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CYCLOSTEPHANOS, TAXONOMIC SYNONYM OF *STEPHANODISCUS*

CYCLOSTEPHANOS, *SINONIMO TAXONOMICO DE* STEPHANODISCUS

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ABSTRACT

The problem of generic circumscription of *Cyclostephanos* is discussed. A bibliography revision of species is done with the aim of analyzing the diagnostic features of the genus in contrast with those of its closest neighbour *Stephanodiscus*. The analysis proves that there is no discontinuity between *Cyclostephanos* and *Stephanodiscus*; it is thus proposed to unite both taxa under the name of *Stephanodiscus* Ehrenberg. The nomenclatural changes resulting are also made.

KEYWORDS: *Cyclostephanos*, *Stephanodiscus*, taxonomy.

RESUMEN

En el presente trabajo se discute sobre los problemas referidos a la circunscripción del género *Cyclostephanos*. Una revisión de la bibliografía sobre las especies que conforman este género se ha realizado con el objeto de analizar los caracteres diagnósticos de este taxón contrastándolo con su vecino más cercano *Stephanodiscus*. El analisis prueba que no hay discontinuidad alguna entre *Cyclostephanos* y *Stephanodiscus*, por lo tanto se propone unir ambos taxones bajo el nombre de *Stephanodiscus* Ehrenberg. Se realizaron los cambios nomenclaturales derivados de las ideas expuestas en este trabajo.

PALABRAS CLAVES: *Cyclostephanos*, *Stephanodiscus*, taxonomía.

INTRODUCTION

At present there is no agreement among diatomologists about generic concepts. Round *et al.* (1990) pointed out that "...a genus is merely a cluster of species between which, in the opinion of the taxonomists, the differences are nowhere large enough to allow further subdivision. As in other categories, no character need be common to all the species included in the genus...". Medlin (in Poulin 1991) pointed out that "Characters used to define a genus should be qualitative not quantitative and should include the presence not absence of features. A range of variation in each feature should be expected and not all members of a genus will necessarily posses all features". We consider that a genus should fulfil three requirements: all its species should have at least one character or a combination of characters in common, it should be separated from other neighbouring genera by some discontinuity and, it should present some evolutionary novelty which makes it different from the rest of the taxa with which it shares the taxonomic category immediatly superior.

Since creation of the genus *Cyclostephanos* (Round 1982) several new species have been set up within it and some others have been transferred from *Stephanodiscus*, enlarging considerably the generic limits established by Round. This resulted in problems of circumscribing the genera *Cyclostephanos* and *Stephanodiscus*. With the aim of clarifying these taxonomic pro-

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blems Theriot & Kociolek (1986), Theriot *et al.* (1987b), Håkansson & Kling (1990) and Round & Håkansson (1992) proposed new diferential characters. However, studing materials from Argentine (Sala 1990, 1994) we realized that the difficulty of delimiting both taxa still exists. In view of all this we decided to carry out this research, the aim of which is to discuss the generic limits of *Cyclostephanos* on the basis of the analysis of the "pool" of characters considered so far.

MATERIAL AND METHODS

The method used for checking the generic limits of *Cyclostephanos* and its nearest neighbour *Stephanodiscus* was to contrast the characters pointed out by Round & Håkansson (1992) and Theriot *et al.* (1987b) with the bibliographic evidences of each species. This analysis was carried out character by character. The species analysed were *C. fenestratus* Theriot & Kociolek, *C. lacrimis* Theriot & Bradbury, *C. guatemalae* Theriot & Bradbury, *C. tholiformis* Stoermer Håkansson & Theriot emend. Håkansson & Kling, *C. novaezeelandiae* Cleve, *C. dubius* (Fricke) Hustedt, *C. damasii* (Hustedt) Stoermer & Håkansson, *C. invisitatus* (Hohn & Hellerman) Theriot Stoermer & Håkansson, *C. delicatus* (Genkal) Kling & Håkansson, *C. costatilimbus* (Kobayasi & Kobayashi) Stoermer Håkansson & Theriot and *C. undatus* Theriot & Kociolek. *C. pliocenicus* (Churs.) Mukhina, *C. ponticus* (Jouse) Churs., *C. marginatus* (Mukhina) Churs. and *C. stelliformis* Churs. et Mukhina have been excluded since we had no access to the corresponding literature. Nevertheless, we consider that the inclusion of these species would not have changed the results stated in this paper. On the other hand *C. omarensis* (Kupts.) Churs. et Log.; *C. costatus* Lupik. et Churs.; *C. sibiricus* (Skabitsch.) Genkal & Popovsk. and *C. pantocsecki* (Fricke) Kupts. et Churs. are not under this discussion since these species have been transfered to the genus *Pliocaenicus* Round & Håkansson.

