

THE GROWTH RINGS OF CLAM SHELLS FROM TWO PENTLATCH MIDDENS
AS INDICATORS OF SEASONAL GATHERING

by

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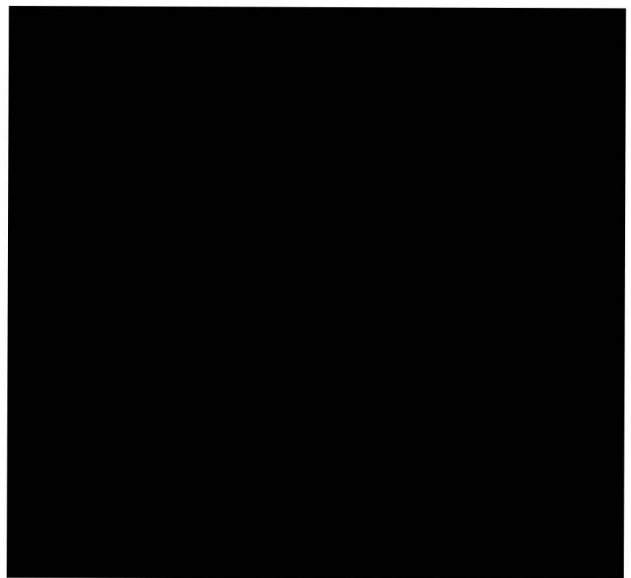
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ABSTRACT

Until recently, there have not been effective or reliable techniques that enabled archaeologists to infer site seasonality or seasonal resource usage from their data. This has been a major problem in the reconstruction of Gulf of Georgia prehistoric ways of life for although the ethnographic record at the time of contact is reasonably clear on the seasonal nature of subsistence activities it has been very difficult to ascertain how far into the past these economic patterns existed. As many shellfish fauna now have been found to exhibit different anatomical characteristics in their growth rings at specific times of the year, and as shellfish, such as clams, are frequently more common and more easily sampled in archaeological strata than are other vertebrate seasonal markers, this study attempted to use clam remains from two Pentlatch middens to help reconstruct patterns of seasonal clam resource usage for the northern Gulf of Georgia area. Northwest Coast ethnographic shellfish gathering data were reviewed and, from this information a hypothesis was constructed regarding the likely seasons of clam exploitation at the Tsable River Bridge and Buckley Bay sites. In order to test the hypothesis, growth increments beyond the last winter ring before death were measured on midden bivalves and then compared to the average annual growth increases of recent clams that were the same species and age at death. Gathering seasons were then inferred for the midden clams as the annual growth increases for the various beach clam species had been divided into four quarters that corresponded to certain seasons. In many of the natural strata the seasonal clamming pattern that prevailed was Salishan in nature: some gathering was done year-round, but most

gathering was done in the summer months with a lesser amount in the spring period. Chi-square figures calculated for the larger of these distributions from the various strata indicated that they were significant (.05-.001). This seasonal patterning of clam gathering also seemed to remain virtually unchanged through time in the excavation units of both sites. In terms of the species being exploited, both butter clam and littleneck were present in virtually every season. Rock cockle was present in most matrices as well but sampling difficulties due to breakage made it difficult to determine in which seasons it had been taken.



ERRATA IN THE GROWTH RINGS OF CLAM SHELLS FROM TWO PENTLATCH
MIDDENS AS INDICATORS OF SEASONAL GATHERING BY SHARON KEEN.

- ** In the Abstract, Table Titles, and text, wherever ROCK COCKLE appears read COCKLE CLAM instead.
- page 5, on the map, change the "6" beside the current arrow to "4"
- page 20, 6th line down, change "six knots" to "four knots."
- page 67, put square brackets around "butterf clam" on the 10th line from the page bottom, and square brackets around "littleneck clam" on the 3rd line from the bottom of the page.
- page 72, line 15, change "Wilburn and Owen" to "Wilbur and Owen."
- References that were referred to in Appendix II were omitted from the "References Cited" on pages 60-63. Please add the following:

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1964 "Microtextural Variation in Pelecypod Shells."
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New York.
- Errata page 72, line 15, change "Wilburn and Owen"
to "Wilbur and Owen"

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INTRODUCTION

A major problem in the reconstruction of Gulf of Georgia prehistoric ways of life centres on the question of site seasonality or seasonal resource useage. Ethnographic sources, such as Barnett (1955: 19-34), suggest that a patterned, annual round of moves and differentiated subsistence activities were major characteristics of the economy of Coast Salish groups and were the means by which full advantage could be taken of greatly diversified, yet spatially and temporally varied food resources (after Suttles 1962: 102).

Suttles (1960: 302) has also stated for the Southern Gulf of Georgia Salish that

In the spring the different families occupying the sections of a big house left the community, perhaps separately, to spend a good part of the year moving from place to place accumulating stores of food. But this food quest was not at all a random movement. People knew quite well where and when they were likely to find what food and so they generally exploited a certain place at a certain time for a certain thing.

Although the ethnographic record at the time of contact is reasonably clear on the seasonal nature of subsistence pursuits, reading seasonality into the archaeological record has proven to be unusually difficult. Northwest coast archaeologists suggest that such ethnographic economic patterns hold for some distance into the past, but effective and reliable techniques have been lacking for confirmation of this from archaeological data.

The problem has concerned archaeologists working in other parts of the world as well, and so far, the principal archaeological indicators of seasonal site usage that have been found are particular faunal remains. If the species of birds, mammals, and fish that are present in a prehistoric

site are only available locally during a certain season or seasons they indicate food collecting, and possibly site occupation, during those periods (for example, Boehm 1973; Howard 1929; Neil, Gut and Brodkorb 1956; Shawcross 1967). To date, this is the most common method by which site fauna have been used as evidence for seasonal gathering, but two additional methods are also used. If certain biological characteristics of a species make it edible or desirable as a resource only during certain parts of the year, then its presence in a site may be used as an indication of gathering during these more favourable periods. And secondly, some fauna exhibit different anatomical characteristics at specific times of the year and these respective traits may therefore be interpreted as evidence of seasonal collecting. All of these techniques have been applied primarily to vertebrate fauna and invertebrate remains have not been used to any advantage as seasonal indicators in sites. Ambrose (1967: 180-1) noted, for instance, in conjunction with using growth zones on fish bones and scales to indicate seasonality that:

Similarly, for some species of shellfish annual growth rings are fairly pronounced and could also provide information on seasonal gathering. However, the presence of marked annual rings on some species may only occur in colder latitudes where a definite cessation of growth occurs, such as for example with Mytilus.

Mollusk midden material has been analyzed by several people, but mainly in order to gain information about problems other than seasonal gathering (Ambrose 1967; Matteson 1960; Meighan 1959; Terrell 1967). On the coast of British Columbia many of the prehistoric sites contain large quantities of shell, but analysis of these remains in archaeological reports written to date has been restricted to providing species lists for particular cultural strata (for example, King 1950; Mitchell 1971).

As the clam species found in the Gulf of Georgia area do possess the marked annual growth rings that Ambrose referred to, and as clams are frequently more common and more easily sampled in archaeological strata than are vertebrate seasonal markers, it seems worthwhile to attempt to use clam remains to help reconstruct patterns of seasonal site useage in this area. The primary objective of this study therefore will be to examine the growth rings of clam specimens recovered from two northern Gulf of Georgia middens as a means of determining patterns of seasonal gathering.¹

II. SHELLFISH GATHERING

Ethnographic Data

Shellfish formed one of the regular components of the Coast Salish diet (Barnett 1955: 60), but the part that clam-gathering played in this yearly cycle of subsistence activities is not particularly clear-cut, especially for the Pentlatch who lived in the area with which this study is concerned.

Summer movements are indicated by Barnett (1955: 24) for the Pentlatch outward from the mouth of the Puntledge River at Courtenay to Kye Bay and Union Bay, but he does not say for what resources or in what months. Also, the group we specifically want were located further south at Buckley Bay and Fanny Bay (see Fig. 1), and the only reference made to them was that "southward from Union Bay to Deep Bay, lived their [the Pentlatch proper] linguistic relatives, the s:uckan" (1955: 24). However, for reasons to be outlined below, we can assume that the s:uckan also made seasonal use of particular locales and resources.

Generally, references to the seasons of clam-gathering are rare in the literature on Northwest Coast ethnology. The specific though meagre clamming data we have, for example, on other Coast Salish groups is as follows:

(a) Puget Sound Salish:

In May, the people left their winter houses to get clams and other kinds of shellfish. When a large supply was obtained and dried they took them back to their winter house (Haeberlin and Gunther 1930: 20).

(b) Puyallup-Nisqually:

Roots were dug in the spring when they first sprouted. When the dogwood bloomed², it was a sign that clams were good. Butter clams were dug early in the season, horse clams³ as late as September. All clams and shellfish were dug at night at low tide preferably when the moon was full (Smith 1940: 271).

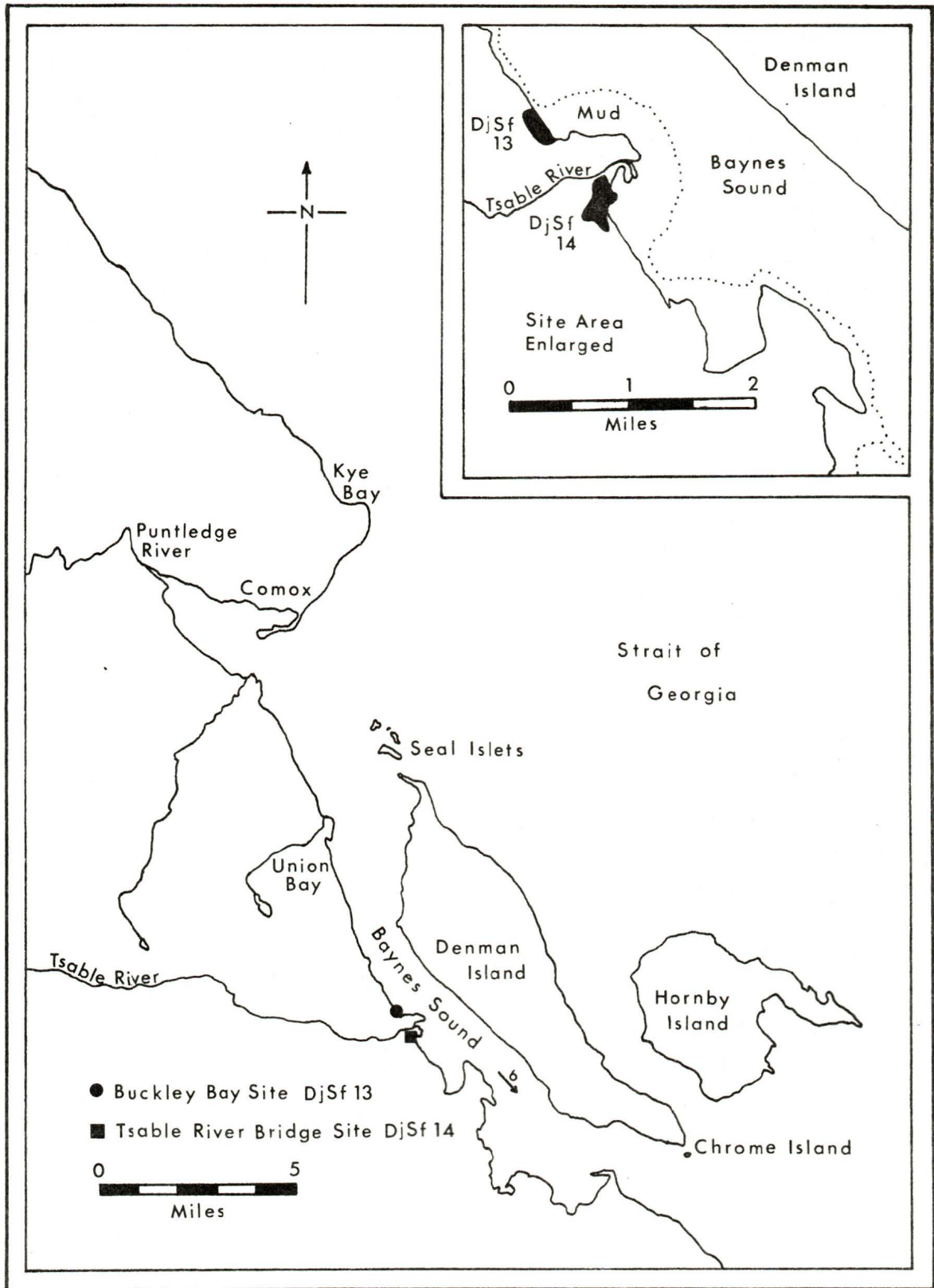


Figure 1. Map locations of the Buckley Bay and Tsable River Bridge sites.

(c) Twana:

Women gathered molluscs during the warmer months of the year Some species, particularly clams, were obtained in large quantities and furnished an important part of the Twana diet.

Clam digging started in May in the region at the head of Hood Canal (dux^wle'lap) and continued through the summer. As the season grew later the best [emphasis mine] were found farther down the canal; the latest intensive clam digging was in August on beaches in the area termed słca'wks, on the east shore of the lower (northern) canal. Here work parties from various Twana communities foregathered in the late summer (Elmendorf 1960: 123).

(d) Upper Skagit:

Although none of the villages of the Upper Skagit were located on salt water, in the seasonal round of activity, they visited relatives on the nearby beaches during the summer (Collins 1974: 45).

While the Upper Skagit did not have shellfish in their own territory, they had access to shellfish beds on the shores where many of their relatives lived Clams were strung on a stick and smoked for winter use (Collins 1974: 51).

(e) Samish:

They caught halibut off Lopez, Blakely and Cypress Islands, and dug clams on the east shore of Lopez in the early summer, and in the mid-summer engaged in reef-netting for sockeye off the south shore of Lopez (Suttles 1951: 41).

(f) Semiahmoo:

In the summer, they moved across to the Cannery Point on Point Roberts where they shared the extensive reef-netting grounds with Saanich, Lummi, and members of other groups. During the summer they also went to Boundary Bay to dig clams and harpoon sturgeon (Suttles 1951: 27).

(g) Saanich:

[In September] Other men fished near the village, or hunted deer, while the women gathered clams, made blankets and rush mats, and attended to other duties around the homes.

In that month [November] the villagers settled down for the winter, and the women left their homes only to gather clams and fern-roots while the men made canoes, and hunted and fished in the immediate neighbourhood.

[December-February] On fine days the men fished off shore for cod and gathered clams and a variety of seaweed, green with brown edges; but for the most part the people subsisted on the dried fish and berries they had gathered during the summer (Jenness 1940: 7-9).

(h) Nanaimo:

Their salmon fishing was done here [mouth of the Nanaimo River] from August until December. For clamming, egging and other gathering activities all of them moved to the temporary sites on False Narrows and Gabriola Island (Barnett 1955: 22).

These river villages [on the Nanaimo River] were occupied only from about September till Christmas, when their inhabitants moved to Departure Bay to celebrate their winter dances The Solachwan natives, however, occupied their village until about April, when they joined the others in moving out to False Narrows and Gabriola Island to fish for cod, grilse and other species, to hunt seals and sea-lions, and to gather clams and camass; In August all the Indians moved again to the mouth of the Fraser River (Jenness 1940: 10).

Mr. Kinkade has a vivid recollection of the hordes of Indians arriving in canoes every July and August to gather clams and cockles at Mosquito and Grandon Creeks

In September the Indians and their families would return to the Little Qualicum to catch and smoke tons of salmon for the Winter. Many of them visited Hamilton Swamp to pick cranberries (Kinkade 1946: 22).

(i) Sliammon:

Then, during May and June, clams were dug on the coast wherever they were to be found (Barnett 1955: 29).

This pattern of late spring/summer clam-gathering by all of these Coast Salish groups, except the Saanich, seems to differ from the seasonal mollusk gathering pattern of the Kwakiutl, Nootka, and Tlingit.

Rohner notes for the Kwiksootainuk Kwakiutl, for example:

Throughout most of the year, and especially during the period from fall through spring, a large amount of time is devoted to domestic subsistence activities

Food fishing and clam digging for family use are two major subsistence activities (Rohner 1967: 59).

The clam season opens in November and closes at the end of May; the people of Gilford began digging for family use before November, and commercial operations cease before the end of May (Rohner 1967: 62).

A very interesting comment by Rohner, about the relative importance of shellfish in the annual cycle, was that an almost equal amount of time was devoted to both clam-digging and fishing although the latter was more important in the over-all process and self-definition of the Indians (1967: 49).

Clam-gathering is also mentioned in several Kwakiutl myths recorded by Boas (1902: 350, 353; 1910: 347), and although the months are not specified, collecting is associated with halibut, cod, and herring fishing which would seem to indicate the period of spring/early summer (Rohner 1967: 51, 61, 62).

Of the Northern and Central Nootka, Drucker has written:

For this month and the following two [late October to late January], men went cod fishing when the weather was not too bad, and set traps for kelpfish and perch. Women took advantage of low ebb tides to gather clams, and could fill baskets with winter huckleberries (1951: 37).

The winter season was not, of course, the only time for gathering these products [marine invertebrates]. Some varieties were to be found near the outer beaches, in fact, and were collected in spring and summer rather than in the winter months (1951: 39).

Among the Tlingit, shellfish were primarily gathered in March with minor gathering being done in various other months:

Shellfish are their best in March. On the islands great quantities of clams and mussels are taken and

dried, smoked, and packed in airtight boxes or hung in the roof where they keep dry (Oberg 1973: 67).

From March until July, deep sea fishing and trout fishing form the major portion of the food collecting activities followed by the collection of such shore foods as shellfish and seaweeds (Oberg 1973: 73).

The over-all pattern for these groups thus seems to be one of heavy gathering of various clam species at specific locales for two to four months in the winter/early spring or late spring/summer, with lighter, more sporadic gathering often taking place in several other months. In Oberg's Figure 2, for example, which shows the relative amounts of time spent each month gathering individual resources, only the months of July, August, and September show no shellfish gathering as salmon fishing becomes the major food collecting activity (1973: 74, 75).

Variables Affecting Clam Gathering Seasons

Most of the other ethnographic sources referred to above also imply that clamming and salmon fishing were mutually exclusive activities done at different times of the year with other economic pursuits such as eulachon, cod, and halibut fishing, hunting, seaweed and camas gathering, and bird hunting being done during the clamming periods (Barnett 1955: 22; Drucker 1951: 58; Elmendorf 1960: 60; Haeberlin and Gunther 1930: 20; Jenness 1940: 10; Rohner 1967: 62).

Generally, the pacific salmon species spawn from late summer to late autumn (Clemens and Wilby 1961: 106), so that if the spawning months have not changed and if the above pattern was holding, one would expect few clams to be gathered in these months. This would leave the period of mid-winter to late summer available for shellfish gathering. Recent salmon escapement statistics for the Tsable River (adjacent to one of the sites used in this study) show minor runs of pinks, chums,

and coho occurring from August through December (see Table I), (Aro and Shephard 1967: 246, 260, 307).

Two more variables, though, that may have influenced the times of such gathering were spawning cycles and shellfish poisoning -- the former causing deterioration in clam quality and the latter occasionally causing death in the consumer. Oberg (1973: 73), for instance, stressed that although shellfish gathering could be carried on during most of the year, it was the quality of the resource in the spring that helped account for their storage at that period. Both Suttles (1962: 527) and Elmendorf (1960: 123, 124), in reference to the Coast Salish, also bring up this point of seasonal differences in desirability or quality:

Clams, it is said, could be dug most easily and were best at the time of the lowest tides in summer; at any rate this is the time of year when butter-clams and horse-clams were dug for preserving for winter.

Two kinds of horse clams were eaten. One, termed st'æ'bdza, had a more elongated and curved siphon end of the shell, especially when mature;.... The meat of this type was good at any time of the year, although old specimens were apt to have poor and little meat and were preferable in winter. The other horse clam, a'a'qid, had a cleaner shell. Its meat was best in summer, poor in winter The above apparently represent varieties of Schizothaerus nuttalli, perhaps the varieties nuttalli and capax.

Quayle (1970: 51-52) notes with regard to these species of horse clam that Swan "has demonstrated a variability in edibility that may be due to the fact that the two types spawn at different times of the year, with Schizothaerus nuttalli a summer spawner and the form Schizothaerus capax a winter spawner." His more recent report notes:

Tresus nuttalli [formerly genus Schizothaerus] is considered to be a summer spawner. Observations at Seal Island and plankton tows taken in the Strait of Georgia show that T. capax spawns in late February or early March (1972: 58-59).

TABLE I

Months of Clam Gathering and Salmon Fishing for Various Northwest
Coast Indian Groups

Group	Winter			Spring			Summer			Fall		
	Dec	Jan	Feb	Mar	Apr	May	J	Jy	Aug	S	Oct	Nov
Puget Sound						**		--	--	--	--	
Puyallup					**	**	**	*	*	--	--	--
Twana						**	**	**	*	--	--	-
Upper Skagit						-	**	**	**	-	--	--
Samish					-	-	**	--	--	-	-	-
Semiahmoo							--	**	--	-	-	-
Saanich	*	*	*				-	--	--	**		*
Nanaimo					**	**	*	**	*	--	--	-
Sliammon						**	**		--	--	--	
Kwiksootainuk	**	**	**	*	*	*		--	--	--	--	**
Nootka	**	**		*	*	*	*	*	*	--	-	**
Tlingit	*	*	*	**	**	*	*	--	--	--		**

** Major clam gathering month

* Minor clam gathering month

-- Major salmon fishing month

- Minor salmon fishing month

For clams generally, several biologists have stated that a clam in spawning condition is white and plump and in prime condition for use, but after spawning is thin and watery for several months, usually until mid-summer when sexual development begins again and proceeds throughout the fall and winter (Fraser and Smith 1928: 267; Quayle and Bourne 1972: 3).

Although such variation in meat quality was recognized by these Salish groups, the major period of gathering appears to have occurred when the shellfish would not be of what is now considered to be top quality due to spawning. All of the species under consideration (butter and littleneck clam, and rock cockle) spawn primarily in the spring months of April and May, but sporadic spawning may take place throughout the summer, especially with the rock cockle (Quayle and Bourne 1972: 27-28, 43, 57).

