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Are there any Triassic Bellerophontacea in Central Europe?

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With 1 plate

Schlüsselwörter
Trias
Gastropoda
Bellerophontacea
Mitteleuropa
Revision

Abstract

Reports of bellerophontaceans in Triassic strata are based mostly on records three-quarters of a century old. The material on which these records are based has not been illustrated adequately. Several reports may be discounted, as the specimens cited either are not bellerophontaceans or are from localities no longer considered as young as Triassic. The available information indicates that original erroneous interpretations of age have been sanctified by repetition.

Some of the older locality and age data are too generalized to confirm; however, not all reports can be automatically discounted. If bellerophontaceans do extend into the Early Triassic, they must be exceedingly rare; the last systematic notation on one was made more than 30 years ago. Detailed collecting at several localities is nedeed to confirm or refute the dubious Mesozoic occurrence of this characteristically Paleozoic superfamily. We redescribe and reillustrate the first reported Triassic species, *B. vaceki* Bittner.

Zusammenfassung

Nahezu alle Berichte über Bellerophontacea aus der Trias Mitteleuropas beruhen auf älteren Beschreibungen ohne ausreichende Abbildungen. Es wird hier gezeigt, daß einige dieser Funde keine Bellerophontacea sind und andere nicht in die Trias, sondern in das Jungpaläozoikum einzustufen sind. Bei einigen der im Bereich der Paläozoikum-Mesozoikumgrenze auftretenden Bellerophontacea ist das Alter aufgrund ungenauer Fundortsangaben ungewiß. Um das triadische Alter dieser Formen nachweisen zu können, wären neue detaillierte Aufsammlungen nötig.

Die zuallererst als triadisch bezeichnete und in der Literatur häufig erwähnte Art *Bellerophon vaceki* Bittner wird neu beschrieben und abgebildet.

Introduction

Hutchins (1966, p. 72) crisply described a well-known phenomenon when he wrote "One of the unfortunate things about 'facts' that are recorded in scientific journals is that once they have appeared in print it is difficult to eliminate them and they are quoted again and again for many years". The Bellerophontacea are a gastropod superfamily in which the shells are commonly coiled with bilateral symmetry; these gastropods form a characteristic part of faunas from the Late Cambrian to the Late Permian. They have been reported from beds of Triassic age, but whether they do in fact cross the

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Paleozoic-Mesozoic boundary is an interesting question. Most of the scanty systematic information on Triassic bellerophontaceans stems ultimately from the work of BITTNER. Since his time, few new data have been added, though the "fact" of bellerophontacean presence in the Triassic continues to be repeated.

We have chosen an historical approach, for this seems to demonstrate best how repetition can solidify an original notion and gradually modify the original data. Accordingly, we summarize the appropriate literature bearing on the issue, for this has not been done previously. We recognize three possible areas for confusion concerning our question. First, specimens identified as bellerophontaceans may be incorrectly assigned. Second, localities originally assumed to be of Triassic age subsequently may be judged to be Paleozoic or may not be susceptible to dating. Third, and most difficult to judge, true bellerophontaceans may occur in Triassic strata but may be fossils reworked from Permian beds.

In order not to mislead the reader, we note here that we are unable to answer categorically the question posed in the title. Some reports of Triassic bellerophontaceans can be removed from the record of "facts", but others must remain open. We have limited our inquiry to central Europe, as it is here that bellerophontaceans were first reported from Triassic beds. Fieldwork is needed in several critical areas, especially in the Alps, to see whether bellerophontaceans occur in beds currently judged to be Triassic. Triassic bellerophontaceans have been reported from Greenland, North America, Siberia, India, and Australia.

Examination of collections shows that if bellerophontaceans do occur in the Triassic they must be exceedingly rare. We have found none in a survey of Triassic collections in the Naturhistorische Museum, Vienna, or in the U. S. Geological Survey. Current workers on the Alpine Triassic know these fossils only from the literature. H. ZAPFE, for example, has never seen one (oral communication, August 1975). Our survey raises considerable doubt in our minds whether bellerophontaceans do occur in the Triassic in central Europe. To demonstrate that they do extend into the Mesozoic is a matter for further study, not a "fact" to be quoted.

Acknowledgements

Authorities of the Geologische Bundesanstalt, Vienna, kindly made collections available to us. In particular we thank Dr. F. STOJASPAL who searched diligently to find material described by BITTNER and searched equally hard but unsuccessfully for specimens cited by BUKOWSKI.

Some colleagues have assisted us with pertinent literature; others have aided by advising us that they have not encountered bellerophontaceans in the course of their work on Triassic beds. For specimens or literature we are indebted to: Prof. Dr. H. ZAPFE, University of Vienna; I. DOBRUSKINA, Geological Institute, Moscow; M. V. SHASTY, Geological Survey of India; and E. VEGH-NEUBRANDT, University of Budapest.

