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The Biostratigraphy of the Lower Pliensbachian at the Type Locality (Pliensbach, Württemberg, SW-Germany)

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With 4 plates, 5 figures, and 1 table

1. Introduction

The type locality of the Pliensbachian, at foot of the Swabian Alb, is situated about 35 km SE of Stuttgart. In the region of Pliensbach there are several localities well-known in the geological literature, e. g. Boll, Holzmaden, Ohmden, and Zell. East of Pliensbach a brook, named Pliensbach too, passes along. On both sides of the Pliensbach there are a lot of small exposures showing the layers of the middle Lias. But it is difficult to correlate these incoherent exposures and to integrate them into one profile, because the layers are poor in fossils and the lithology is very monotonous. Therefore a digging has been necessary to obtain a continuous section (see fig. 1).

In the autumn 1975 an excavation has been made near the village. The results of this digging have made it possible to correlate the different sections.

Nürtingen, the other well-known locality for lower Pliensbachian ammonites, has been researched too. There the aggregate thickness of the middle Lias is greater than at the type locality. Fossil material from Nürtingen is kept in many European museums and geological institutes. Especially in the beginning of this century a lot of well preserved ammonites were found during the working of raw material for the production of cement (ENGEL 1911, 139). In the monograph about the Liparoceratidae in the British Museum several ammonites from Nürtingen have been listed and figured by SPATH (1938). The production of cement was finished a long time ago. Therefore it was necessary to open the profile again. During the summer 1976 the author researched this section and collected bed by bed a rich fauna. Now the old pit is filled up with rubble.

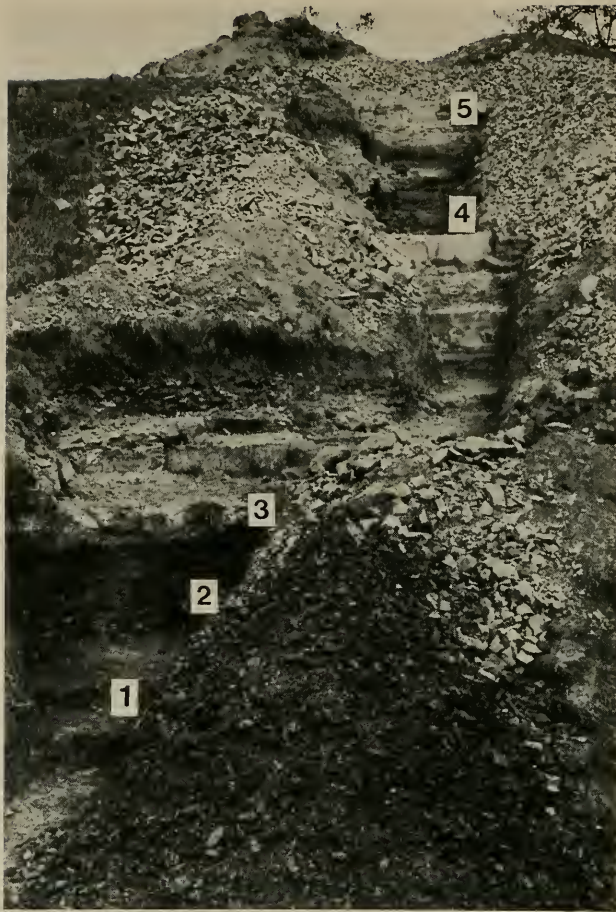


Fig. 1. Section opened by digging at the type locality (autumn 1975) showing the beds from the *raricostatum* Zone to the *ibex* Zone. The numbers mark the following important parts of the section:

- 1 Raricostatenbasisbank (sensu SÖLL 1956, 380)
- 2 uppermost part of the Raricostatenton limited above by a thin layer with fucoids
- 3 Cymbiumbank
- 4 first appearance of *Uptonia*
- 5 first appearance of *Tragophylloceras ibex* (QU.)

1.1. History

The area of Pliensbach, particularly the small village Boll, had been often mentioned in earlier times. The sulphur-bath at Boll was visited regularly by a lot of people. The fourth volume of BAUHINUS (1602) represents the first natural description of Württemberg. In an important part of this volume the medical value of this mineral water is treated in detail. In another chapter numerous ammonites are described and figured from this region. The designation of the bath as "württembergisches Wunderbad" refers not only to the efficiency of the water, but also to the discovery of the numerous fossils occurring there. In 1811 there was a decree of Wilhelm I (king of

Württemberg) requesting the people to collect fossils and to exhibit them in the bath of Boll.

As time went on scientists began to describe the fossils of this region. Therefore the name of Pliensbach is found in several publications at the beginning of the 19th century. To this pioneer period of scientific geologists the following well-known fossil collectors should be mentioned: STAHL (1824), ZIETEN (1830–1833), v. MANDELSLOH (1834), and HEHL (1834).

ZIETEN described and figured some fossils of Pliensbach in his monograph. A specimen of an ammonite, determined as *Ammonites crenatus* REINECKE by ZIETEN, is figured herein (original of ZIETEN 1830, pl. 1, fig. 4 a–d; see pl. 2, fig. 5 a, b). DONOVAN & FORSEY (1973, 10, pl. 2, fig. 2 a, b) have designated it as the lectotype of *Coeloceras pettos* (Qu.). In contrast to the data in ZIETEN who cited it from the “Lias-shales of Gamelshausen” the original label refers to Pliensbach, where this ammonite seems to have been found.

QUENSTEDT (1843, 520; 1858, 117; 1867, 8) first mentioned the locality Pliensbach, where the layers of the „Schwarzer Jura“ (Black Jurassic) are well exposed.

The middle Lias formed the subject of OPPEL’s first work in 1853. In the publication “Der mittlere Lias Schwabens“ OPPEL, a pupil of QUENSTEDT, adopted the lithologic subdivision (Schwarzer Jura γ and δ) of his master. And following the results of OPPEL in stratigraphy of the middle Lias, PFIZENMAYER (under the direction of QUENSTEDT) included them in the table produced in 1853 (see tab. 1).

The most important landmark in the progress of stratigraphic geology was OPPEL’s “Die Juraformation Englands, Frankreichs und des südwestlichen Deutschlands“ in 1856–1858. This remarkable work about the jurassic biostratigraphy contains the definition of the “Pliensbachian“ or “Pliensbachgruppe“ (1858, 248 f.) to replace D’ORBIGNY’s term “Étage Liasien“. It is understandable that OPPEL selected the type locality in this region because the geology of the Pliensbach area has been well documented since earlier times. OPPEL himself has never given a detailed stratigraphic description of the section of Pliensbach. In generalized schemes OPPEL (1856, 237, 243, 259) shows what he means by the different biostratigraphic subdivisions. The term zone (“Zone“) has never been defined by him. The zone itself is characterized by a well documented list of their fossil contents (OPPEL 1856, 135).

Later QUENSTEDT (1885) published his monograph about the ammonites of the Swabian Jurassic (part I, Schwarzer Jura) in which many Pliensbachian forms are listed and described.

The ammonites of the Schwarzer Jura γ have been receiving attention by BERTSCH (1876; 1878). This study was initiated by QUENSTEDT.

After a longer intervall RAPP (1931) published a lot of sections in the Schwarzer Jura γ of the Middle Swabian Alb. The subdivision of the various sections is based only on their lithologic sequence.

An important contribution to the knowledge of the geological situation in the region of the type locality was given by GOTTLIEB (1955) in form of a geological map (sheet Weilheim/Teck, no. 7323) including a detailed explanation. In this paper the section (exposed along the brook) of the lower Pliensbachian at the type locality is described and figured for the first time. The lithologic subdivision is put in the foreground in the manner of RAPP (1931). The first biostratigraphic study about the lower Pliensbachian at the type locality was published by GEYER (1964). In this paper a preliminary biostratigraphic subdivision of the Pliensbachian is proposed.

A detailed study of the stratotype including the comparison with the subdivision into zones and subzones made by DEAN et al. (1961) is missing. GEYER (1964, fig. 2) indicates mainly the occurrence of the index species for zones.

This fact forms the subject of this recent paper and in the same way it represents a preliminary note of a greater investigation on this matter by the author.

2. Stratigraphy

2.1. The "Numismalismsergel" sensu QUENSTEDT

The middle Lias has been subdivided in different manners by several authors (see tab. 1). In the upper row of the table the subdivisions sensu QUENSTEDT are given. For the definition of the „Numismalismsergel“ QUENSTEDT used lithologic terms and significant fossils. But the base and the top of this sequence of layers are defined only by the lithologic change from clay to marl (Raricostatenton, Amaltheenton). The subdivisions in the lower row are based on the biostratigraphic zonal scheme sensu OPPEL. To exclude confusions these two parts of the table have to be distinguished strictly.

QUENSTEDT (1843; 1853; 1884) divided his "Numismalismsergel" (= Schwarzer Jura γ) into lithologic units. He named them often after characteristic fossils (e.g. "Basaltformenbank" with *Pentacrinites basaltiformis*) or after the preservation (calcareous or pyritized casts) of their fossil contents, e.g. "Region der verkiesten Ammoniten" in the middle part of Schwarzer Jura γ .

Based on this criterion of preservation BERTSCH (1876; 1878) subdivided the Schwarzer Jura γ into three parts.

Following OPPEL (1856–1858), but used in a different sense, the primary lithologic units have been characterized in biostratigraphic terms or with characteristic ammonites by several authors (e.g. QUENSTEDT 1884; ENGEL 1883; 1908). For these units QUENSTEDT (1884, 200) used the term "Treppe" (stair; "Stufe" in modern German) (e.g. "Treppe des *Ammonites jamesoni*", p. 200). It was understood herein in a geomorphologic sense. This mixture of methods in biostratigraphy and in lithostratigraphy was the cause of misinterpretation. In various works of QUENSTEDT the definition of the Numismalismsergel had been improved following the progress of OPPEL's biostratigraphic scheme. The best example for this fact is given in the definition of the limit Schwarzer Jura γ/δ in QUENSTEDT (1858, 116). The whole series of marls and limestones belong to the Schwarzer Jura γ , regardless of the appearance of Amaltheids in the upper part of the Numismalismsergel. QUENSTEDT designated this uppermost part of the Numismalismsergel as "Zwischenkalke" (1858, 116), or later as "Zwischenlager" (1885, 303) (see tab. 1).

This terminology was necessary, because OPPEL (1856, 251) had distinguished between a lower and an upper zone of *Ammonites margaritatus*. The lower part corresponds, as observed by OPPEL (1856, 251), to the marl facies of the Numismalismsergel (sensu QUENSTEDT).

This important fact has been often overlooked by several recent authors. The result is a misinterpretation, i.e. an equation of QUENSTEDT's limit Schwarzer Jura γ/δ with OPPEL's limit *davoei* Zone / lower *margaritatus* Zone. This misconception has been discussed and rectified by SCHIRMER (1965, 194 f.).

