SOME OBSERVATIONS ON SHELL-DEPOSITS OF THE OYSTER *CRASSOSTREA GRYPHOIDES* (SCHLOTHEIM)

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Introduction

During the course of examination of oyster *C. gryphoides* for the study of its biology, the presence of chalk-like areas in definite regions on the internal faces of the shells was observed to be almost regular. In these chalky areas, the nacreous layer of shell is replaced by material laid down in an amorphous soft white mass, chalky in appearance and consistency. Hence preliminary observations about the distribution, nature and chemical composition of these deposits were carried out and included in this paper.

Previous work on the chalky deposits of oysters has been done by Orton (1925 and 1927), Ranson (1939), Medcof (1944), Galstoff *et al.* (1947) and Korringa (1951 and 1952).

Material and Method

The material for the present study was brought from an oyster farm at the village Kelwa about fifty miles north of Bombay. Oysters for laying on this farm are collected from the rocks around Kelwa and the adjoining seaside villages.

The present paper is based upon the examination of 384 oyster shells wherein an approximate centre of each shell was found out. This generally falls at the inner tip of the muscle scar. The shell was divided into four quadrants by drawing two diameters, perpendicular to each other. Each quadrant was further divided into approximately two equal parts by drawing a dividing line passing through the centre. Two concentric circles were drawn: outer, of the radius of two centimetres from the centre and the inner of the radius of one centimetre from the centre. The shell was thus divided into 24 areas as indicated in Figs. 1 and 2.

The distribution of chalky deposits was noted in each of the above-mentioned areas and any area containing either a large or a small deposit was

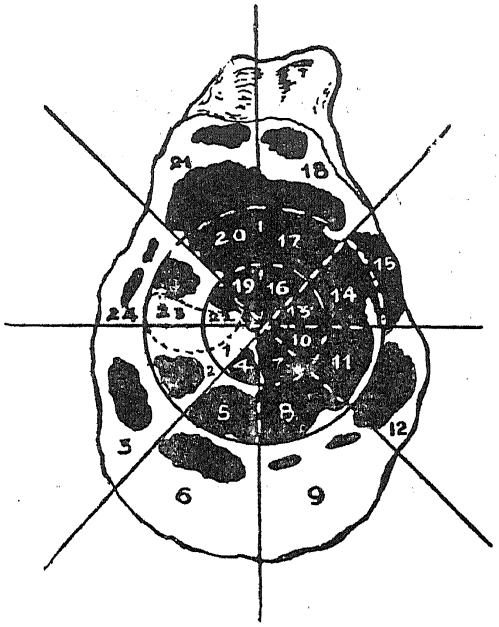

FIG. 1

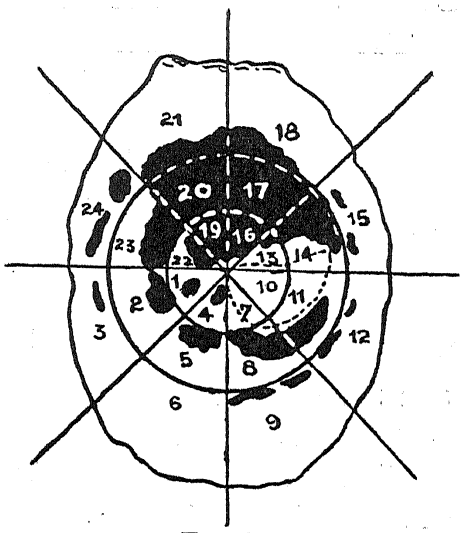

FIG. 2

FIG. 1. Showing the division of the internal face of the lower valve into arbitrary areas and the mean general distribution of chalky deposits in it in case of *C. gryphoides*. (*a*) Area No. 1 contains no deposit in 84% of shells and hence shown blank; (*b*) Areas Nos. 9, 22, 24 though do not contain any deposit in more than 50% of shells, are shown to contain little deposits. (*c*) Areas, completely black-shaded, contain in majority of shells full deposits. (*d*) Remaining areas contain deposits in varying quantities in majority of shells.

