HELFORD
VOLUNTARY MARINE
CONSERVATION AREA

Studies of the sedentary polychaete *Sabella pavonina* Savigny 1820 (Peacock Worm)

with particular reference to the Helford River intertidal population

Pamela E Tompsett

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The author is registered as a PhD student with the Department of Biological Sciences, University of Exeter and this is a report of her studies to date.

Copies of this and other published reports are available on request from:

The HVMCA Group Co-ordinator

Pamela E Tompsett CBiol MIBiol
Cornwall Wildlife Trust
Five Acres, Allet
Truro, Cornwall TR4 9DJ
Tel: 01872 273939
e-mail *petomp@cornwt.demon.co.uk*

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Studies of the sedentary polychaete *Sabella pavonina* Savigny 1820 with particular reference to the Helford River intertidal population

SUMMARY

The sedentary polychaete *Sabella pavonina* inhabits the lower littoral and shallow sublittoral zones in areas of the Helford River (often referred to as Estuary) where there is a moderate tidal flow. It is now widespread, with the main colonies found at depths between 0 and 1m above Chart Datum although there are substantial numbers growing subtidally to 3m towards the mouth of the Estuary. The species appears to be tolerant of considerable variation in the substrate particle size and type of the upper 10-20cm layer which surrounds its tubes, providing the site is reasonably stable and underlain with clitter or small stones. The species diversity at most sites is good and typical of high salinity, mixed sediment shores under sheltered conditions. Reproduction appears to be possible periodically over an extended period from May onwards as shown by the size and development of the ova and activity of the spermatozoa in randomly selected worms.

The historical perspective of this study relates to information available from 1895 to 1998 during which period the *Sabella pavonina* population in the Helford River has been observed to fluctuate. During the mid 1980s the population crashed and its present recovery will be assessed to provide baseline data for future monitoring.

INTRODUCTION

Sabella pavonina Savigny, 1820, syn. *Sabella penicillus* Linnaeus, 1767, is one of over 290 described species in the tube-dwelling polychaete family Sabellidae (Fauchald, 1977). Sabellids are found on man-made marine structures, on rocky shores, in *Zostera* spp. beds, in saline estuaries and on shell, cobble, gravel and mud bottoms often in considerable numbers.

Sabella pavonina has been recorded from many shores around Britain from the north of Scotland to Wales, Ireland and the south coast. Although the JNCC database holds many records of the species, all recording relates to recording effort and it is difficult to assess the overall abundance. The reproduction, settlement and development pattern of this species has not been extensively studied in the field (McEuen *et al* 1983). The sexual mode is dioecious with a suggested season May, August and September in the northern hemisphere when the gametes are broadcast into the water and larvae may be actively swimming for over 6 days (Wilson, 1936; Thomas, 1940). Despite an extensive literature search Rouse and Fitzhugh (1994) found little to add.

Historically the fauna and flora of the Helford River or Estuary have been well recorded from the exposed reefs at the mouth of the River which gradually give way to sheltered rocky shores with mixed sediment banks and sand flats to silt filled creeks extensively overhung with deciduous woods.

In spite of the muddy conditions a deep water channel extending to the upper reaches at Gweek remains in regular use. Fishing boats and recreational craft are major users of the waterway whilst the collection of shellfish and bait species is widespread. Good water quality is essential for the historic cultivation of oysters and the impact of unwelcome changes can be reflected both in these cultivated species and a wide range of naturally occurring fauna and flora. For instance the effects of tri-butyl-tin from anti-fouling paints in the water during the 1970 to mid-1980s period caused great concern. A slow recovery followed after a ban on its use was imposed in 1987.

