Thematic set:
Cyprideis torosa

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New occurrences of *Cyprideis torosa* (Crustacea, Ostracoda) in Germany

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Abstract: Living *Cyprideis torosa* (Jones, 1850) was found in Germany along the North Sea coast and on some islands, within the Baltic Sea and in coastal waters near the Baltic Sea, but also in some inland natural and anthropogenic saline waters. The natural inland waters were probably colonized by birds because this species was found only in permanent saline shallow lakes that provide resting places for migrating birds. Information on the fossil and Recent record and on the biology of *C. torosa* and its accompanying ostracod fauna is discussed.

Keywords: *Cyprideis torosa*; inland waters; athalassic; bird migration; distribution

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Two kinds of saline inland waters are distinguished: thalassic and athalassic waters. Thalassic waters have an ionic composition similar to that of seawater, athalassic waters have a quite different ionic composition from those with dissolved salts derived from seawater and have never been connected to the sea during geologically Recent times (Cole 1983). Brackish waters must have a connection to the sea (De Deckker 1981). Here we provide two examples for athalassic waters in Germany. Some of the inland saline waters in Germany have their origin in the solution of a salt dome underground by groundwater (Fig. 1). Lake Arendsee, northeastern Germany, Sachsen-Anhalt, is an example of such a lake (Fig. 2). During Late Permian time thick layers of salt from a desiccating sea were deposited. The salt became thermoplastic under high pressure and temperature and ascended via fault zones through the cover deposits. Springs with water that had contact with a salt dome are more or less saline. These are natural saline athalassic inland waters. Thus, solution of the top of the salt dome can impact the formation of a lake over the salt dome (Stottmeister 1998; Leineweber *et al.* 2009; Scharf *et al.* 2009).

Since 1889, a potash factory (Salz- und Kalihersteller K+S in Kassel, Germany) has extracted potash from the salt of a salt dome and discharged its saline waste water into the River Werra and consequently into the River Weser and the North Sea (Fig. 2). This is an anthropogenic saline inland water.

Cyprideis torosa (Jones, 1850) occurs mainly in thalassic brackish waters with fluctuating salinity, from hypersaline to freshwater in range. It is found in brackish coastal waters of Europe, western and central Asia, the Mediterranean region, the Middle East, lakes in central Africa (Meisch 2000), in the Seychelles (Wouters 2002) and South Africa (Wouters 2003).

The aim of this study is to show where *Cyprideis torosa* can be found in Germany, especially in inland waters of Germany, to compile information on the life conditions of *C. torosa* and on the accompanying ostracod fauna at sample sites with *C. torosa* or at these samples sites where we expected to find *C. torosa*.

Material and methods

The data of the sampled sites are compiled in Table 1. Waters of sites 1–2 are situated on islands in the North Sea, site 3 in the River Peene which connects the Oder lagoon and the Baltic Sea, sites 4–9 are located in the biggest saline spring area of NE Germany, at Sülldorf near Magdeburg (Fig. 2), sites 10–16 are situated in the River Weser's floodplain or in this river itself downstream of the city of Bremen. In Bremen there is a weir in the River Weser which stops the influence of the North Sea, the end of the estuary. Site 17 is a harbour in the River Weser, *c.* 25 km upstream (south) of Bremen (Fig. 2). Sites 18–21 are ditches or ponds near natural inland salt marshes, north of the Harz mountain range (Janssen 1986; Janssen & Brandes 1989*a*, *b*).

The method of collecting and separating the living ostracods from the surrounding sediment is described by Scharf *et al.* (2014). The sampled area was mostly *c.* 0.25 m^2. At each site, the temperature was measured with a standard mercury thermometer, the conductivity with a Multi-Parameter PCTestr^{TM} 35 of EUTECH Instruments OAKTON®, the salinity with the refractometer REF 211 (Arcarda® GmbH), the pH-value colourimetry (pH-indicator solution pH 4.0–10.0, MERCK®), and the coordinates were taken by means of Garmin GPSmap76 (WGS 84).

