Primary Article

Anthropogenic Mechanisms in Bio- Morphological Evolution

A case study of Öset & Rynningeviken Evolutionary Biology

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ABSTRACT

The paper is a study of micro and macro biological changes of wetland ecology, a region once used for both agricultural and industrial purposes. It is now under wetland restoration. The study area has been used both as a waste dump, fossil fuel deport and extensive cultivation around lake Hjälmaren on the Eastern side of Örebro City.

Keywords:

Anthropogenic Mechanisms , Morphological , Evolutionary Biology.

Introduction:

The study of complex ecosystem is incomplete without the study of the entire geography of the area. This paper accomplishes that task with a comprehensive compilation of the variables, which make the study of fragile wetlands more broad and thorough. In such studies, where anthropogenic activities are concerned, attention to biomorphological futures especially within urbanised settlements is crucial, to mapping evolutionary biology processes derived wherefrom.

It is essentially useful too, to integrate short time period bio-morphologies processes in order to the track down the historical arrays of anthropogenic effects over given time periods and as a result understanding ecosystems, species life cycles, food chains and population changes.

Background

Öset and Rynningeviken are two geographical locations on the eastern part of Örebro City along the shores of fresh Water Lake Hjälmaren.

In 1910 Erik Rosenberg discovered Rynningeviken for its ornithological value. 1943 Öset was made a national park and in 1968 it become a natural reserve covering 85 hectares of water and 90 hectare of land. It was not until 1995 that Rynningeviken also become a natural reserve covering 115 hectares of water and 365 hectare of land.

Historically, the region has gone through considerable ecological changes over the past hundred of years. Changes which are as a result of anthropogenic activities such as systematic Germanic derived rectangular city planning for a trading centre around the middle of 1500, agricultural activities, and intensive industrial growth that resulted into partial draining of the lake to reclaim the richer wetland for crop farming and pasture.

Öset was also used as a waste disposal dump for Örebro municipality, which resulted into gradual destruction of the wetland. Industrial waste, a military exercising field and an oil depot were located on the boarders of this ecosystem.

The mosaic of the wetland vegetation, the adjacent boreal forest and bushes give a paleo-ecological impression of the past rich biota that could sustain not only a considerable population of flora but also a rich fauna.

Geographically the region is south of the northern forest corridor, which would act as a natural habitat for small vertebrates surviving on wetland vegetation and canine mammals predatory on birds and aquatic animals like the amphibians and fish. The forest would also act as a corridor for highland fauna north west of the wetland, which today cover the mainland and human settlements.

The purpose for this paper is not only to investigate into macro-biological changes over time and effects on a given mosaic but also to closely examine the consequences of human intervention into fragile ecosystems. Hopefully the paper will lay ground and act as a reference for further ecological and evolutionary biology studies into how changes in adaptive functions of phenotypes in given bio-geographical locations can result into both dynamic and static genotype variations hence a diminishing bio-diversity or dominance of a particular species.

It goes without saying that the purpose for the restoration of the named wetland, was partially to restore its ecology hence its becoming a natural reserve in order to reinstate the original rich diversity.

Recent history of the study area, shows heavy pollution from the oil deport. That is no longer there, however the effects on river Svartån, affluent, the cumulative effects of the nutrient load through adjoining farm land plains, the sewerage plant in the vicinity, waste dumps, the effects of pine forest excretion of acid content upland etc., are quite visible.

Notably, the latitude of the location allows ground water level during wet and mild rain seasons to rise above ground. The topographic nature of Örebro municipality attests to this fact and will naturally presuppose that water flows towards the wetland. Given to the dominating soil chemical composition of aluminium and silicate oxide compounds, will most certainly add to a high pH value levels thus increased pressure on the wetland if the carbon content in the soil and biota to rejuvenate humus levels are not sufficient.

The study region is dotted with peat, which naturally will suck up water to about 12 meters below ground. Implying there will be considerable effects of water impurity on the flora and fauna habituating in this bio-geographical location. The high concentration of heavy metals in water discharged from the purification water dams makes suspect the ability of plants of plants to chemically break them down. Indeed different metals have different life periods in nature. This case will be revisited under the course of the study inhere.

Hjälmarens active history

River Svartån is the major source of 55% of flow water into the lake with 30% coming from Kvismar channel.