Upper Triassic of Central Europe

Two Late Triassic bellerophontaceans have been mentioned in the literature. Neither is correctly assigned, though reasons are different for each species.

Bellerophon pereginensis LAUBE was first described as part of the Late Triassic St. Cassian fauna. Nevertheless, LAUBE (1968, p. 64, translated) clearly stated that it was "... older than other members of the St. Cassian fauna. The rock in which it occurs is a dark colored dolomite limestone, whose age is unknown". STACHE (1877, p. 301) described

specimens from the Late Permian Bellerophon-Kalk, though he also reported the species as occurring in the St. Cassian beds. Subsequent workers have reported the species as occurring in the Bellerophon-Kalk. It continues to be listed as a species from the Permian and the Triassic (BRANSON, 1948, p. 658). However, BRANSON overlooked a comment by KITTL (1891, p. 223) in his monographic treatment of the St. Cassian gastropods. KITTL noted that the species occurred only in the Bellerophon-Kalk. There is no reason to perpetuate the original error of a Mesozoic occurrence for this species.

To the best of our knowledge, only one other bellerophontacean has been mentioned from Upper Triassic beds, all other reports being based on presumed Lower Triassic occurrences. KITTL (1891, p. 223, pl. 4, fig. 5) described *Bucania? rumpfli* from the St. Cassian beds. This original reference is the only one listed by DIENER (1926, p. 12) in his catalogue, and we know of no additional reports. Examination of St. Cassian material in the Naturhistorische Museum, Vienna, did not reveal any additional specimens.

The holotype of *B.? rumpfli* measures 8.3 mm in maximum width and 5.6 mm in maximum length. Unfortunately, KITTL's three views of it are drawn at natural size and do not properly convey the features; we reproduce it herein somewhat enlarged (figures 1—3). The specific name is taken from a KLIPSTEIN manuscript, where it was originally assigned to *Capulus*. KITTL did not accept this manuscript assignment and was more impressed with the presence of a raised ridge in approximate median position, which he assumed was a selenizone.

Several crenulations on the specimen parallel to the aperture are at a slight angle to this ridge and do not appear to have had their courses interrupted by it. No growth lines are preserved anywhere on the shell, and there is no basis for KITTL's assumption that a selenizone is present. Faint spiral lirae more or less parallel to the ridge are the only lines present. Similar ornament occurs in several species in the fauna which have the same general shape, such as *Capulus? fenestratus* LAUBE or *Eumarginella muensteri* PICTET. The type of *B.? rumpfli* is slightly asymmetrical, especially so in the early growth stages. It expands at a rapid rate from the oblique elongate nucleus.

The morphology is not that of a *Bellerophon*, though it is easy to see how KITTL was misled for the asymmetry is not obvious. We reassign the species to *Capulus* with question until such time as the Triassic patelliform gastropods are systematically revised.

Lower Triassic of Central Europe

Bellerophontaceans were first reported nearly a century ago in Triassic strata from south of Bozen, now in northern Italy. VACEK (1882, p. 44, translated) described his discovery as follows:

> "The dolomite passes up into bluish-gray marly limestones which are usually very thinly bedded and which only rarely, for example at the long straight part of the new Mendelstrasse, are thicker bedded. Above these, forming the base of the Werfener Schichten, which are well characterized by fossils, lies a bed of about one meter thickness of yellow sandy marl completely full of bivalves and small bellerophontids. These bellerophontids are not the same as others known from South Tyrol, according to Director STACHE. The occurrence of this genus directly above the horizon of limestone and dolomite, which GÜMBEL thought was parallel to the Bellerophon-Kalk only because of its similar position, is of great interest. From its petrographic characteristics, the bank containing bellerophontids initiated the thick sequence of sandy, marly beds which are summarized under the term Werfener Schichten and which are developed in astonishingly similar petrographic and faunistic character throughout the Etschbucht."

Some years later, VACEK (1894, p. 435, translated) elaborated on his discovery:

"Of particular interest is a bank about 1 meter thick of soft fine micaceous yellowish marl which occurs above the oolite strata and bears many myacitids, myophorids, Pseudomonotis etc., that also characterize the lower part of the marly shales, as well as the remains in great abundance of a small bellerophontid, which according to an oral communication from Director STACHE is a new species. The occurrence of bellerophontids in a bank which immediately follows the dolomite-oolite strata in the Etschbucht is an equivalent of the typical Bellerophonkalk which occurs in Gröden and abundantly farther to the east. Nevertheless the complete difference in the petrographic and faunistic characteristics of the two sediments should be especially stressed and it must be stated that the typical Bellerophonkalk has not yet been found in the Ennebergische region. "

"Immediately above the layer with small bellerophontids, there occurs in great abundance, filling entire beds, the index fossil of the so-called Seiser Schichten *Avicula Clarai* EMMRICH ...".

