Ytre Hvaler nasjonalpark

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Ana Teresa Capucho

Saksbehandler Monika Olsen **Vår ref.** 2024/40930-4 432.3 **Deres ref.** **Dato** 30.10.2024

Ytre Hvaler nasjonalpark - Innsamling av sedimentprøver - Naturhistorisk museum UiO

Søknad datert 18.10.24 ble behandlet i Ytre Hvaler nasjonalparkstyre 01.11.24.

Saksfremlegg til nasjonalparkstyret
Sak 2024-13 Ytre Hvaler nasjonalpark - Innsamling av sedimentprøver - Naturhistorisk museum UiO

Nasjonalparkstyrets vedtak
Settes inn

Sekretariatets forslag til vedtak
Med hjemmel i naturmangfoldloven § 48, gir Ytre Hvaler nasjonalparkstyre Naturhistorisk museum UiO dispensasjon til innsamling av sedimentprøver til Artsprosjektet MeioSkag. Det kan samles 10 liter sedimentprøver per strand fra de to omsøkte strendene på Storesand i Ytre Hvaler nasjonalpark (vedlegg 1). Dispensasjonen gjelder for avd.ingeniør Ana Teresa Capucho med kollegaer.

Vi forutsetter at innsamlingen gjennomføres i samsvar med beskrivelsene i søknaden og i tråd med Artsprosjektet MeioSkag (vedlegg 2).

Tillatelsen skal være tilgjengelig i felt, og kunne vises oppsyn og politi. Dispensasjonen gjelder for 2024 og 2025.

Dispensasjon er gitt i samsvar med naturmangfoldloven § 48 første ledd første alternativ.

Søknad til nasjonalparkstyret

My colleagues and I are researching meiofauna (<1mm marine invertebrates that live in between the sand grains) in the Skagerrak, as part of a project funded by Artsdatabanken at the Natural History Museum of Oslo, and we would like to collect a few sediment samples at Ytre Hvaler National Park. This would be a maximum of 0,01m3 of sand per beach.

We are planning to collect sediment at the shoreline on two beaches within the National Park, close to Skjærhalden (Prestesand and Liten Strand, see map below) (vedlegg 1). These beaches seem to be used for recreational purpose and adding this to the small

amount of sediment we aim to collect, we believe there is no impact at all on the surroundings and ultimately it may aid to the conservation of the park, as we can share the results of our research with you.
Meiofauna is an understudied group, despite their importance to the environment (e.g. bioindicators, part of food chains…), and there has never been an inventory of this kind of animals done in the Skagerrak.

Lovgrunnlag
Ytre Hvaler nasjonalparkstyre er forvaltningsmyndighet for Ytre Hvaler nasjonalpark. Vi forvalter verneområdet etter en egen forskrift med bestemmelser som sier noe om formålet med vernet, og hvilke tiltak og aktiviteter som er tillatt, forbudt eller som krever tillatelse.

Ytre Hvaler nasjonalpark ble opprettet 26.06.2009. Formålet (§ 2) er å:
- bevare et egenartet, stort og relativt urørt naturområde ved kysten i sørøst-Norge,
- bevare et undersjøisk landskap med variert bunntopografi,
- bevare økosystemer på land og i sjø med naturlig forekommende arter og bestander, kystlandskap med sjøoverflate og havbunn med korallrev, hard- og bløtbunn.
Allmennheten skal gis anledning til naturopplevelse gjennom utøvelse av tradisjonelt og enkelt friluftsliv med liten grad av teknisk tilrettelegging.

Etter verneforskriften § 3 punkt 1.1 er området vernet mot inngrep av enhver art. I hht. § 3 punkt 2.1 er vegetasjonen på land og i sjø, herunder døde busker og trær, vernet mot all skade og ødelegging. I henhold til §3 pkt 3.1 a) i verneforskriften er dyrelivet på land og i sjø, herunder hi, reir, hekke-, yngle- og gyteplasser vernet mot skade og unødvendig forstyrrelse.

Nasjonalparkstyret vurderer søknaden etter den generelle dispensasjonsbestemmelsen i naturmangfoldloven (nml) § 48. Vi kan gi dispensasjon dersom tiltaket ikke er i strid med verneformålet og ikke vil påvirke verneverdiene nevneverdig, eller dersom sikkerhetshensyn eller hensynet til vesentlige samfunnsinteresser gjør det nødvendig. Det gir ikke krav på dispensasjon selv om vilkårene er oppfylt. Bestemmelsen er en kan-bestemmelse, som innebærer at det skal foretas en konkret vurdering av om det skal gis en dispensasjon dersom vilkårene er oppfylt.

Det følger av naturmangfoldloven § 7 at prinsippene i lovens §§ 8-12 skal legges til grunn ved behandling av søknader om dispensasjon fra verneforskrifter. Prinsippene gjelder kunnskapsgrunnlaget §8, føre-var-prinsippet §9, økosystemtilnærming og samlet belastning §10, hvem som skal bære kostnadene ved miljøforringelse §11 og miljøforsvarlige teknikker og driftsmetoder §12.

Vurdering av saken

Vilkåret for å kunne gi dispensasjon etter § 48 i naturmangfoldloven er at tiltaket ikke er i strid med verneformålet eller påvirker verneverdiene nevneverdig. I avveiningen av om dispensasjon skal gis må det foretas en skjønnsmessig vurdering. Blant annet vil omfanget, miljøvirkningen og nødvendigheten av det tiltaket som det søkes dispensasjon for, ha betydning.

I forvaltningsplanen for Ytre Hvaler nasjonalpark er det gitt retningslinjer for vurdering av søknader om forskning og undervisning. Forskning er et viktig virkemiddel for å få til en kunnskapsbasert forvaltning. Gjennom formidling og undervisning kan man gi skoleelever og

andre verdifull kunnskap om naturen, og gode holdninger til vernet. Nasjonalparkstyret er positiv til forskning som kan bidra til økt artskunnskap og som er relevant for forvaltningens kunnskapsbehov. Det vitenskapelige motivet bak vernet vil kunne begrunne en mer liberal dispensasjonspraksis når det ikke er tale om etablering av faste anlegg (ny infrastruktur) eller terrenginngrep i verneområdene. Nasjonalparkstyret legger tilsvarende retningslinjer til grunn for vurderingen av denne søknaden. Vi vurderer at Naturhistorisk museum er tilknyttet et fagmiljø med kompetanse som vil kunne sikre at tiltaket utføres med tilstrekkelig kvalitetssikring.

Det framgår av naturmangfoldlovens § 8 at alle vedtak som berører naturmangfoldet skal bygge på vitenskapelig og erfaringsbasert kunnskap om naturmangfoldet og virkningen på det. Opplysningene om naturmangfoldet er i hovedsak hentet fra Naturbase og Artskart. Kart hentet fra Naturbase (vedlegg 3) viser at det er gjort mange artsregistreringer på Storesand og de omsøkte strendene i dette området, også i området langs strandkanten, men lite er registrert i det omsøkte strandområdet ytterst.

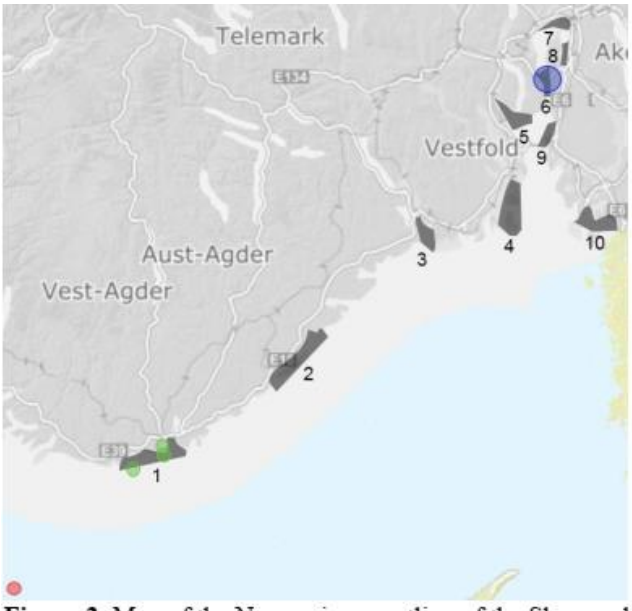


Figure 2. Map of the Norwegian coastline of the Skagerrak with records of the four lophotrochozoan groups as off October 18th, 2023 in ArtsKart. Red = Gastrotricha; Green = Annelida; Blue = Platyhelminthes. Small circles = 1 specimen; large circle = 42 specimens. Gnathostomulida have not been found. The grey areas indicate the 10 regions from which samples shall be taken throughout the project.

