Henneguya mbakaouensis sp. nov., *Myxobolus nounensis* sp. nov. and *M. hydrocyni* Kostoingue & Toguebaye, 1994, Myxosporea (Myxozoa) parasites of Centropomidae, Cichlidae and Characidae (Teleosts) of the Sanaga basin in Cameroon (Central Africa)

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Summary :

The study of 102 teleost freshwater fishes of Sanaga basin in Cameroon revealed the presence of three myxosporean species, among which two were new. Host fishes were of three families: Centropomidae, Cichlidae and Characidae. New species were identified as *Henneguya mbakaouensis* sp. nov., a gill parasite of *Lates niloticus* and *Myxobolus nounensis* sp. nov. found in the kidney and spleen of *Sarotherodon galilaeus* and *Tilapia mariae*. *Myxobolus hydrocyni* Kostoïngue & Toguebaye, 1994, previously described in Chad, was also found in Cameroon; complementary informations were given on that parasite which seemed to be specific to its host.

KEY WORDS : Myxosporea, *Henneguya*, *Myxobolus*, Fish, Centropomidae, Cichlidae, Characidae, Cameroon, Afrique.

Résumé : *Henneguya mbakaouensis* sp. nov., *Myxobolus nounensis* sp. nov. et *Myxobolus hydrocyni* Kostoingue & Toguebaye, 1994, Myxosporea (Myxozoa) parasites de Centropomidae, Cichlidae et Characidae (Teleosts) du bassin de la Sanaga au Cameroun

L'examen de 102 poissons Téléostéens d'eau douce du bassin de la Sanaga au Cameroun a permis d'identifier trois espèces de myxosporidies, dont deux nouvelles. Les hôtes examinés appartiennent à trois familles : Centropomidae, Cichlidae et Characidae. Les nouvelles espèces sont Henneguya mbakaouensis *n. sp., parasite des branchies de* Lates niloticus *et* Myxobolus nounensis *n. sp., parasite des reins et de la rate de* Sarotherodon galilaeus *et* Tilapia mariae. Myxobolus hydrocyni *Kostoïngue & Toguebaye, 1994, espèce antérieurement décrite au Tchad, a été retrouvée au Cameroun ; des informations complémentaires sont données sur cette myxosporidie qui semble spécifique de son hôte.*

MOTS CLÉS : *Myxosporea*, Henneguya, Myxobolus, *poisson, Centropomidae, Cichlidae, Characidae, Cameroun, Afrique.*

INTRODUCTION

Numerous species of myxosporean have been described throughout the world. According to Lom & Dykova (1992), more than 1,330 species are known. Nevertheless, data available on myxosporidians of african fishes are still less abundant and some descriptions are very incomplete and give no satisfaction. In spite of an increasing interest in Cichlidae rearing in Africa, little is known about their parasites in general and about their myxosporidian parasites in particular. However, some complete works have been realised in this continent: Fomena (1986, 1995), Sakiti (1997) and Kabre (1997). In order to facilitate future descriptions and identifications of species, Fomena & Bouix (1997a) published keys to genera and species of myxosporean parasites of freshwater fishes in Africa. In that important work, 83 species were recorded. A complete list of parasites and their hosts, affected organs, locality (country), references of the descriptions and systematic revision of some species are also given.

Today, myxosporean parasites of freshwater fishes in africa are known to belong to 10 genera: *Thelohanellus* Kudo, 1933; *Myxidium* Buetschli, 1882; *Sphaerospora* Thelohan, 1892; *Myxobilatus* Davis, 1944; *Myxobolus* Buetschli, 1882; *Unicauda* Davis, 1944; *Henneguya* Thelohan, 1892; *Kudoa* Meglitsch, 1947; *Chloromyxum* Mingazzini, 1890 and *Parahenneguya* Sakiti, 1997.

During a general study of myxosporean parasites of freshwater teleosts in Cameroon, we found two new species that are described in the present paper: *Henneguya mbakaouensis* sp. nov., a parasite of *Lates niloticus* (Centropomidae) and *Myxobolus nounensis* sp. nov., a parasite of *Sarotherodon galilaeus* and *Tilapia mariae* (Cichlidae). Complementary data are also given on *Myxobolus hydrocyni* Kostoïngue & Toguebaye, 1994, a gill parasite of *Hydrocynus forskalii* (Characidae).