The occurrence of this Triassic guide fossil above the shale containing small bellerophontaceans is shown clearly in a table, all beds between Muschelkalk and Rothliegendes are labelled 'Röth und Buntsandstein' so that not only are the bellerophontid bed and the underlying oolite-dolomite-niveau automatically placed in the Triassic, but two additional underlying units also are included therein.

It is evident from VACEK's original remarks, and further clarified in his later comments, that the bed containing bellerophontaceans does not have in it any fossils of undoubted Triassic age. The bed underlies *bona fide* Triassic and overlies unfossiliferous rocks. The notion that it is of Triassic age rests on the assumption of a sedimentary cycle ending in the Paleozoic and another beginning in the Mesozoic. The Permian-Triassic boundary in this area was drawn at a convenient position for mapping purposes and has no other basis.

After VACEK's report of bellerophontaceans in the Triassic of the Southern Tyrolean area, BUKOWSKI (1895, p. 134—135) noted an occurrence in Dalmatia. It is not unequivocable, for he wrote (translated and slightly abridged)

"In the area between Golo brdo and Crni rat, fossils were found in the Werfener Schichten in thin-bedded shales and thin layers of sandstone and lime. The following fossils were obtained (footnote-determinations were made by BITTNER): *Pseudomonotis ovata* SCHAUR., *Pseudomonotis* sp., *Avicula venetia* HAUER?, *Myopyoria* cf. *ovata* SCHAUR., small gastropods (*Turbonilla*, *Naticella* and others), *Bellerophon* sp.

"Concerning the association of typical species from the Werfen horizon with *Bellerophon* sp., it would be extremely important to recognize the exact sucession of beds. Unfortunately, it is not possible because in the whole area, the sediments have been completely crumpled so that it is not possible to decide which parts are lower and which are upper."

"Concerning the occurrence of several specimens of the *Bellerophon* I can only say they come out of a greenish-gray, sandy, soft marl strata in the midst of the other rocks which contain the Werfen fossils. This interesting record follows in sequence that which M. VACEK made in 1881 in Southern Tyrol in the area of the Etsch valley where a layer of sandy marl which was within the Werfener Schichten, especially within the horizon of *Avicula clarai* EMMRICH, also contained little bellerophonts. The conformable base of this marl is here a dolomite-oolite stratum and von GÜMBEL considers it to be a facies of the Bellerophonkalk. Equivalent beds could not be found in our area. Otherwise, the petrographic equivalence between the marls containing *Bellerophon* in Southern Tyrol and these of the Krčevac region in Spizza is exceedingly striking. Here, as well as in that area, in addition to *Bellerophon* there are small *Pseudomonotis* and myacitids. The *Bellerophon* species itself is not identical with that from Southern Tyrol according to BITTNER."

"So far as my current research shows I am forced to put the entire complex of Krčevac into the Werfener-Schichten and I explain the occurrence of *Bellerophon* only in that the genus in Southern Tyrol is in the lower layers of the Bunter Sandstone. From the paleontological records we currently have, it is without doubt that this is a very low horizon within the Werfener-Schichten."

BUKOWSKI apparently did not understand the full significance of VACEK's (1894) remarks that *Avicula clarai* EMMRICH did not occur with the bellerophontaceans, for

that was his strongest reason in assigning all beds he studied to the Werfen. One can only say that his specimens, like VACEK's are not independently dated as Triassic by the presence of other fossils. Because of the contortion of the beds, the specimens might even have originated in the Bellerophon-Kalk. BUKOWSKI's specimens have not been described, and they are not available in the collections of the Geologische Bundesanstalt. To the best of our knowledge, no other workers have confirmed this occurrence. Until additional specimens might be collected, we suggest that reference to *Bellerophon* in the Triassic of southern Dalmatia no longer be cited in the literature.

The presumed Triassic age of the original find by VACEK was accepted as fact when the bellerophontacean was finally described. BITTNER (1899a, p. 9) named the form *Bellerophon vaceki*. BITTNER indicated that the species was found "... in very low horizons of the Werfen Slates on each side of the Etsch, south of Bozen on the Mendelstrasse, and near Montan".

Bellerophon vaceki BITTNER is described in a work dealing with Triassic fossils from the Himalayas and apparently this association has served further to fix the age as undoubtedly Triassic. The historic position of the Permian-Triassic boundary in the Salt Range of Pakistan has varied, for example compare WAAGEN (1880), GRIESBACH (1891) and KUMMEL and TEICHERT (1970). Position of the boundary is not generally agreed upon. Indeed, even some "*Ceratites*" of WAAGEN (1895) once thought to be Triassic guide fossils, are now Permian ammonites in other genera. Definition of basal Triassic is difficult (TOZER 1972) and its precise position depends upon the group of fossils chosen as guides (KUMMEL and TEICHERT 1970, p. 77). We have not fully investigated the position of specimens from the Salt Range that BITTNER tentatively assigned to *B. vaceki* BITTNER, but even if these turn out to be from Triassic-age beds — a consideration that remains to be proven — this has no direct bearing on the European material.

