VARIATION IN AURELIA AURITA.

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In 1895 an article on the Variation of the Tentaculocysts of *Aurelia aurita* (Linn.), written by me, was published in the *Quarterly Journal of Microscopical Science*. The chief object of the research, suggested by Professor Weldon, was the finding out the variation in the number of tentaculocysts, and if a variation occurred among the Ephyrae to see how far it affected the adults. The material for that investigation was collected in Plymouth Sound by the officials of the Marine Biological Association in 1893 and 1894. The results showed that there was a considerable variation in the number of tentaculocysts. The number of tentaculocysts (marginal sense-organs) is definitely fixed in the larval stage, commonly known as an Ephyra. A normal Ephyra has eight marginal lobes, or arms, each with a terminal sense-organ (tentaculocyst), and a prolongation of the stomach, forming a canal, runs along the middle of each lobe to the sense-organ.

A variation in the number of lobes affects also the number of tentaculocysts and the number of radial canals. The three are distinctly correlated, except when a twinning of the tentaculocysts occurs. This is very rare and only occurred five times in 1000 adult specimens.

It is easy to detect cases of twinning in the adults but not in the larval Ephyrae. Occasionally an Ephyra is found having two tentaculocysts at the end of an arm and the canal bifurcated. In some specimens, no doubt, this is genuine twinning, but it is possible for the two tentaculocysts to become widely separated by the growth of the umbrella, and each to have its own canal system. I have, therefore, included twinning in the variation as it does not practically interfere with the results.

It may be taken for granted, that, whatever number of tentaculocysts an Ephyra starts life with, that number remains constant during the whole life of that individual and that no further increase in number takes place during development.

The specimens collected in 1893 belonged to the Ephyra stage and the examination of 359 individuals showed that 22·6 p.c. had either more or less than the normal number (eight) of tentaculocysts. (Table I.)

TABLE I.

Percentage Comparison of the Numerical Variation in the Tentaculocysts of the specimens taken in 1893, 1894, *and* 1898.

		1893	1894	1894	1898	1898	1898
		Ephyrae	Ephyrae	Adults	Series A Small Adults	Series B Large Adults	A and B combined
		359	*1116*	*383*	*2000*	*1000*	*3000*
Number of Tentaculocysts	*4*				0·05	0·2	0·1
	5		0·1		0·1	0·1	0·1
	6	1·1	0·5	0·5	0·6	0·8	0·7
	7	2·2	3·0	4·7	3·7	4·7	4·1
	8	77·4	79·1	77·3	79·8	77·1	78·9
	9	6·1	6·7	8·6	5·7	7·5	6·3
	10	5·0	5·5	4·2	4·5	5·2	4·8
	11	3·3	3·1	2·6	3·6	1·9	3·0
	12	3·9	1·5	1·8	1·2	1·8	1·4
	13	0·8	0·3		0·3	0·5	0·4
	14		0·1		0·1	0·1	0·1
	15			0·3	0·1	0·1	0·1

In the spring of 1894 a larger number of Ephyrae were taken and 1116 specimens examined. The tentaculocysts were found to vary in 20·9 p.c.

In the summer of 1894 large adult specimens were caught and in 383 individuals it was found that 22·8 p.c. showed variation in the number of tentaculocysts.

Race of Aurelia in the River Tamar.

During my visit to the Marine Laboratory at Plymouth in 1898 I was glad to hear from my friend Mr E. W. L. Holt that he had seen Aurelia in shoals at Saltash. This town is situated on the River Tamar and is about three miles from Plymouth Sound, into which the river flows. It was near the mouth of this river that the specimens were taken in 1893 and 1894, so it is very probable that they also belong to the Tamar race of Aurelia. The river is tidal for about 20 miles and its water is very muddy and polluted. How far above and below Saltash the Aurelia ascend and descend with the tide has not yet been definitely ascertained, but under ordinary conditions they do not come down with the tide into Plymouth Sound. The Aurelia were first discovered by Mr Holt at Saltash in 1897, and since then they have been seen yearly in the Tamar. I think that the Tamar Aurelia may be safely regarded as a local race, and that they are born in the waters of the Tamar and spend their whole lives in the river or its tributaries.

In Plymouth Sound Aurelia is not at all a common jelly-fish, and shoals are rarely seen.

2000 *Small Adults taken in April*, 1898. *The Range and Numerical Variation of their Tentaculocysts.* (*Series A.*)

On April 23rd, Mr Holt and I started operations to catch Aurelia and tried first Barnpool, a small bay at the mouth of the Tamar, but we only caught two specimens, one at the surface and another in a shrimp-trawl. We then proceeded up the Tamar and put out the trawl net near the mouth of the river Lynher, one of the tributaries of the Tamar, about half a mile below Saltash. With two hauls of the trawl nearly 400 specimens were taken. The muddy state of the water prevented an Aurelia from being seen at a depth of about two feet below the surface, and as a very few were visible the hand-nets were not often used. In the evening of the same day Mr Holt saw a shoal of Aurelia swimming with the tide, close to the surface, near the Railway Bridge at Saltash. The next evening in that locality we caught with hand-nets over 1000 specimens. On April 27th, a second visit was made and we captured about 800 specimens.