ENGEL (1883; 1908), RAPP (1931), and GOTTLIEB (1955) subdivided the middle Lias into lithologic units as did QUENSTEDT. RAPP (1931, 6, tab. 1) numbered the layers and distinguished between marl, indurated marl, and compact limestone

("Fleckenkalk"). The numbering of the layers was used to correlate the diverse sections along the Middle Alb.

In GOTTLIEB (1955, 26, fig. 5) the section of Pliensbach and the well-known section of Kirchheim/Teck have been correlated, based on the number of layers. According to GOTTLIEB, in both sections there are 25 distinct layers.

In the same way SCHWEIZER (1968, tab. 21) has represented a continuous section of the middle Lias along the Swabian Alb from Aselfingen (South Baden) to Seerdendorf (NE of Aalen). Most of the sections were based on the results of RAPP (1931). The profiles were correlated layer by layer, and the sequence was subdivided into Schwarzer Jura γ_1 , γ_2 , γ_3 . In the introduction (p. 9) it is shown what SCHWEIZER understands by these terms. The three lithologic terms have been equated by him uncorrectly with biostratigraphic units ($\gamma_1 = jamesoni$ Zone, $\gamma_2 = ibex$ Zone, $\gamma_3 = davoei$ Zone). This example may be representative for a widespread view in the geological literature.

2.2. Biostratigraphy

To replace d'ORBIGNY's "Étage liasien" OPPEL (1858, 248 f.) introduced the term "Pliensbachian" or "Pliensbachgruppe", named after the village Pliensbach near Boll (footnote p. 249). Since the term "Étage liasien" without a local reference may cause confusion with the term Lias for the lower part of the Jurassic system, OPPEL has rejected it. The meaning of the terms Carixian (LANG 1913), Domeriano (BONARELLI 1894), Charmouthian (MAYER-EYMAR 1864) is explained in detail by DONOVAN & HOWARTH (1964, 169 f.), CITA (1964, 173 f.), and DONOVAN & HOWARTH (1964, 171 f.). A summary is given by DEAN et al. (1961, 461 f.).

OPPEL (1856, 237, 248; 1858, tab. 64) defined its "Pliensbachgruppe" without explaining what he understood by the term "Zone". He subdivided the Pliensbachian from the bottom to the top into five zones. The natural division of the Pliensbachian stage into two parts at the first occurrence of the Amaltheids was recognized by OPPEL (1856, 236). The designations "Unter-Pliensbachium" and "Ober-Pliensbachium", never mentioned by OPPEL, must be understood in this original sense (LANG 1913, 401 f.).

1. *jamesoni* Zone (Jamesonibett, Zone des *Ammonites jamesoni*)

OPPEL 1856, p. 238 f.

The lower part is characterized by the questionable term "Armatusbett" (syn. "Untere Jamesonischichten", p. 239)

2. *ibex* Zone (Ibexbett, Zone des *Ammonites ibex*)

OPPEL 1856, p. 242 f.

3. *davoei* Zone (Davöibett, Zone des *Ammonites davöi*)

OPPEL 1856, p. 246 f.

The *margaritatus* Zone (OPPEL 1856, p. 249 f.) and the *spinatum* Zone (OPPEL 1856, p. 258 f.) are treated by URLICHS 1977.

OPPEL (1853; 1856—1858; 1862) has never described the stratotype of the Pliensbachian. FUTTERER (1893) published a detail study about the occurrence of the ammonites in the lower Pliensbachian at Östringen (near Langenbrücken, south of Heidelberg). A rich material has been obtained from there, and for the first time the biostratigraphic subdivision of the lower Pliensbachian according to OPPEL (1856—1858) has been used successfully in Baden-Württemberg.

About seventy years later GEYER (1964) was the first who described the biostratigraphy of the lower Pliensbachian at the stratotype. The occurrence and the vertical range of several ammonites, especially the index species for zones, has been recognized and a subdivision into biozones has been proposed by him. The *taylori* Subzone (sensu DEAN et al. 1961, 462) has been raised to the rank of a zone.

In the subsequent paper of GEYER & GWINNER (1968, fig. 21) the proposed *taylori* Zone (sensu GEYER 1964) has been considered again as a subzone without explanation.

The ammonites of the lower Pliensbachian described by BERTSCH (1876; 1878), FUTTERER (1893), and RAPP (1931) can no longer be found (pers. commun. by J. WENDT/Tübingen, G. MAYER and E. SITTIG/Karlsruhe, and G. KAUFMANN/Marburg).

Unfortunately the most important original material, collected by GOTTLIEB (1955) and GEYER (1964) at the type locality, has been lost (pers. commun. O. F. GEYER, Stuttgart).

3. The lower Pliensbachian in the type area

3.1. The lithologic sequence of the lower Pliensbachian

A strict subdivision, based on the change of lithologic units to obtain continuous and direct measurements of the layers, is impossible in the region of the type locality. The Numismalismergel represents a succession of more or less indurated marls and splintery limestone beds or nodules. By weathering the more indurated parts of the sequence become visible as separate benches. In this case the field geologist is attempted to number the layers (as did RAPP 1931 and GOTTLIEB 1955) and to base on it stratigraphic conclusions. In an unweathered section obtained by digging it is impossible to distinguish different separate beds (see ETZOLD 1975, 127; also fig. 2 of this paper).

A splintery limestone bench changes laterally into indurated marls or limestone nodules. This lateral transitions are fluent and could be observed over a short distance in every researched profile. Therefore the horizon of the fossils has been determined by a leveling glass related to fixed points in the exposure.



Fig. 2. Sequence of layers within the *ibex* Zone at Nürtingen (excavation summer 1976). It is impossible to distinguish separate benches. The transitions between limestone, marl or indurated marl are fluent within the Numismalismergel.

NEUMAYR (1868) and SCHWEIZER (1968; 1971) have given a detailed study of the geochemical composition of the Numismalimergel. According to SCHWEIZER (1968), the average contents of carbonate in the Schwarzer Jura γ comes to 56–87%. The layers enriched in carbonate contain about 4% MgCO_3 . Dolomite cannot be proved radiographically.

3.2. Biostratigraphy of the stratotype

3.2.1. Preservation of the ammonites

The majority of the ammonites of the lower Pliensbachian are pyritized. In the lowermost part of the Schwarzer Jura γ and in the transition γ/δ the ammonites are in preservation of calcareous casts, and a large number of them are compressed. The pyritized ammonites, advanced *Uptonia* s.l., are preserved completely as rarities. Normally only the outer whorl is in a good state of preservation and the inner whorls and the body-chamber are crushed. The difficulty in determination is to recognize the relations between the small pyritized ammonites and the separated outer whorls (see also QUENSTEDT 1885, 200, 258 f.; SPATH 1928, 222).

3.2.2. The boundary upper Sinemurian/lower Pliensbachian

OPPEL (1856, 12, 57, 117, 270) fixed the limit Sinemurian/Pliensbachian above the so-called "Raricostatusbett" (OPPEL 1856, 57). This bed corresponds with the uppermost part of the Schwarzer Jura β (QUENSTEDT 1853; 1858 he called it "Raricostatenbank", and 1884, p. 167, "Ammonitenregion 5" with *Ammonites raricostatus* which is limited at the top by the Raricostatenbank sensu QUENSTEDT 1853).

FRAAS (1847, 210) mentioned nodules with big specimens of *Ammonites raricostatus* from the "Eyachriss" at Balingen. In QUENSTEDT (1843) a corresponding remark is missing. The ammonites occurring in nodules within this bed seem to be preserved as calcareous casts only in the region Rottweil-Balingen (ENGEL 1883; 1908; FISCHER 1912, 18; HOFFMANN 1964, 141). The Raricostatusbett sensu OPPEL (1856, 57) does not exist in the region of Kirchheim/Teck (see also SÖLL 1956, 381).

A layer about 8 cm thick with fucoids is situated between the Raricostatenton and the Numismalimergel (sensu QUENSTEDT 1843, 540).

The subdivision of the *raricostatum* Zone, as used in Britain according to DEAN et al. 1961, into the Subzones of *Cruciloboceras densinodulum* BUCKMAN, *Echioceras raricostatum* (ZIETEN) (= Subzone of *Echioceras raricostatoides* VADASZ, according to GETTY 1973, 3, fig. 1), *Leptechioceras macdonnelli* (PORTLOCK), and *Paltechioceras aplanatum* (HYATT) is also applicable for the biostratigraphy of the upper Sinemurian in Germany.

According to HOFFMANN (1964, 141), there is a non-sequence representing the *macdonnelli* and *aplanatum* Subzones along the Middle Swabian Alb. A remarkable footnote is given by HOFFMANN (1964, 141) mentioning a record of *Euechioceras* aff. *nobile* TRUEMAN & WILLIAMS from Betzgenriet (near Pliensbach) found in layers which are referable to the *taylori* Subzone. According to GETTY (1973, 20) the genus *Euechioceras* is to regard as a junior synonym of *Paltechioceras*. In the same paper

the vertical range of *Paltedhioceras* in Britain is shown on table 1 from the uppermost part of the *raricostatoides* Subzone to the *aplanatum* Subzone inclusive. Therefore the existence of a non-sequence and the possible range of it in the region of Pliensbach is questioned here.

In the Franconian Alb, ZEISS (1965, 47) has recognized the *macdonnelli* and *aplanatum* Subzones for the first time.

HOFFMANN (1964, 139) has pointed out the existence of the two subzones in the section of Aselfingen (South Baden).

In the stratotype of the Pliensbachian the *raricostatum* Zone is represented by a series of dark clays about 90 cm thick. The base of this sequence corresponds with the so-called "rauhe Mergelage IV" (see SÖLL 1956, 371, 380 f.). In this only a few centimeters thick layer fragments of bivalves and crinoids are enriched. The ammonites of the genus *Echioceras* are crushed, but appear in this bed for the first time. *Echioceras raricostatum* (ZIETEN) (see the designated neotype of this species in GETTY 1973, 13, pl. 1, fig. 7), *Echioceras raricostatoides* VADASZ, and *Cruciloboceras densinodum* (QU.) are referable to the *raricostatum* Zone. A distinction between the *raricostatoides* and the *densinodulum* Subzones is impossible, because there is an assemblage of the index species of both subzones in Pliensbach (see also HOFFMANN 1964, 141). Therefore the designation of a *raricostatoides* — *densinodum* Subzone is indicated herein, based on the ammonites *Echioceras raricostatoides* VADASZ and *Cruciloboceras densinodum* (QU.) (common in SW Germany).

