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TAXONOMIC REVIEW OF *CHONDRITES AFFINIS* (STERNBERG, 1833) FROM CRETACEOUS-NEOGENE OFFSHORE-DEEP-SEA TETHYAN SEDIMENTS AND RECOMMENDATION FOR ITS FURTHER USE

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Abstract. The branched trace fossil *Chondrites affinis* (Sternberg, 1833), synonymised so far with *C. targionii* (Brongniart, 1828), has been analyzed in an exceptionally well preserved specimen from the Saraceno Formation (?Upper Cretaceous; ?Eocene-Miocene) in the southern Italy, its holotype (Prague Museum), and in other materials. It appeared that *C. affinis* displays a smaller burrow system/burrow width ratio and a larger size (burrow width typically over 4 mm and burrow system width over 150 mm) than *C. targionii*, without continuity of the latter parameters between these ichnospecies. Therefore, *Chondrites affinis* is considered as a separate ichnospecies, and is recommended for further use. It occurs in Upper Cretaceous to Neogene offshore, deep-sea, mostly marly sediments, and its unquestionable occurrences are known so far from the European Alpides.

Riassunto. La traccia fossile ramificata *Chondrites affinis* (Sternberg, 1833) finora in sinonimia con *C. targionii* (Brongniart, 1828), è stata analizzata in un campione eccezionalmente ben conservato proveniente dalla Formazione del Saraceno (?Cretaceo sup. o ?Eocene-Miocene) in Italia meridionale, nel suo olotipo (custodito nel Museo di Praga) e in altri campioni. *C. affinis* mostra un ridotto rapporto tra sistema-tana e larghezza dei singoli tunnel e una dimensione maggiore (larghezza dei tunnel oltre i 4 mm e larghezza del sistema-tana oltre i 150 mm) rispetto a *C. targionii*, senza soluzione di continuità di questi ultimi parametri tra queste icnospecie. Quindi *Chondrites affinis* è considerata una icnospecie a se stante, che è raccomandata per usi successivi. Essa è presente in sedimenti cretacico-neogenici, prevalentemente marnosi, di piattaforma esterna e mare profondo, e la sua presenza è indiscutibilmente ben nota nelle catene alpine europee.

Introduction

About 150 ichnospecies of *Chondrites* von Sternberg, 1833 were synonymized with *Chondrites intricatus* (Brongniart, 1823), *Chondrites targionii* (Brongniart, 1828), *Chondrites patulus* Fischer-Ooster, 1858 and *Chondrites recurvus* (Brongniart, 1823), which were considered as the only useful ichnospecies (Fu 1991). This synonymization is based on the mode of branching as the only taxonomic criterion, i.e. ichnotaxobase. Uchman (1999) pointed out that also the ratio of the burrow width to the radius of the burrow system expresses the morphology of *Chondrites* and can be used as an additional ichnotaxobase, which allowed distinguishing *Chondrites stellaris* Uchman, 1999. Also, this author mentioned that *Chondrites caespitosus* (Fischer-Ooster, 1858) is a distinct taxon. We propose here that the combination of the mode of branching and morphometric parameters is a compromise between the radical synonymization proposed by Fu (1991) about the poorly grounded distinguishing of many ichnospecies in 19th century in the "age of fucoids", when *Chondrites* was considered as an alga. Such a combination refers better to morphology and allows separation of ichnospecies that show a similar mode of branching, but differ considerably in their morphometric parameters.

In this study, we present *Chondrites affinis* (Sternberg, 1833) as a distinct ichnospecies on the basis of its holotype (?Late Cretaceous from the Wienerwald, National Museum in Prague), an exceptional specimen and other specimens from the Saraceno Formation (Late Cretaceous-Eocene) in the Southern Apennines in Italy, a few other European collections, above all from Brongniart's material in the Museum of the Natural History in Paris, and the literature data. The above mentioned spe-

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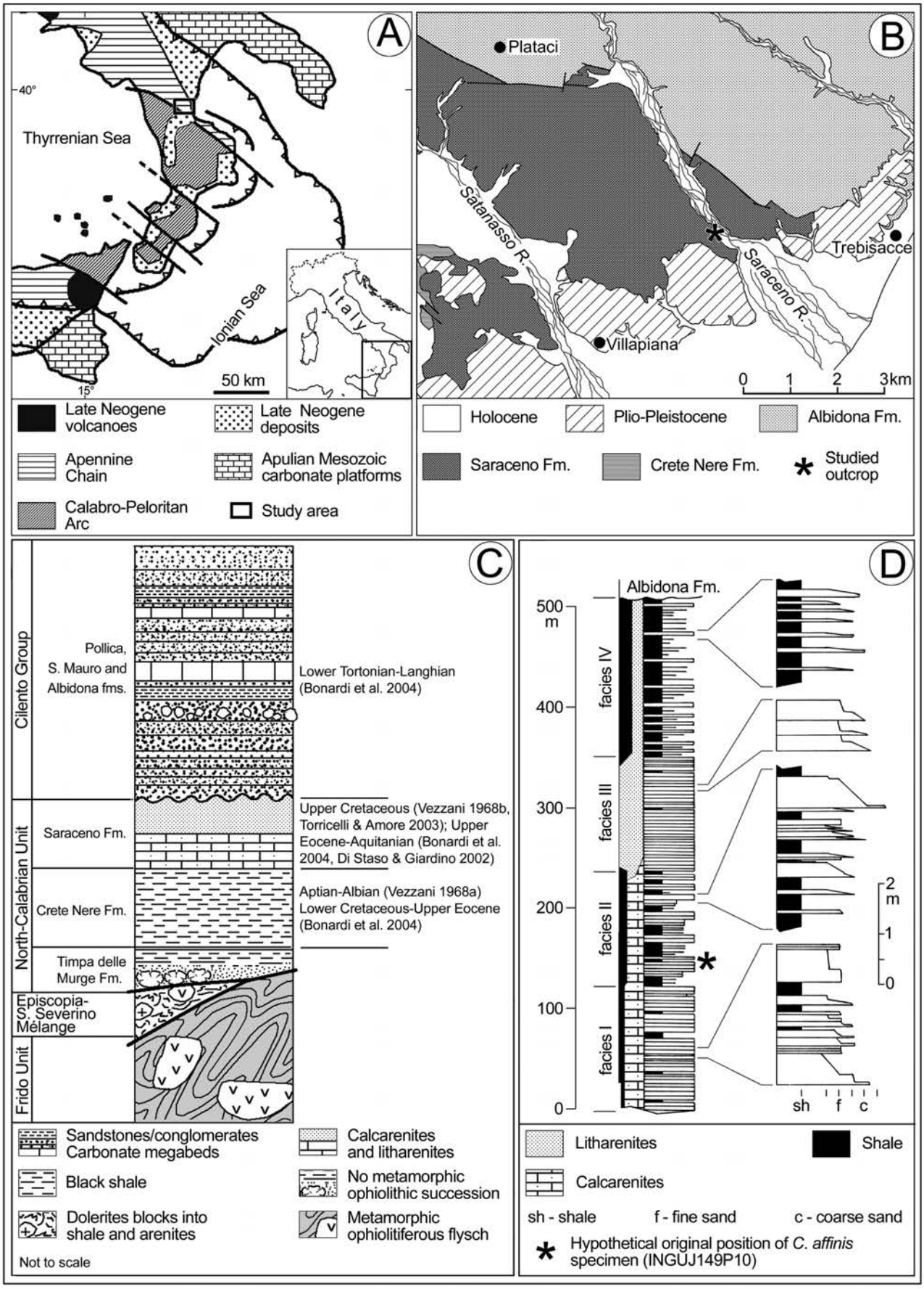