FIG. 2. Showing the division of the internal face of the upper valve into arbitrary areas and the mean general distribution of chalky deposits in *C. gryphoides*. (*a*) Areas which contain deposits in less than 20% shells are left blank. (*b*) Areas, completely black shaded, contain in majority of shells full deposits. (*c*) Remaining areas contain deposits in varying quantities in majority of shells.

recorded as showing a deposit. For assessing the amount of deposit in each area, the area was considered a unit and the amount was determined by visual inspection. For sake of convenience the amounts were determined only in five categories such as, some, $\frac{1}{4}$, $\frac{1}{2}$, $\frac{3}{4}$ and full.

RESULTS AND DISCUSSION

The results of this analysis of shell deposits are given in Tables I and II. In Fig. 1 showing the areawise division of the lower (left) valve, the areas numbered 1 to 6 fall near rectum (exhalent region), 7 to 12 on the boundary of the inhalent and exhalent regions, 13 to 18 in the vicinity of palps (inhalent region), and 19 to 24 beneath the visceral mass. In Fig. 2 showing the areawise division of the upper (right) valve, the areas 1 to 6 fall on the boundary of inhalent and exhalent regions, 7 to 12 in the exhalent region, 13 to 18 beneath the visceral mass and 19 to 24 in the inhalent region.

It is noticed from Figs. 1 and 2 that the deposits, in areas falling near the palps, at the boundary of the inhalent of exhalent regions and to some extent in those falling immediately beneath the visceral mass, are continuous, excluding, of course, the areas lining the margin of the shell. However, the areas on the boundary of exhalent and inhalent regions, in case of the upper valve, do not show a continuous deposit. It is also noticed that the areas falling on the muscle scar show a total absence of deposits while those lining the shell-margin show a little occurrence of deposits.

A glance at the graphs in Fig. 3 indicates a definite area-wise distribution of chalky deposits in the following manner.

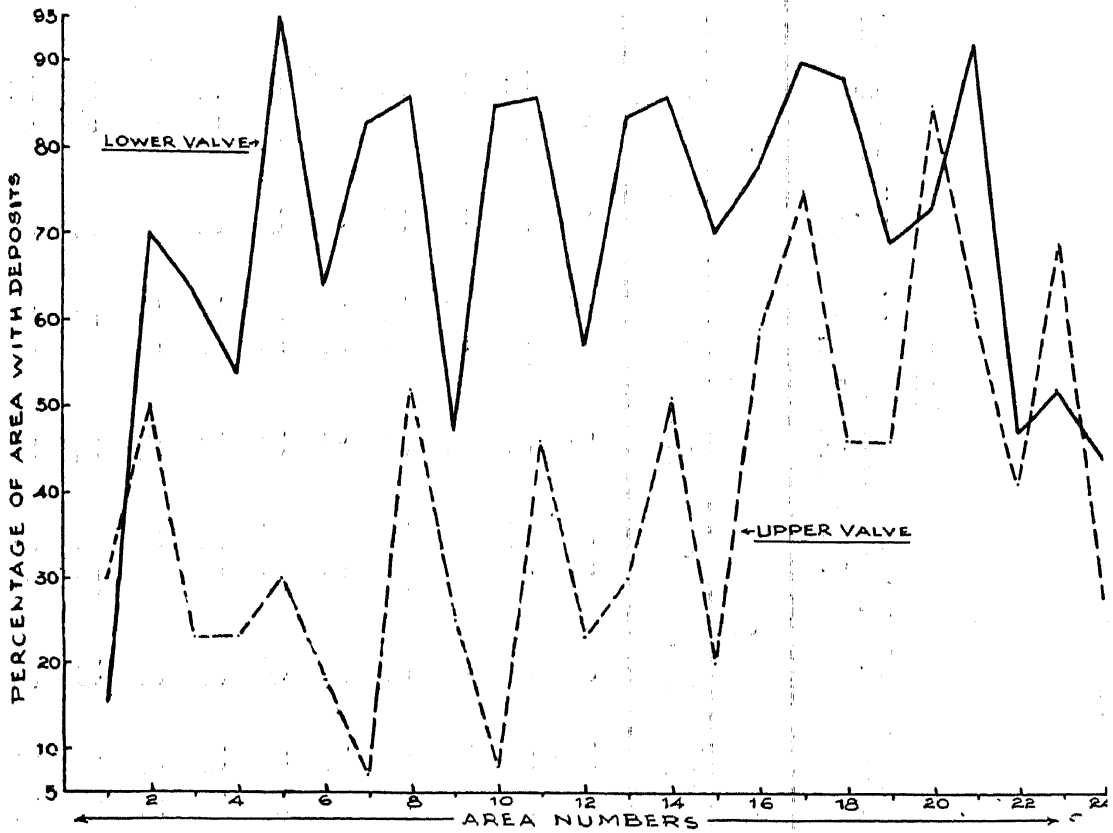

FIG. 3. Showing the percentage frequencies of different areas containing chalky deposits of any extent in the upper and the lower shell-valves of *C. gryphoides*.