The upper limit of the dark clays, represented by the thin marl layer with fucoids, is not fossiliferous. There is only one ammonite record of a questionable *Hemimicroceras* from it. This record indicates *raricostatum* Zone (Staatl. Mus. f. Naturk., Stuttgart, no. 23197).

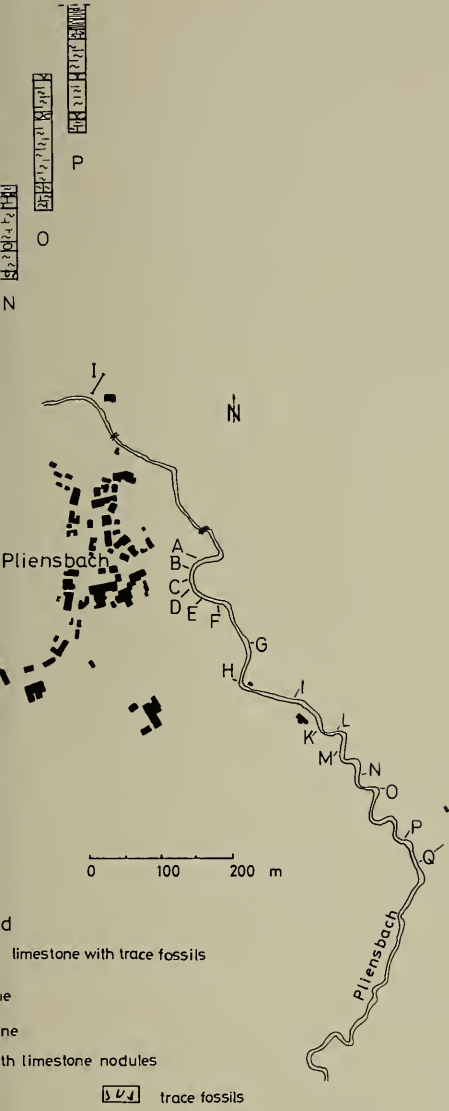
Apoderoceras nodogigas (QU.) (see also Pl. 1, fig. 1 a, b), a significant index species of the *taylori* Subzone (see also DEAN et al. 1961, 463), recognized only about 15 cm above the (?) *Hemimicroceras*, marks the beginning of the lower Pliensbachian (*taylori* Subzone) (see fig. 3, section I).

3.2.3. The *jamesoni* Zone

The zone is here used in the sense of OPPEL (1856, 238). According to OPPEL's definition it comprises beds from the *taylori* Subzone to the *masseanum* Subzone inclusive. In the stratotype *Uptonia jamesoni* (SOW.) persists into the beds of *Tropidoceras masseanum* (D'ORB.) in contrast to the situation in Britain, where the beds of *Uptonia jamesoni* (SOW.) and its allies and the beds of *Tropidoceras masseanum* (D'ORB.) are strictly separated (DEAN et al. 1964, 464).

In the publication of GEYER (1964) a record of *Tropidoceras* is not mentioned. Therefore the *masseanum* Subzone is included into the uppermost part of the *jamesoni* Zone (see figs. 3, 4, and tab. 1). About the range and the occurrence of the index species of the *jamesoni* Zone a detailed note is given in the subzone concerned.

Based on the distribution of the belemnites and ammonites in the Belemnite Marls of the Dorset coast (according to LANG 1928; 1936), PALMER (1972, 52) proposed to recognize a *polymorphus* Zone (characterized by *Polymorphites* and *Platypleuroceras*) between the *raricostatum* Zone (sensu DEAN et al. 1961) and a reduced *jamesoni* Zone. After examining the LANG-Collection in the British Museum by the author the necessity of such a change in the biostratigraphic scheme (sensu DEAN et al. 1961) depends on a revision of the fauna collected by LANG.



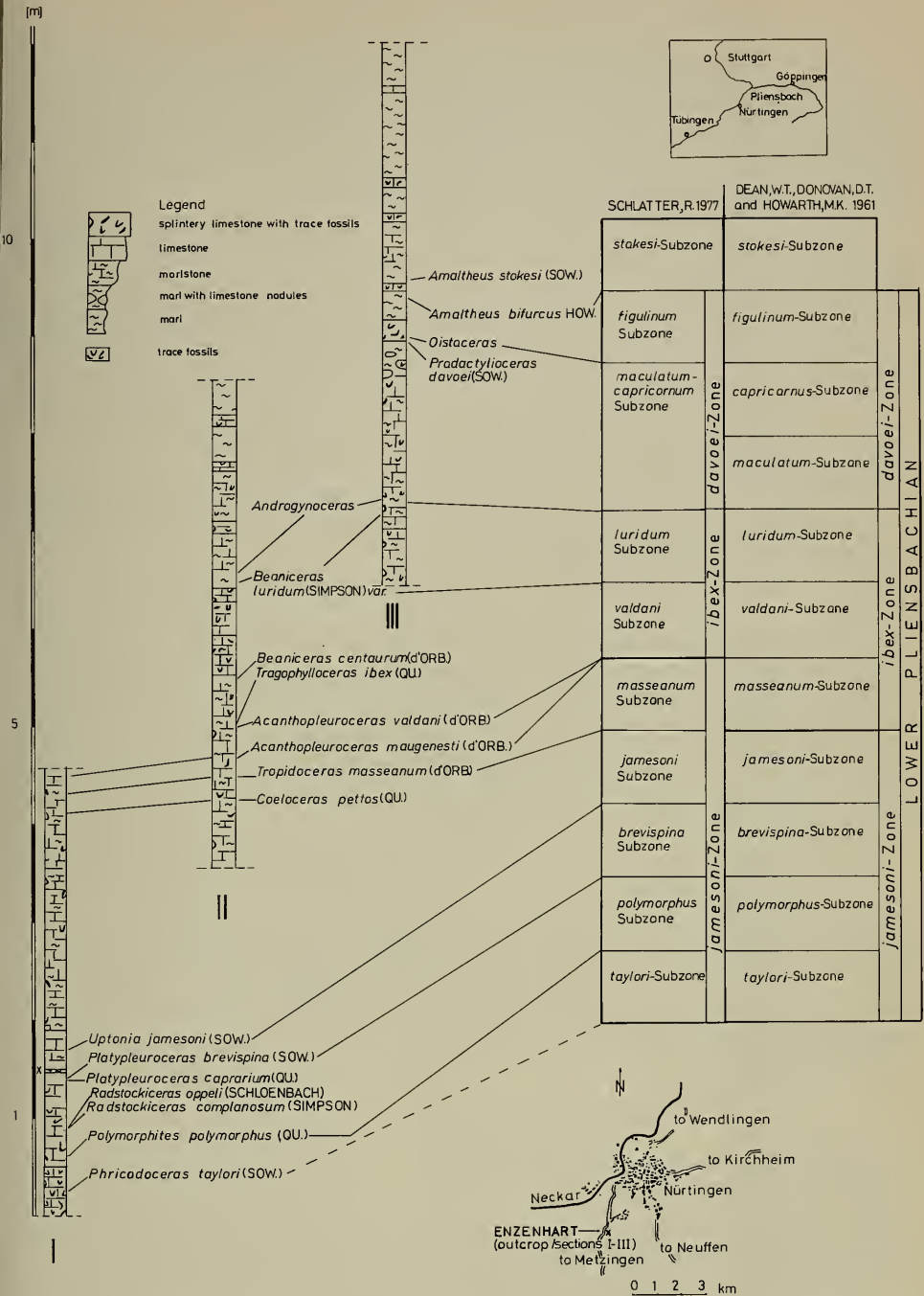


Fig. 4. Sections within the lower Pliensbachian at Nürtingen. The limit upper Sinemurian / lower Pliensbachian is situated about 1,5 m below the base of section 1.

The *taylori* Subzone

GEYER (1964, 164) has proposed to raise the *taylori* Subzone (sensu DEAN et al. 1961, 462) to the rank of a zone, because *Uptonia* occurs later than *Phricodoceras*. For reasons discussed below (see *jamesoni* Subzone) there is a considerable interval between the *taylori* and the *jamesoni* Subzones, and therefore it is not necessary to establish a separate zone of *Phricodoceras taylori* (Sow.).

In the middle part of the Cymbiumbank, only a few centimeters above the lithologic change Schwarzer Jura β/γ , *Apoderoceras nodogigas* (Qu.) appears (see pl. 1, fig. 1 a, b; figs. 1, 3).

In this relation the following note is remarkable. The term *Armatusbett*, defined by OPPEL (1856, 237, 239), who used it for the basal bed of the Pliensbachian, but pointed out that the usage depends on the correct identification of SOWERBY's *Ammonites armatus*, was rejected by SPATH (1942). The "*Ammonites armatus*" (sensu OPPEL 1856) belongs to the genus *Apoderoceras* (*nodogigas* group) in the Eoderoceratids (according to SPATH 1942; DEAN et al. 1961, 459).

The genus *Apoderoceras* is characteristic of the lower part of the *taylori* Subzone of the stratotype. An assemblage of *Apoderoceras* (*nodogigas* group) and *Phricodoceras* cannot be observed at Pliensbach.

In the upper part of the *taylori* Subzone the index species appears (see pl. 1, fig. 2 a, b).

The vertical range of *Phricodoceras taylori* (Sow.) is reduced to only about 30 cm at the stratotype. The vertical range of about 1 m, as stated by GEYER (1964, fig. 2), is not confirmed. In BERTSCH (1878, 51), QUENSTEDT (1884, 200), and RAPP (1931, 11) the very limited vertical range of *Phricodoceras* is emphasized too. The appearance of *Radstockiceras complanosum* (SIMPSON) before the first occurrence of *Phricodoceras taylori* (Sow.) (as stated by GEYER 1964, fig. 2) is in contrast to the observations of the author (see *polymorphus* Subzone).

In the condensed succession of Aselfingen (South Baden) HOFFMANN (1964, 139) recorded *Apoderoceras nodogigas* (Qu.) and only a few centimeters above *Metoxy-noticeras oppeli* (SCHLOENBACH). Both ammonites appear in a splintery, grey, partly phosphoritic limestone of about 30–40 cm thickness. The remarkable occurrence of *Phricodoceras taylori* (Sow.) in layers referable to the *ibex* Zone, as mentioned by FUTTERER (1893, 285, 289, 323) from Östringen (Langenbrückener Senke, south of Heidelberg), is not confirmed in the type area.

The *polymorphus* Subzone

A "*polymorphus* horizon" introduced by SPATH (1923, 9) and later abandoned (1942) has been defined as a subzone by DEAN et al. (1961, 463). The first occurrence of the genus *Radstockiceras* (= *Metoxynoticeras*) can be recognized directly above the bed with *Phricodoceras taylori* (Sow.) in Pliensbach and Nürtingen (see pl. 1, fig. 4; figs 3, 4). The index species *Polymorphites polymorphus* (Qu.) (see pl. 1, fig. 3 a, b) (according to the lectotype designated by DONOVAN & FORSEY 1973, 11) appears in the same horizon as *Radstockiceras* in both sections.

