

Dactylogyrids (Platyhelminthes: Monogenea) of *Labeo* (Teleostei: Cyprinidae) from West African Coastal Rivers

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ABSTRACT: Dactylogyrids from *Labeo parvus* Boulenger, 1902, *L. alluaudi* Pellegrin, 1933, and *L. rouaneti*, Daget, 1962, were studied in Atlantic coastal basins in West Africa. Nine species (6 new) of Dactylogyridae were found: *Dactylogyrus longiphallus* Paperna, 1973, *D. falcilocus* Guégan, Lambert, and Euzet, 1988, and *Dogielius kabaensis* sp. n. from *L. parvus* populations in coastal rivers of Guinea, Sierra Leone, and Liberia; *Dactylogyrus longiphalloides* sp. n. and *Dogielius kabaensis* sp. n. from *L. alluaudi* in the river Bagbwe in Sierra Leone; *Dactylogyrus sematus* sp. n., *D. jucundus* sp. n., *D. omega* sp. n., and *Dogielius rosumplicatus* sp. n. from *L. rouaneti* in the Konkouré system in Guinea. *Dactylogyrus brevicirrus* Paperna, 1973, characteristic of *L. parvus* in the large Sahel-Sudan basins, was not found in coastal rivers of Guinea, Sierra Leone, and Liberia. *Labeo alluaudi* from the rivers Cavally and Nipoué in Côte d'Ivoire and Liberia were not parasitized.

Comparison of branchial monogeneans in different populations of *L. parvus* in West Africa shows that there are 2 host groups. The first consists of host populations in Guinean coastal basins, characterized by *Dactylogyrus longiphallus*, *D. falcilocus*, and *Dogielius kabaensis* sp. n. The second comprises the other populations in adjacent basins, marked by *Dactylogyrus brevicirrus*, whose presence is interpreted as a host switching. Importance of isolation phenomena in monogeneans and their cyprinid hosts is discussed.

KEY WORDS: West Africa, Guinean ridge, Dactylogyridae, *Dactylogyrus longiphallus*, *Dactylogyrus brevicirrus*, *Dactylogyrus falcilocus*, *Dactylogyrus longiphalloides* sp. n., *Dactylogyrus sematus* sp. n., *Dactylogyrus jucundus* sp. n., *Dactylogyrus omega* sp. n., *Dogielius kabaensis* sp. n., *Dogielius rosumplicatus* sp. n., Cyprinidae, *Labeo*, parasite specificity, parasite communities, host switching, endemism, refugia, biogeography.

Monopisthocotylean monogeneans on species of *Labeo* (Teleostei: Cyprinidae) are known in Africa through the studies of Price and Yurkiewicz (1968) in Rhodesia, Price et al. (1969) in South Africa, Paperna (1969, 1973, 1979) in Uganda, Kenya, Tanzania, and Ghana, and in Mali (Guégan et al., 1988, 1989), in Guinea, Sierra Leone, and Côte d'Ivoire (Guégan and Lambert, 1990). *Labeo* is represented in West Africa by 7 species (Lévêque and Daget, 1984). Some have a large distribution: *L. senegalensis* Valenciennes, 1842, in Chad, Niger, Senegal, Gambia, Volta river basins and several short coastal basins of West Africa; *L. coubie* Rüppell, 1832, from the Nile to the Senegal, in the Volta, in the Sahel basins, and in several coastal systems; *L. parvus* Boulenger, 1902, in Zaïre, Chad, Senegal, Gambia, Volta, Niger, Ouémé, Mono, and numerous small Atlantic systems. Other species have a more limited distribution: *L. roseopunctatus* Paugy, Guégan, and Agnèse, 1990, from the middle Niger in Mali and the upper Baoulé in the Senegal basin; *L. rouaneti* Daget, 1962, from the Konkouré basin in the Republic of Guinea; *L. alluaudi* Pellegrin, 1934, from the Cavally (Cess) and the Nipoué in Côte d'Ivoire

and Liberia: distribution of this species has been extended to the Bagbwe (Sewa) in Sierra Leone by Paugy (pers. comm.); *L. djourae* Blache and Miton, 1960, from the upper Bénoué (Niger basin) in Cameroon. Finally, 2 species are known only by the types: *L. curriei* Fowler, 1919, in the Saint Paul river in Liberia and *L. brachypoma* Günther, 1863 (type locality unknown), probably from western Nigeria (Reid, 1985).

Monogeneans from *Labeo coubie*, *L. senegalensis*, *L. roseopunctatus*, and from populations of *L. parvus* in the Niger and the Senegal basins, have been discussed by Guégan et al. (1988, 1989). In the present paper, the parasites of *L. alluaudi*, *L. rouaneti*, and *L. parvus* in coastal basins in West Africa are reported. The first 2 hosts are well defined taxonomically. The third, *L. parvus*, consists of individuals belonging to a species complex (Reid, 1985). Jégu and Lévêque (1984) and Daget and Iltis (1965) stressed the affinities between the different species described as synonymous while accepting that the variations observed in the different populations might be caused by morphological or geographical variability (Jégu and Lévêque, 1984). However, we recently recognized a new species of *Labeo*, *L.*

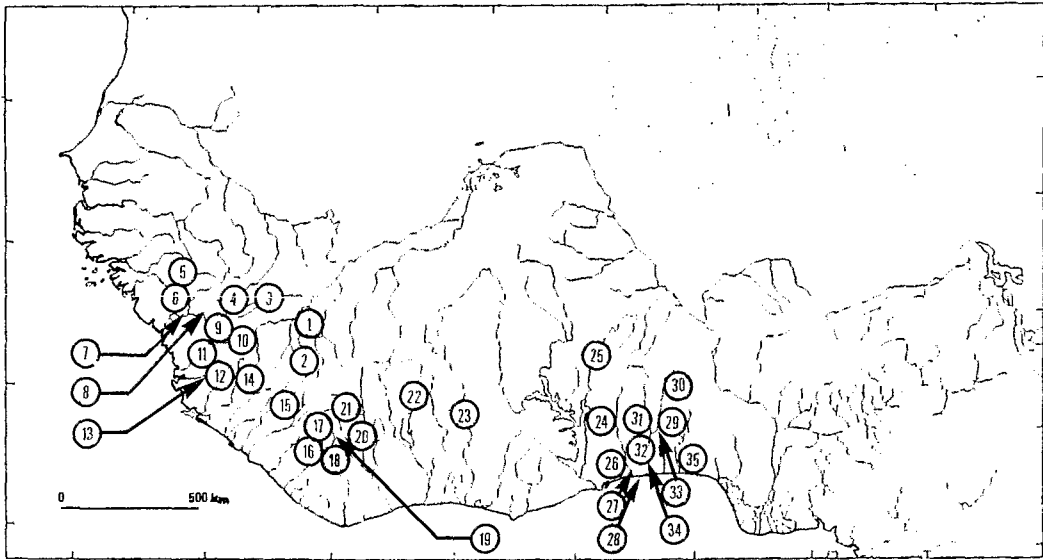


Figure 1. Distribution of the different stations sampled in West Africa (1–35). Niger basin: 1 and 2 Milo; 3 Tinkisso. Senegal basin: 4 Bafing. Tomine basin: 5 Tomine (or Rio Corubal). Fatala basin: 6 Fatala. Konkouré basin: 7 Konkouré; 8 Kakrma. Little Scarces basin: 9 Kaba; 10 and 11 Mongo. Rokel basin: 12 and 13 Rokel. Bagbwe basin: 14 Bagbwe. Loffa basin: 15 Loffa. Nipoué basin: 16, 17 Nipoué (or Cess); 19 Boan. Cavally basin: 18 Cavally. Sassandra basin: 20 Sassandra; 21 Feredougouba. Bandama basin: 22 Bandama blanc. Comoé basin: 23 Comoé. Volta basin: 24 Wawa; 25 Oti. Tadjie basin: 26 Tadjie. Togo lake system: 27 Haho; 28 Sio. Mono basin: 29 and 30 Mono; 31 Anié; 32: Amou; 33: Aou; 34: Na. Ouémé basin: 35 Ouémé.

roseopunctatus Paugy et al., 1990, based on 3 simultaneous and independent approaches: parasite, allozyme, and morphometric data.

The coastal rivers in West Africa which flow from the Guinean ridge to the Atlantic Ocean form a separate catchment unit (Grove, 1985) characterized by a large number of endemic fishes (Daget, 1962). Isolation of fish populations in these basins is a good model for studying evolutionary biology of host-parasite relationships and may provide answers to the following questions: Are branchial monogeneans of endemic species of *Labeo* vicarious forms of those found in species of *Labeo* in peripheral basins? Do small endemic host populations affect the branchial parasite communities? These questions are appropriate with regard to the strict host specificity exhibited by the Dactylogyridae (Guégan et al., 1988, 1989).