The 'Index and bibliography of nonmarine/marine Ostracoda' by E. K. Kempf (see Viehberg *et al.* 2014) was used intensively and species listed in this work can be found in this publication. The ostracods are deposited in the collection of BS.

Results

The abundance of *Cyprideis torosa* and the accompanying ostracod fauna can be found in Table 2. The most specimens of *C. torosa* were found in locality 12, a loam pit in the floodplain of the River Weser with more than 2000 individuals per sample. In a ditch in the estuary's floodplain of the River Weser 450 individuals were present in a sample (10). In all other sample sites the number of *C. torosa* was fewer.

Near Magdeburg is the biggest saline spring of northern Germany (sites 4–9 in Tables 1 and 2). *Cyprideis torosa* was found at this locality only at sites 8 and 9 and there not alive. Here the effluent of the saline spring is dammed (Fig. 3a, d). The pond was hypereutrophic (many submerged macrophytes and slight smell of H_2S) and this is probably the reason why only empty carapaces and

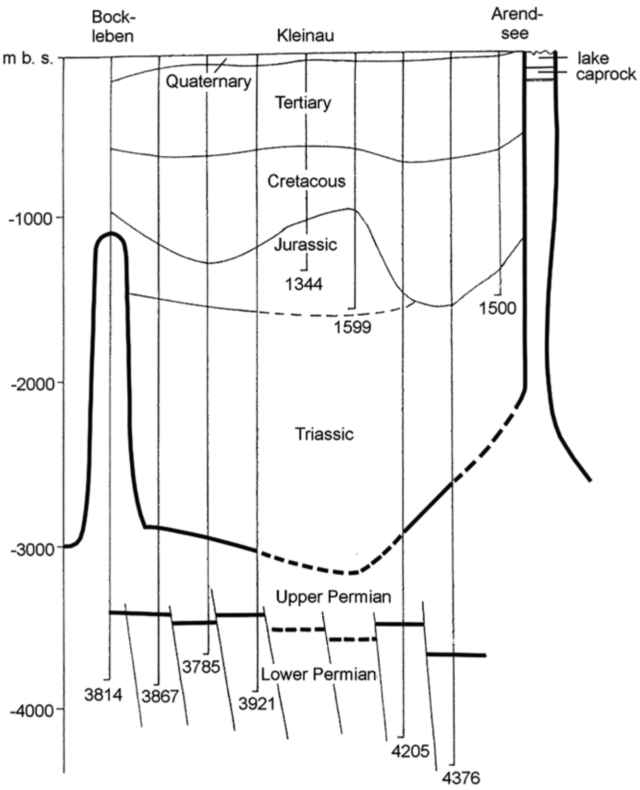

Fig. 1. Position of the salt dome under Lake Arendsee (after Stottmeister 1998, modified). Lower Permian to Quaternary sediments, depths (metres) below surface (mbs), the depths of boreholes between Arendsee and Bockleben SW of Arendsee are presented. The saline (evaporite) deposits of the Upper Permian are marked by a bold line.

valves of *C. torosa* were present in August and October 2014. The number of dead animals shows that there was an important population of this species. Also, none of the accompanying species was found living (Table 2). At sample sites 15–17 only juveniles were found.

Among the accompanying species only the following show an abundance of more than 26 individuals per sample (abundance: IV and V): *Candona neglecta* (localities 10–13, 17), *Cyclocypris ovum* (locality 2), *Cypria ophtalmica* (13), *Heterocypris salina* (21), *Ilyocypris monstrifica* (12), *Physocypria kraepelini* (12), *Plesiocypridopsis newtoni* (1), *Prionocypris zenkeri* (5, 7, 19), *Sarscypridopsis aculeata* (1, 20, 21).

Discussion

Quaternary findings of Cyprideis torosa *in Germany*

Fossil *Cyprideis torosa* have been recorded from 45 inland localities in Germany, 32 of them at a distance of more than 200 km away from the coasts of the Baltic and the North seas. The species occurred especially during interglacial periods, including the Holocene, and can be used as an indicator for palaeosalinity and palaeoclimate (Gramann 2000; Frenzel *et al.* 2012, Pint *et al.* 2012, 2015).