BITTNER (1899b) also described, but did not name, a *Bellerophon* sp. from presumed Triassic beds at Ussurim not far from Vladivostok in easternmost Siberia. Triassic cephalopods from the area were described separately (DIENER, 1895) and apparently do not occur with this *Bellerophon*; further faunal data on this area are needed.

The first person to suggest that the alpine beds containing the bellerophontaceans might not be Triassic was TORNQUIST (1901, p. 83, translated).

> "These upper Permian beds are developed similarly to those at the Nonsberg. Here VACEK found an intimate connection of Permian sandstone with dolomitic and marly beds so that, as in the Vicentin, it was not possible to draw a boundary between these two. At the Nonsberg the dolomites are richer in fossils, one finds myophorids and gervillids; the oolite beds are sometimes packed with small slim shells of snails (*Holopella gracilior* SCHAUR.) while the bedding planes are often densely covered with a bivalve that is closely related to "*Ostrea*" *ostracina* SCHL. The uppermost complex, which does not appear to be especially resistant at the Nonsberg, contains a bed of a soft finely micaceous, yellowish marly shale of 1 meter thickness which contains besides masses of myacitids, myophorids, *Pseudomonotis*, etc. small bellerophontaceans; above this bed are the typical Seiser Schichten."

The next comment was by ARTHABER (1906, p. 257, translated), writing under the heading Seiser Schichten:

> "A basal conglomerate which has been placed stratigraphically at the base of the Triassic or on the boundary of the Paleozoic is followed above by well-bedded greenish-gray shales with mica on the bedding planes, or sandy marly thin-bedded limestones, or beds of yellow marly limestone or dolomite between the sandy shale layers. The fauna is meager and consists mainly of bivalves. The most important forms are: *Pseudomonotis* (*Claraia*) *Clarai* EMMRICH sp., *Anodontophora* (*Myacites*) *fassanensis* WISSM. sp., *Myphoria laevigata* ALB., *M. ovata* BRAUN, *Bellerophon Vaceki* BITTNER."

An accompaning footnote gives a marvellous example of circular reasoning:

"Because *Bellerophon* has now been found in four areas, South Tyrol, south Dalmatia, the Himalayas and Ussuri associated with typical Triassic forms, the correct stratigraphic position of the occurrence in South Tyrol, which had been doubted by TORNQUIST is proved."

ARTHABER's illustrations (pl. 34, figs. 1a—1c, 2) appear to be a form more compressed than that described by BITTNER. After a comparison of ARTHABER's and BITTNER's illustrations was made, ARTHABER's turned out to be simply new drawings of the two specimens originally with the type lot illustrated by BITTNER.

Bellerophon was reported next from an area in Hungary. FRECH (1912, p. 44—45, translated) provided some florid writing and possibly a new piece of information when he stated that

"*Bellerophon vaceki* BITTNER is a crippled dwarf form, the last remains of the richly developed large and beautiful bellerophonts which in the Alps and the Salt Range mark the upper edge of the Dyas. In addition to the hitherto known localities (South Tyrol, South Dalmatia, Himalaya, etc.) there is now added the Hungarian Balaton area, where *Bellerophon* occurs with typical Triassic bivalves. The species is a crippled side-branch which reminds one of *B. orientalis* WAAGEN ... Localities: Upper Seiser Schichten; Nadaskut near Csopak. Collected by LOCZY jun. Also at the Mendelstrasse and other localities in Southern Tyrol."

The occurrence in Hungary is not so certain as FRECH indicated. In the geological summary of the Balatonsee work, LOCZY (1916, p. 60—70) listed *Bellerophon vaceki* BITTNER at three localities. At the first locality, Vörösbernény, *B. vaceki* does not occur with any undoubted Triassic pelecypods. At the second, Csopak, it occurs with *Pseudomonotis clarai* EMMRICH, among other fossils, but comments accompanying the list state that the list is a composite of specimens obtained from digging the foundation of a villa. The third locality is Nádaskut, where "*Lingula tenuissima* BRONN, *Rhynchonella*? sp., *Anoplorophora fassaensis* WISSM., *Myophoria* cf. *laevigata* GOLDF., *Pseudomonotis inaequicostata* KLIPSTEIN, *P. aurita* HAUER, and *P. clarai* EMMRICH" were all reported together. This would appear to be sufficient proof that *B. vaceki* BITTNER is truly Triassic.

