### 3.3.2 Mollusca in the Antarctic deep sea – preliminary notes on their taxonomy, biogeography and diversity

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ANT-XIX/3 / ANDEEP I (KL, LA) and ANT-XIX/4 / ANDEEP II (KL, MS, CRMC, LA)

The break-up of the continental bridge between South America and the Antarctic Peninsula was a major event that influenced the evolution of the Antarctic marine benthic fauna. A better understanding of the mollusc distribution in the Antarctic deep sea of the Peninsula and Scotia Sea region will throw further light on the evolution and radiation of the present fauna. ANDEEP provided the ideal opportunity to study the missing faunal link between the temperate South America, the South Atlantic deep-sea and the Antarctic shelf fauna.

The material collected will be the basis for species descriptions, critical taxonomic revisions and zoogeographic analyses. The biodiversity of different molluscan classes will be assessed and latitudinal species diversity gradients will be studied. Studies on the phylogeny and population dynamics of selected taxa using traditional and modern methods may elucidate the role of the Southern Ocean as a center of radiation for Atlantic taxa and possibly as a continuing portal for colonization from the Indo-Pacific. These studies may also explain the origin of the recent Antarctic molluscan fauna.

We sorted and pre-identified Mollusca from nine EBS stations of ANDEEP I (2300-5200 m) as well as from the 20 AGT stations (1120-5200 m) of both legs. The material collected by the EBS on ANDEEP II has still to be sorted and identified. To date we have found 119 species and 1787 specimens in the samples from both gears.

The epibenthic sledge with a mesh-size of 300 $\mu$m in the cod ends was very efficient in collecting macrobenthic molluscs. To date we have identified 86 species belonging to five molluscan classes and have collected 1405 specimens (Table 3.3.2-1). With 41 species, gastropods are the dominant group in terms of species numbers followed by bivalves with 30 species. Aplacophoran species were quite common with five morphotypes of Caudofoveata and seven morphotypes of Solenogastres. Three species of scaphopods were found. The ratio of 1.37 gastropod to bivalve species is quite interesting bearing in mind that three times more gastropod species are known from the Southern Ocean than bivalve species. Further studies on the EBS samples from ANDEEP II will show whether this ratio is consistent for the Antarctic deep-sea. HAIN (1990), POWELL (1958) and EGOROVA (1982) reported ratios for gastropods and bivalves in the range of 1.94–2.94 in their studies on the Antarctic shelf (93 G: 39 B - Weddell Sea, 97 G: 33 B – Enderby Land to Ross Sea, 98 G: 50 B - Davis Sea).

The species populations seem to be small and very patchy in distribution. Almost two-thirds of all species found are represented in the material by specimens only found at one or two locations or by single specimens. High numbers of specimens were observed only for *Solenogaster* sp. 3, *Genaxius* sp., *Kingiella* sp., *Yoldiella* cf. *valettei*, *Philine* sp. 1, and *Siphonodentalium* sp.

There seems to be no relation between increasing water depth and species numbers (Fig. 3.3.2-1). Species numbers per station are more or less consistent over the depth range from 2300 m to 5200 m. Only station 46-7 shows increased species numbers, as well as increased

