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Freshwater bryozoans in the backwaters of the Danube and Traun Rivers south-east of Linz, Upper Austria

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Abstract: A faunistic census of freshwater bryozoans has been carried out in backwaters along a 5 km stretch of the Danube River south-east of Linz. The investigation area is situated within the impoundment area of the hydroelectric power station Abwinden-Asten. Nine backwaters in these floodplains on both sides of the Danube River were chosen. These backwaters, which are partly also under the influence of the hydrological regime of the Traun River, are mostly shallow and show little fluctuation in water level during the year. A total of six bryozoan species was found at four sites: *Paludicella articulata*, *Fredericella sultana*, *Cristatella mucedo*, *Plumatella casmiana*, *Plumatella fungosa* and *Plumatella repens*. Notably missing from these sites were *P. emarginata*, *P. fruticosa* and *Hyalinella punctata*, three species that occur downstream in Danube River backwaters in Lower Austria. However, the occurrence of *Plumatella casmiana* in the backwater "Ringelau" south-east of Linz is the first record of this species in a floodplain area of the Danube River in Austria. It also increases the number of freshwater bryozoan species for Upper Austria to eight.

Key words: Freshwater bryozoan species, faunistic census, *Plumatella casmiana*, Danube River, floodplain area, Linz.

1 Introduction

Until recently, only few studies were devoted to freshwater bryozoans in Austria. These include scattered reports on occurrences in lakes on the northern edge of the Alps (CORTI 1898; MICOLETZKY 1912; HAEMPEL 1918; BREHM & RUTTNER 1926; ZEITLINGER 1928; FOISSNER 1979) and some recordings in the Danube River (LIEPOLD 1926). During the last two decades, however, research has increased and several studies were conducted, mainly in backwaters of riverine forests or smaller stagnant water bodies in eastern Austria. The study sites included the Altenwörther/Grafenwörther Au (WÖSS 1990, 1991), the floodplain areas of the Danube River east of Vienna (WÖSS 1989, 1994) and the Laxenburg Pond (WÖSS 1996, 2000). Furthermore, distribution data of freshwater bryozoans in Carinthia are now available (TROYER-MILDNER 2005). A long-term study of benthos in the Danube River also yielded numerous findings of bryozoans, especially in the form of dormant bodies (FESL et al. 2005).

In total, ten freshwater species are reported for Austria (WÖSS 2005), seven for Upper Austria (WEIBMAIR 1999). The investigations of floodplain areas in Austria revealed nine species. As living colonies of *Lophopus crystallinus* have only been found at one site in a backwater of the March River (WÖSS 1995), the number of species in the riverine forests

of the Danube river is restricted to eight, five of them also verified for the backwaters along Danube stretches in the Upper Austrian region.

This study focuses on the occurrence of bryozoans in backwaters of the Upper Austrian section of the Danube River south-east of Linz (Fig. 1). The Austrian part of the Danube is 351 km long and, since the early 1950's, has developed into a power-generating waterway: 80 % of the Austrian stretch is used for energy production. The continuity of the river is interrupted by nine transverse barrages used for hydroelectric power stations; only two stretches of the river remain free-flowing (HUMPESCH 1996). The stretch south-east of Linz belongs to the impoundment area of the power station Abwinden-Asten, which was built in 1976-79. This regulation of the Danube River has caused massive hydrological changes, whereby flooding by superficial waters no longer takes place. Nevertheless, the floodplains on the right bank of the river have been granted Natura 2000 status. This area therefore still has the highest value for natural habitats and species of plants and animals which are rare, endangered or vulnerable in the European Community (ZANINI & REITHMAYER 2004).

2 Investigation area

The sampling area is located in a backwater area south-east of Linz on both banks of the Danube River along a 5-km-long stretch (Danube River kilometre 2125 to 2120 from estuary, Fig. 2). The maximal width of the floodplain area is about 1 km. The stretch starts at the mouth of the Traun River into the Danube and ends close to the dam of the Abwinden-Asten power station. Since impoundment construction, the groundwater level has remained at a relatively constant level. The backwaters are mostly shallow and rarely reach or exceed a water depth of 2 m. In general, the water levels of all water bodies in the area show little fluctuation during the year.

The river floodplain area on the left bank of the Danube is delimited by a highway running along its border and narrows as little as 100 m towards Abwinden-Asten. Several water bodies are heavily influenced by commercial gravel mining, while others have been altered by tourism and are used as public bathing lakes. Within this area the backwaters Neuau (1), Pond at Ringelau (2) and a long backwater stretch towards Abwinden-Asten (3) were chosen for investigations. Backwaters 1 + 3 can be classified as running water bodies whereas "Ringelau" (2), is a private pond.