The specimens collected on these occasions ranged from large Ephyrae up to small immature adults not exceeding 40 mm. in diameter. Very few Ephyrae were present as it was about a month too late for them.

I examined 2000 specimens and measured the diameter of the umbrella. All the measurements were made after preservation and the umbrella was perfectly flat, resting on the bottom of an ordinary photographic dish.

The numerical variation of the tentaculocysts is shown in Table II. The range of variation is from 4 to 15 tentaculocysts, and 20·2 p.c. of specimens have either more or less than the normal number.

TABLE II.

The Numerical Variation of the Tentaculocysts of 2000 *Adults, collected in April*, 1898.

Number of Tentaculocysts	Diameter of the Umbrella in Millimetres: Up to 5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95	100	Total	Percentage
4			1																		1	0·05
5		2																			2	0·1
6		3	2	4	1	2															12	0·6
7		13	20	29	8	5															75	3·75
8		270	442	446	280	102	29	7	(normal)												1596	79·8
9		17	30	38	17	8	4	1													115	5·75
10		15	28	23	18	6	1														91	4·55
11		17	19	17	12	5	1	1													72	3·6
12		3	6	4	8	2	2														25	1·25
13		3	2	1	1																7	0·35
14		1				1															2	0·1
15				1	1																2	0·1
Totals		344	550	583	346	131	37	9													2000	100 p.c.

1000 *Large Adults taken in June*, 1898. *The Range and Numerical Variation of their Tentaculocysts.* (*Series B.*)

About a month later, on May 27th, and June 2nd, we again visited Saltash for the purpose of collecting a supply of large adult specimens, sufficient to ensure the possession of 1000 specimens in good condition. We tried, at first, to catch them with a large trawl-net, which was kept expanded by the tide from the Laboratory steamboat "Busy Bee" at anchor. This method had to be abandoned as the Aurelia got crushed in the net and most of them were found badly torn and damaged. To obtain specimens in perfect condition we found that catching them, one by one, in a hand-net, as they floated past the steamer, was the best method. The specimens were taken within two feet of the surface; the river being too muddy to see anything at a greater depth. I feel much indebted to my friends, Mr E. W. L. Holt, Mr W. I. Beaumont, and Mr L. W. Byrne, for their kindness in catching nearly all the specimens; my share of the work was the preservation.

This series of specimens ranged from 20 mm. to 95 mm. in diameter, and most of the larger ones carried planulae in the pouches on the oral arms, showing that they had reached full maturity. The majority of the specimens were from 40 mm. to 65 mm. in diameter.

The numerical variation of the tentaculocysts is given in Table III. The range of variation is the same as that of the small adults collected in April, but the percentage of specimens showing a variation is greater, 22·9 p.c., being 2·7 p.c. more than in the small adults.

TABLE III.

The Numerical Variation of the Tentaculocysts of 1000 *Adults, collected in June*, 1898.

Diameter of the Umbrella in Millimetres																					Total	Per-centage
Up to		*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*50*	*55*	*60*	*65*	*70*	*75*	*80*	*85*	*90*	*95*	*100*		
Number of Tentaculocysts	*4*									1	1											2	0·2
	5										1											1	0·1
	6									1	3	1	1	1	1							8	0·8
	7						1	1	3	11	10	2	4	5	3	5	1	1				47	4·7
	8	(normal)				4	11	27	39	97	128	138	111	83	57	37	22	9	7	1		771	77·1
	9					1	3	2	4	13	12	12	8	4	6	6	1		2	1		75	7·5
	10								3	7	7	14	9	7	4		1					52	5·2
	11				1			1	1	1	4	2	3	5	1							19	1·9
	12						1		2	5	1	3	1	2	1	2						18	1·8
	13							2	1	1			1									5	0·5
	14												1									1	0·1
	15										1											1	0·1
Totals					1	5	16	33	53	137	168	172	139	107	73	50	25	10	9	2		1000	100 p.c.

The Combination of the Small and Large Adults.

The result of the combination of the small adults (Table II.) and the large adults (Table III.) is shown in Table IV. which is illustrated by a curve (1) showing the frequency of the tentaculocysts.

