Chapter 10
BREMEN: The Paleontological Research Collection of the Geosciences Collection of the University of Bremen

Jens Lehmann

10.1 Introduction

The paleontological collection owned by Germany's smallest federal state Bremen, Germany, underwent a couple of complete relocations and one full rearrangement and a refurbishment of data over the past decades. Originally it was placed in the Übersee-Museum, an internationally highly recognized Natural History and Ethnographic museum in Bremen, integrating topics of nature, culture and distribution across the world in its exhibitions. On the other hand, the history of the Übersee-Museum dates back to the seventeenth century.

In the 1990s a relocation of geoscientific specimens of the same museum to the University of Bremen took place. They were unified as "Geosciences Collection of the University of Bremen". The main part is fossils, but this also included a comprising and scientifically valuable collections of modern gastropods, a fact in particularly the relocation of the latter was highly debated throughout the museums scene in the country. It took a while until the relocation got accepted as positive for the development of the collection, its accessibility and visibility on all fields (Lehmann 2016). Among others convincing arguments are the establishment of new collection rooms including an office and well-equipped laboratory facilities in 2004, when the collection moved into the newly built Marum building on the campus of the University of Bremen. This definitely triggered the evolution of the Geosciences Collection of the University of Bremen to a lively place of research and international academic exchange during the last decades on the field of paleontology. The combination of collection development and research projects is very intensive, particularly excavations in the early Cretaceous of North Germany coined

J. Lehmann
Faculty of Geosciences, University of Bremen, Bremen, Germany
e-mail: jens.lehmann@uni-bremen.de

L. A. Beck, U. Joger (eds.), *Paleontological Collections of Germany, Austria and Switzerland*, Natural History Collections,
https://doi.org/10.1007/978-3-319-77401-5_10

this approach (Lehmann 2012). The latter is resulting in a series of research papers on both, micro- and macropaleontology (Schlak et al. 2016 and references therein) and is described below in Chap. 4. The collection is part of the Faculty of Geosciences, one of Germany's newly-founded universities, established in 1971 and according to an overview on all paleontology collections in Germany it belongs to Germany's mid-size academic collections (Jansen and Steininger 2002). General accounts on the collection are given by Kruckow (1954), Kuster-Wendenburg (1999), Lehmann (2017) and on specific aspects of the paleontological collection Lehmann and Menzel (2005; otoliths), Lehmann (2003a; Berriasian fossils from Obernkirchen).

The modern image of the main room of the collection is dominated by the skeleton of a giant deer and a cast of an iguanodontid dinosaur that were transferred from the former permanent exhibition of the Übersee-Museum in 2014 (Lehmann 2014; Fig. 10.1).

This paper aims to give an overview about the paleontological content to an international community, since the collection comprises scientifically significant material including types. The most valuable scientific assemblages are listed and the key papers are cited. After an historical overview this contribution is presenting essential information, including aspects of collection management and conditions. The focal points are presented and the state of the art of research is given, including

Fig. 10.1 Main hall of the Geosciences Collection of the University of Bremen, with a cast of *Iguanodon bernissartensis* of the type series in the foreground. The compact shelving unit housing the paleontological part of the collection can be seen in the center and left of the background. Photo: V. Diekamp

its potencies. The Geosciences Collection presents some specimens to the public, among others by touring exhibitions. In the final paragraphs of this paper the didactic conceptions are briefly discussed.

10.2 History of the Collection

In the fifteenth to seventeenth century the systematic collection of natural history specimens started, with the founding of rarity and curiosities compilations across Europe, initiated by peers or social societies. The specimens collected during this period later formed the base for newly founded Natural History Museums in the nineteenth century. Particularly in the Hanseatic City of Bremen a long tradition of trading triggered to collect natural history specimens from all over the world, but this is mainly true for the neontological part of the collection focused herein (Lehmann 2016). Nevertheless, systematic collection of fossils started in Bremen around the seventeenth century and this was also the beginning of the collection known as Geosciences Collection today. The historical development of the geoscientific collection was described by Kuster-Wendenburg (1999).

The early development of the natural history collections in general is less relevant for the assemblage of today's paleontological collection, for an outline Lehmann (2017) can be considered. Most of the material acquired after 1820 was presented and thus additions were less systematic, only in few cases individual geological specimens were purchased (Abel 1970). However, even the purchase of a comprising assemblage of fossils from the Triassic of the Alps from Prof. von Klippstein (city of Gießen) around 1850 was rather an exceptional coincidence than a systematic approach of increasing the paleontological collection. In the year 1911an extension of the museum's building made more space available (Abel 1970). Particularly the important malakozoological collections, but also the geological collections including fossils, were processed during the first world war, since the curator responsible at that time (F. Borchering), was too old to join the army (Abel 1970). However, the build-up of exhibits and probably also the processing of raw material were stopped in 1914 by recruiting the preparators to the military service.

After the World War I there was the intention to establish Bremen as "Stadt der Kolonien" (city of colonies; Abel 1970), and the reinforcement of the collections from the former colonies was in the focus during the period around world war II, material has been purchased mainly focusing on Africa (Abel 1970). Consequently, the name "Deutsches Kolonial- und Übersee-Museum" was established in 1935. This period was less important for the paleontological part of the collection. Among the prominent people influencing the build-up of Bremen natural history collections there is Franz Stapelfeldt (born 1877, deceased 1954). During the 1930s until the end of the second world he was a prominent person involved in the special circumstances of the third Reich history of modern Geosciences Collection of the Bremen university, but only few fossils present in the modern collection can be attributed to

his activities according to extensive but unpublished provenance research by Bettina von Briskorn (Übersee-Museum Bremen; see Lehmann 2016).

The Bremen collection did not undergo much damage directly by destruction in World War II, but a significant loss of information has to be stated for parts of the material by various moving during times of war but also before and after.

A turning point and a significant reinforcement of the fossil collection at Bremen was the establishment of a full-time position for geology in 1953 (Abel 1970). Shortly before the museum was renamed to today's designation Übersee-Museum (established in 1951, see Abel 1970). Thorwald Kruckow was hired for this function and his expertise led to a distinguished curation until the end of the year 1981 when he retired, including a sophisticated labeling (Abel 1970; Kuster-Wendenburg 1999). In the 1950s a proper repository was build. From now on curation of paleontological specimens was almost continuous, since Elisabeth Kuster-Wendenburg took over the curatorial care in 1984 (Kuster-Wendenburg 1999). The number of fossils was rising mainly between the 1950s and 1970s. However, after further relocations the storage of the collections became poor again and was in urgent need of improvement.

Kuster-Wendenburg became vice director of the Übersee-Museum, but continuous personal arguments ended up in a relocation of all geoscientific material, including the paleontological specimens, as well as the malakozoological collections to the fairly newly established geosciences department of the University of Bremen (Kuster-Wendenburg 1999). This triggered the development of the collection significantly, new cupboards were purchased, among others with financial support by the ODP project (http://www.iodp.org/about-iodp/history; accessed 5th of January 2017). The collection was housed in the central area of the university first. The early years at the university were dominated by extensive labeling, the compilation of a database and a rearrangement of the collection. Almost no new fossil material was acquired. In the year 1999 E. Kuster-Wendenburg became retired and as new collection manager the present author was hired in 2000 (Willems 2001). Around the turn of the millenium several occasions of flowing water by accident disqualified the first site of housing on the campus. These disasters and no climate control reduced the number of pyritized fossils drastically, particularly the collections from the Lower Cretaceous (upper Valanginian) and Middle Jurassic (Callovian) of North Germany and there was an apparent need for further action. In 2001 a first laboratory for the preparation of fossils was established, including a special binocular microscope sponsored by special grants by the chancellor of the university. Nevertheless, the rooms did not match modern standards of safety and thus not only the collection housing was in need for a further change.