Historical and new findings of living Cyprideis torosa *in Germany*

In the literature there are some records on the occurrence of *Cyprideis torosa* in Germany. Klie (1938) mentions the following findings of *C. torosa*:

(1) Coastal occurrence: Borkum (island within the North Sea), Kolberger Heide (salt marsh at the Baltic Sea near Kiel), Schlei (estuary at the Baltic Sea, 25 km NW of Kiel), Waterneverstorfer See (lake, *c.* 30 km east of Kiel near the Baltic Sea), Bay of Wismar (Baltic Sea), Saaler Bodden (lake connected with the Baltic Sea, near the island Rügen), Greifswald (Baltic Sea), Frisches Haff (lagoon near Baltic Sea, 50 km east of Gdansk, since 1945 in Poland).

(2) Inland occurrences: Mansfeld (with the lake Salziger See (Fig. 2) and lake Süßer See; lake Salziger See was drained in 1892 and *C. torosa* disappeared at this locality), Oldesloe (saline spring, *c.* 20 km west of Lübeck (Klie 1925)), and recorded from the Glockensee, near Bad Laer, *c.* 120 km west of Hannover, Lower Saxony (Gramann 2000). Freshwater lakes mentioned by Klie (1938): Gruber See (lake with a connection to the Baltic Sea, subsequently drained, *c.* 40 km north of Lübeck), Trammer See (periphery of Plön; Trammer See is situated over a salt dome).

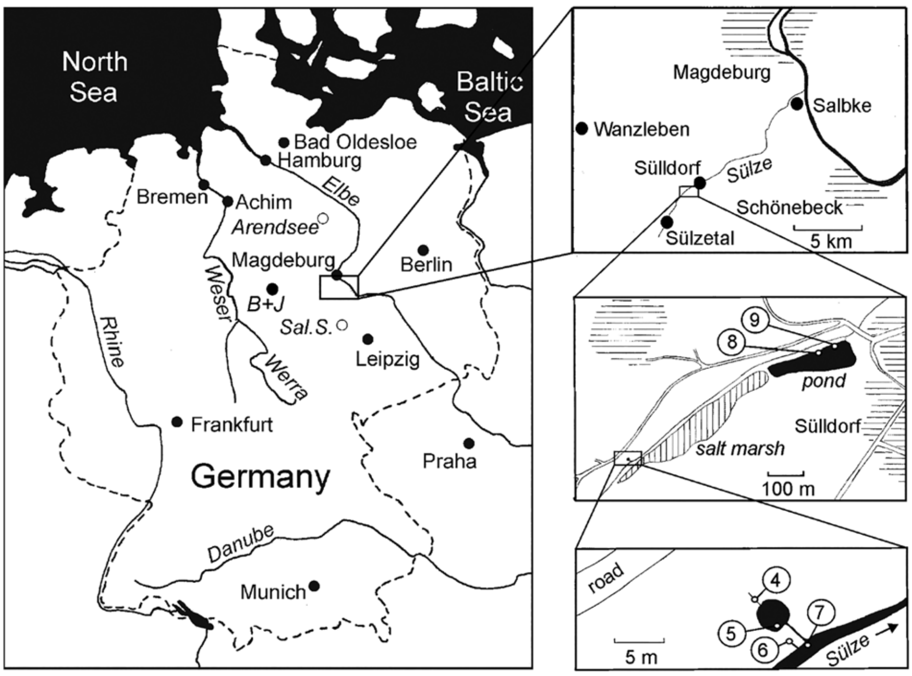

Fig. 2. Location map. *B+J* denotes villages Barnstorf and Jerxheim with salt marshes; *Sal. S* denotes Salziger See; 4–9 are the sample sites in the vicinity of Sülldorf village.

