Henneguya logonensis Kostoïngué, Diebakate, Faye et Toguebaye, 2001 in the primary gill lamellae of ***Citharinus citharus*** (Chad)

Henneguya mailaoensis Kostoïngué, Diebakate, Faye et Toguebaye, 2001 in the primary gill lamellae of ***Mormyrus caschive*** (Chad)

Henneguya malapteruri Fomena et Bouix, 1996 in the skin and muscles of ***Malapterurus electricus*** (Cameroon)

Henneguya mandouri Rabie, Mohammed, Hussein et Hussein, 2009 in the middle and base of gill filaments of ***Lates niloticus*** (Egypt)

Henneguya maraensis Kostoïngué, 1997 in the gills and intestine of ***Lates niloticus*** (Chad)

Henneguya massii Kostoïngué, Diebakate, Faye et Toguebaye, 2001 in the primary gill lamellae of ***Lates niloticus*** (Chad)

Henneguya mbakaouensis Fomena et Bouix, 2000 in the gills of ***Lates niloticus*** (Cameroon)

Henneguya mormyri Kostoïngué, Diebakate, Faye et Toguebaye, 2001 in the primary gill lamellae of ***Mormyrus caschive*** (Chad)

Henneguya nkamensis Fomena, Folefack et Bouix, 2008 in the secondary gill lamellae of ***Hepsetus odoe*** (Cameroon)

Henneguya ntemensis Fomena et Bouix, 1996 in the gall bladder, kidney and spleen of ***Brienomyrus brachyistius*** (Cameroon)

Henneguya ntondei Fomena, Folefack et Bouix, 2008 in the secondary gill lamellae of ***Schilbe mystus*** (Cameroon)

Henneguya nyongensis Fomena et Bouix, 1996 in the gills and muscles of ***Marcusenius moorii*** (Cameroon)

Henneguya odzai Fomena et Bouix, 1996 in the gills of *Brevimyrus niger*, *Hyperopisus bebe*, ***Marcusenius moorii*** (Cameroon), *M. senegalensis*, *Mormyrus rume*

Henneguya pethericii Fomena, Folefack et Bouix, 2008 in the secondary gill lamellae of ***Ctenopoma petherici*** (Cameroon)

Henneguya samochimensis Reed, Basson et Van As, 2003 in the primary gill filaments of ***Clarias gariepinus*** (Botswana)

Henneguya sarotherodoni Fall, Fomena, Kostoïngué, Diebakate, Faye et Toguebaye, 2000 in the intestine of ***Sarotherodon galilaeus*** (Chad)

Henneguya somahiensis Sakiti, 1997 in the gills of ***Ctenopoma kingsleyae*** (Benin)

Henneguya suprabranchiae Landsberg, 1987 in the accessory breathing organ of *Clarias anguillaris*, ***C. gariepinus***, *Oreochromis niloticus*

Myxobolus Bütschli, 1882

Myxobolus africanus Fomena, Bouix et Birgi, 1989 in the brain, gill adductor muscle, muscles of the operculum, bile duct and gall bladder wall of ***Hepsetus odoe*** (Cameroon)

Myxobolus agolus Landsberg, 1985 [syn. *Myxobolus melenensis* Fomena, Bouix et Birgi, 1985] in the kidney, spleen and gills of *Coptodon guineensis*, *Hemichromis fasciatus*, *Oreochromis niloticus*, *Sarotherodon galilaeus*

Myxobolus amieti Fomena, Bouix et Birgi, 1989 in the gills, eye, superficial mandibular muscles, muscles of the operculum and pharyngeal wall and connective tissue covering the gill arches of ***Microctenopoma nanum*** (Cameroon)

Myxobolus bagri Negm-Eldin, Govedich et Davies, 1999 in the gills of ***Bagrus bajad*** (Egypt)

Myxobolus beninensis Sakiti, Blanc, Marquès et Bouix, 1991 in the gills of ***Sarotherodon melanotheron*** (Benin)

Myxobolus bilongi Fomena, Marquès, Bouix et Njiné, 1994 in the gills and fins of ***Labeo* sp.** (Cameroon)

Myxobolus bizerti Bahri et Marquès, 1996 in the gills of ***Mugil cephalus*** (Tunisia)

Myxobolus bouixi Fomena, Folefack et Tang, 2007 in the gills of ***Chrysichthys nigrodigitatus*** (Cameroon)

Myxobolus brachysporus (Baker, 1963) in the spleen and kidney of *Coptodon guineensis*, ***Oreochromis esculentus*** (Uganda), *O. niloticus*, *O. niloticus* × *S. galilaeus*, *O. variabilis*, *Sarotherodon galilaeus*

Myxobolus branchiophilus Abdel-Ghaffar, El-Toukhy, Al-Quarishy, Al-Rashid, Abdel-Baki, Hegazy et Bashtar, 2008 in the gill filaments of ***Oreochromis niloticus*** (Egypt)

Myxobolus burkinei Kabré, 1995 in the gills and fins of ***Labeo coubie*** (Burkina Faso)

Myxobolus camerounensis Fomena, Marquès et Bouix, 1993 in the gills, eyes and muscles of ***Oreochromis niloticus*** (Cameroon)

Myxobolus caudatus Ali, Al-Rasheid, Sakran, Abdel-Baki et Abdel-Ghaffar, 2002 in the tail and fins of ***Labeobarbus bynni*** (Egypt)

Myxobolus charii Fomena, 2004 in the skin of ***Citharinus citharus*** (Chad)

Myxobolus chrysichthyi Negm-Eldin, Govedich et Davies, 1999 in the gills of ***Chrysichthys auratus*** (Egypt)

Myxobolus clarias Negm-Eldin, Govedich et Davies, 1999 in the gills of ***Chrysichthys auratus*** (Egypt)

Myxobolus comoei Kabre, Sakiti, Marquès et Sawadogo, 1995 in the fins and gills of ***Clarias anguillaris*** (Burkina Faso)

Myxobolus dahomeyensis (Siau, 1971) in the ovaries of *Coptodon zillii*, *Oreochromis niloticus*, *O. mossambicus* × *O. niloticus*, *Sarotherodon melanotheron*, ***Synodontis ansorgii*** (Benin)

Myxobolus diamaensis Diamanka, Faye, Fall et Toguebaye, 2007 in the gill filaments of ***Sarotherodon melanotheron*** (Senegal)

Myxobolus distichodi Kostoingué et Toguebaye, 1994 in the gills, intestine and liver of ***Distichodus engycephalus*** (Chad)

Myxobolus djoudjensis Diamanka, Faye, Fall et Toguebaye, 2007 in the ovaries of ***Coptodon guineensis*** (Senegal)

Myxobolus dossoui Sakiti, Blanc, Marquès et Bouix, 1991 in the gill arches and cartilage of ***Coptodon zillii*** (Benin), *Hemichromis fasciatus*, *Oreochromis mossambicus* x *O. niloticus*

Myxobolus egypticus (Ali, Al-Rasheid, Sakran, Abdel-Baki et Abdel-Ghaffar, 2002) [syn. *M. intestinalis* Ali, Al-Rasheid, Sakran, Abdel-Baki et Abdel-Ghaffar, 2002] in the intestine of ***Labeobarbus bynni*** (Egypt)

Myxobolus equatorialis (Landsberg, 1985) in the spleen and kidney of *Coptodon guineensis, Oreochromis niloticus*, *Sarotherodon galilaeus*

Myxobolus etsataensis Reed, Basson et Van As, 2002 in the gills of ***Enteromius thamalakanensis*** (Botswana)

Myxobolus exiguous Thélohan, 1895 in the scales of *Chelon aurata*, *Mugil cephalus*

Myxobolus fahmii Ali, Al-Rasheid, Sakran, Abdel-Baki et Abdel-Ghaffar, 2002 in the gills of ***Labeobarbus bynni*** (Egypt)

Myxobolus fobobi (Fomena, 1985) [syn. *Myxobolus barbi* Fomena, 1985] in the gills of ***Enteromius aspilus*** (Cameroon), *E. camptacanthus*, *E. jae*, *E. guirali*, *E. martorelli*

Myxobolus fomenai Abdel-Ghaffar, El-Toukhy, Al-Quarishy, Al-Rashid, Abdel-Baki, Hegazy et Bashtar, 2008 in the muscles, intestine and kidney of ***Oreochromis niloticus*** (Egypt)

Myxobolus fotoi Fomena, Marquès and Bouix, 1993 in the gills of ***Oreochromis niloticus*** (Cameroon)

Myxobolus galilaeus Landsberg, 1985 in the kidney, spleen, eyes, gills and intestine of *Coptodon guineensis*, *Oreochromis niloticus*, *O. niloticus* × *S. galilaeus*, ***Sarotherodon galilaeus***

Myxobolus gandiolensis Fall, Fomena, Kostoïngué, Diebakate, Faye et Toguebaye, 2000 in the kidney of ***Coptodon guineensis*** (Senegal)