MATERIALS AND METHODS

The fishes were obtained from the Sanaga basin, precisely from the Mbakaou dam constructed on the river Djerem (Adamoua province) and the Bamendjing dam constructed on the river Noun (West

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province). The catches were made with a casting net or hooks. From January to August 1998, 102 fishes were examined: 10 *Lates niloticus* (Linnaeus, 1762); 10 *Hydrocynus forskalii* (Cuvier, 1819); 10 *Tilapia mariae* (Boulenger, 1899) and 72 *Sarotherodon galilaeus* (Linnaeus, 1758).

Brought alive in the laboratory, host fishes were sacrified and examined. Fins, eyes and scales were examined microscopicaly and with the aide of a stereoscopic microscope. Gills were removed and observed individually. Smears were made on cysts and internal organs such as liver, spleen, kidneys and gonads. These smears were studied with the aide of an objective × 100 of a microscope Olympus CH-2. Measurements were made from at least 40 fresh spores with a micrometer objective. Permanent preparations were fixed with methanol and stained using May-Grünwald-Giemsa method. Micrographs of cysts and spores were taken with a stereoscopic microscope Olympus B-061 and a microscope Olympus CH-2 respectively, with an Olympus microphotography apparatus.

RESULTS

We present here the main features of the three species.

HENNEGUYA MBAKAOUENSIS SP. NOV.
(Figs 1-2, 8)

Cysts: whitish, ovoid or subspherical, lying parallel to the long axis of the primary gill filament (Fig. 1) and measuring 120-470 × 60-230 µm, polysporous. The location of cysts is variable along the gill filament and cysts of different size can be observed on the same gill arch (Fig. 1). An individuel host fish can carry up to 30 cysts.

Spores: mature spores are long (mean length: 61.8 µm). The spore body is ovoid or subspherical, widest towards the posterior end of polar capsules (Figs 2, 8). In side view, spores are fusiform. Shell valves are thin and smooth. Caudal process are thin, equal in size and separated along their entire length (Figs 2, 8). Remarkably long, the caudal expansions represent 4/5 of the total length of the spore. Polar capsules are pyriform, convergent and equal (Fig. 2). They fill more than 1/3 of the spore cavity. Polar filaments are coiled in four to five spirals lying perpendicular to the long axis (Fig. 8). The rest of the spore cavity is filled with the sporoplasm.

Measurements: see Table I.

Type host: *Lates niloticus* (Linnaeus, 1758) (Centropomidae).

Locality: Mbakaou dam, on the river Djerem (Adamoua province).

Location: gills.