Table 1. *Sample sites*

Site	Water body	Coordinates	Date	Temperature (°C)	Salinity (psu)	Conductivity (µS cm^{-1})	Remarks
1	Pond	53° 38′ 20″ N 06° 52′ 11″ E	1976–87			750–2500 m = 1257 (*n* = 13)	New house pond on the North Sea island Memmert
2	Pond	53° 42′ 51″ N 08° 08′ 47″ E	19 July 1974				House pond on the North Sea island Mellum
3	Harbour	54° 02′ 48″ N 13° 46′ 48″ E	7 September 1995		3.5		Harbour of Wolgast, River Peene
4	Brook	52° 01′ 23″ N 11° 33′ 09″ E	4 October 2014	14	4	3190	Sülldorf: effluent of a spring
5	Pond	52° 01′ 24″ N 11° 33′ 09″ E	25 August 2014			77 400	Sülldorf: limnocrene with a diameter of *c.* 3 m with saline spring.
5			4 October 2014	11	50		
6	Spring	52° 01′ 23″ N 11° 33′ 09″ E	4 October 2014	11	67		Sülldorf: limnocrene with a diameter of 0.3 m
7	Brook	52° 01′ 23″ N 11° 33′ 09″ E	4 October 2014	15	5	3240	Sülldorf: fast-flowing brook Sülze with sand substrate and many submerged macrophytes at the shore
8	Pond	52° 01′ 29″ N 11° 33′ 26″ E	25 August 2014			44 900	Sülldorf: artificial pond near the brook Sülze, thick layer of biogenically precipitated small calcite plates
8			4 October 2014	19	33		
9	Pond	52° 01′ 30″ N 11° 33′ 28″ E	25 August 2014			44 900	Sülldorf: same pond as 8, thick layer of biogenically precipitated small calcite plates
10	Ditch	53° 19′ 35″ N 08° 31′ 24″ E	21 October 2012				Ditch in the floodplain of the River Weser
10			4 August 2013	26		1560	
11	Pit	53° 16′ 00″ N 08° 30′ 48″ E	5 May 2012	13		1046	Loam pit in River Weser flood plain
12	Pit	53° 11′ 22″ N 08° 30′ 59″ E	13 December 2009	5		1277	Loam pit in River Weser floodplain
12			18 April 2010	18		1453	
12			4 September 2010	17		1260	
13	Ditch	53° 11′ 22″ N 08° 30′ 59″ E	13 December 2009	5		1277	Effluent of pit 12
13			4 September 2010	17		1260	
14	Ditch	53° 11′ 25″ N 08° 30′ 52″ E	4 September 2010	19		1073	*c.* 150 m downstream of ditch 13
15	River arm	53° 11′ 03″ N 08° 31′ 46″ E	13 December 2009	7		1205	Arm of the River Weser
16	River	53° 04′ 08″ N 08° 48′ 52″ E	17 October 2010	12		1284	River Weser at Bremen
17	Harbour	52° 59′ 45″ N 09° 03′ 04″ E	7 March 2014	9		1330	Harbour of the River Weser at Achim-Uesen
17			12 July 2014	23		1282	
18	Ditch	52° 06′ 02″ N 10° 48′ 33″ E	18 July 2015	19	2	1634	Barnstorf: effluent of a salt marsh
19	Spring	52° 06′ 01″ N 10° 48′ 34″ E	18 July 2015	12	3	2370	Barnstorf: spring within ditch 18
20	Pond	52° 06′ 01″ N 10° 48′ 47″ E	18 July 2015	24	5	6140	Barnstorf: artificial pond for fishing
21	Pond	52° 04′ 15″ N 10° 55′ 11″ E	18 July 2015	25	8	9100	Jerxheim: artificial pond below the salt marsh ‘Seckertrift’, dug 10 to 15 years ago (C. Evers, Braunschweig, pers. comm.)

Ponds and lakes of central Germany have no evidence for living individuals of *C. torosa*, only empty valves of *C. torosa* are present in waters with higher salinity. Five localities are mentioned by Pint *et al.* (2015): Gründelsloch near Bilzingsleben, the artificial lake of Kelbra, the pond of Stotternheim, Bindersee, and Süßer See.

