Polish Botanical Journal 55(1): 119–126, 2010

A RE-EXAMINATION OF THE TYPE MATERIAL OF *CYMBELLA KAPPII* (BACILLARIOPHYCEAE)

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Abstract. The type material of *Cymbella kappii* (Cholnoky) Cholnoky has never been photographed or documented under LM or SEM and at one time was thought to have been lost. This taxon is one of the most commonly occurring *Cymbella* species in Southern Africa and thus is of great value in biomonitoring studies. The original material from the Hennops River (South Africa) has been re-examined and a lectotype slide is also designated. This species has been found to occur throughout South Africa in moderately alkaline waters of good quality and with low to moderate electrolyte content. It seems also to be more widely distributed in Southern Africa, with some additional records from elsewhere in Africa. Records of this species from New Zealand are considered questionable because it may have been confused with *Cymbella novazeelandiana* Krammer.

Key words: *Cymbella kappii*, type material, lectotypification, ecology, distribution

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INTRODUCTION

South Africa has a number of *Cymbella* C. Agardh species which commonly occur in inland waters. The most common of these species is *Cymbella kappii* (Cholnoky) Cholnoky 1956. It was first observed from rivers and streams around Pretoria (Kapp 1941). Kapp noted that the diatom appeared to be a new form of *Cymbella turgidula* but it was not adequately described.

Cholnoky described *Cymbella turgidula* var. *kappii* in 1953, citing Kapp's comments on its status as a new variety and naming the variety in his honour (Cholnoky 1953). Cholnoky then raised *C. turgidula* var. *kappii* to specific rank in 1956. This species is widely distributed and was reported in subsequent works of Schoeman (1973a), Archibald (1983) and more widely through the African continent, for example from Morocco (Krammer 2002).

Despite the common occurrence of *C. kappii* in South Africa, no detailed SEM illustrations or illustrations of living material have ever been presented besides those found in Taylor *et al*. (2007). An emended description of *C. kappii* was given previously (Archibald 1983) but the type material was listed as missing and thus no examination of this material was possible. The original material has now been discovered in the South African National Diatom Collection, Potchefstroom, providing a unique opportunity to present and designate a type slide for *Cymbella kappii* with accompanying illustrations of the distinguishing features of this taxon.

MATERIALS AND METHODS

Samples originating from the Hennops River and Tugela (Thukela) River (Table 1) were re-cleaned with hydrogen peroxide and examined using both light and electron micro-

* Dedicated to Dr. Kurt Krammer on the occasion of his 85th birthday

Table 1. Origin of material used in study.

Sample number/ name	Slide number	Locality	Habitat	Date of collection	Collector
Hennopsrivier 2	NIWR 235/4683 (Lectotype)	Hennops River near Pretoria. Gauteng Province	Small pool, standing water, full sun, dolomite bed	15 June 1952	H. G. Schweickerdt
Tug. 10a/2	NIWR 177/3539	Tugela (Thukela) River at Harts Hill below Colenso. Kwa-Zulu Natal	Small pool beside river, shallow, open sun	09 July 1954	W. D. Oliff
SANDC 09-616	SANDC 09-616	Thomeng 'Little Heaven' – abandoned limestone quarry near Taung. Tufa waterfall, North-West Province	Trickling water, shaded, sample scraped from calcareous deposits	18 Dec. 2009	J. C. Taylor

scopy. Material from Thomeng was cleaned and mounted using the methods summarized in Taylor *et al*. (2005).

Light micrographs were captured using a Nikon DS-U2 5mp digital camera mounted on a Nikon 80i compound light microscope equipped with a 1.4 N.A. oil immersion objective lens. Scanning electron microscopy was carried out using a FEI Quanta 2000 E-SEM (10 kV, WD 10 mm) housed at the Laboratory for Electron Microscopy, North-West University, Potchefstroom, South Africa.

Selection of type material

Generally, Cholnoky described species from multiple gatherings or samples, usually from the same geographical area (e.g., river system or catchment basin). More often than not, drawings were made from just one or at most two samples, although all sites from a particular sampling effort that contained the species with the species descriptions were listed. The type material selected in this case was the material used for the majority of illustrations, that is, the material designated by Cholnoky as 'Hennopsrivier 2'. This method of selecting type material was also applied by Schoeman and Archibald (1986).

