Diving Activity Report

Scientific diving mission along the Gerlache Strait (West Antarctic Peninsula) 27th February - 20th March 2019

Introduction

The Belgica121 expedition took place between 23rd of February and 24th of March 2019. Departure from Ushuaia on board of the research vessel RV *Australis* (support vessel, see more details below) foresaw the crossing of the Drake Passage and the arrival on 28th of February at the first investigation site: Omega Bay in Melchior Island (S064.19.257, W062.55.467). Sampling focused on intertidal and shallow areas from a total of eight locations in the Gerlache Strait. The scientific activities included scuba diving, ROV exploration, video transects, Rauschert dredge, intertidal sampling, fishing and fish line/nets deployment. The detailed science report for Belgica121 will be written by the scientific team and finalised by the chief scientist Bruno Danis in the following weeks/months after the return of the expedition and will be published online together with the present diving report.

The expedition diving activities did support the scientific programs envisioned within the vERSO-RECTO projects (BRAIN-be Belspo funded, contract numbers BR/132/A1/vERSO and BR/154/A1/RECTO) ran by the consortium of Belgian institutions Ghent University (UGENT), the Free University of Brussels (ULB), Royal Belgian Institute of Natural Science OD-Nature (RBINS), the Free University of Brussels (VUB) and University of Liége (ULg). Along with the vERSO-RECTO consortium, external collaboration with the University of Hull (Hull, United Kingdom) and University of Burgundy (Dijon, France) has been granted for this scientific mission in light of their complementary expertise. This mission to the Antarctic represents the first of its kind since Adrien de Gerlache led the Belgian Antarctic Expedition of 1897-99, therefore bringing new prestige and expertise to the contemporary Belgian Antarctic Marine Science.

This scientific diving mission included a diving team formed by Belgian and French scientific divers. The scientific diving activities were supervised by the Belgian dive leader Francesca Pasotti (UGent, ABSD 00002) following Belgian Scientific Diving regulations and the Operational Risk Assessment (ORM).

This ORM was based on the Belgian regulation[1] and develop within the general Risk Assessment procedures and did follow the precautionary approach while dealing with the risks related to the specificities of the mission (lack of hyperbaric chamber, remoteness of diving locations, limited access to hospital facilities) and the platform used for it (*RV Australis* + zodiacs). ORM was accepted by all parties prior the start of the expedition.

The diving team (in accordance with ESDP rules and certificates)

Dr Francesca Pasotti (UGENT, ABSD) dive-leader, diver, standby diver and tender

Drs. Charléne Guillaume (ULB, CAH IB) diver, standby diver

Dr. Thomas Saucéde (University of Dijon, CAH IB) second chief diver, standby diver and tender

Certification acronyms:

BSD = Belgian Scientific Diver (Belgian legal certification fully equivalent to European Scientific Diver)

ESD= European Scientific Diver

ABSD= Advanced BSD, legal dive leader level

CAH IB = Certificat d'aptitude a l'hyperbarique (French legal certification for scientific diving), class IB

All divers did provide a medical certificate attesting their fitness for scientific diving, an up to date oxygen provider (less than 2 years old) and medic first aid (less than 2 years old) prior to the cruise.

D*iving general procedures during B121*

Daily briefings were carried out each morning prior to the beginning of the daily scheduled events. During day 1 at each new location the ROV exploration and the shoreline scanning for suitable beach landing sites were the first priority. After the visualisation of the underwater ROV videos the exact points where video transects, hand picking of specimens, and/or sediment sampling by divers for various analyses were decided together with the Chief Scientist Bruno Danis. Dives were done within the depth limitations (max depth 30 m, max depth during cruise < 25 m) outlined by the ORM, with no more than 2 repetitive dives happening during one day for each diver. Divers dove in a buddy system (or alone depending on task and experience) and a safety on the zodiac, with one diver standby in case of solo dives. One of the divers of a buddy system would always be tethered to the surface, and the buddy joined to him/her by a buddy line. The dive group was composed during each sampling event by the three divers and in case of zodiac needs, the first mate Ryan Houston (PADI Intructor) was helping during the dive. Once the divers would start their descent, radio communication would happen to inform the skipper and the chief scientist of the beginning of the dive so that the event log could be updated and the time noted. Once the divers would be on the bottom starting their task, a 3+1 pull signal would be given by the diver on the tether, and the tender would reply accordingly. From that time, a maximum bottom time of "NDC time limit - 2 minutes" would be considered for the dive task. At the end of each task the diver would communicate with the surface the intention to terminate the dive (3+1 pull again) and start ascent. Ascent to the surface was controlled with a speed of 10 m per minute, and a safety stop of 3 min at 5 meters was done at the end of each dive. The detailed tasks are presented in the dive logbook table in Annex 1. A list of pull signals is presented in the table below.