10.3 General Information

10.3.1 Official Label, Conditions and Contact

The Geosciences Collection of the University of Bremen, in German "Geowissenschaftliche Sammlung der Universität Bremen", is an administrative part of the "Fachbereich Geowissenschaften" (Faculty of Geosciences) with an

independent annual budget available for collection affairs. The acronym is GSUB. All fossils are given a large letter (e.g. G = fossil gastropods). The main part of the collection is housed on the ground floor of the Marum building on the campus of the University of Bremen, Leobener Strasse, in 28357 Bremen, Germany. Specimens are housed in a total number of 144 individual units. These are either individual rows of drawers within a coherent cupboard system made of metal or rows in a manual mobile shelving system. The main hall of the collections also includes some workplaces for micropaleontological studies with binocular microscopes (Fig. 10.2).

One chemical laboratory and one workshop for technical preparation and cleaning that are separated from the collection room are exclusively associated to the collection. Additionally, there is an outpost in the "Verfahrenstechnik" building in the central area of the campus. The later is currently housing raw material and rock samples among minor parts of the main collection. Also there are a few large-size specimens, including a cave bear of unknown provenance, mounted in its nineteenth century display case, a bedding plane with an accumulation of *Ceratites* from the Middle Triassic of southern Germany (Schindgasse, Kraichgau, southern Germany, for locality details see Hölder 1960; Mayer 1961, 1967) and some raw material of Middle Jurassic rock slabs from northern France (Landaville) containing accumulations of regular echinoderms (for locality details see Richter 2003).

All enquiries to the collection should be made to PD Dr. Jens Lehmann, Faculty of Geosciences, University of Bremen, Klagenfurter Strasse 4, 28359 Bremen. e-mail: jens.lehmann@uni-bremen.de

Fig. 10.2 Workplaces for micropaleontological studies in the Geosciences Collection. Photo: M. Krogmann

10.3.2 Management Techniques Used

10.3.2.1 Registration

A part of the holdings was registered in a relational database based on Microsoft Access that was adapted to the specific needs (Kuster-Wendenburg 2008). About one third of the paleontological section of the collection has been fully inventorized (missing are vertebrates except for otoliths, crustaceans and fishes); only the recent marine gastropods are fully registered. Paper labels were printed-out directly from this computer program, limited by the fact that not all fields potentially included in the relational database fitted on the print-out and consequently a selection of database fields has been printed for space reasons. Avoiding these limits the registration of new entries to the collection today is realized in a Microsoft word file and the full set of information is printed on one, or in case of too many information, on subsequently numbered labels. All of these entries are continuously amended in Microsoft Access too. The language of registration changed from German to English at the beginning of the year 2005, generally for all specimens of the collection.

10.3.2.2 Techniques of Labeling

In earlier years labeling of specimens was very heterogeneous in general. Since 2010 on-specimen labeling is improved to enhance permanence by first applying a basic coat and secondly, after drying of the first, an India ink is used for the acronym-number labeling and at last a finish is coated, principally following the method described by Davidson et al. (2006). A couple of years before 2010 paper labeling was improved by laminating the hardcopies produced by a laser printer. After a short experimental stage with glossy laminating foils that are disadvantageous with respect to photography works, matt surface laminating foil is used today.

10.3.3 Focal Points

The most important main group of the paleontological compilation is mollusks. This fits well to the focal point of the neontological part of the collection. During the past 15 years the mollusk compilation has been systematically enlarged on the field of ammonites and particularly Cretaceous ammonites—due to the research focus of the head of the current head of the collection. Ammonites of the Cretaceous are particularly interesting because their evolution reveals a broad variety of morphotypes, including a large number of heteromorph ammonites (Lehmann 2015a). The research potential is high by evolutionary relationships still unexplained for many groups and a vague life style, anatomy and generally an uncertain biology (Klug and Lehmann 2015). There is important material housed in the collection that made

significant scientific progress on the fields of anatomy and diet of ammonites (Wippich and Lehmann 2004; Klug et al. 2012; Klug and Lehmann 2015).

The collection comprises ammonite material from all over the world in the systematic part as well as in the collections related to publications (Table 10.1). Nevertheless, there is a focus on some regions, particularly North America, France, North Africa and Germany. In Germany the focus is on Cenomanian-Turonian ammonites from Westphalia and Lower Saxony as well as on those from the Aptian of Westphalia.

Table 10.1 Focal points of the "fossil assemblages related to publications" section of the Geosciences Collection

Field	Country	Main groups of fossils/specifics	Selected publications	Nb. of drawers	Stratigraphy
105	Sinai, Tunisia, Morocco, Jordan	Ammonites, bivalves	Bauer et al. (2001); Heldt et al. (2008, 2010); Lehmann and Herbig (2009); Lehmann et al. (2009); Wendler et al. (2010); Wiese and Schulze (2005); work in progress	1–15	Cretaceous: Aptian, Cenomanian, Turonian
100	England (Isle of Wight)	Ammonites, bivalves/mainly bed-by-bed collecting	Lehmann (2015b): work in progress	1–20	Cretaceous: Aptian
97	Germany (mainly Hohendorf, Mecklenburg and Lengerich, Westphalia)	Ammonites/soft tissues preservation (Lengerich)	Klug et al. (2012); Klug and Lehmann (2015); Lehmann et al. (2008, 2013, 2016a)	1–4	Cretaceous: Albian, Cenomanian/ Turonian
95–96	Germany (Alstätte, Westphalia)	Ammonites, belemnites, bivalves	Lehmann et al. (2012, 2016b); von Bargen and Lehmann (2014)	1–20 and 1–23	Cretaceous: Aptian
94	France (Rosans area)	Ammonites	Work in progress	1–10	Cretaceous: Albian
92	USA (South Dakota)	Ammonites	Work in progress	1–9	Cretaceous: mainly Turonian
91	USA (Texas)	Ammonites, bivalves, gastropods/ mainly bed-by-bed collecting	Reichelt 2005 and work in progress	1–6	Cretaceous: Albian

The column "Selected publications" refers to the particular publications dealing with the material listed

A further special collection is on statoliths—primarily otoliths of fish. This collection has been assembled by the honored amateur enthusiast Herbert Menzel (Litt 2003; Lehmann 2003b, 2010b). A former curator of the collection, T. Kruckow (see paragraph 2), encouraged him to do research on otoliths and he became a recognised specialist and presented his collection to the university in 2002. This collection is mainly including otoliths from Northern Germany, especially from the Oligocene and Miocene, with a significant part originating from the famous former Sunder clay pit in Twistringen, south of Bremen (locality details see e.g. Janssen 1983 and Hagemeister 1988; Menzel 1997). In co-operation with the institute for subsurface research of the state of Lower Saxony Menzel worked on many drilling holes in Lower Saxony. This work was based on fossil material for comparison from other parts of Germany as well as Belgium, Denmark, France, Italy, Austria and the Netherlands. A full summary of this statolith collection, including quite a few figures of specimens, can be found in Lehmann and Menzel (2005).

