Quantitative sampling of benthic organisms by diving on the Swedish west coast

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KURZFASSUNG: **Quantitative Erfassung benthischer Organismen mit Hilfe der Tauchtechnik an der schwedischen Westküste.** Durch GISLÉN (1929–1930) wurde eine umfassende ökologische Untersuchung der Epibiosen im Gullmar-Fjord an der schwedischen Skagerrak-Küste vorgenommen. Anhand zahlreicher Probenentnahmen durch einen Taucher wurde der Organismenbestand qualitativ und quantitativ untersucht. Im gleichen Gebiet wurden 40 Jahre später Vergleichsuntersuchungen durchgeführt, um Veränderungen in der Zusammensetzung und Verteilung der Biozönosen zu ermitteln. Parallele und divergierende Befunde hinsichtlich der Artenzusammensetzung der benthonischen Lebensgemeinschaften werden gegenübergestellt und diskutiert.

INTRODUCTION

To scrape off all organisms within chosen test squares and to scrutinize the samples would seem a reasonable way to collect material for describing submarine benthic biocoenoses, their constancy and variation. But is it sufficient for the assessment of changes in the fauna and flora of a region to compare such samples taken at different times?

Looking for an answer to this question, an opportunity for a critical test arose in the Gullmar Fjord on the west coast of Sweden. Forty years ago the first comprehensive investigation on its submarine biocoenoses was started by GISLÉN (1929–1930). His results appeared in a now classical work "Epibioses of the Gullmar Fjord". During a period of four years GISLÉN analysed what he called epibioses at 35 stations in outer and inner parts of the fjord, in the archipelago off the mouth of the fjord and in adjacent water systems. At each station 1 to 10 samples were taken from different depths. The greatest depth sampled was 33.6 m. In all, 190 scraped squares were registered; in addition, at 43 points – preferably near the surface – associations were described in a simpler way.

PROBLEMS AND RESULTS

Would it be advisable to repeat the investigation of GISLÉN using identical methods, and if so, how should this be done to give comparable results? Or should such ecological work today be based on a different approach?

My first intention was to undertake this task on the basis of an approach completely unbiased by GISLÉN's previous results. I noted locality and depths, went down

Table 1

Station 3d Smedjan, outer archipelago, 0.8 m – a comparison of my findings (August 5, 1966) and those of GISLÉN (August 5, 1926); wet weight in g per quadrat

August 5, 1966		August 5, 1926	
Plants:		Plants:	
Polysiphonia urceolata	95	*Corallina officinalis*	750
Cladophora albida	75	Animals:	
Chordaria flagelliformis	70	*Purpurea lapillus*	55
Animals:		*Saxicava rugosa*	12.5
Mytilus edulis	2588	*Littorina littorea*	10
Littorina littorea	7.5	*Nereis pelagica*	7.5
Saxicava rugosa	2.5	*Littorina obtusata* + *Metridium dianthus*	2.5
Mytilis-dominated biotope		According to GISLÉN: Corallina association	

Table 2

Abundant species in test areas (1/4 m²); given are wet weights in g; Station 14f, 11 m. W. Hågarnskären, outer part of the fjord. A comparison of three squares from 1966 with that of GISLÉN from 1926