| Class | Species | 41-3 | 42-2 | 43-8 | 46-7 | 99-4 | 105-7 | 114-4 | 129-2 | Σ |
|---|---|---|---|---|---|---|---|---|---|---|
| Caudofoveata | *Chaetoderma* sp. | | | | | | | 1 | | 1 |
| | *Falcidens* sp. 1 | | 1 | | | 2 | | | | 3 |
| | *Falcidens* sp. 2 | | 6 | | | | 1 | 1 | | 8 |
| | *Falcidens* sp. 3 | | | | 2 | | | | | 2 |
| | *Limifossor* sp. | | 1 | | | | | | | 1 |
| Solenogastres | *Neomenia* sp. | | | | | | | 1 | 1 | 2 |
| | Solenogaster sp. 1 | | 1 | | 4 | 1 | | 1 | | 7 |
| | Solenogaster sp. 2 | 5 | | 1 | 39 | | | 8 | | 53 |
| | Solenogaster sp. 3 | 6 | 17 | 7 | 137 | | 6 | 44 | 4 | 221 |
| | Solenogaster sp. 4 | 3 | | | 1 | | | 2 | | 6 |
| | Solenogaster sp. 5 | 3 | 4 | | 1 | | | 2 | | 10 |
| | Solenogaster sp. 6 | | 2 | 1 | | | | | | 3 |
| Gastropoda | ?*Toledonia* sp. | | | 1 | | | | | | 1 |
| | Aeolidacea sp. | | | | 1 | | | | | 1 |
| | *Anatoma* cf *timora* | 2 | | | 3 | | | | | 5 |
| | *Brookula* sp. | 4 | 2 | 2 | 2 | | | | | 10 |
| | Buccinidae sp. 1 | | | | 1 | | 1 | | 1 | 3 |
| | Buccinidae sp. 2 | 2 | | | | | | | | 2 |
| | *Cheritiella* sp. | | 1 | | | | | | | 1 |
| | *Chlanidota* cf *lamyi* | | | | 1 | 1 | | 2 | | 4 |
| | *Cylichna* sp. 1 | | | | | | | 1 | | 1 |
| | *Diaphana* cf *inflata* | 1 | | | 4 | | | | | 5 |
| | Gastropoda eggs | | 1 | 1 | 4 | | | | | 6 |
| | Lamellaria sp. | 1 | | | | | | | | 1 |
| | Littorinidae sp. | 2 | | | | | | | | 2 |
| | *Melanella* sp. | | 1 | | 3 | 5 | | | | 9 |
| | Mesogastropda sp. 5 | | | | 1 | | | | | 1 |
| | Mesogastropoda sp. 2 | 3 | | | | | | | | 3 |
| | Mesogastropoda sp. 3 | 1 | | | 1 | | | | | 2 |
| | Mesogastropoda sp. 4 | | | | 1 | | | | | 1 |
| | Mesogastropoda sp. 6 | | | | 2 | | | | | 2 |
| | Mesogastropoda sp. 7 | | | | | | | 1 | | 1 |
| | Mesogastropoda sp.1 | | | | 1 | | | | | 1 |
| | Naticidae sp. | 2 | | 1 | | | | | | 3 |
| | *Newnesia* sp. | | | | 1 | | | | | 1 |
| | *Notoadmete* sp. | | | 6 | 2 | | | | | 8 |
| | Opisthobranchia sp. | | | | 1 | | | | | 1 |
| | *Parabucciunum* sp. | | | 4 | 1 | | | | | 5 |
| | *Pareuthria* sp. | | 1 | | | | | | | 1 |
| | *Philine* sp. 1 | 2 | 15 | | 50 | 4 | | 10 | | 81 |
| | *Philine* sp. 2 | | | | | 1 | 1 | | | 2 |
| | *Philine* sp. 3 | | | | 3 | | | | | 3 |
| | *Probuccinum* cf *costatum* | | | | | | | | 1 | 1 |
| | *Prosipho* sp. | 1 | | | | | | | | 1 |
| | *Seguenzia antarctica* | 6 | | | | 12 | 1 | 1 | | 20 |
| | *Sinuber* sp. | | 1 | | | | | | | 1 |
| | Skeneidae sp. 1 | | | | | | | | 2 | 2 |
| | *Stilapex* sp. | | | 1 | | | | | | 1 |