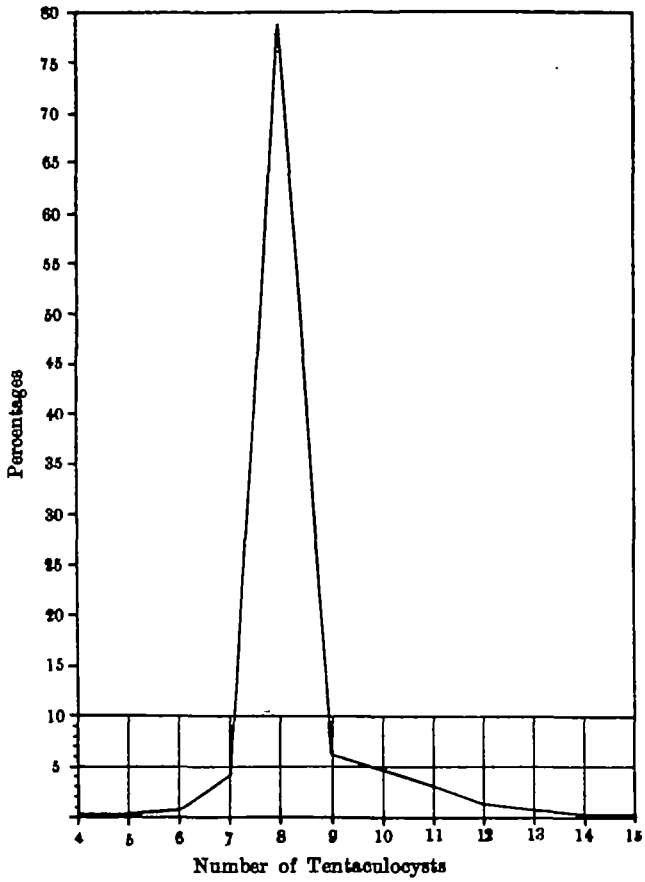
This combination gives a grand total of 3000 specimens belonging to the same race, and it shows that 21·1 p.c. have more or less than the normal number of tentaculocysts. I think that 21 p.c. may be regarded as the normal amount of variability of the Tamar race.

The table also shows that 4·9 p.c. of the specimens have less (4 to 7) than the normal number of tentaculocysts, and that 16·1 p.c. have an excess (9 to 15) of the normal number.

TABLE IV.

The Numerical Variation of the Tentaculocysts of 3000 *Adults.*
(Tables II. and III. combined.)

		Diameter of the Umbrella in Millimetres																			Total	Per-centage
	Up to	*5*	*10*	*15*	*20*	*25*	*30*	*35*	*40*	*45*	*50*	*55*	*60*	*65*	*70*	*75*	*80*	*85*	*90*	*95*	*100*		
Number of Tentaculocysts	*4*			1						1	1											3	0·1
	5		2								1											3	0·1
	6		3	2	4	1	2			1	3	1	1	1	1							20	0·67
	7		13	20	29	8	6	1	3	11	10	2	4	5	3	5	1	1				122	4·07
	8		270	442	466	284	113	56	46	97	128	138	111	83	57	37	22	9	7	1		2367	78·9
	9		17	30	38	18	11	6	5	13	12	12	8	4	6	6	1		2	1		190	6·33
	10		15	28	23	18	6	1	3	7	7	14	9	7	4		1					143	4·77
	11		17	19	18	12	5	2	2	1	4	2	3	5	1							91	3·03
	12		3	6	4	8	3	2	2	5	1	3	1	2	1	2						43	1·43
	13		3	2	1	1		2	1	1			1									12	0·4
	14		1				1						1									3	0·1
	15				1	1					1											3	0·1
Totals			344	550	584	351	147	70	62	137	168	172	139	107	73	50	25	10	9	2		3000	100



CURVE 1.

Percentage curve showing the numerical variation in the tentaculocysts of 3000 adults taken in 1898. (Table IV.)

Comparison between the Smallest and Largest Adults.

The measurement of the diameter of the umbrella of all the specimens was made in order that the variability of the smallest immature adults might be compared with that of the large mature ones.

The specimens have been separated into four groups for comparison (Table V.). The percentage of variability is practically the same in the smallest (5 to 10 mm.) and the largest (56—95 mm.) adults. Curve 2. The percentage of specimens with less than the normal number of tentaculocysts is almost the same in both groups and it therefore follows that that with the excess is also the same.

It appears, then, that neither a decrease nor an increase in the number of tentaculocysts is injurious to the race, and that no selection is taking place in the young and adult stages in the number of tentaculocysts.

TABLE V.

Comparison between the Smallest and Largest Adults taken in 1898.

		5 to 15 mm. Umbrella-diameter		46 to 55 mm. Umbrella-diameter		5 to 10 mm. Umbrella-diameter		56 to 95 mm. Umbrella-diameter	
		Number of Specimens	Per-centage	Number of Specimens	Per-centage	Number of Specimens	Per-centage	Number of Specimens	Per-centage
Number of Tentaculocysts	*4*	1	0·11	1	0·29	0		0	
	5	2	0·22	1	0·29	2	0·58	0	
	6	5	0·56	4	1·18	3	0·87	3	0·72
	7	33	3·69	12	3·53	13	3·78	19	4·58
	8	712	79·65	266	78·24	270	78·49	327	78·79
	9	47	5·26	24	7·06	17	4·94	28	6·75
	10	43	4·81	21	6·18	15	4·36	21	5·06
	11	36	4·03	6	1·76	17	4·94	9	2·17
	12	9	1·00	4	1·18	3	0·87	6	1·45
	13	5	0·56	0		3	0·87	1	0·24
	14	1	0·11	0		1	0·29	1	0·24
	15	0		1	0·29	0		0	
Totals		894	100	340	100	344	99·99	415	100