Cyprideis torosa does not occur in the North Sea (Vesper 1972*a*), but in ditches along the North Sea coast and on islands within the North Sea (Vesper 1972*a*; Hollwedel & Scharf 1988; Scharf & Hollwedel 2010). This species is very frequent in the Sehlendorfer Binnensee near the Baltic Sea ([54° 18′ 25″ N, 10° 40′ 59″ E]; Rosenfeld & Vesper 1977; Rosenfeld 1979) and in the shallow brackish waters (called ‘Bodden’) around the island of Rügen within the Baltic Sea (Schäfer 1953; Frenzel 1991, 1996; Frenzel & Oertel 2002; Frenzel & Viehberg 2004; Frenzel & Boomer 2005; Frenzel *et al.* 2005, 2010; Borck & Frenzel 2006). Many studies on *C. torosa*, especially concerning nodding, were performed in the Schlei estuary, connected to the Baltic Sea (Jaeckel 1962; Vesper 1972*b*; Keyser & Aladin 2004).

Table 2. *Ostracod distribution*

		Cyprideis torosa			
Site	Date	males	females	juveniles	Accompanying ostracods and [reference]
1	19 July 1974	1	5	14	*Heterocypris salina* III, *Plesiocypridopsis newtoni* IV, *Potamocypris unicaudata* II, *Sarscypridopsis aculeata* IV [Hollwedel & Scharf 1988]
2	17 June 1970	(1)			*Candona candida* II, *Cyclocypris ovum* IV, *Eucypris virens* II, *Notodromas monacha* I [Hollwedel & Scharf 1988]
3	7 September 1995	5	15	2	*Candona neglecta* (I), *Darwinula stevensoni* III, *Limnocythere inopinata* I
4	4 October 2014				*Candona neglecta* I, *Ilyocypris bradyi* II, *Prionocypris zenkeri* (I), *Pseudocandona albicans* I
5	25 August 2014				*Candona neglecta* (II), *Cypria ophtalmica* (I), *Eucypris* sp. (I), *Heterocypris salina* (I), *Ilyocypris bradyi* (II), *Prionocypris zenkeri* (V)
5	4 October 2014				*Candona neglecta* (II), *Ilyocypris bradyi* (II), *Prionocypris zenkeri* (V)
6	4 October 2014				*Candona neglecta* (I), *Prionocypris zenkeri* (I)
7	4 October 2014				*Candona candida* I, *C. neglecta* III, *Cypria ophtalmica* I, *Ilyocypris bradyi* II, *Prionocypris zenkeri* V
8	25 August 2014	(19)	(28)	(22)	*Candona neglecta* (I), *Ilyocypris* sp. (I), *Heterocypris salina* (II)
8	4 October 2014	(2)	(7)	(4)	*Candona neglecta* (I), *Heterocypris incongruens* (I), *H. salina* (I), *Ilyocypris bradyi* (II), *Prionocypris zenkeri* (I)
9	25 August 2014	(12)	(12)	(4)	*Heterocypris incongruens* (I), *H. salina* (II), *Ilyocypris* sp. (II)
10	21 October 2012	32	29	74	*Candona neglecta* IV, *Cypria ophtalmica* II, *Darwinula stevensoni* I, *Fabaeformiscandona levanderi* (I), *Ilyocypris* sp. I, *Prionocypris zenkeri* (II)
10	4 August 2013	90	110	250	*Candona neglecta* II, *Cypria ophtalmica* I, *Darwinula stevensoni* II, *Ilyocypris bradyi* I, *I. monstrifica* I
11	5 May 2012		1		*Candona candida* (I), *C. neglecta* IV, *Cypria ophtalmica* III, *Cypridopsis vidua* I, *Cypridopsis.* sp. II, *Eucypris virens* (I), *Fabaeformiscandona levanderi* (I), *Ilyocypris bradyi* (I), *I. monstrifica* (I), *Plesiocypridopsis newtoni* (I), *Potamocypris smaragdina* II, *Sarscypridopsis aculeata* I
12	13 December 2009	28	50	68	*Candona candida* I, *C. neglecta* IV, *Candonocypris novaezelandiae* I, *Cypria ophtalmica* I, *Cypridopsis vidua* II, *Darwinula stevensoni* I, *Herpetocypris reptans* (I), *Ilyocypris decipiens* II, *I. monstrifica* II, *Physocypria kraepelini* IV, *Prionocypris zenkeri* (I), *Stenocypria fischeri* (I)