Det søkes om å ta ut ca. 0,01 m^3 (10 liter) sedimentprøver i strandkanten på hver av de to strendene, for å undersøke om det finnes meiofauna her. Artsprosjektet beskriver denne meiofaunaen slik:
«En stor del av det biologiske mangfoldet i havet fins i rommet mellom sandkorna, grusen og steinene på bunnen, det såkalla marine interstitium. Men kunnskapen om disse artene er mangelfull. Mangfoldet kjent som meiofauna eller interstitiell fauna, inneholder arter fra de fleste dyregrupper. De er et viktig bindeledd i økosystemet, mellom mikrofauna, som bakterier og protister, og makrofauna som større ormer, snegler og blåskjell. Trass i meiofaunaens viktige rolle i økosystema er kunnskapen om taksonomien, utbreiinga og økologien til disse artene, i beste fall mangelfull både globalt og i Norge. Informasjonen som eksisterer, er ofte bare på rekke- eller familienivå - sjelden på slekts- eller artsnivå. I tillegg er det mange uavklarte taksonomiske spørsmål, inkludert kryptiske arter. Det er derfor på tide å samle inn og kartlegge arter fra den norske meiofaunaen.

Geografisk skal prosjektet konsentrere seg om den norske kystlinja i Skagerrak, fra foten av sanddynene ned til 50 meters dyp. Innsamling av meiofauna vil skje ved å samle inn sediment fra de utvalgte lokalitetene. Mer spesifikt skal det samles sediment fra tre dybdesoner på ti lokaliteter. I laboratorium skal arter ekstraheres fra sedimenta, for deretter å bli identifiserte til artsnivå ved hjelp av morfologiske og molekylære metoder.»

§10 krever at tiltaket vurderes opp mot samlet belastning som økosystemet er eller vil bli utsatt for. Vi skal vurdere om den omsøkte innsamlingen kan føre til forstyrrelse, eller ødeleggelse av verneverdiene på et slikt nivå at verneverdiene vi skal beskytte blir negativt påvirket. Fra før er badestrendene på Storesand benyttet mye av både barn og voksne, og barna bedriver selvfølgelig ofte graving i sanden med spade og bøtte når de er på stranda. Områdene ytterst på strender blir også stadig påvirket av bølger og tidevann, sedimenter og steiner flytter på seg, og sedimentene er absolutt ikke urørt; dette er en naturlig del av økosystemets dynamikk. Som prosjektet beskriver, kjenner vi lite til hvilke arter som finnes i disse sedimentene. Etter vår vurdering vil innsamling av ca.10 liter sand/sediment trolig ha ubetydelig effekt på verneverdiene. Vi forutsetter at innsamling av sedimentprøver ikke skjer der det vokser vegetasjon eller er registrert rødlistede arter. Vi vurderer da at tiltaket utføres i tråd med nml. § 12, slik at bestand/ populasjoner ikke skades eller forringes, og ikke vil påvirke verneverdiene nevneverdig.

Nasjonalparkstyret legger til grunn for vår vurdering av søknaden at det foreligger tilstrekkelig informasjon om naturverdiene og tiltaket. På bakgrunn av dette er det ikke aktuelt å legge vekt på føre-var-prinsippet i denne saken, jf. § 9 i naturmangfoldloven. Vurdering etter § 11 anses ikke som aktuell i denne sammenheng.

Etter vår vurdering vil innsamlingen i seg selv ha liten effekt på verneverdiene, og tiltaket er ikke i strid med verneformålet, men kan på sikt bidra til å gi oss en bedre kunnskap om arter og økosystem i disse områdene. Vilkåret for å gi dispensasjon etter nml § 48 anses derfor å være oppfylt.

Klageadgang
Dette vedtaket kan med hjemmel i forvaltningsloven påklages til Miljødirektoratet innen tre uker etter at dette brevet er mottatt. En eventuell klage sendes til Miljødirektoratet via nasjonalparkstyret.

Med hilsen

Monika Olsen
nasjonalparkforvalter

Etter våre rutiner er dette brevet godkjent og sendt uten underskrift

Vedlegg:

1	Application Ana Capucho.pdf
2	ProjectDescription Final.pdf
3	kart naturyper

Kopi til:

HVALER KOMMUNE	Storveien 32	1680	SKJÆRHALDEN
STATSFORVALTEREN I ØSTFOLD, BUSKERUD, OSLO OG AKERSHUS AVD MOSS	Postboks 325	1502	MOSS

Natural History Museum

Ytre Hvaler Nasjonalparkstyre

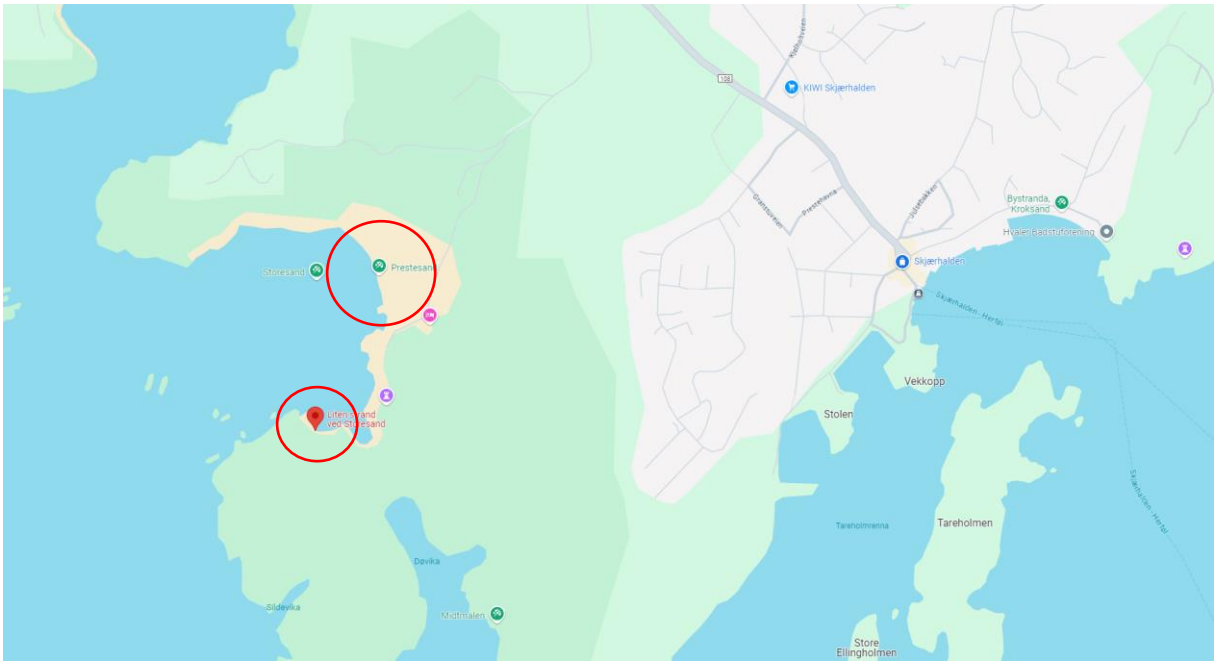
18.10.2024

Application for collecting sediment samples at Ytre Hvaler National Park

My colleagues and I are researching meiofauna (<1mm marine invertebrates that live in between the sand grains) in the Skagerrak, as part of a project funded by Artsdatabanken at the Natural History Museum of Oslo, and we would like to collect a few sediment samples at Ytre Hvaler National Park. This would be a maximum of 0,01m3 of sand per beach. We are planning to collect sediment at the shoreline on two beaches within the National Park, close to Skjærhalden (Prestesand and Liten Strand, see map below). These beaches seem to be used for recreational purpose, and adding this to the small amount of sediment we aim to collect, we believe there is no impact at all on the surroundings and ultimately it may aid to the conservation of the park, as we can share the results of our research with you. Meiofauna is an understudied group, despite their importance to the environment (e.g. bioindicators, part of food chains…), and there has never been an inventory of this kind of animals done in the Skagerrak.
We are planning to do this sampling next Wednesday, the 23rd of October.

