The cephalopods in the paleontological collection Georg Gasser (1857–1931)

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ABSTRACT

In Gasser's paleozoological collection, cephalopods account for 12 % of all specimens. Ammonoidea, Coleoidea, Orthoceratoidea, Nautiloidea and Bactritoidea are the groups represented. Ammonoidea are best documented, with a good variety of genera and species. A preliminary revision was carried out by a former volunteer at the museum (Helmuth Buratti) some ten years ago. Unfortunately, about 40 % of the specimens lack information related to their geographic origin. The largest portion of the cephalopod collection comes from Central Europe with the main areas of origin being Germany and the territories of the former Austro-Hungarian Empire. Historical Fossil-Lagerstätten and famous fossiliferous lithostratigraphic groups like the Muschelkalk and Solnhofen Plattenkalks of the German regions of Baden-Württemberg and Bavaria, are well represented by ammonoids, nautiloids and coleoids. The oldest specimens date back to the Silurian and Devonian and come from the German regions of Sauerland (North-Rhine Westphalia) and Hesse, as well as from Poland or from the classic "Barrandian" area in the Czech Republic. The youngest specimen is from the Early Oligocene at Itzehoe (northern Germany). Interestingly, ammonoids from Northern Italy, and especially Trentino-South Tyrol, are relatively rare in the collection. They seem to be linked rather to chance findings by local collectors or Georg Gasser himself, than to a systematic collecting activity. The area is represented, e.g., by some Triassic ammonoids from the St. Cassian Formation (Dolomites; Bozen/Bolzano Province).

KEY WORDS

ammonoids, nautiloids, St. Cassian Formation, Dolomites.

1. INTRODUCTION

Georg Gasser (1857–1931) compiled one of the most extensive collections of natural objects (minerals, fossils and zoological specimens) in Tyrol. His mineralogical collection is well-known whereas his paleontological collection has not been available to the general public since the closure of his exhibition in 1931. What survives of his paleontological collection (about 3,500 specimens) is today stored in the Museum of Nature South Tyrol (NMS) in Bozen/Bolzano. The overarching number of fossils (92 %) belongs to all major animal groups excluding microfossils. Only approximately 8 % are plant fossils. The biggest part of the invertebrate collection is assigned to molluscs, ammonoids are the third best represented group by number of specimens. Unfortunately, several relocations during the life and after the death of the collector, have affected the preservation of the fossils and the presence and quality of the labels.

The aim of this paper is to give an overview of the cephalopods of the collection and to identify the distinctive characters of the collection in a historical context trying to understand the stratigraphic and geographical distribution of the fossils also from a geopolitical perspective. This is particularly interesting since cephalopods and especially ammonoids are in general the most intensively sampled fossils by local collectors since they are very characteristic in their structure and relatively easy to find, also in the Dolomites where several formations are rich in ammonoids. Thus, the collection has also a high potential to give insights in the scientific memory of the local and foreign collecting areas during the 19th and 20th centuries. Some of the areas sampled during those times may not be available anymore due to constructions and/or changes in the natural or human-based landscape.

2. MATERIALS AND METHODS

In the last two years, a project funded by the Museum of Nature South Tyrol (see Kustatscher et al., this volume) has been carried out to quantify the heritage of the paleontological collection compiled by Georg Gasser (1857–1931). The goal was to conserve and enhance the collection and to return it to the community, as was Gasser's original idea. This was carried out by studying the historical documents left by the collector and his heirs (Wagensommer, this volume a, b; Wagensommer et al., this volume a, b) and by cleaning, inventorying and, when possible, reviewing the paleontological collection (Kustatscher et al., this volume; Tomelleri et al., this volume a, b; Baucon et al., this volume). Each specimen has been assigned a number

FIG. 1: Glass plate from the Georg Gasser Collection with multiple specimens of *Amaltheus* spp., scale bar = 1 cm.

in the catalogue of the Museum of Nature South Tyrol (NMS acronym) within the catalogue of Paleozoology (PZO); the specimens are stored in the paleozoological collection of the Museum of Nature South Tyrol.

Unfortunately, the complicated pandemic situation linked to Covid-19, together with missing labels and information on their provenience, made a detailed systematic revision difficult. For this reason, the overview given here includes both historical names of Georg Gasser and modern revisions. In order to distinguish between reviewed and not-reviewed specimens, an asterisk is indicated to express the names reported by Gasser.

An additional element present among the ammonoid collection is the exhibition purpose, adopted frequently by Gasser, to collect and glue various specimens on a glass plate. This type of exhibition bears an intrinsic historical value, as it shows how Georg Gasser tried to express, through an association of specimens, similarities within the same taxonomic group or differences between distinct taxonomic groups. Some examples are the plates that collect different species of ammonites of the genus *Amaltheus* (Fig. 1). This treatment of specimens is, however, a hinderance during a taxonomic revision since the specimen treated in this way cannot be studied from all sides, and diagnostic characters may be hidden.

3. THE CEPHALOPODS IN THE COLLECTION – AN OVERVIEW

What remains of the cephalopod collection of Georg Gasser is composed of 399 specimens (see also Wagensommer et al., this volume a, b), which represent 12 % of the entire paleozoological collection. The major groups, such as ammonoids, bactritoids, coleoids, nautiloids, and orthoceroids are represented, in different percentage ratios, preserved as molds, impressions or recrystallized shells.

The oldest finds of this group in the collection are orthoceroids from the Silurian of Böhmen (German for "Bohemia", today mainly Czech Republic), the youngest finds are nautiloids from the Oligocene (Rupelian) of Itzehoe (Germany). The Mesozoic is the best-documented time interval with several taxa from the Triassic St. Cassian Formation (latest Ladinian–early Carnian) and the Jurassic of the Swabian Jura, in Baden-Württemberg, now an UNESCO Global Geopark. Some of the best-represented German localities are those of Balingen, Solnhofen and Nusplingen. Famous fossil sites from Austria are also present within the collection. Early Jurassic specimens from Breitenberg (Upper Austria) and Kammerköhr (Tyrol) are accompanied by rare specimens from the Late Triassic of the famous Feuerkogel (Styria).

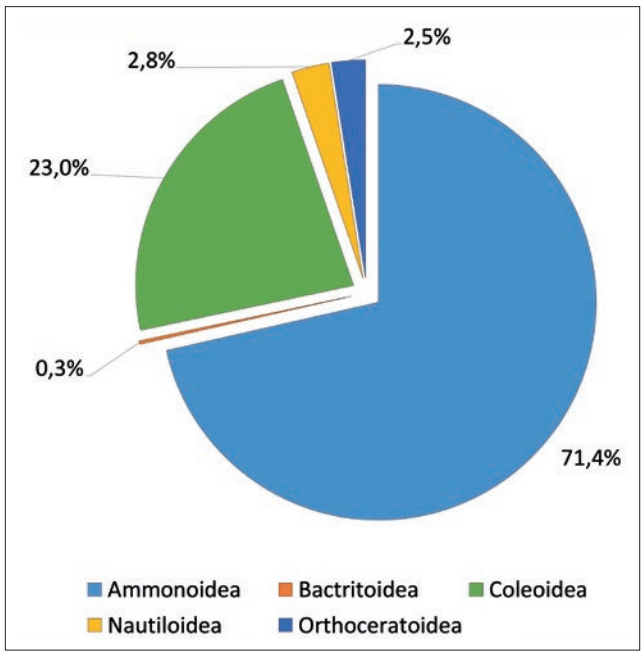

FIG. 2. Main cephalopods groups in the Georg Gasser Collection and their relative abundance.

