



PHYTOSAURIAN NOMENCLATURE: PARASUCHIA, BELODONTIA OR PHYTOSAURIA?

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ABSTRACT – The nomenclatural status of *Phytosaurus* Jæger is here analyzed in accordance with the International Code of Zoological Nomenclature. In the past, several authors have interpreted it as both a family-group and/or a genus-group name, but each of these approaches fails in several articles of the *Code*. *Phytosaurus* Jæger is here interpreted as originally established for a collective-group and cannot be used as a nominal genus in binomina, but takes precedence over any other younger homonym, and the first available one is *Phytosaurus* Wagler. Being an invalid junior homonym, the class-group name Phytosauria Baur and the family-group name Phytosauridae Lydekker, which are based on *Phytosaurus* Wagler, are ultimately rejected. Conversely, the class-group names Parasuchia Huxley and Belodontia Brauns, as well as the family-group name Belodontidae Cope, are older but have some taxonomic restrictions in relation to *Belodon plieningeri* Meyer. To avoid proposing new names for old ones, the solution to fix the higher-order nomenclature for phytosaurs is to designate a neotype for *Belodon plieningeri* Meyer.

Keywords: Parasuchia, Phytosauria, Belodontia, Archosauriformes, Triassic, collective-group.

RESUMO – O status nomenclatural de *Phytosaurus* Jæger é aqui analisado de acordo com o Código Internacional de Nomenclatura Zoológica. No passado, vários autores o interpretaram como um nome de grupo-família e/ou de grupo-gênero, mas cada uma dessas abordagens contraria vários artigos do *Código*. *Phytosaurus* Jæger é aqui interpretado como originalmente estabelecido para um grupo-coletivo e não pode ser usado como um gênero nominal em binômios, mas tem prioridade sobre qualquer outro homônimo mais novo, e o primeiro disponível é *Phytosaurus* Wagler. Sendo um homônimo júnior inválido, os nomes de grupo-classe Phytosauria Baur e grupo-família Phytosauridae Lydekker, que são baseados em *Phytosaurus* Wagler, acabam por serem rejeitados. Por outro lado, os nomes de grupo-classe Parasuchia Huxley e Belodontia Brauns, bem como o nome de grupo-família Belodontidae Cope, são mais antigos, mas possuem algumas restrições taxonômicas em relação a *Belodon plieningeri* Meyer. Para evitar propor novos nomes para aqueles antigos, a solução para corrigir a nomenclatura de mais alta ordem para os fitossauros é designar um neótipo para *Belodon plieningeri* Meyer.

Palavras-chave: parassúquios, fitossáurios, belodôncios, arcossauriformes, Triássico, grupo-coletivo.

INTRODUCTION

Phytosaurs are an extinct and well-defined Triassic group of the archosauriforms (Stocker & Butler, 2013). Their phylogenetic position as a basal archosauriform (Stocker *et al.*, 2017) or as an early-branching clade of the crocodylian lineage of archosaurs (Ezcurra *et al.*, 2020, 2021) is open to debate yet. They are mainly known from the Late Triassic of Laurasia in present-day Europe and North America, and also from the Late Triassic of the northern and eastern portions of Gondwana, on what it is today Africa, India, and Madagascar (see Stocker & Butler, 2013, for a review), with a report from western Gondwana, in South America (Kischlat & Lucas, 2003) and Africa (Barrett *et al.*, 2020). Phytosaurs are longirostrine forms that show a very similar general morphology to extant crocodiles and had a supposed semi-aquatic lifestyle.

The higher nomenclature of the group is not well resolved. There are three competing class-group names which had been applied to phytosaurs (Parasuchia Huxley, 1875; Belodontia Brauns, 1890, and Phytosauria Baur, 1894) plus other three, based on coordination to such names (Parasuchoidea Nopcsa, 1928; Phytosauriformes Hay, 1930; and Phytosauromorphi Hay, 1930).

The goal of this paper is to analyze which names are available and valid following the International Code of Zoological Nomenclature (I.C.Z.N., 1999; hereinafter referred to as the *Code*), and its consequences. Throughout the body of this paper, its articles are precisely cited when and where they are relevant. Availability and validity are different concepts. Briefly, an available zoological name is any that conforms to all mandatory provisions of the *Code* (I.C.Z.N., 1999:108), and an unavailable one is any that does not conform or is formally excluded (I.C.Z.N.,

1999:110). Unavailable names are termed *nomina nuda* (I.C.Z.N., 1999:111, “*nomen nudum*”). A valid name is the correct available name for a taxon, potentially the oldest one (I.C.Z.N., 1999:110), and an invalid name is any available name that are a junior homonym/synonym or was formally rejected/suppressed (I.C.Z.N., 1999:109).

THE CLASS-GROUP NAMES

The Copenhagen Decisions (I.C.Z.N., 1957:38) called “‘Order/Class-Group’ of categories to denote all the categories from Sub-Order to Super-Class (both inclusive)” and was the intention extend the Principle of Coordination with a designation of “a type genus for every nominal unit in the group in question”. But this was not implemented (see Hemming, 1958) in the four following official editions of the *Code* (1961, 1964, 1985, 1999). Dubois (1984:8) propose to shorten the term “Order/Class-Group” names as only class-group (“groupe-classe”) names. Today the *Code* partially rules the class-group names in Art. 1.2.2. that expressly notes that the “Articles 1-4, 7-10, 11.1-11.3, 14, 27, 28 and 32.5.2.5 also regulate names of taxa at ranks above the family group”.