12	18 April 2010	600	650	1050	*Candona candida* II, *C. neglecta* V, *Cypria ophtalmica* (I), *Cypridopsis vidua* I, *Candonopsis* sp. I, *Darwinula stevensoni* II, *Herpetocypris chevreuxi* (I), *Ilyocypris bradyi* I, *I.* sp. (I), *Isocypris beauchampi* I, *Limnocypthere inopinata* (I), *Physocypria kraepelini* V, *Prionocypris zenkeri* I, *Stenocypria fischeri* (I)
12	4 September 2010	4	10	2	*Candona neglecta* II, *Candonocypris novaezelandiae* (I), *Cypria ophtalmica* III, *Cypridopsis vidua* II, *Herpetocypris reptans* (I), *Ilyocypris bradyi* I, *I. decipiens* I, *I. monstrifica* IV, *Notodromas monacha* (I), *Physocypria kraepelini* I
13	13 December 2009	4	9	17	*Candona neglecta* IV, *Cypria ophtalmica* IV, *Cypridopsis vidua* II, *Herpetocypris chevreuxi* I, *Ilyocypris decipiens* (I), *Isocypris beauchampi* I, *Limnocythere inopinata* (I), *Notodromas monacha* (I), *Physocypria kraepelini* II, *Prionocypris zenkeri* (I)
13	4 September 2010	3	3	2	*Candona neglecta* III, *Cypria ophtalmica* II, *Cypridopsis vidua* (I), *Herpetocypris reptans* (I), *Ilyocypris bradyi* I, *I. decipiens* I, *I. monstrifica* IV, *Limnocythere inopinate* (I), *Physocypria kraepelini* II, *Prionocypris zenkeri* (I)
14	4 September 2010		1		*Candona neglecta* II, *Cypria ophtalmica* I, *C. subsalsa* I, *Cypridopsis vidua* II, *Herpetocypris reptans* I, *Ilyocypris bradyi* (I), *I. monstrifica* I, *Notodromas monacha* (I), *Physocypria kraepelini* I, *Pseudocandona* sp. (I), *Stenocypria fischeri* I
15	13 December 2009			(3)	*Candona neglecta* I, *Cypria ophtalmica* I, *Cypria subsalsa* III, *Cytheromorpha fuscata* (I), *Darwinula stevensoni* I, *Ilyocypris bradyi* I, *Leptocythere ilyophila* II, *Physocypria kraepelini* I, *Pseudocandona* sp. II
16	17 October 2010			(1)	*Cypria subsalsa* III, *Cypridopsis vidua* (I), *Darwinula stevensoni* I, *Limnocythere inopinata* I, *Ilyocypris bradyi* II, *I. decipiens* (II), *Pseudocandona* sp. (I), *Psychrodromus* sp. (I)
17	7 March 2014			12	*Candona candida* (I), *C. neglecta* IV, *Cypria ophtalmica* II; *C. subsalsa* II, *Dawinula stevensoni* II, *Fabaeformiscandona levanderi* II, *Ilyocypris bradyi* (I), *I. monstrifica* (I), *Limnocythere inopinata* (I), *Physocypria kraepelini* (II), *Psychrodromus olivaceus* (I)
17	12 July 2014			12	*Candona neglecta* III, *Cypria ophtalmica* III, *C. subsalsa* II, *Cypridopsis vidua* (1), *Darwinula stevensoni* II, *Limnocythere inopinata* II, *Physocypria kraepelini* (II), *Prionocypris zenkeri* I
18	18 July 2015				*Candona candia* II, *Cypria opthalmica* I, *Ilyocypris inermis* I, *Prionocypris zenkeri* (III)
19	18 July 2015				*Candona candiada* I, *Cypria ophtalmica* I, *Ilyocypris inermis* I, *Potamocypris sp.* (I), *Prionocypris zenkeri* (IV), *Pseudocandona* sp. (II)
20	18 July 2015				*Cyclocypris ovum* IV, *Cypria ophtalmica* I, *Cypridopsis vidua* (I), *Herpetocypris chevreuxi* III, *Notocromas monacha* (I), *Sarscypridopsis aculeata* IV
21	18 July 2015				*Heterocypris salina* IV, *Ilyocypris gibba* II, *Sarscypridopsis aculeata* IV