Kind regards

Ana Teresa Capucho
Avdelingsingeniør



Coordinates:

Prestesand: 59°01'29.8"N 11°01'03.9"E

Liten Strand: 59°01'19.4"N 11°00'55.5"E

1. TITLE

MeioSkag - Meiofauna and interstitial fauna of four lophotrochozoan groups of the Skagerrak

2. RELEVANCE TO THE CALL

The main focus of the Norwegian Taxonomy Initiative is to fund inventories of poorly known taxa and, among others, to map all animals in Norway. Both at the global and the Norwegian scale, the knowledge of species occurring in the marine interstitium, that is the space between sand grains, gravel and stones, is very poor to almost non-existing in terms of their distribution and ecology including habitat preferences, and at best poor concerning their taxonomy. This is the case even though such meiofaunal or interstitial species are known from most animal phyla, and they are an important component of marine ecosystem. This is probably because biodiversity assessments of species from these habitats are time-consuming and laborious, often require the identification of living specimens and taxonomic experts for these groups are rare in Norway and globally. Maybe not surprisingly, in the 14 years of Artsprosjektet of the Norwegian Taxonomy Initiative, it has funded only a single project targeting one of these taxa, Kinorhyncha. In consequence, there is no baseline present to which we can monitor changes of meiofauna in distribution during climate change. Given Norway's latitudes, Norway is likely to be more exposed than most places to shifts in distribution and invasion by Mediterranean and subtropical Atlantic species might well be more acute than we know due to lack of baseline data.

Herein, we aim to remedy this huge knowledge gap by targeting meiofaunal and interstitial species of four phyla: Gnathostomulida, Gastrotricha, Platyhelminthes (i.e., four orders) and Annelida (i.e., 10 interstitial families). Knowledge about their distribution and habitat preferences in Norway is very poor to non-existent. Artskart, Artsobservasjoner and NorBol together list only 31 species with 230 records. In contrast, macrofaunal Nereididae (Annelida) has 2503 records of 11 species in this decade and Artkart alone. Moreover, across the four groups, barcodes in NorBOL are only reported for three species with only one approved. Given the challenges named above (e.g., time-consuming, living specimens), we will focus on an inventory of meiofaunal and interstitial species of these four groups at the Norwegian coastline of the Skagerrak from the supralittoral to sublittoral depths of 40-50m. We will collect and curate specimens including photo-documentation, develop keys, molecularly identify them using COI barcoding combined with genome-skimming and determine abiotic parameters of the sediment, their habitat. This will also provide both baseline and molecular data to detect hidden invasions in future studies targeting larger regions such the Northeast Atlantic and Mediterranean Sea. We will also promote them to the public, among others, by integrating them into a planned exhibition.

3. SCIENTIFIC PART

a) Abstract

A substantial part of marine biodiversity occurs in the space between the sand grains, gravel and stones of sediments, the marine interstitium. This biodiversity is also known as meio- or interstitial fauna and such species are part of most animal phyla. They are a crucial link in the ecosystem between the bioproduction and consumption of microfauna such as bacteria and protists to the macrofauna such as larger worms, snails, mussels and eventually fish and other vertebrates at top level of ecological networks. Despite this the knowledge about their taxonomy, distribution and ecology is at best poor both globally and in Norway and in dire need of improvement. Records are often only down to the phylum to family level and rarely the genus or even species level. Additionally, many have unresolved taxonomic issues including cryptic species.

This is why we urgently need to conduct a field inventory and collect species of such taxa in Norway. Given the vastness of this huge knowledge gap; we will target meiofaunal and interstitial species of Gastrotricha, Gnathostomulida, four Platyhelminthes orders and 10 Annelida families. Globally these taxa comprise about 3,700 species with 31 species documented in Norwegian databases. Moreover, we will concentrate on the Norwegian coastline of the Skagerrak from the foot of the dunes to a depth of 50m. With morphological and molecular methods, we will determine species and learn more about their distribution (including published reports) and their association with Norwegian nature types and different sediment types. Therefore, we also want to digitize records from existing literature, which is not reflected in databases like Artskart. Through the planned project, we will contribute to basic biosystematics and species distribution research in general, and more specifically, we will provide much needed baseline data for nature conservation management actions for this important part of biodiversity, which is entirely lacking at present for both Norway and globally.

b) Goals

The main goal of the project is to generate an overview about the distribution of marine meiofaunal and interstitial species of four lophotrochozoan groups along the Norwegian coastline of the Skagerrak. In specific,

we focus on species from the phyla Gnathostomulida and Gastrotricha, the Platyhelminthes orders Macrostomorpha, Prolecithophora, Proseriata and Rhabdocoela, and 10 so-called interstitial Annelida families.

(1) We collect sediment samples from 10 regions from 3 different zones. In specific, the supralittoral and eulittoral zone, the shallow sublittoral zone to 5-8m and the deeper sublittoral zone to 40-50m (F2-F3 in Table 2 "Progress plan" below). (2) Specimens are extracted in the lab alive using different methods, identified to species level, photo-documented using a DIC microscope and preserved for different purposes (F2-F3). (3) New and more specific COI-barcoding primers are determined using genome skimming and more than 1000 specimens are barcoded to confirm the species identification and to detect cryptic species. Crucially for metabarcoding-based environmental monitoring, this also provides reference barcodes for these species, most of which are at present not available in NorBOL (M1-M2). (4) Habitat preferences with respect to different abiotic environmental factors and distribution in relation to the NiN system of nature types is determined for the species from these four groups. For the latter, this is the first time (D1-D2). (5) We deliver a comprehensive species list, species occurrence records, excellent picture material, and keys for species determination (D1-D2, MS1-MS3). (6) We publish scientific and popular science publications about our results as well as these species and habitats in general and integrate our results into an exhibition (O1-O3). (7) We increase general competence by teaching a technician, Bachelor and Master students and offering a workshop (F1, O4-O5).

c) Background and state of knowledge

The marine realm is an environment that is highly structured due to the presence of several different zones influenced by different oceanographic factors such as depth or tidal movements as well as biotic ones like floral and faunal composition. The four major vertical zones are supralittoral, littoral, and sublittoral divided into shelf and deep-sea zones. The shallow sublittoral, coastal environment comprises some of the most productive and species-rich environments in the sea. In addition to these zones, the marine habitats can also be separated into different ecological groups given the size of the organisms. Both in the pelagos and the benthos, three groups are usually considered such as micro-, meio- and macrofauna. Meiofauna is officially classified by comprising all organisms passing through sieve-sizes ranging from 500 - 1,000 µm and being restrained by sieves of 22 - 44 µm [1-5], but these ranges represent a convenient (yet somewhat arbitrary) definition. In the benthos, meiofauna inhabits or lives on the different types of sediments that can be found in the sea, as well as composing a member of the periphyton. The fauna living in the space between sand grains is also generally known as interstitial fauna [6]. The terms meiofauna and interstitial species are often used synonymously in the literature. For instance, several interstitial species are considerably larger than 1,000 µm such as the well-known annelid *Polygordius* and hence, strictly spoken, do not belong to the meiofauna. On the other hand, some meiofauna are not strictly interstitial as they burrow through the sediment due to the small open space available. They are nonetheless referred to as interstitial (e.g., some Nerillidae species (Annelida) living in muddy sediments). In this project, we will concentrate on both marine meiofaunal and interstitial species and consider them synonymously and refer to both as meiofauna for consistency with the literature, where this term is more commonly used than interstitial [4].

While in the pelagic realm the importance of the meso-plankton as an ecological link between the micro- and macrofauna, e.g., in trophic networks, is well established and studied, for the meiobenthos, similar comprehensive studies on the distribution and ecology of these species are sparse [2, 5]. Today we know that marine sediments whether belonging to the supralittoral or the deep sea comprise a considerable diversity of meiofauna and under a "footprint of moist shore sediment [one] often [finds] 50,000-100,000 meiobenthic animals" [2, 5]. Moreover, meiofaunal species are known from 22 metazoan phyla including exclusively meiofaunal phyla like Gastrotricha, and Gnathostomulida [1, 3, 4]. Nonetheless, meiobenthic studies are often still restricted to purely alpha-taxonomic studies (e.g., [7-16]), where the description of new species is based on records from a single or a few patchy localities and comprehensive distribution studies are lacking [1, 2, 5].