The importance of a type-genus for class-group names had been noted by some authors (*e.g.*, Mayr, 1969:359; Dubois, 1984:8) and this idea returned with a new dressing in the Phylogenetic System when Padian *et al.* (1999:70) propose “anchoring clades with their eponymous genera” as a specifier in a clade definition (Serenó, 2005:598). The result is that the eponymous genus works as a type-genus. As every genus has type-species, there is no need to repeat the species name. For example, *Crocodylia* Loveridge, 1946 (see Ross *et al.*, 2010:25), has a non-sense usage if not including *Crocodylus* Laurenti, 1768, which is firmly tied to its type-species *Crocodylus niloticus* Laurenti, 1768. As a result, *C. niloticus* is the only nomenclatural true *Crocodylus*, and the currently remaining species included in this nominal genus are so included because of some subjective taxonomic convenience. There are six available and valid genus-group names (*Oopholis* Gray, 1844; *Palinia* Gray, 1844; *Motinia* Gray, 1844; *Bombifrons* Gray, 1862; *Temsacus*, Gray, 1862; and *Philas* Gray, 1874) subsumed under the current taxonomic framework of the nominal genus *Crocodylus* (see Pan *et al.*, 2020). However, some class-group names were proposed before a fake-eponymous genus-group name, only available later (*e.g.*, *Archosauria* Cope, 1869, and *Archosaurus* Tatarinov, 1960; *Dinosauria* Owen, 1842, and *Dinosaurus* Fischer-von-Waldheim, 1847) and this is the case of *Parasuchia* Huxley, 1875, and *Parasuchus* Lydekker, 1883.

Parasuchia Huxley, 1875

Parasuchia was introduced by T.H. Huxley (1875:427, 430; “suborder”) including *Stagonolepis* Agassiz, 1844, and *Belodon* Meyer, 1842, as a basal grade of crocodylian evolution. It must be noted that *Parasuchus* was not included, and it is a fake-eponymous name. It was cited in Huxley

(1870:49) as a *nomen nudum*, and later in a transcription of the discussion after the presentation of T.H. Huxley at the Geological Society of London (Huxley, 1875:437), also as a *nomen nudum*. The genus name *Parasuchus* would be formally available later in Lydekker (1883:65, 1885:22).

Huxley (1875:429) divided the crocodylians into three grades of evolution. The most basal ones (*Parasuchia*), intermediate forms (*Mesosuchia*), and the most advanced ones, “the most Crocodylian of Crocodyles” (*Eusuchia*).

Although *Stagonolepis* was introduced to name supposed fish scales (Agassiz, 1844:139), additional material cleared its unambiguous nature as crocodylian relative (see Huxley, 1859, 1875, 1877; Walker, 1961; Gower & Walker, 2002), but *Belodon* turned to be quite obscure among additional fragmentary material from different localities (Meyer, 1844, 1847; Plieninger, 1857).

Nopcsa (1928:182) proposed the suborder *Parasuchoidea* also including aetosaurs (family “*Aëtosauridae*”) and phytosaurs (family *Belodontidae*) in a meaning virtually identical to Huxley (1875) as a group of archosaurs. We should note that Nopcsa (1928) did not mention *Parasuchus* Lydekker, 1883 (or 1885). *Parasuchoidea* Nopcsa, 1928, would be a junior homonym of the theoretical older superfamily name (*Parasuchoidea*) coordinated to *Parasuchidae* Lydekker, 1885 (*cf.* Art. 29.2), and it is here proposed to not be used anytime. Although it is available (Arts. 1.2.2), as representing a junior homonymous name (Art. 10.6) of *Parasuchoidea* Lydekker, 1885, it is invalid.

Romer (1956:597) applied the name *Parasuchia* to *Parasuchus* Lydekker, 1883, and its allies (*Belodon* was included with doubts), in the exclusion of *Stagonolepis*. Later, Sereno (1991:15) defined *Parasuchia* as the clade comprising “*Angistorhinus*, *Francosuchus*, *Myrstriosuchus*, *Nicrosaurus*, *Parasuchus*, *Rutiodon*, and all descendants of their common ancestor”. This nodal definition did not use *Belodon* as a specifier nor does its original phylogenetic extension include *Stagonolepis*, to the contrary, *Stagonolepis* was excluded as in Romer (1956). It also does not support the incorporation of newly discovered basal phytosaurian taxa, that will bridge the morphological gap with other groups.

The lectotype of *Parasuchus hislopi* Lydekker, 1883, is fragmentary (Chatterjee, 1974:252), and a neotype, described in Chatterjee (1978) and Kammerer *et al.* (2016), was recently proposed (Chatterjee, 2001:35; Hungerbühler, 2001:229; I.C.Z.N., 2003a:174).

Belodontia Brauns, 1890

Belodontia was introduced by Brauns (1890:202) citing *Belodon* Meyer, 1842 (page 160) as related to crocodylians, noting similar skull openings as figured in Nicholson (1879) and Hoernes (1884). So, Meyer’s (1842) authorship was indirectly referred. Brauns (1890) is an obscure paper and the only reference to it in the phytosaur literature was in Hay (1930:140). Baur (1894:317,322), when introducing *Phytosauria*, indicated *Belodontia* as an alternative name

(“Phytosauria (Belodontia)”) without any reference to Brauns (1890). On the other hand, Marsh (1895:485, 1896:232) cited Belodontia for “another group of extinct Reptiles, which may be termed the *Belodontia*”, again with no reference to Brauns (1890). Concerning the family-group name, Cope (1871:234) was the first to introduce “Belodontidæ”.

Belodontia Brauns, 1890, is a perfect name and any problem with its usage is related to its eponym *Belodon* Meyer, 1842, which also has the same taxonomic limitations as one of the original specifiers of Parasuchia.