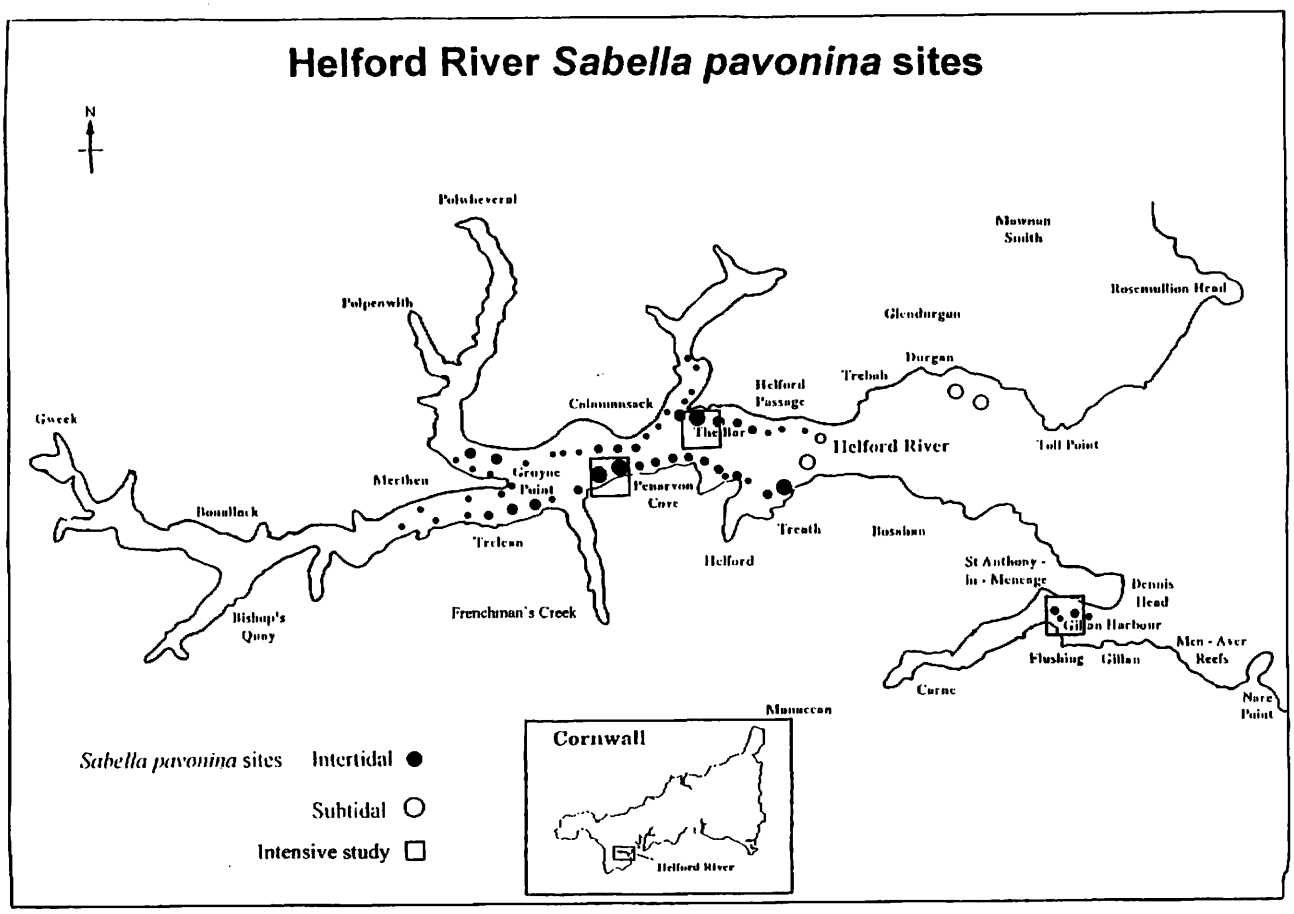
Occasional extremes of climate or tide can modify habitats and populations almost overnight and some of the earliest references to the Helford Passage community of *Sabella pavonina* Savigny relate to severe easterly gales in 1895 which devastated this prodigious population

through the deposition of several inches of sediment (Vallentin, 1898). Clark (1906) records them as occurring 'Sparingly off the bar at Helford'.

The 1949 intertidal survey of the Helford River fauna and flora described *Sabella pavonina* as numerous at Helford Point and Penarvon, common or patchy in the Helford Passage area, occasional off Calamansack and present but not common at Treath (Spooner and Holme, 1949). By 1986 the species had virtually disappeared from the traditional intertidal sites on the north and south banks and Gillan inlet. At Helford Passage a population previously recorded as 300 per sq. m (Turk & Burrows, 1972, unpublished data) was reduced to less than 10 worms on the whole shore (Covey and Hocking, 1987) and coincided with the disappearance of all intertidal *Zostera* spp. Subtidally there were very few indeed (Rostron, 1987).

In 1987 the whole estuary was designated as a Voluntary Marine Conservation Area and monitoring was carried out as part of the survey programme.
The present study arose from indications that from 1990 this sedentary polychaete, *Sabella pavonina,* was returning to these shores (Tompsett, 1997a) with a distinct increase in numbers particularly at the lower littoral level by 1992 (Tompsett, 1994 & 1997b). This project concentrated on the collection of basic information.
As the work progressed it became clear that a number of more complex questions needed to be answered. These related to a clearer understanding of the larval settlement criteria, to the biodiversity of the sites, the material used for the tube and an evaluation of environmental factors on comparative sites.

Figure I The Helford River locations



THE STUDY AREA AND SAMPLING/INVESTIGATIVE METHODS

Helford River, a ria formed by the drowning of the valley at the end of the last Ice Age, offers a sheltered marine environment. It is situated within the O.S.Grid Ref. SW 72 on the south coast of Cornwall. Stretching 9.2 km inland from the east coast of the Lizard Peninsula through sloping farmland and dense woods, the total area within normal tidal limits to an imaginary line from Rosemullion Head to Nare Point is 568 ha The intertidal area being 186.1 ha and 44.3 km of shoreline at extreme high water spring level. (Davdison *et al*, 1991; Neil, 1995).