Fig. 1 - Location and stratigraphic sections of the Saraceno Formation. A) Structural sketch map of Southern Italy. B) Geological sketch map of the study area. C) General stratigraphic scheme of the Southern Apennine Chain. D) Schematic stratigraphic section (modified from Sonnino 1984) of the Saraceno Formation and some detailed portions of the four lithofacies.

cimen from the Saraceno Formation is the most complete example of this trace fossil, and allows better insight into its morphology than the less complete holotype and other specimens.

Geological setting of the Saraceno Formation

The Saraceno Formation (Selli 1962) is a lithostratigraphic unit in the Apennine Chain (Amodio-Morelli et al. 1976) in the North-Calabrian Unit (ex Liguride Complex; Ogniben 1969) and represents the final stage of the Neo-Tethys closure. It crops out between Calabria and Basilicata (Fig. 1A), mainly in the Saraceno and the Satanasso valleys on the Ionian coast (Fig. 1B). It overlies the Cretaceous black shales with sandstone beds of the Crete Nere Formation (Vezzani 1968a) and it is overlain unconformably by the calcareous and arenaceous-conglomerate megaturbidites of the Albidona Formation of the Cilento Group (Bonardi et al. 1988, 2004), which was dated to Oligocene-Miocene (Zuppetta et al. 1984) and emended to Eocene by Baruffini et al. (2000) (Fig. 1C). The Saraceno Formation was tectonically deformed before the deposition of the Albidona turbidites.

The Saraceno Formation, ~500 m thick, is subdivided into four main lithofacies (Sonnino 1984; D'Alessandro et al. 1986; fig. 1D), which show an increase of siliciclastics towards the top, from marls (locally with chert nodules) to calcarenites, litharenites and shales. They record an evolution from outer shelf to deep-sea fan deposits (Sonnino 1984) as confirmed by the presence of hummocky cross-stratification and symmetrical ripples in the lower part of the formation (Natoli 2010; Caruso et al. 2011) and turbidites in its upper part. This interpretation is in opposition to entirely turbiditic origin of the formation postulated by Vezzani (1968b), De Blasio et al. (1978), Di Staso & Giardino (2002) and Torricelli & Amore (2003).

The age of the Saraceno Formation is a matter of debate. According to Bonardi et al. (1988) and to Di Staso & Giardino (2002), its late Eocene-Aquitanian age is based on pelagic foraminifers and nannoflora. In contrary, Torricelli & Amore (2003) dated it to the Late Cretaceous on the basis of dinoflagellate cysts and calcareous nannofossils, in accordance with planktonic foraminiferal age determinations (Vezzani 1968b).

The studied outcrop occurs in the Saraceno River Valley (Fiumara Saraceno), type section of which has been already described by Vezzani (1968b), De Blasio et al. (1978), Sonnino (1984), D'Alessandro et al. (1986), Critelli (1993), Critelli & Le Pera (1994), Critelli et al. (1995), Natoli (2010), and Caruso et al. (2010, 2011). It is located about 3 km east of the village of Trebisacce, between Punta del Saraceno and Fosso Malodente (Fig. 1B), where beds, corresponding to the first and to the second lithofacies (Fig. 1D) defined by Sonnino (1984) and D'Alessandro et al. (1986), are upright or overturned due to intense folding.

The best specimen of *Chondrites affinis* was collected as a part of a loose block, about 30 cm thick, without traces of longer transportation, near a rocky wall corresponding to the second lithofacies (Fig. 1D) in the southern margin of the Saraceno Valley (GPS coordinates: N39°51.783′; E016°29.310′; ±18 m). Also other specimens of this ichnospecies have been noted nearby. The outcrop and nearby debris contain the trace fossils *Chondrites intricatus*, *C. targionii*, *C. stellaris*, *Taenidium dieslingi*, *Rhizocorallium* isp., *Zoophycos* isp., *Trichichnus* isp., *Pilichnus* isp., ?*Phymatoderma* isp., and *Planolites* isp.