The type-species of *Belodon* is *B. plieningeri* Meyer, 1842. It was introduced (Meyer, 1842:302) in an abstract noting “a saur with a more common tooth structure, which I named *Belodon plieningeri* because of the arrow-shaped format of its teeth” (“ein Saurus mit gewöhnlicherer Zahn-Struktur, dem ich wegen der Pfeil-förmigen Gestalt seiner Zähne den Namen *Belodon plieningeri* gegeben habe”). The *Code* (Art. 12.1) asks that names published before 1931 “must be accompanied by a description or a definition of the taxon that it denotes”. Concerning this Art 12.1, it is only necessary the existence of a description or, alternatively, a definition, intending to separate the new taxon from its supposed kins. Hence any posterior subjective evaluation understanding this description/definition as complete or incomplete, good or bad, correct or wrong, clever or dumb, extensive or short, up-to-date or obsolete, is irrelevant. These are personal concepts that change in time. I accept Meyer’s (1842) description (*contra* Hungerbühler, 1998:248), although very poor, almost an etymological explanation, it is still a description. The type-series came from Löwenstein (Stubensandstein, northern Württemberg, Germany), with doubts from Affaltrach (Hungerbühler, 2002:377). The syntypes comprise two teeth with one in place in a fragment of a mandible (Meyer, 1844:43, pl. 12, figs. 20 & 21; 1847:148, plate 20, figs. 2 & 3; Hungerbühler, 1998:248) and they are now probably lost (Hungerbühler, 1998:375). As such, *Belodon plieningeri* had been considered a *nomen dubium* by many authors (e.g., McGregor, 1906:31; Westphal, 1963:161, 1976:111; Gregory, 1969:44; Gregory & Westphal, 1969:1296; Ballew, 1989:326; Hunt & Lucas, 1989:340; Long & Murry, 1995:62; Hungerbühler, 1998:249; Hungerbühler & Hunt, 2000:475) but no one challenged its nature as a phytosaur (using Jæger’s, 1828, name in vernacular English, see ahead). As *Belodon* is a phytosaur, Belodontia Brauns, 1890, is an available formal name for the group. Therefore, Belodontia was phylogenetically defined by Kischlat (2002:283) as all the ancestry of *Belodon* and its descendants, not shared by *Aetosaurus* and/or *Crocodylus* (“toda a ancestralidade de *Belodon* e sua descendência, não compartilhada por *Aetosaurus* e/ou *Crocodylus*”).

Phytosauria Baur, 1894

Phytosauria has a competing usage with Parasuchia as a class-group name (e.g., Romer, 1956:597; Appleby *et al.*, 1967:709) for phytosaurs. The history of the name is complex, but it was introduced, as such, by Baur (1894:317, 322)

giving “*Phytosaurus* oder *Belodon*” as examples. As a result, *Phytosaurus* is the eponym. Other class-group names were also introduced using the same eponym: Phytosauromorphi (“order”) and Phytosauriformes (“suborder”), both from Hay (1930:137, 140).

Jæger (1828:22) introduced *Phytosaurus* in an ambiguous way. First (page 22) he noted: “However, it would be quite possible that this bone belonged to one of the **two following new genera of reptiles**, which were only discovered in the same type of rock in Autumn 1826, and **which I refer to under the common name *Phytosaurus***” (“Es wäre jedoch gar wohl möglich, daß dieser Knochen einer der **zwei** folgenden **neuen Reptiliengattungen** zugehörte, die erst im Herbst 1826 in derselben Gebirgsart entdeckt wurden, und **die ich voläufig mit dem gemeinschaftlichen Namen *Phytosaurus* bezeichne**”, my bold). Here it is clear that he was not talking about the *Gattung* (= genus) *Phytosaurus*, but about two following new reptile genera (“neuen Reptiliengattungen”) that would be described on pages ahead as *Cylindricodon* and *Cubicodon*, and *Phytosaurus* would be some category above both.

On page 23 he continued: “This is particularly noticeable in the pieces which contained the remains of bones of the **first species or genus of *Phytosaurus*, which I call *Cylindricodon*** [...]” (“Dieß bemerkt man auch insbesondere an den Stücken, welche die nun zu beschreibende Ueberreste von Knochen der **ersten Art oder Gattung von *Phytosaurus*, welche ich *Cylindricodon* nenne** [...]”, my bold).

On the same page: “The stone, in which teeth and remnants of the jaw of a **second species or genus, which I would like to call *Cubicodon***, were found, showed almost the same quality [...]” (“Dieselbe Beschaffenheit beinahe zeigte der Stein, in welchem sich Zähne und Ueberreste des Kiefers einer zweiten **Art oder Gattung fanden, die ich *Cubicodon* nennen möchte** [...]”, my bold).

On page 38, it was written: “The somewhat different manner in which the teeth are fastened seems to me to permit the association of this fossil reptile **under the same genus or family *Phytosaurus***, and I have named **the genus or species *Cubicodon*** after the shape of the teeth, since the teeth in the nature of the outer surface many resemblances to those of the *Cylindricodon* [...]” (“Die etwas verschiedene Art der Befestigung der Zähne scheint mir doch die Vereinigung dieses Fossilen Reptils **unter dieselbe Gattung oder Familie *Phytosaurus*** zu gestatten, und ich habe die **Gattung oder Art** nach der Form der Zähne *Cubicodon* genannt, da zwar die Zähne in der Beschaffenheit der äußeren Oberfläche viele Aehnlichkeit mit denen des *Cylindricodon* [...]”, my bold).

In the end, on page 44: “Only when several remains of these animals have been brought together will it be possible to decide **whether the two species mentioned exist as separate genera** or whether they can perhaps be united with the *Iguanodon* and several living reptiles **to form a family of herbivorous reptiles, for which I propose the name *Phytosaurus***” (“Es wird sich wohl erst, wenn mehrere Ueberreste dieser Thiere zusammengebracht sind,

entscheiden lassen, ob die angeführte **beide Arten als besondere Gattungen für sich bestehen** oder vielleicht mit dem *Iguanodon* und mehreren lebenden Reptilien wenigstens **zu einer Familie pflanzenfressender Reptilien vereinigt werden können, für welche ich den Namen *Phytosaurus* vorschlagen möchte**”, my bold).

In Jæger’s (1828:48) “explanation of the images” (“Erklärung der Abbildungen”) these names were used in a uninominal nomenclature (i.e., “*Phytosaurus*”, “*Cylindricodon*” and “*Cubicodon*”), at the same time using several other binomina which were discussed in the text (e.g., “*Crocodylus bollensis*” and “*Ichthyosaurus tenuirostris*”).

In sum, Jæger (1828) introduced *Phytosaurus* as a family-group name **or, alternatively**, a genus-group name, and not as a family-group name **and** a genus-group name. The names were **not introduced simultaneously in both categories, and both categories mutually exclude each other** (cf. Art. 1.2.2). In the same way, *Cylindricodon* and *Cubicodon* were proposed as genus-group names **or, alternatively**, as species-group names and not as genus-group names **and** species-group names. They also were **not introduced simultaneously in both categories**, and again, **both categories are mutually exclusive** (cf. Art. 1.2.2). And in the case of *Phytosaurus* being a family-group name, it could also include *Iguanodon* Mantell, 1825.

