WHAT IS *ORTHOCERAS*?

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ABSTRACT.

The genus *Orthoceras* is to be ascribed to Bruguière, and *Hippurites bioculata* Lamarck, a pelecypod, should be regarded as the genotype. *Orthocera* should be ascribed to Modeer, and its genotype is probably a foraminifer. *Orthoceratites* should be ascribed to Gmelin, and its genotype is a poorly known Devonian cephalopod. The name *Orthoceras* should be used to refer to pelecypods only, but the term *Orthoceros* (which was introduced by Brünnich in 1771 and which has priority over *Orthoceras*) can be used for straight cephalopods. *Orthoceratites regularis* Schlotheim (which has been regarded as the genotype of *Orthoceras*) can be used as the genotype of *Orthoceros*.

During recent years, the scope of the genus *Orthoceras* has been progressively restricted, and we now need to determine exactly what in a modern sense is to be understood by this generic term. Since the genus has previously been reported from all of the Paleozoic systems and from the Triassic, its status should be of interest to most paleontologists. Recently this matter has been taken up by Foerste (1924, 1928), Troedsson (1931), and Miller, Dunbar, and Condra (1933), who, from quite different lines of reasoning, all arrived at the conclusion that *Orthoceratites regularis* Schlotheim (1820) might be regarded as the genotype of *Orthoceras*. However, Foerste (1929) and Troedsson (1932) subsequently rejected their conclusions; Miller, Dunbar, and Condra recognized that their conclusion rested on a very insecure basis; and after a thorough review of the literature we are not satisfied with the evidence. We recognize that the status of the genus *Orthoceras* is probably a matter for the International Commission on Zoölogical Nomenclature to settle, but on the following pages we wish to present the pertinent facts and to suggest a way out of the involved difficulties.

The name *Orthoceras* was used in print for the first time in 1732 by Breyn, who has always been cited as its author. In his discussion of fossils obtained from glacial boulders near Danzig, he (p. 28) defined the term as follows: "Orthoceras est Polythalamium in lineam rectam, vel proxime ad rectam accedentem extensum." On the next page of the same publication, Breyn defined the term *Orthoceratites* in the following manner: "Orthoceratites est lapis in cavitatibus Orthoceratis sub terra concretus, ejus tum externam figuram, tum internam fabricam referens." It appears that Breyn applied the term

Orthoceratites to fossils (internal molds) and that he used *Orthoceras* to refer to the conch or perhaps to the living animal—since his discussion is accompanied by excellent plates, it is quite clear that he was referring to cephalopods.

As both Galloway and Miller, Dunbar, and Condra have pointed out, Bruguière (1789,[1] p. xvi) was the first to use the name *Orthoceras* as a generic term in a Linnean sense. He gave the following definition: "Coquille conique, composée de cloisons transverses, & d'une gouttière sur un des côtés, l'ouverture fermée par un opercule." No specific name accompanies this definition, but it is clear from the rest of the volume that Bruguière applied the principles of binominal nomenclature; he therefore established the genus and it should be ascribed to him. Since "it is not evident from the original publication of the genus how many or what species are involved, the genus contains all of the species of the world which would come under the generic description as originally published, and the first species published in connection with the genus . . . becomes *ipso facto* the type." (Summary of Opinion 46 of the International Commission on Zoölogical Nomenclature.)

No species were published in connection with generic name *Orthoceras* until 1791 when Batsch referred fourteen species of straight and slightly curved foraminifera to it—he regarded *Orthoceras* as a subgenus of *Nautilus*. It might be assumed that the genotype of *Orthoceras* would have to be selected from among these fourteen species of foraminifera, but, as has already been pointed out by Miller, Dunbar, and Condra, none of them comes under the generic description as originally published, and therefore none can be established as the type of Bruguière's genus; that is, *Orthoceras* Batsch is a homonym, not a synonym, of *Orthoceras* Bruguière.

