#184 Coelenterata - Anthozoa

Hand: Sea Anemones

Cadet H Hand.

A study of the intertidal sea anemones of the Tomales Bay Region

A STUDY OF THE INTERTIDAL SEA ANEMONES OF THE MONTEREY BAY REGION

There has been for many years a need for a comprehensive account of the sea anemones of the Pacific Coast and it is hoped that this report will be one step in that direction.

The general structure, anatomy and histology of sea anemones has been set forth many times in many languages, and there is neither time nor need for such material here. An excellent exposition of this material is set forth in Volume I of Prof. T.A.Stephenson's Ray Society Monograph "The British Sea Anemones", 1928, London. However before one can even attempt to classify sea anemones a thorough knowledge of this material is indispensible. In Appendix II to this report I will try to point out some of the difficulties facing an Actinarian taxonomist. Appendix I of this report is a slightly revised key to the anemones including the Monterey Bay area as well as its old coverage.

The following is an outline of the major taxonomic groups of sea anemones including only such species as have been found in this area.

phylum----Coelenterata

class-----Anthozoa

sub-class--Zoantharia

order------Actiniaria

tribe I----Corallimorpheae

family-----Corallimorphidae

Corynactis californica Carlgren

tribe II----Nynantheae

sub-tribe---Athenaria

family------Halcampidae

Halcampa duodecimcirrata (M. Sars)

family---Halcampidae (cont.)

Cactosoma arenaria Carlgren

family----Ilyanthidae

unidentified species

sub-tribe---Endomyaria

family----Actiniidae

Bunodactis elegantissima (Brandt)

Anthopleura xanthogrammica (Brandt)

Tealia felina (Linnaeus)

Epiactis prolifera Verrill

sub-tribe---Acontiaria

family----Diadumenidae

Diadumene luciae (Verrill)

Diadumene sp.

family----Metridiidae

Metridium senile (Linnaeus)

family----- ?

(This represents two anemones which cannot be identified)

Family--Corallimorphidae

Corynactis californica Carlgren

(Carlgren,O,1936,Some West American Sea Anemones, Jour. Wash. Acad. Sci. 26:16-23.)

Description:

Color: column-red,brown,crimson,pink,lavender,or white
tentacles-white or white tipped with proximal portion grey-green or brown

Column: smooth;showing septal insertions as white or light lines at extension

Base: well developed and firmly adherent to rocks or pilings

Disc: same color as the column or a lighter shade; septal insertions showing as darker lines; lips usually white although they may be colored

Tentacles: capitate and mostly stubby;exocoelic tentacles being longer and larger than the endocoelic;one tentacle to an exocoel and 2 to 5 to an endocoel

The type of this species was established by Carlgren from preserved material which was supplied to him by Ricketts. These specimens were taken from Monterey Bay at a depth of 6-8 fathoms and no reference is made to their occurence either the intertial area or on the pilings at Monterey Harbor. The nematocysts of the harbor and intertidal form agree well with the type, however, and there seems to be no need or grounds to consider these forms as separate species. There are other differences however,of a more gross nature, such as color,size and mode of growth,which would seem to indicate that the species consists of two or possibly three ecotypes.

Ecotype #1.

This represents the type of the species;a deeper water form. The color is known only from formalin preserved material and was "Column brown,other parts uncolored". Its size was "Largest breadth and length 1.3cm." This appears to agree favorably with some of the harbor forms although the harbor forms size can be far in excess of this.

Ecotype #2.

The rocky intertidal form.

This type is common locally from Point Pinos southward to Point Lobos on the outer rocky coast,and is very plentifully respresented at Carmel Cove. They are less plentifull along the north side of Point Pinos and are scarse at the Hopkins Marine Station.

The color of this type is characteristically a dark reddish or red-orange with the typical white,capitate tentacles. It reaches its maximum density of population from the zero tide level to well into the low tide area.They do on occasions, however,extend well up into zone III and probably extend to much greater depths than were observed. Specimens may be found on horizontal,vertical or over-hanging rock surfaces,but are most plentifull on horizontal and vertical faces in areas protected from direct wave action.They may occur in what appear to be unprotected areas but here the populations are small and spotty.Such places as the landward side of large rocks or on small rocks protected by large rocks seem to offer the optimum and large growths are usually found in caves or under ledges in the low tide area.Sometimes specimens may be obtained from the under sides of stones well up into the mid tide area.These specimens which occur on the edges and under edges of rocks

show a color variation not found in those which are more directly exposed to sun light.These specimens are paler and may be so light as to be hardly pink at all.The darker red forms are always found where a greater amount of light is present.

The size of this type is definitely smaller than the type specimen,and none have been found which are as LARGE AS the type.The endocoelic tentacles seem to be at a maximum only four as opposed to five for the type.This discrepancy presumably may be correlated with their smaller size although only rarely even in the harbor form were five endocoelic tentacles encountered.

This form occurs on rocks as discrete individuals,and there is no apparent sign of asexual division.The individuals are usually spaced about an individuals diameter apart,and only rarely do two individuals occur directly in contact with one another.The absence of asexual reproduction has not been definitely established,but certainly it plays no such important role as does asexual reproduction in the harbor form.

Ecotype #3

The harbor form

In this type the color variation is striking.Individuals may be found which are crimson,red,red-orange,orange,brown or lavender.Many intermediate shades are also present,especially pale reds,browns and pinks.The individuals here are in densely packed colonies with no free space between individuals and each member of any colony has the same color as any other member of that colony.They occur from about the zero tide level or slightly above to a depth of about minus four feet.This seemed to be as far down as the colonies extended although they may extend much deeper.