The characters analized were: valve topography, distribution of mantle areolae, developement of interfascicles, external morphology of the fultoportulae, position and external morphology of the rimoportulae, spines or other ornamentations, morphology of the internal valve surface, and characteristics of the mantle criba.

RESULTS AND DISCUSSION

Round & Håkansson (1992) have discussed at length the generic characters of *Cyclostephanos* and *Stephanodiscus*. The taxonomic criterion used by these authors includes the one stated by Theriot & Kociolek (1986) and Håkansson & Kling (1990). Thus, we will analyze the characters pointed out by Round & Håkansson (1992) for the genus *Cyclostephanos* and contrast them to the *Stephanodiscus* (Table I).

1-"Valve face concentrically undulate"

Although most species taken into account present this type of valve surface, *C. costatilimbus* (figs. 12, 14 and 15, Stoermer *et al.* 1987) and *C. invisitatus* (figs. 20 and 23, Theriot *et al.* 1987b) have flat valve surfaces. *C. undatus* Theriot & Kociolek (figs. 2, 4a, 5a and 6a, Theriot & Kociolek 1986) presents valve face transversely undulate, a character which has been marked as differencial between *Pliocenicus* and *Cyclostephanos-Stephanodiscus* by Round & Håkansson (1992). This species which presents other characters of the genus *Pliocenicus* requires a critical review so as to revaluate its systematic position.

In the genus *Stephanodiscus* the valve surface appears concentrically undulate or flat, the same as in *Cyclostephanos*. Consequently, the valve topography can be taken as a common character to both genera.

2- "Valve face with uniseriate, radial areolae becoming multiseriate towards the mantle. Markedly fasciculate and interfascicles often domed externally".

The valve surface ornamentation pattern of all species of the genus *Cyclostephanos*, is the same as members of the genus *Stephanodiscus*.

3- "Additional mantle areolae below the external openings of the fultoportula - interfascicles continuing to the valve mantle edge (sometimes difficult to discern in external view but clear on the inside)".

Although many species of the genus *Cyclostephanos* have areolae below the fultoportulae, other species like *C. dubius* (fig. 12, Round 1982), *C. novaezeelandiae* (fig. 2, Round 1982 and fig. 7, Theriot *et al.* 1987b), *C. costatilimbus* (fig. 13, Stoermer *et al.* 1987), *C. undatus* (figs. 4a and 4b, Theriot & Kociolek 1986) and *C. guatemalae* (figs. 13 and 16, Theriot & Bradbury 1989) do not show this feature.

Besides, in most species of *Cyclostephanos* the interfascicles reach the mantle edge, in *C. novaezeelandiae* (figs. 6-7, Theriot *et al.* 1987 b) do not reach the margin, in *C. fenestratus* (figs. 11 and 15 Theriot & Kocioleck 1986) they do not exceed the level of the fultoportulae and in *C. delicatus* (figs. 18 and 20, Håkansson & Kling 1990) they are restricted to the valve face. These two latter character states have been pointed out by Round & Håkansson (1992) as being proper to the genus Stephanodiscus.

When comparing the lists of characters stated by Round & Håkansson for the genera *Cyclostephanos* and *Stephanodiscus*, it is possible to infer that extension of the interfascicles is, in their opinion, a differential character between both taxa. Nevertheless, from our point of view, the above mentioned exceptions invalidate it.

4 - "External openings of the fultoportulae lacking tubuli".