When it happens, paralytic shellfish poisoning usually takes place between May and October as summer conditions of light, temperature, salinity, nutrients, minerals, and vitamins are present in the right combination to cause rapid multiplication of the uni-cellular organisms that contain poison and are ingested by the mollusks. The actual period of lethal toxicity may only last a week or two with the amount of toxin in all but the butter clam declining and becoming non-lethal in four to six weeks once the organism disappears. Concentrations of the toxin may be stored in the neck and gills of the butter clam and only be lost slowly over several years, although that in the body is lost relatively rapidly (Quayle 1966: 2-3, 5).

Several of the ethnographic sources referred to mention poisonous clams and mussels:

Informants say that the toxic content of clams in certain areas during the summer is too high for

safe commercial use, although some Indians continue to eat them throughout the year (Rohner 1967: 49).

Immediately they replied to him, and said they had four boys and four girls who had died. They had eaten clams at the place Çē'g·äqe. Now no clams from that place are eaten. The clams of Çē'g·äqe are poisonous. That is the reason why the clams are not eaten (Boas 1910: 375, 377).

Some informants said mussels were poisonous in summer. The appearance of some large migratory bird in late spring indicated that it was time to stop eating them [late April-May] (Drucker 1951: 39).

The eating of the mussel is not without danger, for at certain times they are regarded as poisonous by the natives. Vancouver lost one of his men who ate some of these mussels, while another became ill, and in 1789 a group of more than one hundred Aleut (Konjagen) who, during a rest period in Peril Straits, ate some of these mussels died within two hours in terrible agony (Krause 1956: 61).

Thus, between spawning and possible bivalve poisoning the months of April to October would not seem to be the most auspicious ones for gathering shellfish. Part of this period, as mentioned earlier, would also overlap with the salmon fishing months.

On this point, however, there is a conflict in the ethnographic data regarding the degree of influence that meat quality had in determining the periods of clamming activity: April, May, and June are specified, plus the summer, for several Coast Salish groups when the clams would have been spawning or recovering from spawning. Oberg and Rohner, in reference to non-Salish peoples, mentioned two or three of these months in the mid-late spring/early summer also, but pointed out that the major shellfish gathering took place in the winter/early spring, a time during which the clams would have been in top quality (see Table I). Drucker emphasizes the late fall/winter months for clam-gathering, but also mentions the spring and summer. A better climate plus somewhat lower

tides would seem to be the main advantage of clamming in the late spring/summer period. As Barnett noted that culturally, the Comox together with the Pentlatch formed a Salish subgroup with a decided Kwakiutl aspect (1955: 26), perhaps their clamming activities followed the patterns of these more northern, non-Salish groups. Farden, however, has found that Pentlatch subsistence pursuits and overall technology were more similar to other Salishan groups than to any neighbouring Kwakiutl ones (1972: 21-22).

Assumptions and Hypothesis

Certain assumptions may be derived from this information that will underlie the hypothesis stated below. The assumptions are as follows:

- 1) The people who occupied the prehistoric sites at Tsable River Bridge and Buckley Bay were Pentlatch, or were culturally very similar.
- 2) Like other Coast Salish groups, the Pentlatch had a seasonal round of economic activity that involved movement to certain sites at certain times for certain resources.
- 3) Clam gathering overlapped very little in time with the major months of salmon fishing.
- 4) Salmon spawning months have changed little over time.
- 5) The quality of the clam meat influenced the periods during which they were gathered.

On the basis of the above assumptions, the hypothesis of this study is that clams were gathered in certain seasons at the Tsable River Bridge and Buckley Bay sites, and that the seasonal pattern was either Salishan or Kwakiutl in nature with primary collecting done either in the late spring to summer (the Salishan practice) or in the winter to early spring (the Kwakiutl pattern). By using the procedure outlined below, in which the amount of growth beyond the last winter growth marker is examined on

the clam shells from the natural midden strata, this hypothesis can be tested.

The winter to early spring is expected to be possibly the heaviest period of clam gathering as the mollusks would have been in prime condition and other major economic activities such as salmon fishing would not have been occurring during the same time span. Although the clams in the late summer would have pretty well recovered from spawning and the heavy salmon runs would not have begun yet, there is the possibility that shellfish poisoning could occur which would seem to make this period less desirable than the former one for shellfish gathering.

A secondary, but related, issue to the hypothesis that will be dealt with is whether or not any particular bivalve species was being selected over another in any season. The ethnographic records on bivalve collecting generally do not mention the species involved, but Ham (unpublished manuscript: 35-36) has suggested that different species were selected by season in the Gulf of Georgia: deep beach living horse and butter clams were procured when the lowest summer tides permitted long periods of beach exposure, and shallow living littleneck clams were obtained in the winter when the higher tides and shortened intertidal periods made it easier to collect them. Species distributions for each natural midden strata were calculated by using all the complete clam valves and umbo fragments from each faunal column sample. These species distributions were then compared to the seasons of gathering inferred from the growth rings.

If clams were gathered seasonally, no matter what the species or periods, one could infer that the sites were occupied at least during the months of gathering. Follow-up examinations of mollusk remains from nearby sites, such as those on Denman Island, plus more complete studies of

vertebrate fauna and floral remains from all of the sites would help to reconstruct more completely Pentlatch patterns of seasonal site usage and occupation.

III. SOURCE OF THE DATA

Site Descriptions

The Buckley Bay site and the Tsable River Bridge site in Fanny Bay are a quarter of a mile apart, and each lies respectively in slight bays at the north and the south parts of a large flat that has formed at the mouth of the Tsable River which enters Baynes Sound about midway along its western shore (see Fig. 1).

The Buckley Bay site originally extended along the entire beach frontage of the bay, but owing to the construction of a ferry dock and a log-sorting ground, only the southern approximately two-hundred metres are relatively intact at present. This site does not seem to extend west on the other side of the Island Highway even though the terrain is gently sloping upward for a short way. Site elevation is the highest in the northwest portion, about nine metres above the hightide vegetation line, and slopes downward both to the beach and to the southern half of the site. A small stream flows across the latter section and onto the beach (see Fig. 2).

The Tsable River Bridge site has been cut in two by the highway. It extends about four-hundred metres along both sides of the highway south of the Tsable River. Adjoining the western side of the midden is a small hill with scattered shell deposits on the top, but the major portion of the site begins lower down the hill and declines down to the beach, forming a site elevation of about nine metres in total. A grass flat lies at the base of this site, and it is virtually covered in water at higher high tides. A small slough adjacent to the midden provides water access to Fanny Bay during normal high tides (Fig. 3).

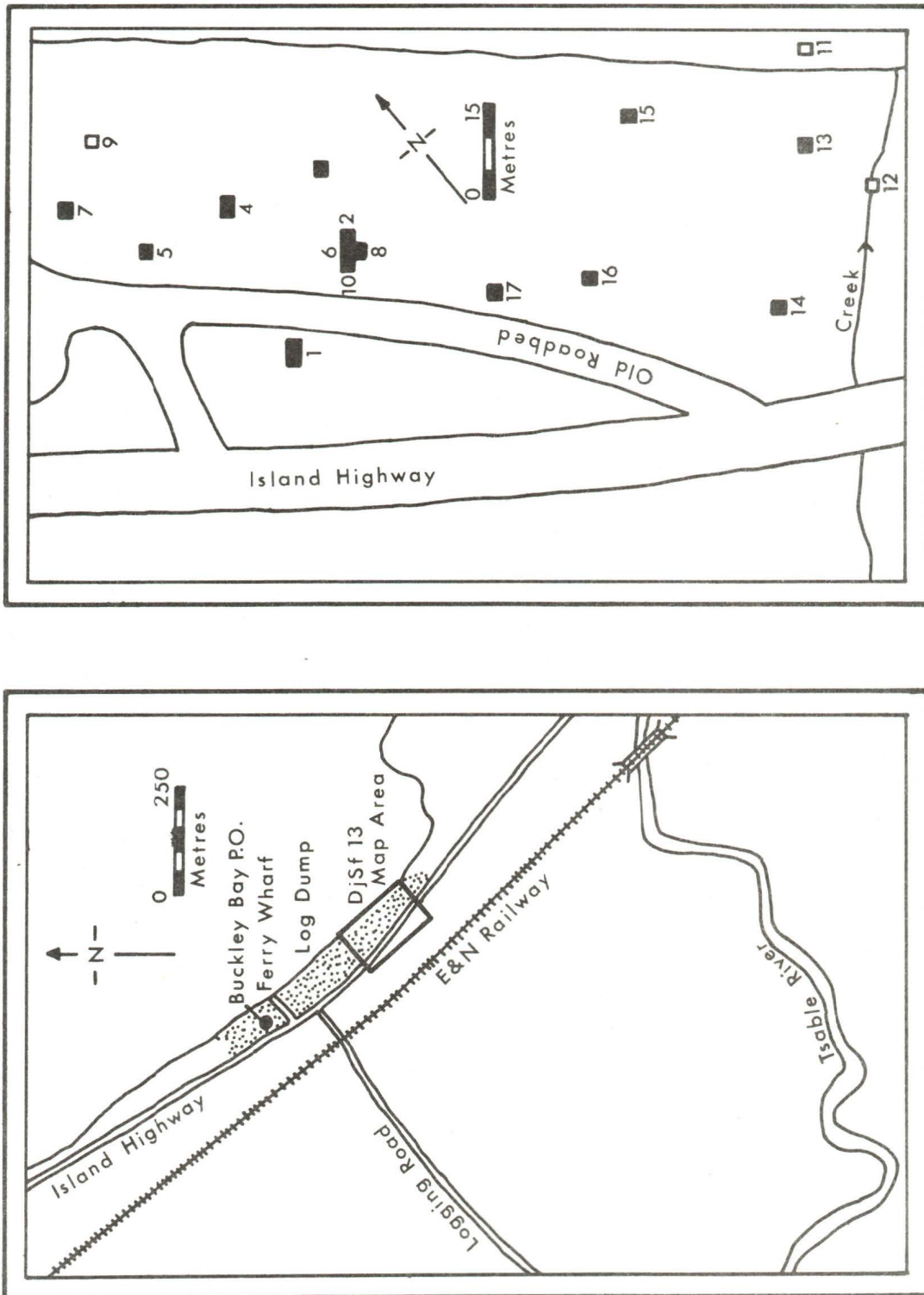


Figure 2. Detailed map of the Buckley Bay site (DjSf 13) and the test cut locations.

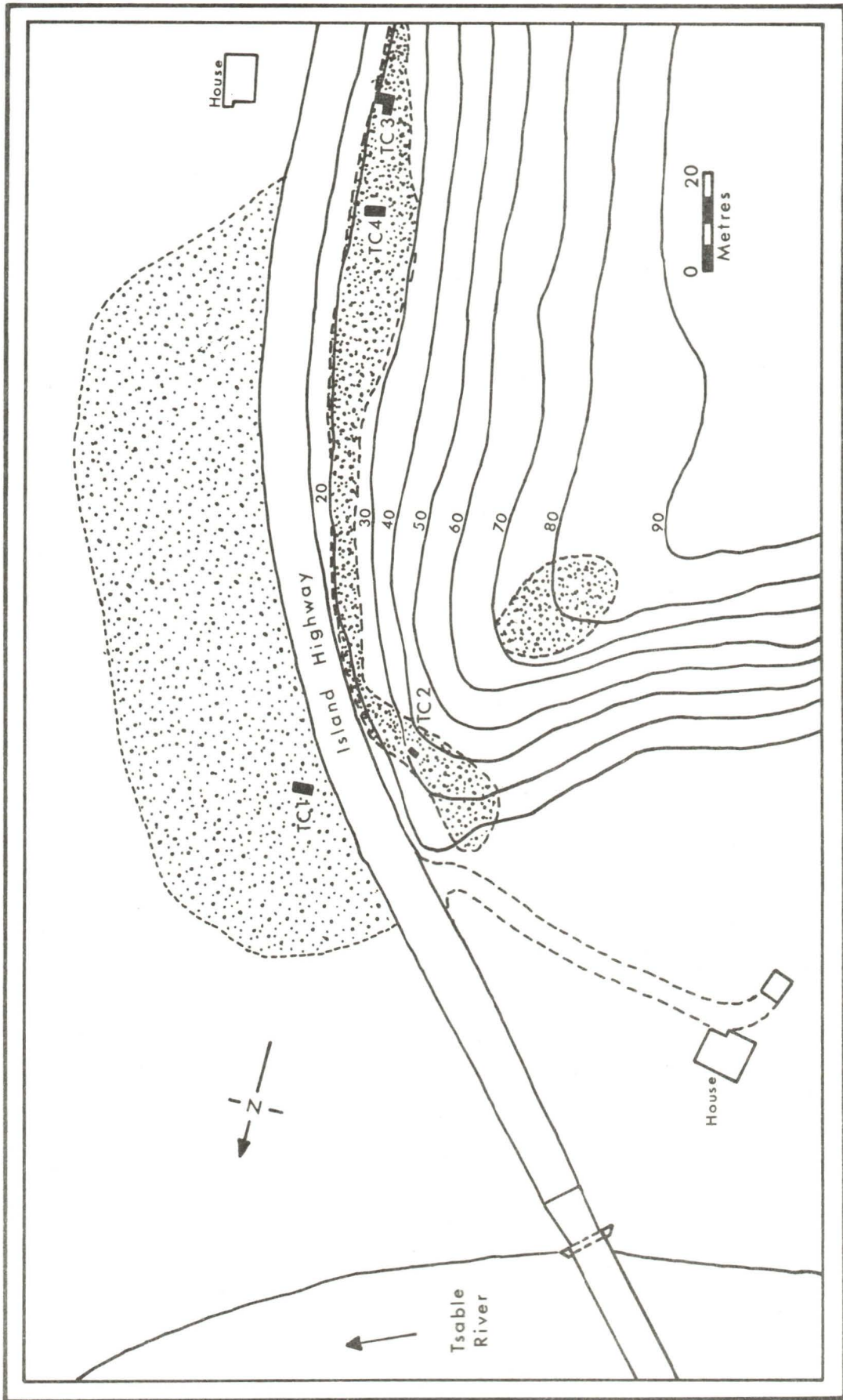


Figure 3. Detailed map of the Tsable River Bridge site (DjSf14) and the test cut locations.

Site Habitats

Mitchell's (1971: 2-18) detailed coverage of the Gulf of Georgia's natural environment includes information applicable to these sites on matters such as landforms, hydrography, climate, precipitation, winds, and biomes. In terms of marine environments, each of these sites lie on a protected waterway close to relatively strong food-supplying tidal currents of up to six knots, and both provide mud and sand flats in a bay-estuary setting for a variety of animals including the clam species that were recovered in the middens. The particular environmental requirements of each species of clam are as follows:

Butter clams (Saxidomus giganteus) live in a wide variety of soil types from pure sand to pure gravel, but the typical substrate is a porous mixture of sand, broken shell, and small gravel. They occur mainly in the lower third of the tidal zone, but are also found to a depth of thirty feet below the zero tide level. Pure sand may be a good substrate providing there is no significant wave action; when found on exposed beaches the clams tend to be stunted. They can withstand a fairly wide range of temperature and salinity (Quayle and Bourne 1972: 27).

Littleneck clams (Protothaca staminea) are usually found along with butter clams but they usually occur in a more gravelly, firmer type of beach, and at a slightly higher tide level (Quayle and Bourne 1972: 43).

Cockle clams (Clinocardium nuttalli) are widely distributed in British Columbia but nowhere are they abundant. They inhabit sand-mudsoil and often live in beds of eelgrass. Subtidal populations exist but are not extensive (Quayle and Bourne 1972: 57).

Fraser and Smith also comment that for all three varieties of clam, their position in relation to tidal currents (Fig. 1), and exposure to, or protection from storms seems to have much more to do with rate of growth than has the actual composition of the beach, as these factors very largely influence the extent and constancy of the food supply (Fraser and Smith 1928: 265-266, 268, 277; Fraser 1931: 64). The

locations of the two beaches under consideration would seem to provide these conditions for optimum clam growth. The habitats are suitable too for edible mussel and wrinkled purple snails (Mytilus edulis and Thais lamellosa), two other shellfish species that were relatively abundant in the midden deposits, although on the beaches, mussels now seem to have been replaced by Japanese oysters.

Faunal Columns

A randomly selected faunal column was taken from a wall in each test cut at both the Tstable River Bridge and the Buckley Bay sites, and the growth rings of all the relatively whole shells from the three clam species represented in each of these columns were examined. Samples were ten centimetres thick and, depending on the natural strata, usually ten to twenty centimetres deep. Soil samples from each of the involved strata were also checked for additional specimens both to increase sample sizes and to remove any ambiguities as to the season(s) represented by a natural stratum if an individual faunal column sample happened to have included shellfish from more than one "natural" layer (Figs. 15-19). Both the test cuts and faunal columns at Buckley Bay were randomly located, while only the faunal columns from within the excavation units at the Tstable River Bridge site were random. Columns from the four excavated test cuts at the Tstable River Bridge site ranged in depth from one to slightly over four metres, while the thirteen from Buckley Bay ranged from one-half to two metres. Each individual faunal column sample was weighed, dry-screened and sorted into components of stone, bone, shell, and soil before the shell specimens were analyzed so that data on possible changing faunal frequencies could be gathered concurrently.

It is my feeling that faunal column samples have been taken the last several years here by various coastal archaeologists primarily to try and ensure that more representative and more quantifiable samples of shellfish remains were kept, as compared to what was retained in level bag samples, rather than to test any particular hypothesis. An important aim of this thesis, therefore, in using such faunal column samples, is to help delineate some specific problems that may be examined by using such data.

IV. METHODS OF ANALYSIS

Annual Growth Rings of Clams

With regard to the annual growth rings of clams in British Columbia, Quayle and Bourne (1972: 8) have commented that:

The growth rate of most clams is relatively slow and decreases with age. Growth is rapid in spring and summer when abundant food is present and water temperatures are high, [emphasis mine] but decreases and virtually stops in winter, forming annual checks (Fig. 8). However, these winter growth checks must not be confused with other checks laid down during the summer. With practice it is possible to decide which rings are true winter checks, and by counting them the growth rate and age of a clam may be determined.

Fraser and Smith have also observed species differences in growth patterns that should be noted:

(a) Butter Clam:

Both the predominant ages and maximum ages were greater than in the littleneck clam and as with the possible exceptions in the earlier years the annual increment in length or breadth becomes less and less with advancing age, the 'winter checks' are closer together near the margin and hence harder to distinguish, making the measurements more difficult. Then too, the 'disturbance checks' seem to be more frequent and more pronounced in many cases and they are often difficult to distinguish from 'winter checks'. In consequence, a greater number of shells had to be discarded as unsuitable for recording (Fraser and Smith 1928: 272).

(b) Littleneck Clam:

The method [annual ring counts] proved satisfactory for Paphia in the great majority of specimens. Not uncommonly there were 'disturbance checks' present as well as the 'winter checks', but after some experience in noting the differences these extra checks were readily recognized (Fraser and Smith 1928: 255).

(c) Cockle Clam:

It is true that the shape and thickness of the shell makes the animal better able to withstand such adverse conditions and that may be the reason that while the

disturbance checks are numerous they are not so pronounced as they are in other species. The winter check, however, does stand out prominently, and in consequence, it is an easy matter to read the age from the shell (Fraser and Smith 1931: 61).

Seasonal Clam Growth Rates

Apart from the general statements on seasonal growth rates at the beginning of the previous subsection, there is very little information on specific monthly growth sequences for the various clam bivalves of this area:

In the shells of the clams [littleneck] collected in May, particularly the earlier ones, the check was almost at the margin, but at the end of July the growth represented the greater portion for the year [emphasis mine] (Fraser and Smith 1928: 255, and Plate II, Fig. 3).

Young-of-the-year [butter clam] may be found in the fall. If spawned early enough in the spring, they may be 1/4 inch or more in length when growth ceases at the end of October, [emphasis mine] but if spawned late in the summer they may be less than 1/8 inch in length (Quayle and Bourne 1972: 28).

The Pacific oyster is the only other bivalve from this area for which monthly growth increments are available (Quayle 1950), but it seems to have a very similar growth pattern to the clams in that May-July are the major months of size increase with growth virtually ceasing by the end of October (Table II). Coe's growth findings for the Pismo clam in California are somewhat similar (Table III), although differences in seawater temperatures and other environmental factors make it unreasonable to carry this comparison too far. Colder water temperatures here, for instance, seem to curtail or lessen bivalve growth especially in the winter-spring periods.

If the monthly grand mean seawater temperatures are examined for a ten year period from Chrome Island, the nearest shore station to the

TABLE II

Monthly Percentage Increases in Length and Width Dimensions of Six to Eight Year Old Pacific Oysters (*Ostrea gigas*) as Compared to Seawater Temperatures and Seasons, Ladysmith Harbour, 1950 *

Season	Month	Seawater Temp. F ^o	Length Growth %	Breadth Growth %	% Breadth Growth by Seasons
Winter	December	42.7 ^o	0.0	0.0	0.0
	January	38.2 ^o	0.0	0.0	
	February	42.5 ^o	0.0	0.0	
Spring	March	45.2 ^o	0.0	0.0	29.7
	April	47.9 ^o	9.0	7.9	
	May	55.3 ^o	13.2	21.9	
Summer	June	63.0 ^o	12.2	17.2	47.7
	July	67.5 ^o	21.2	22.7	
	August	65.3 ^o	14.8	7.8	
Fall	September	60.8 ^o	24.3	13.3	22.6
	October	50.8 ^o	5.3	9.3	
	November	47.0 ^o	0.0	0.0	
TOTAL			100%	100%	100%

* Based on Quayle (1950: 87, 89) with seasons and the percentage of breadth growth by seasons added. Seawater temperatures range almost thirty degrees from 38^o-67.5^oF.