The river floodplain area on the right bank is strongly influenced by the Traun River, a large alpine tributary which was rich in bedload deposits before power plant construction (HOHENSINNER et al. 2005). Here four ponds – the Kleiner Weikerlsee (4), Großer Weikerlsee (6), Ausee (8), a smaller pond opposite the crayfish breeding area (9) – and two running water bodies – the connective backwater between Kleiner and Großer Weikerlsee (5) and the Mitterwasser (7) – were chosen for bryozoan surveys. Despite its Natura 2000 status the area along the right bank has also been undergoing remarkable changes. Again, tourism plays a role: the Kleiner Weikerlsee is used as a recreation area of the newly founded quarter of the town ("Solar City"), and the Ausee has been integrated in a camping place zone, including an adaptation of the water body for waterskiing. Economic use of the floodplain area is evident at the south-eastern end, where a crayfish breeding enterprise is running several ponds.

3 Methods

In the last week of July 2005, sampling of colonies took place in the nine backwaters described above. Between one and five sites were chosen as sampling areas at each waterbody. A total of 28 sites was examined for bryozoan settlement (Tab. 1). The minimum sampling time per site was 15 minutes.

Tab. 1: Studied waterbodies and number of sampling sites per waterbody.

Investigated backwaters of the floodplain area south-east of Linz			Number of sampling sites
Backwaters along left bank of Danube	1	Backwater stretch at Neuau	3
	2	Pond at Ringelau	3
	3	Backwater stretch towards Abwinden Asten	3
Backwaters along right bank of Danube	4	Kleiner Weikerlsee	5
	5	Connective backwater stretch	1
	6	Großer Weikerlsee	3
	7	Backwater stretch Mitterwasser	4
	8	Ausee	3
	9	Pond opposite crayfishing area	3

Colonies were collected by investigating natural substrates such as submerged branches, roots, aquatic plants and stones for aufwuchs. Sampling was carried out by wading in the water bodies and using a long rake to thoroughly comb the bottom for substrates. Small pruning-shears were used to cut smaller branches or twigs, a handsaw for thicker branches. In the case of logs or other objects that could not be removed, the colonies were scratched from the substrate with a knife. All substrates with traces of colonies were transported in water-filled 10 litre tanks to the laboratory for species identification.

Colony abundance is described using a rank scale (Tab. 2), referring to a substrate sampling time of 15 minutes per site.

Tab. 2: Rank abundance of bryozoan colonies, sampling unit: 15 minutes.

Abundance	Number of colonies
Low	1-4
Intermediate	5-24
High	>25

4 Results

Bryozoan colonies were found in one backwater in the floodplain area north of the Danube (= left river bank) and in three backwaters on the southern area (= right bank). The following six species were recorded (Tab. 3, Fig. 3).

Tab. 3: List of bryozoan species in the floodplain area of the Danube River south-east of Linz.

Gymnolaemata
Ctenostomata
Paludicellidae
<i>Paludicella articulata</i> (EHRENBERG 1831)
Phylactolaemata
Fredericellidae
<i>Fredericella sultana</i> (BLUMENBACH 1779)
Plumatellidae
<i>Plumatella casmiana</i> OKA 1907
<i>Plumatella fungosa</i> (PALLAS 1768)
<i>Plumatella repens</i> (LINNAEUS 1758)
Cristatellidae
<i>Cristatella mucedo</i> CUVIER 1789

4.1 Floodplain area on the left bank of the Danube

No traces of freshwater bryozoans were found in backwater 1 ("Neuau"), a stream-like water body about 2 m deep and colonised by *Elodea canadensis*. In backwater 3 ("long backwater stretch towards Abwinden-Asten"), a shallow water body with several sections only a few decimetres deep, substrates were heavily covered by filamentous algae but bryozoans were lacking.

In backwater 2, ("Pond at Ringelau"), however, five species were recorded (Tab. 4). *Plumatella casmiana* was very abundant in all three of the sites, with numerous colonies occurring on twigs and wooden fragments along the shoreline. The colonies were mostly small, many of them showing the typical growth pattern of colonies developing from larvae ("flabellum-mode") and containing both sessoblasts (Fig. 4a) and floatoblasts. *Fredericella sultana* was the second most common species, although much less abundant and without formation of piptoblasts. The remaining three species were quite rare: Four colonies of *Paludicella articulata* were found, two of them without living zooids. Three *Plumatella repens* colonies were present, one of them with mature floatoblasts (Fig. 4b). One small living colony of *Cristatella mucedo* was recorded; it showed no statoblast formation.

Tab. 4: Backwater 2: total number of bryozoan colonies, total sampling time: 45 minutes (3 sites).