(a) August 3, 1966		(b) August 13, 1966 (80⁰)	
Algae:		Algae:	
Corallina officinalis	44	*Lomentaria clavellosa*	14
Ceramium rubrum	12	*Furcellaria fastigiata*	7
Furcellaria fastigiata	9	*Phyllophora membranifolia*	7
Lomentaria clavellosa	8	*Desmarestia aculeata*	6
Chondrus crispus	7	*Delesseria sanguinea*	5
Phyllophora brodiaei	8		
Animals:		Animals:	
Pomatoceros triqueter	145	*Ascidiella scabra*	23
Asterias rubens	20	*Pomatoceros triqueter*	11
Ascidiella scabra-Corella	9		
Modiolaria marmorata	7		
(c) August 13, 1966 (60⁰)		(d) August 3, 1926 (GISLÉN)	
Algae:		Algae:	
Chondrus crispus	39	*Furcellaria fastigiata*, *Phyllophora brodiaei*, *Brongniartella byssoides*, *Stilophora rhizoides*, *Rhodomela virgata*, *Delesseria sanguinea*	450
Delesseria sanguinea	24		
Lomentaria clavellosa	20		
Phyllophora membranifolia	12		
Furcellaria fastigiata	11		
Corallina officinalis	5	*Laminaria saccharina*, fragments	40
Animals:		Animals:	
Pomatoceros triqueter	41	*Ascidiella aspersa*	53
Modiolaria marmorata	29	*Styela rustica*	35
Ascidiella scabra	13	*Alcyonium digitatum*	9
Kirchenpaueria pinnata	8	*Balanus balanus*	
Balanus balanus	5	+ *Anomia pat.*	7
		Association according to GISLÉN "Mottled"	

and chose a test square (quadrat) that appeared to be representative; I did this without looking into the key about the type of community provided by GISLÉN.

This "unbiased" method gave only one information, a rather expected one, namely, that at a certain place and depth there are different communities. One can hit upon something related to the old quadrats but one is just as likely to find something else. An example is shown in Table 1.

Another way to work would be to take parallel samples and then see if the 40 year old registrations fall within or outside the present variation (Tables 2 and 3).

Table 3

Abundant species in test areas (1/4 m²); given are wet weights in g. See text to Table 2; depth: 16 m

(a) August 3, 1966 (90⁰)		(b) August 13, 1966 (60⁰) (adjacent to square a)	
Algae:		Algae:	
Delesseria sanguinea	1	*Delesseria sanguinea*	7
Animals:		Animals:	
Alcyonium digitatum	530	*Ascidiella scabra*	5
Ascidiella scabra	169		
Ascidia mentula	63		
Asterias rubens	17	(d) August 3, 1926 (GISLÉN)	
Styela rustica	5	Algae:	
		Delesseria sanguinea + *Phycodrys rubens*	62
(c) August 13, 1966 (80⁰)		Animals:	
Algae:		*Ascidiella aspersa*	225
Delesseria sanguinea	12	*Alcyonium digitatum*	113
Animals:		*Asterias rubens*	109
Alcyonium digitatum	42	*Ciona intestinalis*	60
Ascidiella scabra	17	*Metridium dianthus*	32
Corella parallelogramma	9	*Corella parallelogramma*	25
		Ascidia mentula	5
		Association according to GISLÉN: "Upper ascidian"	

The results show that three test squares sampled at the same time and under the same conditions can be so different that we cannot expect coincidence between two individual samples taken in 1926 or 1966 respectively. Still less is it permitted to assume that the differences noted are significant for changes which may have occurred during the time which has passed between 1926 and 1966.

Adjacent test squares with different slopes show differences which may be as pronounced as those between samples from different depths. Here Scuba-diving is a tool that can give us rich and exact information. Another important aspect which cannot be approached by employing dredges and bottom samplers, is the difference between apparently comparable localities such as are free from sediments and those covered by sedimented particles (detritus, mud, dead organisms).

A locality heavily covered by soft sediments is, for example, Station 10i, 17 m, at the border between fjord-mouth and archipelago. Here the faintest movements stir up impenetrable sediment clouds. The bottom as well as the frame used became invisible when collecting started. The most abundant species were *Furcellaria, Phyllo-*

phora, Chondrus and *Corallina*. These species had replaced *Delesseria, Brongniartella* and *Rhodomela virgata* which grew at similar, but "dust-free" places, i.e. at Station 14g, 16 m. At the sediment-rich station echinoderms were very abundant; on the 30° slope of the rock the encrusting alga *Cruoria* was totally lacking, as were *Balanus* and *Pomatoceros*. These species were covering the steeper rock at Station 14g. This difference between clean and dusty slopes may be typical of coasts such as the Swedish one where the tide amplitude amounts to some 30 cm.

