

# The origin and interpretation of Bahia la Choya (Northern Gulf of California) taphocoenoses: implications for paleoenvironmental analysis

By  
FRANZ T. FÜRSICH and KARL W. FLESSA\*

With 2 Figures in the text

## ABSTRACT

The analysis of ecological and taphonomic data preserved in skeletal elements of the benthic macrofauna of the Bahia la Choya macrotidal complex permits fine-scale discrimination

of environments. Despite certain limitations, the combined paleoecological and taphonomic approach is a powerful tool for the recognition and interpretation of paleoenvironments.

## ZUSAMMENFASSUNG

Die ökologische und taphonomische Analyse der schalenragenden benthonischen Makrofauna von Bahia la Choya erlaubt eine Feingliederung des Gezeitenbereichs der Bucht (vom flachen Subtidal bis zur supratidalen Marsch). Trotz ge-

wisser Einschränkungen ist der kombinierte palökologische und taphonomische Ansatz sehr gut dafür geeignet, fossile Ablagerungsräume zu erkennen und zu analysieren.

## INTRODUCTION

The taxonomic and ecological composition, the taphonomic signatures, and the distribution pattern of the shelly macrobenthos of the tidal flats of Bahia la Choya and of adjacent Pleistocene rocks have been described in detail (ABERHAN & FÜRSICH, FEIGE & FÜRSICH, FLESSA & FÜRSICH, FÜRSICH & SCHODLBAUER; all this volume). An outline of the physical environment of this macrotidal system near the head of the Gulf of California can be found in FÜRSICH et al. (this volume). In this paper we focus on the implications that our results have for paleoenvironmental analysis in general.

According to our studies of the shelly macrofauna of the Bahia la Choya tidal flat complex, composition and taphonomic characteristics of the taphocoenoses are affected by three major factors (Fig. 1):

- (1) original species composition and relative abundance,
- (2) taphonomic processes, and
- (3) time.

In the following, we discuss the impact of each of these factors and conclude with a discussion of the limitations and strengths of our approach.

## ORIGINAL SPECIES COMPOSITION AND RELATIVE ABUNDANCE

Original species composition and relative abundance of taxa at Bahia la Choya are controlled by a number of abiotic

factors, the most important of which are substrate (in particular consistency and degree of stability), food distribution, duration of subaerial exposure, and energy level (FÜRSICH & SCHODLBAUER, this volume). The same factors control the distribution of trophic and substrate adaptations, that is the type of feeding and the mode of life. Of the biotic factors, chance settlement of larvae and settlement of opportunistic species

\* K. W. FLESSA, Department of Geosciences, University of Arizona, Tucson, AZ 85 721, USA; F. T. FÜRSICH, Institut für Paläontologie der Universität Würzburg, Pleicherwall 1, W-8700 Würzburg, Germany

are thought to be important. Finally, historic factors should not be overlooked, as they are responsible for composition of the species pool in the northern Gulf of California and for the affiliation of the fauna with the Panamic faunal province.

All these factors regulate a moderately diverse molluscan fauna, dominated by suspension-feeding bivalves and detri-

tus-feeding/herbivorous gastropods. The fauna decreases in diversity from the shallow subtidal to the supratidal as a result of increasing environmental stress in the same direction. In contrast, the density of live fauna is highest in the supratidal marsh and inner tidal flats (caused by abundant herbivorous and detritus-feeding gastropods) and decreases seaward.

## TAPHONOMIC PROCESSES

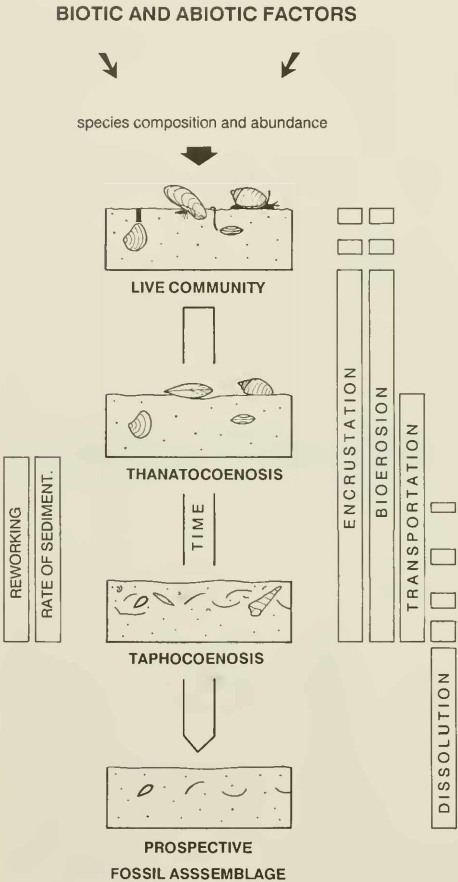


Fig. 1: Factors responsible for the transition from the live community to the prospective fossil assemblage in the tidal flat complex at Bahía la Choya.

In general, taphonomic processes have differential effects on different species depending on size, mineralogy and mechanical strength of the hardparts as well as on life habits (e. g. infaunal versus epifaunal) (FEIGE & FÜRSTICH, this volume). This leads to changes in the relative abundance of species in taphocoenoses. In the following, the impact of the various taphonomic agents on the skeletal elements of the Bahía la Choya fauna is briefly discussed.