4. THE COMPOSITION OF THE COLLECTION

The major groups identified in the collection and their relative abundance are illustrated in Fig. 2.

4.1 AMMONOIDEA

This is the most successful group among the cephalopods with more than 8,000 species described. They appeared during the Devonian and vanished at the Cretaceous-Paleogene extinction event. The name "ammonite" was inspired by the spiral shape of the shells, which resemble tightly coiled rams horns. They were already mentioned by Plinius Secundus (d. 79 AD near Pompeii), who called fossils of these animals *ammonis cornua* ("horns of Ammon") because the Egyptian god Ammon (Amun) was typically depicted wearing rams horns (MURPHY, 2004). This is also the best-documented group in the cephalopod section of the Gasser collection, including 285 specimens. The most common genera in the collection are, in alphabetic order: *Amaltheus*, *Amauroceras*, *Arietites*, *Ataxioceras*, *Celtites*, *Ceratites*, *Cladiscites*, *Dactylioceras*, *Discosphinctoides*, *Echioceras*, *Gymnites*, *Harpoceras*, *Klipsteinia*, *Laevaptychus*, *Lecanites*, *Leioceras*, *Leptosphinctes*, *Lytoceras*, *Macrocephalites*, *Macrophylloceras*, *Nannites* (Fig. 4C), *Orthosphinctes*, *Orthosphinctes*, *Paracoroniceras*, *Perisphinctes*, *Phylloceras*, *Pleuroceras*, *Reineckeia*, *Schlotheimia*, *Taramelliceras*, and *Trachyceras*.

4.2 BACTRITOIDEA

This group includes more or less straight-shelled (orthoconic) cephalopods that first appeared during the Emsian (Devonian) and persisted until the Carnian Pluvial Episode in the upper

FIG. 3: Examples of ammonoids in the Georg Gasser Collection. Scale bars = 1 cm. **A.** *Clymenia undulata*, Weilburg (Germany), PZO 12519; **B.** *Joannites cymbiformis*, Bad Aussee (Austria), PZO 12916; **C.** *Leioceras opalinum*, Mössingen (Germany), PZO 12514; **D.** *Ammonites bucklandi**, Stuttgart-Vaihingen (Germany), PZO 12995; **E.** *Harpoceras falciferum*, Bad Boll (Germany), PZO 12240; **F.** cf. *Kepplerites* sp., Balingen (Germany), PZO 12505.

middle Carnian (Late Triassic). They are considered ancestors of the ammonoids, as well as of the coleoids. Only one specimen, *Bactrites gracilis* (Fig. 6F) from the Devonian of Beul near Eisborn (Germany), is present in the collection.

4.3 COLEOIDEA

The coleoids are the first of only two subclasses of the cephalopods that have extant representatives. Today's living coleoids include squids, cuttlefish and octopus, the major extinct group is that of the belemnites. Coleoids differ significantly from all other cephalopods by the fact that they lack external shells. Many taxa, in fact, do not have shells at all; the shells of those that do, are completely internalized. The collection of Georg Gasser includes 94 specimens belonging to this group, although with a limited variety of genera (*Atractites*, *Aulacoceras*, *Belemnitella*, *Hibolithes*, *Megateuthis*, *Passaloteuthis*, *Salpingoteuthis*, Fig. 5B).

FIG. 4: Examples of ammonoids in the Georg Gasser Collection. Scale bars = 1 cm.
A. A sample of Triassic ammonites from the St. Cassian Formation (*Trachyceras basileus*, *Celtites buchii*, *Klipsteinia boetus*, *Arpadites ruppeli*), St. Kassian/San Cassiano (Italy), PZO 13002-13005;
B. *Passendorferia birmensdorfense*, Trento (Italy), PZO 12303; **C.** *Arinoceras* sp., Breitenberg (Austria), PZO 12323; **D.** *Taramelliceras costatum*, Balingen (Germany), PZO 12920;
E. *Laevaptychus* sp., Solnhofen (Germany), PZO 12490.

FIG. 5: Examples of coleoids in the Georg Gasser Collection. Scale bars = 1 cm.
A. *Passaloteuthis paxillosus*, Baden-Württemberg (Germany), PZO 12516-12518;
B. *Salpingoteuthis acuaria ventricosa*, unknown locality, PZO 12936; **C.** *Belemnitella mucronata*, Rügen (Germany), PZO 12925; **D.** *Megateuthis giganteus*, Bopfingen (Germany), PZO 12524;
E. *Hibolithes semihastatus*, "Prague" (?northern Bohemia), PZO 12954.

4.4 NAUTILOIDEA

The nautiloids are the second of only two subclasses of the cephalopods that have extant representatives. Today there are only six living species belonging to two extant genera *Nautilus* and *Allonautilus.* The oldest representatives come from shallow marine environments of the late Cambrian in China; they reached their heyday during the Ordovician to Devonian. From the Devonian onwards they began to decline due to the competition with the ammonoids. In the collection this subclass is not well represented, including only 11 specimens belonging to the genera *Cenoceras*, *Cimomia*, *Endoceras*, *Germanonautilus*, *Koenenia*, *Paracymatoceras*, *Protophragmoceras* and *Trochoceras*.

4.5 ORTHOCEROIDEA

Orthoceratoidea is a subclass of the nautiloid cephalopods characterized by orthoconic (straight) to slightly cyrtoconic (curved) shells, and central to subcentral, calciosiphonate connecting rings with a porous and calcitic inner layer (Kröger & Evans, 2011; King & Evans, 2019). This group is represented in the Gasser collection by 8 specimens including the genera *Michelinoceras, Orthoceras, Plagiostomoceras* and *Virgoceras*.

5. CHRONOSTRATIGRAPHIC DISTRIBUTION OF THE SPECIMENS

The cephalopods in the collection of Georg Gasser do not continuously document the entire chronostratigraphic scale. The findings are concentrated on particular geological intervals, evidencing the fact that the collection is not constructed in a

FIG. 6: Examples of nautiloids, bactritoids and orthoceratoids in the Georg Gasser Collection. Scale bars = 1 cm. **A.** *Plagiostomoceras* sp., "Böhmen" (Czech Republic), PZO 12934; **B.** *Michelinoceras michelini*, "Böhmen" (Czech Republic), PZO 12889; **C.** *Cenoceras striatum* Balingen (Germany), PZO 12315; **D.** *Endoceras annulatum*, Kosoř (Czech Republic), PZO 12320; **E.** *Protophragmoceras* sp., Prague (Czech Republic), PZO 12487 and *Trochoceras secula*, "Böhmen", PZO 12488; **F.** *Bactrites gracilis*, Beul near Eisborn (Germany), PZO 12890.

rigorous way to represent the cephalopod evolution through time and/or all the iconic taxa of the different time periods (Figs. 7, 8, 9). The oldest fossils in the collection are some Paleozoic cephalopods, such as six orthoceratoids and three nautiloids, from the Silurian of Bohemia (today Czech Republic and Poland). One specimen each of *Clymenia undulata* (Fig. 3A) and *Bactrites gracilis* (Fig. 6F) are reported from the Devonian of Nassau, a historical region of Germany. The Ordovician, Carboniferous and Permian, on the other hand, are not represented in the collection.

