Reply to the Critical review of Francisco Soto on the paper by A. May "*Radiastraea* (Anthozoa, Rugosa) from the Emsian and Eifelian (Devonian) of Aviados, Northern Spain"

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MAY, A. 2007. Reply to the Critical review of Francisco Soto on the paper by A. May "*Radiastraea* (Anthozoa, Rugosa) from the Emsian and Eifelian (Devonian) of Aviados, Northern Spain". *Bulletin of Geosciences 82(3)*, 293–296. Czech Geological Survey, Prague. ISSN 1214-1119. Manuscript received March 6, 2007; issued September 30, 2007. DOI 10.3140/bull.geosci.2007.03.293

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At first I would like to thank F. Soto (2007) for commenting on my paper. I have to admit that he is correct concerning the fig. 1 of May (2006): In fact, the correct location of the "El Cueto" outcrop (letter E) is situated to the north of the road LE-626.

The first point of criticism of Soto is the stratigraphical interpretation of the outcrop "El Cueto". Soto doesn't agree with the conclusion of May (2006, p. 152) that "the outcrop "El Cueto" is upper Emsian or lower Eifelian in age and belongs (based on the lithology described by Almela & Revilla 1950) to the Santa Lucía Formation". Soto bases his (implicitly given) assignation of "El Cueto" to the Givetian on two different sources.

Soto's first source is the information on the fossil content of "El Cueto" given by Almela & Revilla (1950, pp. 50, 51). Soto says that "the majority of the cited specimens are Givetian, and, consequently, mainly come from the Portilla Formation". May (2006, p. 152), analyzing exactly the same fossil list, concluded that "the outcrop "El Cueto" is upper Emsian or lower Eifelian in age". To see whose interpretation is correct, an analysis of the stratigraphical reliability of each element of the fossil list of Almela & Revilla (1950), which is discussed by Soto, is necessary:

Almela & Revilla (1950, p. 51) cited *Spirifer cultrijugatus*, but they gave no illustration or description. May (2006, p. 152) said: "Regardless of whether this was a true *Paraspirifer cultrijugatus* (F. Roemer, 1844) or only another species of *Paraspirifer*, the stratigraphical information is evident: *Paraspirifer* originated in the lower upper Emsian and became extinct in Europe and Northern Africa at the end of the lower Eifelian (Godefroid 1980, pp. 85–92; May 1996, pp. 39, 40; May & Avlar 1996, p. 51; May 1997, pp. 295, 296; García-Alcalde *et al.* 2002, pp. 75, 80). It is important to note that no brachiopod exists in the Givetian and Frasnian that could be confused with *Paraspirifer cultrijugatus.*" This statement is fully accepted by Soto, who writes: "I agree with the author that the above mentioned species, or any other of the same genus, cannot be easily misunderstood." And it would be very easy for the author to add much more publications which confirm and document the biostratigraphical value of "*Spirifer cultrijugatus*" and *Paraspirifer*. As examples may be given the classical monograph on *Paraspirifer* of Solle (1971) and the article by Struve (1982).

Almela & Revilla (1950, p. 51) cited *Orthis dumontiana*, but again gave no illustration or description. Soto uses this citation of *Orthis dumontiana* as a proof for Frasnian age. However, there are existing many other orthid brachiopods which are at least superficially similar to the Frasnian species *Cariniferella dumontiana*. Consequently, without any illustration or specimen, which can prove the identity with *Cariniferella dumontiana*, it is not appropriate to base a stratigraphical interpretation on this citation of *Orthis dumontiana.*

Almela & Revilla (1950, p. 51) cited *Aviadocrinus sampelayoi* nov. g. nov. sp. and described it on pp. 55–59. Soto uses the occurrence of *Aviadocrinus sampelayoi* (= *Cupressocrinites sampelayoi*) as a proof for Givetian age and gives as reference for this stratigraphical assignation Breimer (1962, p. 160). To value the biostratigraphical reliability of *Cupressocrinites sampelayoi* (Almela & Revilla, 1950) it is necessary to know that Breimer (1962, pp. 160, 161) had for his redescription of *Cupressocrinites sampelayoi* only relatively little material. The majority of specimens came from "El Cueto", which is the type locality of *Cupressocrinites sampelayoi*. Breimer (1962, p. 161) described this species only from one other locality: "Las Peñotas (León)". Breimer (1962, p. 161) assigned both localities to the Portilla Formation (Givetian), but he gave no reason for this assignation. Concluding, the bulk of the material of *Cupressocrinites sampelayoi* comes exactly from the locality, which shall be dated with it. And the remaining material comes from a locality, whose stratigraphical assignation is not proven, too. Consequently, it is not acceptable to use *Cupressocrinites sampelayoi* as an index for any stratigraphical age.

