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REGULAR PAPER

New or otherwise interesting desmid taxa from the Bangweulu region (Zambia). 2. Genera *Staurodesmus*, *Staurastrum* and *Xanthidium* (Desmidiales)

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Background and aims – In a second contribution to the desmid flora of the Bangweulu wetlands in Zambia a selection of species from the genera *Xanthidium*, *Staurodesmus* and *Staurastrum* is discussed for their taxonomy and geographical distribution.
Material and methods – Samples were collected from Lake Bangweulu and adjacent swamps as well as from Lake WakaWaka. Collection was by squeezing submerged plant material or using a plankton net.
Key results – Four taxa are described as new to science: *Staurodesmus bangweuluensis*, *Std. coutei*, *Std. thomassonii* and *Staurastrum onychophorum*. Three taxa are recombined: *Staurastrum zahlbruckneri* var. *africanum* to *S. bidentulum* var. *africanum*, *Staurastrum unicorne* to *Staurodesmus unicornis* and *Arthrodesmus curvatus* to *Staurodesmus curvatus*. *Xanthidium decoratum* var. *longispinum* is raised to species level whereas two taxa, *Staurodesmus subunguiferus* var. *longiradiatus* and *Std. longiradiatus* var. *granulatus* were provided with new names: *Staurastrum zambiense* and *S. zambiense* var. *granulatum*, respectively.
Conclusions – Almost all taxa discussed may be considered African endemics underlining the specific character of the African desmid flora. Many identifications in older desmid literature from Africa, especially infraspecific taxa assigned to species originally described from Europe, appear to need a critical revision.

Key words – Desmids, *Xanthidium*, *Staurodesmus*, *Staurastrum*, Zambia, Bangweulu, WakaWaka, taxonomy, geographical distribution.

INTRODUCTION

In a second contribution to the desmid flora of the Bangweulu wetlands region and the relatively nearby small, shallow Lake WakaWaka the authors focus on the genera *Staurodesmus*, *Staurastrum* and *Xanthidium*. Emphasis is put on species completely unknown from literature, labouring under a confusing taxonomy or marked by a highly limited geographical distribution.

MATERIAL AND METHODS

Lake Bangweulu is a large lake (c. 75 km × 35 km) situated in the northern part of Zambia. On the south-eastern side it is bordered by extensive swamps holding numerous smaller and larger ponds. Lake WakaWaka, located about 150 km south-east of Lake Bangweulu, is much smaller and surrounded by woodlands. Desmid samples were mostly collected by squeezing submerged water plants, preferably species of the genus *Utricularia*, or using a plankton net. Samples were partly immediately fixed for drawing desmid taxa later on, partly taken home alive for photographing and possible culturing. For a description of the sampling areas and detailed information on the collection sites, see Coesel & Van Geest (2014).

TAXONOMIC ACCOUNT

Staurodesmus bangweuluensis Coesel & Van Geest, **sp. nov.**
Figs 1A & B, 3D

Diagnosis – Cells biradiate, in frontal view distinctly broader than long, with a deep median constriction. Sinus from its apex closed to about halfway, then opening widely. Semicells about semicircular, the basal angles provided with a downwardly projected spine. Cells in apical view with a fusiform

semicell body, at the poles passing into a spine. Chloroplast in each semicell with two pyrenoids. Dimensions: cell length 27–33 µm, cell breadth exclusive of spines 36–40 µm, including spines 46–57 µm, breadth of isthmus 9–11 µm, cell thickness c. 17 µm. – Type: Zambia, swamp near Mpanta, 11°27′04″S 29°50′35″E, 24 Sept. 2012, *Hugo de Vries Lab.* 2012.03 (holo-: L), preserved as a natural sample, and illustrated in fig. 1A.

Taxonomic remarks – At first sight, our newly described species seems just another variety of the cosmopolitan species *Std. convergens* marked by strongly depressed cells, the spines of the opposing semicells touching or even crossing each other at the sinus. However, *Std. convergens* just like the vast majority of *Staurodesmus* species is a so-called monocentric species, i.e. each semicell contains an axile chloroplast with one, central pyrenoid (Teiling 1967: 475). West & West (1912) in their well-known flora state this species to be characterized by a single central pyrenoid only 'as a rule', but all chloroplast pictures in literature that could be traced show but a single pyrenoid. According to Teiling (1967), the number of pyrenoids in *Staurodesmus* species is to a large extent linked to cell size: chloroplasts with two or more pyrenoids are particularly found in some large-sized species. When considering the size of *Std. convergens* cells depicted with a single pyrenoid in e.g. the floras by West & West (1912, pl. 116: 7), Lenzenweger (1997, pl. 21: 19, 20) and Coesel & Meesters (2007, pl. 85: 13), those cell dimensions are considerably higher than in our newly described taxon. Especially since no 'true' *Std. convergens* was met with in our Zambia collections, we prefer to render it the rank of a separate species.

Staurodesmus bangweuluensis was only encountered in sample nr. 2012080 originating from the Bangweulu swamps near Mpanta, where it was rather common and very consistent in its morphology.

Staurodesmus coutei Coesel & Van Geest, **sp. nov.**
Fig. 1C

Diagnosis – Cells triradiate, in frontal view broader than long, with a deep median constriction. Sinus V-shaped. Semicells broadly cup-shaped, the apical angles gradually attenuated into rather stout, about horizontal spines, the apex with a distinct median depression. Cells in apical view triangular with convave sides gradually passing into the spines. Dimensions: cell length 30–40 µm, cell breadth including spines 50–65 µm, breadth of isthmus 15–16 µm. – Type: Zambia, swamp in the Chipundu region, 11°44′02″S 29°46′01″E, 25 Sept. 2012, *Hugo de Vries Lab.* 2012.04 (holo-: L), preserved as a natural sample, and illustrated in fig. 1C.