Geographical Framework, Materials and Methods

Collection sites were in several river systems in West Africa (Fig. 1). The systems consisted of the upper Niger basin (Milo and Tinkisso rivers in Guinea), and upper Senegal basin (Bafing, Baoulé, and Bakoye rivers in Guinea), and of a series of Atlantic coastal basins.

Rivers and tributaries are located on the coastal slope of the Guinean ridge which runs from the Fouta Djallon mountains (Guinea) to the Nimba mountains (frontier between Guinea, Côte d'Ivoire, and Liberia). A site on the Mariti Iga river, an endorheic basin in the Sudan, is included but not illustrated on the map (Fig. 1).

In addition the following cyprinid specimens were examined for parasites from the collection of the Ichthyology Laboratory of the MNHN (Museum National d'Histoire Naturelle, Paris): *Labeo alluaudi* (MNHN 1979-128) Cavally river, Boan tributary near Danané (19), Côte d'Ivoire; *Labeo rouaneti* (MNHN 1988-1889) Konkouré system, Kakrma river near Kasserri (8), Republic of Guinea; *Labeo parvus* (MNHN 1988-1888) Niger system, upper Milo near Konsankoro (2), Republic of Guinea. (MNHN 1981-902) Tomine river at Gaoual (5), Republic of Guinea, (MNHN 1988-1887) Konkouré basin, Kakrma tributary near Kasserri (8), Republic of Guinea. (MNHN 1988-1886) Little Scarces basin, Mongo river near Marela (10), Republic of Guinea. (MNHN 1988-1885) Little Scarces system, Kaba river near Kouloundala (9), Republic of Guinea. (MNHN 1982-1170, 1982-1172) Loffa river near Macenta (15), Republic of Guinea. (MNHN 1981-900) Comoé system, Comoé (23), Côte d'Ivoire; Wawa river (24), lake Volta system, Ghana. (MNHN 1981-912) Oti river (25), lake Volta system, Ghana; Tadjie river (26), Ghana; Haho river (27), Lake Togo system, Togo. (MNHN 1982-959) Sio at Kali (28), Lake Togo system, Togo. (MNHN 1981-909) Mono system, Mono at Kpessi (29), Togo. (MNHN 1989-1033) Mono system, Mono near Tchamba (30), Togo. (MNHN 1989-1036)

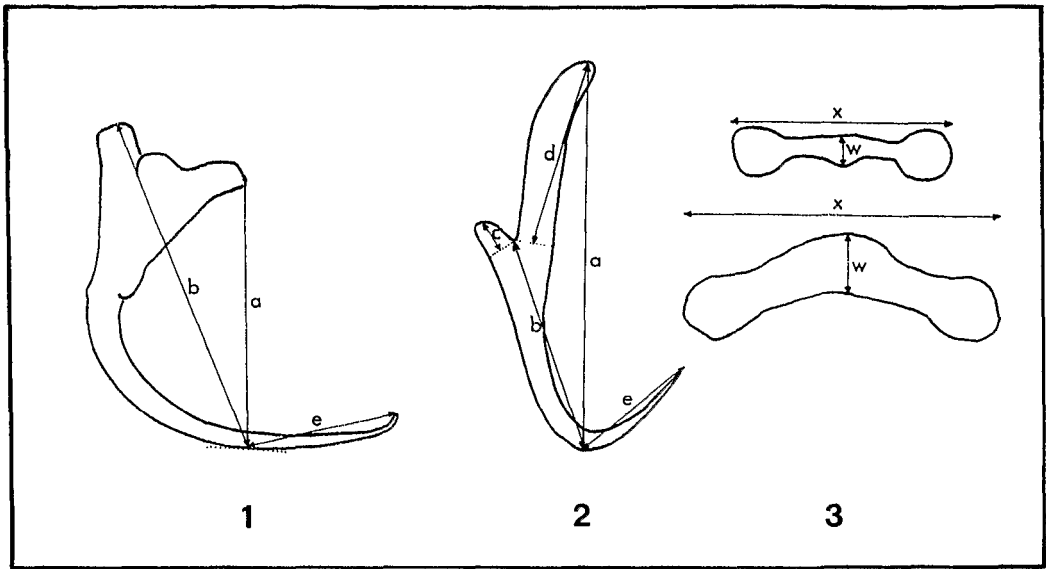


Figure 2. Measurements of haptor pieces used in this work. 1. *Dogielius hamuli*. 2. *Dactylogyrus hamuli*. 3. Transverse bars. a. Overall hook length. b. Length of shaft and inner root (1). b. Length of shaft (2). c. Length of outer root. d. Length of inner root. e. Length of the tip. W, width of transverse bar; X, length of transverse bar.

Mono system, Anié river at Anié (31), Togo, (MNHN 1989-1060) Mono system, Amou river at Amou-Oblo (32), Togo, (MNHN 1989-1058) Mono system, Aou at Aou-Losso (33), Togo, Mono system, Na river at Paratao (34), Togo, (MNHN 1989-1061) and (MNHN 1981-957) Mariti Iga river near Juba, Sudan. Monogeneans from these hosts were mounted directly in Berlese liquid and observed with a microscope.

Five field missions were carried out in West Africa and specimens of the following species were collected: *Labeo alluaudi* (MNHN 1988-1949) Nipoué river at Gbé-Nda (17), Côte d'Ivoire; Bagbwe river at Yfin (14), Sierra Leone, no collection code; *Labeo rouaneti* (MNHN 1988-1898, 1988-1899), Konkouré system, Konkouré near Télimélé (7), Republic of Guinea; *Labeo parvus*, Niger system, Milo at Boussoulé (1), Republic of Guinea, Fish not deposited, (MNHN 1988-1892) Niger system, upper Tinkisso near Dabola (3), Republic of Guinea, (MNHN 1988-1894, 1989-980) Senegal system, upper Bafing near Sokotoro (4), Republic of Guinea, (MNHN 1989-984) Fatala system, Fatala near Mabé (6), Republic of Guinea, (MNHN 1988-1895, 1989-985) Konkouré system, Konkouré near Télimélé (7), Republic of Guinea, (MNHN 1989-983) Little Scarcies system, Mongo at Moussaïa (11), Sierra Leone, (MNHN 1988-1896, 1988-1897) Little Scarcies system, Kaba river near Kouloundala (9), Republic of Guinea, (MNHN 1988-1893) Little Scarcies system, Mongo at Marela (10), Republic of Guinea, (MNHN 1989-982) Rokel river at Bumbuna (12), Sierra Leone, (MNHN 1989-1001) Rokel river at Kondembaya (13), Sierra Leone, (MNHN 1989-1002, 1989-1003) Bagbwe river at Yfin (14), Sierra Leone, Loffa river near Macenta (15), Guinea, Fish not conserved,

(MNHN 1989-1045) Nipoué at Toyébli (16), Côte d'Ivoire, (MNHN 1989-1047) Nipoué at Gbé-Nda (17), Côte d'Ivoire (MNHN 1989-1044, 1989-1051) Cavally at Sahoubli (18), Côte d'Ivoire, (MNHN 1989-1025) Sassandra system, Sassandra at Sémien (20), Côte d'Ivoire, Sassandra system, FéréDougouba tributary near Touba (21), Côte d'Ivoire, Fish not conserved, (MNHN 1989-1024) Bandama blanc near Marabadiassa (22), Côte d'Ivoire, Ouémé near Porto-Novo (35), Bénin, Fish not conserved. These fish were caught with gill nets and cast-nets. Various species of *Labeo* were identified by ORSTOM (Institut Français de Recherche pour le Développement en Coopération) ichthyologists. Nomenclature of Lévêque and Daget (1984) was used. The various individuals studied were deposited as vouchers at the Laboratoire d'Ichtyologie Générale et Appliquée, MNHN, Paris. The gills of fishes caught during field missions were placed in tubes (Eppendorf type), labelled, referenced, and then placed in liquid nitrogen in a cryogenic container. Liver and skeletal muscle were sampled in the same fish to study the polymorphism of enzyme proteins. Transport of the samples to France was effected either in an insulated box or a cryogenic container. In the laboratory, the detached gill arches were immersed in fresh water for examination under a binocular microscope. The monogeneans collected were fixed between slide and cover slip in Malmberg's mixture (glycerine and ammonium picrate). The preparations were sealed, and the parasites examined under a microscope. The sclerotized haptor parts and the copulatory apparatus were drawn with the aid of a drawing tube. Naming and numbering of haptor parts were in conformity with those adopted at ICOPA IV (Euzet and Prost, 1981).