Diving platform

Dives happened both directly from the RV Australis and from the zodiacs which brought the divers at a specific location nearby the vessel. Ice conditions (presence of large icebergs or ice growlers, presence of dense pack ice) were monitored prior and during the dives and the dives were postponed or aborted when necessary. A leopard seal watch was active from aboard the Australis and from the zodiacs during the duration of each dive: dives always happened in the vicinity of the Australis to always allow monitoring of the activity by means of a binocular and allow unhindered radio communication.

Tanks

The compressor of the Australis was new and it was tested for air quality prior to departure. Air int he tanks was always smelled to check for possible exhausts in the air. The refilling of the tanks was carried out by the first mate of the Australis, Ryan Houston who had been trained to take care of the compressor onboard of the Australis. Tanks were filled only when the boat was anchored (hence no engine was working and producing exhaust) and the air was dry (hence not during rainy days or snow to avoid presence of moisture in the tanks and prevent freezing at depth).

Tether/Line signals

Signal	Line	Meaning	Task
3+1	Tether	Start of task / end of the dive	Any task would require to reach the bottom or start an activity - from this first signal the maximum bottom time has to be calculated / end of the dive means divers ascent at 10m/min to reach the safety stop depth (3 min at 5m)
2 (repeated)	Racks rope	Pull the racks on board	During cores sampling the containing racks were attached to another rope to facilitate use by the diver. Once the racks were full the rack rope would be pulled twice, the cores would be pulled till the weight would be felt and hence the racks would be suspended in the water column. At this point the pulling would stop to allow the diver to make sure the cores would be ready to be pulled on board and that the diver would not be entangled with the rack line. At this point another 2 pulls on the rack line would be given by the diver and the racks would be pulled completely on board
2	Tether	Change direction/ stop going in that direction	To avoid problems with passing ice growlers, the divers would be communicated by the tender to stop proceeding in one direction by means of 2 pulls till the new direction would be appropriate
1 sharp	Tether	Just checking that everything is ok and that the connection between tender and diver is not lost due to possible entanglement	During any task carried out in the presence of other lines (e.g. anchor line) or in case of surface disturbance by ice growlers and brash ice, tension along the tether could be lost momentarily. Both the diver and the tender could use this signal to confirm tension along the tether line
1 slow/long	Tether/ rack rope	Give me more slack	In case of too high tension on the life line or in need to move the racks to a farther location, this slow pull would communicate to give more slack to the tester or the rack rope

Diving equipment

Diving tanks were 15 L steel tanks, with double tap which followed EU regulation. Regulators were all cold water regulators with fully enclosed membrane system and added metal surface for heat exchange on both I stage and II stage and flow regulation of II stage. The low pressure hoses were distributed between the two first stages so to have the main regulator on one first stage and the jacket/dry suite on another, to avoid breathing to happen at the same time as inflating the jacket/suite and double the air flow and hence increase the chance for freezing. Divers were using

normal masks with ice hoods. OTS full face mask was used during one dive but problems with the II stage induced the diver to use the standard mask. The dry suites were personal and were previously tested with the specific cold water under dry suite. Dry gloves were the preferred option although also three finger semidry gloves were used. Hand warmers inside the dry gloves were also used as extra heat option. The tether was made of 10 mm diameter polypropylene floating line and was of a light blue colour for a length of 60 m. The tether was attached to the diver by means of a knot and a mousketton on the jacket D-rings to allow better motility during work.

