Institut royal des Sciences naturelles de Belgique	Koninklijk Belgisch Instituut voor Natuurwetenschappen
BULLETIN	MEDEDELINGEN
Tome XLI, n° 7	Deel XLI, nr 7
Bruxelles, juin 1965.	Brussel, juni 1965.

CRUSTACEAN PARASITES OF AFRICAN FRESHWATER FISHES, MOSTLY COLLECTED DURING THE EXPEDITIONS TO LAKE TANGANYIKA, AND TO LAKES KIVU, EDWARD AND ALBERT BY THE INSTITUT ROYAL DES SCIENCES NATURELLES DE BELGIQUE,

Geoffrey FRYER (*)

Through the kindness of Dr A. CAPART I have been able to study the parasitic crustaceans of fishes collected during the Belgian expeditions to Lake Tanganyika in 1945-1947 and to Lakes Kivu, Edward and Albert in 1952-1954. I have also examined a number of African freshwater fishes in the collection of the Institut royal des Sciences naturelles de Belgique and discovered on them several parasites. These fishes came from various parts of Africa. Because of the scattered sources of the material it seems best to collect into one paper all the information gained rather than publish separate short accounts in the series of publications which record the results of the expeditions. The results are recorded here in systematic order, biological information being added where appropriate. Where numbers are given they are those under which the specimens were recorded during the expeditions or under which they, or in some cases their hosts, are catalogued in the museum.

(*) Freshwater Biological Association, The Ferry House, Far Sawrey, Ambleside, Westmorland, England.

COPEPODA.

Lamproglena monodi CAPART.

Luapula River, Kasanga (= Kasenga ?). One specimen on *Tilapia macrochir* BOULENGER.
Lake Edward. 3 specimens on *Haplochromis nubilus* (BOULENGER) (K. E. A. 572).
1 specimen on *Haplochromis* sp. (K. E. A. 572).

Lamproglena hemprichii HARTMANN.

« Crique de Banana ». 3 specimens on *Hydrocyon* sp. (I. G. M. 394).
Lake Tanganyika, Albertville. 3 specimens. No host data.
Lake Albert. 2 specimens on *Hydrocyon forskali* CUVIER (K. E. A. 1001).
2 specimens on *Hydrocyon forskali* CUVIER (K. E. A. 1159).

The record for Tanganyika is the first for that lake and that for Banana extends the known distribution of this species to the Lower Congo.

Of the specimens from Lake Albert the first two each had a typical long abdomen. The other two had an abdomen which was shorter than is usual. These four specimens, from the same host species in the same lake, confirm the variability of this species.

Opistholernaea laterobrachialis (FRYER).

(Figures 1-3)

Lake Mweru. One specimen on *Tilapia macrochir* BOULENGER (354).

In assigning this and the next mentioned species to *Opistholernaea*, a genus erected by YIN (1960), and not to *Lernaea* I follow YIN, LING, HSÜ, CHEN, KUANG and CHU (1963).

O. laterobrachialis was known previously only from Lake Bangweulu (FRYER 1959) where it occurs on the same host. Its occurrence in Lake Mweru is therefore not unexpected.

The single available specimen was attached to a piece of flesh and bone, apparently the palate though this is not certain. Fortunately it was possible to remove it intact, which is seldom possible as much of the body in this species is firmly embedded in the tissues of its host. Some features of the specimen are shown in figs. 1-3. The branches, both anterior and posterior, of the dorsal arms of the anchor, were longer and more pointed than in the types from Lake Bangweulu, and the lateral

« arm » of the trunk, although somewhat collapsed, was also larger and the neck region more swollen than in the Bangweulu material. The form of the anchor, neck and lateral « arm » of the trunk are obviously much influenced by the nature of the tissues through which they pass or against which they press. The head and anchor were not embedded in a fibrous, cancerous capsule as was always the case in the Bangweulu material. This may have been related to the fact that, so far as could be ascertained from the piece of tissue in which the specimen was embedded, the anchor had not succeeded in finding its way into the socket of the eye but was pressed against the bony palate.

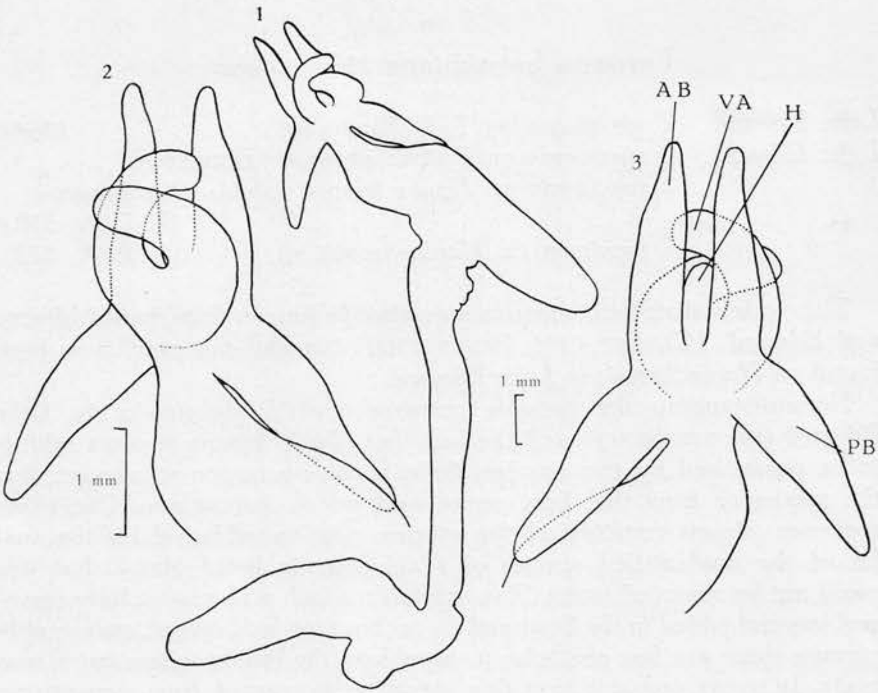

Fig. 1-3. — *Opistholernaea laterobrachialis* (FRYER).
1 : Adult ♀, ventral. 2 : The anchor, ventral. 3 : Head and anchor, dorsal.
AB : Anterior branch of dorsal arm. PB : Posterior branch of dorsal arm.
VA : Ventral arm. H : Head.

Opistholernaea longa (HARDING).

Lake Tanganyika, Albertville. 3 specimens on « Sangala » and « Nonzi ». (330).

The above are local names for *Lates angustifrons* BOULENGER and *L. microlepis* BOULENGER respectively. All the specimens were embedded in a piece of flesh from which they could not be removed, and the anchors of two at least had been severed, but their indentity is not in doubt.