A minor focus of the collection is amber from different countries, but mainly Baltic amber. The scientifically most interesting inclusion is a fossil tick enclosed in amber (Fig. 10.3). It represents the only known adult tick in Baltic amber and is among the few records of this group of animals of the Paleogene and Cretaceous. It is the type of *Ixodes succineus*, a species described by Weidner (1964). The latter authors assumed a very close relationship to the recent and widely distributed European Castor Bean Tick, *Ixodes ricinus.* However, modern technology of X-ray tomography revealed that the closest living relative of the tick from the Baltic amber is the Asian tick *Ixodes ovatus* (Dunlop et al. 2016) and thus promoted this important find quite recently.

There are a few outstanding single specimens in the collection not embedded in one of the focal points of the collection that are scientifically important. Among these is a jawbone of a hitherto unknown reptile from the Middle Triassic from the famous Rüdersdorf quarry near Berlin that is a good example for the active research

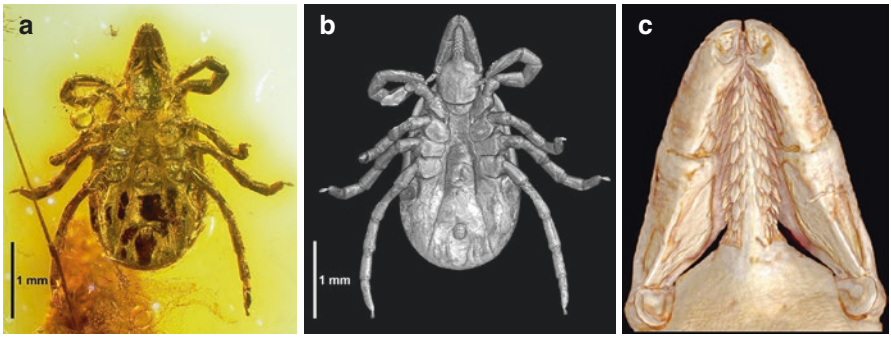

Fig. 10.3 Holotype of the Baltic amber tick *Ixodes succineus* Weidner, 1964; GSUB I21. (**a**) Binocular image, photo J. Dunlop. (**b**) Tomographic rendering. (**c**) Details of gnathosoma, tomographic rendering. Image (**b**) and (**c**) by F. Fusseis, M. Ehlke, S. Zachow, X. Xiao, R. Hoffmann. GSUB is the acronym of Geosciences Collection of the University of Bremen

Fig. 10.4 Hypotypoid of the very rare gar species *Obaichthys decoratus* Wenz and Brito, 1992 from the Santana Formation (Lower Cretaceous) of Brazil; GSUB V2251. (**a**) Specimen as a split fossil, the original condition after cracking the concretion with the fossil. (**b**) Specimen after acid preparation allowing the detailed anatomical studies used for the monograph of Grande (2010). Photos: M. Krogmann

policy of the collection. It was originally referred to as a new species of primitive ichthyosaur, *Omphalosaurus peyeri* by Maisch and Lehmann (2002), but modern X-ray tomography reveals a quite different phylogenetic alignment. This fossil probably belongs to an unknown placodontid (pers. commun. Tanja Wintrich, Bonn, 3rd of February 2015). Another example is a fossil garfish from the Lower Cretaceous of Brazil (Fig. 10.4), first misidentified as *Rhacolepis* sp. (Kuster-Wendenburg 1996), but later recognized as a belonging to *Obaichthys decoratus*, a rare gar species described by Wenz and Brito (1992). This drew the attention of a gar specialist of the Field Museum in Chicago to this fossil that has been borrowed and acid prepared in the United States after the turn of the millennium (Fig. 10.4). Later the fossil was enclosed into a comprehensive monograph about this group, adding some important anatomical details (Grande 2010).

The main hall of the collection is dominated by the cast of a dinosaur skeleton of *Iguanodon bernissartensis* from a skeleton of the collection of the Natural History Museum of Brussels (Fig. 10.1). This cast is widely known since it is used in the German and English version of the online encyclopedia Wikipedia (Lehmann 2014). Although the cast is not very detailed, it perfectly serves to indicate that the Geosciences Collection of the University of Bremen is mainly a paleontology collection and it illustrates the trace-maker of the *Iguanodontipus* ichnosp. Track on display in the same room (Lehmann 2003a). There are also some monetary valuable original specimens in the main hall of the collection on display (Fig. 10.5; Lehmann 2008a, 2014). One is a complete skeleton of a giant deer, *Megaloceros giganteus*, from the late Pleistocene of Ireland - a fossil typical for fossil trading in

Fig. 10.5 Giant deer *Megaloceros giganteus* Blumenbach, 1799, a very valuable fossil of the Geosciences Collection Bremen; late Pleistocene of Ireland, purchased for display in 1894. Photo: M. Krogmann

the nineteenth century (Aughey et al. 2016) and a demanded and pricy exhibit (Monaghan 1997). This specimen was purchased from the former director of the Breslau zoo, Mr. Stechmann, in 1894 (Kruckow 1964; Kruckow 1966b erroneously states 1896). This giant deer was on display in the Übersee-Museum until recently.

A very large rock slab from the Green River Formation (Eocene) of Wyoming, USA is on display at the entrance of the collection (Lehmann 2008a). It bears a palm leaf with a length of 165 cm and two completely preserved large fish (*Mioplosus labracoides,* maximum length 36 cm; *Diplomystus dentatus*, maximum length 50 cm). The specimen was originally purchased in 1993 for the "North America" exhibition of the Übersee-Museum (Lüderwaldt 1993) that was dismounted in 2007.

The largest part of the paleontological collection is arranged systematically in a compact shelving unit composed of nine individual rows. Each row consists of 10 fields, thus the whole shelving unit consists of 110 individual rows. Each row is filled with a maximum of 25 drawers, depending on the size of the specimens. In rows one to seven of the compact shelving unit an individual pragmatic systematic classification based on an arrangement depending on the individual holdings of the Bremen collection is used. The trace fossil collection (field 84–85 of row 7) is not arranged according to the systematic classification of organisms, but in an individual classification scheme for ichnofossils. Furthermore, a couple of topics are arranged separately, not following any systematic approach, namely the amber collection and the collection of curiosities and specific Bremen exhibits.

10.4 Research and Research Potencies

A large part of the collection, currently comprising several thousands of specimens, is summarized under "fossil assemblages related to publications" and is ordered after the individual countries the material originates from. Table 10.1 is summarizing the focal points of this part of the collection.

The research collections comprise type specimens of species critical for the evolution of certain groups of organisms (Fig. 10.6, Lehmann et al. 2017) as well as paleobiologically important finds, like the most spectacular soft tissue preservation found in the Cretaceous of Germany yet (Fig. 10.7, Klug et al. 2012; Klug and Lehmann 2015).