| Class | Species | 41-3 | 42-2 | 43-8 | 46-7 | 99-4 | 105-7 | 114-4 | 129-2 | Σ |
|---|---|---|---|---|---|---|---|---|---|---|
| | *Tomthompsonia* sp. | 1 | | | 1 | | | | | 2 |
| | Trochidae sp. | 1 | | | | | | | | 1 |
| | *Trophon drygalski* | | | | | | 1 | | | 1 |
| | *Volutomitra* sp. | | | | | | 1 | | | 1 |
| | Zerotulanidae sp. | | | | 1 | 33 | | 6 | | 40 |
| Bivalvia | Bivalvia indet | | | | 5 | 4 | | | | 9 |
| | *Cardiomya* sp. | | 1 | | | 2 | | | | 3 |
| | *Cuspidaria* cf *tenella* | 3 | | | 13 | | 1 | 1 | 4 | 22 |
| | *Cuspidaria* sp. 1 | | 2 | | | 2 | | | | 4 |
| | *Cuspidaria* sp. 2 | 7 | 1 | | | | | | | 8 |
| | *Cyamiocardium* sp. | 24 | | | 14 | | 1 | | | 39 |
| | *Cyclopecten* sp. 1 | | | | | | | 3 | | 3 |
| | *Cyclopecten* sp. 2 | 3 | | | 1 | | | 1 | 1 | 6 |
| | *Dacrydium* sp. | 9 | | | 21 | 6 | | | 3 | 39 |
| | *Genaxius* cf *bongraini* | | 12 | 3 | 66 | 4 | | 4 | | 89 |
| | *Genaxius* sp. | 6 | 28 | 3 | 35 | 4 | 3 | 50 | 1 | 130 |
| | *Kingiella* sp. | 1 | 4 | 4 | | 85 | 2 | 11 | 4 | 111 |
| | *Limatula (Antarctolima)* sp. | 1 | | | 5 | 4 | | 2 | | 12 |
| | *Limatula (Limatula)* sp. | 1 | 4 | 6 | 3 | | | | | 14 |
| | *Limopsis marionensis* | 3 | | | | | | 4 | 1 | 8 |
| | *Limopsis tenella* | | | | | | | 1 | | 1 |
| | *Mysella* sp. | | | | 1 | | | 1 | | 2 |
| | *Nucula* sp. 1 | | | | | | | 3 | | 3 |
| | *Nucula* sp. 2 | | 12 | 1 | | | | | | 13 |
| | *Silicula* sp. | | | | 3 | 1 | | | | 4 |
| | *Solecardia* sp. | | 2 | | | | | 1 | | 3 |
| | *Subcuspidaria* cf *kerguelensis* | | | | | | | | 1 | 1 |
| | *Thyasira* sp. | | | | 1 | | | | | 1 |
| | *Tindaria* sp. | | 2 | 1 | 3 | 2 | | 1 | 1 | 10 |
| | *Yoldia* sp. | | 4 | | | | | | | 4 |
| | *Yoldiella* cf *vallettei* | 5 | 10 | 15 | 50 | 2 | 1 | 10 | | 93 |
| | *Yoldiella* cf. *ecaudata* | 1 | 14 | | 3 | 2 | | | 1 | 21 |
| | *Yoldiella sabrina* | | | 9 | | 5 | 1 | | | 15 |
| | *Yoldiella* sp. 2 | | | 10 | | 1 | | 1 | | 12 |
| | *Yoldiella* sp.1 | | 36 | | 1 | 3 | 2 | | | 42 |
| Scaphopoda | *Cadulus dalli antarcticus* | 1 | | | | | | | | 1 |
| | *Pulsellum* sp. | | 29 | | 1 | 1 | | | 2 | 33 |
| | *Siphonodentalium* sp. | | 49 | | 45 | | | | | 94 |
| | | 111 | 215 | 77 | 495 | 187 | 23 | 175 | 28 | 1405 |