TABLE III

Average Monthly Increase in Length, Eighteen Month Old Pismo
Clams, as Compared With Seawater Temperatures and Seasons*

Season	Month	Seawater Temp. F°	Length Growth mm.	Length Growth %	Percentage Length Growth by Seasons, Three Combinations		
Winter	December	58°	1.2	5.7	13.3	19.0	28.5
	January	56°	0.9	4.3			
	February	56°	0.7	3.3			
Spring	March	58°	1.2	5.7	26.1		
	April	61°	2.0	9.5			
	May	64°	2.3	10.9			
Summer	June	67°	2.4	11.4	31.8	52.2	42.9
	July	68°	2.3	10.9			
	August	69°	2.0	9.5			
Fall	September	67°	2.3	10.9	29.0	29.0	29.0
	October	65°	2.1	10.0			
	November	60°	1.7	8.1			
TOTAL			21.1 mm	100.2%	100.2	100.2	100.2

* After Coe (1948: 589) with seasons added. Seawater temperature ranges thirteen degrees from 56°-69°F.

TABLE IV

Chrome Island, Monthly Grand Mean Seawater
Temperature in Degrees Fahrenheit, Years 1961-1970 *

Season	Month	Grand Mean	SD
Winter	December	45.7	0.6
	January	44.0	1.1
	February	44.3	1.0
Spring	March	45.2	0.7
	April	47.5	0.7
	May	52.8	0.8
Summer	June	59.1	2.1
	July	62.2	1.6
	August	61.9	2.7
Fall	September	57.1	1.2
	October	51.5	0.6
	November	48.1	0.6

* Based on Hollister and Sandnes (1972: 76)
with the seasons added. Seawater temperature ranges eighteen degrees from 44°-62°F.

sites studied (Fig. 1), the months of May to October are also the warmest (Table IV). Quayle and Bourne state that temperature is not the only critical variable affecting clam growth (refer to the quotation in the previous subsection), but Coe also cites its importance to the monthly growth increments of the Pismo clam, and House and Farrow do the same for Cardium edule, or the common British cockle, in Wales:

As indicated in Table I and Fig. 1, both the bay-mussel and the clam showed a maximum rate of growth in June [the third warmest month after August and July] and a minimum in January and February, the months of average lowest temperatures (Coe 1948: 589).

For all the shells we studied growth was most rapid during the first two months after settlement (August and September 1963), when rates as high as 250 μ /day were attained. This represents the maximum rate of growth reached in the entire life span of the shells and is not exceeded even by the early summer peak of 1964 (Fig. 2). The rate of growth diminished sharply in October, November and December, the curves becoming asymptotic about February 1964, corresponding to the minimum sea temperatures of winter (House and Farrow 1968: 1384).

Both sources mention that growth rates did not correlate exactly with sea temperatures, especially during the warmer months, or in other words, the most growing was not always done in the warmest month due to other factors such as food supply, solar radiation, and spawning (Coe 1948: 590, 597; House and Farrow 1968: 1385) but, the critical point to note is that the periods of greatest growth took place in the warmer months, a span of usually three to six months. Food, one of the other critical growth variables for clams, also turns out to be closely dependent on seawater temperatures:

It may be noted that in the Strait of Georgia the greatest production of phytoplankton is during the months of July and August when the temperature is the highest and that temperature greatly exceeds anything obtained in the open sea (Hutchinson 1928: 306).

On this available information then, the following monthly growth pattern is suggested for clam bivalves in this area. The greater portion of growth would occur in the summer months of June, July, and August, with a gradual decreasing of growth happening through September, October, and November, the fall period. An almost complete cessation of growth would prevail through the winter and be followed in the spring months, especially April and May, by a gradual increase in growth that would lead up to the spawning period and the major growth time mentioned above.

Inferred Season of Gathering

In order to infer the season of clam death or gathering from the amount of breadth growth completed since the last winter ring, the following interpretations are proposed:

1) "Annual checks" will indicate winter and early spring when virtually no clam growth occurred. These individuals will be included in the first growth quarter: zero growth.

2) Growth slightly beyond the "annual check" will indicate mid to late spring: zero to one-quarter of the average annual breadth growth, or 25%.

3) Breadth growth between one-quarter and three-quarters of the average annual amount will indicate the summer period when the greatest growth happened: 50% of the average annual breadth increase, with approximately 25% occurring during June to mid-July, the early to mid-summer, and 25% happening approximately over mid-July to August, the mid to late summer.

4) Over three-quarters of a clam's yearly growth will be inferred as the fall period when a gradual lessening of growth transpired: 25% of the average annual growth (Table VI).

TABLE V

Proposed Season of Death or Gathering Inferred From the Percentage of Breadth Growth Past the Last Winter Ring, for Three Clam Species in the Gulf of Georgia

Season	Month	Growth Pattern	% Breadth Growth
Winter	December January February	<u>Almost</u> complete cessation of growth: formation of winter ring.	0%
Spring	March April May	Very gradual increase in breadth past the winter ring until <u>early</u> May.	25%
Summer	June July August	Major portion of breadth growth occurs between May and the end of July.	50%*
Fall	September October November	Gradual decrease in breadth growth especially by the end of October.	25%

* 25% during May-June, or late spring/early summer.
25% during July-August, or mid-late summer.

A similar study to this one by Ham and Irvine (1975: 364-5) noted that most clam growth occurred in the spring and summer (1975: 364-5), but they gave no further explanation as to their seasonal interpretations of clam death based on the various percentages of growth past the last winter check. A spring season was inferred when 10 and 11% of the previous year's growth had occurred after the most recent winter ring; early summer was indicated if growth of 28, 30 and 33% had happened; summer was assumed when increases of 62 and 65% were evident; and winter was indicated if growth amounts of 93 and 100% were present (1975: 367, Tables I-IV). As the maximum and minimum ranges of growth for each season are not specified, it is difficult to compare these seasonal percentages to the ones proposed for this study (Table V). Also, the fall season does not seem to be delineated at all in terms of a percentage of annual growth, and this has been attempted here.

Information on the average annual growth rates by age and species was available for clams taken from various types of beaches between Victoria and Nanaimo (Fraser 1931; Fraser and Smith 1928), and by using these data, tables of growth were constructed to which the archaeological specimens were then compared (Tables X-XII). Appendix I and II contain a detailed discussion of the techniques used. It was initially assumed that the growth patterns of the midden specimens had not changed from those growth patterns of more recent beach clams of the same species. This assumption was confirmed early in the study when size and age calculations had been compiled for some of the prehistoric bivalves, and then compared to similar calculations for recent bivalves of the same species. At present, this information on growth patterns is not included in the thesis.

TABLE VI

Proposed Season of Death Inferred From the Percentage of the Previous Year's Breadth Growth Past the Last Winter Ring, for Four Clam Species in the Gulf of Georgia *

Season	% Breadth Growth
Winter	93%, 100%
Spring	10%, 11%
Early Summer	28%, 30%, 33%
Summer	62%, 65%
Fall	(?)

* After Ham and Irvine (1975: Tables I-IV).

As the dominant clam gathering season was hypothesized to be either winter to early spring (Kwakiutl) or late spring to summer (Salishan), growth amounts were expected to be primarily either in the first quarter or in the third quarter with respective average annual growth amounts of $0-1/4$ or $1/2-3/4$ being evident. Few clams were expected to have been gathered in the second and fourth quarters because clam spawning would make them less desirable, and because this was the period during which the major subsistence effort was directed towards the salmon harvest.

V. DATA USED TO TEST THE HYPOTHESIS

Presented in this section are the results of the comparison between midden clam growth increments beyond their last winter marker before death and beach clam growth increments of individuals of the same species and age at death. The average annual growth increment for each species of beach clam was divided into four quarters that corresponded closely to the proposed seasonal growth patterns discussed earlier, and this enabled the formation of inferences about gathering seasons for the midden specimens, based on their growth gains before death. Species proportions are also presented, for each natural stratum in the various faunal columns in order to determine if particular clams were being gathered in certain seasons. Each site is summarized in turn by both excavation units and strata. The histograms within this section are based on the data presented in Appendix III, Tables XIII-XXXVI, which contain the raw information.

Units of Analysis

The units of analysis in the above procedures are the natural strata within the faunal column of a test cut: the midden bivalves within each natural stratum are compared to beach clams of the same species and age at death. These natural strata proved to be the most feasible units of analysis as the time depth reflected by the different cultural layers made it difficult to treat each test excavation as a unit, and the lack of similarity in strata between test excavations made it impossible to use site-wide strata as units.

Strata Seasonality: Tsable River Bridge

Some of the strata in Excavation Unit 1 contained shellfish remains so fragmented or deteriorated that identifiable samples available from the faunal columns were very small (see Tables XIII-XIV and Fig. 14). Soil

samples were, therefore, also checked for bivalves, but only Soil Sample 18 from a pocket of whole clam in the East 4.0 metre wall provided any additional specimens.

As the histogram in Fig. 4 shows, Faunal Samples 9-12 from a dark brown soil stratum had 82%, or nine out of eleven undisturbed bivalves in the second and third quarters of growth beyond the last winter check before death. The suggested seasonal interpretation for each of these amounts of growth is the summer: early to mid summer for the second quarter, and mid to late summer for the third quarter. Two specimens, or 18% were in the fourth quarter, or fall period.

A similar pattern with the summer season predominating also occurred in Soil Sample 18 where 77%, or ten out of thirteen specimens were in the second and third growth quarters. Three individuals, or 23%, were in the first quarter of growth, or spring season. Unfortunately the small sizes of these two strata samples made it impracticable to use the chi-squares test for the significance of these seasonal distribution.

Species occurrences by season are also uncertain for these strata due to the sample sizes, but histograms in Fig. 5 and Tables XV-XVIII show that butter clam were collected in all of the seasons and littleneck clam were gathered at least in the spring and early to mid summer. It is important to remember that relative species quantities represented in the seasonal histograms and tables may be greatly affected by the exclusion of disturbed and broken specimens. A more quantifiable species distribution by strata, although one that is not seasonal, is therefore based on umbo counts of all specimens whether disturbed or broken (Table XIX). For these reasons, the former types of data will be used to infer only the presence or absence of a species in any given season and not to infer the relative importance of a species in a particular season.

Figure 4. Histograms, Fraction of Annual Growth at Death by Undisturbed Clams in the Faunal Column and Soil Samples, Two Natural Strata*, Excavation Unit 1, Tstable River Bridge, 1973.

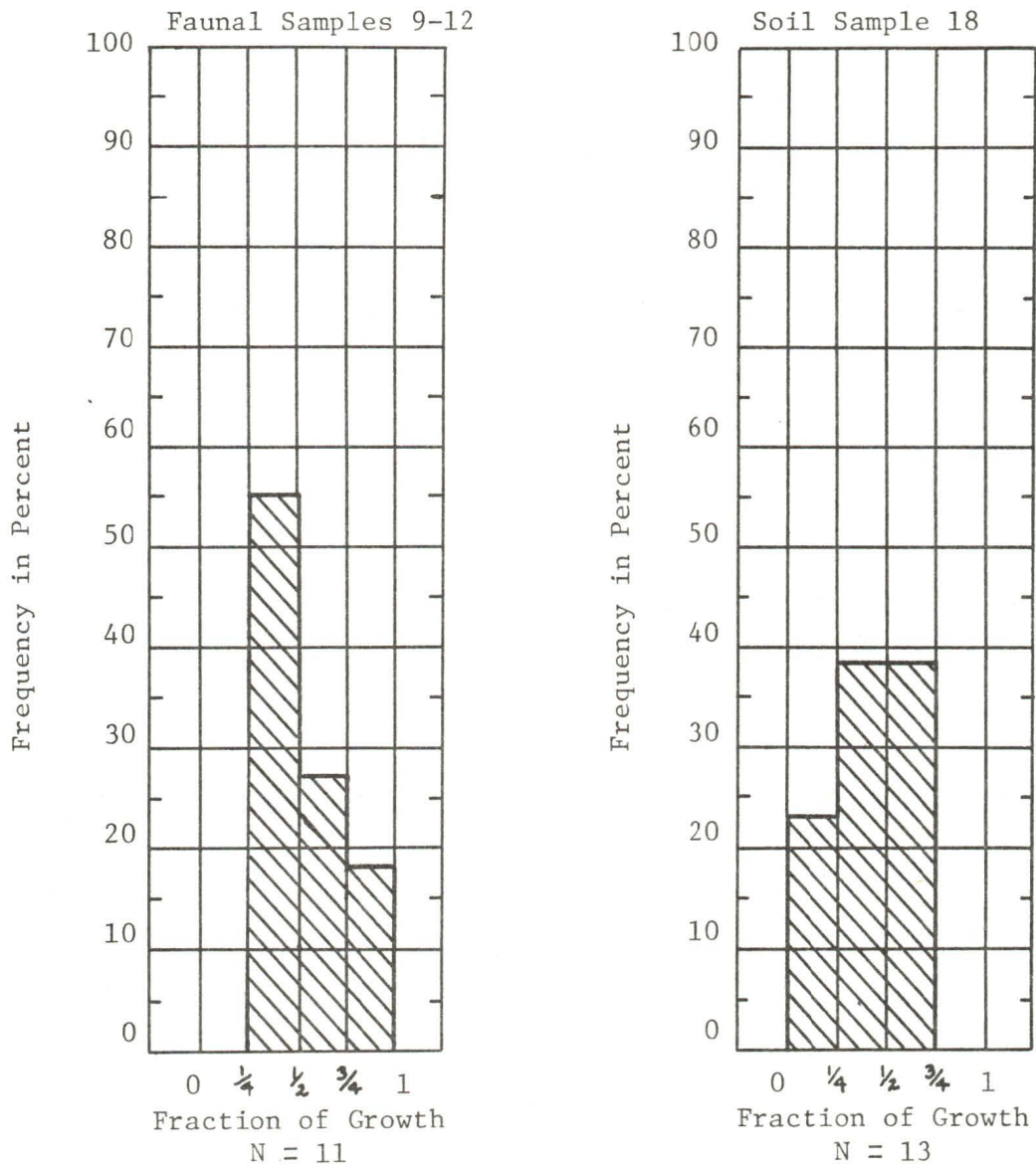
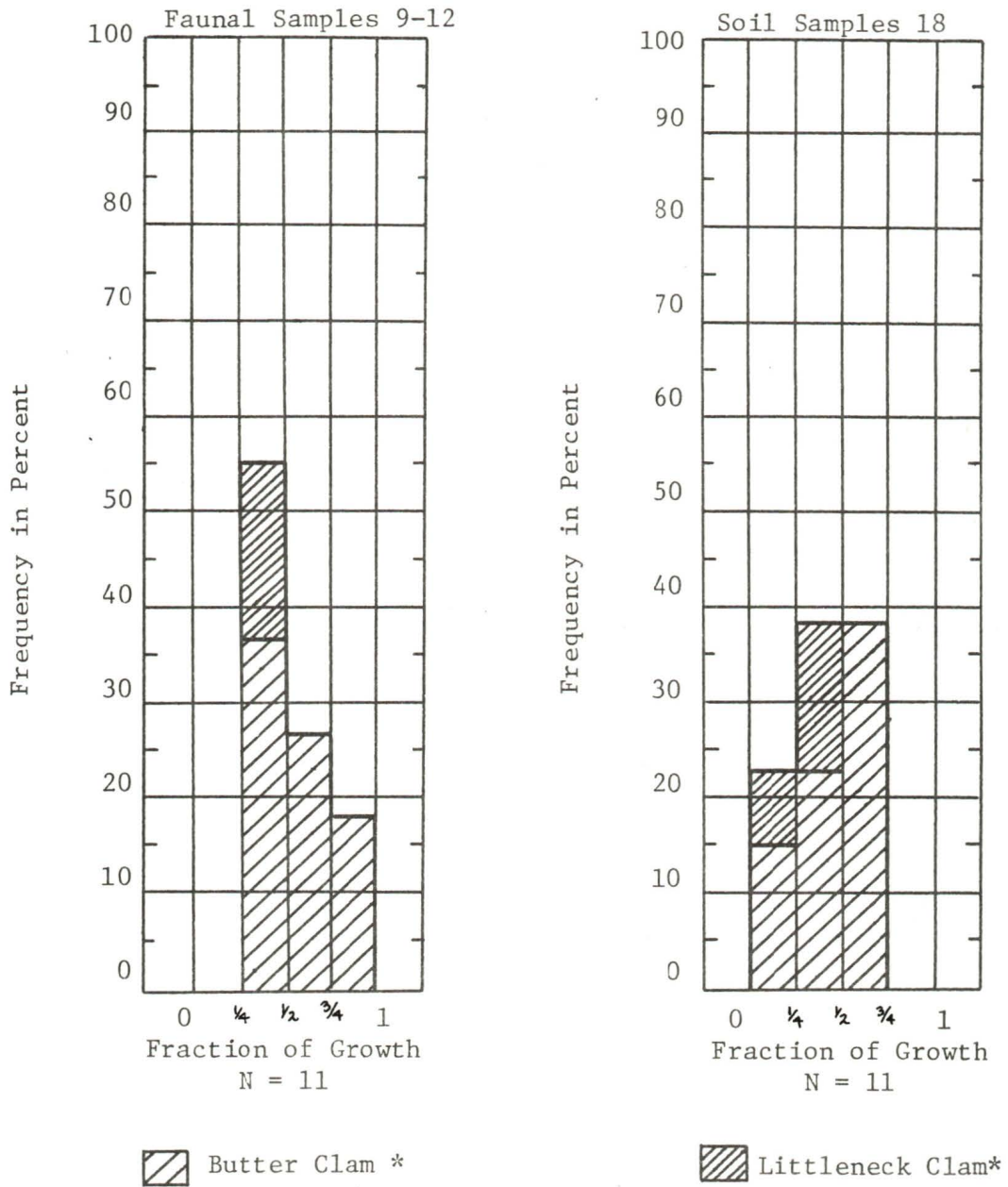


Figure 5. Histograms, Species Distribution and Fraction of Annual Growth at Death for Clams in the Faunal Column and Soil Samples, Two Natural Strata*, Excavation Unit 1, Tstable River Bridge, 1973.



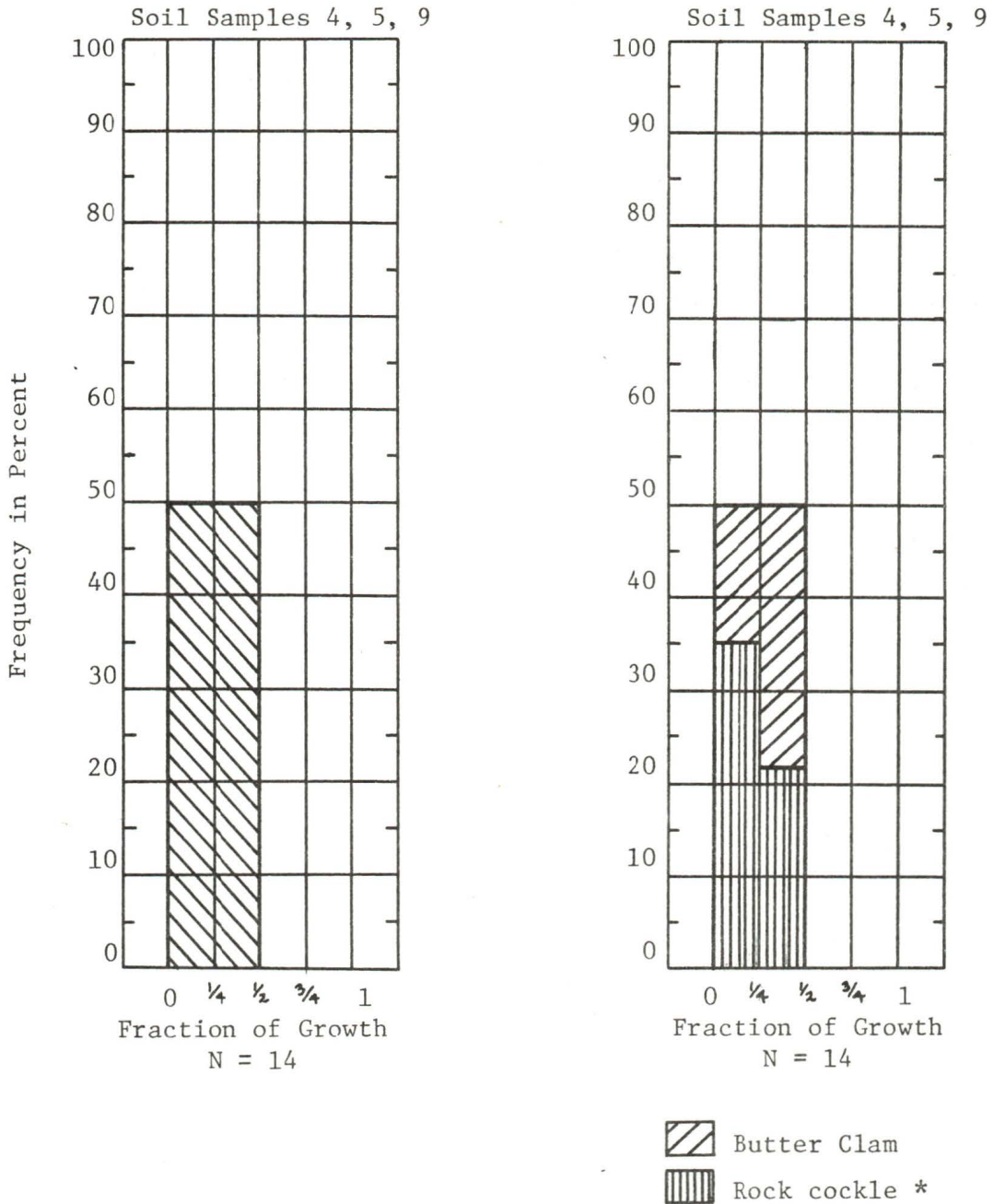
* These species keys are used in the following histograms.