In 1795 Spalowsky described a foraminifer as *Orthoceras gazellicorne*; in 1796 Schrank used *Orthoceras* for a genus of insects; and in 1811 Perry applied this generic term to two species of modern foraminifera, which he called *O. scalaria* and *O. decussata*. Thereafter the name apparently disappears

[1] In Sherborn's *Index Animalium* the date of the appearance of Bruguière's description is given as 1789, but in the *Nomenclator animalium generum et subgenerum*, edited in Berlin, it is 1792. In the Proceedings of the Zoölogical Society of London, p. 583, 1893, Sherborn and Woodward communicate that the first volume of Bruguière's *Histoire naturelle des Vers* was edited in two parts, pp. 1-344 appearing in 1789 and pp. 345-757 in 1792, but they do not state whether the introduction, pp. i-xviii, was published with the first or the second part—with the first, however, seems to be the more likely.

from paleozoölogical literature for a considerable period of time, and insofar as we have been able to ascertain it was not used again until 1824 when de Blainville published it in connection with three species of foraminifera and one species of cephalopods (*Orthoceratites gracilis* Blumenbach). As a matter of fact, no species has ever been referred to *Orthoceras* that comes "under the generic description as originally published," and therefore none can be chosen as the genotype.

In order to find a way out of these difficulties, Miller, Dunbar, and Condra suggested that perhaps Bruguière's definition could be applied to *Orthoceratites regularis* Schlotheim, which has become well known through the investigations of Noetling and Troedsson. There are very peculiar longitudinal impressions on the living chamber of representatives of that species, and it was suggested that one of these impressions might be the "gouttière sur un des côtés" which Bruguière mentions. Moreover, it was postulated that Bruguière might have been studying a fragment of the chambered portion of the conch which ended adorally with a septum, and that he might have mistaken such a septum for an operculum. However, unless we assume that he had several specimens, these observations seem to exclude each other, for if he was studying a portion of a phragmacone he could not have observed an impression in a living chamber, and if he had in hand a specimen in which the living chamber was preserved, it would not be bounded adorally by a septum. It therefore seems unlikely that *Orthoceratites regularis* can be regarded as the genotype of *Orthoceras* for it probably does not "come under the generic description as originally published."

Since in Bruguière's time it was customary to confound cephalopods and foraminifera, it is possible that Bruguière had a foraminifer in mind. Miller, Dunbar, and Condra state that this is not likely since all of Bruguière's other genera refer to mega-fossils or shells, but this statement is in error. However, insofar as we have been able to ascertain, there is no foraminifer known to-day that comes under Bruguière's description of *Orthoceras*.

A third possibility, which has not yet been considered, seems to lie much nearer. As early as 1781 Lapeirouse used the term *Orthoceratites* for fossil shells which later on were called *Hippurites*, but he did not apply the principles of binominal nomenclature. Lamarck in 1799 (p. 81) used *Orthoceratites* in the same sense, and therefore *Orthoceratites* Lamarck 1799 is

not a cephalopod, as Troedsson (1931) thought, nor is it a foraminifer, as Galloway (1933) and Miller, Dunbar, and Condra (1933) suggested, but a *Hippurites*, as the original definition of *Hippurites* in Lamarck's paper of 1801 is essentially identical with his definition of *Orthoceratites* in 1799—as early as 1849 Herrmannsen (p. 164) took cognizance of this fact and three years later it was again noted by Giebel (p. 222). Moreover, Bruguière's definition of *Orthoceras* is strikingly similar to the two just mentioned; the following are complete quotations from the original texts:

Orthoceras Bruguière 1789	*Orthoceratites* Lamarck 1799	*Hippurites* Lamarck 1801
Coquille conique, composée de cloisons transverses, & d'une gouttière sur un des côtés, l'ouverture fermée par un opercule.	Coq. conique, droite ou arquée, munie intérieurement de cloisons transverses, et de deux arrêtes longitudinales obtuses, convergentes, la dernière loge fermée par un opercule.	Coq. conique, droite ou arquée, munie intérieurement de cloisons transverses et de deux arrêtes longitudinales, latérales, obtuses et convergentes. La dernière loge fermée par un opercule.