However, the locality Nádaskut is described in some detail following the faunal list. It was a vineyard, and the only rocks in the area are those that resulted from deep plowing of the soil. The stones piled up by the workers between the rows were collected for fossils. *Bellerophon vaceki* BITTNER and *Claraia* occur in the same vineyard, but are not necessarily known in the same bed!

Transition beds between the Permian and Triassic at Vörösberény have recently been exposed exceptionally well, according to E. VEGH-NEUBRANDT (written communication, 1976). No specimens of a bellerophontacean were found in the *Claraia clarai* beds. The specimen of *Bellerophon* mentioned by LOCZY is on a piece of greenish-yellow dolomitic shale. Judging from the lithology, *Bellerophon* was collected in transition beds between the underlying red sandstones and the *Claraia* beds.

The locality Csopak is still problematic. *Bellerophon* reported by LOCZY, according to Prof. VEGH, occurs on rocks together with bivalves such as gervillids and anophorids. *Claraia* is absent. Nevertheless, Prof. VEGH suggested that this bivalve faunule might be indicative of Triassic age. Current stratigraphic practice in Hungary appears to be to draw the Permian-Triassic boundary at or close to the lithologic change from red beds to Werfen beds; *Claraia clarai* EMMRICH and *C. aurita* HAUER are found 10—15 meters above the uppermost red beds.

None of the three occurrences indicates Triassic fossils at or below the level that yielded the bellerophontaceans. Although LOCZY's specimens exist, they have not been properly described and illustrated. Frech gave no illustrations, and his description

consists of comparisons with other forms; the only pertinent fact to be gleaned is that the material consists of steinkerns. Thus, it may not be possible to determine whether these fossils are reworked or even whether they are bellerophontaceans.

One summary work written a decade later is of particular interest. DIENER (1925, p. 49, translated) remarked: „The straggler of the genus *Bellerophon* occurs in the Lower Triassic of the Alps, as *B. Vaceki* BITTNER in the Werfener Schichten of the southern Alps, and further the subgenus *Stachella* WAAGEN in the Ceratiten-Schichten of the Salt Range". Three of ARTHABER's figures of *Bellerophon vaceki* BITTNER were reproduced by DIENER to illustrate this species. Inclusion of this form, known only from several scattered localities, in a book of guide fossils certainly gave the weight of authority to this species as being of Triassic age. DIENER's remark about *Stachella* added fresh data, but it is not supported by any reference.

It is interesting to note that nowhere in the detailed work of OGILVIE-GORDON (1927) on the Southern Tyrol area is any mention of a bellerophontacean in the Triassic. Her sections show that commonly 10—30 meters of strata is present above undoubted Bellerophonkalk and below beds containing *Claraia*.

LEONARDI (1935, p. 83, pl. 5, figs. 8, 10) noted the occurrence of *B. vaceki* BITTNER in the Siusi beds (Seiser-Schichten) at Monte Cucal, Tesero (Val di Fiemme), and at Auronzo (Cadore). The two localities are about 40 km apart. One of two illustrations is of a specimen that has been deformed by pressure acting on an oblique angle to the plane of symmetry of the shell.

No details are given concerning the rocks at Auronzo. At Val di Fiemme (LEONARDI, 1935, p. 15), the bellerophontacean is reported with "*Myacites*" and with other gastropods typical of the Werfen beds. The accompanying section on Monte Cucal indicates that *B. vaceki* BITTNER occurs in a bed 2 meter thick, the base of which is 6.4 meters above the Bellerophonkalk but below the lowest bed containing *Claraia*. In another section at Tesero (LEONARDI, 1935, p. 18), *B. vaceki* BITTNER is reported from two beds. The lowest is 1.30 meters thick; its base is 6.6 meters above the Bellerophonkalk section. A second bed, 0.8 meters higher, is 2.0 meters thick. This higher bed is still 6 meters below the first occurrence of *Claraia*. The presence of the bellerophontacean stratigraphically so high above the Bellerophonkalk and in two different beds appears to rule out the possibility that it had been reworked from the underlying Permian limestone.

In his summary work on the Dolomite Alps, LEONARDI (1967, p. 123) listed *B. vaceki* BITTNER as occurring at Fiemme and Cadore; one of his 1935 photographs showing the distorted specimen is reproduced on his plate 20, figure 13. His section of the Lower Werfen at Tegero (1967, p. 111—112) is essentially a duplicate of that given in 1935, again *B. vaceki* BITTNER being below *Claraia*; no details are given on the Cadore section at Auronzo. BOSELLINI (1964) studied the sedimentary petrology of this Fiemme section and others across the Permian-Triassic boundary. He apparently did not include faunal evidence in placing the boundary but presumed that all beds above the Bellerophonkalk were part of the Werfen and that the Werfen was Triassic.