The Mesozoic is the best documented era with 383 specimens. The Triassic is particularly well represented (38 specimens) by ammonoids of the St. Cassian Formation, latest Ladinian–early Carnian in age. This lithostratigraphic unit yielded a selection of ammonites showing the diversity in forms and taxa, including *Arpadites ruppeli* (Fig. 4A), *Badiotites eryx*, *Cladiscites ungeri*, *Klipsteinia boetus* (Fig. 4A), *Nannites spurius*, *Trachyceras aon*, *Trachyceras basileus* (Fig. 4A), and *Lecanites glaucus*. More Triassic cephalopods come from the Middle Triassic Muschelkalk of Eisenach in Germany (*Ceratites* sp.) and the Upper Triassic "Hallstätterkalk" of Bad Aussee in Austria (*Joannites cymbiformis*, Fig. 3B).

The Jurassic is the best represented geological period with 213 specimens. The ammonites of the region Baden-Württemberg are dominant, with a good variety of genera (24) and species (25); especially well-represented is the area of Balingen. Most aptychi remains (*Laevaptychus* sp., *Lamellaptychus* sp.) come from the Upper Jurassic plattenkalks of Solnhofen and Nusplingen. *Also Megateuthis giganteus* (Fig. 5D), *Passaloteuthis paxillosus* (Fig. 5A) and *Salpingoteuthis*, as examples of Coleoidea, come from Baden-Württemberg. The only specimen of *Hibolithes semihastatus* derives from the Prague Basin (Fig. 5E). Few

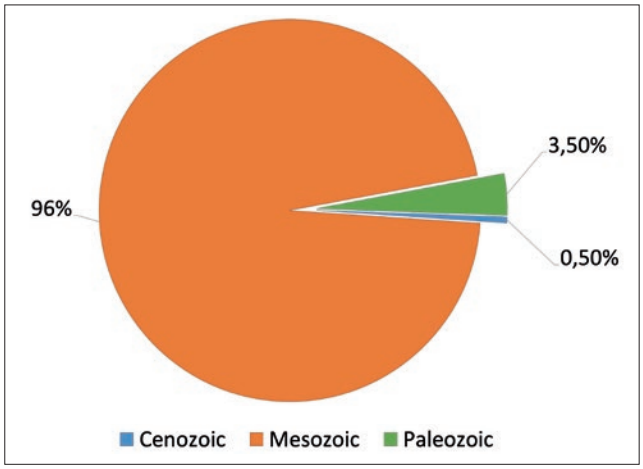

FIG. 7: Distribution of the specimens by age.

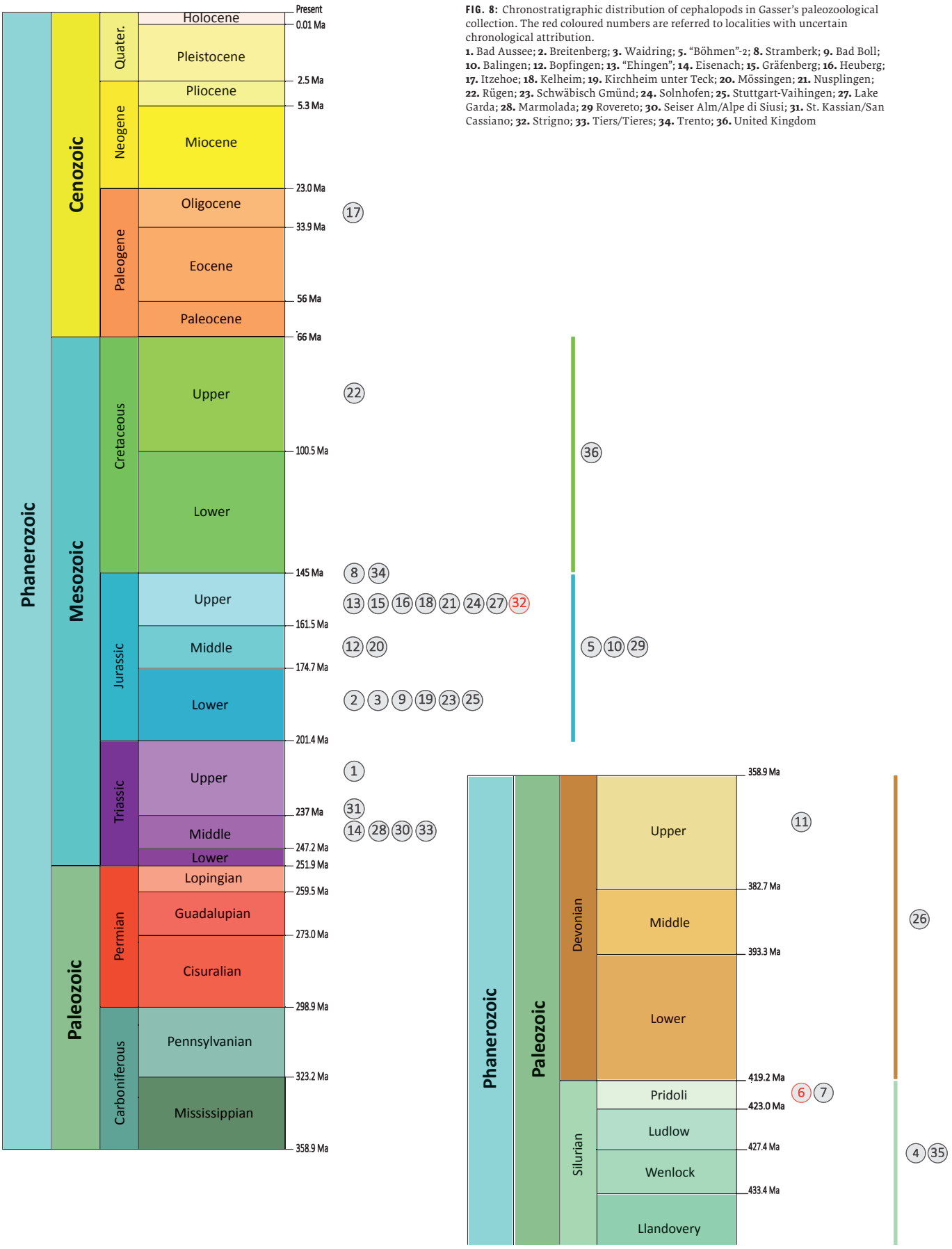

FIG. 8: Chronostratigraphic distribution of cephalopods in Gasser's paleozoological collection. The red coloured numbers are referred to localities with uncertain chronological attribution.
1. Bad Aussee; **2.** Breitenberg; **3.** Waidring; **5.** "Böhmen"-2; **8.** Stramberk; **9.** Bad Boll; **10.** Balingen; **12.** Bopfingen; **13.** "Ehingen"; **14.** Eisenach; **15.** Gräfenberg; **16.** Heuberg; **17.** Itzehoe; **18.** Kelheim; **19.** Kirchheim unter Teck; **20.** Mössingen; **21.** Nusplingen; **22.** Rügen; **23.** Schwäbisch Gmünd; **24.** Solnhofen; **25.** Stuttgart-Vaihingen; **27.** Lake Garda; **28.** Marmolada; **29** Rovereto; **30.** Seiser Alm/Alpe di Siusi; **31.** St. Kassian/San Cassiano; **32.** Strigno; **33.** Tiers/Tieres; **34.** Trento; **36.** United Kingdom

FIG. 9: Chronostratigraphic distribution of cephalopods in Gasser's paleozoological collection. The red coloured numbers are referred to localities with uncertain chronological attribution.
4. "Böhmen"-1; **6.** Kosor; **7.** Prague; **11.** Beul, Eisborn; **26.** Weilburg; **35.** Głogów.

