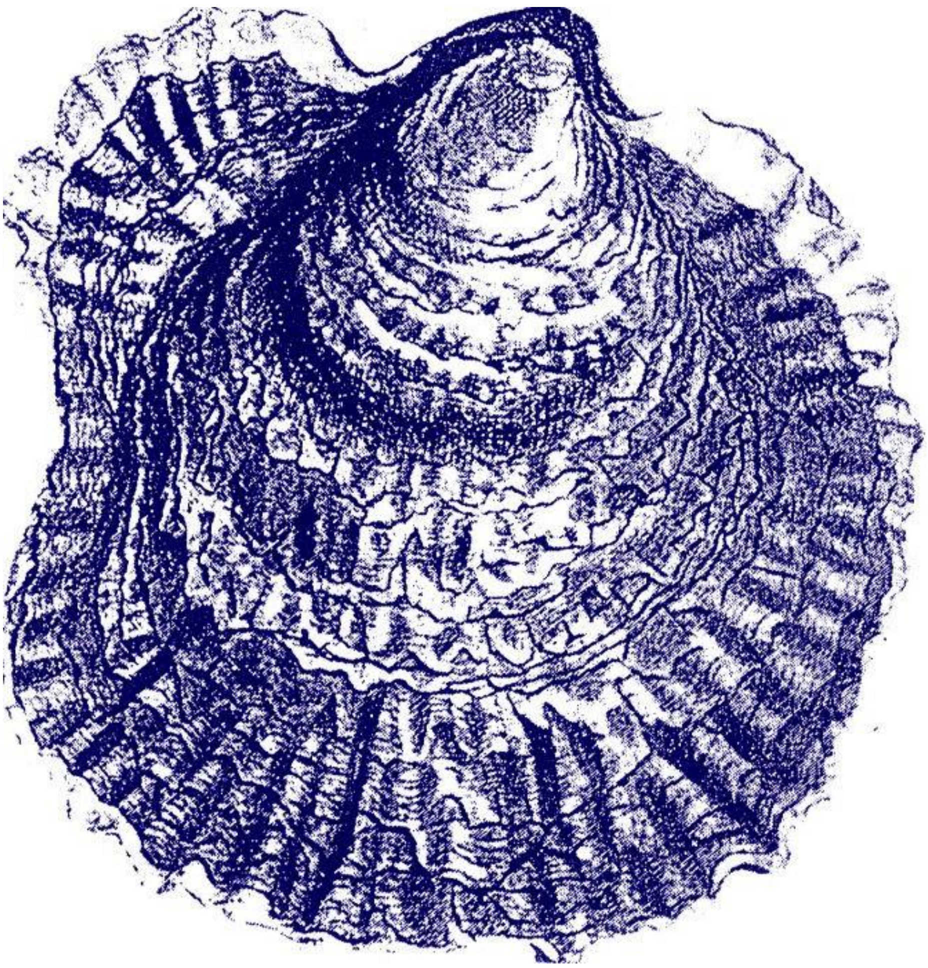
OYSTER SHELLS FROM ARCHAEOLOGICAL SITES

A brief illustrated guide to basic processing



Jessica M. Winder 2011

Oysters etc. (Archaeomalacology)

Oyster shells from archaeological sites

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Important notes

This manual describes a simple way of recording details of the macroscopic appearance in oyster shells recovered from archaeological excavations, with a view to quantifying their natural and man-made characteristics, to understand about their exploitation, and enable comparisons to be made between oyster shell samples within the various contexts of a single site, or between samples from different sites, and different periods. It describes a recording method which was devised in 1975, and finally written up and published informally on-line in 2011.

The method was designed to be easily learnt and used by non-specialists. This means that it is also easy to miss-apply. Originally, the technique was taught side-by-side with the expert in a training session so that checks were possible while recording was in progress, and the accuracy of the trainee's independently obtained results could be determined by carrying out statistical tests for comparability between the results of the expert and the trainee for selected samples. This ensured consistency of results.

I would like therefore to urge caution in the use of the manual at the present time on four fronts:

1. Before commencing full recording of the archaeological oyster shells, question whether the samples are valid for further study. Do the samples comply with the standards and requirements outlined in Campbell (2015, 2017)?

2. In recognition of the development of other approaches to studying archaeological oyster shells during the 45 years since this methodology was first devised, and the advancement in technological methods of analysis, is this recording technique the most appropriate to use?

3. Given the importance of comparability between samples both spatially on an intra-site and inter-site basis, and temporally between historical periods, what quality control measures are in place to ensure accuracy and consistency of the recording? Can the results be trusted in comparisons between samples recorded by different individuals?

4. Finally, an editorial correction regarding the names of the dimensions being measured. The measurement from the umbo to the ventral margin which is termed maximum width in the manual is more correctly called the maximum height. This was corrected in Winder (2017).

About the handbook

- *Oyster shells from archaeological sites: a brief illustrated guide to basic processing* is a starter's guide to handling oyster shells (British Native Oyster, European Flat Oyster, *Ostrea edulis* Linnaeus) from archaeological excavations.

- The guide provides useful information for recognising observable macroscopic details. It suggests some simple methods for processing archaeological oyster shells that may be useful for collecting and collating data, in both a qualitative and quantitative way, prior to further statistical analyses and interpretation.

- Thirty Figures with 63 colour photographs illustrate the topics discussed.

- Sources of information are provided in a bibliography; and relevant textbooks are recommended.

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INTRODUCTION

The shells of the European Flat Oyster (*Ostrea edulis* Linnaeus) differ in many ways and these variations are useful for archaeological site interpretation. Ways have been devised for quantifying the variations. The techniques fulfil a number of requirements. The methods are simple to use so that they can be carried out with a minimum of training by people of all levels and backgrounds. The equipment is inexpensive because not every archaeological project is funded or funded adequately. Cost is a primary consideration in any archaeological unit or department. Simple facilities are all that is necessary for the basic work to be carried out. Finally, with practice, the processing of oyster shells can be carried out speedily - which is an important factor when large numbers of oyster shells need to be examined.

CONSERVATION AND STORAGE

The condition of oyster shells from archaeological excavations can differ within a site or from site to site. Sometimes the condition of the shells can be related to factors such as primary, secondary or tertiary deposition. Direct disposal in pits or ditches and immediate burial will tend to preserve while dispersal over large internal floor or external yard surfaces, and later burial, will lead to wear and breakage. Chemical degradation can occur in certain soil conditions or burial circumstances; acid soils, for example, may destroy the organic matrix of the shell and may etch into the calcium component as well, but large numbers of shells may actually create a micro-environment with a low pH that preserves shells (except those on the periphery of the deposit) and also other environmental material both within and beneath the deposit. Additionally, mechanical damage can be caused during excavation when heavy implements are used to remove large deposits or immediately after excavation if shells are stored in the open air subject to frosts and other adverse conditions. The specific effects of different factors on the survival condition of oyster shells are not fully understood at the present.