Additionally, the taxonomic affiliation has often to be reconsidered using modern analytical methods (e.g., [17-28]). For example, the so-called "meiofauna paradox" assuming a cosmopolitan distribution of the meiofaunal species with seemingly low dispersal potential has very often been shown to reflect a combination of more restricted distributions and the lack of recognizing supposed cosmopolitan species as complexes of cryptic species [4, 5]. Hence, the actual number of species occurring in a locality might be considerably higher than what is known to date. For example, mostly by using molecular data the meiofaunal genus *Stygocapitella* (Parergodrilidae, Annelida) has been elevated from just one cosmopolitan species to 12 species with restricted distribution in just a decade [24, 27, 29]. Interestingly, given Artskart as off October 18th 2023 the genus is not recorded in Norway. However, recent studies [27, 30] and own personal observations found two *Stygocapitella* species occurring at localities from the Bunnefjord in the Inner Oslofjord along Bergen and the Lofoten to Tromsø. In summary, on both the global and the Norwegian scale our knowledge of the taxonomy, distribution,

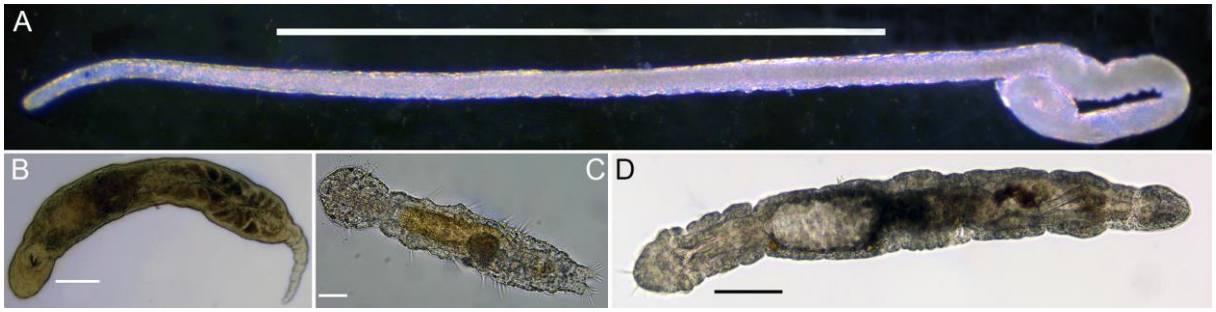


Figure 1. Representative species of the four lophotrochozoan groups. A) *Nematoplana coelogynoporoides* (Nematoplanidae, Proseriata, Platyhelminthes), scale bar = 2 mm; B) *Gnathostomula paradoxa* (Gnathostomulidae, Bursovaginoidea, Gnathostomulida), scale bar = 75 µm; C) *Dactylopodola baltica* (Dactylopodolidae, Macrodasyida, Gastrotricha), scale bar = 25 µm; D) *Trilobodrilus axi* (Dinophilidae, Annelida), scale bar = 100 µm; © Torsten Struck

and ecology of marine meiofaunal and interstitial species in general is scarce and patchy as comprehensive studies of their distribution are lacking for most parts of the world including the Norwegian coastlines.

As mentioned above 22 phyla have meiofaunal representatives and hence this would be a too-demanding effort to tackle all of them within one project as it among others would require very broad and different taxonomic expertise. We therefore concentrate on the representatives from four phyla in this project (Fig. 1). In specific, besides the entire phylum of Gnathostomulida (Fig. 1B), we will assess for Platyhelminthes the four orders Macrostomorpha, Prolecithophora, Proseriata and Rhabdocoela (Fig. 1A), for Annelida the so-called interstitial polychaete families (Fig. 1D) as well as the marine gastrotrichs (Fig. 1C). All species from these four phyla are soft-bodied, worm-like animals and can be investigated in similar manner from the collection of the sediments, the extraction of the animals from the sediments, the microscopic and molecular analyses as well as the preservation of the tissue for different studies. Hence, the same methodology can be applied to them. Moreover, species of all of them can occur in both very high and very low abundancies (for example, on the German North Sea Island Sylt (e.g., [31-36] & pers. obs. Struck)), hence covering the full spectrum of occurrence patterns in meiofaunal species.

The interstitial families of Annelida comprise in total 10 families (Table 1; [30]). These families do not form a monophyletic group but are distributed across the annelid phylogeny [37, 38]. They all comprise only meiofaunal species, which inhabit the interstitial realm permanently and have supposedly low dispersal potentials with only few offspring. Elven & Søli [39] only assess Annelida and "Polychaeta" in general. For "Polychaeta", they assess that there is only weak knowledge about the taxonomy, distribution, and ecology. Given Artskart, Artsobservasjoner & NorBOL, very little information is available at all for these 10 families in Norway (Table 1). Only five genera are reported and only two genera have been identified to three species. Also, the number of records is very low, with only 74 records for the entirety of the Norwegian coastlines including the deep sea. Hence, the knowledge for these families concerning their taxonomy, and distribution in Norway can be considered as non-existent to very weak (levels 0 and 1 in Elven & Søli [39]). It is not even certain, how many of the globally occurring 32 genera and 175 species are expected to occur in Norway.

The knowledge of the taxonomy of the entire phylum Gastrotricha is assessed as being at an acceptable level as 54 species of gastrotrich have been reported from Norway and 66 are expected to be found. According to Elven & Søli [39], this applies only to marine gastrotrichs as no freshwater gastrotrichs are known in Norway. Interestingly, this is in stark contrast to the records on NorBOL, where 449 records are about freshwater gastrotrichs, while only 23 are from marine gastrotrichs (Table 1). These latter ones are records of two *Turbanella* species from a single locality in Norway or Svalbard, respectively [18, 40]. Moreover, in Artskart and Artsobservasjoner are only 6 records of Gastrotricha in total, none of which is even identified to the genus level (Table 1). Hence, there is a clear discrepancy between the records in the databases and the assessment by Elven & Søli [39]. This mostly stems from the fact that actually several marine gastrotrich species have been described from Norwegian waters (e.g., [8, 9, 12, 14, 15, 40]), but like mentioned above this is often from a single locality only or at best a few. Hence, we might have a fair knowledge about their taxonomy, but like for other meiofaunal species, increasingly studies show that also gastrotrich species are complexes of cryptic species including ones occurring in Northeastern Atlantic waters (e.g., [18, 23, 41]). On the other hand, our knowledge about their distribution is poor. Elven & Søli [39] assess the knowledge on distribution as weak and the one on ecology as lacking. However, given the presentation in public databases on Norwegian biodiversity the knowledge of their distribution is better characterized as very weak.

Elven & Søli [39] assessed the knowledge about the phylum Gnathostomulida as very weak concerning their taxonomy and non-existent for their distribution and ecology. Only one species of the expected 20 is known. Similarly, there are no records at all about gnathostomulid species in Artskart, Artsobservasjoner &

NorBOL (Table 1). Hence, the general knowledge level for this phylum is extremely poor in Norway. On the other hand, gnathostomulids are often found in association with seagrasses meadows, which Torsten Struck and his collaborators already targeted for the occurrence of different macrofaunal taxa in the Artsdatabanken project "Assessing biodiversity in the marine algae belt" besides kelp forests and other algae habitats.

Finally, similar to Annelida, Elven & Søli [39] assess only "Turbellaria" (i.e., free-living Platyhelminthes, which are non-monophyletic) in general and not the specific orders of this project. The knowledge about the taxonomy of "Turbellaria" is regarded as acceptable with 198 of 250 expected species known. The situation for the marine, meiofaunal turbellarians is comparable to the situation described for the gastrotrichs. Several species have been described from Scandinavian waters (e.g., [7, 10, 11, 13, 16]), but often only from single or few localities. On the other hand, in the public databases the number of records is very low. There are only 134 records of 28 species in 22 genera in Artskart and Artsobservasjoner (Table 1). There are no records at all about these flatworms in NorBOL. Using molecular data, the occurrence of cryptic species has been revealed also for these species (e.g., [42, 43]). Hence, like for marine gastrotrichs, we might have a fair knowledge about their taxonomy, but uncertainty exists due to the lack of molecular data concerning the occurrence of cryptic species. Our knowledge about their distribution is poor. Elven & Søli [39] assess the knowledge on distribution and ecology for all turbellarians as weak but given the presentation in public databases of the meiofaunal turbellarian species herein the knowledge of their distribution is better assessed as very weak.

