RV SONNE - SO 293 "AleutBio"

Aleutian Trench Biodiversity Studies

24.July – 06. September 2022

Dutch Harbor (Alaska, USA) – Vancouver (Canada)

4th Weekly Report

8. August – 14. August 2022

During the past week we finalized the first transect across the Aleutian Trench (station areas 4-6) and spent more than three days at the second hadal station (station area 7) at about 7255 m depth (Fig. 1).

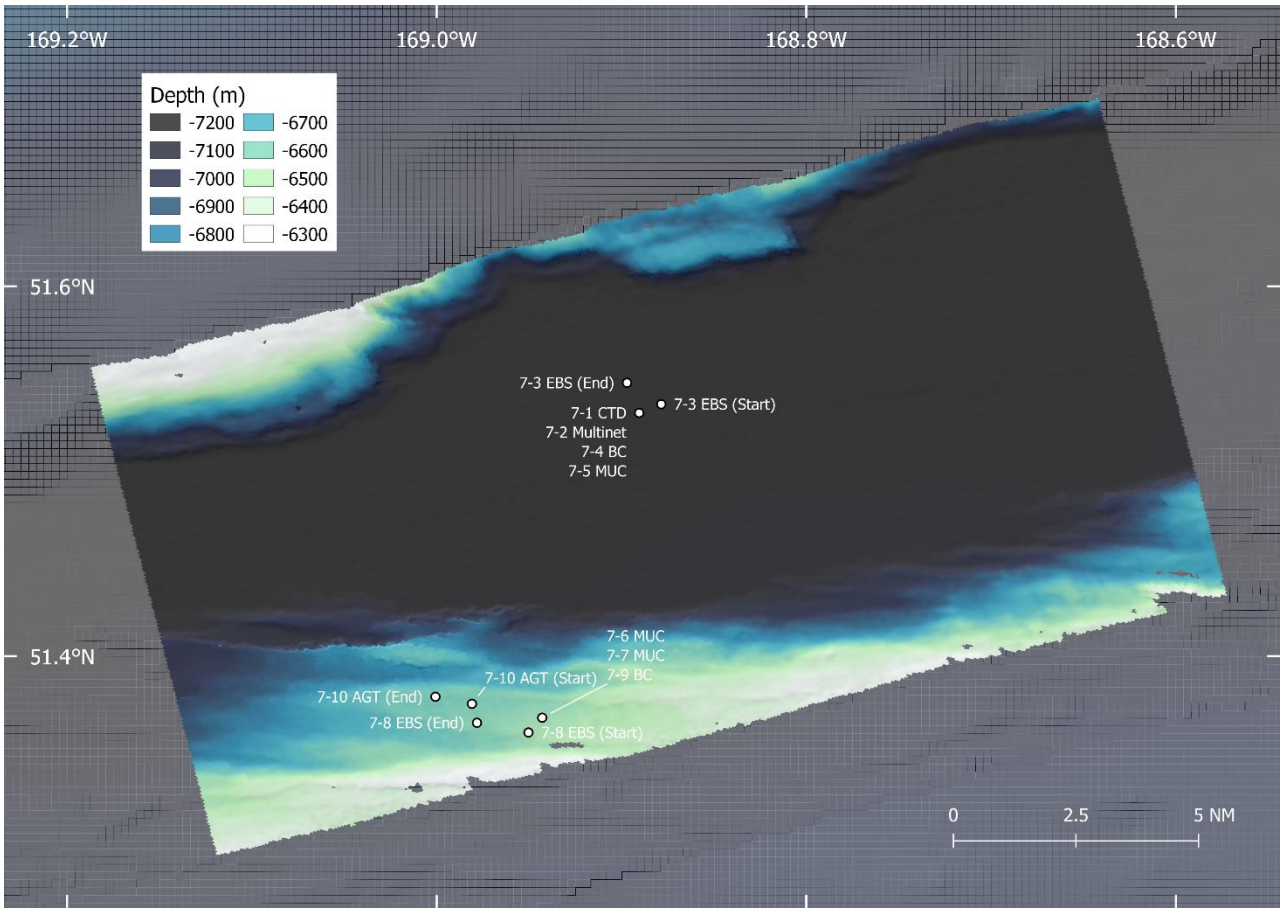


Figure 1: Bathymetric map of station area 7 at approximately 51°31,892' N168°53,394' W, 7255 m.