However, it is possible to make basic recommendations for the conservation of oyster shells and the preservation of any environmental evidence on or in them. When the shells are removed from the soil, they should be handled with at least as much care as other faunal remains like bones. On no account should the shells be cleaned. Any mud or other accretions should be allowed to dry naturally on the shells. Once dry, the shells should be packed in paper or polythene bags, or directly into storage boxes but using common sense and discretion about the quantities that can be packed together. If shells are more friable, fewer can be placed on top of each other without causing more damage. Care should be taken that smaller or more fragile marine mollusc species are not crushed by the heavier oyster shells. If possible, they should be put in a separate bag or container (plastic box or vial) on top of the oyster shells. It is not necessary to mark each individual shell or shell fragment with Indian ink. One or more clearly and indelibly written waterproof labels within each bag or other container should suffice, and the same information on the outside of the container.

Oyster shells (and other marine molluscs) should be only washed with the supervision of the specialist. When shells are washed in the customary way with a tooth or nail brush, vital evidence is lost by two means. First of all, useful environmental evidence can be scrubbed off with the mud. Often it is only the mud that holds barnacles and calcareous seaweeds in place on the shell. Some encrusting worm tubes are actually constructed of mud or sand grains. It is important that the finds assistant understands what these things look like, and how to remove the mud while retaining the evidence. Secondly, scrubbing can etch into the soft shell removing such features as the growth lines by which the shells can be aged. Ideally, if the shells need washing, they should be held under a gentle stream of cold water over a 1mm sieve while dirt is removed carefully with a soft-bristled paintbrush. The shells are then air dried. The condition of the shells will dictate the speed and amount of care needed for washing. It is not considered necessary to produce a perfectly clean shell. Only enough dirt needs to be removed to facilitate handling, to record measurements and other characters, and to examine the growth lines.

EQUIPMENT

The following items are useful for processing oyster shells:

- A good quality (e.g. Veteran) transparent plastic ruler marked with millimetres; this is easier and quicker than a caliper for taking measurements of oyster shells.
- (A Vernier caliper is best for measuring limpets, cockles, winkles and mussels).
- Sheet of white paper used in the estimation of measurements for broken shells.
- A supply of old clean newspapers on which to place the shells so that dust and debris can easily be tipped straight into a dustpan or bin after each sample is recorded.
- Pencils or pens.
- A notebook of 5mm squared paper ruled up appropriately or readymade recording sheet (see details below)
- Hand lens particularly useful for examining Bryozoa on shells.
- Anglepoise-type desk lamp especially useful for examining growth lines.
- Scientific calculator
- Millimetre graph paper

It is possible to enter data directly onto computer spreadsheet for analysis and graphics but this facility is not assumed. A lap-top type computer for portability, sealed but operable within a plastic cover to prevent damage to the system by the inevitable generation of dust while handling shells, would be ideal.

TECHNIQUES

Initial recording: the record sheet

Recording characters that are visible to the naked eye - that is macroscopic, albeit with occasional help of a hand lens and well-angled light source, meets the need for simplicity, speed and cost-effectiveness when processing the shells. The record sheet, a copy of which is included with these guidelines, sets out a grid on which to record up to 26 items of information about each shell either by entering an appropriate figure or comment or by marking with an oblique line the presence of a characteristic. It is possible to record whether the shell is a right or left valve, its maximum width and maximum length, the age (from the right valve), the eight types of evidence for infesting or encrusting organisms (details of which are given separately below), twelve descriptive categories (details are given below) and a space for comments. The photographic illustrations, given below, use both archaeological and modern material to demonstrate these different characteristics in oyster shells.

Example of a spreadsheet for recording details of oyster shells from archaeological deposits

Identification and Sorting

Shells should be carefully tipped onto a sheet of newspaper on a large table top or other flat surface. Samples will frequently contain not only oyster but other shells as well. The shells should be sorted into species and identified. Reference material should be consulted when possible to verify identifications. It is a good idea to build up a reference collection of shells of both archaeological and modern marine shell specimens for which the identity has been confirmed by a specialist. Several useful books for identification are listed in the bibliography. These include *Collins Pocket Guide to the Sea Shore* by Barrett and Yonge (1958) and *Handbook of the Marine Fauna of North-West Europe* edited by Hayward and Ryland (1995). For gastropod identification there is also, for example, *British Prosobranch Molluscs* by Alastair Graham (1971). For bivalve identification *British Bivalve Seashells* by Norman Tebble (1966) is a recommended book (now available as a CD).

Specimens need to be counted to enable an assessment of the minimum number of individuals (MNI). In oysters, whichever of the right or left valve totals is the greatest is considered to be the minimum number of individuals. The left and right valves in oysters are distinct. The left or lower valve tends to be shallowly concave when viewed with the inner smooth surface uppermost. Externally, the left valve tends to have frilly concentric shell outgrowths centred on the hinge or ligament area. It also tends to have broad radiating ribs on the outer surface. In contrast, the right or upper valve is usually flat but this can vary with greater or lesser degrees of concavity or convexity. The right valve lacks the ribs and concentric upstanding growth shoots found on the left valve but usually the growth rings are easily discerned. Examples of right and left valves in modern oysters can be seen in Figures 2 and 3 below.

Regarding other mollusc species than oysters, fragments of bivalves such as cockles are only counted if they include the hinge or umbone on the valve. It is possible to distinguish the right from the left valves in most specimens. If it is not possible to differentiate between left and right valves in smaller species, the number of individuals for bivalves is considered to be the total number of valves divided by two. Fragments of gastropods like winkles are counted if the apex is present. Pieces without apices are not counted.

Recording size

Oysters should then be divided into shells that can be measured and those that are too broken to measure accurately. The criteria of suitability for measurement are the possession of the umbo/ligament scar, the adductor muscle scar on the internal surface and at least two thirds of the shell intact. Shells are measured by placing them with the internal surface downwards onto a ruler which lies across a piece of plain paper.

For the maximum width measurement the hinge or umbonal end is placed on the zero mark and the shell aligned on the ruler so that maximum distance between the hinge and the opposite edge/periphery of the shell along the axis of growth can be measured. The maximum length of the shell is measured along the greatest distance between the margins of the shell at right angles to the maximum width measurement. See Figure 1 below.

Where part of the edge of the shell is missing, it is often possible to estimate its position by following the natural curve of the periphery between the two ends of the break. This can either be done by eye or by drawing in the line with a pencil on the piece of plain paper on which the ruler rests. Any measurements taken like this should be marked with a > sign denoting that the measurement is at least that size. Measurements should be taken to the nearest millimetre and efforts made to ensure consistency and accuracy by reading the measurements always with the ruler in the same position both on the table top and in relation to the body. This means that the angle at which the eye observes the gradations of the ruler is always the same. This is important.

Recording age

The procedure outlined here is not generally recommended today because more accurate scientific techniques have been developed to investigate growth, age and seasonality. These techniques are a specialist domain and outside the area of expertise of most people. However, anyone wishing to investigate these processes further is recommended to search the literature for current work. The excellent work *Shells* by Cheryl Claassen (1998) is a good place to start the search.