In the Saraceno Formation, D'Alessandro et al. (1986) recognized nineteen ichnospecies, including five morphotypes of *Chondrites*, *Cosmorhaphe lobata*, *Fucusopsis* isp. (now named *Halopoa*), *Helminthoida labyrinthica* (now named *Nereites irregularis*), *Paleodictyon* isp., *Palaeophycus tubularis*, *Phycosiphon incertum*, *Rhizocorallium irregulare*, *Scolicia* isp., *Taenidium annulatum* (now named *Cladichnus fischeri*), *Muensteria* isp. (later named *Taenidium satanassi*, now *T. dieslingi*), *Teichichnus* isp., *Thalassinoides* isp., *Zoophycos* (two morphotypes). Caruso et al. (2011) added *Chondrites targionii*, *C. intricatus*, *C. stellaris*, *C. affinis*, *Phycosiphon hamata*, *Planolites* isp., ?*Phymatoderma* isp., *Pilichnus* isp. and *Trichichnus* isp. to the list.

Systematic Palaeontology

Chondrites Sternberg, 1833

Diagnosis: Regularly branching tunnel systems consisting of a small number of master shafts open to the surface which ramify at depth to form a dendritic network (after Osgood 1970; Fürsich 1974).

Chondrites affinis (Sternberg, 1833)

Figs 2-3

*v1833 *Sphaerococcites affinis* – Sternberg, p. 28, pl. 7, fig. 1 [included in *Chondrites targionii* (Brongniart, 1828) by Fu (1991) and Uchman (1999)].

?1833 *Caulerpites pyramidalis* – Sternberg, p. 21, pl. 7, fig. 2 [included in *Chondrites targionii* (Brongniart, 1828) by Fu (1991) and Uchman (1999)].

1841 *Sphaerococcites affinis* Sternb. – Unger, p. 28.

1845 *Sphaerococcites affinis* Sternb. – Unger, p. 13.

1849 *Chondrites affinis* Sternb. (*Sphaerococcites*) – Brongniart, p. 12.

1849 *Sphaerococcites affinis* Sternb. – Bronn, p. 8.

1850 *Chondrites affinis* Sternb. (*Sphaerococcites*) – Brongniart, p. 353.

1850 *Sphaerococcites affinis* Sternb. – Unger, p. 24.

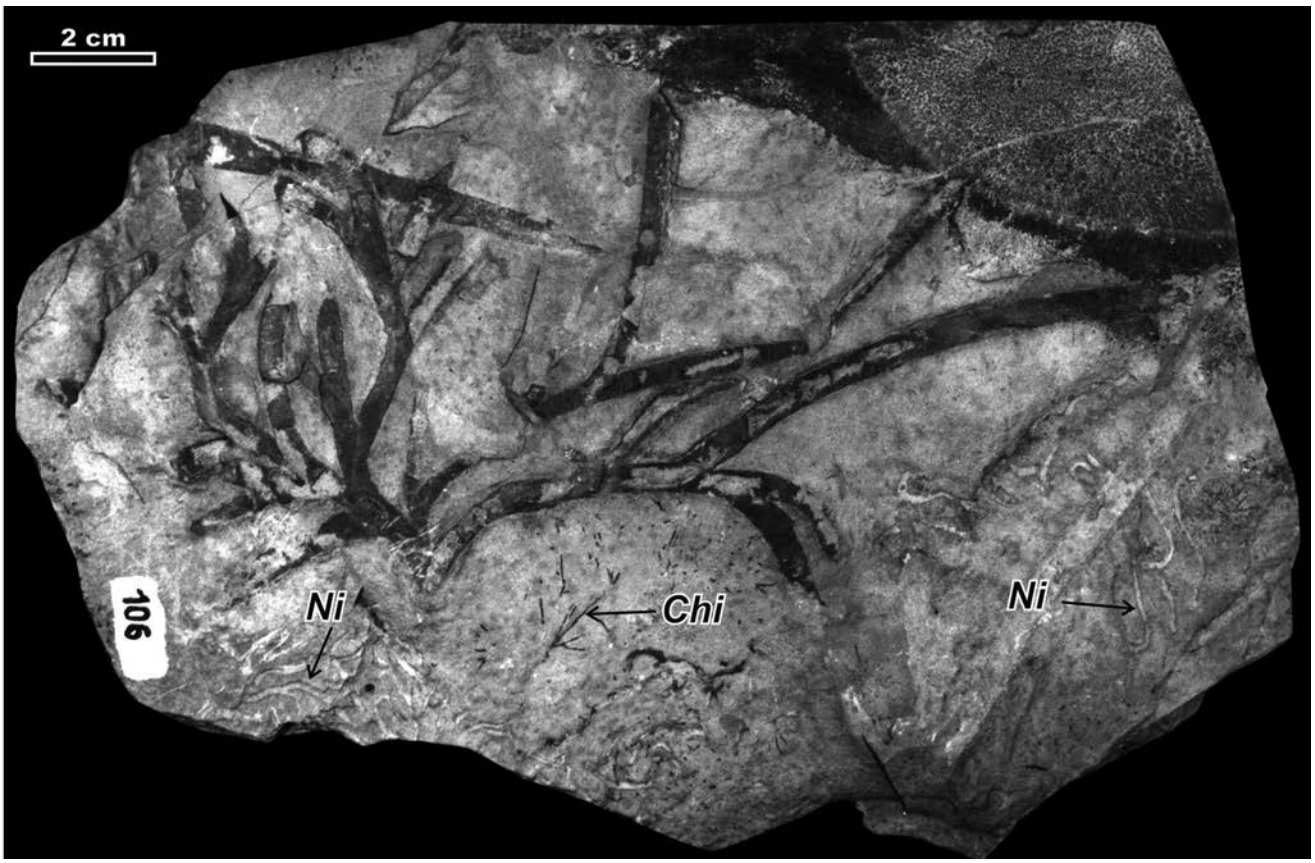

Fig. 2 - The holotype of *Chondrites affinis* (Sternberg, 1833). A) Specimen catalogue numbers 106, E11, Wienerwald, probably the Khalenberger Formation (Santonian-Maastrichtian, most possible the Campanian part), National Museum, Prague, Czech Republic. Associated trace fossils: *Chi* - *Chondrites intricatus*, *Ni* - *Nereites irregularis*. B) Copy of the original drawing by Sternberg (1833, pl. 7, fig. 1).