This is the first record of this species from Lake Tanganyika. Previously it has been recorded from Lake Rudolf (HARDING 1950), Lake Albert (FRYER 1964), and the Lualaba River (FRYER 1960), always as a parasite of *Lates*.

In two specimens the pregenital prominence was even more strongly developed than in the specimen from the Lualaba figured by FRYER (1960), which itself had a more strongly developed pregenital prominence than specimens from Lake Rudolf. In this respect the other specimen was much as that figured from the Lualaba.

Lernaea barnimiana (HARTMANN).

Lake Mweru.	2 specimens on *Tylochromis* sp.	(354).
Lake Edward.	2 specimens on *Barbus altianalis* BOULENGER	
	2 specimens on *Haplochromis nubilus* (BOULENGER)	(K. E. A. 572).
	1 specimen on *Haplochromis* sp.	(K. E. A. 572).

This widely distributed species was already known from Lakes Mweru and Edward, (CAPART 1944, FRYER 1960) but had not previously been found on *Haplochromis* in Lake Edward.

Notwithstanding the possible occurrence of *L. cyprinacea* in Lake Edward (see next entry) and the fact that *Haplochromis* appears seldom to be parasitised by this species, there seems no reason to suspect that the specimens from that host genus were not *L. barnimiana*. One other specimen, almost certainly of this species, was embedded above the anal fin of the unidentified species of *Haplochromis* listed above, but this could not be removed intact. The specimen which was successfully removed was embedded in the head and its anchor was well spread, presumably because there are few obstacles to growth in the region where entry was made. It seems probable that this species is prevented from parasitising many specimens of *Haplochromis* because they are small and their scales do not offer the opportunities for flank settlement in the way described for *Barbus* and *Tilapia* (FRYER 1961b). Successful attachment to small fishes probably demands deep penetration, as in this case.

Lernaea cyprinacea L. ?

Large numbers of copepodid larvae of a species of *Lernaea* were found on the gills of *Bagrus docmac* (FORSKÅL) (K. E. A. 364) from Lake Edward. This may indicate that *L. cyprinacea* occurs in this lake, for in Lake Victoria copepodid larvae, proved to be of *L. cyprinacea* by infection experiments, have been found to occur in large numbers on the gills of *Bagrus docmac* (FRYER 1961a, b). No specimens of *L. barnimiana* were reared from these larvae from Lake Victoria even though suitable hosts were provided. Considering the histories of Lakes Edward and Victoria and the fact that *L. cyprinacea* probably invaded Africa via the Nile Valley, its occurrence in Lake Edward would not be unexpected.

Very slender evidence in support of the suggestion that *L. cyprinacea* occurs in Lake Edward is provided by a specimen found just inside the lip of an individual of *Tilapia nilotica regani* Poll in the fish collection. This specimen, which could not be removed intact, was slender as is *L. cyprinacea* found in similar situations on *Tilapia* spp. in Lake Victoria. It is not, however, possible to be sure that this was not an immature specimen of *L. barnimiana*. Further collections in Lake Edward are desirable.

Lernaea bistricornis HARDING ?

Lake Tanganyika. 1 specimen on *Boulengerochromis microlepis* (BOULENGER) (D2. IG).

This specimen, a not fully developed female attached at the base of the pectoral fin, cannot be identified with certainty, but showed incipient development of protuberances at each side of the head which suggest that it belongs to this species. *L. bistricornis* is known only from Lake Tanganyika where it has so far been found only on cichlid fishes, and always near the base of the fins (HARDING 1950, FRYER 1958).

Ergasilus kandti VAN DOUWE.

Lake Albert. On *Lates niloticus albertianus* WORTHINGTON. Many specimens (K. E. A. 1148).
On *Lates niloticus albertianus* WORTHINGTON. Several specimens (K. E. A. 1127).

Lake Tanganyika. On *Tilapia* sp. Numerous specimens (328).
On *Limnotilapia dardennei* (BOULENGER). One specimen (D. 2).
On *Plecodus paradoxus* BOULENGER. Several specimens (D. 2).
On *Tilapia tanganicae* (GÜNTHER). Several specimens (163).
On *Tilapia tanganicae* (GÜNTHER). Many specimens (31).
On *Lamprologus lemairei* BOULENGER. Two specimens (D2 IG).

As the records show, many specimens of this species were collected from Lakes Albert and Tanganyika, from both of which it was already known, but the host data are useful. It is obvious that wide host tolerance is shown.

Very heavy infestations were noted in some cases and on one specimen of *Lates* from Lake Albert as many as 15 specimens were found on a single gill filament. Always the parasites were settled on the lower (basal) parts of the gill filament, though when many specimens were present they extended over a considerable distance, but they were never located near the tips. (See also p. 15). The gill tissues of cichlid fishes suffer considerable damage as a result of the presence of this parasite. Much proliferation of gill tissue, takes place so that the antennae become buried and are not easy to remove intact. The gills of *Lates*, however, are much less delicate and appear to suffer little damage.

The spine formula was obtained from a specimen from Lake Albert and is given below.

P1	Exopodite	1 - 0	0 - 1	2 - 5
	Endopodite	0 - 1	0 - 1	2 - 4
P2	Exopodite	1*- 0	0 - 1	0 - 6
	Endopodite	0 - 1	0 - 2	1 - 4
P3	Exopodite	0 - 0	0 - 1	0 - 6
	Endopodite	0 - 1	0 - 2	1 - 4
P4	Exopodite	0 - 0	0 - 5	
	Endopodite	0 - 1	0 - 2	1 - 3

(*) A very small spinule.

If the presence or absence of minute spinules such as that indicated by the asterisk, and which is a trivial point probably subject to individual variation, be ignored, then the spine formula of *E. kandti* is the same as that of most species of the genus.

Many of the setae of the thoracic legs of this species break off as they do in *E. nodosus* Wilson and in the new species described below.

In specimens from Lake Tanganyika, in addition to the denticle near the base of the penultimate segment of the antenna, which is so characteristic of this species, there are two minute and widely separated denticles near its distal extremity and also a minute denticle in the middle of the anterior edge of the adjacent, more basal, segment. All these are easy to overlook. This suggests incipient allopatric speciation, as perhaps do the host preferences in the two lakes.

Further information on this species is given on p. 15 where its ecological relationships with *E. megacheir* are discussed.

Ergasilus flaccidus sp. nov.

(Figs. 4-8)

Lake Tanganyika. On *Tilapia tanganicae* (GÜNTHER). Many specimens (31).

Adult female.