For those who are interested in the old method described by Winder (1980; 1993), this is not an exact science and tends to involve a subjective judgement in some cases. Attempts have been made to define the way in which the concentric growth rings evident on bivalve shells relate to age in many species. Some of the work has been in tremendous detail on both a macroscopic and microscopic level (for example, Pannella and MacClintock, 1968; Barker, 1964; Deith, 1983). However, there would appear to be only two papers dealing with the problems of "aging" oysters macroscopically. Massey (1914) tried to relate growth rings on the left or cupped valve to the known age of oysters without great success. She quotes a Danish worker, who had tried to do the same thing (Petersen, 1908), as saying "certainly the zones of growth on the shells have something to do with growth periods, but it is often not easy to determine them with certainty". Probably the greater degree of ornamentation in the form of growth shoot "frills" on the left valve is a complicating factor in age assessment. Therefore, only the right flat valves of oysters were used for aging in the Hamwic material by Winder.

The shell can be seen to be covered in broad concentric bands. These are made up of a series of relatively widely-spaced lines representing the growth in the warmer months (approximately March to late October or November), and closely arranged lines representing growth in the colder winter months. The first growth band, closest to the hinge, represents the growth attained by the spat (young) oyster between setting in July or August and the onset of cold weather, that is only half a year. A great problem exists in exactly pin-pointing the limits of each growth band, partly because of the variations in the widths separating the lines (being primarily due to change in weather conditions at the time the shell was laid down) and the fact that growth does not actually stop in cold weather. Added to this is the complication of wear in archaeological specimens.

Measurements in width of growth bands would be inaccurate or impossible. Overall measurement is possible. Addition in linear dimensions decreases with age; the growth bands become progressively narrower at the margins of older shells so that they may be almost vertical in arrangement. This must be borne in mind when aging the shell. In 'stunters' the rapid fall-off in growth occurs prematurely. Small oysters, particularly thick ones, may therefore be stunted oysters of some age.

Where it is difficult to visually discriminate between the yearly growth bands, there are some simple techniques that may improve the accuracy with which oyster shells are allocated to year groups. There is a tendency for each growth band to follow a slight curve upwards from the surface of the shell when rapid growth has taken place, and inwards towards the surface during slower growth. These "ridges" can sometimes be felt by passing the pad of the thumb gently over the surface of the shell. An oblique light source will cause the ridges to cast shadows so that they can be seen in relief. If the shell is held so that the lateral margins are viewed instead of the surface, a series of "steps" may be seen with relatively prominent horizontal lamellae (plates) marking the end of each year's rapid growth.

Despite the fact that these methods may be criticised as subjective, results seem to indicate that they are not so very inaccurate especially when using large samples of 100 or more shells. For example, growth curves derived from these data approximate closely to the sigmoid curve typical in modern bivalves.

Recording infestation

Eight types of evidence for infesting or encrusting organisms can be recorded on a presence or absence basis by an oblique stroke in the appropriate columns on the record sheet. The epibiont organisms associated with oysters are an important indicator of both local and regional environment. These eight types of infesting or encrusting organism commonly leave traces on oyster shells. The only remaining evidence in oyster shells is left by animals which either alter the structure of the shell or attach hard parts to it. In the current recording methodology, only presence or absence of a characteristic is recorded for individual shells that are measurable. The level of infestation or encrustation, which may be slight to severe, is not quantified although a qualitative note can be made. It is the percentage frequency of occurrence of each characteristic that is calculated for the whole sample and used is subsequent statistical analyses such as Principal Component Analysis. It is therefore really important to record infestation damage or encrustation even if this is a single burrow or tube.

Marine polychaete worms are responsible for most of the visible signs of infestation. *Polydora ciliata* (Johnston) is a worm up to 25mm long, but usually smaller, which burrows into the general outer surface of the shell. The burrows are normally very small but may extend over the entire surface of the shell. See Figures 4 and 6. Their presence has little effect on the health of the living oyster. However, in cases of severe infestation the shell may be riddled with the burrows right through to the inner layer. The oyster reacts by sealing off such intrusions with patches of green-black conchiolin. Diverting shell growth resources in such defence mechanisms can seriously weaken the oyster. The organic conchiolin patches have usually disappeared in archaeological specimens but a badly affected shell will break readily.

A much larger related marine polychaete, *Polydora hoplura* Claparède, which grows to 50mm in length, makes clearly distinguishable U-shaped burrows on the inner surface of the margins of the shell. See Figures 4b. This organism can have a more immediately deleterious effect on the well-being of the oyster because its presence affects the ability of the bivalve to close its shell. This may result in inefficient respiration and possible dehydration in intertidal beds. The oyster responds to this pest by secreting a layer of shell around the worm with its mud and mucous tube. The resulting mud-filled blisters (Figure 5) are easily recognisable in both modern and archaeological shells. When the fragile blisters are accidentally broken, the U-shaped burrows created by *Polydora hoplura* become visible (Figure 5).

Cliona celata Grant is a sponge which initially finds shelter, like the two *Polydora* worms, among the frilly growth shoots and crevices of the oyster shell (Figure 6). Like the *Polydora* worms, it is thought that the metabolic waste products of the organism gradually dissolve the shell. In shells affected by *Cliona* neat round holes perforate the surface of the shell. As the sponge increases its hold on the shell, the holes and borings link up to form an internal network that resembles honeycomb (Figure 7). In life the sponge is visible as small yellow pustules over the surface of the shell.

Some marine worms live in calcareous tubes that they secrete and attach to the outer surface of oyster shells. The two most commonly occurring are made by *Pomatoceros triqueter* (Linnaeus) and *Hydroides norvegica (Gunnerus). Pomatoceros* tubes are often referred to as "German writing" because of their supposed resemblance to Gothic script. The tube has an approximately triangular cross-section and a longitudinal keel (Figure 8 top). *Hydroides* tubes are slightly larger with a circular cross-section and no keel (Figure 8 bottom). Neither of these organisms can be considered as pests to the oyster.

Barnacles, usually acorn barnacles of the *Balanus* type, can be found as whole shells attached to the surface, or inverted and embedded in oysters that have settled on a substrate covered with barnacles. See Figures 9 and 10. The shells are composed of six loosely-associated plates around the diameter and four smaller plates acting as a lid. These are easily broken and frequently become detached during post-excavation handling. However, the place of attachment is still often visible as a round scar-like basal plate of cement. Entire oyster shells can be covered by barnacles but oysters are only minimally affected by their presence. The greatest problem is that areas heavily colonised by barnacles prevent the settlement of young spat oysters.

Bryozoa are minute invertebrates occupying individual box-like cells that are joined together in large colonies. See Figure 11. To the naked eye the colonies look like moss or lace on the shell. The microscopic physical remains of the colonies are diagnostic in shape. A microscope is needed to see the identifying features. Frequently occurring damage to the delicate structures in archaeological specimens also makes identification a problem. To date, specific identification of Bryozoa in archaeological material has not been attempted but this is a potentially rewarding area of study for the future.

Several species of gastropod mollusc are active predators on oysters, especially young, thin-shelled ones. The sting-winkle *Ocenebra erinacea* (Linnaeus) and the dog-whelk *Nucella lapillus* (Linnaeus) use the tooth-bearing radula (tongue) to bore neat, round holes through the shell (Figure 12 left). Boreholes can clearly perforate the shell. Once the shell has been penetrated, the predator sucks out the meat within. This action in a young specimen would probably result in death. Since larger oyster shells sometimes have boreholes that do not penetrate the shell (Figure 12 right), it is obvious that predatory gastropods may become detached before completing the attack, or older oysters can fend off attack by rapidly laying down new shell layers to seal the holes.