In summary, for the interstitial polychaete families and Gnathostomulida, we have a very poor knowledge about their taxonomy in Norwegian waters, while for the marine gastrotrichs and meiofaunal flatworms the

Table 1. Records of the four lophotrochozoan groups in Norway entirely at the family or higher taxonomic levels. The data are from Artskart, Artsobservasjoner (Artsobs) & NorBOL as off October 18th, 2023. The number of genera, species and records are shown; app. = approved. Annelida refers only to the 10 interstitial families listed below it; Gastrotricha only to the marine records; Platyhelminthes only to the four orders and the interstitial and meiofaunal families; Total to the sum of all above. The global numbers are based on https://www.gbif.org/ for Platyhelminthes and Schmidt-Rhaesa [1] for the others. NOTE: Global species records have changed since 2020 and are higher for several groups, but for consistency we used the numbers from 2020.

Taxon	Genera		Species					Records				
	Global	Artskart	Global	Artskart	Artsobs	NorBOL		Artskart	Artsobs	NorBOL		
						app.	all			app.	all	public
Annelida	32	5	175	3	1	1	1	74	2	1	1	1
Psammodrilidae	1		13									
Apharyngtidae	1		1									
Dinophilidae	2		14									
Diurodrilidae	1		7									
Nerillidae	15	1	59	1	1			14	2			
Parergodrilidae	2		4									
Polygordiidae	1	1	15	2		1	1	37		1	1	1
Protodrilidae	6	1	37					21				
Protodriloididae	1	1	2					1				
Saccocirridae	2	1	23					1				
Gastrotricha	50		505				2	6			23	18
Macrodasyida	35		369				2	1			23	18
Macrodasyidae								1				
Turbanellidae							2				23	18
Gnathostomulida	26		101									
Platyhelminthes	615	22	2919	27	1			133	1			
Macrostomorpha	15	1	176	2				5				
Microstomidae	5	1	52	2				5				
Prolecithophora	38	5	199	11	1			32	1			
Plagiostomidae	11	2	121	7	1			15	1			
Pseudostomidae	15	3	57	4				17				
Proseriata	118	3	527	2				10				
Archimonocelididae	9	1	38	1				2				
Monocelididae	33	2	212	1				8				
Rhabdocoela	444	9	2017	8				76				
Byrsophlebidae	4	2	11	2				18				
Cicerinidae	9	1	29	1				2				
Jenseniidae	7	1	21	1				2				
Koinocystididae	29	1	68	1				8				
Polycystididae	61	1	277	1				4				
Promesostomidae	23	1	109	1				18				
Solenopharyngidae	15	1	27					3				
Trigonostomidae	29	1	118	1				21				
Total	723	23	3700	26	2	1	3	203	3	1	24	19

taxonomic knowledge might be fair to acceptable. However, also for the latter it clearly needs confirmation by modern microscopic and molecular methods. In this respect, the representation of all four groups in NorBOL is extremely poor with a total of only 24 records from Norway for three species across all groups. For all these groups, we have only a very poor knowledge about their distribution in Norway in general and their ecology.

As mentioned above, assessing all meiofaunal phyla is not feasible, similarly it is also too demanding to assess the meiofauna of just these four groups in all habitats in Norwegian waters. We decided therefore to restrict our efforts in two ways. The NHM has a small boat allowing taking samples with a Van-Veen grab down to 40 to 50m. We will therefore sample only habitats from the supralittoral to sublittoral depths of 40 to 50m to be independent of ship time but still covering very different coastal water bodies. Moreover, the meiofaunal species of these groups are best extracted and investigated alive as many characteristics are better observable in living specimens. Accordingly, a comprehensive investigation of their distribution in Norway would require months-long stays at different marine stations along the Norwegian coastline. This would be beyond the financial possibilities of the project. We therefore restrict our collections effort to the Norwegian coast of the Skagerrak. In this way, we can collect sediment samples at a locality and bring them back to our facilities at the NHM in less than a day after collecting, where we can keep them a low temperature around 4°C in our cold rooms and oxygenate them with aquarium pumps ensuring that the samples can be processed in our lab in due time. This will allow us to take samples and process them throughout the entire year. Even during the winter months, it will be possible to take samples from deeper regions. Finally, the knowledge about the distribution about meiofaunal species from these four groups is poor in the Skagerrak as it is for the whole of Norway (Fig. 2). In Artskart, there is only one deep-sea record of a gastrotrich known, but not which species or genus, three records of two species (*Polygordius lacteus* and *Nerilla antennata*) of interstitial polychaetes from Kristiansand (Agder) and 42 records of 13 flatworm species of 11 genera from Drøbak (Viken). However, the example of *Stygocapitella* and the mismatch between described and recorded species from Norway indicate that much more species can be expected to occur along the Norwegian coastline of the Skagerrak.

Hence, the available distribution information is not sufficient for an inventory of these four groups along the Norwegian coast in general and the Skagerrak in specific and is far from being usable for, e.g., red listing or other management actions for these groups and detecting possible invasive species. Thus, there is an urgent need to inventory them. In this project, we aim to thoroughly assess their occurrence and distribution in many different meiofaunal habitats of the Skagerrak including different sediments with different grain sizes, tidal influence, exposure to wave action and annual and daily environmental changes as well as different levels of salinity from the brackish conditions in the Bunnefjord (region 8 in Fig. 2) to full salinity around Kirstiansand (region 1 in Fig. 2). This will serve a model for the whole of Norway. As both have similar poor knowledge parameters and similar habitats to depths of 50m, we can extrapolate from the improvement of knowledge due to this project in the Skagerrak on the improvement that can be expected for Norway as whole if similar projects would be conducted in other Norwegian regions belonging to different zoogeographic regions. Despite the restriction to one region, across all taxa we expect to be able to provide taxonomical and distribution information including habitat preferences for at least 50 species. This is based on the facts that across all groups herein globally 3700 (or more) species are described with a much higher species diversity known from other interstitial habitats in the Northeastern Atlantic (e.g., Armonies 2018) and that both for marine gastrotrichs and gnathostomulids of the 55 species known from Norway only two are reported for the whole of Norway and of these one from the Skagerrak in public databases (i.e., NorBOL) and for annelids and platyhelminths only 15 species of the recorded 31 Norwegian species are recorded from the Skagerrak. In the long run, our project will also allow characterizing the marine NiN nature types for meiofaunal habitats more accurately than it is the case at the moment. The NiN system is at present entirely based on macrofaunal characteristics, which do not necessarily match with the meiofaunal characteristics.

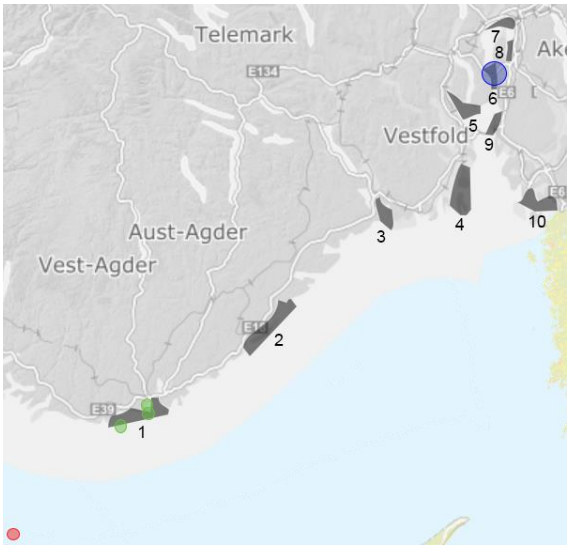


Figure 2. Map of the Norwegian coastline of the Skagerrak with records of the four lophotrochozoan groups as off October 18th, 2023 in ArtsKart. Red = Gastrotricha; Green = Annelida; Blue = Platyhelminthes. Small circles = 1 specimen; large circle = 42 specimens. Gnathostomulida have not been found. The grey areas indicate the 10 regions from which samples shall be taken throughout the project.

d) Methods

Field work

We will target 10 different regions along the almost entire Norwegian coastline of the Skagerrak. The regions experience different oceanographic conditions. Regions 1 to 4 and 10 are more openly exposed to large open-water bodies, while region 5 to 9 are in the Oslofjord. Regions 3 & 5 are located at the deltas of the Skien and Drammen freshwater drainage systems. Regions 4 and 10 are protected to some degree by offshore islands like the Ytre Hvaler National Park. Regions 6 & 9 are at the transition from the outer to the inner Oslofjord and exhibit a surface salinity between the regions south of them and regions 7 & 8, which show more brackish conditions in surface salinity. All regions have higher depth salinities beyond 30 at 20-30m depth and have depth beyond 50m. Similarly, all regions have seagrass meadows mostly consisting of *Zostera marina* or *Z. noltei*. Finally, the regions are differently exposed to anthropogenic impact with regions 1, 4 & 7 having the strongest one, especially region 7.