Myxobolus gariepinus Reed, Basson et Van As, 2003 in the ovaries of ***Clarias gariepinus*** (Botswana)

Myxobolus heterosporus (Baker, 1963) [syn. *Myxosoma heterospora* Baker, 1963] in the kidney, liver, spleen, gills, intestine and gall bladder of *Coptodon zillii*, *Hemichromis fasciatus, Oreochromis niloticus*, *Sarotherodon melanotheron*

Myxobolus heterotisi Bongou, Kabré, Sakiti, Marquès et Sawadogo, 2006 in the primary gill filaments of ***Heterotis niloticus*** (Burkina Faso)

Myxobolus homeosporus (Baker, 1963) in the muscles and cornea of *Coptodon zillii*, ***Oreochromis esculentus*** (Uganda), *O. niloticus*, *O. variabilis*, *Sarotherodon galilaeus*

Myxobolus hydrocyni Kostoïngué et Toguebaye, 1994 in the gills of ***Hydrocynus forskahlii*** (Chad)

Myxobolus imami Ali, Al-Rasheid, Sakran, Abdel-Baki et Abdel-Ghaffar, 2002 in the kidney of ***Labeo niloticus*** (Egypt), *Labeobarbus bynni*

Myxobolus israelensis Landsberg, 1985 in the kidney, spleen and gills of *Coptodon cameronensis*, *C. guineensis*, *Oreochromis niloticus*, ***O. niloticus* × *O. aureus***, *Sarotherodon galilaeus*, *S. mvogoi*

Myxobolus kainjiae (Obiekezie et Okaeme, 1990) [syn. *M. ovariae* Paperna, 1973] in the ovaries and urinary bladder of *Coptodon nyongana*, ***Haplochromis angustifrons*** (Uganda), *H. elegans*, *Oreochromis niloticus*, *Sarotherodon galilaeus*

Myxobolus kouoptamoensis Nchoutpouen et Fomena, 2011 in the gills, spleen and kidney of ***Labeo parvus*** (Cameroon)

Myxobolus kribiensis Fomena et Bouix, 1994 in the skin, eye sclera and kidney of ***Brycinus longipinnis*** (Cameroon)

Myxobolus labeoi Boungou, Kabré, Sakiti, Marquès et Sawadogo, 2006 in the fin rays of ***Labeo coubie*** (Burkina Faso)

Myxobolus labiae Negm-Eldin, Govedich et Davies, 1999 in the gills of ***Labeo niloticus*** (Egypt)

Myxobolus latesi Kostoïngué et Toguebaye, 1994 in the gills and intestine of ***Lates niloticus*** (Chad)

Myxobolus latis Negm-Eldin, Govedich et Davies, 1999 in the gills of ***Lates niloticus*** (Egypt)

Myxobolus lazera (Mandour, Galal et Abed, 1993) [syn. *M. clarii* Mandour, Galal et Abed, 1993] in the testes of ***Clarias gariepinus*** (Egypt)

Myxobolus mbailaoi Fomena, 2004 in the operculum, skin and intestine of ***Citharinus citharus*** (Chad)

Myxobolus naffari Ghaffar, Ibrahiem, Bashtar et Ali, 1998 in the gills of ***Labeo niloticus*** (Egypt) and *Labeobarbus bynni*

Myxobolus nchoutnounensis Nchoutpouen et Fomena, 2011 in the gills, scales, liver, fins, spleen, kidney and eyes of ***Labeo parvus*** (Cameroon)

Myxobolus negmgoda (Negm-Eldin, Govedich et Davies, 1999) [syn. *M. synodontis* Negm-Eldin, Govedich et Davies, 1999] in the gills of ***Synodontis schall*** (Egypt)

Myxobolus ngassami Lekeufack Folefack, Defoueng et Fomena 2017 in the fins, operculum, skin and sclera of the eye of ***Enteromius callipterus*** (Cameroon)

Myxobolus nilei (Faisal et Shalaby, 1987) [syn. *Myxosoma tilapiae* Faisal et Shalaby, 1987] in the gills, skin, eyes, kidney and pancreas of ***Oreochromis niloticus*** (Egypt)

Myxobolus niloticus Fahmy, Mandour et El-Naffar, 1971 in the tail fin rays and operculum of ***Labeo niloticus*** (Egypt)

Myxobolus njinei Fomena, Bouix et Birgi, 1985 in the gill arch of ***Enteromius camptacanthus*** (Cameroon), *E. guirali*, *E. martorelli*

Myxobolus njoyai Nchoutpouen et Fomena, 2011 in the gills, scales, fins, spleen and kidney of ***Labeo parvus*** (Cameroon)

Myxobolus nkolyaensis Fomena et Bouix, 1994 in the gills and caudal muscles of ***Enteromius jae*** (Cameroon)

Myxobolus nokoueensis Sakiti, 1991 in the gills of ***Sarotherodon melanotheron*** (Benin)

Myxobolus nounensis Fomena et Bouix, 2000 in the kidney and spleen of ***Sarotherodon galilaeus*** (Cameroon)

Myxobolus nyongana (Fomena, Bouix et Birgi, 1985) [syn. *Myxobolus barbi* Fomena, Bouix et Birgi, 1985] in the gills and eyes of *Alestes dentex*, *Enteromius aspilus*, *E. camptacanthus*, *E. guirali*, ***E. jae*** (Cameroon), *E. martorelli*, *Labeo parvus*, *Sarotherodon melanotheron*

Myxobolus occularis Abu-El-Wafa, 1988 in the eyes of ***Tilapia* sp.** (Egypt)

Myxobolus oloi Fomena et Bouix, 1994 in the gill arch epithelium, kidney and heart of ***Enteromius aspilus*** (Cameroon), *E. camptacanthus*, *E. guirali, E. martorelli*

Myxobolus ovoidalis Fantham, 1930 in the subcutaneous tissue of *Barbus* sp., ***Cyprinus carpio*** (South Africa), *Salvelinus fontinalis*

Myxobolus paludinosus Reed, Basson et Van As, 2002 in the gills of ***Enteromius paludinosus*** (Botswana)

Myxobolus perforata Ali, Al-Rasheid, Sakran, Abdel-Baki et Abdel-Ghaffar, 2002 in the internal surface of operculum of ***Hydrocynus forskahlii*** (Egypt)

Myxobolus pethericii Fomena, Folefack et Tang, 2007 in the gills, fins, stomach wall, liver, small intestine, operculum and kidney of ***Ctenopoma petherici*** (Cameroon)

Myxobolus polycentropsi Fomena, Bouix et Birgi 1985 [syn. *M. microcapsularis* Sakiti, Blanc, Marquès et Bouix, 1991] in the gills arch cartilage of ***Polycentropsis abbreviata*** (Cameroon), *Coptodon zillii*

Myxobolus saintlouisiensis Diamanka, Faye, Fall et Toguebaye, 2007 in the gill filaments of ***Oreochromis niloticus*** (Senegal)

Myxobolus sanagaensis Lekeufack Folefack, Defoueng et Fomena 2017 in the heart auricles of ***Enteromius callipterus*** (Cameroon)

Myxobolus sangei Fomena, Folefack et Tang, 2007 in the gills, skin, kidney of ***Brycinus macrolepidotus*** (Cameroon)

Myxobolus sarigi (Landsberg, 1985) in the kidney and spleen of *Coptodon margaritacea*, *C. guineensis*, *Oreochromis niloticus*, *O. niloticus* × *Sarotherodon galilaeus*, *S. galilaeus*

Myxobolus sarotherodoni Sakiti, Blanc, Marquès et Bouix, 1991 in the gills of ***Sarotherodon melanotheron*** (Benin)

Myxobolus sessabai Lekeufack Folefack, Defoueng et Fomena, 2017 in the skin of ***Enteromius callipterus*** (Cameroon)

Myxobolus sheroidalis Abu-El-Wafa, 1988 in the viscera of *Clarias* sp., ***Tilapia* sp.** (Egypt)

Myxobolus sourouensis Bongou, Kabré, Sakiti, Marquès et Sawadogo, 2006 in the primary gill filaments of ***Heterotis niloticus*** (Burkina Faso)

Myxobolus stenosus Paperna, 1973 in the gills and kidney of *Synodontis clarias*, ***S. schall*** (Uganda)

Myxobolus synodonti Fomena, Bouix et Birgi, 1985 in the stomach wall of ***Synodontis batesii*** (Cameroon)

Myxobolus tilapiae Abolarin, 1974 in the buccal cavity, gills, fins, kidney and spleen of *Coptodon margaritacea*, *C. rendalli*, *C. zillii*, ***Oreochromis niloticus*** (Nigeria), *Sarotherodon galilaeus*, *S. mvogoi*

Myxobolus tingrelaensi Bongou, Kabré, Sakiti, Marquès et Sawadogo, 2006 in the fin rays of ***Sarotherodon galilaeus*** (Burkina Faso)