Taxonomic remarks – *Staurodesmus coutei* was previously described and figured by Bourrelly & Couté (1991: 121, pl. 45: 10) from Madagascar as a form of *Staurodesmus crassus* var. *productus* (Skuja) Teiling (1967). The latter taxon, however, described by Skuja (1964) from Swedish Lappland as *Arthrodesmus crassus* var. *productus*, is a biradiate one and characterized by divergent instead of parallel spines, whereas the apices are slightly convex instead of distinctly concave. So it is quite clear that it essentially differs from our African taxon under discussion.

Only a few specimens of *Std. coutei* were found in a single sample, viz, nr. 2012088, originating from a Bangweulu swamp in the Chipundu region.

Staurodesmus curvatus (W.B.Turner) Coesel & Van Geest, **comb. nov.**
Figs 1D & E, 3A & B

Basionym – *Arthrodesmus curvatus* W.B.Turner, Kungliga Svenska Vetenskapsakademiens Handligar 25(5): 135, pl. 11: 33, pl. 12: 2. 1893 (Turner 1893).

Taxonomic remarks – Teiling (1967) in his comprehensive work of the genus *Staurodesmus*, records this species as *Staurodesmus curvatus* (Turner) Thomasson without giving any reference to the paper in which Thomasson would have performed the recombination in question. Actually, the only record of *Std. curvatus* by Thomasson is in his paper on the algal vegetation of Lake Kariba where he makes mention of the taxon *Std. curvatus* var. *latus* (A.M.Scott & Prescott) Thomasson comb. nov. (Thomasson 1965: 22). Apart from the fact that this recombination formally is invalid by want of a full reference to its basionym (McNeill et al. 2012, art. 41), he does not explicitly recombine the species *Arthrodesmus curvatus* as such, see also Compère (1977). Compère (1977) states the name of *Std. curvatus* (Turner) Thomasson to be also an illegitimate homonym of *Std. curvatus* (W.West) Thunmark. However, as Thunmark (1948) mentioned *Std. curvatus* without any author name, literature reference or diagnostic characteristic, it should not be considered a homonym but a nomen nudum without nomenclatural consequences. By providing the reference to Turner (1893) as yet we herewith validate the name of *Std. curvatus*.

Staurodesmus curvatus is principally defined by its stout apical spines that are knee-like bent at their base. It is a tropical species mainly known from the Asian continent. From Africa, the only known report is that by Thomasson (1965) referring to Lake Kariba. However, a number of records of other taxa can be related to our species under discussion, e.g. *Std. glabrus* f. *subglabrus* (Grönblad) Teiling as represented in Thomasson (1960a) from the Bangweulu area, *Std. dejectus* var. *convergens* (Wolle) Thomasson as represented in Thomasson (1966) from Lake Shiwa Ngandu, and *Staurastrum dejectum* var. *subglabrum* f. *major* Bourr. described by Bourrelly (1957) from French Sudan.

In our present investigation, *Std. curvatus* was regularly encountered in some of our samples from Lake WakaWaka. In all cells observed, the spines were remarkably yellow-brownish coloured (fig. 3A & B).

Staurodesmus thomassonii Coesel & Van Geest, **sp. nov.**
Fig. 1F & G

Diagnosis – Cells triradiate, in frontal view slightly broader than long, with a deep median constriction. Sinus V-shaped. Semicells cup-shaped with a short cylindric base, the apical angles slightly inflated and abruptly passing into rather long, divergent spines. Cells in apical view triangular, sides of the semicell body with an indentation near each of the angles. Dimensions: cell length exclusive of spines 23–29 µm, including spines 30–50 µm, cell breadth including spines 44–61 µm, breadth of isthmus 10–13 µm. – Type: Zambia, Lake