**Tab. 3.3.2-1:** Mollusca collected by the EBS on ANDEEP I.

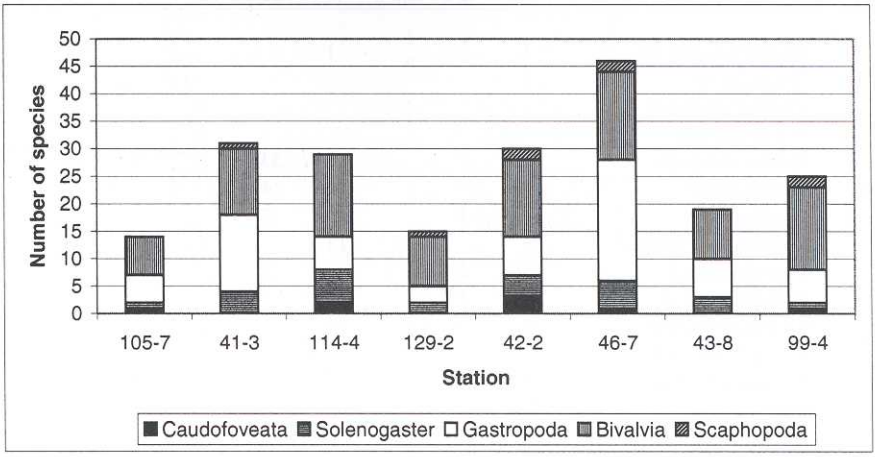


**Fig. 3.3.2-1:** Species – station distribution. Stations are ordered by increasing depth.

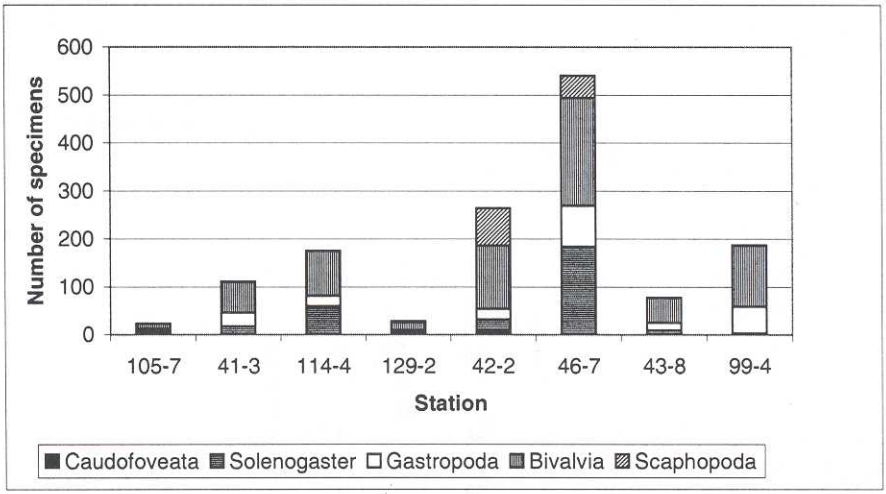


**Fig. 3.3.2-2:** Specimen – station distribution. Stations are ordered by increasing depth.

specimen numbers (Fig. 3.3.2-2). The location of the station in a depression may explain this.

A principal components analysis was conducted on the covariance/variance matrix of the station by species matrix of ANDEEP I. Four significant axes determined by the broken-stick method were obtained and cummulatively accounted for 98.2 % of the variance in the data set. Two stations, 99-4 and 46-7, plot independently from the other stations (Figs. 3 and 4). Station 99-4 separates from the others by increased abundances of a bivalve *Kingiella* sp. The seguenziid gastropod *Seguenzia antarctica* and a unidentified gastropod species possibly in the family Zerotulanidae also exhibits an influence on the faunal makeup of the station. These three species account for 69.5 % of individuals at this station (45.5, 6.4, and 17.6 % respectively). Station 46-7 is also dissimilar from the other stations. The faunal distinctness is attributed to the greatly

increased dominance of an aplacophoran *Solengaster* sp. 3 and the bivalve *Genaxius* cf *bongraini*. *Solengastor* sp. 3 is represented by 132 individuals at this station but never reaches an abundance of over 26 individuals at any of the others. In addition, *Genaxius* cf *bongraini* represents 61 individuals at this station but never more than 10 at any other.

A cluster analysis shows stations 105-7,129-2,43-8,41-3 contain a very similar molluscan fauna (83.6 %, Fig. 3.3.2-4). Stations 114-4 and 42-2 cluster with the previous stations at 61.83 %. Quite discrete from the others, stations 46-7 and 99-4 are only 13.36-23.06 % and 49.05-52.05 % similar in taxonomic makeup to the others.