Myxobolus zillii Sakiti, Blanc, Marquès et Bouix, 1991 [syn. *Myxobolus latesi* Kostoïngué et Toguebaye 1994] in the gills and intestine of ***C. zillii*** (Benin), *Lates niloticus*

Thelohanellus Kudo, 1933

Thelohanellus assambai Fomena, Marquès, Bouix et Njine, 1994 in the gills and fins of ***Labeo* sp.** (Cameroon)

Thelohanellus bicornei Kabre, Sakiti, Marquès et Sawadogo, 2002 in the gills of ***Labeo coubie*** (Burkina Faso)

Thelohanellus citharini Kostoïngué, Fall, Faye et Toguebaye, 1999 in the heart of ***Citharinus citharus*** (Chad)

Thelohanellus costeae Sakiti, 1997 in the gills of ***Labeo senegalensis*** (Benin)

Thelohanellus lagdoensis Fomena, Farikou-Oumarou, Tang et Bouix, 2007 in from the intestine of ***Citharinus citharus*** (Cameroon)

Thelohanellus ndjamenaensis Kostoïngué, Fall, Faye et Toguebaye, 1999 in the gills of ***Labeo parvus*** (Chad)

Thelohanellus niloticus Abdel-Ghaffar, Morsy, Bashtar, El-Ganainy et Gamal, 2013 [syn. *Myxobolus unicapsulatus* Gurley, 1893] in the gills of ***Labeo niloticus*** (Egypt)

Thelohanellus njinei Fomena, Farikou-Oumarou, Tang et Bouix, 2007 in the intestine of ***Schilbe mystus*** (Cameroon)

Thelohanellus rhabdalestus Azevedo, Samuel, Saveia, Delgado et Casal, 2011 in the liver and heart of ***Rhabdalestes maunensis*** (Angola)

Thelohanellus sanagaensis Fomena, Marquès, Bouix et Njine, 1994 in the gills and fins of ***Labeo* sp.** (Cameroon)

Thelohanellus taguii Fomena, Abakar-Ousman, Ngassam et Bouix, 2004 in the gills, liver, opercular muscles and intestine of ***Citharinus citharus*** (Chad)

Thelohanellus valeti Fomena et Bouix, 1987 in the stomach wall, gill filaments, muscles and operculum of *Enteromius aspilus*, ***E. jae*** (Cameroon), *Oreochromis niloticus*

Unicauda Davis, 1944

Unicauda strongylura (Gurley, 1893) [syn. *Henneguya strongylura* (Gurey, 1893) Labbé, 1899] in the tissues of ***Synodontis schall*** (Egypt)

VARIISPORINA Lom et Noble, 1984

Chloromyxum Mingazzini, 1890

Chloromyxum alii Abdel-Baki, 2007 in the gall bladder of ***Schilbe mystus*** (Egypt)

Chloromyxum birgii Fomena et Bouix, 1994 in the gall bladder of *Amphilius longirostris*, *Enteromius aspilus*, ***E. martorelli*** (Cameroon)

Chloromyxum vanasi Ali, 1998 in the gall bladder of ***Bagrus bajad*** (Egypt)

Hoferellus Berg, 1898

Hoferellus gnathonemi Alama-Bermejo, Jirků, Kodádková, Pecková, Fiala et Holzer, 2016 in the kidney of ***Gnathonemus petersii*** (Nigeria)

Myxidium Bütschli, 1882

Myxidium beninensis Sakiti, 1997 in the gall bladder of *Chrysichthys auratus*, ***C. nigrodigitatus*** (Benin)

Myxidium birgii Fomena et Bouix, 1986 in the gall bladder of ***Aphyosemion bivittatum*** (Cameroon)

Myxidium bouixi Siau, 1971 in the gall bladder of ***Synodontis ansorgii*** (Benin)

Myxidium brienomyri Fomena et Bouix, 1986 in the gall bladder of ***Brienomyrus brachyistius*** (Cameroon)

Myxidium camerounense Fomena et Bouix, 1986 in the gall bladder of ***Neolebias ansorgii*** (Cameroon)

Myxidium distichodi Kostoïngué, Faye et Toguebaye, 1998 in the gall bladder of ***Distichodus engycephalus*** (Chad), *Parachanna obscura*

Myxidium latesi Kostoïngué, Faye et Toguebaye, 1998 in the gall bladder of ***Lates niloticus*** (Chad)

Myxidium mendehi Fomena et Bouix, 1994 in the kidney of ***Enteromius guirali*** (Cameroon), *E. martorelli*

Myxidium nkamense Fomena, Folefack et Bouix, 2010 in the gall bladder of ***Clarias pachynema*** (Cameroon)

Myxidium nyongense Fomena et Bouix, 1986 in the gall bladder of *Enteromius aspilus*, *E. camptacanthus*, *E. guirali*, ***E. jae*** (Cameroon), *E. martorelli*

Myxidium parachannae Sakiti, 1997 in the gall bladder of ***Parachanna obscura*** (Benin)

Myxidium petrocephali Fomena et Bouix, 1986 in the gall bladder of *Ctenopoma petherici*, ***Petrocephalus simus*** (Cameroon)

Myxidium sangei Fomena, Folefack et Bouix, 2010 in the gall bladder of ***Parachanna obscura*** (Cameroon)

Myxidium schalli Abdel Ghaffar, El-Shahawi et Naas, 1995 in the gall bladder of ***Synodontis schall*** (Egypt)

Myxidium schilba Ali, Sakran et Abdel-Baki, 1999 in the gall bladder of ***Schilbe mystus*** (Egypt)

Myxidium shamama Ali, Sakran et Abdel-Baki, 1999 in the kidney of ***Labeo niloticus*** (Egypt)

Myxobilatus Davis, 1944

Myxobilatus accessobranchialis Obiekezie et Okaeme, 1987 in the accessory breathing organs of ***Heterobranchus bidorsalis*** (Nigeria)

Myxobilatus synodontis Siau, 1971 in the gills of ***Synodontis ansorgii*** (Benin)

Ortholinea Shulman, 1962

Ortholinea africanus Abdel-Ghaffar, El-Toukhy, Al-Quraishy, Al-Rasheid, Abdel-Baki, Hegazy et Bashtar, 2008 in the urinary bladder of ***Oreochromis niloticus*** (Egypt)

Sphaerospora Thélohan, 1892

Sphaerospora melenensis Fomena, Marquès et Bouix, 1993 in the kidney of ***Oreochromis niloticus***

Sphaerospora sangmelimaensis Fomena, Marquès et Bouix, 1993 in the kidney of ***Brienomyrus brachyistius*** (Cameroon), *Hepsetus odoe*, *Petrocephalus simus*

Sphaerospora tilapiae Fomena, Marquès et Bouix, 1993 in the kidney and spleen of ***Oreochromis niloticus*** (Cameroon)

Triangula Chen et Hsieh, 1984

Triangula egyptica Abdel-Ghaffar, El-Toukhy, Al-Quraishy, Al-Rasheid, Abdel-Baki, Hegazy et Bashtar, 2008 in the kidney of ***Oreochromis niloticus*** (Egypt)

Zschokkella Auerbach, 1910

Zschokkella nilei Abdel-Ghaffar, El-Toukhy, Al-Quraishy, Al-Rasheid, Abdel-Baki, Hegazy et Bashtar, 2008 in the kidney of ***Oreochromis niloticus*** (Egypt)

MULTIVALVULIDA Shulman, 1959

Kudoa Meglitsch, 1947

Kudoa eleotrici Siau, 1971 in the gills of ***Kribia kribensis*** (Benin). Note: this is a very exceptional finding as species of *Kudoa* are typically parasites of marine fishes.

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Chapter 4.4.
MONOGENEA

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Monogenea – basic characteristics, life cycles, classification and principal diagnostic features

- parasitic flatworms with a syncytial tegument (Platyhelminthes: Neodermata)
- over 5,500 species allocated to more than 750 genera
- mostly parasites of freshwater, brackish water and marine fishes; a number of species parasitise crustaceans, cephalopods, amphibians, reptiles and a mammal
- majority of African species found on external surfaces (gills, skin, fins, rarely mouth cavity and nostrils); a few species are endoparasitic (*Enterogyrus* – foregut and stomach, *Urogyrus* – urinary bladder)
- body dorsoventrally flattened, varying in size from *ca.* 100 µm up to 4 cm long (typically 0.3-10 mm)
- main attachment organ on the posterior end called haptor (or opisthaptor) houses a variable array of sclerotised (hard) structures; number, shape and configuration of the haptoral structures are key to species identification and classification
- simple digestive system consisting of mouth, pharynx and intestine with no terminal opening (anus)
- intestine usually with two simple or branched stems often fusing (anastomosing) posteriorly
- hermaphroditic (commonly protandrous), usually with cross-fertilisation
- distal parts of the male and female reproductive system (male copulatory organ, vagina) may contain sclerotised elements (*e.g.*, copulatory tube, accessory piece) that help in species identification
- direct life cycles (no intermediate host required) (Fig. 4.4.1)
- oviparous (oncomiracidium larva), viviparous (sequential polyembryony)
- a high degree of host and site (microhabitat) specificity

The classification of monogeneans is still under discussion. Even the name of the class, Monogenea (used by the majority of workers) or Monogenoidea, is controversial (Wheeler & Chisholm 1995). There are several classifications of monogeneans that are based on morphology, ontogeny and spermatology (Bychowsky 1957; Yamaguti 1963; Lebedev 1988; Malmberg 1990; Justine 1991; Boeger & Kritsky 1993, 2001). The system of Boeger and Kritsky (1993,

Fig. 4.4.1. Life cycles of monogeneans (no intermediate host required). **A.** Oviparous life cycle (*Dactylogyrus* sp.); **B.** Viviparous life cycle (*Macrogyrodactylus* sp.). (Illustrations by M. Luo.)