Phytosaurus Jæger, 1828, as a family-group name

Meyer (1861:253) was the first to accept *Phytosaurus* Jæger, 1828, as a family (“Familie der Phytosaurier”). He expressly noted (Meyer, 1861:294) that Jæger’s (1828) “own family of herbivorous saurs, **the phytosaurs**, of which he differentiates between **two genera, *Cylindricodon* and *Cubicodon***” (“eigenen Familie pflanzenfressender Saurier, **den Phytosauriern**, beilegt, deren er **zwei Gattungen, *Cylindricodon* und *Cubicodon***, unterscheidet”). Later, Lydekker (1888:123), proposed “family Phytosauridae” as an alternative name for Belodontidae Cope, 1871.

Concerning the *Code*, a family-group name must be first published as “a noun in the nominative plural formed from the stem of an available generic name [...]; the generic name must be a name then used as valid in the new family-group taxon [...] (use of the stem alone in forming the name is accepted as evidence that the author used the generic name as valid in the new family-group taxon unless there is evidence to the contrary)” (Art. 11.7.1.1 [& Arts. 29, & 63, & 64]). As Jæger’s (1828) “Familie *Phytosaurus*” and “Gattung *Phytosaurus*” are mutually exclusive, the theoretical family Phytosaur[idae] will not include the genus *Phytosaurus*. But the genus-group names *Cylindricodon* und *Cubicodon* Jæger, 1828, even with no species associated (cf. Art. 67.2.2), would be available because “every new name published before 1931 *must* [...] *be accompanied by a description* [...]” (Art. 12.1, my italics). And this was originally done by Jæger (1828).

In sum, the putative family-group name *Phytosaurus* Jæger, 1828, is unavailable because it is not originally “in the nominative plural” (Art. 29) and “the generic name [*Phytosaurus*] must be a name then used as valid in the new

family-group taxon” (Arts. 63, & 64). Alternatively, the now new name “Familie der Phytosaurier”, as used by Meyer (1861:253), is also unavailable because it has the same problems: not in the German nominative plural (cf. Art. 11.7.2, should be Familie der Phytosauriden, *contra* Doyle & Sues, 1995:546) and *Phytosaurus* was not “used as valid in the new family-group taxon” (Arts. 63, & 64).

The conclusion is that:

- (i) *Phytosaurus* Jæger, 1828; and “Familie der Phytosaurier” Meyer, 1861, are both unavailable (*contra* Doyle & Sues, 1995:546) as family-group names (Arts. 11.7.1.1, & 11.7.2, & 29, & 63, & 64);
- (ii) The family-group name Phytosauridae Lydekker, 1888, is not a latinization of Meyer’s (1861), as such considered by Doyle & Sues (1995:546), but a new proposed name and the putative *Phytosaurus* Jæger, 1828, **is not** its type-genus (see ahead);
- (iii) The genus-group names *Cylindricodon* Jæger, 1828, and *Cubicodon* Jæger, 1828, are available (cf. Meyer, 1860a:212; cf. Romer, 1956:598, 1966:368), even with no species associated, because they were originally described (Arts. 12.1, & 67.2.2).

Phytosaurus Jæger, 1828, as a genus-group name

The *Code* expressly asks for the “Principle of Binominal Nomenclature” where the “scientific name of a species, and not of a taxon of any other rank, is a combination of two names (a binomen), the first being the generic name and the second being the specific name” (Art. 5). As Jæger (1828) did not use in any place the binominal nomenclature concerning *Phytosaurus* associated with *Cylindricodon*, and *Phytosaurus* associated with *Cubicodon*, at the same time he used some other binomina in his text (e.g., “*Crocodylus bollensis*” and “*Ichthyosaurus tenuirostris*”), it is clear that was not his intention to propose “*Phytosaurus cylindricodon*” and “*Phytosaurus cubicodon*” (cf. Art. 11.4.1) as used by many later authors (e.g., Wagler, 1830:140; Meyer, 1832:114, 222; Bronn, 1835:192; McGregor, 1906:93; Huene, 1911:38; Mehl, 1915:161; Camp, 1930:140; Gregory, 1962:679). In the absence of the binominal nomenclature the putative genus-group name *Phytosaurus* Jæger, 1828, is unavailable.

The *Code* also asks that “a species-group name must be published in unambiguous combination with a generic name (either explicit, or implicit by context)” (Art. 11.9.3) which is not originally the case in Jæger (1828). It must be noted that the usage of uninominal nomenclature by him where *Phytosaurus* could be a genus-group name or not, and *Cylindricodon* and *Cubicodon* could be species-group names, or not. The absence of combination, even implicit, of the names *Cylindricodon* and *Cubicodon* to *Phytosaurus* makes them unavailable as species-group names.

The first author who unambiguously accepted *Phytosaurus* as a genus-group name was Wagler (1830:140) who expressly wrote the binomina “*Phytos[aurus] cubicodon*” and “*Phytos[aurus] cylindricodon*”, indicating (cf. Art. 12.2.1) both as from Jæger (1828). As the *Code* (Art. 50.1)

asks that the “author of a name or nomenclatural act is the person who first publishes it [...] in a way that satisfies the criteria of availability [...]” the binomina *Phytosaurus cylindricodon* and *Phytosaurus cubicodon* are from Wagler (1830). Or, in other words, the nominal genus *Phytosaurus* and the nominal species [*Phytosaurus cylindricodon* and [*Phytosaurus*] *cubicodon*], have all the same authorship to be credited to Wagler (1830). Later, Lydekker (1888:124) fixed *Phytosaurus cylindricodon* Wagler, 1830, as the type-species of *Phytosaurus* Wagler, 1830.

In the unavailability of *Phytosaurus* Jæger, 1828, as a genus-group name, the family-group name Phytosauridae Lydekker, 1888, will have *Phytosaurus* Wagler, 1830, as its type-genus (although wrongly credited to “Jäger”, 1828).