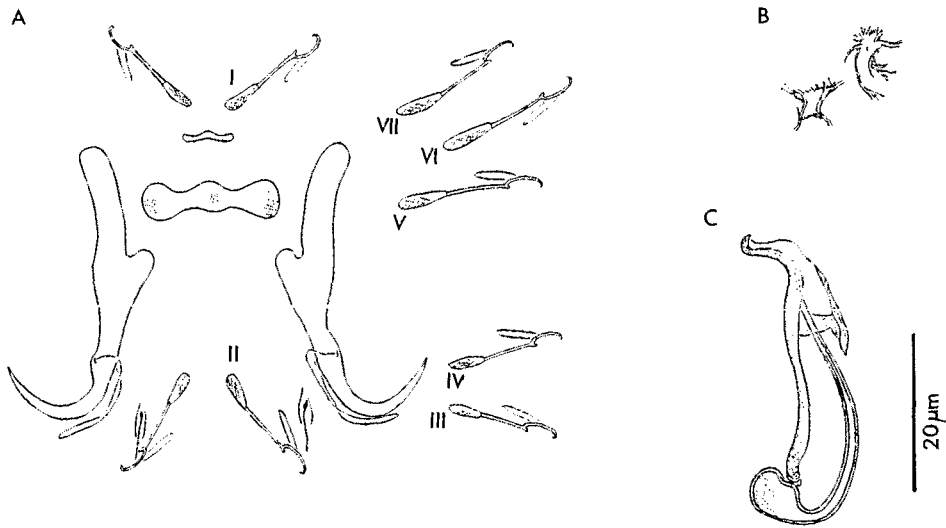


Figure 3. *Dactylogyrus longiphallus* Paperna, 1973. A. Haptoral apparatus. B. Vagina. C. Male copulatory organ. I to VII. Marginal hooklets.

Hamuli measurements of *Dactylogyrus* were those proposed by Gussev (1962) (Fig. 2). Slide b measurements of *Dogielius* species were defined in a slightly different manner (Fig. 2). All measurements are in micrometers (μm). In all cases in which there was a doubt as regards to the value of the morpho-anatomical criterion, analysis of variance (ANOVA) was applied to a set of quantitative variables corresponding to measurements of haptoral parts (a, b, c, d, e, X, W) (Fig. 2) and of the copulatory apparatus (accessory piece length, penis length). The results obtained for 2 discriminant variables to within the threshold of security are shown by a scatter diagram. Analyses were carried out using BIOMECA Version 3.2 supplied by CEPE-CNRS Biometry Group, route de Mende, BP 5051, 34033 Montpellier CEDEX, France.

Results and Descriptions

Dactylogyrus longiphallus Paperna, 1973 (Fig. 3)

TYPE HOST AND LOCALITY: *Labeo victorianus*: Victoria lake, Uganda and Nzoia river, Victoria lake system, Kenya (Paperna, 1973).

OTHER RECORDS: *L. forskali*, Albert lake, Uganda; *Barbus* cf. *kersteni*, Mobuku river, Monts Ruwenzori, Lake Georges system, Uganda; *B. altianalis*, Kazinga channel, Uganda; *Labeo* sp. 1 and *Labeo* sp. 2, Ruaha river, Tanzania (Paperna, 1973, 1979).

NEW RECORDS: *Labeo parvus*, localities 2-4, 6-7, 9-16, 18, 20-26, 29, 31-32, 34-35, and Mariti Iga river, Sudan.

SPECIMENS: Syntypes M.T. 35.702 (Paperna, 1973).

REMARKS (based on 30 specimens in toto):

Body length 390 (280-480); greatest width 70 (40-80) usually at level of ovary. Hamuli lengths: a: 38 (35-41); b: 23 (20-26); c: 2-3; d: 16 (14-18); e: 11 (10-13). Dorsal transverse bar 16-19 long, vestigial ventral bar 5-8 long. Hook lengths: I, II, III, IV: 14-17; V, VI, VII: 16-20; 4A: 7-9. Male copulatory apparatus (38-45) long, consisting of basal ampulla (diameter 6-8) followed by narrow, tubular penis tapering distally. Accessory piece (31-40) fixed to basal ampulla, forming a fork, 1 branch of which continued by finely sclerotized sheath, serving as penis guide. Vagina slightly and irregularly sclerotized near vaginal pore.

This species occurs on *Labeo parvus* in numerous basins in West Africa. Paperna (1973, 1979) reported *Dactylogyrus longiphallus* on *L. victorianus* in Uganda and Kenya, on *L. forskali*, *Barbus* cf. *kersteni*, *B. altianalis* in Uganda and on 2 unclassified *Labeo* in Tanzania. Paperna revealed considerable morphometric variation in haptoral parts and in the copulatory apparatus. The individuals presented here are of similar size to the parasites of *L. victorianus* from the Nzoia river (Lake Victoria system) in Kenya. The specific diversity of the hosts studied (sometimes unclassified), and their varied biogeographical origins, suggest that a complex of parasite species exists. However, no criterion appeared to us to be sufficiently weighty to discriminate a new species.

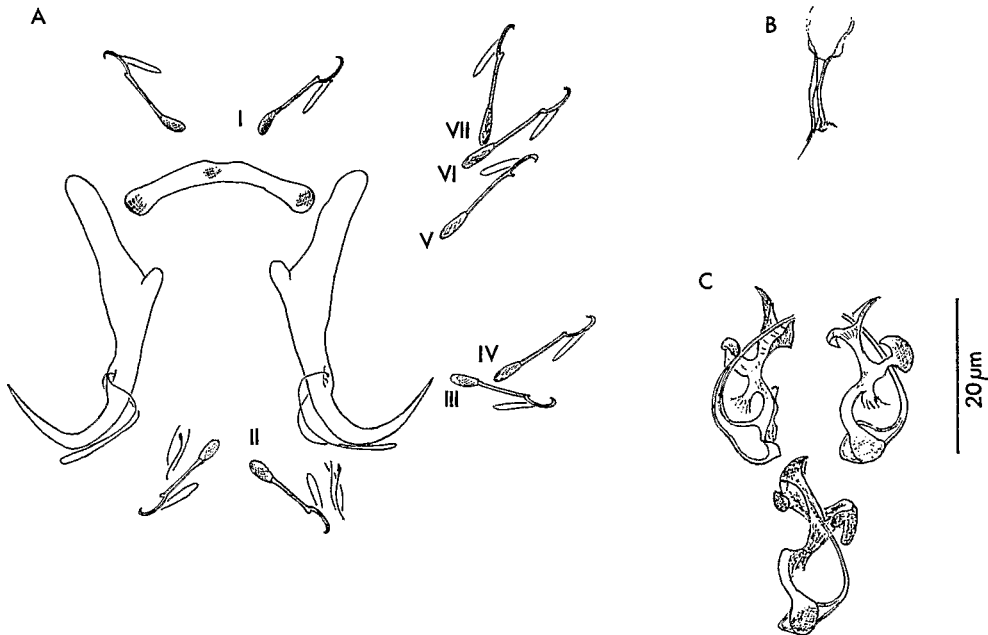


Figure 4. *Dactylogyrus falcilocus* Guégan, Lambert, and Euzet, 1988. A. Haptoral apparatus. B. Vagina. C. Male copulatory organ. I to VII. Marginal hooklets. Drawn after specimens from *Labeo parvus* from the Little Scarcies.

Dactylogyrus brevicirrus Paperna, 1973

TYPE HOST AND LOCALITY: *Labeo victorianus*; Victoria lake, Uganda (Paperna, 1973).

OTHER RECORDS: *L. victorianus*, Nzoia river, lake Victoria system, Kenya; *L. forskali* and *Barilius niloticus*, lake Albert (Mobutu), Uganda and Zaïre; *Barbus perince*, Sonso river, lake Albert system, Uganda; *B. neglectus*, lake Edward, Uganda; *B. kersteni*, Jinja bay, lake Victoria, Uganda; *B. altianalis*, Nzoia river, Kenya; *Labeo cylindricus*, Ruaha river, Tanzania (Paperna, 1973, 1979).

NEW RECORDS: *Labeo parvus*, localities 3–5, 18, 20, 22–23, 25–26, 29, 31, 35.

SPECIMENS: Holotype, paratypes M.T. 35.706 (Paperna, 1973).

Dactylogyrus falcilocus

Guégan, Lambert, and Euzet, 1988

(Fig. 4)

TYPE HOST AND LOCALITY: *Labeo coubie*; Niger system at Bamako, Mali.

OTHER RECORDS: *Labeo coubie*, Senegal system, Baoulé river at Missira and Dlaba, Mali (Guégan et al., 1988).

NEW RECORDS: *Labeo parvus*, localities 1, 3, 4, 7, 9–14, 22; *Barbus wurtzi*, localities 9–11.

SPECIMEN: Holotype MNHN 264 HC.

DESCRIPTION (based on 20 specimens in toto):

Body length 400 (320–520); greatest width 80 (60–100) usually at level of ovary. Hamuli lengths: a: 36 (34–39); b: 23 (22–24); c: 1–3; d: 16 (14–18); e: 12–14. Dorsal transverse bar 23–27 long, 2–4 wide. Hook length (all pairs) 14–17; 4A: 7–10. Male copulatory apparatus (20–24) consisting of basal ampulla followed by a fine penis (18–23). Sclerotized bifid accessory piece (15–20) fixed to ampulla: proximal branch forming elbow; distal part in shape of small gutter with raised edges. Vagina with finely sclerotized wall, forming a pocket prolonged by hollow tube (10–14).