Risks encountered during the B121 diving activities and remediation procedures

Brash ice and ice growlers

Many of the locations were surrounded by active calving glaciers which could produce, especially overnight, a large amount of brash ice and ice growlers which, depending on the tidal currents or the wind direction, could complicate the diving activities. In general, diving was delayed when the surface nearby the entrance for divers and the overall task diving area was too packed with brash ice or was surely going to be affected by a large number of ice growlers. In fact in that case, the risk for the divers in need for an emergency ascent (e.g. frozen regulator, leopard seal) could have been the inability to surface and the risk to be hurt by the packing brash ice or by moving growlers. Further, the presence of large growlers could have created a problem for the tether line and dragged the diver at depth if caught into the ice and not freed timely. Divers at depth who were moving in the direction of a large growler, would be signalled to change direction with the 2 pulls signal by the surface tender. During the expedition the dives were managed to lower the risk of these situations (one dive was finished when brash ice and ice growlers were starting to concentrate on the surface - one dive was slightly delayed to await for clearing of the sea surface - one dive made use of the 2 pulls signal to divert divers direction) and no problem was encountered in relation to these risks.

Entanglement with other deployed lines

Dives were carried out from both the *RV Australis* and from the zodiacs. When diving from the ship, the anchor and other deployed lines such a fishing lines could represent a risk for entanglement with the diver tether line. To avoid such risks any fishing lines would be taken out of the water for the duration of the dive. Direction of divers would be closely followed to understand the possible entanglement with the anchor chain and the floating tether would be disentangled from onboard by passing the line around the obstacles. While diving for core sampling, the rack tether line (a common non floating line connecting the two core racks by means of mousketon to the surface for easy retrieval onboard of the filled racks upon completion of the task at depth) would be managed at depth by the diver with the following procedure: The diver would work around the tether carefully avoiding to get entangled. Upon completion of the task a first signal (2 pulls) would be given to the surface and the racks would be pulled up until their weight would be felt by the person onboard. At this point the diver at depth would control that the racks would be well organised avoiding loss of samples and would make sure not to have her own tether entangled with the rack line. Once this would be ensured, the diver would give another 2 pulls on the rack line and the racks would be taken on board. This would avoid that any further activity by the divers would incur in the risk of entanglement with the rack line. During B121 there have been entanglement situations but non resulted in an accident since they all have been managed promptly and the risk avoidance did improved with time and the direct experience on site.

Leopard seals

Leopard seals were present in some of the locations where the divers worked, whereas some other locations seemed to be free from their presence for the period of the campaign. No

underwater encounter with a leopard seal has taken place. The leopard seal watch was always on during the complete diving time. Sighting of a leopard seal near the returning divers rubber boat happened with no incident.

Freezing of regulators

Temperature of the water at the various diving locations varied from -1°C to 2°C. Air temperature were close to freezing (diving happened during gentle snow fall) and wind could chill the air even further. In general as previously mentioned, diving equipment was fit for cold water conditions, and assembled to lower the risk for first or second stage freezing. Tanks were filled avoiding moisture in the air. Nevertheless one case of frozen regulator happened during dive #34 and caused the divers to resurface quickly. The divers were working at 20 min for less than 10 min and after the surfacing they dove again to finish the task and also as an "old school" recompression procedure, where they then continued the dive for another 20 min at 15m depth, before resurfacing and carrying out a 3min 5 m safety stop. Divers were closely monitored for half hour after the dive and no signs of decompression illness were reported.

Decompression illness

In addition to the incident reported in the previous section in relation to the frozen regulator, no other issues related to potential decompression illness have been reported. Dives were all performed at depths shallower than 25 m (average depth 18.7 m) following No Decompression Dive Limits and making use of standard safety stops. Divers were always having a minimum of 2 h surface interval between dives and in between two consecutive days a minimum of 18h surface interval was present between the last dive of the day before and the first dive of the day after. In light of the potentially changeable nature of the weather conditions, the first day off was only taken after 11 days of continued work, but general tiredness conditions of the divers and overall personal energy level were constantly monitored and willingness/fitness to dive constantly assessed prior to each dive.