In each region, we conduct three independent sampling activities targeting different habitats. Each activity will collect many different sediment samples. One activity will target the eulittoral and supralittoral habitats. Depending on the region, we will collect sediments of different granulometry (coarse vs. fine vs. muddy), at different positions in comparison to the waterline (at the low water line, at spring horizon, at the highwater line, above the higher water line) and different exposures to the tidal wave on megaripples. The other activity will target the shallow sublittoral to a depth of 5-8m, which can be sampled via snorkeling. Due to the regulations related to professional diving, which we cannot fulfill, we restrict ourselves to snorkeling. In this depth range, we will target different sediment types and different habitat types like sediments occurring in pits on rocky shores, at the roots of seagrass meadows, kelp forests and other macro-algae and finally open sublittoral sand- and mudflats. The third activity will target deeper sublittoral habitats to a depth of 40-50m. We will use a small boat with an outboard motor and a Van Veen grab to collect manually sediment samples at different depths. Depth will be determined using the app "På sjøen", which provides relatively accurate depth maps in combination with the GPS signal of the mobile phone. Struck already successfully used this procedure at a workshop of the Artsdatabanken project mentioned above. We will also target differently exposed areas with different velocities of water flow. All samples will be taken qualitatively and not quantitively as the goal of the project is to determine the occurrence of as many species as possible and not the exact abundance of them. Nonetheless, within the limitations of a qualitive approach, we will roughly assess for each species if it was highly abundant (>100 individuals in a processed samples), abundant (10-100 individuals) or rare (<10 individuals). Hence, we can provide a first rough assessment providing guidance for future studies on abundance of selected species.

Sample processing

For 15 of the sediment samples taken, we will extract animals from four subsamples of about 50 cm^2 each. This is a number which can be processed later in the lab in due time without the risk of dying animals in the samples. Samples will be chosen to reflect the diversity of types collected. For two subsamples, we will use the anaesthetizing and decanting $MgCl_2$-method using a 5:1 ratio of isotonic $MgCl_2$ to seawater allowing species with duo-gland systems to release themselves from sand grains. For the other two, we will use the Uhlig seawater-ice method, which forces meiofaunal species out of the sediment due to temperature and salinity gradients. Finally, one of the two samples will be processed relatively quickly after collection, while the other one will be processed after a few days resulting in an enrichment of meiofauna in by aggregation in the upper layers due to oxygen depletion. We will carefully monitor these samples to avoid complete oxygen depletion in the sediment and will process less oxygenated samples before fully oxygenated ones. Using these different methods will substantially increase the chances to extract not only abundant, but also rare species from the sediment samples [1, 2]. From the remaining sediment samples, we will extract specimens using either $MgCl_2$ or seawater-ice on enriched samples depending on the fine-material content of the sample.

Species from the 4*15 chosen sediment samples will be sorted using a Leica S 9D stereomicroscope, which will also be used to take pictures & video of the samples for photo-documentation and outreach activities. Each species and more specifically each preserved specimen will be identified and photo-documented alive and anaesthetized using a Zeiss Axio Imager M2 Brightfield & DIC microscope. Species identification will be based on relevant keys (e.g., [1, 30, 44]), original species descriptions and consultation with the three taxonomic experts. Even though we concentrate on four Platyhelminthes orders, we will also document the occasional species of marine catenulids, maricolans, or gnosonesimids if they should occur. For each species and population, we will preserve voucher specimens both in 4% formaldehyde and as microscopic slides [2]. In addition, specimens will be preserved for molecular work using both by snap-freezing in liquid nitrogen for genomic approaches and in 96% ethanol for DNA barcoding. Finally, we will preserve specimens also in

SPAFG for SEM investigations [45] and RNAlater for transcriptomics for other projects if we have sufficient numbers of specimens. Moreover, abiotic environmental parameters such as water content, grain size distribution, and organic content will be determined using a muffle furnace, weighing, sets of sieves, and loss-on-ignition determining carbon content as a proxy of organic content [2]. The specimens extracted from the remaining sediment samples as well as all specimens not individually preserved will be preserved as a bulk sample in 96% ethanol and included into the bulk collection scheme of NHM, which has been recently established for this kind of samples. These samples will be available for future projects such as metabarcoding projects (e.g., MSc theses). Admittingly, vouchering and species identification are strongly compromised, but it enables further assessing of meiofaunal communities beyond the time, scope, and funding of this project.

Molecular lab work

We will also use the barcoding approach to identify specimens and to confirm the morphological species delineation. Given that the occurrence of cryptic species is high and often occurring in sympatry, detailed morphological examinations of the specimens should be complemented by molecular data (e.g., [4, 23, 27, 41-43, 46]). Besides the barcoding via NorBOL, molecular analyses will be conducted at molecular lab of NHM. This is crucial for developing an accurate list of species. Therefore, we plan to sequence the COI gene of 1,000 specimens ourselves to complement the sequencing data generated by NorBOL. As we expect to find and investigate about 50 morphospecies in more detail across all groups, for the 10 regions and the 3 different events we could analyze about 23-25 specimens (including the ones sequenced by NorBOL) per species. This will allow assessing the distribution of species more accurately as well as detecting possible cryptic species.

However, recent years have shown that the standard barcoding primers for COI often do not work for marine invertebrates in general and meiofauna specifically (e.g., [47-49]; own personal experience from the Artsdatabanken project above and from others on marine invertebrates). Accordingly, in our previous project we had to design primers specifically targeting families, genera or species to obtain the COI sequence given the available public data. As this is very time-consuming and public data for the groups herein are sparse (see Table 1), we decided to use genome skimming to obtain the mitochondrial genome of one specimen from each morphospecies. High molecular weight (HMW) DNA will be extracted using the Quick-DNA Tissue/Insect Microprep Kit (Zymo Research). Extracted DNA will be sequenced using the Oxford Nanopore Technologies (ONT) MinION to a coverage of up to 10x. If more than >1 ng HMW DNA is extracted, we will prepare and multiplex the libraries using the ONT ultra-low input SQK-RPB114 library prep kit. If it is <1 ng HMW DNA, we will amplify the whole genome (WGA) using the REPLI-g Advanced DNA Single Cell kit and the SQK-NBD114.24 library prep kit. Struck had good experience with WGA in his FRIPRO project "InvertOmics" sequencing the genomes of different meiofaunal species. The ONT sequence data will be assembled using Guppy v.6.0.1 for base-calling and filtering and Flye v2.9.2 for assembling. The mitochondrial genome will be retrieved from the contigs as previously described [50, 51]. Then we will design specific primer covering the COI region using Primer3. These primers will be used for barcoding.

Literature research

As described above, information about occurrences of meiofauna species in Norway is often not reflected in Artskart. We will compile the literature on all four groups for the whole of Norway and add these records to Artskart. We will also collect the sparse information on these groups from the Norwegian scientific collections. However, for example, the Invertebrate collection at NHM contains only 23 records of Parergodrilidae across all groups herein. The situation is similar dire at the other museums (T. Bakken & N. Budaeva, pers. comm.). We will also assess this sparse material when it is not identified yet and not included in Norwegian databases.

e) Geographic areas and ecosystem types

The geographic areas of this project are described above and shown in Fig. 2. Similarly, the different ecosystem types that shall be sampled are described above. With respect to NiN types, the types of nature we will cover with our inventory occur at the coastline and in fjords (NiN: H1-5 and H2-1). The habitats occur mostly on soft substrates, but also to a small degree on hard substrates such as M1 & M3, occurring in the supralittoral, eulittoral and sublittoral zones. Accordingly, NiN subcategories of the main categories "Marine benthic systems (M)" and "Mainland systems (T)" are primarily covered by our project. In specific, these are the basic types T21-1 and T29-7 to T29-9 for the supralittoral zones and M4-1 to M4-44, M7-1 to M7-4, M9-1 to M9-9, M13-1 & M13-3, M14-1 & M14-2 and M15-1 for the eulittoral and sublittoral zones. By sampling most of the meiofauna from these habitats, the results will also lead to a better knowledge about their ecological biotic composition and the habitats in general and generally close an important gap of knowledge with respect to the lower supralittoral and intertidal zones.

f) Competence

We also have different competence transfer activities planned. First, the technician of the project will be trained in these four groups by us. Second, like in our previous project about the marine algae belt, we will conduct UiO:Life Science summer projects involving usually Bachelor students in all steps from the fieldwork to the lab work. In the previous project, we did it two times with great success; each time the students won the popular poster price at the final event. Third, we will recruit MSc students conducting their thesis on parts of the project. In our previous project, a MSc student wrote about the taxonomy and distribution of Caprellidae. Finally, like in our previous project we will conduct a final taxonomic workshop at the end of the project, which will include the whole process from collection to species identification and documentation. The course will be offered to students, PostDocs, and employees of consulting companies. We aim at 12 participants and will cover all expenses during the course except for travelling. In the previous workshop, the consultants were very eager to obtain taxonomic competence in groups they are less familiar with and they were very grateful for it. In general, this will enable future researchers and consultants to conduct their own inventory projects on meiofauna.