The seafloor at this location, in the deepest part of the trench, documented very similar sediment as the seafloor of stations 5. Unfortunately, the sediment was extremely fluid and the sediment in the MUC leaked on deck. We therefore moved some gear to the hadal bottom of the slope to sample the edge of the canyon bottom. We revealed interesting biogeochemical results.

The Danish Center for hadal Research (HADAL) is represented by three participants during So293 (JP Balmonte, F Wenzhöfer & RN Glud). Their investigations focus on element cycling and microbial life in the hadal realm and has previously documented elevated biological activity along hadal trench axes compared to adjacent abyssal settings. The intensified activity is mainly mediated by flourishing microbial communities at the extreme pressure and is sustained by downslope focusing of organic material. The preliminary investigations suggest that this scenario is also at play in the Aleutian Trench. However, the trench also has some surprising and unique features. In contrast to other trench systems, the seabed along the Aleutian Trench axis consists of fluid mud rather than consolidated sediment. The reason for this sediment texture could be due to recent mass wasting events or intensified ongoing downslope material transport. The fluid mud is largely deprived of fauna, but act as a 'microbial reactor' with high diagenetic activity. This is exemplified by high ammonia concentrations in the sediment as compared to adjacent abyssal sites (Fig 2) and high O_2 consumption rates measured in recovered sediment cores. These novel findings are exciting and raise a number of questions: Which pathways mediate the intensified diagenetic activity and who are the microbial players involved in these processes? How do microbial communities in the Aleutian Trench compare to those from other trench settings with consolidated sediment, from the adjacent abyssal plains and from marine sediments in general? Are the communities unique and adapted to these special settings and the extreme hydrostatic pressure? What is the source of the organics that sustain the elevated microbial activity and what is the overall biogeochemical function and importance of the Aleutian trench? These questions and many more will be addressed by the samples that are collecting and from onboard experiments. Thus far it appears that the central Aleutian Trench functions differently compared to other deep sea areas and form a unique habitat that warrant detailed microbiological and biogeochemical investigations.

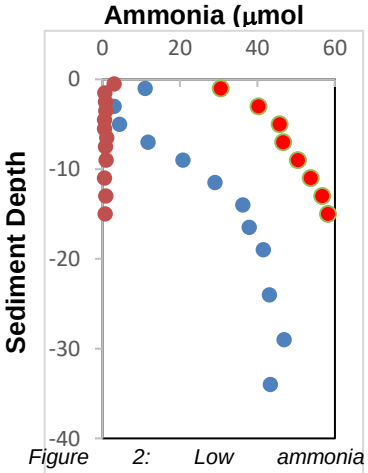
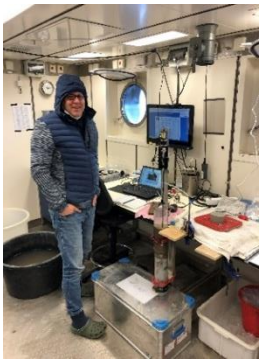


Figure 2: Low ammonia concentration at abyssal depths (4642 m depth, orange symbols) compared to elevated concentrations at two sites along the trench axis (7239 m and 7211 m depth, red and blue symbols).

John Paul Balmonte measuring the enzymatic activity of microbial communities in fluid mud recovered from the trench axis.



Frank Wenzhöfer measuring the O_2 penetration in recovered sediment.

Within the plankton samples collected by means of the multinet we caught a beautiful pelagic specimen of the genus *Topopteris* between 1000-600 m depth (Fig. 3). We still have to investigate whether this is a new species or known to the area.

Figure 3: Tomopteris ssp. From the hadal of the Aleutian Trench.