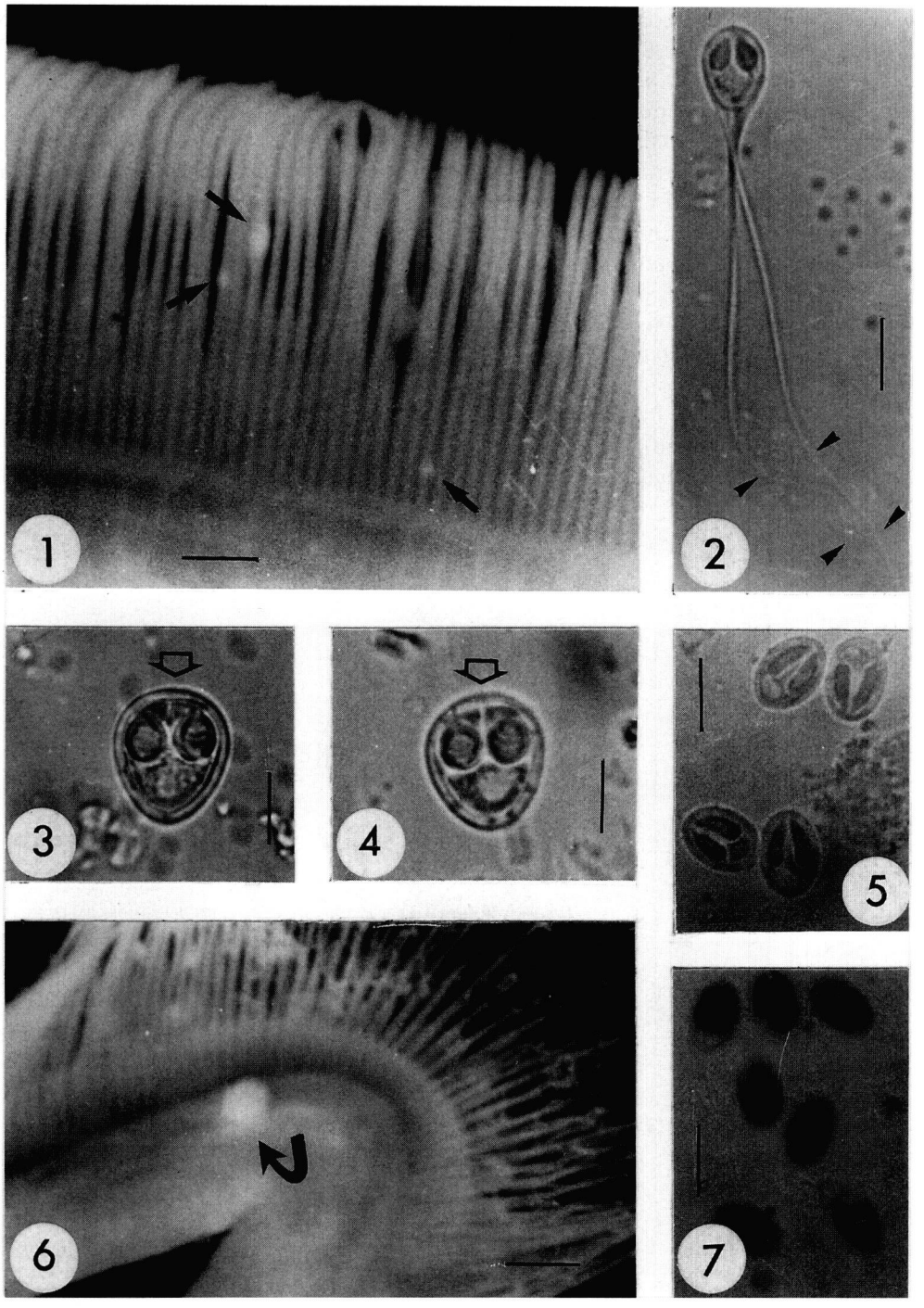
Prevalence: 100 % (all the fishes examined are parasitized).

Discussion: two species of *Henneguya* are reported in fishes of the genus *Lates*. In India, Tripathi (1951) described *Henneguya latesi* in *Lates calcarifer*. The species differs from our parasite by its shorter spores (26,2-36,2 µm). Paperna (1973) found an *Henneguya* in the gills of *Lates albertianus* in Uganda. Nevertheless, no description was given to that parasite. Mor-

	***Henneguya mbakaouensis* sp. n.**	***Myxobolus nounensis* sp. n.**	***Myxobolus hydrocyni* Kostoïngue & Toguebaye, 1994**
Length of spore (or spore body) (L)	10.8 ± 0.1 (10-12) µm	14.3 ± 0.2 (13-15) µm	9.4 ± 0.1 (8.6-10.2) µm
Width of spore (W)	7.5 ± 0.4 (7-9.9) µm	12.8 ± 0.3 (11.5-14) µm	6.6 ± 0.1 (5.8-7.3) µm
Thickness of spore	5.0 ± 0.04 (4.8-5.2) µm	–	–
L/W	1.4	1.1	1.42
Length of polar capsule (L')	4.0 ± 0.1 (3.5-4.7) µm	5.8 ± 0.1 (5-6.5) µm	5.1 ± 0.1 (4.3-6.1) µm
Width of polar capsule (W')	2.5 ± 0.1 (2-3) µm	4.5 ± 0.2 (4-5) µm	1.8 ± 0.05 (1.4-2) µm
L'/W'	1.6	1.3	2.8
L'/W	0.37	0.4	0.54
Number of coils in polar capsule	4-5	4-5	10-13
Length of caudal processes	50.9 ± 1.4 (40-59) µm	–	–
Total length of spore	61.8 ± 1.3 (51.5-69.2) µm	–	–

Mean values are given with range within parentheses; ± : standard deviation.

Table I. – Measurements in the spores of different species studied.