REMARKS: Specimens collected on *Labeo parvus* in numerous basins are similar to *Dactylogyrus pseudanchoratus micronchus* Paperna, 1979, from unidentified *Labeo* in the Ruaha river in Tanzania, except for the presence of a sclerotized vagina. These parasites are identified as *D. falcilocus* Guégan, Lambert, and Euzet, 1988, reported previously as specific to *L. coubie* in the middle Niger and upper Senegal basins. *Dactylogyrus falcilocus* is absent from *L. parvus*, which is sympatric with *L. coubie* in these 2 basins (Guégan et al., 1988). This monogenean is found on another cyprinid, *Barbus wurtzi*, in the Little

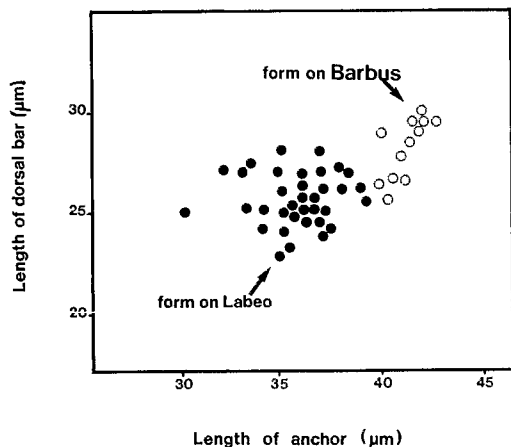


Figure 5. Scatter diagram representing length of anchor versus length of dorsal bar for 2 forms of *Dactylogyrus falcilocus*: form on *Labeo coubie* (Niger and Senegal basins) and *Labeo parvus* (short coastal rivers), and form on *Barbus wurtzi* (Little Scarcies basin) ($P < 0.05$).

Scarcies basin of Guinea and Sierra Leone (Guégan and Lambert, 1990; Lévêque and Guégan, 1990). A biometric analysis carried out on the parasites occurring on *L. coubie*, *L. parvus*, and *B. wurtzi* resulted in 2 distinct morphotypes: the

first is that of individuals found on *Labeo* and the second on *Barbus* (Fig. 5).

Dogielius kabaensis sp. n.
(Fig. 6)

TYPE HOST AND LOCALITY: *Labeo parvus*; Little Scarcies system, Kaba at Kouloundala, Republic of Guinea (locality 9).

OTHER RECORDS: *L. parvus*, localities 6-7, 10-11, 13-15; *Labeo alluaudi*, locality 14.

SPECIMENS: Holotype MNHN 454 HC, slide Tj 241; paratype MNHN 454 HC, slide Tj 241 bis.

DESCRIPTION (based on 19 specimens in toto):

See Table 1. Male copulatory apparatus short, with double accessory piece: first piece initially thin, spoon-shaped with edges slightly raised; second piece more sclerotized, bifid distally. Penis slightly incurvate, tubular slides in elbow formed by outermost branch of accessory piece. Vagina forming small pocket, with finely sclerotized walls.

ETYMOLOGY: The specific name is derived from the name of the tributary where the species was initially found.

REMARKS: Paperna (1979) characterized 2 subspecies of *Dogielius junorstroma* Price and

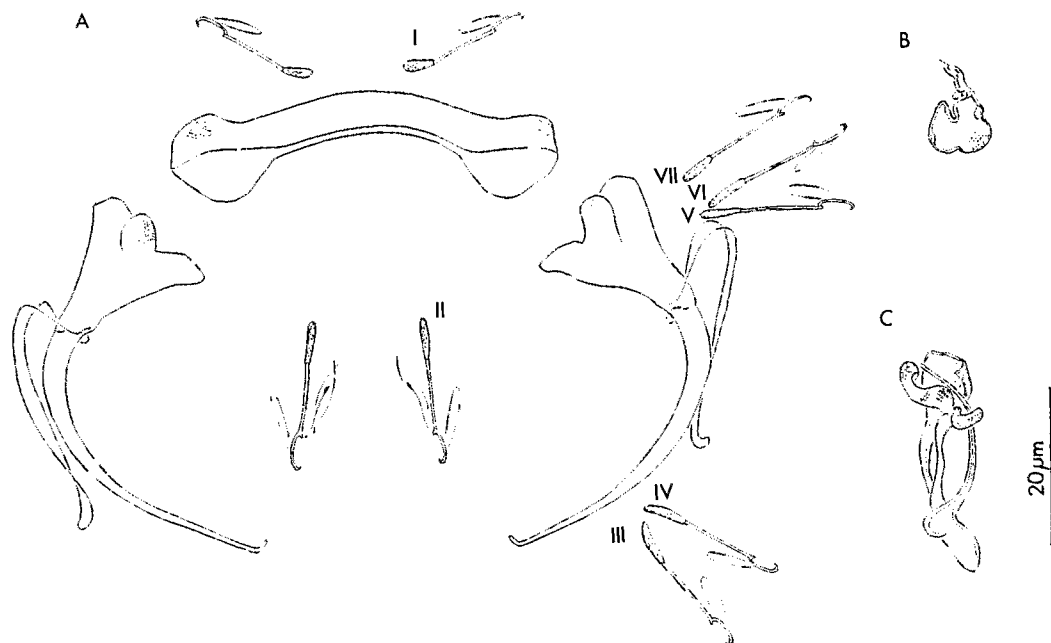


Figure 6. *Dogielius kabaensis* sp. n. A. Haptoral apparatus. B. Vagina. C. Male copulatory organ. I to VII. Marginal hooklets.

Table 1. Measurements of *Dogielius kabaensis* sp. n. in relation to the host species.

Locality:	Form on <i>Labeo parvus</i> (N = 14) Coastal rivers	Form on <i>Labeo alluaudi</i> (N = 5) Bagbwe river
Body length	370 (330–420)	320 (280–380)
Body width	70 (60–80)	60 (50–80)
Anchor lengths a	33 (30–36)	28–30
b	43 (41–45)	34–37
c	16 (14–17)	17–20
Dorsal bar length	50–56	40–42
Dorsal bar width	5–7	4–5
Hook lengths I	16–18	16–18
II	16–18	16–18
III	16–18	16–18
IV	16–18	16–18
V	20–22	18–20
VI	20–22	18–20
VII	20–22	18–20
4A	8–10	7–10
Copulatory organ length	28–31	30–32
Accessory piece length	19–22	20–24
Penis length	22–30	25–30

Yurkiewicz, 1968: *D. junorstrema victorianus* from *L. victorianus* and *Barbus altianalis* in Kenya; *D. junorstrema ruahae* from *L. cylindricus* and an unclassified *Labeo* in Tanzania. Similarities of morphology and size of individuals described here and *D. junorstrema victorianus* Paperna, 1979, are apparent. Paperna (1979) felt that these morphs belong to the same species and that they are encountered in different hosts in different basins. These worms also have affinities with *Dogielius parvus* Guégan, Lambert, and Euzet, 1989, from *Labeo parvus* in the Niger and the Senegal basins (Guégan et al., 1989). Present specimens differ from *D. parvus* in the morphology of the accessory piece, the presence of a sclerotized vagina and size of the haptor pieces (Fig. 7). Distinction is made between forms of *D. kabaensis* sp. n. occurring on *L. parvus* and *L. alluaudi*. We are of the opinion that they represent a complex of species which is difficult to characterize with usual anatomical criteria.

***Dactylogyrus longiphalloides* sp. n.**
(Fig. 8)

TYPE HOST AND LOCALITY: *Labeo alluaudi*; Bagbwe river near Yfin, Sierra Leone (locality 14).

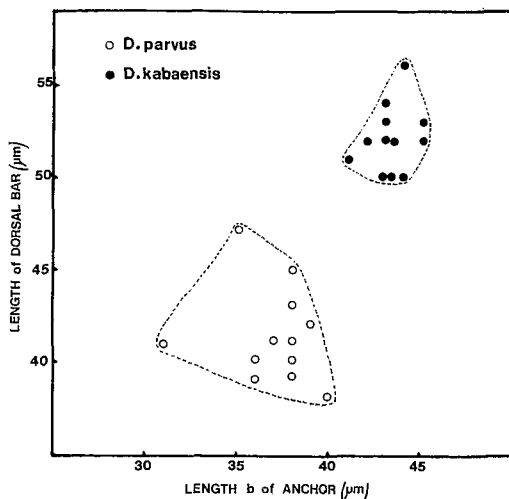


Figure 7. Scatter diagram of length b of anchor versus length of dorsal bar for 2 species of *Dogielius*: *D. parvus* from *Labeo parvus* (Niger and Senegal basins) and *D. kabaensis* sp. n. from *L. parvus* in short coastal rivers (Guinea, Sierra Leone, and Liberia) ($P < 0.05$).