The Agassiz trawl brought rich megabenthos on deck, especially from the last hadal station (Station 7).

While in the Bering Sea the deep-sea sponge fauna was mostly dominated by demosponges of the order Suberitida, mainly *Stylocordyla borealis* and *Suberites* cf. *japonicus*, which were common in both AGT catch and OFOS dives besides a rich in hexactinellid fauna including two possible new species of *Bathydorus* sp. In the Aleutian Trench and nearby areas, the sponge fauna appears to be different from that in the Bering Sea, with the disappearance of *S. borealis* and an increase in the occurrence of carnivorous and hexactinellid sponges (Figs. 4 – 5). The observed and collected organism greatly expand the known bathymetric distributions for several species, even for those already considered 'deep-sea' fauna. As an example, the hexactinellid *Docosaccus maculatus* had only been found down to 4000 m depth, while now its distribution is expanded by ca. 2000 m to a maximum depth of approximately 6000 m, reaching the upper limit of the hadal zone. Moreover, until recently the genus *Docosaccus* was considered endemic to the Southern Ocean. Hence, the presence of *D. maculatus* in North Pacific waters represents a major change for the genus, which now shows an almost bipolar distribution, with representatives located in both the North Pacific and the Southern Ocean. Similarly, *S. borealis* is a well-known dweller of north Atlantic Arctic waters, with its confirmed presence in the Bering Sea conferring it a circumpolar Artic distribution. Nevertheless, and while still preliminary, the study of the collected samples shows subtle but consistent differences between the Pacific and north Atlantic individuals, which could indicate local adaptations or a recent speciation process for the Bering Sea population. Overall, these preliminary

findings document that the poriferan samples obtained during the AleutBio expedition might serve as excellent candidates for much-needed biogeographical studies on deep-sea sponges and will help to understand connectivity patterns of poriferan abyssal and hadal fauna across the globe.