The conclusion is that:

- (i) *Phytosaurus* Jæger, 1828, as a genus-group name, is unavailable (Art. 11.4.1), otherwise *Phytosaurus* Wagler, 1830, is available;
- (ii) The putative binomina *Phytosaurus cylindricodon* Jæger, 1828, and *Phytosaurus cubicodon* Jæger, 1828, are unavailable (Art. 11.9.3), otherwise the binomina *Phytosaurus cylindricodon* Wagler, 1830, and *Phytosaurus cubicodon* Wagler, 1830, are available;
- (iii) The type-genus of Phytosauridae Lydekker, 1888, is *Phytosaurus* Wagler, 1830;
- (iv) The type-species of *Phytosaurus* Wagler, 1830, is *Phytosaurus cylindricodon* Wagler, 1830.

Phytosaurus Jæger, 1828, as a collective-group name

“Collective-group” is textually cited in several articles of the four editions of the *Code*: First & Second Edition (I.C.Z.N., 1961 & 1964): Arts. 13(b)(i), 42(c), 42(c)(i), 56, 57, 58, 66; Third Edition (I.C.Z.N., 1985): Arts. 1(d), 10(d), 13(b), 23(g), 23(g)(i), 23(g)(ii), 42(b)(i), 56(a), 57(a), 58, 66, 67(m); Fourth Edition (I.C.Z.N., 1999): Arts. 1.2.1, 10.3, 13.3, 13.3.2, 16.3, 23.7, 23.7.1, 23.7.2, 35.1, 42.2.1, 42.3.1, 56.1, 57.1, 58, 66, 67.14. In the glossaries “collective group” is defined as: First & Second Editions (I.C.Z.N., 1961:148, 1964:148) “An assemblage of identifiable species of which the generic positions are uncertain; treated as a genus-group for taxonomic convenience”; Third Edition (I.C.Z.N., 1985:255) “An assemblage of nominal species that cannot be placed with certainty in known genera; names proposed expressly for collective groups are treated as generic names”; Fourth Edition (I.C.Z.N., 1999:105) “An assemblage of species, or stages of organisms (e.g., eggs or larvae), that cannot be allocated with confidence to nominal genera. Names proposed or used for collective groups are treated as genus-group names but special provisions apply to them”.

This concept was introduced in the parasitological literature by C.W. Stiles (1898:13, 28, 1902:25, 1904:12; Stiles & Hassall, 1905:55). It was proposed to be part of the *Code* also by C.W. Stiles in the Zoological International Congress in 1907 at Boston (Stiles, 1907:521, 1912:36) as a Recommendation defined as “Certain biological groups which *have been proposed* distinctly as collective groups, *not*

as systematic units, may be treated for convenience as if they were genera, but they require no type species” (my italics) and this Recommendation was inserted in several early versions of the *Code* under Art. 8 (e.g., I.C.Z.N., 1912:41, 1914:896).

Collective-groups are “names established expressly for certain assemblages of taxonomic convenience” (Art. 42.2.1) and its application is also retroactive (cf. Art. 13.3.2, “any time”). When a name is “*established expressly* for a collective group [it] does not compete in priority with other genus-group names” (Art 23.7.1, my italics).

Moore & Sylvester-Bradley (1957:6–7) proposed the concept of “Parataxon” for a “nomenclature of fragments” which in Paleontology “are indispensable for correlations of many rock formations in the earth’s crust and for aid in establishing a trustworthy geochronology of the post-Precambrian part of geological time”. And Moore (1957:117) raised the applicability of this concept in Vertebrate Paleontology to “isolated fragments of vertebrate skeletons (teeth, scutes or scales, otoliths, etc.) that are unidentifiable in terms of whole-animal taxa and in greatly varying manner some of these can be so identified reasonable”. Finally, “the problem facing parasitologists and that facing paleontologists seems fundamentally the same” (Bradley, 1957:167). These opinions were part of an extensive discussion on “Paranomenclature” reported by I.C.Z.N. (1979).

“Kollektivegruppe” (Kraus, 2000:39) is the nowadays German translation for “collective group” in the *Internationale Regeln der Zoologischen Nomenklatur*. But in the past, in the version approved in the International Zoological Congress in 1927 at Budapest, the German translation was “Sammelgruppe” (Heikertinger, 1930:3).

Jæger (1828) used the German vernacular “gemeinschaftlich” (an adjective meaning common; Sporschil, 1830:265). Today, the adjective “kollektiv” is synonym of “gemeinschaftlich” (Drosowski *et al.*, 1989:860) and came from French (Kluge, 2011:514). In the past, “kollektiv” (or “collectif”) was not a German word (Sporschil, 1830:139, 369; Kluge, 1899:69, 218), and the French adjective word “collectif” (from the Latin *collectivus*) was indicated as a translation of “gemeinschaftlich” (Schuster & Régnier, 1870a:334, 1870b:242). In sum, Jæger (1828) did use the German adjective word “gemeinschaftlich” of his time as corresponding to the nowadays adjective word “kollektiv”.

There are provisions applying to the name *Phytosaurus* Jæger, 1828, as “*established expressly* for a collective group” (Art 23.7.1, my italics) because collective names have a suite of special properties: (1) they should be treated as a genus-group name (Art. 10.3); (2) they compete in homonymy (Art. 56.1); (3) but they never compete in priority (Art. 23.7.1); (4) they have no type-species (Arts. 13.3.2, & 42.3.1, & 66) and any type-species designation is disregarded (Art. 67.14). As a consequence (1) any younger available genus-group homonymous name of *Phytosaurus* Jæger, 1828, is invalid and cannot be used (Arts. 23.7, & Art. 56.1); (2) any other younger available genus-group name is valid to use in the place of *Phytosaurus* Jæger, 1828 (Art. 23.7.1); (3) as a collective name, it cannot be the type of any family-group

name (I.C.Z.N., 1999:XIX-XX) because it does not follow the Principles of Coordination (Art. 43), Typification (Art. 61), and Binominal Nomenclature (Art. 5); and (4), by extension and analogy, it would also be rejected to serve formally as the eponym of any class-group name.