specimens come from the Jurassic of Italy such as for example *Discosphinctoides geron*, *Passendorferia birmensdorfense* (Fig. 4B) (Trento), *Macrophylloceras ptychostoma*, *Ptychophylloceras ptychoicum* (Rovereto), *Phylloceras* sp. (Lake Garda).
Interesting from an historical point of view, Gasser used on his labels the historical German terminology to subdivide the Jurassic: "Schwarzer Jura", "Brauner Jura" and "Weisser Jura" ("black", "brown" and "white"; respectively Early, Middle and Late Jurassic). The terms are derived from the local lithology and appearance of the strata in outcrop, as typical in southern Germany, and refer to the predominant colour of the sediments. As Germany has a long tradition in private fossil collecting, an extensive non-professional literature on fossils exists; in such amateur publications the terms "black", "brown" and "white" Jurassic are still in use today (e.g., Richter, 2000).
Most Cretaceous cephalopods (17 specimens in total) come from the Isle of Rügen (Germany), such as *Belemnitella mucronata* (Fig. 5C), whereas one sample comes from England (*Douvilleiceras monile*). Additional specimens come from Italy (Trento Province).
Cenozoic specimens are extremely rare (2) with only one example with certain provenance: a nautiloid from the Oligocene (Rupelian) of Itzehoe.

6. GEOGRAPHIC DISTRIBUTION OF THE SPECIMENS

The collection is a geographical representation of some of the most important and/or open digging areas with cephalopod remains during the lifetime of Georg Gasser (1857–1931). His preferential communication route with territories under the control of either the Austro-Hungarian or the German Empire (see Wagensommer et al., this volume a, b) is well visible in the collection. For this reason, German localities predominate, with some examples referring to other areas, under the same sphere of geopolitical influence (Czech Republic, Austria, Poland). Only a small part of the collection comes from local successions, with finds from the surroundings of Bolzano and the nearby sites of the Dolomites (Figs. 10, 11, 12).
An overview of the localities of provenance of the specimens is presented here, based on the information provided by the associated labels, integrated, where it was possible, by literature. The presentation is sorted by state and, if appropriate, the historical name as used on Gasser's labels is reported in brackets after the current name of the locality. Unfortunately, due to the loss of tags, 42 % specimens lack a specific source area. In other cases (18 %) the geographic indication is too generic, and it was not possible to narrow down its geographic position (i.e., Bohemia, Baden-Württemberg, Dolomites, Lake Garda, North America). Here we discuss some of the fossiliferous localities that are mentioned in the collection. In the list also those referred to generic geographical areas are cited, reporting the specimens attributed.

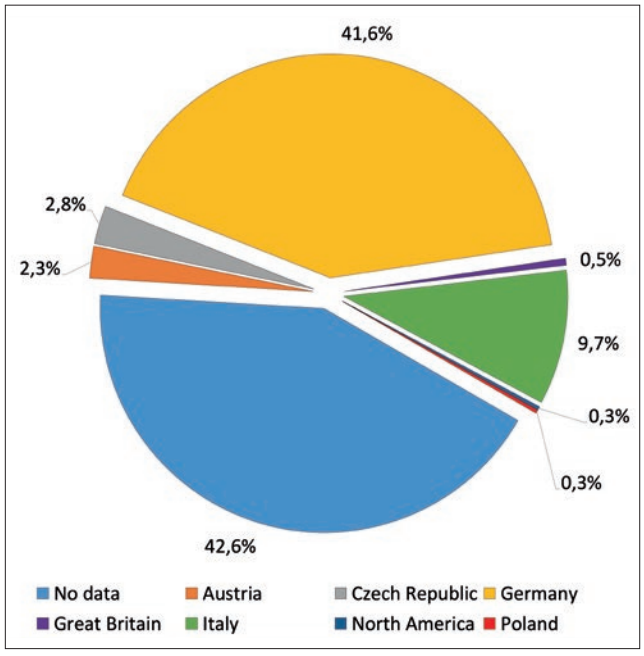

FIG. 10: Distribution of the specimens by country.

6.1 AUSTRIA

Bad Aussee (Styria)
Age: Carnian (Late Triassic)
Specimen from red condensed limestones of the Hallstätter Kalk Formation (see Piller et al., 2004) in the Northern Calcareous Alps, most probably from the famous historical locality Feuerkogel (Mojsisovics, 1882, 1893). The Feuerkogel plateau is one of the best-known localities worldwide for Upper Triassic ammonoids and object of attention by many collectors during Gassers lifetime (Diener, 1921).
Collection Georg Gasser: *Joannites cymbiformis* (PZO 12916, Fig. 3B)

Breitenberg (Salzkammergut, Upper Austria)
Age: Hettangian-Sinemurian (Early Jurassic)
Red condensed, micritic limestones of the Kendlbach Formation (Breitenberg Subformation) of Early Jurassic age crop out in the well-known fossiliferous site of Breitenberg close to St. Wolfgang (Neumayr, 1879). There existed an old quarry, now abandoned (Suess & Mojsisovics, 1868; Blind, 1963; Meister & Böhm, 1993). Ammonites are most abundant in the "Osterhornscholle" Unit which is part of the Tyrolic Nappe system, accompanied by brachiopods, bivalves and gastropods (Blind, 1963; Meister & Böhm, 1993).
Collection Georg Gasser: *Arinoceras* sp. (PZO 12323, Fig. 4C)
Remarks: There is an additional questionable specimen of *Paracoroniceras* sp. (PZO 12343) in the collection assigned just to Salzburg without any further details. It is not excluded that it comes from the same locality, though other localities like the region of Adnet are also plausible.

Waidring in Tyrol
Age: Hettangian-Sinemurian (Early Jurassic)
Near Waidring in Tyrol several sections of the Kammerköhralm area crop out. On top of the Triassic Steinplatte shallow water reef limestones in northern Tyrol follows a red condensed, biomicritic limestone of Early Jurassic age (Vortisch, 1926; Rakus & Lobitzer, 1993). The area is well-known for its fossil rich layers with abundant ammonoids in the Adnet Formation type facies.
Collection Georg Gasser: 6 specimens, *Nevadaphyllites* sp. (PZO 12917, 12949), *Atractites* sp. (PZO 12348, 13058), *Analytoceras* sp. (PZO 12950, 12347)