(1) The percentage frequency of deposits in the areas 2 to 24 is higher in the case of lower (left) valve than in the corresponding areas in the upper valve (right).

(2) The deposits are concentrated in the areas around the centre of the shell.

TABLE I

Percentage frequencies of different areas containing different quantities of deposits in the lower valve of C. gryphoides

No.	Nil		Some		¼		½		¾		Full	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	324	84·37	28	7·29	12	3·12	8	2·08	6	1·56	6	1·56
2	112	29·17	52	13·54	54	14·00	72	18·75	74	19·27	20	5·20
3	140	36·46	44	11·46	30	7·81	42	10·93	36	9·37	92	23·96
4	176	45·82	54	14·06	34	8·85	22	5·72	32	8·32	66	17·19
5	16	4·16	30	7·81	12	3·12	48	12·50	116	30·21	162	42·19
6	136	35·42	62	16·14	66	17·19	56	14·58	48	12·50	16	4·16
7	64	16·66	20	5·20	16	4·16	30	7·81	32	8·32	222	57·81
8	52	13·54	34	8·85	28	7·29	54	14·00	124	32·29	92	23·96
9	200	52·08	66	17·19	22	5·72	30	7·81	44	11·46	22	5·72
10	54	14·00	20	5·20	12	3·12	26	6·77	36	9·37	236	61·46

11	52	13·54	48	12·50	62	16·14	62	16·14	78	20·32	82	21·35
12	162	42·19	38	9·89	16	4·16	28	7·29	26	6·77	114	29·69
13	58	14·10	14	3·65	18	4·68	26	6·77	38	9·89	230	59·89
14	52	13·54	38	9·89	34	8·85	42	10·93	68	17·71	150	39·06
15	112	29·12	46	11·98	18	4·68	32	8·32	44	11·46	132	34·38
16	144	37·50	38	9·89	32	8·32	14	3·65	44	11·46	112	29·17
17	36	9·37	20	5·20	22	5·72	30	7·81	58	15·10	218	56·76
18	46	11·98	44	11·46	54	14·00	66	17·19	108	28·13	66	17·19
19	116	30·21	48	12·50	18	4·68	22	5·72	28	7·29	152	39·59
20	102	26·57	28	7·29	44	11·46	32	8·32	64	16·66	114	29·69
21	30	7·81	32	8·32	68	17·71	80	20·84	100	26·04	74	19·27
22	200	52·08	38	9·89	22	5·72	20	5·20	36	9·37	68	17·71
23	182	47·32	72	18·75	30	7·81	32	8·32	38	9·89	30	7·81
24	212	55·21	30	7·81	30	7·81	24	6·23	38	9·89	50	13·02

TABLE II

Percentage frequencies of different areas containing different quantities of chalky deposits in the upper valve of C. gryphoides

No.	Nil		Some		¼		½		¾		Full	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1	266	69·28	42	10·93	18	4·68	16	4·16	24	6·23	18	4·68
2	192	50·00	64	16·66	54	14·06	38	9·89	24	6·23	12	3·12
3	292	76·05	36	9·37	14	3·65	14	3·65	10	2·60	18	4·68
4	294	76·56	44	11·46	10	2·60	8	2·08	14	3·65	14	3·65
5	266	69·28	58	15·10	26	6·77	22	5·72	10	2·60	2	0·52
6	312	81·25	36	9·37	6	1·56	20	5·20	8	2·08	2	0·52
7	354	92·19	14	3·65	10	2·60	Nil	..	2	0·52	4	1·04
8	182	47·40	50	13·02	32	8·33	30	7·81	74	19·27	16	4·16
9	288	75·01	44	11·46	26	6·77	22	5·72	4	1·04	Nil	..
10	350	91·14	22	5·72	8	2·08	2	0·52	2	0·52	Nil	..