The conclusion is that:

- (i) The availability of *Phytosaurus* Jäger, 1828, as originally proposed as a collective name (“gemeinschaftliche Name”) is sustained, and any discussion about which category it pertains turns out to be irrelevant because it should be treated as a genus-group name (Art. 10.3);
- (ii) The vernacular English phytosaur or its translation for other languages (phytosaur in French, Phytosaurier in German, fitossauro in Portuguese, fitosauro in Spanish, and so on) is a direct application of this name originally proposed in Latin (*Phytosaurus*);
- (iii) The availability of the nominal genus *Phytosaurus* Wagler, 1830, is sustained, but it is invalid because it is a junior homonym of *Phytosaurus* Jäger, 1828 (Art. 56.1);
- (iv) As *Phytosaurus* Jäger, 1828, is available as a collective-group, all coordinated names (e.g., Phytosauridae and, by extension, Phytosauria, Phytosauromorphi, and Phytosauriformes) are not coordinated to it (Art. 43), but to *Phytosaurus* Wagler, 1830;
- (v) As *Phytosaurus* Wagler, 1830, is available but invalid due to be a junior homonym of *Phytosaurus* Jäger, 1828, the coordinated names Phytosauridae (cf. Art. 39, type-genus), Phytosauria, Phytosauromorphi, and Phytosauriformes (by extension and analogy to Art. 39, eponym), are all available but invalid;
- (vi) Concerning the two new genus-group names (“zwei [...] neuen Reptiliengattungen”) *Cylindricodon* and *Cubicodon*, both are available and valid originally as from Jäger (1828), even with no species associated, because they were originally described (cf. Arts. 12.1, & 67.2.2);
- (vii) The species-group names [*Phytosaurus*] *cylindricodon* and [*Phytosaurus*] *cubicodon*, not more from Jäger (1828), but now from Wagler (1830), are available, even associated with an invalid generic name (cf. Art. 11.9.3.1);
- (viii) It is necessary to associate both the available and valid genus-group names *Cylindricodon* and *Cubicodon* from Jäger (1828), respectively with both available and valid species-group homonymous names from Wagler (1830) as “*Cylindricodon cylindricodon* (Wagler, 1830)” and “*Cubicodon cubicodon* (Wagler, 1830)” in absolute tautonymy (Art. 68.4);
- (ix) The utility of *Cylindricodon cylindricodon* (Wagler, 1830) and *Cubicodon cubicodon* (Wagler, 1830) should be properly evaluated under taxonomic purposes, but nomenclaturally they are in accordance with the *Code* (Art. 51.3).

DISCUSSION

Cylindricodon cylindricodon (Wagler, 1830) and *Cubicodon cubicodon* (Wagler, 1830), are based in the same individual specimen, but in different parts of this same specimen (Meyer, 1861:301; Huene, 1911:100; Hungerbühler, 1998:246). So, both names are mutually objective synonyms of each other and *Cylindricodon cylindricodon* has priority of page. As *Belodon plieningeri*, both binomina were considered as *nomina dubia* by many authors (e.g., Westphal, 1963:168; Gregory & Westphal, 1969:1296; Ballew, 1989:325; Hungerbühler, 1998:139; Hungerbühler & Hunt, 2000:471), but Hungerbühler (1998:246) rejected the idea of “invalidity” of *Cylindricodon cylindricodon* (as *Phytosaurus cylindricodon*) on the grounds of supposed poor preservation. The whole individual specimen was once identified as representing the same taxon named later as *Nicrosaurus kapffi* (Meyer, 1861:346; Huene, 1911:102) and, more recently, it was included in the new taxon introduced by Hungerbühler & Hunt (2000) as *Nicrosaurus meyeri* (Hungerbühler, 1998:139; Hungerbühler & Hunt, 2000:471).

In sum, *Cylindricodon cylindricodon*, *Cubicodon cubicodon*, and *Belodon plieningeri* had been considered as *nomina dubia* by many authors. Except for any declaration of the International Commission on Zoological Nomenclature (Art. 81) a *nomen dubium* cannot be suppressed (Art. 10.6). The *Code* (I.C.Z.N., 1999:111) defined *nomen dubium* as a “name of unknown or doubtful application”. As noted by Mones (1989:232), a “*nomen dubium* denotes ignorance, incapability to interpret the facts, insufficient diagnosis, or actual poorness of the type specimen”. *Nomina dubia* are ghosts wandering the nomenclatural eternity, haunting taxonomists and seeking their place in [paleo]zoology until a final judgment. In sum, *nomen dubium* has a stand-by status until clarification. It cannot be suppressed, disregarded, or ignored and all the passages of the *Code* dealing with a *nomen dubium* (I.C.Z.N., 1999:XXVII, Art. 75.5) are related to the designation of a neotype to replace an “unidentifiable name-bearing type”.

Additional material with a gracile, extremely long and narrow snouted (“lange schmale Schnautze”) was referred to *Belodon plieningeri* (Meyer, 1860a, 1861) and material with a robust tall rostral crest (“mehr noch durch Höhe als durch Breite”) was assigned to a new species called *Belodon kapffi*, honoring the collector Sixt Friedrich Jacob von Kapff (Meyer, 1860b, 1861, 1863, 1864, 1865a, 1865b, 1866). Recently it was suggested (Zeigler *et al.*, 2002, 2003) that the gracile and robust morphotypes in phytosaurs are related to sexual dimorphism and *plieningeri* gracile morphotype would represent the female, while *kapffi* robust morphotype would be the male (Kimblings, 2009:20; Kimming & Spielman, 2011:291). Both morphotypes came from the same locality (Meyer, 1861:256; Kapff, 1859:94, 1875:303) identified as probably Heschlacher Wand (Hungerbühler, 1998:383).