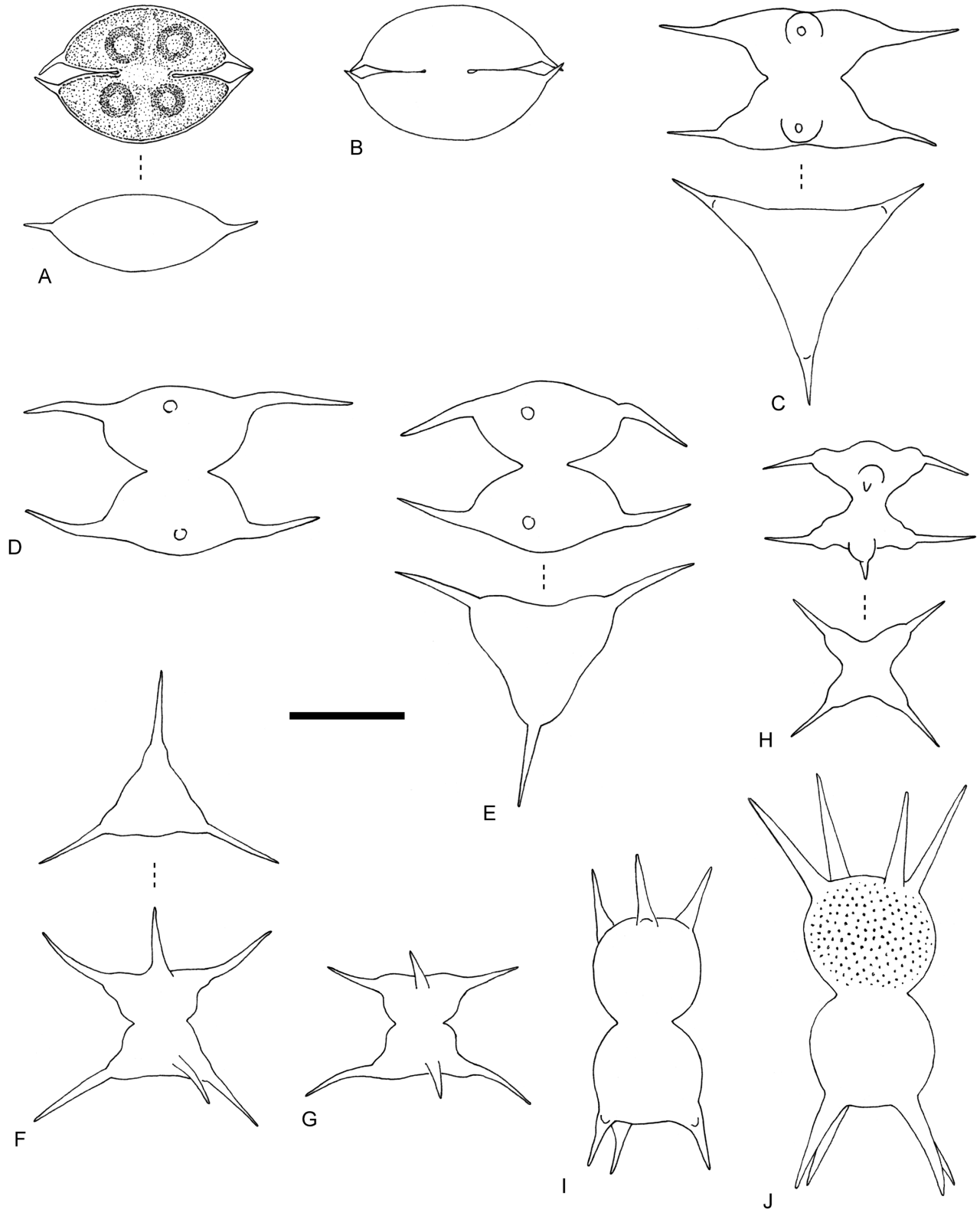

Figure 1 – Selected desmid taxa: A & B, *Staurodesmus bangweuluensis* (sample nr. 2012080); C, *Staurodesmus coutei* (sample nr. 2012088); D & E, *Staurodesmus curvatus* (sample nr. 2012075); F & G, *Staurodesmus thomassonii* (sample nr. 2012075); H, *Staurodesmus unicornis* (sample nr. 2012075); I, *Staurodesmus subunguiferus* (sample nr. 2012075); J, *Staurastrum zambiense* (sample nr. 2012075). Scale bar represents 25 µm.

WakaWaka, 12°30′37″S 30°36′23″E, 22 Sept. 2012, *Hugo de Vries Lab.* 2012.05 (holo-: L), preserved as a natural sample, and illustrated in fig. 1F.

Taxonomic remarks – The above-diagnosed alga is quite similar to *Staurodesmus connatus* var. *africanus* (Bourr.) Thomasson as represented by Thomasson (1960a: 34, pl. 10: 20). However, Thomasson (1960a) considered it identical to *Staurastrum connatum* var. *africanum* described by Bourrelly (1957: 1082, Fig. 115) whereas the present authors are of opinion that two different species are at issue. Our newly described species differs from *Std. connatus* var. *africanus* in a less open sinus, its cylindrical basal part of the semicell body and its inflated apical angles. Whereas, in apical view, the median part of the semicell sides in *Std. thomassonii* is convex, that in *Std. connatus* var. *africanus* is concave.

Thomasson (1960a) encountered our newly described species in the Bangweulu area. In our present study it was found to be widely distributed in both Lake WakaWaka and the Bangweulu wetlands.

Staurodesmus unicornis (W.B.Turner) Coesel & Van Geest, **comb. nov.**
Figs 1H & 3C

Basionym – *Staurastrum unicorne* W.B.Turner, Kungliga Svenska Vetenskapsakademiens Handligar 25(5): 107, pl. 15: 16. 1893 (Turner 1893).

Taxonomic remarks – Just like in *Std. curvatus*, Teiling (1967) when providing the name of *Std. unicornis* (W.B.Turner) Thomasson fails to give any reference to the paper in which Thomasson would have performed the recombination in question. The only reference in this context by Teiling (1967) to a paper by Thomasson is the one to Thomasson (1960b) dealing with New Zealand desmids. In that paper, Thomasson uses the name of *Staurodesmus unicornis* (Turner) Thomasson, it is true, but without referring to any paper in which this name would have been used earlier. So, as far as could be checked, a formal recombination of the name in question has never taken place.

Staurodesmus unicornis is mainly recorded from tropical Asia (e.g. Turner 1893, Agarcar et al. 1983, Shaji & Patel 1991) but also from (sub)tropical regions in Australia (Scott & Prescott 1958) and South America (Tell & Zalocar de Domitrovic 1984, Thérézien 1989). It turns out to be a polymorphic species giving rise to many varieties (Teiling 1967) a number of which, however, in our opinion should be considered separate species. Thus far, the only African record was from Madagascar (Bourrelly & Couté 1991). Our Zambian material somewhat differs from the original description in Turner (1893) by longer spines and a slightly longer isthmus. In that respect, our material agrees with *Std. unicornis* as depicted by Bourrelly & Couté from Madagascar, but we think this difference is too small to describe our form as a separate, African variety.

Staurodesmus unicornis was only found in small numbers. In Lake WakaWaka cells were quadriradiate whereas in the Bangweulu region only triradiate cells were encountered.

Staurodesmus subunguiferus (F.E.Fritsch & F.Rich) Thomasson
Figs 1I & 3J

Basionym – *Staurastrum subunguiferum* F.E.Fritsch & F.Rich, Transactions of the Royal Society of South Africa 25: 213, Fig. 27F–J. 1937 (Fritsch & Rich 1937).

By stating the above basionym the recombination performed by Thomasson (1960a: 35) is validated.

Staurodesmus subunguiferus was found both in Lake WakaWaka and the Bangweulu area but only in very small cell numbers. In taxonomic terms it should be compared with *Staurastrum zambiense* dealt with below.