1851 *Fucoides* (*Chondrites*) *furcatus* Brongn. – Savi & Meneghini, p. 404.

1851 *Fucoides furcatus* Brongn. – Schafhäutl, p. 140, pl. 4, fig. 7, pl. 5, fig. 6 [included in *Chondrites targionii* (Brongniart, 1828) by Fu (1991) and Uchman (1999)].

1858 *Chondrites affinis* Brong. – Fischer-Ooster, p. 53, pl. 11, fig. 1.

1858 *Phycopsis* - Fischer-Ooster, p. 64.

1858 *Chondrites affinis* Brongn. var. *latitor* Fischer-Ooster, p. 54, pl. 11, fig. 2. [ascribed to *Halymenites flexuous* by Fischer-Ooster, 1858, appendix].

1859 *Sphaerococcites affinis* Sternb. – Debey & Ettinghausen, p. 210.

1863 *Chondrites affinis* Brongn. – Ettingshausen, p. 460.

1863 *Chondrites furcatus* Sternb. var. *affinis* Ettingshausen, p. 465.

?1865 *Chondrites furcatus* Sternb. – Sismonda, p. 10, pl. 2, fig. 2.

1873 *Chondrites affinis* Sternb. – Sordelli, p. 419.

1877 *Chondrites affinis* Sternb. – Heer, p. 153, pl. 59, figs. 1-2, pl. 60, figs. 1-4 (fig. 2 re-figured in Schimper & Schenk 1890, fig. 52), pl. 61, fig. 7.

1879 *Chondrites affinis* Sternb. – De Stefani, p. 448.

non 1881 *Chondrites affinis* Heer – De Gregorio, p. 48, pl. 3, fig. 4.

1883 *Chondrites affinis* (Sternb.) – Simonelli, p. 237.

1885 *Chondrites affinis* Sternb. – Fugger & Kastner, p. 68.

1887 *Chondrites ligurianus* sp. n. – Squinabol, p. 550, pl. 14, figs. 1-3, 8.

1890 *Chondrites affinis* Heer – Schimper & Schenk, p. 66, fig. 52.

1890 *Chondrites affinis* Sternb. – Squinabol, p. 176, pl. 9, fig. 1.

1891 *Chondrites affinis* Sternb. – Squinabol, p. 14, pl. A, fig. 1.

1892 *Chondrites affinis* Sternb. – Meschinelli & Squinabol, p. 42.

1893 *Chondrites affinis* Heer – Fuchs, p. 566.

?1896 *Phycopsis affinis* Sternb. – Rothpletz, p. 885, pl. 22, figs 1-2.

1897 Fucoiden [larger form] – Suess, p. 4, fig. 2.

1902 *Phycopsis* (*Chondrites*) *affinis* Sternb. – Rothpletz, fig. 10a.

1911 *Phycopsis affinis* Sternb. – Mylius, pp. 497, 555.

1914 *Chondrites affinis* Sternb. – Jaeger, p. 132.

1951 *Chondrites affinis* Brongn. – Venzo, p. 228.

1951 *Chondrites affinis* var. *latirol* Fisch.-Oost. – Venzo, p. 228.

1954 *Chondrites affinis* – Seilacher, p. 216.

v 1977 *Chondrites affinis* (Brongniart, 1849) – Książkiewicz, p. 78, pl. 4, fig. 11 [included in *Chondrites targionii* (Brongniart, 1828) by Uchman (1998)].

?non 1980 *Chondrites affinis* - Alexandrescu & Brustur, p. 20, pl. 1, fig. 1.

1986 *Chondrites* type 4 – D'Alessandro et al., p. 299, fig. 4D.

1991 *Chondrites affinis* - Leszczyński & Uchman, p. 282.

1991 *Chondrites affinis* – Uchman, p. 209.

1992 *Chondrites affinis* – Cieszkowski et al., p. 94.

1992 *Chondrites affinis* - Malata et al., p. 99.

1992 *Chondrites affinis* - Oszczypko et al., p. 102.

1992a *Chondrites affinis* – Uchman, p. 55.

1992b *Chondrites affinis* – Uchman, p. 431.

?1993 *Chondrites affinis* - Alexandrescu & Brustur, p. 18.