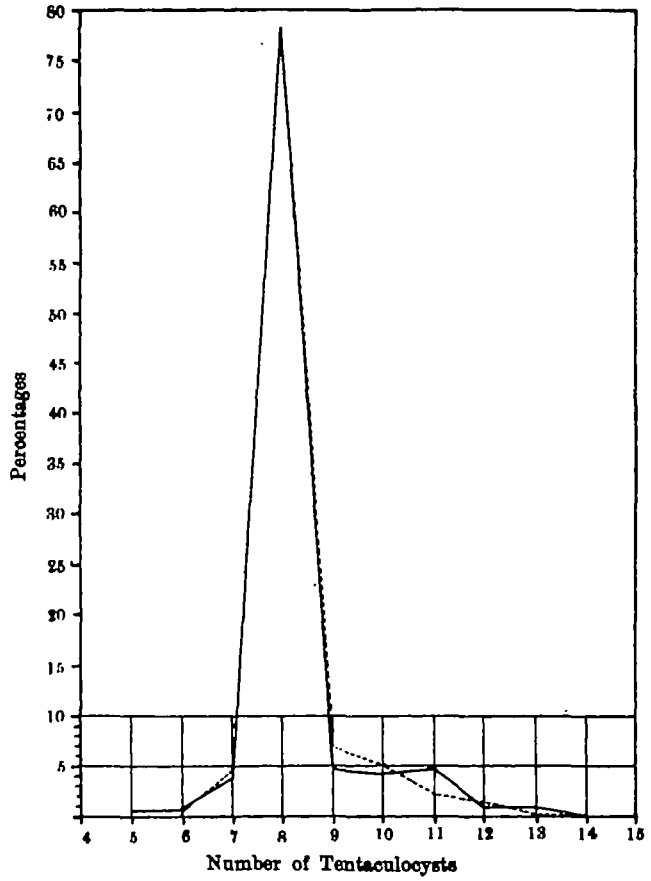
Combination of the Ephyrae and Adults taken in 1893, 1894, *and* 1898.

As evidence is in favour of the specimens taken in 1893 and 1894 belonging to the Tamar race of Aurelia, a Table (VI.) is given showing the results of combining all the specimens into one series, giving a total of 4858 specimens. These show that 21·29 p.c. have more or less than the normal number of tentaculocysts and the individual percentages compared with those of the 3000 taken in 1898 (Table III.) show a great similarity.

TABLE VI.

The Numerical Variation in the Tentaculocysts of the specimens taken in 1893, 1894, *and* 1898.

Year	Stage	Number of Specimens	Number of Tentaculocysts											
			4	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
1893	Ephyra	359	0	0	4	8	278	22	18	12	14	3	0	0
1894	Ephyra	1116	0	1	6	34	883	75	61	35	17	3	1	0
1894	Adult	383	0	0	2	18	296	33	16	10	7	0	0	1
1898	Adult	3000	3	3	20	122	2367	190	143	91	43	12	3	3
Totals		4858	3	4	32	182	3824	320	238	148	81	18	4	4
Percentages			0·06	0·08	0·66	3·75	78·72	6·59	4·90	3·05	1·67	0·37	0·08	0·08



CURVE 2.

Percentage curves of the smallest adults (5 to 10 mm. in diameter) and the largest adults (56—95 mm.) taken in 1898. (Table V.)

Continuous line for the smallest adults.

Dotted line for the largest adults.

Further Observations on the 1000 *Large Adults taken in June.* (*Series B.*)
A Correlation between the Radial Canals and the Tentaculocysts.

The excellent condition of the large adults afforded a good opportunity of examining the radial canal system. The few figures given by Romanes and other observers show distinctly that there is a correlation between the radial canals and the tentaculocysts, and my observations confirm theirs.

In the 1000 adult specimens I found that every tentaculocyst (twinning excepted) had its own branched canal leading direct from the stomach, and always separated from the adjacent branched canals by a simple unbranched canal. By means of the canals the origin of the tentaculocyst could be traced home to either the perradial or interradial system.

An increase or decrease in the number of tentaculocysts usually leads to an asymmetrical arrangement of the canals, so that a tentaculocyst situated in a strictly adradial position may be traced by its canal to either the perradial or interradial system.

Three diagrams have been prepared to illustrate the correlation of the radial canal system and the tentaculocysts. Diagram I. shows the arrangement of the canals and tentaculocysts in a normal specimen. There are four branched perradial canals and four branched interradial canals which are separated by simple unbranched adradial canals. The branched canals are all of the same pattern, but show a considerable amount of variation.

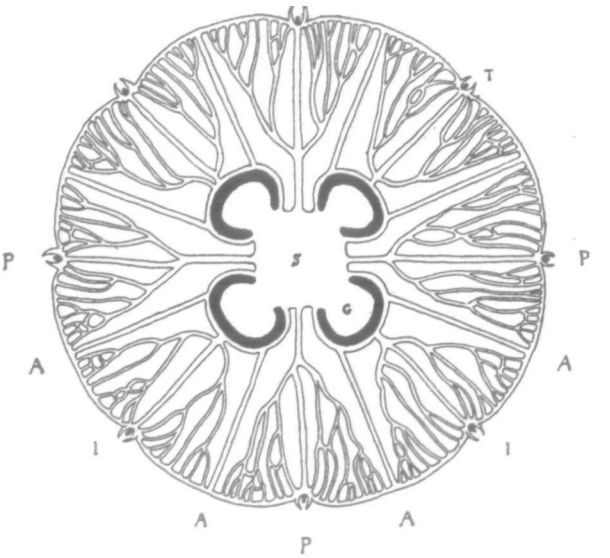


DIAGRAM I.