SPECIMENS: Holotype MNHN 80 HF slide 95 Ti; paratype MNHN 80 HF slide 96 Ti.

DESCRIPTION (based on 7 specimens in toto): Body length 370 (250–460); greatest width 60 (40–80) usually at level of ovary. Hamuli lengths: a: 43 (40–45); b: 25 (24–28); c: 1–3; d: 20 (19–21); e: 12–14. Dorsal transverse bar 18 (17–20) long, 3–5 wide; vestigial ventral bar length 8–10 long. Hook lengths: I, II: 16 (15–18); III, IV: 15–16; V, VI, VII: 18 (17–19); 4A: 8–10. Male copulatory apparatus 50 (45–52), forming a tubular penis 40–46 long which becomes thinner towards its extremity. Bifid accessory piece 48–54 long, 2 branches connected by a fine sclerotized formation. Vagina finely sclerotized near the pore.

ETYMOLOGY: The species name is derived from the similarity of the copulatory organ to that of *Dactylogyrus longiphallus*.

REMARKS: *Dactylogyrus longiphalloides* found in *Labeo alluaudi* from the Bagbwe in Sierra Leone resemble *Dactylogyrus longiphallus* Paperna, 1973, from *L. parvus* in numerous basins in West Africa. Although they are of the same morphological type, the specimens presented differ from *D. longiphallus* insofar as they have larger haptor pieces (length of a, length of d, lateral hooklets V, VI, VII), and copulatory apparatus. A scatter diagram is presented in which distinction can be made between the 2 groups

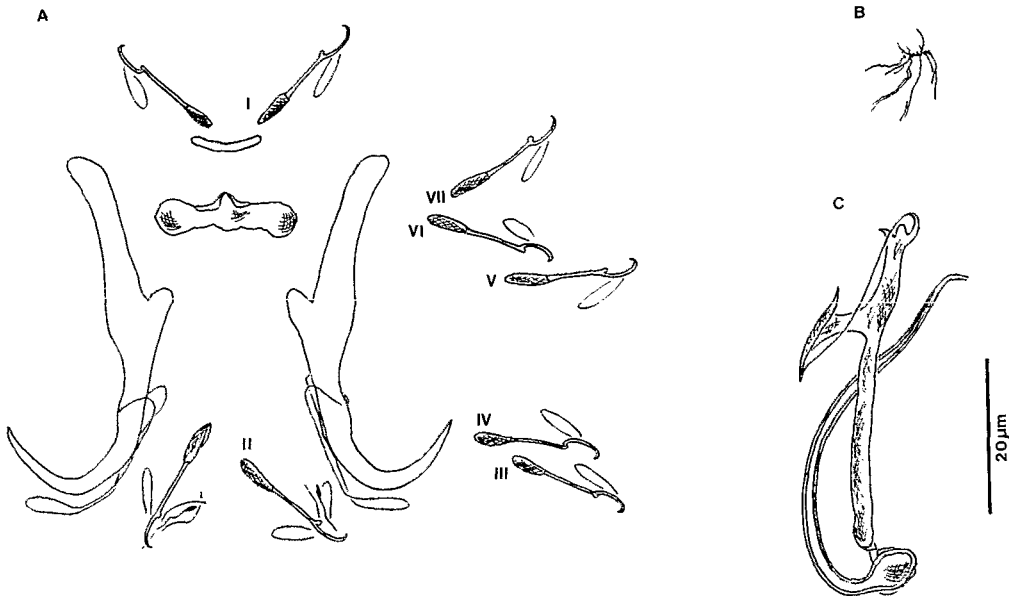


Figure 8. *Dactylogyrus longiphalloides* sp. n. A. Haptoral apparatus. B. Vagina. C. Male copulatory organ. I to VII. Marginal hooklets.

(*D. longiphallus* from *L. parvus* and *D. longiphalloides* from *L. alluaudi*) (Fig. 9). The fact that there is no overlapping between measurements of the genital parts leads us to consider that the 2 groups are well isolated.

Paperna (1979) observed similar variations according to host species and basin. He deduced that individuals of *D. longiphallus* from different isolated populations belong to a species complex (cf. discussion on *Dactylogyrus longiphallus*). The simultaneous presence of *D. longiphallus* on *L. parvus* and of *D. longiphalloides* on *L. alluaudi* in the Bagwe basin in Sierra Leone suggests to us that there are 2 distinct but related species, each associated with a different but related host species. This monogenean was not found in Nipoué and Cavally *L. alluaudi* populations at the Liberia-Côte d'Ivoire border.

***Dactylogyrus sematus* sp. n.**
(Fig. 10)

TYPE HOST AND LOCALITY: *Labeo rouaneti*; Konkouré system, Konkouré river near Téli-mélé. Republic of Guinea (locality 7).

OTHER RECORDS: *L. rouaneti*, locality 8.

SPECIMENS: Holotype MNHN 450 HC, slide Tj 237; paratype 450 HC, slide Tj 237 bis.

DESCRIPTION (based on 26 specimens in toto): Body length 370 (220–670); greatest width 70 (40–110) usually at level of ovary. Hamuli lengths:

a: 41 (39–43); b: 25 (23–27); c: (3–5); d: 20 (18–21); e: 14 (13–15). Dorsal transverse bar 19–23 long, 3–5 wide; vestigial transverse ventral bar 8–10 long. Hook lengths: I, II: 16–19; III, IV:

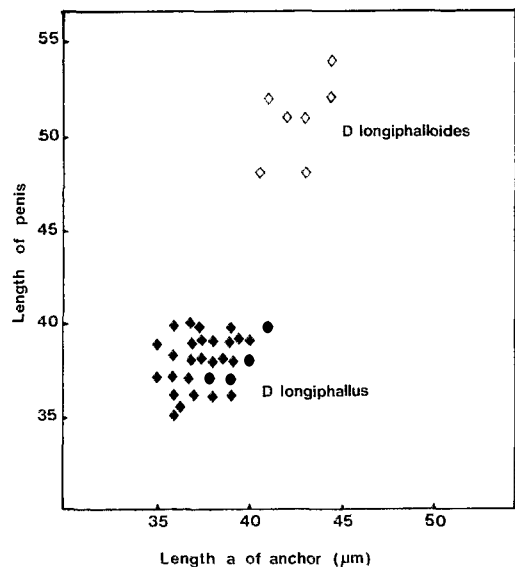


Figure 9. Scatter diagram representing length a of anchor versus length of penis for 2 species of *Dactylogyrus*: *D. longiphallus* from *Labeo parvus* (short coastal rivers) and *D. longiphalloides* sp. n. from *L. alluaudi* (Bagwe river) ($P < 0.01$).

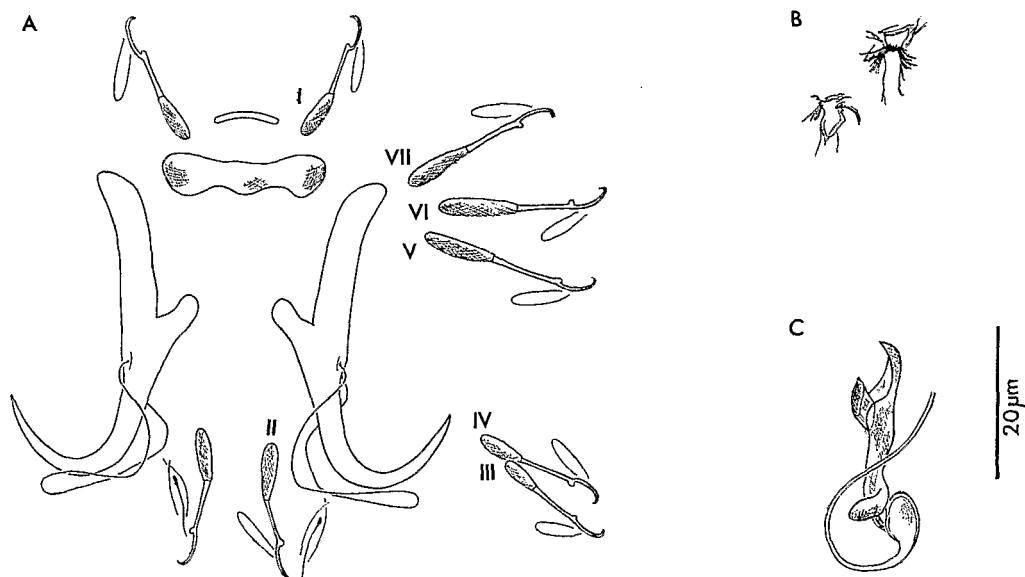


Figure 10. *Dactylogyrus sematus* sp. n. A. Haptoral apparatus. B. Vagina. C. Male copulatory organ. I to VII. Marginal hooklets.