2001) is followed here for the higher taxonomical levels, based on a variety of anatomical and ultrastructural characters. The subclasses as listed below are now well accepted, as is the division of Heteronchoinea into two infrasubclasses (*i.e.*, Oligonchoinea and Polystomatoinea).

Generic classification of monogeneans is based mainly on characters associated with the attachment structures. However, information on the internal anatomy and sclerotised distal parts of the male and female reproductive system is also important, as an integral part of the generic definition.

Species identification of monogeneans (especially so-called lower monogeneans – Polyonchoinea) is based on the morphology of the sclerotised structures of the haptor and distal parts of the reproductive systems (*i.e.*, male copulatory organ

and vagina). However, details on the arrangement of internal structures may also supplement the taxonomical evaluation, and should ideally be a part of the species description.

The unique and characteristic morphological feature of the Monogenea is the presence of the posterior attachment organ called the haptor (or opisthaptor). It is a complex organ composed of the attachment disc and various sclerotised structures (Fig. 4.4.2). The terminology of the haptoral structures is not unified and some researchers use these terms differently. Here, the following terms are used in keying out these parasites:

Anchors (hamuli, grypi, large hooks, central hooks, Mittelhakens) are paired trifid structures situated on the ventral and/or dorsal surface of the central part of the haptor. One or two pairs of anchors may be present, but in some monogeneans (*e.g.*, species of *Heteronchocleidus*, *Trianchoratus*, *Urogyrus*) one of the anchors may not be fully developed, *i.e.*, it is much reduced in size and shape. In a typical case, the anchor consists of inner root (superficial root, ventral root, guard), outer root (deep root, dorsal root, shaft), base, shaft (blade) and point; the membranous structures arising from the convex surface of the shaft are termed anchor filaments (wings, filament loops). The anchors of some genera may possess accessory sclerites (patch, cuneus) associated with the tip of the inner root (*e.g.*, species of *Birgiellus*, *Paraquadriacanthus*, *Quadriacanthus*).

Bars (connecting bars, transverse bars) are one or two-piece structures connecting the basis of individual members of a pair of anchors. Generally, each pair of anchors has a bar and together they form the so-called ventral and/or dorsal anchor-bar complex. In a number of genera with two pairs of anchors, only one pair has a bar (*e.g.*, species of *Enterogyrus*, *Eutrianchoratus*). Conversely, two bars (ventral and dorsal) may be present in some monogeneans with one pair of anchors (*e.g.*, species of *Dactylogyrus*, *Gyrodactylus*).

Needles (4A hooks) are paired delicate (usually poorly detectable) splinter-like structures of which the nature and origin have not yet been clearly documented. Mostly they are considered to be vestigial anchors or vestigial hooks (*e.g.*, species of *Dactylogyrus*, *Dogielius*, *Schilbetrematoides*).

Hooks (marginal hooks, uncinuli) are bilaterally arranged pairs of small sickle-shaped structures. In a typical case, each hook consists of a sickle (with sickle-filament loop or FH loop) and a handle. There are two types of hooks called unhinged and hinged hooks. The sickle of a hinged hook is movable in relation to the handle. The number of hooks is 14 in species with unhinged hooks (Dactylogyridae, Diplectanidae) and 16 in species with hinged hooks (Gyrodactylidae). There are several types of numbering systems for hook pairs; here the system of Mizelle (1936) is adopted, because it is the only currently used method that considers both the anteroposterior and dorsoventral positions of the respective hook pairs in the adult haptor.

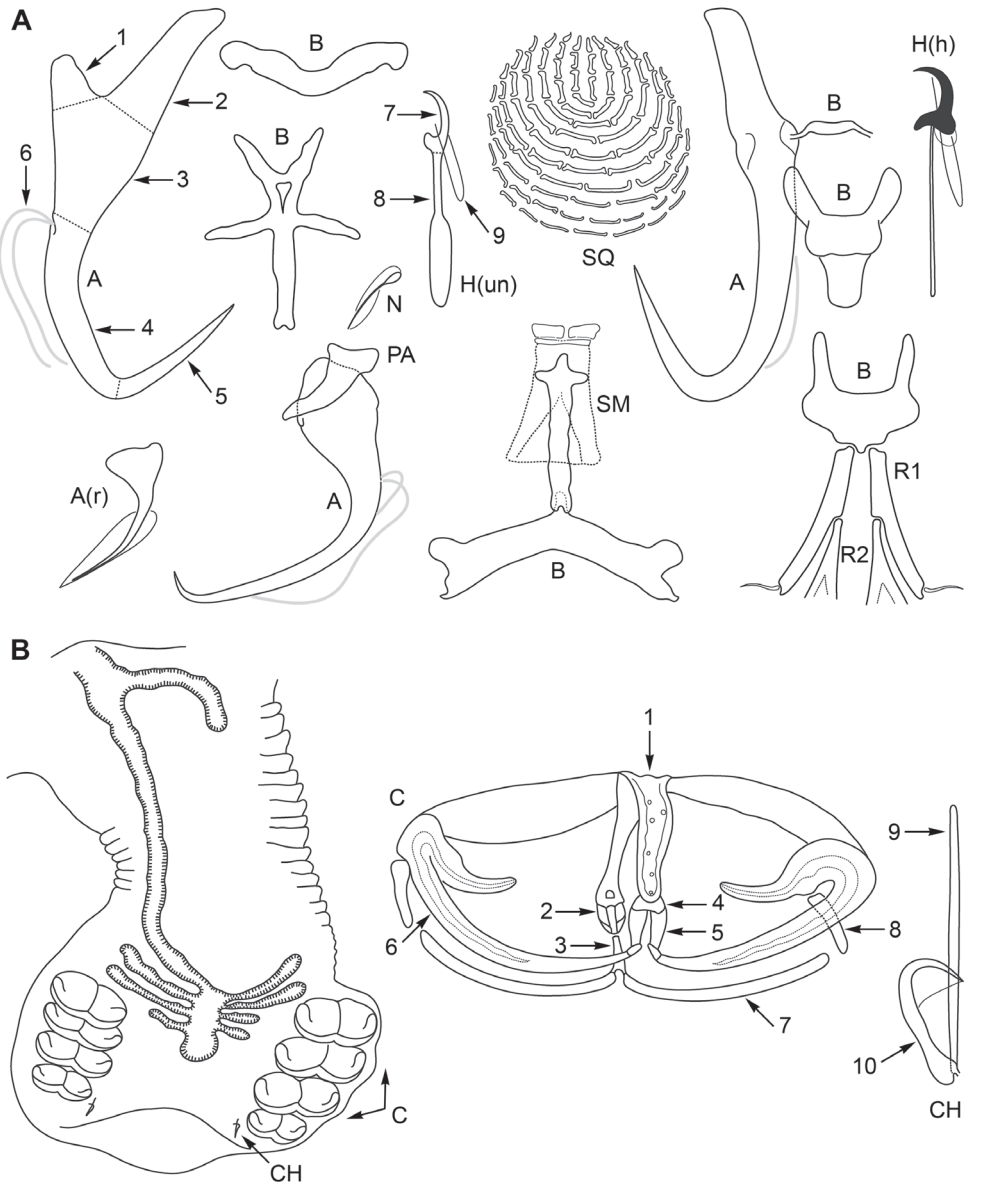

Fig. 4.4.2. Examples of haptoral attachment structures, as typically seen in papers describing new species. **A.** Polyonchoinea. A = anchor, A(r) = anchor (rudimentary), B = bar, H(h) = hook (hinged), H(un) = hook (unhinged), N = needle, Pa = patch, R = rods, SM = supporting membrane, SQ = squamodisc, 1 = outer root, 2 = inner root, 3 = base, 4 = shaft, 5 = point, 6 = filament, 7 = sickle, 8 = handle, 9 = FH loop; **B.** Oligonchoinea. (Modified after Khotenovsky 1985.) C = clamps, CH = central hook, 1 = median plate, 2 = proximal additional sclerite, 3 = distal additional sclerite, 4 = trapeze spur, 5 = anterior joining sclerites, 6 = anterior jaw, 7 = posterior jaw (median sclerite), 8 = posterior jaw (lateral sclerite), 9 = handle, 10 = sickle.