The normal arrangement of the radial canal system in a normal specimen.

P, perradial. *I*, interradial. *A*, adradial. *G*, genital sac with gonad. *S*, stomach. *T*, tentaculocyst.

In the diagrams the oral arms are omitted (they are perradially situated) and also the tentacles which form a fringe round the margin of the umbrella.

The normal type is seen at the top of Diagram I. (perradial). There is a straight canal running direct from the stomach to the tentaculocyst, and it gives off two opposite branches, each of which is subdivided into many branches, all entering the ring canal. There are many modifications of this type and several are illustrated in the diagrams. The lateral branches are often not opposite each other, and in some specimens the main canal looks like a branch from one of the lateral canals.

The interradial branched canal is of the same pattern as the perradial. In some specimens it looks however quite different, but it is only a modification of

the normal type and probably due in many cases to the outward growth of the genital sacs cutting off the base of the canal. Instead of one canal leaving the stomach there are three. The central one runs direct from the stomach to the tentaculocyst and the lateral ones are branched.

The adradial canals are always simple and unbranched and never run to a tentaculocyst.

Specimens which have less than the normal number of tentaculocysts have usually a corresponding decrease in the number of branched radial canals. If one perradial tentaculocyst be absent, the branched canal is also absent and its place taken by a simple unbranched canal. The loss of one or more branched canals does not produce a vacant space, the adjacent branched canals spread out and occupy a larger area.

A decrease in the number of tentaculocysts may occur through injury done to the umbrella. This can, as a rule, be detected by a careful examination of the margin with a lens. The presence of a branched canal without a tentaculocyst is suspicious, and if there were any traces of an old injury which had healed up, leaving a slight or an irregular margin to the umbrella, the specimen was rejected as a damaged one.

In a few specimens a branched canal without a tentaculocyst was found with the margin in a perfect condition and these were considered cases of genuine variation.

Anastomosing of the radial canals by cross branches forming a kind of network occurs in nearly all the large adults. It is rarely present in the small adults. The amount of anastomosing is very variable and not always regularly distributed amongst the radial canals. Often one or two quadrants in a specimen show considerable anastomosing, whilst the other quadrants are comparatively free from it. In two specimens, having the same sized umbrella, one may show a considerable amount of anastomosing, the other practically none at all. The adradial canals are often anastomosed to the branches of the perradial and interradial canals.

The Position of the Tentaculocysts in Specimens having a Decrease in Number.

In my previous publication on Aurelia there is a sentence which is rather misleading and requires an explanation. "An examination of the specimens (adults) does not show that any particular position on the margin of the umbrella is favoured either by an increase or decrease of the tentaculocysts." If the position of the tentaculocysts on the margin of the umbrella were marked down on skeleton diagrams, no attention being paid to the radial canal system, then the above statement would be correct. The material upon which that statement was based (adults of 1894) was not in first class condition and no attempt was made to

examine the radial canal system, but only the number of tentaculocysts was marked on skeleton diagrams.

In the 1000 adults (Series B) there are 58 specimens (5·8 p.c.) with less than the normal number of tentaculocysts and the majority show that the absent tentaculocyst belongs to the perradial system.

The exact position of the absent tentaculocysts cannot be conveniently shown by the use of tables, but full details are given below. Specimens with less than the normal number of genital sacs have usually a decrease in the number of radial canals and tentaculocysts (Table VII.).

The Position of the Tentaculocysts in Specimens having an Increase in Number.

No less than 171 specimens (17·1 p.c.) show an increase in the number of tentaculocysts compared with 5·8 p.c. showing a decrease. This excess is one of the characteristic features of the variation and occurs in every series examined (Tables I. and VI.) and it clearly shows that the tendency is towards an increased number of sense-organs. It was to find out whether the perradial or the interradial series were more subject to variation that the radial canal system was examined, as it was the only reliable means of exactly locating the original source of the tentaculocysts. A tentaculocyst may be adradially, or nearly adradially, situated on the margin of the umbrella, but its canal may curve and join the perradial system or it may curve the opposite way and belong to the interradial system.

I have not called any tentaculocysts or branched canals adradial, though they may be in some specimens adradially situated. The increase in the perradial system is simply a case of doubling or trebling the number of canals and tentaculocysts; in the interradial system only doubling occurs. To call such canals and tentaculocysts adradial would imply that the interradial canal and tentaculocyst were absent, and this is not the case (Diagram III.).

The examination of the canal system shows that the increase is generally perradial and details are given on page 102.

Specimens with more than the normal number of genital sacs have usually an increase in the number of radial canals and tentaculocysts (Table VII.).

If a very slow and gradual change is taking place in the number of tentaculocysts then the tendency is towards the establishment of a race with ten tentaculocysts, due to an increase of two opposite perradial tentaculocysts arranged thus:—

Perradial	2 . 1 . 2 . 1.
Interradial	1 . 1 . 1 . 1.