The colonies range in size from a few square inches to several

square feet.Within a colony there is no color variation,but in an immediately adjacent colony the color is frequently quite different.That is,on one side of a piling we may find a crimson colony while the other side or even part of the same side may be covered with a brown or lavender colony.

Large old Balanus nubilis shells seem to offer good ground for these colonies although they may be found on old steel cables,pieces of rope,or on either the cement or wooden piles. These colonies are most plentiful on the newer cement piles under the Municipal Pier and seem to occur only rarely nearer shore on the old wooden piles.This may be due to the fact that the older piles are completely covered by barnacles and Metridium and thus no settling space is available.The newer piles have only small spotty colonies of Metridium on them and this certain- reduces the competition for space.

Close observation of a colony shows that in many cases adjacent individuals are connected by common tissue at their bases,and frequently large parts of a colony are so connected. This certainly is positive indication that they commonly repro- asexually as is also the constancy of color of a colony.

The close packed mode of habit of this form as compared to the open coast form may well be explained in part by conditions in their immediate environment.The canneries nearby,wastes from the fish pier,oil from the many boats and sewage all contribute to the pollution of these waters and therefore it may well be that it is only occasionly or with difficulty that their larvae are able to survive.However,these forms thrive as adults and certainly there is no bar to asexual reproduction. This phenomemon of asexual reproduction replacing sexual(and certainly this species moved onto the pilings only after man

put them there and was already polluting the once clean water) is indicated in other species (Metridium,Diadumene,Bunodactis) where the chances for larval survival are low.

The size of this type is on the whole twice as large as the open coast form and the larger individuals are 3 cm long and have a crown diameter of over 2 cm.This is also considerably larger than is reported for the type of the species.

General:

The type represented by the type of this species is unknown to me but there are indications that it represents a somewhat different form than the others (see above).In all three types there appear to be common requirements.This species is never found in stagnant or waters as foul as those presented at Elkhorn Slough.On the open coast they are frequently subjected to periods of drying in direct sunshine,but they seem to survive this and more frequently when they are uncovered by the tide they are found to be covered by masses of alge such as Egregia. They appear to demand a good circulation ofwater and probably a good supply of planktonic food.They do not readily feed on small fisf or crabs,but small annelids seem to be taken readily. Small copepods are readily accepted(Tigriopus)and from this it follows that other small crustacea or crustacean larvae would be. The full significance of the three types can not beestimated nor can the color variations be completely explained.From some work on coelenterate pigments(Fox,at Scripps,reference not available)we know that feeding is important in color variation, however, it hardly ~~it hardly~~ appears likely that the food of a colony on one side of a pile is significally different from that on the other side.There may,however,be differences in the food of the harbor and open coast form which would account for

the constancy of color in the coast form and the great variation in the harbor form. Perhaps another solution might be found in the genetic and physiological changes which may well have taken place in the process of becomming adapted to a new environment. Certainly the striking difference in habit between the harbor and open coast form is significant, andit is felt that the explanation offered above concerning the disadvantages in the environment which the larvae faces is a reasonable explanation.

Family----Halcampidae

Halcampa duodecimcirrata (M.Sars)

Description:

Color: column and tentacles- cream or white

Column: elongate and vermiform; smooth in extention and with many fine transverse wrinkles in contraction; tenaculi(microscopic glandular suckers) may be present and lightly holding sand grains; in full extension septal insertions show thru as white lines.

Base: a physa, either inflated of forming a small concavity.

Tentacles: robust; accuminated; 10 in number (9-11)

Size: up to several centimeters long by .25 to .50 cm dia. crown probably never more 1 cm. in dia.

I have only seen four specimens of this species and know very little concerning it. It has been reported from Pysht, Wash., Alaska and in my experience from Tomales Point and Carmel Cove. Mac Ginitie(Mac Ginitie, 1935, Ecological Aspects of a Marine Estuary, Am. Mid. Nat. 16:629-769) reports a ten tentacled anemone from Elkhorn Slough whose identity is unknown but if

this form should turn out to be the species being considered here my opinion of its typical habitat will have to be modified.

Three specimens were taken by Messrs. Woodbury and Dixon from the roots of eel grass,Carmel Cove,at about the minus one foot tide level.The other specimen was taken from a compound tunicate colony at Tomales Point.(tunicate was Eudistoma psammion) This anemone is restricted to the low tide region and deeper waters. Nothing is known of its life history or food habits.

Cactosoma arenaria Carlgren

Description:

Color: column-bright orange to light orange
tentacles-light grey marked with brown and white bands and spots

Column: smooth;conical;flaring at the base;marked by six ridges in region of the scapulus

Base: a physa which is expanded into a broad disc;more than three times the diameter of the scapulus when extended

Disc: orange to brown and marked with white or light lines at septal insertions

Tentacles: 24 in number (6-6-12);rather short (3 mm) and blunt;may expand into a longer taper

Size: largest specimen 1.8 cm dia. at base;scapulus 3 mm dia.;tentacles - 8mm dia. of crown;heigth 1.5 cm

Four specimens of this species were found;one from a dredged sample taken at 15 fathoms on shale bottom off Del Monte and the other three from a large agal holdfast which washed ashore at the break water in Monterey Harbor.