4. IMPLEMENTATION, ORGANISATION AND COOPERATION

a) Progress plan

Table 2. Schedule of the work packages and milestones as well as the assigned persons with main responsibilities (THS = Torsten H. Struck, TA = Technical assistant, C = Collaborators as indicated in their support letters).

	Activities	**Main responsibility**	**From**	**To**
WP1	*Field work & sampling processing*		*06/2024*	*11/2026*
F1	Teaching of technical assistant in species identification	THS, C	06/2024	11/2024
F2	Collecting and processing of sediment samples of 10 out of 30 events	TA, THS	06/2024	03/2025
F3	Collecting and processing of sediment samples of next 10 events	TA, THS, C	04/2025	01/2026
F4	Collecting and processing of sediment samples of final 10 events	TA, THS, C	02/2026	11/2026
WP2	*Molecular work*		*08/2024*	*02/2027*
M1	Genome skimming of one specimen per morphospecies	TA	08/2024	01/2027
M2	Barcoding of additional specimens per morphospecies	TA	09/2024	02/2027
WP3	*Data compilation*		*06/2024*	*05/2027*
D1	Literature survey of meiofaunal species from these groups and Norway	THS	06/2024	05/2026
D2	Curation of specimen samples including uploading to databases	TA	10/2024	05/2027
WP4	*Outreach, teaching and dissemination*		*06/2024*	*05/2027*
O1	Outreach about meiofauna in blogs, public events, and the exhibition	THS, TA	06/2024	05/2027
O2	Presentations at different conferences and seminars	THS	10/2024	05/2027
O3	Writing of papers and development of keys	THS, TA, C	10/2025	05/2027
O4	Teaching BSc & MSc students by UiO:Life science projects & theses	THS	06/2024	05/2027
O5	Workshop in Drøbak about “Meiofauna in the Skagerrak”	THS, C	04/2027	05/2027
	Milestones		*08/2025*	*08/2027*
MS1	Preparation and submission of first report	THS	08/2025	09/2025
MS2	Preparation and submission of second report	THS	08/2026	09/2026
MS3	Preparation and submission of final report	THS	06/2027	08/2027

b) Organisation and collaboration

Table 2 shows the schedule of our project, which is organized in four work packages and a set of reports as milestones. The details for each work package are provided above in the methods sections and below in section 5. We plan one sampling event per month on average. Each fieldtrip will take about 1-2 working days, the sampling processing including analysis of abiotic factors about 13-15 and the molecular work about 5 days per sampling event. However, this does not mean that we will have one sampling events per months. These are planned given the weather conditions and hence more sampling events take place in the spring, summer and fall months and lab work will have a stronger emphasis in the winter months. In addition, we expect that molecular work will go on for two and three months longer, respectively to collect the molecular data from the last sampling event. In parallel, we will also conduct the literature survey, curate the specimens and data, and start analyzing and presenting the results. However, these steps will be the main goals towards the end.

Torsten H. Struck is the project manager of the project. Struck has worked with all four groups and collects them regularly in Europe for other projects (e.g., [27, 37, 50-55]). He gathered especially experience with them collecting and identifying them for different projects on the North Sea Island Sylt, which is one of the best studied places in the world with respect to meiofauna. He is especially a taxonomic expert on several of the annelid interstitial families. He has also taught about these groups at different taxonomic workshop in his career. He is also a world-renowned expert on the phylogenomic analyses of these groups using genome-scale data from all of them for more than a decade already. The latest are his project “InvertOmics” and his

involvement in the national project EBP-Nor and the international projects ERGA and BGE. He has leadership experience from several projects (including Artsdatabanken) and being the group leader of the FEZ group.

Three collaborators have agreed to provide training, assist in species identification, and participant in some of the sampling events and in the workshop at the end of the project. They will also be involved in the analyses and publication of the results. Katrine Worsaae (Danmark) is a world-renowned expert on meiofauna in general, their morphology and especially of interstitial annelid families and gnathostomulids (e.g., [17, 22, 26, 56]). Christopher Laumer (UK) is at the forefront of genomic research in meiofauna having developed protocols for HMW DNA extraction and amplification from them and is a taxonomic expert on interstitial platyhelminthes (e.g., [19-21]). Alex Kieneke (Germany) has published intensively on the phylogeny, phylogeography and taxonomy of marine gastrotrichs using both morphological and molecular data (e.g., [18, 23, 28]). Hence, the team of experts has the relevant taxonomic expertise for the groups of this project.

The specific responsibilities for each activity are also provided in Table 2. The number of specimens obtained as part of this project will be very high for a diverse set of invertebrates. Sorting, species identification, photo-documentation and curating all the specimens including the meta-data as well as the molecular work is labor-intensive. Therefore, a technical assistant (TA) is needed for the full project period to assist with all these tasks. Additionally, the TA will be trained in the taxonomy of all groups. The intensive training sessions will be given by us in well-studies regions of Europe such as the North Sea Island Sylt in Germany. We will announce the TA position as soon as possible if the project should get funded. We hope to be able to hire Ana Teresa Capucho, who already worked as TA on a previous Artsdatabanken project with Struck and has experience with all tasks herein. Moreover, her MSc thesis with Ulf Jondelius (Sweden) on acoels provided here already with experience about meiofaunal species from the field to the lab.

All of us have an intensive network through other projects with the marine meiofauna community, which we will be able to utilize if needed, but they will not be formal collaborative partners of the project. For example, we will collaborate with Kevin Kocot's projects on meiofauna in the USA sharing experiences and protocols. Kocot is a collaborator in the "InvertOmics" project of Struck. We will use, and if needed, update the relevant parts of WoRMS (World register of marine species) in close cooperation with the relevant subject editors for the groups (e.g., Geoff Read/New Zealand for Annelida, Tom Artois/Belgium for Platyhelminthes, Antonio Todaro/Italy for Gastrotricha or Wolfgang Sterrer/Bermudas for Gnathostomulida).

c) Coordination with other inventories or research projects

None of the ongoing Artsdatabanken projects targets meiofaunal organisms, or either suitable habitats or uses appropriate sampling procedure to sample meiofauna. So far, only one project on a meiofaunal group, Kinorhyncha, has been conducted. Samples on non-kinorhynch species from this project are still available in ethanol, but as they were sampled by the "bubble-and-blot" method not suitable for the species of this project (Lutz Bachmann, pers. comm.), they will rather be of only limited use for this project. Otherwise, if small-sized animal groups have been targeted, they were either parasitic or pelagic ones. Similarly, projects targeting specific regions or habitats like the projects about the annelids from the Skagerrak or animals from the Sognefjord targeted macrofauna only. Hence, at present no recent or previous inventory is there to be able to coordinate with. In our opinion, this highlights the especially strong demand for a project on meiofaunal species as there is a huge knowledge gap not only for a specific taxonomic group, but for an entire large and important component of the marine ecosystem.