Lapeirouse mentions (p. 9) that his *Orthoceratites* bears a "gouttière formée par deux arrêtes mousses et convergentes," and both Lamarck (1801, p. 104) and de Montfort (1808, p. 287) list *Orthoceratites* Lapeirouse as a synonym of *Hippurites*. In 1822 (p. 597) Lamarck explained that the forms which he was referring to *Hippurites*, "qu'on a aussi nommées orthocératites," could be divided into two groups: "Dans les uns, les cloisons sont transversées par un siphon qui ne communique, en aucune manière, avec les concamérations ou loges du tuyau. Dans d'autres, au lieu de siphon on ne trouve qu'une gouttière latérales, c'est-à-dire un canal formé par deux arrêtes longitudinales, mousses ou obtuses." The first of these divisions comprises cephalopods, as was pointed out for the first time by Defrance in 1828 (p. 482), and the name *Hippurites* is now applied to only the second. When we take into consideration the fact that Bruguière referred to a "gouttière," whereas Lamarck referred to "deux arrêtes longitudinales" which presumably formed that "gouttière," it becomes evident that Bruguière's description of *Orthoceras* is almost identical with Lamarck's description of *Orthoceratites* of 1799 and his description of *Hippurites* of 1801, and that all of these correspond to the second division of *Hippurites* as defined by Lamarck in 1822. We then arrive at the con-

clusion that *these three names are exact synonyms*, and *Hippurites bioculata* Lamarck 1801 should be regarded as the genotype of *Orthoceras* Bruguière.

Now the question arises: Who first used the name *Orthoceras* for cephalopods and when did they do so? Troedsson thought it was de Blainville in 1825, but he overlooked the fact that in the previous year (1824, p. 192) de Blainville had already used the term, and there is no doubt that de Blainville then had in mind the same fossils that Lamarck had designated *Orthocera* in 1799 (p. 80). Lamarck's and de Blainville's definitions read as follows:

Orthocera Lamarck 1799	*Orthocera* Lamarck 1801	*Orthoceras* de Blainville 1824
Coq. droite ou arquée, plus ou moins conique, loges distinctes, formées par des cloisons transverses, simples, perforées par un tube, soit central, soit latéral.	Coq. droite ou arquée, un peu conique, loges distinctes, formées par des cloisons transverses simples, perforées par un tube, soit central, soit latéral.	Coquille droite ou à peine courbée, conique, partagée en un assez petit nombre de loges renflées par des cloisons transverses plus étroites et percées par un siphon central ou marginal.

De Blainville's definition of *Orthoceras* in 1825 is identical with that of 1824. *Orthocera* Lamarck 1799 (not Modeer 1796) is a monotypic genus with the foraminifer *Nautilus raphanus* Linné as genotype. *N. raphanus* is one of the four species mentioned by de Blainville in 1824 under the generic name *Orthoceras*; the other three species belong in established genera, and *Orthoceras* de Blainville 1824 should be regarded as a synonym of *Orthocera* Lamarck. This conclusion was eventually reached by de Blainville, himself, for in 1828 he (p. 485) abandoned the term *Orthoceras* and enumerated under *Orthocera* a number of species of foraminifera, including *Nautilus raphanus*.

It seems that Phillips in England and Quenstedt in Germany, incidentally in the same year (1836), were the first to apply the name *Orthoceras* exclusively to undoubted cephalopods. About the same time several new genera were established for certain of the straight fossil nautiloids: *Melia* Fischer 1829, *Actinoceras* Bronn 1837, *Ormoceras* Stokes 1838, and a little later *Cameroceras* Conrad 1842, *Loxoceras* McCoy 1844, *Cycloceras* McCoy 1844, *Endoceras* Hall 1847, and *Gonioceras* Hall 1847, if only the older genera be mentioned. The name *Orthoceras* remained a "catchall," which up to the pres-

ent day received at any time those forms for which a correct name did not exist.

We should consider the possibility of such names as *Orthoceratites* and *Orthocera* replacing *Orthoceras*.