In Excavation Unit 2 the large soil samples were relied upon for specimens as a faunal column was not taken. Crushed shell comprised most of the cultural strata, however, so that just a small sample was available from both a pocket of whole butter clam and a lens of whole rock cockle (see Table XX and Fig. 16). This was one of the few samples of rock cockle from the site as this species formed a much smaller percentage of the bivalve remains than had been expected considering the suitable environmental conditions of the nearby beaches and the fact that they usually turn up concurrently with butter and littleneck clams (Fraser 1931: 60; Quayle and Bourne 1972: 57). Rock cockle comprised an average of 12% of the samples taken from thirty-two beaches studied by Fraser (Table XXXVII), but in the Tsable River Bridge and Buckley Bay faunal columns, they formed an average of 1-6% of the umbos present. Quite a few faunal column samples contained no rock cockle mixed in with the other species, and when it did occur, it was usually badly broken up.

In terms of strata, both the small lens of rock cockle and the pocket of whole butter clam from which Soil Samples 5 and 9 were obtained, appear to be incorporated within the thick stratum from which Soil Sample 4 was taken. A histogram in Fig. 6 shows that the first and second quarters of growth were equally represented by seven bivalves each. The proposed seasonal interpretations for these quarters are spring and early to mid summer. Chi-squares again were not calculated to test the significance of these seasonal distributions due to the small sample sizes.

In terms of species for Excavation Unit 2, both rock cockle and butter clam appear to have been collected in both of the above seasons (see Fig. 6). Some littleneck clam was present in this stratum, but no whole specimens were available to examine for the amount of growth past the last winter ring.

Figure 6. Histograms, Fraction of Annual Growth at Death and Species Distribution, of Undisturbed Clams, in the Soil Samples From One Natural Stratum, Excavation Unit 2, Tssable River Bridge, 1973.



* The same species key is used in a following histogram.

Faunal column samples of shellfish from the strata in Excavation Unit 3 were somewhat larger, but the bottom metre of cultural deposits had almost no shell present at all (see Tables XXI-XXII and Fig. 17). There was a fairly high disturbance rate in several samples, such as Faunal Samples 7 and 11, especially of littleneck clams, which unfortunately reduced the sample sizes by 38-55%. About 55% of the useable samples came from the two strata that comprised Faunal Column Samples 6 to 7, and 15 to 18: a thin layer of whole butter clam with some littleneck, and a thick layer of whole and broken clam shell mixed with crushed mussel and oyster shell (see Fig. 17). The stratum of light brown gravelly soil with broken clam shell furnished another 20% of the samples from Faunal Column Samples 12 to 14, and 15% of the remaining quarter of the sample came from the various thin layers of brown soil mixed with whole and broken clam in Faunal Samples 8 to 11. Histograms in Fig. 7 portray the seasonal distributions of the bivalves in these four major natural strata, and Table VII gives the results of the chi-squares calculated from these distributions (after Siegel 1956: 42-47).

Within Faunal Column Samples 6 to 7, 42% and 41% of the undisturbed bivalves occurred in the first and second quarters of growth, and the third and fourth quarters followed with 16% and 1% of the sample (N = 66). Thus, if the seasons represented are ranked, the spring and the early to mid summer seasons are almost equally represented in first and second places with the mid to late summer a lagging third season, and the fall period an almost nonexistent fourth season. This pattern is very significant according to the chi-square figures.

All four seasons are almost equally stressed in Faunal Column Samples 10 to 11, with 25% in the spring, 29% in the early to mid summer,

Figure 7. Histograms, Fraction of Annual Growth at Death by Undisturbed Clams, in the Faunal Column and Soil Samples From Four Natural Strata, Excavation Unit 3, Tsable River Bridge, 1973.

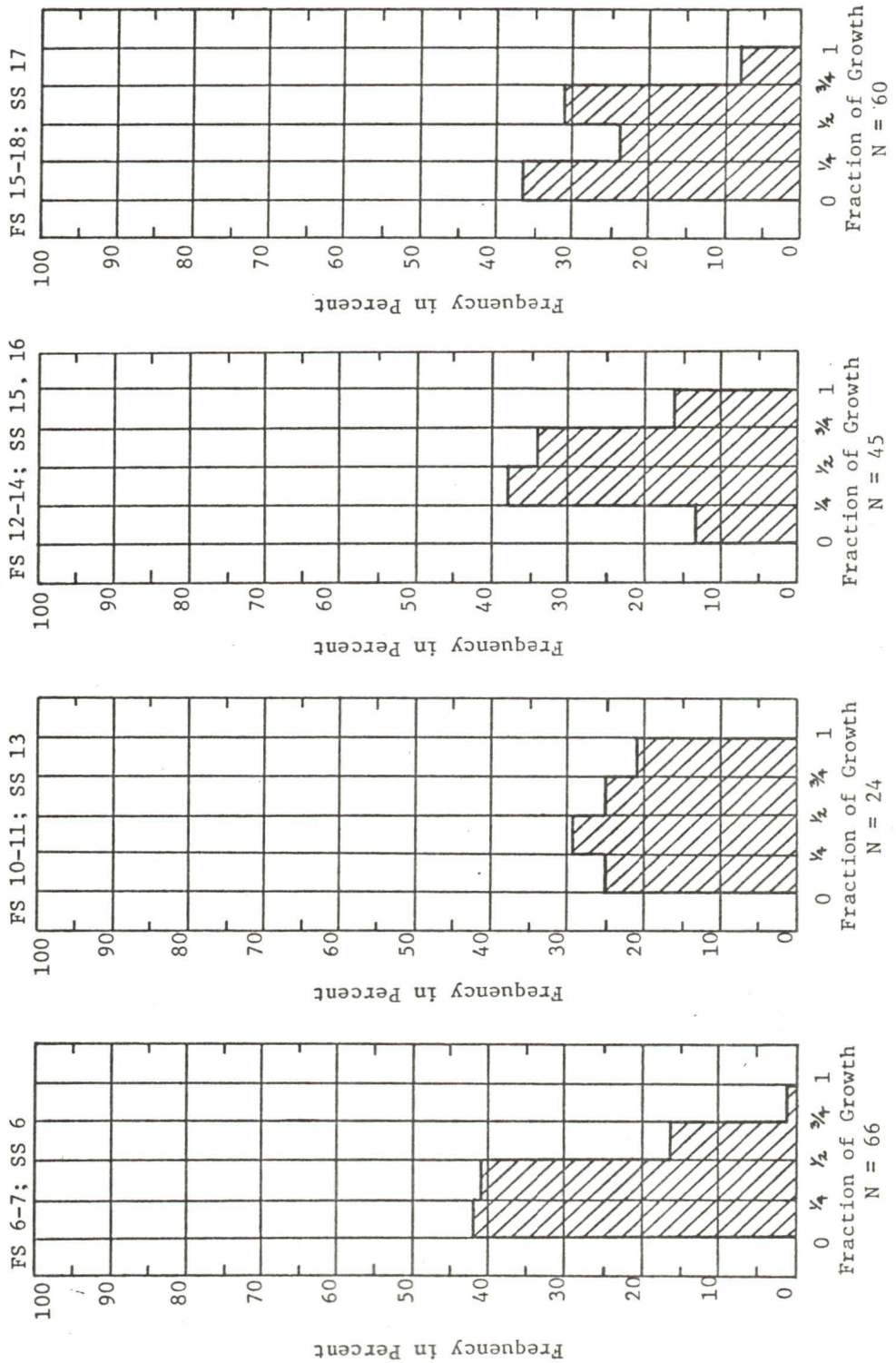


TABLE VII

Chi-Squares and Degrees of Probability, For the Fractions of
 Annual Growth at Death by Clams in Four Natural Strata,
 Excavation Unit 3, Tsable River Bridge, 1973

Natural Strata	Fractions of Annual Growth					x ²	P
	0-1/4	1/4-1/2	1/2-3/4	3/4-1	N		
FS 6-7 SS 6	28	27	10	1	66	31.9	.001
FS 10-11 SS 13	6	7	6	5	24	.32	.95
FS 12-14 SS 15, 16	6	17	15	7	45	8.25	.05
FS 15-18 SS 17	22	14	19	5	60	11.11	.01

FS = the Faunal Column Samples from the stratum.

SS = the Soil Sample from the stratum.

25% in the mid to late summer, and 21% in the fall. The sample size of 24 is quite small, however, and the chi-square test indicates that these results are likely not significant.

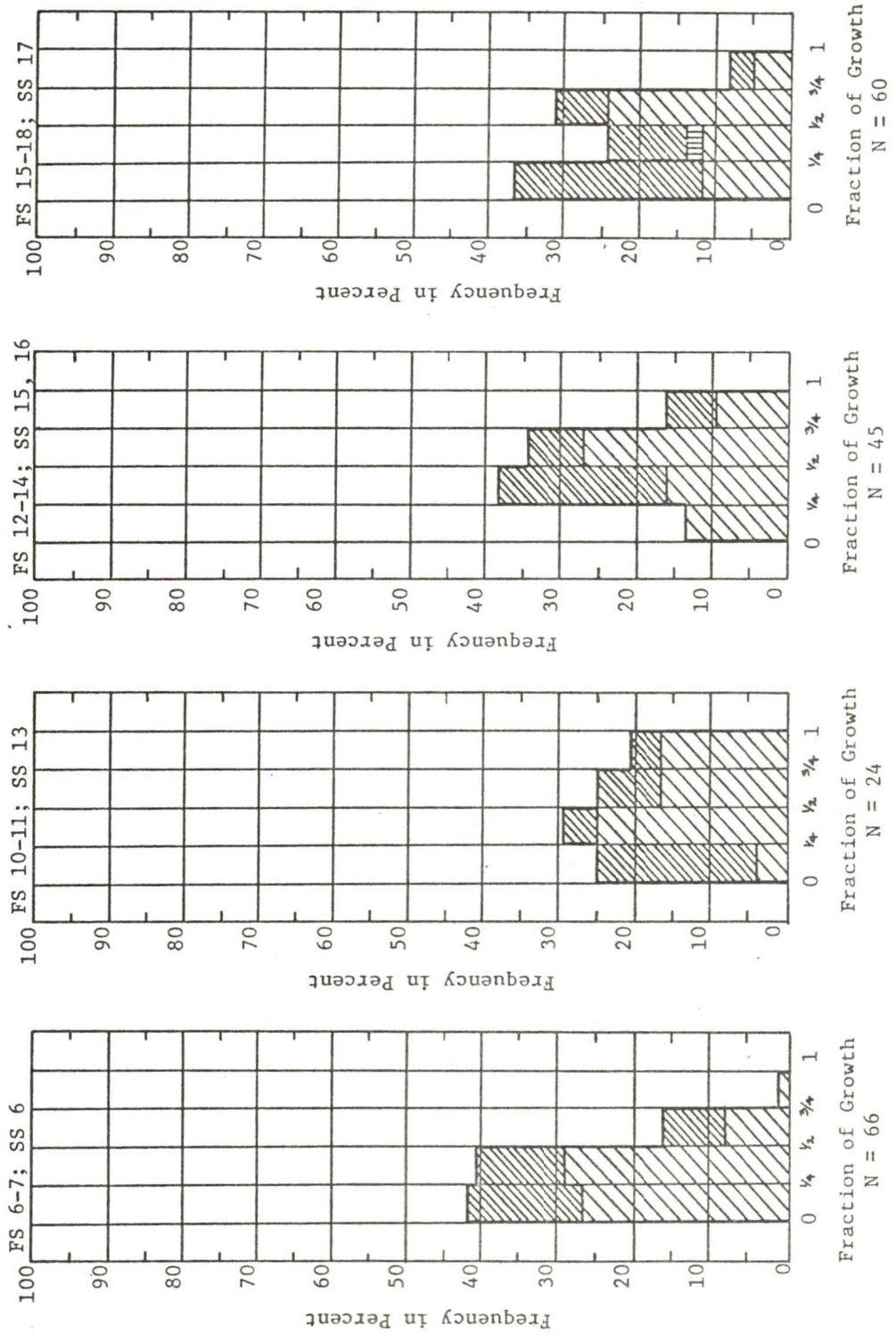
As with the strata of Excavation Unit 1, the summer months are the most important in Faunal Column Samples 12 to 14, with 38% and 34% of the clams having growth increments at death in the second and third quarters. The fall period occupies an unusual third ranked position with 16% of the sample, and the spring is last with 13% of it (N = 45). The probability of this seasonal pattern being due to chance is very small.

In Faunal Column Samples 15 to 18, both the spring and summer periods are important with 37%, 22% and 34% of the specimens occurring in the first three quarters. The fall period seems a relatively unimportant gathering time again with only 8% of the sample (N = 60). A very high significance level for this seasonal distribution was also calculated.

Tables XXIII-XXVI and Fig. 8 provide information on the collection of particular clam species by season for Excavation Unit 3. In each of the four natural strata, no matter what the season, there are few instances where both littleneck and butter clam were not present or being gathered. There seems to be no consistency by season through time with one species being exploited over another. Although rock cockle specimens formed 2-10% of the umbo count in these various strata, they were usually too broken up to examine their growth increments and infer the season of gathering. This likely accounts for their restricted presence in only one season of one stratum in this unit.

In Excavation Unit 4, the thick stratum of broken and whole shell that Faunal Column Samples 8 to 14 came from provided over three-quarters of the bivalves used in the analysis. This stratum may be a continuation

Figure 8. Histograms, Species Distribution and Fraction of Annual Growth at Death for Clams in the Faunal Column and Soil Samples From Four Natural Strata, Excavation Unit 3, Tsable River Bridge, 1973.



of the thick whole and broken clam shell layer in Excavation Unit 3, but the sloping of the strata between these units, even though they are not very far apart, makes this difficult to confirm positively at this stage of the site analysis. Samples 5 to 7, primarily from the layer of gray-burnt clam and whelk, contained slightly over one-eighth of the clams, followed by Samples 2 to 4 with less than one-eighth of the specimens from the two lens of crushed and broken clam shell, and whole clam shell. The bottom half metre of cultural strata in Excavation Unit 4 contained very little shell. In the thickest natural strata, however, there seemed to be an especially high degree of disturbance for both the littleneck and butter clams such that the age and growth patterns of slightly over one-half of these shellfish from this stratum could not be reliably ascertained. As disturbances may occur virtually at any time of the year, due to a variety of environmental and biological conditions (see page 20 and Appendix II, p. 72), there is no reason to suspect that the seasonal distribution is being distorted badly by discarding such a high proportion of individuals. The seasonal distributions of the clams in the three natural strata referred to above are illustrated in Fig. 9, and the chi-squares calculated from these proportions are given in Table VIII.

The ranked seasonal distribution of clams within Faunal Column Samples 2 to 4 included 40% in the mid to late summer period, plus 27% in both the spring and early to mid summer periods, and 7% in the fall interval. Again, as in several previous strata from other units, the emphasis is mainly on the first three growth quarters, or the spring through summer seasons. On the basis of the chi-square results this seasonal strata pattern is very significant.

Figure 9. Histograms, Fraction of Annual Growth at Death by Undisturbed Clams in the Faunal Column and Soil Samples From Three Natural Strata, Excavation Unit 4, Tsable River Bridge, 1973.

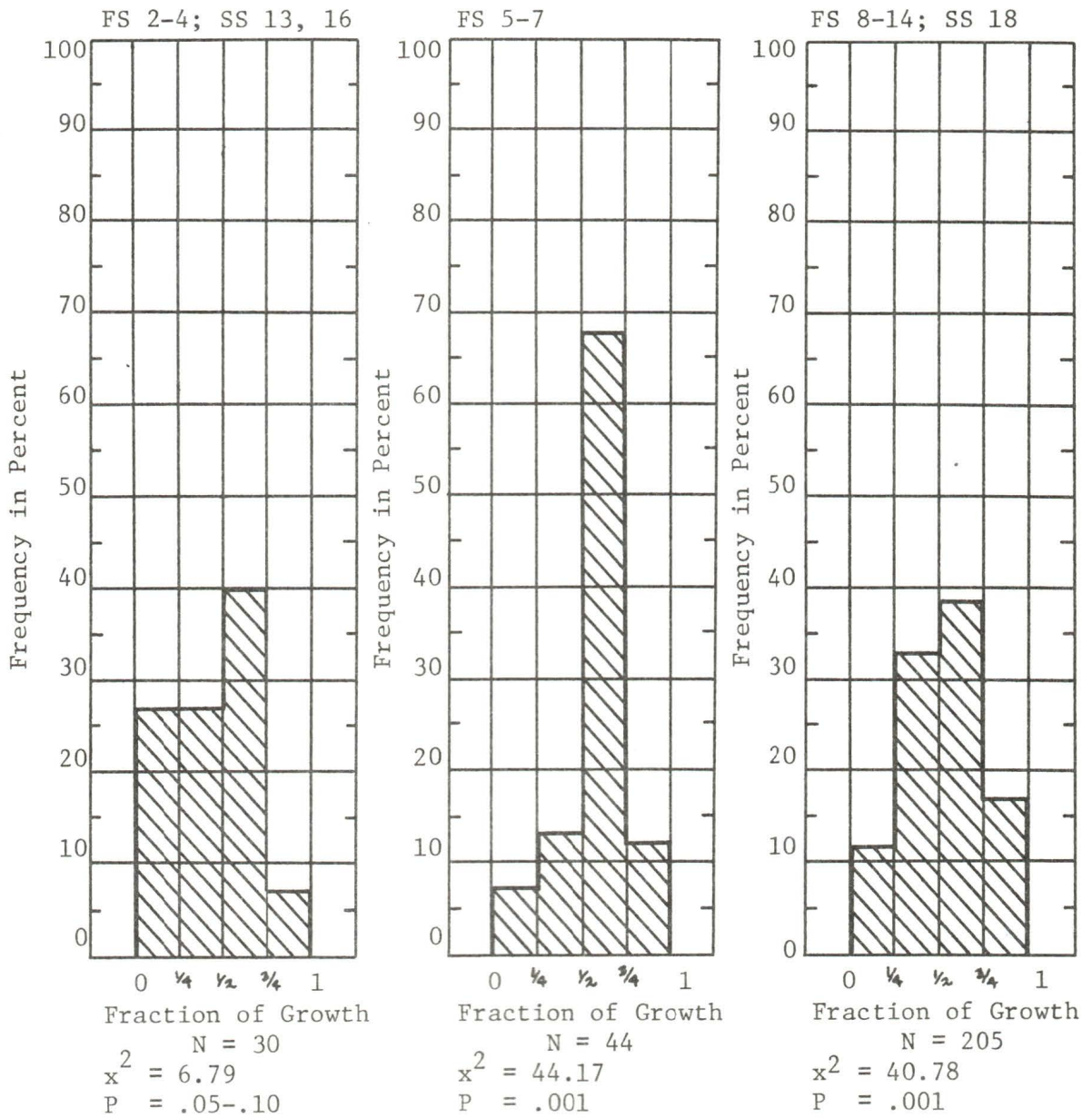


TABLE VIII

Chi-Squares and Degrees of Probability For the Fractions
of Annual Growth at Death by Clams in Three Natural
Strata, Excavation Unit 4, Tstable River Bridge, 1973

Natural Strata	Fractions of Annual Growth					χ^2	P
	0-1/4	1/4-1/2	1/2-3/4	3/4-1	N		
FS 2-4 SS 13, 16	8	8	12	2	30	6.79	.10
FS 5-7	3	6	30	5	44	44.17	.001
FS 8-14 SS 18	24	67	79	35	205	38.96	.001

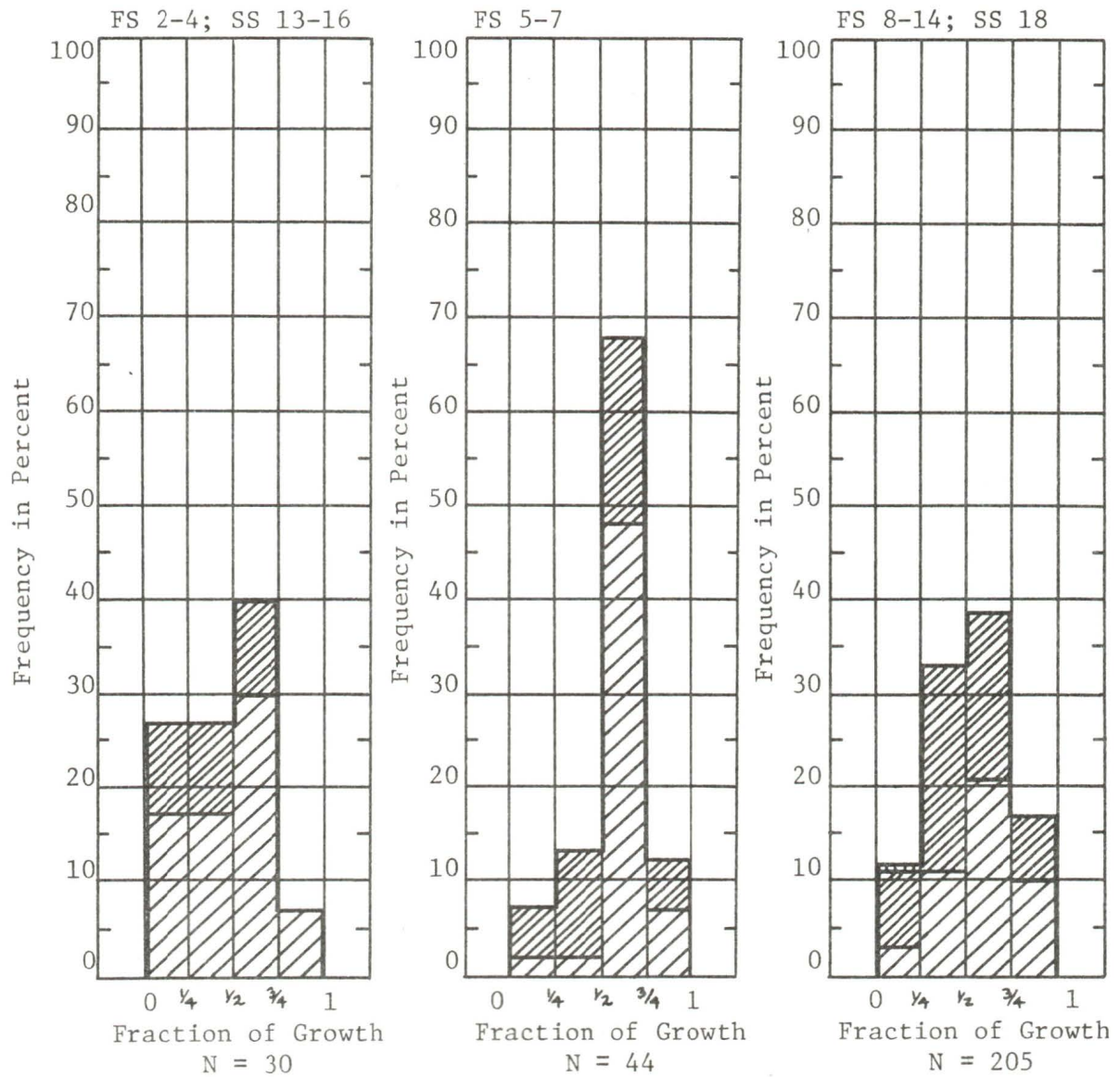
FS = Faunal Column Samples from the stratum.