### Transportation

Despite the high tidal range and resulting strong tidal currents, between-habitat transport of shells by physical agents is limited and largely confined to the main tidal channel. There, shells of taxa indicative of marsh and inner flat areas (e. g. *Cerithidea*, *Tagelus*) are transported in an offshore direction. Transport of gastropod shells (mainly *Cerithium*) is, in addition, caused by a biological agent, i. e. hermit crabs. This biogenic transport largely takes place in the mid channel area where most hermit crabs live. Another mode of transport, shell-floating, occurs when dried, convex-up shells are floated and carried landward on the incoming tide. However, this is not a volumetrically significant factor.

Transport can mainly be recognised by abrasion and the resulting loss of shell ornament, and by breakage. The activity of hermit crabs is indicated by selective abrasion caused by the shells being dragged across the surface in a certain position. In addition, ecological analysis of the faunal composition may reveal transported shells, if they represent modes of life not in accordance with that of the remaining fauna (e. g. elements of marsh fauna in outer flat environments). Finally, biofabric and orientation patterns (e. g. preferred convex-up orientation) of shells give hints as to the influence of currents and hence transport.

### Abrasion and breakage

Abrasion and breakage frequently occur in association with transport, but – largely when due to wave influence – may also occur within habitats. Not surprisingly, the highest degrees of abrasion and fragmentation occur in the tidal channel and in the outer flat region close to the breaker zone.

Abrasion of skeletal elements is strongly controlled by their shape (e. g. gastropod shells roll more easily than bivalves) and microarchitecture and depends on whether the shells are inhabited by hermit crabs (such gastropod shells are better preserved). Physical abrasion is often difficult to distinguish from bioerosion caused by endophytes. In addition, physical abrasion frequently destroys evidence of other taphonomic agents such as boring or encrustation.

Breakage is caused either by physical agents or by predatory organisms such as sea gulls, fish, and crabs. Biotic breakage patterns may be quite distinct. Breakage is greatly facilitated by a high degree of abrasion, maceration, and boring.

The taphonomic imprints left by abrasion and breakage are usually easily recognised and consist of broken or partly fragmented shells and loss of luster and shell ornament.

## Bioerosion

Boring organisms include predators such as naticid and muricid gastropods and *Octopus*. The more or less circular holes they create are fairly diagnostic of their producers. This allows identification of fossil boreholes in many cases. Most borings, however, are created to provide protection for the producer. At Bahía la Choya such borings include the U-shaped tunnels of sponiid polychaetes, interconnected chambers of clionid sponges, club-shaped cavities of bivalves, and the delicate imprints of ctenostome bryozoans (FIGGE & FURSICH, this volume). Also very abundant are the minute tunnel systems of endophytes (algae, bacteria, and fungi). Their effect on shells is often difficult to distinguish from that of mechanical erosion (see above).

Erosion caused by boring organisms is a widespread feature on shells of the Bahía la Choya tidal flat. It is most pronounced in the outer flat and still common in shells from mid flat and outer to mid channel areas. There is a clear positive correlation between degree of bioerosion and residence time of shells on the sediment and therefore an inverse relationship between degree of bioerosion and rate of net sedimentation. The abundance of borings is also correlated with the period of time shells are submerged and with the mode of life of the host (epifaunal versus infaunal).

## Encrustation

The most important encrusting organisms are serpulids, bryozoans, vermetid gastropods, balanids, foraminifera, and crustose coralline algae. Their preservation potential depends on skeletal mineralogy (e. g. aragonite versus calcite) and durability as well as on the preferred site of colonisation (organisms that preferentially encrust the umbonal cavity of bivalves fare better than those encrusting the shell exterior). The preservation potential of encrusters strongly depends on the degree of abrasion and bioerosion the encrusted shells are subject to. On the other hand, encrustation enhances the preservation potential of the host shell. Encrustation may protect the shell from breakage, abrasion, and bioerosion.

Encrustation is most abundant on the outer shelf and in the tidal channel. There is a clear relationship – as in the case of borers – with low rates of net sedimentation and time of submergence. Furthermore, epifaunal species are more subject to encrustation than infaunal ones, as the former can be encrusted while alive, whereas in the latter encrustation only takes place post-mortem and requires exhumation.

## Dissolution

At Bahía la Choya dissolution of shells only occurs in the channel draining the salt marsh (estero channel) and in the salt marsh itself. Dissolution can be explained by the acidic pore water of the marsh sediments. Apart from showing solution pits and general loss of shell substance, many of the shells have a chalky appearance caused by maceration. In some cases dissolution apparently starts while the shells are alive, but continues after burial. It is a process that generally takes considerably more time than any of the taphonomic processes discussed earlier.

The distinctive texture and features caused by dissolution often oversprint and obliterate other taphonomic features such as abrasion, bioerosion, and encrustation.

## Reworking

Reworking is either caused by physical or biological processes and is related therefore to the energy level, the rate of net sedimentation or the population density of infaunal organisms. In many cases reworking results in the formation of skeletal concentrations. At Bahía la Choya three time frames of reworking can be recognised:

- (1) short term ( $10^1$  to  $10^3$  yrs),
- (2) medium term ( $10^3$  yrs), and
- (3) long term ( $10^4$  to  $10^5$  yrs).