The list of individual compilations given above already illustrates that the research focus of the collection is currently on the Cretaceous and ammonoids. However, in earlier years the former head of the collection, E. Kuster-Wendenburg, worked on Neogene gastropods (e.g. Kuster-Wendenburg 1986) and underwent excavation to obtain material from the famous Miocene localities Miste in the Netherlands and Twistringen near Bremen in Germany (locality details see Chap. 10.3.3). Additionally there is material from the Pliocene of

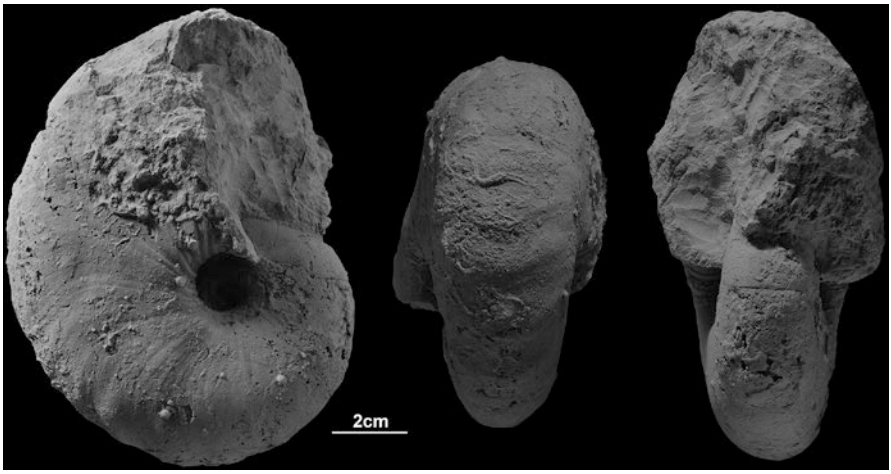

Fig. 10.6 Holotype of the nautiloid *Anglonautilus praeundulatus* Lehmann et al. 2017, the earliest representative of the *Anglonautilus* evolutionary lineage; Lower Cretaceous, Lower Aptian of Spain; GSUB C7505. Photos: M. Krogmann

Italy (Isle of Sicily, Rome area) collected at historical times by Förstner, Kemna and Klipstein (Kuster-Wendenburg 1999) that might have research potential. The same is true for Eocene gastropods and bivalves from classical localities of the Paris basin (Chauvey, Cuise, Damery, Grignon, Lizy, Chaumont) collected by Klipstein and obtained in 1896.

Scientific work in the collection was and is dominated for several years by the "*Alstätte project*." Alstätte is a town near Ahaus in Westphalia, directly on the border with the Netherlands. From August 2009 until June 2012, the collection carried out digging and probation campaigns in a clay pit near Alstätte that is now closed again. Many hundreds of macrofossils and microsamples were collected and documented: Their interpretation is still in progress (Fig. 10.8). Clay stones of the early Cretaceous period were quarried here in the 1960s before the companies were closed down, thus the recent excavation for the covering of a landfill in this period was a great chance. In contrast to earlier investigations at this site an exact documentation of the findings and the section itself has been carried out and therefore it became a scientific success with many unexpected results (see Schlak et al. 2016 and Lehmann et al. 2016b for further references). The project was supported by the local amateur geologist Thomas Hemker, who additionally collected hundreds of fossils bed-by-bed. Furthermore, a series of nine bachelor and master theses resulted from these activities, partly published in peer-review journals already, and one Ph.D. thesis (Schlak et al. 2016; von Bargen 2016; von Bargen et al. 2016). This project was also extensively used for educational work, namely public talks, journal articles (Lehmann 2012) and forthcoming exhibitions as outline in the following paragraph.

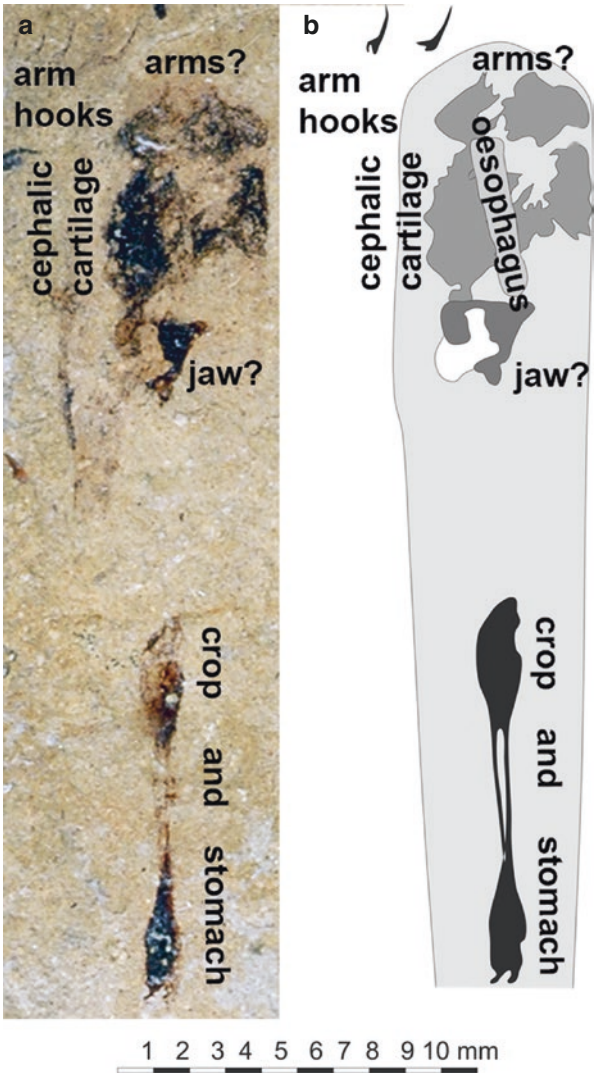

Fig. 10.7 Spectacular soft tissue preservation of a near-complete baculitid ammonite from the Cenomanian/Turonian black shales of North Germany. The specimen is showing remains of digestive tract, probably parts of buccal mass, cephalic cartilage and questionable arm crown; associated pair of coleoid arm hooks; GSUB C5836. Image: C. Klug

10.5 Educational Work

The images of rooms presented here (Figs. 10.1 and 10.5) indicate that the collection has exhibition qualities and owns a few display cases. Nevertheless, the rooms of the Geosciences Collection of the University of Bremen are generally designed as serving for research, thus the concept does not include opening hours for display cases and large fossils presented in the main hall on a regular base. The