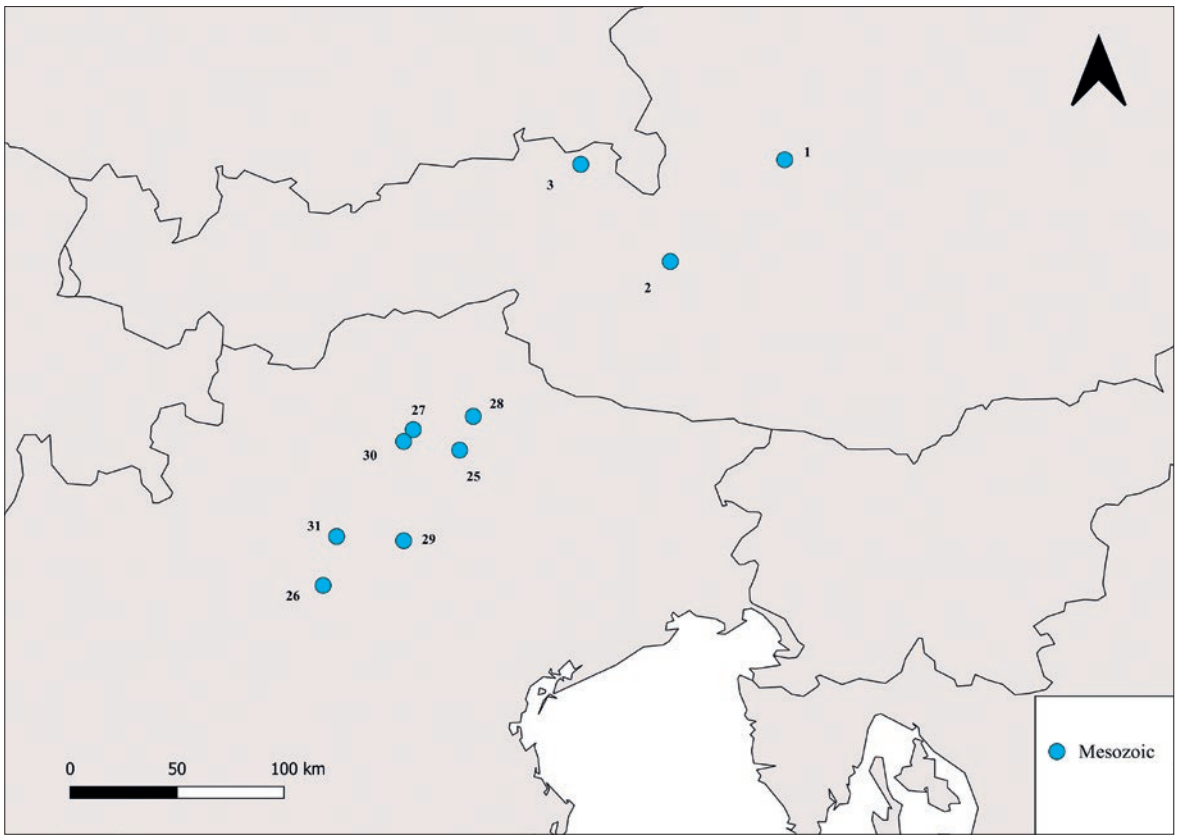

FIG. 11: Map of the eastern Alpine region, with localities from which come the cephalopods in the Georg Gasser collection. **1.** Bad Aussee; **2.** Breitenberg; **3.** Waidring; **25.** Marmolada; **26.** Rovereto; **27.** Seiser Alm/Alpe di Siusi; **28.** St. Kassian/San Cassiano; **29.** Strigno; **30.** Tiers/Tieres; **31.** Trento.

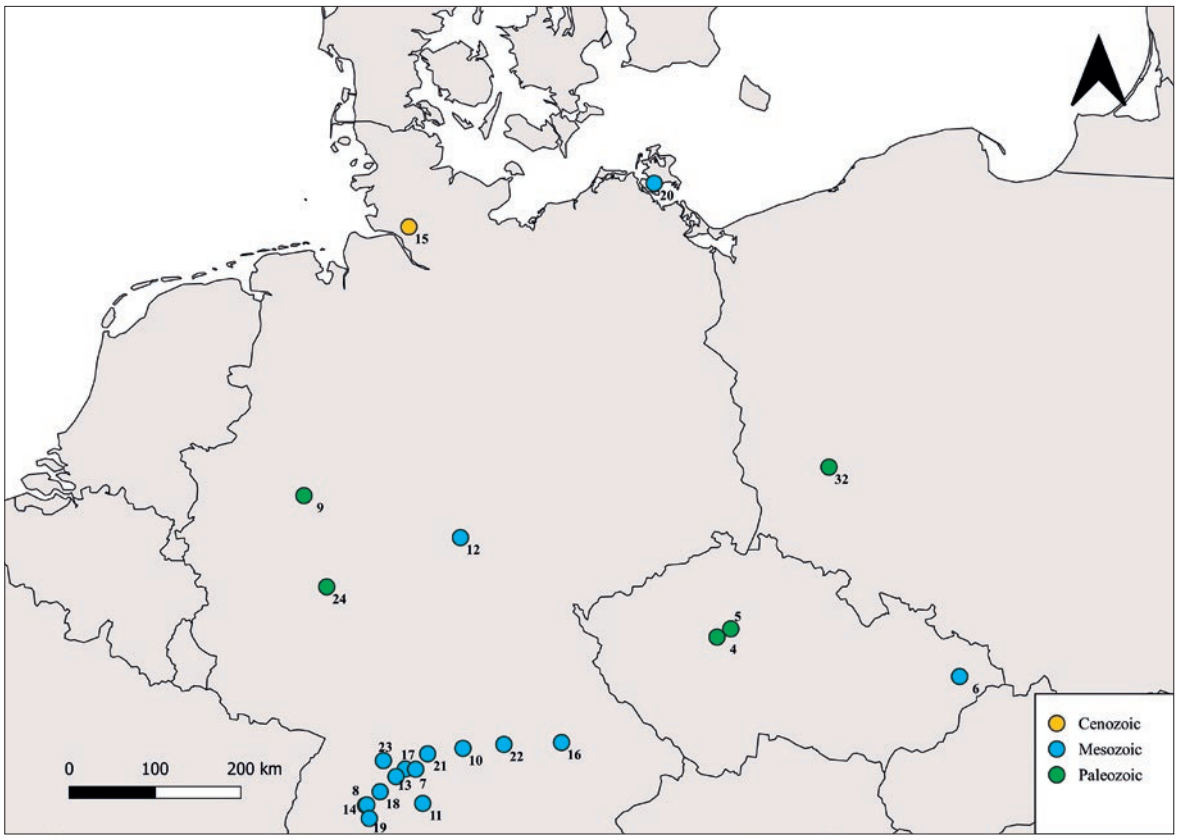

FIG. 12: Map of the central-northern part of Europe with the localities from which come the cephalopods in the Georg Gasser collection. **4.** Kosoř; **5.** Prague; **6.** Stramberk; **7.** Bad Boll; **8.** Balingen; **9.** Beul, Eisborn; **10.** Bopfingen; **11.** "Ehingen an der Donau";**12.** Eisenach; **13.** Gräfenberg; **14.** "Heuberg"; **15.** Itzehoe; **16.** Kelheim; **17.** Kirchheim unter Teck; **18.** Mössingen; **19.** Nusplingen; **20.** Rügen; **21.** Schwäbisch Gmünd; **22.** Solnhofen; **23.** Stuttgart-Vaihingen; **24.** Weilburg; **32.** Głogów.

6.2 CZECH REPUBLIC

"Böhmen" – 1

Age: Silurian

Collection Georg Gasser: 6 specimens, *Plagiostomoceras* sp. (PZO 12933, 12934, Fig. 6A), *Orthoceras* sp. (PZO 12322, 12377, 12486), *Michelinoceras michelini* (PZO 12889, Fig. 6B), *Trochoceras secula* (PZO 12488, Fig. 6E)

Remarks: It is possible that the specimens come from the Prague Basin, well known in literature for its Silurian Cephalopods limestones (i.e. Ferretti & Kříž, 1995) since the first studies of the area, made by Barrande (1846, 1865–1877).