If no check occurs and the variation still continues in the perradial system the ultimate result will probably be a race with twelve tentaculocysts arranged thus:—

Perradial 2.2.2.2,
Interradial 1.1.1.1,

the medusa having eight perradial tentaculocysts and canals, four interradial tentaculocysts and canals, and eight adradial unbranched canals.

A Detailed Account, giving the Position of the Tentaculocysts in the Specimens (Large Adults belonging to Series B) having more or less than the Normal Number.

Four Tentaculocysts. (*Two specimens.*)

Perradial 0.0.0.0.
Interradial 1.1.1.1.

One specimen with only four interradial tentaculocysts.

The interradial branched canals occupy the four quadrants. There are no adradial canals, but four simple unbranched canals, perradially situated. It is probable that in this specimen the perradial canal system is absent and the simple canals, perradially situated, are the representatives of the adradial system removed from their proper position.

Perradial 1.1.1.
Interradial 0.0.1.

One specimen with three genital sacs and three oral arms.

Five Tentaculocysts. (*One specimen.*)

Perradial 1.0.1.
Interradial 1.1.1.

This specimen has three genital sacs and three oral arms.

Six Tentaculocysts. (*Eight specimens.*)

Perradial 1.0.1.0. 1.1.0.0.
Interradial 1.1.1.1. 1.1.1.1.

Two specimens with two perradial tentaculocysts absent.

Perradial 1.0.1.1.
Interradial 1.1.0.1.

Two specimens with one perradial and one interradial tentaculocyst absent.

Perradial 2.0.2.0.
Interradial 0.1.0.1.

The above specimen is bilaterally symmetrical. In each half of the umbrella there are three branched canals with tentaculocysts.

Perradial 1.1.1.
Interradial 1.1.1.

Three specimens with three genital sacs and three oral arms.

Seven Tentaculocysts. (*Forty-seven specimens.*)

Perradial 0.1.1.1.
Interradial 1.1.1.1.

Thirty specimens with one perradial tentaculocyst absent.

Perradial 1.1.1.1.
Interradial 0.1.1.1.

Fourteen specimens with one interradial tentaculocyst absent.

When a perradial or an interradial tentaculocyst is absent the branched radial canal is usually absent and in its place is a simple unbranched canal.

Perradial 1.1.1. 1.2.1.
Interradial 1.2.1. 1.1.1.

Three specimens with three genital sacs and three oral arms.

Nine Tentaculocysts. (*Seventy-five specimens.*)

Perradial 2.1.1.1.
Interradial 1.1.1.1.

Sixty-three specimens have the extra tentaculocyst perradially situated.

In the place of a single branched perradial canal there are two perradial branched canals usually occupying about the same space as a normal single branched canal.

In two specimens the increase of tentaculocysts is due to twinning.

There is one normal branched canal with two tentaculocysts very close together, just separated by a few marginal tentacles.

Perradial 2.0.2.1.
Interradial 1.1.1.1.

One specimen with two extra opposite perradial tentaculocysts and one perradial tentaculocyst and branched canal absent.

Perradial 2.1.1.1. 2.1.1.1.
Interradial 2.1.1.0. 2.1.0.1.

Three specimens with an extra perradial tentaculocyst, and an extra interradial in one quadrant, but one absent in the adjacent or opposite quadrant.

Perradial 1.1.1.1.
Interradial 2.1.1.1.

Five specimens have an extra interradial tentaculocyst.

In one specimen the increase is due to twinning.

Three specimens with more than the normal number of genital sacs.

One with six genital sacs and six oral arms.

One with five genital sacs and five oral arms.

One with three genital sacs and three oral arms, and the tentaculocysts arranged thus:—

Perradial	3.2.2.
Interradial	0.2.0.

Ten Tentaculocysts. (*Fifty-two specimens.*)

Perradial	2.2.1.1.
Interradial	1.1.1.1.

Nineteen specimens have an extra tentaculocyst in adjacent quadrants.

Perradial	2.1.2.1.
Interradial	1.1.1.1.

Seventeen specimens have an extra tentaculocyst in opposite perradii. In one specimen the increase is due to twinning which occurs in the opposite perradii.

Perradial	3.1.1.1.
Interradial	1.1.1.1.

Three specimens have two extra perradial tentaculocysts in the same perradius.

Perradial	2.1.1.1.
Interradial	1.1.2.1.

Six specimens with an extra perradial and an extra interradial tentaculocyst.

Seven specimens have more than the normal number of genital sacs and oral arms.

Five with six genital sacs and six oral arms. Radial canals and tentaculocysts arranged thus:—

Perradial	1.0.1.0.1.1.	1.0.1.1.1.1.
Interradial	1.1.1.1.1.1.	1.1.1.0.1.1.

Two specimens with five genital sacs and five oral arms. Radial canals and tentaculocysts arranged thus:—

Perradial	1.1.1.1.1.
Interradial	1.1.1.1.1.

Eleven Tentaculocysts. (*Nineteen specimens.*)

Perradial	2.2.2.1.
Interradial	1.1.1.1.

Eleven specimens have three extra perradial tentaculocysts. In one of the specimens the increase of one tentaculocyst is due to twinning.