The type specimen and original material belong to the South African National Diatom Collection presently housed at North-West University, Potchefstroom, South Africa, under the curatorship of the corresponding author. However, the official custodian of the collection is the South African Institute of Aquatic Biodiversity (SAIAB) based in Grahamstown.

Images from material in the Tug 10a/2 sample (Tugela Basin – Kwa-Zulu Natal, South Africa) are also presented here, as it is this material that was used for the illustrations presented in 1956 by Cholnoky when he elevated *C. kappii* to species rank.

Additional material (sample SANDC 09-616) was sampled in December 2009 (Table 1) and has been used for illustrative purposes, including living material. This material originates from the calcareous waterfall known as 'Thomeng' or 'Little Heaven' in North-West Province. This is one of only three known tufa or travertine waterfalls in South Africa. *Cymbella kappii* occurred en masse at this site and as such provided sufficient material to illustrate the size range from a single population.

Results

Cymbella kappii (Cholnoky) Cholnoky

Oesterr. Bot. Z. **103**: 61. 1956.

Basionym: *Cymbella turgidula* var. *kappii* Cholnoky, Verh. Zool.-Bot. Ges. Wien **93**: 142, Figs 12–16. 1953.

Lectotype (here designated): SOUTH AFRICA, Hennops River near Pretoria, collected 15 June 1952, *leg. H. G. Schweickerdt* [Slide no. NIWR 235/4683 in South African National Diatom Collection, North-West University, Potchefstroom, South Africa (Fig. 1b)]. Note. The lectotype slide was made from material marked 'Hennopsrivier 2'. The original Cholnoky slides have disappeared. The original label for the sample was found mounted on a card inside Cholnoky's folded anal-