These specimens all were much more irritible than is the average anemone and the slightest agitation of their container caused them to with draw their tentacles immediately. This contraction caused them to take on the appearance of a truncate cone and after this contraction a longer time than is taken by most anemones was required before they again expanded.

Nothing is known concerning the life history of this species. It apparently is a deeper water form and may on occasion be taken in the inter-tidal as indicated above.

Family---Ilyanthidae

genus and species not known:

Color: column-grey-green to cream or white
tentacles-transpatent with grey tips;white spots and frequently a white line on the oral side
lips-grey
disc-ground work grey;white patches or powdery white circles frequently present;septal insertions marked by paired golden or grey lines, some times both alternately;distinct grey circles around bases of tentacles

Column: very elongate in extension;usually larger distally; smooth in extension;transversely wrinkled in con-contractraction;septal insertions as many paired paired white lines.

Base: a physa;may may assume many shapes;conical,~~globular~~ globular or concave;capable of firm attchment being frequently wrapped around Phoronis tubes,bits of old clam shells,etc.

Tentacles: up to 1 cm long and very slender;inner cycle or two held over mouth while other cycles hang

lips-grey

downward;96 or more tentacles (6-6-12-24-48-*---)
smallest individuals may have only 48

Size: length-- up to 20 cm
dia. of crown---- up to 2 cm
dia. of physa----up to 1.5 cm
dia. of column---up to 1.5 cm

This anemone was extremely common at Elkhorn Slough where itoccured in large beds on the mud flats at about zero tide level. It seemed most concentrated along the landward edge of the bar formed between the north and east forks of the slough. These beds extended about 30 feet in from the channels and about 150 feet along each fork.In no location were any anemones found which were in the shifting sands along the edges of the channels. The substrate in which they were located varied from fine silty mud to muddy sand. There did not seem to be any actual burrows or tubes in which this form lives, but without exception the physa was in each case clasping some object.The anemones were oriented at many angles to the substrate but there appeared to be no constant angle or direction.

The habit of carrying some of the tentacles over the mouth is a characteristic of the genus Ilyanthus but the genus cannot be positively determined without histological preparations.The arrangement of the mesenteries indicates the family Ilyanthidae and I feel no hesitancy in placing it here.

In natural conditions a half inch or more of this anemone is usually extended above the sand and in this position it appears tolie in wait for food.The tentacles are usually in motion making short twitching movements.If an amount of Tigriopus is introduced into a container containg this species the action of the tentacles is much greater.The Tigriopus,however,are too

active,by and large,to be held by this anemone.The copepods seem to be momentarily knocked out after contact with a tentacle but they soon appear to recover and usually escape after a brief struggle.Many which escape are seen to later fall to the bottom of the dish where they apparently die.The anemones also eat some of the copepods which strike their tentacles but in life this form of food probably plays only a minor in their diet. Possibly smaller less active crustacea are more important to this form.Another interesting observation was the fact that there seens to be a sheet of mucous leading from the actinostome to the base of the tentacles.It was noticed on several occasions that this sheet is drawn intothe mouth.The disc is ciliated and the beat of the cilia is directed away from the mouth which keeps the mucous sheet spread.This all would seem to indicate a mucoid or possibly aciliary-mucoid type of feeding.This sort of feeding is not known for the anemones but is common among the corals.My obsevations are as yet too scanty to draw any final conclusions.

One specimen , a female, was known to have spawned.This occured during the night and about one eigth of the bottom of a four inch finger bowl was covered.by eggs.These eggs were in bad shape when seen by me but in the hope that the presence of these eggs might cause a male to release sperm I added several other anemones to the bowl ~~with the bowl~~ with the female and the eggs.There was no response by the added specimens,however, although being unable to sex anemones I may well not have added any males!

Preparations have been made to study this anemone further during the rest of the year.

of feeding is not known for the anemones but is common among the

Family-----Actiniidae

Bunodactis elegantissima (Brandt)

Description:

Color: column-variable;white,cream to yellow, green or grey-green;the upper part usually darker than lower

tentacles-usually pink tipped with the main portion grey,green or white

disc- frequently with red or reddish lines marking the septal insertions on a green background; in the white form the disc too is white and the septa appear as white lines;frequently there is a vivid green mark at each end of the actinostome marking the two siphonoglyphs

Column: divided into a scapus and scapulus;scapulus short; verrucae(sucking structure on a papilla)smaller and more numerous on the scapulus;verrucae of scapus usually in definite rows;large and regularly shaped as compared to Anthopleura verrucae

Base: a true muscular base,usually well attached to rock or other firm substrate

Tentacles: blunt to pointed,thick to thin depending on degree of expansion

Size: up to five centimeters diameter of base and column; heigth up to six centimeters;diameter of tentacular crown probably never greater than seven centimeters

This species is extremely difficult to separate from the one that follows(Anthopleura xanthogrammica),but from a study of the nematocysts of these two it can be seen that this form is truly distinct.The separating character between the two genera is the presence of acrorhagi in Anthopleura and

pseudo acrorhagi in Bunodactis.(Acrorhagi are hollow knobs at the top of the parapet or on the scapulus and usually head rows of verrucae)The distinction between acrorhagi and pseudo acrorhagi is that the true acrorhagi possess nematocysts of a different type than those of the surrounding column ectoderm.Whether or not this character is of generic rank would seem highly questionable but a discussion of this point will not be included here. (SeeStephenson,1935,The British Sea Anemones, Vol.II Ray Society,London,pp.156 and Torrey,1906,The California shore anemone,Bunodactis xanthogrammica,U.C.Publ. Zool. 3:41-47)

This anemone is frequently called the "ubiquitous anemone" or the "aggregating anemone".It is reported to range from Alaska to Panama and is a prominent member of the mid tide zone. It is found in completely unprotected to completely protected areas.Frequently this form occurs on vertical rock faces facing the open ocean , but the greater populations seem to occur high in the mid tide zone where it frequently becomes covered with sand and gravel which adhere to the verrucae.This covering of these colonies offers them protection against drying although the large amounts of water held internally plus the mucous secreted externally probably offer plenty of protection.In spite of the dense ness of these colonies they seem to offer little protection to other forms of life save perhaps a few hermit crabs and isopods.