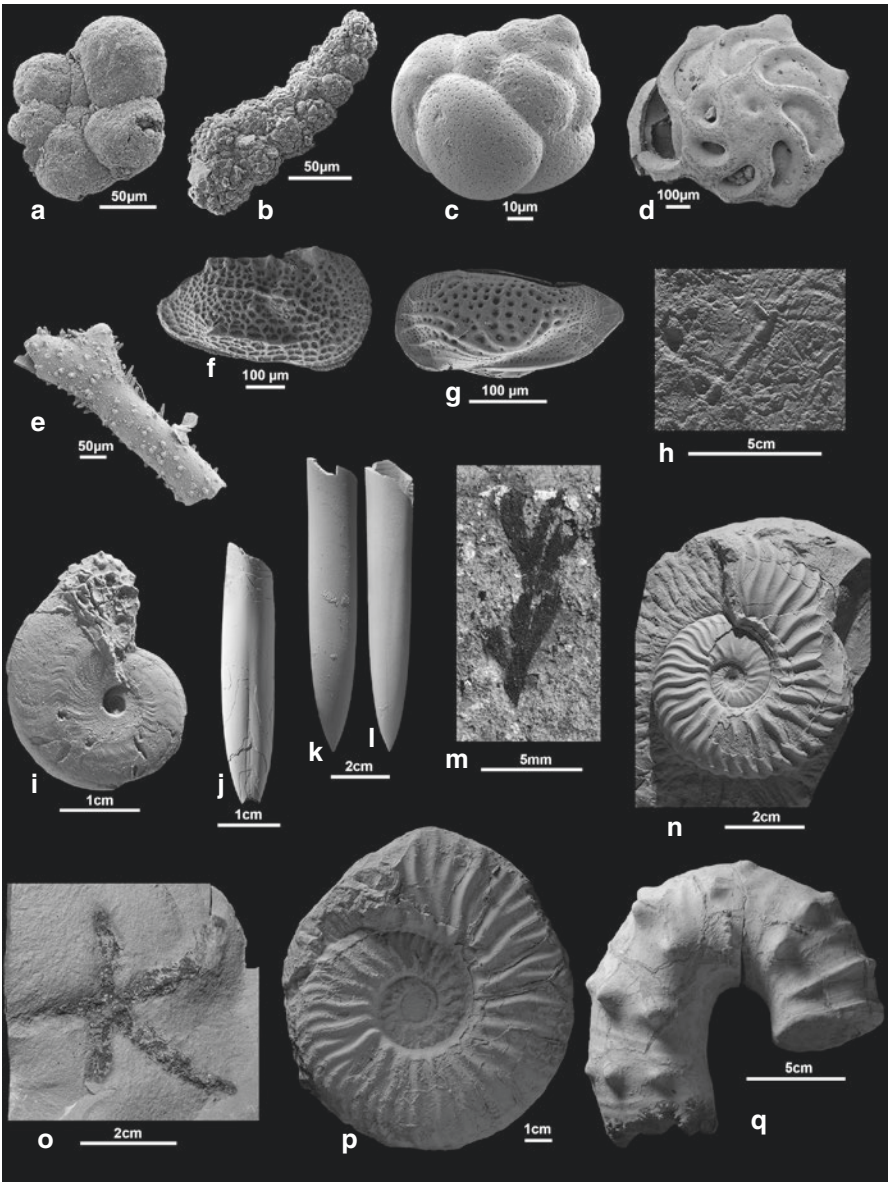

Fig. 10.8 Fossils obtained in the framework of the German Research Foundation (DFG) project of the Geosciences Collection Bremen on the Early Cretaceous (Aptian) of Alstätte, North Germany. (**a**) Benthic foraminifer *Falsogaudryinella* sp., GSUB M50. (**b**) Benthic foraminifer *Reophax* spp., GSUB M56. (**c**) Benthic foraminifer *Gubkinella graysonensis*, GSUB M38. (**d**) Benthic foraminifer *Epistomina ornata*, GSUB M61. (**e**) *Ramulina aculeata*, GSUB M63. (**f**) Ostracod gen. et sp. indet., GSUB M75. (**g**) Ostracod *Paranothacythere paraglobosa*, GSUB M71. (**h**) Trace fossils on a supposed firmground, GSUB I81. (**i**) Ammonite *Aconeceras nisoides,* GSUB C5818. (**j**) Belemnite *Duvalia grasiana,* GSUB C6173. (**k**, **l**) Belemnite *Oxyteuthis depressa*, GSUB C5668. (**m**) Plant fragment, GSUB P1402. (**n**) Ammonite *Deshayesites fissicostatus*, GSUB C5922. (**o**) Starfish, non det., GSUB E3195. (**p**) Ammonite *Deshayesites fissicostatus,* GSUB C5742. (**q**) Heteromorph ammonite, *Audouliceras urbani,* GSUB C5765. Photos: M. Krogmann

existing exhibit is presented for guided tours though, presenting topics like evolution of terrestrial and marine ecosystems. A recently invented booster club plans to expand offers to the public (Lehmann and Liebenberg 2015). Outside the campus some material is permanently on display in the Übersee-Museum. Following the conceptual framework of the museum geoscientific specimens are not concentrated at a certain site, but today are embedded in the individual topics presented by the museum (e.g. parts of the world like Oceania, Africa). This included some unique material occasionally on display, like a specimen of the largest ammonoid species recorded, *Parapuzosia seppenradensis*, from the late Cretaceous (Campanian) of Seppenrade in North Germany (Lehmann and Becker 2002). The latter represents a topotype and is of special interest since the locality is inaccessible today (Kennedy and Kaplan 1995) and has been formerly one of the central specimens in the exhibition "evolution" in the Übersee-Museum (Hohmann and Kuster-Wendenburg 1992).

In the field of public understanding of science material of the Bremen collection is on display in special exhibitions (e.g. Lehmann 2006b, 2017). A distinguished project was the special exhibition in the "Haus der Wissenschaft" (house of science) in Bremen in 2006 about dinosaurs (Lehmann 2006a), as it constitutes the most successful show in this institution yet. The special topic have been the local dinosaur track occurrence in the sandstones of the lowermost Cretaceous at Münchehagen and Obernkirchen in Lower Saxony, Germany, and the involvement of the Geosciences Collection in these findings (Lehmann et al. 2006). The conceptual framework used the local relation of Bremen to the quarrying of these sandstones centuries ago and the wide usage of this material in the Bremen city center (Kuster-Wendenburg 1999, 2002; Lehmann 2010a) to attract the audience. A comprising exhibition catalogue has been produced, documenting this event permanently (Lehmann 2006b).

The Geosciences Collection is also intensively cooperating with the Center of Marine Environmental Sciences at the University of Bremen (Marum) and this incorporates special exhibitions at exceptional places. An example is the "Geoschiff" (geoship) project realized in the "Year of Geosciences" in Germany in 2002. This was a 105 m long inland water vessel altered to contain a 600 square meter exhibition "Abenteuer Meeresforschung" (adventure marine science), visited by117,000 visitors in 62 cities across Germany during a period of almost 6 month (details see Lehmann 2016).

Another distinguished cooperation is "MeerErleben" ("Experience Ocean")—a traveling exhibition initialized by the Marum at the University of Bremen and financed by a shopping center project management company currently managing 199 centers in a total number of 14 countries (Fig. 10.9; Gerdes and Pätzold 2012, Lehmann 2017). These shopping centers attract around 4.6 million visitors, ideal places to predestine people over visual and acoustic stimuli for topics beyond consumption. Although the cooperation with the shopping centers came to an end this high quality exhibition is still occasionally on display, e.g. currently at the Deutsches Museum in Bonn in cooperation with the German Research Foundation (DFG; see Lehmann 2017). It should be mentioned that this cooperation of science with free economy has been also sponsoring the acquisition of new specimens as well as research activities.

Fig. 10.9 A display board showing the evolution of huge Cretaceous ammonites featured in the public exhibit "Experience the sea" (German title "MeerErleben") on display in a shopping mall in Germany in 2016. Photo: J. Lehmann

The striking feature of exhibits drafted by the Geosciences Collection is the combination of paleontological and biological specimens, covering the key topics evolution, biodiversity and constructional morphology. Examples are the display "Evolution" during the geoship tour (Krogmann and Lehmann 2002) and that on diversity and evolution in the currently running presentation "Experience Ocean" (Lehmann 2017). In this general conception spectacular specimens, like giant ammonites (Fig. 10.9), are embedded in "display landscapes", behind their natural occurrences. In the case figured the evolutionary sequence species from the Lower Cretaceous is arranged on the background of a cliff wall in southern England, showing individual beds. Captions to individual specimens are preferably very short, inconspicuously embedded and refer to daily subjects everybody is familiar with, a concept that is owed to the fact that some exhibits attract visitors at places untypical for displays. In other words people are getting involved that are usually not systematically visiting museums or public displays. These ideas are strongly influenced by the Tübingen paleontology school of the twentieth century (e.g. Seilacher and

Gishlick 2014). These didactical conceptions are also used for illustrating aspects of constructional morphology of organisms, including its analogies with daily life.