Staurastrum zambiense Coesel & Van Geest, **nom. nov., comb. nov. & stat. nov.**
Fig. 1J

Synonym – *Staurodesmus subunguiferus* forma *longiradiatus* Thomasson, Nova Acta Regiae Societatis Upsaliensis, ser. 4, vol. 17, no. 12: 35, Fig. 12: 15, 1960 (Thomasson 1960a).

Type (iconotypus): Thomasson 1960a: Fig. 12: 15.

Synonym – *Staurodesmus longiradiatus* (Thomasson) Thomasson, Exploration hydrobiologique du bassin du Lac Bangweolo et du Lac Luapula, vol. 4, fasc. 2: 28, pl. 14: 13, 14. 1966 (Thomasson 1966).

Staurastrum zambiense Coesel & Van Geest **var. *granulatum*** (Thomasson) Coesel & Van Geest, **nom. nov. & comb. nov.**
Fig. 3E & F

Synonym – *Staurodesmus longiradiatus* var. *granulatus* Thomasson, Hydrobiological Survey of the Lake Bangweulu Luapula River Basin, vol. 4, fasc. 2: 29, pl. 1: 8, pl. 14: 15, 16. 1966 (Thomasson 1966).

Type (iconotypus): Thomasson 1966: pl. 1: 8.

Taxonomic remarks – This quadriradiate taxon was originally described from the Bangweulu area as *Staurodesmus subunguiferus* var. *longiradiatus* Thomasson (1960a). Later on, when Thomasson encountered it also in the Zambian lake Shiwa Ngandu, it was raised to species level: *Staurodesmus longiradiatus* Thomasson (1966). In that same paper, Thomasson (1966) described also *Std. longiradiatus* var. *granulatus* differing from the nominate variety in the occurrence of two granules below each of the four spines, just above the isthmus. As Thomasson (1960a, 1966) in his description of both *Std. subunguiferus* var. *longiradiatus* and *Std. longiradiatus* var. *granulatus* fails to state a nomenclatural type (McNeill et al. 2012, art. 40) we provide that information as yet.

When comparing *Std. longiradiatus* with the triradiate species *Std. subunguiferus* it is quite obvious that we are dealing with different species indeed. Not only they differ in number, length and shape of the apical spines but also in cell wall sculpture. Fritsch & Rich (1937) describe the cell wall in *Std. subunguiferus* to be characterized by some radiating series of ‘granules’ (what they mention as ‘granules’, according to their Figs 27: I, J, are most likely deepened pore

fields). A roughly similar cell wall sculturing is depicted by Bourrelly & Manguin (1949) but in most other papers dealing with this species it is wanting. This could be explained by the fact that the pore fields are very tiny, so will be easily overlooked, see our fig. 3J. So, the cell wall in *Std. subunguiferus* largely makes a smooth impression. The cell wall in *Std. longiradiatus* however, according to Thomasson (1960a, Fig. 12: 15) is marked by densely set, coarse scrobiculae, see also our fig. 3F.

Thomasson (1966), when describing *Std. longiradiatus* var. *granulatus*, notes that the relationship with the nominate variety of this species is undisputable and we can fully agree with that, encountering the two varieties next to each other in one and the same sample. However, considering the stout, basal granules in var. *granulatus* (fig. 3E) it is quite clear that the taxon in question formally does not meet the requirements of the genus *Staurodesmus*, a genus characterized by the exclusive ornamentation of a single spine on each of its semicell lobes (Coesel & Meesters 2013). Therefore, we prefer to transfer the species in question to *Staurastrum*, a genus with a much broader definition. The name of *Staurastrum longiradiatum* already being used for another species (West & West 1896) a new species name, *Staurastrum zambiense*, was chosen.

Both the nominate variety of *Staurastrum zambiense* and its variety *granulatum* were encountered in small numbers in WakaWaka sample nr. 2012075.

Staurastrum bidentulum Grönblad **var. *africanum*** (F.E.Fritsch & F.Rich) Coesel & Van Geest, **comb. nov.**
Fig. 3G–I

Basionym – *Staurastrum zahlbruckneri* var. *africanum* F.E. Fritsch & F.Rich, Transactions of the Royal Society of South Africa 25: 214, Fig. 27C, D. 1937 (Fritsch & Rich 1937).

The taxon depicted in our fig. 3G–I fully agrees with *S. zahlbruckneri* var. *africanum* as described by Fritsch & Rich (1937) from South Africa. However, this taxon essentially differs from *S. zahlbruckneri* originally described by Lütkemüller (1900) from central China. The latter one is a conspicuous, cosmarioid species characterized by two-lobed basal semicell angles. Variety *africanum* differs from the nominate variety not only by distinctly smaller cell dimensions and a predominantly slightly crenulate cell wall but, most essentially, in that the basal semicell angles are not di-