11	208	54·17	48	12·50	30	7·81	50	13·02	40	10·42	8	2·08
12	294	76·56	46	11·98	14	3·65	12	3·12	16	4·16	2	0·52
13	266	69·28	32	8·33	18	4·68	18	4·68	22	5·72	28	7·29
14	188	48·96	62	16·14	20	5·20	42	10·93	40	10·42	32	8·33
15	304	79·16	32	8·33	4	1·04	18	4·68	6	1·56	20	5·20
16	204	53·13	38	9·89	22	5·72	14	3·65	34	8·85	72	18·75
17	96	25·00	42	10·93	30	7·81	32	8·33	76	19·79	108	28·13
18	204	53·13	62	16·14	14	3·65	52	13·54	40	10·42	12	3·12
19	204	53·13	30	7·81	20	5·20	26	6·77	28	7·29	76	19·79
20	54	14·06	32	8·33	20	5·20	44	11·46	92	23·96	142	36·98
21	146	38·02	70	18·23	30	7·81	56	14·58	62	16·14	20	5·20
22	226	58·86	52	13·54	14	3·65	12	3·12	30	7·81	50	13·02
23	118	30·73	56	14·58	34	8·85	68	17·71	60	15·63	48	12·50
24	280	72·91	22	5·72	10	2·60	16	4·16	6	1·56	50	13·02

(3) In both the valves, the frequency of deposits in the areas 13 to 21 is higher than in any other areas.

(4) The percentage frequency of deposits is low in the areas lining the shell boundary.

(5) In lower valve, the percentage frequency of full deposition is generally more in the areas 10 to 20, excluding 18 (Table I).

(6) In the lower valve, the percentage frequency of $\frac{3}{4}$th deposits is high in the areas 5, 8, 18 and 21.

(7) The areas 1, 9, 22 and 24 in the lower valve are in majority of shells without any deposits.

(8) Areas, other than those mentioned above in case of the lower valve, contain deposits in varying quantities, *i.e.*, some $\frac{1}{4}$, $\frac{1}{2}$, etc., as mentioned above.

(9) In the upper valve, the percentage frequency of full and $\frac{3}{4}$ deposits is higher in the areas 8, 11, 14, 17, 18, 20, 21 and 23 (Table II).

(10) Percentage frequency of areas having no deposits is constantly high in the upper valve.

(11) In case of upper valve, areas, other than those mentioned above, contain deposits in varying quantities as mentioned earlier.

Thus it is seen that the depsoits in the upper valve are less frequent and less extensive than those in the lower. It is also observed that the maximal occurrence of deposits fall in the areas lying near the inhalent region of the oyster. It may be that the deposition of chalky material commences near about the middle of the inhalent region. The deposits are also fairly distributed in the areas, lying beneath the visceral mass and on the boundary of inhalent and exhalent regions. In the exhalent region the deposits are scanty and with lower percentage frequency. Such an area-wise distribution of chalky deposits has been shown by Orton and Amirthalingam (1927) and also by Korringa (1952) in *O. edulis* and *O. angulata*. Medcof (1944) observed this phenomenon on *O. virginica*.

It seems from the above observations that the general distribution of deposits is more in case of *C. gryphoides* than in *O. edulis* (Orton and Amirthalingam, 1927). They also found a more prevalent and abundant deposition in *O. angulata* than in *O. edulis*. In *O. edulis* deposits are seen more on the upper valve than on the lower valve, while in *C. gryphoides* it is exactly reverse, more deposits being on the lower valve. Further it is observed that in *O. edulis*, the deposits are more common in the exhalent region whereas in *C. gryphoides*, they are more common in the inhalent region. Orton (1927),

on finding similar diversities in *O. edulis* and *O. angulata*, observes that such diversities may afford a character of physiological difference in these oysters.

The percentage frequency of deposits in certain areas is low. The deposits in these areas are generally the extension of the main deposits. In *C. gryphoides*, the whole of the interior of the shell is rarely covered with deposits as in *O. edulis* (Orton, 1927). In the upper valve there is a considerable deposition of challky material approximately opposite the main deposition on the lower valve.