Length to about 900μ, but specimens only about 600μ in length may carry egg sacs. Cephalothorax fused to somite of leg 1, longer than wide and bluntly rounded anteriorly. (The first thoracic tergite is still discernible in what are presumably young adults). Dorsal sculpturing consisting of an inverted T of thickened chitin, anterior to which is an ovoid area of thin cuticle. No posterior marking. Somites of legs 2 to 5 distinct, but somite 5 very narrow and no distinct tergite seen.

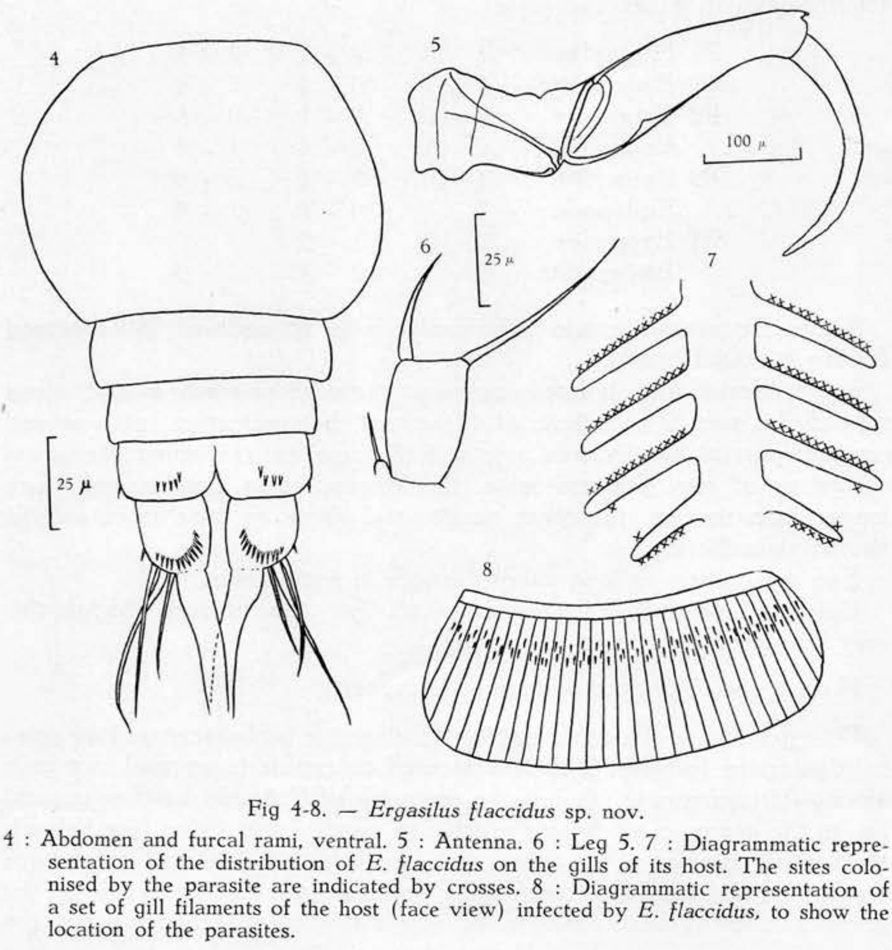

Fig 4-8. — *Ergasilus flaccidus* sp. nov.

4 : Abdomen and furcal rami, ventral. 5 : Antenna. 6 : Leg 5. 7 : Diagrammatic representation of the distribution of *E. flaccidus* on the gills of its host. The sites colonised by the parasite are indicated by crosses. 8 : Diagrammatic representation of a set of gill filaments of the host (face view) infected by *E. flaccidus*, to show the location of the parasites.

Abdomen of three somites. Genital somite wider than long and bulged laterally so that widest part is in the middle or a little posterior to it. Last two abdominal somites very short. Telson with a group of 4 or 5 spinules ventrally on each side as shown in fig. 4 and with a minute lateral spinule on each side. Furcal rami simple, about as wide as long; each with an arc of about 12 fine spinules ventrally and a minute spinule laterally. Terminal armature consisting of four unjointed terminal setae. Innermost seta much the longest, swollen at base and very indistinctly demarcated from the furcal ramus. Other setae as shown in fig. 4.

Antennule of 5 segments. Antenna prehensible and as shown in fig. 5. Near the end of segment 2 is a small chitinous « finger ». Terminal segment simply curved and with a thin walled cuticle, so much so that it seems almost flexible.

Mouthparts typical of the genus and offering no outstanding peculiarities.

Legs 1 - 4 of structure typical for the genus and having the following arrangement of spines and setae.

P1	Exopodite	1 - 0	1 - 1	2 - 5
	Endopodite	0 - 1	0 - 1	2 - 4
P2	Exopodite	1 - 0	0 - 1	0 - 6
	Endopodite	0 - 1	0 - 1	1 - 4
P3	Exopodite	1 - 0	0 - 1	0 - 6
	Endopodite	0 - 1	0 - 1	1 - 4
P4	Exopodite	1 - 0	0 - 5	
	Endopodite	0 - 1	0 - 1	1 - 3

Spines frequently broken off cleanly as in *E. nodosus* WILSON and *E. kandti* VAN DOUWE.

Leg 5, located and directed somewhat dorsally, so much so that it can scarcely be seen from below; of 1 segment, but indications of a second segment present basally, and a seta of this segment is distinct. Armature consisting of two terminal setae, the longest being slender and much longer than the leg, the other stouter and about as long as or a trifle shorter than the leg.

Egg sacs almost as long as total length in some cases.

Colour of preserved specimens white. No pigment seen though this may be present in life.

Host. — *Tilapia tanganicae* (GÜNTHER).

Diagnostic features. — This species is characterised by several distinctive features. The 5-segmented antennule is unusual, not only among African species (though the antennule of *E. kandti* has 5 segments) but in the genus as a whole; the antenna is very distinctive (see below); the ventral spinules of the telson and furcal rami are themselves perhaps diagnostic, and both the absence of a posterior area of thin cuticle on the dorsal surface of the cephalothorax, and in particular the armature of the legs, are also distinctive. The second segment of the endopod of legs 2 and 3 bears only a single seta. This segment bears two setae in the following African species — *E. nodosus* WILSON, *E. macrodactylus* SARS, *E. cunningtoni* CAPART, *E. sarsi* CAPART, *E. lamellifer* FRYER, *E. latus* FRYER and *E. kandti* VAN DOUWE — and this seems to be usual in the genus, being so for example in the Eurasian *E. sieboldi* NORDMANN and in all save one (*E. maniculatus* WILSON which lacks setae on this segment) of the North American species listed by WILSON (1911), and in most of the Chinese species described by YIN (1956).