In 1758, the year which "is accepted as the starting point of zoölogical nomenclature and of the Law of Priority," Gesner used the term *Orthoceratites* and defined it (p. 42) almost literally the same as Breyn had defined *Orthoceras* in 1732. There is no good reason to doubt that Gesner applied the name *Orthoceratites* to cephalopods, but we are very uncertain as to whether or not he can be regarded as a Linnean author—though he did not use binominal nomenclature, he introduced and used generic names, and it seems that he defined them as such.

After 1758 the term *Orthoceratites* was used by a number of non-Linnean authors, Lapeirouse, Ure, Walch, and others, but here these can be left out of consideration. In 1776 the term was used by da Costa to refer to illustrations of a foraminifer and a cephalopod which in the text are termed *Orthoceros*, no specific names being mentioned. Da Costa did not define *Orthoceratites* and it seems that he thought the difference between it and *Orthoceros* to be negligible. He frequently quoted Breyn, and it is probably safe to assume that he merely repeated Breyn's name without trying to establish it definitely as a generic name, and that *Orthoceratites* should therefore not be ascribed to da Costa.

In 1793 Gmelin (p. 412) used *Orthoceratites* as a generic term. His references and his long list of localities indicate clearly that he applied the name in a very collective sense to fossil cephalopods. Though he did not refer any species to the genus, it now seems to us that Gmelin is probably to be regarded as the "author" of *Orthoceratites*.

It should perhaps be emphasized in this connection that whether *Orthoceratites* is to be ascribed to Gesner, da Costa, or Gmelin, *Orthoceratites gracilis* Blumenbach 1803, a Devonian cephalopod which is very poorly known, becomes the genotype, for it is the first species published under this name and in any case it comes "under the generic description as originally published." Link in 1807 was the first to refer a large number of cephalopods to *Orthoceratites*, but most of his species, which came from the region of the Baltic, will probably remain unrecognizable. During the first half of the nineteenth century many authors, for example, Schlotheim,

Münster, Wahlenberg, Hisinger, Defrance, and d'Orbigny followed Link and applied the name *Orthoceratites* to various kinds of straight fossil cephalopods. *Molossus* de Montfort (p. 350, 1808) is an exact synonym of *Orthoceratites* Gmelin as both have the same genotype, but unfortunately it is not known whether or not species other than *O. gracilis* belong in this genus—in 1931 Troedsson (p. 10) pointed out that *Molossus* is a synonym of *Orthoceratites*.

The name *Orthocera* was established in 1796 by Modeer, who applied it to six species of cephalopods and nineteen species of foraminifera. Galloway has recently designated as the genotype one of these species, *Orthocera siphunculus* Modeer, which is probably a foraminifer, and therefore this name cannot be used for cephalopods. As was recognized for the first time by d'Orbigny in 1826, *Orthocera* Lamarck 1799 and 1801 (a homonym of *Orthocera* Modeer 1796) is probably to be regarded as a synonym of *Nodosaria* Lamarck 1812, of which the genotype is *Nautilus radicula* Linné, a foraminifer. Sowerby (1812) was the first to use the term *Orthocera* for cephalopods, and during the first half of the nineteenth century several authors, for example, Fleming, Pander, Deshayes, and Agassiz in Europe and Eaton in America, used the name in the same sense. However, d'Orbigny (p. 161, 1826) lists *Orthocera* Sowerby as a synonym of *Orthoceratites* Breyn, apparently realizing that the name could not be used for cephalopods.

Summarizing, we get the following list of synonyms and homonyms:

Orthoceras Bruguière 1789.—Moll., Lamell.

Synonyms:	Homonyms:
Orthoceratites Lamarck 1799	*Orthoceras* Batsch 1791.—Foram.
Hippurites Lamarck 1801	*Orthoceras* Spalowsky 1795.—Foram.
	Orthoceras Schrank 1796.—Insects
	Orthoceras Perry 1811.—Foram.
	Orthoceras de Blainville 1824.—Foram. and Cephal.
	Orthoceras Phillips 1836.—Cephal.
	Orthoceras Quenstedt 1836.—Cephal.

Orthoceratites Gmelin 1793.—Moll., Cephal.