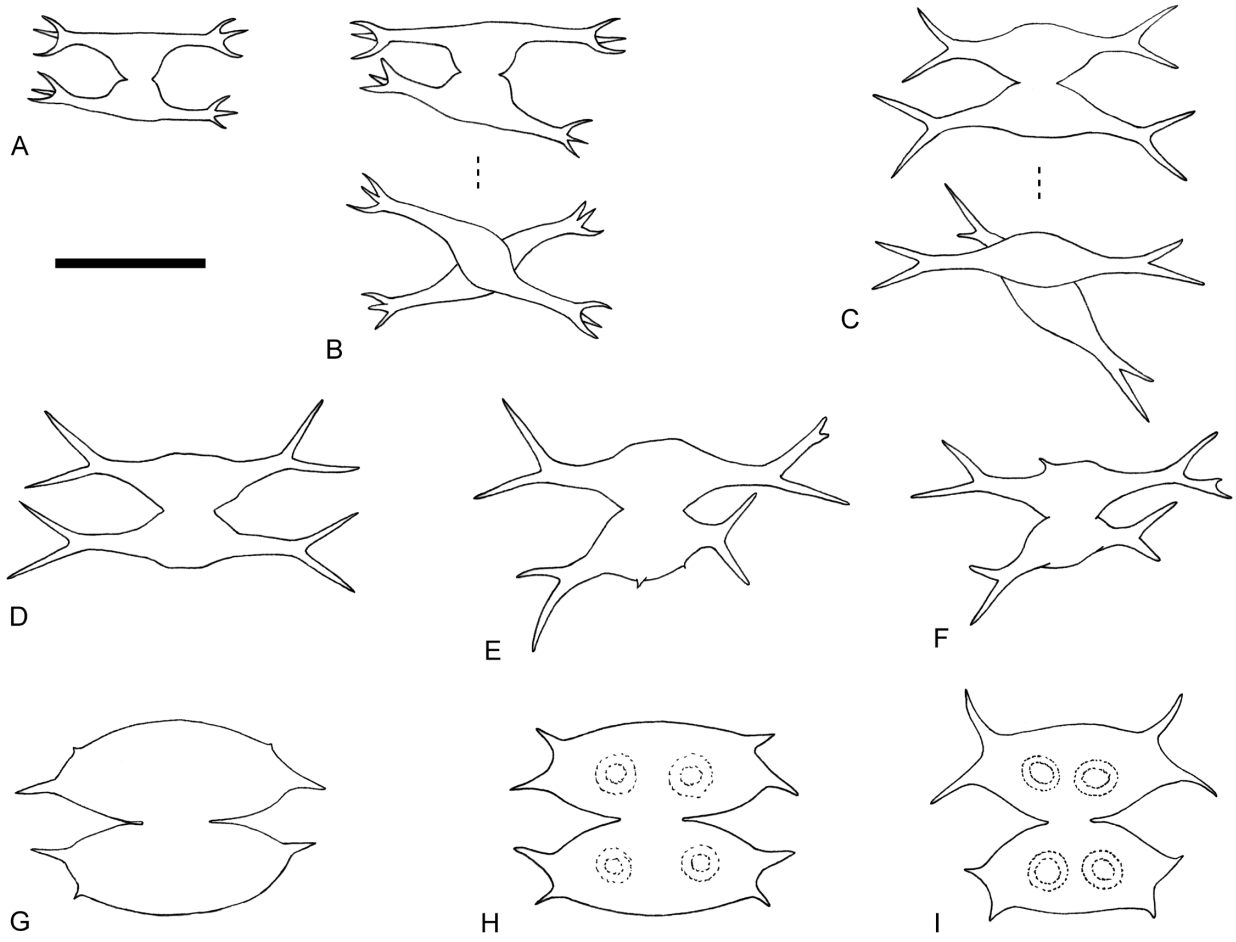

Figure 2 – Selected desmid taxa: A & B, *Staurastrum onychophorum* (sample nr. 2012076); C–F, *Staurastrum livingstonii* (sample nr. 2012076); G–I, *Xanthidium mucronulatum* (sample nr. 2012075). Scale bar represents 25 µm.

vided into two separate lobes. Instead of that, the basal angles are furnished with some three big granules. In that respect there is much more similarity with *S. bidentulum* Grönblad (1945), a taxon originally described from Brazil but known from (sub)tropical regions in North and South America, Asia, Australia and Africa (Coesel & Van Geest 2009). The only obvious difference is in the number of protrusions at the basal angles: two in *S. bidentulum*, three in *S. zahlbruckneri* var. *africanum*. In our opinion this small difference does not justify separation at species level, so we herewith propose to transfer *S. zahlbruckneri* var. *africanum* to *S. bidentulum*.

Staurastrum bidentulum var. *africanum* is only known (as *S. zahlbruckneri* var. *africanum*) from Africa (Fritsch & Rich 1937, Bourrelly & Couté 1991) and northern Australia (Scott & Prescott 1958). In our Zambia material, only a few cells were encountered in sample nr. 2002073 originating from Lake WakaWaka.

Staurastrum onychophorum Coesel & Van Geest, **sp. nov.**
Figs 2A & B, 3L–N

Diagnosis – Cells biradiate, in frontal view much broader than long, with a deep median constriction and twisted at the isthmus. Sinus acute-angled. Semicells cup-shaped, the apical angles attenuated into about horizontal, arm-like processes tipped by some three, relatively stout spines that are claw-like curved. Cells in apical view with an elliptic semicell body rather abruptly passing into the processes. Dimensions: cell length 14–17 µm, cell breadth 34–38 µm, breadth of isthmus 4–6 µm, thickness of semicell body c. 8 µm. – Type: Zambia, Luapula River near Mpanta,11°27′15″S 29°49′35″E, 24 Sept. 2012, *Hugo de Vries Lab.* 2012.06 (holo-: L), preserved as a natural sample, and illustrated in fig. 2B.

Taxonomic remarks – *Staurastrum onychophorum* (Greek for 'equipped with claws'), a rather small-sized species is most characteristic by its strongly twisted cells, more or less horizontal processes and relatively stout, curved terminal spines. Actually, in desmid literature no other taxon could be traced with a similar appearance. Remarkably, Thomasson (1957, 1960a) in his investigation of Bangweulu samples does not make mention of a suchlike cell form whereas the present author(s) encountered it in a number of samples originating from both the proper Lake Bangweulu and swamp areas near Mpanta and Chipundu.

Staurastrum doidgei Fritsch & Rich
Fig. 3O–R

Staurastrum doidgei is a cosmarioid *Staurastrum* species described by Fritsch & Rich (1937) from South Africa. Its cell shape, particularly in apical view, is most characteristic, i.e. strongly concave sides passing into broadly truncate semicell lobes. Semicell lobes are furnished with concentric series of granules, towards the semicell body merging into bigranulate verrucae but lacking in the central part of the semicell apex. Remarkably, despite its peculiar appearance, after the description by Fritsch & Rich (1937) *S. doidgei* was never reported again. The present authors encountered a few cells in sample nr. 2012075 originating from Lake WakaWaka.