Figs 1-7. – Cysts and spores of different species studied.
1-2. *Henneguya mbakaouensis* sp. nov. (1) Cysts on gill filaments (arrows). Scale: 800 µm. (2) Fresh spore; caudal expansions are long and thin (arrows). Scale: 8 µm.
3-4. Spores of *Myxobolus nounensis* sp. nov. (3) Intercapsular appendage (arrow). Scale: 8 µm. (4) Intercapsular appendage (arrow) and iodinophilous vacuole in the sporoplasm. Scale: 8 µm.
5-7. *Myxobolus hydrocyni*. (5) Fresh spores. Scale: 8 µm. (6) Cyst located in connective tissue of the gill arch (arrow). Scale 1,600 µm. (7) Stained spores (May-Grünwald-Giemsa). Scale: 8 µm.

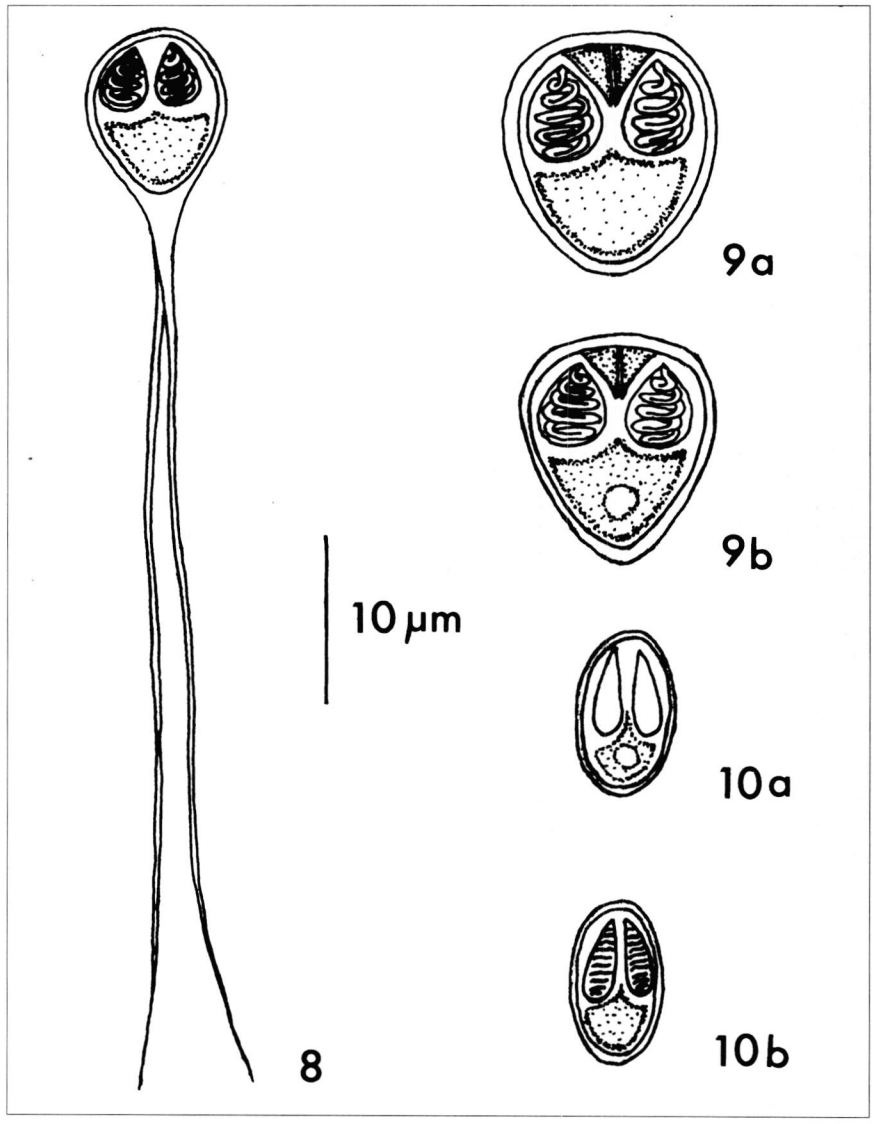
phology and size of spore body bring together the present parasite and *Henneguya zschokkei* (Gurley, 1894), a parasite of Salmonid fishes. In spite of these similarities, *H. zschokkei* has shorter caudal process (26-40 µm). *Henneguya* sp.1 Fomena & Bouix, 1987 is a gill parasite of *Ctenopoma maculatum* (Anabantidae) in Cameroon. Its caudal processes are long and thin but they are still shorter compared to those of the presently described species (26-43 µm). *Henneguya clariae* Abolarin, 1971, a gill parasite of *Clarias lazera* in Nigeria, differs from our species in numerous aspects: longer spore body (mean length: 22 µm), anterior end of the spore narrower; total length of the spore (mean: 88µm). *Henneguya malapteruri* Fomena & Bouix, 1997 is a gill and muscle parasite of *Malapterurus electricus* (Malapteruridae) in Cameroon (Fomena & Bouix, 1997b). This species differs with the following characteristics: longer spore body (14-18 µm), shorter caudal processes (24-36,5 µm) bearing a characteristic bulge at their base. Last, following species described in african fishes differ from the parasite of *L. niloticus*: *Henneguya bopeleti* Fomena & Bouix, 1987; *H. odzai* Fomena & Bouix, 1996; *H. nyongensis* Fomena & Bouix, 1996; *H. somahiensis* Sakiti, 1997; *H. diensis* Kabre, 1998.