The lake itself in connection to the study area was once used as a dumping post for industrial waste a composition of wood fibres (600 kg/ day) from Supras Industries and about 5 % of phosphate compounds from the municipal sewerage purification plant.

It is also calculated that 130 ton of phosphate compounds and about 2300 tonnes of nitrate compounds where deposited into the lake per year.

Such nutrient load, certainly creates the biological instability problems for the rich Rynningeviken ecosystem, which I will later study independently as variables in the bio-morphological changes in natural habitats.

General study

Given that the studied area is quite a fascinating post-industrial region now being reclaimed to its former bio-geographical status, has both paleoecological significance and future importance in the study of evolutionary biology. I'll therefore set myself a task in this paper to theoretically show the correlation between five basic criteria in relation to human activities namely:

a). Hydrology
b). Lithographic composition
c). Topology
d). Climate
e). Flora and Fauna

Naturally these variables are crucial in the ecosystem of the location this paper is studying. It will be noted that anthropogenic activities are directly subject to the above named variables, which later act as mechanisms to observable dynamics of ecosystem biology, which is of primary importance to this study work.

-It is quite obvious that for a fragile ecological system to be self-sustaining with such a diverse life component, water systems here should be of a particular quality if given niches for particularised species are to survive. I'll therefore examine the hydrological qualities of the area but also due to the fact that there is a sewerage plant in the vicinity and as a result of the recorded values of river Svartån nutrient load status.

Phosphate, and nitrate compounds concentration plus increased water alkalinity does affect the growth of plant and animal plankton. These two act as an indicator for the health of the lake and determines its biological status. The levels of chlorophyll concentration will be directly affected by the concentration of the above said compounds and so is the low-level of plankton which is food for aquatic organisms.

The reason for looking at the hydrological variables are multiple due to the fact that the study area was heavily drained and at the same time polluted undermining the survival rate of both micro and macro organisms in the soil and surrounding vegetation.

Surface water factors such as turbidity, conductivity, pH value and heavy metal content offer invaluable data on the survival of given organisms into the study location. In the tables below, data shows a clear correlation between both surface and under-ground water quality.

In case of abiotic sediment continually being recorded seem to be causing a considerable damage on ecosystems' ecology for example with algae growth especial blue-green algae (cyanobacteria) in lake shore regions exposed to heavy nutrient load. (Edna Granéli: 199_ Giftiga algblomingar – Människans verk.)

Table Örebro Weekly Organic Pollutants monitoring 1997/40 - 1998/13

Bensen ug/m3	Toluen ug/m3	mp-xylen ug/m3	O-xylen ug/m3
1,4	4	2,2	0,8
1,8	4,7	2,3	0,9
1,4	3,5	1,7	0,6
1,6	3,2	1,4	0,5
1,5	3,3	1,5	0,6
4,4	9,9	5,4	2
2,7	6,2	2,8	1
2,5	5,4	2,5	1
3,9	7,6	3,5	1,3
3,8	8,7	4	1,5
3,3	7,7	3,2	1,2
3,5	7,6	3,4	1,2
3,5	6,5	2,6	1
1,7	3,6	1,4	0,5
2,5	5,3	2,3	0,9
2,2	4,9	2,3	0,9
2	3,6	1,5	0,5
1,6	3,1	1,3	0,6
2,1	4,6	2,1	0,8
1,7	3,6	1,5	0,5
1,1	1,8	0,8	0,3
1,2	2,3	1	0,4
2	4	1,7	0,7
2	4,6	2,1	0,8
1,6	3,2	1,5	0,6
1,7	3,3	1,5	0,6

Source: Örebro kommun

There are visible consequences in the estuary of river Svartån with high concentration of insoluble particles, which lower water conductivity and turbidity. Had water been of higher quality for example in Svartån, it would offer rich biotic sediment, which will attract high microbial activity hence increase in fauna activities during summer period.

Some of the nutrients like iron, phosphate compounds etc., are indeed necessary for plant growth and are consumed in given amounts. It is therefore realistic to note that what is shown in the tables, are figures converted into quantities above allowed limit levels, of what is required in the nutrient cycle of bio-chemical processes of living organisms. Effects of excessive nutrient load for example, led to massive death of fish in Hjälmren 1976 and since then water quality is only resorted through heavy carbonation of the lake.