The AGT catches of ANDEEP were not as rich as the EBS ones but still 45 molluscan species and 385 specimens were collected (Table 3.3.2-2). The catches from ANDEEP I and II were quite distinct from each other. Again, with 31 collected species, gastropods were the species richest group, followed by bivalves with 14 species. Polyplacophorans (1 sp), scaphopods (3 spp.) and octopods (2 spp.) were scarce and often occurred on one station only. On ANDEEP I the catches were clean and sediment free (exception 46-8), while the

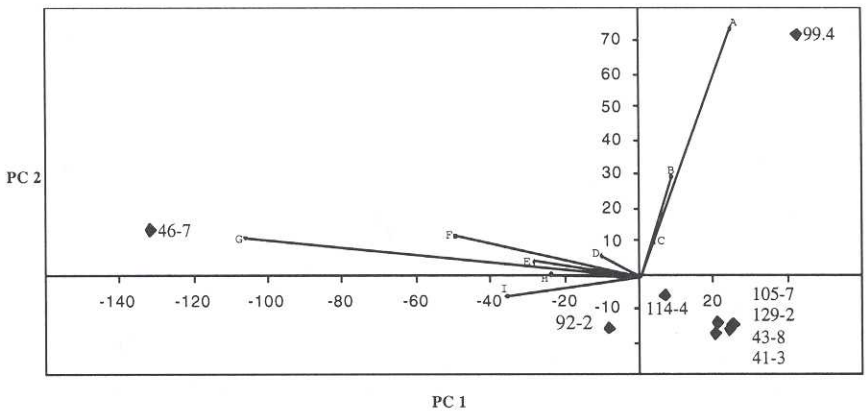


**Fig. 3.3.2-3:** Principal components analysis plot of ANDEEP I stations with species weightings. A. *Kingiella* sp., B. *Solecardia* sp., C. *Seguenzia antarctica*, D. *Dacrydium* sp., E. *Genaxius cf bongraini*, F. *Solenogaster* sp. 2, G. *Solenogaster* sp. 3, H. *Genaxius* sp., I. *Siphonodentalium* sp.

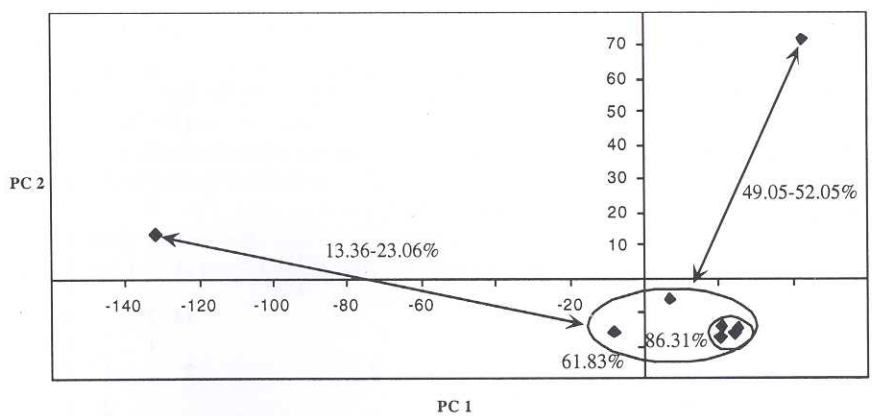


**Fig. 3.3.2-4:** Principal components analysis plot of ANDEEP I stations with a superimposed cluster analysis conducted on Euclidean distances.

catches on ANDEEP II consisted in varying volumes of mud and coarse sediment. This might explain why small macrobenthic molluscs were absent the former samples. Although the AGT catches are small they are of great scientific value because rare species were collected for further taxonomic work, e.g. see below paragraph on Octopodidae. For example further specimens of three rare species of deep water Trochidae (*Calliotropis* (*Solaricida*) *antarctica* Dell, 1990, *Falsimargarita benthicola* Dell, 1990 and *F. georgiana* Dell, 1990) were collected which were described by DELL (1990) on material collected with RV *Eltanin* in the deep sea off the Antarctic Peninsula, off the South Orkneys and South Georgia.