Pond at Ringelau	
Species	Number of colonies
<i>Plumatella casmiana</i>	> 100
<i>Fredericella sultana</i>	15
<i>Paludicella articulata</i>	4
<i>Plumatella repens</i>	3
<i>Cristatella mucedo</i>	1

4.2 Floodplain area on the right bank of the Danube

In backwater 4 ("Kleiner Weikerlsee"), a stagnant and shallow water body, gravel has been artificially strewn along the shore. The submerged substrates were densely covered

with algae, and hydrozoans were frequent. No bryozoan aufwuchs was detected despite intense sampling at 5 sites. However, in a narrow, 350 m-long backwater (5) with a steep shoreline and connected to the Großer Weikerlsee, one colony of *Plumatella repens* was discovered. It measured 3 × 6 cm and contained no statoblasts (Tab. 5).

Tab. 5: Backwater 5: total number of bryozoan colonies, total sampling time: 15 minutes (1 site).

Connective backwater stretch between Kleiner and Großer Weikerlsee	
Species	Number of colonies
<i>Plumatella repens</i>	1

Backwater 6 ("Großer Weikerlsee"), a pond measuring about 1 × 0.5 km, is less affected by tourism. Here, riverine forest surrounds the water body, and twigs and branches ly in the water. Bryozoan colonies were present, although no dense coverage was found at any of the three investigated sites. A total of five species were recorded (Tab. 6). *Fredericella sultana* was clearly the dominant species and quite frequently covered branches, twigs and stones (Fig. 5a), followed by *Paludicella articulata*, *Plumatella fungosa*, *P. repens* and *Cristatella mucedo*. In contrast to backwater 2, piptoblasts were found in *Fredericella sultana* colonies (Fig. 6a), although most were still immature. Both *Plumatella fungosa* colonies had sessoblasts (Fig. 6c), but no mature floatoblasts; the colony of *Cristatella mucedo* contained spinoblasts (Fig. 6b).

Tab. 6: Backwater 6: total number of bryozoan colonies, total sampling time: 45 minutes (3 sites).

Großer Weikerlsee	
Species	number of colonies
<i>Fredericella sultana</i>	>75
<i>Paludicella articulata</i>	15
<i>Plumatella fungosa</i>	3
<i>Plumatella repens</i>	2
<i>Cristatella mucedo</i>	1

Backwater 7 ("Mitterwasser") flows from the Großer Weikerlsee and forms a stretch along nearly the whole length of the alluvial forests south of the Danube River. This running water is more than 5 km long with a maximal width of 50 m. At three of the four investigated sites, bryozoans were found (a total of four species; Tab. 7). Most of the colonies were sampled at the first site directly next to the Großer Weikerlsee (Fig. 2). *Cristatella mucedo* was most abundant, covering submerged branches and stones with extraordinarily high densities. The caterpillar-like zooaria, lying side by side, completely enclosed the substrate (fig 5b). Only sponges were even more frequent. *Paludicella articulata* was quite numerous, while *Fredericella sultana* was less common. *Plumatella fungosa* remained rare, despite the impressive size of one of its colonies (Fig. 5c). In contrast to *P. fungosa* colonies elsewhere, which were smaller and contained only sessoblasts, both types of statoblasts could be found here.

In two further water bodies, the Ausee (backwater 8) and a small pond east of the crayfish breeding ponds (backwater 9), no bryozoans were found.

Tab. 7: Backwater 7: total number of bryozoan colonies, total sampling time: 60 minutes (4 sites).

Backwater stretch Mitterwasser	
Species	Number of colonies
<i>Cristatella mucedo</i>	>100
<i>Paludicella articulata</i>	30
<i>Fredericella sultana</i>	10
<i>Plumatella fungosa</i>	3

4.3 Summary: Occurrence and abundance of freshwater bryozoans in the floodplain area south-east of Linz (Tab. 8)

In total, four species were present in three water bodies (*Cristatella mucedo*, *Fredericella sultana*, *Paludicella articulata*, and *Plumatella repens*), while *P. fungosa* was found in two backwaters and *P. casmiana* in one. *Cristatella mucedo*, *Fredericella sultana* and *Plumatella casmiana* developed high abundances in at least one of the water bodies. The abundance of *Fredericella sultana* was quite variable, ranking from low, intermediate to high, while *Cristatella mucedo* was either present in mass occurrences or with few colonies. *Paludicella articulata* ranged from low to intermediate abundance, whereas the two plumatellid species *Plumatella fungosa* and *P. repens* remained rare.

Tab. 8: rank abundance of bryozoan species in the backwaters south-east of Linz, 29.7.-31.7.2005.