It's of cardinal importance to note that Örebro city, is located along river Svartån which will naturally have acted as a drainage system for rain water, in combination with the population growth concentration of the city. The effects on the palaecology status along the river estuary and its catchment which is the river drainage region, and the wetland are quite considerably in historical terms. The historical growth of the city does show trends of declining diversity. (Gustaf Jonasson Medeltidens Örebro: 96-106)

-Soil profiles and types do also contribute to vegetation diversity in the surrounding region, which is a common future in the selection of species and niches alike, for specialised birds and animals etc,. Soils have got a life cycle and need to be nourished, particularly those soils found in the wetlands. We can assume that water levels and dead organic matter in wetlands generate a process whereby decomposition is accelerated.

Decomposing detritus and other soluble products (biota) carried down into the wetland contribute to leaching of value minerals and nutrients.

The above might generate higher oxidation rates by microbes hence increasing the rate of food making processes for the fauna.

Heavily contaminated soils posses a danger to fauna, flora and the health of the soils. Abiotic matter reduces the mineralisation processes through reduction of the oxygen content into the water and soil. Oxygenation of the wetland is of crucial importance to soil profiles, i.e. microbial survival, which in terms of micro-climatic variables like temperature, humidity and aeration of the substratum will increase decomposition rates hence decreased rates of acidification or strike a balance between oligotrophic (acid) and eutrophic (base rich) content in the wetland.

Notice that high acid content in the soil will increase weathering processes lowering the oxygen content process, which is quite visible up on the north-western side of Örebro city.

Local soil composition

Oxide	weight %	Ave.Error	Min %	Max %
Al2O	*11.8*	*0.36*	*9.6*	*14.9*
CaO	*1.2*	*0.08*	*0.7*	*1.9*
Fe2O3	*3.6*	*0.33*	*2.3*	*6.9*
K2O	*3.2*	*0.13*	*2.4*	*4.2*
MgO	*0.9*	*0.10*	*0.5*	*2.1*
MnO	*0.0*	*0.01*	*0.0*	*0.1*
Na2O	*2,4*	*0.1*	*1.6*	*3.3*
P2O3	*0.1*	*0.01*	*0.0*	*0.2*
SiO2	*76.3*	*0.88*	*67.7*	*81.9*
TiO2	*0.4*	*0.04*	*0.2*	*0.7*

-Vegetation as well as animal species might disappear all together or just not be suitable to adapt to a heavily utilised bio-geographical location with either heavy metals or nutrient load content. Soil composition can also contribute to increased toxicity of both the flora and fauna. This is the case in the study area in regards to soil type composition westwards.

From the table above it is clearly indicated that there is high content of aluminium and silicate oxides in the soil profiles of Örebro. The oxidant levels shown above must be of significant importance in the biological determinants of micro-organism life cycles. Sinking of water levels and re-emergence of disappearing plants in this water depression reflects the soil nutrient richness since the same plants could not survive in adjacent wetland.

The shores and the ecology of Lake Hjälmaren were affected by sunken water levels in the 1882 and 1886 by 1,2 m and 0,7 m respectively.

Notice that there were positive effects in regard to flora emergence of new species and older ones thanks to the rich biodiversity of birds and mammals that resided in the area contributing to the spread of seeds. Selim Birger Gotthard has written extensively about the changes in the botanical futures on both the islands in the lake that remained after lowering of water levels and floras spread off shores.

He notes for example that between 1886 and 1904 there appeared both disappearing and new flora of which not less than 260 phanerogam and cryptogam where registered, 45 mosses, 35 lichens.

Here once again, the soil composition of the place does play a role in flora spread but there are also other factors namely:

a.Water quality
b.Wind for seed dispersal
c.Animals (human beings inclusive) also in seed dispersal

For birds this might come in form of where they build nests, depending on the type of grasses they use as building material.

-Climate too plays a pivotal role for example in the lives of birds. The survival of many migratory birds depends on good sources of food especial specialised insectivorous, which depends on both the micro and macroclimatic factors. The climate aspect as a function of temperature, rainfall and wind will most certainly influence the duration of given species habitation in a particular place. It is clearly observable with small boreal forest birds, which stay on during wintertime periods since they can find food in the warmth generated by boreal biota.