The other varieties of the genus *Polymorphites*, listed and figured by QUENSTEDT (1849, pl. 4, fig. 1–13), appear in the upper part of the *polymorphus* Subzone and are very common in the middle part of the *brevispina* Subzone. *Platypleuroceras ca-*

prarium (Qu.) (see pl. 2, fig. 1 a, b) is referable to the higher beds of the *polymorphus* Subzone (SPATH 1926, 47; DEAN et al. 1961, 463).

The stratigraphic horizon of *Platypleuroceras caprarium* (Qu.) can be fixed by only a few specimens of Nürtingen (section I). A questionable outer whorl was found in a corresponding horizon at the stratotype (Staatl. Mus. f. Naturk. Stuttgart, no. 23198). *Platypleuroceras caprarium* (Qu.) seems to be rare in SW Germany (QUENSTEDT 1858, 131). This is confirmed by examining the collections at Tübingen, Karlsruhe, Heidelberg, Munich.

In the intervall between the *taylori*- and *polymorphus* Subzones the genera *Epi-deroceras*, *Hyperderoceras*, *Microderoceras*, and (?) *Coeloderoceras* appear as rarities. In this transition the first Liparoceratids, such as *Liparoceras (Parinodicerias) reineckii* (Qu.) (Staatl. Mus. f. Naturk. Stuttgart, no. 23199), occur in Pliensbach. Based on this record the stratigraphic horizon of this species can be fixed accurately for the first time in Baden-Württemberg (see also SPATH 1938, 34, 81).

The great development of *Tragophylloceras numismale* (Qu.) in the *polymorphus* Subzone is noteworthy. In Nürtingen *Tragophylloceras numismale* (Qu.) represents about two thirds of the ammonite fauna collected in the sequence between the first appearance of *Radstockiceras* and the beginning of the *brevispina* Subzone, marked by the occurrence of *Platypleuroceras brevispina* (Sow.) (see also HOWARTH & DONOVAN 1964, 293, fig. 2). In this connection it is remarkable that there is no lithologic change in this layers containing the numerous Phylloceratids.

In a study about the Lias of the Langenbrückener Senke (section Zeutern, south of Heidelberg) HOFFMANN (1935, 71) distinguished in a corresponding horizon a "Zone des *Tragophylloceras heterophyllus numismale* (Qu.)". This proposed Zone is represented by a marl sequence of 1.40 m, situated below beds representing the *jamesoni* Zone [Zone der *Dumortieria jamesoni* (Sow.)].

The top of the *polymorphus* Subzone is marked by the occurrence of diverse species of *Crucilobicerias* [above all *Crucilobicerias submuticum* (OPPEL) and its allies].

The *brevispina* Subzone

The identification of the index species *Platypleuroceras brevispina* (Sow.) is doubtful because the holotype represents only a fragmentary outer whorl (examined by the author). Therefore this species cannot be properly interpreted.

Regarding this fact it is very difficult to identify a corresponding specimen in the collected material from Pliensbach and Nürtingen. The figured specimen on pl. 2, fig. 2 a, b, and an additional specimen (Staatl. Mus. f. Naturk. Stuttgart, no. 23293) from the same bed agree not only well with SOWERBY's type figure, but also with the specimen figured in QUENSTEDT (1885, pl. 33, fig. 6).

Further significant indications about *Platypleuroceras brevispina* (Sow.) and *Platypleuroceras caprarium* (Qu.) are given by QUENSTEDT (1885, 261, pl. 33, fig. 6) and SCHINDEWOLF (1962, 528, fig. 116).

The large number of ammonites described as "*Ammonites natrix rotundus*" and "*Ammonites natrix oblungus*" by QUENSTEDT (1885) show partly a more complicated suture and differ in the whorl-section and the ribbing. In the more recent geological literature this questionable group of ammonites is listed often under the genus *Crucilobicerias* (BREMER 1965; HOFFMANN 1973, 3). A more detailed account about the state of this heterogenous group is in preparation and will be not treated in this preliminary paper.

The genus *Platypleuroceras* is not abundant in the lower Pliensbachian of the type area. In Nürtingen *Platypleuroceras brevispina* (Sow.) occurs in association with *Cruciloboceras submuticum* (OPPEL) (see pl. 2, fig. 3 a, b) and *Cruciloboceras rotundum* (Qu.) (see pl. 2, fig. 4 a, b) and its allies. The determination of the genus of both species is based on the revised nomenclature in "Ammoniten des Schwäbischen Jura. I Schwarzer Jura; QUENSTEDT 1882—1885" proposed by HOFFMANN (1973, 3).

About in the middle part of the subzone a very fossiliferous bed (5 ± 2 cm thick) is found in Pliensbach and Nürtingen (see fig. 3, 4; the bed is marked by a x-sign). The ammonite fauna is characterized by a large number of *Polymorphites*, such as *Polymorphites lineatus* (Qu.) and *Polymorphites mixtus* (Qu.). Contrary to GEYER (1964, fig. 2) *Platypleuroceras brevispina* (Sow.) does not reach into the beds of *Uptonia* in Pliensbach and Nürtingen.

The *brevispina* Subzone includes a part of the "Natrices-Stufe" in the sense of QUENSTEDT (1884, 200) (see tab. 1). With the beginning of the *brevispina* Subzone the following genera disappear: *Epideroceras*, *Hyperderoceras*, and *Microderoceras*.

The *jamesoni* Subzone

The base of the subzone is marked by the appearance of the genus *Uptonia*. The identification of the index species *Uptonia jamesoni* (Sow.) is very problematic, according to SOWERBY 1827, pl. 555, fig. 1 (see also QUENSTEDT 1858, 125).

The neotype proposed by DONOVAN & FORSEY (1973, 13, pl. 4, fig. 3 a, b) corresponds well in the whorl-section with the type figure, except of having a finer ribbing (the original of the neotype has been examined by the author). The determination herein has been made according to the proposed neotype. The presence of identical rib-densities on two successive whorls, corresponding to the type figure in SOWERBY, is confirmed by only a few specimens from Nürtingen, but some of these differ in having a more or less rounded whorl section (cf. QUENSTEDT 1885, pl. 34, figs. 1—3). This type of *Uptonia* (Staatl. Mus. f. Naturk. Stuttgart, no. 23200) represents the first occurrence of this genus in Nürtingen and marks the base of the *jamesoni* Subzone. The base is only a few centimeters above the fossiliferous bed containing the rich *Polymorphites* fauna (see *brevispina* Subzone).

A corresponding situation has been observed at the stratotype.

The appearance of *Uptonia jamesoni* (Sow.) and its allies, as stated by RAPP (1931, 58, section Nürtingen) and GEYER (1964, fig. 2, section Pliensbach) in association with *Acanthopleuroceras maugenesi* (D'ORB.), is not confirmed. QUENSTEDT (1858, 125; 1885, 252) emphasized the more reduced vertical range of *Uptonia* and used this fact against OPPEL's definition of the Jamesonibett. In 1884 QUENSTEDT (p. 200) introduced a "Stufe des *Ammonites jamesoni*" situated above the Natrices Stufe (see tab. 1). The occurrence of *Ammonites jamesoni* Sow. within the "Zwischenkalke" γ/δ , as observed by QUENSTEDT (1884, 200) and BERTSCH (1878, 39; only in the "Davoeibank"), must be a confusion with the genus *Oistoceras* looking like an *Uptonia* on the external side.

The different forms of *Uptonia*, recognized in Pliensbach and Nürtingen, show a great variability in the density of ribbing and in the whorl-section. The change from finer to coarser ribbed specimens is documented in a large number of transition stages. A study of evolutionary trends in these forms is in preparation by the author.

In the upper part of the *jamesoni* Subzone the genus *Uptonia* is very common (see pl. 3, fig. 1 a, b). In the section of reduced thickness at Pliensbach this fact is conspicuous.

The great vertical range of *Uptonia* in the stratotype, as recognized by GEYER (1964, fig. 2), is in contrast to my results. The later appearance of *Uptonia*, as observed by the author, transferred into the scheme of GEYER (1964, fig. 2) would constitute a non-defined interval between the *taylori* and the *jamesoni* Zones (sensu GEYER). There is thus no reason for defining a separate *taylori* Zone. In the same way the author should have to define a *polymorphus* and a *brevispina* Zone according to the considerations for defining the *taylori* Zone by GEYER. Moreover the use of stratigraphic terms like this would mean an unnecessary change of the well documented biostratigraphic scheme of DEAN et al. 1961.

A noteworthy horizon can be fixed in the uppermost part of the *jamesoni* Subzone containing a large number of *Coeloceras pettos* (Qu.) and its allies, such as *Coeloceras pettos grenouillouxi* (D'ORB.), (?) *Coeloceras pettos planula* (Qu.), and as rarity *Coeloceras pettos pinguecostatum* BREMER. This remarkable bed can be fixed about 20 cm in Pliensbach and about 40 cm in Nürtingen below the beds characterized by the first appearance of the genus *Tropidoceras*. The vertical range of *Coeloceras pettos* (Qu.) corresponds to a marl sequence of about 15 cm at both localities. In the upper *ibex* and *davoei* Zones the occurrence of *Coeloceras* and forms of the Eoderoceratids and Polymorphitids could not be ascertained.

BEURLEN (1924) recorded a few of these forms of the upper Pliensbachian as rarities.

The observation of this reduced vertical range of *Coeloceras pettos* (Qu.) and its allies in Pliensbach and Nürtingen stands in contrast to the records made by GEYER (1964, fig. 2), but agrees to the results obtained by THOMPSON (1899, 75) and LANG (1928, 192) in the British succession.

The genus *Polymorphites* is less abundant in the *jamesoni* Subzone than in the *brevispina* Subzone.

The assemblage of the following ammonites within the *jamesoni* Zone listed by RAPP (1931, 57 f.) and GEYER (1964, fig. 2) is questioned:

Acanthopleuroceras valdani (D'ORB.)

Acanthopleuroceras maugenesti (D'ORB.)

Acanthopleuroceras natrix (ZIETEN)? non SCHLOTHEIM

The holotype of "*Ammonites natrix* SCHLOTHEIM (?)" (in: ZIETEN 1830, 5, pl. 4, fig. 5) can no longer be found (according to GETTY 1970, 105, and vain attempts by the author). A specimen corresponding to the type figure could not be found in Pliensbach and Nürtingen. The broad and blunt venter of the type figure represents the most conspicuous feature. According to GETTY (1970, 106) and the author, an objective base for interpreting the species is impossible.