Backwaters	Species	Abundance
2,6,7	<i>Cristatella mucedo</i>	low to high
2,6,7	<i>Fredericella sultana</i>	low to high
2,6,7	<i>Paludicella articulata</i>	low to intermediate
2,5,6	<i>Plumatella repens</i>	low
6,7	<i>Plumatella fungosa</i>	low
2	<i>Plumatella casmiana</i>	high

5 Discussion

5.1 Comparison with former reports from bryozoan findings in the floodplain area south-east of Linz

The present investigation extends the former list of five bryozoan species in the floodplain area south-east of Linz by adding *P. casmiana*. The species is now recorded for the first time in Upper Austria as well as for a backwater in an Austrian floodplain area in general. Previous reports stem from certain Carinthian lakes (TROYER-MILDNER 2005) and from the Laxenburg Pond in Lower Austria, where it was the dominant of eight species for years (WÖSS 2000).

The remaining five species of the present investigation coincide with those already described for that region. For example, mass occurrences of *Cristatella mucedo* were also mentioned from the Mitterwasser in August 1983, with coverage up to 1 m² and single colonies reaching a length of 20 cm. WEIBMAYR (1999) reported high abundances of *Plumatella fungosa* in the Großer Weikerlsee as well. In contrast to *Cristatella mucedo* however, colonies of *Plumatella fungosa* were not found in higher numbers in July 2005. This reflects the life cycle of this species, which exhibits high colony abundances in spring and autumn and lower abundances during the summer months (WÖSS 1994, 2002). A further visit to the Großer Weikerlsee and to the Mitterwasser revealed remarkable colony growth of *Plumatella fungosa* as well: on 11 September 2005, numerous colonies of this species and of *Cristatella mucedo* covered the bottom, although sponges were even more frequent.

5.2 Comparison of bryozoan occurrence in floodplain areas of Upper and Lower Austria (Tab. 9)

Two former investigation areas are situated along the Lower Austrian stretch of the Danube (Fig. 1), one within the impoundment area of Altenwörth/Grafenwörth ("A./W.", River kilometre 1987-1982), the other further downstream at one of the only two remaining free-flowing sections of the Danube River in Austria, extending from Fischamend to Bad Deutsch-Altenburg ("F.-B.", River kilometre 1905-1987.5). The hydrological data of Altenwörth/Grafenwörth are comparable with those of Linz, although the variety of habitats is somewhat larger in Lower Austria (WÖSS 1991). The stretch from Fischamend to Bad Deutsch-Altenburg lies within the National Park Donau-Auen and differs considerably as it is a very dynamic ecosystem. These backwaters are flooded regularly by the Danube, with high and low water levels varying by as much as 7 m.

Tab. 9: Occurrence of freshwater bryozoans in three floodplain areas of the Danube River: Linz, Altenwörth/Grafenwörth and Fischamend to Bad Deutsch-Altenburg. Species are listed in order of their abundance.

Danube backwaters		
impounded floodplains		free-flowing stretch of the river
Linz	Altenwörth/ Grafenwörth	Fischamend to Bad Deutsch-Altenburg
river-km 2125-2120	river-km 1987-1982	river-km 1905-1887,5
9 backwaters	23 backwaters	14 backwaters
4 with bryozoans	15 with bryozoans	14 with bryozoans
6 species	7 species	8 species
<i>F. sultana</i> , <i>C. mucedo</i> , <i>P. articulata</i> , <i>P. repens</i> , <i>P. fungosa</i> , <i>P. casmiana</i>	<i>P. fungosa</i> , <i>C. mucedo</i> , <i>P. repens</i> , <i>P. emarginata</i> , <i>P. fruticosa</i> <i>F. sultana</i> , <i>H. punctata</i>	<i>P. fungosa</i> , <i>P. emarginata</i> , <i>F.</i> <i>sultana</i> , <i>C. mucedo</i> , <i>H. punctata</i> , <i>P.</i> <i>repens</i> , <i>P. articulata</i> , <i>P. fruticosa</i>

The Lower Austrian backwaters were strongly colonised by bryozoans. Particularly in the stretch from Fischamend to Bad Deutsch-Altenburg, colonies were present in all 14 investigated water bodies. *Plumatella fungosa* was consistently the most widely distributed species. In summary, species richness was higher than in the Upper Austrian section of the Danube River because species like *P. emarginata*, *P. fruticosa* and *Hyalinella*

punctata were present in both studied Lower Austrian floodplain areas. Note, however, that records of these three species exist in Upper Austria; these include *Plumatella emarginata* in the Danube River at Jochenstein (database of the University of Natural Resources and Applied Life Sciences) and in ponds around Steyr (WEIBMAYR 1999). In one of these ponds, the Gartner-Teich, *Hyalinella punctata* has also been collected. *Plumatella fruticosa* was first recorded for Upper Austria in September 2005 (Oberer Gosausee, manuscript in preparation).