SS = Soil Sample(s) from the stratum.

An unusually large number of the shellfish in Faunal Column Samples 5 to 7 had fractions of growth in the third quarter or mid to late summer season. Sixty-eight percent of the sample (N = 44) occurred in it, followed by 13%, 12%, and 7% respectively in the early to mid summer, the fall, and the spring. Both the first and second quarters seem to have been less important seasons of clam gathering in this strata than in several others. This distribution is also not due to chance according to the chi-square figures in Table VIII.

The thickest stratum in Excavation Unit 4 has a bivalve seasonal pattern almost identical to that of Faunal Column Samples 12 to 14 in Excavation Unit 3. Months of the summer dominate with 38.5% of the sample (N = 205) in the mid to late summer and 33% in the early to mid summer. In a somewhat unusual third rank is the fall season with 17% of the clams, followed by the spring with only 11%. The probability of the seasonal sequence being due to chance is very slight. There was one clam in Faunal Sample 9 from this stratum, and several in Faunal Sample 3, that appeared to have the last winter check on their shell edge, or very close to it. The suggested seasonal interpretation for them is winter to early spring, and they are tallied in the first growth quarter as "zero" increment. It is important to note that the first growth quarter has been interpreted as spring rather than winter to early spring so far, because the growth increments in the vast majority of the "spring" specimens approached one-quarter of their average annual growth beyond the last winter marker, rather than zero growth. In other words, there were primarily "late-spring" clams in the first growth quarter, rather than "winter to early spring" ones.

Figure 10. Histograms, Species Distribution and Fraction of Annual Growth at Death of Clams, in the Faunal Column and Soil Samples, From Three Natural Strata, Excavation Unit 4, Tssable River Bridge, 1973.



For all three of these strata, an examination of the species present by season shows that both butter clam and littleneck were being collected whenever this subsistence activity took place (see Tables XXX-XXXII and Fig. 10). Rock cockle also appear to have been gathered as they form 1-2% of the umbo count in each strata, but the seasons in which they were procured are generally not known.

Most of the natural strata in the four excavation units at Tsable River Bridge from which there were samples, therefore exhibit significant seasonal distributions of clam gathering. The relative importance of the seasons varies from strata to strata but often the most bivalves were gathered in the summer months and considerably fewer were taken in the spring and fall periods. No particular clam species seems to have been exploited over another in any given season as both littleneck and butter clam were being used in virtually all seasons of gathering.

Strata Seasonality: Buckley Bay

Only eight of the thirteen test cuts at Buckley Bay provided shellfish samples from their faunal columns and these samples ranged in size from 7 to 282 specimens. Only Excavation Units 1, 2, 4, 5 and 7, had what were felt to be adequate samples of bivalves from each of as many natural strata as possible. After the Tsable River Bridge analysis had been completed and the Buckley Bay column samples had been weighed, dry-screened and sorted into components, it was decided to carry out the growth ring examination of bivalves from only one of the excavation units with suitable samples, unless the results were markedly different from those of the other site. Excavation Unit 4 with the second largest sample was chosen because Excavation Unit 7 with the largest sample contained numerous signs of recent disturbance. Tin cans, glass, a nail, and a spoon

were found at different levels and, although they were located in the opposite side of the pit from the faunal column, it was felt safer to treat the whole pit as disturbed at this stage of the site analysis. If the units of analysis, or natural test cut strata, were mixed up, then the seasons represented by the various proportions of clams in each of them likely would have been equally confused or disturbed.

Faunal Column Samples 2 to 5 provided few specimens from the top thick stratum of light brown soil with some broken clam, and although specimens were substantially greater in Faunal Column Samples 7 to 9 from the layer of whole clam, many individuals had to be excluded due to their old age. Decreasing growth rates as they approached maximum size had resulted in the last several winter rings being so close together that the growth increments were negligible and could not be measured (see Table XXXIII and Fig. 19).

Although the small sample size makes the seasonal pattern somewhat unreliable for this first natural stratum, it does reflect the pattern of the second stratum which was based on a larger sample. The early to mid summer quarter of growth is dominant with 60% of the sample ($N = 10$), followed in order by the fall quarter with 20% and the spring and mid to late summer quarters with 10% each (see Fig. 11). It was not possible to calculate chi-square for these distributed sizes.

Of 62 clams in the second stratum, a high proportion, or 58%, also had growth increments in the early to mid summer quarter. The mid to late summer period included 22.5% of the sample, followed by the spring interval with 14.5%, and the fall period with 5%. This sequence of seasonal quantities is very significant according to the chi-square calculations in Table IX.

Figure 11. Histograms, Fraction of Annual Growth at Death of Undisturbed Clams in the Faunal Column Samples from One Natural Stratum, Excavation Unit 4, Buckley Bay, 1973

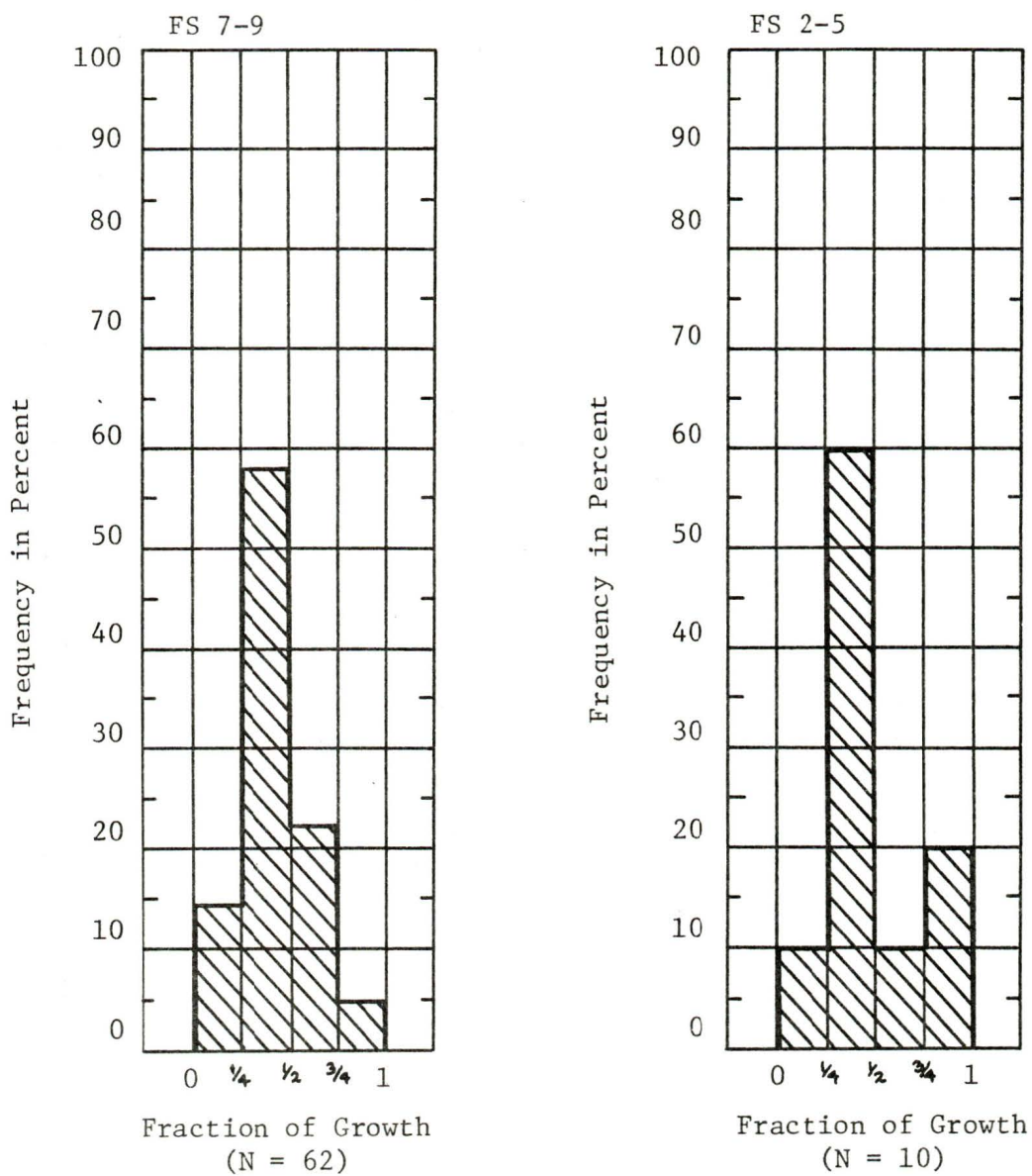


TABLE IX

Chi-Square and Degree of Probability For the Fractions of
Annual Growth at Death by Clams in One Natural Strata,
Excavation Unit 4, Buckley Bay, 1973

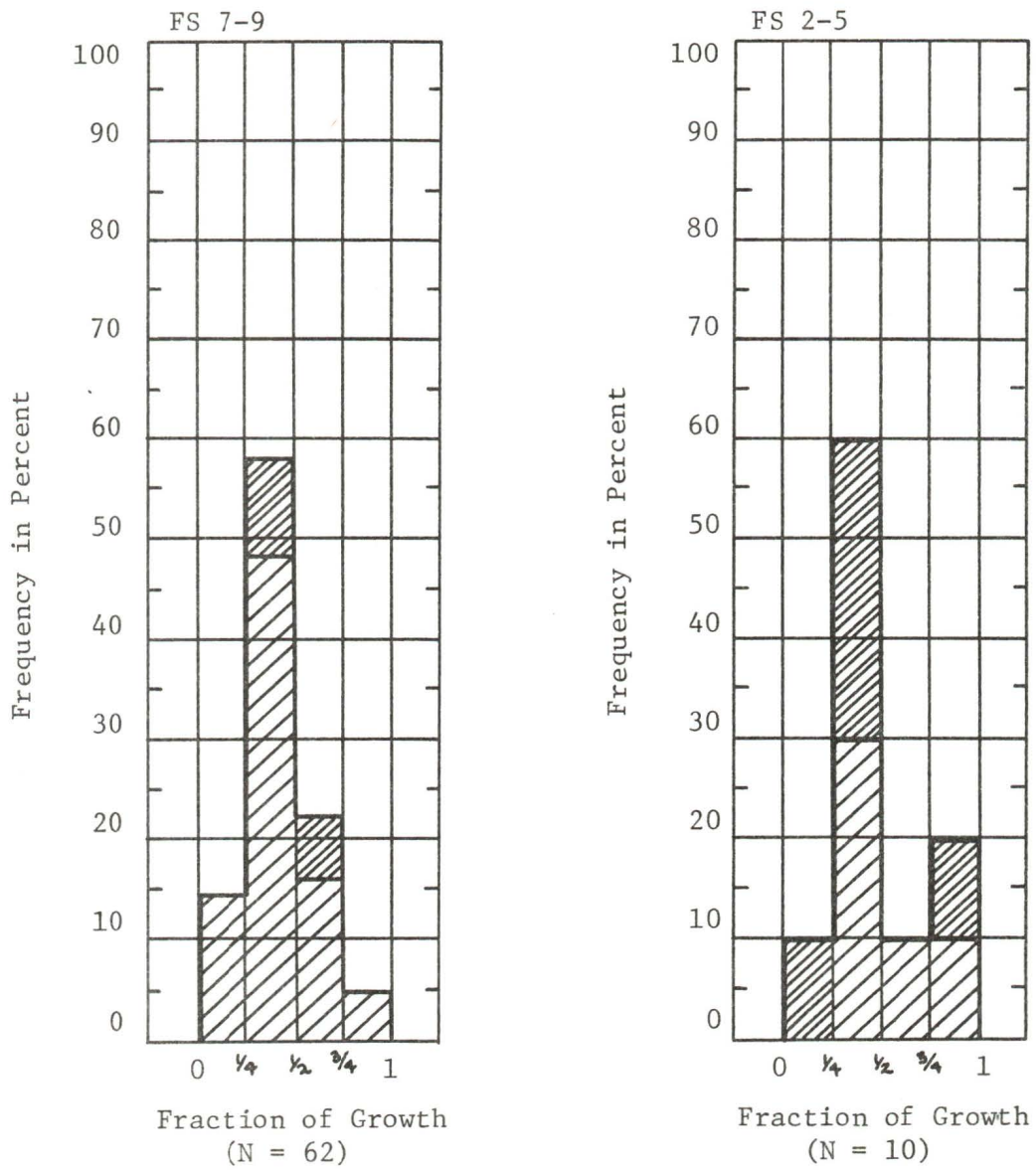
Natural Strata	Fractions of Annual Growth					χ^2	P
	0-1/4	1/4-1/2	1/2-3/4	3/4-1	N		
FS 7-9	9	36	14	3	62	40.07	.001

FS = Faunal Column Samples from the stratum.

Usually, in both of the above strata, butter clam and littleneck occurred together in any one season (see Tables XXXIV-XXXVI). Although rock cockle clams form 3% of the umbo count in these natural layers, there were no suitable individuals to use for the seasonality study, so they do not show up as a species in Fig. 12 histograms. These seasonal diagrams for times of shellfish gathering can really be used to infer only the presence or absence of a species in any given period and not to infer the relative importance of a species in a particular season.

In summary, the two natural strata of Excavation Unit 4 at Buckley Bay do exhibit definite seasonal patterns of clam collecting with the earlier part of the summer being the most important period. There also are no distinct patterns of a particular species being exploited over another in the various seasons of clam gathering.

Figure 12. Histograms, Species Distribution and Fraction of Annual Growth at Death, of Clams, in the Faunal Column Samples, Excavation Unit 4, Buckley Bay, 1973.



CONCLUSIONS

The seasonal distributions of bivalves represented in the Tsable River Bridge and Buckley Bay site strata indicate that clams were usually being gathered year-round, but that there was an emphasis on the collection of these food resources in the spring to late summer period. As mentioned earlier in the discussion of Excavation Unit 4 at Tsable River Bridge, most of the shellfish in the first growth quarter have been seasonally interpreted as spring, rather than as winter to early spring because the vast majority of them approached one-quarter of their average annual growth beyond the last winter marker instead of zero growth. In other words, bivalves do not seem to have been gathered extensively in either the fall or the winter seasons. Although relative seasonal frequencies did vary considerably between natural strata, they often were noticeably larger in one or both of the summer growth quarters, with the spring growth quarter in either a close or lagging third position. Chi-square figures calculated for the larger of these seasonal clam distributions from the various strata confirmed that they were significant. The first part of the hypothesis, that clams were gathered in certain seasons, is thus substantiated at least for most of the tested natural strata at each site. This seasonal patterning of clam gathering seems to remain virtually unchanged through time in the excavation units of both sites. Carbon 14 date estimates have not been obtained yet for either site, so the actual time span involved is unknown, but there are typological grounds for considering that the sites span the periods when southern Gulf of Georgia sites were occupied by groups whose cultures were of the Locarno Beach, Marpole, and Gulf of Georgia types. The second part of the hypothesis suggested that the seasonal

pattern would be either Salishan or Kwakiutl in nature with primary collecting done either in the late spring to summer or in the winter to early spring. For the natural strata sampled from each site, a Coast Salish or more southern coastal pattern appears to have occurred. Neither summer changes in clam meat quality due to spawning, nor the possibility of shellfish poisoning in the late summer months seem to have been very important variables that influenced these primary clam gathering periods. The occurrence of major salmon runs in the fall period, however, may help to account for the small amount of clamming that was carried on in that season.

In terms of seasonal shellfish gathering and the natural strata of the sites, each individual layer that was sampled contained clams with growth increments terminating in two to four different periods. These results are similar to Boehm's findings (1973: 85) with vertebrate fauna:

Perhaps the most interesting observation concerning season is the fact that animal bones indicative of more than one season were consistently found in clearly separated single-matrix units.

At present, the occurrence of various clam species both within a particular season and within a single matrix seems to be more the result of the natural species variability that occurs on beaches in the area than the result of the selection of any one species over another. To help examine this hypothesis, however, it would be necessary to have the existing shellfish populations sampled not only from the site beaches, but also from the nearby beaches that are closer to the sites than the ones studied by Fraser (see Table XXXVII). In the Glenrose Cannery report, Ham (1974: 32-37) suggests that littleneck and butter clam were selectively being gathered in the winter and summer months respectively,

and that these patterns were related to the ease of gathering a particular species at various tidal levels in each of these seasons. Considering the size of the samples examined, however, the high degree of overlap by these species in beach habitats here, and the ethnographic data from many parts of the coast that suggests a particular species was not being selected seasonally over another, this interpretation is not yet well substantiated by his evidence. At any rate, in this study there is no consistent pattern at all of butter clam or littleneck being exploited over the other either by season within a single natural matrix, or by season through time. Sampling difficulties with rock cockle made it difficult to ascertain its presence seasonally, but it did occur in most matrices along with butter clam and littleneck.

Although there are problems involved with some of the techniques and procedures used here (see Appendices I-II), it is felt that shellfish faunal analysis, and faunal analysis generally, can add considerably to any regional reconstruction of resource exploitation and site useage, so that any problems encountered are worth pursuing and solving. Fauna that exhibit different anatomical characteristics at different periods of the year, such as the bivalves do with their growth ring patterns, also seem to be some of the most useful and specific seasonal indicators that archaeologists have found to date. Our understanding of the culture history of regions such as the Gulf of Georgia will also be greatly increased if it is possible to use faunal analysis to determine how long ethnographic economic patterns have persisted and how they may have changed through time.

FOOTNOTES

¹This problem was first formulated in February 1974, and it was found out later the same year that Leonard Ham also was engaging in similar research (see references cited). As of August 1976, it also was learned that Rob Ferguson has recently completed an unpublished seasonality study on shellfish from one of the Prince Rupert sites excavated by George MacDonald.

²C.P. Lyons notes that Pacific Dogwood (Cornus nuttalli) blossoms appear from April to June and sometimes again in September (1965: 52).

³This may be Schizothaerus capax, a winter spawning horse clam as opposed to Schizothaerus nuttalli (see the references to Quayle on page 10).

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APPENDIX I

POPULATION GROWTH DATA

Growth data on recent clam populations from the site beaches was not available, but there was information from thirty-two other beaches between Victoria and Nanaimo on each of the three clam species examined in this paper (Fraser 1931; Fraser and Smith 1928). Average, or mean figures on the various clam attributes such as length, breadth, and breadth growth, by both species and age, were provided from these studies for each beach. For comparison to the archaeological bivalves, "grand" overall ranges and averages, or means, in both size and annual breadth growth were calculated by summarizing these figures for all thirty-two beaches (Tables X-XII). This latter step was carried out, as, on the basis of the marine environmental details given, it was not possible to decide which of the thirty-two beaches were the most similar to those at Tsable River and Buckley Bay. Even if the necessary marine information had been provided, it likely still would be more reliable to compare the midden shellfish to bivalves of the same species from a variety of beaches as the growth rates of each of these bivalves may vary between years, beach level, and even beaches in close proximity to one another:

A comparative study of measurements of winter growth checks confirmed that growth rates of butter clams vary along the coast. Table 13 shows the considerable variation in growth on various beaches, even those in close proximity (Quayle and Bourne 1972: 33).

It took but little collecting to discover that, even on taking into consideration the variation in each locality, there was a general difference in size, often even in beaches not far from one another. It was necessary to decide whether this difference was due to a general difference in age or to a difference in rate of growth of those [littleneck] of the same age or to both (Fraser and Smith 1928: 255).

In studying the size and age of Cardium, possibly the most striking feature that becomes evident is the great variation in size at any particular age, a much greater variation than that observed in Paphia, Saxidomus, or Siliqua. This is particularly noticeable in the first year, or, at any rate, in the amount of growth before the first winter check (Fraser 1931: 60).

The formula used to calculate "the mean of means", or the "grand mean" was

$$\bar{\bar{X}} = \frac{\sum \bar{X}}{N}$$

where $\bar{\bar{X}}$ = grand mean

\sum = sum of

\bar{X} = the mean for each locality

N = number of localities, or beaches

Simpson (1960: 68-69) notes that such a calculation treats each locality as a separate entity and the grand mean thus calculated ignores the frequency distribution of the particular attribute within each locality. In other words, the means of size and growth from each beach used to calculate the grand means are not weighted by the total frequency or sample size for that locality. A second possible formula that was "weighted" in this way would ignore the differences between localities entirely and treat all individuals as a single sample (Simpson 1960: 69). Owing to the above-mentioned beach variation, it was felt preferable to treat each locality as a separate entity and use the first formula. Also, from the data provided it was not possible to determine exactly how many of the total sample from a particular beach were used to calculate the clam size and growth figures by age for that beach. The sample size for each place was given and it was broken down by age groups

as well, but when it came to the size measurements and the growth increments "cumulative" samples were used from each beach. For example, in determining the mean size and the mean amount of breadth growth for two year old butter clams at a certain beach, both the clams that had just reached two and all those that had gone beyond two were used in the calculations. Thus the growth figures given for the bivalves in their earlier years are based on much greater numbers of specimens than are the growth figures for bivalves in their later years (Fraser 1931: 63; Fraser and Smith 1928: 257, 273).