Especially at the beginning of this century many authors considered the type figure in ZIETEN ("*Ammonites natrix* SCHLOTHEIM (?)" ; pl. 4, fig. 5) as a synonym to the group of ammonites such as *Ammonites natrix rotundus* (Qu.) and *Ammonites*

natrix oblungus (Qu.) (QUENSTEDT 1849, pl. 4, fig. 16, 17). This confusion and the uncertainty of the interpretation of "*Ammonites natrix* SCHLOTHEIM (?)" (sensu ZIETEN) is treated more in detail by BREMER (1965, 185 f., 191) and GETTY (1970, 105 f.; 1973, 13).

The *masseanum* Subzone

For reasons discussed in the introduction to the *jamesoni* Zone, the *masseanum* Subzone (sensu DEAN et al. 1961, 464) is included into the *jamesoni* Zone herein.

At the type locality the index species *Tropidoceras masseanum* (D'ORB.) (see pl. 3, fig. 2 a, b) and its allies appear before the extinction of *Uptonia*. OPPEL (1853, 41; 1856, 238, 281) signified *Tropidoceras masseanum* (D'ORB.) as a typical ammonite of his Jamesonibett.

In Pliensbach and Nürtingen *Tropidoceras* persists into the beds with *Acanthopleuroceras valdani* (D'ORB.). In the transition *jamesoni/masseanum* Subzone *Tragophylloceras undulatum* (SMITH) appears (see also HOWARTH & DONOVAN 1964, 297 f.).

Basing on the sections of Pliensbach and Nürtingen the vertical range of *Tropidoceras* is fixed for the first time.

3.2.4. The *ibex* Zone

The sequence of layers representing the *ibex* Zone has been studied more in detail in the section of Nürtingen. The index species *Tragophylloceras ibex* (Qu.) (see pl. 3, fig. 3 a, b) is more abundant in Nürtingen than at the type locality. The vertical range is restricted to a marl sequence of about 20 cm at Nürtingen and in Pliensbach it is even more reduced. RAPP (1931, 58) listed no specimens from Nürtingen.

The *ibex* Zone is characterized by the appearance of the genus *Acanthopleuroceras*, too. An assemblage of the genus *Tropidoceras* and *Acanthopleuroceras* can be observed in both localities. *Tropidoceras* appears as a rarity in these higher beds. This overlapping has been observed and fixed accurately in Nürtingen only.

The record of *Acanthopleuroceras maugenesti* (D'ORB.) in the same horizon where *Uptonia* occurs for the first time (as mentioned in GEYER 1964, fig. 2, section Pliensbach) is very questionable.

The *valdani* Subzone (= *binotatum* Subzone sensu GETTY 1970)

According to the definition in DEAN et al. (1961, 465), *Acanthopleuroceras* is characteristic of the *valdani* Subzone. In Nürtingen and Pliensbach the beginning of the subzone is marked by the appearance of *Acanthopleuroceras maugenesti* (D'ORB.) and its allies, such as *Acanthopleuroceras arietiforme* (OPPEL). The bed with these ammonites can be distinguished from a higher sequence of marls signified by the first occurrence of *Acanthopleuroceras valdani* (D'ORB.) [= *Acanthopleuroceras binotatum* (OPPEL) according to GETTY 1970, 108] (see pl. 4, fig. 1 a, b). In the transition part *Tragophylloceras ibex* (Qu.) appears as rarity, but in the higher bed with *Acanthopleuroceras valdani* (D'ORB.) it is more common.

The species *Beaniceras centaurus* (D'ORB.) is identified in the same horizon where *Acanthopleuroceras valdani* (D'ORB.) occurs (see pl. 4, fig. 2 a—c).

The subdivision of the *ibex* Zone into a "*maugenesti*, *actaeon*, and *centaurus* horizon" proposed by SPATH (1923, 9) is questionable. *Tropidoceras actaeon* (D'ORB.) may represent an undeterminable inner whorl. Forms corresponding to the text-figure (D'ORBIGNY 1842, pl. 61, fig. 1—3) have been found too in the *masseanum* Subzone in Nürtingen. The species *Beaniceras centaurus* (D'ORB.) survives into higher beds than *Acanthopleuroceras valdani* (D'ORB.).

In the upper half of the *valdani* Subzone species of *Liparoceras* occur, such as *Liparoceras zietenii* (Qu.) and *Liparoceras bronni* SPATH.

The *luridum* Subzone

An undeterminable variation of the index species *Beaniceras luridum* (SIMPSON) has been recorded from the section of Nürtingen for the first time. Based on this record it is given the first proof of the *luridum* Subzone in Baden-Württemberg. The specimen (figured herein, pl. 4, fig. 3) corresponds well with the listed specimen from the Dorset Coast (bed 121) by SPATH (1938, 102; B.M.C. 39159, J. Francis Coll. 1927). The original of SPATH has been examined by the author in the British Museum (Natural History). On the original label this ammonite is determined as *Beaniceras luridum* (SIMPSON) by SPATH.

In Nürtingen two beds of *Beaniceras* can be distinguished. The lower one belongs to the higher part of the *valdani* Subzone (see above). It contains mainly a large number of *Beaniceras centaurus* (D'ORB.). Less abundant are species such as *Beaniceras costatum* S. BUCKMAN and *Beaniceras rotundum* S. BUCKMAN. About half a meter above *Beaniceras centaurus* (D'ORB.) can no longer be found.

This level is poor in ammonites but contains forms which belong to the *luridum* group. A more detailed account about the ammonite succession in these beds is in preparation.

According to the determination by ZEISS (1965, 47) of the "*Ophioceras* cfr. *rari-costatum* (ZIET.) Qu." listed in KRUMBECK (1932, 89) as *Beaniceras luridum* (SIMPSON), it is given an identification of the *luridum* Subzone in the Franconian Alb.

The supposed assemblage of *Tragophylloceras ibex* (Qu.) with *Androgynoceras maculatum* (YOUNG & BIRD) (see GEYER 1964, 164) is not confirmed in both sections.

The species *Tragophylloceras loscombi* (Sow.) characteristic of the uppermost part of the *ibex* Zone in the British succession (DEAN et al. 1961, 466; DONOVAN & HOWARTH 1964, 293, 301 f.) is absent in Pliensbach and Nürtingen and has been never recorded and figured from Baden-Württemberg so far. A large number of "*Tragophylloceras loscombi* (Sow.);" listed and figured in the geological literature of SW Germany corresponds with the similar *Tragophylloceras undulatum* (SMITH) (e.g. FUTTERER 1893, 302 f., pl. 8, figs. 5—8) which is common and widely distributed in Baden-Württemberg.

3.2.5. The *davoei* Zone

The index species *Productylioceras davoei* (Sow.) (see pl. 4, fig. 4) occurs in a very characteristic limestone, indicated as "*Davoeibank*" by RAPP (1931) and GOTTLIEB (1955, fig. 5). This splintery compact limestone of a light colour with dark spots representing trace fossils is a good reference point for the geologist in the field.

In accord to the observations made by RAPP (1931, 57; section Nürtingen only) and in contrast to GOTTLIEB (1955, 29; section Pliensbach) the index species has been only found in the layer no. 25 (sensu GOTTLIEB). Mainly the upper third of the Numismalmergel is built up by a sequence of compact limestones and marls. Therefore it is possible to compare the sections in RAPP (1931; section Nürtingen), GOTTLIEB (1955; section Pliensbach), and GEYER (1964, fig. 2; section Pliensbach). This possibility is not given in generalized sections, e. g. representations like tab. 1, 2 in RAPP (1931) and in GEYER (in GEYER & GWINNER 1962, fig. 10). In the publications of GOTTLIEB (1955, fig. 5) and GEYER (1964, fig. 2) the Davoeibank of the stratotype has been figured twice (corresponding remarks, see 3.2.6).

The *maculatum-capricornus* Subzone

The preservation of the fossils in the layers representing the *davoei* Zone is very bad in the type area. Only fragments of the ammonites are preserved in the compact and splintery limestone. If the venter is visible the two genera *Androgynoceras* and *Oistoceras* can be recognized. Therefore the base of the *maculatum-capricornus* Subzone is defined herein by the first appearance of the genus *Androgynoceras*.

It is remarkable that SPATH (1938) listed *Androgynoceras maculatum* (Y. & B.) from Nürtingen and Göppingen (on p. 132, 133) and *Androgynoceras capricornus* (SCHLOTHEIM) from Pliensbach and Göppingen. The two figured *Androgynoceras* (pl. 4, fig. 5 a, b and 6 a, b) indicate the *maculatum* and *capricornus* Subzones, as proposed by DEAN et al. (1961, 466 f.) for the British succession. But in the type area the limit between the two subzones cannot be fixed, because there are intervals of marls and indurated marls which contain a lot of crushed indeterminable ammonites of the genus *Androgynoceras* s. l. The specimens of *Androgynoceras* mentioned by SPATH (see above) descend from the compact limestone (examined by the author).

The *figulinum* Subzone

In the sections of Pliensbach and Nürtingen the genus *Oistoceras* appears in association with *Productylioceras davoei* (Sow.). According to the definition in DEAN et al. (1961, 468), the base of the *figulinum* Subzone is marked by the appearance of the genus *Oistoceras*. The species *Oistoceras figulinum* (SIMPSON), well-known in the uppermost part of the *davoei* Zone in Britain, seems to be replaced by *Oistoceras angulatum* (Qu.) (see pl. 4, fig. 7 a, b) in Baden-Württemberg. *Oistoceras figulinum* (SIMPSON) has been never recorded or figured from SW Germany so far. JORDAN (1960, 122) mentioned a record of "*Oistoceras figulinum?*" from the section at Aselgingen (South Baden).

The occurrence of *Androgynoceras* s. str. in beds with *Oistoceras*, as recognized by MOUTERDE (1953, 409) from the northern side of the Massif Central and SPATH (1956, 145) from Gloucester and Lincolnshire, cannot be confirmed in Pliensbach and Nürtingen. But it must be pointed out that this statement includes an uncertainty factor depending on the bad preservation of the ammonites in the type area of the Pliensbachian.

The species *Bedheiceras bedhei* (Sow.) occurs in the beds with *Productylioceras davoei* (Sow.), but it has been recognized in higher beds too representing the *marginatus* Zone. According to SPATH (1956, 145), the less stratigraphic value of this species in Britain is also confirmed in the type area.