"Böhmen" – 2

Age: Jurassic

Collection Georg Gasser: 1 specimen, *Hibolithes semihastatus* (PZO 12954, Fig. 5E)

Remarks: The label associated to the specimen reports "Ob. braun. Jura. Die Localangabe Prag entschieden unrichtig" ("Brauner Jura. The local indication Prag certainly not correct"). Probably, even if the reference to Prague as locality was incorrect, the region was still Bohemia. Remains of *Hibolithes semihastatus* are, in fact known from the Jurassic limestones of northern Bohemia (Geist, 2020). From the 17th century the area was mined, after the 19th century mining was progressively abandoned (Geist, 2020). Therefore, ammonoids of the area are well-known in historical collections; currently findings are very rare. Oskar Lenz (1870) was one of the first to conduct systematic paleontological studies on the fossil content of these rocks. His work "Über das Auftreten Jurassischer Gebilde in Böhmen" (Lenz, 1870) is one of the few scientific publications on these finds. Later, Bruder (1882) continued the studies and included also other groups such as belemnites.

Kosoř (= Kozorz)

Age: Late Silurian?

The locality Kosoř, few kilometres west of Prague, was well-known during the 19th century for the incredible abundance of cephalopods (Barrande, 1865–1877; Bigsby, 1868).

Collection Georg Gasser: 1 specimen, *Endoceras annulatum* (PZO 12320, Fig. 6D)

Prague

Age: Late Silurian

The first significative publication on the rich Silurian cephalopod fauna of the Prague Basin was compiled by Barrande in the 19th century (Barrande, 1865–1877). Most cephalopods were recovered from the Ludlow and Přídolí cephalopod limestones, with a dominance of "orthocerids" with longicone shells, whereas phragmoceratids forms of nautiloids rarely occur (Manda, 2008).

Collection Georg Gasser: 2 specimens, *Michelinoceras michelini* (PZO 12319), *Protophragmoceras* sp. (PZO 12487, Fig. 6E)

Stramberk (= Stramberg)

Age: Late Jurassic-Early Cretaceous

Štramberk is historically famous for its fossil richness. The Štramberk Limestone is exposed as carbonate megablocks, breccias and conglomerates at several quarries (i.e., Kotouč, Municipal, Horní Skalka and Castle Hill) near the town of Štramberk (Vašíček et al., 2017, 2018) Although today ammonites are rarely found and specimens are in general not well preserved, during the 19th century this area yielded good specimens, now deposited in several museums, often with the generic indication "Stramberg" or "Stramberk" (Vašíček et al., 2017, 2018).

Collection Georg Gasser: 1 specimen, *Ptychophylloceras ptychoicum* (PZO 12316)

6.3 GERMANY

Bad Boll

Age: Toarcian (Early Jurassic)

The oldest figures of ammonites from the Early and Middle Jurassic in the vicinity of Bad Boll date back to the end of the 16th Century (Bauhinus, 1598). This locality is well-known for its Lower and Middle Jurassic outcrops and fossils (i.e., Quenstedt 1883–1885, 1886–1887). One of the specimens (*Harpoceras falciferum*) in Gasser's collection comes from the Posidonienschiefer Formation (Posidonia Shale), which occur at the foot of the Swabian and Franconian Jura, corresponding to the *tenuicostatum*, *falciferum* and *bifrons* ammonite zones (Riegraf et al., 1994; Hess, 1999a).

Collection Georg Gasser: 2 specimens, *Harpoceras falcifer* (PZO 12240, Fig. 3E), *Salpingoteuthis* (PZO 12935)

Balingen

Age: Jurassic

Various successions of Jurassic age crop out in the Balingen area in the Swabian Jura, and its ammonites are frequent in many collections. Former quarrying activities in the area pushed paleontological discoveries and studies, discussed also by Quenstedt (1883–1885). However, Linnaeus already cited this place for its "Nautilites" in his "Systema naturae" (1793).

Collection Georg Gasser: 56 specimens, cf. *Kepplerites* sp. (Middle Jurassic, PZO 12505, Fig. 3F), *Taramelliceras costatum* (Late Jurassic, PZO 12920, Fig. 4D), *Amaltheus* sp. (PZO 13033), *Amaltheus laevigatus* (PZO 12998, 12999), *Amaltheus margaritatus* (PZO 13030, 13031, 13034), *Ammonites** (PZO 13000, 13024–13029, 13035–13036, 13062–13075, 13077, 13078–13091, 14930), *Dactylioceras anguinum* (PZO 13032), *Acanthopleuroceras* sp. (PZO 13001), *Cenoceras striatum* (Arietenkalk, PZO 12315, Fig. 6C, and, probably, PZO 12341; see remarks), *Schlotheimia angulata* (PZO 12291), *Leioceras opalinum* (Middle Jurassic, PZO 12287, 12522), *Cheltonia occipitris* (PZO 13076), *Pleurolytoceras hircinum* (PZO 13061)

Remarks: Though mostly Early Jurassic in age, a few specimens attributed by Gasser to this locality are in fact younger (Middle or even Late Jurassic) and must come from other localities in the surroundings of Balingen. A nautiloid fragment labelled as "*Nautilus bidorsatus*, Lias, Balingen" (PZO 12341) probably belongs to *Cenoceras*, rather than to the Triassic form *Germanonautilus bidorsatus*.

Beul, Eisborn

Age: Late Devonian

Less than one km northwest of Eisborn, the Beul hills present several outcrops with a good Frasnian–Famennian transition (Girard et al., 2005; Helling & Becker, 2022).

Collection Georg Gasser: *Bactrites gracilis* (PZO 12890, Fig. 6F)

Remarks: On the label associated to the specimen is indicated "Beul bei Bonn", probably a mistake in the report of the locality.

Bopfingen
Age: Middle Jurassic
Bopfingen is located in the easternmost Swabian Jura. The paleozoological fauna of the Middle Jurassic lithostratigraphic units are famous. Discussing the lithofacies in his work on the ammonites, Quenstedt (1886–1887) cited, specifically, the Ipf relief ("Nipf" – *sic*) near Bopfingen, as a locality where it was possible to find remains of *Belemnites giganteus*.
Collection Georg Gasser: 4 specimens, *Megateuthis giganteus* (PZO 12524, Fig. 5D, 12525, 12955, 12956)

"Ehingen"
Age: Late Jurassic
Locality sited in the Swabian Jura, a chain of Jurassic highlands in Baden-Württemberg, whose lithostratigraphic sequence was first studied in detail by Quenstedt (1843) (Ziegler, 1977).
Collection Georg Gasser: 1 specimen, *Amauroceras* sp. (PZO 12638)
Remarks: The genus *Amauroceras* comes from the Amaltheenton Formation and is Early Jurassic in age. This is not compatible with the locality Ehingen (comm. pers. Günter Schweigert). It could, thus be an error in attribution of the locality.

Eisenach
Age: Anisian (Middle Triassic)
In southwest Germany, the Upper Muschelkalk was also historically defined with the terms "Hauptmuschelkalk" or Alberti's "Friedrichshall Limestone". The label associated to the specimen report "Kalkstein von Friedrichshall im Muschelkalk", to identify the lithostratigraphic unit.
Collection Georg Gasser: 1 specimen, *Ceratites* sp. (PZO 12919)

Gräfenberg
Age: Late Jurassic
Gräfenberg, placed in the Middle Franconian Jura, is well-known for its well-preserved ammonites that are still copiously extracted from active quarries such as Endress (Alessi, 2013) and Deuerlein (Maisch & Matzke, 2018), providing useful material for the study of the Late Jurassic cephalopods in this area (Schairer & Schlampp, 2003).
Collection Georg Gasser: 2 specimens, indeterminate ammonite fragments, impression and mould (PZO 12952, 12953)
Remarks: An ammonite from Gräfenberg is cited in the inventory of a collection drawn up at the end of the 18th century (Esper, 1789).