In case of birds and small mammals, climatic conditions are of crucial importance for their survival. As a matter of fact, marshy wetland ecology with short bushes and grasses will most certainly suit the adaptive functions of given species also in their reproductive processes.

It's observed that climatic factors have a correlation with vegetation cover and the biotic types found in particular location. It thus shows that it is exactly the changes in vegetation cover, which generated the collapse of the Öset and Rynningeviken ecology.

These changes are crucial since sustainable food chains in fragile ecosystems depend on the mosaics of the particular bio-geographical location, which if the chain is broken terminates specific niches into such areas.

E.g. when water levels are not sufficient or its purity is questionable, particular amphibians and reptiles sustainability will hence see a decline given to the bird species which have their food chain as a component of marshy wetland amphibians and reptiles.

There is a wealth of material written on amphibian population which have picked up in the recent past as a result of the on- going restoration of the study area.

Pivotal to this study area is how future populations will phenotypically adapt their morphology to man made environments that are still highly under historical anthropogenic pressure and if it might or not lead to new ecotypes.

Population structure

Studies, which have been carried out here over some period, shows that there was a sharp decline in species population densities in Rynningeviken.

It is quite important too for this paper to show the circumstances that leads to decline in flora and fauna. It should be noted that differences in population density reflect the circumstances under which the quality of the environment is in. These might be as a result of territorial pressures between humans and animal species but also in case of Rynningeviken micro-biochemical factors like water pollution.

In concert with Örebro original fauna and flora it will be of interest to qualitatively know the reason behind its decline in consideration of given facts and how that could be measured hence;

a.Reproductive rates (Rn) where Rn = Nt/No No= initial number of reproductive adults and Nt = specified period of time (t) the number individuals remaining (Nt).
b.Growth or declining rates in population groups. Population growth rate over time Nt + 1 = Nt + (B –D)-(I-E)

where

N = number
t = base time
t + 1 = one unit of time (e.g. one year) after the base time
B = number of births in the unit of time being considered
D= number of deaths in the unit of time being considered
I = number of in-migrants in the unit of time being considered
E= number of out-migrants in the unit of time being considered.

It is quite clear that the decline of Örebro's wetland flora and fauna was not due to land carrying capacity. But rather as a function of territorial pressure and systematic degradation of Rynningeviken's environment.

Marshy wetland functions

Öset and indeed Rynningeviken over a long period of time must have biologically been going through evolutionary processes during the formation of the lake depression and hydraulic activities of the lake and river Svartån.

To fully appreciate the biological dynamics of the ecosystems, the one referred to here one has to set the focus on the population changes in the location of study over the years. (see table 2.)

That both local and migratory birds have found sanctuary and use in the area for hatching and for reproduction, most certainly modify the behaviour of other animals in the surrounding area not least the plants and insect balance. Besides insectivorous birds it is most logical that the population of scavenger birds will on the one hand be in proportional numbers feeding on bird chicks. The topology of the area shows high areas that will be habituated by scavengers, that is the region up West and North West. The scavenger bird population has been declining over the years as per the data collected in the study region.

As stated in the red listed (rödlistade 2001), it is apparently clear that over the years there was a considerable decline of population variations of the study area. It reflects a serious biological problem, which implies that a once rich genetic pool has over the years been gradually depleted of its variation.

Vena Waste water dams

The Vena waste water dams are artificial creations to replicate the natural process in water purification process. It covers 6000 m3. Table 1 and 2 shows the level of nutrient load ranging from heavy metals to soluble material, which are released into the wetland area.

After removing solid waste from sewerage, water is pumped through the wetland land dams where it is then evaluated for its purity level which is a three phased process; incoming and discharge leached water, water in the dikes, and ground water. Positive results show chlorine reduction by 50% that is a hundred percent in discharged water into the wetland dams.

Hadn't such a dam handling leaching nutrient been into place the shores of Hjälmaren would certainly be under extreme pressure from an environmental point of view with highly none degradable aboitic sediment.