Occurrence on host. — Many specimens were present on some preserved gills of the host. Their location, both on the gill filaments themselves and on the various gills, is shown diagrammatically in figs. 7 and 8. Sometimes two or three parasites occurred one below the other on the same gill filament. *Ergasilus kandti* was present on the same host and has a similar distribution. (Compare the relationships of *E. kandti* and *E. megacheir*, p. 15).

Remarks. — The specific epithet refers to the distal segment of the antenna which is thin walled. As soon as an antenna is placed in polyvinyl lactophenol in which a chitin-staining dye is dissolved this segment very rapidly takes up the stain and immediately becomes very soft and flexible. The rest of the appendage remains rigid and stains only slowly. This possession of a flexible segment may facilitate accommodation to gills of different sizes.

The host fish is one of many Tanganyikan endemics, and the parasite too may well be confined to this lake.

Variation. — The number of ventral spinules of the telson is variable, sometimes being different even on the two sides of a single individual (fig. 4). The form of the swelling at the base of the long terminal seta of the furcal ramus seems also to vary slightly in shape.

Syntypes of this species are in the collection of the Institut royal des Sciences naturelles de Belgique, and other specimens are in the collection in the British Museum (Natural History).

Ergasilus megacheir (SARS).

(Figs. 9-12.)

Lake Tanganyika. On *Cyphotilapia frontosa* (BOULENGER). Several specimens (D2 IG).
On *Bathybates minor* BOULENGER. Several specimens (D2 IG).
On *Bathybates minor* BOULENGER. Several specimens (Sta 70).
On *Bathybates fasciatus* BOULENGER. Several specimens (D2 —).

On *Haplotaxodon microlepis* BOULENGER. Several specimens (D2 IG).
On *Plecodus paradoxus* BOULENGER. Several specimens (D2 IG).
On *Limnotilapia dardennei* (BOULENGER). Several specimens.

Reasons for suppressing the genus *Ergasiloides* SARS, to which this species has hitherto been assigned, are given below. *E. megacheir* was described by SARS (1909) on the basis of immature specimens from Lake Tanganyika, and until CAPART (1944) discovered a few adults in the same lake it was by no means certain that the characteristics on which SARS based his genus *Ergasiloides* would hold good in adult individuals, particularly as Gurney (1928) had seen older, but not adult, specimens which even at that stage of development rendered necessary a modification of SARS' generic definition. CAPART's findings, however, showed

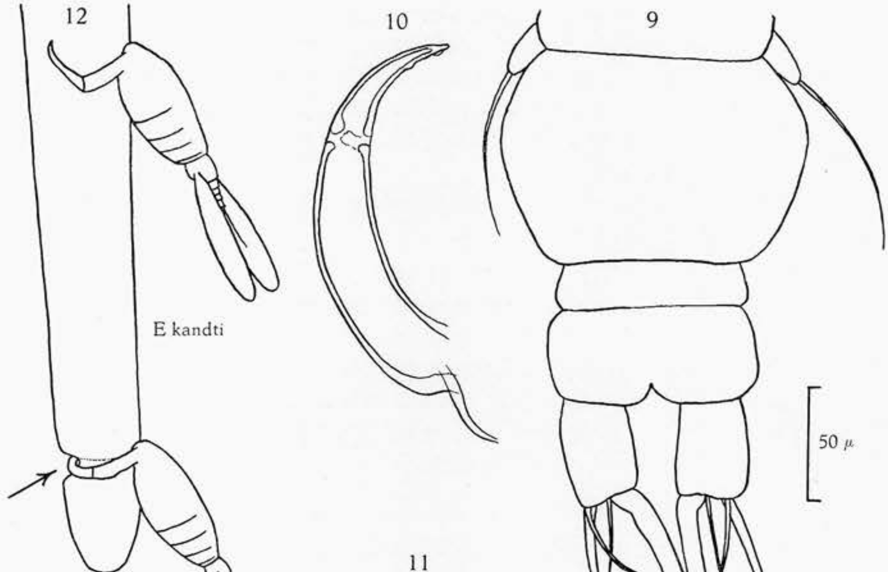

Fig. 9-12. — *Ergasilus megacheir* (SARS) and *E. kandti* VAN DOUWE.

9 : *E. megacheir*, abdomen and furcal rami, ventral. 10 : *E. megacheir*, antenna. 11 : *E. megacheir*, tip of antenna of another specimen. 12 : Diagrammatic representation of specimens of *E. kandti* and *E. megacheir* on a single gill filament to show the difference in the positions selected and the different methods of attachment. The arrow is directed to the groove made by *E. megacheir*.

that the distinction pointed out by SARS between *Ergasilus* and *Ergasiloides* persisted, though in a modified form, in the adult, and that in contrast to *Ergasilus*, the adult female of which has three abdominal somites, that of *Ergasiloides*, has only two. That this distinction serves only to obscure phyletic relationships is demonstrated below.

The collection contains numerous specimens which, though they differ in trivial respects from previous descriptions, I assign with confidence to this species.

The spine formula of the legs of *E. megacheir* has never been recorded though SARS figures some of the legs, which had already acquired three-segmented rami in his material. His figure of leg 3 shows only a single seta on the second segment of the endopod and this characteristic is confirmed in adult specimens, the spine formula of which is :

P1	Exopodite	1 - 0	1 - 1	2 - 5
	Endopodite	0 - 1	0 - 1	2 - 4
P2	Exopodite	0 - 0	0 - 1	0 - 6
	Endopodite	0 - 1	0 - 1	1 - 4
P3	Exopodite	0 - 0	0 - 1	0 - 6
	Endopodite	0 - 1	0 - 1	1 - 4
P4	Exopodite	0 - 0	0 - 5	
	Endopodite	0 - 1	0 - 1	0 - 3

This spine formula is different from that of most species of *Ergasilus* but, apart from the absence of spines or spinules at the distal outermost corner of the basal segment of the exopodite of each leg, which is trivial, is the same as that of *E. flaccidus* of the same lake (see p. 8). This is discussed below.

Most of the present specimens tended to be somewhat less squat than those described by CAPART (1944). There is variation of the form of the tip of the antenna. In some specimens the minute hook shown by SARS and CAPART is present near the tip (Fig. 11) in other specimens a mere wrinkling of the chitin can be seen (fig. 10) and in other specimens the tip is devoid of ornamentation. The hook seems to be present in small specimens and it may be that as they grow, as they undoubtedly do after settlement, though they do not moult, the distal segment of the antenna elongates and the hook disappears. A minute hyaline lamella is often to be seen near the extreme tip of the antenna as indicated in fig. 10. CAPART's specimens had short egg sacs but, although this was sometimes the case in the present material, this is not characteristic of the species and the egg sacs are in fact often as long as the body of the animal.