15–17; V, VI, VII: 19–23; 4A: 8–10. Male copulatory apparatus starts with oval basal ampulla from which long, fine, convoluted penis originates (35–42). Sclerotized accessory piece attached to basal ampulla by stem, possessing proximal elbow, distal bifid expansion. Vagina is finely sclerotized near vaginal pore.

ETYMOLOGY: The species name is derived from the accessory piece, which is simple and bare in comparison to other species (Latin *sematus*, half full, half empty).

REMARKS: The male copulatory apparatus of this species is of the same morphotype as that of species of *Dactylogyrus* from *Barbus* spp. in southern Cameroon (Birgi and Lambert, 1987). However, details of morphology and size differ in parasites from *Labeo rouaneti*. *Dactylogyrus sematus* do not resemble any known parasite from *Labeo* or from great *Barbus* in West Africa.

***Dactylogyrus jucundus* sp. n.**
(Fig. 11)

TYPE HOST AND LOCALITY: *Labeo rouaneti*; Konkouré system, Konkouré river near Téli-mélé, Republic of Guinea (locality 7).

OTHER RECORDS: *L. rouaneti*, locality 8. *L. parvus*, localities 4, 7, and 14.

SPECIMENS: Holotype MNHN 451 HC, slide Tj 238; paratype MNHN 451 HC, slide Tj 238 bis.

DESCRIPTION (based on 15 specimens in toto):

Body length 490 (250–630), greatest width 90 (40–120) usually at level of ovary. Hamuli lengths: a: 50 (47–55); b: 30 (26–33); c: 4 (3–6); d: 26 (22–29); e: 17–18. Dorsal transverse bar 22–26 long; vestigial ventral transverse bar 8–10 long. Hook lengths: I, II, III, IV: 18–20; V, VI, VII: 20–22; 4A: 8–10. Male copulatory apparatus (26–30) has an oval basal ampulla with long (40–47), curved penis. Sclerotized accessory piece (26–30) attached to ampulla by stem, finely sclerotized first shaft and characteristic main swelling forming a beak at the distal extremity. Vagina finely sclerotized near the pore.

ETYMOLOGY: The species name is derived from Latin, *jucundus*, charming, appealing.

REMARKS: The general morphology of the male copulatory apparatus is similar to that of *Dactylogyrus helicophallus* Paperna, 1973, found on *Labeo forskali* (type host) in Uganda, *L. victorianus* in Kenya and in 2 unclassified species of *Labeo* from the Ruaha river in Tanzania (Paperna, 1973, 1979). However, penis and accessory piece morphology and hooklet size are different. The genital morphology of these parasites also resembles that of *D. longiphallus gracilis* Paperna, 1979, from *Barbus ablades* in Ghana (Paperna, 1979). However, *D. helicophallus* and *D. longiphallus gracilis* are distinctly different from *D. jucundus* in the size of the male copulatory apparatus and hamuli morphology and size. We report a sclerotized vagina, a feature not



Figure 11. *Dactylogyrus jucundus* sp. n. A. Haptoral apparatus. B. Vagina. C. Male copulatory organ. I to VII. Marginal hooklets.

mentioned in the original descriptions of *D. helicophallus* and *D. longiphallus gracilis*. *Dactylogyrus jucundus* possesses a copulatory apparatus accessory piece of the same type as *D. decaspirus* Guégan, Lambert, and Euzet, 1988, a parasite of *L. coubie*, and *D. senegalensis* Paperna, 1969, found on *L. senegalensis* from the Niger and Senegal basins (Paperna, 1969; Guégan et al., 1988). However, individuals examined in this study differed in that they had a shorter, non-spiral penis.

***Dactylogyrus omega* sp. n.**
(Fig. 12)

TYPE HOST AND LOCALITY: *Labeo rouaneti*; Konkouré system, Konkouré river near Téli-mélé, Republic of Guinea (locality 7).

OTHER RECORDS: *L. rouaneti*, locality 8. *L. parvus*, localities 14 and 20.

SPECIMENS: Holotype MNHN 452 HC, slide Tj 239; paratype MNHN 452 HC, slide Tj 239 bis.

DESCRIPTION (based on 31 specimens in toto):

Body length 530 (360–830); greatest width 100 (70–120) usually at level of ovary. Hamuli lengths: a: 35 (32–36); b: 28 (26–30); c: 5 (3–6); d: 12 (10–14); e: 14 (13–15). Dorsal transverse bar 24–28 long, 4–6 wide. Small longitudinal ventral

sclerification (4–6). Hook lengths: I: 18–20; II: 20–22; III, IV, V, VI, VII: 15–16; 4A: 8–10. Male copulatory apparatus (35–42) has large basal ampulla from which runs a hollow penis (diameter 2–3), forming a loose single spiral. Ampulla bears finely sclerotized accessory piece in the shape of an elongated ring lying on either side of the cirrus. No sclerotized vagina observed.

ETYMOLOGY: The species name is derived from the similarity of the penis to the Greek letter Ω .

REMARKS: This parasite is found on *Labeo rouaneti*, mainly in the Konkouré basin. A low prevalence is found on *L. parvus*. Morphology of male copulatory apparatus is similar to that of *Dactylogyrus cyclocirrus* on *L. cylindricus* (type host) in Tanzania, on *L. victorianus* in Kenya, and in *L. coubie* and *L. senegalensis* in Ghana (Paperna, 1973). The haptoral pieces of our specimens are very similar to measurements of worms described on *L. victorianus* from the Nzoia river in Kenya. Paperna (1979) reported that individuals of *D. cyclocirrus* varied morphometrically depending on collection site and host species. *D. cyclocirrus* also was observed on *Labeo senegalensis* in West Africa (Guégan et al., 1988), but the parasite was specific to this host species. Monogeneans from *L. rouaneti* (Konkouré ba-

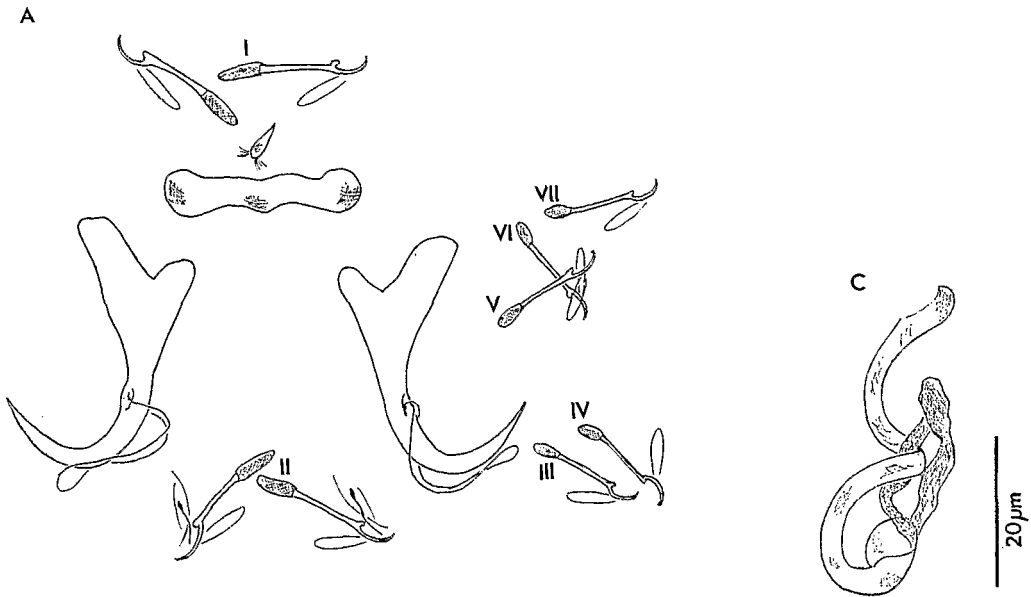


Figure 12. *Dactylogyrus omega* sp. n. A. Haptoral apparatus. B. Vagina. C. Male copulatory organ. I to VII. Marginal hooklets.

sin) and *L. senegalensis* (Niger and Senegal basins) are distinguished based on length of transverse bars versus total length of hamulus (Fig. 13). Although the individuals described here are morphologically similar to *D. cyclocirrus*, they are distinguished by a smaller penis diameter, different size of hamuli and geographical distribution.

***Dogielius rosumplicatus* sp. n.**
(Fig. 14)

TYPE HOST AND LOCALITY: *Labeo rouaneti*; Konkouré system, Konkouré river near Téli-mélé, Republic of Guinea (locality 7).

OTHER RECORDS: *L. rouaneti* and *L. parvus*, locality 8.

SPECIMENS: Holotype MNHN 453 HC, slide Tj 240; paratype MNHN 453 HC, slide Tj 240 bis.