No explanation can be given yet why these three species are lacking in the floodplain area south-east of Linz. The conclusion that the backwaters in the free-flowing section of the Lower Austrian Danube are consistently richer in bryozoan species would be premature because these sites were monitored intensively for a longer period of time. In some Upper Austrian backwaters, environmental conditions that are relevant for bryozoan growth – such as availability of suitable substrates and sufficient water depth – were only present to a certain extent. Moreover, the tourism- and commerce-related changes to the backwaters in Linz are taking place on a much larger scale than in the other two areas, no doubt negatively impacting bryozoan habitats there.

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7 Zusammenfassung

Die Studie behandelt eine im Juli 2005 durchgeführte semiquantitative Erhebung der Moostierfauna in den Augewässern südöstlich von Linz. Das untersuchte Auengebiet liegt zu beiden Seiten eines 5 km langen Donau-Abschnitts im Rückstaubereich des Kraftwerkes Abwinden-Asten. Auf Grund der im Zuge des Kraftwerkbbaus erfolgten Flußregulierungen weisen alle neun untersuchten Gewässer, die überwiegend als seicht einzustufen sind, nur geringe jahreszeitliche Wasserspiegelschwankungen auf. Die rechtsufrige Au wird zudem vom hydrologischen Regime der Traun beeinflusst und besitzt den Status eines Natura 2000 - Gebietes.

In vier Augewässern (Teich in der Ringelau, Großer Weikerlsee, Verbindungsarm zwischen Großem und Kleinem Weikerlsee, Mitterwasser) wurden in Summe sechs Moostierarten gefunden: *Paludicella articulata*, *Fredericella sultana*, *Cristatella mucedo*, *Plumatella casmiana*, *Plumatella fungosa* und *Plumatella repens*. Vier Arten traten dabei in drei Wasserkörpern auf (*C. mucedo*, *F. sultana*, *P. articulata* und *P. repens*), *P. fungosa* wurde in zwei und *P. casmiana* in einem der Augewässer festgestellt. Das Vorkommen von *F. sultana* war höchst variabel, erreichte jedoch in der Ringelau und im Großen Weikerlsee hohe Abundanzen. *C. mucedo* zeichnete sich durch Massenvorkommen im Mitterwasser aus, ebenso waren die Funde von *P. casmiana* als zahlreich zu bezeichnen. *P. articulata* erzielte nur mittlere Abundanzen, während die beiden Plumatelliden *P. repens* und *P. fungosa* im gegebenen Untersuchungszeitraum selten auftraten, im Gegensatz zur Stichprobe im September 2005, bei der eine hohe Anzahl von *P. fungosa* – Funden festzustellen war.

Der Vergleich mit Bryozoen-Vorkommen der niederösterreichischen Donau – Auen bringt das Fehlen von *Plumatella emarginata*, *Plumatella fruticosa* und *Hyalinella punctata* im untersuchten

oberösterreichischen Donau-Abschnitt zu Tage. Der Nachweis von *P. casmiana* in der Ringelau ist erstmalig für ein Augebiet Österreichs und erhöht die Anzahl der in Oberösterreich vorkommenden Bryozoen-Spezies auf acht Arten.

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Fig. 1: Sampling areas for bryozoans in floodplains along the Danube River in Austria. Linz (present study); A./G.= Altenwörth/Grafenwörth area; F.-B .:= area between Fischamend and Bad Deutsch-Altenburg.

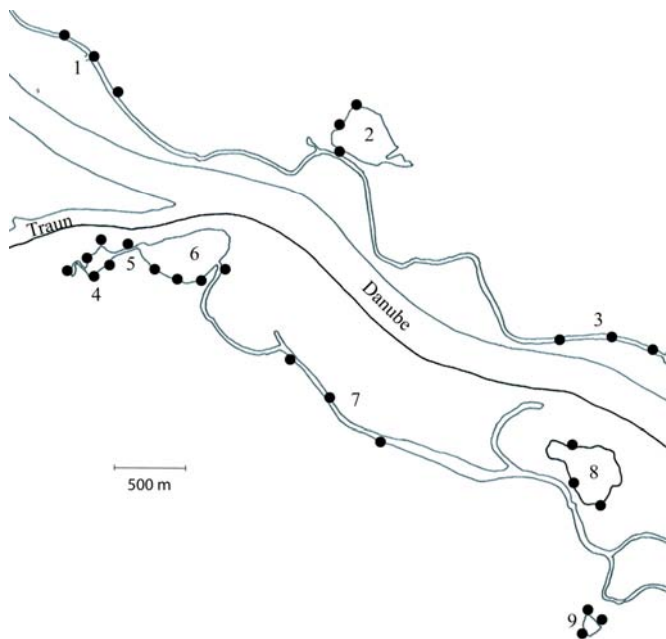


Fig. 2: Location of sampling sites in nine water bodies in the floodplain area south-east of Linz.