While an ovoid area of thin chitin is easy to see anterior to the chitinous thickening in the dorsal surface of the cephalothorax, no posterior area was detected though this is shown by SARS for immature specimens and by CAPART for adults.

Some details of the anatomy of *E. megacheir* are shown in fig. 9-11 and aspects of its ecological relationships and affinities are given below.

Ergasilus cf. megacheir.

Lake Tanganyika. On *Synodontis multipunctatus* BOULENGER. Several specimens. (Sta. 70).
On *Synodontis multipunctatus* BOULENGER. Several specimens. (Sta. 88).
On *Synodontis granulosus* BOULENGER. Several specimens.

Specimens of an *Ergasilus*, similar in most respects to those of *E. megacheir* from cichlid fishes, but differing in certain ways, occurred on two mochochid fishes of the genus *Synodontis*. The swimming legs of these specimens had the same spine formula as had individuals of *E. megacheir* parasitising cichlids except that a small spinule was present on the basal segment of the exopod of legs 2, 3 and 4. The antenna of these specimens had a less conspicuous « notch » than had that of specimens from cichlid fishes and its form approached that seen in *E. sarsi* CAPART. They were also larger than the individuals parasiting cichlid fishes, but size is of very dubious taxonomic significance in these parasites. Their location on the gill was exactly the same as was that of specimens parasitising cichlid fishes (see below).

At present it is impossible to say with certainty whether these differences, are imposed by the host (though this seems rather unlikely) or whether we are dealing with what are in fact distinct sibling species. Proof of this can come only from infection experiments, supplemented by further field data, and at present we can do no more than note the existence of this problem.

The reason why the name *E. megacheir* has been assigned to the individuals from cichlid fishes rather than to the form from *Synodontis* is because it was from cichlid fishes that CAPART (1944) first recorded adults under this name and because SARS (1909) in his figure shows no spine on the basal segment of the endopod of leg 3. Little reliability can be placed on the latter point at present, however, and if the two forms eventually prove to be separate species it may never be possible to say with certainty of which one SARS described a larval stage.

Remarks on the affinities of *Ergasilus cunningtoni*, *E. sarsi*, *E. megacheir* and *E. flaccidus*, and a re-definition of the genus *Ergasilus*.

Although hitherto assigned to two genera, *Ergasilus* and *Ergasiloides*, there is no doubt that the first three of the four species listed above are closely related, the species hitherto called *Ergasiloides megacheir*, for example being obviously more closely related to *Ergasilus cunningtoni* than is the latter to, say the American *Ergasilus caeruleus* WILSON. The artificiality of the two genera is clearly apparent. The difference between *Ergasilus and Ergasiloides*, while apparently constant, involves no more than the loss of an abdominal somite (or fusion of two somites) in *Ergasiloides*, a feature that would be of great significance in some groups of the Crustacea, but which is not unexpected in parasites of this sort. Study of abundant material of some of these species in the present collection, and previous experience of others, has convinced me that affinities could best be expressed by uniting the two genera, even though taxonomic problems are thereby involved. A genus should be a phylogenetic unit. It might be noted that some comprehensive generic definitions of *Ergasilus* such as those of WILSON (1911) and GURNEY (1933) would accommodate *Ergasiloides* as hitherto recognised, and would exclude *Ergasilus kandti* on the basis of the segmentation of the antennule ! An amended definition of *Ergasilus* which eliminates these anomalies and includes the Sarsian genus *Ergasiloides* is given below.

The situation is made more complex by the fact that YAMAGUTI (1939), unaware of SARS's genus, also erected a genus *Ergasiloides*. That this was preoccupied was pointed out independently by Yin (1949), who proposed the name *Nipergasilus* for Yamaguti's genus, and by FRYER (1956) who, unaware of Yin's correction, proposed the name *Yamagutia*. Of these names *Nipergasilus* takes preference. If *Ergasiloides* SARS is submerged in the genus *Ergasilus* NORDMANN then the homonym *Ergasiloides* YAMAGUTI (as it originally was) had it not been noticed and corrected, would have become valid. For this generic name, however, *Nipergasilus* was substituted and this must be used in future, for article 36 of the International Rules of Zoological Nomenclature states clearly that « Rejected homonyms can never be used again ». In his recently published monograph Yamaguti (1963) does use the generic name *Nipergasilus*, but erroneously gives the date of its erection as 1956 instead of 1949. Further consideration of YAMAGUTI's definition, however, indicates that the genus *Nipergasilus* is in any case of doubtful validity, the characteristic on which most stress is laid, namely the fusion of thoracic somites four and five, being certainly insufficient to merit the erection of a new genus. An unstressed difference, however, is that in the single species so far assigned to this genus the fourth thoracic leg of the female has both an endopod and an exopod of only two segments. Typically the endopod of this limb has three segments. For the time being therefore the genus *Nipergasilus* (= *Ergasiloides* YAMAGUTI) can be left outside the genus *Ergasilus*, though its inclusion may well prove to be merited at some future date. The genus *Pseudergasilus* YAMAGUTI (YAMAGUTI 1936) seems not to merit separation from *Ergasilus* and is embraced by the definition given below, which has been in no way widened to make this

Redefinition of the genus *Ergasilus* NORDMANN.

Poecilostomous cyclopoid copepods whose females are parasitic on the gills of fishes, mostly in freshwater. Cephalothorax of adult female united with somite of leg 1, and often inflated. Four succeeding thoracic somites sometimes distinct, sometimes apparently confluent, particularly those of legs 4 and 5. Abdomen short, of 2 or, more usually, 3 somites of which the genital somite is much the largest. Segmentation of abdomen sometimes indistinct. Body terminating in a telson with simple furcal rami armed with terminal setae of which the innermost is by far the longest.

Antennule short, of 5 or 6 segments. Antenna conspicuous, always prehensile in female. Mouthparts minute, located on a projection usually near middle of cephalothorax. Mandibles saw-like, often with a saw-like palp of uncertain homology. Maxillule vestigial and bearing two spines. Maxilla terminating in an anteriorly-directed lobe armed with minute spinules. Maxilliped absent.

Legs 1 to 4 biramous and with very broad coxa and basis. Exopod and endopod of three segments except for leg 4 whose exopod is two-segmented. Leg 5 small and cylindrical, or even reduced to a single spine. (Absent in some species ?). Egg sacs paired, ovoid in shape, often elongate. Eggs small and numerous.