Table 4

Wet weight of plants and animals in g per test quadrat. A comparison of collectings from 1926 and from parallels in 1966

Station		Epibioses 1926				Revisit 1966				Difference 1966–1926	
Nr.	Depth	Wet weight plants	Wet weight animals	Total weight of 1/4 m²	Plant percentage	Wet weight plants	Wet weight animals	Total weight of 1/4 m²	Plant percentage	Total 1966 –total 1926	Plant % 1966–1926
3d	0.8	750	88	838	89.5	243	2595	2838	8.5	+2000	—81
3f	5	2541	197	2738	92.8	2007	87	2094	95.9	— 644	3
3g	6.5	555	32	587	94.6	2047	295	2342	87.4	+1755	— 7
10i	17	67	1212	1279	5.2	109	621	730	14.9	— 549	10
14f	3. 8. 11	490	122	612	80.1	97	185	282	34.4	— 330	—46
14f	80° 11	„	„	„	„	43	53	96	44.8	— 516	—35
14f	60° 11	„	„	„	„	114	107	221	51.6	— 391	—28
14g	90° 16	62	577	639	9.7	1	803	804	0.1	+ 165	—10
14g	60° 16	„	„	„	„	12	12	24	50	— 615	40
14g	80° 16	„	„	„	„	14	79	93	15.1	— 546	5
24a	0.25	2925	19	2944	99.4	1471	160	1631	90	—1313	— 9
	0.4	—	—	—	—	75	10	85	86.3		
24b	1.5	1186	318	1503	78.9	332	198	530	62.7	— 973	—16

There seems to be a discrepancy on two points. GISLÉN records 43 findings of 27 species of algae, while I have noted 118 findings of 52 species from the corresponding squares. The difference depends mainly on the fact that GISLÉN has noted only bigger specimens (and a zooendophyte) while I have taken interest also in smaller species. Further, the weight of the collected material is definitely lower in most of my samples than in GISLÉN's.

The explanation in this last point could be, that by false ambitions the diver appointed by GISLÉN has yielded to the temptation to pick up some nice specimens from the immediate surroundings of the square or at least to put the frame over some big and beautiful specimens. Other explanations could be either diminished light today, or the fact that the winter before my collecting had included an unusually long period of ice-cover. On the other hand the summer afterwards was warm. Own observations, however, point to an important fact: pressure can produce a slight depth intoxication making the diver more generous than desirable. We must consider such psychological factors as well as hydrographical observations.

To be able to demonstrate slight changes or differences it is necessary to study as

many test squares as possible. Only in this way may we try to allow for the mosaic patterns of many rocky sea bottom communities.

SUMMARY

1. In the Gullmar Fjord (west coast of Sweden) bottom test squares had been sampled 40 years ago by GISLÉN (1929–30). Studying the same squares in 1966, using skin diving equipment, has led to different results in regard to the fauna and flora found.
2. If the old records are compared with a number of new ones, obtained from the same place and depth, the degree of variation encountered in the new samples may serve as indicator for assessing true differences between biocoenoses in 1926 and 1966.
3. Differences between adjacent test squares depend mainly on the slope of the rock. Other factors which may affect the community structure over short distances are direction and light.
4. Certain organisms settle on bottom areas where calm waters allow sedimentation.
5. Increasing pollution demands sufficient and extensive registration of the actual situation in order to allow for comparisons. For this purpose even a lot of scattered observations can never be equal to numerous data from each of a few chosen places, which are representing the main trends in the sea bottom mosaic.

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Discussion following the paper by MICHANEK

SVENDSEN: How close did you get to GISLÉN's localities?

MICHANEK: GISLÉN gives his localities rather carefully, e. g. Station 10i, Spättan shoal east, 17 m. East of this shoal this depth can be found only at a certain distance. Normally I should not miss the point by many meters, say not more than by 10 m.

SVENDSEN: Wet weight of algae is difficult to define. How did you proceed in weighing?

MICHANEK: According to GISLÉN the coarser algae were weighed after the water was allowed to run away and as much as possible shaken off. The tender ones were pressed between the fingers until no more water dropped from them.