Their food consists of hermit crabs,Pachycheles,and many other small crabs.(Petrolisthes,Cancer,Paahygrapsus)Small fish both dead and alive are taken and certain of the gastopods are eaten. (Tegula,Thais and littorines)How much agal material they use for food is questionable but I have on several taken partly digested pieces of Ulva from them.This anemone undoubtedly depends on the turbulent swirling of the waves to bring much of its food

to it and this food may already be dead or nearly so.How much smaller food in the form of plankton and detritus is eaten is not known but this form feeds greedily on Tigriopus.Hermit crabs may be seen to wander with impertinence upon the discs of Bunodactis, but patient observation shows that these are frequently eaten.

The most obvious form of reproduction in this species is longitudinal fission.This fission starts with the foot and proceeds toward the mouth.It splits the mouth at right angles to its long axis.The result is the massive colonies so common along the shore.If sexual reproduction is resorted to in this species it remains to be determined.In all colonies observed almost every member had recently undergone fission ~~recently~~; this is easily determined because fission leaves unmistakable marks in the ~~crown~~ (CROWN BECOMES ASYMMETRICAL; COLUMN IS SCARRED) crown and on the column.Several Bunodactiswhich were being kept in a tank in Berkeley were seen to undergo fission during May of the past year so this phenomenon may well be seasonal.If a colony is observed in low zone II where the rocks are covered with a hard coat of green alga it it can be seen that thecolony has recently expanded its size. This is established by removing the individuals around the periphery of the colony.When this is done it is seen that these individuals are attached to alga covered rocks as opposedto the individuals in the middle of the colony which are on bare rocks. Certainly the alga can not exist long in the covered condition so its presence here is taken to mean that the colony has only expanded recently.

As mentioned previously in this report there appears to be a correlation between asexual reproduction and environmental conditions.The conditions Bunodactis is subject to may be more favorable for larval survival than in the case of the harbor

Bunodactiswhich were being kept in a tank in Berkeley were seen

form of Corynactis,but certainly the losses of larvae must be great here too due to wave action,exposure to drying,heat and possible dilution of salinity due to rain.When more is known concerning the life history of this species more definite conclusions may be drawn concerning this subject.

Anthopleura xanthogrammica (Brandt)

Color: column-dark green, brown or yellowish
tentacles- greenish or grey-green although forms may frequently be seen in which the tentacles are striped or mottled with white
disc-septal insertions usually not visible due due to the dark green color

Column: completely covered with verrucae which may appear in rows but more frequently are scattered;verrucae smaller and not as distinct as in Bunodactis;irregular rather than round;acrorhagi present on parapet or scapulus and usually heading short rows of verrucae

Tentacles: never pink-tipped;blunter and shorter than in Bunodactis

Base: true muscular base;always firmly attached to the substrate

Size: crown dia. up to 20cm
column dia. up to 15cm
heigth probably not over 30cm

This common anemone parallels the range of Bunodactis but according to Ricketts and Calvin south of central California it seems to be the dominant form and replaces Bunodactis.(see

Ricketts and Calvin,1939,Between Pacific Tides,Stanford Press pp.30.)

In the low tide region or higher up in deep crevaces or in tide pools with good circulation this anemone is very common. It seems to seek deep crevaces and places which offer more protection than that demanded by Bunodactis, and almost always in well lighted places.

Some differences between this species and Bunodactis have already been noted but there are others.Asexual reproduction does not seem to play an important part in its life history nor is there the pronounced tendancy for aggregation that is seen in Bunodactis.(although the lack of this latter phenomenon may well be corellated with the lack of asexual reproduction) Occasionally along with the colonies of Bunodactis a small colony of Anthopleura may be found and these colonies seem to show signs of asexual reproduction but this seems to be limited to these small individuals and no large individuals have ever been found which have divided recently.Anthopleura seems to be restricted to more protected spots than does Bunodactis and the maximum size to which individuals grow is far greater in Anthopleura.

The food of this anemone is much the same as in Bunodactis but much larger objects may be handled.I have taken whole large Cancer antennarius carapaces from an Anthopleura's insides andan Anthopleura only five inches in diameter ate a Strongylocentrotus purpuratus which was just over five inches in diameter (including the spines,and 18 hours later a well cleaned 3 inch dimeter test was recovered from the disc of the same individual.

these colonies seem to show signs of asexual reproduction but

Tealia felina (Linnaeus)

Description:

Color: column-dark red with white verrucae

tentacles-rose colored to pale pink;usually with white at the base and tips and frequently white bands

disc- lighter than the column with red lines marking septal insertions;lips and actinostome a bright red or pink

Column: upper three fourths is provided with verrucae to which gravel usually adheres;acrorhagi present on the scapulus

Base: firmly adherent to rocky substrate although the column may be burried in sand or gravel

Tentacles: blunt and short; about 80 (10 + 10 + 20 + 40) more may be present and the cycles may not be in even numbers

Size: largest specimens are about 70 cm high and about the same for the dia. of the crown; column may reach 7.0 cm in dia.