Regularly public talks are offered for a broad audience, including a series of lectures organized ten times a year by the Geosciences Collection and that is announced in the local press and on various websites. These talks often focus on research topics of the collection, but guest lecturers are also invited on a regular base.

Almost all of the outstanding single fossils of the collection and some of the focal points have been subject in popular books and public understanding of science journal articles. The popularization of paleontology is a declared aim of the collection and of the associated booster club. The following table (Table 10.2) lists the most prominent individual fossils:

Table 10.2 Examples of popularizing science in the Geosciences Collection and promotion of individual fossils in journals and books

Identification	Description of specimen (inventory number)	Popular references
Diplomystus dentatus (Cope 1877) *Mioplosus labracoides* (Cope 1877) *Sabalites* sp.	Large slab from the Eocene Green River Formation (GSUB V2431, V2432, P1288)	Lehmann (2008b)
Goniopholis simus (Owen 1878)	Crocodile skull from the earliest Cretaceous of North Germany, discovered in the debris of a natural building stone; building destroyed during world war II in the city of Bremen (GSUB V2297)	Kruckow (1966a); Kuster-Wendenburg (1999); Polenz and Spaeth (2004); Lehmann (2005, 2006b)
Iguanodontipus ichnosp.	Dinosaur trackway (large slab on display in collection; GSUB I1)	Lehmann (2006b); Polenz and Spaeth (2004)
Ixodes succineus (Weidner 1964)	Tick preserved in Baltic amber, holotype (GSUB I21)	Weitschat (2004); Wichard and Weitschat (2004); Lehmann (2007)
Obaichthys decoratus (Wenz and Brito 1992)	Lower Cretaceous gar fish (very rare) from the Santana Formation of Brazil (GSUB V2251)	Becker (2012); Lehmann (2013)
Pleurosternon bullockii (Owen 1842)*	Very well preserved imprint of a carapace of a very large turtle from the earliest Cretaceous of North Germany (GSUB V1434)	Lehmann (2006b)
indet.	Bird bones from the Miocene of North Germany, very rare (GSUB V2481)	Lehmann (2011)
Various species	Statolith collection of H. Menzel (various GSUB numbers)	Lehmann (2010c)

The column "Selected publications" refers to the particular publications dealing with the material listed. Asterisk: following the revision by Karl et al. (2007) of this specimen that is a historical original to Ludwig (1879) who referred to it as *Plesiochelys menki*

Acknowledgments I am thankful to Martin Krogmann (Bremen) for technical assistance. Volker Diekamp (Bremen) and Jason Dunlop (Berlin) are thanked for taking pictures used herein. Christian Klug (Zürich) provided the graphic of soft-tissue preservation in ammonites. Bettina von Briskorn (Bremen) gave valuable information about the history of collection material during world war II. I thank the German Research Foundation (DFG) particularly for funding the project "Palaeobiology, morphology and diversity of macrofaunas: A case study on Early Cretaceous ammonites", LE 1241/2-1 and for supporting the special exhibition "MeerErleben". I also thank the ECE Projektmanagement G.m.b.H. & Co. KG for an extensive cooperation in the "MeerErleben" project as well as for sponsoring. I am grateful to U. Joger (Braunschweig) who kindly reviewed this manuscript.

References

Abel H (1970) Vom Raritätenkabinett zum Bremer Überseemuseum. Die Geschichte einer hanseatischen Sammlung aus Übersee anläßlich ihres 75jährigen Bestehens. Röver, Bremen, p 352

Aughey K, Carden RF, Habermann S (2016) The conservation of a 19th century giant deer display skeleton for public exhibition. Geological Curator 10:221–232

Bauer J, Marzouk AM, Steuber T, Kuss J (2001) Lithostratigraphy and biostratigraphy of the Cenomanian-Santonian strata of Sinai, Egypt. Cretac Res 22:497–526

Becker PR (2012) Eine kurze Geschichte von Fischen und Menschen. In: Becker PR, Beichle U (eds) Katalog zur Sonderausstellung "Mensch, Fisch!", vom 10. November 2012 nis zum 07. April 2013. Schriftenreihe des Landesmuseums Natur und Mensch. Isensee, Oldenburg, p 9–18

Blumenbach JF (1799) Handbuch der Naturgeschichte. Johann Christian Dieterich, Göttingen, p 697

Cope ED (1877) A contribution to the knowledge of the ichthyological fauna of the Green River shales. Bulletin of the United States Geological and Geographical Survey 3:807–819

Davidson A, Alderson S, Fox M (2006) Assembling an archival marking kit for paleontological specimens. In: Society of Vertebrate Paleontology, Abstracts Poster Presentations 66th Annual Society of Vertebrate Paleontology Meeting, Oct 2006, Ottawa, Canada. Society of Vertebrate Paleontology, Ottawa, p 1–6

Dunlop JA, Apanaskevich DA, Lehmann J, Hoffmann R, Fusseis F, Ehlke M, Zachow S, Xiao X (2016) Microtomography of the Baltic amber tick *Ixodes succineus* reveals affinities with the modern Asian disease vector *Ixodes ovatus*. BMC Evol Biol 16:1–8

Gerdes A, Pätzold M (2012) Wie das Meer an Land kommuniziert wird. Zielgruppenorientierte Öffentlichkeitsarbeit am MARUM. In: Dernbach B, Kleinert C, Münder H (eds) Handbuch Wissenschaftskommunikation. VS Verlag für Sozialwissenschaften, Berlin, pp 127–132

Grande L (2010) An empirical synthetic pattern study of gars (Lepisosteiformes) and closely related species, based mostly on skeletal anatomy: the resurrection of Holostei. In: American Society of Ichthyologists and Herpetologists, p i–x + 871

Hagemeister D (1988) Die Tongrube Twistringen. In: Weidert W-K (ed) Klassische Fundstellen der Paläontologie - Band I. Klassische Fundstellen der Paläontologie. Goldschneck-Verlag, Korb, p 162–169

Heldt M, Bachmann M, Lehmann J (2008) Microfacies, biostratigraphy, and geochemistry of the hemipelagic Barremian–Aptian in north-central Tunisia: Influence of the OAE 1a on the southern Tethys margin. Palaeogeogr Palaeoclimatol Palaeoecol 261:246–260

Heldt M, Lehmann J, Bachmann M, Negra MEH, Kuss J (2010) Increased terrigenous influx but no drowning: palaeoenvironmental evolution of the Tunisian carbonate platform margin during the Late Aptian. Sedimentology 57:1–25

Hohmann H, Kuster-Wendenburg E (1992) Die neue Dauerausstellung >>Evolution<< im Übersee-Museum Bremen. Mitteilungsblatt des Museumsverbandes für Niedersachsen und Bremen 43:39–46

Hölder H (1960) Alter Meeresboden im Museum. Aus der Heimat 68:131–139

Jansen U, Steininger FF (2002) Die paläontologischen Sammlungen in Deutschland. Inhalte, Erfassung und Gefährdung. In: E Schweizerbart'sche Verlagsbuchhandlung, Stuttgart, p 101

Janssen AW (1983) An account of the Cancellariidae (Gastropoda) of Winterswijk-Miste (Miocene, Hemmoorian), The Netherlands. Scr Geol 68:1–39