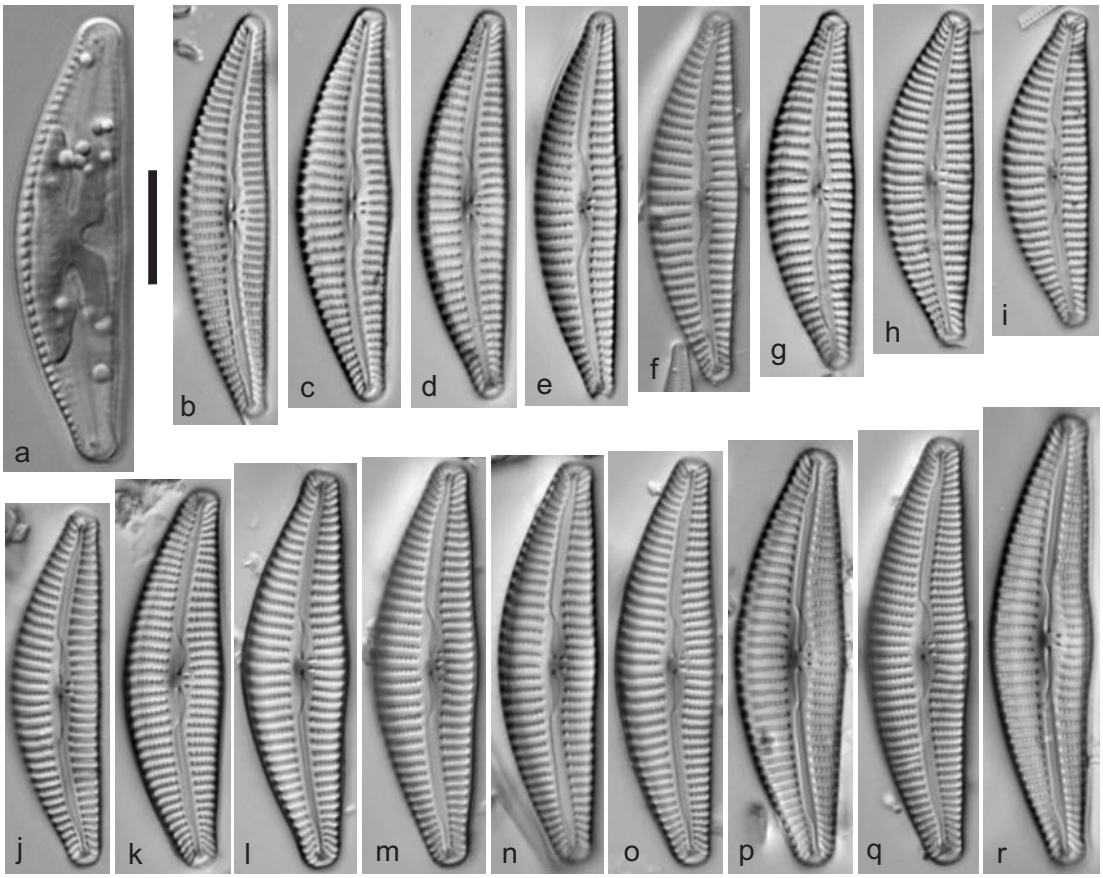

Fig. 1. *Cymbella kappii* (Cholnoky) Cholnoky: a – living cell; b–i – specimens from type locality, Hennops River, Pretoria, South Africa (b – lectotype); j–r – specimens from the Tugela Basin, Kwa-Zulu Natal, South Africa. Scale bar = 10 µm.

ysis sheet for this site. The label bears the following information: *Pool* (*standing water*) *full sun, dolomite bed, 15/6/52*. Cholnoky added the following information to the card: '*Hennopsrivier 2. Leg. Prof Dr H. G. Schweickerdt*'. This information is in agreement with the published information by Cholnoky (1953).

Living cells: Figure 1a shows a living (motile) *C. kappii* cell. It has the typical H-shaped chloroplast found in a number of *Cymbella* species, lapping around the cell with the central pyrenoid against one side of the girdle (Cox 1996).

Cholnoky's original drawings from the type material are presented in Figure 2. Representatives of the type population from the Hennops River are shown in Figures 1b–i and 4a–d, and representatives of the Tugela population in Figures 1j–r and 5a–f.

Cells presented in Figure 3 range from 26 to 53 µm long, with the longest being initial auxospore cells (Fig. 3a & b). Striae densities are in agreement with Krammer (2002).

Scanning electron micrographs of the type material from the Hennops River are presented in Figure 4 and material from the Tugela samples is illustrated in Figure 5. SEM shows cells from both populations to have striae composed of linear areolae (Fig. 4a–c & 5a, c, d). Internally the striae are separated by prominent ribs (Figs 4d, 5b). The stigmata (usually 2) have a simple round opening externally; there is an elongated slit-like structure with denticulations internally (Fig. 5f). This

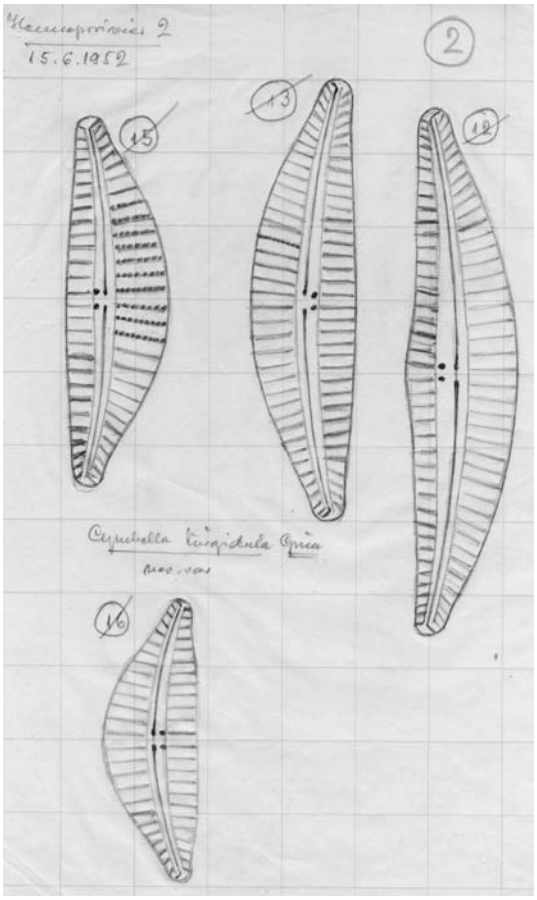

Fig. 2. Original unpublished line drawings of *Cymbella turgidula* var. *kappii* by Cholnoky from the Hennopsrivier 2 site, Pretoria, South Africa (no scale), housed in the South African Diatom Collection, North-West University.

is similar in structure to those of *C. novazeelandiana.* The proximal raphe fissures (Fig. 5d) are slightly enlarged externally and the distal ends curve towards the dorsal side of the cell (Fig. 5c). The raphe ends distally in a small helictoglossa internally (Fig. 5e). Apical pore fields are visible at both poles of the cell (Fig. 5c & e).