The chalky deposits are sometimes powdery on the surface and in some cases covered with a thin nacreous layer of shell material. Sections of the shell show that the chalky deposit is not necessarily exposed on the face of the shell only. Several sections were taken in the plane hinge to opposite end, and they show successive chalky deposits alternating with varying thicknesses of nacreous deposits (Fig. 4). This tends to show that during the life of an oyster, there may be a succession of chalky deposits. This succession

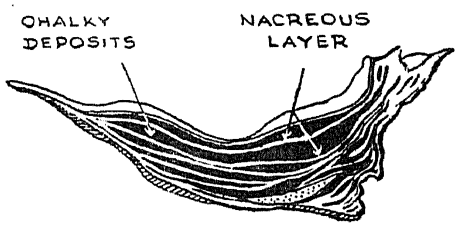

FIG. 4. Showing the section of a lower valve of a shell with heavy chalky deposition.

occurs in the same relative position on the shell with or without alternating deposits of a nacreous layer.

Nature of chalky and nacreous deposits.—For the study of this aspect, sections of shells were taken and mounted in cooked canada balsam. Some loose grains obtained by crushing the shells were also mounted permanently by the usual method. The material was then studied with the help of a petrological microscope.

The micro-sections show alternate arrangement of cystalline and amorphous layers in majority of shells. However, no layer shows perfect crystalline nature in form, transparency and the other optical properties such as cleavage sets, etc. The so-called crystalline layers do transmit polarized light through them and show some optical activity. These crystalline layers when studied between crossed nicols and in convergent polarized light show good distinct uniaxial negative interference figures, indicating the presence of calcite in

somewhat crystalline form. Crystalline layers also show irregular organic shapes.

The chalky material does not show any optical property and is practically amorphous, and porous. Medcof (1944) found chalky areas in *O. virginica* to be composed of large vertical calcite crystals in a porous mass of smaller crystals with a protein matrix.

Function and causes of chalky deposits.—Southern (1916) suggests that the formation of chalky deposits in case of chambered shells is to accommodate the increase in size of the animal during the spawning season. However, Orton (1927) observes that the chalky deposits are due to local unsuitabilities of the contour of the shell. These deposits fill up the unwanted spaces like crevices, etc. The contour of the shell depends on the substratum. Ranson (1939) observes that ample "Chalky" deposits are secreted only where the substratum is rich in lime, Medcof (1944) and Korringa (1952) suggest that "Chalky" deposits are used in smoothing out the shell's interior surface and thus "they help to maintain certain topographical features of the shell interior, preserve a size relationship between meats and shell cavity and regulate the curvature of the inner face of the shell".

In case of *C. gryphoides*, the deposition, as already stated, is particularly in the inhalent region. If the substratum plays an important role in the formation of contours and the consequent chalky deposition, then in case of *C. gryphoides* the chalky deposits should have been found spread over the shell instead of being concentrated in a particular region. This does not appear in the case of oysters under discussion. Hence, it is likely that the deposition of chalky material in a specific area like the inhalent chamber may be a character of physiological difference in *C. gryphoides*. It may be mentioned that Ranson (1950) considers structure of the chalky deposit as one of the characters in the systematics of oysters.

It is also not improbable, as stated by Orton (1927), that these shell formations, which are determined by the shape of the mantle, are controlled largely by the feeding habits imposed by the local conditions.

Chemical composition of chalky deposits.—For the study of the chemical composition of chalky deposits, oysters were opened and their meats removed. The shell liquor was drained off and the inner faces of the shells were quickly wiped out by soft absorbent cloth. The chalky deposits were then scrapped only from the lower valves of 4 oysters, as the lower valves yield more material than the upper ones. The material was immediately taken up for analysis. Samples of the scrappings of the chalky material were accurately weighed and

dried for 24 hours in an oven maintained at 95°–100° C. and then weighed to constant weight to obtain the amount of water. To know the amount of organic matter, dried material was ashed in a muffle furnace at 600° C. for an hour and weighed to constant weights.

The calcium was estimated by the permangnate method while phosphorus was estimated colorimetrically.

Approximate chemical composition of chalky material is as follows:

Water	65·68%
Ash	27·71%
Organic matter	6·59%

Minerals

$CaCo_3$	33·175 g.%
P_2O	0·052 g.%

Similar studies have been made by Bull (1927) on the chalky deposits of *O. edulis*.

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