Fultoportulae lacking external tubuli are only found in *C. damasii*, *C. novaezeelandiae*, *C. fenestratus* and *C. lacrimis*. *C. guatemalae* (fig. 16, Theriot & Bradbury 1989), *C. dubius* (figs. 7, 9 and 12, Round 1982), *C. invisitatus* (fig. 22, Theriot *et al.* 1987b), *C. costatilimbus* (figs. 4,5 and 13, Kobayasi & Kobayashi 1986), *C. delicatus* (fig. 19, Håkansson & Kling 1990), *C. tholiformis* (fig. 26, Håkansson & Kling 1990) and *C. undatus* (figs. 4a and b, Theriot & Kociolek 1986) present external openings of the process, ranging from sligthly domed to short tubuli.

In the genus *Stephanodiscus* this character is multistate, some species present short or domed tubes similar to those observed in *Cyclostephanos*. In order to ilustrate this, we have selected *S. neoastraea* Håkansson & Hickel (figs. 8 and 9, Håkansson & Hickel 1986), *S. alpinus* Hustedt (figs. 14 and 16, Håkansson & Stoermer 1984) and *S. parvus* Stoermer & Håkansson (figs. 4, 6-8, Stoermer & Håkansson 1984).

From what has been formerly stated it can be concluded that the external morphology of the fultoportulae does not make it possible to determine any differences between both genera.

5- "External opening of the rimoportulae lacking tubuli" .

Round and Håkansson understood that this character makes it possible to distinguish *Cyclostephanos* and *Stephanodiscus* in external valve view.

Although most species of the genus *Cyclostephanos* present rimoportulae without external tube, *C. costatilimbus* (fig. 17, Stoermer *et al.* 1987), *C. tholiformis* (fig. 26, Håkansson & Kling 1990) and *C. invisitatus* (figs. 21-22, Theriot *et al.* 1987b) present a short domed tube.

When analysing the external opening of the rimoportulae in *Stephanodiscus*, we observed that this character is variable to such an extent that it presents a small dome similar to those of the species of *Cyclostephanos* above mentioned, in some specimens of *S. minutulus* (Kützing) Cleve & Möller presented by Kobayasi *et al.* (1985, figs. 8 and 20). Consequently, from our point of view there exists no discontinuity between both genera regarding the external opening of the rimoportulae.

6- "Spines present or absent. Other ornamentation rare".

The absence of spines in *Cyclostephanos* and the absence of other ornamentations in *Stephanodiscus* have been mentioned by Round & Håkansson as characters which partially differenciate both genera. However, the species of *Cyclostephanos* which were analysed present a row of spines in the union between the valve surface and the mantle, either placed in all the interfascicles or only in some of them. This is also observed in most of the species of *Stephanodiscus* that have been considered, with the exception of the *S. nipigonensis* Kling & Håkansson (fig. 15, Håkansson & Kling 1990) which may lack spines. On the other hand, this taxon presents other ornamentation on the mantle, like other species of *Cyclostephanos*, for example *C. delicatus* (figs. 17 and 18, Håkansson & Kling 1990). Therefore, these states of character have no differential value at all.

7- "Internal valve face with prominent marginal costae"

Within the genus *Cyclostephanos* there are species with prominent internal costae and marginal laminae which delimit chambers such as *C. novaezeelandiae* and *C. dubius* (figs. 5, 6, 13 and 14, Round 1982), *C. lacrimis* and *C. guatemalae* (figs. 6, 17 and 18, Theriot and Bradbury 1989) and *C. undatus* (figs. 5a, 6a and 6b Theriot and Kocioleck 1986). *C. damasii* (figs 7a and 10, Stoermer and Håkansson 1983) presents equally prominent costae but it lacks chambers.

Unlike the formerly quoted species, *C. costatilimbus* (fig. 6, Kobayasi & Kobayashi 1986), *C. delicatus* and *C. tholiformis* (figs. 18, 21 and 25, Håkansson & Kling 1990) posses costae which are slightly above the level of the internal valve surface. Finally, *C. fenestratus* (figs. 13a-16, Theriot and Kociolek 1986) and *C. invisitatus* (fig. 24, Theriot *et al.* 1987b) do not present internally elevated costae.

Round & Håkansson point out that *Cyclostephanos* and *Stephanodiscus* differ in the presence or absence of prominent marginal costae respectively. Taking into account the variability found within *Cyclostephanos* and considering that species like *C. fenestratus* and *C. invisitatus* present a plain internal valve surface, such as the species of the genus *Stephanodiscus*, we draw the conclusion that this character cannot be regarded as differential between both genera.