Squamodiscs are circular or oval plate-like formations, which are found only in certain monogeneans of the Diplectanidae. There are, typically, two squamodiscs (one ventral and one dorsal) located anteriorly to the anchor-bar complexes. Each disc possesses scales embedded in the tegument, which appear under the microscope as rootlets arranged in rows.

Clamps are metamorphosed suckers characteristic of higher monogeneans (Oligonchoinea). They are highly specialised structures, often armed with sclerotised elements. The number of clamps varies from two to many; they are distributed symmetrically or asymmetrically. The number and arrangement of clamps as well as the number, shape and size of clamp sclerites are of taxonomic importance in differentiating taxa.

4.4.1. Identification keys for monogeneans (adults)

The guide to the monogeneans parasitising African freshwater fishes is presented here as keys to individual genera and higher-level taxa. Every step in the keys refers to a corresponding figure for a better understanding of identifying feature(s). Figures are labelled to illustrate the used terminology of the sclerotised structures; taxonomically important characters indicated by arrows. In case of hooks, only half of them is depicted in the key to the Dactylogyridae. The genus *Ancyrocephalus* is not included in the keys. Following the emendation of the generic diagnosis for *Ancyrocephalus* of Bychowsky and Nagibina (1970), *A. barilli*, *A. claveaui*, *A. limnotrissae* and *A. pellonulae* do not belong to the genus *sensu stricto*. Nevertheless, we retain them in *Ancyrocephalus* until their generic status is formally resolved. Thus, these species are listed below under *Ancyrocephalus sensu lato*.

Key to the subclasses/infrasubclasses of monogeneans

1 (2) Hook-like sclerites with various connecting and supporting sclerites (*e.g.*, bars, squamodiscs) are main attachment structures of haptor [Fig. 4.4.2A]……**Polyonchoinea**

2 (1) Main attachment structures of haptor are morphologically and functionally changed suckers – clamps [Fig. 4.4.2B]……**Oligonchoinea**

Key to the families of the Oligonchoinea Bychowsky, 1937

1 (2) Haptor with 4 + 4 clamps; male copulatory organ armed with a circle of spines, present in anterior part of the body (just behind pharynx); no fused (concrescent) individuals occur [Fig. 4.4.3]……**Diclidophoridae**

2 (1) Haptor with 4 + 4 and more clamps; one pair of posteriorly situated hooks (central hooks) usually present; male copulatory organ absent; already in juvenile stage, two individuals (diporpae) permanently fused forming an X-shape [Fig. 4.4.4]……**Diplozoidae**

Key to the genera of the Diplozoidae Tripathi, 1959

1 (2) Haptor with 4 + 4 laterally situated clamps and one pair of small central hooks; gill parasites of *Brycinus macrolepidotus* (Alestidae) and Cyprinidae [Fig. 4.4.4A]…….***Paradiplozoon***

2 (1) Haptor with more than 4 + 4 laterally situated clamps (up to 15 pairs) and one pair of small central hooks; gill parasites of *Alestes baremoze* (Alestidae) and Cyprinidae [Fig. 4.4.4B]…….***Afrodiplozoon***

Key to the families of the Polyonchoinea Bychowsky, 1937

1 (2) Oviparous, usually with two pairs of eye spots; haptor with unhinged (dactylogyrid) hooks [Fig. 4.4.5A]……..……3

2 (1) Viviparous or oviparous, eye spots are lacking; haptor with hinged (gyrodactylid) 8 + 8 hooks [Fig. 4.4.5B]……..**Gyrodactylidae**

3 (4) Haptor with 7 + 7 unhinged hooks, two pairs of anchors (one or two anchors may be rudimentary), two bars (one may be rudimentary or absent) [Fig. 4.4.6A]……...**Dactylogyridae**

4 (3) Haptor with 7 + 7 unhinged hooks, two pairs of anchors, two bars (dorsal bar two-pieced); accessory adhesive organs (squamodiscs) present [Fig. 4.4.6B] ..... **Diplectanidae**

Key to the genera of the Dactylogyridae Bychowsky, 1933

1 (2) Dactylogyrids parasitising internal organs……3

2 (1) Dactylogyrids parasitising external organs……..5

3 (4) In stomach; haptor with two pairs of anchors; ventral anchors associated with the ventral bar (*i.e.*, ventral anchor-bar complex present); dorsal anchors with recurved inner root, elongate outer root; dorsal bar absent; male copulatory organ a spirally coiled tube; in Cichlidae [Fig. 4.4.7A]…… ***Enterogyrus***

4 (3) In urinary bladder; haptor with one pair of ventral anchors associated with the ventral bar; right anchor rudimentary (reduced in size and shape); dorsal anchor-bar complex absent; in Cichlidae [Fig. 4.4.7B]……***Urogyrus***

5 (6) Haptor with two developed anchors (ventral or dorsal pair) and two anchors reduced or replaced by needles (poorly defined)……7

6 (5) Haptor with more than two developed anchors……13

7 (8) Ventral anchor-bar complex developed; dorsal anchors modified into spike-like sclerites; dorsal bar absent; gill parasites of *Citharinus citharus*

(Citharinidae) [Fig. 4.4.8A]…….……***Nanotrema***

8 (7) One pair of delicate splinter-like structures (needles) located near hook pair V present……...9

9 (10) Only one bar present; anchors with short roots (inner root often with basal fold) of similar size, poorly differentiated shafts and points (with subterminal curvature and strongly recurved tip) directing towards each other (like a pair of pincers); gill parasites of Cyprinidae [Fig. 4.4.8B]…… ……...***Dogielius***

10 (9) One or two bars present……11

11 (12) Dorsal bar present; ventral bar usually smaller than the dorsal one, rudimentary or absent; dorsal anchors often with roots of unequal size, well-differentiated shaft and point; mostly on gills of Cyprinidae [Fig. 4.4.9A] ……***Dactylogyrus***

12 (11) Ventral bar simple, rod-shaped; dorsal bar complex, comprising bar proper and massive shield-like structure posteriorly serving as a guide for anchor points; dorsal anchors with elongate inner root having a superficial protuberance near mid-length; gill parasites of *Schilbe* (Schilbeidae) [Fig. 4.4.9B]……...***Schilbetrematoides***

13 (14) Three developed and one (ventral) rudimentary (*i.e.*, markedly reduced in size and shape) anchors present……15

14 (13) Four (two pairs) developed anchors present……17

15 (16) Two bars present; developed anchors (two dorsal, one ventral) with well-differentiated roots; dorsal anchors usually differ from each other in size and shape; gill parasites of *Ctenopoma* (Anabantidae) [Fig. 4.4.10A] ……***Heteronchocleidus***

16 (15) One bar present; developed anchors (two left, one right) in a claw-like position, each with stout inner root and poorly developed outer root; a circular muscle attached terminally to the inner root of the left ventral anchor detectable; gill parasites of *Parachanna obscura* (Channidae) [Fig.4.4.10B]……***Eutrianchoratus***

17 (18) One or both pairs of anchors associated with a two-piece bar……19

18 (17) Each anchor pair associated with a one-piece (solid) bar……25

19 (20) Both bars two-pieced; ventral and dorsal anchors similar in shape and size; base of copulatory tube delicate, usually with finger-like processes; gill parasites of Mormyridae [Fig. 4.4.11A…… ***Bouixella***

20 (19) Ventral bar two-pieced; dorsal bar solid……21

21 (22) Ventral bar comprising two well-separated components; ventral anchors

markedly smaller than dorsal anchors; dorsal bar straight, broadly V- or M-shaped; gill parasites of Cichlidae [Fig. 4.4.11B]……***Onchobdella***

22 (21) Ventral bar comprising two components articulating medially……23

23 (24) Anchors with patches, rootless; dorsal bar T-shaped, with bilateral arms and expanded mid-region with posterior process; gill parasites of Clariidae, *Bagrus* (Bagridae), and *Papyrocranus afer* (Notopteridae) [Fig. 4.4.12A] ……...***Quadriacanthus***

24 (23) Anchors without patches; dorsal anchors with inner root terminally curled; ventral anchors with thickened ridge extending from outer root across base to shaft; pouch-like structure (onchium), through which dorsal extrinsic muscles extend, present in the anterior region of haptor; gill parasites of *Chrysichthys* (Claroteidae) and *Malapterurus electricus* (Malapteruridae) [Fig. 4.4.13]……..***Protoancylodiscoides***

25 (26) Anchors with patches……27

26 (25) Anchors without patches……..31

27 (28) Patches on ventral anchors only; anchors large, with poorly developed outer root; bars simple in shape; gill parasites of *Heterotis niloticus* (Arapaimidae) [Fig. 4.4.12B]……...***Heterotesia***