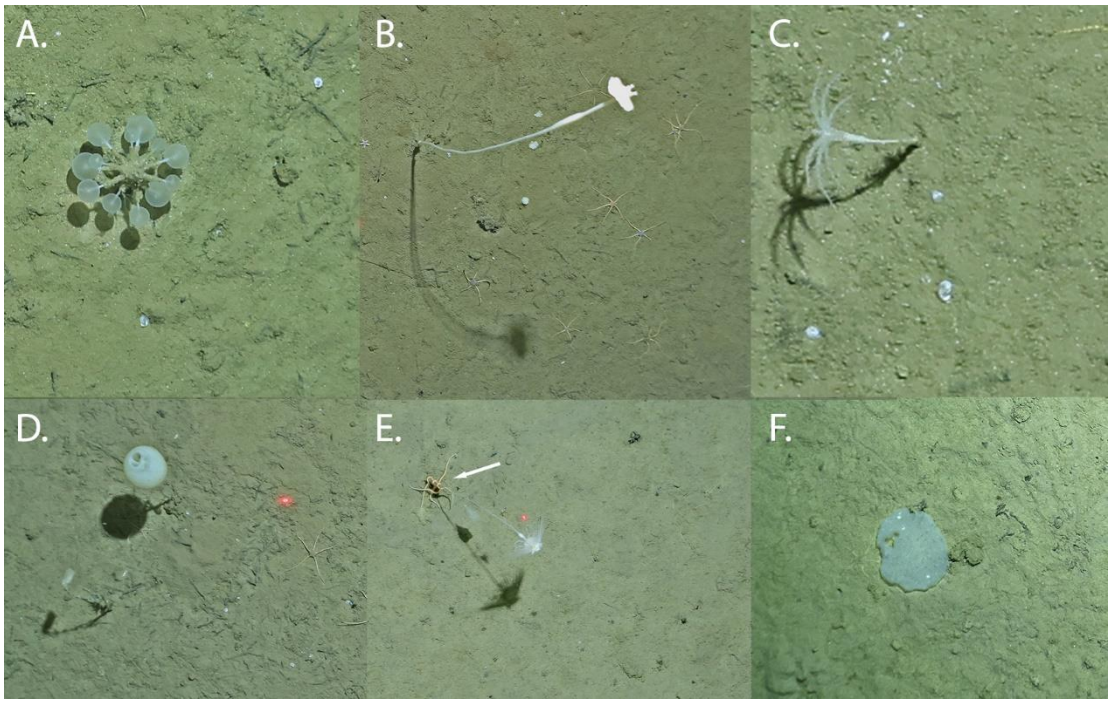


Figure 4: Carnivorous sponges: A) In situ image of Chondrocladia sp. 1; B) In situ image of Chondrocladia sp. 2; C) In situ image of Cladorhiza sp. 1; E) In situ image of Cladorhiza sp. 2, with an ophiouroid entangled at its base: Hexactinellids: D) in situ image of Hyalonema sp.; F) in situ image of Bathydorus laniger, Kahn et al. (2013), this being the 3rd record for the species.

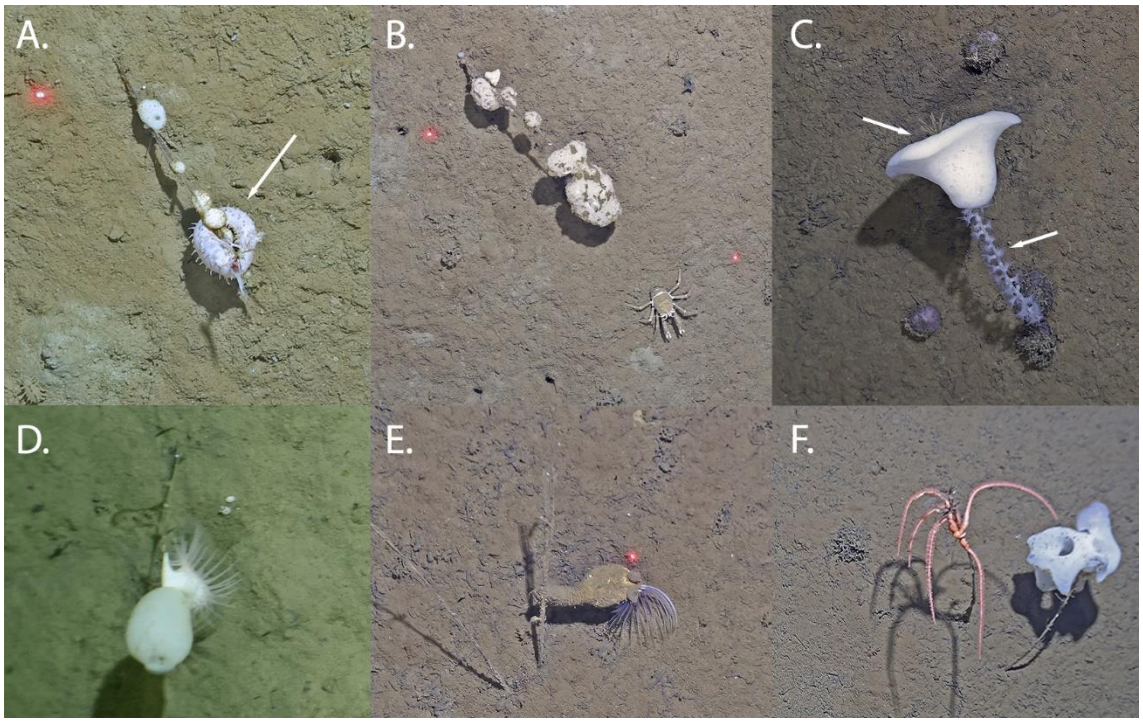


Figure 5. In situ images of the usage of hexactinellid stalks as substrate by other deep-sea organisms. A) Unidentified holothurian (arrow) and S. cf. japonicus (white balls); B) S. cf. japonicus (white balls) and a Munidopsis sp. crab; C) Crinoid (white arrow, top of the sponge) and unidentified zoantharian (white arrow, attached to the stalk) on Caulophacus sp. D) Anemone attached to the stalk of Hyalonema sp.; E) Unknown barnacle F) Ophiuroid on a dead stalk next to an unknown Hexactinellida.