Male smaller than female. Body cylopiform. Antenna prehensile but smaller than that of female. Mouthparts similar to those of female, but prehensile maxilliped present whose terminal segment is long and curved. Both rami of all swimming legs three-segmented. Abdomen with one segment more than female.

Almost cosmopolitain in distribution.

Type species. — *E. sieboldi* NORDMANN.

The similarity of *E. cunningtoni, E. sarsi* and *E. megacheir* is readily apparent to anyone who has tried to separate them, and although *E. megacheir* is distinguished by the reduced segmentation of its abdomen and by the spine formula of its swimming legs, the close relationship of the three species cannot be doubted. The form of the antenna, at first sight distinctive in *E. megacheir,* is less useful as a means of separation than might be supposed, particularly when the form from *Synodontis,* whatever its status, is taken into account.

E. cunningtoni and *E. sarsi* are even more similar to each other and, while the types of *E. cunningtoni* from the Lower Congo are morphologically distinct from individuals of *E. sarsi* from localities in the upper parts of the same river system, the distinctions tend to break down in some individuals from an intermediate locality (FRYER 1964). Here some specimens are assignable to *E. cunningtoni;* in others the antenna is as similar to that of *E. sarsi* as to that of *E. cunningtoni,* and in others it is like that of *E. sarsi*. In all cases, however, leg 5 lacks the lateral spine which is present in *E. sarsi* and which, in spite of CAPART's statement, cannot be seen in the types of *E. cunningtoni*, the armature of whose fifth leg is as shown by him in his illustration. Whether we are dealing here with hybridisation of subspecies of a single species or with clinal variation (which seems less likely on the basis of available material) must await more information from other localities in the Congo.

E. flaccidus co-exists in Lake Tanganyika with *E. megacheir*. Both have the same, and unusual, spine formula, but are distinct in many other respects. The available evidence suggests that the same spine formula has arisen independently rather than that the two have a common proximate ancestor. Their co-existence geographically is, from this point of view, fortuitous.

The ecological relationships of *Ergasilus kandti*, *E. flaccidus* and *E. megacheir*.

Little can be said at present about the host preferences of these species, and what has been learned from the present collections is apparent from the lists of hosts. While there appears to be no difference between the sites of attachment of *E. kandti* and *E. flaccidus* on the one host species on which they have been recorded together, there is a distinct and constant difference between the sites selected by *E. kandti* and *E. megacheir* which frequently co-exist on the same host. In such cases, which have so far always concerned cichlid fishes, *E. kandti* is located some way along the gill filament, usually in the basal third, and never near the tip, while *E. megacheir* is always located near the tip so that its egg sacs protrude beyond the end of the gill filament (Fig. 12). The effect of the two parasites on the gill filament is also different. *E. kandti* causes considerable damage and the antennae become overgrown by host tissue : *E. megacheir* causes a distinct indentation of the gill filament where the antennae embrace it (indicated by an arrow in fig. 12) but seems never to cause proliferation of host tissue.

BRANCHIURA.

Argulus striatus CUNNINGTON.

(Fig. 13.)

Lake Tanganyika.	1 ♂ on *Auchenoglanis occidentalis* (CUVIER and VALENCIENNES).	(Sta. 254).
	1 ♀ on *Tilapia tanganicae* (GÜNTHER).	(Sta. 254).
	1 ♂, 1 ♀ on *Heterobranchus* sp.	(Sta. 28).
	1 ♂. Host unknown.	(Sta. 215).

1 ♂, 1 ♀, On « Singa » = *Dinotopterus cunningtoni* BOULENGER. (Sta. 109).
2 ♂♂, 3 ♀♀, On « Singa » = *Dinotopterus cunningtoni* BOULENGER. (Sta. 254).

The illustration of the armature of the posterior spines of the antennule and antenna given here are, it is hoped, somewhat more accurate than those of CUNNINGTON (1913).

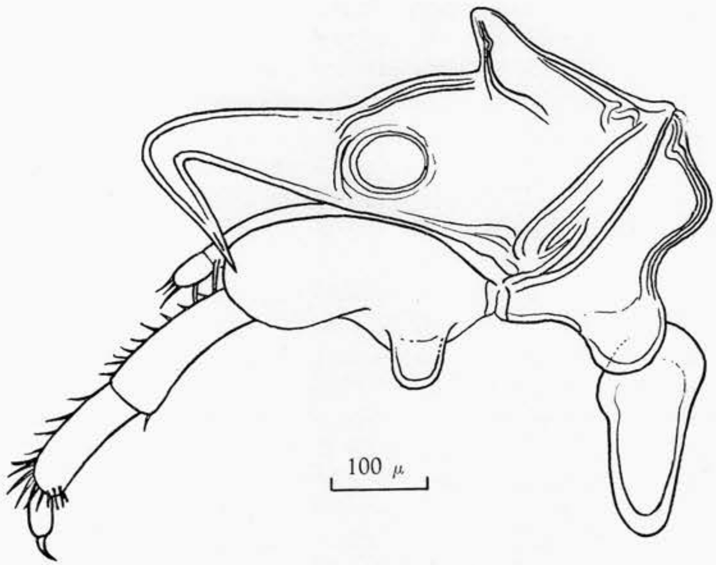

Fig. 13. — *Argulus striatus* CUNNINGTON.
Antennule and antenna.

The right antennule of one specimen was very distorted : the distal portion was much contracted and the usually conspicuous distal hook was not present. The palp was also lost. No sign of injury was apparent, though this may have occurred during an earlier instar. On the other hand this may have been a genetic abnormality as were apparently some specimens of *A. africanus* from the same lake (see notes on this species).

This species is, so far as is known, endemic to Lake Tanganyika.

Argulus personatus CUNNINGTON.

Lake Tanganyika. 2 specimens on *Bathybates fasciatus* BOULENGER. (D. 2).

Although the lateral hook of the antennule is longer than is shown by CUNNINGTON (1913) there is no doubt that these specimens belong to possible.

A. personatus. The male claspers are distinctive. One specimen was from the mouth, the other from the branchial chamber of the host.

Only five specimens of this endemic Tanganyikan species were known before the present material was collected, and all these occurred on a member of the genus *Bathybates*. This suggests that, as might be expected, host preference has played a part in speciation of the argulids of Lake Tanganyika.

Argulus rubropunctatus Cunnington.

(Fig. 14.)

Lake Tanganyika. 3 ♂♂ on *Lates microlepis* Boulenger. (Sta. 154).
2 ♂♂, 2 ♀♀ on « Nonzi » = *Lates microlepis* (Sta. 292).
8 ♂♂, 5 ♀♀ on « Sangala » = *Lates angustifrons* (Sta. 330).