Shore surveys and baseline mapping

A survey of the entire intertidal area of the Helford River complex was commenced in 1995 to locate the existing *Sabella pavonina* population and to select areas for more intensive study; 95% of the shoreline has been explored to date (June 1998). All areas will eventually be covered but the limitations imposed by accessibility, tide conditions and time have delayed completion. Factors such as frequency, the viability of the worms in their exposed tubes, length, substrate type, associated species, air and water temperatures and small scale assessment of density were investigated during the two low tide periods per lunar month during which the lower part of the shore was exposed. Spot checks of the adjacent subtidal sections have been carried out with the assistance of volunteer divers wherever possible. Since the study is being carried out within a voluntary marine conservation area, specimen collection has been kept to a minimum. Photographic records are an important part of this study.

Intensive survey areas

Three areas with extensive worm populations were selected for intensive study :

a) Helford Passage (SW 7575 2690), a south facing, mixed sediment site below and adjacent to well-used cockle beds (*Cerastoderma edule)*
b) a north facing, undisturbed, muddy, main river shore East of Frenchman's Creek entrance (SW 7482 2638)
c) Gillan Harbour (SW 7838 2553), a moderately exposed, shallow water sand/mixed sediment site amongst embedded rocks and summer moorings.

Baseline grids 5m x 10m (200 quadrats 500mm x 500mm) were established to determine population density, spatial distribution and other comparisons using counts within 50 random squares on an annual basis. The studies were carried out over a period of three years 1996-1998 and the results are currently being analysed.

Sediment assessment

Ten random sediment samples of 150cc, from 7-10cm depth were collected from the perimeter of each of the three intensive survey sites. These were washed, sieved, graded, dried and weighed to categorise the percentage constituent grades into a Coarse fraction (over 500μ), a Sand to fine fraction (500μ-90μ) and a Fine fraction (below 90μ).

Associated macrofaunal species as determined by total count

A single quadrat, 500mm square, was designated alongside each of the intensive survey population grids and excavated to depth of approx. 200mm.corresponding to the lower limit of polychaete tubes and concentrating on the maximum macrofauna of the muddy sand layer. This depth was realistic in respect of the practical limitations of time, tide and site disturbance. It also took into account the potential damage to soft-bodied fauna resulting from deeper excavations

involving the sieving of the heavier stones and gravel material which typically underlies the Helford *Sabella* populations. The excavated material was sieved as carefully as possible in adjacent seawater through a 300mm square sieve with a 2mm mesh size using a gentle up and down pumping action. Fauna was either identified on site or preserved in formalin for laboratory examination.

Reproductive cycle
Determination of reproductive factors is in progress using monthly random sampling. Measurements such as crown length, live and dry worm weights and tube dimensions are being related to the size of the developing ova extracted from individual worms to indicate breeding condition. A series of microscopical preparations of material taken from the fresh worms and stained with borax carmine are being prepared for photographing measurement and assessment.

Settlement and growth *in situ*
Constant monitoring of species occupying the lower littoral is not easy and a pilot study of single 500x500mm quadrats in the main beds at Helford Passage, Bar Beach and East of Frenchman's Creek was set up.
Coloured plastic pegs were used to mark each quadrat within which the number and size of viable worm tubes located in each 100mm sub-square was noted and photographed from a 1m height. This recording was carried out monthly whenever the tide was at a sufficiently low level. There was no disturbance of the sites and the first two counts have been completed.

Larval settlement
A procedure has been established recently to sample the surface sediment within the main beds, extract, preserve and stain any larvae for identification. This is at a very early stage.

RESULTS AND DISCUSSION

Shore surveys and baseline mapping
Most of the creeks and upper to mid river shores are exposed regularly as the tide falls and at Extreme Low Water Spring tides, leaving only trickles of water winding through deep mud from the creeks to join the much reduced main channel.

Sabella pavonina was widespread both on very muddy and fairly sandy substrates where there was underlying clitter, pebbles and gravel and always in areas of good tidal flow. Under these conditions the greatest concentrations were found on shores only uncovered from mid to low water, approximately 0 - 1m above Chart Datum (Lowest Astronomical Tide). Tubes appeared to be less frequent below the ELWS height towards the main channel, an almost inaccessible area, but whether this was due to substrate instability, an unacceptably vigorous tidal flow or other factors has yet to be determined. When the study has been completed it may be possible to relate exposed tube lengths and possibly worm size to site factors.

Sabella pavonina appears to survive amongst thick growths of green algae such as *Enteromorpha* spp which occasionally occur although these are usually of short duration. This is not a new phenomenon as it was noted at Penarvon Cove in 1949 (Spooner & Holme, 1986).

Towards the mouth of the estuary where the shores are steeper and less muddy and more exposed to easterly winds and rough seas, there were no intertidal colonies but divers reported moderate numbers at depths up to 3m above Chart Datum both in clear water and amongst the *Zostera marina* beds (A Sutton, *pers.comm.*)

Megalomma vesiculosum (Montagu, 1815), a closely related sabellid, was common throughout the more sandy, less muddy areas usually at a slightly higher position up the shore.