Short term reworking refers to bioturbation, migration of tidal channels, storm erosion and redeposition. This time frame can be recognised by burrows, erosion surfaces, and the biofabric of skeletal concentrations. Short term reworking is an ubiquitous feature across the tidal flat, channel, and marsh. Physical processes dominate in the outer to mid shelf areas and the channel, whilst biological agents are more pronounced in inner flat and marsh.

Reworking over intermediate time frames is caused by erosion of skeletal elements from the shelly spit and their incorporation in the Recent fauna of the tidal flat or salt marsh. This process can be recognised by ecological incompatibility of faunal elements and by their different taphonomic signatures. An example of ecological incompatibility is the presence of lower intertidal to subtidal taxa such as *Dosinia* and *Pteria* in sediments of the salt marsh or the salt marsh channel ("estero"). An example of a distinctive taphonomic signature is the typical abrasion texture exhibited by taxa from the spit. Due to a different taphonomic history shells of the gastropod *Cerithidea* from the spit are strongly polished and can easily be distinguished from *Cerithidea* shells of the inner flat or marsh which – even when strongly abraded – lack the smooth surface of the spit specimens.

Reworking representing long periods of time is caused by erosion of shells from the Pleistocene rocks that surround Bahía la Choya and those that crop out particularly in the northern part of the bay. Pleistocene components are most easily recognised by their matrix that still adheres to shells and differs in composition and degree of lithification from Recent sediments. Pleistocene shells eroded from the banks of the estero channel differ by being highly chalky and by having lost luster and color. They also differ drastically in composition from the surrounding salt marsh and estero channel fauna (FURSICH & FLESSA 1987).

## Rate of sedimentation

Due to limited sediment input into the northern Gulf of California, rates of sedimentation at Bahía la Choya are rather low. Within the bay, net sedimentation rates approach zero in the northern part, but are higher in the southern part, particularly in the inner flat. The low rate of net sedimentation strongly affects the residence time of shells on the sediment surface and thus the impact of taphonomic processes such as



bioerosion and encrustation. It is partly responsible for the high shell density across much of the tidal flats. Furthermore,

the rate of sedimentation decisively influences the degree of time-averaging of the fauna (see below).

## TIME

The time factor is closely related to sedimentation rate and rate of shell production and thus influences the shell density as well as the intensity of many taphonomic features. Time-averaging, the mixing of skeletal elements of non-contemporaneous populations or communities (WALKER & BAMBACH 1971), is consequently common and widespread in Bahía la Choya. The time span involved is up to 100 000 years (in the case of reworked Pleistocene skeletal elements); more often a time range of several thousand years is represented (MELDAHL 1987). Time-averaging is caused either by physical reworking of the sediment in conjunction with extremely low net sedimentation rates, or else by biological reworking (e.g. by populations of the ghost shrimp *Callinassa* on the inner flat – see MELDAHL 1987). Time-averaging is easily recognised in the case of introduction of shells from the Pleistocene or from the subrecent spit where either the taphonomic signatures differ substantially or else ecological incompatibility exists. In these cases, time-averaging is, strictly speaking, allochthonous (FURSICH & ABERHAN 1990). Short autochthonous time-averaging is recognised, for example, by the abundance of the small bivalve *Parivulcina mazatlanica* in taphocoenoses of the outer to midflat, whilst in the living communities this bivalve is extremely rare.

The use of faunal composition to infer time-averaging is, however, strongly limited in the fossil record where the precise composition of living assemblages is often not known. In such cases time-averaging may be recognised by using the frequency distribution of the taphonomic condition of the skeletal elements. Fig. 2 shows schematically four “taphograms” of skeletal elements (comparable to psychograms of human populations) from hypothetical samples. In our opinion, they allow inferences about the presence/absence and intensity of time-averaging.

In taphogram A all skeletal elements are poorly preserved and exhibit a narrow peak along the preservation gradient. This implies that the rate of shell destruction is much higher than the rate of shell production. Such a taphogram could result from transport or winnowing and generally reflects a uniform taphonomic history of the shells. Time-averaging cannot be inferred. If however shell distribution along the preservation gradient is polymodal, then this will most likely reflect discontinuous time-averaging (FURSICH & ABERHAN 1990).

Taphogram B shows a broad distribution of shells with a modest peak at poor conditions. Here, the rate of destruction is higher than the rate of shell production. The presence of many different modes of preservation reflects different taphonomic histories and is thus indicative of time-averaging.

In taphogram C we encounter a broad distribution of shells along the preservation gradient with a modest peak at good condition. This is a result of the rate of shell production being higher than the rate of destruction. As argued for taphogram

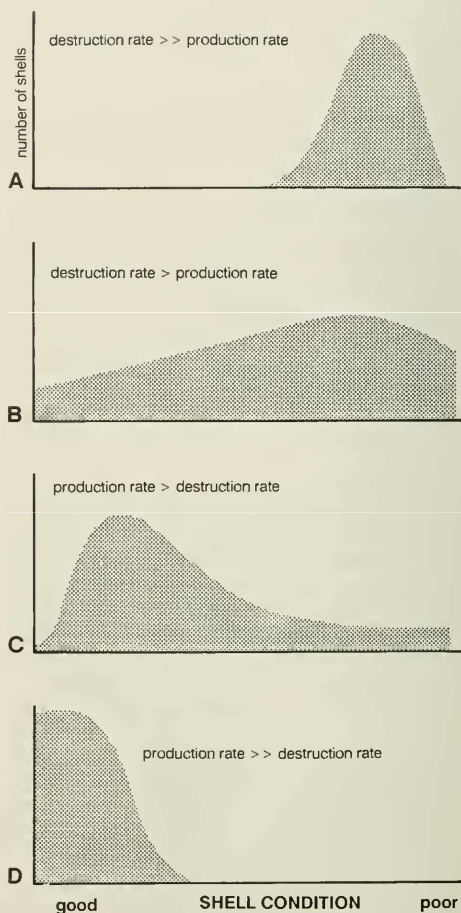


Fig. 2: Model of the frequency distribution of the taphonomic condition of skeletal elements (“taphograms”). For explanation see text.