Concluding remarks

It is calculated that between 1966-69 the geese fish was responsible for 73% of the fish catch that in real terms is about 250 tonnes of fish caught during the period.
Therefore the bird population was high as a result of the fish population.
Wetland ecology mainly in the study area is renowned for its bird population, which certainly would be attracted here for food i.e. fish.
The decline of fish stocks therefore is an indicator for a declining ecology.
Since humans are part and parcel of the ecology in question – it is of crucial importance to examine human settlement into the study are for its anthropogenic activities which contribute to the decline of biological diversity into the studied zone.
Johan Torings map of Örebro (see appendix) from 1652 clearly shows a growing city across the main supplying source, river Svartån to Lake Hjälmaren.

Urban planning and ecology

It is therefore important that urban planning is organised in such a manner that will not affect or compromise the survival and stability of ecological systems. Notice too that the study area is just about 1 kilometre away from the city and human settlements.

The topology of Örebro City suits the mechanical engineering of the sewerage plant that was evidently a planning mistake, only suitable simple engineering and mechanical transportation purposes of urban waste. Notice that waste water will automatically flow east wards into the wetland.

Had the city not been planned in such a manner the wetland would not be under the ecological pressure thus shown.

Water purification dams would have been place high above hence releasing clear water into the wetland.

Örebro street design too makes Svartån the major outlet from both rain water drainage system and polluted snow overflow. Loaded with Hydrocarbon compounds, Street impurities like aromatic hydrocarbons shown in the table above are transferred directly into the water system and directly delivered into the river estuary which feed both the wetland and the lake.

The aerial photography of Lake Hjälmaren shows heavy sedimentation deposits along the shore and into the bay. However the flood portion of the wetland does have residues of contents of water impurities that does not allow a high bio-diversity but rather just suffocates it off.

Human settlements too around the study area, acts as a permanent enclosure which implies that the mosaic of the study location is limited to flying and small mammals which can take themselves around through the remaining vegetation corridors, which will not be sufficient for bigger mammals.

In short Öset and indeed Rynningeviken, though historically have been immensely important to Örebro as an agricultural and industrial region, but YET still its future prospects are still ecologically and biologically diversity which as of now are still dim.

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Leakage water from wetland dams in the study area
Testing location Venan

		01-03-29	01-04-25	01-06-07	01-10-31	Average 01
Suspended particles	mg/l	36	25	8,9	10	20
pH		6,7	8,1	8,3	8,3	7,9
Conductivity	mS/m	190	110	110	110	130
Chloride	mg/l	86	49	100	46	70
BOD_7	mg/l	6	6	12	10	9
COD(Cr)	mg/l	130	140	210	170	163
Ammonia-nitrate	mg/l	71	26	16	1,5	29
Nitrate	mg/l	<0,01	0,22	0,88	0,79	0,5
Total Nitrate	mg/l	76	35	25	5,5	35
Total phosphate	mg/l	0,057	0,13	0,19	0,094	0,12
Arsenic	mg/l	<0,001	0,0017	0,0024	0,0012	0,0016
Lead	mg/l	<0,001	<0,001	<0.001	<0,0005	0,0008
Bor	mg/l	0,32	0,24	0,37	0,39	0,33
Iron	mg/l	8	5,7	3,6	3,1	5,1
Cadmium	ug/l	0,19	<0,1	<0,1	<0,1	0,12
Potassium	mg/l	53	37	53	59	51
Copper	mg/l	0,0018	0,0044	0,0037	0,0015	0,0029
Chrome	mg/l	0,015	0,0056	0,0055	0,0039	0,0075
Mercury	ug/l	<0,2	<0,2	<0,2	<0,2	0,2
Magnesium	mg/l	27	25	33	28	28
Manganese	mg/l	1,5	0,82	0,13	0,058	0,63
Nickel	mg/l	0,015	0,01	0,013	0,0073	0,011
Strontium	mg/l	0,36	0,3	0,37	0,31	0,34
Zinc	mg/l	0,0021	0,0083	<0.005	<0,005	0,005
AOX	mg/l			0,18		0,18

Table 1.
Source: Örebro Kommun, Teknisk Förvaltningen Atleverket Tippen.