Tab. 1. Comparison of subdivisions of the Numismalmergel in Baden-Württemberg

| QUENSTEDT 1843 | OPPEL 1855 | PFIZENMAYER & QUENSTEDT 1855 | QUENSTEDT 1856 | Section Hinterweiler (region of Balingen) BERASCHE 1876/1878 | QUENSTEDT 1884, 1885 | RAPP 1931 Middle Swabian Alb | GOTTLIEB 1955 Sections Pliensbach and Kirchheim |
|---|---|---|--|--|--|--|---|
| Amaltheenthone [clays with Amaltheids] = Schwarzer Jura δ | Eigentliche Amaltheenthone [clays with Amaltheids] Hellblaue Thone, dazwischen die Lineatenbank [light blue clays with the intermediate "Lineaten" bench] | Eigentliche Amaltheenthone [clays with Amaltheids] Region des <i>Ammonites lineatus</i> [sequence with <i>Ammonites lineatus</i>] | Amaltheenthon [clays with Amaltheids] Zwischenkalke (γδ) [intermediate limestones between γδ] | Upper γ | Region der Lineaten (with a reference note to the publication of 1853) Zwischenlager (γ/δ) [transition intervall γ/δ] | Amaltheenbank [bench with Amaltheids] Übergangshorizont γ/δ (sensu QUENSTEDT 1858; 1885) Upper γ | Both sections Pliensbach and Kirchheim have been subdivided into 25 benches by GOTTLIEB. The list of ammonites (p. 28 f.) is insufficient to give an interpretation of the biostratigraphy in the type area. Upper γ benches 17–25 (oo. 25 = "Davoeibank") |
| Numismalmergel [numismal marls] = Schwarzer Jura γ | Region des <i>Ammonites davoei</i> (the top is characterized by the appearance of <i>Inoceramus nobilis</i> (GOLDFUSS)) Muscheln verkalkt [the fossils are preserved as calcareous casts] | Davoei Kalke [davoei limestones] | Davoeikalke [davoei limestone] Dunkel gefleckte Kalkbänke [dark spotted limestones] | Obergrenze Bank mit <i>Inoceramus nobilis</i> (GOLDFUSS) [top, indicated by a bench with <i>Inoceramus nobilis</i>] Davoeibänke or Davoeiregion [davoei benches] | Four geomorphologic "Treppen" (QUENSTEDT 1884, 200): Vierte Treppe: <i>Ammonites davoei</i> | Fleckenkalkbänke A–D [spotted limestone benches A–D] | Middle γ benches 6–16 |
| or: Region der Steinmergel [sequence of marlstones] or: Grauschläger Steinmergel mit <i>Terebratalia numismalis</i> [spotted marlstones with <i>Terebratalia numismalis</i>] | Middle Lias γ Region der verküsten Ammoniten [sequence with pyritized ammonites] | Region der verküsten Ammoniten [sequence with pyritized ammonites] | Rostige Kallmergel [rusty marl stones] include: Subangulaten- und Basal- formenbank (named after crinoids). | Middle γ Auftreten der verküsten Ammoniten or: Region der verküsten Ammoniten [sequence with pyritized ammonites] | Dritte Treppe: <i>Ammonites jamesoni</i> Zweite Treppe: Natries Erste Treppe: <i>Ammonites taylori</i> | Middle γ spotted limestone benches III–a; 4 i.e. 3 benches depends on the inclusion of bench a. | Middle γ benches 1–5 (benches 1 + 2: "Cymbium-Region") |
| Turnerithone [turneri clays] = Schwarzer Jura β | Lower Lias γ Hauptregion der <i>Gryphaea cymbium</i> [this part of the section is characterized by the large number of <i>Gryphaea cymbium</i>] Muscheln verkalkt [the fossils are preserved as calcareous casts] | Cymbienbank [cymbium bench] (named after <i>Gryphaea cymbium</i>) | Spiriferinenbank [bench with Spiriferids] ("Spiriferina verrucosus") <i>Gryphaea cymbium</i> is mentioned as a characteristic fossil of the transition Schwarzer Jura β γ. The term "Cym- biumbank" is used again in the following works (QUENSTEDT 1867; 1884) | Lower γ Gryphaeenbank [bench with <i>Gryphaea</i>] The top of the lower " is defined by the disappearance of <i>Gryphaea cymbium</i> | Cymbiumbank mit <i>Ammonites arnatus</i> nodigiger QU. [bench with <i>Gryphaea cymbium</i> and <i>Amn. arnatus nodigiger</i>] Cymbiumbank + 4 "Treppen" = 5 "Abtheilungen" (QUENSTEDT 1884, 200) | Lower γ Kalkbank I, Fleckenkalkbank II und III [limestone bench I, spotted lime- stone benches II and III] | Lower γ benches 1–5 (benches 1 + 2: "Cymbium-Region") |
| Geodenbank mit <i>Amn. raricosatus</i> [nodules with <i>Amn. raricosatus</i>] Turnerithone [turneri clays] | Raricostatenbank [horizon with <i>Ammonites raricosatus</i>] (The Turnerithone represent the base of the Schwarzer Jura β) | Raricostatenbank [sequence with <i>Amn. raricosatus</i>] | Raricostatenbank [sequence with <i>Amn. raricosatus</i>] | Ammonitenregion 5 mit <i>Ammonites raricosatus</i> [Ammonite horizon no. 5, characterized by <i>Ammonites raricosatus</i>] | Ammonitenregion 5 mit <i>Ammonites raricosatus</i> [Ammonite horizon no. 5, characterized by <i>Ammonites raricosatus</i>] | Ammonitenregion 5 mit <i>Ammonites raricosatus</i> [Ammonite horizon no. 5, characterized by <i>Ammonites raricosatus</i>] | |
| OPPEL 1856–1858 | FUTTERER 1893 Östringen (south of Heidelberg), Langenbrückener Senke | GEYER (in: GEYER & GWINNER 1902) | GEYER 1904 Pliensbach, Type locality | SCHLATTER 1977 Pliensbach, Nürtingen (Type area) | | | |
| Margaritatusbett Unteres Margaritatusbett = untere Zone des <i>Ammonites margaritatus</i> [lower zone of <i>Ammonites margaritatus</i>] [this lower zone of <i>Ammonites margaritatus</i> is situated in the upper part of the "Numismalmergel" QUENSTEDT's] | Grenzkalke Schwarzjura Ober-γ [upper γ] | Zone der <i>Uptonia jamesoni</i> (Sow.) [jamesoni Zone] | Zone der <i>Uptonia jamesoni</i> (Sow.) [jamesoni Zone] | Zone der <i>Uptonia jamesoni</i> (Sow.) [jamesoni Zone] | Zone der <i>Uptonia jamesoni</i> (Sow.) [jamesoni Zone] | Zone der <i>Uptonia jamesoni</i> (Sow.) [jamesoni Zone] | The Schwarzer Jura γ includes in the upper part a sequence of marls and limestones referable to the Unteres Margaritatusbett = lower <i>margaritatus</i> Zoone sensu OPPEL (1856, 251). stohesi Subzone |
| Davöibett Zone des <i>Ammonites davöi</i> [Zone of <i>Ammonites davöi</i>] | Davöischichten [davoei beds] | Zone des <i>Productyllocceras davoei</i> (Sow.) [davoei Zone] | Zone des <i>Productyllocceras davoei</i> (Sow.) [davoei Zone] | Zone des <i>Productyllocceras davoei</i> (Sow.) [davoei Zone] | Zone des <i>Productyllocceras davoei</i> (Sow.) [davoei Zone] | Zone des <i>Productyllocceras davoei</i> (Sow.) [davoei Zone] | fig. 1. an Subzone |
| Ibexbett Zone des <i>Ammonites ibex</i> [Zone of <i>Ammonites ibex</i>] | Ibexschichten [ibex beds] or: Zone of <i>Ammonites binotatus</i> OPPEL proposed as synonym, because <i>Phyllocceras ibex</i> occurs as rarity at Östringen. | Zone des <i>Tragophyllocceras ibex</i> (QU.) [ibex Zone] | Zone des <i>Tragophyllocceras ibex</i> (QU.) [ibex Zone] | Zone des <i>Tragophyllocceras ibex</i> (QU.) [ibex Zone] | Zone des <i>Tragophyllocceras ibex</i> (QU.) [ibex Zone] | Zone des <i>Tragophyllocceras ibex</i> (QU.) [ibex Zone] | ibex Zone valdani Subzone |
| Jamesonibett Zone des <i>Ammonites jamesoni</i> [Zone of <i>Ammonites jamesoni</i>] ?) Arnatusbett ? bed with SOWERBY's <i>Ammonites arnatus</i> or: Untere Jamesoni-Schichten [lower jamesoni beds] | Jamesonikalke [jamesoni limestones] According to FUTTERER this sequence of layers corre- sponds with the "3. Stufe mit <i>Amn. jamesoni</i> " QUENSTEDT (1884, 200). The occurrence of <i>Phricodoceras taylori</i> (Sow.) in layers referable to the ibex Zone is remarkable. Ac- cording to HOFFMANN (1935, 71) <i>Phricodoceras tay-</i> <i>lori</i> (Sow.) seems to be absent in the middle Lias succession of the Langenbrückener Senke (section Zeutern, near Östringen). | Zone der <i>Uptonia jamesoni</i> (Sow.) [jamesoni Zone] — at the base including the <i>taylori</i> Subzone | Zone der <i>Uptonia jamesoni</i> (Sow.) [jamesoni Zone] — at the base including the <i>taylori</i> Subzone | Zone der <i>Uptonia jamesoni</i> (Sow.) [jamesoni Zone] Zone des <i>Phricodoceras taylori</i> (Sow.) [taylori Zone] In the publication produced by GEYER & GWINNER 1904 the term <i>taylori</i> Zone (as proposed GEYER 1904; Coll. Jurassique, Luxembourg) is used as subzone again without explanation. | Zone der <i>Uptonia jamesoni</i> (Sow.) [jamesoni Zone] Zone des <i>Phricodoceras taylori</i> (Sow.) [taylori Zone] In the publication produced by GEYER & GWINNER 1904 the term <i>taylori</i> Zone (as proposed GEYER 1904; Coll. Jurassique, Luxembourg) is used as subzone again without explanation. | Zone der <i>Uptonia jamesoni</i> (Sow.) [jamesoni Zone] Zone des <i>Phricodoceras taylori</i> (Sow.) [taylori Zone] In the publication produced by GEYER & GWINNER 1904 the term <i>taylori</i> Zone (as proposed GEYER 1904; Coll. Jurassique, Luxembourg) is used as subzone again without explanation. | massanum Subzone jamesoni Subzone brevispina Subzone phricodoceras Subzone taylori Subzone |