Intensive survey areas

These studies were continued for a third year during which time the Frenchman's Creek population increased each year. The numbers at Helford Passage which were constant for the first two years increased in 1998. In both sites the main beds were concentrated in a band along the lower littoral with isolated tubes widely scattered up the shore.

The picture in Gillan Harbour was rather different. Here the whole cove is vulnerable to severe easterly winter/spring gales which have become more prevalent in recent years, occasionally causing a widespread scouring of the coarser sandy, gravel and mud substrate. In 1996 the population was scattered and sparse but a large increase was observed in 1997. This fell in 1998 but how far this related to a period of easterly gales is uncertain.

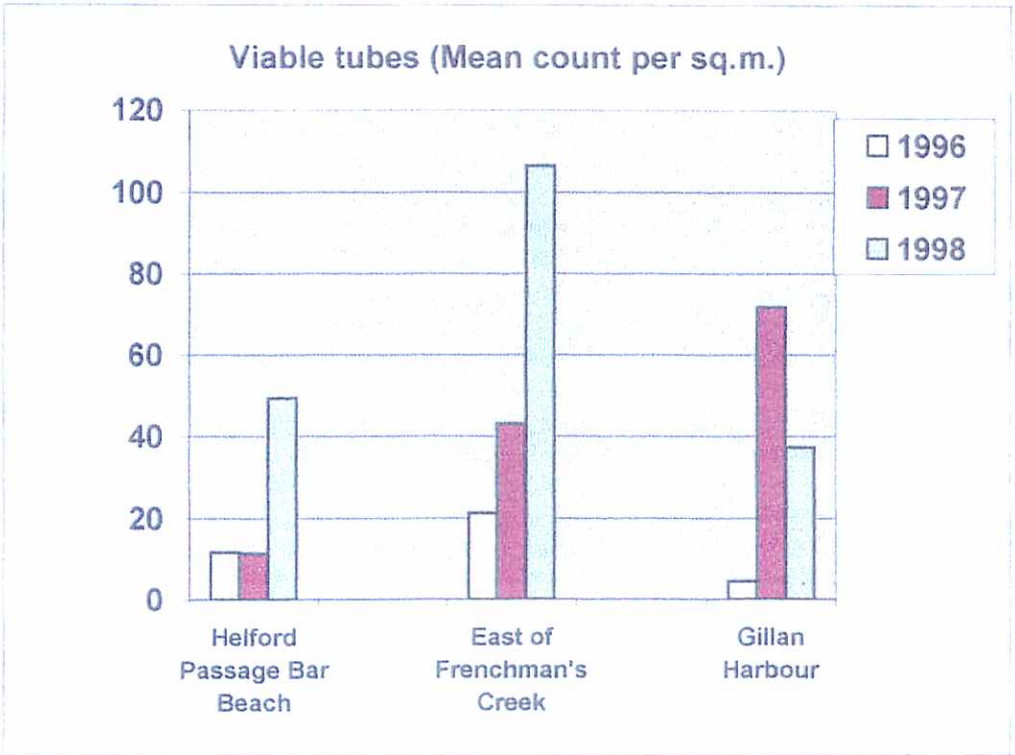
Much of the considerable volume of data from these surveys is awaiting analysis.

Sediment assessment

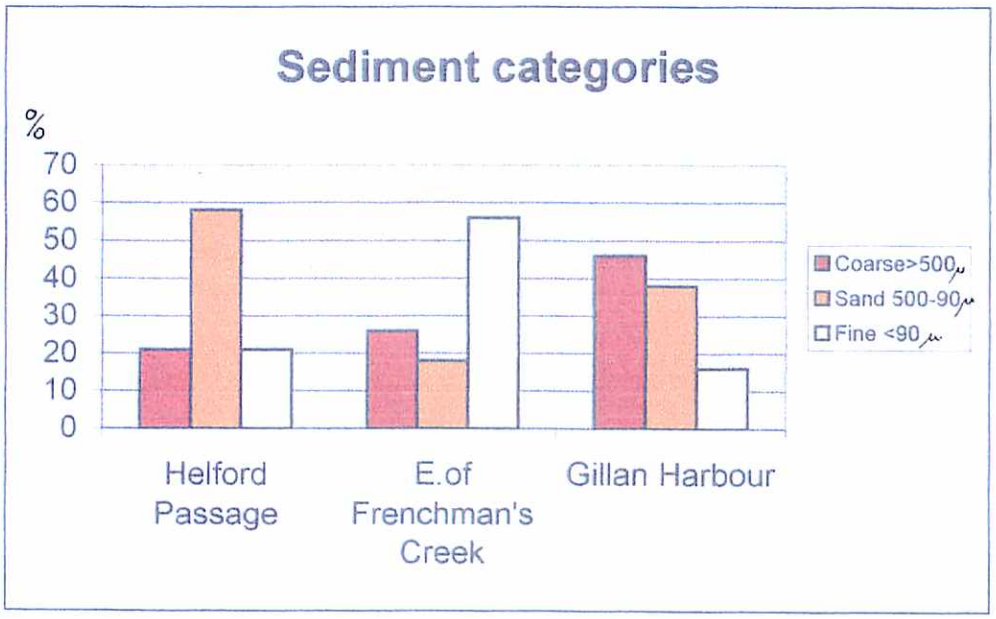
The *Sabella pavonina* populations were thriving at the three sites despite the marked difference in the proportions of the sediment grades. These samples relate to the sediment occupied by the filter-feeding worm in its tube and in each case the substrate beneath the tubes was clitter, small stones and pebbles in a dark , apparently anoxic layer.