| Species | 41 -4 | 42 -3 | 43 -9 | 46 -8 | 94 -1 | 99 -4 | 10 5-8 | 114 -10 | 12 9-3 | 13 2-2 | 13 3-3 | 13 4-4 | 13 5-3 | 13 6-x | 13 7-3 | 13 8-4 | 13 9-5 | 14 0-7 | 141 -8 | 14 3-2 | Σ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Polyplacophora sp. | | | | | | | | | | | | | | | | | | | | 5 | 5 |
| *?Bathyberthella sp.* | | | | | | | | | | 1 | | | | | | | | | | | 1 |
| ?*Ponthiothauma* sp. | | | | | | | | | | | | 1 | | | | | | | | | 1 |
| *Anatoma* cf *amoena* | | | | | | | | | | | | | | | | | | 2 | 5 | | 7 |
| *Anatoma* cf *timora* | | | | | | | | | | 1 | | | | | | | | | | | 1 |
| *Antarctoneptunea* sp. | | | | | | | | | | | | | | | | | | 1 | | | 1 |
| Buccinidae sp. 1 | | | | | | | 2 | | | | | | | | | | | | | | 2 |
| Buccinidae sp. 2 | | | | | | | 1 | | | | | | | | | | | | | | 1 |
| Buccinidae sp. 3 | | | | | | | 1 | | | | | | | | | | | | | | 1 |
| *Calliotropis* cf *antarctica* | | | | | | | | | | 1 | | | | | | | | | 17 | 2 | 20 |
| *Chlanidota* sp. 2 | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| *Chlanidota* sp.1 | | | | | | | | | | | | 1 | | | | | | | | | 1 |
| *Eatoniella* sp. | | | | | | | | | | | | | 1 | | | | | | | | 1 |
| *Falsimargarita* cf *benthicola* | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| *Falsimargarita* cf *georgiana* | | | | | | | | | | 1 | | | | | | | | | | | 1 |
| Gastropod eggs | | | | | | | | | | 1 | | | 1 | | | | | | | 8 | 10 |
| *Harpovoluta* sp. | | | | | | | | | | | | | | | | | | | | 2 | 2 |
| *Iothia* sp. | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| *Marginella* sp. | | | | | | | | | | | | | | | | | 3 | | | | 3 |
| *Melanella* sp. | | | | | | | | | | | | | | | | | | | 2 | | 2 |
| Mesogastropoda sp. 1 | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| Mesogastropoda sp. 2 | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| *Milomelon turnerae* | | | | 1 | | | | 10 | | | | | | | | | | | | | 11 |
| Naticidae sp. | | | | | 1 | | | | | | | | | | | | | 1 | 3 | | 5 |
| *Newnesia* sp. | | | | 3 | | | | | | | | | | | | | | | | | 3 |
| Rissoidae sp | | | | | | | | | | | | | | | | | | | 2 | 1 | 3 |
| Tracolira sp. 1 | | | | | | | | | | | | | | | | | | 2 | | | 2 |
| Turridae sp. 1 | | | | | | | | | | | | | | | | | | 1 | | | 1 |
| Turridae sp. 2 | | | | | | | | | | | | | | | | | | 2 | 2 | | 4 |
| Turridae sp.3 | | | | | | | | | | | | | | | | | | | | 1 | 1 |
| Turridae sp.4 | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| Turritellidae sp. | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| *Amussium* sp. | | | | | | | | | | | | 2 | | | 1 | 1 | | | | | 4 |
| *Cuspidaria* cf *tenella* | | | | | | | | | | | | | | | 1 | | | | | | 1 |
| *Cyamiocardium* sp. | | | | | | | | | | | | | | | | | | 18 | 28 | | 46 |
| *Cyclopecten* sp. | | | | | | | | | | | | | | | | | | | 1 | | 1 |
| *Dacrydium* sp. | | | | | | | | | | | | | 2 | | | | | 2 | | 1 | 5 |
| *Genaxius* cf *bongraini* | | | | | | | | | | | | | | | | | | | | 2 | 2 |
| *Kingiella* sp. | | | | | | | | | | | | | | | | | | | 42 | | 42 |
| *Limatula* (*A*) sp. | | | | | | | | | | | | | | | | | | 8 | 1 | | 9 |
| *Limopsis marionensis* | | | | | | | | | | | | | | | | | 1 | 16 | 66 | 50 | 133 |