Discussion

Krammer (2002) discussed *Cymbella kappii* in some detail and expressed doubts as to whether the *Cymbella* species illustrated from the Tugela Basin (Cholnoky 1956) and elevated to specific rank from *C. turgidula* var. *kappii* by Cholnoky was in fact the same taxon as the type specimen from the Hennops River (Cholnoky 1953). Krammer (2002) presented a reproduction of Cholnoky's line drawings (Plate 51, fig. 17) as made from the Hennops River, but these are in fact the drawings from the Tugela material. It has been suggested that Cholnoky had difficulty delineating *C. kappii*, leading to some doubts (Krammer 2002) as to whether the taxon illustrated from the type locality is in fact conspecific with the illustrated population from the Tugela Basin (Cholnoky 1956). These two populations seem to be markedly similar, with the exception of the consistently narrower apices observed in specimens from the type material**.** This should not, however, be considered a distinguishing characteristic between these two populations, as the size of the apices varies in cells of a similar size within a single population, as illustrated in Figure 3n (wide) and Figure 3o (narrow). Krammer gives a wider range of cell size in specimens than described by Cholnoky (1956) or Archibald (1983), namely 22–58 µm long and 7.0–10.5 wide with 8–12 dorsal and ventral striae in 10µm at the centre of the cell. It was also noted that cells commonly have 2 and up to 4 stigmata. In the present study a single small cell from the type material with only one stigma was observed, but this is most uncommon.

Krammer (2002) also considers that *C. kappii* and *C. sumatrensis* Hustedt may be conspecific. However, he retains them as separate species due to their differing ecology. In addition, it is worth noting that *C. kappii* most commonly has 2 stigmata while *C. sumatrensis* most commonly has 4. The apices of *C. kappii* are slightly more produced than those of *C. sumatrensis*.

Distribution

Cymbella kappii has been widely reported from around the world, but its distribution outside of Africa is uncertain. Diatomists have recorded this species in samples from Sri Lanka (Foged 1976) and India (Prasad & Srivastava 1982) but the illustrated cells bear little resemblance to *C. kappii* s.str. Confusion regarding distribution may also