This suggests that this species is tolerant of considerable variation in the substrate providing there is reasonable site stability. Factors relating to settling opportunities for the early larvae may also be important. The turbidity of the water was very variable at all sites depending on the general water conditions. *Sabella pavonina* was never found in areas of high silt and extremely anoxic substrates in relatively slack water.

Intensive survey viable tube counts



Sediment assessment



Associated species as determined by total count

Table I Total species list for each site (Algae are shown in shaded area but not included in total)

Species per 0.25 sq.m quadrat	Helford Passage	E of Frenchman's Creek	Gillan Harbour
Enteromorpha intestinalis	+	0	+
Ulva lactuca	0	0	+
Fucus serratus	+	0	0
Sargassum muticum	0	0	+
Lithothamnaceae	0	+	0
Gracilaria gracilis	+	0	+
Ceramium rubrum agg.	0	0	+
Metridium senile	0	1	0
Sagartigeton undatus	2	0	1
Melinna palmata	1	1	1
Sthenelais boa	3	2	1
Cirriformia tentaculata	20	16	0
Marphysa sanguinea	0	1	0
Glycera tridactyla	1	1	3
??*Nicomache lumbricalis*	1	0	0
Nephtys sp	1	7	0
Platynereis dumerilii	1	2	18
Nereis pelagica	1	0	0
Lanice conchilega	7	0	27+
Sabella pavonina	6	2	1
Megalomma vesiculosum	2	0	3
Pomatoceros sp on shells	4+	1	0
Spirorbis spirorbis on *Fucus serratus* ++	++	0	0
Golfingia (Golfingia) vulgaris	1	0	0
Balanus crenatus	0	+	0
Elminius modestus	0	+	0
Gammarus sp	11	0	8
Atylus swammerdami	0	0	1
Crangon crangon	0	0	1
Carcinus maenas adult	1	0	0
Carcinus maenas v.small	1	0	1
Littorina littorea	1	2	1
Littorina obtusata	2	0	0
Bittium recticulatum	0	0	1
Bittium recticulatum empty shell	0	0	1
Calyptrea chinensis	0	0	1
Crepidula fornicata	1	0	0
Ostrea edulis	2	0	0
Cerastoderma edule	1	3	-
Cerastoderma edule 1yr old	-	-	2
Cerastoderma edule 2yr old	-	-	1
Chaelea gallina	0	0	1
Dosinia exoleta	0	0	2
Tapes (Ruditapes) decussatus	0	2	0
Venerupis senegalensis	2	2	0
Angulus tenuis	0	1	1
Ascidiella aspersa	1	1	0
Botryllus schlosseri	+	+	0
Alcyonidium hirsutum	0	+	0
Cryptosula pallasiana	0	+	0
TOTAL NUMBER FAUNAL SPECIES	26	21	20

Table II Faunal species ranking by numbers

Rank	Helford Passage	E of Frenchman's Creek	Gillan Harbour
1	*Cirriformia tentaculata*	*Cirriformia tentaculata*	*Lanice conchilega*
2	*Gammarus* sp	*Nephtys* sp	*Platynereis dumerilii*
3	*Lanice conchilega*	*Cerastoderma edule*	*Gammarus* sp
4	*Sabella pavonina*	*Sthenelais boa* *Platynereis dumerilii* *Sabella pavonina* *Littorina littorea* *Tapes (Ruditapes) decussatus* *Venerupis senegalensis*	*Glycera tridactyla* *Megalomma vesiculosum* *Cerastoderma edule*
5	*Pomatoceros* sp on shells	*Metridium senile* *Melinna palmata* *Marphysa sanguinea* *Glycera tridactyla* *Pomatoceros* sp on shells *Angulus tenuis* *Ascidiella aspersa*	*Dosinia exoleta* *Bittium recticulatum*
6	*Sthenelais boa*		*Sagartigeton undatus* *Melinna palmata* *Sthenelais boa* *Sabella pavonina* *Atylus swammerdami* *Crangon crangon* *Carcinus maenas* *Littorina littorea* *Calyptrea chinensis* *Chaelea gallina* *Angulus tenuis*
7	*Sagartigeton undatus* *Megalomma vesiculosum* *Carcinus maenas* *Littorina obtusata* *Ostrea edulis* *Venerupis senegalensis*		
8	*Melinna palmata* *Glycera tridactyla* *??Nicomache lumbricalis* *Nephtys* sp *Platynereis dumerilii* *Nereis pelagica* *Golfingia (Golfingia) vulgaris* *Littorina littorea* *Crepidula fornicata* *Cerastoderma edule* *Ascidiella aspersa*		

The results from intensive sampling at the three selected sites show that the Helford Passage area had a greater diversity of species than the two other widely differing sites near Frenchman's Creek and Gillan Harbour.