This genus is monotypic although its distribution includes most of the north temperate hemisphere. There are several varieties of the species and our common form probably is the crassicornis of Verrill although this has not yet been definitely established.

Fertilization is internal and the planulae are held within the body of the parent untill they are ready to metamorphose into young adults at which time they are released. Asexual reproduction is not known for this species.

In captivity this form is a sluggish feeder. It will not readily accept food of any kind and many things were offered.

Of all the substances offered to Tealia it appeared that a definite preference was shown toward food which was partially decayed. Such objects as decaying fish and dead hermit crabs were readily accepted but fresh pieces of fish are not even ingested and live hermits soon scramble off the discs. There is good evidence therefore that this anemone feeds only on dead material which is washed its way and certainly is not a very active predator. It is not known whether or not this anemone feeds on any small live material such as copepods, etc.

In the rocky intertidal this anemone is definitely restricted to particular areas. It seeks highly protected spots such as the bottom of deep pools between large rocks , small crannies under the edges of over hanging rocks or any other position whish offers at once protection from direct wave action, shade and a good circulation of sea water. The other requirement which seems to have to be fullfilled is the nature of the substrate. With the exception of a single questionable specimen all the Tealia taken were found in a shallow gravel covered area with a firm rock substrate and in pools which probably are never without water. The questionable specimen mentioned was taken from the vertical face of a rock in a protected area at Escadero Point. This specimen was Tealia like in general appearance but was considerably smaller than any others seen and its tentacles were much longer and narrower. It can not be decided at this time whether this is just a variation or whether it is is a truly distinct form. It may of course be merely a young specimen. Tealia is found in the low tide zone for the most part but an occasional specimen may be taken well up into zone III where the conditions are as outlined above. This species appeared to be most numerous at Escadero Point athough nowhere did it approach the density of such a form as Anthopleura.

Epiactis prolifera Verrill

Description:

Color: column: variable; red, green, brown, yellow or lavender; frequently the limbus is differntly colored than the column and is always marked with vertical white lines;

tentacles-usually same as the column but paler; frequently green, grey or grey-green

disc- septal insertions marked by white lines; usually a white powdery ring or series of marks are present

Column: smooth, with a wrinkle just above the limbus and at this point commonly young polyps are located in a circle

Base: a true muscular base; usually not too firmly attached: sometimes this species is taken free and floating

Tentacles: long and gently tapering; usually 48 to 96 present (6 + 6 + 12 + 24 + 48); last cycle not present in smaller individuals

Size: largest crown dia. approx. 3 cm

largest dia. of base 3 cm

column up to 2 cm dia.

heigth never more than 2.5 cm

This common anemone is distributed all along the Pacific coastfrom Alaska to at least the Monterey Peninsula. At the southern edge of Alaska it is replaced by another species which carries its young in a brood pouch.

This species reaches its maximum density at about the zero tide level although it may be found well above and below this limit. It appears to be more common on the under side of rocks

than on the upper but no actual counts were made and it certainly is quite common on the upper surfaces in areas which are well covered by such alga as Egregia. It is frequently taken from the stipes of Lamminaria and may be found on Ulva and some of the Gigartinales. Occasionly it is seen floating with the base uppermost. The significance of this and its importance is not known.

It reproduces sexually and at an appropriate age the planulae migrate to the top of the limbus from within the coelenteron and develope to young individuals on the outside of the column. Nothing is known of its food habits and asexual reproduction is not known for the group.

Subtribe-----Acontiaria

Family-------Diadumenidae

Diadumene luciae (verrill)

Description:

Color: column-green, olive-green, or brownish with orange lines marking septal insertions
tentacles-green or greyish green
disc-translucent, grey, green or an even bluish; usually with white powdery markings; septal insertions as dark lines

Column: divided into scapus and scapulus; smooth with cinclides not visible with the naked eye

Base: a true muscular base; firmly attached

Tentacles: irregularly arranged but basically 6 + 6 + 12 etc. about 5 cycles

Size: rarely over one cm in dia. of column; heigth a max. of 2 cm; dia. of tentacular crown 2 cm

This is a hardy species and is even reported to recover after being frozen solid. It presumably was introduced from either the Atlantic coast or directly from Japan which is reported to be its native area. It is known to attach to ships bottoms and is common on oysters both in this country and Japan so there certainly have been many chances for it to be introduced. It is known all along this coast but always in bays or harbors and never on the open coast.

The species is common along the shores of Elkhorn Slough and San Francisco Bay and its estuaries. It is not known as a sexual form on this coast, and previous observations of my own tend to bear this out. In Japan this form is a sexually producing anemone, and this has been taken as evidence that it is a native there. As in the case of Corynactis and Bunodactis we see here an anemone which may face conditions which are adverse to larval survival and as such there seem to have been readjustments in its mode of reproduction so that now only asexual reproduction occurs.

Diadumene luciae is found in the high intertidal zone, usually between the lower high water level and the higher low water level. It readily feeds on Tigriopus and small annelids and its food is probably of this order.

Diadumene sp.