The latest work on the position of the Permian-Triassic boundary in the southern Alps appears to be that of ASSERETO and others (1973). They place the boundary between the Bellerophon Formation and the overlying Werfen Formation, the lowest unit of which is the Tesaro member varying from 0—6 meters in thickness and consisting of oolitic limestones and dolomites. It is overlain by the Mazzin Member, varying from 30—70 meters in thickness and consisting of shales and marly micrites. *Bellerophon vaceki* BITTNER is reported only from the lower part of the Mazzin Member (ASSERETO and others, 1973). As VACEK (1882) has reported the occurrence of *Bellerophon* from the

lowermost meter of the Werfen Formation he has obviously considered the Tesero Member as part of the Bellerophon Formation.

While fossils are comparatively rare in the area where *Bellerophon vaceki* BITTNER has been described from ASSERETO and others found conodonts within the Mazzin Member approximately 40 kilometers to the ENE, in the Secedo section of the Grödner valley. From the lowermost part, 1.6 meters above the base of the Werfen Formation, *Anchignathodus typicalis* SWEET has been recorded. It occurs otherwise in Upper Permian to Lower Triassic rocks in W Pakistan, Idaho, Wyoming, East Greenland, Northwestern Iran and in the *Otoceras-Ophiceras* beds of the Spiti District in Northern India. 28 meters above the base of the Werfen formation and therefore considerably higher in the section representatives of the conodont *Anchignathus isarcicus* SWEET and probably *Ellisonia teicherti* SWEET have been found. The upper part of the Mazzin Member is therefore of a Lower Griessbachian (Lower Triassic) age. For the lower part with *Bellerophon vaceki* BITTNER an Upper Permian age can not be excluded (W. SWEET, oral comm. 1977).

We conclude that a bellerophontacean occurs in the soft marly beds of the basal Werfen

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Plate 1

All illustrations three times natural size; specimens coated with ammonium chloride before photography.

Fig. 1— 3: *Capulus? rumpfli* (KLIPSTEIN in KITTL, 1891). The holotype of *Bucania? rumpfli* figured by KITTL (1891, pl. 4, fig. 5) from the St. Cassian beds, at St. Cassian. 1. View of dorsum; 2. apical view; 3. right-side view. Naturhistorisches Museum, Vienna (Inv.Nr. 1899/VII/9).

Fig. 4—22: *Bellerophon vaceki* BITTNER.

4, 5, 8, 9: Lectotype from Werfen beds, Mendelstrasse. 4. Left-side view; 5. right-side view; 8. dorsoapertural view, showing the sinus; 9. dorsal view, showing distorsion of profile on right half of specimen. This specimen is the original of BITTNER (1899a), pl. 1, fig. 13; four views and of ARTHABER (1906, pl. 24, fig. 1a—1c). Geologische Bundesanstalt, Vienna (GBA 1899/01/9).

6—7: Paralectotype from "Tiefste Werfener (Seiser) Sch. mit Bellerophon sp., Ober Montan", collected by M. VACEK, 1881. 6. Right-side view; 7. apertural view. Geologische Bundesanstalt, Vienna (GBA 1978/05/1).

10, 11, 14: Paralectotype from Werfen beds, Mendelstrasse. 10. Right-side view; 11. left-side view; 14. dorsoapertural view, showing the sinus. This specimen is the original of BITTNER, 1899a, pl. 1, fig. 14, and ARTHABER, 1906, pl. 34, fig. 2. Geologische Bundesanstalt, Vienna (GBA 1899/01/9a).