Lates appears to be the most frequent host genus for this species, being the only one on which Cunnington (1913) found it and the only one on which it occurred in the present collection. Monod (1928), however, records it from both *Lates* and *Clarias*.

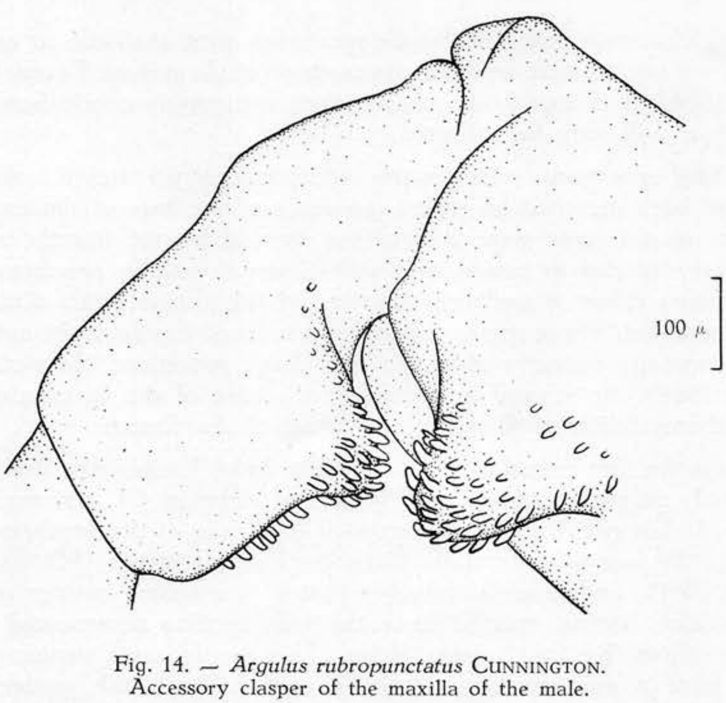

Fig. 14. — *Argulus rubropunctatus* Cunnington.
Accessory clasper of the maxilla of the male.

As in the case of specimens studied by both CUNNINGTON and MONOD, males preponderated. Of all the specimens of this species yet known, 107 are males and only 37 are females.

Examination of the maxilla of this species reveals that the papillae sketched rather crudely on the antepenultimate and adjacent segment by CUNNINGTON (who refers to this appendage as the maxilliped) are confined to the male and presumably represent an accessory clasping device. Details of these papillae are shown in fig. 14. In addition to the coarse denticles with which the papillae are armed there are around their bases, numerous scales with fimbriated margins such as are often seen in argulids, but which are too small to be shown accurately on the figure. So far as I have been able to ascertain *A. rubropunctatus* is the only species of *Argulus* in which claspers occur on the maxilla though a similar, and exaggerated, development which gives a prehensile structure, exists in some species of *Chonopeltis*. The maxillary clasper is additional to and not a substitute for, the claspers of the thoracic legs, and adds even more to the extremely striking sexual dimorphism exhibited by this species.

Argulus schoutedeni MONOD.

Lake Tanganyika. 2 ♀ ♀ on *Citharinus gibbosus* BOULENGER. (Sta. 143).

It is unfortunate that only female specimens were available, as members of this sex are scarcely separable from those of *A. monodi* FRYER (FRYER 1959, 1964). It is hoped that males, which will readily check these determinations, will soon be collected.

In these specimens, which were approximately 6.1 and 6.5 mm long and had been mounted on slides, the spine at the base of the antennule and the mesial spine were present but were short and bluntly rounded and were reduced in comparison with those of smaller specimens from the Chuapa River, a southern tributary of the Congo, with which they were compared. These spines thus become reduced in size as the individual grows, and are virtually absent in very large specimens (MONOD 1928, FRYER 1964). An inward projection at the base of the antennule seems to be characteristic of this species but not of *A. monodi*.

This is the first record of this species for Lake Tanganyika from which previously only one non-endemic species of *Argulus (A. africanus)* was known. It has previously been recorded from two of the southern tributaries of the Congo system, including the Upper Lualaba (MONOD 1928, FRYER 1964), and it seems possible that it is a recent invader of Lake Tanganyika, having entered since the lake became reconnected to the Congo system by the Lukuga River. This would seem distinctly probable from a consideration of the parasite alone, and appears even more probable when the distribution of the host is taken into account. *Citherinus gibbosus* is one of the non-endemic species of Lake Tanganyika and has a wide distribution in the Congo system, and POLL (1953) has already suggested that it may be a recent invader of the lake, where it occurs particularly near the mouths of affluent rivers whose lower reaches it penetrates.

Argulus rhipidiophorus MONOD.

Lake Edward. One ♀. No host data. (K. E. A. 360).
One ♀. Host data not clear but perhaps on *Haplochromis pappenheimi* (BOULENGER). (K. E. A. 553).
Lake Kivu. 6 specimens on *Tilapia nilotica regani* POLL. (K. E. A. 245).
1 specimen on *Tilapia nilotica regani* POLL. (K. E. A. 128).

The numbers given for the specimens from Lake Kivu are those of the fishes in whose mouths the parasites were found during an examination of the fish collection. This is, from the zoogeographical point of view, the most interesting record in the collection. *A. rhipidiophorus* has not previously been recorded from Lake Kivu and is the only parasitic crustacean so far found in that lake. This record will be considered further elsewhere when a study of certain argulids from lakes draining or formerly draining into the Upper Nile is completed.

Of more than fifty specimens of *T. nilotica regani* from Lake Kivu which were examined, only two were parasitised by this species. Specimens of several other species from Lake Kivu were examined but on none of them was this or any other crustacean parasite present.

Argulus africanus THIELE.
(Fig. 15.)

Lake Mweru. 2 specimens on *Tilapia macrochir* BOULENGER. (357).
Lake Edward. 1 specimen in the mouth of *Clarias* sp. (K. E. A. 364).
Lake Tanganyika. 2 specimens on *Heterobranchus* sp. (Sta. 28).
2 specimens on *Hydrocyon lineatus* BLEEKER.
1 specimen on *Chrysichthys brachynema* BOULENGER.
1 specimen on *Polypterus* sp. (Sta. 163).

Both specimens from *Hydrocyon lineatus* BLEEKER in Lake Tanganyika exhibited abnormalities of certain spines though the abnormality was not the same in the two cases. One, a male, had a typical broad mesial spine behind the antenna (fig. 15,a) but on the left side the mesial spine was elongate and sharply pointed (fig. 15,b). The other, a female, exhibited a similar modification of spines on the left maxilla. Here the two outermost of the basal group of three spines were normal while the innermost was pointed, as was the spine internal to it. In both these specimens the spine on the second segment of the antennule was also more sharply pointed than is usually the case in this species.