Description:

Color: column-brown, orange-brown, or white; frequently a grey or dirty white

tentacles-transparent, usually lighter than the column and with marks causing concentric circular patterns to appear in the crown

Column: variable in form; typically a cylinder capable of

adverse to larval survival and as such there seem to have been

great elongation;the length in extension usually two diameters long; the scapulus appears as a trumpet shaped cone;the collar may disappear in full extension but usually is visible; column is smooth in extension ; cinclides visible and scattered; cinclides restricted to the scapus

Tentacles: the crown usually round but tends to be lobed; tentacles irregularly arranged; 6 appears to be the basic number but this tends to be obscured by the numbers present;tentacles long, slender, tapering; special tentacles may be present in the inner cycle, these are longer, thinner and more translucent in expansion than the others; in contraction they appear thick, stubby and opaque.

Base: a true muscular base which spreads over the substrate; irregular in outline

Size: dia. of base and crown up to 6 cm; column dia. probably never greater than 3 cm; heigth in average state of extension 6 cm.

This species can be distinguished from Metridium senile by the type of nenatocysts present in the special tentacles and acontia and by its lack of a sphincter. (this latter character is a character of the genus and has not been confirmed for this species.) The distinction in the field is difficult and unless the special tentacles are present the chances of a correct identification are poor. There is, however, another character which seems to be of diagnostic value. This is the occurence of visible cinclides scattered on the column, but usually the anemone is in such a state of contractraction at the time of c

appear thick, stubby and opaque.

collection that this character is not of much help.

This species is found on the pilings at the Municipal Pier and other wharfs at Monterey Harbor. Its abundance is striking athough no true measure was made due to the fact that it is mixed in with masses of Metridium. These masses are accounted for by the method of reproduction resorted to by these two species (if indeed they are separate). Metridium is known to undergo longitudinal fission, pedal laceration and sexual reproduction while Diadumene is known to reproduce at least by longitudinal fission.Certainly these two taken together represent a dominant in the fauna of the pilings.

Nothing is known of the food habits of this species and its true identity is not determined. The nematocysts of this species agree closely with those of Metridium with the exceptions already noted but this is in agreement with the two genera under consideration. However due to the nebulous condition of the whole genus Diadumene it probably will be extremely difficult to establish with any degree (OF CERTAINTY) the position of this species.Certainly the general aspect of this species and its close affinities to Metridium do not simplify the problem.

This species is found on pilings,as indicate above, from the + 3.5 foot tide level to a depth of at least several feet. It was not possible to determine its absolute lower limit on the pilings due to the lack of proper equipment , but specimens were taken from adpth of at least - 3 feet. Its range on the pilings appears to be coincidental with that of Metridium.

Family----Metridiidae

<u>Metridium senile</u> (Linnaeus)

Descriptions:

Color: column-white, grey-white or brown;

tentacles-transparent; usually lighter than the column and with white markings which cause concentric patterns to appear in the crown; usually white at their bases

Column; variable in form; typically a cylinder capable of great elongation;the length comonly twice the diameter but this is frequently exceeded;us- a pilar with the scapus as a flaring truncate cone;collar present at the junction of the scapus and scapulus; column smooth in expansion but cinclides not visible; cinclides restricted to the scapulus

Tentacles: up to 800 or more in very large specimens; irreg- but in small specimens on the plan of 6 + 6 + 12...etc.; appearing thin and translucent in expansion with the outer cycles never as as fully expanded as the inner.

Size: up to 8 to 10 inches in diameter at a maximum with the column a foot long; more frequently size is same as Diadumene sp. just considered.

The confusion concerning the smaller members of this species was treated under the last form discussed but there is no doubt as to the identity of the larger forms. Of the larger forms seen all were pure white and are lower on the pilings than the smaller forms.These larger forms appear first just above zero tide line and extend down at least 10 feet. They are scarce down to the - 1 foot tide level but become relatively plentiful at - 5 or -6 feet (several to a piling).These larger forms are never found near shore and seem to be restricted to the piles which extend into deeper water as opposed to the massive colonies

in expansion with the outer cycles never as

of smaller individ uals found near shore.

Large colonies of Metridium were also found at Elkhorn Slough where they covered the piles of the highway bridge and an old wharf on the east branch of the slough. Their vertical extent seems to be the same here as at Monterey Harbor.

Metridium apparently prefers bay waters, and it is typically found in harbors thruout the northern hemisphere. It is common along much of our coast and I have seen it at several places around San Francisco Bay, Drake's Estuero at Pt. Reyes and now two localities in the Monterey region. Its food habits are not known by me.

This form can stand prolonged periods out of water in at least its younger stages. An odd characteristic of the species is its way of hanging from a piling when it is exposed by an ebbing tide. The form characteristically hangs like an old sac full of water. This holding of water plus its coat of mucous certainly prevents desiccation but it may well be that this very factor is the limiting factor in the distribution of the larger sized individuals. Certainly the strain placed on an anemone which could easily hold two quarts of water would be large and in fact might well pull the anemone off the piling.

Here again we encounter an anemone whose mode of reproduction is largely asexual, and again it occurs in a situation which is not completely condusive to larval survival. This common correlation between adverse conditions and asexual reproduction is too obvious to ignore but more evidence as to the actual ability of the larvae of the various forms involved to survive in the various adverse conditions which they certainly face in nature, is needed.

Family------ ?

Family----- ?