28 (27) Patches on both dorsal and ventral anchors……29

29 (30) Ventral and dorsal anchors rootless; patches small; dorsal anchors with shaft sharply (at about 90º) bent proximally; dorsal bar cross-shaped; ventral bar triangular or three-armed; gill parasites of *Clarias* (Clariidae) [Fig. 4.4.14A]……***Birgiellus***

30 (29) Dorsal anchors robust, with flange on superficial surface of base, large patch (wings unequal); ventral anchors small, with delicate patch; dorsal bar complex, with anterior shield and posterior arrow- or T-shaped process; ventral bar broadly U-shaped; in the nasal cavity of *Clarias gariepinus* (Clariidae) [Fig. 4.4.14B]……***Paraquadriacanthus***

31 (32) Dorsal bar with two submedial auricles ……33

32 (31) Dorsal bar lacking auricles……35

33 (34) Dorsal bar with long auricles and lateral wing-shaped enlargements; ventral bar associated with supporting membrane marked by fan-shaped median thickenings; gill parasites of Cichlidae [Fig. 4.4.15A…… ……***Scutogyrus***

34 (33) Dorsal bar with auricles variable in length; ventral bar not associated with supporting membrane, V-shaped, usually with a medial portion reduced in diameter; an auxiliary plate lying in close proximity of the male copulato-

ry organ sometimes present; gill parasites of *Aphyosemion cameronense* (Nothobranchiidae), Cichlidae and *Polycentropsis abbreviata* (Nandidae) [Fig. 4.4.15B]……...***Cichlidogyrus***

35 (36) Both ventral and dorsal bar associated with lightly sclerotised (sometimes poorly defined) supporting membrane; ventral bar often with median process; anchors with inner roots having recurved (erect) terminal half, elongate shaft and short point; gill parasites of Alestidae [Fig. 4.4.16A]…….***Annulotrema***

36 (35) Supporting membrane absent or associated with only one bar……37

37 (38) Bar(s) with a median projection and/or two bilateral anterior arms (*i.e.*, bar ends bent at about 90° anteriorly)……39

38 (37) Bars lacking median projection and such bilateral anterior arms……47

39 (40) Median projection articulated to the ventral bar and associated with lightly sclerotised skirt-like supporting membrane; dorsal bar yoke-shaped with a posterior shield; gill parasites of *Auchenoglanis occidentalis* (Claroteidae) [Fig. 4.4.16B]……..***Bagrobdella***

40 (39) Median projection arising (not articulated) from the ventral bar……41

41 (42) Ventral anchors modified in shape……43

42 (41) Ventral anchors with basal surface protuberance……45

43 (44) Ventral anchors with recurved inner root, elongate (erected) outer root, and diagonally truncate point; ventral bar with two bilateral anterior arms, small/delicate posteromedial projection usually present; dorsal bar simple, rod-shaped; gill parasites of Alestidae [Fig. 4.4.17A]…… ……...***Characidotrema***

44 (43) Ventral anchors with prominent superficial knob on base near its union with the shaft, shaft sharply (usually at about 90º) bent proximally, roots variable in shape; bars usually with lateral, subterminal (often horn-shaped) and medial anterior projections; accessory sclerite associated with anteromedial projection of the ventral bar may be present; gill parasites of Schilbeidae [Fig. 4.4.17B]……***Schilbetrema***

45 (46) Ventral anchors with pestle-shaped protuberance diagonally extending from outer root to inner side of proximal part of the shaft; ventral bar with lobed ends and medial projection; dorsal anchors with small to reduced outer root; dorsal bar simple, with indistinct supporting membrane; gill parasites of *Synodontis* (Mochokidae) [Fig. 4.4.18A]…… …… ***Synodontella***

46 (45) Ventral anchors robust, with leaf-shaped protuberance extending along medial part of base; ventral bar with lobed ends and medial projection;

dorsal anchors with shaft slightly swollen at its union with base; dorsal bar with two subterminal joint-like thickenings; gill parasites of *Gnathonemus petersii* (Mormyridae) [Fig. 4.4.18B]…….***Archidiplectanum***

47 (48) Bars (primarily ventral bar) with recurved ends, subterminal constrictions; dorsal bar with indistinct supporting membrane; ventral anchors with wide base; gill parasites of Cichlidae in Madagascar [Fig. 4.4.19A]…… ……***Insulacleidus***

48 (47) Ventral bar saddle-shaped, with enlarged (bulbous) terminations and rectangular enlargement of anteromedial margin; dorsal bar rod- or broadly U-shaped; anchors with enlarged roots and relatively delicate shaft; gill parasites of *Distichodus* (Distichodontidae) [Fig. 4.4.19B]…… ……***Afrocleidodiscus***

Key to the genera of the Gyrodactylidae van Beneden et Hesse, 1863

1 (2) Haptor with 16 hooks of the same type; ventral and dorsal bar present……3

2 (1) Haptor with 16 hooks of two different types (ten hooks with large falculate sickles, six smaller hooks with well-articulated sickles), a pair of muscular adhesive discs situated on the side of anchors; no dorsal bar present; gill parasites of *Polypterus senegalus* (Polypteridae) [Fig. 4.4.20A]…… ……..***Diplogyrodactylus***

3 (4) Hooks evenly distributed along the edge of haptor……5

4 (3) Hooks distributed unevenly; 14 hooks arranged in a row along the posterior margin of haptor; two hooks located on anterolateral lobes, reflected forwards; peg-like tegumental extensions (supporting struts) present on lateral and anterior margins of haptor; inner roots of anchors associated with accessory bars; ventral bar associated with two pairs of supporting rods (not incorporated in the bar); gill, skin/fin parasites of Clariidae, *Ctenopoma muriei* (Anabantidae), *Lates niloticus* (Latidae) and Polypteridae [Fig. 4.4.20B]…….***Macrogyrodactylus***

5 (6) Haptor with four pairs of accessory bars; three (two lateral, one central) supporting rods incorporated in ventral bar present; skin/fin parasites of *Marcusenius macrolepidotus* (Mormyridae) [Fig. 4.4.21A]…….***Mormyrogyrodactylus***

6 (5) Haptor lacking accessory bars……7

7 (8) Anchors with two developed roots; outer root conspicuous, approximately half-length of inner root; ventral bar without membrane and anterolateral processes; gill, skin/fin parasites of Alestidae [Fig. 4.4.21B] ……***Afrogyrodactylus***

8 (7) Anchors with only one (inner) developed root……9

9 (10) Ventral bar with membrane, anterolateral processes may be present; male copulatory organ bulbous, equipped with one apical spine and row(s) of small spines; gill, skin/fin parasites of various host families [Fig. 4.4.22A] ……***Gyrodactylus***

10 (9) Anchors with a constriction between shaft and point; ventral bar with membrane, anterolateral processes lacking; male copulatory organ muscular, consists of a central curved cone and a muscular pouch armed with numerous small spines; gill parasites of *Citharinus citharus* (Citharinidae) [Fig. 4.4.22B]……***Citharodactylus***

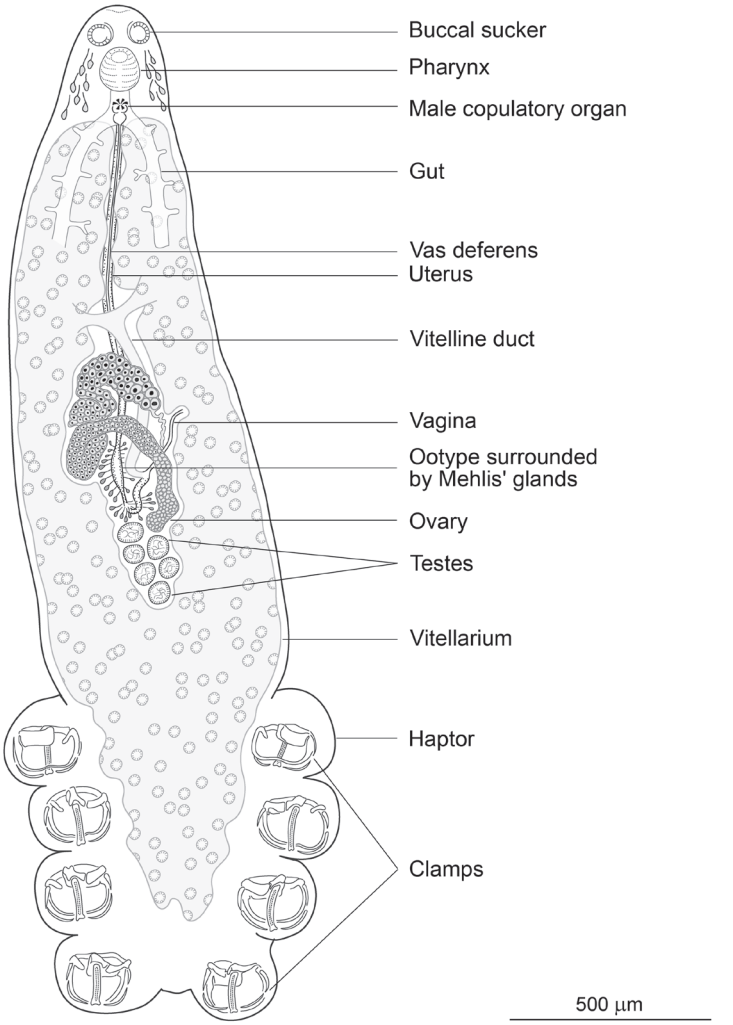

Fig. 4.4.3. Monogenea (Diclidophoridae). *Heterobothrium fluviatilis* Euzet et Birgi, 1975 from *Tetraodon lineatus*. (Modified from Euzet & Birgi 1975.)