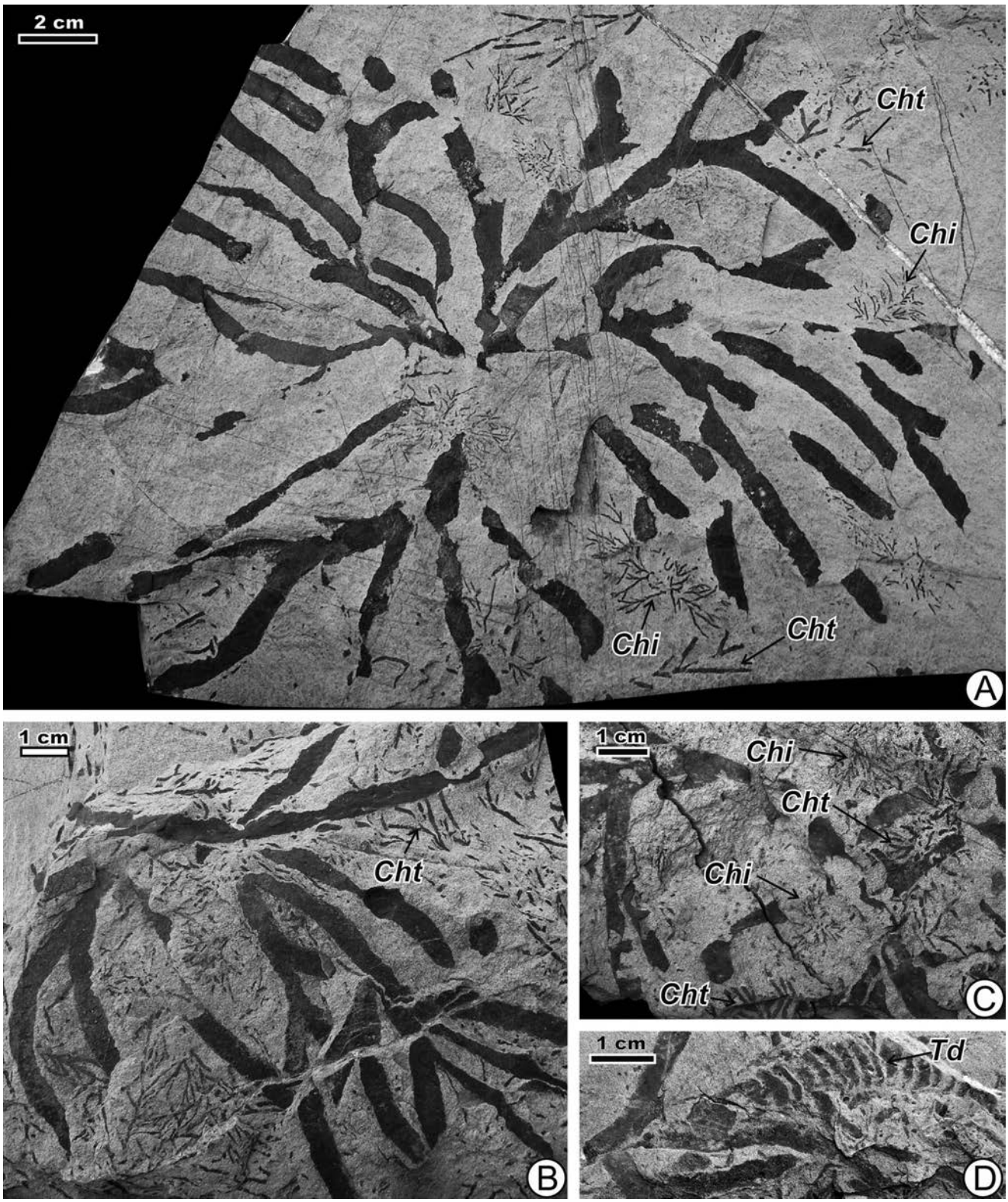

Fig. 3 - *Chondrites affinis* and associated trace fossils (*Chi* - *Chondrites intricatus*, *Cht* - *C. targionii*) from the second lithofacies of the Saraceno Formation in the Saraceno Fiumara type section, Southern Apennines, Italy. A) Upper surface of slab INGUJ149P10, housed in the Institute of Geological Sciences, Jagiellonian University, Kraków, Poland. B) A fragment of a slab showing *Chondrites targionii* (*Cht*) cross cut by *C. affinis*. Field photograph. C) A fragment of a slab showing *Chondrites targionii* (*Cht*) crossing *C. affinis*. Field photograph. D) *Taenidium dieslingi* (*Td*) cross cut *C. affinis*. Field photograph.

non 1993 *Chondrites affinis* Brongniart – Özkul, p. 19, fig. 3a.

?1994 *Chondrites* ichnosp. – Mikuláš, p. 78, fig. 1.

1999 *Chondrites affinis* – Cieszkowski et al., p. 335.

partim 1999 *Chondrites targionii* (Brongniart, 1828) – Monaco & Uchman, p. 43.

partim 1999 *Chondrites targionii* (Brongniart, 1828) – Uchman, p. 92, pl. 5, fig. 3, pl. 3, fig, 7.

2003 *Chondrites* isp. B – Leszczyński, p. 113, fig. 19-1.

?2003 *Chondrites targionii* (Brongniart, 1828) – Metz, p. 208, fig. 3A.

?2006 *Chondrites affinis* – Metz, p. 156.

partim 2007 *Chondrites targionii* (Brongniart, 1828) – Uchman, p. 987, fig. 3B.

partim 2009 *Chondrites targionii* (Brongniart, 1828) – Uchman, figs 31-32.

Diagnosis: *Chondrites* with branchings that are commonly slightly curved and with angles of branching that are usually sharp. Most of the tunnels are more than 4 mm wide. Burrow system is typically more than 150 mm wide.

Remarks. The discussed trace fossil was described as the new algal species *Sphaerococcites affinis* by Sternberg (1833, p. 28, pl. 7, fig. 1). Its Latin original description reads: "Fronde plana bipinnatim ramosa subdichotoma, ramis infimis divaricatis, reliquis patentibus, ramulis sparsis late linearibus obtusis aequilatis elongatis unci alibusque. In schisto calcareo griseo saxi arenacei viennensis". This translates as: "Flat bipinnate sub-dichotomous branched leaves, the lowest branches (of the leaves are) divaricate (spreading), the rest (are) patent (outspread, diverging from the axis at almost 90°), the branchlets are broadly linear blunt equal-sided and 1 inch long. In calcareous sandy shale of the Vienna sandstones".

The holotype. The holotype of *Sphaerococcites affinis* Sternberg (1833, p. 28, pl. 7, fig. 1) is housed in the National Museum in Prague, Czech Republic, under catalogue numbers 106 and E11, but was neither listed by Mikuláš & Straková (1994) nor by Mikuláš (2006) who reviewed and catalogued trace fossils in the Sternberg collection. However, it was seen and photographed (Fig. 2A) by A. Uchman in the museum in 1994. The drawing by Sternberg (1833, pl. 7, fig. 1) shows the same specimen (Fig. 2B). This is a thin slab of silty marlstone-marlstone, which apart from *C. affinis* contains also fragmentary preserved *Chondrites intricatus* and *Nereites irregularis*. The locality is unknown, but the lithology is very similar to other trace fossils from the Sternberg collection having close collection numbers, which derive from Weidling (or Weidlingbach) and Halterbuch, where the Campanian "fucoidal marls" of the Khalenberger Formation crop out (see Mikuláš & Uchman 1996). It is confirmed that *C. affinis* occurs in this deep-sea turbiditic formation in the Wienerwald area (Uchman 1999; see the synonymy list).