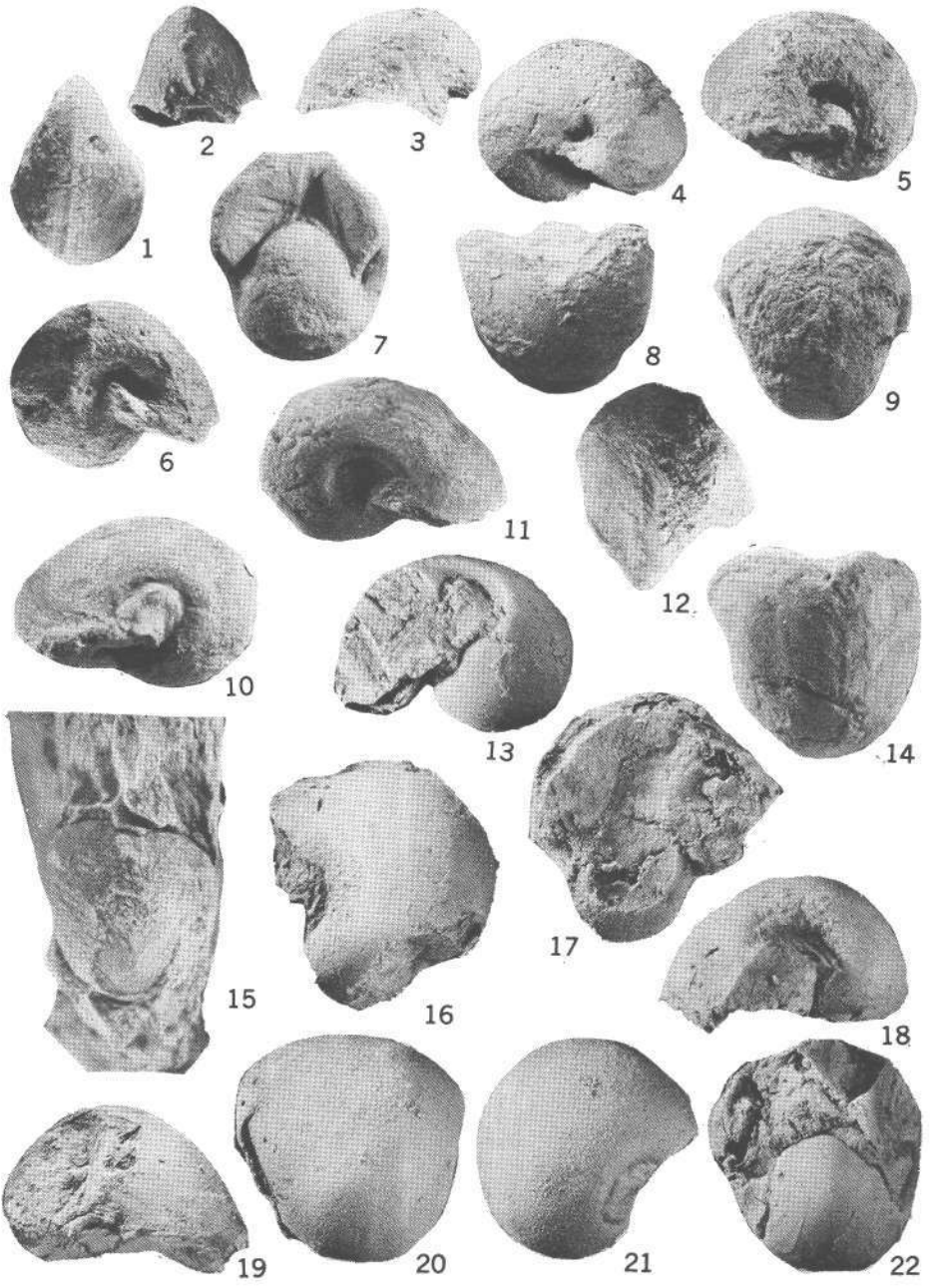
12: Paralectotype from same locality as figure 6, in dorsal view. Geologische Bundesanstalt, Vienna (GBA 1978/05/2).

13, 22: Latex cast of paralectotype from Werfen beds, Mendelstrasse. 13. Oblique right-side view; 22. apertural view. Geological Survey of India, No. 6326.

15: Paralectotype from "Tiefste Werfener Sch. mit *Bellerophon* spec., Mendelstrasse", collected by VACEK, 1881. Dorsal view; to the lower left, the steinkern may be seen; most of the specimen retains an inner shell layer; in the upper center, the raised flattened selenizone may be seen on the true outer shell layer (GBA 1978/05/3).

20, 21: Plaster cast of paralectotype, Werfen beds, Mendelstrasse. 20. Dorsal view; 21. oblique right-side view, showing a faint dorsal depression toward the lower left of the specimen. This specimen is a cast of the same specimen illustrated in figures 13 and 22, but because of the different casting medium it shows other features of this steinkern. Geological Survey of India, No. 6326.

16—19: Latex impression of paralectotype. The specimen seems to show a .less globular profile than the specimen illustrated in figure 13, but it is incomplete. 16. dorsal view; 17. apertural view, mainly of broken surface, but showing the whorl profile below; 18. left-side view. 19. right-side view. Geological Survey of India, No. 6325.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sedimentary cycle in Central and Southern Europe. However, no evidence has been found showing that this form occurs with *Claraia* or any other fossil commonly assumed to be of Triassic age. At those localities for which stratigraphic details are available, clearly the bellerophontacean occurs below undoubted Triassic fossils. From the available data we cannot infer whether the Werfen sedimentary cycle has in spite of the commonly accepted opinion already begun in the Permian or whether the strata with bellerophontaceans are of Lower Triassic age.

Systematic Paleontology

Bellerophon vaceki BITTNER
Pl. 1, figs. 4—22

Bellerophon vaceki BITTNER, 1899a, p. 9, Pl. 1, figs. 13—14.

