepted, the non-degenerate specimens can be quoted simply as Blastozooid A, the rest over 3 mm. left doubtful ; and the remarks about swarming, reaction to rain, optimal horizon, &c., can be taken to refer to blastozooids as a whole irrespective of species, since they omit only 5 specimens.

ii. THE HEMIMYARIA.

This group presented no features of great interest, unless the scarcity of its representatives be reckoned as such. So far as the captures go, they confirm the conclusion of Apstein * that *Salpæ* do not extend deeper than about 218 fathoms (400 metres), as the lowest haul with the closing-net which contained *Salpæ* was 350, 250–150 fathoms. At no horizon were they plentiful; only 29 specimens were distributed over 15 hauls.

The occurrences are noted in the General Table (pp. 100–101).

The species captured were :—

SALPA RUNCINATA-FUSIFORMIS, Cham. Cuv.

Of these there were eight *gregatæ*, one *solitaria*.

SALPA ECHINATA, Herdman (? *fusiformis*, var. *echinata*, Apstein).

Two specimens were taken, by which the distribution of the species is considerably extended northward.

SALPA DEMOCRATICA-MUCRONATA ?, Forskål.

Eighteen badly damaged specimens were perhaps referable to the *gregata* form of this species.

In the following General Table of Distribution the first three hauls are those made with the closing-trawl.

The letters have the following significance :—

B = Blastozoid.

G = Gonozoid.

Gr = Gregata.

P = Phorozoid.

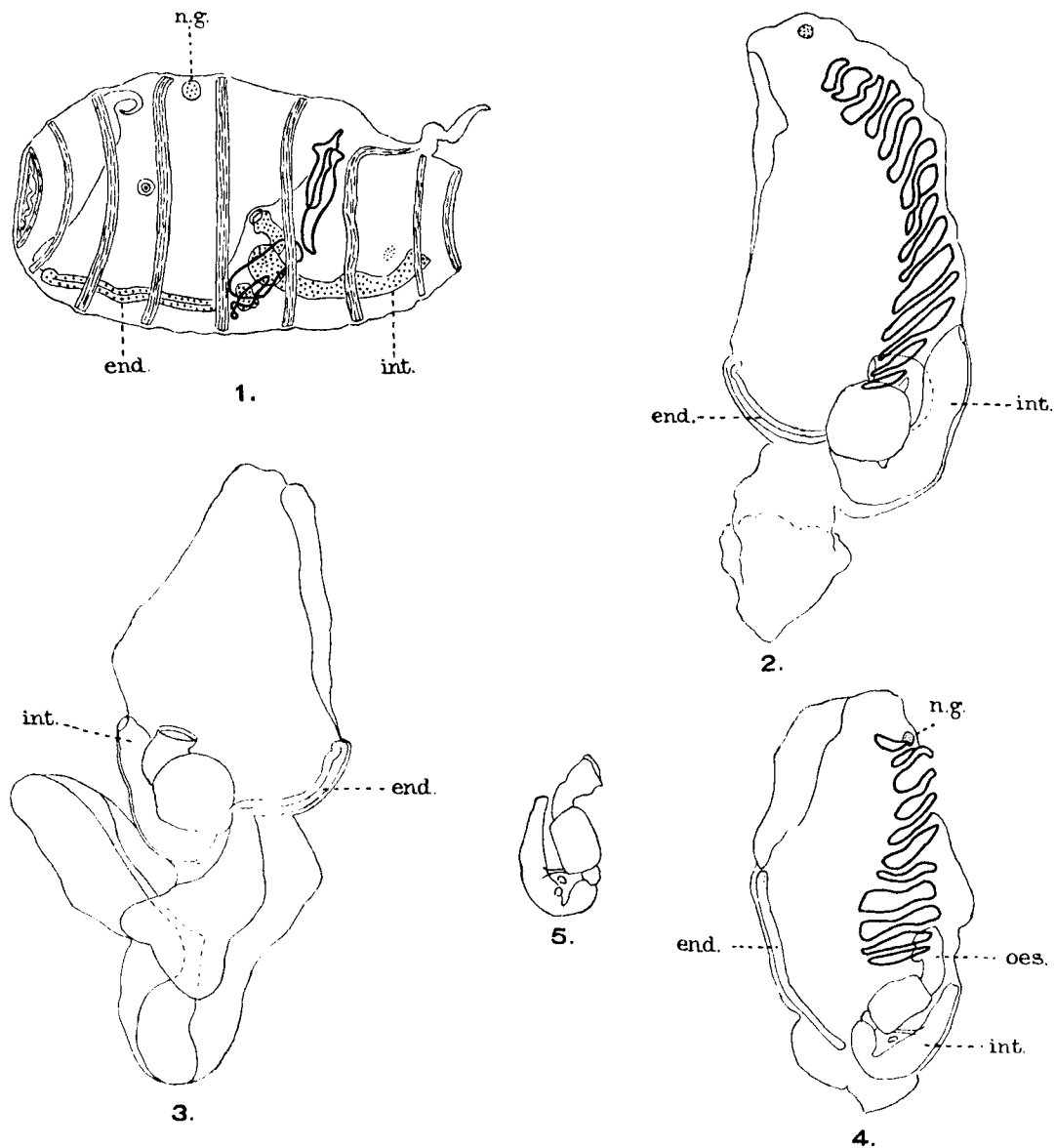
So = Solitaria.