Meanwhile, Fraas (1866:210) coined the genus-group name *Nicrosaurus* (the “Neckarsaur”, lizard from the Neckar) for *B. kapffi* (as “*Kapffii*”, from Kapffius, the Latinized form

for Kapff, *cf.* Arts. 31.1.1, & 33.4) giving a photograph of the skull (Fraas, 1866:209, fig. 75) and indicating Meyer (1863). “*Kapffii*” is an incorrect subsequent spelling, and it is not available (Art. 33.3) and should be automatically corrected to “*kapffi*”. Later, Mehl (1915:163) proposed *Lophoprosopus* also for *Belodon kapffi* (by monotypy, *Belodon buceros* Cope, 1881, was included with doubts, see Arts. 67.2.5, & 68.3). More recently, Hungerbühler & Hunt (2000:471), introduced the binomen *Nicrosaurus meyeri* for the long and narrow snouted taxon, with the holotype coming from a locality (quarry “Weißer Steinbruch”, Pfaffenhofen; Hungerbühler & Hunt, 2000:474) which is not the same as Meyer’s (1861) additional specimens.

Belodon (= *Nicrosaurus*) *kapffi* Meyer, 1860b, does not have a formally fixed lectotype (*cf.* I.C.Z.N. 2003b, Art. 74.7.3), but the specimen figured in Meyer (1861, plate 30) was improperly indicated as such (*cf.* Hungerbühler, 1998:35; Stocker & Butler, 2013:94). And it was noted (Hungerbühler & Hunt, 2000:475) that if a neotype is designated for *Belodon plieningeri*, the genus-group name *Nicrosaurus* Fraas, 1866, would turn to be a junior subjective synonym of *Belodon* Meyer, 1842, which does have priority.

Because *Belodon* Meyer, 1842, has priority over *Nicrosaurus* Fraas, 1866; the unavailability of *Phytosaurus* Jæger, 1828, as a genus-group name, and the invalidity of the junior homonym *Phytosaurus* Wagler, 1830, all coordinated names (*e.g.*, Phytosauria and Phytosauridae) should be rejected. Otherwise, *Belodon* Meyer, 1842, has its own coordinated names (*Belodontia* Brauns, 1890, and *Belodontidae* Cope, 1871) that should be used in taxonomy in the same places (clades) of the current usage of Phytosauria and Phytosauridae (see Stocker & Butler, 2013; and Kammerer *et al.*, 2016) preventing the creation of new names for old ones.

At this point, it is good to remember J.C. Bradley’s preface of the First Edition of the *Code* (I.C.Z.N., 1961:IV) when he wrote that zoological nomenclature “has been the result of ignorance, of vanity, obstinate insistence on following individual predilections”. But going back to Strickland *et al.* (1843:107), the first *Code* proposition when regarding the confusion of nomenclature in Zoology, and, as a consequence, the communication: “the practice of gratifying individual vanity by attempting on the most frivolous pretexts to cancel the terms established by original discoverers, and to substitute a new and unauthorized nomenclature in their place”. Because of this, the “Law of Priority” was originally introduced (Strickland *et al.*, 1843:108) to consider “those who are continually attempting to subvert the established language of zoology by substituting terms of their own coinage”.

Nomenclature is “a system of names, and provisions for their formation and use” (I.C.Z.N., 1999:111). Otherwise, Taxonomy is “the theory and practice of classifying organisms” (I.C.Z.N., 1999:119). Therefore, Nomenclature concerns with “implications of the taxonomic operations in question and not the operations themselves” (I.C.Z.N., 1950:73-74). It “does not determine the inclusiveness or exclusiveness of any taxon, nor the rank to be accorded to

any assemblage of animals, but, rather, provides the name that is to be used for a taxon whatever taxonomic limits and rank are given to it” and “the device of name-bearing types allows names to be applied to taxa without infringing upon taxonomic judgment” (I.C.Z.N., 1999:XIX).

Until now there was no consensus about the authorships of Phytosauria and Phytosauridae (see Huene, 1911:120, 1922:158; Camp, 1930:139; Kuhn, 1933:17, 1961:93; Hofstetter, 1955:666; Gregory, 1962:653; Westphal, 1963:168, 1976:108; Doyle & Sues, 1995:546; Hungerbühler, 1998:17, 2002:380; Hungerbühler & Hunt, 2000:470). On the other hand, *Belodontia* was credited to Marsh (1896) by Kuhn (1961:93). In sum, there was a general preference in the usage of Phytosauria and Phytosauridae in the place of *Belodontia* and *Belodontidae* because *Phytosaurus* Jæger, 1828, was older than *Belodon* Meyer, 1842. But this is not correct because *Belodontia* and *Belodontidae* (1890 and 1871, respectively) are both older than Phytosauria and Phytosauridae (1896 and 1888, respectively), *Phytosaurus* Jæger, 1828, is not available as a genus-group name, and *Phytosaurus* Wagler, 1830, is invalid to be used.

Belodontia and *Belodontidae*, although older and nomenclaturally available and valid, are taxonomically weak as a representative of any group (or clade) because the type-material of *Belodon plieningeri* is undiagnostic inside phytosaurs. This problem was raised by Kammerer *et al.* (2016:18) when noting the nomenclatural application of the family-group name Phytosauridae in phylogenetic taxonomy. So, for nomenclatural stability in taxonomy, *Belodon plieningeri* should have a new and better type material.

CONCLUSIONS

Taxonomy is not the goal of the present paper but there are potentially five binomina (using the invalid junior homonym *Phytosaurus* Wagler, 1830) for the same phytosaur taxon present in the Löwenstein Formation (Stubensandstein) of Baden-Württemberg (southern Germany). The gracile morphotype has four binomina available: *Phytosaurus* (= *Cylindricodon*) *cylindricodon* Wagler, 1830; *Phytosaurus* (= *Cubicodon*) *cubicodon* Wagler, 1830; *Belodon plieningeri* Meyer, 1842, and the recently proposed *Nicrosaurus meyeri* Hungerbühler & Hunt, 2000; and the robust morphotype has the binomen *Belodon* (= *Nicrosaurus*) *kapffi* Meyer, 1860b, available.