| Species | 41 -4 | 42 -3 | 43 -9 | 46 -8 | 94 -1 | 99 -4 | 10 5-8 | 114 -10 | 12 9-3 | 13 2-2 | 13 3-3 | 13 4-4 | 13 5-3 | 13 6-x | 13 7-3 | 13 8-4 | 13 9-5 | 14 0-7 | 141 -8 | 14 3-2 | Σ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Nucula* sp. | | | | | | | | | | | | | | | | | | 7 | | | 7 |
| *Yoldia* sp. | | | | | | | | | | | | 1 | | | | | | | | | 1 |
| *Yoldiella* cf *vallettei* | | | | | | | | | | | | | 1 | | | | | | | | 1 |
| *Yoldiella* sp. 1 | | | | | | | | | | | | | | | | | | 5 | 3 | | 8 |
| *Yoldiella* sp. 2 | | | | | | | | | | | | | 1 | | 1 | | | 4 | | | 6 |
| *Dentalium megathyris* | | | | | | | | | | 15 | | | | | | | | | | | 15 |
| *Pulsellum* sp. | | | | | | | | | | | 2 | | 1 | | | | | | | | 3 |
| Scaphopoda sp. | | | | | | | | 1 | | | | | | | | | | | | | 1 |
| *Thaumeledone* sp. | | | | 2 | | | | | | | | | | | | | | | | | 2 |
| *Bentheledone* sp. | | | | 1 | | | | | | | | | | | | | | | | | 1 |
| SUM | 0 | 0 | 0 | 4 | 1 | 0 | 0 | 15 | 0 | 20 | 2 | 5 | 7 | 0 | 3 | 1 | 4 | 69 | 179 | 72 | 385 |

**Tab. 3.3.2-2:** Mollusca collected by the AGT on ANDEEP I (41-4 to 129-3) and ANDEEP II (132-2 to 143-2)

### 3.3.3 *Philobrya* - Tracer for the possible Antarctic colonisation routes

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ANT-XIX-4 / ANDEEP II

The bivalve genus *Philobrya* (Fam. Phylobryidae: order Arcoidea) seems to be suited for studies on the potential origin of Antarctic marine taxa. The Philobryidae have a rich fossil history since the Eocene (c. 58-36 my) and *Philobrya* itself since the Miocene (22 my) from marine sediments in New Zealand. The recent distribution of the 45 described species of *Philobrya* is almost entirely restricted to the Southern Hemisphere, mostly to the southern tips of the America, Africa, Australia, and New Zealand and to Antarctica. The majority of species are recorded from Antarctic and sub-Antarctic waters (15 spp.), New Zealand (7 spp.), and from the Magellan region (6 spp.). The origin of the genus and Antarctic species is still unknown. Species of *Philobrya* occur from intertidal areas to a depth of 1000 m; deeper records are unknown. During ANDEEP the aim was to collect and prepare more deep-water material of *Philobrya* and related genera such as *Adacnarca*, *Lissarca* and *Limopsis* for further analysis (SEM, PCR).

During ANDEEP no specimens of *Philobrya* were captured, strengthening the hypothesis that *Philobrya* is a shelf species. Fourteen specimens of a new species of *Adacnarca* were collected at station 133-4 (1120 m) and fixed for molecular and morphological studies. Specimens of two species of *Limopsis* (*L. marionensis* and *L. tenella*) were collected to serve as the arcoid outgroups in the molecular analysis. The taxonomic and molecular studies on these specimens will be carried out at the British Antarctic Survey in Cambridge/U.K.

Additionally brachiopods were collected from seven locations (41-3, 101-1, 129-1, 133-4, 140-7, 141-8, and 143-2) for molecular analysis and phylogenetics.