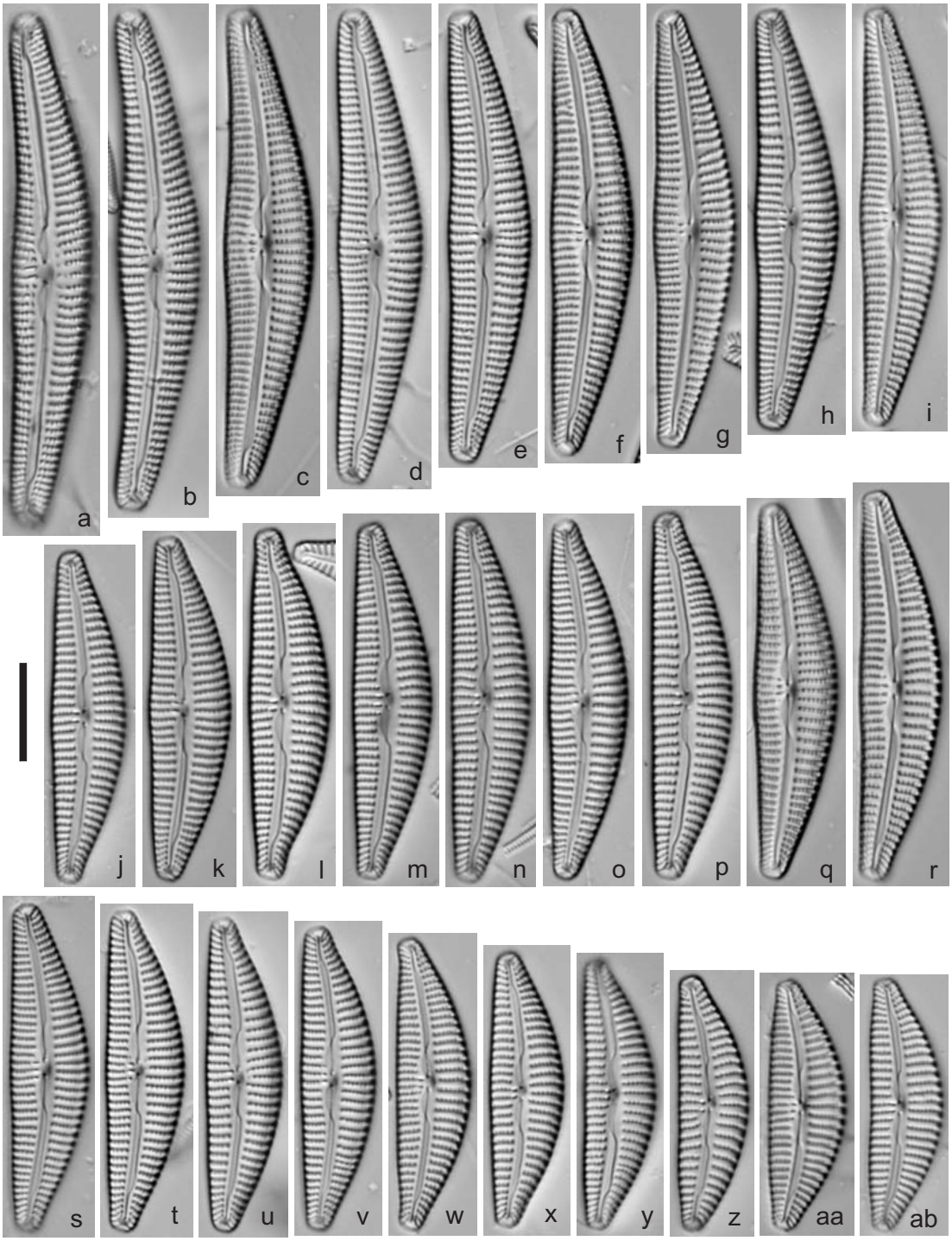

Fig. 3. *Cymbella kappii* (Cholnoky) Cholnoky from Thomeng tufa formation, North-West Province, South Africa: a & b – auxospore initial cells; c–ab – cells from a single population, showing size range. Scale bar = 10 μm.

arise given the close resemblance of *C. kappii* to *C. novazeelandiana* Krammer. There are many reports of *C. kappii* from New Zealand (e.g., Biggs *et al.* 2002; Lancashire *et al*. 2002; Thompson & Townsend 2003) but these may in fact be *C. novazeelandiana*. This relatively recently described species differs from *C. kappii* in outline, length/breadth ratio and its distinct central area (Krammer 2002). *Cymbella kappii* has also been reported from as far afield as China (Su *et al*. 2009).

Cymbella kappii has been reported in Africa from the Ruwenzori Mts (Cholnoky 1964) and the Okavango Delta (Cholnoky 1966b), Tanzania (Bowker & Denny 1978), Northern Sahara (Fontes *et al*. 1985), and Morocco (Krammer 2002). It has been reported in Southern Africa from Southern Rhodesia (Zimbabwe) (Cholnoky 1954), Natal (Cholnoky 1960) and Cape Province (Cholnoky 1962b), from the Eastern Transvaal, now Mpumalanga (Cholnoky 1962a), from the Amatola Mts and the Sundays River, Eastern Cape (Giffen 1966; Archibald 1983), from Lesotho (Schoeman 1969), from the Vaal Dam catchment (Archibald 1971), from the Klip River system (Hancock 1973), from the northern Transvaal (Schoeman 1973b), from the Jukskei River (Schoeman 1982) and from Swaziland (Cholnoky 1962c; Archibald & Schoeman 1987), and it is widely distributed in the Crocodile-West Marico WMA (Taylor *et al.* 2007).