Tubes of sand are created by worms of the *Sabellid* type and cemented to oyster shells (Figure 13). These can be individual tubes or massive colonies of them commonly called "ross". These are often mistaken for post-depositional sediment adhering to the shell and accidentally removed by washing.

Recording descriptive characters

Twelve qualitative characteristics can be recorded in columns on the record sheet. These refer to the following: relative thickness and weight (Figure 14); chambering (Figure 15a) and chalky deposits formed during rapid salinity changes and possibly indicating estuarine conditions (Figure 15b); degree of wear; natural colour (Figure 16) or post-burial staining; attachment of adult or spat oysters (Figures 17 to 19); irregularity of shape (Figure 20 to 22); man-made notches or cuts (Figures 23 to 25); and the presence of a ligament (Figures 26 and 27). The material on which the juvenile or "spat" oyster originally settled often remains attached to the mature oyster shell. When this material has been deliberately laid down to encourage settlement of oyster spat it is referred to as "cultch". Examples of such settlement materials can be seen in figures 28 to 30.

Finally

The speed with which the basic information can be recorded in oyster shells depends on many factors. With some experience, and large samples to handle, perhaps a hundred shells an hour can be recorded. Numerous, small, individually wrapped samples or samples characterised by heavily infested shells will take a lot longer to process.

The methods for recording macroscopic characteristics in archaeological oyster shells have been outlined here. Data has been recorded in this way for samples from over forty archaeological sites in Britain. Intrasite and intersite variation in the size, infestation and other characters of archaeological oyster shells has been demonstrated spatially and temporally. Analyses indicate that this type of information is a good indicator of locality of origin for the oysters and also highlights changes taking place in growth characteristics of oysters over the last two thousand years which may be attributable to climatic change.

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THE FIGURES

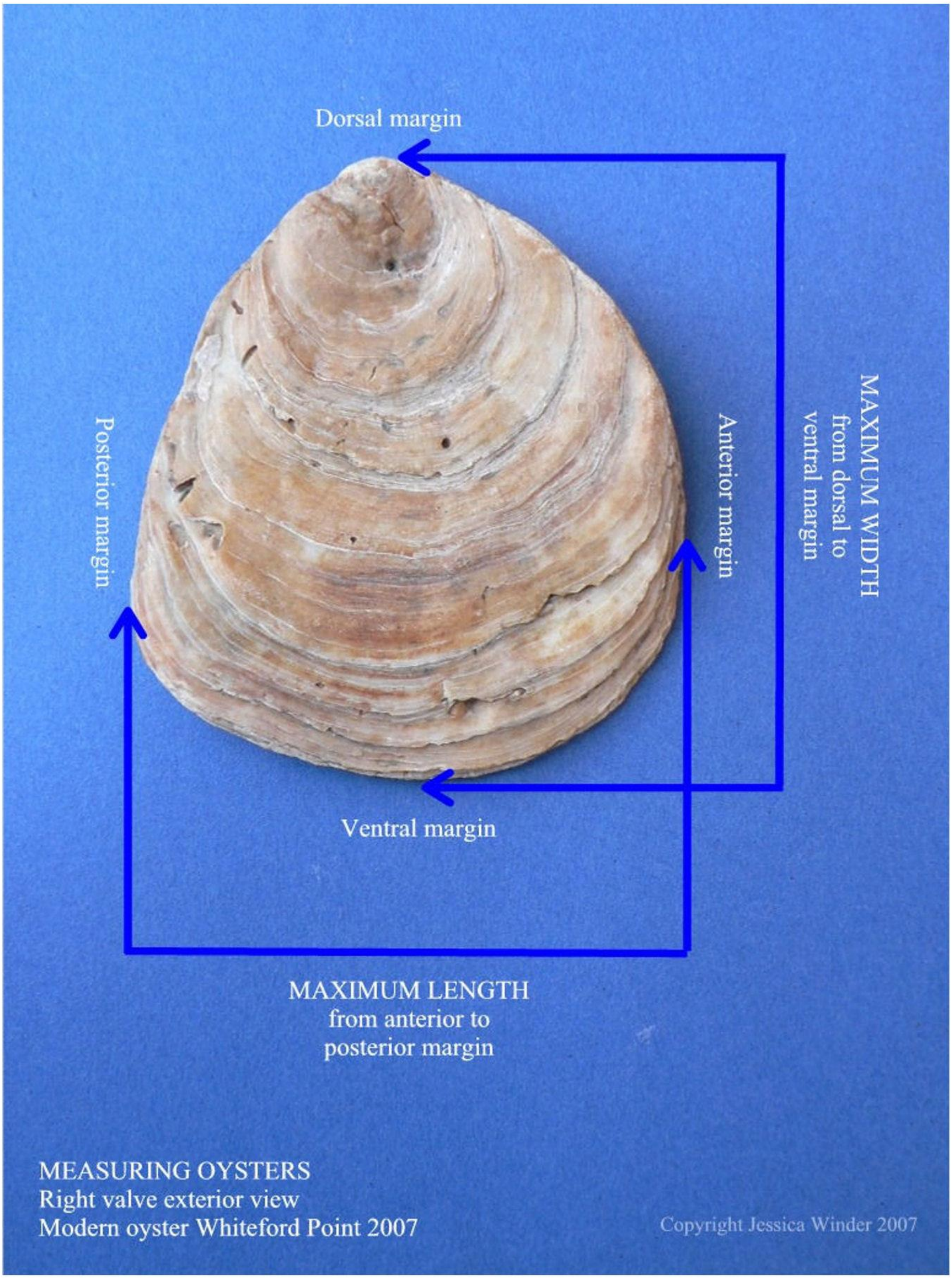

Figure 1 Measuring oyster shells

Figure 2 Distinguishing characteristics of right valves compared with left valves in modern specimens of Ostrea edulis Linnaeus - British Native Oyster or European Flat Oyster.

Figure 3 Characteristics of right valves compared with left valves in Ostrea edulis Linnaeus - British Native Oyster or European Flat Oyster - freshly harvested small modern oysters. Above, left valve external view and left valve internal view; below, right valve outside and right valve inside views.

Figure 4 Marine polychaete worm burrows in modern oysters from Poole Harbour, Dorset, UK. Above, burrows of *Polydora ciliata* (Johnston) on exterior left valve; below, *Polydora hoplura* Claparède on interior left valve visible through nacreous layer.

Figure 5 Worm burrows in archaeological oysters from Saxon Melbourne Street, Southampton, UK. Above, U-shaped burrow of *Polydora hoplura* Claparède revealed by eroded nacreous layer; below, "blister" of nacreous material covering a *Polydora hoplura* Claparède burrow.