At Helford Passage the community is typical of mid to high salinity level and moderately sheltered estuarine habitats.

The presence of *Lanice conchilega* has a stabilising effect on surface substrates and the local effect of their tubes in low concentrations, can create a more varied habitat encouraging a diverse community of infauna and epifauna (Neil, 1995). However, *Sabella pavonina* was absent or sparsely scattered where the concentration of *Lanice conchilega* was very high particularly where the *Lanice conchilega* in sandier substrates had created drier areas, which were often further up the shore. In Gillan Harbour both species were widely scattered.
Although *Lanice conchilega* and *Cirriformia tentaculata* were present in large numbers they are surface detritus feeders which would not be in direct competition with *Sabella pavonina*, a filter feeder.
Another sabellid, *Megalomma vesiculosum*, is frequently found amongst and above the *Sabella pavonina* beds on the Helford River shores but was poorly represented in the sample.

Reproductive cycle
In the random samples of worms collected, ova, which are shed into the coelomic fluid, were observed to begin their development as small spheres, diameter 25-35μ, gradually gathering cytoplasm and reaching up to 300μ.

During the period October through to January small spheres were detected in a number of worms. From February to September larger ova with cytoplasm were present peaking in May to July.

The selected photographs show borax carmine stained cells of undeveloped ova and some larger ova apparently ready for release. The pattern of shedding is not clear as individual worms may carry ova at many different stages. Work on the relationship between size factors and ova development has been
continued and the results are not yet available.

The ratio of males to females has been consistently 50:50. Active spermatozoa have been found in males in most months but a technique for assessing the developmental stage needs some further work. *In vitro* tests are scheduled for later in the season.

Coelomic cells, 50-90μ diameter seemed to decrease gradually in number during the earlier part of the year but a sudden increase was noted in some worms in July when the ova appeared to be approaching maturity.

The mild winter meant that the temperature of the water remained above 7°C and this should be noted as lower temperatures might affect the breeding cycle in a different way. Earlier workers have conducted laboratory studies at room temperatures of approx.20°C.

Settlement and growth *in situ*
The marked quadrats have been recorded twice and further results are needed to show changes. It was encouraging to see that the plots had not been tampered with. A heavy covering of algae created some difficulties in location in March.

Larval settlement
Results are not yet available.

Future work will be structured along the path summarised in the enclosed **Further Research Plan**.

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FURTHER RESEARCH PLAN SUMMARISED

A. FIELDWORK

Certain aspects have already been undertaken as M Phil study

1. Baseline mapping and shore survey
2. Intensive study of population density, spatial distribution and other comparisons
3. Simple sediment assessment
4. Associated macrofaunal species
5. Basic reproductive cycle

1. Biodiversity

i) In relation to existing sites

Extension of fieldwork to date – examine sedentary species in co-existence with *Sabella pavonina*

ii) On new sites

Examine sedentary species in co-existence with *Sabella pavonina*

Collect and collate information through literature search of survey work on site observations.

Look at potential differences in conditions both on recently examined sites and any from earlier reports.

2. Sedimentology

i) On-site observations

a. Using well-established field sedimentology i.d. techniques

b. Direct observations supported by photographic record

ii) Laboratory examination based on analysis of naturally occurring substrate and material used by worms in the manufacture of tube. Techniques such as SEM, XRC, etc. may be used.

An ultimate aim would be to detect the presence or absence of polluting substances, which might be of significance to the organism.

3. Physical factors

i) Relate *Sabella* beds to periods of tidal cover and uncover

ii) Examine turbidity e.g. using Secchi disc

iii) Sample organic loading and sediment e.g. plankton net trawls

B. EXPERIMENTAL

1. Larval development

Preliminary work on gametogenesis, which has been undertaken as part of the MPhil study, will be extended into programme of *in vitro* fertilisation and the development of larvae (hopefully) to settlement.

As well as improving the understanding of the worm's biology this would also generate material for further laboratory investigation.