The parasite of *L. niloticus* is considered to be new and the name of *Henneguya mbakaouensis* sp.nov. is proposed, referring to the Mbakaou dam where host fishes are captured.

MYXOBOLUS NOUNENSIS SP. NOV.
(Figs 3-4, 9)

Cysts: cysts were not observed; mature spores were seen in melano-macrophage centers of spleen and kidneys, dispersed throughout the tissue.

Spores: subspherical in front view, with a flattened anterior end, wider than the posterior end (Figs 3, 4



Figs 8-10. – Spores of myxosporean studied (for all, scale: 10 µm).
8 *Henneguya mbakaouensis* sp. nov. The spore body is subspherical; caudal expansions are thin and long.
9 *Myxobolus nounensis* sp. nov. (a) Note the presence of an intercapsular appendage. (b) Posterior end of some spores is narrow; note the presence of iodinophilous vacuole in the sporoplasm.
10 *Myxobolus hydrocyni.* (a) Observe the polar capsules and the iodinophilous vacuole. (b) Polar filament displays ten coils or more in each polar capsule.

and 9). The larger diameter can be obtained at the anterior 1/3 of the spore (Fig. 9a).

Shell valves are ovoid, of equal size and well developed. They are no convergent, each terminating approximately 2-3 µm from the center of the anterior end of the spore (Figs 3, 9a). A triangular and well developed intercapsular appendage is present, with a base ranging from 4,2 to 6 µm long (Fig. 9). This particular appendix is made up with two symetric triangular appendage which are not completely fused so that one can see a space between the two (Figs 4, 9a). In each polar capsule, there are four to five loosely arranged coils of the polar filament, lying perpendicularly to the great axis (Fig. 9a). The polar capsules occupy more than 1/3 of the spore cavity. A triangular-like sporoplasm contain an iodophilous vacuole (Fig. 9b).

Measurements: see Table I.

Type host: *Sarotherodon galilaeus* (Linnaeus, 1758) and *Tilapia mariae* (Boulenger, 1899) (Cichlidae).

Locality: Bamendjing dam on the river Noun (West province).

Location: kidney and spleen.

Prevalence: 12.2 % (10 parasitized fishes out of 82 observed). A prevalence of 9.7 % was obtained with *S. galilaeus* (seven affected fishes out of 72 observed). With *T. mariae*, three individual hosts harboured the parasite out of 10 examined (prevalence: 30 %). The same individual host can carry the parasite either in the spleen or in the kidney, sometimes in both organs.