As shown, the name *Phytosaurus* Jæger, 1828, is not a genus-group name, and *Phytosaurus* Wagler, 1830, and its coordinated names Phytosauridae and Phytosauria, although available are all invalid in the light of the *Code*. Therefore, it is time to fix the higher-level taxonomy of phytosaurs. To complete this process, and using parsimony and the Principle of Priority, a request to the International Commission on Zoological Nomenclature to set aside under its plenary power (Arts. 75.5, & 81) the original syntypes of *Belodon plieningeri* Meyer, 1842, is necessary. There is a general agreement that they are lost and all the available illustrations (Meyer, 1844:43, plate 12, figs. 20 & 21; 1847:148, plate 20,

figs. 2 & 3) of them are undiagnostic (e.g., Hungerbühler & Hunt, 2000:475). The neotype should be chosen among the assemblage of specimens described by Meyer (1861, 1865a), and the best specimen, as previously noted in Hungerbühler (1998:137) and Hungerbühler & Hunt (2000:475), will be that figured in Meyer (1861, plate 28; plate 29, figs. 1-5 & 8-10; and plate 37, fig. 27) and in Hungerbühler (1998:432-433, figs. 2.45 & 2.46). It came from the same locality as also the suggested lectotype of *Belodon kapffi* which is probably Heschlacher Wand (Hungerbühler, 1998:383). So, both supposed female and male name-bearing specimens and morphotypes came from the same type-locality.

This request should also include the suppression of both nominal genera *Cylindricodon* Jæger, 1828, and *Cubicodon* Jæger, 1828, as well of both nominal species [*Phytosaurus*] *cylindricodon* Wagler, 1830, and [*Phytosaurus*] *cubicodon* Wagler, 1830, in the prevailing usage (cf. Art. 23.9.1.1, Recommendation 23A) of both younger nominal genera *Belodon* Meyer, 1842, and *Nicrosaurus* Fraas, 1866, and both younger nominal species [*Belodon*] *plieningeri* Meyer, 1842, and [*Belodon*] *kapffi* Meyer, 1860b.

The result is that the younger genus-group name *Nicrosaurus* Fraas, 1866, will be only subsumed under the older *Belodon* Meyer, 1842, if the hypothesis of sexual dimorphism for gracile and robust forms applies, or in the subjective approach in naming a clade with both full sister taxa *plieningeri*+*kapffi* under the same genus-group name (as in Hungerbühler & Hunt, 2000, and Hungerbühler, 2002).

With these nomenclatural adjustments, the class-group name *Parasuchia* Huxley, 1875, could well be used taxonomically. I propose that this name remains to be linked to Huxley's (1875) original phylogenetic hypothesis, naming a clade (stem) comprising the common ancestor of *Belodon* Meyer, 1842, and *Stagonolepis* Agassiz, 1844, which is not shared by *Crocodylus* Laurenti, 1768. So, this definition should be known as the "Parasuchian Hypothesis".

A nomenclatural synopsis is provided in Appendix 1.

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Appendix 1. Nomenclatural synopsis.Collective-group name

Phytosaurus Jæger, 1828:22 (“gemeinschaftliche Name”). It could not be the type (eponym) of any name in any category (Art. 43), nor type-species is required (Art. 42.3.1).

Class-Group names

Parasuchia Huxley, 1875:427 (“suborder”). No eponymous name included. Definition (herein): the clade (stem) comprising the common ancestry of *Belodon* Meyer, 1842, and *Stagonolepis* Agassiz, 1844, which is not shared by *Crocodylus* Laurenti, 1768.

Belodontia Brauns, 1890:202 (?Unterordnung). Eponym: *Belodon* Meyer, 1842. Definition: the ancestry (stem) of *Belodon* and its descendants, not shared by *Aetosaurus* and/or *Crocodylus* (cf. Kischlat, 2002:283).

Phytosauria Baur, 1894:322 (“Gruppe”). Eponym: *Phytosaurus* Wagler, 1830 (*non* Jæger, 1828). Rejected by junior homonymy of an older valid genus (collective) name (analogy to Art. 39).

Parasuchoidea Nopcsa, 1928:182 (“suborder”). No eponymous name included. Rejected by junior homonymy of the superfamily name Parasuchoidea Lydekker, 1885.

Phytosauromorphi Hay, 1930:137 (“order”). Eponym: *Phytosaurus* Wagler, 1830 (*non* Jæger, 1828). Rejected by junior homonymy of an older valid genus (collective) name (analogy to Art. 39).

Phytosauriformes Hay, 1930:140 (“suborder”). Eponym: *Phytosaurus* Wagler, 1830 (*non* Jæger, 1828). Rejected by junior homonymy of an older valid genus (collective) name (analogy to Art. 39).

Family-Group names

Belodontidae Cope, 1871:234. Type-genus: *Belodon* Meyer, 1842.

Parasuchidae Lydekker, 1885:22. Type-genus: *Parasuchus* Lydekker, 1883.

Phytosauridae Lydekker, 1888:123. Type-genus: *Phytosaurus* Wagler, 1830 (*non* Jæger, 1828). Invalid by junior homonymy of an older valid genus (collective) name (Art. 39).

Genus-Group names

Cylindricodon Jæger, 1828:23. Type-species: *Phytosaurus cylindricodon* Wagler, 1830 (fixed by subsequent monotypy herein [Art. 69.3]).

Cubicodon Jæger, 1828:33. Type-species: *Phytosaurus cubicodon* Wagler, 1830 (fixed by subsequent monotypy herein [Art. 69.3]).

Phytosaurus Wagler, 1830:140 (*non* Jæger, 1828). Type-species: *Phytosaurus cylindricodon* Wagler, 1830 (fixed by subsequent designation of Lydekker, 1888:124 [Art. 69.1]). Invalid by junior homonymy of an older valid genus (collective) name (Art. 56.1).

Belodon Meyer, 1842:302. Type-species: *Belodon plieningeri* Meyer, 1842 (fixed by monotypy [Art. 68.3]).

Nicrosaurus Meyer, 1860:556. Type-species: *Belodon kapffi* (as “*kapffii*”) Meyer, 1860 (fixed by monotypy [Art. 68.3]).

Lophoprosopus Mehl, 1915:163. Type-species: *Belodon kapffi* Meyer, 1860 (fixed by monotypy [Art. 68.3]).