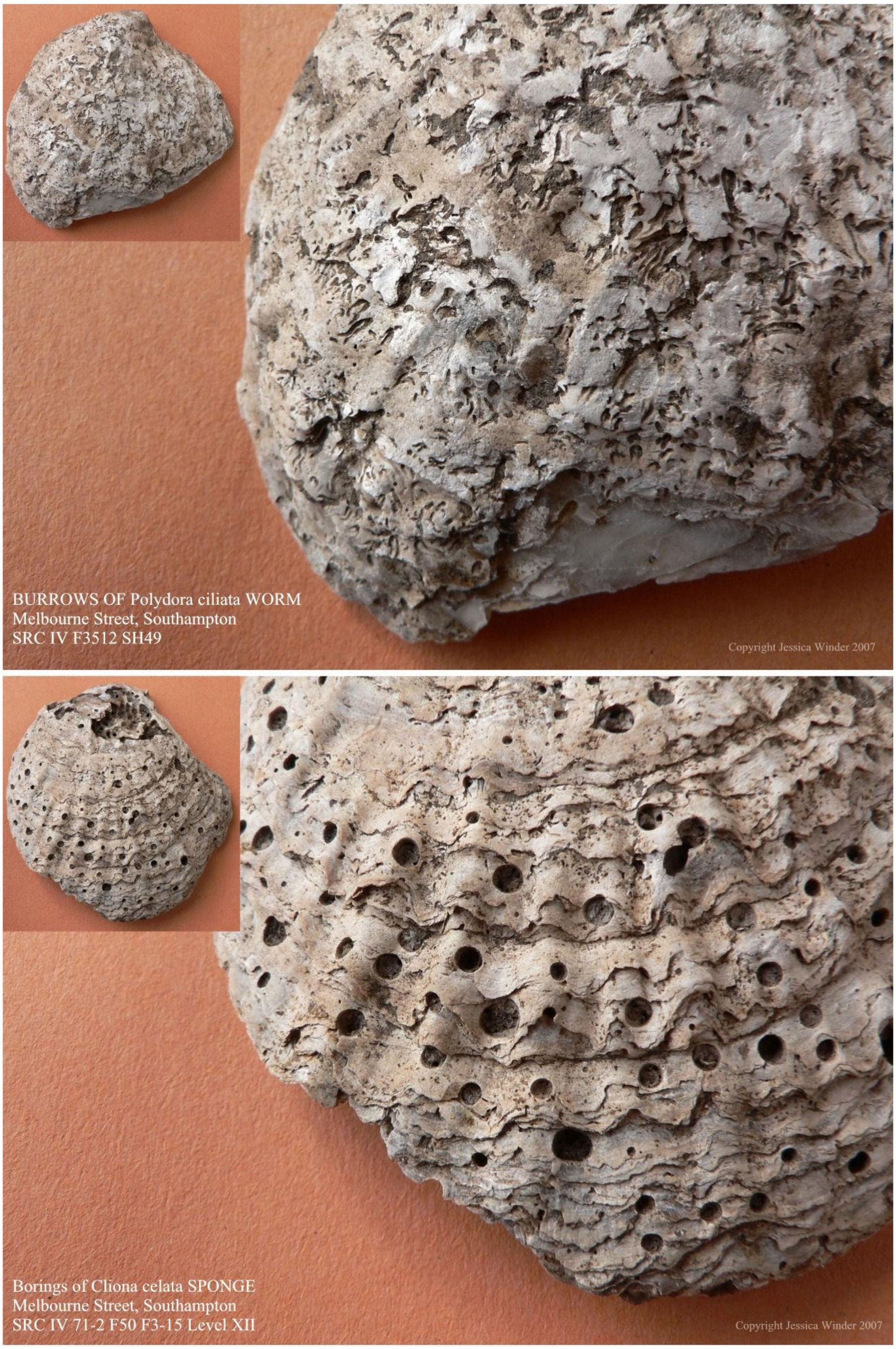

Figure 6 More burrows in archaeological oyster shells from Saxon Melbourne Street, Southampton, UK. Above, burrows of *Polydora ciliata* (Johnston) on exterior left valve; below, borings of *Cliona celata* Grant sponge on exterior of left valve.

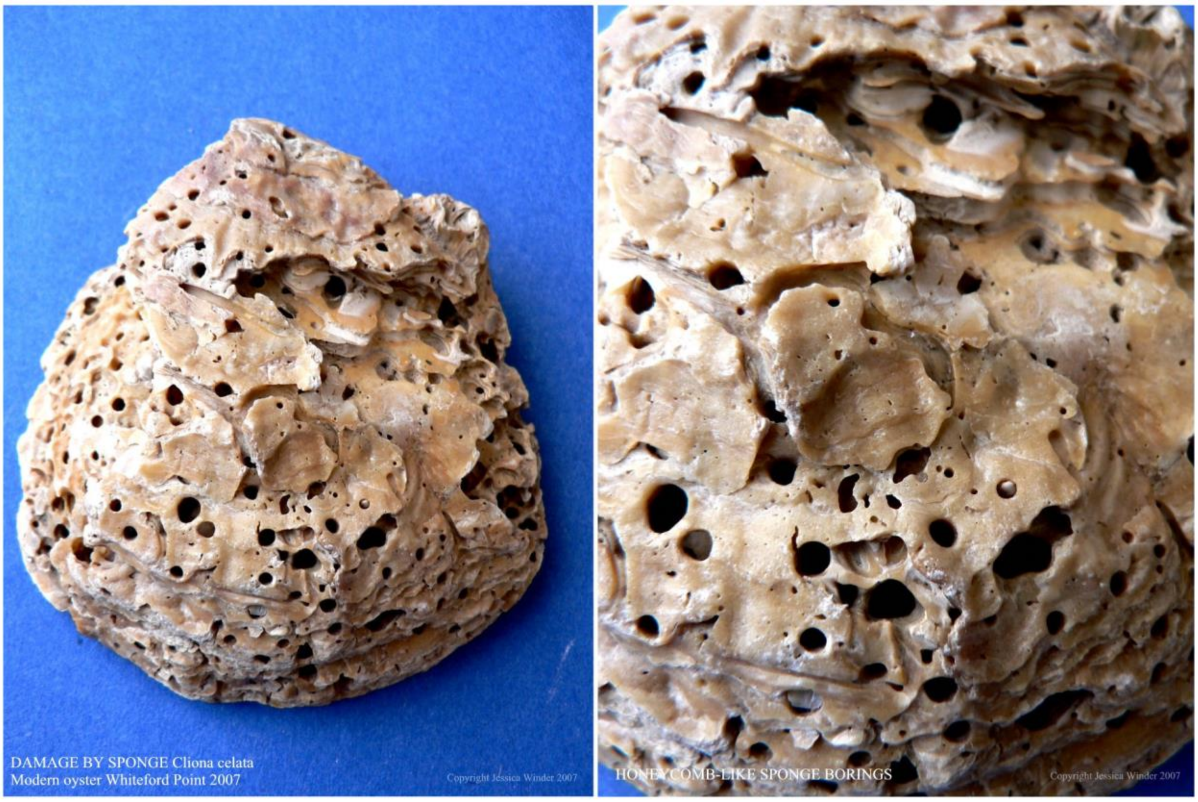

Figure 7 Borings of the sponge *Cliona celata* Grant in a modern oyster shell from Whiteford Point, Gower, UK. Detail showing honeycomb-like appearance in severely affected shell.