B, the presence of different modes of preservation reflects time-averaging.

Finally, taphogram D exhibits a narrow peak and all shells are well preserved. The rate of shell production by far exceeds the rate of shell destruction. Such conditions result for example from rapid burial of shells. The lack of an extensive and varied taphonomic history shows that time-averaging did not play any role.

Apart from the analysis of taphograms, there are additional lines of evidence that can be used to recognise time-averaging in Bahía la Choya and elsewhere in the fossil record and cru-

dely estimate the minimum length of time involved. They include cross-cutting borings in shells. This relationship implies filling of the first generation of boreholes with sediment and lithification of the fill, most likely during a burial phase of the shell, prior to subsequent attack by a second generation of borers. Another example is a partially eroded boring that is overgrown by epizoans. In this case substantial erosion involving a certain length of time has taken place between the two colonisation phases. Finally, shells with attached matrix

that differs from the surrounding sediment are another clear sign of non-contemporaneity and hence time-averaging.

Although not immediately apparent, the time factor exerts great influence on the composition and preservation of skeletal elements. For this not hundred thousands or even millions of years need to be involved, but a few thousand or even only a few hundred years will suffice, as the Bahia la Choya example shows.

## INTEGRATED APPROACH TO PALEOENVIRONMENTAL ANALYSIS

Paleoenvironmental analyses are usually carried out by sedimentologists. In the last few decades, the contribution paleoecologists and ichnologists can make to fine-tuning paleoenvironments has been recognised (e. g. SEILACHER 1967, DODD & STANTON 1981). In the last few years, taphonomy has been added as a tool to decipher environmental processes (e. g. BRETT & BAIRD 1986). In combining faunal and taphonomic substrate information with information from taphonomic signatures of skeletal elements (combining studies of biofacies and taphofacies), paleontology can significantly contribute to paleoenvironmental analysis. As our studies of the tidal flat complex at Bahia la Choya have shown, there are limitations to this approach in the fossil record: Life habit and trophic data (in particular of gastropods) may be difficult to retrieve, because information from living representatives or analogs is required. The time factor strongly influences diversity and other ecological data as do taphonomic processes that selectively remove components of the fauna. Taphonomic features may not be preserved, or may be thoroughly overprinted.

Set against these limitations are the strengths of the combined approach. Faunal and trophic data allow inferences about the distribution of food and its availability in the sediment versus the water column, and thus indirectly about the energy level. Faunal/trophic data yield also information about stress gradients caused by abiotic environmental factors such as oxygen, salinity, or time of subaerial exposure. Taphonomic features furnish information about the energy level, reworking events, degree of transport, rate of sedimentation, and time frames. Gaining an idea of the latter enables us to adequately interpret ecological data, in particular diversity.

The example of Recent sediments and Pleistocene rocks at Bahia la Choya illustrates that use of both approaches permits fine-scale discrimination of environments and thus is indeed a powerful tool for paleoenvironmental analysis.

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## Appendix 1

Distribution of live fauna along Transect A.  
Numbers refer to individuals per 9 l sediment sample.

Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
<b>BIVALVES</b>																							
<i>Cardita affinis</i>	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Chione californiensis</i>	-	-	-	-	-	3	-	-	4	-	2	-	6	-	-	-	-	-	-	-	-	-	-
<i>Chione fluctifraga</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>Donax navicula</i>	-	-	-	-	-	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Dosinia dunkeri</i>	-	-	-	-	-	-	-	-	4	-	-	3	-	-	-	-	-	-	-	-	-	-	-
<i>Felaniella sericata</i>	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lucina lampra</i>	-	-	1	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Mytella guyanensis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
<i>Parvilucina mazatlanica</i>	-	-	-	2	4	-	3	9	2	2	2	3	-	-	2	-	-	-	-	-	-	-	-
<i>Protothaca grata</i>	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	3	1	1	-	-	-	-	-
<i>Stingilla interrupta</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tagelus affinis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	1	1	1	1	1	1	1	-
<i>Tellina carpenteri</i>	-	-	-	-	-	-	-	-	2	-	-	3	-	-	-	-	-	-	-	-	-	-	-
<b>GASTROPODS</b>																							
<i>Agaronia testacea</i>	8	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Anachis nigricans</i>	-	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cerithiidea mazatlanica</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	8	15	44	84	28	11	289	-
<i>Cerithium stercusmuscarum</i>	-	-	-	714	4	39	18	9	16	6	4	27	12	72	22	22	2	1	-	-	1	-	-
<i>Crassispira kluthi</i>	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Crepidula striolata</i>	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Nassarius brunneostoma</i>	-	-	-	-	-	-	-	-	2	8	10	12	6	12	18	10	13	30	112	43	15	-	-
<i>Nassarius iodes</i>	-	-	-	-	-	15	3	21	36	18	34	33	24	40	18	1	7	-	7	2	-	-	-
<i>Nassarius tiarula</i>	-	-	-	-	2	3	9	3	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-
<i>Oliva spicata</i>	-	-	-	-	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Pedipes unisulcatus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
<i>Solenosteira macrospira</i>	-	-	-	4	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Terebra amillata</i>	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Theodoxus luteofasciatus</i>	-	-	-	8	6	3	3	3	-	-	-	-	-	4	2	-	-	-	-	-	-	-	-
<b>BRACHIOPODS</b>																							
<i>Glottidia</i> sp.	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>ECHINOIDS</b>																							
<i>Encope micropora</i>	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Mellita longifissa</i>	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
total number of specimens /91	11	4	3	742	24	66	39	48	72	34	54	84	48	128	70	45	39	77	204	74	28	295	