Same sampling sites as Table 1. Abundance of the accompanying fauna: I = 1–3 individuals per sample; II = 4–10 ind.; III = 11–25 ind.; IV = 26–100 ind.; V = >100 ind.; () denotes only subrecent records.

Fig. 3. Some studied localities: (**a**) aerial view of the saltmarsh of Sülldorf, 4–9 are the sample sites (see Fig. 2); (**b**) sample sites 4–7, in the background the red prostrate glasswort *Salicornia ramosissima*; (**c**) sample site 4; (**d**) pond with sample sites 8 and 9; (**e**) aerial picture of the saltmarsh with sample sites 18–20; (**f**). aerial picture of the salt marsh with sample site 21. (a)–(d) from Google Earth 2015.

Cyprideis torosa is probably transported by ship from the estuary of the River Weser to the harbour on the river at Achim-Uesen (site 17) with its artificially increased salinity from the waste water of the potash factory. The finding of *C. torosa* in lake Gemündener Maar (Scharf 1980) is probably due to a collecting net not thoroughly cleaned (B.S. opinion; the previously collected sample was from a locality in Greece with many specimens of *C. torosa*). The report of *C. torosa* in lake Gemündener Maar due to passive transport by migratory birds and unsuccessful colonization (Scharf 1980) is probably an error.

Biology of Cyprideis torosa

There are two forms of *Cyprideis torosa.* (e.g. Frenzel & Oertel 2002). The valves of the first form show nodes that are absent in the second one. The formation of nodes depends on the salinity of the water (e.g. Vesper 1972*b*; Frenzel & Boomer 2005; Frenzel *et al.* 2012; Pint *et al.* 2012, 2015) and the calcium-ion content of the water (Frenzel *et al.* 2012) results in a failure of osmoregulation (Keyser & Aladin 2004).

Experimental studies by Frenzel *et al.* (2012) have shown that noding occurs below a salinity of 14 psu and, therefore, often occurs in freshwater and brackish habitats. *Cyprideis torosa* occurs above a salinity of 0.5 psu, but also in hypersaline lagoons and lakes. In these environments it often appears monospecifically. The noded form reaches 10% in the salinity range from 2–7 psu and is dominant below 2 psu (Frenzel *et al.* 2012). It is holeuryhaline and polythermophilic (0–26, rarely up to 32°C). The larval development starts above 12°C. One can find the species in very shallow to shallow waters. It is oligorheophilic. It occurs in estuaries, ponds and lagoons and salt marshes. It prefers mud as a sediment substrate and lives endobenthically and epibenthically. It tolerates low oxygen (data from Frenzel *et al.* 2010). *Cyprideis torosa* was found at a pH range between 7.5 and 8.5 on the island Terschelling in The Netherlands (Scharf & Hollwedel 2010). *Cyprideis torosa* is a brackish-water species (Meisch 2000), it does not occur in freshwater or in strictly marine environments, e.g. the North Sea (Vesper 1972*a*; Pint *et al.* 2015).

The species shows a high tolerance to low oxygen and high hydrogen sulphide values in the surrounding water (Gamenick *et al.* 1996; Jahn *et al.* 1996). *Cyprideis torosa* oxidizes sulphide to non-toxic thiosulphate and sulphite and eliminates the oxidation products rather quickly (Jahn *et al.* 1996). Additionally, the species is able to switch over at anaerobiosis (Jahn *et al.* 1996). These characteristics allow *C. torosa* to survive in an environment with often low oxygen content and high hydrogen sulphide concentration, e.g. if the sediment is covered by the macrophyte *Fucus vesiculosus. Cyprideis torosa* appears as the first immigrant in areas that were earlier deoxygenated and with high content of hydrogen sulphide (Gamenick *et al.* 1996).