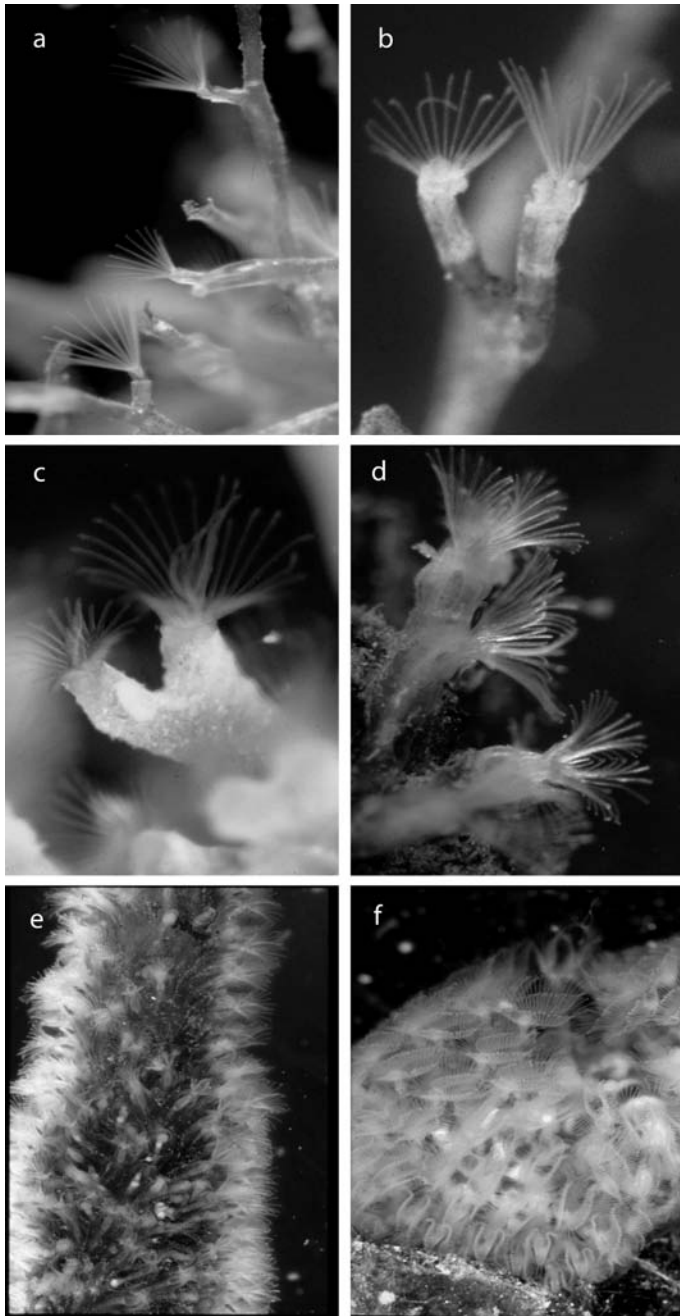


Fig. 3: Bryozoans in the floodplain area south-east of Linz, zooids: **a** – *Paludicella articulata*, **b** – *Fredericella sultana*, **c** – *Plumatella casmiana*, **d** – *Plumatella repens*, **e** – *Plumatella fungosa*, **f** – *Cristatella mucedo*. Single zooid size: 1-2 mm.