Discussion: comparisons can be made beetween the parasite of the cameroonian Cichlidae and other species which present spores with broader anterior end. *Myxobolus nilei* Fomena & Bouix, 1997 develops macroscopic and microscopic cysts in various organs such as gills, eyes, skin, spleen and kidney of *Oreochromis niloticus* in Egypt. Despite similarities with spore shape, host family (Cichlidae), location in host, *M. nilei* differs with the following aspects: spore smaller in size (12.3 × 8.2 µm), intercapsular appendage absent, polar capsules convergent, coils of polar filament lying obliquely. Despite the presence of a triangular intercapsular appendage, *Myxobolus dossoui* Sakiti *et al.*, 1991, a parasite of various Cichlidae in Benin, shows inegal polar capsules. Widespread in kidney and spleen of african fishes (Landsberg, 1985; Obiekezie & Okaeme, 1990; Fomena, 1995; Kabre, 1997), *Myxobolus sarigi* is found in numerous Cichlidae: *Oreochromis niloticus*, *O. galilaeus*, *O. niloticus* x *O. galilaeus* hybrid, *O. aureus* x *O. niloticus* hybrid. In spite of large and flattened anterior end of its spores, they are smaller in size (6.9-9.6 µm in width) and intercapsular appendage is absent. Sakiti (1997) described *Myxobolus coupei*, a gill parasite of *Pagrus coupei* captured in Guinea bay (Atlantic Ocean). Despite of the morphology of spores and the presence of an intercapsular appendage, its spores are smaller in size (7-8.5 × 4.5-5.5 µm). *Myxobolus sphaerocapsulata* Shulman, 1962 develop cysts in muscles of *Acheilognathus chankaensis* in China. Spores are ovoid with a flattened anterior end and an intercapsular appendage; however, they are longer (17-18µm) with polar capsules larger (7-8 × 5-6.5 µm) and contain 14 coils of polar filament.

The myxosporidia of *S. galilaeus* and *T. mariae* is new and we propose the name *Myxobolus nounensis* sp.nov., referring to the river Noun where fishes were captured.

MYXOBOLUS HYDROCYNI KOSTOINGUE & TOGUEBAYE, 1994
(Figs 5-7, 10)

Cysts: whitish-coloured, subspherical and polysporous. They were preferentialy located in the connective tissue of the gill arch (Fig. 6). Cysts were also found in the gill arch. Some were macroscopic and measured from 0.5 to 1 mm in diameter. In affected hosts, gills arches were observed to carry only one cyst each.

Spore: small (10.2 µm in maximal length). They are ellipsoidal with anterior end as wide as posterior end (Figs 5, 10). Shell valves are thin and smooth. Polar capsules are pyriform and equal. They are elongated (ratio length/width: 2.8) and reach the posterior half of the spore cavity (Fig. 10). In each capsule, polar filament display about 10 coils lying perpendicularly (Fig. 10b). In stained spores, the sporoplasm appears granular and contains a spherical iodinophilous vacuole (Figs 7, 10a).

Measurements: see Table I.

Type host: *Hydrocynus forskalii* (Cuvier, 1819) (Characidae).

Locality: Mbakaou dam on the river Djerem (Adamoua province).

Location: gills.

Prevalence: 50 % (five parasitized fishes out of 10 examined).

Discussion: Fomena *et al.* (1985) described *Myxobolus amieti*, a parasite forming cysts in gills, eyes, jaws, spleen and general cavity of *Ctenopoma nanum* (Anabantidae) in Cameroon. In spite of the morphology of spores and polar capsules, *M. amieti* differs from the parasite of *H. forskalii* by the following characteristics: spore longer (14.06 µm), polar capsule longer ((6-10 µm) and thinner (ratio length/width: 4.4), three threads of polar filament lying obliquely. *Myxobolus kingsleyae* Sakiti, 1997 is found in cartilaginous and connective tissues of gill arches of *Ctenopoma kingsleyae* in Benin. This species differs in forming spores with broader anterior end, its capsules containing five coils of polar filament, its host belonging to the Anabantidae family.

In 1994, Kostoïngue & Toguebaye described *Myxobolus hydrocyni*, a parasite that develop numerous cysts in gills of *Hydrocynus forskalii* at Mailao in Chad. Spores described in Chad are longer (13.78 × 8.56 µm), polar capsules are larger (2.31 µm). Despite slight differences in measurements, the present species is referred to *Myxobolus hydrocyni* on account of morphology of spores, host fish and location on host. Then *M. hydrocyni* shows a great variability in spore size (8.6-14 × 5.8-10 µm). In its diagnosis, we should add that polar filament displays about 10 coils in polar capsule, characteristic not mentioned in original description. Present in Chad and Cameroon, this myxosporidia seems to be widespread in Africa since its host fish is found in west, north and central parts of the continent. Moreover, the parasite seems to be specific to its host.

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