8- "Mantle criba not domed".

Round & Håkansson among other authors, have pointed out that *Cyclostephanos* presents flat mantle criba, while *Stephanodiscus* has domed criba. However there are no data concerning the morphology of the criba in *C. dubius*, *C. damasii*, *C. novaezeelandiae*, the evidence being confusing in the case of *C. tholiformis* and in *C. guatemalae*.

Moreover out of twelve species of *Stephanodiscus* that we analysed, the presence of domed criba could be determined only in *S. nipigonensis* and *S. alpinus*.

This facts reveal that this character cannot be used as differential, unless a detailed review of the mantle criba in both genera is carried out.

In adition to those characters mentioned by Round & Håkansson (1992) Theriot *et al.* (1987b) considered the position of the external opening of the rimoportulae (Table 1, column 9) as a valid character to distinguish the genus *Cyclostephanos* from *Stephanodiscus*. According to these authors, in the genus *Cyclostephanos* the external opening of the rimoportulae is located under a spine, whereas in *Stephanodiscus* it takes the place of a spine. They pointed out that only a group of species of *Cyclostephanos* corresponds to this description (Table 1 in Theriot *et al.* 1987b). We can add that the position of the rimoportulae differs from the mentioned pattern in *C. damasii* where the process can be located either under a spine (fig. 11, Theriot *et al.* 1987 b) or on a fascicle (figs. 11-12, Stoermer & Håkansson 1983) and in *C. delicatus* (fig. 16 and 19, Håkansson & Kling 1990) where it is beside or slightly below a spine. In the genus *Stephanodiscus*, some species differ from the described pattern. In *S. neoastrea* Håkansson & Hickel (fig. 8, Håkansson & Hickel 1986) the rimoportulae is on the mantle, while in *S. vestibulis* Håkansson, Theriot & Stoermer (figs. 3-7, Håkansson *et al.* 1986) and *S. niagarae* Ehremberg (figs. 8-10, Theriot & Stoermer 1981) at the same level or beneath the ring of spines. In *S. niagarae* var. *magnifica* Fricke (pl. 3, Theriot & Stoermer 1984) the position of the rimoportulae is between the ring of spines and the fultoportulae. The variation of the rimoportulae position found among and even within species, suggests to us that is not possible to use this character as a basis for delimiting both genera.

CONCLUSIONS

We agree with Medlin (in Poulin 1991) in that all members of a genus will not necessarily posses all features, but unlike Round *et al.* (1990) we consider that it is an unfailing condition to have at least one character or a combination of characters in common which represents an evolutionary novelty and allows separation of the genus from the other neibouring genera.

The results obtained evidenced to us that there is no discontinuity between the genera *Cyclostephanos* and *Stephanodiscus* in reference to the characters discussed. To the contrary the distribution of the areolae in fascicles, separated by interfascicles, radiating from the valve centre is a

character shared by the species of both genera. In adition, considering that this character represents an evolutionary novelty for the centric diatoms and makes it posible to establish a discontinuity between these two genera and its nearest neighbours, *Cyclotella* Kützing ex Brébisson and *Pliocenicus* Round & Håkansson, we propose to unite the genera *Cyclostephanos* and *Stephanodiscus*, under the name *Stephanodiscus* Ehremberg 1845.

NOMENCLATURAL CHANGES:

Stephanodiscus fenestratus (Theriot & Kociolek) *nov. comb.*

BASIONYM: *Cyclostephanos fenestratus* Theriot & Kociolek in Theriot *et al.* 1987a, p. 347.
SYNONYM: *Cyclostephanos fenestratus* Theriot & Kociolek 1986, p. 125, figs. 7-16 (valid name in Theriot *et al.* 1987a.)

Stephanodiscus lacrimis (Theriot & Bradbury) *nov. comb.*

BASIONYM: *Cyclostephanos lacrimis* Theriot & Bradbury 1989, p. 76, figs. 1-9.

Stephanodiscus guatemalae (Theriot & Bradbury) *nov. comb.*

BASIONYM: *Cyclostephanos guatemalae* Theriot & Bradbury 1989, p. 79, figs. 10-19.