2. Tolerance

Tolerance experiments would involve *in vitro* experimentation on *Sabella* with controlled "toxic" substances using:

a. laboratory generated material
b. field collected material

C. WIDER ASPECTS OF THE WORK

As time permits, locate other populations in: -

a. clean environments
b. any potentially polluted and easily accessible sites

This might be extended to include observations from the wider geographical aspect e.g. Environment Agency surveys

D. PRIORITISATION

1. As soon as the reproductive cycle of the *Sabella pavonina* permits, artificial fertilisation needs to be commenced to allow for anticipated practical difficulties
2. Field sampling programme is currently on-going and will be continued

New aspects will be incorporated into the existing programme as appropriate, particularly in respect of sampling for laboratory analyses

E. EQUIPMENT

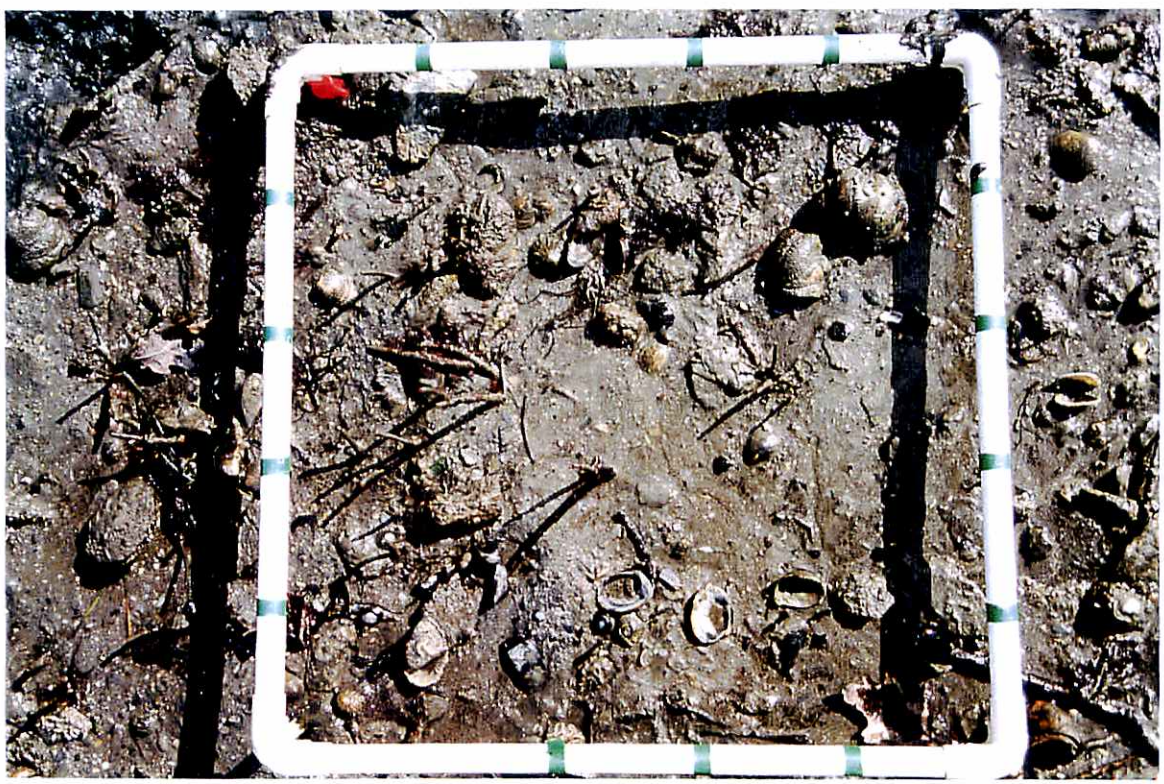
1. Field investigation - simple and readily available
2. Laboratory investigation - some purchased, the most urgent being aquarium tanks plus simple cooling and circulatory apparatus
3. Other investigations, which may need some financial support, include SEM and some analytical procedures.