The holotype of *C. affinis* is a structure composed of almost horizontal, flat, unlined, branched tunnels, which are 4-5 mm wide. The branched tunnels form three twigs running within a half circle from the same stem. The structure is up to 169 mm wide. Taking into account that the complete trace fossil is more or less symmetrical, the total width can be double. Up to three-orders of branching are present. They are almost straight to slightly, gently curved in one side, 10-134 mm long. The segments without branching are up to 85 mm long. The branches never cross (phobotaxis). The branches protruding farther from the stem truncate those which are closer, i.e. they are protrusive (see Fu 1991 and Seilacher 2007 for protrusive/retrusive mode of *Chondrites*). The tunnel terminations are rounded. The filling is massive, composed of dark mudstone, deriving probably from the overlying background sediments.

Material from the Saraceno Formation. The large slab (INGUJ149P10; Institute of Geological Sciences, Jagiellonian University) of calcarenite, 10 cm thick, collected from ~30 cm thick calcarenite-marlstone bed from the Saraceno Formation, contains *Chondrites affinis* and *C. intricatus* (Fig. 3A). *C. affinis* is here much more complete than the holotype. It is composed of four or five twigs running outward from an empty centre. The twigs are composed of branched tunnels, which are almost straight or slightly curved, 4-6 mm wide. Up to three-order branches are present. The burrow system is at least up to 252 mm wide, however 20-30 mm should be added because the most distal parts of the tunnels are broken. As in the holotype, the branches are also protrusive.

Moreover, at least ten, less complete specimens have been found nearby, photographed and left in the field. Their tunnels are 4 to 7.5 mm wide, and the complete burrow system may attain 340 mm across. *C. affinis* cross cuts *C. intricatus* and *C. targionii* (Fig. 3B) but locally *C. targionii* cross cuts *C. affinis* (Fig. 3C). In some slabs *C. affinis* is cross cut by *Taenidium dieslingi* (Fig. 3D).

Comments to the synonymy list. *Sphaerococcites affinis* Sternberg was included in *Chondrites* Sternberg as *Chondrites affinis* by Brongniart (1849). Fischer-Ooster (1858) proposed the new genus *Phycopsis* for this trace fossil, but this recommendation was rarely followed and it can be proposed as a junior subjective synonym of *Chondrites*. Fuchs (1909) noted that *C. affinis* is a burrow (see Bather 1910). Generally, *Chondrites affinis* was quite popular in 19th century and almost forgotten after first decade of the 20th century (see the synonymy list). Fu (1991), who took shape of branching as an expression of behaviour and the only ichnotaxobase, included it in *Chondrites targionii* (Brongniart, 1828). This idea was followed by Uchman (1998) but is revised in this paper.

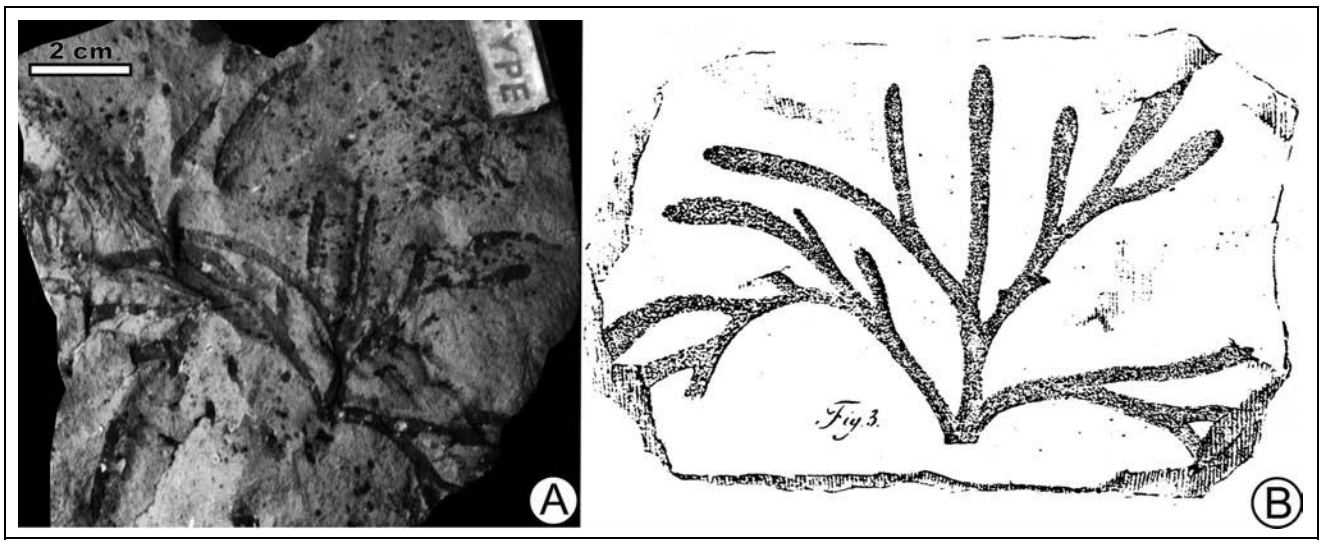

Fig. 4 - The holotype of *Chondrites furcatus* (Brongniart, 1823). A) Specimen R54446, grey limestone, Neocomian, Vernasca, Piacenza, Northern Italy. Natural History Museum, Paris. B) A copy of the original lithography (mirror expression) from Brongniart (1823, pl. 19, fig. 3).