T = Trophozoid.

* C. Apstein : 'Die Thaliacea der Plankton-Expedition.—B. Vertheilung der Salpen,' p. 49.

Depth in fathoms.	Haul.	<i>Doliolum Tritonia.</i>	<i>Doliolum B.</i>	<i>Doliolum Nationalis.</i>	<i>Doliolum Krohnii.</i>	<i>Doliolum</i> sp., Borgert.	<i>Salpa runcinata fusiformis.</i>	<i>S. echinata.</i>	<i>S. democratica-macronata?</i>
500—250	29 a								
1500—750	30 a								
2000—1000	30 e								
0	21 e								
	21 f								
	21 i	B G P	T						
	22 d	B P T							
	22 e	B P T							
	22 g	B							
	23 b	B G P T							
	23 c								
	23 d	B G P T	T						
	23 e	B G P T							
	24 c								
	24 f								
	24 g								
	24 h								
	24 i	B							
	24 k								
	25 a								
	25 b								
	25 h								
	25 i								
	25 l								
	30 c								
	32 c								
	33 a								
	33 b								
25—0	28 a	B							
	30 b	B							
	30 m	B G P							
	31 a	B G P							
	32 b								
	32 e	B							
	33 e	B	....	....	....	....	Gr		
	33 g								
	34 a								
	34 g	B							
	35 w								
50—0	36 c								
	21 g	B G P T							
	25 e								
	25 g	B							
	25 k	B	....	....	....	....	Gr		
	26 c	B							
	30 d	B G	B T						
	30 l	B G P	....	G					
	31 b	B G P	....	....	....	....	Gr		
	32 a	B							
	32 h	B	....	....	B				
	33 c	B							
	33 f	....	....	....	....	....	So		
	36 d	B							
75—0	30 f	B							
	32 g	B							
	32 m	B							
	32 o	B							
	33 h	B							
	34 c	B	....	....	? B				
	35 a	B							
	35 c								
	35 e								
	35 y	....	....	....	....	....		So	
	36 a	B							