Description. — Bellerophontacean gastropods with a very short U-shaped notch at the base of a wide sinus. Shell uniformly coiled; whorl profile seemingly moderately well rounded, approaching the arc of a circle, without any prominent carina and apparently not laterally compressed. Aperture with an exceedingly short broad slit, opening into a wide sinus, the sides of which diverge at an angle of about 65° from the median line, gradually curving so that near midwhorl the edge of the outer lip lies in a plane normal to the coil and continuing to the umbilical area where there is a geniculation of the lip, bending it slightly upward from the horizontal plane; distance from outermost extent of lip to base of slit about one-eighth of total whorl. Growth lines unknown; traces of growth lines closely spaced, occurring on the most mature one-quarter of the whorl only; trace of selenizone limited to area where traces of growth lines appear; lunulae and other details of selenizone unknown. True umbilici apparently not present, but seemingly with paired shallow indentations behind the point of geniculation on the outer lip. Ornament unknown.

Discussion

Because of the historical review of the literature, there is little point in presenting a formal synonymy. It is more appropriate to reexamine the primary material. To avoid any future confusion, we here designate the original of BITTNER's fig. 13, reproduced here as figures 4, 5, 9 and 10 as the lectotype. We assume that all material we have seen was examined by BITTNER, and we assign to it the status of paralectotypes. We have studied the two specimens figured by BITTNER (1899a) and five associated speciemens. These are all labeled as coming from the Mendelstrasse with a date and collector of VACEK 1881; one of these is illustrated in figure 15. We cannot determine whether the specimens figured by BITTNER and the accompanying specimens were separated out in 1894 or whether they constitute a new collection. We are treating them all as a single lot.

There are also four specimens of the bellerophontacean from "Ober Montan", collected by VACEK in 1881. Their preservation is not as good as the two specimens figured by BITTNER but is slightly superior to the bulk of the material from Mendelstrasse.

About 40 pelecypods, probably constituting five genera, are in another three boxes. The matrix is similar to that of the bellerophontaceans, and the pelecypods are indicated as coming from the same locality. On none of the preserved matrix is any trace of a gastropod.

In addition, we have received plaster and latex casts of two specimens that BITTNER deposited in India. These, too, should be part of the primary lot.

We have not seen a cast of the specimen that was illustrated by BITTNER (1889a, pl. 1, fig. 15) and tentatively assigned to this species; that species was reported from the "Otoceras beds from the locality N. W. from Kiunglung". There is no particular reason to exclude the specimen from this species, though we do not believe that this specific name indicates a taxon that can be identified by unique features. The Himalayan specimen probably goes in the same "wastebasket" as the type lot.

Bellerophon vaceki BITTNER is poorly known, even after the type lot has been redescribed and reillustrated. All specimens are steinkerns. What can be seen of the growth lines is actually preserved on a thin layer impressed on the steinkern, not on the true outer shell layer. Most specimens are distorted, although the two figured by BITTNER do provide a fair approximation of the shape.

There are no true umbilici. Their apparent presence on most specimens is due to solution of the columella. One specimen appears to have an umbilicus on one side and a solid structure, surrounded by a ridge, on the other. The ridge is actually a fragment of the succeeding whorl or some impression from it, but the solid columella is not secondarily modified.

No ornament has been preserved. There is nothing striking about *B. vaceki* BITTNER. Until well-preserved topotypes can be collected and the morphology of this species put on a firm basis, we suggest that the specific name not be applied to any additional material.

The shape of the aperture does show a very short broad slit in a shallow U forming about half the width of the outer lip. This shape is characteristic of *Euphemites* and *Warthia*. However, these genera commonly have a sickle-shaped curve to the outermost part of the lip and lack any umbilical indentations; some Permian species illustrated by YOCHELSON (1960) are not similar to *B. vaceki* BITTNER in apertural shape.

B. vaceki BITTNER may be a true *Bellerophon*, but it might also be a *Retispira*. The material is both generically and specifically indeterminate. This species is more globose than *Bellerophon bittneri* NEWELL & KUMMEL (1942), but comparison with Permian and other reported Triassic bellerophontaceans seems unwarranted.

In a sense it is surprising that *B. vaceki* BITTNER received so much early publicity. No one seems to have been particularly concerned that the species was based on steinkerns, and poorly preserved ones at that. Although sharp steinkerns in fine-grained limestone may occasionaly yield muscle scars and other points of interest, those composed of silty to limy shale show only gross shape and often are deformed. The presumed Triassic species has a small average size, as do many Permian species. It is not a dwarf, nor is it crippled and deformed. This latter notion stems from the fact that the steinkerns preserve occasional patches of shell at the umbilical areas in an erratic manner. Thus, on morphologic grounds, there is no reason to conclude that this species is the youngest of a long lineage. Certainly, the Triassic age of *B. vaceki* BITTNER remains to be demonstrated.

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