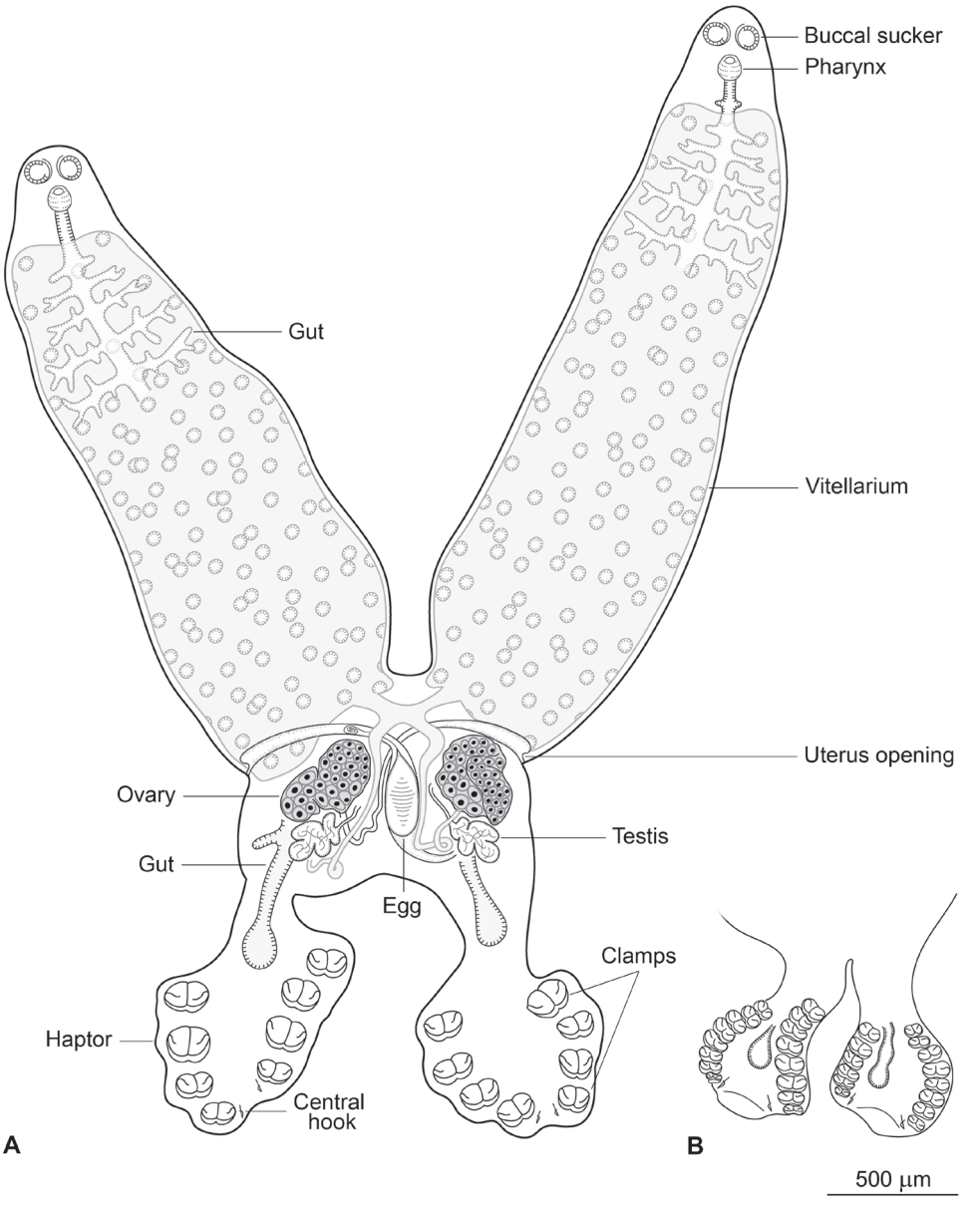

Fig. 4.4.4. Monogenea (Diplozoidae). **A.** *Paradiplozoon ghanense* (Thomas, 1957) from *Brycinus macrolepidotus*; **B.** *Afrodiplozoon polycotyleus* (Paperna, 1973) from *Enteromius cercops*. (Modified from Khotenovsky 1985.)

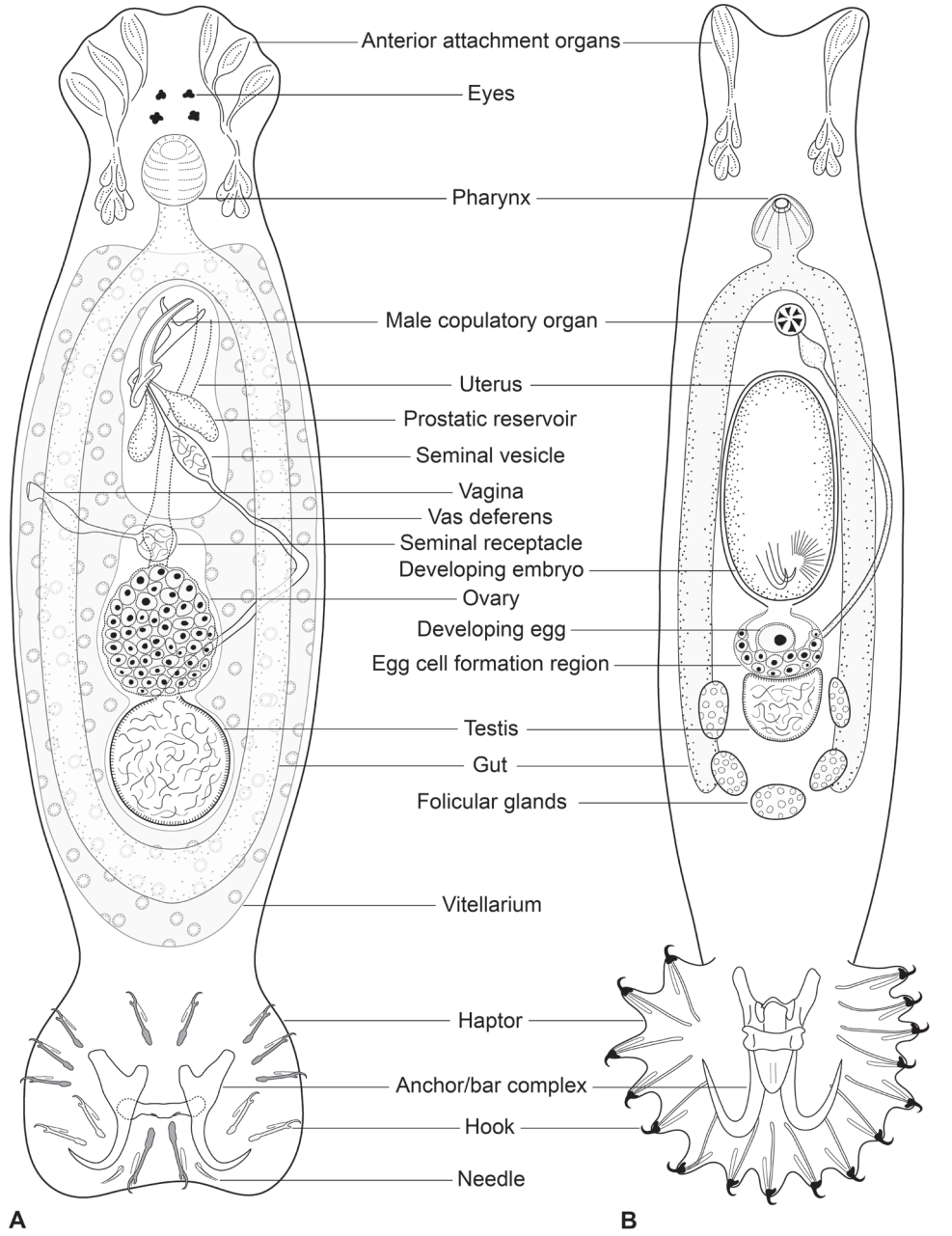

Fig. 4.4.5. Monogenea (Polyonchoinea). **A.** Generalised anatomy of oviparous *Dactylogyrus* sp., ventral view; **B.** Generalised anatomy of viviparous *Gyrodactylus* sp., ventral view. (Modified from Roberts *et al.* 2013.)