"Heuberg"
Age: Late Jurassic
Großer Heuberg (Great Heuberg) or simply Heuberg is a plateau in the Swabian Jura near Nusplingen cited, among others, by Quenstedt in several works (i.e., Quenstedt, 1849, 1858, 1887-1888) for the presence of Late Jurassic ammonoids.
Collection Georg Gasser: 5 specimens, *Ataxioceras polyplocum* (PZO 12629, 12630, 12631), *Perisphinctes martelli* (PZO 12633), *Streblites levipictus* (PZO 12634)
Remarks: The writing on these labels is very dificult to read. It could mean Henberg, but such a locality yielding ammonoids does not exist. The most similar-named locality would be Heuberg, in the Swabian Jura. Another possible interpretation is Honberg near Tuttlingen in the upper Donau Valley, where these fossils could theoretically occur as well (pers. comm. Günter Schweigert).

Itzehoe
Age: Rupelian (Early Oligocene)
The locality is little known in literature. Haas (1889) drew up a list of molluscs from the "Rupelthon" (Rupelian) of Itzehoe in the Kiel (?) collection, describing some new forms, such as the nautiloid *Koenenia alseni*.
Collection Georg Gasser: 1 specimen, *Koenenia alseni* (PZO 13838)

Kelheim an der Donau
Age: Late Jurassic
Kelheim in the Franconian Jura (South Germany) is one of the localities where the lithographic limestones of Bavaria crop out, famous for the outstanding preservation of invertebrate and vertebrate fossils (e.g., Schwarz-Wings et al., 2011). Historically, the Kelheim area was an important quarry site for *Plattenkalk*, now abandoned (Crook, 1894; Kölbl-Ebert & Cooper, 2018).
Collection Georg Gasser: 1 specimen, ?*Lithacoceras* sp. (PZO 12966)

Kirchheim unter Teck
Age: Pliensbachian (Early Jurassic)
Ammonites from Kirchheim unter Teck were described in Quenstedt's (1883–1885) monograph about Lower Jurassic sites in Swabian Jura.
Collection Georg Gasser: 1 specimen, *Androgynoceras capricornus* (PZO 13374)

Mössingen
Age: Aalenian (Middle Jurassic)
Mössingen in the Swabian Jura is well-known in literature for its Jurassic successions and ammonite faunas. Quenstedt (1883–1885), in his monograph, discusses the easy finds of *Leioceras opalinum* in the surroundings of this town.
Collection Georg Gasser: 3 specimens, *Leioceras opalinum* (PZO 12513, 12514, Fig. 3C, 12515)

Nusplingen
Age: Kimmeridgian (Late Jurassic)
Nusplingen, located in the western Swabian Jura, is one of the most iconic fossil localities of the lithographic limestones, famous for the good preservation of their fossils, making it an important Fossil-Lagerstätte, like the famous and slightly younger site of Solnhofen. The first fossils from the Nusplingen Lithographic Limestone were reported in the mid-19th century. In this area several excavation campaigns took place, at first for commercial purposes, then for scientific interests as far as it become a Protected Excavation Area in 1983 (i.e., Dietl & Schweigert, 2004; Schweigert & Roth, 2021).
Collection Georg Gasser: 4 specimens, Aptychus indet. (PZO 13048, 13049), *Laevaptychus* sp. (PZO 13051), *Lamellaptychus* sp. (PZO 13052)

Rügen
Age: Late Cretaceous (Maastrichtian)
The Isle of Rügen is one of the classic Upper Cretaceous localities in Europe. The white chalk cliffs and quarries have yielded numerous fossils studied by many German paleontologists, since the 19th century (e.g., Reich & Frenzel, 2002).
Collection Georg Gasser: 11 specimens, *Belemnitella mucronata* (PZO 12925, Fig. 5C, 12926, 13037, 13038, 13039, 13040, 13041, 13042, 13043, 13044, 13045)

Schwäbisch Gmünd

Age: Early Jurassic

The Lower Jurassic foreland around Schwäbisch Gmünd is well-known for a variety of fossiliferous sites and the good preservation of the fossils. In the Gmünd area, fossils can be found in different Lower Jurassic lithostratigraphic units, although the so-called Arietenkalk (Lower Sinemurian) stands out, also for historical reason, since this limestone was object of quarry activity. Therefore, many ammonites were collected through time and hosted in museums such as, for example, the State Museum of Natural History in Stuttgart (Mayer, 2010).

Collection Georg Gasser: 1 specimen, *Ataxioceras geniculatum* (PZO 14935)

Remarks: The specimens was assigned by the historical labels to *Harpoceras murchisoni*, a species that does not exist. A restudy by Günter Schweigert assigns it to *Ataxioceras geniculatum*, a taxon typical of the Late Jurassic Lacunosamergel-Formation (Kimmeridgium, upper Platynota-Zone). This formation does outcrop only at a certain distance from Schwäbisch Gmünd. It cannot be excluded that at some point the label got mixed up.

Solnhofen

Age: Late Jurassic (Tithonian)

The Plattenkalk of the Solnhofen Fossil-Lagerstätte are famous for their rich paleofauna, collected for hundreds of years and exhibited in natural history museums around the world. Ammonoids can be found frequently in the Plattenkalk, most of them preserved as flattened imprints and with common presence of aptychi inside the body-chambers (Keupp, 2007).

Collection Georg Gasser: 2 specimens, *Laevaptychus* sp. (PZO 12490, Fig. 4E, 13050)

Stuttgart-Vaihingen

Age: Early Jurassic

At Vaihingen, today part of Stuttgart, in the Swabian Jura, there are temporary outcrops of the Angulatensandstein (Hettangian) and Arietenkalk (Sinemurian) formations. Between the 18th and 19th centuries, a quarrying activity for the extraction of pavement and building stones interested the area. In this period many ammonites were extracted, going to feed numerous collections thanks to the good preservation conditions (Albert et al., 2016; Scherzinger et al., 2020). The Sinemurian Arietenkalk Formation is partly very rich in ammonites and other invertebrates (Scherzinger et al., 2020, and references therein). Among the others, Quenstedt was one of the first that described ammonites from this area, in his studies and monographs about cephalopods of Germany (i.e., Quenstedt, 1849; 1883–1885).

Collection Georg Gasser: 5 specimens, *Ammonites bucklandi** (PZO 12994–97, Fig. 3D), *Schlotheimia angulata* (PZO 12289)

Remarks: The specimens labelled by Gasser as "*Ammonites bucklandi*" belong to different genera and species and may include juvenile specimens of *Arietites* and *Coroniceras* (PZO 12994, 12996) and possibly also Pliensbachian forms of the Liparoceratidae. A closer determination is made difficult by the specimens being glued on a glass plate, with their ventral area partly covered by the neighbouring specimens.

Weilburg

Age: Devonian

Sited, at Gasser's time, in the historical district of Nassau, Weilburg is placed, geographically, in the southeast of the Rheinische Schiefergebirge. It is characterized by outcrops of Middle Devonian volcanic rocks and minor reef limestones, the presence of Upper Devonian Adorf-Plattenkalk (thin-bedded limestone) and Kalkknotenschiefer (lime nodular slate) with basaltic intrusions and by Lower Carboniferous Alaunschiefer (black alum slate) (Moe, 2000). The cephalopod fauna is Upper Devonian in age. Sandberger (1855) described a specimen of what he called "*Clymenia subnautilina*" from the Weilburg area.