Depth in fathoms.	Haul.	<i>Doliolum Tritonia.</i>	<i>Doliolum B.</i>	<i>Doliolum Nationalis.</i>	<i>Doliolum Krohn.</i>	<i>Doliolum</i> sp., Borgert.	<i>Salpa ruscinalis-fusiformis.</i>	<i>S. echinata.</i>	<i>S. democratica-macronotata</i> f
100—0	21 <i>h</i> 21 <i>l</i> 22 <i>a</i> 24 <i>b</i> 24 <i>d</i> 24 <i>e</i> 25 <i>d</i> 30 <i>g</i> 30 <i>h</i> 32 <i>d</i> 32 <i>i</i> 32 <i>n</i> 32 <i>p</i> 33 <i>d</i> 34 <i>b</i> 34 <i>d</i> 35 <i>b</i> 35 <i>d</i> 35 <i>f</i> 35 <i>x</i> 36 <i>b</i> 36 <i>e</i>	B G P T B B B B B B B G P T B B B B B B B B B .....	....	....	G				
150—0	36 <i>f</i>	.....	.....	.....	.....	.....	.....	.....	Gr
150—50	21 <i>p</i>							So	
150—100	21 <i>n</i>								Gr
200—0	21 <i>a</i> 36 <i>g</i>								Gr
200—100	21 <i>b</i> 21 <i>o</i> 26 <i>e</i> 34 <i>h</i> 35 <i>m</i> 35 <i>n</i> 35 <i>t</i>								Gr
250—0	36 <i>h</i> 36 <i>i</i>	.....	.....	.....	.....	.....	.....	.....	Gr
250—150	35 <i>o</i> 35 <i>p</i> 35 <i>s</i>	.....	.....	.....	.....	P	.....	.....	Gr
300—0	36 <i>k</i>								
300—200	21 <i>o</i> 26 <i>f</i> 35 <i>l</i>	.....	.....	.....	.....	P			
350—0	36 <i>l</i>	.....	.....	.....	.....	G			
400—300	21 <i>k</i> 32 <i>l</i> 35 <i>k</i>	.....	.....	.....	.....	P P			
500—400	21 <i>m</i> 35 <i>h</i> 35 <i>i</i>	.....	.....	.....	.....
750—500	22 <i>b</i> 30 <i>k</i> 34 <i>e</i> 34 <i>f</i>	.....	.....	.....	.....
1000—750	23 <i>a</i> 27 <i>c</i> 31 <i>d</i> 32 <i>f</i> 32 <i>k</i>	.....	.....	.....	.....	P			
1250—1000	24 <i>a</i> 27 <i>b</i> 31 <i>c</i>	.....	.....	.....	.....
1500—1250	25 <i>f</i> 30 <i>i</i>	.....	.....	.....	.....
2000—1500	25 <i>c</i> 26 <i>b</i>	.....	.....	.....	.....



BISCAYAN THALIACEA.

ALL FIGURES ARE MULTIPLIED 37 TIMES.

FIG. 1. BLASTOZOOID A (? = *DOLIOLUM TRITONIS*, HERDMAN).2. TROPHOZOOID A (? = *DOLIOLUM TRITONIS*, HERDMAN), FROM THE LEFT SIDE. THE STALK WAS LONG AND TURNED DOWNWARDS TO A NEARLY TRIANGULAR BASE.

3. TROPHOZOOID A: ANOTHER SPECIMEN, FROM THE RIGHT SIDE, THE GILL-SLITS OMITTED. THE STALK WAS SHORT AND CARRIED TWO LARGE FLAPS, APPARENTLY OF TEST-SUBSTANCE, FOLDED OVER.