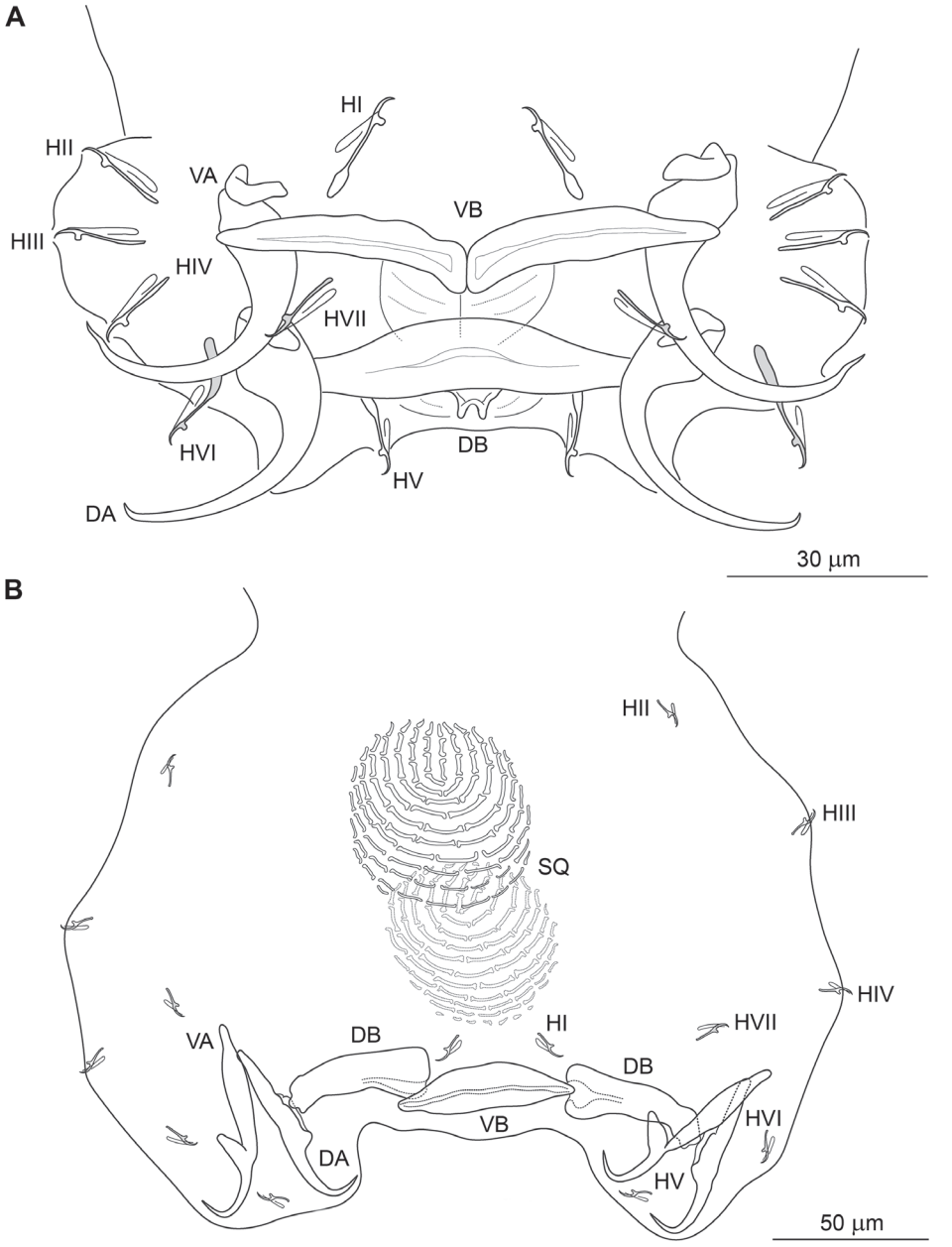

Fig. 4.4.6. Monogenea (Polyonchoinea). **A.** Haptor of *Quadriacanthus ashuri* Kritsky et Kulo, 1988 (Dactylogyridae) from *Clarias gariepinus*. **B.** Haptor of *Diplectanum lacustre* Thurston et Paperna, 1969 (Diplectanidae) from *Lates niloticus*. (Modified from Kritsky & Kulo 1988.) VA = ventral anchor; VB = ventral bar; DA = dorsal anchor; DB = dorsal bar; HI-VII = hooks; SQ = squamodiscs.

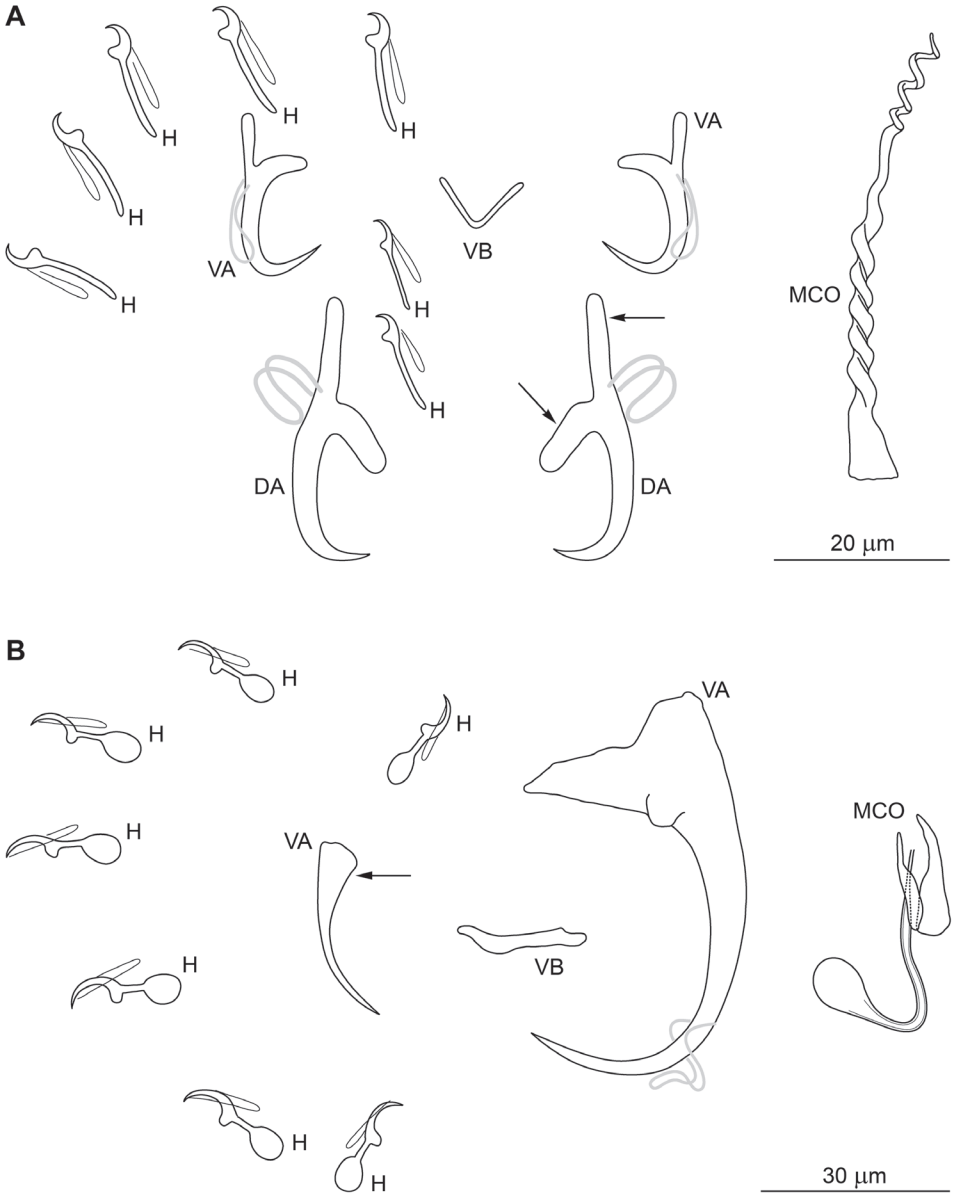

Fig. 4.4.7. Monogenea (Dactylogyridae). **A.** *Enterogyrus amieti* Bilong Bilong, Euzet et Birgi, 1996 from *Sarotherodon galilaeus*; **B.** *Urogyrus cichlidarum* Bilong Bilong, Birgi et Euzet, 1994 from *Benitochromis batesii*. (Modified from Bilong Bilong *et al.* 1994, 1996.) VA = ventral anchor; VB = ventral bar; DA = dorsal anchor; H = hook; MCO = male copulatory organ.