Stephanodiscus tholiformis (Stoermer Håkansson & Theriot emend. Håkansson & Kling) *nov. comb.*

BASIONYM: *Cyclostephanos tholiformis* Stoermer, Håkansson & Theriot *emend* Håkansson & Kling 1990, p. 282, figs. 22-28.

Stephanodiscus novaezeelandiae Cleve 1881, p. 21, pl. 5, fig. 62.

SYNONYM: *Cyclostephanos novaezeelandiae* (Cleve) Round in Theriot *et al.* 1987a, p. 346; *Cyclostephanos novaezeelandiae* (Cleve) Round 1982, p. 326, figs. 1-6 (valid name in Theriot *et al.* 1987a).

Stephanodiscus dubius (Fricke) Hustedt 1928, p.367, fig. 192.

BASIONYM: *Cyclotella dubia* Fricke 1900 in Schmidt *et al.* 1874, pl. 222, figs. 23-24.
SYNONYM: *Cyclostephanos dubius* (Fricke) Round in Theriot *et al.* 1987a: 346; *Cyclostephanos dubius* (Fricke) Round 1982, p. 326, figs. 7-18 (valid name in Theriot *et al.* 1987a)

Stephanodiscus damasii Hustedt 1949, p.57, pl. 1, figs. 2-5.

SYNONYM: *Cyclostephanos damasii* (Hustedt) Stoermer & Håkansson in Theriot *et al.* 1987a, p. 346; *Cyclostephanos damasii* (Hustedt) Stoermer & Håkansson 1983, p. 250, pl. 1, figs. 1-6, pl. 2, figs. 7-10, pl. 3, figs. 11-14 (valid name in Theriot *et al.* 1987a).

Stephanodiscus invisitatus Hohn & Hellerman 1963, p. 325, pl. 1, fig. 7.

SYNONYM: *Cyclostephanos invisitatus* (Hohn & Hellerman) Theriot, Stoermer & Håkansson 1987b, p. 256, figs. 18-24.

Stephanodiscus delicatus Genkal 1985, p. 31, figs. 2-3.

SYNONYM: *Cyclostephanos delicatus* (Genkal) Kling & Håkansson in Håkansson & Kling 1990, p. 280, figs. 16-21.

Stephanodiscus costatilimbus Kobayasi & Kobayashi 1986, p. 8, pl. 1, figs. 1-7, pl. 2, figs. 10-13

SYNONYM: *Cyclostephanos costatilimbus* (Kobayasi & Kobayashi) Stoermer, *et al.* 1987b, p. 357, figs. 11-20.

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Table I. Variation of the characters, stated by Round & Håkansson (1992) and Theriot *et al.* (1987 b) for the genus *Cyclostephanos*, in species of this genus and *Stephanodiscus*. Characters: 1. valve face concentrically undulate (+), 2. fascicles of areolae uniseriate becoming multiseriate towards the mantle (+), 3.a. additional mantle areolae below the external openings of the fultoportulae(+), b. interfascicles continuing to the valve mantle edge (+), 4. external openings of the fultoportulae lacking tubuli (+), 5. external opening of the rimoportulae lacking tubuli. 6. a. spines present (+) or absent (-), b. other ornamentation present (+), 7. Internal valve face with prominent marginal costae (+), 8. mantle criba plain, 9. external opening of the rimoportulae beneath a spine (+).

	1	2	3 (a / b)	4	5	6 (a / b)	7	8	9
C. fenestratus	+	+	+	+/-	+	+	+	-	-	+	-?
C. lacrimis	+	+	+	+	+	+	+	-	+	+	+
C. guatemalae	+	+	-	+	-	+	+	-	+	?	+
C. tholiformis	+	+	+	+		-	+	-	+	?	+
C. novaezeelandiae	+	+	-	-	+	+	+	-	+		+
C. dubius	+	+	-	+	-	+	+	-	+	?	+/-
C. damasii	+	+	+	+	+	+	+	-	+	?	+/-
C. invisitatus	-	+	+	+	-	-	+	-	-	+	+
C. delicatus	+	+	+	-	-	+	+	+	+	+	+
C. costatilimbus	-	+	-	+	-	-	+	-	+	+	+
C. undatus	-	-	-	+	-	+	+	-	+	+	-/?
Stephanodiscus	+/-	+	+	-	-	-	+/-	+/-	-	-/?	-