APPENDIX II
MEASURING TECHNIQUES

Length and breadth measurements were taken on each complete valve and reconstructed if possible on partial valves so that the archaeological specimens could be compared to living populations of the same species. As the growth patterns did not appear to have noticeably altered in the studied specimens the above information also turned out to be helpful in giving an approximate idea of a clam's age and thereby acting as a rough double check on the counting of the winter rings especially if there were disturbance rings during some years of growth.

Definitions of length and breadth were borrowed from Quayle and Bourne:

The length of a clam is the greatest distance between the anterior and posterior margin of the shell; the height is the distance from the umbo to the ventral margin (1972: 2) (Fig. 12).

In the case of the height measurement, however, there can be quite a bit of variation depending on whether or not it is taken at right angles to the longest axis or along the greatest radius with the umbo as the centre. The recent Fraser and Smith growth studies to which the midden bivalves were compared had used the former height calculation for butter clams and the latter for littleneck clams:

The shape of the shell butter clam is much more suitable for measurement than that of Paphia, since the line of greatest breadth is nearly at right angles to the line of greatest length, hence these were used as the basis for measurement (1928: 272).

In measuring for length, the greatest length was used littleneck clam and for breadth, the greatest radius with the umbo as the centre. On account of the variation in the shape of the shell,

it was considered better to do this than to try and measure along any line more nearly at right angles to the right axis (1928: 255).

Fraser's methods of measuring rock cockle are ambiguously described. All that he mentions is that "the method of reading the age and of measuring the growth was similar to that employed with other species (1931: 61). For this study, height was taken at right angles to the line of greatest length for all species, as the greatest radius method was found to be too variable in the littleneck depending along which radial sculpture line from the umbo the measurement was read. This meant, however, that the archaeological littleneck breadth measurements were somewhat underestimated (Fig. 13) and this had to be allowed for when comparing them to the breadth ranges and averages of the more recent individuals. The most expeditious arrangement for taking these length-height readings seemed to be to place each valve on grid paper so that all four of its margins were touching vertical and horizontal lines on the paper and then to measure each necessary axis.

The amount of growth since the last winter ring was measured along the same breadth or height axis using a set of calipers that indicated tenths of a millimetre. It is important to note when trying to compare clam growth data that quite a few studies examine the yearly length increments rather than the yearly breadth additions (Clark 1968; Coe 1948; Coe and Fitch 1950; Coutts 1970; Coutts and Higham 1971; Craig and Hallam 1963; Schmidt and Warne 1969; Weide 1969). If one is involved in doing cross-sections of the valves, however, or seldom have whole valves to work with, it is obvious that height increments are the more useful ones to calculate (Barker 1964; Berry and Barker 1968; Ham and Irvine 1975; House and Farrow 1968; Pannella and MacClintock 1968). The

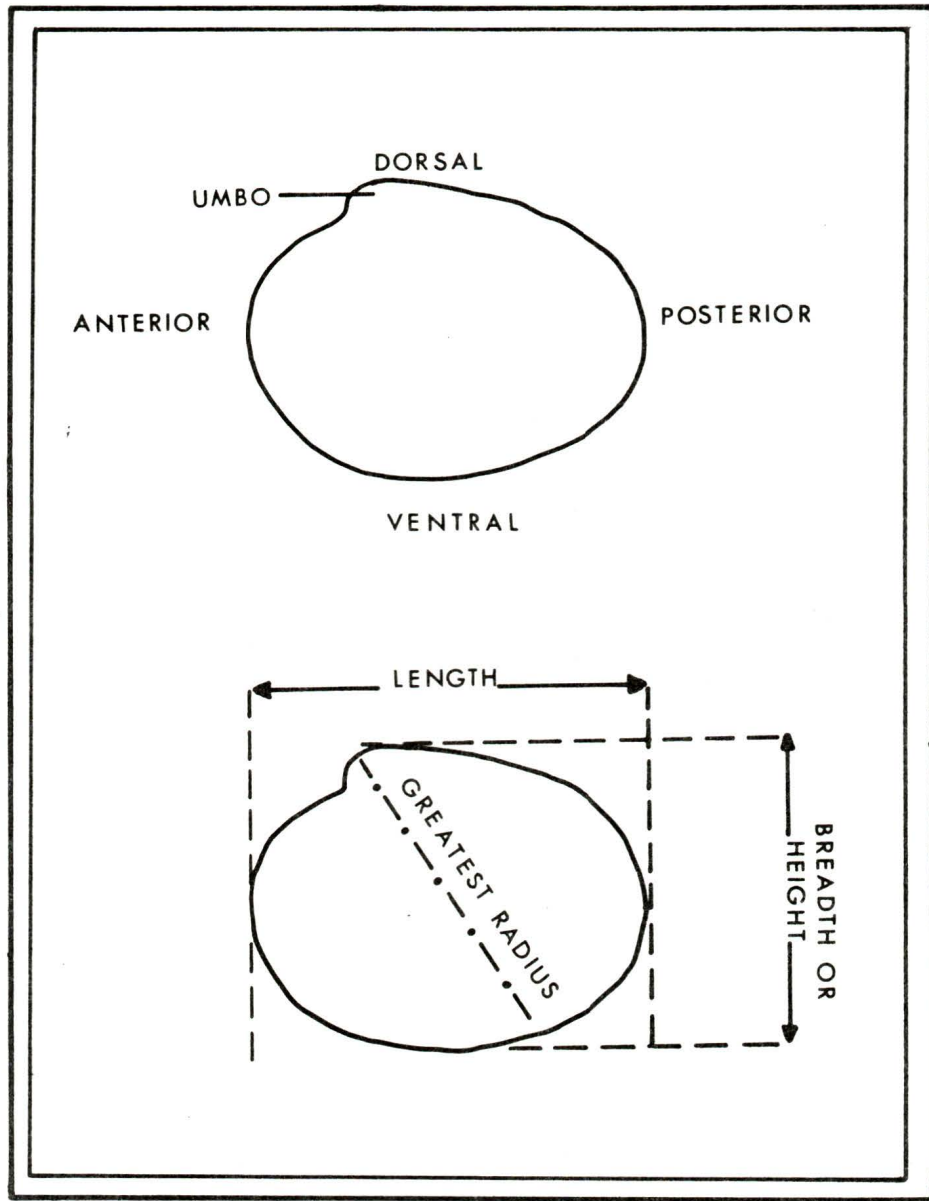


Figure 13. Bivalve length and height measurements.

archaeological shells in this study could have been compared in either dimension to the Fraser and Smith studies as annual growth increases were given for both length and height, but height was chosen for the previous reasons.

The following steps were thus carried out for each specimen in order to ascertain the size, age, breadth growth since the last winter ring, and the season of death or gathering:

- 1) The clam valve length and height or breadth were measured.
- 2) Both by looking at the exterior winter rings and by comparing the size figures of the clam to recent size data of the same species, the age was determined.
- 3) The amount of breadth growth from the last winter ring was measured unless the winter ring was right at the ventral edge of the valve.
- 4) The amount of breadth growth was then compared to three recent breadth growth figures for a clam of similar age: the range in breadth growth, the mean breadth growth, and half the average breadth growth.

If the amount of breadth growth past the last winter check in the archaeological specimen was less than one-half of the average annual breadth growth for a recent clam of the same age, the season of death inferred was spring/early summer: spring was inferred when less than one-quarter of the mean annual growth had occurred, and early-mid summer was inferred if between one-quarter and one-half of the mean annual growth was evident.

If the amount of breadth growth past the last winter ring for the archaeological clam was more than one-half of the average annual breadth

growth for a recent bivalve of the same age, the season of gathering inferred was late-summer/fall: between one-half and three-quarters of the average annual growth was inferred as the mid-late summer, and over three-quarters of the average annual breadth growth was interpreted as the fall.

5) When the exterior pattern of "winter rings" was very irregular, or did not seem to be spaced at intervals that corresponded to even the minimum yearly breadth growth increments in Tables X-XII, it was assumed that the clam was badly disturbed with "non-winter rings" and that the age, breadth growth beyond the last winter ring, and the season of death could not be reliably calculated. "Disturbed" ring patterns were also suspected if a clam's size measurements were abnormally small or large for a clam of its "estimated" age.

6) The valve was then broken in two so that a "double-check" of the exterior ring reading was made by examining a cross-section of the interior growth rings. This step was carried out on a majority of the valves except for those too deteriorated or extremely badly disturbed externally. In most cases the cross-section was "partial" and extended from the ventral edge half-way to the umbo rather than extending the whole ventral edge-umbo distance. The longitudinal edge of the cross-section was smoothed with various grades of metal files and sandpapers, moistened, and then examined under a binocular microscope with a magnification of 40X.

Barker (1964: 69, 73-74, 81) found two dominant variations in the growth layers of his thirty bivalves that are important to be aware of when examining growth increments cross-sectionally. Type A consisted of cryptocrystalline calcium carbonate, appeared light in colour, and

was produced under slow-growing conditions. Type B was composed of opaque or semi-opaque conchiolin, appeared darker in colour, and was formed under fast-growing conditions. In other words, thick, opaque conchiolin-rich layers are created in the summer and thin, crystalline conchiolin-poor or crystalline calcium carbonate-rich layers occur in the winter when shell growth almost ceases (1964: 80, 82).

These patterns are quite discernible in clam cross-sections that have been smoothed and magnified 40X, but a methodological problem comes when trying to distinguish the winter rings from "disturbance rings" that may be produced during other times of the year. Many conditions such as too high or too low water temperatures, new spring growth, violent wave action, spawning, and handling, may temporarily hinder the shell growth and result in a "winter-like" check externally and probably internally as well (Fraser and Smith 1928: 255, 272; 1931: 61; Quayle and Bourne 1972: 8; Pannella and Macclintock 1968: 71; Wilburn and Owen 1964: 223). In this regard Barker remarks:

It is probable that equinoctial storms inhibit shell growth, causing the formation of very fine carbonate-rich layers that differ markedly from the thick conchiolin-rich layers produced during calmer periods (1964: 80).

One cannot, therefore, necessarily interpret the last deep exterior ring or the last translucent interior ring of a clam bivalve as the most recent winter check. A recent study by Ham and Irvine, for instance (1975) produced conflicting results when comparing exterior with interior rings: the former indicated primarily summer growth at death and the latter indicated primarily winter growth for three of four species examined. As the "modern" specimens had been collected in the summer (Ham and Irvine 1975: 366), I suggest that the "winter rings" appearing

near the ventral edge in many of the cross-sections was probably a "summer disturbance ring" instead.

Initially, in the Tsable River Bridge and Buckley Bay samples, surface rings on the mantles were examined, but later when interior cross-sections were compared to them it was still not possible in many cases to separate winter rings in erratic exterior patterns of growth from other seasonal disturbance rings by looking at the interior rings. The end result either way was that one-third to one-half of the samples had to be excluded as they appeared to have non-winter disturbance checks near their ventral edges. One possible solution to this dilemma was tried by Craig and Hallam:

Like Orton, we frequently found it impossible to distinguish winter rings from disturbance rings and decided that the most objective method of determining the winter rings was to measure all visible growth-rings and then plot their size-frequency distribution. The resulting histograms, therefore, show the sizes of the modal growth-rings in the sample (1963: 738).

Pannella and MacClintock seemed to have little difficulty in detecting seasonal rings from accidental or breeding rings in their cross-sections (1968: 71) but this is likely a reflection of the degree of magnification used which was mainly X200 but varied from X56 to X640.

These above "solutions" were not used in this study for several reasons. Firstly, there was no indication in the bivalve studies for this area as to what actual percentage of specimens were "disturbed" and, as the samples from the two sites examined here were fairly large, it was hoped this would compensate for any discarded specimens. Unfortunately the disturbed percentage was high enough that Craig and Hallam's method should probably have been used, or else even larger faunal samples taken. D.B. Quayle in a personal communication (1976) recalled that about ten

percent of his samples had to be discarded, but there are no figures on disturbed clams in the studies by Fraser and Smith. Quayle also commented that the incidence of disturbed specimens in a sample was likely a reflection of both the beach the clams came from and the amount of experience an individual has had in examining growth rings. Secondly, the study was not concerned with any finer growth rings than the annual ones, so that microscopic equipment for high-power magnifications and materials for doing thin sections were not readily available.

Butter clams generally seemed to provide the least problems for both the interior and exterior ring examinations -- possibly because their cross-sections were larger than those of the littleneck clams, and they did not have vertical radial ridges that made it more difficult to look at the external horizontal ridge patterns. Unfortunately, quite a few still had to be excluded from the sample because they were so old: decreasing growth rates as they approached maximum size had resulted in the last several winter rings being so close together that the growth increments were negligible. Figure 14 illustrates the external and internal growth ring patterns that were then interpreted as the various seasons.

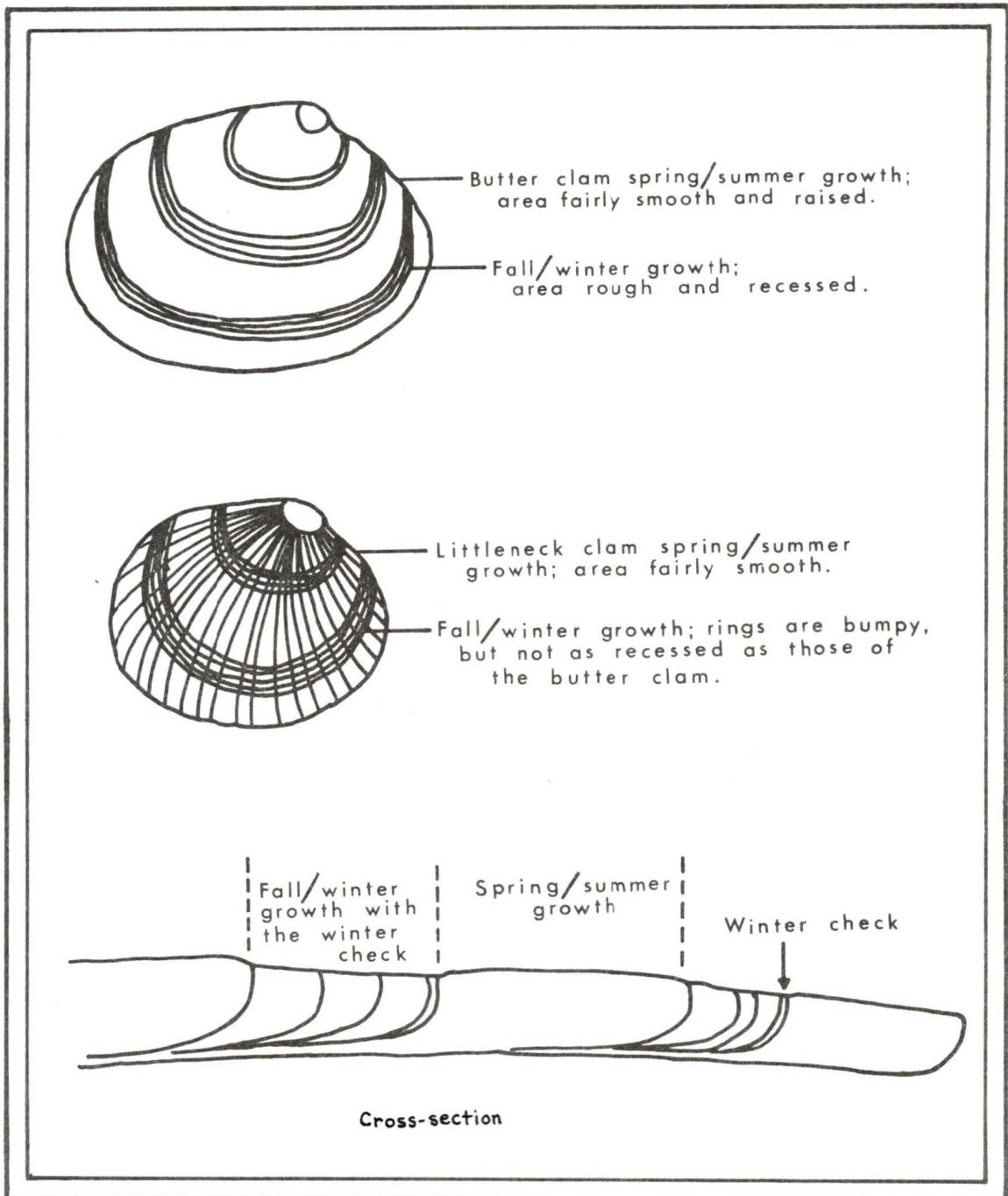


Figure 14. External and internal growth ring patterns.

TABLE X

Butter Clam Population Growth Statistics by Age, in Millimetres, From Thirty-Two Beaches Between Victoria and Nanaimo, 1928 *

Age	Length Range	Mean Length	Breadth Range	Mean Breadth	Breadth Growth Range	Mean Breadth Range	$\frac{1}{2}$ Mean Br. Growth
1	11.9-23.0	18.1	9.1-17.3	13.2	9.1-17.3	13.6	6.8
2	27.4-40.0	33.5	20.2-28.8	24.5	9.0-13.1	11.0	5.5
3	40.6-54.5	45.8	29.4-39.1	34.0	7.4-11.0	9.3	4.7
4	48.1-68.1	56.4	35.6-49.7	42.2	6.1-11.4	8.4	4.2
5	55.1-78.0	64.5	41.3-57.8	48.7	5.2-8.6	6.6	3.3
6	60.4-85.9	71.1	45.3-64.5	54.3	3.9-7.3	5.7	2.9
7	64.2-92.8	76.6	48.9-70.5	58.9	3.1-6.9	4.7	2.4
8	67.5-97.7	81.3	52.1-75.5	62.9	1.5-6.5	4.0	2.0
9	70.6-101.1	84.8	55.1-78.0	66.2	2.0-6.2	3.5	1.8
10	74.0-102.0	86.4	57.6-78.5	67.6	0.8-6.0	2.8	1.4
11	77.0-100.0	86.8	59.0-78.2	69.0	1.4-3.3	2.5	1.3
12	78.7-101.2	88.6	61.1-80.2	70.8	1.1-3.4	2.5	1.3
13	81.4-107.2	92.8	62.3-79.5	74.2	1.2-5.0	2.9	1.5
14	88.6-107.2	97.8	65.0-84.4	78.5	1.5-4.9	2.8	1.4
15	101.1-101.1	101.1	81.6-83.8	82.7	1.5-2.0	1.8	0.9
16	104.8	104.8	83.0-87.4	85.2	1.4-3.6	2.5	1.3

* Based on Fraser and Smith (1928: 278-280, 282). N = 2523, with the clams less than one-year old excluded from this sample.

TABLE XI

Littleneck Clam Population Growth Statistics by Age, in Millimetres, From Thirty-Two Beaches Between Victoria and Nanaimo, 1928 *

Age	Length Range	Mean Length	Breadth Range	Mean Breadth	Breadth Growth Range	Mean Breadth Range	½ Mean Br. Growth
1	11.1-15.7	13.1	9.4-14.7	11.3	9.4-14.7	11.2	5.6
2	22.0-32.7	26.0	19.3-29.2	23.1	9.2-15.0	11.8	5.9
3	30.6-44.4	34.5	27.2-39.5	32.0	6.8-11.1	9.1	4.6
4	36.2-50.6	42.6	32.6-45.7	38.8	5.4-8.1	6.8	3.4
5	40.9-54.1	47.4	38.6-49.9	43.5	2.7-6.4	4.9	2.5
6	44.2-57.3	50.7	40.2-53.8	47.1	2.2-6.1	4.0	2.0
7	47.4-59.9	53.7	43.6-55.6	50.2	1.2-7.3	3.2	1.6
8	48.7-60.7	54.6	45.5-59.1	52.4	0.9-5.4	3.1	1.6
9	49.9-62.2	55.7	46.9-59.5	52.9	1.4-3.3	2.3	1.2
10	53.8-63.4	58.6	53.2-62.2	57.6	1.5-4.8	3.3	1.7

* Based on Fraser and Smith (1928: 258-259, 261-262). N = 2975, with the clams less than one-year old excluded from this sample.

TABLE XII

Rock Cockle Population Growth Statistics by Age, in Millimetres, From Thirty-Two Beaches Between

Victoria and Nanaimo, 1931 *

Age	Length Range	Mean Length	Breadth Range	Mean Breadth	Breadth Growth Range	Mean Breadth Range	$\frac{1}{2}$ Mean Br. Growth
1	4.2-18.9	10.1	4.0-17.6	9.2	4.0-17.6	9.5	4.8
2	31.4-54.0	40.8	35.3-54.6	44.3	27.6-43.1	34.3	17.2
3	47.2-64.9	60.6	59.8-77.0	69.8	19.1-32.0	24.8	12.4
4	60.8-76.9	70.8	74.5-94.8	84.8	12.5-23.6	16.4	8.2
5	71.4-86.2	78.0	83.8-109.2	94.2	4.4-14.4	11.0	5.5
6	72.0-95.6	84.1	88.8-108.1	103.1	3.3-14.8	12.6	6.3
7	83.9-99.4	92.0	104.5-111.8	107.8	1.0-6.4	3.6	1.8

* Based on Fraser (1931: 62, 65, 66, 68). N = 760.