Subdivision sensu QUENSTEDT and their usage by later authors

Biostratigraphic subdivisions based on the zonal scheme sensu OPPEL

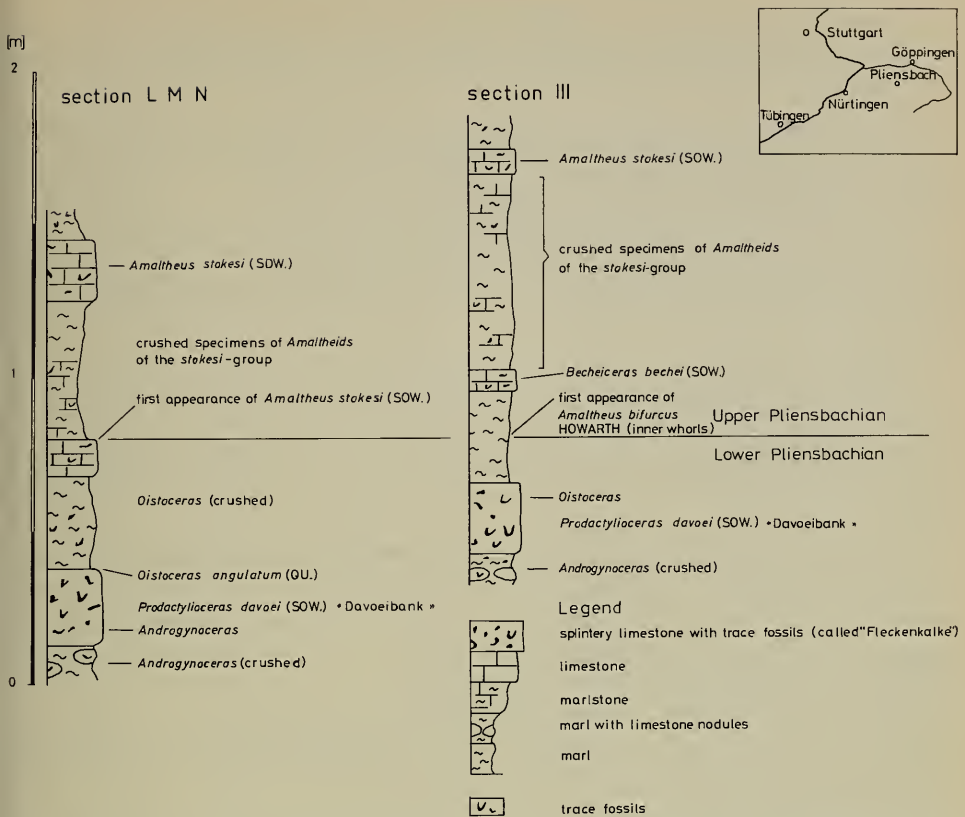


Fig. 5. Detailed sections representing the limit lower/upper Pliensbachian from Pliensbach (left) and Nürtingen (right).

3.2.6. The limit lower Pliensbachian/upper Pliensbachian

According to DEAN et al. (1961, 469), the beginning of the *margaritatus* Zone (i. e. the basal *stokesi* Subzone) is marked by the appearance of *Amaltheus stokesi* (Sow.). The biostratigraphic situation at Pliensbach and Nürtingen is shown on text-fig. 5.

A comparison between these sections shows that the index species referable to the *stokesi* Subzone, such as *Amaltheus stokesi* (Sow.) and *Amaltheus bifurcus* HOWARTH, appear for the first time in different lithologic horizons. In Nürtingen and Pliensbach ammonites of the *davoei* Zone still occur in marls above the Davoeibank. Therefore it is not possible to use the so-called "Davoeibank" as limit between lower and upper Pliensbachian (see the signification in GOTTLIEB 1955, fig. 5, in the profile of Pliensbach and the corresponding uppermost limestone bench of the *davoei* Zone in GEYER 1964, fig. 2).

An overlapping of the highest *Oistoceras* and the first *Amaltheus* has not been observed in the type area. *Amaltheus stokesi* (Sow.) is recorded at the type locality and Nürtingen for the first time. The supposition of GEYER (1964, 166) about the existence of the *stokesi* Subzone at Pliensbach can be ascertained here.

In the condensed facies of Aselfingen (South Baden) JORDAN (1960, 121 f.) has recognized a corresponding succession of ammonites in the boundary lower/upper Pliensbachian.

The mentioned "*Amaltheus*-Form" from Kirchheim by RAPP (1931, 42, tab. 2), recognized about 70 cm below the Davoeibank and characterized by having no crenulated keel, might be a crushed *Androgynoceras* s. l., because it had been found in a marl sequence and therefore a determination is problematic.

Accurate measuring of the sequence of layers in the upper part of the lower Pliensbachian at the type locality shows a remarkable difference in comparison with the measures of the sections figured in GOTTLIEB (1955, fig. 5) and GEYER (1964, fig. 2).

Between the exposures L and M (see fig. 3) a fault is present. In consequence of this fault the benches no. 23 and 25 (GOTTLIEB 1955, fig. 5) and the two benches representing the upper half of the *davoei* Zone (see GEYER 1964, fig. 2) have to be classified as one limestone bench. The fault is proved too by the double occurrence of the following ammonite succession: *Androgynoceras* — *Oistoceras* — *Amaltheus stokesi*.

The aggregate thickness of the lower Pliensbachian at the type locality is 9 meters.

In the transition lower/upper Pliensbachian there is no lithologic change. About 3 m above this limit the facies is changing from marls and limestones into dark clays. This horizon marks the limit Schwarzer Jura γ/δ (Numismalimergel / Amaltheenthone sensu QUENSTEDT 1843, 540).

In the biostratigraphic sense the interval between the first occurrence of *Amaltheus stokesi* (Sow.) and the lithologic limit γ/δ corresponds to the "Untere Zone des *Ammonites margaritatus*" (OPPEL 1856, 237, 251):

"*Amm. margaritatus* durchläuft also zwei Zonen, von welchen die untere noch mehr den Charakter der Numismalisschichten besitzt, die obere meist viel mächtigere, dagegen den Typus der eigentlichen Margaritatusschichten trägt." (OPPEL 1856, 251.)

[Translated: "Thus *Amm. margaritatus* passes through two zones, the lower one still exhibiting the character of the Numismalis beds whereas the upper, mostly much thicker zone shows the type of the true *Margaritatus* beds".]

The limit Schwarzer Jura γ/δ corresponds to the limit lower *margaritatus* Zone / upper *margaritatus* Zone (sensu OPPEL 1856, 251). The limit lower / upper Pliensbachian is situated about 3 m below the limit γ/δ at the stratotype.

Corrigenda

Fig. 3, 4: For '*capricornum*', read '*capricornus*'. (*maculatum-capricornus* Subzone')
For '*centaurum*', read '*centaurus*'. (*Beaniceras centaurus* D'ORB.)

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Plate 1

- Fig. 1. *Apoderoceras nodogigas* (QUENSTEDT). Schwarzer Jura γ , *jamesoni* Zone, *taylori* Subzone; Dewangen. Coll. Fraas 1867.
a. lateral view, b. ventral view.
Staatl. Mus. f. Naturk. Stuttgart, no. 23179. — x 1/2.
- Fig. 2. *Pluricodoceras taylori* (SOWERBY). Schwarzer Jura γ , *jamesoni* Zone, *taylori* Subzone; Pliensbach (section B).
a. lateral view, b. ventral view.
Staatl. Mus. f. Naturk. Stuttgart, no. 23180. — x 1.
- Fig. 3. *Polymorphites polymorphus* (QUENSTEDT). Schwarzer Jura γ , *jamesoni* Zone, *polymorphus* Subzone; Nürtingen (section I).
a. lateral view, b. ventral view.
Staatl. Mus. f. Naturk. Stuttgart, no. 23181. — x 1.
- Fig. 4. *Radstockiceras complanosum* (SIMPSON). Schwarzer Jura γ , *jamesoni* Zone, *polymorphus* Subzone; Nürtingen (section I).
Staatl. Mus. f. Naturk. Stuttgart, no. 23182. — x 2/3.



1b



1a



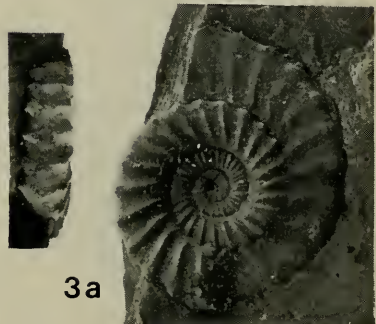
4



2a



2b



3b

3a

Plate 2

- Fig. 1. *Platypleuroceras caprarium* (QUENSTEDT). Schwarzer Jura γ , *jamesoni* Zone, *polymorphus* Subzone (upper part); Nürtingen (section I).
a. lateral view, b. ventral view.
Staatl. Mus. f. Naturk. Stuttgart, no. 23183. — x 1.
- Fig. 2. *Platypleuroceras brevispina* (SOWERBY). Schwarzer Jura γ , *jamesoni* Zone, *brevispina* Subzone; Nürtingen (section I).
a. lateral view, b. ventral view.
Staatl. Mus. f. Naturk. Stuttgart, no. 23184. — x 2/3.
- Fig. 3. *Crucilobicerias submuticum* (OPPEL). Schwarzer Jura γ , *jamesoni* Zone, *brevispina* Subzone; Nürtingen (section I).
a. lateral view, b. ventral view.
Staatl. Mus. f. Naturk. Stuttgart, no. 23185. — x 2/3.
- Fig. 4. *Crucilobicerias rotundum* (QUENSTEDT). Schwarzer Jura γ , *jamesoni* Zone, *brevispina* Subzone (upper part); Nürtingen (section I).
a. lateral view, b. ventral view.
Staatl. Mus. f. Naturk. Stuttgart, no. 23186. — x 1.
- Fig. 5. *Coeloceras pettos* (QUENSTEDT). Original of ZIETEN 1830, p. 1, pl. 1, fig. 4 a—d: *Ammonites crenatus* REINECKE; designated lectotype and refigured by DONOVAN & FORSEY 1973, p. 10, pl. 2, fig. 2 a, b. Schwarzer Jura γ , *jamesoni* Zone („Lias-Schiefer von Gamelshausen“); Pliensbach (original label).
a. lateral view, b. ventral view.
Bayerische Staatssammlung für Paläontologie und historische Geologie, München. — x 1.