Almela & Revilla (1950, p. 50) cited *Phillipsastrea torreana*, *Phillipsastrea torreana* var. *minuta* nov. var. and *Phillipsastrea cantabrica.* None of the species was described and only one specimen of *Phillipsastrea torreana* was figured by Almela & Revilla (1950, pl. 3, fig. 4). Exactly this specimen was described as *Radiastraea arachne* Stumm, 1937 by May (2006). Soto says that this corallum is a *Phillipsastrea*, but his opinion will be disproved further below. Actually there exists no hint that at "El Cueto" occur any true *Phillipsastrea*, because we cannot exclude that all the citations of Almela & Revilla (1950, p. 50) refer to *Radiastraea* or other colonial rugose corals. However, even if there (hypothetically) would be found a true *Phillipsastrea* at "El Cueto", it would not prove a (late) Givetian or Frasnian age. The genus *Phillipsastrea* has its acme in the late Givetian and Frasnian, but true *Phillipsastrea* species are also known from the Lower Devonian of China, the Emsian of Australia and the Eifelian of Russia and China (Hill 1942, p. 153; McLean 1993, p. 58; Zhen 1995, pp. 224, 225). Taking all this into account, there is no reason for the statement of Soto that "the numerous Phillipsastreidae cited in the list" would prove a "late Givetian" age.

Concluding, from the four taxa discussed by Soto, only one gives reliable biostratigraphic information: *Spirifer cultrijugatus*. The resulting stratigraphical position is very clear: Upper Emsian to Lower Eifelian. And an extension of this biostratigraphic analysis to other names in the fossil list of "El Cueto" given by Almela & Revilla (1950, pp. 50, 51) will not change this result. Knowing this, May (2006, p. 152) focussed directly on *Spirifer cultrijugatus*.

By the way, the first name in the fossil list of "El Cueto" given by Almela & Revilla (1950, pp. 50, 51) could be taken directly as a hint of Emsian age. It is "*Acervularia pradoana*" (= *Argutastrea? pradoana*). The holotype of *Argutastrea? pradoana* probably comes from the Emsian of the Sierra Morena (Coen-Aubert 2002, p. 33). However, because of the fact that until now only the holotype could be assigned to *Argutastrea? pradoana*, the mere citation of this species cannot give any reliable biostratigraphical information.

As another reason for his stratigraphical designation of "El Cueto" Soto states: "El Cueto outcrop is located within a fairly continuous calcareous band of the Portilla Formation". This argument, the lateral geographical continuity, could be an acceptable reason for the stratigraphical designation of a locality if the tectonic structure of the mapped area was simple and without faults and without intense folding. However, exactly these essential prerequisites are not given in the case of the Aviados area. Soto himself says: "In a region like the Cantabrian Zone with very complex tectonics (especially in the Aviados area due to the Sabero-Gordon fault)..." Consequently, to apply under such circumstances the argument of lateral geographical continuity is scientifically inappropriate.

Resulting from this, it must be stated that all arguments of Soto to assign the outcrop "El Cueto" to the Portilla Formation and the upper Givetian are invalid. The only available valid argument for the stratigraphical designation of "El Cueto" – the citation of *Spirifer cultrijugatus* by Almela & Revilla (1950, p. 51) – has been discussed in detail by May (2006, p. 152).

In addition, Soto says that the description of the "Sierra Carro" outcrop by Almela & Revilla (1950, p. 51) is incorrect. He says that in fact it is the "Pico Cutión". However, it is necessary to realize that all explanations of Soto on this topic are of speculative character and, up to now we cannot be sure that the outcrop described by Almela & Revilla (1950, p. 51) under the name "Sierra Carro" in fact is the "Pico Cutión".

Based on this unproven assumption that "Sierra Carro" in fact is the "Pico Cutión", Soto then says: "This outcrop constitutes the northern limb of the same anticline which the El Cueto one belongs to. Consequently, this calcareous band corresponds to the Portilla Formation..." Again, Soto uses the argument of lateral geographical continuity, which has been discarded clearly above in the case of "El Cueto". Furthermore, in the case of "Sierra Carro" the use of the argument of lateral geographical continuity is even more inappropriate than in the case of "El Cueto" for two reasons:

1. The exact geographical position of the locality is currently under discussion.

2. Soto says: "In the Pico Cutión, a calcareous band crops out, fitted between two satellite faults related to the Sabero-Gordón fault." This means that the calcareous band of Pico Cutión has only a tectonic contact to the limestones of the Portilla formation!

Furthermore, Soto says about the stratigraphical designation of the "Sierra Carro" outcrop: "The Givetian age of this outcrop is based on the same findings as those cited in the El Cueto outcrop." This comment has to be understood as a reference to the fossil list of "Sierra Carro" given by Almela & Revilla (1950, pp. 51, 52). This fossil list is much shorter than the fossil list of "El Cueto" given by Almela & Revilla (1950, pp. 50, 51). The fossil list of "Sierra Carro" contains *Phillipsastrea torreana*, *Phillipsastrea torreana* var. *minuta* nov. var. and *Phillipsastrea cantabrica*, but it does not contain *Spirifer cultrijugatus, Orthis dumontiana* or *Aviadocrinus sampelayoi.* That the occurrence of *Phillipsastrea* cannot be taken as proof of Givetian or Frasnian age, has been explained above. It must also be stated that the fossil list of "Sierra Carro" contains no fossil that would allow an unequivocal stratigraphical assignment.