DESCRIPTION (based on 24 specimens in toto):

Body length 330 (250–450); greatest width 80 (70–90) usually at level of ovary. Hamuli lengths: a: 34 (32–36); b: 43 (41–45); e: 16 (15–18). Dorsal transverse bar 50–57 long, 8–10 wide. Hook lengths: I, II, III, IV, V, VI, VII: 20–22; 4A: 7–8. Male copulatory apparatus (30–36), with slightly incurvate penis, 25–30 long. Distal part of accessory piece is palette-shaped with lateral extensions, one of which is an elbow in which

the penis slides. Vagina is well sclerotized around its opening, walls becoming less distinct.

ETYMOLOGY: The species name is derived from the combination of 2 Latin words that reflect the aspect of the accessory piece (*plico*, to bend, and *rosum* from *rodo*, deckle-edged, shabby).

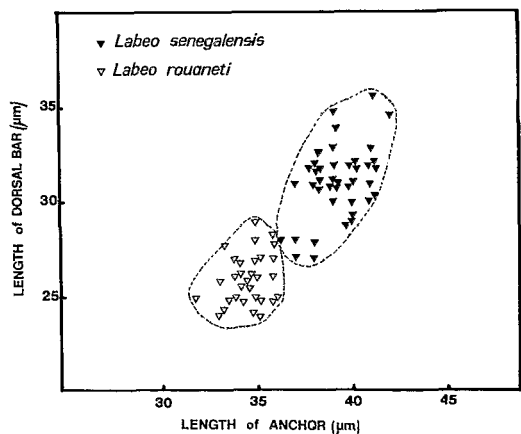


Figure 13. Scatter diagram of length of anchor versus length of dorsal bar representing *D. cyclocirrus* from *Labeo senegalensis* (Niger and Senegal basins) and *D. omega* sp. n. from *L. rouaneti* (Konkouré basin) ($P < 0.01$).

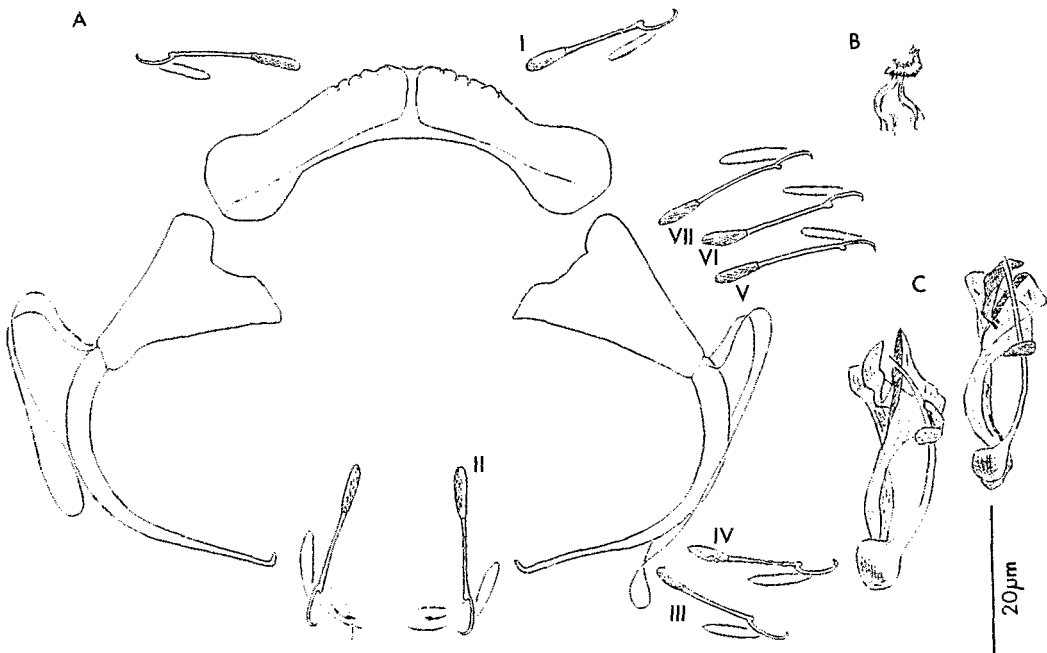


Figure 14. *Dogielius rosumplicatus* sp. n. A. Haptor apparatus. B. Vagina. C. Male copulatory organ. I to VII. Marginal hooklets.

REMARKS: This monogenean resembles *Dogielius harpagatus* Guégan, Lambert, and Euzet, 1989, and *D. clavipenis* Guégan, Lambert, and Euzet, 1989, from *Labeo coubie* in the Niger and Senegal basins (Guégan et al., 1989). It displays the same morphological type of accessory piece but differs in hamuli size and morphology of the copulatory apparatus.

Discussion

Dactylogyridae described herein from *Labeo* (Teleostei: Cyprinidae) in coastal river basins in West Africa are different from those of *Labeo* in Sahel-Sudan basins in Niger and in the Senegal basin in Mali (Guégan et al., 1988, 1989). Affinities between the different species of *Labeo* and those observed in their parasitofauna are compared. With regard to biogeographical features, we noted presence of monogeneans in populations of *L. parvus* in the large Sahel-Sudan basins, in Côte d'Ivoire systems, in Ghana, Togo and Benin systems, and their absence in the short coastal basins running from the Guinean ridge in Guinea, Sierra Leone, and Liberia. The distribution of *Labeo parvus* (Fig. 15a) and 2 species of dactylogyrids, *Dactylogyrus longiphallus* and *D. brevicirrus* (Fig. 15b), are compared. The monogenean populations of *L. parvus* from the

Guinean short coastal basins differ from populations of adjacent basins in that *D. brevicirrus* is absent. It is presumed that this is the result of a "host switching" followed by speciation on a new host (Guégan and Agnèse, 1990). A comparable phenomenon is observed for monogeneans on cyprinid species, genus *Barbus*, where there is exclusion of very primitive parasite forms on *B. petitjeani*, *B. sacratus*, and *B. parawaldroni* from small coastal basins and their replacement by more derived species in barbels of the *B. bynni* group in peripheral basins (Guégan and Lambert, 1990; Lévêque and Guégan, 1990). The variations in parasitism observed between the different populations of the *L. parvus* complex suggest that fishes in the Guinean zone have not been affected by invasion of *D. brevicirrus*. The parasitism observed is certainly similar to the original parasitofauna of the ancestor(s) of *L. parvus*. Parasite distribution defines 2 different biogeographical regions marked by isolated river systems. Our study concluded that there are considerable differences in the parasitofauna in these 2 host populations which are separated by a natural barrier. This supports Pellegrin's (1908) hypothesis distinguishing *L. obscurus* limited to a few basins in Guinea and Sierra Leone, from all the other populations of *L. parvus*. However, it

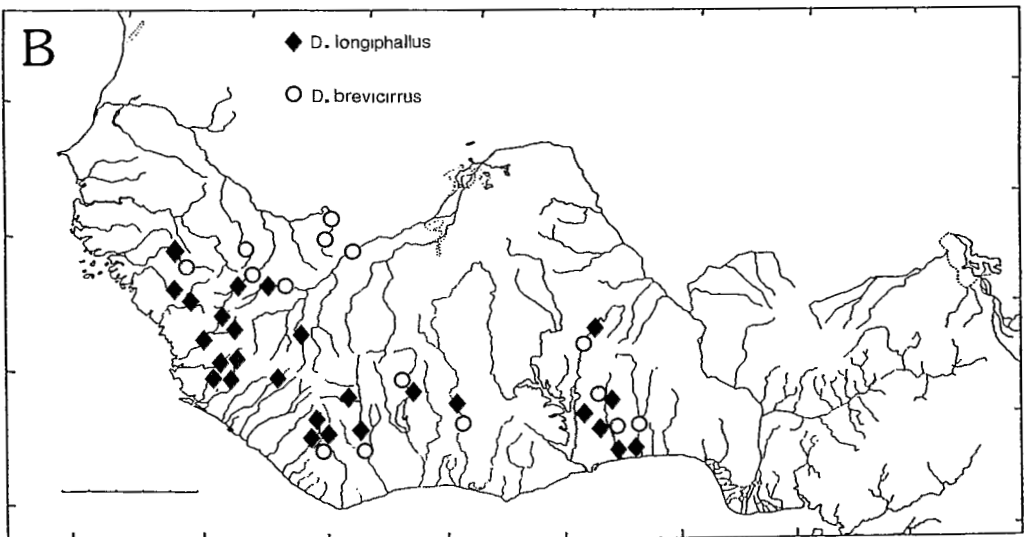
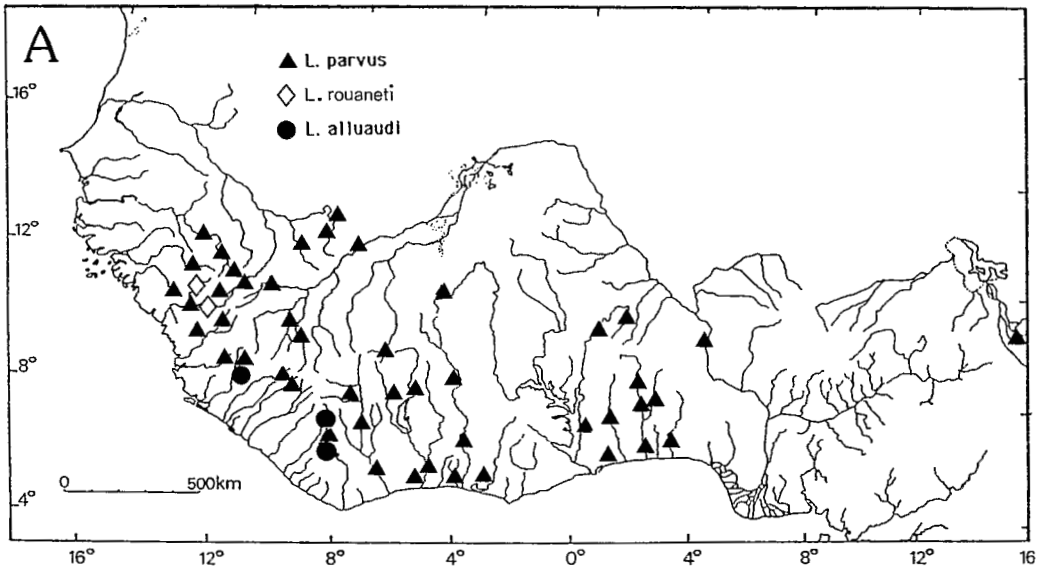