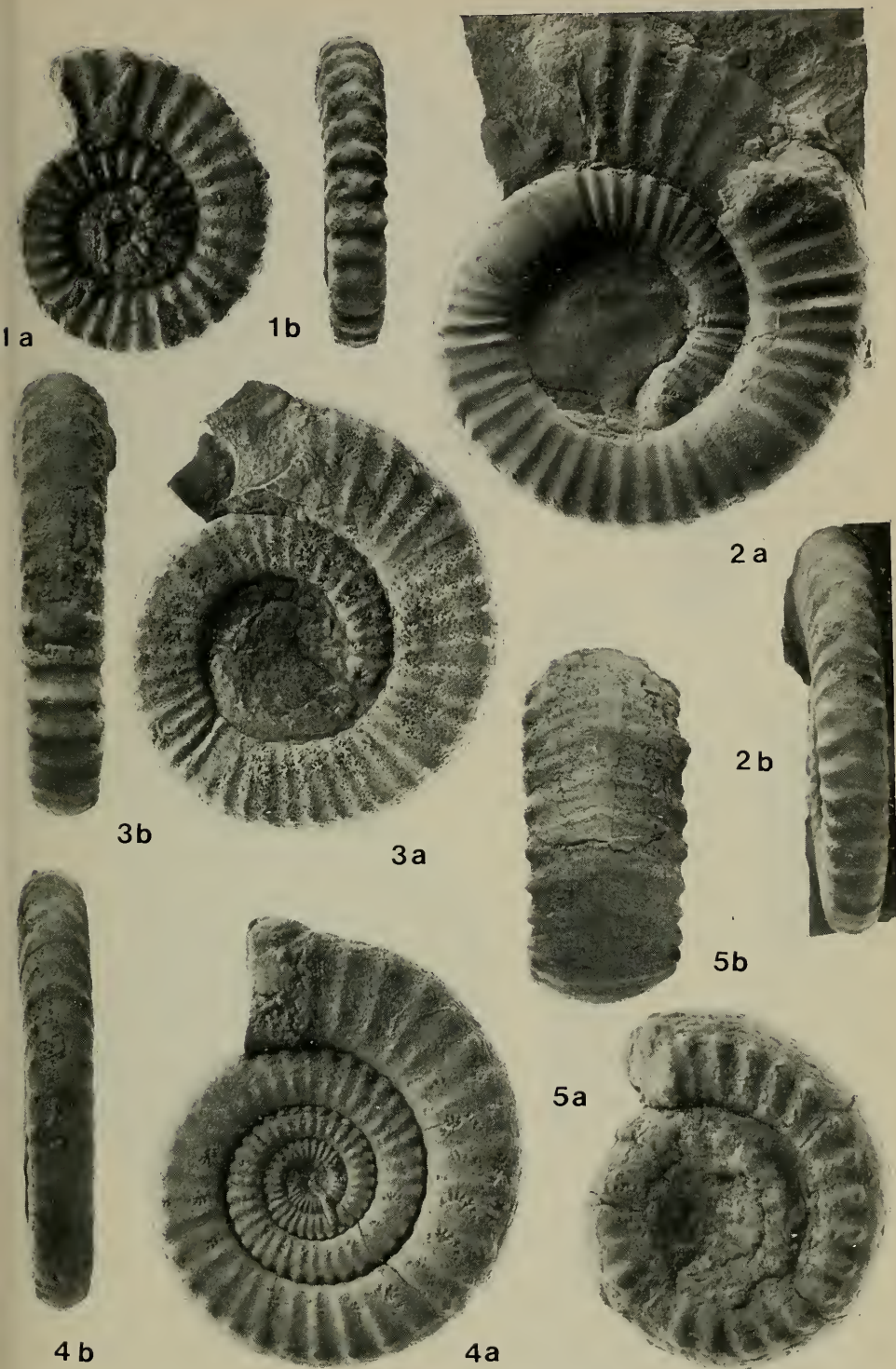


Plate 3

- Fig. 1. *Uptonia „jamesoni“* (SOWERBY). The determination herein has been made according to the proposed neotype (DONOVAN & FORSEY 1973, 13, pl. 4, fig. 3 a, b). Schwarzer Jura γ , *jamesoni* Zone, *jamesoni* Subzone (upper part); Holzmaden (Lindach).
a. lateral view, b. ventral view.
Staatl. Mus. f. Naturk. Stuttgart, no. 23187. — x 2/3.
- Fig. 2. *Tropidoceras masseanum* (D'ORBIGNY). Schwarzer Jura γ , *jamesoni* Zone, *masseanum* Subzone; Nürtingen (section III). Coll. R. Flaig, Unterensingen.
a. lateral view, b. ventral view.
Staatl. Mus. f. Naturk. Stuttgart, no. 23188. — x 2/3.
- Fig. 3. *Tragophylloceras ibex* (QUENSTEDT). Schwarzer Jura γ , *ibex* Zone; Nürtingen (section II).
a. lateral view, b. ventral view.
Staatl. Mus. f. Naturk. Stuttgart, no. 23189. — x 1.



1a



1b



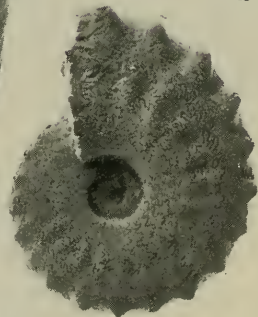
2a



2b



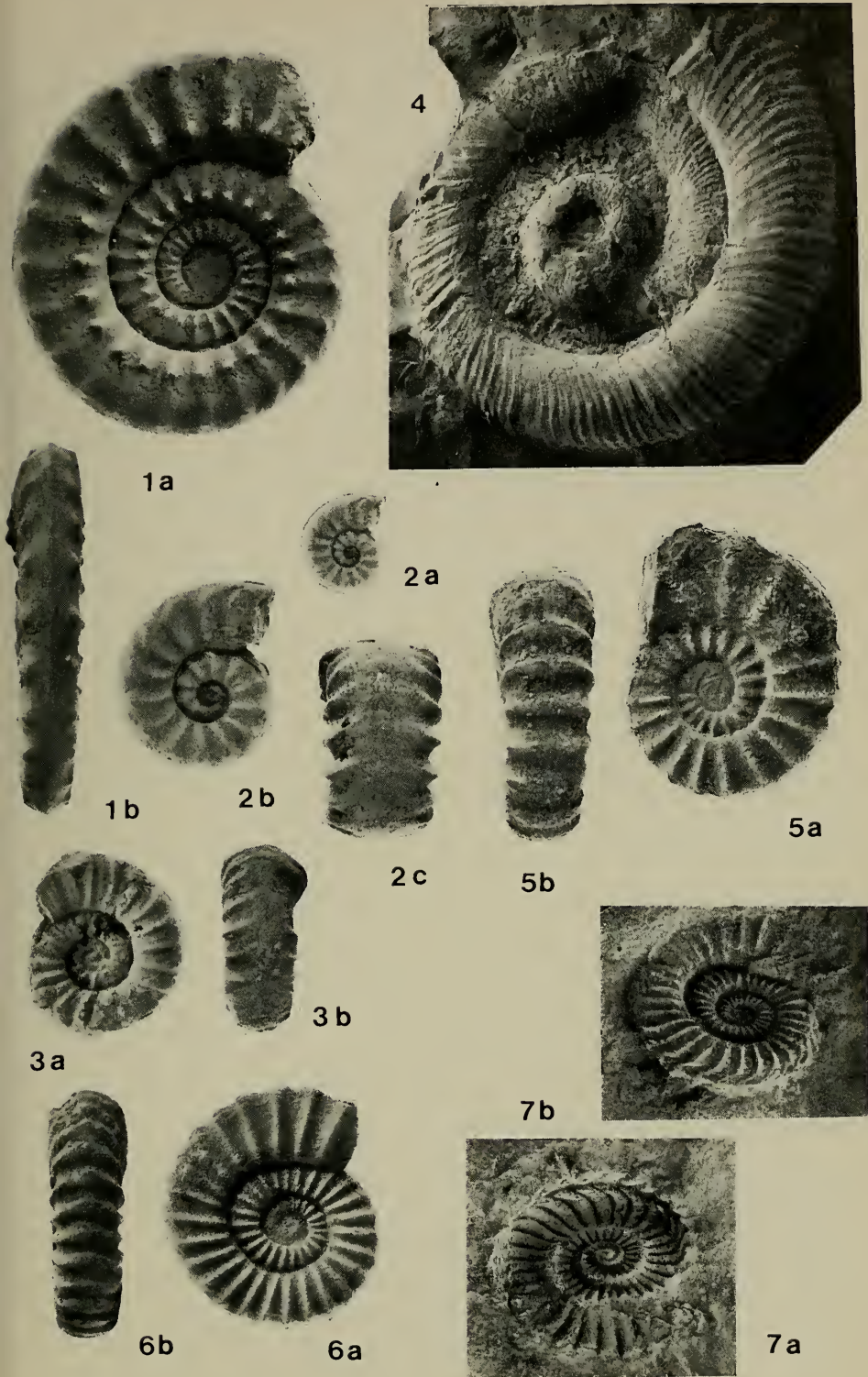
3b



3a

Plate 4

- Fig. 1. *Acanthopleuroceras valdani* (D'ORBIGNY). Schwarzer Jura γ , *ibex* Zone, *valdani* Subzone; Nürtingen (section II).
a. lateral view, b. ventral view.
Staatl. Mus. f. Naturk. Stuttgart, no. 23190. — x 1.
- Fig. 2. *Beaniceras centaurus* (D'ORBIGNY), Schwarzer Jura γ , *ibex* Zone, *valdani* Subzone; Nürtingen (section II).
a. lateral view. — x 1. b. lateral view. — x 2. c. ventral view. — x 2.
Staatl. Mus. f. Naturk. Stuttgart, no. 23191.
- Fig. 3. *Beaniceras luridum* (SIMPSON) var. SPATH. Schwarzer Jura γ , *ibex* Zone, *luridum* Subzone; Nürtingen (section II).
a. lateral view, b. ventral view.
Staatl. Mus. f. Naturk. Stuttgart, no. 23192. — x 1.
- Fig. 4. *Prodactylloceras davoei* (SOWERBY). Schwarzer Jura γ , "Davoeibank", *davoei* Zone; Pliensbach (section L).
Staatl. Mus. f. Naturk. Stuttgart, no. 23193. — x 2/3.
- Fig. 5. *Androgynoceras maculatum* (YOUNG & BIRD). Schwarzer Jura γ , *davoei* Zone, *maculatum-capricornus* Subzone; Nürtingen. Coll. Köstlin.
a. lateral view, b. ventral view.
Staatl. Mus. f. Naturk. Stuttgart, no. 23194. — x 1.
- Fig. 6. *Androgynoceras capricornus* (SCHLOTHEIM). Schwarzer Jura γ , *davoei* Zone, *maculatum-capricornus* Subzone; Kirchheim. Coll. Hermann 1947.
a. lateral view, b. ventral view.
Staatl. Mus. f. Naturk. Stuttgart, no. 23195. — x 1.
- Fig. 7. *Oistoceras angulatum* (QUENSTEDT). Schwarzer Jura γ , "Davoeibank", *davoei* Zone, *figulinum* Subzone; Pliensbach (section M).
a. negative, b. silicone cast.
Staatl. Mus. f. Naturk. Stuttgart, no. 23196. — x 1.



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