Collection Georg Gasser: 1 specimen, *Clymenia undulata* (PZO 12519, Fig. 3A)

6.4 ITALY

Lake Garda area

Age: Late Jurassic

Collection Georg Gasser: 3 specimens, *Ammonites** (PZO 12292), *Phylloceras* sp. (PZO 12965, 12309)

Marmolada

Age: Middle Triassic

The Marmolada bears the only glacier of the Dolomites but is famous also for its Marmolada limestone that yielded invertebrates fossils that are sometimes preserved with original colour (mostly gastropods).

Collection Georg Gasser: 1 specimen, *Aulacoceras* sp. (PZO 13223)

Rovereto

Age: Jurassic

On the reliefs on the eastern edge of Val d'Adige, directly behind Rovereto, successions from the Lower to Upper Jurassic crop out. The specimens in the collection could be attributed to the unit of Rosso Ammonitico Veronese (Bajocian-Tithonian), a reddish limestone subject of mainly paleontological studies since the nineteenth century.

Collection Georg Gasser: 2 specimens, *Ptychophylloceras ptychoicum* (PZO 12475) *Macrophylloceras ptychostoma* (PZO 12259)

Seiser Alm/Alpe di Siusi

Age: Middle Triassic

The St. Cassian Formation or the Pachycardien Tuffe is the lithostratigraphic unit, exposed on the Seiser Alm/Alpe di Siusi, that could have returned the two sample in the collection, considering what is indicated on the label associated: "Petrefakten aus d. Porphyrtüffen d. Seiser Alpe" (Petrefacts from the porphyry tuff of the Seiser Alm).

Collection Georg Gasser: 2 specimens, *Ammonites** (PZO 15244, 15245)

St. Kassian/San Cassiano

Age: Middle-Late Triassic (Late Ladinian–Early Carnian)

Near the village of St. Kassian/San Cassiano, the St. Cassian Formation crops out, that is well-known for its abundance of fossils. It attracted the scientific interest since the first half of the 19th century. Particularly well-known is the ammonoid fauna of this formation, object of monographs by Münster (1841), Klipstein (1843), and Mojsisovics (1882) (e.g., Urlichs, 2017).

Near St. Kassian/San Cassiano village, a section, that has been much debated in literature is that of Prati di Stuores/Stuores Wiesen, at the head of Cordevole Valley. This siliciclastic and

mixed hemipelagic succession of the Wengen and St. Cassian formations, has been adopted as the GSSP of the Carnian Stage and its ammonoid fauna was studied in detail (Mietto et al., 2008).
Collection Georg Gasser: 18 specimens, *Arpadites ruppeli* (PZO 13005, Fig. 4A), *Badiotites eryx* (PZO 13008), *Celtites buchii* (PZO 13003, Fig. 4A), *Cladiscites ungeri* (PZO 13011, 13012, 13013), *Klipsteinia boetus* (PZO 13004, Fig. 4A, 13007), *Nannites spurius* (PZO 13009, 13010), *Trachyceras aon* (PZO 13006), *Trachyceras basileus* (PZO 13002, Fig. 4A), *Lecanites glaucus* (PZO 12959, 12960, 12961), *Orthoceras politum*? (PZO 14370), undetermined Ammonoidea (PZO 15443, 15444)

Strigno
Age: Late Jurassic?
The specimen in the collection is conserved in a facies reminiscent of the Rosso Ammonitico Veronese, which does not crop out in the immediate surroundings of Strigno but only a few kilometres away.
Collection Georg Gasser: 1 specimen, indeterminate ammonite (PZO 12252)

Tiers/Tieres
Age: Middle Triassic
Tires is situated on the southern slope of the Sciliar massif. Close to this locality there are outcrops of a succession that spans from the Permian to the Middle Triassic. The specimen can be attribute to the Schlern Dolomite that constitutes the core of the massif.
Collection Georg Gasser: 1 specimen, indeterminate ammonite (PZO 12650)

Trento
Age: Late Jurassic–Early Cretaceous
Among the lithostratigraphic units that crop out close to Trento, the Rosso Ammonitico Veronese and the Maiolica seemed the closest related source rocks for the specimens of the collection.
Collection Georg Gasser: 5 specimens, *Ammonites** (PZO 14944), *Discosphinctoides geron* (PZO 12260), *Passendorferia birmensdorfense* (PZO 12303, Fig. 4B, PZO 12307), *Crussoliceras* cf. *acer* (PZO 12951)

6.5 POLAND

Głogów (Glogau)
Age: Silurian
There are limited notes about this locality, cited in the 19th century as a place where it was possible to observe Silurian deposits of "Orthocerenkalk" (Roemer, 1885).
Collection Georg Gasser: 1 specimen, *Orthoceras* (PZO 12489)

6.6 UNITED KINGDOM

Age: Cretaceous
Collection Georg Gasser: *Douvilleiceras monile* (PZO 12476)

6.7 NORTH AMERICA

Age: Mesozoic
Collection Georg Gasser: indeterminate ammonite (PZO 12964)

7. CONCLUSIONS

Analysing the cephalopod assemblage within the Georg Gasser collection a close connection between the source areas and the geopolitical texture during Georg Gasser's lifetime becomes evident, except for extremely rare case (i.e., North America, England). Unlike the paleobotanical collection, the local area is represented quite well, although in general with common and didactic specimens. Due to this, the Triassic is well represented in the collection. This documents also the most famous Central European outcrops with special attention to the southern part of Germany and Austria, especially for the outcrops of the Plattenkalke or Lithographische Schiefer. In this way the Mesozoic, particularly for the Triassic and the Jurassic, is the best represented time interval.
The remaining eras of Earth History are only poorly illustrated. Paleozoic specimens are very rare and come, for the most part, from the Prague Basin, whose Silurian cephalopods limestone are well-known in literature. The Cenozoic is only represented by two specimens, one of which has a clear geographic attribution. On the other hand, it is also true that the heyday of the cephalopods was the late Paleozoic and the Mesozoic, especially in Central Europe. Looking at it from this way it could be said that the collection reflects the relative abundance of cephalopods in Central Europe through time with an essential focus on former German and Austrian boundaries.
As far as the type of display is concerned, it is possible to observe the educational purpose that moved Gasser in the making of his collection, providing both the possibility to achieve comparisons and the potential use of fossils as exemplary documentation of a particular locality. The inventory work and the collection of data so far carried out, is intended to create a preliminary basis to promote any future insights, also at the light of a complete review.

ACKNOWLEDGMENTS

This research project would never have been carried out without the support of the Research funds of the Betrieb Landesmuseum ("Die Fossiliensammlung von Georg Gasser (1857-1931)", CUPH54I19000540005). Benno Baumgarten moved the historical collection in 1992 to the Museum of Nature South Tyrol and stored both the collection and historical documents, making them available for study. Helmuth Buratti provided a first revision identifying a part of cephalopod fauna in the collection. We thank also the collaborators of the museum Francesca Conci, Francesca Uzzo, Roberta Branz, Barbara Lanthaler, Hendrik Nowak, and several short-time internships that helped with the logistic move of the collection as well as during the inventarisation process. We thank also very much Günther Schweigert (Stuttgart), which helped us to improve the paper very much, thanks to several revision of German ammonites and remarks on occurrences.

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Eingereicht am: 18.11.2022
Angenommen am: 21.11.2022