Dive log

The expedition achieved to explore 8 different locations (see dive log for sites code and coordinates) with a total of 37 dives carried out during a total of 19 working days and 3 days off with the collection of up to 333 samples. Tasks have been the following: perspex push cores taking, video transects, hand picking of animals, surface sediment scooping. A table with the dive log is presented below.

Dive Log

Date	Dive n°	Divers	Safety	Tender	Location ID	Latitude	Longitude	Time in	Time out	Max Depth	Total dive time	Task
27/02/2019	1	Thomas + Charlene		Francesca	MI_Dive1	62°19.246 S	62°55.375W	1500	1530	20	27	Check dive + exploration + samples and quadrants
	2	Francesca	Charlene	Thomas	MI_Dive2	62°19.246 S	62°55.375W	1550	1617	16.7	14	Check dive + exploration
28/02/2019	3	Thomas + Charlene		Francesca	MI_Dive3	62°19.246 S	62°55.375W	1054	1130	19.6	36	Attempt video with ROV skate + samples for biodiversity and trophic ecology
01/03/2019	4	Francesca	Charlene	Thomas	MI_Dive4	62°19.246 S	62°55.375W	1100	1130	17.8	37	Sediment cores sampling (10X) for meiofauna + trophic ecology + biogeochemistry
	5	Thomas + Charlene		Francesca	MI_Dive5	62°19.246 S	62°55.375W	1200	1240	20	39	Sediment for microplastic + biodiversity sampling
	6	Thomas + Charlene		Francesca	MI_Dive6	62°19.246 S	62°55.375W	1657	1738	22	41	Search for lost fishing line + video transect + sediment sampling
02/03/2019	7	Francesca+Charlene		Thomas	MI_Dive7	62°19.246 S	62°55.375W	1200	1228	18	28	Sediment cores sampling (10X) for meiofauna + trophic ecology + biogeochemistry
	8	Thomas + Charlene		Francesca	MI_Dive8	62°19.246 S	62°55.375W	1627	1703	19.8	36	Video transect
04/03/2019	9	Francesca + Thomas		Charlene	NH_Dive_9	62°50.565 S	62°32.009 W	1003	1030	23.6	27	Sediment sampling + limpets picking and macroalage picking
	10	Thomas + Charlene		Francesca	NH_Dive_10	62°50.565 S	62°32.009 W	1541	1619	16	38	Video transect from the ship
05/03/2019	11	Thomas + Charlene		Francesca	NH_Dive_11	62°50.565 S	62°32.009 W	1112	1147	18.6	35	Video transect+ hand picking
	12	Francesca + Charlene		Thomas	NH_Dive_12	62°50.565 S	62°32.009 W	1605	1633	16.4	28	Sediment scooping
06/03/2019	13	Francesca + Thomas		Charlene	NH_Dive_13	62°50.565 S	62°32.009 W	1000	1026	17.9	26	Sediment scooping
07/03/2019	14	Thomas + Charlene		Francesca	UI_Dive_14	64° 43.136'S	62° 52.173 W	938	1017	20	39	Video transect + hand picking for biodiversity
	15	Francesca + Thomas		Charlene	UI_Dive_15	64° 43.136'S	62° 52.173 W	1518	1555	20	35	Sediment sampling
08/03/2019	16	Francesca + Charlene		Thomas	UI_Dive_16	64° 43.136'S	62° 52.173 W	1030	1104	22	35	Sediment core sampling + hand picking + GoPro video amphipod traps and dive
	17	Thomas + Charlene		Francesca	UI_Dive_17	64° 43.136'S	62° 52.173 W	1523	1558	21	35	Video transect / hand picking / sediment scooping
09/03/2019	18	Francesca + Charlene		Thomas	SK_Dive_18	64°54,183'S	62°51.826'W	1043	1117	10	35	Sediment cores around a macro algae patch
	19	Thomas + Charlene		Francesca	SK_Dive_19	64°54.248'S	62°51.777'W	1604	1637	21	35	Video transect + hand picking