Karl H-V, Staesche U, Tichy G, Lehmann J, Peitz S (2007) Systematik der Schildkröten (Anapsida: Chelonii) aus Oberjura und Unterkreide von Nordwestdeutschland. Geol Jahrb 98:5–89
Kennedy WJ, Kaplan U (eds) (1995) *Parapuzosia (Parapuzosia) seppenradensis* (Landois) und die Ammonitenfauna der Dülmener Schichten, unteres Unter-Campan. Westfalen, Münster
Klug C, Lehmann J (2015) Soft part anatomy of ammonoids: reconstructing the animal based on exceptionally preserved specimens and actualistic comparisons. In: Klug C, Korn D, De Baets K, Kruta I, Mapes RH (eds) Ammonoid Paleobiology: from anatomy to ecology. Topics in Geobiology. Springer, Dordrecht, pp 507–529
Klug C, Riegraf W, Lehmann J (2012) Soft–part preservation in heteromorph ammonites from the Cenomanian–Turonian Boundary Event (OAE 2) in north–west Germany. Palaeontology 55:1307-1331
Krogmann M, Lehmann J (2002) Evolution. In: Bremen U (ed) Das Geoschiff: Abenteuer Meeresforschung, 11. April (Potsdam) bis 6. Oktober (Würzburg), Bremen, p 2–7
Kruckow T (1954) Notizen zur Geschichte der mineralogisch-petrographischen und geologisch-paläontologischen Sammlungen des Übersee-Museums in Bremen. Abhandlungen herausgegeben vom Naturwissenschaftlichen Verein zu Bremen 33:481–489
Kruckow T (1964) 100 Jahre Naturwissenschaftlicher Verein zu Bremen. In: 100 Jahre Naturwissenschaftlicher Verein zu Bremen, Bremen, p 11–47
Kruckow T (1966a) Das Krokodil der Nordkredit. Flyer of an exhibition in the “Nordkredit”. Norddeutsche Kreditbank, Bremen, p 4
Kruckow T (1966b) Über vorzeitliche Riesenhirsche im Wesergebiet bei Bremen. Die Weser 40:194–196
Kuster-Wendenburg E (1986) Pyramidellidae (Gastropoda, Mollusca) aus dem Miozän des nordwestdeutschen Tertiärs. Beiträge zur regionalen Geologie der Erde, Berlin–Stuttgart, p 370–411
Kuster-Wendenburg E (1996) Die geowissenschaftlichen Sammlungen. Fachbereich 5 Universität Bremen. Universität Bremen, Bremen, p 49
Kuster-Wendenburg E (1999) Der Bremer Stein und die Dinosaurier. Die Geschichte einer Sammlung. Aschenbeck & Holstein, Bremen, p 95
Kuster-Wendenburg E (2002) Der Bremer Stein und die Weserrenaissance. In: Wefer G (ed) Universität Bremen, Bremen, p 36
Kuster-Wendenburg E (2008) Die rezenten Gastropoden in der Geowissenschaftlichen Sammlung der Universität Bremen. Abhandlungen herausgegeben vom Naturwissenschaftlichen Verein zu Bremen 46:143–272
Lehmann J (2003a) Dinosaurierfährten aus dem Obernkirchen Sandstein (Unterkreide, Berriasium) in der Geowissenschaftlichen Sammlung der Universität Bremen. Abhandlungen herausgegeben vom Naturwissenschaftlichen Verein zu Bremen 45:473–486
Lehmann J (2003b) Verleihung der Karl-Alfred von Zittel-Medaille der Paläontologischen Gesellschaft 2003 an Herbert Menzel. GMit. Geowissenschaftliche Mitteilungen 14:90–92
Lehmann J (2005) Das Krokodil der Nordkredit. Fossilien 22:247–251
Lehmann J (2006a) Dinosaurier—Spuren einer vergangenen Welt. GMit. Geowissenschaftliche Mitteilungen 26:74–75
Lehmann J (2006b) Dinosaurier—Spuren einer vergangenen Welt. Münchehagen, der Bremer Stein und die Saurierfährten. Haus der Wissenschaft 3, Bremen, p 91
Lehmann J (2007) Fossile Zecke im baltischen Bernstein. Fossilien 24:226–228
Lehmann J (2008a) Eine *Diplomystus-Sabalites*-Assoziation aus der Green River Formation von Nordamerika (Osteichthyes,Angiospermae, Paläogen). Abhandlungen herausgegeben vom Naturwissenschaftlichen Verein zu Bremen 46:273–277
Lehmann J (2008b) Fundort und Fundschicht unbekannt. Der Paläontologe als Kriminalist Fossilien 25:344–346
Lehmann J (2010a) Der Bremer Stein und die Dinosaurier: Ein Baustein erzählt Geschichten. In: Santos M, Wefer G (eds) 100 x Wissen um 11. Haus der Wissenschaft, Bremen, p 60
Lehmann J (2010b) Geologie und Paläontologie des nordwestdeutschen Raumes—die Beiträge von Herbert Menzel. Abhandlungen herausgegeben vom Naturwissenschaftlichen Verein zu Bremen 46:393–396
Lehmann J (2010c) Statolithen—kleine Fossilien ganz groß. Fossilien 27:359–366
Lehmann J (2011) Vogelknochen aus dem Miozän von Niedersachsen. Fossilien 28:359–366