APPENDIX III

FAUNAL COLUMN DATA AND EXCAVATION PROFILES

TABLE XIII

Fraction of Annual Growth at Death by Undisturbed
Clams, in the Faunal Column, Excavation Unit 1, Tstable
River Bridge, 1973

Faunal Sample	Fraction of Annual Growth at Death								Disturbed		TOTAL N
	0-1/4		1/4-1/2		1/2-3/4		3/4-1				
	No.	%	No.	%	No.	%	No.	%	No.	%	
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	2	100	2
3	0	0	0	0	0	0	0	0	0	0	0
4	1	33	0	0	0	0	0	0	2	67	3
5	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	2	100	0	0	0	0	2
7, 8	1	11	1	11	0	0	0	0	7	78	9
9-12	0	0	6	46	3	23	2	15.5	2	15.5	13
13-17	0	0	0	0	0	0	0	0	0	0	0
TOTAL	2	7	7	24	5	17	2	7	13	45	29

TABLE XIV

Fraction of Annual Growth at Death by Undisturbed
Clams, in a Soil Sample, Excavation Unit 1, Tstable
River Bridge, 1973

Soil Sample	Fraction of Annual Growth at Death								Disturbed		TOTAL N
	0-1/4		1/4-1/2		1/2-3/4		3/4-1				
	No.	%	No.	%	No.	%	No.	%	No.	%	
18	3	16	5	26	5	26	0	0	6	32	19

TABLE XV

Species Distribution and Fraction of Annual Growth at
Death for Clams, in the Faunal Column, Excavation Unit 1, Tstable
River Bridge, 1973

Faunal Sample	Fraction of Annual Growth at Death								Disturbed		TOTAL	
	0-1/4		1/4-1/2		1/2-3/4		3/4-1					
	BC	LN	BC	LN	BC	LN	BC	LN	BC	LN	BC	LN
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	2	0	2
3	0	0	0	0	0	0	0	0	0	0	0	0
4	0	1	0	0	0	0	0	0	0	2	0	3
5	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	1	1	0	0	0	0	1	1
7, 8	0	1	0	1	0	0	0	0	2	5	2	7
9-12	0	0	4	2	3	0	2	0	0	2	9	4
13-17	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	0	2	4	3	4	1	2	0	2	11	12	17

TABLE XVI

Species Distribution and Fraction of Annual Growth at
Death for Clams, in a Soil Sample, Excavation Unit 1, Tstable
River Bridge, 1973

Soil Sample	Fraction of Annual Growth at Death								Disturbed		TOTAL	
	0-1/4		1/4-1/2		1/2-3/4		3/4-1					
	BC	LN	BC	LN	BC	LN	BC	LN	BC	LN	BC	LN
18	2	1	3	2	5	0	0	0	5	1	15	4

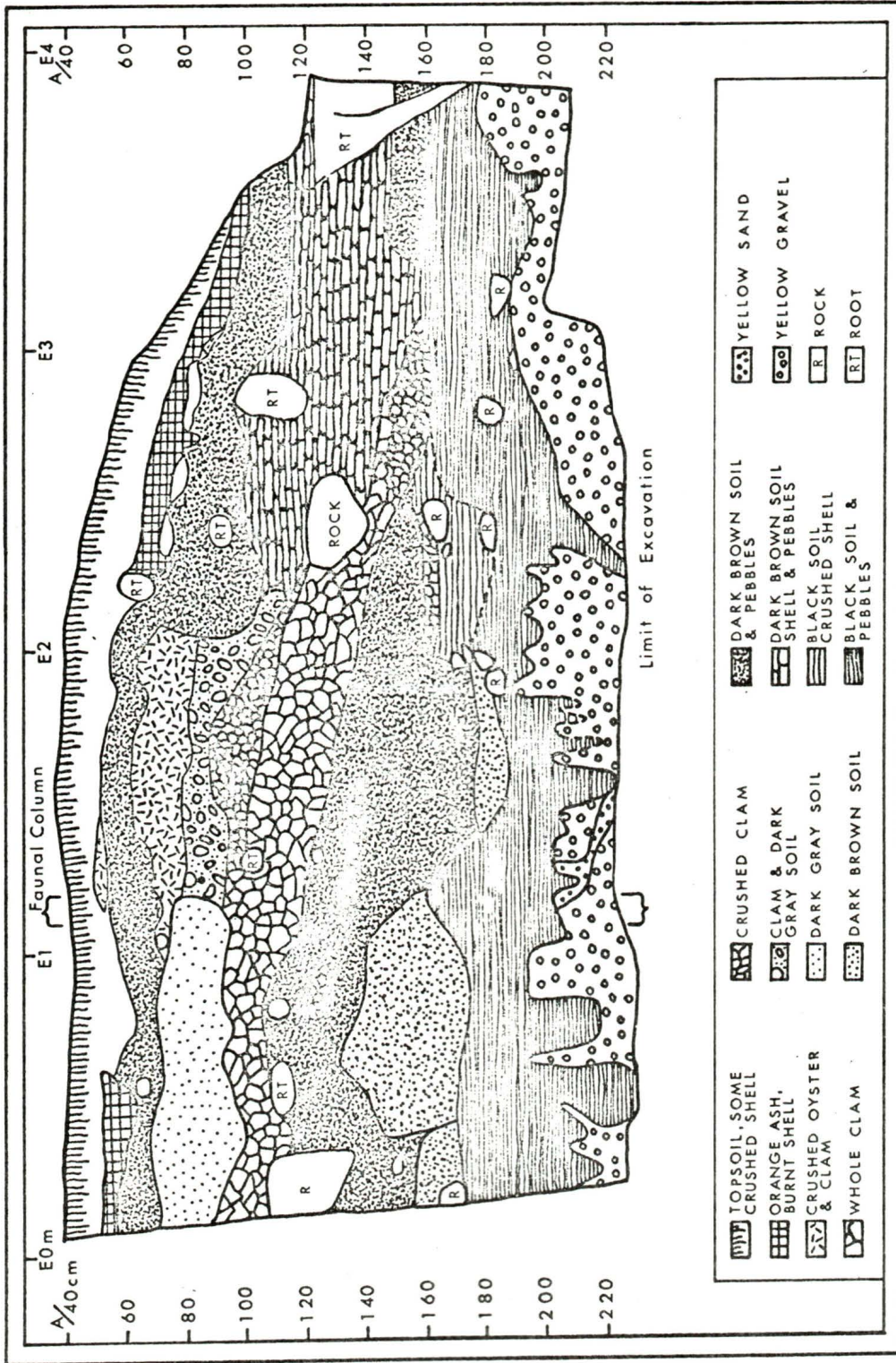


Figure 15. Excavation profile of North 2 metre wall, Excavation Unit 1, showing the location of the faunal column, Isable River Bridge, 1973.

TABLE XVII

Species Percentages of Undisturbed Clams, by Fraction of Annual Growth
at Death, From the Faunal Column Samples,
Excavation Unit 1, Tstable River Bridge, 1973

Faunal Samples	Fraction of Annual Growth at Death								TOTAL		
	0-1/4		1/4-1/2		1/2-3/4		3/4-1		BC	LN	N
	BC	LN	BC	LN	BC	LN	BC	LN			
4	0	100	0	0	0	0	0	0	0	100	1
6	0	0	0	0	50	50	0	0	50	50	2
7-8	0	50	0	50	0	0	0	0	0	100	2
9-12	0	0	37	18	27	0	18	0	82	18	11
TOTALS	0	12.5	25%	19%	25%	6%	12.5	0	62.5	37.5	16
	17%		41%		34.5%		7%				

TABLE XVIII

Species Percentages of Undisturbed Clams, by Fraction of Annual Growth
at Death, in a Soil Sample, Excavation Unit 1,
Tstable River Bridge, 1973

Faunal Samples	Fraction of Annual Growth at Death								TOTAL		
	0-1/4		1/4-1/2		1/2-3/4		3/4-1		BC	LN	N
	BC	LN	BC	LN	BC	LN	BC	LN			
SS 18	15.5	7.5	23	15.5	38.5	0	0	0	77	23	13

TABLE XIX

Species Numbers and Percentages of Umbos, for all Clams, in the
Faunal Column, Excavation Unit 1, Tstable River Bridge, 1973 *

Faunal Sample	Umbos by Clam Species						TOTAL	
	Butter Clam		Littleneck		Rock Cockle		No.	%
	No.	%	No.	%	No.	%		
1	0	0	0	0	0	0	0	0
2, 3	2	20	8	80	0	0	10	100
4	5	42	7	58	0	0	12	100
5	20	95	1	5	0	0	21	100
6	43	63	25	37	0	0	68	100
7, 8	66	62	38	36	2	2	106	100
9-12	36	45	43	54	1	1	80	100
13-17	0	0	0	0	0	0	0	0
TOTAL	172	58	122	41	3	1	297	100

* These umbo counts, at present, include all specimens in the faunal column sample that were caught in screens with mesh sizes of 6.4 mm. or larger. Materials caught in the smallest (2.0 mm.) screen and the catch pan have not been analyzed yet.

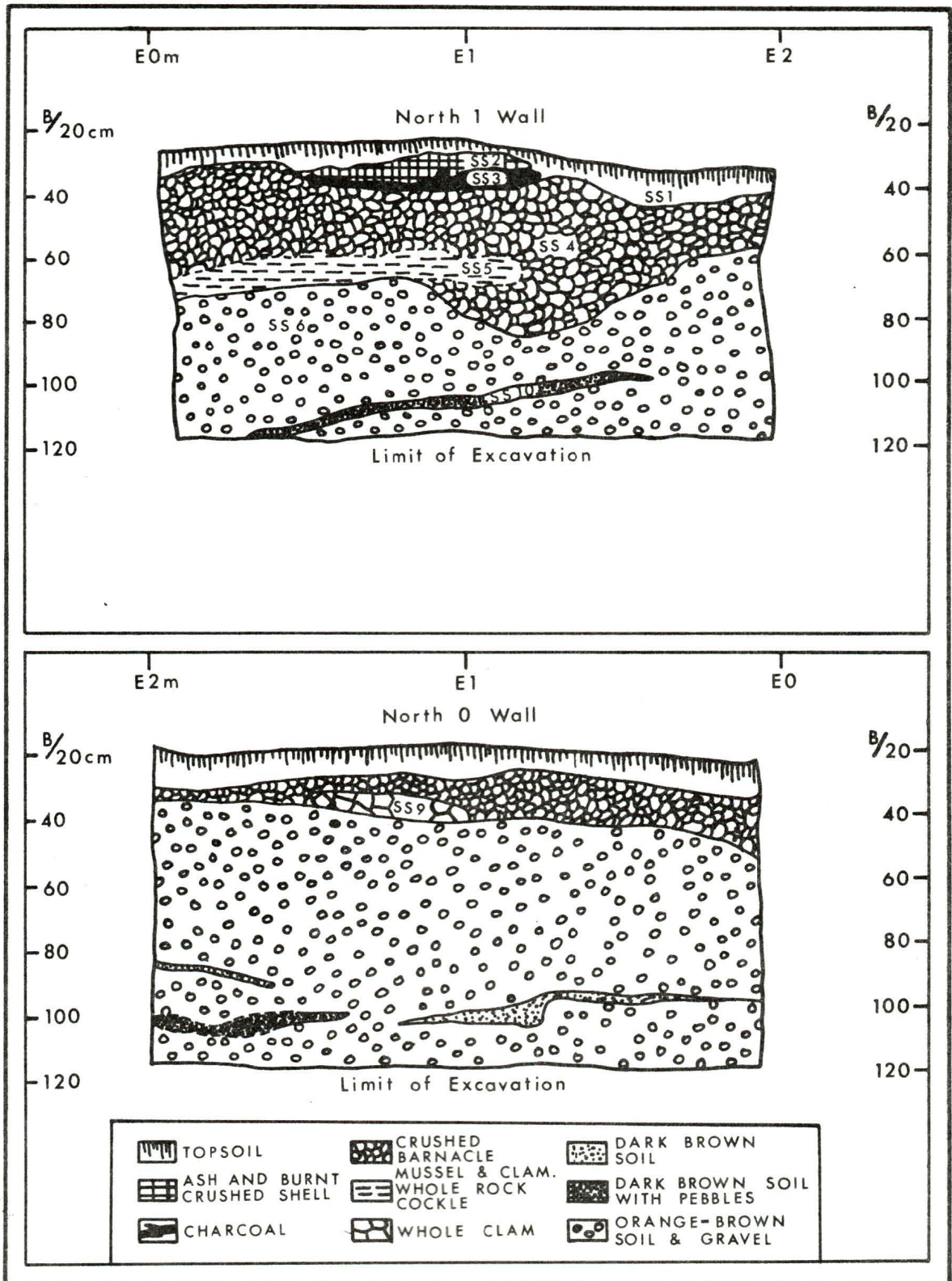


Figure 16. Excavation profiles of North 1 and 0 metre walls, showing soil sample locations, Tsable River Bridge, 1973.

TABLE XX

Fraction of Annual Growth at Death by
 Undisturbed Clams, in the Soil Samples,
 Excavation Unit 2, Tsable River Bridge, 1973 *

Soil Sample	Fraction of Annual Growth at Death								Disturbed		TOTAL
	0-1/4		1/4-1/2		1/2-3/4		3/4-1		No.	%	N
	No.	%	No.	%	No.	%	No.	%			
4	0	0	1	100	0	0	0	0	0	0	1
5	5	62.5	3	37.5	0	0	0	0	0	0	8
9	2	28.5	3	43	0	0	0	0	2	28.5	7
TOTAL	7	44	7	44	0	0	0	0	2	12	16

* Soil Samples 4 and 9 consist of Butter clams, and Soil Sample 5 consists of Rock cockles.

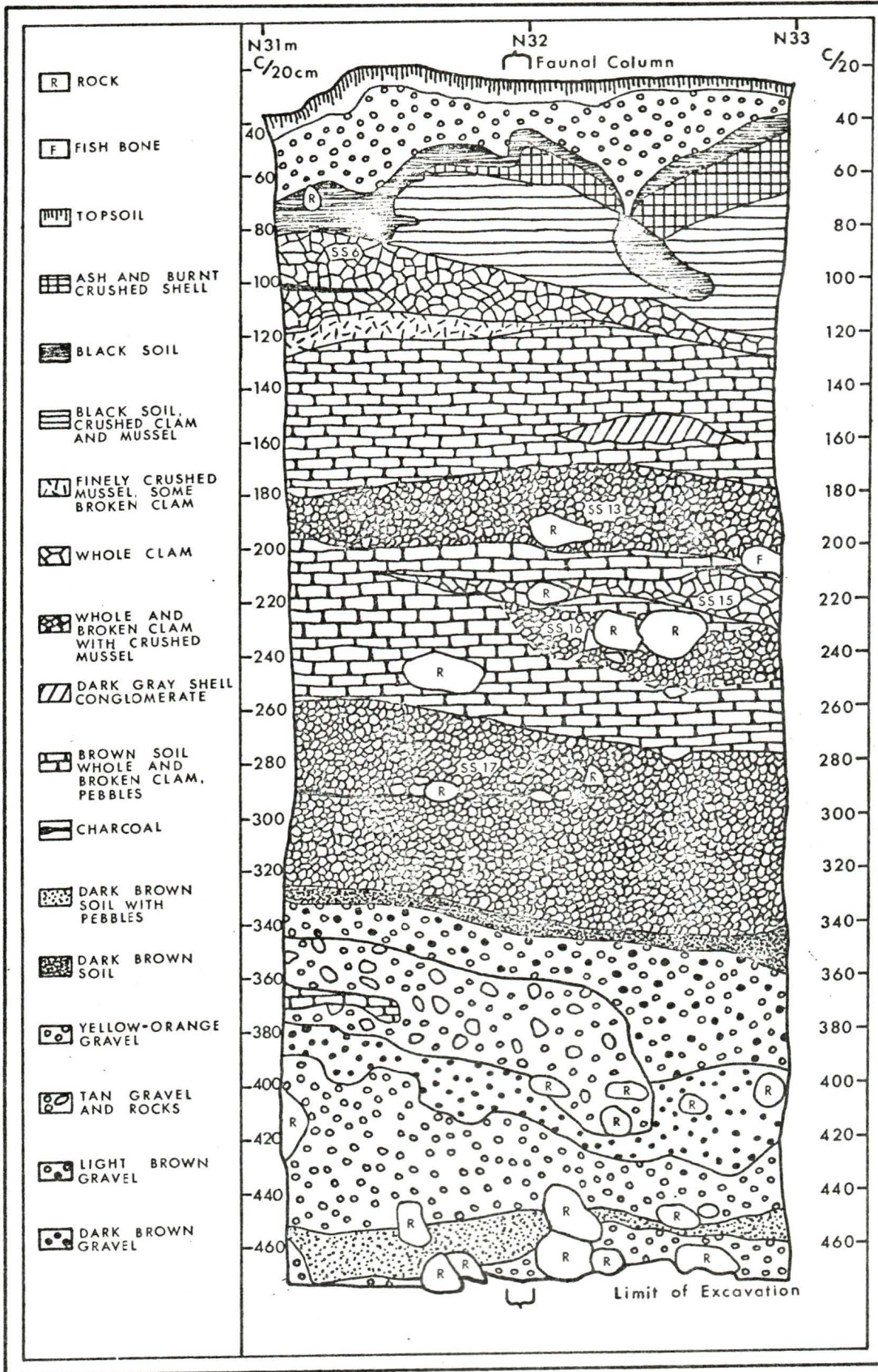


Figure 17. Excavation profile of West 2 metre wall, Excavation Unit 3, showing soil sample and faunal column sample locations, Tsable River Bridge, 1973.

TABLE XXI

Fraction of Annual Growth at Death, by Undisturbed Clams, in the
Faunal Column, Excavation Unit 3, Tstable River Bridge, 1973

Faunal Sample	Fraction of Annual Growth at Death										TOTAL N
	0-1/4		1/4-1/2		1/2-3/4		3/4-1		Disturbed		
	No.	%	No.	%	No.	%	No.	%	No.	%	
1	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0
3	3	21.5	1	7	7	50	1	7	2	14	14
4, 5	6	46	5	38.5	0	0	0	0	2	15.5	13
{ 6 *	10	32	8	26	7	23	1	3	5	16	31
{ 7	15	31	13	27	2	4	0	0	18	38	48
{ 8	0	0	7	39	2	11	1	6	8	44	18
{ 9	0	0	0	0	0	0	0	0	1	100	1
{ 10	1	6	2	13	1	6	4	25	8	50	16
{ 11 *	5	16	5	16	4	13	0	0	17	55	31
{ 12 *	1	33	1	33	0	0	0	0	1	33	3
{ 13 *	1	5.5	5	28	4	22	2	11	6	33.5	18
{ 14	4	15.5	5	19	5	19	3	11.5	9	35	26
{ 15 *	6	19	3	9	6	19	3	9	14	44	32
{ 16	8	24	8	24	3	9	0	0	14	42.5	33
{ 17	3	16.5	2	11	5	28	1	5.5	7	39	18
{ 18	4	22	1	5.5	4	22	0	0	9	50	18
19	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0
TOTAL	67	21	66	20.5	50	15.5	16	5	121	38	320

* See Table XXII for additional specimens from the Soil Samples.

TABLE XXII

Fraction of Annual Growth at Death by Undisturbed Clams, in the Soil
Samples, Excavation Unit 3, Tsable River Bridge, 1973

Faunal Sample Relat'n	Soil Sample	Fraction of Annual Growth at Death										TOTAL N
		0-1/4		1/4-1/2		1/2-3/4		3/4-1		Disturbed		
		No.	%	No.	%	No.	%	No.	%	No.	%	
6	6	3	20	6	40	1	7	0	0	5	33	15
11	13	0	0	0	0	1	50	1	50	0	0	2
{ 12	15	0	0	3	25	6	50	1	8	2	17	12
{ 13	16	0	0	3	60	0	0	1	20	1	20	5
15	17	1	16.5	0	0	1	16.5	1	16.5	3	50	6
TOTAL		4	10	12	30	9	22.5	4	10	11	27.5	40

TABLE XXIII

Species Distributed and Fraction of Annual Growth at Death for Clams, in the
Soil Samples, Excavation Unit 3, Tsable River Bridge, 1973

Soil Sample	Fraction of Annual Growth at Death										TOTAL	
	0-1/4		1/4-1/2		1/2-3/4		3/4-1		Disturbed		BC	LN
	BC	LN	BC	LN	BC	LN	BC	LN	BC	LN		
6	2	1	4	2	1	0	0	0	1	4	8	7
13	0	0	0	0	1	0	0	1	0	0	1	1
15	0	0	2	1	6	0	1	0	1	1	10	2
16	0	0	1	2	0	0	0	1	0	1	1	4
17	0	1	0	0	1	0	1	0	2	1	4	2
TOTAL	2	2	7	5	9	0	2	2	4	7	24	16

TABLE XXIV

Species Distribution and Fraction of Annual Growth at Death for Clams,
in the Faunal Column, Excavation Unit 3, Tsable River Bridge, 1973

Faunal Sample	Fraction of Annual Growth at Death										TOTAL	
	0-1/4		1/4-1/2		1/2-3/4		3/4-1		Disturbed			
	BC	LN	BC	LN	BC	LN	BC	LN	BC	LN	BC	LN
1	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0
3	1	2	1	0	3	4	0	1	0	2	5	9
4, 5	4	2	1	4	0	0	0	0	0	2	5	8
{ 6	5	5	6	2	2	5	1	0	2	3	16	15
{ 7	11	4	9	4	2	0	0	0	5	13	27	21
{ 8	0	0	2	5	0	2	0	1	3	5	5	13
{ 9	0	0	0	0	0	0	0	0	1	0	1	0
{ 10	0	1	1	1	1	0	4	0	3	5	9	7
{ 11	1	4	5	0	2	2	0	0	6	11	14	17
{ 12	1	0	1	0	0	0	0	0	1	0	3	0
{ 13	1	0	2	3	4	0	1	1	1	5	9	9
{ 14	4	0	1	4	2	3	2	1	4	5	13	13
{ 15	2	4	2	1	6	0	2	1	6	8	18	14
{ 16*	4	4	3	4	3	0	0	0	5	9	15	17
{ 17	0	3	2	0	4	1	0	1	1	6	7	11
{ 18	1	3	0	1	0	4	0	0	1	8	2	16
19	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	35	32	36	29	29	21	10	6	39	82	149	170

* There was one Rock cockle specimen in Faunal Sample 16 that had completed 1/4-1/2 of its average annual breadth growth too.