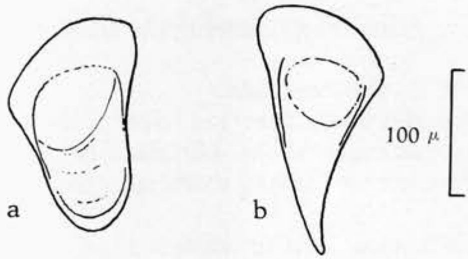

Fig. 15. — *Argulus africanus* THIELE.
Mesial spines of, a, the right antenna which is normal and, b, the left antenna which is abnormal — and similar to that of certain other species.

Such abnormalities are worth recording for they affect structures of taxonomic importance. Should more spines ever be modified, misidentifications may result.

Dolops ranarum (STUHLMANN).

Lake Mweru. 2 ♂♂ and 2 ♀♀ on two specimens of *Tilapia macrochir* BOULENGER (K. E. A. 354 et 357).

Chonopeltis schoutedeni BRIAN.

Lake Mweru, Pweto. 2 ♀♀ on *Gnathonemus moeruensis* BOULENGER

These were found under the operculum of two separate individuals of the host fish preserved in the fish collection.

ACKNOWLEDGEMENTS

I am very grateful to Dr. A. CAPART who very kindly put this collection at my disposal and did everything possible to facilitate its study, and to M. J. P. GOSSE for similar kindness when I examined some of the fishes under his charge.

SUMMARY.

African material, mostly from Lakes Tanganyika, Kivu, Edward and Albert, collected by the expeditions of the Institut royal des Sciences naturelles de Belgique, includes at least ten species of parasitic Copepoda and eight species of Branchiura. Of these one copepod *Ergasilus flaccidus*, from Lake Tanganyika, is described as new.

It is possible that another copepod, which differs anatomically only very slightly from *Ergasilus megacheir*, but which perhaps has different host preferences, exists in Lake Tanganyika.

Several of the records are the first for the localities concerned.

The genus *Ergasiloides* SARS is suppressed, and the species formerly assigned to it are transferred to *Ergasilus*, which is re-defined.

Notes on individual species are given where appropriate.

INDEX BIBLIOGRAPHIQUE.

CAPART, A.

1944. *Notes sur les copépodes parasites. III. Copépodes parasites des poissons d'eau douce du Congo Belge.* (Bull. Mus. Hist. nat. Belg., 20 (24) : 1-24.)

CUNNINGTON, W. A.

1913. *Zoological results of the Third Tanganyika Expedition 1904-1905. Report on the parasitic Branchiura.* (Proc. Zool. Soc. Lond., 1913 : 262-283.)

FRYER, G.

1956. *A report on the parasitic Copepoda and Branchiura of the fishes of Lake Nyasa.* (Proc. Zool. Soc. Lond., 127 : 293-344.)

1958. *A note on Lernaea bistricornis* HARDING, *a parasitic Copepod from Lake Tanganyika.* (Rev. Zool. Bot. Afr., 58 : 214-216.)

1959. *A report on the parasitic Copepoda and Branchiura of the fishes of Lake Bangweulu (Northern Rhodesia).* (Proc. Zool. Soc. Lond., 132 : 517-550.)

1960. *Studies on some parasitic crustaceans on African freshwater fishes, with descriptions of a new Copepod of the genus Ergasilus and a new Branchiuran of the genus Chonopeltis.* (Proc. Zool. Soc. Lond., 133 : 629-647.)

1961a. *The parasitic Copepoda and Branchiura of the fishes of Lake Victoria and the Victoria Nile.* (Proc. Zool. Soc. Lond., 137 : 41-60.)

1961b. *Variation and systematic problems in a group of Lernaeid Copepods.* (Crustaceana 2 : 275-285.)

1964. *Further studies on the parasitic Crustacea of African freshwater fishes.* (Proc. Zool. Soc. Lond., 143 : 79-102.)

GURNEY, R.

1928. *Some Copepoda from Lake Tanganyika collected by* Mr. S. R. B. PASK. (Proc. Zool. Soc. Lond., 1928 : 317-332.)

1933. *British freshwater Copepoda.* (vol. 3, London : Ray Society.)

HARDING, J. P.

1950. *On some species of Lernaea (Crustacea, Copepoda : Parasites of freshwater fish).* (Bull. Brit. Mus. (nat. Hist.) Zool. 1 : no. 1, 1-27.)

MONOD, T.

1928. *Les Argulidés du Musée du Congo.* (Rev. Zool. Bot. Afr. 16 : 242-274.)

POLL, M.

1953. *Poissons non Cichlidae.* (Résult. Sci. Explor. Hydrobiol. Lac Tanganika 3, Fasc. 5A : 1-251.)

SARS, G. O.

1909. *Zoological results of the Third Tanganyika Expedition 1904-1905. Report on the Copepoda.* (Proc. Zool. Soc. Lond., 1909 : 31-76.)

WILSON, C. B.

1911. *North American parasitic copepods belonging to the family Ergasilidae.* (Proc. U. S. nat. Mus., 39 : 263-400.)

YAMAGUTI, S.

1936. *Parasitic Copepods from Fishes of Japan. Part 1. Cyclopoida 1.* (Published by author : 1-8.)

1939. *Parasitic Copepods from Fishes of Japan. Part 4. Cyclopoida II.* (vol Jubil. Prof. S. YOSHIDA, Osaka 2 : 391-415.)

1963. *Parasitic Copepoda and Branchiura of fishes.* vii + 1104. (New York and London. Interscience Publishers.)

YIN, W. Y.

1949. *Three new species and a new genus of parasitic copepods (Ergasilidae) from Chinese pond fishes.* (Sinensia 20 : 32-42.)

1956. *Studies on the Ergasilidae (Parasitic Copepoda) from the freshwater fishes of China.* (Acta Hydrobiol. Sinica 1956 No. 2. 209-270.) (Chinese : English summary.)

1960. *Four new species and a new genus of Lernaeans parasitising Ctenopharyngodon and Ophiocephalus in China.* (Acta Hydrobiol. Sinica 1960 No. 1 : 1-7.) (Chinese : English summary.)

YIN, W. Y., LING, M. E., HSÜ, G. A., CHEN, I. S., KUANG, P. R. and CHU, S. L.

1963. *Studies on the Lernaeosis (Lernaea, Copepoda Parasitica) of freshwater fishes of China.* (Acta Hydrobiol. Sinica 1963, No. 2 : 48-117. Chinese : English summary.)

AD. GOEMAERE, Imprimeur du Roi, 21, rue de la Limite, Bruxelles-3