4. TROPHOZOOID B, FROM THE LEFT SIDE.

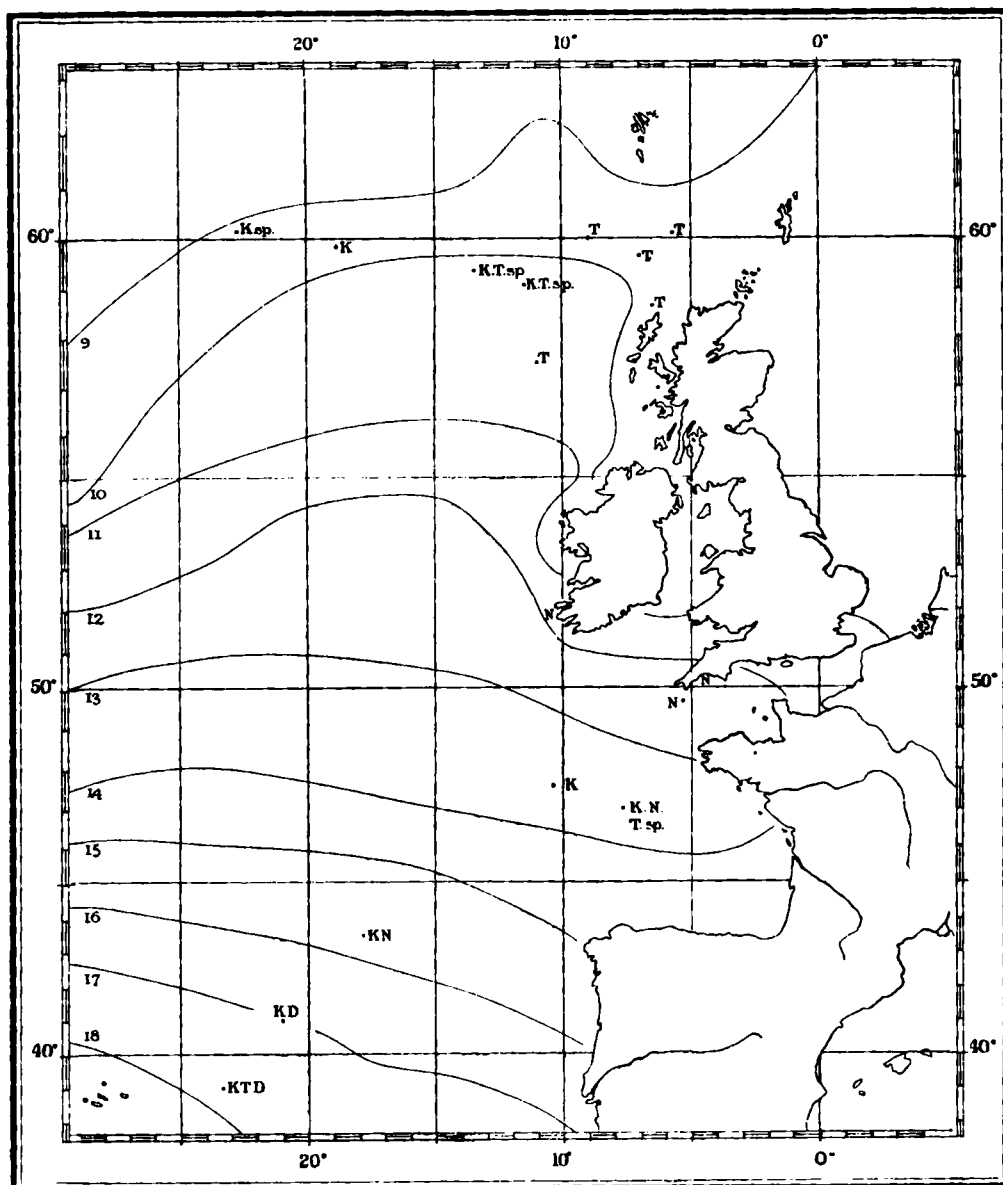
5. INTESTINE OF THE SAME SPECIMEN, FROM THE RIGHT SIDE.

end. endostyle.

int. intestine.

n.g. nerve-ganglion.

oes. œsophagus.



DISTRIBUTION OF THALIACEA.

ON THIS PLATE HAVE BEEN APPROXIMATELY CHARTED THE RECORDS OF VARIOUS SPECIES OF *DOLIOLUM* IN THE NEIGHBOURHOOD OF THE BRITISH ISLANDS; THEY INCLUDE THE CAPTURES OF H.M.S. 'TRITON' (1882), H.M.S. 'RESEARCH' (1896, 1897, 1900), s.s. 'HOLSATIA' (1885), s.s. 'NATIONAL' (GERMAN PLANKTON EXPEDITION, 1889).

AS ALL ARE EPIPLANKTON RECORDS, EXCEPT THOSE OF *DENTICULATUM* AND *D. SP.*, BORGERT, THE MEAN ANNUAL SURFACE ISOTHERMS HAVE ALSO BEEN PLOTTED IN DEGREES CENTIGRADE FROM DR. SCOTT'S RESULTS.

D. D. DENTICULATUM.
K. D. KROHN.
N. D. NATIONALIS.

sp. D. SP., BORGERT.
T. D. TRITONIS.