Concluding, all arguments of Soto, to assign the outcrop "Sierra Carro" to the Portilla Formation of the upper

Givetian, are invalid. Consequently, up to now the statement of May (2006, p. 152) is valid: "We cannot be sure that this locality belongs to the upper Emsian or (lower) Eifelian or to the upper Givetian."

Soto says that the species determined and described by May (2006, pp. 153–156) as *Radiastraea arachne* Stumm, 1937, belongs to the genus *Phillipsastrea.* This is impossible because the specimen shows no horseshoe dissepiments. However, a very important criterion for *Phillipsastrea* is the existence of "an intermittently to completely developed pipe of horseshoe dissepiments" (May 2006, p. 156; McLean 1993, p. 53). On the other hand, the corallum described by May (2006, pp. 153–156) fits very well with the definition of *Radiastraea* given by Soto himself. The first criterion of Soto are "thin, sometimes carinate septa". The corallum under discussion has septa, which are in most parts of the corallum thin and which occasionally develop very weak carinae (May 2006, p. 153, fig. 2B). The second criterion of Soto is a "tabularium structure consisting of incomplete, axially convex ... tabulae". The description and the illustration of May (2006, p. 153, fig. 2C) show that this criterion is fulfilled, too.

Problematic is only the third criterion of Soto: "periaxially very arched (concave) tabulae (see Pedder 1964, pl. 72, fig. 2, pl. 73, fig. 2, and Oliver 1976, pl. 66, fig. 4)." In fact, the longitudinal section of the holotype of *Radiastraea arachne* Stumm, 1937 by Oliver (1976, pl. 66, fig. 4) shows few very arched periaxially tabellae, which occur together with slightly concave, horizontal and slightly convex periaxial tabellae. Furthermore, a comparison with the longitudinal sections of the hypotypes of *Radiastraea arachne* Stumm, 1937 figured by Pedder (1964, pl. 72, figs 1, 2, pl. 73, figs 1–3) shows clearly that these very arched tabellae are always exceptions. Finally, I would like to remember that Pedder (pers. comm. 2005) considers the existence of periaxially elevated tabellae as a diagnostic feature of *Radiastraea arachne* (May 2006, p. 154). If periaxially elevated tabellae are characteristic for *Radiastraea arachne*, the type species of *Radiastraea*, how can it be that periaxially very arched (concave) tabellae are characteristic for the genus? Obviously, the definition of *Radiastraea*, which is used by Soto, is not fully correct! By the way, the Spanish material also shows periaxially elevated tabellae, although they are not as well developed as in the holotype of *Radiastraea arachne* (May 2006, p. 154).

Concluding, it is obvious that even Soto, if he would follow his own definition of *Radiastraea* (except for the error with the periaxially arched tabulae), would have to admit that the corallum described by May (2006, pp. 153–156) is a typical *Radiastraea*!

Soto says: "The two species described in the work in discussion as *Phillipsastrea torreana torreana* (pp. 156, 157, without illustration) and *P. torreana minuta* (pp. 157, 158, fig. 2D–F) show a corallite diameter, number of septa and tabularium diameter within the variability boundaries established by Coen-Aubert (2002, p. 30) for the species *Phillipsastrea torreana*." It is totally correct that the *Phillipsastrea torreana torreana* (Milne-Edwards & Haime, 1851) described by May (2006, pp. 156, 157) is in the variability boundaries established by Coen-Aubert (2002, p. 30) for the species *Phillipsastrea torreana* (Milne-Edwards & Haime, 1851). Coen-Aubert (2002, pp. 30, 31, pl. 4, figs 1, 2) had only the lectotype, which has a 6.4–9 mm corallite diameter, 22–28 septa and a 2.1–2.7 mm tabularium diameter. *Phillipsastrea torreana minuta* Almela & Revilla, 1950 has mostly a 6.0–7.5 mm corallite diameter, 20–24 septa and a 1.9–2.1 mm tabularium diameter (May 2006, p. 157). This shows that the lectotype of *Phillipsastrea torreana minuta* Almela & Revilla, 1950 is not within the variability boundaries of *Phillipsastrea torreana torreana* (Milne-Edwards & Haime, 1851), but is in all skeletal dimensions somewhat smaller than the lectotype of *Phillipsastrea torreana torreana* (Milne-Edwards & Haime, 1851). Furthermore, the thamnasterioid parts have a higher frequency in *minuta* than in *torreana* (May 2006, p. 158). Of course, these differences would not justify a separation into different species, but a separation into different subspecies is justified. Further arguments for separation in subspecies are given by May (2006, p. 158).

The last criticism of Soto is that "the study of museum samples, as is the case, is very hazardous". I agree fully with this statement. However, there are situations in which it is unavoidable: for example, if someone wants to investigate the type material of a species or subspecies (as it was in this case with *Phillipsastrea torreana minuta* Almela & Revilla, 1950); or if the museum contains a very rare specimen, which has never been found again (as it was in this case with the Spanish specimen of *Radiastraea arachne* Stumm, 1937).

Finally, it must be stated that almost all the criticisms of Soto are totally unfounded. Furthermore, some arguments given by Soto to justify his stratigraphical designations could be characterized as scientifically inappropriate (for details see above).

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