Synonyms:
Orthoceratites Blumenbach 1803
Mollossus de Montfort 1808

Homonyms:
Orthoceratites Lamarck 1799.—Lamell.
Orthoceratites Link 1807.—Cephal.

Orthocera Modeer 1796.—Rhiz., Foram.?

Homonyms:
Orthocera Lamarck 1799.—Foram.
Orthocera Lamarck 1801.—Foram.
Orthocera Sowerby 1812.—Cephal.
Orthocera de Blainville 1828.—Foram.

There does not seem to be any possibility of retaining the name *Orthoceras* for cephalopods. In order to make it available for cephalopods, five valid claims of priority would have to be suspended. Nevertheless, the name has been applied to cephalopods by many paleontologists all over the world for approximately one hundred years, and its cephalopod connotation has become deeply imbedded in the literature and in geologic as well as paleontologic terminology. Although we hesitate to take the responsibility for deciding such a difficult case, we believe we have discovered a way out of the difficulty that will be welcomed by most paleontologists:

In 1771 (p. 232) the Danish zoölogist Brünnich used the term *Orthoceros* for straight chambered cephalopods. He did not define or diagnose the genus, but in the Danish text he translates the name "Langhorn" and in the Tabula Synoptica on page 246 we find the following key to the genera:

Testaceum,
  Univalve,
    Multiloculare,
      Siphone interiori communicans,
        Spirale rotundatum.....*Nautilus.*
        Elongatum rectiusculum.....*Orthoceros.*
    Siphone exteriori communicans.....*Ammonia.*

No species is mentioned as Brünnich was writing a textbook of zoölogy and was not concerned with species, but generic

names are used as such and from a study of other works by the same author it is clear that he is to be regarded as a strictly binominal author.

The generic name *Orthoceros* was available to Brünnich in 1771, and according to Opinion 46 of the International Commission on Zoölogical Nomenclature the genus comprises all of the species of straight chambered fossil cephalopods of the world. In 1776 da Costa applied the same name to both Recent foraminifera and fossil cephalopods, but since he did not mention species by name, his use of the term is without influence on the status of Brünnich's genus. Insofar as we have been able to ascertain, the name *Orthoceros* has never been used in connection with a specific name and consequently there could not be any legal objection to the designation of *Orthoceratites regularis* Schlotheim 1820 as the genotype of *Orthoceros* Brünnich 1771—this species cannot remain in the genus *Orthoceratites* as it is not congeneric with the type species of that genus, and it has never been made the genotype of a valid cephalopod genus.

Several advantages would accrue from the resurrection of *Orthoceros* Brünnich, with *Orthoceratites regularis* Schlotheim as genotype: A very similar name would be preserved for the group of "*Orthoceras regulare*"; the family name would have to be changed only slightly, that is, from Orthoceratidae to Orthocerotidae; and we could continue to talk of orthoceroids, or better, orthocerotoids. The name *Orthoceras* could not be used legally to refer to cephalopods and it would therefore have to disappear from cephalopod literature. Consequently it could no longer be used as a "catchall" for species of uncertain affinities. The term *Orthoceros* would not simply replace the familiar *Orthoceras*, but it would become the name of a valid genus which would be exemplified by a genotype, *Orthoceratites regularis*,[2] well known through the recent investigations of Troedsson—it might even be possible to change the spelling of Brünnich's name to *Orthoceras*, but we do not think that such a procedure is necessary or advisable.

[2] *Orthoceratites regularis* of the Ordovician (Chazian equivalent) of Öland and Estonia and the glacial boulders that came from there, is a long, narrow, straight (that is, orthoceraconic) nautiloid with straight transverse growth-lines and sutures and a subcentral orthochoanitic siphuncle; there are a few prominent but short longitudinal grooves or fossae on the living chamber and in some cases there is a broad, shallow, transverse constriction near the aperture. Similar forms without the longitudinal grooves should be referred to *Michelinoceras* Foerste 1932.

Since so many different organisms have in the past been termed *Orthoceras*, it would almost certainly result in greater confusion than uniformity to attempt to replace the generic term *Hippurites* with this name, and a suspension of the Règles will probably be attainable for this case.

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