Staurastrum livingstonii Thomasson
Figs 2C–F & 3K

Staurastrum livingstonii was described by Thomasson (1957) from the plankton of Lake Bangweulu. It applies to a rather small-sized, biradiate species with a stout bifurcation of the processes rendering it a most characteristic shape. As far as could be traced, no other finds have been published. Whereas Thomasson observed only a few specimens we encountered this species in the Bangweulu area rather regularly in a number of samples from both the Mpanta and the Chipunda region. Noticeably, next to specimens with a smooth-walled semicell body agreeing with Thomasson's (1957, Fig. 13a–c) drawings, also cells were found with a variable number of additional mucros on the cell surface (fig. 3K). Moreover, terminal spines often showed an extra furcation (fig. 2E & F).

Xanthidium bangweuluense Thomasson
Fig. 4A & B

Taxonomic remarks – By providing a nomenclatural type Förster (1983) validated the name of *Xanthidium bangweuluense* Thomasson (1960a). The species in question was lowered in rank to a variety of *Xanthidium sansibarense* (Hieron.) Schmidle by Thomasson (1966) but the present authors are of opinion that the morphological differences are large enough to justify discrimination at species level. As compared to the nominate variety of *X. sansibarense* as described by Schmidle (1898), *X. bangweuluense* has less but larger marginal crenations and the shape of the semicell is trapezoid rather than hexagonal. The most important difference, however, is the frontal ornamentation in *X. bangweuluense* consisting of some two transversal rows of conspicuous spines (compare fig. 4A & B with 4C).

Xanthidium sansibarense is widely spread in Africa, e.g. Sansibar (Schmidle 1898), South Africa (Fritsch & Rich 1937), French Sudan, today's Mali (Bourrelly 1957), Sudan (Grönblad et al. 1958), Madagascar (Bourrelly & Couté 1991), Uganda (Lind 1971), Ivory Coast (Bourrelly 1961), Zambia (Thomasson 1960a, 1966). The only records from outside that continent are by Scott & Prescott (1961) from Borneo and Sumatra, and by Wei (2014) from China. *Xanthidium bangweuluense*, on the contrary, is only known from the Bangweulu swamps (Thomasson 1960a) and the relatively nearby Lake Shiwa Ngandu (Thomasson 1966). The present authors encountered it in low cell numbers in Bangweulu samples nr. 2012078 and 2012092.

Xanthidium longispinum (Thomasson) Coesel & Van Geest, **comb. nov. & stat. nov.**
Fig. 4G–L

Basionym – *Xanthidium decoratum* var. *longispinum* Thomasson, Hydrobiological Survey of the Lake Bangweulu Luapula River Basin, vol. 4, fasc. 2: 26, pl. 9: 10, pl. 10: 9. 1966 (Thomasson 1966).

Type (iconotypus): Thomasson (1966), pl. 9: 10.

Tanonomic remarks – The description of *X. decoratum* var. *longispinum* by Thomasson (1966) is formally invalid as no nomenclatural type is indicated (McNeill et al. 2012, art. 40).