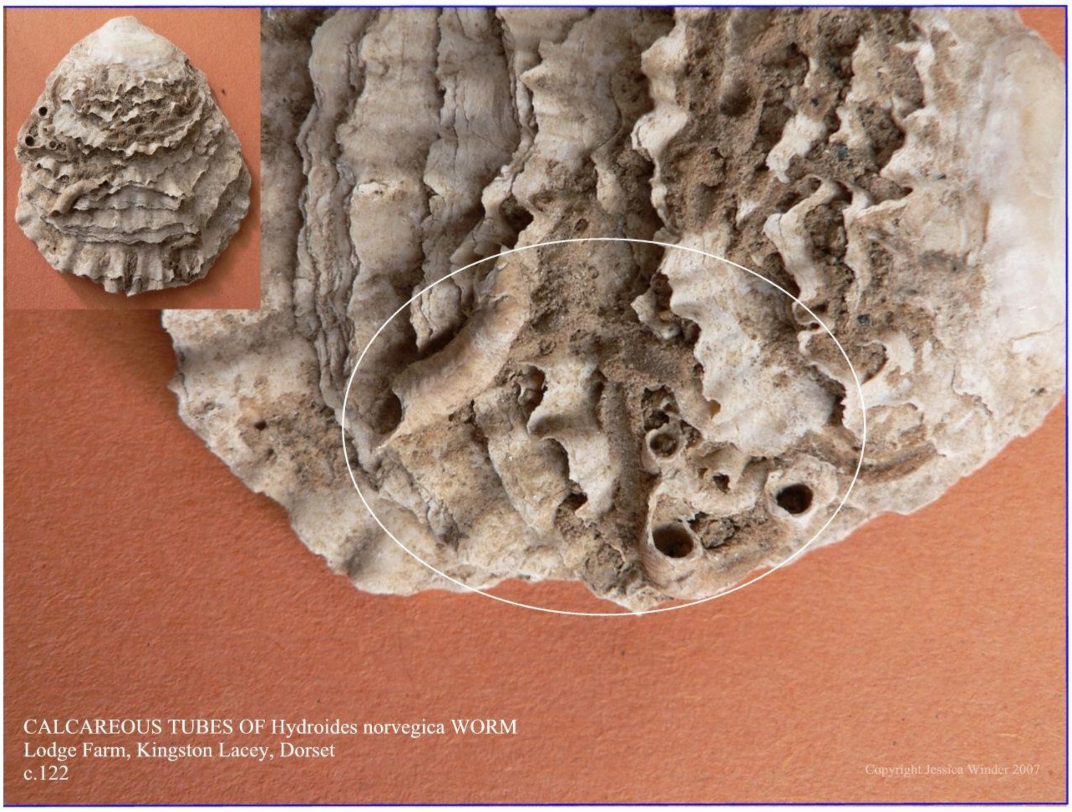

Figure 8 Calcareous worm-tubes on archaeological oysters from Medieval Lodge Farm, Kingston Lacy, Dorset, UK. Above, tube of *Pomatoceros triqueter* (L.); below, tubes of *Hydroides norvegica* (Gunnerus).

Figure 9 Barnacles on modern oyster shells. Above - barnacles on exterior left valve from Calshot Bed, Solent, UK; below - barnacles and "scars" left by the attachment cement when barnacles become detached, surrounded by Bryozoa or sea mat (Poole Harbour, Dorset, UK).

Figure 10 Barnacle attachment cement "scar" on a modern oyster shell (*Ostrea edulis* Linnaeus) from Poole Harbour, Dorset, UK.

Figure 11 Bryozoa or sea mats. Above, Bryozoa or sea mat on exterior of archaeological oyster shell (*Ostrea edulis* Linnaeus) left valve. Below, Bryozoa on interior surface of right valve of modern oyster "clock" (*O. edulis* L.) from Poole Harbour, Dorset, UK.

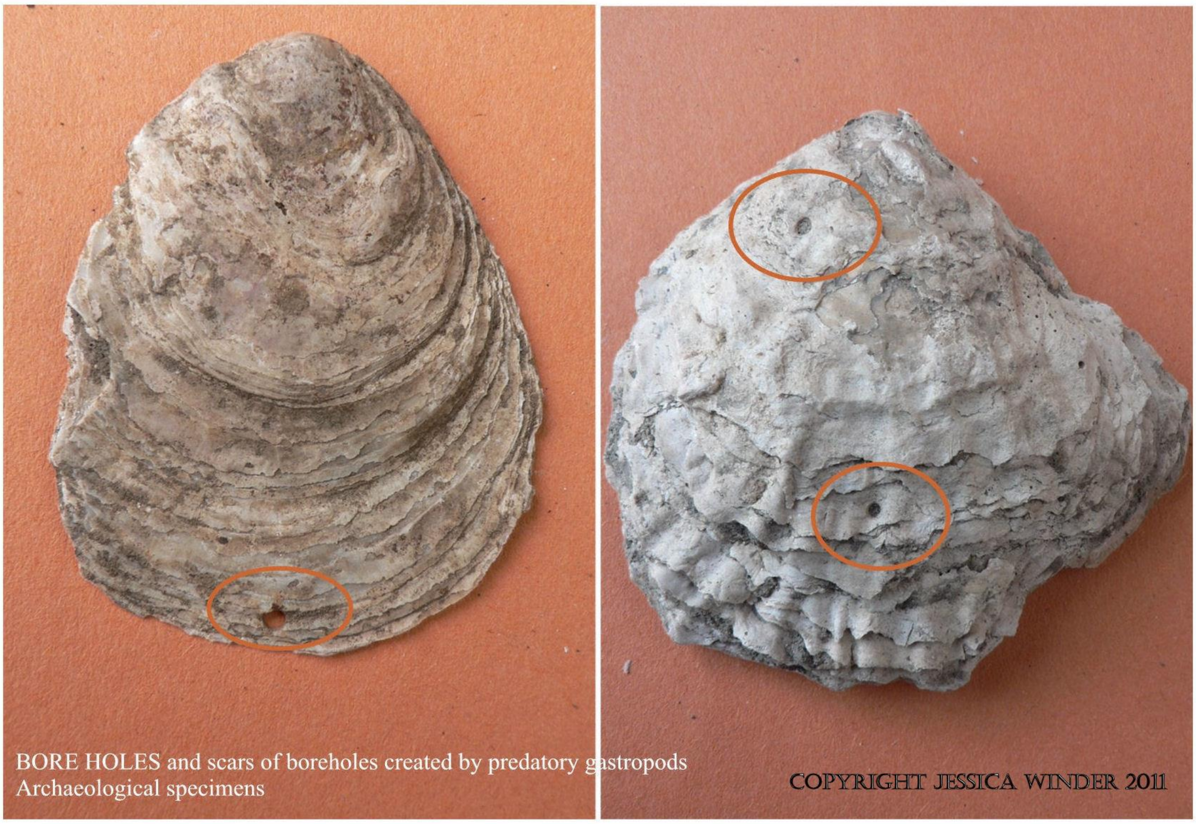

Figure 12 Bore holes created by predatory marine gastropod molluscs in archaeological oyster shells. Left - bore hole perforating edge of right shell valve. Right - bore holes on left valve sealed off by the oyster during life and therefore not perforating the shell.

Figure 13 Encrusting sand tubes or "ross" of marine Sabellid polychaete worms surviving on the surface of archaeological oyster shells.

Figure 14 Very old thick specimens of oyster left valve shells (Ostrea edulis Linnaeus). Above - archaeological specimen. Below - modern Poole, Dorset, UK, "clock".