Intensive Survey Population Grid Sampling

PET Neg 0

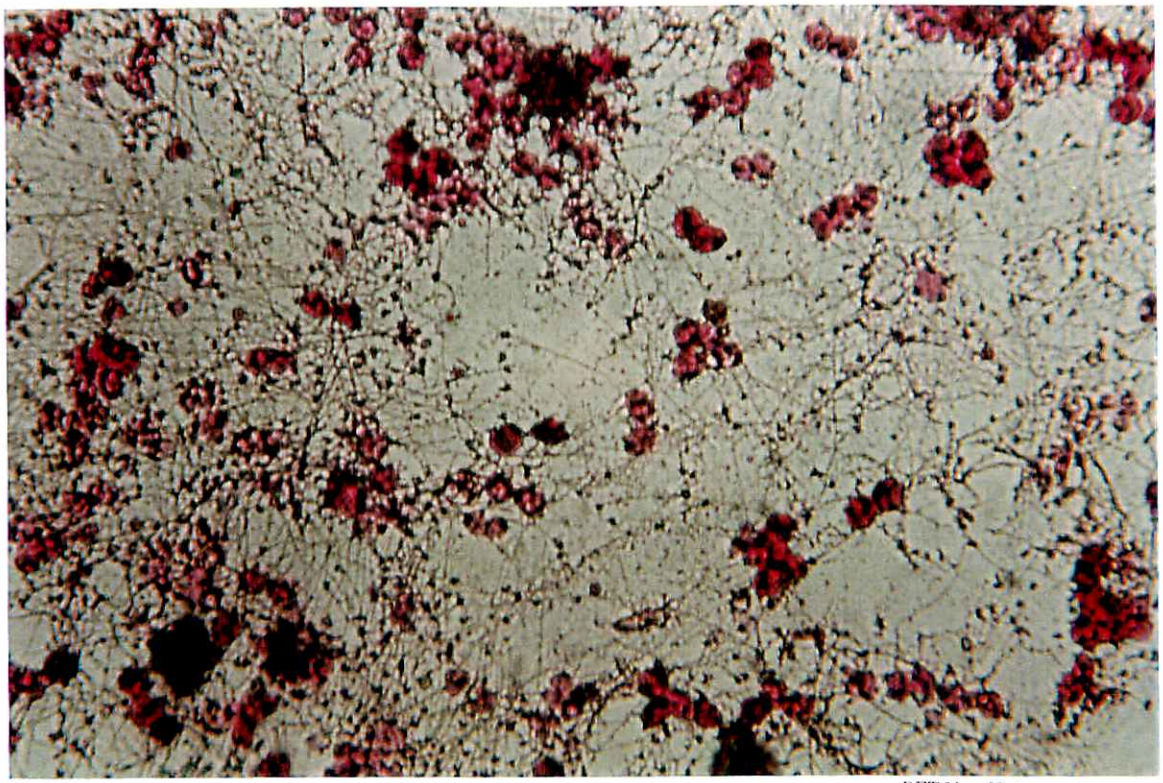
Gillan Harbour Site - March 1998

Settlement and growth *in situ*



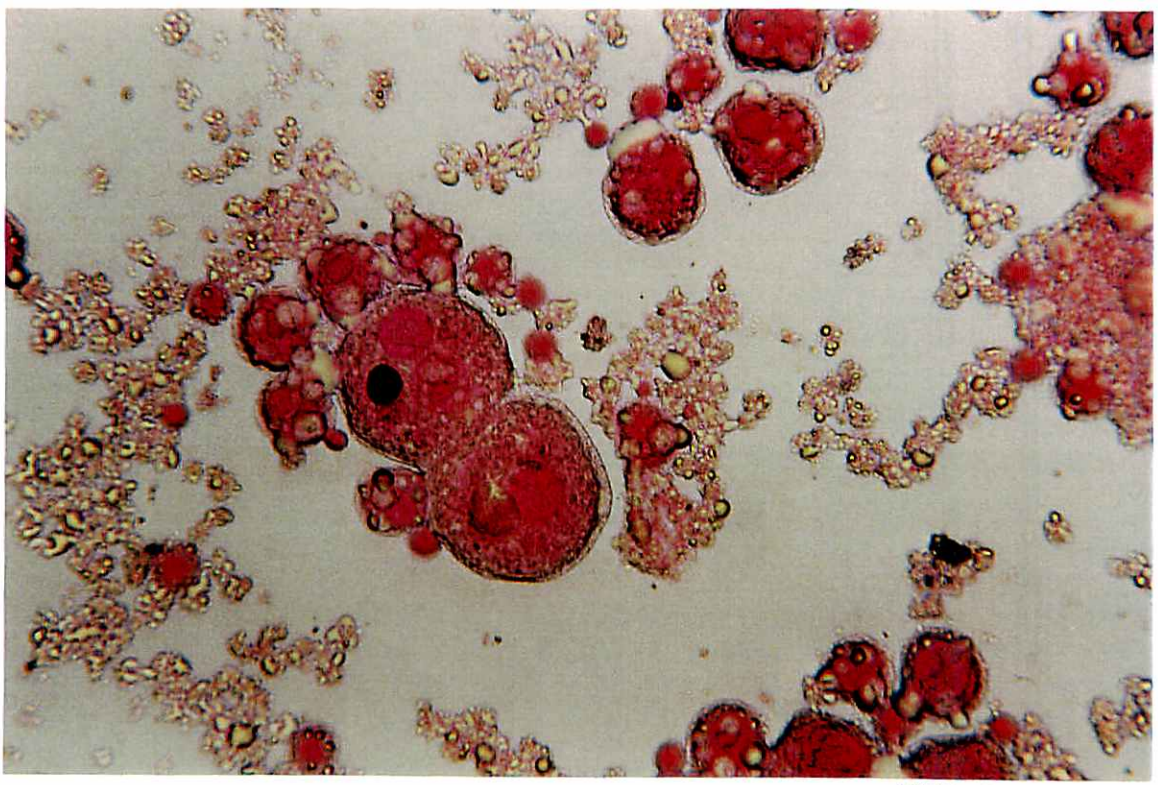
PET Neg 19

Quadrat - East of Frenchman's Creek Site - March 1998



PET Neg 18A

Spermatozoa and coelomic cells in fluid extract
Borax carmine stain Mag. x400



PET Neg 9A

Ova and coelomic cells in fluid extract, note oil droplets
Borax carmine stain Mag. x100