On the other hand, due to our sampling efforts and our aim to preserve species for different purposes, we will deposit more specimens for many species than necessary for this project. These specimens preserved in formalin, SPAFG, RNAlater, or ethanol or frozen will be interesting for other research projects in our team like the nanopore-based transcriptome project on meiofauna of Laumer, but also for other projects on phylogenetic, macroevolutionary, phylogeographic, molecular, morphological, SEM and taxonomical studies on these groups. An example of this is the global genome initiative EBP, which aims at sequencing the genome of each eukaryote species on Earth. We will make our snap-frozen samples available for whole genome sequencing to such efforts by national EBP initiatives like EBP-Nor and DToL or international consortia like ERGA and BGE. Struck and Laumer are members of all these initiatives, partly in leading functions. Finally, in parallel to this proposal, NTNU has submitted a proposal for a national infrastructure called "NorBOL2 – Norwegian Infrastructure of Molecular Biodiversity Research", which besides automized barcoding also includes optimization of genome skimming and whole genome sequencing protocols. In the latter work package, led by Struck, especially the protocols of whole genome sequencing of meiofaunal taxa shall be optimized. Hence, there are strong synergies between these two projects should both get funded as this project provides information on abundant meiofaunal species close to the lab, while NorBOL2 can provide optimized protocols for genome skimming.

5. TERMS

a) Dissemination

NHM is developing a new permanent exhibition about animals including meiofaunal groups specifically. Struck is in the development team and results from this project can be included as local examples of meiofauna of not only Norway, but the Oslofjord. Hence, knowledge about these animals is not only provided to experts, consultants and students, but also to the public at large. Additional outreach activities comprise communicating our results via journals to a broader public (e.g., the oldest Norwegian popular science magazine "Naturen"). Additionally, FEZ has an ongoing blog for several years in which we will present our work on this project as done previously (https://blog.annelida.de/artsdatabanken/). We will also present our results at different public venues such as faglig-pedagogisk dag at UiO and seminars at our and other institutions such the Thursday lunch seminar at NHM visited by all employees.

The results will be distributed to the scientific community via different means. The deposited specimens and barcode material accessible, e.g., through GBiF and BOLD, will by themselves contribute to taxonomical research (e.g., on the phylogeny and phylogeography of selected species, or the evolution of cryptic species). The keys with high quality picture material, but also morphological details generated in this project will lead to a better understanding of the studied genera and be used in the future for species identification. Generally, we will summarize the results by writing scientific publications on Norwegian meiofaunal species in peer-reviewed journals including reports on species distribution and the description of new species if detected according to the international code of zoological nomenclature (ICZN). Results are presented at different venues like ArtsDagene, ForBio annual meetings, the German Zoological Society or BioSyst.EU.

b) DNA barcoding

Depending on the sampling success, we will barcode as much species as possible by sending them to NorBOL. Additionally, we will obtain the barcode COI gene for around 1,000 specimens (see budget) of around 50 species. As outlined above and shown in Table 1, at present, barcodes are hardly available for Norwegian species of these groups. However, it should be pointed out here that the prime purpose of the sequencing by us is in species identification and assistance in species delineation and not the generation of DNA barcodes *per se*. However, to increase the synergies between our and NorBOL's sequencing efforts as well as to be able to exploit the ever-increasing BOLD database with barcodes for species identification, we also choose the same marker for the species delineation and identification for our project.

All barcode data and photos will be delivered to NorBOL. In addition, upon publication the data will also be published in NCBI by pushing them from BOLD to it. Hence, we are following the FAIR, CARE and Open Access principles in sharing our scientific results generated by public funding. Finally, the genome skimming approach will provide both specific primers working for as well as the mitochondrial genomes of different meiofauna taxa, which will be beneficial for other studies on these groups in general.

c) Reference material

As described above all species and specimens will be preserved in formalin, SPAFG, RNAlater, ethanol or snap-frozen depending on future usage. All information concerning sampling site (position, depth, and habitat), sampling method, date, collector, identifier, means of identification and so forth will always be associated with the samples as well as the photo-documentation of the physical specimen. As we need entire animals for the molecular work the pictures will serve as reference for the physical specimen and included in the collection as an eVoucher. We are establishing the procedures for this right now. However, some specimens will always be preserved as proxy voucher specimen for the specimens used for molecular work. The morphological vouchers and eVouchers will be deposited in the Invertebrate collection of the NHM. Additionally, all samples preserved for molecular work, but not used for it, will be deposited in the DNA bank of NHM, which is a GGBN associated biobank. All remaining DNA extracts of specimen will also be deposited at the DNA bank. All this different collection material will be recorded in the Corema database of NHM, which is regularly harvested by GBIF and Artskart. Hence, all are available as geo-referenced entries in databases such as GBIF and Artskart following again the FAIR, CARE and Open Access principles.

d) Other information

The plan is also to have a communication plan to inform the public on these Norwegian species (article in newspapers, social media outlets and News in general). A project outcome is to establish a close collaboration with Norwegian institutions and their students about meiofauna. We are open to the possibility to arrange further workshops like the one we plan in collaboration with other similar projects. As mentioned above we develop identification keys for the species of these four groups occurring in the Skagerrak.

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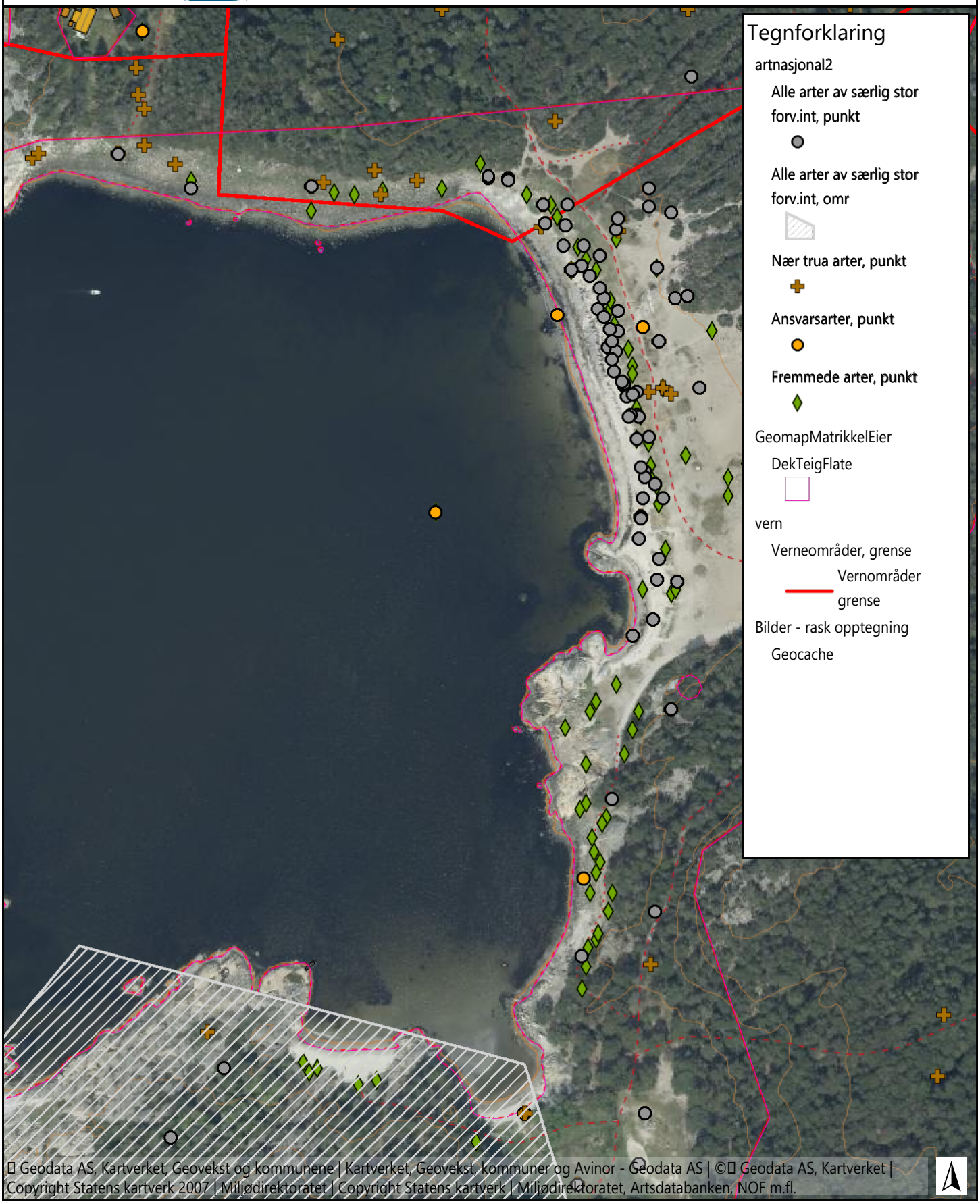
Oslofjord GIS

Innsamling av sedimentprøver - Natur...



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Kommentarer

Utvalgt naturtype, sårbare arter