Figure 15 Above: chambering on inner left valve shell of an archaeological specimen of oyster (*O. edulis* L.). Below: chalky deposit on inner left valve shell of modern oyster from Calshot Bed, Solent, UK.

Figure 16 Colour banding in left valve shells of the British Native Oyster (*Ostrea edulis* Linnaeus) from excavations at the 12th century Shipwright's Arms, Poole, Dorset, UK.

Figure 17 Young oyster shell (*Ostrea edulis* Linnaeus) attached to outer surface of a mature oyster left valve shell in modern specimen.

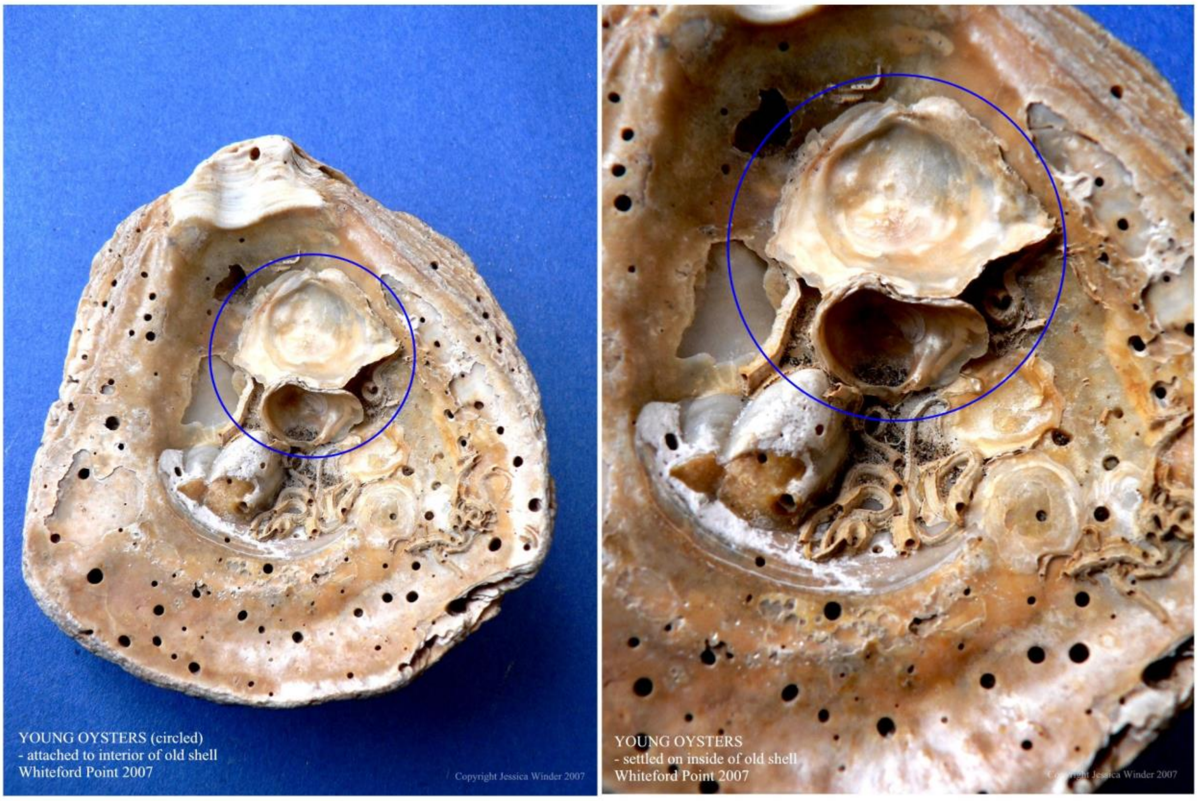

Figure 18 Shells of young oysters, *Ostrea edulis* Linnaeus, (together with calcareous tubes of marine worms) attached to the inner surface of a modern, beach-worn oyster left valve shell riddled with sponge borings.

Figure 19 Shell of young oyster (*Ostrea edulis* Linnaeus) attached to the outer left valve of a modern mature oyster shell from Poole Harbour, Dorset, UK.

Figure 20 Distorted left valve shell of archaeological oyster (*Ostrea edulis* Linnaeus) from Saxon Six Dials, Southampton, UK. External view, above. Internal view, below.

Figure 21 Elongate and round shell shapes in archaeological oyster specimens (*Ostrea edulis* Linnaeus) from excavations of Medieval Poole, Dorset, UK. Above, external view. Below, internal views.

Figure 22 Irregular shapes on oyster shells (*Ostrea edulis* Linnaeus) from archaeological excavations. Above - irregular heel exterior view. Below - irregular ligament area internal view.

Figure 23 Cut marks on internal surfaces of archaeological oyster shells (*Ostrea edulis* Linnaeus) from excavations at Saxon Six Dials, Southampton, UK.

Figure 24 W-shaped notches on the edges of archaeological oyster shells (*Ostrea edulis* Linnaeus) from excavations of Medieval Poole, Dorset, UK.

Figure 25 Above: man-made perforation on right valve shell of British Native Oyster (*Ostrea edulis* Linnaeus). Below: V-shaped notch on the edges of paired oyster shells. Specimens from archaeological excavations of UK Medieval sites.

Figure 26 Above: unusual remains of the ligament on right archaeological oyster shell (*Ostrea edulis* Linnaeus). Below: rare survival of the horny scales on the exterior of an archaeological right oyster valve.