Incoming leakage water into the wetland dams
Testing location Venan

		01-01-16	01-03-29	01-07-16	01-09-26	01-11-28	Average 01
Suspended particles	mg/l	74	220	21	33	8	**71**
pH		7,7	6,7	7,6	7,5	8,4	**7,6**
Conductivity	mS/m	180	260	190	230	160	**204**
Chloride	mg/l	74	130	190	180	120	**139**
BOD_7	mg/l	6	9	<3	4	<3	**5**
COD(Cr)	mg/l	130	200	160	190	96	**155**
Ammonium Nitrate	mg/l	48	92	42	66	30	**56**
Nitrate	mg/l	0,69	<0,01	0,76	1,3	12	**3**
Total Nitrate	mg/l	48	90	87	73	43	**68**
Total phosphate	mg/l	1	0,21	0,21	0,24	0,04	**0,34**
AOX	mg/l				0,0002		**0,0002**
Arsenic	mg/l	<0,001	<0,001	0,0018	0,013	0,00076	**0,0035**
Lead	mg/l	<0,001	0,0018	0,00016	<0,0005	<0,0005	**0,0008**
Bor	mg/l	0,36	0,48	0,57	0,61	0,51	**0,51**
Iron	mg/l	29	73	9,3	6,1	1,6	**24**
Cadmium	mg/l	0,0016	0,00035	<0,001	<0,001	<0,0001	**0,0008**
Potassium	mg/l	55	78	68	100	63	**73**
Copper	mg/l	0,006	0,0034	0,002	0,0023	0,0085	**0,0044**
Chrome	mg/l	0,022	0,035	0,011	0,015	0,0058	**0,018**
Mercury	ug/l	<0,0002	0,0003	<0,0002	<0,0002	<0,0002	**0,0002**
Magnesium	mg/l	33	38	38	45	33	**37**
Manganese	mg/l	1,9	1,8	0,71	0,59	0,5	**1,1**
Nickel	mg/l	0,021	0,016	0,012	0,0075	0,012	**0,014**
Strontium	mg/l	0,42	0,58	0,6	0,52	0,37	**0,50**
Zinc	mg/l	0,05	0,05	0,0083	0,01	<0,005	**0,02**

Table 2
Source: Örebro Kommune, Teknisk Förvaltningen Atleverket Tippen.

Ground water- testing point Venan

		G11		G12		G13		G14	
		01-04-25	01-09-04	01-04-25	01-09-04	01-04-25	01-09-04	01-04-25	01-09-04
Turbidity	FNU	2,7	10	29	120	950	1100	720	1100
pH		8,2	7,8	8,2	7,7	7,9	7,2	8,1	7,2
Alkalinity	mg/l	310	290	320	300	410	370	650	670
Sulphate	mg/l	25	22	63	49	6,6	16	<1	7,7
Conductivity	mS/m	70	70	70	68	160	160	170	180
Chloride	mg/l	49	45	33	25	290	280	280	220
COD(Cr)	mg/l	<30	<30	<30	<30	94	84	140	110
Ammonium Nitrate	mg/l	0,08	0,09	0,36	0,41	0,7	0,76	5,9	6,4
Nitrate	mg/l	<0,01	0,01	<0,01	<0,01	<0,01	<0,01	<0,01	<0,01
Total Nitrate	mg/l	0,56	0,37	0,7	0,6	18	1,3	63	6,7
Bor	mg/l	0,11	0,25	0,11	<0,05	0,25	0,17	0,25	0,25
Cd	ug/l	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1	<0,1
Cr	mg/l	<0,001	<0,001	0,002	0,0011	0,0025	0,0037	0,0065	0,0062
Cu	mg/l	0,02	0,0045	0,0062	0,0067	0,005	0,0047	0,0056	0,0022
Iron	mg/l	1,7	1,4	11	10	81	85	80	91
Potassium	mg/l	10	7,3	6,8	4,8	20	12	15	15
Magnesium	mg/l	19	12	24	15	62	40	45	41
Manganese	mg/l	0,71	0,61	2,1	1,9	8,6	6,8	6,7	6
Nickel	mg/l	0,0012	0,002	0,0012	<0,001	<0,001	0,0022	0,0087	0,0064
Strontium	mg/l	0,26	0,19	0,52	0,34	1,2	0,8	0,86	0,81
Zinc	mg/l	0,024	0,037	0,023	0,027	0,022	0,064	0,042	0,021

Table 3.
Source: Örebro Kommune, Teknisk Förvaltningen Atleverket Tippen.