Remarks on accompanying ostracods in inland saline waters

In the area of Sülldorf, near Magdeburg, there are many small and big saline springs (Table 1, Figs 2 and 3). They have different salinities: in October 2014 the salinity at sample site 4 was 4 psu; at 5 it was 50 psu; at 6, 67 psu; at 7, 5 psu; at 8 and 9, 33 psu. At site 6, no ostracods were present; site 4 is the effluent of a rheocrene with low discharge. Some ostracod species (*Candona neglecta*, *Ilyocypris bradyi*, *Prionocypris zenkeri*, *Pseudocandona albicans*) could be found in the short distance (*c.* 5 m) between the spring and pond 5 (Table 2). These species are known to tolerate waters flowing from springs and to tolerate a slight increase in salinity (Meisch 2000). Site 5 is a pond with a strong underwater spring. One can see the sand moving over this spring. It was surprising to find 20 carapaces and 68 valves of *Prionocypris zenkeri*, all dead, but some with soft parts. This species lives in freshwater and prefers slowly flowing waters (Meisch 2000). Ostracods of flowing waters must move upstream, because the drift transports them downstream. We assume that *P. zenkeri* moves up from the brook Sülze (site 7) into the discharge of pond 5, and that they die eventually when they arrive in the pond, caused by the high salinity in the pond.

The famous saline springs north of the Harz Mountains were also studied: springs near the village of Barnstorf (springs and discharge of a salt marsh; sites 18–20) and pond 21 in the salt marsh 'Seckertrift' near the village of Jerxheim (Janssen 1986; Janssen & Brandes 1989*a*, *b*). There were no living animals nor empty carapaces nor valves of *Cyprideis torosa* in samples 18–21. The salt marshes near Sülldorf (sites 4–9) as well as those of Barnstorf and Jerxheim have existed for a long time. The difference between these salt marshes and those of Sülldorf and the ancient Salziger See is the extent of the stagnant waters. In Barnstorf and Jerxheim only small discharges exist which are overgrown by reeds so that there is no visible water, while in Sülldorf and in the ancient Salziger See large areas of stagnant waters are visible and are visited by migrating birds. This may be an explanation for the lack of *C. torosa* in Barnstorf and Jerxheim; however, the samples contained some interesting co-occurring species with two forms of *Sarscypridopsis aculeata*. In the pond at Jerxheim (21), *S. aculeata* was in the typical form, but in the separate fishery pond at Barnstorf (20), *S. aculeata* was found with a distinct postero-dorsal angle in lateral view (compare Meisch 2000, fig. 163 D) which Hollwedel & Scharf (1988) have found also on some islands in the North Sea. We also have the first records of *Ilyocypris inermis* (sites 18 and 19) and *Prionocypris zenkeri* (sites 4–8, 10, 12, 13, 17–19) in a saline environment.

Conclusion

In Germany *Cyprideis torosa* colonizes mainly the brackish shallow habitats in the Baltic Sea itself or in estuaries near the Baltic Sea, and brackish ditches and ponds near the coast of the Baltic and the North Sea. But this species was also found far from the coast, such as in saline springs at Bad Oldesloe (Klie 1925), lakes Salziger and Süßer See (Klie 1925) (Fig. 2) and Glockensee (Gramann 2000), many sites in central Germany (Pint *et al.* 2015), and a saline pond at Sülldorf (this paper, Fig. 2). It is absent in the small ditches at Sülldorf (this paper), in the salt marshes, small ponds and their drainage ditches at Barnstorf and Jerxheim (this paper) and in the saline ditch at Salzkotten where *Candona* species and *Heterocypris salina* were present [51° 39′ 60″ N, 8° 35′ 56″ E] (Schmidt 1913). It seems that *C. torosa* occurs inland only in saline waters of significant extent which provide resting places for migrating birds. This hypothesis should be examined in future research.

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