Genus and species unidentified-- 2 species

This refers to two somewhat similar forms which cannot be identified. THey both are members of the Acontiaria and due to differences in nematocyst patterns, general external differences and different color paterns are believed to represent two distinct species. One of these presumably is the Sagartia (?) stimpsoni of the key, but due to the lack of suckers which are one of the defining characters of the genus Sagartia this anemone must certainly be in the wrong genus. (or could it be that we are in the wrong genus !!??) At the moment , however, there appears no other place to put this species and the form which the original author of the key had in mind might well have been a Sagartia. This anemone appears to be the species described by Fewkes as Anemonia stimpsoni but due to recent restrictions in the definition of the genus Anemonia it no longer can be considered as a member of this genus either, while until about 1920 it would have fitted well within the limits of the genus Sagartia.

The second form is a small orange anemone which was found too late for detailed study. Some of its nematocysts were measured and this immediately established its distinctness from other forms encoumtered locally. It was taken at the edge of a tidal channel in front of the Hopkins Marine Station. It occured at about the zero tide level in a substrate of sand and algae and was associated with the rocky intertidal phoronid and a number of compound tunicates.Its elongate body was wedged into and between the above animals but the base appeared to be very lightly attached.

IT is unfortunate that more data was not obtained on these last two species, but this must wait until some later date.

APPENDIX I

The key which follows is a somewhat modified copy of the one which occurs in the invertebrate manual (S.F. Light, 1941, Laboratory and Field Text in Invertebrate Zoology). The following are additions to the key.

Diadumene sp.

Halcampa duodecimcirrata (M. Sars)

Cactosoma arenaria Carlgren

Ilyanthidae, unidentified burrower

Two changes in nomenclature were also made. They were

Tealia crassicornis Verrill to Tealia felina (Linnaeus)

Corynactis sp. to Corynactis californica Carlgren

A few technical terms are to be found in the key and it will be well to consider these at this point.

Definitions:

Acontia--nematocyst filled threads which the members of the Acontiaria usually extrude when irritated.

Nematocysts:

spirulae--nematocysts whith the thread the same diameter throughout.

penicilli--the basal part of the tread of the nematocyst is expanded in this type and appears as a bottle brush due to the spines present. (Normally a magnification of about 300 X is needed to satisfactorily distinguish between the above two types and the preparations must be made from live material.)

physa---a modified base, frequently present in burrowing forms: without basilar muscles. (Usually bulbous and not appearing as a true base.)

Sphincter---a circular muscle at the top of the column which constricts the disc. (Usually a histological character).

Acontia--nematocyst filled threads which the members of the

True base-- with basilar muscles (a histological character).

Verrucae--hollow tubercles which are capable of holding bits of shell, gravel, etc.

This key of necessity deals with superficialities for the most part and as such is not completely reliable. In every case if a positive determination is to be obtained it will be necessary to section the material and to make smears and to note the size and types of nematocysts of the various tissues. For most specimens, however, the key appears quite workable.

KEY TO THE SEA ANEMONES

Modified from the key in S.F.Light,1941,Laboratory and Field Text in Invertebrate Zoology to include the anemones of the Monterey Bay area.

1. True base present;attached to rock,wood,or other firm substrate ---------- 2

1. Aboral end a physa;unattached or lightly so;in eel grass, algal holdfasts,mud or compound tunicate colonies ------- 15

2. Tentacle free area around the mouth very small or lacking --- 3

2. Large amount of free space around the mouth ---------- 4

3. Margin of tentacle bearing disc deeply frilled or lobed when extended;tentacles short,very numerous and all alike;in large specimens the nematocysts of the acontia are all or nearly all spirulae;small specimens (where penicilli are present) the penicilli and spirulae about the same size;sphincter mesogleal--*Metridium senile*

3. Tentacular disc slightly lobed or not at all;tentacles short and inner cycle may be of a different nature than other cycles;special tentacles when present appear more opaque in contraction and are and more transparent and longer than the other tentacles when extended; nematocysts of the acontia both spirulae and penicilli; no sphincter----------*Diadumene* sp.

4. Column thickly covered with verrucae (tubercles capable of holding bits of shells,sand,etc.)---------- 5

4. Column smooth or wrinkled in contraction;verrucae never present ---------- 9

5. With relatively small verrucae,probably suckers,extending over the upper two thirds of the column in longitudinal rows; living completely covered in sand but attached to rock------"the Sand Anemone"----unidentified.

5. With verrucae practically covering the whole column----------6

6. Column embedded in mud;found along the bay shore where mud and rocks occur together------

"the Mud Anemone"----unidentified.

6. Column never embedded in mud---------- 7

7. Column dark red,often with brown patches;tentacles blunt, sometimes with the middle half of the tentacles rose tinted or white----------Tealia felina

7. Column green to yellowish white---------- 8

8. Verrucae irregular,branching,not conspicuously in longitudinal rows;tentacles uniform in color,not tipped with pink---

----Anthopleura xanthogrammica

8. Verrucae round;arranged in longitudinal rows;tentacles usually tipped with pink;color of column variable usually in close set aggregations--------

----Bunodactis elegantissima

9. Usually with lateral or young anemones attached in a circlet around the base;edge of base always marked with fine vertical white lines----Epiactis prolifera

9. Never with young on column nor with white lines on base-------10

10. Tentacles capitate----------Corynactis californica

10. Tentacles otherwise----------11

11. Tentacles opposite each end of mouth slit differently marked from others by having a yellow base in contrast to the dark reddish-brown base of the other tentacles; main part of the tentacles yellowish or banded with alternate yellowish or brown bands;faint radiating lines from the mouth all yellow;found on pilings at Fruitvale Bridge--"Yellow Striped Anemone"--unidentified.