Perradial	2.1.2.1.	2.2.1.1.
Interradial	1.2.1.1.	1.2.1.1.

Two specimens have two extra perradial tentaculocysts and one extra interradial.

Perradial	1.2.1.1.
Interradial	1.2.1.2.

One specimen with one extra perradial and two extra interradial tentaculocysts.

Perradial	1.1.1.1.
Interradial	2.2.2.1.

One specimen with the normal number of perradial tentaculocysts, but with three extra adjacent interradial tentaculocysts.

Five specimens with more than the normal number of genital sacs.

One with ten genital sacs and ten oral arms.

Three with six genital sacs and six oral arms.

One specimen with five genital sacs and five oral arms.

Twelve Tentaculocysts. (*Eighteen specimens.*)

Perradial	2.2.2.2.
Interradial	1.1.1.1.

Six specimens have an extra tentaculocyst in each of the four perradii.

Perradial	3.2.1.2.	3.2.2.1.	3.3.1.1.
Interradial	1.1.1.1.	1.1.1.1.	1.1.1.1.

Three specimens have extra tentaculocysts all perradially situated, but only in two or three perradii as shown in the above formulae.

Perradial	2.2.2.1.	2.2.1.1.
Interradial	2.1.1.1.	1.2.1.2.

Three specimens have extra perradial and interradial tentaculocysts as shown in the above formulae.

Six specimens have more than the normal number of genital sacs.

Four with six genital sacs and six oral arms. Tentaculocysts arranged thus:—

Perradial	1.1.1.1.1.1.
Interradial	1.1.1.1.1.1.

Two with five genital sacs and five oral arms. Tentaculocysts arranged thus:—

Perradial	1.1.1.1.1.
Interradial	1.2.1.2.1.

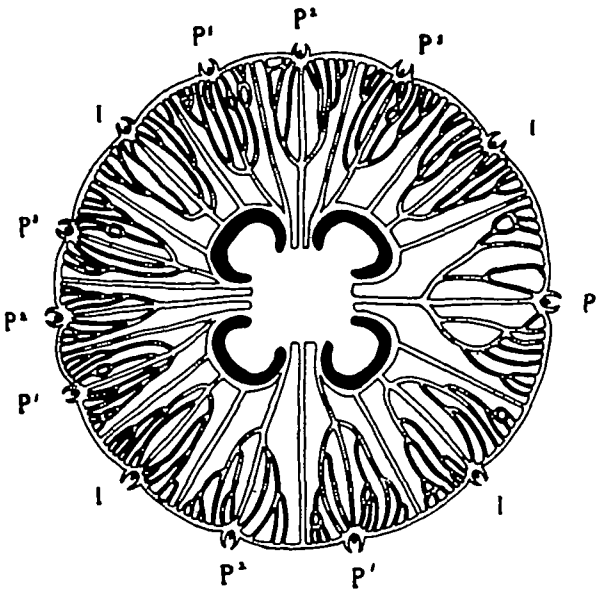


DIAGRAM II.

The arrangement of the radial canals in a specimen with thirteen tentaculocysts.

Perradial 3.3.1.2.
Interradial 1.1.1.1.

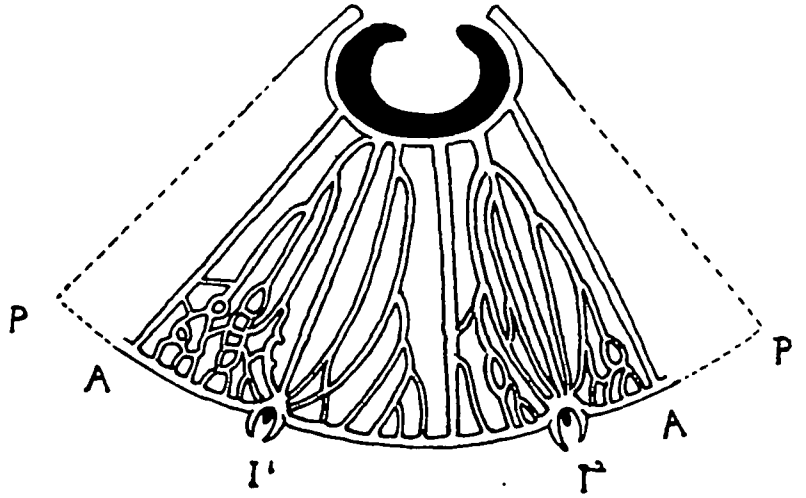


DIAGRAM III.

The arrangement of the interradial canals when an increase occurs in the number of interradial tentaculocysts.

Thirteen Tentaculocysts. (*Five specimens.*)

Perradial	3.2.2.2.	3.3.1.2.	
Interradial	1.1.1.1.	1.1.1.1.	(Diagram II.)

Two specimens with five extra perradial tentaculocysts.

Perradial	2.2.2.2.
Interradial	2.1.1.1.

One specimen with four extra perradial tentaculocysts and one extra interradial.

Two specimens with more than the normal number of genital sacs.

One with six genital sacs and six oral arms.

One with five genital sacs and five oral arms.

Fourteen Tentaculocysts. (*One specimen.*)

This specimen has eight genital sacs and eight oral arms.