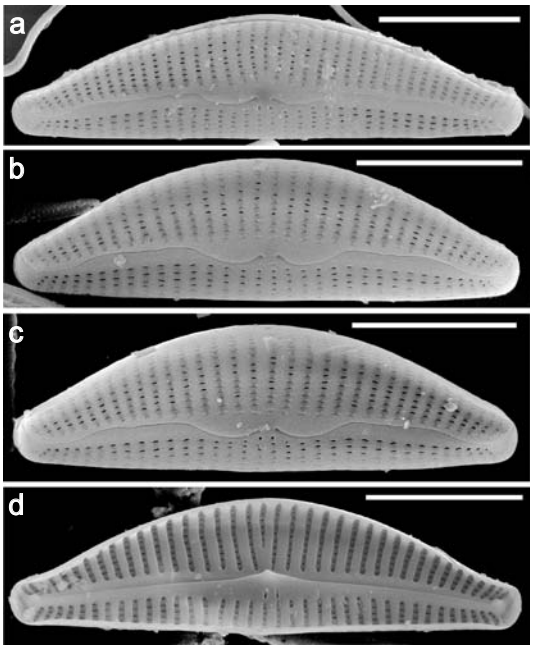

Fig. 4. *Cymbella kappii* (Cholnoky) Cholnoky from the Hennopsrivier 2 sample, Pretoria, South Africa: a–c – external valve views, SEM; d – internal valve view, SEM. Scale bars = 10 μm.

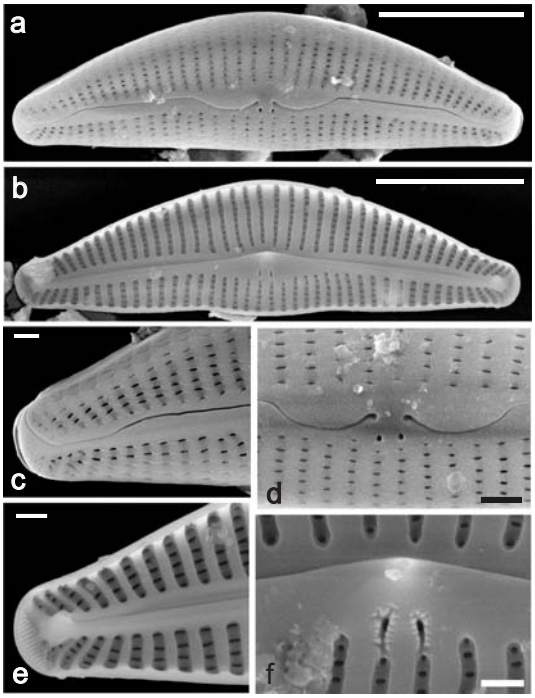

Fig. 5. *Cymbella kappii* (Cholnoky) Cholnoky from the Tug10/2a sample, Tugela Basin, Kwa-Zulu Natal, South Africa: a – external valve view, SEM; b – internal valve view, SEM; c – external valve view of distal raphe fissure, SEM; d – external view of proximal raphe fissure and external openings of stigmata, SEM; e – internal view of helictoglossa and apical pore field, SEM; f – internal valve view of stigmata. a–b scale bars = 10 μm. c–f scale bars = 1 μm.

Ecology

Cholnoky (1968) considered *Cymbella kappii* to have an affinity for oligotrophic, oxygen-rich, weakly alkaline waters with low to average electrolyte content. The recorded pH optimum for this species ranged between 7.5 and 7.8 (Cholnoky 1968). Based on more recent observations this species has been shown to have an affinity for calcareous

waters, as evidenced by its mass occurrence in the Mooi River (North-West Province). This site has dolomitic bedrock and hard water (a characteristic feature which is consistent with the type locality). A similar mass occurrence was also observed at a sedimentary limestone tufa formed by precipitation of carbonate material at ambient temperatures at Thomeng. The sample was collected from a ledge over which water was trickling. The following parameters were measured in the water during sampling: temperature 18.46°C, pH 8.14, electrical conductivity 782 $\mu S \cdot cm^{-1}$ (78.2 $mS \cdot m^{-1}$), and oxygen concentration 9.13 $mg \cdot l^{-1}$ (measurements taken at midday). This species almost certainly forms mucilage stalks, as many of them were observed in the sample. However, *C. kappii* apparently is easily detached from these stalks and as yet no attached specimens have been observed. Individual cells are highly motile.

ACKNOWLEDGEMENTS. We thank the Council for Scientific and Industrial Research (CSIR) for allowing us to use the material in the diatom collection, and two anonymous reviewers for valuable comments on the manuscript.

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Received 15 February 2010