Squinabol (1887, 1890, 1891) and Meschinelli & Squinabol (1892) presented longer synonymy list of *Chondrites affinis*, in which *Fucoides recurvus* Brongniart, 1823 (Brongniart 1823, p. 309, pl. 19, fig. 4) was placed with reservation expressed by a question mark, but inconsistently, without reservation, the same species illustrated later by Brongniart (1828, p. 62, pl. 5, fig. 2) was placed therein. The Squinabol's (1891) synonymy list contains also *Fucoides furcatus* Brongniart, 1823 but only with reference to two specimens illustrated by Brongniart (1828, p. 62, pl. 3, fig. 2, pl. 5, fig. 1). However one of them (the one cited in Brongniart's pl. 5, fig. 1), which is the holotype of *F. furcatus*, was treated inconsistently because as illustrated in the original paper by Brongniart (1823, p. 309, pl. 19, fig. 3) and in Schimper (1869, p. 169, pl. 3, fig. 8; here already as *Chondrites furcatus*) it was not included in the list. The holotype of *C. furcatus* is housed in the Museum of Natural History in Paris but its photography (Fig. 4A) has so far never been published. It is a *Chondrites* displaying 2-3 mm wide branches and its burrow system is at least 130 mm wide. It fits better to *Chondrites targionii* (Brongniart, 1828) and can be consider as its junior subjective synonym, in agreement with the opinion of Fu (1991). The second specimen *of F. furcatus* from Squinabol's (1891) list, illustrated by Brongniart (1828, p. 62, pl. 3, fig. 2), is a fragment of a rather tubular, branched trace fossil with "granules", probably part of the crustacean trace fossil *Thalassinoides*, which according to the original description by Brongniart derives from "calcaires oolitoques schisteux de Stonesfield". At Stonesfield near Oxford, England, Middle Jurassic deposits bearing dinosaur remains crop out (e.g. Benson 2009), which conform such an interpretation. The same specimen was re-figured by Pilla (1846, p. 19, pl. 2, fig. 3), who however noted the occurrence of *Fucoides furcatus* in "argille scagliose" in the Bologna Apennines, together with *F. targionii* and *F. intricatus*. It was placed in Squinabol's synonymy list of *C. affinis*. Probably, Pilla noted real *Chondrites*, but referred to the wrong type.

Occurrences. Unquestionable *Chondrites affinis* has so far been noted only in the European Alpides, mainly in the Apennines, Alps and the Carpathians, exclusively in deep-sea turbiditic deposits. The occurrence of *C. affinis* in the Turonian of southern Chile (Cecioni 1957) is not confirmed. Bronn (1849) listed it in the "Middle Molasse" of the pre-Alpine foredeep, but no more details are known relating to this matter. The ichnospecies name was used for some ?*Chondrites* from shallow subtidal Silurian (Metz 2006) and shallow subtidal Devonian (Metz 2003), both in New Jersey, USA, but it is not convincing that this is *C. affinis*. Concerning the stratigraphic range, Ksiazkiewicz (1977) noted *C. affinis* in the Berriasian-Oligocene units of the Polish Carpathians, however the Lower Cretaceous specimens are rare and Oligocene occurrences are not documented by specimens. Judging from the literature and field observations, this trace fossil is most common in the Campanian-Paleocene, especially in marly turbiditic deposits.

Discussion and concluding remarks

The plot of the width of tunnels versus the width of the burrow system (Fig. 5) was prepared for *Chondrites intricatus, C. stellaris, C. targionii*, and *C. affinis*, which show a similar branching type. The plot shows that all these ichnospecies occupy separate fields. For the purpose of this paper, the most important is the

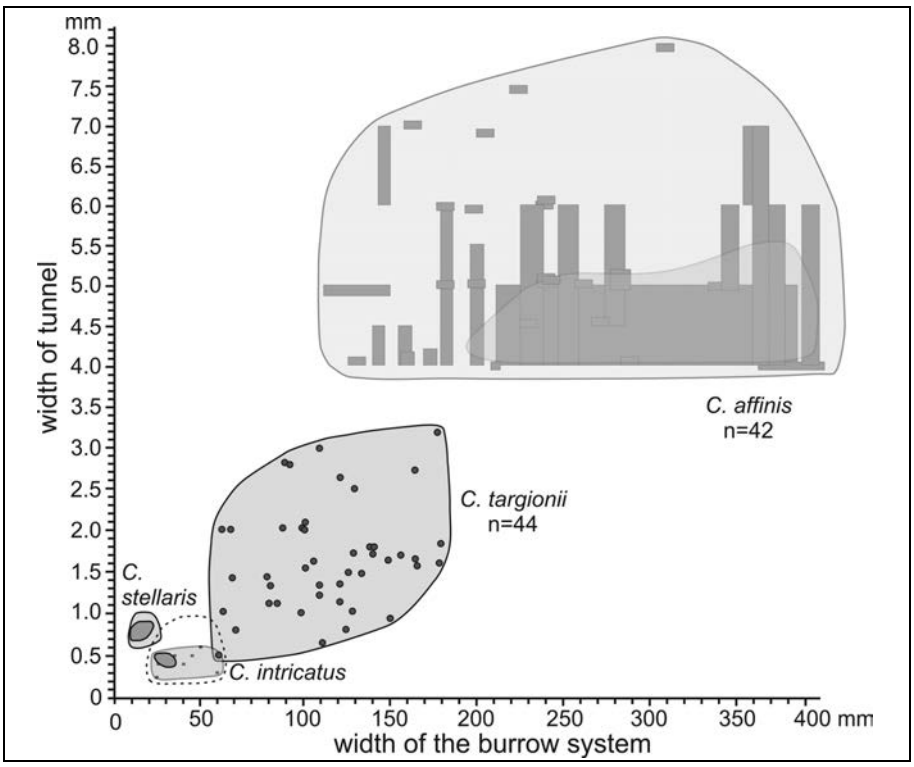

Fig. 5 - Diagram of relations between some *Chondrites* ichnospecies. The darker stippling indicates fields of clustered measurements. The dashed line indicates a possible range of *C. intricatus* based on incomplete specimens. The data on *Chondrites stellaris* and *Chondrites intricatus* from Uchman (1999).