## Appendix 2

Distribution of live fauna along Transect B.  
Numbers refer to individuals per 9 l sediment sample.

Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
<b>BIVALVES</b>																									
<i>Chione californiensis</i>	-	-	-	-	-	1	1	2	-	1	-	3	-	1	1	-	-	-	-	6	-	-	-	-	-
<i>Cooperella subdiaphragma</i>	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Corbula marmorata</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Diplodonta subquadrata</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Donax navicula</i>	-	-	-	1	2	-	5	6	5	2	-	3	-	6	3	4	1	3	-	-	-	-	-	-	-
<i>Dosinia dunkeri</i>	-	-	-	-	-	-	-	2	1	2	1	2	-	1	-	-	-	-	-	-	-	-	-	-	-
<i>Felaniella sericata</i>	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lucina lampra</i>	-	-	-	-	1	-	3	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Parvilucina mazatlanica</i>	-	-	2	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Protothaca grata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	3	2	90	27	-	-	-	-	-
<i>Strigilla interrupta</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tagelus affinis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	3	-	3	-	-	-	-	-	-
<b>GASTROPODS</b>																									
<i>Agaronia testacea</i>	3	8	-	1	-	2	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cerithiidea mazatlanica</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	15	3	4	114	12	-	-
<i>Cerithium stercusmuscarum</i>	-	-	-	-	-	1	1	-	-	1	1	-	189	2	12	-	1	1	345	642	-	-	-	-	-
<i>Nassarius brunneostoma</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	15	3	2	1	-	-	-
<i>Nassarius iodes</i>	-	-	-	6	10	20	4	25	16	39	21	60	30	22	19	21	17	1	78	-	-	-	-	-	-
<i>Nassarius tiarula</i>	-	-	-	-	-	-	-	-	-	-	-	1	9	-	-	-	-	-	-	-	-	-	-	-	-
<i>Terebra amillata</i>	-	-	-	1	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Theodoxus luteofasciatus</i>	-	-	-	-	1	1	-	-	6	-	-	4	102	1	-	1	1	-	1	381	-	-	-	-	-
<b>ECHINIDS</b>																									
<i>Encope micropora</i>	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Mellita longifissa</i>	-	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
total number of specimens/9 l	8	8	14	9	16	26	11	43	28	47	25	73	330	33	36	30	26	7	547	1062	6	115	12	0	



## Appendix 3

Distribution of live fauna along Transect C.  
Numbers refer to individuals per 9 l sediment sample.

Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
<b>BIVALVES</b>																									
<i>Atrina</i> sp.	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cardita affinis</i>	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Chama</i> sp.	-	-	-	-	2	1	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cerithiidea mazatlanica</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>Chione californiensis</i>	-	-	-	-	2	-	-	-	-	1	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-
<i>Chione fluctifraga</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>Corbula marmorata</i>	3	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Donax gracilis</i>	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Donax navicula</i>	-	-	-	-	-	-	-	1	-	-	1	1	1	2	1	-	-	1	1	-	1	1	1	-	-
<i>Dosinia dunken</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-
<i>Lucina lampra</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
<i>Modiolus capax</i>	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Nucula declivis</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Parvilucina mazatlanica</i>	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-
<i>Protothaca grata</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
<i>Strigilla interrupta</i>	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>Tagelus californianus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>Tagelus</i> sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
<b>GASTROPODS</b>																									
<i>Agaronia testacea</i>	8	4	1	2	-	-	-	-	2	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
<i>Agladrillia pudica</i>	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Anachis adelinae</i>	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Anachis sanfelipensis</i>	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Anachis nigricans</i>	-	-	-	-	-	1	2	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Anachis varia</i>	-	-	-	2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Arene fricki</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cerithium stercusmuscarum</i>	-	-	-	1	1	322	-	2	-	2	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Columbella strombiformis</i>	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Conus</i> sp.	-	-	-	1	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Conus regularis</i>	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Crassispira kluthi</i>	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cymatium gibbosum</i>	-	-	-	-	2	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-
<i>Nassarius brunneostoma</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	2	1	2	1	17	-
<i>Nassarius iodes</i>	-	4	-	3	-	-	-	2	8	6	1	7	4	3	11	5	7	13	5	10	2	1	-	-	-
<i>Nassarius tiarula</i>	-	-	-	-	1	1	-	1	-	2	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-
<i>Natica chemnitzii</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
<i>Oliva spicata</i>	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Olivella dama</i>	-	-	-	2	10	2	1	-	6	3	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Pilsbryspira bacchia</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Pilsbryspira garciacubasi</i>	-	-	-	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Solenosteira macrospira</i>	-	-	-	2	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Terebra amillata</i>	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-
<i>Turritella</i> sp.	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<b>ECHINOIDS</b>																									
<i>Mellita longifissa</i>	-	-	-	-	-	-	-	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-
total number of specimens/9 l	14	8	1	10	23	344	7	9	21	15	10	14	9	6	17	8	8	14	6	13	4	6	2	20	

## Appendix 4

Distribution of live fauna along Transect D.  
Numbers refer to individuals per 9 l sediment sample.

Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
<b>BIVALVES</b>																			
<i>Cardita affinis</i>	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Chama</i> sp.	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Chione fluctifraga</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>Chione californiensis</i>	1	2	-	-	4	2	-	-	1	1	1	1	-	-	1	1	-	-	-
<i>Corbula mamorata</i>	-	-	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-	-	-
<i>Donax navicula</i>	-	-	-	-	-	-	1	1	1	6	2	5	-	-	5	-	-	-	-
heterodont sp. H	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lucina lampra</i>	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Megapitaria squalida</i>	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Modiolus capax</i>	1	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Orobitella zorita</i>	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Parvilucina mazatlanica</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
<i>Protothaca grata</i>	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-
<i>Tellina coani</i>	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tellina meropsis</i>	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tivela byronensis</i>	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
<b>GASTROPODS</b>																			
<i>Agaronia testacea</i>	2	8	-	2	-	-	1	-	-	1	-	-	-	-	-	-	-	-	-
<i>Anachis adelinae</i>	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Anachis nigricans</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-
<i>Anachis varia</i>	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cerithium stercusmuscarum</i>	-	-	103	4	2	11	1	5	-	31	22	8	26	15	9	2	2	50	-
<i>Olivella dama</i>	4	-	-	4	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Nassarius brunneostoma</i>	-	-	-	-	-	1	-	-	-	-	2	-	13	9	8	6	-	14	-
<i>Nassarius iodes</i>	-	-	-	-	-	-	7	11	7	1	6	-	8	5	8	10	1	-	-
<i>Nassarius tiarula</i>	-	-	-	-	-	-	-	-	1	2	1	-	-	-	-	-	-	-	-
<i>Pilsbryspira garciacubasi</i>	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Solenosteira macrospira</i>	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Theodoxus luteofasciatus</i>	-	-	-	-	-	-	-	-	-	2	2	5	4	6	-	-	-	11	-
total number of specimens/9l	13	10	107	12	15	22	10	18	11	44	36	18	52	35	31	20	7	77	-



Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
<i>Theodoxus luteofasciatus</i>	-	-	-	18	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Vermetus indentatus</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
<i>Dentalium semipolitum</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	24	-	-	-	-	-	-	-	-
number of additional taxa (representing <1% each)	16	0	13	35	34	33	49	48	56	46	60	55	53	55	41	20	0	0	0	0	0	0	7

## Appendix 6

Distribution of shells within taphocoenoses along Transect B.  
 Only those taxa are listed which represent one or more percent of the individuals within the particular sample.  
 Numbers refer to individuals.

Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
<b>BIVALVES</b>																									
<i>Arca pacifica</i>		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Arcopsis solida</i>		3	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
<i>Asthenosphaerus villosior</i>		3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cardita affinis</i>		5	4	-	-	-	8	4	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Chione californiensis</i>		3	28	-	51	8	52	39	49	62	32	17	87	261	19	6	-	7	4	-	30	1	2	93	29
<i>Chione fluctifraga</i>		-	-	17	9	-	-	-	6	14	-	-	12	81	19	9	5	4	-	-	-	-	-	-	-
<i>Chione pulchra</i>		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-
<i>Corbula marmorata</i>		2	4	-	-	5	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	12
<i>Crassostrea corteziensis</i>		-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	27	-
<i>Cryptomya californica</i>		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	1	-	-	-	-
<i>Cuningia lamellosa</i>		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Diplodonta orbella</i>		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Diplodonta subquadrata</i>		14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Donax gracilis</i>		7	14	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Donax navicula</i>		2	4	2	45	8	40	70	48	80	41	-	58	171	23	12	4	8	4	-	-	2	2	72	35
<i>Dosinia dunken</i>		-	-	-	20	2	5	-	4	9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Felaniella sericata</i>		-	-	2	78	11	48	66	10	42	32	6	31	54	11	11	3	-	3	-	-	-	-	60	8
<i>Glycymeris multicostata</i>		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
heterodont bivalve		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-
<i>Hiatella arctica</i>		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Laevicardium elenense</i>		30	16	4	16	3	8	15	6	15	8	2	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lucina lampra</i>		4	-	2	95	11	78	118	55	77	67	18	103	297	20	10	6	4	4	-	-	-	2	150	58
<i>Megapitaria squalida</i>		2	14	2	18	5	12	16	9	10	8	4	-	-	-	-	-	-	1	-	-	-	-	-	4
<i>Modiolus capax</i>		-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Orebitella zornia</i>		-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Ostrea</i> sp.		10	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Parvilucina approximata</i>		2	4	-	-	-	5	-	-	2	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
<i>Parvilucina mazatlanica</i>		5	6	-	205	51	107	204	79	231	127	44	65	171	-	20	4	6	3	-	-	-	2	48	44
<i>Parvilucina prolongata</i>		3	4	-	8	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	1	-	33	24	-
<i>Petricola exarata</i>		15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Pitar heleneae</i>		2	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Protothaca grata</i>		-	-	-	-	-	23	18	23	24	5	10	153	32	10	4	-	-	42	30	-	2	78	20	-
<i>Sirigilla interrupta</i>		12	4	-	26	4	12	-	7	12	8	4	-	-	-	-	-	2	-	1	-	-	-	-	-
<i>Tagelus affinis</i>		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	2	-	-	-	-
<i>Tellina amianta</i>		5	14	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tellina carpenteri</i>		-	-	-	9	2	-	11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tellina coani</i>		7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Thracia squamosa</i>		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Trachycardium panamense</i>		4	-	2	9	3	8	10	4	13	8	2	9	-	-	-	-	-	1	-	-	-	-	-	13
<b>GASTROPODS</b>																									
<i>Agaronia testacea</i>		-	8	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Calyptrea mamillaris</i>		-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cerithidea mazatlanica</i>		-	-	-	-	6	-	-	45	11	5	99	1586	250	118	30	26	3	201	450	5	18	606	54	-
<i>Cerithium stercusmuscarum</i>		-	-	1	-	6	14	-	8	14	11	-	47	2781	328	96	22	23	1	486	639	1	10	219	18
<i>Collisella acutapex</i>		2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
<i>Crepidula striolata</i>		3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Crepidula uncata</i>		6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Crucibulum concameratum</i>		3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
<i>Crucibulum spinosum</i>		2	6	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Nassarus brunneostoma</i>		-	-	-	-	-	-	-	-	-	-	-	180	21	17	-	2	1	24	-	-	7	72	5	-
<i>Nassarus iodes</i>		-	-	-	-	2	11	-	-	17	12	-	46	1089	183	17	18	10	1	-	1	-	60	12	-
<i>Nassarus tiarula</i>		-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	1	-	-	-
<i>Oliva spicata</i>		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-
<i>Olivella dama</i>		2	-	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Terebra armillata</i>		-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Theodoxus luteofasciatus</i>		-	-	-	-	-	-	-	-	-	-	847	105	10	-	2	-	213	192	-	-	-	-	-	-
<i>Turbo</i> sp.		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-
<i>Vermetus indentatus</i>		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	15	15	1	4	-	9	-
number of additional taxa (representing <1% each)		17	18	0	49	35	39	48	38	36	34	8	37	30	40	23	12	10	0	19	10	0	12	39	19





Stations	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
<i>Crucibulum spinosum</i>	5	-	3	-	-	-	2	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
<i>Diodora alta</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
<i>Diodora inaequalis</i>	-	-	-	-	26	-	2	-	2	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Diodora inaequistriata</i>	-	12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Lucapinella millen</i>	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Oliva spicata</i>	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Olivella dama</i>	-	-	-	-	-	-	1	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Nassarius brunneostoma</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	5	-	-
<i>Nassarius iodes</i>	-	-	-	-	22	18	1	-	7	-	8	-	-	-	-	-	-	4	3	-	-	2	2	-	-
<i>Nassarius tiarula</i>	-	-	-	-	-	14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Terebra annulata</i>	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Vermetus indentatus</i>	-	8	-	-	-	14	2	6	4	8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Vermicularia pellucida</i>	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
number of additional taxa (representing <1% each)	46	23	0	65	58	58	0	28	20	48	22	24	25	39	42	11	12	23	18	11	5	0	10	14	

## Appendix 8

## Distribution of shells within taphocoenoses along Transect D.

Only those taxa are listed which represent one or more percent within the particular sample.  
Numbers refer to individuals.