Lehmann J (2012) Fossilien aus dem norddeutschen Aptium—Grabungen in Alstätte. Fossilien 29:336–344
Lehmann J (2013) Ein toller Hecht! Fossilien 30:121–124
Lehmann J (2014) Wikipedia-*Iguanodon* und -Riesenhirsch nun in der Geowissenschaftlichen Sammlung der Universität Bremen. GMit. Geowissenschaftliche Mitteilungen 58:84–85
Lehmann J (2015a) Ammonite biostratigraphy of the Cretaceous—an overview. In: Klug C, Korn D, De Baets K, Kruta I, Mapes RH (eds) Ammonoid paleobiology: from macroevolution to paleogeography. Topics in Geobiology. Springer, Dordrecht, p 403–429
Lehmann J (2015b) The Ammonoidea of the Lower Greensand—a revision of the British ammonite fauna (including a comparison with continental faunas). Newsletter of the Palaeontographical Society London: 4–5
Lehmann J (2016) Geosciences collection of the University of Bremen: the recent mollusk compilation. In: Beck LA (ed) Zoological collections of Germany—the animal kingdom in its amazing plenty at museums and universities. Springer, Berlin
Lehmann J (2017) "MeerErleben"—Ein Ausflug in die fossile Geschichte und Gegenwart der Meere. Fossilien 34:9–12
Lehmann J, Becker PR (2002) Riesenammonit—vom lebenden Tier zum Fossil. In: Wefer G (ed) Geologischer Streifzug durch Bremer Museen. Bremer Geo-Touren. Universität Bremen, Bremen, p 47
Lehmann J, Friedrich O, Von Bargen D, Hemker T (2012) Early Aptian bay deposits at the southern margin of the Lower Saxony Basin: integrated stratigraphy, palaeoenvironment and OAE 1a. Acta Geol Pol 62:35–62
Lehmann J, Heldt M, Bachmann M, Negra MEH (2009) Aptian (Lower Cretaceous) biostratigraphy and cephalopods from north Central Tunisia. Cretac Res 30:895–910
Lehmann J, Herbig H-G (2009) Late Cretaceous ammonites from the Bou Angueur syncline (Middle Atlas, Morocco)—stratigraphic and palaeobiogeographic importance. Palaeontographica 289:45–87
Lehmann J, Hoffmann R, Owen HG, Beckert W (2016a) Cephalopoden aus unterkreidezeitlichen Geschieben der Region um Wolgast-Hohendorf, Vorpommern. Archiv für Geschiebekunde 7:401–530
Lehmann J, Krogmann M, Richter U, Broschinski A (2006) Neue Dinosaurierfährten vom Rang eines Naturdenkmals in den Sandsteinen der Bückeberg Formation (Unterkreide, Berriasium) von Münchehagen (Niedersachsen). Abhandlungen herausgegeben vom Naturwissenschaftlichen Verein zu Bremen 46:27–38
Lehmann J, Liebenberg W (2015) Neuer Förderverein der Geowissenschaftlichen Sammlung der Universität Bremen. GMit. Geowissenschaftliche Mitteilungen 59:75–76
Lehmann J, Maisch MW, Baudouin C, Salfinger-Maisch A (2017) Origin and evolutionary history of *Anglonautilus* (Nautilida, Cymatoceratidae) and a new species from the lower Aptian of Spain. Cretac Res 72:66–80
Lehmann J, Menzel H (2005) Die Otolithen der Geowissenschaftlichen Sammlung der Universität Bremen—Provenienzen und Katalog der Originale. Abhandlungen herausgegeben vom Naturwissenschaftlichen Verein zu Bremen 45:657–678
Lehmann J, Owen HG, Beckert W (2013) A new ammonite fauna from NE-Germany—evidence for an Early Albian cooling and the initial transgression in the Danish-Polish Trough. Neues Jahrb Geol Palaontol Abh 268:199–235
Lehmann J, Tröger K-A, Owen HG (2008) Ammonites and associated macrofauna from the early Late Albian of the Zippelsförde 1/64 core, NE-Germany. Acta Geol Pol 58:437–453
Lehmann J, Von Bargen D, Engelke J, Claßen J (2016b) Morphological variability in response to palaeoenvironmental change—a case study on Cretaceous ammonites. Lethaia 49:73–86
Litt T (2003) Protokoll der ordentlichen Mitgliederversammlung am 1. Oktober 2003 in Mainz. GMit. Geowissenschaftliche Mitteilungen 14:83–86
Lüderwaldt A (1993) 1992/1993—Das Übersee-Museum und die Erweiterung seiner Bestände—Ankäufe, Spenden, Geschenke und Leihgaben. TenDenZen 93:127–130
Ludwig H (1879) Plesiochelys Menki (Emys Menkei Fr. Ad. Römer). Ein Beitrag zur Kenntniss der Schildkröten der Wealdenformation. Palaeontographica 26:2–12

Maisch MW, Lehmann J (2002) A new basal omphalosaurid from the Middle Triassic of Germany. Neues Jb Geol Paläontol Monat 2002:513–525
Mayer G (1961) Weitere Grabungsbeobachtungen im mittleren Hauptmuschelkalk von Bruchsal. Der Aufschluss 12:62–70
Mayer G (1967) Muschelkalkaufschlüsse im südlichen Kraichgau. VIII. Bruchsal. Der Aufschluss 12:332–344
Menzel H (1997) Die Ziegeleitongrube Sunder in Twistringen-Typuslokalität miozäner Fossilien. Der. Aufschluss 48:154–160
Monaghan NT (1997) From grave to cradle, the changing fortunes of the giant Irish deer. In: Nudds JR, Pettitt CW (eds) The value and valuation of natural sciences collections. Geological Society, London, Special Publications. Geological Society, London, p 144–148
Owen RC (1842) Report on British fossil reptiles, part II. Report of the British Association for the Advancement of Science 11:60–204
Owen RC (1878) Monograph on the fossil reptilia of the Wealden and Purbeck formations. Supplement VII. Crocodilia (*Goniopholis, Pterosuchus*, and *Suchosaurus*). Palaeontographical Society Monographs 1878:1–15
Polenz H, Spaeth C (2004) Saurier, Ammoniten, Riesenfarne. Deutschland in der Kreidezeit. In:Konrad Theiss, Stuttgart, p 159
Reichelt K (2005) Late Aptian-Albian of the Vocontian Basin (SE-France) and Albian of NE-Texas: Biostratigraphic and paleoceanographic implications by planktic foraminifera faunas. Eberhard-Karls-Universität Tübingen, Tübingen, p 119
Richter AE (2003) Richters Sammeltipp. Seeigelparadies Landaville in NE-Frankeich. Fossilien 20:334–341
Schlak S, Von Bargen D, Lehmann J (2016) Paleoecological and paleoenvironmental implications of planktonic foraminifera from a restricted basin deposit of the Early Aptian of North Germany. In: Khosla A, Lucas SG (eds) Cretaceous period: biotic diversity and biogeography. New Mexico Museum of Natural History and Science Bulletin. New Mexico Museum of Natural History, Albuquerque, p 287–298
Seilacher A, Gishlick AD (2014) Morphodynamics. CRC Press, Boca Raton, London & New York, p 551
Von Bargen D (2016) Organismic response to habitat change in the Early Cretaceous (Aptian) of the Boreal epicontinental sea. University of Bremen, Bremen, p 190
Von Bargen D, Lehmann J (2014) Benthic ecosystem response to the deposition of lower Aptian black shales in an epicontinental sea. Cretac Res 51:208–224
Von Bargen D, Lehmann J, Unverfärth J (2016) Ostracod response to habitat change in an early Aptian shelf sea. Palaeogeogr Palaeoclimatol Palaeoecol 459:518–536
Weidner H (1964) Eine Zecke, *Ixodes succineus* sp. n., im baltischen Bernstein. Veröffentlichungen aus dem Übersee-Museum in Bremen 3:143–151
Weitschat W (2004) Zecken im Bernsteinwald—wahre Raritäten. ImpfDialog 4:11–12
Wendler JE, Lehmann J, Kuss J (2010) Orbital time scale, intra-platform basin correlation, carbon isotope stratigraphy and sea-level history of the Cenomanian-Turonian Eastern Levant platform, Jordan. In: Homberg C, Bachmann M (eds) Evolution of the Levant Margin and Western Arabia Platform since the Mesozoic. Geological Society, London, Special Publications. p 171–186
Wenz S, Brito PM (1992) Première découverte de Lepisosteidae (Pisces, Actinopterygii) dans le Crétacé Inférieur de la Chapada do Araripe (N-E du Brésil): consequences sur la phylogenie des Gynglymodi. Comptes Rendus de l'Academie des Sciences 314:1519–1525
Wichard W, Weitschat W (2004) Im Bernsteinwald. Gebrüder Gerstenberg, Hildesheim, p 168
Wiese F, Schulze F (2005) The upper Cenomanian (Cretaceous) ammonite *Neolobites vibrayeanus* (d'Orbigny, 1841) in the Middle East: taxonomic and palaeoecologic remarks. Cretac Res 26:930–946
Willems H (2001) Neuer Leiter der Geowissenschaftlichen Sammlung an der Universität Bremen. GMit. Geowissenschaftliche Mitteilungen 4:102
Wippich MGE, Lehmann J (2004) *Allocrioceras* from the Cenomanian (mid-Cretaceous) of the Lebanon and its bearing on the palaeobiological interpretation of heteromorphic ammonites. Palaeontology 47:1093–1107