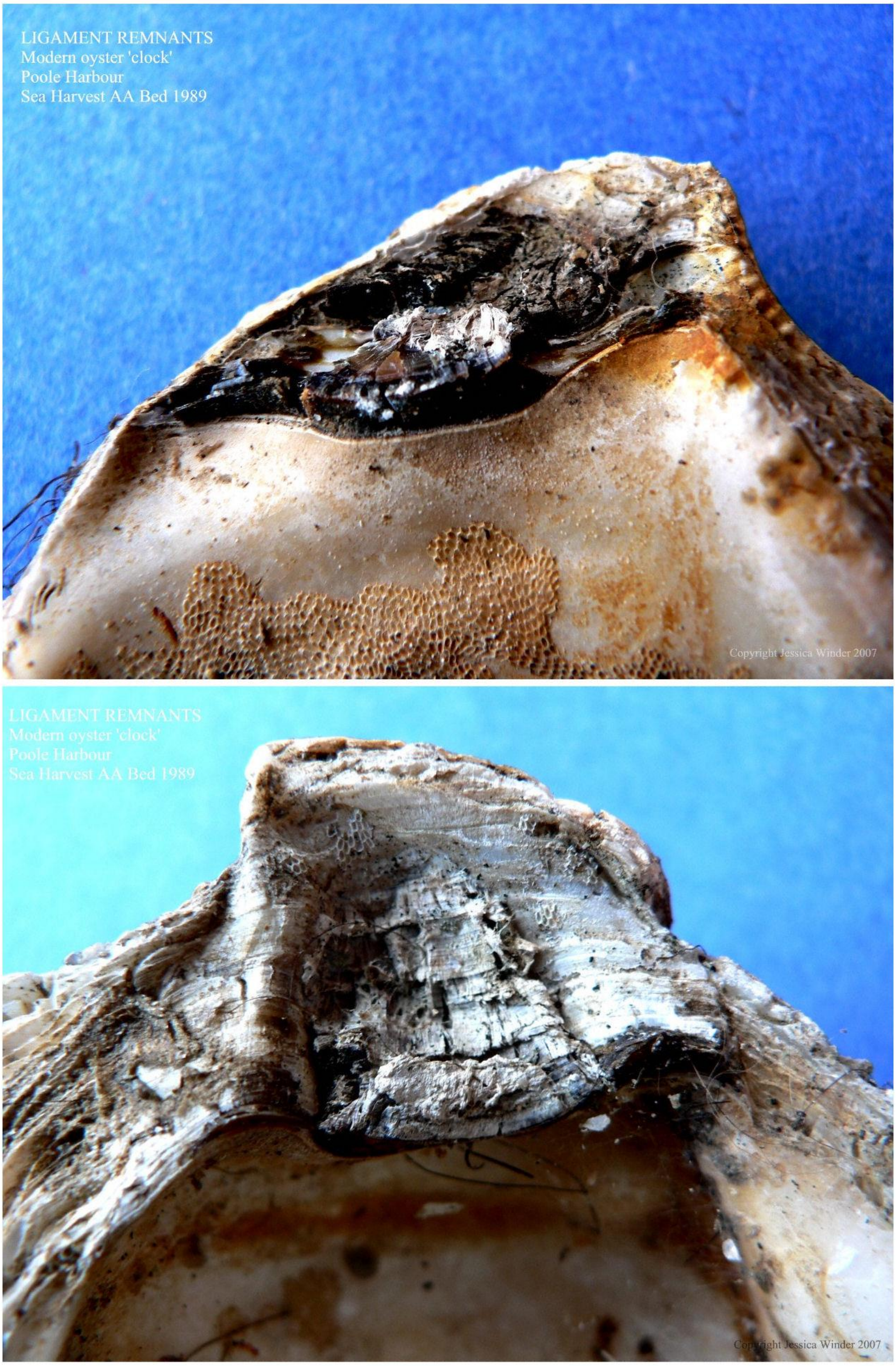

Figure 27 Ligament remnants on modern oyster shell (*Ostrea edulis* Linnaeus) "clocks" from Poole Harbour, Dorset, UK.

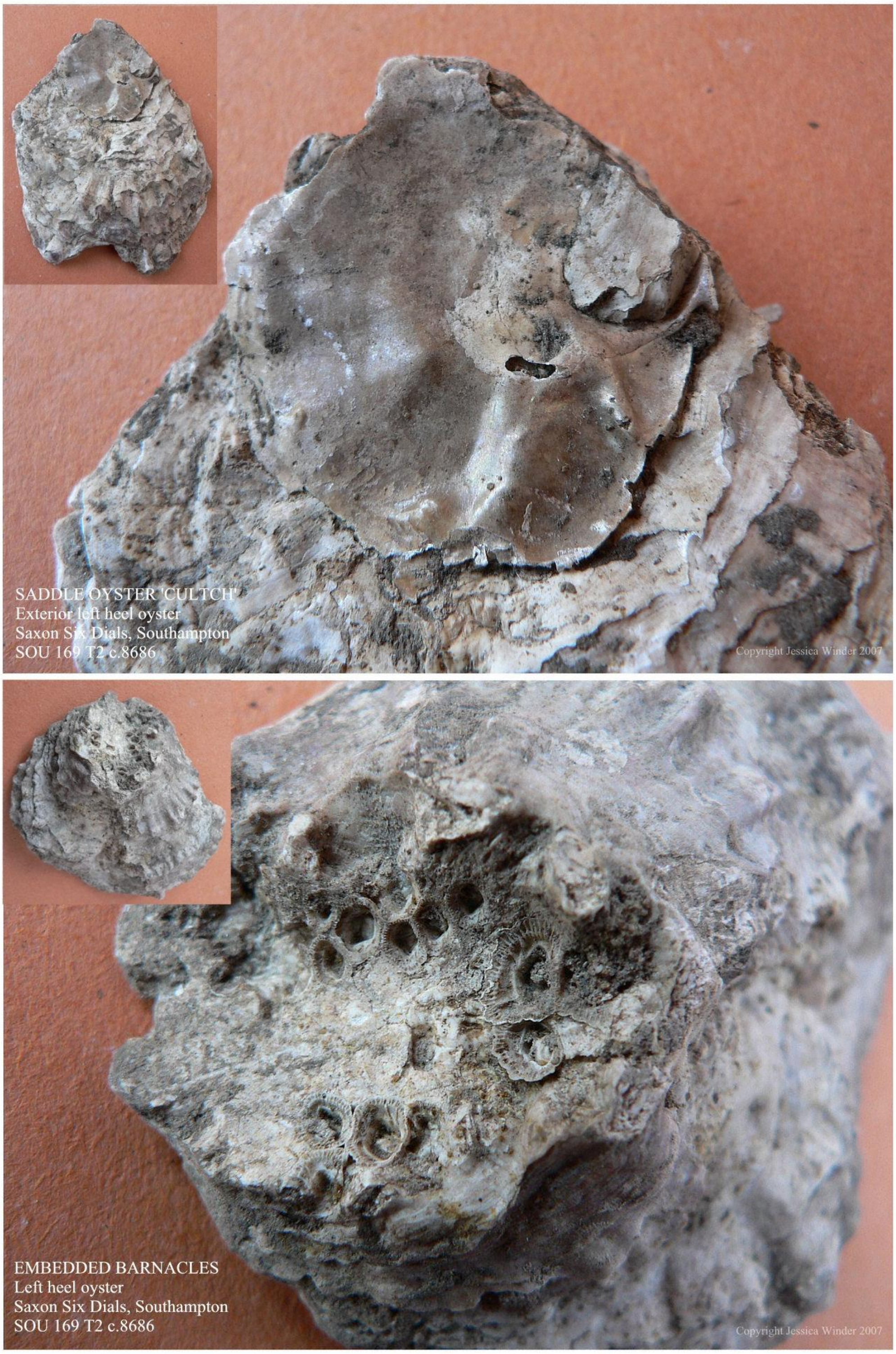

Figure 28 Attachment materials or "cultch" in archaeological specimens of oyster shell (*Ostrea edulis* Linnaeus). Above: Saddle Oyster (*Anomia ephippium* L.) on the heel of an exterior left valve shell from archaeological excavations at Saxon Six Dials, Southampton, UK. Below: embedded acorn barnacles in the outer heel of a left valve oyster shell from the same site.

Figure 29 Attachment materials or "cultch" in archaeological specimens of oyster shell (*Ostrea edulis* Linnaeus). Above: Common Cockle shell (*Cerastoderma edule L.)* on heel of exterior left oyster shell. Below: Common Mussel shell (*Mytilus edulis* L.) on heel of exterior left valve. Both specimens from archaeological excavations of Saxon Six Dials in Southampton, UK.

Figure 30 Attachment materials or "cultch" on archaeological specimens of oyster shell (*Ostrea edulis* Linnaeus). Above, Sting Winkle shell (*Ocenebra erinacea* (L.) and below, a flint pebble on the outer heels of left valve shells excavated from Saxon Six Dials, Southampton, UK.