Fifteen Tentaculocysts. (*One specimen.*)

Perradial	2.1.3.3.
Interradial	1.2.1.2.

There are five extra perradial and two extra interradial tentaculocysts.

Numerical Variation of the Genital Sacs of 3000 *Adults taken in* 1898. (*Series A and B.*)

Previous accounts by other writers on the Variation of Aurelia have been mostly confined to the variation of the genital sacs, and numerous illustrations have been published. (Ballowitz, 1899.)

In the Ephyra stage the genital sacs are not present, but their position and number are marked by the bundles of gastric filaments. Normally there are four interradial bundles of filaments. The gastric filaments are not figured in the diagrams of the adults. They are always situated along the inner side of the gonads.

In the small Ephyrae an increase or decrease in the number of gastric filaments indicates that the specimen will probably have an increase or decrease in the number of genital sacs, as the numbers of bundles and gonads are correlated. It is not however easy to count the number of bundles of gastric filaments in the small Ephyrae, especially when there are indications of an increase, as then owing to the closeness of the bundles they form occasionally an unbroken ring. When an Ephyra has developed into the adult form and the gonads begin to appear, and also the genital sacs, then any variation in the number of gonads or genital sacs is easily seen.

The 3000 specimens taken in 1898 show that 2·4 p.c. have more or less than the normal number (four) of genital sacs. The range of variation is from 2 to 10, and most of the specimens show an increase in number (Table VII.).

TABLE VII.

The Numerical Variation of the Genital Sacs of 3000 *specimens and its relation with the Numerical Variation of the Tentaculocysts.*

		Number of Genital Sacs									Abnormal Cases
		2	*3*	*4* Normal	*5*	*6*	*7*	*8*	*9*	*10*	
Number of Tentaculocysts	*4*	1	1	(*1*)							2
	5		2	(*1*)							2
	6		6	(*14*)							6
	7		5	(*117*)							5
	8		2	(*2363*)	1			1			4
	9		1	(*185*)	2	2					5
	10			(*131*)	4	8					12
	11			(*73*)	3	10	4			1	18
	12			(*30*)	3	10					13
	13			(*10*)	1	1					2
	14			(*2*)				1			1
	15			(*1*)			2				2
Totals		1	17	(*2928*)	14	31	6	2	0	1	72

There is a perfect correlation between the number of genital sacs and the number of oral arms, and I have not found any exceptions; a specimen with six genital sacs has always six oral arms.

There is not a perfect correlation between the number of genital sacs and the number of radial canals and tentaculocysts, though a decrease in the number of genital sacs is usually accompanied by a decrease in the number of radial canals and tentaculocysts, and an increase by an increase in the number of the radial canals and tentaculocysts.

In the 3000 adults 21·1 p.c. show a variation in the number of tentaculocysts and 2·2 p.c. of these have an abnormal number of genital sacs. But the variation in the number of genital sacs has a considerable effect upon the numerical variation of the tentaculocysts. Only four specimens out of 72 with an abnormal number of genital sacs have eight tentaculocysts.

The adults collected in 1894 (383 specimens) showed 2·08 p.c. with an abnormal number of genital sacs.

Method used for the Preservation of Aurelia.

The large adults were placed in buckets containing Formaline 5 p.c. solution in sea-water. (Formaldehyde 5 c.c. and sea-water 95 c.c.) They quickly died in a good state of expansion. When the bucket was full of specimens about 100 c.c. of strong Formaldehyde was added. The specimens were allowed to soak in this for six hours and occasionally stirred up. After this preliminary soaking in Formaline they were removed, one by one, and placed in a mixture of Formaline and Chromic Acid.

Formaline, 10 p.c. in freshwater .....9 volumes.
Chromic Acid, 5 p.c. solution .....1 volume.

They were left in this mixture for 24 hours; occasionally stirred up and a little strong Formaldehyde added. It is very important that the specimens should be thoroughly saturated with Formaline. The specimens were removed from the Chromic-Formaline solution and finally stored in bottles containing Formaline 10 p.c. in freshwater. I prefer storing in a 10 p.c. solution of Formaline, as there is then a fair margin against deterioration of strength.

These specimens are now three years old and are still in excellent condition. The addition of Chromic Acid greatly improves the specimens. The opaque whiteness, produced when Formaline only is used, is not so conspicuous and the jelly becomes more translucent. The specimens are also tougher and more pliable and can be handled without fear of damage. The yellowish-brown colour due to the Chromic Acid gradually disappears owing to oxidation and the specimens turn to a pale bluish-green. An ordinary black xylonite photographic dish is an excellent thing to examine the specimens in. The black background shows up the radial canal system.

References.

Ballowitz, E., 1899. "Ueber Hypomerie und Hypermerie bei Aurelia aurita." *Archiv für Entwickelungsmechanik der Organismen*, Bd. VIII. pp. 239—252.

(This paper contains a good Bibliography and summary of the literature relating to the variation of Aurelia.)

Browne, E. T., 1895. "On the Variation of the Tentaculocysts of Aurelia aurita." *Quart. Journ. Micro. Sci.*, Vol. XXXVII. pp. 245—251.