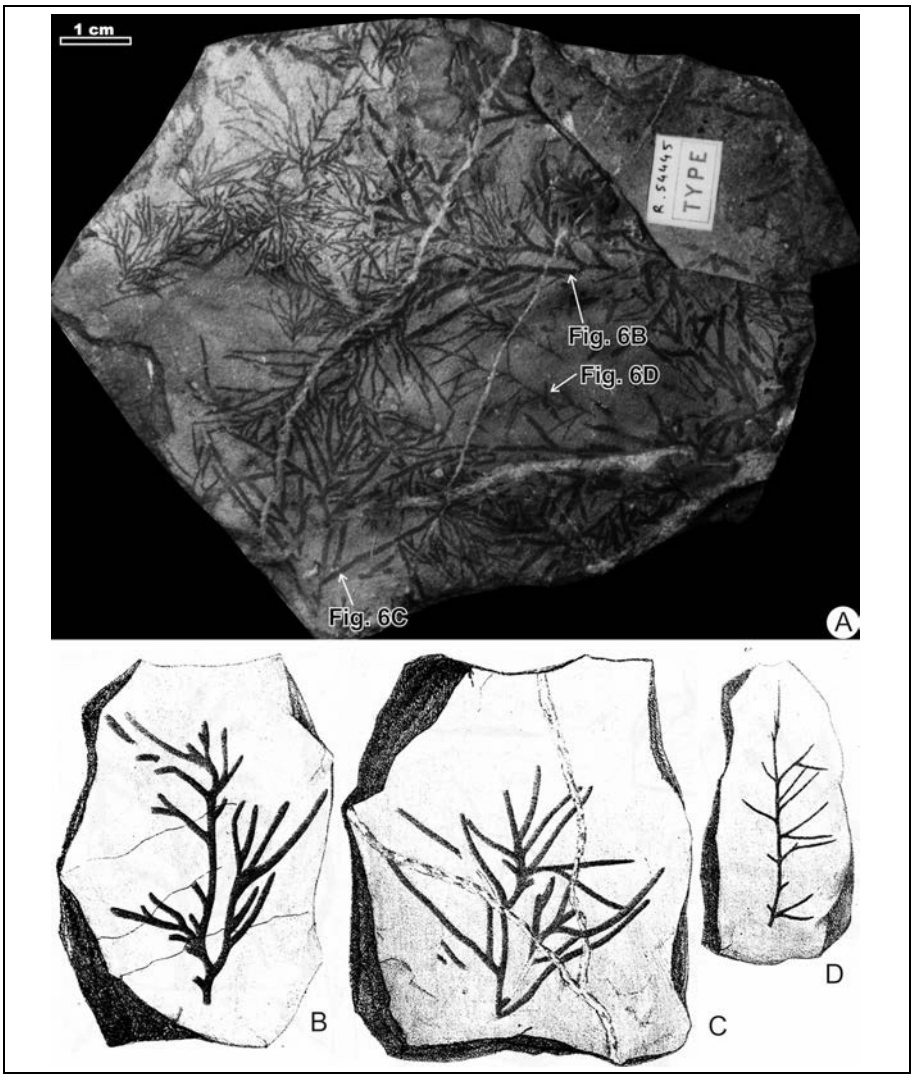

Fig. 6 - The type of *Chondrites targionii* (Brongniart, 1828). A) Specimen R54445, Museum of Natural History, Paris; upper surface of a turbiditic sandstone bed, Lower Cretaceous, Doccia di Ginori, Toscana, Italy. Individual trace fossils have been illustrated by Brongniart (1828) (see B-C). The trace fossils in the left side can be assigned to *C. intricatus*. B-D) Copy of original illustrations of *C. targionii* by Brongniart (1828, pl. 5); B – pl. 5, fig. 2. This is the holotype by the illustration order priority; C – pl. 5, fig. 3; D – pl. 5, fig. 6. Note that all the three illustrations are mirror lithography of originals shown in A and that edges of individual trace fossils are artistic artefacts.

difference between *C. targionii* and *C. affinis*; these two ichnospecies have been so far synonymised (Fu 1991; Uchman 1999). Their mode of branching (acute angle of branching, slightly curved or winding branches) is the same but the morphometric parameters are different. This concerns also the holotype of *C. targionii* (Brongniart, 1828), which is housed in the Museum of Natural History in Paris, but the photograph of which (Fig. 6) has so far never been published. There is a gap in the width of tunnels between these two ichnospecies between 3 and 4 mm. Tunnels in most specimens of *C. targionii* are 1.5-2.5 mm wide, while tunnels of most specimens of *C. affinis* are 4-5.5 mm wide. Brongniart (1828: 56, pl. 5, fig. 6) included in *C. targionii* also specimens whose tunnels are about 0.5 mm wide and overlap in size parameters with those of *C. intricatus* (Fig. 6A, C). The latter, however, displays straight or almost straight branches (see Fu 1991; Uchman 1999).

The width of the burrow system/burrow width ratio in *C. affinis* and *C. targionii* partly overlaps but generally it is smaller in *C. affinis*, which is more stout. If the differences in size parameters between these two ichnospecies are related to ontogenic growth of the trace-maker, a gap in the burrow width is not expected. The gap is probably rooted in taxonomic differences between trace-makers. This causes a dilemma between the recommendations by Bertling et al. (2006), according to which size is not the ichnotaxobase, but it is recommended to find morphological criteria as much as related to biological aspects. However, the width of the burrow system/burrow width ratio does not express pure size parameters but foremost shape, i.e. it expresses in fact morphology. Therefore, we consider that the recommendations are followed and *Chondrites affinis* (Sternberg, 1833) can be recommended for further use. The separation of *C. affinis* and *C. targionii* increases the precision of ichnological information, bringing a benefit that should not be neglected.

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