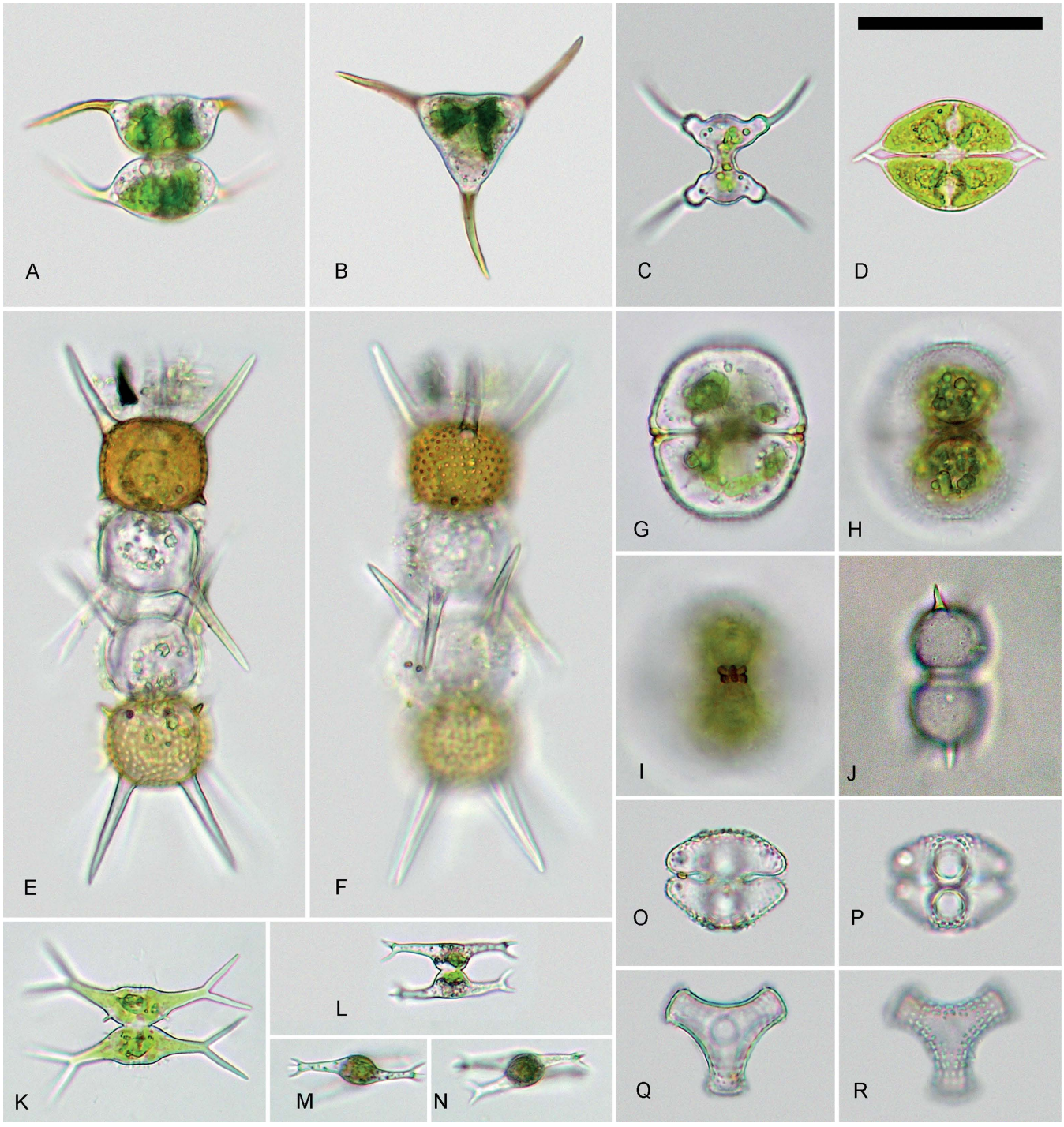

Figure 3 – Micrographs of selected desmid taxa: A & B, *Staurodesmus curvatus* (sample nr. 2012075); C, *Staurodesmus unicornis* (sample nr. 2012075); D, *Staurodesmus bangweuluensis* (sample nr. 2012080); E & F, focus–through picture of *Staurastrum zambiense* var. *granulatum* (sample nr. 2012073); G–I, focus–through picture of *Staurastrum bidentulum* var. *africanum* (sample nr. 2012073); J, *Staurodesmus subunguiferus* (sample nr. 2012073); K, *Staurastrum livingstonii* (sample nr. 2012079); L–N, *Staurastrum onychophorum* (sample nr. 2012076); O–R, *Staurastrum doidgei* (sample nr. 2012075). Scale bar represents 50 µm.

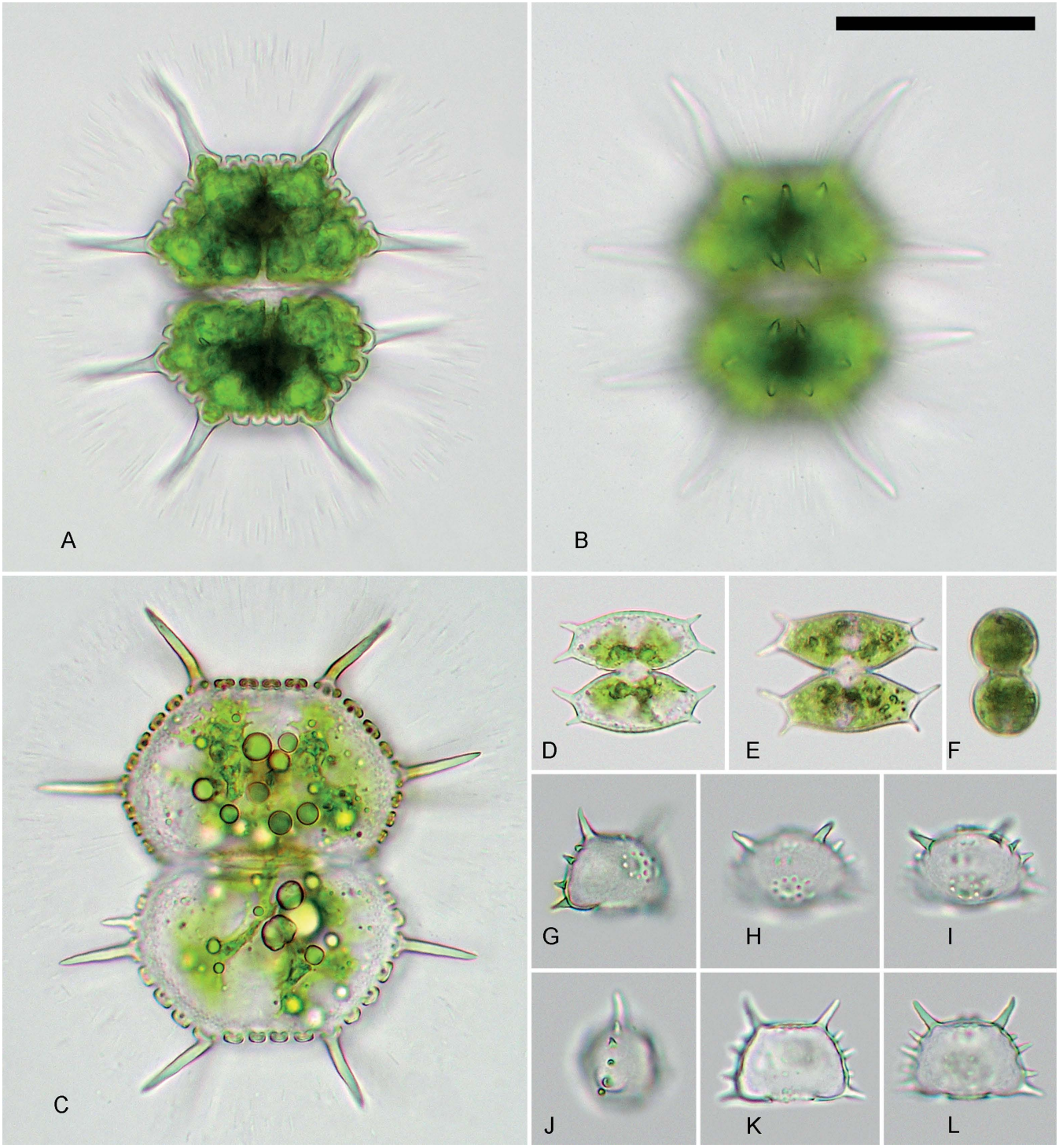

Figure 4 – Micrographs of selected desmid taxa: A & B, focus–through picture of *Xanthidium bangweuluense* (sample nr. 2012092); C, *Xanthidium sansibarense* (sample nr. 2012073); D–F, *Xanthidium mucronulatum* (sample nr. 2012073); G–L, *Xanthidium longispinum* (sample nr. 2012078). Scale bar represents 50 µm.