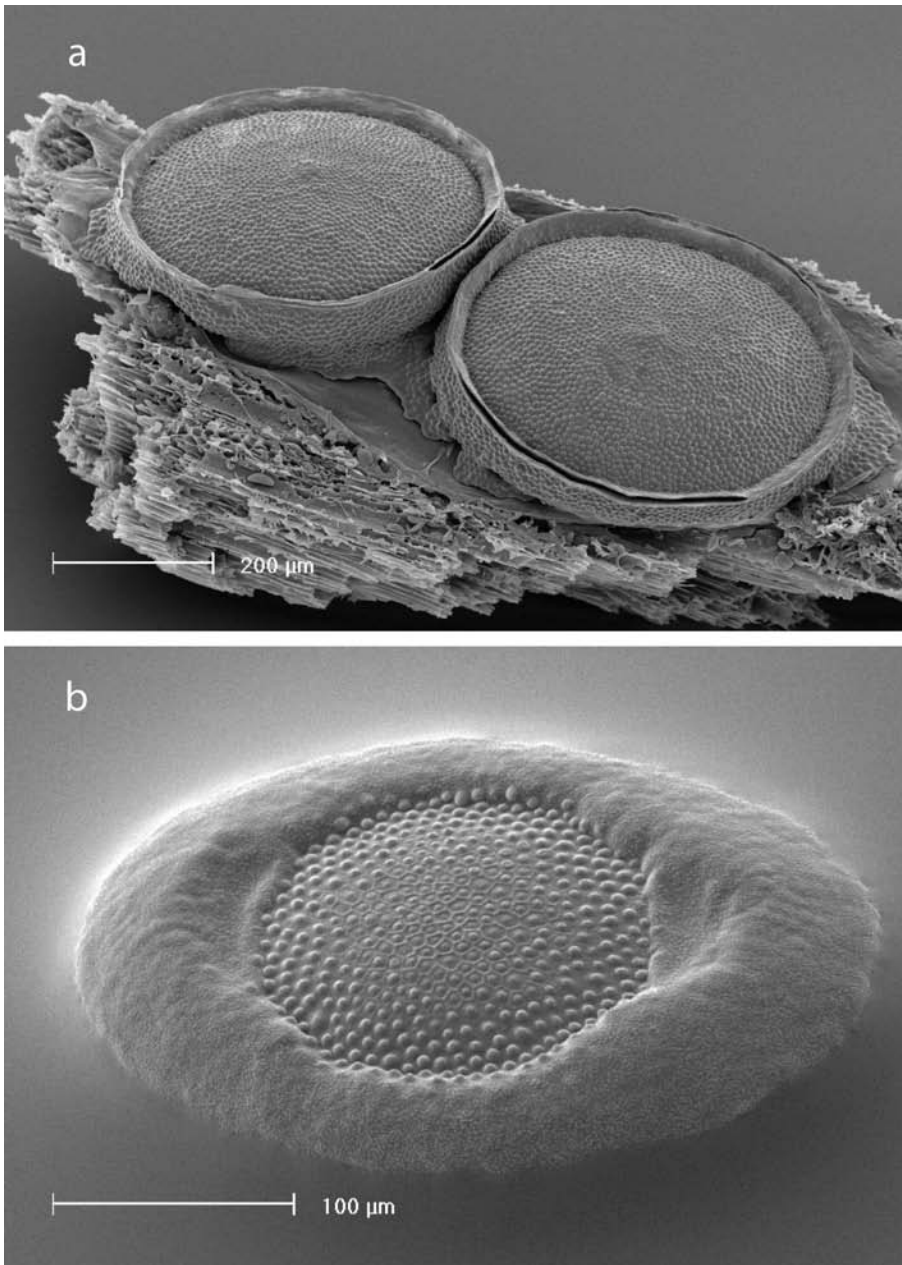


Fig. 4: Bryozoan statoblasts I: **a** – sessoblast of *Plumatella casmiana*, **b** – floatoblast of *Plumatella repens*.