Figure 15. Area of distribution of 2 species and 1 complex of species of *Labeo*: *L. rouaneti*, *L. alluaudi*, and *L. parvus* complex in West Africa (Fig. 15a), and distribution of 2 species of *Dactylogyrus*: *D. longiphallus* and *D. brevicirrus* identified on *L. parvus* complex (Fig. 15b).

is impossible to specify the degree of divergence acquired by the various populations of the *L. parvus* complex since only a study of breeding would enable evaluation of their taxonomic levels.

Labeo rouaneti, which is considered to be phylogenetically close to *L. coubie* (Reid, 1985), displays a branchial parasitofauna that was not a precise reflection of the assumed affinity of these hosts. *Dactylogyrus jucundus* sp. n. and *Dogielius rosumplicatus* sp. n. are similar to 2 derived parasite forms found on *L. coubie*. The same does not apply to the other monogeneans present on *L. rouaneti*: *Dactylogyrus omega* sp. n. is morphologically close to *D. cyclocirrus* described on several cyprinids in East Africa (Paperna, 1973, 1979), and which we report in West Africa on *L. senegalensis* (Guégan et al., 1988); *D. sematus* sp. n. belongs to a completely original type of dactylogyrid monogenean from West African species of *Labeo* since it is similar to certain *Dactylogyrus* on small *Barbus* in southern Cameroon (Birgi and Lambert, 1987). In a biogeographical study on the ichthyological communities of the various basins in West Africa, Huguény (1989) demonstrated the faunistic similarities between Guinea and the Cameroon-Gabon area. The presence of *D. sematus* sp. n. in a Guinean basin supports this hypothesis.

The monogeneans found on *L. alluaudi* in Sierra Leone are closely related to those on *L. parvus* populations in short coastal basins. It can be imagined that the parasites evolved in a concomitant way, speciation of the fish being followed by that of the monogeneans. On the basis of the parasite criterion, we accept the theory put forward by Reid (1985) who classified *L. alluaudi* as part of the *L. parvus* group. The absence of monogeneans in the *L. alluaudi* populations of the rivers Cavally and Nipoué might be explained by the ecological conditions of this fish (small rapids in the upper course of the river).

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Literature Cited

- Birgi, E., and A. Lambert. 1987. Les Dactylogyridae (Plathelminthes, Monogenea) des Cyprinidae du genre *Barbus* du sud-Cameroun. *Revue d'Hydrobiologie Tropicale* 20:37-48.
- Daget, J. 1962. Les poissons du Fouta-Djalou et de la basse-Guinée. Mémoire de l'Institut Français d'Afrique Noire 65:1-210.
- , and A. Itfis. 1965. Poissons de Côte d'Ivoire (eaux douces et saumâtres). Mémoire de l'Institut Français d'Afrique Noire 74:1-385.
- Euzet, L., and C. Combes. 1980. Les problèmes de l'espèce chez les animaux parasites in Les problèmes de l'espèce dans le règne animal. Mémoire de la Société Zoologique de France 40:239-283.
- , and M. Prost. 1981. Report of the meeting on Monogenea: problems of systematics biology and ecology. Proceedings of the Fourth International Congress of Parasitology (ICOPA IV). Review of Advances in Parasitology. pp. 1003-1004.
- Grove, A. T. 1985. The physical evolution of the river basins. Pages 21-61 in A. T. Grove, ed. The Niger and its Neighbours. Environmental History and Hydrobiology. Human Use and Health Hazards of the Major West African Rivers. A. A. Balkema Publishers, The Netherlands.
- Guégan, J. F., and J. F. Agnès. 1990. Host phylogeny infers parasite evolutionary events: the case of monogenean gill parasite of *Labeo* (Teleostei, Cyprinidae). *Canadian Journal of Zoology*. (In press.)
- , and A. Lambert. 1990. Twelve new species of dactylogyrids (Plathelminthes, Monogenea) from West African barbels (Teleostei, Cyprinidae) with some biogeographic implications. *Systematic Parasitology*. (In press.)
- , ———, and L. Euzet. 1988. Etude des Monogènes des Cyprinidae du genre *Labeo* en Afrique de l'Ouest. —I. Genre *Dactylogyrus* Diesing, 1850. *Revue d'Hydrobiologie Tropicale* 21:135-151.
- , ———, and ———. 1989. Etude des Monogènes des Cyprinidae du genre *Labeo* en Afrique de l'Ouest. —II. Genre *Dogielius* Bykhowsky, 1936. *Revue d'Hydrobiologie Tropicale* 22:35-48.
- Gussev, A. V. 1962. Key to parasites of freshwater fish of the U.S.S.R. In I. E. Bykhovskaya-Pavlovskaya. *Akademiia Nauk, S.S.S.R.* 919 pp. (Translated from Russian by Israel Program for Scientific Translations.)
- Huguény, B. 1989. West African rivers as biogeographic islands: species richness of fish communities. *Oecologia* 79:236-243.
- Jégu, M., and C. Lévêque. 1984. Les espèces voisines ou synonymes de *Labeo parvus* (Pisces, Cyprinidae) en Afrique de l'Ouest. *Cybiurn* 8:45-58.
- Lévêque, C., and J. Daget. 1984. Cyprinidae. Pages 217-342 in Daget, Gosse, and Thys van den Audenaerde, eds. CLOFFA I: Check-List of the Freshwater Fishes of Africa. MRAC-ORSTOM Publishers, Paris.

- , and J. F. Guégan. 1990. Les grands *Barbus* (Teleostei, Cyprinidae) d'Afrique de l'Ouest. *Revue d'Hydrobiologie Tropicale* 23:41–64.
- Paperna, I. 1969. Monogenetic trematodes of the fish of the Volta basin and South-Ghana. *Bulletin de l'Institut Français d'Afrique Noire* 31:840–880.
- . 1973. New species of Monogenea (Vermes) from African freshwater fish. A preliminary report. *Revue de Zoologie et de Botanique Africaines* 87:505–518.
- . 1979. Monogenea of inland water fish in Africa. *Annales du Musée Royal d'Afrique Centrale* 226:1–131.
- Paugy, D., J. F. Guégan, and J. F. Agnèse. 1990. Three simultaneous and independent approaches to the characterization of *Labeo roseopunctatus* sp. n. (Teleostei, Cyprinidae) in West Africa. *Canadian Journal of Zoology* 68:1124–1131.
- Pellegrin, J. 1908. Poissons recueillis par le Dr. Wurtz en Guinée française. Description de quatre espèces nouvelles. *Bulletin du Muséum National d'Histoire Naturelle de Paris* 14:204–209.
- Price, C. E., K. S. Korach, and R. McPott. 1969. The monogenean parasites of African species.—V. Two new *Dactylogyrus* species from Natal cyprinids. *Revue de Zoologie et de Botanique Africaines* 79: 273–279.
- , and W. J. Yurkiewicz. 1968. The monogenean parasites of African fishes.—VIII. A re-evaluation of the genus *Dogielius* Bykhowsky, 1936 with the description of a new species. *Revista Iberica Parasitologia* 28:467–472.
- Reid, G. M. 1985. A revision of African species of *Labeo* (Pisces, Cyprinidae) and a redefinition of the genus. Thesis Zoologicae, Braunschweig Verlag von J. Cramer 6:1–322.