TABLE XXV

Species Percentages Distribution of Undisturbed Clams by Species, Strata, and Fraction of Growth Past the Last Winter Ring, From the Faunal Column and Soil Samples, Excavation Unit 3, Tsable River Bridge, 1973

Faunal Samples	Fraction of Annual Growth at Death								TOTAL		
	0-1/4		1/4-1/2		1/2-3/4		3/4-1		BC	LN	N
	BC	LN	BC	LN	BC	LN	BC	LN			
3	8	17	8	0	25	34	0	8	42	58	12
4, 5	36.5	18	9	36.5	0	0	0	0	45	55	11
6, 7	27	15	29	12	8	8	1	0	65	35	66
8, 9	0	0	20	50	0	20	0	10	20	80	10
10, 11	4	21	25	4	17	8	17	4	62.5	37.5	24
12-14	13	0	16	22	27	7	9	7	64	36	45
15-18*	12	25	12	10*	23	8	5	3	52	46	60*
20-24	0	0	0	0	0	0	0	0	0	0	0
TOTALS	16	15	19	15	16	8	5	4	56	42	228
	31%		36%*		24%		9%		100%		

* Include 1 Rock cockle specimen in Faunal Sample 16 (2%) that had completed 1/4-1/2 of its annual breadth growth.

TABLE XXVI

Species Numbers and Percentages of Umbos, for all Clams, in the
Faunal Column, Excavation Unit 3, Tstable River Bridge, 1973

Faunal Samples	Umbos by Clam Species						TOTAL N
	Butter Clam		Littleneck		Rock Cockle		
	No.	%	No.	%	No.	%	
3	34	47	27	38	11	15	72
4, 5	84	39	125	59	5	2	214
6, 7	133	40	178	54	18	6	329
8, 9	54	37	82	56	10	7	146
10, 11	142	43	170	52	17	5	329
12-14	120	38	187	60	6	2	313
15-18	171	33	299	57	51	10	521
20-24	8	100	0	0	0	0	8
TOTALS	746	39	1068	55	118	6	1932

TABLE XXVII

Fraction of Annual Growth at Death, by Undisturbed Clams, in the
Faunal Column, Excavation Unit 3, Tstable River Bridge, 1973

Faunal Sample	Fraction of Annual Growth at Death								Disturbed		TOTAL N	
	0-1/4		1/4-1/2		1/2-3/4		3/4-1		No.	%		
	No.	%	No.	%	No.	%	No.	%	No.	%		
1	0	0	0	0	0	0	0	0	0	1	100	1
{ 2 *	0	0	0	0	0	0	0	0	0	3	100	3
{ 3	4	23	3	18	3	18	0	0	7	41		17
{ 4 *	2	9	2	9	7	32	2	9	9	41		22
{ 5	2	8	1	4	6	24	4	16	12	48		25
{ 6	0	0	1	8	2	15	0	0	10	77		13
{ 7	1	2	4	8.5	22	47	1	2	19	40.5		47
{ 8	5	9	3	5	17	30	3	5	29	51		57
{ 9	1	1.5	7	11.5	19	31.5	2	3	31	51.5		60
{ 10 *	4	6	4	6	11	16	4	6	45	66		68
{ 11	3	4.5	13	19.5	6	9	4	6	41	61		67
{ 12	3	5	10	16.5	12	20	2	3.5	33	55		60
{ 13	3	6	14	27.5	7	14	8	15.5	19	37		51
{ 14	5	8	14	23.5	6	10	12	20	23	38.5		60
{ 15	1	20	1	20	1	20	0	0	2	40		5
{ 16	0	0	0	0	0	0	1	25	3	75		4
{ 17	0	0	0	0	0	0	0	0	0	0		0
{ 18	0	0	1	20	2	40	0	0	2	40		5
{ 19	1	50	1	50	0	0	0	0	0	0		2
{ 20	0	0	1	50	0	0	0	0	1	50		2
TOTAL	35	6	80	14	121	21.5	43	7.5	290	51		569

* See Table XXVII for additional specimens from the Soil Samples.

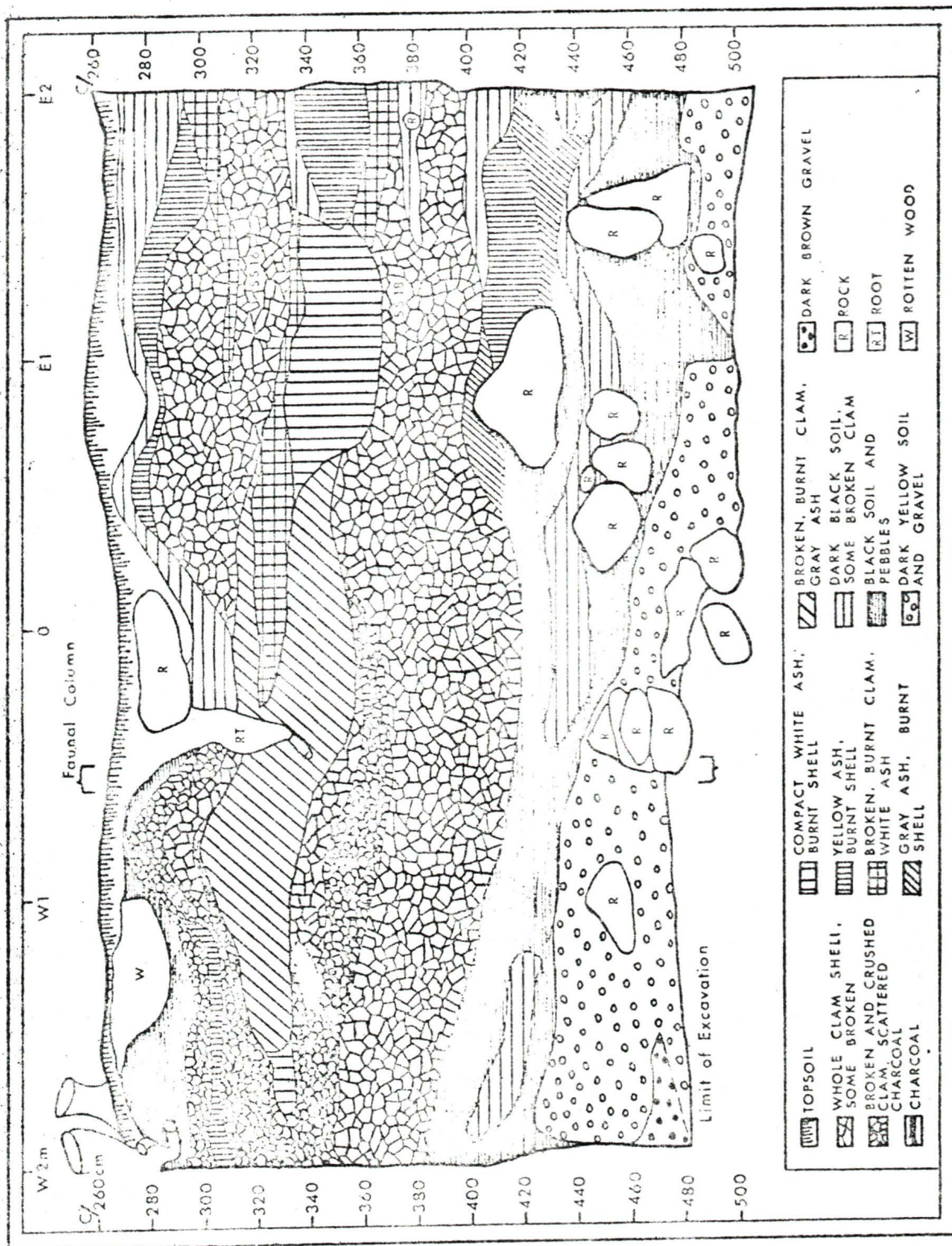


Figure 18. Excavation profile of North 56 metre wall, Excavation Unit 4, showing faunal column sample and soil sample locations, Tsable River Bridge, 1973.

TABLE XXVIII

Fraction of Annual Growth at Death by Undisturbed Clams in the Soil Samples,
Excavation Unit 4, Tsable River Bridge, 1973

SS*	FS	Fraction of Annual Growth at Death										TOTAL N
		0-1/4		1/4-1/2		1/2-3/4		3/4-1		Disturbed		
		No.	%	No.	%	No.	%	No.	%	No.	%	
13	2	1	50	1	50	0	0	0	0	0	0	2
16	4	1	11	2	22	2	22	0	0	4	44.5	9
18	10	0	0	2	29	1	14	0	0	4	57	7
TOTAL		2	11	5	28	3	16.5	0	0	8	44.5	18

* SS stands for Soil Sample and FS stands for Faunal Sample: the SS is from the same stratum as the FS.

TABLE XXIX

Species Distribution and Fraction of Annual Growth at Death for Clams, in the
Soil Samples, Excavation Unit 4, Tsable River Bridge, 1973

SS	FS	Fraction of Annual Growth at Death										TOTAL	
		0-1/4		1/4-1/2		1/2-3/4		3/4-1		Disturbed		BC	LN
		BC	LN	BC	LN	BC	LN	BC	LN	BC	LN		
13	2	0	1	0	1	0	0	0	0	0	0	0	2
16	4	0	1	1	1	2	0	0	0	3	1	6	3
18	10	0	0	1	1	0	1	0	0	0	4	1	6
TOTAL		0	2	2	3	2	1	0	0	3	5	7	11

TABLE XXX

Species Distribution and Fraction of Annual Growth at Death for Clams,
in the Faunal Column, Excavation Unit 4, Tsable River Bridge, 1973

Faunal Sample	Fraction of Annual Growth at Death										TOTAL	
	0-1/4		1/4-1/2		1/2-3/4		3/4-1		Disturbed			
	BC	LN	BC	LN	BC	LN	BC	LN	BC	LN	BC	LN
1	0	0	0	0	0	0	0	0	0	1	0	1
{ 2	0	0	0	0	0	0	0	0	3	0	3	0
{ 3	3	1	2	1	1	2	0	0	1	6	7	10
{ 4	2	0	2	0	6	1	2	0	4	5	16	6
{ 5	1	1	1	0	6	0	2	2	6	6	16	9
{ 6	0	0	0	1	0	2	0	0	2	8	2	11
{ 7	0	1	0	4	15	7	1	0	5	14	21	26
{ 8	2	3	1	2	7	10	3	0	13	16	26	31
{ 9	0	1	2	5	14	5	2	0	12	19	30	30
{ 10	2	2	1	3	2	9	0	4	12	33	17	51
{ 11*	0	2	2	11	5	1	3	1	11	30	21	45
{ 12	2	1	5	5	7	5	2	0	14	19	30	30
{ 13	0	3	7	7	1	6	6	2	5	14	19	32
{ 14	0	5	3	11	6	0	5	7	7	16	21	39
{ 15	0	1	0	1	1	0	0	0	0	2	1	4
{ 16	0	0	0	0	0	0	0	1	0	3	0	4
{ 17	0	0	0	0	0	0	0	0	0	0	0	0
{ 18	0	0	0	1	1	1	0	0	2	0	3	2
{ 19	0	1	1	0	0	0	0	0	0	0	1	1
{ 20	0	0	0	1	0	0	0	0	1	0	1	1
TOTAL	12	22	27	53	72	49	26	17	98	192	235	333

* There was one Rock cockle specimen in Faunal Sample 11 that had completed 0-1/4 of its average annual breadth growth too.

TABLE XXXI

Species Percentages Distribution of Undisturbed Clams by Fraction of Annual Growth At Death, From the Faunal Column and Soil Samples, Excavation Unit 4, Tstable River Bridge, 1973

Faunal Samples	Fraction of Annual Growth at Death								TOTAL		
	0-1/4		1/4-1/2		1/2-3/4		3/4-1				
	BC	LN	BC	LN	BC	LN	BC	LN	BC	LN	N
1	0	0	0	0	0	0	0	0	0	0	0
2-4	17	10	17	10	30	10	7	0	70	30	30
5-7	2	5	2	11	48	20	7	5	59	41	44
8-14*	3	8	11	22	20.5	18	10	7	44.5	55	205*
15, 16	0	25	0	25	25	0	0	25	25	75	4
17-20	0	17	17	33	17	17	0	0	33	67	6
TOTALS	4	8	10	19	25.5	18	9	6	48.5	51	289
	12.5%*		29%		43.5%		15%		100%*		

* Includes 1 Rock cockle specimen in Faunal Sample 11 (5%) that had completed 0-1/4 of its annual breadth growth.

TABLE XXXII

Species Numbers and Percentages of Umbos, for all Clams, in the
Faunal Column Excavation Unit 4, Tsable River Bridge, 1973 *

Faunal Samples	Umbos by Clam Species						TOTAL No.
	Butter Clam		Littleneck		Rock Cockle		
	No.	%	No.	%	No.	%	
1	0	0	0	0	0	0	0
2-4	83	56	64	43	2	1	149
5-7	124	37	204	61	6	2	334
8-14	330	30	752	68	19	2	1101
15, 16	7	29	15	63	2	8	24
17-20	8	53	7	47	0	0	15
TOTAL	552	34	1042	64	29	2	1623

* The specimens in the above table that were used for the growth study are included in these figures.

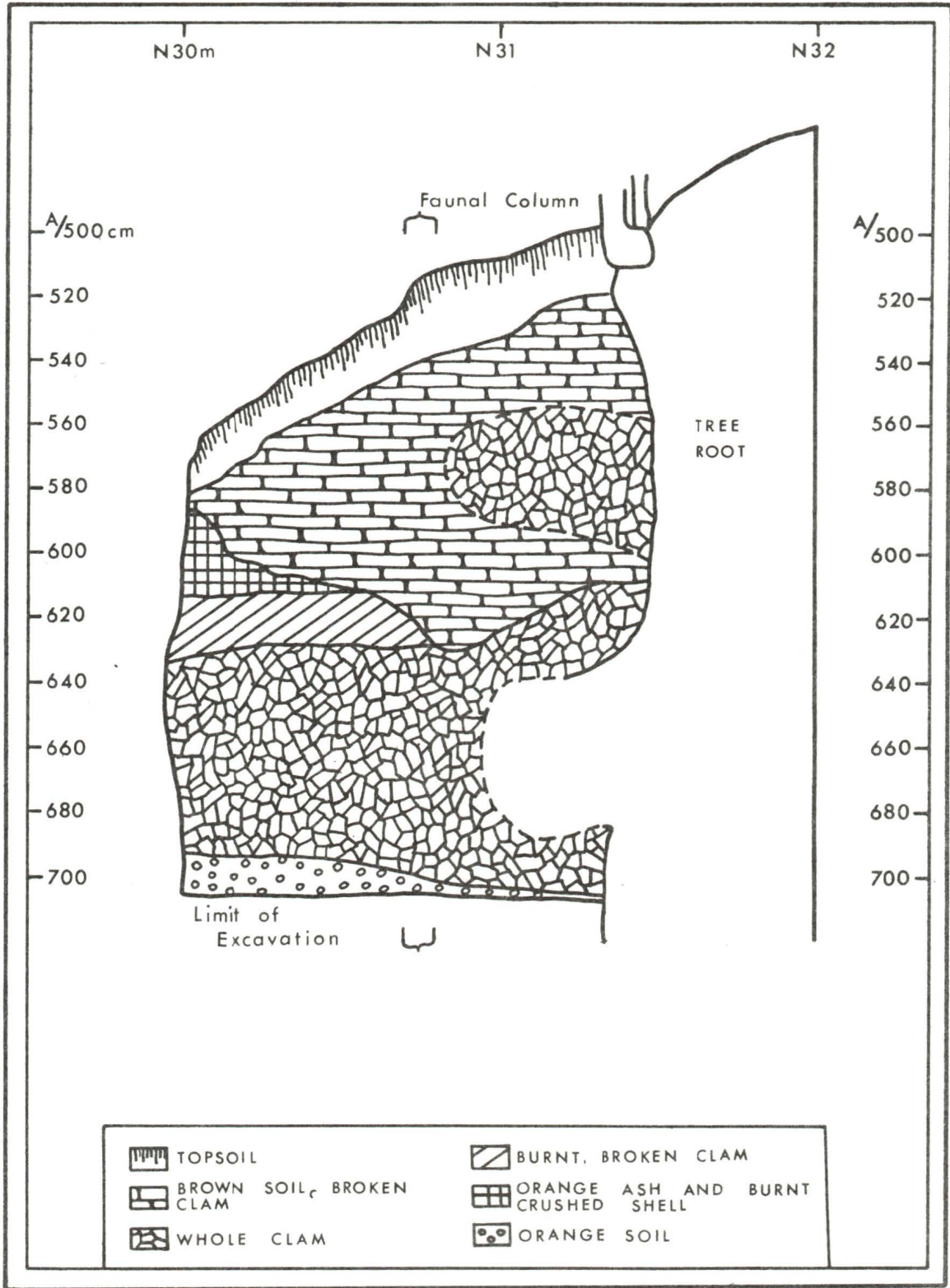


Figure 19. Excavation profile of East 14 metre wall, showing faunal column sample locations, Buckley Bay, 1973.

TABLE XXXIII

Fraction of Annual Growth at Death by Undisturbed Clams,
in the Faunal Column, Excavation Unit 4, Buckley Bay, 1973

Faunal Sample	Fraction of Annual Growth at Death								Disturbed		TOTAL N
	0-1/4		1/4-1/2		1/2-3/4		3/4-1		No.	%	
	No.	%	No.	%	No.	%	No.	%	No.	%	
1	0	0	0	0	0	0	0	0	0	0	0
{ 2	0	0	2	29	0	0	1	14	4	57	7
{ 3	0	0	2	20	1	10	1	10	6	60	10
{ 4	1	25	1	25	0	0	0	0	2	50	4
{ 5	0	0	1	33	0	0	0	0	2	67	3
6	0	0	2	33	0	0	0	0	4	67	6
{ 7	0	0	13	45	3	10	2	7	11	38	29
{ 8	4	11	10	26	3	8	0	0	21	55	38
{ 9	5	10.5	13	27	8	16.5	1	2	21	44	48
10	0	0	0	0	0	0	0	0	0	0	0
TOTAL	10	7	44	30	15	10	5	4	71	49	145

TABLE XXXIV

Species Distribution and Fraction of Annual Growth at Death for Clams,
in the Faunal Column, Excavation Unit 4, Buckley Bay, 1973

Faunal Sample	Fraction of Annual Growth at Death										TOTAL	
	0-1/4		1/4-1/2		1/2-3/4		3/4-1		Disturbed			
	BC	LN	BC	LN	BC	LN	BC	LN	BC	LN	BC	LN
1	0	0	0	0	0	0	0	0	0	0	0	0
{ 2	0	0	2	0	0	0	1	0	1	3	4	3
{ 3	0	0	1	1	1	0	0	1	4	2	6	4
{ 4	0	1	0	1	0	0	0	0	2	0	2	2
{ 5	0	0	0	1	0	0	0	0	1	1	1	2
6	0	0	2	0	0	0	0	0	4	0	6	0
{ 7	0	0	11	2	3	0	2	0	8	3	24	5
{ 8	4	0	10	0	2	1	0	0	18	3	34	4
{ 9	5	0	9	4	5	3	1	0	17	4	37	11
10	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL	9	1	35	9	11	4	4	1	55	16	114	31

TABLE XXXV

Species Percentages of Undisturbed Clams by Fraction of Annual
Growth at Death, From the Faunal Column,
Excavation Unit 4, Buckley Bay, 1973

Faunal Samples	Fraction of Annual Growth at Death								TOTAL		
	0-1/4		1/4-1/2		1/2-3/4		3/4-1				
	BC	LN	BC	LN	BC	LN	BC	LN	BC	LN	N
1	0	0	0	0	0	0	0	0	0	0	0
2-5	0	10	30	30	10	0	10	10	50	50	10
6	0	0	100	0	0	0	0	0	100	0	2
7-9	14.5	0	48	10	16	6.5	5	0	84	16	62
10	0	0	0	0	0	0	0	0	0	0	0
TOTALS	12	1.5	47	12	15	5.5	5.5	1.5	80	20	74
	13.5%		59%		20.5%		7%		100%		

TABLE XXXVI

Species Numbers and Percentages of Umbos, for all Clams, in the Faunal
Column, Excavation Unit 4, Buckley Bay, 1973 *

Faunal Samples	Umbos by Clam Species						TOTAL N
	Butter Clam		Littleneck		Rock Cockle		
	No.	%	No.	%	No.	%	
1	2	67	1	33	0	0	3
2-5	195	67	88	30	9	3	292
6	33	72	11	24	2	4	46
7-9	213	68	91	29	8	3	312
10	0	0	0	0	0	0	0
TOTALS	443	68	191	29	19	3	653

* The specimens in the above table that were used for the growth study are included in these figures.

TABLE XXXVII

Clams Species Distribution in Nos. and %'s From Thirty-Two Beaches
(Between Victoria and Nanaimo), Collected by Fraser, 1926 and 1927*

Beach	Butter Clam		Littleneck		Rock Cockle		TOTAL
	No.	%	No.	%	No.	%	N
1	115	76	33	22	3	2	151
2	21	23	48	52	23	25	92
3	50	94	2	4	1	2	53
4	14	31	4	9	27	60	45
5	294	83	9	3	50	14	353
6	11	19	0	0	47	81	58
7	74	89	5	6	4	5	83
8	31	49	9	14	23	37	63
9	35	95	2	5	0	0	37
10	57	41	78	57	3	2	138
11	75	60	48	38	3	2	126
12	58	12	379	80	37	8	474
13	4	4	88	80	18	16	110
14	275	41	336	51	52	8	663
15	83	21	161	41	150	38	394
16	23	19	100	81	0	0	123
17	32	34	28	30	33	36	93
18	11	25	24	53	10	22	45
19	199	41	256	53	29	6	484
20	37	27	96	69	5	4	138
21	54	40	81	60	0	0	135
22	241	38	395	62	0	0	636
23	40	46	44	51	3	3	87
24	96	32	171	58	29	10	296
25	51	41	49	40	24	19	124
26	50	38	39	29	44	33	133
27	67	52	41	31	22	17	130
28	24	21	63	55	27	24	114
29	34	23	86	57	30	20	150
30	24	75	8	25	0	0	32
31	55	45	56	46	11	9	122
32	288	50	236	41	52	9	576
TOTALS	2523	40	2975	48	760	12	6258

* These figures exclude the bivalves less than one year old (Fraser 1928, 1931).

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