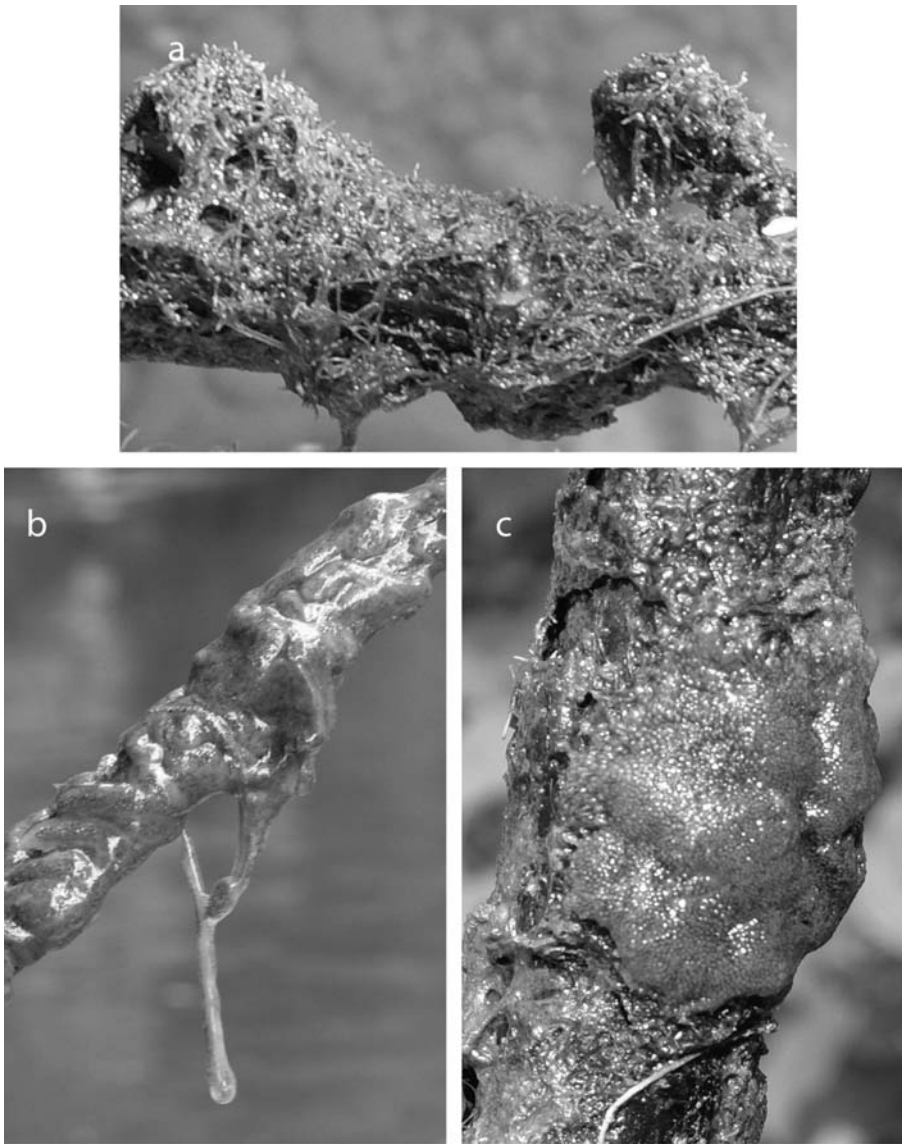


Fig. 5: Bryozoans in the floodplain area south-east of Linz, colonies: **a** – *Fredericella sultana* (Großer Weikerlsee), Ø branch 2 cm, **b** – *Cristatella mucedo* (Mitterwasser), Ø branch 2 cm, **c** – *Plumatella fungosa* (Großer Weikerlsee), Ø branch 3.5 cm.

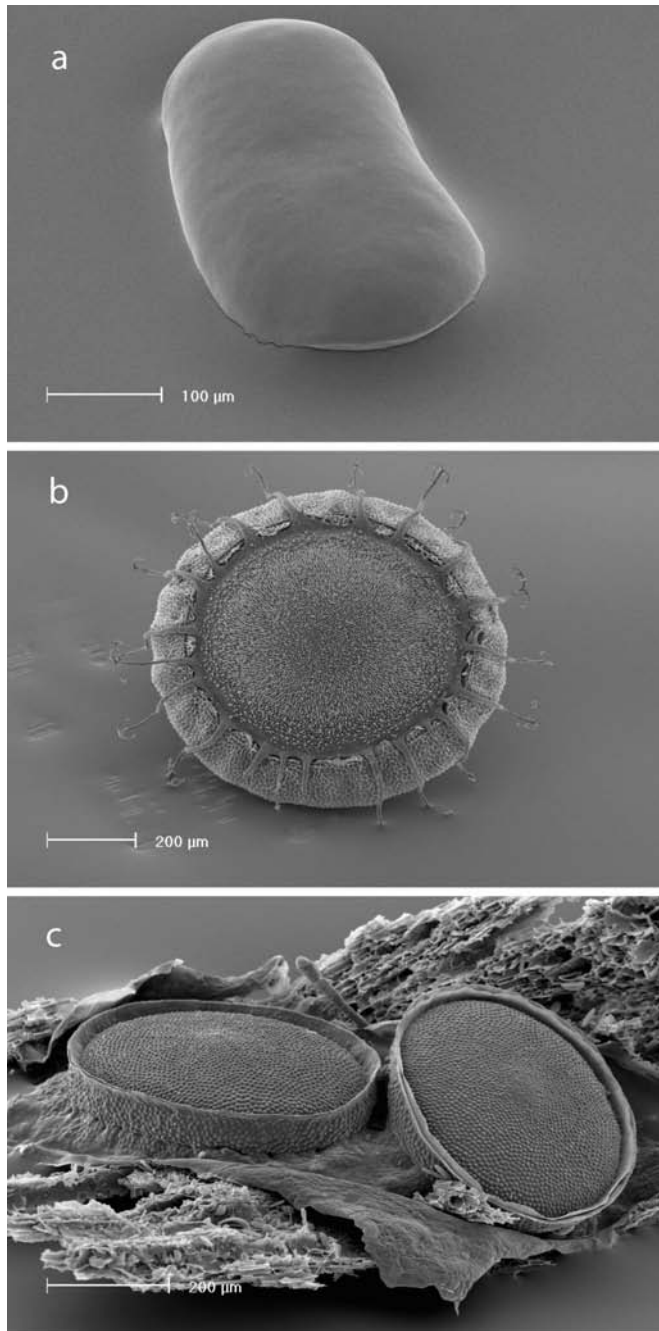


Fig. 6: Bryozoan statoblasts II: **a** – piptoblast of *Fredericella sultana*, **b** – spinoblast of *Cristatella mucedo*, **c** – sessoblast of *Plumatella fungosa*.

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