10/03/2019	20	Francesca + Thomas		Charlene	SK_Dive_20	64°54.196S	62°51.41.4'W	952	1028	17.1	35	Sediment cores (non successful) and sediment scooping for meiofauna and trophic ecology
	21	Thomas + Charlene		Francesca	SK_Dive_21	64°54.299'S	62°51.898'W	1559	1631	21	32	Video transect + hand picking
DAY OFF												
12/03/2019	22	Francesca + Charlene		Thomas	HI_Dive_22	65°06.057'S	64°04.992'W	1202	1236	14.7	34	Sediment cores (meiofauna) + sediment scooping (trophic ecology + micro plastic)
	23	Thomas + Charlene		Charlene	HI_Dive_23	65°06.057'S	64°04.992'W	1707	1741	11.6	34	Video transect + hand picking
13/03/2019	24	Francesca	Charlene	Thomas	HI_Dive_24	65°06.049'S	64°04.920'W	930	939	20	9	Sediment cores in anoxic sediment
	25	Thomas + Charlene		Francesca	HI_Dive_25	65°06.057'S	64°04.992'W	1016	1039	10	24	Hand picking and sediment for micro plastic
	26	Francesca + Thomas		Charlene	HI_Dive_26	65°06.196'S	64°04.042W	1600	1624	20	24	Sediment scooping for meiofauna and microplastics
14/03/2019	27	Thomas + Charlene		Francesca	BI_Dive_27	65°19.713'S	64°08.310'W	1200		20	31	Video transect + hand picking + micro plastic sediment scooping
	28	Francesca + Charlene		Thomas	BI_Dive_28	65°19.713'S	64°08.310'W	1530	1601	15.5	21	Sediment scooping for meiofauna + sediment granulometry + hand picking
DAY OFF												
16/03/2019	29	Thomas + Charlene		Francesca	GR_Dive_29	64° 43.550'S	63°16.959'W	1005	1042	19	37	Video transect + hand picking
	30	Francesca	Charlene	Thomas	GR_Dive_30	64° 43.550'S	63°16.959'W	1135	1201	17.9	26	Sediment cores
	31	Thomas + Charlene		Francesca	GR_Dive_31	64° 43.550'S	63°16.959'W	1545	1614	19	29	hand picking for stable isotopes and genomics
17/03/2019	32	Thomas + Charlene		Francesca	GR_Dive_32	64° 43.550'S	63°16.959'W	1030	1109	19	39	hand picking for stable isotopes and microporousastics and genpmics
	33	Francesca + Charlene		Thomas	GR_Dive_33	64° 43.550'S	63°16.959'W	1515	1532	11.8	17	Sediment scooping for meiofauna and biogeochemistry
DAY OFF												
19/03/2019	34	Thomas + Charlene		Francesca	FH_Dive_34	64°32.801'S	61°59.880'W	937	1014	21	39	Video transect + hand picking
	35	Francesca + Thomas		Charlene	FH_Dive_35	64°32.762'S	61°59.914'W	1500	1528	18	28	Sediment cores + sediment for micro plastics
20/03/2019	36	Francesca	Thomas	Charlene	FH_Dive_36	64°32.762'S	61°59.914'W	930	1013	18	38	Sediment cores
	37	Thomas + Charlene		Francesca	FH_Dive_37	64°32.801'S	61°59.880'W	1100	1131	24	31	Hand picking and sediment for micro plastic

This Diving Report is comprehensive of the main information regarding the diving activities carried our during the Scientific Expedition Belgica 121. For more information and detail on the complete scientific program of the cruise please read the online report “Danis, B., Christiansen, H., Guillaumot, C., Heindler, F., Houston, R., Jossart, Q., Lucas, K., Moreau, C., Pasotti, F., Robert. H., Wallis, B., Saucède, T., 2019. Report of the Belgica121 expedition to the West Antarctic Peninsula. 91 pp.”

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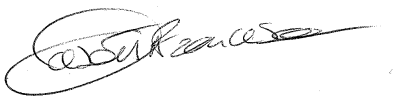

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