Stations:	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
<b>BIVALVES</b>																			
<i>Arca pacifica</i>	-	-	3	12	-	6	-	-	-	-	-	1	-	-	-	1	-	-	-
<i>Arcopsis solida</i>	7	10	-	-	6	7	-	5	-	3	-	3	3	-	-	-	-	5	-
<i>Argopecten circularis</i>	13	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
<i>Barbatia rostrae</i>	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-
<i>Cardita affinis</i>	31	22	3	-	26	37	9	18	28	5	5	4	11	13	23	8	26	14	-
<i>Chione californiensis</i>	110	112	5	274	52	73	34	48	22	5	24	6	28	54	131	17	65	107	-
<i>Chione cortezi</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	-
<i>Chione fluctifraga</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9	1	-	-
<i>Chione mariae</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
<i>Chione squamosa</i>	9	-	-	-	-	2	-	-	-	-	-	-	-	-	-	1	-	-	-
<i>Corbula</i> sp. A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-
<i>Corbula bicarinata</i>	-	-	-	-	-	2	-	-	-	2	-	-	-	-	-	-	-	-	-
<i>Corbula marmorata</i>	35	14	-	40	13	21	7	14	18	-	4	3	9	22	29	6	24	17	-
<i>Crassostrea corteziensis</i>	-	-	-	32	-	-	-	-	-	-	-	3	-	-	1	9	12	-	-
<i>Cumingia lamellosa</i>	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Donax gracilis</i>	13	14	-	18	5	-	-	-	2	-	-	-	-	-	1	-	-	-	-
<i>Donax navicula</i>	-	3	2	-	8	8	4	8	18	3	4	9	11	13	41	10	18	10	-
<i>Dosinia ponderosa</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
<i>Felaniella sericata</i>	-	-	-	-	-	-	-	-	-	-	2	2	-	10	2	7	7	-	-
<i>Glycymeris multicostata</i>	8	-	2	30	8	-	3	3	7	-	2	-	4	4	7	2	-	-	-
<i>Laevicardium elenense</i>	68	4	-	12	12	-	-	-	-	2	2	-	-	-	-	-	-	-	-
<i>Lucina lampra</i>	8	18	2	44	19	8	2	6	22	3	9	7	20	32	56	12	42	27	-
<i>Megapitaria squalida</i>	-	26	54	12	7	4	5	7	-	4	2	4	7	17	2	8	-	-	-
<i>Modiolus capax</i>	-	-	4	-	-	2	-	-	-	-	-	-	-	-	-	-	-	12	-
<i>Ostrea</i> sp.	22	26	2	-	11	-	7	-	-	1	-	8	-	1	-	-	-	-	-
<i>Parvilucina approximata</i>	-	-	-	20	4	-	3	4	-	-	3	-	9	3	-	-	-	-	-
<i>Parvilucina mazatlanica</i>	11	12	2	48	24	17	3	7	7	3	5	4	5	12	17	3	16	12	-
<i>Parvilucina prozongata</i>	-	4	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
<i>Phlyctiderma discrepans</i>	-	-	-	-	-	-	-	-	-	-	1	-	-	-	1	-	-	-	-
<i>Protohaca grata</i>	-	-	-	-	-	-	-	-	-	-	1	12	54	24	5	12	10	-	-
<i>Pteria sterna</i>	77	18	-	28	11	13	2	4	-	2	2	-	-	-	-	1	-	-	-
<i>Saccostrea palmula</i>	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
<i>Semele</i> sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
<i>Semele guaymasensis</i>	-	6	-	10	-	-	-	4	-	-	-	-	-	8	-	-	-	-	-
<i>Sphenia fragilis</i>	-	-	-	-	-	-	-	-	-	-	-	-	4	1	-	-	-	-	-
<i>Strigilla interrupta</i>	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-
<i>Tagelus affinis</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
<i>Tellina</i> sp.	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tellina amianta</i>	28	-	-	26	6	-	3	7	-	-	-	-	-	-	-	1	-	-	-
<i>Tellina coani</i>	10	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tellina meropsis</i>	10	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Tellina simulans</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
<i>Trachycardium panamense</i>	-	-	-	10	5	6	-	3	-	2	3	2	-	-	-	-	-	-	-
<i>Trigoniocardia biangulata</i>	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
<b>GASTROPODS</b>																			
<i>Agaronia testacea</i>	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-
<i>Anachis nigricans</i>	-	-	-	-	-	-	-	-	-	-	-	5	6	7	-	-	9	-	-
<i>Anachis varia</i>	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Cerithium stercusmuscarum</i>	-	-	90	26	19	90	6	43	38	44	17	6	29	35	132	1	46	195	-
<i>Crepidula onyx</i>	-	-	-	10	4	-	-	-	-	-	1	-	-	-	-	-	-	-	-
<i>Crepidula incurva</i>	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-
<i>Crepidula striolata</i>	-	-	-	10	7	17	3	7	9	-	3	3	-	-	-	-	-	-	-
<i>Crepidula uncata</i>	8	8	-	-	-	8	-	5	-	3	-	-	-	-	-	-	-	-	-
<i>Crucibulum spinosum</i>	25	-	2	-	-	-	7	5	-	1	-	-	-	-	-	-	-	-	-
<i>Diodora inaequalis</i>	-	5	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-
<i>Nassarius brunneostoma</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	12	-
<i>Nassarius guaymasensis</i>	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Nassarius iodes</i>	-	-	-	-	-	-	4	-	-	2	-	4	14	14	-	7	16	-	-
<i>Olivella dama</i>	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13
<i>Serpulorbis oryzata</i>	-	-	-	-	-	19	-	-	-	-	-	-	-	-	-	-	-	-	-
<i>Theodoxus luteofasciatus</i>	-	-	-	-	-	-	-	-	6	2	-	-	-	16	-	9	7	-	-
<i>Vermetus indentatus</i>	-	-	8	72	55	71	2	20	33	19	12	4	7	27	24	-	16	45	-
number of additional taxa (representing <1% each)	58	31	23	50	47	54	21	29	38	21	41	15	37	33	51	0	42	55	-

# ZOBODAT - [www.zobodat.at](http://www.zobodat.at)

Zoologisch-Botanische Datenbank/Zoological-Botanical Database

Digitale Literatur/Digital Literature

Zeitschrift/Journal: [Zitteliana - Abhandlungen der Bayerischen Staatssammlung für Paläontologie und Histor. Geologie](#)

Jahr/Year: 1990

Band/Volume: [18](#)

Autor(en)/Author(s): Fürsich Franz Theodor, Flessa Karl W.

Artikel/Article: [The origin and interpretation of Bahia la Choya \(Northern Gulf of California\) taphocoenoses: implications for paleoenvironmental analysis 165-180](#)