Station area 7 in about 7255 m depth also brought a rich AGT sample on deck with the deepest recorded neomeniid Solenogaster (Fig. 7). The EBS and AGT brought rich samples on deck and we curiously await the OFOS deployment in the night. We are currently working at station-area 8 in 4600 m depth which is very interesting and documents a thriving macro- and megafauna with lots of echinoderms.

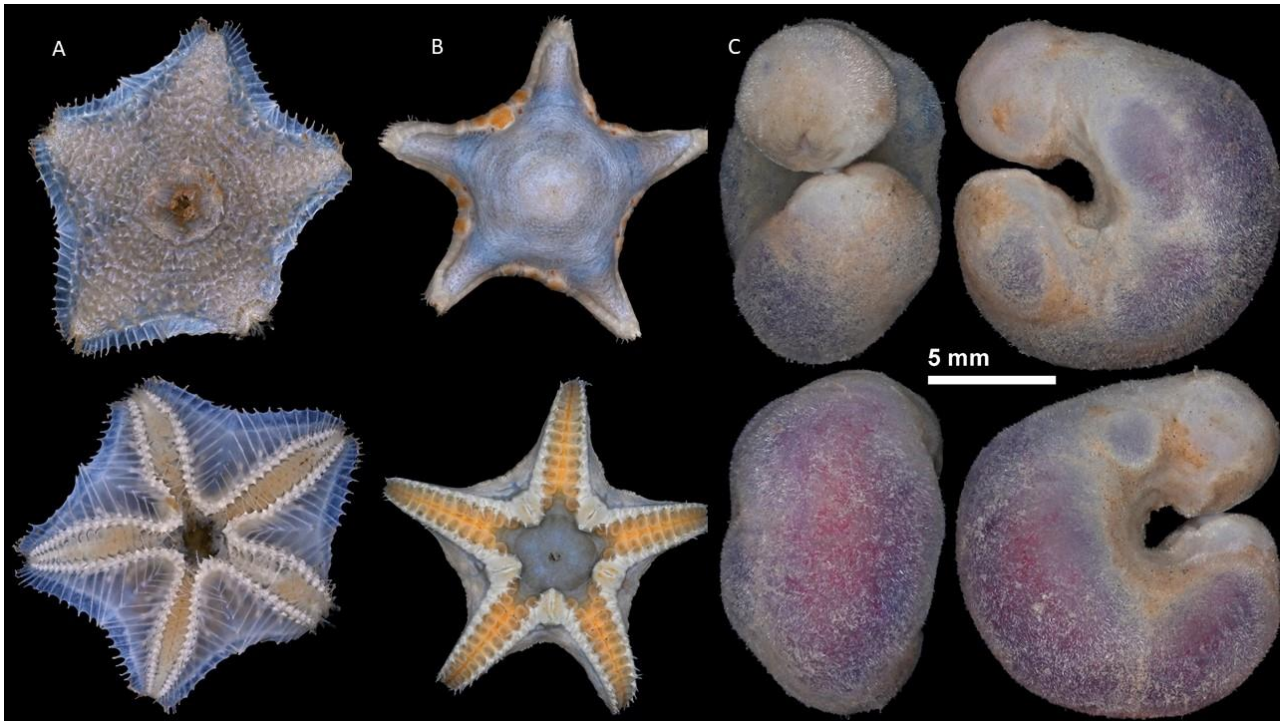


Figure 6: Starfishes (A, B) of the AleutBio expedition from stations 7 and 8 and the deepest recorded Solenogaster of the family Neomeniidae*, a probable new species (C).*

All are well and send greetings home with halo around the sun from the RV SONNE.

Angelika Brandt (on behalf of all scientists of the expedition AleutBio).

Senckenberg Research Institute and Natural History Museum Frankfurt