11. Tentacles opposite ends of mouth slit not differently

---Bunodactis elegantissima

colored from others----------12

12. Column olive-green,often with vertical orange stripes; small,extended column never greater length than 2cm.; common along bay shores,on or under rocks,or on pilings---------- Diadumene luciae

12. Not as above----------13

13. Same as D. luciae(may be a variety)except that every specimen has longitudinal double rows of white lines on the column;found on pilings at Fruitvale Bridge-- ----"Double Striped Anemone"-unidentified.

13. Column never olive-green----------14

14. Column bright orange-red;inner base of each tentacle with white spot;oral opening surrounded by flaky white ring with white lines radiating out to tentacles;on ocean coast----------Sagartia(?)stimpsonii

14. Column and tentacles flesh colored to salmon;column long and slender when extended;septal insertions show thru column as white lines;on wood at Lake Merritt and Fruitvale Bridge----------Sagartia(?)leucolena

15. Column elongate,vermiform;cream or white;10 tentacles present----------Halcampa duodecimcirrata

15. More than ten tentacles present----------16

16. 24tentacles present;aboral end expanded as a broad disc; may be found in washed up holdfasts;lightly attached; deep water form.----------Cactosoma arenaria

16. More than 24 tentacles(96 or more in adults);column elongate(6-7 inches in extension);aboral end a disc which may appear flat,bulbous or concave,common in mud or muddy sand at Elkhorn Slough---------- ----Ilyanthidae--unidentified burrower.

APPENDIX II

Actinarian Taxonomy

The evolution of the anemones is considered to have followed a path which their embryology and early history recapitulates for us today and the larger groups are clearly defined on a basis of an increasing order of complexity. Such characters as the number and kinds of septa present, the location and type of the sphincter retractor and basilar muscles and the arrangement of the tentacles are all used. This is all well and good and by and large is clearly defined, but in such a group as this, which have no hard parts,, the finer details of their classification are based on the finer details of their structure and this entails many histological preparations.

In the first place there are as yet no complete works on the sea anemones. Stephenson's two volumes are the closest approach, and this is useful only in a limited way in that he covers only the British fauna. The literature of the group is scattered, and the authors for the mst part were not specialists in the field. The synonomy of many of the species is startling in its length and the genera which have been sunk, revised and described are innumerable. The authors which have described our west coast fauna are few and their works have been incomplete, and most of the descriptions are of pickled material so that we have no descriptions as to how the anemones may have appeared in life which can be diametrically opposed to what one sees in a poorly preserved specimen. (Due to the extreme contractillity of these animals and their high sensitivity to most anaesthetics it is extremely dificult to obtain well preserved and life like specimens.)

During the last 40 years there has been almost no work done on the west coast anemones besides a few small notes by Dr. Carlgren of Sweden. These papers are only partly satisfactory in that the descriptions are of only one or two specimens, which were necessarily preserved and poorly so at that. Almost nothing is known of color variations and there are no comprhensive accounts

in a limited way in that he covers only the British fauna. The literature

of variations within a species save a single paper on Metridium by Dr. Torrey and this only considers variation in the number of septa. It thus becomes apparent that the difficulties facing a taxonomist are great and unfortunately this is only part of the difficulty.

As is usual in taxonomy the larger evolutionary trends are quite readily visible, but it is the evolution within the smaller groups, the speciation and adaptive radiation which are difficult to define. There are no generic monographs and within the families the true affinities are not known, certainly much remains to be done.

The anemones possess one hard part, the nematocyst, which has become a useful systematic tool. This only began to be used in about 1920 and has caused some considerable reshuffling of genera and species but the work is progressing slowly. The amount of variation which may occur in the nematocysts of a single species is distressingly great and its absolute value is yet to be determined. In no case has a really significant number of nematocysts been measured so that its size can be absolutely defined. The variations of kinds of nematocysts in a given type of tissue is perhaps not as great as the variation in size, and although there are 17 described types of nematocysts even this does not seem to be sufficient. Their terminology is clumsy and the Actinarian taxonomists have chosen to lump all nematocysts into two classes. This frequently leads to misunderstandings and certainly needs modification. Another unfortunate factor about nematocysts is their small size. They frequently fall in the range of 10 to 18 mu long by 1 to 2 mu wide and the threads and barbs are usually below the resolving power of even the best oil immersion systems so that detailed study of their important characters becomes very difficult. Dark field illumination might well improve this situation as far as determining some of the finer details of barb and thread structure, but this does not seem to have been resorted to by taxonomists.

In spite of what appears to represent a confusing and difficult group, the taxonomy of the anemones is not in as bad condition as it was in 1920. Dr. Oskar Carlgren has made huge strides in organizing the group and has done much toward establishing the nematocyst as a useful character. Our west coast forms are not wellknown, and therefore conscientious study will repay any investigator with a wealth of new data. Almost nothing is known of the natural history and life cycles of our anemones and any additons along these lines would most certainly be welcome. The taxonomy of the group is not a problem to be chosen lightly, because for adequate work comparative material is desirable and is difficult to obtain.

However, the variation within a single species is knowledge we must obtain and would make excellent term problems where equipment for making histological preparations is available.

It is unfortunate that a group of intertidal animals which are so important and obvious should have been ignored for so long, but it is hoped that in a few years much of this will be changed.