We herewith validate the name in question by indicating one of Thomasson's pictures as holotype.

The pictures of our taxon under discussion in Thomasson (1966) are photographs of cells containing remnants of chloroplasts masking possible cell wall sculpture in the centre of the semicells. Yet, there can be hardly any doubt that those pictures refer to the same species as represented in our fig. 4G–L. Not only cell size and outline are in agreement but also the decoration of the lateral sides with a relatively long spine at the apical and basal angles and some 3 or 4 shorter spines in between is similar. Also a subapical row of 2 or 3 prominences mentioned by Thomasson (1966) can be detected (fig. 4L). Finally, Thomasson makes mention of large pores in face view. Those are not to be seen in his pictures as they are masked by chloroplast material but the pictures of our empty semicell show a circle of pits around a slight, central protuberance.

Considering the above-described morphological details we prefer to distinguish this taxon at species level from *Xanthidium decoratum* as described by Fritsch & Rich (1937) from South Africa, a taxon widely spread in Africa and also quite common in our Zambia samples. Semicells in the latter taxon lack the basal and lateral spines so prominent in *X. longispinum*. Moreover, in frontal view they are marked by two transversal series of conspicuous tubercles. Actually, *X. decoratum* has more in common with many *Cosmarium* species than with most *Xanthidium* species, therefore it was renamed as *Cosmarium pseudoxanthidium* by Coesel & Van Geest (2009).

Only a single semicell of *X. longispinum* was encountered in our Zambia material, in sample nr. 2012078.

Xanthidium mucronulatum (Nordst.) Couté & Tell
Figs 2G–I & 4D–F

Taxonomic remarks – *Xanthidium mucronulatum* was originally described as *Arthrodesmus mucronulatus* Nordstedt (Nordstedt 1870) from Brazil. It was characterized by ovate to subhexagonal semicells, the proximal angles being furnished with a short, straight spine, the distal ones being mucronate; as well as by chloroplasts with two pyrenoids. As the name of the genus *Arthrodesmus* Ralfs (1848) appeared to be an illegitimate homonym of the chlorococcalean genus *Arthrodesmus* Ehrenberg (1838), Compère (1976) recombined the species in question to *Staurodesmus mucronulatus* (Nordstedt) Compère. However, the genus *Staurodesmus* formally is characterized by so-called monospinous species, i.e. semicells provided with a single spine per radius (Teiling 1948) whereas semicells of our species under discussion usually are marked by two spines per radius. Therefore, Couté & Tell (1981) recombined it to *Xanthidium mucronulatum* (Nordstedt) Couté & Tell. Obviously, the latter feature was overlooked by Förster (1983) when presenting that same name as a new recombination by himself.

Xanthidium mucronulatum is known as a polymorphic taxon. The number of spines/mucros per semicell is usually four but may range from two to six, and also their length and projection may vary, even within one and the same cell (e.g. Bicudo 1975).

Xanthidium mucronulatum is a predominantly (sub)tropical species widely distributed in both South America and Africa. In our Zambia material it was only incidentally encountered in some samples from Bangweulu swamps in the Mpanta region.

DISCUSSION

Most of the taxa discussed in the present paper belong to the genus *Staurodesmus*. Molecular studies have indicated this genus to be highly polyphyletic. It could be split up into at least four phylogenetic clades, some of them incorporating also species of the genera *Staurastrum* and *Cosmarium* (Gontcharov & Melkonian 2005, 2011). The rather arbitrary delimitation of the traditional, morphology-based genera *Staurastrum* and *Staurodesmus* is also reflected in the present study, in the taxa *Staurodesmus subunguiferus* and *Staurastrum zambiense*. *Staurastrum zambiense* was originally described by Thomasson (1960a) as *Staurodesmus subunguiferus* f. *longiradiatus* and later on (Thomasson 1966) raised to species level: *Staurodesmus longiradiatus*. As argued above, however, the occurrence of granulate cell forms in that latter species formally prevents inclusion of this species in the genus *Staurodesmus*. Yet it is possible, considering their rather similar, peculiar cell shape, that those taxa are closely affiliated which cannot be expressed in the framework of the existing, traditional genera.

Another example of questionable taxonomic classification is found in the species *Xanthidium mucronulatum* which was orginally described as *Arthrodesmus mucronulatus* Nordstedt (Nordstedt 1870). As explained in our discussion on that species, in the first instance it was transferred to the genus *Staurodesmus*, and later on to the genus *Xanthidium*. As classification in that latter genus is not very satisfactory either, Compère (1996) placed it in his newly erected genus *Octacanthium*. However, that genus presumably includes also a number of but little related species, such as *Octacanthium borgei* (Thomasson) Compère which in our opinion most likely has to be considered a biradiate form of *Staurastrum wildemanii* Gutw. (Thomasson 1960a). For pragmatic reasons we prefer to maintain the name of *Xanthidium mucronulatum* but it should be clear that molecular studies are highly desirable to elucidate phylogenetic relationships within this group of taxa. Referring to such studies, it is noteworthy that the species *Xanthidium octocorne* Ralfs, the type species of Compère's genus *Octacanthium*, appears to be closer to a group of *Staurodesmus* species than to traditional *Xanthidium* species such as *X. antilopaeum* Kütz., *X. brebissonii* Ralfs and *X. cristatum* Ralfs (Gontcharov & Melkonian 2011, Šťastný et al. 2013). It would not surprise us if *Xanthidium mucronulatum* also appeared to be related to particular species of *Staurodesmus*, e.g. to our newly described *Staurodesmus bangweuluensis*, both species being characterized by dicentric chloroplasts and only differing in number and projection of their cell wall spines.

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